2020 Water Master Plan

Town of Sylvan Lake

Final Report

September 2020

ISL Engineering and Land Services Ltd. Is an award-winning full-service consulting firm dedicated to working with all levels of government and the private sector to deliver planning and design solutions for transportation, water, and land projects.

Corporate Authorization

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Sep. 18, 2020

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2020-09-18

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Permit to Practice
ISL Engineering and Land Services Ltd.
RM Signature:
RM APEGA ID: 71183
Date: **Sep. 18, 2020**
Permit Number P4741
The Association of Professional Engineers and Geoscientists of Alberta

Acronym List

Acronym	Full Name
STDP	Short term development pressures
22K	22,000 population scenario (approximately 5-years of growth, 2025)
30K	30,000 population scenario (approximately 2035)
45K	45,000 population scenario (approximately 2050)
60K	60,000 population scenario (approximately 2060)
75 – 100K	75,000 to 100,000 population scenario (beyond 2060)
PRV	Pressure reducing valve
ADD	Average day demand
MDD	Maximum day demand
PHD	Peak hour demand
C-value	Hazen-Williams friction coefficient
FFT	Fire flow test
HGL	Hydraulic grade line
ATS	Automatic transfer switch
VFD	Variable frequency drive
SCADA	Supervisory control and data acquisition
HMI	Human machine interface
HVAC	Heating, ventilation and air conditioning
NBC	National Building Code
MCC	Motor Control Centre

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TABLES

EXHIBITS

1.0 Introduction

1.1 Background

The Town of Sylvan Lake (the Town) has retained ISL Engineering and Land Services Ltd. (ISL) to provide professional engineering services to conduct additional hydraulic modelling of the water distribution network and prepare a water distribution master plan.

1.1.1 Water Supply

The Town is supplied with water from several wells located throughout the Town and along the eastern shore of Sylvan Lake. These wells draw from the Paskapoo Aquifer. There are a total of 8 active wells that the Town utilizes to supply all of the raw water needs. There are 3 wells located in the north which have chlorination capabilities and supply water to the lower pressure zone of the Town's distribution system as well as the north reservoir. These wells are located within Red Deer County on the eastern side of Sylvan Lake. The remaining 5 wells are located in the southern portion of the Town in the middle pressure zone of the Town's distribution system. These wells are located within Town limits and they supply the south reservoir with water.

There have been discussions regarding the benefits of switching to a regional system feeding the Town from Red Deer, but no plans have been implemented as of yet. A detailed assessment of the watershed and the water supply system was not part of the scope of work included in the water distribution master plan. It is recommended that the Town undertake a comprehensive well supply study (Groundwater Source Assessment) to better understand the capacity of the aquifer to supply the raw water needs of the Town in the longer term. This assessment would need to include the following in the scope of work as a minimum:

- Data collection for all existing wells (license information, current usage, draw downs, pumping capacities)
- Numerical modeling of the aquifer and the lake
- Factor in other users of the lake and aquifer
- Consumption demand projections for the Town
- Regulatory and licensing considerations and constraints imposed on the aquifer and lake by Alberta Environment and Parks
- Available projected supply capacities from any regional water supply sources being considered
- Projected cost of supply information for the well system versus cost of purchase from a regional system

The study area includes the Town of Sylvan Lake and potential growth areas to the west, south, and northeast, as shown in Exhibit 1.1. The locations of supply wells have been annotated on the map as well. The scope of work briefly includes analyzing the impacts of growth with the Town. Exhibits 1.2 and 1.3 show the water main type (supply versus distribution) and material type as per the Sylvan Lakes GIS database, respectively.

Previously, Stantec completed the Town of Sylvan Lake Municipal Water Reservoir: Preliminary Design Report (Stantec report) in 2018, which is to be used as one of the background documents for this work. The WaterCAD model from this report has been reviewed with current GIS data from the Town to ensure that it is up-to-date and accurate. Additionally, any new development pressures will be integrated into the original growth projections from the Stantec report such that future scenarios are up to date. Additionally, the Wastewater Master Plan and Inflow and Infiltration Study, Associated Engineering 2020 (Wastewater Master Plan) was used to align growth projections so both water and sanitary upgrades can be coordinated together.

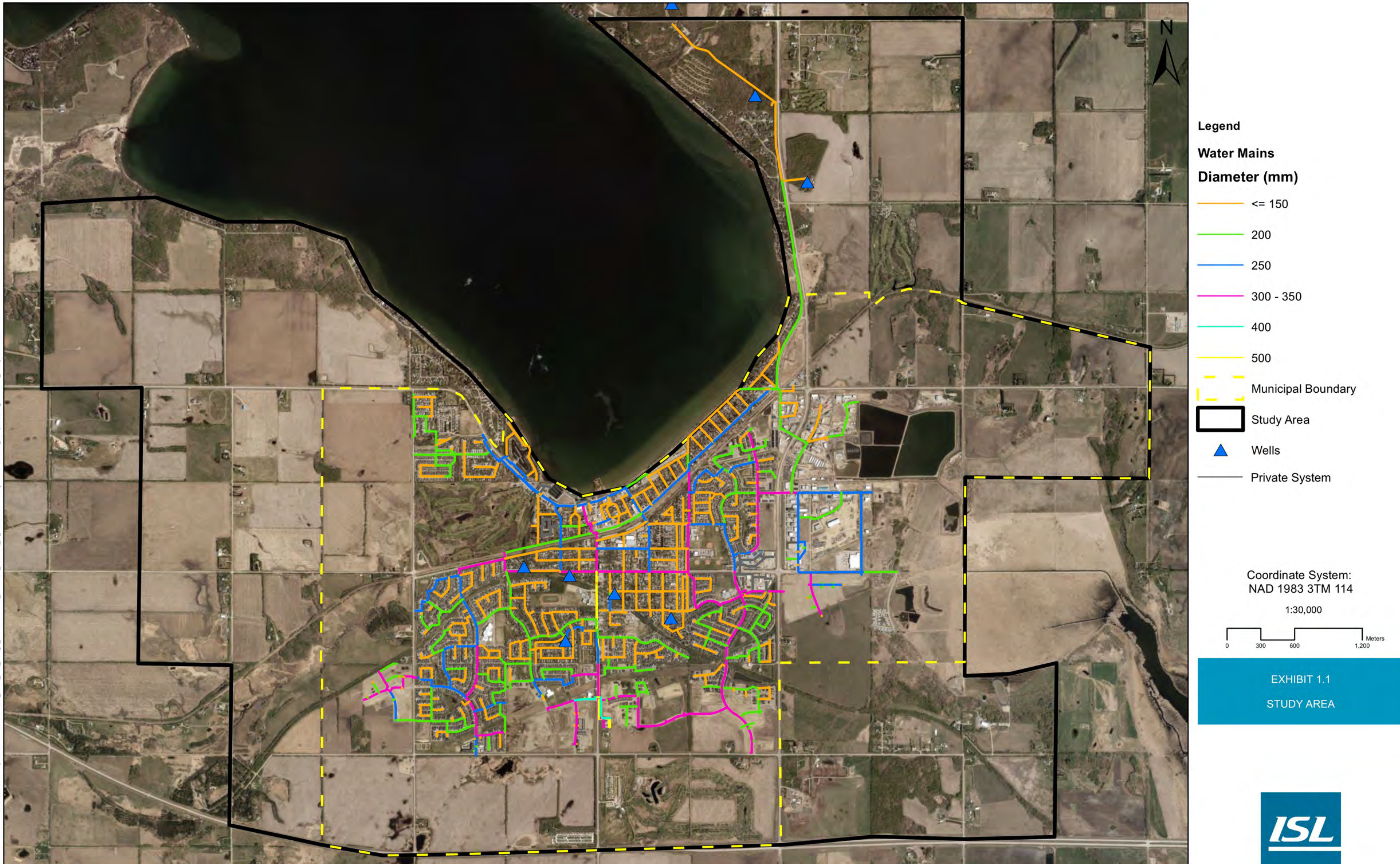
Limitations of this study include accurately projecting growth within the Town as certain developments do not have guaranteed timelines. Additionally, projecting water demands for growth areas introduces a level of uncertainty as exact demands cannot be discretized perfectly, and assumptions have to be made regarding how much water will be used.

1.2 Scope of Work

The scope of work for this project included analyzing the existing water network for deficiencies and recommending a staged implementation plan for upgrades and growth such that existing deficiencies are resolved and future developments are adequately serviced. The growth projections considered include:

- existing conditions;
- short-term development pressures (STDP);
- growth up to 2025 – population approximately 22,000 (22K);
- growth up to 2035 – population approximately 30,000 (30K);
- growth up to 2050 – population approximately 45,000 (45K);
- growth up to 2060 – population approximately 60,000 (60K); and,
- growth beyond 2060 – population approximately 100,000 (100K).

Implementation of the North Reservoir has been analyzed, and the impact of the new reservoir on the network has been quantified. An intensive review of the pumphouses and the pressure reducing valve (PRV) settings has been done to ensure that the implementation of the North Reservoir will result in the north and south reservoirs working efficiently together. Conceptual twinning of a watermain from the North Reservoir to the existing system (NE Gateway Watermain) has been analyzed to determine the hydraulic benefits of different alignments.



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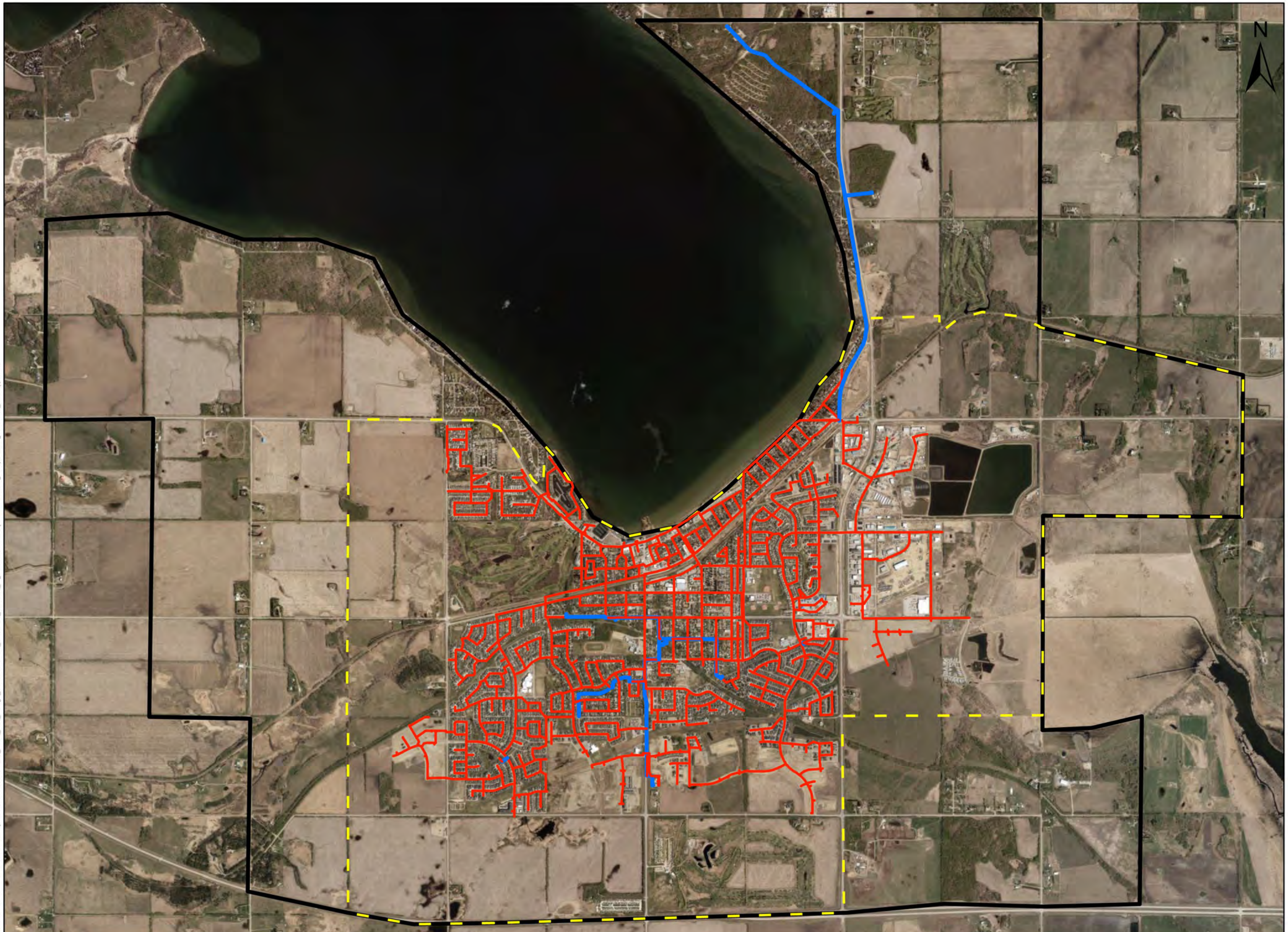


Legend

Water Main

Type

- Supply
- Distribution
- Study Area
- Municipal Boundary

Coordinate System:
NAD 1983 3TM 114

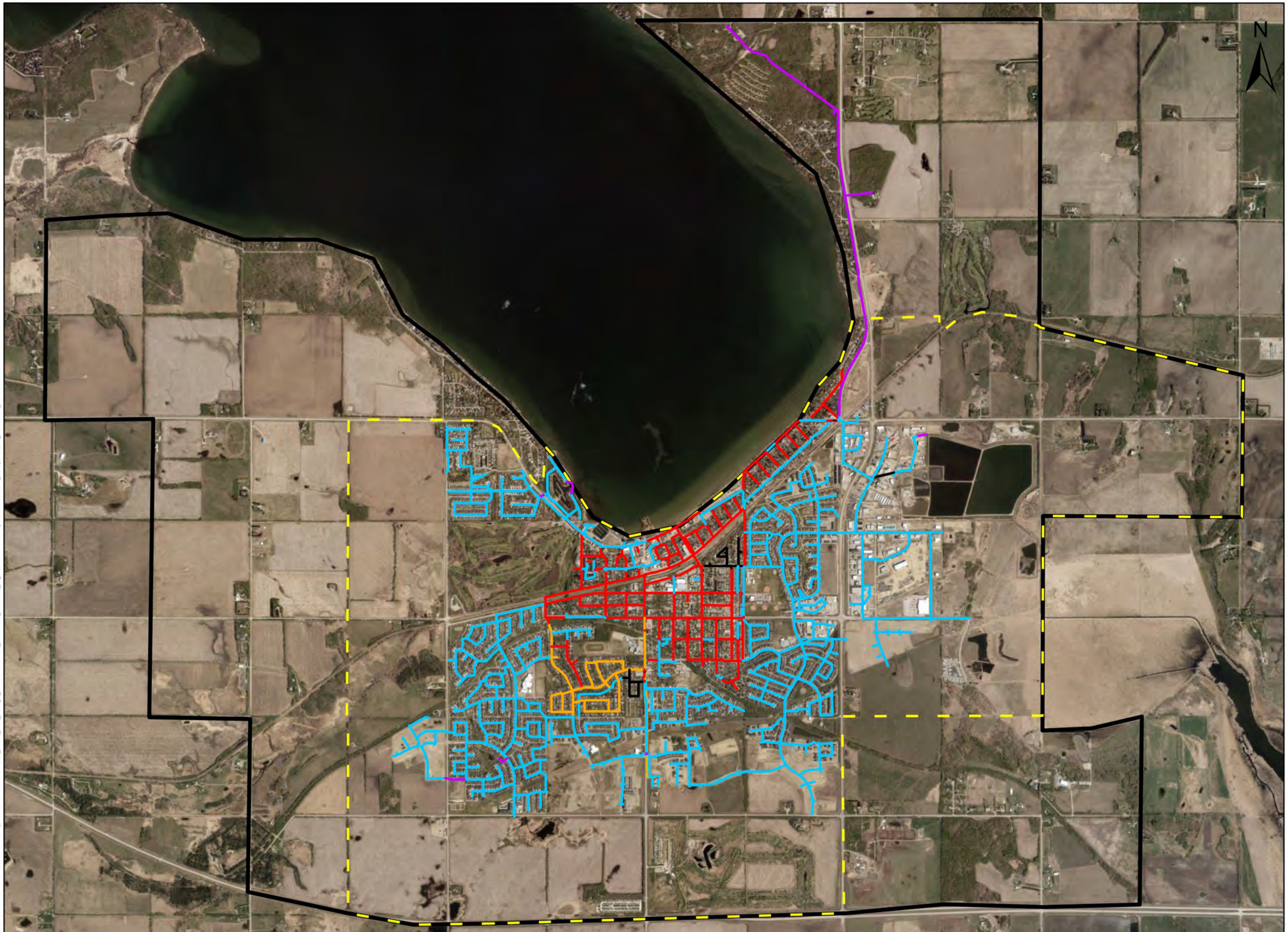
1:30,000

0 300 600 1,200 Meters

EXHIBIT 1.2

WATER MAIN
TYPE

ISL



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Water Main Material

- Unknown
- HDPE
- PVC
- AC / CONCRETE
- DI / STEEL
- Study Area
- Municipal Boundary

Coordinate System:
NAD 1983 3TM 114

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0 300 600 1,200 Meters

EXHIBIT 1.3

WATER MAIN MATERIAL

ISL

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2.0 Growth Projections

2.1 Previous Population Projections and Demands

The original growth projection plans are based on the 2018 Stantec report, which gave an estimate for existing (ADD) average day demands (2015), 2021 demands, 30K demands (2040), and 60K demands (2060). Maximum day demand (MDD) and peak hour demands (PHD) peaking factors were 2 and 4, respectively. Table 2.1 shows the original Stantec projections. The Stantec report mentioned that the Sylvan Lake standards of 750 L/c/d for MDD and 1,500 L/c/d for PHD are too conservative and the report recommended using typical MDD/ADD and PHD/ADD factors (peaking factors) of 2 and 4, respectively. The current Town ADD is approximately 271 L/c/d, and the current MDD and PHD peaking factors are 2 and 4, respectively.

Table 2.1: Original population projections and water demands

Horizon	Population	ADD (L/s)	MDD (L/s)	PHD (L/s)
2015	14,310	44.5	89.1	178.2
2021	17,146	59.5	119.1	238.1
2040 (30K)	30,000	104.2	208.3	416.7
2060 (60K)	60,000	208.3	416.7	833.3

2.2 Short-Term Changes to Population Projections and Demands

There have been some modifications to the growth projections based on new information provided by the Town. Short-term development pressures include redevelopment in West Village to multi-storey condos.

Exhibit 2.1 shows the location of the STDP redevelopment area and the rest of the growth areas and their timeframes.

Table 2.2 summarizes the ADD flow projection estimates for West Village using a residential generation rate of 271 L/c/d. The overall demand was calculated and evenly distributed amongst representative nodes in the model.

Table 2.2: Short term development pressure demand updates

Location	Res Area (ha)	Population (c)	G_{Res} (L/c/d)	ADD (L/s)	MDD (L/s)	PHD (L/s)
West Village Condos	15.9	853	271	2.7	5.4	10.7

2.3 Updated Population Projections and Demands

Residential demands were projected using the standard value of 271 L/c/d. Previous report findings from the Stantec and Tagish reports (2014 Tagish Infrastructure Study) calculated commercial water use to be 9,432 L/ha/d and industrial water use to be 6,288 L/ha/d. These non-residential consumption rates are more realistic and less conservative than the Sylvan Lake standard value of 0.2 L/s/ha (17,280 L/ha/d). The Wastewater Master Plan found from flow monitoring results that commercial / industrial areas had a generation rate close to 0.03 L/s/ha but used 0.1 L/s/ha to be slightly conservative. Going forward, ISL will use 0.1 L/s/ha to be consistent with the wastewater masterplan.

The updated model populations and flows are given in Table 2.3. These growth horizons are shown on Exhibit 2.1. Based on the projections from the Wastewater Master Plan, the % residential and % non-residential area contributions were estimated to ensure that the population targets were consistent. Additionally, the existing population has increased from an original estimate of 14,310 people to 18,197 people.

The existing model has an ADD of 45 L/s which was unchanged and only the difference in population was added to the existing condition. The change in population is 3,887 people and was added to the existing demands using 271 L/c/d and distributed evenly across the model. It should be noted that the populations in Table 2.3 were estimated based on land parcels (quarter sections) assigned to each growth horizon and do not match the scenario name specifically. For instance, the 22K scenario is a 5-year growth scenario where the estimated population is actually 26,000. For consistency with the Wastewater Master Plan, the scenario names were unchanged.

Table 2.3: Updated population projections and water demands

Area Name	Gross Area (ha)	% Res	Res. A (ha)	% Non-Res	Non-Res A (ha)	Population (c)	ADD (L/s)	MDD (L/s)	PHD (L/s)
Existing	-	-	-	-	-	18,197	**57.2**	**114.4**	**228.8**
West Village	15.9	100%	15.9	0%	0	854	2.7	5.4	10.8
Total-STDP						**19,051**	**59.9**	**119.8**	**239.6**
Grayhawk	68.96	43%	29.67	57%	39.29	1,335	8.1	16.2	32.5
Pogadl Park	33.13	43%	14.26	57%	18.87	642	3.9	7.8	15.6
60 St	36.94	43%	15.90	57%	21.04	715	4.3	8.7	17.4
Westridge	25.31	43%	10.89	57%	14.42	490	3.0	6.0	11.9
Ryder	74.84	43%	32.20	57%	42.64	1,449	8.8	17.6	35.2
Iron Gate	62.90	82%	51.50	18%	11.30	2,318	8.4	16.8	33.6
Norrell Business Park	65.00	0%	0.00	100%	65.00	0	6.5	13.0	26.0
Total-22K						**26,000**	**102.9**	**205.9**	**411.8**
60 St South	82.6	60%	49.57	40%	33.04	2,230	10.3	20.6	41.2
South	83.6	60%	50.14	40%	33.43	2,256	10.4	20.8	41.7
Lighthouse Pointe	64.9	54%	34.90	46%	30.00	1,571	7.9	15.9	31.7
Sanbar Estates	47.9	60%	28.72	40%	19.15	1,292	6.0	11.9	23.9
Total-30K						**33,350**	**137.6**	**275.1**	**550.2**
Meadowlands	119.1	60%	71.45	40%	47.64	3,215	14.8	29.7	59.4
Southeast 1	123.3	60%	73.99	40%	49.33	3,330	15.4	30.8	61.5
Northern Gateway	346.7	0%	0.00	100%	346.71	0	34.7	69.3	138.7
East Sanbar	78.4	89%	69.50	11%	8.90	3,128	10.7	21.4	42.8
North Sanbar	253.5	60%	152.08	40%	101.38	6,843	31.6	63.2	126.4
Total-45K						**49,866**	**244.8**	**489.5**	**979.0**
West (i) [North]	62.3	90%	56.11	10%	6.23	2,525	8.5	17.1	34.2
West (ii) [South]	61.8	90%	55.66	10%	6.18	2,505	8.5	16.9	33.9
Southwest	121.0	90%	108.86	10%	12.10	4,899	16.6	33.2	66.3
Total-60K						**59,794**	**278.4**	**556.7**	**1113.4**

Area Name	Gross Area (ha)	% Res	Res. A (ha)	% Non-Res	Non-Res A (ha)	Population (c)	ADD (L/s)	MDD (L/s)	PHD (L/s)
Northwest	464.0	80%	371.21	20%	92.80	16,704	61.7	123.3	246.7
Far West	395.6	80%	316.45	20%	79.11	14,240	52.6	105.2	210.3
South East 2	240.4	80%	192.31	20%	48.08	8,654	32.0	63.9	127.8
Total-75-100K						**99,393**	**424.6**	**849.1**	**1698.2**

Table 2.3 is summarized in Table 2.4 below by growth horizon.

Table 2.4 Summary of growth horizon populations and flows

Scenario Name	Population (c)	Year	ADD (L/s)	MDD (L/s)	PHD (L/s)
Existing	18,197	2019	57	114	229
Short-term development pressures	19,051	2020	60	120	240
22K	22,000	2025	103	206	412
30K	30,000	2035	138	275	550
45K	45,000	2050	245	490	979
60K	60,000	2060	278	557	1,113
75K - 100K	≤100,000	> 2060	425	849	1,698

Note:

1. These populations and demands are for the entire Town and are not discretized by pressure zone.
2. Assumes 271 L/c/d for future residential areas.
3. Assumes 0.1 L/s/ha for future non-residential areas.

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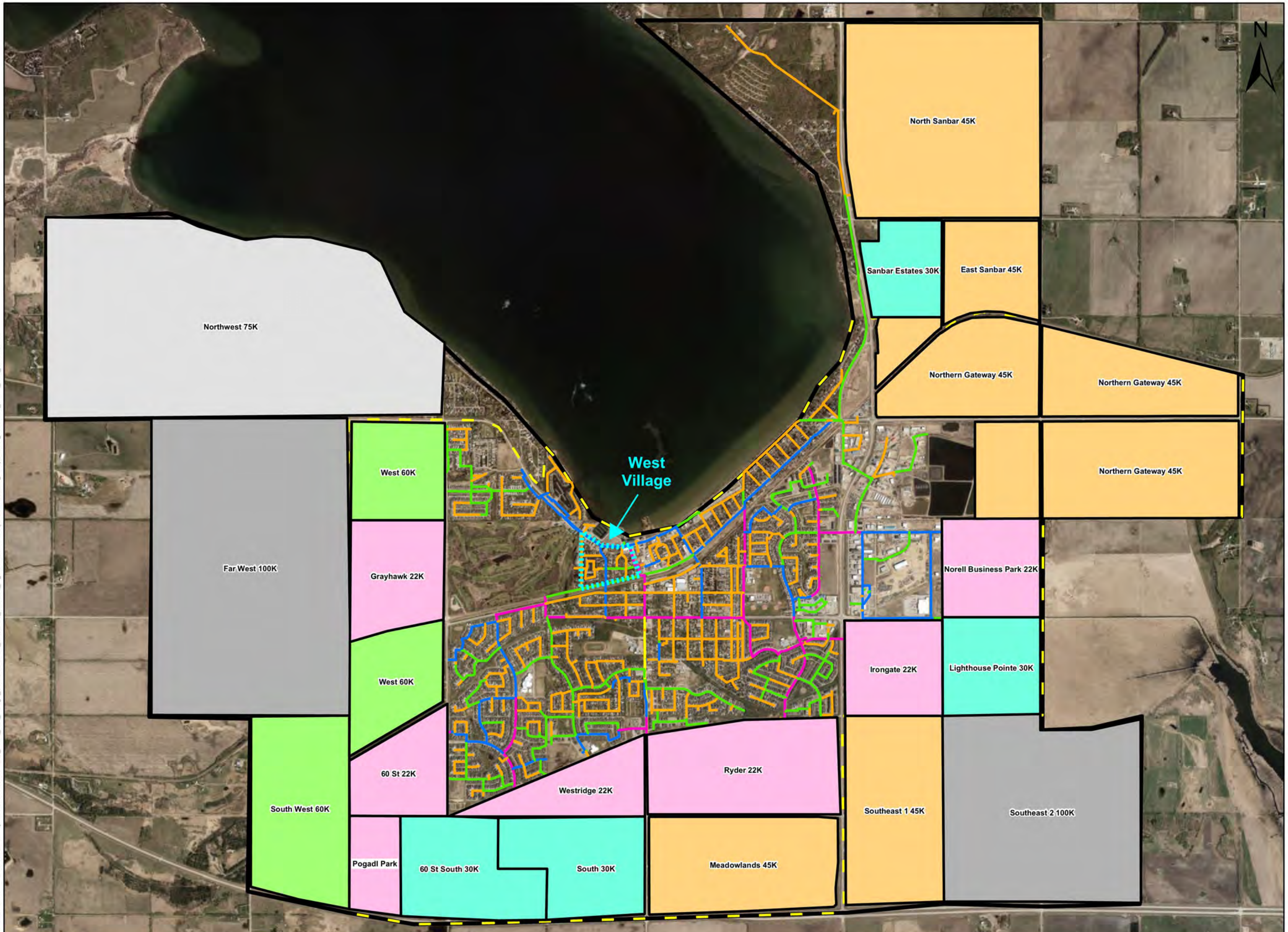

Legend

Water Mains

Diameter (mm)

- <= 150
- 200
- 250
- 300 - 350
- 400
- 500
- West Village

Future Plan Areas

Planning Horizon

- 22K (~5 years)
- 30K (~15 years)
- 45K (~30 years)
- 60K (~40 years)
- 75K (>40 years)
- 100K (>40 years)
- Municipal Boundary
- Study Area

Coordinate System:
NAD 1983 3TM 114

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0 300 600 1,200 Meters

EXHIBIT 2.1

GROWTH PROJECTIONS AND TIMELINE

ISL

3.0 Model Review and Validation

3.1 Standards Review

The Town of Sylvan Lake standards specify the following:

Fire Flow Conditions:

- Minimum fire flow used for single family residential neighbourhoods is 4,500 L/min or 75 L/s. The Town uses 150 L/s for commercial/industrial land uses.
- Minimum residual line pressure during maximum day plus fire flow conditions is 150 kPa at ground level at any point in the system.
- Main line flow velocities shall not exceed 2.5 m/s during maximum day plus fire flow conditions.

Peak Hour Demand Conditions:

- Minimum residual line pressure during peak hour flow conditions is 300 kPa.
- Main line flow velocities shall not exceed 1.5 m/s during peak hour flow conditions.

Residential Per Capita Consumption Rates:

- Average Day Demand (ADD): 271 litres per capita per day.
- Maximum Day Demand (MDD): 750 litres per capita per day.
- Peak Hour Demand (PHD): 1,500 litres per capita per day.

Table 3.1 summarizes a comparison between Sylvan Lake design standards and other municipalities. Sylvan Lake design standards are similar to the Red Deer County standards. Sylvan Lake fire flow requirements are somewhat less than the City of Edmonton but are comparable to other smaller municipalities.

Table 3.1: Comparison of Sylvan Lake water design standards

Scenario	Parameter	Town of Sylvan Lake	Red Deer County	City of Edmonton	City of Grande Prairie
Residential Consumption Rates	Average Day Demand (L/c/d)	271	-	250	275
	Maximum Day Demand (L/c/d)	750	750	425	550
	Peak Hour Demand (L/c/d)	1,500	1,500	750	825
Non-Residential Consumption Rates	Average Day Demand (L/s/ha)	0.20	0.20	0.20	0.12 – 0.30
Fire Flow Conditions	Minimum Fire Flow (L/s)	75	75	100 - 180	95 – 130
	Non-Residential Fire Flow	-	150	300	180 – 225
	Minimum Residual Pressure (kPa)	150	150	140	140
	Maximum Pipe Velocity (m/s)	2.5	2.5	3.0 (6.0 on dead ends)	-
Peak Hour Demand	Minimum Residual Pressure (kPa)	300	300	280	280
	Maximum Velocity (m/s)	1.5	1.5	1.5	-

It should be noted that the Town of Sylvan Lake design standards only reference a minimum fire flow of 75 L/s for residential properties. Based on discussions with the Town, it was confirmed that the Town targets 150 L/s for high-value properties such as commercial and industrial lots. Going forward, it is recommended that this standard be written into the design standards.

Average day demand refers to the amount of water consumed over any typical day. Maximum day demand represents the maximum volume of water consumed during a 24-hour period within a given year. Peak hour demand identifies the maximum water volume consumed over a 1-hour interval throughout the entire year. For the Town of Sylvan Lake, both scenarios will occur during the summer months when many tourists are visiting. Because of the tourism in Sylvan Lake, the standards have adopted 750 L/c/d and 1,500 L/c/d for MDD and PHD, respectively. These water demands are approximately 3 times and 5.5 times the average day demand, respectively, which is very high compared to other municipalities.

MDD and PHD factors of 2 and 4 will be used in the modelling going forward. ISL recommends that the Town undertakes a consumption monitoring study going forward to accurately determine what these consumption rates should be. Fire flow requirements of 75 L/s for residential areas and 150 L/s for non-residential areas will be used as the standards for this analysis. As mentioned in Section 2.0, non-residential unit rates will be 0.1 L/s/ha to more accurately reflect monitored data while still being somewhat conservative.

3.2 Model Set Up & System Wide Audit

The most up-to-date water network database was analyzed for comparison purposes to the model. The following conclusions were made:

- The existing model matches the GIS database accurately and only a few missing pipes needed to be added to the model.
- There were a couple of locations where pipe materials/diameters were incorrect and were updated in the model to reflect the most recent conditions.

Exhibit 3.1 shows the pipe database by diameter with bold pipes being changes/new additions to the WaterCAD model. For more information regarding the water model database, see Appendix A, which shows a pipe database table.

At 45 Ave between 50 St and 49 St, the GIS database shows a "supply line", which is likely indicative of a raw water line and not a distribution main. Nevertheless, any cross connections between pressure zones without pressure reducing valves (PRV) will need to be isolated going forward to ensure that the North Reservoir and South Reservoir are utilized optimally.

Table 3.2 summarizes the PRV settings that have been used in the existing system model. HGL refers to the hydraulic grade line. The upper zone refers to the higher elevation areas which are found to the south of Sylvan Lake. The lower zone makes up the low-lying areas including the east industrial area and along Lakeshore Dr. The middle zone is an intermediate zone between the upper and lower zones. The Town's elevation drops heading north and cannot be pressurized under one pressure zone. The impact of this would cause both over-pressurization and bursting of mains near Lakeshore Dr and other low-lying areas simultaneously with below standard pressures in the high elevation areas. As a result, the Town has been separated into three zones based on ground elevations in order to achieve a pressure ranging from 300 – 620 kPa. Pressures outside this range can be problematic for the distribution network. PRVs are used to decrease the pressure from the south as it transitions to the lower zone.

Table 3.2: Pressure zone PRV settings

Zone Name	Pressure Zone HGL (m)
Upper	1026
Middle	1018
Lower	996

Pump control logic at the south reservoir is summarized in Table 3.3. Pump details for Beacon Hill are summarized in Table 3.4 below.

Table 3.3: South Reservoir Pump Information

Pump Station	Pump #	Capacity (L/s)	Head (m)
South Reservoir (Lower/Middle Zone)	M.PUMP2 (Lead)	97.5	20.5
	M.PUMP1 (Lag)	97.5	20.5

Table 3.4: Beacon Hill Pump Information

Pump Station	Pump #	Capacity (L/s)	Head (m)
Beacon Hill (Upper Zone)	Pump #1	25	39
	Pump #2	50	39
	Pump #3	75	39
	Pump #4	75	39

Overall, based on the PRVs in the model just downstream of the South Reservoir Pumphouse, the operating HGL range is between 1,018.2 m (227 kPa discharge header pressure) and 1,029.2 m (345 kPa discharge header pressure). This range encompasses the pressure zone HGL of the middle and upper zone, therefore is consistent with the Stantec report.

Table 3.5 shows the pumping capacity at the North Reservoir. The pumps are configured such that when P-102 comes online, then P-101 turns off. Pumps P-102 through P-105 are configured that at most, three are online at any time. This implies that the North Reservoir will require assistance from the South Reservoir during a fire at a non-residential location where 150 L/s fire flow is required.

Table 3.5: North Reservoir Pump Information

Pump Station	Pump #	Capacity (L/s)	Head (m)
North Reservoir (Lower Zone)	P-101	15	66
	P-102	50	66
	P-103	50	66
	P-104	50	66
	P-105	50	66

Exhibit 3.2 shows the PRV locations in black, and the pressure zones based on the following color scheme:

- Lower Zone – Pink
- Middle Zone – Yellow
- Upper Zone – Blue
- PRVs – Black

3.3 Calibration

To calibrate a water model, hydrant fire flow tests (FFT) need to be conducted at various points in the water network. Each hydrant flow test requires two hydrants, a flow hydrant where water is released at, and a residual hydrant, which is adjacent to the flow hydrant and where pressures are recorded. The steps to perform a hydrant flow test include the following:

- Record the static discharge header pressure at the reservoir and the static pressure at the residual hydrant before the flow hydrant is opened.

- Open the flow hydrant and record the flow coming out of both ports.
- Once the pressures stabilize in the network with both ports open, record the pressure at the residual hydrant.

To calibrate the model, the demands are added in at representative nodes in the model, and the model pressures at the residual hydrant and discharge header are compared to the test results. The empirical C-values, or Hazen-Williams coefficients, represent the friction in the water mains. By adjusting these empirical values within reasonable limits, the model can be calibrated such that the pressures match the test results.

The original model has been updated substantially, and the calibration was reviewed to ensure it was still relevant. On average, the model varies by about 48 kPa, which shows that the calibration is reasonable; however, the pressure losses are consistently higher in the model during the hydrant tests. To address this inconsistency, the Hazen-Williams coefficients (C) were adjusted as shown in Table 3.6. Additionally, calibration was conducted based on flows of 30% higher than ADD (1.3*ADD) to estimate the demands based on the time of the hydrant tests.

Table 3.6: Calibrated Hazen-Williams Coefficients

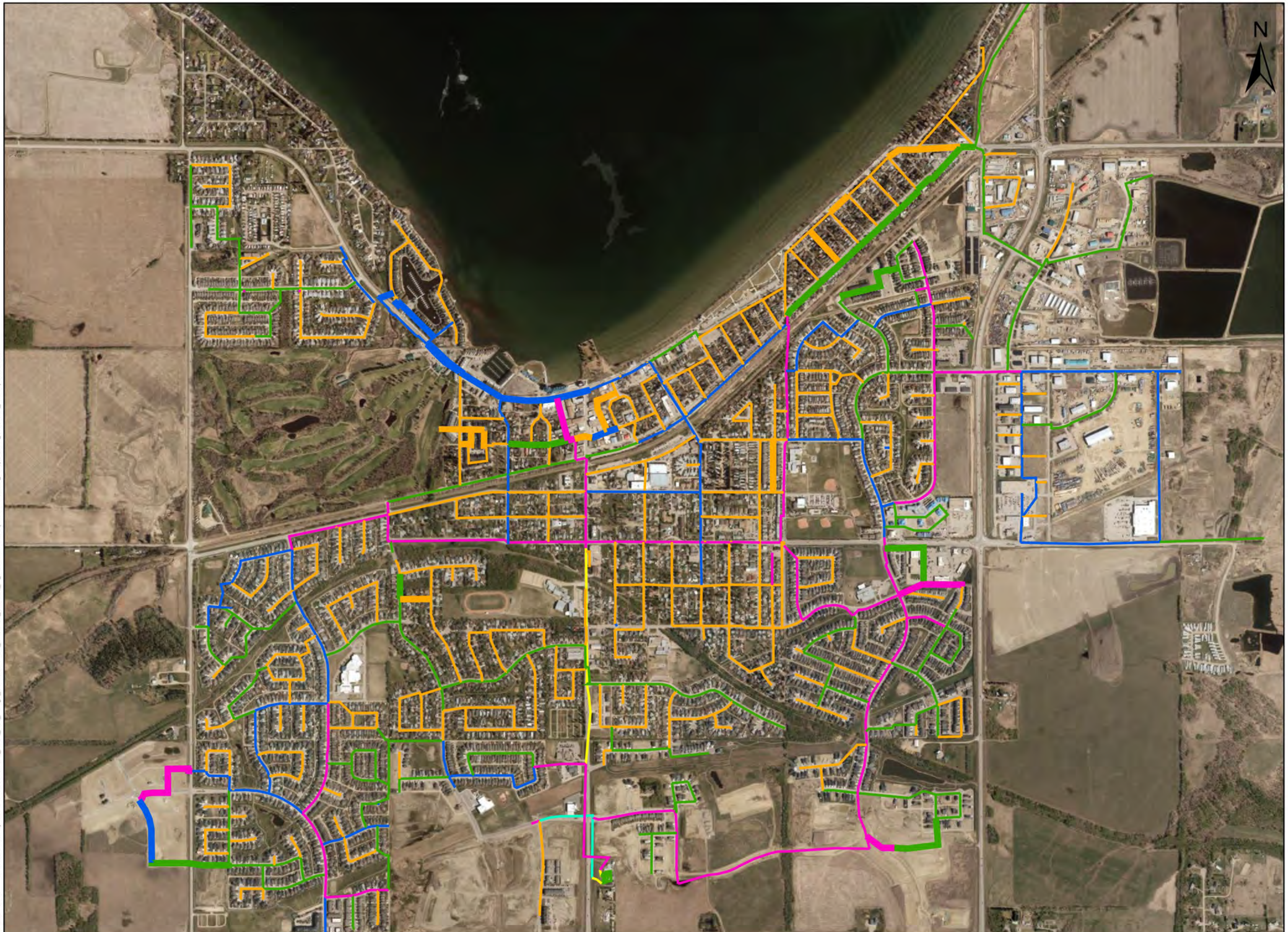
Pipe Material	Stantec Model C-Value	Calibrated C-Value
Ductile Iron	75	85
Concrete	80	85
Asbestos Cement	80	90

The final calibration results are shown in Table 3.7. Based on the calibration, the static pressures in the model are much closer to the model results. Additionally, the hydrant test results have improved slightly as well. FFT2 shows that the model under-predicts the residual pressure by 131 kPa (20 psi). More calibration could be conducted to further improve the accuracy of the model.

Table 3.7: Calibration Model Results

Calibration Summary	Field Test Results		Calibrated Model			
Fire Flow Test	Static Pressure (kPa)	Hydrant Flowed Pressure (kPa)	Static Pressure (kPa)	Hydrant Flowed Pressure (kPa)	ΔP During Static Case (kPa)	ΔP During Hydrant Test (kPa)
FFT1	400	276	387	250	-13	-26
FFT2	414	331	421	200	8	-131
FFT3	427	359	432	313	4	-46
FFT4	552	400	546	383	-6	-17
FFT5	552	483	563	456	12	-27
FFT6	496	427	504	407	8	-20
FFT7	483	386	468	393	-14	7
FFT8	558	469	570	483	12	14
FFT9	579	441	590	386	10	-55
FFT10	593	455	594	399	1	-57

Exhibit 3.3 shows a map of the fire flow testing locations.



Legend

Water Network - Unchanged

Diameter (mm)

- <= 150
- 200
- 250
- 300 - 350
- 400
- 500

Updated Water Network

Diameter (mm)

- <= 150
- 200
- 250
- 300 - 350
- 400
- 500

Coordinate System:
NAD 1983 3TM 114

1:15,000

0 150 300 600 Meters

EXHIBIT 3.1

WATER MODEL UPDATES

Date: 2020-05-05 Document: G:\Projects\15000\15200\15222_North_Res_Design_Construction\02_CADD\25_GIS\251_Figures\Additional Hydraulic Modeling Scope Change\GIS\3.1_AuditUpdates.mxd

Integrated Expertise. Locally Delivered.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

EXHIBIT 3.2

PRESSURE ZONE BOUNDARIES

ISL

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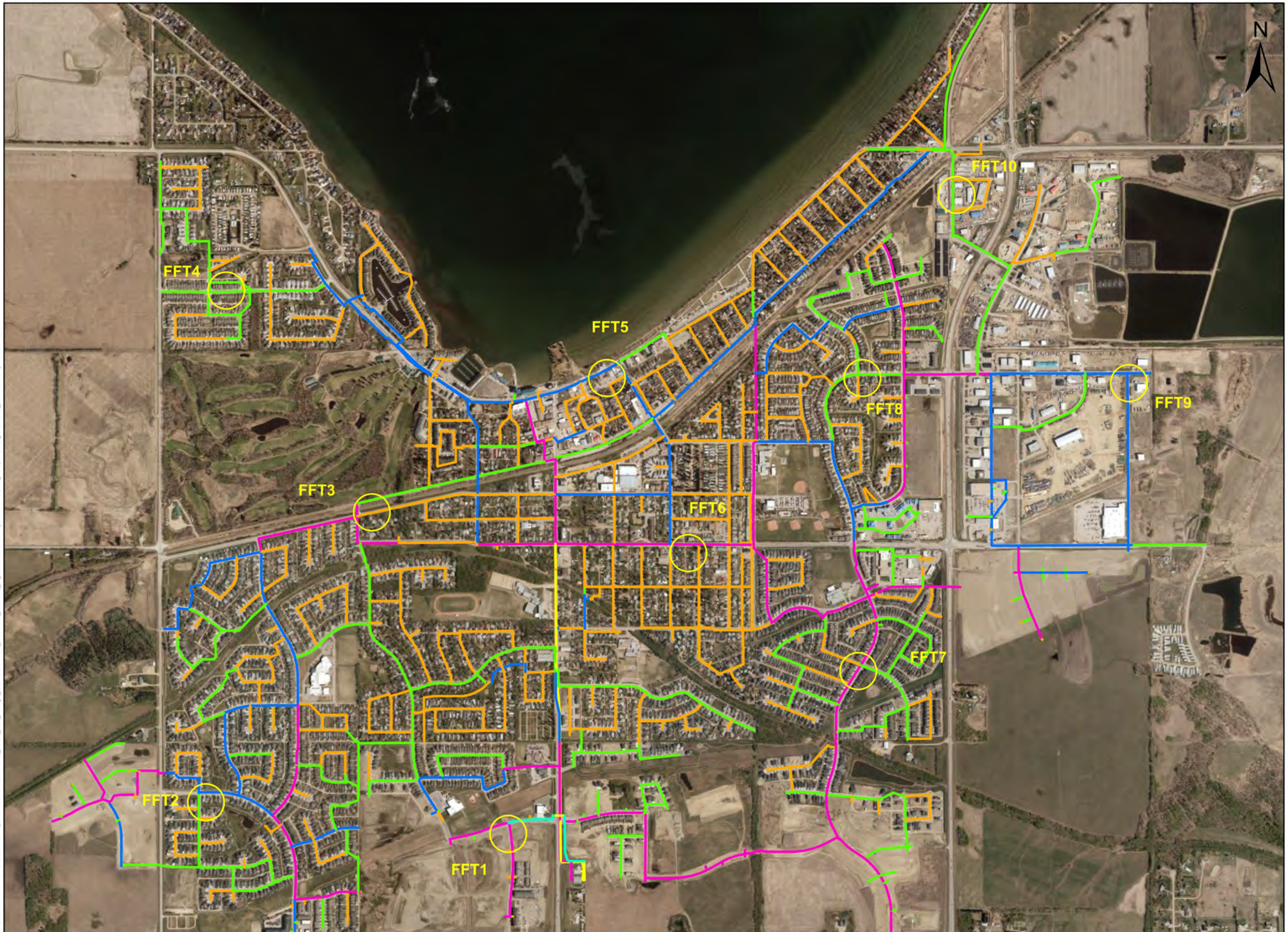

Legend

Water Mains

Diameter (mm)

- <= 150
- 200
- 250
- 300 - 350
- 400
- 500
- FFT - Fire Flow Test

Coordinate System:
NAD 1983 3TM 114

1:15,000

0 150 300 600 Meters

EXHIBIT 3.3

CALIBRATION HYDRANT LOCATIONS

ISL

Date: 2020-05-05 Document: G:\Projects\15000\15200\15222_North_Res_Design_Construction\02_CADD\25_GIS\251_Figures\Additional Hydraulic Modeling Scope Change\GIS\3.3_CalibrationHydrants.mxd

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4.0 Existing Water System Analysis

4.1 Impact of New North Reservoir and Northeast Gateway Water Supply Main

4.1.1 Hydraulics of the North and South Reservoir

With the construction of the North Reservoir and the current PRV settings, the north and south reservoir will be pumping against each other. Table 4.1 shows the demands during different scenarios for the existing water network.

Table 4.1: Current Demand breakdown by pressure zone

Demand Scenario	Lower Zone (L/s)	Middle Zone (L/s)	Upper Zone (L/s)	Total Demand (L/s)
ADD	37.7	18.7	0.8	57.2
MDD	75.4	37.4	1.6	114.4
PHD	150.8	74.8	3.2	228.8

With the North Reservoir online and the PRVs set at their current set points, the reservoir contributions are not balanced, and the south reservoir will outcompete the north reservoir, resulting in underutilization of the north reservoir. As shown, a lot of the lower zone is fed from the south reservoir while the North Reservoir is not fully utilized.

Table 4.2: Existing Reservoir Contributions with Current PRV Settings

Demand Scenario	South Reservoir (L/s)	North Reservoir (L/s)
ADD	51.2	6.0
MDD	102.4	12.0
PHD	204.8	24.0

Note: Assumes NE Gateway has been constructed and low-mid zone PRVs are active.

To properly utilize the North Reservoir, the following changes to the network are recommended:

- Set the PRV on 50 St between the middle and lower zones to a HGL = 985 m.
- Set the PRV on Old Boomer Rd between the middle and lower zones to a HGL = 985 m.
- Set the PRV on Ryders Ridge Blvd between the middle and lower zones to a HGL = 985 m.
- Based on the elevations in the lower zone, the North Reservoir was set at an outgoing HGL of 1,000 m to ensure pressures do not exceed 620 kPa (90 psi) in the lower zone.

These PRV settings will isolate the north and south reservoirs during ADD and PHD. During fire flows, the two PRVs set to 985 m will provide some fire flows to the west of the lower zone where the North Reservoir cannot provide adequate fire flows. There are bottlenecks along Lakeshore Drive and suppling fire flows to the western area of the lower zone is difficult to achieve without extensive upgrading. The upgrades required to resolve all of these bottlenecks would not be cost-effective.

4.1.2 Northeast Gateway Water Supply Main

The existing 200 mm water main along Hwy 20 from Township Rd 391 to 33 St cannot provide adequate fire flows to the lower zone, thus it is currently being twinned with a 450 mm water supply main called the Northeast Gateway Water Supply Main (NE Gateway). Exhibit 4.1 shows the two potential alignments that are currently being considered.

The two options are summarized below:

1. **Option 1:** From the North Reservoir, head east on Township Rd 391 and turn south on Range Road 12. Continue along Range Road 12 and turn west and tie into Cuendet Industrial Way. This alignment is approximately 4.7 km.
2. **Option 2:** From the North Reservoir, head east on Township Rd 391 and turn south along the western edge of Lakewood Golf Resort. Head south until Highway 11A (33 St) and turn east until Range Road 12. From here, continue to Cuendet Industrial Way following the Option 1 alignment the rest of the way. This alignment is also approximately 4.7 km.

At the intersection of Township Rd 391 and Range Rd 12, Option 1 reaches a ground elevation of 972 m. With the North Reservoir HGL of 1,000 m, this provides only 274 kPa of pressure assuming no head losses. Thus, to service the area around Township Rd 391 and Range Rd 12, a booster station would be needed to provide an additional 3 m of head to the area. The issue applies to both alignment options but is more critical for Option 1 as it passes through the higher ground area with expectations for servicing directly off the transmission main. In order to service these areas adjacent to Option 1 near Township Rd 391 and Range Rd 12, it would be necessary to either:

- operate the North Reservoir at a higher pressure and use PRVs to reduce the HGL to 1,000 m downstream of the high point;
- install a local booster station to service the higher ground area; or
- establish a maximum serviced ground elevation of 969 m (lands above this elevation could be park area or graded to 969 m).

Operating the North Reservoir at a higher pressure is not recommended and was not considered further. The Town can consider other options in response to development pressures.

Both alignments are the similar in length and tie into the same main along Cuendet Industrial Way and therefore, both options are hydraulically similar.

With input from ISL, the Town decided that Option 2 would be pursued going forward. Thus, the water system analysis will use the Option 2 twinning alignment going forward.

4.2 Hydraulic Assessment

For the hydraulic assessment, Tables 4.3 and 4.4 represent the pressure legend and available fire flow legend for the peak hour and fire flow scenarios. It should be noted that the fire flow scenario assumed maximum velocity constraints of 6 m/s. While the standards suggest 2.5 m/s at most, restricting velocities this much would cause significant fire flow restrictions throughout the entirety of Sylvan Lake. For comparison, the City of Edmonton recommends a velocity constraint of 3 m/s and no more than 6 m/s on dead end mains. Paralleling this, ISL set maximum velocity constraints to 6 m/s to isolate the most severe fire flow deficiencies.

Table 4.3: Peak Hour Pressure Node Colour Code Legend

Node Colour	Pressure Range (kPa)	Pressure Range (psi)	Notes/Level of Service
(red)	< 300	22 – 43	Below peak hour pressure requirement (300 kPa).
(yellow)	300 – 400	43 – 58	Acceptable pressures.
(green)	400 – 500	58 – 72	
(blue)	500 – 620	72 – 90	Acceptable but somewhat high.
(purple)	> 620	> 90	Excessive pressures.

Table 4.4: Fire Flow Availability Node Colour Code Legend

Node Colour	Fire Flow Available (L/s)	Notes/Level of Service
(red)	< 75	Fails to meet minimum fire flow standard for residential land use
(orange)	75 – 100	Meets minimum fire flow standard for residential land use
(yellow)	100 – 125	
(green)	125 – 150	
(blue)	> 150	Meets residential and non-residential (high value) fire flow objectives

4.2.1 Analysis of Beacon Hill Reservoir – Existing Development Demands

There is interest in abandoning the South Reservoir Pumphouse and feeding the upper and middle zones through the Beacon Hill Pumphouse alone (at the South Reservoir). Exhibit 4.2 shows the locations of upgrades (300 mm) required to service the lower and middle zones from Beacon Hill Pumphouse alone. The upgrades are summarized as follows:

- Extend a 300 mm main from the existing 300 mm main on Broadway Rise westwards towards Lucky Pl.
- The original 300 mm line from the South Reservoir Pumphouse heading north on 50 St was assumed to be reused as a connection to Beacon Hill.
- A PRV set to a HGL of 1,018 m was outfitted along the 300 mm line as Beacon Hill transitions from the upper zone to the middle zone.

The upgrade shown on Exhibit 4.2 is schematic and is based on the pipe network that was built into the model previously by Stantec. Going forward, this upgrade could be adjusted to something hydraulically similar along an easier alignment.

The results of peak hour demand and fire flow availability are shown in Exhibits 4.3 and 4.4, respectively. Minimum peak hour pressures are maintained with these upgrades, and there are only a few fire flow deficiencies, most notably along dead ends or off 150 mm mains that cannot achieve 150 L/s.

4.2.2 Existing Development Demands – Entire Town

For this scenario, it was assumed that the PRVs between the middle and lower zones were set such that the South Reservoir and North Reservoir are isolated, except during fire flows. With NE Gateway Option 2 in service, Exhibit 4.5 shows the modelling results for peak hour demands for the existing level of development. Areas along the pressure zone boundary in the lower zone fail to meet peak hour demand requirements.

Exhibit 4.6 shows the fire flow availability utilizing the NE Gateway Option 2 for existing levels of development. It should be noted that these available fire flows assume a velocity constraint of 6 m/s. To achieve adequate fire flows using 2.5 m/s, a lot more upgrades would be required. The deficiencies listed below are the worst within the network, thus, upgrades recommended will target the most deficient areas.

A summary of fire flow deficiencies/risks is described below:

1. The Westwood neighborhood in the northwest corner of the Town is deficient due to being fed from a single main on Lakeshore Dr and being located far from the North Reservoir.
2. 49 St and 48 St south of 47 Ave consist of 150 mm pipes and only have a few connections back into the main network.
3. The neighborhood on Perry Drive just east of 50 St in the middle zone is serviced by a single 200 mm main and has no looping back to the main on 50 St.
4. The industrial area to the east of Highway 20 struggles to achieve 150 L/s at dead end mains along Industrial Dr and Sylvaire Close. Additionally, 150 mm dead ends along Thevenaz Ind. Trail and Beju Ind. Drive cannot achieve 150 L/s.

4.3 Upgrades for Existing Water Network

To achieve sufficient fire flows throughout the entire Town would be very expensive; however, the upgrades described below aim to target the most critical areas. Thus, not every dead end within the Town has proposed upgrades as this would not be cost effective. All upgrades shown in Exhibit 4.7 are schematic, and detailed design should identify optimized alignments to reduce construction costs and minimize the amount of infrastructure conflicts. A summary of the proposed existing system upgrades is described below:

A. Add a 300 mm connection from 50 St into the dead end along Cole Way.

B. Open the PRV on Perry Drive to allow better fire flow looping.

C. Add a 200 mm connection from 47 St to 48 St along 45 Ave and upgrade the main on 49 Street south of 47 Ave to a 300 mm main.

D. Create a 300 mm loop along 48 Ave, south along 60 St, and connecting through Fieldstone Way. Extend this 300 mm line north along 60 St and connect to Wildrose Dr and up to the existing 200 mm main on 60 St just south of Westwood Crescent. This will vastly improve the fire flows to the Fern, Fieldstone and Westwood neighborhoods.

E. Set the North Reservoir discharge HGL to 1,000 m (510 kPa) and set the PRVs on Old Boomer Rd, Ryders Ridge Blvd, and 50 St to 985 m. At this setting of 985 m, the South Reservoir will supplement the lower zone only during fire flows. This HGL will increase the pressure near the pressure zone boundary without over-pressurizing the lower elevation areas. After upgrades during the PHD scenario, areas along the lower-middle zone boundary within Exhibit 4.8 are within 15 % of the pressure requirement except for the dead end along 49 St Close. Increasing PRV or reservoir HGL set points any further will result in the lower regions being over pressurized during ADD. The only solution to resolve the pressure deficiency at 49 St Close involves using a booster station which would only benefit a handful of homes, therefore is not recommended.

F. East Industrial Area:

- Proposed upgrades:
  - Upsize the existing 200 mm along Industrial Dr between Cuendet Industrial Way and Erickson Dr to 350 mm.
  - The dead-end northwards along Industrial Way can be upgraded to 250 mm as well if it is desired to remove the deficiency at the dead end. This dead end will be tied into the 45K network during the 45K future scenario; therefore, this short-term upsizing isn't recommended.
  - The dead end on Sylvaire Close was tied into NE Gateway to improve looping as well.
  - Upgrade the 250 mm main on Cuendet Industrial Way to a 450 mm from the tie in of NE Gateway to Charles Ind. Way and upgrade to 350 mm from Charles Ind. Way to Schenk Ind. Rd.
  - This improves the fire flows along the primary 250 mm and 300 mm network throughout the industrial area but does not resolve all of the industrial deficiencies.
- Upgrades not recommended:
  - If Sylvan Lake aims to achieve 150 L/s at all dead ends, connections could be made south along Beju Industrial Drive to connect the dead ends along Beju Ind. Dr. and achieve 150 L/s fire flows.
  - These dead-end upgrades are not recommended since a single hydrant is not able to discharge more than 100 L/s, thus upgrading all dead ends is not cost effective or practical.
  - Also, the main along Thevenaz Ind. Trail can provide 150 L/s so acceptable fire flows are within 225 m.

G. Beacon Hill Reservoir Main Upgrade:

- Based on the analysis in Section 4.2.1, a 300 mm upgrade should be connected westwards towards the middle zone from Broadway Rise to Lucky Pl. This will allow the Beacon Hill Pumphouse to supply all of the middle and upper zones in the south.
- A 300 mm PRV is proposed along the proposed 300 mm set at an HGL of 1,018 m to isolate the middle zone from the upper zone.
- There is interest in abandoning the South Reservoir Pumphouse and supplying the upper and middle zones entirely from the Beacon Hill Pumphouse. Depending on when the South Reservoir Pumphouse is

abandoned, this upgrade will be required (assumed to be required within the next few years). Additional information related specifically to the assessment of the South Reservoir Pumphouse can be found in Section 6.0 of this document.

Exhibit 4.7 shows the locations of the upgrades pursued where black lines represent the existing network and pink lines are proposed mains or locations where existing mains were upgraded. The three PRVs on Old Boomer Rd, 50 St and Ryders Ridge Blvd have been set to 985 m and the PRV on Perry Dr was disabled and opened to allow better looping. These PRVs are highlighted pink on Exhibit 4.7.

Exhibit 4.8 shows the peak hour pressures after upgrades with the North Reservoir PRVs set to 1,000 m.

Excluding dead end fire flow deficiencies, the upgrades shown above generally resolve most of the fire flow constraints. The Town can pursue additional looping upgrades to resolve the dead-end deficiencies if desired. Orange, yellow and green nodes (75 – 149 L/s) are sufficient for residential areas, and blue nodes (150 L/s) are acceptable for commercial/industrial land uses. Exhibit 4.9 shows the fire flow availability after upgrades.

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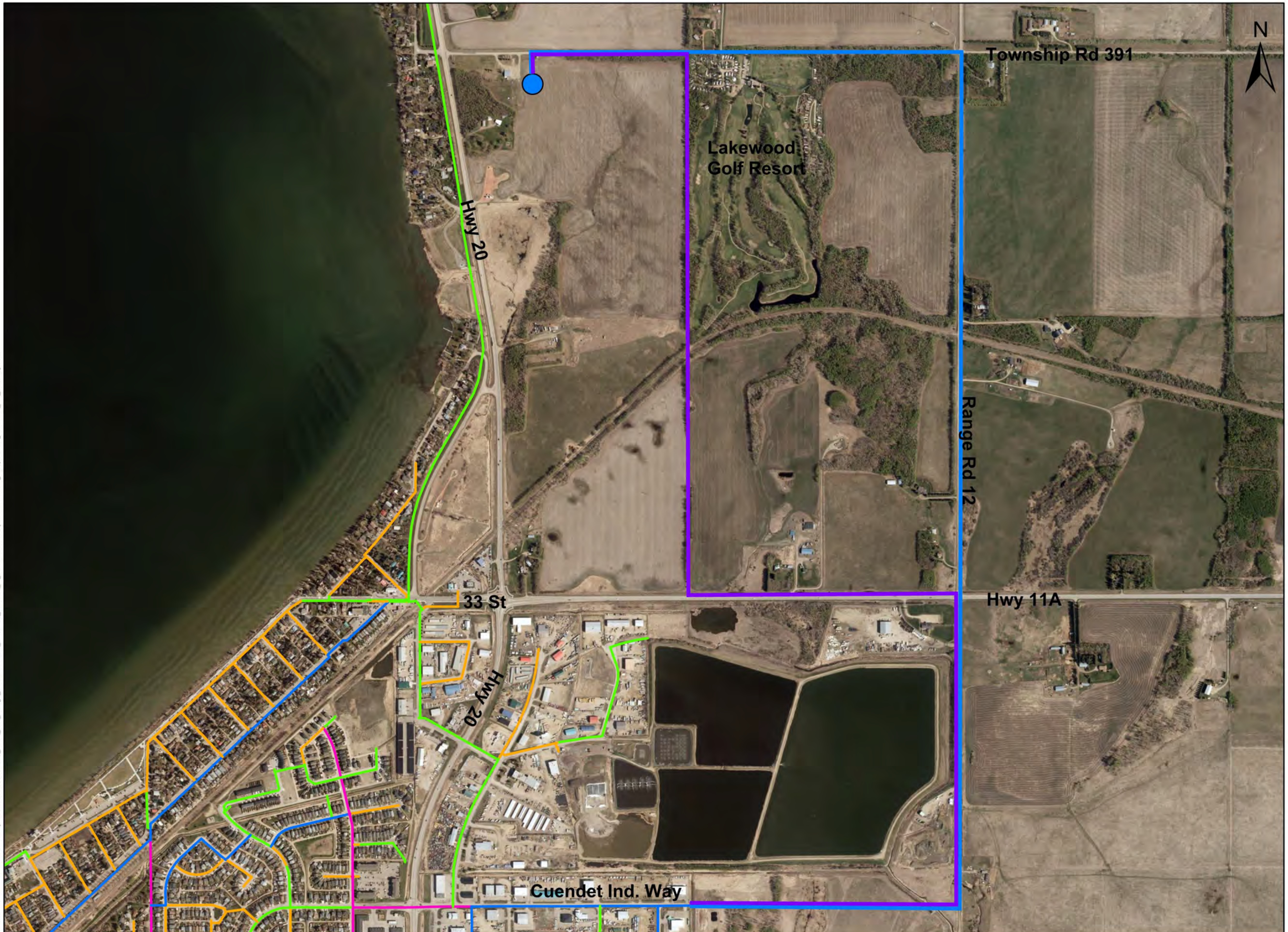

Legend

Water Mains

Diameter (mm)

- <= 150
- 200
- 250
- 300 - 350
- 400
- 500

North Reservoir Twinning

NE Gateway

- Option 1
- Option 2
- North Reservoir

Coordinate System:
NAD 1983 3TM 114

1:11,000

0 110 220 440 Meters

EXHIBIT 4.1

ALIGNMENT OPTIONS FOR NE GATEWAY

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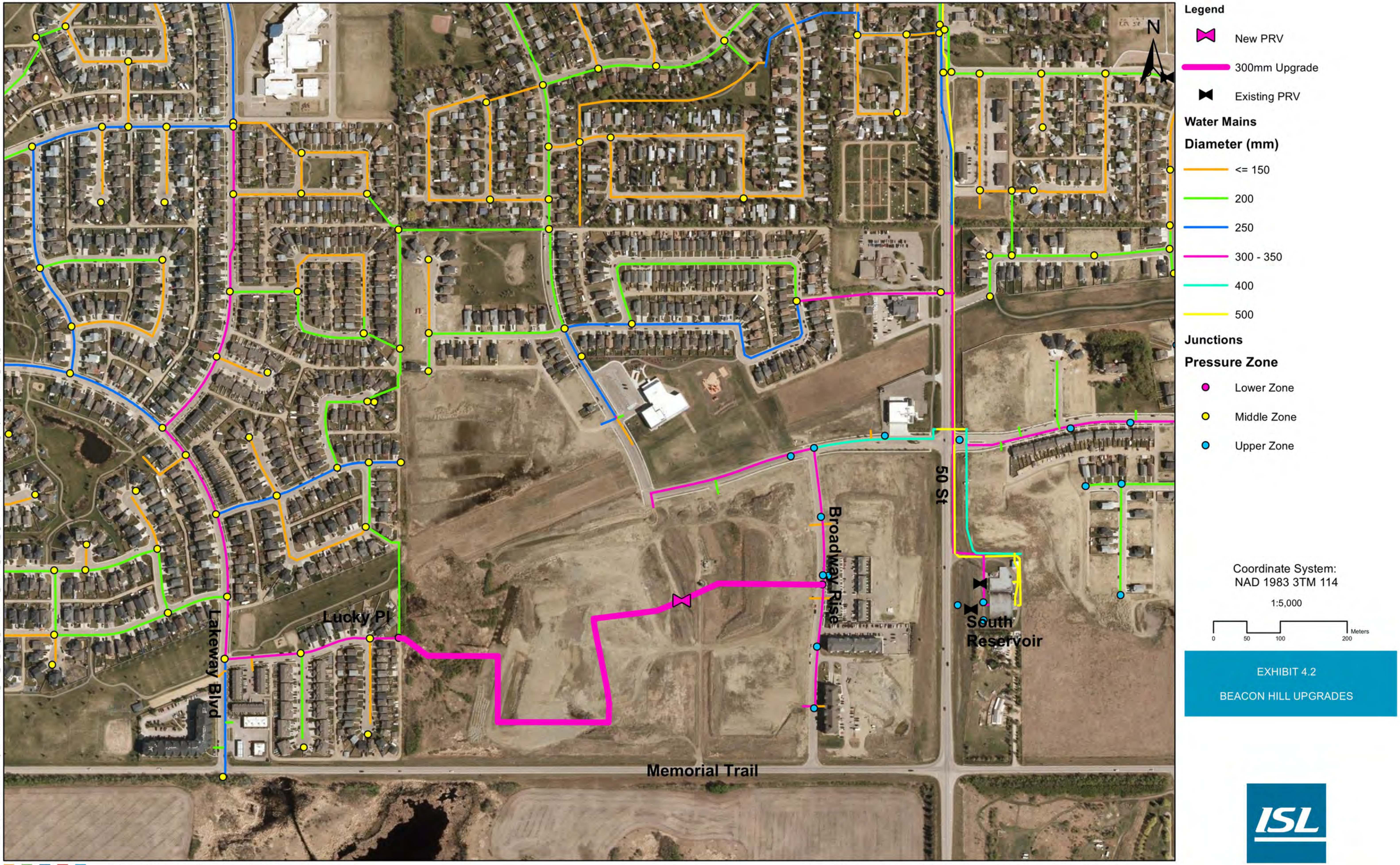
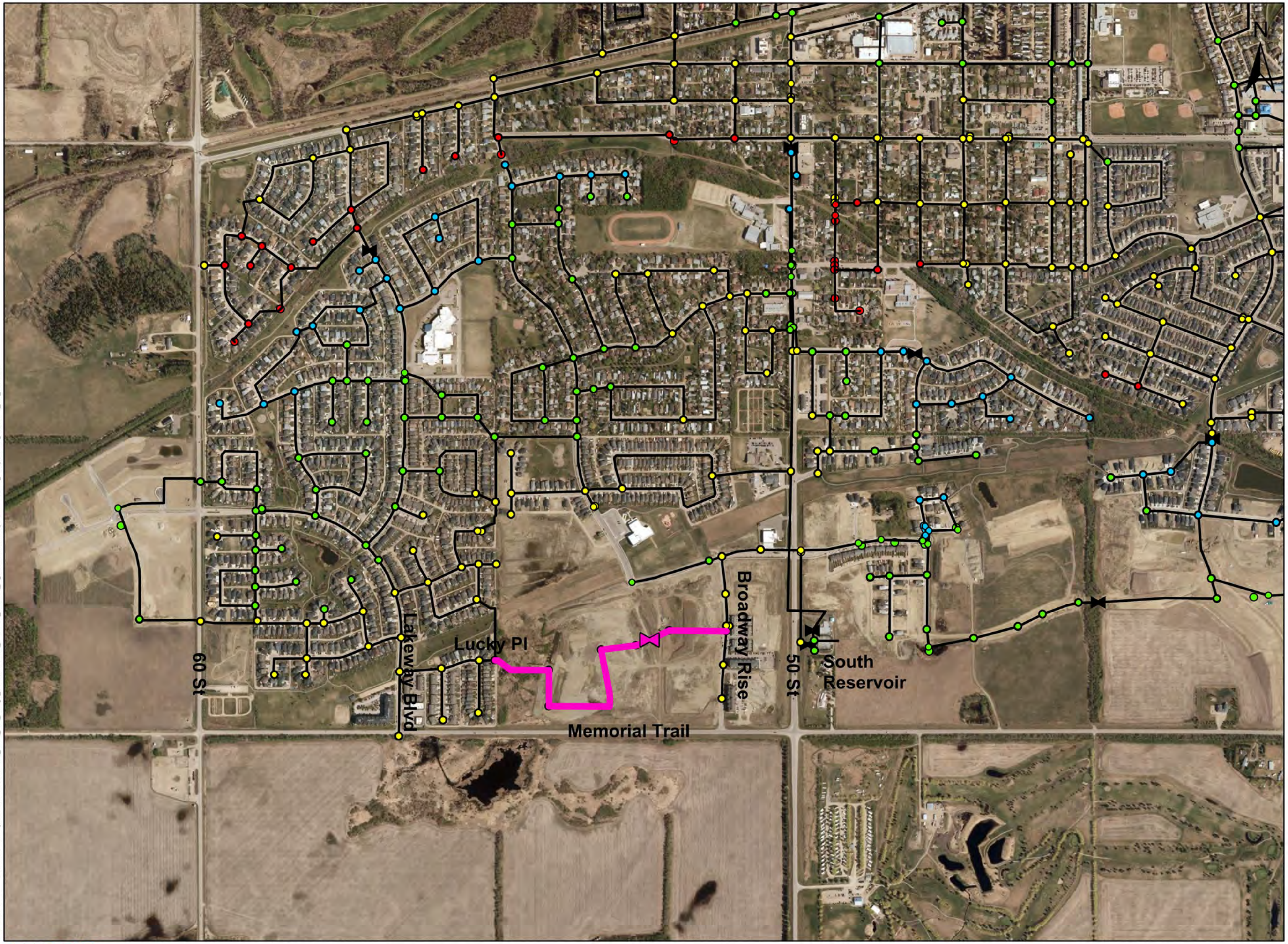

Lakeway Blvd
Lucky Pl
Broadway Rise
50 St
South Reservoir
Memorial Trail
N
Legend
New PRV
300mm Upgrade
Existing PRV
Water Mains
Diameter (mm)
<= 150
200
250
300 - 350
400
500
Junctions
Pressure Zone
Lower Zone
Middle Zone
Upper Zone
Coordinate System:
NAD 1983 3TM 114
1:5,000
0
50
100
200
Meters
EXHIBIT 4.2
BEACON HILL UPGRADES



Legend

Peak Hour Pressures (kPa)

- < 300
- 300 - 400
- 400 - 500
- 500 - 620
- > 620
- New PRV
- 300mm Upgrade
- Existing PRV
- Existing Pipes

Coordinate System:
NAD 1983 3TM 114

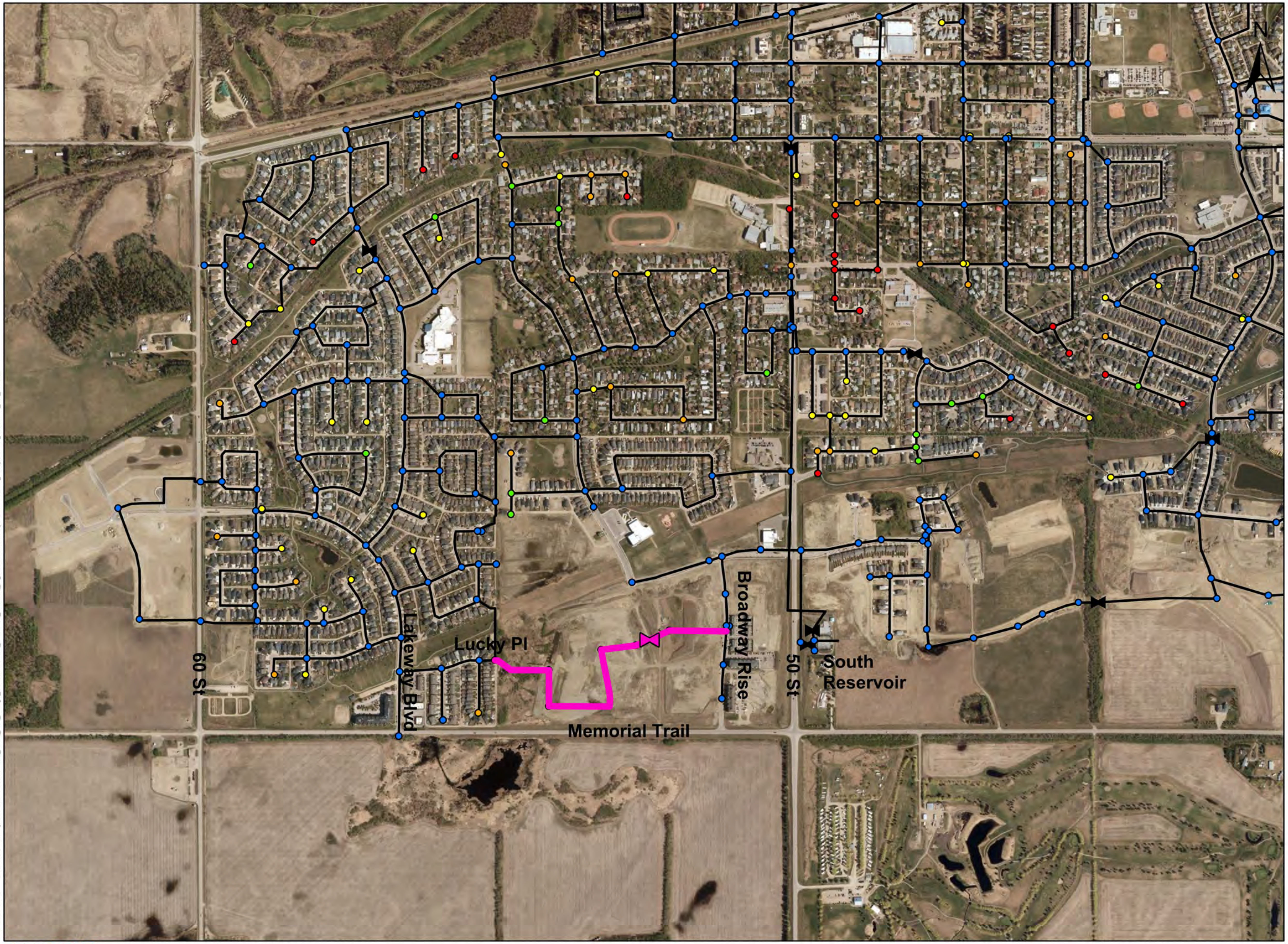
1:10,000

0 100 200 400 Meters

EXHIBIT 4.3

BEACON HILL UPGRADES
PEAK HOUR DEMAND

ISL



Legend

MDD + FF Available (L/s)

- < 75
- 75 - 100
- 101 - 125
- 126 - 150
- > 150
- New PRV
- 300mm Upgrade
- Existing PRV
- Existing Pipes

Coordinate System: NAD 1983 3TM 114

1:10,000

0 100 200 400 Meters

EXHIBIT 4.4

BEACON HILL UPGRADES
MDD + FIRE FLOW

ISL

Legend

Peak Hour Pressures (kPa)

- < 300
- 300 - 400
- 400 - 500
- 500 - 620
- > 620
- Proposed NE Gateway
- Existing Water Network

Coordinate System:
NAD 1983 3TM 114

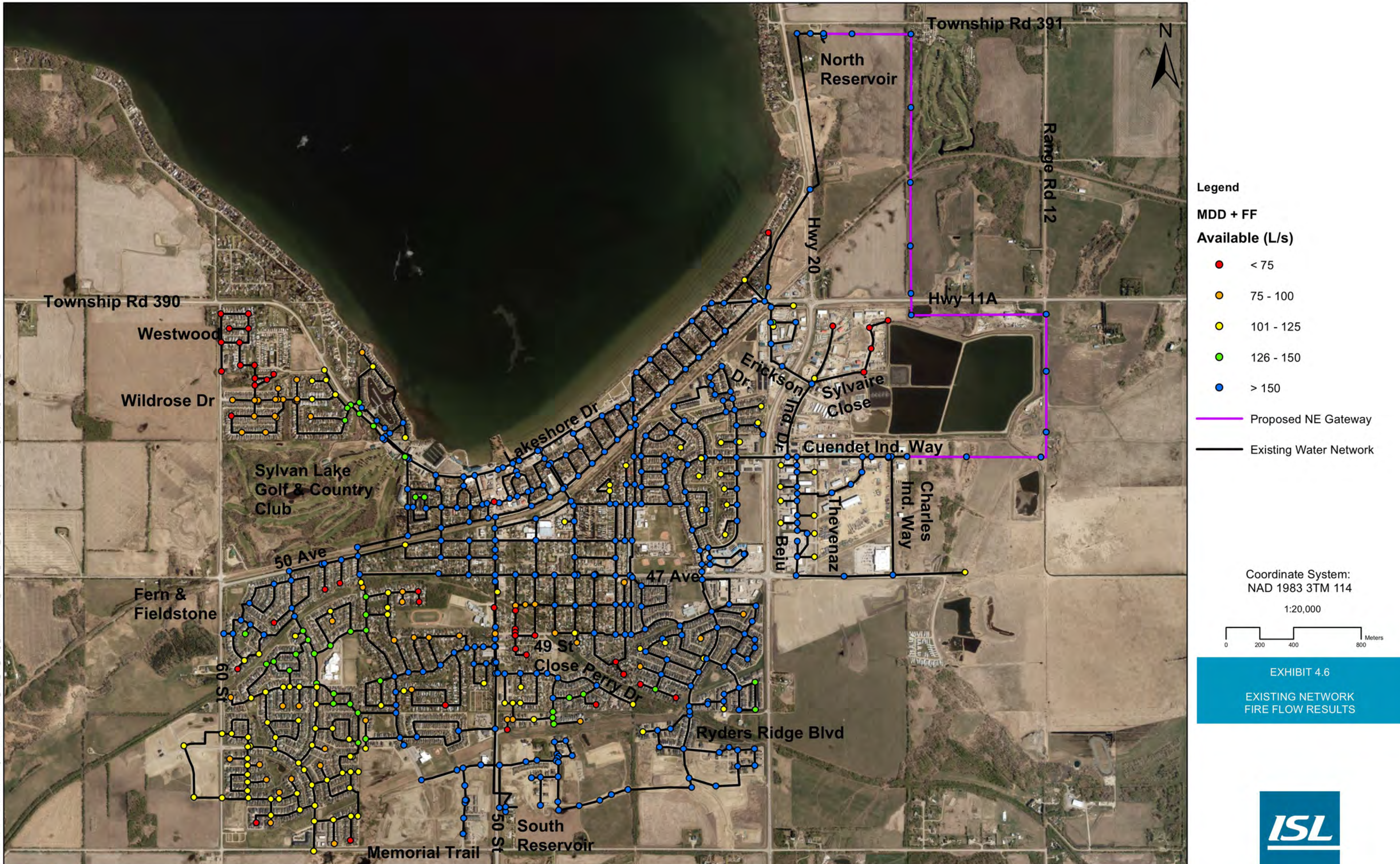
1:20,000

0 200 400 800 Meters

EXHIBIT 4.5

EXISTING NETWORK
PEAK HOUR PRESSURES

ISL



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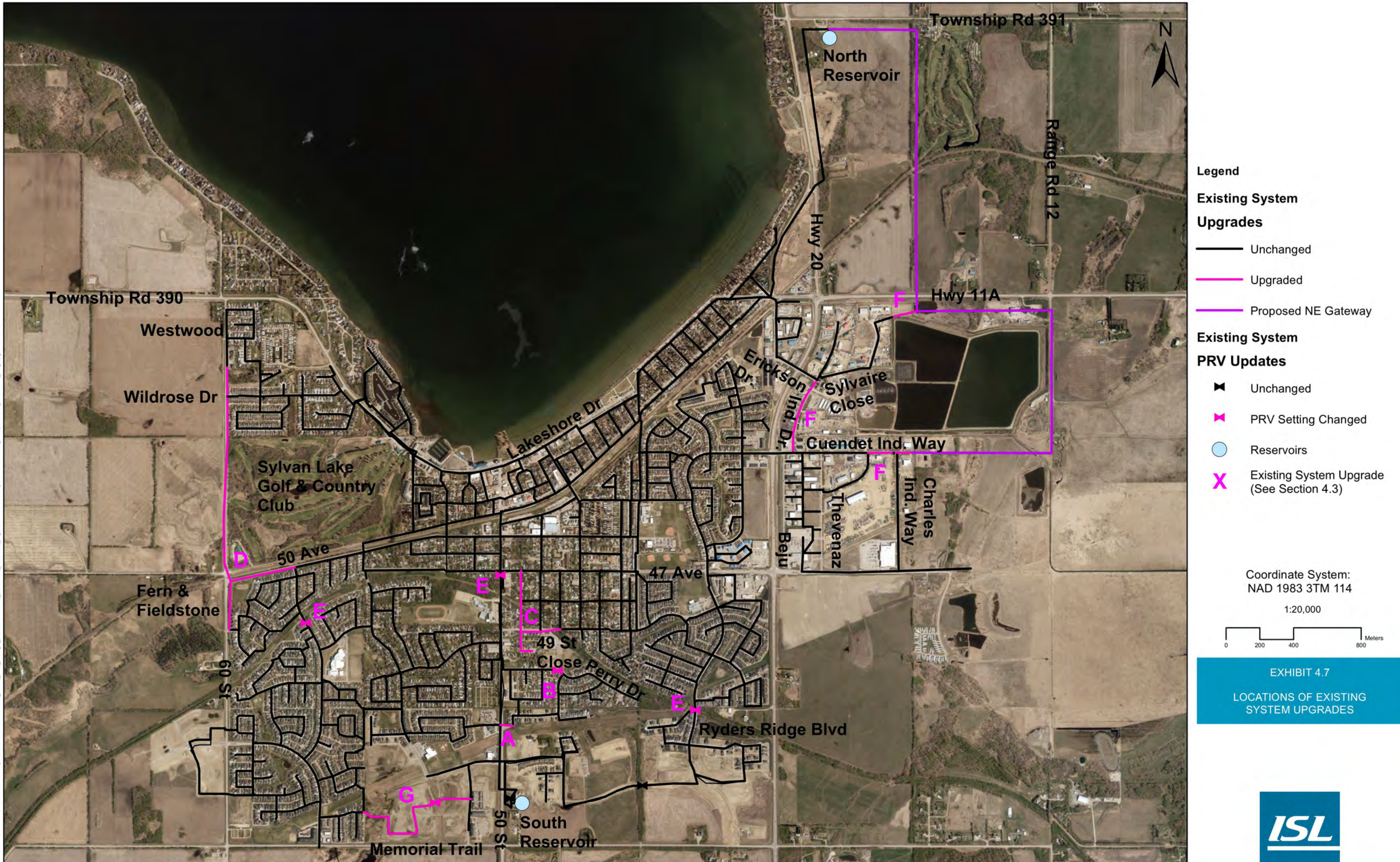

EXHIBIT 4.7

LOCATIONS OF EXISTING SYSTEM UPGRADES

Legend

Peak Hour Pressures (kPa)

- < 300
- 300 - 400
- 400 - 500
- 500 - 620
- > 620
- Upgraded Network

Coordinate System:
NAD 1983 3TM 114

1:20,000

0 200 400 800 Meters

EXHIBIT 4.8

UPGRADED NETWORK FOR EXISTING DEMANDS PEAK HOUR PRESSURES

ISL

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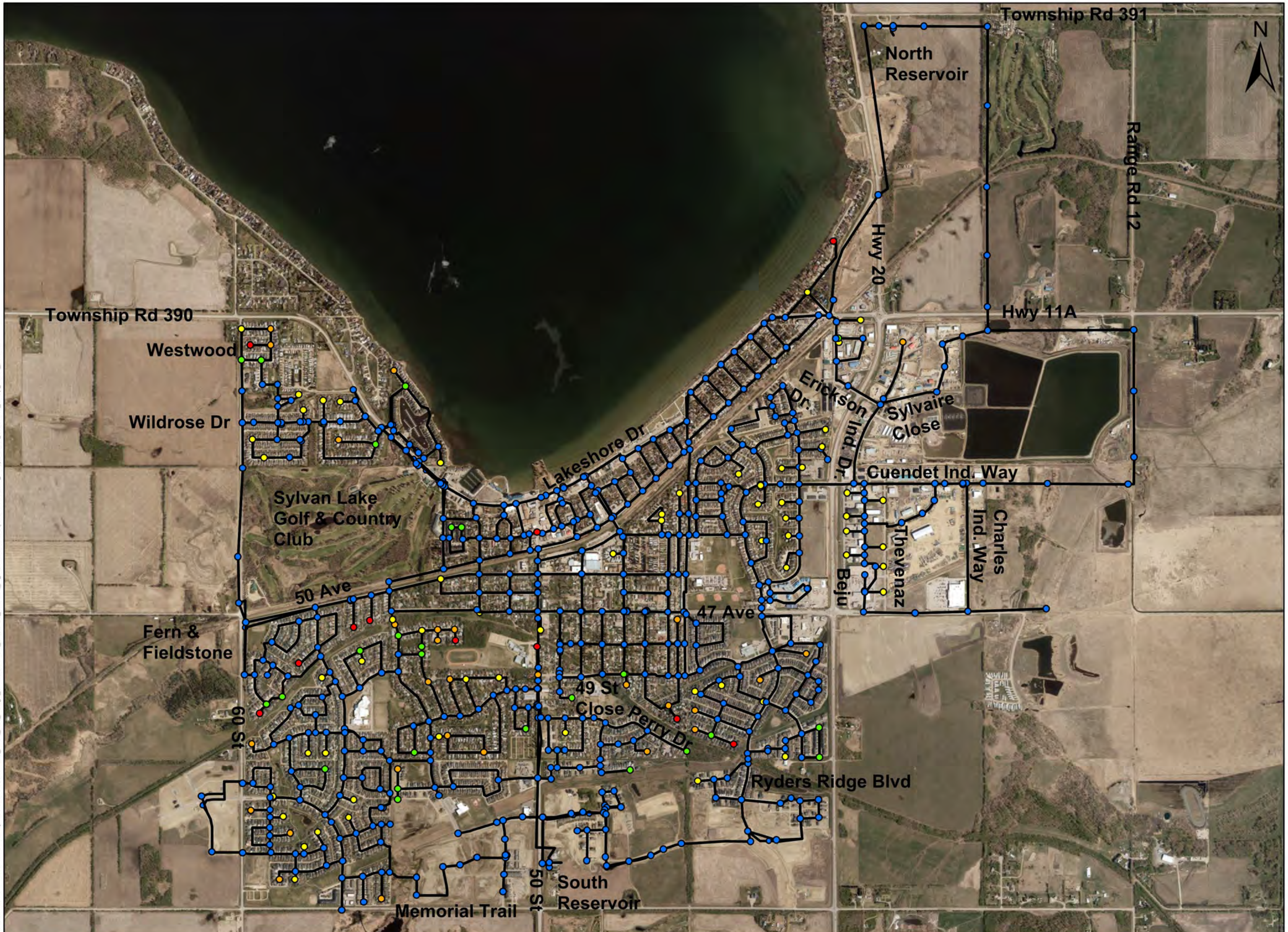

Legend

MDD + FF

Available (L/s)

- < 75
- 75 - 100
- 101 - 125
- 126 - 150
- > 150
- Upgraded Network

Coordinate System:
NAD 1983 3TM 114

1:20,000

0 200 400 800 Meters

EXHIBIT 4.9

UPGRADED NETWORK FOR EXISTING DEMANDS FIRE FLOW AVAILABILITY

ISL

Date: 2020-05-13 Document: G:\Projects\15000\15200\15222_North_Res_Design_Construction\02_CADD\25_GIS\251_Figures\Additional Hydraulic Modeling Scope Change\GIS\4.9_ExUpgrades_FF.mxd

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5.0 Future Water System and Upgrade Requirements

5.1 Introduction

The Town of Sylvan Lake is going to update their design standards to require 150 L/s of fire flow for high value properties, which will be reflected in the analyses below. The overall demands for each growth scenario are summarized in Tables 2.3 and 2.4.

The reservoir contributions are summarized in Table 5.1. For the purposes of determining reservoir contributions, the fire analysis was assumed to be in the West Village development within the lower zone. As soon as short-term development pressures are pursued, it is assumed that the south reservoir will provide additional flows in the event of a fire in the lower zone through adjustment and calibration of the PRVs.

Table 5.1: Reservoir Contribution Estimations during Growth Scenarios.

Scenario	Reservoir	ADD (L/s)	MDD (L/s)	MDD + 150 L/s Fire flow (L/s)	PHD (L/s)
Existing Network (Updated PRV settings)	Total	57.2	114.4	264.4	228.8
	North Reservoir	37.8	75.6	158.9	150.9
	Beacon Hill	19.4	38.8	104.5	77.9
Short-Term Development Pressures (STDP)	Total	59.9	119.8	269.8	239.6
	North Reservoir	39.5	79.0	162.7	157.9
	Beacon Hill	20.4	40.8	107.2	81.6
22K	Total	102.9	205.9	355.9	411.8
	North Reservoir	62.5	125.0	142.7	164.8
	Beacon Hill	40.4	80.8	212.8	247.0
30K	Total	137.6	275.1	425.1	550.2
	North Reservoir	76.4	152.8	179.4	226.7
	Beacon Hill	60.2	120.4	242.1	319.6
45K	Total	244.8	489.5	639.5	979.0
	North Reservoir	161.8	323.5	359.1	558.9
	Beacon Hill	83.0	165.9	279.6	420.0
60K	Total	278.4	556.7	706.7	1113.4
	North Reservoir	175.4	345.5	358.7	556.6
	Beacon Hill	102.9	211.0	347.4	556.9
75 – 100K	Total	424.6	849.1	999.1	1698.2
	North Reservoir	210.9	349.9	389.8	596.8
	Beacon Hill	114.1	225.3	278.9	541.1
	West Reservoir	99.6	273.8	330.4	560.1

For the future scenario upgrades, Table 5.2 summarizes the colour scheme to represent the time frame of future upgrades required. The time frames below are estimates and are not representative of the actual construction time frame for system upgrades. This colour coding is used to show the estimated timelines of upgrades as shown in Exhibits 5.1, 5.4, 5.7, 5.10, 5.14, 5.18 and 7.2.

Table 5.2: Growth Projection Upgrades Legend.

Growth Projection	Estimated Time Frame	Pipe Colour Legend
Proposed NE Gateway Option 2	2020 – 2025	
Existing System Upgrades	2020 – 2025	
Short Term Development Upgrades	2020 – 2025	
22K Upgrades and Growth	2025	
30K Upgrades and Growth	2035	
45K Upgrades and Growth	2050	
60K Upgrades and Growth	2060	
75 – 100K Upgrades and Growth	> 2060	

5.2 Short-Term Development Pressure Analysis

5.2.1 Summary of Distribution System for Short-Term Development Pressures

The short-term development pressures include development that is likely to go forward within the next few years and includes West Village which is to redevelop with several 5 – 6 story condo buildings. This redevelopment will have noticeable impacts on the network; however, the increase in demand is quite small relative to the fire flow requirements. Thus, upgrades going forward are typically required to achieve 150 L/s fire flows at high-value properties.

5.2.2 Upgrades Required for Short-Term Development Pressures

Upgrades required for short-term development are shown in Exhibit 5.1, where pink lines show the upgrades required for the existing system and cyan lines show the short-term development upgrades. The short-term development upgrades (cyan lines) are summarized below. It is noted that upgrades recommended within Rainbow Parks are part of a private development. If this area is to be redeveloped, then these upgrades should go forward, otherwise Rainbow Parks will remain deficient in fire flows if it not re-developed or upgraded.

A. West Village upgrades:

- The water main on 53 St between 50 Ave and Lakeshore Dr needs to be upgraded to 200 mm.
- Replace the 150 mm interior mains of West Village with 200 mm mains (53 St to 50A St and 50 Ave to Lakeshore Dr) excluding the existing 200 mm water main on 50A Ave between 52 St and 50A St which was upgraded recently.
- These upgrades ensure that there is at least 150 L/s fire flows when West Village re-develops.

B. Commercial upgrades east of West Village:

- The back alley north of 50 Ave between 50 St an 49 St has recently been upgraded to 250 mm and does not need to be upsized.
- Upgrade the main on 44 St between 50 Ave and Lakeshore Dr to 250 mm.
- These upgrades are to provide the required 150 L/s fire flows to the commercial areas within the area.

Results for peak hour pressures are shown in Exhibit 5.2. The deficiencies along the lower-middle zone boundary are typically within 15 % of the standard value except for the dead end on 49 St Close, which can only achieve 220 kPa during PHD. The HGL at the North Reservoir cannot be increased to increase the pressure at 49 St Close because lower elevation areas will consequently reach upwards of 690 kPa (100 psi) during ADD. The only solution for the lack of PHD pressures along 49 St and 49 St Close would be to install a booster station. This would be an expensive fix to raise the pressures of ~ about 10 – 20 impacted homes and therefore is not recommended.

Exhibit 5.3 shows the results for fire flow availability. Similar to above, most of the 250 – 300 mm network has 150 L/s and only dead ends and 150 mm areas are deficient.

5.3 22,000 Growth Scenario Analysis

The 22K scenario will involve development in Grayhawk, west of 60 St and south of the abandoned rail tracks (including Pogadl Park), Westridge, Ryder, Irongate and Norell Business Park. Some of these areas are partially developed and this has been accounted for with the demand projections.

The development and upgrades for the 22,000 scenario (approximately 5-year projection) is shown in orange on Exhibit 5.4. Most of the new development assumes a 300 mm grid with 400 m intervals which is schematic and is subject to change based on future development reports.

The only upgrade not directly associated with future growth is summarized below:

A. The PRVs on Old Boomer Road, 50 St, and Ryders Ridge Boulevard which separate the middle zone from the lower zone should be adjusted from 985 m to 992 m. As demands increase, the Fern and Fieldstone neighbourhood will mostly fail PHD pressure requirements with nodes reaching as low as 220 kPa. Adjusting the PRVs will allow the Beacon Hill pumphouse to compensate for this lack of pressure.
B. Pogadl Park will be temporarily serviced from the middle zone by connections from 60 St and Memorial Trail and from the 300 mm main just west of 60 St and parallel to Lakeway Boulevard. As described in the 30K growth scenario, these connections will be isolated as Pogadl Park will shift to the upper pressure zones once the 30K network is developed.

By adjusting the PRV settings, the balancing of flows between the north and south reservoirs will shift as shown in Table 5.1. As shown, the contributions from the North Reservoir have decreased since the south reservoir will be supplying more to the west side of the lower zone. The reason the PRVs weren't originally set to 992 m was to ensure that the north reservoir was properly utilized during the existing and STDP scenarios.

Exhibit 5.5 shows the peak hour pressure results after the upgrades shown above are pursued. Similar to above, the only pressure deficiencies are along the lower-middle zone boundary. There is one node within Pogadl Park that can only achieve 294 kPa which is within 5 % of the pressure requirement.

Exhibit 5.6 shows the fire flow availability during the 22K scenario. The newly developed area can provide more than 150 L/s during a fire since they were assumed to be constructed using a 300 mm grid. The grid network for future scenarios is conceptual and the minimum size for residential and non-residential land uses should be designed to ensure 75 L/s and 150 L/s, respectively.

5.4 30,000 Growth Scenario Analysis

The 30,000 growth scenario involves development south of Memorial Trail from 50 St to just west of 60 St, west of Irongate in the Lighthouse Pointe quarter section, and Sanbar Estates near the North Reservoir.

Exhibit 5.7 shows the infrastructure and upgrades required for the 30K scenario in green, assuming a grid of 300 mm mains. The major upgrade required for the 30K scenario is:

A. As the area south of Memorial Trail develops, loop into Pogadl Park and bring it into the upper pressure zone. This will require that the connections to the middle zone are closed. This will boost the peak hour pressures within Pogadl Park.
B. Isolate the two water mains connecting Pogadl Park to the middle zone to ensure the newly switched upper zone of Pogadl Park does not freely flow into the middle zone.

Exhibits 5.8 and 5.9 show the results of peak hour pressures and fire flow availability during the 30K scenario. All new growth areas have more than 150 L/s fire flows and adequate peak hour pressures.

5.5 45,000 Growth Scenario Analysis

The 45,000 scenario consists of Meadowlands south of Ryder, two quarter sections south of Irongate, Northern Gateway, East Sanbar and North Sanbar. As the 45,000 scenario is developed, the pressure zones become quite complex and a glimpse of the ultimate network pressure zones is shown on Exhibit 5.10 where pink shows the lower zone, yellow shows the middle zone, and blue represents upper zones. The green zone shown is a low-lying area that is too low for even the lower zone, thus, needs PRVs to ensure safe pressures. In the ultimate scenario, the 300 mm grid has natural breaks, which are indicative of the pressure zone boundaries.

The upgraded 45,000 network is shown on Exhibit 5.11.

The North Sanbar growth area rises in elevation and a separate pressure zone is required. This area is expected to be serviced by the North Reservoir and will require that the Town implements the high-pressure pumping upgrades that have already been designed into the North Reservoir. This would be the implementation of the second set of pumps. In the exhibits below, the use of the new high-pressure pumps are assumed, but the modelling results between both scenarios are identical. The HGL of the new high-pressure pumps are set at 1,029 m to ensure PHD pressures were acceptable.

Peak hour demand pressures are shown on Exhibit 5.12. Based on the new discharge header set at 1,029 m, the pressures in North Sanbar acceptable.

Fire flow availability throughout the 45,000 scenario is shown on Exhibit 5.13. All of the newly developed areas can easily achieve 150 L/s if built using 300 mm mains with adequate looping.

In summary, the upgrades are summarized below and are labelled in Exhibit 5.11.

A. Implementation of the high-pressure pump upgrades (HGL = 1,029 m) is proposed from the North Reservoir to supply the northern upper zone area in the NE using a 450 mm water main.
B. Looping of the dead end main on Industrial Drive into the East Sanbar growth area will provide better fire flow to the industrial area south of Highway 11.

5.6 60,000 Growth Scenario Analysis

The 60,000 scenario consists of the quarter section west of Westridge, and areas west of Fern & Fieldstone and Pogadl Park. Exhibit 5.14 shows the full build out to the 60K population.

The two western growth areas of the 60K scenario are to be serviced by the lower zone whereas the southwest growth polygon (adjacent to Pogadl Park) is to be serviced by the upper zone and the Beacon Hill pumphouse.

Exhibit 5.15 shows the results of the peak hour demand pressures within the 60K network. As development expands to the west within the lower zone, the pressures drop just below the threshold of 300 kPa showing that any further development to the west will require a new reservoir. While these three nodes within the lower zone fail to meet peak hour pressure requirements, they achieve at least 275 kPa which is generally acceptable in other municipalities. To resolve these minor pressure deficiencies, booster stations could be utilized but aren't recommended because they would only service a very small localized area. Within the 60K region located in the upper pressure zone, there is one junction at 290 kPa during peak hour demand, which is within 5% of the standard pressure requirement.

Exhibit 5.16 shows the fire flow availability throughout the 60K network. All of the newer 60K growth areas can achieve 150 L/s assuming a 300 mm looped grid.

Besides the water mains required to service these new developments, no upgrades are required to the existing system to service the 60K network.

5.7 75,000 – 100,000 Growth Scenario Analysis

The 75,000 – 100,000 growth scenario will involve approximately 860 ha of new development to the west of the Town boundaries and 240 ha (4 quarter sections) south and east of Lighthouse Pointe.

For the new development to the west of Sylvan Lake, a new reservoir, referred to as the West Reservoir will be required. Conceptual sizing of this reservoir is shown in Table 5.3 below. Additionally, the same calculations are shown for the south and north reservoirs to show upgrading requirements for them as well. Based on the reservoir utilization, the south reservoir appears to have adequate storage, but the North Reservoir will need an additional 2,852 m^3 of storage by the time the 100K scenario is achieved. The West Reservoir will require a storage volume of 8,294 m^3 which is required for the area it services (mostly the west area and some of the lower zone during higher demands). The lack of storage capacity within the north reservoir could be accounted for by increasing the West Reservoir by 2,852 m^3 to a total storage volume of 11,146 m^3.

The variable A refers to the fire storage required, B refers to the equalization storage which is 25% of MDD, and C refers to the Emergency Storage which is 15% of ADD. These parameters are based on the Fire Underwriter's Survey, 1999 assuming 150 L/s of fire flow is required.

Table 5.3: West Reservoir Conceptual Sizing

Property	South Reservoir	North Reservoir	West Reservoir	Units
Existing Storage	11,320	8,500	-	m^3
ADD	9,737	18,092	8,640	m^3
MDD	19,466	30,231	23,674	m^3
Fire flow	150	150	150	L/s
Duration	2.0	2.0	2.0	h
Fire flow Volume	1,080	1,080	1,080	m^3
Fire Storage, A	1,080	1,080	1,080	m^3
Equalization Storage, B	4,866	7,558	5,918	m^3
Emergency Storage, C	1,461	2,714	1,296	m^3
Storage Required, S	**7,407**	**11,352**	**8,294**	m^3

The grid to the west will be serviced by the West Reservoir with a discharge header set to 1,033 m. This outgoing HGL was set to balance the pressures during ADD and PHD. From the West Reservoir heading north, there are two rows of PRVs, which separate the upper zone from the middle zone, and the middle zone from the lower zone. PRVs to the middle zone are set at 1,020 m, and PRVs to the lower zone are set to 996 m. During ADD, the North Reservoir services all of the lower zone, but during PHD and fire flows, assistance is required on the west side of Town from the West and South Reservoirs due to the bottlenecks within the existing network. Conceptual sizing of the West Reservoir is provided in Table 5.3. The West Reservoir was preliminarily sized at 8,294 m^3 as per the Fire Underwriter's Survey, 1999, and the Standards & Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, 2012.

There are four quarter sections to the south east that are to be developed in the 75 – 100K scenario which can be broken down into the "south area" and "north area" based on their location relative to the abandoned railway line. Model simulations showed that the south area is at too high of an elevation to be part of the lower zone and too low to be part of the upper zone. This implies that a simple extension from the 45K network isn't possible since this adjacent neighbourhood is part of the upper zone.

There are two potential options to consider for this area:

1. Utilize PRVs set at ~1,010 m (slightly below the middle zone) to extend from the 45K region to the east, or
2. Extend water mains from Ryder to the SE into this area as part of the middle zone.

Due to the distance from Ryder, it is assumed that Option 1 will be more feasible and is presented going forward.

The north area (north of the abandoned railway) is at one of the lowest elevations in the Town and will require PRVs to prevent ADD pressures from exceeding 680 kPa (100 psi). To reduce the risk of main breaks, PRVs were built into the model at an HGL target of 986 m to reduce the pressure of this low-lying area. There are other lower areas that are nearby that could be included in this reduced pressure zone. It is recommended that a detailed network study be performed within the next 5 – 10 years when the master plan is updated to finalize the ultimate network pressure zone boundaries.

The ultimate network for the 75,000 – 100,000 growth scenario is shown on Exhibit 5.17.

Exhibit 5.18 shows the peak hour pressures during the 75 – 100K scenario. As previously noted, the elevations on the west side of Sylvan Lake vary too much to be serviced by a single zone, and several PRVs are required to transition from upper zone to middle to lower zone as the water network approaches the lake shore. This will ensure that there is sufficient pressure throughout the western area during PHD while the pressures remain below 620 kPa (90 psi) during ADD. All of the newer development to the west will be able to achieve PHD pressure requirements.

Fire flow availability is shown in Exhibit 5.19 during the 100K scenario. During the fire flow scenario, all newer areas can sufficiently provide > 150 L/s. As stated before, all new growth was assumed to be serviced by a grid of 300 mm pipe which can supply well over 150 L/s. To ensure pipe velocities did not exceed 2.5 m/s during MDD + FF, the mains extending from the West Reservoir were assumed to be 450 mm. Ideally, mains should not exceed 2.5 m/s throughout the network; however, there are certain locations such as 150 mm dead ends that require higher velocities to achieve reasonable fire flows. In situations like this, the modeling velocity constraints were lessened to 6 m/s to mirror EPCOR standards for dead end velocity constraints during fire flows. The implementation plan in Section 7.0 shows the specific mains that have been selected as 450 mm (Exhibit 7.1).

In summary, the upgrades required for the ultimate network are summarized below and are labelled in Exhibit 5.17:

A. Commission the West Reservoir with a discharge header HGL = 1,033 m with pumping capacity based on the demand required in Table 5.2.
B. PRVs south of Township Rd 390 set to 1,020 m are required to transition from the West Reservoir upper zone to the middle zone on the west side of Town.
C. PRVs north of Township Rd 390 set to 996 m are required to transition from the West Reservoir middle zone to the lower zone in the NW corner of the Town.
D. PRVs east of Highway 20 and north of David Thompson Highway set to an HGL of 1,010 m to service the "South Area" described above. This area is annotated on Exhibit 5.17.
E. PRVs south of Lighthouse Pointe set at an HGL of 986 m servicing the "North Area" described above due to low-lying elevations that cannot be serviced by the lower zone. This area is annotated on Exhibit 5.17.

Legend

Network Upgrades

Estimated Timeframe

- Existing Network
- 2019
- 2020
- Proposed NE Gateway

PRV Updates

Estimated Timeframe

- Unchanged
- 2019
- Reservoirs
- X STDP System Upgrade (See Section 5.2.2)

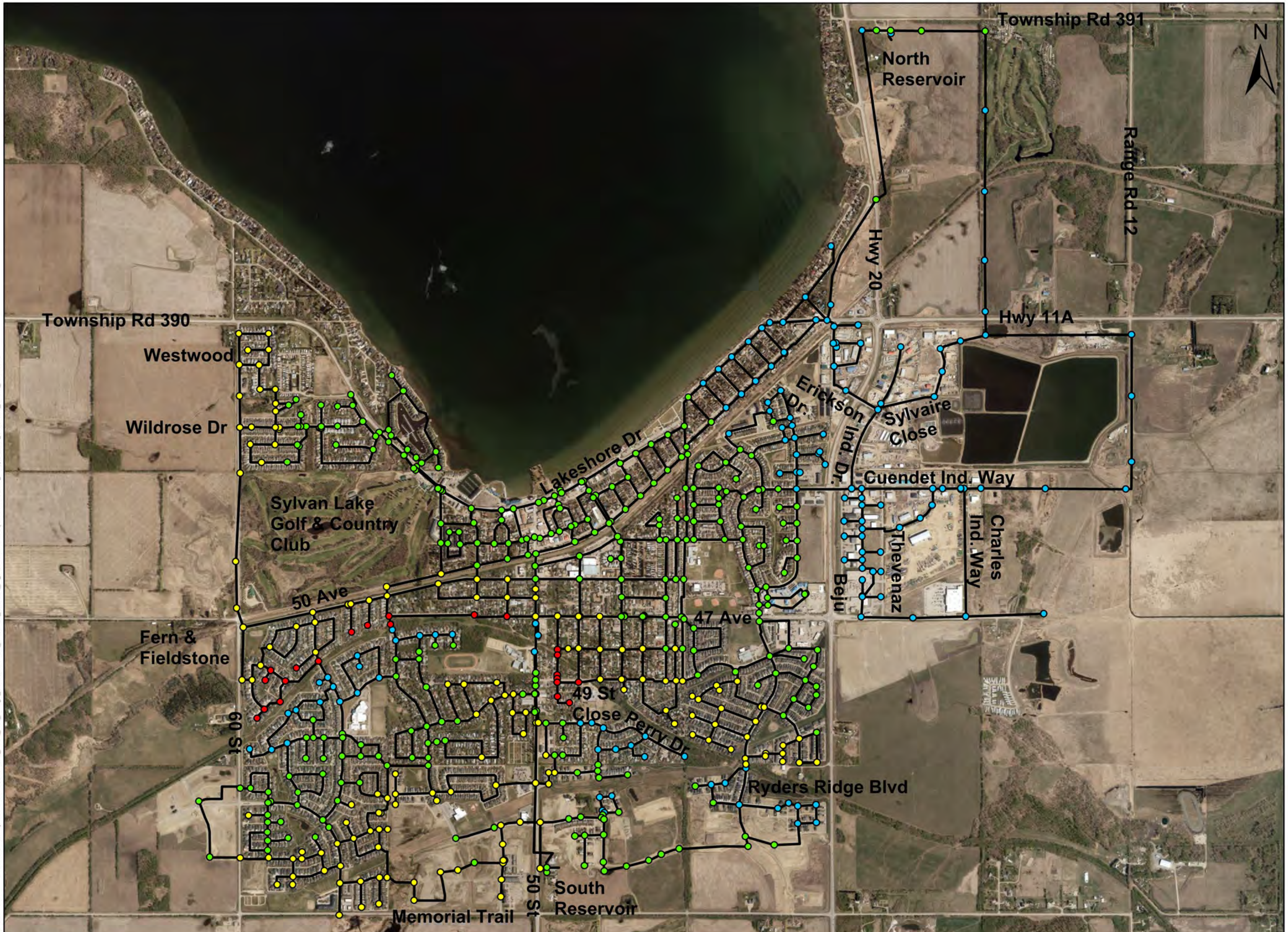
Coordinate System:
NAD 1983 3TM 114

1:20,000

0 200 400 800 Meters

EXHIBIT 5.1

LOCATION OF STDP SYSTEM UPGRADES



Legend

Peak Hour Pressures (kPa)

- < 300
- 300 - 400
- 400 - 500
- 500 - 620
- > 620
- Short Term Development Network

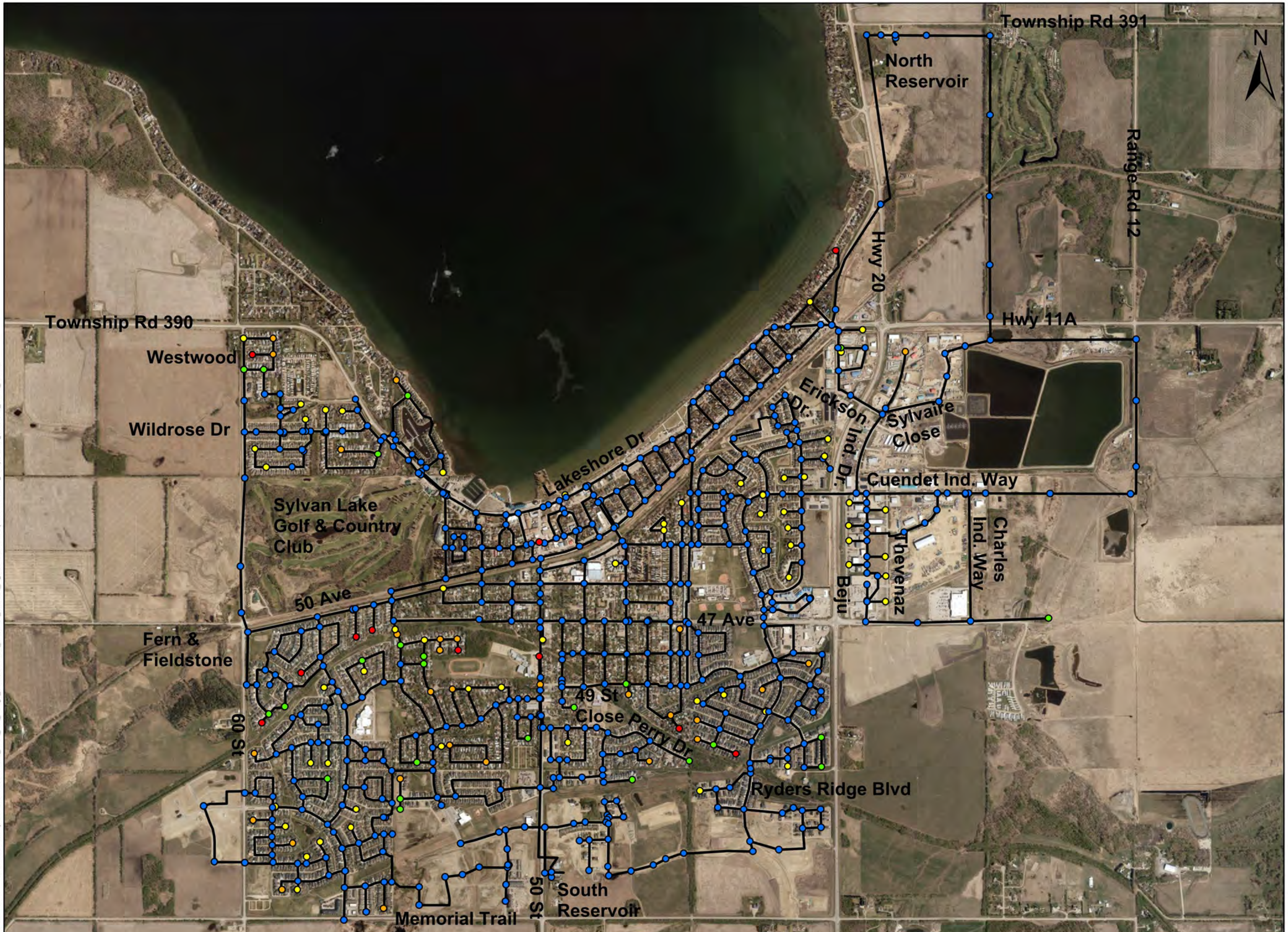
Coordinate System:
NAD 1983 3TM 114

1:20,000

0 200 400 800 Meters

EXHIBIT 5.2

STDP UPGRADED NETWORK
PEAK HOUR PRESSURES



Legend

MDD + FF Available (L/s)

- < 75
- 75 - 100
- 101 - 125
- 126 - 150
- > 150
- Short Term Development Network

EXHIBIT 5.3

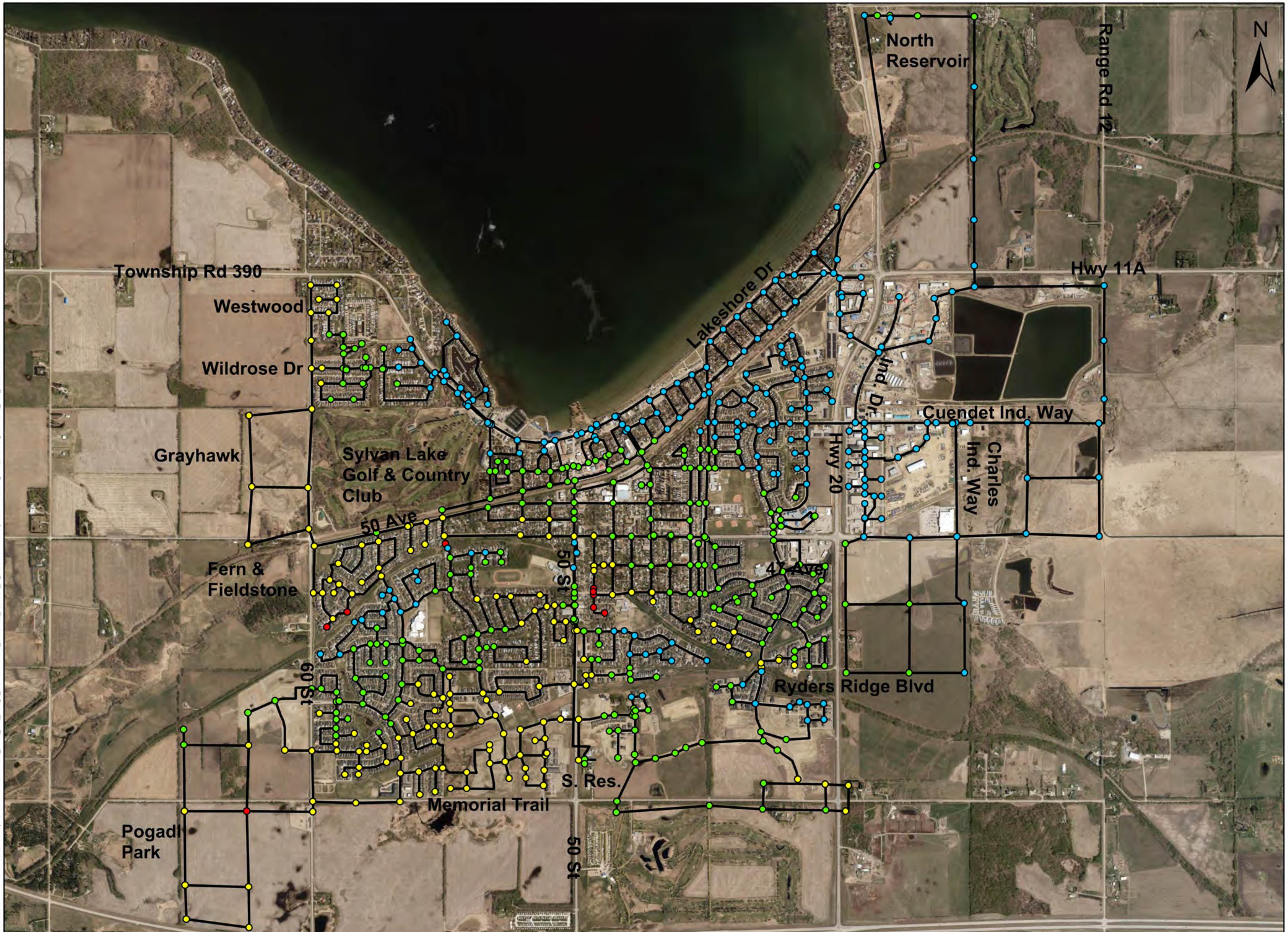
STDP UPGRADED NETWORK AVAILABLE FIRE FLOWS

ISL

EXHIBIT 5.4

LOCATIONS OF 22K UPGRADES & DEVELOPMENT

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend

Peak Hour Pressures (kPa)

- < 300
- 300 - 400
- 400 - 500
- 500 - 620
- > 620
- 22K Network

Coordinate System:
NAD 1983 3TM 114

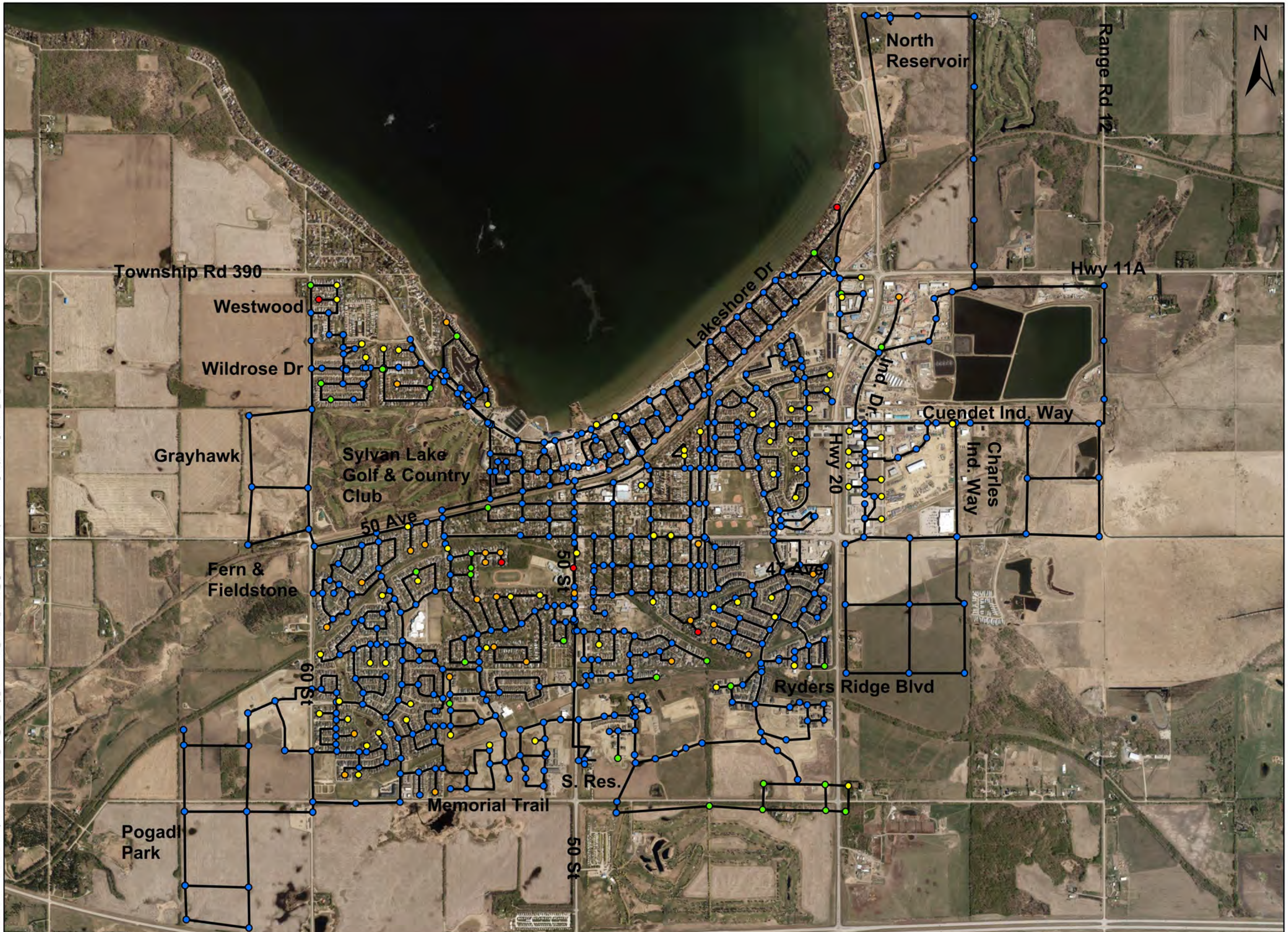
1:22,500

0 225 450 900 Meters

EXHIBIT 5.5

22K UPGRADED NETWORK
PEAK HOUR PRESSURES

ISL



Legend

MDD + FF

Available (L/s)

- < 75
- 75 - 100
- 101 - 125
- 126 - 150
- > 150
- 22K Network

Coordinate System:
NAD 1983 3TM 114

1:22,500

0 225 450 900 Meters

EXHIBIT 5.6

22K UPGRADED NETWORK AVAILABLE FIRE FLOWS

ISL

Date: 2020-05-14 Document: G:\Projects\15000\15200\15222_North_Res_Design_Construction\02_CADD\25_GIS\251_Figures\Additional Hydraulic Modeling Scope Change\GIS\5.6_22K_FF.mxd

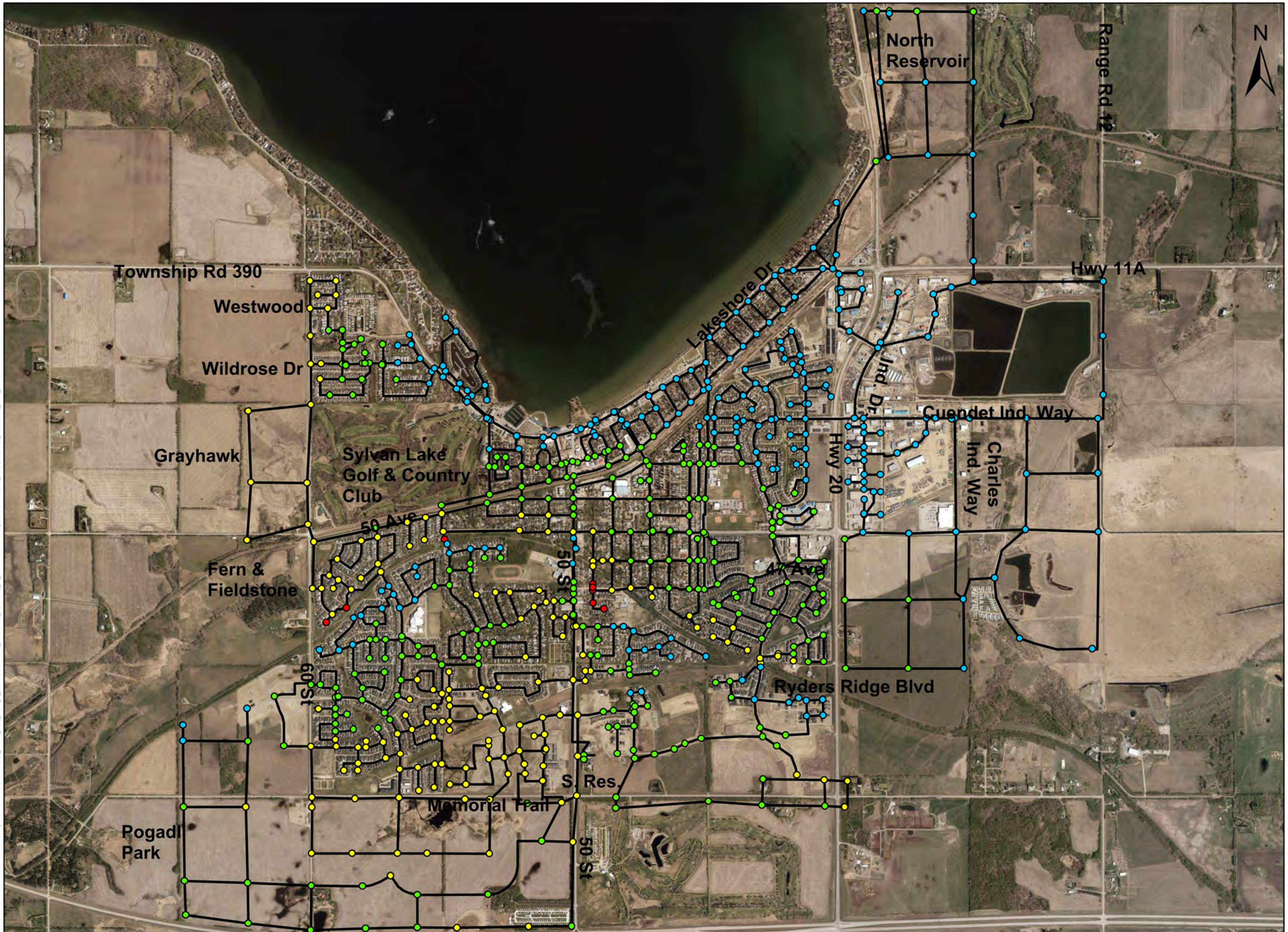
Integrated Expertise. Locally Delivered.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

EXHIBIT 5.7

LOCATIONS OF 30K SYSTEM UPGRADES & DEVELOPMENT

ISL



Legend

Peak Hour Pressures (kPa)

- < 300
- 300 - 400
- 400 - 500
- 500 - 620
- > 620
- 30K Network

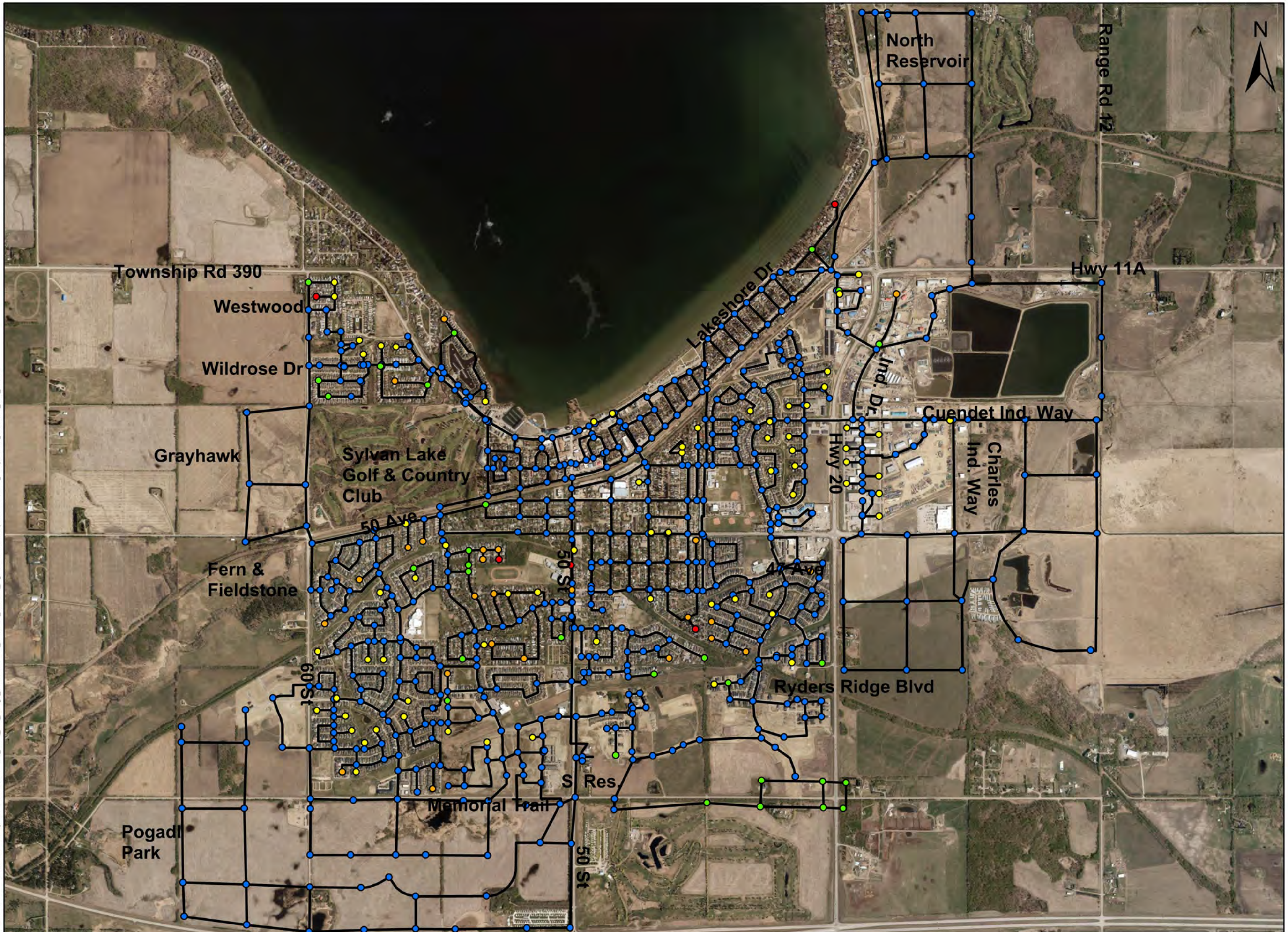
Coordinate System:
NAD 1983 3TM 114

1:22,500

0 225 450 900 Meters

EXHIBIT 5.8

30K UPGRADED NETWORK
PEAK HOUR PRESSURES



Legend

MDD + FF

Available (L/s)

- < 75
- 75 - 100
- 101 - 125
- 126 - 150
- > 150
- 30K Network

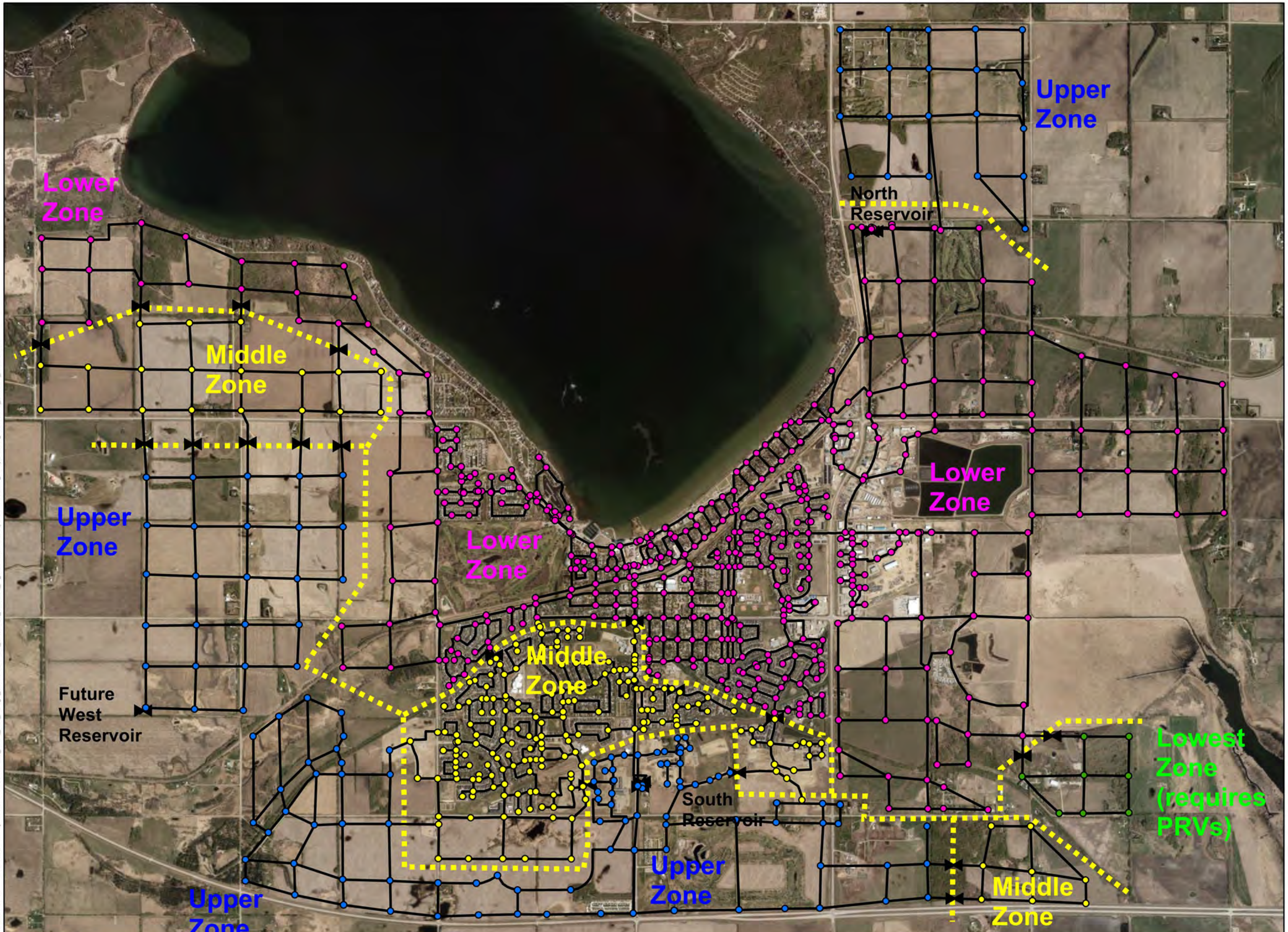
Coordinate System:
NAD 1983 3TM 114

1:22,500

0 225 450 900 Meters

EXHIBIT 5.9

30K UPGRADED NETWORK AVAILABLE FIRE FLOWS



Legend

Ultimate Network

ZONE

- Lowest Zone (requires PRVs)
- Lower Zone
- Middle Zone
- Upper Zone
- 75-100K Pressure Zone Boundaries
- 100K Network
- Ultimate Network PRVs

Coordinate System:
NAD 1983 3TM 114

1:30,000

0 300 600 1,200 Meters

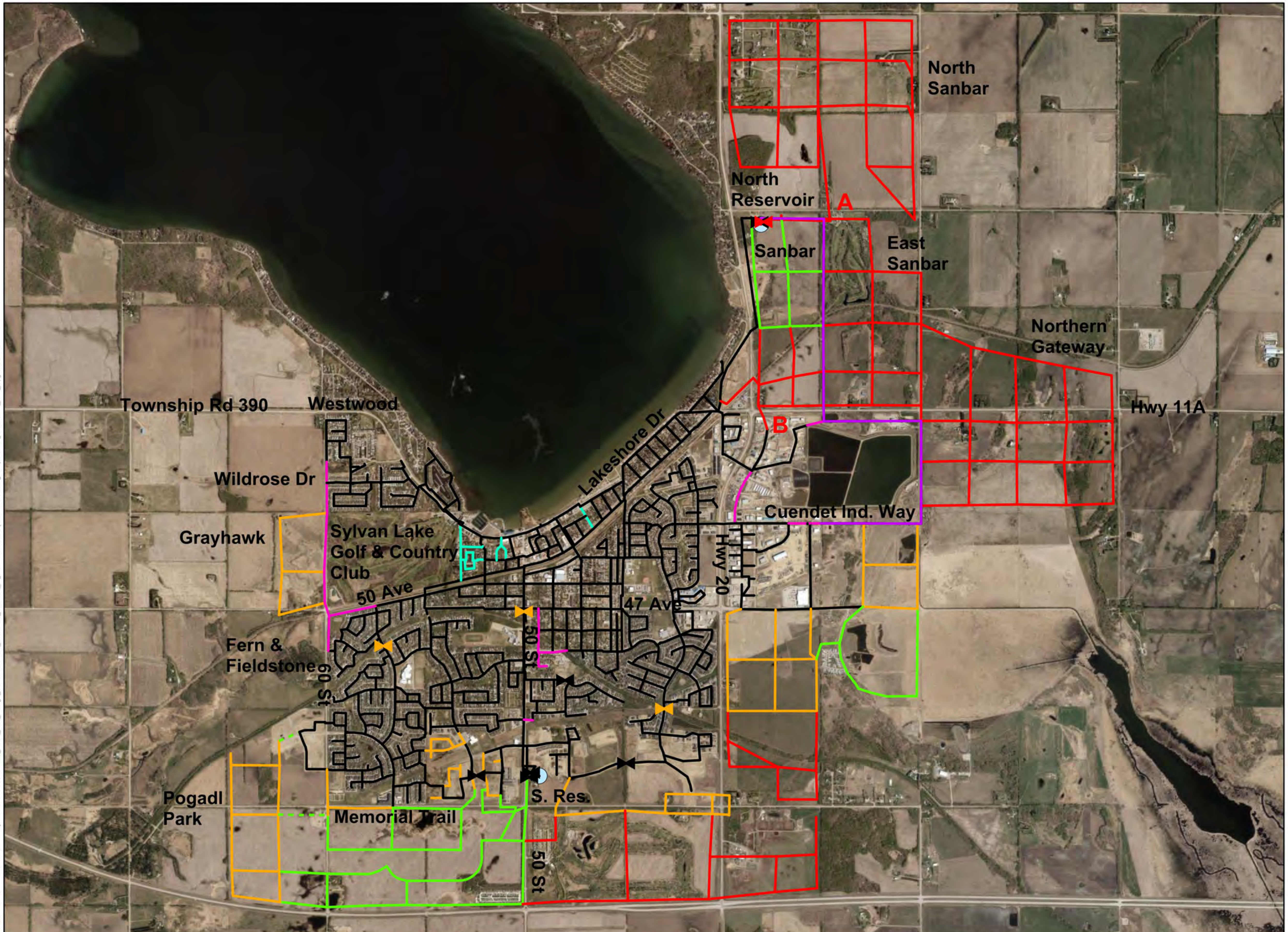
EXHIBIT 5.10

PRESSURE ZONE BOUNDARIES AND PRV LOCATIONS FOR ULTIMATE NETWORK

ISL

Date: 2020-05-21 Document: G:\Projects\15000\15200\15222_North_Res_Design_Construction\02_CADD\25_GIS\251_Figures\Additional Hydraulic Modeling Scope Change\GIS\5.10_Ultimate_Zones.mxd

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend

Network Upgrades

Estimated Timeframe

- Existing
- 2020
- 2021
- 2025
- 2035
- Isolated in 2035
- 2050
- Proposed NE Gateway

PRV Updates

Estimated Timeframe

- Existing PRV
- 2025
- 2050
- Reservoirs
- X 45K System Upgrade (See Section 5.5)

Coordinate System:
NAD 1983 3TM 114

1:30,000

0 300 600 1,200 Meters

EXHIBIT 5.11

LOCATIONS OF 45K SYSTEM UPGRADES & DEVELOPMENT

ISL

Date: 2020-05-15 Document: G:\Projects\15000\15200\15222_North_Res_Design_Construction\02_CADD\25_GIS\251_Figures\Additional Hydraulic Modeling Scope Change\GIS\5.11_45K_Upgrades.mxd

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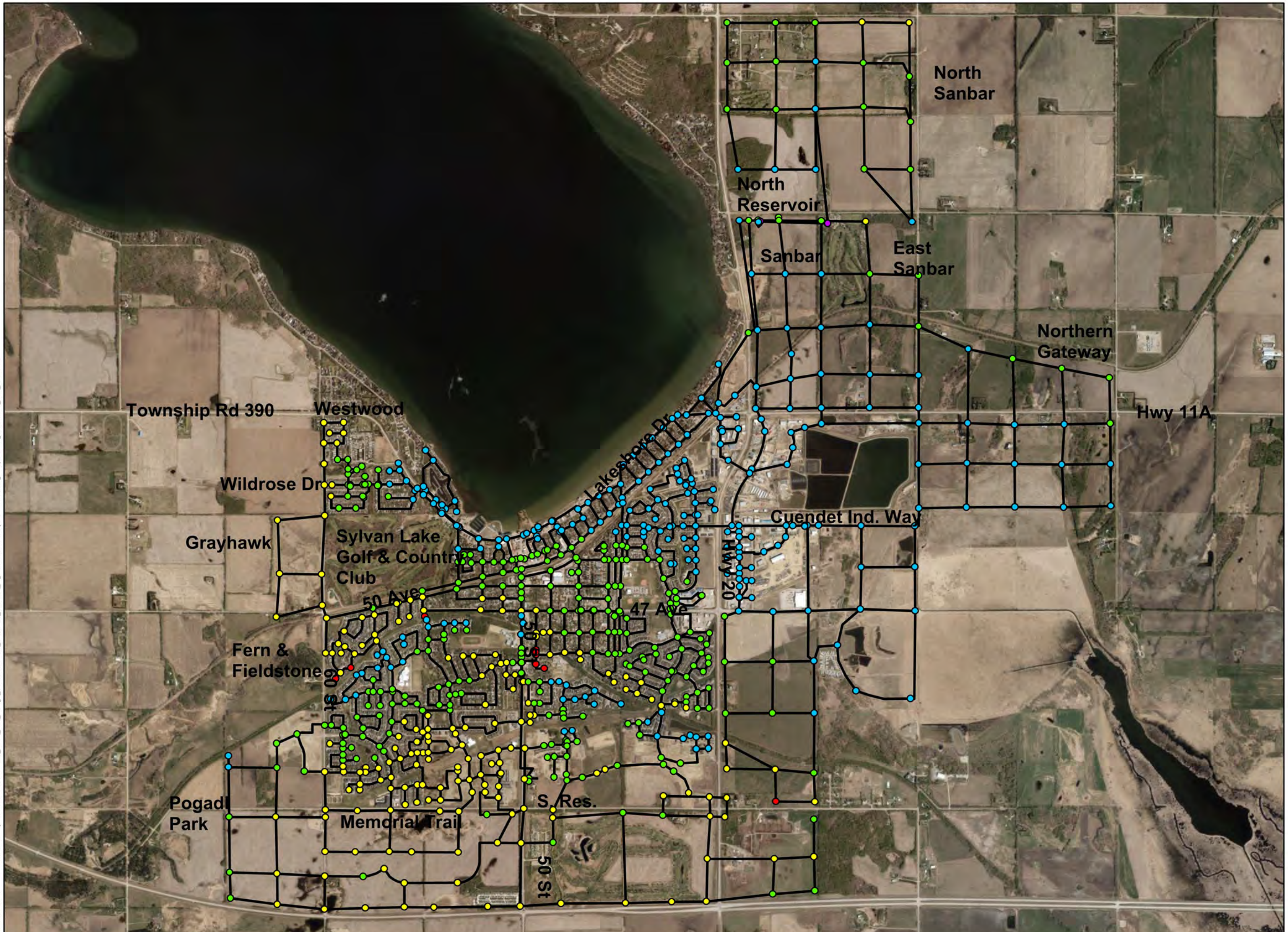


Legend

Peak Hour

Pressure (kPa)

- < 300
- 300 - 400
- 400 - 500
- 500 - 620
- > 620
- 45K Network

Coordinate System:
NAD 1983 3TM 114

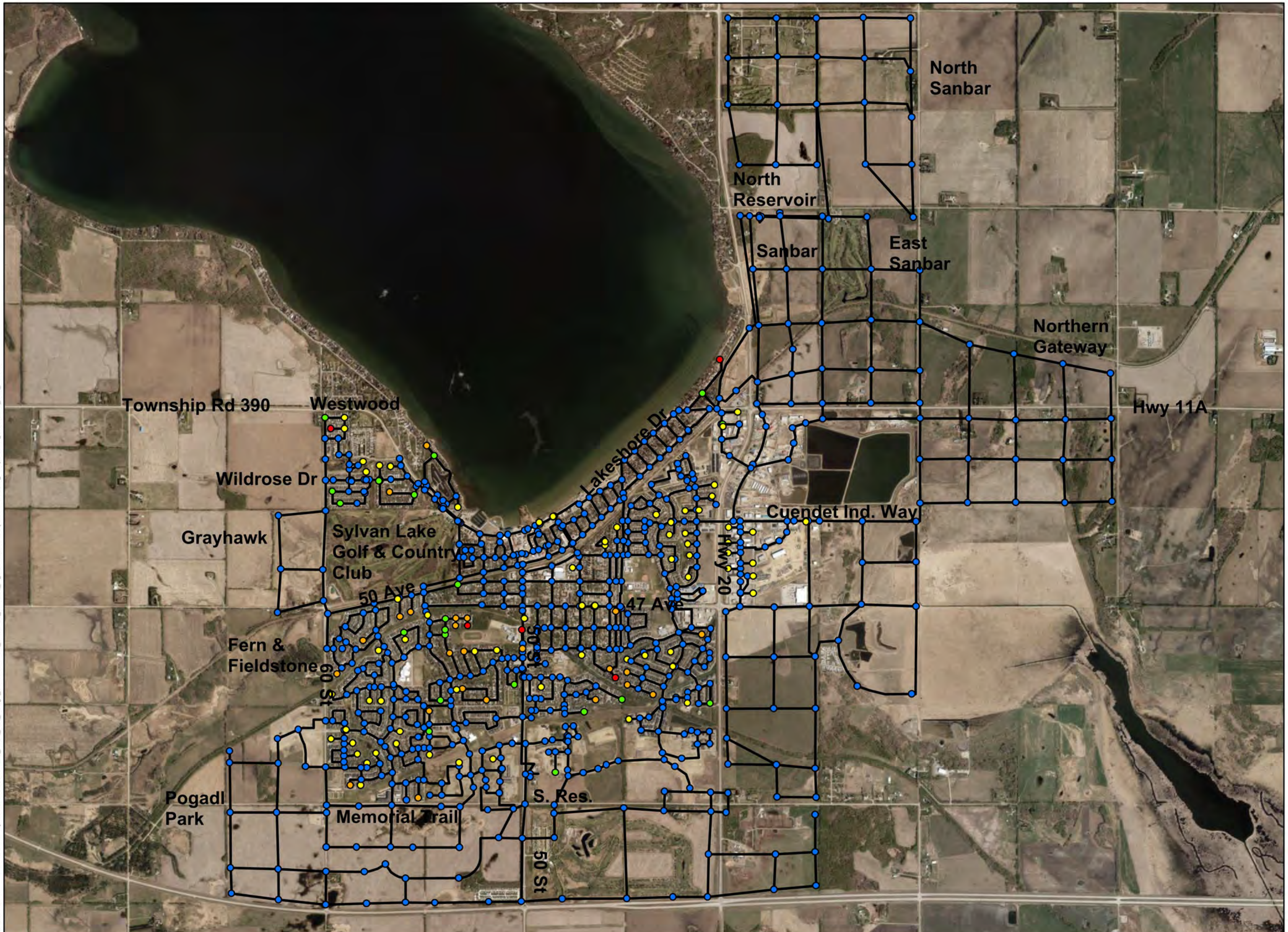
1:30,000

0 300 600 1,200 Meters

EXHIBIT 5.12

45K UPGRADED NETWORK
PEAK HOUR PRESSURES

ISL



Legend

MDD + FF

Availabe (L/s)

- < 75
- 76 - 100
- 101 - 125
- 126 - 150
- > 150
- 45K Network

Coordinate System:
NAD 1983 3TM 114

1:30,000

0 300 600 1,200 Meters

EXHIBIT 5.13

45K UPGRADED NETWORK
AVAILABLE FIRE FLOWS

ISL

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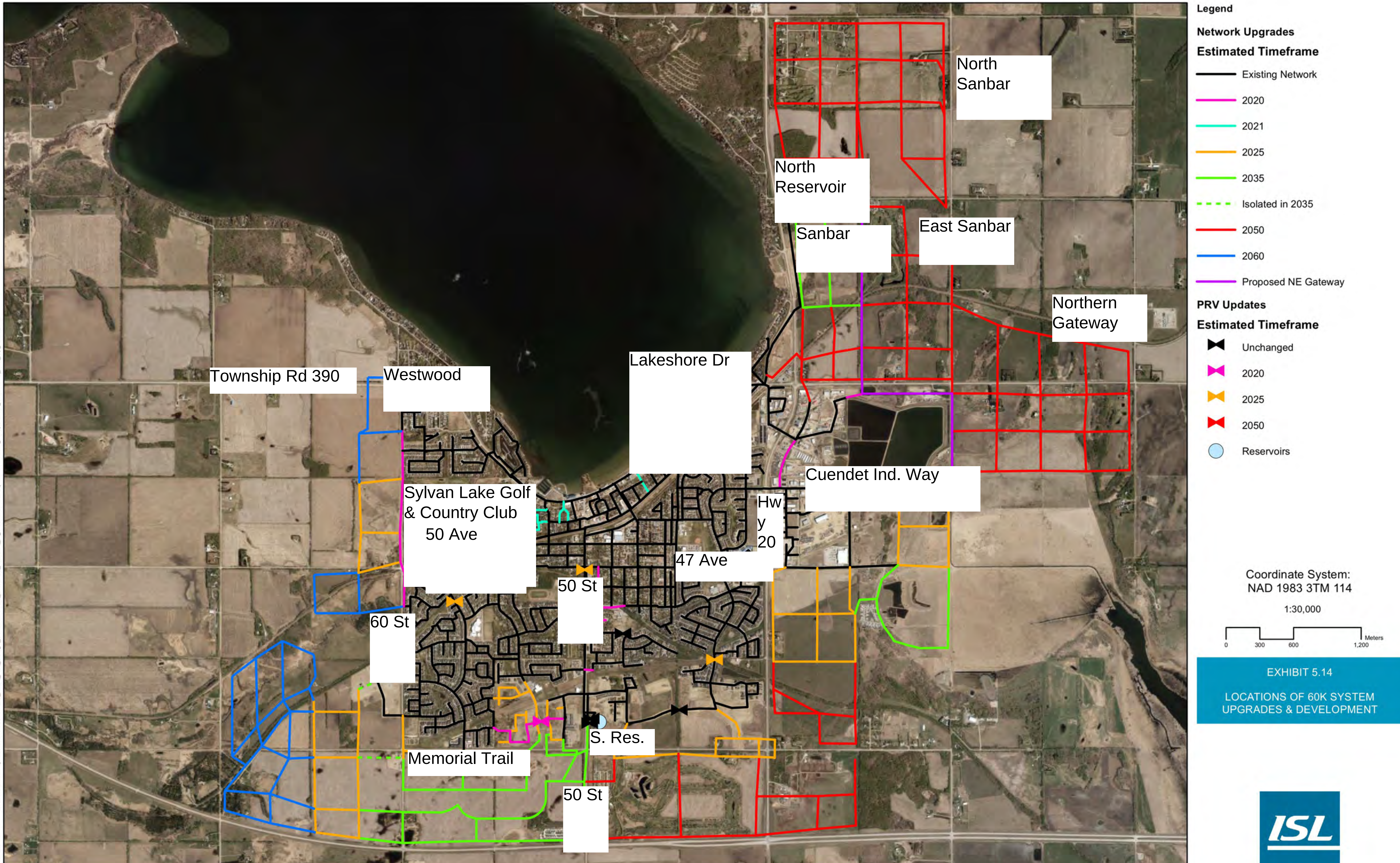
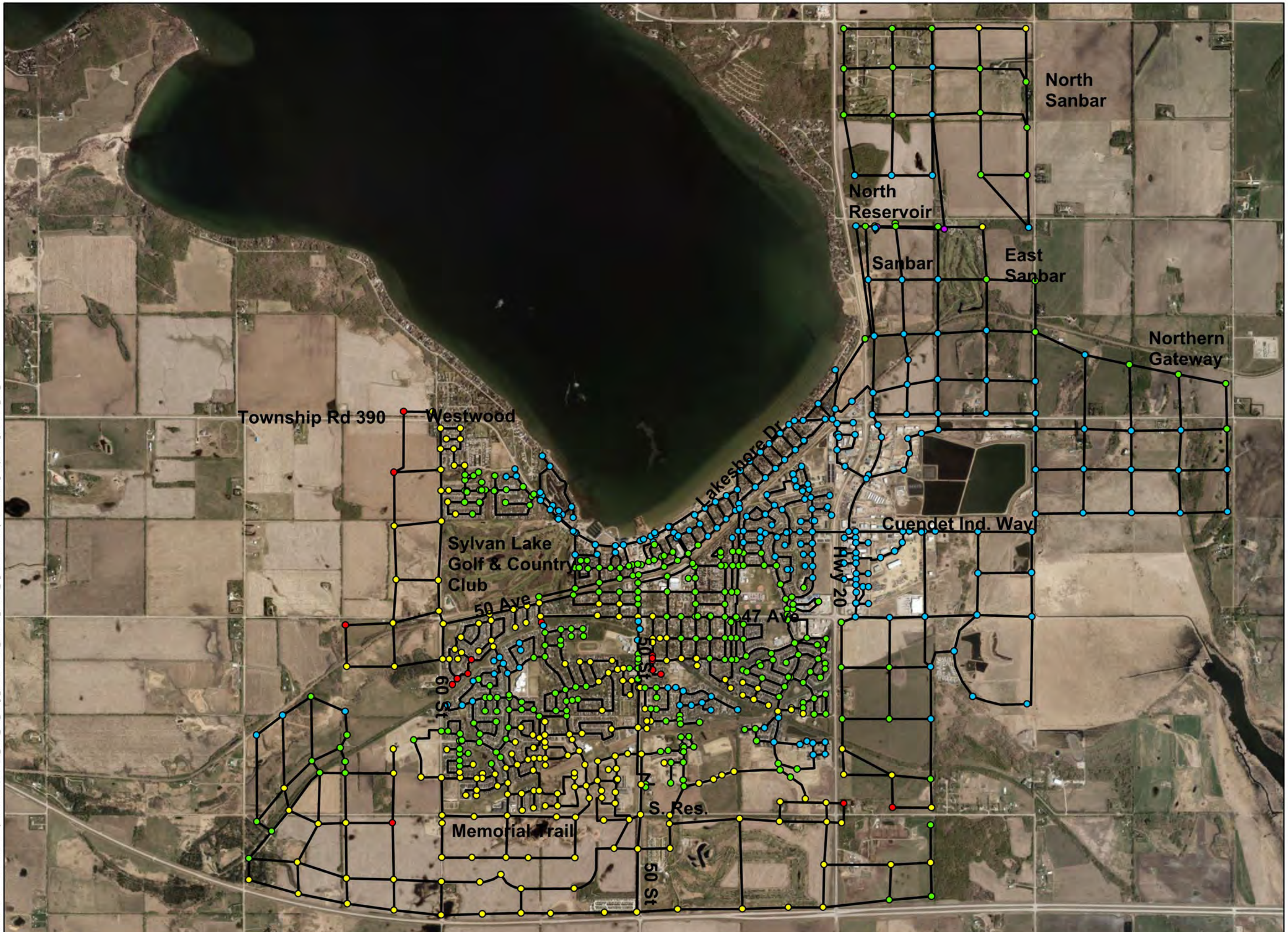
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Date: 2020-05-15 Document: G:\Projects\15000\15200\15222_North_Res_Design_Construction\02_CADD\25_GIS\251_Figures\Additional Hydraulic Modeling Scope Change\GIS\5.13_45K_FF.mxd



North Sanbar
North Reservoir
Sanbar
East Sanbar
Northern Gateway
Lakeshore Dr
Township Rd 390
Westwood
Sylvan Lake Golf & Country Club
50 Ave
Cuendet Ind. Way
Hwy 20
47 Ave
50 St
60 St
S. Res.
Memorial Trail
50 St
Legend
Network Upgrades
Estimated Timeframe
Existing Network
2020
2021
2025
2035
Isolated in 2035
2050
2060
Proposed NE Gateway
PRV Updates
Estimated Timeframe
Unchanged
2020
2025
2050
Reservoirs
Coordinate System:
NAD 1983 3TM 114
1:30,000
0
300
600
1,200
Meters
EXHIBIT 5.14
LOCATIONS OF 60K SYSTEM UPGRADES & DEVELOPMENT
ISL



Legend

Peak Hour Pressures (kPa)

- < 300
- 300 - 400
- 400 - 500
- 500 - 620
- > 620
- 60K Network

Coordinate System:
NAD 1983 3TM 114

1:30,000

0 300 600 1,200 Meters

EXHIBIT 5.15

60K UPGRADED NETWORK
PEAK HOUR PRESSURES

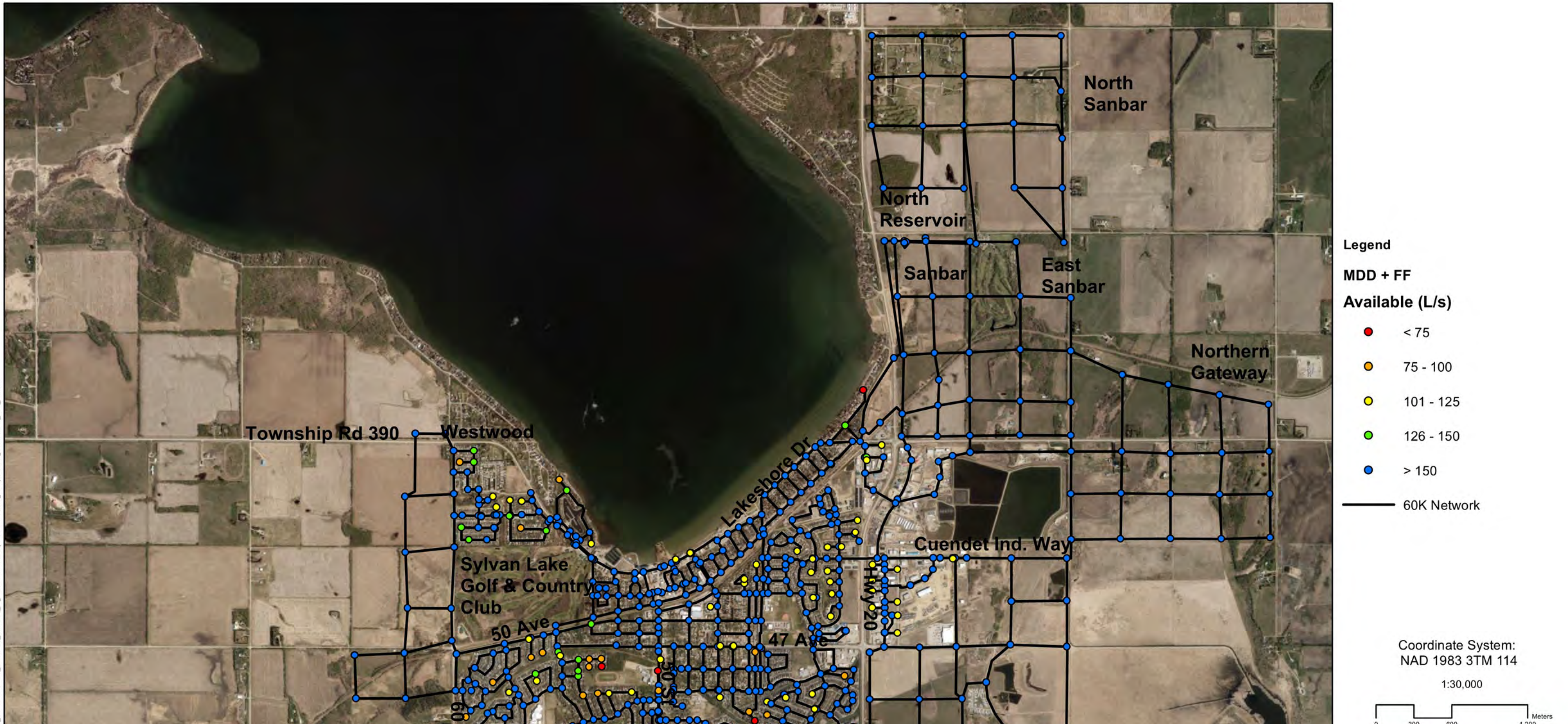


EXHIBIT 5.16

60K UPGRADED NETWORK AVAILABLE FIRE FLOWS

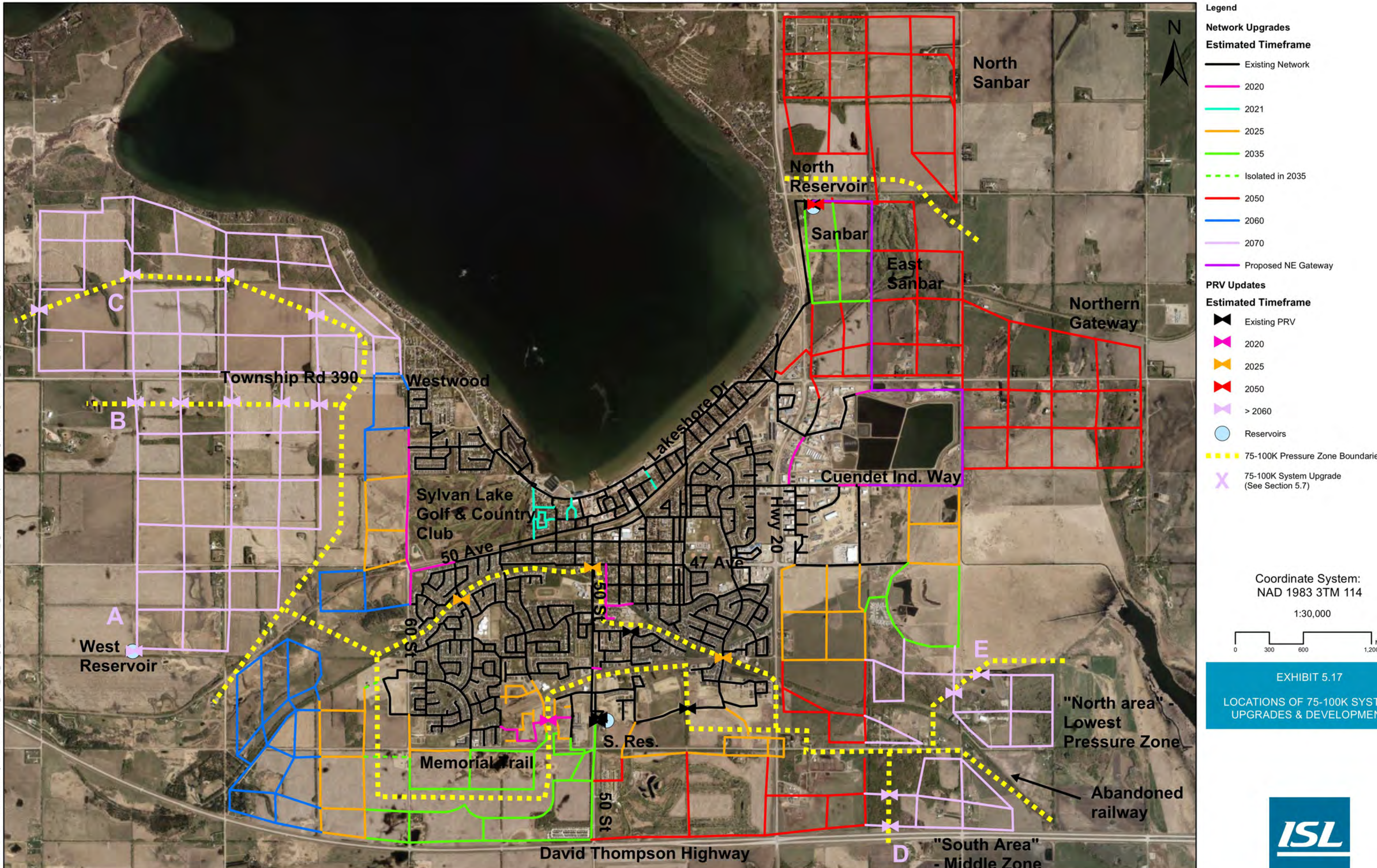
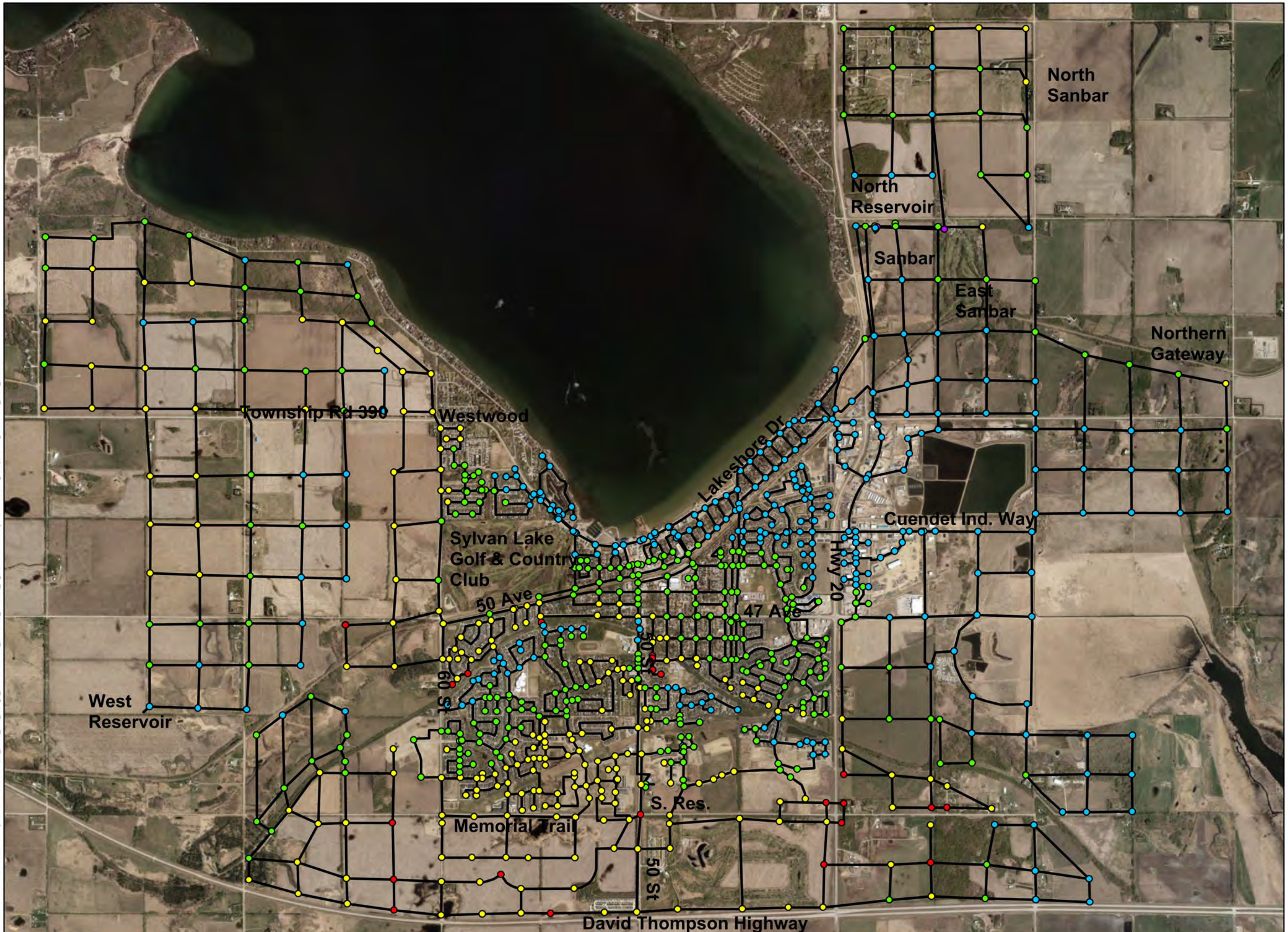


EXHIBIT 5.17

LOCATIONS OF 75-100K SYSTEM UPGRADES & DEVELOPMENT

ISL



Legend

Peak Hour

Pressure (kPa)

- < 300
- 300 - 400
- 400 - 500
- 500 - 620
- > 620
- 100K Network

Coordinate System:
NAD 1983 3TM 114

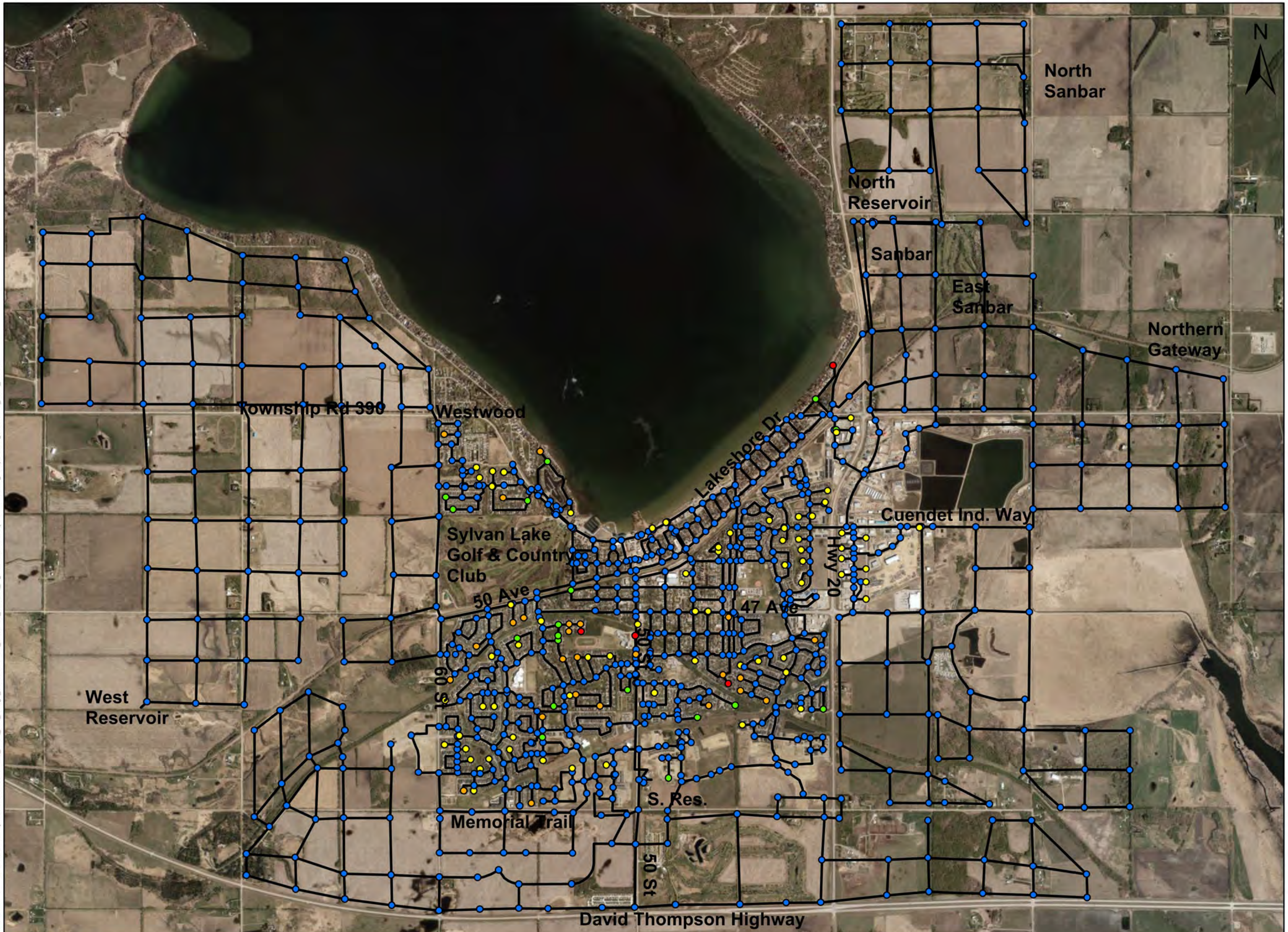
1:30,000

0 300 600 1,200 Meters

EXHIBIT 5.18

75-100K UPGRADED NETWORK
PEAK HOUR PRESSURES

ISL



Legend

MDD + FF

Available (L/s)

- < 75
- 76 - 100
- 101 - 125
- 126 - 150
- > 150
- 100K Network

Coordinate System:
NAD 1983 3TM 114

1:30,000

0 300 600 1,200 Meters

EXHIBIT 5.19

75-100K UPGRADED NETWORK AVAILABLE FIRE FLOWS

ISL

6.0 South Reservoir & Pumphouse Assessment

6.1 General Introduction

Part of the scope of work involved in the design of the North Reservoir project was to complete an assessment of the South Reservoir Pumphouse. During the course of the modelling work involved in preparing this master plan, it became clear that with the North Reservoir and Pumphouse coming online, the South Reservoir Pumphouse would not be needed any longer.

The South Reservoir Pumphouse, along with the Beacon Hill Booster Station, currently provides potable water to all of Sylvan Lake. With the North Reservoir Pumphouse now taking on the supply responsibilities for the lower zone, there will be additional pumping capacity made available for the pumps in the South Reservoir and Beacon Hill pumphouses. This is due to the lower demands that result from these pumps no longer needing to supply the large lower zone with potable water on a daily basis. From this perspective, it makes operational and economic sense to simplify the Town's reservoir and pumping infrastructure accordingly.

This section of the master plan summarizes the assessment work that was completed and provides the justification for the recommendation to decommission the South Reservoir Pumphouse. The decommissioning of this pumphouse and the re-purposing of the Beacon Hill Pumphouse was assessed and incorporated into the strategies and recommendations already made in the previous sections of this master plan document. The analysis, assessment, and efficacy of these other recommendations also supports the conclusions that will be outlined in this section.

6.2 South Reservoir & Pumphouse

6.2.1 Background Information & History

Based on the record information provided by the Town, the existing South Reservoir was originally constructed in 1980.The water storage reservoir is currently the only reservoir that the Town has, until the North Reservoir and Pumphouse comes online in 2020. At that time when the South Reservoir was constructed, the distribution supply piping from the reservoir supplied the Town via gravity. Disinfection was achieved with a chlorine gas system with the chlorine solution being injected into the water as it left the reservoir for distribution.

Due to growth in Sylvan Lake, the South Reservoir was upgraded in 1999. At that time, mechanical pumping provisions were added that created the pumphouse. With these upgrades, the building was also expanded to accommodate for backup power through the installation of an electrical generator. In addition to the major changes, the chlorination system was modified to reroute the chlorine solution injection line through the reservoir to a new injection point on the raw water supply main from the wells to improve the contact time. A new sample line was installed just downstream of the raw water static mixer and was routed through the reservoir to a new chlorine analyzer located in the valve chamber to provide better control and monitoring of the disinfection process.

In 2001, the monitoring and control systems at the pumphouse were upgraded further along with some of the instrumentation. In 2019, the chlorine gas system was upgraded to a liquid sodium hypochlorite-based system to match the same type of system that will be implemented with the North Reservoir project. The chlorine gas system was experiencing performance issues and was no longer deemed reliable.

6.2.2 Assessment Objectives

The original objective of the assessment of the South Reservoir Pumphouse facility was to review the piping, pumps, and ancillary equipment and provide a conceptual design and a high-level cost estimates for the recommended modifications/upgrades. The Town was concerned about the general condition of this pumphouse given the age of the equipment and the fact that there are visible signs of corrosion and wear. The conceptual designs and cost estimates would have been used for capital planning purposes.

6.2.3 General Facility Review

The South Reservoir and Pumphouse are currently used to supply potable water to the entire Town. As stated earlier, once the North Reservoir and Pumphouse comes online in 2020, the South Reservoir and Pumphouse will be used to supply water to the upper and middle pressure zones on a daily basis as noted in previous sections of this master plan.

The South Reservoir and Pumphouse are composed of the following pieces of equipment and appurtenances:

1. Water storage cells (x3) – total storage volume of 11,320 m^3.
2. Electrical room c/w MCC, 347/600V, 150kVA utility service, with a 130kW natural gas generator and 225A Automatic Transfer Switch (ATS) (separate room).
3. Pump P-001 – 40 Hp inline pump, 575 V, 3 Phase, 60 HZ, variable speed pump operated with a Variable Frequency Drive (VFD).
4. Pump P-002 – 40 Hp inline pump, 575 V, 3 Phase, 60 HZ, variable speed pump operated with a VFD.
5. Pump P-003 – 3 Hp booster pump, 575 V, 3 Phase, 60 Hz, fixed speed pump.
6. Pump P-004 – 3 Hp booster pump, 575 V, 3 Phase, 60 Hz, fixed speed pump.
7. Sump Pump located in the lower level of the valve chamber.
8. Sodium hypochlorite based disinfection system (separate room).
9. Hach CL17 chlorine analyzer.
10. Severn Trent 1770 Chlorine analyzer (not used).
11. Various valves (control valves and isolation valves).
12. Painted Carbon Steel Piping – 100 mm, 200 mm, 300 mm, 500 mm.
13. Control room c/w SCADA and HMI (separate room).
14. Ancillary HVAC equipment and plumbing.

Exhibit 6.1 below shows the general layout of the valve/pump room in the lower level of the pumphouse.

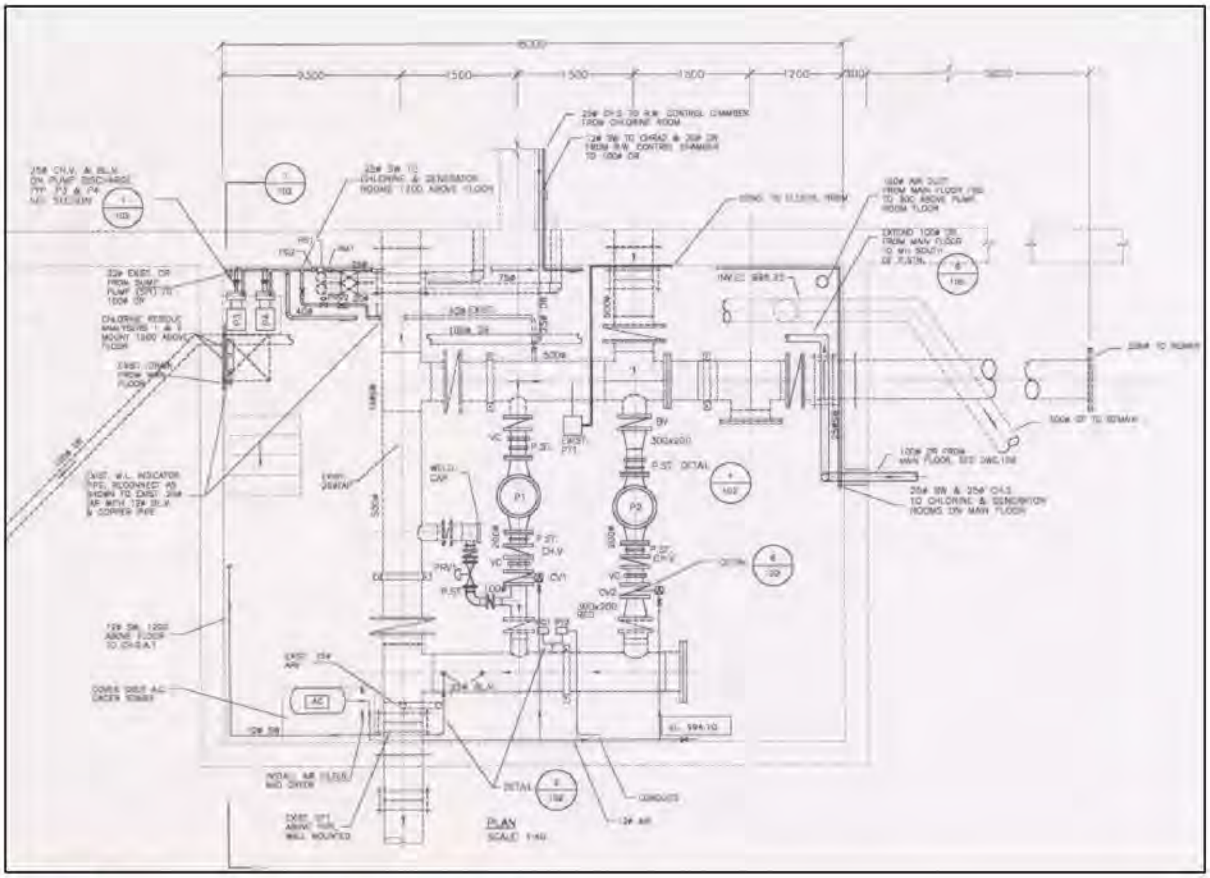


Exhibit 6.1: Valve/Pump Room General Layout

6.2.4 General Facility Operation

In order to meet most of the current demand situations, one of the two larger 40 Hp pumps typically operate (P-001 or P-002). Each pump has a duty point of 97.5 L/s at 20.5 m of head. The pumps are capable of variable speeds as they operate using VFDs and they are configured to run in a duty/standby mode of operation. The pumps operate to maintain a pressure set point in the distribution pipe header leaving the facility. When the duty pump cannot satisfy the pressure requirement in the distribution header, the standby pump starts and assists.

The South Reservoir Pumphouse operates to supply pressure directly to the middle pressure zone. These pumps also supply pressure indirectly to the lower zone through the pressure reducing valve (PRV) stations that separate the two zones.

The booster pumps (P-003 or P-004) are used to supply motive water for the chlorination system. It is the water that runs through the injection pipes of a gaseous chorine injection system. The chlorinator injects the gaseous chlorine into the motive water within the chlorine room. After that, the booster pumps transfers the gaseous chlorine/water solution to the injection point on the raw water line coming into the reservoir. These pumps are operated in a duty/standby configuration and they are started and stopped based on a signal received from the pressure switch in the injection line. The booster pumps are still used for the liquid sodium hypochlorite system that was installed in 2019. The motive water system is used to transfer the liquid chlorine/water solution to the injection point.

The sump pump in the lower level valve/pump room pumps sits in a small sump located in the floor of the room in the southwest corner at the bottom of the stairs. The sump collects water from the floor drain system as well as any water that is present on the floor of the valve/pump room that can make its way into the sump. The sump pump then provides mechanical lift to the wastewater that has accumulated in the sump and it pumps it to the exterior of the facility to the foundation drainage manhole that is located outside.

There is a gravity feed line from the South Reservoir storage cell to the Beacon Hill Booster Station. The Beacon Hill Booster Station has 4 pumps that currently supply the upper pressure zone for the Town. From a cursory standpoint, the Beacon Hill pumps appear to be underutilized.

6.2.5 Condition Assessment

General Structural

From the site review completed, the general condition of the reservoir walls that could be seen, and the pumphouse building itself appeared to be good condition given the age of the facility. No concerns were identified with respect to any structural elements.

Identified Concern Summary:

1. No concerns identified.

Building Mechanical – Heating

The HVAC system that serves the pumphouse consists of a series of basic natural gas unit heaters, electric heaters, louvers/dampers, and exhaust fans. There are two unit heaters that provide the heat to the building. A gas fired unit heater is located in the main entry area and services the control room, the main entry and the electrical/genset room. There is an electric unit heater that provides the heat for the chlorine room.

The gas unit heater was installed as part of the 1999 upgrades. It is a 100,000 BTU unit and has a thermal efficiency of only 80%. This unit will be nearing the end of its useful life, and there are more efficient units available currently. The unit does not have a dedicated combustion air intake supply associated with it. This is a contradiction of the current natural gas and propane installation code.

The 2 kW electric unit heater in the chlorine room is covered in corrosion due to the chlorine gas vapours and poor ventilation. This unit is nearing the end of its useful life. The heating elements are likely corroded as well, which significantly reduces the heating efficiency.

Identified Concern Summary:

1. Gas unit heater is aged, not as efficient, lacks dedicated combustion air intake supply.
2. Electric heater in chlorine room is corroded, likely has reduced heating efficiency.

Building Mechanical – Ventilation

Ventilation throughout the facility is accomplished through fans, which move air from room to room that appears to be the primary way that the air is circulated throughout the facility. These fans provide little to no air exchanges with the outside environment and would not meet the building occupancy air exchange rates required by the National Building Code (NBC).

There is an inline duct fan that draws air from the ceiling of the main entry area, where the gas fired unit heater is located, and discharges that air at floor level in the electrical/genset room. This provides some air circulation and moves warm air from the unit heater to the electrical/genset room.

There is another inline duct fan located near the ceiling in the control room that supplies warm air to the lower level valve/pump area. The air is discharged near the floor on the lower level valve/pump floor. There is no air supplied to the control room. The only air that enters the control room is through the doorways should they be left open.

The lower valve/pump area has an exhaust fan located under the stairwell that pulls air from near the floor and discharges the exhaust air to the exterior of the building. This discharge is located very near the main entry door to the facility. The lower level valve/pump room is very damp and the equipment shows signs of corrosion. This is an indication that the air in the room is likely not being properly ventilated and changed out adequately and that the air is saturated with water vapour. Fresh air supply appears to be simply provided via the opening between the floors that is used to house the staircase. There is a forced air exhaust fan and associated duct work located adjacent to the staircase which seems to be the only way spent air is exhausted from the space. This design likely creates a short-circuiting effect for air changes as fresh air comes down through the staircase from above and then is sucked right back out through the exhaust fan in the same area of the room with little air circulation provided to the far side of the room. Any upgrades being contemplated for this valve/pump room need to include for HVAC upgrades to improve the circulation of fresh air to control moisture levels.

The ventilation for the generator appears to be designed and set up correctly in accordance with current standards and codes. Ambient air within the electrical room is simply recirculated until the temperature in the room rises enough to trigger the closing of the recirculation dampers. When this occurs, the exhaust damper opens to the exterior and the warm air is expelled to the outside of the building. There does not appear to be any dedicated combustion air supplied for the generator. There is also no insulation on the genset engine exhaust pipe. Current standards and codes require that this type of pipe be insulated as someone could injure themselves on the hot exhaust pipe should they touch it by accident. Cooling of the electrical room is provided by a separate exhaust fan. Mechanical cooling of the room is not provided.

Chlorine room ventilation is accomplished with an inline duct fan that draws air from near the floor and it discharges the spent air at ceiling height near the chlorine room entry door. There is a fresh air intake into the chlorine room near the floor level, directly under the chlorine room exhaust air discharge. The exhaust fan for the chlorine room appears to be inadequate and it does not meet today's standards and codes for proper ventilation of a chemical storage room subject to off-gassing of stored chemicals. It is noted that since the time of the original site assessment that the chlorine gas system has been decommissioned and replaced with a liquid sodium hypochlorite system which is not as toxic as chlorine gas. However, off-gassing of chemicals is always a concern and while the room is isolated from the rest of the building a more detailed code review for the HVAC system serving this room is recommended.

Identified Concern Summary:

1. Control room does not have separate dedicated supply air or return exhaust air ducts.
2. The lower level valve/pump room is very damp and the equipment shows signs of corrosion. The room is likely not being properly ventilated sufficiently and likely is experiencing short-circuiting for air exchanges.
3. Lack of dedicated combustion air supply for the generator. No insulation on the generator exhaust pipe.
4. Ventilation for chemical room appears to be inadequate for current codes and standards.

Building Mechanical – Plumbing

The plumbing system for the South Reservoir facility is fairly basic and consists of floor drains and a few hose bibbs. The facility does not really have a proper service water system complete with a backflow preventer assembly. As such, there are no pressurized safety eyewash/shower stations. This is a safety concern as the facility does store and use liquid chlorine. By current codes and standards, an emergency eyewash and shower station should be provided in the event of an accidental exposure. The facility also does not have a washroom or any washing sinks for the operators to clean up after doing any maintenance on equipment.

Identified Concern Summary:

1. Facility does not have a proper service water design complete with backflow preventers per current codes and standards.
2. Facility has a lack of pressurized safety eyewash/shower stations per current codes and standards given chemical storage and injection functionality.
3. Lack of washroom and washing sinks for cleanup and sanitary provisions.

Electrical/MCC/Generator Systems

The electrical system is composed of the following components:

- 150 kVA transformer secondary service supply.
- 150 Amp main utility service breaker.
- Standby generator rated for a 600 V, 130 kW supply complete with a 150 Amp disconnect breaker (the rating of the generator is reduced to 80% for a continuous maximum load of 130 Amps and an intermittent (< 2hrs) load of 150 Amps).
- 600 V, 225 Amp automatic transfer switch (ATS).
- Variable Frequency Drives (VFD's) and direct online starters for the various pumps.
- Various equipment breakers and disconnects.
- Low voltage distribution panel which supplies 120 V single phase power to the facility.

The single line diagram of the electrical system is shown in Exhibit 6.2.

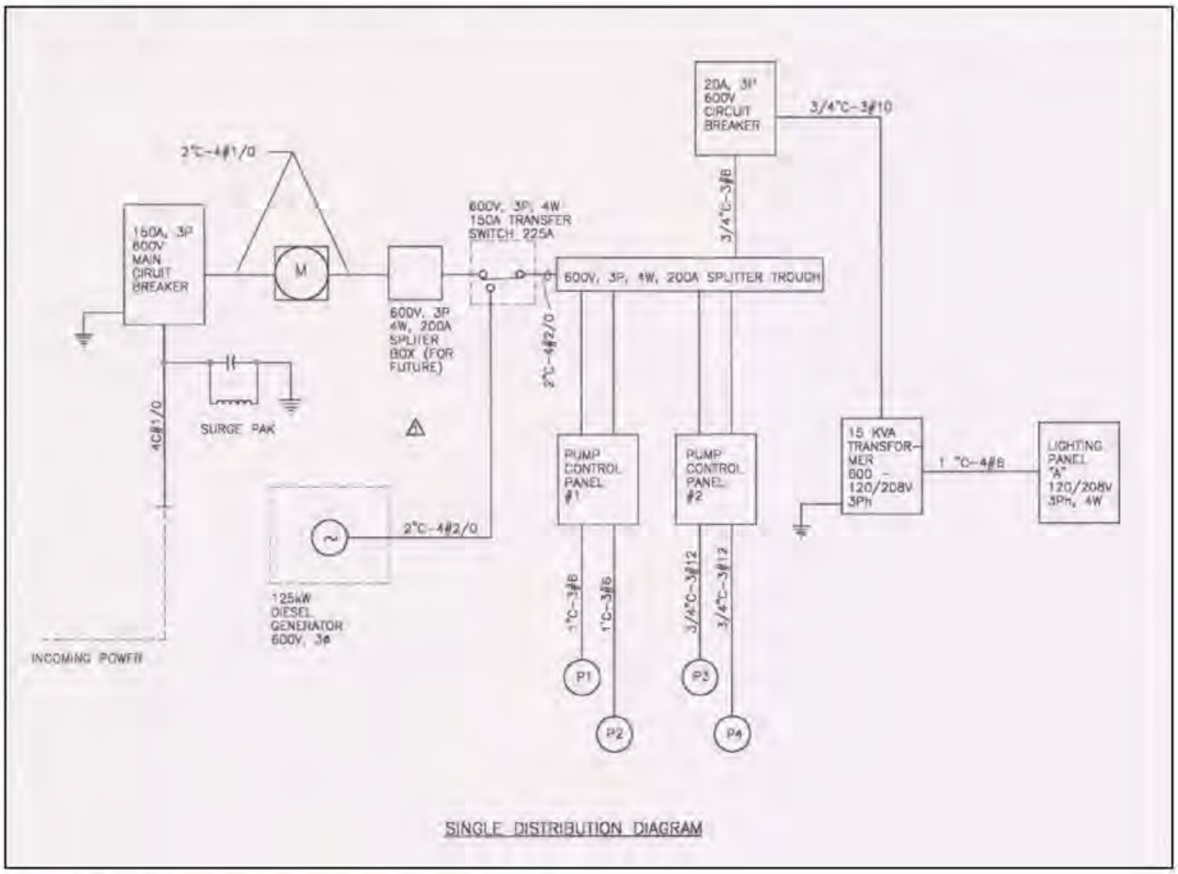


Exhibit 6.2: Electrical System Single Line Diagram

In general, the electrical, MCC, and generator systems appear to be adequate for the needs of the facility.

Identified Concern Summary:

1. No concerns identified.

Control Room

The control room is basic and can be found in a small secondary room that was created to the west of the chlorine room. There is not a lot of space in the control room and it is fairly cramped. At the time of this assessment, it was noted by the Town that the SCADA and communication systems were going to be reviewed in detail by a third party under a separate contract. As such, this assessment focused on the general of the control room.

As stated, the room is small as shown in Exhibit 6.3. There is a small single desk where the HMI and SCADA computer are located. In addition to the SCADA desk, there are some shelves and the room is used for storage of random equipment and supplies. There is a lack of space for storage and filing of documents such as operational records and maintenance information. Ventilation is provided via the door to the room. There is a lack of any lab space for testing and analysis purposes as well as a lack of any proper storage space for samples.

Identified Concern Summary:

1. Lack of space for storage and filing of current operational records and maintenance information.
2. Lack of proper ventilation and control of air quality suitable for computer hardware.
3. Lack of lab space for storage, analysis, and testing of samples.

Exhibit 6.3: Control Room

Chlorine Disinfection System

As previously noted, subsequent to the site assessment, and during the summer of 2019, the chlorine gas system was decommissioned and was replaced with the new liquid sodium hypochlorite system. The system was installed in the same chlorine room as previously. At the time the upgrades were contemplated, the design of the permanent full scale-system was meant to have two dosing pumps and use a barrel and day tank based sodium hypochlorite storage system as shown in Exhibit 6.4.

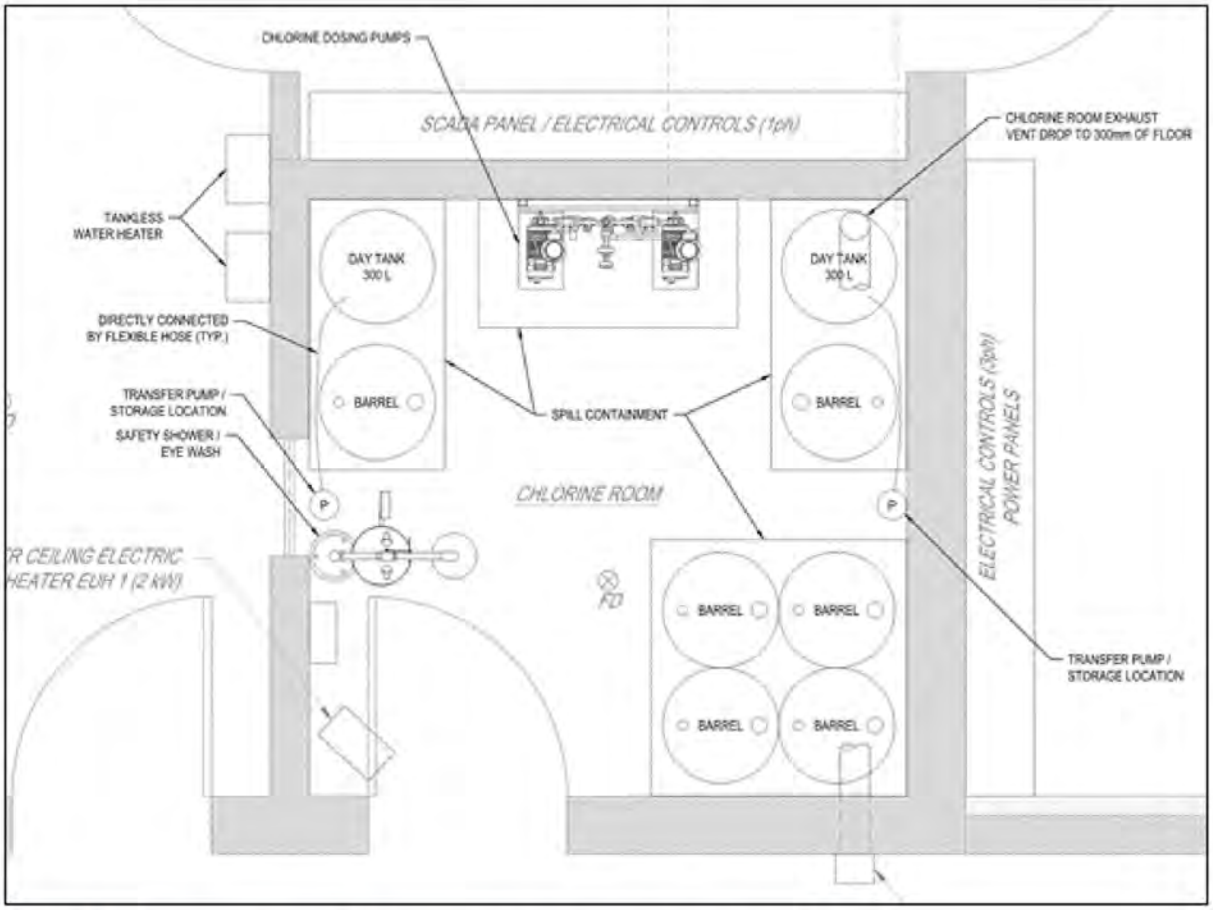


Exhibit 6.4: Proposed Layout of Permanent Sodium Hypochlorite Dosing System

Exhibit 6.5: Small-Scale Sodium Hypochlorite System

At the time the upgrades were completed, the Town was in an emergency situation with respect to the imminent failure of the existing chlorine gas system. As a result, the decision was made to implement a "small-scale system" version of the proposed system shown in Exhibit 6.4. In late April of 2019, the gaseous chlorine system was decommissioned, and small-scale sodium hypochlorite system was constructed as shown in Exhibit 6.5.

This small-scale system consists of two barrels of sodium hypochlorite solution, a single dosing pump, and a spill container. The motive water system is still being used to deliver the chlorine solution to the injection point. The dosing pump is capable of injecting the sodium hypochlorite solution at the injection point directly which would allow for the decommissioning of the motive water system, however, a new dedicated injection line from the pumps would need to be installed through the reservoir to do so. This would involve taking down the reservoir temporarily to permit for the installation of the new injection line. At the time of the disinfection system upgrades in 2019, the Town was not in a position to shut the South Reservoir down as it is the only supply of stored water for the town. Until this is done, failures that occur in the aging motive water system (pumps and pipes) will inhibit the chlorine dosing system from providing chlorine to the raw water and achieving proper disinfection. This is a level of unnecessary risk that is being assumed by the Town at this point that should be corrected once the North Reservoir and Pumphouse are fully commissioned.

The Town has expressed that the current small-scale system is adequate on an interim basis, but that they wish to move to a permanent system similar to the one shown in Exhibit 6.4. However, the Town would like to that system designed using totes and day tanks rather than barrels. This type of system would be similar to the one that was designed for North Reservoir project and shown in Exhibit 6.6. The chemical room for the North Reservoir measures 6.3 m by 4.7 m (29.6 m^2) in size and includes a roll up door and a loading dock for the effective loading and unloading of the totes from the supply vehicles. In addition, a proper emergency eyewash station is provided along with a hose bibb for cleanups. Chemical transfer pumps are going to be used to limit manual handling of chemicals and proper spill containment is designed and sized to handle a full tank volume of chemical from the day tanks.

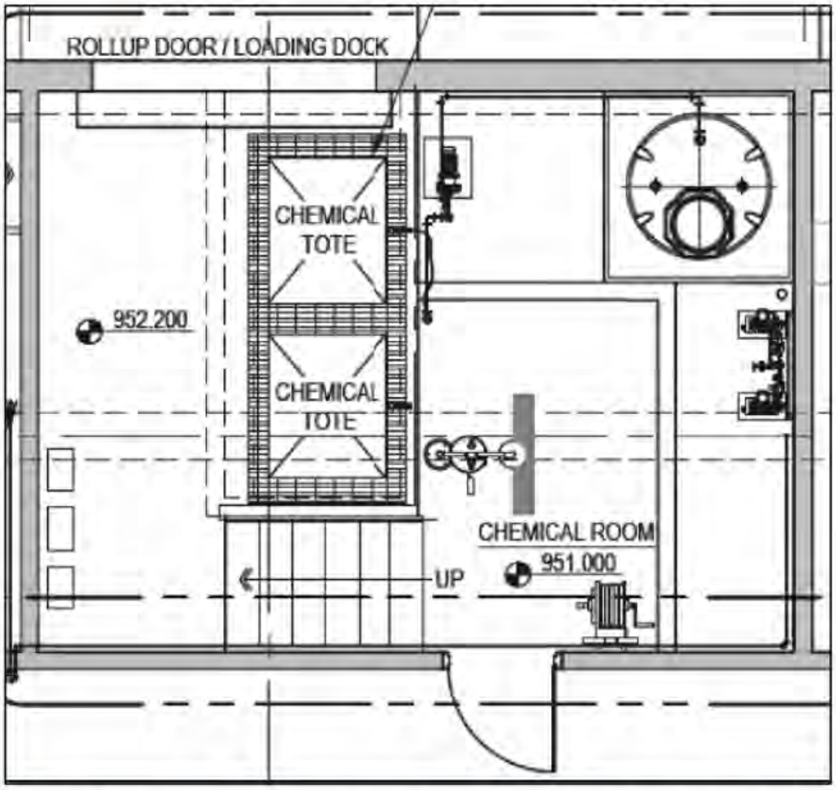


Exhibit 6.6: General Layout of North Reservoir Chlorine Disinfection System

The size of the existing chlorine room for the South Reservoir Pumphouse is approximately 3 m by 3 m (9 m^2). The size of the chlorine room for the North Reservoir is approximately 3 times larger than that of the South Reservoir. In order to accommodate for the use of totes at the South Reservoir, the size of the existing chlorine room will need to be expanded and walls would need to be moved. This would have structural implications and this type of analysis is beyond the scope of this assessment. Alternatively, a new separate chlorine room could be designed and constructed to accommodate the tote-based system.

The supply and delivery of chemical totes is typically done off of larger trucks. Even if the totes could be lowered, the ground from the truck via hydraulic lift gate, maneuvering the totes into their proper positions requires mechanical assistance through the use of pallet jacks which in turn requires flat smooth surfaces to operate on. Considering the winter climate in Alberta, and the amount of snow and ice that can accumulate, considerations for these elements must be included in the design. Proper thought must be given to how trucks would maneuver at the South Reservoir site and how totes can be moved from the outside to the inside as safely and effectively as possible.

Anecdotally, the Town has expressed concerns that the main flow meter for the facility is not functioning properly and that maintenance and potential replacement are problematic due to the current design and configuration. This creates a challenge for Operations in being able to accurately calculate and report the CT value for the facility to the regulators. It is recommended that the design of the flow meter(s) and the automation of the CT calculations be reviewed to help ensure compliance.

Identified Concern Summary:

1. Current system functionality unnecessarily relies on the continuing use of the aging motive water system and creates additional modes of failure and risk for disinfection system.
2. Lack of available space in current size of chemical room prohibits implementation of a tote-based sodium hypochlorite system.
3. Moving bulk chemical from the outside of the building to the inside poses challenges and involves a high degree of manual handling.
4. Re-design and replace the main flow meter, automate the CT calculations it the SCADA system for reporting purposes.

Pumps

As stated previously, the current pumps were added to the South Reservoir in 1999. These pumps were installed in the lower level valve/pump room. There is limited access to this area, which makes it difficult to service or remove the pumps. Access in and out of the lower level room is provided by the single metal staircase mounted on the south wall as shown in Exhibit 6.7.

In order to maintain and work on the pumps or maintain and operate the valves, operations personnel have to climb over top of the large diameter piping (500 mm). This is a safety concern. A crossover ladder is provided as shown in the left-hand portion of the exhibit; however, this does not meet current safety codes as there are no handrails. In addition, the rise and run of the steps does not meet acceptable standards.

Exhibit 6.7 shows that there is very limited space in this lower level valve/pump room as the piping is fairly close to the walls, and there is very limited space provided for unrestricted walking access. This is unfortunately a reflection of the time in which this facility was designed as it would appear as though the addition of the pumps at a later date were not planned out as good as that could have been.

Exhibit 6.7: South Reservoir Pumphouse Lower Level Valve/Pump Chamber

The existing facility does not have any access hatches so that the pumps can be lifted directly up in a vertical fashion to the main floor level or higher via a crane. For the operators to remove the pumps, or any of the heavy equipment for that matter, the equipment needs to be disassembled and lifted up and over the piping manually to get to the staircase. Once at the staircase, the equipment then needs to be carried up the stairs by hand to the main floor. Unfortunately, there are no acceptable anchor points to attach any secondary lifting devices to assist with moving heavy equipment from this lover level room up to the main floor. There is a small gantry rail currently installed in line with the pumps, which can be seen in the exhibit. It does not have enough of a span to get the pumps to the staircase or to even get the pumps to any clear floor space (such as the far corner) so they can serviced or dismantled within the valve/pump room.

The pumps themselves, being approximately 20 years old, have reached a point in their life where they will need to have major repairs done or to be replaced completely. Mechanical equipment such as this has a typical life expectancy of 25 years in ideal environments. As noted earlier, the lower valve/pump room has issues with corrosion and moisture which only accelerate the aging process of mechanical and electrical equipment. While the pumps don't appear to have any operational issues, it is difficult to be able to properly maintain and service them given the awkward constraints of trying to work in the valve/pump room. It should be noted that the pump casings are showing signs of significant corrosion as can be seen in Exhibit 6.8.

Exhibit 6.8: Visible Corrosion on Pump Casings

Identified Concern Summary:

1. Pumps are approaching end of service life.
2. Lack of unrestricted access to pumps.
3. Crossover ladder does not meet current safety codes and standards.
4. Limited clear space provided to work on the pumps. Pumps need to be manually lifted and carried up the stairs if they need to be removed.
5. Pump casings showing very visible signs of exterior corrosion and are reaching the end of their serviceable life.

Valves

As seen in Exhibits 6.1 and 6.7, there are several manually operated isolation valves of various sizes (butterfly valves), two check valves on the discharges of the pumps, and two automated pump control valves. These valves do not require the level of maintenance that the pumps do, and they need to be left in place. Anecdotal information from the Operators suggests that manual isolation valves (butterfly valves) do not get exercised (opened and closed) on a regular basis.

Exercising valves in this way is done to ensure that they properly seat and seal (thus isolate) as they are intended to do so. In the event the flow of water needs to be stopped or diverted, these valves need to be in good working order to do so. Unfortunately, these valves are difficult to access in the same way that the pumps are difficult to access given the awkward access constraints of the valve/pump room. In addition, the valve operation mechanisms (stems, gears, and wheels) are subject to the same corrosion conditions that the piping is currently subject to given the poor air circulation and high humidity. Exhibit 6.9 shows signs of corrosion on some of the valve operators and flanges. The protective paint coating is also shown to be wearing away on some of the valves.

Exhibit 6.9: Visible Corrosion and Coating Degradation on Valves

At the time of the assessment, operator confidence was low that the valves could be properly operated without an issue, and there was not a lot of confidence that they could be relied upon for effective isolation of flow. This has secondary implications, which may be more serious in terms of the fact that the Town may not be able to properly isolate the individual storage cells in the event they need cleaning due to contamination or regular maintenance/repair. If these valves are not working, then the Town would have to take down the entire storage system to be able to work on or clean any of the storage cells.

Identified Concern Summary:

1. Lack of unrestricted access to valves.
2. Valves not exercised on a regular basis. Confidence low that these valves can be used for isolation and diversion purposes.
3. Some valve bodies showing signs of exterior corrosion and failure of the protective coating.

6.2.6 Piping

The piping in the valve/pump room is composed of painted carbon steel piping that is 100 mm, 200 mm, 300 mm, and 500 mm in diameter. The 500 mm diameter sections of pipe are original and were installed when the reservoir was first built in 1980, which is almost 40 years in age. The purpose of these pipes are to move the stored water between the cells.

The piping runs of 100 mm, 200 mm, and 300 mm were installed when the pumps were added in 1999 (20 years old). These pipes connect P-001 and P-002 to the 500 mm diameter pipes. See Exhibit 6.1.

The piping is displaying signs of significant surface corrosion at many places, as shown in Exhibits 6.10 and 6.11.

Exhibit 6.10: Close Up Image of Corrosion on Piping

Exhibit 6.11: Corrosion on Piping

In February of 2018, the Town had Thickness Testing completed on the pipes through a non-destructive testing firm (Red Flame Industries). 26 separate tests were completed at various locations on the piping. The tests measured the minimum thickness of the pipe wall at each location. The test results were then compared to the original design wall thickness for typical carbon steel pipe of the same pressure rating.

For 100% of the tests completed, the minimum measured wall thickness was found to be greater than the typical allowable minimum wall thickness for new carbon steel pipe of the same pressure rating. For 69% of the tests (18/26), the minimum measured wall thickness was found to be equal to or greater than the nominal wall thickness of new carbon steel pipe of the same pressure rating. This suggests that the wall thickness has increased in depth which means that deposits are likely accumulating on the inside of the pipes which is restricting the cross-sectional area (tuberculation). These deposits may be due to the corrosion that is occurring, or they may be deposits coming from precipitation events within the water. What cannot be stated for certain however is how much of the measured wall thickness is actual pipe material versus the deposits. It is difficult to get an actual idea of the wall thickness that is remaining when deposits are found.

For 31% of the tests (8/26), the minimum measured wall thickness was found to be less than the nominal wall thickness of new carbon steel pipe of the same pressure rating. This suggests that there is some loss of pipe material and thickness that is occurring. As stated earlier, 100% of the tests showed that the measured minimum wall thickness was greater than the comparable minimum wall thickness of new carbon steel pipe. This would typically mean that the pipe wall thickness is still within its original specification and thus the pressure rating is still applicable. However, tuberculation and growth deposits are evident as the testing shows and so a definitive conclusion cannot be drawn with regards to how much actual original pipe material remains. This pipe is not under significant pressures so potential for de-rating the pressure class of the pipe is of less of a concern than the potential for loss of flow as the pipes are chocked off with deposits or loss of water through the continued development of pinholes due to the corrosion that is occurring on the exterior surfaces.

Identified Concern Summary:

1. Pipe showing very visible signs of exterior corrosion. Protective coating failing.
2. Non-destructive testing potentially indicating growth of deposits (tuberculation) on the inside of the pipes which could be restricting flow, could be masking loss of pipe wall material.

6.3 Conclusions & Recommendations

6.3.1 Conclusion

As noted at the start of this section of the master plan, the South Reservoir Pumphouse, along with the Beacon Hill Booster Station, currently provides potable water to all of Sylvan Lake. With the North Reservoir Pumphouse now taking on the supply responsibilities for the lower zone, there will be additional pumping capacity made available for the pumps in the South Reservoir and Beacon Hill pumphouses.

From the modelling work completed, it has been shown that the newer Beacon Hill Pumphouse is capable of meeting the water supply needs for the upper and middle zones once the North Reservoir and Pumphouse is commissioned. From the assessment work completed for the South Reservoir Pumphouse it is clear that there are several deficiencies, concerns, and issues that need correcting for this pumphouse to continue operating as a pumphouse. The primary conclusion that can be drawn from these points is that it makes sense for the Town to simplify their operations and begin to plan for the decommissioning of the South Reservoir Pumphouse. The South Reservoir would still serve as a reservoir and the chlorine disinfection system would still need to operate and provide disinfection treatment.

6.3.2 Recommendations

ISL recommends that the Town completes a feasibility and conceptual design study for the South Reservoir and Pumphouse. This study would focus on the following 5 key aspects:

1. The work that would be involved in fully decommissioning the pumphouse portion of the facility and converting operations to strictly a disinfection and storage facility.
2. Addressing the identified concerns that have been listed for the various systems and rooms that need to be addressed to bring them up to current codes and standards.
3. Review and assessment of the general security and protection measures in place at the facility (and other facilities) to allow for the development of a Water System Protection Plan which helps guide measures to ensure compliance with regulatory requirements for security and the protection of public health.
4. Coordinating with any upgrades that are being contemplated with the SCADA and communications systems assessment project.
5. Assessing the costs of decommissioning the facility and what the impacts would be on daily operations and workflows along with potential savings in long term operating costs.

In order to physically implement the decommissioning of the South Reservoir Pumphouse, the 300 mm diameter interzone connection pipe from Broadway Rise to Lucky Place needs to be in place along with the associated PRV as recommended in the master plan. The design and implementation of this distribution system upgrade hinges on the pace of development in the noted lands and coordination with developers. This distribution system upgrade has been identified in the master plan as the final step in the list of recommended existing system upgrades that can occur at any time.

Planning for the decommissioning of the South Reservoir Pumphouse will require some time. It is recommended that the Town looks at potentially starting this study work once the overall SCADA system assessment and upgrade work has started. Any planned upgrades for the SCADA and communication systems need to be incorporated into upgrade plans for the facility identified for the decommissioning study and vice versa. If the pumping system is being decommissioned and that functionality is being transferred fully to the Beacon Hill Booster Station, the SCADA and communication upgrades will need to reflect that. Further, if the SCADA and communication upgrades require additional space or improved conditions (ventilation etc.) then that needs to be coordinated with any planned room or building system modifications that might be contemplated in the decommissioning study. Coordination between the two scopes of work needs to occur to avoid re-work and re-design. Now is the time to plan all of this work out.

Table 6.1 below summarizes all of the concerns that have been identified for each system or room.

Table 6.1: Identified Concern Summary Table

System / Room	Concern #	Concern Description
Building Mechanical – Heating	1.	Gas unit heater is aged, not as efficient, lacks dedicated combustion air intake supply.
	2.	Electric heater in chlorine room is corroded, likely has reduced heating efficiency.
Building Mechanical – Ventilation	1.	Control room does not have separate dedicated supply air or return exhaust air ducts.
	2.	The lower level valve/pump room very damp not being properly ventilated, likely experiencing air exchange short-circuiting.
	3.	Lack of dedicated combustion air supply for the generator, no insulation on the generator exhaust pipe.
	4.	Ventilation for chemical room appears to be inadequate for current codes and standards.
Building Mechanical – Plumbing	1.	Facility does not have a proper service water design complete with backflow preventers per current codes and standards.
	2.	Facility has a lack of pressurized safety eyewash/shower stations per current codes and standards.
	3.	Lack of washroom and washing sinks for cleanup and sanitary provisions.
Control Room	1.	Lack of space for storage and filing of current operational records and maintenance information.
	2.	Lack of proper ventilation and control of air quality suitable for computer hardware.
	3.	Lack of lab space for storage, analysis, and testing of samples.
Chlorine Disinfection System	1.	Current system functionality unnecessarily relies on the continuing use of the aging motive water system and creates additional modes of failure and risk for disinfection system.
	2.	Lack of available space in current size of chemical room prohibits implementation of a tote-based sodium hypochlorite system.
	3.	Moving bulk chemical from the outside of the building to the inside poses challenges and involves a high degree of manual handling.
	4.	Re-design and replace the main flow meter, automate the CT calculations it the SCADA system for reporting purposes.
Pumps	1.	Pumps are approaching end of service life.
	2.	Lack of unrestricted access to pumps.
	3.	Crossover ladder does not meet current safety codes and standards.
	4.	Limited clear space provided to work on the pumps, pumps need to be manually lifted and carried up the stairs if they need to be removed.
	5.	Pump casings showing very visible signs of exterior corrosion and are reaching the end of their serviceable life.
Valves	1.	Lack of unrestricted access to valves.
	2.	Valves not exercised on a regular basis, confidence low that these valves can be used for isolation and diversion purposes.
	3.	Some valve bodies showing signs of exterior corrosion and failure of the protective coating.
Piping	1.	Pipe showing very visible signs of exterior corrosion, protective coating failing.
	2.	Non-destructive testing potentially indicating growth of deposits (tuberculation) on the inside of the pipes which could be restricting flow, could be masking loss of pipe wall material.

The study would need to review current codes and standards for all the remaining systems and rooms. Given that the pumps would be decommissioned, the study should also examine following design aspects/improvements that could be made:

1. Look at staging and implementation of the decommissioning as well as any identified upgrades, the facility needs to remain operational throughout the entire conversion.
2. Look at how the entire pumphouse space be reconfigured upon decommissioning of the pumps.
3. Alternative methods of valve operation could also be examined such as the use of electric actuators so that exercising and isolation procedures could be done through the SCADA system and automated.
4. Look at isolation methods for the three storage cells. At the time of this assessment, reliable record information could not be provided by the Town demonstrating how the flow through the storage system could be modified by isolating cells one at a time and creating bypass situations. The ability to isolate and clean different portions of a multi-cell storage system is a best practice and it should be provided for if possible.
5. Alternative pipe materials and coatings could be looked at so that the pipes are more resistant to corrosion. Stainless steel, PVC, or even epoxy coated steel pipe should be reviewed for applicability.

6.4 Study Schedule & Budget Estimates

6.4.1 Schedule Estimate

It is estimated that a study such as this would take 4 to 6 months to complete. At this point in time, the accuracy of the record information that the Town has for the South Reservoir and Pumphouse is in question, and so there would need to be time provided to collect all field data that needs to be considered. This could be accomplished fairly quickly through the use of 3D laser scanning technologies rather than hand measuring and confirming the accuracy of the 2D record drawings that the Town has available. However, there are some items such as the intercell reservoir piping that may require the need to access individual storage cells. This requires time and planning to coordinate. In addition, the staging of the work needs to be properly planned out and worked through with operations at this stage as it is critical that the facility remain operational at all times. This will also require time to figure out and allowances for meetings and workshops to work through all the details.

6.4.2 Budget Estimate

A study of this scope and timeframe requires a fair amount of effort to complete. It is not just a pure decommissioning project as the facility is being converted in functionality, but there are required upgrades as well. As stated, the facility needs to remain operational at all times, and it is anticipated that there will be a fair amount of effort involved in determining the staging that will be required even at the conceptual level. A reasonable budget to carry for a study of this anticipated scope would be approximately $65,000 to $75,000.

7.0 Staged Implementation Plan

7.1 Implementation Plan

All the upgrades are summarized in Exhibits 7.1 and 7.2, which show the upgrades by diameter and growth scenario, respectively. The implementation of upgrades should be as follows:

North Reservoir and NE Gateway Commissioning:

1. Commission North Reservoir with a discharge header HGL of 1,000 m (discharge header pressure 510 kPa) with the pumping information provided in Table 3.5.
2. Construct the NE Gateway 450 mm twinning line from the North Reservoir along Alignment Option 2 and tie into Cuendet Industrial Way.

Existing System Upgrading:

3. Upon completion of NE Gateway, set the PRVs between the middle and lower zones (Old Boomer Rd, 50 St, and Ryders Ridge Blvd) to an HGL setting of 985 m. This will isolate the South Reservoir from feeding the lower zone, except during fire flows.
4. Open/remove the PRV on Perry Dr east of 50 St to provide better local looping to that neighbourhood.
5. Tie in the dead end on Sylvaire Close into NE Gateway along Hwy 11a.
6. Upgrade the existing 250 mm main on Cuendet Industrial Way to a 450 mm main from the NE Gateway tie-in to Charles Industrial Way. Upgrade the existing 250 mm main on Cuendet Industrial Way to a 350 mm main from Charles Industrial Way to Schenk Industrial Road.
7. Upgrade the existing 200 mm main on Industrial Dr to a 350 mm main from Cuendet Industrial Way to Erickson Dr.
8. Install a 300 mm main east along Cole Way from 50 St and tie into the existing 150 mm dead end. This will provide better fire flow looping to the neighbourhood off Perry Dr.
9. Create a 300 mm loop along 48 Ave, south along 60 St, and connecting through Fieldstone Way. Then, extend this 300 mm main north along 60 St and connect to Wildrose Dr and up to the existing 200 mm main on 60 St just south of Westwood Crescent. This will vastly improve the fire flows to the Fern, Fieldstone and Westwood neighborhoods.
10. Add a 200 mm connection from 47 St to 48 St along 45 Ave and upgraded the main on 49 Street south of 47 Ave to a 300 mm main. This upgrade is schematic and future design should have an analysis of what alignments would be cost effective. For instance, the nearby trail along the former railroad track could be used as an alternative alignment to reduce the costs of rebuilding roads and the amount of infrastructure conflicts.
11. Beacon Hill Pumphouse Main Upgrade:
    - Based on the analysis in Section 4.2.1, a 300 mm main should be installed from Broadway Rise to Lucky Pl. This will allow the Beacon Hill Pumphouse to supply all of the middle and upper zones in the south.
    - Install a 300 mm PRV set at an HGL of 1,018 m to isolate the middle zone from the upper zone.
    - Switch to pumping only being supplied by the Beacon Hill Pumphouse.
    - Decommission the South Pumphouse and upgrade the chlorination system.

Short Term Development Upgrades:

12. West Village upgrades:
    - Upgrade the main on 53 St between 50 Ave and Lakeshore Dr needs to 200 mm.
    - Upgrade to 200 mm mains on 50b Ave between 53 and 52 St, 50a Ave from 53 to 52 St, and 51 & 51a St from Lakeshore Dr to 50a Ave.
    - These upgrades ensure that there is at least 150 L/s fire flows when West Village redevelops.
13. Commercial upgrades east of West Village:

- Upgrade the main on 44 St between 50 Ave and Lakeshore Dr to 250 mm.
- These upgrades are to provide the required 150 L/s fire flows to the commercial areas within the area.

22K Network Upgrades:

14. The PRVs on Old Boomer Rd, 50 St, and Ryder's Ridge Blvd which separate the middle zone from the lower zone should be adjusted from 985 m to 992 m.
15. Southeast Servicing for Pogadl Park:
    - Install a 250 mm main on 60 St south of the existing 200 mm main that crosses 60 St near Lakeland Rd.
    - Extend a 250 mm main west along Memorial Trail from Lakeway Blvd to 60 St.
    - These alignments are schematic and could be further optimized by constructing through the available green space nearby.
16. Temporary looping of Pogadl Park into 60 St and Memorial Tr and west of the intersection of 60 St and Lakeway Blvd. This will service Pogadl Park as part of the middle zone temporarily until the 30K network is built out and Pogadl Park can be serviced through the upper zone from the south. Once this happens, valves will need to be shut on the temporary connections.

30K Network Upgrades:

17. Looping into Pogadl Park from just north of David Thompson Highway from the 30K area. Once this connection is made the temporary connections to the middle zone from Pogadl Park will need to be shut.

45K Network Upgrades:

18. Implement the high-pressure pump upgrades and 450 mm main for the North Reservoir to supply the North Sanbar area in the NE.
19. Loop the dead end on Industrial Dr into the 22K grid to increase the available fire flows to the industrial area that was identified as a deficiency in the existing system analysis.

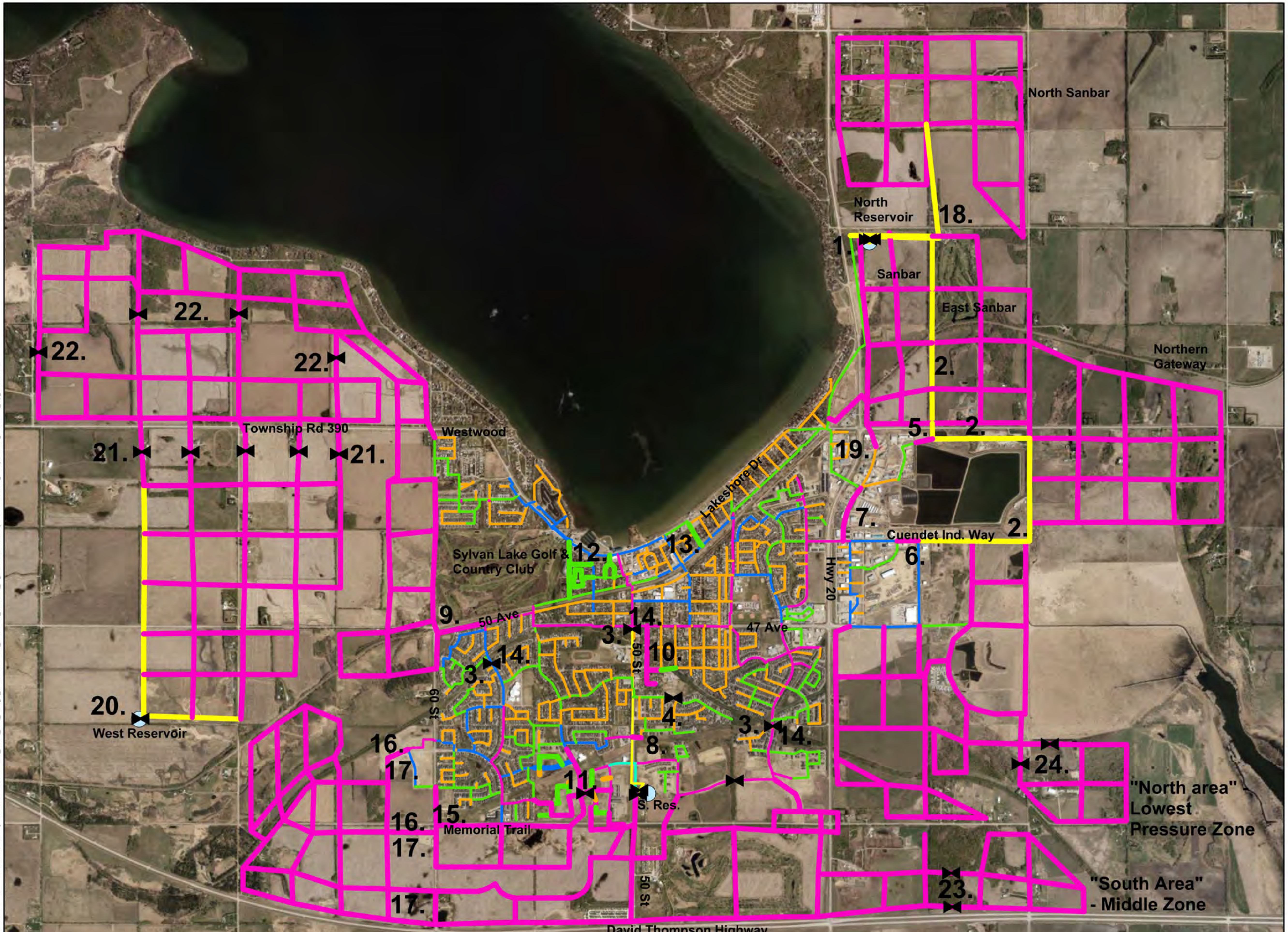
60K Network Upgrades:

There are no system deficiencies that need to be addressed for 60K development assuming upgrades 1 through 19 have been pursued by this point.

75 – 100K Network Upgrades:

20. Commission West Reservoir with a discharge header HGL = 1,034 m (discharge pressure of 525 kPa approximately) to ensure PHD pressures are at least 300 kPa. Pumping capacity requirements should be based on the West Reservoir contributions from Table 5.2 above.
21. PRVs south of Township Rd 390 set to 1,020 m are required to transition from the West Reservoir upper zone to the middle zone on the west side of the Town.
22. PRVs north of Township Rd 390 set to 996 m are required to transition from the West Reservoir middle zone to the lower zone in the NW corner of Town.
23. PRVs east of Highway 20 and north of David Thompson Highway set to an HGL of 1,010 m to service the "South Area" annotated on Exhibits 7.1 and 7.2. This will put this region in a pressure zone similar to the Middle Zone.
24. PRVs south of Lighthouse Pointe set at an HGL of 986 m servicing the "North Area" annotated on Exhibits 7.1 and 7.2. This area is the lowest pressure zone within the network and the only area isolated by PRVs set to 986 m.

A high-level cost estimate has been prepared for the upgrades above and is shown in Table 7.1 on the following page. For more information regarding the cost estimates, see Appendix B – High Level Costing Estimate.



Legend

Existing Network

Diameter (mm)

- 150
- 200
- 250
- 300 - 350
- 400
- 450 - 500

Upgrades and Development

Diameter (mm)

- 150
- 200
- 250
- 300 - 350
- 400
- 450 - 500
- PRV Locations
- Reservoirs

Coordinate System:
NAD 1983 3TM 114

1:30,000

0 300 600 1,200 Meters

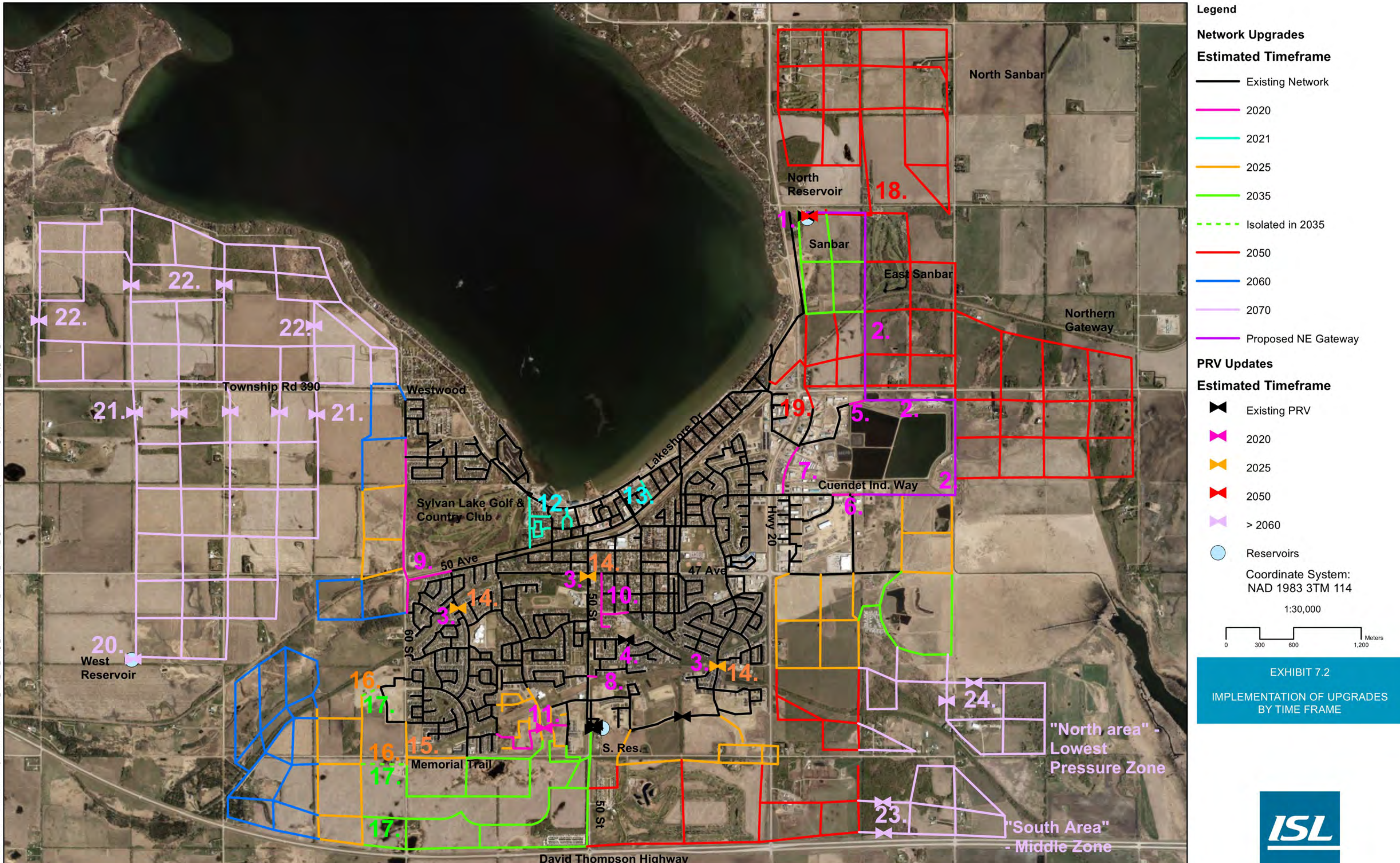
EXHIBIT 7.1

IMPLEMENTATION OF UPGRADES

ISL

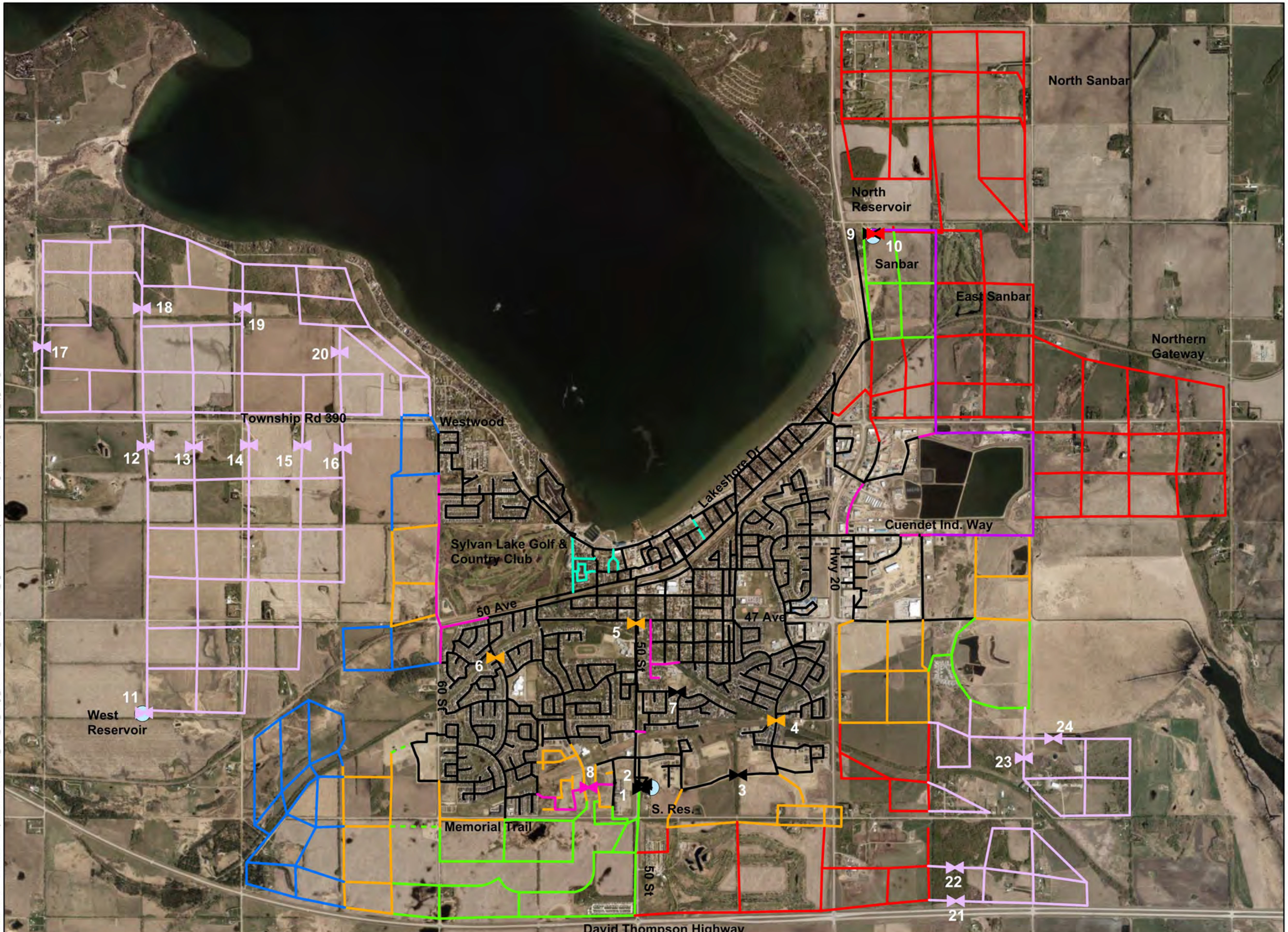
Integrated Expertise. Locally Delivered.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Integrated Expertise. Locally Delivered.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend

Network Upgrades

Estimated Timeframe

- Existing Network
- 2020
- 2021
- 2025
- 2035
- Isolated in 2035
- 2050
- 2060
- 2070
- Proposed NE Gateway

PRV Updates

Estimated Timeframe

- Existing PRV
- 2020
- 2025
- 2050
- > 2060
- Reservoirs

Coordinate System: NAD 1983 3TM 114

1:30,000

0 300 600 1,200 Meters

EXHIBIT 7.3

PRV NUMBERING & LOCATIONS

ISL

Integrated Expertise. Locally Delivered.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

7.2 Summary of PRV Settings

A summary of proposed PRV settings is shown in Table 7.1 below. See Exhibit 7.3 for the numbering of PRVs and their locations. These values should be used by a trained professional technician to properly set and calibrate the actions of each PRV to ensure that they respond as desired. The trained technician will verify the speed of the response for each valve and properly set them to reduce the risk of cavitation. Note that the upstream and downstream pressures need to be recorded immediately once the PRV are properly set according to Table 7.1. These pressures are the baseline pressures that can now be used during future inspections to verify that the stations are still set correctly and that the setpoints have not drifted or that the valves are malfunctioning somehow.

It should be noted that the pressure settings proposed in Table 7.1 reflect the modeling that was conducted. The PRVs within the model were set to pressure settings that ensured adequate pressures were maintained during peak hour and maximum day + fire flow scenarios. It is understood that these events are rare and do not occur often. For the case of average day demands, the following criteria should apply to zone boundary PRVs and reservoir PRVs:

- Zone Boundary PRVs: can be maintained at the values listed in the table since pressures are generally acceptable along the zone boundaries during ADD.
- Reservoir PRVs: can be reduced during low flow scenarios, particularly at the north reservoir. This will need to be optimized in further detail once the north reservoir is running and a better idea of the flow demands can be established. For instance, when the north reservoir is operating at 1,000 m, the industrial area has higher than ideal pressures, but setting the smaller PRV to 996 m can reduce the pressure by 40 kPa (~ 6 psi) if high pressures are observed while maintaining the overall HGL within the zone.

Another important consideration is that the elevations provided in this table are estimates and may not reflect accurate field elevations. Thus, pressures in the table are provided as a reference but should be reviewed in greater detail with accurate survey information to ensure the zones aren't over or under pressurized.

Table 7.1: Summary of Proposed PRV Settings.

PRV	Location	Property	Time Frame							
			Today's Setting	Existing System Changes	STDP	22K	30K	45K	60K	75 - 100K
1	S. Res. Upper Zone PRV	El. (m)	994							
		HGL (m)	1,029	1,029	1,029	1,029	1,029	1,029	1,029	1,029
		P (kPa)	343	343	343	343	343	343	343	343
		P (psi)	50	50	50	50	50	50	50	50
2	S. Res. Middle Zone PRV	El. (m)	995							
		HGL (m)	1,018	1,018	1,018	1,018	1,018	1,018	1,018	1,018
		P (kPa)	228	228	228	228	228	228	228	228
		P (psi)	33	33	33	33	33	33	33	33
3	Upper-Middle Zone PRV (South)	El. (m)	982							
		HGL (m)	1,018	1,018	1,018	1,018	1,018	1,018	1,018	1,018
		P (kPa)	354	354	354	354	354	354	354	354
		P (psi)	51	51	51	51	51	51	51	51

PRV	Location	Property	Time Frame							
			Today's Setting	Existing System Changes	STDP	22K	30K	45K	60K	75 - 100K
4	Ryder's Ridge PRV (Middle-Lower)	El. (m)	956							
		HGL (m)	996	985	985	992	992	992	992	992
		P (kPa)	392	284	284	353	353	353	353	353
		P (psi)	57	41	41	51	51	51	51	51
5	50 Street PRV (Middle-Lower)	El. (m)	955							
		HGL (m)	996	985	985	992	992	992	992	992
		P (kPa)	403	295	295	364	364	364	364	364
		P (psi)	59	43	43	53	53	53	53	53
6	Old Boomer Road (Middle-Lower)	El. (m)	961							
		HGL (m)	996	985	985	992	992	992	992	992
		P (kPa)	343	235	235	304	304	304	304	304
		P (psi)	50	34	34	44	44	44	44	44
7	Perry Drive PRV	El. (m)	962							
		HGL (m)	996	Inactive	Inactive	Inactive	Inactive	Inactive	Inactive	Inactive
		P (kPa)	336	Inactive	Inactive	Inactive	Inactive	Inactive	Inactive	Inactive
		P (psi)	49	Inactive	Inactive	Inactive	Inactive	Inactive	Inactive	Inactive
8	Beacon Hill Upper-Middle PRV	El. (m)	985							
		HGL (m)	-	1,018	1,018	1,018	1,018	1,018	1,018	1,018
		P (kPa)	-	324	324	324	324	324	324	324
		P (psi)	-	47	47	47	47	47	47	47
9	North Reservoir Lower Zone PRV	El. (m)	948							
		HGL (m)	-	1,000	1,000	1,000	1,000	1,000	1,000	1,000
		P (kPa)	-	510	510	510	510	510	510	510
		P (psi)	-	74	74	74	74	74	74	74
10	North Reservoir Future Upper Zone PRV[1]	El. (m)	965							
		HGL (m)	-	-	-	-	-	1,029	1,029	1,029
		P (kPa)	-	-	-	-	-	628	628	628
		P (psi)	-	-	-	-	-	91	91	91
11	West Reservoir Upper Zone PRV	El. (m)	982							
		HGL (m)	-	-	-	-	-	-	-	1,033
		P (kPa)	-	-	-	-	-	-	-	500
		P (psi)	-	-	-	-	-	-	-	73
12	Future West Upper-Middle PRV (i)	El. (m)	987							
		HGL (m)	-	-	-	-	-	-	-	1,020
		P (kPa)	-	-	-	-	-	-	-	324
		P (psi)	-	-	-	-	-	-	-	47

PRV	Location	Property	Time Frame							
			Today's Setting	Existing System Changes	STDP	22K	30K	45K	60K	75 - 100K
13	Future West Upper-Middle PRV (ii)	El. (m)	985							
		HGL (m)	-	-	-	-	-	-	-	1,020
		P (kPa)	-	-	-	-	-	-	-	343
		P (psi)	-	-	-	-	-	-	-	50
14	Future West Upper-Middle PRV (iii)	El. (m)	978							
		HGL (m)	-	-	-	-	-	-	-	1,020
		P (kPa)	-	-	-	-	-	-	-	412
		P (psi)	-	-	-	-	-	-	-	60
15	Future West Upper-Middle PRV (iv)	El. (m)	975							
		HGL (m)	-	-	-	-	-	-	-	1,020
		P (kPa)	-	-	-	-	-	-	-	441
		P (psi)	-	-	-	-	-	-	-	64
16	Future West Upper-Middle PRV (v)	El. (m)	970							
		HGL (m)	-	-	-	-	-	-	-	1,020
		P (kPa)	-	-	-	-	-	-	-	491
		P (psi)	-	-	-	-	-	-	-	71
17	Future West Middle-Lower PRV (i)	El. (m)	960							
		HGL (m)	-	-	-	-	-	-	-	996
		P (kPa)	-	-	-	-	-	-	-	353
		P (psi)	-	-	-	-	-	-	-	51
18	Future West Middle-Lower PRV (ii)	El. (m)	957							
		HGL (m)	-	-	-	-	-	-	-	996
		P (kPa)	-	-	-	-	-	-	-	383
		P (psi)	-	-	-	-	-	-	-	55
19	Future West Middle-Lower PRV (iii)	El. (m)	955							
		HGL (m)	-	-	-	-	-	-	-	996
		P (kPa)	-	-	-	-	-	-	-	402
		P (psi)	-	-	-	-	-	-	-	58
20	Future West Middle-Lower PRV (iv)	El. (m)	960							
		HGL (m)	-	-	-	-	-	-	-	996
		P (kPa)	-	-	-	-	-	-	-	353
		P (psi)	-	-	-	-	-	-	-	51
21	David Thompson Upper-Middle PRV (i)	El. (m)	968							
		HGL (m)	-	-	-	-	-	-	-	1,010
		P (kPa)	-	-	-	-	-	-	-	411
		P (psi)	-	-	-	-	-	-	-	60

PRV	Location	Property	Time Frame							
			Today's Setting	Existing System Changes	STDP	22K	30K	45K	60K	75 - 100K
22	David Thompson Upper-Middle PRV (ii)	El. (m)	974							
		HGL (m)	-	-	-	-	-	-	-	1,010
		P (kPa)	-	-	-	-	-	-	-	355
		P (psi)	-	-	-	-	-	-	-	52
23	Ultimate Network Lower-Lowest PRV (i)	El. (m)	938							
		HGL (m)	-	-	-	-	-	-	-	986
		P (kPa)	-	-	-	-	-	-	-	472
		P (psi)	-	-	-	-	-	-	-	68
24	Ultimate Network Lower-Lowest PRV (ii)	El. (m)	930							
		HGL (m)	-	-	-	-	-	-	-	986
		P (kPa)	-	-	-	-	-	-	-	549
		P (psi)	-	-	-	-	-	-	-	80

Notes:

1. Future North Reservoir PRV to northern upper zone elevation was assumed at the downstream end of the transmission main instead of at the reservoir to prevent high pressures in the transmission main heading north to the new zone.

7.2.1 Additional General Commentary on Operation, Inspection and Maintenance of PRV's

7.2.2 PRV Station Operation

Exhibit 7.4 shows a clipping from the record drawings obtained from the Town for the Perry Drive PRV Station that was upgraded in 1999. This exhibit shows that the PRV Station is composed of 3 sections of pipe. The purpose of each is as follows:

1. Bypass Pipe (Straight Run of Pipe with no PRV)
   a. This section of pipe has an isolation valve that is normally closed and serves as an un-regulated bypass connection between the two adjacent pressure zones.
   b. This section of pipe should only be opened during maintenance of the PRV's when the valves need to be taken off-line and flow between the pressure zones needs to be maintained to continue to provide service to the Town's residents.
   c. This pipe typically is equipped with the pressure gauges which can be used to determine the pressure from each zone on either side of the PRV Station at any given time when the isolation valve is closed.
2. Smaller Diameter PRV
   a. This PRV is typically set to maintain a hydraulic grade line (HGL) on the downstream side of the valve under lower flow or average conditions (ADD) that is suitable to provide the desired level of service for the downstream zone in terms of pressure for these conditions.
   b. Under normal conditions, this PRV will open and close to maintain a pressure setpoint in the downstream pressure zone.
3. Larger Diameter PRV
   a. This PRV is typically set to maintain a lower hydraulic grade line (HGL) than the small diameter PRV on the downstream side of the valve under max day and fire flow conditions (MDD plus Fire) that is suitable to provide the desired level of service for the downstream zone in terms of pressure for these conditions.

b. When emergencies or fires happen, the small diameter PRV is typically 100% open and cannot maintain its HGL setpoint so pressures continue to drop. The larger PRV senses that the pressure is dropping, and it opens up as it is set to a lower HGL than the smaller diameter. Under normal conditions, this valve remains closed because the HGL condition is satisfied by the small diameter PRV.
c. As pressures return to normal the larger diameter PRV closes first as its lower setpoint for the required HGL is satisfied first and normal operation resumes with the smaller diameter PRV.

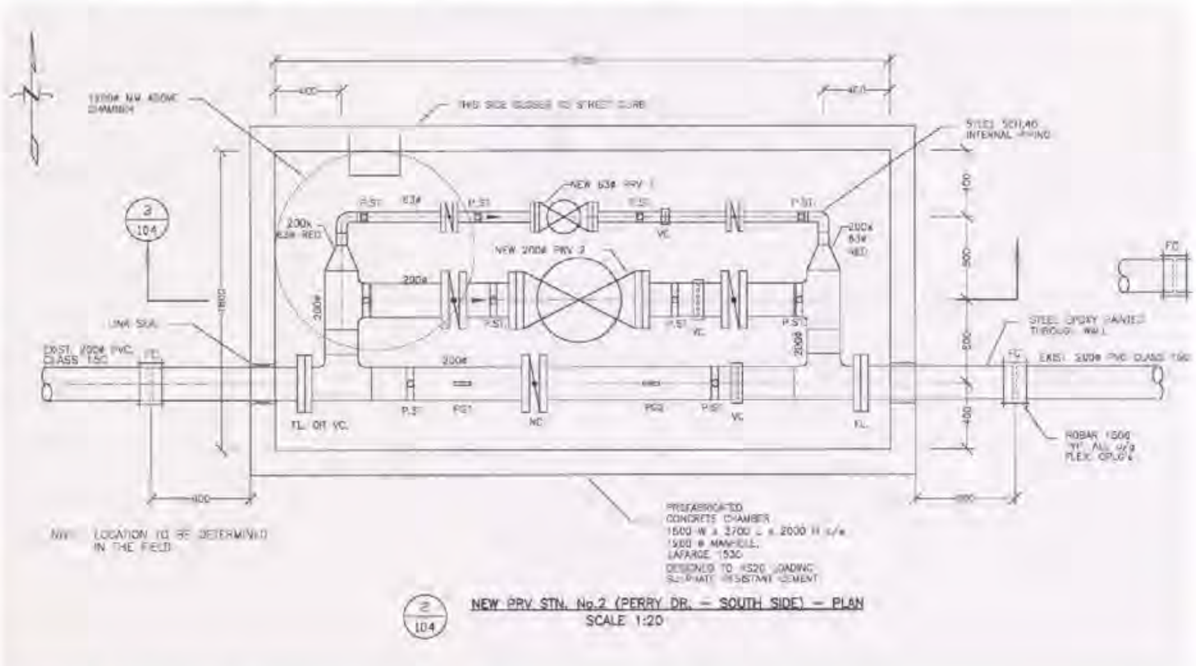


Exhibit 7.4 Typical PRV Station Configuration

7.2.3 PRV Station Inspection & Maintenance

In general, inspections on the PRV stations should be completed annually as a minimum. However, ISL would recommend that the PRV stations be inspected twice per year, once during summer peak demand periods and once during the fall/winter when demands are typically lower. This provides operations with the best snapshot of how the valves are performing during your most extreme operational conditions in your distribution system.

Specific inspection and maintenance requirements for each valve can vary by manufacturer and are dependent on how the valve is set up with the piloting etc. If they Town has not done so already, an inventory of the make, model, and serial number of each valves should be established so that you can contact the manufacturer and obtain the specific inspection and maintenance requirements for each valve.

The items that the Town should review for each inspection are as follows:
1. Check for leaks in the piping and leaks in the structure.
2. Ensure that the valves that are to be normally closed are closed. This should be the bypass valve only. Briefly exercise the valve to ensure it can be opened and that it seats properly when closed. When it is slowly opened, the PRV valves might close. This should be expected.
3. Observe and record the pressures on the upstream and downstream sides of the station and ensure that the pressure gauges are working.

4. Slowly close the downstream isolation valves on the PRV lines and observe that the PRV valves respond by closing. Closing the isolation valves simulates that there is adequate pressure and no need for the valve to be open. Listen to the valve and verify that there are no leaks or bypassing flow.
5. Slowly open the downstream isolation valve for the larger diameter PRV and observe that the PRV responds by opening.
6. Slowly open the downstream isolation valve for the smaller diameter PRV and observe that this PRV responds by opening and that the larger dimeter PRV closes.
7. Always record the observed pressures during each stage of the testing and keep for record purposes.
8. Verify that all the valves have been returned to the normal operating positions and that the station appears to be functioning properly.

7.3 Cost Estimates

Table 7.2: High Level Cost Estimate of Upgrades Required.

Growth Projection	Item	Construction ($)	Engineering ($) (15 %)	Contingency ($) (30 %)	Total Cost ($)
Existing	2	2,941,000	441,000	882,000	4,264,000
	5	59,000	9,000	18,000	86,000
	6	198,000	30,000	60,000	288,000
	7	338,000	51,000	101,000	490,000
	8	43,000	6,000	13,000	62,000
	9	894,000	134,000	268,000	1,296,000
	10	428,000	64,000	128,000	620,000
	11	488,000	73,000	146,000	707,000
				Total Existing Costs	**7,813,000**
STDP	12	730,000	109,000	219,000	1,058,000
	13	100,000	15,000	30,000	145,000
				Total STDP Costs	**1,203,000**
22K	15	330,000	50,000	100,000	480,000
	16	271,000	41,000	81,000	393,000
				Total 22K Costs	**873,000**
30K	17	374,000	56,000	112,000	542,000
				Total 30K Costs	**542,000**
45K	18	613,000	92,000	184,000	889,000
	19	67,000	10,000	20,000	97,000
				Total 45K Costs	**986,000**
75 - 100K	20	8,294,000	1,244,000	2,488,000	12,026,000
	21	500,000	75,000	150,000	725,000
	22	400,000	60,000	120,000	580,000
	23	200,000	30,000	60,000	290,000
	24	200,000	30,000	60,000	290,000
				Total 100K Costs	**13,621,000**
				Total Overall Costs	**25,328,000**

Table 7.2 shows the overall costs for each upgrade recommended but does not discretize them by Town versus Developer costs. Table 7.3 shows a breakdown of potential cost sharing for each development area as shown on Exhibit 2.1. The costs of upgrades were split over the benefitting areas.

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Item	Description	Total ($)	Total Area (ha)	Existing Town	West Village	Grayhawk	Pogadl Park	60 St	Westridge	Ryder	Iron Gate	Norrell Business Park	60 St South	South	Lighthouse Pointe	Sanbar Estates	Meadowlands	Southeast 1	Northern Gateway	East Sanbar	North Sanbar	West (i) [North]	West (ii) [South]	Southwest	Northwest	Far West	South East 2	Total ($)
	Time Frame			Existing	STDP	22K							30K				45K					60K			100K			
	Total Area (ha)			1,171	16	69	33	37	25	75	63	65	83	84	65	48	119	123	347	78	253	62	62	121	464	396	240	
2	Construct NE Gateway 450 mm line along alignment option 2.	4,264,000	640	679,596	0	0	0	0	0	0	0	433,076	0	0	0	318,944	0	0	2,310,028	522,356	0	0	0	0	0	0	0	**4,264,000**
5	Tie in dead end on Sylvaire Close into NE Gateway along Hwy 11a.	86,000	-	86,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**86,000**
6. a)	Upgrade existing 250 mm on Cuendet to a 450 mm from NE Gateway to Charles Ind. Way.	105,000	-	105,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**105,000**
6. b)	Upgrade existing 250 mm on Cuendet to a 350 mm main from Charles Ind. Way to Schenk Ind. Rd.	183,000	-	183,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**183,000**
7	Upgrade the existing 200 mm main on Industrial Dr. to a 350 mm main from Cuendet Ind. Way to Erickson Dr.	490,000	-	490,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**490,000**
8	Install a 300 mm main east along Cole Way from 50 St and tie into the existing 150 mm dead end.	62,000	-	62,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**62,000**
9	300 mm loop along 48 Ave, south along 60 St and connecting through Fieldstone Way. Extend north along 60 St to existing 200 mm main north of Wildrose Dr.	1,296,000	274	383,594	0	325,772	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	294,498	292,136	0	0	0	0	**1,296,000**
10. a)	250 mm connection from 47 St to 48 St along 45 Ave.	91,000	-	91,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**91,000**
10. b)	Upgrade the main on 49 St south of 47 Ave to 300 mm.	529,000	-	529,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**529,000**
11. a)	300 mm main from Broadway Rise to Lucky Pl.	562,000	37	180,756	0	0	0	0	381,244	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**562,000**
11. b)	PRV along 300 mm main from Broadway Rise to Lucky Pl. set to HGL = 1,018 m.	145,000	37	46,636	0	0	0	0	98,364	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**145,000**
12. a)	Upgrade main on 53 St between 50 Ave and Lakeshore Dr to 200 mm.	314,000	16	0	314,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**314,000**
12. b)	200 mm mains on 50b Ave (53 - 52 St), 50a Ave (53-52 St including the loop in Rainbow Park Condominiums), and 51 St & 51a St (Lakeshore Dr - 50a Ave).	744,000	16	0	744,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**744,000**
13	Upgrade the main on 44 St between 50 Ave and Lakeshore Dr to 200 mm.	145,000	16	0	145,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**145,000**
15. a)	Install a 250 mm main on 60 St south of the existing 200 mm main that cross 60 St near Lakeland Rd.	172,000	275	0	0	0	20,751	23,138	0	0	0	0	0	52,345	0	0	0	0	0	0	0	0	0	75,765	0	0	0	**172,000**
15. b)	Extend a 250 mm main west along Memorial Trail from Lakeway Blvd to 60 St.	308,000	300	0	0	0	34,024	37,936	25,993	0	0	0	0	85,824	0	0	0	0	0	0	0	0	0	124,223	0	0	0	**308,000**
16	Temporary looping of Pogadl Park into 60 St and Memorial Tr and west of the intersection of 60 St and Lakeway Blvd.	393,000	191	0	0	0	68,157	75,995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	248,847	0	0	0	**393,000**
17	Looping into Pogadl Park from north of David Thompson Highway & disconnecting temporary looping.	542,000	275	0	0	0	65,391	72,911	0	0	0	0	0	164,949	0	0	0	0	0	0	0	0	0	238,748	0	0	0	**542,000**
18	Install a new discharge header from the North Reservoir to North Sanbar.	889,000	253	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	889,000	0	0	0	0	0	0	**889,000**
19	Loop dead end on Industrial Dr into Northern Gateway grid for improved fire flows.	97,000	68	29,956	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67,044	0	0	0	0	0	0	0	0	**97,000**
20	Commission West Reservoir with a discharge header HGL = 1,034 m.	12,026,000	860	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,491,832	5,534,168	0	**12,026,000**

Item	Description	Total ($)	Total Area (ha)	Existing	STDP	22K							30K			45K					60K			100K					Total ($)
				Existing Town	West Village	Grayhawk	Pogadl Park	60 St	Westridge	Ryder	Iron Gate	Norrell Business Park	60 St South	South	Lighthouse Pointe	Sanbar Estates	Meadowlands	Southeast 1	Northern Gateway	East Sanbar	North Sanbar	West (i) [North]	West (ii) [South]	Southwest	Northwest	Far West	South East 2	
				1,171	16	69	33	37	25	75	63	65	83	84	65	48	119	123	347	78	253	62	62	121	464	396	240	
21	Five PRVs south of Township Rd 390 set to 1,020 m to transition from upper zone to middle zone.	725,000	860	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	391,367	333,633	0	**725,000**
22	Four PRVs north of Township Rd 390 set to 996 m are required to transition from middle zone to lower zone.	580,000	464	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	580,000	0	0	**580,000**
23	Two PRVs separating the 45K southeast area (upper zone) from the southeast middle zone.	290,000	240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	290,000	**290,000**
24	Two PRVs separating lower zone of Lighthouse Pointe from the very low area of the 100K SE area.	290,000	240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	290,000	**290,000**
Total Cost ($):				**2,866,538**	**1,203,000**	**325,772**	**188,324**	**209,981**	**505,601**	**0**	**0**	**433,076**	**0**	**393,118**	**0**	**318,944**	**0**	**0**	**2,377,072**	**522,356**	**389,000**	**294,498**	**292,136**	**587,584**	**7,463,199**	**5,867,801**	**580,000**	**25,328,000**

8.0 Conclusions and Recommendations

8.1 Conclusions

Major conclusions from this study include the following:

1. The Sylvan Lake water model has been updated to match the most up-to-date GIS database available from the Town of Sylvan Lake.
2. With consultation from the Town, the growth projections from the original WaterCAD model have been updated to reflect the most up-to-date developer interests within Sylvan Lake. A new scenario referred to as short term development pressures includes these interests.
3. Reviewing the Town of Sylvan Lake development standards, the residential and non-residential consumption rates appear to be slightly conservative. In particular, MDD of 750 L/c/d, PHD of 1500 L/c/d and non-residential ADD of 0.20 L/s/ha (17,280 L/ha/d) are very high relative to what is typically monitored. There is some uncertainty regarding these values due to the potential of high peak summer tourist demands.
4. With the changes in the model, the calibration was still adequate, but was improved further. Using 10 hydrant flow tests, residual model pressures were matched with monitored pressures by adjusting the empirical friction factors in the model.
5. With the construction of the North Reservoir, the following conclusions have been made:
   - The existing 200 mm water main heading south along Hwy 20 is insufficient to provide fire flows to the lower zone without assistance from the lower zone.
   - NE Gateway Option 2 is the preferred option for twinning the North Reservoir into the lower zone.
   - With the current PRV settings along Old Boomer Rd, 50 St and Ryders Ridge Blvd (middle to lower zone boundary), the North Reservoir cannot be utilized effectively and will pump against the south reservoir.
6. Under existing demands, assuming the North Reservoir and NE Gateway are constructed, and that the lower zone is isolated from the middle and upper zones, there are fire flow deficiencies at the following locations:
   - Westwood neighbourhood in the NW corner of Town.
   - Fern and Fieldstone neighborhoods to the west.
   - Industrial network to the east near Cuendet Ind. Way and Industrial Dr.
   - Along the pressure zone boundary near 49 St & 49 St close, and along some dead ends in the Fern & Fieldstone neighbourhood.
   - The neighbourhood just near Perry Drive in the middle zone is somewhat lacking due to a single connection point and would greatly benefit from a short connection back into 50 St to complete a loop for the neighbourhood.
7. An analysis was completed to determine the feasibility of suppling all of the middle and upper zones from the Beacon Hill Pumphouse. It was determined that this was feasible with minor upgrades to the network. The assessment work completed on the South Reservoir Pumphouse determined that it makes logical sense for the Town to plan on decommissioning this pumphouse to simplify operations.
8. The future water network assumed a 300 mm grid separated at 400 m intervals. This provided enough fire flows to be consistently above 150 L/s while meeting all demands. Provided that future growth is given adequate looping, there should not be any deficiencies within the future network.
9. The future western development area in the 100K scenario should have its own reservoir, as it is difficult to meet the demands to the west from the south and north reservoirs.

8.2 Recommendations

Recommendations from this study include the following:

1. It is recommended that the Town of Sylvan Lake conducts a consumption monitoring study to accurately determine what the consumption rates are for residential and non-residential water users. This issue was also raised in the Water Well Capacity Memo written by ISL and submitted to the Town in October of 2019.
2. Include 150 L/s for non-residential, high-value properties as a fire flow requirement.
3. Upgrade the water network based on the implementation plan described in Section 7.0.
4. Initiate the separate study to look at decommissioning the South Reservoir Pumphouse.
5. It is recommended that a detailed network study be performed within the next 5 – 10 years when the master plan is updated.

APPENDIX
Pipe Database Table

A

ID	Label	Length (Scaled) (m)	Diameter (mm)	Material	Hazen-Williams C
645	50 A Ave/Lakeshore	183.57	150	Ductile Iron	85
646	50 Ave/53 St.	305.25	200	Ductile Iron	85
647	Hwy 11 A/50 Ave	60.49	200	PVC	140
648	Lakeshore/46 St.	251.24	200	Ductile Iron	85
649	40 St./50 Ave	121.07	200	PVC	140
650	32 St./Hwy 11 A	174.06	150	Ductile Iron	85
651	50 Ave/53 St	202.54	200	Ductile Iron	85
652	Hwy 11 A/50 A Ave	180.55	200	PVC	140
653	40 St./50 A Ave	169.66	150	Ductile Iron	85
654	50 Ave/50 A St	44.61	300	Ductile Iron	85
655	Lakeshore/53St.	184.43	250	PVC	140
656	47 Ave/Westview Dr.	467.99	300	Ductile Iron	85
657	47Ave/Cottonwood connector lower zone	48	200	Ductile Iron	85
658	Westview Dr./48 Ave	51.17	300	Ductile Iron	85
659	Westview Dr/47 Ave	120.38	300	Ductile Iron	85
660	SylvanDr/Westview Dr.	86.04	200	Asbestos Cement	90
661	Cottonwood Dr/Westview	132.44	150	PVC	130
662	Sylvan Dr/Forrest Dr.	87.05	200	Asbestos Cement	90
663	Sylvan Dr/Garden Ct	114.05	200	Asbestos Cement	90
664	Lakeview Cres/Sylvan Dr.	182.12	150	Asbestos Cement	90
665	Garden Ct/Lakeview Cres.	88.02	150	Asbestos Cement	90
666	Garden Court	211.36	150	Asbestos Cement	90
667	Sylvan Dr/Lakeview Cres	111.04	200	Asbestos Cement	90
668	Sylvan Dr/Parkland Ave	79.13	200	Asbestos Cement	90
670	Parkland Dr/Sylvan Dr	404.85	150	Asbestos Cement	90
671	Parkland Dr/Northstar Dr.	289.39	150	Asbestos Cement	90
672	NorthStar Dr/Parkkland Dr	290.58	150	Asbestos Cement	90
673	Westview Dr./Northstar Dr.	92.54	200	Asbestos Cement	90
675	Perry Dr.	255.27	200	PVC	130
676	Peterson Way	94.53	150	PVC	130
685	52 St/48 Ave	76.07	250	Ductile Iron	85
686	48 Ave/Westview Dr.	287.93	150	Ductile Iron	85
687	48 Ave/53 St.	213.17	150	Ductile Iron	85
688	52 St/47A Ave	99.68	250	Ductile Iron	85
690	47A Ave/53 St	290.09	150	Ductile Iron	85
691	50 St/47 Ave Supply line	25.25	500	Ductile Iron	85
692	48 Ave/50 St	240.72	150	Ductile Iron	85
693	48 Ave/48 St	228.86	150	Ductile Iron	85
694	43 St/47 Ave	219.05	300	Ductile Iron	85
696	43 St/48 Ave	218.24	300	Ductile Iron	85
697	Harper Dr/43 St. Alley	43.72	250	PVC	130
698	Harper Dr/Hallgren Dr	137.92	150	PVC	130
699	Harrigan St/Hallgren Dr	137.53	150	PVC	130
700	Hallgren Dr/Harrigan St	91.51	150	PVC	130
701	Hallgren Dr/Halsall St	90.28	150	PVC	130
702	Hallsall St/Halgren Dr	145.52	150	PVC	130
703	Harper Dr/Halsall St.	91.63	150	PVC	130
704	Hallgren Dr/Harrison Rd	99.71	150	PVC	130
705	Harrison Rd/Hallgren/Dr	169.27	250	PVC	130
706	Harper Dr/Harrison Rd.	103.91	150	PVC	130
707	49 Ave43 St	38.69	250	PVC	130
708	45 Ave/47 St	117.24	150	Ductile Iron	85
710	45 Ave/45 St	130.63	150	Ductile Iron	85
712	47 Ave/44 St	85.45	300	Ductile Iron	85
713	45 St Cres	278.25	150	Ductile Iron	85
714	45 Ave/43 St	36.23	150	Ductile Iron	85
715	45 Ave/44 St	54.99	150	Ductile Iron	85
716	45 St.Cres	198.63	150	Ductile Iron	85
717	48 Ave/46 St	243.08	150	Ductile Iron	85
719	44 St/48 Ave	215.34	150	Ductile Iron	85
720	50 St/49 Ave	66.31	350	Ductile Iron	85
721	50 St/48 Ave	71	350	Ductile Iron	85
723	50 St/47 Ave	102.07	350	Ductile Iron	85
724	50 Ave/52 St	171.27	200	Ductile Iron	85
725	50 Ave/51 St	112.58	200	Ductile Iron	85
726	Lakeshore Dr/51 St.	66.74	250	PVC	140
727	Lakeshore Dr/52 St.	165.7	250	PVC	140
728	52 St/50 Ave	123.29	250	Ductile Iron	85
729	50 A St/50 Ave	88.48	300	Ductile Iron	85
730	51 St/50 Ave	84.56	150	Ductile Iron	85
731	49 Ave/50 St	248.06	150	Ductile Iron	85
732	48 St/ 48 Ave	127.47	150	Ductile Iron	85
733	47 Ave/48 St.	109.93	300	Ductile Iron	85
734	48 St/47 Ave	204.31	150	Ductile Iron	85
737	47 Ave/47 St	118.3	300	Ductile Iron	85
739	50 Ave/50 St.	230.53	200	Ductile Iron	85
741	50 Ave/40 St.	194.65	200	PVC	140
742	39 St/50 Ave	183.07	150	Ductile Iron	85
745	37 St/ 50 Ave	184.02	150	Ductile Iron	85
746	35 St/50 Ave	184.19	150	Ductile Iron	85
747	42 St/50 Ave	168.65	150	Ductile Iron	85
748	Sylvan Dr/Lakeview Cr	48.14	200	Asbestos Cement	90
750	43 St/45 Ave	176.69	150	Ductile Iron	85
751	43 St Alley/45 Ave	180.3	150	Ductile Iron	85
752	46 Ave/ 43 St Alley	39.88	150	Ductile Iron	85

ID	Label	Length (Scaled) (m)	Diameter (mm)	Material	Hazen-Williams C
753	44 St/45 Ave	176.93	150	Ductile Iron	85
754	44 St/46 Ave	173.4	150	Ductile Iron	85
755	46 Ave/44 St	50.85	150	Ductile Iron	85
757	46 St/45 Ave	162.07	150	Ductile Iron	85
758	46 St/46 Ave	180.69	150	Ductile Iron	85
759	47 St/45 Ave	164.67	150	Ductile Iron	85
760	47 St/46 Ave	178.82	150	Ductile Iron	85
761	46 Ave/47 St	121.42	150	Ductile Iron	85
763	46 Ave/48 St.	116.26	150	Ductile Iron	85
765	47 Ave/50 St	120.97	300	Ductile Iron	85
768	45 St/45 Ave	168.32	150	Ductile Iron	85
769	45 St/46 Ave	174.51	150	Ductile Iron	85
770	46 Ave/46 St	113.47	150	Ductile Iron	85
771	46 Ave/ 45 St	126.12	150	Ductile Iron	85
772	Sylvan Dr/ White Cap	101.24	150	PVC	130
774	Lakeshore Dr/35 St	104.93	150	Ductile Iron	85
776	Westview Dr/Sylvan Dr.	331.1	200	Asbestos Cement	90
777	Forest Dr/Sylvan Dr.	210.29	150	Ductile Iron	85
779	PRV/50 St.	14.64	500	Concrete (centrif. spun)	85
781	50 St /PRV	76.25	150	Ductile Iron	85
782	53 St/50 Ave	169.71	150	Ductile Iron	85
789	Lakeshore/50 St	141.08	250	PVC	140
791	50St/Sylvan St RES Line	45.37	500	Concrete	85
804	Fox Cl./Fox Run Dr	101.37	300	PVC	125
808	P-305	93.35	300	PVC	130
809	P-306	101.16	200	PVC	130
810	P-254	112.66	200	PVC	130
811	P-335	93.78	150	PVC	130
812	P-340	101.45	150	PVC	130
813	P-249	48.07	250	PVC	130
814	P-239	106.68	300	PVC	130
815	P-255	136.97	200	PVC	130
816	P-274	224.78	200	PVC	130
817	P-318	165.93	150	PVC	130
818	P-408	76.37	250	PVC	145
819	P-529	129.99	250	PVC	130
820	P-331	113.11	150	PVC	130
821	P-317	62.95	200	PVC	130
822	P-267	92.47	200	PVC	130
823	P-500	161.81	250	PVC	130
824	P-497	94.39	150	PVC	130
825	P-343	21.52	150	PVC	130
826	P-321	157.54	150	PVC	130
827	P-338	466.75	200	PVC	130
828	P-352	297.39	150	PVC	130
829	P-516	279.42	300	PVC	130
830	P-353	148.39	200	PVC	130
831	P-251	100.03	250	PVC	130
832	P-487	125.54	150	PVC	130
834	P-260	113.81	150	PVC	130
835	P-284	39.85	200	PVC	130
836	P-522	201.69	200	PVC	130
837	P-332	113.72	150	PVC	130
838	P-490	99.57	200	PVC	130
839	P-423	128.51	250	PVC	130
840	P-342	101.89	250	PVC	130
841	P-410	88.43	150	PVC	130
842	P-292	108.53	250	PVC	130
843	P-387	5.84	250	PVC	130
844	P-528	146.49	300	PVC	130
845	P-250	96.57	150	PVC	130
846	P-527	101.22	200	PVC	130
847	P-482	59.77	250	PVC	130
848	P-311	60.85	150	PVC	130
849	P-494	94.86	300	PVC	130
850	P-344	122.39	150	PVC	130
851	P-437	43.42	250	PVC	130
852	P-303	93.9	300	PVC	130
854	P-268	88.48	150	PVC	130
855	P-499	100.05	300	PVC	130
856	P-355	54.94	150	PVC	130
857	P-523	71.02	200	PVC	130
858	P-324	57.13	250	PVC	130
859	P-505	213.25	250	PVC	130
860	P-290	58.23	250	PVC	130
861	P-430	161.21	150	PVC	130
862	P-385	87.29	200	PVC	130
863	P-356	144.11	150	PVC	130
864	P-489	62.4	200	PVC	130
865	P-269	96.22	300	PVC	130
866	P-288	57.87	250	PVC	130
867	P-304	68.31	200	PVC	130
868	P-330	38.87	250	PVC	130
869	P-488	129.12	250	PVC	130
870	P-422	63.79	250	PVC	130

ID	Label	Length (Scaled) (m)	Diameter (mm)	Material	Hazen-Williams C
872	P-258	96	200	PVC	130
873	P-232	47.73	250	PVC	130
874	P-511	120.91	200	PVC	130
875	P-271	59.19	150	PVC	130
876	P-302	18.65	150	PVC	130
877	P-261	71.26	150	PVC	130
878	P-283	59.51	200	PVC	130
879	P-223	61.89	150	PVC	130
880	P-421	42.02	250	PVC	130
881	P-354	277.2	150	PVC	130
882	P-246	10.95	250	PVC	130
883	P-520	386.95	250	PVC	130
884	P-417	105.13	150	PVC	130
885	P-234	175.38	200	PVC	130
886	P-412	207.84	150	PVC	145
887	P-241	141.23	200	PVC	130
888	P-295	100.07	250	PVC	130
890	P-224	183.06	250	PVC	130
892	P-314	183.07	200	PVC	130
893	P-399	331.84	150	PVC	130
894	P-525	95.01	250	PVC	130
895	P-225	125.01	300	PVC	130
896	P-495	95.25	300	PVC	130
897	P-322	166.72	150	PVC	130
898	P-229	46.48	200	PVC	130
899	P-307	90.45	300	PVC	130
900	P-243	135.65	150	PVC	130
901	P-244	45.78	150	PVC	130
902	P-273	70.07	200	PVC	130
903	P-301	96	150	PVC	130
904	P-233	161.63	200	PVC	130
905	P-396	112.54	150	PVC	130
907	P-313	124.91	200	PVC	130
908	P-337	50.98	250	PVC	130
909	P-386	133.45	150	PVC	130
910	P-272	13.81	150	PVC	130
911	P-393	25.43	150	PVC	130
912	P-319	91.76	200	PVC	130
913	P-501	53.71	300	PVC	130
914	P-390	159.34	250	PVC	130
916	P-230	140.14	150	PVC	130
917	P-419	407.76	150	PVC	130
918	P-231	93.98	300	PVC	130
919	P-524	171.94	200	PVC	130
920	P-285	47.65	200	PVC	130
921	P-247	97.72	200	PVC	130
922	P-518	300.74	300	PVC	130
923	P-492	77.21	200	PVC	130
924	P-439	137.45	150	PVC	130
925	P-429	89.34	150	PVC	145
926	P-506	52.75	250	PVC	130
927	P-432	36.35	150	PVC	130
928	P-291	99.69	300	PVC	130
929	P-389	203.53	250	PVC	130
930	P-315	55.88	200	PVC	130
931	P-496	67.61	300	PVC	130
932	P-238	104.23	250	PVC	130
933	P-404	109.47	150	PVC	130
934	P-325	97.5	150	PVC	130
935	P-339	100.58	300	PVC	130
937	P-329	109.21	250	PVC	130
938	P-253	38.23	150	PVC	130
939	P-296	70.15	250	PVC	130
940	P-406	72.58	200	PVC	130
941	P-388	173.13	150	PVC	130
942	P-222	108.09	200	PVC	130
943	P-498	260.33	150	PVC	130
944	P-270	71.81	150	PVC	130
945	P-282	160.73	150	PVC	130
946	P-293	277.75	150	PVC	130
947	P-526	134.48	300	PVC	130
948	P-519	56.45	300	PVC	130
949	P-242	143.95	150	PVC	130
950	P-418	90.88	150	PVC	130
951	P-530	83.15	250	PVC	130
952	P-226	99.63	150	PVC	130
953	P-428	169.65	200	PVC	130
954	P-420	100.86	250	PVC	130
955	P-504	53.47	250	PVC	130
956	P-312	98.06	150	PVC	130
957	P-483	89.44	250	PVC	130
959	P-514	221.99	150	PVC	130
960	P-287	59.57	200	PVC	130
961	P-440	130.94	200	PVC	130
962	P-830	178.14	200	PVC	130

ID	Label	Length (Scaled) (m)	Diameter (mm)	Material	Hazen-Williams C
963	P-831	111.9	200	PVC	130
964	P-834	108.81	200	PVC	130
965	P-835	134.11	150	PVC	130
966	P-812	345.84	150	Ductile Iron	85
968	P-810	124.52	200	PVC	130
970	P-807	56.33	200	PVC	130
971	P-813	133.3	150	PVC	130
973	P-815	99.58	250	PVC	130
974	P-816	51.19	150	PVC	130
975	P-817	54.54	150	PVC	130
976	P-818	36.03	150	PVC	130
977	P-819	63.17	150	PVC	130
978	P-820	127.18	250	PVC	130
979	P-821	87.62	150	Asbestos Cement	90
980	P-822	78.66	150	Asbestos Cement	90
981	P-823	44.56	150	PVC	130
982	P-824	88.64	150	Asbestos Cement	90
983	P-825	145.67	150	Asbestos Cement	90
984	P-826	315.42	150	Asbestos Cement	90
985	P-827	154.44	150	PVC	130
986	P-828	101.44	300	PVC	130
987	P-829	140.04	150	PVC	130
988	P-838	93.31	200	PVC	130
989	P-839	177.42	250	PVC	130
990	P-836	160.01	150	PVC	130
994	P-842	108.02	250	PVC	145
995	P-844	101.57	250	PVC	145
996	P-845	77.93	150	PVC	145
1000	P-848	116.87	150	PVC	145
1001	P-850	97.47	200	PVC	130
1002	P-854	175.21	150	PVC	130
1003	P-855	230.4	150	PVC	130
1004	P-856	91.68	200	PVC	130
1005	P-769	226.2	200	PVC	130
1006	P-770	142.01	250	PVC	130
1007	P-771	288.23	150	PVC	130
1008	P-772	211.32	250	PVC	130
1009	P-773	51.69	250	PVC	125
1010	P-774	137.02	150	PVC	130
1011	P-775	340.91	150	PVC	130
1012	P-776	103.96	250	PVC	130
1013	P-777	164.61	250	PVC	130
1015	P-779	157.4	200	PVC	130
1016	P-781	92.77	300	PVC	130
1017	P-782	176.32	250	PVC	130
1018	P-783	114.39	300	PVC	130
1019	P-784	34.59	150	PVC	140
1020	P-785	215.28	150	PVC	130
1022	P-787	98.77	150	Ductile Iron	85
1023	P-788	182.06	150	Ductile Iron	85
1024	P-789	107.36	150	Ductile Iron	85
1025	P-790	84.96	250	Ductile Iron	85
1026	P-791	114.23	250	Ductile Iron	85
1027	P-792	183.91	150	Ductile Iron	85
1028	P-793	76.43	200	PVC	140
1029	P-794	94.67	200	PVC	140
1030	P-795	142.24	150	Ductile Iron	85
1031	P-796	54	150	Ductile Iron	85
1032	P-797	142.31	150	Ductile Iron	85
1033	P-798	29.33	300	PVC	140
1034	P-799	74.56	200	PVC	140
1035	P-800	178.59	300	PVC	140
1036	P-801	68.66	250	PVC	140
1037	P-803	51.69	150	Ductile Iron	85
1038	P-804	222.79	150	PVC	140
1039	P-805	45.69	250	PVC	140
1040	P-806	91.51	150	Ductile Iron	85
1041	P-832	69.47	150	Ductile Iron	85
1042	P-851	23.77	150	Ductile Iron	85
1043	P-852	152.67	150	Ductile Iron	85
1044	P-857	21.3	150	Ductile Iron	85
1045	P-858	142.03	150	Ductile Iron	85
1046	P-859	77.98	150	Ductile Iron	85
1047	P-860	95.67	250	Ductile Iron	85
1048	P-861	119.72	250	Ductile Iron	85
1049	P-862	81.06	150	Ductile Iron	85
1050	P-863	61.13	250	Ductile Iron	85
1051	P-865	207.93	150	Ductile Iron	85
1052	P-864	45.53	250	Ductile Iron	85
1053	P-866	163.19	250	Ductile Iron	85
1054	P-867	120.51	150	Ductile Iron	85
1055	P-868	88.56	150	Ductile Iron	85
1056	P-870	108.87	250	Ductile Iron	85
1057	P-871	100.46	150	Ductile Iron	85
1058	P-872	142.48	150	Ductile Iron	85

ID	Label	Length (Scaled) (m)	Diameter (mm)	Material	Hazen-Williams C
1059	P-873	102.55	150	Ductile Iron	85
1060	P-874	18.31	150	Ductile Iron	85
1061	P-875	13.29	250	Ductile Iron	85
1062	P-876	103.56	250	Ductile Iron	85
1063	P-877	165.57	150	Ductile Iron	85
1064	P-878	99.11	150	Ductile Iron	85
1065	P-879	101.09	150	Ductile Iron	85
1066	P-880	99.94	250	Ductile Iron	85
1067	P-881	104.33	250	Ductile Iron	85
1068	P-882	189.22	150	Ductile Iron	85
1069	P-883	106.18	250	Ductile Iron	85
1070	P-884	44.96	300	PVC	140
1071	P-885	184.13	300	Ductile Iron	85
1072	P-886	41.4	250	Ductile Iron	85
1073	P-887	103.17	150	Ductile Iron	85
1074	P-888	104.66	150	Ductile Iron	85
1075	P-889	142.94	150	Ductile Iron	85
1076	P-890	103.12	200	PVC	140
1077	P-891	179.84	150	Ductile Iron	85
1078	P-893	7.56	200	PVC	140
1079	P-894	253.21	200	PVC	140
1080	P-895	121.99	150	Ductile Iron	85
1081	P-896	101.04	150	PVC	140
1082	P-897	104.37	200	PVC	140
1083	P-898	118.04	200	PVC	140
1084	P-899	185.33	150	Ductile Iron	85
1085	P-900	241.73	200	PVC	130
1086	P-901	122.91	150	PVC	130
1087	P-902	124.79	150	PVC	130
1089	P-904	82.77	150	PVC	130
1090	P-905	62.23	200	PVC	130
1091	P-907	273.4	150	PVC	130
1092	P-906	95.73	200	PVC	130
1094	P-909	80.55	150	PVC	130
1095	P-910	86.12	250	Ductile Iron	85
1096	P-911	31.55	250	Ductile Iron	85
1097	P-912	234.68	150	Ductile Iron	85
1098	P-913	217.05	150	PVC	130
1099	P-914	36.45	150	PVC	130
1100	P-915	78.04	150	PVC	130
1101	P-916	217.52	150	PVC	130
1102	P-917	34.4	150	PVC	130
1103	P-918	111.32	150	PVC	130
1104	P-919	166.07	300	Ductile Iron	85
1105	P-920	116.92	300	Ductile Iron	85
1106	P-921	51.33	150	PVC	130
1107	P-922	59.91	150	PVC	130
1108	P-923	52.25	150	PVC	130
1109	P-924	117.15	150	PVC	130
1110	P-925	73.66	150	PVC	130
1113	P-928	166.98	150	Ductile Iron	85
1114	P-929	152.5	150	Ductile Iron	85
1115	P-930	167.27	150	Ductile Iron	85
1116	P-931	153.15	150	Ductile Iron	85
1117	P-932	100.45	150	Ductile Iron	85
1118	P-933	182.73	300	Ductile Iron	85
1119	P-934	154.33	300	Ductile Iron	85
1120	P-935	103.38	150	Ductile Iron	85
1121	P-936	99.41	250	Ductile Iron	85
1122	P-937	105.33	250	Ductile Iron	85
1123	P-938	103.62	150	Ductile Iron	85
1124	P-939	102.86	150	Ductile Iron	85
1125	P-940	241.87	150	Ductile Iron	85
1126	P-941	198.41	200	PVC	130
1127	P-942	43.08	300	PVC	130
1128	P-943	241.01	150	PVC	130
1129	P-944	184.63	150	PVC	130
1141	P-958	92.98	300	PVC	130
1142	P-960	36.64	300	PVC	130
1143	P-961	103.81	300	PVC	130
1148	P-966	219.24	300	PVC	130
1160	P-978	101.75	250	PVC	130
1161	P-979	353.17	250	PVC	130
1162	P-981	409.57	200	PVC	130
1163	P-982	151.51	250	PVC	130
1166	P-985	74.61	300	PVC	130
1167	P-986	394.41	150	PVC	130
1168	P-987	121.62	300	PVC	130
1169	P-988	138.61	300	PVC	130
1170	P-989	88.43	150	PVC	130
1171	P-990	241.34	300	PVC	130
1172	P-991	56.99	200	PVC	130
1175	P-994	211.04	300	PVC	130
1176	P-995	101.23	300	PVC	130
1177	P-996	131.33	150	PVC	130

ID	Label	Length (Scaled) (m)	Diameter (mm)	Material	Hazen-Williams C
1178	P-997	200.2	300	PVC	130
1180	P-999	36.8	150	PVC	130
1182	P-1001	91.07	300	PVC	130
1183	P-1002	95.98	300	PVC	130
1184	P-1003	188.1	200	PVC	130
1185	P-1004	132.38	150	PVC	130
1190	P-1009	69.23	150	PVC	130
1191	P-1010	104.15	200	PVC	130
1192	P-1011	30.86	200	PVC	130
1193	P-1012	39.22	200	PVC	130
1199	P-1019	61.73	150	Asbestos Cement	90
1200	P-1018	69.86	250	PVC	125
1201	P-1020	31.17	250	PVC	130
1202	P-1022	328.23	500	Concrete (centrif. spun)	85
1213	P-1036	46.73	200	PVC	130
1214	P-1037	252.42	200	PVC	130
1217	P-1040	252.82	200	PVC	130
1218	P-1041	233.1	200	PVC	130
1219	P-1042	7.29	200	PVC	130
1294	P-1137	92.37	300	PVC	130
1352	P-1159	44.7	200	PVC	130
1353	P-1160	54.78	200	PVC	130
1355	P-1161	51.42	200	PVC	130
1356	P-1162	44.53	200	PVC	130
1358	P-1164	289.83	150	PVC	130
1360	P-1165	40.88	200	PVC	130
1361	P-1166	67.34	200	PVC	130
1363	P-1167	105.78	150	PVC	130
1365	P-1168	127.38	200	PVC	130
1367	P-1169	29.53	150	PVC	130
1368	P-1170	117.47	200	PVC	130
1373	P-1173	94.76	150	PVC	130
1374	P-1174	93.95	200	PVC	130
1376	P-1175	131.38	150	PVC	130
1378	P-1176	134.1	200	PVC	130
1379	P-1177	199.99	150	PVC	130
1380	P-1178	94.37	200	PVC	130
1392	P-1186	96.33	150	PVC	130
1393	P-1187	88.37	150	PVC	130
1405	P-1194	90.69	250	PVC	130
1448	P-1216	55.22	300	PVC	130
1782	P-1405	40.23	250	PVC	130
1784	P-1406	102.22	150	PVC	130
1790	P-1411	700.86	250	PVC	130
1859	P-1455	100.32	150	PVC	130
1862	P-1457	185.51	150	PVC	130
1865	P-1459	64.18	500	Concrete	85
1866	P-1460	94.14	500	Concrete	85
1872	P-1464	12.76	200	Ductile Iron	85
1873	P-1465	87.16	200	Ductile Iron	85
1874	P-1466	80.16	200	PVC	130
1875	P-1467	49.13	150	PVC	130
1914	P-1495	92.13	200	PVC	130
1915	P-1496	50.69	200	PVC	130
1916	P-1497	174.45	150	PVC	130
1918	P-1498	268.39	500	Concrete (centrif. spun)	85
1919	P-1499	70.91	500	Concrete (centrif. spun)	85
1926	P-1505	12.28	200	PVC	130
1937	P-1512	55.78	150	PVC	130
1938	P-1513	61.73	150	PVC	130
1957	P-1525	114.72	300	Ductile Iron	85
1958	P-1526	6.57	300	Ductile Iron	85
1959	P-1527	174.42	150	Ductile Iron	85
1961	P-1528	106.91	150	Ductile Iron	85
1962	P-1529	9.4	150	Ductile Iron	85
1966	P-1531	34.02	250	PVC	130
1968	P-1533	218.61	250	PVC	140
1970	P-1534	12.77	250	Ductile Iron	85
1973	P-1536	15.13	150	PVC	145
1976	P-1538	14.23	250	Ductile Iron	85
1977	P-1539	169.44	250	PVC	140
1979	P-1540	4.9	150	Ductile Iron	85
1980	P-1541	20.09	150	Ductile Iron	85
1981	P-1542	173.6	150	Ductile Iron	85
1983	P-1543	216.15	300	PVC	130
1990	P-1544	76.63	150	Ductile Iron	85
1991	P-1545	155.14	150	Ductile Iron	85
2002	P-1550	117.89	150	PVC	130
2011	P-1556	29.64	150	PVC	130
2020	P-1562	78.14	150	PVC	130
2035	P-1574	131.61	200	PVC	145
2037	P-1575	92.49	200	PVC	145
2039	P-1576	135.19	150	PVC	145
2041	P-1577	160.72	150	PVC	145
2043	P-1578	140.63	150	PVC	145

ID	Label	Length (Scaled) (m)	Diameter (mm)	Material	Hazen-Williams C
2045	P-1579	149.43	200	PVC	145
2048	P-1581	88.99	200	PVC	145
2053	P-1584	79.67	150	PVC	145
2054	P-1585	59.31	150	PVC	145
2056	P-1586	41.52	200	PVC	145
2058	P-1588	77.39	150	PVC	145
2060	P-1589	86.8	150	PVC	130
2062	P-1590	93.23	150	PVC	130
2064	P-1591	61.04	150	PVC	130
2066	P-1592	59.37	150	PVC	130
2068	P-1593	86.36	150	PVC	130
2072	P-1597	29.49	250	PVC	130
2077	P-1601	161.78	150	Ductile Iron	85
2082	P-1605	104.13	200	Asbestos Cement	90
2083	P-1606	92.47	200	Asbestos Cement	90
2084	P-1607	126.42	150	Ductile Iron	85
2087	P-1609	39.91	150	Ductile Iron	85
2088	P-1610	88.65	150	PVC	140
2095	P-1615	42.08	250	PVC	130
2096	P-1616	85.32	250	PVC	130
2098	P-1617	98.88	150	PVC	130
2101	P-1619	41.63	250	PVC	130
2103	P-1620	97.83	150	PVC	130
2108	P-1623	98.35	150	PVC	130
2110	P-1624	110.04	250	PVC	130
2113	P-1626	102.17	150	PVC	130
2115	P-1627	44.25	250	PVC	130
2116	P-1628	86.55	250	PVC	130
2118	P-1629	100.45	150	PVC	130
2120	P-1630	5.61	250	PVC	130
2124	P-1633	45.63	250	PVC	130
2127	P-1635	157.52	250	PVC	130
2128	P-1636	75.17	250	PVC	130
2130	P-1637	44.79	150	PVC	130
2138	P-1640	88.03	250	PVC	130
2143	P-1642	289.74	250	PVC	130
2144	P-1643	282.28	250	PVC	130
2149	P-1647	221.28	200	PVC	130
2153	P-1650	92.9	200	PVC	130
2155	P-1651	126.73	200	PVC	130
2156	P-1652	98.07	200	PVC	130
2158	P-1654	54.69	300	PVC	130
2161	P-1656	138.58	200	PVC	140
2167	P-1660	109.47	150	PVC	130
2170	P-1662	174.71	150	PVC	130
2171	P-1663	130.12	150	PVC	130
2173	P-1664	51.76	200	Asbestos Cement	90
2174	P-1665	65.69	200	Asbestos Cement	90
2176	P-1666	109.76	150	Asbestos Cement	90
2177	P-1667	188.53	150	Asbestos Cement	90
2199	P-1678	235.38	150	PVC	130
2211	P-1684	170.67	200	PVC	130
2215	P-1685	56.79	150	PVC	130
2222	P-1690	251.3	400	PVC	130
2224	P-1691	159.86	300	PVC	130
2226	P-1692	63.44	300	PVC	130
2228	P-1693	113.38	300	PVC	130
2232	P-1695	148.36	300	PVC	130
2234	P-1696	49.21	300	PVC	130
2236	P-1697	124.89	300	PVC	130
2240	P-1699	103.13	300	PVC	130
2244	P-1701	142.11	200	PVC	130
2246	P-1702	99.91	150	PVC	130
2248	P-1703	75.92	150	PVC	130
2250	P-1704	88.94	150	PVC	130
2255	P-1707	325.02	300	PVC	130
2256	P-1708	53.92	300	PVC	130
2258	P-1709	14.53	300	PVC	130
2270	P-1716	123.03	200	PVC	130
2273	P-1718	129.07	200	PVC	130
2275	P-1719	312.17	150	PVC	130
2276	P-1720	146.77	200	PVC	130
2282	P-1723	145.66	200	PVC	145
2283	P-1724	90.37	200	PVC	145
2286	P-1725	203.03	200	PVC	130
2287	P-1726	177.98	200	PVC	130
2289	P-1727	54.34	250	PVC	130
2296	P-1731	89.35	250	PVC	145
2299	P-1733	110.87	250	PVC	145
2302	P-1735	125.45	300	PVC	130
2303	P-1736	75.42	300	PVC	130
2309	P-1740	40.64	250	Ductile Iron	85
2311	P-1741	64.64	250	Ductile Iron	85
2312	P-1742	30.28	250	Ductile Iron	85
2320	P-1747	89.79	200	PVC	130

ID	Label	Length (Scaled) (m)	Diameter (mm)	Material	Hazen-Williams C
2321	P-1748	21.96	200	PVC	130
2327	P-1749	44.09	300	PVC	130
2329	P-1750	158.75	300	PVC	130
2331	P-1751	95.72	200	PVC	130
2333	P-1752	58.7	200	PVC	130
2335	P-1753	47.94	150	PVC	130
2336	P-1754	94.51	150	PVC	130
2339	P-1755	213.88	200	PVC	130
2341	P-1756	65.59	200	PVC	130
2343	P-1757	50.78	200	PVC	130
2345	P-1758	100.69	200	PVC	130
2347	P-1759	97.79	200	PVC	130
2349	P-1760	101.06	200	PVC	130
2350	P-1761	96.44	200	PVC	130
2352	P-1762	172.4	300	PVC	130
2354	P-1763	68.08	200	PVC	130
2356	P-1764	47.1	200	PVC	130
2358	P-1765	79.52	200	PVC	130
2360	P-1766	93.18	200	PVC	130
2362	P-1767	106.32	200	PVC	130
2364	P-1768	159.85	200	PVC	130
2366	P-1769	130.3	200	PVC	130
2368	P-1770	96.38	150	PVC	130
2370	P-1771	162.07	150	PVC	130
2371	P-1772	100.1	150	PVC	130
2373	P-1773	95.73	200	PVC	130
2375	P-1774	42.77	200	PVC	130
2377	P-1775	44.85	150	PVC	130
2379	P-1776	94.61	200	PVC	130
2385	P-1779	13.57	200	PVC	130
2387	P-1780	121.1	300	PVC	130
2388	P-1781	29.34	300	PVC	130
2389	P-1782	115.58	200	PVC	130
2390	P-1783	114.6	200	PVC	130
2391	P-1784	120.87	200	PVC	130
2393	P-1785	188.3	150	PVC	130
2400	P-1788	202.77	200	PVC	130
2401	P-1789	109.45	150	PVC	130
2403	P-1790	57.41	200	PVC	130
2405	P-1791	49.18	250	PVC	130
2407	P-1792	131.65	150	PVC	130
2409	P-1793	16.87	200	PVC	130
2411	P-1794	24.38	200	PVC	130
2413	P-1795	73.68	200	PVC	130
2415	P-1796	66.69	200	PVC	130
2417	P-1797	95.57	200	PVC	130
2419	P-1798	78.45	200	PVC	130
2421	P-1799	16.42	300	PVC	130
2422	P-1800	84.83	300	PVC	130
2423	P-1801	36.41	200	PVC	130
2426	P-1802	54.07	200	PVC	130
2427	P-1803	102.34	200	PVC	130
2429	P-1804	166.44	200	PVC	130
2431	P-1805	112.29	200	PVC	140
2432	P-1806	112.46	200	PVC	140
2434	P-1807	112.37	150	Ductile Iron	85
2435	P-1808	110.86	150	Ductile Iron	85
2436	P-1809	183.98	150	Ductile Iron	85
2439	P-1810	47.06	150	Asbestos Cement	90
2440	P-1811	47.1	150	Asbestos Cement	90
2447	P-1815	42.8	150	PVC	130
2448	P-1816	47.92	150	PVC	130
2450	P-1817	96.99	200	PVC	130
2452	P-1818	33.38	150	PVC	130
2454	P-1819	60.64	150	PVC	130
2456	P-1820	123.06	200	PVC	130
2458	P-1821	113.09	200	PVC	130
2460	P-1822	37.67	200	PVC	130
2462	P-1823	158.5	200	PVC	130
2463	P-1824	35.17	150	PVC	130
2469	P60k-1828	427.59	200	PVC	130
2471	P-1829	11.48	200	PVC	145
2472	P-1830	122.73	200	PVC	145
2476	P-1832	82.69	200	PVC	145
2478	P-1834	119.95	200	PVC	145
2480	P-1835	78.37	200	PVC	145
2481	P-1836	85.37	200	PVC	140
2484	P-1837	93.65	250	Ductile Iron	85
2485	P-1838	113.9	250	Ductile Iron	85
2486	P-1839	55.89	150	PVC	130
2489	P-1840	30.09	200	PVC	145
2490	P-1841	15.02	200	PVC	145
2491	P-1842	64.36	150	PVC	145
2493	P-1843	10.55	300	PVC	130
2494	P-1844	201.78	300	PVC	130

ID	Label	Length (Scaled) (m)	Diameter (mm)	Material	Hazen-Williams C
2495	P-1845	147.25	150	PVC	130
2497	P-1846	108.2	400	PVC	130
2498	P-1847	109.98	400	PVC	130
2500	P-1848	56.2	350	Ductile Iron	85
2501	P-1849	46.59	350	Ductile Iron	85
2505	P-1850	87.29	300	PVC	130
2506	P-1851	13.97	300	PVC	130
2508	P-1852	8.03	300	PVC	130
2510	P-1853	147.45	250	PVC	130
2511	P-1854	16.16	250	PVC	130
2513	P-1855	4.76	150	PVC	130
2515	P-1856	197.44	300	PVC	130
2516	P-1857	15.8	300	PVC	130
2518	P-1858	5.15	150	PVC	130
2520	P-1859	103.48	200	PVC	145
2521	P-1860	19.35	200	PVC	145
2523	P-1861	8.99	300	PVC	145
2525	P-1862	7.29	150	PVC	130
2527	P-1863	18.21	300	Ductile Iron	85
2528	P-1864	98.66	300	Ductile Iron	85
2530	P-1865	6.97	150	PVC	130
2532	P-1866	15.79	150	PVC	130
2533	P-1867	234.94	150	PVC	130
2535	P-1868	5.48	150	PVC	130
2537	P-1869	5.54	150	PVC	130
2539	P-1870	99.57	250	PVC	130
2540	P-1871	19.69	250	PVC	130
2542	P-1872	6.34	150	PVC	130
2544	P-1873	14.25	150	PVC	130
2545	P-1874	135.14	150	PVC	130
2547	P-1875	22.61	150	PVC	130
2550	P-1876	25.09	500	PVC	130
2551	P-1877	20.22	500	PVC	130
2553	P-1878	28.74	500	Concrete (centrif. spun)	85
2590	P-1880	529.74	150	PVC	145
2591	P-1881	9.75	150	PVC	145
2597	P-1884	8.52	300	PVC	145
2599	P-1885	11.1	250	Ductile Iron	85
2600	P-1886	124.82	250	Ductile Iron	85
2602	P-1887	3.75	150	PVC	140
2604	P-1888	8.32	300	Ductile Iron	85
2605	P-1889	117.92	300	Ductile Iron	85
2607	P-1890	5.91	150	PVC	130
2629	P-1895	86.68	200	PVC	130
2653	P-1904	545.65	500	PVC	140
2657	P-1906	64.63	750	PVC	140
2658	P-1907	26.74	300	PVC	140
3053	P60k-232	643.96	200	PVC	130
3413	P60k-467	961.1	200	PVC	130
3476	P60k-495	302.84	300	PVC	140
3480	P60k-496(1)	314.7	250	PVC	140
3483	P-1734(1)	74.4	250	PVC	145
3484	P-1734(2)	25.86	250	PVC	145
3486	P-521(1)	35.01	150	PVC	130
3487	P-521(2)	252.48	150	PVC	130
3488	P60k-497	54.89	250	PVC	140
3490	48 Ave/44 St(1)	55.6	150	Ductile Iron	85
3491	48 Ave/44 St(2)	43.27	150	Ductile Iron	85
3492	P60k-498	218.93	150	PVC	140
3493	P60k-499	319.19	200	PVC	140
3495	P-1008(1)	203.23	300	PVC	130
3496	P-1008(2)	45.39	300	PVC	130
3498	P60k-500	312.5	200	PVC	140
3499	P60k-501	110.93	300	PVC	140
3500	P60k-502	165.08	300	PVC	140
3502	P-1786(1)	95.35	150	PVC	130
3503	P-1786(2)	87.2	200	PVC	130
3505	P-1705(1)	178.51	300	PVC	130
3506	P-1705(2)	57.83	300	PVC	130
3510	P60k-503	250.12	200	PVC	140
3519	P-786(2)	74.38	150	PVC	130
3521	P-786(1)(1)	74.47	150	PVC	130
3522	P-786(1)(2)	54.06	150	PVC	150
3525	Lakeshore Dr/34 St(1)	71.78	200	PVC	140
3526	Lakeshore Dr/34 St(2)	54.45	150	Ductile Iron	85
3530	P-1659(1)	18.83	150	PVC	130
3531	P-1659(2)	20.47	150	PVC	130
3573	P60k-479(2)	15.05	500	PVC	140
3747	P60k-468(1)	77.79	200	PVC	140
3748	P60k-468(2)	78.63	200	PVC	140
3822	P60k-496(2)(1)	168.57	200	PVC	140
3823	P60k-496(2)(2)	159.6	200	PVC	140
3886	P60k-514(1)	23.49	500	PVC	150
3887	P60k-514(2)	20.63	500	PVC	150
4021	P60k-585	163.74	300	PVC	140

ID	Label	Length (Scaled) (m)	Diameter (mm)	Material	Hazen-Williams C
4039	P-1414(1)	43.17	150	PVC	140
4079	P-1510	183.19	150	PVC	140

Legend

Water Network

Diameter (mm)

- 150
- 200
- 250
- 300
- 350
- 400
- 500

Coordinate System:
NAD 1983 3TM 114

1:15,000

0 150 300 600 Meters

EXHIBIT A.1

EXISTING WATER MODEL
PIPE DATABASE

ISL

Date: 2020-05-15 Document: G:\Projects\15000\15200\15222_North_Res_Design_Construction\02_CADD\25_GIS\251_Figures\Additional Hydraulic Modeling Scope Change\GIS\A.1_Pipe_Labels.mxd

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APPENDIX B
Costing

Table B.1: Detailed Cost Estimate Breakdown

Growth Projection	Item	Description	PRV / Reservoir Cost Base Cost Estimate ($)	Case Boring Length (m)	Case Boring Unit Cost ($/m)	Open Cut Length (m)	Size (mm)	Unit Cost ($/m)	Construction ($)	Engineering ($) (Assumed 15 %)	Contingency ($) (30 %)	Total ($)
Existing System Upgrades	2	Construct NE Gateway 450 mm line along alignment option 2.	$ -	60	$ 800	4,585	450	$ 631	$ 2,941,000	$ 441,000	$ 882,000	$ 4,264,000
	5	Tie in dead end on Sylvaire Close into NE Gateway along Hwy 11a.	$ -	0	$ -	141	300	$ 417	$ 59,000	$ 9,000	$ 18,000	$ 86,000
	6. a)	Upgrade existing 250 mm on Cuendet to a 450 mm from NE Gateway to Charles Ind. Way.	$ -	0	$ -	91	450	$ 791	$ 72,000	$ 11,000	$ 22,000	$ 105,000
	6. b)	Upgrade existing 250 mm on Cuendet to a 350 mm main from Charles Ind. Way to Schenk Ind. Rd.	$ -	0	$ -	174	350	$ 724	$ 126,000	$ 19,000	$ 38,000	$ 183,000
	7	Upgrade the existing 200 mm main on Industrial Dr. to a 350 mm main from Cuendet Ind. Way to Erickson Dr.	$ -	0	$ -	467	350	$ 724	$ 338,000	$ 51,000	$ 101,000	$ 490,000
	8	Install a 300 mm main east along Cole Way from 50 St and tie into the existing 150 mm dead end.	$ -	0	$ -	74	300	$ 577	$ 43,000	$ 6,000	$ 13,000	$ 62,000
	9	300 mm loop along 48 Ave, south along 60 St and connecting through Fieldstone Way. Extend north along 60 St to existing 200 mm main north of Wildrose Dr.	$ -	150	$ 800	1,855	300	$ 417	$ 894,000	$ 134,000	$ 268,000	$ 1,296,000
	10. a)	250 mm connection from 47 St to 48 St along 45 Ave.	$ -	0	$ -	119	250	$ 528	$ 63,000	$ 9,000	$ 19,000	$ 91,000
	10. b)	Upgrade the main on 49 St south of 47 Ave to 300 mm.	$ -	0	$ -	632	300	$ 577	$ 365,000	$ 55,000	$ 109,000	$ 529,000
	11. a)	300 mm main from Broadway Rise to Lucky Pl.	$ -	0	$ -	930	300	$ 417	$ 388,000	$ 58,000	$ 116,000	$ 562,000
	11. b)	PRV along 300 mm main from Broadway Rise to Lucky Pl. set to HGL = 1,018 m.	$ 100,000	0	$ -	0	-	$ -	$ 100,000	$ 15,000	$ 30,000	$ 145,000
										Existing Upgrades Total		$ 7,813,000
STDP	12. a)	Upgrade main on 53 St between 50 Ave and Lakeshore Dr to 200 mm.	$ -	0	$ -	452	200	$ 479	$ 217,000	$ 32,000	$ 65,000	$ 314,000
	12. b)	200 mm mains on 50b Ave (53 - 52 St), 50a Ave (53-52 St including the loop in Rainbow Park Condominiums), and 51 St & 51a St (Lakeshore Dr - 50a Ave).	$ -	0	$ -	1,072	200	$ 479	$ 513,000	$ 77,000	$ 154,000	$ 744,000
	13	Upgrade the main on 44 St between 50 Ave and Lakeshore Dr to 200 mm.	$ -	0	$ -	209	200	$ 479	$ 100,000	$ 15,000	$ 30,000	$ 145,000
										STDP Total		$ 1,203,000
22K	15. a)	Install a 250 mm main on 60 St south of the existing 200 mm main that cross 60 St near Lakeland Rd.	$ -	30	$ -	284	300	$ 417	$ 118,000	$ 18,000	$ 36,000	$ 172,000
	15. b)	Extend a 250 mm main west along Memorial Trail from Lakeway Blvd to 60 St.	$ -	30	$ -	508	300	$ 417	$ 212,000	$ 32,000	$ 64,000	$ 308,000
	16	Temporary looping of Pogadl Park into 60 St and Memorial Tr and west of the intersection of 60 St and Lakeway Blvd.	$ -	30	$ 800	592	300	$ 417	$ 271,000	$ 41,000	$ 81,000	$ 393,000
										22K Total		$ 873,000
30K	17	Looping into Pogadl Park from north of David Thompson Highway & disconnecting temporary looping.	$ -	60	$ 800	781	300	$ 417	$ 374,000	$ 56,000	$ 112,000	$ 542,000
										30K Total		$ 542,000
45K	18	Install a new discharge header from the North Reservoir to North Sanbar.	$ -	30	$ -	1,469	300	$ 417	$ 613,000	$ 92,000	$ 184,000	$ 889,000
	19	Loop dead end on Industrial Dr into Northern Gateway grid for improved fire flows.	$ -	30	$ 800	104	300	$ 417	$ 67,000	$ 10,000	$ 20,000	$ 97,000
										45K Total		$ 986,000
60K										60K Total		$ -
75 - 100K	20	Commission West Reservoir with a discharge header HGL = 1,034 m.	$ 8,294,000	0	$ -	0	-	$ -	$ 8,294,000	$ 1,244,000	$ 2,488,000	$ 12,026,000
	21	Five PRVs south of Township Rd 390 set to 1,020 m to transition from upper zone to middle zone.	$ 500,000	0	$ -	0	-	$ -	$ 500,000	$ 75,000	$ 150,000	$ 725,000
	22	Four PRVs north of Township Rd 390 set to 996 m are required to transition from middle zone to lower zone.	$ 400,000	0	$ -	0	-	$ -	$ 400,000	$ 60,000	$ 120,000	$ 580,000
	23	Two PRVs separating the 45K southeast area (upper zone) from the southeast middle zone.	$ 200,000	0	$ -	0	-	$ -	$ 200,000	$ 30,000	$ 60,000	$ 290,000
	24	Two PRVs separating lower zone of Lighthouse Pointe from the very low area of the 100K SE area.	$ 200,000	0	$ -	0	-	$ -	$ 200,000	$ 30,000	$ 60,000	$ 290,000
										100K Total		$ 13,911,000
										TOTAL COST		$ 25,328,000

Notes:
1. PRV costs assumed to be $100,000, not including contingency or engineering.
2. Reservoir cost assumed to be $1,000/m³.
3. Road rehabilitation and restoration costs added into base unit cost where applicable. Assume $160/m.