REPORT

Town of Bon Accord

Sanitary Master Plan Update

OCTOBER 2019

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1 INTRODUCTION

1.1 Background

Recent interest in new development within the Town of Bon Accord has triggered a need for the Town to update their current utility and transportation information. The Town would like the ability to provide potential developers a framework in which to plan their developments while meeting the Town's vision for growth. As such, the Town has engaged Associated Engineering to develop Water, Sanitary, Storm, and Transportation Master Plans for the Town.

1.2 Study Area

The Study Area, presented on **Figure 1-1**, is comprised of approximately six quarter sections, with undeveloped lands located north, west, and east of the current development area. Future development is anticipated to include commercial land to the southwest, industrial land to the northeast, and residential development to the west, north, and east. The topography is generally flat, with low ridge lines occurring throughout the future development areas. There is a large low area in the southeast corner of the Town and there are additional isolated local low areas throughout the future development areas.

1.3 Scope and Objectives

The primary objective of this project is to develop Water, Sanitary, Storm, and Transportation Master Plans for the Town of Bon Accord. The Master Plans are intended to provide guidance for system planning and operation, to identify and prioritize capital upgrades, and to establish high level servicing concepts to guide future development.

In general, the scope of work for each utility will involve the following major tasks:

- Review background information;
- Establish design criteria;
- Evaluate the existing system;
- Propose recommended upgrades to the existing system;
- Develop an ultimate development servicing concept;
- Establish high level capital cost estimates; and
- Prepare a comprehensive report complete with conclusions and recommendations.

1.4 References

In the preparation of this Sanitary Master Plan, we reviewed the following documents:

- Town of Bon Accord Servicing Master Plan (AECOM, 2010);
- Town of Bon Accord Annexation Servicing Study (MPE Engineering, 2016);
- Re-imagine. Plan. Build. Edmonton Metropolitan Region Growth Plan (Edmonton Metropolitan Region Board, 2017);
- Town of Bon Accord Minimum Design Standards for Design of Local Improvements (2003);
- Town of Bon Accord Wastewater Collection Annual Reports (2013 through April 2019);
- Municipal Affairs Population Lists (Government of Alberta, 2013 through 2018); and
- Available Record Drawings.

1.5 Acknowledgements

Associated Engineering gratefully recognizes the contributions from the Town of Bon Accord in the development of this Master Plan. Special thanks to Joyce Pierce, Ken Reil, and Dianne Allen who collaborated on this project.

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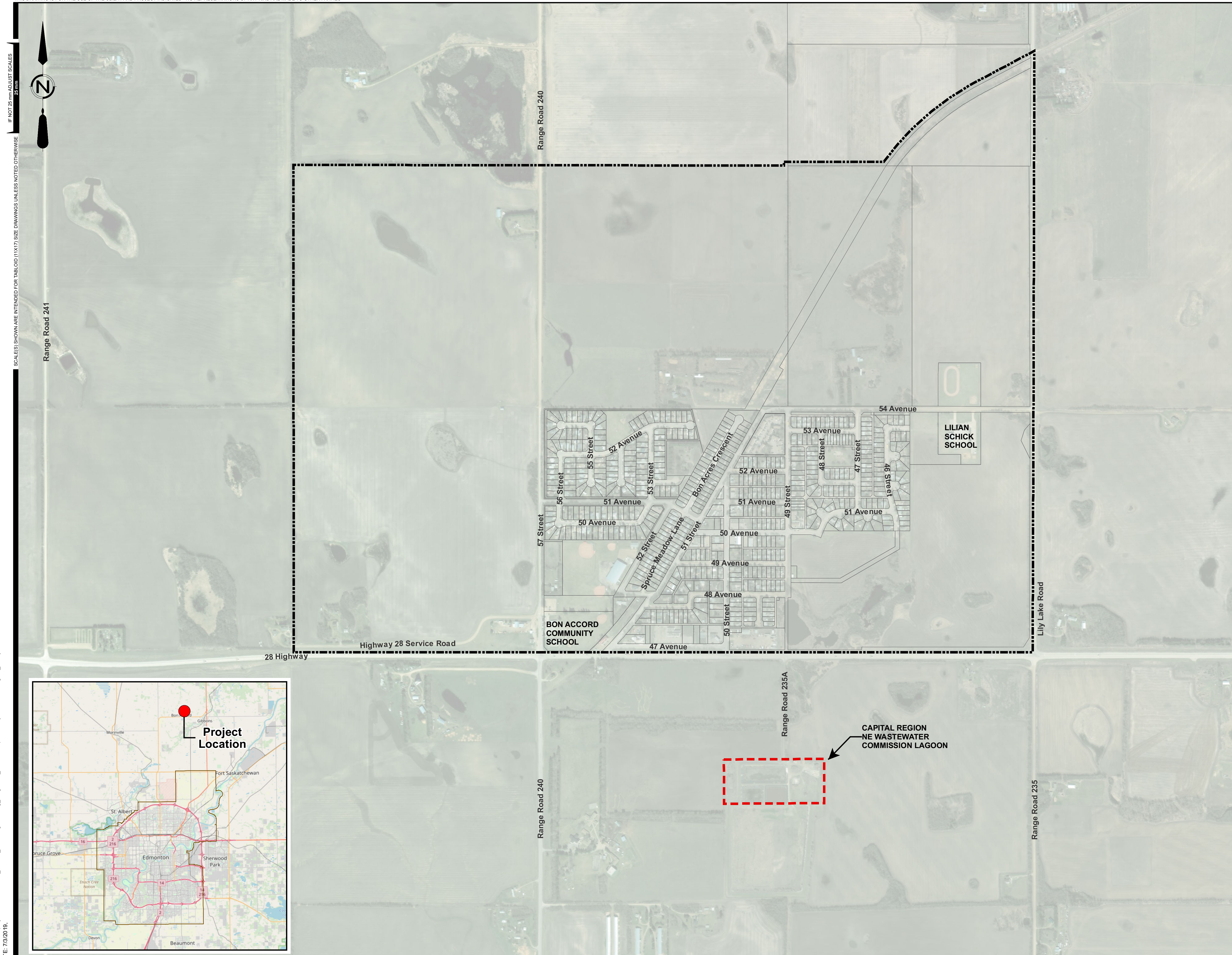
SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

IF NOT 25 mm ADJUST SCALES



Associated Engineering

Legend:

- Lagoon
- Town Boundary

Town of Bon Accord
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FIGURE No. 1-1

TOWN OF BON ACCORD
SANITARY MASTER PLAN UPDATE

STUDY AREA AND KEY PLAN

AE PROJECT No.	2019-3459
SCALE	1:12,000
COORD. SYSTEM	NAD 1983 3TM 114
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

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DATE: 7/3/2019.

2 DESIGN CRITERIA

2.1 General

2.1.1 Population

One of the main variables in assessing a community's municipal servicing components is the population. The population will provide a measure of the quantity of wastewater generated and will have an impact on the distribution and collection systems based on population density.

Table 2-1 presents historical population for the Town of Bon Accord, from 1996 onward, obtained from federal census data. Based on the data, the average annual growth rate was 0.12% from 1996 through 2016.

Table 2-1
Historical Population Statistics

Year	Population	5 Year Annual Growth Rate
1996	1,493	
2001	1,532	+0.5%
2006	1,534	+0.03%
2011	1,488	-0.6%
2016	1,529	+0.6%

The Edmonton Metropolitan Region Board (EMRB) published "Re-imagine. Plan. Build. Edmonton Metropolitan Region Growth Plan" in 2017. In this document, the EMRB projects that the Town will have a population ranging from 2,700 to 3,300 by the year 2044. This results in an average annual growth rate ranging from 2.1% per year to 2.8% per year.

The Annexation Servicing Study (MPE Engineering, 2016) applied a growth rate of 2%.

Based on a meeting with the Town on March 22, 2019, the Town proposed an annual growth rate of 0.5% to 1.0%; therefore, our analysis used an annual growth rate of 1.0%. A population of 1,575 people has been established for 2019, using the 2016 historical population and an annual growth rate of 1.0%.

Table 2-2 presents the projected population for the next 25 years, in 5-year increments.

Table 2-2
Projected Population (25 Years)

Year	Population
2019	1,575
2024	1,656
2029	1,740
2034	1,829
2039	1,922
2044	2,020

2.1.2 Population Density

Population densities are used to estimate the population or equivalent population for different land use areas. These values are used in conjunction with the per capita daily consumption / sewage generation rates to estimate the demands on the water system and flows within the sewer system.

Population densities for several communities have been reviewed, compared, and discussed with the Town; our analyses used the following population densities:

Existing Development Areas

- Single Family Residential / Low Density Residential — 30 people / ha
- Multi-Family Residential / Medium Density Residential — 75 people / ha (2.5 times the density of Single Family Residential)
- High Density Residential (walk-up apartments) — 150 people / ha (5 times the density of Single Family Residential)
- Commercial / Institutional (equivalent population, ep) — 30 ep / ha
- Industrial (equivalent population, ep) — 25 ep / ha

Future Development Areas

- Single Family Residential — 40 people / ha
- Commercial / Institutional (equivalent population, ep) — 30 ep / ha
- Industrial (equivalent population, ep) — 25 ep / ha

2.1.3 Land Use

Refer to **Figure 2-1** for the Land Use Map, developed for use for this project. **Figure 2-1** is a compilation of the land use map presented in the 2016 Town of Bon Accord Land Use Bylaw, the "Meadows of Bon Accord Servicing Study" (Stantec, 2007), and the "Annexation Servicing Study" (MPE Engineering, 2016). Some adjustments have been made to the various existing and proposed land use designations as appropriate for the current project.

2.2 Sanitary System

Wastewater is comprised of dry weather flow and wet weather flow. The dry weather flow is the wastewater generated by people during their day-to-day activities in their homes and businesses. Wet weather flow is generated through rainwater inflow and groundwater infiltration. Residential wastewater is calculated based on the estimated population determined by the zoning of the development. Wastewater flows from commercial developments are either based on an equivalent population or the average daily rate of flow per area of development.

2.2.1 Dry Weather Flows (DWF)

2.2.1.1 Residential Dry Weather Flow

Sanitary flows from residential land uses are calculated using the following formula:

$$Q_{PDW} = G*P*PF / 86,400$$

Where:

Q_{PDW} = peak dry weather flow rate (L/s)
G = per capita daily sewage generation rate
P = contributing population
PF = residential peaking factor

G, Per Capita Daily Sewage Generation Rate

The Town of Bon Accord has provided water consumption and wastewater generation records for the past six years. A summary is provided in Table 2-3.

Table 2-3
Historical Wastewater Generation

	2013	2014	2015	2016	2017	2018[1]	2019[2]
Total Water Usage (m^3/year – Excluding Truck Fill Usage)	152,901	146,056	147,058	105,340	102,213	40,236	35,074
Total Wastewater Generated (m^3/year)	125,911	128,780	112,779	68,964	70,223	22,936	15,937
Percent Wastewater	82%	88%	77%	65%	69%	57%	44%
Average Daily Wastewater Generation (L/day)	344,962	352,822	308,984	188,942	192,392	149,908	150,349
Population	1,504[3]	1,512[3]	1,521[3]	1,529[4]	1,544[5]	1,560[5]	1,575[5]
Per Capita Per Day (L/c/d)	229	233	203	124	125	96	95

Notes:

[1] Only data from the months of August through December 2018 were used, due to a malfunctioning flow meter.

[2] Only data for the months of January through mid-April were available for 2019.

[3] The growth rate from 2011 to 2016 (Table 2-1) was used to interpolate the populations in 2013 - 2015.

[4] 2016 census population.

[5] The design population growth rate of 1.0% was used to estimate the population in 2017 and 2018.

As shown in Table 2-3, the percentage of wastewater generated compared to the water usage varies widely, from 44% to 88%, with generation rates varying from 95 to 233 L/c/d. These wastewater generation rates are relatively low when compared with the design criteria for similar communities in Alberta.

A wastewater generation rate of 200 L/c/d was used in our calculations, which is approximately 90% of the proposed water consumption rate (Water Master Plan Update, Associated Engineering, 2019).

PF, Residential Peaking Factor

Harmon's Formula was used in the calculation of the residential dry weather flow.

$$PF = 1 + 14 / (4 + P_{PF}^{0.5})$$

Where:

P_{PF}	= contributing population in 1,000s
PF	= minimum of 3.0
	= maximum of 4.5

2.2.1.2 Commercial / Industrial / Institutional Dry Weather Flow

Sanitary flows from commercial, industrial, and institutional land uses can be calculated in two ways:

- Based on the type of commercial / industrial / institutional land use (restaurant, school, retail, etc.) and the floor area. Alternatively, if the type of development is unknown, a general allowance can be made, for planning purposes, based on the gross area of the development; or
- Based on applying an equivalent population to the gross area of the development.

At a master planning level of analysis, the second method of calculating commercial / industrial / institutional wastewater generation (based on an equivalent population) is commonly used. We have used the following equivalent populations:

- Commercial / Institutional (equivalent population, ep) 30 ep / ha
- Industrial (equivalent population, ep) 25 ep / ha

Because the commercial / institutional / industrial wastewater generation is estimated based on an equivalent population, Harmon's Formula was used to calculate the peaking factor.

2.2.2 Wet Weather Flows (WWF)

The wet weather flow includes the dry weather flow, as well as flows from the following sources:

- Rainwater inflow and groundwater infiltration through joints, leaky pipes, etc.;
- Rainwater inflow from manhole vents in sag locations; and
- Foundation drains (weeping tiles) in older neighbourhoods. Prior to 2000, foundation drains were typically connected to the sanitary sewer system and have been found to generate significant inflow rates during storm events.

2.2.2.1 Inflow / Infiltration Allowance

Alberta Environment and Parks requires that all areas, regardless of land use, apply an allowance of 0.28 L/s/ha to account for inflow and infiltration into the sanitary sewer.

We used an inflow and infiltration allowance of 0.28 L/s/ha for all existing and proposed areas. The Town of Bon Accord Servicing Master Plan (AECOM, 2010) included an inflow and infiltration allowance of 0.07 L/s/ha; however, there is no data to support a reduction of the provincial standard.

2.2.2.2 Sag Manhole Allowance

Manholes located in sags allow a higher portion of rainwater to enter the sanitary sewer via vent holes in the covers. It is good practice to avoid the installation of sanitary manholes in sag locations. A typical allowance for inflow into sag manholes is 0.4 L/s/sag manhole.

Due to the Town of Bon Accord being located near marshy areas, and the relatively flat topography, we assumed that 20% of existing and proposed manholes are / will be located in sags.

2.2.2.3 Foundation Drain Allowance

The Town of Bon Accord has indicated that some of the older areas of Town may have foundation drains connected to the sanitary sewer. We included an allowance of 0.6 L/s/ha for foundation drains in the residential area between 48 Avenue and 52 Avenue, from 49 Street to 51 Street, as identified by the Town.

No allowance has been made for future residential areas as connecting foundation drains to the sanitary sewer is no longer an accepted practice.

2.2.3 Pipe Roughness

For gravity sewers, a Manning's roughness coefficient of 0.015 was used for concrete and clay tile pipes and a Manning's roughness coefficient of 0.013 was used for PVC pipes. A Hazen-Williams "C" value of 120 was used for force mains.

2.2.4 Velocity

The following minimum and maximum velocities were used for the sanitary sewer system:

Table 2-4
Velocity Requirements

System	Minimum Velocity	Maximum Velocity
Gravity Sewer	0.6 m/s	3.0 m/s
Force Main	0.75 m/s	2.5 m/s

2.2.5 Pipe Slope

Minimum pipe slopes are required to achieve a 0.6 m/s scour velocity. All proposed pipes were given slopes meeting the Alberta Environment and Parks guidelines, summarized in Table 2-5.

Table 2-5
Minimum Pipe Slopes

Diameter	Minimum Slope
200 mm	0.40%
250 mm	0.28%
300 mm	0.22%
375 mm	0.15%
450 mm	0.12%
525 mm	0.10%
600 mm	0.08%

We have applied minimum slopes in our sizing calculations for future pipes. Once detailed grading plans are known for the future development areas, it is recommended that the design of the sanitary sewer consider the road grades. As such, there may be an opportunity to reduce pipe sizes based on the optimized pipe slopes.

2.2.6 Minimum Pipe Size

Pipe sizes (gravity and force main) were determined based on anticipated peak wet weather wastewater flows. As a minimum, there are no future sanitary sewers smaller than 200 mm in diameter.

2.2.7 Lift Stations

The lift station pumping capacities are based on conveying the design peak wet weather flow. This is calculated by adding the estimated wet weather flows with the peak dry weather flows. The peak dry weather flow is based on the population projection, sewage generation rate of 200 L/c/d, and the Harmon's peaking factor.

The wet well size is analyzed based on storing one half of the peak wet weather flow for five minutes.

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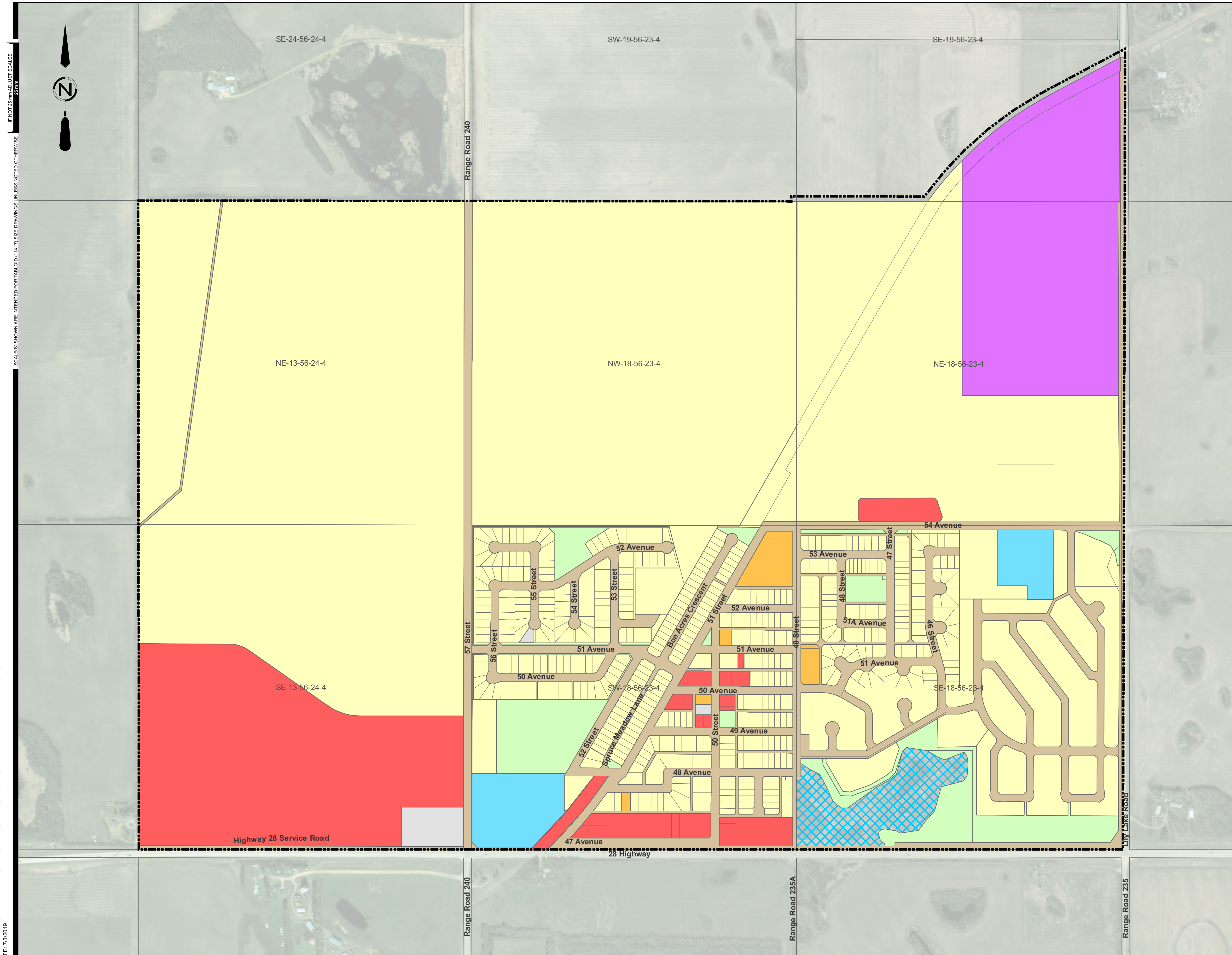

Associated Engineering

Legend:
- Low Density Residential
- Medium Density Residential
- Commercial
- Industrial
- Institutional
- Public Utility
- Park/Open Space/ER
- Roadways
- Stormwater Retention Area
- Town Boundary

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FIGURE No. 2-1

TOWN OF BON ACCORD
SANITARY MASTER PLAN UPDATE

LAND USE MAP

AE PROJECT No.	2019-3459
SCALE	1:9,000
COORD. SYSTEM	NAD 1983 3TM 114
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE
IF NOT 25 mm ADJUST SCALES 25 mm

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DATE: 7/3/2019.

3 EXISTING SYSTEM

3.1 Existing Facilities

3.1.1 Existing Sanitary Sewer System

The existing gravity sanitary sewer system consists of clay tile, concrete, and PVC pipes. The majority of the existing gravity system consists of 200 mm diameter pipes; however, there are also areas with 300 mm diameter pipes. **Figure 3-1** presents the existing sanitary sewer system and indicates the pipe sizes and materials. **Figure 3-2** presents the existing sanitary catchment areas used in our calculations.

3.1.2 Existing Lift Stations and Force Mains

There are two lift stations currently operating in the Town of Bon Accord; refer to **Figure 3-1**. Details of the lift stations follow:

Springbrook Lift Station

The Springbrook Lift Station is located at the end of the 55 Street cul-de-sac and is accessed from 51 Avenue. The Springbrook Lift Station services the lands west of 52 Street and is comprised of a wet well (2.7 m x 3.8 m interior dimensions) with a pumphouse located above. Two pumps were installed within the lift station and are rated at 14.1 L/s at 20.7 m head. The downstream force main discharges to MH S110 and is 100 mm in diameter and 388 m in length (Town of Bon Accord Servicing Master Plan, AECOM, 2010).

Main Lift Station

The Main Lift Station is located along 49 Street, south of 49 Avenue, and services the entire Town. It is comprised of a wet well (2.7 m x 3.8 m interior dimensions) with a pumphouse located above. Two pumps were installed within the lift station and are rated at 38 L/s at 39 m head. The downstream force main discharges to the existing sewage lagoon located south of Highway 28 and is comprised of two sections: 190 m of 200 mm PVC pipe and 575 m of 150 mm AC pipe (Town of Bon Accord Servicing Master Plan, AECOM, 2010).

3.2 Existing System Assessment

3.2.1 Sanitary Sewer

The existing sanitary sewer system has been analyzed based on the land use map (**Figure 2-1**) and design criteria outlined in Section 2. Existing pipe and manhole information was obtained from the existing XPSWMM model and the Town Utility Map (AECOM, 2010).

Our analysis included review of record information provided by the Town to confirm if there had been any upgrades to the sanitary sewer since the Town Utility Map was created. It is our understanding that there have been several spot repairs since 2010, but that there have been no upgrades to the sanitary sewer. The sanitary main on 53 Street from MH S99 to MH S102 was lined; therefore, a Manning's roughness coefficient of 0.013 was used to calculate the capacity of the lined sewer.

The results of our analysis of the existing sanitary sewer system are presented in **Table 3-1**.

Figure 3-2 is a pictorial representation of the utilization of the existing sanitary sewer system. Pipes which are less than 80% full are identified in **green**; pipes that are between 80% and 100% full are identified in **blue** and pipes that are 100% full or greater are identified in **purple**.

Figure 3-3 is a pictorial representation of the amount of cover (depth to invert) over the pipes in the existing sanitary sewer system. Pipes which have 2.75 m cover or greater are identified in **green**; pipes that have between 2.45 m and 2.75 m cover are identified in **blue** and pipes that have less than 2.45 m cover are identified in **purple**. The minimum depth of cover of 2.75 m (depth to invert) was obtained from the Town of Bon Accord's Minimum Design Standards for Design of Local Improvements (March 2003 Revision) provided by the Town.

During our analysis of the existing sanitary sewer system, we noted several undeveloped areas. These undeveloped areas have been considered potential infill areas for future development and are identified on **Figure 3-1**. These areas were not included in our analysis of the existing sanitary sewer system; these infill areas were included in the analysis of the ultimate sanitary sewer system.

As indicated on **Figure 3-1**, there is a 75 mm diameter force main from the water reservoir located at the southwest corner of 57 Street and Highway 28. In a meeting held on June 26, 2019, the Town indicated that this force main is no longer active; therefore, it has been considered negligible in our analyses.

As indicated on the Town Utility Map, the service from the Bon Accord Community School is a 100 mm diameter force main. There is no information available for the flow rate in the force main from the school; therefore, it has been modelled as a gravity connection in our analyses.

Table 3-1
Existing Sanitary Sewer Analysis

Town of Bon Accord Sanitary Master Plan

PIPE INFORMATION						RESIDENTIAL / ICI CONTRIBUTION			INFLOW / INFILTRATION CONTRIBUTION				RESULTS			
From MH	To MH	Length (m)	Slope (%)	Pipe Diameter (mm)	Capacity, Q_c (L/s)	Cumulative No. of People	Residential Peaking Factor, PF	Peak Dry Weather Residential Flow (L/s)	General I / I Allowance (L/s)	Sag MH Allowance (L/s)	Foundation Drain Flow (L/s)	Cumulative I / I Allowance (L/s)	Total Design Peak Flow Rate (L/s)	Utilization	Is Pipe < 100% Full? [Yes / No]	Velocity (m/s)
S87	S88	119.10	0.425	200	18.5	45	4.32	0.45	0.42	0.08	0.00	0	0.95	5%	Yes	0.37
S88	S89	96.08	1.281	200	32.2	64	4.29	0.64	0.17	0.08	0.00	0.75	1.39	4%	Yes	0.61
S85	S86	138.09	0.276	200	14.9	43	4.33	0.43	0.40	0.08	0.00	0	0.91	6%	Yes	0.32
S86	S89	115.07	0.429	200	18.6	65	4.29	0.65	0.20	0.08	0.00	0.76	1.41	8%	Yes	0.42
S89	S90	91.02	0.338	200	16.5	154	4.19	1.49	0.22	0.08	0.00	1.82	3.31	20%	Yes	0.49
S90	S91	27.86	0.158	200	11.3	167	4.18	1.61	0.15	0.08	0.00	2.05	3.66	32%	Yes	0.37
S91	S92	32.02	0.437	200	18.8	167	4.18	1.61	0.00	0.08	0.00	2.13	3.74	20%	Yes	0.56
S84	S83	33.06	0.181	200	12.1	10	4.41	0.10	0.09	0.08	0.00	0	0.27	2%	Yes	0.19
S83	S82	118.07	0.427	200	21.4	54	4.31	0.54	0.41	0.08	0.00	1	1.19	6%	Yes	0.40
S77	S78	89.81	0.401	200	20.8	0	4.50	0.00	0.00	0.08	0.00	0	0.08	0%	Yes	0.16
S78	S82	74.03	0.453	200	22.1	50	4.31	0.50	0.46	0.08	0.00	1	1.12	5%	Yes	0.40
S82	S81	30.07	0.276	200	17.2	117	4.22	1.14	0.11	0.08	0.00	1.47	2.61	15%	Yes	0.43
S79	S80	53.34	0.337	200	19.1	20	4.38	0.20	0.19	0.08	0.00	0.27	0.47	2%	Yes	0.27
S80	S81	120.07	0.507	200	23.4	62	4.29	0.62	0.39	0.08	0.00	0.73	1.35	6%	Yes	0.44
S81	S93	77.03	0.493	200	23.0	179	4.17	1.73	0.00	0.08	0.00	2.28	4.01	17%	Yes	0.59
S101	S100	90.09	2.435	200	44.4	33	4.35	0.33	0.31	0.08	0.00	0.39	0.72	2%	Yes	0.62
S100	S99	37.48	1.993	200	40.1	41	4.33	0.41	0.07	0.08	0.00	0.54	0.95	2%	Yes	0.63
S98	S99	53.24	0.464	200	19.4	10	4.41	0.10	0.09	0.08	0.00	0.17	0.27	1%	Yes	0.26
S99	S102	115.07	0.342	200	19.2	81	4.27	0.80	0.27	0.08	0.00	1.06	1.86	10%	Yes	0.42
S102	S104	85.05	0.381	200	17.5	104	4.24	1.02	0.21	0.08	0.00	1.35	2.37	14%	Yes	0.47
S103	S104	88.05	2.149	200	41.7	7	4.43	0.07	0.06	0.08	0.00	0.14	0.21	1%	Yes	0.40
S104	S105	39.01	0.172	200	11.8	118	4.22	1.15	0.06	0.08	0.00	1.63	2.79	24%	Yes	0.36
S105	S94	92.09	0.344	200	16.7	121	4.22	1.18	0.02	0.08	0.00	1.73	2.91	17%	Yes	0.48

Associated Engineering

Table 3-1
Existing Sanitary Sewer Analysis

Town of Bon Accord Sanitary Master Plan

PIPE INFORMATION						RESIDENTIAL / ICI CONTRIBUTION			INFLOW / INFILTRATION CONTRIBUTION				RESULTS			
From MH	To MH	Length (m)	Slope (%)	Pipe Diameter (mm)	Capacity, Q_c (L/s)	Cumulative No. of People	Residential Peaking Factor, PF	Peak Dry Weather Residential Flow (L/s)	General I / I Allowance (L/s)	Sag MH Allowance (L/s)	Foundation Drain Flow (L/s)	Cumulative I / I Allowance (L/s)	Total Design Peak Flow Rate (L/s)	Utilization	Is Pipe < 100% Full? [Yes / No]	Velocity (m/s)
S97	S96	98.05	0.240	200	13.9	32	4.35	0.32	0.29	0.08	0.00	0.37	0.69	5%	Yes	0.28
S96	S95	28.23	0.174	200	11.8	49	4.32	0.49	0.15	0.08	0.00	0.61	1.09	9%	Yes	0.28
S95	S94	33.06	0.460	200	19.3	49	4.32	0.49	0.00	0.08	0.00	0.69	1.17	6%	Yes	0.41
S94	S93	64.01	0.736	200	24.4	172	4.17	1.66	0.01	0.08	0.00	2.51	4.17	17%	Yes	0.69
S93	S92	34.06	0.470	200	19.5	352	4.05	3.30	0.01	0.08	0.00	4.88	8.18	42%	Yes	0.68
S92	SB LS	15.14	0.925	200	31.5	519	3.97	4.76	0.00	0.08	0.00	7.09	11.85	38%	Yes	0.96
SB LS	S110			100			4.50	0.00	0.00	0.08	0.00		14.00	(FORCE MAIN)		
S118	S116	94.03	0.455	200	22.1	31	4.35	0.31	0.29	0.08	0.00	0.37	0.68	3%	Yes	0.34
S117	S116	84.06	0.452	200	22.1	26	4.36	0.26	0.24	0.08	0.00	0.32	0.58	3%	Yes	0.32
S116	S40	54.13	0.573	200	24.8	57	4.30	0.57	0.00	0.08	0.00	0.76	1.33	5%	Yes	0.46
S40	S39	66.73	0.403	200	18.0	164	4.18	1.59	0.44	0.08	0.00	1.28	2.86	16%	Yes	0.50
S42	S41	89.02	1.883	200	39.0	28	4.36	0.28	0.26	0.08	0.41	0.75	1.03	3%	Yes	0.63
S41	S39	90.09	2.412	200	44.1	53	4.31	0.53	0.23	0.08	0.36	1.42	1.94	4%	Yes	0.84
S39	S38	15.26	0.904	200	27.0	217	4.13	2.08	0.01	0.08	0.00	2.78	4.86	18%	Yes	0.78
S38	S37	88.05	0.291	200	15.3	217	4.13	2.08	0.05	0.08	0.00	2.91	4.99	33%	Yes	0.51
S34	S33	33.02	0.497	200	20.0	12	4.41	0.12	0.10	0.08	0.00	0.18	0.31	2%	Yes	0.27
S33	S35	40.71	0.120	200	9.9	18	4.39	0.18	0.05	0.08	0.00	0.32	0.50	5%	Yes	0.20
S35	S36	97.08	3.645	200	54.3	51	4.31	0.51	0.30	0.08	0.48	1.18	1.69	3%	Yes	0.93
S36	S37	93.09	0.409	200	18.2	83	4.26	0.82	0.22	0.08	0.34	1.82	2.64	15%	Yes	0.50
S37	S28	103.08	0.335	200	16.4	313	4.07	2.95	0.11	0.08	0.11	5.03	7.98	49%	Yes	0.59
S32	S31	105.02	2.670	200	53.6	55	4.31	0.55	0.20	0.08	0.00	0.28	0.83	2%	Yes	0.67
S31	S30	13.34	0.690	200	23.6	55	4.31	0.55	0.00	0.08	0.00	0.36	0.91	4%	Yes	0.43

Table 3-1
Existing Sanitary Sewer Analysis

Town of Bon Accord Sanitary Master Plan

PIPE INFORMATION						RESIDENTIAL / ICI CONTRIBUTION			INFLOW / INFILTRATION CONTRIBUTION				RESULTS			
From MH	To MH	Length (m)	Slope (%)	Pipe Diameter (mm)	Capacity, Q_c (L/s)	Cumulative No. of People	Residential Peaking Factor, PF	Peak Dry Weather Residential Flow (L/s)	General I / I Allowance (L/s)	Sag MH Allowance (L/s)	Foundation Drain Flow (L/s)	Cumulative I / I Allowance (L/s)	Total Design Peak Flow Rate (L/s)	Utilization	Is Pipe < 100% Full? [Yes / No]	Velocity (m/s)
S30	S29	100.08	0.347	200	19.3	88	4.26	0.87	0.30	0.08	0.48	1.23	2.10	11%	Yes	0.44
S29	S28	91.02	0.350	200	16.8	108	4.23	1.06	0.18	0.08	0.24	1.73	2.79	17%	Yes	0.48
S115	S110	141.83	0.391	200	20.5	40	4.33	0.40	0.37	0.08	0.00	0.45	0.85	4%	Yes	0.35
S110	S111	42.19	0.356	200	19.6	49	4.32	0.49	0.08	0.08	0.00	0.61	15.10	77%	Yes	0.67
S113	S112	114.59	0.375	200	20.1	35	4.34	0.35	0.33	0.08	0.00	0.41	0.76	4%	Yes	0.33
S112	S111	112.36	0.356	200	19.6	68	4.29	0.67	0.31	0.08	0.00	0.79	1.47	7%	Yes	0.40
S111	S26	64.88	0.539	200	24.1	117	4.22	1.14	0.00	0.08	0.00	1.49	16.63	69%	Yes	0.81
S26	S28	99.08	0.362	200	17.1	138	4.20	1.34	0.19	0.08	0.30	2.06	17.41	102%	No	0.69
S28	S22	101.04	0.440	200	21.8	577	3.94	5.26	0.20	0.08	0.23	9.33	28.59	131%	No	#NUM!
S21	S22	71.03	0.459	200	19.3	14	4.40	0.14	0.13	0.08	0.14	0.35	0.49	3%	Yes	0.31
S24	S23	85.05	2.497	200	44.9	21	4.38	0.21	0.19	0.08	0.31	0.58	0.79	2%	Yes	0.64
S23	S22	84.05	0.453	200	19.1	39	4.34	0.39	0.17	0.08	0.25	1.07	1.46	8%	Yes	0.43
S22	S9	103.04	0.316	200	16.0	646	3.91	5.85	0.14	0.08	0.19	11.16	31.02	194%	No	#NUM!
S76	S14	75.03	0.400	200	18.0	150	4.19	1.46	1.39	0.08	0.00	1.47	2.93	16%	Yes	0.51
S13	S14	43.93	0.728	200	24.3	15	4.40	0.15	0.13	0.08	0.00	0.21	0.37	2%	Yes	0.33
S12	S14	109.07	2.376	200	43.8	25	4.37	0.25	0.23	0.08	0.00	0.31	0.56	1%	Yes	0.56
S14	S15	71.22	0.407	200	18.1	200	4.15	1.92	0.09	0.08	0.00	2.17	4.09	23%	Yes	0.55
S15	S114	17.03	0.176	200	11.9	200	4.15	1.92	0.00	0.08	0.00	2.25	4.17	35%	Yes	0.40
S24	S25	88.51	1.027	200	28.8	12	4.41	0.12	0.10	0.08	0.12	0.30	0.42	1%	Yes	0.39
S25	S114	79.63	1.487	200	40.0	26	4.36	0.26	0.12	0.08	0.00	0.51	0.77	2%	Yes	0.53
S114	S16	62.03	0.440	200	18.9	244	4.12	2.32	0.11	0.08	0.14	3.08	5.41	29%	Yes	0.61
S16	S17	77.06	0.336	200	16.5	266	4.10	2.52	0.20	0.08	0.08	3.44	5.96	36%	Yes	0.56

Table 3-1
Existing Sanitary Sewer Analysis

Town of Bon Accord Sanitary Master Plan

PIPE INFORMATION						RESIDENTIAL / ICI CONTRIBUTION			INFLOW / INFILTRATION CONTRIBUTION				RESULTS			
From MH	To MH	Length (m)	Slope (%)	Pipe Diameter (mm)	Capacity, Q_c (L/s)	Cumulative No. of People	Residential Peaking Factor, PF	Peak Dry Weather Residential Flow (L/s)	General I / I Allowance (L/s)	Sag MH Allowance (L/s)	Foundation Drain Flow (L/s)	Cumulative I / I Allowance (L/s)	Total Design Peak Flow Rate (L/s)	Utilization	Is Pipe < 100% Full? [Yes / No]	Velocity (m/s)
S17	S18	41.05	0.551	200	21.1	281	4.09	2.66	0.14	0.08	0.00	3.65	6.31	30%	Yes	0.69
S18	S9	118.11	1.244	200	31.7	309	4.07	2.91	0.26	0.08	0.34	4.33	7.24	23%	Yes	0.97
S12	S11	102.04	1.475	200	34.5	9	4.42	0.09	0.08	0.08	0.00	0.16	0.25	1%	Yes	0.37
S11	S10	106.08	3.352	200	52.0	29	4.36	0.29	0.19	0.08	0.00	0.42	0.72	1%	Yes	0.68
S10	S9	97.05	0.375	200	17.4	60	4.30	0.60	0.28	0.08	0.00	0.78	1.38	8%	Yes	0.40
S9	S7	108.04	0.355	300	57.7	1030	3.79	9.04	0.14	0.08	0.14	16.63	39.67	69%	Yes	0.86
S8	S7	102.04	0.572	200	21.5	74	4.28	0.73	0.68	0.08	0.00	0.76	1.49	7%	Yes	0.47
S7	S6	62.03	0.206	300	43.9	1116	3.77	9.74	0.11	0.08	0.10	17.69	41.42	94%	Yes	0.69
S6	S5	10.2	1.471	300	117.3	1127	3.77	9.82	0.10	0.08	0.00	17.87	41.69	36%	Yes	1.57
S5	S4	13	0.869	300	90.2	1130	3.77	9.85	0.03	0.08	0.00	17.97	41.82	46%	Yes	1.27
S4	S2	46.5	0.978	300	95.7	1130	3.77	9.85	0.03	0.08	0.00	18.08	41.93	44%	Yes	1.33
S20	S19	110.11	0.414	200	18.3	33	4.35	0.33	0.31	0.08	0.48	0.87	1.20	7%	Yes	0.40
S19	S3	54.04	0.622	200	22.4	33	4.35	0.33	0.03	0.08	0.00	0.98	1.31	6%	Yes	0.47
S3	S2	5.09	19.096	200	143.3	33	4.35	0.33	0.00	0.08	0.00	1.06	1.39	1%	Yes	1.53
S2	S1	20.1	0.403	300	61.4	1163	3.76	10.11	0.01	0.08	0.00	19.23	43.34	71%	Yes	0.92
S43	S44	47.01	1.257	200	31.9	14	4.40	0.14	0.13	0.08	0.00	0.21	0.35	1%	Yes	0.39
S44	S45	80.02	0.979	200	28.1	24	4.37	0.24	0.09	0.08	0.00	0.38	0.62	2%	Yes	0.43
S45	S46	99.08	1.572	200	35.6	55	4.31	0.55	0.28	0.08	0.00	0.74	1.29	4%	Yes	0.64
S48	S47	83.05	2.081	200	41.0	19	4.38	0.19	0.17	0.08	0.00	0.25	0.45	1%	Yes	0.50
S47	S46	86.05	0.847	200	26.2	28	4.36	0.28	0.08	0.08	0.00	0.41	0.70	3%	Yes	0.43
S46	S53	133.09	0.502	200	20.1	117	4.22	1.14	0.31	0.08	0.00	1.54	2.69	13%	Yes	0.54
S54	S53	53.04	0.534	200	20.8	11	4.41	0.11	0.10	0.08	0.00	0.18	0.29	1%	Yes	0.27
S53	S52	41.05	0.473	200	19.5	134	4.21	1.30	0.05	0.08	0.00	1.85	3.16	16%	Yes	0.55
S48	S50	133.14	1.992	200	40.1	39	4.34	0.39	0.36	0.08	0.00	0.44	0.83	2%	Yes	0.60

Associated Engineering

Table 3-1
Existing Sanitary Sewer Analysis

Town of Bon Accord Sanitary Master Plan

PIPE INFORMATION						RESIDENTIAL / ICI CONTRIBUTION			INFLOW / INFILTRATION CONTRIBUTION				RESULTS			
From MH	To MH	Length (m)	Slope (%)	Pipe Diameter (mm)	Capacity, Q_c (L/s)	Cumulative No. of People	Residential Peaking Factor, PF	Peak Dry Weather Residential Flow (L/s)	General I / I Allowance (L/s)	Sag MH Allowance (L/s)	Foundation Drain Flow (L/s)	Cumulative I / I Allowance (L/s)	Total Design Peak Flow Rate (L/s)	Utilization	Is Pipe < 100% Full? [Yes / No]	Velocity (m/s)
S49	S50	41.05	0.392	200	17.8	9	4.42	0.09	0.08	0.08	0.00	0.16	0.25	1%	Yes	0.24
S50	S51	112.04	0.343	200	16.6	66	4.29	0.66	0.17	0.08	0.00	0.84	1.50	9%	Yes	0.40
S51	S52	17.03	0.452	200	22.1	69	4.28	0.68	0.03	0.08	0.00	0.95	1.63	7%	Yes	0.45
S52	S74	46.01	0.589	200	25.2	203	4.15	1.95	0.00	0.08	0.00	2.88	4.83	19%	Yes	0.66
S74	S75	24.02	0.175	200	13.7	203	4.15	1.95	0.00	0.08	0.00	2.96	4.91	36%	Yes	0.41
S75	S67	45.04	0.482	200	22.8	203	4.15	1.95	0.00	0.08	0.00	3.04	4.99	22%	Yes	0.62
S73	S72	50.04	0.400	200	20.7	66	4.29	0.66	0.61	0.08	0.00	0.69	1.34	6%	Yes	0.40
S72	S71	42.01	2.226	200	48.9	66	4.29	0.66	0.02	0.08	0.00	0.79	1.45	3%	Yes	0.75
S71	S70	19	0.705	200	27.5	66	4.29	0.66	0.01	0.08	0.00	0.88	1.54	6%	Yes	0.51
S70	S69	53.01	0.362	200	19.7	66	4.29	0.66	0.03	0.08	0.00	0.99	1.65	8%	Yes	0.41
S69	S68	74.06	0.494	200	23.1	95	4.25	0.93	0.27	0.08	0.00	1.34	2.27	10%	Yes	0.51
S68	S67	80.02	0.270	200	17.0	110	4.23	1.08	0.13	0.08	0.00	1.55	2.63	15%	Yes	0.43
S67	S66	12	0.458	200	22.2	316	4.07	2.98	0.02	0.08	0.00	4.70	7.67	35%	Yes	0.67
S65	S66	34.01	1.926	200	45.5	20	4.38	0.20	0.18	0.08	0.00	0.26	0.47	1%	Yes	0.49
S66	S64	98.05	0.276	200	17.2	354	4.05	3.32	0.16	0.08	0.00	5.20	8.52	49%	Yes	0.55
S63	S64	34.01	2.929	200	56.1	18	4.39	0.18	0.17	0.08	0.00	0.25	0.43	1%	Yes	0.56
S64	S60	88.29	0.057	200	7.8	387	4.03	3.61	0.14	0.08	0.00	5.67	9.28	119%	No	#NUM!
S55	S56	36.77	1.004	200	32.9	22	4.37	0.22	0.20	0.08	0.00	0.28	0.51	2%	Yes	0.41
S56	S57	50.99	1.567	200	41.1	31	4.35	0.31	0.08	0.08	0.00	0.45	0.76	2%	Yes	0.54
S57	S59	89.05	1.707	200	42.9	57	4.30	0.57	0.24	0.08	0.00	0.77	1.33	3%	Yes	0.66
S58	S59	25	2.648	200	53.4	16	4.39	0.16	0.15	0.08	0.00	0.23	0.39	1%	Yes	0.52
S59	S60	88.05	0.837	200	30.0	86	4.26	0.85	0.11	0.08	0.00	1.19	2.04	7%	Yes	0.59
S60	S61	48.51	0.594	200	25.3	486	3.98	4.48	0.11	0.08	0.00	7.05	11.53	46%	Yes	0.80

Associated Engineering

Table 3-1
Existing Sanitary Sewer Analysis

Town of Bon Accord Sanitary Master Plan

PIPE INFORMATION						RESIDENTIAL / ICI CONTRIBUTION			INFLOW / INFILTRATION CONTRIBUTION				RESULTS			
From MH	To MH	Length (m)	Slope (%)	Pipe Diameter (mm)	Capacity, Q_c (L/s)	Cumulative No. of People	Residential Peaking Factor, PF	Peak Dry Weather Residential Flow (L/s)	General I / I Allowance (L/s)	Sag MH Allowance (L/s)	Foundation Drain Flow (L/s)	Cumulative I / I Allowance (L/s)	Total Design Peak Flow Rate (L/s)	Utilization	Is Pipe < 100% Full? [Yes / No]	Velocity (m/s)
S61	S62	22.02	0.095	200	10.1	491	3.98	4.52	0.04	0.08	0.00	7.17	11.70	115%	No	#NUM!
S62	S106	47.4	0.302	300	53.1	491	3.98	4.52	0.02	0.08	0.00	7.28	11.80	22%	Yes	0.64
S106	S107	109.2	0.270	300	50.3	491	3.98	4.52	0.04	0.08	0.00	7.40	11.92	24%	Yes	0.62
S107	S108	105.5	0.240	300	47.4	491	3.98	4.52	0.04	0.08	0.00	7.52	12.04	25%	Yes	0.59
S108	S109	74.3	0.195	300	42.7	491	3.98	4.52	0.04	0.08	0.00	7.64	12.16	28%	Yes	0.55
S109	S1	80.3	0.341	300	56.5	491	3.98	4.52	0.03	0.08	0.00	7.75	12.27	22%	Yes	0.68
S1	MAIN LS	7	2.371	300	148.9	1654	3.65	13.97	0.00	0.08	0.00	27.06	55.03	37%	Yes	2.01

3.2.2 Lift Stations

A lift station drawdown test was not completed for either lift station; therefore, a high-level assessment of the estimated pump capacities was undertaken to identify if they are anticipated to be operating near their respective duty points. Based on the following assumptions, it appears that both pumps may be operating close to their design flows:

- Hazen-Williams "C" Factor of 120;
- Force main pipe lengths from previous model; and
- Force main pipe profile elevations.

The Springbrook Lift Station pumps may be operating at (or marginally less than) the design flow of 14 L/s, while the Main Lift Station pumps may be operating at (or slightly more than) the design flow of 38 L/s. The pump design flows have been adopted for this assessment.

3.2.2.1 Pumping Capacity

Springbrook Lift Station

The pumping capacity of the Springbrook Lift Station is currently 14 L/s. The calculated peak wet weather inflow rate is 11.9 L/s. Based on this comparison, the pumps in the Springbrook Lift Station are adequately sized to service the currently-developed lands west of 52 Street.

Main Lift Station

The pumping capacity of the Main Lift Station is currently 38 L/s. The calculated peak wet weather inflow rate is 55.0 L/s. Based on this comparison, the pumps in the Main Lift Station are undersized to service the currently-developed areas in the Town of Bon Accord.

3.2.2.2 Wet Well Capacity

Springbrook Lift Station

The wet well capacity of the Springbrook Lift Station has been calculated to be 3.1 m^3 based on an operating depth of 0.3 m. Based on the calculated peak wet weather inflow rate of 11.9 L/s, a wet well volume of 1.8 m^3 is required. Based on this comparison, the wet well in the Springbrook Lift Station has ample capacity to service the currently-developed lands west of 52 Street.

Main Lift Station

The wet well capacity of the Main Lift Station has been calculated to be 6.2 m^3 based on an operating depth of 0.6 m. Based on the calculated peak wet weather inflow rate of 55.0 L/s, a wet well volume of 8.3 m^3 is required. Based on this comparison, the wet well in the Main Lift Station, operating at the current setpoints, is undersized to service the currently-developed areas in the Town of Bon Accord.

3.2.2.3 Force Mains

Springbrook Force Main

The calculated velocity in the 100 mm diameter force main from the Springbrook Lift Station is 1.8 m/s based on the pumps operating at 14 L/s. The calculated velocity falls within the target range of 0.75 m/s to 2.5 m/s; therefore, the force main from the Springbrook Lift Station is adequately sized to accommodate the outflow from the lift station.

Main Force Main

With the pumps operating at 38 L/s, the calculated velocity in the 200 mm diameter portion of the force main from the Main Lift Station is 1.2 m/s and the calculated velocity in the 150 mm diameter portion of the force main from the Main Lift Station is 2.2 m/s. The calculated velocities fall within the target range of 0.75 m/s to 2.5 m/s; therefore, the force main from the Main Lift Station is adequately sized to accommodate the outflow from the lift station.

3.2.2.4 Summary

Table 3-2 summarizes the results of our analysis of the existing lift stations and force mains.

Table 3-2
Lift Stations and Force Mains – Existing Conditions

Parameter	Spring Brook Lift Station	Main Lift Station
Pumping Capacity	Adequate	Undersized
Wet Well Capacity	Adequate	Undersized
Force Main Velocity	Adequate	Adequate for existing pump flow rate

3.3 Upgrades to Existing System

3.3.1 Sanitary Sewer

Based on the results presented in Table 3-1 and Figure 3-3, we recommend the following upgrades to the existing sanitary sewer system to meet the Town's current needs.

50 Street Upgrades

As shown in Figure 3-3 and Table 3-1, the following pipes are over-capacity:

- MH S26 to MH S28 (200 mm diameter) 102% Full
- MH S28 to MH S22 (200 mm diameter) 131% Full
- MH S22 to MH S9 (200 mm diameter) 194% Full

These over-capacity pipes result in surcharging levels of up to 1.2 m above pipe obvert, extending to MH S115, MH S113, MH S23, and MH S21.

To alleviate the surcharging issues, we recommend that the 200 mm diameter sewer between MH S28 to MH S22 be replaced with a 250 mm diameter sewer and the 200 mm diameter sewer between MH S22 and MH S9 be replaced with a 300 mm diameter sewer. These recommended sewer upgrades are identified on Figure 3-5. Despite the 200 mm diameter sewer between MH S26 and MH S28 being 102% full, post-upgrade surcharging levels are expected to be no more than an inch above the pipe obvert.

Alternatively, if the flow from Springbrook Lift Station was redirected, these upgrades to the existing sanitary sewer on 50 Street would not be required. As discussed further in Section 4.2, development to the west will necessitate a new lift station (LS1-W). Upon construction of LS1-W, Springbrook Lift Station could be decommissioned and a new gravity sewer installed from the former Springbrook Lift Station to LS1-W. This is an option which could be considered in the future; however, the Town may want to replace the two sections of gravity sewer on 50 Street in the meantime as the timeline for development to the west, and construction of LS1-W, is unknown.

46 Street Upgrades

As shown in **Figure 3-3** and **Table 3-1**, the following pipes are over-capacity:

- MH S64 to MH S60 (300 mm diameter) 119% Full
- MH S61 to MH S62 (300 mm diameter) 115% Full

These over-capacity pipes result in surcharging levels of up to 0.1 m above pipe obvert, extending to MH S64. These pipes are flat (0.01% to 0.06%); the performance of these pipes would greatly improve with increased pipe slopes.

These over-capacity pipes are 300 mm in diameter, as are the pipes downstream to the Main Lift Station. Upsizing these over-capacity pipes would require the downstream sewer (from MH S62) to be upsized all the way to the Main Lift Station to ensure that the pipe diameter did not decrease downstream. The remainder of the downstream sewer is adequately sized; therefore, upgrades to the downstream sewer are not necessary and are not recommended. To alleviate surcharging, we recommend that the sanitary sewer be removed and reinstalled to provide increased pipe slopes. These upgrades can be postponed until the next time there is work planned along the southern portion of 46 Street as the level of surcharging is not anticipated to result in sewage back-up into basements.

Minimum Cover

As identified on **Figure 3-4**, several pipes have less than minimum cover. We recommend that further investigation be done to identify if there is an opportunity to lower the mains with less than minimum cover. These areas should also be compared with the results of any CCTV inspections which have been done to determine if any of the affected areas are flagged for sewer replacement. Any sewers flagged for replacement could have insulation installed to help protect the sanitary sewer from freezing.

3.3.2 Lift Stations and Force Mains

Table 3-2 indicates that the Main Lift Station is undersized for the calculated peak wet weather inflow.

Pumping Capacity

The pumps in the Springbrook Lift Station are suspected to be currently operating at 14 L/s, which exceeds the calculated peak wet weather inflow rate of 11.9 L/s. No pump upgrades are recommended for the Springbrook Lift Station to meet the Town's current needs.

The pumps in the Main Lift Station are suspected to be operating at 38 L/s, which is less than the calculated peak wet weather inflow rate of 55.0 L/s. It is recommended that the existing pumps be replaced with two pumps each capable of operating at 58 L/s. This will allow the Main Lift Station to accommodate the calculated peak wet weather inflow rate to meet the Town's current needs as well as an allowance for 15 years of growth at the assumed growth rate of 1%.

Wet Well Capacity

The wet well in the Springbrook Lift Station has a capacity of 3.1 m^3, based on an operating depth of 0.3 m. The wet well exceeds the calculated required volume of 1.8 m^3, based on the calculated peak wet weather inflow rate of 11.9 L/s. No upgrades to the wet well are recommended for the Springbrook Lift Station to meet the Town's current needs.

The wet well in the Main Lift Station has a capacity of 6.2 m^3, based on an operating depth of 0.6 m. The wet well is undersized to accommodate the calculated storage volume of 8.3 m^3, based on the calculated peak wet weather inflow rate of 55.0 L/s.

To allow the Main Lift Station to accommodate the calculated peak wet weather inflow rate as well as 15 years of growth, the required wet well capacity is 8.7 m^3. This volume can be accommodated by the existing wet well structure by adjusting the "Start Lead Pump" setpoint. The recommended adjustments are summarized in Table 3-3.

Table 3-3
Main Lift Station – Recommended Setpoint Adjustments

Level	Current Elevation (m)	Recommended Elevation (m)
High Level Alarm	693.80	
Start Lag Pump	693.65	
Start Lead Pump	693.05	693.30
Stop Pumps	692.45	
Bottom of Wet Well	692.00	

As identified in Table 3-3, increasing the "Start Lead Pump" setpoint by 0.25 m will provide the calculated required wet well capacity of 8.7 m^3. This will reduce the difference between the "Start Lead Pump" and "Start Lag Pump" setpoints from 0.6 m to 0.35 m.

Force Mains

As discussed in Section 3.2.3, the force main from the Springbrook Lift Station is adequately sized to accommodate the outflow from the lift station. No force main upgrades are recommended from the Springbrook Lift Station to meet the Town's current needs.

If the pumps in the Main Lift Station were replaced based on the calculated peak wet weather (including 15 years of growth) inflow rate of 58.0 L/s, the resulting velocities in the force main from the Main Lift Station would be:

- 200 mm diameter portion: 1.8 m/s; and
- 150 mm diameter portion: 3.3 m/s.

If the pumps were replaced to operate at the calculated peak wet weather (including 15 years of growth) inflow rate of 58.0 L/s, the calculated velocity for the 200 mm diameter portion would fall within the target range of 0.75 m/s to 2.5 m/s; therefore, the 200 mm diameter portion of the force main is adequately sized to accommodate the calculated outflow from the lift station. The calculated velocity for the 150 mm diameter portion would exceed the target maximum of 2.5 m/s; therefore, the 150 mm diameter portion is undersized to accommodate the calculated outflow from the lift station. It is recommended that the 150 mm diameter portion be replaced with 200 mm diameter HDPE pipe.

Prior to implementation of upgrades to either lift station, it is recommended that the Town:

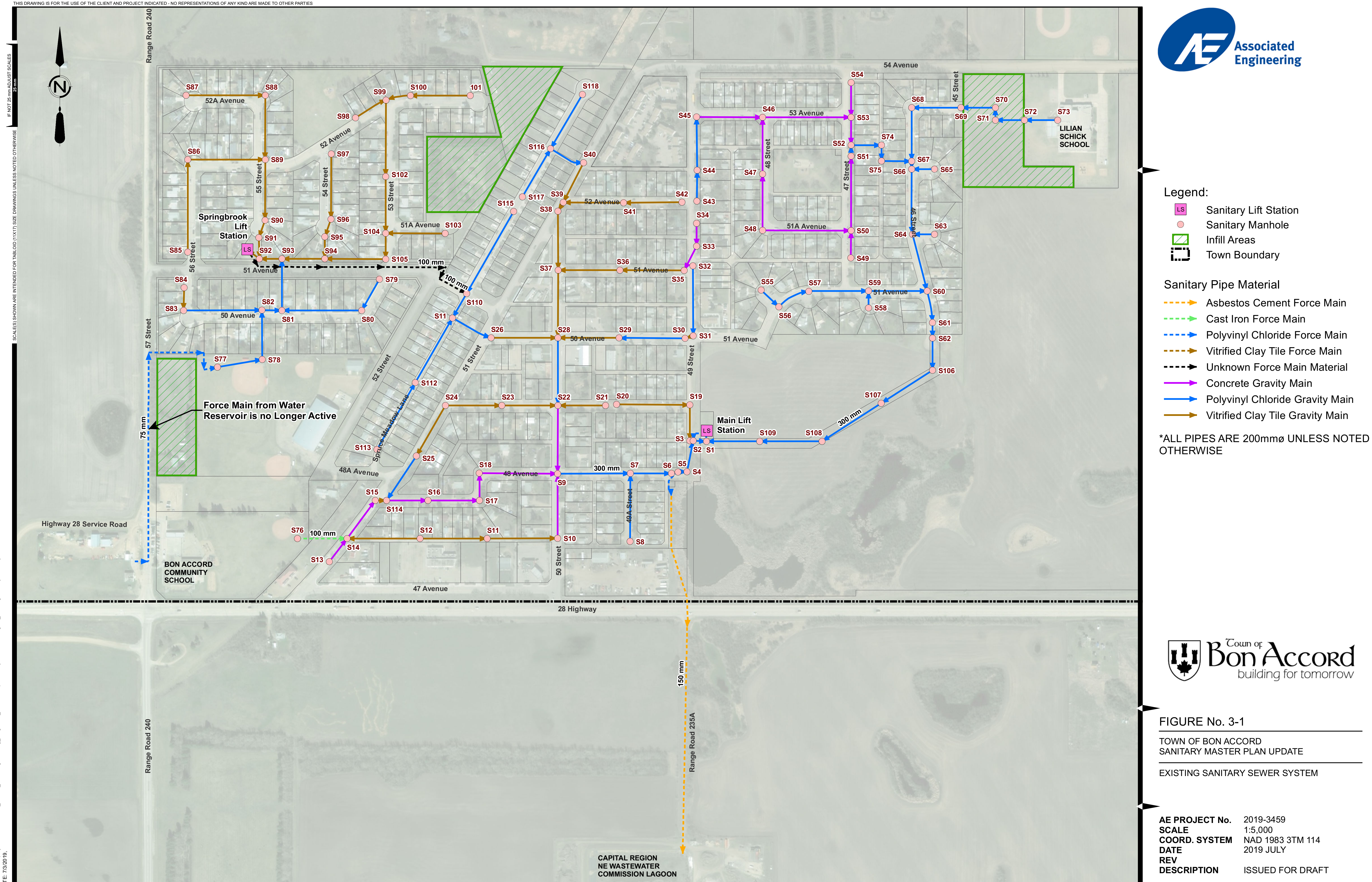
- Monitor operation of the lift stations during wet weather conditions to get a better understanding of their capacities.
- Perform a lift station drawdown test at each facility to confirm current pumping capacities.
- Verify the current setpoints to confirm the actual wet well capacities.
- Confirm the pumping rates for individual pumps as well as during combined operation.

3.4 Existing Model Update

The XPSWMM model completed by a previous consultant has been converted to a PCSWMM model and updated to reflect the Town's existing sanitary sewer system. Physical properties only (pipe length, diameter, inverts, slope, Manning's roughness coefficient, etc.) have been updated at this time. The following parameters required for modelling flow rates were unknown at the time this report was written:

- Hourly diurnal flow pattern for the Town;
- Unit hydrographs (RTK parameters and initial abstraction depths for fast, medium, and slow responses); and
- Design storm events.

We recommend that the Town undertake a flow monitoring program to determine the above parameters. Upon verification of these parameters, the model can be updated and calibrated to reflect actual loading conditions on the existing sanitary sewer.



Associated Engineering

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FIGURE No. 3-1

TOWN OF BON ACCORD
SANITARY MASTER PLAN UPDATE

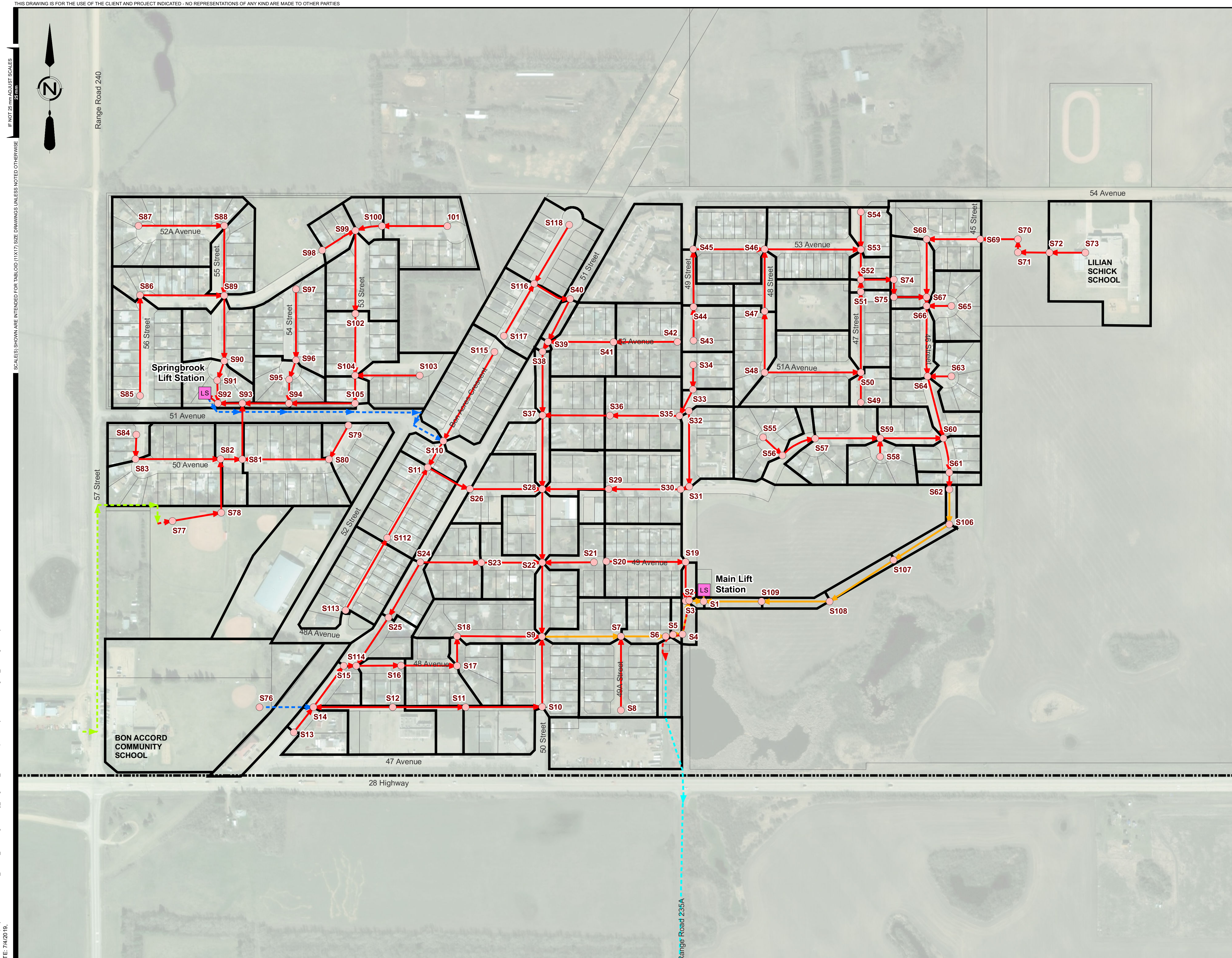
EXISTING SANITARY SEWER SYSTEM

AE PROJECT No.	2019-3459
SCALE	1:5,000
COORD. SYSTEM	NAD 1983 3TM 114
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

IF NOT 25 mm ADJUST SCALES
SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

\\s-edm-fs-01\projects\20193459\00_Master_Servicing\Working_Dwgs\010_GIS\ArcMap\SanitaryMasterPlan\Fig3-1_ExistingSanitarySewerSystem.mxd
DATE: 7/3/2019

THIS DRAWING IS FOR THE USE OF THE CLIENT AND PROJECT INDICATED - NO REPRESENTATIONS OF ANY KIND ARE MADE TO OTHER PARTIES



Associated Engineering

Legend:

- Existing Catchment Areas
- Sanitary Manhole
- LS Sanitary Lift Station
- Town Boundary

Distribution System

- Existing 75 mmø Force Main
- Existing 100mmø Force Main
- Existing 150mmø Force Main
- Existing 200 mmø Force Main
- Existing 200mmø Gravity Main
- Existing 300mmø Gravity Main

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FIGURE No. 3-2

TOWN OF BON ACCORD
SANITARY MASTER PLAN UPDATE

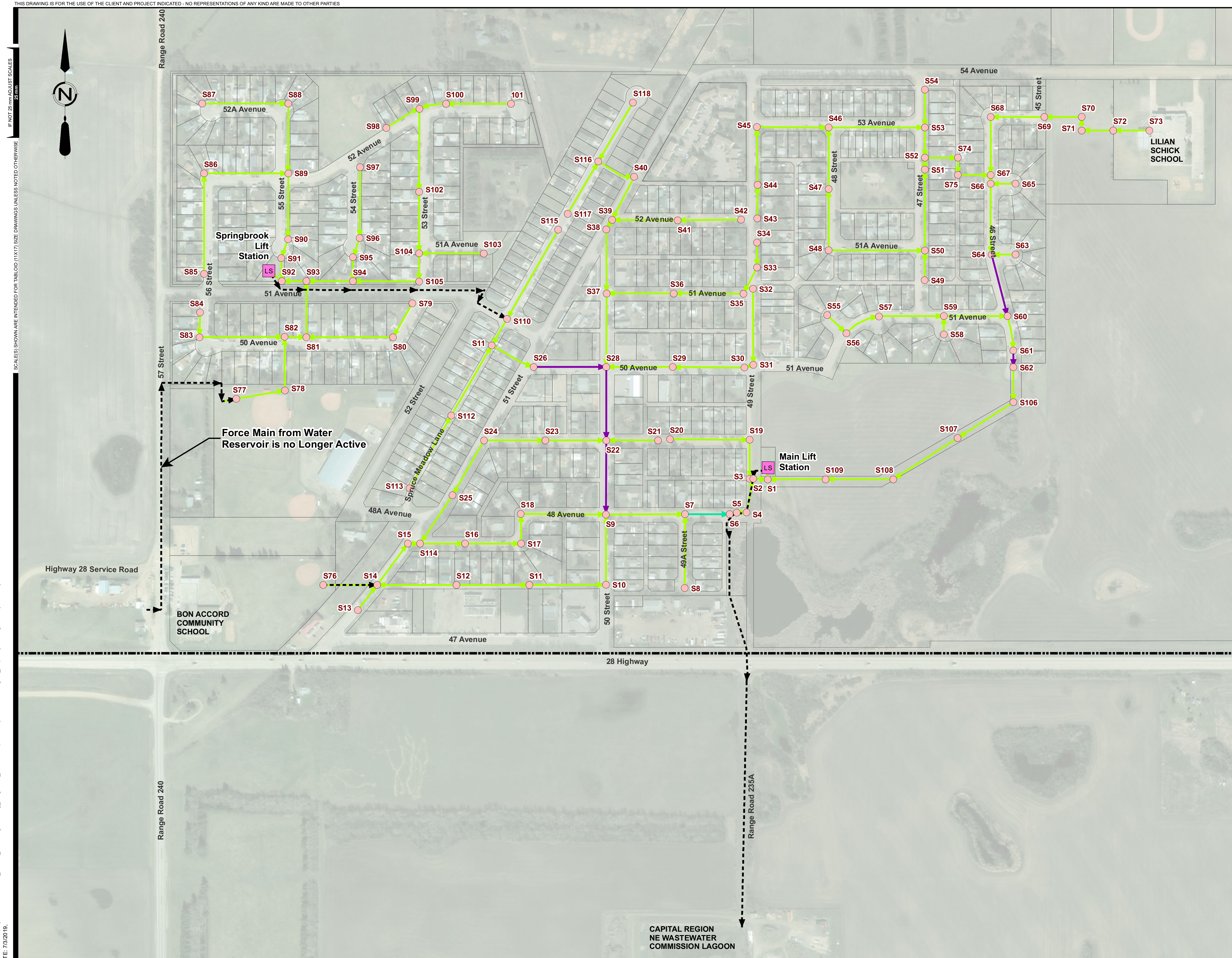
EXISTING SANITARY CATCHMENT AREAS

AE PROJECT No.	2019-3459
SCALE	1:5,000
COORD. SYSTEM	NAD 1983 3TM 114
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

IF NOT 25 mm ADJUST SCALES 25 mm

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

\\s-edm-fs-01\projects\20193459\00_Master_Servicing\Working_Dwgs\010_GIS\ArcMap\SanitaryMasterPlan\Fig3-2_ExistingSanitaryCatchmentAreas.mxd DATE: 7/4/2019.



Associated Engineering

Legend:
- LS Sanitary Lift Station
- Sanitary Manhole
- Town Boundary
- Force Main

Sanitary Pipe Utilization
- > 100%
- 80 - 100 %
- < 80%

*REFER TO FIG 3-1 FOR PIPE SIZES

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FIGURE No. 3-3

TOWN OF BON ACCORD
SANITARY MASTER PLAN UPDATE

CAPACITY OF EXISTING SANITARY
SEWER SYSTEM

AE PROJECT No.	2019-3459
SCALE	1:5,000
COORD. SYSTEM	NAD 1983 3TM 114
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

IF NOT 25 mm ADJUST SCALES 25 mm
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\\s-edm-fs-01\projects\20193459\00_Master_Servicing\Working_Dwgs\010_GIS\ArcMap\SanitaryMasterPlan\Fig3-3_CapacityExistingSanitarySewerSystem.mxd
DATE: 7/3/2019;

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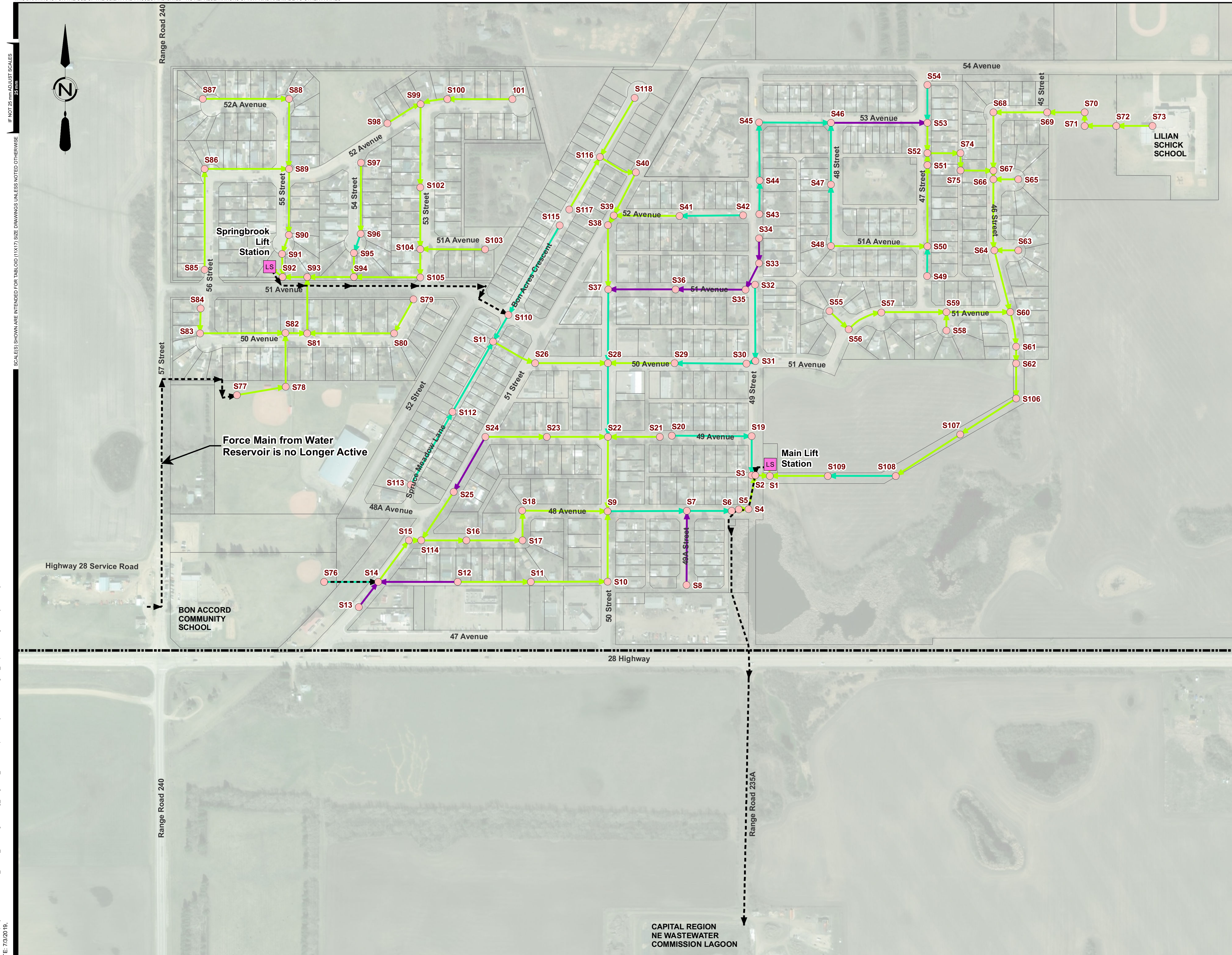

Associated Engineering

Legend:
- Sanitary Lift Station
- Sanitary Manhole
- Town Boundary
- Force Main

Depth to Invert (m)
- < 2.45m
- 2.45m - 2.75m
- > 2.75m

*REFER TO FIG 3-1 FOR PIPE SIZES

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FIGURE No. 3-4

TOWN OF BON ACCORD
SANITARY MASTER PLAN UPDATE

DEPTH OF EXISTING SANITARY SEWER SYSTEM

AE PROJECT No.	2019-3459
SCALE	1:5,000
COORD. SYSTEM	NAD 1983 3TM 114
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

IF NOT 25 mm ADJUST SCALES

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

\\s-edm-fs-01\projects\20193459\00_Master_Servicing\Working_Dwgs\010_GIS\ArcMap\SanitaryMasterPlan\Fig3-4_DepthofExistingSanitarySewerSystem.mxd
DATE: 7/3/2019.

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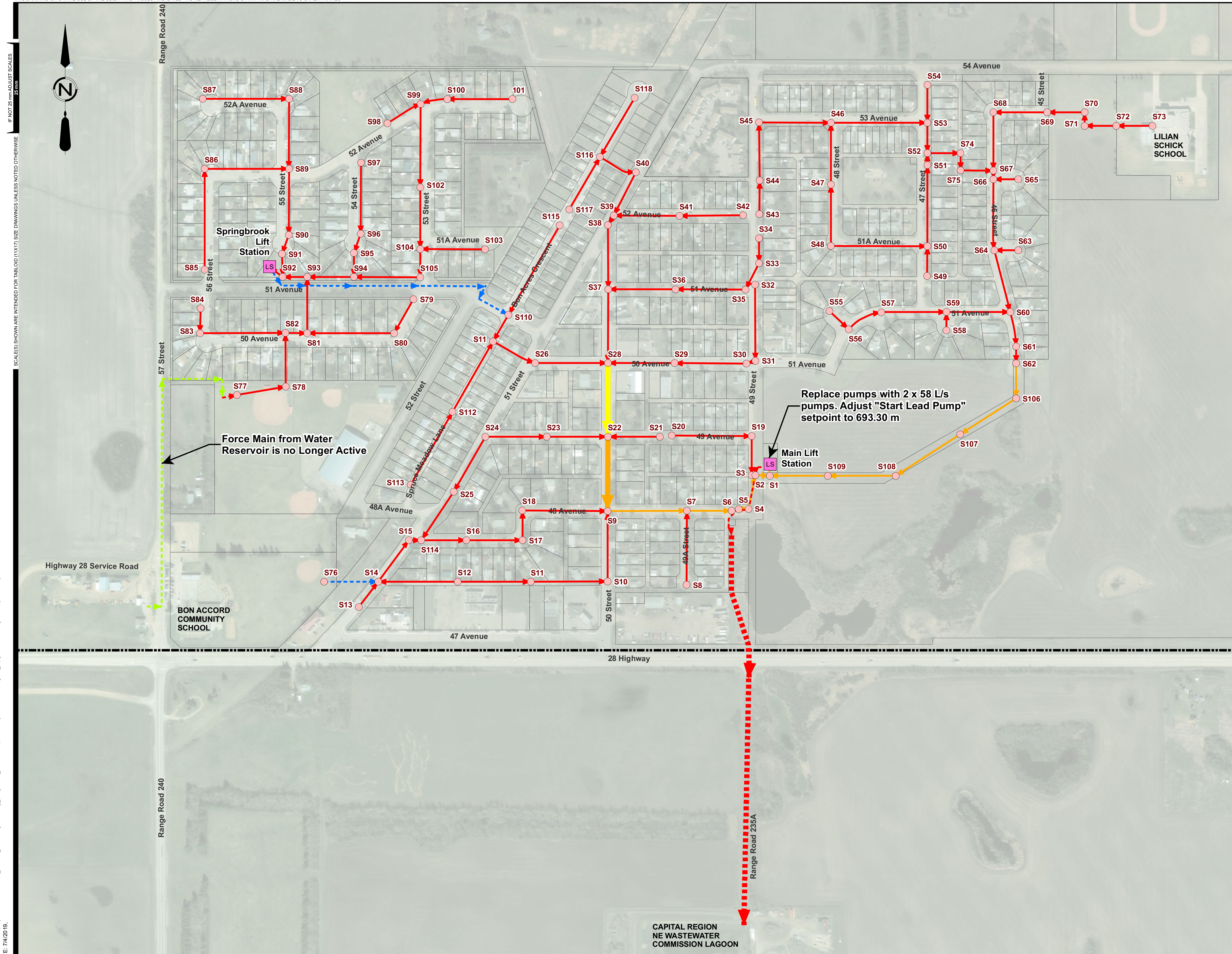

Associated Engineering

Legend:

- Lagoon
- LS Sanitary Lift Station
- Sanitary Manhole
- Town Boundary

Distribution System

- Existing 75 mmø Force Main
- Existing 100mmø Force Main
- Existing 150mmø Force Main
- Existing 200 mmø Force Main
- Existing 200mmø Gravity Main
- Existing 300mmø Gravity Main
- Proposed 250 mmø Gravity Main
- Proposed 300 mmø Gravity Main
- Proposed 200mmø Force Main

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FIGURE No. 3-5

TOWN OF BON ACCORD
SANITARY MASTER PLAN UPDATE

UPGRADES TO EXISTING
SANITARY SEWER SYSTEM

AE PROJECT No.	2019-3459
SCALE	1:5,000
COORD. SYSTEM	NAD 1983 3TM 114
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

IF NOT 25 mm ADJUST SCALES 25 mm

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

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DATE: 7/4/2019.

4 SYSTEM EXPANSION

4.1 Ultimate Sanitary Sewer System

Figure 4-1 presents the ultimate sanitary sewer system; **Figure 4-2** presents the future sanitary catchment areas used in our calculations. The future sanitary sewer system is proposed to consist of gravity sewers and lift stations and force mains. The future gravity sewers range in size from 200 mm to 375 mm in diameter; refer to Section 4.2 for information on the future lift stations and force mains.

The sanitary sewer layout for the undeveloped areas to the west, north, and east is conceptual only and is subject to change pending future developments, street alignments, stormwater management facility locations, etc.

The infill areas identified on **Figure 3-1** have been included in our calculations for the ultimate servicing concept. No additional pipe upgrades, over and above those identified in Section 3.3, are required to support development of the infill areas.

4.2 Ultimate Lift Station / Force Main Configuration

Figure 4-1 presents the ultimate sanitary sewer system, including the proposed locations of lift stations and force mains.

Based on the local topography, we estimate that an additional four lift stations will be required to service the undeveloped areas to the west, north, and northeast. The wastewater collected by LS1-N, LS2-W, and the gravity system to the west and north will discharge to LS1-W and be pumped through a 300 mm diameter force main to the Main Lift Station. The wastewater collected by the gravity system in the northeast will discharge to LS1-NE and be pumped through a 200 mm diameter force main to the Main Lift Station.

4.3 Ultimate Upgrades to Main Lift Station

Upon ultimate development of the Town of Bon Accord, the Main Lift Station will require complete reconstruction, including:

- A wet well with a capacity of 35 m^3;
- Two pumps each capable of operating at 232 L/s; and
- Replacement of the 200 mm diameter force main to the lagoon with a 350 mm diameter force main.

When significant interim upgrades to the Main Lift Station are required, we recommend the Town undertake an investigation to determine the feasibility of expanding / upgrading the existing Main Lift Station or relocating the Main Lift Station and constructing the ultimate structure.

4.4 Staging

The proposed future concept focuses on a staged approach for development, with an "inner ring" of initial development and an "outer ring" of ultimate development; **Figure 4-1** illustrates this development concept. Construction of LS1-W will facilitate development of a large portion of the west and north, and construction of LS1-NE will facilitate development of the northeast. The east area can be developed at any time as it is proposed to be serviced by expanding the existing gravity sewer system in that area.

4.5 Design Constraints

4.5.1 Grading

Inverts and depths of cover for proposed sanitary sewers servicing undeveloped areas have not been identified as they are dependent on the post-development grading plans. Due to the undulating topography, with several hills and low areas, it is assumed that significant earthworks will be required as part of future developments.

4.5.2 Northwest Corner of 54 Avenue and Range Road 235

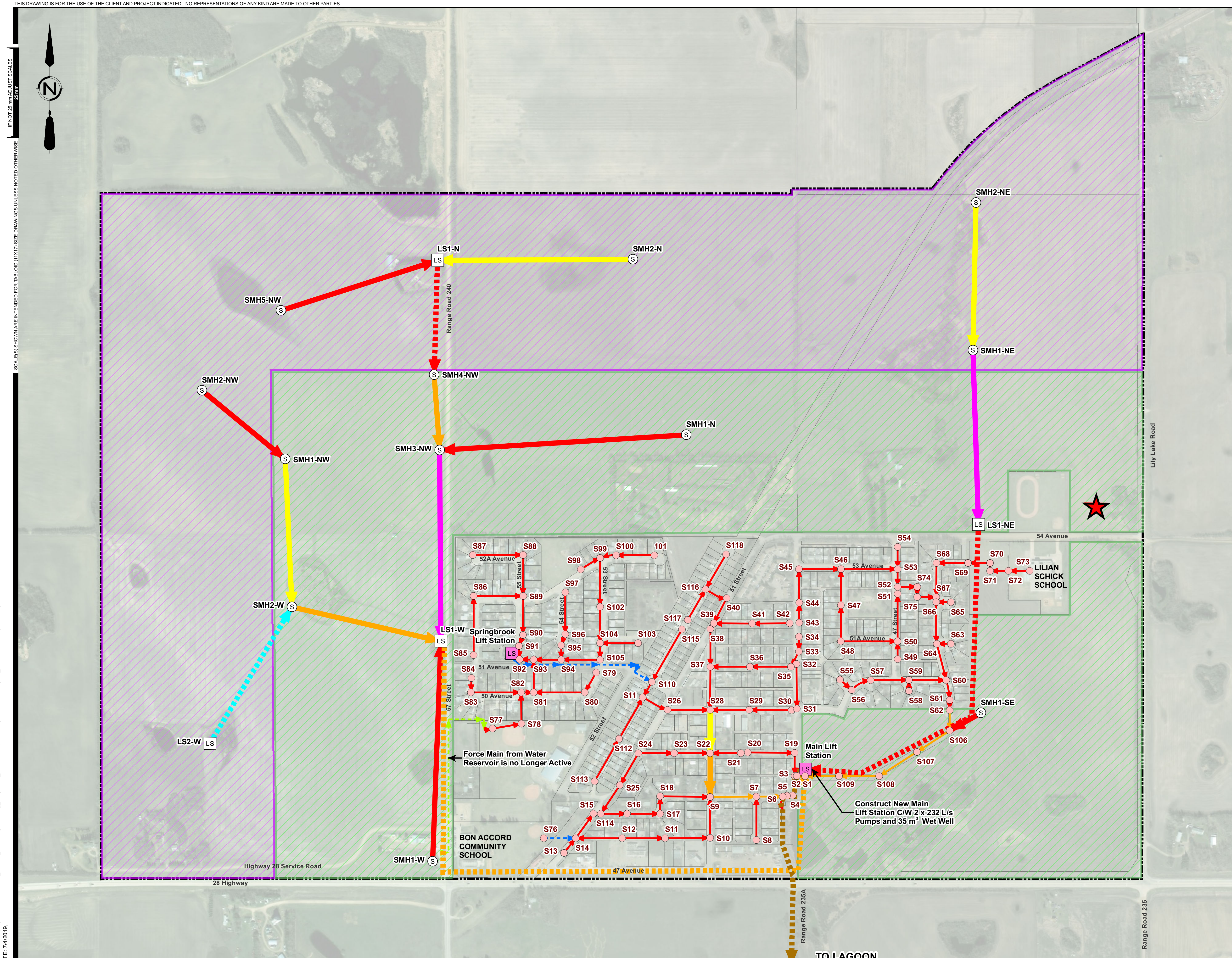
The area north of 54 Avenue, between the Lilian Schick School recreation area and Lily Lake Road (Range Road 235), as identified by a star symbol on **Figure 4-1**, is significantly lower than the Lilian Schick School recreation area. This area will need to be filled in prior to supporting residential development. We have assumed that this area will eventually drain west to the sanitary sewer serviced by the proposed northeast lift station.

4.5.3 Northeast Industrial Area

The upper portion of the northeast industrial area is located in a low area. It is assumed that a stormwater management facility will be located in the low area; however, we have included the entire industrial area in our calculations for the ultimate servicing concept. The entire industrial area has been accommodated in the gravity calculations; however, a portion of the industrial area may need to be serviced by low pressure sewer services.

4.6 Regional Collection

The capacity of the Capital Region Northeast Wastewater Commission lagoon located south of Highway 28 has not been assessed as it is not within the scope of this study.



Associated Engineering

Legend:

- Lagoon
- Existing Lift Station
- Proposed Lift Station
- Proposed Sanitary Manhole
- Initial Development
- Ultimate Development
- Town Boundary

Distribution System

Existing Force Mains
- 75 mmø
- 100mmø
- 150mmø
- 200 mmø

Existing Gravity Mains
- 200mmø
- 300mmø

Proposed Force Mains
- 150 mmø
- 200 mmø
- 300 mmø
- 350 mmø

Proposed Gravity Mains
- 200 mmø
- 250 mmø
- 300 mmø
- 375 mmø

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FIGURE No. 4-1

TOWN OF BON ACCORD
SANITARY MASTER PLAN UPDATE

ULTIMATE SANITARY SEWER SYSTEM

AE PROJECT No.	2019-3459
SCALE	1:8,500
COORD. SYSTEM	NAD 1983 3TM 114
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

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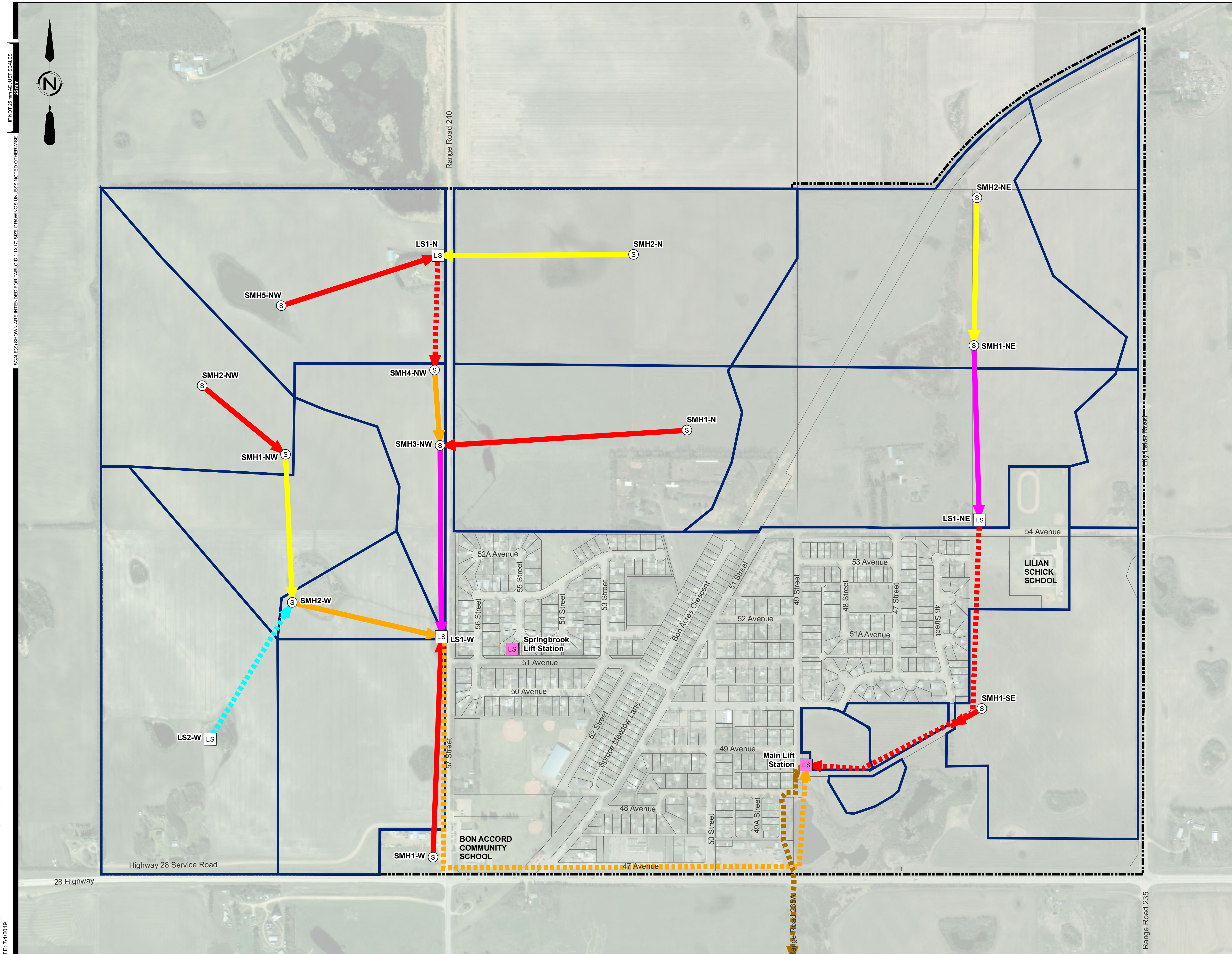

Associated Engineering

Legend:

- Future Catchment Areas
- Town Boundary
- Proposed Lift Station
- Proposed Sanitary Manhole

Proposed Force Mains

- 150 mmø
- 200 mmø
- 300 mmø
- 350 mmø

Proposed Gravity Mains

- 200 mmø
- 250 mmø
- 300 mmø
- 375 mmø

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FIGURE No. 4-2

TOWN OF BON ACCORD
SANITARY MASTER PLAN UPDATE

FUTURE SANITARY CATCHMENT AREAS

AE PROJECT No.	2019-3459
SCALE	1:8,500
COORD. SYSTEM	NAD 1983 3TM 114
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

5 COST ESTIMATES

5.1 Infrastructure to Meet Town's Current Needs

Table 5-1 summarizes the capital costs associated with upgrading the Town's existing infrastructure to meet their current needs. The estimate presented includes an allowance for engineering (15%) and contingency (15%) but does not include GST. Costs are in 2019 dollars; refer to Appendix A for unit costs and detailed estimates.

Table 5-1
Capital Costs – Infrastructure to Meet Town's Current Needs

Item	Cost
Gravity System	
Replace pipe from MH S28 to MH S22 with 250 mm diameter PVC pipe.	$213,000
Replace pipe from MH S22 to MH S9 with 250 mm diameter PVC pipe.	$218,000
Springbrook Lift Station	
There are currently no upgrades identified for the Springbrook Lift Station.	
Main Lift Station	
Replace pumps with 2 x 58 L/s pumps and adjust "Start Lead Pump" setpoint to expand wet well from 6.2 m^3 to 8.7 m^3.	$390,000
Replace 150 mm diameter portion of force main with 200 mm diameter HDPE pipe.	$325,000
TOTAL (Excl. GST)	**$1,146,000**

5.2 Infrastructure to Meet Town's Ultimate Needs

Table 5-2 summarizes the capital costs associated with the new infrastructure and upgrades required to meet the Town's needs upon complete development of the Town. These capital costs are anticipated to be recovered through development charges. The estimate presented includes an allowance for engineering (15%) and contingency (15%) but does not include GST. Costs are in 2019 dollars; refer to Appendix A for unit costs and detailed estimates.

Table 5-2
Capital Costs – Infrastructure to Meet Town's Ultimate Needs

Item	Cost	Benefiting Area (ha)	Off-Site Levy
Gravity System			
All costs associated with gravity system extensions shall be borne by the developer(s).			
Lift Stations and Force Mains			
LS1-W c/w 17.5 m^3 wet well and 2 x 115 L/s pumps	$5,250,000	188.2	$27,896 / ha
300 mm diameter HDPE force main from LS1-W to Main Lift Station	$1,190,000	188.2	$6,323 / ha
LS1-NE c/w 7 m^3 wet well and 2 x 45 L/s pumps	$2,100,000	79.9	$26,283 / ha
200 mm diameter HDPE force main from LS1-NE to Main Lift Station	$524,000	79.9	$6,558 / ha
*All other costs associated with the remaining lift stations (LS2-W and LS1-N) and force mains shall be borne by the developer(s).			
Main Lift Station Upgrades			
Construct new lift station (c/w 2 x 232 L/s pumps and 35 m^3 wet well)	$10,500,000	402.6	$26,080 / ha
Replace 200 mm diameter force main with 350 mm diameter HDPE pipe	$539,000	402.6	$1,339 / ha
TOTAL (Excl. GST)	**$20,103,000**		

6 CONCLUSIONS & RECOMMENDATIONS

6.1 Conclusions

6.1.1 Gravity Sanitary Sewer

Generally, the existing gravity sanitary sewer system is adequate to accommodate the calculated peak wet weather flows within the currently-developed portion of the Town of Bon Accord; however, several pipes have less than minimum cover.

The following upgrades are required:

- Replace the 200 mm diameter sewer between MH S28 to MH S22 (50 Street) with a 250 mm diameter sewer.
- Replace the 200 mm diameter sewer between MH S22 and MH S9 (50 Street) with a 300 mm diameter sewer.
- Remove and reinstall the sewer between MH S64 and MH S62 (46 Street) to increase pipe slopes. This work can be postponed until the next time there is work planned along the southern portion of 46 Street as the level of surcharging in these pipes is not anticipated to result in sewage back-up into basements.

No upgrades to the gravity sanitary sewer to support future development to the east are currently recommended. The gravity sanitary sewer is not anticipated to be impacted by future developments to the north and west.

6.1.2 Springbrook Lift Station and Force Main

The Springbrook Lift Station (pumps and wet well) and force main are adequately-sized to accommodate the calculated peak wet weather flows from the currently-developed lands west of 52 Street. No upgrades to the Springbrook Lift Station and force main are currently recommended. The Springbrook Lift Station is not anticipated to be impacted by future developments to the west, north, or east.

6.1.3 Main Lift Station and Force Main

The Main Lift Station (pumps and wet well) and force main are undersized to accommodate the calculated peak wet weather flows from the currently-developed areas in the Town of Bon Accord. Since there are required upgrades to the Main Lift Station, it is prudent to allow for growth over the lifespan (15 years) of the new pumps. The following upgrades to the Main Lift Station are required:

- Replace the 2 x 38 L/s pumps with 2 x 58 L/s pumps.
- Adjust the “Start Lead Pump” setpoint from 693.05 m to 693.30 m.
- Replace the 150 mm diameter portion of the force main from the Main Lift Station with 200 mm diameter HDPE pipe.

Significant upgrades to the Main Lift Station are required to support the ultimate development of the Town of Bon Accord. It is not feasible to modify the existing structure (which will have reached the end of its anticipated service life); therefore, a new structure will need to be constructed, with the following elements:

- 2 x 232 L/s pumps;
- 35 m^3 wet well storage capacity; and
- Replacement of the 200 mm diameter force main from the Main Lift Station to the lagoon south of Highway 28 with a 350 mm diameter force main.

6.2 Recommendations

6.2.1 Gravity Sanitary Sewer

As identified on **Figure 3-4**, several pipes have less than minimum cover. We recommend that further investigation be done to identify if there is an opportunity to lower the mains with less than minimum cover. These areas should also be compared with the results of any CCTV inspections which have been done to determine if any of the affected areas are flagged for sewer replacement. Any sewers flagged for replacement could have insulation installed to help protect the sanitary sewer from freezing.

6.2.2 Lift Stations and Force Mains

Prior to implementation of upgrades to either lift station, it is recommended that the Town:

- Monitor operation of the lift stations during wet weather conditions to get a better understanding of their capacities.
- Perform a lift station drawdown test at each facility to confirm current pumping capacities.
- Verify the current setpoints to confirm the actual wet well capacities.
- Confirm the pumping rates for individual pumps as well as during combined operation.

Additionally, when significant interim upgrades to the Main Lift Station are required to support future developments, we recommend the Town undertake an investigation to determine the feasibility of expanding / upgrading the existing Main Lift Station or relocating the Main Lift Station and constructing the ultimate structure.

6.2.3 Model Calibration

We recommend that the Town undertake a flow monitoring program to determine the following parameters.

- Hourly diurnal flow pattern for the Town;
- Unit hydrographs (RTK parameters and initial abstraction depths for fast, medium, and slow responses); and
- Design storm events.

Upon verification of these parameters, we recommend that the model be updated and calibrated to reflect actual loading conditions on the existing sanitary sewer.

6.2.4 Additional Recommendations

- We recommend that this Sanitary Master Plan be reviewed in 5 to 10 years or when sufficient modelling data is available.
- We recommend that the Town coordinate with the Capital Region Northeast Wastewater Commission to undertake a separate investigation to confirm the capacity of the Capital Region Northeast Wastewater Commission lagoon and determine whether upgrades to the lagoon are required to support future developments within the Town of Bon Accord.

CLOSURE

This report was prepared for the Town of Bon Accord to provide a Sanitary Master Plan update.

The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering Alberta Ltd.

2019-10-03
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2019-10-03
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2019-10-07
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ASSOCIATED ENGINEERING
QUALITY MANAGEMENT SIGN-OFF

Signature: ____________________

Date: **October 4, 2019**

APEGA Permit to Practice P 3979

APPENDIX A - DETAILED COST ESTIMATES

Table A-1
Cost Breakdown

Town of Bon Accord Sanitary Master Plan

Upgrades to Existing Gravity System

Location	From	Start Node	To	Stop Node	Length (m)	Diameter (mm)	Unit Cost ($/m)	Pipe Cost	Type
50 Street	50 Avenue	MH S28	49 Avenue	MH S22	101	250	$2,110	$213,110	Developed
50 Street	49 Avenue	MH S22	48 Avenue	MH S9	103	300	$2,120	$218,360	Developed
							Total Upgrades to Existing Gravity System	**$431,000**	

Upgrades to Main Lift Station and Force Main

Item	From	Start Node	To	Stop Node	Unit	Quantity	Unit Cost	Cost	Type
Replace pumps with 2 x 58 L/s pumps (incl. adjustment of lead pump setpoint)	N/A	N/A	N/A	N/A	ea	2	$195,000	$390,000	Developed
Replace 150 mm diameter portion of force main with 200 mm diameter HDPE pipe	Main Lift Station	N/A	Lagoon	N/A	m	541	$600	$324,600	Developed
							Total Upgrades to Main Lift Station and Force Main	**$715,000**	

Ultimate Development

Location	From	Start Node	To	Stop Node	Unit	Quantity	Unit Cost	Cost	Type
New Lift Stations and Force Mains									
LS1-W c/w 17.5 m^3 wet well and 2 x 115 L/s pumps	N/A	N/A	N/A	N/A	m^3	17.5	$300,000	$5,250,000	Undeveloped
300 mm diameter HDPE force main from LS1-W to Main Lift Station	LS1-W	N/A	Main Lift Station	N/A	m	1,700	$700	$1,190,000	Undeveloped
LS1-NE c/w 7 m^3 wet well and 2 x 45 L/s pumps	N/A	N/A	N/A	N/A	m^3	7	$300,000	$2,100,000	Undeveloped
200 mm diameter HDPE force main from LS1-NE to Main Lift Station	LS1-NE	N/A	Main Lift Station	N/A	m	874	$600	$524,400	Undeveloped
Main Lift Station Upgrades									
Construct new lift station c/w 35 m^3 wet well and 2 x 232 L/s pumps	N/A	N/A	N/A	N/A	m^3	35	$300,000	$10,500,000	Developed
Replace 200 mm diameter force main with 350 mm diameter HDPE pipe	Main Lift Station	N/A	Lagoon	N/A	m	673	$800	$538,400	Developed
							Total Ultimate Development	**$20,103,000**	

Associated Engineering

Table A-2
Gravity Sewer Unit Costs ($/m)

Town of Bon Accord Sanitary Master Plan

Developed Lands

Item	200mm	250mm	300mm	375mm	450mm	525mm	600mm	750mm	900mm	1500mm Conc
Asphalt Pavement Removal	$53	$53	$53	$79	$79	$79	$105	$105	$105	$105
Granular Base Removal and Disposal	$37	$37	$37	$53	$53	$53	$68	$68	$68	$68
Curb, Gutter, Sidewalk Removal	$58	$58	$58	$58	$58	$58	$58	$58	$58	$58
Trenching and Backfilling	$420	$420	$420	$473	$473	$473	$525	$525	$525	$525
Pipe Zone Material	$32	$32	$32	$58	$58	$58	$84	$84	$84	$84
Supply and Install PVC DR35 Pipe	$58	$63	$69	$76	$110	$158	$210	$273	$452	$1,500
Monolithic Sidewalk, Curb and Gutter	$221	$221	$221	$221	$221	$221	$221	$221	$221	$221
Existing Pavement Repair	$231	$231	$231	$231	$231	$231	$231	$231	$231	$231
Reconnection of Services	$231	$231	$231	$231	$0	$0	$0	$0	$0	$0
Manholes (1 every 100 m)	$131	$131	$131	$131	$131	$131	$131	$131	$131	$131
Miscellaneous (Mob/De-Mob, Survey, Signage) (10%)	$147	$148	$148	$161	$141	$146	$163	$170	$188	$292
Total Construction	$1,619	$1,625	$1,631	$1,772	$1,555	$1,608	$1,796	$1,866	$2,063	$3,215
Contingency (15%)	$243	$244	$245	$266	$233	$241	$269	$280	$309	$482
Engineering (15%)	$243	$244	$245	$266	$233	$241	$269	$280	$309	$482
Total (rounded)	**$2,100**	**$2,110**	**$2,120**	**$2,300**	**$2,020**	**$2,090**	**$2,340**	**$2,430**	**$2,680**	**$4,180**