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April 26, 2024

Mr. Shawn Chaisson
First Mutual Properties
175 Main Street #203
Dartmouth, NS
B2X 1S1

Re: 70 First Lake Drive, Lower Sackville Nova Scotia – Downstream Wastewater Sewer Analysis

First Mutual Properties is proposing to add two (2) apartment buildings with a total of 154 units to their property at 70 First Lake Drive in Lower Sackville. Based on a density of 2.25 people per unit, this equates to an additional 346 people. The analysis of the original downstream sewers to the First Lake Drive pump station can be found in the SDMM December 2023 downstream report. A sketch of this development (Figure 1) is in the appendix. This report will analyze sections of the Glendale Drive sewer starting from a point downstream of the First Lake Drive Pump Station to the designated terminus point as well as confirm the existing pump station capacity. As per Halifax Water Design and Construction Specifications (2023), Section 4.2.1 and at the request of First Mutual Properties, SDMM has prepared the following capacity analysis for the sewer systems downstream of the proposed development.

Tributary Drainage Areas & Population

The downstream terminus of this analysis was established based on correspondence with Halifax Water staff and was determined to be the existing manhole MH68346 at the intersection of Rankin Drive and Glendale Drive in Sackville. This required five (5) sections of gravity sewer downstream of the redevelopment to be analyzed as well as the First Lake Drive pump station capacity. Existing and proposed tributary areas for these sewers are depicted in Figure 2 of the appendix.

SDMM determined equivalent populations for the existing sewer sheds based on the following resources:

- Halifax Water Design & Construction Specifications (2023)
- Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal (2006)
- Zoning information from the HRM Land-Use By-Law for Sackville
- Correspondence with Halifax Water – Figure 3 (Population Densities & Terminus Point)

A summary of the density calculations is presented in Table 1 of the appendix. Tributary areas and population calculations, including the proposed development, are presented in Tables 2A and 2B of the appendix.

Estimated Wastewater Flow Calculations

Estimated wastewater flows were calculated based on the hydraulic design formula outlined in Section 4.2.2 of the Halifax Water Design & Construction Specifications (2023). Flows calculated include the Halifax Water safety factor of 1.25 with allowances of 0.30m^3 per person per day for residential development and 24m^3 per gross hectare per day for infiltration/inflow.

Existing flows for each section of sewer downstream from the development were calculated. Existing theoretical flows conveyed tot eh pump station, based on zoning and population of areas A & B were estimated to be 10,496m^3/d (121.5L/s).

However, the flows from the First Lake Drive pump station were based on the existing pump station pump shop drawings provided by Halifax Water on the most recent station upgrades to add a third pump for redundancy. This information identified the existing pump station capacity or duty point of 1 pump to be 75L/s at a head of 11.2m. Given that Halifax Water pump station design criteria requires 1 pump being capable of pumping the design flow for the tributary area, this pump flow of 75L/s was used for the analysis of the pipe reaches downstream of the forcemain outlet into pipe A.

A summary of the theoretical estimated flows is presented in Table 3A and 3B. Note, Table 3A includes the flow that the 1 pump from the First Lake Drive pump station can deliver to pipe A. This flow of 75 L/s or 6480 m^3/d was established as the maximum flow from the pump station.

Existing Pipe Capacity

Existing pipe capacities were calculated using Manning's Equation for each reach of downstream sewer utilizing pipe characteristics provided by Halifax Water GIS information. A summary of the existing pipe capacities is presented in Table 4 of the appendix.

Existing Pump Station and Manhole Flow Monitoring

Flow monitoring data was made available from Halifax Water at 5 flow monitoring points (FG573, FG539, FG577, FG533 & FG12) inside of the study area and identified in Figure 3. The data was collected between January 1, 2023 & February 28, 2024 with flow readings taken every 5 minutes. This data was used to review average monthly flows observed over the 14-month period of data collection. To ensure the analysis used a conservative approach, the highest recorded flow over the entire 14 months was used to compare to estimated theoretical flows.

As these monitoring points were inside Area 1, sub-Areas A, B and C were created and labelled in Figure 4. These areas B and C were created to reflect the tributary areas of the respective

flow monitoring points. This allowed us to directly compare theoretical estimated flows to the actual flows from the flow monitoring data.

Flows from monitoring points FG539, FG577 and FG573 were collected every 5 minutes. For our analysis of actual flows, we chose the highest flow registered over the 14 months of monitoring as a worst-case scenario at each of the three monitoring stations and used that value to calculate the maximum daily flows. Each of these were upstream of the first lake pump station.

Flows conveyed to the First Lake Drive pump station are generated from Areas 1 & 2 combined. Total flows in table 3C for the combined areas of 1 & 2 saw flows of 4337m^3/d or 50.2L/s.

Given FG12 was downstream of the First lake Drive pup station, we looked closer at minimum and maximum average flows to reflect when the pump was either on or off. As a result, FG12 saw a minimum average flow of 385 m^3/d in February 2024 and a maximum average flow of 688 m^3/d in the month of August, 2023. By comparison the highest calculated daily flow of 1203 m^3/day using the observed flows was on July 22, 2023 (calculated using the highest measured 5-minute increment flow). This maximum day flow of 1203 m^3/day was used as actual flow for our analysis. Similar monthly averages and maximum flows for the other 4 flow monitoring points and can be found in Tables 5A-5E.

Calibration of the theoretical estimated flows using flow monitoring Data

By comparing actual flow data to theoretical estimated flows, allows our analysis to calibrate or adjust our estimated flows through the use of ratios of actual flows to theoretical flows.

For the gravity flows of subareas B & C, theoretical flows based on population and areas are calculated in Table 2B. This flow information could then be compared to the actual maximum day flows from flow monitoring data. In general, this analysis indicated an overestimation of theoretical flows vs actual flows as shown in Table 3C. For tributary areas outside of the flow monitoring points, we applied the same actual to theoretical flow ratios using areas adjacent to calibrate our flows as shown in Table 3C.

One example of this was for Area A (outside of a flow monitoring), which was deemed to share the same actual to theoretical flow ratio as area C (tributary to a flow monitoring point). The same was done for calculating flows in area 4 which shares the same estimated to measured flow ratio as area 3. Also, for areas 6 and 7, which share the same flow ratio as area 5.

As the flow monitoring points FG533 and FG12 were after the pump station, average daily flows, excluding peaks when the pump would be on was used to compare to theoretical estimated gravity flows of upstream tributary areas to come up with the actual to theoretical flow ratios. The maximum of these “pump off” flows taken as the value to use in our calculations. The one pump flow rate was then added to the calibrated gravity flows to analyze the Glendale Drive pipe capacities.

Flows to the First Lake Drive pump station were first calculated to establish theoretical flows based on land zoning and population. This resulted in a theoretical flow rate of 121.5L/s. By comparison actual flows conveyed to the First Lake Drive pump station presented in table 3C for the combined areas of 1 & 2 was 50.2L/s.

Conclusion

Considering the Halifax Water design principal for pump stations of one pump flow rate, calculating actual flows from monitoring points and applying flow ratios to corresponding estimated theoretical flows, has confirmed the Glendale Drive sanitary system has the capacity for the expected flows, including the proposed development.

The measured flows at the 5 monitoring points indicate the actual flows to be below theoretical estimates. This is highlighted in table 3C under the flow ratio column comparing the two. Maximum daily flows from flow monitoring were calculated and applied to each section of pipe. For example, Pipe A had a maximum actual flow of 883.6 m^3/d on February 28, 2024. By comparison, the theoretical estimated flow was 4520 m^3/d resulting in an actual to theoretical flow ratio of 19.5%.

Looking at the worst case of measured flows to be within pipe capacity limits, we can look at Area C, which had the highest actual flows to theoretical flow ratio at 54.4%. The differences in flow could be due to overestimated population, flows, safety factors applied in the calculations or non-full buildout of some properties within the tributary areas analyzed.

The analysis of flows to existing pipe capacity are presented in table 4. Although the comparisons range from 16% to 67% of pipe capacities, with Pipe F being the highest at a 67% capacity, all expected flows are below existing pipe capacity.

In addition, checking the calibrated estimated theoretical flows to the single pump capacity, we find the expected flows to the First Lake Drive pump station to be 50.2L/s. With a single pump flow rate of 75L/s, the flows to the pump station will remain below the pump capabilities and no upgrades will be required.

For additional information or comment please contact the undersigned.

Regards,

Servant, Dunbrack, McKenzie & MacDonald Ltd.

Original Signed

Ray Landry, MASc., P.Eng.
Project Engineer
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APPENDIX

Figure 1: Proposed Development Sketch

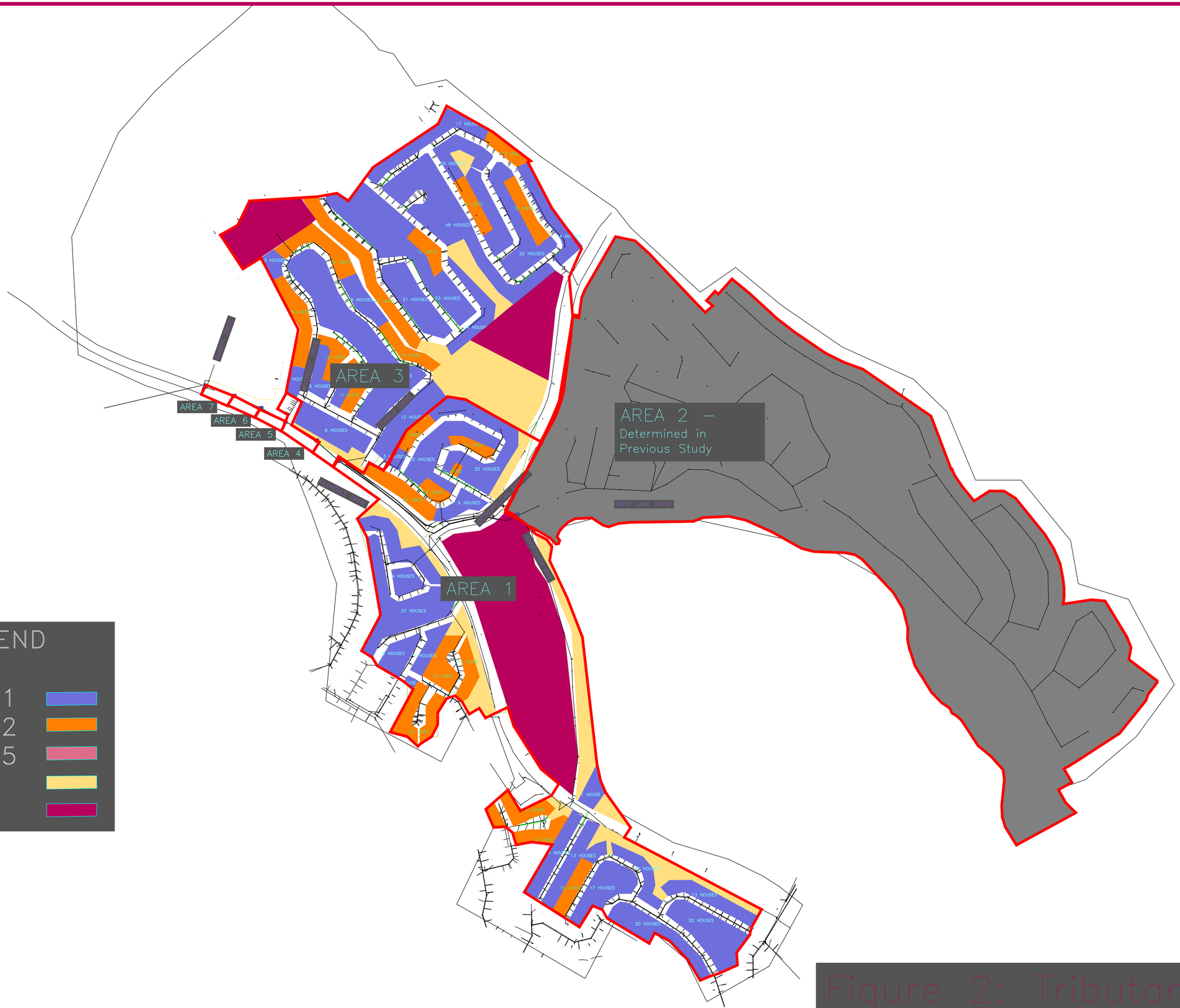

Figure 2: Tributary Areas

Figure 3: Halifax Water Flow Monitoring Points

Figure 2: Flow Monitoring Areas

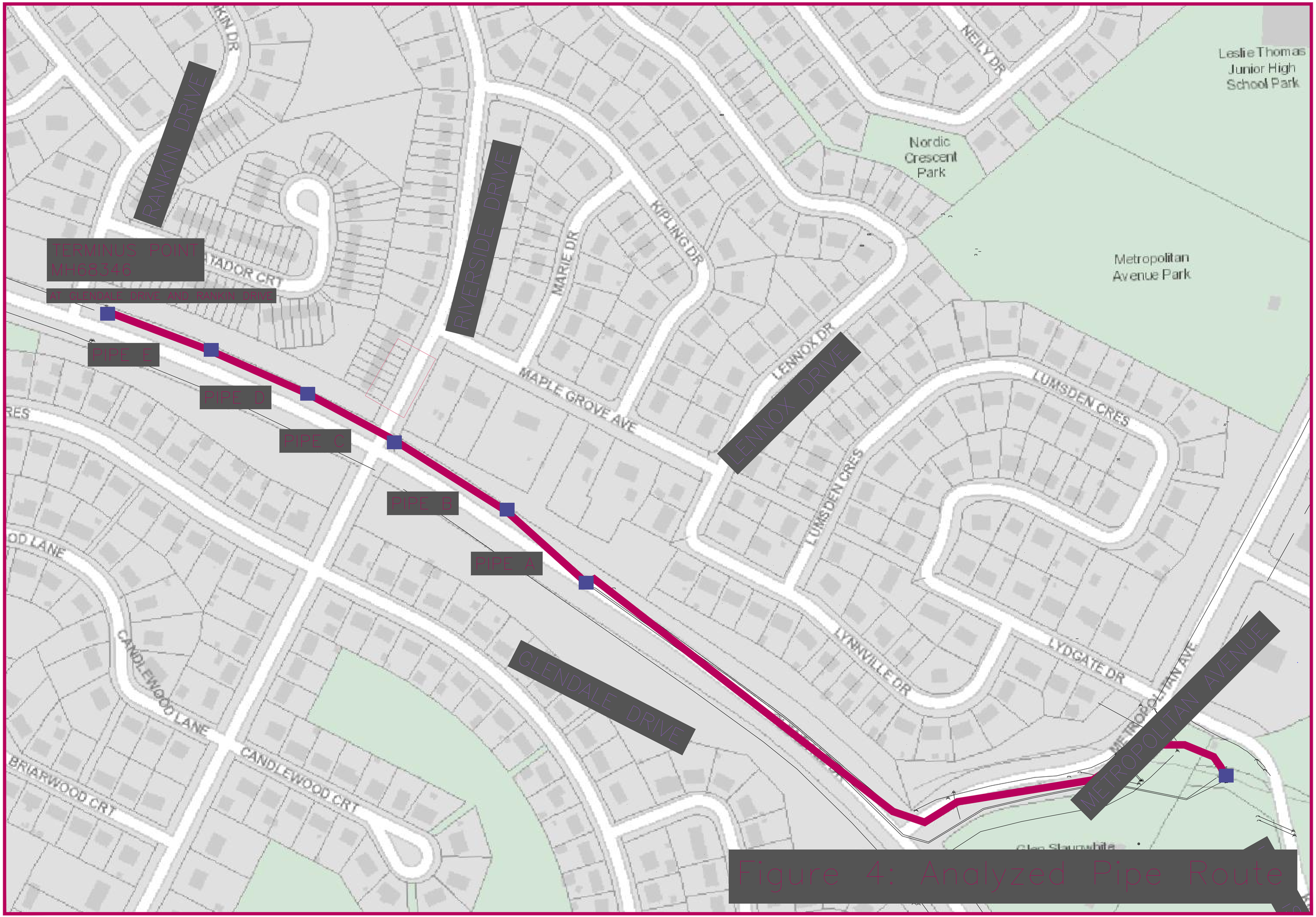

Figure 4: Analyzed Pipe Route

SH Sarah Howlett <sarahh@halifaxwater.ca>

To: Ray Landry Thu 3/7/2024 11:53 AM

Cc: Ben Chaisson <ben@firstmutualproperties.com>; Cody MacDonald <codym@halifaxwater.ca>

Hello Ray,

Please take the downstream analysis to MH68346, including the analysis of the pumping station, of which I will confirm the details.

In the meantime, please email gisproducts@halifaxwater.ca with your request for record/shop drawings. They will provide available record information as well as a data licensing agreement for you to sign. Once we have the signed data licensing agreement I can provide the updated flow monitoring, as well as any additional pump station data.

I'll be following up soon.

Thanks,
Sarah

Figure 6: Email from Halifax Water Regarding Terminus

Table 1: Sackville Land Use Density Values				
Zoning	**Number of Units**	**People per unit (HW)**	**People per Hectare**	**People per Property**
ER-1 - Established Residential 1 Zone				
	1	**3.35**	**-**	**3.35**
ER-2 - Established Residential 2 Zone				
	2	**3.35**	**-**	**6.70**
ER-5 Townhouse Dwelling Zone				
	2 to 6	**3.35**	**-**	**6.70 to 20.10**
P-1 - Open Space Zone				
	***Atlantic Canada Wastewater Guidelines**		**85**	**-**
P-2 - Community Facility Zone				
	***Atlantic Canada Wastewater Guidelines**		**85**	**-**

Table 2A - Tributary Areas and Population						
Area	**Sub-Area**	**Number of Units**	**People per Unit**	**People per Hectare**	**Tributary Area (ha)**	**Equivalent Population**
Area 1						
	ER-1	215	3.35			720
	ER-2	162	3.35			543
	P-1			85	5.30	450
	P-2			85	10.68	908
	Road and Remaining Land				32.44	
				Sub-Totals	**48.41**	**2,621**
Area 2						
	Pre-determined amount from previous study					
				Sub-Totals	**80.52**	**3,639**
Area 3						
	ER-1	324	**3.35**			1,085
	ER-2	192	**3.35**			643
	P-1			85	**5.00**	425
	P-2			**85**	**4.99**	424
	Road and Remaining Land				37.46	
				Sub-Totals	**47.45**	**2,578**
Area 4						
	ER-5	7	3.35			23
	Road and Remaining Land				0.49	
				Sub-Totals	**0.49**	**23**
Area 5						
	Road and Remaining Land				0.18	
				Sub-Totals	**0.18**	
Area 6						

	Road and Remaining Land				0.19	
				Sub-Totals	**0.19**	
Area 7						
	Road and Remaining Land				0.19	
				Sub-Totals	**0.19**	
Area 8						
	ER-1	322	3.35			1,079
	ER-2	116	3.35			389
	ER-5	75	3.35			251
	P-1			85	5.6198	478
	P-2			85	0.1134	10
	Road and Remaining Land				36.77	
				Sub-Totals	**42.51**	**2,206**
				Totals	**220**	**11,067**

Table 2B - Tributary Areas and Population at Flow Monitoring Stations

Area	Sub-Area	Number of Units	People per Unit	People per Hectare	Tributary Area (ha)	Equivalent Population
Area A - Flow Point MH FG539						
	Pre-determined amount from previous study					
				Sub-Totals	**80.52**	**3,639**
Area B - Flow Point MH FG577						
	ER-1	112	3.35			375
	ER-2	110	3.35			369
	P-1			85	1.92	163
	Road and Remaining Land				17.18	
				Sub-Totals	**19.10**	**907**
Area C - Flow Point MH FG573						
	ER-1	103	3.35			345
	ER-2	52	3.35			174
	P-1			85	2.11	180
	Road and Remaining Land				12.15	
				Sub-Totals	**14.26**	**699**
Area D - Flow Point MH FG533						
	Refer to Areas 1-3 in Table 2A					
				Sub-Totals	**176.38**	**8,837**
Area E - Flow Point MH FG12						
	Refer to Areas 1-5 in Table 2A					
				Sub-Totals	**177.05**	**8,861**

Table 3A - Estimated Sanitary Sewer Flow Calculations

Pipe	Population Area Numbers (s)	Peaking Factor, M, (Wastewater Flows)	Safety Factor	Equivalent Population, P	Average Dry Weather Flow, a (m^3 per person/d)	Infiltration/Inflow Allowance, b (m^3/d) (Wastewater Flows)	Infiltration, I (10% of P*a) (m^3/d)	Estimated Theoretical Flow, q (m^3/d)	Pump Spec Flow (m3/d)	Adjusted Flow Using Flow data, q (m^3/d)	Comments
FORCE MAIN	Area 1	*3.49*	1.25	2621	0.30	1162	79	4593		**4593**	
FORCE MAIN	Area 1-2	*3.15*	1.25	6260	0.30	3094	188	10496		**10496**	Includes area previously calculated in past study
A	Area 1-3	*3.50*	1.25	2578	0.30	1139	77	4520	6480.0	**11000**	Areas before area 3 only factor in maximum pump station flow
B	Area 1-4	*3.49*	1.25	2601	0.30	1151	78	4559	6480.0	**11039**	Areas before area 3 only factor in maximum pump station flow
C	Area 1-5	*3.49*	1.25	2601	0.30	1155	78	4563	6480.0	**11043**	Areas before area 3 only factor in maximum pump station flow
D	Area 1-6	*3.49*	1.25	2601	0.30	1159	78	4568	6480.0	**11048**	Areas before area 3 only factor in maximum pump station flow
E	Area 1-7	*3.49*	1.25	2601	0.30	1164	78	4573	6480.0	**11053**	Areas before area 3 only factor in maximum pump station flow

Table 3B - Measured Sanitary Sewer Flow Calculations										
Pipe	Population Area Numbers (s)	Peaking Factor, M, (Wastewater Flows)	Safety Factor	Equivalent Population, P	Average Dry Weather Flow, a (m^3 per person/d)	Infiltration/Inflow Allowance, b (m^3/d) (Wastewater Flows)	Infiltration, I (10% of P*a) (m^3/d)	Estimated Theoretical Flow, q (m^3/d)	Model Calibration Factor *	Adjusted Flow Using Flow data, q (m^3/d)
A-2	Area B - Flow Point MH FG577	*3.83*	1.25	906.78	0.30	458.43	27.20	1759.77	1.00	**1759.77**
A-3	Area C - Flow Point MH FG573	*3.89*	1.25	698.83	0.30	342.33	20.96	1363.05	1.00	**1363.05**

Table 3C - Estimated Sanitary Sewer Flow Calculations Using Flow Data							
Pipe	Name of Area	Pump Spec. (m3/d)	Estimated Flow Without Pump (m3/d)	Monitored Flow (Daily Average with Highest 5 Minute Interval) (m3/d)	Flow Ratio (Highlighted Cells are Copied Ratio From Nearby Pipes)	Theoretical Flow With Pump (m3/d)	Comments
FORCE MAIN	Area C (FG573)		1363	*742.18*	54.4%		Estimated Flow Calculated in Table 3B
FORCE MAIN	Area A		1470	*800.66*	54.4%		Estimated Flow Calculated by having A, B and C equal to Area 1 Flows
FORCE MAIN	Area B (FG577)		1760	*613.44*	34.9%		Estimated Flow Calculated in Table 3B
FORCE MAIN	Area 1 (A, B and C)		4593	2156	46.9%	2156	
FORCE MAIN	Area 2 (FG539)		5903	*2180.74*	36.9%	2181	"Estimated Flow Without Pump" Is only the flow of area 2, excluding any combined flow
A	Area 3 (FG533)	6480	4520	*883.61*	19.5%	7364	"Estimated Flow Without Pump" only considers flow received after the pump
B	Area 1-4	6480	4559	*891.32*	19.5%	7371	"Estimated Flow Without Pump" only considers flow received after the pump
C	Area 5 (FG12)	6480	4563	*1202.79*	26.4%	7683	"Estimated Flow Without Pump" only considers flow received after the pump
D	Area 1-6	6480	4568	*1203.97*	26.4%	7684	"Estimated Flow Without Pump" only considers flow received after the pump
E	Area 1-7	6480	4573	*1205.19*	26.4%	7685	"Estimated Flow Without Pump" only considers flow received after the pump

Table 4: Existing Pipe Capacity Calculations

Pipe	Sewer Type	Pipe Shape	Pipe Diameter (mm)	Material	Slope (%)	Mannings Coefficient, n	Manning's Capacity, Qc (m^3/d)	% of Capacity
A (Area 1-3)	Sanitary	Round	450	CONC	1.17	0.013	**26,645**	**28%**
B (Area 1-4)	Sanitary	Round	450	CONC	0.61	0.013	**19,239**	**38%**
C (Area 1-5)	Sanitary	Round	450	CONC	2.06	0.013	**35,355**	**22%**
D (Area 1-6)	Sanitary	Round	450	CONC	4.05	0.013	**49,573**	**16%**
E (Area 1-7)	Sanitary	Round	450	CONC	0.22	0.013	**11,554**	**67%**

Table 5A - Existing Flows at Manhole Flow Monitor Data Received from Halifax Water (FG539) At First Lake Drive/Metropolitan Avenue Pump Station		
Month	**Average Flow (L/s)**	**Average Flow (m3/day)**
Jan-23	9.52	822.5
Feb-23	7.84	677.4
Mar-23	7.73	667.9
Apr-23	7	604.8
May-23	6.82	589.2
Jun-23	8.11	700.7
Jul-23	9.64	832.9
Aug-23	9.38	810.4
Sep-23	9.26	800.1
Oct-23	11.4	985.0
Nov-23	11.41	985.8
Dec-23	12.32	1064.4
Jan-24	12.22	1055.8
Feb-24	9.52	822.5
Maximum Flow Recorded (7/21/2023 at 19:10)	**25.2**	**2180.7**

Table 5B - Existing Flows at Manhole Flow Monitor Data Received from Halifax Water (FG577) At Metropolitan Avenue / Glendale Dr MH16795		
Month	**Average Flow (L/s)**	**Average Flow (m3/day)**
Jan-23	5.33	460.5
Feb-23	3.9	337.0
Mar-23	3.61	311.9
Apr-23	2.28	197.0
May-23	1.94	167.6
Jun-23	2.94	254.0
Jul-23	3.46	298.9
Aug-23	3.12	269.6
Sep-23	1.88	162.4
Oct-23	2.24	193.5
Nov-23	3.39	292.9
Dec-23	3.47	299.8
Jan-24	2.86	247.1
Feb-24	3.73	322.3
Maximum Flow Recorded (7/11/2023 at 16:05)	**7.1**	**613.4**

Table 5C - Existing Flows at Manhole		
Flow Monitor Data Received from Halifax Water (FG573) At King Fisher Way / Glendale Dr MH15597		
Month	**Average Flow (L/s)**	**Average Flow (m3/day)**
Jan-23	2.79	241.1
Feb-23	1.53	132.2
Mar-23	1.54	133.1
Apr-23	1.2	103.7
May-23	1.14	98.5
Jun-23	2.11	182.3
Jul-23	3.53	305.0
Aug-23	3.12	269.6
Sep-23	2.97	256.6
Oct-23	2.93	253.2
Nov-23	3.04	262.7
Dec-23	2.43	210.0
Jan-24	2.67	230.7
Feb-24	2.89	249.7
Maximum Flow Recorded (7/3/2023 at 19:35)	**8.6**	**742.2**

Table 5D - Existing Flows at Manhole		
Flow Monitor Data Received from Halifax Water (FG533) At Glendale Dr / Lennox Dr MH16762		
Month	**Average Flow (L/s)**	**Average Flow (m3/day)**
Jan-23	6.58	568.5
Feb-23	6.00	518.2
Mar-23	5.96	515.1
Apr-23	4.83	417.6
May-23	5.38	465.2
Jun-23	6.01	519.0
Jul-23	5.25	454.0
Aug-23	4.04	348.9
Sep-23	4.04	349.2
Oct-23	3.63	313.9
Nov-23	4.54	392.1
Dec-23	5.46	471.6
Jan-24	7.96	688.1
Feb-24	8.34	720.6
Maximum Daily Flow Recorded (2/28/2024)	**10.2**	**883.6**

*No Data Has Been Recorded From December 22, 2023 Until January 2, 2024

Table 5E - Existing Flows at Manhole Flow Monitor Data Received from Halifax Water (FG12) At Glendale Dr / Riverside Dr MH16765		
Month	**Average Flow (L/s)**	**Average Flow (m3/day)**
Jan-23	6.40	552.7
Feb-23	6.45	557.2
Mar-23	7.42	641.4
Apr-23	5.91	510.3
May-23	5.92	511.4
Jun-23	6.25	540.4
Jul-23	6.18	534.1
Aug-23	7.97	688.5
Sep-23	6.91	597.0
Oct-23	5.59	482.9
Nov-23	4.82	416.8
Dec-23	5.56	480.2
Jan-24	5.46	472.1
Feb-24	4.46	385.6
Maximum Daily Flow (07/22/2023)	**13.9**	**1202.8**