East Hants Servicing Capacity Study

Technical Memorandum #5
Wastewater Distribution Capacity Assessment and Capital Plan

Prepared for:
Municipality of East Hants

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RVA 226421

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East Hants Servicing Capacity Study
Wastewater Distribution Capacity Assessment and Capital Plan

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1.0 Introduction

The Municipality of East Hants (Municipality) is currently divided into three (3) wastewater distribution systems:

1) Milford Distribution System – Provides wastewater transmission services for the community of Milford.
2) Shubenacadie Distribution System - Provides wastewater transmission services for the community of Shubenacadie and,
3) Regional Distribution System – Provides wastewater transmission services for the communities of Enfield, Elmsdale and Lantz.

The Municipality has been considered one of the fastest growing communities in Nova Scotia and it is important to maintain a reliable and accurate wastewater hydraulic model to assist the Municipality with planning for wastewater servicing requirements that are directly attributed to the growth in population. The Municipality retained R.V. Anderson and Associates (RVA) to complete an update and calibration of the existing wastewater hydraulic model and perform a system capacity assessment under existing and future conditions, to determine the impacts of planned developments, future growth and future sewer flows may have on the current infrastructure. The report will also provide recommendations pertaining to necessary future upgrades and operational improvements for optimal operations.

1.1 Background

1.1.1 Milford WW System

The Milford sanitary sewer collection system comprises of approximately 7.90 km of gravity sewer, 0.7 km of forcemains, 122 manholes and 1 pumping station. The wastewater generated within the service area discharges to the Milford Wastewater Treatment Plant (WWTP) for treatment and disposal. Figure 1-1 and Appendix A shows the Milford WW System.

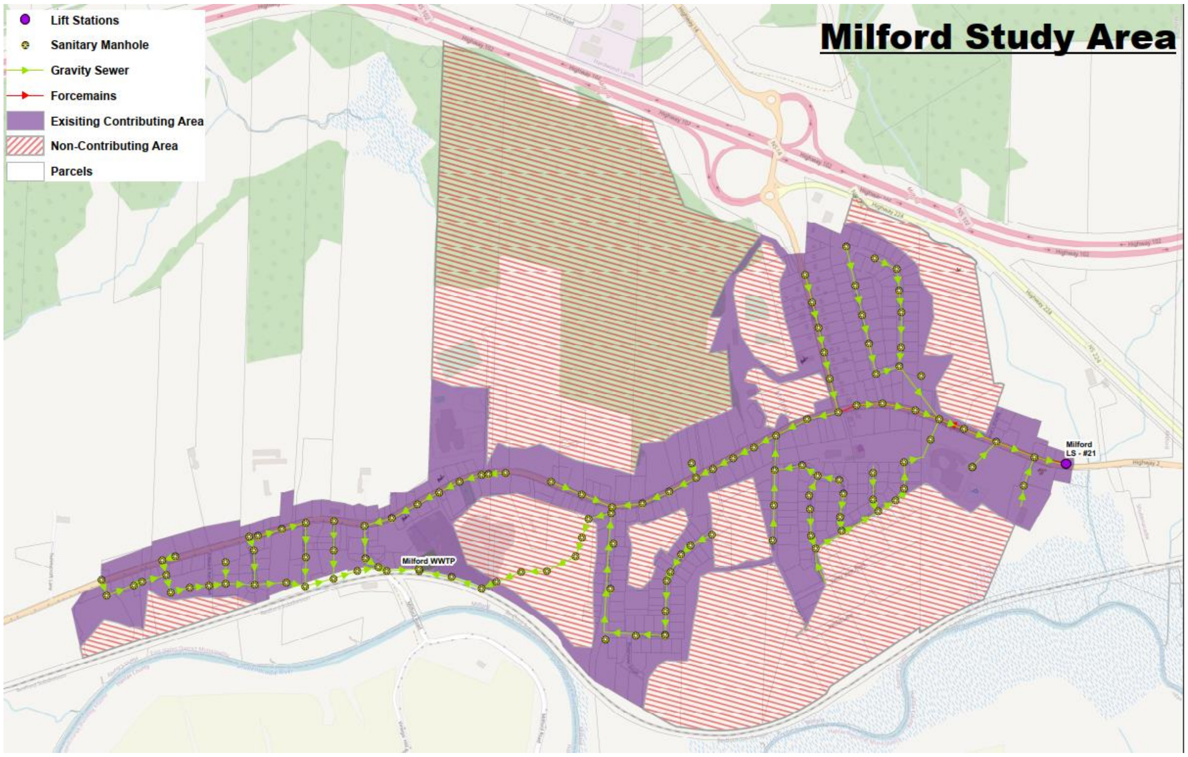


FIGURE 1-1 MILFORD STUDY AREA

1.1.2 Shubenacadie WW System

The Shubenacadie sanitary sewer collection system comprises of approximately 6.90 km of gravity sewer, 0.75 km of forcemains, 98 manholes and 3 pumping stations. The wastewater generated within the service area discharges to the Shubenacadie Wastewater Treatment Plant (WWTP) for treatment and disposal. Figure 1-2 and Appendix A shows the Shubenacadie WW System

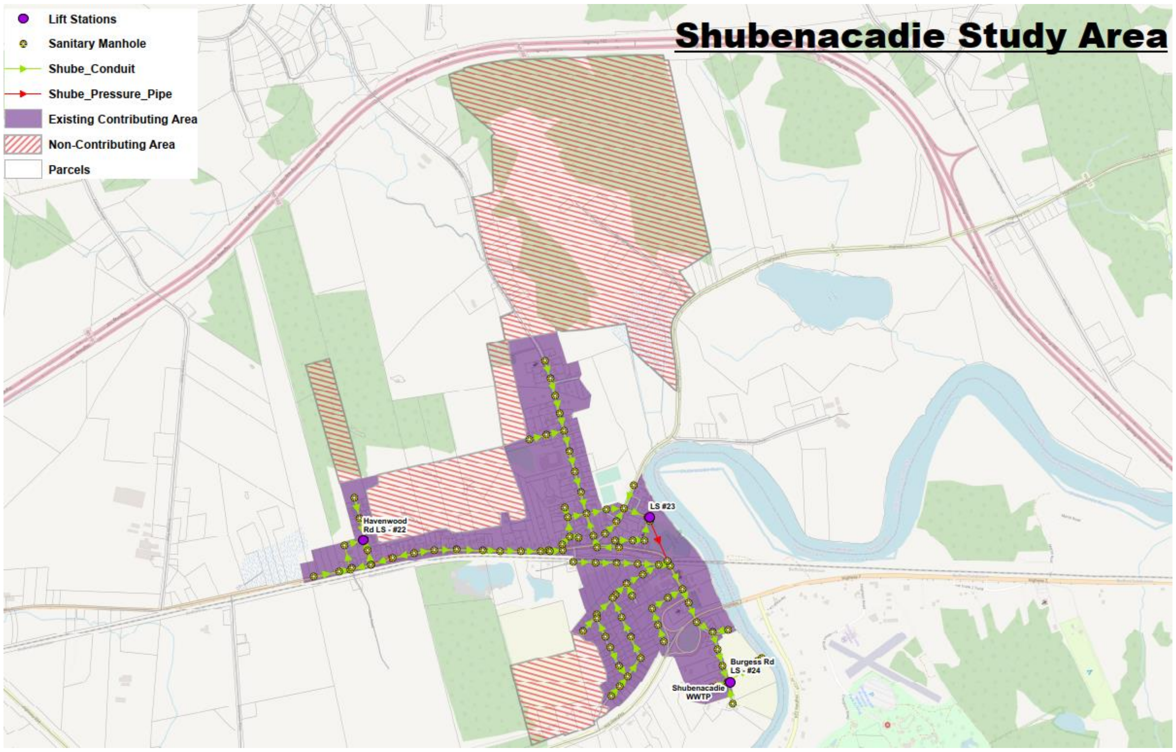


FIGURE 1-2 SHUBENACADIE STUDY AREA

1.1.3 Regional WW System

The Regional sanitary sewer collection system, which serves the communities of Enfield, Elmsdale and Lantz, comprises of approximately 47.1 km of gravity sewer, 15.1 km of forcemains, 669 manholes and 24 pumping stations. The wastewater generated within the service area discharges to the Lantz Wastewater Treatment Plant (WWTP) for treatment and disposal. Figure 1-3 and Appendix A shows the Regional WW System.

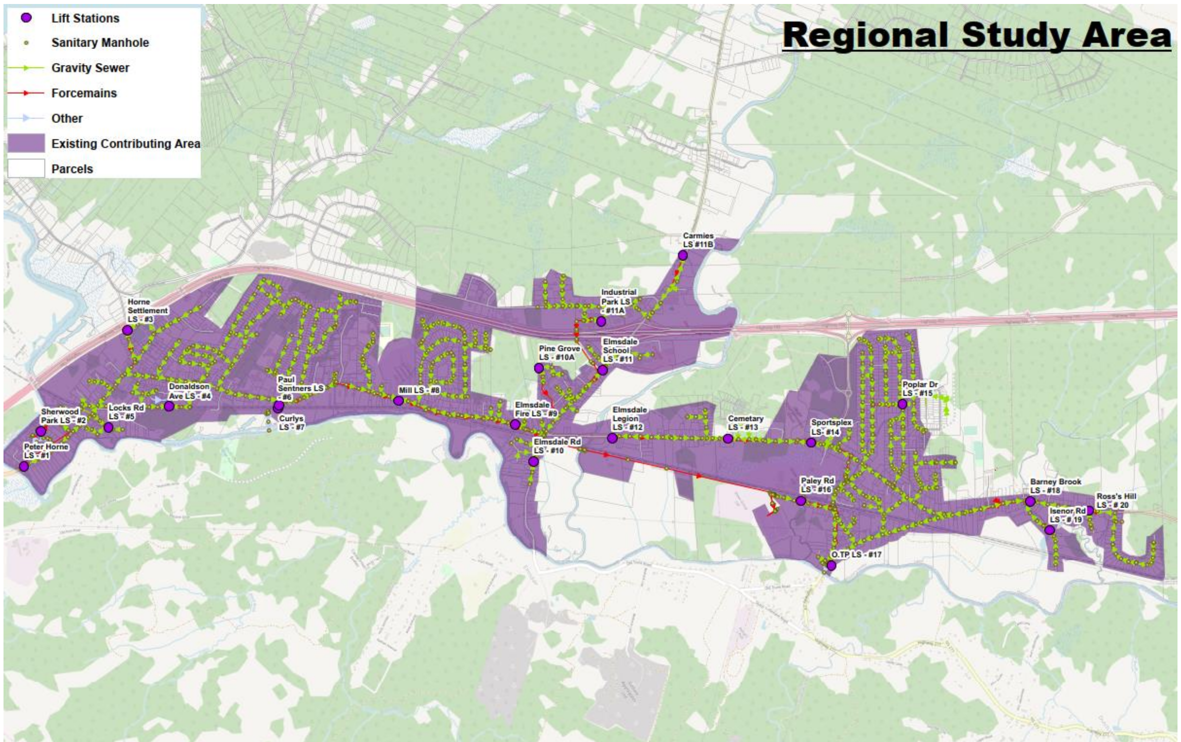


FIGURE 1-3 REGIONAL STUDY AREA

1.2 Project Scope

The project scope included:

1) Review of background information such as GIS datasets, flow and rainfall monitoring data, pump curves, and existing reports to assist with model updates and calibrations.

2) Review and update the existing SewerGEMS models (three models, one for each system) for both existing and future conditions based on completed/planned infrastructure and/or operational developments.

3) Calibrate the updated model based on WWTPs flows, flow and rainfall monitoring data to improve accuracy of the models.

4) Analyze the performance of the system under the existing, 2031 and 2045 peak wet weather flow conditions.

5) Identify system capacity constraints and propose gravity sewer/forcemains/pumps improvements to mitigate capacity issues identified. Prepare cost estimate of the proposed improvements.

6) Prepare a technical report to document all model update procedures, calibration results and capacity analysis findings.

2.0 Data Collection and Review

A significant amount of effort is allocated to the collection of the data from various sources as well as the review of the collected data to confirm the functionality and the reliability of the sanitary sewer model.

The data collected as part of this study, included existing SewerGEMS models for three service area, GIS data, previous reports, operational records, system maps, wastewater treatment plant data and pump station data. All provided/existing data was reviewed for completeness and accuracy to identify if any critical data sets are missing and need to be requested by from the Municipality. A request for information was created to collect critical information to fill in the missing data required for the model update and calibration.

2.1 Existing Hydraulic Models

As part of this study, the Municipality had provided a copy of the hydraulic model files of the existing sanitary sewer systems for Milford, Shubenacadie and Regional service area, developed in SewerGEMS modeling platform. The models were built in 2015 as part of another study that was completed by another consultant. The hydraulic models included infrastructure data, pump station details, operational data (on/off level), and sanitary and inflow and infiltration flows at selected manholes/wet wells. The model included infrastructure data for sewer mains, manholes, pump stations, and outfalls (locations where flow exits the service area). **Table 2-1** to **Table 2-3** below presents a summary of model elements based on the review of the models for the Milford, Shubenacadie and Regional wastewater systems.

TABLE 2-1 MODEL INFORMATION SUMMARY – MILFORD SYSTEM

Model Element	No. of Elements	Key Information
Pipe	112	Total Length = 10 km Diameter = 150 mm to 250 mm
Manhole	122	99% manholes have invert elevation assigned
Pump	2	No. of pump stations = 1 Actual pump curves are assigned to all locations
Wet Well	1	Wet wells size and operating range was assigned

TABLE 2-2 MODEL INFORMATION SUMMARY – SHUBENACADIE SYSTEM

Model Element	No. of Elements	Key Information

Pipe	103	Total Length = 7.65 km Diameter = 100 mm to 200 mm
Manhole	98	99% manholes have invert elevation assigned
Pump	6	No. of pump stations = 3 Actual pump curves are assigned to all locations
Wet Well	3	Wet wells size and operating range was assigned

TABLE 2-3 MODEL INFORMATION SUMMARY – REGIONAL SYSTEM

Model Element	No. of Elements	Key Information
Pipe	762	Total Length = 63.3 km Diameter = 75 mm to 650 mm
Manhole	669	99% manholes have invert elevation assigned
Pump	44	No. of pump stations = 22 Actual pump curves are assigned to all locations
Wet Well	22	Wet wells size and operating range was assigned

Below is a breakdown on the key elements that were analyzed pertaining to the components that make up the hydraulic model:

2.1.1 Model Pipes Review

Pertinent sewer pipe data included invert elevations, pipe size / diameter, roughness, length, and connectivity with manholes. Pipe roughness was set at a Manning's "n" value of 0.013 based on standard practice for a typical sewer pipe (regardless of material). Model pipes were compared with the latest GIS database provided by the Municipality. The key findings are summarized under three categories, detailed below.

1. **Pipes that are not present in the existing model**: pipes which were present in the latest GIS database but not present in the existing model were identified. A total of 133 pipes fell in this category. These pipes were further reviewed prior to adding them to the model.

2. **Pipes present in the existing model and the GIS database**: pipes which were present in both the model and the GIS were identified for review (planned developments). Pipe attributes such as diameter and invert elevations were compared between the model and the latest GIS database. The purpose of this exercise was to ensure that the updated model includes the latest data available.

2.1.2 Model Junctions Review

Pertinent manhole data included rim elevations, manhole depth and invert elevation. Manholes included in the model were compared with the latest GIS and manholes that need to be added to the model were identified.

2.1.3 Pump Station Data Review

Each pump station consists of wet well, pumps, pump station piping and a downstream forcemain. Wet well data assigned to the model includes wet well size and operating range. Pump curve was assigned to each pump in the model. Wet well area, operating range, and pump curves for duty and standby pumps were reviewed and compared against the information provided by the Municipality for Regional (22 pump stations), Shubenacadie (3 pump stations) and Milford (1 pump station) systems.

2.2 Flow Monitoring Data Review

A short-term flow monitoring program was conducted to collect sewer flow data within the Municipality's Regional sanitary sewer system. The data was utilized to calibrate the hydraulic model and to assess the performance of the existing sewer system under various rainfall events. The flow monitoring program was undertaken by Biomaxx Environmental and consisted of the installation of three (3) temporary flow monitors for over a three-month period. As part of the study, the rainfall data was obtained from the weather station located at the Halifax Stanfield International Airport, which is approximately twenty (20) km away from the study area, which is not ideal for this type of study.

The details pertaining to the flow monitors installed as part of this program are detailed in Table 2-4 below:

TABLE 2-4 FLOW MONITORING LOCATION DETAILS – REGIONAL SYSTEM

Site ID	Site Address	Site Location	Monitored Pipe Diameter (mm)	Installation Date	Removal Date
East Hants 1	720 HWY #2, Elmsdale	Manhole Located on the shoulder	200	November 22, 2022	April 11, 2023

East Hants 2	118 Elmsdale Rd. Elmsdale	Manhole located at the intersection of Elmsdale Rd. and School Rd.	300	November 22, 2022	April 11, 2023
East Hants 3	176 NS-277, Lantz	Manhole located close to intersection of HWY 27 and Preepers Ln.	200	November 22, 2022	April 11, 2023

Figure 2-1 and Appendix A shows the locations on the flow monitors installed on Regional system.

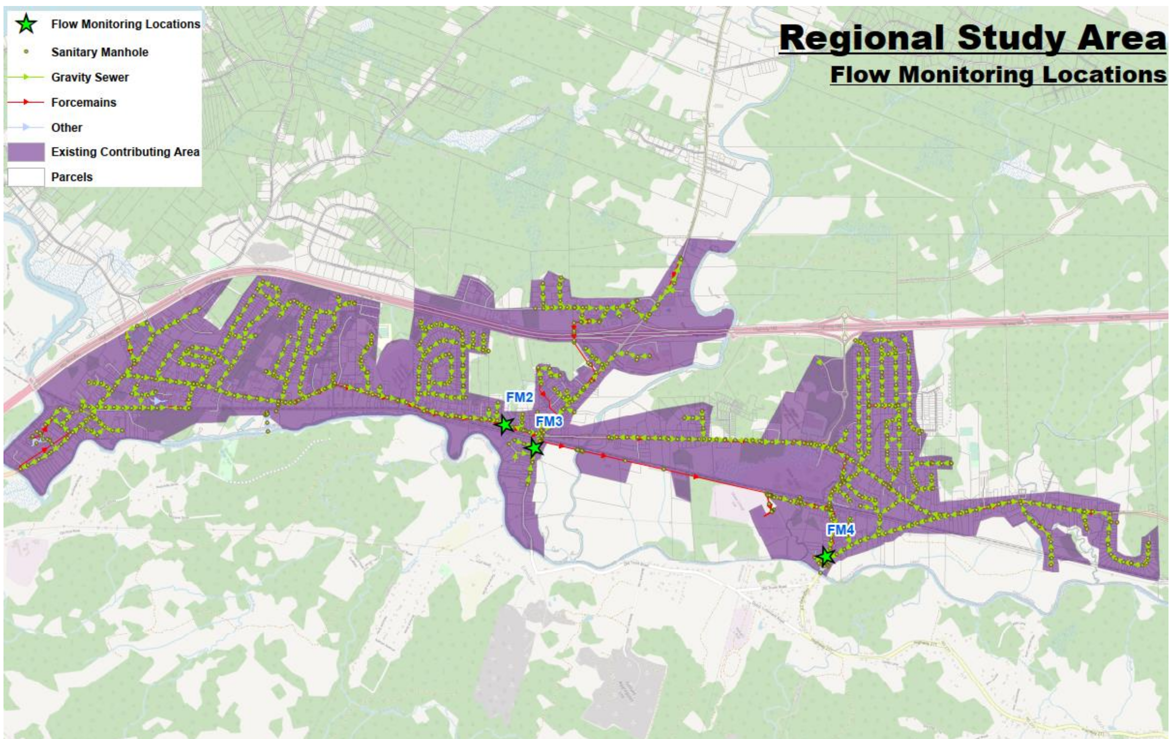


FIGURE 2-1 FLOW MONITORING LOCATIONS - REGIONAL SYSTEM

The overall data quality of the flow monitoring data collected as part of the program is summarized in Table 2-5 below:

TABLE 2-5 FLOW MONITORING DATA QUALITY SUMMARY – REGIONAL SYSTEM

Site ID	Data Quality Comment	Manual Depth Reading (mm)	Manual Velocity Reading (m/s)
East Hants 1	Site had poor data quality because of silt/debris build up on velocity sensor	102	0.25
East Hants 2	Site had good data quality and displayed a repeatable dry weather diurnal pattern. The data did not show good correlation with the rainfall data used	54	0.85
East Hants 3	Site had good data quality and displayed a repeatable dry weather diurnal pattern. The data did not show good correlation with the rainfall data used	110	0.41

2.3 Wastewater Treatment Plant (WWTP) Data Review

To further assist with the model calibration, RVA also reviewed the influent data from the Milford WWTP and the effluent data from the Shubenacadie WWTP and the Regional WWTP, as provided by the Municipality from 2022-2023. It should be noted that the effluent data is not ideal for data analysis as the data does not provide a accurate representation of the upstream flows discharged to the plant. The purpose of the review was to verify and calibrate the average dry weather flows (ADWF) for each of the three (3) WWTP's. Table 2-6 below summarizes the average dry weather flows at each WWTP:

TABLE 2-6 WWTP AVERAGE DRY WEATHER FLOW SUMMARY

Site ID	Data Type	ADWF (L/s)
Milford WWTP	Influent Data	3.10
Shubenacadie WWTP	Effluent Data	2.32
Regional WWTP	Effluent Data	35.0

2.4 Planned Developments

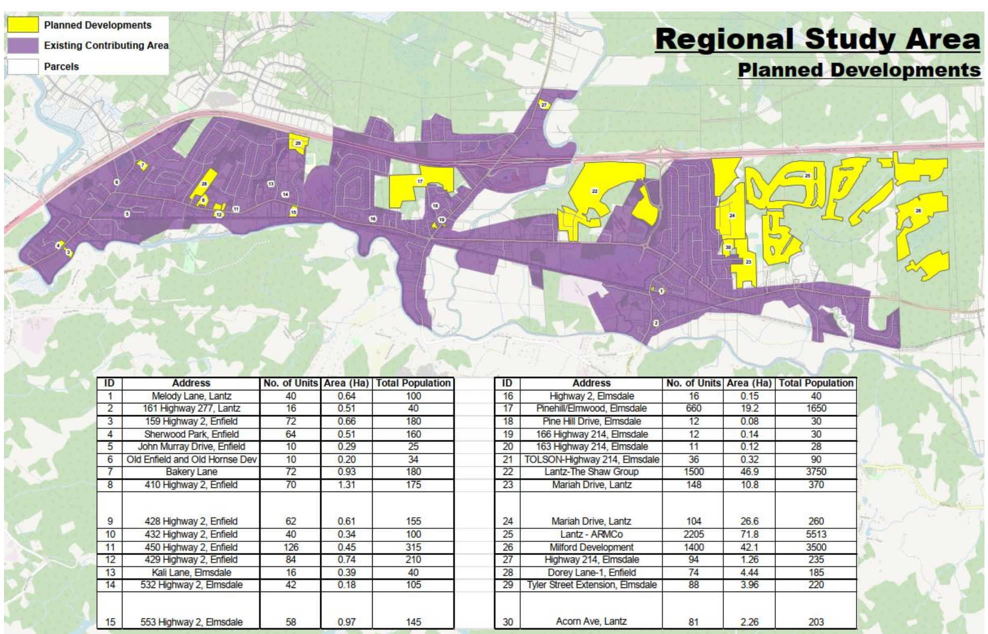
As part of the information gathering process, RVA also reviewed plan and profile drawings that was provided for the proposed and approved developments that will directly impact the sanitary sewer capacity in the near future. As per the information provided by the Municipality, all developments were planned in the Regional system of the Municipality, and no developments are planned in either the Milford or Shubenacadie system at this time. Table 2-7 below provides a summary of the planned developments within the regional system:

TABLE 2-7 PLANNED DEVELOPMENT SUMMARY – REGIONAL SYSTEM

Applicant/Owner	Location	Status	# of Units
WM Fares/R Ghosn	159 Highway 2, Enfield	Approved DA/SP/Subdivision	72
The Stevens Group of Companies	410 Highway 2, Enfield	Approved DA/SP/Subdivision	70
3265722 NS Ltd/Faddoul	428 Highway 2, Enfield	Approved DA/SP/Subdivision	62
Rakesh Malhotra	553 Highway 2, Elmsdale	Approved DA/SP/Subdivision	58
Leno Ribahi	Bakery Lane	Approved DA/SP/Subdivision	72
4324108 NS Ltd. (Les Turner)	Highway 2, Elmsdale	Approved DA/SP/Subdivision	16
4332419 Nova Scotia Limited/J Ghosn	Highway 214, Elmsdale	Approved DA/SP/Subdivision	94
RYC Property Limited	John Murray Drive, Enfield	Approved DA/SP/Subdivision	10
Hoffman	Kali Lane, Elmsdale	Approved DA/SP/Subdivision	16
The Shaw Group	Lantz	Approved DA/SP/Subdivision	1479
Armco	Lantz	Approved DA/SP/Subdivision	2205
FH Developments	Pinehill/Elmwood, Elmsdale	Approved DA/SP/Subdivision	660
FH Developments	Tyler Street Extension, Elmsdale	Approved DA/SP/Subdivision	88
Versailles Holdings Limited	161 Highway 277, Lantz	Active Application	16
Leno Ribahi	429 Highway 2, Enfield	Active Application	84
ELT Property Holdings Limited	432 Highway 2, Enfield	Active Application	40
Monk Mobile Corporation	450 Highway 2, Enfield	Active Application	126
Abboud & Diala Zhouri	532 Highway 2, Elmsdale	Active Application	42
Seven Lakes Developments	Mariah Drive, Lantz	Active Application	104
FH Developments	Milford	Active Application	1495
Abdul Habboush	Pinehill Drive, Elmsdale	Active Application	12

Applicant/Owner	Location	Status	# of Units
Talal Waeb	166 Highway 214, Elmsdale	Current Speculation	12
Dorey Thompson/Darren Rogers	Dorey Lane, Enfield	Current Speculation	74
Elegant Acreage Land Company Limited	Hazelwood Dr, Lantz	Current Speculation	81
Tolson Developments	Highway 214, Elmsdale	Current Speculation	36
Seven Lakes Developments	Mariah Drive, Lantz	Current Speculation	148
Seven Lakes Developments	Sherwood Park, Enfield	Current Speculation	64
Tolson Developments	163 Highway 214, Elmsdale	Built-Out Developments	11
Dean Shea	Corner of Old Enfield Rd and Old Horne Settlement Rd	Built-Out Developments	10
Abruzzi Properties	Melody Lane, Lantz	Built-Out Developments	40

The development areas pertaining to each planned development was estimated by utilizing the GIS information and site plan drawings (if applicable) provided by the Municipality. The GIS information included parcel information as well as an interactive map spatially showing the exact locations where the developments will be constructed. Figure 2-2 and Appendix A shows the locations of all planned developments that will be completed within the Regional system.



ID	Address	No. of Units	Area (Ha)	Total Population	ID	Address	No. of Units	Area (Ha)	Total Population
1	Melody Lane, Lantz	40	0.64	100	16	Highway 2, Elmsdale	16	0.15	40
2	161 Highway 277, Lantz	16	0.51	40	17	Pinehill/Elmwood, Elmsdale	660	19.2	1650
3	159 Highway 2, Enfield	72	0.66	180	18	Pine Hill Drive, Elmsdale	12	0.08	30
4	Sherwood Park, Enfield	64	0.51	160	19	166 Highway 214, Elmsdale	12	0.14	30
5	John Murray Drive, Enfield	10	0.29	25	20	163 Highway 214, Elmsdale	11	0.12	28
6	Old Enfield and Old Hornse Dev	10	0.20	34	21	TOLSON-Highway 214, Elmsdale	36	0.32	90
7	Bakery Lane	72	0.93	180	22	Lantz-The Shaw Group	1500	46.9	3750
8	410 Highway 2, Enfield	70	1.31	175	23	Mariah Drive, Lantz	148	10.8	370
9	428 Highway 2, Enfield	62	0.61	155	24	Mariah Drive, Lantz	104	26.6	260
10	432 Highway 2, Enfield	40	0.34	100	25	Lantz - ARMCo	2205	71.8	5513
11	450 Highway 2, Enfield	126	0.45	315	26	Milford Development	1400	42.1	3500
12	429 Highway 2, Enfield	84	0.74	210	27	Highway 214, Elmsdale	94	1.26	235
13	Kali Lane, Elmsdale	16	0.39	40	28	Dorey Lane-1, Enfield	74	4.44	185
14	532 Highway 2, Elmsdale	42	0.18	105	29	Tyler Street Extension, Elmsdale	88	3.96	220
15	553 Highway 2, Elmsdale	58	0.97	145	30	Acorn Ave, Lantz	81	2.26	203

FIGURE 2-2 PLANNED DEVELOPMENTS - REGIONAL SYSTEM

3.0 Model Update and Calibration

The following section provides a brief overview of the steps carried out during the model update process. The model updated included the review of existing infrastructure as defined in Section 2 as well as the inclusion of new infrastructure data sets based on the planned developments. This section will also provide results of the model calibration.

3.1 Model Updates

The existing SewerGEMS model was updated to reflect the latest addition to the infrastructure prompted by the planned developments that will be completed in the near future. The new additions were made only to the Regional system as all planned developments were found to be within this area. The plan and profiled drawings (if available) were used to add the new pipes and manholes that will be added and connected to the existing system as the developments are built out. Planned developments that are to be constructed in already developed areas are assigned to the nearest sanitary sewer that is part of the existing system. It is important to note that no new pipes and manholes were added to the sanitary sewer model for Milford and Shubenacadie study area.

Table 3-1 to Table 3-3 below presents a summary of model elements that are present in the updated model.

TABLE 3-1 MODEL UPDATE SUMMARY – MILFORD SYSTEM

Model Feature	Updated Model*	Comment
No. of Pipes	112	No Change
No. of Manholes	122	No Change
No. of Pump Stations	1	No Change

TABLE 3-2 MODEL UPDATE SUMMARY – SHUBENACADIE SYSTEM

Model Feature	Updated Model*	Comment
No. of Pipes	103	No Change
No. of Manholes	98	No Change
No. of Pump Stations	3	No Change

TABLE 3-3 MODEL UPDATE SUMMARY – REGIONAL SYSTEM

Model Feature	Updated Model*	Comment
No. of Pipes	901	# new pipes added = 139
No. of Manholes	802	# new manholes added = 133
No. of Pump Stations	24	# pump stations added = 2

**based on plan and profile drawings and other pertinent data provided by the Municipality*

3.1.1 Conduits and Junctions Update

As part of the model update, conduits and junctions were updated based on a review of the existing model and plan and profile drawings provided by the Municipality for the planned developments that would be taking place in the regional system. A total of 139 pipe segments were added to the existing model. Connectivity, pipe diameters, invert elevations and lengths were all based on the information provided in the plan and profile drawings for a particular development. Planned developments taking place in pre-developed areas were simply connected to the existing system using the existing infrastructure set in place. Pipe roughness was initially assigned a Manning's "n" value of 0.013 based on standard practice for a typical sewer pipe (regardless of material).

In addition to the pipe segments, 133 maintenance holes were added to the existing model. Ground and pipe invert elevations were obtained using the plan and profile drawings provided by the Municipality for the development. Certain developments are planned to take place in pre-developed areas. As a result, these new developments will be connected to the existing infrastructure. Figure 3-1 and Appendix A shows the new conduits and junctions added to the model.

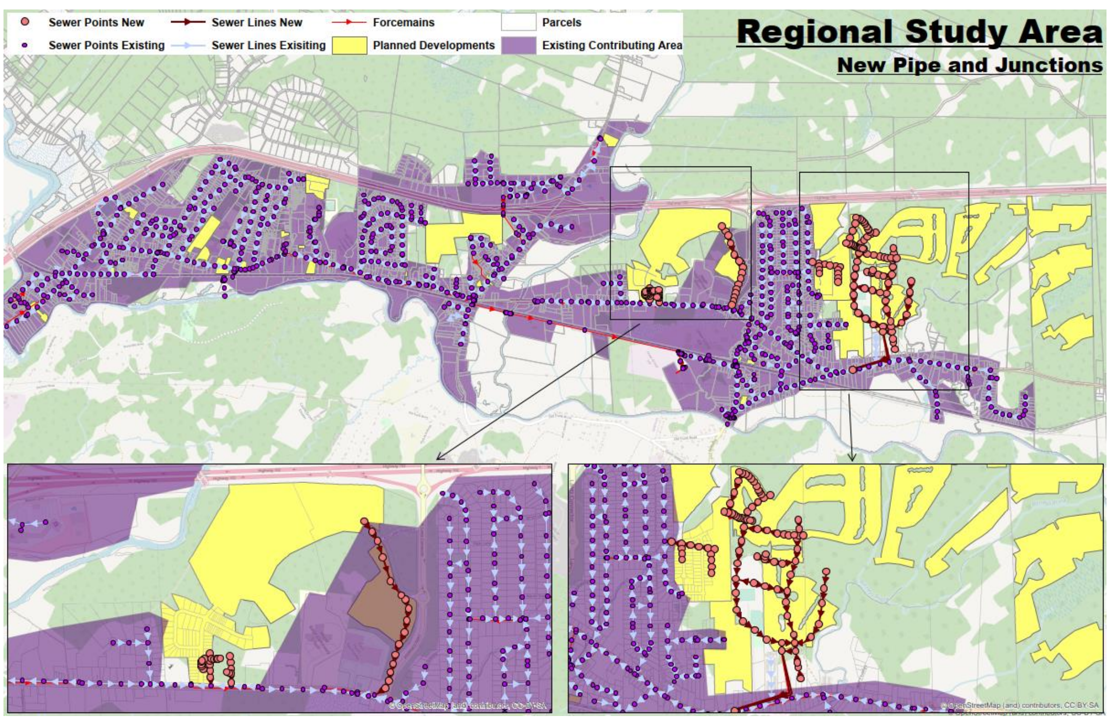


FIGURE 3-1 NEW PIPES AND JUNCTIONS - REGIONAL SYSTEM

3.1.2 Pump Station Update

Pump station attributes include wet well area, depth, pumps control data and pump curve. These attributes were updated in the existing model based on the available information. The manufacturer-provided pump curves were updated in the model to ensure the pump stations were simulated accurately in the model. RVA utilized the pre-programmed settings in the existing model that would allow the pumps to turn on and off at a certain set point.

Two (2) new pump stations were added to the model to service a future development located in Lantz, Nova Scotia. The planned development will consist of 2205 units of varying unit types and is set to be completed by the year 2045. Table 3-4 to Table 3-6 below provides a summary of the pump station data included in the update model.

TABLE 3-4 SUMMARY OF PUMP STATION DATA INCLUDED IN THE UPDATED MODEL – MILFORD SYSTEM

Label	Wet Well Details			No. of Pumps	Pump No. 1		Pump No. 2		Pump No. 3	
	Diameter (m)	Area (Average) (m²)	Depth (m)		Start Level (m)	Stop Level (m)	Start Level (m)	Stop Level (m)	Start Level (m)	Stop Level (m)
PS21	1.83	-	3.51	2	8.78	7.47	8.00	7.46	-	-

TABLE 3-5 SUMMARY OF PUMP STATION DATA INCLUDED IN THE UPDATED MODEL – SHUBENACADIE SYSTEM

Label	Wet Well Details			No. of Pumps	Pump No. 1		Pump No. 2		Pump No. 3	
	Diameter (m)	Area (Average) (m²)	Depth (m)		Start Level (m)	Stop Level (m)	Start Level (m)	Stop Level (m)	Start Level (m)	Stop Level (m)
PS22	1.83	-	1.22	1	16.73	15.73	-	-	-	-
PS23	1.83	-	5.40	2	4.50	3.95	4.88	3.95	-	-
PS24	1.83	-	7.00	2	3.50	2.51	3.95	2.51	-	-

TABLE 3-6 SUMMARY OF PUMP STATION DATA INCLUDED IN THE UPDATED MODEL – REGIONAL SYSTEM

Label	Wet Well Details			No. of Pumps	Pump No. 1		Pump No. 2		Pump No. 3	
	Diameter (m)	Area (Average) (m^2)	Depth (m)		Start Level (m)	Stop Level (m)	Start Level (m)	Stop Level (m)	Start Level (m)	Stop Level (m)
ArmcoPS1	-	21.4	7.41	3	14.87	13.27	14.27	13.27	14.57	13.27
ArmcoPS2	1.8	-	5.39	2	21.74	21.29	22.04	21.29	-	-
PS01	1.82	-	3.94	2	12.47	10.87	13.29	10.87	-	-
PS02	3.6	-	3.4	2	11.58	11.38	11.8	11.38	-	-
PS03	1.8	-	4	2	13	11.97	13.5	11.97	-	-
PS04	1.8	-	4.97	2	10.3	9.75	10.6	9.75	-	-
PS05	1.5	-	5.77	2	9.36	8.86	9.86	8.86	-	-
PS07		9.3	6.2	2	9.97	9.47	10.47	9.47	-	-
PS08	2.4	-	6.35	2	7.6	7.31	8	7.31	-	-
PS09	1.82	-	3.76	2	11.84	9.96	12.33	9.96	-	-
PS10	1.82	-	5.01	2	9.7	9.23	10.5	9.23	-	-
PS10A	1.82	-	2.7	2	12.8	12.3	13.3	12.3	-	-
PS11	2.44	-	3.71	2	12.59	12.44	12.89	12.44	-	-
PS11A	1.82	-	5	2	16.8	16.3	17.2	16.3	-	-
PS11B	1.82	-	7.2	2	16.1	15.6	16.6	15.6	-	-
PS12	1.83	-	5.37	2	10.36	9.23	10.86	9.23	-	-
PS13	2.44	-	6.84	2	13	12.67	14	12.67	-	-
PS14		9.3	6.2	2	12.6	12.39	13.39	12.39	-	-
PS15	1.82	-	7.26	2	19.8	19.46	20.16	19.46	-	-
PS16	1.82	-	4.57	2	11	10.7	11.31	10.7	-	-
PS17		9.3	6.36	2	8.5	7.54	9	7.54	-	-
PS18	1.82	-	5.56	2	10.79	10.29	11.29	10.29	-	-
PS19	1.8	-	5.54	2	13.09	11.88	13.59	11.88	-	-
PS20	1.82	-	4.16	2	12.93	12.63	13.31	12.63	-	-

3.2 Model Flow Allocation

Determining representative flows and the spatial distribution of these loads throughout the network model is a key element of sanitary sewer collection system modeling. The existing peak flows (sanitary and Inflow/infiltration) allocation in the model was maintained in the updated model.

For the future scenarios, the flows (sanitary and inflow/infiltration) from individual developments were assigned based on the proximity to the manholes (existing or new). The average DWF for a particular loading manhole included the residential DWF and non-residential DWF (if applicable). The residential DWFs were calculated using the contributing populations for each sewer shed and a per capita wastewater generation rate based on the Municipality's design standards. The flows from non-residential areas were calculated by using the Industrial / Commercial / Institutional (ICI) areas and the Municipality's design standards.

3.2.1 Existing Conditions

RVA utilized the pre-loaded flows that were previously assigned to the existing manholes within the model as a starting point to validate the accuracy of the model provided by the Municipality. The total flows allocated to the existing manholes were compared to the flows discharged to the respective WWTP to confirm if the flows allocated for the existing conditions were still valid or needed to be updated before proceeding to a future condition analysis.

The adjustments to the flow values are further discussed in the model calibration section of the technical memorandum. Table 3-7 below provides details pertaining to the sanitary flows used in the existing conditions.

TABLE 3-7 EXISTING CONDITION FLOWS – ALL SYSTEMS

Existing Conditions (WSP Load Allocation)				
Item	Milford	Shubenacadie	Regional	Comment
Existing Peak Residential Flows (L/s)	21.25	15	144.38	From the WSP model
Existing Peak ICI Flows (L/s)	2.77	-	29.1	From the WSP model
Population	1000	785	9040	
Harmon Peaking Factor	3.8	3.87	3	
Existing Residential Average Dry Weather Flow (L/s)	5.59	3.88	48.16	
Existing Per Capita Consumption (L/Cap/d)	483	427	460	Higher than Municipal design standard of

				340 L/Cap/d and need to be adjusted

3.2.2 Future Conditions

Once the existing conditions flows were calibrated, the additional flows that were directly attributed to future developments were calculated and were added to the model to develop the future condition scenarios. The additional flows were either:

- Assigned to the nearest existing manhole that is part of the existing infrastructure, found adjacent to the proposed development or,
- Assigned to a newly digitized manhole, that was added using the plan and profile drawings provided by the Municipality for certain developments.

All proposed developments are planned to be completed within the Regional system, with no developments planned within the Milford and Shubenacadie Systems. The flows for the planned developments were calculated using the Municipality's guidelines and they are as follows:

- Average Dry Weather Flows: 340 liters per person per day
- Design Peak Flows: 1,490 liters per person per day
- Inflow and Infiltration Flows: 25, 920 liters per hectare per day

The additional flows generated pertaining to each planned development is shown in Table 3-8 and Appendix C below. Figure 3-2 and Appendix A shows the updated locations of the loading manholes for the future conditions.

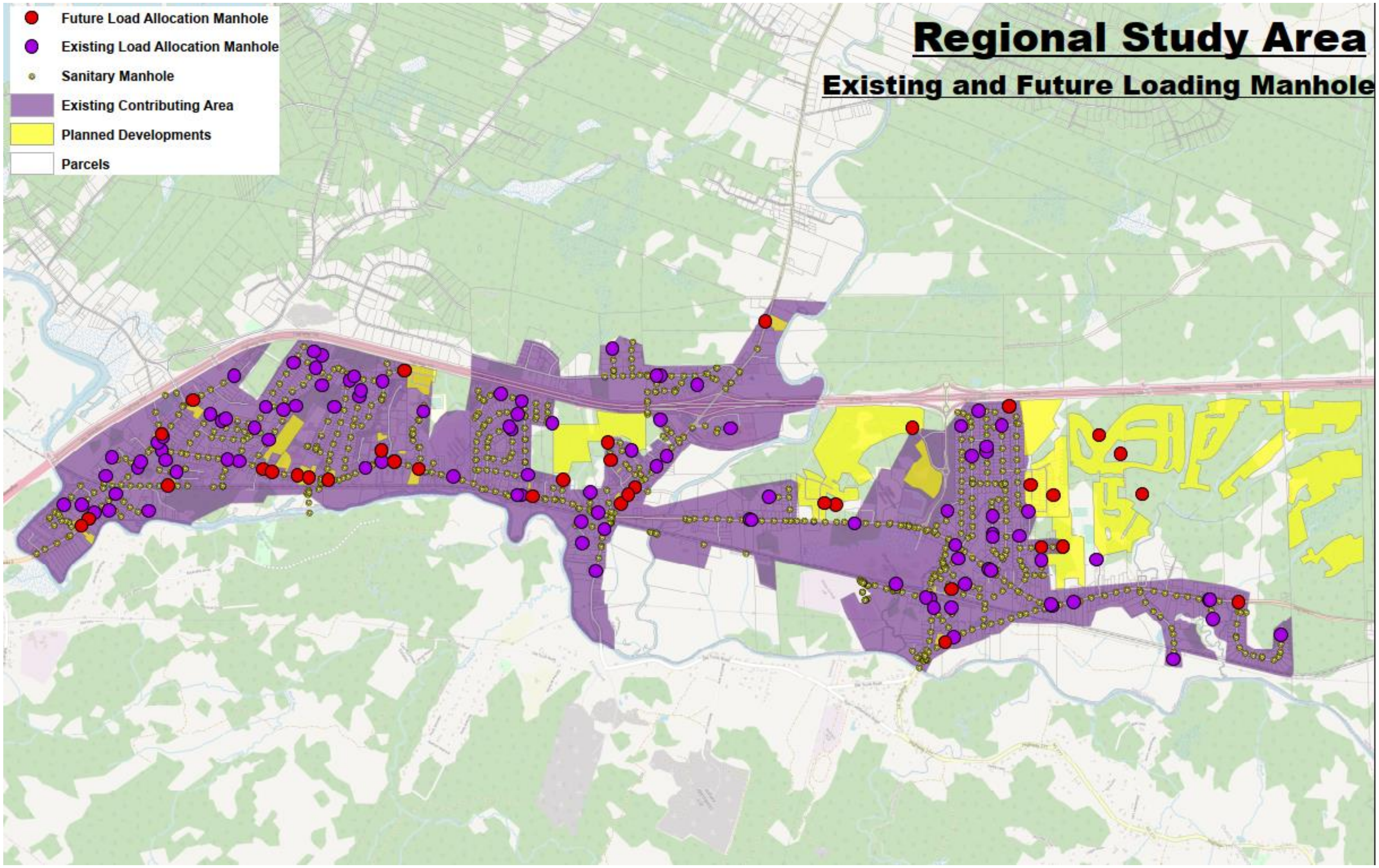


FIGURE 3-2 EXISTING AND FUTURE LOADING MANHOLES

TABLE 3-8 SUMMARY OF CALCUALTED DESIGN FLOWS FOR ALL PLANNED DEVELOPMENTS

Applicant/Owner	Location	Dev Area (Ha)	Total Residential Units	Equivalent Population (2.5 person per unit)	ICI Units	ICI Area (Ha)	Equivalent ICI population (45 persons per Ha)	Total Population	Avg DWF (340 L/Cap/d) (L/s)	Peak Flow (1490 L/Cap/d) (L/s)	I/I Flow base don (25,920 L/Ha/d) (L/s)	Peak WWF (L/s)
WM Fares/R Ghosn	159 Highway 2, Enfield	0.66	72	180	0	0	0	180	0.71	3.10	0.20	3.3
Versailles Holdings Limited	161 Highway 277, Lantz	0.51	16	40	0	0	0	40	0.16	0.69	0.15	0.8
Tolson Developments	163 Highway 214, Elmsdale	0.12	11	28	0	0	0	28	0.11	0.47	0.03	0.5
Talal Waeb	166 Highway 214, Elmsdale	0.14	12	30	0	0	0	30	0.12	0.52	0.04	0.6
The Stevens Group of Companies	410 Highway 2, Enfield	1.31	70	175	0	0	0	175	0.69	3.02	0.39	3.4
3265722 NS Ltd/Faddoul	428 Highway 2, Enfield	0.61	62	155	0	0	0	155	0.61	2.67	0.18	2.9
Leno Ribahi	429 Highway 2, Enfield	0.74	84	210	0	0	0	210	0.83	3.62	0.22	3.8
ELT Property Holdings Limited	432 Highway 2, Enfield	0.34	40	100	0	0	0	100	0.39	1.72	0.10	1.8
Monk Mobile Corporation	450 Highway 2, Enfield	0.45	126	315	0	0	0	315	1.24	5.43	0.14	5.6
Abboud & Diala Zhouri	532 Highway 2, Elmsdale	0.18	42	105	0	0	0	105	0.41	1.81	0.05	1.9
Rakesh Malhotra	553 Highway 2, Elmsdale	0.97	58	145	0	0	0	145	0.57	2.50	0.29	2.8
Leno Ribahi	Bakery Lane	0.93	72	180	0	0	0	180	0.71	3.10	0.28	3.4
Dean Shea	Corner of Old Enfield Rd and Old Horne Settlement Rd	0.20	10	25	1	0.2	9	34	0.13	0.59	0.06	0.6
Dorey Thompson/Darren Rogers	Dorey Lane, Enfield	4.44	74	185	0	0	0	185	`	3.19	1.33	4.5

Applicant/Owner	Location	Dev Area (Ha)	Total Residential Units	Equivalent Population (2.5 person per unit)	ICI Units	ICI Area (Ha)	Equivalent ICI population (45 persons per Ha)	Total Population	Avg DWF (340 L/Cap/d) (L/s)	Peak Flow (1490 L/Cap/d) (L/s)	I/I Flow base don (25,920 L/Ha/d) (L/s)	Peak WWF (L/s)
Elegant Acreage Land Company Limited	Hazelwood Dr, Lantz	2.26	81	203	0	0	0	203	0.80	3.49	0.68	4.2
4324108 NS Ltd. (Les Turner)	Highway 2, Elmsdale	0.15	16	40	0	0	0	40	0.16	0.69	0.05	0.7
4332419 Nova Scotia Limited/J Ghosn	Highway 214, Elmsdale	1.26	94	235	0	0	0	235	0.92	4.05	0.38	4.4
Tolson Developments	Highway 214, Elmsdale	0.32	36	90	0	0	0	90	0.35	1.55	0.10	1.6
RYC Property Limited	John Murray Drive, Enfield	0.29	10	25	0	0	0	25	0.10	0.43	0.09	0.5
Hoffman	Kali Lane, Elmsdale	0.39	16	40	0	0	0	40	0.16	0.69	0.12	0.8
The Shaw Group	Lantz	46.9	1479	3698	0	0	0	3698	14.55	63.76	14.08	77.8
Armco	Lantz	71.8	2205	5513	0	0	0	5513	21.69	95.07	21.55	117
Seven Lakes Developments	Mariah Drive, Lantz	26.6	104	260	0	0	0	260	1.02	4.48	7.98	12.5
Seven Lakes Developments	Mariah Drive, Lantz	10.8	148	370	0	0	0	370	1.46	6.38	3.25	9.6
Abruzzi Properties	Melody Lane, Lantz	0.64	40	100	0	0	0	100	0.39	1.72	0.19	1.9
FH Developments	Milford	42.1	1495	3738	0	0	0	3738	14.71	64.45	12.63	77.1
Abdul Habboush	Pinehill Drive, Elmsdale	0.08	12	30	0	0	0	30	0.12	0.52	0.03	0.5
FH Developments	Pinehill/Elmwood, Elmsdale	19.2	660	1650	0	0	0	1650	6.49	28.45	5.77	34.2
Seven Lakes Developments	Sherwood Park, Enfield	0.51	64	160	0	0	0	160	0.63	2.76	0.15	2.9
FH Developments	Tyler Street Extension, Elmsdale	3.96	88	220	0	0	0	220	0.87	3.79	1.19	5.0

3.3 Model Calibration

Model calibration is a critical step in the model development process. It is the process of adjusting model parameters until the model results match the field conditions within an acceptable range. A well calibrated hydraulic model increases confidence in the model results for the current and future capacity assessment of the system.

Based on generally accepted practice, model accuracy and robustness are achieved by setting the model calibration parameters such that the model's predicted response matches that of an observed or measured response (e.g., monitored field conditions, WWTP influent data, etc.). Before performing any calibration, it is important to understand the actual conditions observed using the either the collected flow monitoring and/or provided WWTP data. Table 3-9 below provides details pertaining to the actual flow conditions that were used as a basis for model calibration.

TABLE 3-9 ACTUAL FLOW CONDITIONS BASED ON OBSERVED DATA – ALL SYSTEMS

Actual Conditions (RVA Analysis)				
Item	Milford	Shubenacadie	Regional	Comment
Average Daily Dry Weather Flow (L/s)	3.5	2.32	35	WWTP 2022-23 flows
Average Daily Residential Flows (L/s)	2.58	2.32	25.3	
Average Daily ICI Flows (L/s)	0.92	-	9.7	Obtained from WSP Model
Actual Per Capita Consumption (L/Cap/d)	222	255	242	Reasonable value based on the guidelines

3.3.1 Dry Weather Flow Calibration

Determining representative DWF and the spatial distribution of these loads throughout the network model is a key element of sanitary sewer collection system modeling. As part of this study, a preliminary DWF allocation was completed by utilizing the pre-allocated loadings defined on the manholes that were included in the existing manhole (see section 3.2). The results of the allocations were compared to the average dry weather flows (ADWF) recorded at the WWTP.

Table 3-10 below provides details pertaining to the calibrated peak dry weather flow (DWF) parameters used in the updated models. As seen from the table, the peak residential flows were reduced to match the values recorded at the WWTP. As per best practices, it best not to change any non-residential flows without a thorough evaluation of they type of non-residential property and consumption patterns.

TABLE 3-10 CALIBRATED DRY WEATHER FLOWS - ALL SYSTEMS

Calibrated Dry Weather Flow (RVA Analysis)				
Item	Milford	Shubenacadie	Regional	Comment
Peak Residential Dry Weather Flows (L/s)	9.79	8.97	76	**Milford**: Peak residential flow **reduced by 46%** **Shubenacadie**: Peak residential flow **reduced by 60%** **Regional**: Peak residential flow **reduced by 53%**
Peak ICI Dry Weather Flows (L/s)	2.77	-	29.1	ICI flows unchanged
Peak Dry Weather Flows (L/s)	12.56	8.97	105	Calibrated flow values

3.3.2 Wet Weather Flow Calibration

As mentioned in Section 2, three (3) flow monitors were installed on the Regional system for over a 3-month period to assist with Regional system model calibration. However, no rain gauge installation was completed as part of the program, prompting RVA to rely on the rainfall data collected at the Halifax Stanfield International Airport, which is approximately twenty (20) kilometers from our study area. Given the nearest rain data source is far from the targeted study area, no correlation between the flow and the rainfall data was observed.

It should be noted that, since the rain gauge is located further away from the study area, a wet weather calibration becomes inaccurate as it becomes difficult to obtain a valid wet weather correlation between the flow and rainfall monitoring data, leading to an over/under estimation of the wet weather flow results. Rainfall data that is obtained further away from the targeted study areas, could be susceptible to highly localized events, leading to a false narrative that the targeted study received the same amount of rainfall, but the sanitary sewer response was not as accurate. As a result, a wet weather calibration utilizing the flow monitoring data was not completed as part of this study.

4.0 System Analysis

To analyse the performance of the system under peak wet weather flow conditions, the inflow and infiltration (I/I) flows were estimated based on the Municipality's guidelines which is 25,920 Liter per day per hectare or 0.30 liters per second per hectare. The I/I flow was estimated for each service area (Milford, Shubenacadie and Regional) and was added to the calibrated peak DWF to determine the peak wet weather flow (WWF). **Table 4-1** provides the summary of the peak wet weather flows for all three systems.

TABLE 4-1 PEAK WET WEATHER FLOWS - ALL SYSTEMS

Peak Wet Weather Flows (RVA Analysis)				
Item	Milford	Shubenacadie	Regional	Comment
Total Service Area (Ha)	292	236	1792	Based on GIS data provided
Contributing Area (Ha)	120	84	1009	Used for I/I estimation (based on aerial map review)
Total Peak Dry Weather Flows (L/s)	12.3	9.0	105.0	Calibrated flow values
Calculated I/I (L/s)	35.9	25.3	302.6	Estimated based on 0.3 L/s/ha
Peak Wet Weather Flows (L/s)	48.5	34.3	407.6	Flows used for system analysis

4.1 System Analysis Results

The calibrated hydraulic model was utilized to assess the systems performance only under the existing condition for the Milford and Shubenacadie systems, as there are no developments planned within these systems to warrant a future condition system analysis at this time. Improvements to the systems were identified as part of the existing scenario and are discussed further in the sections below.

For the Regional system, in addition to the existing condition scenario, an interim condition scenario which looked at the development build out until 2031 and final condition scenario which looked at the full build-out by 2045 was analyzed as part system analysis. Improvements to the systems were identified as part of the existing scenario and are discussed further in the sections below.

The results include tabulated summaries of any system upgrade recommendations as well as the timeline by which the system upgrade should be implemented by. The results also include maps that show the locations of the proposed upgrades for all three (3) systems.

4.1.1 Milford Wastewater System

The modelling results for the Milford wastewater system showed that there are no immediate capacity concerns with the existing infrastructure found within the system, except for a singular location where a pipe upgrade is recommended. Table 4-2 below provides the details regarding the pipe segment with a capacity constraint as well the recommended size the pipe should be upgraded to resolve the capacity constraint. Figure 4-1 and Appendix A shows the location of the sanitary sewer within the system.

TABLE 4-2 PROPOSED SANITARY SEWER UPGRADES - MILFORD SYSTEM

Location	Length (m)	Current Diameter (mm)	Proposed Diameter (mm)	To be installed by
Influent to WWTP	10	250	300	Immediately

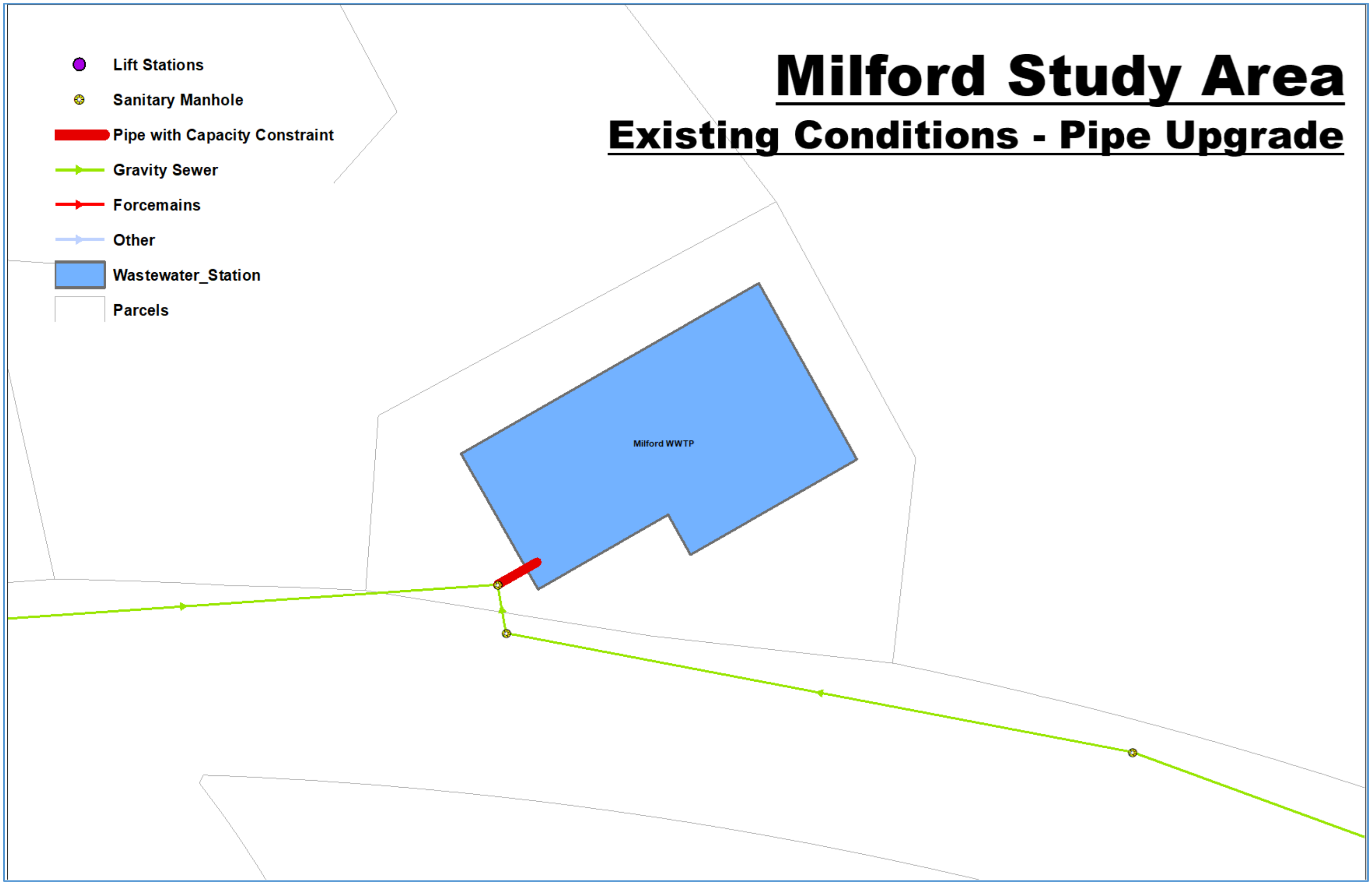


FIGURE 4-1 PROPOSED SANITARY SEWER UPGRADE – MILFORD SYSTEM

4.1.2 Shubenacadie Wastewater System

The modeling results for the Shubenacadie system showed that there are some locations that are currently experiencing capacity constraints. Figure 4-2 and Appendix A shows the locations of the sanitary sewers identified with capacity constraints. Table 4-3 below provides the recommended size. Figure 4-3 and Appendix A shows the locations where a sanitary sewer upgrade was proposed.

TABLE 4-3 PROPOSED SANITARY SEWER UPGRADES - SHUBENACADIE SYSTEM

Pipe ID	Length (m)	Current Diameter (mm)	Proposed Diameter (mm)	To be installed by
MH43 to MH66	610	200	250	Immediately
MH69 to MH68	275	200	300	Immediately

In addition to the proposed sanitary sewer upgrade, the pumps at Maitland Road Pumping Station (PS23) were found to be significantly oversized, which in turn caused a capacity constraint issue within the downstream sewers as well as led to high velocities within the forcemains.

The PS23 pumps are recommended to be downsized with a design capacity of 20 liters per second at 10 meters of total dynamic head.

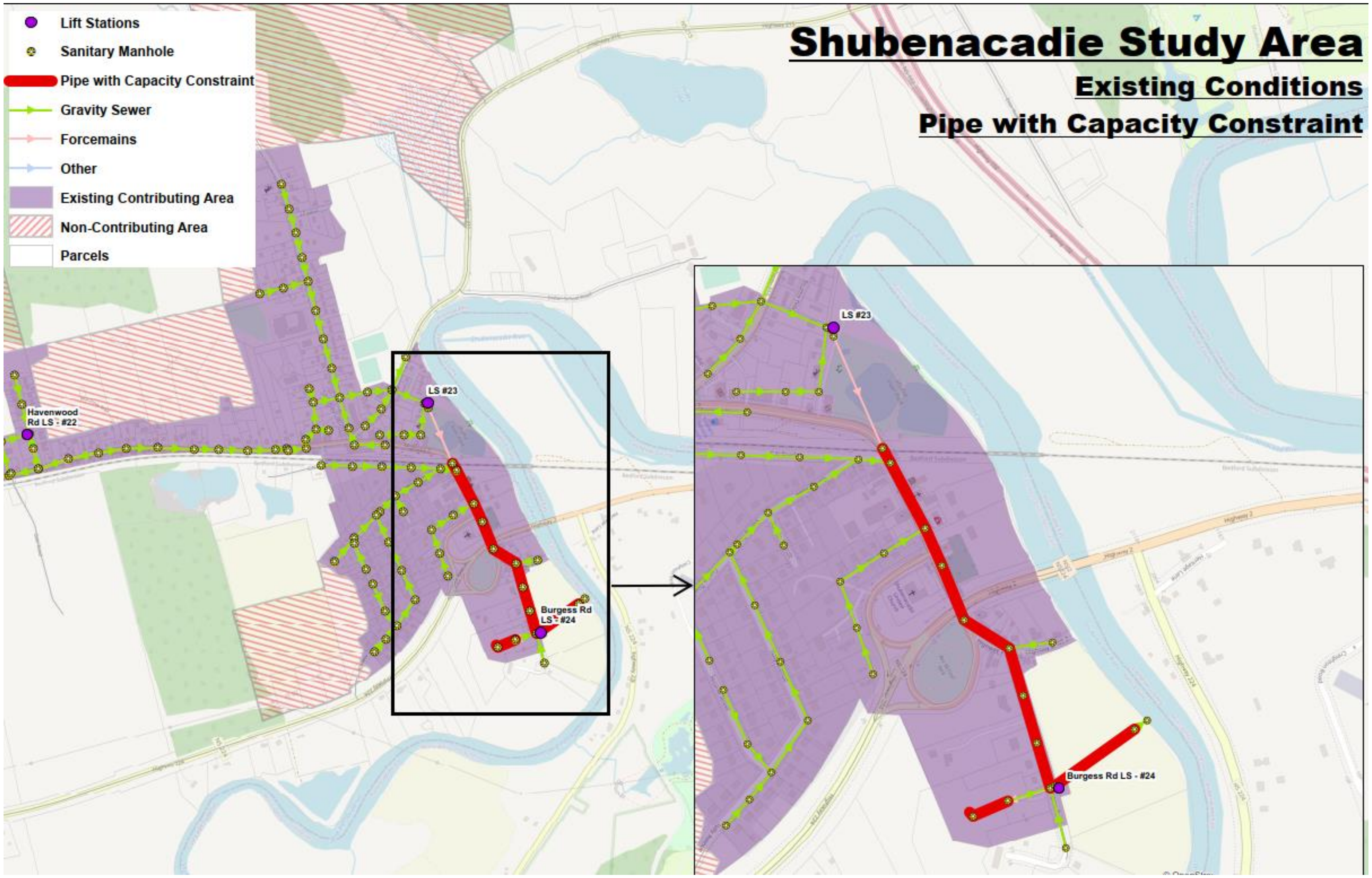


FIGURE 4-2 SANITARY SEWER WITH CONSTRAINTS - SHUBENACADIE SYSTEM

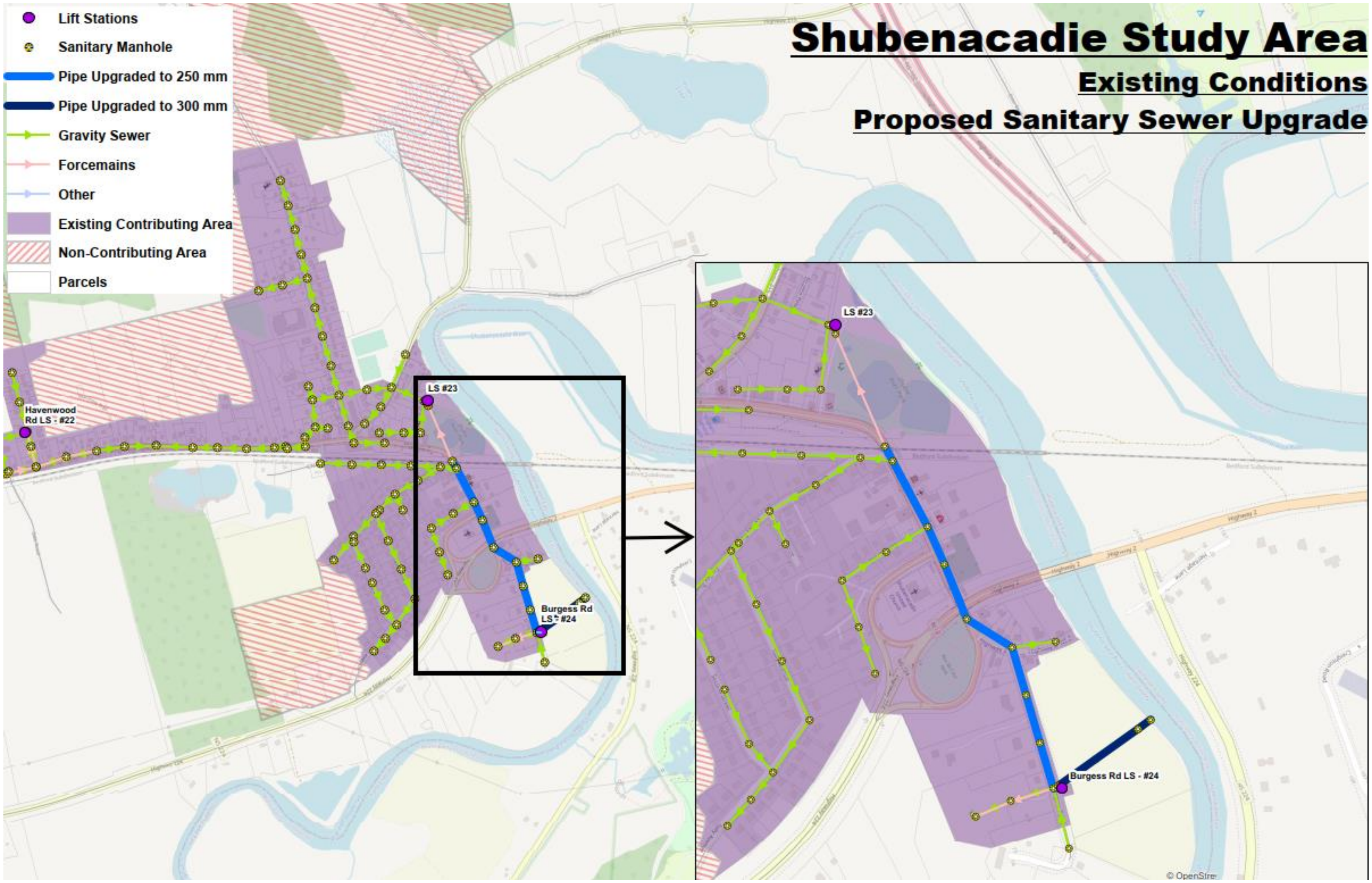


FIGURE 4-3 PROPOSED SANITARY SEWER UPGRADES - SHUBENACADIE SYSTEM

4.1.3 Regional Wastewater System

The modeling results for the Regional system demonstrated capacity constraints at several locations, including gravity sewers, forcemains and pump stations. Figure 4-4 and Appendix A shows the locations of the sanitary sewers identified with capacity constraints during the existing conditions. Figure 4-5 and Appendix A shows the locations of the sanitary sewers identified with capacity constraints during the future (2031/2045) conditions. Table 4-4 below provides the details pertaining to the sanitary (gravity) sewer constraints as well as the recommended size the pipe should be upgraded to resolve the capacity constraint. Figure 4-6 and Appendix A shows the locations where a sanitary sewer upgrade was proposed.

TABLE 4-4 PROPOSED SANITARY (GRAVITY) SEWER UPGRADES - REGIONAL SYSTEM

Location ID	Length (m)	Current Diameter (mm)	Proposed Diameter (mm)	To be installed by
EH_R1	850	200	250	Immediate
EH_R2	885	200	250	2031/2045
EH_R3	452	200	250	2031/2045
EH_R4	333	200	300	Immediate
EH_R5	574	250	300	2031/2045
EH_R6	786	200	300	2031/2045
EH_R7-A	724	200	525	Immediate
EH_R7-B	253	250	525	Immediate
EH_R9	505	200	375	2031/2045
EH_R8	301	300	525	2031/2045
EH_R10	110	200	375	2031/2045
EH_R11	164	200	300	Immediate

Table 4-5 below provides details pertaining to the sanitary (forcemains) sewers that are to be upgraded as part of the sanitary sewer upgrade program. Figure 4-7 and Appendix A shows the locations of where the forcemains upgrades will take place.

TABLE 4-5 PROPOSED SANITARY (FORCEMAINS) SEWER UPGRADES - REGIONAL SYSTEM

Location ID	Length (m)	Current Diameter (mm)	Proposed Diameter (mm)	To be installed by
EH_F1	189	75	100	Immediate
EH_F2	205	150	250	Immediate
EH_F3	296	100	150	Immediate

EH_F4	275	75	100	Immediate
EH_F5	1308	300	350	2031/2045
EH_F6	596	150	250	2031/2045
EH_F7	121	150	200	2031/2045

In addition to the proposed sanitary sewer upgrades, it also recommended that the pumps be upgraded at several pumping stations located within the Regional system. Table 4-6 below summarizes the proposes pump upgrades recommended for the Regional system.

TABLE 4-6 PROPOSED PUMP UPGRADES - REGIONAL SYSTEM

Pump Station	Flow (L/s)	Head (m)	Horsepower* (Hp)	To be installed by
PS03	17	24	10	Immediate
PS07	182	90	300	Immediate
PS10	96	15	30	Immediate
PS11A	45	40	35	Immediate
PS16	12.5	12	3	Immediate
PS17	100	18	35	Immediate
PS17**	250	50	250	2031/2045
PS18	115	40	90	2031/2045
PS20	85	5	10	2031/2045

*Estimated horsepower for each pump station is the total horsepower required to convey the design flow and head condition. For simplicity, it is assumed that one duly pump will convey the design flow and head conditions. It is assumed that the number of duty pumps (1, 2 or 3) will be determined at the design stage. Accordingly, the horsepower of individual pumps can be estimated.

**Requires another upgrade to accommodate 2031/2045 flows

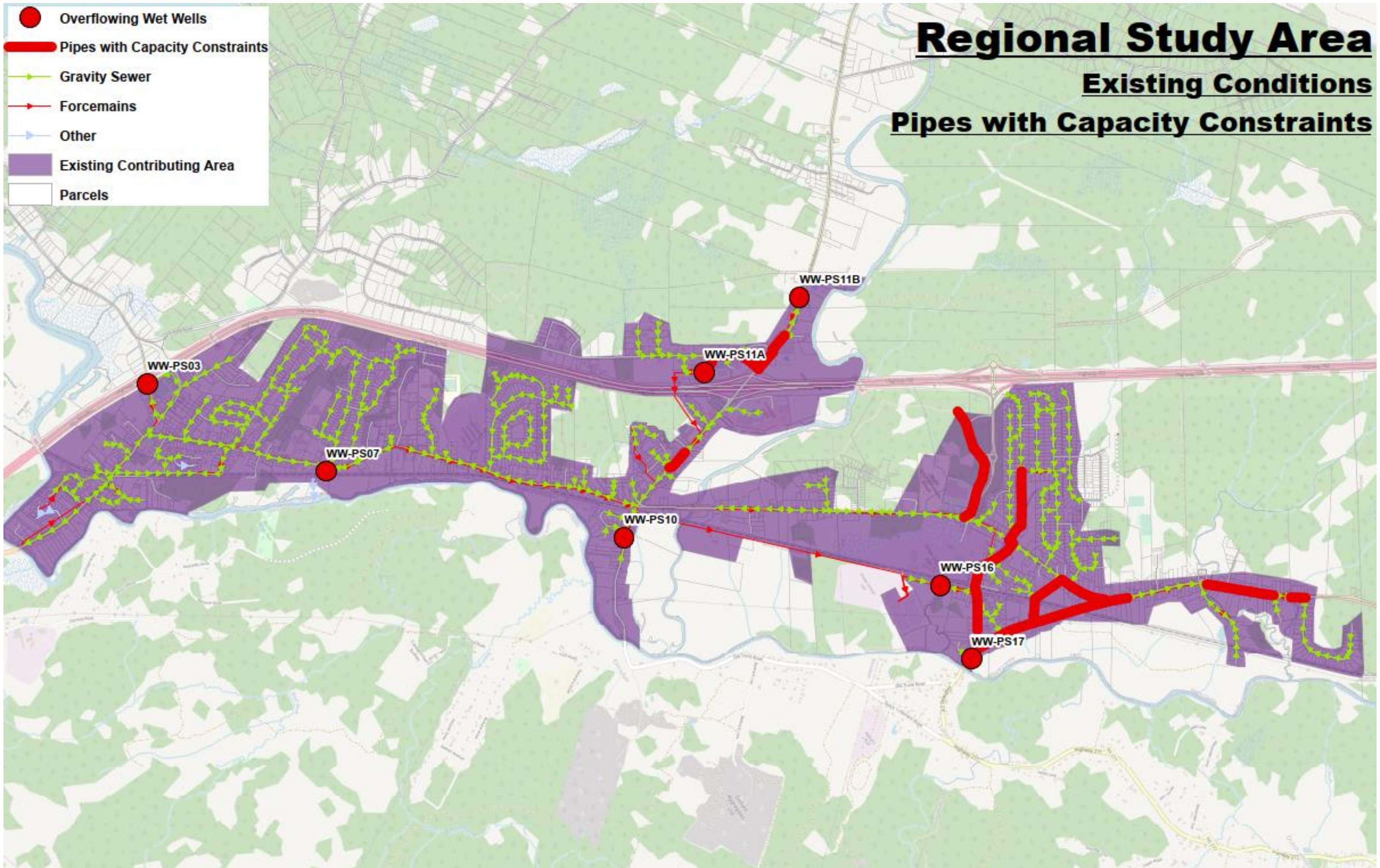


FIGURE 4-4 SANITARY SEWER WITH CONSTRAINTS (EXISTING CONDITIONS) – REGIONAL SYSTEM

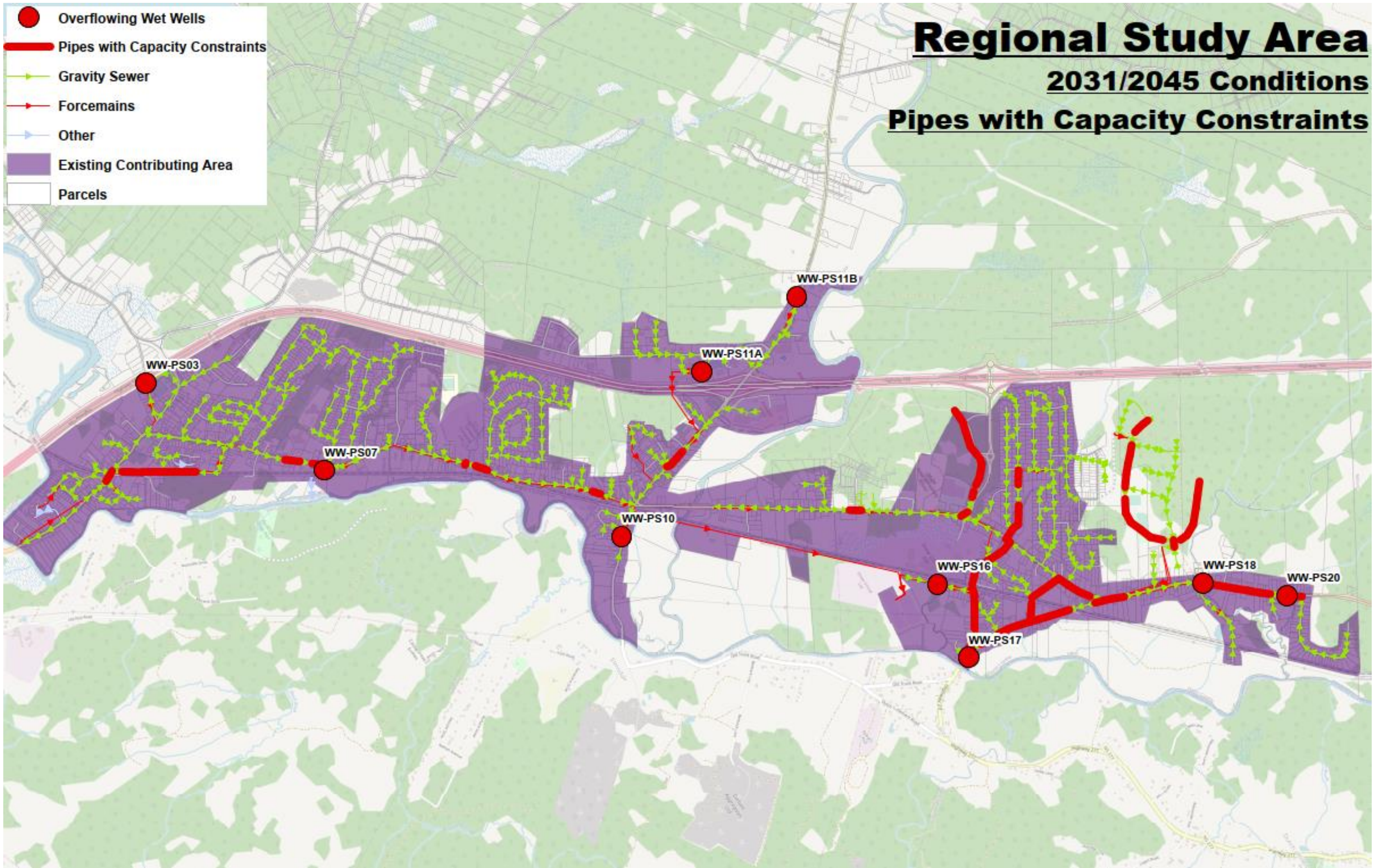


FIGURE 4-5 SANITARY SEWER WITH CONSTRAINTS (2031/2045 CONDITIONS) – REGIONAL SYSTEM

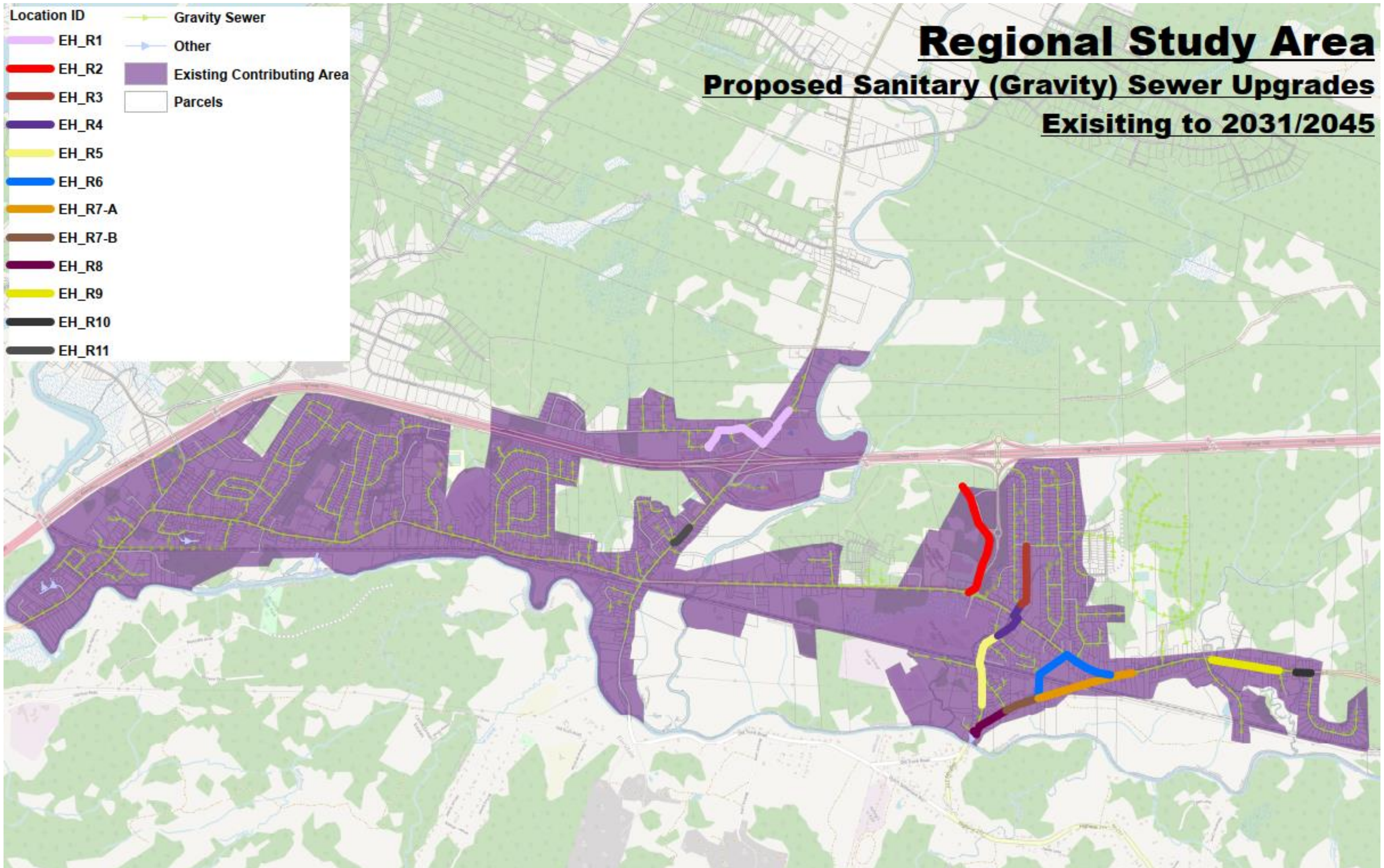


FIGURE 4-6 PROPOSED SANITARY SEWER (GRAVITY) UPGRADES - REGIONAL SYSTEM

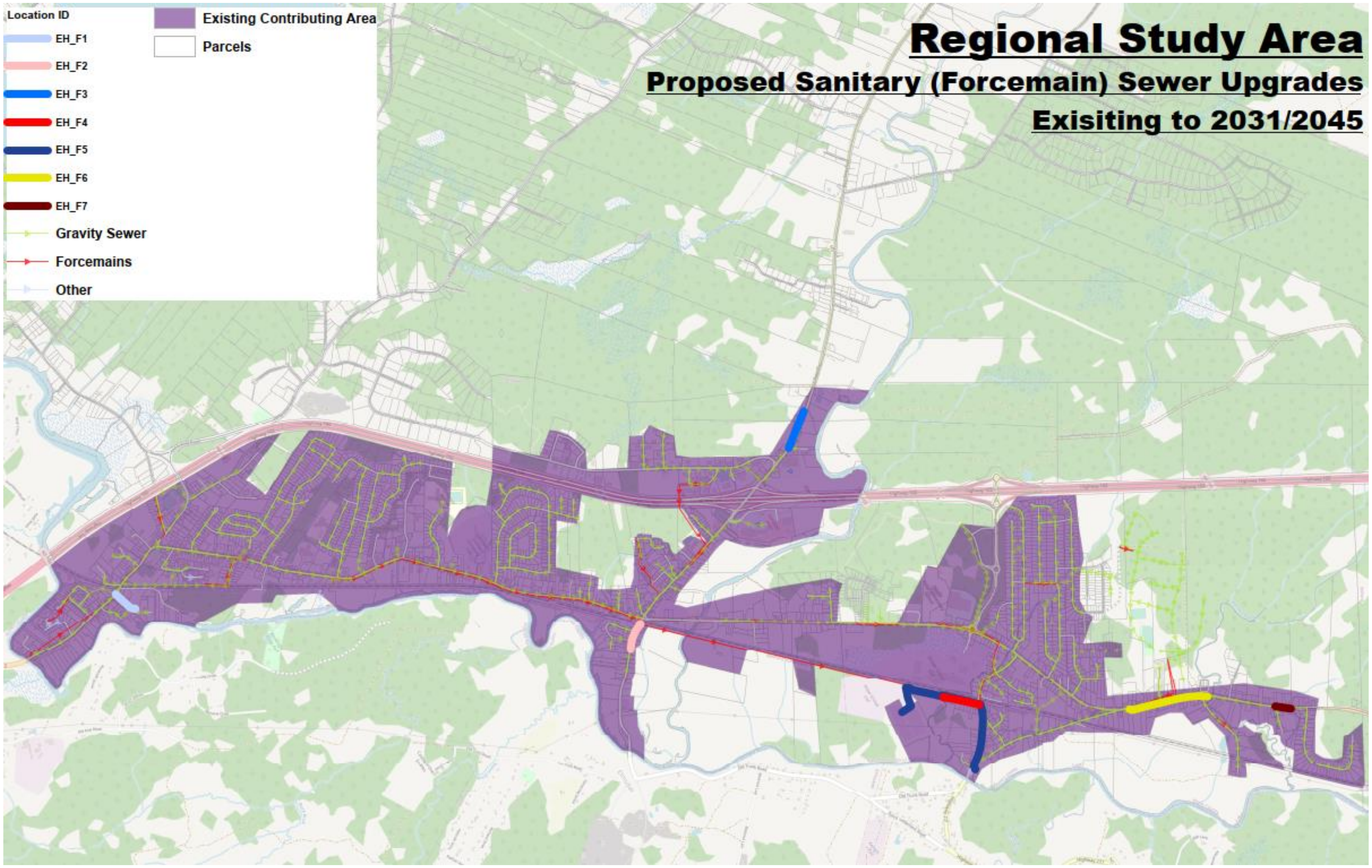


FIGURE 4-7 PROPOSED SANITARY SEWER (FORCEMAIN) UPGRADES - REGIONAL SYSTEM

5.0 Opinion of Probable Cost

The following section will provide an overview of the proposed costs associated with the various sanitary sewer upgrades or the Shubenacadie and Regional systems.

5.1 Shubenacadie System

Table 5-1 and Table 5-2 below provides an opinion of probable costs for the proposed upgrades in the Shubenacadie system.

TABLE 5-1 PROPOSED COSTS FOR SANITARY SEWER UPGRADES - SHUBENACADIE SYSTEM

Location	Length (m)	Prop Diameter (mm)	Cost	Cost (Millions)
MH43 to MH66	610.00	250.00	$ 721,630.00	$ 0.72
MH69 to MH68	275.00	300.00	$ 357,500.00	$ 0.36

TABLE 5-2 PROPOSED COSTS FOR PUMP UPGRADE - SHUBENACADIE SYSTEM

Pump Station	Flow (L/s)	Head (m)	Horsepower (Hp)	Cost*
PS23	20	10	4	$ 67,500.00

*Includes Control panel replacement and wet well hardware replacement costs

5.2 Regional System

Table 5-1, Table 5-4 and Table 5-5 below provides an opinion of probable costs for the proposed upgrades in the Regional system.

TABLE 5-3 PROPOSED COSTS FOR SANITARY (GRAVITY) SEWER UPGRADES - REGIONAL SYSTEM

Location	Length (m)	Prop Diameter (mm)	Cost	Cost (Millions)
EH_R1	850	250	$ 1,005,550.00	$ 1.01
EH_R4	333	300	$ 432,900.00	$ 0.43
EH_R7-A	724	525	$ 993,328.00	$ 0.99
EH_R7-B	253	525	$ 347,116.00	$ 0.35
EH_R11	164	300	$ 213,200.00	$ 0.21
EH_R8	301	525	$ 412,972.00	$ 0.41
EH_R2	885	250	$ 1,046,955.00	$ 1.05

EH_R3	452	250	$ 534,716.00	$ 0.53
EH_R5	574	300	$ 746,200.00	$ 0.75
EH_R6	786	300	$ 1,021,800.00	$ 1.02
EH_R9	505	375	$ 656,500.00	$ 0.66
EH_R10	110	375	$ 143,000.00	$ 0.14

TABLE 5-4 PROPOSED COSTS FOR SANITARY (FORCEMAINS) SEWER UPGRADES – REGIONAL SYSTEM

Location ID	Length (m)	Proposed Diameter (mm)	Cost	Cost (Millon)
EH_F1	189	100	$206,388.00	$0.21
EH_F2	205	250	$242,515.00	$0.24
EH_F3	296	150	$327,080.00	$0.33
EH_F4	275	100	$300,300.00	$0.30
EH_F5	1308	350	$1,700,400.00	$1.70
EH_F6	596	250	$705,068.00	$0.71
EH_F7	121	200	$133,705.00	$0.13

TABLE 5-5 PROPOSED COSTS FOR PUMP UPGRADE - REGIONAL SYSTEM

Pump Station	Flow (L/s)	Head (m)	Horsepower* (Hp)	Cost*
PS03	17	24	10	$77,200
PS07	182	90	300	$496,200
PS10	96	15	30	$113,500.00
PS11A	45	40	35	$146,950.00
PS16	12.5	12	3	$67,550.00
PS17	100	18	35	$146,950.00
PS17**	250	50	250	$496,200
PS18	115	40	90	$165,400
PS20	85	5	10	$77,200

*Estimated horsepower for each pump station is the total horsepower required to convey the design flow and head condition. For simplicity, it is assumed that one duly pump will convey the design flow and head conditions. It is assumed that the number of duty pumps (1, 2 or 3) will be determined at the design stage. Accordingly, the horsepower of individual pumps can be estimated.

**Includes Control panel replacement and wet well hardware replacement costs

6.0 Summary and Recommendations

6.1 Summary

As part of this study,

- The existing (2015) SewerGEMS sanitary model was obtained from the Municipality and was a thoroughly reviewed to verify the information provided regarding the existing infrastructure that was included in the model.
- A flow monitoring program was implemented on the Regional system only, which comprised of the installation of three (3) flow monitors for over a three-month period.
- No rain gauges were installed within the study area as part of the monitoring program. The rain gauge closest to the study area was found at Halifax Stanfield International Airport, which is approximately 20 kilometres away from the study area.
- The model was updated to include any new infrastructure that will be added because of any planned developments that will be taking place in any of the three (3) wastewater systems.
- The information provided showed that there are no planned developments within the Milford and Shubenacadie system. Therefore, no conduits and/or manholes were added to either the Milford or Shubenacadie models at this time. This may change in the future, after which further model updates can be considered.
- A total of thirty (30) planned developments were identified within the Regional system. Utilizing the plan and profile drawings of specific developments, the model was updated to include any new pipes and manholes that will be added as a direct result of the subdivision being built out.
- A total of 139 pipes, 133 manholes and 2 pump stations were added to the model, along with all relevant information such as pipe size, pipe material, pipe shape and pipe and manhole invert information.
- The design flows pertaining to each development were calculated using the Municipal guidelines for new developments. This included:
  - Average Dry Weather Flows: 340 liters per person per day
  - Design Peak Flows: 1,490 liters per person per day
  - Inflow and Infiltration Flows: 25, 920 liters per hectare per day

- The existing pumps located at each of the lift stations located within each system were updated using the latest pump curve information to improve model accuracy and to ensure that the model results are in no way influenced by unnecessary pump inefficiencies.
- The existing model underwent a dry weather flow (DWF) calibration prior to setting up any future scenarios to ensure that the existing model is accurate. The DWF were compared with he averages daily dry weather flow recorded at either the influent or effluent of the nearest WWTP. The results of the DWF calibration concluded that:
    - The peak dry weather flow for the Milford system was reduced by 46% of the dry weather flows assigned in the existing model.
    - The peak dry weather flow for the Shubenacadie system was reduced by 60% of the dry weather flows assigned in the existing model.
    - The peak dry weather flow for the Regional system was reduced by 53% of the dry weather flows assigned in the existing model.
- A wet weather flow (WWF) calibration utilizing the flow monitoring data was not completed due to the poor correlation of the flow and rainfall data available.
- An inflow and infiltration (I/I) allowance of 0.3 L/s/ha was used to estimate the design I/I per the Municipality of East Hants guidelines. The I/I was added to the calibrated peak dry weather flows to determine the peak wet weather flows (WWF) for system analysis.
- Future flows were estimated for the new developments (planned/approved) in the Regional System.
- The calibrated hydraulic model was then utilized to evaluate system's capacity under existing, interim (2031), and full buildout (2045) flow conditions. The system capacity constraints were reviewed and proposed improvements were identified.
- In general, the existing sanitary sewer system for Milford and Shubenacadie demonstrated sufficient capacity to accommodate existing flows, with the system only requiring minor upgrades for optimal performance.
- The Regional system experienced several capacity limitation under the existing and future peak wet weather flow conditions, and required gravity sewer, forcemain and pumps upgrade to mitigate the capacity issues identified. The estimate of probable construction cost for each proposed development was calculated.

6.2 Model Assumptions and Limitations

As mentioned previously, the existing (2015) sanitary model provided by the Municipality, required a thorough review to develop a complete understanding of how the model was set up and identify deficiencies in the logistics applied to the model for it to run. The information regarding the model set up was found to be scarce, which in turn led to RVA making a number of assumptions while updating and calibrating the model. Below are some of the key model assumptions/limitations identified through our review:

- The information pertaining on how the sanitary loadings inflow and infiltration flows were allocated was not documented completely in the original model. RVA assumed that the preliminary flow allocations within the model to be accurate and used it as the starting point for further model calibration.
- Unavailability of rainfall monitoring data to assist with wet weather calibration of the model.
- Unavailability of influent flow data to Shubenacadie and Regional WWTP to assist with the model calibration.
- The original model set up didn't utilize any hydrologic parameters to simulate the inflow and infiltration and therefore, as such the model cannot simulate the wet weather flows under different storm events.
- The model simulates that all locations will discharge peak flow at the same time, which over estimates loadings on the conveyance systems.

6.3 Recommendations

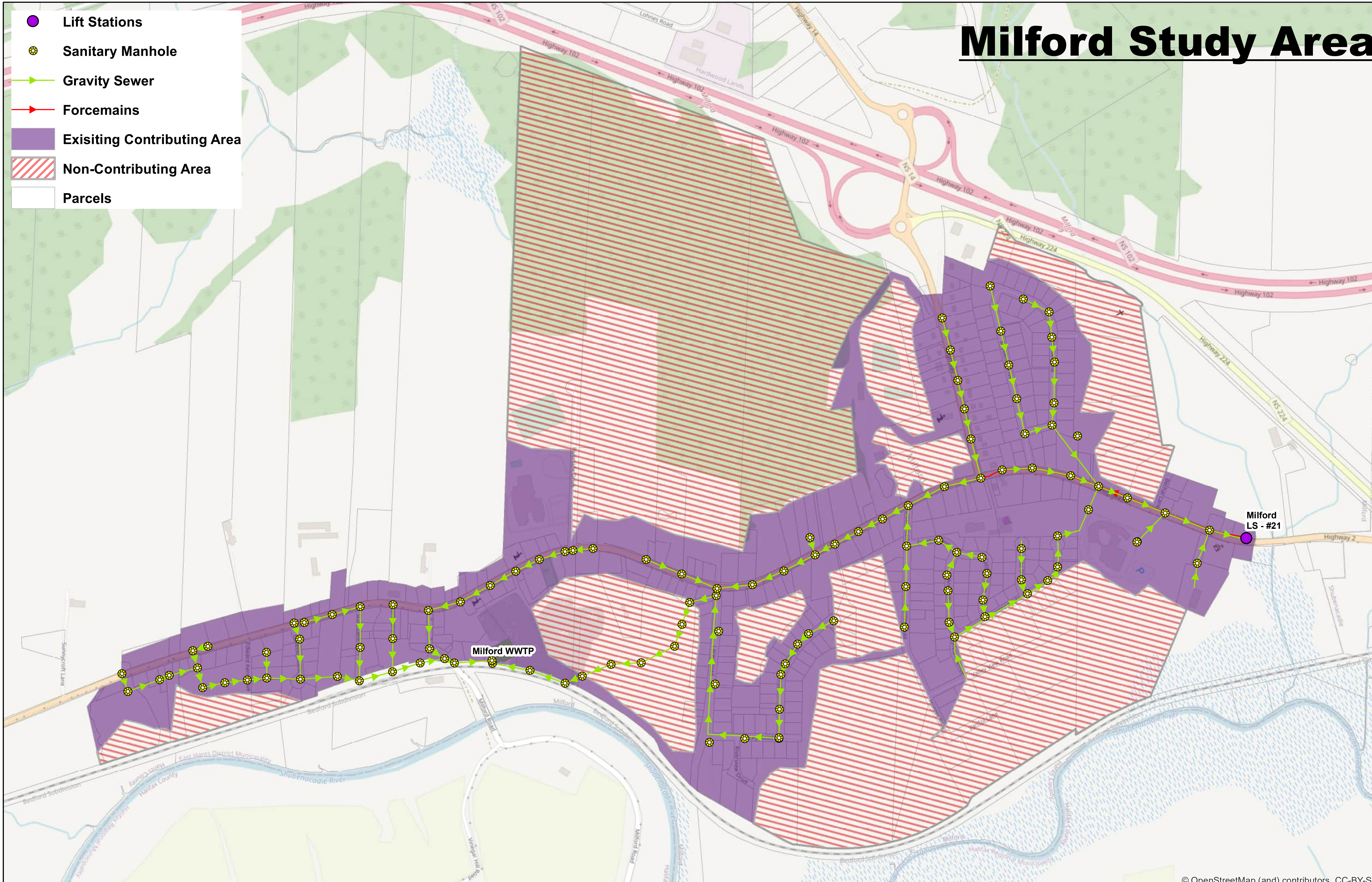
For effective future development and land use planning, the hydraulic models must provide a representative analysis of actual system performance. In order to improve the accuracy of the model and confidence in the model predictions, the models should be regularly updated and calibrated based on latest infrastructure information available. The following summarizes the recommendations that are a result of this study:

- Extensive flow and rainfall monitoring are recommended in the areas that are identified to undergo major developments in order to clearly develop an understanding of the current sewer capacity and identify areas with inflow and infiltration through a wet weather flow analysis.
- It is recommended that the Municipality monitors hourly influent flows at the treatment plants, which will help simulating the dry and wet weather flows discharged from the conveyance system.

- Pump stations' performance couldn't be verified because of unreliable SCADA flow data for the pump stations. Accurate/reliable SCADA flow data is necessary for pumping capacity evaluations. It is recommended to conduct pump tests to determine the performance of the existing pumps;
- The original model set up didn't utilize any hydrologic parameters, and therefore the current model can not simulate the wet weather flows under different storm events. Due to this limitation, the inflow and infiltration flow to the system was calculated based on the Municipality's guidelines, which could be higher or lower than the actual flows expected under design storm event. It is recommended to review the load allocation and update the model to include hydrologic parameters.

APPENDIX 1

PDF MAPS


Milford Study Area
Lift Stations
Sanitary Manhole
Gravity Sewer
Forcemains
Exisiting Contributing Area
Non-Contributing Area
Parcels
Milford WWTP
Milford
LS - #21
Highway 102
Highway 224
Highway 2
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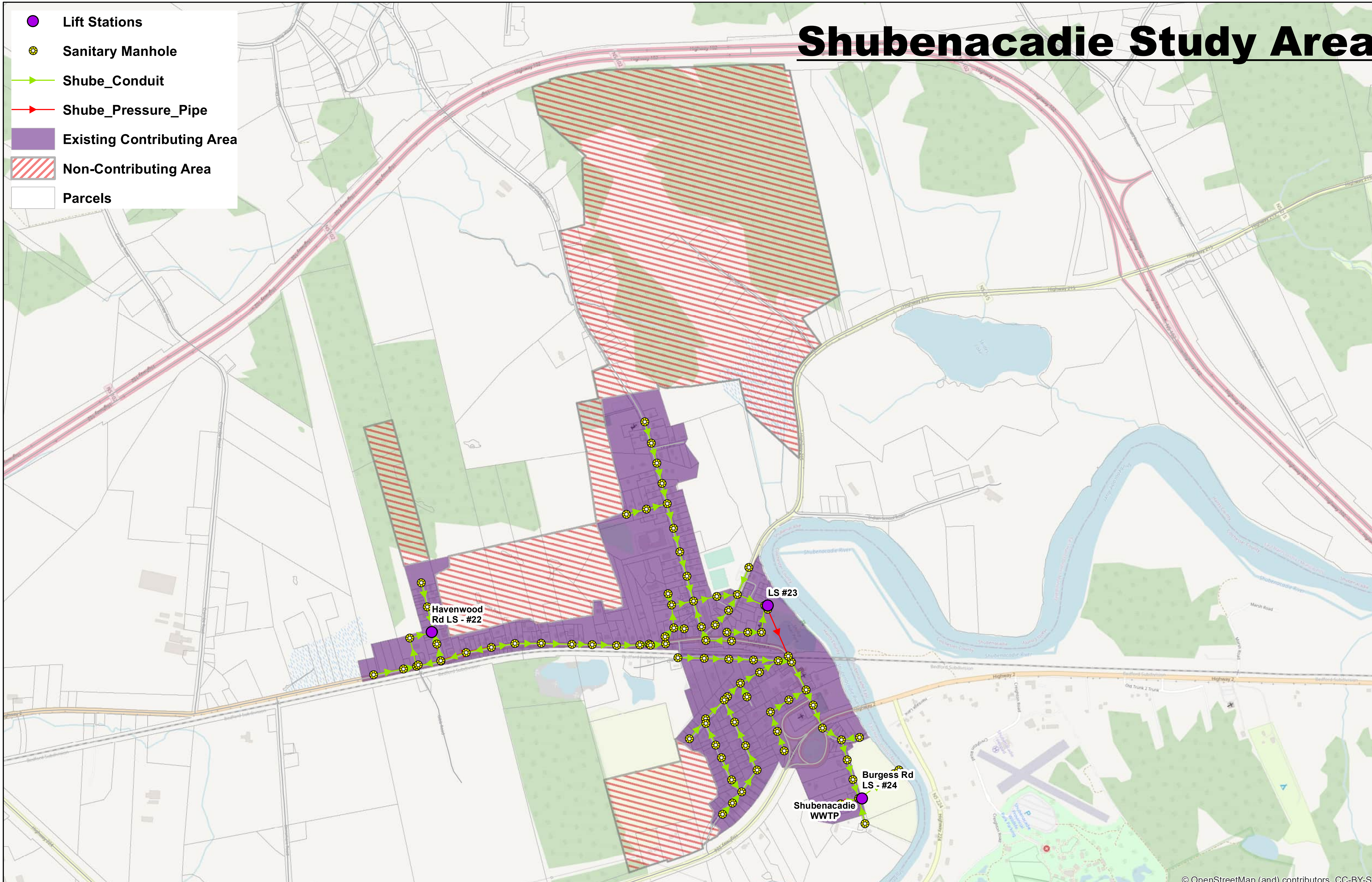

Shubenacadie Study Area
Lift Stations
Sanitary Manhole
Shube_Conduit
Shube_Pressure_Pipe
Existing Contributing Area
Non-Contributing Area
Parcels
LS #23
Havenwood Rd LS - #22
Burgess Rd LS - #24
Shubenacadie WWTP
Shubenacadie River
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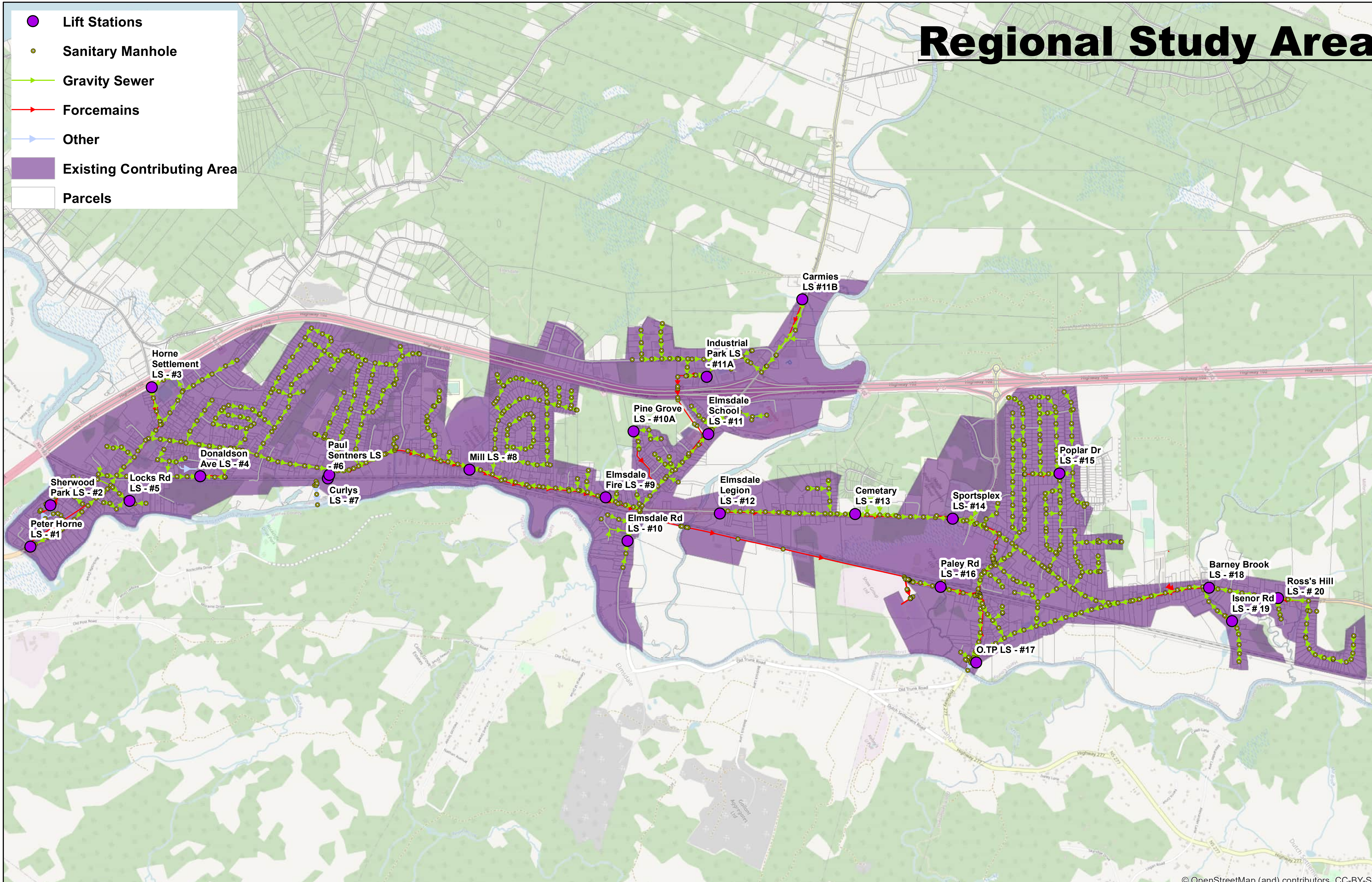
Regional Study Area



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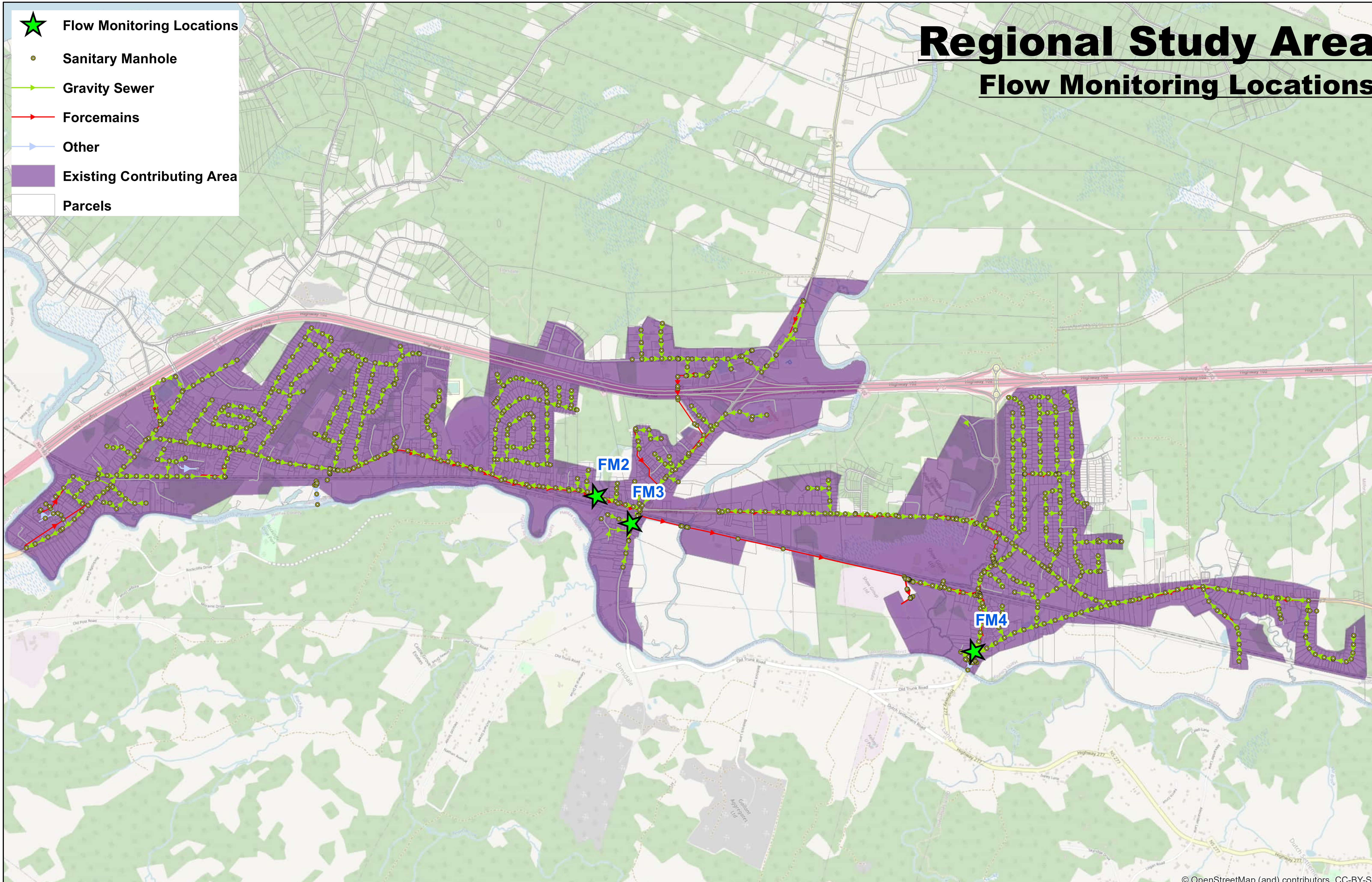

Regional Study Area
Flow Monitoring Locations
Flow Monitoring Locations
Sanitary Manhole
Gravity Sewer
Forcemains
Other
Existing Contributing Area
Parcels
FM2
FM3
FM4
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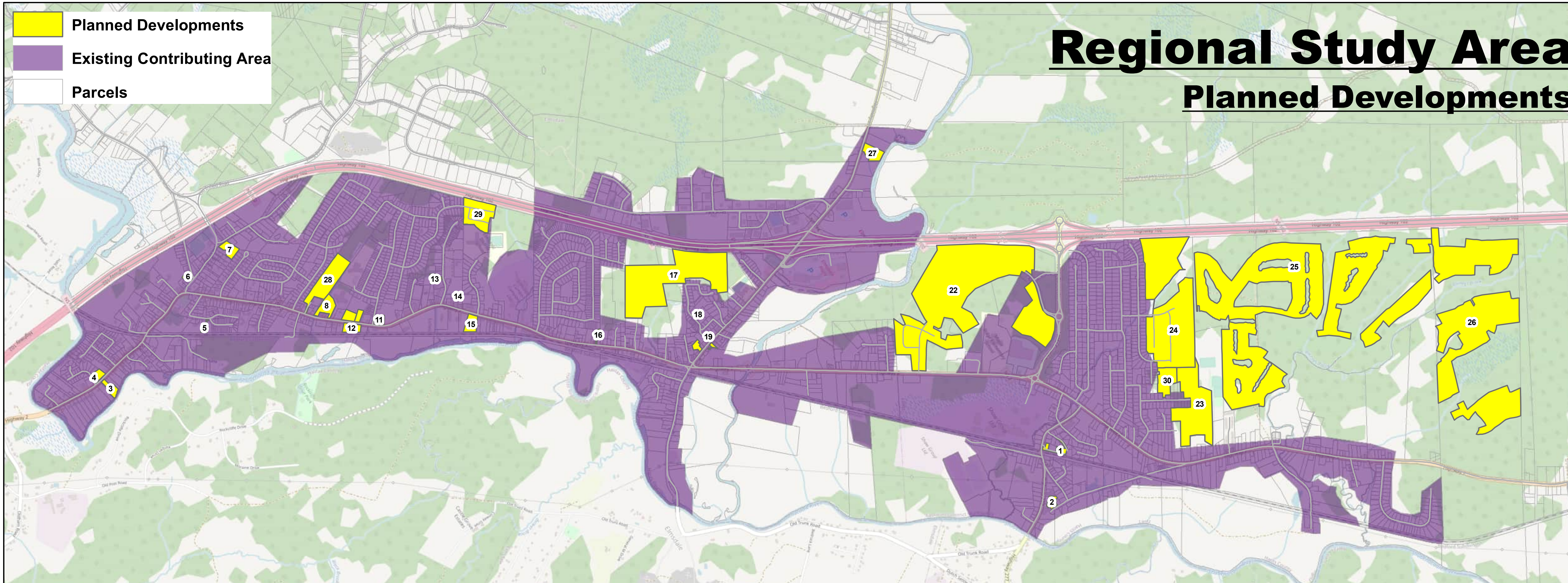
Regional Study Area

Planned Developments



ID	Address	No. of Units	Area (Ha)	Total Population
1	Melody Lane, Lantz	40	0.64	100
2	161 Highway 277, Lantz	16	0.51	40
3	159 Highway 2, Enfield	72	0.66	180
4	Sherwood Park, Enfield	64	0.51	160
5	John Murray Drive, Enfield	10	0.29	25
6	Old Enfield and Old Hornse Dev	10	0.20	34
7	Bakery Lane	72	0.93	180
8	410 Highway 2, Enfield	70	1.31	175
9	428 Highway 2, Enfield	62	0.61	155
10	432 Highway 2, Enfield	40	0.34	100
11	450 Highway 2, Enfield	126	0.45	315
12	429 Highway 2, Enfield	84	0.74	210
13	Kali Lane, Elmsdale	16	0.39	40
14	532 Highway 2, Elmsdale	42	0.18	105
15	553 Highway 2, Elmsdale	58	0.97	145

ID	Address	No. of Units	Area (Ha)	Total Population
16	Highway 2, Elmsdale	16	0.15	40
17	Pinehill/Elmwood, Elmsdale	660	19.2	1650
18	Pine Hill Drive, Elmsdale	12	0.08	30
19	166 Highway 214, Elmsdale	12	0.14	30
20	163 Highway 214, Elmsdale	11	0.12	28
21	TOLSON-Highway 214, Elmsdale	36	0.32	90
22	Lantz-The Shaw Group	1500	46.9	3750
23	Mariah Drive, Lantz	148	10.8	370
24	Mariah Drive, Lantz	104	26.6	260
25	Lantz - ARMCo	2205	71.8	5513
26	Milford Development	1400	42.1	3500
27	Highway 214, Elmsdale	94	1.26	235
28	Dorey Lane-1, Enfield	74	4.44	185
29	Tyler Street Extension, Elmsdale	88	3.96	220
30	Acorn Ave, Lantz	81	2.26	203

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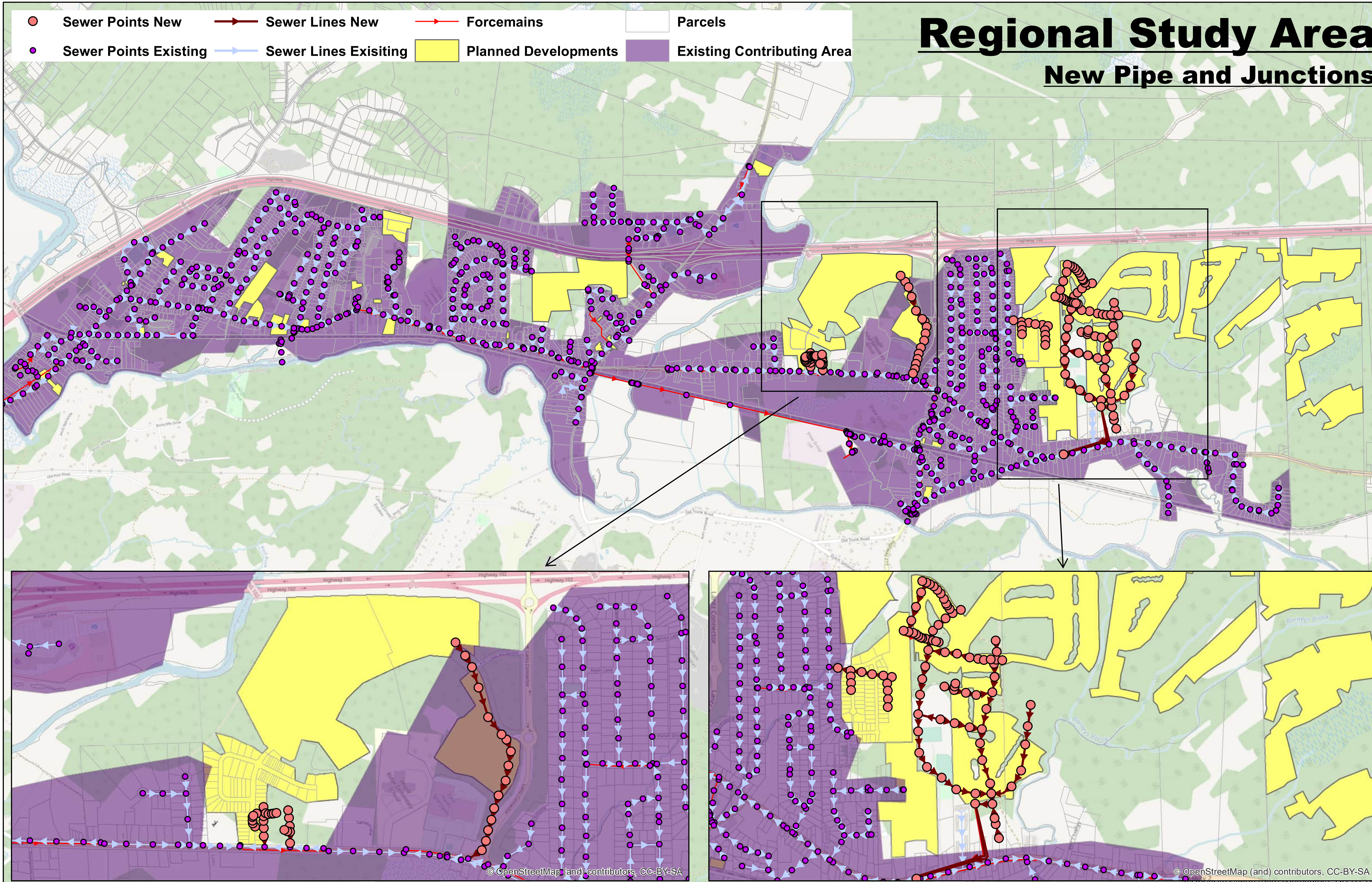

Regional Study Area
New Pipe and Junctions
Sewer Points New
Sewer Points Existing
Sewer Lines New
Sewer Lines Exisiting
Forcemains
Planned Developments
Parcels
Existing Contributing Area
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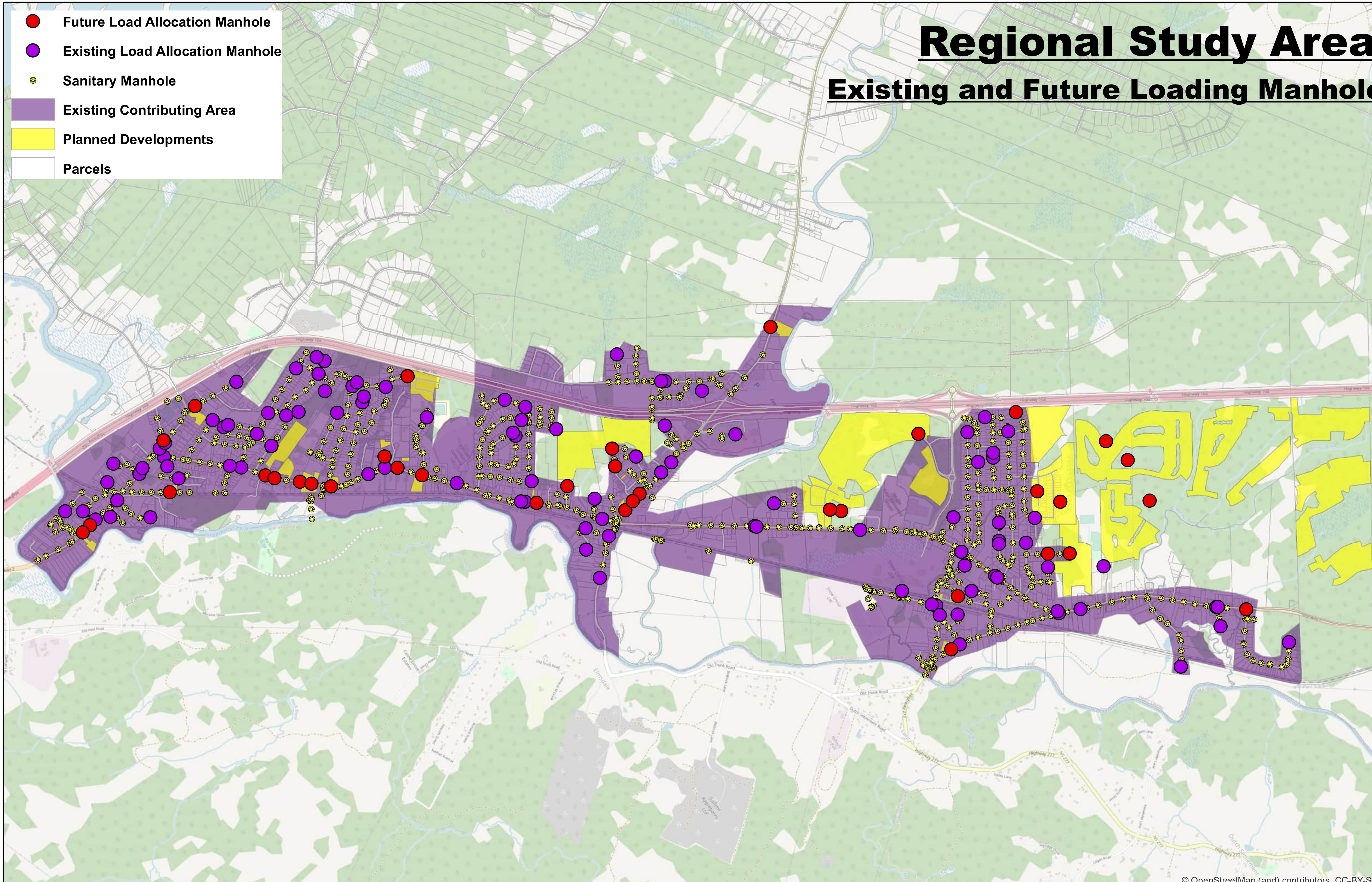
Regional Study Area

Existing and Future Loading Manhole



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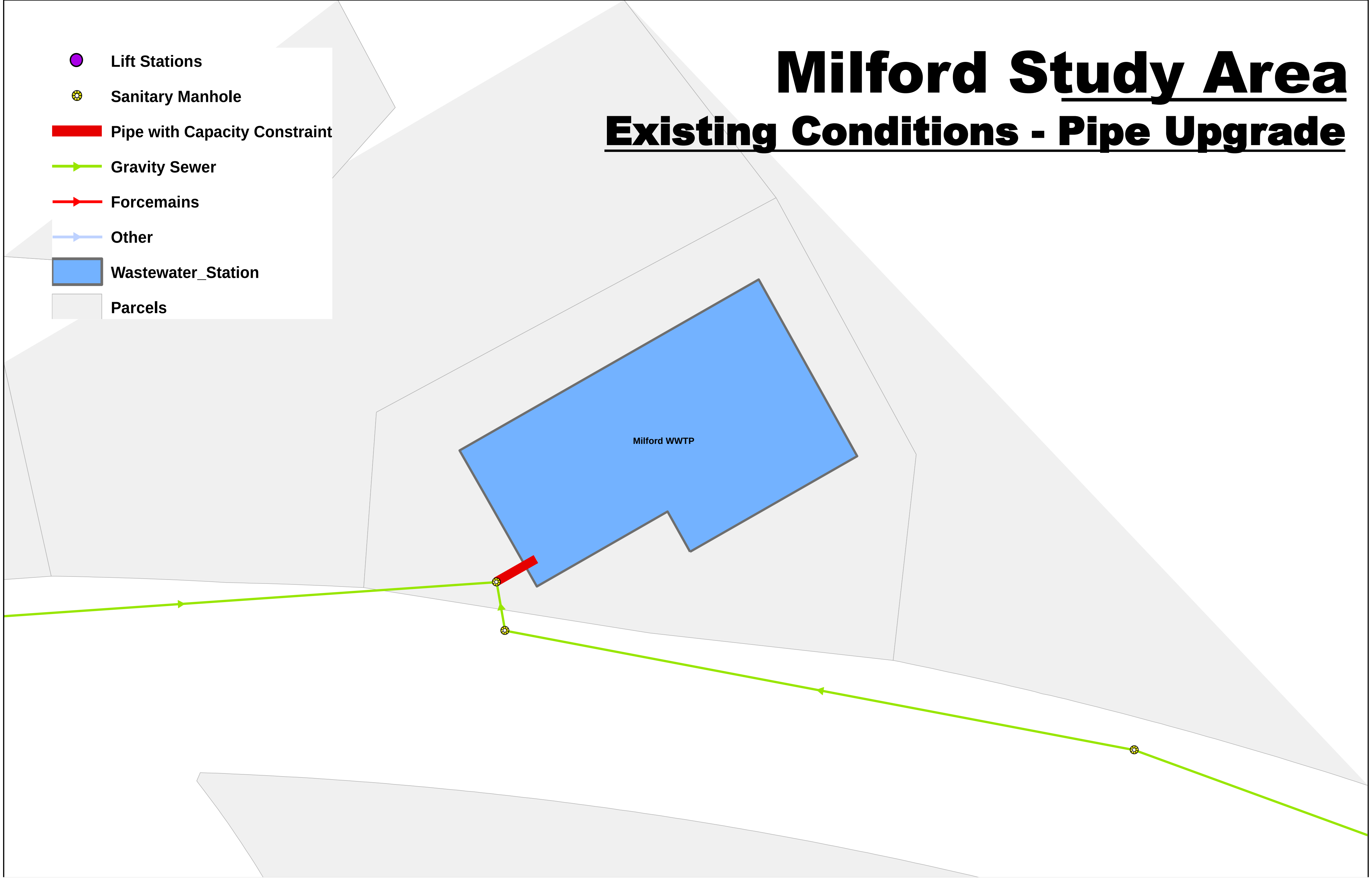
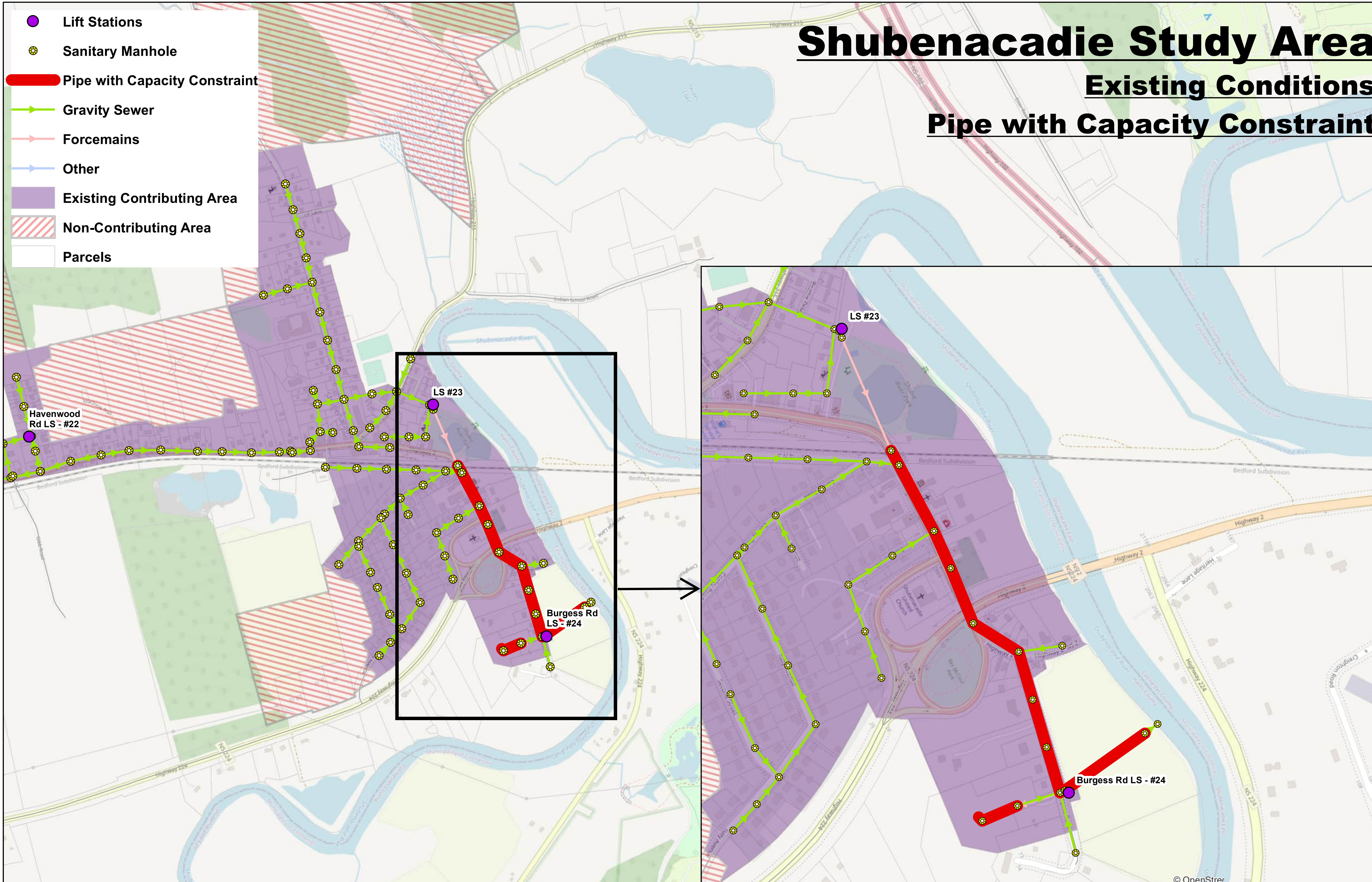
Milford Study Area

Existing Conditions - Pipe Upgrade





Shubenacadie Study Area
Existing Conditions
Pipe with Capacity Constraint
Lift Stations
Sanitary Manhole
Pipe with Capacity Constraint
Gravity Sewer
Forcemains
Other
Existing Contributing Area
Non-Contributing Area
Parcels
LS #23
Havenwood Rd LS - #22
Burgess Rd LS - #24
Shubenacadie River
Bedford Subdivision
Highway 2
Highway 224
Burgess Rd LS - #24
LS #23
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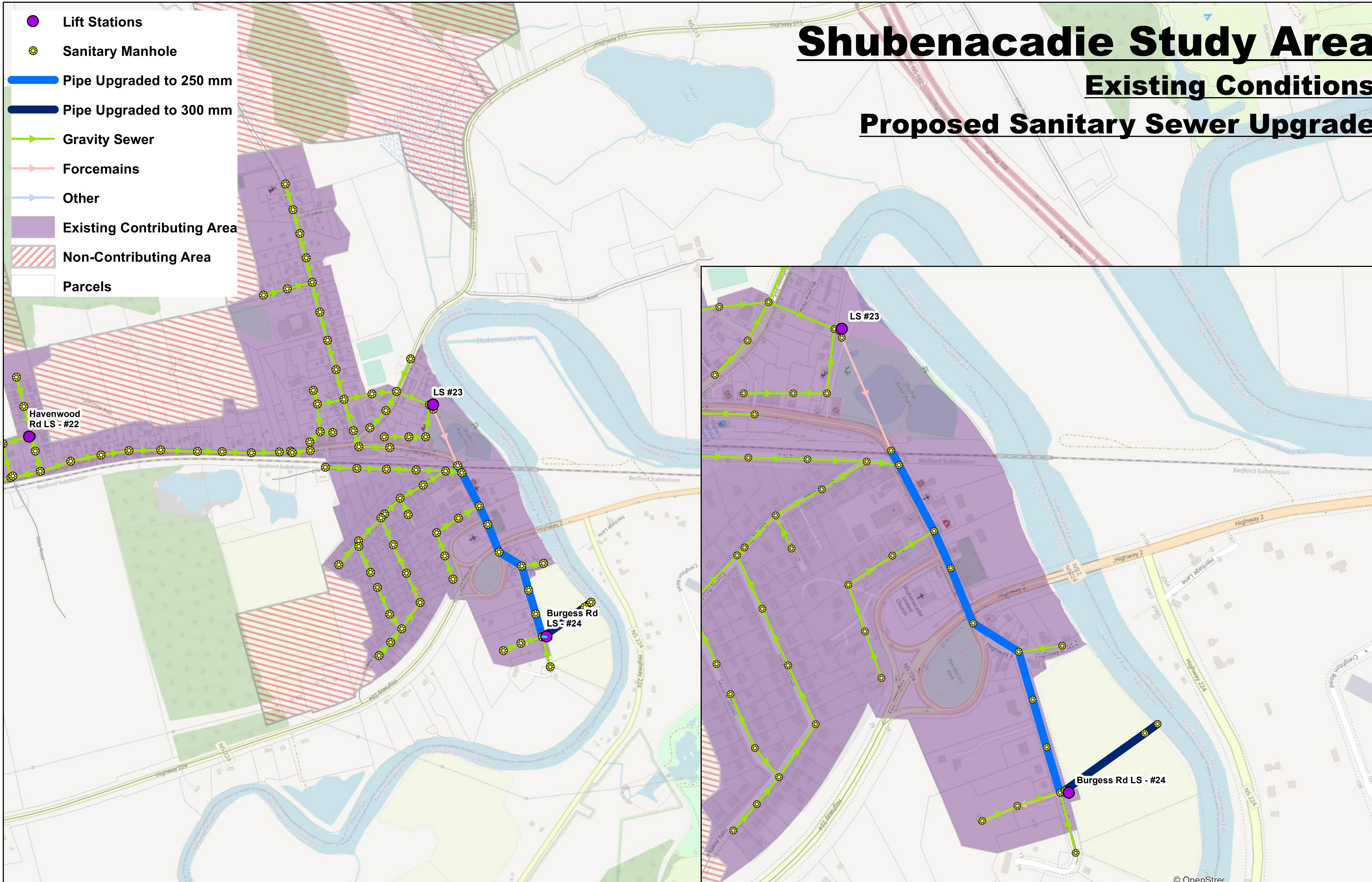
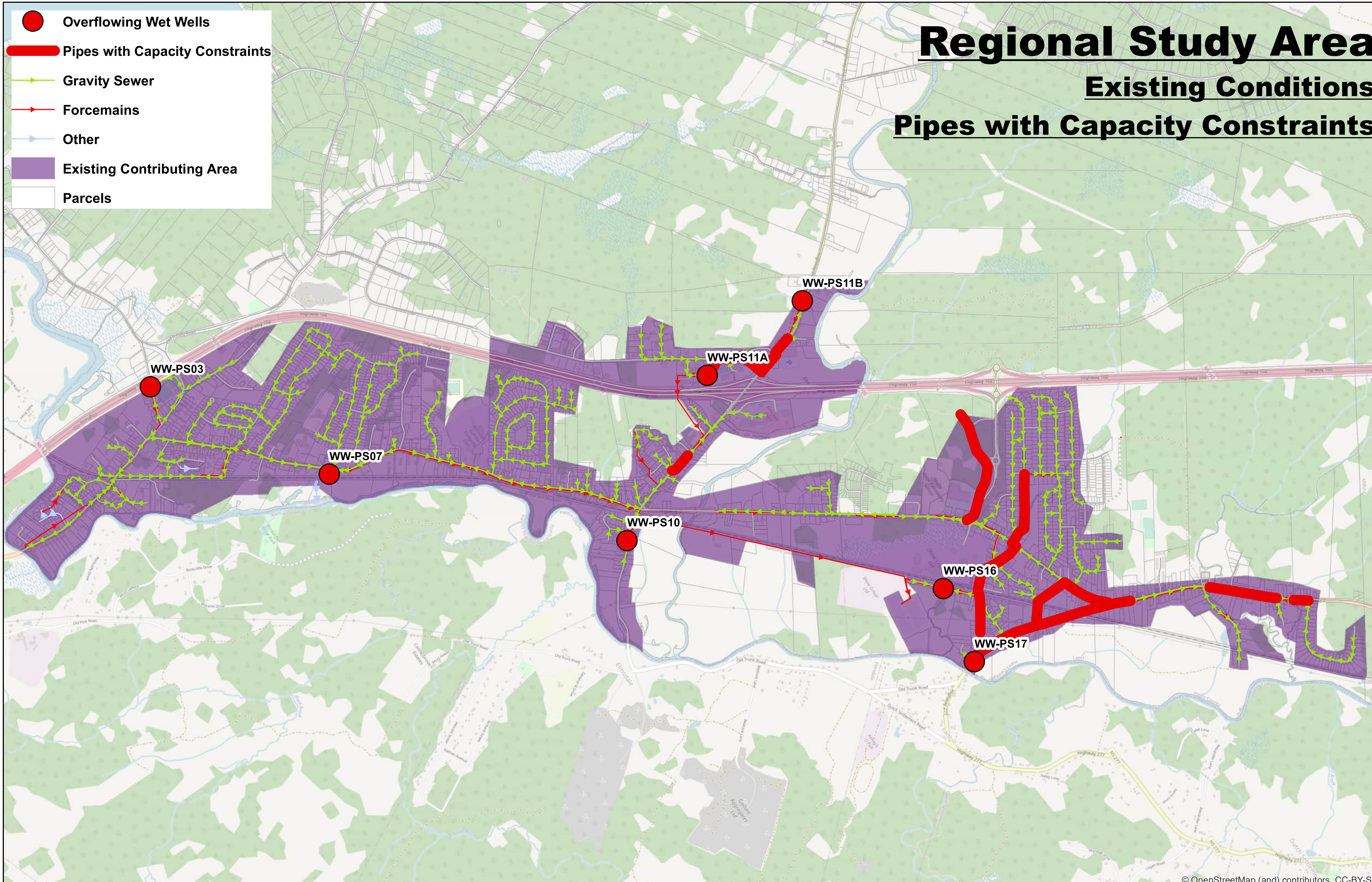


Shubenacadie Study Area
Existing Conditions
Proposed Sanitary Sewer Upgrade
Lift Stations
Sanitary Manhole
Pipe Upgraded to 250 mm
Pipe Upgraded to 300 mm
Gravity Sewer
Forcemains
Other
Existing Contributing Area
Non-Contributing Area
Parcels
Havenwood Rd LS - #22
LS #23
Burgess Rd LS - #24
Shubenacadie River
Highway 2
Highway 224
Bedford Subdivision
© OpenStre



Regional Study Area
Existing Conditions
Pipes with Capacity Constraints
Overflowing Wet Wells
Pipes with Capacity Constraints
Gravity Sewer
Forcemains
Other
Existing Contributing Area
Parcels
WW-PS03
WW-PS07
WW-PS10
WW-PS11A
WW-PS11B
WW-PS16
WW-PS17
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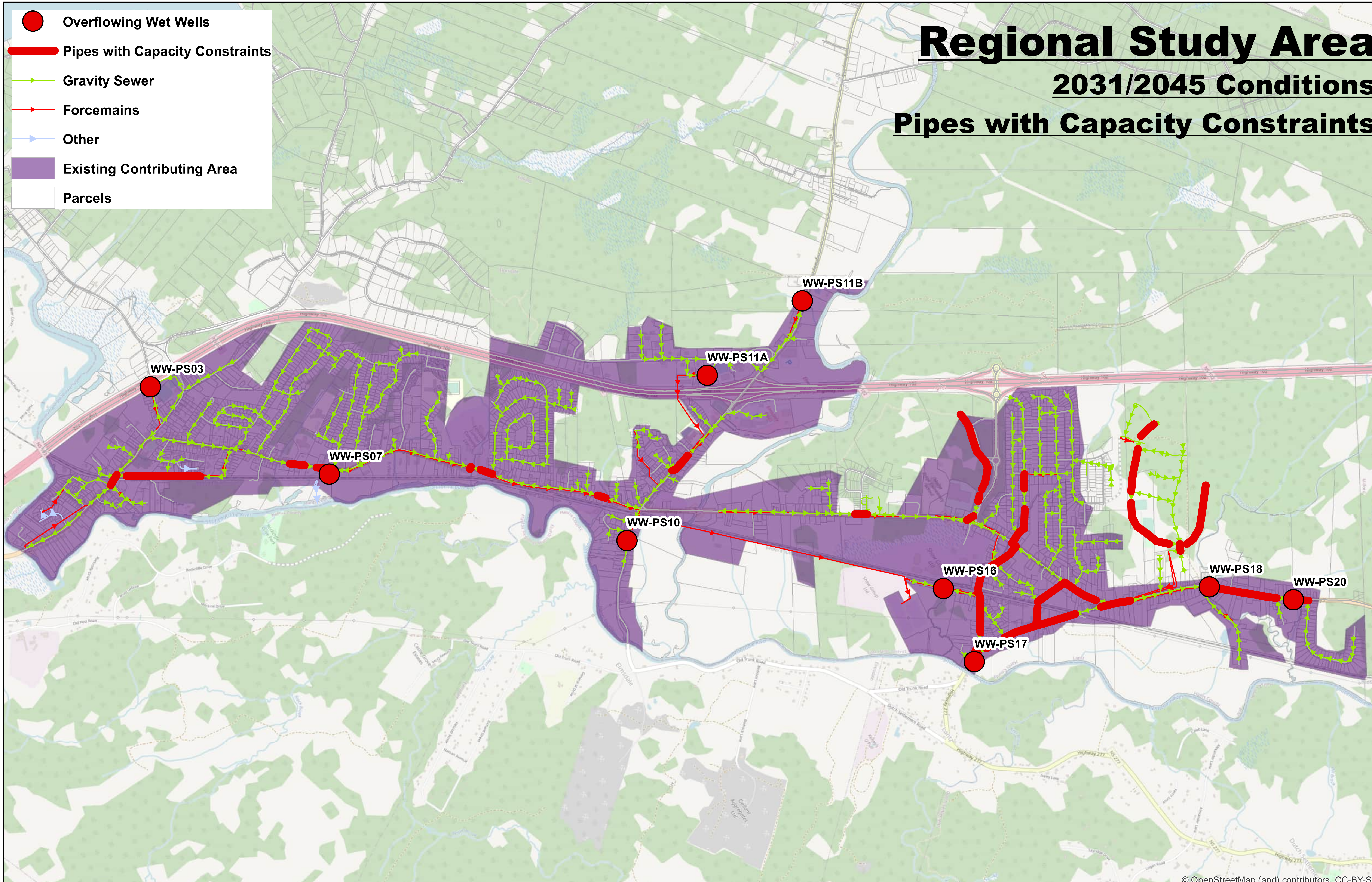
Regional Study Area
2031/2045 Conditions
Pipes with Capacity Constraints
Overflowing Wet Wells
Pipes with Capacity Constraints
Gravity Sewer
Forcemains
Other
Existing Contributing Area
Parcels
WW-PS03
WW-PS07
WW-PS10
WW-PS11A
WW-PS11B
WW-PS16
WW-PS17
WW-PS18
WW-PS20
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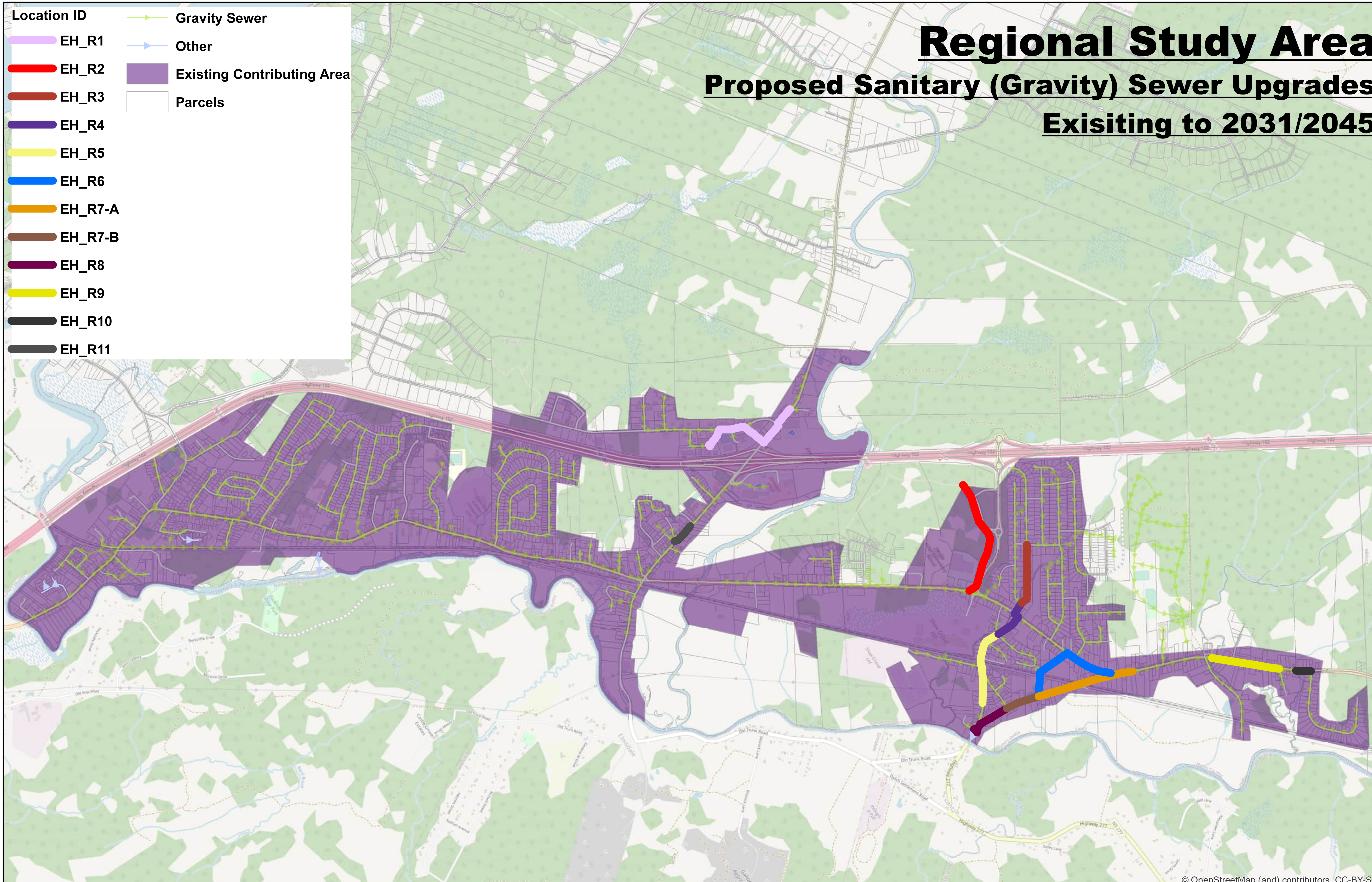

Regional Study Area
Proposed Sanitary (Gravity) Sewer Upgrades
Exisiting to 2031/2045
Location ID
EH_R1
EH_R2
EH_R3
EH_R4
EH_R5
EH_R6
EH_R7-A
EH_R7-B
EH_R8
EH_R9
EH_R10
EH_R11
Gravity Sewer
Other
Existing Contributing Area
Parcels
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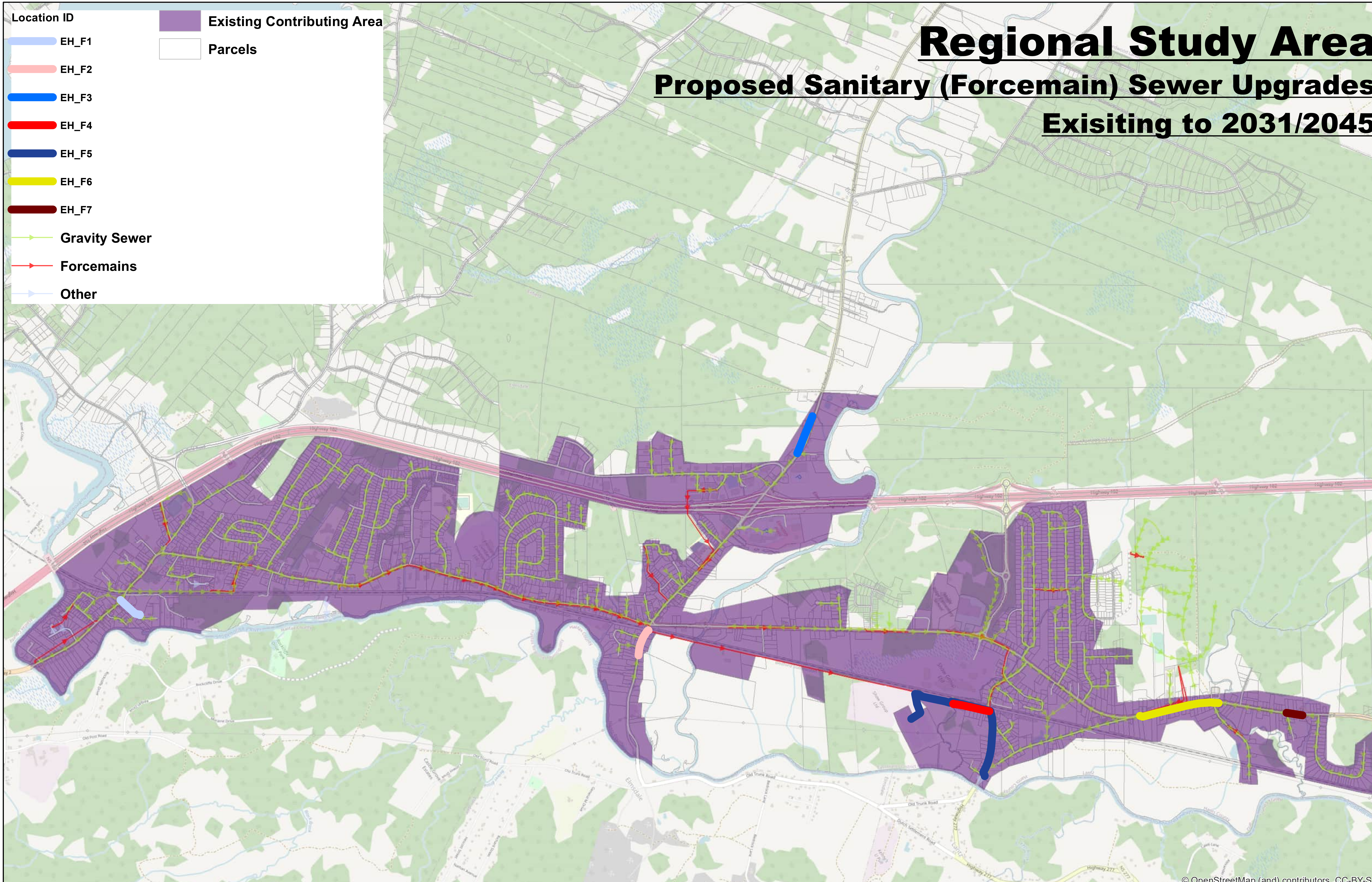
Regional Study Area
Proposed Sanitary (Forcemain) Sewer Upgrades
Exisiting to 2031/2045
Location ID
EH_F1
EH_F2
EH_F3
EH_F4
EH_F5
EH_F6
EH_F7
Gravity Sewer
Forcemains
Other
Existing Contributing Area
Parcels
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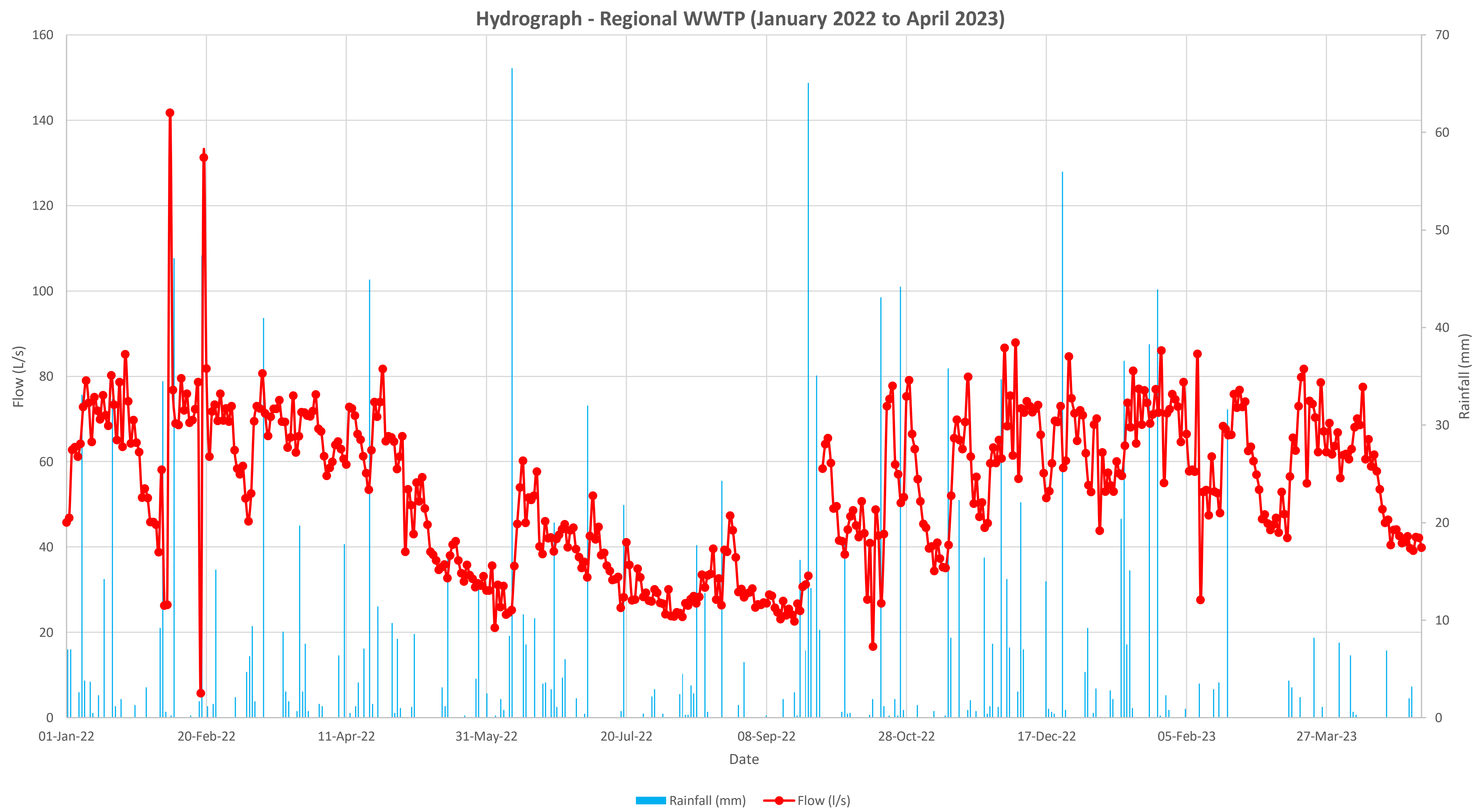
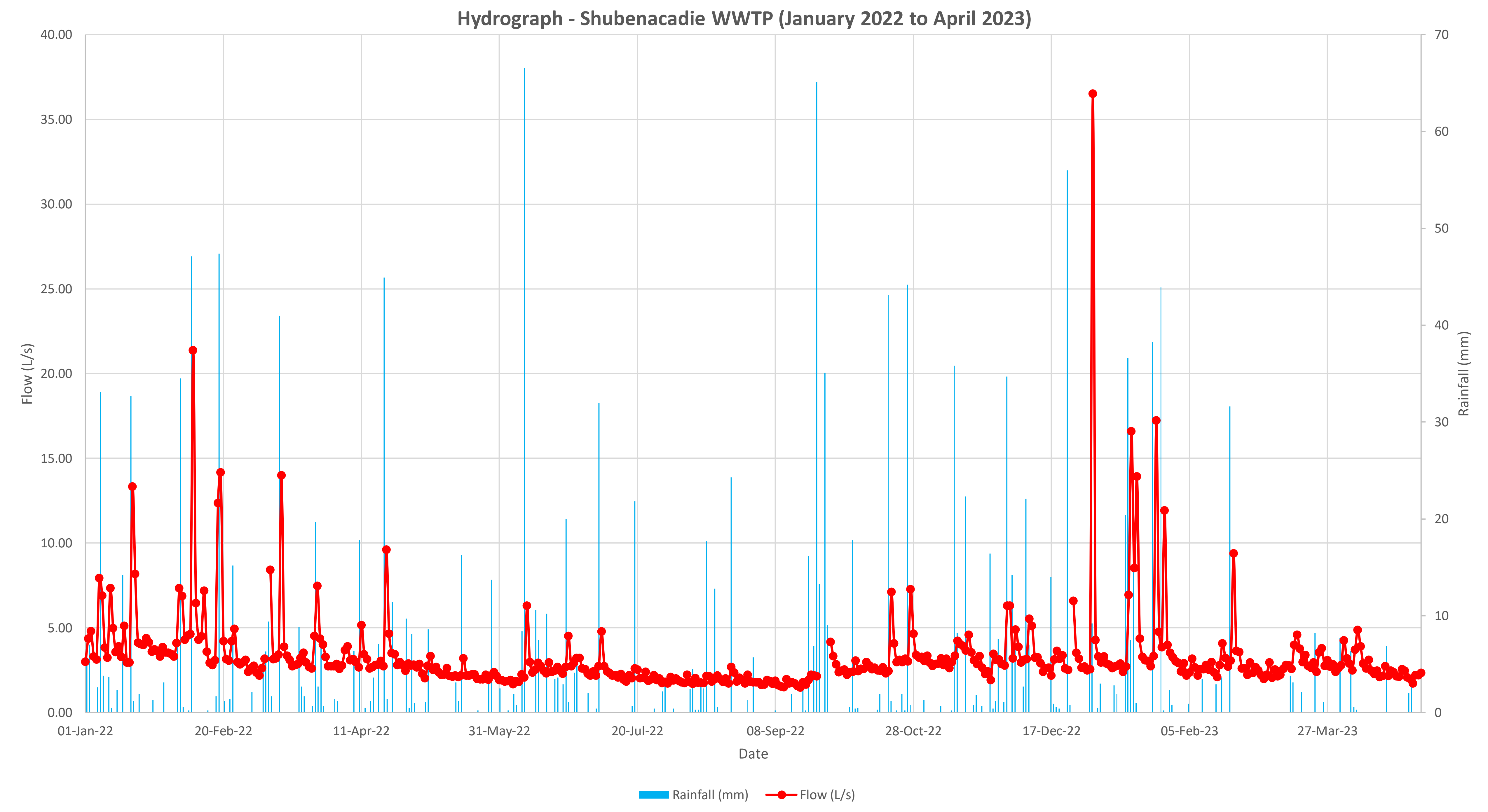
APPENDIX 2

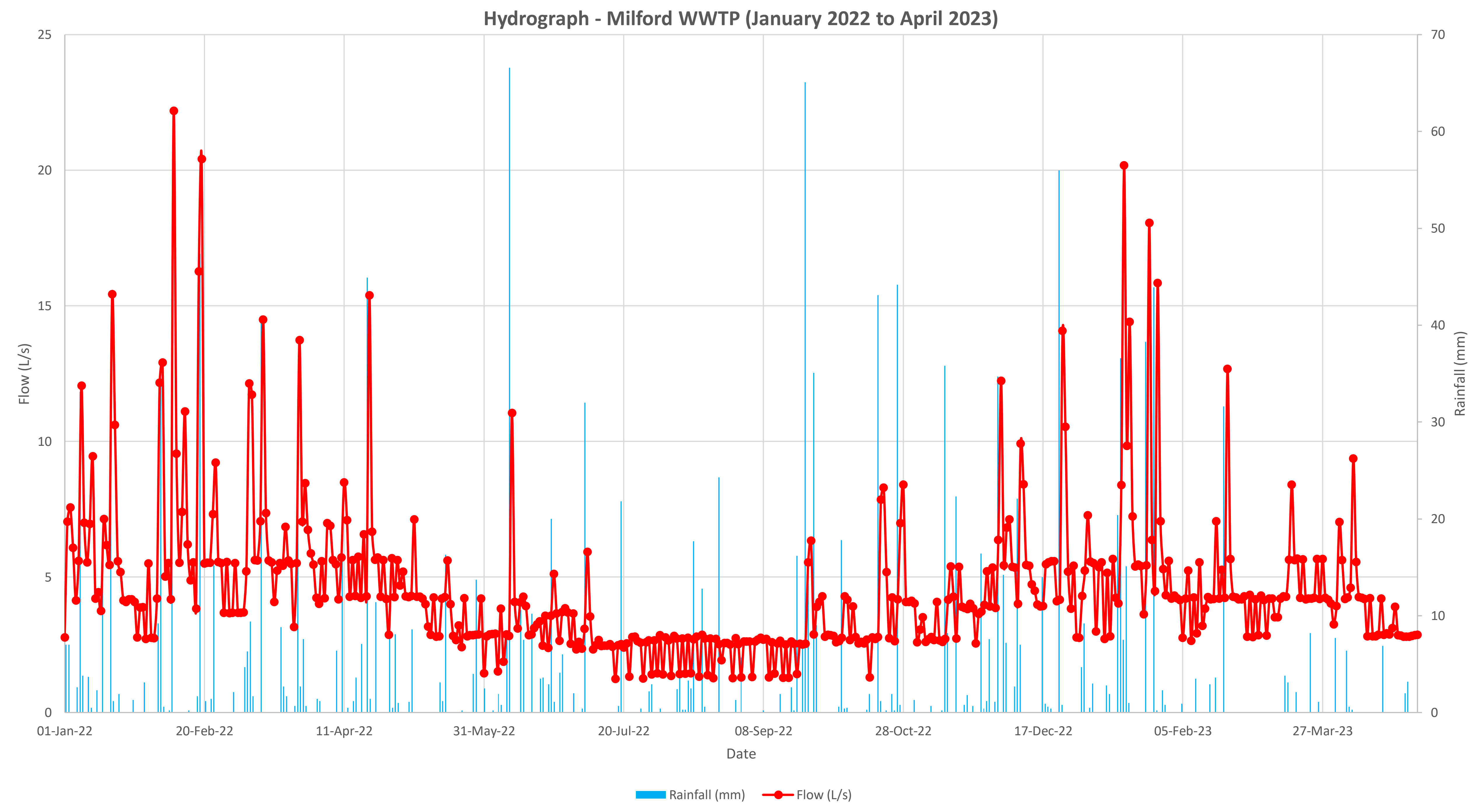
HYDROGRAPHS – FLOW MONITORING AND WWTP LOCATIONS



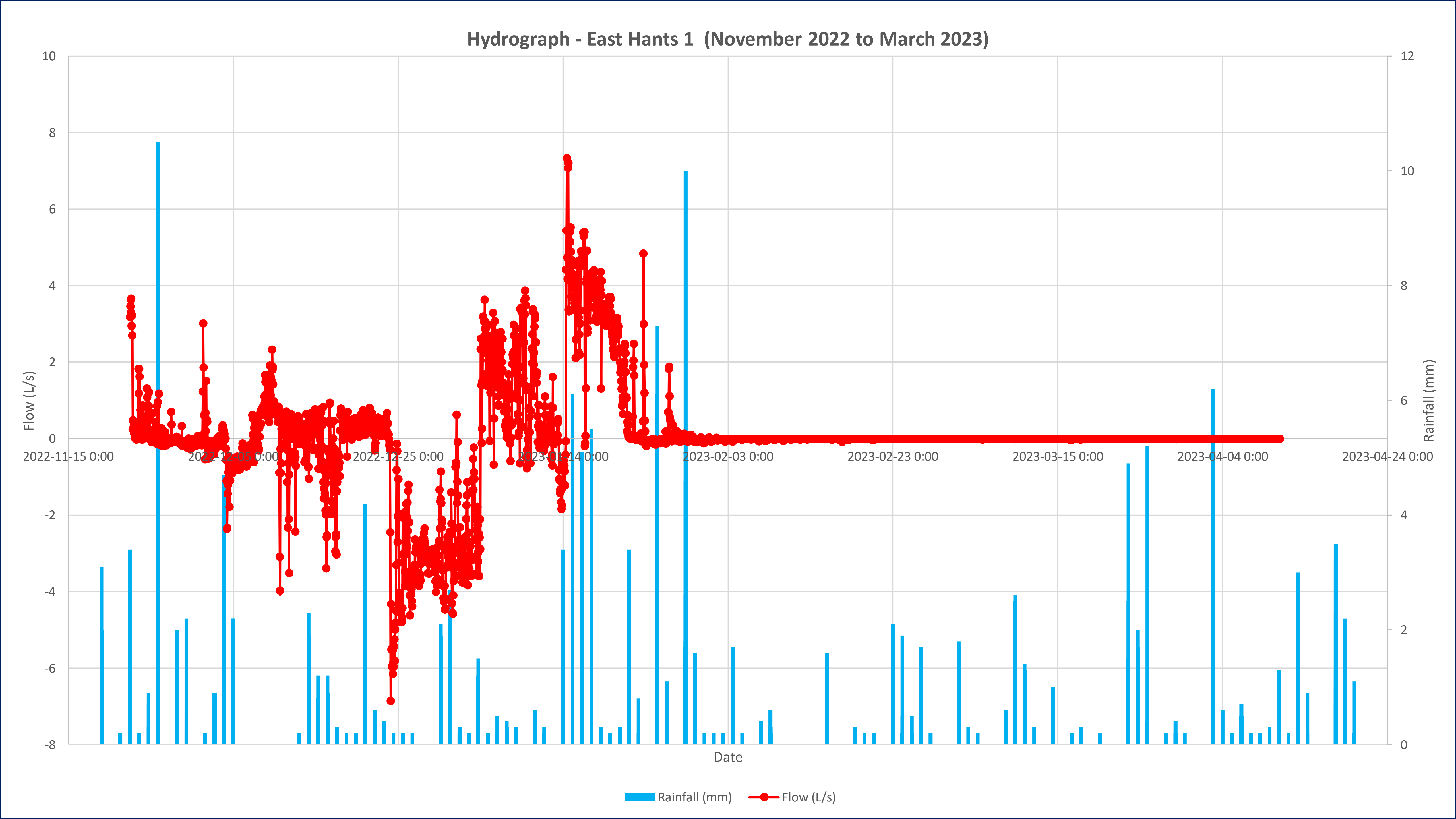
Hydrograph - Regional WWTP (January 2022 to April 2023)
Flow (L/s)
Rainfall (mm)
Date
0
20
40
60
80
100
120
140
160
0
10
20
30
40
50
60
70
01-Jan-22
20-Feb-22
11-Apr-22
31-May-22
20-Jul-22
08-Sep-22
28-Oct-22
17-Dec-22
05-Feb-23
27-Mar-23
Rainfall (mm)
Flow (l/s)



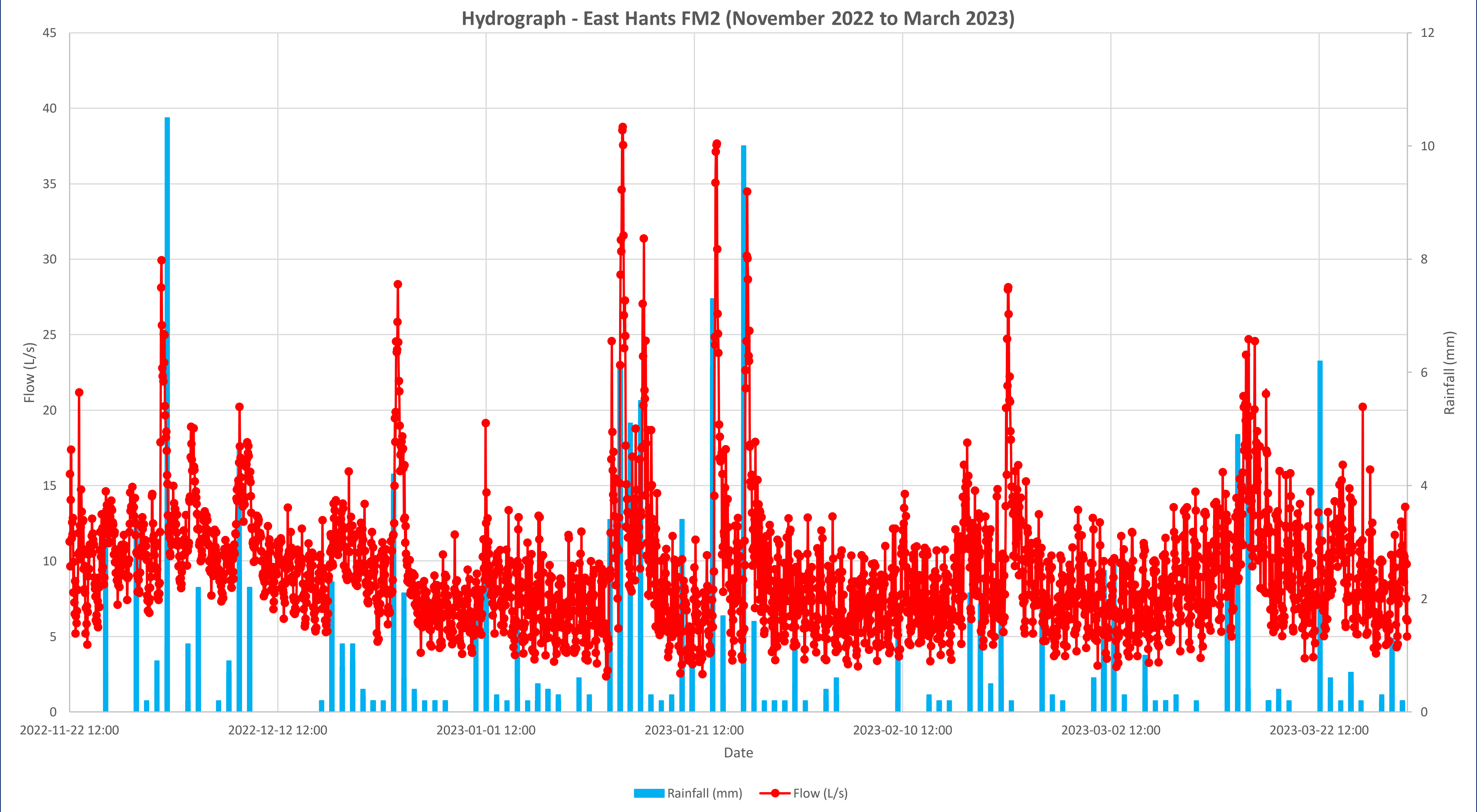
Hydrograph - Shubenacadie WWTP (January 2022 to April 2023)
Flow (L/s)
Rainfall (mm)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
70
60
50
40
30
20
10
0
01-Jan-22
20-Feb-22
11-Apr-22
31-May-22
20-Jul-22
08-Sep-22
28-Oct-22
17-Dec-22
05-Feb-23
27-Mar-23
Date
Rainfall (mm)
Flow (L/s)



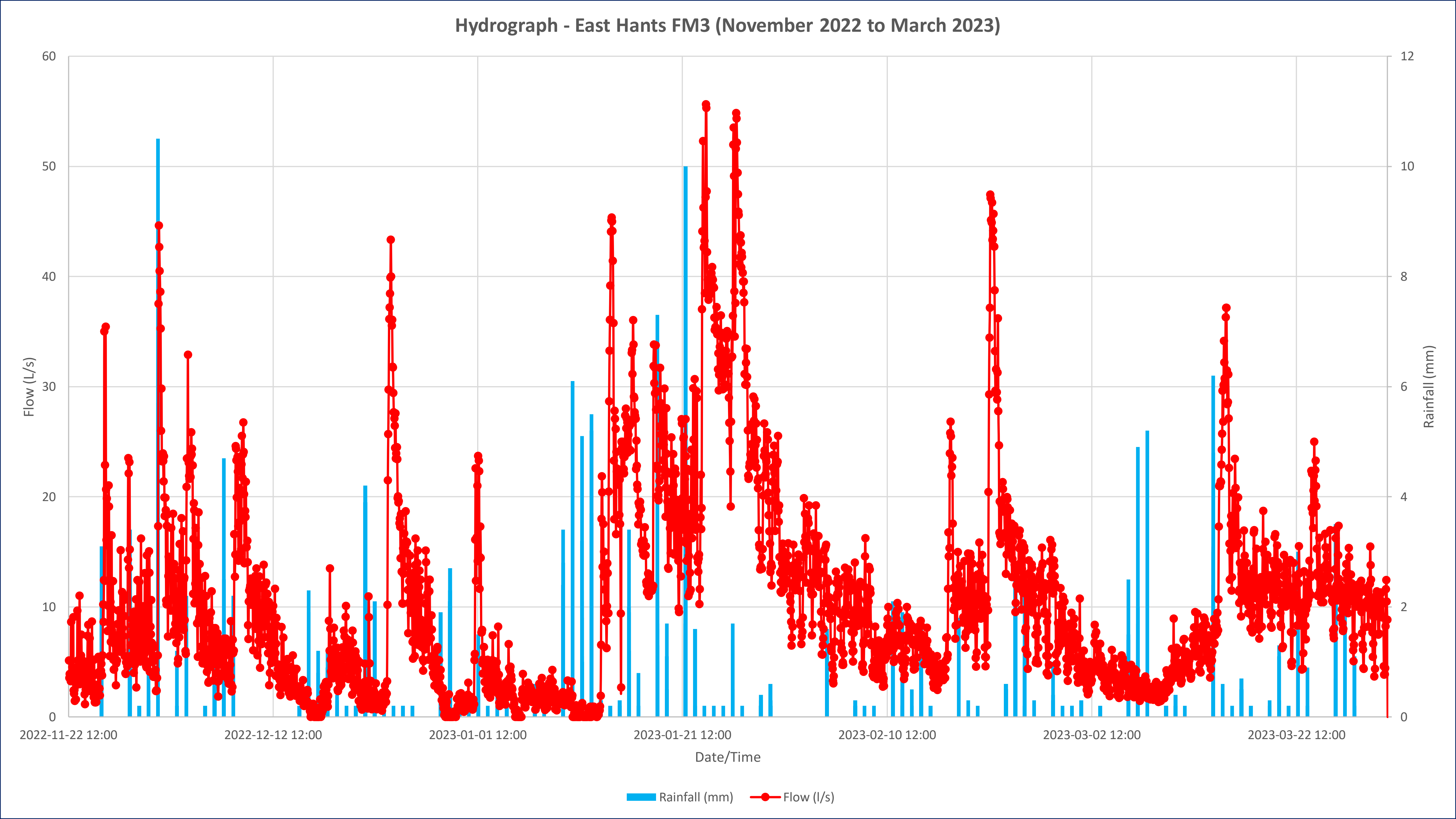
Hydrograph - Milford WWTP (January 2022 to April 2023)
Flow (L/s)
Rainfall (mm)
Date
0
5
10
15
20
25
0
10
20
30
40
50
60
70
01-Jan-22
20-Feb-22
11-Apr-22
31-May-22
20-Jul-22
08-Sep-22
28-Oct-22
17-Dec-22
05-Feb-23
27-Mar-23
Rainfall (mm)
Flow (L/s)



Hydrograph - East Hants 1 (November 2022 to March 2023)
Flow (L/s)
Rainfall (mm)
Date
10
8
6
4
2
0
-2
-4
-6
-8
12
10
8
6
4
2
0
2022-11-15 0:00
2022-12-05 0:00
2022-12-25 0:00
2023-01-14 0:00
2023-02-03 0:00
2023-02-23 0:00
2023-03-15 0:00
2023-04-04 0:00
2023-04-24 0:00
Rainfall (mm)
Flow (L/s)



Hydrograph - East Hants FM2 (November 2022 to March 2023)
Flow (L/s)
Rainfall (mm)
Date
2022-11-22 12:00
2022-12-12 12:00
2023-01-01 12:00
2023-01-21 12:00
2023-02-10 12:00
2023-03-02 12:00
2023-03-22 12:00
0
5
10
15
20
25
30
35
40
45
0
2
4
6
8
10
12
Rainfall (mm)
Flow (L/s)



Hydrograph - East Hants FM3 (November 2022 to March 2023)
Flow (L/s)
Rainfall (mm)
60
50
40
30
20
10
0
12
10
8
6
4
2
0
2022-11-22 12:00
2022-12-12 12:00
2023-01-01 12:00
2023-01-21 12:00
2023-02-10 12:00
2023-03-02 12:00
2023-03-22 12:00
Date/Time
Rainfall (mm)
Flow (l/s)

APPENDIX 3

PLANNED DEVELOPMENT – FLOW CALCULATIONS

Future Development Flows – 2031 Conditions (Interim)

Applicant/Owner	Location	Status	Assign Flows to (Label)	Development Area (Ha) Estimated	Total # of Units Planned	Total Residential Units	% Area Developed	Area Developed (Ha)	Equivalent Population (2.5 persons per unit)	ICI Units	ICI Area (Ha)	Equivalent ICI population (45 persons per hectare)	Total Population	Average DWF based on 340 L/Cap/d (L/s)	Peak Dry Weather (1490 L/cap/day)	Peak Dry Weather Flow (L/s)	I/I Flow (25,920 L/Ha/day)	I/I Flow (L/s)	Peak WWF (L/s)
WM Fares/R Ghosn	159 Highway 2, Enfield	Approved DA/SP/Subdivision	MH134	0.66	72	72	100%	0.66	180	0	0	0	180	0.71	268200	3.1	17056	0.20	3.3
Versailles Holdings Limited	161 Highway 277, Lantz	Active Application	MH116	0.51	16	16	100%	0.51	40	0	0	0	40	0.16	59600	0.7	13125	0.15	0.8
Tolson Developments	163 Highway 214, Elmsdale	Built-Out Developments	MH10	0.12	11	11	100%	0.12	28	0	0	0	28	0.11	40975	0.5	3012	0.03	0.5
Talal Waeb	166 Highway 214, Elmsdale	Current Speculation	MH13	0.14	12	12	100%	0.14	30	0	0	0	30	0.12	44700	0.5	3732	0.04	0.6
The Stevens Group of Companies	410 Highway 2, Enfield	Approved DA/SP/Subdivision	MH605	1.31	70	70	100%	1.31	175	0	0	0	175	0.69	260750	3.0	34053	0.39	3.4
3265722 NS Ltd/Faddoul	428 Highway 2, Enfield	Approved DA/SP/Subdivision	MH607	0.61	62	62	100%	0.61	155	0	0	0	155	0.61	230950	2.7	15896	0.18	2.9
Leno Ribahi	429 Highway 2, Enfield	Active Application	MH608	0.74	84	84	100%	0.74	210	0	0	0	210	0.83	312900	3.6	19127	0.22	3.8
ELT Property Holdings Limited	432 Highway 2, Enfield	Active Application	MH608	0.34	40	40	100%	0.34	100	0	0	0	100	0.39	149000	1.7	8697	0.10	1.8
Monk Mobile Corporation	450 Highway 2, Enfield	Active Application	MH285	0.45	126	126	100%	0.45	315	0	0	0	315	1.24	469350	5.4	11763	0.14	5.6
Abboud & Diala Zhouri	532 Highway 2, Elmsdale	Active Application	MH60	0.18	42	42	100%	0.18	105	0	0	0	105	0.41	156450	1.8	4731	0.05	1.9
Rakesh Malhotra	553 Highway 2, Elmsdale	Approved DA/SP/Subdivision	MH58	0.97	58	58	100%	0.97	145	0	0	0	145	0.57	216050	2.5	25209	0.29	2.8
Leno Ribahi	Bakery Lane	Approved DA/SP/Subdivision	MH530	0.93	72	72	100%	0.93	180	0	0	0	180	0.71	268200	3.1	24141	0.28	3.4
Dean Shea	Corner of Old Enfield Rd and Old Horne Settlement Rd	Built-Out Developments	MH465	0.20	10	10	100%	0.20	25	1	0.2	9	34	0.13	50660	0.6	5219	0.06	0.6
Dorey Thompson/Darren Rogers	Dorey Lane, Enfield	Current Speculation	MH604	4.44	74	74	100%	4.44	185	0	0	0	185	0.73	275650	3.2	115152	1.33	4.5
Elegant Acreage Land Company Limited	Hazelwood Dr, Lantz	Current Speculation	MH255	2.26	81	81	100%	2.3	203	0	0	0	203	0.80	301725	3.5	58551	0.68	4.2
4324108 NS Ltd. (Les Turner)	Highway 2, Elmsdale	Approved DA/SP/Subdivision	MH33	0.15	16	16	100%	0.15	40	0	0	0	40	0.16	59600	0.7	3923	0.05	0.7
4332419 Nova Scotia Limited/J Ghosn	Highway 214, Elmsdale	Approved DA/SP/Subdivision	MH631	1.26	94	94	100%	1.26	235	0	0	0	235	0.92	350150	4.1	32674	0.38	4.4
Tolson Developments	Highway 214, Elmsdale	Current Speculation	MH4	0.32	36	36	100%	0.32	90	0	0	0	90	0.35	134100	1.6	8379	0.10	1.6
RYC Property Limited	John Murray Drive, Enfield	Approved DA/SP/Subdivision	MH278	0.29	10	10	100%	0.29	25	0	0	0	25	0.10	37250	0.4	7439	0.09	0.5
Hoffman	Kali Lane, Elmsdale	Approved DA/SP/Subdivision	MH573	0.39	16	16	100%	0.39	40	0	0	0	40	0.16	59600	0.7	10077	0.12	0.8
The Shaw Group	Lantz	Approved DA/SP/Subdivision	20% to MHOIS07_RVA 20% to MHMKS06_RVA 60% to MHASS07_RVA	46.9	1479	1479	100%	46.9	3698	0	0	0	3698	14.55	5509275	63.8	1216375	14.08	77.8
Armco	Lantz	Approved DA/SP/Subdivision	33% to MHSA42_RVA 33% to END_CAP_RVA 34% to MHSA20_RVA	71.8	2205	1075	49%	35.0	2688	0	0	0	2688	10.58	4004375	46.3	907803	10.51	56.9
Seven Lakes Developments	Mariah Drive, Lantz	Active Application	40% to MH588 30% to MHS11_RVA 30% to MHS7_RVA	26.6	104	104	100%	26.6	260	0	0	0	260	1.02	387400	4.5	689372	7.98	12.5
Seven Lakes Developments	Mariah Drive, Lantz	Current Speculation	MH570	10.8	148	148	100%	10.85	370	0	0	0	370	1.46	551300	6.4	281165	3.25	9.6
Abruzzi Properties	Melody Lane, Lantz	Built-Out Developments	MH98	0.64	40	40	100%	0.64	100	0	0	0	100	0.39	149000	1.7	16671	0.19	1.9
FH Developments	Milford	Active Application	MH357	42.1	1495	450	30%	12.7	1125	0	0	0	1125	4.43	1676250	19.4	328593	3.80	23.2
Abdul Habboush	Pinehill Drive, Elmsdale	Active Application	MH469	0.08	12	12	100%	0.08	30	0	0	0	30	0.12	44700	0.5	2177	0.03	0.5
FH Developments	Pinehill/Elmwood, Elmsdale	Approved DA/SP/Subdivision	50% TO MH44 50% TO MH471	19.2	660	594	90%	17.3	1485	0	0	0	1485	5.84	2212650	25.6	448563	5.19	30.8
Seven Lakes Developments	Sherwood Park, Enfield	Current Speculation	MH332	0.51	64	64	100%	0.51	160	0	0	0	160	0.63	238400	2.8	13236	0.15	2.9
FH Developments	Tyler Street Extension, Elmsdale	Approved DA/SP/Subdivision	MH459	3.96	88	88	100%	3.96	220	0	0	0	220	0.87	327800	3.8	102660	1.19	5.0
													Totals	49.8		218.1		51.26	269.4

Future Development Flows – 2045 Conditions (Full Buildout)

Applicant/Owner	Location	Status	Assign Flows to (Label)	Development Area (Ha) Estimated	Total # of Units Planned	Total Residential Units	Equivalent Population (2.5 persons per unit)	ICI Units	ICI Area (Ha)	Equivalent ICI population (45 persons per hectare)	Total Population	Average DWF based on 340 L/Cap/d (L/s)	Peak Flow (1490 L/per/day)	Peak Flow (L/s)	I/I Flow (25,920 L/Ha/day)	I/I Flow (L/s)	Peak WWF (L/s)
WM Fares/R Ghosn	159 Highway 2, Enfield	Approved DA/SP/Subdivision	MH134	0.66	72	72	180	0	0	0	180	0.71	268200	3.10	17056	0.20	3.3
Versailles Holdings Limited	161 Highway 277, Lantz	Active Application	MH116	0.51	16	16	40	0	0	0	40	0.16	59600	0.69	13125	0.15	0.8
Tolson Developments	163 Highway 214, Elmsdale	Built-Out Developments	MH10	0.12	11	11	28	0	0	0	28	0.11	40975	0.47	3012	0.03	0.5
Talal Waeb	166 Highway 214, Elmsdale	Current Speculation	MH13	0.14	12	12	30	0	0	0	30	0.12	44700	0.52	3732	0.04	0.6
The Stevens Group of Companies	410 Highway 2, Enfield	Approved DA/SP/Subdivision	MH605	1.31	70	70	175	0	0	0	175	0.69	260750	3.02	34053	0.39	3.4
3265722 NS Ltd/Faddoul	428 Highway 2, Enfield	Approved DA/SP/Subdivision	MH607	0.61	62	62	155	0	0	0	155	0.61	230950	2.67	15896	0.18	2.9
Leno Ribahi	429 Highway 2, Enfield	Active Application	MH608	0.74	84	84	210	0	0	0	210	0.83	312900	3.62	19127	0.22	3.8
ELT Property Holdings Limited	432 Highway 2, Enfield	Active Application	MH608	0.34	40	40	100	0	0	0	100	0.39	149000	1.72	8697	0.10	1.8
Monk Mobile Corporation	450 Highway 2, Enfield	Active Application	MH285	0.45	126	126	315	0	0	0	315	1.24	469350	5.43	11763	0.14	5.6
Abboud & Diala Zhouri	532 Highway 2, Elmsdale	Active Application	MH60	0.18	42	42	105	0	0	0	105	0.41	156450	1.81	4731	0.05	1.9
Rakesh Malhotra	553 Highway 2, Elmsdale	Approved DA/SP/Subdivision	MH58	0.97	58	58	145	0	0	0	145	0.57	216050	2.50	25209	0.29	2.8
Leno Ribahi	Bakery Lane	Approved DA/SP/Subdivision	MH530	0.93	72	72	180	0	0	0	180	0.71	268200	3.10	24141	0.28	3.4
Dean Shea	Corner of Old Enfield Rd and Old Horne Settlement Rd	Built-Out Developments	MH465	0.20	10	10	25	1	0.2	9	34	0.13	50660	0.59	5219	0.06	0.6
Dorey Thompson/Darren Rogers	Dorey Lane, Enfield	Current Speculation	MH604	4.44	74	74	185	0	0	0	185	`	275650	3.19	115152	1.33	4.5
Elegant Acreage Land Company Limited	Hazelwood Dr, Lantz	Current Speculation	MH255	2.26	81	81	203	0	0	0	203	0.80	301725	3.49	58551	0.68	4.2
4324108 NS Ltd. (Les Turner)	Highway 2, Elmsdale	Approved DA/SP/Subdivision	MH33	0.15	16	16	40	0	0	0	40	0.16	59600	0.69	3923	0.05	0.7
4332419 Nova Scotia Limited/J Ghosn	Highway 214, Elmsdale	Approved DA/SP/Subdivision	MH631	1.26	94	94	235	0	0	0	235	0.92	350150	4.05	32674	0.38	4.4
Tolson Developments	Highway 214, Elmsdale	Current Speculation	MH4	0.32	36	36	90	0	0	0	90	0.35	134100	1.55	8379	0.10	1.6
RYC Property Limited	John Murray Drive, Enfield	Approved DA/SP/Subdivision	MH278	0.29	10	10	25	0	0	0	25	0.10	37250	0.43	7439	0.09	0.5
Hoffman	Kali Lane, Elmsdale	Approved DA/SP/Subdivision	MH573	0.39	16	16	40	0	0	0	40	0.16	59600	0.69	10077	0.12	0.8
The Shaw Group	Lantz	Approved DA/SP/Subdivision	20% to MHOIS07_RVA 20% to MHMKS06_RVA 60% to MHASS07_RVA	46.9	1479	1479	3698	0	0	0	3698	14.55	5509275	63.76	1216375	14.08	77.8
Armco	Lantz	Approved DA/SP/Subdivision	33% to MHSA42_RVA 33% to END_CAP_RVA 34% to MHSA20_RVA	71.8	2205	2205	5513	0	0	0	5513	21.69	8213625	95.07	1862051	21.55	116.6
Seven Lakes Developments	Mariah Drive, Lantz	Active Application	40% to MH588 30% to MHS11_RVA 30% to MHS7_RVA	26.6	104	104	260	0	0	0	260	1.02	387400	4.48	689372	7.98	12.5
Seven Lakes Developments	Mariah Drive, Lantz	Current Speculation	MH570	10.8	148	148	370	0	0	0	370	1.46	551300	6.38	281165	3.25	9.6
Abruzzi Properties	Melody Lane, Lantz	Built-Out Developments	MH98	0.64	40	40	100	0	0	0	100	0.39	149000	1.72	16671	0.19	1.9
FH Developments	Milford	Active Application	MH357	42.1	1495	1495	3738	0	0	0	3738	14.71	5568875	64.45	1091659	12.63	77.1
Abdul Habboush	Pinehill Drive, Elmsdale	Active Application	MH469	0.08	12	12	30	0	0	0	30	0.12	44700	0.52	2177	0.03	0.5
FH Developments	Pinehill/Elmwood, Elmsdale	Approved DA/SP/Subdivision	50% TO MH44 50% TO MH471	19.2	660	660	1650	0	0	0	1650	6.49	2458500	28.45	498403	5.77	34.2
Seven Lakes Developments	Sherwood Park, Enfield	Current Speculation	MH332	0.51	64	64	160	0	0	0	160	0.63	238400	2.76	13236	0.15	2.9
FH Developments	Tyler Street Extension, Elmsdale	Approved DA/SP/Subdivision	MH459	3.96	88	88	220	0	0	0	220	0.87	327800	3.79	102660	1.19	5.0
											Totals	71.1		314.75		71.71	386.5