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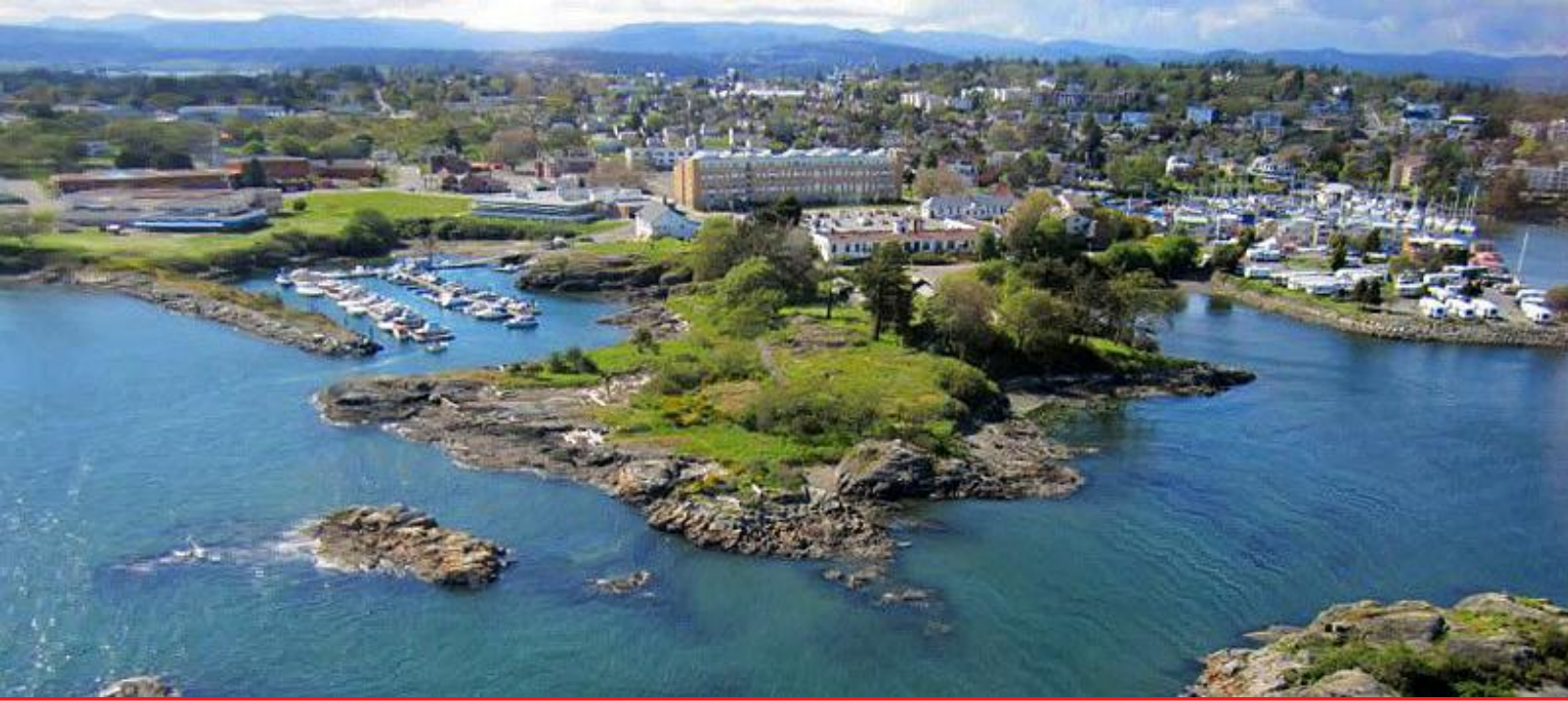
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GEOADVICE FINAL REPORT



Sanitary Sewer Asset Management Plan Township Of Esquimalt, BC

Prepared For:

Township of Esquimalt
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Executive Summary

The Township of Esquimalt, BC (Township) retained GeoAdvice Engineering Inc. (GeoAdvice) to develop a Sanitary Sewer Asset Management Plan (SSAMP) that comprehensively evaluates the current performance of the sanitary sewer infrastructure and establishes a strategic framework for future improvements.

The Township of Esquimalt, located in the Greater Victoria area of British Columbia, is a diverse community of approximately 17,500 residents with a significant portion of the community relying on the sanitary sewer system for wastewater management, with approximately 3,000 sewer service connections. The sanitary sewer system spans ten (10) catchment areas across 530 ha, with regional trunk sewers operated by the Capital Regional District (CRD). Since 2017, the Township has completed over 80% of CCTV inspections of sewer mains, though condition data on manholes, pump stations, forcemains, and service laterals remains limited. Despite ongoing efforts, the Township lacked a comprehensive sewer management plan, prompting the development of this SSAMP to guide future upgrades, support growth, and improve system performance.

Project Objectives and Scope

In response to evolving community needs and increasing development pressures, the Sanitary Sewer Asset Management Plan (SSAMP) was developed to provide the Township with a clear, data-driven roadmap for system upgrades and long-term planning. The objectives of the SSAMP include:

- **Updating the hydraulic model** using InfoSWMM (Autodesk software), incorporating the latest Geographic Information System (GIS) data, historical hydraulic models, as-built drawings, and recent field measurements. The model was refined through a comprehensive review of data gaps and connectivity issues to ensure an accurate representation of current infrastructure.
- **Quantifying base sanitary flows (BSF) and inflow & infiltration (I&I)** contributions, including ground water infiltration (GWI) and rainfall-dependent inflow & infiltration (RDI&I), to determine current loading conditions across the Township's sanitary network.
- **Detailing the model calibration and validation process**, using flow data collected during both dry weather flow (DWF) and peak wet weather flow (PWWF) events. Calibration adjustments were made to align the model with field data.
- **Forecasting future sanitary loading scenarios** by assessing multiple planning horizons: interim, Official Community Plan (OCP), and full buildout. These projections incorporate updated population growth estimates and current development applications to assess the long-term capacity of the system.



- **Assessing the condition and operational performance** of the existing sanitary sewer infrastructure, leveraging recent inspection data, flow monitoring, and condition assessments from past studies.
- **Prioritizing capital improvements through a risk-based framework** that integrates hydraulic capacity constraints, asset condition scores, and the potential consequences of failure. This approach informs a prioritized list of capital projects aimed at ensuring the system remains resilient, efficient, and capable of supporting both current and future demands.

Key Findings

The Township's sanitary sewer system was evaluated based hydraulic level of service criteria, which define acceptable system performance during peak wet weather flow (PWWF) conditions. Using the updated InfoSWMM model, the assessment considered four (4) planning scenarios: existing, interim, Official Community Plan (OCP), and full buildout, each reflecting increasing levels of population growth and development. The analysis identified areas where pipes and pump stations exceed capacity during peak wet weather events, particularly in catchments with high inflow and infiltration. The findings also assessed the ability of the CRD outfall system to handle Esquimalt projected flows and supported the identification of priority areas for capital improvements.

A risk-based capital improvements plan was developed to address capacity constraints and asset condition deficiencies identified through the hydraulic analysis and field assessments. The plan integrates system performance, asset risk scores, and I&I impacts to prioritize upgrades over a 10 and 20-year planning horizon. Key recommendations include targeted upgrades to undersized gravity mains and pump stations, as well as measures to mitigate high inflow and infiltration rates. These improvements aim to enhance system reliability, support future growth, and align with the Township's I&I reduction goals and regulatory commitments. The capital plan summary is provided in **Table 1**.



Table 1: Capital Plan Summary

	Linear Assets	Pump Stations	Renewal Value
Short Term (1-10 Years)	13.2 km (204 assets) • 2.7 km (39 assets) upgrade - capacity triggered • 10.5 km (165 assets) renewal - condition triggered	• Grafton Pump Station and Forcemains • Uganda Pump Station • Forshaw Pump Station • Canteen Pump Station • Constance (complete condition-based upgrades when funds become available)	\$56,951,000
Long Term (11-20 Years)	13.0 km of renewal • 40 m (2 assets) upgrade - capacity triggered • 13.0 km (190 assets) renewal - condition triggered	• Kinver Pump Station • Lampson Pump Station • Luscombe Pump Station	\$53,328,000

Conclusions and Recommendations

The results indicate that several areas within the Township of Esquimalt sanitary sewer system require targeted improvements to meet future demands and mitigate risks associated with I&I. The report recommends a series of phased capital investments to address immediate capacity constraints, incorporate proactive maintenance strategies, and adapt to projected population growth and development pressures. These measures are anticipated to enhance system performance, support sustainable urban growth, and contribute to long-term environmental and operational objectives.

The SSAMP provides a robust framework for prioritizing upgrades, optimizing asset management, and guiding infrastructure investments over the coming decades. By leveraging state-of-the-art hydraulic modeling, rigorous calibration processes, and comprehensive field data integration, GeoAdvice Engineering Inc. has equipped the Township with actionable insights to ensure that its sanitary sewer system remains safe, efficient, and adaptable for future needs.



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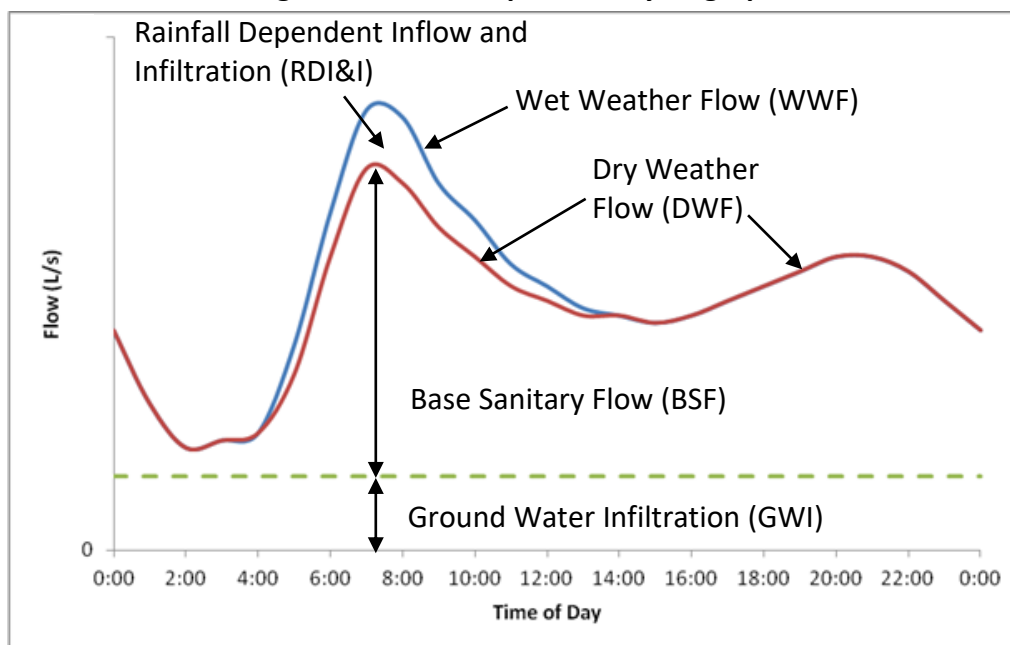
Abbreviations and Definitions

Daily flow conveyed in a sanitary sewer system can be generally divided into five (5) components:

- 1 Ground Water Infiltration (GWI)
- 2 Base Sanitary Flow (BSF)
- 3 Dry Weather Flow (DWF)
- 4 Rainfall Dependent Inflow and Infiltration (RDI&I)
- 5 Wet Weather Flow (WWF)

Their relationship is shown in **Figure 1**.

Figure 1: Flow Components Hydrograph



Ground Water Infiltration (GWI) – Ground water infiltration results from the movement of ground water in the saturated zone into the sewer system through defects in the components of the sewer system located below the water table.

Base Sanitary Flow (BSF) – All wastewater from residential, commercial, institutional, and industrial sources that the sanitary sewer system is intended to convey.

Dry Weather Flow (DWF) – The portion of the total flow that is composed of BSF and GWI. $DWF = GWI + BSF$. Typically, dry weather days are selected after a period of five (5) days free of rainfall.



Average Dry Weather Flow (ADWF) – The value of the diurnally varying Dry Weather Flow, averaged over a 24-hour period.

Rainfall Dependent Inflow & Infiltration (RDI&I) – Rainfall dependent inflow & infiltration represents surface inflow and additional infiltration through pipe defects directly related to rainfall events.

Wet Weather Flow (WWF) – All flow contributions carried by the sanitary sewer system during wet weather. $WWF = GWI + BSF + RDI\&I$.

Peak Wet Weather Flow (PWWF) – All flow contributions carried by the sanitary sewer system during peak wet weather.



1.0 Introduction

The Township of Esquimalt, BC (Township) retained GeoAdvice Engineering Inc. (GeoAdvice) to develop a Sanitary Sewer Asset Management Plan (SSAMP) that will help the Township prioritize system improvements to meet current and future needs.

A critical component of the SSAMP was to update the model of the Township's sanitary sewer system. GeoAdvice updated the model of the current sanitary sewer collection system using the InfoSWMM software program (Innovyze). InfoSWMM is a fully dynamic sanitary sewer management modeling software package from Innovyze Inc. The primary data used to update the hydraulic model included GIS data, as-built drawings and previously developed model for the Township. The model was calibrated to 2021 flow data provided by the Township and the the Capital Regional District (CRD). The main components of the Township model are summarized in **Table 1.1**.

Table 1.1: Model Statistics of Current System

Component	Total
Manholes	892
Pump Stations	11 (Township) 2 (DND*) 1 (CRD**)
Gravity Mains	52.1 km
Forcemains	12.2 km
Tributary Area	528 ha

*Department of National Defense

**Capital Regional District

Urban Systems Ltd. (USL) completed a detailed condition assessment of the Township and DND pump stations. The results of the conditions assessment were integrated into the capital improvement plan.

GeoAdvice assessed system capacity based on a multi-parameter hydraulic level of service criteria to determine capacity-based gravity main and pump station deficiencies. USL integrated these capacity results, along with asset condition scores and consequences of asset failure to develop a prioritized risk score to inform critical projects for the 20-year capital plan.



In the preparation of this report, GeoAdvice would like to acknowledge the support of the following Township Staff:

- Charles Davie, ASct, MMCD CCA
- Joel Clary, P. Eng., PMP
- Braylon Lumb
- Bill Brown, MCIP

1.1 Background

The Township of Esquimalt is located in the Greater Victoria area of British Columbia, bordered by the City of Victoria to the southeast and the Strait of Juan de Fuca to the south. As an integral part of the Capital Regional District (CRD), Esquimalt is a diverse community that includes residential, commercial, and industrial areas. The Township is home to a population of approximately 17,500 residents, with a significant portion of the community relying on the sanitary sewer system for wastewater management, with approximately 3,000 sewer service connections.

The Township's sanitary sewer system spans ten (10) distinct catchment areas, covering roughly 530 ha. The CRD is responsible for operating the major trunk sewers that collect sanitary sewer discharge from multiple locations within the Township.

Since 2017, the Township has been actively inspecting sewer mains through CCTV, with over 80% of the data collected and the remainder expected to be completed by 2023. Unfortunately, data on the conditions of manholes, pump stations, forcemains, and service laterals remains unavailable.

Inflow and Infiltration (I&I) are pressing concerns for the Township, aligning with the commitment to reduce wet weather flows to 4 x ADWF by 2030 in the Core Area Liquid Waste Management Plan. Kerr Wood Leidal Associates Ltd. (KWL) formulated an I&I Management Plan in 2021 to address this challenge.

Despite these efforts, the Township currently lacks an overarching sewer management plan. This necessitates leveraging existing studies and inspections to develop a strategic roadmap for maintaining service levels efficiently while accommodating development and achieving I&I reduction goals. This proactive approach ensures the Township's sewer management aligns dynamically with evolving needs and objectives.



2.0 Sanitary Sewer Hydraulic Model Update

The hydraulic network model update was divided into multiple tasks as follows:

- Task 1: Data collection and review
- Task 2: Network update
- Task 3: Data gaps and connectivity analysis
- Task 4: Primary System Components
- Task 5: Existing base sanitary flow (BSF) calculation and allocation
- Task 6: Future base sanitary flow calculation
- Task 7: Inflow & infiltration calculation and allocation

The coordinate system used in the model is UTM NAD 83 Zone 10.

2.1 Data Collection and Review

Prior to updating the model, information on the Township sanitary sewer system was compiled, collected and reviewed. This included reviewing the following pertinent information:

- Township GIS Data (received on August 14, 2023)
- Inflow and Infiltration KWL Masterplan (received on August 14, 2023)
- Township As-built Data (received on August 28, 2023)
- CRD and Township Flow Monitoring and Rainfall Data (received on August 28, 2023)
- Garthland Pump Station Flow Monitoring (received on October 4, 2023)
- Population Data (received on October 12, 2023)

Additional data was collected, independently, by GeoAdvice:

- 2018 InfoSWMM hydraulic model
- 2018 GeoAdvice System Modeling and Capacity Analysis Report
- Historic IDF curves for Victoria Gonzales CS weather station (IDF-CC)
- Climate change adjusted IDF curves for Victoria Gonzales CS weather station (IDF-CC)
- Core Area Inflow and Infiltration Program 2019 Report

2.2 Network Update

The Township GIS data was compared against the 2018 sewer model's database to identify any missing pipe upgrades or new gravity mains and forcemains that should be added to the model. Further updates were made to the sewer model as additional discrepancies were discovered.

The entirety of the InfoSWMM model was also reviewed for pipe profile continuity in the gravity main network. This is a critical step when developing a model using a SWMM-based engine, as profile continuity errors can increase run-time and create unstable models.



In addition to adding new pipes and updating model parameters, a customized field was added into the model to track the 2023 model updates. In summary:

- Ten (10) pipes were added.
- Ten (10) pipes were split.
- Nine (9) pipes had their attributes changed.

2.3 Data Gaps and Connectivity Analysis

After the model was updated, the next task involved reviewing the database information, identifying data gaps (e.g. missing invert) and checking system connectivity (e.g. orphan node). All data gaps and connectivity issues were addressed and resolved as part of this task. As much as possible, a one-to-one relationship between the model and GIS data was maintained to facilitate future model updates.

2.4 Primary System Components

The Township operates and maintains eleven (11) sanitary pump stations throughout the sanitary network. Additionally, there are two (2) DND pump stations and one (1) CRD pump station modeled. Pump and wet well hydraulic modeling data are summarized in **Appendix A**.

2.5 Existing Base Sanitary Flow (BSF) Calculation and Allocation

The base sanitary flows (BSF) established in the 2018 study served as the starting point for determining the existing BSF. Additionally, as requested by the Township, specific developments completed since the previous study were included in the model, as summarized in **Table 2.1** and shown in **Figure 2.2**.



Table 2.1: Completed Developments Population Summary

Dwelling Type	Location	Number of Units or ICI Area*	Population**
Mixed-Use	Esquimalt Town Square	102 units Office: 0.28 ha Restaurant: 0.05 ha	153
Apartment	687 Admirals Rd	48	72
	838-842 Admirals Rd	28	42
	638 Constance Ave	71	107
	835 Dunsmuir Rd	32	48
	Triangle Lands	73	110
	Esquimalt Legion	181	272
Townhouse	937 Colville Rd	6	12
	955 Colville Rd	10	20
	632 (formerly 636) Drake Ave	7	14
	615 Fernhill Rd	10	20
	1052 Tillicum Rd	5	10
	1048-1050 Tillicum Rd	5	10
Total			890

*Data provided by the Township.

**Calculated based on 1.5 cap/unit for *Mixed-Use* and *Apartment* and 2 cap/unit for *Townhouse*, as confirmed by the Township.

The development residential and ICI loads were estimated using the rates summarized in **Table 2.2**, which are based on the Master Municipal Construction Documents (MMCD) design guidelines.

Table 2.2: Completed Developments and Future Load Rates

Loading Type	Loading Rate
Residential BSF Rate (Metered Systems)	240 L/cap/day
Industrial, Commercial and Institutional (ICI) BSF Rate	25,000 L/ha/day

The BSF were subsequently adjusted during the calibration process. **Table 2.3** summarizes the existing BSF loading.



Table 2.3: Calibrated Existing BSF Load Summary

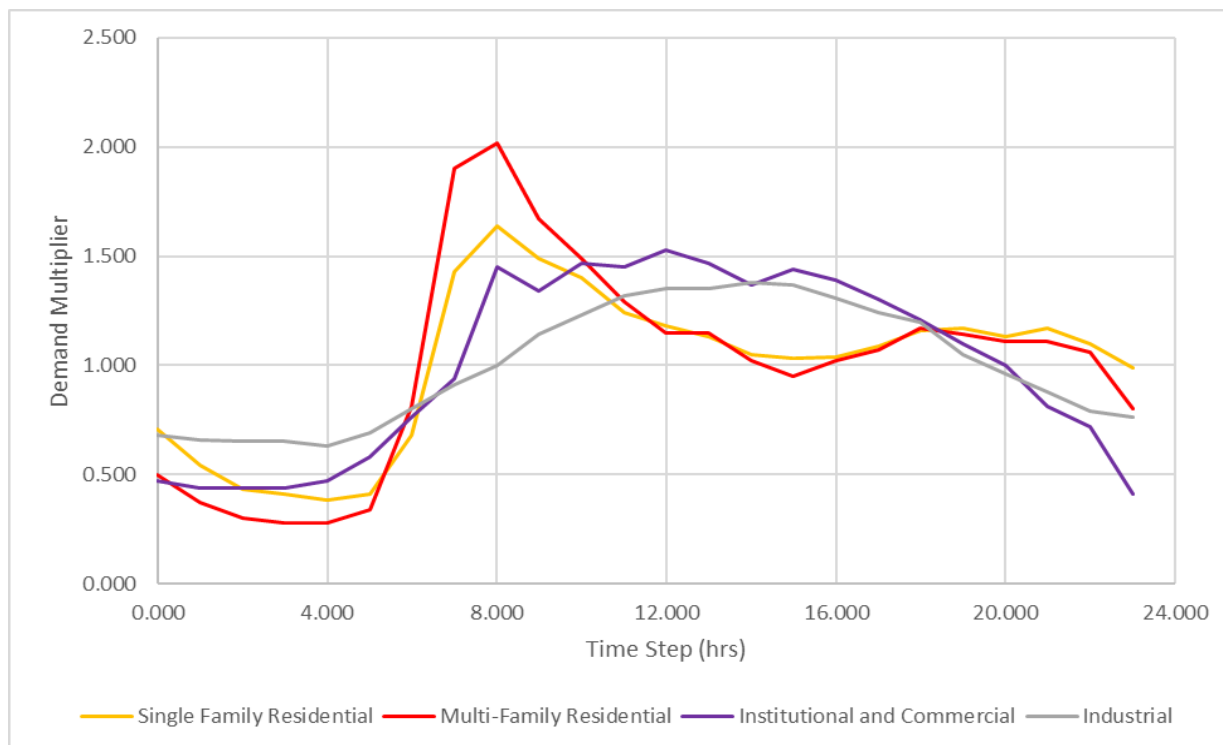
Land Use	Base Sanitary Flow (L/s)
Single Family	14.2
Multi-Family	15.3
Institutional	6.2
Commercial	5.8
Industrial	0.8
Total	42.3

The allocation of sewer loads in the model is consistent with the methodology established in the 2018 study. The methodology involves using the “Closest Pipe – Upstream Manhole” method; and subsequently the spatial allocation was verified against the service lines provided in the Township’s GIS and updated to ensure that loads were being directed along the correct flow path.

Diurnal patterns were used to characterize the BSF loads over time and include multipliers or peaking factors (e.g. 24 multipliers) that are applied to the BSF load to estimate the actual load for a given time period (e.g. 1 hour). A 24-hour extended period simulation (EPS) was set up for evaluating the hydraulic capacity of the Township sewer system over time. The modeled diurnal patterns can be found in **Figure 2.1**. The patterns provided are based on those used in the City of Victoria sewer model.



Figure 2.1: Load Patterns Per Land Use Type



2.6 Future Base Sanitary Flow Calculation

Four (4) time horizons were considered for the capacity analysis: existing, interim, OCP and buildout. The existing population was provided by the Township. The interim population considers current development applications added on top of the existing population. The OCP scenario accounts for growth on any lots with a land use change between existing and OCP. The buildout scenario accounts for all lots being built out to their maximum potential under the OCP land use.

The existing and future population data are summarized in **Table 2.4**.

Table 2.4: Existing and Future Residential Population Projections

Projection	Population	Description
Existing	17,533*	Existing population
Interim	23,482	Existing population + Current development applications
OCP	38,080	Existing population + Future growth (Current development applications and OCP growth)
Buildout	51,080	Full buildout potential of OCP land-use

*Data provided by the Township



The Township's current development applications are summarized in **Section 2.6.1**.

2.6.1 Current development Applications

The development applications that will be included in the interim and OCP scenarios, as requested by the Township, are summarized in **Table 2.5** and shown in **Figure 2.2**.

Table 2.5: Development Application Population Summary

Dwelling Type	Location	Number of Units or ICI Area*	Population**
Mixed-Use	1006-1010 Craigflower Rd	134 units Commercial: 0.11 ha	201
	820 (formerly 826) Esquimalt Rd	135 units Commercial: 0.02 ha	203
	500 Park Place	40 units Commercial: 0.05 ha Firehall: 0.14 ha	60
	852 (formerly 856/858) Esquimalt Rd	198 Commercial: 0.08 ha	297
	602-608-612 Nelson St and 1319-1331-1347 Sussex St	314 Commercial: 0.04 ha	471
	614 Grenville Ave	132 Commercial: 0.04 ha	198
Apartment	664 Admirals Rd	83	125
	1221 Carlisle Ave	198	297
	1223 Carlisle Ave	22	33
	900 Carlton Terr/900 Esquimalt Rd	272	408
	612 Constance Ave	129	194
	817 Esquimalt Rd	104	156
	861-865 Esquimalt Rd	43	65
	899 Esquimalt Rd - Pacific House	66	99
	874 Fleming St	60	90
	880 Fleming St	45	68
	460-464 Head St - West Bay Quay	12	18
	884 Lampson St	119	179
	1338-1350 Saunders St	72	108
	734 Sea Terr	17	26
	815-825 Selkirk Ave	46	69
	1075 Tillicum Rd	99	149
	530-534-538 West Bay Terr	105	158



Dwelling Type	Location	Number of Units or ICI Area*	Population**
Apartment	1100-1108 Esquimalt Rd and 610-612-618 Lampson St	89	134
	English Inn	227	341
	812 Craigflower Rd	10	15
Townhouse	904 Admirals Rd	4	8
	914 McNaughton Ave	4	8
	485 S Joffre St	6	12
	878 Colville Rd	6	12
	820 Dunsmuir Rd	7	14
	876 Dunsmuir Rd***	4	8
	861 Kindersley Rd	5	10
	756-758 Lampson St	11	22
	851 Lampson St***	4	8
	906 Old Esquimalt Rd	5	10
	958 Wollaston St	4	8
Federal Land (DND Housing)	CFB Esquimalt – Work Point	532	1,064
	CFB Esquimalt – Colville Road	304	608
Total			5,949

*Data provided by the Township.

**Calculated based on 1.5 cap/unit for *Mixed-Use* and *Apartment* and 2 cap/unit for *Townhouse* and *Federal Land (DND Housing)*, as confirmed by the Township.

***The Township indicated by email on May 17, 2024, that these developments were now completed.

2.6.2 OCP Population Growth

To determine the spatial allocation of future OCP population growth, the existing land use designations were compared against the proposed land use designations from the Township OCP. Growth was allocated to parcels where the land use is proposed to change in the future.

The densities per land use used to estimate the population growth at each parcel with a proposed land use change are summarized in **Table 2.6**.



Table 2.6: Population Density Per Land Use

Land Use Designation	Density
Low Density Residential	95 cap/ha
Townhouse Residential	169 cap/ha
Medium Density Residential	477 cap/ha
High Density Residential	743 cap/ha
Neighbourhood Commercial Mixed-Use	411 cap/ha
Commercial/Commercial Mixed-Use	1,035 cap/ha

The population densities summarized in **Table 2.6** were derived from the data on completed development and development application populations along with their corresponding areas.

Table 2.7 summarizes the estimated population growth per land use designation. Note that the OCP population growth presented in **Table 2.7** is an addition to the development specific growth.

Table 2.7: Population Growth Per Land Use

Land Use Designation	Development Specific Population Growth	OCP Population Growth
Low Density Residential	38	3
Townhouse Residential	181	4130
Medium Density Residential	1269	3537
High Density Residential	897	3369
Neighbourhood Commercial Mixed-Use*	588	3046
Commercial/Commercial Mixed-Use**	963	513
English Inn Mixed-Use	341	0
Federal Land (DND Housing)	1672	0
Total	5,949	14,598
	20,547	

*Growth Commercial area for Neighbourhood Commercial Mixed-Use land use = 7.40 ha

**Growth Commercial area for Commercial/Commercial Mixed-Use land use = 0.50 ha

Note: No business or institutional growth outside of the mixed-use designations.

The spatial allocation for future population growth is shown in **Figure 2.2**, including development specific and OCP population growth.

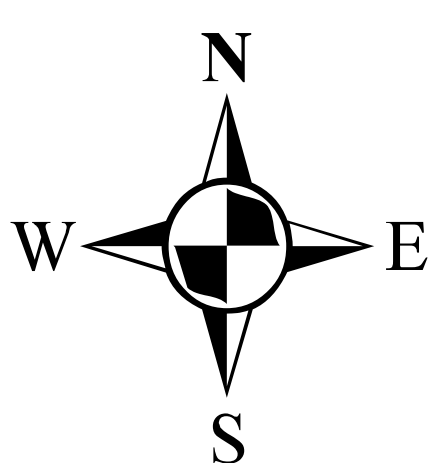
The future residential loads and ICI rates were estimated using the observed residential rate of 145 L/cap/day, calculated by dividing the existing residential BSF (29.5 L/s) by the total existing population (17,533 capita). The ICI loads were estimated using the rate presented in **Table 2.2**.

Legend

- Ocean
- Parcel
- Proposed Future OCP Land Use Change**
- New Low Density Residential
- New Townhouse Residential
- New Medium Density Residential
- New High Density Residential
- New Parks and Open Space
- New Neighbourhood Commercial Mixed-Use
- New Commercial/Commercial Mixed-Use
- New Business
- New Institutional
- Development Application
- Completed Development

Township of Esquimalt
Completed Developments,
Development Applications and
Future OCP Growth Lots

Figure 2.2





2.6.3 Ultimate Buildout Growth

To determine the spatial allocation of future buildout population growth, all lots were considered to be built out to their maximum potential under the OCP land use.

The densities per land use and the estimated total buildout population are summarized in **Table 2.8**.

Table 2.8: Total Buildout Population Per Land Use

Land Use Designation	Density*	Total Buildout Population
Low Density Residential	36 cap/ha**	6,125
Townhouse Residential	122 cap/ha	5,326
Medium Density Residential	420 cap/ha	14,858
High Density Residential	986 cap/ha	8,180
Neighbourhood Commercial Mixed-Use	570 cap/ha	6,401
Commercial/Commercial Mixed-Use	986 cap/ha	8,645
English Inn Mixed-Use	194 cap/ha	341
Esquimalt Town Square	188 cap/ha	143
Federal Land (DND Housing)	N/A	1,000***
RV Park Commercial	N/A	60***
Total		51,080

*Data provided by the Township.

**Density rate increased by 20% to account for Bill 44, as confirmed by the Township.

***Population assumption provided by the Township.

Table 2.9 summarizes the existing and future sewer loads in the Township model.

Table 2.9: Existing and Future BSF Sewer Load Summary

Existing	Interim	OCP	Buildout
42.3 L/s	52.4 L/s	79.2 L/s	158.5 L/s

2.7 Inflow & Infiltration Calculation and Allocation

Inflow and Infiltration (I&I) represent additional loading on the sanitary sewer system during dry and wet weather. They are categorized into the following:

- Ground Water Infiltration (GWI)
- Rainfall Dependent Inflow and Infiltration (RDI&I)

2.7.1 Ground Water Infiltration

The Stevens – Schultzbach method served as the starting point for determining the ground water infiltration loads for each flow monitoring catchment. The Stevens – Schultzbach method



uses a curve fitting technique to estimate ground water infiltration for a wide range of catchment sizes. This method is based on average dry weather flow (ADWF) and minimum nightly flow (MNF) experienced in typical residential flow patterns. The Stevens – Schultzbach equation is included below:

$$GWI = \frac{0.4 MNF}{1 - 0.6 \left(\frac{MNF}{ADWF} \right)^{ADWF^{0.7}}}$$

The GWI was subsequently adjusted until the model results closely match the field dry and wet weather flow data.

Table 2.10 summarizes the GWI allocated to each flow monitoring catchment. Total GWI loads and GWI rates were calculated at the catchment level. GWI loads were then spatially distributed to each serviced parcel based on the respective parcel area and catchment GWI rate.

Table 2.10: GWI Allocation per Flow Monitoring Catchment

Flow Monitoring Catchment	MNF (L/s)	ADWF (L/s)	GWI* (L/s)	Catchment Area (ha)	GWI (L/ha/day)
Anson	0.01	0.1	1.1**	10	9,500
Devonshire	6.3	14.7	1.3	141	900
Esquimalt Panhandle	0.2	1.2	0.2	16.8	1,000
Head	5.3	14.4	1.7	124	1,200
Kinver	0.7	2.5	3.5***	39	7,800
Lang Cove DND	1.4	2.3	1.2	30	3,500
Lang Cove Esquimalt	1.5	4.0	0.5	55.9	800
Lyall Mag Meter	2.5	5.6	1.6	75.3	1,900
Wilson	1.9	3.4	1.7	18.6	8,000
Forshaw	0.9	2.1	0.1	34.0	300
Uganda	0.7	2.8	0.6	17.7	2,900
Canteen	0.1	0.1	0.1	1.4	4,100
Constance	0.1	0.1	0.01	1.3	3,300
Garthland	0.7	1.8	0.6	6.6	8,100
Grafton	0.4	0.9	0.3	34	800
Luscombe	0.1	0.3	0.1	2.6	4,200
Sea Heaven	0.2	0.6	0.1	5.7	2,300

*Wet GWI values presented in the table.

**Dry GWI = 0.01 L/s. The GWI was scaled up for the WWF calibration to better align with the field data.

***Dry GWI = 0.6 L/s. The GWI was scaled up for the WWF calibration to better align with the field data.



Typical GWI rates are between 1,000-3,000 L/ha/day. Higher or lower rates are possible depending on catchment characteristics and the accuracy of the flow data and estimated tributary area.

The calculated GWI rates for Anson, Garthland, Kinver, and Wilson catchments are high compared to the typical expected range and the other catchments. The calculated GWI rate for the Forshaw catchment is low compared to the typical expected range and the other catchments. This is potentially due to the magnitude of the minimum night flow being very small. Flow monitors tend to be less accurate under low flow conditions. Small changes in the MNF and ADWF measurements at this location could have a significant impact on the GWI rate. However, any increases in GWI rate would only be a small increase in GWI flow, and as such, no further changes or investigation are recommended.

2.7.2 Rainfall Dependent Inflow & Infiltration

The RTK method was used to quantify the rainfall dependent inflow & infiltration for the wet weather flow calibration. Refer to **Section 3.3** for further details regarding the RTK method.

Historical IDF curves for use in the model were obtained from the IDF-CC tool (<https://www.idf-cc-uwo.ca/>) with historical data sourced from the Environment Canada *Victoria Gonzales CS* weather station.

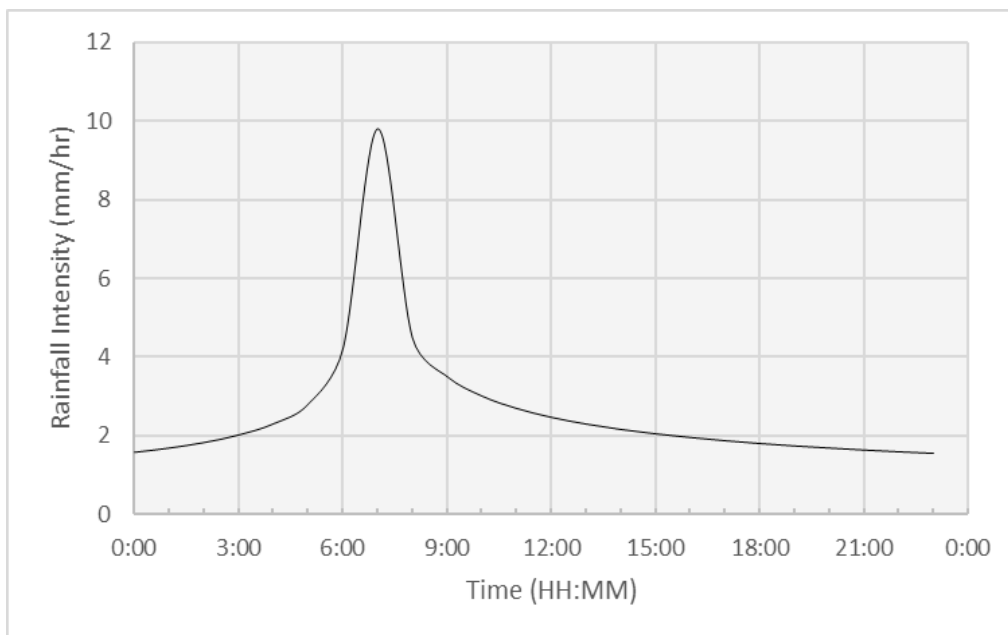
Climate change was accounted for by using the IDF-CC tool to develop climate change-adjusted IDF curves based on historical data from the *Victoria Gonzales CS* weather station and an ensemble of global, bias corrected, climate change models. Projections were developed for the OCP planning horizon assuming a 'moderate' climate change scenario corresponding to RCP 4.5 (https://www.ipcc-data.org/guidelines/pages/glossary/glossary_r.html).

As the Township does not have a specific design storm distribution defined, GeoAdvice recommended the use of the Modified Chicago design storm ($r = 0.3$, 24-hour). The Modified Chicago distribution is described as an "all-durations" design storm, corresponding to all points on a single return period of an IDF curve. This synthetic distribution results in a design event that contains all durations and intensities defined for a given return period. This distribution ensures that all naturally occurring intensities and durations in the rainfall records are contained in the storm. These design storms were created for 5-year return period. The 5-year design storm was used under the existing, interim OCP and buildout scenarios. The above assumptions were confirmed with the Township prior to completing the capacity analysis.

An example of the Modified Chicago design storm distribution, for an hourly rainfall, is provided in **Figure 2.3**.



Figure 2.3: 5-Year, 24-hour Modified Chicago Design Storm (Historic IDF)



The IDF curves for both historic (existing and interim scenarios) and climate-change adjusted (OCP and buildout scenarios) events have been included in **Appendix H**.

The design storms used in the Township model are summarized in **Table 2.11** and **Table 2.12**.

Table 2.11: Victoria Gonzales CS Design Storms (Historic IDF)

Return Period	Distribution	Duration (hours)	Total Rainfall (mm)	Average Intensity (mm/hr)	Peak Rainfall Intensity (mm/hr)
5-year	Modified Chicago	24	62.4	2.6	9.8

Table 2.12: Victoria Gonzales CS Design Storms (Climate Change IDF)

Return Period	Distribution	Duration (hours)	Total Rainfall (mm)	Average Intensity (mm/hr)	Peak Rainfall Intensity (mm/hr)
5-Year	Modified Chicago	24	67.0	2.8	10.5

The design storms along with the calibrated RTK parameters were used to quantify the RDI&I in the Township's network. I&I rates under the 5-year design storm with and without climate change in **Table 2.13**. As with GWI, I&I rates were calculated at the catchment level and I&I loads were then spatially distributed to each serviced parcel based on the respective area.



Table 2.13: I&I Allocation per Flow Monitoring Catchment (GWI + RDI&I)

Flow Monitoring Catchment	Catchment Area (ha)	GWI (L/ha/day)	I&I 5-yr (L/ha/day)	I&I 5-yr CC (L/ha/day)
Anson	10	9,500	66,000	70,100
Devonshire	141	900	92,600	94,000
Esquimalt Panhandle	16.8	1,000	24,400	26,100
Head	124	1,200	72,300	77,500
Kinver	39	7,800	49,100	52,100
Lang Cove DND	30	3,500	36,300	38,700
Lang Cove Esquimalt	55.9	800	40,500	43,500
Lyall Mag Meter	75.3	1,900	85,700	91,800
Wilson	18.6	8,000	103,700	110,700
Forshaw	24.8	400	61,000	65,500
Uganda	17.7	2,900	63,700	68,200
Canteen	1.4	4,100	83,500	89,400
Constance	1.3	3,300	85,200	91,200
Garthland	6.6	8,100	69,300	73,800
Grafton	34	800	85,000	91,200
Luscombe	2.6	4,200	38,400	41,000
Sea Heaven	5.7	2,300	36,900	39,500

In general, the I&I rates are high compared to the typical design rates for sanitary sewer networks (~10,000-20,000 L/ha/day). This is to be expected as the system is relatively old in many areas and there are known to be cross connections with storm flow entering the system.

The calculated I&I rates in **Table 2.13** were compared against the rates calculated by the CRD in the *Core Area Inflow & Infiltration Program 2019 Report*. Overall, the rates calculated in this report are comparable to those calculated by CRD. Discrepancies are expected between the two reports as the RTK method was used to calculate the I&I rates in this report, while the CRD used the “Envelope” method to calculate I&I rates.

To summarize, **Table 2.14** shows the existing and future population and loading data.



Table 2.14: Existing and Future Population and Loading Summary

Parameter	Existing-WWF	Interim-WWF	OCP-WWF-CC	BULDOUT-WWF-CC
Total Population	17,533	23,482	38,080	51,080
Area	530 ha	530 ha	530 ha	530 ha
BSF	42.3 L/s	52.4 L/s	79.2 L/s	158.5 L/s
GWI	14.8 L/s	14.8 L/s	14.8 L/s	14.8 L/s
RDI&I (24-hour Maximum Average)	278.3 L/s	278.3 L/s	298.8 L/s	298.8 L/s
RDI&I (Peak)	419.1 L/s	419.1 L/s	450.0 L/s	450.0 L/s
Average Wet Weather Flow	335.4 L/s	345.5 L/s	392.8 L/s	472.1 L/s
Peak Wet Weather Flow	506.3 L/s	526.6 L/s	610.4 L/s	768.8 L/s



3.0 Model Calibration

Before describing how the model was calibrated, it is useful to examine why a hydraulic model may not match the field data. Most of the sources of errors or mismatches are:

- Input data errors
- System loading errors
- Operational control errors
- Poorly calibrated measuring equipment
- Outdated data

The cumulative effect of these areas of uncertainty or “approximation” is that, without verification and validation of the model’s ability to recreate known conditions, it is likely that the modeling results would be grossly misleading.

The main reasons for and benefits of a well calibrated model are listed below:

- Confidence: Demonstrate the model’s ability to reproduce existing conditions.
- Understanding: Confirm the understanding of the performance of the system.
- Troubleshooting: Uncover missing information and misinformation or anomalies about the system.

3.1 Field Data Review

Flow data at nine (9) CRD flow monitoring locations and at eight (8) Township flow monitor locations were provided by the Township. A total of eleven (11) sites were used for calibration and six (6) sites were used for validation. For the CRD flow monitoring sites, data was provided in 5-minute intervals for periods between January 1st, 2020 and April 1st, 2023. For the Township flow monitoring sites, data was provided in 1-hour intervals for periods between September 1st, 2018 and February 15th, 2022.

Canteen, Constance, Garthland, Grafton, Luscombe and Sea Heaven were not selected as calibration sites because their data did not exhibit distinct rainfall responses in the flow data. Additionally, trying to match model flows precisely with field data can be challenging under low flow rates.

The data collected at the other eleven (11) flow monitors were reviewed to determine the average dry weather flow (ADWF) and peak wet weather flow (PWWF), and to develop the flow hydrographs for model calibration. Rainfall and flow data were reviewed for the flow monitoring period to select the largest rainfall event with the most distinct rainfall response in the flow data. November 8 to December 4, 2021 was selected as the wet weather calibration period. **Table 3.1** summarizes the ADWF and PWWF at each flow monitoring site. The storm



event in November of 2021 was used to calibrate the modeled RTK parameters for the wet weather flow calibration.

Table 3.1: Flow Monitor Locations and Flow Summary

Calibration/ Validation	CRD/Township	Flow Monitoring Site	Average Dry Weather Flow (L/s)	Peak Wet Weather Flow (L/s)
Calibration	CRD	Anson	0.1	13.7
		Devonshire	14.7	245.0
		Esquimalt Panhandle	1.2	14.3
		Head	14.4	199.5
		Kinver	2.5	38.8
		Lang Cove DND	2.3	31.2
		Lang Cove Esquimalt	4.0	50.4
		Lyall Mag Meter	5.6	65.4
		Wilson	3.4	40.1
	Township	Forshaw	2.1	32.3
		Uganda	2.8	23.6
Validation	Township	Canteen	0.1	9.3
		Constance	0.1	2.5
		Garthland	1.8	1.9
		Grafton	0.9	18.0
		Luscombe	0.3	0.9
		Sea Heaven	0.6	1.9

3.2 Dry Weather Flow Calibration Results

Modeling results were first reviewed, and then key model parameters were adjusted until the model results closely matched the dry weather flow field data. A summary of the calibration changes is shown in **Table 3.2**.

Table 3.2: Calibration Adjustments

Parameter	Adjustment
GW	Adjusted GW (see Table 2.10)
BSF	Adjusted sanitary sewer loads for all load types (see Table 2.3)

Table 3.3 summarizes the dry weather flow (DWF) calibration results. Dry weather flow calibration hydrographs can be found in **Appendix B**.



Table 3.3: Dry Weather Flow Calibration Results

Flow Monitor	Average Flow (L/s)			Peak Flow (L/s)		
	Field	Model	Difference	Field	Model	Difference
Anson	0.1	0.7	+ 0.6	0.4	1.1	+ 0.7
Devonshire	14.7	15.4	+ 0.8	25.2	24.7	- 0.5
Esquimalt Panhandle	1.2	1.1	- 0.1	2.0	1.7	- 0.3
Head	14.4	14.4	- 0.0	23.7	24.0	+ 0.3
Kinver	2.5	3.3	+ 0.9	4.4	5.1	+ 0.7
Lang Cove DND	2.3	3.6	+ 1.3	5.1	4.7	- 0.4
Lang Cove Esquimalt	4.0	4.2	+ 0.2	9.5	8.9	- 0.6
Lyll Mag Meter	5.6	5.5	- 0.1	8.8	7.8	- 1.0
Wilson	3.4	3.3	- 0.1	4.6	4.7	+ 0.1
Forshaw	2.1	6.4	+ 4.3	3.1	13.5	+ 10.4
Uganda	2.8	2.3	- 0.5	4.1	3.6	- 0.5

Table 3.4 summarizes the dry weather flow (DWF) validation results. Dry weather flow validation hydrographs can be found in **Appendix C**.

Table 3.4: Dry Weather Flow Validation Results

Flow Monitor	Average Flow (L/s)			Peak Flow (L/s)		
	Field	Model	Difference	Field	Model	Difference
Canteen	0.1	0.2	+ 0.1	0.2	0.2	+ 0.0
Constance	0.1	0.1	+ 0.0	0.2	0.2	+ 0.0
Garthland	1.8	1.5	- 0.3	2.7	2.3	- 0.3
Grafton	0.9	3.8	+ 3.0	1.4	6.8	+ 5.4
Luscombe	0.3	0.5	+ 0.1	0.5	0.8	+ 0.3
Sea Heaven	0.6	0.6	+ 0.0	1.1	1.0	- 0.1

Overall, the calibrated model shows a good agreement with the observed dry weather field data at the flow monitoring sites. More detailed explanations can be found in **Appendix F**. In summary, the following sites show larger differences between the model and the field data:

- Anson: It is important to acknowledge that matching model flows precisely with field data can be challenging under low flow rates. The inherent flow variability in small catchments as well as higher errors in flow monitor readings at low flows can lead to minor discrepancies. In this case, the observed flow difference between the model and field of only 0.6 L/s is within the expected margin of error for a catchment of this size. Additionally, the model is conservative.
- Forshaw and Grafton: The effect of the upstream pump station is higher in the model data than the field data. This is likely a result of the model flows being attenuated



quicker than field flows due to limitation in the model's engine. However, the average model and field flows at this location have a good match. Additionally, the model is conservative.

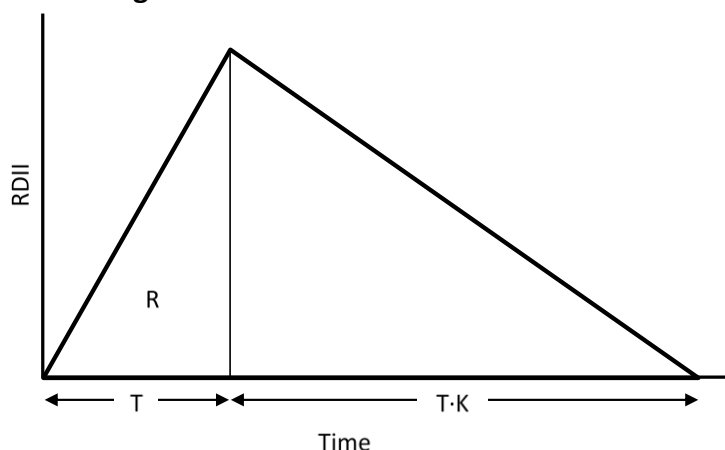
3.3 RTK Wet Weather Flow Calibration

The RTK method was used to quantify the rainfall dependent inflow & infiltration for the wet weather flow calibration. With the RTK method, RDI&I is simulated using three triangular unit hydrographs representing fast, medium and slow responses to rainfall. The shape of each of the three triangles is quantified by three parameters:

- R: the fraction of effective rainfall volume over the watershed that enters the sewer system.
- T: the time to peak in hours.
- K: the ratio of the time to recession to the time to peak.

The relationship between the R, T, and K parameters is shown in **Figure 3.1**.

Figure 3.1: RTK Method Parameters



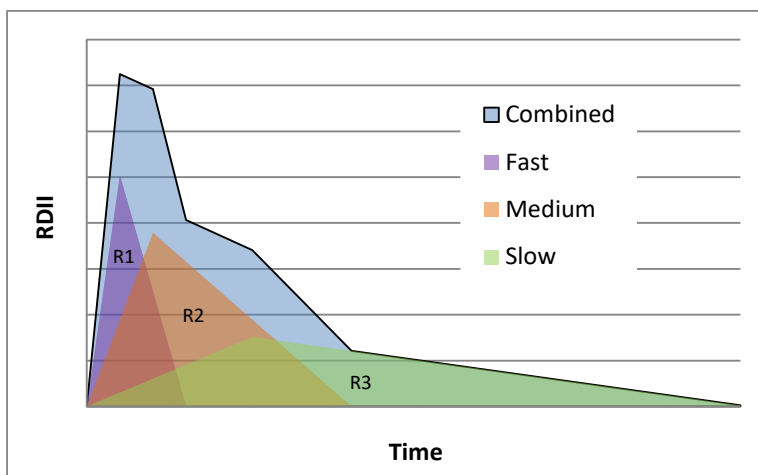
The sum of the three R-values (R1, R2, and R3) equals to the total fraction of rainfall volume over the watershed that enters the sewer system:

$$R = R1 \text{ (fast)} + R2 \text{ (medium)} + R3 \text{ (slow)}$$

The total RDI&I represents the sum of the three components, as shown in **Figure 3.2**.



Figure 3.2: RTK Method



The calibration of the RTK parameters requires sewer flow data and corresponding rainfall hyetographs. It is performed using the following steps:

- Step 1. Wet weather flow (WWF) analysis
- Step 2. Dry weather flow (DWF) analysis
- Step 3. Unit hydrograph curve fitting analysis

Wet weather calibration was completed for one (1) storm event, recorded in November 2021. **Table 3.5** summarizes the wet weather flow (WWF) calibration results. Wet weather flow calibration hydrographs can be found in **Appendix D**. The final, calibrated RTK parameters for each catchment are detailed in **Appendix G**.

Table 3.5: RTK Wet Weather Flow Calibration Results Summary

Flow Monitor	Peak Flow (L/s)		
	Field	Model	Difference
Anson	13.7	15.9	+ 2.2
Devonshire	245.0	204.1	- 41.0
Esquimalt Panhandle	14.3	11.1	- 3.2
Head	199.5	215.4	+ 15.9
Kinver	38.8	42.4	+ 3.6
Lang Cove DND	31.2	24.4	- 6.8
Lang Cove Esquimalt	50.4	56.9	+ 6.5
Lyall Mag Meter	65.4	64.9	- 0.5
Wilson	40.1	37.6	- 2.5
Forshaw	32.3	50.5	+ 18.2
Uganda	23.6	28.2	+ 4.6



Table 3.6 summarizes the wet weather flow (WWF) validation results. Wet weather flow validation hydrographs can be found in **Appendix E**.

Table 3.6: RTK Wet Weather Flow Validation Results Summary

Flow Monitor	Peak Flow (L/s)		
	Field	Model	Difference
Canteen	9.3	2.3	- 7.0
Constance	2.5	2.2	- 0.4
Garthland	1.9	11.5	+ 9.7
Grafton	18.0	24.3	+ 6.3
Luscombe	0.9	2.8	+ 1.8
Sea Heaven	1.9	5.4	+ 3.5

Overall, the calibrated model shows a good agreement with the observed wet weather field data at flow monitoring sites. More detailed explanations can be found in **Appendix F**. In summary, the following sites show larger differences between the model and the field data:

- Devonshire: The average flow difference is within 5% and the peak flow difference is within 17%. The measured peak flow looks questionable, given the otherwise strong alignment of the rest of the storm event with the model.
- Forshaw: It appears that data are missing in the field at the time of the peak flow.
- Garthland, Luscombe and Sea Heaven: It appears that the field data during the storm event were not significantly affected by the rainfall, raising suspicion given the nature of the storm. The DWF calibration resulted in an excellent match, and the model is conservative.



4.0 System Capacity Analysis

The following section summarizes the capacity analysis of the Township's existing sanitary sewer collection system. The purpose of the analysis is to determine the performance of the system under existing and future scenarios. The hydraulic capacity analysis was performed using the updated Township sewer model using InfoSWMM modeling software.

4.1 Hydraulic Level of Service Criteria

The criteria outlined in **Table 4.1** and **Table 4.2** were used to assess the capacity of all gravity mains within the Township's system and to assign a hydraulic level of service (HLoS) rating. The HLoS methodology below is based on q/Q results (max flow/full pipe flow) rather than d/D results (depth/Diameter). The q/Q methodology provides a better picture of the hydraulic condition of each gravity main and how the HLoS is impacted by downstream conditions.

Table 4.1: Hydraulic Level of Service Criteria Scoring (Gravity Main)

Criteria	Score
Hydraulic Capacity (q/Q^*)	
$q/Q < 0.7$	1
$0.7 \leq q/Q < 1.0$	2
$q/Q \geq 1.0$	3
Hydraulic Grade Line (HGL)	
$HGL < \text{Crown}$	1
$\text{Crown} \leq HGL < \text{Rim Elevation}$	2
$HGL > \text{Ground Elevation}$	3
Velocity (v)	
$v < 0.6 \text{ m/s}$	Fail
$v \geq 0.6 \text{ m/s}$	Pass

* q/Q = peak flow / full pipe flow.



Table 4.2: Hydraulic Level of Service Ratings (Gravity Main)

HLoS Rating	Capacity	HGL	Velocity	Description
A	1	1	Pass	Pipe performing as designed
B	1	1	Fail	Adequate capacity, low velocity indicates potential sedimentation
C	1	2 or 3	Pass or Fail*	Adequate capacity, backwater caused by downstream conditions
D	2	1, 2 or 3	Pass or Fail*	Marginal capacity, backwater caused by downstream conditions
	3	1	Pass or Fail*	Capacity exceeded and surcharging unlikely
E	3	2	Pass or Fail*	Capacity exceeded and surcharging likely
F	3	3	Pass or Fail*	Capacity exceeded and flooding likely

*HLoS ratings from 'C' to 'F' are independent of velocity criteria.

In general, ratings of 'A', 'B', 'C' and 'D' will not trigger an upgrade as there is capacity available in the gravity main to convey flows. Gravity mains receiving a HLoS rating of 'C' or 'D' may show surcharging or flooding on connected nodes; however, these cases would indicate that the surcharged condition is due to downstream hydraulic deficiencies.

Only gravity mains receiving an HLoS rating of 'E' and 'F' were considered for upgrade. A gravity main receiving an 'E' rating requires an upgrade as the hydraulic capacity has been exceeded and is likely causing surcharging to occur. A gravity main receiving an 'F' rating indicates that surcharging to the manhole rim is likely, increasing the priority of the upgrade.

Table 4.3 and **Table 4.4** provide a summary of the criteria used to assess the Township's pump stations. A pump station is comprised of three (3) components: pump(s), wet well and downstream forcemain. Each component was assessed to determine the overall pump station HLoS rating.



Table 4.3: Hydraulic Level of Service Criteria Scoring (Pump Station)

Criteria	Result
Pump Capacity	
PWWF* ≤ Firm Capacity**	Pass
PWWF* > Firm Capacity**	Fail
Wet Well Capacity	
Max. Operating Level < Inlet Pipe Invert	1
Max. Operating Level ≥ Inlet Pipe Invert (Submerged Inlet)	2
Max. Operating Level ≥ Max. Physical Depth	3
Forcemain Velocity	
$v < 0.75 \text{ m/s}$	Fail
$0.75 \text{ m/s} \leq v \leq 3.0 \text{ m/s}$	Pass
$v > 3.0 \text{ m/s}$	Fail

*PWWF = Peak Wet Weather Flow

**The Pump station firm capacity determined with the station's largest pump out of service.

Table 4.4: Hydraulic Level of Service Ratings (Pump Station)

HLoS Rating	Pump Capacity	Wet Well Capacity	Forcemain Velocity	Description
A	Pass	1	Pass	Pump station performing as designed
B	Pass	1	Fail	Forcemain velocity outside of design range
C	Pass	2	Pass or Fail	Inlet pipe invert within pump operating range and backup likely
D	Fail	1	Pass or Fail	Pump capacity exceeded but sufficient wet well capacity to attenuate additional flow
E	Fail	2	Pass or Fail	Pump capacity exceeded and backup likely
F	Pass or Fail	3	Pass or Fail	Wet well capacity exceeded and overflow likely

Pump stations receiving a HLoS rating of 'C' indicate that the lead pump on-level is higher than the inlet pipe invert, causing backup to occur in the upstream pipes. The Township should assess these pump stations and adjust the operating conditions as required.

Pump stations receiving a HLoS rating of 'D', 'E' or 'F' indicate that the pump capacity has been exceeded with varying levels of surcharge risk.



4.2 Analysis Scenarios

Table 4.5 summarizes the modeling scenarios that were used to assess the Township sewer system capacity.

Table 4.5: Modeling Scenario Summary

Scenario	Base Sanitary Flow	Inflow & Infiltration	Purpose
Existing-PWWF ₅	Existing	5-year I&I without Climate Change	Identify System Deficiencies
Interim-PWWF ₅	Existing + Developments	5-year I&I without Climate Change	Identify System Deficiencies/Timing
OCP-PWWF ₅	Existing + OCP Landuse Changes	5-year I&I with Climate Change	Identify System Deficiencies/Timing
Buildout-PWWF ₅	Full Buildout	5-year I&I with Climate Change	Identify System Deficiencies/Timing Size System Improvements

The existing modeling scenarios were used to identify existing system deficiencies; whereas, the future modeling scenarios were used to identify projected future system deficiencies. All recommended system improvements were sized under the future buildout scenario.

In addition to the base analysis scenarios above, one (1) sensitivity analysis scenario was assessed, the OCP PWWF with I&I reduction, to assess the impact of potential future I&I remediation efforts. The original sensitivity analysis scenario aimed to reduce the wet weather flows to below four times dry weather flows. However, considering the Township's CRD connections capacity limit of 28.36 ML/day, it was more beneficial to focus on an I&I reduction that would meet this limit. Based on this target, it was determined that an I&I reduction of 20% would be necessary, an achievable goal for the Township.

4.3 Hydraulic Level of Service Results

Table 4.6 summarizes the gravity mains HLOS results for each scenario.



Table 4.6: Gravity Mains HLoS Results Summary

HLoS Rating	Number of Gravity Mains			
	Existing PWWF	Interim PWWF	OCP PWWF	Buildout PWWF
A	298	299	314	323
B	426	420	394	354
C	47	48	53	68
D	47	50	47	51
E	21	22	31	41
F	2	2	2	4

As shown in the table above, the model predicts 23 HLoS gravity main deficiencies under the existing scenario, 24 deficiencies under the interim scenario, 33 deficiencies under the OCP scenario and 45 deficiencies under the buildout scenario. HLoS results are shown on **Figure 4.1** to **Figure 4.4**. It is worth noting that the I&I load is approximately 65% to 85% of the overall loading on the system. As such, population growth has little to no effect on system deficiencies.

Table 4.7 to **Table 4.10** summarize the pump station HLoS results for each scenario.

Table 4.7: Existing Pump Station HLoS Results

Pump Station	Firm Capacity (L/s)	Peak Inflow (L/s)	Excess Capacity (L/s)	HLoS Rating
Canteen	1.4	1.5	- 0.1	E
Constance	7.1	1.4	+ 5.7	B
Craigflower	20.8	6.7	+ 14.1	A
Forshaw	30.0	34.8	- 4.8	E
Garthland	15.9	7.1	+ 8.8	C
Grafton	18.3	40.2	- 21.9	E
Kinver	40.9	26.1	+ 14.8	C
Lampson	21.2	2.1	+ 19.1	A
Luscombe	18.5	1.8	+ 16.6	A
Seahaven	14.1	3.3	+ 10.8	A
Uganda	23.7	16.1	+ 7.6	B



Table 4.8: Interim Pump Station HLoS Results

Pump Station	Firm Capacity (L/s)	Peak Inflow (L/s)	Excess Capacity (L/s)	HLoS Rating
Canteen	1.4	1.5	- 0.1	E
Constance	7.1	1.4	+ 5.7	B
Craigflower	20.8	6.7	+ 14.1	A
Forshaw	30.0	35.5	- 5.5	E
Garthland	15.9	7.1	+ 8.8	C
Grafton	18.3	40.2	-21.9	E
Kinver	40.9	26.1	+ 14.8	C
Lampson	21.2	2.7	+ 18.5	A
Luscombe	18.5	1.8	+ 16.6	A
Seahaven	14.1	3.3	+ 10.8	A
Uganda	23.7	16.6	+ 7.1	B

Table 4.9: OCP Pump Station HLoS Results

Pump Station	Firm Capacity (L/s)	Peak Inflow (L/s)	Excess Capacity (L/s)	HLoS Rating
Canteen	1.4	1.9	- 0.5	E
Constance	7.1	1.5	+ 5.6	B
Craigflower	20.8	7.1	+ 13.7	A
Forshaw	30.0	37.4	- 7.4	E
Garthland	15.9	7.5	+ 8.4	C
Grafton	18.3	45.9	- 27.6	E
Kinver	40.9	27.5	+ 13.4	C
Lampson	21.2	3.8	+ 17.4	A
Luscombe	18.5	1.9	+ 16.6	A
Seahaven	14.1	3.3	+ 10.5	A
Uganda	23.7	20.6	+ 3.1	B



Table 4.10: Buildout Pump Station HLoS Results

Pump Station	Firm Capacity (L/s)	Peak Inflow (L/s)	Excess Capacity (L/s)	HLoS Rating
Canteen	1.4	2.6	- 0.5	E
Constance	7.1	1.6	+ 5.5	B
Craigflower	20.8	12.8	+ 8.0	A
Forshaw	30.0	36.2	- 6.2	E
Garthland	15.9	6.6	+ 9.3	C
Grafton	18.3	54.6	- 36.3	E
Kinver	40.9	28.1	+ 12.8	C
Lampson	21.2	5.7	+ 15.5	A
Luscombe	18.5	1.4	+ 17.0	A
Seahaven	14.1	5.6	+ 8.5	A
Uganda	23.7	28.1	- 4.4	D

As shown in the above tables, Canteen, Forshaw and Grafton pump stations are predicted to be deficient under all the scenarios and the Uganda pump station is predicted to be deficient under the buildout scenario.

The Township should confirm the firm capacity presented in this report for all pump stations.

Note that for the Canteen Pump Station, an investigation should be conducted before implementing any upgrades due to the ideal pump assumption made for the Dockyard Pump Station, which impacts the capacity of the Canteen Pump Station.

Legend

- Ocean
- Parcel
- CRD Outfall
- DND Pump Station
- CRD Pump Station
- CRD Main
- Forcemain
- Surcharged Above Pipe Crown (41)
- Flooding Manhole (3)

Gravity Main Hydraulic Level of Service

- A - (297) Pipe Performing as Designed
- B - (430) Adequate Capacity, Low Velocity Indicates Potential Sedimentation
- C - (45) Adequate Capacity, Downstream Condition Causing Backwater
- D - (46) Marginal Capacity
- E - (22) Capacity Exceeded
- F - (1) Capacity Exceeded and Overflow Likely

Pump Station Hydraulic Level of Service

- A - (4) Pump station performing as designed
- B - (2) Forcemain velocity outside of design range
- C - (2) Inlet pipe invert within pump operating range and backup likely
- D - (0) Pump capacity exceeded but sufficient wet well capacity to attenuate additional flow
- E - (1) Pump capacity exceeded and backup likely
- F - (0) Wet well capacity exceeded and overflow likely
- Township Pump Station Not Assessed

Existing-PWWF
Hydraulic Level of Service
Results

Figure 4.1

Legend

- Ocean
- Parcel
- CRD Outfall
- DND Pump Station
- CRD Pump Station
- CRD Main
- Forcemain
- Surcharged Above Pipe Crown (42)
- Flooding Manhole (3)

Gravity Main Hydraulic Level of Service

- A - (300) Pipe Performing as Designed
- B - (421) Adequate Capacity, Low Velocity Indicates Potential Sedimentation
- C - (47) Adequate Capacity, Downstream Condition Causing Backwater
- D - (50) Marginal Capacity
- E - (22) Capacity Exceeded
- F - (1) Capacity Exceeded and Overflow Likely

Pump Station Hydraulic Level of Service

- A - (4) Pump station performing as designed
- B - (2) Forcemain velocity outside of design range
- C - (2) Inlet pipe invert within pump operating range and backup likely
- D - (0) Pump capacity exceeded but sufficient wet well capacity to attenuate additional flow
- E - (1) Pump capacity exceeded and backup likely
- F - (0) Wet well capacity exceeded and overflow likely
- Township Pump Station Not Assessed

Interim-PWWF
Hydraulic Level of Service
Results

Figure 4.2

Legend

- Ocean
- Parcel
- CRD Outfall
- DND Pump Station
- CRD Pump Station
- CRD Main
- Forcemain
- Surcharged Above Pipe Crown (52)
- Flooding Manhole (4)

Gravity Main Hydraulic Level of Service

- A - (314) Pipe Performing as Designed
- B - (396) Adequate Capacity, Low Velocity Indicates Potential Sedimentation
- C - (51) Adequate Capacity, Downstream Condition Causing Backwater
- D - (48) Marginal Capacity
- E - (30) Capacity Exceeded
- F - (2) Capacity Exceeded and Overflow Likely

Pump Station Hydraulic Level of Service

- A - (4) Pump station performing as designed
- B - (2) Forcemain velocity outside of design range
- C - (2) Inlet pipe invert within pump operating range and backup likely
- D - (0) Pump capacity exceeded but sufficient wet well capacity to attenuate additional flow
- E - (1) Pump capacity exceeded and backup likely
- F - (0) Wet well capacity exceeded and overflow likely
- Township Pump Station Not Assessed

OCP-PWWF
Hydraulic Level of Service
Results

Figure 4.3

Legend

- Ocean
- Parcel
- CRD Outfall
- DND Pump Station
- CRD Pump Station
- CRD Main
- Forcemain
- Surcharged Above Pipe Crown (71)
- Flooding Manhole (11)

Gravity Main Hydraulic Level of Service

- A - (323) Pipe Performing as Designed
- B - (356) Adequate Capacity, Low Velocity Indicates Potential Sedimentation
- C - (67) Adequate Capacity, Downstream Condition Causing Backwater
- D - (49) Marginal Capacity
- E - (40) Capacity Exceeded
- F - (6) Capacity Exceeded and Overflow Likely

Pump Station Hydraulic Level of Service

- A - (4) Pump station performing as designed
- B - (1) Forcemain velocity outside of design range
- C - (2) Inlet pipe invert within pump operating range and backup likely
- D - (1) Pump capacity exceeded but sufficient wet well capacity to attenuate additional flow
- E - (1) Pump capacity exceeded and backup likely
- F - (0) Wet well capacity exceeded and overflow likely
- Township Pump Station Not Assessed

Buildout-PWWF
Hydraulic Level of Service
Results

Figure 4.4



4.4 CRD Outfall Analysis

The CRD outfall flows were analyzed under each scenario. **Table 4.11** summarizes the average dry weather flow (ADWF) at the CRD outfalls under each scenario. The maximum 24-hour averaged wet weather flow (AWWF) is shown in **Table 4.12**.

Table 4.11: CRD Outfalls - 24-hour Average Dry Weather Flow (ML/d)

CRD Outfall ID	CRD Allocation Limit*	Existing ADWF	Interim ADWF	OCP ADWF	Buildout ADWF
Esquimalt Panhandle	0.12	0.12	0.12	0.12	0.40
Lang Cove Pump Station**	1.28	0.66	0.88	1.40	2.33
Dockyard (Lyll)	1.01	0.45	0.45	0.62	1.09
Kinver + Pooley Place	0.50	0.59	0.63	0.63	0.73
Devonshire	1.85	1.28	1.39	1.86	3.41
Wilson	0.37	0.29	0.34	0.65	1.12
Head	1.68	1.33	1.75	2.53	5.54
Anson	0.24	0.15	0.30	0.30	0.30
Total	7.10***	4.86	5.85	8.11	14.92

*CRD allocation limit as presented in the CRD Bylaw NO. 2312 *Liquid Waste Management Core Area And Western Communities Service Establishment Bylaw NO. 1, 1995* (Consolidated for Convenience May 2022).

**Lang Cove Esquimalt + Lang Cove DND

***7.10 ML/d per the CRD total allocation limit. Individual components do not add to exact total due to rounding errors.

Table 4.12: CRD Outfalls – Maximum 24-hour Averaged Wet Weather Flow (ML/d)

CRD Outfall ID	CRD Allocation Limit	Existing WWF	Interim WWF	OCP WWF	Buildout WWF
Esquimalt Panhandle	0.48	0.44	0.44	0.46	0.75
Lang Cove Pump Station**	5.12	2.84	3.06	3.74	4.68
Dockyard (Lyll)	4.04	2.99	2.99	3.06	3.10
Kinver + Pooley Place	2.00	2.06	2.12	2.23	2.30
Devonshire	7.40	10.71	10.82	11.94	13.28
Wilson	1.48	1.30	1.36	1.74	2.21
Head	6.72	7.24	7.67	8.90	11.89
Anson	0.97	0.58	0.74	0.77	0.77
Total	28.36***	28.17	29.20	32.85	38.99

*CRD allocation limit as presented in the CRD Bylaw NO. 2312 *Liquid Waste Management Core Area And Western Communities Service Establishment Bylaw NO. 1, 1995* (Consolidated for Convenience May 2022).

**Lang Cove Esquimalt + Lang Cove DND

***28.36 ML/d per the CRD total allocation limit. Individual components do not add to exact total due to rounding errors.



As shown in **Table 4.11**, the model predicts that the total load allocation at the CRD outfalls is adequate under the existing and interim ADWF scenarios. However, capacity is exceeded under the OCP and buildout ADWF scenarios. Key points to note are:

- Under the existing and interim ADWF scenarios, the Kinver + Pooley Place connection slightly exceeds the CRD allocation limit. However, there is residual unused capacity from Lang Cove Pump Station and Dockyard (Lyall) connections that can be utilized for the Kinver + Pooley Place connection, without significantly affecting the western part of CRD system. The total CRD ADWF allocation limit of the four (4) western connections (Esquimalt Panhandle, Lang Cove Pump Station, Dockyard (Lyall) and Kinver + Pooley Place) is 2.91 ML/d. The existing and interim flows under the ADWF scenarios at these (4) connections are 1.82 ML/d and 2.08 ML/d, respectively. Since the Kinver + Pooley Place connection is at the downstream end of the western branch of the CRD system, it can be concluded that the CRD trunk mains should have sufficient capacity for the sections downstream of the Kinver + Pooley Place connection to accommodate the marginal overage in allocation at this connection.
- Under the interim ADWF scenario, Head and Anson connections exceed the CRD allocation limits. The eastern CRD system has sufficient overall capacity. The total CRD ADWF allocation limit of the four (4) eastern connections (Devonshire, Wilson, Head and Anson) is 4.14 ML/d. The interim flow under the ADWF scenario at these junctions is 3.77 ML/d. Since the Head and Anson connections are at the downstream end of the eastern branch of the CRD system, it can be concluded that the CRD trunk mains should have sufficient capacity for the sections downstream of Head and Anson connections to accommodate the overage in allocation at these connections. While Anson connection is not considered critically deficient, a catchment reallocation is recommended for the Head connection to address this deficiency, as detailed in **Section 6.0**.

As shown in **Table 4.12**, the model predicts that the total load allocation at the CRD outfalls is adequate under the existing AWWF scenario. However, capacity is exceeded under the interim, OCP and buildout AWWF scenarios. Key points to note are:

- Under the existing and interim AWWF scenarios, the Kinver + Pooley Place connection slightly exceeds the CRD allocation limit. However, there is residual unused allocation from Esquimalt Panhandle, Lang Cove Pump Station and Dockyard (Lyall) connections that can be utilized for the Kinver & Pooley Place connection, without significantly affecting the western part of CRD system. The total CRD AWWF allocation limit of the four (4) western connections (Esquimalt Panhandle, Lang Cove Pump Station, Dockyard (Lyall) and Kinver + Pooley Place) is 11.64 ML/d. The existing and interim flows under the AWWF scenarios at these (4) connections are 8.34 ML/d and 8.61 ML/d, respectively. Since the Kinver + Pooley Place connection is at the downstream end of the western branch of the CRD system, it can be concluded that the CRD trunk mains should have sufficient capacity for the sections downstream of Kinver + Pooley Place connection.



- Under the existing and interim AWWF scenarios, Devonshire and Head connections exceed the CRD allocation limits. A catchment reallocation is proposed for the Head connection to address this deficiency, as detailed in **Section 6.0**. In addition to a catchment reallocation, it is also recommended to develop an I&I rehabilitation plan at Devonshire and Wilson catchments, having both significant I&I rates. The eastern CRD system does not have sufficient overall capacity. The total CRD AWWF allocation limit of the four (4) eastern connections (Devonshire, Wilson, Head and Anson) is 16.57 ML/d. The existing and interim flows under the PWWF scenarios at these junctions is 19.84 ML/d and 20.59 ML/d, respectively. Therefore, to accommodate flows in the eastern part of the network under the interim PWWF scenario, an I&I reduction plan should lead to a decrease of 4.02 ML/d. If the decrease is considered for both Devonshire and Wilson catchments, totaling an area of 159.6 ha, the I&I target rate for both Devonshire and Wilson catchments should be 68,700 L/ha/d, representing a decrease of approximately 30 %.

4.5 Development Capacity Analysis

Additional analysis was completed to determine the Township's capacity for development within their existing system, considering development applications already submitted (i.e. under the interim scenario). Existing gravity main reserve capacity was converted to a population equivalent that could be added upstream of each pipe.

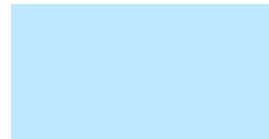
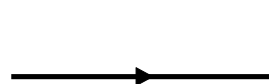
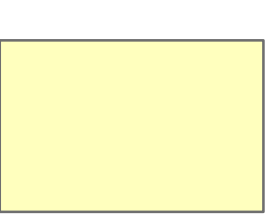
The following assumptions were made in order to convert residual flow capacity to population:

- Interim peak wet weather flow (historic 5-year I&I) was used to determine the residual pipe capacity.
- The observed residential rate of 145 L/cap/day was used.
- Assumed that base sanitary flow will be peaked according to the multi-family diurnal pattern (i.e. the majority of development that will occur will be multi-family).
- The calculated population equivalent does not account for additional I&I if development occurs in new areas.

The results of this reserve capacity analysis serve as a tool for the Township to quickly assess development-restricted flow paths and determine if specific developments will introduce capacity deficiencies to the system.

The development capacity analysis results are shown on **Figure 4.5**.

Legend

-  Ocean
 -  Parcel
 -  CRD Outfall
 -  Township Pump Station
 -  DND Pump Station
 -  CRD Pump Station
 -  CRD Main
 -  Forcemain
- Upstream Development Capacity
Population Equivalent (PE) (# of
Pipes)**
-  0 PE (39)
 -  < 100 PE (2)
 -  101-500 PE (3)
 -  501-1,000 PE (5)
 -  1,001-1,500 PE (9)
 -  1,501-2,000 PE (6)
 -  2,001-5,000 PE (127)
 -  >5,000 PE (650)
-  Upstream Development Capacity
Population Equivalent (PE) for
Township Pump Station

Interim-PWWF
Upstream Residual
Development Capacity

Figure 4.5



4.6 I&I Reduction Sensitivity Analysis

An additional scenario was modeled to assess the impacts of a lower I&I rate. A reduction of 20% of the RDI&I was used to simulate the effects of I&I reduction to meet the CRD allocation limit.

The impacts of I&I reduction on the gravity mains in the separated sanitary sewer catchments are summarized in **Table 4.13**.

Table 4.13: I&I Reduction OCP Gravity Main HLoS Results Summary

HLoS Rating	Number of Gravity Mains	
	OCP PWWF 5-Year I&I w/ Climate Change	OCP PWWF 5-Year I&I w/ 20% I&I Reduction
A	314	304
B	394	419
C	53	50
D	47	44
E	31	23
F	2	1

As shown in the table above, 9 deficiencies (23% of the total length of the HLoS gravity main deficiencies) could be eliminated if the District were able to achieve an RDI&I reduction of 20%. Further details on how the I&I reduction impacts the capital plan can be found in **Section 5.0**.

Table 4.14 summarizes the future lift station HLoS results with I&I reduction.



Table 4.14: I&I Reduction OCP Lift Station HLoS Results Summary

Pump Station	Firm Capacity (L/s)	Peak Inflow (L/s)	Excess Capacity (L/s)	HLoS Rating
Canteen	1.4	1.7	-0.3	E
Constance	7.1	1.3	5.8	B
Craigflower	20.8	6.0	14.8	A
Forshaw	30.0	33.3	-3.3	E
Garthland	15.9	6.5	9.4	C
Grafton	18.3	42.1	-23.8	E
Kinver	40.9	23.6	17.3	C
Lampson	21.2	3.4	17.8	A
Luscombe	18.5	1.7	16.8	A
Seahaven	14.1	3.1	11.0	A
Uganda	23.7	18.0	5.7	B

As shown in the table above, all of the deficient lift stations deficiencies remain deficient with the RDI&I reduction of 30%.

Regarding the CRD outfall flow, the maximum 24-hour averaged wet weather flow (AWWF) is summarized in **Table 4.15**.

Table 4.15: CRD Outfalls – Maximum 24-hour Averaged Wet Weather Flow (ML/d)

CRD Outfall ID	CRD Allocation Limit	OCP WWF	OCP WWF w/ I&I Reduction
Esquimalt Panhandle	0.48	0.46	0.40
Lang Cove Pump Station**	5.12	3.74	3.06
Dockyard (Lyall)	4.04	3.06	2.99
Kinver + Pooley Place	2.00	2.23	1.93
Devonshire	7.40	11.94	10.00
Wilson	1.48	1.74	1.53
Head	6.72	8.90	7.65
Anson	0.97	0.77	0.68
Total	28.36***	32.85	28.36

*CRD allocation limit as presented in the CRD Bylaw NO. 2312 *Liquid Waste Management Core Area And Western Communities Service Establishment Bylaw NO. 1, 1995* (Consolidated for Convenience May 2022).

**Lang Cove Esquimalt + Lang Cove DND

***28.36 ML/d per the CRD total allocation limit. Individual components do not add to exact total due to rounding errors.



5.0 Capital Improvements Plan

This section identifies the required capacity and condition-based improvement projects along with their associated risk priority, recommended project schedule, and estimated cost.

Capacity-based deficiencies were identified in **Section 4.0**. System upgrade recommendations were proposed to eliminate these deficiencies as summarized in the following sections. All recommended system improvements have been sized to meet the buildout demand scenario system requirements.

Based on the Township's design specifications and discussions with the Township, the design criteria shown in **Table 5.1** were used to size capacity-deficient infrastructure.

Table 5.1: Hydraulic Design Criteria

Facility	Criterion	Parameter Value
Gravity Main	Design Flow	Buildout Peak Wet Weather Flow w/ Climate Change
	Max. depth/Diameter ratio	$d/D < 0.5$ (Diameter ≤ 250 mm) $d/D < 0.7$ (Diameter ≥ 300 mm)
	Min. Velocity	Velocity ≥ 0.6 m/s
	Max. Velocity	Velocity ≤ 6.0 m/s
	Min. Pipe Diameter	D = 200 mm D = 150 mm for the upstream section of a residential sewer where future extension is not possible
	Manning Roughness Coefficient	n = 0.013 for concrete pipes n = 0.011 for PVC pipes
Forcemain	Min. Velocity	Velocity ≥ 0.75 m/s
	Max. Velocity	Velocity ≤ 3.0 m/s
	Min. Pipe Diameter	D = 100 mm
	Hazen-Williams Roughness Coefficient	C = 120
Pump	Design Flow	Buildout Peak Wet Weather Flow w/ Climate Change
	Max. Pump Flow	PWWF = Firm Capacity

*d= flow depth, D = Diameter, n = Manning coefficient, C = Hazen Williams coefficient

System improvements that are required for condition only (i.e. not capacity deficient) were assumed to be replaced with the same size/capacity as the existing infrastructure.

A risk-based assessment methodology was used to prioritize the City's capital improvements. To assess the risk associated with each proposed system improvement, both likelihood of failure and consequence of failure were used to develop an overall risk score. The risk analysis



was completed by USL and the full methodology is detailed in Appendix A of the USL technical memorandum *Infrastructure Prioritization & Capital Planning* (January 29, 2025), attached in **Appendix I**.

Each system improvement has been categorized into one of three prioritization categories, P1 through P3, with P1 indicating the highest priority. The risk priority descriptions are summarized in **Table 5.2**.

Table 5.2: Priority Description for Sanitary Sewer Utility Assets

Risk Priority	Gravity Mains	Pump Stations
P1	Projects that exhibit the highest level of risk, associated with an elevated likelihood of failure triggered by both condition and capacity concerns, and an elevated consequence of failure.	Projects that exhibit the highest level of risk, associated with an elevated likelihood of failure triggered by both condition and capacity concerns, and an elevated consequence of failure.
P2	Projects that exhibit either: - A high likelihood of failure (triggered by condition and capacity) but less severe consequence, relative to P1 assets. - A moderate likelihood of failure (triggered by condition or capacity, but not both) and a high consequence of failure.	Projects that exhibit either: - A high likelihood of failure (triggered by condition and capacity) but less severe consequence, relative to P1 assets. - A moderate likelihood of failure (triggered by condition or capacity, but not both) and a high consequence of failure.
P3	Projects that exhibit modest risk, driven by a moderately high likelihood of failure (triggered by condition or capacity, but not both) but with less severe consequences of failure.	Projects that exhibit modest risk, driven by a moderately high likelihood of failure (triggered by condition or capacity, but not both) but with less severe consequences of failure.
Non-ranked	All remaining gravity mains.	All remaining pump stations.

Table 5.3 and **Table 5.4** summarize the assets in each risk category for the existing and buildout scenarios, respectively. Project costs were estimated based on the unit rates summarized in the Appendix C of the USL technical memorandum *Infrastructure Prioritization & Capital Planning* (January 29, 2025), attached in **Appendix I**.



Table 5.3: Existing Risk Priority Summary

Risk Priority	Number of Gravity Mains	Total Asset Length	Number of Pump Stations	Aggregate Renewal Cost
P1	39	2.7 km	0	\$10.6M
P2	60	3.7 km	4	\$23.0M*
P3	105	6.8 km	0	\$23.3M
Total	204	13.2 km	4	\$56.9M

*\$16.5M (Gravity Mains) + \$6.5M (Pump Stations \$5.5M and Forcemains \$1.0M) = \$23.0M

Table 5.4: Future Risk Priority Summary

Risk Priority	Number of Gravity Mains	Total Asset Length	Number of Pump Stations	Aggregate Renewal Cost
P1	2	0.04 km	0	\$0.2M
P2	116	8.0 km	2	\$35.7M*
P3	74	5.0 km	1	\$17.4M**
Total	192	13.0 km	3	\$53.3M

*\$35.5M (Gravity Mains) + \$0.2M (Pump Stations) = \$35.7M

**\$17.4M (Gravity Mains) + \$0.04M (Pump Stations) = \$17.4M

The capital plan was then further prioritized into short term (1-10 year) and long term (11-20 years) capital priorities. The 20-year capital plan is summarized in **Table 5.5** and shown in **Figure I.1**. The capital plan was completed by USL and the full methodology is detailed in their technical memorandum *Infrastructure Prioritization & Capital Planning* (January 29, 2025), attached in **Appendix I**.



Table 5.5: Capital Plan Summary

	Linear Assets	Pump Stations	Renewal Value
Short Term (1-10 Years)	13.2 km (204 assets) 2.7 km (39 assets) upgrade - capacity triggered 10.5 km (165 assets) renewal - condition triggered	- Grafton Pump Station and Forcemains - Uganda Pump Station - Forshaw Pump Station - Canteen Pump Station - Constance (complete condition-based upgrades when funds become available)	\$56,951,000
Long Term (11-20 Years)	13.0 km of renewal 40 m (2 assets) upgrade - capacity triggered 13.0 km (190 assets) renewal - condition triggered	- Kinver Pump Station - Lampson Pump Station - Luscombe Pump Station	\$53,328,000

The sensitivity analysis scenario (I&I reduction) was assessed to determine the cost savings to the capital plan, as summarized in **Table 5.6**.

Table 5.6: Sensitivity Analysis with I&I Reduction - Cost Savings

Short Term (1-10 Years)	Long Term (11-20 Years)
\$0.3M	\$0.3M

As shown above, I&I reduction efforts shows approximately \$0.6M in total cost savings. These cost savings are based on the pipes in **Table 5.7** that do not require an upgrade with the I&I reduction.



Table 5.7: Sensitivity Analysis with I&I Reduction – Pipes No Longer Requiring Upgrade

Pipe ID	Location	Existing Diameter (mm)	Length (m)	Upgrade Timing	Cost Savings
SGM0559	Ellery St	200	73.2	Short Term	\$0.3M
SGM0939	Head St	250	31.2	Long Term	\$0.1M
SGM1090	Head St	250	44.5	Long Term	\$0.2M

Based on the above, note that:

- A 20% I&I reduction is likely not a cost-effective solution for reducing capital upgrade costs.
- Further analysis is needed to determine the optimal level of I&I reduction that maximizes capital cost savings.
- I&I reduction efforts should be targeted in catchments with high I&I and/or upstream of capacity-based projects.
- The capital plan includes a significant number of condition-based improvements. The Township should monitor I&I as these improvements are implemented to assess whether they provide sufficient reductions without additional remediation efforts. If condition-based improvements do not effectively reduce I&I, a private-side remediation program should be considered.



6.0 CRD Outfall Proposed Improvements

The Township currently meets the total CRD allocation limits for both average dry weather flow (ADWF) and maximum 24-hour averaged wet weather flow (AWWF) under existing conditions. However, the allocation limits are not met at each individual CRD connection. Under the interim AWWF scenario, the total flow at CRD locations exceeds the limit. Therefore an I&I rehabilitation plan could help reducing I&I and meet the CRD allocation limits. Under the OCP and buildout scenarios, as confirmed by CRD, a new plant should be designed and constructed to provide additional capacity for all contributors, including the Township of Esquimalt.

To address pipe deficiencies along Lyall Street, a catchment reallocation was recommended, as shown in **Detail 4 of Figure L.1**. The catchment reallocation will connect to the CRD system at Lyall Street and Swinford Street. This catchment reallocation will also address the allocation deficiency for the Head connection, under the interim ADWF and existing and interim WWF scenarios.

Regarding the allocation deficiency at Devonshire connection under both existing and interim PWWF scenarios, it is recommended to develop an I&I rehabilitation plan. As explained in **Section 0**, to accommodate flows in the eastern part of the network under the interim PWWF scenario, an I&I reduction plan should lead to a decrease of 4.02 ML/d. If the decrease is considered for both Devonshire and Wilson catchments, totaling a area of 159.6 ha, the I&I target rate for both Devonshire and Wilson catchments should be 68,700 L/ha/d, representing a decrease of approximatively 30 %.

Table 6.1 summarizes the ADWF at the CRD outfalls under each scenario with the proposed catchment reallocation. The maximum 24-hour AWWF is shown in **Table 6.2**.

Table 6.1: CRD Outfalls with Catchment Reallocation - 24-hour Average Dry Weather Flow (ML/d)

CRD Outfall ID	CRD Allocation Limit*	Existing ADWF	Interim ADWF	OCP ADWF	Buildout ADWF
Head	1.68	1.09	1.42	2.12	4.76
New connection at Lyall Street and Swinford Street	N/A	0.24	0.33	0.42	0.78

*CRD allocation limit as presented in the CRD Bylaw NO. 2312 *Liquid Waste Management Core Area And Western Communities Service Establishment Bylaw NO. 1, 1995* (Consolidated for Convenience May 2022).



Table 6.2: CRD Outfalls with Catchment Reallocation – Maximum 24-hour Averaged Wet Weather Flow (ML/d)

CRD Outfall ID	CRD Allocation Limit	Existing WWF	Interim WWF	OCP WWF	Buildout WWF
Head	6.72	5.80	6.13	7.18	9.83
New connection at Lyall Street and Swinford Street	N/A	1.44	1.53	1.71	2.08

*CRD allocation limit as presented in the CRD Bylaw NO. 2312 *Liquid Waste Management Core Area And Western Communities Service Establishment Bylaw NO. 1, 1995 (Consolidated for Convenience May 2022)*.

Note that the additional flow at the new connection (at Lyall Street and Swinford Street) can be accommodated by the western branch of CRD network, as there is residual unused allocation from Esquimalt Panhandle, Lang Cove Pump Station and Dockyard (Lyall) connections that can be utilized for new connection, without significantly affecting the western CRD system.

- The total CRD ADWF allocation limit of the three (3) western connections (Esquimalt Panhandle, Lang Cove Pump Station, Dockyard (Lyall)) is 2.41 ML/d. The interim flows under the ADWF scenarios at three (3) connections plus at the new connection is 1.79 ML/d. Since the new connection Street is at the downstream end of the western branch of the CRD system, it can be concluded that the CRD trunk mains should have sufficient capacity for the sections downstream of the new connection to accommodate the additional 0.33 ML/d of flow at this new connection under the interim ADWF scenario.
- The total CRD AWWF allocation limit of the three (3) western connections (Esquimalt Panhandle, Lang Cove Pump Station, Dockyard (Lyall)) is 9.64 ML/d. The interim flows under the AWWF scenarios at three (3) connections plus at the new connection is 8.03 ML/d. Since the new connection at Lyall Street and Swinford Street is at the downstream end of the western branch of the CRD system, it can be concluded that the CRD trunk mains should have sufficient capacity for the sections downstream of the new connection to accommodate the additional 1.53 ML/d of flow at this new connection under the interim AWWF scenario.



7.0 Summary and Recommendations

7.1 Summary

GeoAdvice Engineering Inc. was retained by the Township of Esquimalt to develop the Township's Sanitary Sewer Asset Management Plan (SSAMP). The following is a summary of the tasks and findings from the study:

- The Township's GIS and as-built drawings were used to develop a hydraulic model of the Township's sanitary sewer collection system using the InfoSWMM modeling software (Innovyze).
- The existing population estimate used for this study was 17,533 capita, with a calibrated per capita base sanitary flow rate of 145 L/cap/day. The total calibrated base sanitary flows for the existing scenario are 42.3 L/s (including institutional, commercial and industrial loads).
- Three (3) future scenarios were developed: the interim, OCP and buildout scenarios.
 - The interim scenario was developed based on development applications provided by the Township. A total growth of 5,959 capita was estimated.
 - The OCP scenario was developed based on the Township OCP and the development applications of the interim scenario. OCP Growth was allocated to parcels where the land use is proposed to change in the future. The OCP growth represent 14,598 capita, with an additional 5,959 capita from development applications.
 - To develop the buildout scenario, all lots were considered to be built out to their maximum potential under the OCP land use. A total population of 51,080 capita was considered.
- Dry weather and wet weather flows were calibrated to nine (9) CRD and two (2) Esquimalt flow monitors. Six (6) Township sites were used for validation. CRD flow data was provided for periods between January 1st, 2020 and April 1st, 2023. For the Township flow monitoring sites, Township flow data was provided for periods between September 1st, 2018 and February 15th, 2022.
- Groundwater infiltration was calculated using the Stevens – Schultzbach Method, with GWI rates ranging between 300-9,500 L/ha/day. Typical GWI rates are between 1,000-3,000 L/ha/day. Higher or lower rates are possible depending on catchment characteristics and the accuracy of the flow data and estimated tributary area.
- The 5-year I&I rates for the catchments are between 26,100-110,700 L/ha/day. In general, the I&I rates are high compared to the typical design rates for sanitary sewer networks (~10,000-20,000 L/ha/day). This is to be expected as the system is relatively



old in many areas and there are known to have cross connections with storm flow entering the system.

- The hydraulic modeling results indicate that there are 23 gravity main deficiencies (HLoS rating of 'E' or 'F') under the existing scenario, 24 deficiencies under the interim scenario, 33 deficiencies under the OCP scenario and 45 deficiencies under the buildout scenario.
- The hydraulic modeling results indicate that there are 46 marginal capacity gravity mains (HLoS rating of 'D') under the existing scenario, 50 marginal capacity gravity mains under the interim scenario, 48 marginal capacity gravity mains under the OCP scenario and 49 marginal capacity gravity mains under the 2046 scenario. Upgrades were not recommended for these pipes; however, these are potential low priority upgrades that should be further investigated in more detail during development reviews.
- The pump station capacity analysis indicates that there are 3 pump station deficiencies (HLoS rating of 'E' or 'F') under the existing, interim and OCP scenarios, and there are 4 pump station deficiencies under the buildout scenario.
- A detailed risk assessment was completed by USL, combining the capacity and condition likelihoods of failure with the consequence of failure for each infrastructure element.
- The costs for all capital improvements identified through this study are approximately \$56.9M in the short term (1-10 years) and \$53.3M in the long term (11-20 years).

7.2 Recommendations

1. Verification of Sanitary Sewer Collection Data

Prior to undertaking any capacity related capital improvement projects, the Township should conduct a survey to confirm the diameter and invert information for the proposed upgrades. A significant portion of the data was inferred or taken from old record drawings and may be prone to discrepancies with what is currently in the field. Verification of the inverts and diameters, in conjunction with modeling to verify deficiencies, can confirm the need, timing, and sizing for specific projects.

2. Additional Flow Monitoring

The Township should consider implementing a long-term temporary flow monitoring program to further discretize the I&I rates within each catchment. Potential locations have been provided in this report but alternative locations and/or additional sites can be installed to fit the Township's needs. Maintaining these flow monitors while the Township conducts I&I remediation work will also provide data to track progress and determine which catchments should be higher priority.



3. Pump Station Survey and Drawdown Testing

The Township should compile any available information and then undertake survey and pump drawdown tests in order to verify critical hydraulic modeling information.

4. Extended Modeling Support Services

GeoAdvice can assist the Township in maintaining and operating the model on one (or more) year contracts, updating the Township of the model's operational status on a quarterly basis via a written status report. It is understood that during this period, we will respond to specific queries to model scenarios from the Township for capital planning, development, and operational needs.

5. Maintenance of Sanitary Sewer System Model

Ongoing development, zoning and infrastructure changes dictate that updates should be completed at least every year. Piping capacities should be updated where investigations indicate discrepancies from assumptions used in the model development. Model updates, conducted on a yearly basis, are significantly more cost-effective than larger projects done in 5-year (or greater) increments. Additionally, the cost of model updates, relative to the infrastructure decisions they impact, are marginal.

6. Small Scale Multi Unit Housing Modeling (Bill 44)

The Township should consider developing a modeling scenario to determine the impacts of the Small Scale Multi-Unit Housing (SSMUH) initiative laid out in Bill 44. The potential growth due to this initiative will likely occur in areas that were not previously expected to see significant growth at an OCP or build-out horizon and could trigger deficiencies within the sanitary sewer collection system.



Submission

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Werner de Schaetzen, Ph.D., P.Eng.
Senior Modeling Review



Appendix A Primary System Components

Table A.1: Pump Model Data

Pump Station Name	Model ID	Firm Capacity* (L/s)	Pump On Level (m)	Pump Off Level (m)
Canteen	PMP-CANTEEN-1	1.4	0.61	0.37
	PMP-CANTEEN-2		0.91	0.37
Constance	PMP-CONSTANCE-1	7.1	0.87	0.15
	PMP-CONSTANCE-2		1.04	0.15
Craigflower	PMP-CRAIGFLOWER-1	20.8	0.55	0.34
	PMP-CRAIGFLOWER-2		0.70	0.46
Forshaw	PMP-FORSHAW-1	30.0	1.04	0.55
	PMP-FORSHAW-2		1.22	0.58
Garthland	PMP-GARTHLAND-1	15.9	0.55	0.27
	PMP-GARTHLAND-2		0.64	0.30
Grafton	PMP-GRAFTON-1	18.3	0.67	0.30
	PMP-GRAFTON-2		0.72	0.46
Kinver	PMP-KINVER-1	40.9	1.30	0.43
	PMP-KINVER-2		1.45	0.43
Lampson	PMP-LAMPSON-1	21.2	0.61	0.15
	PMP-LAMPSON-2		0.94	0.15
Luscombe	PMP-LUSCOMBE-1	18.4	1.22	0.64
	PMP-LUSCOMBE-2		1.31	0.76
Seahaven	PMP-SEAHAVEN-1	14.1	1.25	0.82
	PMP-SEAHAVEN-2		1.45	0.91
Uganda	PMP-UGANDA-1	23.7	1.22	0.64
	PMP-UGANDA-2		1.52	0.91
Beatty (DND)	PMP-BEATTY	IP**	NA***	NA***
Dockyard (DND)	PMP-DOCKYARD	IP**	NA***	NA***
Lang Cove (CRD)	PMP-LANGCOVE	IP**	NA***	NA***

*Firm capacity determined by the model's predicted operating point based on the pump curve and forcemain parameters. Assumes the largest pump out of service.

**Pump curve not available. Modeled as an "Ideal Pump" (inflow = outflow).

***Data for CRD and DND pump stations not available. Modeled as "Ideal Pump" (inflow = outflow).



Table A.2: Wet Well Model Data

Pump Station Name	Model ID	Dimensions	Bottom Elevation (m)	Maximum Depth (m)	Volume (m ³)
Canteen	WW-CANTEEN	2.13 m x 2.13 m	6.59	2.85	12.93
Constance	WW-CONSTANCE	Ø 1.15 m	5.35	2.32	2.41
Craigflower	WW-CRAIGFLOWER	Ø 1.83 m	-1.35	2.75	7.23
Forshaw	WW-FORSHAW	3.53 m x 3.00 m	-1.43	3.71	39.29
Garthland	WW-GARTHLAND	2.03 m x 1.52 m	1.01	1.94	5.99
Grafton	WW-GRAFTON	Ø 2.03 m	2.94	4.16	13.40
Kinver	WW-KINVER	3.08 m x 1.50 m	-0.29	3.55	16.40
Lampson	WW-LAMPSON	Ø 1.83 m	2.32	3.11	8.18
Luscombe	WW-LUSCOMBE	Ø 1.83 m	11.44	4.07	10.70
Seahaven	WW-SEAHAVEN	Ø 1.83 m	14.22	5.37	14.12
Uganda	WW-UGANDA	4.60 m x 2.44 m	-0.80	2.40	26.94
Beatty (DND)	WW-BEATTY	NA*	NA*	NA*	NA*
Dockyard (DND)	WW-DOCKYARD	NA*	NA*	NA*	NA*
Lang Cove (CRD)	WW-LANGCOVE	NA*	NA*	NA*	NA*

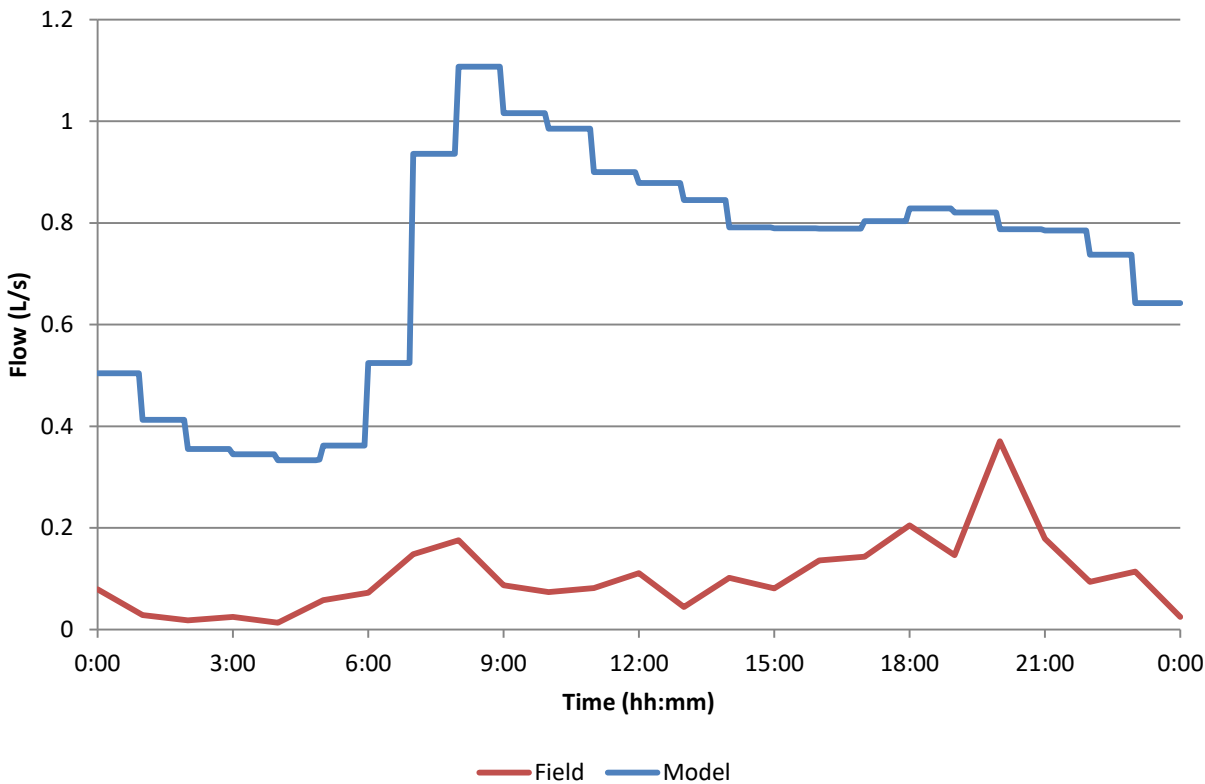
*Data for CRD and DND wet wells not available.



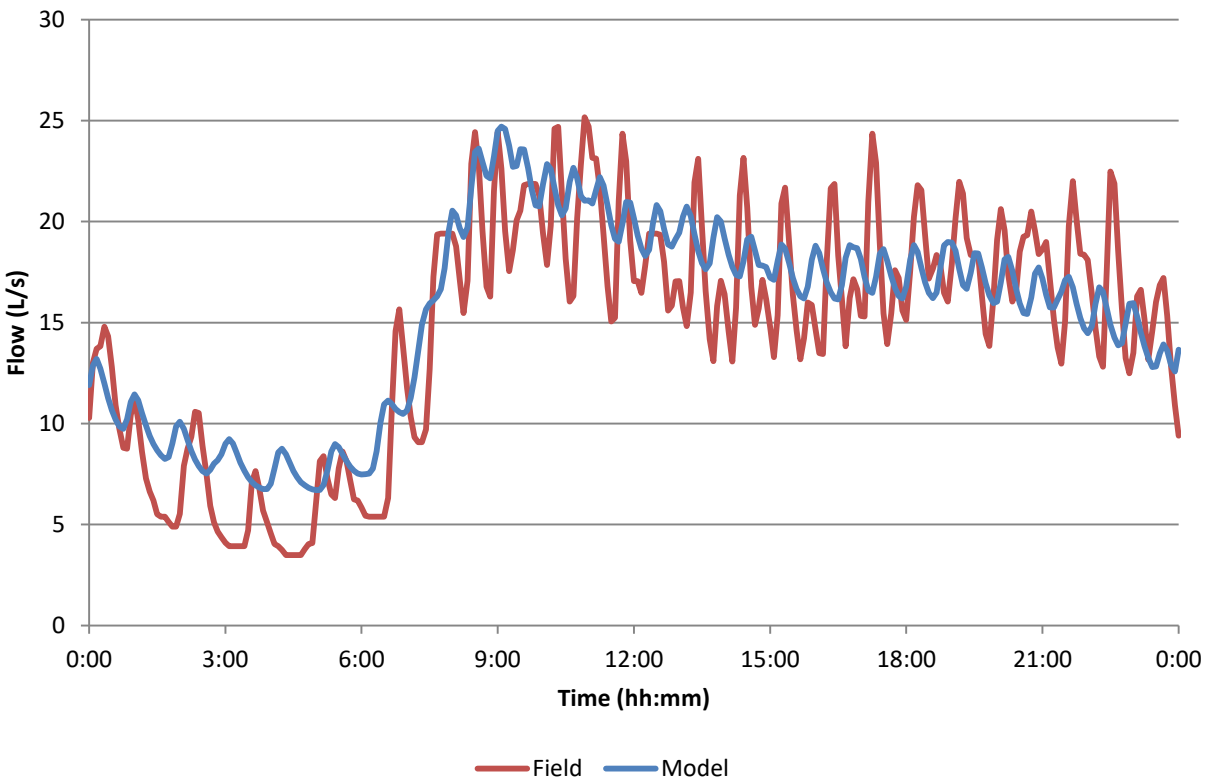
Appendix B DWF Calibration Hydrographs

Esquimalt Sewer Model
DWF Calibration Graphs

Anson

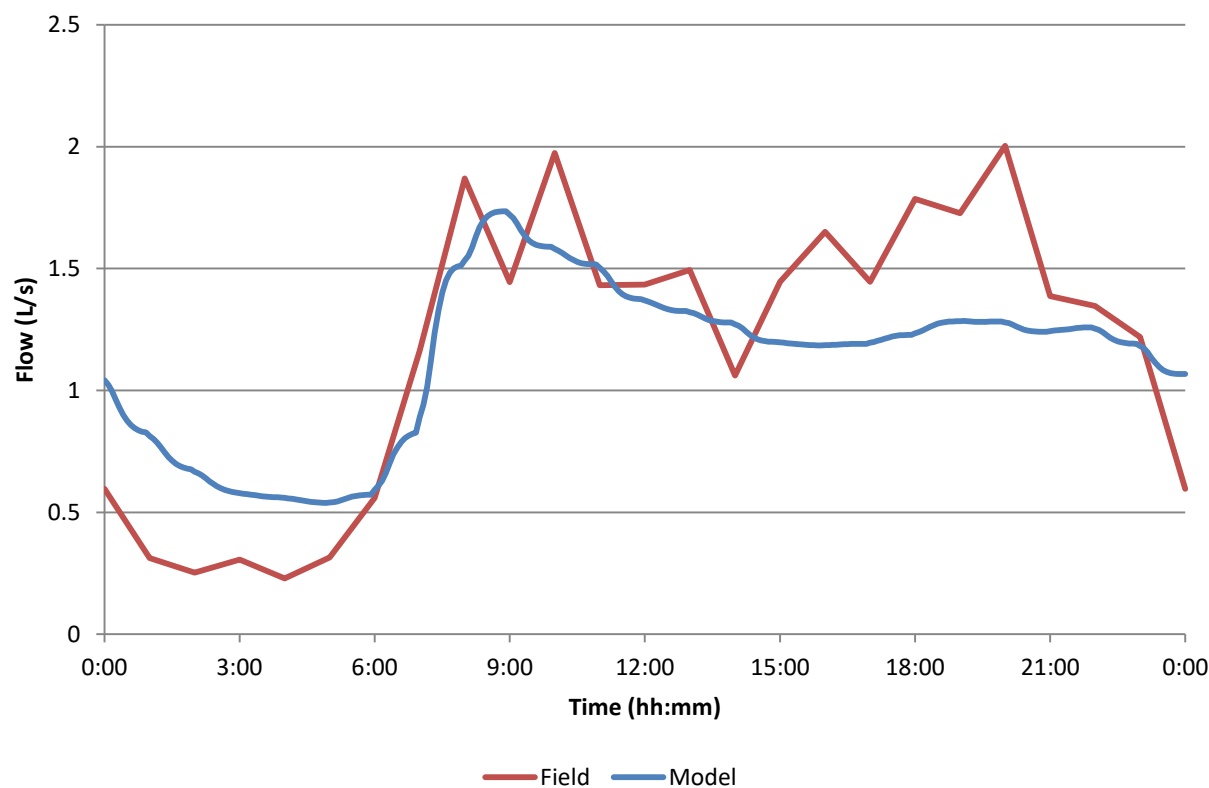


Devonshire

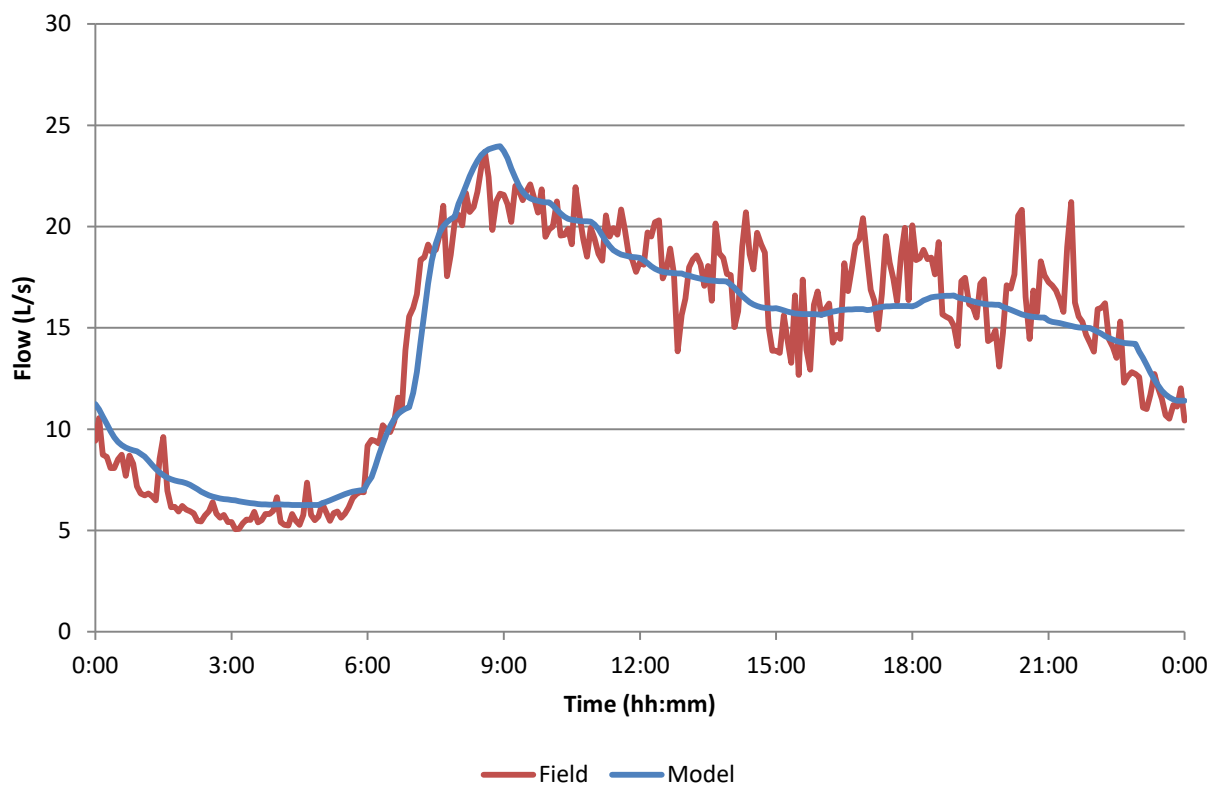


Esquimalt Sewer Model
DWF Calibration Graphs

Esquimalt Panhandle

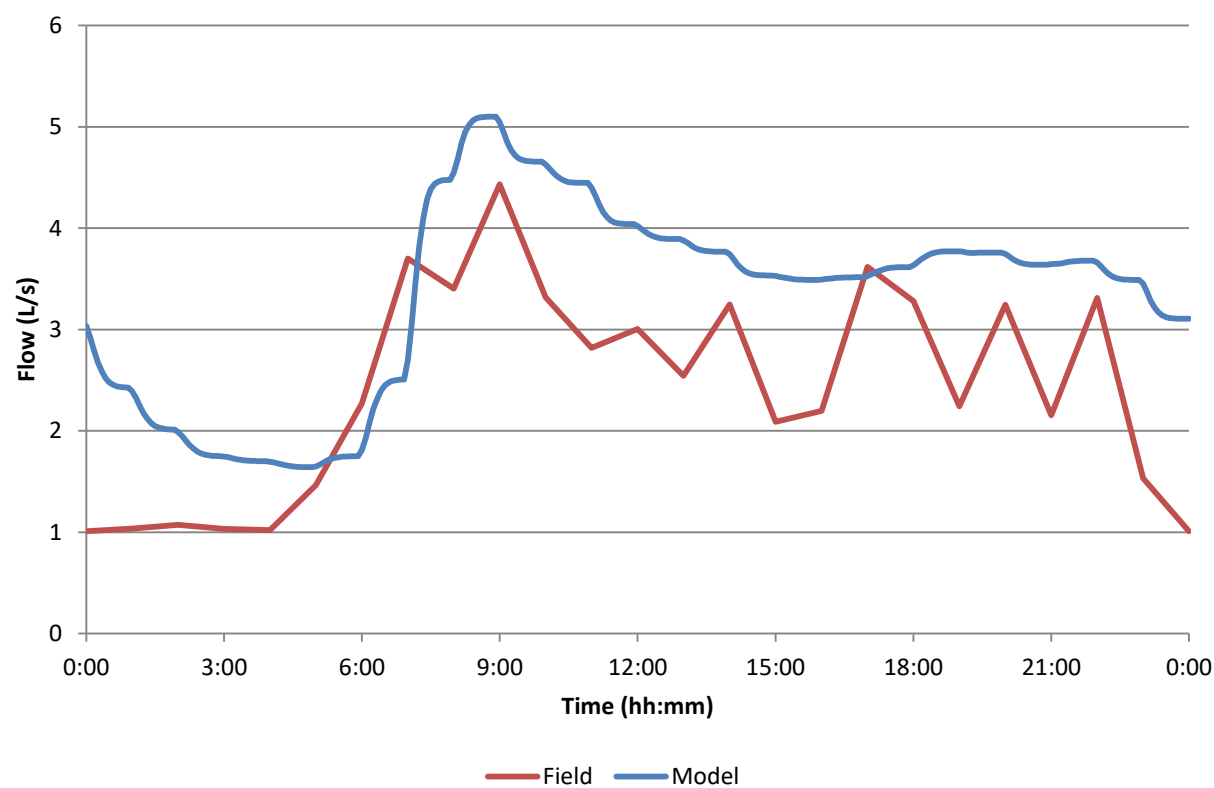


Head

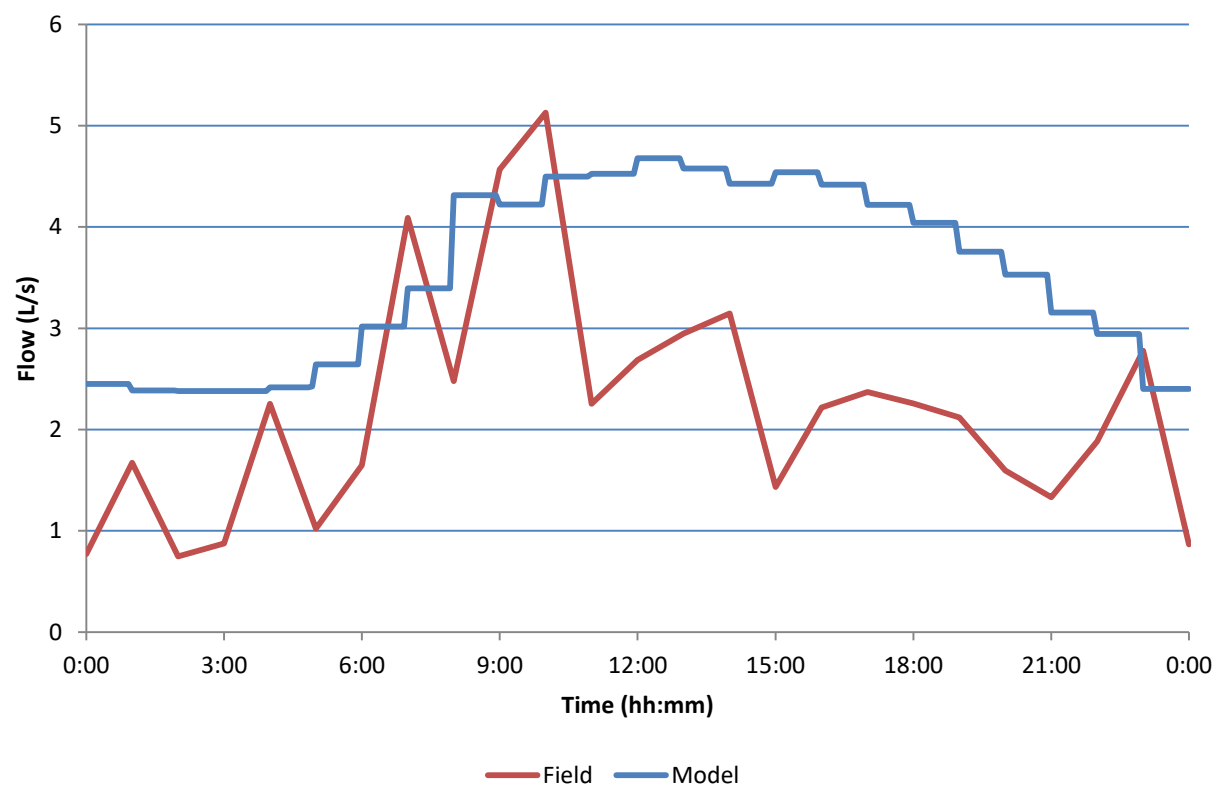


Esquimalt Sewer Model
DWF Calibration Graphs

Kinver

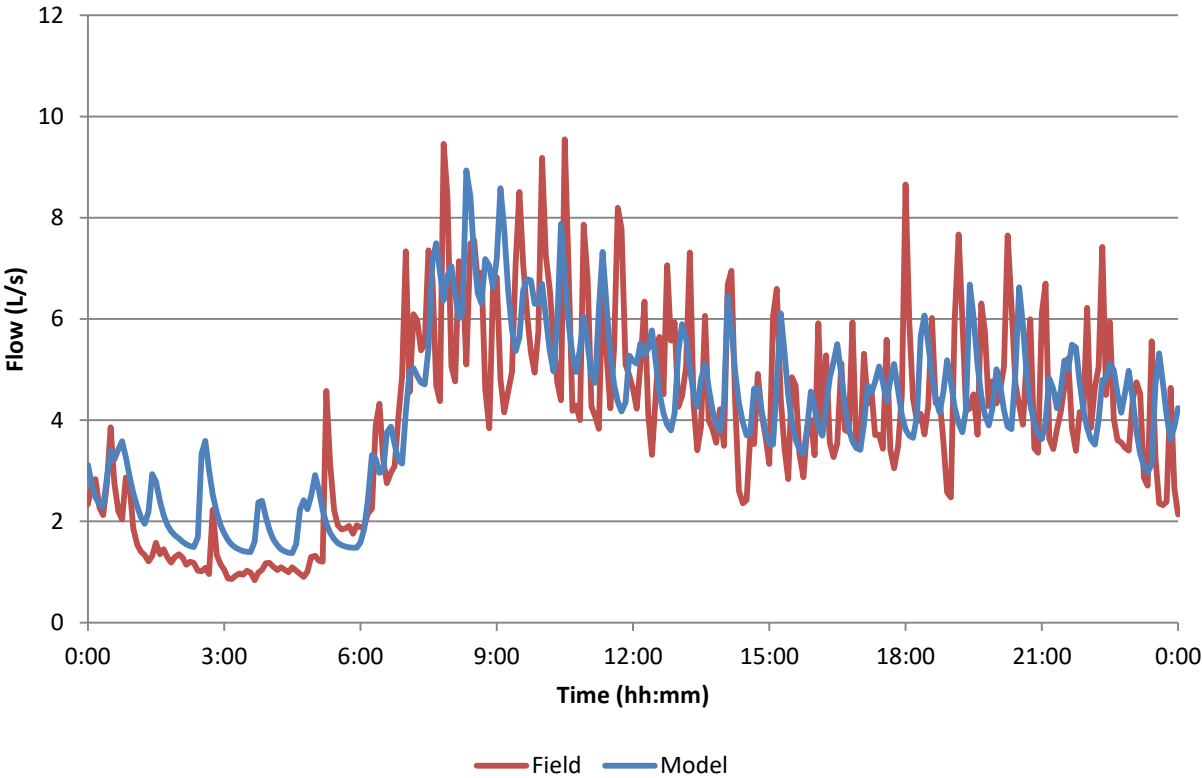


Lang Cove DND

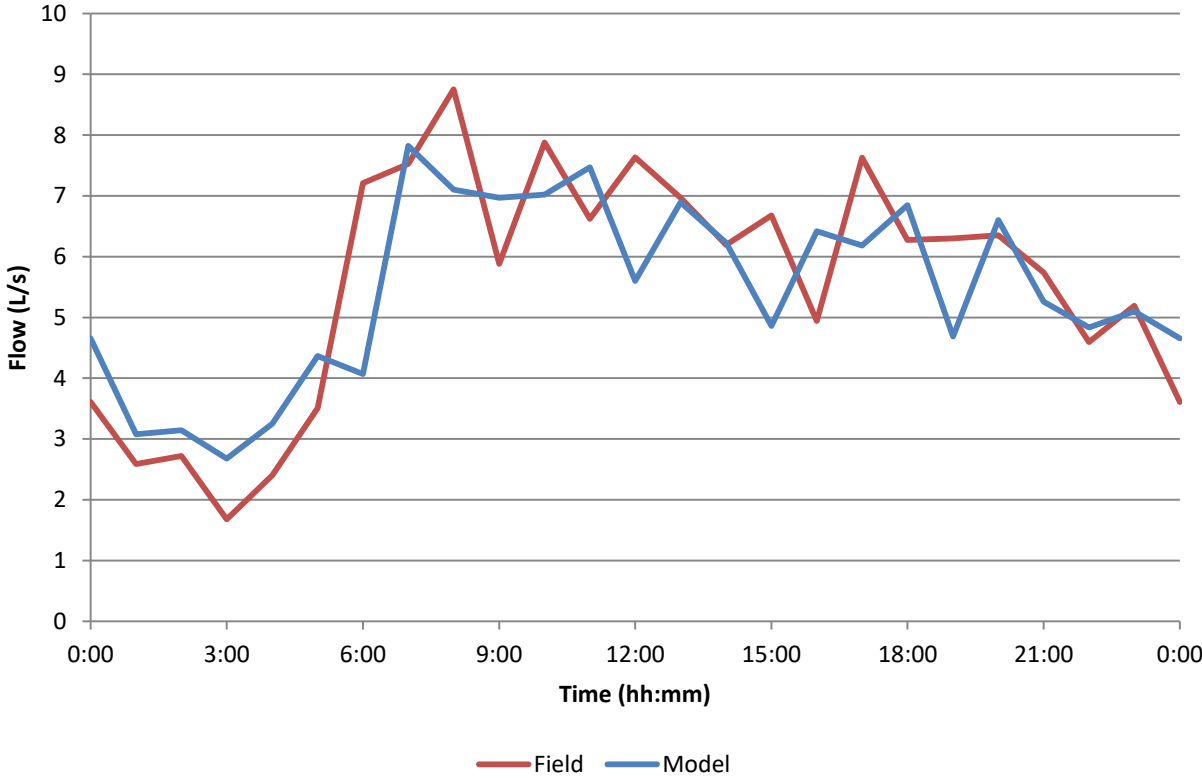


Esquimalt Sewer Model
DWF Calibration Graphs

Lang Cove Esquimalt

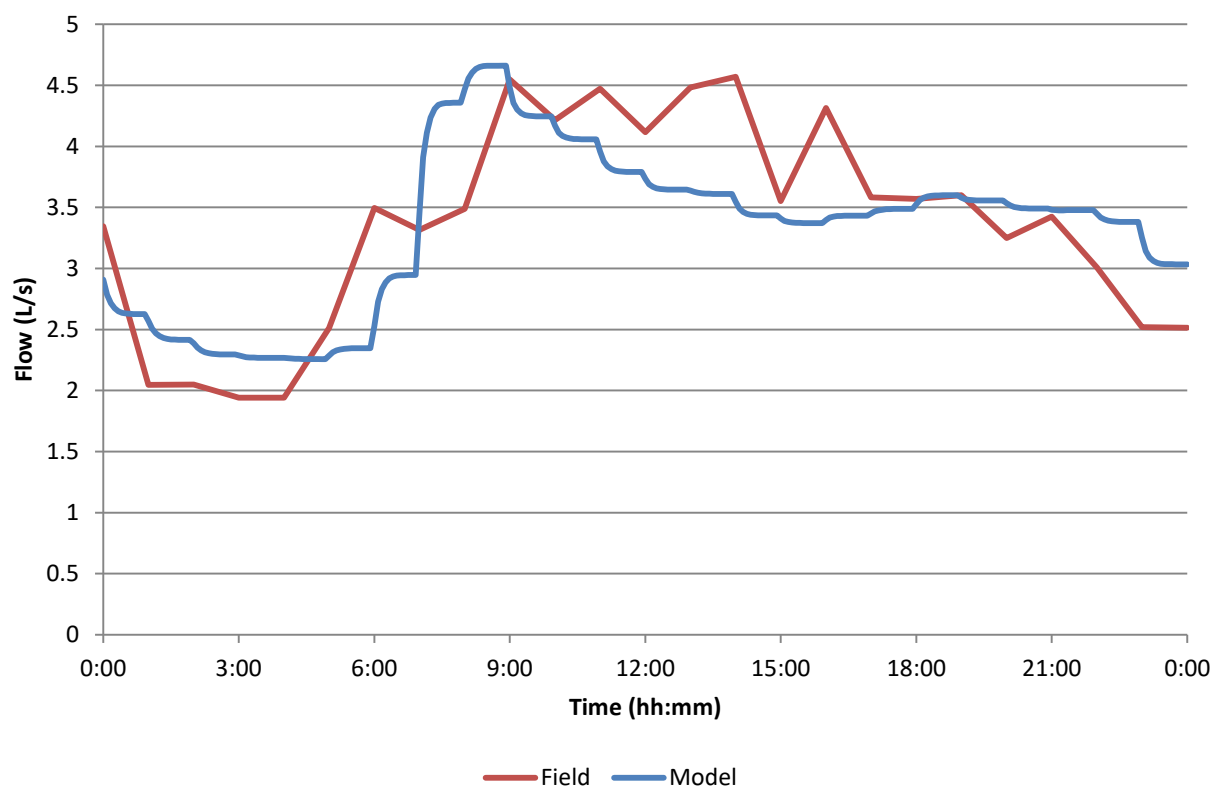


Lyll Mag Meter

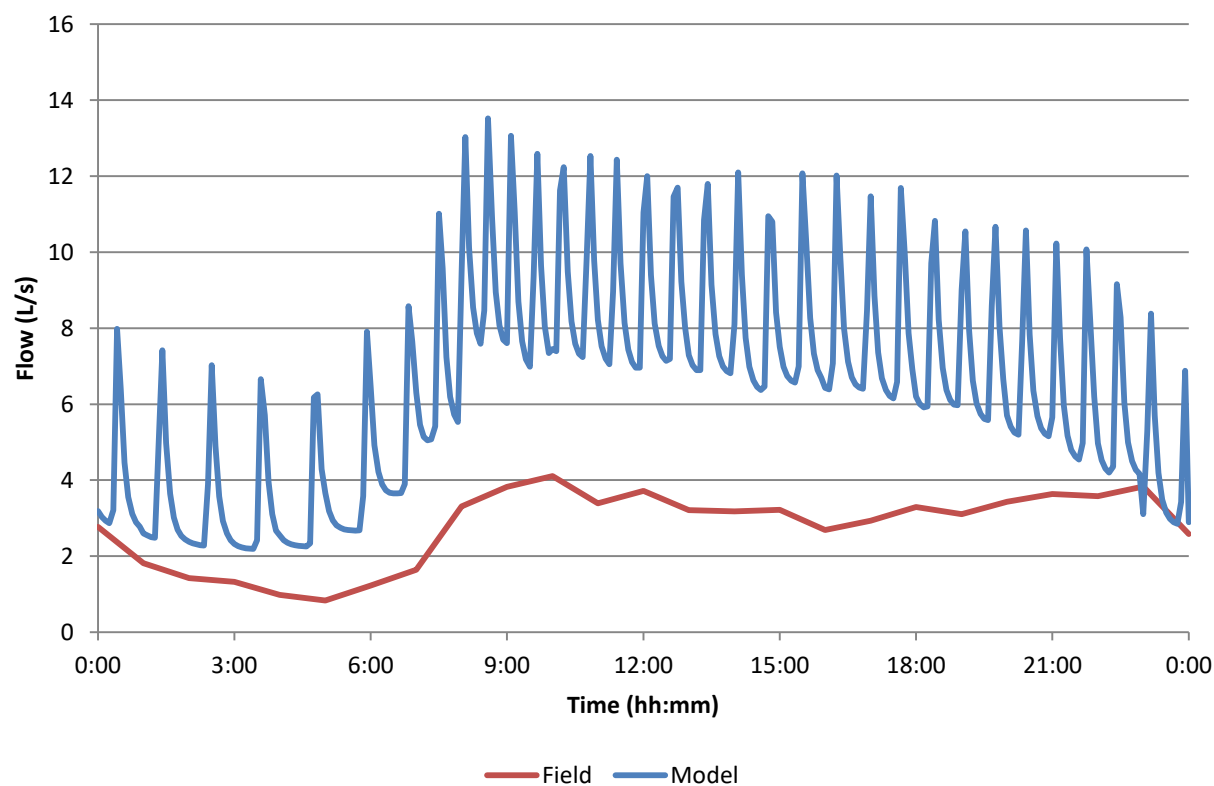


Esquimalt Sewer Model
DWF Calibration Graphs

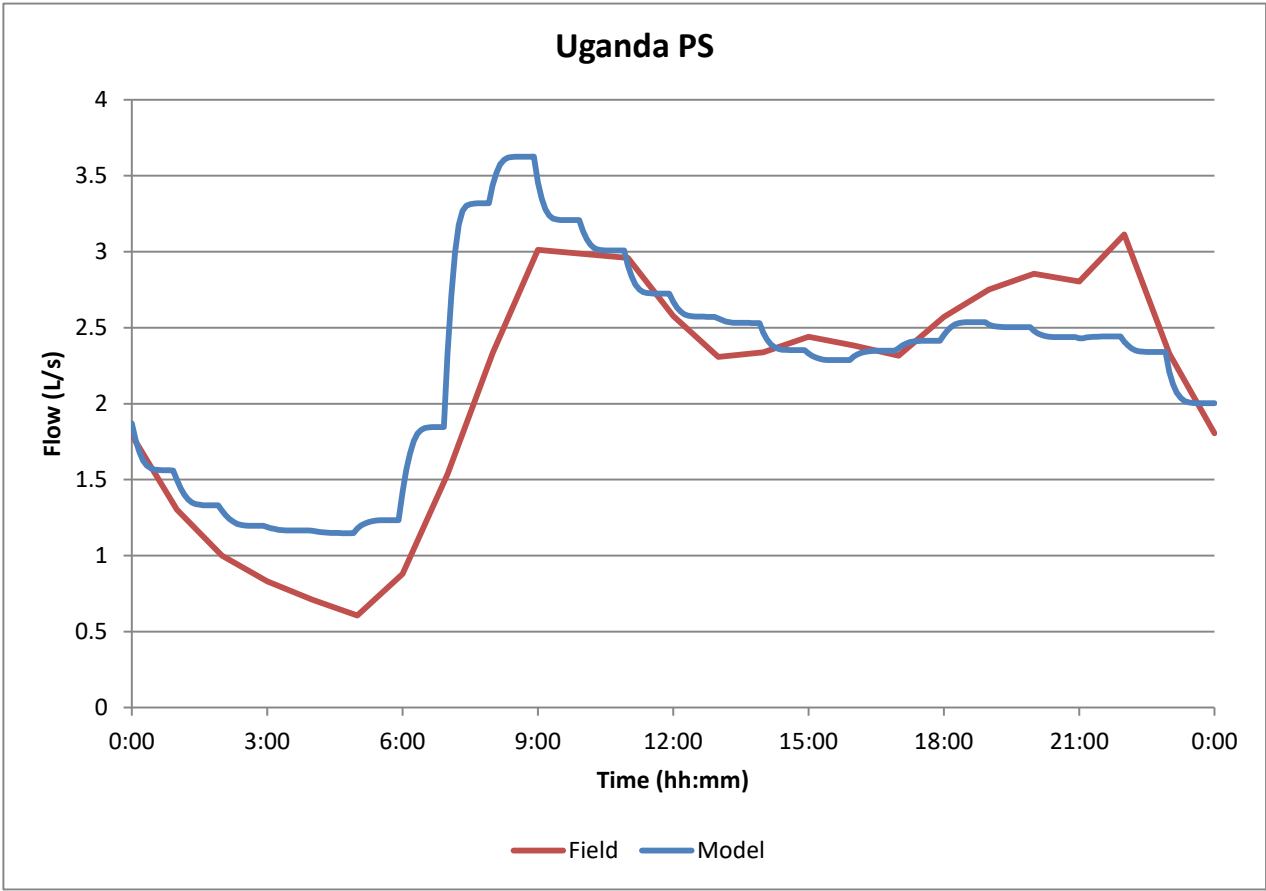
Wilson



Forshaw PS



Esquimalt Sewer Model
DWF Calibration Graphs





Appendix C DWF Validation Hydrographs

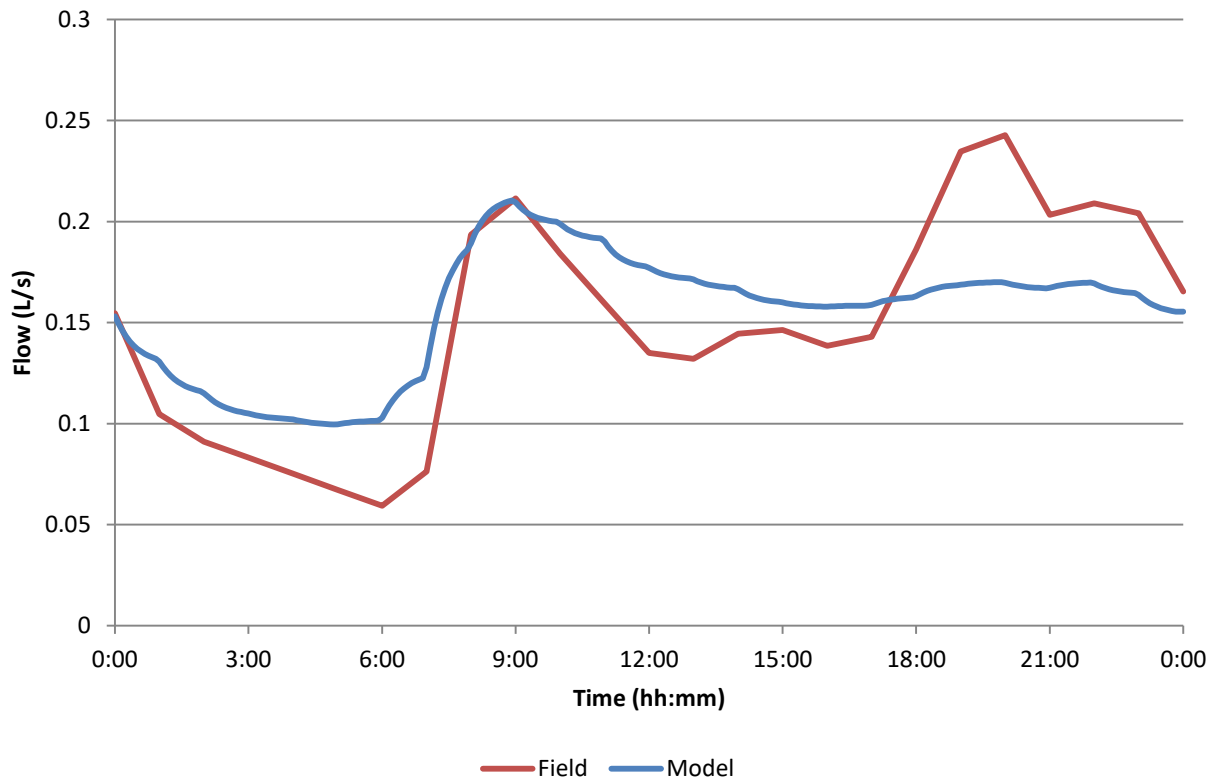


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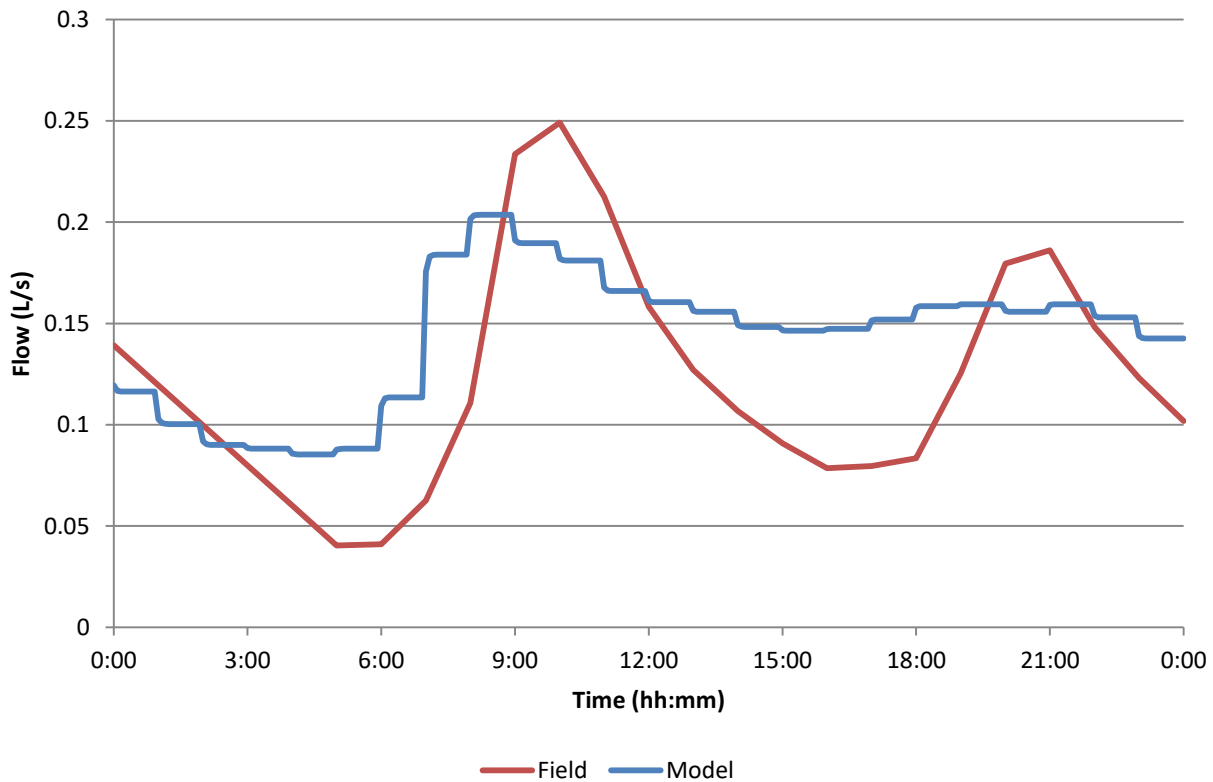
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Esquimalt Sewer Model
DWF Validation Graphs

Canteen

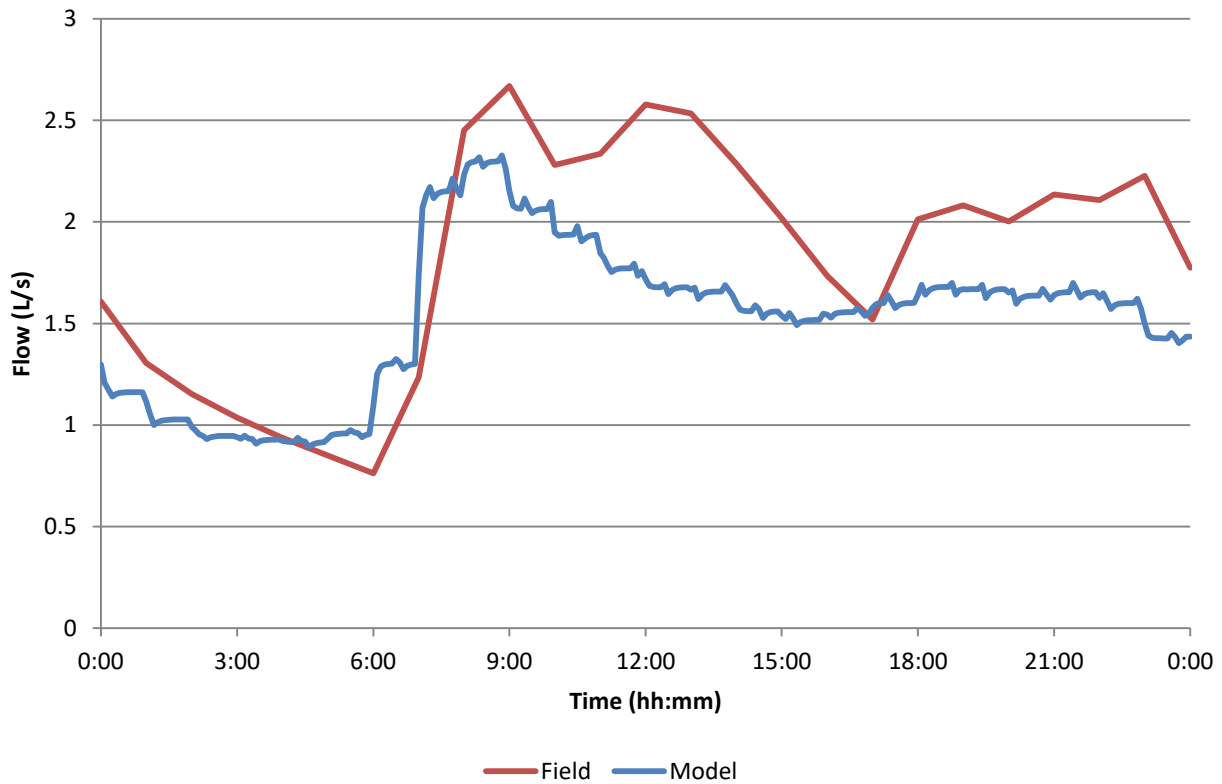


Constance

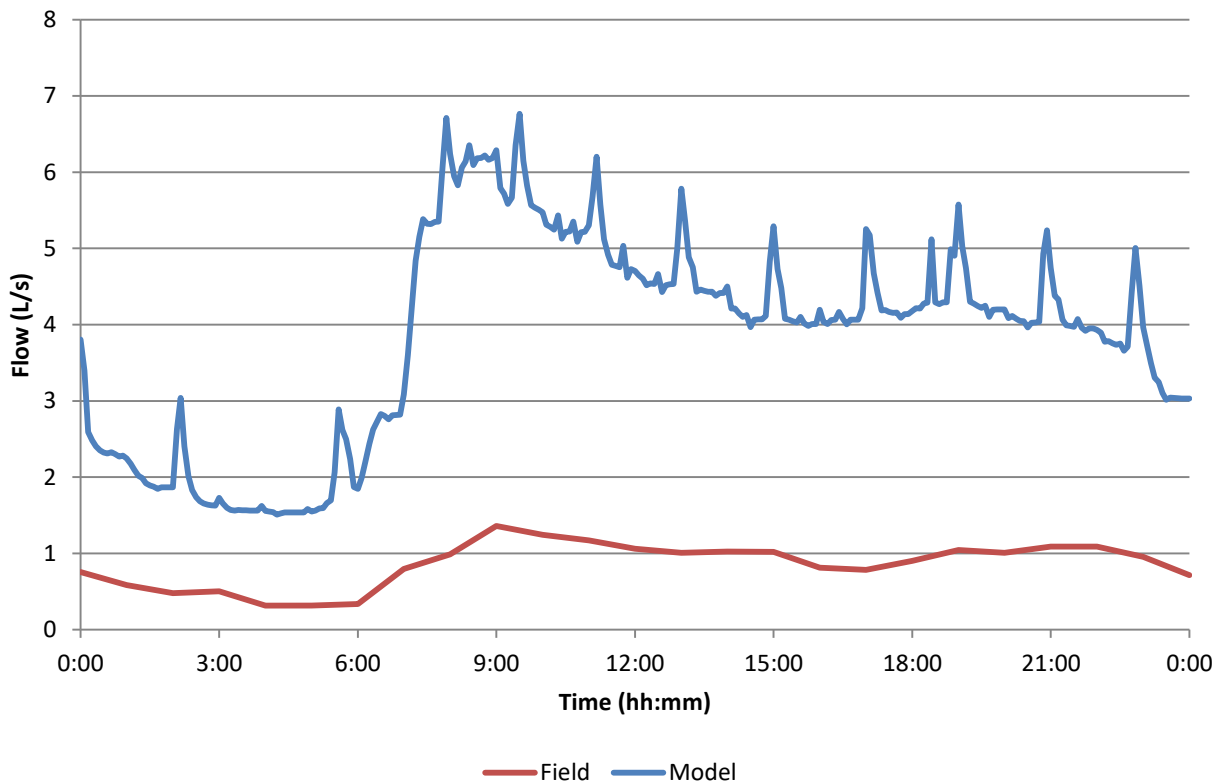


Esquimalt Sewer Model
DWF Validation Graphs

Garthland

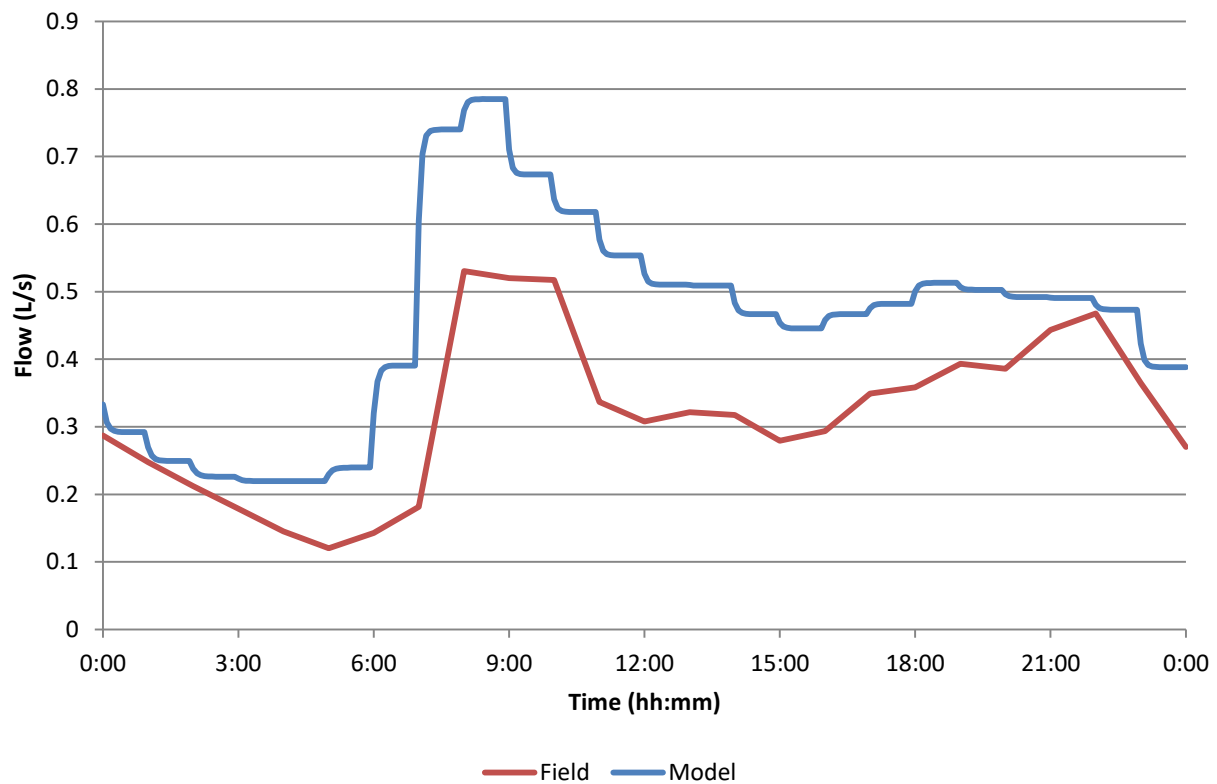


Grafton

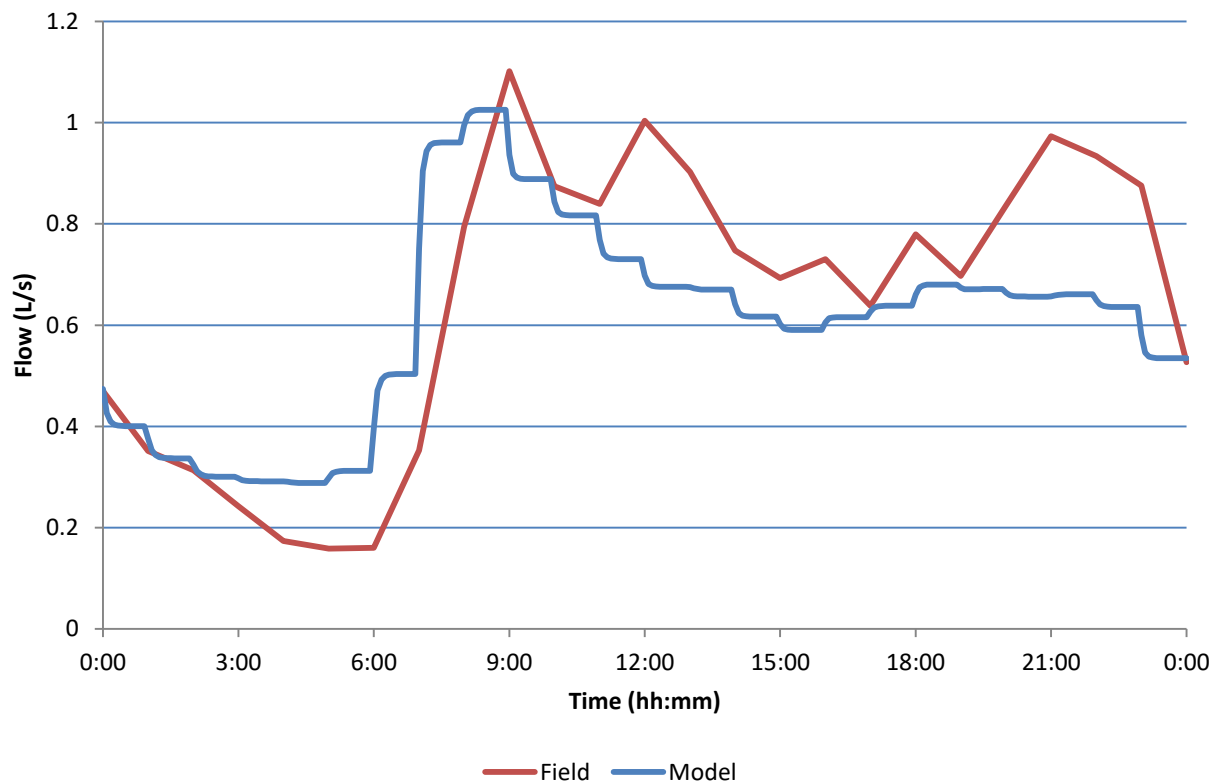


Esquimalt Sewer Model
DWF Validation Graphs

Luscombe



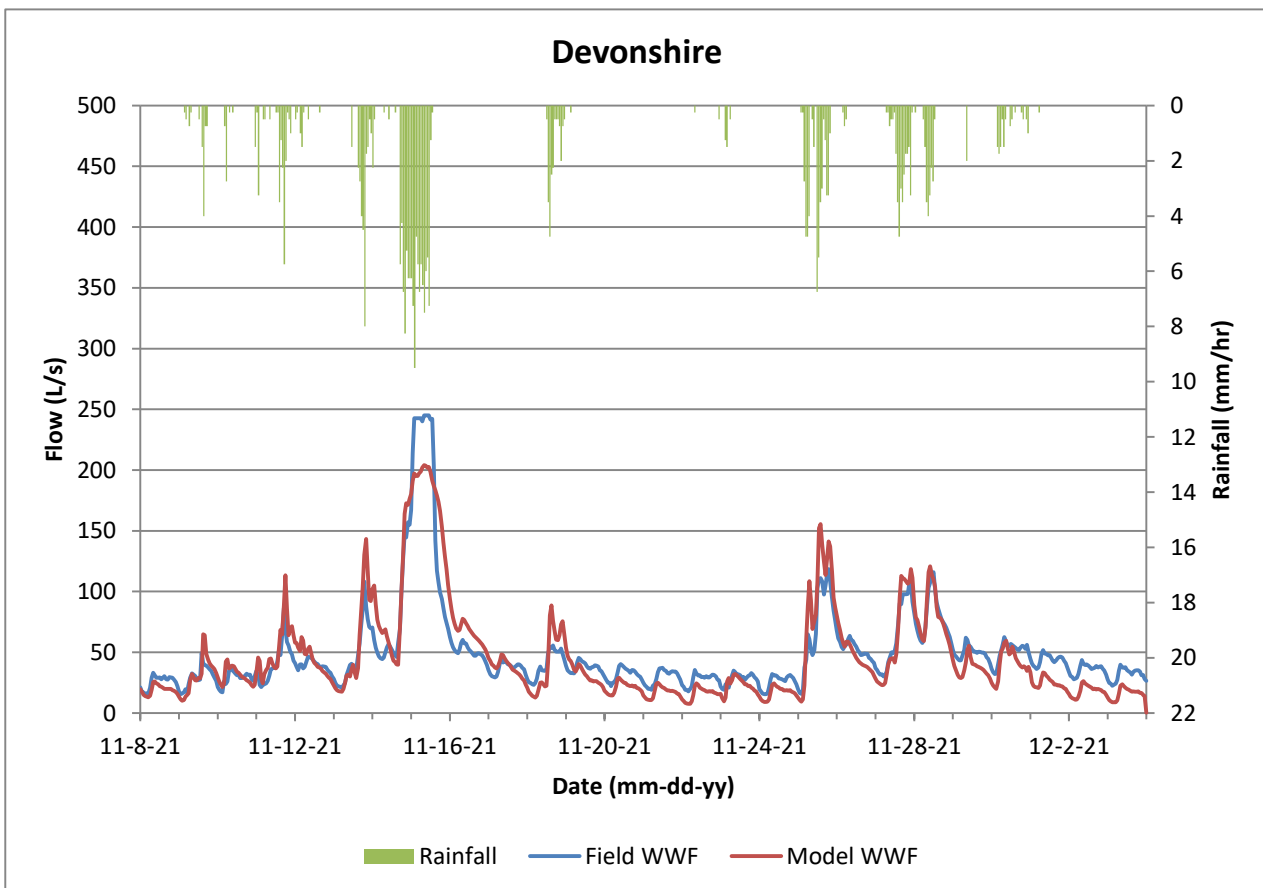
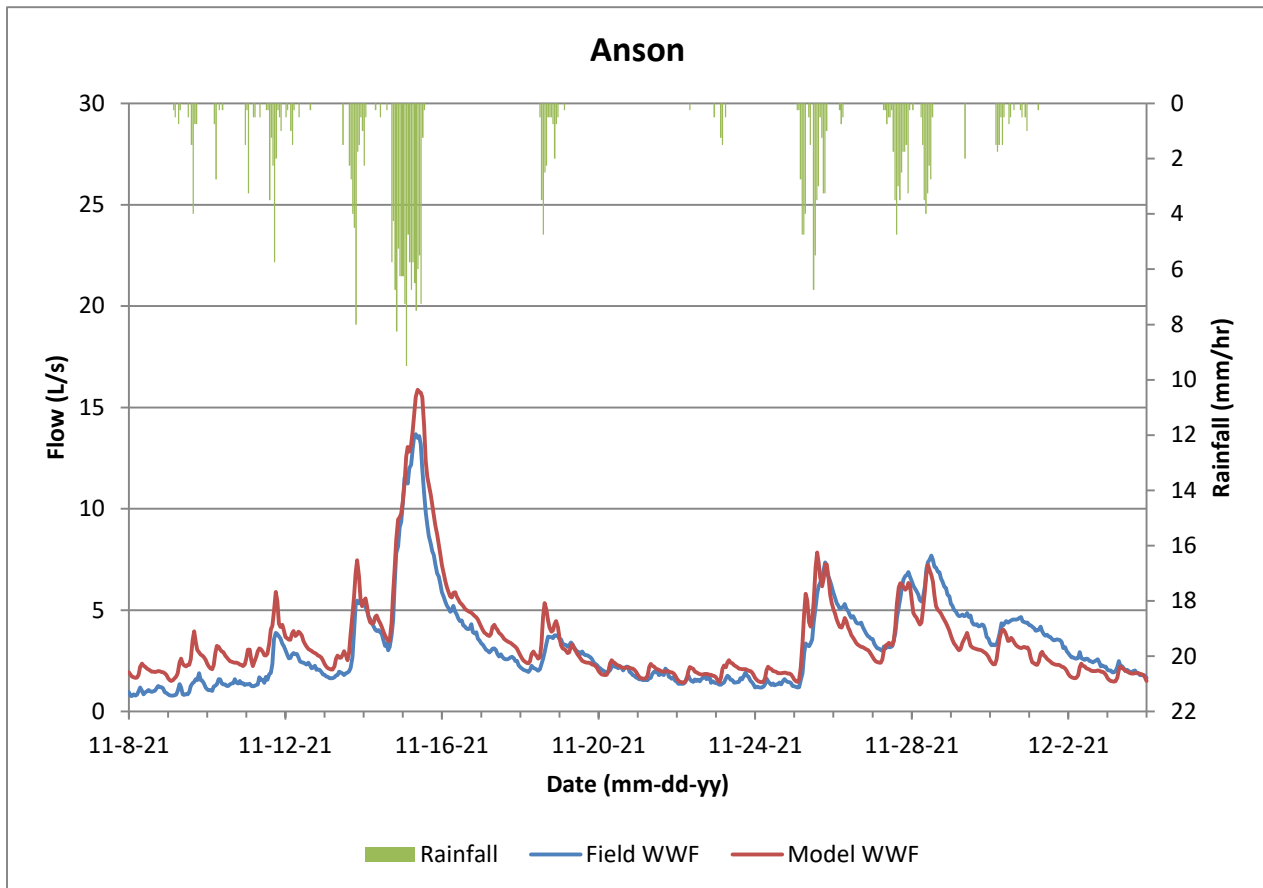
Sea Heaven





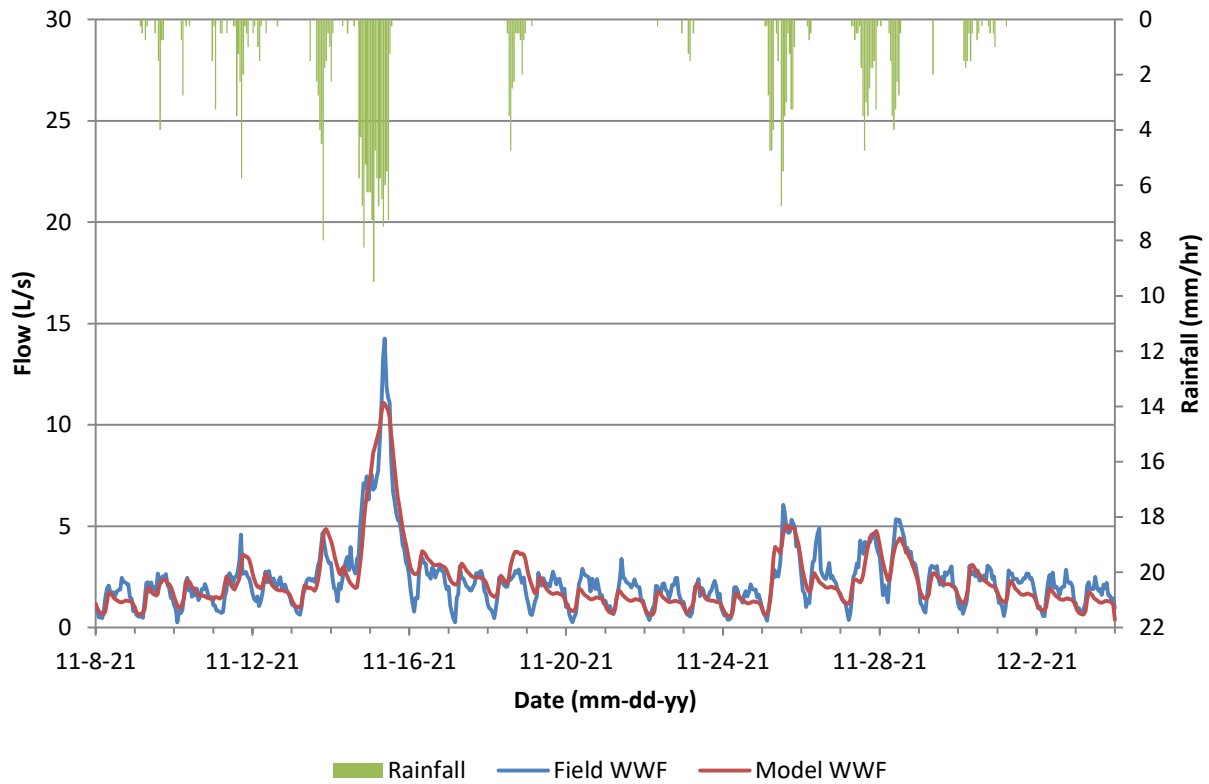
Appendix D WWF Calibration Hydrographs

Esquimalt Sewer Model
WWF Calibration Graphs (November 2021)

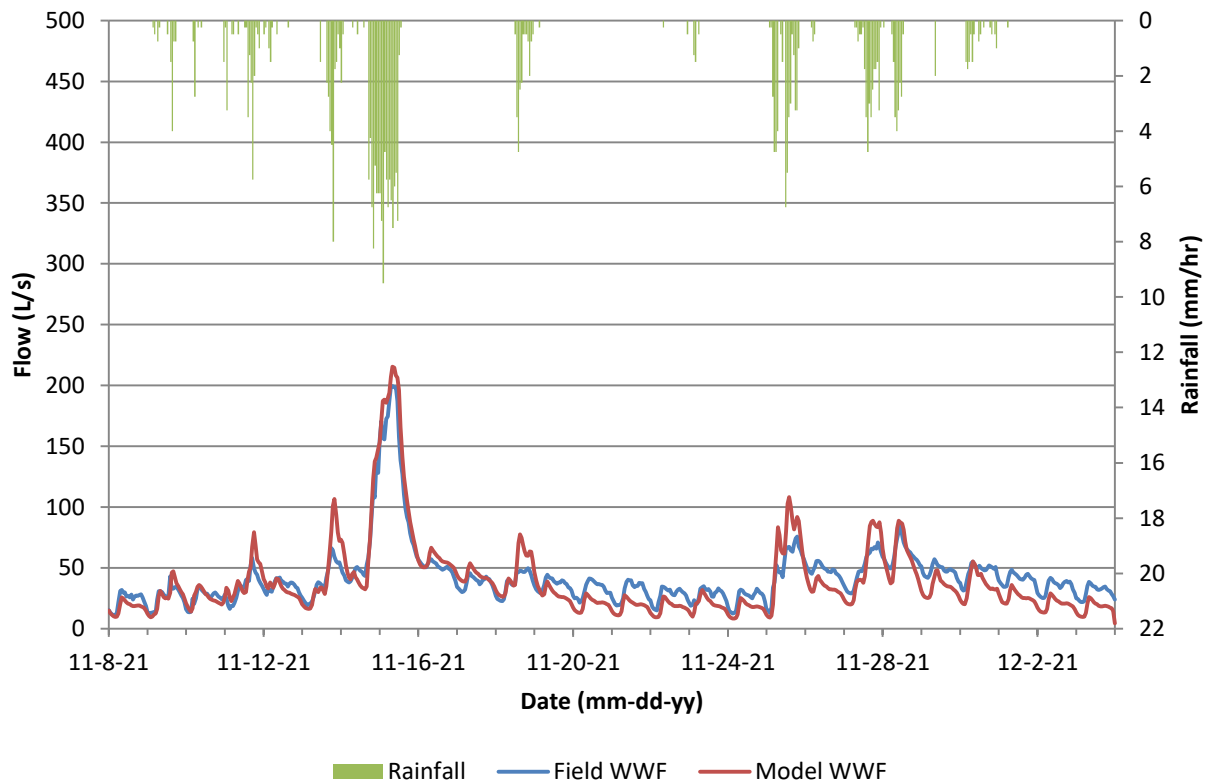


Esquimalt Sewer Model
WWF Calibration Graphs (November 2021)

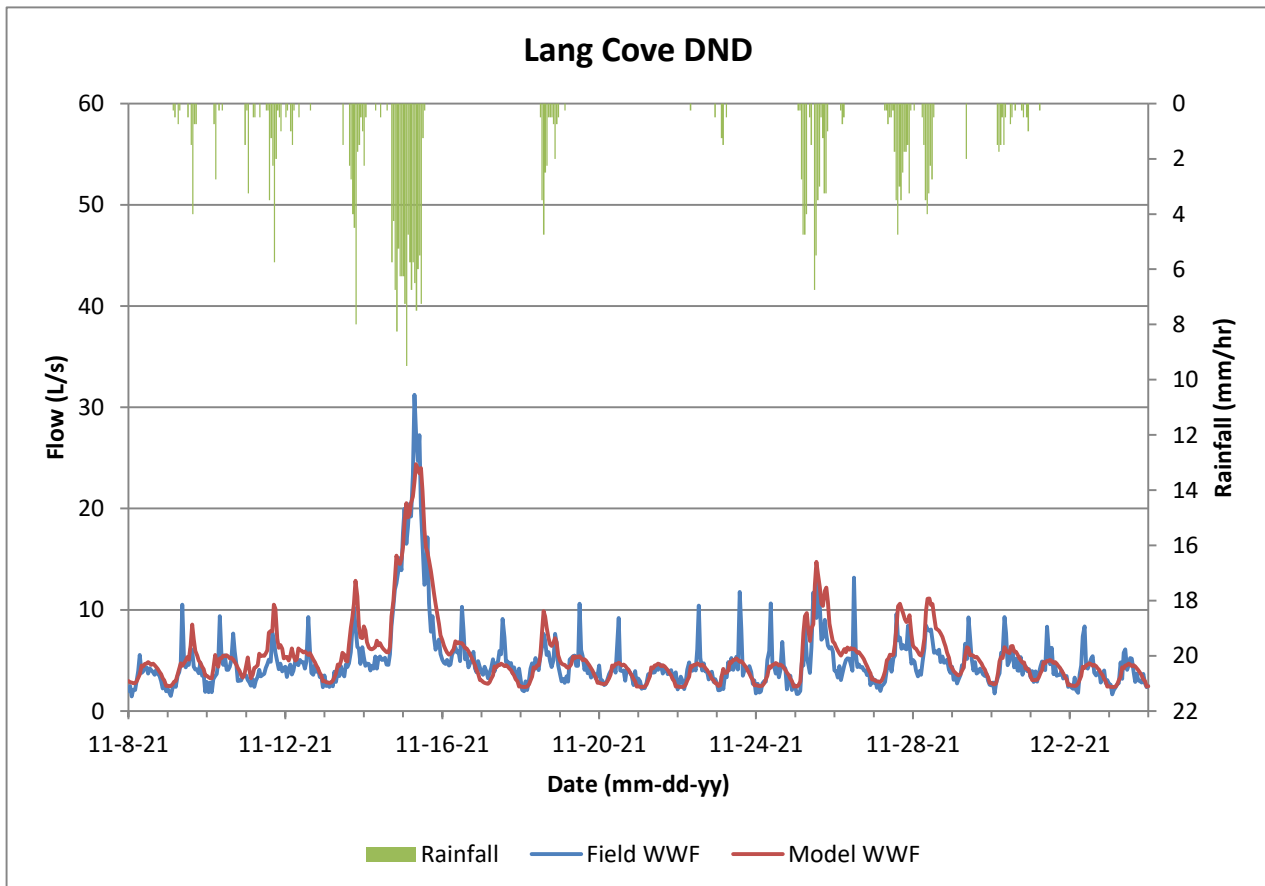
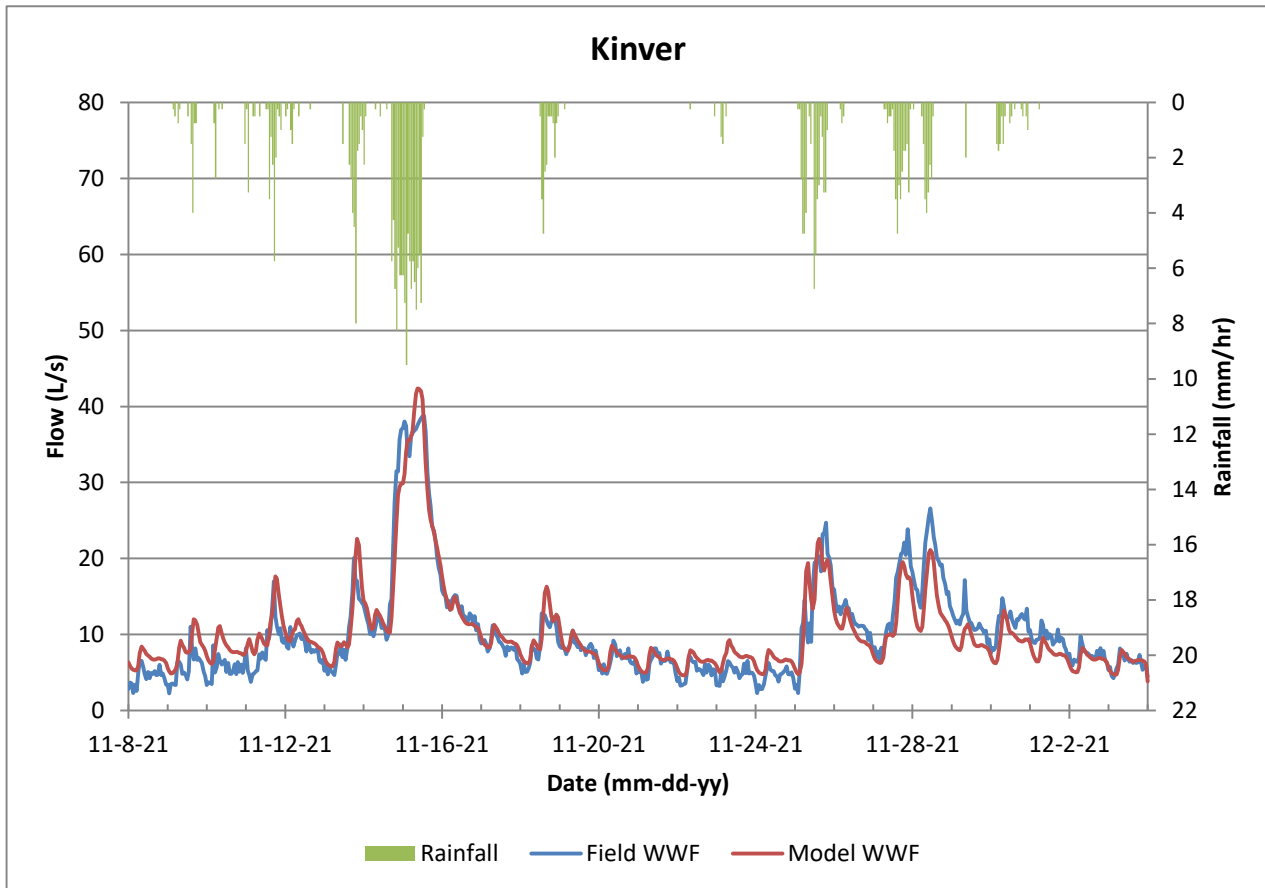
Esquimalt Panhandle



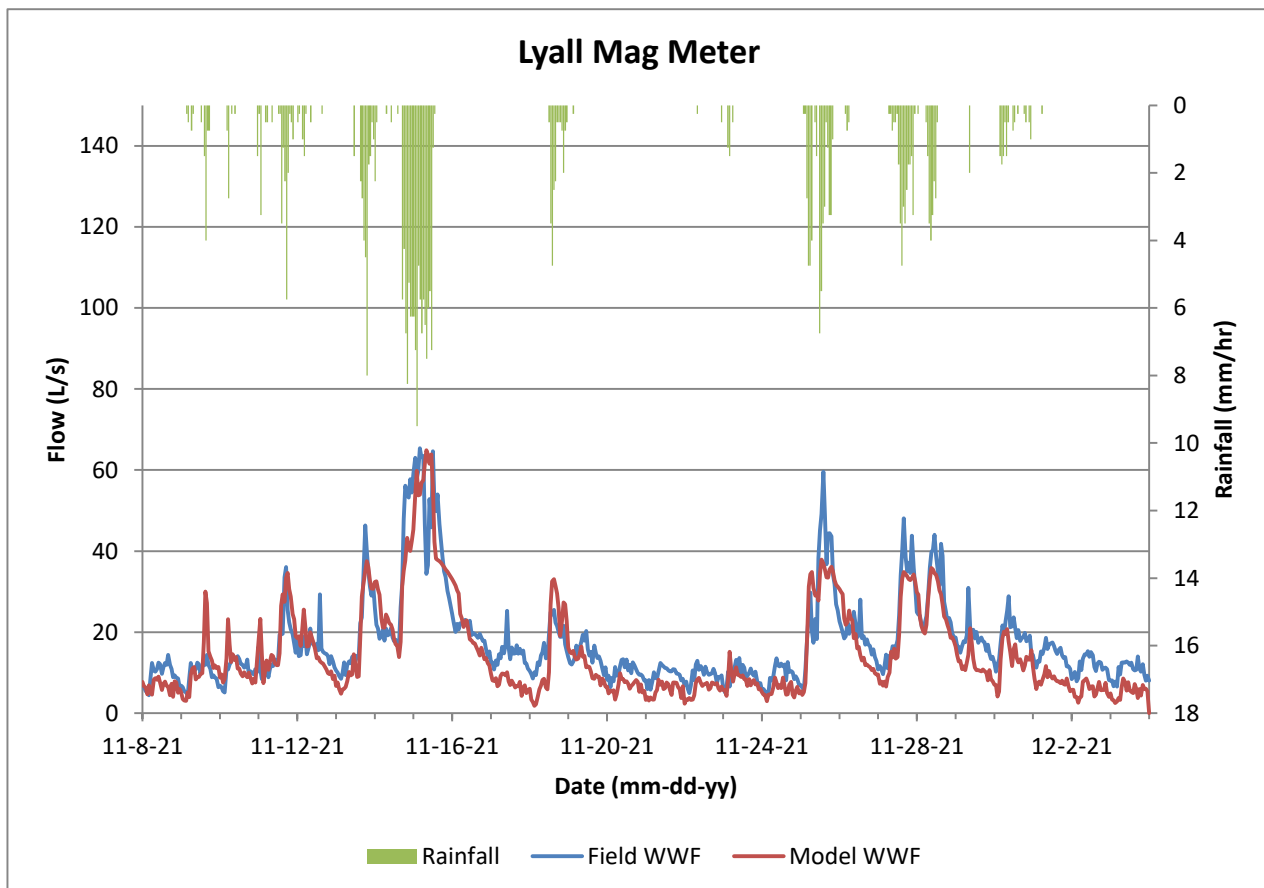
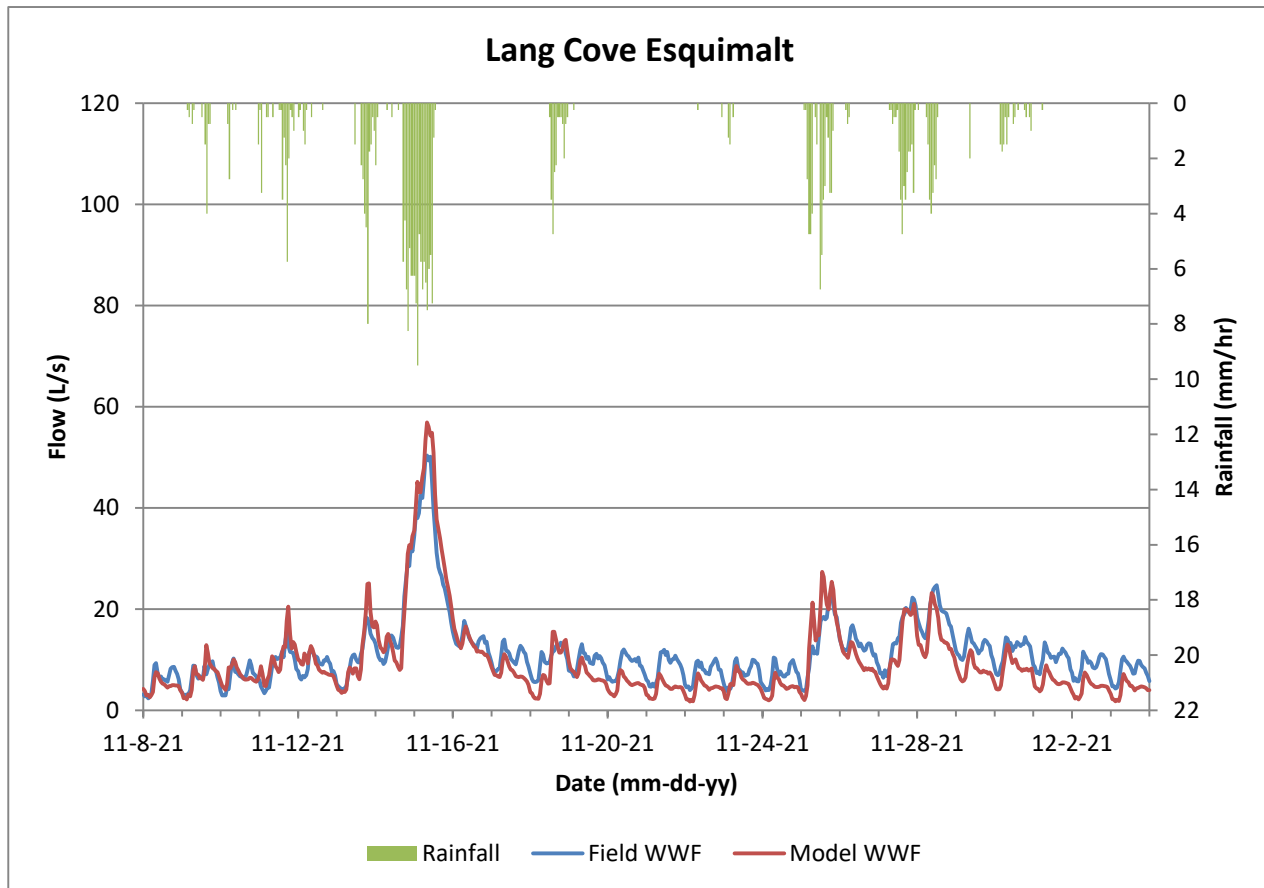
Head



Esquimalt Sewer Model
WWF Calibration Graphs (November 2021)

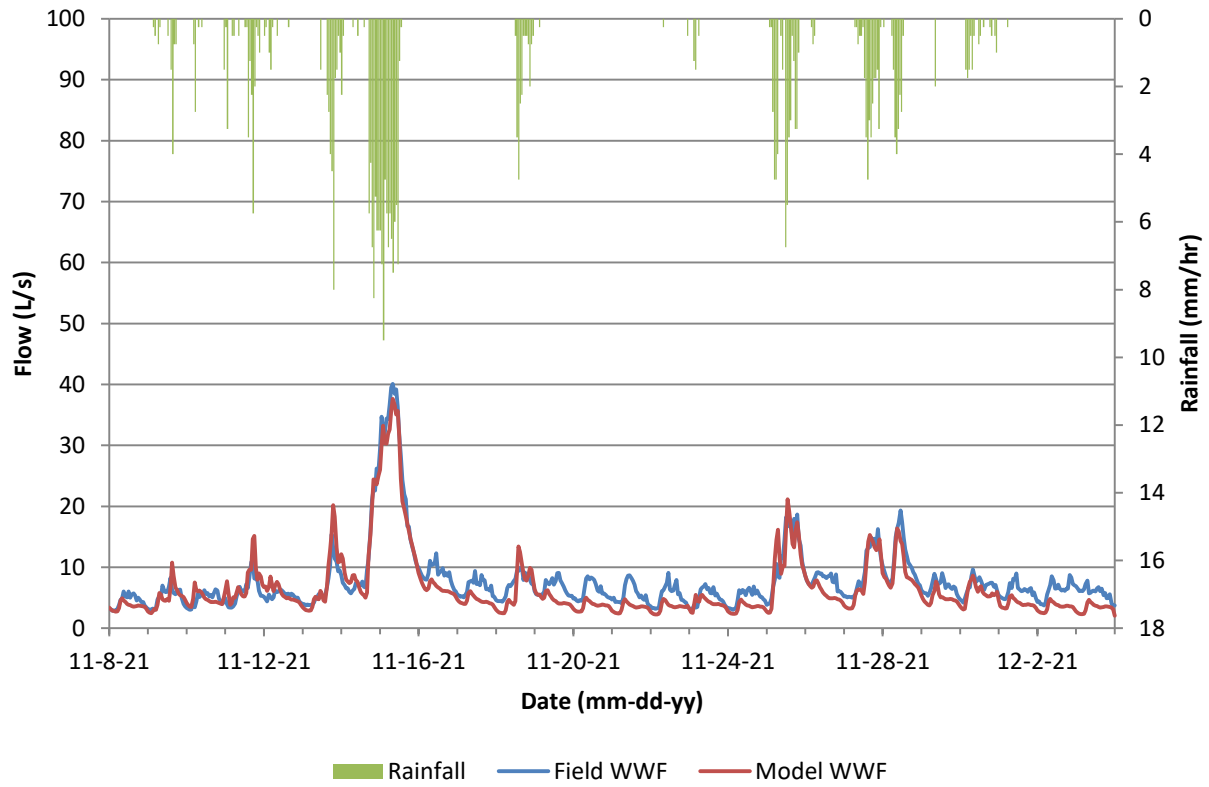


Esquimalt Sewer Model
WWF Calibration Graphs (November 2021)

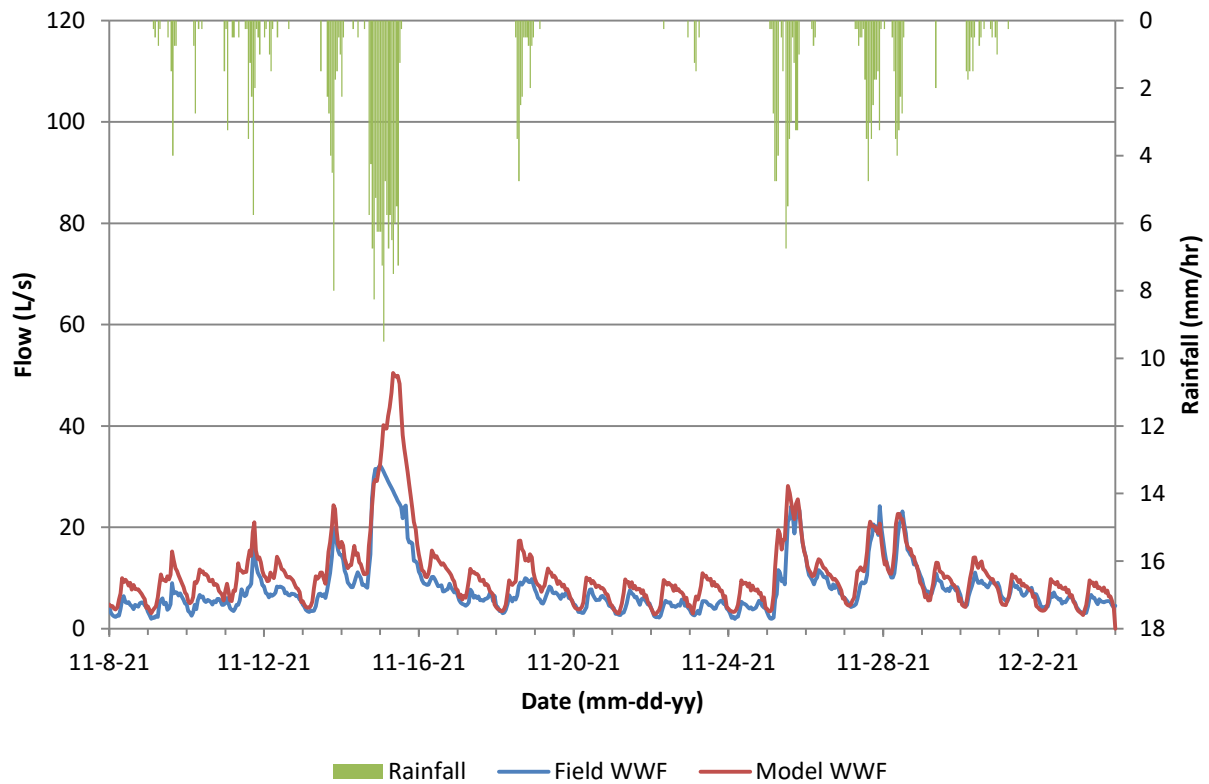


Esquimalt Sewer Model
WWF Calibration Graphs (November 2021)

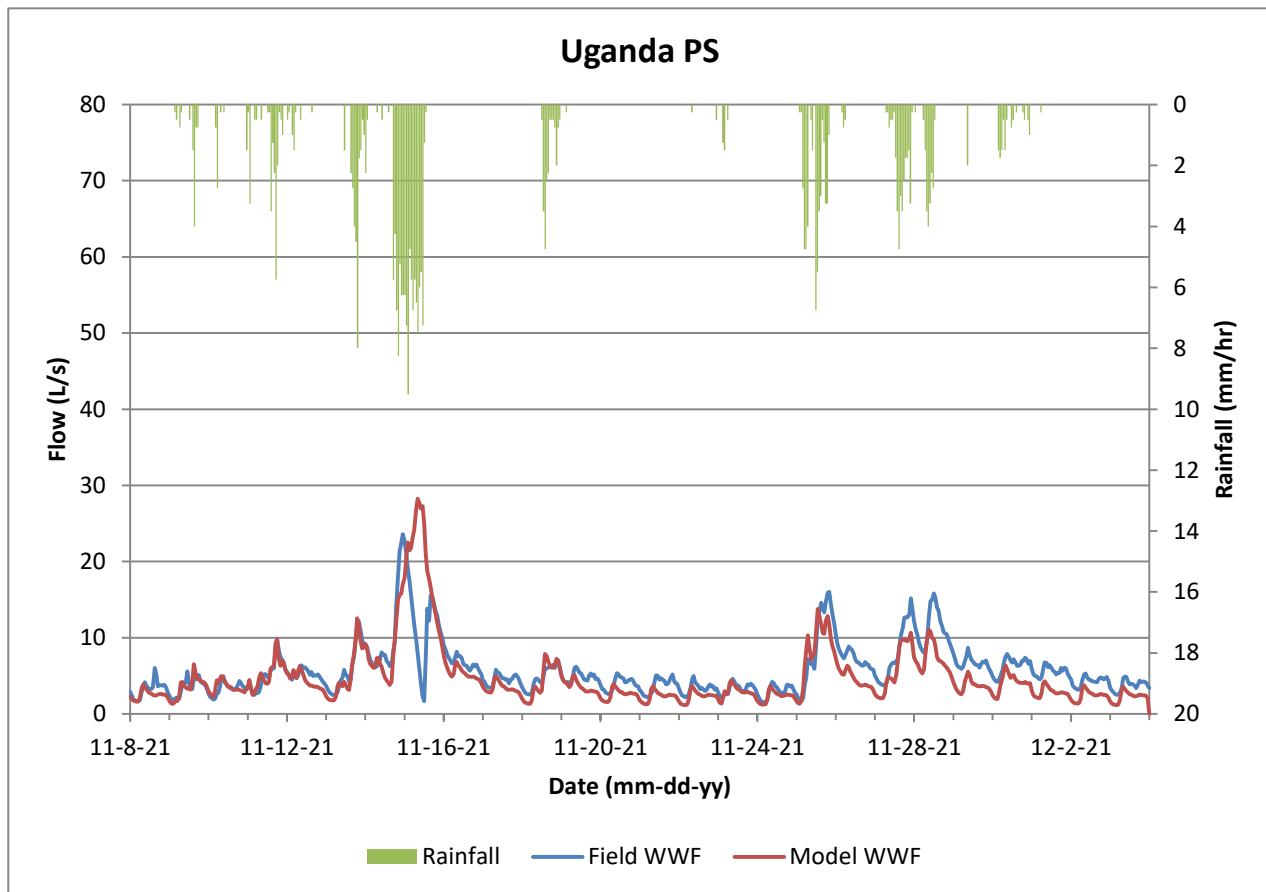
Wilson



Forshaw PS



Esquimalt Sewer Model
WWF Calibration Graphs (November 2021)





Appendix E WWF Validation Hydrographs

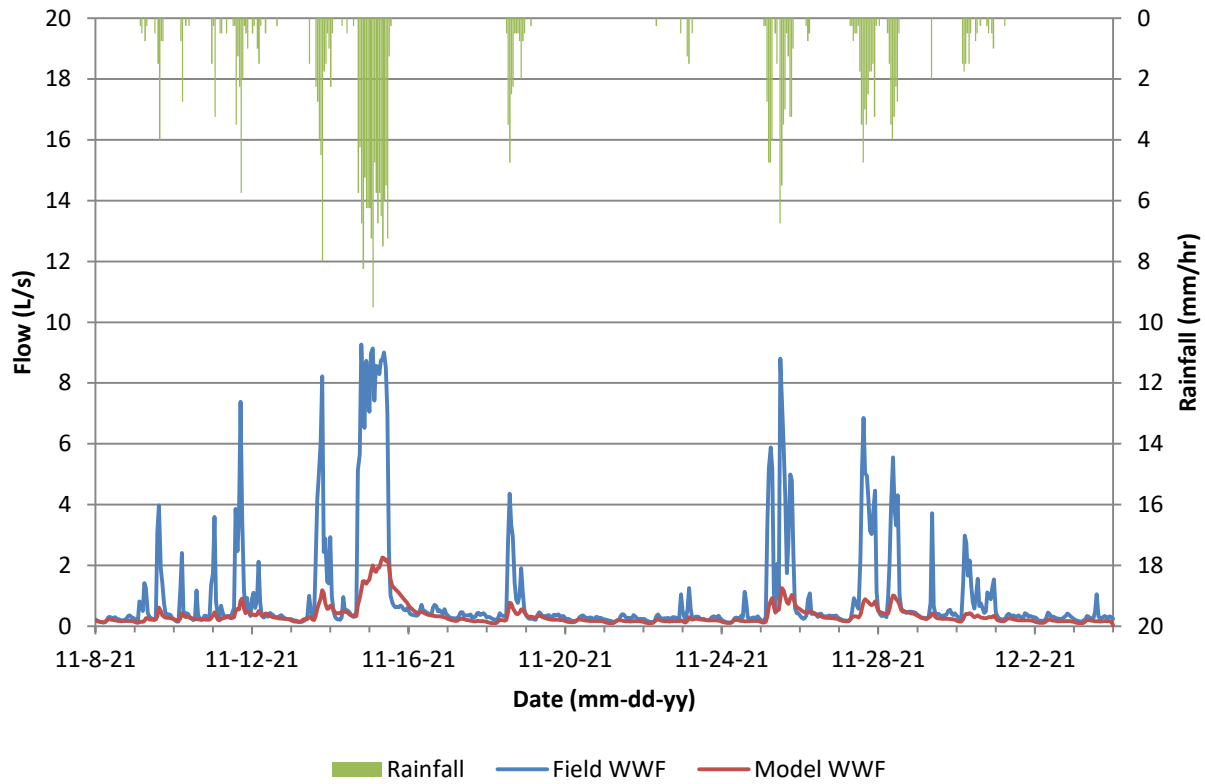


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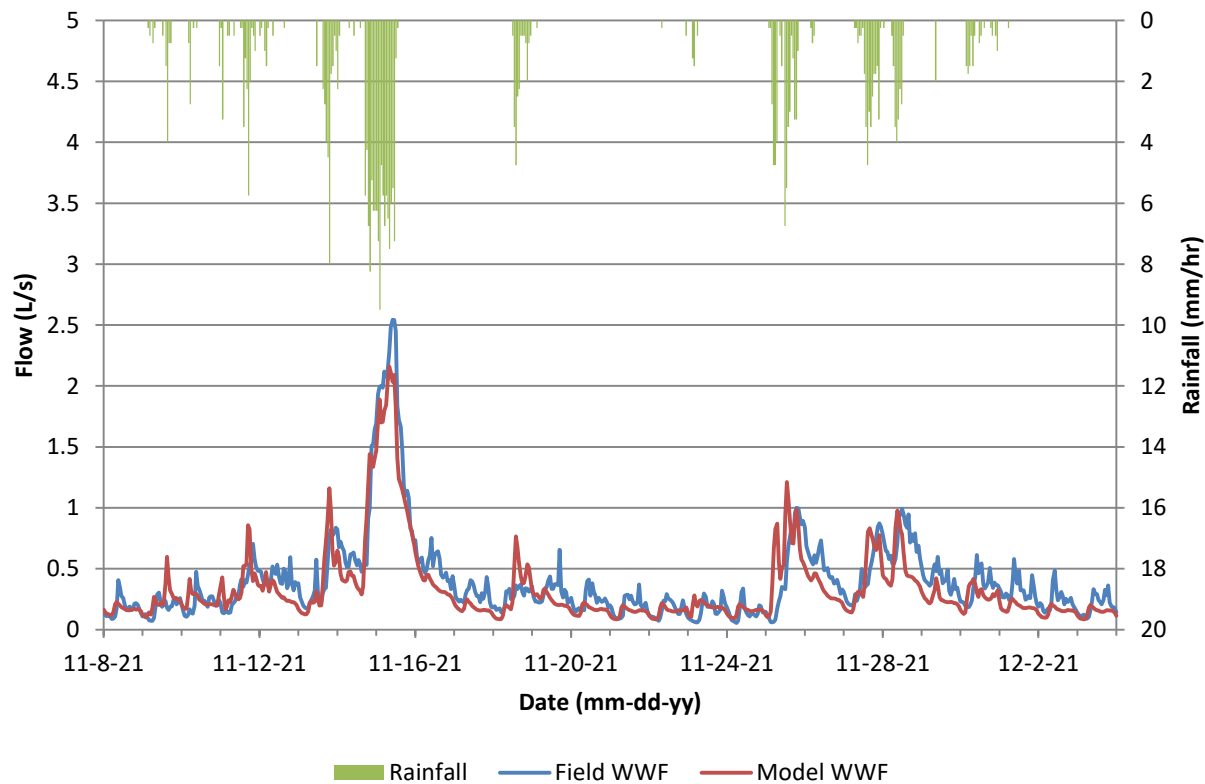
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WWF Validation Graphs (November 2021)

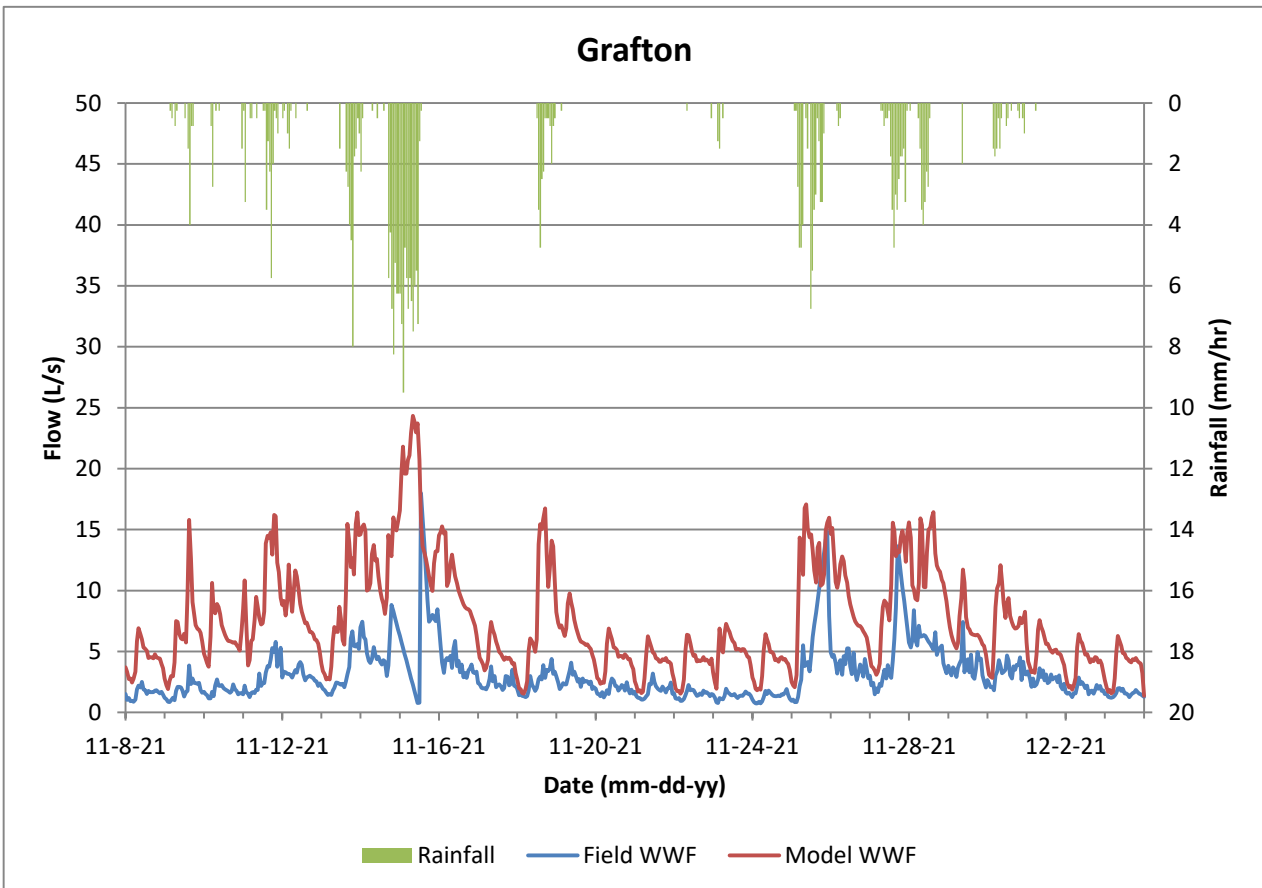
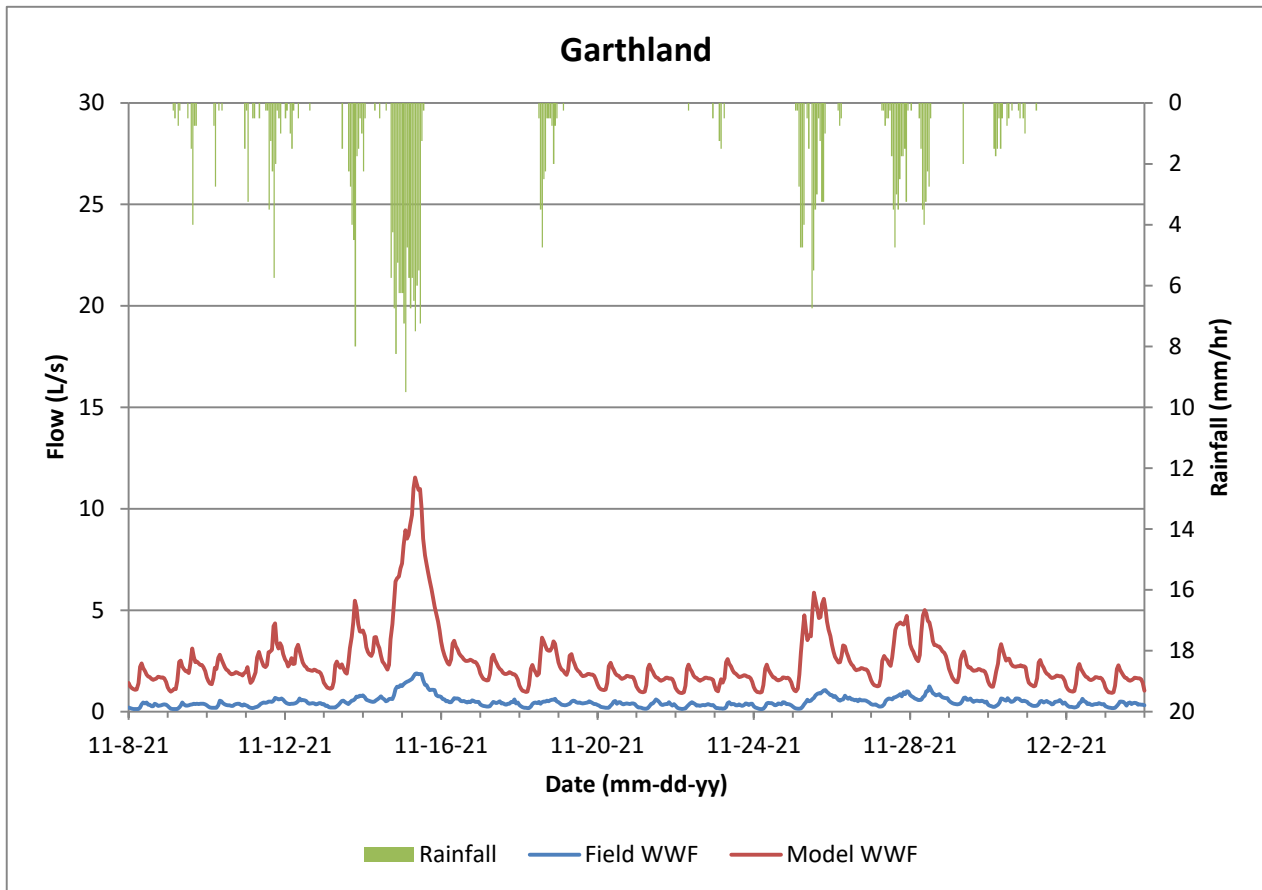
Canteen



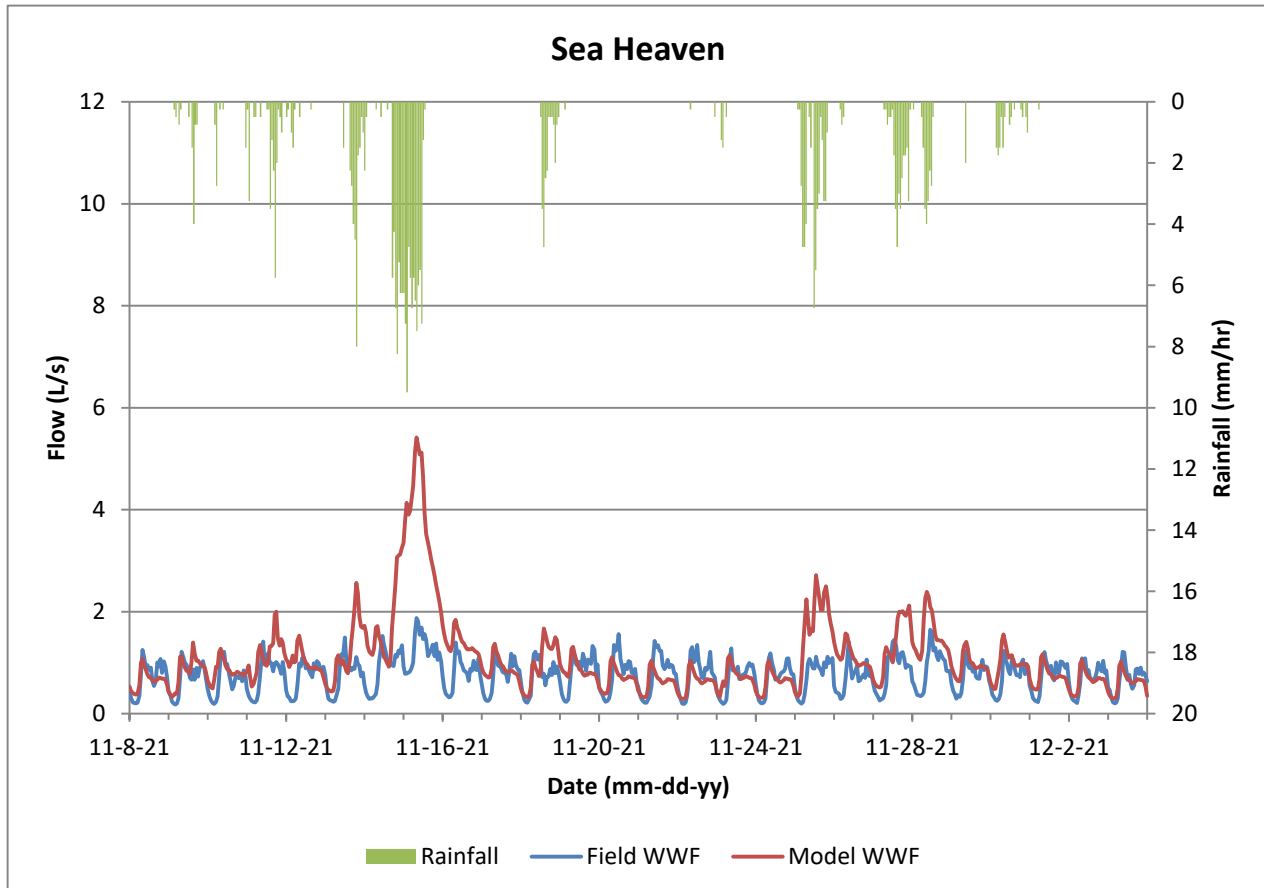
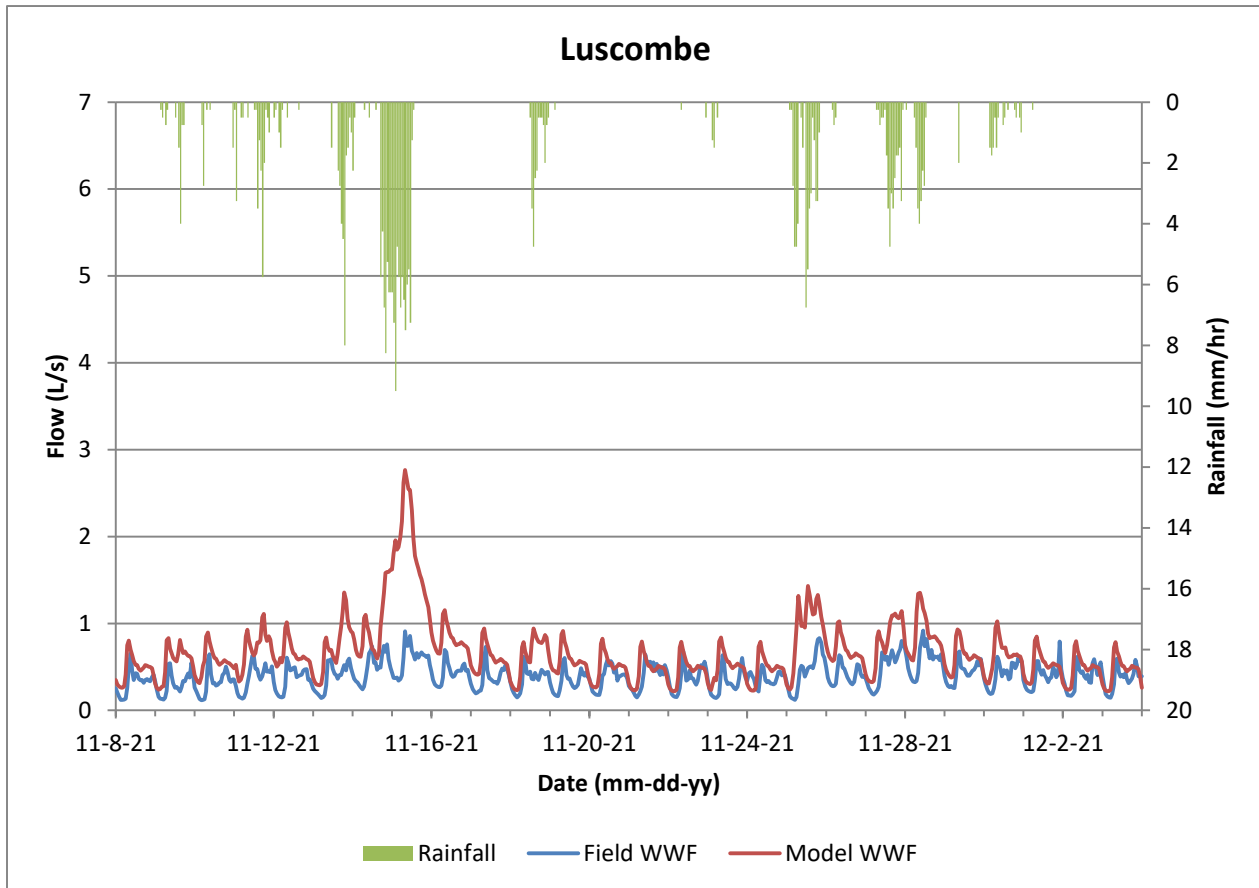
Constance



Esquimalt Sewer Model
WWF Validation Graphs (November 2021)



Esquimalt Sewer Model
WWF Validation Graphs (November 2021)





Appendix F DWF and WWF Results Comparison



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Sites	Calibration/Validation	DWF Calibration/Validation - Results Comparison	WWF Calibration/Validation - Results Comparison
Anson	Calibration Sites	It is important to acknowledge that matching model flows accurately with field data can be challenging at low flow rates. The inherent flow variability in small catchments as well as higher errors in flow monitor readings at low flows can lead to minor discrepancies. In this case, the observed flow difference between the model and field of only 0.6 L/s is within the expected margin of error for a catchment of this size. Additionally, the model is conservative.	Excellent match
Devonshire		Excellent match	The average flow difference is within 5% and the peak flow difference is within 17%. The measured peak flow looks questionable, given the otherwise strong alignment of the rest of the storm event with the model. As such, no further changes were made to the graphs.
Esquimalt Panhandle		Excellent match	Excellent match
Head		Excellent match	Excellent match
Kinver		Excellent match	Excellent match
Lang Cove DND		Good match	Excellent match
Lang Cove Esquimalt		Excellent match	Excellent match
Lyall Mag Meter		Excellent match	Excellent match
Wilson		Excellent match	Excellent match
Forshaw PS		The effect of the upstream pump station is higher in the model data than the field data. This is likely a result of the model flows being attenuated quicker than field flows due to limitation in the model's engine. However, the average model and field flows at this location have a good match. Additionally, the model is conservative.	It appears that data are missing in the field at the time of the peak flow. As such, no further changes were made to the graphs.
Uganda PS		Excellent match	Excellent match
Canteen	Validation Sites	Excellent match	Flow too low and excellent match for the DWF calibration.
Constance		Excellent match	Excellent match
Garthland		Excellent match	It appears that the field data during the storm event were not significantly affected by the rainfall, raising suspicion given the nature of the storm. The DWF calibration resulted in an excellent match, and the model is conservative. Therefore, no further changes were made to the model.
Grafton		The effect of the upstream pump station is higher in the model data than the field data. This is likely a result of the model flows being attenuated quicker than field flows due to limitation in the model's engine. However, the average model and field flows at this location have a good match. Additionally, the model is conservative.	Good match
Luscombe		Excellent match	It appears that the field data during the storm event were not significantly affected by the rainfall, raising suspicion given the nature of the storm. The DWF calibration resulted in an excellent match, and the model is conservative. Therefore, no further changes were made to the model.
Sea Heaven		Excellent match	It appears that the field data during the storm event were not significantly affected by the rainfall, raising suspicion given the nature of the storm. The DWF calibration resulted in an excellent match, and the model is conservative. Therefore, no further changes were made to the model.



Appendix G Final RTK Calibration Parameters

Table G.1: Catchment RTK Parameters

Flow Monitoring Catchment	R Total	R1	R2	R3	T1	T2	T3	K1	K2	K3
Anson	0.120	0.025	0.045	0.050	2.0	6.0	24.0	1.0	3.0	3.0
Devonshire	0.190	0.050	0.075	0.065	1.0	6.0	20.0	2.0	2.0	3.0
Esquimalt Panhandle	0.052	0.005	0.025	0.022	1.0	4.0	24.0	3.0	3.0	4.0
Head	0.120	0.030	0.040	0.050	1.0	5.0	24.0	3.0	2.0	4.0
Kinver	0.070	0.025	0.025	0.020	2.0	7.0	24.0	2.0	3.0	3.0
Langcove DND	0.043	0.015	0.015	0.013	1.0	6.0	10.0	2.0	2.0	4.0
Lang Cove Esquimalt	0.057	0.015	0.022	0.020	1.0	5.0	15.0	2.0	3.0	4.0
Lyll Mag Meter	0.100	0.040	0.035	0.025	1.0	6.0	12.0	2.0	3.0	4.0
Wilson	0.115	0.045	0.045	0.025	1.0	5.0	15.0	2.0	3.0	4.0
Forshaw	0.095	0.025	0.045	0.025	1.0	5.0	15.0	2.0	3.0	4.0
Uganda	0.095	0.025	0.045	0.025	1.0	5.0	15.0	2.0	3.0	4.0



Appendix H IDF Curves

The IDF curves utilized in the model are summarized in **Table H.1** and **Table H.2**.

Table H.1: Historic IDF (Environment Canada Victoria Gonzales CS) – Modified Chicago Distribution (All values are rainfall depths in mm)

Return Period Duration	2 years	5 years	10 years	20 years	25 years	50 years	100 years
5 min	1.83	2.58	3.15	3.76	3.97	4.66	5.42
10 min	2.59	3.60	4.38	5.23	5.52	6.48	7.55
15 min	3.18	4.26	5.13	6.10	6.44	7.60	8.93
30 min	4.66	5.82	6.78	7.88	8.27	9.62	11.20
1 h	7.36	8.98	10.11	11.22	11.58	12.72	13.89
2 h	11.51	14.27	16.14	17.95	18.53	20.34	22.16
6 h	22.70	29.33	34.15	39.13	40.79	46.15	51.86
12 h	33.77	45.33	53.70	62.29	65.14	74.31	84.03
24 h	43.96	61.36	74.67	88.97	93.85	110.00	127.85

Table H.2: OCP Climate Change-Adjusted IDF (Environment Canada Victoria Gonzales CS) – Modified Chicago Distribution (All values are rainfall depths in mm)

Return Period Duration	2 years	5 years	10 years	20 years	25 years	50 years	100 years
5 min	1.98	2.76	3.37	4.07	4.35	5.16	6.04
10 min	2.81	3.87	4.68	5.66	6.04	7.17	8.37
15 min	3.46	4.58	5.43	6.56	7.01	8.31	9.78
30 min	5.07	6.25	7.22	8.48	8.96	10.47	12.12
1 h	8.01	9.64	10.78	12.16	12.65	14.37	15.55
2 h	12.53	15.31	17.21	19.48	20.27	23.02	24.94
6 h	24.72	31.43	36.34	42.53	44.88	51.65	57.87
12 h	36.77	48.59	57.15	67.79	71.73	83.19	94.20
24 h	47.62	65.81	79.74	96.35	102.79	121.87	142.14

Note: Data projected for the period 2021 – 2051, assuming the RCP 4.5 climate change scenario and utilizing all ensembles with PCIC bias correction.



Appendix I USL Technical Memorandum – Infrastructure Prioritization & Capital Planning (January 29, 2025)

DATE: January 29, 2025
TO: Joel Clary, P.Eng.
CC: Adrien d'Andrade, P.Eng.
FROM: Kara Labelle, Alex Kempa, Mark Stafford, P.Eng.
FILE: 3275.0021.01
SUBJECT: Sanitary Sewer Asset Management Plan: Infrastructure Prioritization & Capital Planning

1.0 INTRODUCTION

The Sanitary Sewer Asset Management Plan is a comprehensive, 20-year guide for managing the utility with regard to capital and select project improvements. This memo summarizes the results of a risk-based infrastructure assessment guided by the methodology outlined in the *Esquimalt Sanitary Sewer Asset Management Plan: Risk Prioritization* (August 14, 2024), attached in Appendix A to create a list of priority renewal projects for linear infrastructure and lift stations in the Township of Esquimalt (the Township). The outcomes of the risk assessment are integrated into various funding scenarios to help facilitate discussions with Finance and Council. As recommended herein, these discussions will focus on raising infrastructure funding needs, managing risk levels, and efficiently delivering projects to support the long-term service delivery of the sanitary sewer system. In addition to capital prioritization, the Township's operation and maintenance practices for the sewer system were reviewed, with recommendations to maintain and/or enhance service delivery based on best practices or insights from Township staff. The results from this review are appended and include high level cost estimates to give an order of magnitude understanding of the funding required to align with industry standards.

2.0 ASSET MANAGEMENT

The Township owns, operates, and maintains approximately 57.3 km of gravity sewers, 3.8 km of forcemains, and 13 pump stations. Each year, Engineering and Public Works replaces or refurbishes portions of this infrastructure to maintain system performance. Approximately 23% (based on pipe length) of the Township's linear sanitary sewer network has exceeded its design life, indicating an existing backlog of asset replacement. Based on discussion with the Township, historic capital spending levels for sanitary sewer rehabilitation drastically fluctuate, as rehabilitation efforts are primarily reactive. For the purpose of setting a baseline in this report, staff recommended using \$1M. Further information on capital spending for the sanitary sewer is included in Section 4.0.

The total value of the Township's gravity assets, forcemains, and pump stations, based on the unit rates reported in the *Sanitary Asset Management Plan Unit Cost Estimating* (August 12, 2024) technical memo appended to this report, are approximately \$223.3 M, \$6.6 M, and \$15.6 M, respectively. Many municipalities use a life-cycle planning approach to support capital planning and ensure adequate funding is invested and evenly distributed, year over year. For instance, the estimated service life of linear sewer assets ranges from 50 – 85 years depending on the material type. The life-cycle planning approach evenly distributes capital investments over this 50-to-85-year period which translates to an annual investment of roughly 1-2% of the total value of linear sewer infrastructure. In comparison, lift stations have a relatively shorter service life, (typically around 35 years), which means the annual investment is relatively higher (roughly 3 – 5% annually). Applying this approach to Esquimalt's linear assets and lift stations would require a minimum annual investment of approximately \$3.5 M and \$0.4 M respectively, for a total average annual life cycle investment (AALCI) of \$3.9 M. The AALCI becomes a key metric for comparison in Section 4.0 which explores the gap between existing spending levels, the cost of capital needs determined through the risk assessment, and sustainable funding levels based on the AALCI. Closing the gap between existing spending and funding targets is largely influenced by the existing cost recovery mechanisms

funding service delivery. Therefore, the following section provides an overview of the Township's current sanitary sewer funding sources.

2.1 SANITARY SEWER FUNDING MECHANISMS

The Township currently funds sanitary sewer rehabilitation through property taxes. A portion of the Township's annual property tax revenue is allocated to the maintenance and improvement of public infrastructure, including the sanitary sewer system. These funds support capital projects like the construction of new sewer lines, pump stations, or upgrades to existing infrastructure. Currently, there is no utility fee specific to sanitary sewer use within the Township (e.g., a sanitary sewer user fee). Overall, a dedicated utility fee can help ensure there is adequate funding to address important cost pressures, leading to a more equitable and sustainable funding model for maintaining and operating a utility.

Understanding the funding sources and fee structure of Esquimalt's sanitary sewer system is essential for identifying factors that can be adjusted to meet risk-based capital requirements and achieve sustainable funding goals. Related recommendations are outlined in Section 5.0.

3.0 RISK ASSESSMENT RESULTS

Risk rankings consider and weigh an asset's likelihood to fail, which is determined by condition and capacity, and the associated consequence should it fail, informed by a triple bottom line evaluation of financial, social and environmental risks. These rankings are assigned on a scale from priority 1 through priority 3 for linear assets and lift stations, defined as follows.

- **Priority 1 (P1):** Projects that exhibit the highest level of risk, associated with an elevated likelihood of failure triggered by both condition and capacity concerns, and an elevated consequence of failure.
- **Priority 2 (P2)** Projects not already captured by P1 that have a moderately high level of risk driven by either:
 - A high likelihood of failure (triggered by condition and capacity) but less severe consequence, relative to P1 assets.
 - A moderate likelihood of failure (triggered by condition or capacity, but not both) and a high consequence of failure.
- **Priority 3 (P3):** Projects that exhibit modest risk, driven by a moderately high likelihood of failure (triggered by condition or capacity, but not both) but with less severe consequences of failure.
- **Non-Ranked:** all other projects in the sewer network.

These priority rankings are first assigned to assets based on existing conditions (e.g., existing flows), referred to as the existing scenario. Assets prioritized under the existing scenario are required to address deficiencies, driven by condition and/or capacity concerns that exist today. Typically, assets identified as priorities under the existing scenario are recommended for renewal in the next 10 years. This process is repeated for the future scenario which identifies renewal needs to accommodate increases to sewer flows from population growth, and deteriorating asset condition. Assets flagged for renewal under the future scenario are typically recommended for replacement in years 11 – 20.

In addition to priority rankings, linear assets are also assigned priority triggers, which identify the reason for asset prioritization. These triggers are further described below and are included as a field in the enclosed list of risk assessment results:

- **Capacity:** The asset is deemed capacity deficient only.
- **Condition:** The asset is deemed condition-deficient only. Condition is informed by CCTV data, or by asset age if CCTV data is not available.
- **New main:** The asset does not currently exist within the Township's network, and is proposed as a new asset to resolve a capacity deficiency elsewhere.
- **Capacity project:** The asset becomes capacity deficient as a result of an upstream upgrade that releases backlogged flows. Without upstream upgrades, assets with this trigger are otherwise operating sufficiently under existing conditions. To account for these instances, project numbers are assigned to assets required to resolve hydraulic deficiencies. All assets with the same project number must be resolved together to address deficiencies. Therefore, all assets with a common project number are assigned the same priority ranking based on the highest risk asset in the group. For example, if a project consists of two pipes, one that is not prioritized, and one that is ranked a P1, both pipes in this project receive a modified prioritization ranking of P1. A project number field is included in the enclosed risk results for gravity assets.
- **Abandon:** The asset is to be abandoned as part of a project to resolve a capacity deficiency in the network. The asset may or may not be deficient itself.
- **Capacity deficiency resolved through rerouting upstream flow:** The asset is capacity deficient but does not require upgrade as upgrades recommended elsewhere in the network will resolve its deficiency.
- **Plug:** The asset is to be deactivated ("plugged")

The existing and future prioritization results are discussed in following subsections. A more comprehensive list of individual asset prioritization ratings are included in the accompanied attachment. This file also specifies other critical and supporting information for each prioritized asset including (but not limited to):

- Likelihood of failure score – including condition and capacity scores
- Consequence of failure scores – including financial, social, and environmental scores
- Priority rating – as described above
- Priority trigger – as described above
- Existing and future replacement cost. Where existing costs reflect like-for-like replacement (i.e., no capacity upgrades) and demonstrate the existing value of the utility, and future replacement cost which accounts for pipe upsizing, where deficiencies have been identified.

3.1 EXISTING SCENARIO PRIORITY SUMMARY

The following section discusses the prioritization results for gravity mains, forcemains, and pump stations based on existing conditions. The locations of the prioritized assets are displayed in Figure 1.

3.1.1 Gravity Mains

Table 1 outlines the gravity mains recommended for renewal to address existing condition and/or capacity deficiencies. In total, approximately 13.2 km of pipe are recommended for replacement, equating to approximately 23% of the Township's total network length. It should be noted that the costs included in Table 1 reflect full asset replacement, and account for any pipe upgrades needed to resolve capacity deficiencies identified by the hydraulic model. In some cases, alternative renewal options, such as relining or point repairs, may be considered for condition-deficient pipes, granted there are no capacity deficiencies associated with that asset. Given the high number of condition-driven assets, discussed further below, alternative approaches to full replacement should be evaluated for suitability on a case-by-case basis. Therefore, to remain conservative, the recommended costs herein assume full replacement.

As shown in Table 1, P3 assets account for the majority of prioritized assets (approximately 12% of the total network length), followed by P2 assets (approximately 6% of the total network) and P1 assets (approximately 5% of the total network). Assets triggered solely by condition account for 93% and 97% of the P2 and P3 assets, respectively. Overall, approximately 75% of the prioritized assets (based on replacement cost) are triggered by condition only, emphasizing the deteriorating nature of the Township's sewer network.

It should be noted that of all assets triggered by condition, only one of these assets is triggered based on age (SGM0060, ranked as P3), the remaining condition-triggered priorities are informed by closed circuit television (CCTV) inspection. Because assets are known to both out- and under-serve their design lives, this influences the confidence of capital decisions based on age, whereas CCTV inspection offers a more accurate assessment of asset condition and therefore improves the confidence of capital decision making. Although not a major consideration for the existing scenario priorities, in general, it is recommended that any asset triggered by condition, informed by age (i.e. SGM0060), be inspected by CCTV ahead of complete replacement to confirm the extent and timing of the upgrade. As a best practice, the Township should also aim to complete point repairs or rehabilitation of assets that are structurally failing based on CCTV inspection within 1-year of inspection.

It should be noted that the following assets are triggered under the existing scenario based on condition, however, require upgrades in the future scenario to resolve capacity deficiencies: SGM0945 and SGM0037. These pipes are flagged to assist the Township in proactive planning, and to avoid a scenario where these assets undergo like-for-like replacement to resolve condition concerns, followed shortly by the need for additional capacity to accommodate future growth. Under existing conditions, these assets have prioritization rankings of P2 and P3, respectively, and total nearly 146 m in length, and \$0.74 M in renewal costs (including upgrades) which are captured in the Table 1 summary.

DATE: January 29, 2025 FILE: 3275.0021.01 PAGE: 5 of 24
SUBJECT: Sanitary Sewer Asset Management Plan: Infrastructure Prioritization & Capital Planning

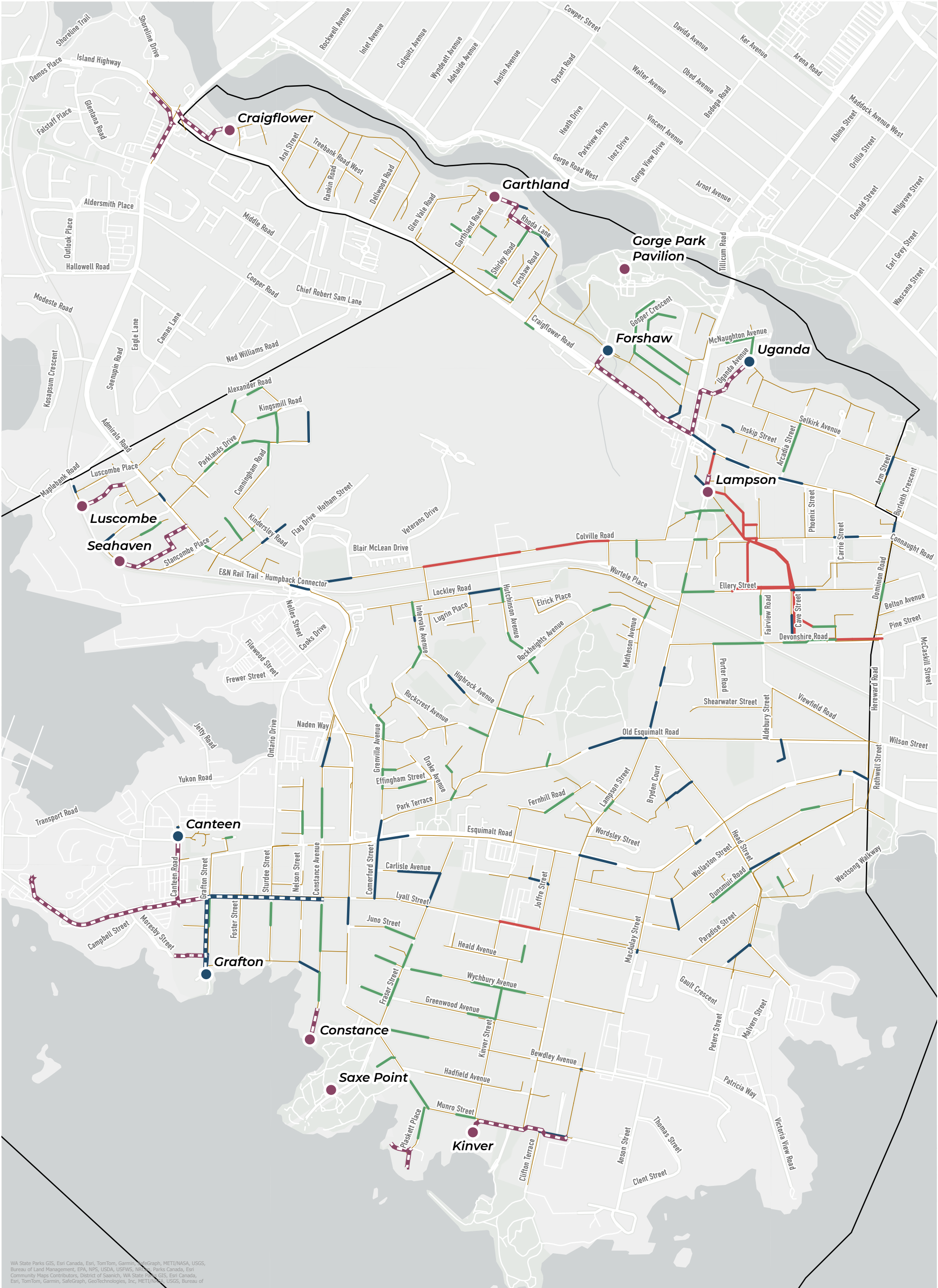
Table 1: Existing Scenario (Years 1-10) Priorities and Triggers

EXISTING PRIORITIZATION AND TRIGGERS	ASSET COUNT	LENGTH (KM)	PERCENT OF PRIORITIZATION CATEGORY (BY LENGTH)	REPLACEMENT COST (2024 \$)
P1	39	2.74		10,574,000
Condition and capacity	2	0.18	6.57%	883,000
Capacity ¹	9	0.58	21.17%	3,086,000
New main	10	0.71	25.91%	3,446,000
Capacity project only, no other triggers	6	0.51	18.61%	2,433,000
Abandon	11	0.62	22.63%	-
Plug ²	1	0.13	4.74%	725,000
P2	60	3.70		16,518,000
Condition and capacity project	1	0.10	2.70%	536,000
Capacity	1	0.004	0.10%	21,000
Condition	56	3.44	92.97%	15,087,000
Capacity project only, no other triggers	2	0.16	4.32%	874,000
P3	105	6.76		23,318,000
Condition and capacity project	1	0.05	0.74%	204,000
Condition	101	6.57	97.19%	22,457,000
Capacity project only, no other triggers	2	0.07	1.04%	226,000
Condition, and capacity deficiency resolved through rerouting upstream flow	1	0.07	1.04%	431,000
TOTAL	204	13.20		50,410,000

¹ Recall, P1 assets are triggered by condition and capacity deficiencies. The assets in this category (P1 capacity) are capacity-deficient (but not condition deficient), however, receive a priority ranking of P1 because they are part of a project group that contains a P1 pipe, driven by condition and capacity. As a reminder, assets in a common project group must be resolved together to resolve deficiencies and are therefore assigned the priority ranking of the highest risk asset in the group.

² Related to catchment reallocation to address CRD allocation deficiency for head connection.

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Project #: 3275.0021.01
Author: RB
Checked: KL
Status:
Revision: A
Date: 2024 / 12 / 16

0 100 200 300
Meters

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
- Township of Esquimalt
- GeoAdvice
- Urban Systems Ltd.

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

Scale: 1:11,500
(When plotted at 11"x17")

Legend

- Gravity Main Prioritization**
- P1
 - P2
 - P3
 - Gravity Main
- Forcemain Prioritization**
- P2
- Pump Station Prioritization**
- P2
 - Pump Stations
 - Township Boundary
- Force main**



Township of
ESQUIMALT

**Sanitary Asset
Management Plan**

**Existing
Prioritization**

3.1.2 Pump Stations and Forcemains

Table 2 outlines the pump stations recommended for renewal to address existing condition and/or capacity deficiencies. The condition of each lift station was determined through site inspections completed in 2023 that evaluated the condition of approximately 33 sub-components, typically found as part of a lift station, across four functional disciplines, including civil, mechanical, electrical, and structural components. The individual condition scores for each component along with their importance weighting (representing their criticality to station operation) were used to determine overall condition scores for each lift station. The likelihood of failure scoring ranged from 1 to 5, where 1 indicates the lowest likelihood of failure due to condition, and 5 indicates the highest likelihood of failure due to condition. Additional details on this evaluation process and the lift station condition assessments are provided in the *Lift Station Condition Assessment Report* (Urban Systems, 2025).

For stations triggered by capacity deficiencies (e.g. Grafton, Forshaw, and Canteen), the upgrade costs in Table 2 conservatively reflect full station replacement, assuming that the entirety of the station will require upgrading/replacement to accommodate additional capacity needs. This means that upgrades to any capacity-triggered station will also resolve any condition-improvements identified in the *Lift Station Condition Assessment Report*. For stations triggered solely by condition deficiencies (e.g. Uganda), the replacement cost reflects the cost of addressing the specific component deficiency identified in the *Lift Station Condition Assessment Report* (e.g. kiosk improvements, valve chamber upgrades etc.) It is understood that for the Uganda pump station, condition-related upgrades have been initiated, and costs included in Table 2 reflect budgetary pricing provided during the scope development phase of the project. For more information on component replacement needs at each station, please refer to the *Lift Station Condition Assessment Report*.

It should be noted that while the Constance station is not prioritized in the existing or future scenario (i.e. it is not considered condition or capacity deficient by the risk methodology), field inspections have identified the station as needing a Human Machine Interface (HMI) replacement. Although the criticality of this component alone is not enough to trigger the station as a priority, replacement of the HMI is recommended when funds become available, and is therefore included in Table 2. It should also be noted that while the Lampson, Luscombe, and Kinver stations also exhibit existing condition-deficiencies based on field inspections, these stations are not prioritized under the risk methodology until the future scenario (unlike Constance which is not prioritized over the next 20 years). Therefore, the replacement needs for Lampson, Luscombe, and Kinver stations (totaling \$228,000) are reported with future scenario results in Section 3.2.2.

Table 2: Existing Scenario Priorities - Pump Stations

PUMP STATION	EXISTING PRIORITY	EXISTING PRIORITY TRIGGER	UPGRADE COST (2024 \$)
Grafton	P2	Capacity	1,893,000
Uganda	P2	Condition	313,680
Forshaw (Nursery)	P2	Capacity	1,893,000
Canteen	P2	Capacity	1,373,000
Constance	N/A – Complete condition-based upgrades when funds become available		4,180
TOTAL			5,477,000

Note, for the Canteen Pump Station, an investigation regarding this station's capacity should be conducted prior to proceeding with station upgrades, as the Dockyard station (upstream of the Canteen pump station) was assumed to operate as an ideal pump, impacting the modelled capacity of Canteen. Additionally, despite this station being deemed deficient from a modeling perspective, field draw down tests indicated that the pumping capacity of the station, approximately 20L/s, greatly exceeds the future peak flow needs estimated at only 2.6 L/s. Despite this, modelling results have identified circumstances during which the Canteen station may exhibit limited or deficient capacity, such as when multiple stations (i.e. Grafton, Dockyard and Canteen) are running simultaneously (due to the high pressure in the shared forcemains along Lyall Street) and/or during periods of heavy rainfall combined with only a single pump operating. These circumstances likely represent short-lived, infrequent, and highly conservative conditions which are not anticipated to cause station flooding (however, pump capacity may be exceeded, and backup may occur). Once these conditions are relieved (i.e. lag pump turns on, and other stations drain relieving shared forcemain pressure etc.), the Canteen station is predicted to operate at a sufficient capacity. Discussions with Township staff also confirm that the Canteen station has not been known to exhibit significant capacity concerns. Therefore, while the Canteen station has been identified as a capital priority, this prioritization reflects a suite of rather conservative and unique scenarios. Therefore, further investigation into the influences of the Dockyard pump station should be confirmed, along with downstream impacts on the Canteen pump station before pursuing upgrades to Canteen. The Township should also consider developing a robust set of SCADA controls and pump station programming such that coordination between stations and pumping priority can be determined in scenarios such as this.

Table 3 outlines the forcemains recommended for renewal to address existing concerns. While the assets in Table 3 are not deficient under existing conditions in terms of capacity nor condition, the proposed upgrading of the Grafton pump station (see Table 2) will require the simultaneous upgrades to the associated forcemains (from 150mm to 250mm, as specified in the enclosed risk assessment results). As a reminder, based on the risk methodology, forcemain capacity is assessed based on forcemain velocity. While the existing velocities of all forcemains are currently sufficient, upgrading the capacity of the Grafton pump station triggers deficiencies in the Grafton forcemain requiring upgrades simultaneous with the pump station. Therefore, the Grafton pump station and forcemain share the same prioritization ranking of P2. Note that the proposed upgrade sizes of the force mains along Lyall Street (SGM0026 and SGM0027), should be confirmed to accommodate the incoming flows of the Dockyard station, prior to the replacement of these assets.

Table 3: Existing Scenario Priorities - Force mains

ASSET ID	PUMP STATION	LENGTH (KM)	EXISTING PRIORITY	EXISTING PRIORITY TRIGGER	TOTAL UPGRADE COST (2024 \$)
SFM0025	GRAFTON	0.25	P2	Upgrade with Grafton station (P2)	410,000
SFM0026	GRAFTON	0.04	P2		68,000
SFM0027	GRAFTON	0.34	P2		586,000
TOTAL		0.63			1,064,000

3.2 FUTURE SCENARIO PRIORITY SUMMARY

The following section discusses the prioritization results for gravity mains, forcemains, and pump stations based on future conditions. The locations of the prioritized assets are displayed in Figure 2.

3.2.1 Gravity Mains

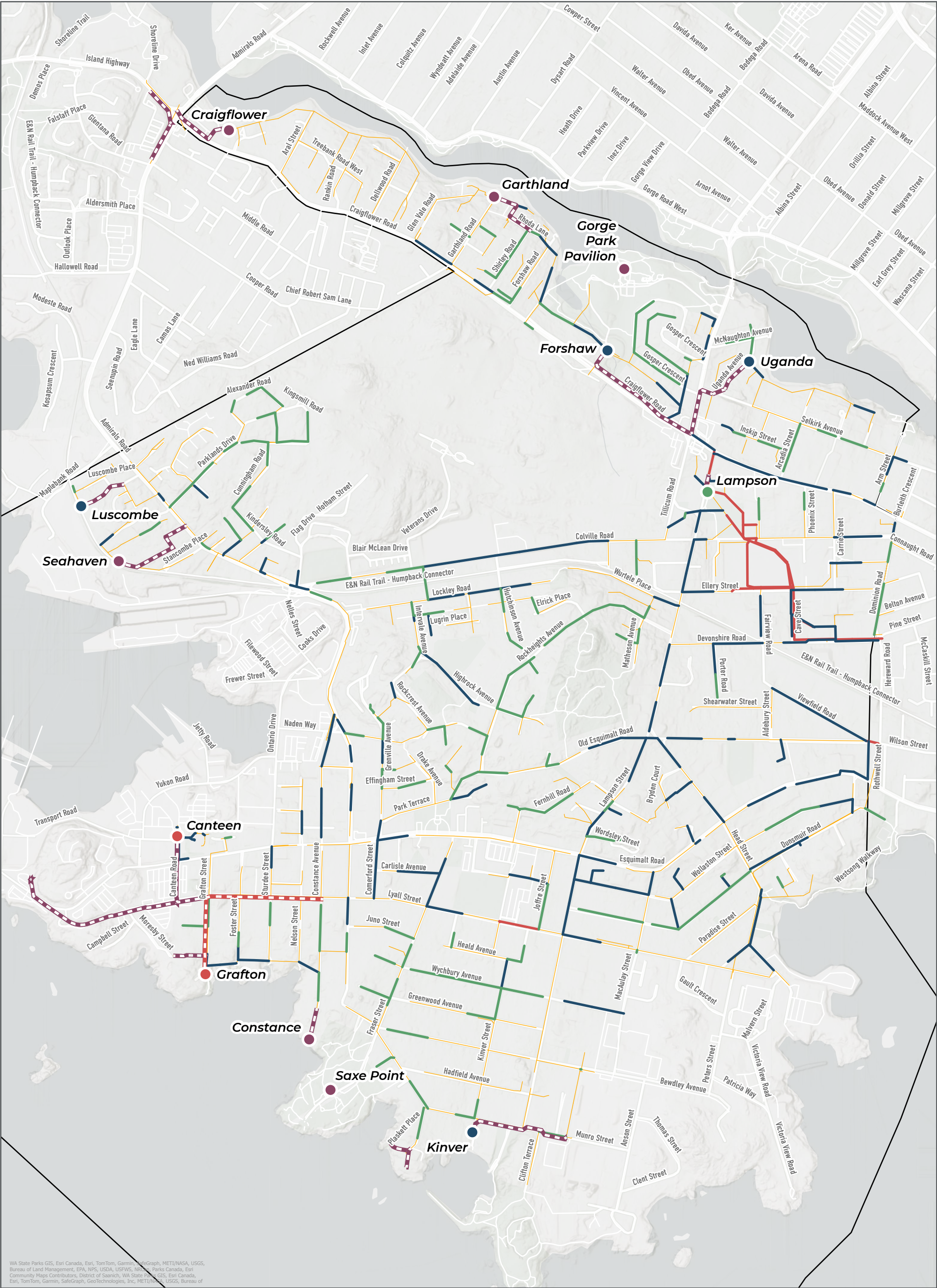
Table 4 outlines the gravity mains recommended for renewal to address future condition and/or capacity deficiencies driven by increases in flow from population growth and deteriorating asset condition. In total, approximately 13.1 km of additional pipe is recommended for upgrade in the future scenario, equating to approximately 22.5% of the Township's total network. Overall, the length of pipe prioritized in the future scenario is similar to that prioritized under existing conditions.

In contrast to priorities triggered under existing conditions, P2 assets account for the majority of prioritized assets in the future scenario (approximately 14% of the total network length), followed by P3 assets (approximately 9% of the total network) and P1 assets (approximately 0.1% of the total network). Approximately 96% of the prioritized assets (based on replacement cost) are triggered by condition only.

Similar to the existing scenario results, assets triggered by condition deficiencies in the future are predominately informed by CCTV, whereby existing CCTV scores are ranked on a scale of 0 – 5 (0 indicating no defects, and 5 indicating defects requiring immediate attention) and increased by a score of 1 to a maximum of 5 to account for pipe deterioration over the next 10 plus years. There are relatively more age-based priorities in the future scenario (48 pipes in total) compared to the existing scenario. These age-based priorities are distributed across priorities P2 and P3 and equate to approximately \$13.9 M in replacement value. As a reminder, prioritized assets triggered solely by age should be inspected through CCTV ahead of replacement to confirm the pipe's condition. This consideration is incorporated into the recommendations presented in Section 5.0.

Costs in Table 4 conservatively reflect full asset replacement, however as stated in Section 3.1.1, alternative renewal options, such as relining, may be considered for assets deemed condition deficient, on a case-by-case basis.

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Project #: 3275.0021.01
Author: RB
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Legend

- Gravity Main Prioritization
- P1
 - P2
 - P3
 - Gravity Main
- Forcemain Prioritization
- P1
 - Force main

Pump Station Prioritization

- P1
- P2
- P3
- Pump Stations
- Township Boundary



Township of
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**Sanitary Asset
Management Plan**

**Future
Prioritization**

Table 4: Future Scenario (Years 11-20) Priorities and Triggers

FUTURE PRIORITIZATION AND TRIGGERS	ASSET COUNT	LENGTH (KM)	PERCENT OF PRIORITIZATION CATEGORY (BY LENGTH)	REPLACEMENT COST (2024 \$)
P1	2	0.04		157,000
Condition and capacity	1	0.03	75.00%	126,000
Capacity ³	1	0.01	25.00%	31,000
P2	116	8.04		35,512,000
Capacity	4	0.23	2.86%	1,037,000
Condition	108	7.60	94.53%	33,496,000
Capacity project only, no other triggers	2	0.11	1.37%	456,000
Condition, no capacity upgrade recommended, minimal surcharging	1	0.04	0.50%	253,000
Condition, and capacity deficiency resolved through rerouting upstream flow	1	0.06	0.75%	270,000
P3	74	4.97		17,431,000
Capacity	1	0.01	0.20%	47,000
Condition and capacity project	1	0.14	2.82%	515,000
Condition	72	4.82	96.98%	16,870,000
TOTAL	192	13.05		53,100,000

3.2.2 Pump Stations and Forcemains

Table 5 outlines the pump stations recommended for renewal to address future deficiencies and includes the Kinver, Lampson, and Luscombe pump stations. The condition of these stations was assessed through field inspections, and like the CCTV scores, were increased by a score of 1, to a maximum of 5 to account for deteriorating condition into the future. All pump stations identified for renewal in the future scenario are triggered by condition only (i.e. no stations are capacity-deficient). As such, the replacement costs shown in Table 5 represent the estimated costs of the specific components requiring replacement as identified through the field inspections.

³ While linear assets which are only capacity deficient cannot achieve a P1 by the risk methodology (i.e. only condition and capacity triggered assets can achieve the highest priority), if the asset is associated with a project that has a P1 asset within it, it will be assigned a P1 ranking as well.

As discussed in Section 3.1.2, the risk methodology has classified the Kinver, Lampson, and Luscombe pump stations as future priorities, however field inspections have revealed component-based condition deficiencies exist today. These stations were not prioritized under the existing scenario through the risk methodology as the existing condition of the deficient *components* were not critical enough to influence the *entire* station's condition score such that the full station prioritization was triggered. This is a result of either a limited number of deficient components at a station, or those components were not deemed particularly critical to station operation, corresponding to a lower weighting of their condition scores in the calculation of the station's total condition score. Additional details related to the calculation of a station's condition score are provided in the *Lift Station Condition Assessment Report*. Overall, while the stations identified in Table 5 may be prioritized in the future scenario, it is suggested that deficient components identified through the field inspections be replaced as soon as funds become available within the next 10-years. As such, the replacement cost for these three stations is allocated under the first 10-years of the capital plan in Section 4.0.

Table 5: Future Scenario Priorities - Pump Stations

PUMP STATION	FUTURE PRIORITY	FUTURE PRIORITY TRIGGER	UPGRADE COST (2024 \$)
Kinver	P2	Condition	130,200
Lampson	P3	Condition	42,500
Luscombe	P2	Condition	55,090
TOTAL			228,000

In contrast to the existing scenario results, no force mains are recommended for upgrade within the future scenario.

4.0 CAPITAL PRIORITIZATION

This section combines the findings from Section 2.0: Asset Management, and the risk assessment results from Section 3.0 to provide an understanding of planned budgets, and how these compare to sustainable funding levels (the AALCI), and prioritized capital needs. These metrics are displayed over a 20-year time frame in Figure 3 and further discussed below. Given the high proportion of condition-triggered deficiencies, the cost of condition-triggered projects have been categorized into those informed by CCTV and those informed by asset age (i.e. lacking CCTV data). The remaining project costs represent projects driven by triggers other than condition only, as defined in Section 3.0.

URBAN SYSTEMS MEMORANDUM

DATE: January 29, 2025 FILE: 3275.0021.01 PAGE: 13 of 24
SUBJECT: Sanitary Sewer Asset Management Plan: Infrastructure Prioritization & Capital Planning

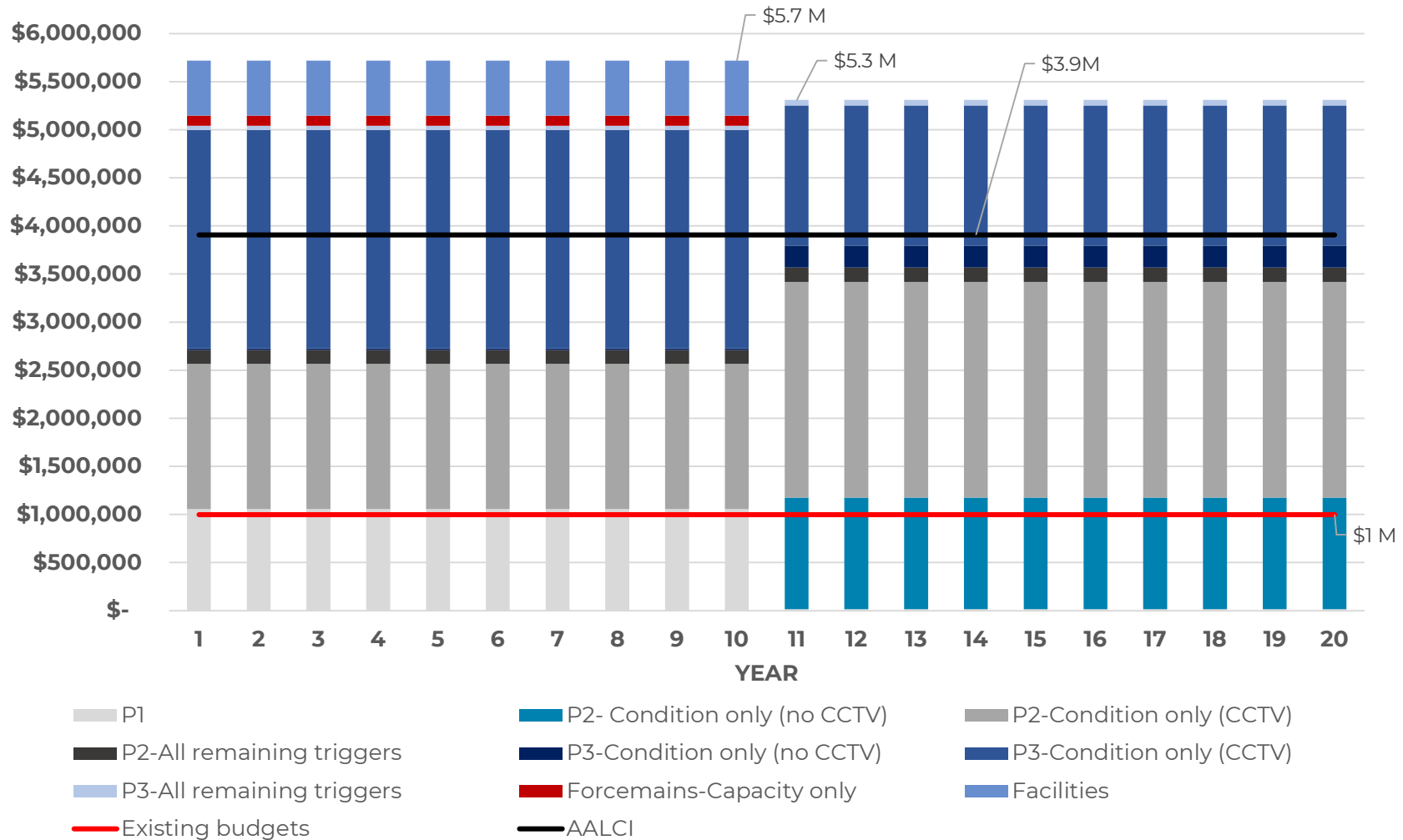


Figure 3: Capital Prioritization Summary, 20-Year Outlook

Figure 3 illustrates the following concepts:

- Existing and future deficiencies signal annual investment needs of approximately \$5.7 M for years 1-10 and \$5.3 M for years 11-20.
 - Note that the annual investment need of \$5.7 M for the first 10-years includes the costs associated with component upgrades for the Constance, Kinver, Lampson, and Luscombe pump stations. Although not prioritized under the existing scenario, these stations have existing, component-specific condition deficiencies of approximately \$232,180 (refer to Tables 2 and 5). These upgrades should be addressed following the replacement of other prioritized assets in years 1 - 10, as funds become available or as cost-saving opportunities emerge.
- Based on historic capital spending levels of roughly \$1 M annually, there exists a gap in annual spending and capital replacement needs. Over the first 10-year horizon, this gap is approximately \$4.7 M, annually, and approximately \$4.3 M annually over the second 10-year horizon. This signals that a significant increase in funding levels is needed to mitigate deficiencies.
- The gap between existing spending levels (\$1 M) and the AALCI (\$3.9 M) is approximately \$2.9 M annually. The \$2.9 million gap indicates a funding shortfall of approximately 75% compared to the required investment. This shortfall means the Township is not currently investing sufficiently in the rehabilitation and replacement of its aging infrastructure, causing a growing backlog of deferred rehabilitation. As a result, the Township may face increasing risks associated with infrastructure failure, higher emergency repair costs, and potential service disruptions.
- The majority of P1 projects are triggered under the existing scenario (years 1-10). Total replacement costs for P1 projects equates to approximately \$10.6 M and \$0.2 M for the existing and future horizons, respectively.
 - Although total project costs significantly exceed existing budgets, current spending appears sufficient to complete nearly all P1 projects under the existing scenario (gap of \$0.06M per year) and all future P1 projects. This means current funding levels are close to accomplishing the most critical projects over the next 20 years. As a reminder, all P1 projects over the next 20 years are focused on gravity main replacement.
- The majority of prioritized linear assets are triggered by condition deficiencies compared to capacity, for both the existing and future scenarios (75% and 96%, respectively, based on replacement value of prioritized gravity assets). In general, there exists a high-level of confidence in the prioritization of these condition-deficient assets as they are primarily informed by CCTV data, rather than asset age.
 - Recall, in Sections 3.1.1 and 3.2.1, only 0.3% of existing prioritized assets (by length), and 26% of the future prioritized assets (by length), are solely prioritized based on asset age. Age-based renewals account for roughly \$0.2 M over the first 10-years and roughly \$13.9 M over the second 10-year horizon.
- No forcemain upgrades are recommended in the future scenario. Overall, pump station and forcemain upgrades in the existing scenario comprise only a small portion (12%) of the total project costs.

Over time, infrastructure repair and replacement haven't kept pace with aging systems, leading to a growing backlog of needs. Current spending falls short of what's required to close the gap. Addressing this will require thoughtful increases in spending, guided by the community's tolerance for risk. Additionally, enhancing capacity to manage and deliver larger capital projects will be key as the scale of work expands.

4.1 FUNDING CONSIDERATIONS

Based on the capital needs presented herein and shown in Figure 3, several funding scenarios have been reviewed to help close the gap between existing spending levels, and capital needs. All scenarios assume an annual increase to current funding levels (~\$1M) but differ by the rate of increase and the maximum funding levels achieved over 20 years. These scenarios highlight the trade-offs between capital investment and risk tolerance, with more aggressive funding approaches reducing infrastructure risk through higher annual increases, while modest increases defer investments, heightening long-term risks. Each of the scenarios are briefly described below and are displayed in Figure 4.

- Achieve existing scenario capital needs (\$5.7 M) by year 10.** This scenario reflects the second-most aggressive funding strategy and requires existing spending levels to increase by 470% over the next 10-years. This corresponds to an increase in current spending of approximately \$0.52 M, or 52%, on an annual basis. Once the funding levels reach existing capital needs in year 10, this funding level remains constant for years 11 – 20. Adopting this strategy would allow all existing and future capital priorities to be funded by year 23 (assuming no projects arise reactively).
- Achieve the AALCI (\$3.9 M) by year 10.** Recall, the AALCI represents the average annual life cycle investment and evenly distributes the capital replacement needs of an asset over its service life to help build an appreciation for sustainable funding needs. This scenario reflects the least aggressive funding strategy and requires existing spending levels to increase by 290% over the next 10-years. This corresponds to an increase in current spending of approximately \$0.32 M, or 32%, on an annual basis. Once the funding levels reach the AALCI in year 10, this funding level remains constant for years 11 – 20. Adopting this strategy would mean existing and future capital priorities are not fully funded until year 32 (assuming no projects arise reactively), resulting in a moderate amount of deferral and long-term risk compared to the other scenarios explored.
- Increase property taxes by 1% annually.** This scenario reflects the current annual increase to property taxes within the Township which would result in approximately \$368,000 dedicated to capital funding annually, to be distributed amongst various capital works categories, such as sewer, roads, drainage, water etc. For the purposes of this analysis, it has been assumed, conservatively, that the entirety of the \$368,000 would be dedicated towards sewer capital funding only. This approach maximizes funding through tax allocation to ensure sewer capital priorities are addressed as quickly as possible. However, in reality, this annual increase in funding for capital works will be distributed to other infrastructure categories, lengthening the time to reach the maximum sanitary capital funding needs. For simplicity, we have also assumed a constant annual increase of \$368,000 until the maximum capital funding need of \$5.7M (annually) is reached in year 14. By this time, existing spending levels will have increased by roughly 470%. Overall, these assumptions reveal that even by allotting the full capital funding amount towards sewer alone for years 1-14, existing and future capital priorities are not fully funded until year 25 (assuming no projects arise reactively), resulting in some deferral and long-term risk, but only half the amount of the AALCI funding scenario presented above. This scenario represents the second least-

aggressive funding scenario, and offers insight on the long-term impacts of the Township's current funding practices.

- Increase property taxes by 2% annually.** This scenario reflects the annual rate increase to property taxes explored by the Township as part of their Financial Sustainability Analysis (2024), which would result in approximately \$736,000 dedicated to capital funding annually, to be distributed amongst various capital works categories, such as sewer, roads, drainage, water etc. Consistent with the previous scenario presented, it has been assumed, conservatively, that the entirety of the \$736,000 would be dedicated towards sewer capital funding only, increasing existing funding levels by approximately 470% by year eight. We have also assumed that once the funding levels reach the annual capital requirements of the existing scenario (\$5.7M), they remain constant. This scenario represents the most aggressive funding scenario. Adopting this strategy would allow all existing and future capital priorities to be funded by year 22 (assuming no projects arise reactively), resulting in the lowest amount of deferral and long-term risk of all the scenarios evaluated.

Table 6 compares the funding scenarios described above and displayed on Figure 4 in terms of capital projects funded and deferred. This comparison reflects a purely financial perspective and does not consider other resources necessary to complete capital works (e.g. labourers, equipment, management etc.). Additionally, these scenarios assume that no new or unexpected capital priorities arise during the subject time period.

Table 6: Financial Comparison of Funding Scenarios

Scenario	Existing Scenario (Year 1 – 10)	Future Scenario (Year 11 – 20)	Costs of Deferred Projects (Year 1 – 20)
Achieve Existing Capital Needs by Year-10	59% of all existing projects funded - Total funding: \$33.6 M	108% of all future projects funded - Total funding: \$57.2 M	\$19.51 M
Achieve the Average Annual Life-Cycle Investment (AALCI) by Year-10	43% of all existing projects funded - Total funding: \$24.5 M	74% of all future projects funded - Total funding: \$39.1 M	\$46.7 M
Increase Property Taxes by 1% Annually	46% of all existing projects funded - Total funding: \$26.6 M	104% of all future projects funded - Total funding: \$55.2 M	\$28.6 M
Increase Property Taxes by 2% Annually	69% of all existing projects funded - Total funding: \$39.6 M	108% of all future projects funded - Total funding: \$57.2 M	\$13.5 M

As expected, when funding levels increase more aggressively, fewer capital projects are deferred, leading to a reduction in future failure risks. Alternatively, more modest funding increases result in a larger backlog of deferred projects, indicating a greater acceptance of risk and a more reactive strategy for addressing capital needs. However, even the most aggressive scenarios fail to fund all capital projects within a 10-year period, nor *all* capital projects within a 20-year period. This is largely due to current spending levels relative to the existing backlog of deficient infrastructure. As such, some project deferral is inevitable from a financial perspective whereby projects identified in the existing scenario will require deferral to the future period, when funding becomes available, and/or the risk of failure becomes too high to reasonably defer any further. Similarly, some projects identified in the future scenario will require deferral past the 20-year horizon, and again, addressed when funding becomes available, or the risk of failure becomes too high.

When considering deferral, it is important to acknowledge the role of borrowing as a potential mechanism to address funding shortfalls. While this analysis does not factor in recurring borrowing as long-term strategy, it recognizes that loans may serve as a bridge for the Township to address emergency failures. This is common practice to address funding shortfalls but is not an optimal strategy to finance long-term funding needs.

Even with significantly increased funding, fully catching up on infrastructure needs within the next 10 to 15 years will be challenging. Some level of deferral is expected as part of Esquimalt's capital implementation plan, which is common for local governments in British Columbia and across Canada. Moving forward, the Township will need to focus on raising more funds for infrastructure, accepting some level of risk, and ensuring priority projects are delivered efficiently. Until a comprehensive financing discussion takes place with Finance and Council, the Township should be prepared to rely on loans for emergency failures while projects are being deferred.

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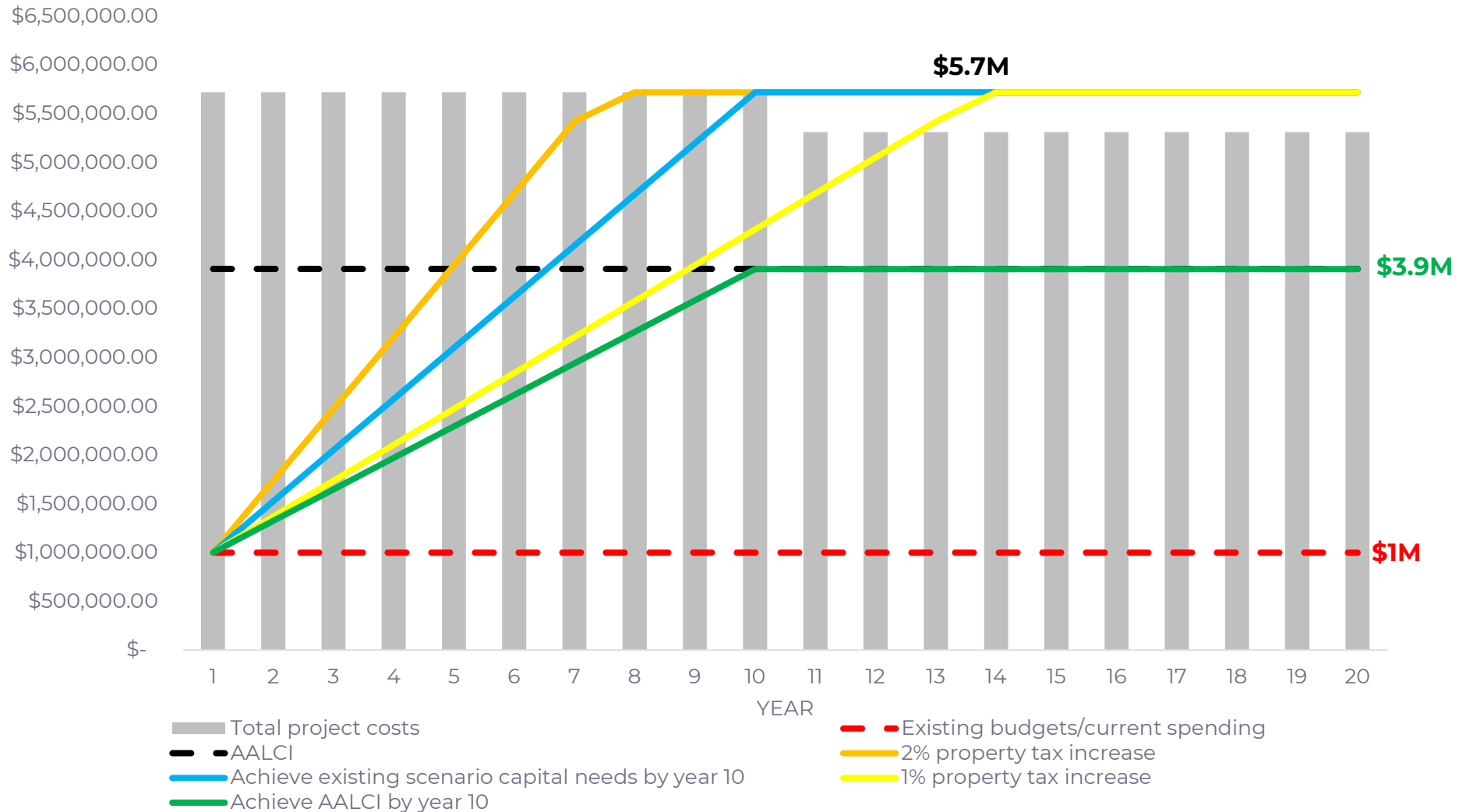


Figure 4: Funding Scenarios for Sanitary Sewer Capital Projects

5.0 RECOMMENDATIONS SUMMARY

The following recommendations arise from the findings of this risk assessment and are aimed to support the Township in making confident and consistent capital decisions, and to ensure investments are strategically dedicated towards the areas they are needed most:

- Work with the Township's Finance Department to review the sanitary sewer funding scenarios outlined in Section 4.1 along with the considerations below. Prepare to increase spending levels, balancing the trade-offs between capital investment and risk tolerance.
 - At a minimum, over the long-term, the Township should focus on achieving sustainable funding targets (the AALCI) and should account for this investment level within sanitary utility budgets. The AALCI value should be regularly reassessed to account for inflation, asset upgrades, and new assets introduced into the network,
 - Maximize funding to sewer infrastructure through the current property tax funding mechanism by increasing the property tax allocation for sanitary capital needs, raising overall property taxes and therefore the proportion dedicated to the sanitary sewer system, or implementing a combination of both strategies, and
 - Create targeted reserve values that align with anticipated capital needs.
- Address capital projects identified under the existing scenario, in order of prioritization (P1 assets, followed by P2 and P3). When projects share a common prioritization ranking and resources are limited, consider the following to help discern which project to proceed with next:
 - Align sewer priorities with other corridor upgrades (e.g., water mains, roads, etc.) to optimize resource allocation and realize cost savings. This includes reviewing local-to-regional opportunities for optimized service delivery (e.g., collaborating with the CRD on localized projects, and/or the City of Victoria vis a vis water upgrade projects),
 - Confirm with Public Works staff where there are routine maintenance issues or challenges. If clusters of assets emerge in a common area, address these together as a single project, and
 - Address condition-driven assets confirmed by CCTV inspection ahead of those prioritized based on age, as these assets are known to be condition deficient. As a reminder, prioritized assets triggered solely by age should be inspected through CCTV ahead of replacement to confirm the pipe's condition.
- To support the delivery of higher volumes of capital projects, the Township should develop a targeted list of key stakeholders to facilitate streamlined and high-quality service delivery. This list should include project managers, administrative staff, Public Works and contractors. More specifically the Township should:
 - Define clear roles and responsibilities for staff involved in capital works to ensure accountability and clarity.

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- Assign a dedicated staff member to keep information systems up to date as work progresses, including the integration of real-time field data into project identification and delivery processes (e.g., repair records, CCTV inspections etc.),
 - Hire a dedicated capital project manager to oversee planning, delivery, and coordination of the expanded sewer program, and
 - Build internal capacity for engaging with external consultants and contractors to improve oversight and decision-making.
- Regardless of the funding scenario selected, infrastructure deferral is expected. The Township should prepare for this by:
 - Adapting current maintenance practices (refer to Appendix B - Sanitary Sewer Asset Management Plan: Operations and Maintenance Practices Review) with the aim of preserving/extending asset life as long as possible, and
 - Being prepared to borrow funds for reactive infrastructure replacement, as needed.
- Use the outcomes of this assessment to identify a list of eligible development cost charge (DCC) projects, including the appropriate benefit allocation to support fund raising for capacity-triggered capital projects.
- Retrofit lift stations to include back-up generators. The cost per generator will depend on the horsepower of the station, however, the Township should budget approximately \$55,000 - \$75,000 per station. The timing of these retrofits should be determined as the Township completes their emergency response plan – a recommendation from the attached Operations and Maintenance Practice review.
- Re-CCTV any pipes near the end of their service lives, or in an area with known inflow and infiltration issues every 5-years. Target complete CCTV inspection of the entire network every 10 years.
- Initiate detailed facility condition assessments every 5 years, using the results of these inspections to inform/update the prioritization of facility renewal.
- Complete sanitary sewer network model updates every 5 years and/or when network conditions change significantly, or if new information arises which is relevant to the model.
- Complete the risk-assessment process, at a minimum, every 5 years and incorporate the latest data (e.g., storm main physical inspection data, pump station condition, model results, etc.) to improve near-term decision-making confidence.

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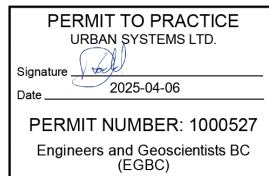
SUBJECT: Sanitary Sewer Asset Management Plan: Infrastructure Prioritization & Capital Planning

Sincerely,

URBAN SYSTEMS LTD.



Kara Labelle, EIT
Civil Engineer-in-Training



Alex Kempa, EIT
Project Engineer



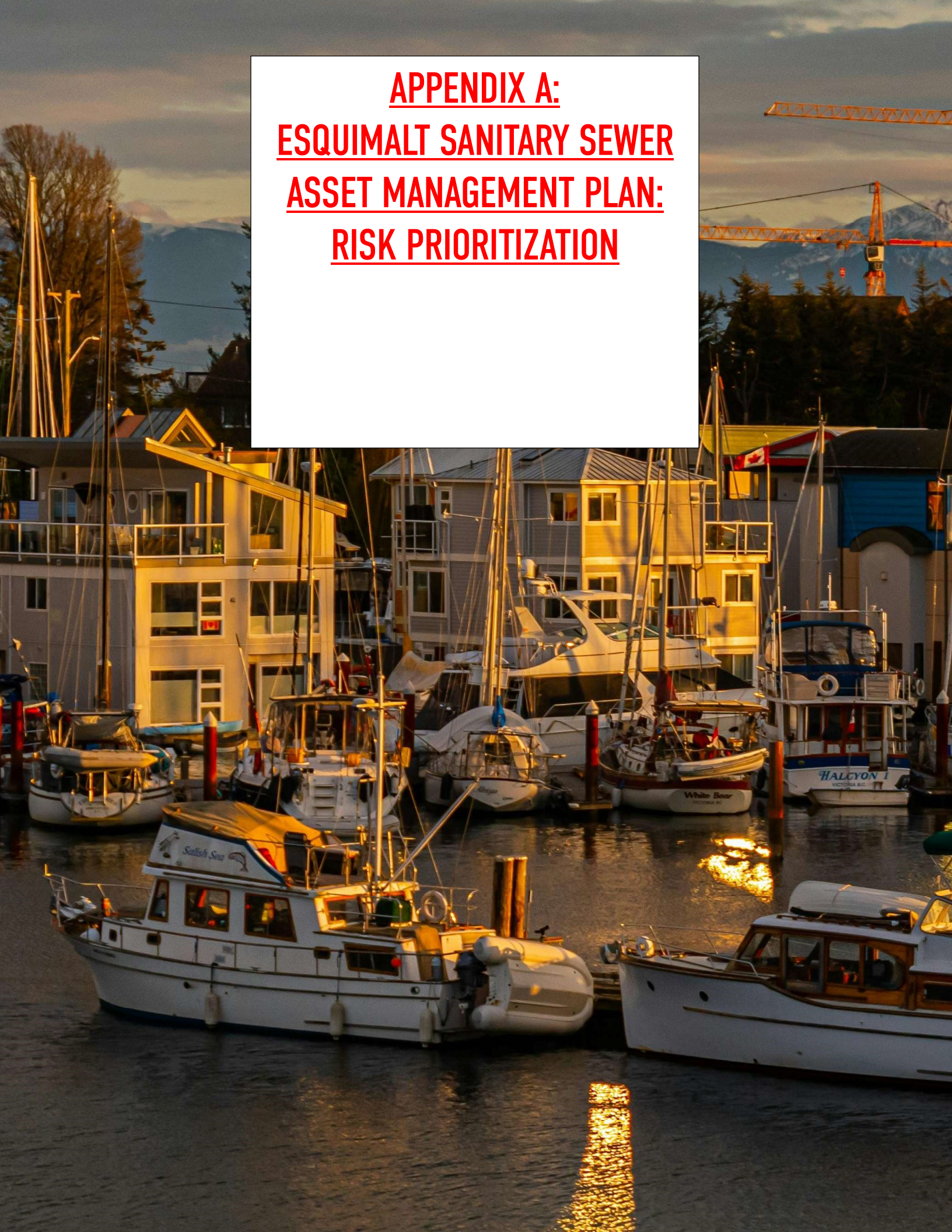
Mark Stafford, P.Eng.
Project Lead

cc: Adrien d'Andrade, P.Eng., GeoAdvice Engineering Inc.

/kl/ak
Enclosure

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APPENDIX A:
ESQUIMALT SANITARY SEWER
ASSET MANAGEMENT PLAN:
RISK PRIORITIZATION



DATE: August 14, 2024
TO: Joel Clary, P.Eng, PMP
CC: Adrien d'Andrade, P.Eng
FROM: Alex Kempa, E.I.T, Kara Labelle, E.I.T, Mark Stafford, P.Eng
FILE: 3275.0021.01
SUBJECT: Esquimalt Sanitary Sewer Asset Management Plan: Risk Prioritization

1.0 INTRODUCTION

The following memo outlines the risk methodology developed for prioritizing the renewal of the Township of Esquimalt's (the Township) linear sanitary sewer assets and lift stations, as part of the Sanitary Sewer Asset Management Plan.

Risk of failure is a primary consideration for determining *when* and *why to renew* an asset. It is determined by considering two key components:

1. **Likelihood of failure**— typically based on an asset's condition and capacity to identify the probability of failure (both structurally and hydraulically), where failure is defined as the inability to meet level of service commitments (e.g. providing adequate capacity, ensuring protection of the environment and property).
2. **Consequence of failure** – evaluates the level of impact an asset's failure would have on elements such as economics, the environment, and social considerations.

When a specific asset's likelihood and consequence of failure are both high, the risk associated with failure is high, therefore warranting a high priority ranking on the list of renewals. Alternatively, when an asset's likelihood and consequence are both low, the risks associated with failure are also low, suggesting renewal of that asset is a lower priority. The methodology outlined below specifies how likelihood and consequence of failure are each determined, and how they are combined to determine risk and arrive at a prioritization ranking for each asset. Applying this framework contributes to consistent and confident asset renewal decision-making.

The outcomes of this process are intended to be considered alongside other capital priorities to develop an integrated capital plan. This may include aligning sewer asset renewals with adjacent scheduled projects where appropriate.

2.0 GRAVITY MAIN METHODOLOGY

The methodology for assessing the risk of failure for linear sewer assets consists of three parts:

- An assessment of the combined likelihood of failure;
- An assessment of the combined consequence of failure; and
- Combining these condition and consequence assessments to produce asset risk and prioritization ratings

2.1 COMBINED LIKELIHOOD OF FAILURE

The combined likelihood of failure is a function of an asset's condition and capacity deficiencies.

2.1.1 Condition

One of the most common technologies used to evaluate the structural integrity of a gravity main includes closed-circuit television (CCTV). Currently, the Township employs a contractor (Victoria Drains) to perform CCTV inspections of the sanitary sewer system, with results reported digitally on a monthly basis.

The Township collects CCTV data in accordance with the Pipeline Assessment Certification Program (PACP) which uses a standard format and methodology for collecting CCTV data, coding, observations, and data storage. The PACP condition grades assess defects related to either pipe structure or operations and maintenance (O&M). Whereas O&M grades typically trigger routine maintenance and operational activities (e.g., pipe cleaning), the structural grades signal more urgency for replacement or rehabilitation needs which directly informs the prioritization of capital replacement projects, and will therefore be used to inform condition-based likelihood of failure scoring for this analysis. More specifically, the first two values of the structural quick rating provided by PACP will be used in this analysis:

- The **first digit** represents the highest structural defect grade of a pipe segment, where a structural defect affects the structural integrity of the pipe, such as breaks, separation, and pipe deformation, among others. These grades are assigned on a scale of 1-5, with a score of 5 indicating failure and 1 indicating minor defects with failure unlikely in the foreseeable future, as outlined by Table 1.

Table 1: PACP Scoring System—Structural Defect Grade Descriptions

Structural Defect Grade	Defect Description	Estimated Time to Failure
1	Minor defects	Unlikely in the foreseeable future
2	Minor defects	≥ 20 years
3	Moderate defects that will continue to deteriorate	10 – 20 years
4	Severe defects that will become Grade 5 in the foreseeable future	5 – 10 years
5	Defects requiring immediate attention	Has failed or will likely fail within the next 5 years

- The **second digit** represents the number of times the highest structural defect grade has occurred for a pipe segment

PACP combines these two digits, and divides by 10 to achieve a PACP-based likelihood of failure score which will be used to inform the condition rating of gravity mains, where available.

For example, a quick score of 4232 means that the highest structural defect grade of a pipe is 4 and is observed twice over the pipe segment. As a result, the PACP-based likelihood of failure score for this pipe is 4.2. Note, the last two digits of the quick score are not used for this analysis: they represent the next highest structural severity

grade and occurrence of this grade over the pipe. The PACP LoF scores range from 1 to 6, however, this risk methodology uses a 1 to 5 scoring system, where 1 indicates very good condition, and 5 indicates very poor condition. Table 2 translates PACP LoF scoring into a 1 to 5 condition ranking that will later be combined with capacity considerations to determine an overall likelihood of failure score for each gravity main.

In certain cases, CCTV data is not always available for the Townships' gravity mains. Therefore, an asset's age and standard service life (based on pipe material) will be used to estimate the remaining useful life of a pipe and gauge its condition ranking. This correlation between remaining useful life and condition rating is described in Table 2. While age serves as a supplemental proxy for condition, its accuracy in representing condition is less certain relative to results from physical property technologies (e.g., CCTV), particularly considering the Township's uncertainty in install year records. For this reason, an asset's age is only recommended to gauge condition in the absence of more reliable data (CCTV). Moreover, to reduce the number of capital projects driven by age alone, the maximum possible condition ranking based on asset age is 4, also shown in Table 2.

Table 2: Condition Rank Corresponding to Estimated Remaining Life of Asset

Condition Rank	PACP Likelihood of Failure (LoF)	Asset Age Relative to Design Life (DL)	Condition Description
1	$1 \leq \text{PACP LoF} < 1.5$	Asset Age is $< 75\%$ of DL	Very good condition
2	$1.5 \leq \text{PACP LoF} < 2.5$	Asset age is $\geq 75\%$ of DL, and $< 100\%$ of DL	Good condition
3	$2.5 \leq \text{PACP LoF} < 3.5$	Asset age exceed DL by 0-25%	Fair condition
4	$3.5 \leq \text{PACP LoF} < 4.5$	Asset age exceed DL by $> 25\%$	Poor condition
5	$4.5 \leq \text{PACP LoF} \leq 6$	Only applicable where actual, field-level condition data is available	Very poor/failed condition

The following service life estimates will be used for evaluating pipe condition and are based on a combination of service lives from other local municipal asset management plans and Township staff recommendations:

Asbestos Concrete (AC) = 85 Years

Polyvinyl Chloride (PVC)= 80 Years

Reinforced Concrete (RC)= 50 years

Vitrified Clay (VIT)=70 Years

Resin-Lined (RL)= 60 years

Unknown= 60 years

2.1.2 Capacity

For capacity, the likelihood of asset failure is based on the hydraulic capacity, hydraulic grade line (HGL) and flow velocity of the pipe under the PWWF of a 5-year storm event. Together, Tables 4 and 5 define how these attributes correlate to an overall capacity grade from A (no concerns) to F (significant concerns). These grades will be linked with condition scoring to arrive at a combined likelihood of failure score, as detailed in section 2.1.3. It is

recommended that for sewer mains showing the HGL above the crown of the sewer, that services in the area be compared to the HGL during pre-design of identified upgrades.

Table 3: Hydraulic Level of Servicing Criteria for Scoring

Criteria	Score
Hydraulic Capacity (q/Q^*)	
$q/Q < 0.70$	1
$0.70 \leq q/Q < 1.0$	2
$q/Q \geq 1.0$	3
Hydraulic Grade Line (HGL)	
HGL < Crown	1
Crown $\leq$ HGL < Rim Elevation	2
HGL > Ground Elevation	3
Velocity (v)	
$v < 0.6\text{m/s}$	Fail
$v \geq 0.6\text{m/s}$	Pass

Table 4: Gravity Main Hydraulic Level of Servicing Rating

Capacity Rank (Grade)	Capacity	HGL	Velocity	Description
A	1	1	Pass	Gravity Main performing as designed
B	1	1	Fail	Adequate capacity, low velocity indicates potential sedimentation
C	1	2 or 3	Pass or Fail ¹	Adequate capacity, backwater caused by downstream conditions
D	2	1,2, or 3	Pass or Fail	Marginal capacity, backwater caused by downstream conditions
	3	1	Pass or Fail	Capacity exceeded and surcharging unlikely
E	3	2	Pass or Fail	Capacity exceeded and surcharging likely
F	3	3	Pass or Fail	Capacity exceeded and potential flooding

¹ ratings from 'C' to 'F' are independent of velocity criteria

2.1.3 Likelihood of Failure: Combining Condition and Capacity

A combined likelihood of failure score is derived by linking an asset's individual condition and capacity scores. Table 5 outlines how the condition and capacity of an asset are considered together to arrive at a combined likelihood of failure score whereby 5 indicates that the probability of failure is very high and a score of 1 indicates that the likelihood of failure is very low.

Table 5: Combined Likelihood of Failure (Gravity Mains)

LoF Score	Condition Ranking	Capacity (hydraulic level of service rating)	Overall Combined Score (Start at bottom, assess if the statement is true to determine overall score. If false, continue upwards until true)
1	1—Very good condition	A/B-Adequate capacity, low velocity may indicate potential sedimentation	All remaining scores
2	2—Good condition	C-Adequate capacity, downstream condition causing backwater	Condition OR capacity scores: ≥2
3	3—Fair condition	D-marginal capacity, downstream condition causing backwater	Condition OR capacity scores : ≥3
4	4—Poor condition	E ² - Capacity exceeded and surcharge likely	Condition OR capacity scores: ≥4
5	5—Very Poor/failed condition	F ² -Capacity exceeded and potential flooding	Both condition AND capacity score: ≥4

2.2 COMBINED CONSEQUENCE OF FAILURE

The combined consequence of failure is typically a function of the social/community service impacts, financial liabilities (incurred directly or indirectly by the Township), and environmental impacts that might occur should the infrastructure fail. The magnitudes of these categories are respectively estimated using adjacent up and downstream land uses, road classification, and proximity to sensitive ecosystems, as further described in the following sections.

Health and safety, and reputation are among other categories sometimes considered in evaluating consequence, however, proxies of the former category are typically unknown, while proxies for the latter are already represented by existing categories. The severity of injury/illness (health and safety consequence) in the case of a sewer asset failure is difficult to accurately estimate and without accurate estimation, this category provides minimal value in the consequence assessment.

² E and F capacity priorities only apply where an upgrade to that pipe addresses the deficiency (e.g., not rectified by downstream upgrade)

2.2.1 Social/Community Service Consequences

The scale of population impacted by a service failure is the dominant driver for social/community service consequence. This is estimated based on the upstream and downstream land uses immediately adjacent to the pipe, as the repair of an asset located in a highly populated area (e.g., commercial area) is likely to inflict greater social impacts in comparison to that located within a minimally populated area (e.g. industrial area). These impacts are primarily associated with the asset repair/construction process, rather than service interruptions, which can typically be rapidly mitigated by bypass pumping. Therefore, adjacent land use designations are used to assign a baseline score for social/community service consequences on a scale from 1 to 5, as shown in Table 6, where 1 indicates minimal/ no social impacts and 5 indicates high social impacts.

A main's depth is another factor that can impact social consequence by prolonging the level of service disruption. Therefore, the baseline score for social consequence (described above) increases when a gravity main is at a depth of 3m or greater.

2.2.2 Financial Consequences

The cost to repair a sewer main is often closely linked to the type of road affected. For instance, a failure within an arterial corridor or highway presents greater traffic control and road reconstruction requirements compared to a failure within a local residential road. Road classification, therefore, serves as a proxy to establish a baseline score for financial consequence on a scale from 1 to 5, as shown in Table 6. A score of 1 indicates that the financial liabilities incurred by the Township are lower, whereas 5 indicates that financial implications are significant.

A main's proximity to neighbouring structures is another factor that can also impact financial consequence of failure. Therefore, the baseline score for financial consequence increases when a main is within 6 m of a structure.

Finally, the size and depth of a main also impacts the cost of a repair. As such, the consequence increases with mains 375 mm and larger or at depths of 3m or greater.

2.2.3 Environmental Consequences

Sewers located near sensitive ecosystems present various degrees of impact in the event of a failure. For this reason, the scoring of environmental consequence is based on a pipe's proximity to sensitive ecosystems as defined in Table 6. The baseline scoring for environmental consequence ranges from 1 to 5, where a 1 indicates that asset failure would have minimal impacts on sensitive ecosystems, whereas a 5 indicates that a sensitive ecosystem is close, and failure would have significant impacts.

2.2.4 Combined Consequence of Failure

Typically, the more significant the combined social, financial and environmental consequences, the greater the reputational impact of an asset's failure. Therefore, the combined consequence of failure scores quantified in Table 6 can also be considered the reputational consequence, whereby the greater the combined consequence, the greater the reputational risk.

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SUBJECT: Esquimalt Sanitary Sewer Asset Management Plan: Risk Prioritization

Table 6: Combined Consequence of Failure Matrix for Gravity Mains

Score	Social/Community Services ³ Indicator: Immediate adjacent upstream land uses	Financial ⁴ Indicator: Road classification	Environmental Indicator: Proximity to environmental areas ⁵	Combined (Reputational) Consequence (start at bottom, assess if the statement is true to determine overall score, continue upwards until true)
1	Agricultural land uses (lowest risk, <5 people impacted, if any)	RSV (service road)	No downstream sensitive ecosystems within 50m	All remaining scores
2	Industrial land uses (low risk, approx. 5-20 people impacted)	RLN (road lane), RRT (restricted road, not publicly accessible)	Asset is 30m to 49m from downstream sensitive ecosystem	1 category scores: 3 OR ≥ 2 categories score: 2
3	Low-density land uses (moderate risk, approx. 20-50 people impacted)	RLO (local road), RST (strata road)	Asset is 15m to 30m from downstream sensitive ecosystem ⁴	1 category scores: 4 OR ≥ 2 categories score: 3
4	Medium-density land uses (high risk, approx. 50-100 people impacted)	RC1 (major collector), RC2 (minor collector), RRC (recreation road), RYL (yield lane)	Asset is 10m to 15m from downstream sensitive ecosystem or runs below water course	1 category scores: 5 OR ≥2 categories scores: 4
5	High-density and critical land uses (highest risk, approx. 100-500 people impacted)	RA1 (major arterial)	Asset is within 10m of downstream sensitive ecosystems or sanitary sewer runs above watercourse	≥ 2 categories score: 5 OR 1 category scores: 5 AND 2 categories score: 4

³ Increase score by 1 (to a maximum of 5) if depth of pipe is ≥3m

⁴ Increase score by 1 (to a maximum of five) if pipe size is ≥ 375mm, or depth of pipe is ≥3m

⁵ Where sensitive ecosystems include environmental areas identified by provincial data

2.3 RISK FACTORS FOR CAPITAL PLANNING

Integrated capital planning is reliant on the prioritization of asset renewal. This process is driven by the risks associated with individual asset failure and derived from the asset's combined likelihood (probability) and consequence (impact) of failure. Table 7 correlates the combined likelihood and consequence of failure into a risk-based prioritization ranking for capital planning. This table uses input values resulting from the combined likelihood and consequence of failure tables above to determine a risk-based priority ranking from P1 (Priority 1, top priority) to P3 (Priority 3) whereby a P3 asset renewal is important, but less urgent in comparison to the higher risk P1 or P2 assets.

Table 7: Risk Prioritization Matrix for Gravity Mains

Combined Consequence of Failure	5				P2	P1
	4				P2	P1
	3				P3	P2
	2				P3	P2
	1				P3	P2
		1	2	3	4	5
		Combined Likelihood of Failure				

The risk-matrix above builds off asset management best practices and is tailored to serve the unique needs and data availability of the Township. We have seen similar prioritization schemes adopted by other municipalities on Vancouver Island, all rooted in the following core principles:

- As a critical community service, the sanitary sewer system demands proactive attention and investment decisions. The goal is to replace assets before they fail and cause service disruptions and other impacts, as described above. Therefore, all assets with a likelihood of failure (LoF) of 4 or 5 (i.e., failed or failing) are prioritized, regardless of the consequence of failure (CoF) score (as asset failure is not accepted even when the consequence of failure is low).
 - Recall that assets with a LoF score of 5 are characterized by either failing (or nearing failure) in terms of condition AND capacity, while assets with a LoF score of 4 are characterized by failing (or nearing failure) in terms of condition OR capacity.
- Priority ratings are additionally differentiated by CoF scores; sewers with a high combined CoF (4 or 5) naturally presents higher risks, but such risks may be managed by performing maintenance/upgrades throughout the asset's life. The need for more extensive maintenance associated with these higher risk assets results in their prioritization over sewers with lower CoF scores (3 or lower).
- The renewal of lower priority assets may require deferral depending on funding availability. A tool is needed (e.g., the risk-matrix and methodology) to help understand which prioritized assets can be safely deferred (if needed) and what this means for risk tolerance levels. Deferring the renewal of prioritized assets will be discussed on an as-needed basis in the Master Plan, pending results of the risk assessment.

It is important to recognize that an asset with a moderate or unclassified prioritization ranking may transition to having a higher risk and prioritization over time, becoming a more urgent priority due to the simple deterioration of the asset. With this in mind, there must be emphasis on keeping the risk and prioritization assessment a dynamic and living process, requiring monitoring and reviews on a regular basis. Many municipalities have CCTV inspection programs to assess their entire sewer network every 5 years, with 1/5 of the network being completed each year.

3.0 LIFT STATIONS

The methodology for assessing the risk of failure for lift stations includes three parts: an assessment of the combined likelihood of failure, an assessment of the combined consequence of failure, and the combination of these condition and consequence assessments to produce asset risk-based prioritization ratings.

3.1 COMBINED LIKELIHOOD OF FAILURE

The combined likelihood of failure is a function of a lift station condition and capacity deficiencies.

3.1.1 Condition

The condition of each lift station was determined through site inspections that evaluated the condition of approximately 33 sub-components, typically found as part of a lift station, across four functional disciplines, including civil, mechanical, electrical, and structural components. The individual condition scores for each component along with their importance weighting (representing their criticality to station operation) were used to determine overall condition and likelihood of failure scores for each lift station. The likelihood of failure scoring ranged from 1 to 5, where 1 indicates the lowest likelihood of failure due to condition, and 5 indicates the highest likelihood of failure due to condition. Additional details on this evaluation process and the lift station condition assessments will be provided in a separate report.

The condition values for lift stations will be combined with a capacity of failure score to arrive at an overall likelihood of failure score for each station.

3.1.2 Capacity

For lift station capacity, the likelihood of failure is based on three parameters: pump capacity, wet well capacity, and force main velocity as shown in Table 8. The parameters correlate to a grading scale from A to F shown in Table 9, where A indicates no capacity concerns, and F indicates significant capacity concerns.

Table 8: Lift Station Hydraulic Level of Service Criteria Scoring

Criteria	Score
Pump Capacity	
PWWF ⁶ ≤ Firm Capacity ⁷	Pass
PWWF > Firm Capacity ⁸	Fail
Wet Well Capacity	
Maximum Operating Level < Inlet Pipe Invert	1
Maximum operating Level ≥ Inlet Pipe Invert	2
Maximum Operating Level ≥ Maximum Physical Depth	3
Forcemain Velocity	
$v < 0.75 \text{ m/s}$	Fail
$0.75 \text{ m/s} \leq v \leq 3.0 \text{ m/s}$	Pass
$v > 3.0 \text{ m/s}$	Fail

Table 9: Lift Station Hydraulic Level of Servicing Rating

Grade	Pump Capacity	Wet Well Capacity	Force main Velocity	Description
A	Pass	A	Pass	Pump station performing as designed
B	Pass	A	Fail	Forcemain velocity outside of design range
C	Pass	B	N/A	Inlet pipe invert within pump operating range and backup unlikely (submerged inlet)
D	Fail	A	N/A	Pump capacity exceeded but sufficient wet well capacity to attenuate additional flow
E	Fail	B	N/A	Pump capacity exceeded and backup likely
F	N/A	C	N/A	We well capacity exceeded and overflow likely

⁶ PWWF= Peak Wet Weather Flow

⁷ Pump station firm capacity determined with the station's largest pump out of service

3.1.3 Likelihood of Failure: Combining Condition and Capacity

A combined likelihood of failure score is derived by combining a lift station's individual condition and capacity scores. Table 10 correlate the condition and capacity of a station to arrive at a combined likelihood of failure score on a scale from 1 to 5. A 5 indicates that the probability of failure is very high, whereas a score of 1 indicates that the likelihood of facility failure is very low.

Table 10: Combined Likelihood of Failure Matrix for Lift Stations

Score	Condition	Capacity (Hydraulic Level of Service Rating)	Overall Combined Score (Start at bottom, assess if the statement is true to determine overall score. If false, continue upwards until true)	Score
1	Informed by condition inspections	HLoS = A (Adequate capacity, performing as designed)	All remaining scores	1
2		HLoS = B (Adequate capacity although forcemain velocity is outside design range)	Condition <u>or</u> capacity scores: 2	2
3		HLoS = C (Moderate capacity, inlet pipe invert within pump operating range, backup likely) OR HLoS = D (Pump capacity exceeded but sufficient wet well capacity to attenuate additional flows)	Condition <u>or</u> capacity scores: 3	3
4		HLoS = E (Pump capacity exceeded, backup likely)	Condition <u>or</u> capacity scores: ≥ 4	4
5		HLoS = F (wet well capacity exceeded, overflow likely)	Both condition <u>and</u> capacity score ≥ 4	5

3.2 COMBINED CONSEQUENCE OF FAILURE

The combined consequence of failure is typically a function of the social/community service impacts, financial liabilities (incurred directly or indirectly by the Township), and environmental impacts that might occur should the infrastructure fail. The magnitude of these categories are respectively estimated using Peak Wet Weather Flow (PWWF), total station horsepower, and proximity to sensitive ecosystems.

3.2.1 Social/Community Services Consequences

The social consequence of a lift station failure is proxied using the station's PWWF which typically correlates to the number of people impacted in the case of station failure: the higher the flow entering the lift station, the greater the population upstream contributing to these flows.

PWWF is scored on a scale from 1 to 5, where 1 indicates low social consequence (small population impacted) and 5 indicates high social consequence (large population impacted).

3.2.2 Financial Consequences

There are various financial implications due to lift station failure, ranging from liability costs for private property damage to environmental cleanup fees and emergency repairs. The cost to repair a lift station is closely linked to the station's total horsepower (the sum of horsepower of all pumps within the station). Total pump horsepower serves as a general indicator of the financial impact a station could impose if failure were to occur (relating to property damages, repair costs, environmental control etc.). Financial consequence is scored on a scale from 1 to 5 where 1 indicates minimal financial liabilities should the station fail, whereas a 5 indicates significant financial liabilities. The horsepower for each station has been provided by the Township and is summarized below.

Table 11: Pump Station Horsepower

Station	Total Station Horsepower	Station	Total Station Horsepower
Craigflower	6	Grafton	40
Garthland	10	Constance	5.8
Uganda	40	Kinver	40
Lampson	4.8	Forshaw	40
Canteen	20	Luscombe	20
Seahaven	20	Saxe Point	4
Gorge Park Pavilion	5		

3.2.3 Environment Consequences

Lift stations located nearby sensitive ecosystems present various degrees of impact in the event of a failure. For this reason, the scoring of environmental consequence is based on a station's proximity to environmentally sensitive areas, water bodies, water courses, and the ocean. Environmental consequence is scored on a scale from 1 to 5 where 1 indicates low environmental consequence, and 5 indicates high environmental impact.

3.2.4 Likelihood of Failure: Combining Social, Financial and Environmental Impacts

A combined consequence of failure score is derived from combining a station's individual social, financial, and environmental consequence scores, and can be used to represent reputational consequences as previously discussed in section 2.2.4. Table 14 presents the correlation of these three consequence categories to arrive at a

combined consequence of failure score ranging from 1 to 5. A 5 indicates that the combined consequences of failure are significant, whereas a 1 indicates that combined consequences are minimal.

Table 12: Combined Consequence of Failure Matrix for Lift Stations

Score	Financial Indicator: Total Pump Station Horsepower (TH)	Social Indicator: Peak Wet Weather Flow	Environmental Indicator: Proximity to sensitive ecosystems ⁸	Combined Consequence Evaluation (Start at bottom, assess if the statement is true to determine overall score. If false, continue upwards until true)	Score
1	TH < 5 HP	PWWF ≤ 2 L/s	No downstream environmental concerns within 50 m	All remaining	1
2	5 HP ≤ TH < 10 HP	2 L/s < PWWF ≤ 8 L/s	Asset is 30 m to 49 m from downstream sensitive ecosystem	1 category scores: 3 Or ≥ 2 categories score: 2	2
3	10 HP ≤ TH < 15 HP	8 L/s < PWWF ≤ 15 L/s	Asset is 15 m to 30 m from downstream sensitive ecosystem	1 category scores: 4 Or ≥ 2 categories score: 3	3
4	15 HP ≤ TH < 20 HP	15 L/s < PWWF ≤ 35 L/s	Asset is 10 m to 15 m from downstream sensitive ecosystem	1 category scores: 5 Or > 1 categories score: 4	4
5	20 HP ≤ TH	35 L/s < PWWF	Asset within 10 m of downstream sensitive ecosystems	> 1 categories score: 5 Or 1 category scores: 5 AND 1+ categories score: 4	5

⁸ Where sensitive ecosystems include environmental areas identified by provincial datasets

3.3 RISK FACTORS FOR CAPITAL PLANNING

Integrated capital planning is reliant on the prioritization of facility renewal. This process is driven by the risk of failure and informed by a station's combined likelihood and consequence of failure. Table 13 correlates the combined likelihood and consequence of failure into a prioritization ranking using input values that arise from the tables above. Priorities range from P1 (Priority 1) to P3 (Priority 3), whereby a P3 asset renewal is important, but less urgent in comparison to P1 or P2 assets.

Table 13: Lift Station Risk Prioritization Matrix

Combined Consequence of Failure	5				P2	P1
	4				P2	P1
	3				P3	P2
	2				P3	P2
	1				P3	P2
		1	2	3	4	5
Combined Likelihood of Failure						

The core principles described in Section 2.3 for developing the gravity-main risk-prioritization matrix also apply to the lift station prioritization matrix, with some additional considerations:

- While the risk of lift station failure is generally evaluated using the same methodology as gravity mains, the overall magnitude of lift station failure is higher in comparison to linear assets. A lift station failure presents greater risk than that of the majority of gravity mains, as these assets serve more critical roles in the function of the sanitary sewer system. When it comes to capital planning and funding is limited, a lift station with the same risk rating as a gravity main will likely be renewed first (if funding allows) due to higher relative risk. The execution of priority projects should also be aligned with other capital projects (e.g. road replacements) to optimize dedication of resources.

It is important to recognize that a facility with a moderate or unclassified prioritization may transition to having a higher risk (prioritization) over time due to the simple aging of the asset, or the introduction of new demands from growth. With this in mind, there must be emphasis on keeping the risk and prioritization assessment a dynamic and recurring process.

From a prioritization perspective, priorities and timing recommendations move from the highest risks (likelihood x consequence) through to lower risk scores.

It is recommended that the prioritization of lift station upgrades be reviewed and updated at least once every 5 years with lift station condition inspections completed as part of this cycle.

4.0 FORCE MAINS

Consistent with gravity mains and lift stations, force mains also rely on likelihood and consequence of failure to inform capital prioritization, as outlined below.

4.1 COMBINED LIKELIHOOD OF FAILURE

The combined likelihood of failure of a forcemain is a function of forcemain condition, and velocity, used as a proxy for capacity.

4.1.1 Condition

Like lift stations, a physical condition assessment of force main's is planned for 2024. The results of this work will include a separate force main condition report detailing these results which will be translated into condition scores on a 1 to 5 scale for use in this prioritization risk assessment herein.

The condition values for each forcemain will be combined with a capacity of failure score to arrive at an overall likelihood of failure score for each forcemain.

4.1.2 Capacity

Force main capacity will be evaluated by velocity, as depicted in Table 14. In contrast to gravity mains and lift stations, forcemain capacity may only be assigned a 1 or a 5, with a 1 corresponding to a sufficient velocity (a "pass" in terms of Table 14) or a 5, corresponding to an insufficient velocity (a "fail" in terms of Table 14).

Table 14: Force Main Capacity Rating

Criteria (forcemain velocity)	Score
$v \leq 3.0 \text{ m/s}$	Pass (1)
$v > 3.0 \text{ m/s}$	Fail (5)

4.1.3 Likelihood of Failure: Combining Condition and Capacity

A combined likelihood of failure score is derived by combining a force main's individual condition and capacity scores. Table 15 correlate the condition and capacity of a forcemain to arrive at a combined likelihood of failure score on a scale from 1 to 5. A 5 indicates that the probability of failure is very high, whereas a score of 1 indicates that the likelihood of facility failure is very low.

Table 15: Combined Likelihood of Failure Matrix for Force Mains

Score	Condition	Capacity (Forcemain velocity, refer to Table 14)	Overall Combined Score (Start at bottom, assess if the statement is true to determine overall score. If false, continue upwards until true)	Score
1	Informed by condition inspections	$v \leq 3.0$ m/s (Pass)	All remaining scores	1
2		N/A	Condition score = 2	2
3			Condition score = 3	3
4			Condition score ≥ 4 <u>or</u> capacity score = 5	4
5		$v > 3.0$ m/s (Fail)	Condition score ≥ 4 <u>and</u> capacity score = 5	5

4.2 COMBINED CONSEQUENCE OF FAILURE

For the purposes of this risk assessment, it is assumed that the consequence associated with force main failure is consistent with its respective lift station. This is based on the premise that a failure of the forcemain will have similar consequences as the pump station being out of service. Moreover, force mains typically represent a relatively small portion of any sewer system, both in terms of asset value, and physical quantity, therefore, developing a unique and complex consequence methodology for force mains often results in negligible returns when it comes to the overall capital plan.

4.3 RISK FACTORS FOR CAPITAL PLANNING

The methodology and principles for combining likelihood and consequence of failure into a risk ranking for force mains is consistent with lift stations, as described in Section 3.3, and repeated below in Table 16.

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Table 16: Force Main Risk Prioritization Matrix

Combined Consequence of Failure	5				P2	P1
	4				P2	P1
	3				P3	P2
	2				P3	P2
	1				P3	P2
		1	2	3	4	5
Combined Likelihood of Failure						

Recall, moderate or unclassified priorities may transition to having a higher risk (prioritization) over time due to the simple aging of the asset, or the introduction of new demands from growth. With this in mind, there must be emphasis on keeping the risk and prioritization assessment a dynamic and recurring process. It is recommended that the prioritization of forcemain upgrades be reviewed and updated at least once every 5 years with condition inspections completed as part of this cycle.

Sincerely,

URBAN SYSTEMS LTD.

A. Kempa

Alex Kempa, EIT
 Civil Engineer

K. Labelle

Kara Labelle, EIT
 Civil Engineer

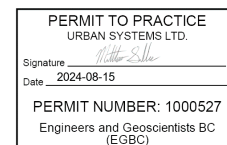


2024-08-15

Mark Stafford, P.Eng
 Project Manager

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APPENDIX B:
SANITARY SEWER ASSET
MANAGEMENT PLAN:
OPERATIONS AND
MAINTENANCE PRACTICES
REVIEW

DATE: January 29, 2025
TO: Joel Clary, P.Eng.
CC: Adrien d'Andrade, P.Eng
FROM: Kara Labelle, Alex Kempa, Mark Stafford, P.Eng.
FILE: 3275.0021.01
SUBJECT: Sanitary Sewer Asset Management Plan: Operations and Maintenance Practices Review

1.0 BACKGROUND

Urban Systems is working with GeoAdvice and the Township of Esquimalt (the Township) to complete a Sanitary Sewer Asset Management Plan (SSAMP) which includes the identification of priority upgrade projects required in the Township's sanitary sewer system. Part of this scope includes identifying the Township's current operation and maintenance (O&M) practices for the sanitary system and comparing them to industry standards / best practices to create a list of recommended improvements. By improving O&M practices, the Township helps optimize system performance, reduces risks of infrastructure failure, and can extend the lifespan of assets.

Generally, the Township's day-to-day O&M activities are reactive in dealing with breaks, backups, root intrusion, new connections, odours and flushing. The Township relies heavily on contractors for O&M services like electrical work, CCTV inspection and Vactor truck needs.

A summary of the Township's existing O&M practices are captured in Table 1 and based on a meeting with Township staff, including Public Works on November 6, 2024. This table also includes a list of recommended actions to help align current practices with industry standards and provides high-level, order-of-magnitude cost estimates that focus on next-step funding needs.

2.0 O&M BUDGET

Annually, the Township budgets approximately \$500,000 for O&M activities. Staff have noted that while the current budget is generally sufficient for existing tasks it often goes underspent, and there is a lack of staffing to manage additional work from recent developments and utility repairs. Although excess funding is available, the existing budget is not large enough to significantly expand services such as a hiring additional staff members, annual CCTV inspections or flushing programs. Furthermore, due to the absence of integrated digital systems, for tracking O&M costs, activities and infrastructure repair expenses, there is an opportunity for the Township to enhance access to detailed information in a centralized manner that would provide a clearer understanding of the breakdown of existing budgets and a more refined estimate of O&M funding needs. In the meantime, this analysis proposes high level budgetary considerations based on our understanding of existing practices, needs identified by staff and alignment with industry standards.

To meet the increasing demands of both capital project delivery and the ongoing maintenance of the existing sanitary system, additional resources will likely be required. This is driven by the dual priorities of replacing deficient infrastructure and addressing the O&M needs of the system to optimize service level and life.

If prioritized replacement projects are deferred, the risk of infrastructure failure escalates, leading to a greater reliance on reactive maintenance to sustain service levels and a lessened ability to complete proactive maintenance. This reactive approach is not only more resource-intensive but can also result in increased service disruptions, higher repair costs, and potential environmental or regulatory consequences. Conversely, timely investment in capital replacement reduces the likelihood of system failures and allows for a more proactive O&M strategy. Balancing these priorities necessitates a robust staffing plan that can effectively support both areas.

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Table 1: Township O&M Practices vs. Recommendations Based on Best Practice

Recommended Practice	Current/Previous Practices	Recommended Actions
CCTV Inspection Program	No active program - temporary program (2017 – 2023) completed for the full sanitary network using the Pipeline Assessment and Certification Program (PACP) rating system.	• Aim to complete full CCTV inspection of network every 10 years. • Identify and re-CCTV any pipes near the end of their service lives, or in an area with known I&I issues, every 5 years. • Aim to complete point repairs/rehabilitation of infrastructure based on CCTV outcomes as soon as funding becomes available. Note, best practice is to complete within one year of inspection, however, this will be difficult given the Township's current backlog of capital priorities but should be a target for the future as backlog is addressed. • Continue using the PACP rating system and ensure inspection results are published in a format compatible with GIS to support future risk-assessment integration. Regularly update the internal CCTV results database as additional inspections are performed. • Continue to complete flushing prior to CCTV inspections.

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Recommended Practice	Current/Previous Practices	Recommended Actions
Gravity Sewer Flushing Program	Flushing is generally preformed reactively, although there are some known problem areas with grease build-up which are flushed twice per year. A more formalized flushing program is desired by the Township.	Identify and document hot spots requiring flushing (e.g., areas prone to grease, debris build up, odours, and/or bellied pipes). Where possible, use existing CCTV data and GIS attributes (e.g., shallow pipe-grade, land uses, average flow velocity, service record call outs etc.) to help inform this list of hot-spots. For each location, determine the frequency of flushing needs to create a flushing schedule, based on a 1, 3 or 6-month cycle.
Forcemain Cleaning	Not implemented. Based on current configuration of lift stations and forcemains, cleaning access is likely limited.	- Retrofit and install pigging chambers at the start of each forcemain to enable forcemain cleaning via polyurethane swabs, also known as poly pigs. Poly pigs are inserted into the main and pressurized behind the device which allows it to scour the inside of the pipe. - Pigging chambers may also serve as an access point for future forcemain condition inspections.
Inspection of Manholes and Laterals	Not implemented	- Create a list of high priority manholes and laterals (e.g., based on history of blockages, backups, I&I, etc.) for annual inspection. Manholes are recommended for visual inspection by public works, whereas the inspection of laterals should be included as part of the Township's CCTV planning. - Continue to install inspection chambers on sewer connections, in alignment with MMCD, and add inspection chambers during renewal of existing laterals, especially in high-priority areas.

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Recommended Practice	Current/Previous Practices	Recommended Actions
Lift Station Maintenance	Stations are washed on a monthly basis with readings collected hourly. Stations are also pumped out annually, with pumps and kiosks inspected. These inspections help identify issues warranting station repair or replacement.	• Continue existing practices, as scheduled, and ensure check valves are inspected and cleaned annually as part of existing procedures. • Semi-annually, or quarterly: ○ Visually inspect / manually operate each pump to ensure proper function ○ Pump down the wet well to lowest point and visually inspect ○ Exercise any suction and discharge isolation valves ○ Test the back-up generator • Check and replace activated carbon as required. • Conduct recurring Arc Flash assessments of electrical components every 3-5 years or specified by electrical inspections. • Complete full condition assessments of the pump stations at 10 years of age and every 5-years following. • Annually exercise air and gate valves for all forcemains to prevent valve seizing. • Review SCADA controls and network-wide pump station programming such that coordination between stations (e.g., Dockyard and Canteen) and pumping priority can be determined.

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Recommended Practice	Current/Previous Practices	Recommended Actions
Record Keeping/ Tracking	Fields reports are currently filled out manually and stored as paper forms with no automated system for collecting cost information on repairs. To help better forecast and plan maintenance practices and asset repair/replacement, the Township has identified a desire to adopt software to track O&M costs and activities, and costs spent on assets.	- Transition from manual, paper-based recordkeeping to specialized software for work order tracking. - Explore available software options and evaluate their complexity, integration requirements, costs, and alignment with operational needs and budget. Consider collaborating with other local governments of similar size to gather input on their experiences and challenges with software adoption.
Flow Monitoring	Hourly data collected by Township at Canteen, Constance, Forshaw, Garthland, Luscombe, Sea Haven, and Uganda pump stations. Two level readers are also used to monitor flow in key locations (see I&I practices below). Flow data also available from the CRD flow meters: Anson, Devonshire, Esquimalt Pump Station, Head, Kinver, Land Cove DND (Department of National Defence), Land Cove Esquimalt, Lyall Mag Meter and Wilson. The location of these meters are appended to this memo.	- Install 3 – 5 flow monitors per catchment and monitor for four months during the winter/spring when rainfall is likely. Aim at monitoring 2 – 3 catchments per year, so the entire Township is monitored over a 5-year period. - Use flow monitoring data to re-calibrate the hydraulic model as part of the next model update. - Complete regular maintenance activities/inspections for active flow meters to ensure good working condition (e.g. cleaning accumulated debris and silt from flow meter area, checking battery state etc.). Maintain records of such activities/inspection.

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Recommended Practice	Current/Previous Practices	Recommended Actions
Asbestos Concrete Pipe Testing	Not implemented, however, Township has expressed desire to test for wall thickness and quality during breaks or exposure of asbestos concrete pipes.	- Collaborate with neighbouring communities regarding their experience with asbestos concrete pipes and results of destructive/non-destructive testing, if complete. - Where there are breaks, or known issues with asbestos concrete pipes, complete destructive/non-destructive testing, to understand pipe condition as it approaches its service life. Testing should be done selectively, where site conditions are varied, to help inform conclusions based on local characteristics.
I&I Monitoring	I&I Master Plan completed in 2021 by KWL. Two level readers are used to monitor flow in key locations. I&I issues are typically addressed reactively when problems arise, rather than through an on-going program. Temporary smoke testing program completed in 2008, covering the entire Township. Updated the sewer model as part of this SSAMP to understand existing I&I responses within the system.	- Complete a comprehensive I&I Master Plan every 5-years. - Consider completing smoke testing in alignment with areas identified by the 2021 I&I Master Plan. If funding is limited, or higher priority catchments have emerged, consider using the outcomes of the updated I&I Master Plan to target and guide key smoke testing areas. - Monitor flows annually, prior to, and following I&I initiatives/activities to help quantify impacts.

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Recommended Practice	Current/Previous Practices	Recommended Actions
Standard Operating / Safe Work Procedures	Not implemented	Create a manual outlining the protocols to perform operations and maintenance practices safely, including confined space entry requirements. These procedures are intended to standardize work processes, ensure compliance with regulatory requirements and enhance safety.
Sanitary Sewer Emergency Response Plan	Not implemented for the sanitary sewer system	Create an Emergency Response Plan specific to the sewer system including the identification of potential emergencies (e.g., power loss) and response plan procedures.
Lifelines Assessment	Not implemented	- Complete a study to assess what sewer infrastructure needs to remain operational post disaster and incorporate results into the next scheduled risk assessment. - Incorporate the results of this study into the emergency response plan as noted above.
Develop a Maintenance Calendar	Not Implemented	- Develop a comprehensive maintenance calendar/guide that documents specific maintenance needs for the various sanitary sewer system components. - Consider dividing the utility into maintenance “zones” such that maintenance practices are completed by zone (e.g. address zones 1 and 2 in Year 1, address zones 3 and 4 in Year 3 etc.). Zones may be based on a variety of factors including infrastructure condition, type, or age, critical service areas/infrastructure, and maintenance access. There will likely be efficiencies to developing this calendar alongside the Standard Operating/Safe Work Procedures.

3.0 RECOMMENDATIONS

Proactive investment in both capital replacement and O&M is essential for managing the sanitary system effectively. While capital projects reduce long-term risks, robust O&M practices are key to maintaining system performance and mitigating immediate challenges.

Overall, the results of the sanitary sewer system risk assessment reveal that the majority of capital priorities are condition deficient, and largely confirmed by CCTV inspection. Furthermore, the funding gap between historic spending levels and capital needs indicates that some level of deferral is expected as part of Esquimalt's capital implementation plan. This emphasizes the importance of operations and maintenance practices, such as continued CCTV inspection, and flushing, among others, to help ensure Esquimalt continues to meet desired service levels.

Acknowledging the need for staffing resources, and additional funding to align with O&M best practices, the list of recommended actions below are categorized based on priority, with consideration of level of effort and staff capacity to adopt and implement.

Due to the limitations of tracking historic O&M costs, activities and infrastructure repair expenses, the budgets proposed below are high-level estimates and based on our understanding of staff O&M practices and our experience working in other communities. As outlined in the list of actions below, there is important foundational work required to finetune future O&M needs and therefore budgets. These items have been prioritized over the short-term to support the Township in advancing their understanding of O&M needs.

HIGH PRIORITY/SHORT-TERM (1 – 2 YEARS)

- Re-CCTV any prioritized pipes based on condition from the SSAMP, pipes that are near the end of their service life, or in an area with known I&I issues every 5-years,
 - **Budget:** Minimum of \$60,000 annually, for the next 5-years. This is based on the SSAMP results, and assets approaching their service life (i.e., ≥95% of their design life). Over time, this level of investment will be dictated by the Township's ability to address condition-based capital priorities.
- Identify and formally document a list of known and potential hot-spots for flushing, including frequency requirements. Implement program within the next 2-years.
 - **Budget:** Estimated \$20,000 investment to set up a database/system (ideally that integrates with the Township's GIS) of hot-spot locations and frequency requirements. The cost of implementation will depend on the results of the initial investigation and should consider flushing that will take place as part of CCTV investigations. Furthermore, the Township will also need to consider if this activity will be completed by Public Works staff or a contractor. To assist with planning, roughly 700m of gravity main can be flushed in a single day. If contracted out, this is equivalent to approximately \$1,800 in flushing fees per day.
- Continue existing lift-station maintenance practices, including monthly washing and semi-annually:
 - Visually inspect / manually operate each pump to ensure proper pumping,
 - Pump down the wet well to lowest point and visually inspect,

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- Exercise any suction and discharge isolation valves,
 - Test the back-up generator,
 - Replace activated carbon (annually),
 - **Budget:** \$25,000 annually. This assumes 2-hours per lift station for monthly maintenance and an additional 2 hours per lift station semi-annually, for one full time Public Works employee.
- Create a list of high-priority manholes and laterals for annual inspection. A budget should be determined following initial investigation, with lateral CCTV inspections added to the Township's CCTV program, and manhole inspections completed annually.
- Complete additional flow monitoring in advance of the next SSAMP, or sooner as funds become available. Additional monitoring will not only help future model updates but will also help potential I&I entry points.
 - **Budget:** \$25,000 per catchment for four months of temporary monitoring. We recommend the Township monitor 2 – 3 catchments per year to capture the entire network over a 5-year period.
- Initiate software exploration/options evaluation for work order tracking, including collaboration with other local governments. While the exploration phase is recommended over the short term, software adoption and integration (e.g., training) will be a multi-year process, whose cost will depend on the outcomes of the options analysis.
 - **Budget:** \$50,000
- Document Standard Operating / Safe Work Procedures and create and maintenance calendar in parallel.
 - **Budget:** \$50,000 - \$100,000
- Create a Sanitary Sewer Emergency Response Plan over the next 2 – 3 years.
 - **Budget:** \$25,000
- Initiate discussions with neighbouring communities on testing practices for asbestos concrete pipes. Use the results of this discussion to budget for testing needs, likely to occur in the near term, or as opportunities for testing arise.
 - **Budget:** \$5,000 is recommended as an interim, annual budget for sampling, assuming approximately \$500/sample of AC pipe 10 times per year.
- Update Township's I&I Master Plan including recommended actions to identify and address I&I concerns.
 - **Budget:** \$20,000 (excluding flow monitoring, and implementation of recommended actions). Please note, this budget is not typically included within the O&M budget profile, however, is listed here to support comprehensive utility planning and to emphasize the importance of future updates to the Master Plans.

MODERATE PRIORITY/NEAR-TERM (3 – 5 YEARS)

- Conduct recurring Arc Flash assessments of electrical components every 3-5 years,
 - **Budget:** \$40,000
- Review SCADA controls and programming
 - **Budget:** \$25,000
- Complete lift station condition assessments, including electrical inspections, within the next 5-years or in alignment with the next SSAMP:
 - **Budget:** \$40,000 - \$50,000
- Complete lifelines assessment for incorporation into the next SSAMP. This could also be included within the scope of the next SSAMP.
 - **Budget:** \$5,000 - \$25,000. Please note, this budget is not typically included within the O&M budget profile, however, is listed here to support comprehensive utility planning and to emphasize the importance of sustainable infrastructure planning.
- Update Township's SSAMP:
 - **Budget:** ~\$200,000. Like the I&I Master Plan update and lifelines assessment, this budget is not typically included within the O&M budget profile, however, is listed here to support comprehensive utility planning and to emphasize the importance of future updates to the Master Plans.

LOWER PRIORITY/LONG TERM (+6 YEARS)

- Complete full CCTV inspection of network every 10-years,
 - **Budget:** \$70,000. Please note, this value reflects CCTV of the entire network. If the Township re-CCTVs concerning pipes/areas, as proposed over the short-term, the outstanding portion of the network to be inspected accounts for approximately \$10,000.
- Retrofit and install pigging launch and retrieval chambers on existing forcemains, and require pigging chambers as part of future lift station/forcemain design. Completing cleaning on a bi-annual basis (every other year) once installed.
 - **Budget:** \$10,000 - \$20,000 per chamber to retrofit/install, depending on depth / diameter / access / etc. We have assumed an annual budget of approximately \$26,000 for forcemain cleaning, however, this should be confirmed following the District's decision to complete this service in-house or through a contractor.

DATE: January 29, 2025

FILE: 3275.0021.01

PAGE: 11 of 11

SUBJECT: Sanitary Sewer Asset Management Plan: Operations and Maintenance Practices Review

BUDGET SUMMARY

Based on the recommendations proposed above, but not including the I&I Mater Plan Update, lifelines assessment, or the SSAMP update, the average annual budget needs for each of the time horizons is estimated as follows:

- High Priority, Years 1 – 2: Approximately \$240,000, annually,
- Moderate Priority, Years 3 -5: Approximately \$180,000, annually,
- Low Priority, Years 6 – 10: Approximately \$130,000, annually.

Please note, these estimates are intended to provide an order of magnitude appreciation for budgetary needs and does not include the effort of existing staff to respond to emergency repairs, back-ups, or new connections which are understood to account for the majority of Public Works' existing day-to-day activities. Furthermore, we have not included fees associated with software adoption/integration (e.g., license fees, procurement, training etc.), smoke testing, manhole/lateral inspection, or annual flushing fees. Budgets for these practices should be determined following additional investigation as proposed above.

Overall, the reactive approach to existing O&M practices is understandable given the poor condition of the sewer system. While existing budgets are generally proportional to those in other communities, the difference primarily lies in system condition – better maintained systems allow others to adopt more proactive practices, rather than react to the demands of a more deteriorated system. The practices and preliminary budgets proposed herein help align the Township with best practices and suggest lower funding requirements than current levels; however, these values will increase as the scope of O&M practices are finetuned, and existing reactionary practices are accounted for.

With the existing resources available to the Township, it will be difficult to increase the volume of capital project delivery, continue to react to system challenges through O&M and increase the level of proactive O&M practices without additional resources. These resources may include the hiring of more staff or external contractors who will likely be needed to support a transition toward more proactive O&M practices while continuing to address the realities of a deteriorated sewer system. Before determining the level of additional resources needed, the Township should complete the investigations proposed herein to identify specific funding needs related to services such as flushing, manhole and lateral inspection, smoke testing, etc. With a cleared understanding of these needs, the Township can better assess the O&M resource gap and plan accordingly.

Sincerely,
URBAN SYSTEMS LTD.



Alex Kempa, EIT
Project Manager



Mark Stafford, P.Eng.
Civil Engineer

cc: Kara Labelle, Urban Systems

/ak

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APPENDIX C:
SANITARY ASSET
MANAGEMENT PLAN UNIT
COST ESTIMATING



DATE: August 12, 2024
TO: Joel Clary, P.Eng
CC: Adrien d'Andrade, P.Eng, Alex Kempa, E.I.T
FROM: Mark Stafford, P.Eng, Kara Labelle E.I.T
FILE: 3275.0021.01
SUBJECT: Sanitary Asset Management Plan Unit Cost Estimating

1.0 INTRODUCTION

Urban Systems is working with the Township of Esquimalt ("the Township") to complete a Sanitary Asset Management Plan (SAMP). The scope of work includes identifying upgrade projects required within the Township's sanitary system infrastructure (considering both pipes and facilities) and preparing Class D cost estimates for these projects. The following technical memorandum details the unit rate costs to be applied in developing these estimates. Insights from Urban Systems' experience with communities similar to the Township (both in location and size) to corroborate unit costs are presented herein.

2.0 COST DERIVATIONS AND BACKGROUND INFORMATION

Sanitary system construction costs have been broken out into two key components of a sanitary network:

- Linear gravity collection sewers and pressurized force mains (\$/m)
- Pump Stations (\$/HP)

In addition to our own project history, reference unit prices published by the City of Nanaimo were used to develop unit costs for linear infrastructure. These reference unit prices are derived from average tender prices of infrastructure replacement projects completed in the City of Nanaimo from 2020 to 2024, and therefore account for inflationary changes during this period and reflect recent market value.

For facility (pump station) unit costs, previous cost estimates completed by Urban Systems for nearby municipalities in 2021 were assumed as base values. These values were then inflated in accordance with construction cost indices published by the Engineering News Record for nearby markets, which indicate a cumulative inflation rate of approximately 16.23% since 2021. This inflation value is conservative compared to the Consumer Price Index¹ (approximately 7% from 2021 to 2023, with data for 2024 not yet available) provided by Statistics Canada for Victoria, BC.

2.1 INCLUSIONS AND ASSUMPTIONS

The following subsections introduce inclusions and assumptions related to the different types of sanitary system infrastructure. For all infrastructure types below, a 30% contingency allowance has been applied to the estimated capital cost. An additional 10% (for linear components) or 15% (for non-linear, station-type components) engineering allowance has been applied to capital and contingency costs. Detailed unit-cost derivations are appended to this memo.

¹ Statistics Canada: Consumer Price Index -- <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810000501>

2.1.1 Gravity Mains

The unit rate cost for gravity sanitary sewer mains includes typical items required for construction, such as:

- Site preparation (asphalt milling, common excavation, rock excavation, traffic control);
- Sanitary gravity works (pipe works, service connections, tie-in to existing systems, manholes); and
- Surface restoration (trench backfill, granular base/subbase, asphalt pavement).

The cost of the scope items listed above are normalized and combined to produce a linear metre unit price. These costs are then added to typical per-metre pipe costs for varying pipe diameters. Additionally, as gravity mains are typically installed within road rights-of-way, cost multipliers have been established, as exhibited in Table 1, for different cross-sectional road types. These multipliers adjust the project base cost (i.e. the cost of the project within a RLO Local Road or RST Strata Road right-of-way) by a certain factor based on road type, accounting for the changes in cost associated with the varying levels of construction complexity among different road classifications (relating to varying requirements for traffic control, removal and replacement of road structure, and removal and replacement of road features such as medians, curb & gutter, sidewalk, electrical conduit crossings, etc.).

Table 1: Cost Multipliers for Various Road Classes within Esquimalt

Road Classification	Cost Multiplier
RSV Service Road, RLN Road Lane, RRT Restricted Road	0.85x
RLO Local Road, RST Strata Road	1.00x
RC1 RC2 Major & Minor Collectors, RRC Recreation Road, RYL Yield Lane	1.25x
RA1 Major Arterial	1.50x

Additionally, since gravity sewers are required to maintain a downward slope along the collection system, installation depth ranges (typical to the Township) have been discretized as follows and costed individually to provide higher accuracy estimates:

- Shallow (<1.5m) installation depth;
- Moderate (1.5-3m) installation depth; and
- Deep (3-6m) installation depth.

The cost derivation is structured such that the volume of earthworks (excavation and backfill) required at each depth interval is factored into the unit-cost estimate.

2.1.2 Force Mains

Pricing for force mains is determined using a similar methodology as applied to gravity mains, but considers some differing components as required (i.e. including air valves but excluding manholes). Unlike gravity mains,

force mains are typically installed at shallow depths (similar to watermains) so this was the only depth-scenario considered for force main cost estimating (<1.5m).

2.1.3 Pump Stations

Pump stations unit costs are based on a single parameter – total installed pump horsepower. Typical complexity and scale of pump station infrastructure has been found to be generally proportional to pump horsepower (with scale and complexity generally increasing with pump horsepower). As such, total station horsepower is considered a strong proxy for station cost.

3.0 CONCLUSION AND RECOMMENDATIONS

3.1 GRAVITY MAINS

Table 2 summarizes the estimated gravity main construction cost at the various installation depths (inclusive of manholes, service connections, roadworks, tie-ins and 30% contingency and 10% engineering for RLO Local and RST Strata roads). These road classifications were assumed as the 'base cost' scenarios; multipliers (listed in Table 1) were then applied to these base costs to produce estimated costs for other road classifications within the Township. Surface paving width was assumed to be 2m for minimum installation depths and increases to approximately 6m width as installation depth increases, assuming the use of trench boxes for the deepest parts of the trench. It is also assumed that the new main will be located in another alignment from the current main such that extensive bypass pumping will not be required. Existing mains are assumed to be capped and abandoned in place. Rock excavation has been assumed for 20% of the pipeline length.

Table 2: Gravity Main Unit Costs at Various Depths for RLO Local and RST Strata Roads

Pipe Size (mm)	Estimated Cost (\$/m) Including E&C for RLO Local and RST Strata Roads		
	<1.5m	1.5m-3m	3-6m
150mm	\$2,167	\$3,532	\$5,328
200mm	\$2,282	\$3,647	\$5,443
250mm	\$2,397	\$3,762	\$5,557
300mm	\$2,550	\$3,915	\$5,710
350mm	\$2,703	\$4,068	\$5,863
375mm	\$2,779	\$4,144	\$5,940
400mm	\$2,874	\$4,257	\$6,071
450mm	\$2,951	\$4,334	\$6,148
525mm	\$3,180	\$4,563	\$6,377
600mm	\$3,371	\$4,755	\$6,569
675mm	\$3,657	\$5,059	\$6,892
750mm	\$3,734	\$5,136	\$6,968
900mm	\$4,040	\$5,442	\$7,274
1050mm	\$4,499	\$5,901	\$7,733
1200mm	\$4,805	\$6,207	\$8,039
1350mm	\$5,111	\$6,513	\$8,345
1500mm	\$5,417	\$6,819	\$8,651

3.2 FORCE MAINS

Table 3 summarizes the estimated force main construction costs located in RLO Local Roads and RST Strata Road Roads, including 30% contingency and 10% design and construction engineering allowances (a detailed cost derivation is appended to this memo). Assumptions related to trench width, rock excavation and abandonment of existing mains are identical to those for gravity main estimates. Costs listed in Table 3 are considered to be

force main base costs—road classification multipliers are then applied to estimate costs associated with force mains installed in other road types (similar to gravity mains), as exhibited in Table 4. This estimate has been compared to and confirmed to align with historical tender pricing provided by the Township.

Table 3: Force Main Unit Costs for RLO Local Roads and RST Strata Road Roads

Road Classification	Pipe Size (mm)												
	50	75	100	150	200	250	300	350	400	450	600	750	900
RLO Local Road, RST Strata Road	\$1,400	\$1,460	\$1,560	\$1,580	\$1,630	\$1,730	\$1,980	\$1,990	\$2,100	\$2,190	\$2,500	\$2,790	\$3,090

Table 4 compares the estimated base-scenario cost for force mains from Table 3 above to scaled costs (applying the multipliers of Table 1) of:

- RSV Service Roads, RLN Road Lanes, and RRT Restricted Roads
- RC1 RC2 Major & Minor Collectors, RRC Recreation Roads, and RYL Yield Lanes
- RA1 Major Arterials

Table 4: Force Main Unit Costs for Various Esquimalt Street Classifications

	Road Classification	Pipe Size (mm)												
		50	75	100	150	200	250	300	350	400	450	600	750	900
Derived Cost Estimates (\$/m)	RSV Service Road, RLN Road Lane, RRT Restricted Road (0.85x)	\$1,190	\$1,241	\$1,326	\$1,343	\$1,386	\$1,471	\$1,683	\$1,692	\$1,785	\$1,862	\$2,125	\$2,372	\$2,627
	RC1 RC2 Major & Minor Collectors, RRC Recreation Road, RYL Yield Lane (1.25x)	\$1,750	\$1,825	\$1,950	\$1,975	\$2,038	\$2,163	\$2,475	\$2,488	\$2,625	\$2,738	\$3,125	\$3,488	\$3,863
	RA1 Major Arterial (1.5x)	\$2,100	\$2,190	\$2,340	\$2,370	\$2,445	\$2,595	\$2,970	\$2,985	\$3,150	\$3,285	\$3,750	\$4,185	\$4,635

3.3 PUMP STATIONS

Table 5 summarizes the estimated pump station replacement costs based on horsepower rating. The total costs assume replacement of all station components, including a wet-well with pumps, internal process mechanical components, and an electrical kiosk and generator of appropriate size to provide redundant power to the station. It should be noted that individual components within a pump station may require upgrading, while the remainder may have sufficient lifespan (e.g. pumps may be replaced while the wet well structure remains). Cost derivations for the values of Table 5, which include prices for the civil, mechanical and electrical components, are appended to this memo.

DATE: August 12, 2024

FILE: 3275.0021.01

PAGE: 6 of 6

SUBJECT: Sanitary Asset Management Plan Unit Cost Estimating

Table 5: Pump Station Cost Estimates for Various Station Sizes

Derived Costs	Pump Ratings	0-5 HP	5-20 HP	20-50 HP	50-100 HP	100+ HP
	Cost	\$633,454	\$706,679	\$918,217	\$1,265,745	\$1,798,078
	Total Cost Incl. Engineering (15%) and Contingency (30%)	\$948,000	\$1,057,000	\$1,373,000	\$1,893,000	\$2,689,000

3.4 RECOMMENDATIONS

The unit rates presented herein reflect recent market prices and inflationary changes, as well as infrastructure and construction costs typical of nearby/comparable municipalities. It is recommended that the proposed unit rates be utilized for estimating costs of projects identified in the Township's Sanitary Sewer Asset Management Plan.

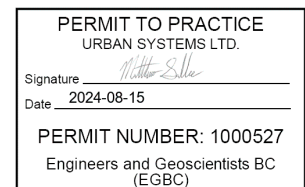
Sincerely,

URBAN SYSTEMS LTD.



Mark Stafford, P.Eng
Project Lead

Kara Labelle, E.I. T
Civil Engineer-in-Training



cc: Alex Kempa, E.I.T

/kl

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Estimated Sanitary Asset Management Plan Project Unit Costs, 2024

Sanitary Main (0-1.5m depth)	Road Classification	150mm	200mm	250mm	300mm	350mm	375mm	400mm	450mm	525mm	600mm	675mm	750mm	900mm	1050mm	1200mm	1350mm	1500mm	Assumptions and Inclusions	
	RSV Service Road, RLN Road Lane, RRT Restricted Road (0.85x)	\$1,842	\$1,940	\$2,037	\$2,167	\$2,297	\$2,362	\$2,443	\$2,508	\$2,703	\$2,866	\$3,109	\$3,174	\$3,434	\$3,824	\$4,084	\$4,344	\$4,605	All road classes include mains, appurtenances, tie-ins, service connections, pavement restoration, engineering (10%), contingency (30%)	
	RLO Local Road, RST Strata Road (1x)	\$2,167	\$2,282	\$2,397	\$2,550	\$2,703	\$2,779	\$2,874	\$2,951	\$3,180	\$3,371	\$3,657	\$3,734	\$4,040	\$4,499	\$4,805	\$5,111	\$5,417		
	RC1 RC2 Major & Minor Collectors, RRC Recreation Road, RYL Yield Lane (1.25x)	\$2,709	\$2,852	\$2,996	\$3,187	\$3,378	\$3,474	\$3,593	\$3,688	\$3,975	\$4,214	\$4,572	\$4,667	\$5,050	\$5,624	\$6,006	\$6,389	\$6,771		
	RA1 Major Arterial (1.5x)	\$3,251	\$3,423	\$3,595	\$3,825	\$4,054	\$4,169	\$4,311	\$4,426	\$4,770	\$5,057	\$5,486	\$5,601	\$6,060	\$6,749	\$7,208	\$7,667	\$8,126		
Sanitary Main (1.5-3m depth)	Road Classification	150mm	200mm	250mm	300mm	350mm	375mm	400mm	450mm	525mm	600mm	675mm	750mm	900mm	1050mm	1200mm	1350mm	1500mm	Assumptions and Inclusions	
	RSV Service Road, RLN Road Lane, RRT Restricted Road (0.85x)	\$3,002	\$3,100	\$3,197	\$3,327	\$3,457	\$3,522	\$3,619	\$3,684	\$3,879	\$4,041	\$4,300	\$4,365	\$4,625	\$5,016	\$5,276	\$5,536	\$5,796	All road classes include mains, appurtenances, tie-ins, service connections, pavement restoration, engineering (10%), contingency (30%)	
	RLO Local Road, RST Strata Road (1x)	\$3,532	\$3,647	\$3,762	\$3,915	\$4,068	\$4,144	\$4,257	\$4,334	\$4,563	\$4,755	\$5,059	\$5,136	\$5,442	\$5,901	\$6,207	\$6,513	\$6,819		
	RC1 RC2 Major & Minor Collectors, RRC Recreation Road, RYL Yield Lane (1.25x)	\$4,415	\$4,559	\$4,702	\$4,893	\$5,084	\$5,180	\$5,322	\$5,417	\$5,704	\$5,943	\$6,324	\$6,420	\$6,802	\$7,376	\$7,758	\$8,141	\$8,523		
	RA1 Major Arterial (1.5x)	\$5,298	\$5,470	\$5,642	\$5,872	\$6,101	\$6,216	\$6,386	\$6,501	\$6,845	\$7,132	\$7,589	\$7,703	\$8,162	\$8,851	\$9,310	\$9,769	\$10,228		
Sanitary Main (3-6m depth)	Road Classification	150mm	200mm	250mm	300mm	350mm	375mm	400mm	450mm	525mm	600mm	675mm	750mm	900mm	1050mm	1200mm	1350mm	1500mm	Assumptions and Inclusions	
	RSV Service Road, RLN Road Lane, RRT Restricted Road (0.85x)	\$4,529	\$4,626	\$4,724	\$4,854	\$4,984	\$5,049	\$5,161	\$5,226	\$5,421	\$5,583	\$5,858	\$5,923	\$6,183	\$6,573	\$6,833	\$7,093	\$7,354	All road classes include mains, appurtenances, tie-ins, service connections, pavement restoration, engineering (10%), contingency (30%)	
	RLO Local Road, RST Strata Road (1x)	\$5,328	\$5,443	\$5,557	\$5,710	\$5,863	\$5,940	\$6,071	\$6,148	\$6,377	\$6,569	\$6,892	\$6,968	\$7,274	\$7,733	\$8,039	\$8,345	\$8,651		
	RC1 RC2 Major & Minor Collectors, RRC Recreation Road, RYL Yield Lane (1.25x)	\$6,660	\$6,803	\$6,947	\$7,138	\$7,329	\$7,425	\$7,589	\$7,685	\$7,972	\$8,211	\$8,614	\$8,710	\$9,093	\$9,666	\$10,049	\$10,431	\$10,814		
	RA1 Major Arterial (1.5x)	\$7,992	\$8,164	\$8,336	\$8,566	\$8,795	\$8,910	\$9,107	\$9,222	\$9,566	\$9,853	\$10,337	\$10,452	\$10,911	\$11,600	\$12,059	\$12,518	\$12,977		
Force Mains (0-1.5m depth)	Road Classification	50mm	75mm	100mm	150mm	200mm	250mm	300mm	350mm	400mm	450mm	600mm	750mm	900mm					Assumptions and Inclusions	
	RSV Service Road, RLN Road Lane, RRT Restricted Road (0.85x)	\$1,190	\$1,241	\$1,326	\$1,343	\$1,386	\$1,471	\$1,683	\$1,692	\$1,785	\$1,862	\$2,125	\$2,372	\$2,627					All road classes include mains, appurtenances, tie-ins, pavement restoration, engineering (10%), contingency (30%)	
	RLO Local Road, RST Strata Road (1x)	\$1,400	\$1,460	\$1,560	\$1,580	\$1,630	\$1,730	\$1,980	\$1,990	\$2,100	\$2,190	\$2,500	\$2,790	\$3,090						
	RC1 RC2 Major & Minor Collectors, RRC Recreation Road, RYL Yield Lane (1.25x)	\$1,750	\$1,825	\$1,950	\$1,975	\$2,038	\$2,163	\$2,475	\$2,488	\$2,625	\$2,738	\$3,125	\$3,488	\$3,863						
	RA1 Major Arterial (1.5x)	\$2,100	\$2,190	\$2,340	\$2,370	\$2,445	\$2,595	\$2,970	\$2,985	\$3,150	\$3,285	\$3,750	\$4,185	\$4,635						
Pump Stations	Pump Ratings (HP)	0-5	5-20	20-50	50-100	100 & above														Assumptions and Inclusions
	\$	\$633,454	\$706,679	\$918,217	\$1,265,745	\$1,798,078														Estimated construction costs include 15% engineering and 30% contingency
	\$ + E&C	\$948,000	\$1,057,000	\$1,373,000	\$1,893,000	\$2,689,000														

SANITARY PIPE COST PER METRE (0-1.5m depth) DERIVATION										
Based on 8.5m / 11.0m RLO Local Road, RST Strata Road Scenario										
Average trench width of 2m straight down (utilize trench box)										
Top trench width of 2m										
Item	Description	Unit	Quantity	Unit Price	Total	Unit Price	Total	Unit Price	Total	
A. SITE PREPARATION										
1.01	Asphalt cutting	lin.m.	2.0	\$ 8	\$ 16	\$ 8	\$ 16	\$ 8	\$ 16	
1.02	Common excavation and off site disposal (roads)	cu.m.	3.0	\$ 35	\$ 105	\$ 35	\$ 105	\$ 35	\$ 105	
1.03	Rock excavation (20%)	cu.m.	0.60	\$ 450	\$ 270	\$ 450	\$ 270	\$ 450	\$ 270	
SUBTOTAL - SECTION A				\$ 391		\$ 391		\$ 391		
B. ROAD WORK RESTORATION										
2.01	Trench backfill (including pipe bedding) and compaction	cu.m.	2.2	\$ 58	\$ 127	\$ 58	\$ 127	\$ 58	\$ 127	
2.02	Granular subbase (200mm depth)	sq.m.	2.0	\$ 12	\$ 24	\$ 12	\$ 24	\$ 12	\$ 24	
2.03	Granular base (150mm depth)	sq.m.	2.0	\$ 11	\$ 22	\$ 11	\$ 22	\$ 11	\$ 22	
2.04	Asphalt (50mm)	sq.m.	2.0	\$ 72	\$ 144	\$ 72	\$ 144	\$ 72	\$ 144	
SUBTOTAL - SECTION B				\$ 317		\$ 317		\$ 317		
C. SANITARY SEWERS										
3.01	Manhole complete (1 per 50m)	ea.	0.02	\$ 6,500	\$ 130	\$ 9,600	\$ 192	\$ 15,200	\$ 304	
3.02	100mm Lot service connection c/w 200mm IC (1 per 10m)	ea.	0.1	\$ 3,235	\$ 324	\$ 3,235	\$ 324	\$ 3,235	\$ 324	
3.03	Tie-in to Existing Manhole (1 per 400m)	ea.	0.0025	\$ 2,000	\$ 5	\$ 2,000	\$ 5	\$ 2,000	\$ 5	
SUBTOTAL - SECTION C				\$459		\$521		\$633		
SUMMARY OF EXTRA COSTS				\$1,166		\$1,228		\$1,340		

Pipe Size (mm)	150	200	250	300	350	375	400	450	525	600	675	750	900	1050	1200	1350	1500
Pipe Cost (supply and install)	\$250	\$325	\$400	\$500	\$600	\$650	\$650	\$700	\$850	\$975	\$1,050	\$1,100	\$1,300	\$1,600	\$1,800	\$2,000	\$2,200
Extra Costs	\$1,166	\$1,166	\$1,166	\$1,166	\$1,166	\$1,166	\$1,228	\$1,228	\$1,228	\$1,228	\$1,340	\$1,340	\$1,340	\$1,340	\$1,340	\$1,340	\$1,340
Traffic Control	\$99	\$104	\$110	\$117	\$124	\$127	\$131	\$135	\$145	\$154	\$167	\$171	\$185	\$206	\$220	\$234	\$248
Subtotal	\$1,516	\$1,596	\$1,676	\$1,783	\$1,890	\$1,944	\$2,010	\$2,063	\$2,224	\$2,358	\$2,558	\$2,611	\$2,825	\$3,146	\$3,360	\$3,574	\$3,788
Contingency (30%)	\$455	\$479	\$503	\$535	\$567	\$583	\$603	\$619	\$667	\$707	\$767	\$783	\$848	\$944	\$1,008	\$1,072	\$1,136
Engineering (10%)	\$197	\$207	\$218	\$232	\$246	\$253	\$261	\$268	\$289	\$306	\$332	\$339	\$367	\$409	\$437	\$465	\$492
TOTAL UNIT COST	\$2,167	\$2,282	\$2,397	\$2,550	\$2,703	\$2,779	\$2,874	\$2,951	\$3,180	\$3,371	\$3,657	\$3,734	\$4,040	\$4,499	\$4,805	\$5,111	\$5,417

SANITARY PIPE COST PER METRE (1.5-3m depth) DERIVATION										
Based on 8.5m / 11.0m RLO Local Road, RST Strata Road Scenario										
Average trench width of 2m straight down (utilize trench box)										
Top trench width of 5.2m										
Item	Description	Unit	Quantity	Unit Price	Total	Unit Price	Total	Unit Price	Total	
A. SITE PREPARATION										
1.01	Asphalt cutting	lin.m.	2.0	\$ 8	\$ 16	\$ 8	\$ 16	\$ 8	\$ 16	
1.02	Common excavation and off site disposal (roads)	cu.m.	6.0	\$ 35	\$ 210	\$ 35	\$ 210	\$ 35	\$ 210	
1.03	Rock excavation (20%)	cu.m.	1.20	\$ 450	\$ 540	\$ 450	\$ 540	\$ 450	\$ 540	
SUBTOTAL - SECTION A			\$766			\$766			\$766	
B. ROAD WORK RESTORATION										
2.01	Trench backfill (including pipe bedding) and compaction	cu.m.	5.2	\$ 58	\$ 300	\$ 58	\$ 300	\$ 58	\$ 300	
2.02	Granular subbase (200mm depth)	sq.m.	5.2	\$ 12	\$ 63	\$ 12	\$ 63	\$ 12	\$ 63	
2.03	Granular base (150mm depth)	sq.m.	5.2	\$ 11	\$ 57	\$ 11	\$ 57	\$ 11	\$ 57	
2.04	Asphalt (50mm)	sq.m.	5.2	\$ 72	\$ 374	\$ 72	\$ 374	\$ 72	\$ 374	
SUBTOTAL - SECTION B			\$794			\$794			\$794	
C. SANITARY SEWERS										
3.01	Manhole complete (1 per 50m)	ea.	0.02	\$ 8,500	\$ 170	\$ 12,200	\$ 244	\$ 18,400	\$ 368	
3.02	100mm Lot service connection c/w 200mm IC (1 per 10m)	ea.	0.1	\$ 3,235	\$ 324	\$ 3,235	\$ 324	\$ 3,235	\$ 324	
3.03	Tie-in to Existing Manhole (1 per 400m)	ea.	0.0025	\$ 2,000	\$ 5	\$ 2,000	\$ 5	\$ 2,000	\$ 5	
SUBTOTAL - SECTION C			\$499			\$573			\$697	
SUMMARY OF EXTRA COSTS			\$2,058			\$2,132			\$2,256	

Pipe Size (mm)	150	200	250	300	350	375	400	450	525	600	675	750	900	1050	1200	1350	1500
Pipe Cost (supply and install)	\$250	\$325	\$400	\$500	\$600	\$650	\$650	\$700	\$850	\$975	\$1,050	\$1,100	\$1,300	\$1,600	\$1,800	\$2,000	\$2,200
Extra Costs	\$2,058	\$2,058	\$2,058	\$2,058	\$2,058	\$2,058	\$2,132	\$2,132	\$2,132	\$2,132	\$2,256	\$2,256	\$2,256	\$2,256	\$2,256	\$2,256	\$2,256
Traffic Control	\$162	\$167	\$172	\$179	\$186	\$190	\$195	\$198	\$209	\$218	\$231	\$235	\$249	\$270	\$284	\$298	\$312
Subtotal	\$2,470	\$2,550	\$2,630	\$2,737	\$2,844	\$2,898	\$2,977	\$3,031	\$3,191	\$3,325	\$3,538	\$3,591	\$3,805	\$4,126	\$4,340	\$4,554	\$4,768
Contingency (30%)	\$741	\$765	\$789	\$821	\$853	\$869	\$893	\$909	\$957	\$997	\$1,061	\$1,077	\$1,142	\$1,238	\$1,302	\$1,366	\$1,430
Engineering (10%)	\$321	\$332	\$342	\$356	\$370	\$377	\$387	\$394	\$415	\$432	\$460	\$467	\$495	\$536	\$564	\$592	\$620
TOTAL UNIT COST	\$3,532	\$3,647	\$3,762	\$3,915	\$4,068	\$4,144	\$4,257	\$4,334	\$4,563	\$4,755	\$5,059	\$5,136	\$5,442	\$5,901	\$6,207	\$6,513	\$6,819

SANITARY PIPE COST PER METRE (3-6m depth) DERIVATION										
Based on 8.5m / 11.0m RLO Local Road, RST Strata Road Scenario										
Average trench width of 2m straight down (utilize trench box)										
Top trench width of 5.6m										
Item	Description	Unit	Quantity	Unit Price	Total	Unit Price	Total	Unit Price	Total	
A. SITE PREPARATION										
1.01	Asphalt cutting	lin.m.	2.0	\$ 8	\$ 16	\$ 8	\$ 16	\$ 8	\$ 16	
1.02	Common excavation and off site disposal (roads)	cu.m.	12.0	\$ 35	\$ 420	\$ 35	\$ 420	\$ 35	\$ 420	
1.03	Rock excavation (20%)	cu.m.	2.40	\$ 450	\$ 1,080	\$ 450	\$ 1,080	\$ 450	\$ 1,080	
SUBTOTAL - SECTION A			\$1,516			\$1,516			\$1,516	
B. ROAD WORK RESTORATION										
2.01	Trench backfill (including pipe bedding) and compaction	cu.m.	11.2	\$ 58	\$ 645	\$ 58	\$ 645	\$ 58	\$ 645	
2.02	Granular subbase (200mm depth)	sq.m.	5.6	\$ 12	\$ 68	\$ 12	\$ 68	\$ 12	\$ 68	
2.03	Granular base (150mm depth)	sq.m.	5.6	\$ 11	\$ 61	\$ 11	\$ 61	\$ 11	\$ 61	
2.04	Asphalt (50mm)	sq.m.	5.6	\$ 72	\$ 403	\$ 72	\$ 403	\$ 72	\$ 403	
SUBTOTAL - SECTION B			\$1,178			\$1,178			\$1,178	
C. SANITARY SEWERS										
3.01	Manhole complete (1 per 50m)	ea.	0.02	\$ 10,500	\$ 210	\$ 14,800	\$ 296	\$ 21,600	\$ 432	
3.02	100mm Lot service connection c/w 200mm IC (1 per 10m)	ea.	0.1	\$ 3,235	\$ 324	\$ 3,235	\$ 324	\$ 3,235	\$ 324	
3.03	Tie-in to Existing Manhole (1 per 400m)	ea.	0.0025	\$ 2,000	\$ 5	\$ 2,000	\$ 5	\$ 2,000	\$ 5	
SUBTOTAL - SECTION C			\$539			\$625			\$761	
SUMMARY OF EXTRA COSTS			\$3,232			\$3,318			\$3,454	

Pipe Size (mm)	150	200	250	300	350	375	400	450	525	600	675	750	900	1050	1200	1350	1500
Pipe Cost (supply and install)	\$250	\$325	\$400	\$500	\$600	\$650	\$650	\$700	\$850	\$975	\$1,050	\$1,100	\$1,300	\$1,600	\$1,800	\$2,000	\$2,200
Extra Costs	\$3,232	\$3,232	\$3,232	\$3,232	\$3,232	\$3,232	\$3,318	\$3,318	\$3,318	\$3,318	\$3,454	\$3,454	\$3,454	\$3,454	\$3,454	\$3,454	\$3,454
Traffic Control	\$244	\$249	\$254	\$261	\$268	\$272	\$278	\$281	\$292	\$301	\$315	\$319	\$333	\$354	\$368	\$382	\$396
Subtotal	\$3,726	\$3,806	\$3,886	\$3,993	\$4,100	\$4,154	\$4,246	\$4,299	\$4,460	\$4,594	\$4,819	\$4,873	\$5,087	\$5,408	\$5,622	\$5,836	\$6,050
Contingency (30%)	\$1,118	\$1,142	\$1,166	\$1,198	\$1,230	\$1,246	\$1,274	\$1,290	\$1,338	\$1,378	\$1,446	\$1,462	\$1,526	\$1,622	\$1,687	\$1,751	\$1,815
Engineering (10%)	\$484	\$495	\$505	\$519	\$533	\$540	\$552	\$559	\$580	\$597	\$627	\$633	\$661	\$703	\$731	\$759	\$786
TOTAL UNIT COST	\$5,328	\$5,443	\$5,557	\$5,710	\$5,863	\$5,940	\$6,071	\$6,148	\$6,377	\$6,569	\$6,892	\$6,968	\$7,274	\$7,733	\$8,039	\$8,345	\$8,651

FORCE MAIN PIPE COST PER METRE (0-1.5m depth) DERIVATION					
Based on 8.5m / 11.0m RLO Local Road, RST Strata Road Scenario					
Average trench width of 2m straight down (utilize trench box)					
Top trench width of 2m					
Item	Description	Unit	Quantity	Unit Price	Total
A. SITE PREPARATION					
1.01	Aspalt cutting	lin.m.	2.0	\$ 8	\$ 16
1.02	Common excavation and off site disposal (roads)	cu.m.	3.0	\$ 35	\$ 105
1.03	Rock excavation (20%)	cu.m.	0.6	\$ 450	\$ 270
SUBTOTAL - SECTION A			\$ 391		
B. ROAD WORK RESTORATION					
2.01	Trench backfill (including pipe bedding) and compaction	cu.m.	2.2	\$ 58	\$ 127
2.02	Granular subbase (200mm depth)	sq.m.	2.0	\$ 12	\$ 24
2.03	Granular base (150mm depth)	sq.m.	2.0	\$ 11	\$ 22
2.04	Asphalt (50mm)	sq.m.	2.0	\$ 72	\$ 144
SUBTOTAL - SECTION B			\$ 317		
C. PIPE WORKS					
Tie-in (1 at pump station, 1 at discharge, assumed average 500m length between pump station and discharge point)					
3.01		ea.	0.004	\$ 5,129	\$ 21
3.02	Air/Vacuum Valve (1 per 500m)	ea.	0.002	\$ 7,000	\$ 14
SUBTOTAL - SECTION C			\$ 35		
SUMMARY OF EXTRA COSTS			\$ 742		

Pipe Size (mm)	50	75	100	150	200	250	300	350	400	450	600	750	900
Pipe Cost (supply and install)	\$170	\$210	\$275	\$290	\$320	\$390	\$550	\$560	\$630	\$690	\$890	\$1,080	\$1,280
Extra Costs	\$742	\$742	\$742	\$742	\$742	\$742	\$742	\$742	\$742	\$742	\$742	\$742	\$742
Traffic Control	\$64	\$67	\$71	\$72	\$74	\$79	\$90	\$91	\$96	\$100	\$114	\$128	\$142
Subtotal	\$976	\$1,019	\$1,089	\$1,105	\$1,137	\$1,212	\$1,383	\$1,394	\$1,468	\$1,533	\$1,747	\$1,950	\$2,164
Contingency (30%)	\$293	\$306	\$327	\$331	\$341	\$363	\$415	\$418	\$441	\$460	\$524	\$585	\$649
Engineering (10%)	\$127	\$132	\$142	\$144	\$148	\$158	\$180	\$181	\$191	\$199	\$227	\$253	\$281
TOTAL UNIT COST	\$1,400	\$1,460	\$1,560	\$1,580	\$1,630	\$1,730	\$1,980	\$1,990	\$2,100	\$2,190	\$2,500	\$2,790	\$3,090

Small Sanitary Pump Station
HP < 5hp

Class D Cost Estimate

Description

This estimate has been prepared to establish budgetary costs for long range financial planning purposes only. The derived cost is an approximate magnitude of cost derived from lump sum and unit costs from recent similar projects. Design and construction engineering and contingency are included in this estimate.

Item	Description	Unit	Total Quantity	Unit Price	Total
A. PUMP STATION					
1.1	Wet well (c/w Pumps and Internal Mechanical Components)	L.S.	1	135,000.00	\$ 135,000
1.2	Valve Chamber (c/w check valves, isolation valves, air valve, bypass)	L.S.	1	45,000.00	\$ 45,000
1.3	Flow Meter (c/w chamber)	L.S.	1	25,000.00	\$ 25,000
TOTAL SECTION A					\$ 205,000
B. ELECTRICAL					
2.1	Electrical Kiosk (c/w Controls, Motor Starters, Power Distribution, Automatic Transfer Switch, Termination Compartment)	L.S.	1	130,000.00	\$ 130,000
2.2	Generator	L.S.	1	38,000.00	\$ 38,000
2.3	General Site Work (Wet Well, Valve Chamber, Luminaire/Antenna Pole)	L.S.	1	54,000.00	\$ 54,000
2.4	BC Hydro Service Utility	L.S.	1	9,000.00	\$ 9,000
2.5	Testing/Commissioning/Permits	L.S.	1	39,000.00	\$ 39,000
TOTAL SECTION B					\$ 270,000
C. CIVIL UTILITIES					
3.1	Connection to Existing Forcemain	L.S.	1	15,000.00	\$ 15,000
3.2	Connection to Existing Gravity Main	L.S.	1	15,000.00	\$ 15,000
3.3	Water Service and Washdown	L.S.	1	7,500.00	\$ 7,500
TOTAL SECTION C					\$ 37,500
D. SITE WORKS AND ACCESS					
4.1	Earthworks, Site Grading, Paving and Landscaping	L.S.	1	25,000.00	\$ 25,000
4.2	Fencing and Bollards	L.S.	1	7,500.00	\$ 7,500
TOTAL SECTION D					\$ 32,500

SUMMARY

A. PUMP STATION		\$ 205,000
B. ELECTRICAL		\$ 270,000
C. CIVIL UTILITIES		\$ 37,500
D. SITE WORKS AND ACCESS		\$ 32,500
SUB-TOTAL:		\$ 545,000
Inflation Rate (2021-2024)		16.23%
Inflation Cost		\$ 88,454
SUB-TOTAL:		\$ 633,454
Contingency (30% of Const.)	L.S. 1	\$ 190,036
Design and Construction Engineering (15% of Const.)	L.S. 1	\$ 123,523
SUB-TOTAL:		\$ 313,559
TOTAL ESTIMATED CONSTRUCTION COST (EXCLUDING TAXES)		\$ 948,000

ASSUMPTIONS

- Pump station will be constructed on existing lot or within road RoW and no land acquisition costs are required.
- Grading and landscaping will be required at the site, but no clearing and grubbing.
- Rock blasting is not required at the site.
- Station will include a FRP wet well and electrical kiosk. Estimates do not include costs for a building.
- Station will include glow meter in standalone below-ground chamber.
- Assumed configuration: Duplex Lift Station, Electrical Kiosk, Generator, Wet Well, Valve Chamber, Flow Meter Manhole
- Assumed voltage is 600V, 3-Phase.
- Assumed labour rate is \$85/hr.
- Assumed Generator Size is 40kW.

Small - Medium Sanitary Pump Station 5hp <= HP < 20hp

Class D Cost Estimate

Description

This estimate has been prepared to establish budgetary costs for long range financial planning purposes only. The derived cost is an approximate magnitude of cost derived from lump sum and unit costs from recent similar projects. Design and construction engineering and contingency are included in this estimate.

Item	Description	Unit	Total Quantity	Unit Price	Total
A. PUMP STATION					
1.1	Wet well (c/w Pumps and Internal Mechanical Components)	L.S.	1	157,500.00	\$ 157,500
1.2	Valve Chamber (c/w check valves, isolation valves, air valve, bypass)	L.S.	1	52,500.00	\$ 52,500
1.3	Flow Meter (c/w chamber)	L.S.	1	35,000.00	\$ 35,000
TOTAL SECTION A					\$ 245,000
B. ELECTRICAL					
2.1	Electrical Kiosk (c/w Controls, Motor Starters, Power Distribution, Automatic Transfer Switch, Termination Compartment)	L.S.	1	134,000.00	\$ 134,000
2.2	Generator	L.S.	1	38,000.00	\$ 38,000
2.3	General Site Work (Wet Well, Valve Chamber, Luminaire/Antenna Pole)	L.S.	1	54,000.00	\$ 54,000
2.4	BC Hydro Service Utility	L.S.	1	12,000.00	\$ 12,000
2.5	Testing/Commissioning/Permits	L.S.	1	40,000.00	\$ 40,000
TOTAL SECTION B					\$ 278,000
C. CIVIL UTILITIES					
3.1	Connection to Existing Forcemain	L.S.	1	25,000.00	\$ 25,000
3.2	Connection to Existing Gravity Main	L.S.	1	15,000.00	\$ 15,000
3.3	Water Service and Washdown	L.S.	1	7,500.00	\$ 7,500
TOTAL SECTION C					\$ 47,500
D. SITE WORKS AND ACCESS					
4.1	Earthworks, Site Grading, Paving and Landscaping	L.S.	1	30,000.00	\$ 30,000
4.2	Fencing and Bollards	L.S.	1	7,500.00	\$ 7,500
TOTAL SECTION D					\$ 37,500
SUMMARY					
A. PUMP STATION				\$	245,000
B. ELECTRICAL				\$	278,000
C. CIVIL UTILITIES				\$	47,500
D. SITE WORKS AND ACCESS				\$	37,500
SUB-TOTAL:				\$	608,000
Inflation Rate (2021-2024)					16.23%
Inflation Cost				\$	98,678
SUB-TOTAL:				\$	706,679
Contingency (30% of Const.)				\$	212,004
Design and Construction Engineering (15% of Const.)				\$	137,802
SUB-TOTAL:				\$	349,806
TOTAL ESTIMATED CONSTRUCTION COST (EXCLUDING TAXES)					\$ 1,057,000

ASSUMPTIONS

- Pump station will be constructed on existing lot or within road RoW and no land acquisition costs are required.
- Grading and landscaping will be required at the site, but no clearing and grubbing.
- Rock blasting is not required at the site.
- Station will include a FRP wet well and electrical kiosk. Estimates do not include costs for a building.
- Station will include flow meter in standalone below-ground chamber.
- Assumed configuration: Duplex Lift Station, Electrical Kiosk, Generator, Wet Well, Valve Chamber, Flow Meter Manhole
- Assumed voltage is 600V, 3-Phase.
- Assumed labour rate is \$85/hr.
- Assumed Generator Size is 40kW.

Medium Sanitary Pump Station 20hp <= HP < 50hp

Class D Cost Estimate

Description

This estimate has been prepared to establish budgetary costs for long range financial planning purposes only. The derived cost is an approximate magnitude of cost derived from lump sum and unit costs from recent similar projects. Design and construction engineering and contingency are included in this estimate.

Item	Description	Unit	Total Quantity	Unit Price	Total
A. PUMP STATION					
1.1	Wet well (c/w Pumps and Internal Mechanical Components)	L.S.	1	217,500.00	\$ 217,500
1.2	Valve Chamber (c/w check valves, isolation valves, air valve, bypass)	L.S.	1	72,500.00	\$ 72,500
1.3	Flow Meter (c/w chamber)	L.S.	1	75,000.00	\$ 75,000
TOTAL SECTION A					\$ 365,000
B. ELECTRICAL					
2.1	Electrical Kiosk (c/w Controls, Motor Starters, Power Distribution, Automatic Transfer Switch, Termination Compartment)	L.S.	1	145,000.00	\$ 145,000
2.2	Generator	L.S.	1	42,000.00	\$ 42,000
2.3	General Site Work (Wet Well, Valve Chamber, Luminaire/Antenna Pole)	L.S.	1	54,000.00	\$ 54,000
2.4	BC Hydro Service Utility	L.S.	1	14,000.00	\$ 14,000
2.5	Testing/Commissioning/Permits	L.S.	1	40,000.00	\$ 40,000
TOTAL SECTION B					\$ 295,000
C. CIVIL UTILITIES					
3.1	Connection to Existing Forcemain	L.S.	1	50,000.00	\$ 50,000
3.2	Connection to Existing Gravity Main	L.S.	1	20,000.00	\$ 20,000
3.3	Water Service and Washdown	L.S.	1	10,000.00	\$ 10,000
TOTAL SECTION C					\$ 80,000
D. SITE WORKS AND ACCESS					
4.1	Earthworks, Site Grading, Paving and Landscaping	L.S.	1	40,000.00	\$ 40,000
4.2	Fencing and Bollards	L.S.	1	10,000.00	\$ 10,000
TOTAL SECTION D					\$ 50,000

SUMMARY

A. PUMP STATION		\$ 365,000
B. ELECTRICAL		\$ 295,000
C. CIVIL UTILITIES		\$ 80,000
D. SITE WORKS AND ACCESS		\$ 50,000
SUB-TOTAL:		\$ 790,000
Inflation Rate (2021-2024)		16.23%
Inflation Cost		\$ 128,217
SUB-TOTAL:		\$ 918,217
Contingency (30% of Const.)	L.S. 1	\$ 275,465
Design and Construction Engineering (15% of Const.)	L.S. 1	\$ 179,052
SUB-TOTAL:		\$ 454,517
TOTAL ESTIMATED CONSTRUCTION COST (EXCLUDING TAXES)		\$ 1,373,000

ASSUMPTIONS

- Pump station will be constructed on existing lot or within road RoW and no land acquisition costs are required.
- Grading and landscaping will be required at the site, but no clearing and grubbing.
- Rock blasting is not required at the site.
- Station will include a FRP wet well and electrical kiosk. Estimates do not include costs for a building.
- Station will include flow meter in standalone below-ground chamber.
- Assumed configuration: Duplex Lift Station, Electrical Kiosk, Generator, Wet Well, Valve Chamber, Flow Meter Manhole
- Assumed voltage is 600V, 3-Phase.
- Assumed labour rate is \$85/hr.
- Assumed Generator Size is 60kW.

Medium - Large Sanitary Pump Station 50hp <= HP < 100hp

Class D Cost Estimate

Description

This estimate has been prepared to establish budgetary costs for long range financial planning purposes only. The derived cost is an approximate magnitude of cost derived from lump sum and unit costs from recent similar projects. Design and construction engineering and contingency are included in this estimate.

Item	Description	Unit	Total Quantity	Unit Price	Total
A. PUMP STATION					
1.1	Wet well (c/w Pumps and Internal Mechanical Components)	L.S.	1	315,000.00	\$ 315,000
1.2	Valve Chamber (c/w check valves, isolation valves, air valve, bypass)	L.S.	1	105,000.00	\$ 105,000
1.3	Flow Meter (c/w chamber)	L.S.	1	125,000.00	\$ 125,000
TOTAL SECTION A					\$ 545,000
B. ELECTRICAL					
2.1	Electrical Kiosk (c/w Controls, Motor Starters, Power Distribution, Automatic Transfer Switch, Termination Compartment)	L.S.	1	155,000.00	\$ 155,000
2.2	Generator	L.S.	1	63,000.00	\$ 63,000
2.3	General Site Work (Wet Well, Valve Chamber, Luminaire/Antenna Pole)	L.S.	1	54,000.00	\$ 54,000
2.4	BC Hydro Service Utility	L.S.	1	17,000.00	\$ 17,000
2.5	Testing/Commissioning/Permits	L.S.	1	43,000.00	\$ 43,000
TOTAL SECTION B					\$ 332,000
C. CIVIL UTILITIES					
3.1	Connection to Existing Forcemain	L.S.	1	75,000.00	\$ 75,000
3.2	Connection to Existing Gravity Main	L.S.	1	40,000.00	\$ 40,000
3.3	Water Service and Washdown	L.S.	1	10,000.00	\$ 10,000
TOTAL SECTION C					\$ 125,000
D. SITE WORKS AND ACCESS					
4.1	Earthworks, Site Grading, Paving and Landscaping	L.S.	1	75,000.00	\$ 75,000
4.2	Fencing and Bollards	L.S.	1	12,000.00	\$ 12,000
TOTAL SECTION D					\$ 87,000
SUMMARY					
A. PUMP STATION				\$	545,000
B. ELECTRICAL				\$	332,000
C. CIVIL UTILITIES				\$	125,000
D. SITE WORKS AND ACCESS				\$	87,000
SUB-TOTAL:				\$	1,089,000
Inflation Rate (2021-2024)					16.23%
Inflation Cost				\$	176,745
SUB-TOTAL:				\$	1,265,745
Contingency (30% of Const.)				\$	379,723
Design and Construction Engineering (15% of Const.)				\$	246,820
SUB-TOTAL:				\$	626,544
TOTAL ESTIMATED CONSTRUCTION COST (EXCLUDING TAXES)					\$ 1,893,000

ASSUMPTIONS

- Pump station will be constructed on existing lot or within road RoW and no land acquisition costs are required.
- Grading and landscaping will be required at the site, but no clearing and grubbing.
- Rock blasting is not required at the site.
- Station will include a FRP wet well and electrical kiosk. Estimates do not include costs for a building.
- Station will include flow meter in standalone below-ground chamber.
- Assumed configuration: Duplex Lift Station, Electrical Kiosk, Generator, Wet Well, Valve Chamber, Flow Meter Manhole
- Assumed voltage is 600V, 3-Phase.
- Assumed labour rate is \$85/hr.
- Assumed Generator Size is 100kW.

Large Sanitary Pump Station 100 <= HP

Class D Cost Estimate

Description

This estimate has been prepared to establish budgetary costs for long range financial planning purposes only. The derived cost is an approximate magnitude of cost derived from lump sum and unit costs from recent similar projects. Design and construction engineering and contingency are included in this estimate.

Item	Description	Unit	Total Quantity	Unit Price	Total
A. PUMP STATION					
1.1	Wet well (c/w Pumps and Internal Mechanical Components)	L.S.	1	487,500.00	\$ 487,500
1.2	Valve Chamber (c/w check valves, isolation valves, air valve, bypass)	L.S.	1	162,500.00	\$ 162,500
1.3	Flow Meter (c/w chamber)	L.S.	1	150,000.00	\$ 150,000
TOTAL SECTION A					\$ 800,000
B. ELECTRICAL					
2.1	Electrical Kiosk (c/w Controls, Motor Starters, Power Distribution, Automatic Transfer Switch, Termination Compartment)	L.S.	1	160,000.00	\$ 160,000
2.2	Generator	L.S.	1	101,000.00	\$ 101,000
2.3	General Site Work (Wet Well, Valve Chamber, Luminaire/Antenna Pole)	L.S.	1	54,000.00	\$ 54,000
2.4	BC Hydro Service Utility	L.S.	1	52,000.00	\$ 52,000
2.5	Testing/Commissioning/Permits	L.S.	1	45,000.00	\$ 45,000
TOTAL SECTION B					\$ 412,000
C. CIVIL UTILITIES					
3.1	Connection to Existing Forcemain	L.S.	1	100,000.00	\$ 100,000
3.2	Connection to Existing Gravity Main	L.S.	1	50,000.00	\$ 50,000
3.3	Water Service and Washdown	L.S.	1	15,000.00	\$ 15,000
TOTAL SECTION C					\$ 165,000
D. SITE WORKS AND ACCESS					
4.1	Earthworks, Site Grading, Paving and Landscaping	L.S.	1	150,000.00	\$ 150,000
4.2	Fencing and Bollards	L.S.	1	20,000.00	\$ 20,000
TOTAL SECTION D					\$ 170,000
SUMMARY					
A. PUMP STATION					\$ 800,000
B. ELECTRICAL					\$ 412,000
C. CIVIL UTILITIES					\$ 165,000
D. SITE WORKS AND ACCESS					\$ 170,000
SUB-TOTAL:					\$ 1,547,000
Inflation Rate (2021-2024)					16.23%
Inflation Cost					\$ 251,078
SUB-TOTAL:					\$ 1,798,078
Contingency (30% of Const.)					\$ 539,423
Design and Construction Engineering (15% of Const.)					\$ 350,625
SUB-TOTAL:					\$ 890,049
TOTAL ESTIMATED CONSTRUCTION COST (EXCLUDING TAXES)					\$ 2,689,000

ASSUMPTIONS

- Pump station will be constructed on existing lot or within road RoW and no land acquisition costs are required.
- Grading and landscaping will be required at the site, but no clearing and grubbing.
- Rock blasting is not required at the site.
- Station will include a FRP wet well and electrical kiosk. Estimates do not include costs for a building.
- Station will include flow meter in standalone below-ground chamber.
- Assumed configuration: Duplex Lift Station, Electrical Kiosk, Generator, Wet Well, Valve Chamber, Flow Meter Manhole
- Assumed voltage is 600V, 3-Phase.
- Assumed labour rate is \$85/hr.
- Assumed Generator Size is 200kW.

Short Term (1-10 Year) Capital Plan

Project Number	Asset ID	Material	Install Year	Length (m)	Existing Diameter (mm)	Renewal Diameter (mm)	Priority	Priority Trigger	Total Renewal Cost
	SGM1004	UNKNOWN	1978	2.7	200	200	P3	CONDITION	\$ 9,848
	SGM0342	VIT	1965	57.8	150	150	P3	CONDITION	\$ 204,278
	SGM0285	PVC	1988	73.5	250	250	P2	CONDITION	\$ 408,462
3	SGM0038	VIT	1961	32.9	300	375	P3	CAPACITY PROJECT ONLY	\$ 114,299
	SGM0473	PVC	1958	36.5	150	150	P3	CONDITION	\$ 128,989
	SGM0040	VIT	1953	51.2	200	200	P2	CONDITION	\$ 146,056
	SGM0094	VIT	1965	4.2	200	200	P2	CONDITION	\$ 22,877
	SGM0651	PVC	1991	51.8	150	150	P2	CONDITION	\$ 112,251
	SGM0218	PVC	1961	38.1	200	200	P2	CONDITION	\$ 207,418
2C	SGM0007	CONC	1965	70.7	375	N/A	P1	ABANDON	\$ -
	SGM0751	UNKNOWN	1977	74.1	200	200	P2	CONDITION	\$ 270,198
2F	SGM0435	VIT	1986	24.2	200	N/A	P1	ABANDON	\$ -
2A	SGM0287	UNKNOWN	1965	12.0	200	675	P1	CAPACITY PROJECT ONLY	\$ 82,568
	SGM0899	PVC	1957	60.7	300	300	P2	CONDITION	\$ 296,809
	SGM0268	RL	1958	101.9	150	150	P3	CONDITION	\$ 359,854
	SGM0127	VIT	1961	42.5	150	150	P2	CONDITION	\$ 187,760
	SGM0220	RL	1965	17.4	200	200	P3	CONDITION	\$ 63,528
2H	SGM0003	AC	1965	91.5	400	N/A	P1	ABANDON	\$ -
	SGM0624	UNKNOWN	1971	15.8	200	200	P2	CONDITION	\$ 57,759
	SGM0824	VIT	1966	108.2	200	200	P2	CONDITION	\$ 394,600
	SGM0685	VIT	1970	114.7	200	200	P2	CONDITION	\$ 418,173
	SGM0360	VIT	1961	67.3	200	200	P2	CONDITION	\$ 306,944
	SGM1130	VIT	1970	20.5	200	200	P3	CONDITION	\$ 46,801
	SGM0172	VIT	1956	79.5	200	200	P3	CONDITION	\$ 181,399
2G/2E	SGM1094	CONC	1965	105.6	375	675	P1	CAPACITY PROJECT ONLY	\$ 482,716
	SGM0877	UNKNOWN	1966	21.4	200	200	P3	CONDITION	\$ 48,843
	SGM0274	VIT	1965	86.2	200	200	P3	CONDITION	\$ 196,657
	SGM0540	RL	1962	87.4	150	150	P3	CONDITION	\$ 189,341
2E	SGM0663	CONC	1965	62.5	375	N/A	P1	ABANDON	\$ -
	SGM0379	VIT	1963	25.2	200	200	P3	CONDITION	\$ 91,896
	SGM0726	PVC	2015	27.6	200	200	P2	CONDITION	\$ 125,710
	SGM0021	VIT	1965	76.0	200	200	P3	CONDITION	\$ 277,171

Project Number	Asset ID	Material	Install Year	Length (m)	Existing Diameter (mm)	Renewal Diameter (mm)	Priority	Priority Trigger	Total Renewal Cost
	SGM0808	VIT	1960	64.2	150	150	P3	CONDITION	\$ 226,650
	SGM0120	RL	1957	98.9	200	200	P3	CONDITION	\$ 360,612
2M	SGM0046	VIT	1985	76.5	200	300	P1	CAPACITY	\$ 546,027
2B	SGM0011	CONC	1963	53.7	375	675	P1	CAPACITY	\$ 370,215
	SGM0009	VIT	1963	84.0	200	200	P3	CONDITION	\$ 306,193
	SGM0438	VIT	1965	76.2	200	200	P3	CONDITION	\$ 277,912
	SGM0706	CONC	1986	3.5	375	375	P2	CAPACITY	\$ 21,042
	SGM0465	RL	1965	67.5	200	200	P3	CONDITION	\$ 246,016
	SGM0177	RL	1965	104.1	200	200	P2	CONDITION	\$ 566,694
	SGM0912	VIT	1965	89.0	200	200	P3	CONDITION	\$ 324,419
	SGM0259	VIT	1957	37.7	150	150	P3	CONDITION	\$ 81,612
	SGM0082	VIT	1962	57.4	200	200	P3	CONDITION	\$ 209,484
	SGM0162	PVC	1966	79.4	200	200	P2	CONDITION	\$ 289,576
	SGM0201	VIT	1960	109.6	150	150	P3	CONDITION	\$ 237,500
9C	SGM0960	VIT	1960	64.7	200	250	P2	CAPACITY PROJECT ONLY	\$ 359,576
	SGM0020	VIT	1965	85.3	200	200	P3	CONDITION	\$ 311,004
	SGM0664	VIT	1966	57.1	200	200	P2	CONDITION	\$ 208,254
	SGM0928	VIT	1960	8.4	200	200	P3	CONDITION	\$ 19,059
	SGM0790	VIT	1957	125.9	200	200	P3	CONDITION	\$ 459,163
	SGM0920	VIT	1957	100.8	200	200	P3	CONDITION	\$ 367,499
	SGM0485	RL	1965	91.3	200	200	P3	CONDITION	\$ 332,946
	SGM0929	VIT	1965	73.4	150	150	P3	CONDITION	\$ 259,365
	SGM0481	VIT	1976	85.1	200	200	P2	CONDITION	\$ 310,262
2H	SGM0276	AC	1965	55.1	400	N/A	P1	ABANDON	\$ -
	SGM0095	VIT	1965	92.1	200	200	P2	CONDITION	\$ 335,888
	SGM0336	VIT	1965	77.3	200	200	P2	CONDITION	\$ 352,252
	SGM0117	VIT	1966	32.5	200	200	P3	CONDITION	\$ 118,662
	SGM0370	VIT	1960	58.5	150	150	P3	CONDITION	\$ 206,573
	SGM0992	RL	1977	90.7	200	200	P2	CONDITION	\$ 330,843
	SGM0684	UNKNOWN	1965	32.5	200	200	P3	CONDITION	\$ 100,745
	SGM0030	VIT	1957	101.2	200	200	P3	CONDITION	\$ 368,939
2K	SGM0502	VIT	1965	84.7	300	450	P1	CAPACITY	\$ 249,989
	SGM0615	RL	1960	51.0	200	200	P3	CONDITION	\$ 185,998

Project Number	Asset ID	Material	Install Year	Length (m)	Existing Diameter (mm)	Renewal Diameter (mm)	Priority	Priority Trigger	Total Renewal Cost
8	SGM0457	VIT	1959	130.4	250	250	P1	PLUG - CATCHMENT REALLOCATION	\$ 724,501
	SGM0418	VIT	1964	94.9	200	200	P2	CONDITION	\$ 516,666
	SGM0633	VIT	1964	73.1	200	200	P3	CONDITION	\$ 266,638
	SGM0941	VIT	1965	24.2	200	200	P3	CONDITION	\$ 88,133
	SGM0066	RL	1965	121.6	200	200	P2	CONDITION	\$ 554,266
	SGM0714	PVC	1992	27.5	150	150	P3	CONDITION	\$ 59,539
	SGM0256	VIT	1957	46.7	150	150	P2	CONDITION	\$ 372,909
	SGM1120	VIT	1965	88.6	150	150	P3	CONDITION	\$ 191,972
	SGM0932	VIT	1965	101.4	200	200	P3	CONDITION	\$ 369,950
	SGM0034	VIT	1995	39.6	200	200	P3	CONDITION	\$ 180,468
	SGM0284	UNKNOWN	1960	26.2	200	200	P3	CONDITION	\$ 59,683
	SGM0812	UNKNOWN	1965	19.1	200	200	P2	CONDITION	\$ 86,961
2H	SGM0226	VIT	1965	13.0	375	N/A	P1	ABANDON	\$ -
2M	SGM0123	CONC	1965	32.4	375	525	P1	CAPACITY	\$ 103,152
	SGM0886	VIT	1965	56.0	150	150	P3	CONDITION	\$ 197,874
	SGM0872	VIT	1965	42.8	200	200	P3	CONDITION	\$ 156,166
	SGM1019	PVC	1991	75.4	150	150	P3	CONDITION	\$ 266,452
4D	SGM1050	RL	1962	118.1	250	300	P1	CAPACITY PROJECT ONLY	\$ 577,768
	SGM0845	VIT	1965	76.1	200	200	P2	CONDITION	\$ 620,967
	SGM1042	UNKNOWN	1965	65.6	100	100	P3	CONDITION	\$ 231,812
	SGM0561	RL	1958	77.7	150	150	P3	CONDITION	\$ 168,414
	SGM0879	PVC	1964	77.6	200	200	P3	CONDITION	\$ 282,850
2H	SGM0900	AC	1965	69.0	400	N/A	P1	ABANDON	\$ -
2F	SGM1021	VIT	1986	105.5	250	N/A	P1	ABANDON	\$ -
2D	SGM0005	CONC	1965	92.0	375	675	P1	CAPACITY	\$ 634,357
	SGM0222	UNKNOWN	1995	3.3	200	200	P2	CONDITION	\$ 11,911
2E	SGM0519	CONC	1965	74.0	375	N/A	P1	ABANDON	\$ -
	SGM0638	PVC	1977	61.1	150	150	P3	CONDITION	\$ 132,407
	SGM0036	PVC	1953	27.4	200	200	P3	CONDITION	\$ 124,781
	SGM0459	VIT	1962	89.1	150	150	P3	CONDITION	\$ 314,642
	SGM0411	VIT	1977	38.0	150	150	P3	CONDITION	\$ 134,161
	SGM1096	VIT	1965	74.2	200	200	P3	CONDITION	\$ 169,303
	SGM0905	VIT	1994	102.8	200	200	P3	CONDITION	\$ 375,057

Project Number	Asset ID	Material	Install Year	Length (m)	Existing Diameter (mm)	Renewal Diameter (mm)	Priority	Priority Trigger	Total Renewal Cost
3	SGM0037	CONC	1961	49.3	300	375	P3	CONDITION AND CAPACITY	\$ 204,102
	SGM0136	VIT	1965	76.2	200	200	P2	CONDITION	\$ 416,797
	SGM0493	VIT	1965	91.1	200	200	P3	CONDITION	\$ 332,370
	SGM0169	VIT	1965	32.7	150	150	P2	CONDITION	\$ 70,935
	SGM0386	VIT	1965	78.8	200	200	P3	CONDITION	\$ 179,835
	SGM0144	VIT	1965	88.3	200	200	P3	CONDITION	\$ 322,175
	SGM0466	PVC	2015	32.4	200	200	P3	CONDITION	\$ 147,818
	SGM0001	VIT	1965	68.4	200	200	P2	CONDITION	\$ 372,016
	SGM0184	VIT	1957	22.9	150	150	P2	CONDITION	\$ 122,224
9B	SGM0945	VIT	1966	96.5	200	250	P2	CONDITION AND CAPACITY	\$ 536,104
4E	SGM0237	VIT	1962	119.2	250	300	P1	CONDITION AND CAPACITY	\$ 583,237
	SGM0271	VIT	1957	80.0	150	150	P3	CONDITION	\$ 282,679
	SGM0772	VIT	1957	27.8	200	200	P3	CONDITION	\$ 63,378
	SGM0914	UNKNOWN	1965	59.5	200	200	P3	CONDITION	\$ 217,049
	SGM0628	RL	1958	93.5	200	200	P3	CONDITION	\$ 341,052
2J	SGM0315	VIT	1965	39.4	300	450	P1	CAPACITY	\$ 116,116
	SGM1026	VIT	1962	96.0	150	150	P2	CONDITION	\$ 208,054
	SGM0563	PVC	1984	40.7	150	150	P3	CONDITION	\$ 143,770
	SGM0948	PVC	1986	97.0	200	200	P3	CONDITION	\$ 353,642
	SGM0864	RL	1957	100.4	200	200	P3	CONDITION	\$ 366,076
2A	SGM0013	RL	1963	85.5	375	675	P1	CAPACITY	\$ 589,430
	SGM0919	PVC	1960	87.1	200	200	P3	CONDITION	\$ 198,794
	SGM0574	VIT	1961	97.7	200	200	P3	CONDITION	\$ 356,122
	SGM0728	VIT	1957	70.1	200	200	P3	CONDITION	\$ 255,470
2F	SGM0559	UNKNOWN	1986	73.2	200	250	P1	CAPACITY	\$ 275,454
	SGM0196	VIT	1957	12.9	200	200	P2	CONDITION	\$ 58,715
	SGM0754	VIT	1957	76.5	200	200	P3	CONDITION	\$ 279,033
	SGM0109	VIT	1963	45.5	200	200	P3	CONDITION	\$ 165,890
	SGM0673	UNKNOWN	1961	3.3	200	200	P2	CONDITION	\$ 11,876
	SGM0629	UNKNOWN	1960	31.2	200	200	P3	CONDITION	\$ 71,234
	SGM0538	VIT	1957	51.2	200	200	P2	CONDITION	\$ 233,365
4C	SGM0989	RL	1962	79.4	250	300	P1	CAPACITY PROJECT ONLY	\$ 388,529
	SGM1029	VIT	1965	76.0	200	200	P3	CONDITION	\$ 277,066

Project Number	Asset ID	Material	Install Year	Length (m)	Existing Diameter (mm)	Renewal Diameter (mm)	Priority	Priority Trigger	Total Renewal Cost
	SGM0993	RL	1960	64.0	200	200	P3	CONDITION	\$ 233,517
	SGM0831	RL	1965	61.1	200	200	P3	CONDITION	\$ 222,794
2G	SGM0816	CONC	1965	63.1	375	525	P1	CAPACITY PROJECT ONLY	\$ 250,783
	SGM0050	PVC	2009	90.0	300	300	P2	CONDITION	\$ 528,644
	SGM0052	RL	1977	61.0	200	200	P2	CONDITION	\$ 278,021
	SGM0174	UNKNOWN	1965	53.2	200	200	P2	CONDITION	\$ 242,484
	SGM0181	CONC	1965	40.3	200	200	P3	CONDITION	\$ 92,007
	SGM0532	RL	1957	101.6	200	200	P2	CONDITION	\$ 553,130
	SGM0080	VIT	1957	8.4	200	200	P2	CONDITION	\$ 30,661
	SGM0363	VIT	1962	41.9	200	200	P3	CONDITION	\$ 152,906
	SGM0648	PVC	1965	22.1	150	150	P3	CONDITION	\$ 47,977
	SGM0813	RL	1964	99.2	200	200	P2	CONDITION	\$ 674,769
	SGM0725	VIT	1960	42.5	200	200	P3	CONDITION	\$ 154,865
	SGM0821	VIT	1959	160.0	200	200	P3	CONDITION	\$ 583,397
	SGM0143	VIT	1965	32.2	150	150	P3	CONDITION	\$ 113,903
4A	SGM0500	VIT	1961	61.3	250	300	P1	CONDITION AND CAPACITY	\$ 300,198
2I	SGM0393	RL	1965	43.0	300	N/A	P1	ABANDON	\$ -
	SGM0544	PVC	1990	44.6	150	150	P2	CONDITION	\$ 96,697
3	SGM0815	RL	1965	40.1	300	375	P3	CAPACITY PROJECT ONLY	\$ 111,544
	SGM0740	PVC	1978	87.0	150	150	P3	CONDITION	\$ 307,334
	SGM0060	VIT	1933	41.5	200	200	P3	CONDITION	\$ 189,376
	SGM0585	UNKNOWN	1961	57.7	200	200	P3	CONDITION	\$ 210,435
	SGM0010	VIT	1963	88.5	200	200	P3	CONDITION	\$ 481,724
4B	SGM0676	RL	1962	133.0	250	300	P1	CAPACITY PROJECT ONLY	\$ 650,916
	SGM0054	VIT	1977	97.0	200	200	P2	CONDITION	\$ 442,330
	SGM0846	RL	1959	106.5	200	200	P2	CONDITION	\$ 388,346
4A	SGM0455	VIT	1961	41.2	250	300	P1	CAPACITY	\$ 201,405
	SGM0861	VIT	1965	53.4	200	200	P3	CONDITION	\$ 194,915
	SGM0984	PVC	1964	80.9	200	200	P3	CONDITION	\$ 294,985
	SGM0463	VIT	1977	21.6	200	200	P2	CONDITION	\$ 117,313
9A	SGM0777	RL	1966	92.5	200	250	P2	CAPACITY PROJECT ONLY	\$ 514,277
	SGM0366	VIT	1977	52.7	150	150	P3	CONDITION	\$ 186,038
	SGM0950	PVC	1985	1.9	200	200	P2	CONDITION	\$ 8,488

Project Number	Asset ID	Material	Install Year	Length (m)	Existing Diameter (mm)	Renewal Diameter (mm)	Priority	Priority Trigger	Total Renewal Cost
	SGM0384	VIT	1976	65.6	200	200	P2	CONDITION	\$ 239,154
	SGM0333	VIT	1991	40.2	200	200	P3	CONDITION	\$ 146,692
	SGM1129	VIT	1956	86.4	200	200	P2	CONDITION	\$ 315,096
	SGM0508	RL	1966	46.8	150	150	P3	CONDITION	\$ 165,377
	SGM0794	VIT	1963	43.6	200	200	P3	CONDITION	\$ 159,030
	SGM0100	VIT	1957	76.1	200	200	P2	CONDITION	\$ 413,971
	SGM0962	VIT	1965	61.4	150	150	P3	CONDITION	\$ 216,914
	SGM0924	VIT	1965	18.1	200	200	P2	CONDITION	\$ 98,351
	SGM0507	VIT	1957	61.2	200	200	P2	CONDITION	\$ 223,345
	SGM0119	VIT	1961	52.4	200	200	P3	CONDITION	\$ 190,945
	SGM0436	VIT	1958	72.6	200	200	P3	CONDITION	\$ 264,855
	SGM0871	VIT	1965	79.1	150	150	P2	CONDITION	\$ 171,419
	SGM0252	PVC	1958	57.9	150	150	P3	CONDITION	\$ 204,538
	SGM0545	VIT	1957	72.8	250	250	P3	CONDITION	\$ 274,026
	SGM0316	VIT	1965	55.5	200	200	P3	CONDITION	\$ 202,423
	SGM0016	CONC	1965	72.6	375	375	P3	CONDITION	\$ 431,397
	SGM0757	VIT	1958	100.9	200	200	P3	CONDITION	\$ 367,867
2L	SGM0045	VIT	1985	13.0	300	N/A	P1	ABANDON	\$ -
	SGM0029	RL	1953	60.9	200	200	P3	CONDITION	\$ 277,793
	SGM0957	UNKNOWN	1992	20.6	200	200	P2	CONDITION	\$ 40,052
	SGM0317	PVC	1965	150.0	200	200	P3	CONDITION	\$ 546,929
	SGM0669	VIT	1963	104.8	250	250	P2	CONDITION	\$ 582,336
	SGM1053	CONC	1965	46.2	200	200	P2	CONDITION	\$ 168,546
	SGM0055	VIT	1966	83.2	200	200	P2	CONDITION	\$ 303,281
	SGM0897	VIT	1965	57.8	200	200	P3	CONDITION	\$ 210,844
	SGM1043	VIT	1962	51.1	200	200	P3	CONDITION	\$ 116,503
	SGM0956	VIT	1965	41.6	150	150	P3	CONDITION	\$ 90,202
	SGM0307	VIT	1957	68.8	150	150	P3	CONDITION	\$ 243,093
	SGM0691	VIT	1965	106.9	200	200	P3	CONDITION	\$ 389,843
	SGM0288	VIT	1960	75.9	150	150	P2	CONDITION	\$ 164,467
2C	GA-SGM0003	N/A	N/A	211.5	N/A	675	P1	NEW MAIN	\$ 1,457,332
2L	GA-SGM0004	N/A	N/A	107.1	N/A	450	P1	NEW MAIN	\$ 464,015
2I	GA-SGM0005	N/A	N/A	45.3	N/A	450	P1	NEW MAIN	\$ 133,769

Project Number	Asset ID	Material	Install Year	Length (m)	Existing Diameter (mm)	Renewal Diameter (mm)	Priority	Priority Trigger	Total Renewal Cost
2H	GA-SGM0006	N/A	N/A	39.9	N/A	375	P1	NEW MAIN	\$ 110,844
8	SGM0412_1	N/A	N/A	2.9	N/A	300	P1	NEW MAIN - CATCHMENT REALLOCATION	\$ 16,370
2E	SGM1094_P1	N/A	N/A	169.0	N/A	675	P1	NEW MAIN	\$ 618,069
2E	SGM1094_P2	N/A	N/A	24.3	N/A	675	P1	NEW MAIN	\$ 88,853
2E	SGM1094_P3	N/A	N/A	106.2	N/A	675	P1	NEW MAIN	\$ 537,221
2F	CDT_14	N/A	N/A	3.9	N/A	300	P1	NEW MAIN	\$ 9,839
2F	CDT_16	N/A	N/A	3.9	N/A	300	P1	NEW MAIN	\$ 9,871
Total				13,198.1					Total \$ 50,409,993

Long Term (11-20 Year) Capital Plan

Project Number	Asset ID	Material	Install Year	Length (m)	Existing Diameter (mm)	Renewal Diameter (mm)	Priority	Priority Trigger	Total Renewal Cost
	SGM0416	VIT	1960	47.4	150	150	P2	CONDITION	\$ 209,303
	SGM0548	PVC	1986	95.7	200	200	P3	CONDITION	\$ 348,934
	SGM0345	UNKNOWN	1961	19.1	200	200	P2	CONDITION	\$ 69,754
	SGM0189	CONC	1956	106.4	200	200	P2	CONDITION	\$ 388,198
	SGM0698	PVC	1957	17.1	300	300	P2	CONDITION	\$ 83,825
	SGM0244	VIT	1966	40.3	200	200	P3	CONDITION	\$ 146,813
	SGM0590	VIT	1965	82.3	200	200	P2	CONDITION	\$ 450,073
	SGM0019	CONC	1965	42.6	375	375	P2	CONDITION	\$ 252,986
	SGM0704	VIT	1976	63.9	200	200	P2	CONDITION	\$ 233,122
	SGM0113	UNKNOWN	1961	66.2	200	200	P2	CONDITION	\$ 241,323
	SGM0301	UNKNOWN	1965	23.8	200	200	P2	CONDITION	\$ 86,881
	SGM0910	CONC	1965	39.4	200	200	P2	CONDITION	\$ 143,626
	SGM0236	RL	1957	91.1	200	200	P2	CONDITION	\$ 495,586
	SGM0701	UNKNOWN	1957	72.9	200	200	P3	CONDITION	\$ 265,873
7	SGM0273	VIT	1976	12.4	200	250	P3	CAPACITY	\$ 46,714
	SGM0878	RL	1961	43.9	200	200	P2	CONDITION	\$ 160,271
	SGM1045	RL	1957	77.3	200	200	P2	CONDITION	\$ 352,158
	SGM0677	RL	1965	75.1	150	150	P3	CONDITION	\$ 265,431
	SGM0433	UNKNOWN	1960	49.0	200	200	P2	CONDITION	\$ 266,728
	SGM0098	RL	1966	99.1	200	200	P2	CONDITION	\$ 361,415
	SGM0489	VIT	1956	48.2	150	150	P2	CONDITION	\$ 130,581
	SGM1037	RL	1957	124.3	200	200	P2	CONDITION	\$ 453,323
	SGM0146	RL	1963	70.1	150	150	P2	CONDITION	\$ 151,964
	SGM0582	VIT	1960	78.1	300	300	P2	CONDITION	\$ 305,702
	SGM0550	VIT	1956	23.5	150	150	P2	CONDITION	\$ 63,761
	SGM0527	VIT	1965	126.5	150	150	P3	CONDITION	\$ 446,731
	SGM0138	VIT	1960	64.7	150	150	P2	CONDITION	\$ 228,439
	SGM0530	UNKNOWN	1960	64.0	200	200	P2	CONDITION	\$ 146,123
	SGM0723	RL	1958	103.5	200	200	P2	CONDITION	\$ 377,464
	SGM0154	RL	1965	36.6	250	250	P2	CONDITION	\$ 87,757
	SGM0093	VIT	1964	91.4	200	200	P3	CONDITION	\$ 333,340
	SGM0656	RL	1957	43.1	200	200	P2	CONDITION	\$ 292,920

Project Number	Asset ID	Material	Install Year	Length (m)	Existing Diameter (mm)	Renewal Diameter (mm)	Priority	Priority Trigger	Total Renewal Cost
	SGM0057	RL	1956	151.3	200	200	P2	CONDITION	\$ 689,644
	SGM0012	AC	1965	139.7	450	450	P2	CONDITION	\$ 858,884
	SGM1071	VIT	1961	58.3	200	200	P3	CONDITION	\$ 212,549
	SGM0392	RL	1960	81.6	150	150	P3	CONDITION	\$ 176,894
	SGM0600	UNKNOWN	1959	13.5	200	200	P3	CONDITION	\$ 73,387
	SGM0523	VIT	1960	78.2	150	150	P3	CONDITION	\$ 276,211
	SGM0748	RL	1960	43.9	375	375	P2	CONDITION	\$ 182,004
	SGM0359	UNKNOWN	1961	7.8	200	200	P2	CONDITION	\$ 28,419
	SGM0361	RL	1965	39.3	200	200	P3	CONDITION	\$ 143,321
	SGM0997	RL	1960	90.0	200	200	P3	CONDITION	\$ 328,057
	SGM0719	VIT	1963	68.5	150	150	P2	CONDITION	\$ 241,819
	SGM0200	RL	1988	52.7	375	375	P2	CONDITION	\$ 218,317
	SGM0587	RL	1956	106.2	200	200	P2	CONDITION	\$ 387,131
	SGM0296	VIT	1965	57.9	200	200	P2	CONDITION	\$ 316,829
	SGM0069	RL	1957	137.1	200	200	P2	CONDITION	\$ 499,997
	SGM0295	RL	1966	78.5	200	200	P3	CONDITION	\$ 286,328
	SGM0129	RL	1956	39.5	150	150	P3	CONDITION	\$ 139,600
	SGM1011	PVC	1986	51.2	200	200	P3	CONDITION	\$ 116,775
	SGM0047	PVC	1985	42.8	250	250	P2	CAPACITY	\$ 241,751
	SGM0975	VIT	1965	45.3	200	200	P3	CONDITION	\$ 165,179
	SGM0768	VIT	1966	95.4	200	200	P3	CONDITION	\$ 347,859
	SGM0250	RL	1957	106.2	200	200	P2	CONDITION	\$ 387,218
	SGM0068	RL	1956	103.6	200	200	P2	CONDITION	\$ 472,175
	SGM0833	RL	1961	112.9	200	200	P2	CONDITION	\$ 411,827
	SGM0072	RL	1959	125.0	300	300	P2	CONDITION	\$ 489,165
	SGM0157	RL	1966	43.8	200	200	P3	CONDITION	\$ 159,741
	SGM0355	VIT	1965	96.4	200	200	P2	CONDITION	\$ 524,761
	SGM1073	RL	1965	67.2	150	150	P2	CONDITION	\$ 356,055
	SGM0769	RL	1957	91.4	200	200	P2	CONDITION	\$ 333,195
	SGM0767	CONC	1965	71.4	200	200	P2	CONDITION	\$ 388,743
	SGM0844	VIT	1959	90.7	200	200	P3	CONDITION	\$ 330,877
	SGM0347	VIT	1965	54.9	200	200	P3	CONDITION	\$ 200,125
	SGM0851	RL	1961	122.4	200	200	P2	CONDITION	\$ 446,544

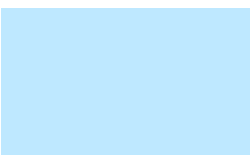
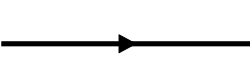
Project Number	Asset ID	Material	Install Year	Length (m)	Existing Diameter (mm)	Renewal Diameter (mm)	Priority	Priority Trigger	Total Renewal Cost
5C	SGM1090	PVC	1965	44.5	250	375	P2	CAPACITY	\$ 184,389
	SGM0061	RL	1956	72.2	200	200	P2	CONDITION	\$ 329,198
	SGM0785	RL	1960	76.8	200	200	P2	CONDITION	\$ 418,048
	SGM0612	RL	1957	61.3	200	200	P3	CONDITION	\$ 223,488
	SGM0688	UNKNOWN	1953	87.8	200	200	P3	CONDITION	\$ 320,076
	SGM0971	RL	1962	77.1	200	200	P2	CONDITION	\$ 351,338
	SGM0662	RL	1959	122.5	200	200	P3	CONDITION	\$ 446,800
	SGM0006	AC	1965	88.2	375	375	P2	CONDITION	\$ 523,615
	SGM0891	CONC	1965	121.6	200	200	P2	CONDITION	\$ 661,784
	SGM0717	VIT	1963	97.9	200	200	P2	CONDITION	\$ 532,717
	SGM0557	RL	1965	29.4	250	250	P2	CONDITION	\$ 110,570
	SGM0609	VIT	1960	56.5	200	200	P3	CONDITION	\$ 205,991
	SGM0779	UNKNOWN	1957	51.2	200	200	P2	CONDITION	\$ 278,901
	SGM0056	UNKNOWN	1958	36.0	200	200	P2	CONDITION	\$ 195,887
	SGM1126	RL	1962	54.9	250	250	P2	CONDITION	\$ 164,354
5A	SGM0221	UNKNOWN	1956	50.2	200	200	P2	CONDITION	\$ 228,756
	SGM0092	VIT	1965	111.0	375	450	P2	CAPACITY	\$ 481,195
	SGM1089	RL	1957	68.1	300	300	P2	CONDITION	\$ 266,420
	SGM0215	UNKNOWN	1957	74.3	200	200	P2	CONDITION	\$ 404,239
	SGM1034	RL	1963	47.6	150	150	P3	CONDITION	\$ 167,969
	SGM0272	VIT	1988	45.3	375	375	P2	CONDITION	\$ 268,790
	SGM1028	UNKNOWN	1953	60.0	200	200	P3	CONDITION	\$ 218,882
	SGM0468	VIT	1965	42.6	150	150	P2	CONDITION	\$ 227,192
	SGM0788	UNKNOWN	1959	45.9	200	200	P2	CONDITION	\$ 249,919
	SGM0843	UNKNOWN	1957	109.6	200	200	P2	CONDITION	\$ 596,750
	SGM0923	RL	1962	75.6	200	200	P3	CONDITION	\$ 275,660
	SGM0873	VIT	1965	23.6	200	200	P2	CONDITION	\$ 129,254
	SGM0694	CONC	1965	68.5	200	200	P2	CONDITION	\$ 316,966
	SGM0870	PVC	1965	91.2	200	200	P3	CONDITION	\$ 332,658
	SGM0114	PVC	1957	70.3	300	300	P3	CONDITION	\$ 344,042
	SGM0300	VIT	1965	47.6	150	150	P3	CONDITION	\$ 103,110
	SGM1088	RL	1966	57.5	200	200	P3	CONDITION	\$ 209,563
	SGM0032	RL	1953	42.7	200	200	P2	CONDITION	\$ 194,800

Project Number	Asset ID	Material	Install Year	Length (m)	Existing Diameter (mm)	Renewal Diameter (mm)	Priority	Priority Trigger	Total Renewal Cost
5C	SGM0409	VIT	1965	27.9	250	300	P2	CAPACITY PROJECT ONLY	\$ 109,050
	SGM1059	VIT	1960	53.6	150	150	P2	CONDITION	\$ 189,318
	SGM0722	UNKNOWN	1961	76.7	200	200	P2	CONDITION	\$ 279,707
	SGM0488	RL	1965	61.9	150	150	P3	CONDITION	\$ 185,765
	SGM0450	RL	1961	61.9	300	300	P2	CONDITION	\$ 242,134
	SGM0170	VIT	1965	108.5	250	250	P3	CONDITION	\$ 408,115
	SGM0225	VIT	1965	60.9	200	200	P3	CONDITION	\$ 222,271
	SGM0583	RL	1961	74.5	200	200	P2	CONDITION	\$ 405,325
5C	SGM0939	PVC	1965	31.2	250	375	P2	CAPACITY	\$ 129,342
	SGM0913	VIT	1957	83.6	200	200	P2	CONDITION	\$ 381,012
	SGM2000	UNKNOWN	1961	3.0	200	200	P2	CONDITION	\$ 10,854
	SGM0934	UNKNOWN	1957	28.8	200	200	P2	CONDITION	\$ 156,516
	SGM0529	RL	1959	60.7	200	200	P3	CONDITION	\$ 221,325
	SGM1121	RL	1956	79.1	200	200	P2	CONDITION	\$ 360,425
	SGM0420	RL	1965	70.1	150	150	P2	CONDITION	\$ 371,288
	SGM0375	RL	1957	133.4	200	200	P2	CONDITION	\$ 608,082
	SGM0643	RL	1962	101.9	150	150	P3	CONDITION	\$ 220,931
	SGM1031	RL	1959	141.0	200	200	P3	CONDITION	\$ 514,244
	SGM0526	PVC	1986	56.8	150	150	P2	CONDITION	\$ 123,067
	SGM0462	VIT	1965	83.0	200	200	P2	CONDITION	\$ 677,419
	SGM0632	RL	1954	132.6	200	200	P3	CONDITION	\$ 483,536
	SGM0112	VIT	1970	51.7	200	200	P2	CONDITION	\$ 188,593
	SGM0408	PVC	1988	99.7	250	250	P2	CONDITION	\$ 375,210
	SGM0551	VIT	1963	50.8	150	150	P3	CONDITION	\$ 110,069
	SGM0541	RL	1962	62.8	200	200	P3	CONDITION	\$ 143,412
	SGM1007	VIT	1956	122.0	200	200	P2	CONDITION	\$ 444,924
	SGM0197	UNKNOWN	1961	1.1	200	200	P2	CONDITION	\$ 4,025
	SGM1080	RL	1965	46.6	200	200	P3	CONDITION	\$ 169,924
	SGM0601	PVC	1991	107.3	200	200	P2	CONDITION	\$ 583,744
	SGM0319	VIT	1966	81.3	200	200	P3	CONDITION	\$ 296,597
	SGM0727	UNKNOWN	1960	51.5	200	200	P2	CONDITION	\$ 350,365
	SGM0789	VIT	1958	119.2	200	200	P2	CONDITION	\$ 648,866
	SGM0031	RL	1953	113.9	200	200	P2	CONDITION	\$ 519,291

Project Number	Asset ID	Material	Install Year	Length (m)	Existing Diameter (mm)	Renewal Diameter (mm)	Priority	Priority Trigger	Total Renewal Cost
	SGM0312	UNKNOWN	1959	74.4	200	200	P2	CONDITION	\$ 271,423
	SGM0350	UNKNOWN	1959	11.1	200	200	P2	CONDITION	\$ 40,409
6	SGM0547	VIT	1956	8.0	200	300	P1	CAPACITY	\$ 31,439
	SGM1010	UNKNOWN	1961	14.6	300	300	P3	CONDITION	\$ 57,170
	SGM1001	VIT	1966	127.3	150	150	P2	CONDITION	\$ 449,516
	SGM0051	VIT	1977	75.9	200	200	P2	CONDITION	\$ 346,216
	SGM0461	UNKNOWN	1965	14.1	200	200	P3	CONDITION	\$ 51,564
	SGM0737	VIT	1957	100.7	200	200	P3	CONDITION	\$ 367,170
	SGM0531	RL	1962	116.4	250	250	P2	CONDITION	\$ 646,728
	SGM0689	UNKNOWN	1959	32.3	200	200	P2	CONDITION	\$ 117,712
	SGM0429	VIT	1965	13.0	150	150	P3	CONDITION	\$ 28,094
	SGM0953	UNKNOWN	1965	70.2	200	200	P2	CONDITION	\$ 256,180
	SGM0063	RL	1956	30.1	200	200	P2	CONDITION	\$ 137,050
	SGM0729	UNKNOWN	1965	48.1	200	200	P3	CONDITION	\$ 175,507
	SGM0422	VIT	1962	55.0	200	200	P3	CONDITION	\$ 200,435
	SGM0292	RL	1965	91.8	200	200	P3	CONDITION	\$ 334,721
	SGM0515	UNKNOWN	1957	51.4	150	150	P2	CONDITION	\$ 181,489
	SGM1081	RL	1965	39.6	200	200	P2	CONDITION	\$ 135,644
	SGM0832	RL	1953	61.3	200	200	P3	CONDITION	\$ 223,613
	SGM0039	CONC	1953	31.0	200	200	P2	CONDITION	\$ 141,312
	SGM0142	UNKNOWN	1965	76.2	200	200	P2	CONDITION	\$ 277,710
	SGM0213	VIT	1960	53.5	150	150	P2	CONDITION	\$ 115,913
	SGM0401	VIT	1959	118.6	250	250	P2	CONDITION	\$ 446,277
	SGM0449	RL	1960	45.4	375	375	P3	CONDITION	\$ 188,084
	SGM0487	VIT	1965	54.5	150	150	P3	CONDITION	\$ 192,589
	SGM0064	VIT	1977	54.3	150	150	P3	CONDITION	\$ 191,784
	SGM0088	RL	1964	102.8	200	200	P3	CONDITION	\$ 374,830
	SGM0437	UNKNOWN	1965	62.5	200	200	P3	CONDITION	\$ 227,800
	SGM0341	RL	1962	46.1	200	200	P3	CONDITION	\$ 168,224
	SGM0520	RL	1966	112.8	200	200	P3	CONDITION	\$ 411,418
	SGM0235	UNKNOWN	1961	30.0	200	200	P2	CONDITION	\$ 85,682
	SGM0258	VIT	1977	93.8	150	150	P3	CONDITION	\$ 331,421
	SGM0697	VIT	1963	32.2	200	200	P3	CONDITION	\$ 117,326
	SGM0491	RL	1957	66.9	200	200	P2	CONDITION	\$ 304,938
	SGM0159	UNKNOWN	1977	62.6	200	200	P3	CONDITION	\$ 142,831

Project Number	Asset ID	Material	Install Year	Length (m)	Existing Diameter (mm)	Renewal Diameter (mm)	Priority	Priority Trigger	Total Renewal Cost
	SGM0693	PVC	1959	87.1	200	200	P3	CONDITION	\$ 317,473
	SGM1024	CONC	1965	51.4	200	200	P3	CONDITION	\$ 187,423
	SGM0002	AC	1965	77.0	375	375	P2	CONDITION	\$ 457,404
	SGM0165	UNKNOWN	1965	50.9	200	200	P3	CONDITION	\$ 185,733
	SGM0168	UNKNOWN	1965	64.0	200	200	P3	CONDITION	\$ 233,291
	SGM0027	RL	1957	85.0	200	200	P2	CONDITION	\$ 309,988
	SGM0627	RL	1965	76.2	200	200	P2	CONDITION	\$ 347,338
5B	SGM0096	PVC	1965	83.8	300	375	P2	CAPACITY PROJECT ONLY	\$ 347,377
7	SGM1063	VIT	1976	137.0	200	250	P3	CONDITION AND CAPACITY	\$ 515,208
	SGM0180	VIT	1965	75.3	150	150	P2	CONDITION	\$ 398,780
	SGM0294	RL	1961	82.1	200	200	P3	CONDITION	\$ 187,349
	SGM0087	VIT	1985	55.2	300	300	P2	CONDITION	\$ 270,125
	SGM0193	VIT	1986	14.7	200	200	P3	CONDITION	\$ 33,641
	SGM0232	RL	1961	118.8	200	200	P3	CONDITION	\$ 541,557
	SGM0893	RL	1958	22.0	200	200	P2	CONDITION	\$ 80,077
	SGM0943	RL	1953	46.0	200	200	P2	CONDITION	\$ 167,645
	SGM0902	PVC	1993	40.8	200	200	P3	CONDITION	\$ 148,747
	SGM0253	UNKNOWN	1956	21.5	200	200	P3	CONDITION	\$ 78,378
	SGM1091	VIT	1958	111.6	200	200	P2	CONDITION	\$ 407,068
	SGM0067	RL	1956	80.0	200	200	P2	CONDITION	\$ 544,265
	SGM0599	VIT	1960	59.4	150	150	P3	CONDITION	\$ 209,703
	SGM0889	RL	1956	80.1	150	150	P2	CONDITION	\$ 216,890
	SGM1072	VIT	1960	42.4	150	150	P3	CONDITION	\$ 91,825
	SGM0983	CONC	1965	77.2	200	200	P3	CONDITION	\$ 281,387
6	SGM0219	UNKNOWN	1957	32.2	200	300	P1	CONDITION AND CAPACITY	\$ 125,959
	SGM0575	VIT	1960	50.3	200	200	P2	CONDITION	\$ 229,483
Total				13,052.2				Total	\$ 53,100,902

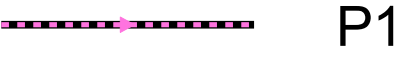
Legend

-  Ocean
-  Parcel
-  CRD Outfall
-  Township Pump Station
-  DND Pump Station
-  CRD Pump Station
-  Pump Station Upgrades (1-10 Years)
-  Pump Station Upgrades (11-20 Years)
-  Forcemain
-  CRD Main
-  Gravity Main
-  Abandoned Main

Forcemain Capital Improvements (1-10 Years)

 P2

Gravity Main Capital Improvements (1-10 Years)

 P1

 P2

 P3

Long-Term Capital Improvements (11-20 Years)

 P1

 P2

 P3

DETAIL 1

DETAIL 2

DETAIL 3

DETAIL 4

Catchment Reallocation
Plug and Flow Diverted to CRD

20-Year
Capital Plan



Appendix J Capacity-Based System Improvements Recommendations

Appendix J provides a more detailed explanation of the capacity-based system improvement recommendations. All these improvements have been included in the 20-Year capital plan, as outlined in **Section 5**.

Based on the HLoS results summarized in **Table 4.6** to **Table 4.10** capacity-based upgrades are required. Note that only gravity mains with an HLoS score of 'E' or 'F' and pump stations with an HLoS score of 'D', 'E', or 'F' were considered deficient and recommended for upgrade.

Upgrades were sized under the Buildout Peak Wet Weather Flow 5-year I&I with Climate scenario. Refer to **Table J.1** for recommended gravity main upgrades.

Table J.1: Capacity Based Gravity Main Upgrade Recommendations

Project ID	Pipe ID	Location	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Upgrade Type
1	SFM0025	Grafton St	150	200	251.2	Upgrade
2A	SGM0013	Devonshire Rd	375	675	85.5	Upgrade
2A	SGM0287	Devonshire Rd	525	675	12.0	Upgrade
2B	SGM0011	Devonshire Rd	375	675	53.7	Upgrade
2C	SGM0007	Devonshire Rd	375	N/A	70.7	Abandon
2C	GA-SGM0003	Devonshire Rd	N/A	675	211.5	New Main
2D	SGM0005	Cave St	375	675	92.0	Upgrade
2E	SGM1094_2	Ellery St	375	N/A	87.7	Abandon
2E	SGM0519	Ellery St	375	N/A	74.0	Abandon
2E	SGM0663	Ellery St	375	N/A	62.5	Abandon
2E	SGM1094_P1	Ellery St	N/A	675	169.0	New Main
2E	SGM1094_P3	Ellery St	N/A	675	106.2	New Main
2E	SGM1094_P2	Ellery St	N/A	675	24.3	New Main
2F	SGM0559	Ellery St	200	250	73.2	Upgrade
2F	SGM1021	Ellery St	250	N/A	105.5	Abandon
2F	SGM0435	Ellery St	200	N/A	24.2	Abandon
2F	CDT_16	Ellery St	N/A	300	3.9	New Main
2F	CDT_14	Ellery St	N/A	300	3.9	New Main
2G	SGM1094	Colville Rd	375	675	17.9	Upgrade
2G	SGM0816	Colville Rd	375	525	63.1	Upgrade
2H	SGM0900	Colville Rd	400	N/A	69.0	Abandon



Project ID	Pipe ID	Location	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Upgrade Type
2H	GA-SGM0006	Colville Rd	N/A	375	39.9	New Main
2H	SGM0003	Colville Rd	400	N/A	91.5	Abandon
2H	SGM0276	Colville Rd	400	N/A	55.1	Abandon
2H	SGM0226	Colville Rd	375	N/A	13.0	Abandon
2I	SGM0393	Colville Rd	300	N/A	43.0	Abandon
2I	GA-SGM0005	Colville Rd	N/A	450	83.7	New Main
2J	SGM0315	Lampson Park	300	450	39.4	Upgrade
2K	SGM0502	Lampson Park	300	450	84.7	Upgrade
2L	SGM0045	Lampson Park	300	N/A	13.0	Abandon
2L	GA-SGM0004	Lampson Park	N/A	450	107.1	New Main
2M	SGM0046_2	Lampson Park	200	300	69.1	Upgrade
2M	SGM0046	Lampson Park	200	300	7.4	Upgrade
2M	SGM0123	Lampson Park	375	525	32.4	Upgrade
3	SGM0815	Transfer St	300	375	40.1	Upgrade
3	SGM0037	Transfer St	300	375	49.3	Upgrade
3	SGM0038	Transfer St	300	375	32.9	Upgrade
4A	SGM0500	Colville Rd	250	300	61.4	Upgrade
4A	SGM0455	Colville Rd	250	300	41.2	Upgrade
4B	SGM0676	Colville Rd	250	300	133.0	Continuity Upgrade
4C	SGM0989	Colville Rd	250	300	134.3	Continuity Upgrade
4D	SGM1050	Colville Rd	250	300	118.1	Upgrade
4E	SGM0237	Colville Rd	250	300	119.2	Upgrade
5A	SGM0092	Head St	375	450	111.0	Upgrade
5B	SGM0096	Head St	300	375	83.8	Continuity Upgrade
5C	SGM0409	Head St	250	300	27.9	Upgrade
5C	SGM0939	Head St	250	375	31.2	Upgrade
5C	SGM1090	Head St	250	375	44.5	Upgrade
6	SGM0547	Wilson St	200	300	8.0	Upgrade
6	SGM0219	Wilson St	200	300	28.3	Upgrade
7	SGM0273	Joffre St	200	250	12.4	Upgrade
7	SGM1063	Joffre St	200	250	137.0	Upgrade
8	SGM0412_1	Lyall St	N/A	300	2.9	New Main
9A	SGM0777	Comeford St	200	250	92.5	Upgrade



Project ID	Pipe ID	Location	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)	Upgrade Type
9B	SGM0945	Comeford St	200	250	96.5	Upgrade
9C	SGM0960	Comeford St	200	250	64.7	Upgrade

In addition to the gravity main upgrade recommendations, **Table L.2** summarize the pump station upgrade recommendations.

Table J.2: Capacity Based Pump Station Upgrade Recommendations

Pump Station	Minimum Total Capacity (L/s)
Canteen	2.6
Forshaw	36.2
Grafton	54.6
Uganda	28.1

Figure J.1 depicts the upgrades summarized in **Table J.1** and **Table J.2**. Refer to **Section 5** for the detailed capital improvement plan.

Legend

- Ocean
- Parcel
- CRD Outfall
- Township Pump Station
- DND Pump Station
- CRD Pump Station
- Pump Station Upgrade
- Forcemain
- CRD Main
- Gravity Main
- Abandoned Main

Forcemain Upgrade Diameter

- 200 mm
- 250 mm
- 300 mm
- 375 mm
- 450 mm
- 525 mm
- 675 mm

New Gravity Main Diameter

- 300 mm
- 375 mm
- 450 mm
- 675 mm

Capacity-Based System
Improvement Recommendations

Figure J.1

DETAIL 1

DETAIL 2

DETAIL 3

DETAIL 4

Catchment Reallocation
Plug and Flow Diverted to CRD

