REPORT

Sanitary Sewer Master Plan
Final

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Prepared for: District of Summerland | File: 0872.0059.01

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District of Summerland
13211 Henry Avenue
Summerland, BC V0H 1Z0

Attention: Kris Johnson

RE: Sanitary Sewer Master Plan – Final

Enclosed please find our Final Sanitary Sewer Master Plan for the District of Summerland. The outcomes of this plan are an updated and calibrated sanitary sewer model as well as a capital plan for system improvements that will position the District well to accommodate future growth.

As with any plan it is important that the District enhance the monitoring of the performance of the existing system – through expanded flow monitoring. This commitment will help ensure that the District can adequately understand and respond to conditions as they change due to aging infrastructure and climate variability.

Sincerely,

URBAN SYSTEMS LTD.

PROFESSIONAL PROVINCE OF S. D. BRUBACHER #27282 BRITISH COLUMBIA ENGINEER

Steve Brubacher, P.Eng.
Principal

Scott Shepherd, AScT
Principal

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Enclosure

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

1.0 INTRODUCTION

The Sanitary Sewer Master Plan outlines an overview of the hydraulic performance of the District of Summerland's sanitary sewage system both under today's conditions as well as projected conditions as growth occurs. This plan integrates with the recently prepared Asset Management Investment Plan. The AMIP outlines condition-based investments while this master plan provides hydraulic performance capacity-based recommendations. Overall the desired outcomes from this master plan are:

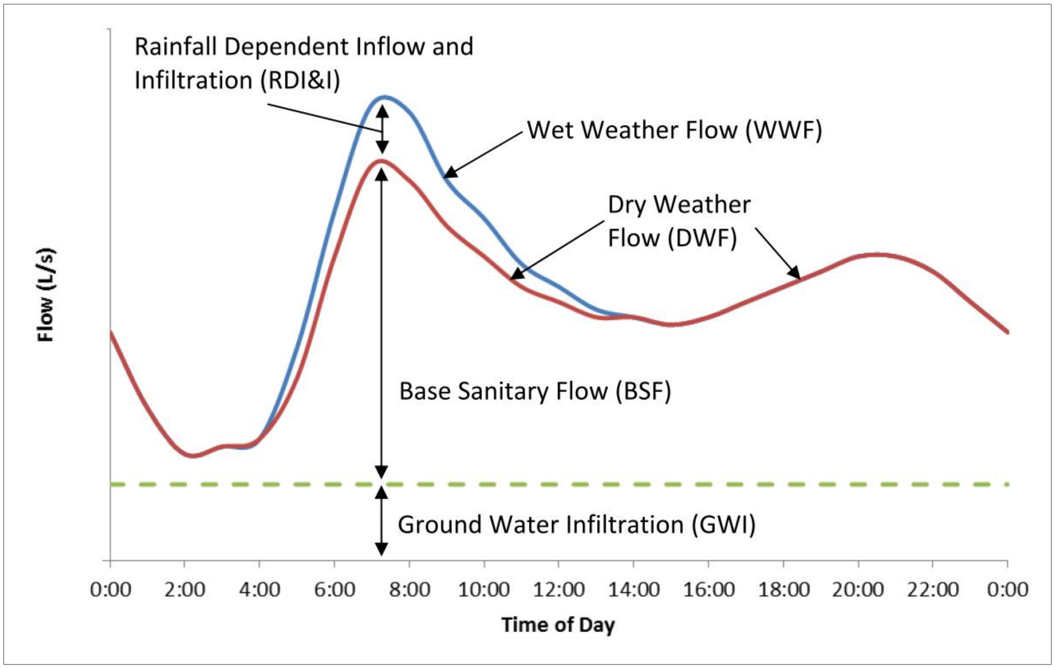
- To update the sanitary sewer collection model so that it integrates with the District's GIS system;
- To recalibrate the model based on recent flow monitoring information;
- To evaluate the performance of the collection system under existing and future flows; and
- To develop a list of capacity-based projects for capital planning.

Daily flow conveyed in a sanitary system can be generally divided into three components:

- Base sanitary flow (BSF);
- Groundwater infiltration (GWI); and
- Rainfall-dependent inflow and infiltration (RDI&I).

The relationship between these components is illustrated in the diagram below and defined later in this section.

Figure 1.1: Relationship between components of sanitary flow



TERMS AND DEFINITIONS

BASE SANITARY FLOW (BSF)

The flows in the sewer system that are the result of direct discharges from residents and businesses. Typically, there is a strong correlation to water consumption.

AVERAGE DRY WEATHER FLOW (ADWF)

The average daily flows within the sanitary sewer collection system that occur when there are no impacts from precipitation and groundwater inflow events.

GROUND WATER INFILTRATION (GWI)

Flows the enter the sewer system due to pipe defects or service connection defects.

RAINFALL DEPENDENT INFLOW AND INFILTRATION (RDI&I)

Flows that enter the sewer system due to precipitation events. These flows can enter the system rapidly through cross connections to storm water collection systems, drains, manhole covers and roof leaders (if cross connected).

INFLOW AND INFILTRATION (I&I)

The combination of groundwater infiltration and rainfall dependent inflow and infiltration.

AVERAGE WET WEATHER FLOW (AWWF)

The average daily flows within the sanitary sewer collection system that occur when the impacts from inflow and infiltration events are included.

PEAK WET WEATHER FLOW (PWWF)

The peak hourly flows within the sanitary sewer collection system that culminate from dry weather and inflow and infiltration.

2.0 MODEL UPDATE, REVIEW AND CALIBRATION

At the outset of this project the District's previous InfoSWMM hydraulic model was reviewed and updated using the District's geographic information system (GIS) records. A detailed summary of this updating is found in Technical Memo 2 in Appendix A. The following **Table 2.1** and **Figure 2.1** summarizes the existing sewer system:

Table 2.1 Existing System Summary

Component	Total
Manholes	844
Gravity Mains	51 km
Force Mains	14.4 km
Lift Stations	7

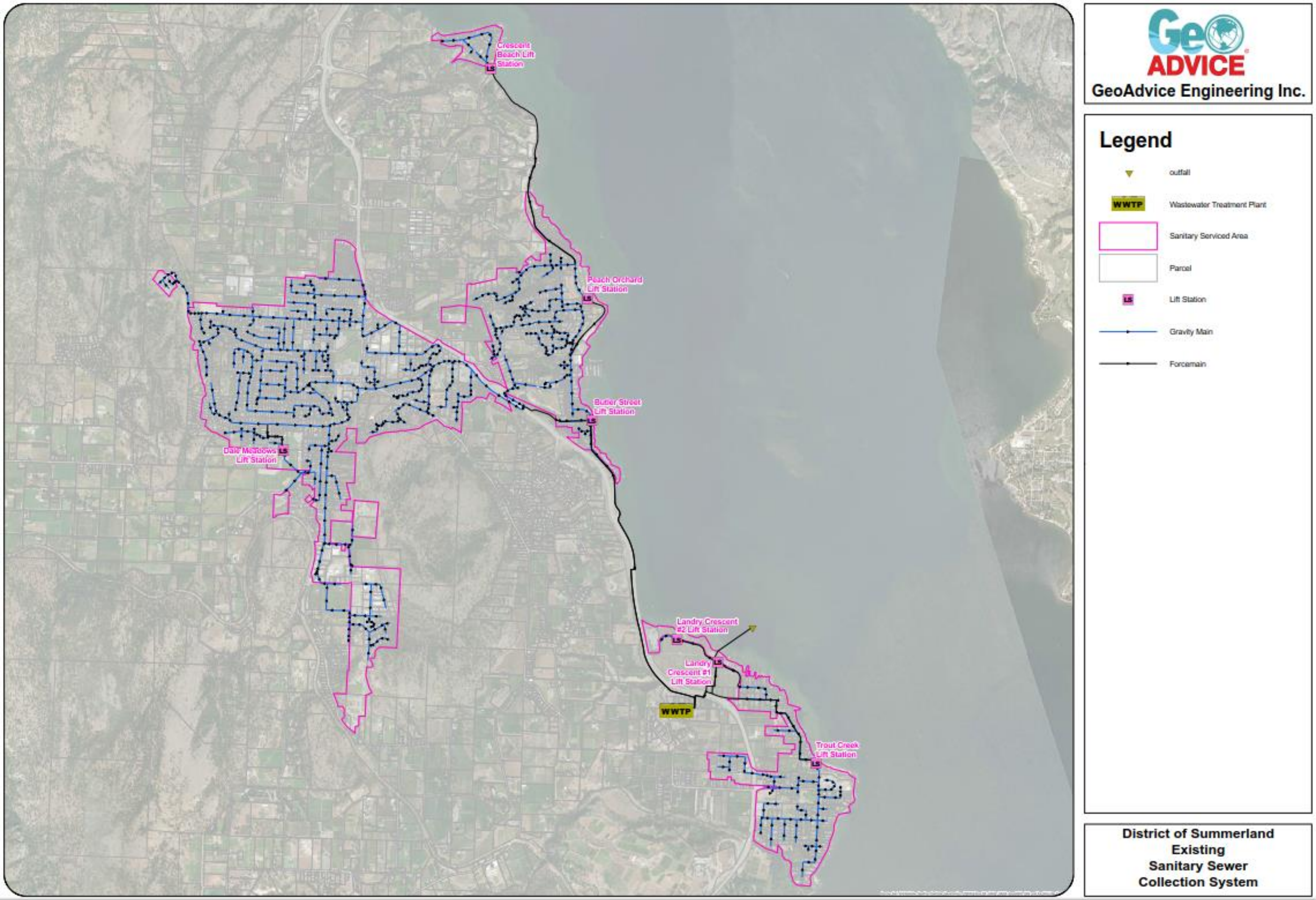
The District provided daily flow totals for six (6) lift stations as well as the influent at the wastewater treatment plant for 2016. These were the only data sources for model calibration. The observed and modelled average dry weather flow rates are within 1-4% demonstrating good model correlation to field conditions.

Table 2.2 Model Calibration Results

Flow Monitoring Site	Observed ADWF (L/s)	Modeled ADWF (L/s)	Difference
Butler Street Lift Station	2.46	2.41	-2%
Crescent Beach Lift Station	0.25	0.25	0%
Dale Meadows Lift Station	0.97	0.96	-1%
Landry #1 Lift Station	n/a	0.09*	n/a
Laundry #2 Lift Station	0.12	0.12	0%
Peach Orchard Lift Station	1.78	1.70	-4%
Trout Creek Lift Station	2.74	2.77	+1%
WWTP Influent	20.9	21.2	+1%

*Estimated value

Figure 2.1 Existing Sanitary Sewer System



With an existing population of approximately 11,615 people the average sanitary sewer is 155 litres/person/day which is representative of the lower end of sewer generation rates.

No inflow and infiltration validation was performed as only total daily volumes were available. Instead the inflow and infiltration rate of 10,000 l/ha/day from the District's development bylaw for older pipes was applied to the model. The inflow and infiltration rate is able to be verified through the flow monitoring program mentioned below.

It is important to note that with ageing infrastructure and climate variability there is a very strong likelihood that future conditions will be different then historic events and the impacts of these future events on the sewer system will need to be monitored so that future system analysis and planning can be kept up to date. The largest variable that can be impacted is the inflow and infiltration into the sewer system.

To improve future calibration efforts, we recommend that the District implement a flow monitoring program using multiple flow monitors (ideally one per catchment) for a minimum duration of three months during the District's typical wet season. It is recommended that flows are recorded at a maximum of 5 minute intervals with corresponding rain gauge readings. It is also recommended that the District ensure that their flow monitoring and data logging equipment at the wastewater treatment plant influent flow meter and lift stations captures at a minimum of one flow data point per hour and even higher resolution if possible. The flow records should be reviewed on an annual basis in order to determine if changes to both dry and wet weather flow events have occurred.

Three future scenarios were created in order to determine the performance of the existing sewer collection system:

Table 2.3 Future Scenarios

Year	Cumulative Population Growth	Cumulative Service Area Growth (ha)
2021	2,424	0
2026	3,488	1.5
2036	3,753	2.6

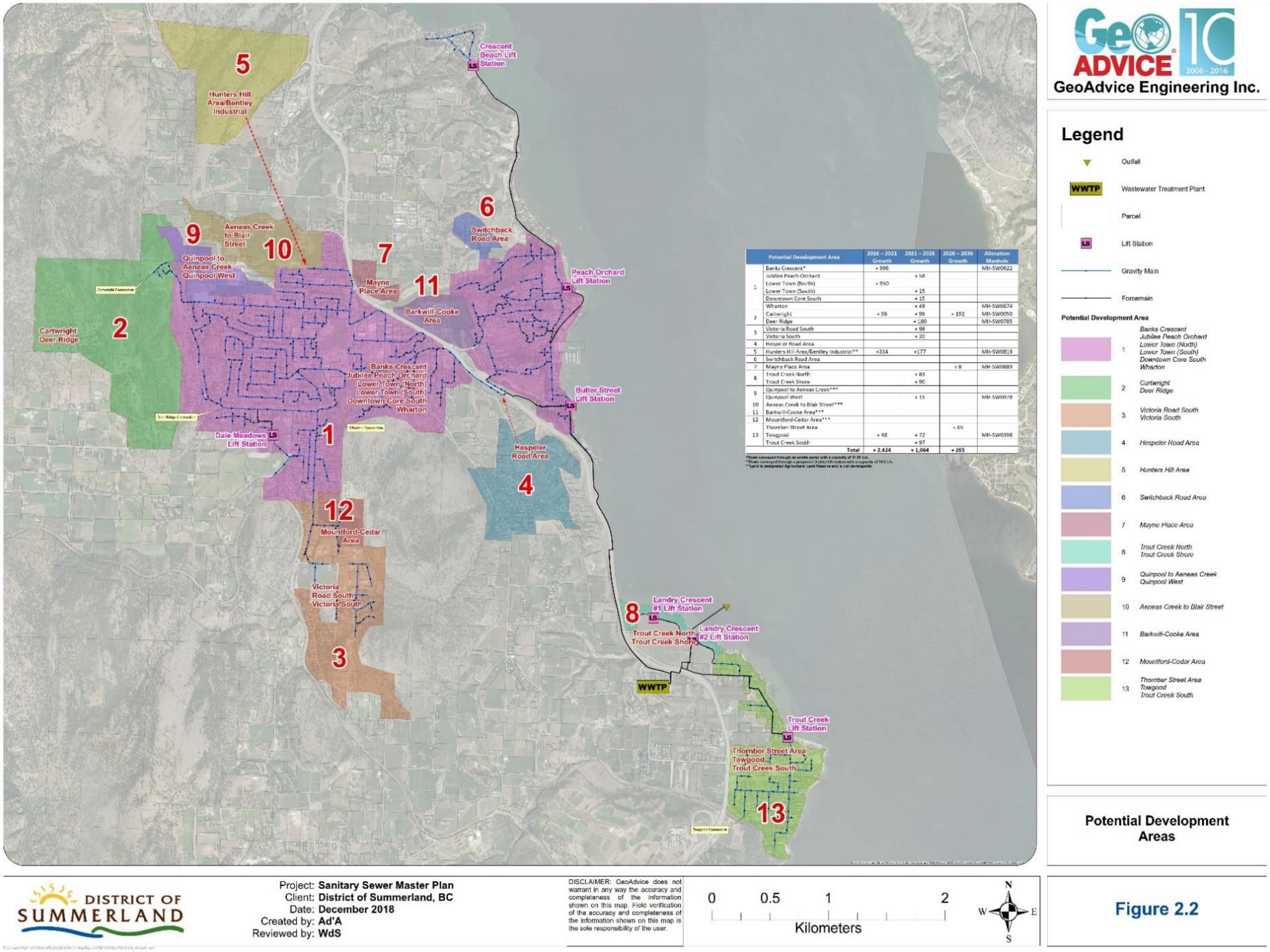
The future growth sewer demands have been modeled at 350 litres/person/day. While this average dry weather flow value is higher than the existing observed sewer flow rates it is a conservative assumption to help ensure there is system capacity for potential future growth changes. In addition, the future service area growth inflow and infiltration rate has been modeled at 8,000 litres/ha/day. Both are consistent with the District's Subdivision and Development Servicing Bylaw.

The locations of the areas of growth are summarized on the attached **Figure 2.2**.

Table 2.4 Summary of Existing and Future Model Loads (L/s)

	2016	2021	2026	2036
Average Dry Weather Flow	21.0	30.8	35.1	36.2
Inflow and Infiltration	52.9	52.9	53.0	53.1
Total Average Wet Weather Flow	73.9	83.7	88.1	89.3

Figure 2.2 Potential Development Areas



	Potential Development Area	2016 – 2021 Growth	2021 – 2026 Growth	2026 – 2036 Growth	Allocation Manhole
1	Banks Crescent*	+ 996			MH-SW0622
	Jubilee Peach Orchard		+ 58		
	Lower Town (North)	+ 950			
	Lower Town (South)		+ 15		
	Downtown Core South		+ 15		
	Wharton		+ 48		MH-SW0674
2	Cartwright	+ 96	+ 96	+ 192	MH-SW0050
	Deer Ridge		+ 180		MH-SW0785
3	Victoria Road South		+ 98		
	Victoria South		+ 20		
4	Hespeler Road Area				
5	Hunters Hill Area/Bentley Industrial**	+334	+177		MH-SW0819
6	Switchback Road Area				
7	Mayne Place Area			+ 8	MH-SW0889
8	Trout Creek North		+ 83		
	Trout Creek Shore		+ 90		
9	Quinpool to Aeneas Creek***				
	Quinpool West		+ 15		MH-SW0[illegible]
10	Aeneas Creek to Blair Street***				
11	Barkwill-Cooke Area***				
12	Mountford-Cedar Area***				
13	Thornber Street Area			+ 65	
	Towgood	+ 48	+ 72		MH-SW0398
	Trout Creek South		+ 97		
	Total	+ 2,424	+ 1,064	+ 265	

*Flows conveyed through an onsite pump with a capacity of [illegible] L/s.
**Flows conveyed through a proposed District lift station with a capacity of [illegible] L/s.
***Land is designated Agricultural Land Reserve and is not developable.

3.0 LEVEL OF SERVICE TARGETS AND DESIGN CRITERIA

The following likelihood of failure criteria were used to assess the gravity mains, pump stations and forcemains.

Likelihood of pipe failure based on the hydraulic modeling was determined by the following criteria in **Table 3.1**:

Table 3.1 Likelihood of Failure Ratings (Gravity Mains)

Likelihood of Failure	Hydraulic Capacity	HGL	Description
1 (Rare)	q/Q ≤ 0.7	HGL < Crown	Pipe performing as designed
2 (Unlikely)	0.7 < q/Q < 1.0	HGL < Crown	Adequate capacity
3 (Possible)	0.7 < q/Q < 1.0	Crown ≤ HGL ≤ 0.3 m above Crown	Adequate capacity, downstream condition causing backwater
3 (Possible)	q/Q ≥ 1.0	HGL < Crown	Marginal capacity however HGL is still within pipe
4 (Likely)	q/Q ≥ 1.0	Crown ≤ HGL ≤ 0.3 m above Crown	Capacity exceeded
5 (Almost Certain)	q/Q ≥ 1.0	0.3 m above Crown < HGL < Ground	Capacity exceeded and overflow possible

q = flow in pipe

Q = pipe capacity at 100% full

HGL = hydraulic grade line

Crown = top of pipe

Likelihood of pump station, wet well and forcemain failure based on the hydraulic modeling was determined by the following criteria in **Table 3.2**:

Table 3.2 Pump Station, Wet Well, and Force Main Likelihood of Failure Ratings

Likelihood of Failure	Pump Capacity	Wet Well Capacity	Forcemain Velocity	Description
1 (Rare)	Q<=Pump Capacity	HGL < Inlet Pipe Invert	V < 1.5 m/s	Pump station performing as designed
2 (Unlikely)	Q<=Pump Capacity	HGL < Inlet Pipe Invert	V >= 1.5 m/s	Adequate pump station capacity, max forcemain velocity exceeded
3 (Possible)	Q<=Pump Capacity	HGL ≥ Inlet Pipe Invert	N/A	Inlet pipe invert within pump operating range and backup likely
3 (Possible)	Q>Pump Capacity	HGL < Inlet Pipe Invert	Check FM Velocity to determine if pump upgrade or FM upgrade required	Pump station capacity exceeded
4 (Likely)	Q>Pump Capacity	HGL ≥ Inlet Pipe Invert		Pump station capacity exceeded and backup likely
5 (Almost Certain)	Q>Pump Capacity	HGL ≥ Maximum Physical Depth		Pump station capacity exceeded and overflow likely

Q = Peak wet weather flow entering the station

Pump Capacity = Pump station capacity with the largest pump out of service

HGL= Hydraulic grade line

V = Velocity

For any pipes that are deficient, as illustrated by a likelihood of failure score of 4 or 5, upgrades have been identified so the depth of flow in the new pipe does not exceed 70%.

4.0 HYDRAULIC PERFORMANCE SUMMARY

Within the sanitary sewer collection system only 3 pipe segments are deficient, and they become deficient by 2021. The locations of the deficient pipes are:

Table 4.1 Hydraulic Performance Summary

Pipe ID	From Address	To Address	Diameter (mm)	Length (m)
SW0471	13426 Lakeshore Drive S.	13410 Lakeshore Drive S.	200	77
SW0735	14218 Rosedale Avenue	14202 Rosedale Avenue	200	101
SW0875	14404 Rosedale Avenue	14218 Rosedale Avenue	200	88

These deficiencies can be attributed to the pumped flows from the Banks Crescent development and the Hunter Hills/Bentley Industrial development.

There are no pump station deficiencies within the system during the planning period.

5.0 PRIORITIZED IMPROVEMENT PLAN

The three deficient areas can be addressed by upgrading the mains from 200mm to 250mm. These two projects are illustrated in **Figure 5.1**. The lengths illustrated in the table below are longer than that shown in Table 4.1 due to additional upgrades needed for diameter continuity. With these upgrades there is one downstream pipe segment that reaches full capacity (with less than 1 cm of surcharging). This pipe has not been identified for upgrading at this time.

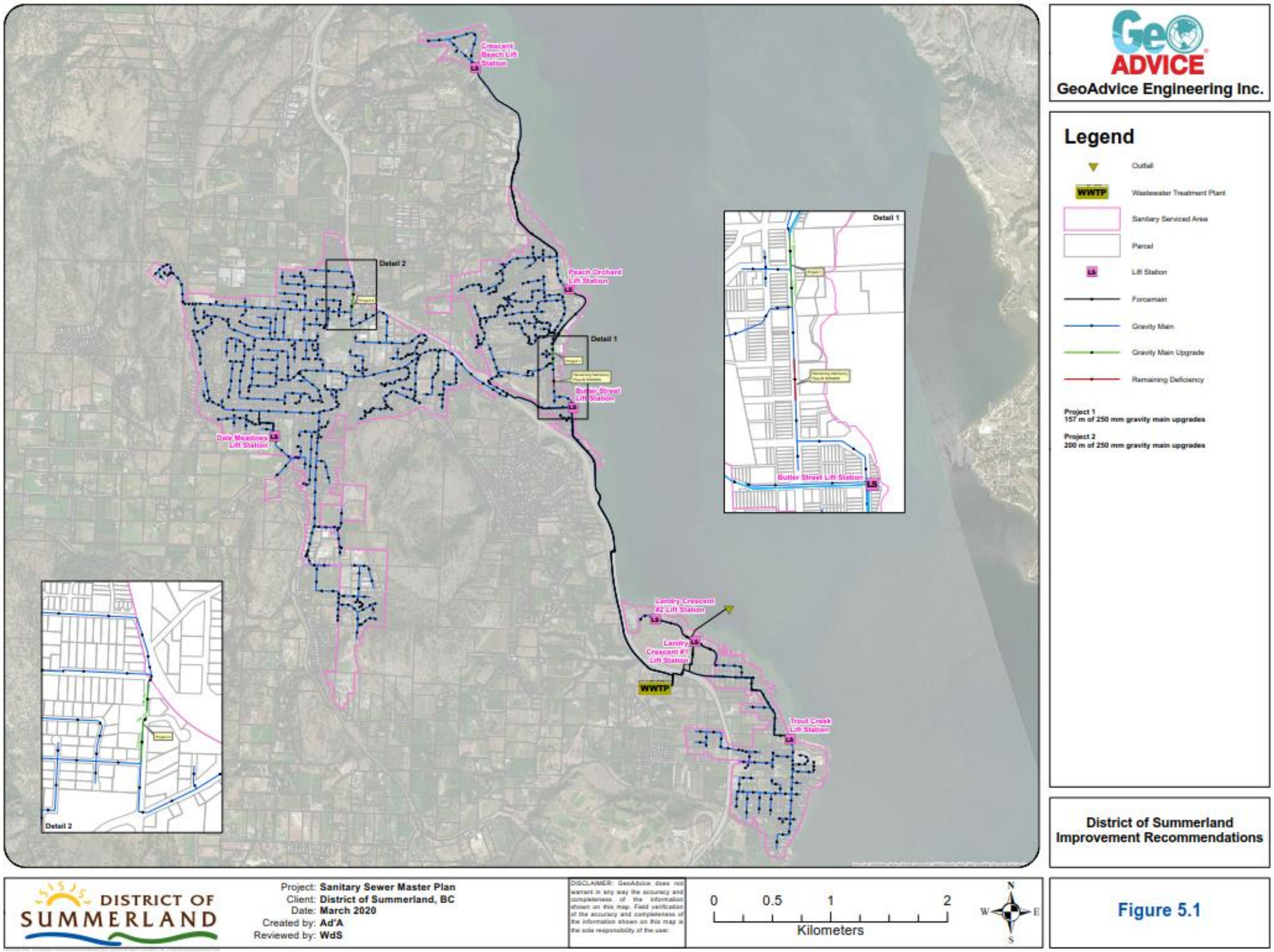
Table 5.1 Capital Improvements

Project	Description	Diameter (mm)	Length (m)	Unit Cost	Total Cost
1	Upgrade gravity mains along South Lakeshore Drive South, south of Solly Road*	250	157	$1,500	$240,000
2	Upgrade gravity mains along Rosedale Avenue between Julia Street and Quinpool Road	250	200	$1,500	$300,000
				Total	**$540,000**

*Note Project 1 is only required once the Banks Crescent development proceeds.

The costs provided are conceptual estimates only and include mains, manholes, tie-ins, service connections, and road restoration (trench only). An allowance of 25% for contingencies and 15% for engineering has been included.

Figure 5.1 Improvement Recommendations



6.0 CONCLUSIONS AND RECOMMENDATIONS

The Sanitary Sewer Master Plan outlines a capital plan for the District to be able to accommodate the forecasted growth over the foreseeable future. The existing system hydraulically only has two projects that are needed by 2021.

The following recommendations are presented in this report:

- Complete flow monitoring during wet weather events to confirm the inflow and infiltration assumptions;
- Ensure that flow trending at the treatment plant influent and pump station flow meters totalizes all flow being conveyed and captures at least one reading per hour;
- Review flow records to the treatment plant and pump stations at least once per year to determine the impacts of climate variability and aging infrastructure;
- That the District integrate the two recommended projects with other capital works and asset replacement investments; and
- That the District update this Master Plan at least once every 5-10 years.

APPENDIX A

Technical Memos

Technical Memorandum 2

Sewer Model Update and Calibration

project: Sanitary Sewer Master Plan
project ID: 2016-078-SUM
date: March 30, 2020
issued to: District of Summerland, BC (Summerland) and Urban Systems Ltd. (USL)
issued by: GeoAdvice Engineering Inc. (GeoAdvice)

1.0 Introduction

The District of Summerland, BC (District) retained Urban Systems Ltd. (USL) to develop a Sanitary Sewer Master Plan. GeoAdvice Engineering Inc. (GeoAdvice) partnered with USL as the modeling sub-consultant for this project. This memo describes GeoAdvice's steps to update and calibrate the hydraulic model of the District's sanitary sewer collection system. GeoAdvice updated and calibrated the model using the hydraulic modeling software InfoSWMM (Innovyze Inc.).

The calibrated model will be a valuable tool for analyzing the hydraulic performance of the District system as well as:

- To understand the hydraulic behaviour of the District system;
- To identify and analyze alternatives for minimizing Inflow and Infiltration (I&I) rates; and
- To identify and analyze alternatives for capacity issues in the District system.

Please refer to the following GeoAdvice technical memorandum related to this study:

- **Technical Memorandum 1** – Data Request List

A list of definitions used in this technical memorandum is provided in **Appendix A**.

2.0 Data Collection, Review and Model Update

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

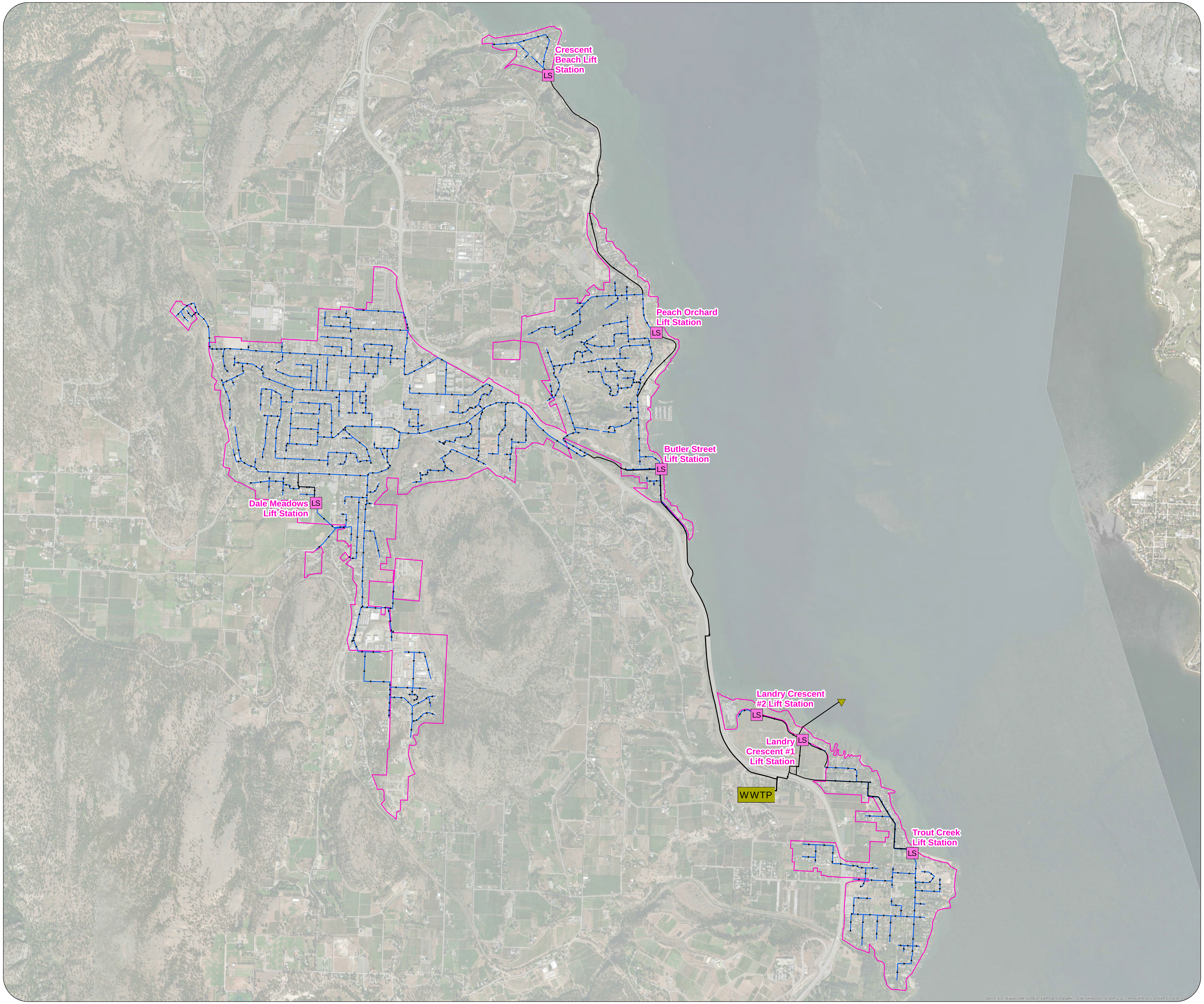
- Previous InfoSWMM hydraulic model
- GIS database
- Lift station operation
- As-built drawings
- Expected development areas
- Lift station flow data
- Wastewater treatment plant flow data

The District's GIS data was the primary source of up-to-date information on the system to update the pipe and node network topology model. Attributes of the sewer mains, such as diameter and material were extracted from the GIS database. The coordinate system used for the model is UTM NAD83 Zone 11N. **Table 2.1** summarizes the modeled sanitary sewer system statistics.

Table 2.1: Existing Sanitary Sewer Collection System Model

Component	Total
Manholes	844
Gravity Mains	50.8 km
Force Mains	14.4 km
Lift Stations	7

Figure 2.1 shows the existing sanitary sewer network.



GeoAdvice Engineering Inc.

Legend

- outfall
- WWTP Wastewater Treatment Plant
- Sanitary Serviced Area
- Parcel
- LS Lift Station
- Gravity Main
- Forcemain

District of Summerland Existing Sanitary Sewer Collection System

DISTRICT OF SUMMERLAND

Project: **Sanitary Sewer Master Plan**
Client: **District of Summerland, BC**
Date: **March 2020**
Created by: **Ad'A**
Reviewed by: **WdS**

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.5 1 2
Kilometers

N W E S

Figure 2.1

Document Path: A:\Projects\2016\2016-078-SUM\08\Reporting Figures\TM 2\2016-078-SUM_Overview.mxd

2.1 Data Gaps and Connectivity Analysis

After the model was updated, the next task involved reviewing the database information, identifying data gaps (e.g. missing diameter and material) and checking system connectivity (e.g. pipe profiles). Refer to **Appendix B** for a list of pipe profile issues found in the model and the assumed inverts used to fix them.

2.2 Primary System Components

One of the most important tasks associated with the model update is incorporating boundary conditions and all major system components (wet wells and lift stations). The District operates and maintains seven (7) sanitary lift stations throughout the sanitary network. For most lift stations, pump capacities, pump controls and wet well dimensions were supplied by the District. Detailed modeling information on all of the District's lift stations are presented in **Appendix C.**

2.3 Manhole Rim Elevation Extraction

The District's contour data was used to create a Digital Elevation Model (DEM) that was used to set rim elevations in the model.

2.4 Field Data Review and Analysis

The District provided daily flow totals for six (6) lift stations as well as the influent at the wastewater treatment plant for 2016. These were the only data sources for model calibration. To improve future calibration efforts, we recommend that the District implement a flow monitoring program using multiple flow monitors (ideally one per catchment) for a minimum duration of three months during the District's typical wet season.

An average dry weather flow (ADWF) was determined by taking an average of the total daily flow for all dry days in 2016. Days where the flow meters were down (small or no readings) were excluded from the average calculation.

No data was available for the Landry #1 lift station. Through discussion with the District operations staff, it was determined that the station services twenty (20) single family residential homes, and generally runs twice per day.

Table 2.2 summarizes the 2016 average dry weather flow observed at the lift stations and WWTP.

Table 2.2: Summary of Field Average Dry Weather Flows

Flow Monitoring Site	ADWF (L/s)
Butler Street Lift Station	2.46
Crescent Beach Lift Station	0.25
Dale Meadows Lift Station	0.97
Landry #2 Lift Station	0.12
Peach Orchard Lift Station	1.78
Trout Creek Lift Station	2.74
WWTP Influent	20.87

With an existing population of 11,615 people and the average dry weather influent flow at the WWTP, the sanitary loading rate is 155 L/cap/day.

Due to the type of field data that was available, analysis could not be conducted to determine the groundwater infiltration component of the dry weather flow. For future studies, flow monitoring with a recording interval of 5 minutes or less is recommended for the calculation of base sanitary flow and groundwater infiltration loads.

2.5 Average Dry Weather Flow (ADWF) Calculation and Allocation

The next step was the calculation and allocation of the existing sewer loads in the model. The model was split into eight (8) catchments representing the contributory areas to each lift station as well as the unpumped area that feeds to the WWTP. An important step in determining the average dry weather flow for each catchment is to determine the flow path from each catchment to the WWTP. **Figure 2.2** shows the catchment flow diagram for the District's sanitary system.

Figure 2.2: Catchment Flow Diagram

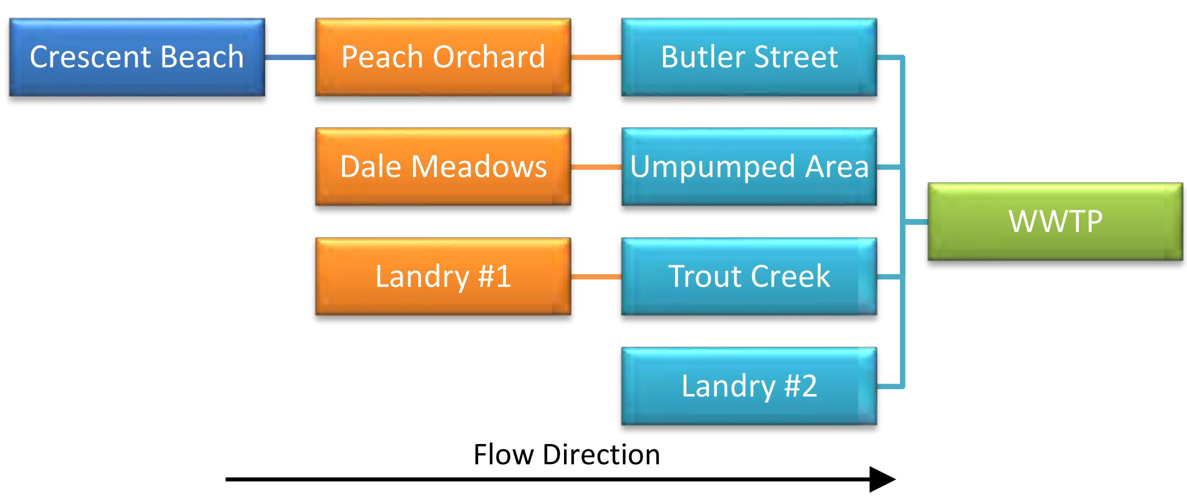


Table 2.3 summarizes the average dry weather flow allocation for each catchment. Loads were evenly distributed to the manholes in each catchment.

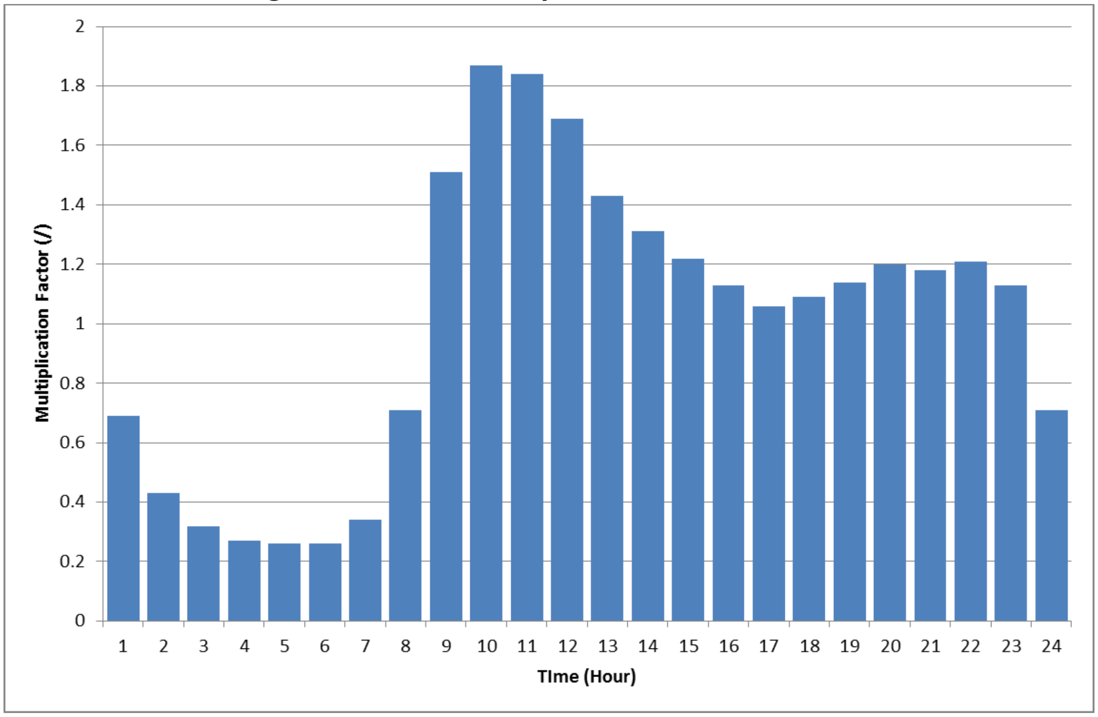
Table 2.3: Model Average Dry Weather Flow Allocation

Catchment	ADWF (L/s)
Butler Street	0.68
Crescent Beach	0.25
Dale Meadows	0.97
Landry #1	0.09*
Landry #2	0.12
Peach Orchard	1.53
Trout Creek	2.62
Unpumped Area	14.69
Total	**20.87**

***Estimated assuming 20 single family residential houses connected with 2.5 cap/house and a sanitary loading rate of 155 L/cap/day**

All dry weather flows were simulated using the diurnal pattern shown in **Figure 2.3**, which was taken from the District's existing InfoSWMM model. Under this pattern, the peak flow is predicted to occur at 10 am with a peaking factor of 1.87. For future studies, flow monitoring with a recording interval of 5 minutes or less is recommended for determining an updated dry weather flow pattern.

Figure 2.3: 24-Hour Dry Weather Flow Pattern



2.6 Inflow & Infiltration Allocation

Inflow and Infiltration (I&I) was calculated using a rate of 10,000 L/ha/day as set out in the District's development bylaw[1] for old pipes. I&I loads were allocated to manholes based on the contributory serviced area. **Table 2.4** summarizes the I&I loads allocated to each catchment.

Table 2.4: I&I Allocation

Catchment	Service Area (ha)	I&I (L/s)
Butler Street	53.4	6.2
Crescent Beach	8.5	1.0
Dale Meadows	14.4	1.7
Landry #1	0.0	0.0
Landry #2	6.6	0.8
Peach Orchard	28.3	3.3
Trout Creek	66.9	7.7
Unpumped Area	278.3	32.2
Total	**456.4**	**52.9**

No I&I validation was performed as only daily total flow volumes were provided. It is important to note that I&I values from observed data would produce an average rate, whereas the modeled I&I value represents a peak rate based on the District's bylaw. Because of this, the model I&I rates cannot be validated against the available field data. For future studies, flow monitoring with a recording interval of 5 minutes or less is recommended for the calculation of I&I rates.

[1]Corporation of the District of Summerland, Subdivision and Development Servicing Bylaw No. 99-004, June 23, 2014

3.0 Model Calibration

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

- Input data errors
- System loading errors
- Elevation 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 misleading.

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 Dry Weather Flow Calibration Results

Table 3.1 shows the comparison between the observed and modeled average dry weather flow.

Table 3.1: Model Calibration Results

Flow Monitoring Site	Observed ADWF (L/s)	Modeled ADWF (L/s)	Difference
Butler Street Lift Station	2.46	2.41	- 2 %
Crescent Beach Lift Station	0.25	0.25	0 %
Dale Meadows Lift Station	0.97	0.96	- 1 %
Landry #2 Lift Station	0.12	0.12	0 %
Peach Orchard Lift Station	1.78	1.70	- 4 %
Trout Creek Lift Station	2.74	2.77	+ 1 %
WWTP Influent	20.87	21.16	+ 1 %

Overall, a good correlation with the field data is predicted by the model for the average dry weather flow. No calibration of the diurnal pattern was completed since only daily flows were provided.

4.0 Future Scenario Development

To assess the future sewer collection system, three (3) scenarios were modeled:

- 2021-PWWF, 2021 Peak Wet Weather Flow
- 2026-PWWF, 2026 Peak Wet Weather Flow
- 2036-PWWF, 2036 Peak Wet Weather Flow

This study considers population growth from 2016 to 2036. The year 2016 is considered to be the existing base scenario, with 2021, 2026, and 2036 being the future scenarios.

Future population values were provided by USL (March 7, 2017, updated on September 20, 2017) for thirteen (13) potential development areas. **Table 4.1** provides the growth for each potential development area and the allocation manhole if a specific location for the development was provided. **Figure 4.1** shows the potential development areas. The existing population is 11,615 and the total future 2036 population is 15,368.

Table 4.1: Future Population Growth Summary

Potential Development Area		2016 – 2021 Growth	2021 – 2026 Growth	2026 – 2036 Growth	Allocation Manhole
1	Banks Crescent*	+ 996			MH-SW0622
	Jubilee Peach Orchard		+ 58		
	Lower Town (North)	+ 950			
	Lower Town (South)		+ 15		
	Downtown Core South		+ 15		
	Wharton		+ 48		MH-SW0674
2	Cartwright	+ 96	+ 96	+ 192	MH-SW0050
	Deer Ridge		+ 180		MH-SW0785
3	Victoria Road South		+ 98		
	Victoria South		+ 20		
4	Hespeler Road Area				
5	Hunters Hill Area/Bentley Industrial**	+334	+177		MH-SW0819
6	Switchback Road Area				
7	Mayne Place Area			+ 8	MH-SW0889
8	Trout Creek North		+ 83		
	Trout Creek Shore		+ 90		
9	Quinpool to Aeneas Creek***				
	Quinpool West		+ 15		MH-SW0978
10	Eneas Creek to Blair Street***				
11	Barkwill-Cooke Area***				
12	Mountford-Cedar Area***				
13	Thornber Street Area			+ 65	
	Towgood	+ 48	+ 72		MH-SW0398
	Trout Creek South		+ 97		
	Total	**+ 2,424**	**+ 1,064**	**+ 265**	

***Flows conveyed through an onsite pump with a capacity of 11.51 L/s.**
****Flows conveyed through a proposed District lift station with a capacity of 18.0 L/s.**
*****Land is designated Agricultural Land Reserve and is not developable.**

As per the District's Subdivision and Development Servicing Bylaw a rate of 350 L/cap/day was applied to the growth population. Growth loads were evenly distributed to manholes within each potential development area unless a specific allocation location was provided (as per **Table 4.1**). The diurnal pattern shown in **Figure 2.3** was also applied to the growth loads.

In addition to population growth, new sewerage areas were provided for three developments. **Table 4.2** summarizes the future sewerage areas and the scenario in which their I&I loads contribute to the sanitary network.

Table 4.2: Future Sewerage Areas

Potential Development Area		Area (ha)	Year Added
2	Deer Ridge	1.5	2026
5	Hunter Hills Area	0.7	2036
6	Switchback Road Area	0.4	2036

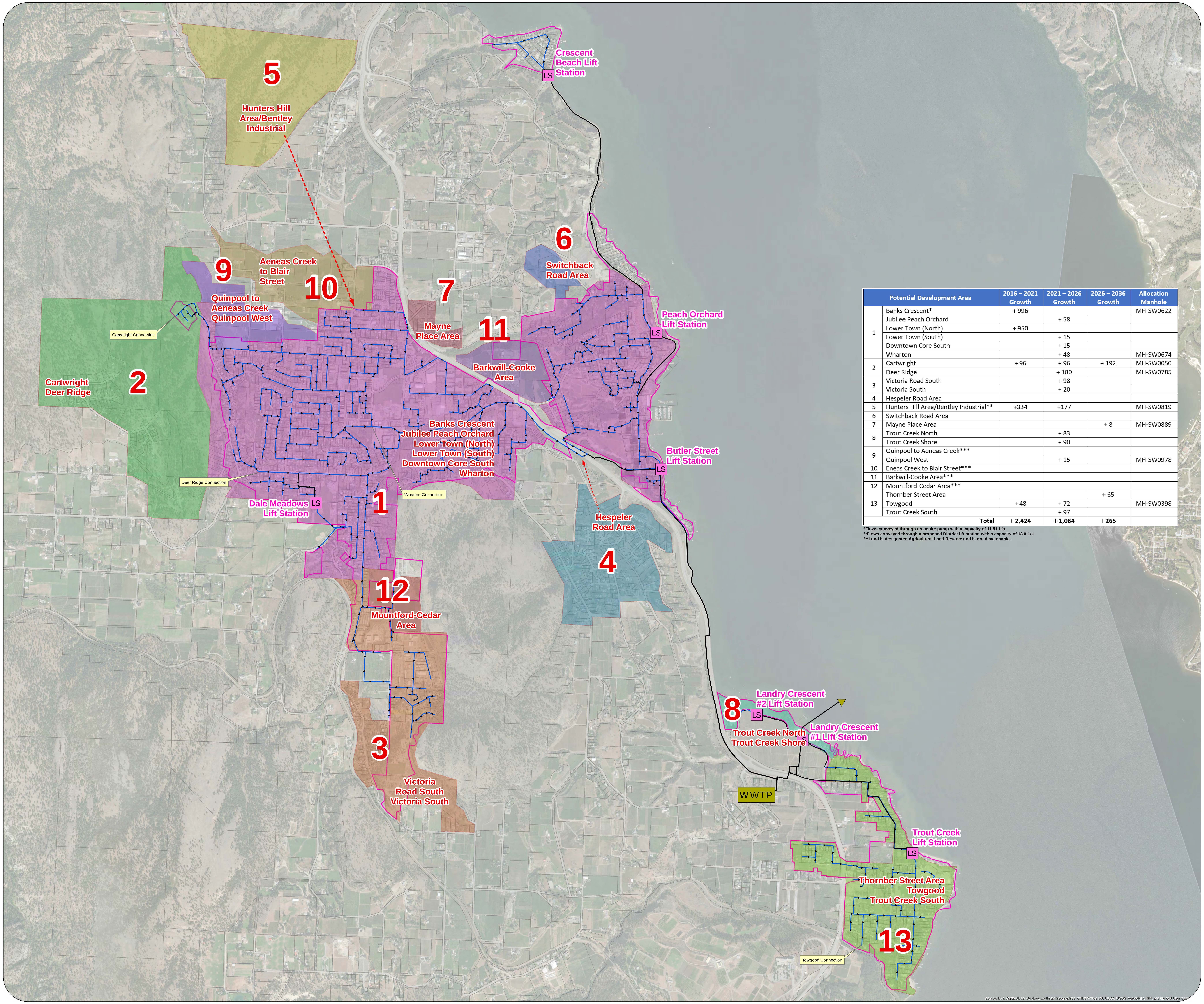
As per the District's Subdivision and Development Servicing Bylaw, a rate of 8,000 L/ha/day for new pipes was applied to the future sewerage areas. The I&I loads were allocated to manholes in their respective potential development area.

Table 4.3 below summarizes the existing and future loads in the model.

Table 4.3: Summary of Existing and Future Model Loads

Load Type	Load (L/s)
Existing ADWF	21.0
Existing I&I	52.9
Total 2016 AWWF*	**73.9**
2016 – 2021 Population Growth	+ 9.8
New I&I	+ 0.0
Total 2021 AWWF*	**83.7**
2021 – 2026 Population Growth	+ 4.3
New I&I	+ 0.1
Total 2026 AWWF*	**88.1**
2026 – 2036 Population Growth	+ 1.1
New I&I	+ 0.1
Total 2036 AWWF*	**89.3**

***AWWF = Average Wet Weather Flow**



Potential Development Area		2016 – 2021 Growth	2021 – 2026 Growth	2026 – 2036 Growth	Allocation Manhole
1	Banks Crescent*	+ 996			MH-SW0622
	Jubilee Peach Orchard		+ 58		
	Lower Town (North)	+ 950			
	Lower Town (South)		+ 15		
	Downtown Core South		+ 15		
	Wharton		+ 48		MH-SW0674
2	Cartwright	+ 96	+ 96	+ 192	MH-SW0050
	Deer Ridge		+ 180		MH-SW0785
3	Victoria Road South		+ 98		
	Victoria South		+ 20		
4	Hespeler Road Area				
5	Hunters Hill Area/Bentley Industrial**	+334	+177		MH-SW0819
6	Switchback Road Area				
7	Mayne Place Area			+ 8	MH-SW0889
8	Trout Creek North		+ 83		
	Trout Creek Shore		+ 90		
9	Quinpool to Aeneas Creek***				
	Quinpool West		+ 15		MH-SW0978
10	Eneas Creek to Blair Street***				
11	Barkwill-Cooke Area***				
12	Mountford-Cedar Area***				
13	Thornber Street Area			+ 65	
	Towgood	+ 48	+ 72		MH-SW0398
	Trout Creek South		+ 97		
	Total	**+ 2,424**	**+ 1,064**	**+ 265**	

*Flows conveyed through an onsite pump with a capacity of 11.51 L/s.
**Flows conveyed through a proposed District lift station with a capacity of 18.0 L/s.
***Land is designated Agricultural Land Reserve and is not developable.

GeoAdvice Engineering Inc.

Legend

- Outfall
- WWTP — Wastewater Treatment Plant
- Sanitary Serviced Area
- Parcel
- LS — Lift Station
- Gravity Main
- Forcemain

Potential Development Area

- 1 — *Banks Crescent, Jubilee Peach Orchard, Lower Town (North), Lower Town (South), Downtown Core South, Wharton*
- 2 — *Cartwright, Deer Ridge*
- 3 — *Victoria Road South, Victoria South*
- 4 — *Hespeler Road Area*
- 5 — *Hunters Hill Area*
- 6 — *Switchback Road Area*
- 7 — *Mayne Place Area*
- 8 — *Trout Creek North, Trout Creek Shore*
- 9 — *Quinpool to Aeneas Creek, Quinpool West*
- 10 — *Aeneas Creek to Blair Street*
- 11 — *Barkwill-Cooke Area*
- 12 — *Mountford-Cedar Area*
- 13 — *Thornber Street Area, Towgood, Trout Creek South*

Potential Development Areas

DISTRICT OF SUMMERLAND

Project: **Sanitary Sewer Master Plan**
Client: **District of Summerland, BC**
Date: **March 2020**
Created by: **Ad'A**
Reviewed by: **WdS**

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Kilometers

N S W E

Figure 4.1

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Submission

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March 30, 2020

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Document History and Version Control

Revision No.	Date	Document Description	Revised By	Reviewed By
R0	June 16, 2017	First Draft	Adrien d'Andrade	Werner de Schaetzen
R1	November 27, 2017	Final	Adrien d'Andrade	Werner de Schaetzen
R2	December 31, 2018	Final	Adrien d'Andrade	Werner de Schaetzen
R3	March 30, 2020	Final	Adrien d'Andrade	Werner de Schaetzen

Statement of Qualifications and Limitations

This document represents the best professional judgment of GeoAdvice Engineering Inc. based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty, expressed or implied is made.

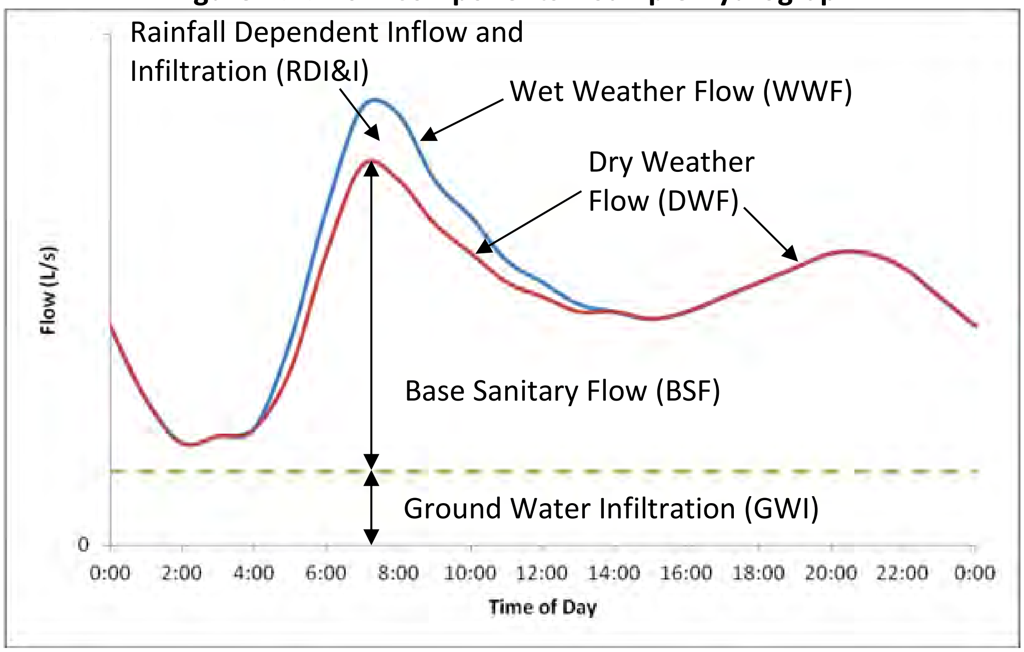
Appendix A Definitions

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 A.1**.

Figure A.1: Flow Components – Sample 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 carry.

Dry Weather Flow (DWF) – The portion of the total flow that is composed of BSF and GWI. DWF = GWI + BSF.

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

Rainfall Dependent I&I (RDI&I) – Rainfall dependent inflow and infiltration equals rainfall-induced infiltration plus all sources of inflow.

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.

Appendix B Pipe Profile Corrections

Table B.1: Pipe Profile Corrections

Model ID	Old Upstream Invert (m)	Old Downstream Invert (m)	Updated Upstream Invert (m)*	Updated Downstream Invert (m)*
SW0009	344.19	0.00	344.19	343.20
SW0010	0.00	0.00	341.75	341.45
SW0013	0.00	0.00	538.43	535.83
SW0015	538.41	539.70	539.70	538.41
SW0027	0.00	0.00	491.81	491.79
SW0035	355.08	343.53	355.05	343.53
SW0039	501.60	500.21	503.08	502.79
SW0040	504.15	501.60	504.15	503.08
SW0049	528.88	522.12	528.63	522.12
SW0053	536.35	536.29	536.32	531.85
SW0058	0.00	0.00	494.69	489.35
SW0085	0.00	0.00	341.12	341.12
SW0129	0.00	535.83	537.80	535.83
SW0132	535.53	535.16	535.53	535.17
SW0142	549.30	541.00	547.83	541.00
SW0148	548.50	549.00	549.35	549.02
SW0152	557.85	541.00	557.28	547.83
SW0161	0.00	535.35	535.98	535.35
SW0165	0.00	524.02	528.74	524.02
SW0166	529.80	0.00	529.80	528.74
SW0167	529.86	0.00	529.86	529.80
SW0170	0.00	0.00	506.86	506.30
SW0172	509.99	506.86	518.22	509.99
SW0179	0.00	0.00	532.70	532.30
SW0180	0.00	0.00	533.69	532.70
SW0181	0.00	0.00	534.29	533.69
SW0182	0.00	0.00	534.93	534.29
SW0192	0.00	532.00	533.96	532.00
SW0195	520.12	515.61	519.12	515.61
SW0200	0.00	0.00	341.34	341.34
SW0203	341.56	341.38	341.34	341.34
SW0204	341.55	0.00	341.34	341.34
SW0206	0.00	0.00	341.38	342.71
SW0222	0.00	0.00	489.75	489.52
SW0225	0.00	0.00	492.34	491.75
SW0226	0.00	0.00	491.79	491.75
SW0227	0.00	440.50	441.18	440.52

Model ID	Old Upstream Invert (m)	Old Downstream Invert (m)	Updated Upstream Invert (m)*	Updated Downstream Invert (m)*
SW0268	0.00	0.00	488.19	487.74
SW0271	0.00	0.00	0.00	345.88
SW0291	339.94	1.31	339.94	339.94
SW0353	0.00	0.00	340.82	340.52
SW0359	343.67	343.24	343.62	343.24
SW0404	344.45	342.87	344.27	342.87
SW0422	338.48	1.62	338.48	338.48
SW0429	0.00	0.00	340.12	340.12
SW0442	0.00	0.00	345.88	345.68
SW0467	458.23	457.93	458.20	457.93
SW0468	0.00	458.20	459.29	458.20
SW0657	482.78	481.28	482.77	481.28
SW0676	480.44	480.44	480.44	479.83
SW0691	489.38	1.31	489.38	489.38
SW0694	0.00	0.00	491.75	491.58
SW0712	0.00	0.00	473.11	472.90
SW0721	0.00	0.00	475.52	473.11
SW0723	0.00	0.00	476.30	474.92
SW0731	0.00	0.00	488.26	488.19
SW0768	479.98	479.03	479.83	479.03
SW0808	0.00	0.00	479.72	478.78
SW0870	478.41	477.79	478.30	477.79
SW0873	478.57	478.30	478.54	478.30
SW0881	0.00	0.00	474.92	474.57
SW1005	0.00	0.00	490.08	489.75
SW1025	495.26	495.61	495.61	495.26
SW0335	0.00	0.00	342.29	344.27
SW0757	0.00	0.00	489.38	492.74
SW1167	0.00	0.00	339.94	345.68

***Pipe profile corrections were made where there were missing inverts or inverts that did not align with the adjoining pipes. The updated inverts were based on the known inverts at adjoining pipes.**

Appendix C Summary of Model Data and System Components

Table C.1: Pump Model Inputs

Lift Station Name	Model ID	Firm Capacity (L/s)	Pump On Level (m)	Pump Off Level (m)
Butler Street Lift Station	PMP_BUTLERSTREET_1	70.0	1.35	0.90
	PMP_BUTLERSTREET_2		1.60	0.90
	PMP_BUTLERSTREET_3		1.70*	0.90
Crescent Beach Lift Station	PMP_CRESCENTBEACH_1	12.0	1.00	0.50
	PMP_CRESCENTBEACH_2		1.25	0.50
Dale Meadows Lift Station	PMP_DALEMEADOWS_1	14.6	1.34	0.95
	PMP_DALEMEADOWS_2		1.44	0.95
Landry #1 Lift Station	PMP_LANDRY1_1	5.4	0.90	0.35
	PMP_LANDRY1_2		0.95	0.35
Landry #2 Lift Station	PMP_LANDRY2_1	12.7	1.20	0.80
	PMP_LANDRY2_2		1.30	0.80
Peach Orchard Lift Station	PMP_PEACHORCHARD_1	15.8	3.27	1.08
	PMP_PEACHORCHARD_2		3.57	1.11
Trout Creek Lift Station	PMP_TROUTCREEK_1	27.5	1.21	0.61
	PMP_TROUTCREEK_2		1.62	0.61

***Data was unavailable. Assumed values for model.**

Table C.2: Wet Well Model Inputs

Lift Station Name	Model ID	X-Sectional Area (m^2)	Bottom Elevation (m)	Maximum Depth (m)	Volume (m^3)
Butler Street Lift Station	WW_BUTLERSTREET	9.90	338.43	1.84	18.22
Crescent Beach Lift Station	WW_CRESCENTBEACH	5.76	338.59	4.37	25.19
Dale Meadows Lift Station	WW_DALEMEADOWS	7.83	488.06	1.54	12.06
Landry #1 Lift Station	WW_LANDRY1	2.35	338.12*	4.57	10.74
Landry #2 Lift Station	WW_LANDRY2	8.92	336.34*	5.00*	65.65
Peach Orchard Lift Station	WW_PEACHORCHARD	5.76	338.85	3.57	20.56
Trout Creek Lift Station	WW_TROUTCREEK	7.83	336.74	1.87	14.64

***Data was unavailable. Assumed values for model.**

Technical Memorandum 3

Capacity Analysis and Improvement Recommendations

project: Sanitary Sewer Master Plan
project ID: 2016-078-SUM
date: March 30, 2020
issued to: District of Summerland, BC (District) and Urban Systems Ltd. (USL)
issued by: GeoAdvice Engineering Inc. (GeoAdvice)

1. Introduction

The District of Summerland, BC (District) retained Urban Systems Ltd. (USL) to develop the 2016 Sanitary Sewer Strategic Plan. GeoAdvice Engineering Inc. (GeoAdvice) partnered with USL as the modeling sub-consultant for this project. This memo describes the results of the sanitary sewer system capacity analysis and system improvement recommendations.

Please refer to GeoAdvice's previous technical memoranda related to this study:

- **Technical Memorandum 1** – Data Request List (**TM 1**)
- **Technical Memorandum 2** – Sewer Model Update and Calibration (**TM 2**)

2. Scenario Development

This study considered population growth from 2016 to 2036. The population in 2016 is considered to be the existing base scenario, with 2036 being the future OCP scenario. To assess the existing and future sanitary sewer collection system, the following scenarios were developed in the model:

2016 Scenario

- Existing 2016 Peak Wet Weather Flow (**2016-PWWF**) – This scenario is used to identify any gravity main or lift station capacity issues that the current system is susceptible to have under the **existing** PWWF condition.

2021 Scenario

- Future 2021 Peak Wet Weather Flow (**2021-PWWF**) – This scenario is used to forecast any gravity main or lift station capacity issues that the current system is susceptible to have at the interim 2021 growth period.

2026 Scenario

- Future 2026 Peak Wet Weather Flow (**2026-PWWF**) – This scenario is used to forecast any gravity main or lift station capacity issues that the current system is susceptible to have at the interim 2026 growth period.

2036 Scenario

- Future 2036 Peak Wet Weather Flow (**2036-PWWF**) – This scenario is used to identify any gravity main or lift station capacity issues that the current system is susceptible to have under the OCP 2036-PWWF condition. This scenario is also used to size deficient gravity mains, forcemains, pumps and wet wells.

Refer to **Technical Memorandum 2** for more information on the growth calculations and allocation assumptions.

3. Design Criteria for Sizing New Gravity Mains, Forcemains and Pumps

Based on the District Bylaws[1] and consultation with the District, the following performance criteria were used for sizing new gravity mains, forcemains and pumps.

Table 3.1: Design Criteria for Sizing New Gravity Mains, Forcemains and Pumps

Facility	Criterion	Parameter Value
Gravity Main	Design Flow	2036-PWWF
	Max. depth/Diameter Ratio	d/D < 0.75
	Min. Velocity	Velocity ≥ 0.6 m/s
	Max. Velocity	Velocity ≤ 3.0 m/s
	Min. Pipe Diameter	D = 200 mm D = 150 mm for the upstream section of residential sewer where future extension is not possible
	Roughness Coefficient	n = 0.013 (Concrete) n = 0.011 (PVC)*
Forcemain	Design Flow	2036-PWWF
	Min. Velocity	Velocity ≥ 1.0 m/s
	Max. Velocity	Velocity ≤ 3.5 m/s
	Roughness Coefficient	C = 120
Pump	Design Flow	2036-PWWF
	Max. Pump Flow	PWWF = Firm Capacity

***It was assumed that all new gravity mains would be PVC.**

[1]Corporation of the District of Summerland, Subdivision and Development Servicing Bylaw No. 99-004, June 23, 2014

4. Capacity Analysis

Model results for gravity mains and lift stations were assessed using a likelihood of failure (LoF) rating system. This section describes the methodology and results for the LoF capacity analysis of the District's gravity mains and lift stations.

4.1. Gravity Main Likelihood of Failure Criteria

Model results for gravity mains were first analyzed to determine deficiencies and assign a LoF rating. **Table 4.1** and **Table 4.2** summarize the criteria used to define the LoF rating for each gravity main.

Table 4.1: Gravity Main LoF Scoring Criteria

Criteria	Result
Hydraulic Capacity	
q/Q < 0.7	A
0.7 ≤ q/Q < 1.0	B
q/Q ≥ 1.0	C
HGL	
HGL < Crown	A
HGL <= 0.3 m above Crown	B
HGL > 0.3 m above Crown	C
Velocity	
v < 0.6 m/s	Fail
v >= 0.6 m/s	Pass

Table 4.2: Gravity Main LoF Ratings

LoF Rating	Hydraulic Capacity	HGL	Velocity	Description
1	A	A	Pass	Gravity main performing as designed
2	A	A	Fail	Adequate capacity, low velocity indicates potential sedimentation
3	A	B or C	N/A	Adequate capacity, downstream condition causing backwater
	B	N/A	N/A	Marginal capacity
	C	A	N/A	
4	C	B	N/A	Capacity exceeded and surcharging likely
5	C	C	N/A	Capacity exceeded and overflow likely

In general, LoF ratings of '1', '2' or '3' will not trigger a gravity main upgrade as there is capacity available in the gravity main to convey flows.

Only gravity mains receiving LoF ratings of '4' or '5' were considered for upgrade. A gravity main receiving a '4' rating requires an upgrade as the hydraulic capacity has been exceeded and is likely causing surcharging to occur. A gravity main receiving a '5' rating indicates potential surcharging to the manhole rim, increasing the priority of the upgrade.

4.2. Gravity Main Likelihood of Failure Rating Results

Table 4.3 summarizes the gravity main performance results under existing and future scenarios.

Table 4.3: Summary of Gravity Main LoF Ratings (Number of Pipes)

LoF Rating	2016-PWWF	2021-PWWF	2026-PWWF	2036-PWWF
1	803	797	796	795
2	13	7	7	7
3	6	15	16	17
4	0	2	2	2
5	0	1	1	1

The table above shows that there are no gravity main deficiencies under the existing 2016-PWWF scenario. Under all future scenarios there are three (3) gravity main deficiencies. The deficient gravity mains are summarized in **Table 4.4**.

Table 4.4: Deficient Gravity Mains

Pipe ID	From Address	To Address	Diameter (mm)	Length (m)	Slope (%)
SW0471	13426 Lakeshore Dr S	13410 Lakeshore Dr S	200	77.4	0.4
SW0735	14218 Rosedale Ave	14202 Rosedale Ave	200	101.1	0.3
SW0875	14404 Rosedale Ave	14218 Rosedale Ave	200	88.4	0.4

The gravity main deficiencies shown above can be attributed to the pumped flows from the Banks Crescent development in Area 1 (SW0471) and the Hunter Hills/Bentley Industrial development in Area 5 (SW0735 and SW0875). Refer to **Technical Memorandum 2** for more information on the loading assumptions for these development areas.

No manhole flooding is predicted under existing or future scenarios.

Figure 4.1 to **Figure 4.4** show the gravity main LoF ratings for the existing and future scenarios.

Refer to **Appendix A** for detailed modeling results of the deficient gravity mains (LoF = '4' or '5').

4.3. Lift Station Likelihood of Failure Criteria

Table 4.5 and **Table 4.6** explain the LoF scoring criteria and ratings for assessing the District lift stations.

Table 4.5: Lift Station LoF Scoring Criteria

Criteria	Result
Pump Capacity	
PWWF ≤ Firm Capacity*	Pass
PWWF > Firm Capacity*	Fail
Wet Well Capacity	
Max. Operating Level < Inlet Pipe Invert	A
Max. Operating Level ≥ Inlet Pipe Invert	B
Max. Operating Level >= Max. Physical Depth	C
Forcemain Velocity	
v < 1.0 m/s	Fail
1.0 m/s ≤ v ≤ 3.5 m/s	Pass
v > 3.5 m/s	Fail

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

Table 4.6: Lift Station LoF Ratings

LoF Rating	Pump Capacity	Wet Well Capacity	Forcemain Velocity	Description
1	Pass	A	Pass	Lift station performing as designed
2	Pass	A	Fail	Forcemain velocity outside of design range
3	Pass	B	N/A	Inlet pipe invert within pump operating range and backup likely (submerged inlet)
	Fail	A	N/A	Pump capacity exceeded but sufficient wet well capacity to attenuate additional flow
4	Fail	B	N/A	Pump capacity exceeded and backup likely
5	N/A	C	N/A	Wet well capacity exceeded and overflow likely

A lift station receiving a LoF rating of '3' indicates that the lead pump "ON" level may be higher than the inlet pipe invert (submerged inlet), causing backup to occur in the upstream pipes. The District should assess these lift stations and adjust the operating conditions as required.

Lift stations receiving LoF ratings of '4' or '5' should be considered for upgrade.

4.4. Lift Station Likelihood of Failure Rating Results

The lift station LoF results for existing and future scenarios are summarized in **Table 4.7**.

Table 4.7: Summary of Lift Station LoF Ratings (Number of Lift Stations)

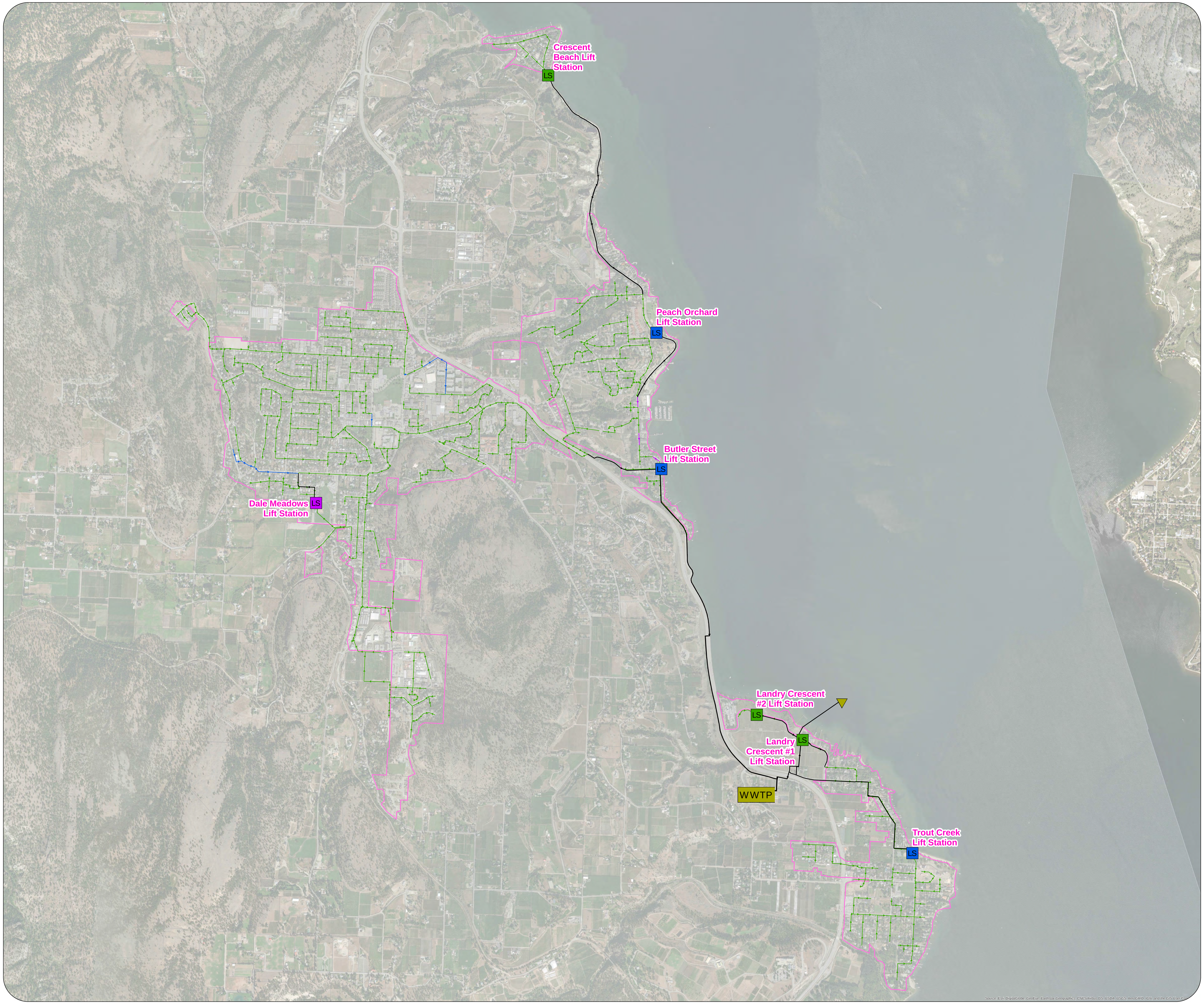
LoF Rating	2016-PWWF	2021-PWWF	2026-PWWF	2036-PWWF
1	3	3	3	3
2	3	3	3	3
3	1	1	1	1
4	0	0	0	0
5	0	0	0	0

The model does not predict any lift station deficiencies within the study period.

The Dale Meadows Lift Station has a LoF rating of ‘3’ in all scenarios, as the lead pump “ON” level is 3 cm higher than the inlet pipe invert. The lift station is operating as designed and the lift station has reserve capacity under all scenarios.

Figure 4.1 to **Figure 4.4** show the lift station LoF ratings for the existing and future scenarios.

The complete lift station capacity results, comparing firm capacity to peak inflow, for existing and future conditions, are provided in **Appendix B**.



GeoAdvice Engineering Inc.

Legend

- Outfall
- WWTP Wastewater Treatment Plant
- Sanitary Serviced Area
- Parcel
- Forcemain

Lift Station LoF Rating

- LS 1
- LS 2
- LS 3
- LS 4
- LS 5

Gravity Main LoF Rating

- 1
- 2
- 3
- 4
- 5

District of Summerland
2016-PWWF
Likelihood of Failure Ratings

DISTRICT OF SUMMERLAND

Project: **Sanitary Sewer Master Plan**
Client: **District of Summerland, BC**
Date: **March 2020**
Created by: **Ad'A**
Reviewed by: **WdS**

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

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Kilometers

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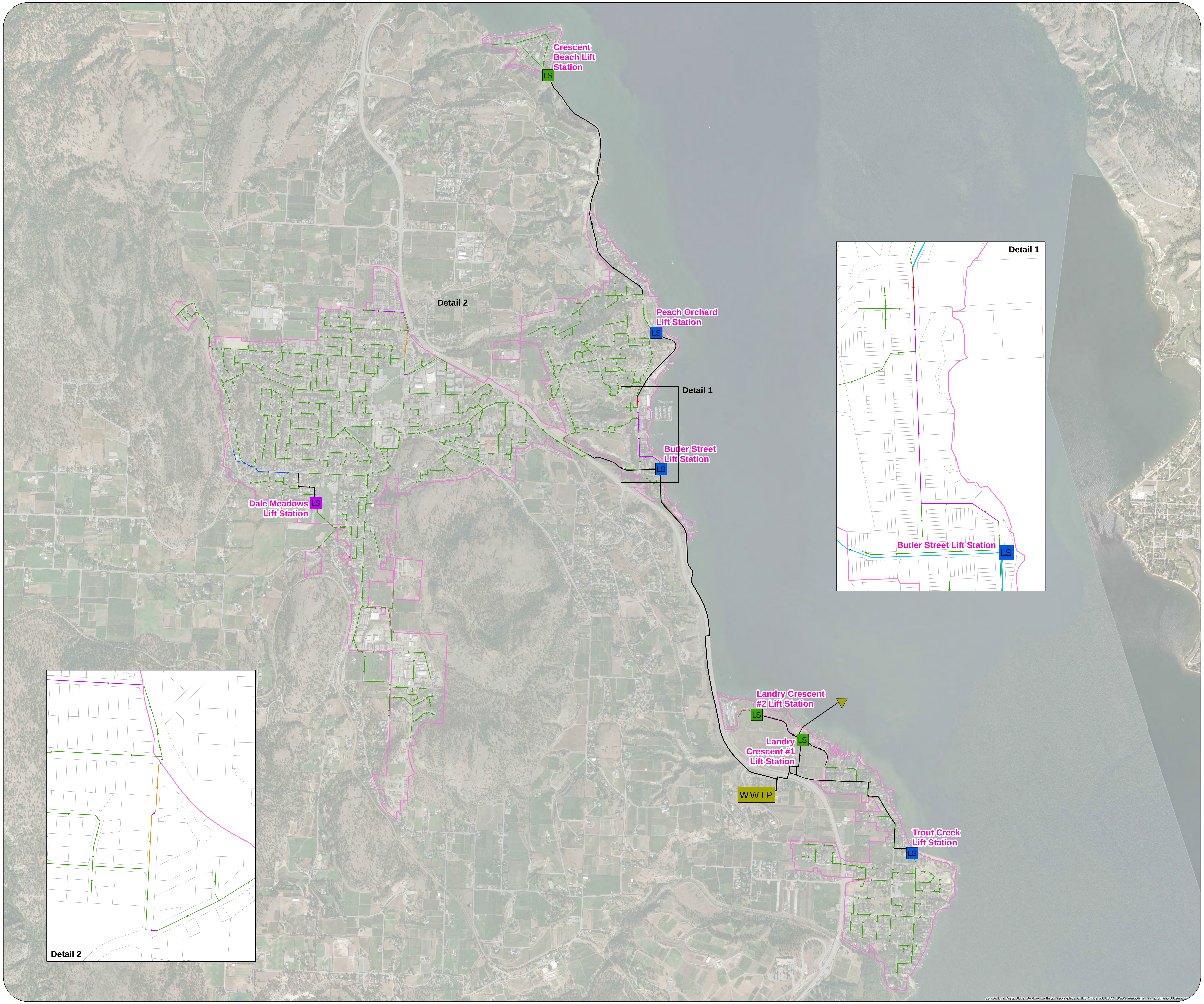
Figure 4.1



GeoAdvice Engineering Inc.

Legend

- Outfall
- WWTP — Wastewater Treatment Plant
- Sanitary Serviced Area
- Parcel
- Forcemain

Lift Station LoF Rating

- LS 1
- LS 2
- LS 3
- LS 4
- LS 5

Gravity Main LoF Rating

- 1
- 2
- 3
- 4
- 5

District of Summerland
2021-PWWF
Likelihood of Failure Ratings

DISTRICT OF SUMMERLAND

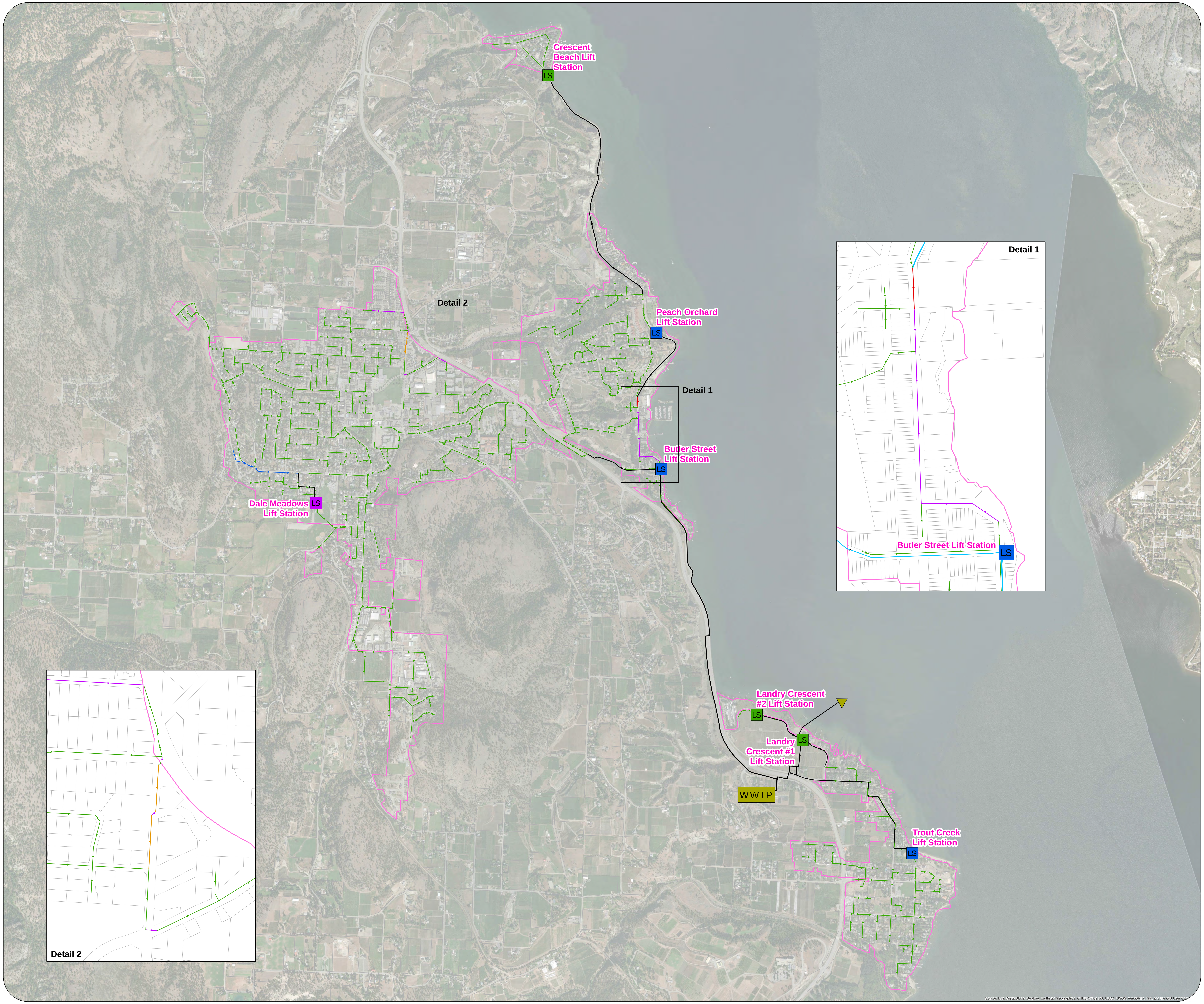
Project: **Sanitary Sewer Master Plan**
Client: **District of Summerland, BC**
Date: **March 2020**
Created by: **Ad'A**
Reviewed by: **WdS**

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.5 1 2
Kilometers

N W E S

Figure 4.2



GeoAdvice Engineering Inc.

Legend

- Outfall
- WWTP Wastewater Treatment Plant
- Sanitary Serviced Area
- Parcel
- Forcemain

Lift Station LoF Rating

- LS 1
- LS 2
- LS 3
- LS 4
- LS 5

Gravity Main LoF Rating

- 1
- 2
- 3
- 4
- 5

District of Summerland
2026-PWWF
Likelihood of Failure Ratings

DISTRICT OF SUMMERLAND

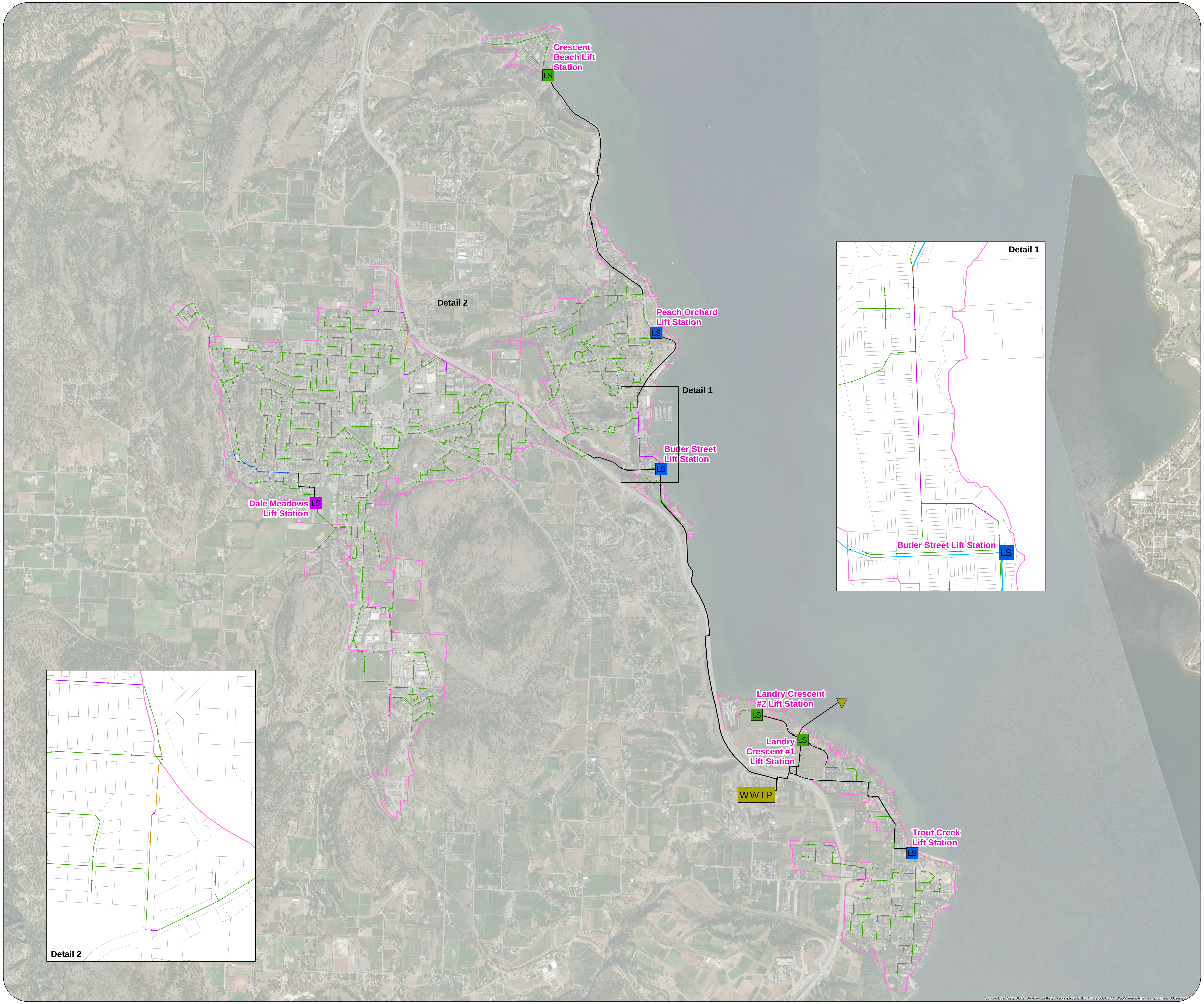
Project: **Sanitary Sewer Master Plan**
Client: **District of Summerland, BC**
Date: **March 2020**
Created by: **Ad'A**
Reviewed by: **WdS**

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.5 1 2
Kilometers

N W E S

Figure 4.3



GeoAdvice Engineering Inc.

Legend

- Outfall
- WWTP Wastewater Treatment Plant
- Sanitary Serviced Area
- Parcel
- Forcemain

Lift Station LoF Rating

- LS 1
- LS 2
- LS 3
- LS 4
- LS 5

Gravity Main LoF Rating

- 1
- 2
- 3
- 4
- 5

District of Summerland
2036-PWWF
Likelihood of Failure Ratings

DISTRICT OF SUMMERLAND

Project: **Sanitary Sewer Master Plan**
Client: **District of Summerland, BC**
Date: **March 2020**
Created by: **Ad'A**
Reviewed by: **WdS**

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.5 1 2
Kilometers

N
W E
S

Figure 4.4

5. Improvement Recommendations

Improvement recommendations have been proposed in order to eliminate deficiencies identified during the capacity analysis.

- The gravity mains with LoF ratings of either '4' or '5' were considered "deficient" and proposed upgrades were considered to eliminate these deficiencies.
- Lift stations with LoF ratings of either '4' or '5' were considered "deficient" and proposed pump, wet well and forcemain upgrades were considered to eliminate these deficiencies

Projects were then prioritized based on the criticality of the deficiencies that the improvement project would address.

As no lift stations received a LoF rating of '4' or '5', no lift station upgrades were recommended.

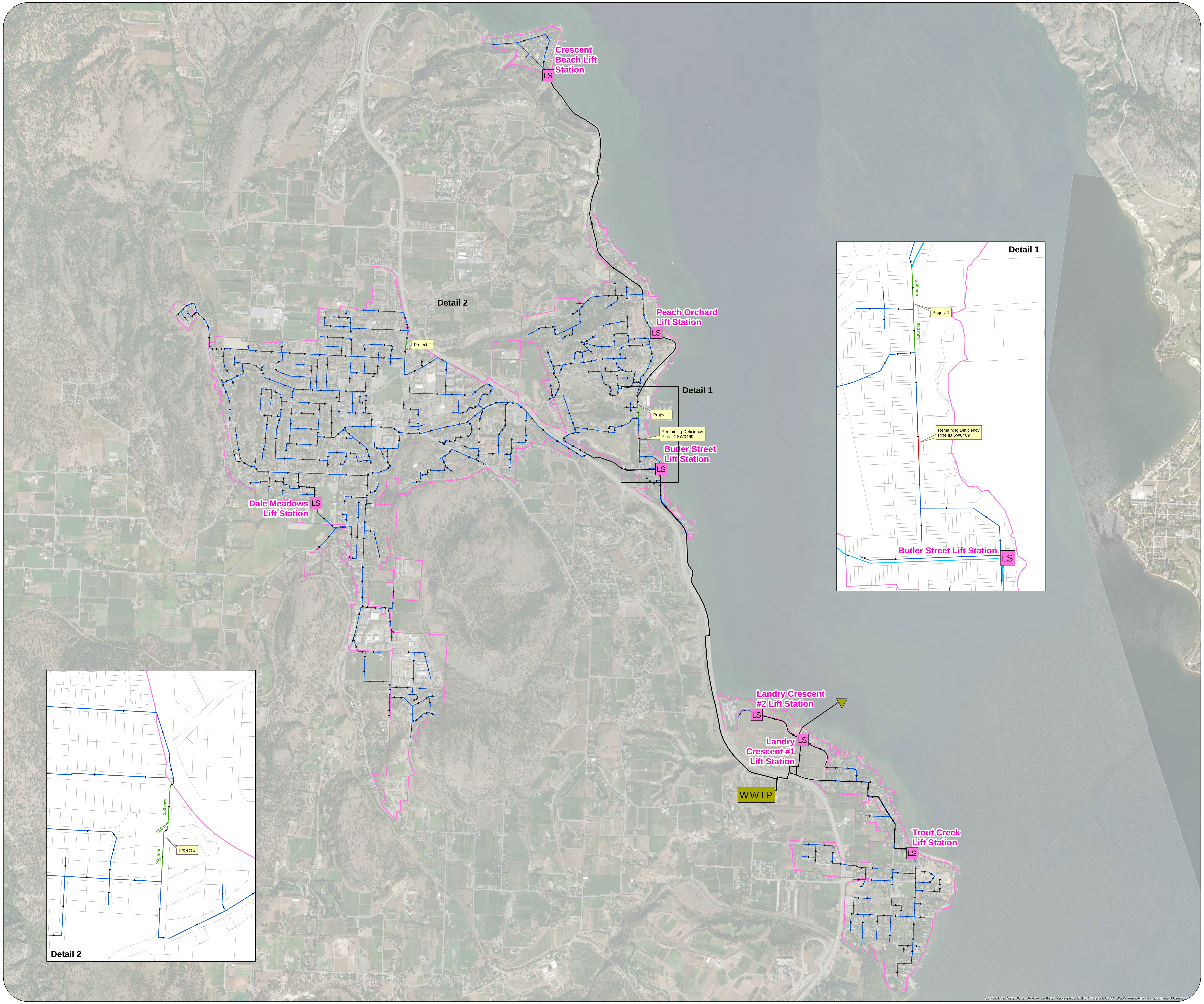
The improvement projects are summarized in **Table 5.1**. Improvement project details can be found in **Appendix C**.

Table 5.1: Sanitary System Improvement Recommendations

Suggested Timing	Project ID	Project Description	Quantity
2021	1*	Upgrade gravity mains along South Lakeshore Drive South, south of Solly Road from 200 mm to 250 mm	157 m
2021	2	Upgrade gravity mains along Rosedale Avenue between Julia Street and Quinpool Road from 200 mm to 250 mm	200 m

***NOTE: Project # 1 is only required once the Banks Crescent development comes in.**

Figure 5.1 illustrates the proposed projects in **Table 5.1**.



GeoAdvice Engineering Inc.

Legend

- Outfall
- WWTP — Wastewater Treatment Plant
- Sanitary Serviced Area
- Parcel
- LS — Lift Station
- Forcemain
- Gravity Main
- Gravity Main Upgrade
- Remaining Deficiency

Project 1
157 m of 250 mm gravity main upgrades

Project 2
200 m of 250 mm gravity main upgrades

District of Summerland
Improvement Recommendations

DISTRICT OF SUMMERLAND

Project: **Sanitary Sewer Master Plan**
Client: **District of Summerland, BC**
Date: **March 2020**
Created by: **Ad'A**
Reviewed by: **WdS**

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Kilometers

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Figure 5.1

The table below summarizes the gravity main performance results under the 2036-PWWF scenario with the proposed upgrades.

Table 5.2: Summary of Gravity Main LoF Ratings (2036-PWWF with Proposed Upgrades)

LoF Rating	2036-PWWF With Upgrades
1	797
2	7
3	17
4	1
5	0

There is one (1) new LoF = '4' gravity main remaining with the proposed upgrades. The details for this gravity main are summarized in **Table 5.3**. The location of the remaining deficiency is shown in **Figure 5.1**.

Table 5.3: Remaining Gravity Main Deficiency

Pipe ID	From Address	To Address	Diameter (mm)	Length (m)	Slope
SW0469	13011 Lakeshore Dr S	12811 Lakeshore Dr S	250	89.6	0.002

The new deficiency is caused due to upstream upgrades in Project 1 relieving a bottleneck and allowing more flow downstream. No upgrade was recommended for this gravity main as the model predicts less than 1 cm of surcharging above the pipe crown.

Submission

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Document History and Version Control

Revision No.	Date	Document Description	Revised By	Reviewed By
R0	November 27, 2017	First Draft	Adrien d'Andrade	Werner de Schaetzen
R1	December 31, 2018	Final	Adrien d'Andrade	Werner de Schaetzen
R2	March 30, 2020	Final	Adrien d'Andrade	Werner de Schaetzen

Statement of Qualifications and Limitations

This document represents the best professional judgment of GeoAdvice Engineering Inc. based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty, expressed or implied is made.

Appendix A Detailed Gravity Main Results

Table A.1: 2021-PWWF Gravity Main Deficiencies

Pipe ID	From Address	To Address	Diameter (mm)	Length (m)	Slope	PWWF (L/s)	q/Q	Surcharge Above Pipe Crown (m)	LoF Rating
SW0471	13426 Lakeshore Dr S	13410 Lakeshore Dr S	200	77.4	0.004	30.6	1.5	0.30	5
SW0735	14218 Rosedale Ave	14202 Rosedale Ave	200	101.1	0.003	21.6	1.2	0.10	4
SW0875	14404 Rosedale Ave	14218 Rosedale Ave	200	88.4	0.004	21.4	1.1	0.06	4

Table A.2: 2026-PWWF Gravity Main Deficiencies

Pipe ID	From Address	To Address	Diameter (mm)	Length (m)	Slope	PWWF (L/s)	q/Q	Surcharge Above Pipe Crown (m)	LoF Rating
SW0471	13426 Lakeshore Dr S	13410 Lakeshore Dr S	200	77.4	0.004	30.7	1.5	0.31	5
SW0735	14218 Rosedale Ave	14202 Rosedale Ave	200	101.1	0.003	21.6	1.2	0.10	4
SW0875	14404 Rosedale Ave	14218 Rosedale Ave	200	88.4	0.004	21.4	1.1	0.07	4

Table A.3: 2036-PWWF Gravity Main Deficiencies

Pipe ID	From Address	To Address	Diameter (mm)	Length (m)	Slope	PWWF (L/s)	q/Q	Surcharge Above Pipe Crown (m)	LoF Rating
SW0471	13426 Lakeshore Dr S	13410 Lakeshore Dr S	200	77.4	0.004	30.7	1.5	0.31	5
SW0735	14218 Rosedale Ave	14202 Rosedale Ave	200	101.1	0.003	21.7	1.2	0.10	4
SW0875	14404 Rosedale Ave	14218 Rosedale Ave	200	88.4	0.004	21.4	1.1	0.07	4

Appendix B Detailed Lift Station Results

Table B.1: 2016-PWWF Lift Station Results

Lift Station	Firm Capacity (L/s)	PWWF (L/s)	Reserve Capacity (L/s)	Wet Well Category	Forcemain Diameter (mm)	Forcemain Velocity* (m/s)	LoF Rating
Butler Street	70.0	22.9	+ 47.1	A	300	0.99	2
Crescent Beach	12.0	1.4	+ 10.6	A	100	1.53	1
Dale Meadows	14.6	3.5	+ 11.1	B	100	1.86	3
Landry 1	5.4	0.2	+ 5.1	A	75	1.21	1
Landry 2	12.7	0.8	+ 12.5	A	100	1.62	1
Peach Orchard	15.8	10.6	+ 5.2	A	150	0.89	2
Trout Creek	27.5	15.6	+ 11.9	A	200	0.88	2

***Forcemain velocity calculated at lift station firm capacity.**

Table B.2: 2021-PWWF Lift Station Results

Lift Station	Firm Capacity (L/s)	PWWF (L/s)	Reserve Capacity (L/s)	Wet Well Category	Forcemain Diameter (mm)	Forcemain Velocity* (m/s)	LoF Rating
Butler Street	70.0	32.8	+ 37.2	A	300	0.99	2
Crescent Beach	12.0	1.4	+ 10.6	A	100	1.53	1
Dale Meadows	14.6	3.8	+ 10.8	B	100	1.86	3
Landry 1	5.4	0.2	+ 5.1	A	75	1.21	1
Landry 2	12.7	0.8	+ 12.5	A	100	1.62	1
Peach Orchard	15.8	11.3	+ 4.5	A	150	0.89	2
Trout Creek	27.5	15.7	+ 11.8	A	200	0.88	2

***Forcemain velocity calculated at lift station firm capacity.**

Table B.3: 2026-PWWF Lift Station Results

Lift Station	Firm Capacity (L/s)	PWWF (L/s)	Reserve Capacity (L/s)	Wet Well Category	Forcemain Diameter (mm)	Forcemain Velocity* (m/s)	LoF Rating
Butler Street	70.0	33.0	+ 37.0	A	300	0.99	2
Crescent Beach	12.0	1.4	+ 10.6	A	100	1.53	1
Dale Meadows	14.6	3.9	+ 10.7	B	100	1.86	3
Landry 1	5.4	1.5	+ 3.9	A	75	1.21	1
Landry 2	12.7	1.0	+ 11.7	A	100	1.62	1
Peach Orchard	15.8	11.3	+ 4.5	A	150	0.89	2
Trout Creek	27.5	17.9	+ 9.6	A	200	0.88	2

***Forcemain velocity calculated at lift station firm capacity.**

Table B.4: 2036-PWWF Lift Station Results

Lift Station	Firm Capacity (L/s)	PWWF (L/s)	Reserve Capacity (L/s)	Wet Well Category	Forcemain Diameter (mm)	Forcemain Velocity* (m/s)	LoF Rating
Butler Street	70.0	33.0	+ 37.0	A	300	0.99	2
Crescent Beach	12.0	1.4	+ 10.6	A	100	1.53	1
Dale Meadows	14.6	3.9	+ 10.7	B	100	1.86	3
Landry 1	5.4	1.5	+ 3.9	A	75	1.21	1
Landry 2	12.7	1.0	+ 11.7	A	100	1.62	1
Peach Orchard	15.8	11.4	+ 4.4	A	150	0.89	2
Trout Creek	27.5	18.4	+ 9.1	A	200	0.88	2

***Forcemain velocity calculated at lift station firm capacity.**

Appendix C Detailed Improvement Recommendations

Table C.1: Detailed Improvement Recommendations

Project ID	Pipe ID	From Address	To Address	Length (m)	Slope	2036-PWWF Design Flow (L/s)	Existing Diameter (mm)	Proposed Diameter (mm)	d/D
1*	SW0471	13426 Lakeshore Dr S	13410 Lakeshore Dr S	77.4	0.004	33.6	200	250	0.63
	SW0472	12620 Lakeshore Dr S	12616 Lakeshore Dr S	79.5	0.014	33.9	200	250	0.55
2	SW0734	14218 Rosedale Ave	14218 Rosedale Ave	10.1	0.055	21.5	200	250	0.45
	SW0735	14218 Rosedale Ave	14202 Rosedale Ave	101.1	0.003	21.6	200	250	0.51
	SW0875	14404 Rosedale Ave	14218 Rosedale Ave	88.4	0.004	21.4	200	250	0.49

***NOTE: Project # 1 is only required once the Banks Crescent development comes in.**