CITY OF PENTICTON
REPORT NUMBR: 20M-00462-00

SANITARY MASTER PLAN

PENTICTON IIMP

JUNE 04, 2021

SANITARY MASTER PLAN

CITY OF PENTICTON

FINAL

PROJECT NO.: 20M-00462-00
DATE: JUNE 04, 2021

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June 04, 2021

Confidential

City of Penticton
616 Okanagan Avenue East
Penticton, BC V2A 3K6

Attention: Tobi Pettet, P. Eng., Project Manager

Dear Madam:

Subject: Sanitary Master Plan
Client ref.: 2020-RFP-01

WSP Canada Ltd. is pleased to submit to the City of Penticton one (1) digital copy of our Sanitary Master Plan, as part of the City of Penticton's Integrated Infrastructure Master Plan. This document summarizes the assumptions and key findings from the sanitary system analysis and provides recommendations to the City to inform the implementation of the 25 year capital programming for the infrastructure.

The analysis involved review of available background information, development of a new hydraulic model, coordination with City GIS databases, and integration of the water, stormwater and transportation infrastructure capital plans.

Should you wish to discuss the contents of this report further please do not hesitate to contact the undersigned.

Yours sincerely,

Stephen Horsman, P. Eng,
P.E.
Manager, Water

Encl.
cc:
WSP ref.: 20M-00462-00

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2021-06-04

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Date

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

The City of Penticton (City) has retained WSP Canada Inc. (WSP) to complete the Integrated Infrastructure Master Plan (IIMP), which includes developing city-wide transportation, water, stormwater and sanitary infrastructure master plans. The purpose of the IIMP is to inform infrastructure capital planning to accommodate the growth and development plans set out in the latest Official Community Plan (OCP) 2045, adopted on August 6, 2019. The OCP 2045 estimates the population to increase from 34,000 in 2016 to 42,000 by 2046, which equates to approximately 0.65% annual growth. The City wishes to determine the required capacity of both existing and proposed infrastructure to support the population growth envisioned in the OCP.

The scope of work for the City's Sanitary Master Plan (SMP) is as follows:

- Model development and validation;
- Capacity assessment with respect to the City's level of service criteria;
- Impact of future developments on the existing system;
- Capital improvement recommendations with Class "D" cost estimates; and
- Integrated schedule for implementation at 5-, 10-, and 25-year horizons.

The existing sanitary system provides service to approximately 1285 ha of the City, which consists of residential, industrial, commercial, institutional and agricultural land uses. The key components of the existing sanitary system are summarized in Table 0-1.

TABLE 0-1 EXISTING SANITARY SYSTEM

ITEM	QUANTITY
Service Area	1285 ha
Number of manholes	2366
Number and length of gravity mains	2375 (157 km)
Number and length of forcemains	19 (8 km)
Number of Lift Stations	9

The piped network and lift stations ultimately convey wastewater from developed urban areas to the Advanced Wastewater Treatment Plant (AWWTP) located at the west end of Waterloo Avenue prior to treatment and eventual discharge to the Okanagan Channel.

The City's original Master Sanitary Plan was completed in 2007 and most recently updated in 2009 with recommendations to address existing deficiencies and to support the expansion of the network through known growth areas. Since completion, much of the major capital projects such as the AWWTP upgrades, Lee Avenue lift station, and the South Main and Green Avenue sewer upgrades have been implemented. Larger projects that have not been completed include the North and South End interceptors, which have been reassessed in this Master Plan based on updated sewage projections. Additionally, smaller projects such as the South and North Lift station pump replacements were competed concurrently with the development of this Master Plan. The latest record drawings (2020) for South and North Lift stations provided by the City have been incorporated in the existing conditions scenario. Based on a long-term planning perspective, the capacity and condition improvements of the sanitary collection system will be largely focused on maintaining the target level of service for critical assets. The City has also recognized the importance of developing integrated capital programs to address the future infrastructure needs, while coordinating with other companion initiatives such as the treatment plant upgrades.

As part of the SMP, WSP developed a model of the City's existing sanitary system using the InfoSWMM software suite (Innovyze Inc.) to integrate with the City's GIS database (Refer to **Technical Memorandum # 1 -** Appendix A). The sanitary network was then updated to represent infrastructure projects implemented since the 2009 SMP Update. The City's original XPSWMM model was used to infer data gaps, where needed. Overall, the hydraulic model consists of gravity mains, forcemains, lift stations and an outfall discharging into the AWWTP. All model elements follow the asset naming convention detailed in **Technical Memorandum # 2** (Appendix B). The sanitary service area was grouped into lot-level subcatchments based on the parcels provided by the City.

Average dry weather flows were subsequently established based on a typical return to sewer rate of 80%, calculated from average day water demands and validated by the observed dry period inflows at the AWWTP. Peaking patterns were also adjusted from the previous model to more accurately reflect the observed AWWTP dry period inflows from the past three years (2017 – 2019). For wet weather flows, an assumed rainfall-dependent inflow and infiltration (RDI&I) rate of 5000 L/ha/d was established and confirmed to match the peak wet weather inflows observed at the AWWTP in the past year (2019). The primary sources of data used in the development of the hydraulic model include the City's GIS database, information collected in the field by City staff, and record drawings. The primary source of model validation was data from AWWTP inflows and lift station pump data, however no flow monitoring was carried out to fully calibrate the model.

For sanitary system assessment, the previous SMP used a peak flow (q/Q) based criterion to identify deficient assets. The level of service criteria for this Master Plan was established based on a flow-depth (d/D) based criterion recommended in the 2014 Master Municipal Construction Document (MMCD) Design Guideline Manual. It is also much more widely used in the industry for Sewer Master Planning. Design parameters from the City's Subdivision and Development Servicing Bylaw – Schedule G (August 2013) were also referred to in establishing the target level of service for forcemains, lift stations and future developments.

The modeling results indicate the sanitary sewer system is adequately sized for existing conditions and requires few improvements to maintain the current level of service for OCP conditions. The purpose of this Master Plan is to account for increase in population up to a planning horizon of 2045, including provision of municipal servicing to future growth areas.

The absence of flow monitoring data precluded detailed calibration of the model and hence only preliminary model validation was possible using anecdotal information collected at the knowledge transfer workshop on June 19, 2020. This limits the use of the model to planning level studies and conceptual recommendations only, with a lower confidence in results produced. Overall, WSP recommends flow monitoring at strategic locations in the short term with model calibration to increase model confidence, where feasible. Once the model is calibrated, the system can be reviewed in detail and an updated capital plan can then be produced, and more confidence placed on the capital plan.

The Master Plan recommendations consist of a series of individual projects prioritized to address sanitary system deficiencies for the 5-, 10- and 25-year horizons. The prioritization approach considered the criticality and magnitude of the noted deficiencies, and categorized improvement projects from high to low, most critical to least critical and lower confidence.

After an initial prioritization approach was completed, results were merged with transportation, stormwater and water system projects. through a sophisticated projects integration approach supported by computer programming and spatial analysis in ArcGIS, with overlapping projects promoted for priority as possible to be implemented at the same time along the same construction corridors. A separate memorandum was produced to capture the integration approach in detail and provides results for those projects re-prioritized due to and across the assets. The updated prioritizations have been considered in this report.

The proposed improvements shown in Appendix F include sanitary main upsizing, new sanitary main construction, slope adjustments and lift station upgrades. Table 0-2 provides a cost summary all projects with “Class D” cost estimates.

TABLE 0-2 CAPITAL COST ESTIMATE

IMPLEMENTATION SCHEDULE	NO. OF PROJECTS	TOTAL COST (2021 $)
1 – 5 Year (High Priority)	2	$ 792,300
5 – 10 Year (Medium Priority) (1)	1	$ 131,400
10-25 Year (Low Priority) (1)	9	$ 807,200
Total	14	$ 1,730,900

(1) Flow monitoring and model calibration are required to validate proposed projects

1 INTRODUCTION

1.1 PURPOSE

WSP Canada Inc. (WSP) was retained by the City of Penticton (City) to complete an Integrated Infrastructure Master Plan (IIMP), which includes developing city-wide transportation, water, stormwater and sanitary infrastructure master plans. The purpose of the IIMP is to inform infrastructure capital planning to accommodate the growth and development plans set out in the latest Official Community Plan (OCP) 2045, adopted on August 6, 2019. The OCP 2045 estimates the population to increase from 34,000 in 2016 to 42,000 by 2046, which equates to approximately 0.65% annual growth. The City wishes to determine the required capacity of both existing and proposed drainage infrastructure to support the population growth envisioned in the OCP.

Currently, the City's sanitary system services approximately 1285 ha of urban and rural catchments. The City's original SMP in 2007 provided several recommendations for system improvements, which were then updated in 2009. Much of the previous recommendations were implemented by the City and some are currently at the design phase. The objective of the SMP is to provide an updated capital works plan that meet the City's OCP 2045 objectives.

1.2 SCOPE OF WORK

The scope of work for the SMP is as follows:

- Develop a hydraulic model of the sanitary system;
- Conduct a capacity assessment to identify existing deficiencies in the sanitary and treatment systems;
- Recommend infrastructure improvements to meet City's level of service assessment criteria and accommodate 2045 OCP growth;
- Provide capital improvement projects with Class "D" cost estimates; and
- Recommend an integrated implementation schedule for the next 5-,10- and 25-year horizon.

According to the discussions with the City, flow monitoring to increase model confidence was considered outside the scope of work. In the absence of model calibration, the modeled results were compared to the previous XPSWMM model and results were discussed with City staff.

1.3 DATA COLLECTION AND INFORMATION REVIEW

The City provided all GIS geodatabases used to build the model. Table 1-1 lists the data collected and reviewed by WSP to develop the SMP. The information was mainly collected in electronic format, and consists of geospatial data, drawings and reports of previous relevant studies.

TABLE 1-1 DATA COLLECTION SUMMARY

DESCRIPTION	DATA TYPE	SOURCE	PURPOSE
Sanitary utility (gravity mains, forcemains, lift stations, manholes and service connections)	Shapefiles	City	Model Development
Base map information (elevation contours and city parcels)	Shapefiles	City	Model Development
Daily AWWTP inflows from 2017 to 2019	Excel	City	Model Validation
AWWTP inflows from July to August 2019 at 15 min. intervals	Excel	City	Model Validation
Lee and SOEC lift station inflows from July to August 2019 at 15 min. intervals	Excel	City	Model Validation
North end trunk sewer flow monitoring data from summer months in 2017 to 2019	Excel	City	Model Validation
Record drawings of lift stations	PDF	City	Model Validation
Pump make and model for lift stations	PDF	City	Model Development
Penticton Sanitary Master Plan (2007) by Earth Tech	PDF	RFP	Background
Penticton Sanitary Master Plan Update (2009) by AECOM	PDF	RFP	Background
Penticton Airport Lands Water and Sanitary Sewer Servicing Assessment (2012) by AECOM	PDF	City	Future Conditions
Proposed Spiller Road Subdivision Water and Sanitary Flows and Network Demands (2018) by McElhanney	PDF	City	Future Conditions
North End Sanitary Servicing Strategy Review (2020) by AECOM	PDF	City	Future Conditions
MMCD Design Guidelines 2014	PDF	MMCD	Level of Service Criteria

A detailed review of the GIS data was completed to address data gaps, connectivity issues and model limitations. A knowledge transfer workshop was conducted with the City on June 19, 2020 to identify model connectivity issues and potential areas of concern.

1.4 ACKNOWLEDGEMENTS

WSP acknowledges the support and cooperation of the City of Penticton and extends its appreciation to Tobi Pettet, P. Eng., Ian Chapman, P. Eng., Michael Hodges, P. Eng. and Joel Mertz, AWWTP Supervisor, for their assistance to the project team in preparing this report and completing this project.

1.5 ABBREVIATIONS

AC	Asbestos Cement
ADWF	Average Dry Weather Flow
BC	British Columbia
CMP	Corrugated Metal Pipe
DCC	Development Cost Charges
GIS	Geographic Information System
Ha	Hectare
HDPE	High Density Polyethylene
L/s	Liters per second
m	Meter
m/s	Meters per second
mm	Millimeter
MMCD	Master Municipal Constructions Document
OCP	Official Community Plan 2045
PDWF	Peak Dry Weather Flow
PIB	Penticton Indian Band
PVC	Polyvinyl Chloride
PWWF	Peak Wet Weather Flow
RDI&I	Rainfall-Dependent Inflow and Infiltration
SMP	Sanitary Master Plan

2 EXISTING SANITARY SYSTEM

2.1 OVERVIEW

The City's sanitary collection system consists of gravity mains, lift stations and forcemains. Table 2-1 provides a summary of existing features in the City's GIS database.

TABLE 2-1 EXISTING SANITARY SYSTEM

ITEM	QUANTITY
Service Area	1285 ha
Number of manholes	2366
Number and length of gravity mains	2375 (157 km)
Number and length of forcemains	19 (8 km)
Number of Lift Stations	9

All sewage collected in the sanitary system is ultimately conveyed to the AWWTP located at the west end of Waterloo Avenue. Sanitary services for urban and rural areas are provided by 157 km of gravity mains, 8 km of forcemains and 9 lift stations. Currently, majority of the gravity mains have a diameter of less than 300 mm while most of the forcemains have a diameter of less than 200 mm, as shown in Figure 2-1 and Figure 2-2, respectively.

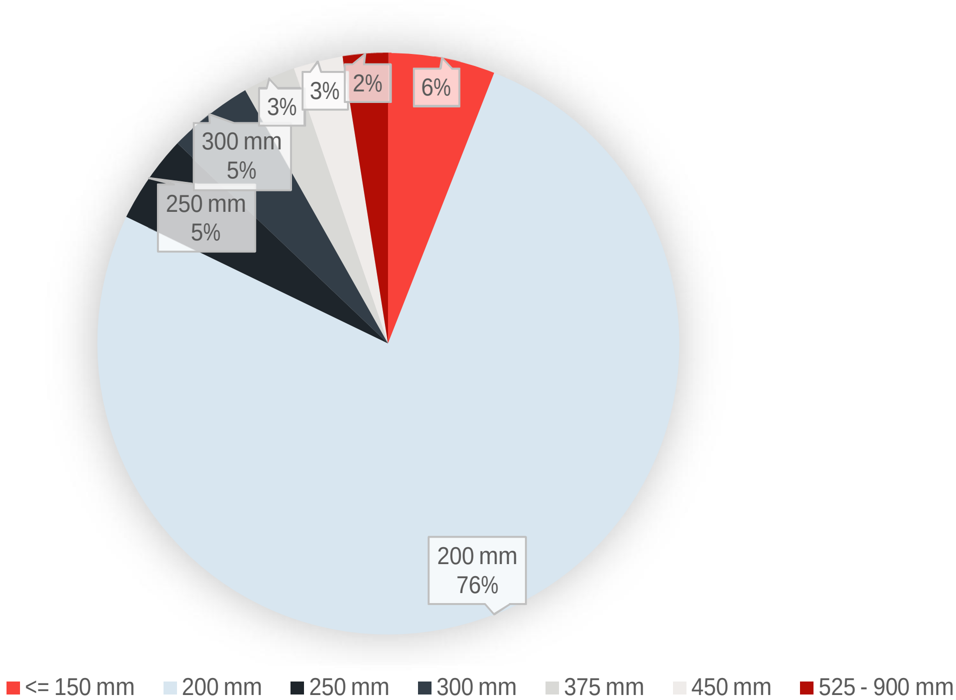


FIGURE 2-1 GRAVITY MAIN SIZE DISTRIBUTION

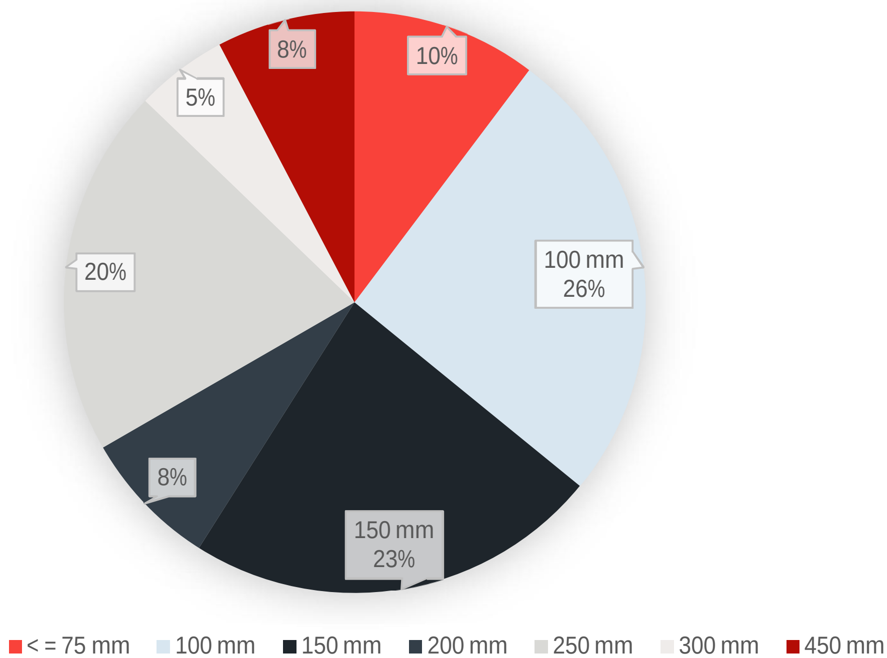


FIGURE 2-2 FORCEMAIN SIZE DISTRIBUTION

2.2 KNOWN ISSUES AND RECENT UPGRADES

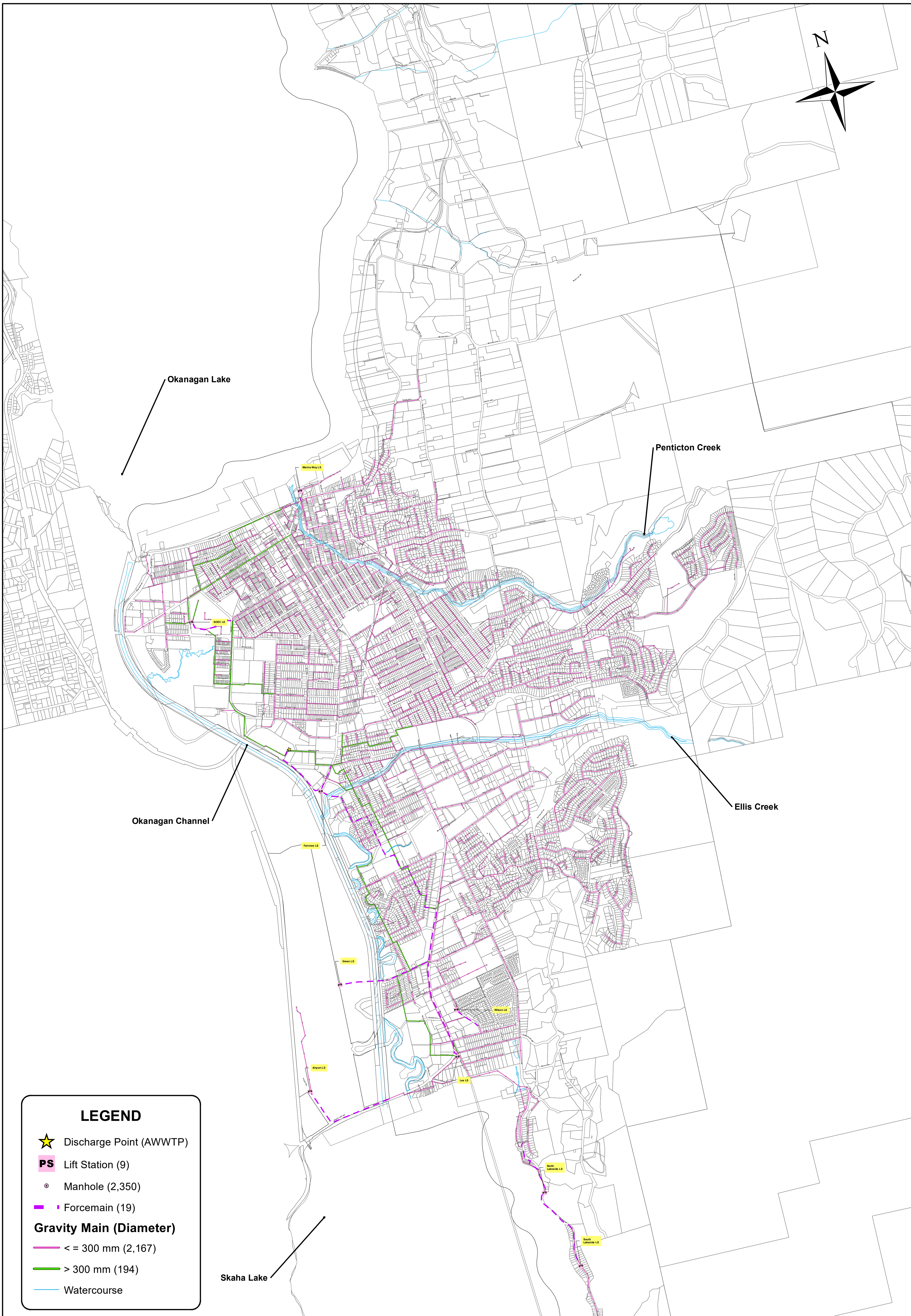
Known sanitary issues observed by the City and discussed at the knowledge transfer workshop on June 19, 2020 are as follows;

- **SOEC lift station** – The City replaced existing pumps in 2016 with three new pumps to address previous deficiencies. The wet well volume is undersized and has been identified as a potential issue when considering OCP 2045 flows.
- **North end interceptor from Duncan Ave. W. to the AWWTP -** The existing 600 mm diameter gravity mains have been identified for improvements to accommodate growth. The proposed upgrade to 750 mm diameter gravity mains are reassessed in this Master Plan.
- **North and South Lakeside lift stations** – The City replaced existing pumps in 2020 to address previous deficiencies. This upgrade is captured in the existing conditions of the hydraulic model according to the record drawings provided by the City.
- **Skaha Lake lift station** – A preliminary design for a new lift station at the southwest end of the City is currently under consideration. This is largely driven by future Penticton Indian Band (PIB) developments, which will discharge sewage east towards Lee Avenue lift station. The proposed new lift station is not included in the model as it is currently under design, pending City approval. Projected sewage flows from the PIB developments are captured in the future conditions of the hydraulic model and loaded onto an existing forcemain.

3 MODEL DEVELOPMENT

3.1 SOFTWARE SELECTION AND DATA SOURCES

The hydraulic model of the City's sanitary system was developed using the InfoSWMM software suite available from Innovyze Inc., as evaluated in **Technical Memorandum # 1** (Appendix A) and selected by the City because of GIS integration capabilities. The model includes manholes, gravity mains, forcemains, lift stations and outfalls that represent the AWWTP. Other sanitary features such as service connection laterals and private infrastructure are excluded from the model. Figure 3-1 illustrates the modeled sanitary system.



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Client: City of Penticton

1:32,000

NAD83 CSRS UTM zone 11N

Meters: 0, 205, 410, 820, 1,230

MODELED NETWORK

Sanitary Master Plan

PROJECT NO. 20M-00462-00

FIGURE NO: 3 -1

DATE: Apr 2021

Path: C:\Users\CAJP063517\Desktop\TMP\Penticton\2. Figures\san mxd\Figure 3-1.mxd

All model elements including dummy nodes and links created for connectivity follow the asset naming convention detailed in **Technical Memorandum # 2** (Appendix B).

The primary source of data used for model development consists of the City's GIS database. Some of the notable data gaps were resolved by the City's operations staff through field surveys in June and September 2020. All remaining data gaps were inferred from the previous sanitary model, record drawings requested by WSP, City's elevation contours and assumptions based on the Subdivision and Development Servicing Bylaw (City Bylaw). Appendix C provides a complete list of data gaps and connectivity assumptions required to complete the sanitary model.

3.2 HYDRAULICS

The hydraulic component of the model routes sewage flows from source (loading manhole) to the outfalls (AWWTP) and consists of the following assets:

- Gravity Mains and Forcemains;
- Manholes;
- Lift Stations and Pumps; and
- Outfalls.

3.2.1 Gravity Mains and Forcemains

Gravity mains and forcemains (pressurized) are conveyance features that are represented as circular conduits in the model. City's GIS database provided information containing size, material, length, and invert offsets. Several dummy mains were created in the model for logical connectivity and recorded in Appendix C for reference.

The Manning's "n" roughness coefficients were assigned to each conduit based City's Subdivision and Servicing Bylaw – Schedule G and *Open Channel Hydraulics* (Chow, 1959), as shown in Table 3-1

TABLE 3-1 ROUGHNESS COEFFICIENTS

MATERIAL	MANNING'S "N"	% OF GRAVITY MAIN
Concrete (1)	0.013	27
Polyvinyl Chloride (PVC) (2)	0.013	32
Asbestos Cement (2)	0.011	15
Vitrified Clay (2)	0.014	10
Unknown / Other (1)	0.013	15

(1) City Bylaw
(2) Open Channel Hydraulics (Chow, 1959)

An iterative approach was used to estimate the Hazen-Williams roughness factor for forcemains. A typical roughness coefficient of 130 was derived using observed data from the Lee and SOEC lift stations.

All recently constructed forcemains (2016 to present) were assigned a value of 145 based on engineering judgement.

3.2.2 Manholes

Sanitary manholes are represented as junctions in the model. Junctions receive sewage from tributary subcatchments, which were delineated on a lot-by-lot basis clipping City's GIS parcel dataset.

Junctions provide connectivity between gravity mains and forcemains. Several dummy junctions were created to connect isolated piped systems, where applicable.

The invert and rim elevations were obtained from the GIS database or assumed as outlined in Appendix C. All missing rim elevations were inferred City's elevation contours.

3.2.3 Lift Stations and Pumps

Lift stations are represented as storage units in the model with constructed wet well volumes and pump set points. All input parameters such as the invert elevations, rim elevations and wet well storage area were derived from record drawings or the previous model, as outlined in Appendix C. All lift stations included in the model are shown in Table 3-2.

TABLE 3-2 LIFT STATIONS

NAME	PUMP MAKE AND MODEL	NO. OF PUMPS
North Lakeside	Gorman-Rupp, Model No. T3A3S-B	2
South Lakeside	Gorman-Rupp, Model No. T3A3S-B	2
Lee	Myers Submersible Pump, Model No. 6VCX500 M4-53	3
Airport	Wemco Torque Flow, Model No. 3S2-QD	2
Wilson	Myers, Model No. 4V50M4-21	2
Fairview	Flygt, Model No. CP3085.182	2
Green	Myers, Model No. 6VCX	2
SOEC	Flygt, Model No. NP 3153.180	3
Marina Way	Myers, Model No. 3VX15M4-21-35	2

Refer to Appendix D for a detailed inventory of each lift station and corresponding pump curves.

3.2.4 Outfalls

Outfalls act as downstream boundary conditions that represent discharge into the AWWTP. One outfall is created in the model with a free-flowing condition to represent AWWTP inflows. The invert and rim elevations are obtained from the City's GIS database and the previous model, as applicable and tagged in the model.

3.3 NETWORK FLOW DEVELOPMENT

The sanitary flows conveyed in the sewer system are categorized into three components as illustrated in Figure 3-2:

1. Ground Water Infiltration (GWI) – Extraneous flow from the ambient long-term water table, not influenced by individual rainfall events and typically calculated as 85 % of the minimum nightly flows.
2. Base Sanitary Flow (BSF) – Average flow generated from domestic, commercial, institutional, industrial and agricultural sources.
3. Rainfall-Dependent Inflow and Infiltration (RDI&I) – rainfall that enters the sanitary system through subsurface soils, direct connections to runoff surface, or structural defects in the sewers.

Dry Weather Flow (DWF) is defined as the sum of BSF and GWI, while Wet Weather Flow (WWF) is defined as the sum of DWF + RDI&I.

– DWF = GWI + BSF
– WWF = DWF + RDI&I

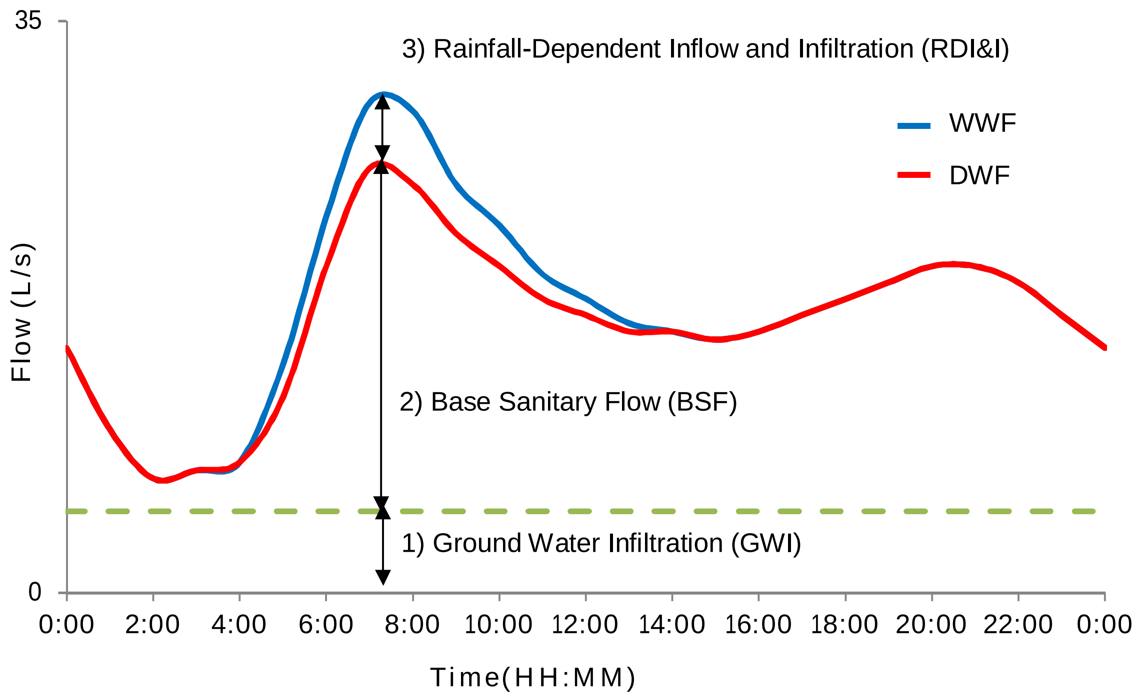


FIGURE 3-2 SANITARY FLOW HYDROGRAPH

The observed inflows from July to August 2019 (15 minutes intervals or less) at the AWWTP were used to derive BSFs, diurnal peaking patterns, and RDI&I. This methodology was used based on past modeling experience to help with the overall system flow confirmation.

Each modeled subcatchment (parcel) contained population as well as water consumption data confirmed with the City. The average DWFs were derived as a percentage of the water meter data. A return to sewer rate of 80% was considered acceptable based on the dry period inflows observed at the AWWTP.

Additionally, a 24-hour diurnal pattern with a peaking factor of 1.4 was also established based on the dry period observations at the AWWTP, as shown in Figure 3-3.

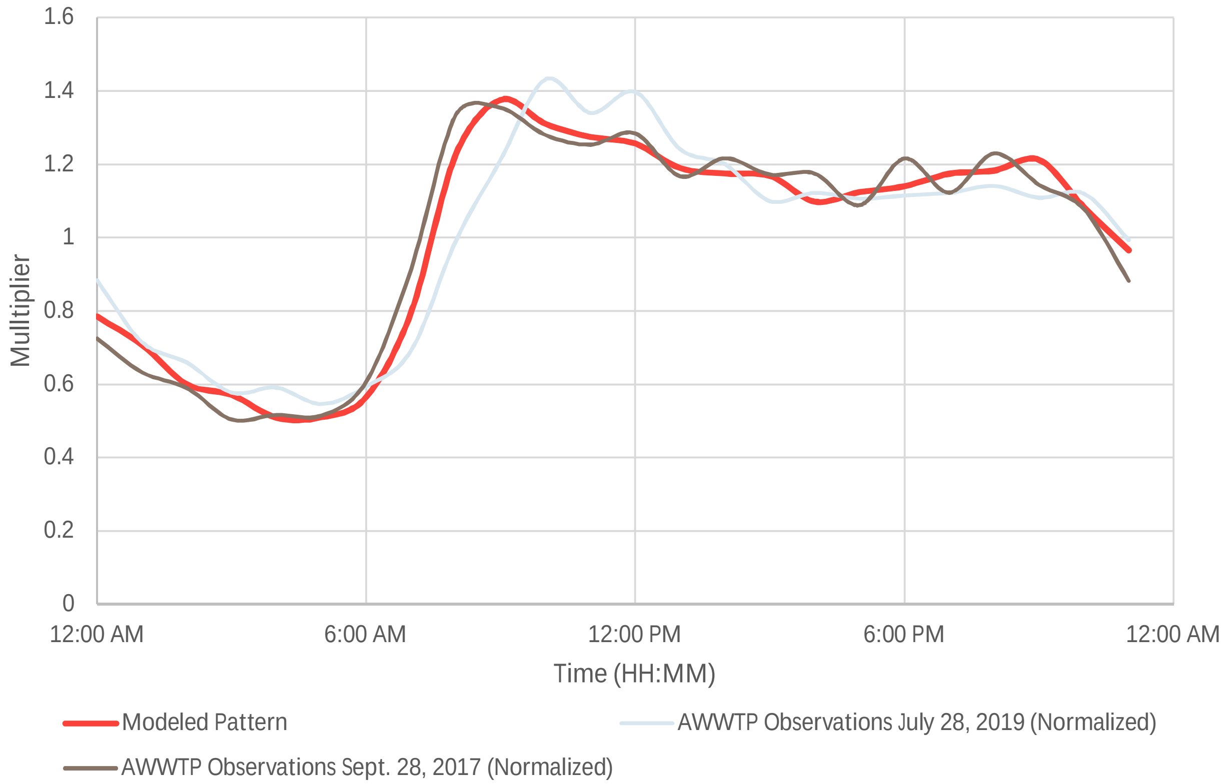


FIGURE 3-3 DIURNAL PATTERN - DRY PERIOD

A synthetic triangular pattern that peaks at the same time as the diurnal pattern was assumed for RDI&I, as illustrated in Figure 3-4. A unit rate of approximately 5000 L/ha/d was determined through iteration, to match the PWWFs observed at the AWWTP, as shown in Figure 3-5.

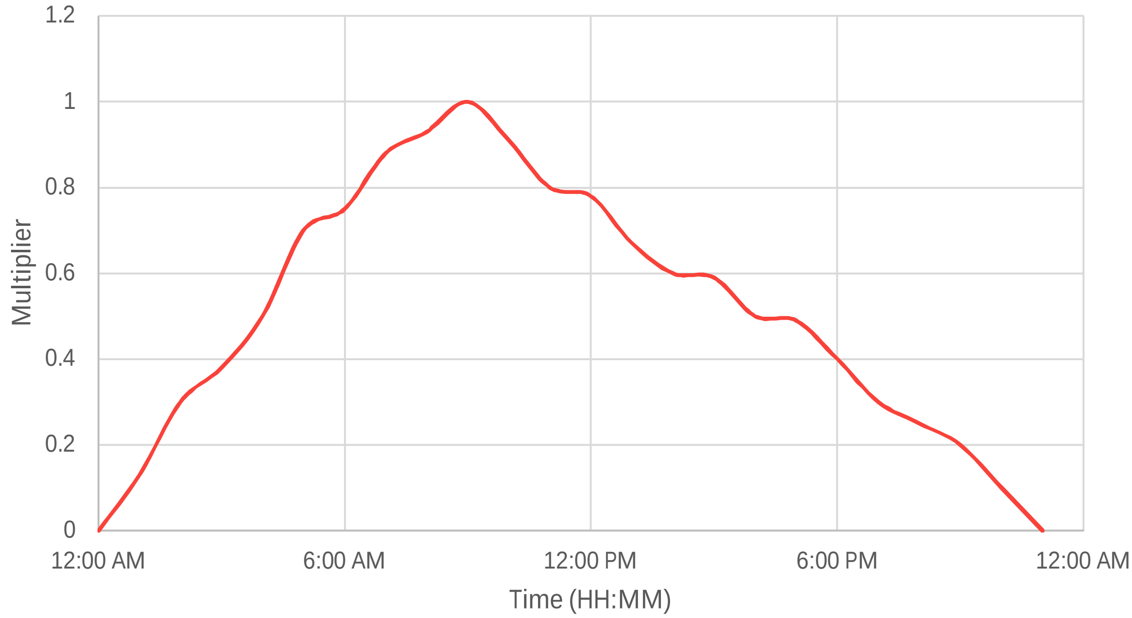


FIGURE 3-4 RDI&I PATTERN

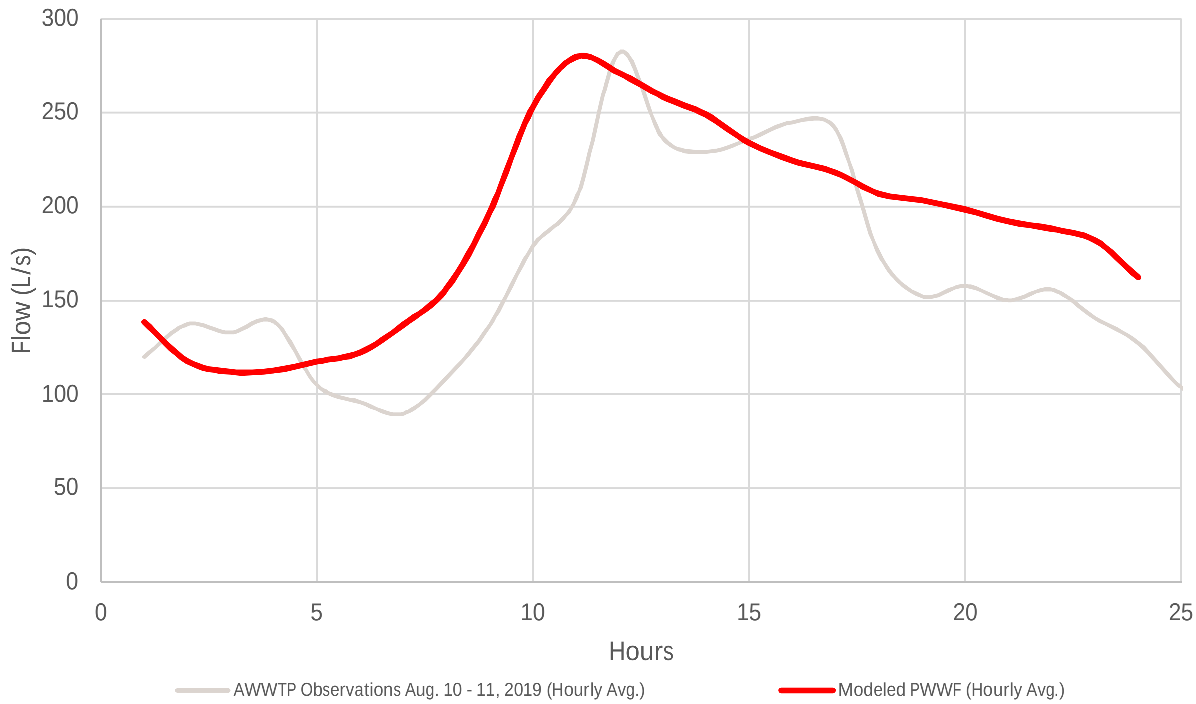


FIGURE 3-5 MODELED HYDROGRAPH

The rainfall intensity and duration from observations on Aug. 10 – 11, 2019 is unknown due to lack of corresponding rainfall data. As such, modeled PWWF cannot be correlated with a rainfall return period event. WSP recommends the City install a rain gauge at center of the City to record rainfall at 5-minute intervals, which coincides with recommendations from the Stormwater Master Plan.

All major components of the sanitary flow hydrograph are summarized in Table 3-3. The relative unit rates are calculated based on a service area of 1285 ha and current population equivalent of 46,326.

TABLE 3-3 HYDROGRAPH ASSUMPTIONS

COMPONENET	MODELED AWWTP INFLOW (L/S)	UNIT RATE
Min. DWF	66	123 L/capita/d
GWF (85 % of above)	56	3769 L/ha/d
ADWF	152	283 L/capita/d
BSF	96	178 L/capita/d
PDWF	210	391 L/capita/d
RDI&I	74	5000 L/ha/d
PWWF	282	525 L/capita/d

3.4 MODEL VALIDATION

Model calibration is an iterative process of comparing the model with observations and revising the input parameters until the predicted results are considered acceptable. In contrast, model validation is the process of testing the accuracy of an existing or previously calibrated model using observations.

In general, two data sources could be used for model calibration/validation:

- Short-term flow monitoring program, which involves running the model with observed rainfall data and calibrating the corresponding hydrographs with observations (calibration);
- Historical (anecdotal) data, which requires knowledge of known system issues and behavior (validation)

A flow monitoring program was considered outside the scope of this report and as such, calibration was not performed. For validation, anecdotal information collected at the knowledge transfer workshop and observed flows were used to validate modeled results. This limits the use of the model to planning level studies and conceptual recommendations only.

3.4.1 Results

In addition to the AWWTP observations used for network flow development, the following sources were also considered for model validation:

- Lee lift station flows from July – August 2019 (15 min. intervals) – large lift station with a tributary catchment area of 399 ha located at the south end of the City. The forcemain from this lift station pumps sewage directly into the AWWTP;
- SOEC lift station flows from July – August 2019 (15 min. intervals) – large lift station with a tributary catchment area of 205 ha located at the north end of the City. The forcemain from the lift station pumps sewage into the north end interceptor; and

- North End interceptor flows from summer months in 2017 to 2019 (5 min intervals) – existing 600 mm diameter gravity mains with a tributary catchment area of 428 ha. These sewers discharge directly into the AWWTP;

Based on a review of available data, the north end interceptor and AWWTP observations were not suitable for validation due to lack of rainfall data. However, the modeled PWWF results were noted to be within an order of magnitude for both sources. Further discussions with City Operations Staff were subsequently required to clarify the pumping on/off sequence and available capacity at the lift stations. Overall, Table 3-4 summarizes validation results which provide moderate level of confidence to the validity of the model.

TABLE 3-4 MODEL VALIDATION

DATA SOURCE	OBSERVED PWWF (1) (L/S)	MODELED PWWF (L/S)	CONFIRMED ASSUMPTION
SOEC (1)	85	88	- Flows with Pump 1 on and Pump 2 and 3 off - The observed flows with 2 pumps on is approximately 110 L/s
Lee (1)	130	133	- Flows with Pump 1 on and Pumps 2 and 3 off
North End Interceptor (2)	112	114	- Rainfall data and return period not available
AWWTP (1)	282	282	- Rainfall data and return period not available

(1) Observed flows from July to August 2019 at 15-min. intervals

(2) Observed flows from summer months in 2018 per the North End Sanitary Servicing Strategy Review (2020)

The previous flow monitoring survey was conducted in the early 2000s as part of the 2007 SMP, and does not accurately reflect current conditions due to significant changes in land use, sewer network and water demand rates throughout the last decade. WSP strongly recommends the City undertake flow monitoring surveys for the purposes of recalibration to increase model confidence.

4 LEVEL OF SERVICE CRITERIA

4.1 SOURCE

The following sources are used to establish the level of service criteria for the SMP:

- The City of Penticton Creek Subdivision and Development Servicing Bylaw – Schedule G; and,
- Master Municipal Construction Document (MMCD) Design Guideline Manual (2014).

4.2 CRITERIA

Table 4-1 provides list of assessment criteria used to assess the sanitary system.

TABLE 4-1 LEVEL OF SERVICE CRITERIA

COMPONENT	CRITERIA	HYDRAULIC INDICATOR
Gravity Mains (1)	- Designed to flow at 80% full to minimize risk of corrosion	Asset is considered deficient if peak depth to maximum depth (diameter) ratio is greater than or equal to 0.8 (d/D >= 0.8)
Forcemains (2)	- Minimum cleansing velocity of 0.6 m/s - Maximum velocity of 3.5 m/s	Asset is considered deficient if the velocities are not within 0.6 to 3.5 m/s (v < 0.6 m/s or v > 3.5 m/s)
Lift Stations (2)	- Able to meet maximum flow condition with one pump failure	Asset is considered deficient if the firm pumping capacity is less than influent PWWFs
Future Developments (2)	- Residential and commercial ADWFs calculated as 400 L/capita/d and 22,000 L/ha/d, respectively - RDI&I calculated as 5000 L/ha/d (not in the water table) or 8000 L/ha/d (in the water table) - Peaking factor calculated per the Harmon Equation (population varying between 1000 to 2000 people)	-

(1) MMCD Design Guidelines (2014)

(2) City Bylaw and USEPA Standards (Wastewater Technology Fact Sheet, Sewers, Force Main, 2000)

Although the gravity mains were previously assessed using a peak flow to maximum flow (q/Q) criterion in the 2007 SMP, the latest MMCD Guidelines from 2014 recommend a flow-depth (d/D) based criterion, which is calculated based on HGL in the connected manholes. This approach is consistent with other municipalities in Metro Vancouver and more commonly used outside of BC.

The hydraulic capacity of circular gravity pipes flowing full is readily calculated from the Manning Formula. However, most pipes are designed to operate under partial flow conditions, where flow is not constant. As such, T.R. Camp (Design of Sewers to Facilitate Flow, 1946) developed the graph shown in Figure 4-1 to illustrate depth of flow in a circular pipe as a fraction of the pipe diameter (y-axis). This relationship correlates flow with depth and is a good indicator of surcharged conditions.

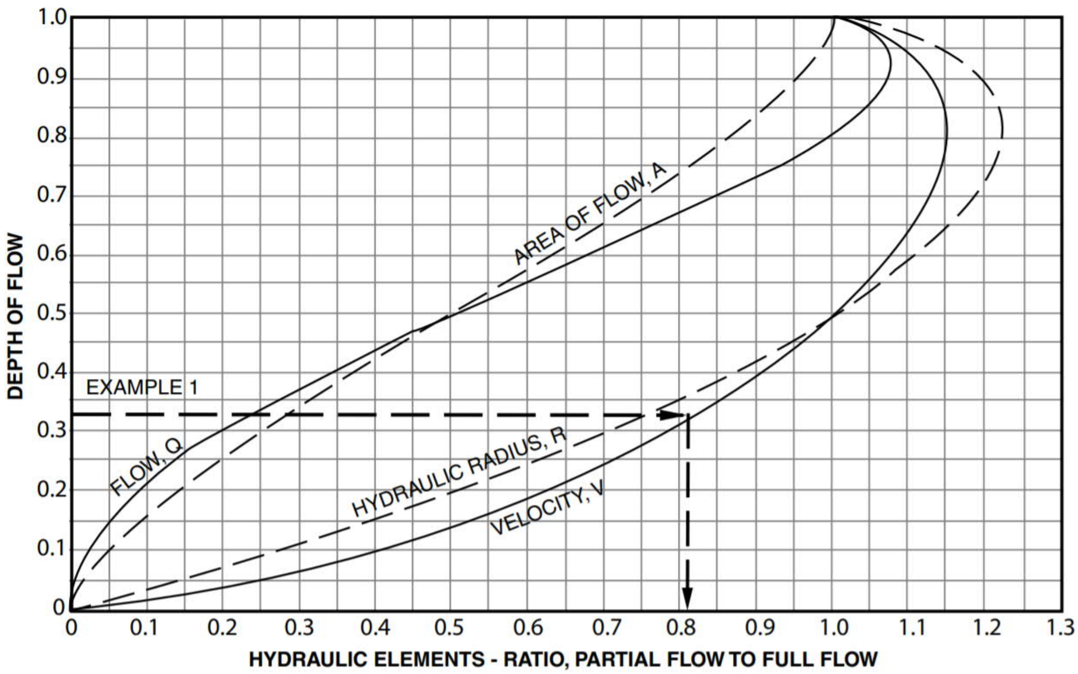


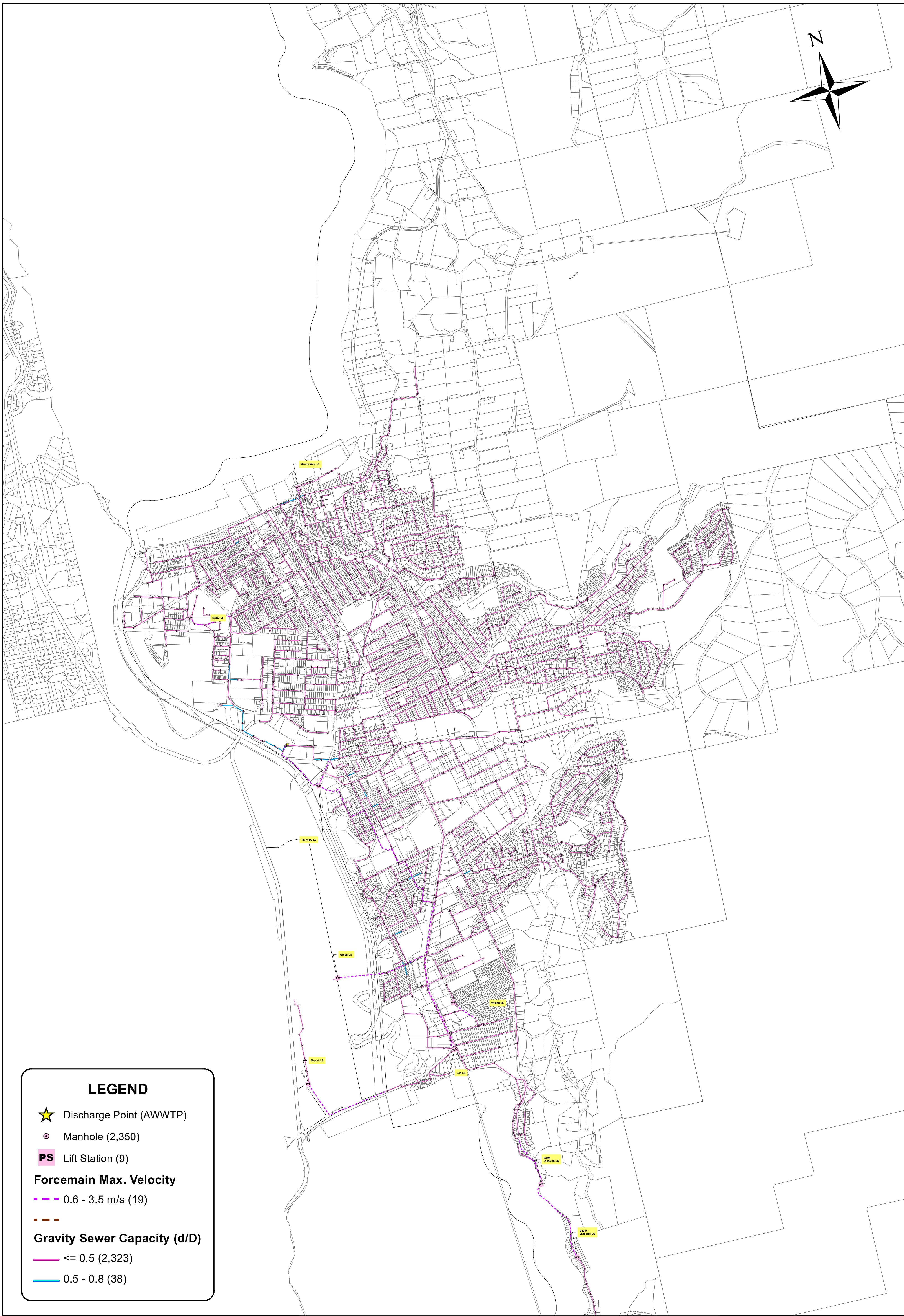
FIGURE 4-1 RELATIVE FLOW IN CIRCULAR PIPE

According to the graph, the peak flow q/Q ratio (x-axis) of 1.0 does not necessarily indicate whether the pipe is full or not because it could result in a flow-depth d/D ratio (y-axis) of 0.8 or 1.0. However, the d/D criterion of 1.0 corresponds to a q/Q value of 1.0 and therefore represents fully surcharged conditions.

5 SANITARY SYSTEM ASSESSMENT

5.1 EXISTING CONDITIONS

Figure 5-1 displays the performance of gravity mains and forcemains under existing PWWFs. The modeled results indicate the piped network is adequately sized to meet the level of service criteria.



WSP PENTICTON IIMP North Vancouver Office, #210 - 889 Harbourside Drive Tel (604) 990 4800 Fax (604) 990 4805 *This drawing and its contents are the property of WSP Canada Limited. Any unauthorised employment of reproduction, in full or in part, is forbidden.*	Client: City of Penticton CITY OF Penticton	1:32,000 NAD83 CSRS UTM zone 11N Meters 0 205 410 820 1,230	**EXISTING SYSTEM PWWF CAPACITY** Sanitary Master Plan PROJECT NO. 20M-00462-00	**FIGURE NO**: 5 -1 **DATE**: Apr 2021

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The existing PWWFs discharging to each lift station are shown in Table 5-1.

TABLE 5-1 EXISTING PUMPING CAPACITY

LIFT STATION	FIRM CAPACITY (L/S)	EXISTING PWWF (L/S)	EXCESS CAPACITY (L/S)
South Lakeside	15.0	1.7	+ 13.3
North Lakeside	11.0	2.1	+ 8.9
Airport	4.0	0.8	+ 3.2
Wilson	24.0	2.2	+ 21.8
Lee (1) (2)	130.0	73.2	+ 56.8
Green	50.0	0.1	+ 49.9
Fairview	28.0	0.4	+ 27.6
Marina Way	26.0	0.4	+ 25.6
SOEC (2)	110	53.7	+ 56.3

(1) Originally designed for 80 L/s with a 200-mm dia. forcemain, which was then replaced with a 450 mm dia. forcemain in 2009 (Table 3-4)

(2) Represents the combined pumping capacity with 2 duty pumps and 1 standby pump (Table 3-4)

Although the results indicate all lift stations meet the level of service criteria, following deficiencies have been noted at the SOEC lift station in the North End Sanitary Servicing Strategy Review (2020) and confirmed in the model:

- Pumps operate with more than 5 starts per hour during PWWF conditions, exceeding City Bylaw limit of 4;
- Low wet well volume that provides minimal retention time in case of failure; and
- No provision for grease removal.

Overall, the SOEC lift station is considered deficient for both existing and future conditions due wetwell limitations (high number of starts, grease removal). Failure of the SOEC lift station would have a significant impact on the level of service to the Downtown core and north end of the system.

5.2 FUTURE CONDITIONS

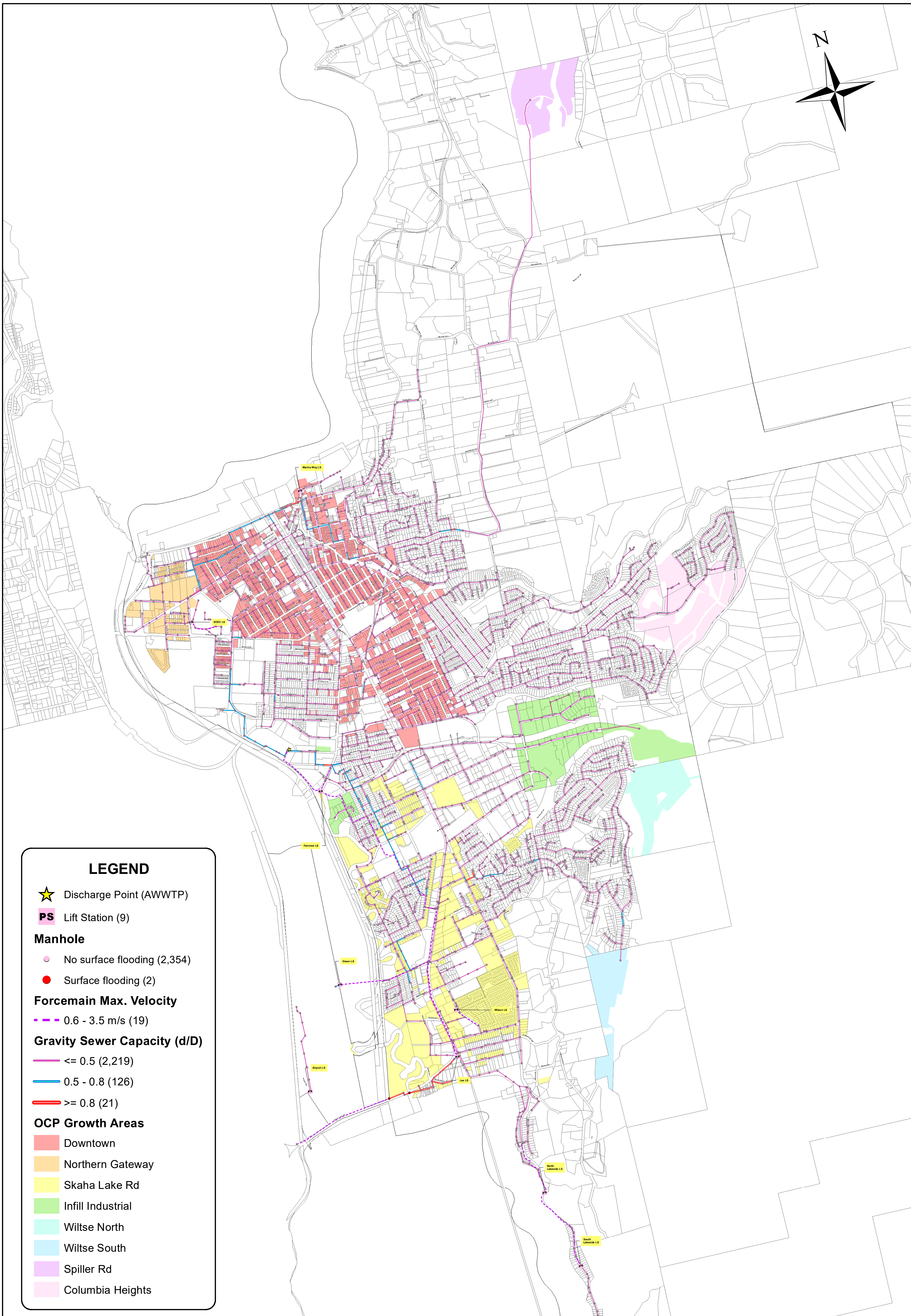
The OCP conditions for each subcatchment are simulated based on projected water demands (80% return to sewer rate), which are estimated from the 2045 population provided in **Technical Memorandum # 5** (Appendix E).

Key future developments identified in the OCP 2045 include Wiltse South, Wiltse North, Spiller Road and Columbia Heights. Dummy elements are created in the OCP model to represent potential service connection points. Projected design sewage flows are calculated from population estimates, approximate development area and servicing studies referenced in Table 1-1.

The OCP condition includes the following:

- **Wiltse North and South, Spiller Road, Columbia Heights and Industrial Infill Area** – proposed connection to the City's network through a dummy gravity main which results in downstream system deficiencies; and
- **Airport and Penticton Indian Band Developments (Arrowleaf, Channel Parkway, barefoot Beach and Wright Campground)** – proposed connection to the City's network via existing 200 mm diameter forcemain along Skaha Lake Road and a dummy gravity main along Green Ave., which also results in downstream system deficiencies.

Alternative service connection options should be investigated by the developer during subsequent design phases. Figure 5-2 displays the performance of gravity mains and forcemains under projected OCP PWWFs. Similar to existing conditions, majority of the piped network is adequately sized to meet the level of service criteria with few deficiencies driven by future developments.



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FUTURE SYSTEM PWWF CAPACITY

Sanitary Master Plan

PROJECT NO. 20M-00462-00

FIGURE NO: 5 -2

DATE: Apr 2021

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The projected OCP PWWFs discharging to each lift station are shown in Table 5-2.

TABLE 5-2 FUTURE PUMPING CAPACITY

LIFT STATION	FIRM CAPACITY (L/S)	FUTURE PWWF (L/S)	EXCESS CAPACITY (L/S)
South Lakeside	15.0	1.7	+ 13.3
North Lakeside	11.0	2.1	+ 8.9
Airport	4.0	0.9	+ 3.1
Wilson	24.0	2.4	+ 21.6
Lee	130.0	123.2	+ 6.8
Green	50.0	49.3	+ 0.7
Fairview	28.0	0.4	+ 27.6
Marina Way	26.0	0.4	+ 25.6
SOEC	110	90.4	+ 19.6
Skaha Lake (PIB)	TBD	50.0	TBD

The results indicate Lee lift station pumping capacity is slightly more than the influent PWWFs. This is largely due to the 55 L/s from future PIB and Airport development areas, which will be controlled through the new Skaha Lake lift station currently at the preliminary design phase. Since the Lee lift station is equipped with a large wet well and 4 m deep manholes upstream, a pump replacement project is not required. In contrast, SOEC lift station is considered deficient as noted in Section 5.1. All other lift stations are adequate to meet the OCP conditions. All forcemains meet the velocity criteria and do not require improvements.

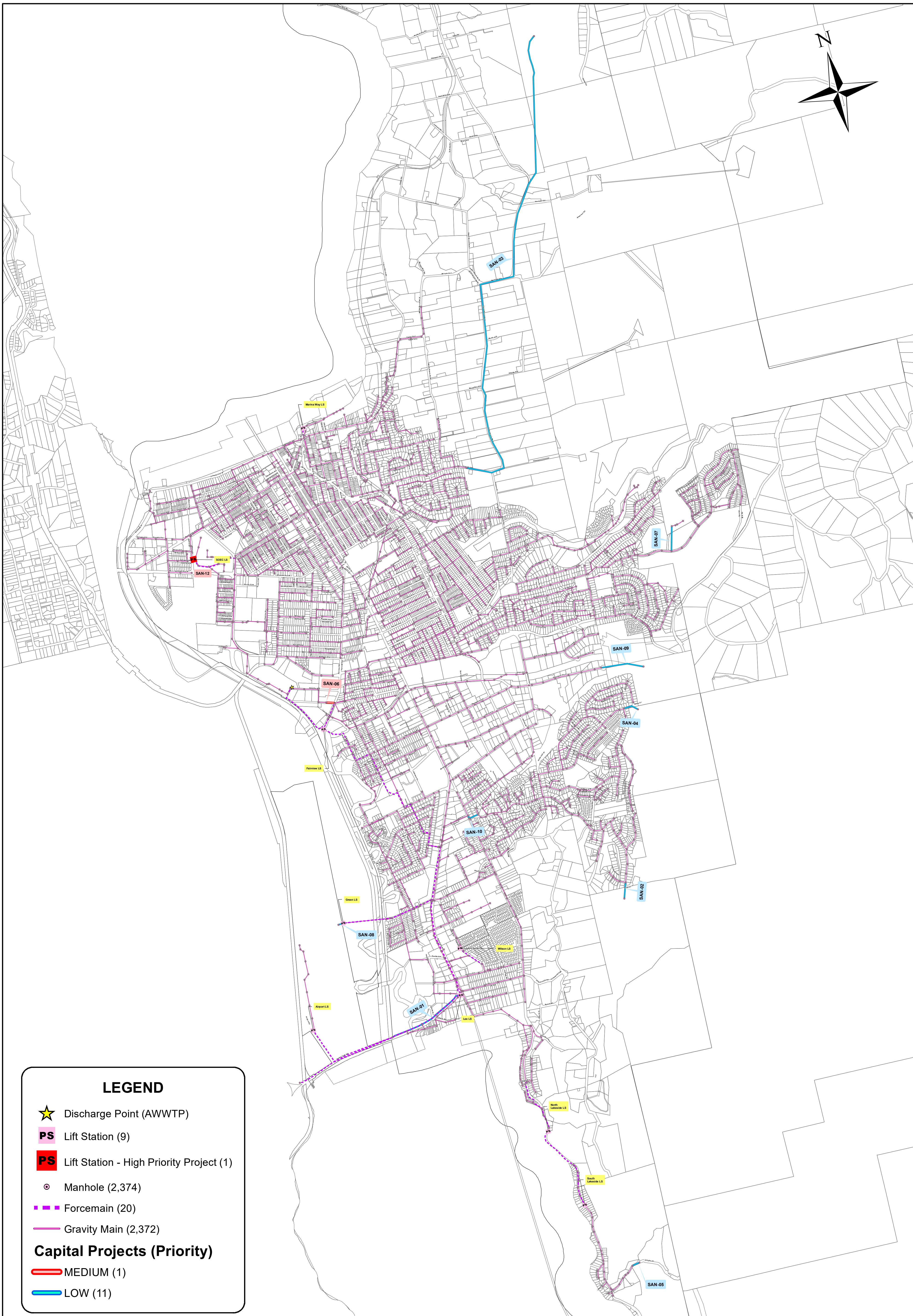
6 CAPITAL IMPROVEMENT PROJECTS

6.1 OVERVIEW

Capital improvement projects are developed using the OCP conditions and shown in Appendix F. All proposed improvements include but are not limited to the following design considerations:

- Upsizing of existing gravity mains;
- Construction of new gravity mains;
- Slope and invert adjustments to create additional capacity;
- Opportunities for flow diversion; and
- Twinning;

Figure 6-1 displays the proposed capital works for the next 25-years.



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CAPITAL PROJECTS

Sanitary Master Plan

PROJECT NO. 20M-00462-00

FIGURE NO: 6 -1

DATE: Apr 2021

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6.2 PROJECTS PRIORITIZATION APPROACH

Table 6-1 provides the framework used to assign project priority and an implementation schedule. Refer to Appendix F for the individual project sheets.

TABLE 6-1 PROJECT PRIORITY

IMPLEMENTATION SCHEDULE	PRIORITY	INDICATOR
1 to 5 Year	High	- Deficient in the model due to existing issues (designed with future capacity included)
5 to 10 Year (1)	Medium	- Assets slightly below deficiency threshold (d/D ~ 0.7) in the existing and model and upgrade required to accommodate future growth - Projects can be implemented in conjunction with proposed AWWTP improvements
10 to 25 Year (1)	Low	- Assets required to service future development areas, where costs fall entirely on the developer

(1) Flow monitoring and model calibration are required to validate proposed projects

WSP strongly recommends the City undertake flow monitoring surveys and model calibration to increase model confidence prior to the implementation of medium and low priority projects.

6.3 COST ESTIMATE BASIS

All cost estimates ("Class D") associated with high and medium priority projects were determined on a unit-cost basis with consideration for mobilization, earthworks, restoration and land acquisition, as shown in the project sheets in Appendix F. An engineering and contingency of 40 % is also applied globally to all projects.

Table 6-2 lists the unit cost rates used to estimate total project cost in Appendix F. These unit cost rates are developed from relevant past projects within BC and WSP's cost database, adjusted to 2021 dollars.

TABLE 6-2 UNIT COST SUMMARY

PIPE DIAMETER (MM)	UNIT COST (2021 $ / M)
200	$760
250	$855
300	$970
375	$1,045

450	$1,175
525	$1,260
600	$1,500
675	$1,600
750	$1,800

6.4 PROJECT LIST

The methodology for implementation is as follows:

- High priority (5-year horizon) projects are identified as deficient in the existing model and designed for the OCP condition. Project SAN-11 (SOEC) was previously under consideration by the City and has been confirmed deficient in the existing model. Project SAN-12 does not involve construction or upsizing of linear assets and can potentially fall under the City's Operation and Maintenance (O&M) budget. A flow monitoring program and model calibration are strongly recommended as part of project SAN-12 to confirm design flows and increase model confidence, prior to the implementation of medium priority projects. The cost estimates provided for flow monitoring assume data collection at 5 sites for a period of 2 months and include model calibration. A flow monitoring program also presents opportunity to characterize spatially varying RDI&I rates observed across the City.
- Medium priority (10-year horizon) project SAN-06 involves upsizing a small portion of the south interceptor, which collects and discharges significant flow into the AWWTP. This upgrade is triggered due to OCP growth areas and can be completed in conjunction with AWWTP upgrades. A field survey is recommended to confirm pipe slopes are accurately represented in the model.
- Low priority (10 to 25-year horizon) projects represent service connections to tie-in future developments envisioned in OCP 2045. These service connections can vary depending on developer grading plans and should be further investigated during subsequent design phases. Projects SAN-01 and SAN-10 represent sewer deficiencies triggered solely due to OCP growth areas. These projects should be completed prior to servicing OCP developments.

Table 6-3 lists the improvement projects for each horizon.

TABLE 6-3 IMPROVEMENT PROJECTS

PROJECT TYPE	PROJECT ID	FIGURE NO.	PROJECT NAME	TOTAL COST (2021 $)	DEVELOPER FUNDED	PRIORITY	HORIZON
Capital	SAN-11	F-11	SOEC Lift Station Wet Well Retrofit	$ 647,300		High	5-Year
Operational	SAN-12	F-12	Flow Monitoring Program & Model Calibration	$ 145,000		High	5-Year
Capital	SAN-06	F-6	South Interceptor	$ 131,400	Yes	Medium	10-Year
Capital	SAN-01	F-1	Skaha Lake Road Upgrades	$ 689,900	Yes	Low	25-Year
Capital	SAN-02	F-2	Wiltse South	TBD	Yes	Low	25-Year
Capital	SAN-03	F-3	Spiller Road Development	TBD	Yes	Low	25-Year
Capital	SAN-04	F-4	Wiltse North	TBD	Yes	Low	25-Year
Capital	SAN-05	F-5	Smythe Road Development	TBD	Yes	Low	25-Year
Capital	SAN-07	F-7	Columbia Heights Development	TBD	Yes	Low	25-Year
Capital	SAN-08	F-8	Channel Parkway Development	TBD	Yes	Low	25-Year
Capital	SAN-09	F-9	Industrial Infill Area	TBD	Yes	Low	25-Year
Capital	SAN-10	F-10	Pineview Road Upgrades	$ 117,300	Yes	Low	25-Year
Total				**$ 1,730,900**			**25-Year**

6.5 SUMMARY

Table 6-4 provides anticipated Capital budget for the design horizons.

TABLE 6-4 TOTAL CAPITAL COSTS

IMPLEMENTATION SCHEDULE	NO. OF PROJECTS	TOTAL COST (2021 $)
1 – 5 Year (High Priority)	2	$ 792,300
5 – 10 Year (Medium Priority) (1)	1	$ 131,400
10-25 Year (Low Priority) (1)	9	$ 807,200
Total	**14**	**$ 1,730,900**

(1) Flow monitoring and model calibration are required to validate proposed projects

6.6 RECOMMENDATIONS

The following recommendations can be drawn from the completion of the SMP:

- Upgrade SOEC lift station per project SAN-11 (Sheet F-1) to increase system reliability and improve grease management
- Infill growth or future developments within the north end of the City (Spiller Road) should consider the potential impact of discharging additional flows to the SOEC lift station or diversion routes
- Infill growth or future developments within the southwest corridor of the City (PIB and Airport) should consider the potential impact of discharging additional flows to the Lee lift station and implement control/diversion where applicable; and
- Flow monitoring and model calibration are recommended to increase model confidence prior to the implementation of medium and low priority projects as well as quantify actual RDI&I.

APPENDIX

A

TECH. MEMO #1: WATER AND SANITARY SEWER MODELLING SOFTWARE

PENTICTON IIMP

MEMO

TO: Tobi Pettet, P. Eng., Project Manager, City of Penticton

FROM: Stephen Horsman, P. Eng., P.E., Clive Leung, P.Eng.

SUBJECT: **Technical Memo #1: Water and Sanitary Sewer Modelling Software Review**

DATE: **June 4, 2020**

WSP Canada Group Limited (WSP) is pleased to provide the following technical memorandum (Memo) detailing a review of hydraulic water and sanitary modeling software alternatives for the City of Penticton (City).

INTRODUCTION

The City has retained WSP to complete the Integrated Infrastructure Master Plan (IIMP), which includes developing city-wide transportation, water, sanitary and stormwater infrastructure master plans. The purpose of the IIMP is to inform infrastructure capital planning to accommodate the growth and development plans set out in the latest Official Community Plan (OCP) 2045, adopted on August 6, 2019.The OCP 2045 estimates the population to increase from approximately 34,000 in 2016 to 42,000 by 2046, which equates to approximately 0.65% annual growth. The City wishes to determine the required capacity of both existing and proposed infrastructure, to support the population growth envisioned in the OCP.

The City currently uses an EPANET water model (current to 2016), and XPSWMM sanitary and stormwater models (current to 2010) as planning tools to support infrastructure planning and prioritize infrastructure upgrades.

This memo provides an evaluation of potential software alternatives and recommendations to meet the hydraulic modelling needs of the City.

BACKGROUND

A hydraulic model is an analytical tool generally used by engineers to assist in the planning, design, analysis and operation of municipal distribution and collection systems. A typical model consists of a network of nodes and links, where nodes represent hydrants, manholes or service connection points, and links represent pipes, siphons, pumps and other conveyance structures. Models also include hydrologic parameters that can be used to characterize subsurface conditions within the study area.

Most industry standard software suites can solve complex mathematical equations through various approximation methods (dynamic and static) which simulate gravity and pressure hydraulics under various conditions (e.g. winter and summer peak flows for water utilities, dry and wet weather conditions for sanitary sewer systems). Model output generally consists of flows (rates and volumes), pressure, water levels, and pipe capacity ratios.

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EVALUATION CRITERIA

The selection of an appropriate hydraulic modeling software varies based on many factors including but not limited to the intended purpose, functionality and end-user requirements. Based on discussions with the City, the preferred software suites will be used for three main applications:

1. Master Utility Plans
2. Development reviews and servicing studies (level of service assessments)
3. Concept and detail design projects (pipe/storage sizing, pump station retrofit etc.)

Additionally, key considerations noted by the City for evaluation include GIS integration, and ease of use. Overall, six categories of criteria summarized in **Table 1** are established to define the hydraulic modelling needs of the City.

TABLE 1 EVALUATION CRITERIA

CATEGORY	DESCRIPTION
GIS and Data Integration	• Direct link with ArcGIS (if available) • GIS compatibility including the ability to import and export shapefiles with associated attributes such as asset IDs and pipe sizes • AutoCAD and MicroStation compatibility • Standalone (Desktop and Cloud) or integrated platform and limitations of each
Ease of Use	• Easy-to-use graphic user interface • Intuitive interface which allows users unfamiliar with the software to pick it up new, or when away from it for a long time • Ability to manipulate large sets of data and layers simply, clearly and accurately • Ability to create quality figures for reports • Adequacy of vendor support and training programs
Functionality and Capability	• Useful and reliable decision-making tool for developing Master Utility Plans, conducting servicing reviews and designing infrastructure • Capable of modelling all City pipes with a high level of detail, including street-by-street representation of all links within the network (a minimum of 2000 links required for water and 3000 links for sanitary/stormwater) • Compatibility with existing models (EPANET or SWMM calculation engine) • Ability to conduct a full dynamic wave analysis as per City's Subdivision and Development Bylaw 2004-81 (applicable for sewer model only)
Model Simulation Time and Stability	• Ability to complete simulations efficiently within a practical run time and without continuity errors

CATEGORY	DESCRIPTION
Features and Tools	• Data validation tools to review input data and identify potential data gaps or connectivity issues such as missing invert elevations or missing links • Ability to create and manage multiple modeling scenarios and track modifications or links between scenarios • Methodology and tools to calibrate model in accordance with City requirements • Asset management capabilities such as ability to track asset life, condition reports, SCADA records etc. • Methodology and flexibility for water quality modeling (applicable for sewer model only) • Ability to simulate Low Impact Development (LID) treatment systems (applicable for sewer model only) • Infiltration inputs such as Green-Ampt, Horton's Infiltration etc. (applicable for sewer model only)
Financial	• Software license costs including annual renewal fees

The City has also expressed the preference for the models to be maintained and updated in-house by trained staff members. It is assumed that the end-user will be a City engineer with proficiency in GIS applications and a strong understanding of hydraulic principles. Ultimately, the City's intended use and specific requirements will dictate the software selection process.

SOFTWARE ALTERNATIVES

A short-list of industry standard software suites that meet the primary objectives of the City are provided in **Table 2**.

TABLE 2 SOFTWARE ALTERNATIVES

MODEL	SOFTWARE	VENDOR
Water	WaterCAD	Bentley Systems
	WaterGEMS	Bentley Systems
	InfoWater	Innovyze
	InfoWater Pro	Innovyze
Sanitary / Stormwater	SewerCAD	Bentley Systems
	SewerGEMS	Bentley Systems
	InfoSWMM	Innovyze

MODEL	SOFTWARE	VENDOR
	XPSWMM	Innovyze
	PCSWMM	CHI

The short-listed alternatives are commonly utilized by local municipalities throughout British Columbia. Brief descriptions of the alternatives are as follows:

- **WaterCAD**: a stand-alone desktop-based platform capable of modeling water distrubtion systems using an EPANET-based calculation engine. This software offers an easy-to-use interface with a high-level of integration with Microstation, CAD and GIS databases.
- **WaterGEMS**: has options for a stand-alone desktop-based or integrated with ArcGIS platform with similar functionality as WaterCAD. In addition to all the features from WaterCAD, model files use the same file format as WaterCAD and therefore can be easily accessed by WaterCAD users.
- **InfoWater**: a desktop-based water distribution software that runs on the ArcGIS platform. This software offers ArcGIS integration through having been set up to operate from within the ArcGIS platform, and uses an an enhanced version of the EPANET calculation engine for hydraulic and water quality analyses.
- **InfoWater Pro**: a cloud-based platform that runs on ArcGIS Pro with similar functionality as InfoWater. This software offers direct ArcGIS Pro integration with ability to create 3D maps. A file conversion is required to share models with InfoWater users.
- **SewerCAD**: a stand-alone desktop-based platform capable of modeling sanitary and stormwater collection systems. A key limitation of SewerCAD is that it is a static model and therefore has limited applications. This software is similar to WaterCAD in terms of user interface and data integration with Microstation, CAD and GIS databases.
- **SewerGEMS**: has options for a stand-alone desktop-based or integrated with ArcGIS platform with similar interface as SewerCAD. In addition to all the features from SewerCAD, SewerGEMs is a fully dynamic model (capable solving full St. Venant equations) with a SWMM-based calculation engine.
- **InfoSWMM**: a desktop-based sanitary and stormwater modelling software that runs on the ArcGIS platform. This software offers ArcGIS integration through having been set up to operate from within the ArcGIS platform, and uses a SWMM-based calculation engine for variety of applications.

- **XPSWMM**: a stand-alone desktop-based platform currently utilized by the City to assess sanitary and stormwater infrastructure. This software allows users to easily import/export GIS data and conduct hydrologic, hydraulic, water quality and 2D flooding analyses using the SWMM-based calculation engine.

- **PCSWMM**: a stand-alone desktop-based platform commonly used to model sanitary and stormwater collection systems. This software is well known for its GIS integration, SWMM5 engine capabilities, practical model run times and affordable licensing costs.

Refer to **Appendix A** for detailed product information obtained from vendors.

EVALUATION

In accordance with the RFP (2.1.2), each short-listed alternative is comparatively and qualitatively evaluated with respect to criteria developed in **Table 1**.

1 The results for water and sanitary alternatives are displayed in **Table 3** and

Table 4, respectively with cost estimates detailed in **Appendix B**. Each alternative is assigned an overall relative ranking, where 1 represents the preferred alternative.

Table 3 Water Modeling Software Evaluation

CATEGORY	WATERCAD	WATERGEMS	INFOWATER	INFOWATER PRO
GIS and Data Integration	• User can import and export GIS data in shapefile format with attributes • Users can open models directly from MicroStation or AutoCAD environments • Desktop-based platform requires users to access models from a designated computer or laptop	• Users can open models directly from ArcGIS, MicroStation or AutoCAD environments, allowing for an easier import and export of data with all associated attributes • Desktop-based platform requires users to access models from a designated computer or laptop	• Users can open models directly from the ArcGIS environment, allowing for easier import and export of GIS data with all associated attributes • There is a big concern regarding the smoothness of GIS data compatibility and transfers between the model and ArcGIS database, often requiring the modeller to press buttons in the software to save every attribute entered. It has been observed that database convergence has been an issue currently and extensively in the past. • Not compatible with AutoCAD or MicroStation (additional effort required to convert data) • Desktop-based platform requires users to access models from a designated computer or laptop	• Users can open models directly from the ArcGIS Pro environment, allowing for easier import and export of GIS data with all associated attributes • Not compatible with AutoCAD, MicroStation or any desktop-based platform • Cloud-based platform allows user to access the model online on any computer or laptop
Ease of Use	• Simple, intuitive, and user-friendly interface • Users can easily edit large sets of data through customizable tables (which can also be copied to external programs such as Excel) and undo changes with keyboard shortcuts • Adequate for generating quality figures • Adequate technical support, training videos and articles readily available through the Vendor website, strong online community for troubleshooting issues,	• Similar to WaterCAD	• ArcGIS interface with additional toolbars, less user friendly and intuitive compared to WaterCAD/GEMS.. • Users can edit large sets of data through database tables (which can also be copied to external programs such as Excel) or ArcGIS tools • Excellent for generating high quality figures • Adequate technical support and training programs provided by the Vendor through paid subscriptions and courses.	• ArcGIS Pro interface with additional tools and controls • Similar to InfoWater in terms of data manipulation, figure production and vendor support
Functionality and Capability	• Adequate for developing Water Master Plans, conducting development reviews and designing infrastructure • Adequate for modelling a network comprised of 4000 links • Compatible with EPANET calculation engine • Adequate for steady-state and transient analysis	• Similar to WaterCAD	• Adequate for developing Water Master Plans, conducting development reviews and designing infrastructure • Adequate for modelling a network comprised of 4000 links • Uses an enhanced version of the EPANET calculation engine • Adequate for steady-state and transient analysis	• Similar to InfoWater
Model Simulation Time and Stability	• Fast and stable results	• Similar to WaterCAD	• Adequate simulation time and stability for static runs, fire flow runs for large domains can take a long time to process. • Past experience from professional users indicates instabilities and performance issues with large networks	• Adequate simulation time and stability
Features and Tools	• Includes data validation tools • Excellent tree-based scenario manager that supports inheritance and allows users to assess and compare an unlimited number of scenarios • Includes calibration tools • Includes asset management tools	• Similar to WaterCAD with 6 additional modules that provide advanced asset management and design tools	• Similar to WaterCAD, • Scenario manager is more rigid and less easy to change/modify after the fact.	• Similar to InfoWater

CATEGORY	WATERCAD	WATERGEMS	INFOWATER	INFOWATER PRO
Financial	Fixed License not available Concurrent License (2,000 Links) ○ Initial purchase cost - $ 13,979 ○ Annual maintenance cost - $ 3,354	Fixed License not available Concurrent License (2,000 Links) ○ Initial purchase cost - $ 22,719 ○ Annual maintenance cost - $ 5,454	Fixed Licence (2,000 Links) ○ Initial purchase cost - $ 9,100 ○ Annual maintenance cost - $ 1,820 Floating Licence (2,000 Links) ○ Initial purchase cost - $ 13,650 ○ Annual maintenance cost - $ 2,730	Fixed Licence (3,000 Links) ○ Initial purchase cost - $ 12,495 ○ Annual maintenance cost - $ 2,499 Floating Licence (3,000 Links) ○ Initial purchase cost - $ 18,743 ○ Annual maintenance cost - $ 3,749
Ranking	**2**	**3**	**1**	**4**

TABLE 4 SANITARY MODELING SOFTWARE EVALUATION

CATEGORY	SEWERCAD	SEWERGEMS	INFOSWMM	XPSWMM	PCSWMM
Functionality and Capability	• Adequate for developing Sanitary and Stormwater Master Plans, conducting development reviews and designing infrastructure • Adequate for modelling a network comprised of 3000 links • Compatible with SWMM calculation engine • Inadequate for full dynamic wave analysis (can only conduct static / steady-state modeling)	• Similar to SewerCAD, however, SewerGEMS can perform full dynamic analysis per City needs	• Adequate for developing Sanitary and Stormwater Master Plans, conducting development reviews and designing infrastructure • Adequate for modelling a network comprised of 3000 links • Compatible with SWMM calculation engine • Can perform full dynamic analysis per City needs	• Similar to InfoSWMM	• Similar to InfoSWMM
Data Integration	• User can import and export GIS data in shapefile format with attributes • Users can open models directly from MicroStation or AutoCAD environments • Desktop-based platform requires users to access models from a designated computer or laptop	• Users can open models directly from ArcGIS, MicroStation or AutoCAD environments, allowing for an easier import and export of data • Desktop-based platform requires users to access models from a designated computer or laptop	• Users can open models directly from the ArcGIS environment, allowing for easier import and export of GIS data with all associated attributes • Not compatible with AutoCAD or MicroStation (additional effort required to convert data) • Desktop-based platform requires users to access models from a designated computer or laptop	• User can import and export GIS data in shapefile format with attributes • Not compatible with AutoCAD or MicroStation (additional effort required to convert data) • Desktop-based platform requires users to access models from a designated computer or laptop	• Similar to XPSWMM
Ease of Use	• Simple and user-friendly interface • Users can easily edit large sets of data through customizable tables (which can also be copied to external programs such as Excel) and undo changes with keyboard shortcuts • Adequate for generating quality figures • Adequate technical support and little to no training programs provided by the Vendor	• Similar to SewerCAD	• ArcGIS interface with additional toolbars • Users can edit large sets of data through database tables (which can also be copied to external programs such as Excel) or ArcGIS tools • Excellent for generating high quality figures • Adequate technical support and training programs provided by the Vendor	• Similar to SewerCAD	• Similar to SewerCAD, however, PCSWMM vendor provides excellent technical support and annual training courses, with step-by-step online instructions for a variety of tasks and analyses available through the support website.
Model Simulation Time and Stability	• Fast and stable results	• Similar to SewerCAD	• Adequate simulation time and stability, however past experience from professional users indicates instabilities and performance issues with large networks	• Adequate simulation time and stability	• Fast and stable results

CATEGORY	SEWERCAD	SEWERGEMS	INFOSWMM	XPSWMM	PCSWMM
Features and Tools	• Includes data validation tools • Excellent tree-based scenario manager that supports inheritance and allows users to assess and compare an unlimited number of scenarios • Includes calibration tools • Includes asset management tools • Not capable of water quality modeling • Not capable of simulating LID controls • No infiltration inputs	• Similar to SewerCAD with 6 additional modules that provide tools for water quality modeling, creating design storms, defining infiltration parameters as well as modeling LID controls	• Includes data validation tools • Excellent tree-based scenario manager that supports inheritance and allows users to assess and compare an unlimited number of scenarios • Includes calibration tools • Includes asset management tools • Capable of water quality modeling • Capable of simulating LID controls • Includes infiltration inputs	• Includes data validation tools • A specialized scenario management tool which can simulate multiple storms in a single run • Includes calibration tools • Limited asset management capability • Capable of water quality modeling • Capable of simulating LID controls • Includes infiltration inputs	• Includes data validation tools • A dedicated scenario management function where combinations of various input data sets and simulation options can be easily selected, and results compared • Includes calibration tools • Limited asset management capability • Capable of water quality modeling • Capable of simulating LID controls • Includes infiltration inputs
Financial	Fixed License not available Concurrent License (2,000 Links) ○ Initial purchase cost - $ 13,979 ○ Annual maintenance cost - $ 3,354	Fixed License not available Concurrent License (2,000 Links) ○ Initial purchase cost - $ 22,719 ○ Annual maintenance cost - $ 5,454	Fixed Licence (3,000 Links) ○ Initial purchase cost - $ 12,250 ○ Annual maintenance cost - $ 2,450 Floating Licence (3,000 Links) ○ Initial purchase cost - $ 18,375 ○ Annual maintenance cost - $ 3,675	Unavailable as software is no longer supported	Fixed Licence (Unlimited Links) • Initial purchase cost - $ 0 • Annual maintenance cost - $ 1,440/user
Ranking	**4**	**3**	**2**	**5**	**1**

SUMMARY & RECOMMENDATIONS

WSP reviewed nine alternative software suites capable of modelling water and sanitary sewer networks. Each alternative was evaluated with respect to user-specific requirements that best meet City objectives. All of the softwares evaluated herein will meet the City's needs, however the following recommendations are provided for consideration by the City.

For water modelling, WaterCAD and InfoWater are the most common water modelling softwares used by municipalities throughout BC, speaking to their relative benefits. InfoWater is the slightly more cost effective and operates on the City's ArcGIS platform. It is noted that WaterCAD offers superior ease of use and model simulation speed, stability, and reliability, however, the has noted that they place a high priority on the GIS compatibility. Based on this, WSP recommends that the City proceed with the procurement of an InfoWater license to develop, update and maintain city-wide water utility data.

For sewer modelling, PCSWMM is the most cost-effective option while meeting the City's needs, however offers slightly less functionality and lower compatibility with ArcGIS. WSP recommends the City proceed with the use of either PCSWMM, or procurement of a InfoSWMM licenses to develop, update and maintain city-wide stormwater and sanitary utilities.

CLOSURE

We trust you will find the foregoing letter report suitable. Please do not hesitate to contact the undersigned should you have any questions.

Stephen Horsman, P.Eng., P.E.
Manager, Water

APPENDIX A - PRODUCT INFORMATION

APPENDIX B – COST ESTIMATES

Table B1 – Water Software Costs

CATEGORY	WATERCAD	WATERGEMS	INFOWATER	INFOWATER PRO
Purchase Cost – **Fixed License** (No. of Max. Links)	n/a	n/a	$ 9,100 (2,000 links)	$12,495 (3,000 links)
Annual Maintenance Cost	n/a	n/a	$ 1,820	$ 2,499
Purchase Cost – **Floating / Concurrent License** (No. of Max. Links)	$ 13,979 (2,000 links)	$ 22,719 (2,000 links)	$ 13,650 (2,000 links)	$18,743 (3,000 links)
Annual Maintenance Cost	$ 3,354	$ 5,454	$ 2,730	$ 3,749

Table B2 – Sanitary/Stormwater Software Costs

CATEGORY	SEWERCAD	SEWERGEMS	INFOSWMM	XPSWMM	PCSWMM
Purchase Cost – **Fixed License** (No. of Max. Links)	n/a	n/a	$ 12,250 (3,000 links)	n/a	$ 0 (Unlimited links)
Annual Maintenance Cost	n/a	n/a	$ 2,450	n/a	$ 1,440
Purchase Cost – **Floating License** (No. of Max. Links)	$ 13,979 (2,000 links)	$ 22,719 (2,000 links)	$ 18,375 (3,000 links)	n/a	n/a
Annual Maintenance Cost	$ 3,354	$ 5,454	$ 3,675	n/a	n/a

The following applies to WaterCAD, WaterGEMS, SewerCAD and SewerGEMS products:

- Prices provided in CAD
- A 10% discount on purchase costs may be applied after negotiation with the sales team
- No fixed licences are available. “Concurrent” licenses are available where multiple users can share the same license, although there is tracking for using the same license at the same time, so if the City has multiple users on the same license at the same time, the City will be sent an invoice.

The following applies to InfoWater, InfoWaterPro, InfoSWMM and XPSWMM products:

- All prices were converted from USD to CAD at the rate of 1 USD = 1.39 CAD
- Fixed and Floating (“Concurrent”) licences are available. “Floating” licenses are available where multiple users can share the same license, and there are controls to block multiple users from accessing the same license at the same time.

APPENDIX

APPENDIX

B

TECH. MEMO #2: INFRASTRUCTURE MODELS ASSET NAMING CONVENTION

MEMO

TO: Tobi Pettet, P.Eng., Project Manager, City of Penticton

FROM: Stephen Horsman, P.Eng., P.E., Michael Levin, P.Eng.

SUBJECT: **Technical Memo #2: Infrastructure Models Asset Naming Convention**

DATE: **June 4, 2020**

WSP Canada Group Limited (WSP) is pleased to provide the following technical memorandum outlining the proposed naming conventions of the asset groups within the individual water, sanitary and stormwater hydraulic models for the City of Penticton (City). The purpose of this memorandum is to document the rational for development of the asset naming conventions for updating the proposed hydraulic models and identify how the model asset IDs will correlate to the City's GIS database.

WATER MODEL NAMING CONVENTIONS

The City's existing EPANET water model (current to 2016) was developed prior to the City moving to a GIS platform for managing their infrastructure data. As such, the water model naming conventions are not consistent with the City's current GIS database. The existing hydraulic water model naming convention uses the respective Pressure Zone ID along the modelling element prefix to label the various junctions, pipes, tanks, pump stations, and PRVs elements.

WSP reviewed the City's GIS database naming conventions in relation to the existing model database and recommend updating the naming convention for water structure facilities, such as pump stations and reservoirs, based on the City's current GIS convention, while following the existing naming convention historically used for watermains and hydrants. Renaming the modelled watermains with the GIS pipe dataset would result in multiple clashes between the modelled and GIS asset databases (e.g. one hydraulic model link may correlate to multiple GIS watermain IDs) offers little benefit. Additionally, this approach allows the primary elements, namely the junctions and watermains, to retain the Pressure Zone ID as set out in the existing model, which allows efficient special locating when reviewing model results.

To assist the City's capital planning and rehabilitation works programs, WSP will correlate the model ID and the City's GIS FACILITYID field within the capital project descriptions so that the associated asset improvements and cost estimates can be readily incorporated into the City's planning cycle and asset management systems.

Based on the foregoing, the following presents the proposed naming conventions that will be used for the existing model elements:

- Point assets such as reservoirs, pumps and PRVs will have prefixes obtained from the FACILITYID field and a one letter tag identifying the type of asset, followed by a numerical identifier; and
- Watermains and junctions representing pipe connections, valves, and hydrants will follow the existing naming convention based on associated pressure zone.

Table 1 lists the proposed naming convention for existing water model elements.

TABLE 1 WATER MODEL NAMING CONVENTION

ASSET TYPE	MODEL ELEMENT	PREFIX
Hydrants/Valves/Pipe Connections	Junction	J-(Pressure Zone ID)-###
Watermains	Pipe	P-(Pressure Zone ID)-###
Water Supply Source	Reservoir	WSR--###
Storage Reservoir	Tank	WST--###
Pump	Pump	WSP--###
PRV	PRV	WSV--###

SANITARY AND STORMWATER MODEL NAMING CONVENTIONS

Similar to the water model files, the City's existing sanitary and stormwater XPSWMM model files (current to 2010) do not follow the City's current GIS naming convention. Based on our review of the existing model naming conventions and the City's current GIS database, WSP proposes to rename all elements to match the City's GIS database. The following outlines our proposed naming convention for existing and dummy[1] model elements for the new sanitary and stormwater models.

All existing model elements will use prefixes that match the FACILITYID field, obtained direct from the City's GIS database, followed by a numerical identifier.

Table 2 and Table 3 lists the recommended naming conventions for different asset groups.

TABLE 2 STORMWATER MODEL NAMING CONVENTION

ASSET TYPE	MODEL ELEMENT	PREFIX
Manhole	Junction	SWMH-###
Discharge Point	Outfall	SWDP-###
Network Structure	Storage	SWNS-###
Stormwater Structure	Storage	SWST-###
Stormwater Detention Area	Storage	SWDA-###
Gravity Main	Conduit	SWGM-###
Culvert	Conduit	SWCU-###
Open Channel/Ditch	Conduit	SWOD-###

[1] Refers to elements required for model network connectivity, which are unique to the hydraulic model and do not correlate to a physical asset.

TABLE 3 SANITARY MODEL NAMING CONVENTION

ASSET TYPE	MODEL ELEMENT	PREFIX
Manhole	Junction	SSMH-###
Pump	Pump	SSPU-###
AWWTP Discharge	Outfall	SSDP-###
Lift Station	Storage	SSNS-###
Gravity Main	Conduit	SSGM-###
Forcemain	Conduit	SSFM-###

For elements required for model network connectivity (i.e. dummy links to connect inlet points or represent conveyance features), which are unique to the hydraulic model development, WSP will assign a prefix of asset group (sanitary or stormwater), followed by type of feature (node or link) and a unique numerical identifier to junctions and pipes respectively.

Table 4 lists the recommended naming conventions for these elements.

TABLE 4 NAMING CONVENTION FOR NETWORK CONNECTIVITY ELEMENTS

ASSET TYPE	MODEL ELEMENT	PREFIX	EXAMPLE
Manhole	Junction	SSN-### SWN-###	Connect isolated conveyance features/links south and north of the City to the Sanitary or Stormwater network
Pipe or Channel	Conduit	SSL-### SWL-###	Connect isolated manholes to the Sanitary or Stormwater network and accurately capture the sewer loading or runoff discharging to the manhole

PROPOSED ELEMENTS NAMING CONVENTION (ALL MODELS)

As part of the model development and planning exercises for all three hydraulic models, the future model files will include proposed assets that are required to service future development areas or replace existing assets. These proposed elements are appended to an existing model to evaluate the behaviour of a system under future conditions. WSP will assign a prefix “P-” (Proposed) followed by asset group, type of feature and a unique locational or numerical identifier.

Table 5 lists the recommended naming conventions.

TABLE 5 NAMING CONVENTION FOR PROPOSED MODEL ELEMENTS

ASSET TYPE	MODEL ELEMENT	PREFIX	EXAMPLE
Facility (Storm or Sanitary ONLY)	Storage	P-SWNS-(Location)-# P-SWST-(Location)-# P-SWDA-(Location)-# P-SSNS-(Location)-#	Detention Pond, Lift Station
Manhole or Outfall	Junction	P-SSN-### P-SSDP-(Location)-# P-SWN-###	New manhole to tie-in future developments
Pipe or Channel	Conduit	P-SSL-### P-SSL-###	New gravity main to service future developments
Hydrants/Valves/Pipe Connections	Junction	P-####	New hydrant or tie-in location for future development
Watermains	Pipe	P-####	New watermain for looping or servicing future development
Storage Reservoir	Tank	P-WST-(Location)-#	New tank or additional cell to existing tank
Pump	Pump	P-WSP-(Location)-#	New pump station or existing pump station upgrades
PRV	PRV	P-WSV-(Location)-#	New PRV station

HYDRAULIC DATA INPUT NAMING CONVENTION (ALL MODELS)

The individual utility models will also include various components such as demand patterns and storage/pump curves. Table 6 and Table 7 lists the recommended naming conventions for hydraulic data with example applications.

TABLE 6 PATTERN NAMING CONVENTION AND APPLICATIONS

TYPE	APPLIES TO	EXAMPLE APPLICATION	PREFIX
Demand Pattern	Junction	System Demand Analysis	D-
Demand Charge Pattern	Pump	Pump Cost Estimates	CH-
Variable Head Pattern	Reservoir	Water Source Analysis	VH-
Pump Energy Rate Pattern	Pump	Energy Management	EG-
Variable Pump Speed Setting Pattern	Pump	Pump Station Optimization	VS-
Water Quality Pattern	Reservoir, Tank or Junction	Water Quality Analysis	WQ-

TABLE 7 CURVE NAMING CONVENTION AND APPLICATIONS

TYPE	APPLIES TO	EXAMPLE APPLICATION	PREFIX
Storage Curve	Storage	Detention Pond Rating Curve	STG-
Pump Curve	Pump	Pump Capacity Analysis	PC-
Efficiency Curve	Pump	Energy Management	EF-
NPSH Curve	Pump	Cavitation Analysis	NS-
Volume Curve	Tank	Variable Area Tank	VC-
Headloss Curve	Valve	General Purpose Valve	HL-
Minor Loss Curve	Valve	Motorized Throttle Valve	ML-
Pressure Demand Curve	Junction	Pressure-dependent Demand	PR-

APPENDIX

C

MODEL ASSUMPTIONS

Table C-1 Dummy Manholes

Name	Tag	Invert Elev. (m)	Invert Elevation Data Source	Rim Elev. (m)	Rim Elevation Data Source
P-SSN-005	Dummy	335.8	Green_Drawing	339.5	1 m Contours
SSN-001	Dummy	342.3	Linear_Interpolation	344.3	1 m Contours
SSN-002	Dummy	473.3	Old_Model	475.4	1 m Contours
SSN-003	Dummy	361.2	Old_Model	363.3	1 m Contours
SSN-004	Dummy	408.0	Old_Model	410.6	1 m Contours
SSN-005	Dummy	343.3	Linear_Interpolation	346.0	1 m Contours
SSN-008	Dummy	337.5	Green_Drawing	339.5	1 m Contours
SSN-009	Dummy	415.7	Old_Model	418.0	1 m Contours
SSN-010	Dummy	346.2	Old_Model	347.5	1 m Contours
SSN-011	Dummy	385.3	Old_Model	389.0	1 m Contours
SSN-012	Dummy	338.7	Old_Model	339.9	1 m Contours
SSN-013	Dummy	374.6	Old_Model	379.5	1 m Contours
SSN-014	Dummy	402.2	Old_Model	404.7	1 m Contours
SSN-015	Dummy	454.0	Old_Model	456.7	1 m Contours
SSN-016	Dummy	354.9	Old_Model	356.7	1 m Contours
SSN-017	Dummy	375.3	Old_Model	378.8	1 m Contours
SSN-018	Dummy	354.0	Old_Model	354.7	1 m Contours
SSN-019	Dummy	410.6	Old_Model	412.4	1 m Contours
SSN-020	Dummy	340.4	Linear_Interpolation	343.4	1 m Contours
SSN-022	Dummy	335.3	Lee_Drawing	340.4	1 m Contours
SSN-023	Dummy	340.0	Old_Model	343.0	1 m Contours
SSN-024	Dummy	384.9	Old_Model	386.5	1 m Contours
SSN-025	Dummy	348.7	Linear_Interpolation	351.2	1 m Contours
SSN-026	Dummy	484.1	Old_Model	486.3	1 m Contours
SSN-027	Dummy	350.8	Old_Model	352.2	1 m Contours
SSN-028	Dummy	344.1	Old_Model	345.9	1 m Contours
SSN-029	Dummy	410.5	Old_Model	412.1	1 m Contours
SSN-030	Dummy	357.0	Linear_Interpolation	359.9	1 m Contours
SSN-031	Dummy	455.4	Old_Model	457.4	1 m Contours
SSN-032	Dummy	345.8	Old_Model	347.5	1 m Contours
SSN-033	Dummy	407.3	Old_Model	409.9	1 m Contours
SSN-034	Dummy	377.0	Old_Model	379.6	1 m Contours
SSN-035	Dummy	341.5	Linear_Interpolation	342.5	1 m Contours
SSN-036	Dummy	357.5	Linear_Interpolation	360.5	1 m Contours
SSN-038	Dummy	340.1	Linear_Interpolation	341.1	1 m Contours
SSN-039	Dummy	345.3	Linear_Interpolation	346.6	1 m Contours
SSN-040	Dummy	397.3	Linear_Interpolation	398.3	1 m Contours
SSN-041	Dummy	347.0	Linear_Interpolation	348.0	1 m Contours
SSN-042	Dummy	345.0	Linear_Interpolation	346.0	1 m Contours
SSN-043	Dummy	358.5	Linear_Interpolation	360.9	1 m Contours
SSN-044	Dummy	340.1	Linear_Interpolation	341.1	1 m Contours
SSN-045	Dummy	339.0	Linear_Interpolation	340.0	1 m Contours
SSN--046	Dummy	409.9	Linear_Interpolation	410.9	1 m Contours
SSN--047	Dummy	588.3	Linear_Interpolation	591.6	1 m Contours

SSN--048	Dummy	340.8	Linear_Interpolation	343.0	1 m Contours
SSN--049	Dummy	346.6	Linear_Interpolation	347.6	1 m Contours
SSN--050	Dummy	366.7	Linear_Interpolation	367.7	1 m Contours
SSN--051	Dummy	492.3	Linear_Interpolation	494.5	1 m Contours
SSN--052	Dummy	346.8	Linear_Interpolation	347.8	1 m Contours
SSN--053	Dummy	336.5	Old_Model	341.7	1 m Contours
SSN--054	Dummy	338.8	WIlson_Drawing	339.9	1 m Contours
SSN--055	Dummy	337.4	Airport_Drawing	339.1	1 m Contours
SSN--056	Dummy	336.4	Old_Model	339.0	1 m Contours
SSN--057	Dummy	343.0	Linear_Interpolation	344.0	1 m Contours
SSN--058	Dummy	346.6	Linear_Interpolation	347.5	1 m Contours
SSN--059	Dummy	339.0	Linear_Interpolation	340.0	1 m Contours
SSN--060	Dummy	340.7	Linear_Interpolation	343.6	1 m Contours
SSN--061	Dummy	338.9	Linear_Interpolation	339.9	1 m Contours
SSN-065	Dummy	339.5	Assumed_Cover	343.1	1 m Contours
SSN-066	Dummy	336.5	Assumed_Cover	341.7	1 m Contours

Table C-2 Dummy Pipes

Name	Tag	Roughness	Modeled Diameter (mm)	Length (m)	Inlet Node	Outlet Node	Inlet Elev. (m)	Outlet Elev. (m)	Cross-Section
P-SSL-005	DUMMY	0.013	250	4	P-SSN-005	SSST-100	335.830	335.820	CIRCULAR
SSL-001	DUMMY	0.011	250	232	SSMH-2247	SSMH-1954	528.580	509.500	CIRCULAR

Table C-3 Lift Stations

Name	Tag	Invert Elev. (m)	Rim Elev. (m)	Data Source	Curve Name
SSNS-5	AIRPORT_LS	335.28	339.07	Record Drawings	AIRPORT
SSST-8	SOEC_LS	335.08	342.70	Record Drawings	SOEC_WELL
SSST-9	LEE_ST	333.65	340.36	Record Drawings	LEE
SSST-12	WILSON_LS	335.67	340.02	Record Drawings	WILSON
SSST-14	SOUTH_LAKESIDE_LS	333.83	339.20	Record Drawings	LAKESIDE_SOUTH
SSST-53	MARINA_WAY_LS	339.60	343.59	Record Drawings	MARINA_WAY
SSST-13	NORTH_LAKESIDE_LS	336.18	342.36	Record Drawings	LAKESIDE_NORTH
SSNS-1	FAIRVIEW_LS	338.83	343.02	Record Drawings	FAIRVIEW
SSST-100	GREEN_LS	333.81	339.50	Record Drawings	GREEN

Table C-4 Lift Station Storage Curves

AIRPORT		FAIRVIEW		GREEN		LAKESIDE_NORTH		LAKESIDE_SOUTH		LEE		MARINA_WAY		SOEC_WELL		WILSON	
Source: Record Drawings		Source: Record Drawings		Source: Record Drawings		Source: Record Drawings		Source: Record Drawings		Source: Record Drawings		Source: Record Drawings		Source: Record Drawings		Source: Record Drawings	
Depth (m)	**Area (m^2)**	**Depth (m)**	**Area (m^2)**	**Depth (m)**	**Area (m^2)**	**Depth (m)**	**Area (m^2)**	**Depth (m)**	**Area (m^2)**	**Depth (m)**	**Area (m^2)**	**Depth (m)**	**Area (m^2)**	**Depth (m)**	**Area (m^2)**	**Depth (m)**	**Area (m^2)**
0.00	2.63	0.00	2.54	0.00	4.67	0.00	5.98	0.00	2.63	0.00	14.10	0.00	4.67	0.00	2.54	0.00	4.67
3.79	2.63	4.19	2.54	5.69	4.67	6.18	5.98	5.37	2.63	5.15	14.10	3.99	4.67	7.62	2.54	4.35	4.67

Table C-5 Pumps

Name	Tag	Inlet Node	Outlet Node	Startup Depth (m)	Shutoff Depth (m)	Data Source
SSPU-001	1677ST_NORTH_LS	SSST-13	SSN--053	0.27	0.071	Record Drawings
SSPU-002	1677ST_NORTH_LS	SSST-13	SSN--053	0.47	0.071	Record Drawings
SSPU-003	SOEC_LS	SSST-8	SSMH-2101	2.62	0.620	Record Drawings
SSPU-004	SOEC_LS	SSST-8	SSMH-2101	2.82	0.620	Record Drawings
SSPU-005	1741_ST_FAIRVIEW_LS	SSNS-1	SSN-023	1.34	0.845	Record Drawings
SSPU-006	1741_ST_FAIRVIEW_LS	SSNS-1	SSN-023	1.24	0.845	Record Drawings
SSPU-007	WILSON_LS	SSST-12	SSN--054	1.00	0.300	Record Drawings
SSPU-008	WILSON_LS	SSST-12	SSN--054	0.90	0.300	Record Drawings
SSPU-009	LEE_ST	SSST-9	SSN-022	1.45	0.914	Record Drawings
SSPU-010	LEE_ST	SSST-9	SSN-022	1.58	0.914	Record Drawings
SSPU-011	AIRPORT_LS	SSNS-5	SSN--055	1.70	1.033	Record Drawings
SSPU-012	AIRPORT_LS	SSNS-5	SSN--055	1.55	1.033	Record Drawings
SSPU-013	1685ST_SOUTH_LS	SSST-14	SSN--056	1.05	0.600	Record Drawings
SSPU-014	1685ST_SOUTH_LS	SSST-14	SSN--056	0.90	0.600	Record Drawings
SSPU-015	565ST_MARINA_WAY_LS	SSST-53	SSN--060	0.95	0.300	Record Drawings
SSPU-016	565ST_MARINA_WAY_LS	SSST-53	SSN--060	1.05	0.300	Record Drawings
SSPU-017	Green_LS	SSST-100	SSN-008	1.65	0.550	Record Drawings
SSPU-018	Green_LS	SSST-100	SSN-008	1.75	0.550	Record Drawings
SSPU-019	SOEC_LS	SSST-8	SSMH-2101	3.02	0.620	Record Drawings
SSPU-020	LEE_ST	SSST-9	SSN-022	1.60	0.914	Record Drawings

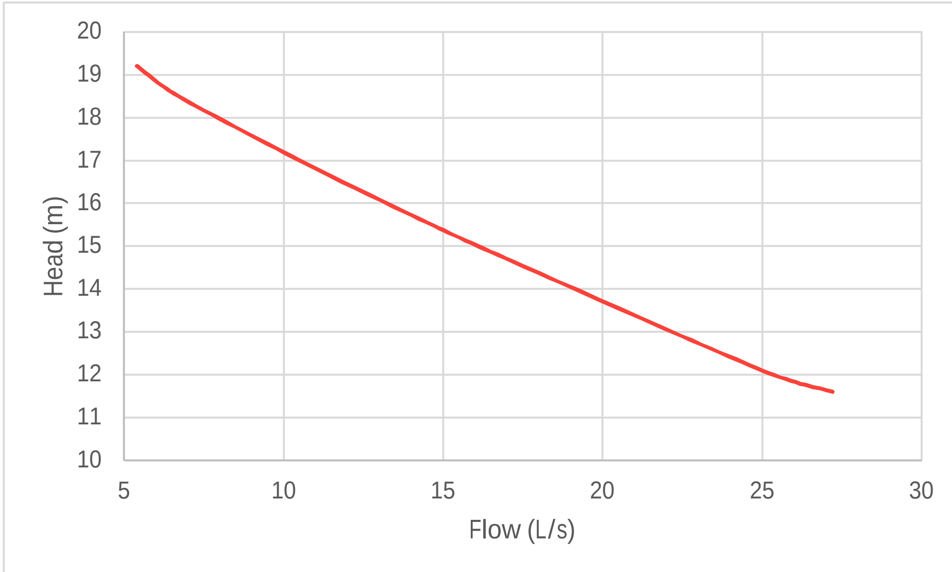
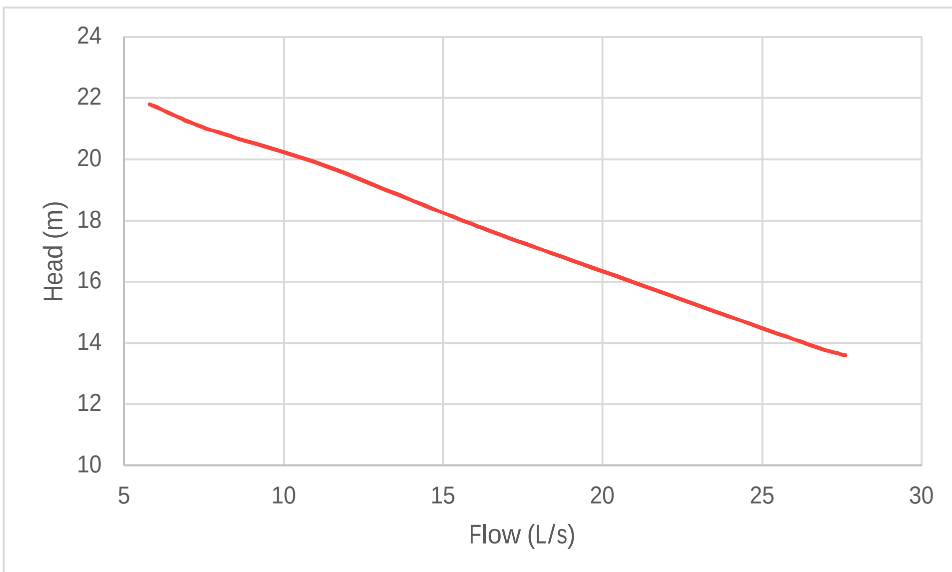
APPENDIX

APPENDIX

D

LIFT STATION INFORMATION

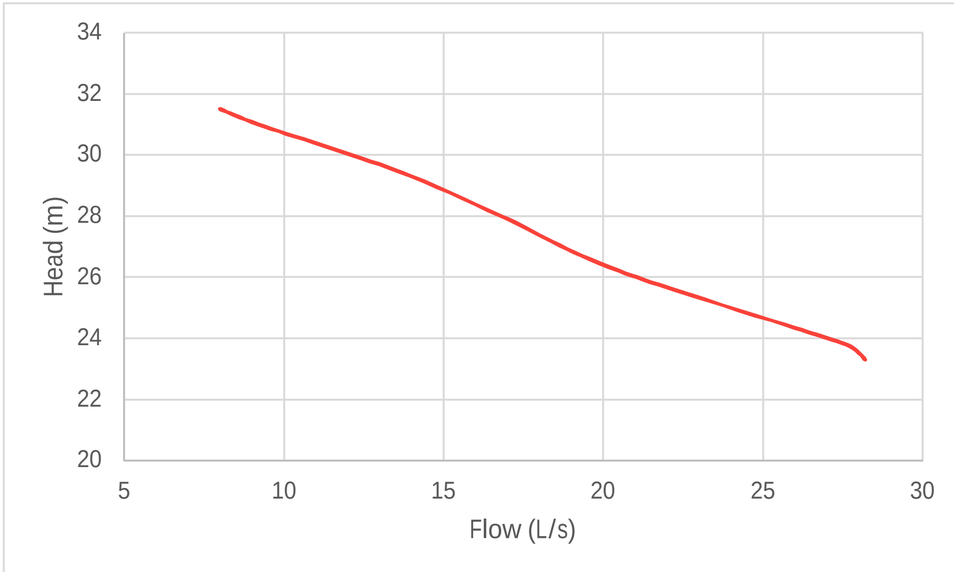
TABLE D-1 NORTH LAKESIDE LIFT STATION

<table>
<tr><th>PUMP MAKE AND MODEL NO.</th><th>PUMP CURVE</th></tr>
<tr><td>Gorman-Rupp, Model No. T3A3S-B (223 mm)</td><td>
</td></tr>
<tr><td>Gorman-Rupp, Model No. T3A3S-B (223 mm)</td><td>
</td></tr>
</table>

Notes:

- Originally constructed in 1963, upgraded in 1997 and 2020
- Two pumps
- Pump 1 Design Point: 11 L/s at TDH of 17 m
- Pump 2 Design Point: 7 L/s at TDH of 21.6 m

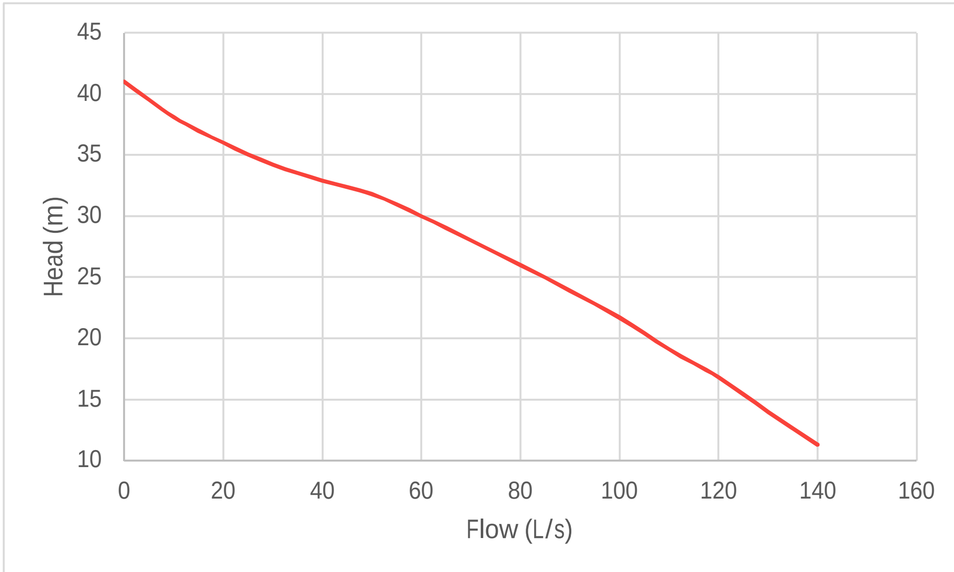
TABLE D-2 SOUTH LAKESIDE LIFT STATION

PUMP MAKE AND MODEL NO.	PUMP CURVE
Gorman-Rupp, Model No. T3A3S-B (223 mm)	

Notes:

- Originally constructed in 1994, upgraded in 2020
- Two pumps
- Design Point: 15 L/s at TDH of 28.4 m

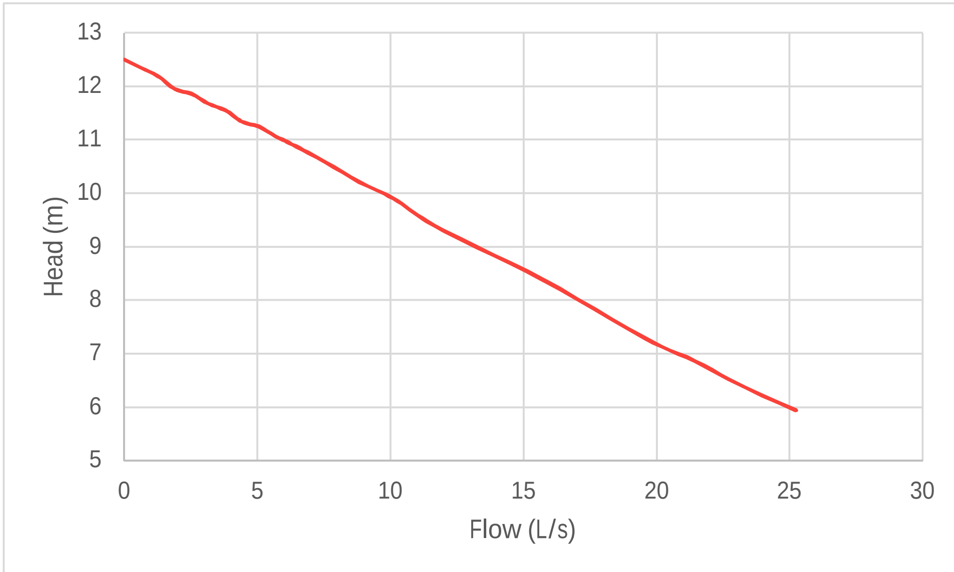
TABLE D-3 LEE AVENUE LIFT STATION

PUMP MAKE AND MODEL NO.	PUMP CURVE
Myers Submersible Pump, Model No. 6VCX500 M4-53 (280 mm)	

Notes:

- Constructed in 1994 and upgraded in 2008
- Three Pumps
- HP: 50
- Pump Speed: 1750 rpm
- Design Point: 118 L/s at TDH of 17 m (450 mm dia. forcemain with no P.I.B. flows)
- Observations from July – August 2019 confirm the lift station operates at 80 L/s with pump 1 on and pump 2 and 3 off
- Observations from July – August 2019 confirm the lift station operates at 130 L/s with pump 1 and 2 on and pump 3 off

TABLE D-4 AIRPORT LIFT STATION

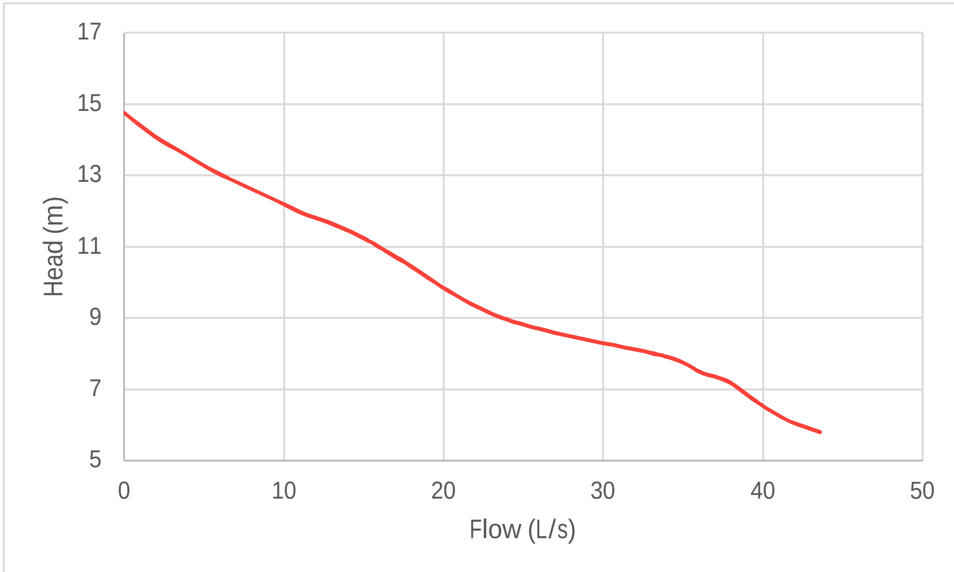
PUMP MAKE AND MODEL NO.	PUMP CURVE
Wemco Torque Flow, Model No. 3S2-QD (75mm)	

Notes:

- Constructed in 1973 and upgraded in 2000
- Two Pumps
- HP: 2.5
- Pump speed: 1735 rpm
- Design Point: 4 L/s at TDH of 12 m

TABLE D-5 WILSON LIFT STATION

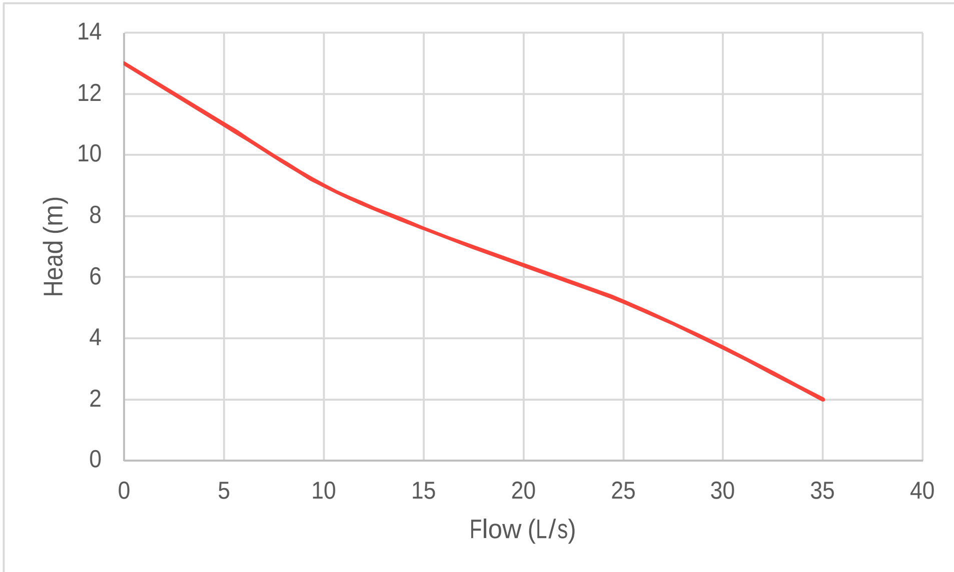
PUMP MAKE AND MODEL NO.	PUMP CURVE
Myers, Model No. 4V50M4-21	



Notes:

- Constructed in 2006
- Two Pumps
- Design Point: 23.7 L/s at TDH of 9 m
- HP: 5
- Pump Speed: 1750 rpm

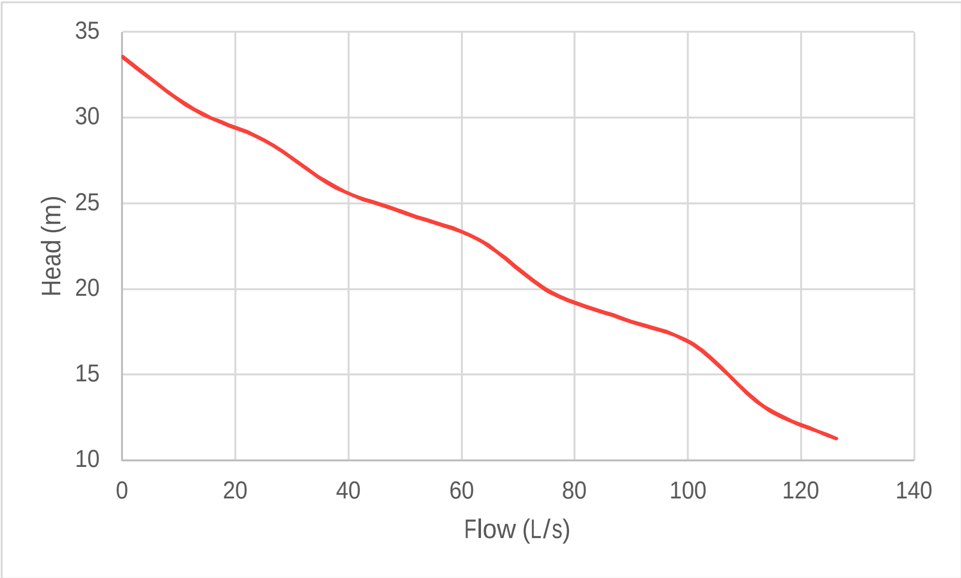
TABLE D-6 FAIRVIEW LIFT STATION

PUMP MAKE AND MODEL NO.	PUMP CURVE
Flygt, Model No. CP3085.182	

Notes:

- Two Pumps
- Design Point: 28 L/s at TDH of 5 m

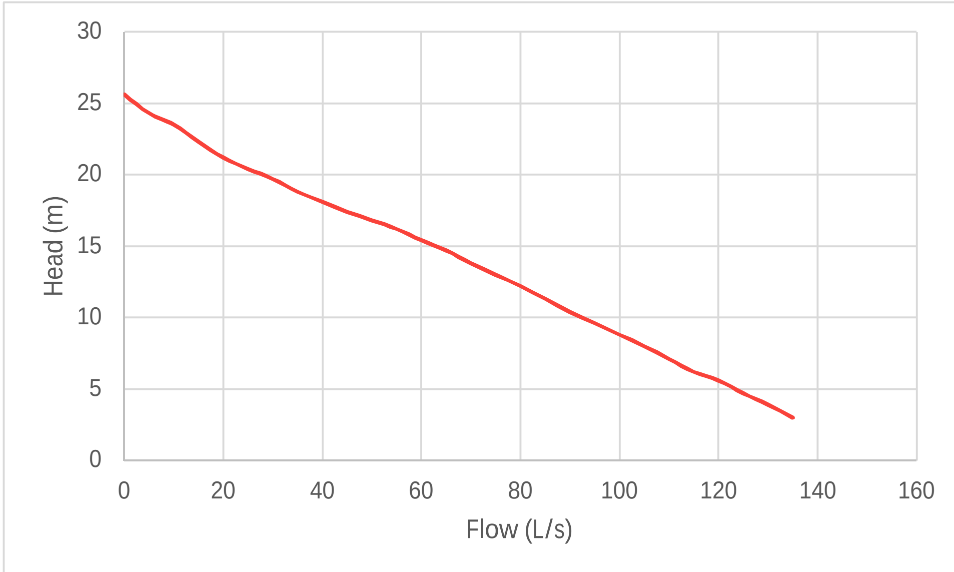
TABLE D-7 GREEN LIFT STATION

PUMP MAKE AND MODEL NO.	PUMP CURVE
Myers, Model No. 6VCX	

Notes:

- Two pumps
- HP: 30
- Pump Speed: 1750 rpm
- Design Point: 50 L/s at TDH of 24 m

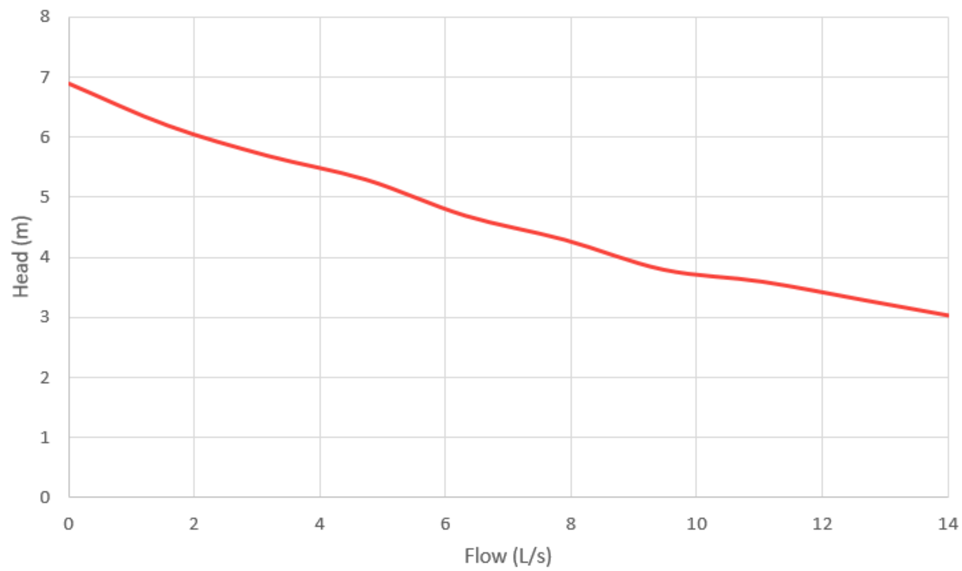
TABLE D-8 SOEC LIFT STATION

PUMP MAKE AND MODEL NO.	PUMP CURVE
Flygt, Model No. NP 3153.180 (227 mm)	

Notes:

- Three pumps
- HP: 25
- Design Point: 65 L/s at TDH of 15 m
- Observations from July – August 2019 confirm the pump operates at 86 L/s with pump 1 on and pumps 2 and 3 off

TABLE D-9 MARINA WAY LIFT STATION

<table>
<tr><th>PUMP MAKE AND MODEL NO.</th><th>PUMP CURVE</th></tr>
<tr><td>Myers, Model No. 3VX15M4-21-35 (64mm)</td><td>
</td></tr>
</table>

Notes:

- Constructed in 2003 and upgraded in 2010
- Two Pumps
- Design Point: 9.5 L/s at TDH of 3.8 m
- HP: 1.5
- Pump Speed: 1750 rpm

APPENDIX

APPENDIX

E

TECH. MEMO #5: POPULATION PROJECTIONS

MEMO

TO: Tobi Pettet, P.Eng., Project Manager, City of Penticton

FROM: Stephen Horsman, P.Eng., P.E.

SUBJECT: **Technical Memo #5: Population Projections**

DATE: **September 4, 2020**

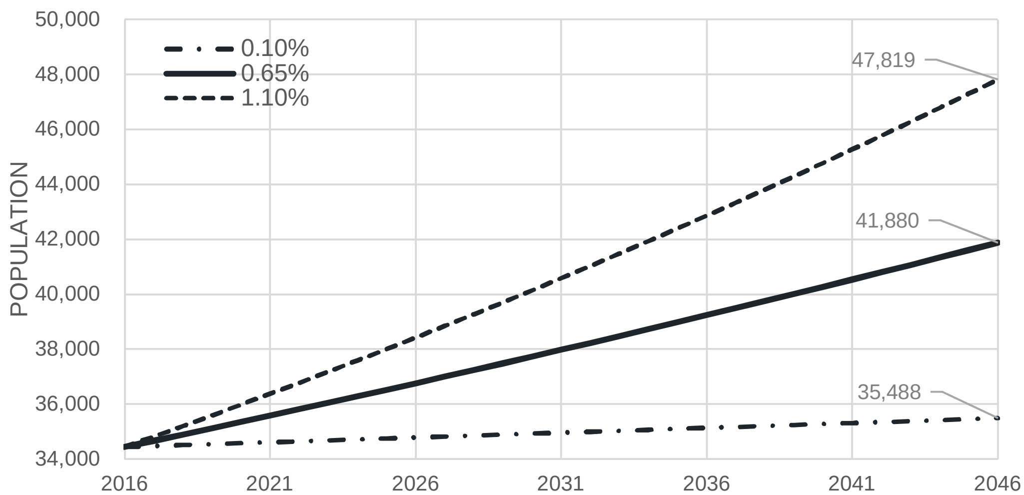
WSP is pleased to provide the following technical memorandum outlining the proposed population projections and future growth planning for the Integrated Infrastructure Master Plan (IIMP). The purpose of this memorandum is to build on the planned growth within the City based on the 2045 Official Community Plan (OCP) to inform the develop and analysis of future infrastructure needs for the City's transportation, water, stormwater and sanitary infrastructure.

POPULATION GROWTH

Based on the most recent 2016 census data, the City's adjusted population was identified to be 34,440 in 2016. over the past twenty years the City has seen moderate but steady population growth, averaging at approximately 0.48% between 2006 and 2016. Based on the 2002 OCP, the City had planned for a population of approximately 45,000 by 2018, however actual growth was significantly less. The 2045 OCP, the City identified a lower growth rate that more closely aligned with historical rates resulting in a median growth rate for future planning within the City to 0.65% between 2016 and 2046. High and low rate projects are listed as 1.1% and 0.1%, respectively.

Figure 1 presents the population projections based on the median, high and low growth rates proposed in the 2045 OCP.

FIGURE 1 2045 OCP POPULATION PROJECTIONS



POPULATION DENSITY

The assumptions for all future residential and future commercial/mixed use areas, when applied to the all quarter sections to be developed within the next 25 years, were calculated to meet the OCP population projections.

RESIDENTIAL

The 2016 Statistics Canada population breakdown by dwelling type (i.e. single-detached house, semi-detached, apartment or flat in a duplex, etc) was extrapolated to the 2017 baseline scenario to determine typical occupancy rates for single family and multi-family dwellings based on the available unit counts for each residence from the City's GIS database, as follows:

- Single Family Detached Dwellings – occupancy rate of 2.6 persons per lot.
- Multi-Family semi-detached, row house, duplex and other attached dwellings – occupancy rate of 2.4 persons per unit.
- Multi-Family movable dwellings and apartments – occupancy rate of 1.6 persons per unit.

The occupancy rates were then applied to the 25-year population forecast to develop dwelling unit counts which were compared to the 2018 Report by Urbanics Consultants Ltd. entitled *City of Penticton Population Projections and Housing Needs Review*. The final population forecasts and unit counts by each year developed for this assignment are comparable to the 2018 Urbanics Report, although some adjustments to dwelling unit counts were required to align population estimates.

Table 1 summarizes the forecasted residential dwelling unit breakdowns to the 2045 OCP horizon.

TABLE 1 RESIDENTIAL DWELLING UNITS BREAKDOWN TO THE 2046 OCP HORIZON

Year	Horizon	Single Family (Detached)	Multi-Family (Category 1) (1)	Multi-Family (Category 2) (2)	Total Residential Units
2016	Latest Census	6,749	3,032	6,047	15,828
2017	Baseline	6,796	3,081	6,038	15,915
2021	-	6,982	3,278	6,013	16,273
2025	5-year horizon	7,126	3,469	6,079	16,675
2026	-	7,162	3,517	6,099	16,778
2030	10-year horizon	7,284	3,712	6,215	17,211
2031	-	7,314	3,761	6,246	17,321
2036	-	7,488	4,038	6,334	17,860
2040	20-year horizon	7,627	4,278	6,396	18,301
2041	-	7,662	4,338	6,414	18,414
2045	25-year OCP horizon	7,676	4,524	6,780	18,980

(1) Multi-Family Category 1 includes semi-detached, row house, duplex and other attached dwellings.
(2) Multi-Family Category 2 includes movable dwellings and apartments.

Table 2 summarizes the forecasted residential population breakdowns to the 2045 OCP horizon.

TABLE 2 RESIDENTIAL POPULATION BREAKDOWN TO THE 2046 OCP HORIZON

Year	Horizon	Single Family (Detached)	Multi-Family (Category 1) (1)	Multi-Family (Category 2) (2)	Total Residential Units
2016	Latest Census	17,455	7310	9,675	34,440
2017	Baseline	17,575	7429	9,661	34,665
2021	-	18,057	7903	9,620	35,581
2025	5-year horizon	18,430	8364	9,727	36,521
2026	-	18,523	8480	9,758	36,760
2030	10-year horizon	18,837	8950	9,944	37,731
2031	-	18,916	9068	9,994	37,978
2036	-	19,366	9736	10,135	39,237
2040	20-year horizon	19,726	10314	10,233	40,273
2041	-	19,816	10459	10,262	40,537
2045	25-year OCP horizon	19,851	10908	10,848	41,608

(1) Multi-Family Category 1 includes semi-detached, row house, duplex and other attached dwellings.
(2) Multi-Family Category 2 includes movable dwellings and apartments.

INSTITUTIONAL, COMMERCIAL/MIXED USE, AND INDUSTRIAL

Population equivalents were calculated for existing ICI properties using the latest available annual water consumption meter data from 2017 for the entire Penticton water network. An overall residential per capita demand rate was applied to ICI metered consumption to estimate population equivalents.

For the OCP horizon, commercial and industrial population equivalents were assumed to increase according to the medium demand projections from the 2018 Report by Colliers International entitled *City of Penticton Commercial and Industrial Capacity Study*. Institutional population equivalents were assumed to increase proportionately to the growth projected in residential populations (i.e. using a median growth rate of 0.65%), while rural areas were not allocated any future growth population equivalents. Table 3 summarizes the forecasted 2045 ICI population equivalents breakdown by land use type.

TABLE 3 ICI POPULATION EQUIVALENTS BREAKDOWN TO THE 2046 OCP HORIZON

Year	Horizon	Institutional	Commercial	Industrial	Rural
2016	Latest Census	-	-	-	-
2017	Baseline	2942	8713	851	1019
2021	-	3020	9195	890	1019
2025	5-year horizon	3100	9705	931	1019
2026	-	3120	9837	941	1019
2030	10-year horizon	3202	10385	985	1019
2031	-	3223	10543	996	1019
2036	-	3330	11379	1012	1019

Year	Horizon	Institutional	Commercial	Industrial	Rural
2040	20-year horizon	3418	12097	1025	1019
2041	-	3440	12284	1028	1019
2045	25-year OCP horizon	3531	13063	1042	1019

PLANNED GROWTH AREAS

The 2045 OCP identified several growth priorities for the City with an increased focus on intensification within the existing developed landbase and reduced focus on expanding service to peripheral areas including hillside developments. The following sections describes each of the planned growth areas, as identified in the OCP.

Table 4 summarizes the population increase for each major OCP growth area.

TABLE 4 2045 POPULATION GAIN BREAKDOWN BY MAJOR OCP GROWTH AREAS

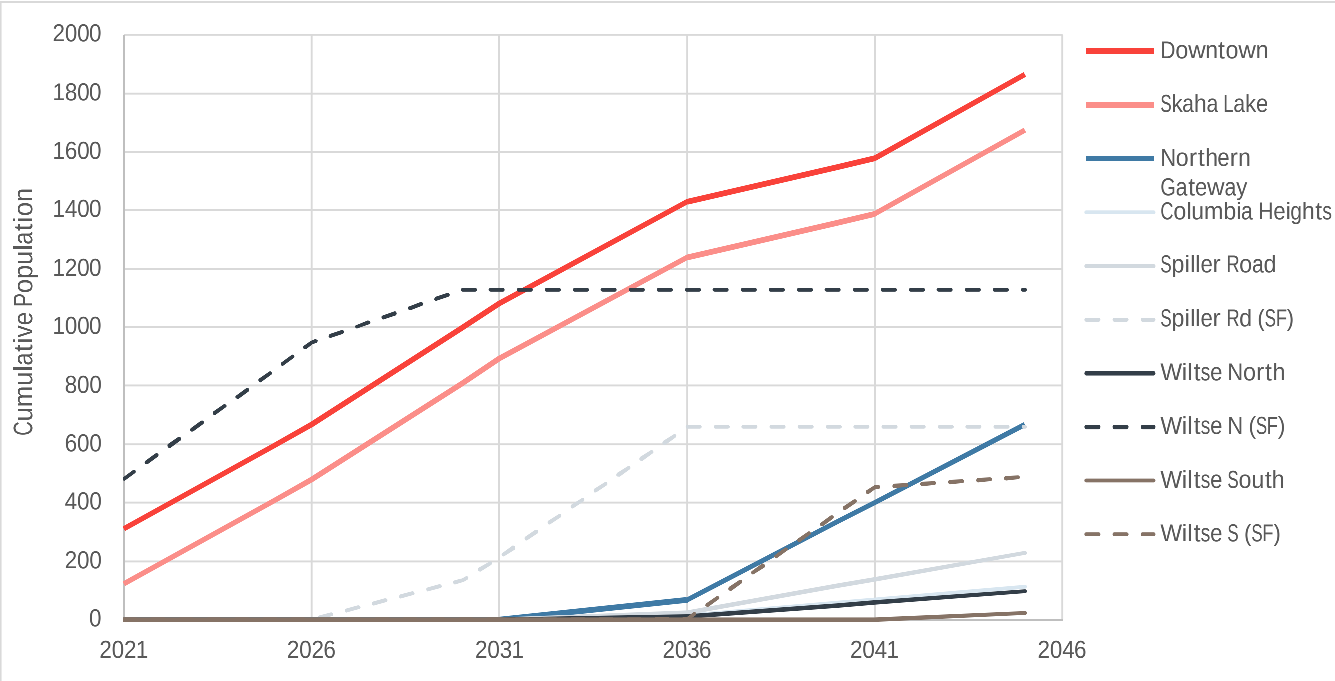
OCP Growth Area(1)	Single Family Population	Multi Family Population	ICI Population Equivalents
Downtown	0	1,865	2,523
Skaha Lake Rd	0	1,674	1,610
Northern Gateway	0	668	807
Infill Industrial	0	0	191
Columbia Heights	0	113	0
Spiller Rd	659	228	0
Wiltse North	1,128	97	0
Wiltse South	488	22	0
Total Population Change	**2,276**	**4,667**	**5,131**

(1) Future OCP areas designated for Agricultural, Natural and Conservation Areas, and Parks zoning were not allocated population equivalents.

It should be noted that subdivision plans were available for the Wiltse and Spiller Rd growth areas which were allocated specific population estimates based on available plans. Plans for redevelopment of the El Rancho Motel property in the Northern Gateway area was also included. However, the remaining growth areas were allocated future populations based on a proportion of rezoned parcels within each growth area.

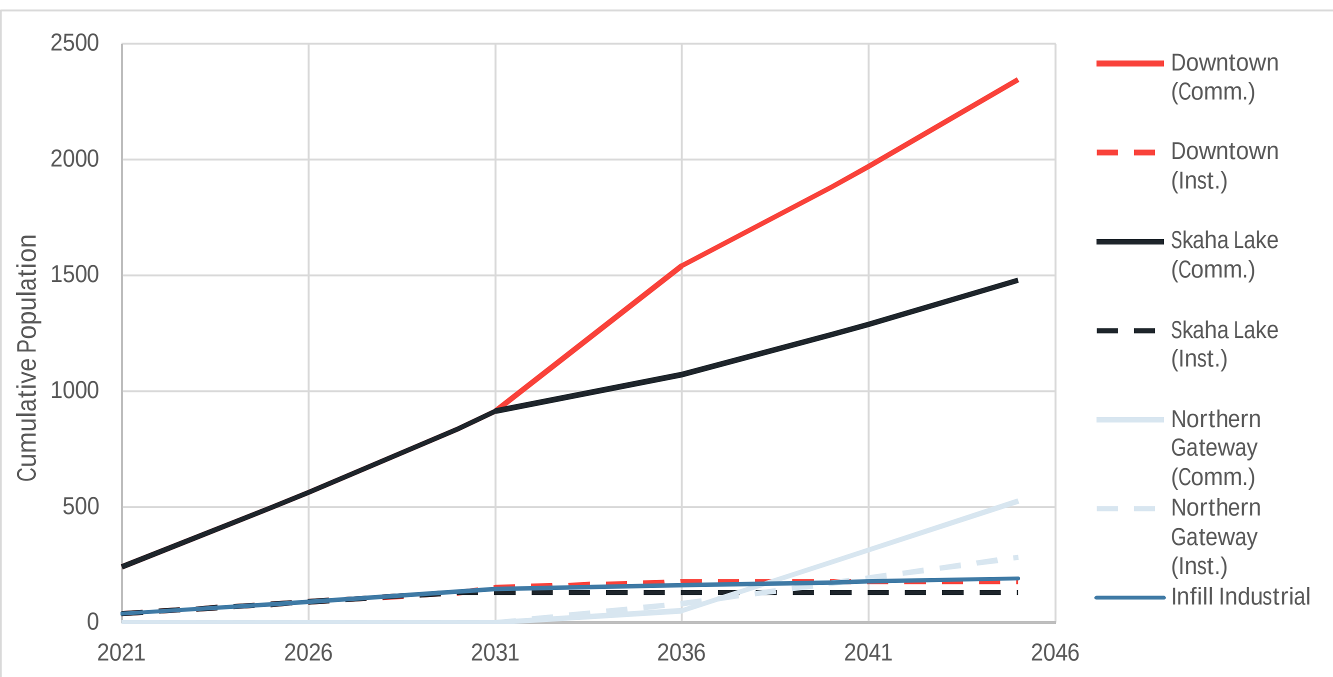
Based on discussions with City planning staff regarding the likely timing of buildout within the major OCP growth areas identified, and the forecasted populations from Tables 2 and 3 for all interim years between present and OCP conditions, the population breakdown per development area was split over the 25-year planning horizon, as illustrated in Figures 2 and 3.

FIGURE 2 CUMULATIVE POPULATION LOADING PER MAJOR OCP GROWTH AREA (SINGLE FAMILY & MULTI-FAMILY)



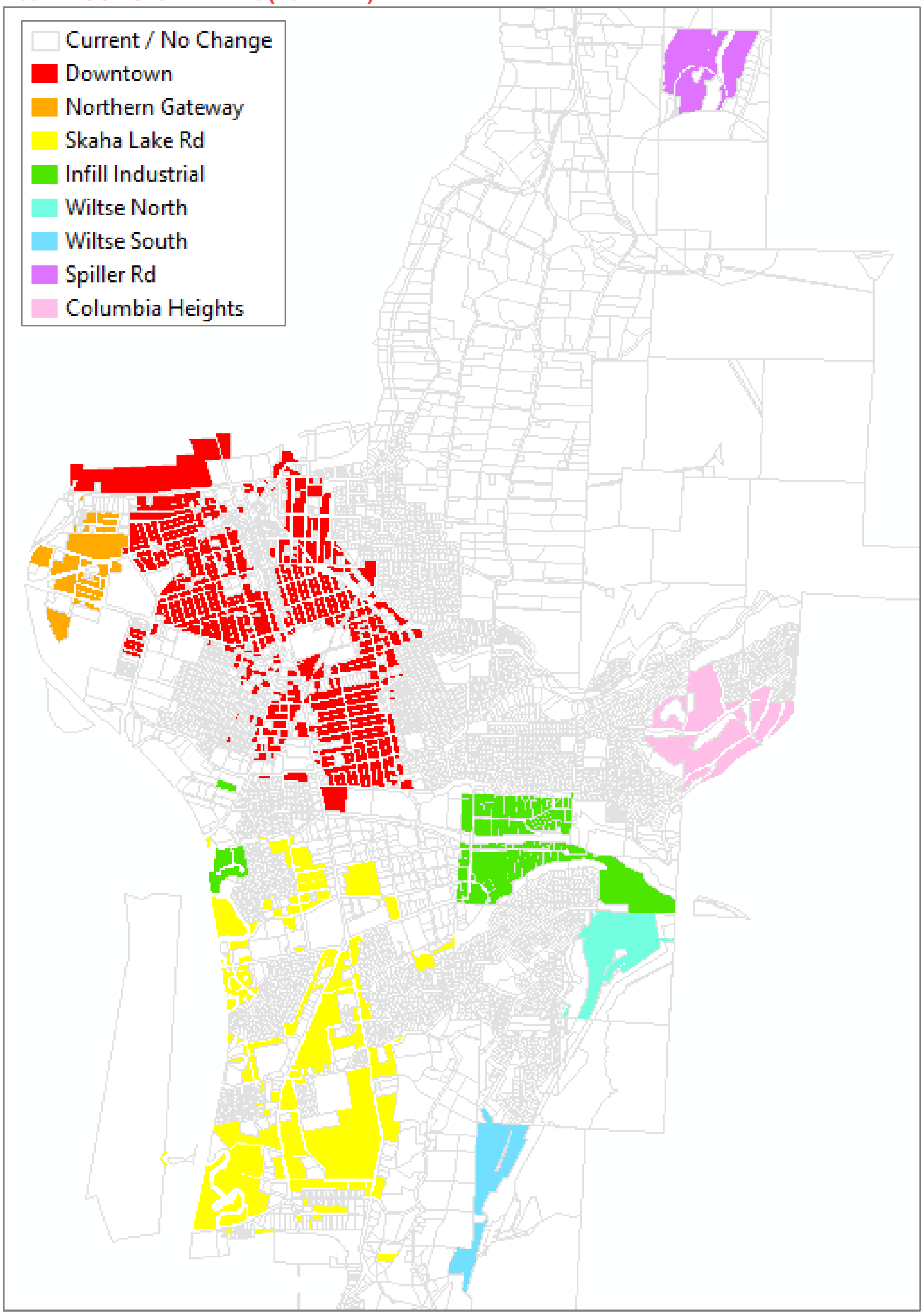
As illustrated in Figure 2, single family infill and growth is predominantly allocated to the Wiltse North and Spiller Road areas in the short-term, with additional single family growth in Wiltse South in the 15 to 20 year horizon. Multi-Family infill and growth is primarily in the Downtown and Skaha Lake areas in the short term, with these areas assumed to see steady growth to the 2045 OCP horizon. Additional multi-family infill and growth is assumed to occur in surrounding areas in the 15 to 25 year horizon.

FIGURE 3 CUMULATIVE POPULATION EQUIVALENT LOADING PER MAJOR OCP GROWTH AREA (ICI)



As illustrated in Figure 3, ICI growth is predominantly within commercial sectors in the Downtown and Skaha Lake areas, with steady institutional and industrial growth across the 25-year horizon. Figure 4 illustrates the locations of the planned growth areas within the City.

FIGURE 4 OCP GROWTH AREAS (ESTIMATED)

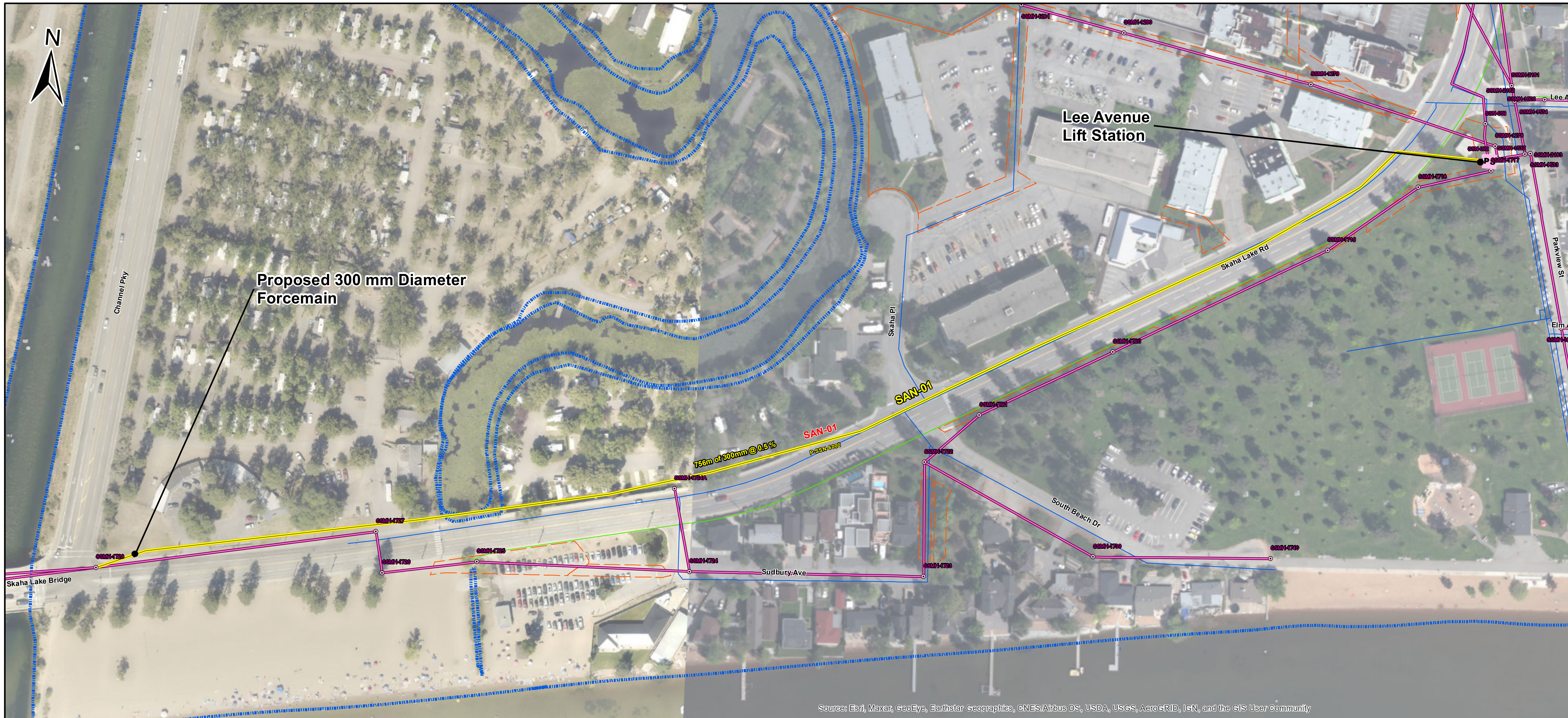


APPENDIX

APPENDIX

F

CAPITAL PROJECTS



SAN-01

Project Name: Skaha Lake Road Upgrades
Project Number: SAN-01

Project Timeline: 25-Year
Project Priority: Low
Estimated Cost ($ 2021): $ 689,900
Upgrade Driver: Future Developments at Penticton Airport, Old Airport Area, Barefoot Beach, Wright Campground and Arrowleaf
Development Cost Charges: Applicable

DESIGN CONSIDERATIONS

The modeling results indicate existing 200 mm diameter mains along Skaha Lake Rd. are undersized for future PIB development flows from the Penticton Airport, Old Airport Area, Barefoot Beach, Wright Campground and Arrowleaf areas.

The City has already commenced preliminary design for a new pump station at the Southwest corner of the City along Penticton Oliver Hwy. The proposed Pump Station will collect flows from all PIB developments and discharge to an existing 200 mm diameter forcemain, which currently outlets to existing 200 mm diameter gravity mains.

In order to avoid upsizing deep sewers along Sudbury Avenue, this project involves constructing a new 300 mm diameter forcemain from Skaha Lake Road to Lee Avenue Lift Station.

COST CONSIDERATIONS

This project was triggered due to future developments south west of the City and therefore all upgrades costs are attributable to developers.

ITEM	DESCRIPTION	COST (2021 $)
1.0	General Requirements	
1.1	Mobilization and Demobilization	$ 28,000
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$ 14,000
1.3	Traffic Management	$ 42,000
2.0	Earthworks	
2.1	Supply and Install New 300 mm Dia. Forcemain	$ 279,100
2.3	Install New Manhole	$ 4,000
3.0	Surface Restoration	
3.1	Trench Path Restoration (4.0 m width)	$ 125,600
3.2	Full Width Restoration	
4.0	Land Acquisition	
4.1	Acquire Easements	
4.2	Acquire Property	
	SUBTOTAL	$ 492,700
5.0	Professional Services and Contingencies	
5.1	Professional Services (15% of Subtotal)	$ 74,000
5.2	Construction Contingency (25% of Subtotal)	$ 123,200
	TOTAL ESTIMATED COST	$ 689,900

PIPE ID	INLET NODE	OUTLET NODE	DESCRIPTION	EX. DIA. (mm)	PROP. DIA. (mm)	LENGTH (m)
P-SWL-6000	SSMH-1728	SSST-9	New Main	0	300	756

Legend

- PS Pump Station
- Sanitary Manhole
- Existing Gravity Main
- Proposed Project
- Nearby Projects
- Watermain
- Stormwater Main
- City Easement
- Watercourse

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PENTICTON IIMP

SAN-01 Skaha Lake Road Upgrades
Sanitary Master Plan

0 37.5 75
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: F-1

Client: City of Penticton

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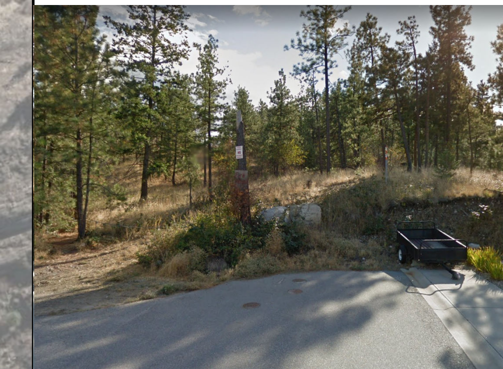
SAN-02



Project Name: Wiltse South Development
Project Number: SAN-02

Project Timeline: 25-Year
Project Priority: Low
Estimated Cost ($ 2021): TBD (Developer Driven)
Upgrade Driver: Future Development/Infill Growth
Development Cost Charges: Applicable

DESIGN CONSIDERATIONS

Developer to investigate potential service connection points.

This project triggers small gravity main improvements downstream along Pineview Road. Project SAN-10 should be completed prior to connecting Wiltse South to the City network.

All cost estimates are subject to change based on developer grading plans and site layout.

COST CONSIDERATIONS

This project was triggered due to future developments/infill growth and therefore all upgrades costs are attributable to developers.

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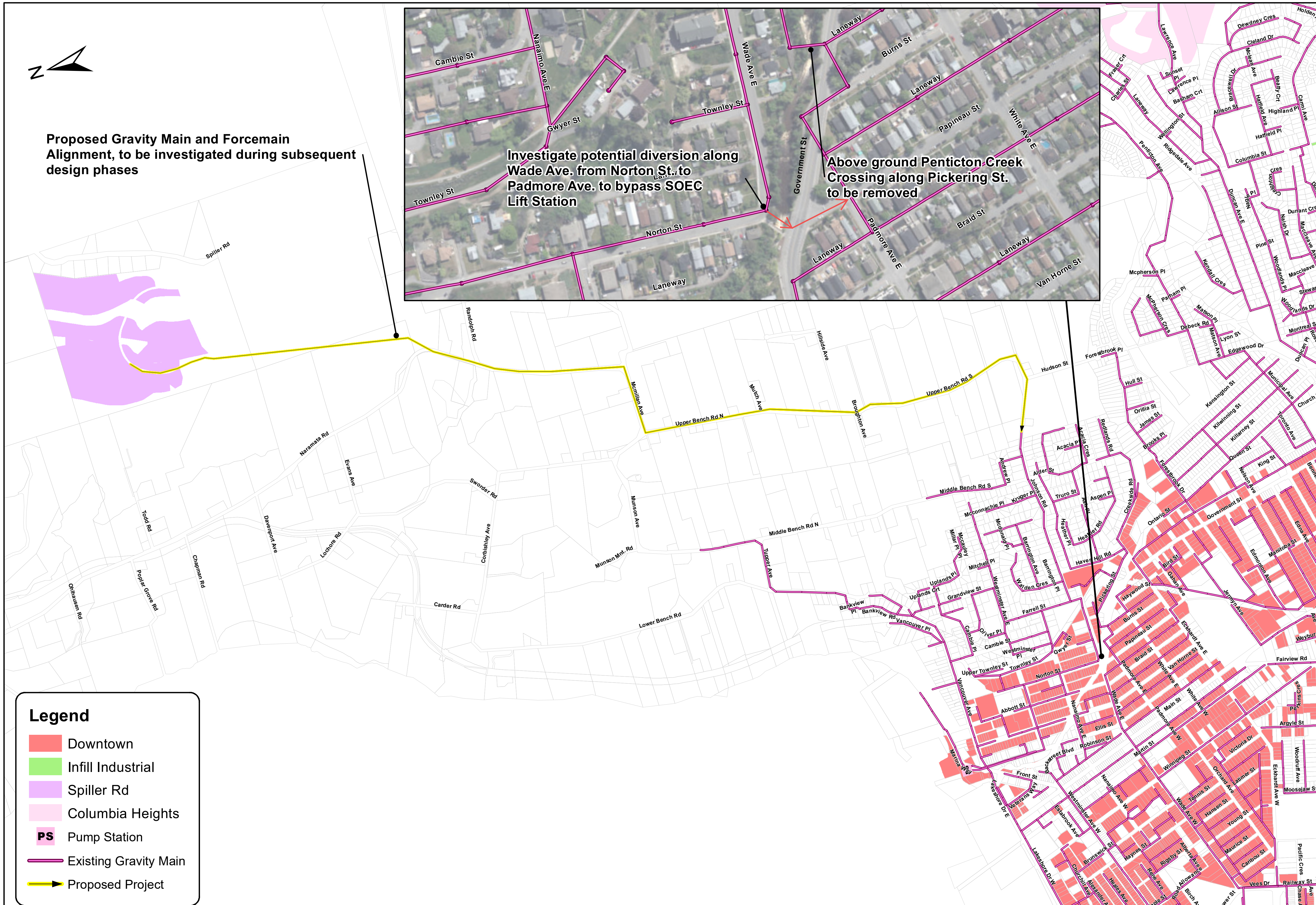
PENTICTON IIMP

SAN-02 Wiltse South Development Sanitary Master Plan

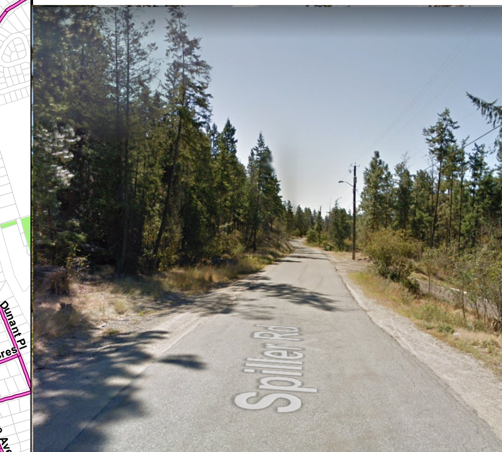
0 30 60
Meters

Project No.:	20M-00462-00
Date:	Apr 2021
Figure No.:	F-2

Client: City of Penticton



SAN-03



Project Name: Spiller Road Development
Project Number: SAN-03

Project Timeline: 25-Year
Project Priority: Low
Estimated Cost ($ 2021): TBD (Developer-Driven)
Upgrade Driver: Future Development/Infill Growth
Development Cost Charges: Applicable

DESIGN CONSIDERATIONS

Potential service connection option to be investigated during subsequent design phases.

A possible diversion along Wade Ave. should be investigated to bypass SOEC Lift Station, which has been identified to be deficient.

All cost estimates and proposed alignment provided are subject to change based on developer grading plans and site layout.

COST CONSIDERATIONS

This project was triggered due to future developments/infill growth and therefore all upgrades costs are attributable to developers.

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PENTICTON IIMP

SAN-03 Spiller Road Development
Sanitary Master Plan

0 285 570
Meters

Project No.: 20M-00462-00
Date: May 2021
Figure No.: F-3

Client: City of Penticton

SAN-04

Project Name: Wiltse North Development
Project Number: SAN-04

Project Timeline:25-Year
Project Priority: Low
Estimated Cost ($ 2021): TBD (Developer-Driven)
Upgrade Driver: Future Development/Infill Growth
Development Cost Charges: Applicable

DESIGN CONSIDERATIONS

Proposed serivce connection and cost estimates are subject to change based on developer grading plans and site layout.

This project triggers small gravity main improvements downstream along Pineview Road. Project SAN-10 should be completed prior to connecting Wiltse South to the City network.

COST CONSIDERATIONS

This project was triggered due to future developments/infill growth and therefore all upgrades costs are attributable to developers.

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PENTICTON IIMP

SAN-04 Wiltse North Development Sanitary Master Plan

0 30 60
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: F-4

Client: City of Penticton

SAN-05

Project Name: Smythe Road Development
Project Number: SAN-05

Project Timeline: 25-Year
Project Priority: Low
Estimated Cost ($ 2021): TBD (Developer-Driven)
Upgrade Driver: Future Development/Infill Growth
Development Cost Charges: Applicable

DESIGN CONSIDERATIONS

Proposed service connection and cost estimates are subject to change based on developer grading plans and site layout.

COST CONSIDERATIONS

This project was triggered due to future developments/infill growth and therefore all upgrades costs are attributable to developers.

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PENTICTON IIMP

SAN-05 Smythe Road Development
Sanitary Master Plan

0 30 60
Meters

Project No.:	20M-00462-00
Date:	Apr 2021
Figure No.:	F-5

Client: City of Penticton

City of Penticton

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SAN-06

Project Name: South Interceptor Upgrades
Project Number: SAN-06

Project Timeline: 5 to 10-Year
Project Priority: Medium
Estimated Cost ($ 2021): $ 131,400
Upgrade Driver: Future Development/Infill Growth
Development Cost Charges: Applicable

DESIGN CONSIDERATIONS

This project involves upsizing a section of the South Interceptor to accomodate future PWWFs. Pipe slopes to be surveyed in the field to confirm modeled results.

This project should be done prior to providing service to future development areas.

COST CONSIDERATIONS

This project was triggered due to future developments/infill growth and therefore all upgrades costs are attributable to developers.

ITEM	DESCRIPTION	COST (2021 $)
1.0	General Requirements	
1.1	Mobilization and Demobilization	$ 4,500
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$ 3,000
1.3	Traffic Management	$ 7,000
2.0	Earthworks	
2.1	Supply and Install New 600 mm Dia. Pipe	$ 44,500
2.3	Remove and Dispose Existing Pipe	$ 6,700
2.4	Install New Manhole	$ 8,000
3.0	Surface Restoration	
3.1	Trench Path Restoration (4.0 m width)	$ 20,100
3.2	Full Width Restoration	
4.0	Land Acquisition	
4.1	Acquire Easements	
4.2	Acquire Property	
	SUBTOTAL	$ 93,800
5.0	Professional Services and Contingencies	
5.1	Professional Services (15% of Subtotal)	$ 14,100
5.2	Construction Contingency (25% of Subtotal)	$ 23,500
	TOTAL ESTIMATED COST	$ 131,400

PIPE ID	INLET NODE	OUTLET NODE	DESCRIPTION	EX. DIA. (mm)	PROP. DIA. (mm)	LENGTH (m)
SSGM-1101-556	SSMH-1101	SSMH-556	Upsize Existing Main	525	600	78

Legend

- Discharge Point (AWWTP)
- Sanitary Manhole
- Existing Gravity Main
- Proposed Project
- Watermain
- Stormwater Main
- City Easement
- Watercourse

wsp

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PENTICTON IIMP

SAN-06 South Interceptor Upgrades
Sanitary Master Plan

0 40 80
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: F-6

Client: City of Penticton

CITY OF Penticton

SAN-07

Project Name: Columbia Heights Development
Project Number: SAN-07

Project Timeline: 25-Year
Project Priority: Low
Estimated Cost ($ 2021): TBD (Developer-Driven)
Upgrade Driver: Future Development/Infill Growth
Development Cost Charges: Applicable

DESIGN CONSIDERATIONS

Proposed alignment and service extension are subject to change based on developer grading plans and site layout.

COST CONSIDERATIONS

This project was triggered due to future developments/infill growth and therefore all upgrades costs are attributable to developers.

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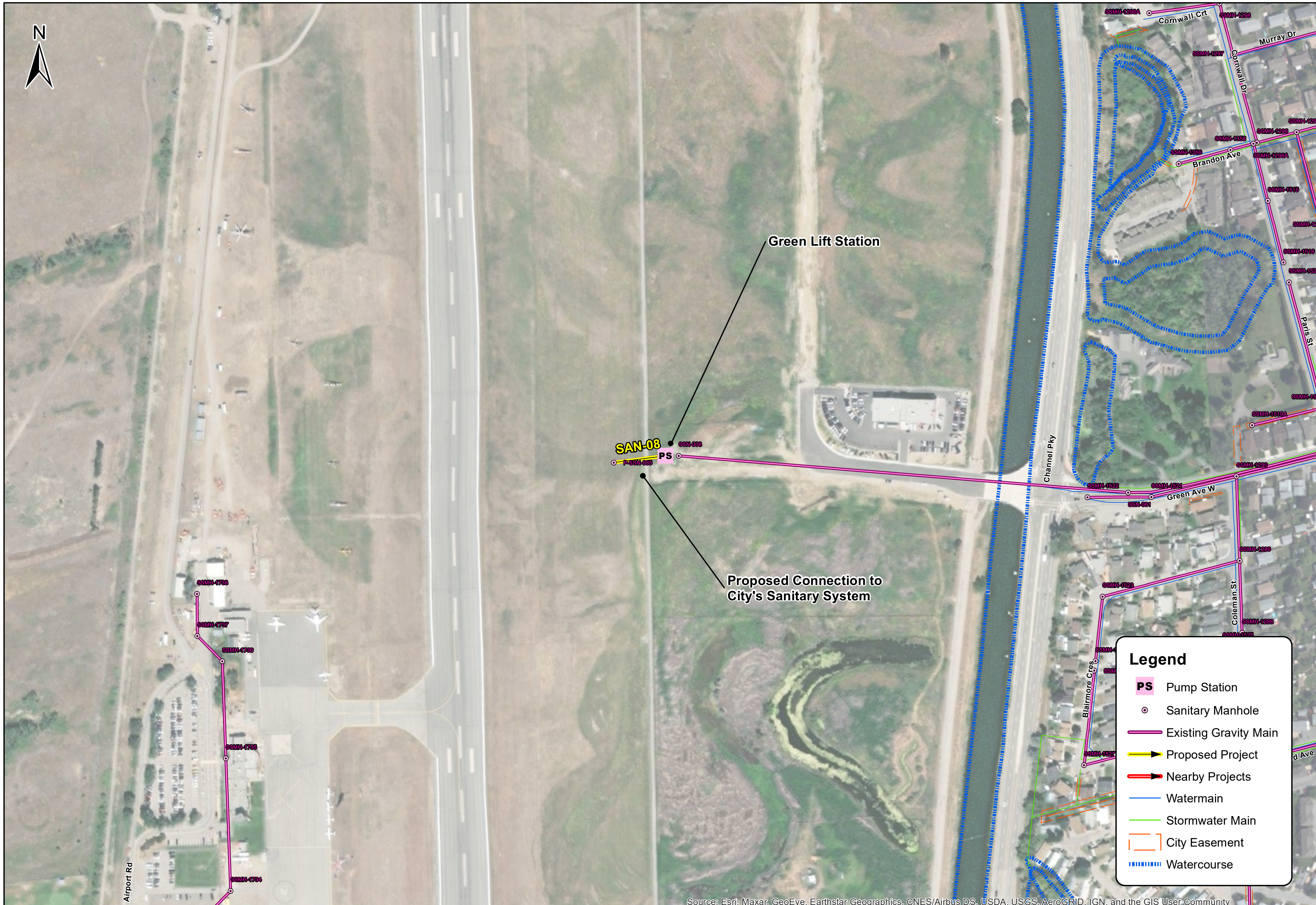
PENTICTON IIMP

SAN-07 Columbia Heights Development
Sanitary Master Plan

0 30 60
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: F-7

Client: City of Penticton



SAN-08

Project Name: Channel Parkway Development
Project Number: SAN-08

Project Timeline: 25-Year
Project Priority: Low
Estimated Cost ($ 2021): TBD (Developer-Driven)
Upgrade Driver: Future Development/Infill Growth
Development Cost Charges: Applicable

DESIGN CONSIDERATIONS

Proposed service extension and cost estimates are subject to change based on developer grading plans and site layout.

COST CONSIDERATIONS

This project was triggered due to future developments/infill growth and therefore all upgrades costs are attributable to developers.

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PENTICTON IIMP

SAN-08 Channel Parkway Development Sanitary Master Plan

0 55 110
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: F-8

Client: City of Penticton

SAN-09

Project Name: Industrial Infill Development
Project Number: SAN-09

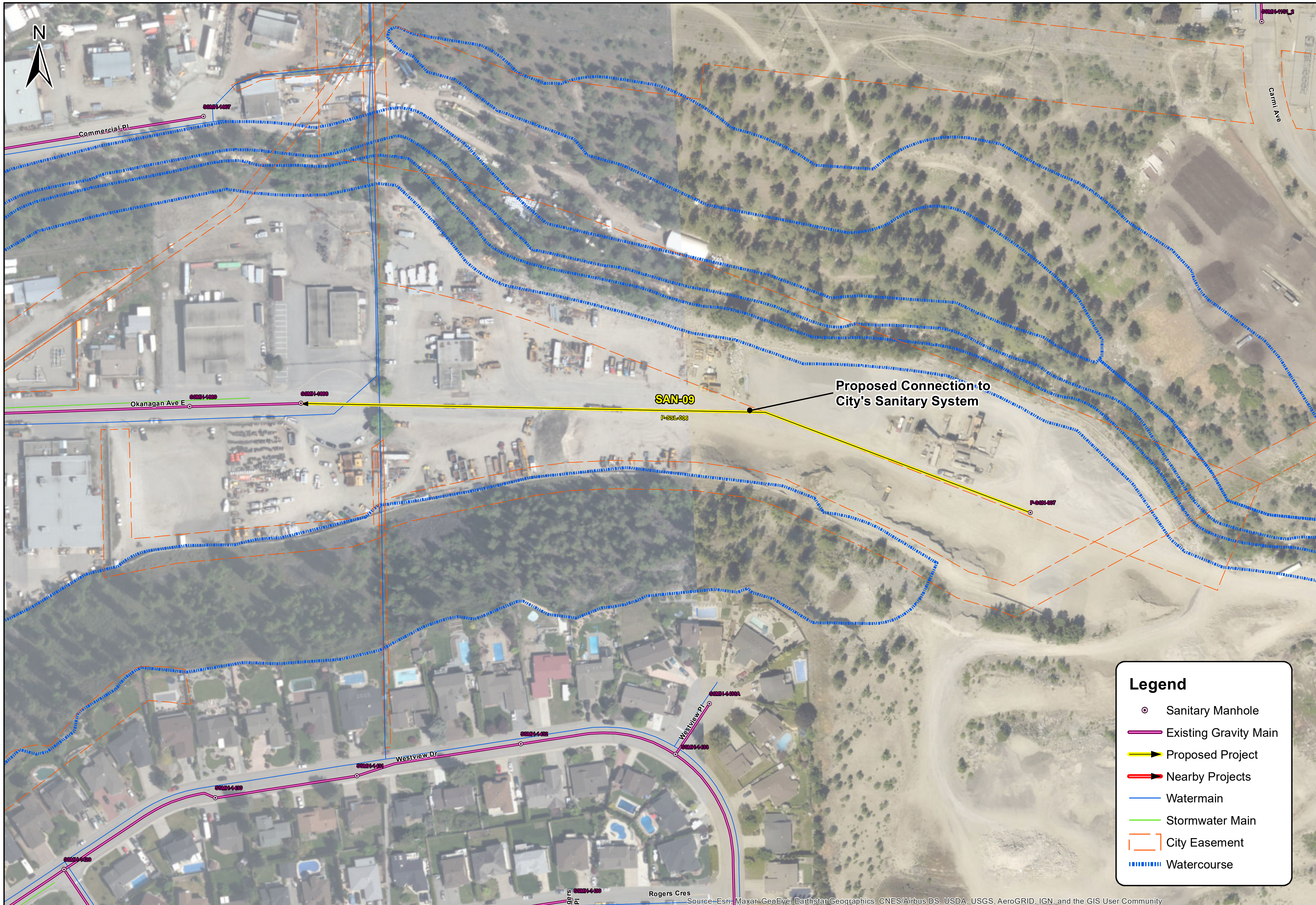
Project Timeline: 25-Year
Project Priority: Low
Estimated Cost ($ 2021): TBD (Developer-Driven)
Upgrade Driver: Future Development/Infill Growth
Development Cost Charges: Applicable

DESIGN CONSIDERATIONS

Proposed alignment and cost estimates are subject to change based on developer grading plans and site layout.

COST CONSIDERATIONS

This project was triggered due to future developments/infill growth and therefore all upgrades costs are attributable to developers.



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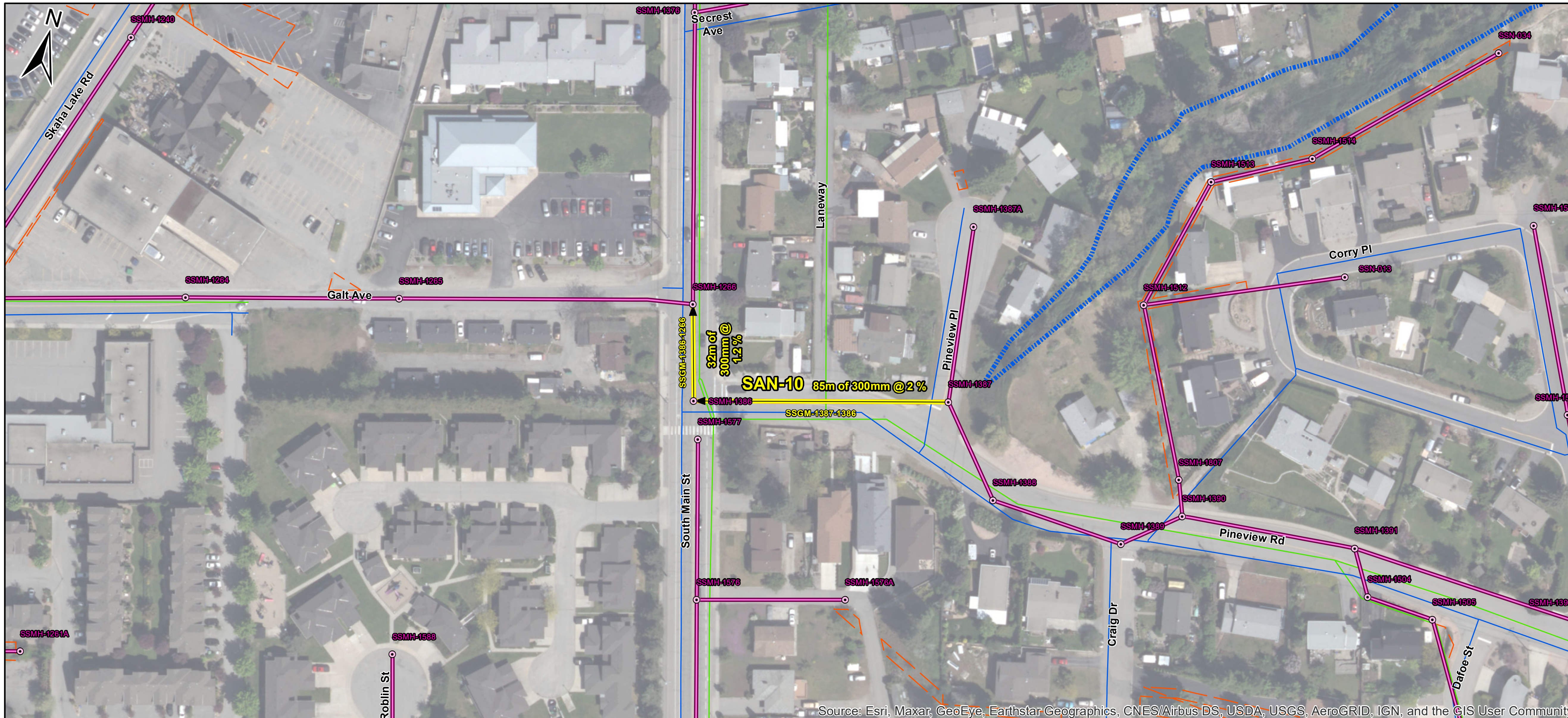
SAN-09 Industrial Infill Development
Sanitary Master Plan

0 30 60
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: F-9

Client: City of Penticton



SAN-10

Project Name: Pineview Road Upgrades
Project Number: SAN-10

Project Timeline: 25-Year
Project Priority: Low
Estimated Cost ($ 2021): $ 117,900
Upgrade Driver: Future Development/Infill Growth
Development Cost Charges: Applicable

DESIGN CONSIDERATIONS

The model results indicate existing sewers are undersized to convey future flows. The increased flows can be largely attributed to Wiltse South and North developments as well as infill growth within the catchment. This project should be done in conjunction with the Galt Ave/Pineview roundabout project.

This project should be completed prior to connecting Wiltse South and North developments (Projects SAN-02 and SAN-04) to the City's sanitary sewer system.

COST CONSIDERATIONS

This project was triggered due to future developments/infill growth and therefore all upgrades costs are attributable to developers.

ITEM	DESCRIPTION	COST (2021 $)	
1.0	General Requirements		
1.1	Mobilization and Demobilization	$	4,400
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$	3,000
1.3	Traffic Management	$	7,000
2.0	Earthworks		
2.1	Supply and Install New 300 mm Dia. Pipe	$	43,300
2.3	Remove and Dispose Existing Pipe	$	6,500
3.0	Surface Restoration		
3.1	Trench Path Restoration (4.0 m width)	$	19,500
3.2	Full Width Restoration		
4.0	Land Acquisition		
4.1	Acquire Easements		
4.2	Acquire Property		
	SUBTOTAL	$	83,700
5.0	Professional Services and Contingencies		
5.1	Professional Services (15% of Subtotal)	$	12,600
5.2	Construction Contingency (25% of Subtotal)	$	21,000
	TOTAL ESTIMATED COST	$	117,300

PIPE ID	INLET NODE	OUTLET NODE	DESCRIPTION	EX. DIA. (mm)	PROP. DIA. (mm)	LENGTH (m)
SSGM-1387-1386	SSMH-1387	SSMH-1386	Upsize Existing Main	200	300	85
SSGM-1386-1266	SSMH-1386	SSMH-1266	Upsize Existing Main	200	300	32
Total						117

Legend

- Sanitary Manhole
- Existing Gravity Main
- Proposed Project
- Nearby Projects
- Watermain
- Stormwater Main
- City Easement
- Watercourse

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SAN-10 Pineview Road Upgrades
Sanitary Master Plan

0 25 50
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: F-10

Client: City of Penticton

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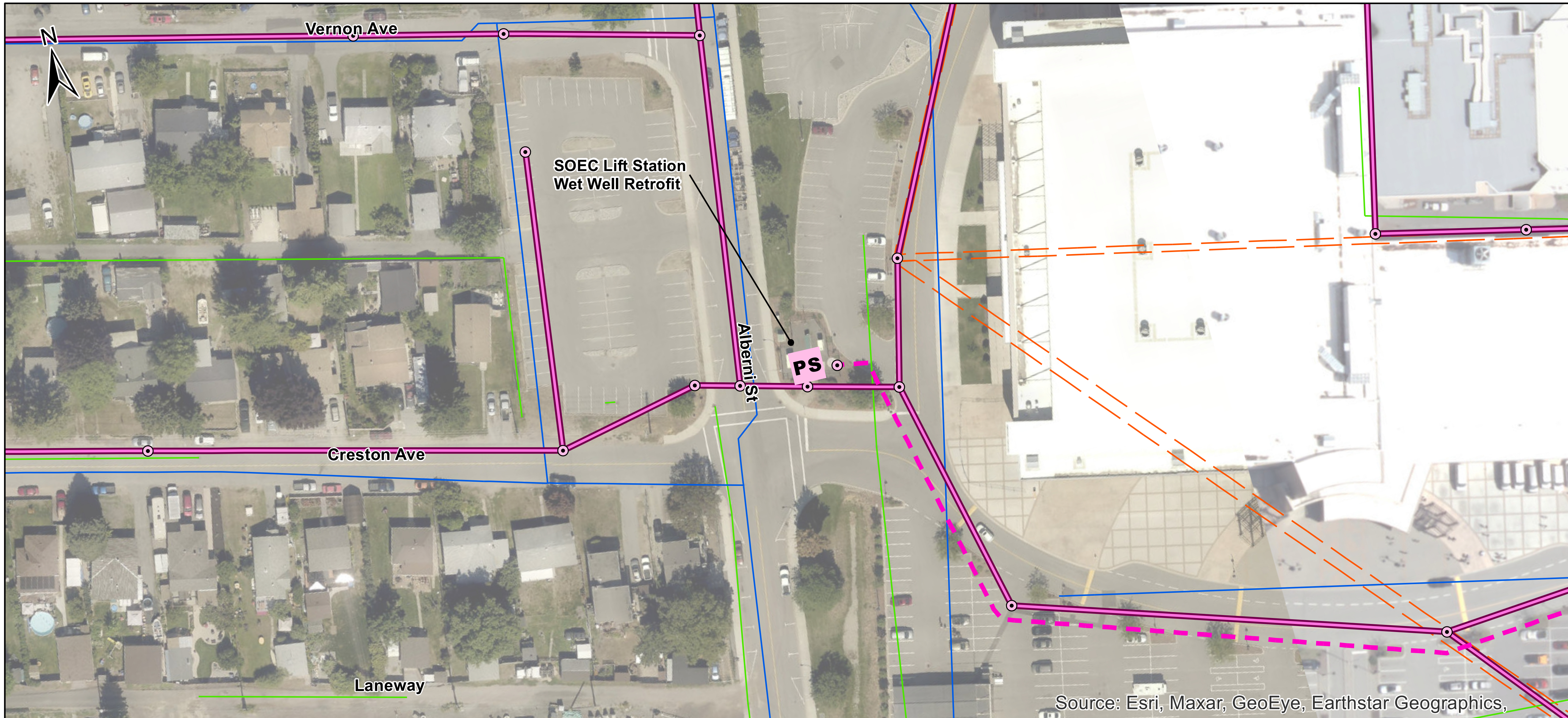

SAN-11

Project Name: SOEC Lift Station Wet Well Upgrades
Project Number: SAN-11

Project Timeline:5-Year
Project Priority: High
Estimated Cost ($ 2021): $ 647,300
Upgrade Driver: Existing Deficiency
Development Cost Charges: N/A

DESIGN CONSIDERATIONS

The modeling results indicate the existing SOEC wet well is undersized for existing and future PWWFs, which results in an high number of pump starts.

This project proposes supplying and installing a new wet well with adequate storage capacity for existing and future flows.

This project should be completed prior to the connecting the Spiller Road development (Project SAN-05) to the City network.

COST CONSIDERATIONS

This project was triggered due to an existing deficiency and therefore all upgrades costs are attributable to existing users.

ITEM	DESCRIPTION	COST (2021 $)
1.0	General Requirements	
1.1	Mobilization and Demobilization	$ 22,500
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$ 12,000
1.3	Traffic Management / Dewatering Allowance	$ 34,000
2.0	Earthworks	
2.1	Supply and Install New Wet Well	$ 225,000
2.2	Gravity and Forcemain Tie-ins	$ 22,500
2.3	Install Electrical and Mechanical Equipment	$ 11,250
2.4	Remove and Dispose Existing Wet Well	$ 33,750
3.0	Surface Restoration	
3.1	Trench Path Restoration (4.0 m width)	$ 101,300
3.2	Full Width Restoration	
4.0	Land Acquisition	
4.1	Acquire Easements	
4.2	Acquire Property	
	SUBTOTAL	$ 462,300
5.0	Professional Services and Contingencies	
5.1	Professional Services (15% of Subtotal)	$ 69,400
5.2	Construction Contingency (25% of Subtotal)	$ 115,600
	TOTAL ESTIMATED COST	$ 647,300

Legend

- PS Pump Station
- Sanitary Manhole
- Existing Gravity Main
- Existing Forcemain
- Watermain
- Stormwater Main
- City Easement

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PENTICTON IIMP

SAN-11 SOEC Lift Station Wet Well Retrofit
Sanitary Master Plan

0 15 30
Meters

Project No.: 20M-00462-00
Date: May 2021
Figure No.: F-11

Client: City of Penticton

CITY OF Penticton

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SAN-12

Project Name: Flow Monitoring Program
Project Number: SAN-12

Project Timeline: 1 to 5 Year
Project Priority: High
Estimated Cost ($ 2021): $ 145,000
Upgrade Driver: N/A
Development Cost Charges: N/A

CONSIDERATIONS

A flow monitoring program commisioned specifically for the purposes of model calibration should be undertaken within the next 5-years to validate medium and low priority projects.

The cost estimates provided include flow monitoring at five sites for a period of two months, and model calibration.

This project can be completed independent of all other projects.

ITEM	DESCRIPTION	COST (2021 $)	
1.0	5 Sites - 2 months of Flow Monitoring	$	100,000
2.0	Model Calibration	$	45,000
	TOTAL ESTIMATED COST	**$**	**145,000**

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SAN-12 Flow Monitoring Program
Sanitary Master Plan

0 1,900 3,800
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: F-12

Client: City of Penticton