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

WATER MASTER PLAN

PENTICTON IIMP

JUNE 04, 2021

CONFIDENTIAL

WATER MASTER PLANWATER MASTER PLAN

CITY OF PENTICTON

FINAL
CONFIDENTIAL

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, NC V2A 3K6

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

Dear Madam:

Subject: Water 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 Water Master Plan, as part of the City of Penticton's Integrated Infrastructure Master Plan.

Yours sincerely,

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

AK/ML/
Encl
cc::
WSP ref.: 20M-00462-00

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REVISION HISTORY

FIRST ISSUE

January 22, 2021	Draft			
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2021-06-07

APPROVED[1] BY *(must be reviewed for technical accuracy prior to approval)*

2021-06-04

Stephen Horsman, P. Eng., P.E.
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CONTRIBUTORS

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EXECUTIVE SUMMARY

The City of Penticton (City) has retained 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 Water Master Plan (WMP) is as follows:

- Model update and calibration;
- 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 water distribution network system provides service to some 35,000 residents, who have residential, industrial, commercial, institutional and agricultural need for water. The key components of the existing water distribution network are summarized in the table below.

EXISTING WATER DISTRIBUTION SYSTEM

ITEM	QUANTITY
Number of Water Sources	2
Number of Water Treatment Pants	1
Number of Reservoirs	7
Number of Pump Stations	4
Number of Pressure Reducing Valve Stations	4
Number of Hydrants	1053
Length of Watermains (Potable)	208 km

Raw water is pumped from Okanagan Lake to the Water Treatment Plant where it is mixed with Penticton Creek Raw water and treated, before distribution throughout the City.

The City's original Water Master Plan was completed in 2005 with recommendations to address existing deficiencies and support known growth areas. An Addendum to the Water Master Plan was completed in 2010, incorporating updated projections and capital projects the City had completed in the interim. Since the completion of the 2010 Addendum, the City has continued to complete projects, notably undertaking several small pipe renewals in the downtown core. The City has also recognized the importance of developing integrated capital programs to address the future infrastructure needs.

As part od this WMP, WSP updated an existing model of the City's water distribution system using the InfoWater software suite (Innovyze Inc.), as recommended in **Technical Memorandum # 1** (Appendix A). The hydraulic model consists of watermains, pump stations, storage reservoirs and pressure reducing valve stations. All model elements follow the asset naming convention detailed in **Technical Memorandum # 2** (Appendix B).

The primary sources of data used in the model update and in the development of the WMP include the City's GIS database, information shared by City staff, previous reports and the existing InfoWater hydraulic model used by the City for capital planning. 2017 water meter data was used as a basis to estimate existing design flows, and OCP developments presented in **Technical Memorandum # 5** (Appendix C) were also considered in the future horizon. The table below summarizes design flows assumed in the Master Plan.

EXISTING AND FUTURE DESIGN FLOWS

HORIZON	ADD (L/s)	MDD (L/ s)	PHD (L/ s)
Existing	223	488	672
Future	295	668	943

The level of service criteria were established using the City's Subdivision and Development Servicing Bylaw – Schedule D (August 2013) and the Master Municipal Construction Document (MMCD) 2014 Design Guideline Manual.

The modeling results indicate the water distribution system is for the most part adequately sized for existing conditions, though some capital improvements are required to address existing deficiencies and to meet the future OCP conditions. Capacity analysis of reservoirs and PRV stations suggest that Ridgedale reservoir and the storages for the 433 m pressure zone are deficient, while Penticton and MacCleave PRV stations also require upgrades to meet minimum service criteria. Notable fire flow deficiencies at the long dead end of Valleyview Road and in the Industrial core persist, which is consistent with the 2010 Addendum. Other localised areas of fire flow deficiency are largely attributed to historical design guidelines (now undersized cast iron watermains) which form the backbone of the City's distribution system and will be addressed as these aging pipes are renewed.

The Water Master Plan recommendations consist of a series of individual projects prioritized to address water distribution system deficiencies for the 5-, 10- and 25-year horizons. The prioritization approach considered the criticality and magnitude of the noted deficiencies (namely fire flow and capacity issues), and categorized improvement projects from high to low, most critical to least critical and accounting for uncertainty in future development.

After an initial prioritization approach was completed, results were merged with transportation, sanitary and stormwater system projects through a sophisticated integration approach supported by computer programming and spatial analysis in ArcGIS, with overlapping projects promoted for priority and as such 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 updated back into this report.

The proposed improvements shown in Appendix E include upsizing or expansion of existing infrastructure such as mains, valves and reservoirs, as well as new installations. The table below provides a cost summary all projects with "Class D" cost estimates.

CAPITAL COST ESTIMATE

IMPLEMENTATION SCHEDULE	NO. OF PROJECTS	TOTAL COST (2021 $)
1 - 5 Year (High Priority)	10	$ 9,647,550 (1), (2)
5 - 10 Year (Medium Priority)	21	$ 3,578,450 (1)
10-25 Year (Low Priority)	7	$ 25,645,850 (1)
Total	38	$ 38,871,850 (3)

(1) INCLUDES $152K FOR 5 YEARS OF HYDRANT INSTALLATION, ASSUMING 10 HYDRANTS PER YEAR, WAT10.

(2) INCLUDES A COST OF $2.95 M FOR THE PENTICTON AVE PRV UPGRADE, WAT-33.

(3) COST SUMMARY DOES NOT INCLUDE WAT-07 BUT DOES INCLUDES PREFERRED ALTERNATIVE WAT-51.

1 INTRODUCTION

1.1 PURPOSE

WSP Canada Ltd. (WSP) was retained by the City of Penticton (City) to complete an 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 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 water distribution infrastructure to support the population growth envisioned in the OCP.

Currently, the City's water distribution system services approximately some 35,000 residents who have residential, commercial, industrial and institutional uses for water. The City's previous Water Master Plan (WMP) in 2005 as well as the Addendum in 2010 noted some 50 projects to ensure the future supply of water and outlined a substantial renewal program of undersized mains throughout the City. This renewal program largely targeted cast iron pipes installed in the 1950s and 1960s which comprise the backbone of the distribution system. These existing considerations, combined with the need to accommodate future growth, present a challenge for the City's OCP 2045 objectives.

1.2 SCOPE OF WORK

The scope of work for the 2020 WMP is as follows:

— Update the City's existing InfoWater model using the latest GIS data and water meter data;
— Undertake a program of hydrant testing and calibrate the updated model with this data;
— Estimate future demand, assuming population increase and future land use from the City's OCP 2045;
— Conduct a capacity assessment with respect to the City's level of service criteria to identify existing and future deficiencies;
— 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-, 20- and 25-year horizon.

1.3 DATA COLLECTION AND INFORMATION REVIEW

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

TABLE 1-1 DATA COLLECTION SUMMARY

DESCRIPTION	DATA TYPE	SOURCE	PURPOSE
City of Penticton Water Model	**InfoWater files**	**City**	**Model Review and Update**

Water Utility GIS Data (watermains, pressure zones, connection points, laterals, hydrants, valves, pumps and other water infrastructure)	**Shapefiles**	**City**	**Model Review and Update**
Base map information (1m contours, city parcels, heritage and hazard areas, watercourses)	**Shapefiles**	**City**	**Model Update and Development**
Penticton Official Community Plan 2045	**PDF**	**City**	**Future Land Use and Population**
Water meter Data	**.xlsx**	**City**	**Existing Demand**
Hydrant Test Data	**.xlsx**	**WSP**	**Model Calibration**
SCADA Data	**.xlsx**	**City**	**Model Calibration**
Penticton Water Master Plan – Final Report December 2005 by Earth Tech	**PDF**	**RFP**	**Background**
Penticton Water Master Plan Addendum – Final Report June 2010 by AECOM	**PDF**	**RFP**	**Background**
The City of Penticton Subdivision and Development Servicing Bylaw	**PDF**	**City**	**Level of Service Criteria**

A knowledge transfer workshop was conducted with the City on July 18, 2020 to identify data gaps, known deficiencies 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 Micheal Firlotte, A.Sc.T, for their assistance to the project team in preparing this report and completing this project.

1.5 ABBREVIATIONS

AC	Asbestos Cement
ADD	Average Day Demand
BC	British Columbia
CI	Cast Iron
CT	Contact Time
DAF	Dissolved Air Flotation

DCC	Development Cost Charges
DI	Ductile Iron
ENR	Engineering News Record
EPS	Extended Period Simulation
GIS	Geographic Information System
HDPE	High Density Polyethylene
HGL	Hydraulic Grade Line
ICI	Industrial/Commercial/Institutional
kPa	Kilopascal
L/c/d	Liters per capita per day
L/s	Liters per second
m	Meter
MDD	Maximum Day Demand
ML	Mega Liter
mm	Millimeter
m/s	Meters per second
NTU	Nephelometric Turbidity Unit
OBWB	Okanagan Basin Water Board
OCP	Official Community Plan 2045
O&M	Operations and Maintenance
PHD	Peak Hour Demand
psi	Pounds per square inch
PRV	Pressure Reducing Valve
PVC	Polyvinyl Chloride
PZ	Pressure Zone
TCU	True Color Unit
TDH	Total Dynamic Head
WMP	Water Master Plan
WTP	Water Treatment Plant

2 EXISTING WATER SYSTEM

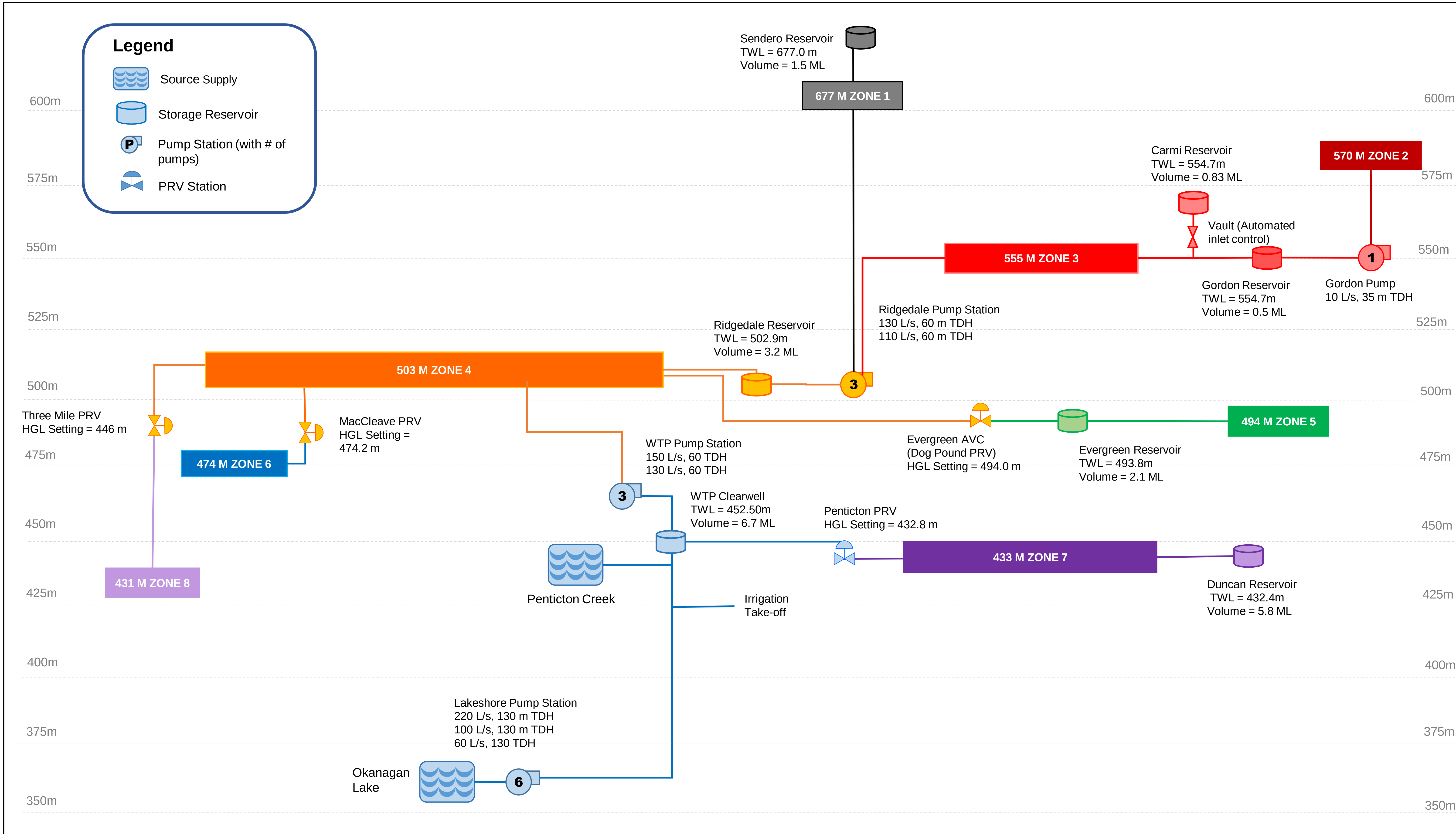
2.1 WATER SYSTEM OVERVIEW

The City's water distribution system consists of watermains, pressure reducing valve and pump stations, reservoirs and a water treatment plant. Table 2-1 gives a summary of the City's potable water infrastructure.

TABLE 2-1 WATER SYSTEM OVERVIEW

ITEM	NUMBER
Number of water sources	2
Number of Water Treatment Pants	1
Number of Reservoirs	7
Number of Pump Stations	4
Number of Pressure Reducing Valve Stations	4
Number of Hydrants	1053
Length of Watermains (Potable)	208 km

The distribution pipes generally range in diameter from 100 mm to 300 mm and were installed between 1952 and 2019. A hydraulic schematic of the City's distribution system is given in Figure 2-1, and shows raw water intakes, water treatment and storage infrastructure as well as pump station, pressure reducing stations and pressure zones.



North Vancouver Office , #210 - 889 Harbourside Drive
Tel (604) 990 4800 Fax (604) 990 4805

Client: CITY OF Penticton

Water System Hydraulic Schematic

Project: 20M-00462-00		Scale: Not to Scale	
Drawn: AK	Approved: ML		
Figure 2.1		Map No:	Date: June 2021
		Revision:	Revision Date:

2.1.1 WATER SUPPLY SOURCES

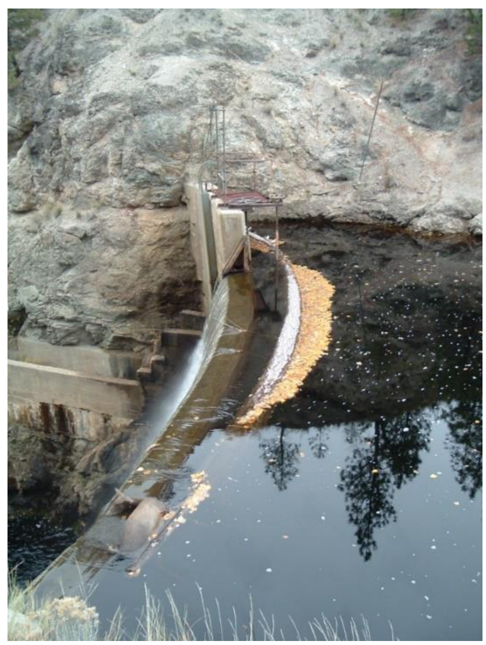
2.1.1.1 OVERVIEW

The City water system utilizes two water supply sources to provide potable water throughout the community. Each source is conveyed to the Water Treatment Plant (WTP) where they are blended and treated before entering the distribution system. The dual source system provides the City with flexibility to dynamically respond to changes in source water quality, source water availability (e.g. drought), and economic factors to ensure safe and reliable supply of water to the community. For example, the City may adjust their reliance on one source water in response to drought conditions or changing water quality.

As noted in the 2005 WMP, the City also has access to an additional groundwater source located at Warren Avenue (known as the Warren Avenue Well), which historically provided water for the City in addition to water from Okanagan Lake. The confined aquifer yield is an estimated 16 ML/day, which after treatment could supply an additional 11 – 13 ML/day to the City. Originally drilled in 1984, the well can deliver water to the distribution system, though it is hard with relatively high levels of Manganese and Iron. The Warren Avenue Well was decommissioned in 2008 and the City has no intention of further use or development of this well source for domestic use.

Penticton and Ellis Creeks have dams to store spring snow melt which are used to supply separate irrigation networks, notably the Naramata Bench area and agricultural bench lands south of the City respectively. These systems are not included in the scope of this master planning study.

2.1.1.2 PENTICTON CREEK



Penticton Creek is characterized as an upland watershed that provides a gravity supply of water to the WTP. Runoff and snow melt are stored in Greyback Dam (earthfill embankment), which is at an elevation of approximately 1649 m AMSL and can hold up to 12,330 ML. From there the water flows into Penticton Creek to the Campbell Mountain Reservoir, with an elevation of approximately 584 m AMSL where water is diverted into the Campbell Mountain Tunnel to supply the northern irrigation system along the Naramata Bench area. Penticton Creek continues to the Penticton Creek Dam 2, with an approximate elevation of 471 m AMSL where water is diverted to the WTP by gravity through a 700 mm steel pipeline. The raw water storage and gravity conveyance infrastructure could supply up to 60 ML/day[2].

Penticton Creek water source is subject to moderate to high colour during the spring freshet, while the turbidity is generally below 10 NTU throughout the year. Outside of the spring freshet, the Penticton Creek water quality remains relatively stable with colour ranging between 20 and 50 TCU and turbidity consistently below 1 NTU.

The Penticton Creek is a prominent natural asset within the community as is travels through the eastern part of the City and through the downtown core before discharging into Okanagan Lake. Recognizing the Creek as a vital natural asset to the community, the City are invested in the restoration and naturalization of the existing Penticton Creek channel downstream of the WTP diversion. The Penticton Creek source has experienced drought conditions in recent years and can be challenged to meet the ecological flow requirements throughout the year. In an effort to understand the hydrology and balance the domestic and ecological demands on the City, the City recently completed a drought management plan. Penticton Creek will continue to serve as a vital water source to meet the domestic water

[2] City of Penticton, Treated Water Capacity Upgrade – Preliminary Design Report, AECOM, 2008.

demands within the community. With consideration to ecological needs and potential drought conditions, the Creek may be relied upon to provide water under normal conditions, with less water available during drought conditions. Specific considerations and recommendations for Penticton source supply management will be outlined in the 2021 Drought Management Plan.

2.1.1.3 OKANAGAN LAKE

Okanagan Lake is the largest body of water in the BC interior and is relied upon by several communities within the Okanagan Valley for provision of drinking water. The City's Okanagan Lake water supply infrastructure consists of a 900 mm submerged lake intake complete with stainless steel fish screen, raw water pump station and dedicated 750 mm diameter ductile iron transmission main that pumps raw lake water to the WTP. The Okanagan Lake raw water pumping and transmission system has a rated capacity of 60 ML/day. The pump station is currently undergoing upgrades to replace the aging electrical systems and provide variable frequency drives on the some of the pumps. The following is a summary of the key infrastructure within the Okanagan Lake transmission system.

- 885 m 900 mm HPDE intake pipeline at a water depth of 40 m;
- Pump Station facility located on the Okanagan Lake foreshore adjacent to the Waterfront Park. The facility includes:
  - Common raw water wet well with provision to isolate the intake via a slide gate;
  - 6 vertical turbine pumps including 4-220 L/s (pumps 1 thru 4), 1-100 L/s (pump 5), and 1-60 L/s (pump 6);
  - electrical systems including 12,500 V x 600 v transformer, MCC, pump drives and disconnects, and automatic transfer switch;
  - 1,000 kW standby power generation system.
- Dedicated 750 mm diameter raw water transmission main (approximately 5.1 km length) from the pump station to the water treatment plant.

The Okanagan Lake water quality remains stable year-round with infrequent excursions where the turbidity exceeds 1 NTU. Water quality changes are typically the result of seasonal lake turn over or seiche events and wave action stirring up lake bottom sediments.

The 2005 WMP estimated an annual supply of more than 22,000 ML from Okanagan Lake, enough water for the City for the foreseeable future. Though the lake is large, with an estimated 483, 000 ML annual inflow on average, regional drought conditions, as observed in 2003, can result in very low lake levels. The Okanagan Basin Water Board (OBWB) serves as a regional champion for information sharing and collaboration by the water purveyors that utilize the Okanagan Lake for domestic and irrigation purposes. The OBWB have a detailed drought action plan that advises on drought action level and activities when drought conditions are encountered. As demands on the water source increase and more extreme weather events are anticipated with climate change, equitable management of Okanagan Lake will become more become important in the future.

2.1.1.4 WATER LICENCES

The City holds 12 water licenses for Okanagan Lake and Penticton Creek, the two water sources for domestic distribution, as summarized in Table 2-2. The projected 2045 annual average water demand and peak daily demand are estimated at 9300 ML and 58 ML/day respectively.

Based on the City's current water licences which total some 19,000 ML per year, there is adequate supply to meet projected demands for the next 25 years. The projected 2045 peak daily demand of 58 ML/day is also well within the current water treatment plant capacity of 88 ML/day.

TABLE 2-2 CITY OF PENTICTON OKANAGAN LAKE AND PENTICTON CREEK LICENSES

LICENSE NO.	WR MAP / POINT CODE	SOURCE	PURPOSE	STORAGE ML/YR	IRRIGATION ML/YR	DOMESTIC ML/YR
C005729	1550 P (PD54515); 1550D C (PD54716); 82.E.053.1.2 B (PD55237)	Penticton Creek	Irrigation		5,397	
"	1550 P (PD54515); 1550D C (PD54716); 82.E.053.1.2 B (PD55237)	Penticton Creek	Domestic			33
C012832	82E/11W(d) F (PD55449)	Penticton Creek	Storage	987		
C014229	1550 P (PD54515); 1550D C (PD54716); 82.E.053.1.2 B (PD55237)	Penticton Creek	Domestic			6,637
C026137	1550D C (PD54716)	Penticton Creek	Storage	62		
C030328	82E/11W(d) F (PD55449)	Penticton Creek	Storage	11,348		
C035678	1550D C (PD54716)	Penticton Creek	Irrigation		19	
C122535	82E/11W(d) F (PD55449)	Penticton Creek	Storage	247		
			Penticton Creek Total	12,644	19	6,670
C116809	1550B WW (PD54710)	Okanagan Lake	Domestic			4,978
C116810	1550B WW (PD54710)	Okanagan Lake	Domestic			4,149
C116811	1550B WW (PD54710)	Okanagan Lake	Domestic			3,319
C130920	1550B WW (PD54710)	Okanagan Lake	Domestic			116
C130923	1550B WW (PD54710)	Okanagan Lake	Domestic			133
"	1550B WW (PD54710)	Okanagan Lake	Irrigation		1,110	
			Okanagan Lake Total		1,110	12,695
			Total (12 Licenses)	12,644	6,526	19,365

2.1.1.5 *SOURCE WATER PROTECTION PLANNING*

Under the Drinking Water Protection Act, drinking water officers can order water systems to prepare a source water assessment and response plan or they can require one as part of the water supplier's operating permit. The province has developed several tools for conducting source water and system assessments and developing response plans. The primary tool is the Comprehensive Drinking Water Source to Tap Assessment Guideline, which outlines a systematic approach to identifying potential hazards within the water system, conducting a risk assessment and then developing actions to manage or mitigate the identified risk to protect the public drinking water supply.

A source water protection plan for Penticton Creek was completed in 2013[3], which identified sedimentation hazards as moderate to very high risk and pathogen contamination as very high risk. Recommendations included increased engagement and education of the users of the watershed including forest licensees, ranchers, and recreational groups. Pathogen contamination including bacteriological, protozoan, and viral contaminants, are currently managed through the multi-barrier treatment approach provided by the water treatment plant. Consideration to ongoing pathogen monitoring and supplemental treatment barriers may be considered to further protect the community water supply.

The City plan to undertake a source water protection plan for the Okanagan Lake source water in 2021. Given the dual nature of the City's source water supply, it is recommended to coordinate the outcomes of the two source water protection plans so that wholistic system management strategies may be developed and implemented to ensure continued safe, reliable access to water for the community.

2.1.2 WATER TREATMENT

The City maintains and operates one Water Treatment Plant capable of delivering a total of 60 ML/day (694 L/s). The plant was commissioned in 1996 and upgraded in 2009 to allow for increased pre-treatment of the Penticton Creek source water.

The original treatment process consisted of a direct filtration process train for the Okanagan Lake source water and a conventional treatment train (i.e. sedimentation followed by high rate granular media filtration) for treating the Penticton Creek water. The split train operation proved to be impractical and the City began blending the source waters at the head of the WTP and treating the full flow through the conventional treatment train. Due to the marked reduction in water quality observed in Penticton Creek during the spring freshet, the City historically took the Penticton Creek source offline between April and September at treated only Okanagan Lake water. Limitations within the original sediment clarification process challenged the WTP to achieve the rated capacity of 60 ML/d (694 L/s) under certain water quality conditions.

The 2009 pre-treatment upgrades increased the clarification capacity to 115 ML/day (1,331 L/s). These upgradese included the addition of a dissolved air flotation (DAF) process to increase the robustness of the treatment plant and allow greater flexibility to treat the Penticton Creek water.

The DAF process is highly effective at removing colour from the source water and provides the City with the option to utilize Penticton Creek throughout the year. Pilot testing showed that the DAF could support running the Creek up to a source water blend ratio of 50:50, however, operational testing indicate that the optimum cost performance

[3] City of Penticton, Penticton Creek Source Assessment Report, Urban Systems, 2013.

occurs at a blend ratio of 70:30 Okanagan Lake to Penticton Creek. This approach balances the pumping costs related to running the Okanagan Lake source water with the pre-treatment chemical costs necessary to remove the color and effectively coagulate the Penticton Creek source water. The City WTP staff continue to adjust the blend ratio to respond to changes in the quality and turbidity within the two source waters.

The installed the filters remain rated at 60 ML/day (694 L/s), however, with the addition of the DAF the existing filters could be re-rated to 88 ML/day (1019 L/s). This would then allow the facility to be rated for a firm capacity of 88 ML/day (1019 L/s).

2.2 KNOWN ISSUES AND RECENT UPGRADES

Existing capacity issues as detailed in previous reports and observed by the City at the knowledge transfer workshop on June 19, 2020 include;

- **Penticton Ave PRV -** The existing configuration of the PRV results in poor cycling of Duncan Reservoir, and there is a current study underway (AECOM) to investigate replacement or reconfiguration of the PRV.
- **Lakeside Road and Valleyview Road -** The existing watermains along Lakeside and Valleyview Road are long dead ends at the southern extent of the existing distribution system, where it is difficult to convey adequate fire flow. Projects WAT-51 (or alternatively WAT-07) and WAT-42 would address these deficiencies and could involve developer contribution as the City negotiates future growth in this area.
- **Ridgedale Reservoir -** The existing reservoir is under capacity for current emergency, fire flow and balancing needs. This deficiency will become more apparent in the future with growth and increasing demand. An expansion of 2,215 cubic metres has been proposed to accommodate current needs and future growth.
- **Aging Cast Iron Mains** – Much of the distribution backbone in the downtown and industrial areas of Penticton is comprised of cast iron mains installed in the 1950s and 1960s. With newer design guidelines and changing land use these ageing mains are now undersized and potentially showing signs of tuberculation and poor performance. Where critical, mains have been identified for replacement to accommodate current fire flow needs, particularly in the industrial area, as well as infill growth.
- **Future Growth** – Future growth in the City needs to be planned for adequately. The proposed development of the Wiltse area, from a water and storm perspective, presents known challenges both from land acquisition and optimum servicing.

3 MODEL AND SCENARIO DEVELOPEMENT

3.1 MODEL SOFTWARE SELECTION

The existing hydraulic model of the City's water distribution system was updated using the InfoWater software suite available from Innovyze Inc., as recommended in **Technical Memorandum # 1** (Appendix A). This modelling platform allows for all components of the distribution network to be represented dynamically, with allowance for multiple scenarios to be generated, including fire flow simulations.

The pre-existing model is an extended period simulation (EPS) with a two week simulation period to dynamically capture changes in the system. All model elements including dummy nodes and have been updated to follow the asset naming convention detailed in **Technical Memorandum # 2** (Appendix B).

The City's GIS database form the primary source of data used for model update. Where newly installed pipes were missing from the model, pipes where imported from the Watermain GIS shapefile, and the City's 1 m contours were used for elevation. Other assumptions have been based on the Subdivision and Development Servicing Bylaw.

3.2 MODEL DEVELOPMENT OVERVIEW

3.2.1 JUNCTIONS

Junctions in the model represent changes in pipe material or diameter in the distribution network and indicate intersections of pipes or locations of hydrants. The City provided GIS data of watermains and other water infrastructure which has been used to update the existing network in the model. New junctions that were added to the model were assigned pressure zone and elevation according to the contour information and pressure data in GIS shapefiles supplied by the City.

3.2.2 PIPES

Watermains in the City's distribution network is modelled in InfoWater as pipes with pressure drop due to friction estimated using the Hazen–Williams equation. In this formulation, friction is proportional to the C-factor, which is a measure of pipe smoothness and dependent on pipe material and install year. The existing model was updated pipe material and install date using information contained in the watermain GIS shapefile supplied by the City. C-factor hydrant tests were undertaken at six sites across the City to calibrate C-factors, as described in greater detail in Section 4.3.1.

The majority of the City's 210 km potable water distribution network consists of PVC (45%) and Cast Iron (34%) pipe, as shown in Figure 3-1.

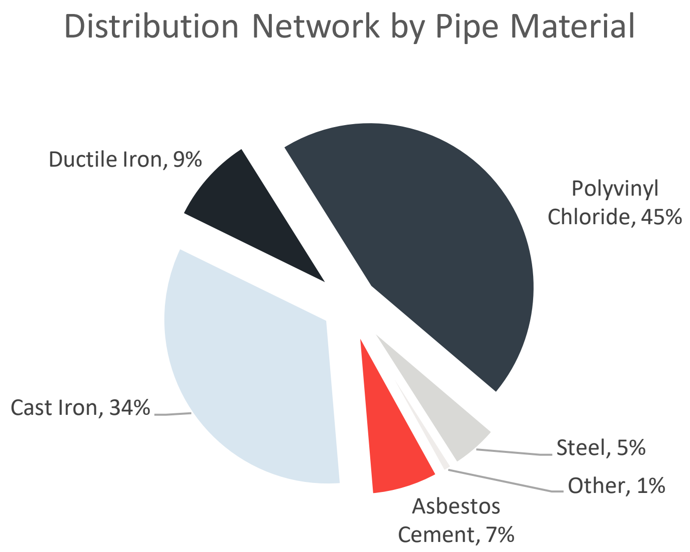


FIGURE 3-1 DISTRIBUTION NETWORK BY PIPE MATERIAL

Previously 85% of the pipes represented in the model were of unknown pipe material. This data gap has been largely closed by comparing the GIS water main shapefile supplied by the City and the pipes in the model, including data such as install year and pipe material as appropriate.

The distribution network consists of a range of pipe diameters, though most commonly pipes are between 100 mm and 250 mm in diameter (85%) as shown in Figure 3-2.

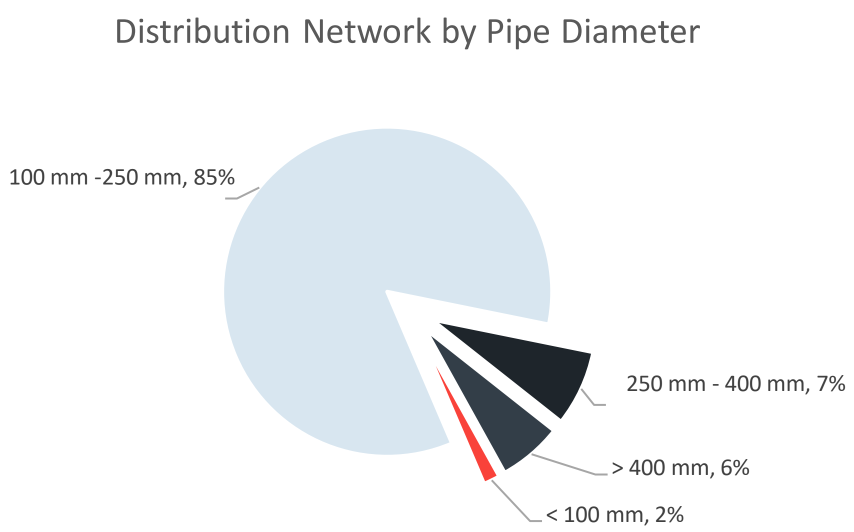


FIGURE 3-2 DISTRIBUTION NETWORK BY PIPE DIAMETER

3.2.2.1 PVC WATERMAINS

PVC is the most common material type in the City's distribution network, totalling some 94 km. PVC pipes began to be installed in the 1970s and have increased in popularity since, with almost 40% of all PVC pipe installed in the 2010s. Two of the six C-factor calibration hydrant flow tests were conducted on PVC pipe.

3.2.2.2 CAST IRON WATERMAINS

Some 70 km of the City's water distribution network is Cast Iron (CI) pipe, installed in the 1950's and 1960's. The majority of cast iron water main diameter is between 100 and 200 mm, and is widespread throughout the network, reflecting the fact that the backbone of the network built 70 years ago was predominantly CI pipe.

Two of the six C-factor calibration hydrant flow tests were conducted on CI pipe which suggested that in both cases tuberculation could be occurring (see section 4.3.1 C-Factor Calibration for more discussion).

3.2.2.3 DUCTILE IRON WATERMAINS

A relatively small proportion of the City's water distribution network (9%) is Ductile Iron (DI) pipe, and dates from the 1970s and 1980s. One of the six C-factor calibration hydrant flow tests was conducted on DI pipe.

3.2.2.4 ASBESTOS CEMENT WATERMAINS

Asbestos Cement (AC) pipe accounts for approximately 7% of the City's water distribution network, installed mainly in the 1960s and 1970s. One of the six C-factor calibration hydrant flow tests was conducted on AC pipe.

3.2.3 RESERVOIRS

Reservoirs in InfoWater represent raw water sources. The Penticton Creek and Okanagan Lake sources are represented in the model as reservoirs with static water levels.

3.2.4 TANKS

Tanks in InfoWater represent storage in the distribution system. WSP reviewed reservoir information such as capacity, base elevation and top water level provided by the City.

There are a total of seven storage reservoirs in the City's water distribution system, as listed in Table 3-1 and shown in Figure 2-1. There are two storage reservoirs (West Bench and Carmi 2) that are privately maintained.

TABLE 3-1 STORAGE RESERVOIRS

RESERVOIR	ELEVATION (M)	TOP WATER LEVEL (M)	STORAGE (ML) (1)
WTP Clearwell	452.5	459.2	8.5
Ridgedale	498.6	502.9	2.35
Carmi	550.2	554.7	2.49
Duncan	427.15	432..4	5.9
Evergreen	487.7	493.8	2.23

Gordon	**550.05**	**554.7**	**0.53**
Sendero	**671.9**	**677.0**	**1.5**

(1) STORAGE IS INCLUSIVE OF EMERGENCY AND FIRE STORAGE.

3.2.5 PUMP STATIONS

Pump in InfoWater are represented by their pump curves. The City supplied nameplates for pumps and WSP checked pump curves from suppliers with the pump curves used in the model. When pumps turn on and off is controlled in the initial status setting of pump components and can also be triggered to turn on when reservoir levels are low using logical statements in control settings. This is pertinent extended period simulation but not necessary to specify for assessment of ADD, MDD and PHD stand alone assessments.

There are four pump stations in the City's water distribution system, as listed in Table 3-2 and shown in Figure 2-1, the water system schematic. There are other pump stations which are privately owned and service small housing developments which are not detailed here.

TABLE 3-2 PUMP STATIONS

PUMP STATION (1)	CAPACITY (L/S)	NO. OF PUMPS AND TOTAL DISCHARGE HEAD
Lakeshore	**220 L/s (pumps 1 to 4) 100 L./s (pump 5) 60 L/s (pump 6)**	**6 pumps with 130 m TDH**
WTP	**150 L/s (pump 1) 130 L/s (pumps 2 and 3)**	**3 pumps with 60 m TDH**
Ridgedale	**130 L/s (pump 1), 110 L/s (pump 2) 40 L/s (Sendero x 2)**	**2 pumps with 60 m TDH 2 pumps with 180 m TDH (Sendero)**
Gordon	**10 L/s**	**1 pump with 35 m TDH**
Duncan Ave	**No longer in service**	

(1) SMALL BOOSTED CLOSE SYSTEMS INCLUDING HOLDEN ROAD AND NARAMATA ARE NOT INCLUDED IN THIS STUDY.

Operation of these pump stations is based on past reports, previous modelling and discussions with the City, and is as follows:

- The Lakeshore Pump Station pumps raw water from Okanagan Lake to the Water Treatment Plant
- The WTP Pump Station supplies the 503 m pressure zone (PZ) and pumps water to Ridgedale Reservoir. This is one of the primary routes leaving the WTP, the other being gravity flow through Penticton PRV, which fills Duncan Reservoir and supplies the core downtown network. Secondary routes are to MacCleave PRV (PZ 474 m), Three Mile PRVs (PZ 431 m) and Evergreen ACV and Reservoir (PZ 494 m).

- Ridgedale Pump Station supplies the 555 m pressure zone, and pumps to Carmi Reservoir, which supplies the 555 m pressure zone, and also the Gordon Reservoir. One pump in the pump station pumps to the Sendero Reservoir which supplies the 612 m pressure zone.
- Gordon Reservoir is fed from the 555 m pressure zone and Gordon Pump Station supplies the 570 m pressure zone, a local booster service area.
- Duncan Ave PS is no longer in service as pumping causes high pressures in the 503 m pressure zone, which would compromise the integrity of the network, as described in the 2010 WMP Addendum.

3.2.6 PRV STATIONS

InfoWater has the capability to model pressure reducing valves, given elevation, valve diameter and setting. WSP reviewed the existing input for PRV stations against contour and operational data supplied by the City. Pineview PRV was noted by operations staff to no longer be in service and therefore removed from the model.

There are four active pressure reducing stations in the City's water distribution system, as listed in Table 3-3 and shown in Figure 2-1, the water system schematic. There are a total of eight pressure zones, spanning from the lowest zone at 431 m (Three Mile) to the highest at 677 m (Sendero).

Table 3-3 Pressure Reducing Stations

PRESSURE REDUCING STATIONS	ZONE	LEAD PRV SIZE (mm)	ELEVATION (m)	HGL SETTING (m)	STATUS
Three Mile PRV	431 m	150	411	446	Active
Penticton Ave PRV	433 m	2 x 300	424.4	432.8	Active
MacCleave PRV	474 m	150	410.9	474.2	Active
Spruce PRV	433 m	150	392	402	Fire Flow PRV
Pineview PRV	-	100	447.9	490.1	Decommissioned

3.3 SCENARIO DEVELOPMENT

The updated hydraulic water model was used to assess the existing and future hydraulic performance of the water network under Average Day Demand (ADD), Maximum Day Demand (MDD), and Peak Hour Demand (PHD) conditions. In addition, fire flows coincident to MDD were also assessed. Prior to conducting these analyses, base user demands were first developed and allocated to model nodes for use under each demand scenario.

The original InfoWater model supplied by the City is an extended period simulation model that uses base demands and diurnal patterns to simulate the water network behavior over a 14-day period. The diurnal patterns are broken down by leakage, base domestic, base ICI, seasonal domestic, seasonal ICI, and park field irrigation water consumption. Steady-state demand simulations under the EPS model are generated by choosing a specific hour during the 14-day simulation period that best represents the average of any given demand condition being assessed.

For example, in the original model, MDD occurred between hours 6:00 and 7:00, while PHD occurred between hours 22:00 and 23:00.

Based on discussions with City staff, the ADD, MDD, and PHD scenarios developed for the present assignment were generated using the pre-existing patterns in order to preserve the basic EPS function of the original model for future use, as detailed in the subsections below. It should be noted that the existing patterns were generated for the 2005 WMP using available SCADA data at the time, therefore the patterns should be updated for current water consumption trends. For the current assignment, it was deemed acceptable to use the existing patterns to scale updated base demands in the model to simulate the latest demand conditions. It is recommended that the next iteration of the WMP include pattern updates to maintain EPS model functionality.

As well, the City requested that the model inputs be changed from base demands (i.e litres per second) to population estimates. Therefore, conversion factors were developed for each scenario and user types so that when multiplied by the population data allocated to model nodes, the corresponding water consumption demand is calculated for each node under all ADD, MDD, and PHD scenarios.

The following section details the methodology for deriving existing and future anticipated population and demand estimates for the City.

3.4 EXISTING POPULATIONS AND WATER DEMANDS

3.4.1 EXISTING DEMAND ESTIMATES

Daily WTP flows were provided from 2010 to 2019. Based on recent consumption patterns, 2017 had the highest Maximum Day Demand in the last five years (488 L/s). Therefore, 2017 was chosen as a representative baseline year for evaluating existing system conditions. Historic ADD and MDD trends are illustrated in Figure 3-3.

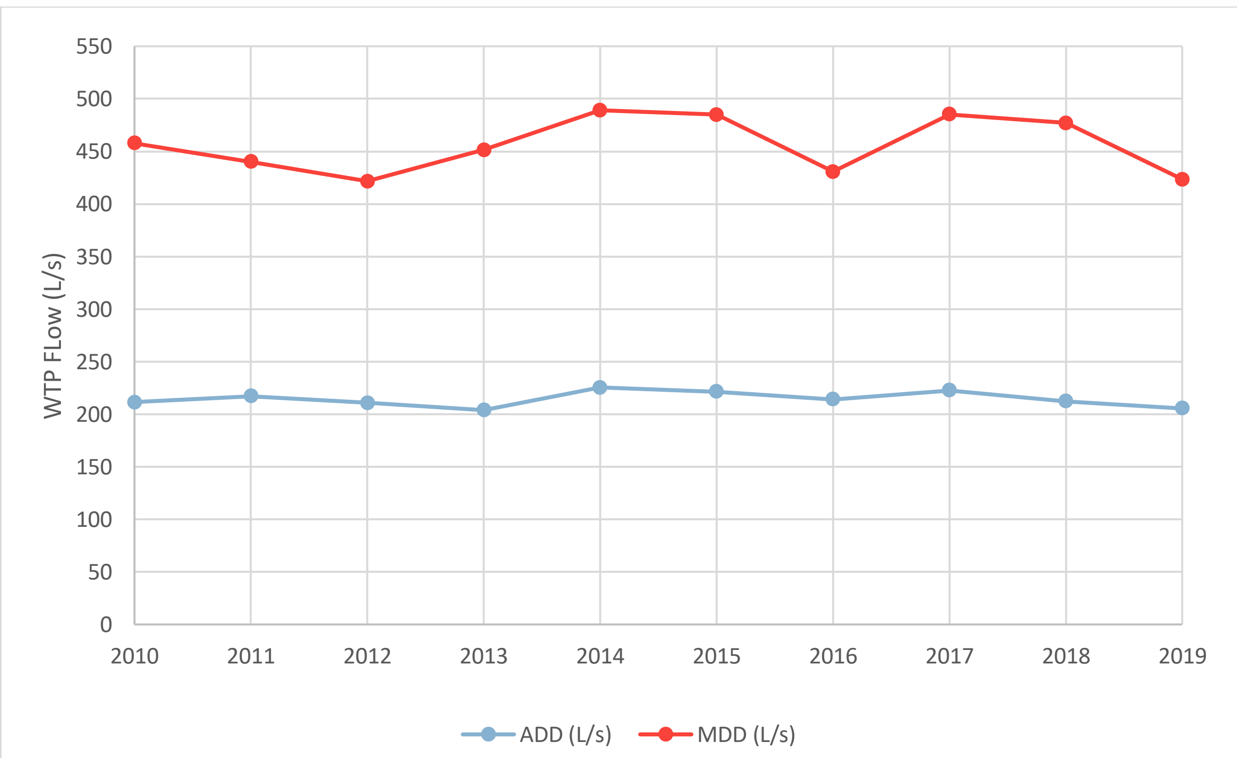


FIGURE 3-3 HISTORIC ADD AND MDD BASED ON RECENT WTP FLOW DATA

2016 to 2019 meter records were provided by the City which are broken down by residential and industrial, commercial and institutional (ICI) users. The Average Day Demand recorded by individual meters for the 2017 baseline year was 199 L/s, compared to the WTP recorded supply of 223 L/s. The estimated 24 L/s in leakage was accounted for by being evenly distributed across nodes within the City's model, proportional to the allocated 2017 metered demands included in the model.

The unaccounted for water in the City is approximately 11% of the production volume which is within the typical range of 10 to 30% for municipalities in BC. The City is aware of leakage within the network and is in the process of developing a leakage detection program. We recommend to continue to improve the supply-side water management to reduce occurances of non-revenue water throughout the system.

Hourly WTP SCADA data as well as hourly reservoir levels across the system for the week of July 1st to July 7th, 2017, was used to calculate the Peak Hour Demand. The Peak Hour Demand estimated for the 2017 baseline year is 672 L/s. It was calculated to occur between 21:00 and 22:00 on July 6th, 2017.

Table 3-4 summarizes the 2017 baseline Average Day, Maximum Day, and Peak Hour Demands, broken down by usage type.

TABLE 3-4 EXISTING DEMAND BY USAGE TYPE AND RESULTING PEAKING FACTORS

USAGE TYPE	EXISTING DEMAND				
	ADD (L/S)	MDD (L/ S)	PHD (L/ S)	MDD/ADD	PHD/ADD
Single Family (1)	78	157	250	2.0	3.2
Multi-Family (2)	36	72	115	2.0	3.2
Multi-Family (3)	46	94	149	2.0	3.2
Inst/Irrigation	14	42	60	3.1	4.4
Industrial	4	9	7	2.5	2.0
Commercial	40	100	80	2.5	2.0
Rural	5	13	10	2.5	2.0
Total	223	488	672	2.2	3.0

(1) SINGLE FAMILY ARE DETACHED HOMES AND DWELLINGS.
(2) MULTI-FAMILY CATEGORY 1 INCLUDES SEMI-DETACHED, ROW HOUSE, DUPLEX AND OTHER ATTACHED DWELLINGS.
(3) MULTI-FAMILY CATEGORY 2 INCLUDES MOVABLE DWELLINGS AND APARTMENTS.

3.4.2 EXISTING POPULATION ESTIMATES

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 using a medium growth rate of 0.65% from the latest OCP 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.

Table 3-5 summarizes the change from census to baseline residential population and includes population equivalents for ICI users.

TABLE 3-5 RESIDENTIAL POPULATION BREAKDOWN

POPULATION TYPE	2016 POPULATION (LATEST CENSUS)	2017 POPULATION (BASELINE)
Single Family (Detached)	17,455	17,575
Multi-Family (Category 1) (1)	7,310	7,429
Multi-Family (Category 2) (2)	9,675	9,661
Institutional (3)	-	2,942
Commercial (3)	-	8,713
Industrial (3)	-	851
Rural (3)	-	1,019
Total	34,440	48,190

(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.
(3) 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 EXISTING POPULATION EQUIVALENTS.

3.5 POPULATION AND DEMAND ALLOCATION

As per the City's request, the updated model is loaded with population rather than demand. Population in the model is converted to demand when the conversion patterns are applied to each population usage type. Current and future population were proportioned and assigned to parcels in the City's parcel GIS shapefile, based on occupancy rates derived from 2016 Census data, current land use and future land use as stipulated in the 2045 OCP. Population was split into the following usage populations for each parcel:

— Single Family Domestic
— Multi-Family Domestic (Category 1 and 2)
— Industrial (population equivalent)
— Commercial (population equivalent)
— Institutional (population equivalent)

The Demand Allocator Tool within InfoWater was used to allocate each parcel (centroid) with its assigned populations to the nearest node in the model.

3.5.1 AVERAGE DAY DEMAND ALLOCATION

The 2017 ADD was used to scale existing usage patterns such that at hour 175 of the extended simulation period the total demand in the model is equal to 222.6 L/s. Hour 175 is assumed to be coincident with ADD as the pattern multipliers for Base Domestic and Base ICI are 1 while the pattern multipliers for Irrigation Domestic, Seasonal ICI and Irrigation Parks and Sport fields are 0, which is consistent with low demand periods during the winter (i.e. little to no irrigation and seasonal demands), as shown in Figure 3-4.

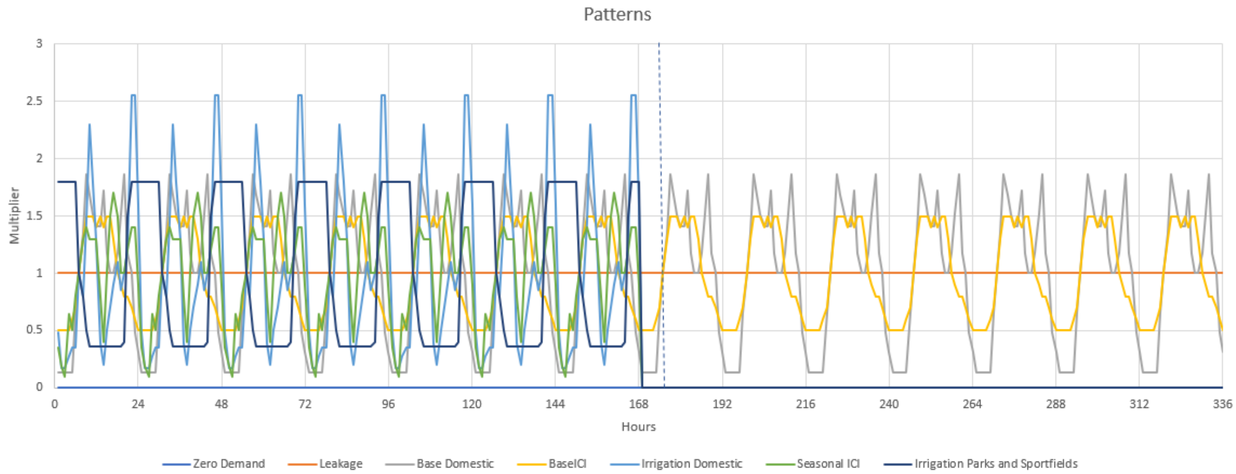


FIGURE 3-4 PREVIOUSLY ASSUMED USAGE PATTERNS IN THE SUPPLIED INFOWATER MODEL; 175 HRS

3.5.2 MAXIMUM DAY AND PEAK HOUR DEMAND ALLOCATION

Hour 15 of the extended period simulation is assumed to coincide with MDD. Base Domestic and Base ICI demands are augmented by Irrigation Domestic, Seasonal ICI and Irrigation for Parks and Sports fields as at this timestep these usage patterns are no longer 0, as shown in Figure 3-5.

Irrigation Domestic, Seasonal ICI and Irrigation for Parks and Sports fields are assumed to contribute to MDD and PHD scenarios as follows:

- Irrigation Domestic demand is proportional to Base Domestic demand;
- Seasonal ICI demand is proportional to Base ICI demand; and,
- Irrigation for Parks and Sports fields is assumed to be proportional to Institutional usage.

The relative proportion of the contributions of these additional patterns has been adjusted using engineering judgement such that the total MDD is equal to the metered MDD in 2017, with the resulting peaking factors reported in Table 3-7 deemed acceptable.

Hour 21 of the extended period simulation is assumed to coincide with PHD, assuming that peak flow is irrigation driven, as per Figure 3-5. As with the MDD scenario, the contribution of Irrigation Domestic, Seasonal ICI and Irrigation for Parks and Sports fields has been adjusted using engineering judgement such that the total PHD is equal to the metered PHD in 2017, with the resulting peaking factor reported in Table 3-7 deemed acceptable.

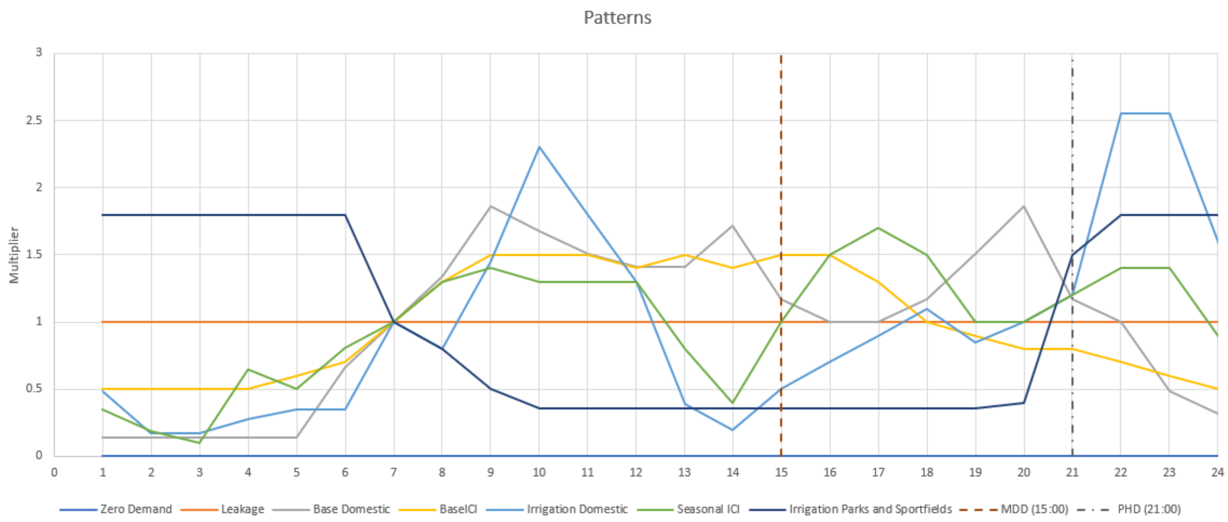


FIGURE 3-5 PREVIOUSLY ASSUMED USAGE PATTERNS IN THE SUPPLIED INFOWATER MODEL; FIRST 24 HRS

3.6 FUTURE POPULATIONS AND WATER DEMANDS

Future population has been estimated using the OCP 2045 population projection together with areas highlighted for intensification and future development.

The following discussion herein is a summary of the WSP Technical Memo #5 Population Projection (dated November 13, 2020), which contains a more detailed description of the assumptions and calculations to derive future population. Technical Memo #5 is given in full in Appendix C.

3.6.1 FUTURE DEMAND BY USAGE TYPE

The 2045 OCP identified several growth priorities for the City with an increased focus on intensification within the existing developed land base and reduced focus on expanding service to peripheral areas including hillside developments.

Future added residential and ICI population has been estimated according to the City's 2045 OCP. Future demand for this added population has been estimated assuming the per capita per day (L/c/d) demand from the City's Subdivision and Development Bylaw 2004-81, Schedule "G" Table 2.1, replicated in Table 3-6. Table 3-7 gives the resulting future demand by usage type.

TABLE 3-6 PER CAPITA DEMAND AS PER BYLAW

DEMAND	FLOW (L/c/d)
Average Day Demand (ADD)	**700**
Maximum Day Demand (MDD)	**1750**
Peak Hour Demand (PHD)	**2625**

TABLE 3-7 FUTURE (2045) DEMAND PER USAGE TYPE

USAGE TYPE	2045 DEMAND PROJECTIONS ADD (L/S)	MDD (L/ S)	PHD (L/ S)	MDD/ADD	PHD/ADD
Single Family	96	204	319	2.1	3.3
Multi-Family (1)	64	143	221	2.2	3.4
Multi-Family (2)	56	118	185	2.1	3.3
Inst/Irrigation	18	54	78	2.9	4.2
Industrial	5	13	13	2.5	2.5
Commercial	50	124	116	2.5	2.3
Rural	5	13	10	2.5	2.0
Total	295	668	943	2.3	3.2

(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.

3.7 DEMAND SUMMARY BY PRESSURE ZONE

Population in the model is converted to demand when the conversion patterns are applied to each population usage type. Conversion patterns were developed for each ADD, MDD and PHD scenario such that when multiplied by population the correct demand is calculated. Table 3-8 is a summary of the demand reported from the model per pressure zone for existing and future ADD, MDD and PHD scenarios.

TABLE 3-8 SUMMARY OF DEMAND BY PRESSURE ZONE

PRESSURE ZONE	EXISTING DEMAND			2045 DEMAND		
	ADD (L/S)	MDD (L/S)	PHD (L/S)	ADD (L/S)	MDD (L/S)	PHD (L/S)
431 m	0.1	0.2	0.1	0.1	0.2	0.1
433 m	171	378	511	220	499	695
474 m	2	5	7	2	5	7
494 m	7	15	23	7	15	23
503 m	23	50	66	24	51	71
555 m	15	30	48	15	32	48

570 m	1.3	1.9	3.4	1.3	1.9	3.4
677 m	4	8	13	5	10	16
Spiller Road	-	-	-	7	18	27
Wiltse North	-	-	-	10	25	37
Wiltse South	-	-	-	4	10	15
Total	223	488	672	295	668	943

Not listed in the table above are the demands assumed for West Bench supply. As agreed with the City, supply to West Bench is assumed to be 40 L/s in the MDD and PHD scenarios.

3.8 FIRE FLOW SCENARIO DEVELOPMENT

Fire flows for each parcel in the City's GIS shapefile were assigned minimum fire flow requirements according to the land use categories provided in the Subdivision and Development Bylaw 2004-81, as shown in Section 5, Table 5-2.

The Demand Allocator Tool available within InfoWater was then used to map the minimum required fire flow of each parcel to the nearest node in the model. In the case where different fire flow requirements were allocated to the same node, the maximum value was taken as the required fire flow for that specific node.

As existing land use designations are subject to change under future conditions, future fire flow requirements were recalculated based on future OCP land use for the ultimate 2045 scenario.

4 MODEL CALIBRATION

4.1 CALIBRATION METHODOLOGY

"Water-distribution-model calibration consists of comparing model results with field measurements, making adjustments to a model, and reviewing field data to improve agreement between the two. The calibration process should result in a more accurate model as well as a better understanding of the strengths and weakness of the model – and in many cases a better understanding of the distribution system itself".

(Committee Report: Defining Model Calibration, AWWA, 2013)

A water model is a decision-support tool. Although a water model can be calibrated to accurately perform an analysis of fire flows, water quality, and/or energy requirements, a model that is calibrated for one of these analyses may not be well calibrated for another. It is how the water model will be used as a decision support tool that will dictate the type and extent of model calibration.

The hydraulic calibration of a water model for fire flow analysis provides a model that is well suited to assess other demands on the system such as ADD, MDD, and PHD and how these demands impact the sizing of reservoirs, sizing of transmission and distribution watermains, pumping capacity, PRV settings, etc. The calibration of the hydraulic water model for a fire flow analysis therefore provides the Town with a tool to develop a cost-effective strategy to manage and upgrade its potable water infrastructure to meet the demands of the current population as well as anticipated growth.

Calibration of a water model is an iterative review process encompassing the details of each component of the water system including: the length, diameter, material, and roughness factors of the watermains; node demands and elevations; and pump configurations and operational settings. The calibration process allows for confirmation and, where appropriate, revisions to the assumptions and/or estimates made in the development of the model.

Calibration requires confirmation of the model predictions by comparison to field measurements. A hydrant flow testing program was developed such that static and residual pressures within the water distribution network could be recorded during a simulation of fire flows, as well as any special operational changes to the system (such as main closures, valve closures, etc). The recorded field results are then compared to the computer water model predicted results through the calibration process.

A program for multi-pressure and C-factor hydrant flow testing was developed to collect field data to use in model calibration. For the multi-pressure tests, a total of three sets of hydrant flow tests were conducted in two of the City's pressure zones. The three sets of hydrant flow tests are listed in Table 4-1 Flow hydrant test locations and presented in detail in Appendix D. The hydrant flow testing program was conducted from August 27, 2020 to August 29, 2020.

TABLE 4-1 FLOW HYDRANT TEST LOCATIONS

FLOW TEST SET	PRESSURE ZONE
Set 1	**433 m**
Set 2	**555 m**
Set 3	**433 m**

Six C-Factor tests were conducted across four of the City's pressure zones. Hydrant testing location and field data are presented in detail in Appendix D.

4.2 HYDRANT TESTING PROGRAM

A multi-pressure hydrant flow testing program includes fully opening a pre-determined hydrant and measuring flow from it, while simultaneously recording residual pressures at four other hydrants in the surrounding area, within the same pressure zone. A C-factor hydrant flow testing program includes isolating supply to and fully opening a pre-determined hydrant and measuring flow from it. Simultaneously, residual pressures were recorded at the adjacent two hydrants upstream. The procedure used to collect data for model calibration is outlined as follows:

— For multi-pressure hydrant flow testing, four high resolutions pressure loggers (± 0.2% of full scale) were installed on predetermined hydrants within the test zone and one was installed on the hydrant adjacent to the flow hydrant. For C-factor hydrant flow testing, two pressure loggers were installed on the hydrants immediately upstream of the flow hydrant;
— One 2.5-inch turbine flow meter (accuracy 0.5%) was installed on a predetermined flow hydrant port to achieve full hydrant flow, this was repeated two more times within each test set;
— WSP and City field crews monitored flow and supervised drainage and dechlorination;
— Flow rates were recorded form an analog readout meter. This flow is later used to simulate flow in the water model to calibrate the modelled system pressure changes to those recorded by the pressure loggers; and,
— Pressure loggers were removed, stopped, and downloaded into a computer program. From this recorded data, static and residual pressures were later retrieved.

The following were considered in the selection of the multi-pressure hydrant flow and pressure locations to obtain representative coverage of the zone:

— All hydrants are in the same pressure zone;
— General location and populated areas; and,
— Land use.

The following were considered in the selection of the C-factor hydrant flow test and pressure locations to obtain representative coverage of the system's watermains:

— All hydrants are in the same pressure zone;
— Range of pipe diameters; and,
— Range of pipe materials.

4.3 RESULTS AND DISCUSSION

4.3.1 C-FACTOR CALIBRATION RESULTS

Watermain materials and years of installation were based on the GIS information provided by the City and corroborated by the pipe metadata reported in the City's hydraulic InfoWater model. Results of the C-factor hydrant testing and calibrated values are summarized in Table 4-2.

Table 4-2 C-Factor Calibration Results

FLOW TEST NO.	FLOW HYDRANT	RESIDUAL HYDRANT 1	RESIDUAL HYDRANT 2	FIELD RECORDED HEAD LOSS (M)	PIPE MATERIAL	PIPE DIAMETER (MM)	PIPE INSTALL YEAR	CALIBRATION C-FACTOR	CALIBRATION CALCULATED HEADLOSS (M)
1	HYD-624	HYD-94	HYD-623	2.44	AC	200	1981	140	2.96
2	HYD-959	HYD-73	HYD-1003	7.16	CI	200*	1964	100	6.54
3	HYD-637	HYD-80	HYD-640	5.94	CI	150*	1950	100	6.08
4	HYD-664	HYD-665	HYD-668	1.01	DI	163	1974	130	3.73
7	HYD-599	HYD-479	HYD-480	3.67	PVC	155	1983	140	4.83
8	HYD-311	HYD-119	HYD-118	3.08	PVC	150	2008	140	3.21

Note that Flow Tests 5 and 6 were abandoned as valves could not be accessed and flow could not be isolated.

C-factor verification was completed using the Hazen-Williams equation, by calculating the C-factor value that provides the closest calculated head loss in comparison to field recorded results. Where some values fell within expected values for C-factor, these have been used and included as updated values into the City's hydraulic water model. Note that the calculated head loss values for Tests 2 and 3 assume a 10% reduction in the cast iron pipe diameter. Tests 2 and 3 suggest that tuberculation could be occurring in the City's cast iron pipes, and with more testing the extent and degree of this within the existing distribution network would be confirmed.

Where values did not fall within expected values, WSP did not include the c-factors into the water model. Specifically, the low recorded head loss in Test 4 suggests that flow was not isolated and potentially a valve was not closed properly. For Test 7, the calculated head loss is 32% different from the recorded head loss, though the pressure difference is only 1.6 psi, well within the accuracy of the pressure gauge. Similarly, for Test 1 the difference between the calculated and recorded head loss is 21%, but the difference in pressures is 0.7 psi, well within the accuracy of the pressure gauge.

Poor correlation is due to suspected field measurement errors or other unknown sources of errors such as valve configurations in the field which were not fully closed as envisioned, or unknown connections. Table 4-3 summarizes the updated C-factors used in the hydraulic model. Unknown or other pipe materials, which make up less than 5% of the network by length, have been assigned the C-factors for PVC pipe (the most common pipe material type), assuming a 2.5 decay in c-factor per decade, as per common industry practise. Steel pipe was not tested, and so c-factors for these pipes remain unchanged.

Table 4-3 Watermain C-Factor Values

INSTALL DECADE	ASBESTOS CEMENT	CAST IRON	DUCTILE IRON	POLYVINYL CHLORIDE
1920s	125	92.5	117.5	-
1930s	127.5	95	120	-
1940s	130	97.5	122.5	-

1950s	**132.5**	**100**	**125**	**-**
1960s	**135**	**100**	**127.5**	**-**
1970s	**137.5**	**102.5**	**130**	**-**
1980s	**140**	**105**	**132.5**	**140**
1990s	**142.5**	**107.5**	**135**	**140**
2000s	**145**	**110**	**137.5**	**140**
2010s	**147.5**	**112.5**	**140**	**142.5**

4.3.2 MULTI-PRESSURE FIELD CALIBRATION RESULTS

The results of the calibration process indicate generally a good correlation between the field pressure measurements and computer predicted results, based on assumed HGL settings at PRV stations between pressure zones. The complete calibration and validation results are provided in Appendix D.

Field investigation by City staff is recommended to confirm PRV settings, and to confirm if throttled or closed valves occur near hydrants which are not well calibrated, which are summarized below:

— All Tests, all sets – one of pressure gauges in the set was consistently showing lower and obviously anomalous pressure readings compared to other static hydrants in the set, and as such has been exempt from the calibration process.

— Hydrant Flow Test Set No. 1, Set 3 – The field recorded pressure of the residual hydrant was significantly lower than the computer simulated residual pressure for this test set. However, for all other hydrants in the set, the computer simulated static and residual pressures were within 10% of the field recorded data. A throttled valve could be the cause of this result, but this behaviour is difficult to replicate in the model.

— Hydrant Flow Test No. 2, Set 2 – The field recorded pressure of the residual hydrant was significantly lower than the computer simulated residual pressure for this test set. However, for all other hydrants in the test, the computer simulated static and residual pressures were within 10% of the field recorded data.

— Hydrant Flow Test No. 3, Sets 2, 3 and 4 – The field recorded pressure of the residual hydrant was significantly different to the computer simulated residual pressure for these tests. However, for all other hydrants in the set, the computer simulated static and residual pressures were within 10% of the field recorded data. The field staff noted that while undertaking the hydrant testing that their appeared to be automatic valving active in the area during the test and this could have had some bearing on the calibration for Test No. 3.

4.3.3 CALIBRATION SUMMARY

90% (86/96) of the hydrant tests were successfully calibrated, showing less than 10% differences between field-recorded and model predicted values. WSP notes that in some cases assumptions were made for pump and valve settings to bring computer modelled results in line with those measured in the field. While the model appears to be sufficiently calibrated for the current system modelling analysis, elevations, and pressure settings should be field checked to improve the accuracy of and confidence in the model.

5 LEVEL OF SERVICE CRITERIA

5.1 SERVICE PRESSURES

Minimum service pressures are the standard for adequate flow and pressure of water to all serviced properties in the City. Maximum service pressures in the system also need to be regulated to prevent over-pressurizing of the system and subsequent breaks or increased leakage. Maximum pressures are normally reviewed under the average day demand scenario.

The City's Subdivision and Development Bylaw 2004-81 established the minimum and maximum system pressures allowed under certain conditions in the distribution network in Schedule "G" Table 5.2, replicated here in Table 5-1. The maximum allowable design velocity in distribution lines is 2 m/s.

TABLE 5-1 SERVICE PRESSURE CRITERIA

SERVICE CRITERIA	ALLOWABLE PRESSURE
Maximum Static Pressure	**1034 kPa (150 psi)**
Minimum Static Pressure at ADD	**275 kPa (40 psi)**
Minimum Static Pressure at PHD	**250 kPa (36 psi)**
Minimum Static Pressure at MDD + Fire Flow	**140 kPa (20 psi)**

5.2 FIRE FLOWS AND DURATION

Water distribution systems must be able to deliver large volumes of water for fire protection in addition to normal water demands. Fire protection assumptions/considerations are:

a) Only one fire will be fought at any one time;

b) To ensure pumper trucks obtain adequate water supplies from hydrants, a minimum residual pressure (20 psi) on the street main is required during fires; and,

c) Fire flow is coincident with maximum day demand.

Table 5-2 shows the minimum fire flow requirements for various land use areas and required fire flow durations for the City, as per Subdivision and Development Bylaw 2004-81, Schedule H, Table 3.2. The maximum allowed velocity throughout the water distribution system during fire flow conditions is 4 m/s.

TABLE 5-2 MINIMUM REQUIRED FIRE FLOW AND DURATION

DESCRIPTION	REQUIRED FIRE FLOW (L/s)	DURATION (hrs)
Single Family	**60**	**2**
Multi Family (less than 5 storeys)	**90**	**2**

DESCRIPTION	REQUIRED FIRE FLOW (L/s)	DURATION (hrs)
Multi Family (5 or more storeys)	150	2.5
Commercial	150	2.5
Downtown Commercial	225	2.5
Industrial	225	3
Institutional	150	2.5
Columbia Heights Development	150	2
Rural/Agriculture	60	2

5.3 SUPPLY STORAGE

Water storage reservoirs are located at specific elevations to establish pressure zones within the distribution system. Water storage is used to balance and optimize supply and delivery of water. When properly sized, reservoirs will store water during low demand periods and supplement the source supply during peak hour demand. Typically, reservoirs are designed to refill every day and to have adequate storage capacity to provide for balancing storage, which is estimated as 25% of maximum day demand, and fire storage based on the required minimum flow and duration listed in Table 5-2. Emergency storage is also required. Following the City's Subdivision and Development Bylaw 2004-81, storage volume requirements are estimated based on the following formula:

$$\text{Volume} = A + B + C$$

Where:

A = Fire Storage (required extent and duration of fire flow as noted in the guidelines above)

B = Equalization Storage (25% of Maximum Day Demand serviced by the Reservoir)

C = Emergency Storage (25% of A + B)

5.4 PUMP STATIONS

As outlined in the City's Subdivision and Development Bylaw 2004-81, pumping capacity should meet the maximum day demand of the downstream service area with the largest pump out of service, provided that balancing storage is available. If balancing storage is not on line, pumping capacity should meet peak hour demand with the largest pump out of service, and stand-by power should be provided to allow the greater of maximum day demand plus fire flow or peak hour demand during a power outage.

5.5 PRESSURE REDUCING STATIONS

PRV Stations should be reviewed for their ability to meet the Peak Hour Demand of their respective downstream service areas without exceeding a maximum velocity of 5.0 m/s. For PRV Stations serving as a backup fire flow supply only, the maximum velocity should not be exceeded under governing fire flow conditions.

5.6 FIRE HYDRANTS

Hydrants must be located so that the spacing is never greater than 180 m in 'Low Density Residential' areas identified within the OCP and 90m in all other areas.

6 WATER SYSTEM ASSESSMENT (ALL HORIZONS)

6.1 TREAMENT PLANT CAPACITY ANALYSIS

The current treatment process is able to achieve the recommended 3 log removal of protozoa through the implementation of the conventional treatment process train and 4 log inactivation of viruses by chlorine addition and CT within the clearwell.

Table 6-1 below presents the unit processes and their associated treatment.

TABLE 6-1 UNIT PROCESSES AND TREATMENT

PROCESS	DESCRIPTION	CAPACITY	COMMENTS
Coagulation	Rapid Mix Chamber with vertical mixer immediately following blend chamber	115 ML/d	18% PACL used at time of study.
Flocculation	Two trains with 3-staged, tapered flocculation	115 ML/d	Flocculant aid polymer added after first stage flocculation
DAF	Two trains that discharge into common channel supplying the filters.	115 ML/d	
Filtration	Deep bed mono media anthracite filters.	60 ML/d	Filters could be re-rated to achieve up to 80 ML/d capacity.
Disinfection	Chlorine addition and contact time (CT) within the existing clearwell.	60 ML/d	Based on a 3.0 m water depth, 1.0 mg/L Cl residual, and BF of 0.30.

As shown in the above table, the WTP has sufficient capacity to meet the current and protected 25 demands. It is recommended that the City consider the following activities as part of future planning and optimization of the water treatment facility:

1. DAF Air Saturation and Recycle Replacement
   a. **Objective:** Reduce energy and equipment replacement costs to operate the air saturation and recycle system.
   b. **Considerations**: Existing recycle pumps require frequent maintenance and nearly their end of service life. Advancements in air flotation treatment processes allow for alternate approaches that do not require large air saturation equipment.

c. **Action:** Complete a desktop study of alternate flotation to document the cost-to benefit of replacing the current recycle system an alternate technology.
d. **Timing:** 1 – 5 years.
e.

2. Filter Media Testing and Replacement
   a. **Objective:** Investigate alternate filter media designs and configurations to determine optimum configuration in advance of replacement of original filter media.
   b. **Considerations:** Existing media design was based on the original two train operation that included provision for direct filtration and treatment of sediment clarifier effluent. With the additional of the DAF process, the filter influent water quality characteristics are different and may warrant an alternate media design for optimum performance.
   c. **Action:** Install filter column pilot testing onsite to treat DAF effluent and conduct series of testing to evaluate the performance of alternate filter media designs and configurations.
   d. **Timing:** 5 – 10 years.
3. UV Disinfection
   a. **Objective:** Provide additional protection against protozoan within the source water and increase the operational flexibility to allow for the potential to operate in direct filtration mode on the Okanagan Lake source.
   b. **Considerations:** Assess the trade off in energy savings to switch off clarification versus the capital costs and energy input require for UV disinfection.
   c. **Action**: Complete a conceptual study may be completed to document the cost-to benefit of adding UV disinfection to the current treatment process.
   d. **Timing:** 5 – 10 years.

6.2 STORAGE CAPACITY ANALYSIS

This section summarizes the assessment of the existing storage capacities of the City's reservoirs to determine if they meet existing and future storage requirements. The fire storage required is governed by the highest fire flow demand required within the serviced area for each reservoir. The balancing, fire, and emergency storage volumes have been calculated based on the design criteria noted in Sections 5.2 and 5.3.

6.2.1 EXISTING STORAGE CAPACITY ANALYSIS

Table 6-2 summarizes the storage reservoir volumes and the respective pressure zones they supply in the water system under existing demand conditions.

TABLE 6-2 EXISTING RESERVOIRS

RESERVOIR	STORAGE VOLUME	SERVICE AREA(S)	EXISTING MDD	GOVERNING FIRE FLOW REQUIREMENT
Clearwell & Duncan	14.4 ML	433 m PZ	377.3 L/s	225 L/s for 3 hours
Ridgedale	2.35 ML	503 m PZ, 431 m PZ, 474 m PZ	54.8 L/s	225 L/s for 3 hours
Evergreen	2.23 ML	494 m PZ	15.1 L/s	150 L/s for 2.5 hours
Carmi & Gordon	3.02 ML	555 m PZ,612 m PZ	32.5 L/s	150 L/s for 2.5 hours

Sendero	1.5 ML	677 m PZ	7.9 L/s	90 L/s for 2 hours
Total	23.5 ML	-	487.7 L/s	-

Table 6-3 compares the total required storage to the existing available storage under existing demand conditions.

TABLE 6-3 EXISTING RESERVOIR CONTRIBUTIONS

RESERVOIR	A – FIRE STORAGE VOLUME (m^3)	B – BALANCING STORAGE VOLUME (m^3)	C – EMERGENCY STORAGE VOLUME (m^3)	A+B+C REQUIRED STORAGE VOLUME (m^3)	AVAILABLE STORAGE VOLUME (m^3)	SHORTFALL / EXCESS VOLUME (m^3)
Clearwell & Duncan	2,430	8,149	2,645	13,224	14,400	1,176
Ridgedale	2,430	1,183	903	4,517	2,350	-2,167
Evergreen	1,350	327	419	2,096	2,230	134
Carmi & Gordon	1,350	703	513	2,566	3,020	454
Sendero	648	171	205	1,024	1,500	476

The above analysis indicates that the Ridgedale Reservoir has a storage volume deficiency of approximately 2.2 ML under existing demand conditions. This is in keeping with the findings of the 2005 WMP and 2010 WMP Addendum Reports. The remaining reservoirs have not been found deficient, due to recent storage capacity upgrades.

6.2.2 FUTURE STORAGE CAPACITY ANALYSIS

Table 6-4 summarizes the storage reservoir volumes and the respective pressure zones they supply in the water system under future 2045 demand conditions. Proposed reservoirs for the future Wiltse and Spiller Road developments have been included in the table for completion. Further details on capital projects associated with planned developments are given in Section 7.

TABLE 6-4 FUTURE RESERVOIRS

RESERVOIR	STORAGE VOLUME	SERVICE AREA(S)	FUTURE MDD	GOVERNING FIRE FLOW REQUIREMENT
Clearwell & Duncan	14.4 ML	433 m PZ	498.8 L/s	225 L/s for 3 hours
Ridgedale	2.35 ML	503 m PZ, 431 m PZ, 474 m PZ	56.5 L/s	225 L/s for 3 hours
Evergreen	2.23 ML	494 m PZ	15.1 L/s	150 L/s for 2.5 hours
Carmi & Gordon	3.02 ML	555 m PZ,612 m PZ	33.9 L/s	150 L/s for 2.5 hours

Sendero	**1.5 ML**	**677 m PZ**	**10.1 L/s**	**90 L/s for 2 hours**
Wiltse	-	*Wiltse North and South Developments*	*35.1 L/s*	*90 L/s for 2 hours*
Spiller Rd	-	*Spiller Road Development*	*18.0 L/s*	*90 L/s for 2 hours*
Total	**23.5 ML**	**-**	**667.6 L/s**	**-**

Table 6-5 compares the total required storage to the existing available storage under future 2045 demand conditions.

TABLE 6-5 FUTURE RESERVOIR CONTRIBUTIONS

RESERVOIR	A – FIRE STORAGE VOLUME (m^3)	B – BALANCING STORAGE VOLUME (m^3)	C – EMERGENCY STORAGE VOLUME (m^3)	A+B+C REQUIRED STORAGE VOLUME (m^3)	AVAILABLE STORAGE VOLUME (m^3)	SHORTFALL / EXCESS VOLUME (m^3)
Clearwell & Duncan	**2,430**	**10,774**	**3,301**	**16,505**	**14,400**	**-2,105**
Ridgedale	**2,430**	**1,220**	**912**	**4,562**	**2,350**	**-2,167**
Evergreen	**1,350**	**327**	**419**	**2,096**	**2,230**	**134**
Carmi & Gordon	**1,350**	**733**	**521**	**2,604**	**3,020**	**416**
Sendero	**648**	**218**	**217**	**1,083**	**1,500**	**417**
Wiltse	*648*	*759*	*352*	*1,759*	-	*-1,759*
Spiller Rd	*648*	*388*	*259*	*1,295*	-	*-1,295*

The above analysis indicates that the existing Ridgedale reservoir storage volume deficiency is slightly worsened under future conditions. Recommendations for reservoir expansion to the existing site with provisions for future storage volumes are detailed in Section 7 of this report.

The analysis also indicates that the WTP Clearwell and the Duncan Reservoir have a combined storage volume deficiency of 2.1 ML under future conditions. This is in keeping with the findings of the 2010 WMP Addendum, which noted that provisions will have to be made for more water storage to supply the 433 m HGL Pressure Zone as the City core undergoes infill growth.

The analysis indicates that the proposed storage reservoirs for the Wiltse and Spiller Road developments should be sized to 1.8 ML and 1.3 ML, respectively. Further details on the capital projects associated with these developer-driven infrastructure needs are included in Section 7.

6.3 PUMP CAPACITY ANALYSIS

This section summarizes the assessment of the existing capacities of the City's pump stations to determine if they meet existing and future pumping requirements, based on the design criteria noted in Section 5.4.

6.3.1 EXISTING PUMP STATION CAPACITY ANALYSIS

Table 6-6 summarizes the pump station capacity assessment under existing demand conditions.

Table 6-6 Existing Pump Station Capacity Analysis

PUMP STATION (1)	SERVICE AREAS	EXISTING MDD (L/s)	ELEVATION GAIN (M)	ESTIMATED REQUIRED HP (2)	FIRM CAPACITY (HP) (3)	SHORTFALL / EXCESS VOLUME (HP)
Lakeshore	433 m PZ, WTP	487.7	111	977	1575	598
WTP	431 m PZ, 494 m PZ, 503 m PZ, Ridgedale	113.7	50	103	400	297
Ridgedale PZ555	555 m PZ, 474 m PZ, 612 m PZ	37.52	52	35	125	90
Ridgedale PZ677	677 m PZ	7.92	174	25	125	100

(1) Only major system pump stations have been assessed. Small pump stations servicing individual subdivisions including but not limited to the Naramata, Randolph, Holden, and Gordon Pump Stations have not been included.
(2) Estimated Required Horsepower assumes 80% Efficiency and 10% hydraulic losses.
(3) Firm capacity assumes single largest pump out of service for the station.

The above analysis indicates that the City's existing pump stations have sufficient pumping capacity to meet the City's existing needs.

6.3.2 FUTURE PUMP STATION CAPACITY ANALYSIS

Table 6-7 summarizes the pump station capacity assessment under ultimate demand conditions.

Table 6-7 Future Pump Station Capacity Analysis

PUMP STATION (1)	SERVICE AREAS	FUTURE MDD (L/S)	ELEVATION GAIN (m)	ESTIMATED REQUIRED HP (2)	FIRM CAPACITY (HP)	SHORTFALL / EXCESS VOLUME (HP)
Lakeshore	433 m PZ, WTP	667.6	111	1338	1575	237
WTP	431 m PZ, 494 m PZ, 503 m PZ, Ridgedale	177.3	50	160	400	240

Ridgedale PZ555	555 m PZ, 474 m PZ, 612 m PZ	74.24	52	70	125	55
Ridgedale PZ677	677 m PZ	10.11	174	32	125	93

(1) Only major system pump stations have been assessed. Small pump stations servicing individual subdivisions including but not limited to the Naramata, Randolph, Holden, and Gordon Pump Stations have not been included. Pumping needs for the future Wiltse and Spiller Road Pump Stations are summarized in their respective project sheets, based on development needs.

(2) Estimated Required Horsepower assumes 80% Efficiency and 10% hydraulic losses.

The above analysis indicates that the City's existing pump stations have sufficient pumping capacity to meet the City's needs under ultimate buildout.

6.4 PRV STATION CAPACITY ANALYSIS

The City's active PRV Stations were reviewed for maximum velocities under MDD+FF and PHD conditions. For each station, the maximum governing flow case was applied. A maximum normal operating velocity of 5 m/s was used for the assessment.

Table 6-8 and Table 6-9 summarize the PRV station velocity review under existing and ultimate buildout demand conditions.

TABLE 6-8 PRV STATION VELOCITY REVIEW – EXISTING CONDITIONS

PRESSURE REDUCING STATIONS	PRV SIZE (mm)	GOVERNING CONDITION	GOVERNING FLOW RATE (L/S)	PEAK VELOCITY (m/s)
Three Mile PRV	150	MDD+FF	60	3.4
Penticton Ave PRV	2 x 300	PHD	506	7.2
MacCleave PRV	75/150	MDD+FF	155	7.5
Spruce PRV	150	MDD+FF	90	5.1

TABLE 6-9 PRV STATION VELOCITY REVIEW – FUTURE 2045 CONDITIONS

PRESSURE REDUCING STATIONS	PRV SIZE (mm)	GOVERNING CONDITION	GOVERNING FLOW RATE (L/S)	PEAK VELOCITY (m/s)
Three Mile PRV	150	MDD+FF	60	3.4
Penticton Ave PRV	2 x 300	PHD	692	9.8

MacCleave PRV	**75/150**	**MDD+FF**	**155**	**7.5**
Spruce PRV	**150**	**MDD+FF**	**90**	**5.1**

As indicated in Table 6-8 and Table 6-9, the Penticton Avenue PRV Station requires upgrades to reduce peak hour velocities within the station under existing and future conditions. A separate study currently being conducted by a another consulting firm is underway to determine the optimal sizing and phasing of upgrades to the Penticton PRV Station. The recommendations from this separate study should be reviewed and implemented upon completion.

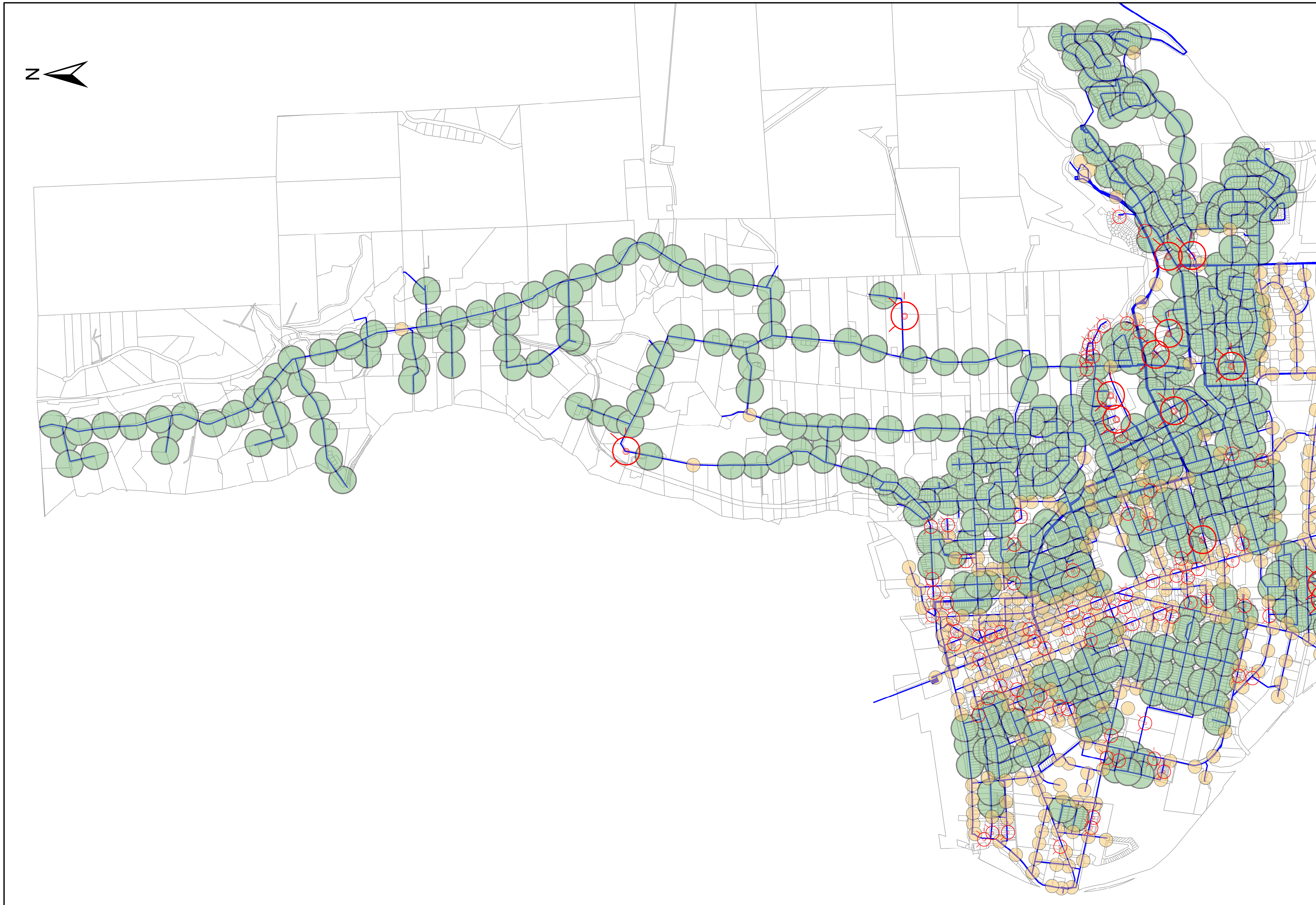
As well, the MacCleave PRV station was found to be deficient under fire flow conditions. While the station can meet downstream PHD conditions, a downstream fire flow requirement of 150 L/s coincident to MDD cannot be supplied without exceeding the maximum allowable velocity in the larger 150 mm lag valve. Assuming 5 m/s can be passed through the smaller 75 mm lead valve, the corresponding maximum velocity in the 150 mm lag valve is 7.5 m/s as shown in Table 6-8 and Table 6-9 above. It is recommended that the lag valve be upsized to a 200 mm PRV.

Lastly, the recently constructed Spruce Place Fire PRV was noted to have a minor velocity exceedance under fire flow conditions. As this is a minimal exceedance and the PRV station is not the only fire flow supply point to its downstream service area, no improvements have been recommended for this station at this time.

6.5 FIRE HYDRANT SPACING ANALYSIS

This section summarizes the assessment of the existing capacities of the City's pump stations to determine if they meet existing and future pumping requirements, based on the design criteria noted in Section 5.6.

Figures 6.1 and 6.2 show the results of the hydrant spacing analysis. The analysis was a GIS exercise to buffer existing residential and ICI hydrants and manually and by eye assess gaps in coverage. An estimated 150 hydrants in total are required to ensure adequate hydrant coverage throughout the City. This is captured in capital project WAT-10 where a program of 10 hydrant installations per year has been budgeted.



Hydrant Spacing Analysis

There are 1053 hydrants in the City.

Low Density Housing or Single Family Residential area hydrants are to have a maximum spacing of 180 m.

For all other ares, including Multi-Family, Industrial, Commercial or Institutional areas, hydrants are to have a maximum spacing of 90 m.

Based on this mapping and hydrant spacing analysis, an estimated 150 hydrants are required to address deficiencies in coverage.

Legend

- Proposed Hydrant
- Multi-Family and ICI Hydrant
- Single Family Residential Hydrant
- Watermain
- Parcels

wsp
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PENTICTON IIMP

Hydrant Spacing Analysis
North Extent

Project No.: **20M-00462-00**

Date: **Apr 2021**

Figure No.: **6.1**

Client: City of Penticton

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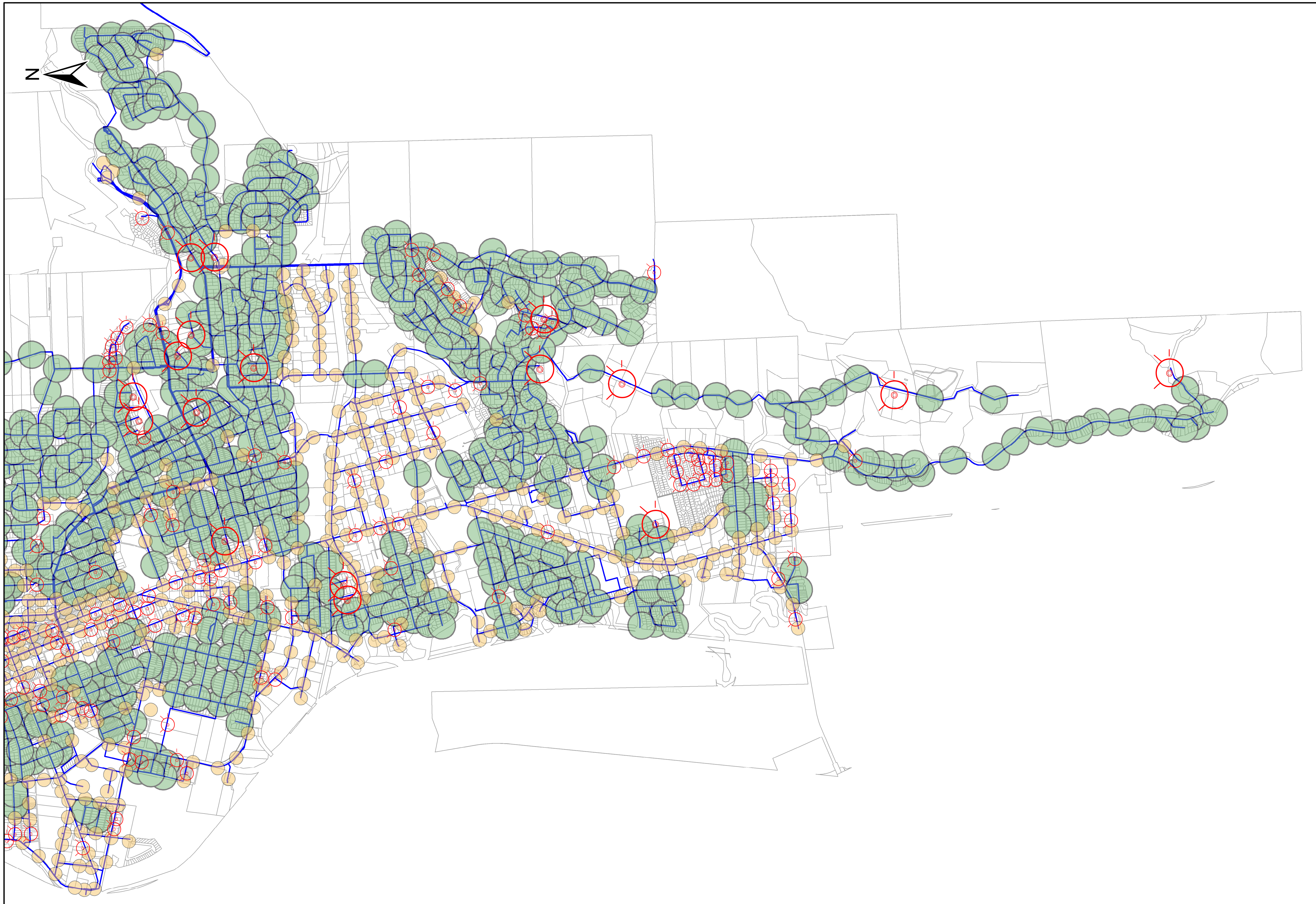

Hydrant Spacing Analysis

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Low Density Housing or Single Family Residential area hydrants are to have a maximum spacing of 180 m.

For all other ares, including Multi-Family, Industrial, Commercial or Institutional areas, hydrants are to have a maximum spacing of 90 m.

Based on this mapping and hydrant spacing analysis, an estimated 150 hydrants are required to address deficiencies in coverage.

Legend

- Proposed Hydrant
- Multi-Family and ICI Hydrant
- Single Family Residential Hydrant
- Watermain
- Parcels

wsp
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PENTICTON IIMP

Hydrant Spacing Analysis
South Extent

0 420 840
Meters

Project No.: 20M-00462-00
Date: Jan 2021
Figure No.: 6.2

Client: City of Penticton

6.6 DISTRIBUTION SYSTEM CAPACITY ANALYSIS

This section assesses the capacity of the City's water distribution mains with respect to their ability to convey adequate flows to meet service pressure requirements and fire flows throughout the system under existing and ultimate demand conditions. The City's hydraulic water model updated and calibrated as part of this study was specifically used to carry out this analysis.

6.6.1 MAXIMUM SERVICE PRESSURES – AVERAGE DAY DEMAND

As discussed in Section 5.1, the allowed normal operating range for the City's water distribution systems is 275 kPa (40 psi) to 1054 kPa (150 psi).

The maximum service pressure within each zone occurs at the properties at the lowest elevation compared to the HGL of the zone set either by a reservoir, PRV, or pump, and typically occurs under low demand conditions. Figure 6-3 illustrates the maximum service pressures assessed under the worst-case condition (in this case, under ADD conditions) for the future horizon. Table 6-10 summarizes the number of demand nodes with greater than 1054 kPa in each pressure zone.

TABLE 6-10 DEMAND NODES WITH GREATER THAN 1054 KPA

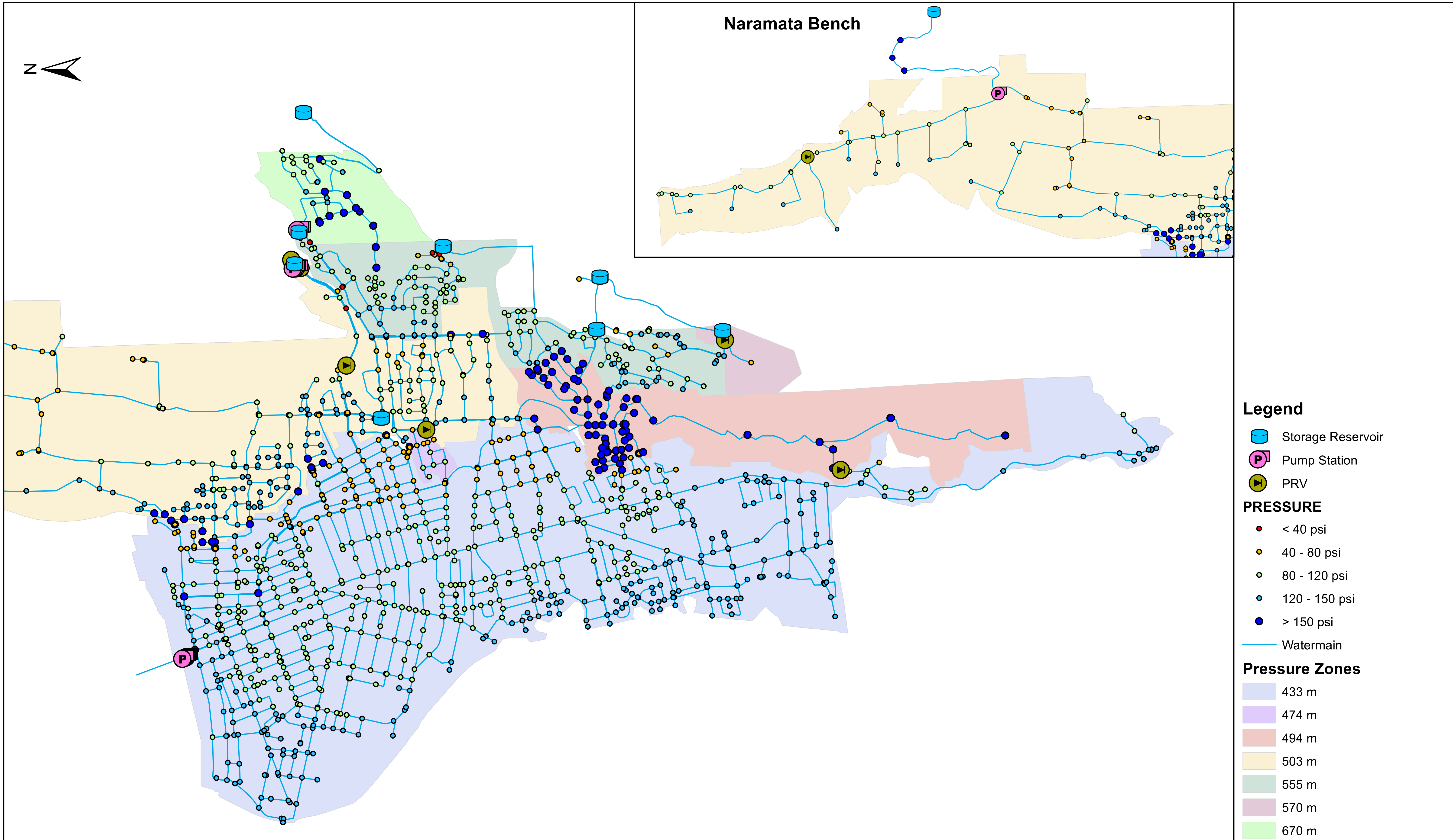
PRESSURE ZONE	NO. NODES WITH > 1054 KPA (150 PSI) EXISTING ADD	NO. NODES WITH > 1054 KPA (150 PSI) FUTURE 2045 ADD
431 m	**0**	**0**
433 m	**0**	**0**
474 m	**0**	**0**
494 m	**4**	**4**
503 m	**23**	**23**
555 m	**18**	**18**
570 m	**0**	**0**
677 m	**17**	**17**

Four pressure zones (PZ) have nodes with greater than 1054 kPa in both the existing and future scenario:

- 494 m PZ: 4 nodes or 6% of the zone, though all the exceedances are within 5% of the allowed maximum.
- 503 m PZ: 23 nodes, or 8% of the zone, though all the exceedances are within 10% of the allowed maximum.
- 555 m PZ: 18 nodes or 11% of the zone, though almost all exceedances are within 10% of the allowed maximum.

- 677 m PZ: 17 nodes, or 41% of the zone, though the nodes that service properties are within 10% of the allowed maximum. Higher pressures exist at the transmission main along the lower elevation section of Lawrence Avenue, but there are currently no services connected from the main in this location.

While improvements to address service pressures exceeding the normal operating range have not been included in this study, as the exceedances are marginal, Figure 6-3 provides City staff with a basis for investigating buildings and households in areas of potential risk due to high service pressures.



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Tel (604) 990 4800 Fax (604) 990 4805

PENTICTON IIMP

Maximum Sevice Pressures
ADD Future 2045 (No upgrades)

0 500 1,000

Meters

Project No.: 20M-00462-00

Date: Apr 2021

Figure No.: 6.3

Client: City of Penticton

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6.6.2 MINIMUM SERVICE PRESSURES – PEAK HOUR DEMAND

The City allows a minimum service pressure under PHD conditions of 250 kPa (36 psi).

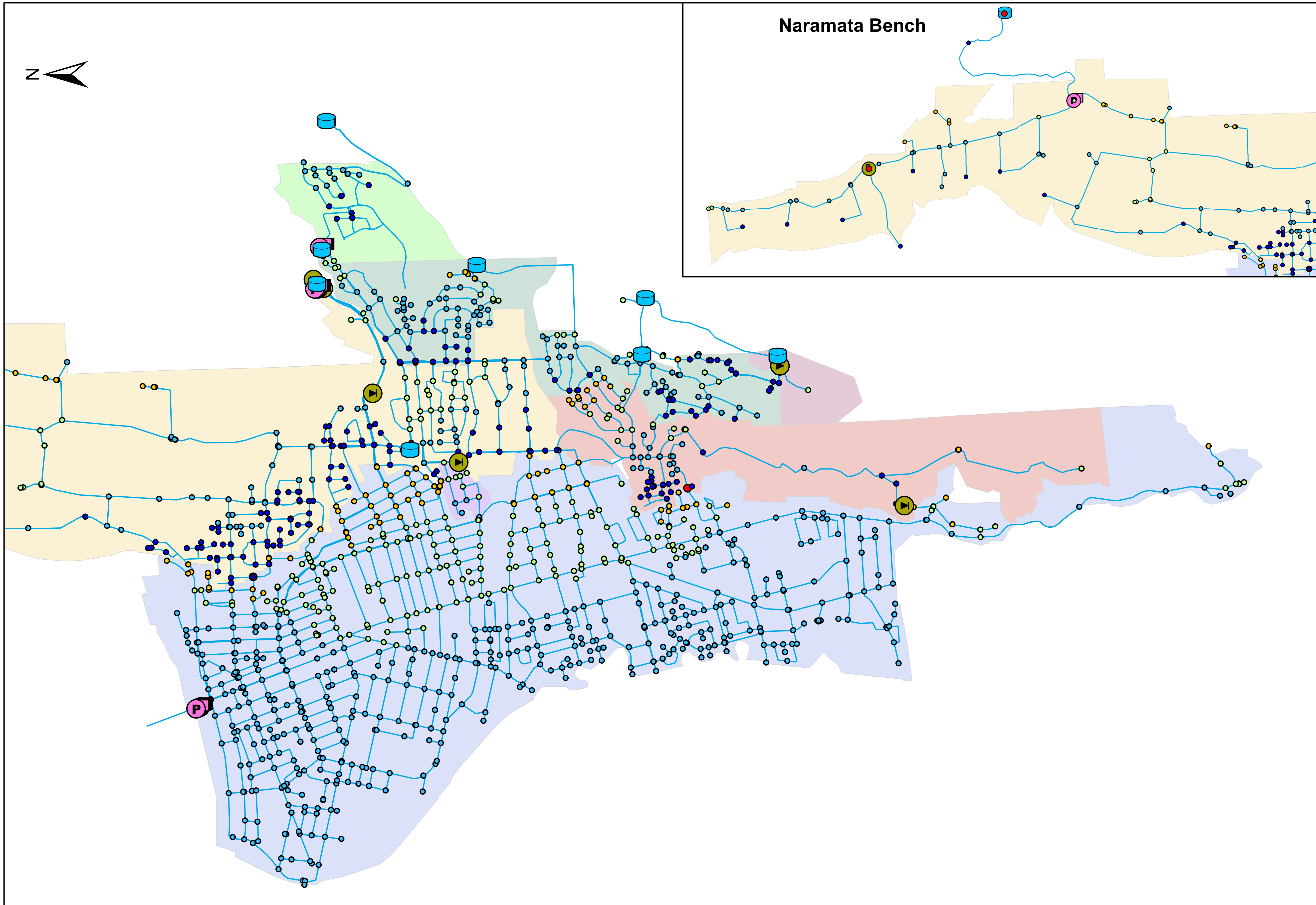
The minimum pressures within each zone occur at the properties at the highest elevation compared to the HGL of the zone set by either by a reservoir, PRV or pump, and typically occurs under high demand conditions. Figure 6-4 illustrates the minimum service pressures assessed under PHD conditions for the future 2045 horizon. Table 6-11 summarizes the number of demand nodes with less than 250 kPa in each pressure zone.

TABLE 6-11 DEMAND NODES WITH LESS THAN 250 KPA

PRESSURE ZONE	NO. NODES WITH < 250 KPA (36 PSI) EXISTING PHD	NO. NODES WITH < 250 KPA (36 PSI) FUTURE 2045 PHD
431 m	**0**	**0**
433 m	**0**	**0**
474 m	**0**	**0**
494 m	**1**	**1**
503 m	**0**	**0**
555 m	**0**	**0**
570 m	**0**	**0**
677 m	**0**	**0**

One pressure zone (PZ) has a node with less than 1054 kPa in both the existing and future scenario:

- 494 m PZ: A local high point near the zone boundary on Greewood Drive. Transfer of approximately 45 m of watermain along Greenwood Dr to PZ 503 and instal of a new valve to relocate zone boundary has been suggested in capital project WAT-W to address this deficiency.



Legend

Storage Reservoir
Pump Station
PRV

PRESSURE

- <36 psi
- 36 - 60 psi
- 60 - 90 psi
- 90 - 120 psi
- 120 - 150 psi

Watermain

Pressure Zones

- 433 m
- 474 m
- 494 m
- 503 m
- 555 m
- 570 m
- 670 m

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PENTICTON IIMP

Minimum Sevice Pressures
PHD Future 2045 (No upgrades)

0 500 1,000
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: 6.4

Client: City of Penticton

6.6.3 FIRE FLOWS COINCIDENT WITH MAXIMUM DAY DEMAND

The results from the fire flow analysis are summarized in Table 6-12 and illustrated in Figure 6-5.

TABLE 6-12 DEMAND NODES WITH LESS THAN THE REQUIRED FIRE FLOW

PRESSURE ZONE	NO. NODES WITH < REQ FIREFLOW (EXISTING MDD+FF)	NO. NODES WITH < REQ FIREFLOW (FUTURE 2045 MDD+FF)
431 m	**0**	**0**
433 m	**37**	**77**
474 m	**1**	**1**
494 m	**12**	**13**
503 m	**15**	**19**
555 m	**1**	**7**
570 m	**0**	**0**
677 m	**0**	**0**

Five pressure zones (PZ) have fire flow deficient nodes in both the existing and future scenario:

- -433 m PZ: 37 nodes or 6% of the zone is deficient for fire flow, though about half of these deficiencies within 10% of the required minimum. Deficiencies increase in the ultimate development scenario.
- 494 m PZ: 12 nodes, or 18% of the zone is deficient for fire flow, and about a quarter of the deficiencies are within 10% of the allowed maximum. The properties along the dead end at Valleyview Road have very little provision for fire flow (less than 20 L/s). Project WAT-7 addresses these deficiencies by upsizing the long dead end along Valleyview Road. An alternate servicing option is presented in WAT-52 and is preferred from a cost-benefit perspective.
- 503 m PZ: 15 node or 7% of the zone is deficient for fire flow, though a third of the deficiencies are within 10% of the allowed maximum. Deficiencies increase in the ultimate development scenario, with half of these within 10% of the required minimum. The Bridgewater estate on Penticton Ave is one location where the fire flow is noted as being deficient. One node on a dead services this estate, where the fire flow requirement is 90 L/s according to assumptions made according zoning. However it is noted that at least 60 L/s is available from this hydrant, which appears to be more in line with the dwellings in the estate.
- 555 m PZ: 1 node or less than 1% of the zone is deficient for fire flow, though the deficiency is within 5% of the allowed minimum. Deficiencies increase in the ultimate development scenario, and though they are all within 10% of the required minimum.

While some deficiencies can be ignored as there are adjacent nodes with sufficient fire flow within the nearby service area, there are some critical locations where the City should improve its water system in order to be able to provide the fire flows. Model nodes with significant fire flow deficiencies have been prioritized over locations with minor deficiencies (i.e. where available fire flows are within 5% of desired levels of service). "Medium Priority" projects (WAT-B to WAT-W).

The City have ongoing renewal program to replace existing watermains defined as undersized according to the City's Subdivision and Development Bylaw 2004-81 and will address the majority of the deficiencies particularly throughout zone 433 m, where much of the City's aging cast iron mains are located.

6.6.4 DISTRIBUTION SYSTEM UPGRADES

The recommendations presented in this section are limited to the main distribution system and generally do not directly address dead end watermains where no hydrants are connected. Improvements for fire flow servicing to dead ends should be addressed on a case-by-case basis, especially as there are opportunities in the future to have required watermain upgrades borne by developers wishing to connect to the existing water system in the future.

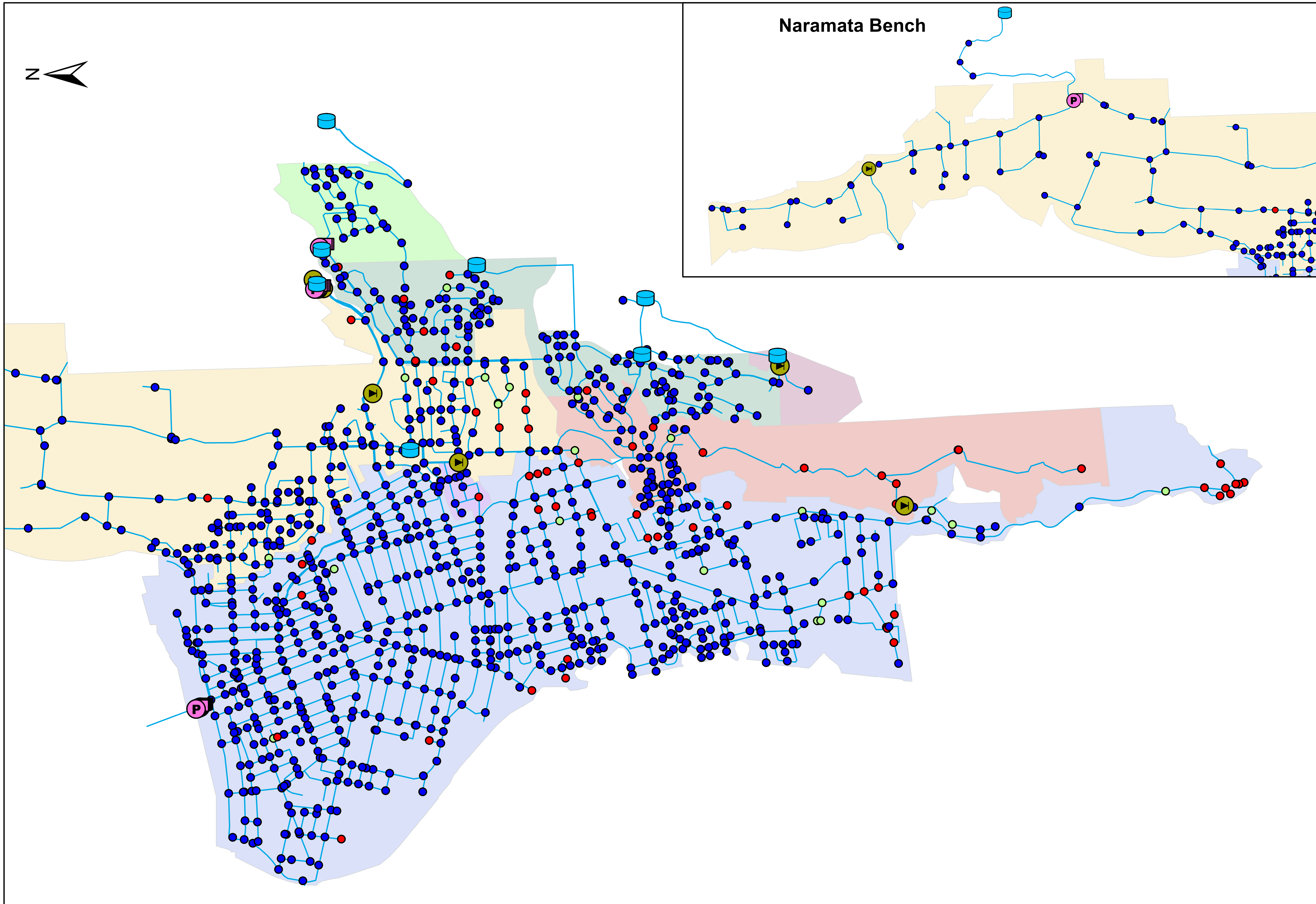
Figure 6-6 summarizes the recommended upgrade works to address existing and future distribution system deficiencies. Section 7 outlines the 25-Year Capital Works Plan which includes these upgrades as well as other strategic system expansion projects.

6.6.5 CAST IRON WATERMAINS

Approximately 70 km of the City's water distribution network is Cast Iron pipe, installed in the 1950's and 1960's. The majority of the cast iron mains are between 100 and 200 mm in diameter, and are widespread throughout the network, reflecting the fact that the backbone of the network built 70 years ago was predominantly CI pipe.

Two of the six C-factor calibration hydrant flow tests were conducted on CI pipe. Results suggested that in both cases tuberculation could be occurring (see section 4.3.1 C-Factor Calibration for more discussion). With more testing the extent and degree of this within the existing distribution network would be confirmed.

Figure 6-7 shows the extent of the cast iron mains in the network. The undersized main renewal program identified as a low priority capital project largely overlaps with the cast iron main network and is further discussed in Section 7.



Legend

- Storage Reservoir
- Pump Station
- PRV

Fire Flow

- Deficient
- Within 5% Sufficient
- Sufficient
- Watermain

Pressure Zones

- 433 m
- 474 m
- 494 m
- 503 m
- 555 m
- 570 m
- 670 m

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PENTICTON IIMP

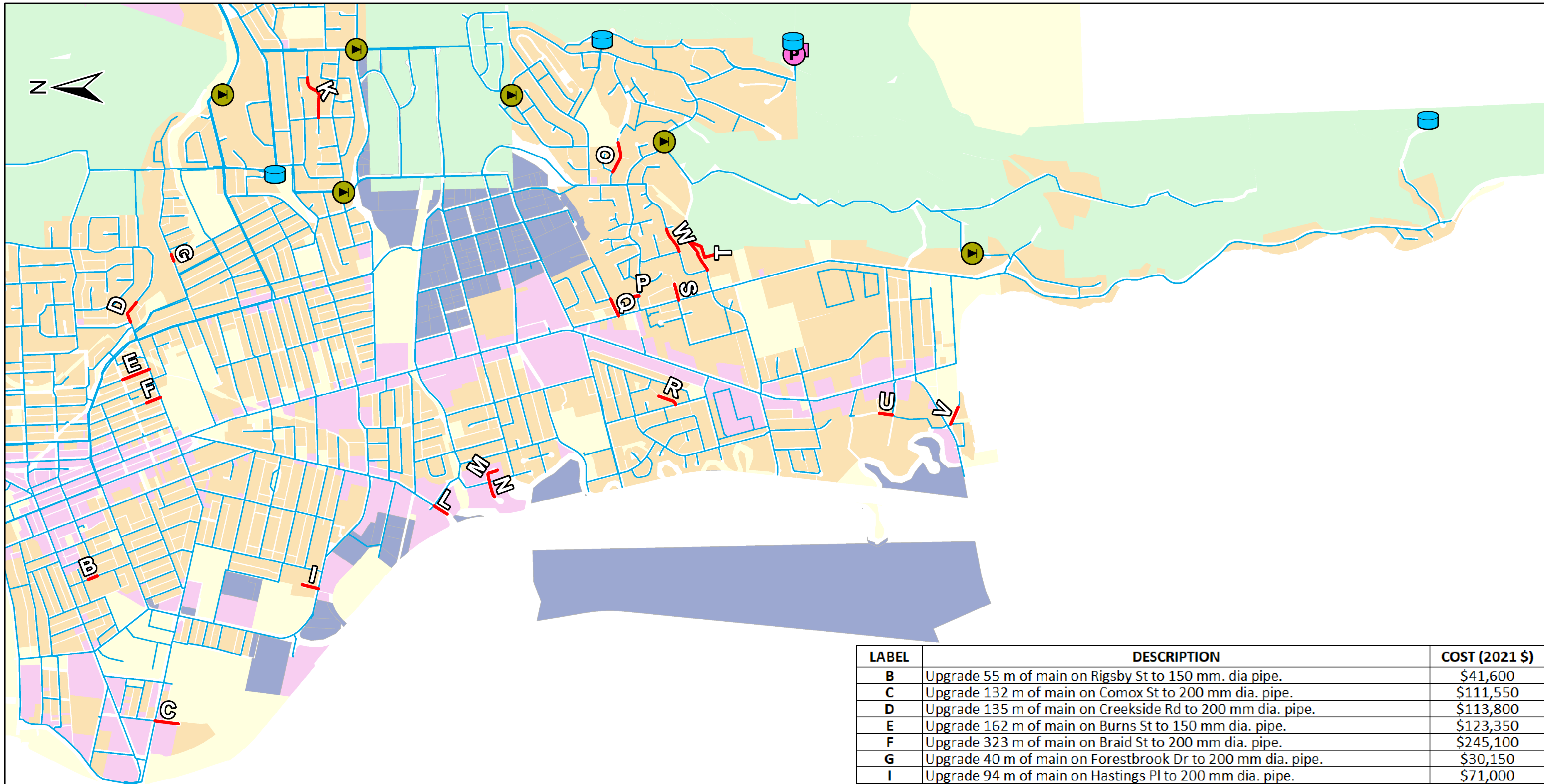
Available Fire Flow
MDD+FF Future 2045 (No upgrades)

0 500 1,000
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: 6.5

Client: City of Penticton

Path: C:\Users\caak070879\Documents\caak070879\02_projects\017_penticton\06_capital_projects_gis\2. Water MP\mxd\Capital Projects\MDD+FF_results.mxd



LABEL	DESCRIPTION	COST (2021 $)
B	Upgrade 55 m of main on Rigsby St to 150 mm. dia pipe.	$41,600
C	Upgrade 132 m of main on Comox St to 200 mm dia. pipe.	$111,550
D	Upgrade 135 m of main on Creekside Rd to 200 mm dia. pipe.	$113,800
E	Upgrade 162 m of main on Burns St to 150 mm dia. pipe.	$123,350
F	Upgrade 323 m of main on Braid St to 200 mm dia. pipe.	$245,100
G	Upgrade 40 m of main on Forestbrook Dr to 200 mm dia. pipe.	$30,150
I	Upgrade 94 m of main on Hastings Pl to 200 mm dia. pipe.	$71,000
K	Upgrade 257 m of main on Naish Dr to 200 mm dia. pipe.	$216,300
L	Upgrade 86 m of main on Fairview Rd to 200 mm dia. pipe.	$72,400
M	Upgrade 105 m of main on Industrial Crt to 200 mm dia. pipe.	$88,550
N	Upgrade 88 m of main on Industrial Pl to 200 mm dia. pipe.	$74,350
O	Upgrade 177 m of main on Balsam Ave to 200 mm dia. pipe.	$149,100
P	Upgrade 83 m of main on Pineview Pl to 200 mm dia. pipe.	$63,250
Q	Upgrade 106 m of main on Secrest Ave to 200 mm dia. pipe.	$89,850
R	Upgrade 111 m of main on Mckeen Pl to 200 mm dia. pipe.	$84,450
S	Upgrade 95 m of main on Dauphin Pl to 200 mm dia. pipe.	$71,750
T	Upgrade 427 m of main on Green Ave and Woodstock Rd to 200 mm dia. pipe.	$41,600
U	Upgrade 76 m of main on Hemlock St to 200 mm dia. pipe.	$57,550
V	Upgrade 104 m of main on South Beach Dr to 200 mm dia. pipe.	$78,900
W	Transfer 45 m of watermain along Greenwood Dr to PZ 503. Install new valve to relocate zone boundary.	$5,000
	TOTAL ESTIMATED COST	$1,829,600

WAT-100

Project Name: Medium Priority Upgrades
Project Number: WAT-100

Project Timeline: 5 to 10 Year
Project Priority: Medium
Estimated Cost ($ 2020): $ 1,829,600
Upgrade Driver: Existing Deficiencies
Developer Contribution: Not Applicable

DESIGN CONSIDERATIONS

Mains highlighted here to address fire flow or are medium priority. These upgrades would fall under the small pipe renewals, but are of higher priority as they rectify existing system deficiencies.

SeeTable for upgrade details.

There is the potential for some of the projects shown in the downtown core to be partially developer funded, if subject to future development. This is to be evaluated on a case by case basis.

Note that WAT-I, -L, -Q and -S have "High" integrated priority.

Legend

- Storage Reservoir
- Pump Station
- PRV
- Proposed Project
- Watermain
- Commercial
- Industrial
- Institutional
- Residential
- Rural

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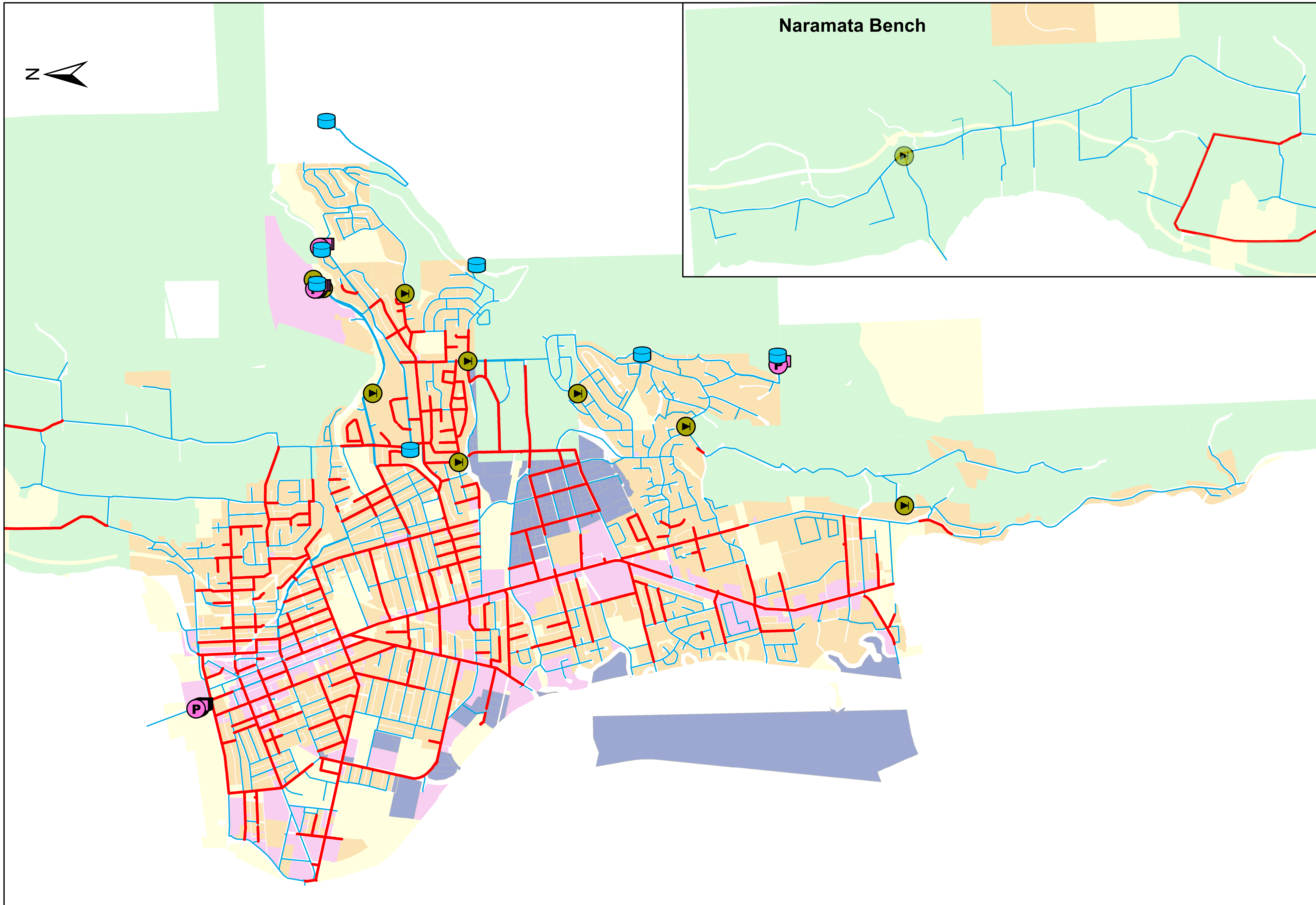
PENTICTON IIMP

Medium Priority Upgrades
Water Master Plan

0 420 840
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: 6.6

Client: City of Penticton



Cast Iron Mains

The City's cast iron mains form the backbone of the City's distribution network, and date mostly from the 1950s and the1960s.

Legend

- Storage Reservoir
- Pump Station
- PRV
- Cast Iron Main
- Watermain
- Commercial
- Industrial
- Institutional
- Residential
- Rural

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PENTICTON IIMP

Cast Iron Mains

0 500 1,000
Meters

Project No.:	20M-00462-00
Date:	Apr 2021
Figure No.:	6.7

Client: City of Penticton

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6.6.6 OPTIONS FOR FIRE PROTECTION TO VALLEYVIEW AND LAKESIDE ROAD AREAS

The long dead ends at the southern extent of Lakeside and Valleyview Roads mean that fire protection in these areas is deficient, and less than the required 60 L/s is currently available for fire fighting purposes.

Two options to increase fire flow to these areas are as follows:

1. Valleyview Road deficiencies:
   a. Upsizing of watermains along Valleyview Road (WAT-7)
   b. Fire Flow Provision from Wiltse South (WAT-51)
2. Lakeside Road deficiencies:
   a. Upsizing of watermains along Lakeside Road (not considered)
   b. Smythe Road Holding Tank to supplement supply during fire fighting (WAT-42)

These options are now discussed in greater detail.

Project WAT-7 Valleyview Road Upgrades

Upsizing watermains along Valleyview Road would address the existing fire flow deficiency at this location. The upgrades are detailed in project WAT-07 and include upgrading the existing undersized 100 mm and 50 mm diameter mains to 200 mm diameter. The existing mains, under the City's Subdivision and Development Bylaw would be classed as undersized. However there is a potential water quality issue introduced when mains are upsized as the dead end is a long stretch with little demand and minimal cycling would result. The total estimated cost is $3.6 M.

Project WAT-51 Valleyview Road Fire Flow Servicing from Wiltse South

An alternative to upsizing mains along Valleyview Road would to provide fire flow from Wiltse South. This option is detailed in WAT-51 and is predicated on the Wiltse South development being constructed. Approximately 1.1 km of 150 mm diameter main from Wiltse South to Valleyview Road tie-in location and upgrade of approx. 1.3 km of existing undersized main would supply the approx. extra 50 L/s required to meet minimum fire protection for the properties at the southern extent of Valleyview Road. A PRV station would be required to reduce pressure from the higher Wiltse South pressure zone during fire flow conditions. The total estimated cost is $1.5 M.

This is an opportunistic alternative and dependent on timing of the Wiltse South development, and the preferred option given given the small number of people benefitting and the high cost of upgrades with WAT-07. In the interim period before development comes on-line, the City can coordinate with the fire department to provide pump trucks to meet existing needs until improvements are made.

Project WAT-42 Smythe Road Holding Tank

The proposed Smythe Road Holding Tank would be located on City lands just beyond the southern end of Lakeside Road at an elevation of approximately 430 m and would be sized at approximately 75 m³ to supply the additional 10 L/s fire flow that is required to meet minimum fire protection requirements in this location. To manage potential water quality issues, a valve is also needed to cycle water from the holding tank.

A similar option was introduced in the 2010 WMP Addendum, and assocaited with Project WAT-42, the Smythe Road Development. At the time of the 2010 WMP Addendum, development in this area was anticipated, with the potential for the reservoir that would be built to be sized so as to benefit existing users along Lakeside Road. However the City recognise that a smaller holding tank would present less water quality issues, would not be contingent on future development which may not eventuate and is therefore preferable.

Projects 17 and 18 in the 2005 WMP involved upgrading the dead end along Lakeside Road from 200 mm diameter mains to 250 mm diameter in order to deliver 60 L/s for fire protection, and would total an estimated $1.5 M. These projects were subsequently deleted from the 2010 WMMP Addendum, and have likewise been removed from current consideration, as any upgrades to meet existing minor deficiencies are low priority given the low number of people benefitting and the high cost of upgrades.

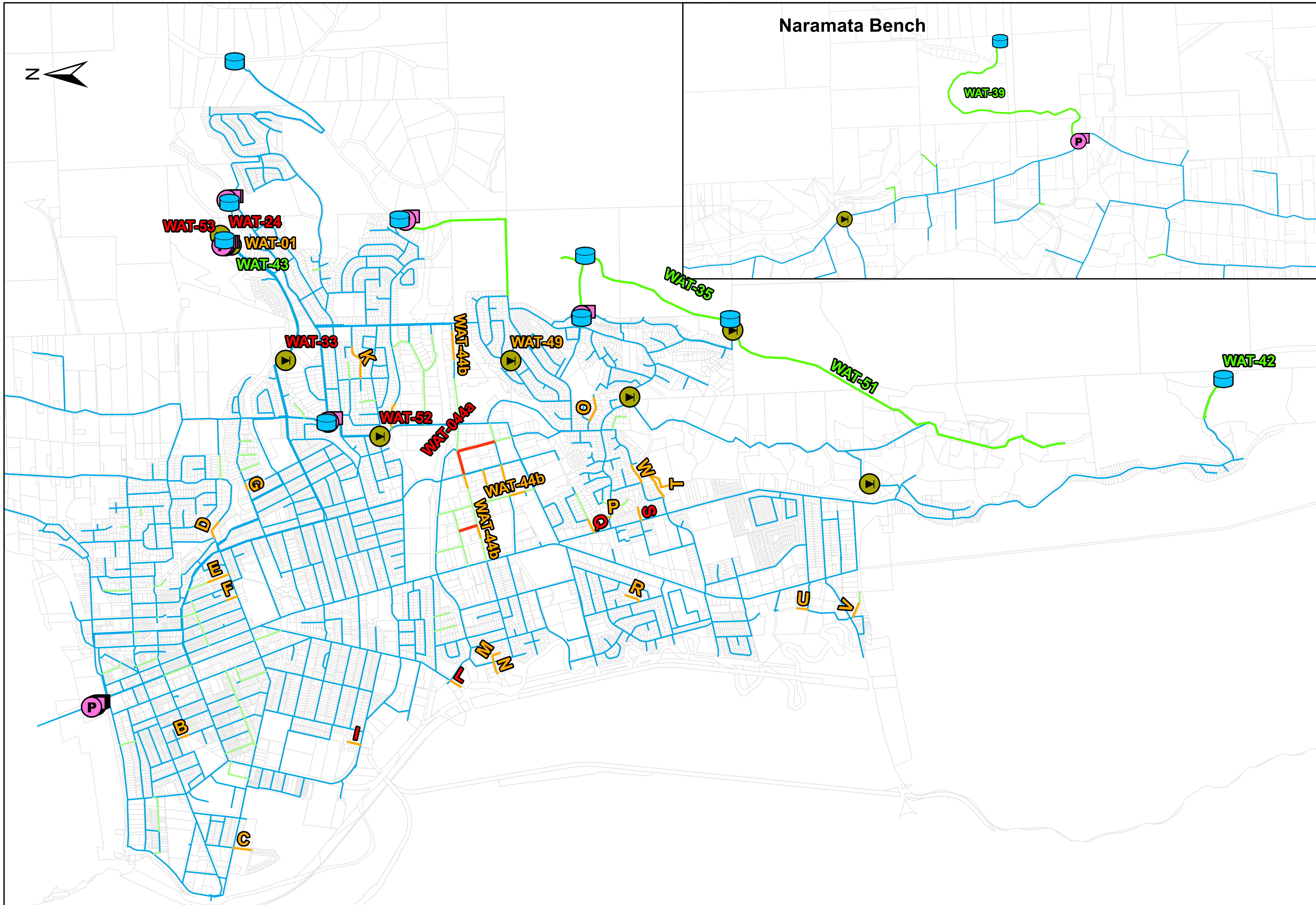
7 IMPROVEMENT PROJECTS SUMMARY

7.1 OVERVIEW

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

— Upsizing of existing watermains, reservoirs and PRVs;
— Construction of new watermains, reservoirs, pump stations and PRVs, and
— Opportunities for zone transfer.

Figure 7-1 shows the proposed capital works for the next 25-years.



Legend

- Storage Reservoir
- Pump Station
- Pump Station
- PRV
- High Priority
- Medium Priority
- Low Priority
- Low Priority (Small main renewals)
- Watermain
- Parcels

Note that WAT-I, -L, -Q and -S have "High" integrated priority following the integration

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PENTICTON IIMP

Capital Projects
Water Master Plan

0 460 920
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: 7.1

Client: City of Penticton

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7.2 PROJECTS PRIORITIZATION APPROACH

Table 7-1 provides the framework used to assign project priority and an implementation schedule.

TABLE 7-1 PRIORITISATION FRAMEWORK

IMPLEMENTATION SCHEDULE	PRIORITY	INDICATOR	FIGURE NO.
1 to 5 Year	High	- Assets are deficient in the model due to existing issues (designed with future capacity included). High priority projects that were identified in the 2010 Addendum that are yet to be completed	E-4, E-5, E-6, E-16, E-53
5 to 10 Year	Medium	- Deficiencies are minor, either localised to a small area or only slightly below minimum thresholds	E-1, E-2, E-11, E-12, E-13, E-18
10 to 25 Year	Low	- Assets required to service future development areas, where costs fall entirely on the Developer	E-3, E-7, E-8, E-9, E-10, E-15

Note that upgrades which are triggered by future development are identified as low priority given the uncertainty on timing of development, but can be reprioritised as needed, depending on updated development plans and secured timelines.

Refer to Appendix E for the individual project sheets. Medium priority upgrades which are minor and localised upgrades to the network are summarised together in one project sheet titled “Medium Priority Projects.”

7.3 COST ESTIMATE BASIS

“Class D” Cost estimates provided in the 25-year Capital Works Plan have been prepared based on unit cost rates from relevant past projects in or near the City and WSP’s cost database, adjusted to 2021 constant dollars. Table 7-2 is the basis for cost estimation of each of the projects in the Capital Works Plan.

As per Table 7-2, costs for general requirements such as mobilisation, bonding and traffic management are assumed to be a percentage of the subtotal for earthworks, supply and install of infrastructure, surface restoration and land acquisition. Professional Services are assumed to be 15% of the total project cost, and an allowance of 25% is given for Contingencies. Applicable Developer costs are estimated according to the City Utility Bylaws.

TABLE 7-2 COST ESTIMATE BASIS

ITEM	DESCRIPTION		
1.0	General Requirements		
1.1	Mobilization and Demobilization	Lump Sum	Assumed as 5% of subtotal of Items 2 to 4

1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	Lump Sum	Assumed as 3% of subtotal of Items 2 to 4
1.3	Traffic Management	Lump Sum	Assumed as 10% of subtotal of Items 2 to 4

2.0	Earthworks and Structures	Unit	UNIT Price (2021 $)
2.1	Supply and Install New 150mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$310
2.2	Supply and Install New 200mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$360
2.3	Supply and Install New 250mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$410
2.4	Supply and Install New 300mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$460
2.5	Supply and Install New 350mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$560
2.6	Supply and Install New 400mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$610
2.7	Supply and Install New 450mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$710
2.8	Supply and Install New 500mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$770
2.9	Supply and Install New 600mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$920
2.10	Supply and Install New 750mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$1,220
2.11	Supply and Install New 900mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$1,480
2.12	Supply and Install New 1,050mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$2,240
2.13	Supply and Install New 1,200mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$2,350
2.14	Supply and Install New 1,350mm Dia. Pipe (incl. 50% excavation cost)	Lin. m	$2,450
2.15	Supply and Install a Hydrant (incl. tee, valve, lead, restoration)	Lump Sum	$8,770
2.16	Pump Station Construction/Expansion (incl. mech. and EIC)	Per HP	$4,180
2.17	Reservoir Construction/Expansion (incl. site grading, piping, valving)	Sq. m	$870
2.18	PRV Station Construction (150 mm - incl. chamber, EIC)	Lump Sum	$114,600
2.19	PRV Station Construction (200 mm - incl. chamber, EIC)	Lump Sum	$137,500
2.20	PRV Station Construction (250 mm - incl. chamber, EIC)	Lump Sum	$171,870

3.0	Surface Restoration	Unit	UNIT Price (2020 $)
3.1	Minor Road Restoration (4.0 m width)	Lin. m	$100
3.2	Major Road Restoration (4.0 m width)	Lin. m	$150
4.0	Land Acquisition	Unit	UNIT Price (2020 $)
4.1	Acquire Easements	Lump Sum	Assumed as 10% of Items 2.1 to 2.14 where mains are new installation
4.2	Acquire Property	Lump Sum	$1 million assumed for projects where relevant
5.0	Professional Services and Contingencies		
5.1	Professional Services	Lump Sum	Assumed as 15% of subtotal of Items 1 to 4
5.2	Construction Contingency	Lump Sum	Assumed as 25% of subtotal of Items 1 to 4

7.4 PROJECT LIST

The methodology for implementation is as follows:

High priority (5-year horizon) projects are identified as deficient in the model. Projects WAT-24 and WAT-44a look to address significant shortfalls in the Valleyview Road area, Ridgedale Reservoir and the industrial core respectively. WAT-10 outlines a hydrant installation program of 10 hydrants while WAT-33 and WAT-52 outline PRV upgrades at Penticton Ave PRV and MacCleave PRV respectively.

Medium priority (10-year horizon) projects represent minorly deficient assets, and the localised minor works throughout the network are collected under the “Medium Priority” projects list (WAT-B to WAT-W), as well as WAT-44b.

Low priority (20 to 25-year horizons) projects outline future development areas where the cost of servicing is entirely borne by the developer. Projects WAT-35 and WAT-39 and represent conceptual, high-level servicing of the future developments envisioned in the OCP 2045, Wiltse and Spiller Road developments respectively. These can vary depending on developer plans and should be further investigated during subsequent design phases. WAT-51 (the preferred alternative to WAT-07) addresses fire flow issues along Valleyview Road and is contingent upon the Wiltse development.

The City has been improving its watermain network over the years, as evidenced by the substantial work completed from the 2005 WMP and 2010 WMP Addendum capital projects list. For consistency, this WMP has taken the remaining projects and in discussion with the City updated the top priority projects for inclusion in this capital projects list. These are projects WAT-01 and WAT-02 in Table 7-3.

TABLE 7-3 IMPROVEMENT PROJECTS

PROJECT TYPE	PROJECT ID	FIGURE NO.	PROJECT NAME	TOTAL COST (2021 $)	DEVELOPER FUNDED	PRIORITY	HORIZON
Capital	WAT-10a	Figure E-4	Fire Hydrants (10 hydrants per year, total 150 hydrants)	$ 152,500 (1)		High	5 -Year
Capital	WAT-24	Figure E-5	Ridgedale Reservoir Expansion	$ 4,857,550	Partially	High	5 -Year
Capital	WAT-33	Figure E-6	Penticton Ave PRV Upgrade	$ 2,950,000 (2)		High	5 -Year
Capital	WAT-44a	Figure E-11	Industrial Area Upgrades	$ 800,250		High	5 -Year
Capital	WAT-52	Figure E-16	MacCleave PRV Upgrade	$ 227,150		High	5 -Year
Study	WAT-53	Figure E-17	DAF Air and Recycle Optimization Study	$ 40,800		High	5 -Year
Capital	WAT-I	Figure E-18	Upgrade 94 m of main on Hastings Pl to 200 mm dia. pipe.	$ 71,000		High	5 -Year
Capital	WAT-L	Figure E-18	Upgrade 86 m of main on Fairview Rd to 200 mm dia. pipe.	$ 72,400		High	5 -Year
Capital	WAT-Q	Figure E-18	Upgrade 106 m of main on Secrest Ave to 200 mm dia. pipe.	$ 89,850		High	5 -Year
Capital	WAT-S	Figure E-18	Upgrade 95 m of main on Dauphin Pl to 200 mm dia. pipe.	$ 71,750		High	5 -Year
Study	WAT-01	Figure E-1	WTP Filter Media Pilot Study	$ 150,000		Medium	10-Year
Capital	WAT-02	Figure E-2	Park Irrigation to Raw Water/Effluent Reuse	$ 333,650		Medium	10-Year
Capital	WAT-10a	Figure E-4	Fire Hydrants (10 hydrants per year, total 150 hydrants)	$ 152,500 (1)		Medium	10 - Year
Capital	WAT-44b	Figure E-12	Industrial Area Upgrades (Cont.)	$ 807,800		Medium	10-Year
Capital	WAT-49	Figure E-13	Wiltse Dr Fire Flow PRV	$ 228,300		Medium	10-Year
Capital	WAT-B	Figure E-18	Upgrade 55 m of main on Rigsby St to 150 mm. dia pipe.	$ 41,600	Partially	Medium	10-Year
Capital	WAT-C	Figure E-18	Upgrade 132 m of main on Comox St to 200 mm dia. pipe.	$ 111,550	Partially	Medium	10-Year
Capital	WAT-D	Figure E-18	Upgrade 135 m of main on Creekside Rd to 200 mm dia. pipe.	$ 113,800	Partially	Medium	10-Year
Capital	WAT-E	Figure E-18	Upgrade 162 m of main on Burns St to 150 mm dia. pipe.	$ 123,350	Partially	Medium	10-Year
Capital	WAT-F	Figure E-18	Upgrade 323 m of main on Braid St to 200 mm dia. pipe.	$ 245,100	Partially	Medium	10-Year

Capital	WAT-G	Figure E-18	Upgrade 40 m of main on Forestbrook Dr to 200 mm dia. pipe.	$ 30,150	Partially	Medium	10-Year
Capital	WAT-K	Figure E-18	Upgrade 257 m of main on Naish Dr to 200 mm dia. pipe.	$ 216,300	Partially	Medium	10-Year
Capital	WAT-M	Figure E-18	Upgrade 105 m of main on Industrial Crt to 200 mm dia. pipe.	$ 88,550	Partially	Medium	10-Year
Capital	WAT-N	Figure E-18	Upgrade 88 m of main on Industrial Pl to 200 mm dia. pipe.	$ 74,350	Partially	Medium	10-Year
Capital	WAT-O	Figure E-18	Upgrade 177 m of main on Balsam Ave to 200 mm dia. pipe.	$ 149,100	Partially	Medium	10-Year
Capital	WAT-P	Figure E-18	Upgrade 83 m of main on Pineview Pl to 200 mm dia. pipe.	$ 63,250	Partially	Medium	10-Year
Capital	WAT-R	Figure E-18	Upgrade 111 m of main on Mckeen Pl to 200 mm dia. pipe.	$ 84,450	Partially	Medium	10-Year
Capital	WAT-T	Figure E-18	Upgrade 427 m of main on Green Ave and Woodstock Rd to 200 mm dia. pipe.	$ 91,250		Medium	10-Year
Capital	WAT-U	Figure E-18	Upgrade 76 m of main on Hemlock St to 200 mm dia. pipe.	$ 57,550		Medium	10-Year
Capital	WAT-V	Figure E-18	Upgrade 104 m of main on South Beach Dr to 200 mm dia. pipe.	$ 78,900		Medium	10-Year
Capital	WAT-W	Figure E-18	Transfer 45 m of watermain along Greenwood Dr to PZ 503.Install new valve to relocate zone boundary.	$ 5,000		Medium	
Capital	WAT-07	Figure E-3	Valleyview Road Upgrades	$ 3,581,850		Low	25-Year
Capital	WAT-10c	Figure E-4	Fire Hydrants (10 hydrants per year, total 150 hydrants)	$ 152,500 (1)		Low	25 -Year
Capital	WAT-35	Figure E-7	Water Supply Upgrade - Wiltse North and South	$ 6,612,250	Yes	Low	25-Year
Capital	WAT-39	Figure E-8	Water Supply Upgrade - Spiller Road Development Area	$ 5,101,000	Yes	Low	25-Year
Capital	WAT-42	Figure E-9	Smythe Road Holding Tank	$ 322,150		Low	25-Year
Capital	WAT-43	Figure E-10	WTP Clearwell Expansion	$ 3,007,850		Low	25-Year
Capital	WAT-50	Figure E-14	Small Main Renewals	$ 8,344,950		Low	25-Year
Capital	WAT-51 (3)	Figure E-15	Wiltse South Fire Flow Provision for Valleyview Road	$ 1,495,150		Low	25-Year

(1) PER YEAR TO INSTALL 10 HYDRANTS.

(2) COST SUPPLIED BY THE CITY.

(3) PROJECT WAT-51 IS THE PREFERRED ALTERNATIVE TO WAT-07, AND IS CONDITIONAL ON THE WILTSE SOUTH DEVELOPMENT.

7.5 SUMMARY

Table 7-4 provides anticipated Capital budget for the 5-, 10- and 25-year horizon.

Table 7-4 Total capital costs

IMPLEMENTATION SCHEDULE	NO. OF PROJECTS	TOTAL COST (2021 $)
1 – 5 Year (High Priority)	10	$ 9,647,550 (1), (2)
5 – 10 Year (Medium Priority)	21	$ 3,573,450 (1)
10-25 Year (Low Priority)	7	$ 25,645,850 (1)
Total	38	$ 38,871,850 (3)

(1) Includes $152 K for 5 years of hydrant installation, assuming 10 hydrants per year, WA-10a,-10b and-10c resepectively.

(2) Includes $2.95 M for the Penticton Ave PRV Upgrade, WAT-33.

(3) Cost summary does not include WAT-07 but does includes preferred alternative WAT-51.

7.6 RECOMMENDATIONS

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

— Existing deficiencies at Valleyview and Lakeside Roads can be addressed with upgrade of the long dead ends in these locations, but the opportunity to additionally service these areas through the Wiltse and Smythe Road future developments;

— Hydrant Installation and Undersized Watermain Renewal long term programs address deficiencies in the network since newer standards of design have been implemented in the City's Subdivision and Development Bylaw, and will improve fire protection across the City, and will allay any potential tuberculation occurring in the City's aging cast iron mains.

APPENDIX

A

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

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.

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

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

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: **December 13, 2020**

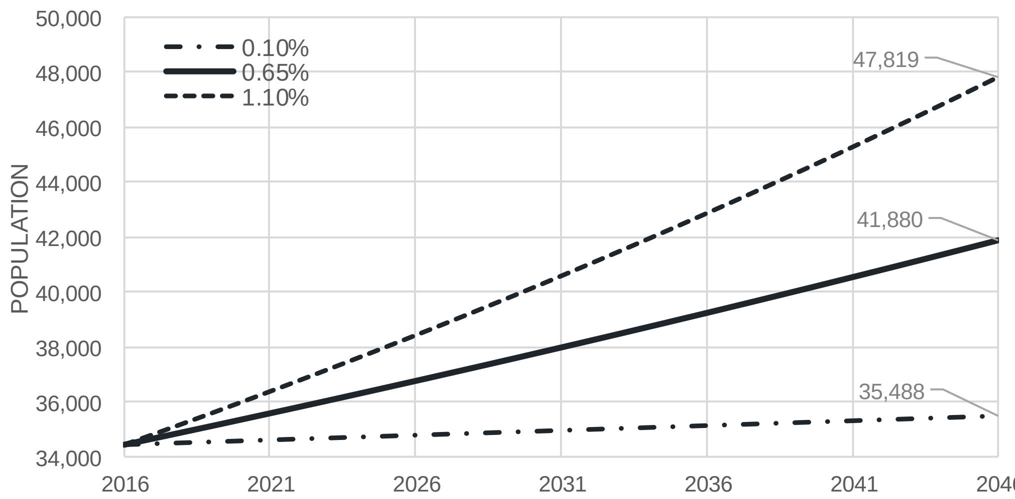
WSP is pleased to provide the following technical memorandum outlining the proposed population projections and future growth planning for the Integrated Infrastructure Master Plan (IIMP). The purpose of this memorandum is to build on the planned growth within the City based on the 2045 Official Community 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 existing 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*. Based on input from City planning staff, the additional retail floor space assumed under the OCP horizon was revised to 205,000 square feet in lieu of the 1.3 million from the 2018 Collier Report; projections for increases to office space and industrial space were not changed from the report. 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	9175	890	1019
2025	5-year horizon	3100	9293	931	1019
2026	-	3120	9323	941	1019
2030	10-year horizon	3202	9444	985	1019

Year	Horizon	Institutional	Commercial	Industrial	Rural
2031	-	3223	9474	996	1019
2036	-	3330	9626	1012	1019
2040	20-year horizon	3418	9749	1025	1019
2041	-	3440	9781	1028	1019
2045	25-year OCP horizon	3531	9906	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

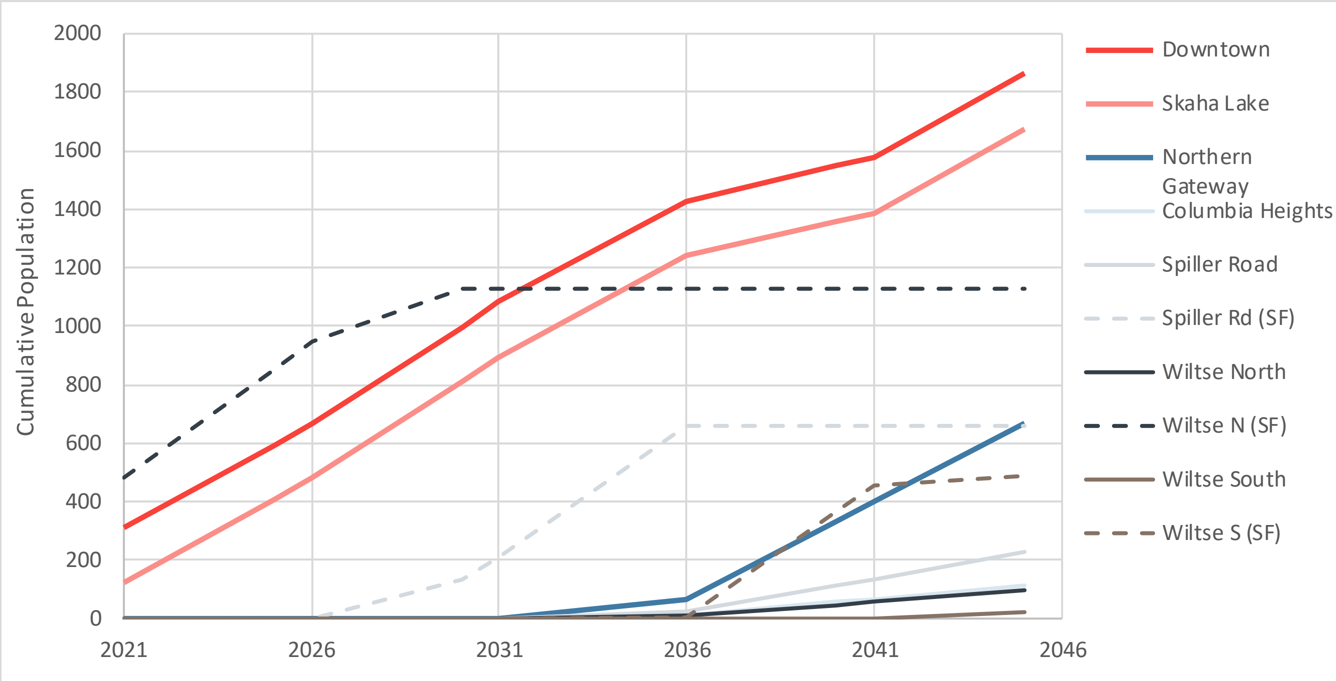
OCP Growth Area[1]	Single Family Population	Multi Family Population	ICI Population Equivalents
Downtown	0	1,865	820
Skaha Lake Rd	0	1,674	536
Northern Gateway	0	668	426
Infill Industrial	0	0	191
Columbia Heights	0	113	0
Spiller Rd	659	228	0
Wiltse North	1,128	97	0
Wiltse South	488	22	0
Total Population Change	**2,276**	**4,667**	**1,974**

(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.

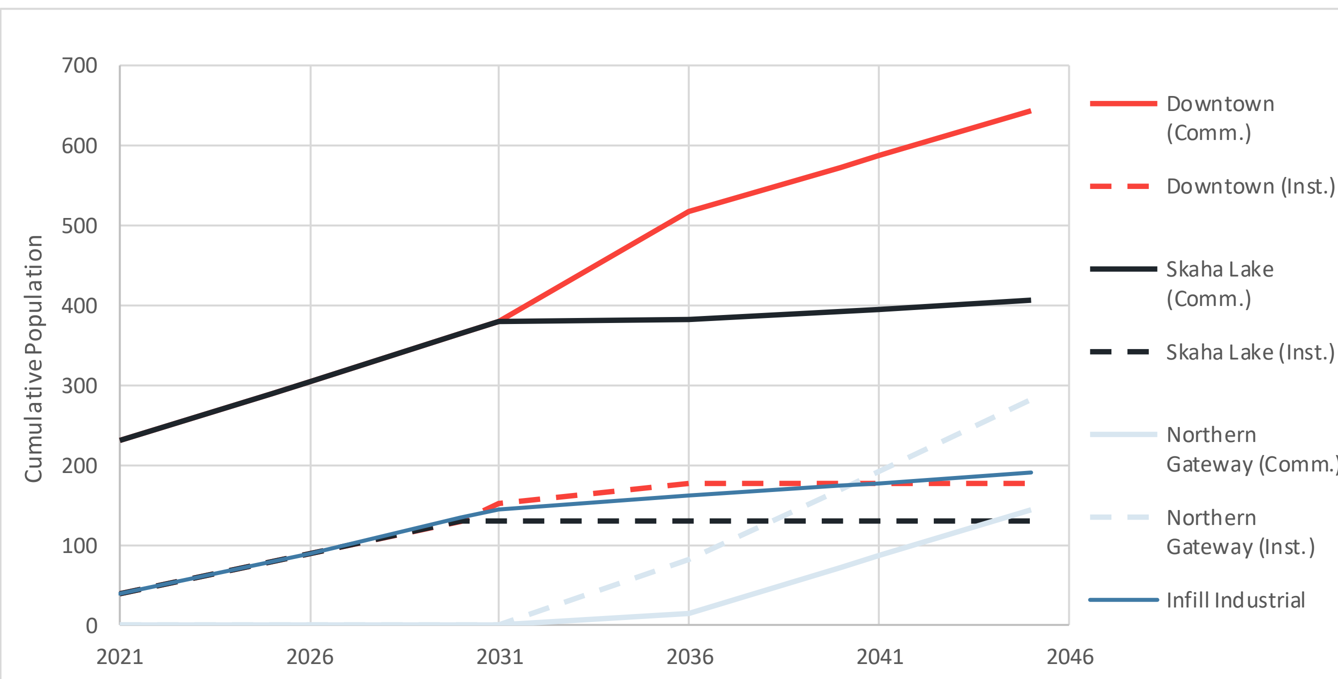
Based on discussions with City planning staff regarding the likely timing of buildout within the major OCP growth areas identified, and the forecasted populations from Tables 2 and 3 for all interim years between present and OCP conditions, the population breakdown per development area was split over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



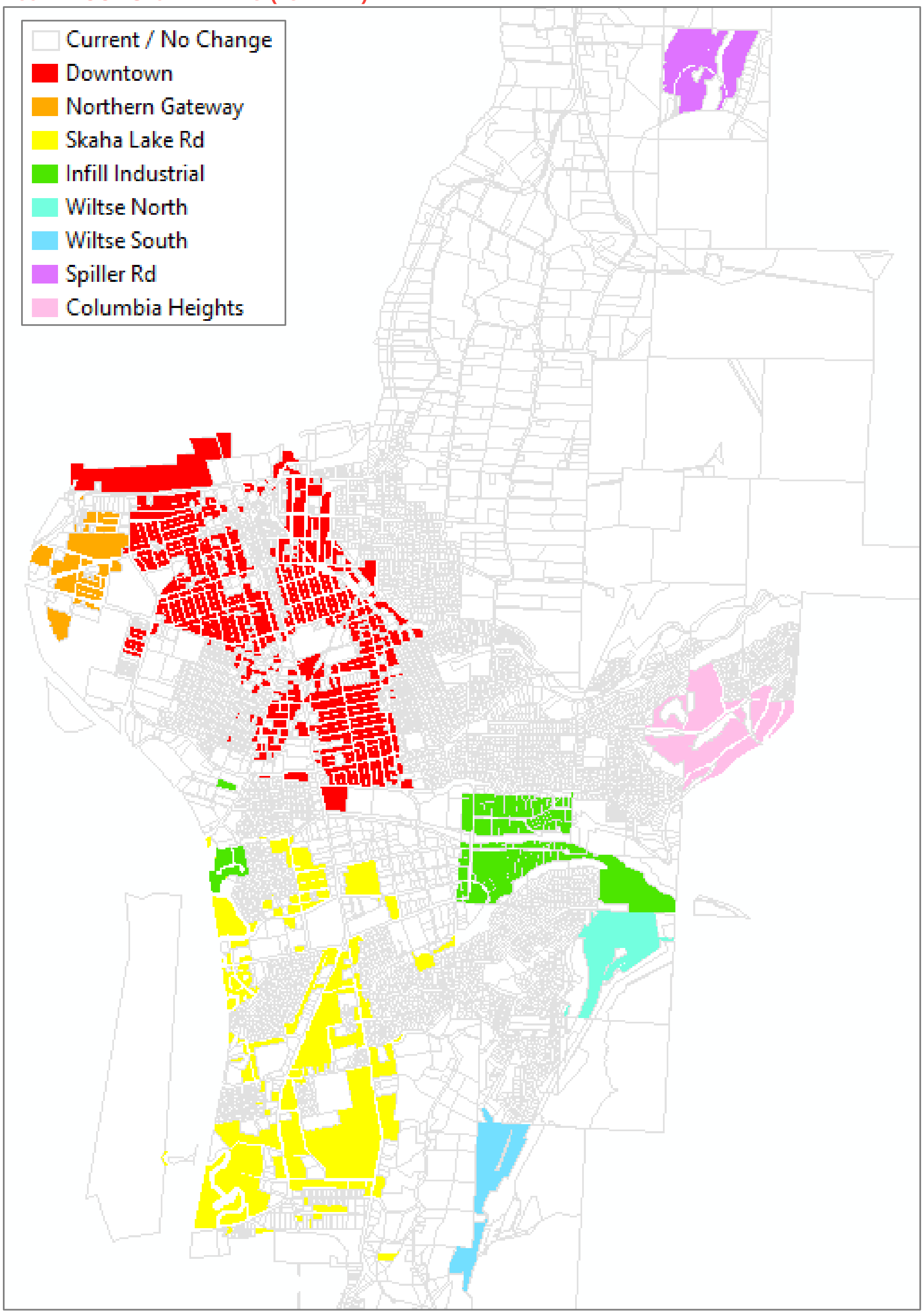
As illustrated in Figure 2, single family infill and growth is predominantly allocated to the Wiltse North and Spiller Road areas in the short-term, with additional single family growth in Wiltse South in the 15 to 20 year horizon. Multi-Family infill and growth is primarily in the Downtown and Skaha 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

D

HYDRANT TEST DATA

APPENDIX

D-1 C-FACTOR TEST FIELD DATA

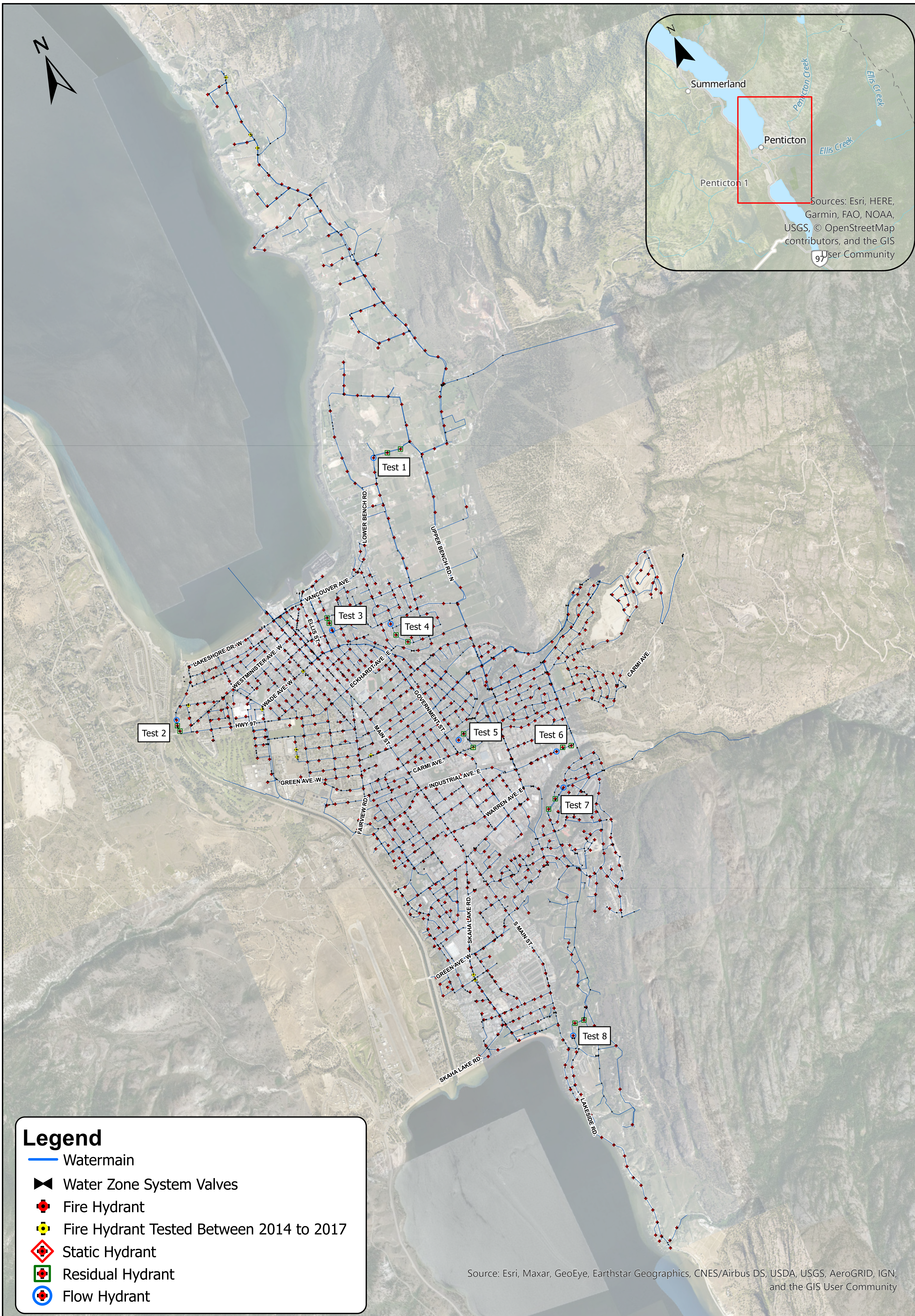


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Figure 4
Existing Water System
C-Factor Hydrant Testing Overview

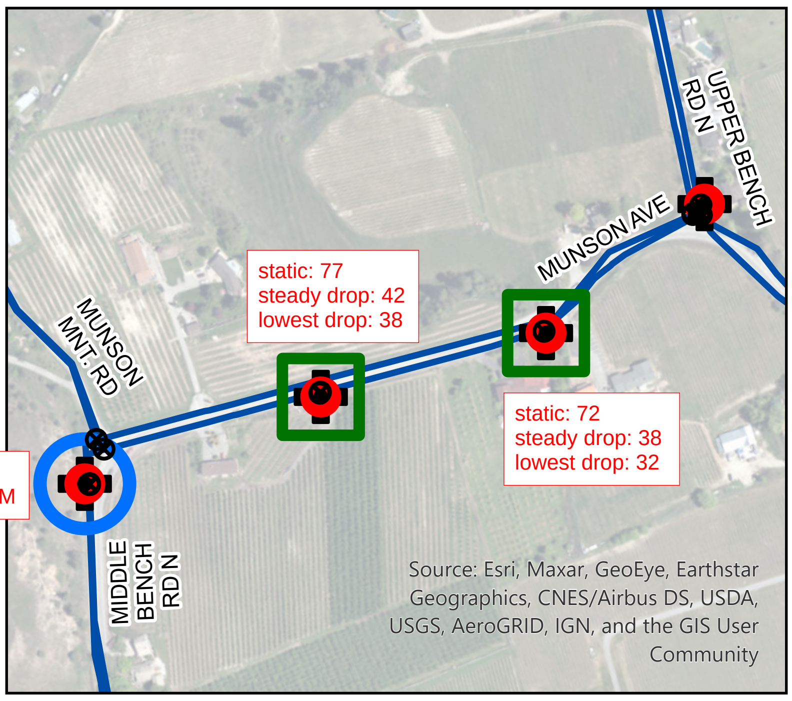
Project No.: **20M-00462-00**

Date: **31/07/2020**

Scale: **1:40,000**

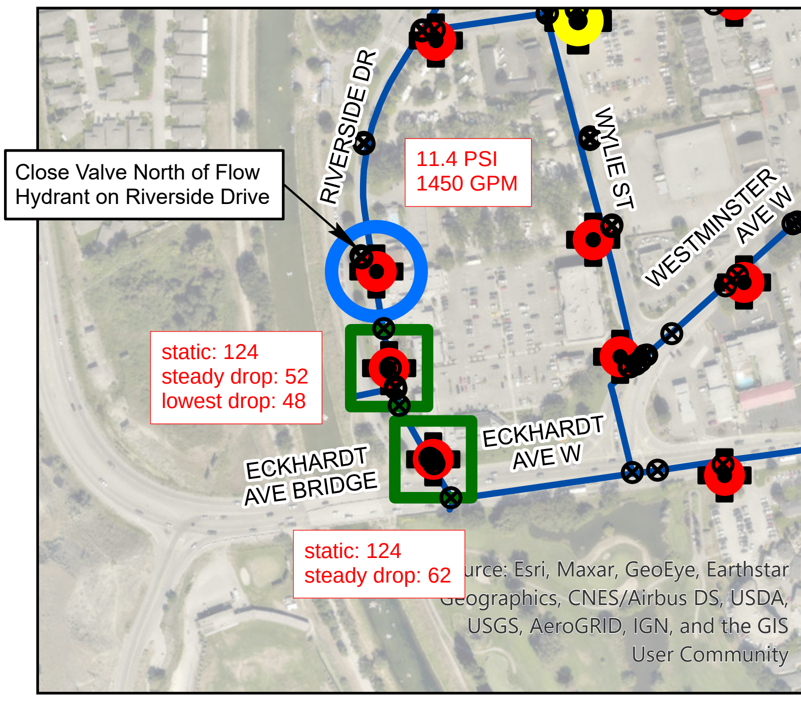
0 50 100 200 Meters

Path: C:\2020-07-08 Penticton IIMP\Water - C-Factor.aprx



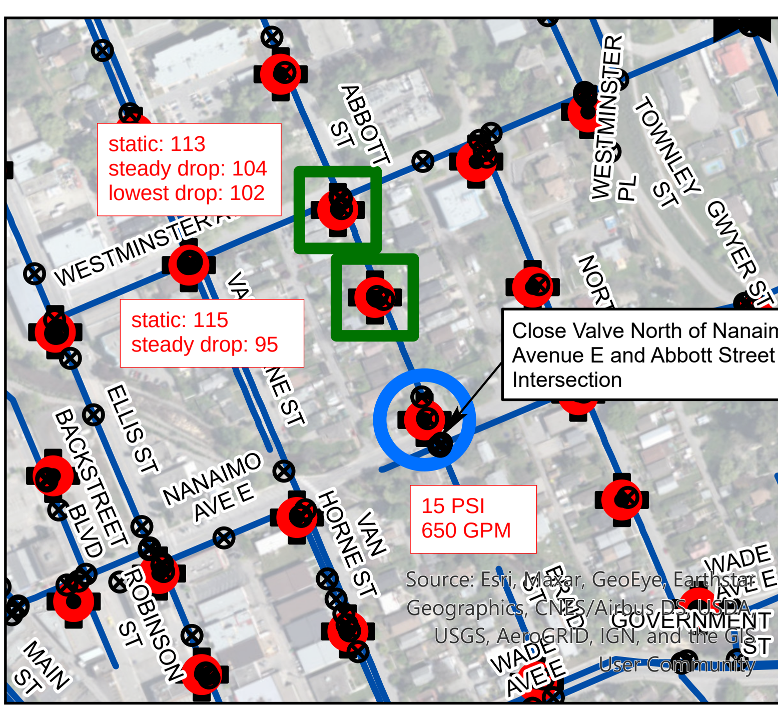
Test 1

Pipe: 200mm AC
Pressure Zone: 3
Port: 4"



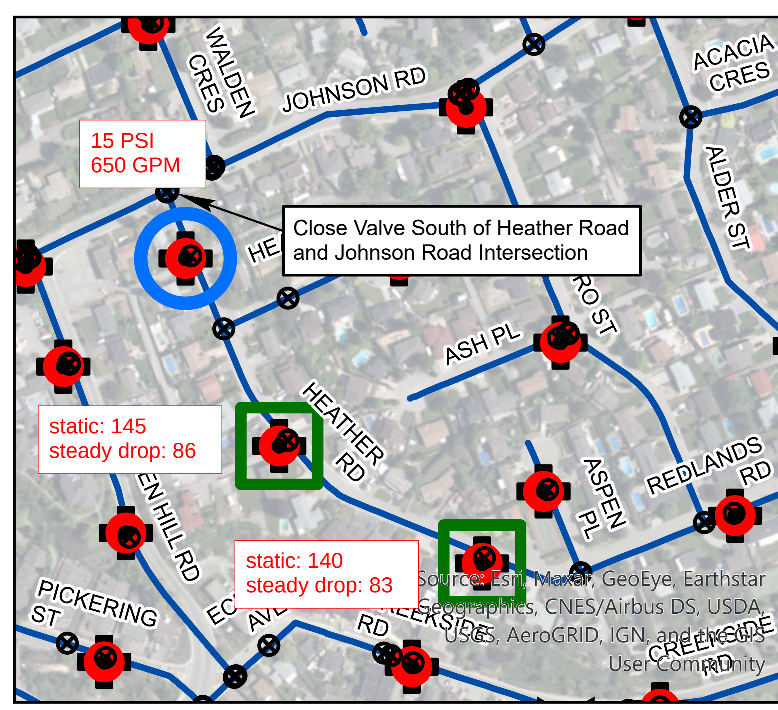
Test 2

Pipe: 200mm CI
Pressure Zone: 7
Port: 4"



Test 3

Pipe: 200mm PVC
Pressure Zone: 7
Port: 2.5"



Test 4

Pipe: 150mm DI
Pressure Zone: 3
Port: 2.5"

Legend

- Watermain
- Water Zone System Valves
- Water Valves
- Fire Hydrant
- Fire Hydrant Tested Between 2014 to 2017
- Residual Hydrant
- Flow Hydrant

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Figure 5
Existing Water System
C-Factor Hydrant Tests 1 - 4

Project No.: **20M-00462-00**

Date: **31/07/2020**

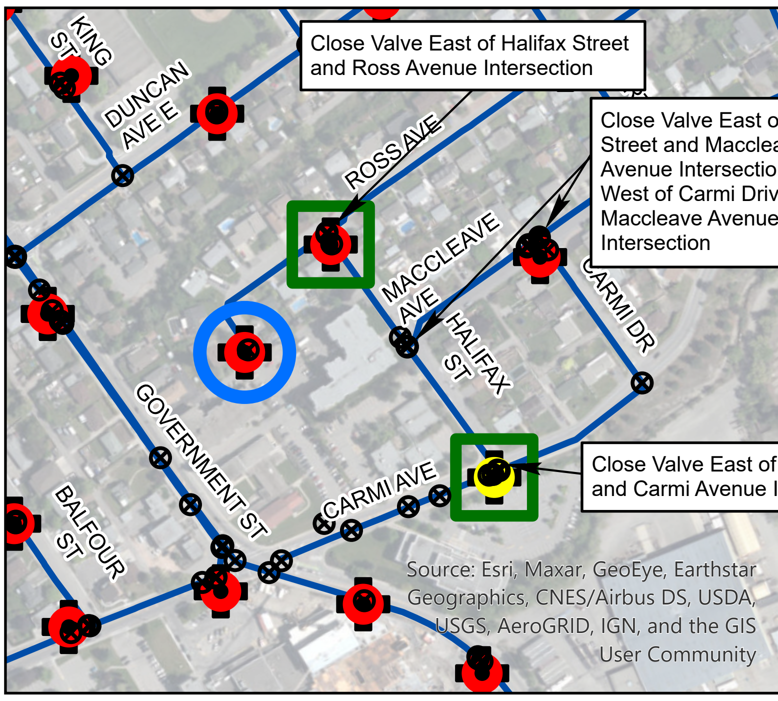
Scale: **1:5,000**

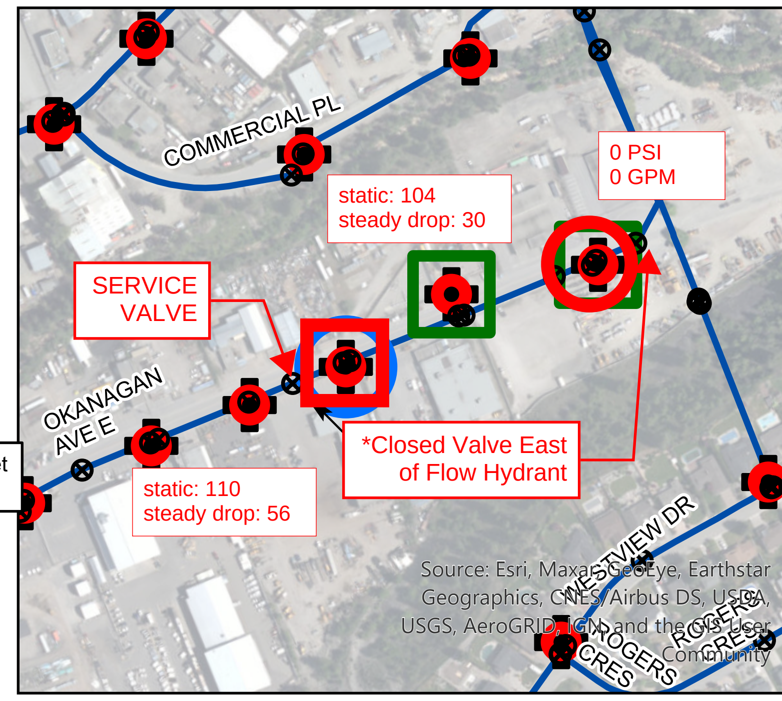
0 50 100 200 Meters

Path: C:\2020-07-08 Penticton IIMP\Water - C-Factor.aprx

AFTER SETTING UP AND SHUTTING OFF VALVES THE FIRST RESIDUAL HYDRANT'S GAUGE DROPPED TO ZERO INDICATING A VALVE ON HALIFAX ST IS CLOSED. THE CITY IS WORKING ON GETTING ACCESS TO THOSE VALVES AS THE VALVE BOX'S LIDS ARE ALL STUCK.

THERE WERE NO IN-LINE VALVES PLACED CONVENIENTLY. WITH THIS SETUP THERE WAS VERY LITTLE FLOW COMING FROM THE DIFFUSER.



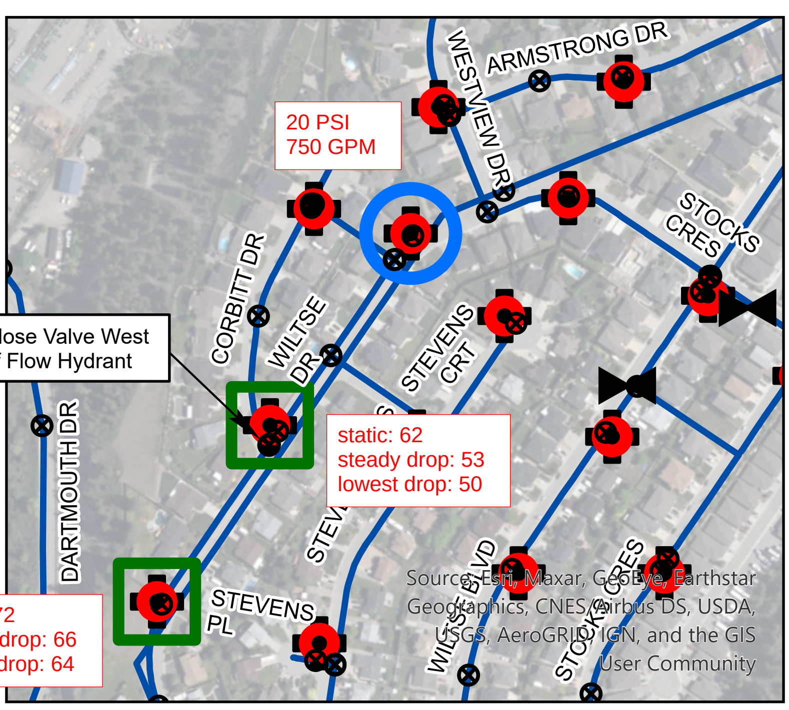


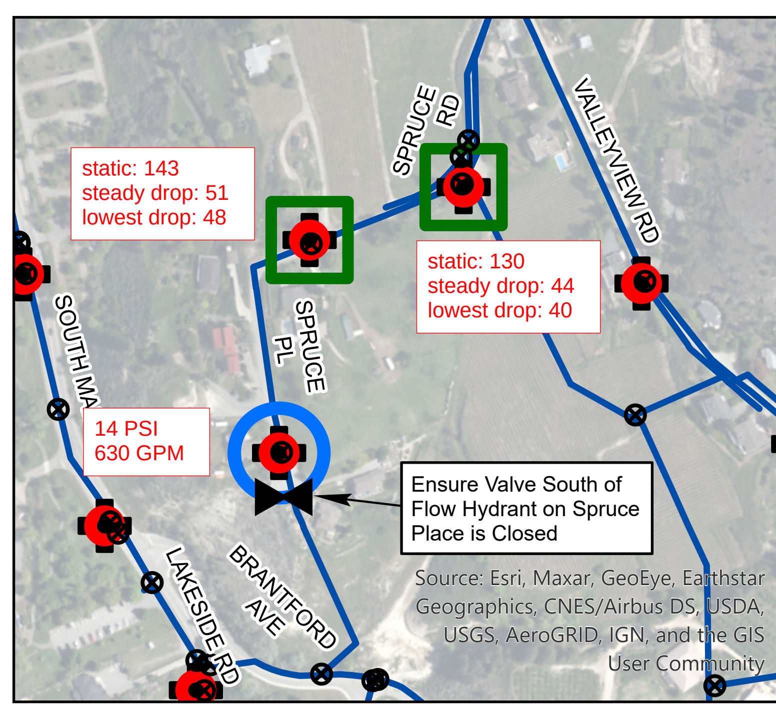
Test 5

Pipe: 150mm CI
Pressure Zone: 6
Port: 2.5"

Test 6

Pipe: 150mm CI
Pressure Zone: 3
Port: 4"





Test 7

Pipe: 150mm PVC
Pressure Zone: 4
Port: 2.5"

Test 8

Pipe: 150mm PVC
Pressure Zone: 5
Port: 2.5"

Legend

- Watermain
- Water Zone System Valves
- Water Valves
- Fire Hydrant
- Fire Hydrant Tested Between 2014 to 2017
- Residual Hydrant
- Flow Hydrant

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Figure 6
Existing Water System
C-Factor Hydrant Tests 5 - 8

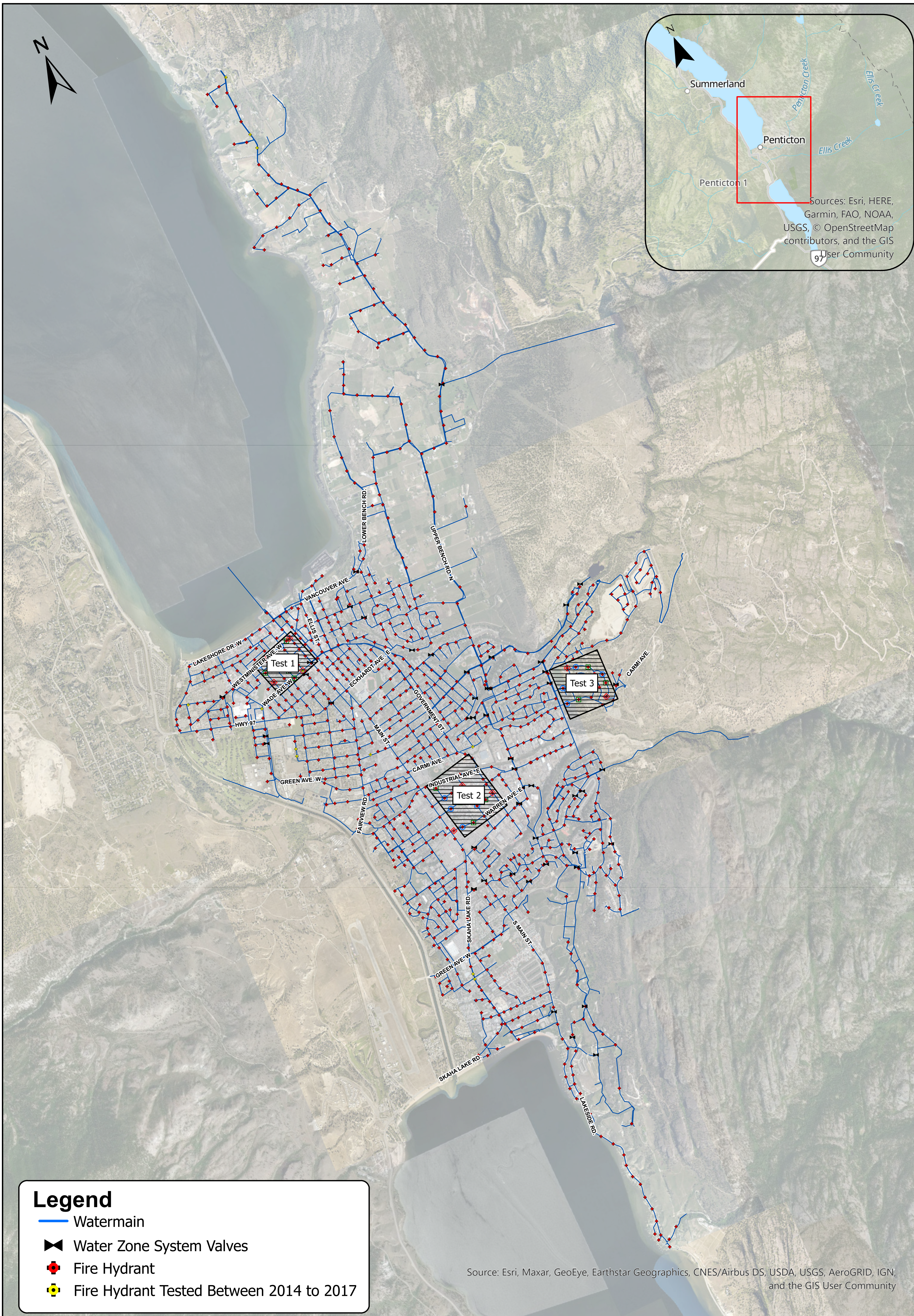
Project No.:	20M-00462-00
Date:	31/07/2020
Scale:	1:5,000

0 50 100 200 Meters

Path: C:\2020-07-08 Penticton IIMP\Water - C-Factor.aprx

APPENDIX

D-2 *MULTI-HYDRANT TEST INFORMATION*



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Client:

CITY OF Penticton

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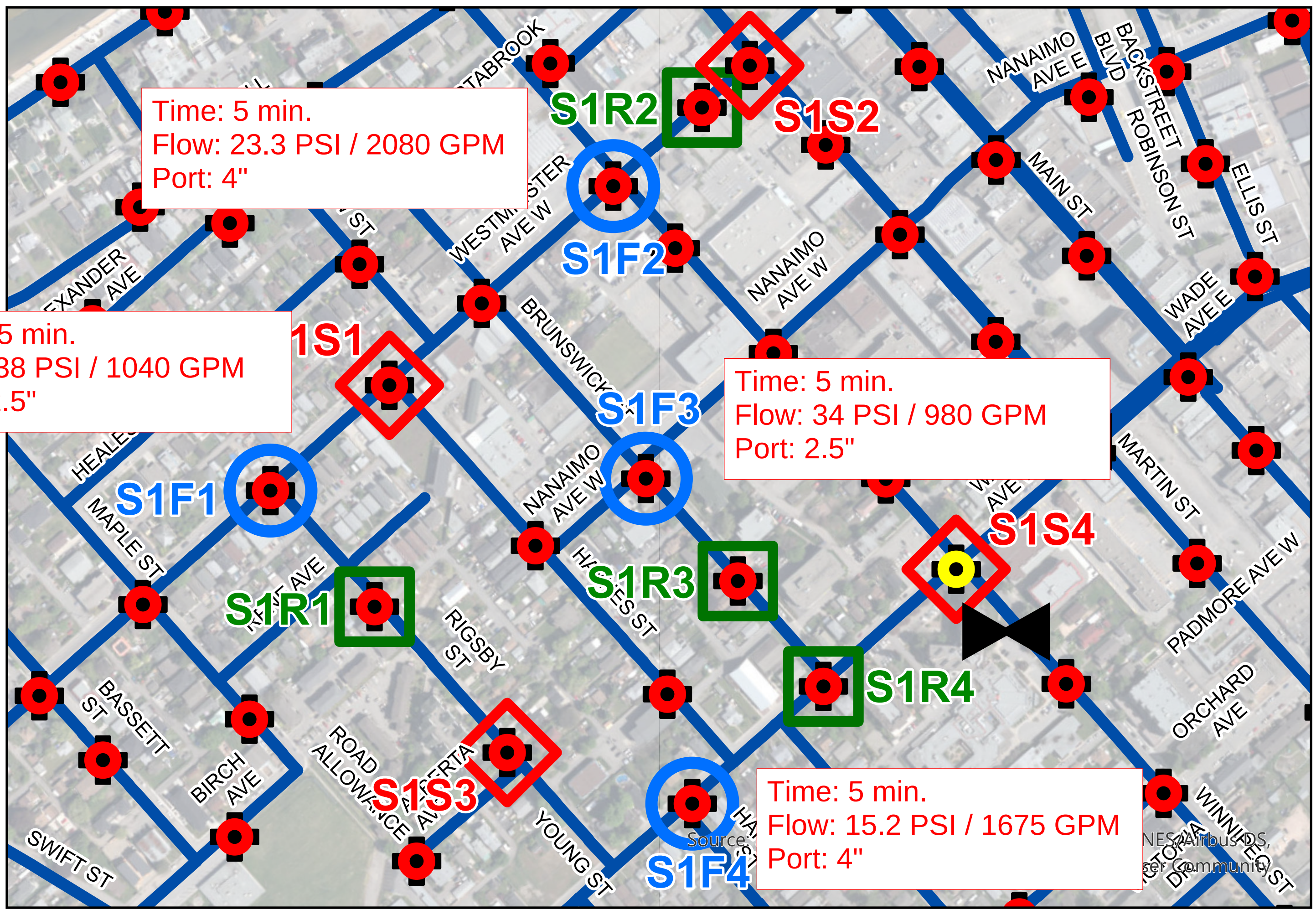
Figure 1
Existing Water System
Multi-Pressure Hydrant Testing
Overview

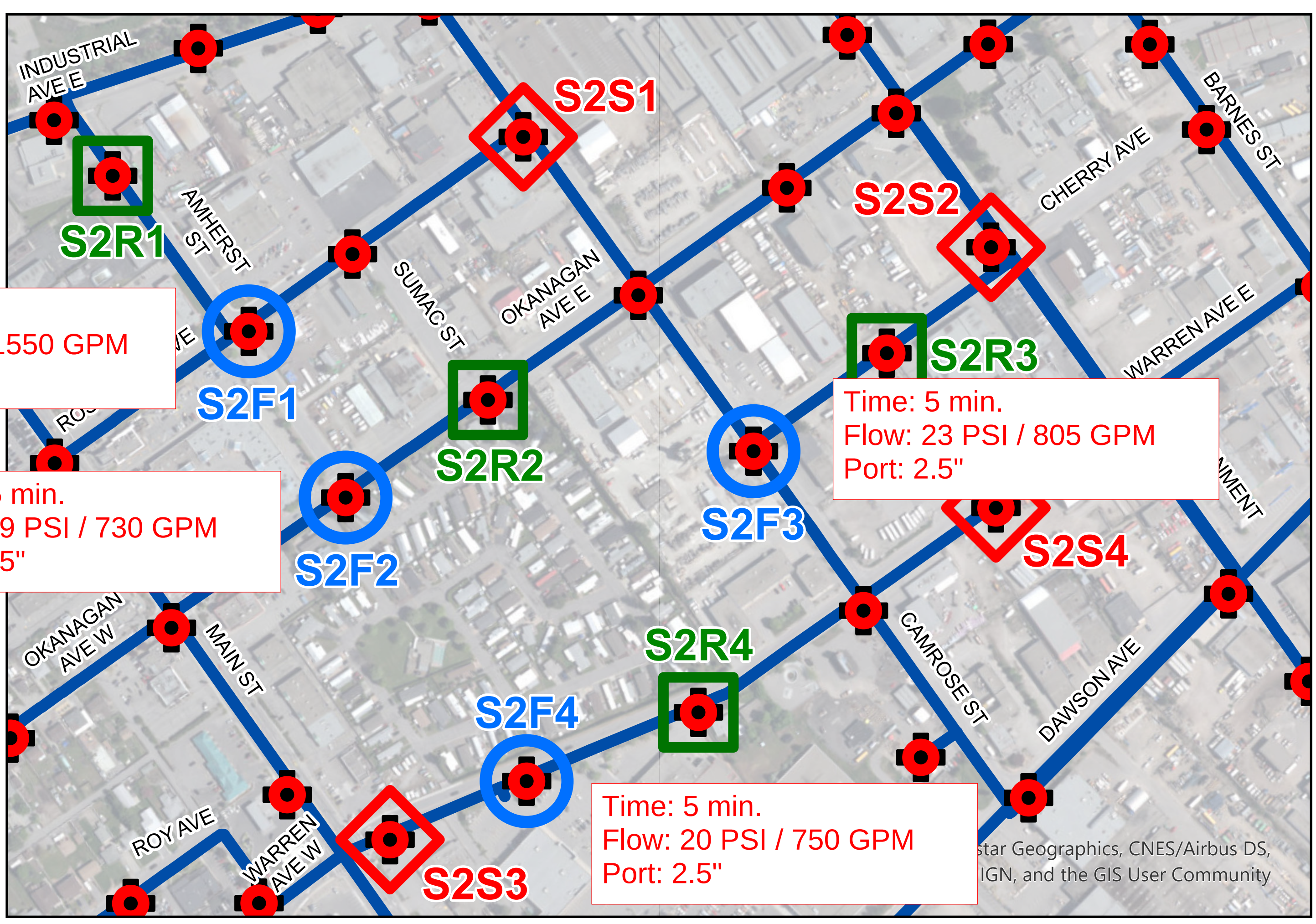
Project No.:	20M-00462-00
Date:	31/07/2020
Scale:	1:40,000

0 50 100 200 Meters

Path: C:\2020-07-08 Penticton IIMP\Water.aprx



Test 1



Test 2

Legend

- Watermain
- Water Zone System Valves
- Fire Hydrant
- Fire Hydrant Tested Between 2014 to 2017
- Static Hydrant
- Residual Hydrant
- Flow Hydrant

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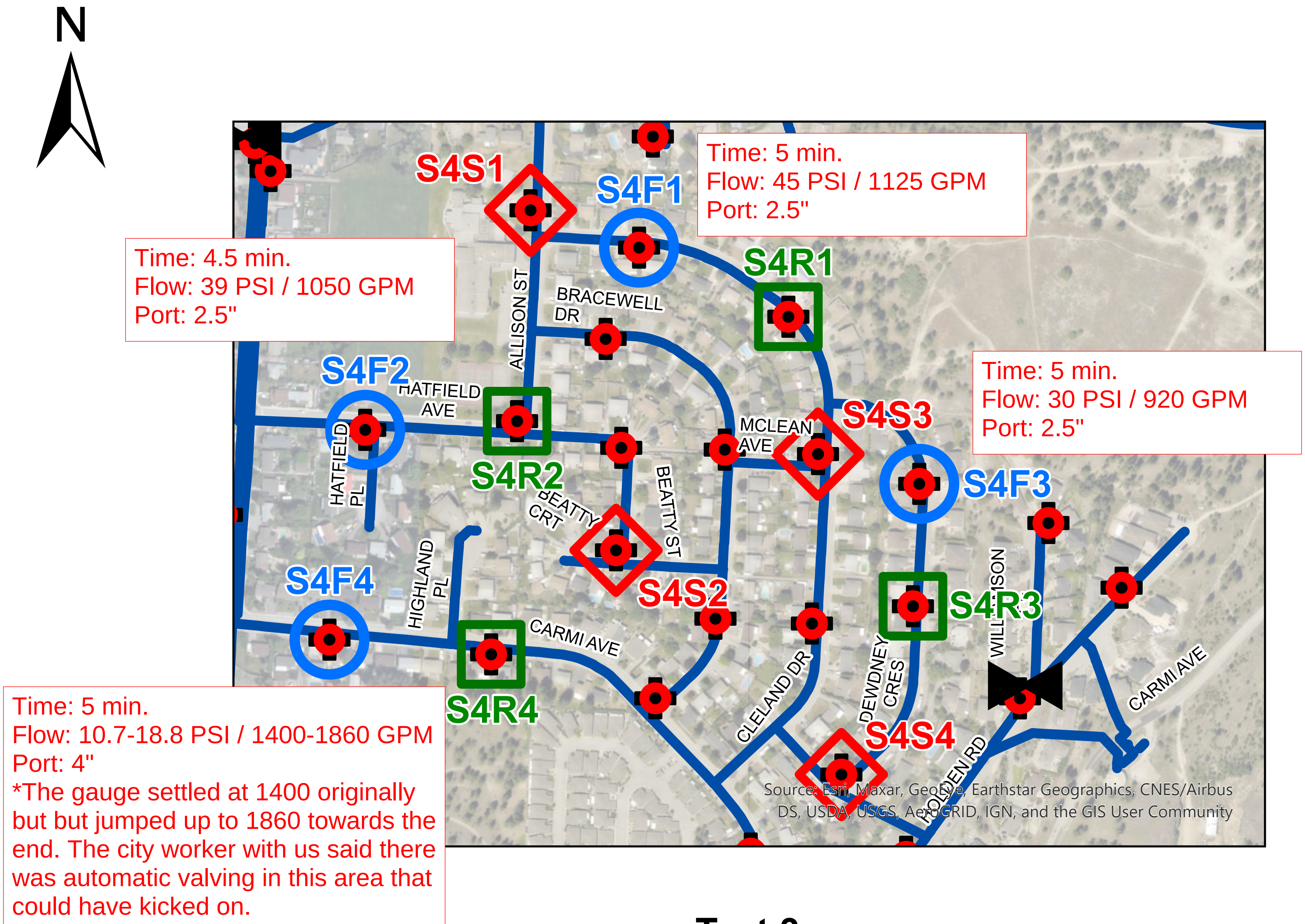
Figure 2
Existing Water System
Multi-Pressure Hydrant Tests 1 & 2

Project No.:	20M-00462-00
Date:	31/07/2020
Scale:	1:5,000

0 50 100 200 Meters

Path: C:\2020-07-08 Penticton IIMP\Water.aprx



Test 3

Legend

- Watermain
- Water Zone System Valves
- Fire Hydrant
- Fire Hydrant Tested Between 2014 to 2017
- Static Hydrant
- Residual Hydrant
- Flow Hydrant

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Figure 3
Existing Water System
Multi-Pressure Hydrant Test 3

Project No.: **20M-00462-00**

Date: **31/07/2020**

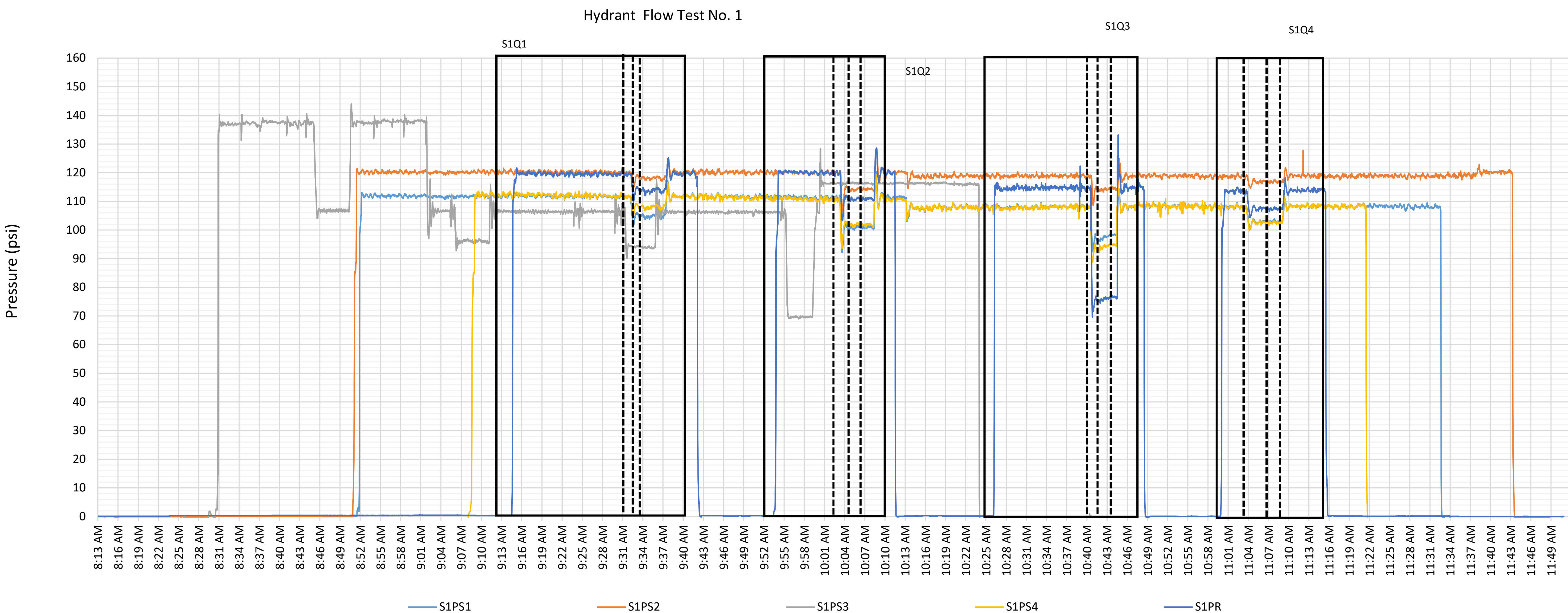
Scale: **1:5,000**

0 50 100 200 Meters

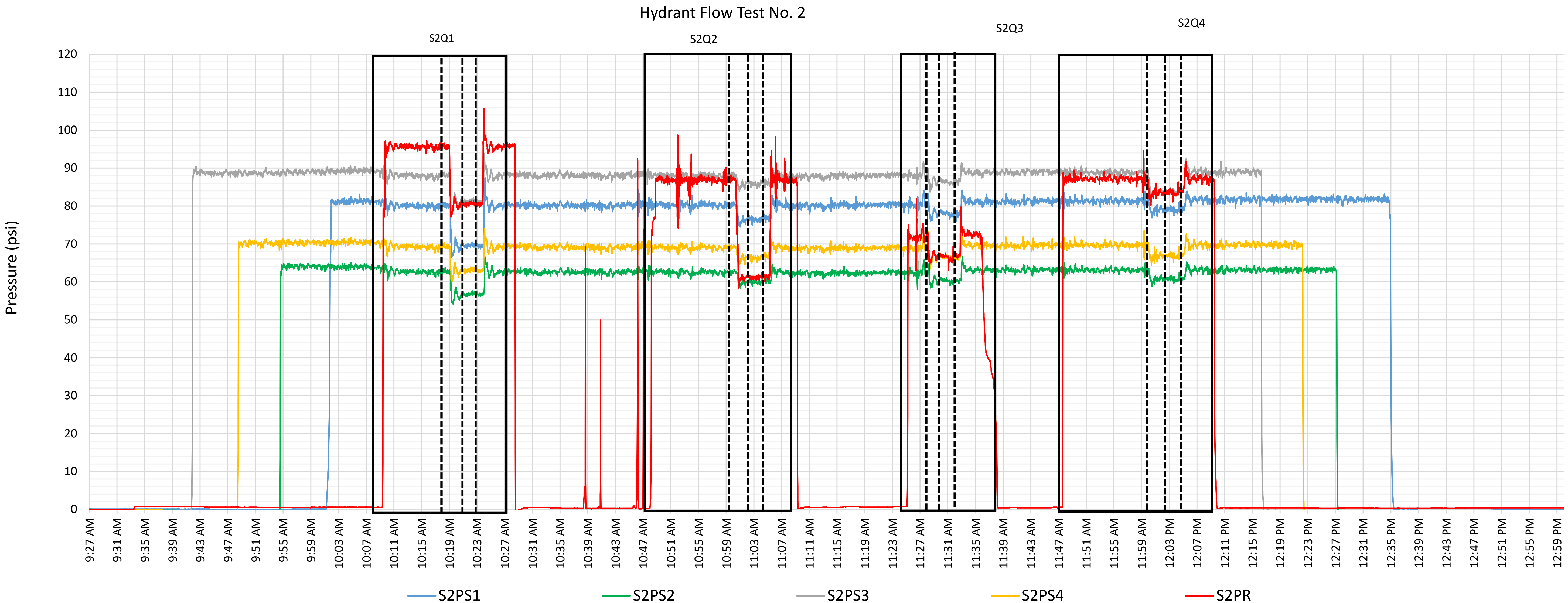
Path: C:\2020-07-08 Penticton IIMP\Water.aprx

APPENDIX

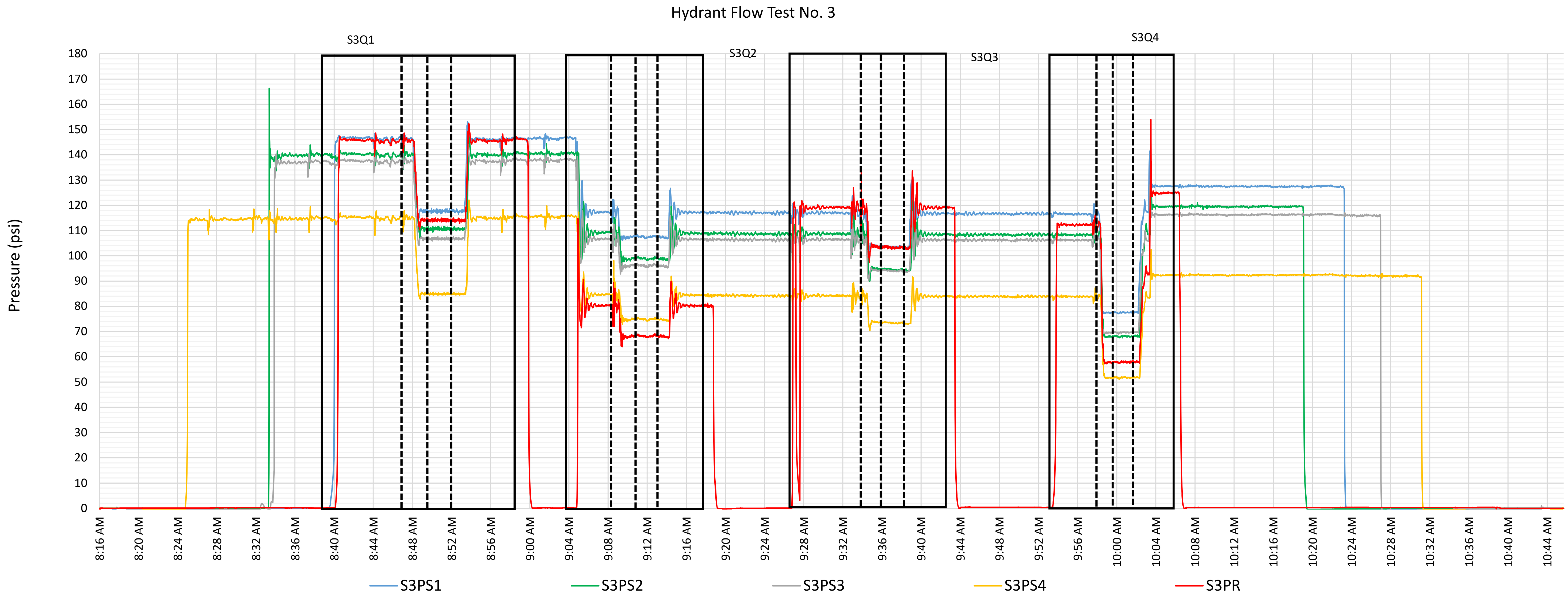
D-3 *MULTI-HYDRANT CALIBRATION*



Date	Flow set no.	Pressure Zone	Location	Hydrant Test No. & Time	Flow (GPM)	Flow (L/s)	Test ID	InfoWater Node	Hydrant Elev. (m)	Field Result					Computer Result				Static Pressure Diff (psi)	% diff Static Pressure	Residual Pressure Diff (psi)	% diff Residual Pressure	Demand Boundary Conditions	Comments
										Static (psi)	Residual (psi)	Static HGL (m)	Residual HGL (m)	Pressure Drop (psi)	Static (psi)	Residual (psi)	Static HGL (m)	Residual HGL (m)						
4-Oct-19	1	433	Downtown Penticton: Wade W Ave and Westminster W Ave, near Brunswick St	Q1			s1f1	J-434-61	344.7															Results from Static 1 logger removed Readings consistenly suspcious for Set 1
				Start			s1r1	J-HYD-929	345.6	119.6	113.7	429.7	425.6	5.8	119.2	115.8	429.4	427.1	-0.4	0%	2.1	2%		
				9:33:00 AM	1040	65.61	s1s1	J-433-42	345.3	-	-	-	-	-	-	-	-	-	-	-	-	-		
							s1s2	J-HYD-69	344.9	120.3	118.1	429.4	427.9	2.2	120.6	118.9	429.7	428.5	0.3	0%	0.9	1%		
				End			s1s3	J-434-45	346.1	117.1	112.9	428.4	425.5	4.2	118.5	115.8	429.4	427.5	1.4	1%	2.8	3%		
				9:37:00 AM			s1s4	J-434-79	349.4	111.9	107.9	428.1	425.3	4.0	114.0	112.0	429.5	428.1	2.1	2%	4.0	4%		
				Q2			s1f2	J-436-47	344.6															
				Start			s1r2	J-433-87	345.0	120.0	110.9	429.4	423.0	9.1	120.5	116.5	429.7	426.9	0.4	0%	5.6	5%		
				10:04:00 AM	2080	131.23	s1s1	J-433-42	345.3	-	-	-	-	-	-	-	-	-	-	-	-	-		
							s1s2	J-HYD-69	344.9	120.1	114.2	429.3	425.2	5.9	120.6	115.7	429.7	426.2	0.5	0%	1.5	1%		
				End			s1s3	J-434-45	346.1	117.1	108.2	428.4	422.2	8.9	118.5	113.8	429.4	426.1	1.4	1%	5.6	5%		
				10:08:00 AM			s1s4	J-434-79	349.4	110.7	101.8	427.3	421.0	8.9	114.0	109.3	429.5	426.2	3.2	3%	7.5	7%		
				Q3			s1f3	J-433-50	345.6															Irratic results for residuals Suspect a throttled valve but difficult to replicate
				Start			s1r3	J-HYD-1004	346.8	114.9	76.4	427.5	400.5	38.5	117.7	114.5	429.5	427.3	2.8	2%	38.1	50%		
				10:42:00 AM	980	61.83	s1s1	J-433-42	345.3	-	-	-	-	-	-	-	-	-	-	-	-	-		
							s1s2	J-HYD-69	344.9	118.9	114.6	428.4	425.4	4.3	120.6	119.0	429.7	428.6	1.8	1%	4.5	4%		
				End			s1s3	J-434-45	346.1	114.6	101.6	426.7	417.6	13.0	118.5	116.3	429.4	427.9	3.9	3%	14.7	14%		
				10:44:00 AM			s1s4	J-434-79	349.4	108.1	94.8	425.4	416.0	13.3	114.0	111.9	429.5	428.1	5.9	5%	17.1	18%		
				Q4			s1f4	J-435-61	346.9															
				Start			s1r4	J-433-55	347.8	113.8	107.4	427.8	423.3	6.5	116.2	112.2	429.5	426.7	2.4	2%	4.8	4%		
				11:06:00 AM	1675	105.68	s1s1	J-433-42	345.3	-	-	-	-	-	-	-	-	-	-	-	-	-		
							s1s2	J-HYD-69	344.9	118.9	116.8	428.4	427.0	2.0	120.6	117.7	429.7	427.6	1.7	1%	0.9	1%		
				End			s1s3	J-434-45	346.1	115.0	108.0	427.0	422.0	7.1	118.5	110.4	429.4	423.8	3.5	3%	2.4	2%		
				11:09:00 AM			s1s4	J-434-79	349.4	108.4	102.6	425.6	421.5	5.8	114.0	110.1	429.5	426.8	5.6	5%	7.5	7%		



Date	Flow set no.	Pressure Zone	Location	Hydrant Test No. & Time	Flow (GPM)	Flow (L/s)	Test ID	InfoWater Node	Hydrant Elev. (m)	Field Result					Computer Result				Static Pressure Diff (psi)	% diff Static Pressure	Residual Pressure Diff (psi)	% diff Residual Pressure	Demand Boundary Conditions	Comments
										Static (psi)	Residual (psi)	Static HGL (m)	Residual HGL (m)	Pressure Drop (psi)	Static (psi)	Residual (psi)	Static HGL (m)	Residual HGL (m)						
				Q1			s2f1	J-438-61	362.2															
				Start			s2r1	J-HYD-528	361.1	95.7	82.9	428.4	419.4	12.8	96.1	90.1	428.7	424.4	0.4	0%	7.1	9%		Results from Static 4 logger removed Readings consistenly suspcious for Set 2 Suspect a throttled valve but difficult to replicate
				10:22:00 AM	1550	97.79	s2s1	J-438-57	371.8	80.2	69.5	428.2	420.7	10.7	81.0	77.1	428.8	426.0	0.8	1%	7.6	11%		
							s2s2	J-438-42	383.5	62.8	56.7	427.6	423.4	6.0	64.5	61.8	428.8	427.0	1.7	3%	5.1	9%		
				End			s2s3	J-HYD-78	360.1	-	-	-	-	-	-	-	-	-	-	-	-	-		
				10:24:00 AM			s2s4	J-HYD-77	378.6	69.4	63.2	427.3	423.0	6.2	71.4	68.5	428.7	426.7	2.0	3%	5.4	9%		
				Q2			s2f2	J-438-46	363.1															
				Start			s2r2	ET-139	368.0	86.9	61.2	429.1	411.1	25.7	86.3	83.8	428.7	427.0	-0.6	-1%	22.6	37%		Suspect a throttled valve but difficult to replicate
				11:02:00 AM	730	46.06	s2s1	J-438-57	371.8	80.4	76.6	428.3	425.7	3.8	81.0	79.3	428.8	427.6	0.6	1%	2.7	4%		
							s2s2	J-438-42	383.5	62.6	60.1	427.5	425.8	2.5	64.5	63.2	428.8	427.9	1.8	3%	3.1	5%		
				End			s2s3	J-HYD-78	360.1	-	-	-	-	-	-	-	-	-	-	-	-	-		
				11:05:00 AM			s2s4	J-HYD-77	378.6	69.1	66.5	427.1	425.3	2.5	71.4	70.0	428.7	427.8	2.3	3%	3.5	5%		
4-Oct-19	2	555	Carmi Ave and Dewdney Cres, near Hadfield Ave	Q3			s2f3	J-438-40	373.8															
				Start			s2r3	J-438-43	378.5	72.5	67.3	429.5	425.8	5.2	71.5	68.5	428.8	426.7	-1.0	-1%	1.2	2%		
				11:30:00 AM	805	50.79	s2s1	J-438-57	371.8	81.1	78.0	428.8	426.7	3.1	81.0	79.2	428.8	427.5	-0.1	0%	1.2	1%		
							s2s2	J-438-42	383.5	63.1	60.3	427.8	425.9	2.8	64.5	62.9	428.8	427.7	1.4	2%	2.6	4%		
				End			s2s3	J-HYD-78	360.1	-	-	-	-	-	-	-	-	-	-	-	-	-		
				11:33:00 AM			s2s4	J-HYD-77	378.6	69.6	66.6	427.5	425.4	3.0	71.4	69.5	428.7	427.4	1.8	3%	2.9	4%		
				Q4			s2f4	J-HYD-538	363.3															
				Start			s2r4	ET-147	369.0	87.1	83.5	430.3	427.7	3.6	84.9	82.1	428.7	426.7	-2.3	-3%	-1.5	-2%		
				12:01:00 PM	750	47.32	s2s1	J-438-57	371.8	81.4	79.1	429.0	427.4	2.3	81.0	79.6	428.8	427.7	-0.4	0%	0.5	1%		
							s2s2	J-438-42	383.5	63.2	60.8	427.9	426.2	2.4	64.5	63.0	428.8	427.8	1.3	2%	2.2	4%		
				End			s2s3	J-HYD-78	360.1	-	-	-	-	-	-	-	-	-	-	-	-	-		
				12:05:00 PM			s2s4	J-HYD-77	378.6	69.7	66.9	427.6	425.6	2.8	71.4	69.5	428.7	427.4	1.6	2%	2.6	4%		



Date	Flow set no.	Pressure Zone	Location	Hydrant Test No. & Time	Flow (GPM)	Flow (L/s)	Test ID	InfoWater Node	Hydrant Elev. (m)	Field Result					Computer Result				Static Pressure Diff (psi)	% diff Static Pressure	Residual Pressure Diff (psi)	% diff Residual Pressure	Demand Boundary Conditions	Comments
										Static (psi)	Residual (psi)	Static HGL (m)	Residual HGL (m)	Pressure Drop (psi)	Static (psi)	Residual (psi)	Static HGL (m)	Residual HGL (m)						
3-Oct-19	4	433	Penticton Industrial Core: Okanagan W Ave and Warren E Ave, near Camrose St	Q1			s4f1	J-HYD-697	466.9															
				Start			s4r1	J-HYD-698	472.9	145.8	114.1	575.4	553.1	31.7	137.5	114.8	569.5	553.6	-8.4	-6%	0.7	1%		Results from Static 1 logger removed Readings consistenly suspcious for Set 3
				8:49:00 AM	1125	70.98	s4s1	J-555-28	463.4	-	-	-	-	-	-	-	-	-	-	-	-	-		
							s4s2	J-555-37	476.3	140.3	110.7	574.9	554.1	29.6	133.1	110.9	569.9	554.3	-7.2	-5%	0.2	0%		
				End			s4s3	J-555-34	477.6	137.5	106.8	574.3	552.7	30.8	130.0	108.5	569.0	553.9	-7.5	-5%	1.8	2%		
				8:53:00 AM			s4s4	J-555-40	492.1	115.3	84.9	573.1	551.8	30.4	106.8	88.1	567.2	554.1	-8.4	-7%	3.2	4%		
				Q2			s4f2	J-555-36	465.4															
				Start			s4r2	J-555-27	469.7	80.3	68.2	526.2	517.6	12.1	119.7	112.2	553.8	548.6	39.3	49%	44.0	64%		Consistently high residual pressures Suspect issue with residual logger for this location
				9:10:00 AM	1050	66.24	s4s1	J-555-28	469.7	-	-	-	-	-	-	-	-	-	-	-	-	-		
							s4s2	J-555-37	476.3	109.2	98.9	553.1	545.8	10.4	110.3	103.6	553.9	549.2	1.1	1%	4.8	5%		
				End			s4s3	J-555-34	477.6	106.7	96.1	552.6	545.2	10.6	108.5	102.5	553.9	549.7	1.8	2%	6.3	7%		
				9:14:00 AM			s4s4	J-555-40	492.1	84.7	74.9	551.6	544.7	9.8	87.9	82.6	553.9	550.2	3.2	4%	7.7	10%		
				Q3			s4f3	J-HYD-699	481.0															
				Start			s4r3	J-HYD-723	485.1	119.2	103.4	569.0	557.8	15.9	97.8	84.3	553.9	544.4	-21.5	-18%	-19.0	-18%		Consistently high residual pressures Suspect issue with residual logger for this location
				9:35:00 AM	920	58.04	s4s1	J-555-28	469.7	-	-	-	-	-	-	-	-	-	-	-	-	-		
							s4s2	J-555-37	476.3	108.7	94.5	552.7	542.7	14.2	110.3	98.8	553.9	545.8	1.5	1%	4.3	5%		
				End			s4s3	J-555-34	477.6	106.5	94.4	552.5	544.0	12.1	108.5	96.9	553.9	545.7	1.9	2%	2.4	3%		
				9:39:00 AM			s4s4	J-555-40	492.1	84.2	73.4	551.3	543.7	10.8	87.9	77.2	553.9	546.4	3.7	4%	3.8	5%		
				Q4			s4f4	J-HYD-463	463.4															
				Start			s4r4	J-555-41	475.2	112.3	57.9	554.2	515.9	54.4	111.9	73.2	553.9	526.7	-0.4	0%	15.3	26%		Suspect a throttled valve but difficult to replicate
				9:59:00 AM	1860	117.35	s4s1	J-555-28	469.7	-	-	-	-	-	-	-	-	-	-	-	-	-		
							s4s2	J-555-37	476.3	108.3	68.1	552.5	524.2	40.2	110.3	72.6	553.9	527.3	1.9	2%	4.5	7%		
				End			s4s3	J-555-34	477.6	106.3	69.7	552.3	526.6	36.6	108.5	72.1	553.9	528.3	2.2	2%	2.5	4%		
				10:02:00 AM			s4s4	J-555-40	492.1	83.9	51.8	551.1	528.5	32.1	87.9	54.9	553.9	530.7	4.0	5%	3.2	6%		

APPENDIX

E

WATER CAPITAL PROJECTS

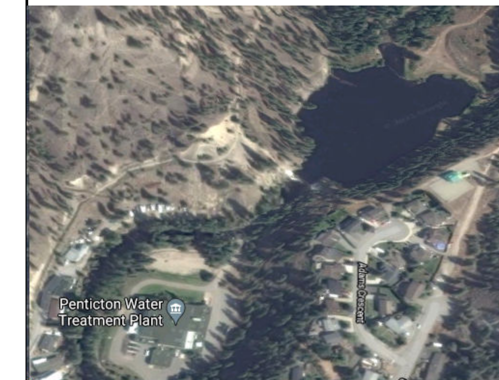
Filter Media Testing and Replacement

Objective: Investigate alternate filter media designs and configurations to determine optimum configuration in advance of replacement of original filter media.

Considerations: Existing media design was based on the original two train operation that included provision for direct filtration and treatment of sediment clarifier effluent. With the additional of the DAF process, the filter influent water quality characteristics are different and may warrant an alternate media design for optimum performance.

Action: Install filter column pilot testing onsite to treat DAF effluent and conduct series of testing to evaluate the performance of alternate filter media designs and configurations.

WAT-01



Project Name: WTP Filter Media Pilot Study
Project Number: WAT-01

Project Timeline: 5 to 10 years
Project Priority: Medium
Estimated Cost ($ 2021): $150,000
Upgrade Driver: Optimization
Developer Contribution: Not Applicable

DESIGN CONSIDERATIONS

A program to optimize the facility would consider DAF Air Saturation and Recycle Replacement (WAT-53) as well as this project for Filter Media Testing and Replacement.

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PENTICTON IIMP

WAT-01 WTP Filter Media Pilot Study
Water Master Plan

0 40 80
Meters

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

Client: City of Penticton

Path: C:\Users\caak070879\Documents\caak070879\02_projects\017_penticton\06_capital_projects_gis\2. Water MP\mxd\Capital Projects\WAT-01.mxd

ITEM	COST PER CONNECTION	UNIT	COST (2021 $)
1.0	**General Requirements**		
1.1	Mobilization and Demobilization	L.Sum	$1,700
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	L.Sum	$1,000
1.3	Traffic Management	L.Sum	$3,350
2.0	**Earthworks**		
2.1	Supply and Install New 150mm Dia. Pipe (incl. 50% excavation cost)	Lin. M	$30,600
3.0	**Surface Restoration**		
3.1	Minor Road Restoration (4.0 m width)	Lin. M	$0
3.2	Major Road Restoration (4.0 m width)	Lin. M	$0
4.0	**Land Acquisition**		
4.1	Acquire Easements	L.Sum	$3,050
4.2	Acquire Property	L.Sum	
	SUBTOTAL		**$39,700**
5.0	**Professional Services and Contingencies**		
5.1	Professional Services (15% of Subtotal)	L.Sum	$5,950
5.2	Construction Contingency (25% of Subtotal)	L.Sum	$9,950
	TOTAL ESTIMATED COST		**$55,600**

	Yet to be Separated	**Irrigation area**	**Annual Demand (ML)**	**Reduction in MDD (ML/day)**	**Source**
1	Gyro Park - 24 Lakeshore Drive	1.7	5.16	0.069	OK Lake
2	Gallery Park - Marina Beach	0.7	2.12	0.029	OK Lake
3	Lakawanna Park - Lakeshore and Power	2.2	6.67	0.090	OK Lake
4	SS Sicamus/Rosegarden - Lakeshore & Riverside	1.2	3.64	0.049	OK Lake
5	Riverside Park - Riverside Drive	3.0	9.1	0.123	OK Lake
6	Kiwanis Park - Edmonton Ave. and 470 Edmonton Avenue	1.9	5.76	0.078	Central
	Sub Total	*10.7*	*32.45*	*0.437*	
	Already Separated				
1	Rotary Park - 15 Martin Street	2.4	7.28	0.098	OK Lake
2	Okanagan Park - 45 Lakeshore Drive	3.6	10.92	0.147	OK Lake
3	McNicoll Rugby / Nkwala Park	6	18.2	0.2449	Central
	Sub Total	*12*	*36.4*	*0.4899*	

WAT-02

Project Name: Park Irrigation to Raw Water/Effluent Reuse
Project Number: WAT-02

Project Timeline: 5 - 10 years
Project Priority: Medium
Estimated Cost ($ 2021): $333,600
Upgrade Driver: Water Conservation
Developer Contibution: Not Applicable

DESIGN CONSIDERATIONS

Conversion of parks and sports fields was identified in the Associated Engineering report on Historical and Projected Water Demands and carried over to the 2010 AECOM WMP Addendum Capital Projects. This project has been included in the current study for consistency.

COST CONSIDERATIONS

The cost benefits to these projects as outlined in previous reports chiefly include the reduction in cost of to pump and treat water, as well as on-going lifecycle cost.

Nine Parks were identified as having potential for raw water or effluent irrigation schemes, 3 of which have had irrigation areas separated as of November 2009 (according to 2010 WMP Addendum, AECOM). The cost estimate assumes 100 m of 150 mm PVC pipe to be installed, and results in a similar estimate to the cost in the previous AMP ($40,000 per park in 2010).

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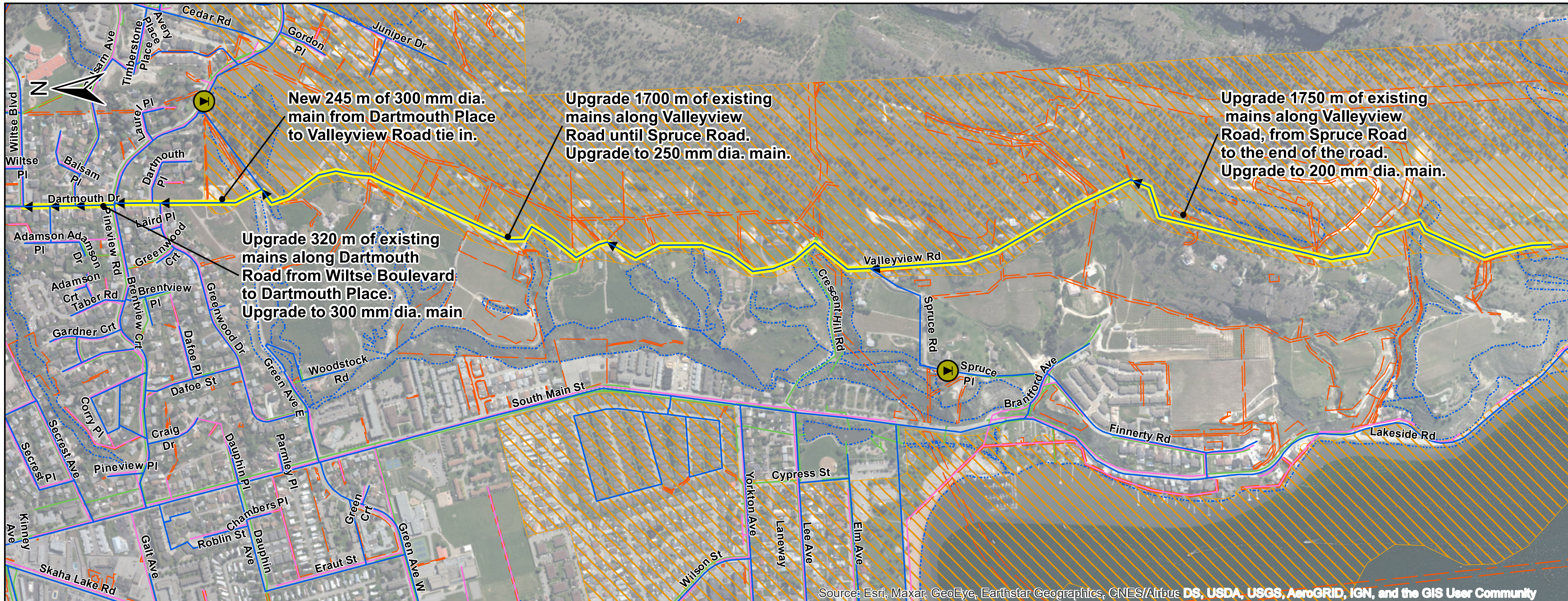
PENTICTON IIMP

WAT-02 Park Irrigation to Raw Water/Effluent Reuse
Water Master Plan

0 40 80
Meters

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

Client: City of Penticton



ITEM	DESCRIPTION	COST (2021 $)
1.0	**General Requirements**	
1.1	Mobilization and Demobilization	$108,400
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$65,050
1.3	Traffic Management	$216,800
2.0	**Earthworks**	
2.1	Supply and Install New 200mm Dia. Pipe (incl. 50% excavation cost)	$626,650
2.2	Supply and Install New 250mm Dia. Pipe (incl. 50% excavation cost)	$796,200
2.3	Supply and Install New 300mm Dia. Pipe (incl. 50% excavation cost)	$147,650
3.0	**Surface Restoration**	
3.1	Minor Road Restoration (4.0 m width)	$57,800
3.2	Minor Road Restoration (4.0 m width)	$529,650
4.0	**Land Acquisition**	
4.1	Acquire Easements	$10,200
	SUBTOTAL	**$2,558,450**
5.0	**Professional Services and Contingencies**	
5.1	Professional Services (15% of Subtotal)	$383,750
5.2	Construction Contingency (25% of Subtotal)	$639,600
	TOTAL ESTIMATED COST	**$3,581,800**

Legend
- PRV
- Proposed Project
- Watermain
- Sanitary Main
- Sanitary Forcemain
- Storm Main
- Watercourse
- City Easement
- Hazard Area

WAT-07

Project Name: Valleyview Road Upgrades
Project Number: WAT-07

Project Timeline: 10 to 25 Year
Project Priority: Low
Estimated Cost ($ 2021): $ 3,581,800
Upgrade Driver: Existing fire flow and peak hour demand minimum pressure deficiencies
Developer Contribution: Not applicable

DESIGN CONSIDERATIONS

The modeling results indicate existing 50 mm, 100 mm and 150 mm diameter mains along Valleyview Road require upgrade to 200 mm and 250 mm to deliver the 60 L/s required for fire flow and to increase PHD pressures. Upsizing these pipes could introduce a potential water quality issue, as demand at the end of the long dead end is low.

This would also include upsizing the 200 mm diameter mains along a section of Dartmouth Road, and installing a new 245 m length of 250 mm diameter main between Dartmouth Drive and Green Avenue.

COST CONSIDERATIONS

This project involves a high investment to improve levels of service to a small number of users, while also potentially introducing water quality issues. An alternate servicing option is to tie-in the Wiltse South development as per WAT-51, and at an estimated cost of approx. $1.5 M this is the preferred option. This is an opportunistic alternative and is dependent on development timing. In the interim period before the development comes on-line, the City can discuss with the fire department the possible provision of pump trucks to meet existing needs until the improvements are made.

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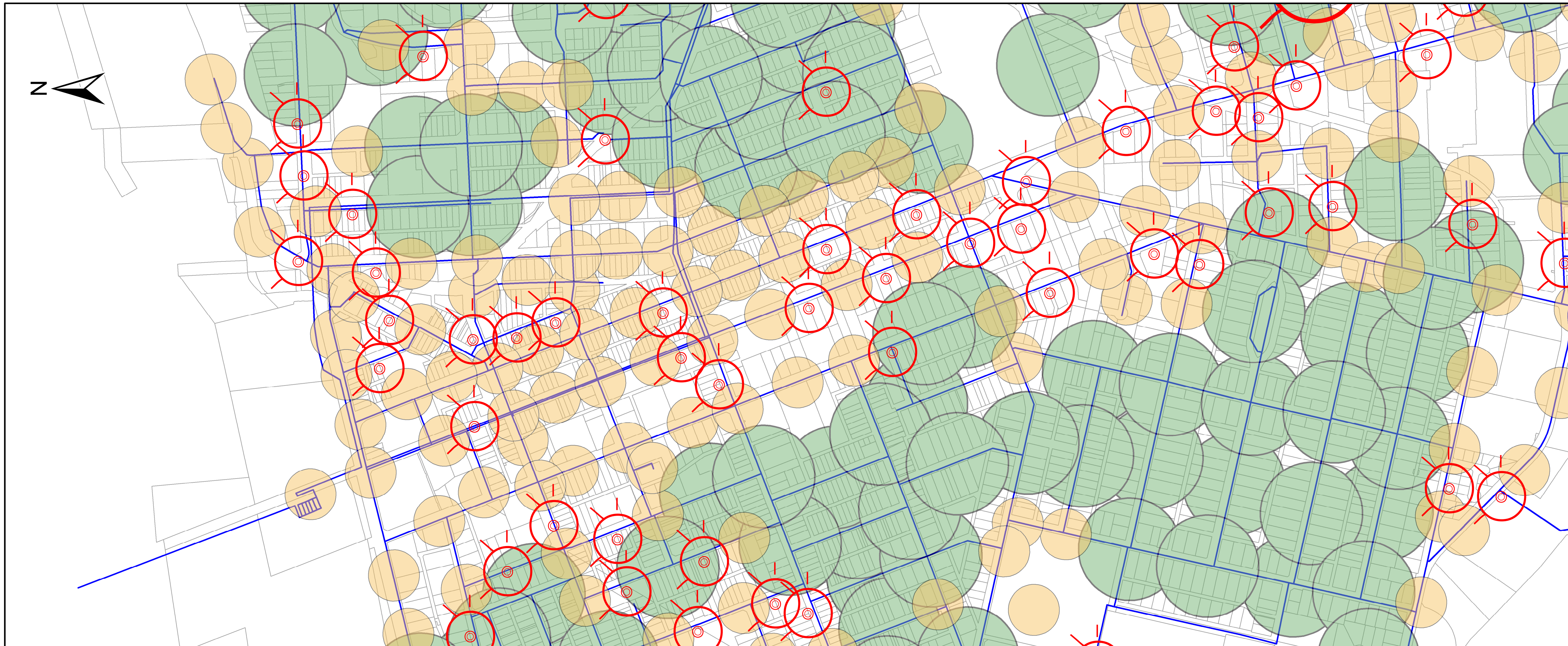
PENTICTON IIMP

WAT-07 Valleyview Road Upgrades
Water Master Plan

0 175 350
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: E-3

Client: City of Penticton



WAT-10

Project Name: Hydrant Installation Program
Project Number: WAT-10

Project Timeline: 1 to 15 year
Project Priority: High
Estimated Cost ($ 2021): $152,500 (per year)
Upgrade Driver: Existing hydrant spacing deficiency
Developer Contribution: Not applicable

DESIGN CONSIDERATIONS

There are 1053 hydrants in the City.

Low Density Housing or Single Family Residential area hydrants are to have a maximum spacing of 180 m. For all other areas, including Multi-Family, Industrial, Commercial or Institutional areas, hydrants are to have a maximum spacing of 90 m.

Based on the mapping and hydrant spacing analysis presented in Section 6.5, an estimated 150 hydrants are required to address deficiencies in coverage, and ensure that every parcel has at least one hydrant servicing it (where there appear to be persisting 'gaps' in coverage.)

This program assumes 10 hydrants installed per year for 15 years. WAT-10 is split into WAT-10a which is the next 5 years (high priority), WAT-10b is the following 5 years (medium priority) and WAT-10c is the final 5 years (low priority).

ITEM	DESCRIPTION	COST (2021 $)
1.0	**General Requirements**	
1.1	Mobilization and Demobilization	$4,650
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$2,750
1.3	Traffic Management	$9,250
2.0	**Earthworks**	
2.1	Supply and Install New 150mm Dia. Pipe (incl. 50% excavation cost)	$1,550
2.2	Supply and Install New 200mm Dia. Pipe (incl. 50% excavation cost)	$1,800
2.3	Supply and Install a Hydrant (incl. tee, valve, lead, restoration)	$87,700
3.0	**Surface Restoration**	
3.1	Minor Road Restoration (4.0 m width)	$500
3.2	Major Road Restoration (4.0 m width)	$750
	SUBTOTAL	**$108,950**
4.0	**Professional Services and Contingencies**	
4.1	Professional Services (15% of Subtotal)	$16,300
4.2	Construction Contingency (25% of Subtotal)	$27,250
	TOTAL ESTIMATED COST	**$152,500**

Legend

- Proposed Hydrant
- Watermain
- Multi-Family and ICI Hydrant
- Single Family Residential Hydrant
- Parcels

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PENTICTON IIMP

WAT-10 Hydrant Installations
Water Master Plan

0 130 260
Meters

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

Client: City of Penticton

CITY OF Penticton

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WAT-24

Project Name: Ridgedale Reservoir Expansion
Project Number: WAT-24

Project Timeline: 1 to 5 Year
Project Priority: High
Estimated Cost ($ 2021): $ 4,857,550
Upgrade Driver: Existing Deficiency
Developer Contribution: Not Applicable

DESIGN CONSIDERATIONS

Storage capacity analysis indicates an estimated 2,215 m^3 of additional storage is required to provide adequate balancing, emergency, and fire storage for the 503 m Pressure Zone. There is limited space at the Ridgedale Reservoir site for expansion, therefore land acquisition is likely necessary. A feasibility study is required to optimize the location of the reservoir expansion and staging.

COST CONSIDERATIONS

A high level cost estimate has been included with a $1 million allowance for land acquisition.

ITEM	DESCRIPTION	COST (2021 $)
1.0	**General Requirements**	
1.1	Mobilization and Demobilization	$147,000
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$88,200
1.3	Traffic Management	$294,050
2.0	**Earthworks**	
2.1	Reservoir Construction/Expansion (incl. site grading, piping, valving)	$1,920,400
3.0	**Surface Restoration**	
3.1	Minor Road Restoration (4.0 m width)	$0
3.2	Major Road Restoration (4.0 m width)	$0
4.0	**Land Acquisition**	
4.1	Acquire Easements	$0
4.2	Acquire Property	$1,000,000
	SUBTOTAL	**$3,449,650**
5.0	**Professional Services and Contingencies**	
5.1	Professional Services (15% of Subtotal)	$517,450
5.2	Construction Contingency (25% of Subtotal)	$862,400
	TOTAL ESTIMATED COST	**$4,829,500**

Legend

- Storage Reservoir
- Watermain
- Watercourse
- Parcels
- City Easement
- Hazard Area

0 40 80
Meters

wsp
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PENTICTON IIMP

WAT-24 Ridgedale Reservoir Expansion
Water Master Plan

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

Client: City of Penticton

CITY OF Penticton

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WAT-33

Project Name: Penticton Avenue PRV Upgrade
Project Number: WAT-33

Project Timeline: 1 to 5 year
Project Priority: High
Estimated Cost ($ 2021): TBD
Upgrade Driver: Existing deficiency
Developer Contribution: Not applicable

DESIGN CONSIDERATIONS

This project to replace the existing aging Clayton style PRV with a new 300 mm dia. PRV was suggested in the 2010 AMP Addendum. As well as increase to PRV capacity, the existing pipe system is aging, and the PRV building requires upgrades.

Currently a PRV study is being conducted by AECOM, and will include the timeline for the proposed installation of the new PRV as well as cost estimates.

COST CONSIDERATIONS

The cost estimate of the upgrade is dependent on the outcome and recommendation of the forthcoming AECOM study.

COSTS FORTHCOMING FROM AECOM CONCEPT

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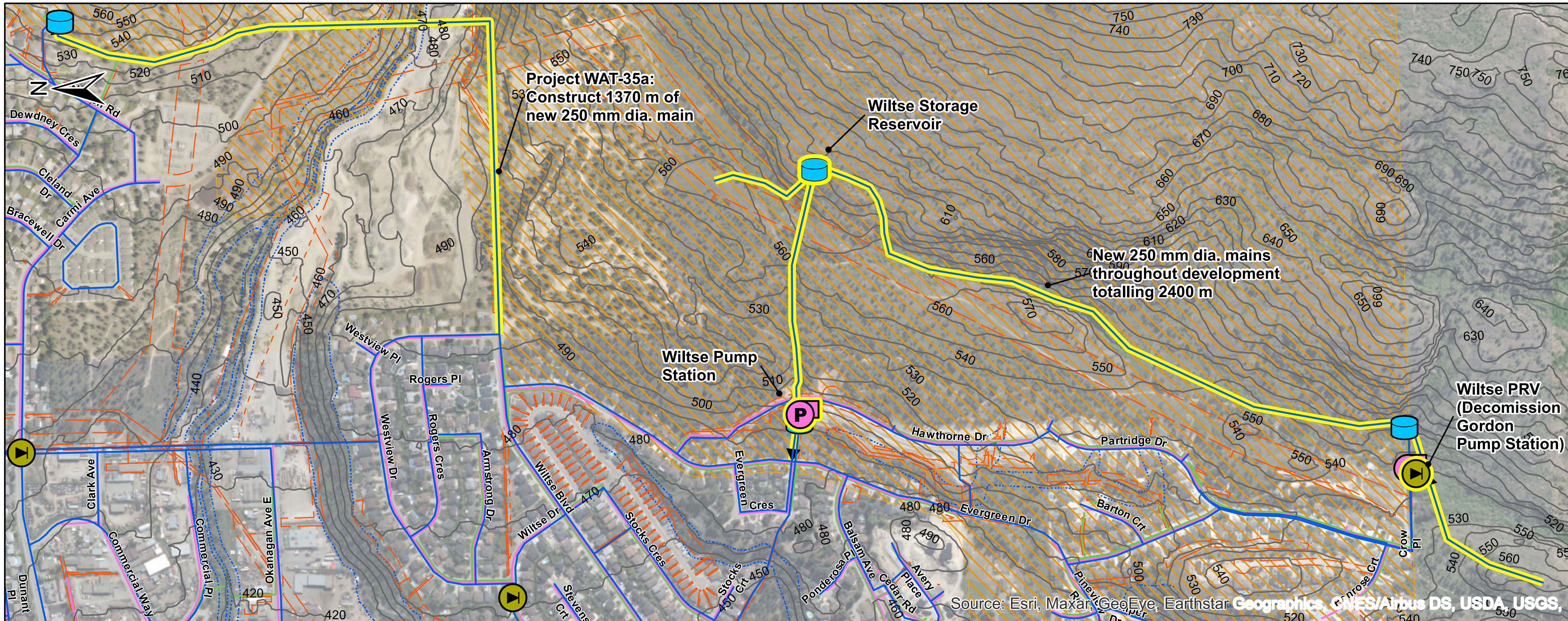
PENTICTON IIMP

WAT-33 Penticton Ave PRV Upgrade
Water Master Plan

0 40 80
Meters

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

Client: City of Penticton



ITEM	WAT-35 DESCRIPTION	COST (2021 $)
1.0	**General Requirements**	
1.1	Mobilization and Demobilization	$200,150
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$120,100
1.3	Traffic Management	$400,250
2.0	**Earthworks**	$0
2.1	Supply and Install New 250mm Dia. Pipe (incl. 50% excavation cost)	$1,539,950
2.2	Remove and Dispose Existing Pipe	$0
2.3	Pump Station Construction/Expansion (incl. mech and EIC)	$627,300
2.4	Reservoir Construction/Expansion (incl. site grading, piping, valving)	$1,525,900
2.5	PRV Station Construction (150 mm - incl. chamber, EIC)	$114,600
3.0	**Surfacing**	
3.1	Minor Road Restoration (4.0 m width)	$40,800
4.0	**Land Acquisition**	
4.1	Acquire Easements	$154,000
	SUBTOTAL	**$4,723,050**
5.0	**Professional Services and Contingencies**	
5.1	Professional Services (15% of Subtotal)	$708,450
5.2	Construction Contingency (25% of Subtotal)	$1,180,750
	TOTAL ESTIMATED COST	**$6,612,250**

ITEM	WAT-35a DESCRIPTION	COST (2021 $)
1.0	**General Requirements**	
1.1	Mobilization and Demobilization	$32,750
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$19,650
1.3	Traffic Management	$65,500
2.0	**Earthworks**	$0
2.1	Supply and Install New 250mm Dia. Pipe (incl. 50% excavation cost)	$558,150
3.0	**Surfacing**	
3.1	Minor Road Restoration (4.0 m width)	$40,800
4.0	**Land Acquisition**	
4.1	Acquire Easements	$55,800
	SUBTOTAL	**$772,600**
5.0	**Professional Services and Contingencies**	
5.1	Professional Services (15% of Subtotal)	$115,900
5.2	Construction Contingency (25% of Subtotal)	$193,150
	TOTAL ESTIMATED COST	**$1,081,650**

Legend

- Storage Reservoir
- Pump Station
- PRV
- Proposed Project
- Watermain
- Sanitary Main
- Storm Main
- Watercourse
- Contours
- City Easement
- Hazard Area

WAT-35

Project Name: Water Supply Upgrade – Wiltse North and South
Project Number: WAT-35

Project Timeline: 10 to 25 Year
Project Priority: Low
Estimated Cost ($ 2021): $ 6,612,250
Upgrade Driver: Future Development
Developer Contribution: Applicable

DESIGN CONSIDERATIONS

The Wiltse developments will be serviced by a 250 mm main from Carmi reservoir connecting into the existing network at the corner of Wiltse and Westview Drive, to supply a new booster pump station located at Evergreen Reservoir which will service the Wiltse Storage Reservoir.

The new reservoir of 1,760 m³ will have a top water level 605 m (as outlined in the 2005 WMP). The new pump station will include 2 x 75 HP pumps (1 duty, 1 standby).

The proposed 250 mm watermain to convey water from the Carmi Reservoir to the new Wiltse Pump Station will require a creek crossing, and will also skirt the Canex property near Westview Drive. The cost of the project may be higher due to creek crossing.

As part of the servicing of Wiltse South, Gordon Pump Station will be decommissioned and the small downstream subzone will be amalgamated into the new Wiltse Pressure Zone, via a backfeed PRV.

COST CONSIDERATIONS

All costs are attributable to the developer, as identified in the OCP. The new main from Carmi reservoir to Westview Drive, which facilitates development, is seperately costed as Project 35a.

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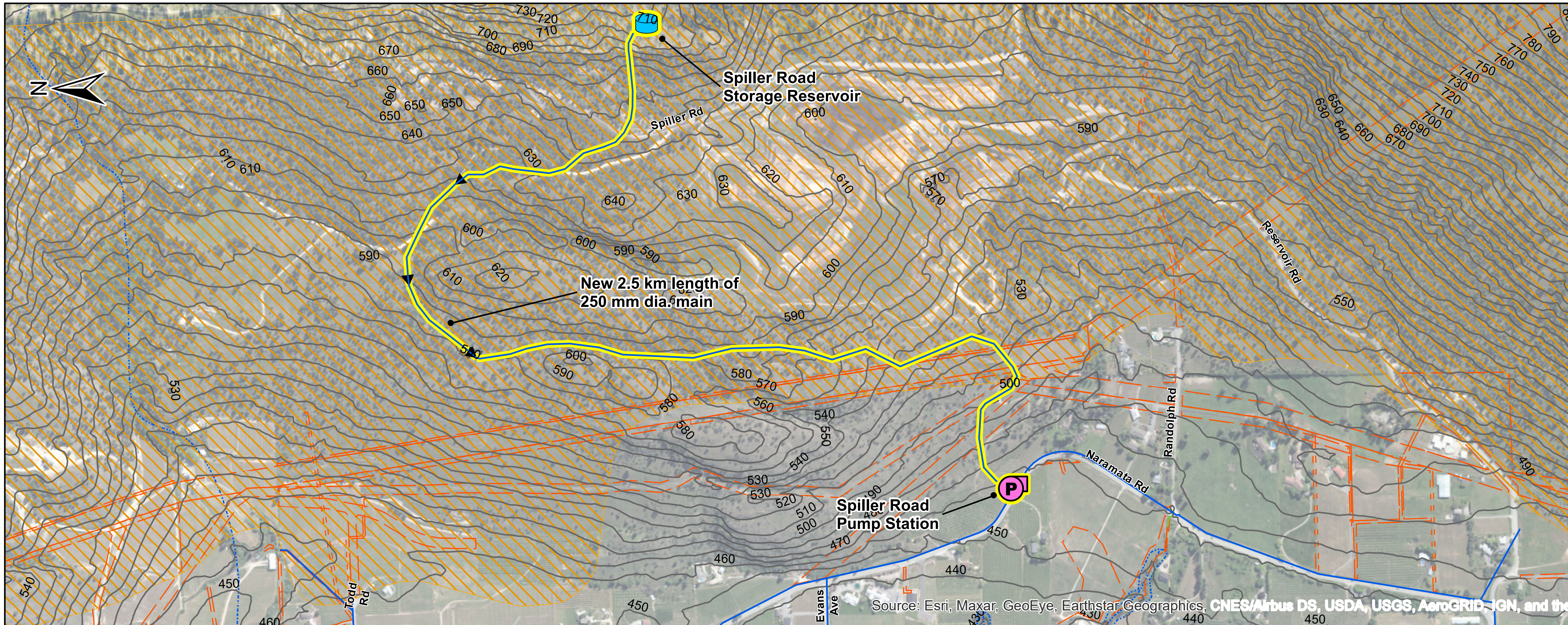
PENTICTON IIMP

WAT-35 Water Supply Upgrade – Wiltse North & South Water Master Plan

0 135 270
Meters

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

Client: City of Penticton



WAT-39

Project Name: Water Supply Upgrade – Spiller Road Development Area
Project Number: WAT-39

Project Timeline: 10 to 25 Year
Project Priority: Low
Estimated Cost ($ 2021): $ 5,001,000
Upgrade Driver: Future Development
Developer Contribution: Applicable

DESIGN CONSIDERATIONS

The Spiller Road Development will require a new pump station, from the Naramata Road watermain, which will feed a new reservoir at the end of the 2.5 km 250 mm dia. new watermain. The new reservoir of 1,300 m³ will have a top water level 715 m (as outlined in the 2005 WMP). The new pump station will consist of 2 no. of 100 HP pumps (1 duty, 1 standby).

COST CONSIDERATIONS

All costs are attributable to the Spiller Road development, as identified in the OCP.

ITEM	DESCRIPTION	COST (2021 $)
1.0	**General Requirements**	
1.1	Mobilization and Demobilization	$154,400
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$92,650
1.3	Traffic Management	$308,800
2.0	**Earthworks**	
2.1	Supply and Install New 250mm Dia. Pipe (incl. 50% excavation cost)	$1,022,300
2.2	Pump Station Construction/Expansion (incl. mech and EIC)	$836,400
2.3	Reservoir Construction/Expansion (incl. site grading, piping, valving)	$1,127,100
3.0	**Land Acquisition**	
3.1	Acquire Easements	$102,250
3.2	Acquire Property	$0
	SUBTOTAL	**$3,643,850**
4.0	**Professional Services and Contingencies**	
4.1	Professional Services (15% of Subtotal)	$546,600
4.2	Construction Contingency (25% of Subtotal)	$910,950
	TOTAL ESTIMATED COST	**$5,101,400**

Legend

- Storage Reservoir
- Pump Station
- Proposed Project
- Watermain
- Storm Main
- Watercourse
- Contours
- City Easement
- Hazard Area

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PENTICTON IIMP

WAT-39 Spiller Road Development
Water Master Plan

0 150 300
Meters

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

Client: City of Penticton

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WAT-42

Project Name: Smythe Holding Tank
Project Number: WAT-42

Project Timeline: 10 to 25 year
Project Priority: Low
Estimated Cost ($ 2021): $322,150
Upgrade Driver: Existing fire flow deficiencies
Developer Contribution: Not applicable

DESIGN CONSIDERATIONS

The existing fire flow deficiency at the end of Lakeside Drive and Smythe Road is a minor deficiency in the order of 10L/s and due to the long dead end servicing this area. A holding tank of approx 75 m³ is proposed at the end of Smythe Road on land owned by the City at an elevation of 430 m. A valve is needed to allow for cycling water from the holding tank to mitigate water quality issues.

COST CONSIDERATIONS

The cost estimates provided here are for a high-level concept design and will be refined. Upgrades of the existing network to meet existing minor deficiencies are low priority given the low number of people benefitting and the high cost of upgrades.

ITEM	DESCRIPTION	COST (2021 $)
1.0	**General Requirements**	
1.1	Mobilization and Demobilization	$9,750
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$5,850
1.3	Traffic Management	$19,500
2.0	**Earthworks**	
2.1	Supply and Install New 150mm Dia. Pipe (incl. 50% excavation cost)	$107,100
2.2	Reservoir Construction/Expansion (incl. site grading, piping, valving)	$65,050
2.3	Valve Station Construction (150 mm - incl. chamber, EIC)	$22,900
	SUBTOTAL	$230,100
3.0	**Professional Services and Contingencies**	
3.1	Professional Services (15% of Subtotal)	$34,550
3.2	Construction Contingency (25% of Subtotal)	$57,550
	TOTAL ESTIMATED COST	$322,150

Legend

- Storage Reservoir
- PRV
- Watermain
- Proposed Project
- Sanitary Main
- Sanitary Forcemain
- Storm Main
- Contours
- Watercourse
- City Easement

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PENTICTON IIMP

WAT-42 Smythe Road Development
Water Master Plan

0 105 210
Meters

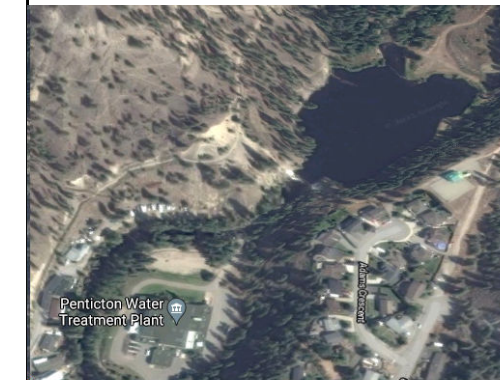
Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: E-9

Client: City of Penticton

WAT-43

Water Treatment Plant

Duncan Avenue Reservoir



Project Name: WTP Clearwell Expansion
Project Number: WAT-43

Project Timeline: 10 to 25 Year
Project Priority: Low
Estimated Cost ($ 2021): $ 3,007,850
Upgrade Driver: Future Deficiency
Developer Contribution: Applicable

DESIGN CONSIDERATIONS

Storage capacity analysis indicates that the WTP Clearwell and the Duncan Reservoir have a combined storage volume deficiency of 2100 m^3 under future conditions. This is in keeping with the findings of the 2010 WMP Addendum, which noted that provisions will have to be made to build or allow more water storage to supply the 433 m Pressure Zone as the City core undergoes infill growth, expansion of the airport lands, and development of the PIB lands.

COST CONSIDERATIONS

There is limited space for expansion at Duncan Reservoir, and if expansion could be accommodated at the WTP Clearwell, a contact time benefit could be realised along with the cost savings associated with no longer needing to acquire land. A feasibility study is recommended to optimize the location of the reservoir expansion and staging.

ITEM	DESCRIPTION	COST (2021 $)
1.0	**General Requirements**	
1.1	Mobilization and Demobilization	$91,050
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$54,600
1.3	Traffic Management	$182,050
2.0	**Earthworks**	
2.1	Reservoir Construction/Expansion (incl. site grading, piping, valving)	$1,820,700
	SUBTOTAL	**$2,148,450**
3.0	**Professional Services and Contingencies**	
3.1	Professional Services (15% of Subtotal)	$322,250
3.2	Construction Contingency (25% of Subtotal)	$537,150
	TOTAL ESTIMATED COST	**$3,007,850**

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PENTICTON IIMP

WAT-43 WTP Clearwell Expansion
Water Master Plan

0 420 840
Meters

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

Client: City of Penticton

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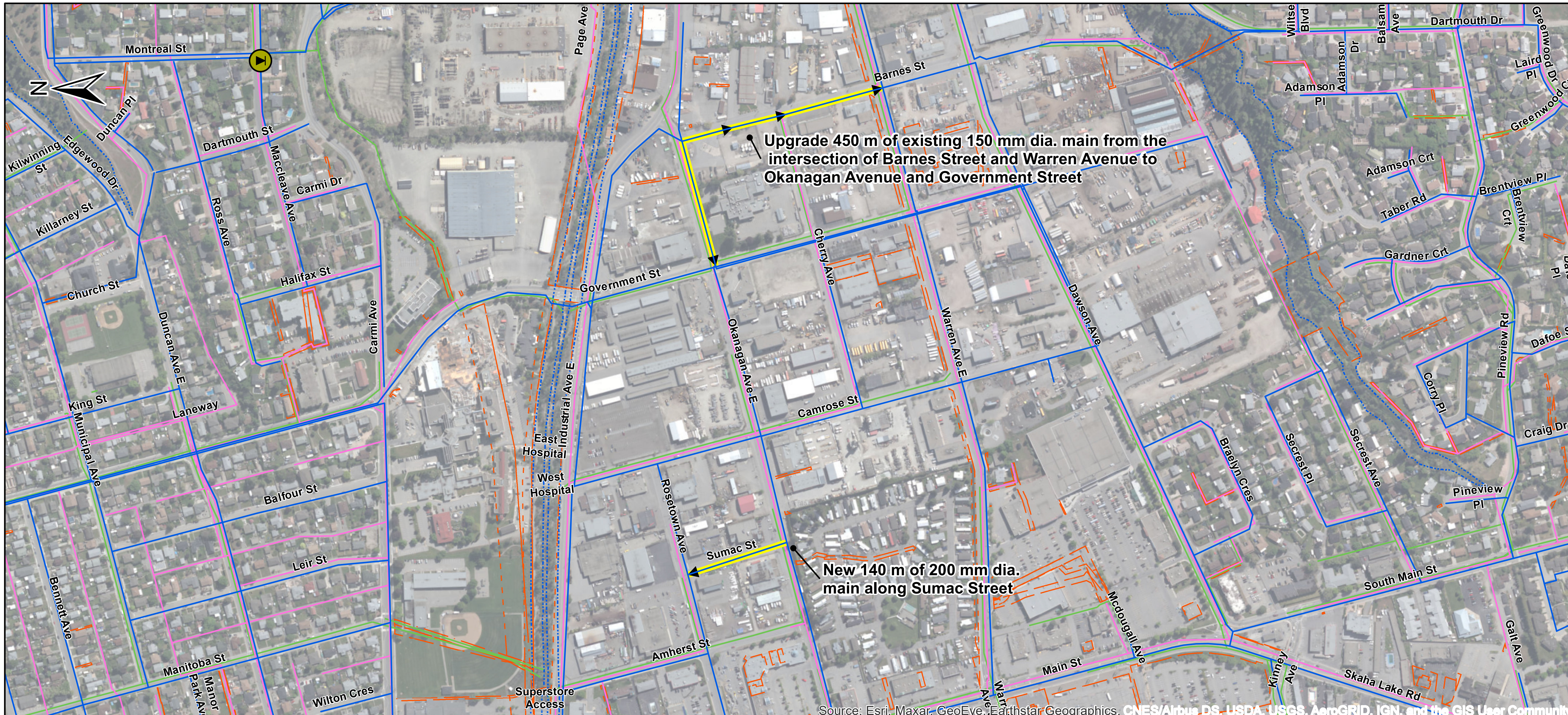

WAT-44a

Project Name: Industrial Area Upgrades
Project Number: WAT-44a

Project Timeline: 1 to 5 Year
Project Priority: High
Estimated Cost ($ 2021): $ 504,550
Upgrade Driver: Existing fire flow deficiencies
Developer Contribution: Not Applicable

DESIGN CONSIDERATIONS

The industrial area has the highest fire flow demand at 225 L/s. Many of the existing cast iron watermains servicing this area date from the1950s and could be undergoing tuberculation.

Mains highlighted in WAT-44a rectify fire flow deficiencies for hydrants located at road intersections and are high priority to ensure adequate fire flow to this area.

Mains highlighted in WAT-44b target the remaining hydrants not at intersections where modelling suggests there is fire flow deficiency.

Mains for upgrade in WAT-44a and WAT-44b total 960 m in length, along portions of Cherry, Warren, Carmi and Okanagan Avenues, Camrose Street, with combined estimated cost of $1.3 M.

ITEM	DESCRIPTION	COST (2021 $)
1.0	**General Requirements**	
1.1	Mobilization and Demobilization	$15,250
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$9,150
1.3	Traffic Management	$30,550
2.0	**Earthworks**	
2.1	Supply and Install New 200mm Dia. Pipe (incl. 50% excavation cost)	$210,300
3.0	**Surface Restoration**	
3.2	Minor Road Restoration (8.0 m width)	$90,150
4.0	**Land Acquisition**	
4.1	Acquire Easements	$5,000
	SUBTOTAL	**$360,400**
5.0	**Professional Services and Contingencies**	
5.1	Professional Services (15% of Subtotal)	$54,050
5.2	Construction Contingency (25% of Subtotal)	$90,100
	TOTAL ESTIMATED COST	**$504,550**

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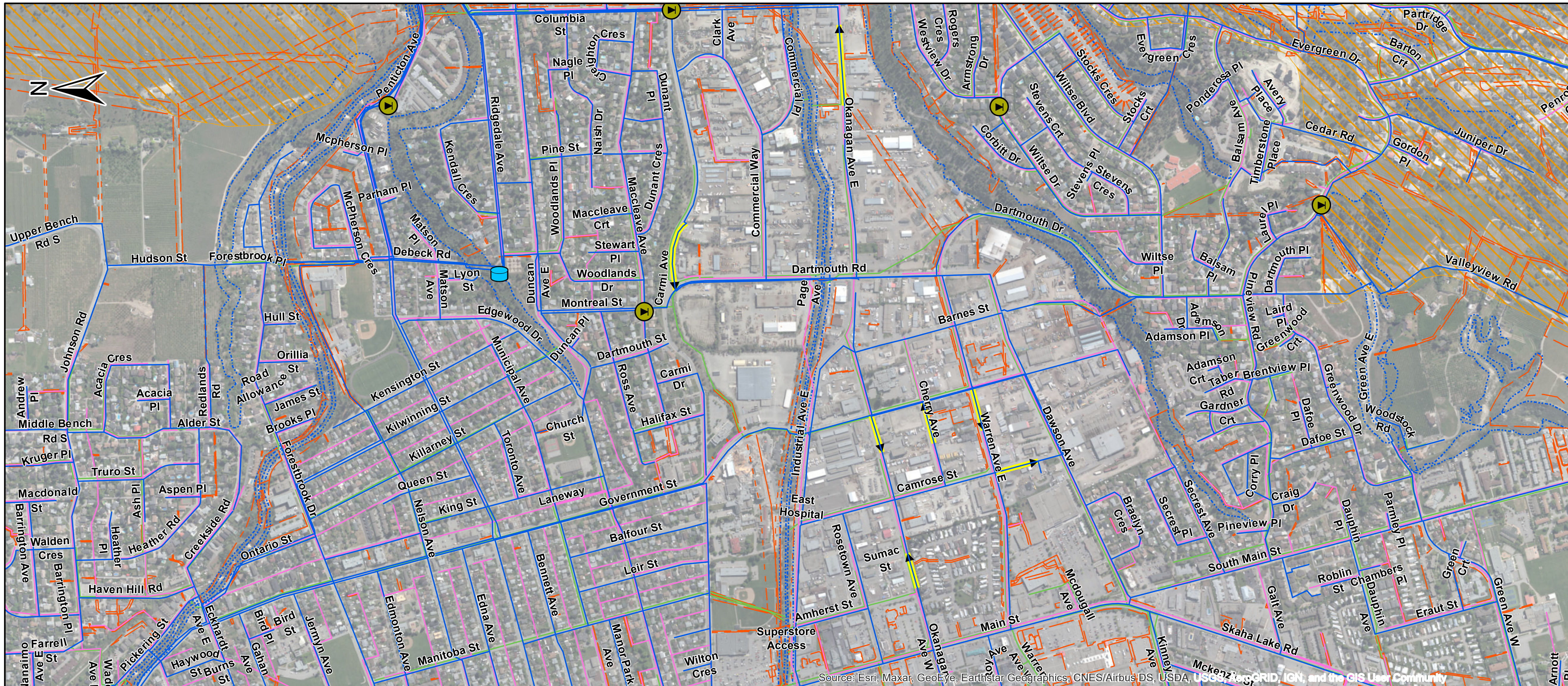
PENTICTON IIMP

WAT-44a Industrial Area Upgrades
Water Master Plan

0 100 200
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: E-11

Client: City of Penticton



ITEM	DESCRIPTION	COST (2021 $)
1.0	**General Requirements**	
1.1	Mobilization and Demobilization	$24,450
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$14,650
1.3	Traffic Management	$48,900
2.0	**Earthworks**	
2.1	Supply and Install New 200mm Dia. Pipe (incl. 50% excavation cost)	$342,300
2.2	Remove and Dispose Existing Pipe	$0
3.0	**Surface Restoration**	
3.1	Major Road Restoration (4.0 m width) - High Priority Upgrades	$146,700
	SUBTOTAL	**$577,000**
4	**Professional Services and Contingencies**	
4.1	Professional Services (15% of Subtotal)	$86,550
4.2	Construction Contingency (25% of Subtotal)	$144,250
	TOTAL ESTIMATED COST	**$807,800**

Legend

- Storage Reservoir
- PRV
- Proposed Project
- Watermain
- Sanitary Main
- Sanitary Forcemain
- Storm Main
- Watercourse
- City Easement
- Hazard Area

WAT-44b

Project Name: Industrial Area Upgrades (Cont.)
Project Number: WAT-44b

Project Timeline: 1 to 10 Year
Project Priority: Medium
Estimated Cost ($ 2021): $ 807,800
Upgrade Driver: Existing fire flow deficiencies
Developer Contribution: Applicable

DESIGN CONSIDERATIONS

The industrial area has the highest fire flow demand at 225 L/s. Many of the existing cast iron watermains servicing this area date from the1950s and could be undergoing tuberculation.

Mains highlighted in WAT-44a rectify fire flow deficiencies for hydrants located at road intersections and are high priority to ensure adequate fire flow to this area.

Mains highlighted in WAT-44b target the remaining hydrants not at intersections where modelling suggests there is fire flow deficiency.

Mains for upgrade in WAT-44a and WAT-44b total 960 m in length, along portions of Cherry, Warren, Carmi and Okanagan Avenues, Camrose Street, with combined estimated cost of $1,3 M.

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PENTICTON IIMP

WAT-44b Industrial Area Upgrades (Cont.)
Water Master Plan

0 200 400
Meters

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

Client: City of Penticton

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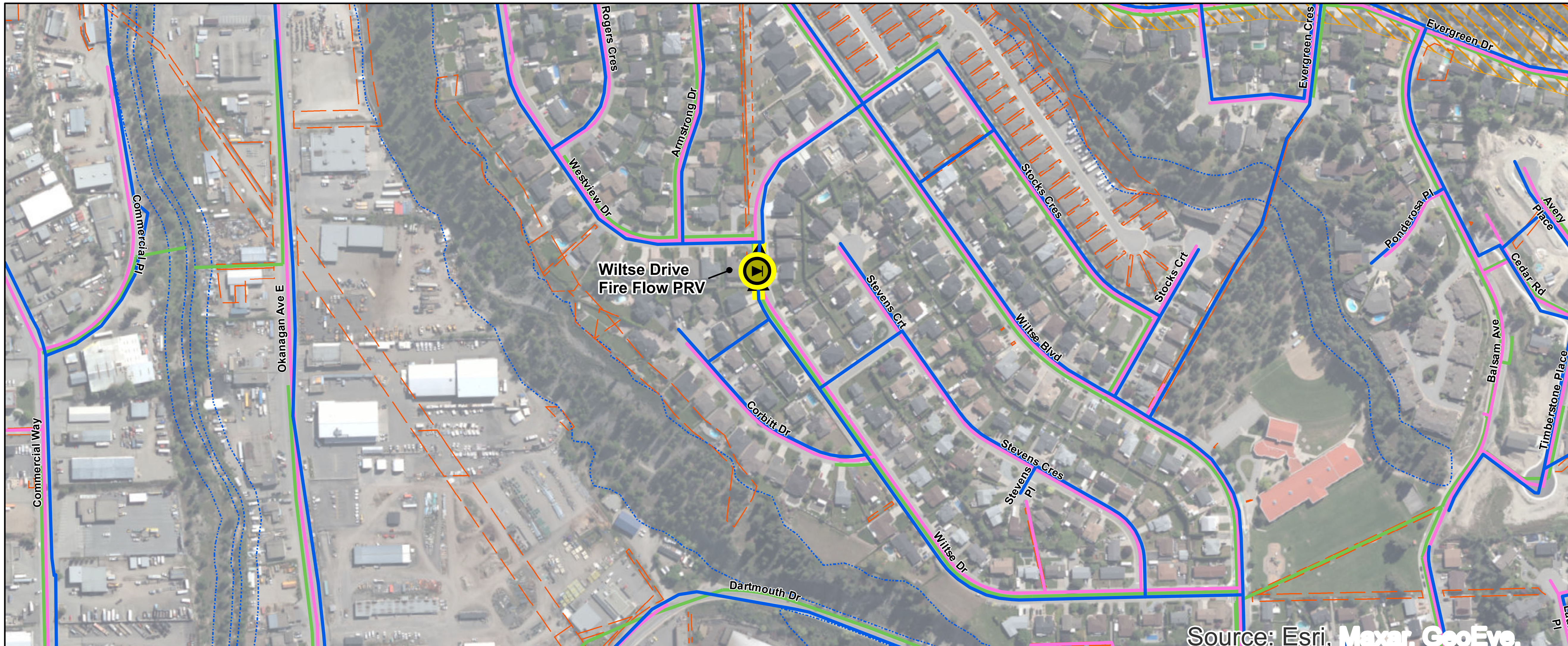
WAT-49

Project Name: Wiltse Dr Fire Flow PRV
Project Number: WAT-49

Project Timeline: 5 to 10 Year
Project Priority: Medium
Estimated Cost ($ 2021): $ 228,300
Upgrade Driver: Existing Deficiency
Developer Contribution: Not Applicable

DESIGN CONSIDERATIONS

The current available fire flow at the end of Wiltse Drive and Stevens Crescent is less than the 60 L/s required during MDD. A 150mm fire flow PRV on Wiltse Drive with connection to the 555 m pressure zone would rectify this deficiency.



ITEM	DESCRIPTION	COST (2021 $)
1.0	**General Requirements**	
1.1	Mobilization and Demobilization	$6,900
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$4,150
1.3	Traffic Management	$13,800
2.0	**Earthworks**	
2.1	Supply and Install New 150mm Dia. Pipe (incl. 50% excavation cost)	$15,750
2.2	PRV Station Construction (150 mm - incl. chamber, EIC)	$114,600
3.0	**Surface Restoration**	
3.1	Minor Road Restoration (4.0 m width)	$0
3.2	Minor Road Restoration (8.0 m width)	$7,850
	SUBTOTAL	**$163,050**
4.0	**Professional Services and Contingencies**	
4.1	Professional Services (15% of Subtotal)	$24,450
4.2	Construction Contingency (25% of Subtotal)	$40,750
	TOTAL ESTIMATED COST	**$228,300**

Legend

- PRV
- Proposed Project
- Watermain
- Sanitary Main
- Storm Main
- Watercourse
- City Easement
- Hazard Area

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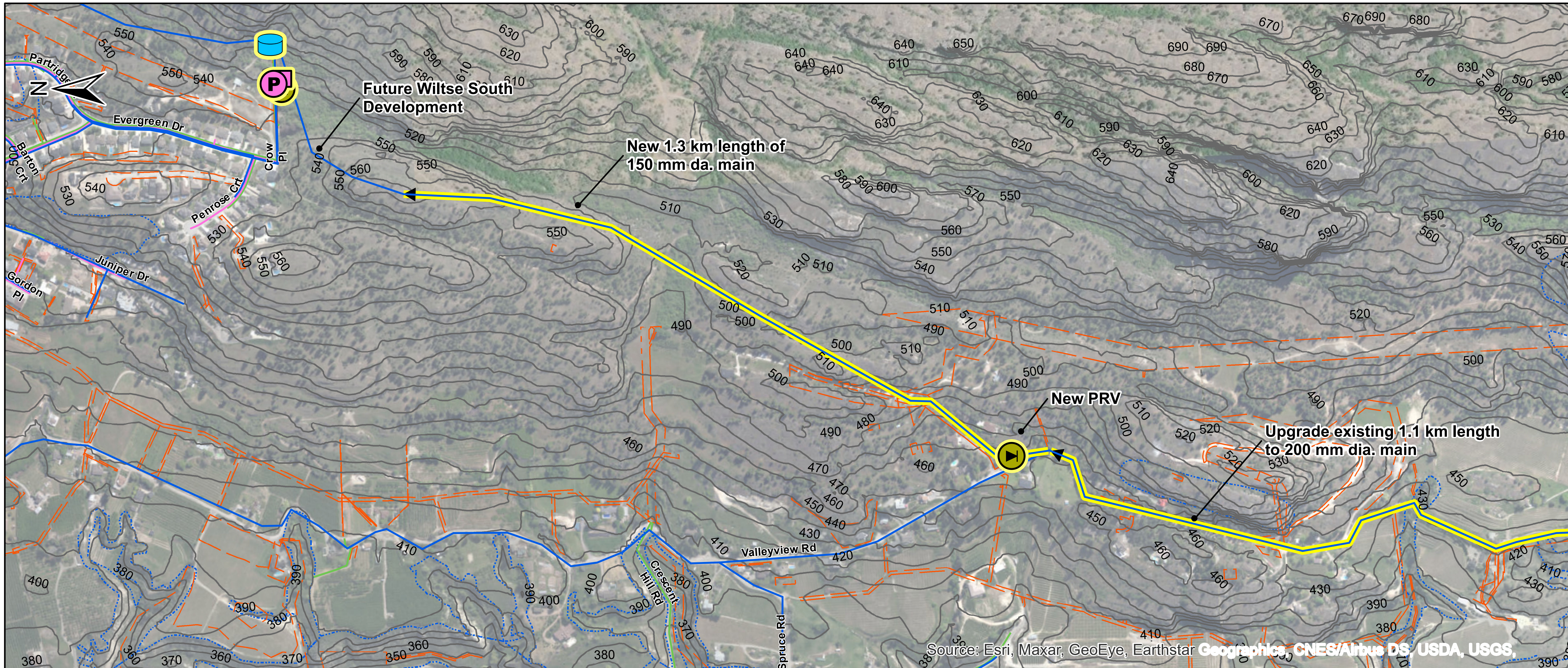
PENTICTON IIMP

WAT-49 Wiltse Dr PRV
Water Master Plan

0 65 130
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: E-13

Client: City of Penticton



ITEM	DESCRIPTION	COST (2021 $)
1.0	**General Requirements**	
1.1	Mobilization and Demobilization	$45,250
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$27,150
1.3	Traffic Management	$90,550
2.0	**Earthworks**	
2.1	Supply and Install New 150mm Dia. Pipe (incl. 50% excavation cost)	$397,800
2.2	Supply and Install New 200mm Dia. Pipe (incl. 50% excavation cost)	$392,700
2.2	PRV Station Construction (150 mm - incl. chamber, EIC)	$114,600
	SUBTOTAL	**$1,068,000**
3.0	**Professional Services and Contingencies**	
3.1	Professional Services (15% of Subtotal)	$160,200
3.2	Construction Contingency (25% of Subtotal)	$267,000
	TOTAL ESTIMATED COST	**$1,495,150**

Legend

- Storage Reservoir
- Pump Station
- PRV
- Proposed Project
- Watermain
- Sanitary Main
- Storm Main
- Contours
- Watercourse
- City Easement

WAT-42

Project Name: Wiltse South Tie-in to Valleyview Road
Project Number: WAT-51

Project Timeline: 10 to 25 year
Project Priority: Low
Estimated Cost ($ 2021): $1,495,150
Upgrade Driver: Existing fire flow deficiencies
Developer Contribution: Not applicable

DESIGN CONSIDERATIONS

This option proposes a 1.3 km new main from the future Wiltse South development to tie-in to Valleyview Road. Further upgrade of the existing undersized main to 200 mm dia. main will address fire flow deficiencies in this area. The cost estimate provided also includes a PRV, required at the tie-in point. Because of the long stretch of dead end with minimal demand, there could be potential water quality issues with upsizing the existing main along Valleyview Road.

COST CONSIDERATIONS

This is an alternate servicing option is to WAT-07 which addresses the fire flow deficiencies at the end of Valleyview Road through a series of pipe upgrades at an estimated cost of approx. $3.6 M. This is an opportunistic alternative and is dependent on timing of the Wiltse South development. In the interim period before the development comes on-line, the City can discuss with the fire department the possible provision of pump trucks to meet existing needs until the improvements are made.

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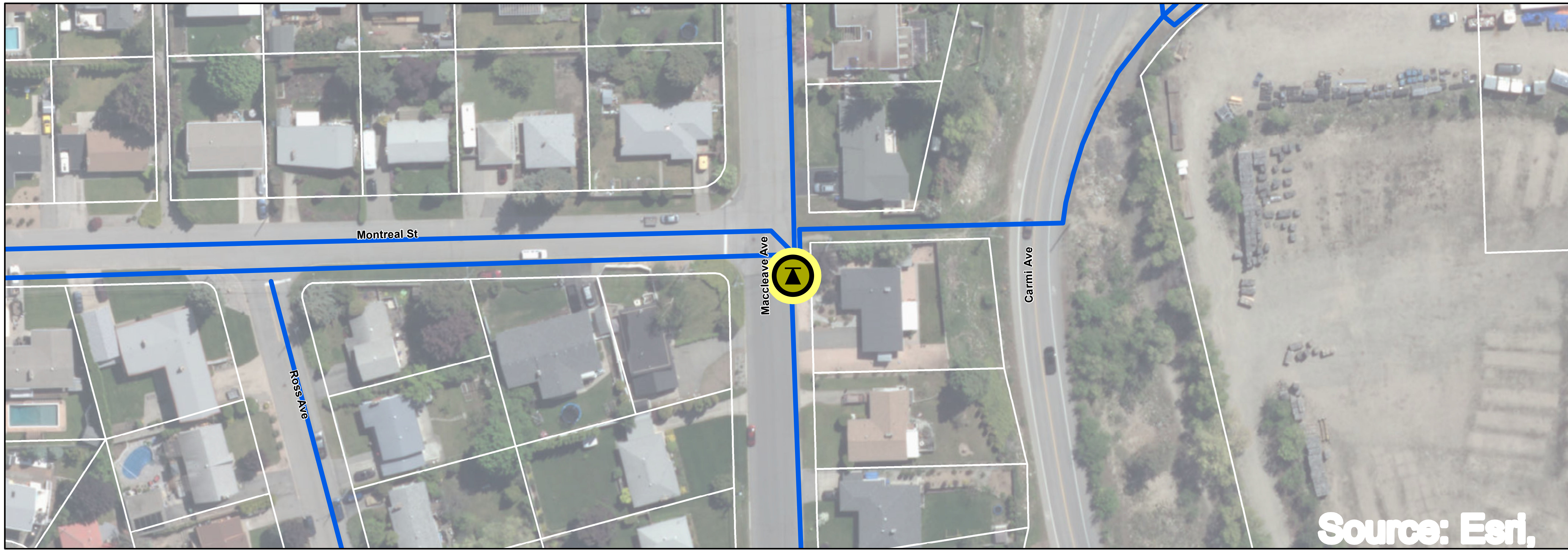
WAT-51 Wiltse South Fire Tie-in to Valleyview Road
Water Master Plan

0 140 280
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: E-15

Client: City of Penticton



WAT-52

Project Name: MacCleave PRV Upgrade
Project Number: WAT-52

Project Timeline: 1 to 5 year
Project Priority: High
Estimated Cost ($ 2021): $227,150
Upgrade Driver: Existing Deficiency
Developer Contribution: Not applicable

DESIGN CONSIDERATIONS

Analysis of MacCleave PRV suggests that while the station can meet downstream PHD conditions, a downstream fire flow requirement of 150 L/s coincident to MDD cannot be supplied without exceeding the maximum allowable velocity in the larger 150 mm lag valve. It is recommended to replace this with a 200 mm valve.

COST CONSIDERATIONS

The cost estimate represented here is calculated using a unit rate to install a new valve and PRV station. The current age and condition of the station are not known, but the cost of this project would reduce if only the valve were to be replaced.

ITEM	DESCRIPTION	COST (2021 $)
1.0	**General Requirements**	
1.1	Mobilization and Demobilization	$6,900
1.2	Bonding, Insurance, Profit, Soft Costs, Etc.	$4,150
1.3	Traffic Management	$13,750
2.0	**PRV Replacement**	
2.1	PRV Station Construction (200 mm - incl. chamber, EIC)	$137,500
	SUBTOTAL	**$162,300**
3.0	**Professional Services and Contingencies**	
3.1	Professional Services (15% of Subtotal)	$24,350
3.2	Construction Contingency (25% of Subtotal)	$40,550
	TOTAL ESTIMATED COST	**$227,150**

Legend

- PRV
- Watermain
- Proposed Project
- Road_Name
- Parcels
- City Easement
- Hazard Area
- Watercourse

wsp

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PENTICTON IIMP

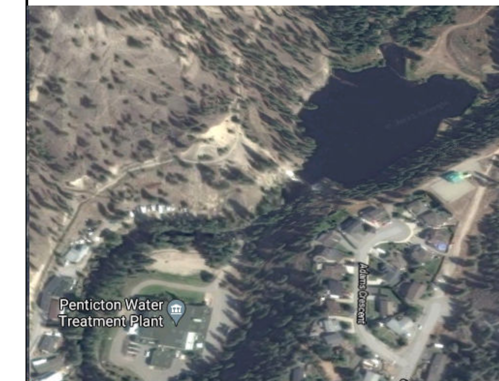
WAT-52 MacCleave PRV Upgrade
Water Master Plan

0 15 30
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: E-16

Client: City of Penticton

WAT-53



Project Name: DAF Air and Recycle Optimization Study
Project Number: WAT-53

Project Timeline: 1 to 5 years
Project Priority: High
Estimated Cost ($ 2021): $40,000
Upgrade Driver: Optimization
Developer Contribution: Not Applicable

DESIGN CONSIDERATIONS

A program to optimize the facility would consider Filter Media Testing and Replacement (WAT-01), as well as this project for potential DAF Air Saturation and Recycle Replacement.

DAF Air Saturation and Recycle Replacement

Objective: Reduce energy and equipment replacement costs to operate the air saturation and recycle system.

Considerations: Existing recycle pumps require frequent maintenance and nearly their end of service life. Advancements in air flotation treatment processes allow for alternate approaches that do not require large air saturation equipment.

Action: Complete a desktop study of alternate flotation to document the cost-to benefit of replacing the current recycle system an alternate technology.

-

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PENTICTON IIMP

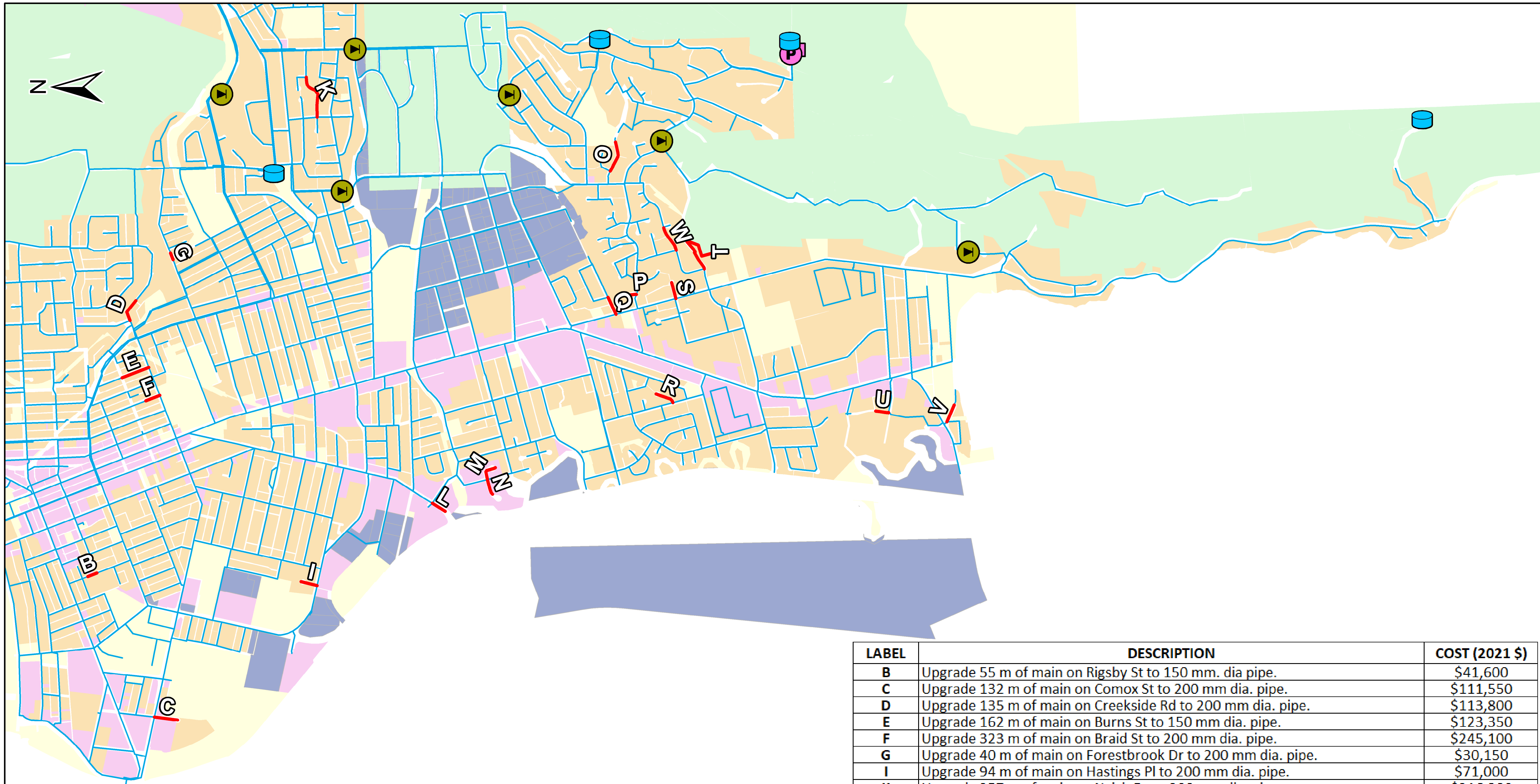
WAT-53 DAF Air and Recycle Optimization Study
Water Master Plan

0 40 80
Meters

Project No.: **20M-00462-00**
Date: **Apr 2021**
Figure No.: **E-17**

Client: City of Penticton

WAT-100



LABEL	DESCRIPTION	COST (2021 $)
B	Upgrade 55 m of main on Rigsby St to 150 mm. dia pipe.	$41,600
C	Upgrade 132 m of main on Comox St to 200 mm dia. pipe.	$111,550
D	Upgrade 135 m of main on Creekside Rd to 200 mm dia. pipe.	$113,800
E	Upgrade 162 m of main on Burns St to 150 mm dia. pipe.	$123,350
F	Upgrade 323 m of main on Braid St to 200 mm dia. pipe.	$245,100
G	Upgrade 40 m of main on Forestbrook Dr to 200 mm dia. pipe.	$30,150
I	Upgrade 94 m of main on Hastings Pl to 200 mm dia. pipe.	$71,000
K	Upgrade 257 m of main on Naish Dr to 200 mm dia. pipe.	$216,300
L	Upgrade 86 m of main on Fairview Rd to 200 mm dia. pipe.	$72,400
M	Upgrade 105 m of main on Industrial Crt to 200 mm dia. pipe.	$88,550
N	Upgrade 88 m of main on Industrial Pl to 200 mm dia. pipe.	$74,350
O	Upgrade 177 m of main on Balsam Ave to 200 mm dia. pipe.	$149,100
P	Upgrade 83 m of main on Pineview Pl to 200 mm dia. pipe.	$63,250
Q	Upgrade 106 m of main on Secrest Ave to 200 mm dia. pipe.	$89,850
R	Upgrade 111 m of main on Mckeen Pl to 200 mm dia. pipe.	$84,450
S	Upgrade 95 m of main on Dauphin Pl to 200 mm dia. pipe.	$71,750
T	Upgrade 427 m of main on Green Ave and Woodstock Rd to 200 mm dia. pipe.	$41,600
U	Upgrade 76 m of main on Hemlock St to 200 mm dia. pipe.	$57,550
V	Upgrade 104 m of main on South Beach Dr to 200 mm dia. pipe.	$78,900
W	Transfer 45 m of watermain along Greenwood Dr to PZ 503. Install new valve to relocate zone boundary.	$5,000
	TOTAL ESTIMATED COST	$1,829,600

Project Name: Medium Priority Upgrades
Project Number: WAT-100

Project Timeline: 5 to 10 Year
Project Priority: Medium
Estimated Cost ($ 2020): $ 1,829,600
Upgrade Driver: Existing Deficiencies
Developer Contribution: Not Applicable

DESIGN CONSIDERATIONS

Mains highlighted here to address fire flow or are medium priority. These upgrades would fall under the small pipe renewals, but are of higher priority as they rectify existing system deficiencies.

SeeTable for upgrade details.

There is the potential for some of the projects shown in the downtown core to be partially developer funded, if subject to future development. This is to be evaluated on a case by case basis.

Note that WAT-I, -L, -Q and -S have "High" integrated priority.

Legend

- Storage Reservoir
- Pump Station
- PRV
- Proposed Project
- Watermain
- Commercial
- Industrial
- Institutional
- Residential
- Rural

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PENTICTON IIMP

Medium Priority Upgrades
Water Master Plan

0 420 840
Meters

Project No.: 20M-00462-00
Date: Apr 2021
Figure No.: E-18

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