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FULFORD WATER SERVICE COMMISSION

Notice of Special Meeting on **Friday, April 14, 2023** at **10:00 AM**
Salt Spring Island Multi Space (SIMS) Boardroom, 124 Rainbow Road, Salt Spring Island, BC

Gary Holman	Carole Eyles	Alan Martin	Anthony Maude	Bren Walker

Zoom Link:
https://us06web.zoom.us/j/87444393034?pwd=UCt6a0JkK094NmJ1dDJHRTB2RytGZz09

AGENDA

1. Territorial Acknowledgement / Call Meeting to Order

2. Election of the Chair

3. Approval of Agenda 1

4. Report

4.1 Fulford Asbestos Cement Watermain Replacement Strategy 2-68

That the Fulford Water Service Commission receives the draft Technical Report from McElhanney for review and comment.

5. Next Meeting – Monday, June 12, 2023 at 10:00AM in the Salt Spring Island Multi Space (SIMS) Boardroom, 124 Rainbow Road, Salt Spring Island, BC V8K 2V5

6. Adjournment

To ensure quorum, advise Shayla Burnham 250 537 4448 if you cannot attend.
EXEC-1295039085-3000

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REPORT TO FULFORD WATER SERVICE COMMISSION
MEETING OF FRIDAY, APRIL 14, 2023

SUBJECT **Fulford Asbestos Cement Watermain Replacement Strategy**

ISSUE SUMMARY

To submit the draft engineering consultant's Technical Report for the replacement strategy for the asbestos cement (AC) water lines for the Fulford water system. The report includes an investigation, analysis, criticality assessment and option review.

BACKGROUND

The Fulford Water System is located in a semi-rural residential community with an elementary school and commercial component. The water system is situated on the north side of Fulford Harbour on Salt Spring Island. Lake Weston supplies raw water to the Fulford Water System and is at an elevation of approximately 60 m above sea level with the topography of the water service area ranging between sea level and 60 m. The area is comprised of 102 parcels of land of which 91 parcels are presently connected to the system.

The Fulford water distribution system consists of 3.4 km of distribution main and is made up of approximately 1.8 km of 50 mm to 100 mm asbestos cement pipe installed in 1970 and approximately 1.6 km of 50 mm to 150 mm PVC pipe installed in the late 2000s. The distribution system also includes fire hydrants, standpipes, gate valves, and water service connections, with the commercial properties fitted with water meters. The intake line running from Lake Weston is approximately 2.9 km long, of which approximately 2.3 km is constructed of 100 mm asbestos cement pipe. All of the asbestos cement pipe in the system is either at or past its useful service life.

ALTERNATIVES

Alternative 1
The Fulford Water Service Commission receives the draft Technical Report from McElhanney for review and comment.

Alternative 2
That the McElhanney Technical Report be referred back to staff for additional information.

IMPLICATIONS

The objective of the Technical Report is to develop a strategy and program for the replacement of the existing 4.1km of AC watermains in the Fulford Water System. It is expected that this will lead to detailed design and a phased construction program to replace all AC watermains and provide a new water meter and new service connection to each property (service connection from main to property line). Where PVC watermains have been installed, the scope will include adding a water meter at the property line and water service replacement (to property line), where required.

CONCLUSION

The asbestos cement pipe in the Fulford Water Service Area is either at or past its useful life. The Technical Report provided by McElhanney lays out an analysis, criticality assessment and option review of the system and provides guidance for the next phase of the project which includes detailed design and a phased construction program to replace all of the AC water mains.

RECOMMENDATION

That the Fulford Water Service Commission receives the draft Technical Report from McElhanney for review and comment.

Submitted by:	Dean Olafson, P. Eng., MBA, Engineering Manager, Salt Spring Electoral Area
Concurrence:	Karla Campbell, MBA, BPA, Senior Manager, Salt Spring Electoral Area

ATTACHMENT

Attachment 1: Technical Report (DRAFT): Fulford Water: AC Watermain Replacement, McElhanney Ltd. March 10th, 2023

McElhanney | CANADA BEST MANAGED COMPANIES

SSI 2022-002

FULFORD WATER: AC WATERMAIN REPLACEMENT

Investigation, Analysis, Criticality Assessment, & Option Review

TECHNICAL REPORT

March 10, 2023 | Revision 01

Prepared for Capital Regional District | Prepared by McElhanney Ltd.

Contact
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soconnor@mcelhanney.com

Address
1 – 1351 Estevan Road,
Nanaimo BC V9S 3Y3

McElhanney Project # 2231-54641-01

Your Challenge.
Our Passion.

March 10, 2023

Our File: 2231-54641-01

Capital Regional District
108 – 121 McPhillips Avenue
Salt Spring Island, BC V8K 2T6

SSI 2022-002 Fulford Water - AC Watermain Replacement: Investigation, Analysis, Criticality Assessment, & Option Review – Technical Report

Please find attached the AC Watermain Replacement (Investigation, Analysis, Criticality Assessment, & Option Review) Technical Report for the Fulford Water System. We note the report has been updated to reflect CRD comments provided on February 8, 2023 and subsequent discussions.

The Technical Report provides a summary of our investigation, analysis, and criticality assessment of the existing system as well as analysis, options review, and recommendations to support the AC watermain replacement in the Fulford Water System. The key information summarized in the report includes:

- Project Rationale
- Design Criteria / Analysis Input
- Watermain Replacement Prioritization (Criticality Assessment)
- System Hydraulic Analysis (Existing System, Proposed System, and Potential Future Expansion)
- Conceptual Design Option Review for Replacement Network – Pipeline Alignments and Sizes
- Recommendations & Next Steps.

Should you have any questions or require additional information, please do not hesitate to contact the undersigned.

Sincerely,
McElhanney Ltd.

Prepared by:

Sean O'Connor

Sean O'Connor, P.Eng., Civil Division Manager
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Quality Reviewer:

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Contents

APPENDICES

TABLES

FIGURES

PART 1. INTRODUCTION

1.1. AUTHORIZATION

In December 2022, the Capital Regional District (CRD) authorized McElhanney Ltd. (McElhanney) to carry out the Fulford Water - AC Watermain Replacement Analysis, Strategy, & Works Program.

1.2. EXISTING WATER SYSTEM

The Fulford Water System is located in a semi-rural residential community with an elementary school and commercial development. The water system is situated on the north side of Fulford Harbour on Salt Spring Island. The project location and existing system configuration is shown in **Figure 1**. The existing water service area and pressure zones are shown in **Figure 2**. The Fulford Water System is primarily comprised of the following assets:

Supply System – Fulford Supply System Piping

The supply system includes approximately 2,330m of 100mm diameter asbestos cement (AC) pipe installed in the 1970s and approximately 600m of 100mm diameter Polyvinyl Chloride (PVC) pipe installed in the late 2000s. The supply system piping (material type & size) is summarized in **Table 1-1**.

Table 1-1: Existing Supply System Piping

Diameter (mm) & Pipe Material		Length (m)	% of Total
100 AC		2330	80%
100 PVC		600	20%
Total		2930	

Supply System – Sunnyside Drive Pump Station

The Sunnyside Drive pump station is located across from the Hilltop Road and Sunnyside Drive intersection, specifically at 105 Hilltop Place. The pump station boosts the water supply from Lake Weston to the water treatment plant at a simultaneous pumping rate of 2.3 L/s (30 gpm) from 2 pumps.

Treatment – Fulford Water Treatment Plant & Pump Station

The water treatment plant draws water from Lake Weston with a treatment process consisting of a rapid mix system, flocculation, dissolved air floatation (DAF), rapid filtration, ultraviolet (UV) disinfection, and chlorination. The water is then pumped to the reservoir.

Storage – Reservoir

The Fulford reservoir has a capacity of 360 m3 (80,000 IG) and is located southwest of Fulford Community Elementary School.

Distribution System – Fulford Distribution System Piping

The Distribution system includes approximately 85m of 50mm diameter High-density polyethylene (HDPE), approximately 1,775m of 50-100mm diameter AC pipe installed in the 1970s and approximately 1,490m of 100-150mm diameter PVC pipe installed in the late 2000s. The distribution system also includes fire hydrants, standpipes, gate valves; and water service connections. The distribution system piping (material type & size) is summarized in **Table 1-2**.

Table 1-2: Existing Distribution System Piping

Diameter (mm) & Pipe Material		Length (m)	% of Total
50 HDPE		85	3%
50 AC		155	5%
100 AC		1620	48%
100 PVC		1170	35%
150 PVC		320	9%
Total		3350	

Distribution System – Sunnyside Drive Pressure Reducing Station

There is one (1) pressure reducing valve station, PRS Sunnyside, in front of 122 Sunnyside Drive. The operator has confirmed set points including inlet pressure = 92 psi and outlet pressure = 45 psi. This creates two pressure zones in the water service area which are shown in **Figure 2**.

1.3. PROJECT RATIONALE

The Fulford Water System Asset Management Plan (AMP) dated May 2020 references several recommendations made in the 2011 AMP regarding the distribution system including:

- "The existing distribution system currently meets the domestic needs of the community but the non-revenue water production of 40% is considered significant. The water distribution system is not designed to provide fire protection. The mains are two-thirds asbestos cement (4,500 m) and reported to have been constructed in the late 1980s[(1)], making them almost 30 years old. The other third of the mains is PVC (2,200 m) and the majority of this pipe is less than 10 years old."
- "A program to replace the asbestos cement distribution mains should be initiated to reduce the water loss in the system. It would be desirable to replace the AC mains within the next five to ten years."
- "The system contains a number of dead-end mains that cannot be interconnected as they service narrow areas that are at the extremities of the system or difficult terrain makes them difficult to loop. Flushing these mains during the summer months will be required to ensure chlorine residual and to maintain water quality."
- "Distribution components associated with the asbestos cement watermains will be replaced as part of any watermain replacement program. Many of these components are as old as the mains. The valves need to be located and those that operate should be exercised regularly. The valves that do not operate should be identified and only replaced if they are critical to the operation of the distribution system."
- "The watermains would need to be upgraded to a minimum 150 mm in order to provide fire protection."

[1] *We note that this statement conflicts with our understanding of the probable AC pipe age and McElhanney AMP dated 2020 which states that the AC watermains were installed in the 1970s.*

1.4. STUDY OBJECTIVES

The objective of this study is to develop a strategy and program for the replacement of the existing 4.1km of AC watermains in the Fulford Water System. It is expected that this will lead to detailed design and phased construction program to replace all AC watermains and provide a new water meter and new service connection to each property (service connection from main to property line). Where PVC watermains have been installed, scope will include adding water meter at property line and water service replacement (to property line), where required.

1.5. STUDY APPROACH / WORK PLAN

The work plan adopted for this study is based on the RFP, including Investigation, Analysis and Criticality Assessment (Step 1) & Renewal Program and Costs (Step 2) which is outlined in our proposal dated November 9, 2022.

1.6. REFERENCE DOCUMENTS

The following documents have been provided by the CRD which have been referenced while completing this study:

- CRD - CAD Standards / Engineering Specifications and Drawings
- Leak Report Data for Fulford
- Subsurface Contours Weston Lake
- Available Record Drawings including, Sunnyside Water Main, Water Main Extension Fulford Ganges Road, & Fulford Reservoir
- Statutory Right-of-Way Plans Raw Water Line
- Info From 2022 Annual Plan, Annual Water Production, Monthly Production, High Lever Meter Data
- Drawing Reservoir and Site Plan
- Drawing Plant Schematic
- Email Information From NSSWW; Plant Settings, PRV Settings, Plant Production, Reservoir Settings

1.7. ACKNOWLEDGEMENTS

McElhanney would like to acknowledge and express their appreciation to the CRD and North Salt Spring Waterworks District (NSSWD) staff during this assignment. A team effort was required to complete this study; and it could not have been completed without the invaluable assistance provided by the following key individuals.

- Dean Olafson, P.Eng., MBA – Manager, Engineering, CRD
- Doug Weihing, C.Tech, NZCE – Engineering Technologist, CRD
- Luke Sturdy – Operations and Maintenance Operator, CRD
- Grant Tamboline – Waterworks Supervisor, NSSWD

LOCATION PLAN
SALT SPRING ISLAND

LEGEND

- WATER SERVICE AREA
- DISTRIBUTION MAIN
- UNTREATED SUPPLY MAIN
- RES — STORAGE FACILITY
- WTP — TREATMENT PLANT
- PUMP STATION
- PRESSURE CONTROL STATION
- W — MANHOLE
- A — AIR VALVE
- H — HYDRANT
- S — STANDPIPE
- M — SUPPLY BULK METER
- CHECK VALVE
- GATE VALVE - CLOSED

Rev	Date	Description	Drawn	Design	App'd
B	2023-03-06	ISSUED FOR REPORT	KB		SO
A	2023-01-30	ISSUED FOR REPORT	KB		SO

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ORIGINAL DWG SIZE: ANSI D (22" x 34")

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PERMIT NUMBER: 1003299
Engineers and Geoscientists of BC

Approved Sealed

CAPITAL REGIONAL DISTRICT
108 - 121 McPHILLIPS AVENUE, SALT SPRING ISLAND BC, V8K 2T6

FULFORD WATER SYSTEM
AC WATER PIPELINES REPLACEMNT
LOCATION PLAN &
EXISTING SYSTEM CONFIGURATION

Drawing No. FIGURE 1

Project Number 2231-54641-01-SK

Rev. B

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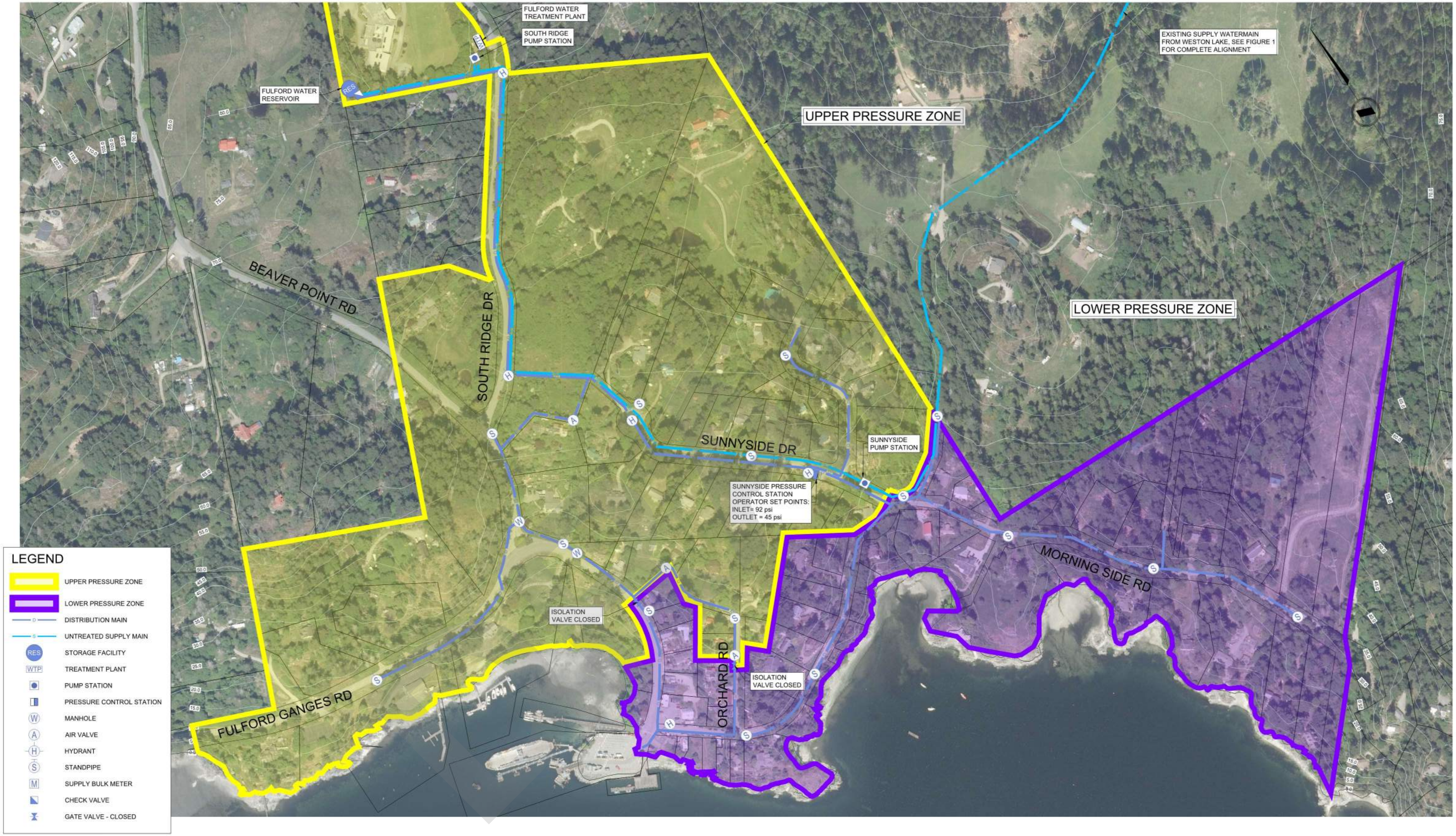

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FULFORD WATER SYSTEM
AC WATER PIPELINES REPLACEMNT
WATER SERVICE AREA &
PRESSURE ZONES

Drawing No. FIGURE 2

Project Number: 2231-54641-01-SK
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PART 2. DESIGN CRITERIA

In establishing the capacity of a water supply and distribution system, three levels of water demand are normally considered, in addition to fire flows. These are:

Average Day Demand (ADD)	=	Total annual consumption / 365 days
Maximum Day Demand (MDD)	=	Day with highest demand for the year
Peak Hour Demand (PHD)	=	Highest flow rate maintained for one hour *(generally occurring on maximum day of the year)*

2.1. SUPPLY

The water supply source(s) must be capable of meeting the system's Maximum Day Demand. The Peak Hour Demand and Fire Flow demands are to be met by the water storage reservoirs.

The CRD has noted that the replacement supply main shall be designed to suit design flow rate of 4.0 L/s which is consistent with the Fulford WTP design treatment capacity.

Note that the supply source review is not included in this study scope.

2.2. STORAGE

Water reservoirs perform three functions:

- Storage for fire fighting
- Storage for emergencies (such as a watermain break or booster pump failure / power outage)
- Storage for equalization to manage hourly peaks in demand

Note that reservoir storage volume review is not included in this study scope.

2.3. DISTRIBUTION SYSTEM

The water distribution system must be capable of delivering all demands as well as delivering fire flow demands during maximum day demands while operating within acceptable pressure ranges.

2.3.1. Pressures & Velocities

The adequacy of the distribution system for various demand conditions is judged by the residual pressure available throughout the system and by the maximum velocity in the mains. The criteria applied to this study are listed in **Table 2-1** which are consistent with the CRD standard requirements.

Table 2-1: Distribution System Design Criteria		
Parameter	**Value**	
Under Peak Hour Demand Conditions		
Minimum residual pressure at road	414 kPa	(60 psi)
Minimum residual pressure at property line	267 kPa	(40 psi)
Maximum pipe velocity	1.5 m/s	(4.9 ft/s)
Under Fire Flow Demand Conditions (during Maximum Day Demands)		
Minimum residual pressure at hydrant	140 kPa	(20 psi)
Maximum pipe velocity	3.0 m/s	(9.8 ft/s)

2.3.2. Unit Design Demands – CRD Standards

Estimating demands should be based on flow meter records and developed for each land use type. In the absence of water consumption records, the CRD Engineering Specifications (2009) - Section 4.12.1 provides guidance for residential and non-residential land-use design demands. These specifications shall govern the design of new waterworks within or connected to the Juan de Fuca Water Distribution System. It has been agreed with the CRD that these standards will not govern the design for the Fulford Water System as water usage records are available.

2.3.3. Unit Design Demands – Proposed

The design demands will be based on available water use records which were provided by the CRD. The water demands including existing usage and projected usage is summarized in Section 2.4 Water Demands.

2.3.4. Fire Flows

We are advised that historically, the Fulford Water System has no mandate to supply fire flow to their customers. Salt Spring Island Fire Rescue (SSIFR) successfully completed the Fire Underwriters Survey (FUS) Superior Tanker Shuttle Service Accreditation Testing requirements on April 9, 2011 and provides fire protection on Salt Spring Island by Superior Tender Shuttle Service rather than local fire hydrants.

In the event that the District decides to provide fire flows in the future, we have summarized common standards for consideration. Note that fire flows shall be in accordance with the bylaws of the municipality having jurisdiction over the area in which the waterworks are to be constructed, and in accordance with Fire Underwriters Survey (FUS). The common standards are compared in **Table 2-2**.

Table 2-2 – Fire Flow Standards (Minimum Required)			
Development	**MMCD**	**FUS**	**CRD**
	Flow (L/s)	**Flow (L/s)**	**Flow (L/s)**
Single/Two Family Residential	60	33-134	80
Apartments, Townhouses	90	-	-
Commercial	150	-	83.3
Institutional	150	-	83.3
Industrial	225	-	83.3

There are several larger wood frame institutional structures and industrial businesses in the Fulford Water Service Area. The fire flow demands for these structures may be higher than the minimum flows listed in **Table 2-2**.

In the event that the District decides to provide fire flows in the future, we have analyzed several design fire flow scenarios for the system, each of which have a different set of upgrades required.

Based on discussions with the District, the following fire flow scenarios have been reviewed:

- Existing System
  - Available Fire Flows
- Proposed System (Existing WSA)
  - Option 1 – Available Fire Flows
    - Based on replacing existing AC watermains with 150mm Dia. PVC
  - Option 2 – Design Flow = 60 L/s
    - Based on MMCD Design Guideline (2014) minimum fire flow requirements for Single/Two Family Residential without sprinklers
- Proposed System (WSA Expansion)
  - Option 3 – Design Flow @ Ocean Estuary Development = 64 L/s
    - Based on Ocean Estuary Development Impact Assessment, Preapred by McElhanney Ltd dated August 29, 2022 (Revision No. 4).

2.4. WATER DEMANDS

2.4.1. Existing Demand Review

We have reviewed the Fulford Water System demands based on the available Fulford Water Service - 2021 Annual Report. This report summarizes the annual usage for the last 6-years which we have projected for 2022. The existing and projected 2022 demands have been summarized in **Table 2-3**.

Table 2-3: Existing Demand Review

Year	Usage (m3 / year)	ADD (L/s) [1]	MDD (L/s) [1]	PHD (L/s) [1]
PF [2]	-	-	*2.5*	*1.4*
2016	27,805	0.88	2.20	3.09
2017	28,336	0.90	2.25	3.14
2018	30,529	0.97	2.42	3.39
2019	27,302	0.87	2.16	3.03
2020	30,494	0.97	2.42	3.38
2021	29,248	0.93	2.32	3.25
2023 [3]	30,834	0.98	2.44	3.42

Notes:

1. Calculations used more significant figures than shown resulting in minor rounding discrepancies
2. Peaking Factors, CRD Engineering Specifications (2009) - Criteria for Design of Facilities
   a. Maximum Day = 2.5 times Average Day Demand
   b. Peak Hour = 1.4 times Maximum Day Demand

3. We have applied 1% increase to the max recent annual usage to estimate 2023 usage.
   It is understood that these demands are from the existing 95 lots connected to the system. Based on our review there are 108 lots that are within the existing water service area. We have therefore increased base design demands accordingly (2023 ADD = 0.98 L/s). Demands used for analysis are as follows:

   - ADD = 1.12 L/s
   - MDD = 2.80 L/s
   - PHD = 3.92 L/s

2.4.2. Future Demand Estimate (Existing Water Service Area)

As noted in the RFP, while the population on Salt Spring is anticipated to grow by approximately 2.5% per year, it is also predicted that water consumption per person will continue to decrease. Unless the boundaries of the water service area are expanded, or significant subdivision occurs within the water service boundaries, it is anticipated that future demand will remain at current levels or perhaps decrease slightly. As there are many factors effecting population growth & related water demands, three growth scenarios have been developed for this report: low; moderate; and high.

A time period of 50 years was applied to calculate varying levels of long-term growth and associated design demands. The future demands have been projected in 10-year increments for each growth rate and are summarized in **Table 2-4**.

Table 2-4: Future Demand Estimate

Year	ADD (L/s)		
	Low Growth (0.5%)	Moderate Growth (1.0%)	High Growth (1.5%)
2023	**1.12**	**1.12**	**1.12**
2033	1.18	1.24	1.30
2043	1.24	1.37	1.51
2053	1.30	1.51	1.75
2063	1.37	1.67	2.03
2073	1.44	**1.84**	2.36
50-Year Increase	28%	64%	111%

We have used the moderate growth (1.0%) scenario for our future design demand (ADD = 1.84 L/s) to review estimate usage within the existing service boundary. This results in the following future (50-year projection) design demands:

- ADD = 1.84 L/s
- MDD = 4.60 L/s
- PHD = 6.45 L/s

2.4.3. Future Demand Estimate (Water Service Area Expansion)

As requested by the CRD, we have considered a future demand scenario which includes expanded water service area to include the "Ocean Estuary Development" and potential service area expansion along the watermain extension. The conceptual water service area expansion is shown in **Figure 3**.

The potential water service expansion area includes 8 additional properties which would result in an estimated design demand of ADD = 0.14 L/s, MDD = 0.49 L/s, & PHD = 0.49 L/s.

It is understood that the "Ocean Estuary Development" would require the following design flows:

- Ocean Estuary MDD = 0.45 L/s (McElhanney October 22, 2018 Technical Memorandum)
- Ocean Estuary PHD = 0.65 L/s (McElhanney October 22, 2018 Technical Memorandum)

Based on the information above, and moderate growth (1.0%) scenario for the existing water service area, this results in the following design demands:

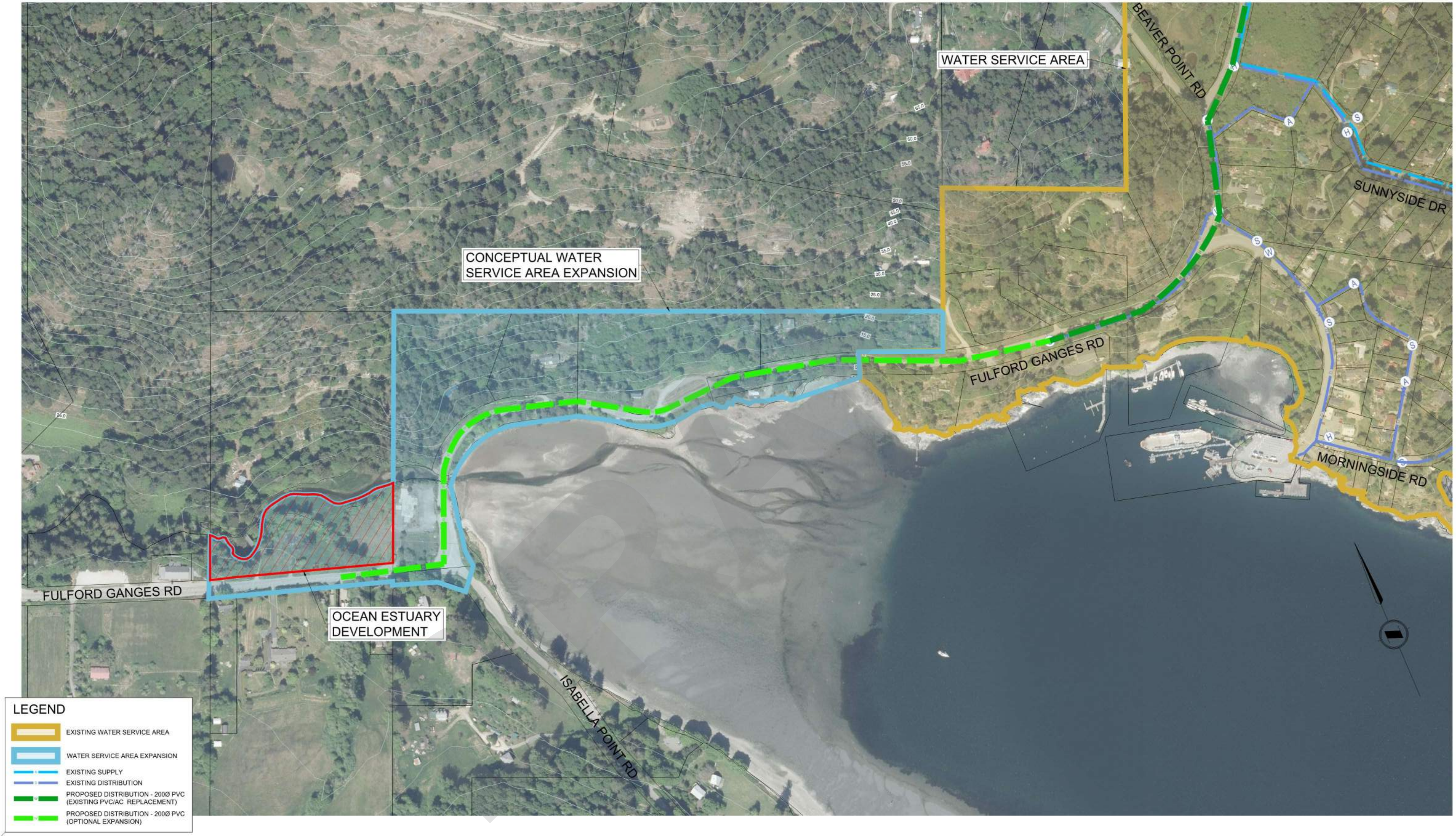
- MDD = 5.40 L/s
- PHD = 7.59 L/s

2.4.4. Design Demand Summary

Design demands for the various scenarios have been summarized in **Table 2-5**.

Table 2-5: Design Demand Summary

Scenario		Design Demands		
System	Properties Serviced	ADD (L/s)	MDD (L/s)	PHD (L/s)
Current Usage	95	0.98	2.44	3.42
Existing System	108	1.12	2.80	3.92
Proposed System (Existing WSA)	108 + 1.0% Growth	1.84	4.60	6.45
Proposed System (WSA Expansion)	108 + 8 + 1.0% Growth + Ocean Estuary	2.16	5.40	7.59



Rev	Date	Description	Drawn	Design	App'd
B	2023-03-06	ISSUED FOR REPORT	KB		SO
A	2023-01-30	ISSUED FOR REPORT	KB		SO

INFORMATION ON EXISTING UNDERGROUND FACILITIES MAY NOT BE COMPLETE OR ACCURATE. McELHANNEY, ITS EMPLOYEES AND DIRECTORS ARE NOT RESPONSIBLE NOR LIABLE FOR THE LOCATION OF ANY UNDERGROUND CONDUITS, PIPES, CABLES OR OTHER FACILITIES WHETHER SHOWN OR OMITTED FROM THIS PLAN. PRIOR TO CONSTRUCTION CONTRACTOR SHALL EXPOSE LOCATIONS OF ALL EXISTING FACILITIES BY HAND DIGGING OR HYDROVAC AND ADVISE THE ENGINEER OF POTENTIAL CONFLICTS.

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ORIGINAL DWG SIZE: ANSI D (22" x 34")

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PERMIT TO PRACTICE
McElhanney Ltd.
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Engineers and Geoscientists of BC

Approved Sealed

CAPITAL REGIONAL DISTRICT
108 - 121 McPHILLIPS AVENUE, SALT SPRING ISLAND BC, V8K 2T6

FULFORD WATER SYSTEM AC WATER PIPELINES REPLACEMNT CONCEPTUAL WATER SERVICE EXPANSION

Drawing No. FIGURE 3

Project Number: 2231-54641-01-SK | Rev. B

DATE: 2023-03-08, 12:38 FILE: Z:\Pro-Active\54641-01 CRD - Analysis, Strategy, Works Program\10.0 Drawings\10.3 Engineering\10.3.2 Sketches\2231-54641-01-SK.dwg

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PART 3. HYDRAULIC MODEL

3.1. COMPUTER PROGRAM

Modelling of the Fulford water distribution system was carried out utilizing the computer software program WaterCAD. This water distribution modelling and management software is in use throughout North America by engineering consultants, municipalities, and utility companies and is used by McElhanney because of its reliability, versatility, AutoCAD and GIS interface, and support by its creator Bentley Systems Inc.

WaterCAD is a powerful, user-friendly program created to analyse, design, and optimize water distribution systems. The programs many features include steady state and extended time modelling, multiple fire flow events modelling while evaluating flows and pressures across the entire system, and peak hour pressure analyses. Modelling results are presented in tabular and graphical form.

3.2. MODEL CREATION

A computer model of the water system (existing and proposed) was created by McElhanney to complete hydraulic analysis of the supply line and distribution network for the purposes of designing replacement pipeline sizing as well as supporting criticality assessment. The water model provides a mathematical representation of the water system.

Model inputs define the physical characteristics of the system and the anticipated flows. Pipes in the model are assigned the physical characteristics of pipes in the field (length, diameter, and roughness), the nodes define the points of connection between the lines and define the water demand in the system (both domestic and fire flows).

3.2.1. Existing Distribution System

The WaterCAD water model layout was developed to reflect the existing distribution system including various pipe sizes and materials. The water system layout including existing pipe size and materials is shown in **Figure 4**. The following references were used to develop the water model:

- System Layout - Available record drawings, CRD water system map, Operator input
- System Elevations - CRD contours
- PRV Set Points – Provided by Operator
- Reservoir HGL – Calculated using PRV pressure set points and estimated CRD contour elevations
- Pressure Zones – System isolation valve locations confirmed by Operator

3.2.2. Future Distribution System (Existing Water Service Area)

The WaterCAD water model layout was updated to reflect the proposed distribution system upgrades to model two design scenarios for the existing water service area. The scenarios and related distribution system upgrades are summarized in **Part 7 (Option 1 & 2)**.

3.2.3. Future Distribution System (Expanded Water Service Area)

As requested by the CRD, we have completed an additional WaterCAD water model layout update to reflect the proposed “Ocean Estuary Development” and potential service area expansion. The related distribution system upgrades are summarized in **Part 7 (Option 3)**.

3.3. MODEL CALIBRATION

The accuracy of the models depends on the calibration process. Calibration can be performed with onsite flow and pressure test results. The calibration process defines the friction coefficients, which may vary a lot depending on the pipe material and age and the corrosiveness of the water.

Calibration of the system has not been included. However, even an un-calibrated model is still a good representation of the system’s behavior under different conditions.

3.3.1. Pipe Friction Factors

A Hazen Williams friction factor was entered in the model for varying pipe materials, as listed in **Table 3-1**.

Table 3-1: Pipe Friction Factors

Pipe Material		Friction Factor, ‘C’ [1] (Hazen Williams Formula)
HDPE	High Density Polyethylene	140
PVC	Polyvinyl Chloride	140
AC	Asbestos Cement	130
DI	Ductile Iron	130
CI	Cast Iron	110

Notes:

1. The modeled friction factors were selected to consider the reduction in capacity that occurs in the distribution system where fittings and service connection points are present and sliming on pipe walls that occurs with age.

To better calibrate the friction factors in the water system, controlled field testing would be required during times of peak hour flows, where pressure losses in the various pipe types and sizes could be determined. Flow testing was not included in the scope of work for this study. Due to the significant system operators’ time required to conduct flow tests, no specific flow testing was carried out. In general, except for the oldest pipe sections, the values listed are believed to be conservative.

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FULFORD WATER SYSTEM
AC WATER PIPELINES REPLACEMNT
WATER SYSTEM LAYOUT
EXISTING PIPE SIZES & MATERIALS

Drawing No. FIGURE 4

Project Number 2231-54641-01-SK

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3.4. ALLOCATION OF DEMANDS

3.4.1. Existing Conditions

Water demands were distributed throughout the model at nodal points (pipe intersections, end of mains and pipe diameter changes) based on relation to properties / expected service locations. The service locations / demand allocation map is summarized in **Figure 5**.

The Average Day Demand was used as the base. Maximum Day Demands were modelled by multiplying each individual demand by the appropriate ratio (ADD to MDD, 2.5 and MDD to PHD, 1.4).

3.4.2. Future Conditions (Existing Water Service Area)

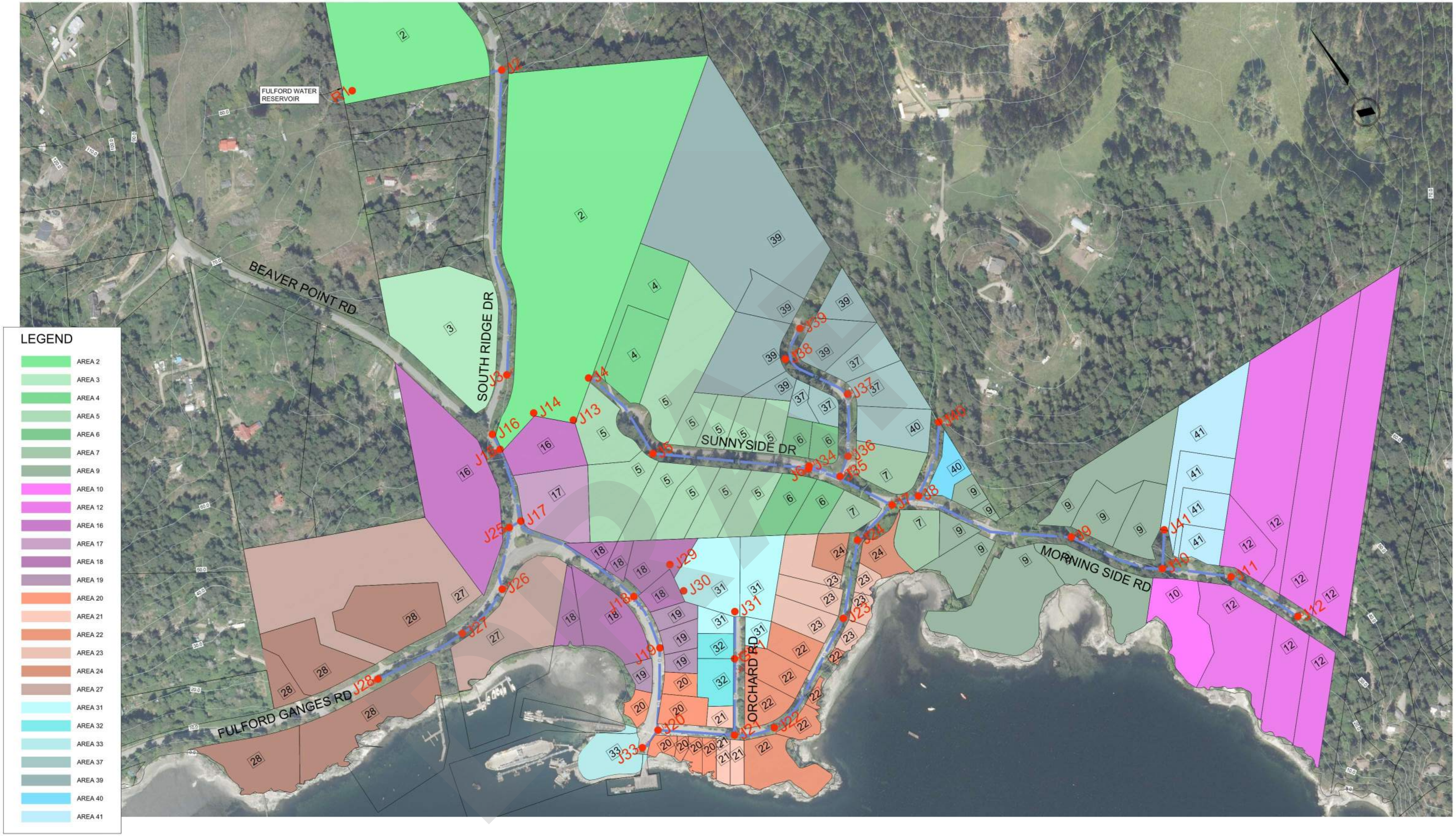
To reflect future demands the existing demands were scaled throughout the model at nodal points (pipe intersections, end of mains and pipe diameter changes) based on our future demand estimate (refer to Section 2.4.2).

The Average Day Demand was used as the base. Maximum Day Demands were modelled by multiplying each individual demand by the appropriate ratio (ADD to MDD, 2.5 and MDD to PHD, 1.4).

3.4.3. Future Conditions (Expanded Water Service Area)

Future demands were added to the model to reflect the "Ocean Estuary Development" which were added to the specific development location as well as potential demands within the potential service area expansion which were added to the expanded water model nodal points (pipe intersections, end of mains and pipe diameter changes).

The Average Day Demand was used as the base. Maximum Day Demands were modelled by multiplying each individual demand by the appropriate ratio (ADD to MDD, 2.5 and MDD to PHD, 1.4).



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FULFORD WATER SYSTEM
AC WATER PIPELINES REPLACEMNT
SERVICE LOCATIONS &
DEMAND ALLOCATION MAP

Drawing No.
FIGURE 5

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PART 4. SYSTEM ANALYSIS (EXISTING WATER SYSTEM)

4.1. DISTRIBUTION SYSTEM

The existing distribution system was evaluated under steady state conditions to determine the system pressures under peak hour conditions and to determine available fire flows during maximum day demands.

4.1.1. Peak Hour Pressures

The system pressures under peak hour demand under existing conditions are shown in **Table 4-1** and illustrated on **Model Figure A (Appendix B)**. Pressures below the acceptable design minimum of 414 kPa (60 psi) have been highlighted in red.

Table 4-1: Peak Hour Pressures (Ex. System)

Node	~ Elevation (m)	Demand (L/s)	Pressure (psi)
J-2	62.7	0.11	43
J-3	40.0	0.03	75
J-4	40.0	0.07	75
J-5	39.2	0.40	76
J-6	28.4	0.14	92
J-7	14.7	0.11	64
J-8	16.0	0.00	62
J-9	14.7	0.33	64
J-10	16.0	0.03	62
J-11	23.0	0.00	52
J-12	26.8	0.26	47
J-13	40.0	0.00	75
J-14	40.0	0.00	75
J-15	40.0	0.00	75
J-16	40.0	0.07	75
J-17	30.7	0.03	88
J-18	16.9	0.22	108
J-19	12.3	0.14	67
J-20	2.3	0.26	81
J-21	10.0	0.14	70
J-22	7.8	0.26	73

Table 4-1: Peak Hour Pressures

Node	~ Elevation (m)	Demand (L/s)	Pressure (psi)
J-23	14.9	0.22	63
J-24	16.0	0.07	62
J-25	30.6	0.00	88
J-26	23.5	0.00	98
J-27	17.3	0.07	107
J-28	14.1	0.18	112
J-29	25.8	0.00	95
J-30	24.9	0.00	97
J-31	26.4	0.11	94
J-32	20.0	0.07	103
J-33	0.0	0.03	85
J-34	28.6	0.00	91
J-35	25.8	0.00	95
J-36	26.8	0.00	94
J-37	34.9	0.14	82
J-38	40.0	0.00	75
J-39	40.0	0.22	75
J-40	29.4	0.03	43
J-41	24.7	0.14	50
J-42	19.4	0.00	57
J-43	16.5	0.00	61

4.1.2. Available Fire Flows

The available fire flows during maximum day demand for the current conditions are shown in **Table 4-2** and illustrated on **Model Figure B (Appendix B)**.

The available fire flows, while maintaining minimum residual pressure in system of 140 kPa (20 psi), are all less than a typical design fire flow of 60 L/s (MMCD Design Guideline (2014) minimum fire flow requirements for Single/Two Family Residential without sprinklers).

Table 4-2: Available Fire Flow (Ex. System)

Node	~ Elevation (m)	Available Fire Flow (L/s)
J-2	62.7	52
J-3	40.0	52
J-4	40.0	52
J-5	39.2	52
J-6	28.4	49
J-7	14.7	49
J-8	16.0	23
J-9	14.7	22
J-10	16.0	18
J-11	23.0	16
J-12	26.8	14
J-13	40.0	23
J-14	40.0	23
J-15	40.0	23
J-16	40.0	23
J-17	30.7	23
J-18	16.9	23
J-19	12.3	17
J-20	2.3	19
J-21	10.0	21
J-22	7.8	22

Table 4-2: Available Fire Flow (Ex. System)

Node	~ Elevation (m)	Available Fire Flow (L/s)
J-23	14.9	23
J-24	16.0	23
J-25	30.6	23
J-26	23.5	23
J-27	17.3	23
J-28	14.1	23
J-29	25.8	23
J-30	24.9	23
J-31	26.4	23
J-33	20.0	6
J-34	0.0	27
J-35	28.6	27
J-36	25.8	27
J-37	26.8	23
J-38	34.9	23
J-39	40.0	23
J-40	40.0	6
J-41	29.4	6
J-32	24.7	23
J-42	19.4	6
J-43	16.5	16

4.2. SUPPLY SYSTEM

The supply system was evaluated under steady state conditions to confirm that the existing supply pipe is hydraulically suitable for the current design flow of 2.4 L/s and the preferred design flow of 4.0 L/s. The general supply system layout and estimated supply system pressures are shown in **Model Figure C (Appendix B)**.

PART 5. WATERMAIN REPLACEMENT PRIORITIZATION (CRITICALITY ASSESSMENT)

This section of the report outlines the risk-based approach to water main replacement for the Fulford Water System to help confirm order of priority for watermain replacement.

5.1. BACKGROUND

5.1.1. Risk Management

Risk management is a systematic and logical approach used to assist in prioritizing infrastructure replacement. Risk depends on both the probability and consequence of an event and is often represented using the following equation:

Probability of Failure (POF) represents the likelihood that that a specific asset will fail (not deliver the required level of service). Consequence of Failure (COF) represents the overall impact of an asset failing.

5.1.2. Approach for Prioritization Analysis

The purpose of a water main prioritization analysis is to provide a systematic methodology for the prioritization of water main replacement based on the consequence of failure (COF) and probability of failure (POF) for each water main segment.

Figure 5-1 illustrates a typical risk matrix. The matrix indicates that a water main with a high consequence of failure and high probability of failure presents a high risk to the District. The higher the risk the more critical the replacement is. Conversely, a water main in very good condition with a low consequence of failure provides a low risk to the District. However, a water main with a high consequence of failure in good condition could still pose a moderate level of risk and consequently requires a greater level of action than a low-risk water main.

FIGURE 5-1: TYPICAL RISK MATRIX

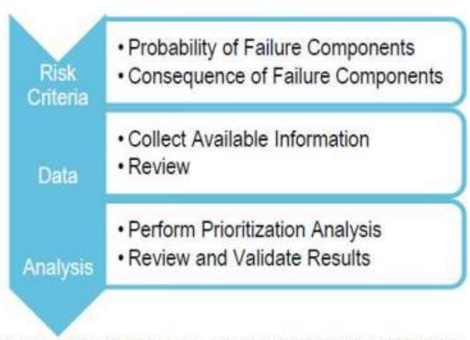


FIGURE 5-2: APPROACH FOR PRIORITIZATION ANALYSIS

The recommended methodology to prioritize the water main replacement program is based on the risk equation that assigns an overall priority to each water main segment. The proposed approach the performing the watermain prioritization analysis is illustrated in **Figure 5-2**.

5.1.3. Probability of Failure

Table 5-1 summarizes potential probability of failure (POF) components for a water main prioritization analysis.

Table 5-1: Probability of Failure (POF) Components for Watermain Prioritization Analysis

Component	Description	Data
Leaks and Breaks	As water mains deteriorate, pipe leaks and/or breaks become more prevalent; therefore, break history can provide a good indication of the condition of the water distribution system and the probability of failure.	• Leak/break location • Date of leak/break • Cause of leak/break
Remaining Useful Life	Water mains generally deteriorate with age.	• Water main installation date • Water main material • Survival curves (normally developed from above data)
Hydraulic Performance	Hydraulic performance (Hazen Williams C-Values) is an indication of the corrosion/condition of the inside of the pipe.	• Hydraulic model (C-values generally determined during calibration of the hydraulic model)
Complaints	Water quality in the distribution network can provide an indication of the condition or deterioration of water mains. For example, high customer complaints (related to water quality issues such as odor, taste, and appearance) can indicate that the mains in that area are corroding or deteriorating	• Historical complaint records ○ Location ○ Date ○ Description/type
Fire Flow Deficiency Improvements	Some water mains may need to be replaced/upsized based on available fire flows in the system.	• Fire flow deficiency results (potentially from hydraulic model) • Pipes identified for replacement
Material	Some communities have historical data indications certain pipe materials are more likely to fail.	• Pipe Material

5.1.4. Consequence of Failure

Table 5-2 summarizes potential consequence of failure components for a water main prioritization analysis.

Table 5-2: Consequence of Failure (COF) Components for Watermain Prioritization Analysis

Component	Description	Data
Critical Users	Consequence of water main failing is generally related to the customers that a water main serves (critical customers) and the number of services each critical customer has.	• Service locations & demand allocation map
Large Users	Consequence of water main failing is related to the volume of water the customers use.	• Service locations & demand allocation map
Land Use/ Type of Use	Land use or type of use (residential, institution, river crossing) is generally a good indicator of the consequence of a water main failing.	• Zoning map
Diameter	Generally, the larger the diameter of the pipe the more significant the pipe is in the overall service to customers; therefore, water main diameter considered for consequence of failure.	• Water main diameter
Sensitive Areas	Specific sensitive areas for repairs/construction may exist including wetlands, contaminated areas, adjacent to street cars, etc.	• Map with sensitive areas
Redundancy	Consequence of water main failing is related to the redundancy of that main. Therefore, mains that provide all or most of the flow to an area (e.g. neighborhood, pressure zone, etc.) have a higher consequence of failure.	• Hydraulic model evaluations and/or engineering judgement/review

5.1.5. Other Considerations

Generally, watermain replacement programs should be coordinated with other construction projects being planned (i.e if road, terminal, or other utilities replacement are being constructed, it may be most efficient to replace segment of watermain at the same time).

5.2. WATERMAIN REPLACEMENT PRIORITIZATION (CRITICALITY ASSESSMENT)

The Fulford Water System Piping (Distribution & Supply) has been broken into segments with each section of piping within the segment having an associated unique identifier. Through the development of a risk matrix, each segment has been ranked by priority. The risk matrix can be found in **Appendix C**.

The result of the Watermain Replacement Prioritization Analysis (Criticality Assessment) is summarized in **Table 5-3** and is illustrated on **Figure 6**.

Table 5-3: Watermain Replacement Prioritization Analysis Results

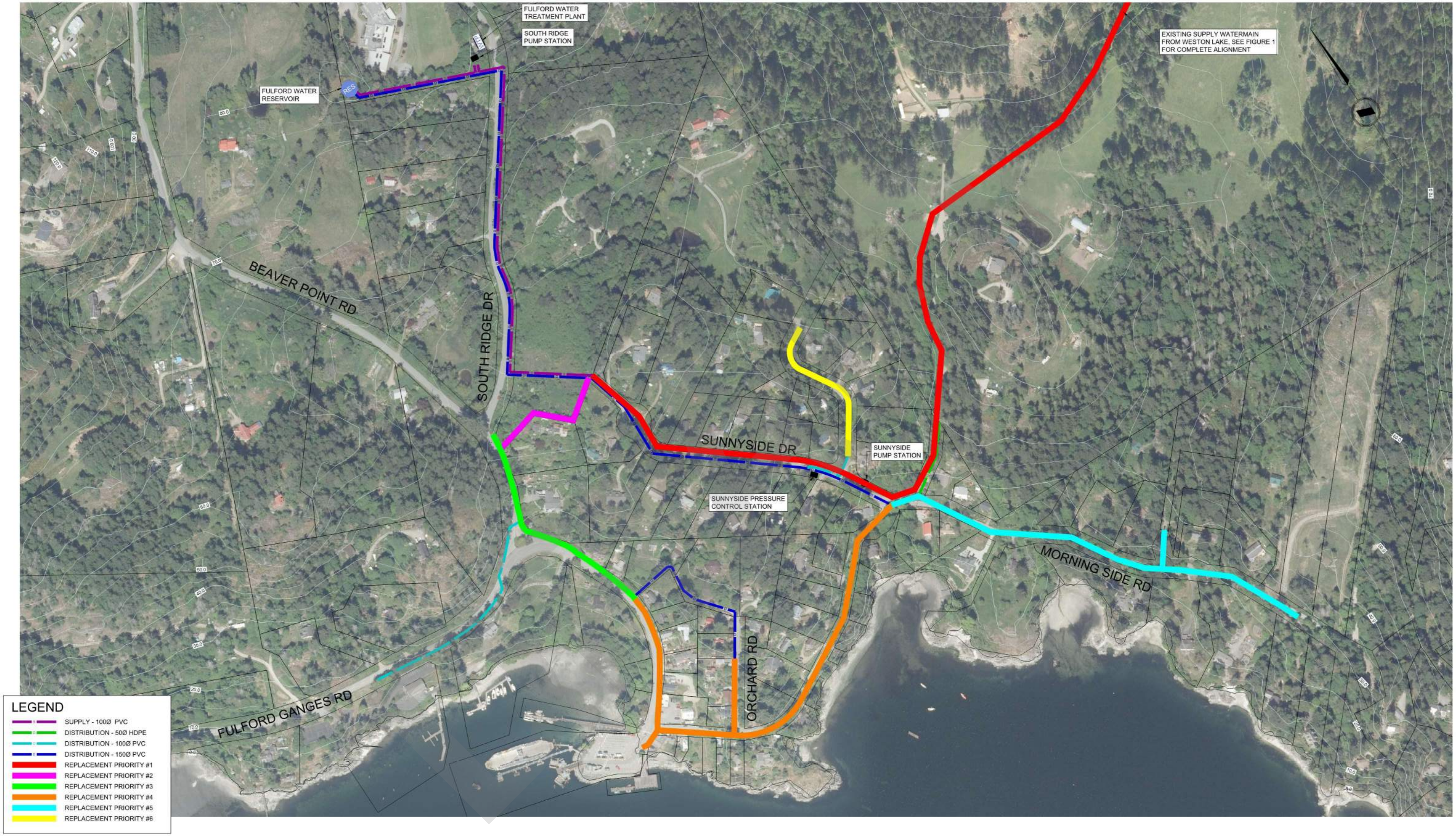
Segment	Label	Length (m)	Start Node	Stop Node	Diameter (mm)	Material
Priority #1	P-50	20	R-2	J-50	100	AC
	P-51	66	J-50	J-51	100	AC
	P-52	125	J-51	J-52	100	AC
	P-53	729	J-52	J-53	100	AC
	P-54	73	J-53	J-54	100	AC
	P-55	129	J-54	J-55	100	AC
	P-56	283	J-55	J-56	100	AC
	P-57	187	J-56	J-57	100	AC
	P-58	260	J-57	J-58	100	AC
	P-59	49	J-58	J-59	100	AC
	P-60	22	J-59	J-60	100	AC
	P-61	57	J-60	PMP-1	100	AC
	P-62	75	PMP-1	J-62	100	AC
	P-63	136	J-62	J-63	100	AC
	P-64	44	J-63	J-64	100	AC
	P-65	63	J-64	J-65	100	AC
		2318			**100**	**AC**
Priority #2	P-12	49	J-4	J-13	100	AC
	P-13	44	J-13	J-14	100	AC
	P-14	54	J-14	J-15	100	AC
		147			**100**	**AC**
Priority #3	P-15	19	J-15	J-16	100	AC
	P-16	82	J-15	J-17	100	AC
	P-17	149	J-17	J-18	100	AC
		250			**100**	**AC**

Table 5-3: Watermain Replacement Prioritization Analysis Results

Segment	Label	Length (m)	Start Node	Stop Node	Diameter (mm)	Material
Priority #4	P-18	63	J-18	J-19	100	AC
	P-19	90	J-19	J-20	100	AC
	P-20	84	J-20	J-21	100	AC
	P-21	45	J-21	J-22	100	AC
	P-22	142	J-22	J-23	100	AC
	P-23	88	J-23	J-24	100	AC
	P-24	54	J-24	J-7	100	AC
	P-33	84	J-32	J-21	50	AC
	P-34	26	J-20	J-33	50	AC
		676			**100/50**	**AC**
Priority #5	P-7	31	J-7	J-8	100	AC
	P-8	174	J-8	J-9	100	AC
	P-9	106	J-9	J-10	100	AC
	P-10	76	J-10	J-11	100	AC
	P-11	85	J-11	J-12	100	AC
	P-42	43	J-10	J-41	100	AC
		515			**100**	**AC**
Priority #6	P-38	68	J-36	J-37	100	AC
	P-39	79	J-37	J-38	100	AC
	P-40	38	J-38	J-39	100	AC
		185			**100**	**AC**

Table 5-3: Watermain Replacement Prioritization Analysis Results

Segment	Length (m)	Diameter (mm)	Material	System
Priority #1	2318	100	AC	Supply
Sub-Total	**2318**			**Supply**
Priority #2	147	100	AC	Distribution
Priority #3	250	100	AC	Distribution
Priority #4	676	100/50	AC	Distribution
Priority #5	515	100	AC	Distribution
Priority #6	185	100	AC	Distribution
Sub-Total	**1773**			**Distribution**
Total	**4091**			**Supply / Dist.**



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FULFORD WATER SYSTEM
AC WATER PIPELINES REPLACEMNT
WATERMAIN REPLACEMENT
PRIORITIZATION MAPING

Drawing No.
FIGURE 6

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PART 6. CONCEPTUAL DESIGN – SUPPLY SYSTEM

We have developed and reviewed four (4) conceptual pipeline alignment routing options for the supply main replacement. This option review considered the existing route and potential alignments along existing road corridors as well as alternate routes to shorten the length of pipe.

6.1. SUPPLY SYSTEM – OPTION A

This proposed supply main replacement option is based on the CRD developed potential routing options sketch included in the RFP. The conceptual replacement alignment runs from Weston Lake along Beaver Point Road and connects to South Ridge Drive through private property.

This option includes the following proposed upgrades:

- New Raw Water Intake from Weston Lake (Beaver Point Road)
- New Pump Station
- New 100mm PVC Supply Watermain – 2,900m long
- Property Acquisition / SRW for connection between Beaver Point Road & South Ridge Drive
- Existing 100mm AC Supply Main Decommissioned

The proposed supply watermain replacement (Option A) is shown on **Figure 7**.

6.2. SUPPLY SYSTEM – OPTION B

This proposed supply main replacement option is similar to Option A however the alignment continues along existing road corridor instead of crossing private property. The conceptual replacement alignment runs from Weston Lake along Beaver Point Road and connects to the existing supply system at the intersection of Beaver Point Road and South Ridge Drive.

This option includes the following proposed upgrades:

- New Raw Water Intake from Weston Lake (Beaver Point Road)
- New Pump Station
- New 100mm PVC Supply Watermain – 3,100m long
- Existing 100mm AC Supply Main Decommissioned

The proposed supply watermain replacement (Option B) is shown on **Figure 8**.

6.3. SUPPLY SYSTEM – OPTION C

This proposed supply main replacement option investigated finding a shorter route from the existing lake intake point to the water treatment plant. The conceptual replacement alignment runs from Weston Lake west, through private property to Reynolds Road, then runs south along Reynolds Road and connects to South Ridge Drive through private property. Two alternate alignments were reviewed for this option.

This option includes the following proposed upgrades:

- Updated Raw Water Intake from Weston Lake (Existing Intake Location)
- New Pump Station
- New 100mm PVC Supply Watermain – 1,700m long (C1) / 2,100m long (C2)
- Property Acquisition / SRW for connection between Intake and Reynolds Road as well as connection between Reynolds Road & South Ridge Drive
- Existing 100mm AC Supply Main Decommissioned

The proposed supply watermain replacement (Option C1/C2) is shown on **Figure 9**.

6.4. SUPPLY SYSTEM – OPTION D

This option review considered replacement of the supply watermain along the existing route which generally follows Weston Creek from Weston Lake to the south. Replacing the supply watermain along the existing alignment would have significant impact on the riparian area.

This option includes the following proposed upgrades:

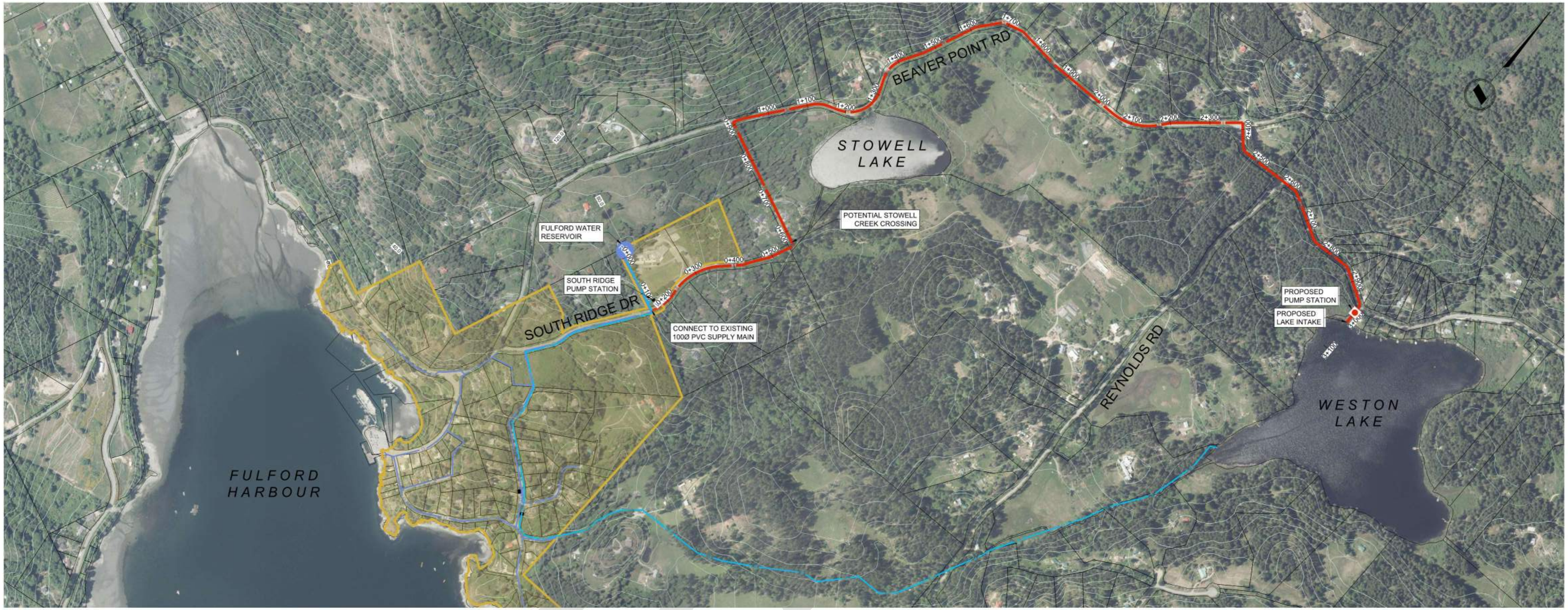
- Updated Raw Water Intake from Weston Lake (Existing Intake Location)
- New 100mm PVC Supply Watermain – 2,300m long
- Replacement along existing SRW, however additional width for installation / access expected for replacement
- Existing 100mm AC Supply Main Decommissioned

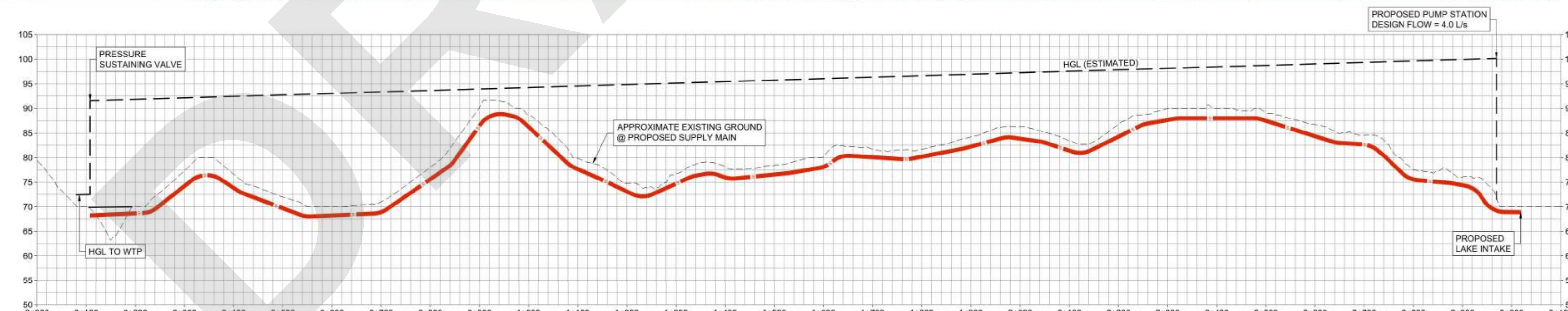
The proposed supply watermain replacement (Option D) is shown on **Figure 10**.

6.5. SUPPLY SYSTEM – OPTION REVIEW SUMMARY

We have summarized the four (4) conceptual pipeline alignment routing options that were reviewed for the supply main replacement in **Table 6-1**.

Table 6-1: Supply System – Watermain Replacement Option Review				
Option	**Land Tenure Requirements**	**Intake / Pumping Requirements**	**Replacement Length (m)**	**Additional Considerations**
A	- MOTI Permitting for installation along roadway (Beaver Point Road) - Two (2) private property crossings anticipated	- New Raw Water Intake from Weston Lake (Beaver Point Road) - New Pump Station	2,900	- Stowell Creek crossing likely required
B	- MOTI Permitting for installation along roadway (Beaver Point Road).	- New Raw Water Intake from Weston Lake (Beaver Point Road) - New Pump Station	3,100	- Several road culverts will need to be crossed - Potential for roadside MUP to be constructed above watermain installation
C1	- MOTI Permitting for installation along roadway (Reynolds Road) - Three (3) private property crossings anticipated	- Updated Raw Water Intake from Weston Lake (Existing Intake Location) - New Pump Station	1,700	- Stowell Creek crossing required - Alignment runs through long section for forested area (on private property)
C2	- MOTI Permitting for installation along roadway (Reynolds Road) - Two (2) private property crossings anticipated	- Updated Raw Water Intake from Weston Lake (Existing Intake Location) - New Pump Station	2,100	- Stowell Creek crossing required - Alignment runs through long section for forested area (on private property)
D	- Replacement along existing SRW. - Additional width for installation / access expected for replacement - Environmental Permitting Required - Environmental Compensation	- Updated Raw Water Intake from Weston Lake (Existing Intake Location) - Existing Sunnyside Pump Station	2,300	- Following Weston Creek





LEGEND

- WATER SERVICE AREA
- EXISTING DISTRIBUTION MAIN
- EXISTING UNTREATED SUPPLY MAIN
- PROPOSED UNTREATED SUPPLY MAIN
- RES EXISTING STORAGE FACILITY
- WTP EXISTING TREATMENT PLANT
- EXISTING PUMP STATION
- EXISTING PRESSURE CONTROL STATION
- PROPOSED PUMP STATION

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FULFORD WATER SYSTEM AC WATER PIPELINES REPLACEMNT PROPOSED SUPPLY MAIN REPLACEMENT (OPTION A)

Drawing No.
FIGURE 7

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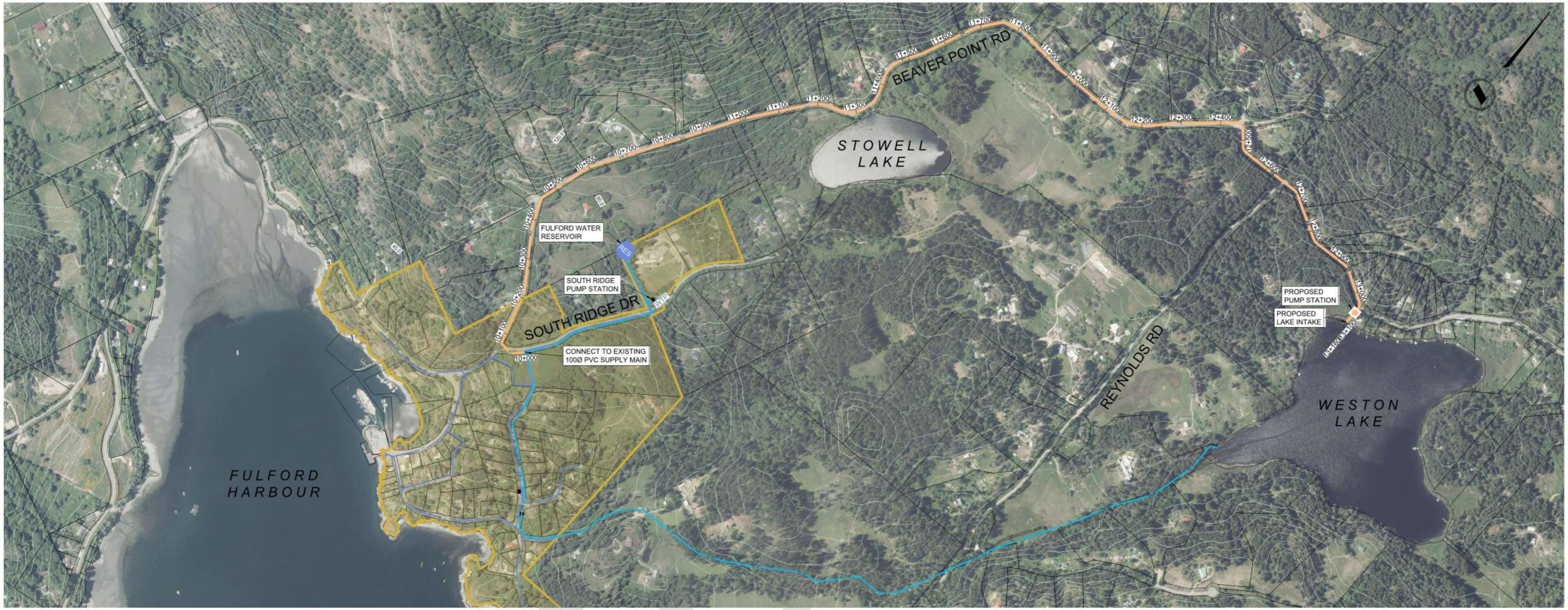

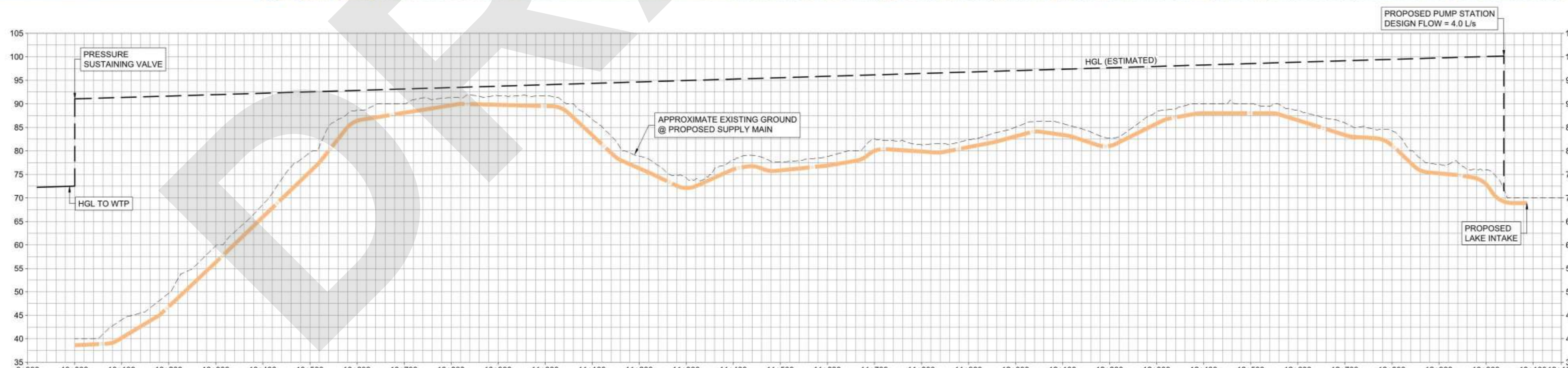

LEGEND

- WATER SERVICE AREA
- EXISTING DISTRIBUTION MAIN
- EXISTING UNTREATED SUPPLY MAIN
- PROPOSED UNTREATED SUPPLY MAIN
- RES — EXISTING STORAGE FACILITY
- WTP — EXISTING TREATMENT PLANT
- EXISTING PUMP STATION
- EXISTING PRESSURE CONTROL STATION
- PROPOSED PUMP STATION

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Engineers and Geoscientists of BC

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FULFORD WATER SYSTEM
AC WATER PIPELINES REPLACEMNT
PROPOSED SUPPLY MAIN
REPLACEMENT (OPTION B)

Drawing No.
FIGURE 8

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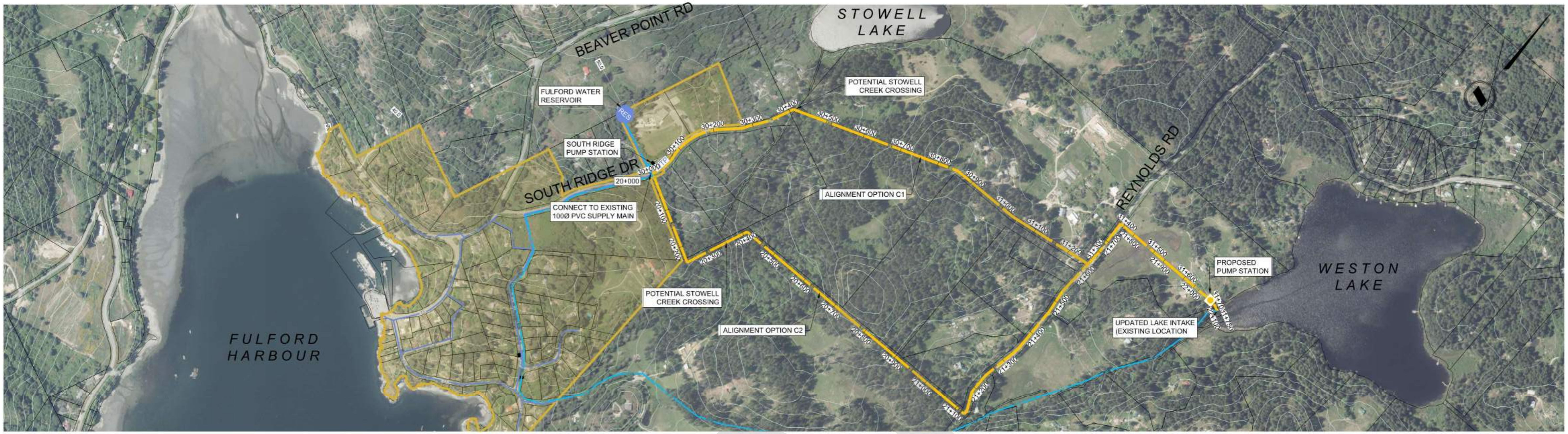
Rev.: B



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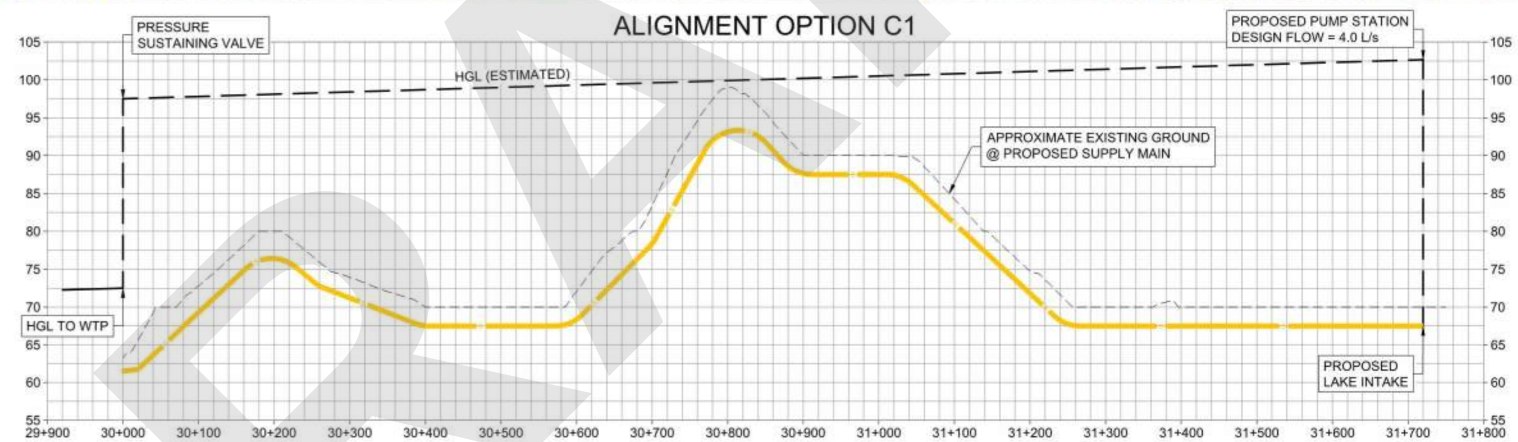

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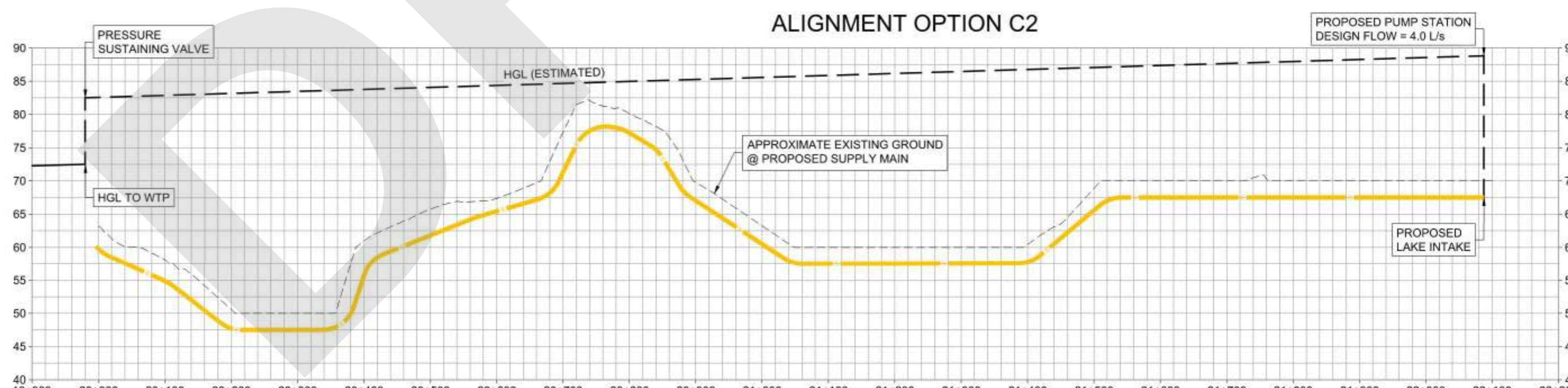

LEGEND

- WATER SERVICE AREA
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- EXISTING UNTREATED SUPPLY MAIN
- PROPOSED UNTREATED SUPPLY MAIN
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FULFORD WATER SYSTEM
AC WATER PIPELINES REPLACEMNT
PROPOSED SUPPLY MAIN
REPLACEMENT (OPTION C)

Drawing No.
FIGURE 9

Project Number: 2231-54641-01-SK
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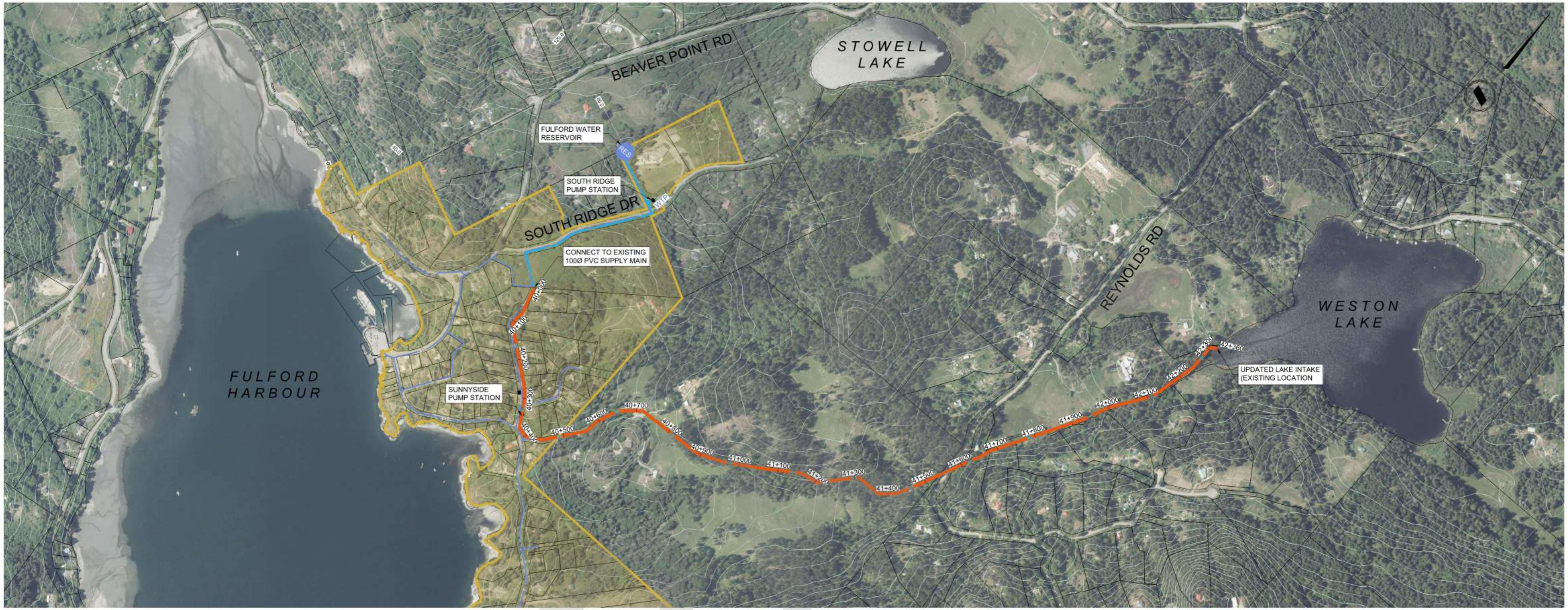

LEGEND

- WATER SERVICE AREA
- EXISTING DISTRIBUTION MAIN
- EXISTING UNTREATED SUPPLY MAIN
- PROPOSED UNTREATED SUPPLY MAIN
- RES — EXISTING STORAGE FACILITY
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- EXISTING PRESSURE CONTROL STATION

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FULFORD WATER SYSTEM
AC WATER PIPELINES REPLACEMNT
PROPOSED SUPPLY MAIN
REPLACEMENT (OPTION D)

Drawing No.
FIGURE 10

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PART 7. CONCEPTUAL DESIGN – DISTRIBUTION SYSTEM (EXISTING WSA)

7.1. DISTRIBUTION SYSTEM – OPTION 1 (EXISTING WSA – AC REPLACEMENT)

The proposed distribution system (Option 1) was evaluated under steady state conditions to determine the system pressures under peak hour conditions and to determine available fire flows during maximum day demands.

This option includes the following proposed upgrades:

- Existing AC Watermains Replaced with 150mm Dia. PVC
- Pressure Control Station Added (Beaver Point Rd / Fulford-Ganges Rd) – Set Point @ 60 psi
- Sunnyside PCS Revised Set Point – Set Point @ 60 psi *(Revised from Current 45 psi)*
- Removal of Check Valves & Opening Isolation Valves to provide looped system

The proposed distribution system (Option 1) is shown on **Figure 11**.

7.1.1. Peak Hour Pressures

The system pressures under peak hour demand under existing conditions are compared to other scenarios in **Table A-1 (Appendix A)** and illustrated on **Model Figure D (Appendix B)**. Pressures below the acceptable design minimum of 414 kPa (60 psi) have been highlighted in red.

7.1.2. Available Fire Flows

The available fire flows during maximum day demand for the proposed upgrades are compared to other scenarios in **Table A-2 (Appendix A)** and illustrated on **Model Figure E (Appendix B)**.

The available fire flows, while maintaining minimum residual pressure in system of 140 kPa (20 psi), are all less than a typical design fire flow of 60 L/s (MMCD Design Guideline (2014) minimum fire flow requirements for Single/Two Family Residential without sprinklers).

7.2. DISTRIBUTION SYSTEM – OPTION 2 (EXISTING WSA – MMCD FIRE FLOW)

The proposed distribution system (Option 2) was evaluated under steady state conditions to determine the extent of required upgrades to provide a typical design fire flow of 60 L/s (MMCD Design Guideline (2014) minimum fire flow requirements for Single/Two Family Residential without sprinklers).

This option would require the following proposed upgrades:

- Pressure Control Station Added (Beaver Point Rd / Fulford-Ganges Rd) – Set Point @ 60 psi
- Sunnyside PCS Revised Set Point – Set Point @ 60 psi
- Removal of Check Valves & Opening Isolation Valves to provide looped system
- Existing PVC & AC Watermains Replaced with 200mm Dia. PVC
    - Some limited sections of existing AC & PVC watermains (P-17 to P-24 & P-33) could be replaced with 150mm Dia. PVC and still achieve design fire flow

The proposed distribution system (Option 2) is shown on **Figure 12**.

7.2.1. Peak Hour Pressures

The system pressures under peak hour demand under existing conditions are compared to other scenarios in **Table A-1 (Appendix A)** and illustrated on **Model Figure F (Appendix B)**. Pressures below the acceptable design minimum of 414 kPa (60 psi) have been highlighted in red.

7.2.2. Available Fire Flows

The available fire flows during maximum day demand for the proposed upgrades are compared to other scenarios in **Table A-2 (Appendix A)** and illustrated on **Model Figure G (Appendix B)**. The Figure also shows the required pipe sizes to meet the design fire flow.

7.3. DISTRIBUTION SYSTEM – OPTION 3 (WSA EXPANSION – DEVELOPER FIRE FLOW)

The distribution system (Option 3) was evaluated under steady state conditions to determine the extent of required upgrades to provide a design fire flow of 64 L/s @ the "Ocean Estuary Development". This target design flow was provided to the CRD by the developer.

Based on our initial review, the minimum watermain size of 200mm dia. is required to provide 64 L/s fire flow while maintaining velocities within maximum of 3.0 m/s. As such this option would require the following proposed upgrades:

- Existing PVC & AC Watermains Replaced with 200mm Dia. PVC from Reservoir (R-1) to end of system on Fulford-Ganges Road (J-28)
- Extension of 200mm dia. PVC watermain from J-28 to development
    - Note that a 300m section of 150mm dia. PVC watermain from the reservoir towards the development wouldn't need to be replaced to provide target fire flow, if the maximum velocity requirement was revised from 3.0m/s to 3.7m/s

The conceptual distribution system (Option 3) is shown on **Figure 13**.

As shown in the figure, this analysis was based on the existing system configuration with upgrades focused on providing design fire flow to the development outside of the current WSA (does not reflect the proposed AC watermain replacements shown in Option 1 & Option 2).

7.3.1. Peak Hour Pressures

The system pressures under peak hour demand under existing conditions are compared to other scenarios in **Table A-1 (Appendix A)** and illustrated on **Model Figure H (Appendix B)**. Pressures below the acceptable design minimum of 414 kPa (60 psi) have been highlighted in red. Pressures above the maximum allowable pressure (MMCD Design Guideline, 2014) of 850 kPa (123 psi) have been highlighted in yellow. The guidelines also note that subject to approval of the local authority, the maximum allowable pressure may be increased to 1035 kPa (150 psi) for systems with multiple pressure zones.

7.3.2. Available Fire Flows

The available fire flows during maximum day demand for the proposed upgrades are compared to other scenarios in **Table A-2 (Appendix A)** and illustrated on **Model Figure I (Appendix B)**.

Available fire flows greater than the design fire flow of 64 L/s have been highlighted in green.

7.4. DISTRIBUTION SYSTEM – OPTION REVIEW SUMMARY

We have summarized the three (3) conceptual options that were reviewed for the distribution system in **Table 7-1**.

Table 7-1: Distribution System – Watermain Replacement Option Review

Option	Design Considerations	Scenario Purpose
1	- Replace AC Watermains with 150mm Diameter PVC pipe for future domestic demand estimates	- To confirm AC watermain replacement sizing (Domestic Demands) and to provide the CRD an understanding of available fire flows
2	- Replace Existing PVC and AC Watermains with PVC pipe, sized to suit MMCD fire flow standards (60L/s)	- To provide the CRD an understanding of required distribution system upgrades to meet a fire flow standard
3	- Replace Existing PVC and AC Watermain with PVC pipe, sized to provide developer fire flow @ Ocean Estuary Development (including potential service expansion area)	- To provide the CRD an understanding of required distribution system upgrades to provide design fire flow at potential development

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FULFORD WATER SYSTEM
AC WATER PIPELINES REPLACEMNT
PROPOSED DISTRIBUTION SYSTEM
(OPTION 1)

Drawing No.
FIGURE 11

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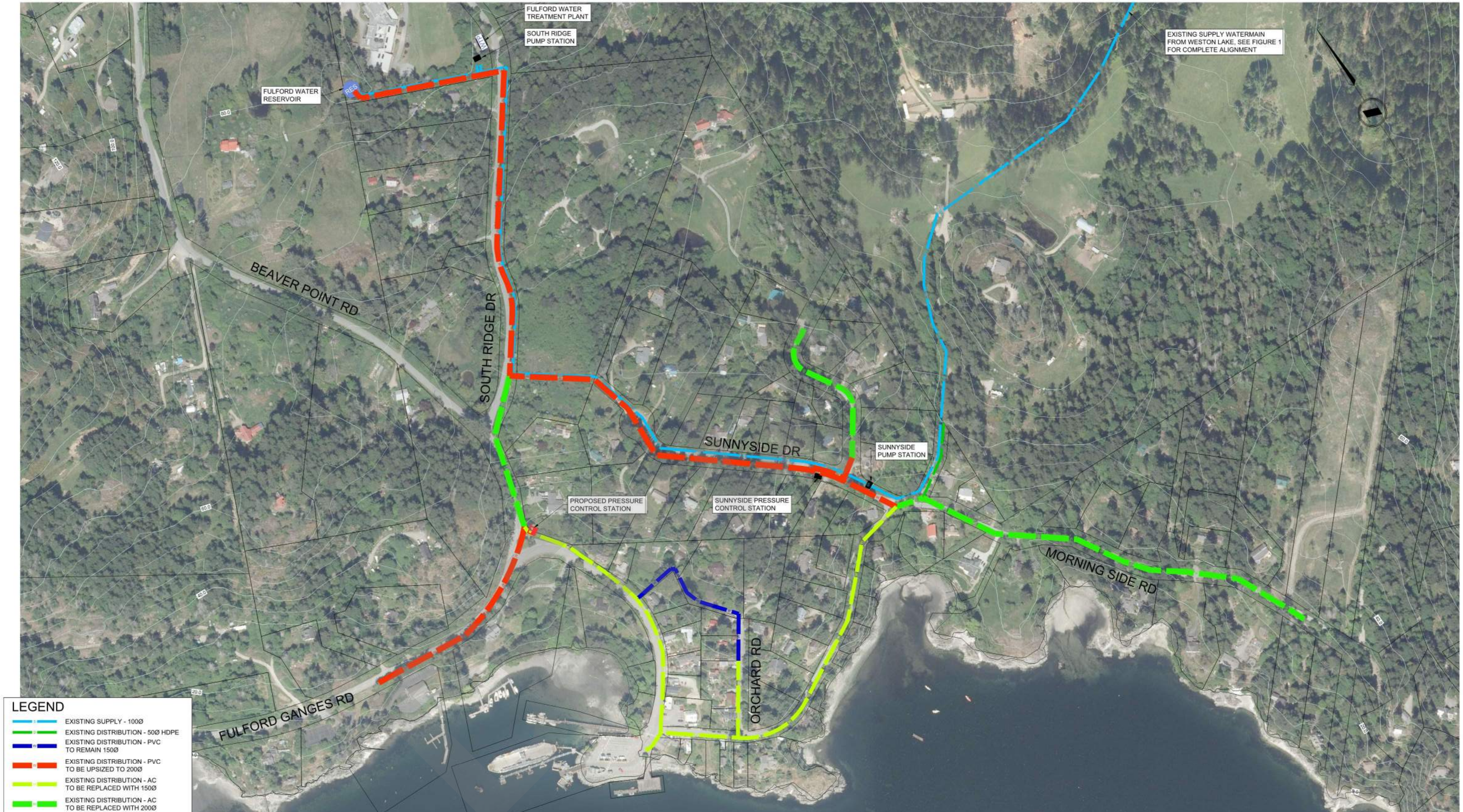

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**FULFORD WATER SYSTEM
AC WATER PIPELINES REPLACEMNT
PROPOSED DISTRIBUTION SYSTEM
(OPTION 2)**

Drawing No. FIGURE 12

Project Number 2231-54641-01-SK Rev. B

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FULFORD WATER SYSTEM
AC WATER PIPELINES REPLACEMNT
PROPOSED DISTRIBUTION SYSTEM
(OPTION 3)

Drawing No.
FIGURE 13

Project Number: 2231-54641-01-SK
Rev.: B

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PART 8. IMPACT ASSESSMENT

8.1. ARCHAEOLOGICAL / HERITAGE

Based on our desktop review of the Remote Access to Archaeological Data (RAAD) Maps it appears that there is a potential for Archaeological / Heritage findings along the proposed watermain replacement alignments.

We recommend that an Archaeological Overview Assessment (AOA) be completed at the start of the detailed design process.

This work would generally include:

- The AOA will review the background data available on the BC Archaeology Branch Remote Access to Archaeological Data (RAAD) website. This includes any previously recorded archaeological sites and/or areas of archaeological potential in conflict or in the vicinity of the project.
- A letter will be compiled with the data collected from the AOA and will make recommendations regarding the need for further archaeological work, such as a permitted archaeological impact assessment, permitted monitored site alterations or no further archaeological work for the construction phase of the project. The AOA will make an estimate of all probable archaeological services costs and time frames for the construction phase as well.
- If additional archaeological work is required, such as an archaeological impact assessment or archaeological permit application, estimated costs will be summarized.

8.2. ENVIRONMENTAL / ECOLOGICAL

Based on our desktop review of the CRD GIS Mapping, it appears that there is a potential for watermain replacement alignments to cross through sensitive environmental / ecological areas.

We recommend that an Environmental Screening Report (ESR) be completed at the start of the detailed design process due to the nature of the site.

The objective of the ESR is to provide an overview of the proposed project and the existing environmental features to determine the level and extent of any further environmental review requirements. This screening level desktop study will provide a general description of the biophysical conditions and natural landscape features of the site and a brief assessment of potential impacts. This report will assist in determining Environmentally Valuable Resources (EVRs) that would require a more in-depth review.

Additional assessments may be required depending on the findings of the ESR, including the development of an Environmental Assessment (EA) that would build on the ESR and include field verification of key EVRs identified in the desktop review. Additional environmental services may be needed to support project permitting requirements and facilitate environmental protection during construction.

We anticipate that the Environmental Screening Report will include the following sections:

- Introduction / Background Information
- Project Description
- Regulatory Framework
- Desktop Assessment of Biophysical Resources, including a review of site photographs
- Potential Impact Assessment (high level)
- Potential Permitting Requirements
- Summary
- References

We also recognize that an Environmental Management Plan should be prepared near the end of the detailed design process.

The Environmental Management Plan (EMP) would be developed by a Qualified Environmental Professional (QEP). The objective of the EMP will be to provide a framework for the Contractor in the development of a Construction Environmental Management Plan (CEMP), to identify key regulatory requirements for the project, and to support permitting applications, if required. The EMP will be included in the tender package to help provide guidance to the Contractor.

PART 9. FINDINGS & RECOMMENDATIONS

We have summarized the key findings of this study below:

1. Existing System Review
   - The Fulford Water System contains approximately 2,330m of AC watermain in the supply system and 1,775m of AC watermain in the distribution system.
   - The existing AC watermain has been broken into six (6) segments which have been ranked in priority for replacement (through a Criticality Assessment). Depending on funding allocation for each "Phase" of replacement, the segments could be combined or constructed individually.
   - Generally, the Fulford Water System cannot achieve sufficient flow for residential or commercial fire protection in accordance with the CRD, MMCD, or FUS guidelines.
   - Sections of existing PVC watermain in the system have not been sized to achieve sufficient flow (while maintaining required system pressures & velocities) for residential or commercial fire protection in accordance with the CRD, MMCD, or FUS guidelines.
2. Supply System Watermain Review
   - Four (4) AC watermain replacement options were reviewed including:
     - Option A - The conceptual replacement alignment runs from Weston Lake along Beaver Point Road and connects to South Ridge Drive through private property.
       - Requires new lake intake, new pump station, supply watermain through MOTI right-of-way, and supply watermain through private property.
       - Connection through private property could have significant impact on schedule and cost. As such, this is not considered the preferred option.
     - Option B – The conceptual replacement alignment runs from Weston Lake along Beaver Point Road and connects to the existing supply system at the intersection of Beaver Point Road and South Ridge Drive.
       - Requires new lake intake, new pump station, and supply watermain through MOTI right-of-way.
       - Although this connection requires longer section of supply watermain, it is considered the preferred option.
       - This option could also allow for the installation of the roadside Multi-Use Path above the proposed watermain to provide connection from Fulford Harbour to Stowell Lake and Weston Lake.

- Option C – The conceptual replacement alignment runs from Weston Lake west, through private property to Reynolds Road, then runs south along Reynolds Road and connects to South Ridge Drive through private property (2 properties minimum).
  - Requires new lake intake, new pump station, supply watermain through MOTI right-of-way, and supply watermain through private property.
  - Although this connection requires shorter section of supply watermain, connection through private properties could have significant impact on schedule and cost. As such, this is not considered the preferred option.
- Option D – The conceptual option review considered replacement of the supply watermain along the existing route which generally follows the creek that outlets from Weston Lake to the south.
  - Based on our site walk as well as desktop review for suitability, ease of construction (access, water control, technologies, risk, etc.), construction cost, and environmental permitting requirements this replacement option is not considered the preferred option.

3. Distribution System Watermain Review

- Three (3) scenarios were reviewed including:
  - Option 1 – This option includes replacing all existing AC watermains with 150mm Dia. PVC watermain and revisions to pressure zones including increasing the lower pressure zone by ~15 psi and looping the system by addition of a second pressure control station.
    - This option provides PVC watermains (AC watermains replaced), improved hydraulic capacity, and improved fire flows, however the available fire flows do not meet CRD, MMCD, or FUS guidelines.
  - Option 2 – This option investigates the required upgrades to provide a typical design fire flow of 60 L/s (MMCD). This option includes replacing all existing watermains with 200mm Dia. PVC watermain (the looped section through “downtown” could be 150mm Dia.) and revisions to pressure zones including increasing the lower pressure zone by ~15 psi and looping the system by addition of a second pressure control station.
    - This option provides replaced AC watermains, improved hydraulic capacity which provides a typical design fire flow of 60 L/s (MMCD Design Guideline (2014) minimum fire flow requirements for Single/Two Family Residential without sprinklers).
    - This option requires replacement of existing undersized PVC watermain including approximately 1,170m of 100mm diameter and 320m of 150mm diameter PVC watermain.
    - Order of magnitude cost to replace these existing sections of PVC piping with adequately sized piping (for fire flows) is approximately $1,000 per meter or about $1.5M.

- Option 3 – This option investigates the required upgrades to provide a design fire flow of 64 L/s @ the Ocean Estuary Development (Design Fire Flow Provided by Developer). This option includes replacing all existing watermains from the reservoir towards the development with 200mm Dia. PVC watermain. The development would also require a 200mm Dia. PVC watermain to be extended outside of the existing Water Service Area.
  - Based on our initial review the minimum watermain size of 200mm dia. is required to provide 64 L/s fire flow while maintaining velocities within maximum of 3.0 m/s.
  - We note that a 300m section of 150mm dia. PVC watermain, from the reservoir towards the development, wouldn't need to be replaced to provide target fire flow, if the maximum velocity requirement was revised from 3.0m/s to 3.7m/s.
  - It is understood that this option would be led by the developer only if the District agrees to expand the Water Service Area.
  - Reservoir storage requirements related to this design fire flow were not reviewed as part of this study.

We have the following recommendations based on the findings in our investigation, analysis, and criticality assessment of the existing system as well as analysis, option review, and recommendations to support the AC watermain replacement in the Fulford Water System:

- Supply System – Develop conceptual design, replacement program, and cost estimate(s) for the AC watermain replacement within the supply system.
  - **Option B Recommended**
- Distribution System – Develop conceptual design, replacement program, and cost estimate(s) for the AC watermain replacement within the distribution system.
  - **Option 1 Recommended**
- Develop detailed design for the replacement program which is to be broken into phases to strategically replace the AC watermain replacement in accordance with the watermain replacement prioritization (criticality assessment).

PART 10. CLOSURE

We trust that the information provided in this document is sufficient for your requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Sincerely,

McElhanney Ltd.

EGBC Permit No. 1003299

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Date	Status	Revision	Author
January 30, 2023	Draft for Client Review	Revision 00	S. O'Connor
March 10, 2023	Issued for Client Review	Revision 01	S. O'Connor

APPENDIX A – WATER MODEL SCENARIO COMPARISON TABLES

Table A-1: Peak Hour Pressures Comparison

			Existing System		Proposed System (Existing WSA) - Option #1		Proposed System (Existing WSA) - Option #2		Proposed System (WSA Expansion) - Option #3	
Node	Approximate Location	~ Elevation (m)	Demand (L/s)	Pressure (psi)	Demand (L/s)	Pressure (psi)	Demand (L/s)	Pressure (psi)	Demand (L/s)	Pressure (psi)
J-2	203 South Ridge Drive	62.7	0.11	43	0.18	43	0.18	43	0.18	43
J-3	132 Beaver Point Road	40.0	0.03	75	0.06	75	0.06	75	0.06	75
J-4	169 Sunnyside Drive	40.0	0.07	75	0.12	75	0.12	75	0.12	75
J-5	154 Sunnyside Drive	39.2	0.40	76	0.65	76	0.65	76	0.65	76
J-6	122 Sunnyside Drive	28.4	0.14	92	0.24	91	0.24	92	0.24	92
J-7	172 Morningside Road	14.7	0.11	64	0.18	81	0.18	81	0.18	110
J-8	191 Morningside Road	16.0	0.00	62	0.00	79	0.00	79	0.00	108
J-9	254 Morningside Road	14.7	0.33	64	0.54	81	0.54	81	0.54	109
J-10	247 Morningside Road	16.0	0.03	62	0.06	79	0.06	79	0.06	107
J-11	266 Morningside Road	23.0	0.00	52	0.00	69	0.00	69	0.00	98
J-12	280 Morningside Road	26.8	0.26	47	0.42	64	0.42	64	0.42	92
J-13	116 Beaver Point Road	40.0	0.00	75	Removed	Removed	Removed	Removed	Removed	Removed
J-14	116 Beaver Point Road	40.0	0.00	75	Removed	Removed	Removed	Removed	Removed	Removed
J-15	116 Beaver Point Road	40.0	0.00	75	0.00	75	0.00	75	0.00	75
J-16	117 Beaver Point Road	40.0	0.07	75	0.12	75	0.12	75	0.12	75
J-17	112 Beaver Point Road	30.7	0.03	88	0.06	88	0.06	88	0.06	88
J-18	2900 Fulford-Ganges Road	16.9	0.22	108	0.36	78	0.36	78	0.36	107
J-19	2901 Fulford-Ganges Road	12.3	0.14	67	0.24	85	0.24	85	0.24	114
J-20	2915 Fulford-Ganges Road	2.3	0.26	81	0.42	99	0.42	99	0.42	128
J-21	117 Morningside Road	10.0	0.14	70	0.24	88	0.24	88	0.24	117
J-22	122 Morningside Road	7.8	0.26	73	0.42	91	0.42	91	0.42	120
J-23	158 Morningside Road	14.9	0.22	63	0.36	81	0.36	81	0.36	109
J-24	164 Morningside Road	16.0	0.07	62	0.12	79	0.12	79	0.12	108
J-25	117 Beaver Point Road	30.6	0.00	88	0.00	88	0.00	88	0.00	88
J-26	2823 Fulford-Ganges Road	23.5	0.00	98	0.00	98	0.00	99	0.00	98
J-27	2825 Fulford-Ganges Road	17.3	0.07	107	0.12	107	0.12	107	0.12	107
J-28	2807 Fulford-Ganges Road	14.1	0.18	112	0.30	111	0.30	112	0.30	112
J-29	131 Orchard Road	25.8	0.00	95	0.00	65	0.00	65	0.00	94
J-30	127 Orchard Road	24.9	0.00	97	0.00	67	0.00	67	0.00	96
J-31	127 Orchard Road	26.4	0.11	94	0.18	64	0.18	64	0.18	94
J-32	120 Orchard Road	20.0	0.07	103	0.12	74	0.12	74	0.12	103
J-33	101 Morningside Road	0.0	0.03	85	0.06	102	0.06	102	0.06	131
J-34	125 Sunnyside Drive	28.6	0.00	91	0.00	91	0.00	91	0.00	91
J-35	108 Hilltop Road	25.8	0.00	95	0.00	95	0.00	95	0.00	95
J-36	120 Hilltop Road	26.8	0.00	94	0.00	93	0.00	94	0.00	94
J-37	117 Hilltop Road	34.9	0.14	82	0.24	82	0.24	82	0.24	82
J-38	136 Hilltop Road	40.0	0.00	75	0.00	75	0.00	75	0.00	75
J-39	140 Hilltop Road	40.0	0.22	75	0.36	75	0.36	75	0.36	75
J-40	110 Tahouney Road	29.4	0.03	43	0.06	60	0.06	60	0.06	89
J-41	252 Morningside Road	24.7	0.14	50	0.24	67	0.24	67	0.24	95
J-42	110 Orchard Road	19.4	0.00	57	0.00	74	0.00	74	0.00	104
J-43	2895 Fulford-Ganges Road	16.5	0.00	61	0.00	79	0.00	79	0.00	108
J-100	2795 Fulford-Ganges Road	15.3							0.00	110
J-101	2683 Fulford-Ganges Road	6.6							0.00	122
J-102	2681 Fulford-Ganges Road	1.0							0.00	130
J-103	2661 Fulford-Ganges Road	1.4							0.49	130
J-104	2621 Fulford-Ganges Road	3.3							0.65	127

Pressures below the acceptable design minimum of 414 kPa (60 psi) have been highlighted in red.
Pressures above the maximum allowable pressure (MMCD Design Guideline, 2014) of 850 kPa (123 psi) have been highlighted in yellow.*
* The guidelines also note that subject to approval of the local authority, the maximum allowable pressure may be increased to 1035 kPa (150 psi) for systems with multiple pressure zones.

Table A-2: Available Fire Flow (MDD + Fire Flow) Comparison

Node	Approximate Location	~ Elevation (m)	Existing System Fire Flow (Available) (L/s)	Proposed System (Existing WSA) - Option #1 Fire Flow (Available) (L/s)	Proposed System (Existing WSA) - Option #2 Fire Flow (Available) (L/s)	Proposed System (WSA Expansion) - Option #3 Fire Flow (Available) (L/s)
J-2	203 South Ridge Drive	62.7	52	50	90	89
J-3	132 Beaver Point Road	40.0	52	50	90	89
J-4	169 Sunnyside Drive	40.0	52	50	90	54
J-5	154 Sunnyside Drive	39.2	52	50	90	54
J-6	122 Sunnyside Drive	28.4	49	49	90	54
J-7	172 Morningside Road	14.7	49	50	90	67
J-8	191 Morningside Road	16.0	23	50	90	23
J-9	254 Morningside Road	14.7	22	50	90	22
J-10	247 Morningside Road	16.0	18	50	90	18
J-11	266 Morningside Road	23.0	16	50	90	16
J-12	280 Morningside Road	26.8	14	49	90	15
J-13	116 Beaver Point Road	40.0	23	Removed	Removed	Removed
J-14	116 Beaver Point Road	40.0	23	Removed	Removed	Removed
J-15	116 Beaver Point Road	40.0	23	50	90	89
J-16	117 Beaver Point Road	40.0	23	50	90	89
J-17	112 Beaver Point Road	30.7	23	50	90	89
J-18	2900 Fulford-Ganges Road	16.9	23	50	77	21
J-19	2901 Fulford-Ganges Road	12.3	17	50	79	21
J-20	2915 Fulford-Ganges Road	2.3	19	50	82	21
J-21	117 Morningside Road	10.0	21	50	88	21
J-22	122 Morningside Road	7.8	22	50	90	21
J-23	158 Morningside Road	14.9	23	50	89	45
J-24	164 Morningside Road	16.0	23	50	76	41
J-25	117 Beaver Point Road	30.6	23	27	90	89
J-26	2823 Fulford-Ganges Road	23.5	23	27	90	89
J-27	2825 Fulford-Ganges Road	17.3	23	27	90	89
J-28	2807 Fulford-Ganges Road	14.1	23	27	90	89
J-29	131 Orchard Road	25.8	23	50	79	21
J-30	127 Orchard Road	24.9	23	50	79	21
J-31	127 Orchard Road	26.4	23	50	81	21
J-32	120 Orchard Road	20.0	23	50	82	21
J-33	101 Morningside Road	0.0	6	24	82	6
J-34	125 Sunnyside Drive	28.6	27	27	90	27
J-35	108 Hilltop Road	25.8	27	27	90	27
J-36	120 Hilltop Road	26.8	27	27	90	27
J-37	117 Hilltop Road	34.9	23	27	90	23
J-38	136 Hilltop Road	40.0	23	27	90	23
J-39	140 Hilltop Road	40.0	23	27	90	23
J-40	110 Tahouney Road	29.4	6	6	6	6
J-41	252 Morningside Road	24.7	18	50	53	6
J-42	110 Orchard Road	19.4	6	50	83	7
J-43	2895 Fulford-Ganges Road	16.5	16	50	64	21
J-100	2795 Fulford-Ganges Road	15.3				89
J-101	2683 Fulford-Ganges Road	6.6				89
J-102	2681 Fulford-Ganges Road	1.0				89
J-103	2661 Fulford-Ganges Road	1.4				89
J-104	2621 Fulford-Ganges Road	3.3				89

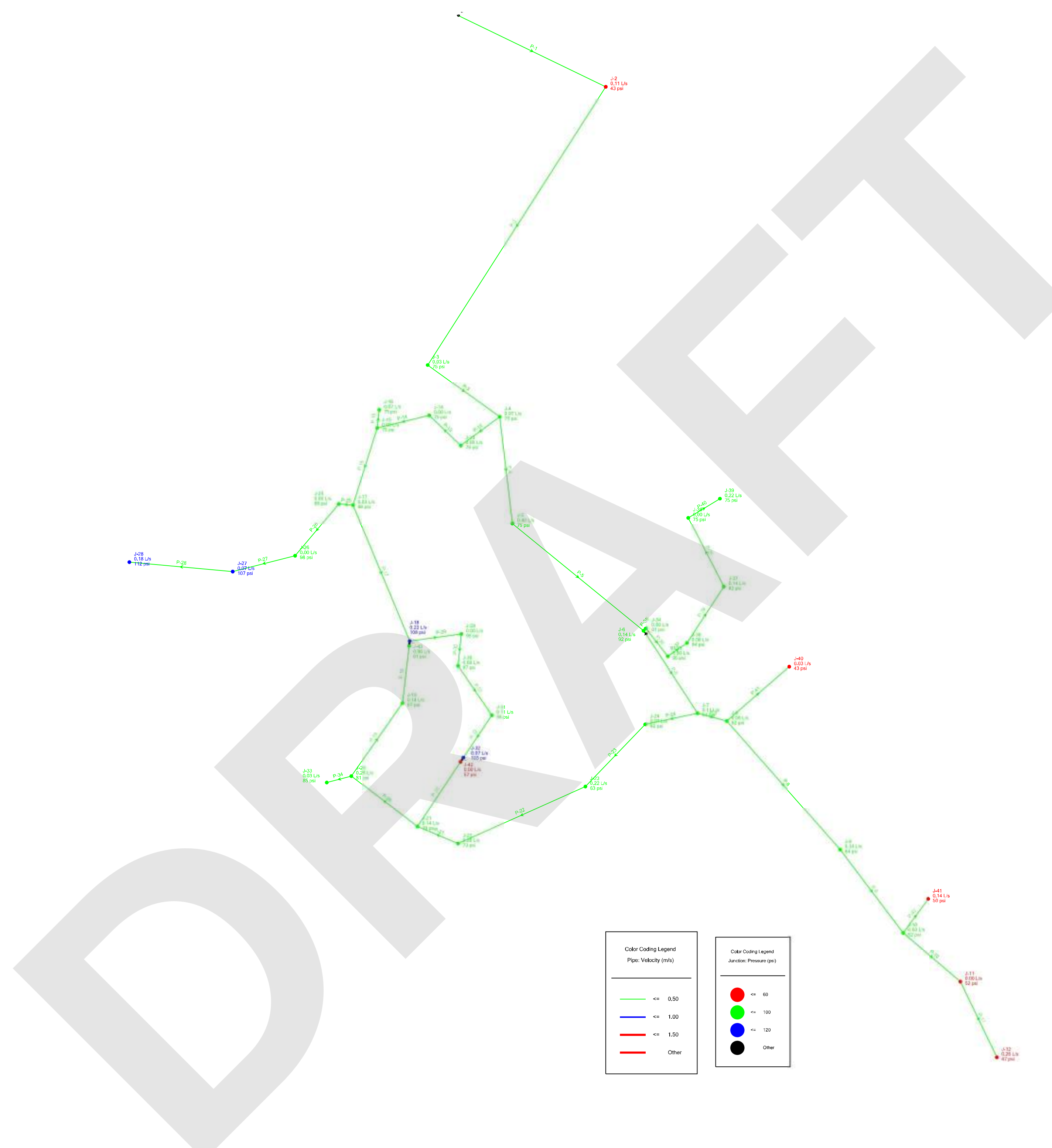
Available fire flows, while maintaining minimum residual pressure in system of 140 kPa (20 psi), less than a typical design fire flow of 60 L/s (MMCD Design Guideline (2014) have been highlighted in red

Available fire flows greater than the design fire flow of 64 L/s have been highlighted in green.

APPENDIX B – WATER MODEL FIGURES

Scenario: PHD - 3.92 L/s

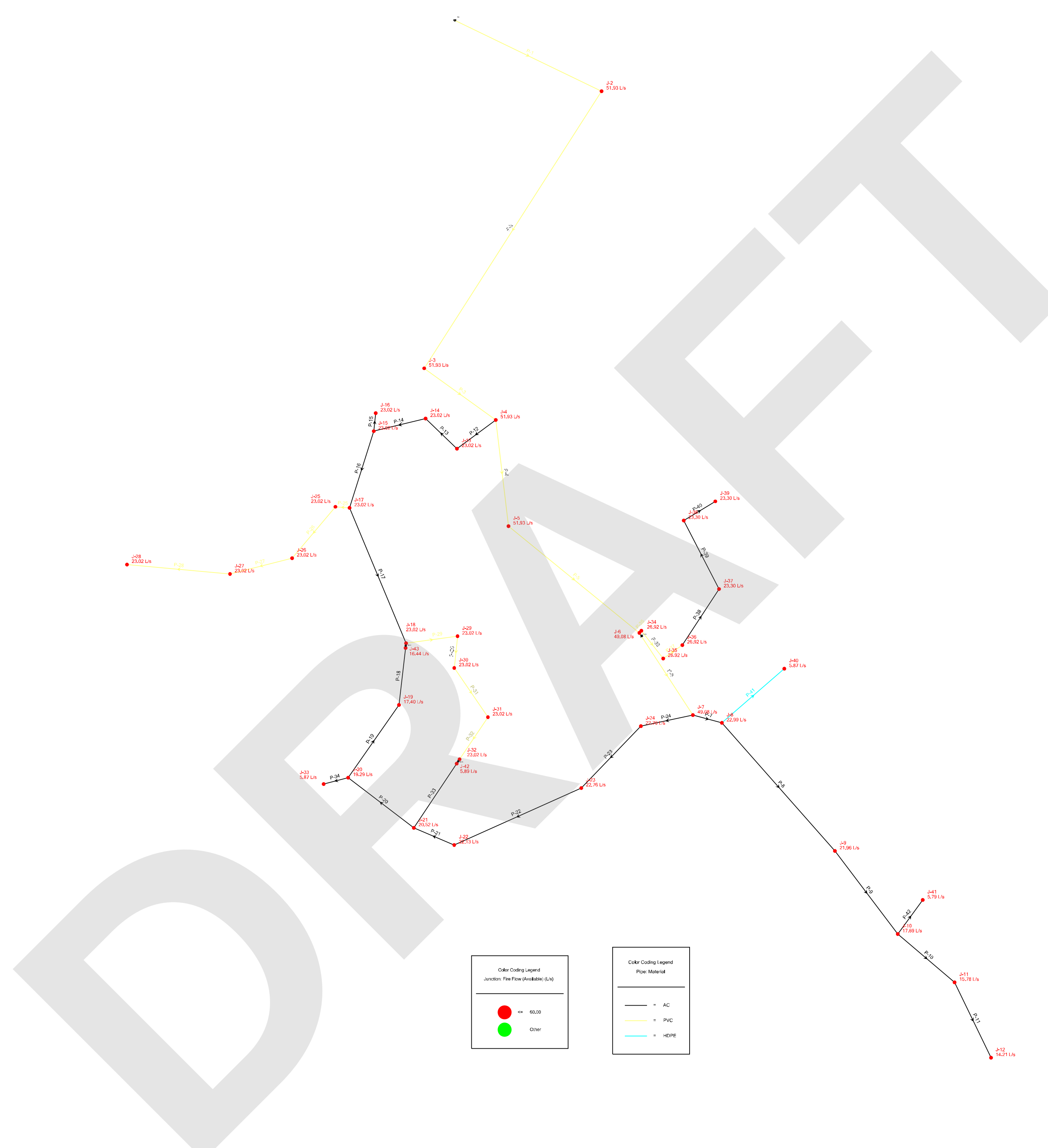
Model Figure A



***Model Figures Scaled for Electronic Viewing Only**
Refer to Model Scenario Tables for summarized Results

Scenario: MDD - 2.80 L/s + Fire Flow

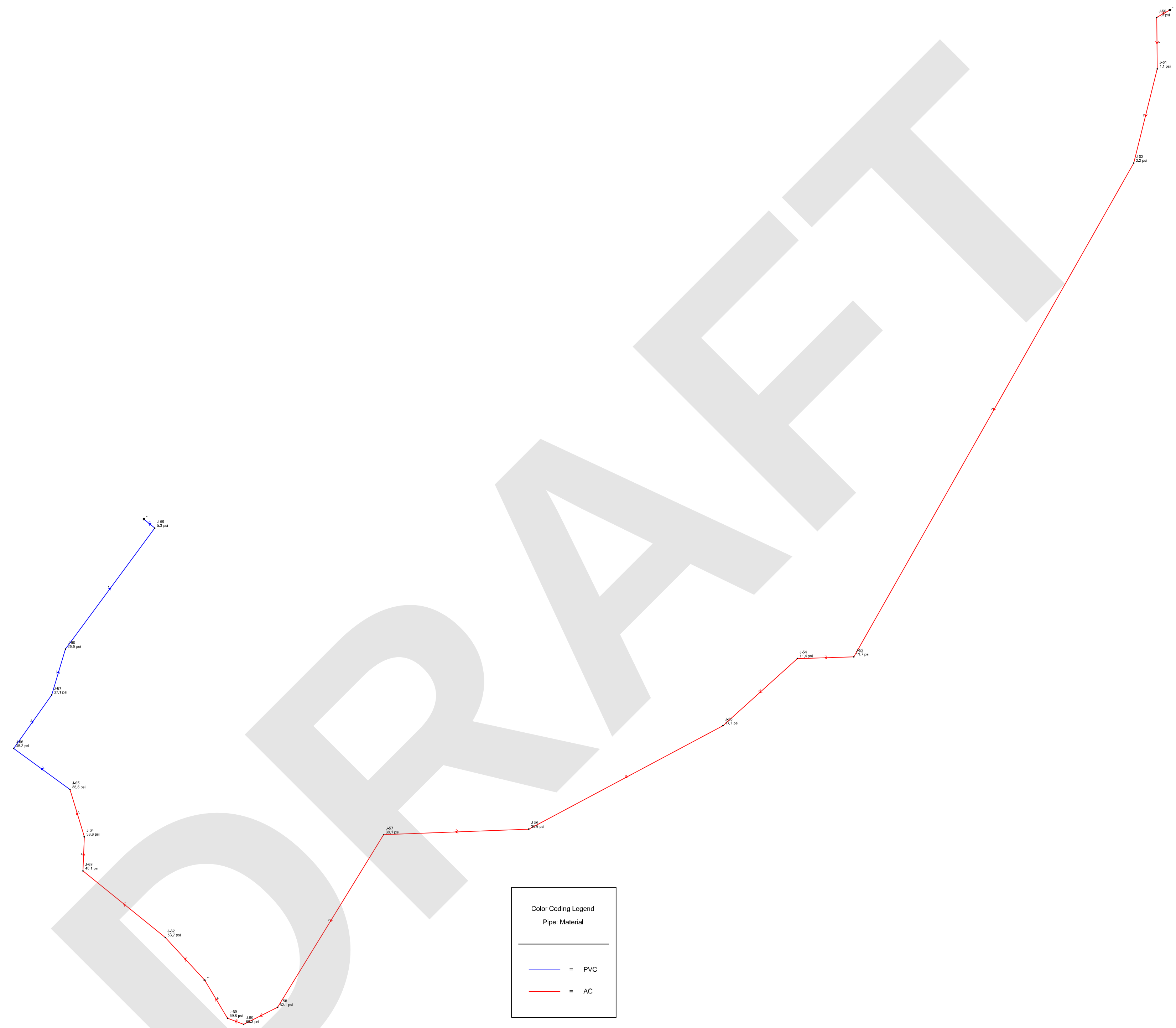
Model Figure B



***Model Figures Scaled for Electronic Viewing Only**
Refer to Model Scenario Tables for summarized Results

Scenario: Base

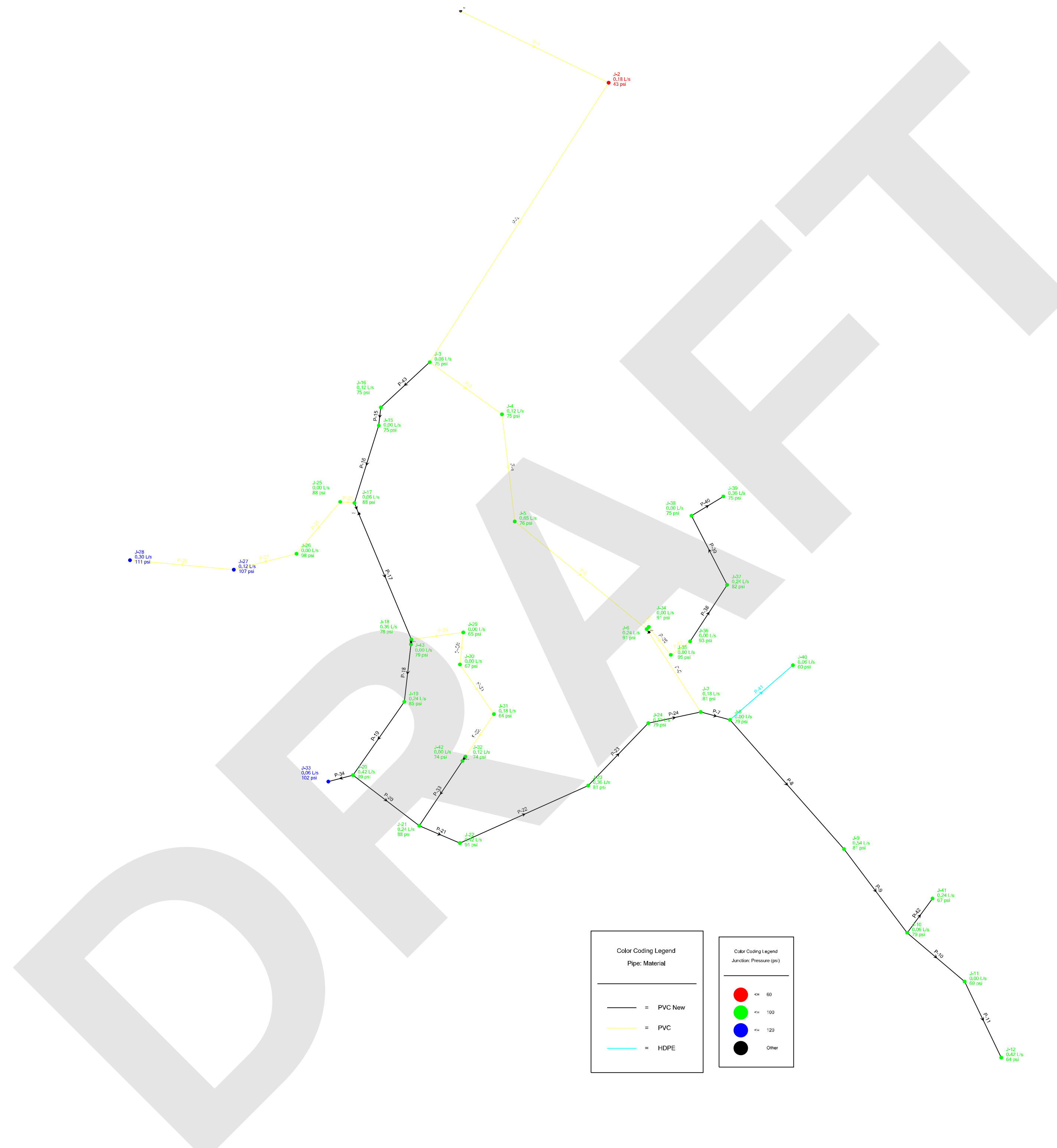
Model Figure C



***Model Figures Scaled for Electronic Viewing Only**
Refer to Model Scenario Tables for summarized Results

Scenario: **PHD - 6.44 L/s**

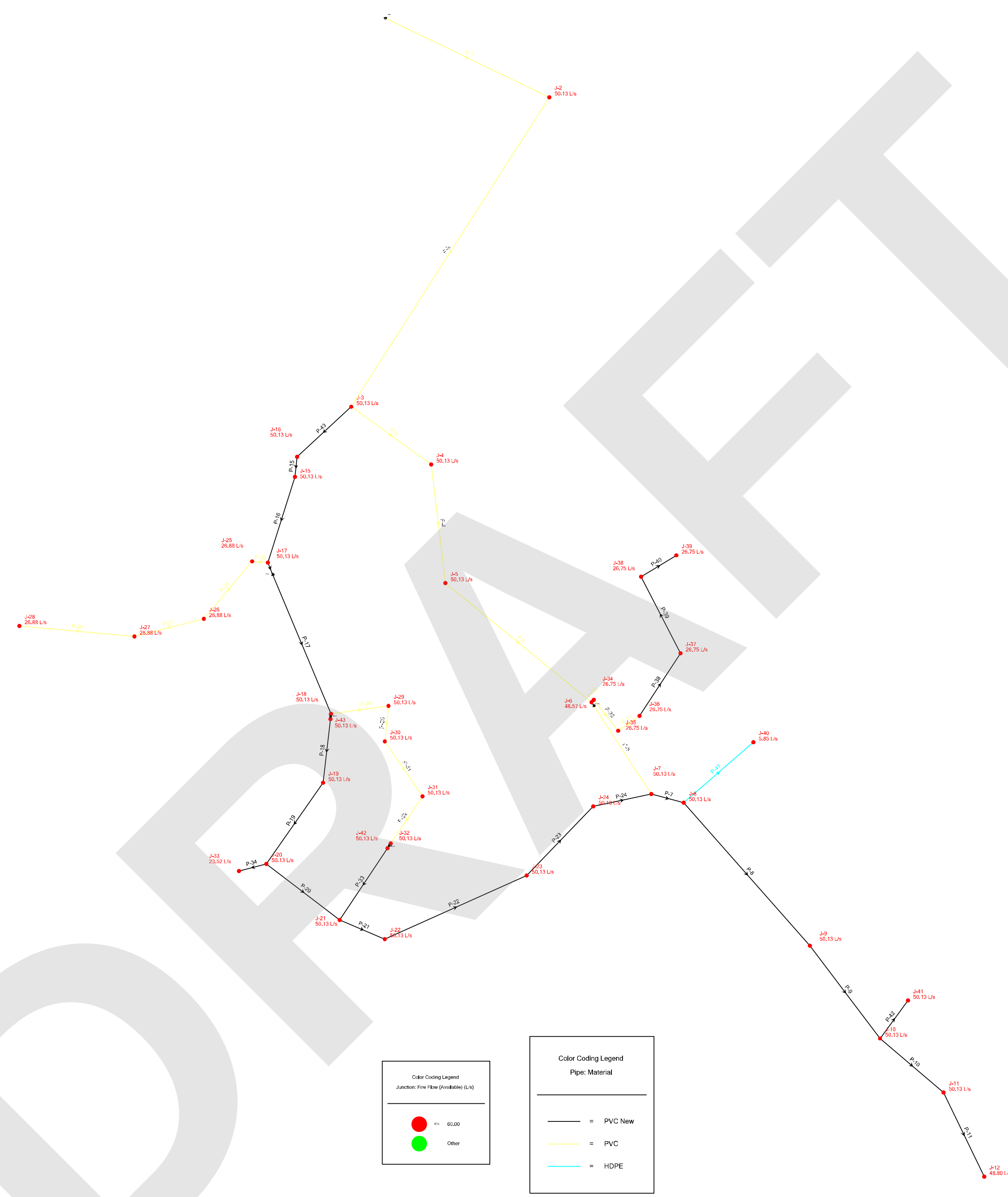
Model Figure D



***Model Figures Scaled for Electronic Viewing Only**
Refer to Model Scenario Tables for summarized Results

Scenario: MDD - 4.60 L/s + Fire Flow

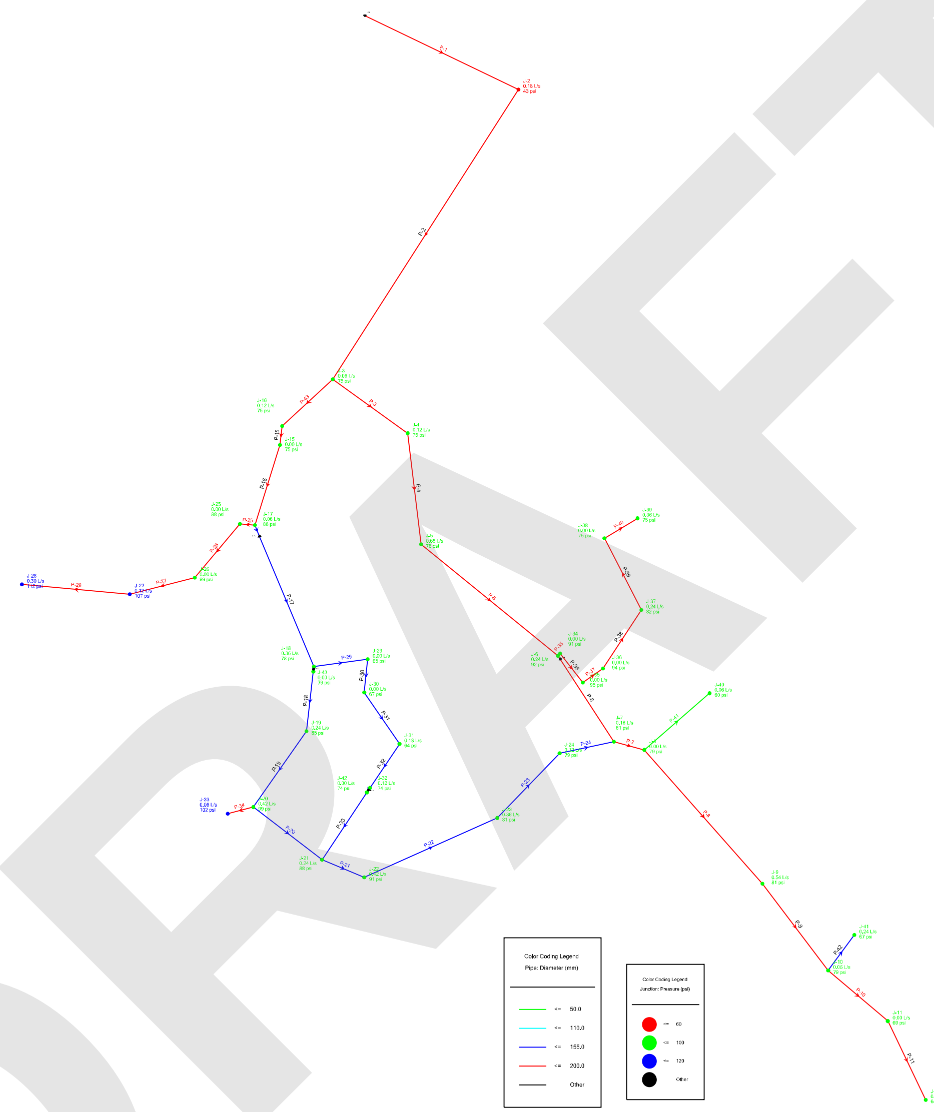
Model Figure E



***Model Figures Scaled for Electronic Viewing Only**
Refer to Model Scenario Tables for summarized Results

Scenario: PHD - 6.44 L/s

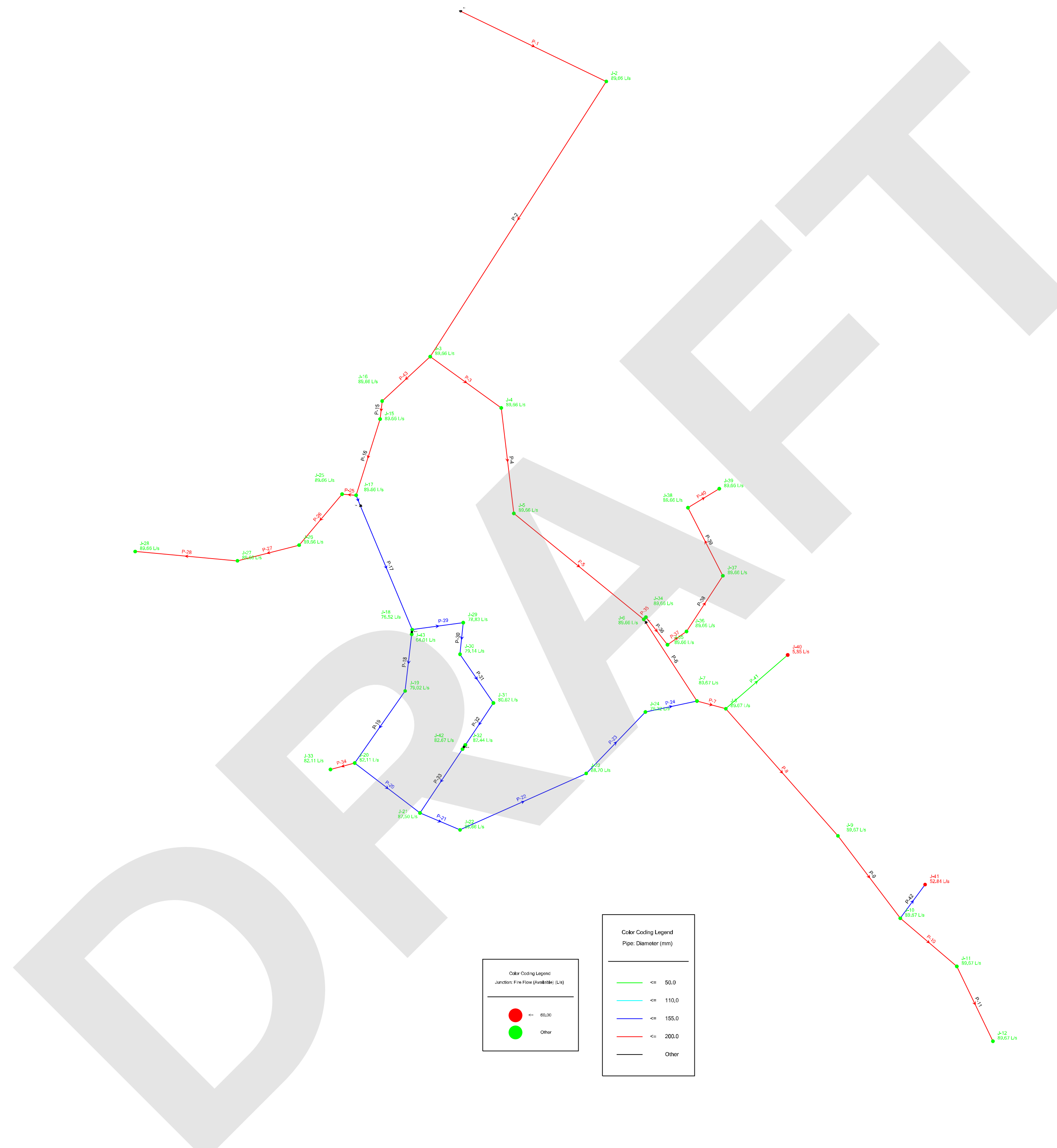
Model Figure F



***Model Figures Scaled for Electronic Viewing Only**
Refer to Model Scenario Tables for summarized Results

Scenario: MDD - 4.60 L/s + Fire Flow

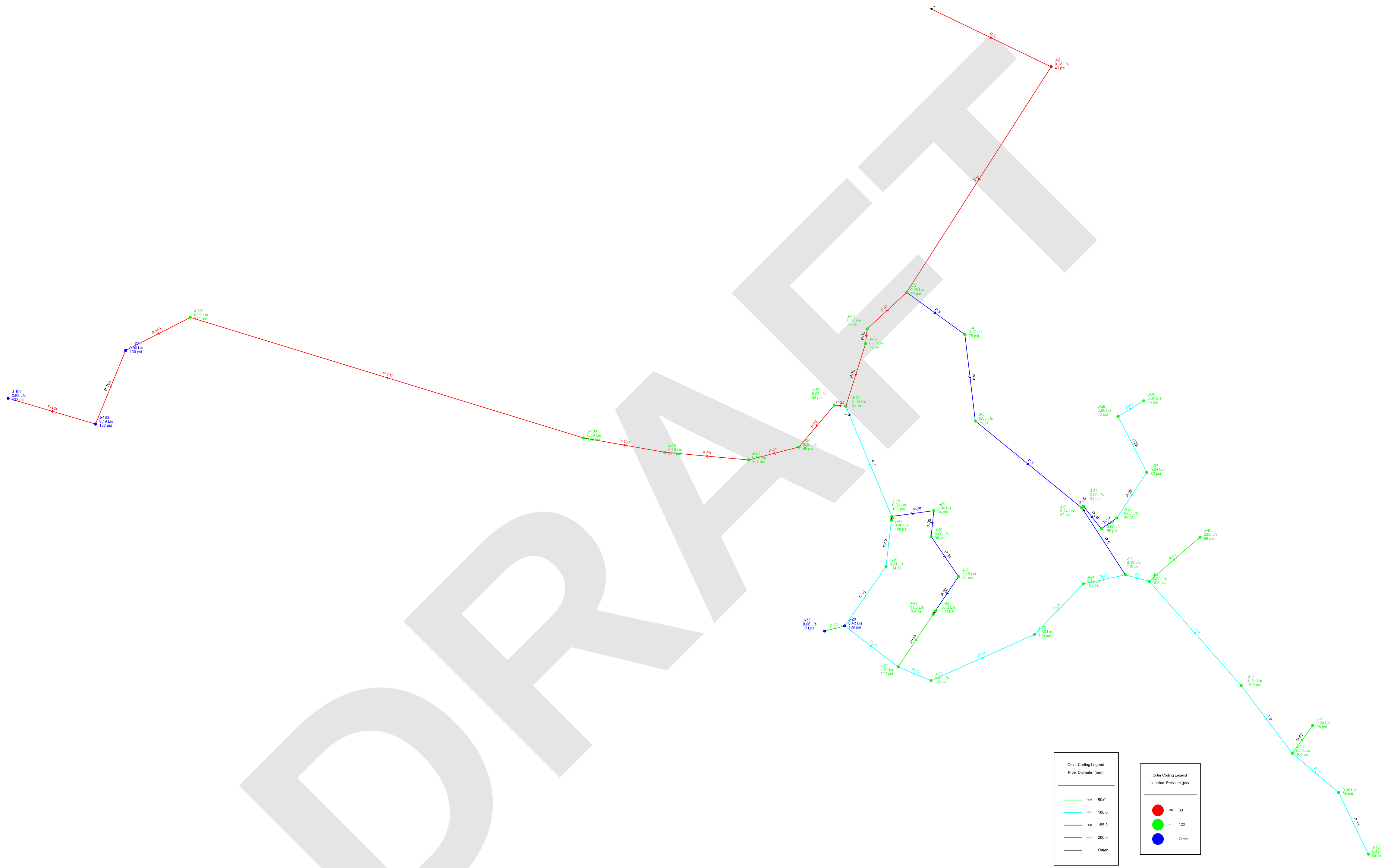
Model Figure G



***Model Figures Scaled for Electronic Viewing Only**
Refer to Model Scenario Tables for summarized Results

Scenario: PHD - 7.59 L/s

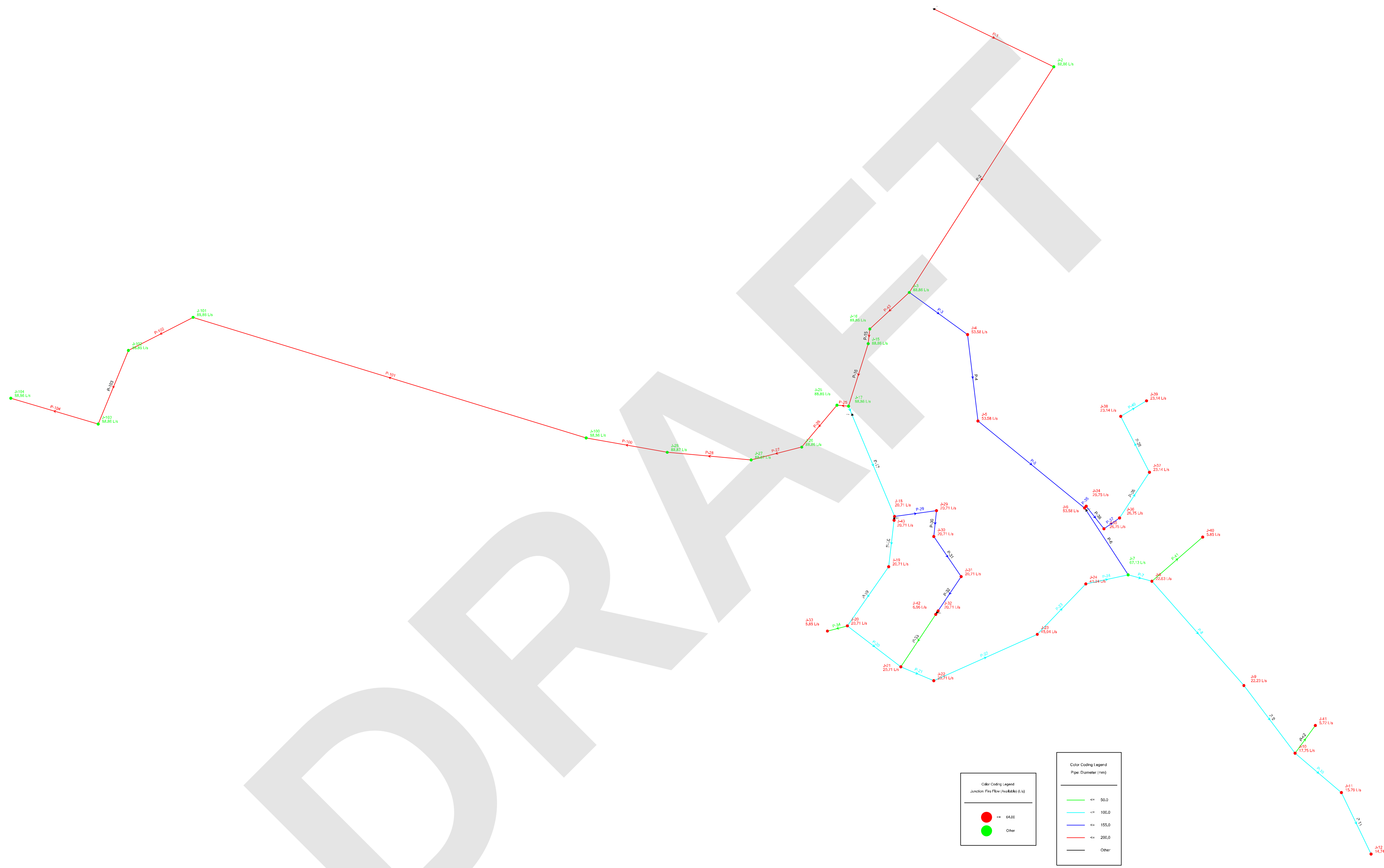
Model Figure H



***Model Figures Scaled for Electronic Viewing Only**
Refer to Model Scenario Tables for summarized Results

Scenario: MDD - 5.40 L/s + Fire Flow

Model Figure I



***Model Figures Scaled for Electronic Viewing Only**
Refer to Model Scenario Tables for summarized Results

APPENDIX C – CRITICALITY ASSESSMENT MATRIX

Capital Regional District
Fulford Water - AC Watermain Replacement: Investigation, Analysis, Criticality Assessment, Option Review
WATERMAIN REPLACEMENT PRIORITIZATION (CRITICALITY ASSESSMENT)

Existing Watermain Details										Components for Watermain Prioritization Analysis								
Section	Segment	Approx. Location	System	Label	Length (m)	Start Node	Stop Node	Diameter(mm)	Material	Leaks and Breaks	Service Connections	Remaining Useful Life	Hydraulic Performance	Complaints	General Land Use	Desktop Condition Assessment	Sensitive Areas	Redundancy
1	N/A	203 South Ridge Drive	Distribution	P-1	166	R-1	J-2	150	PVC		3		Limits Available Fire Flow		Residential			
		132 Beaver Point Road	Distribution	P-2	335	J-2	J-3	150	PVC		1		Limits Available Fire Flow		Residential			
		169 Sunnyside Drive	Distribution	P-3	90	J-3	J-4	150	PVC		2		Limits Available Fire Flow		Residential			
		154 Sunnyside Drive	Distribution	P-4	109	J-4	J-5	150	PVC		11				Residential			
		122 Sunnyside Drive	Distribution	P-5	172	J-5	J-6	150	PVC	1	4				Residential			
		172 Morningside Road	Distribution	P-6	100	J-6	J-7	150	PVC		3				Residential			
2	Priority #5	191 Morningside Road	Distribution	P-7	31	J-7	J-8	100	AC		0	Unknown		Unknown	Residential			
		254 Morningside Road	Distribution	P-8	174	J-8	J-9	100	AC	2	9	Unknown		Unknown	Residential			
		247 Morningside Road	Distribution	P-9	106	J-9	J-10	100	AC		1	Unknown		Unknown	Residential			
		266 Morningside Road	Distribution	P-10	76	J-10	J-11	100	AC		0	Unknown		Unknown	Residential			
		280 Morningside Road	Distribution	P-11	85	J-11	J-12	100	AC		7	Unknown	52 psi < 60 psi @ PHD	Unknown	Residential			
		252 Morningside Road	Distribution	P-42	43	J-10	J-41	100	AC		0	Unknown	57 psi < 60 psi @ PHD	Unknown	Residential			
3	Priority #2	116 Beaver Point Road	Distribution	P-12	49	J-4	J-13	100	AC		0	Unknown	47 psi < 60 psi @ PHD	Unknown	Residential	Key looping section		
		116 Beaver Point Road	Distribution	P-13	44	J-13	J-14	100	AC		0	Unknown		Unknown	Residential	Key looping section		
		117 Beaver Point Road	Distribution	P-14	54	J-14	J-15	100	AC		0	Unknown		Unknown	Residential	Key looping section		
4	Priority #3	117 Beaver Point Road	Distribution	P-15	19	J-15	J-16	100	AC	1	2	Unknown		Unknown	Residential	Several breaks, heavy traffic		
		112 Beaver Point Road	Distribution	P-16	82	J-15	J-17	100	AC	1	1	Unknown		Unknown	Residential	Several breaks, heavy traffic		
		2900 Fulford-Ganges Road	Distribution	P-17	149	J-17	J-18	100	AC	1	6	Unknown		Unknown	Commercial	Several breaks, heavy traffic	Ferry Access	
5	Priority #4	2900 Fulford-Ganges Road	Distribution	P-18	63	J-18	J-19	100	AC	2	4	Unknown		Unknown		Several breaks, heavy traffic	Ferry Access	
		2901 Fulford-Ganges Road	Distribution	P-19	90	J-19	J-20	100	AC	1	7	Unknown		Unknown		Several breaks, heavy traffic		
		2915 Fulford-Ganges Road	Distribution	P-20	84	J-20	J-21	100	AC	1	4	Unknown		Unknown		Several breaks, heavy traffic		
		117 Morningside Road	Distribution	P-21	45	J-21	J-22	100	AC		7	Unknown		Unknown		Key looping section		
		122 Morningside Road	Distribution	P-22	142	J-22	J-23	100	AC		6	Unknown		Unknown		Key looping section		
		158 Morningside Road	Distribution	P-23	88	J-23	J-24	100	AC		2	Unknown		Unknown		Key looping section		
		164 Morningside Road	Distribution	P-24	54	J-24	J-7	100	AC		1	Unknown		Unknown		Key looping section		
		120 Orchard Road	Distribution	P-33	84	J-32	J-21	50	AC		0	Unknown		Unknown		Key looping section		
		101 Morningside Road	Distribution	P-34	26	J-20	J-33	50	AC		1	Unknown		Unknown		Key looping section		
6	N/A	117 Beaver Point Road	Distribution	P-25	14	J-17	J-25	100	PVC		0							
		2823 Fulford-Ganges Road	Distribution	P-26	68	J-25	J-26	100	PVC		0							
		2825 Fulford-Ganges Road	Distribution	P-27	65	J-26	J-27	100	PVC		2							
		2807 Fulford-Ganges Road	Distribution	P-28	105	J-27	J-28	100	PVC		5							
7	N/A	131 Orchard Road	Distribution	P-29	53	J-18	J-29	150	PVC		0							
		127 Orchard Road	Distribution	P-30	33	J-29	J-30	150	PVC		0							
		127 Orchard Road	Distribution	P-31	61	J-30	J-31	150	PVC		3							
		120 Orchard Road	Distribution	P-32	52	J-31	J-32	150	PVC		2							
8	N/A	125 Sunnyside Drive	Distribution	P-35	3	J-6	J-34	100	PVC		0							
		108 Hilltop Road	Distribution	P-36	36	J-34	J-35	100	PVC		0							
		120 Hilltop Road	Distribution	P-37	24	J-35	J-36	100	PVC		0							
9	Priority #6	117 Hilltop Road	Distribution	P-38	68	J-36	J-37	100	AC	1	4	Unknown		Unknown		Service to several residential properties		
		136 Hilltop Road	Distribution	P-39	79	J-37	J-38	100	AC		0	Unknown		Unknown		Service to several residential properties		
		140 Hilltop Road	Distribution	P-40	38	J-38	J-39	100	AC		6	Unknown	43 psi < 60 psi @ PHD	Unknown		Service to several residential properties		
10	N/A	110 Tahouney Road	Distribution	P-41	84	J-8	J-40	50	HDPE		4		50 psi < 60 psi @ PHD					
11	Priority #1	285 Reynolds Road	Supply	P-50	20	R-2	J-50	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water	Watercourse	No Alternate
		285 Reynolds Road	Supply	P-51	66	J-50	J-51	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water	Watercourse	No Alternate
		285 Reynolds Road	Supply	P-52	125	J-51	J-52	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water	Watercourse	No Alternate
		120 Tahouney Road	Supply	P-53	729	J-52	J-53	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water	Watercourse	No Alternate
		120 Tahouney Road	Supply	P-54	73	J-53	J-54	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water	Watercourse	No Alternate
		120 Tahouney Road	Supply	P-55	129	J-54	J-55	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water	Watercourse	No Alternate
		120 Tahouney Road	Supply	P-56	283	J-55	J-56	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water	Watercourse	No Alternate
		120 Tahouney Road	Supply	P-57	187	J-56	J-57	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water	Watercourse	No Alternate
		105 Tahouney Road	Supply	P-58	260	J-57	J-58	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water	Watercourse	No Alternate
		105 Tahouney Road	Supply	P-59	49	J-58	J-59	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water		No Alternate
		172 Morningside Road	Supply	P-60	22	J-59	J-60	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water		No Alternate
		118 Sunnyside Drive	Supply	P-61	57	J-60	PMP-1	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water		No Alternate
		134 Sunnyside Drive	Supply	P-62	75	PMP-1	J-62	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water		No Alternate
		154 Sunnyside Drive	Supply	P-63	136	J-62	J-63	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water		No Alternate
		155 Sunnyside Drive	Supply	P-64	44	J-63	J-64	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water		No Alternate
		169 Sunnyside Drive	Supply	P-65	63	J-64	J-65	100	AC		Provides Supply for All	Unknown		Unknown		Key supply main for all water		No Alternate
12	N/A	132 Beaver Point Road	Supply	P-66	90	J-65	J-66	100	PVC									No Alternate
		143 South Ridge Drive	Supply	P-67	84	J-66	J-67	100	PVC									No Alternate
		155 South Ridge Drive	Supply	P-68	61	J-67	J-68	100	PVC									No Alternate
		169 South Ridge Drive	Supply	P-69	193	J-68	J-69	100	PVC									No Alternate
		203 South Ridge Drive	Supply	P-70	18	J-69	T-1	100	PVC									No Alternate

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CANADA BEST MANAGED COMPANIES