Faulder Water System: Capital Plan

Presented To:

Dated: March 2024
Ecora File No.: 230015

THIS PAGE IS INTENTIONALLY LEFT BLANK

Presented To:

Liisa Bloomfield, P.Eng., PMP
Manager Utilities
Regional District of Okanagan-Similkameen
101 Martin Street
Penticton
BC V2A5J9

Prepared by:

PROFESSIONAL
PROVINCE OF
A. D. JANSEN VAN RENSBURG
58059
BRITISH COLUMBIA
ENGINEER

2024-03-04

Daniel Rensburg, P.Eng. Date
Senior Civil Water Specialist
Daniel.rensburg@ecora.ca

Approved by:

PROFESSIONAL
PROVINCE OF
M. D. YOUNG
22136
BRITISH COLUMBIA
ENGINEER
2024-03-08

ECORA ENGINEERING & RESOURCE GROUP LTD.
ENGINEERS AND GEOSCIENTISTS OF BRITISH COLUMBIA
PERMIT TO PRACTICE # 1001040

RESPONSIBLE REGISTRANT

2024-03-08

DATE

Michael Young, P.Eng. Date
Principal Engineer, Civil
Mike.young@ecora.ca

Version Control and Revision History

Version	Date	Prepared By	Reviewed By	Approved By	Notes/Revisions
A	2023-06-23	DR	GB, MP	MY	
B	2024-01-17	DR	MP	MY	
C	2024-02-14	DR	MP	MY	
0	2024-03-05	DR		MY	

Executive Summary

The RDOS owns and operates the Faulder Community Water System, which includes two wells (FCW1 and FCW2) located on the bank of Trout Creek that supplies domestic water to 81 connections with an estimated population of 215 residents.

The following work was completed for this study:

- Background data and information was gathered and studied.
- A site inspection was conducted together with operational staff.
- Existing service connections were surveyed, and Civil 3D drawings of the existing system were produced.
- Hydraulic modeling was completed.
- The installation dates of portions of the system were verified and the remaining life was estimated.
- Shortcomings of the existing water system were identified.
- Capital projects were identified and prioritized.
- Cost estimates and implementation timeframes were estimated for capital projects.
- An operation and maintenance budget was estimated for the system.
- The replacement cost of the existing infrastructure and the annual contribution for replacement were estimated.

The proposed prioritized projects and their proposed timeframes are presented below:

1) Replacing a 6” and an 8” seized gate valves on Fish Lake Road ....6 months
2) Installing insulation over pipes that are freezing in “Common Property Road” ....6 months
3) Long Term Pumping tests on Well #FCW2 (“new well”) to determine yield/capacity for possible expansion...2 years
4) Flood line/flood zone determination along Trout Creek..2 years
5) Preliminary designs for a new reservoir ....2 years
6) Detail design and construction of a new 430 m^3 reservoir ....8 years
7) UV and Chlorine Disinfection Systems...2 years
8) Fire truck filling turnaround area on Fish Lake Rd. ....5 years
9) 12 new fire hydrants ....8 years

Limitations of Report

This report and its contents are intended for the sole use of the Regional District of Okanagan-Similkameen (RDOS), their agents and the applicable regulatory authorities. Ecora Engineering & Resource Group Ltd. (Ecora) does not accept any responsibility for the accuracy of any data, analyses, or recommendations contained or referenced in the report when the report is used or relied upon by any Party other than the RDOS, their agents, the applicable regulatory authorities or for any Project other than that described in this report. Any such unauthorized use of this report is at the sole risk of the user.

Where Ecora submits both electronic file and hard copy versions of reports, drawings, and other project-related documents, only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Ecora shall be deemed to be the original for the Project. Both electronic file and hard copy versions of Ecora's deliverables shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Ecora.

Table of Contents

List of Tables in Text

List of Figures in Text

Appendices

Acronyms and Abbreviations

FUS	Fire Underwriters Survey Guidelines
GARP	Ground water at risk of containing pathogens
GCDWQ	Guidelines for Canadian Drinking Water Quality
HMI	Human Machine Interface
MAC	Maximum Acceptable Concentration
MDD	Maximum Day Demand
PHD	Peak Hourly Demand
PLC	Programmable Logic Controller
RDOS	Regional District Okanagan-Similkameen
SCADA	Supervisory Control and Data Acquisition
VTSCADA	a visual tag system (or VTS) that generates code in the background based on what you see on the screen
WTP	Water Treatment Plant

1. Introduction

Ecora was retained by the Regional District of Okanagan-Similkameen (RDOS) to produce a Capital Plan for the Faulder Water System in February 2023. The RDOS owns and operates the Faulder Community Water System, which includes two wells (FCW1 and FCW2) located on the bank of the Trout Creek that supplies domestic water to 81 connections with an estimated population of 215 residents. The purpose of this document is to present a capital plan for the Faulder Water System.

1.1 Location

Faulder is situated approximately 7 km west of Summerland along Highway 40 (the Princeton-Summerland Road). The coordinates of the center of the community and a location map are presented in Table 1 and Figure 1 respectively. The Trout Creek flows from the relatively large valley west of Faulder towards Summerland to the east. The ephemeral Darke Creek from the Meadow Valley, north of Faulder, converges with Trout Creek within the village. The village is approximately 200 m higher in elevation than Okanagan Lake and the climate is therefore approximately 1.5 °C colder than Summerland. Faulder is located in Electoral Area “F”.

Table 1: Coordinates of project

Description	Latitude	Longitude
Faulder	49°36'54.09" North	119°46'56.65" West

Figure 1: Location of Faulder in relation to Summerland

1.2 Existing Infrastructure

A layout of the existing infrastructure is presented in Figure 2 below. A detailed engineering layout is presented in Appendix A. Water is pumped from submersible pumps in the “old well” or the “new well” through the uranium water treatment plant into an 8,000 L treated water buffer tank. The two existing wells were drilled into Aquifer #299, which is an underground geological formation consisting of sand and gravel. The hydrogeologists theorize that surface run-off in the Dark and Trout Creeks infiltrate into this aquifer. The ground elevation at the uranium water treatment plant (WTP) is approximately 676 m above mean sea level. The well pump controls and valves are installed inside a cinder block pump house. The WTP is installed inside a 12 ft by 40 ft shipping container. The uranium concentration in the well water is reduced through ion exchange media inside pressure vessels to below acceptable limits. Treated water is pumped from the treated water buffer tank directly into the pressure pipe network by one of the two vertical centrifugal pumps. Only one of these pumps functions at any given time, the second unit was provided for redundancy. The pipe network consists of 150 mm (6”) and 200 mm (8”) mains and 81 service connections. Details of the existing water mains and the 81 service connections are presented in Table 2 and Table 3 below:

Table 2: Details of existing water mains

Installation Year	Type	Diameter (mm)	Material	Length (m)	Pressure Class
1993	Water main	150	PVC	2,421	Class 150, DR 18
1993	Water main	200	PVC	379	Class 150, DR 18
1994	Water main	150	PVC	258	Class 150, DR 18
1994	Water main	200	PVC	200	Class 150, DR 18
1995	Water main	150	PVC	632	Class 150, DR 18

Table 3: Details of service connections

Connection #	Installation Year	Type	Diameter (mm)	Material	Length (m)
1	1993	Service connection	19	Copper	1
2	1993	Service connection	19	Copper	1
3	1993	Service connection	19	Copper	5
4	1993	Service connection	19	Copper	5
5	1993	Service connection	19	Copper	5
6	1993	Service connection	19	Copper	5
7	1993	Service connection	19	Copper	6
8	1993	Service connection	19	Copper	6
9	1993	Service connection	19	Copper	6
10	1993	Service connection	19	Copper	7
11	1993	Service connection	19	Copper	7
12	1993	Service connection	19	Copper	7
13	1993	Service connection	19	Copper	7
14	1993	Service connection	19	Copper	7
15	1993	Service connection	19	Copper	7
16	1993	Service connection	19	Copper	7
17	1993	Service connection	19	Copper	8
18	1993	Service connection	19	Copper	8
19	1993	Service connection	19	Copper	8
20	1993	Service connection	19	Copper	8
21	1993	Service connection	19	Copper	8
22	1993	Service connection	19	Copper	9
23	1993	Service connection	19	Copper	9

Connection #	Installation Year	Type	Diameter (mm)	Material	Length (m)
24	1993	Service connection	19	Copper	9
25	1993	Service connection	19	Copper	9
26	1993	Service connection	19	Copper	9
27	1993	Service connection	19	Copper	9
28	1993	Service connection	19	Copper	10
29	1993	Service connection	19	Copper	10
30	1993	Service connection	19	Copper	10
31	1993	Service connection	19	Copper	10
32	1993	Service connection	19	Copper	10
33	1993	Service connection	19	Copper	10
34	1993	Service connection	19	Copper	10
35	1993	Service connection	19	Copper	11
36	1993	Service connection	19	Copper	11
37	1993	Service connection	19	Copper	12
38	1993	Service connection	19	Copper	12
39	1993	Service connection	19	Copper	12
40	1993	Service connection	19	Copper	13
41	1993	Service connection	19	Copper	13
42	1993	Service connection	19	Copper	16
43	1993	Service connection	19	Copper	17
44	1993	Service connection	19	Copper	22
45	1993	Service connection	19	Copper	23
46	1993	Service connection	19	Copper	23
47	1993	Service connection	19	Copper	24
48	1993	Service connection	19	Copper	25
49	1993	Service connection	19	Copper	26
50	1993	Service connection	19	Copper	27
51	1993	Service connection	19	Copper	28
52	1993	Service connection	19	Copper	28
53	1993	Service connection	19	Copper	29
54	1993	Service connection	19	Copper	29
55	1993	Service connection	19	Copper	32
56	1993	Service connection	19	Copper	32
57	1993	Service connection	19	Copper	32
58	1993	Service connection	19	Copper	35
59	1993	Service connection	19	Copper	42
60	1993	Service connection	19	Copper	43
61	1993	Service connection	19	Copper	180
62	1994	Service connection	19	Copper	2
63	1994	Service connection	19	Copper	5
64	1994	Service connection	19	Copper	7
65	1994	Service connection	19	Copper	9
66	1994	Service connection	19	Copper	10
67	1995	Service connection	19	Copper	3
68	1995	Service connection	19	Copper	3
69	1995	Service connection	19	Copper	7
70	1995	Service connection	19	Copper	8
71	1995	Service connection	19	Copper	15
72	1995	Service connection	19	Copper	16
73	1995	Service connection	19	Copper	16

Connection #	Installation Year	Type	Diameter (mm)	Material	Length (m)
74	1995	Service connection	19	Copper	18
75	1995	Service connection	25	Copper	11
76	1995	Service connection	25	Copper	16
77	1995	Service connection	25	Copper	16
78	1995	Service connection	25	Copper	22
79	2006	Service connection	25	Copper	26
80	2020	Service connection	25	Copper	23
81	2022	Service connection	25	Copper	23

The pressurized water also flows into the existing 164 m^3 reinforced concrete reservoir (at an approximate elevation of 785 m). A relatively small submersible pump inside the existing reservoir supplies pressure for the 8 or 9 service connections on Mountain View Road (>786 m). There is one existing fire hydrant at the northern end of the 150 mm water main running along Fish Lake Road. This hydrant is used to flush the pipes in spring.

1.3 History

Most of the existing water supply pipe network, the well pump station, and the 164 m^3 reinforced concrete reservoir were constructed during 1993 and 1994. The water main and municipal connections on Mountain View Road (towards the west) were constructed after the year 2000. An additional well (FCW2/"new well") was drilled, developed, tested, and equipped during 2015. The water treatment plant, including the treated buffer tank, the vertical centrifugal pumps, and the 80 kW generator was installed in 2015.

1.4 Background Information

Several properties within the community of Faulder supplement their RDOS-supplied domestic water use with private wells to meet their needs for landscape watering and providing water for pets and animals kept for household use. There is a history of water availability concerns for the residents who rely on the Faulder Community Water System for domestic use and within the Faulder and Meadow Valley communities as a whole. Severe watering restrictions were in place in Faulder well before the RDOS drilled a deeper well (FCW2) on the bank of Trout Creek in 2015. In addition, the RDOS has received several new subdivision applications and is not confident that the aquifer can support additional demand. The RDOS, therefore, commissioned Associated Environmental Consultants to conduct hydrogeological studies to confirm the availability of groundwater with a particular focus on the Faulder Community Water System and the Meadow Valley area. Some of the findings from that report were to limit or prevent additional development that draws water out of the aquifer, to promote water conservation efforts, and to conduct a long-term pumping test on FCW2 while monitoring water levels in wells within Faulder to demonstrate that extraction from FCW2 has no/negligible impact on water levels in private wells. (Associated Environmental Consultants Inc., 2022)

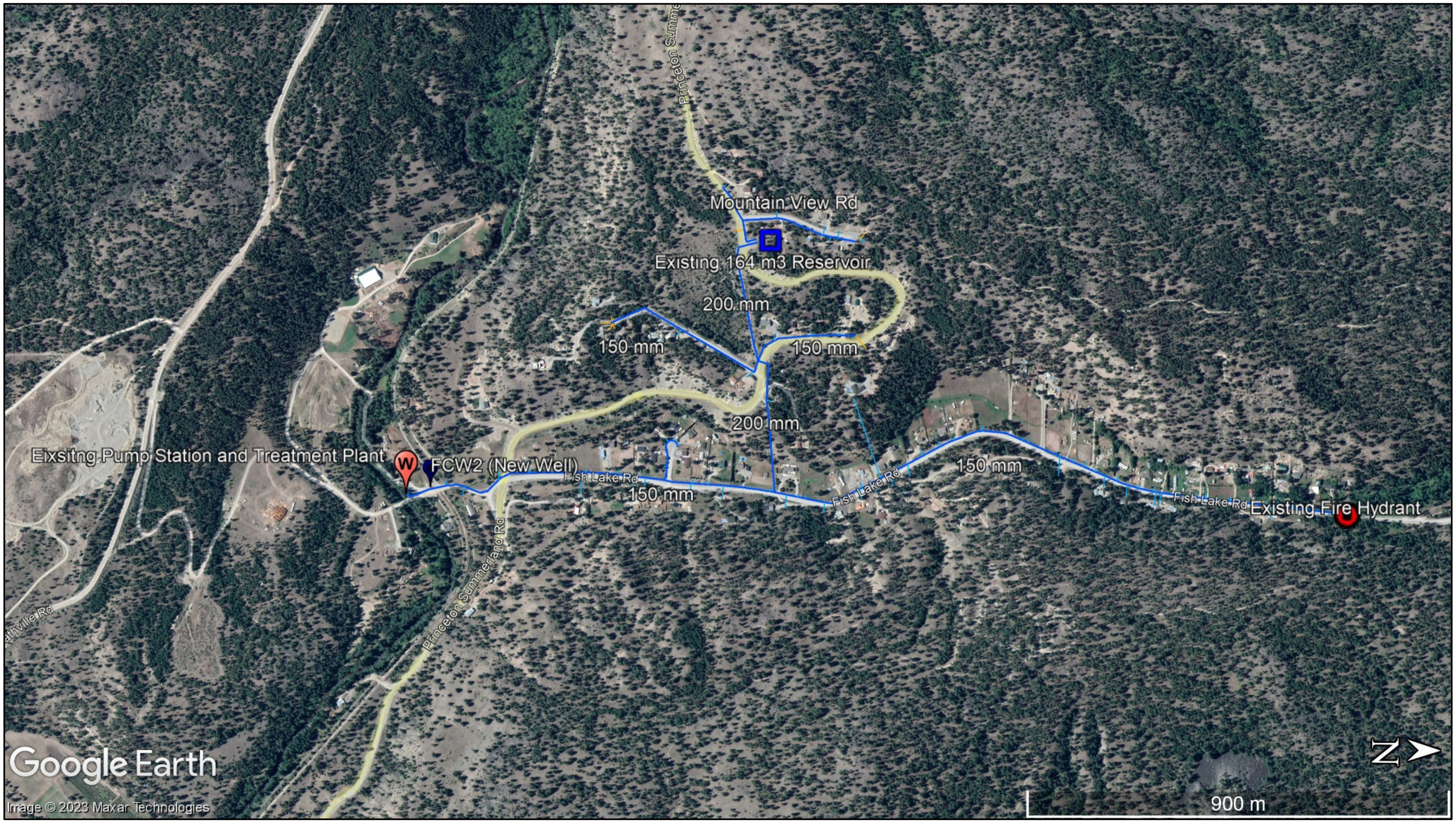


Figure 2: Layout of the existing water system

2. Scope of Work

The scope of work for this project as defined in the RDOS request for proposals (RFP) and our proposal dated February 2, 2023, includes the following tasks:

1. Stage I - Initiation, Data Collection and Site Assessment:
    1.1. Project start-up meeting,
    1.2. Collect and review background data, and
    1.3. Conduct a site assessment.
2. Stage II – As-built Survey, Base Drawing, Water Modelling
    2.1. Survey curb stops for service connections,
    2.2. Compile a base drawing,
    2.3. Hydraulic modeling in *EPANET,*
    2.4. Evaluate supply and distribution,
    2.5. Evaluate reservoir size,
    2.6. Evaluate pump size,
    2.7. Evaluate existing raw water quality and treatment train,
    2.8. Review Meadow Valley Aquifer Study,
    2.9. Obtain long-term pump testing quotations,
    2.10. Fire Underwriters Survey Calculation, Fire Protection & Hydrant Spacing,
    2.11. The lifespan of the water system,
    2.12. Climatic impact, and
    2.13. Produce a list of requirements and prioritize projects.
3. Stage III – Draft Report and Presentation of Findings
    3.1. Draft report,
    3.2. Capital project profiles,
    3.3. Capital project cost estimates (Class “D”),
    3.4. Review draft report, drawings, and cost estimates,
    3.5. Revise draft report,
    3.6. Revise cost estimates, and
    3.7. Present findings to the RDOS.
4. Stage IV – Deliverables:
    4.1. Final report, drawings, and cost estimates

4.2. Fossil fuel reporting.

3. Water System Design Criteria

To evaluate the water system, design criteria must be established for each system component. These criteria are then used to evaluate the capacity of the water system. The following section outlines the recommended design standards.

3.1 Source

The supply source (FCW1 and FCW2) must be capable of supplying the Maximum Day Demand of the community.

3.2 Water Demands

Water demands from the RDOS Subdivision Servicing Bylaw (Regional District of Okanagan-Similkameen, 2021) are as follows:

Maximum Daily Domestic Flow (MDD):	8,000 L/single family unit/day
Peak Hour Demand (PHD):	13,600 L/single family unit/day

An analysis of water demands and calculation of Maximum Day Demands are completed in Paragraph 4.2.

3.3 Water Treatment

The existing well was classified to be at “Low Risk” of containing pathogens. (Golder Associates, 2015) Groundwater sources that are considered at low risk of containing pathogens as a result of a GARP (groundwater at risk of containing pathogens) assessment do not require disinfection. (British Columbia, 2015). However, it is the industry norm to provide some form of water disinfection.

The concentrations of uranium from both wells are higher than the allowable concentrations presented in the Guidelines for Canadian Drinking Water Quality (GCDWQ). The measured concentration of uranium in the “new” well (FCW2) was 0.0252 mg/L and exceeded the GCDWQ maximum acceptable concentration (MAC) of 0.02 mg/L. The water treatment plant that was installed in 2015 reduces uranium levels by ion exchange to below acceptable limits (i.e. <0.02 mg/L).

3.4 Pumping Systems

Typical standards state supply pumps must be capable of meeting maximum day demands with the largest pump out of service and balancing storage online. If no balancing storage is available, pumps must meet peak hour demand with the largest pump out of service. Standby power must also be available.

3.5 Acceptable pressures

The pipe network must supply the MDD and fire flow or the peak hourly demand (PHD) at minimum residual pressures of 140 kPa (20 psi) and 265 kPa (40 psi) respectively. The maximum pressure may not exceed 620 kPa (90 psi) at static conditions.

Flow velocities should be kept to less than 2.0 meters per second except for fire protection. Velocities for fire protection should be less than 4.0 meters per second. Mains should be looped wherever possible.

3.6 Reservoir Capacity

The industry norm is to calculate the reservoir volume as follows:

$$Total\ Storage\ Volume = A + B + C$$

Where A = Fire storage (as determined by the Fire Underwriters Survey Guidelines [FUS])

B = Equalization Storage (25% of the Maximum Day Demand [MDD])

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

3.7 Fire Flows/Storage

RDOS Subdivision Servicing Bylaw No. 2000 – “Schedule A” states that the fire flow shall be in accordance with “Water Supply for Public Fire Protection – A Guide to Recommended Practice” as published by Fire Underwriter’s Survey, but with minimum flow rates for Low-Density Residential and Medium-Density Residential of 60 L/s and 150 L/s respectively.

4. Population and Demands

Population data and water demands are used to evaluate the water supply system capacities. The following sections outline existing populations, projected growth within the community, and an analysis of water demands.

4.1 Populations

There is no specific population data available for Faulder from Census Canada. However, there are 81 lots currently connected to the system. There are 8 lots in the upper zone (Mountain View Road) and 73 in the lower zone. Previous studies indicated a total of 81 lots and a population of 215 people. (Associated Environmental Consultants Inc., 2022) This gives an average of 2.65 people per lot, which seems reasonable. The annual population growth rate for Summerland, which is situated 7km towards the east of Faulder is given as 0.59% per year.

4.2 Water Demand

Using the number of connections and the RDOS subdivision bylaw standards, the MDD for the residential use would be 648 m^3/day (8,000 x 81 / 1,000). We undertook a review of the flow records provided by the RDOS for the year 2022 and it was found that:

- The **average daily demand** was 43.1 m^3/day or an average demand of 172 L/person/day.
- The **day with the maximum demand** occurred on July 20, 2022, when the daily reading was 425 m^3. (5,247 L/household/day). This generally corresponds well with the theoretical MDD of 648 m^3/day (8,000 L/household/day).
- The **day with the lowest demand** occurred on December 28, 2022, when a volume of 24 m^3/day was measured (296 L/household/day).

The theoretical MDD of 8,000 L/day is 0.0926 L/s per lot/household.

The future MDD was estimated for the year 2033 and is presented in Table 4 below:

Table 4: Estimated MDD in 2033

Description	Number	Units
Lots in 2023	81	Lots
Annual growth rate	0.59%	per year
Growth factor for ten years	1.06	-
Estimated number of Lots 2033	86	Lots
Theoretical MDD (2033)	687,263	L/day
Theoretical MDD (2033)	**687**	**m^3**

5. Project Execution

5.1 Stage 1

5.1.1 Kick-off meeting

The project kick-off meeting was held on March 1, 2023. Some of the problems experienced by the operating staff were as follows:

- Reportedly, some of the pipes in the "Common Property Road" were installed too shallow due to bedrock and tend to freeze in the winter.
- Some of the single strap saddles (installed where service connections tie into the water mains) were starting to fail and had to be replaced. These are replaced with more robust double-strap saddles.
- The 8" (200 mm) gate valve in Fish Lake Road at the Tee to the reservoir was seized/stuck in the open position. Another 6" gate valve near the existing fire hydrant at the northern end of Fish Lake Road was also stuck in the open position.

5.1.2 Site Assessment

A site assessment was conducted on March 15, 2023. The existing infrastructure was found to generally be in very good to excellent condition. The existing well pump station and water treatment plant were briefly inspected. Water is mostly supplied from the "new well" (FCW2), but can also be pumped from the old well, situated directly adjacent to the existing well pump house. A backup pump unit was stored in the pump house should problems be experienced with the installed pump. Visible civil infrastructure, and mechanical & electrical components seemed to be in very good condition. There is an 80 kW backup generator available for power outages at the location of the well pump station and WTP.

The existing reservoir and booster pump station were also viewed. The existing booster pump that supplies water to the lots at higher elevations along Mountain View Road is a submersible pump that is installed inside the existing reservoir. A backup pump unit is stored in the pump room. There is a relatively small backup generator at the reservoir which can supply the submersible pump during a power outage.

Limitations of the site inspection:

- No physical tests, such as pressure tests, closed circuit television (CCTV) camera inspections, or concrete scanning were performed.
- The reservoir was not inspected internally.
- No pumping tests or chemical analyses were performed. However, the pump flow rate displayed by the existing magnetic flow meter was noted.

5.2 Stage 2

5.2.1 Surveys and Base Mapping

Ecora received the shapefiles of the existing system and created a base plan in March 2023. LiDAR data for the area was obtained from the LidarBC provincial website. (Province of British Columbia, 2018) Curb stops were surveyed by Ecora in June 2023.

5.2.2 Hydraulic Modeling

Hydraulic modeling was completed for the Faulder Water Network. The full report is attached as Appendix C. Water is pumped directly into the pipe network from the water treatment plant (there is no dedicated force main). It was found that the network consists of two pressure zones, the Lower Faulder area from the well up to the existing reservoir and the “Upper Faulder”/Mountain View Road area supplied by a submersible pump installed inside the existing reservoir. The “Upper Faulder”/Mountain View Rd. zone might have sufficient flow and pressure for a household sprinkler fire protection system for a house with a floor area of 100 m^2 (1000 ft^2), but cannot supply flows to fire hydrants, which require much higher flows. The “Upper Faulder”/Mountain View Road zone will require a fire pump or an additional reservoir at higher elevations to supply hydrants with sufficient flow rates. There is sufficient capacity in the Lower Faulder pressure zone to supply individual fire hydrants with fire flows while the Maximum Day Demand is simultaneously being supplied by the system. However, the maximum flows available to hydrants are around 60 L/s and not as high as 100 L/s, as required by the Fire Underwriters Survey standards. Candidate locations for future hydrants were proposed for the pipe network.

The static pressures in the Lower Faulder zone were found to be relatively high and consistently higher than the maximum pressure prescribed in the RDOS bylaws (of 865 kPa or 620 kPa without and with individual pressure-reducing valves) in Kettle Place Rd. and Fish Lake Rd. However, all the static pressures were still below 1,080 kPa (10 Bar), which is within the industry norms for municipal water systems.

5.2.3 Evaluate supply

FCW2 was tested up to 10.1 L/s and additional long-term well pump tests and aquifer level monitoring are required to determine whether the well can support higher demands in the future. (Associated Environmental Consultants Inc., 2022) The current capacity of FCW2 therefore is 872.6 m^3/day, which is 34% (224.6m^3/day) more than the theoretical MDD of 648 m^3/day and 105% (447.6m^3/day) more than the actual maximum day supplied to consumers in 2022.

5.2.4 Reservoir size

The calculation of the required storage capacity and the shortfall is presented in Table 4 below.

Description	Volume (m^3)
A = Fire Storage (60L/s for 1.4 hr)	302
B = Equalization Storage (25% of the Maximum Day Demand [MDD] in the year 2033)	172
C = Emergency Storage (25% of [A + B])	119
Total Storage Volume (required)=A+B+C	**593**
Size of Existing Reservoir	164
Shortfall in Storage Capacity (2033)	**429**

The water system currently does not have sufficient storage capacity for firefighting. The calculation above was based on minimum fire flows of 60 L/s for low-density residential areas, which is lower than the fire flows determined using the FUS standard.

5.2.5 Pump size

The pumps installed on the water system are presented in Table 5 below:

Table 5: Existing pumps of the water system

Pump Number	Location	Pump Model	Duty Point	kW (hp) Rating
Well Pump #2	FCW1 (Old Well)	Meyers Model 66C40225, 13-stage	13.9 L/s @ 166.1 m TDH (220 GPM @ 545 ft TDH)	30 kW (40 hp)
Well Pump #1	FCW2 (New Well)	Goulds Model No. 160L20 (1 installed and 1 uninstalled on site)	10.1 L/s @ 121.9 m TDH (160 GPM @ 400 ft TDH)	19 kW (25 hp)
Distribution Pumps #1 and #2	High Lift Pumps from WTP to Reservoir	Grundfos CR 32-5 (1 duty and 1 standby. Both installed)	9.9 L/s @ 109.1 m TDH (157 GPM @ 358 ft TDH)	15 kW (20 hp)
Booster Station	Submersible pump in reservoir to Mountain View Rd.	Motor: • Model –Franklin SubDrive30 N3R / 3-Phase: 1.0 – 3.0 hp / 3-Wire: ½ - 2.0hp Pump Wet End: • Model – Franklin 45JS15S4-PE / 45 GPM / 6 STG / Stainless / 1.5 HP	2.83 L/s @ 42 m TDH (44.8 GPM @ 137.8 ft TDH)	1.1 kW (1.5 hp)

All the above pump models (except Well Pump #2) and pipe systems were modeled in EPANET. It was found that the new well pump might be slightly oversized, but that the flow rate and pressure could be reduced with the installed variable frequency drives (VFDs). From the existing SCADA system, it was found that Well Pump #1 and the duty Distribution Pump #1 or #2 are currently set on the VFDs to run at approximately 7.5 L/s. From the hydraulic model, it was found that one distribution pump may deliver approximately 9.6 L/s to the existing reservoir when there is zero demand in the distribution network and the VFD is set to 100%/normal speed. The water treatment plant was designed to deliver 9.5 L/s (150 GPM). The maximum production of the water system is currently limited to 820 m^3/day by the WTP.

It was found that the booster pump inside the existing reservoir could never supply a fire hydrant in Mountain View Road with water, because the maximum flow that this 1.5 hp pump could supply would be in the order of 4 L/s, which is too low for fire hydrants. However, this relatively small pump could probably supply a fire sprinkler system for a medium-sized (100 m^2/1,000 ft^2) house with sufficient flow. This is based on a flow rate of 0.8 L/s/sprinkler and coverage of 25 m^2/sprinkler.

5.2.6 Supervisory Control and Data Acquisition (SCADA)

The following units are installed at the Well Pump Station/Uranium Treatment System (UTS):

- (1) Modicon M340 programmable logic controller (PLC) located at the Well Pump Station/UTS. This PLC controls the well pumps and the high-lift distribution pumps.
- Magnetic flow meters monitoring the following:
  - One (1) in the Well Pump Station reading the flow of the well that is online. This mag meter is used for reporting usage with regard to the Faulder well license.
  - Three (3) in the UTS reading the Treated flow, Raw Bypass flow, and UTS Discharge flow.
- Distribution system pressure monitoring.
- Well level monitoring.
- A human-machine interface (HMI) is located within the Pump Station.

An Ethernet radio link is used to communicate between the Well Pump Station/UTS and the Booster Station/Reservoir.

Booster Station/Reservoir:

- Modicon M340 PLC located at the Booster Station.

A Telus fiber connection at the Booster Station/Resevoir provides the primary connection to an internet service provider that is used to communicate to the SCADA server at the Naramata Water Treatment Plant (WTP). An LTE Gateway connected to a mobile network provides a secondary connection at this site. The visual tag (VT) SCADA system displays all monitored points graphically and provides trending of all data points.

All process alarms for the Faulder water system are generated from the Naramata VT SCADA server and dialed out from the Naramata WTP.

5.2.7 Raw Water Quality and Treatment

Uranium is the only constituent of concern found in the well water thus far. The concentrations measured in the raw water (0.0212 mg/L) are slightly above the Guidelines for Canadian Drinking Water Quality standards (0.0200 mg/L). This is reduced by ion exchange to within the acceptable limits by the existing water treatment plant (typically treated quality ranges between 0.0140 mg/L and 0.0160 mg/L).

The raw water is classified as “moderately hard”. It is unknown whether the ion exchange impacts the hardness. The hardness impacts the aesthetic quality of the water but does not pose any health risks to the community. Excessive hardness of water can give rise to scaling in plumbing and household heating appliances and hence has adverse economic implications. It also poses a nuisance to personal hygiene and cleaning. However, excessive softness may lead to aggressive and corrosive water qualities.

Stasoft software was used to calculate the calcium carbonate precipitation potential. It was found that the water is slightly scale-forming and has a calcium carbonate precipitation potential of approximately 12 mg/L (parts per million [ppm]). This is relatively high because values of between 0 and 4 ppm are considered ideal. However, this is not a major concern and means that corrosion will be inhibited by the formation of a relatively thin layer of limestone ($CaCO_3$) scale inside the piping and plumbing.

The addition of chlorine dosing and UV disinfection, although not currently required in terms of regulations or standards, are recommended to ensure water is suitable for human consumption. It is the current industry norm to provide disinfection for all water utilities, including small systems. It is recommended that UV disinfection be added to the existing water treatment plant. UV disinfection is much more effective against protozoan oocysts such as *Cryptosporidium* and *Giardia* than chlorine. Chlorination is also suggested because chlorine residuals in the water provide protection against accidental re-contamination in the distribution network.

5.2.8 FUS calculation

A Fire Underwriters Survey calculation was performed, and the report is attached as Appendix B. The required fire flow and fire storage volume for the buildings in Faulder is 100 L/s and 720 m^3 respectively. However, the current pipe network mostly consists of 150 mm (6”) pipes, which cannot supply a flow rate of 100 L/s. It was found through hydraulic modeling that 60 L/s is available in most areas for fire hydrants. This is the minimum fire flow prescribed by the RDOS for low-density residential zones.

5.2.9 Life expectancies of water system components

The prescribed service lifespans of water supply components as published by British Columbia for Certificates of Public Convenience and Necessity (CPCN) are presented in Table 6 below:

Table 6: Life expectancies for water infrastructure components

(British Columbia, 2016)

Numbering		Component	Prescribed Service Life (Years)
A		**Source of Supply Plant**	
	304	***Structures and Improvements***	
	304.1	Wood Frame	30
	304.2	Steel	40
	304.3	Cement Block	40
	304.4	Reinforced Concrete or Brick	50
	304.5	Miscellaneous	25
	305	***Collecting and Impounding Reservoirs***	
	305.1	Wood Structures	35
	305.2	Earth Fill Structures	60
	305.3	Concrete Structures	75
	306	***Lake, River, and Other Intakes***	
	306.1	Wood Structures	35
	306.2	Concrete Structures	60
	307	***Wells and Springs***	40
	309	***Supply Mains***	
	309.1	PVC AWWA C900	75
	309.2	HDPE AWWA C906	75
	309.3	Ductile/Cast Iron	60
	309.4	Steel, Cement Lined	50
	309.5	Concrete	50

Numbering		Component	Prescribed Service Life (Years)
	309.6	Sub-Marine Mains	20
	339	**Other Misc. Water Source Plant**	25
B		**Pumping Plant**	
	304	***Structures and Improvements***	
	304.1	Wood Frame	30
	304.2	Steel	40
	304.3	Cement Block	40
	304.4	Reinforced Concrete or Brick	50
	304.5	Miscellaneous	25
	310	***Power Generation Equipment***	25
	311	***Pumping Equipment***	
	311.1	Electric Pumping Equipment	25
	311.2	Diesel Pumping Equipment	25
	311.3	Other Pumping Equipment	25
	339	**Other Miscellaneous Pumping Plant**	25
C		**Water Treatment Plant**	
	304	***Structures and Improvements***	
	304.1	Wood Frame	30
	304.2	Steel	40
	304.3	Cement Block	40
	304.4	Reinforced Concrete or Brick	50
	304.5	Miscellaneous	25
	320	***Treatment Equipment***	
	320.1	Sand & Other Media Filtration Equipment	30
	320.2	Membrane Filtration Equipment	15
	320.3	Chlorination	15
	320.4	Other Water Treatment Equipment	20
	339	**Other Miscellaneous Treatment Plant**	25
D		**Transm. and Distribution Plant**	
	304	***Structures and Improvements***	
	304.1	Wood Frame	30
	304.2	Steel	40
	304.3	Cement Block	40
	304.4	Reinforced Concrete or Brick	50
	304.5	Miscellaneous	25
	330	***Distribution Reservoirs***	
	330.1	Concrete (underground)	60
	330.2	Steel (above ground)	50
D		**Transm. and Distr. Plant (cont)**	
	331	***Transmission and Distribution Mains***	
	331.1	PVC AWWA C900	75
	331.2	HDPE AWWA C906	75
	331.3	Ductile/Cast Iron	60
	331.4	Steel, Cement Lined	50
	331.5	Concrete	50

(British Columbia, 2016)

Numbering		Component	Prescribed Service Life (Years)
	331.6	Sub-Marine Mains	20
	333	***Services***	50
	334	***Meters and Meter Installations***	25
	335	***Hydrants / Standpipes***	50
	339	***Other Transm. and Distribution Plant***	25
E		**General Plant**	
	304	***Structures and Improvements***	
	304.1	Wood Frame	30
	304.2	Steel	40
	304.3	Cement Block	40
	304.4	Reinforced Concrete or Brick	50
	304.5	Miscellaneous	25
	340	***Office Furniture and Equipment***	20
	349	***Computer Equipment***	5
	341	***Transportation Equipment***	7
	342	***Stores Equipment***	20
	343	***Tools, Shop and Garage Equipment***	15
	344	***Laboratory Equipment***	15
	345	***Power Operated Equipment***	15
	346	***Communication Equipment***	10
	346.1	Communication Equipment - SCADA	10
	346.2	Other Communication Equipment	10
	347	***Miscellaneous Equipment***	20
F		**Other Tangible Plant**	
	348	***Other Tangible Plant***[5]	50
G		**Intangible Plant**	
	301	***Organization***	100
	302	***Franchises and Consents***	100

(British Columbia, 2016)

5.2.10 Climate change

Some of the possible effects of climate change are discussed in the following paragraphs. Increased frequency and intensity of extreme weather events: Climate change contributes to more frequent and intense extreme weather events, such as hurricanes, storms, floods, and heat waves. These events can damage or destroy infrastructure, including buildings, roads, power lines, and water supply systems. Heavy rainfall can cause landslides, mudslides, and soil erosion, further impacting infrastructure stability.

Changes in precipitation patterns: Climate change can disrupt rainfall patterns, leading to droughts in some areas and heavy precipitation in others. Extended droughts can affect water supply systems, agricultural activities, and hydropower generation. On the other hand, heavy rainfall can result in flash floods, damaging infrastructure and disrupting transportation networks.

Increased temperature and heatwaves: Rising temperatures and heatwaves can adversely affect civil infrastructure. High temperatures can cause thermal expansion of materials, leading to infrastructure damage like buckling of roads and railways. Heatwaves can strain energy grids as demand for cooling increases, leading to power outages, and affecting infrastructure reliant on continuous energy supply. High temperatures can damage mechanical and electronic equipment.

5.2.10.1 Fire fighting

The frequency and severity of wildfires are expected to increase in the Okanagan and across British Columbia in general. Interface wildfires can threaten homes, businesses, and municipal infrastructure and it is, therefore, recommended to follow best practices for design and to construct water systems with fire protection in mind. However, it should be noted that the original design for the Faulder Water System did not consider fire flows and fire protection. If the RDOS were to consider establishing a fire protection service within the community of Faulder, including a local or contracted fire department the following conditions need to be met:

- The existing reservoir (164 m^3) was not designed to provide firefighting storage capacity. The construction of an additional reservoir with a storage capacity of at least 429 m^3 would be required for Faulder if a fire service were to be introduced.
- The installation of 12 new fire hydrants, complying with spacing requirements as per the RDOS bylaw, is suggested if a fire service is introduced in the future.
- It is suggested that a fire truck filling point with a turnaround be constructed at the existing fire hydrant on Fish Lake Road in the future. A turning radius of 12.2 m is proposed to facilitate the filling of fire trucks. A sketch of the proposed fire truck turnaround is presented in Appendix D.
- The installation of a diesel-driven fire pump station is not suggested for Mountain View Road. The existing booster pump is grossly undersized for hydrant flow rates. However, a fire pump installation is extremely expensive to supply, install, and maintain. The supply, installation, and construction costs are estimated to be approximately $500k, which is excessive. It is recommended that all houses on Mountain View Road be provided with sprinkler systems for fire protection.

Wildfire Urban Interface maps indicate that Faulder is surrounded by “Extreme” and “High” risk areas. (See Figure below.) The Risk Class designation for Faulder is 1, which is the highest designation. (British Columbia, 2023) The fire protection needs of the Faulder community should be considered for future service alterations.

5.2.10.2 Flooding

There are currently no flood lines/flooding zones for Trout Creek and it is, therefore, unknown what the risk of flooding is to the existing WTP and the well pump station. It is suggested that a separate study be conducted to determine the flooded zones for different recurrence intervals around the existing water supply infrastructure.

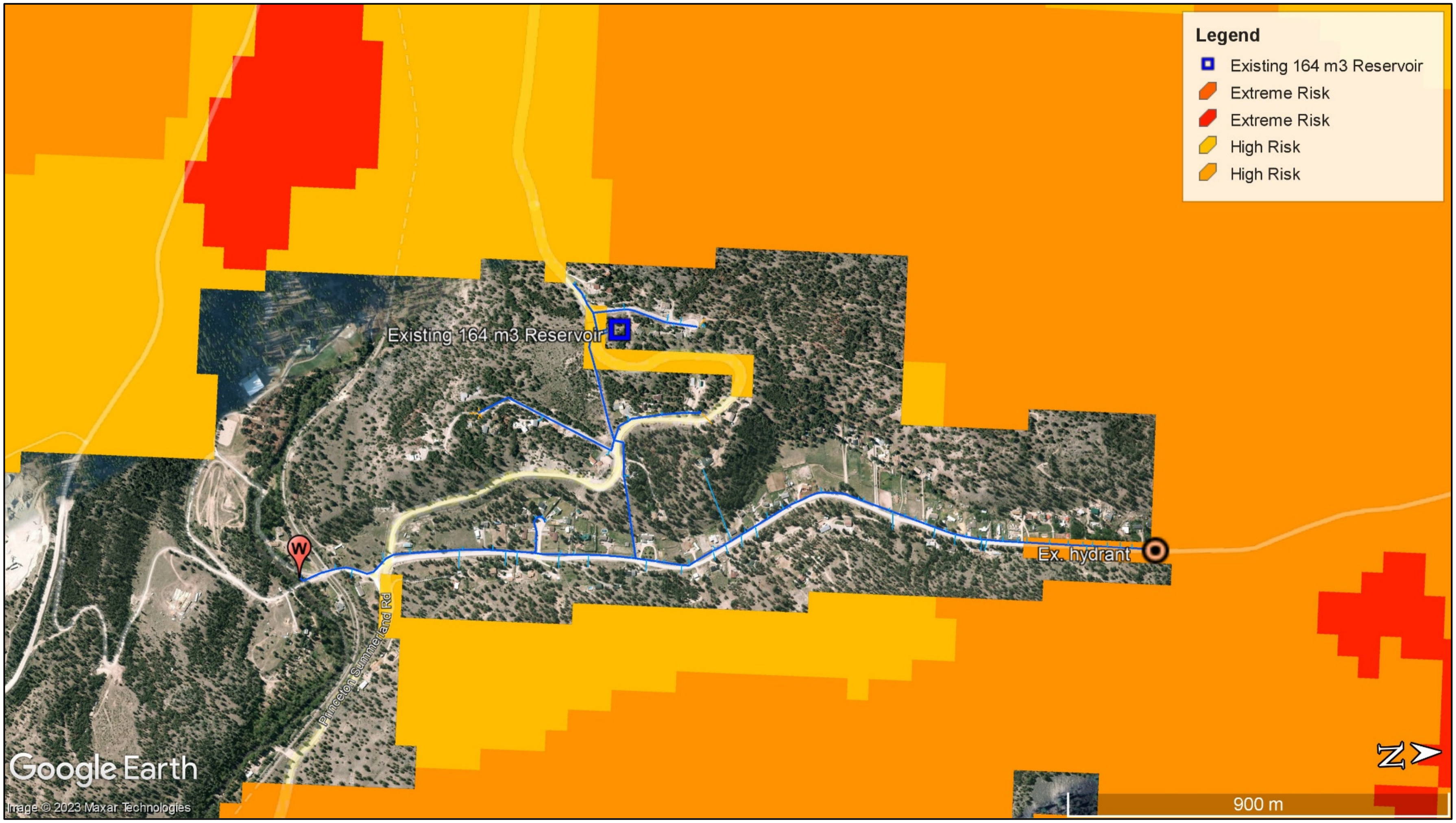


Figure 3: Wildland urban interface risk class map for Faulder

5.3 Stage III

5.3.1 Capital Project Profiles

When prioritizing water system upgrade projects, several criteria are commonly considered to ensure that resources are allocated efficiently and effectively. These criteria may vary depending on the specific circumstances and goals of the water system, but here are some common factors:

1) Health and Safety: Projects that address immediate health and safety concerns are often given high priority. This includes projects that address water quality issues, remove contaminants, or upgrade systems to meet regulatory standards.

2) Infrastructure Condition: The overall condition of the water system infrastructure is an important consideration. Projects that address aging or deteriorating infrastructure, such as pipes, pumps, and treatment plants, may be prioritized to prevent failures and improve system reliability.

3) System Capacity: If the existing water system is approaching or exceeding its capacity, projects that enhance system capacity, such as expanding treatment facilities or increasing storage capacity, may be prioritized to meet growing demand and avoid service disruptions.

4) Vulnerability and Resilience: Projects that improve the resilience of the water system to natural disasters, climate change impacts, or other emergencies may be prioritized. This can include measures like backup power systems, improved water source protection, or flood mitigation strategies.

5) Cost-Benefit Analysis: Analyzing the cost-effectiveness and benefits of different projects is crucial. Projects with a high benefit-to-cost ratio, which provide significant improvements relative to their cost, may receive higher priority.

6) Stakeholder Input: Input from various stakeholders, such as water utility managers, local government officials, community members, and relevant experts, can help prioritize projects. Their insights on system needs, community priorities, and local constraints can influence decision-making.

7) Regulatory Requirements: Projects required to meet regulatory obligations or to address compliance issues may be prioritized to avoid penalties or legal consequences.

8) Long-Term Planning: Projects aligned with long-term planning objectives, such as sustainability goals, water conservation initiatives, or integrated water resource management strategies, may be given priority to ensure a more sustainable and future-proofed water system.

The prioritized projects proposed for the Faulder Water System, together with the proposed timeframes for implementation are listed in Table 7 below:

Table 7: Proposed Capital Projects, their urgency, and factors influencing the proposed timeframes.

Priority (From urgent to less urgent)	Description	Urgency	Factors Influencing Project Priority	Proposed Timeframe
1	Replacing a 6" and an 8" seized gate valves on Fish Lake Road	Immediate (currently not functional)	2) Infrastructure condition	Complete in 6 months
2	Installing insulation over pipes that are freezing in "Common Property Road"	Immediate (currently not functional)	2) Infrastructure condition	Complete in 6 months
3	Long Term Pumping tests on Well #FCW2 ("new well") to determine yield/capacity for possible expansion	Short Term	3) System capacity 8) Long-term planning	Complete within 2 years
4	Flood line/flood zone determination along Trout Creek	Short Term	4) Vulnerability and Resilience	Complete within 2 years
5.1	Preliminary designs for a new reservoir	Short Term	1) Health and safety 4) Vulnerability and resilience	Complete within 2 years
5.2	430 m^3 to 800 m^3 Additional Reservoir Storage Capacity	Short to Medium Term	1) Health and safety 4) Vulnerability and resilience	Complete in 8 years
6	UV and Chlorine Disinfection Systems	Short Term	1) Health and safety	Complete within 2 years
7	Fire truck filling turnaround area on Fish Lake Rd.	Short Term	1) Health and safety 4) Vulnerability and resilience	Complete in 5 years
8	12 new fire hydrants	Short Term	1) Health and safety 2) 4) Vulnerability and resilience	Complete in 8 years

5.3.2 Capital Project Cost Estimates

The estimated costs of listed capital projects are presented in Table 8 below. Detailed breakdowns of cost estimates are attached in Appendix E.

Table 8: Capital project cost estimates

Number	Description	Proposed Timeframe	Estimated Construction Cost (Including 20% Contingency)	Estimated Engineering Fee	Assumed Inflation per Year	Escalation	Total Cost
1	Replacing 6" and 8" seized gate valves on Fish Lake Road	Complete in 6 months	$ 30,000.00	$ 4,000.00	2.2%	$ -	$ 34,000.00
2	Installing insulation over pipes that are freezing in "Common Property Ro	Complete in 6 months	$ 53,000.00	$ 7,000.00	2.2%	$ 1,000.00	$ 61,000.00
3	Long Term Pumping tests on Well #FCW2 ("new well") to determine yiel	Complete in 2 years	$ 144,000.00	$ 60,000.00	2.2%	$ 9,000.00	$ 213,000.00
4	Flood line/flood zone determination along Trout Creek	Complete in 2 years	$ -	$ 150,000.00	2.2%	$ 7,000.00	$ 157,000.00
5.1	Preliminary designs for a new reservoir	Complete in 2 years	$ -	$ 100,000.00	2.2%	$ 4,000.00	$ 104,000.00
5.2	430 m^3 to 800 m^3 Additional Reservoir Storage Capacity	Complete in 8 years	$ 1,036,000.00	$ 173,000.00	2.2%	$ 230,000.00	$ 1,439,000.00
6	UV and Chlorine Disinfection Systems	Complete in 2 years	$ 88,000.00	$ 11,000.00	2.2%	$ 4,000.00	$ 103,000.00
7	Fire truck filling turnaround area on Fish Lake Rd.	Complete in 5 years	$ 54,000.00	$ 7,000.00	2.2%	$ 7,000.00	$ 68,000.00
8	12 new fire hydrants	Complete in 8 years	$ 187,000.00	$ 23,000.00	2.2%	$ 40,000.00	$ 250,000.00
		Total	**$ 1,592,000.00**	**$ 535,000.00**		**$ 302,000.00**	**$ 2,429,000.00**

5.4 Replacement Cost of Infrastructure

A summary of the estimated replacement cost of the existing Faulder Water System is presented in Table 9 below:

Table 9: Estimated replacement cost of existing infrastructure

Description	Replacement Value (2023)	Weighted Lifespan (Years)	Estimate of Remaining Life (Years)	Assumed Inflation per Year	Estimated Cost at Replacement Time (In Year 2055	Annual Budgeting for Replacement	Annual Budget for Replacement Per Lot
Pipe network, valves, bends, thrust blocks (3.8 km linear)	$ 1,684,000.00	61	33	2.2%	$ 3,483,000.00	$ 104,000.00	$ 1,280.00
Existing Reinforced Concrete Reservoir (164m3) and booster pump station (3.5L/s)	$ 733,000.00	47	24	2.2%	$ 1,234,000.00	$ 52,000.00	$ 640.00
Well Pumphouse	$ 1,242,000.00	34	18	2.2%	$ 1,822,000.00	$ 103,000.00	$ 1,270.00
Uranium Water Treatment Plant	$ 682,000.00	30	22	2.2%	$ 1,112,000.00	$ 49,000.00	$ 600.00
TOTALS	**$ 4,341,000.00**				**$ 7,651,000.00**	**$ 308,000.00**	**$ 3,790.00**

5.5 Operation and Maintenance

The estimated operation and maintenance costs are presented in Table 10 below:

Table 10: Estimated annual O&M costs

Description	Unit	Quantity	Unit Price	Cost	Total Lifespan (Years)	Cost Per Year
Re-filling two resin vessels every 3 years	LS	1	$10,000.00	$ 10,000.00	3	$ 3,000.00
Disposing two resin vessels	LS	1	$8,000.00	$ 8,000.00	3	$ 3,000.00
Energy Consumption	kWhrs	18366	$0.20	$ 4,000.00	1	$ 4,000.00
Flushing hydrants (Once per year)	LS	1	$500.00	$ 500.00	1	$ 500.00
Servicing of generators	LS	1	$1,000.00	$ 1,000.00	1	$ 1,000.00
Running generators	hr	200	$2.00	$ 400.00	1	$ 400.00
Salary of O&M Operator (Spending a third of their time on Faulder)	%	33.33%	$50,000.00	$ 16,666.65	1	$ 17,000.00
						$ 28,900.00

6. Conclusion

This capital plan presents an approach to addressing the critical needs of Faulder's water infrastructure. By analyzing the current condition of the system, identifying key challenges, and outlining actionable solutions, this plan lays the foundation for a sustainable supply to this community.

The main objective is to plan for infrastructure renewal and expansion to ensure the delivery of safe, reliable, and high-quality water to all residents.

A few projects were proposed to help the community face the impacts of climate change.

Different funding mechanisms, partnerships, and cost-sharing arrangements must be explored to ensure the implementation of the proposed projects. Ongoing monitoring and evaluation will be required so that plans can be adapted, progress can be tracked, and emerging challenges can be addressed.

This Water System Capital Plan will contribute to the welfare of the Faulder community in the future.

7. References

Associated Environmental Consultants Inc. (2022). *Meadow Valley Aquifer Study: Review of Conceptual Model of Groundwater Flow and Groundwater Availability.* Vernon: Associated Environmental Consultants Inc.

British Columbia. (2015, November). Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia. British Columbia, Canada: British Columbia. Retrieved from https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/documents/ground_water_treatment_objectives_nov2015.pdf

British Columbia. (2016, May 7). CPCN Schedule of Depreciation Rates for Water Systems. *CPCN Schedule of Depreciation Rates for Water Systems*. British Columbia, Canada. Retrieved from https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-licensing-rights/private-water-utilities/water-utilities-application-process

British Columbia. (2023, April 29). Wildland urban interface risk class maps. *Wildland urban interface risk class maps*. British Columbia, Canada: British Columbia. Retrieved from https://www2.gov.bc.ca/gov/content/safety/wildfire-status/prevention/fire-fuel-management/wui-risk-class-maps

Golder Associates. (2015). *Drilling, Construction and Testing of New Potable Water Supply Well: Faulder Well 2 - 133 Kettle Place, Faulder, BC.* Golder Associates.

Province of British Columbia. (2018). Open LiDAR Data Portal: Canadian Geodetic Vertical Datum of 2013. Retrieved from https://governmentofbc.maps.arcgis.com/apps/MapSeries/index.html?appid=d06b37979b0c4709b7fcf2a1ed458e03

Regional District of Okanagan-Similkameen. (2021, January 21). Subdivision Servicing Bylaw No. 2000, 2002: Schedule "A". Penticton, BC, Canada.

Appendix A

Engineering Layout

LEGEND

- HYDRANT
- BLOWOFF VALVE
- CURBSTOP
- WATER WELL
- GATE VALVE
- WATER SERVICE
- WATER MAIN

NO.	DATE (YY/MM/DD)	DRN	REVISION	CH'KD
B	23/08/24	RT	RE-ISSUED FOR REVIEW	SB
A	23/07/26	RT	ISSUED FOR REVIEW	SB

#201-284 MAIN STREET, PENTICTON, BC, V2A 5B2
PHONE: 250-492-2227
www.ecora.ca

PERMIT TO PRACTICE

SEAL

DESIGN: RT
DRAWN: RT
CHECKED: SB
DATE: 2023/07/19
SCALE: 1:2500

RDOS

FAULDER WATER SYSTEM CAPITAL PLAN
RDOS
WATER NETWORK OVERVIEW

Drawing No. 230015-C2.0

Rev.No B

LEGEND
- HYDRANT
- BLOWOFF VALVE
- CURBSTOP
- WATER WELL
- GATE VALVE
- WATER SERVICE
- WATER MAIN

NO.	DATE (YY/MM/DD)	DRN	REVISION	CH'KD
B	23/08/24	RT	RE-ISSUED FOR REVIEW	SB
A	23/07/26	RT	ISSUED FOR REVIEW	SB

ecora™
#201-284 MAIN STREET, PENTICTON, BC, V2A 5B2
PHONE: 250-492-2227
www.ecora.ca

PERMIT TO PRACTICE

SEAL

DESIGN: RT
DRAWN: RT
CHECKED: SB
DATE: 2023/07/19
SCALE: 1:500

RDOS
FAULDER WATER SYSTEM CAPITAL PLAN
RDOS
WATER NETWORK LAYOUT - SHEET 1

RDOS OKANAGAN-SIMILKAMEEN

Drawing No. 230015-C2.1

Rev.No B

LEGEND

- HYDRANT
- BLOWOFF VALVE
- CURBSTOP
- WATER WELL
- GATE VALVE
- WATER SERVICE
- WATER MAIN

NO.	DATE (YY/MM/DD)	DRN	REVISION	CH'KD
B	23/08/24	RT	RE-ISSUED FOR REVIEW	SB
A	23/07/26	RT	ISSUED FOR REVIEW	SB

ecora™
#201-284 MAIN STREET, PENTICTON, BC, V2A 5B2
PHONE: 250-492-2227
www.ecora.ca

PERMIT TO PRACTICE

SEAL

DESIGN: RT
DRAWN: RT
CHECKED: SB
DATE: 2023/07/19
SCALE: 1:500

RDOS

FAULDER WATER SYSTEM CAPITAL PLAN
RDOS
WATER NETWORK LAYOUT - SHEET 2

Drawing No. 230015-C2.2

Rev.No B

LEGEND

HYDRANT	
BLOWOFF VALVE	BO
CURBSTOP	
WATER WELL	W
GATE VALVE	
WATER SERVICE	
WATER MAIN	

NO.	DATE (YY/MM/DD)	DRN	REVISION	CH'KD
B	23/08/24	RT	RE-ISSUED FOR REVIEW	SB
A	23/07/26	RT	ISSUED FOR REVIEW	SB

ecora™
#201-284 MAIN STREET, PENTICTON, BC, V2A 5B2
PHONE: 250-492-2227
www.ecora.ca

PERMIT TO PRACTICE

SEAL

DESIGN: RT
DRAWN: RT
CHECKED: SB
DATE: 2023/07/19
SCALE: 1:500

RDOS

FAULDER WATER SYSTEM CAPITAL PLAN
RDOS
WATER NETWORK LAYOUT - SHEET 3

Drawing No. 230015-C2.3

Rev.No B

FILE LOCATION: Y:\2023\230015\civil\04-Drawings\03-Sheets\230015 C2.0 - WATER NETWORK LAYOUT.dwg PRINTED ON:

CONT'D ON DWG C2.3

CONT'D ON DWG C2.5

LEGEND

- HYDRANT
- BLOWOFF VALVE
- CURBSTOP
- WATER WELL
- GATE VALVE
- WATER SERVICE
- WATER MAIN

NO.	DATE (YY/MM/DD)	DRN	REVISION	CH'KD
B	23/08/24	RT	RE-ISSUED FOR REVIEW	SB
A	23/07/26	RT	ISSUED FOR REVIEW	SB

#201-284 MAIN STREET, PENTICTON, BC, V2A 5B2
PHONE: 250-492-2227
www.ecora.ca

PERMIT TO PRACTICE

SEAL

DESIGN: RT
DRAWN: RT
CHECKED: SB
DATE: 2023/07/19
SCALE: 1:500

RDOS

FAULDER WATER SYSTEM CAPITAL PLAN
RDOS
WATER NETWORK LAYOUT - SHEET 4

Drawing No. 230015-C2.4

Rev.No B

LEGEND

- HYDRANT
- BLOWOFF VALVE
- CURBSTOP
- WATER WELL
- GATE VALVE
- WATER SERVICE
- WATER MAIN

NO.	DATE (YY/MM/DD)	DRN	REVISION	CH'KD
B	23/08/24	RT	RE-ISSUED FOR REVIEW	SB
A	23/07/26	RT	ISSUED FOR REVIEW	SB

ecora
#201-284 MAIN STREET, PENTICTON, BC, V2A 5B2
PHONE: 250-492-2227
www.ecora.ca

PERMIT TO PRACTICE

SEAL

DESIGN: RT
DRAWN: RT
CHECKED: SB
DATE: 2023/07/19
SCALE: 1:500

RDOS

FAULDER WATER SYSTEM CAPITAL PLAN
RDOS
WATER NETWORK LAYOUT - SHEET 5

Drawing No. 230015-C2.5

Rev.No B

LEGEND

HYDRANT	
BLOWOFF VALVE	BO
CURBSTOP	
WATER WELL	W
GATE VALVE	
WATER SERVICE	
WATER MAIN	

NO.	DATE (YY/MM/DD)	DRN	REVISION	CH'KD
B	23/08/24	RT	RE-ISSUED FOR REVIEW	SB
A	23/07/26	RT	ISSUED FOR REVIEW	SB

ecora™
#201-284 MAIN STREET, PENTICTON, BC, V2A 5B2
PHONE: 250-492-2227
www.ecora.ca

PERMIT TO PRACTICE

SEAL

DESIGN:	RT
DRAWN:	RT
CHECKED:	SB
DATE:	2023/07/19
SCALE:	1:500

RDOS

FAULDER WATER SYSTEM CAPITAL PLAN

RDOS

WATER NETWORK LAYOUT - SHEET 6

RDOS OKANAGAN-SIMILKAMEEN

Drawing No.	Rev.No
230015-C2.6	B

LEGEND

HYDRANT	
BLOWOFF VALVE	BO
CURBSTOP	
WATER WELL	W
GATE VALVE	
WATER SERVICE	
WATER MAIN	

NO.	DATE (YY/MM/DD)	DRN	REVISION	CH'KD
B	23/08/24	RT	RE-ISSUED FOR REVIEW	SB
A	23/07/26	RT	ISSUED FOR REVIEW	SB

ecora™
#201-284 MAIN STREET, PENTICTON, BC, V2A 5B2
PHONE: 250-492-2227
www.ecora.ca

PERMIT TO PRACTICE

SEAL

DESIGN: RT
DRAWN: RT
CHECKED: SB
DATE: 2023/07/19
SCALE: 1:500

RDOS

FAULDER WATER SYSTEM CAPITAL PLAN

RDOS

WATER NETWORK LAYOUT - SHEET 7

RDOS OKANAGAN-SIMILKAMEEN

Drawing No. 230015-C2.7

Rev.No B

CONT'D ON DWG C2.7

LEGEND
- HYDRANT
- BLOWOFF VALVE
- CURBSTOP
- WATER WELL
- GATE VALVE
- WATER SERVICE
- WATER MAIN

NO.	DATE (YY/MM/DD)	DRN	REVISION	CH'KD
B	23/08/24	RT	RE-ISSUED FOR REVIEW	SB
A	23/07/26	RT	ISSUED FOR REVIEW	SB

ecora™
#201-284 MAIN STREET, PENTICTON, BC, V2A 5B2
PHONE: 250-492-2227
www.ecora.ca

PERMIT TO PRACTICE

SEAL

DESIGN: RT
DRAWN: RT
CHECKED: SB
DATE: 2023/07/19
SCALE: 1:500

RDOS
FAULDER WATER SYSTEM CAPITAL PLAN
RDOS
WATER NETWORK LAYOUT - SHEET 8

Drawing No. 230015-C2.8

Rev.No B

Appendix B

Fire Underwriters Survey Calculation

Faulder Water System: Fire Underwriters Survey Calculation

Presented To: REGIONAL DISTRICT RDOS OKANAGAN-SIMILKAMEEN

Submission Date: March 28, 2023

Ecora File No.: 230015

Contact: Daniel Rensburg
Senior civil water specialist
daniel.rensburg@ecora.ca

THIS PAGE IS INTENTIONALLY LEFT BLANK

Table of Contents

Version Control and Revision History

Version	Date	Prepared By	Reviewed By	Approved By	Notes/Revisions
1	2023 03 28	Daniel Rensburg	Stuart Betuzzi		

1. Introduction

Ecora was retained by the Regional District of Okanagan-Similkameen (RDOS) to produce a Capital Plan for the Faulder Water System. The Fire Underwriters Survey calculation indicates the volume of water required for fire fighting.

2. Fire Underwriters Survey Calculation and Fire Storage

The following Fire Underwriter's Calculation (FUS) was performed to confirm the fire storage required for the existing reservoir. RDOS Subdivision Servicing Bylaw No. 2000 – "Schedule A" states that the fire flow shall be in accordance with "Water Supply for Public Fire Protection – A Guide to Recommended Practice" as published by Fire Underwriter's Survey, but with minimum flow rates for Low-Density Residential and Medium Density Residential of 60L/s and 150L/s respectively.

FUS calculations were performed for 182 and 54 Fish Lake Rd., two of the larger houses in the area. The following section outlines the procedure utilized to determine the required fire flow. During a site investigation on March 15, 2023, larger buildings were identified and photographed. Roof areas were measured in Google Earth. Roof overhang was subtracted to obtain approximate floor areas. The floor areas were multiplied by the number of stories of each building to obtain the total floor area.

An estimate of the fire flow required for a given area may be determined by the formula:

$$F = 220C\sqrt{A}$$

Building Floor Area
Building floor areas are presented in **Table 1** below:

Table 1: Floor areas

Address	Type	Level Description	Level Floor Area (m^2)	Total Floor Area of the Building (m^2)
182 Fish Lake Rd	Type V Wood frame residential building	Ground Level	102.4	**307.2**
		Second Level	102.4	
		Third Level	102.4	
54 Fish Lake Rd	Type V Wood frame residential building	Ground Level	233.0	**466.0**
		Second Level	233.0	

Type of Construction

The buildings consist of Type V wood frame construction above finished grade

(*C=1.5*)

Type of Construction

The buildings consist of Type V wood frame construction above finished grade

(*C=1.5*)

Occupancy Type

The contents of residential units generally have a low fire hazard of limited combustibility. The occupancy of the buildings can be classified as Class C: Residential.

(Reduction of -15% for occupancy.)

Sprinkler allowance

No sprinklers
(no reduction)

Spatial Separations

Exposed structure details are presented in **Table 2** below:

Table 2: Determination of charge for exposed structures

182 Fish Lake Rd			54 Fish Lake Rd		
North	Distance to exposed building of 11 m Exposed Building Type V – Wood Frame Construction The length of exposure is 3 m The height of the exposed building is 1 story/level Length-height factor of 3 x 1 = 3	**Charge of 10%**	North	Distance to exposed building of 24.3 m Exposed Building Type V – Wood Frame Construction The length of exposure is 7.8 m The height of the exposed building is 2 stories Length-height factor of 7.8 x 2 = 15.6	**Charge of 0%**
South	None	-	South	Distance to exposed building of 33.0 m Exposed Building Type V – Wood Frame Construction The length of exposure is 4 m The height of the exposed building is 1 story Length-height factor of 4 x 1 = 4	**Charge of 0%**
East	None	-	East	None	-
West	None	-	West	None	-
	Total Charge[a]	**10%**		**Total Charge[a]**	**0%**

[a] *The total charge shall not exceed 75%*

Fire-Water Required

Given the above, the calculated flow rate is:

100 L/s or 6,000 lpm or 1,585gpm. This is higher than the minimum required fire flows of 60 L/s for Low-Density Residential areas as published in the RDOS bylaw (Regional District of Okanagan-Similkameen, 2021), and therefore applicable.

Limitations

Building plans were not available to obtain exact floor areas, building materials, and fire ratings. Floor areas were, therefore estimated from Google Earth images together with the site investigation held on March 15, 2023. It was also assumed that most of the houses in the area will be wood-frame buildings.

Water Demand

The current population of Faulder is approximately 215 people from 81 households/families. The calculated Maximum Day Demand (MDD) is 648 m^3/day. This corresponds well with the water use recorded for the Faulder system, which was 643 m^3 in 2007, the highest recorded year thus far. The population in Summerland, the municipality directly to the east of Faulder, increased by approximately 3% between 2011 and 2016. This is equivalent to 0.59% per year. This growth rate was applied to the population in Faulder to estimate the water demand in the year 2033. The results are presented in Table 3 below:

Table 3: Population and water demand in Faulder

Description	Population and Water Demand	
2023 Population (people)	215	people
2023 Households (doors)	81	hh
Maximum Daily Demand per family	8000	L/family/day
2023 Maximum Daily Demand	648000	L/day
The annual population growth rate for Summerland	0.587	%
2033 Population (people)	228	people
2033 Households (doors)	86	hh
Maximum Daily Demand per family	8000	L/family/day
2023 Maximum Daily Demand	688000	L/day

Fire-Water Storage Volume

The duration is 2 hr for 6,000 lpm (Fire Underwriters Survey, 2020) The required fire (only) storage volume is, therefore, 720 m^3.

Total Water Storage Requirement

The calculation of the total water storage requirement is presented in **Table 4** below:

Table 4: Calculation of the Total Required Storage

Storage Component	Storage Requirement	Storage Volume (m^3)
A. Fire Storage	100 L/s for 2.0 hours	720
B. Equalization Storage	25% of MDD	172 (based on 25% of 688m^3)
C. Emergency Storage	25% of (A+B)	0 (based on providing a generator)
Total Storage Required		**892**

3. Conclusion of the FUS calculation

- Faulder does not have a fire department yet, but this will probably change in the next few decades,
- The existing Faulder Water System has a water storage capacity of 164 m^3 in the existing reservoir. This should be increased to a total of 892 m^3 over the next decade to provide sufficient water storage for firefighting.
- The existing network currently only has one fire hydrant. More hydrants are necessary based on FUS requirements.

4. References

Fire Underwriters Survey. (2020). Water Supply for Public Fire Protection - A Guide to Recommended Practice in Canada. Canada: Fire Underwriters Survey. Retrieved from https://fireunderwriters.ca/assets/img/Water%20Supply%20for%20Public%20Fire%20Protection%20in%20Canada%202020.pdf

Regional District of Okanagan-Similkameen. (2021, January 21). Subdivision Servicing Bylaw No. 2000, 2002: Schedule "A". Penticton, BC, Canada.

Appendix C

Hydraulic Modeling Report

Faulder Water System: Hydraulic Modeling Report

Presented To: Regional District Okanagan-Similkameen (RDOS)

Submission Date: May 3, 2023

Ecora File No.: 230015

Contact: Daniel Rensburg, P.Eng.
Senior civil water specialist
daniel.rensburg@ecora.ca

THIS PAGE IS INTENTIONALLY LEFT BLANK

Table of Contents

List of Figures in Text

Version Control and Revision History

Version	Date	Prepared By	Reviewed By	Approved By	Notes/Revisions
1	2023 03 28	Daniel Rensburg	Michael Panidisz		

1. Introduction

Ecora was retained by the Regional District of Okanagan-Similkameen (RDOS) to produce a Capital Plan for the Faulder Water System. Water modeling of the pipe network was performed on computer and the details are discussed in this report.

2. Bylaws

The RDOS Subdivision Servicing Bylaw No. 2000, 2002 – "Schedule A" (Regional District of Okanagan-Similkameen, 2021) was used to determine fire flows and domestic water demands. This bylaw states that the fire flow shall be in accordance with "Water Supply for Public Fire Protection – A Guide to Recommended Practice" as published by the Fire Underwriter's Survey (FUS), but with minimum flow rates for Low-Density Residential and Medium Density Residential of 60 L/s and 150 L/s respectively.

FUS calculations were performed previously, and it was found that a flow rate of 100 L/s (or 6,000 L/min) will be required for the buildings in the area. Furthermore, the bylaw prescribes Maximum Daily Demands (MDD) and Peak Hourly Demands (PHD) of 8,000 L/single family unit/day and 13,600 L/single family unit/day respectively. The minimum pressure in the water network under MDD combined with fire flows must exceed 140 kPa (approximately 14 m of head). The pressure in the water system must exceed 265 kPa (approximately 26.5 m) under Peak Hourly Demand. The maximum allowable pressure in the system (under zero flow conditions) should be less than 620 kPa (approximately 62 m) without pressure-reducing valves or 865 kPa (approximately 86.5m) with individual pressure-reducing valves.

3. Sources of Information

Pipe routes were obtained from RDOS global information system (GIS) data. Pipe locations and diameters were also verified by checking the record drawings (Stanley Associates Engineering Ltd., 1993). LiDAR data for the area was obtained from the LidarBC provincial website. (Province of British Columbia, 2018)

4. Hydraulic modeling

The main purpose of hydraulic modeling is to determine whether the existing pipe network has sufficient capacity to supply the maximum day demand combined with fire flows or the peak hourly demands. The main outcome of hydraulic modeling is to show where the pipe network has insufficient capacity to supply the design flow rates. The hydraulic model is created as follows in *EPANET*:

The existing pipe layout was imported as polylines into *Civil 3D*. A surface was created in the Civil 3D model using LiDAR data. After checking the record drawings, it was assumed that all pipe elevations are approximately 1.5 m below the ground surface. This assumption was found to be sufficiently accurate to do hydraulic modeling of the pipe network. Node coordinates and elevations were exported from *Civil 3D* into the *EPANET* software. *EPANET* automatically calculates pipe lengths from the node coordinate data. Additional information, such as the hydraulic roughness and pipe diameters, is entered. The hydraulic formula to be used for calculating primary friction head loss is selected. The Darcy-Weisbach formula was selected to calculate the primary friction headloss. This formula is presented below. The water demands were entered for the different nodes in the pipe network where water users/plumbing fixtures are located. Other objects such as the existing reservoir and pump stations were also added to the computer model.

Darcy-Weisbach equation for primary friction headloss:

$$H_L = f\frac{L}{d}\frac{v^2}{2g}$$

where H_L=primary friction loss (m)

f=friction factor (-)

L=pipe length (m)

v=average flow velocity (m/s)

d=pipe diameter (m)

g= gravitational acceleration (m/s^2)

The friction factor can be estimated using the Haaland equation:

$$\frac{1}{\sqrt{f}} = -1.8log\left[\left(\frac{\varepsilon}{3.7D}\right)^{1.11} + \frac{6.9}{Re}\right]$$

where f=friction factor (-)

ε=pipe's effective roughness (m), assumed to be 0.1mm for older smooth pipes in a pipe network

D=pipe diameter (m)

Re=Reynolds number

The Reynolds number is calculated as follows:

$$Re = \frac{VD}{v}$$

where Re=Reynolds number (-)

V= average flow velocity (m/s)

D=pipe diameter (m)

ν=kinematic viscosity of water=1.14×10^{-6} at 15°C (m^2/s)

Secondary friction losses are also considered using the following equation and friction factors:

$$h_s = \sum k_i \frac{v^2}{2g}$$

where h_s=secondary friction losses (m)

k=0.5 for sharp entrances into a pipeline

k=1.0 for sharp exists from a pipeline

k=0.4 for a 90° pipe elbow

k=0.3 for a 45° pipe elbow

k=0.35 for an open gate valve

v=average flow velocity (m/s)

g=gravitational acceleration (m/s^2)

The resulting pipe network must supply the MDD and fire flow or the PHD at minimum residual pressures of 140 kPa (14 m) and 265 kPa (26.5 m) respectively. Any negative pressures indicate undersized pipes (or pumps). When all water demands are set to zero, then the static pressure may not exceed the maximum prescribed pressure of 865 kPa (86.5 m). The Faulder Water System consists of two pressure zones, namely the Lower Faulder System from the well pump station up to the existing 164 m^3 steel-reinforced concrete reservoir; and the Upper Faulder System pumped from the reservoir to the ten household connections on Mountain View Road and a few along the main road, all at higher elevations than the reservoir. This is illustrated in Figure 1 below:

5. Positioning of Fire Hydrants

Fire hydrants must be located at maximum intervals of 250 m according to the RDOS bylaws. Furthermore, no house shall be further than 300 m from a hydrant. Fire hydrants should generally be placed at the intersections of roads. Locations were chosen for possible future hydrant locations following these rules. This is shown in Figure 2 below:

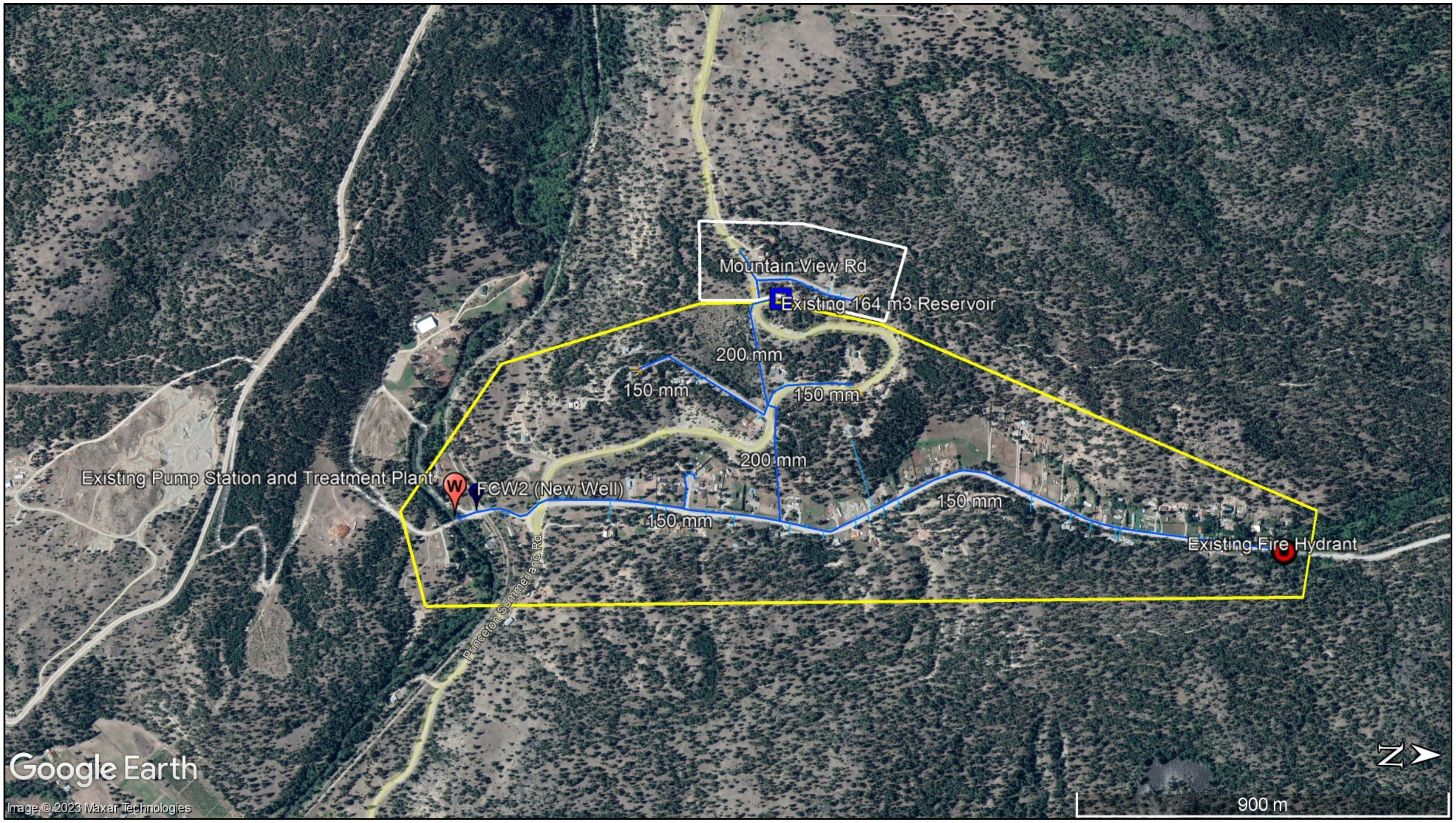


Figure 1: Faulder Water System Pressure Zones

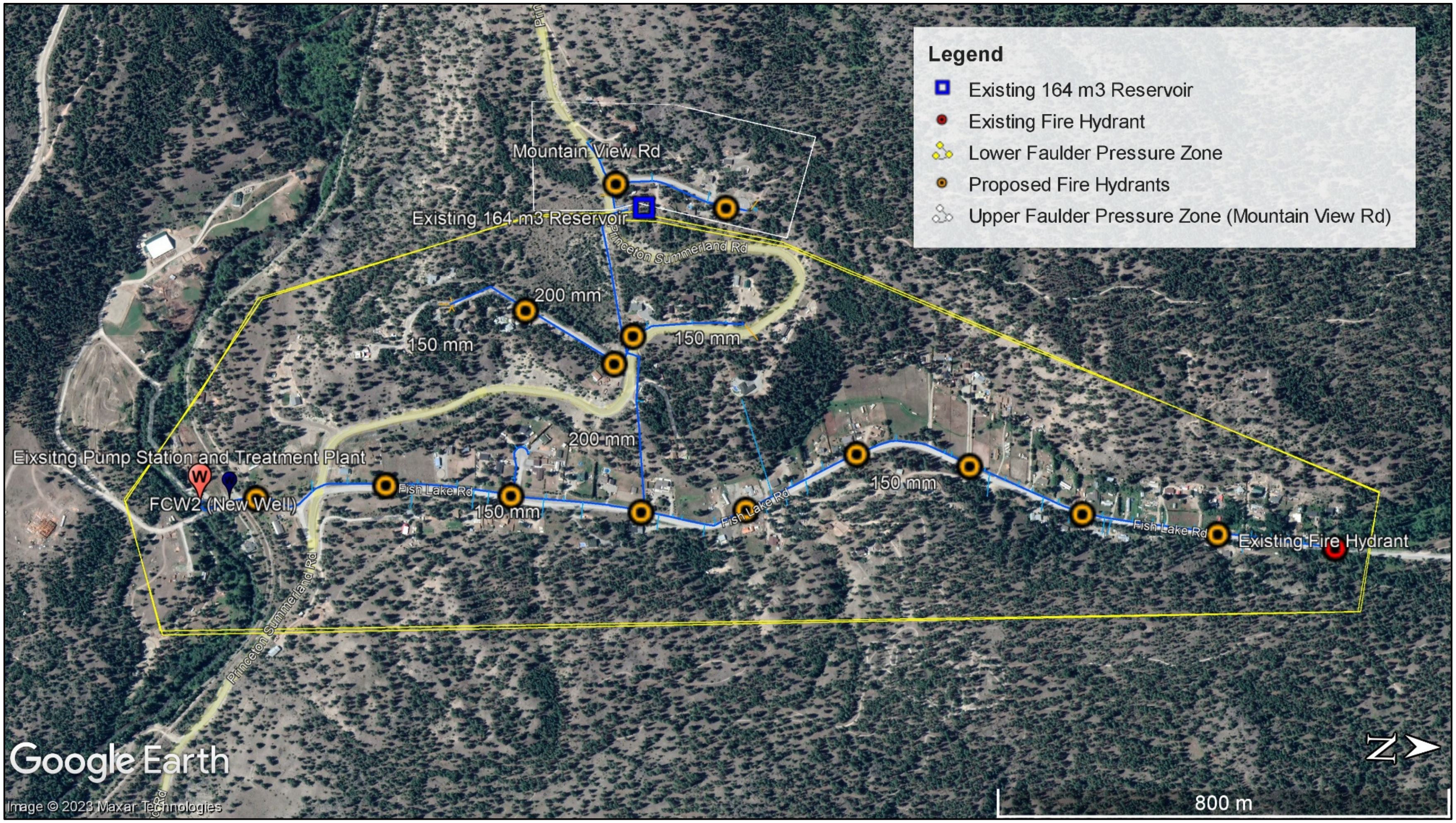


Figure 2: Proposed locations for future fire hydrants

6. Results

The following three scenarios were analyzed:

- Scenario 1: MDD and fire flow
- Scenario 2: PHD
- Scenario 3: Static pressure (zero flow)

Scenario 1: MDD and fire flow:

Lower Faulder Zone: It was found that the Fire Underwriter's Survey (FUS) fire flow of 100 L/s is not available anywhere within the existing system. The required velocity in a 150 mm diameter pipeline to obtain a flow rate of 100 L/s is 5.5 m/s, which is generally not achievable for typical network pressures. (Velocities above 4 m/s in water pipelines are generally also not advisable due to abrasion damage to internal pipe surfaces caused by cavitation.) All of the water mains in the Faulder network have a diameter of 150 mm, except the main line from the reservoir to Fish Lake Road which has a diameter of 200 mm.

It was found that the minimum prescribed fire flow for low-density residential houses of 60 L/s was not available everywhere throughout the pipe network. The maximum approximate fire flow available at each hydrant (alone) on a day of maximum demand is indicated in Figure 3 below.

The pressure in the Lower Faulder System at Maximum Day Demand, while 50 L/s of fire flow is abstracted from the existing hydrant, and the well pump is off, is shown in Figure 5 below. Note that the pressure is lowest near the existing fire hydrant (towards the north) and also at the higher elevations situated closer to the reservoir (towards the west). The excess pressure at the fire hydrant while delivering 50 L/s is approximately 167 kPa (17.0 m). The excess pressure at the end of the "Common Property Road" is approximately 222 kPa (22.6 m). The location of the "Common Property Road" is highlighted in Figure 4 below.

Upper Faulder Zone: The pressure and flow in this zone are currently supplied by the following submersible pump model installed inside the existing reservoir:

- Model – Franklin 45JS15S4-PE / 45 GPM / 6 STG / Stainless / 1.5 HP

This 2.83 L/s (45 gpm), 1.5 hp pump does not have sufficient pressure or flow to supply a fire hydrant. It was therefore assumed that a fire flow of only 3.3 L/s for a household sprinkler system, assuming a floor area of approximately 1000 ft^2 would be supplied for firefighting in this pressure zone. (Note that this "fire flow" is orders of magnitude lower than typical hydrant flow rates.) It was assumed that the fire flow is supplied at the northern end of Mountain View Rd. The resulting pressure ranges are shown in Figure 6.

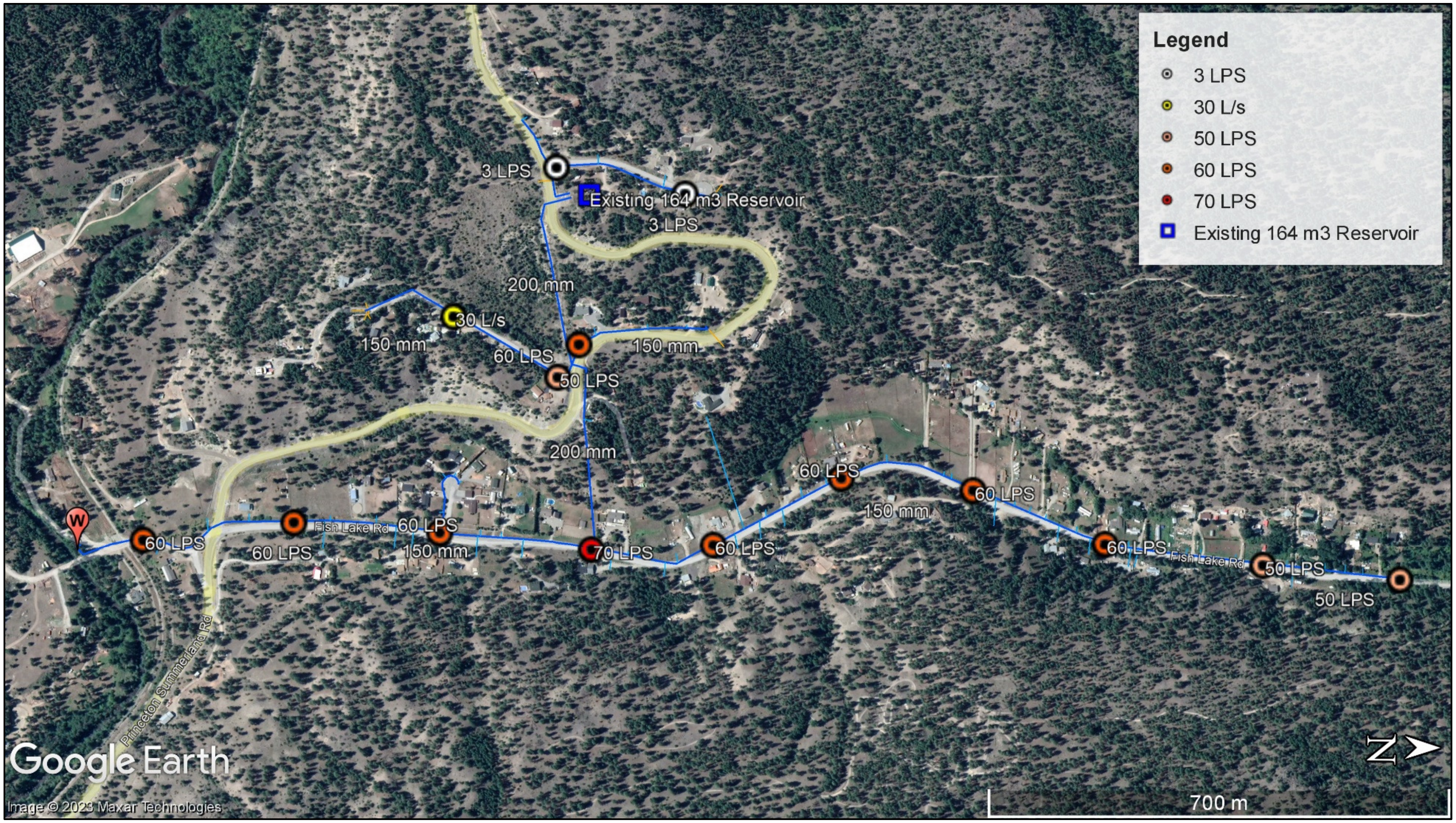


Figure 3: Flow rates available at each hydrant location individually on a day of maximum demand

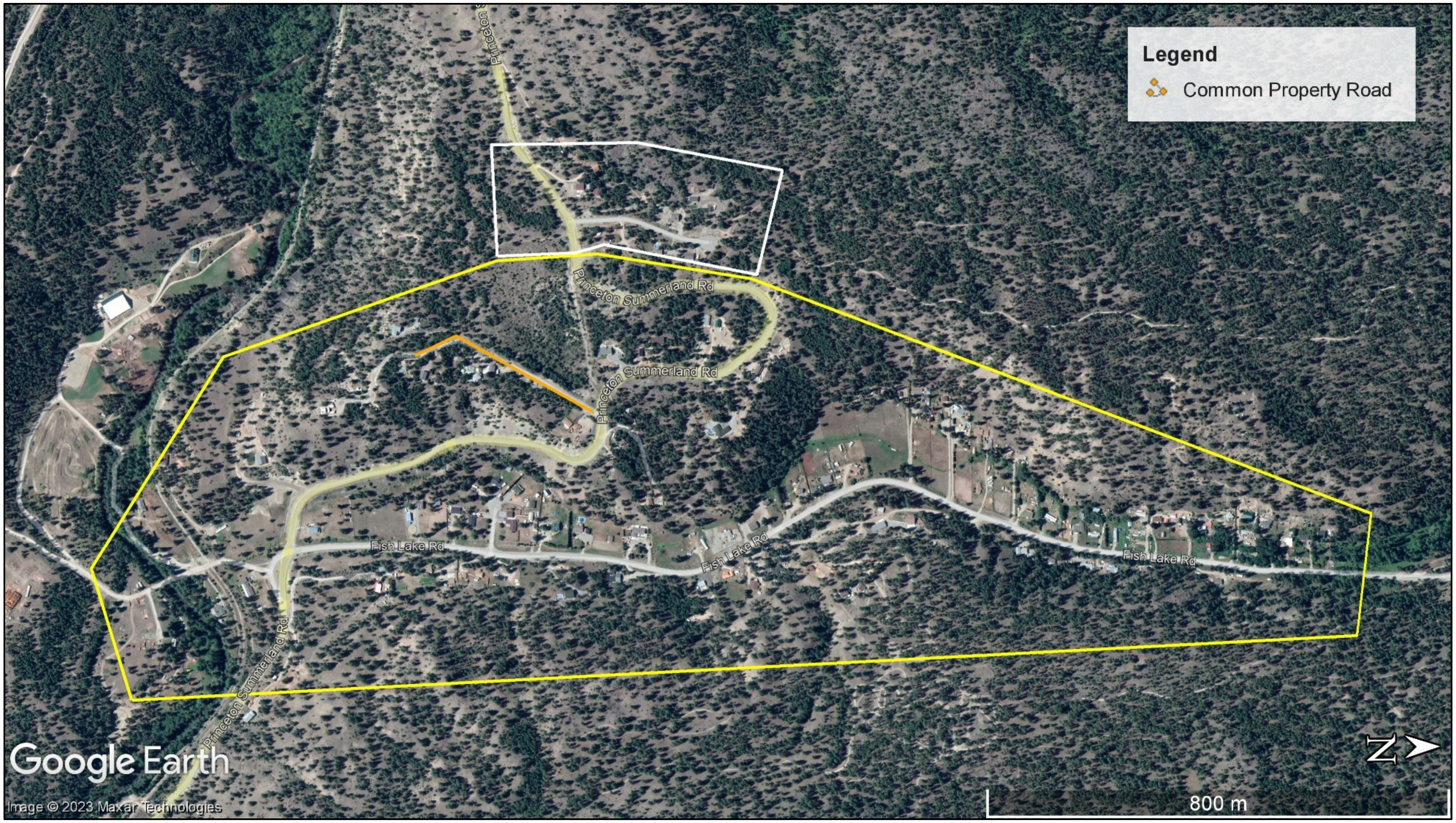


Figure 4: Location of the "Common Property Road" (indicated in orange)

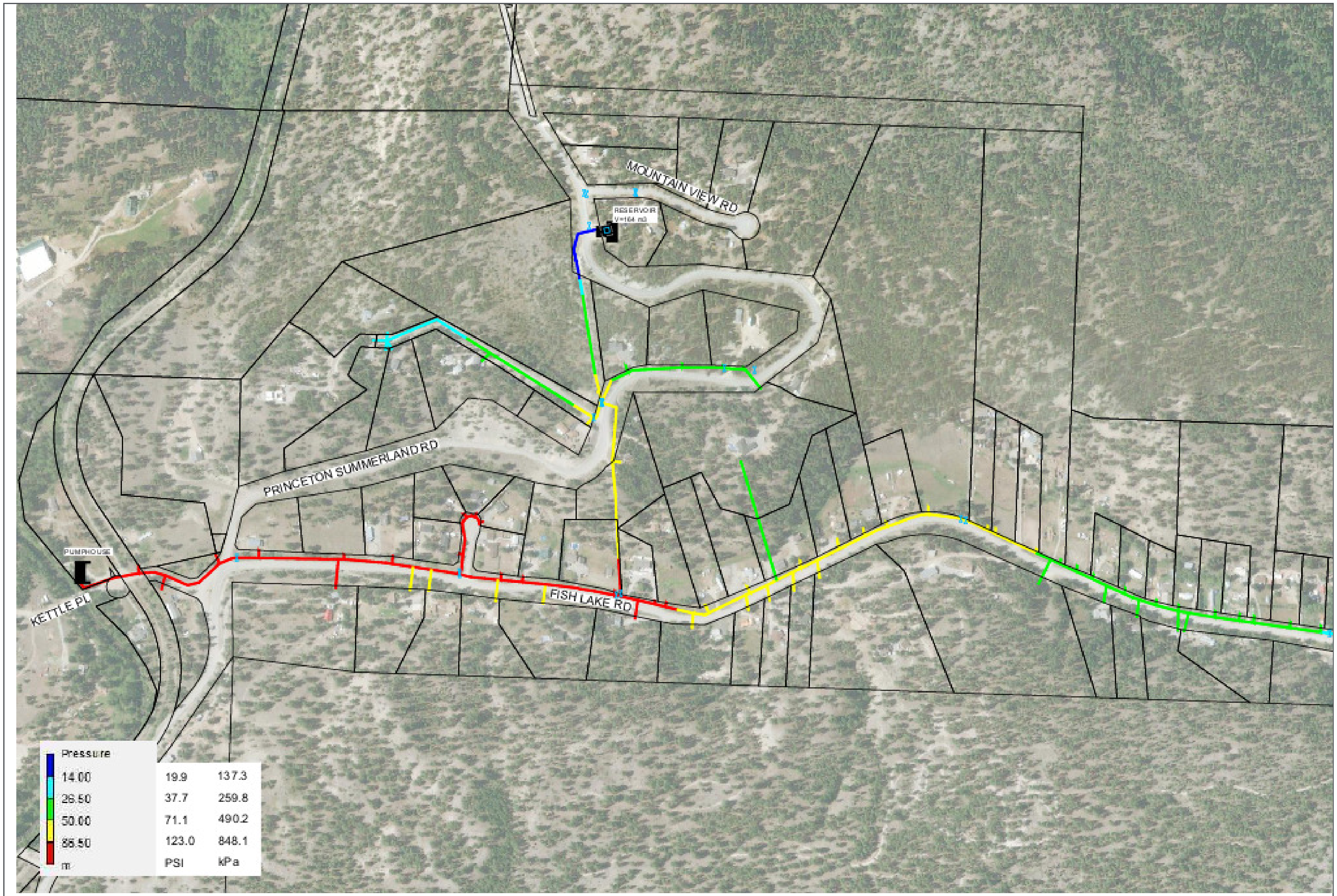


Figure 5: Lower Faulder: Pressure in the water network at Maximum Daily Demand (MDD) when 50 L/s is abstracted from the existing fire hydrant.

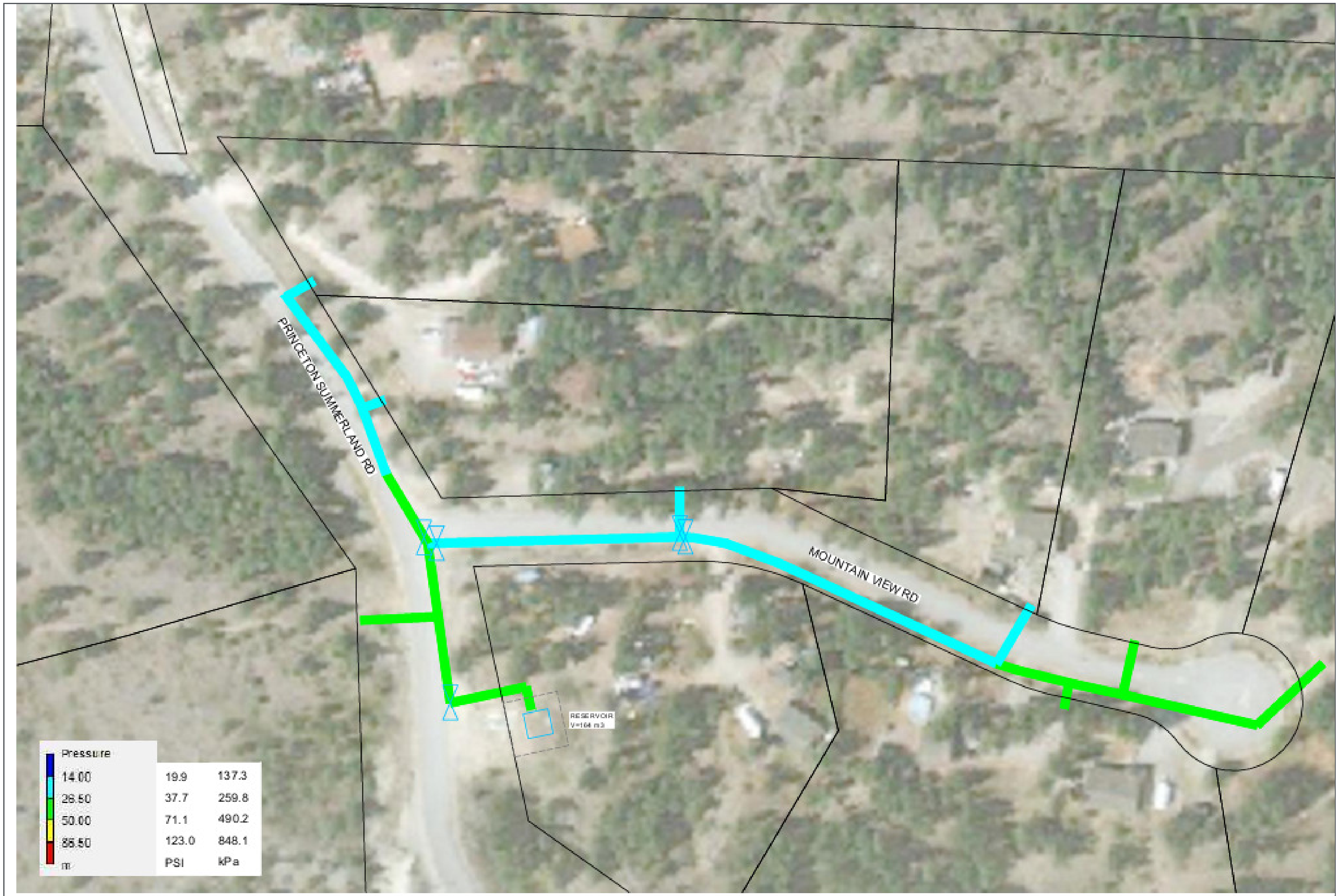


Figure 6: Upper Faulder: Pressure in the water network at Maximum Daily Demand (MDD) when 3.3 L/s of fire flow is abstracted at the Northern end of Mountain View Rd, simulating sprinklers.

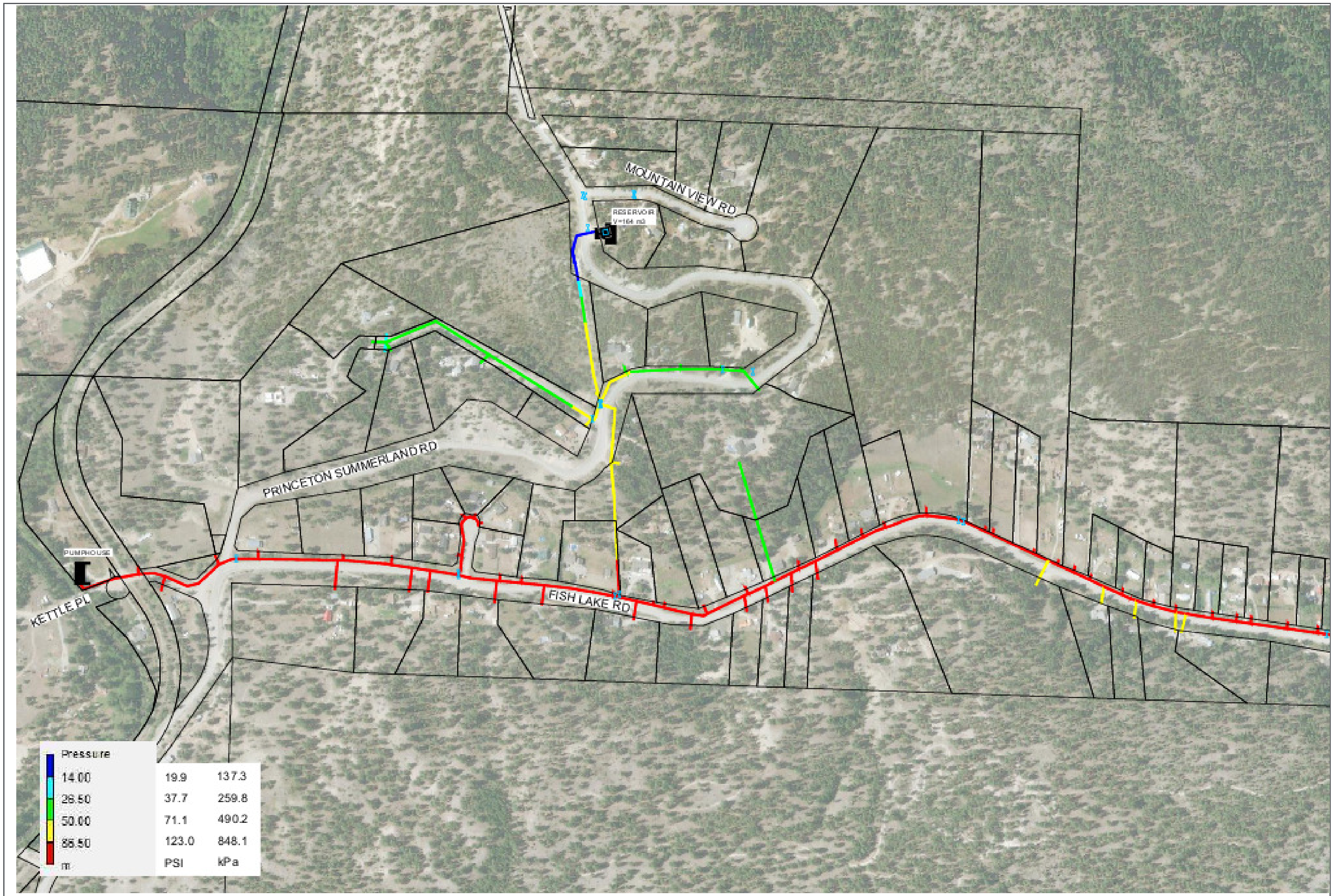


Figure 7: Lower Faulder: Network pressures at Peak Hourly Demand (PHD).

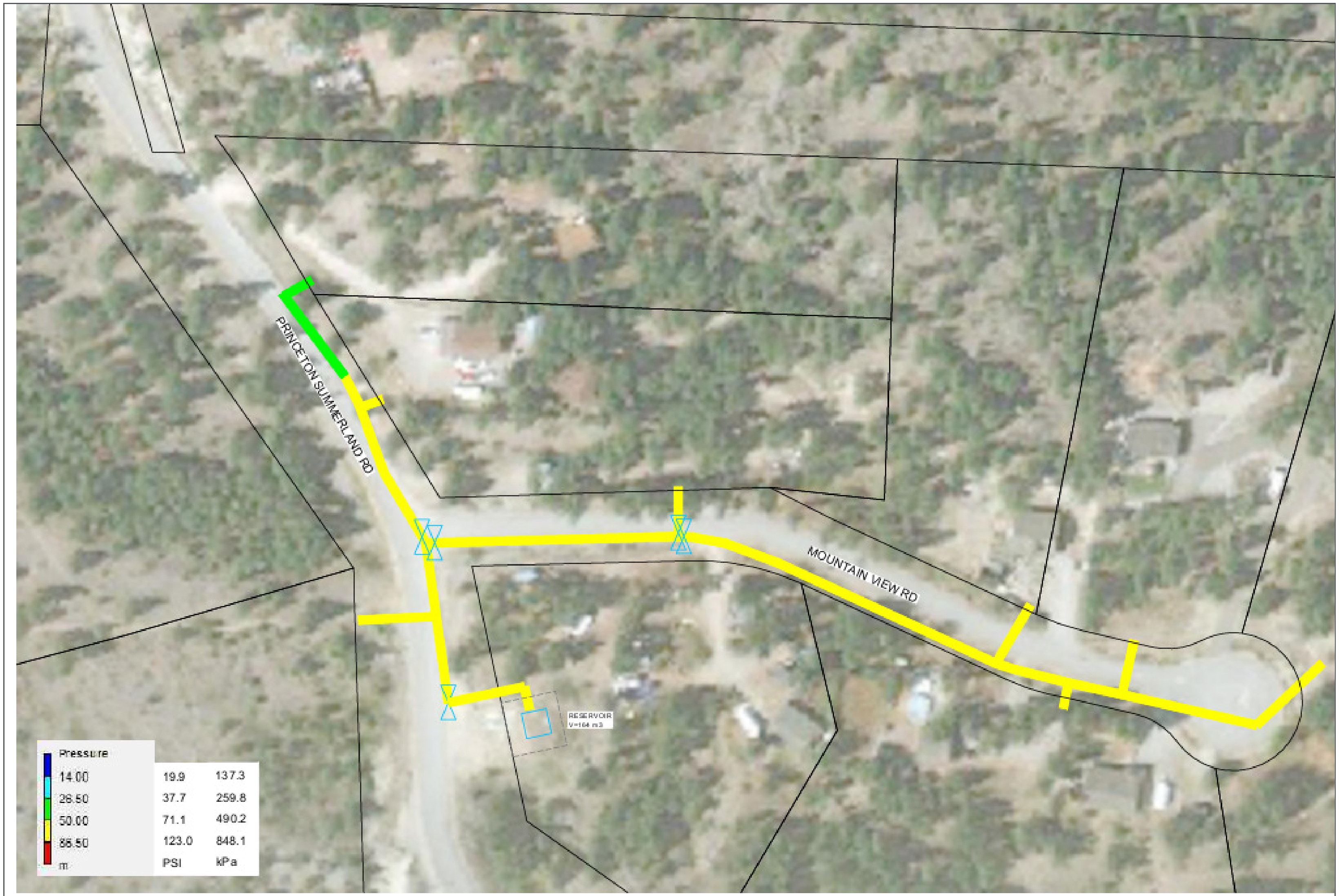


Figure 8: Upper Faulder: Network pressures at Peak Hourly Demand (PHD).

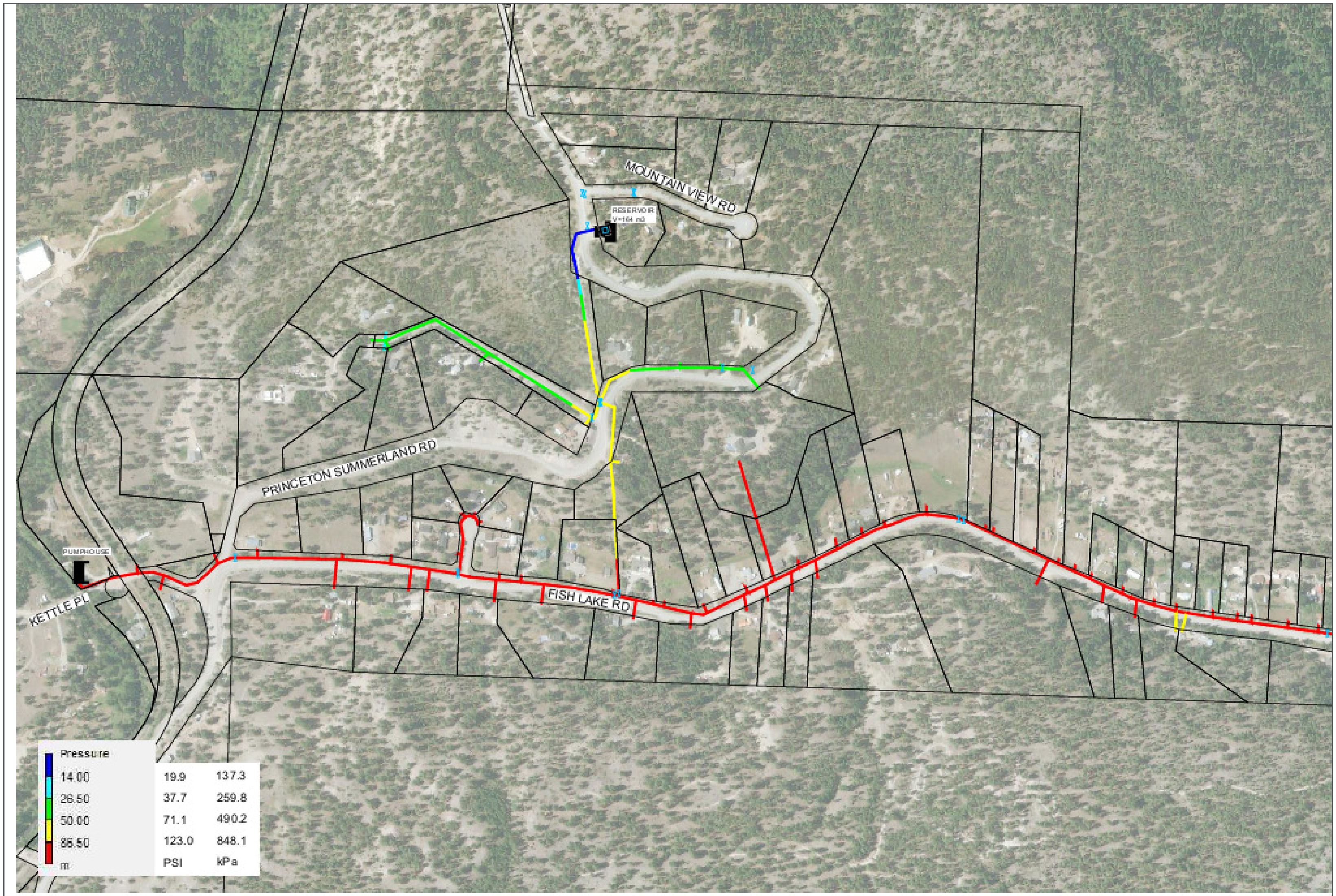


Figure 9: Lower Faulder: Pressure under zero flow conditions.

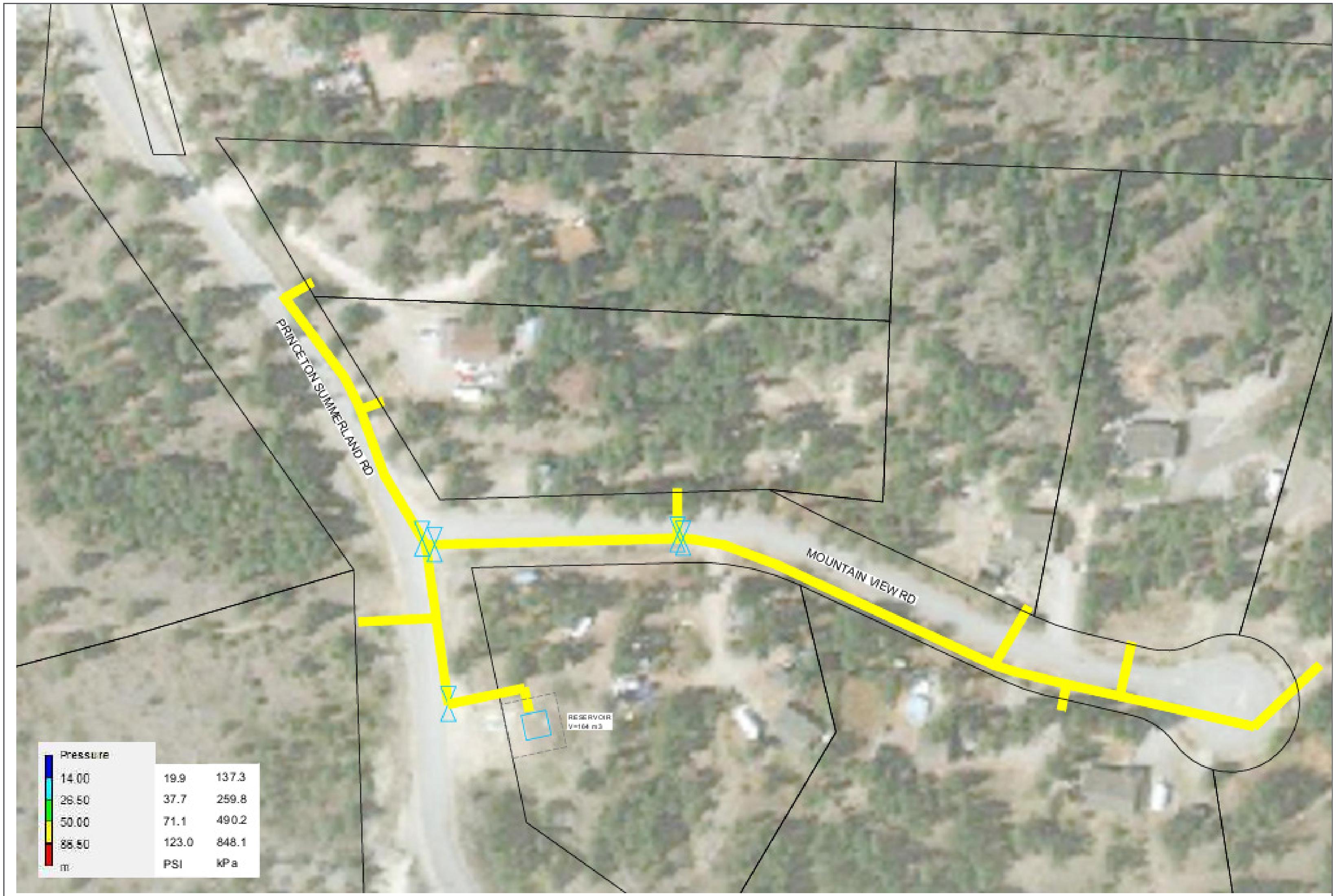


Figure 10: Upper Faulder: Pressure under zero flow conditions.

<u>Scenario 2: Peak Hourly Demand:</u>

Lower Faulder Zone: The minimum pressure in the Lower Faulder pipe network at Peak Hourly Demand (of 13,600 L/single family unit/day) was found to be 235 kPa (24 m) at the highest connection in “Common Property Road”, which is almost compliant with the pressure specified by the bylaw of 265 kPa. The pressures in the pipe network at PHD are shown in Figure 7 above.

Upper Faulder Zone: The results are shown in Figure 8. The pressures under PHD range between 46 m and 57 m, which complies with the RDOS bylaw.

<u>Scenario 3: Static pressure/Zero flow:</u>

Lower Faulder Zone: The pressures along Kettle Place Rd. (at the well pump station) and along Fish Lake Rd. are all above the maximum allowable pressure (865 kPa) specified in the RDOS bylaw. However, all the pressures are below 1,080 kPa (110 m), which is generally acceptable for domestic water supplies. It must be noted that the pressure in the network under zero flow is very similar to the results under PHD because the velocities in the pipes are relatively low under PHD. It is only with fire flows that the pressures drop significantly. The resulting pressures are presented in Figure 9.

Upper Faulder Zone: The results are shown in Figure 10. The pressures are kept between 50 m and 60 m when there is zero flow, which complies with the RDOS bylaw.

7. Conclusion

Water modeling was done for the Faulder Water Network. Water is pumped directly into the pipe network from the water treatment plant (there is no dedicated force main). It was found that the network consists of two pressure zones, the Lower Faulder area from the well up to the existing reservoir and the “Upper Faulder”/Mountain View Rd. area supplied by a submersible pump installed in the reservoir. The “Upper Faulder”/Mountain View Rd. zone might have sufficient flow and pressure for a household sprinkler fire protection system for a house with a floor area of 1000 ft^2, but cannot supply flows to fire hydrants, which require much higher flows. The Upper Faulder zone will require a fire pump or an additional reservoir to supply hydrants if installed in the future. There is sufficient capacity in the Lower Faulder pressure zone to supply most fire hydrants with water while the Maximum Day Demand is being abstracted from the system. However, the maximum flows available to hydrants are around 60 L/s and not as high as 100 L/s, as calculated using the Fire Underwriters Survey standards. Candidate locations for future hydrants were proposed for the pipe network.

The pressure in the Lower Faulder zone was found to be relatively high and consistently higher than the maximum pressure prescribed in the RDOS bylaws (of 865 kPa) in Kettle Place Rd. and Fish Lake Rd. However, all the pressures were still below 1,080 kPa, which might still be acceptable to the municipality.

8. Disclaimer

This report does not provide any information about the condition of the existing pipe network. This report, therefore, does not cover a condition assessment. Theoretical pressures and flow rates were modelled on computer and were based on record drawings available at the time. Assumptions also had to be made about cover depths to pipes, which were not available for all of the pipe sections.

9. References

Fire Underwriters Survey. (2020). Water Supply for Public Fire Protection - A Guide to Recommended Practice in Canada. Canada: Fire Underwriters Survey. Retrieved from https://fireunderwriters.ca/assets/img/Water%20Supply%20for%20Public%20Fire%20Protection%20in%20Canada%202020.pdf

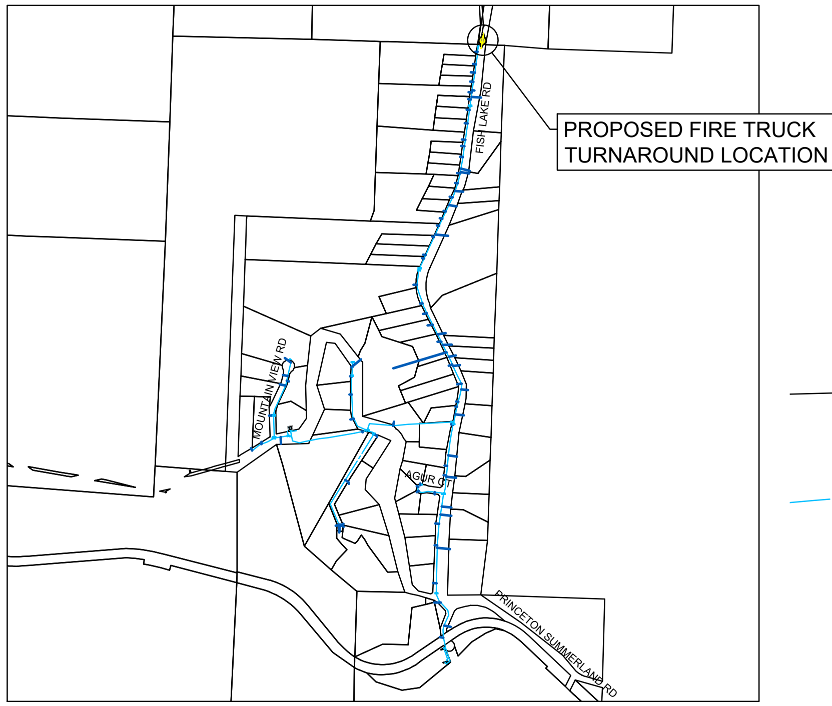
Province of British Columbia. (2018). Open LiDAR Data Portal: Canadian Geodetic Vertical Datum of 2013. Retrieved from https://governmentofbc.maps.arcgis.com/apps/MapSeries/index.html?appid=d06b37979b0c4709b7fcf2a1ed458e03

Regional District of Okanagan-Similkameen. (2021, January 21). Subdivision Servicing Bylaw No. 2000, 2002: Schedule "A". Penticton, BC, Canada.

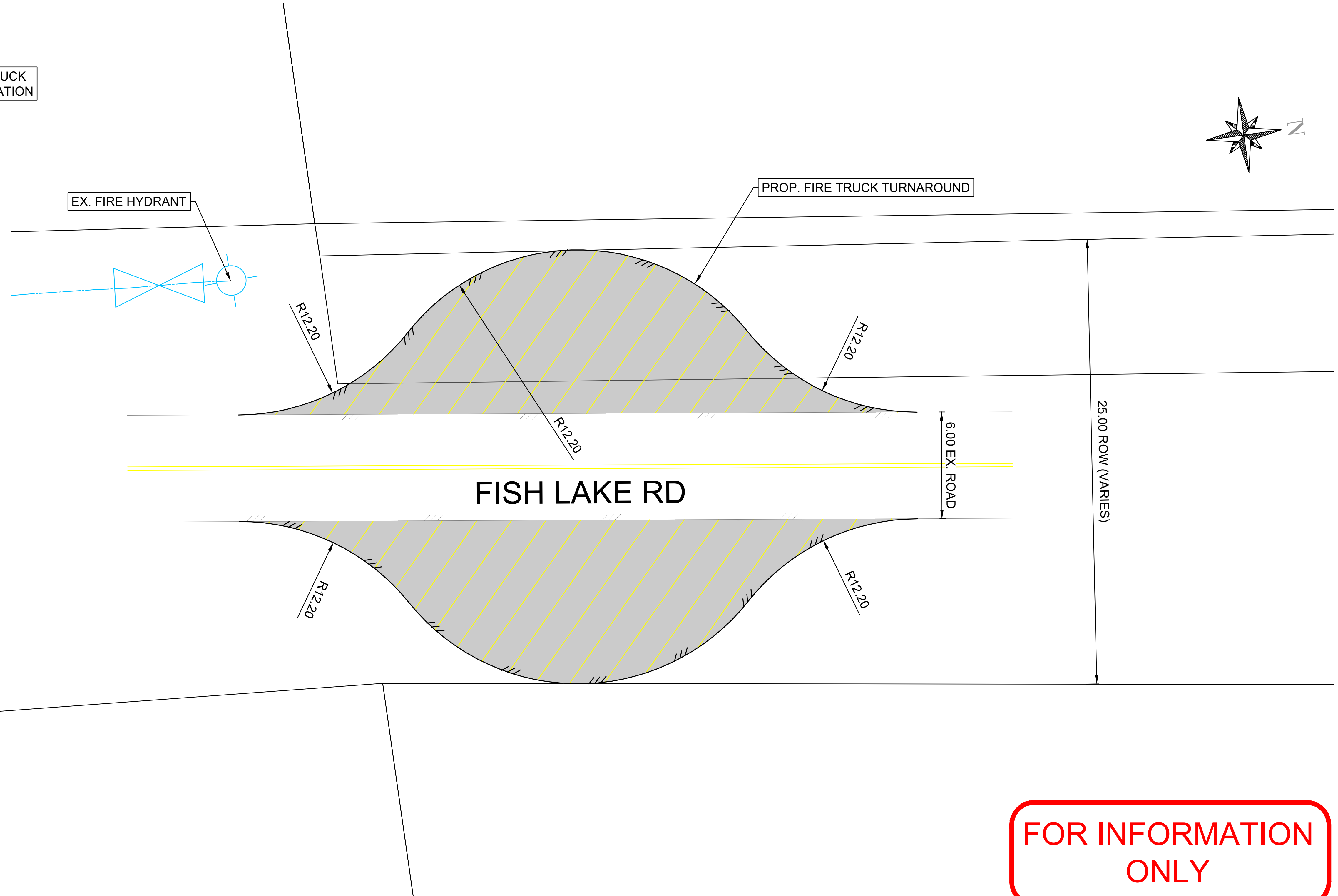
Stanley Associates Engineering Ltd. (1993, October). Faulder Water System Details: Plans of Record.

Appendix D

Fire Truck Turnaround Sketch



KEY PLAN
NTS



FOR INFORMATION ONLY

NO.	DATE (YY/MM/DD)	DRN	REVISION	CH'KD

PERMIT TO PRACTICE

SEAL

DESIGN:	DR
DRAWN:	MAP
CHECKED:	MDY
DATE:	JUNE 2023
SCALE:	1:250

RDOS

FAULDER WATER SYSTEM CAPITAL PLAN
RDOS

FIRE TRUCK TURNAROUND SKETCH

ecora

DRAWING NO.	REV
230015-SK1.0	

Appendix E

Capital Projects: Detailed Cost Estimates

Proposed Capital Projects:

Project Number 1: Seized Gate Valves (6" plus 8") in Fish Lake Road

Description	Unit	Quantity	Unit Price	Cost
200mm H-F Gate Valve - Supply and Install c/w Riser & Nelson Box	ea	1	$2,000.00	$ 2,000.00
150mm H-F Gate Valve - Supply and Install c/w Riser & Nelson Box	ea	1	$1,500.00	$ 1,500.00
Robar Coupler - Supply & Install	ea	2	$1,000.00	$ 2,000.00
200mm C900 PVC - Supply and Install	lm	12	$300.00	$ 3,600.00
Excavate & Remove Seized Gate Valves C/W Offsite Disposal	LS	2	$2,000.00	$ 4,000.00
Water Shutdown, Draining of Waterline, Pumping out Excavation and Notification to Residents	LS	2	$2,500.00	$ 5,000.00
Asphalt Removal c/w Offsite Disposal	m2	24	$35.00	$ 840.00
Sawcut Asphalt Pavement regardless of depth	lm	20	$15.00	$ 300.00
50mm Hot Mix Asphalt - Supply and Install	m2	24	$75.00	$ 1,800.00
100mm 19mm (-) Crushed Gravel Base - Supply and Install	m2	24	$20.00	$ 480.00
150mm 75mm (-) Crushed Gravel Subbase - Supply and Install	m2	24	$30.00	$ 720.00
General Requirements - Mobilization, Traffic Control, Survey, etc.	LS	2	$1,500.00	$ 3,000.00
			Construction Total	**$ 25,240.00**
			Contingency (20%)	**$ 5,048.00**
			Engineering (15%)	**$ 3,786.00**
			Grand Total	**$ 34,074.00**

Proposed Capital Projects:

Project Number 2: Insulation of shallow water main in "Common Property Road"

Description	Unit	Quantity	Unit Price	Cost
Service Detection, including depth	LS	1	$2,500.00	$ 2,500.00
Foamular 400 XPS Rigid Foam Board Insulation, 40 PSI rated, 50mm thick, 1.2m wide, (and 600mm deep on each side to form a "box") joints staggered - Supply and Install	m2	240	$80.00	$ 19,200.00
Asphalt Removal regardless of depth	m2	120	$10.00	$ 1,200.00
Common Excavation - Cut (Stockpile for Re-use)	m3	150	$8.00	$ 1,200.00
Common Excavation - Cut c/w Off-site Disposal	m3	30	$25.00	$ 750.00
Granular Pipe Bedding Material - Supply and Install	m3	50	$40.00	$ 2,000.00
50mm Hot Mix Asphalt - Supply and Install	m2	120	$30.00	$ 3,600.00
75mm 19mm (-) Crushed Gravel Base - Supply and Install	m2	120	$10.00	$ 1,200.00
150mm 75mm (-) Crushed Gravel Subbase - Supply and Install	m2	120	$10.00	$ 1,200.00
Common Excavation - Fill (Stockpiled Native Material)	m3	150	$25.00	$ 3,750.00
General Requirements - Mobilization, Traffic Control, Survey, etc.	LS	1	$7,500.00	$ 7,500.00
			Construction Total	**$ 44,100.00**
			Contingency (20%)	**$ 8,820.00**
			Engineering (15%)	**$ 6,615.00**
			Grand Total	**$ 59,535.00**

Proposed Capital Projects:

Project Number 3: Pumping Tests on Well Number FCW2

Description	Unit	Quantity	Unit Price	Cost
Well Contractors	LS	1	$120,000.00	$ 120,000.00
Hydrogeologists	LS	1	$50,000.00	$ 50,000.00
			Contingency (20%)	**$ 34,000.00**
			Grand Total	**$ 204,000.00**

Proposed Capital Projects:

Project Number 5.2: New Reservoir (429 m^3)

Description	Unit	Quantity	Unit Price	Cost
Clearing, Grubbing and Dust Control	LS	1	$8,500.00	$ 8,500.00
Earthworks (Cut and Fill)	LS	1	$140,000.00	$ 140,000.00
Structural Fill Import	LS	1	$30,000.00	$ 30,000.00
Rock Removal Allowance	LS	1	$50,000.00	$ 50,000.00
Concrete Reinforcement	LS	1	$85,000.00	$ 85,000.00
Cast-In-Place Concrete	LS	1	$295,000.00	$ 295,000.00
Topsoil, Finish Grading, and Seeding	LS	1	$20,000.00	$ 20,000.00
Waterworks - Piping, Fittings etc.	LS	1	$60,000.00	$ 60,000.00
Electrical and Instrumentation	LS	1	$25,000.00	$ 25,000.00
Site Servicing	LS	1	$25,000.00	$ 25,000.00
Site Improvements	LS	1	$10,000.00	$ 10,000.00
Purchase of Statutory Right-of-Way from Landowner	LS	1	$100,000.00	$ 100,000.00
General Requirements - Mobilization, Traffic Control, Survey, etc.	LS	1	$15,000.00	$ 15,000.00
			Construction Total	**$ 863,500.00**
			Contingency (20%)	**$ 172,700.00**
			Engineering (20%)	**$ 172,700.00**
			Grand Total	**$ 1,208,900.00**

Proposed Capital Projects:

Project Number 6: UV Disinfection, Chlorine Disinfection

Description	Unit	Quantity	Unit Price	Cost
Remove 4 of the 8 filtration vessels	LS	1	$4,000.00	$ 4,000.00
Portable emergency shower and eyewash station	LS	1	$5,000.00	$ 5,000.00
10 Gallon Sodium Hypochlorite Tank and Spill Containment	LS	1	$1,000.00	$ 1,000.00
Residual chlorine analyzer, including automation and purge valve	LS	1	$20,000.00	$ 20,000.00
2 x Hallett 1000P UV Disinfection Units (1 x duty and 1 x standby)	LS	1	$38,400.00	$ 38,400.00
General Requirements	LS	1	$5,000.00	$ 5,000.00
			Construction Total	**$ 73,400.00**
			Contingency (20%)	**$ 14,680.00**
			Engineering (15%)	**$ 11,010.00**
			Grand Total	**$ 99,090.00**

Proposed Capital Projects:

Project Number 7: Fire Truck Turnaround in Fish Lake Road

Description	Unit	Quantity	Unit Price	Cost
Common Excavation (0.3m deep) - Strip Topsoil c/w Offsite Disposal	m3	120	$25.00	$ 3,000.00
Grading Works	LS	1	$7,500.00	$ 7,500.00
Subgrade Prep	m2	400	$7.00	$ 2,800.00
50mm Hot Mix Asphalt - Supply and Install	m2	400	$30.00	$ 12,000.00
100mm 19mm (-) Crushed Gravel Base - Supply and Install	m2	400	$12.00	$ 4,800.00
150mm 75mm (-) Crushed Gravel Subbase - Supply and Install	m2	400	$10.00	$ 4,000.00
Asphalt Sawcut regardless of depth	lm	60	$35.00	$ 2,100.00
Line Painting & Signage	LS	1	$1,500.00	$ 1,500.00
Clearing & Tree Removal	LS	1	$3,500.00	$ 3,500.00
General Requirements - Mobilization, Traffic Control, Survey, etc.	LS	1	$4,000.00	$ 4,000.00
			Construction Total	**$ 45,200.00**
			Contingency (20%)	**$ 9,040.00**
			Engineering (15%)	**$ 6,780.00**
			Grand Total	**$ 61,020.00**

Proposed Capital Projects:

Project Number 8: Twelve (12) Fire Hydrants

Description	Unit	Quantity	Unit Price	Cost
Hydrant Assembly - Supply and Install, including Tee and Lead Pipe	ea	12	$7,900.00	$ 94,800.00
Water Tie-in (2 at once)	ea	6	$2,550.00	$ 15,300.00
150mm H-F Gate Valve - Supply and Install c/w Riser & Nelson Box	ea	12	$1,400.00	$ 16,800.00
Pre-Cast Concrete Thrust Block	ea	12	$350.00	$ 4,200.00
Asphalt Removal c/w Offsite Disposal	m2	168	$25.00	$ 4,200.00
Asphalt Sawcut regardless of depth	lm	120	$15.00	$ 1,800.00
50mm Hot Mix Asphalt - Supply and Install	m2	168	$40.00	$ 6,720.00
100mm 19mm (-) Crushed Gravel Base - Supply and Install	m2	168	$14.00	$ 2,352.00
150mm 75mm (-) Crushed Gravel Subbase - Supply and Install	m2	168	$12.00	$ 2,016.00
General Requirements - Mobilization, Traffic Control, Survey, etc.	LS	1	$7,500.00	$ 7,500.00
			Construction Total	**$ 155,688.00**
			Contingency (20%)	**$ 31,137.60**
			Engineering (15%)	**$ 23,353.20**
			Grand Total	**$ 210,178.80**

Capital Project List and Cost Estimate

Number	Description	Proposed Timeframe	Estimated Construction Cost (Including 20% Contingency)	Estimated Engineering Fee	Assumed Inflation per Year	Escalation	Total Cost
1	Replacing 6" and 8" seized gate valves on Fish Lake Road	Complete in 6 months	$ 30,000.00	$ 4,000.00	2.2%	$ -	$ 34,000.00
2	Installing insulation over pipes that are freezing in "Common Property Road"	Complete in 6 months	$ 53,000.00	$ 7,000.00	2.2%	$ 1,000.00	$ 61,000.00
3	Long Term Pumping tests on Well #FCW2 ("new well") to determine yield/capa	Complete in 2 years	$ 144,000.00	$ 60,000.00	2.2%	$ 9,000.00	$ 213,000.00
4	Flood line/flood zone determination along Trout Creek	Complete in 2 years	$ -	$ 150,000.00	2.2%	$ 7,000.00	$ 157,000.00
5.1	Preliminary designs for a new reservoir	Complete in 2 years	$ -	$ 100,000.00	2.2%	$ 4,000.00	$ 104,000.00
5.2	430 m^3 to 800 m^3 Additional Reservoir Storage Capacity	Complete in 8 years	$ 1,036,000.00	$ 173,000.00	2.2%	$ 230,000.00	$ 1,439,000.00
6	UV and Chlorine Disinfection Systems	Complete in 2 years	$ 88,000.00	$ 11,000.00	2.2%	$ 4,000.00	$ 103,000.00
7	Fire truck filling turnaround area on Fish Lake Rd.	Complete in 5 years	$ 54,000.00	$ 7,000.00	2.2%	$ 7,000.00	$ 68,000.00
8	12 new fire hydrants	Complete in 8 years	$ 187,000.00	$ 23,000.00	2.2%	$ 40,000.00	$ 250,000.00
		Total	**$ 1,592,000.00**	**$ 535,000.00**		**$ 302,000.00**	**$ 2,429,000.00**

Replacement Value (2023)

Description	Replacement Value (2023)	Weighted Lifespan (Years)	Estimate of Remaining Life (Years)	Assumed Inflation per Year	Estimated Cost at Replacement Time (In Year 2055	Annual Budgeting for Replacement	Annual Budget for Replacement Per Lot
Pipe network, valves, bends, thrust blocks (3.8 km linear)	$ 1,684,000.00	61	33	2.2%	$ 3,483,000.00	$ 104,000.00	$ 1,280.00
Existing Reinforced Concrete Reservoir (164m3) and booster pump station (3.5L/s)	$ 733,000.00	47	24	2.2%	$ 1,234,000.00	$ 52,000.00	$ 640.00
Well Pumphouse	$ 1,242,000.00	34	18	2.2%	$ 1,822,000.00	$ 103,000.00	$ 1,270.00
Uranium Water Treatment Plant	$ 682,000.00	30	22	2.2%	$ 1,112,000.00	$ 49,000.00	$ 600.00
TOTALS	**$ 4,341,000.00**				**$ 7,651,000.00**	**$ 308,000.00**	**$ 3,790.00**

System Replacement
Existing Pipe Network

Description	Unit	Quantity	Unit Price	Cost	Cost (Incl. Contingency and Engineering)	Total Lifespan (Years)	Remaining Lifespan (Years)
90º Bend (150)	ea	2	$750.00	$ 1,500.00	$ 2,025.00	60	32
45º Bend (150)	ea	9	$750.00	$ 6,750.00	$ 9,112.50	60	32
22.5º Bend (150)	ea	2	$750.00	$ 1,500.00	$ 2,025.00	60	32
Tee (150)	ea	11	$1,350.00	$ 14,850.00	$ 20,047.50	60	32
GV (150)	ea	15	$1,400.00	$ 21,000.00	$ 28,350.00	25	0
C900 PVC Class 150 (150)	lm	2384	$200.00	$ 476,800.00	$ 643,680.00	75	47
C900 PVC Class 200 (150)	lm	811	$250.00	$ 202,750.00	$ 273,712.50	75	47
Steel Casing (300)	lm	56	$400.00	$ 22,400.00	$ 30,240.00	50	22
90º Bend (200)	ea	2	$850.00	$ 1,700.00	$ 2,295.00	60	32
45º Bend (200)	ea	1	$850.00	$ 850.00	$ 1,147.50	60	32
22.5º Bend (200)	ea	1	$850.00	$ 850.00	$ 1,147.50	60	32
11.25º Bend (200)	ea	1	$850.00	$ 850.00	$ 1,147.50	60	32
GV (200)	ea	2	$1,600.00	$ 3,200.00	$ 4,320.00	25	0
Cross (200)	ea	1	$3,500.00	$ 3,500.00	$ 4,725.00	50	22
C900 PVC Class 150 (200)	lm	580	$250.00	$ 145,000.00	$ 195,750.00	75	47
Steel Casing (375)	lm	20	$500.00	$ 10,000.00	$ 13,500.00	50	22
Air Release Valve	ea	1	$8,000.00	$ 8,000.00	$ 10,800.00	25	0
Blowoff	ea	2	$4,000.00	$ 8,000.00	$ 10,800.00	35	7
Hydrant	ea	1	$5,000.00	$ 5,000.00	$ 6,750.00	50	22
Precast Concrete Thrust Block	ea	36	$350.00	$ 12,600.00	$ 17,010.00	50	22
25mm Water Service Connection c/w Curbstop, Double Strap Stainless Steel S	ea	82	$1,200.00	$ 98,400.00	$ 132,840.00	25	0
25mm Municipex Water Service Supply and Install c/w pipe bedding and 2x4 Marker	lm	820	$110.00	$ 90,200.00	$ 121,770.00	25	0
24 m2 Asphalt Patch for Water Service Connection	ea	41	$2,000.00	$ 82,000.00	$ 110,700.00	25	0
General Requirements - Mobilization, Traffic Control, Survey, etc.	LS	1	$30,000.00	$ 30,000.00	$ 40,500.00	50	22
			Construction Total	**$ 1,247,700.00**			
74% built in 1993			**Contingency (20%)**	**$ 249,540.00**			
16% built in 1998 (Common Prop Rd, East leg on Hwy)			**Engineering (15%)**	**$ 187,155.00**			
10% built in 2006 (Mountain View Rd)			**Grand Total**	**$ 1,684,395.00**	$ 1,684,395.00		

System Replacement

Existing Water Storage Reservoir (164 m3) & Booster Station

Description	Unit	Quantity	Unit Price	Cost	Cost (Incl. Contingency and Engineering)	Total Lifespan (Years)	Remaining Lifespan (Years)	Reserve required this year
Clearing, Grubbing and Dust Control	LS	1	$3,230.00	$ 3,230.00	$ 4,360.50	60	30	$ 145.35
Earthworks (Cut and Fill)	LS	1	$53,200.00	$ 53,200.00	$ 71,820.00	60	30	$ 2,394.00
Structural Fill Import	LS	1	$11,400.00	$ 11,400.00	$ 15,390.00	60	30	$ 513.00
Rock Removal Allowance	LS	1	$19,000.00	$ 19,000.00	$ 25,650.00	60	30	$ 855.00
Concrete Reinforcement	LS	1	$32,300.00	$ 32,300.00	$ 43,605.00	60	30	$ 1,453.50
Cast-In-Place Concrete	LS	1	$112,100.00	$ 112,100.00	$ 151,335.00	60	30	$ 5,044.50
Topsoil, Finish Grading, and Seeding	LS	1	$7,600.00	$ 7,600.00	$ 10,260.00	60	30	$ 342.00
Waterworks - Piping, Fittings etc.	LS	1	$22,800.00	$ 22,800.00	$ 30,780.00	25	-5	-$ 6,156.00
Electrical and Instrumentation	LS	1	$9,500.00	$ 9,500.00	$ 12,825.00	15	7	$ 1,832.14
Site Servicing	LS	1	$9,500.00	$ 9,500.00	$ 12,825.00	60	30	$ 427.50
Reinforced Concrete Booster Station Structure	LS	1	$100,000.00	$ 100,000.00	$ 135,000.00	60	30	$ 4,500.00
Booster Pump, System Components, Controls, Electrical - Supply and Install	LS	1	$30,000.00	$ 30,000.00	$ 40,500.00	25	17	$ 2,382.35
Booster Pump, System Components, Controls, Electrical - Supply and Install	LS	1	$30,000.00	$ 30,000.00	$ 40,500.00	25	17	$ 2,382.35
Electrical - Heating, Lighting, Ventilation	LS	1	$30,000.00	$ 30,000.00	$ 40,500.00	15	7	$ 5,785.71
Backup Generator	LS	1	$62,500.00	$ 62,500.00	$ 84,375.00	25	17	$ 4,963.24
Site Improvements	LS	1	$3,800.00	$ 3,800.00	$ 5,130.00	60	30	$ 171.00
General Requirements - Mobilization, Traffic Control, Survey, etc.	LS	1	$5,700.00	$ 5,700.00	$ 7,695.00	60	30	$ 256.50
			Construction Total	**$ 542,630.00**				**$ 27,292.15**
			Contingency (20%)	**$ 108,526.00**				
			Engineering (15%)	**$ 81,394.50**				
			Grand Total	**$ 732,550.50**	**$ 732,550.50**			

Built in 1993

System Replacement

Existing Pumphouse, Water Treatment Plant (Uranium) & Well

Description	Unit	Quantity	Unit Price	Cost	Cost (Incl. Contingency and Engineering)	Total Lifespan (Years)	Remaining Lifespan (Years)	Reserve required this year
Clearing, Grubbing and Dust Control	LS	1	$7,500.00	$ 7,500.00	$ 10,125.00	60	30	$ 337.50
Earthworks (Cut and Fill)	LS	1	$70,000.00	$ 70,000.00	$ 94,500.00	60	30	$ 3,150.00
Reinforced Cinderblock Structure with Skylight for Equipment Access	LS	1	$150,000.00	$ 150,000.00	$ 202,500.00	40	10	$ 20,250.00
Pump, System Components, Electrical - Supply and Install	LS	1	$301,000.00	$ 301,000.00	$ 406,350.00	25	17	$ 23,902.94
SCADA, Modicon M340, 100Ø magnetic flow meter, HMI, Well level, programming	LS	1	$24,000.00	$ 24,000.00	$ 32,400.00	10	2	$ 16,200.00
Well, Submerisble Pump, Components, Piping, Valves	LS	1	$125,000.00	$ 125,000.00	$ 168,750.00	25	17	$ 9,926.47
Electrical - Heating, Lighting, Ventilation	LS	1	$60,000.00	$ 60,000.00	$ 81,000.00	15	7	$ 11,571.43
Site Servicing: Drainage, Conduits	LS	1	$75,000.00	$ 75,000.00	$ 101,250.00	60	30	$ 3,375.00
Backup Generator	LS	1	$62,500.00	$ 62,500.00	$ 84,375.00	25	17	$ 4,963.24
Site Improvements	LS	1	$35,000.00	$ 35,000.00	$ 47,250.00	60	30	$ 1,575.00
General Requirements - Mobilization, Traffic Control, Survey, etc.	LS	1	$10,000.00	$ 10,000.00	$ 13,500.00	60	30	$ 450.00
			Construction Total	**$ 920,000.00**				**$ 95,701.58**
			Contingency (20%)	**$ 184,000.00**				
			Engineering (15%)	**$ 138,000.00**				
			Grand Total	**$ 1,242,000.00**	**$ 1,242,000.00**			

Pump Station built in 1993
WTP & New Well built in 2015

System Replacement

Existing Pumphouse, Water Treatment Plant (Uranium) & Well

Description	Unit	Quantity	Unit Price	Cost	Cost (Incl. Contingency and Engineering)	Total Lifespan (Years)	Remaining Lifespan (Years)	Reserve required this year
Seacan Structure for Water Treatment Plant	LS	1	$85,000.00	$ 85,000.00	$ 114,750.00	25	17	$ 6,750.00
Water Treatment Plant, System Components - Supply and Install	LS	1	$284,000.00	$ 284,000.00	$ 383,400.00	25	17	$ 22,552.94
Three DN100 magnetic flow meters, pressure sensor	LS	1	$16,000.00	$ 16,000.00	$ 21,600.00	10	2	$ 10,800.00
Waterworks - Piping, Fittings etc.	LS	1	$120,000.00	$ 120,000.00	$ 162,000.00	50	42	$ 3,857.14
			Construction Total	**$ 505,000.00**				**$ 43,960.08**
			Contingency (20%)	**$ 101,000.00**				
			Engineering (15%)	**$ 75,750.00**				
			Grand Total	**$ 681,750.00**	**$ 681,750.00**			

Pump Station built in 1993
WTP & New Well built in 2015

O&M Costs

Description	Unit	Quantity	Unit Price	Cost	Total Lifespan (Years)	Cost Per Year
Re-filling two resin vessels every 3 years	LS	1	$10,000.00	$ 10,000.00	3	$ 3,000.00
Disposing two resin vessels	LS	1	$8,000.00	$ 8,000.00	3	$ 3,000.00
Energy Consumption	kWhrs	18366	$0.20	$ 4,000.00	1	$ 4,000.00
Flushing hydrants (Once per year)	LS	1	$500.00	$ 500.00	1	$ 500.00
Servicing of generators	LS	1	$1,000.00	$ 1,000.00	1	$ 1,000.00
Running generators	hr	200	$2.00	$ 400.00	1	$ 400.00
Salary of O&M Operator (Spending a third of their time on Faulder)	%	33.33%	$50,000.00	$ 16,666.65	1	$ 17,000.00
						$ 28,900.00

Based on pumps running approximately for 440hrs per year on average
Based on a 76kVA generator
Based on 300 Watts for lighting and monitoring equipment