INTEGRATED WATER STRATEGY

TOWN OF GOLDEN

May 8, 2025

URBAN SYSTEMS

501 - 121 5th Avenue, Kamloops, BC V2C 0M1 | T: 250.374.8311

CONTACT: Jeremy Clowes, P.Eng.
E: jclowes@urbansystems.ca

PREPARED FOR:

TOWN OF GOLDEN
810 S, 9th Avenue
Golden, BC V0A 1H0

PREPARED BY:

URBAN SYSTEMS LTD.
101 - 612 7th Street N
Golden, BC V0A 1H0
T: 236.536.2105

Robyn Cameron, EIT, Project Engineer

Jill Reynolds, P.Eng., Project Engineer.

Jeremy Clowes, P.Eng., Principal
Water & Wastewater Engineer

PROFESSIONAL
PROVINCE OF
J. D. CLOWES
36363
BRITISH COLUMBIA
ENGINEER
2025-05-09

PERMIT TO PRACTICE
URBAN SYSTEMS LTD.
Signature
Date 2025-05-09
PERMIT NUMBER: 1000527
Engineers and Geoscientists BC (EGBC)

File: 0404.0254.01

CONTENTS

APPENDICES

TABLES

FIGURES

EXECUTIVE SUMMARY

The Town of Golden has undertaken an update to its Integrated Water Strategy to enhance its water system's reliability and efficiency over a 25-year growth horizon. This comprehensive report provides an assessment of the existing water system, projections for future growth, and recommendations for necessary upgrades.

The Town of Golden sources its domestic water from five groundwater wells located in the Columbia River valley. These wells have a combined capacity of 164.5 L/s, producing 10,660 m³/day. The system includes three pressure zones: Northeast Bench (NE), Southeast Bench (SE), and Townsite (Zone 1). The wells supply water to the Gunite Reservoir, which then feeds the Hypalon Reservoir, which supplies the Townsite (Zone 1) pressure zone.

Water is boosted to the NE and SE zones via the Northeast and Selkirk Booster Stations, respectively. The NE Booster Station conveys water to the Lafontaine reservoir complex which supplies the NE pressure zone, while the Selkirk Booster Station conveys water to the Bears Paw reservoir which supplies the SE pressure zone.

The Integrated Water Strategy reviewed the water supply, water storage, water conveyance, and water distribution systems. Upgrades were recommended for the system to operate reliably over the next 25 years, as well as to allow for the projected growth. These upgrades were grouped into high and low priority.

The high priority distribution system upgrades are to address deficiencies for upcoming development, increase system reliability, and provide significant fire flow improvements. The recommended upgrades are described as follows:

1. Replacing the NE and SE booster stations to meet the 25-year demands, as well as to supplement fire storage to the NE and SE pressure zones.
2. Replace the small diameter piping along Lafontaine Road and Gareb road to improve fire flow performance.
3. Construct a second watermain crossing over the Kicking Horse River to improve system reliability as well as to improve fire flow performance.
4. Install generators at Wells 2 and 4 to improve system reliability and to improve fire flow performance.

There are several areas with deficient fire flow currently. While we have identified upgrades (largely increasing pipe size) to improve fire flows to existing developments, the capital costs to rectify all deficiencies are high. Existing deficiencies are understood to have been considered in past FUS reviews for insurance grading and it is possible that insurance costs could be lower with the proposed watermain upsizing. We recommend upsizing pipes to improve fire flow as funds allow. The recommended low priority upgrades are as follows:

1. Upsize approximately 2000 m of watermain in the northwest commercial/industrial portion of Zone 1 to improve fire flow performance.
2. Upsize approximately 1000 m of watermain in the southern industrial portion of Zone 1 to improve fire flow performance.

$12.5 million high priority capital works and $17.9 million low priority capital works have been identified to accommodate the 25-year growth projection, improve system reliability, and/or address deficiencies. The intent is for this strategy to assist the Town of Golden in making informed decisions to ensure a reliable and efficient water system for the future.

1.0 INTRODUCTION

1.1 BACKGROUND

The Town of Golden (Town) has identified the need to update the water system model and the Integrated Water Strategy (previously called the Water Master Plan) to assist with asset management and to guide decision making for future water system upgrades within the Town. This update was conducted alongside the *2024 Sanitary Sewer Model and Master Plan* and *2023 Golden Transportation Plan* to provide a comprehensive projection of system upgrades.

This report covers an assessment of existing system capacity, projections for future growth, upgrade recommendations for the water system to operate reliably and efficiently over the 25 year growth horizon, and a prioritized list of capital improvements.

1.2 STUDY OBJECTIVES

The primary objectives of the Integrated Water Strategy update were to:

- Update the water model from the 2013 Master Plan.
- Review and update design criteria for the 25 year growth horizon.
- Conduct a hydraulic analysis and assessment of the water system under existing and future conditions (10 and 25-year growth conditions).
- Identify upgrades required over the 25 year growth horizon for the water system as a whole system to operate reliably and efficiently.
- Provide Class D cost estimates for the recommended upgrades.
- Provide upgrade recommendations with a risk assessment and project prioritization to assist with management of capital improvements and decision making.

1.3 METHODOLOGY

The methodology used in this study to achieve these objectives was as follows:

- Gather and review background information including water meter data (from 2016 to 2021), record drawings, and GIS data.
- Conduct a land use and water demand analysis and compare the results to the Town of Golden Subdivision Servicing Bylaw, MMCD design standards, and comparable municipalities to identify appropriate design criteria while accounting for climate change.
- Update and validate the WaterCAD model for the existing and future water system.
- Evaluate the steady state performance of the existing system under various demand scenarios to identify any deficiencies.
- Evaluate the water supply system to confirm sufficient water is available to meet projected demands.
- Evaluate the water storage system to confirm storage volumes meet MMCD recommendations.

- Evaluate the water conveyance systems (e.g., booster stations) to confirm sufficient capacity is available to meet future water demands.
- Identification of recommended upgrades, completion of a risk assessment and prioritization of projects based on criticality and risk.
- Prepare an Integrated Water Strategy including all assumptions and information used for the model development and validation, analysis results and mapping of results, conclusions, recommendations, and Class D cost estimates for future water system upgrades.

1.4 REFERENCE STUDIES

The following documents were consulted for this analysis:

1. Golden Sanitary Sewer Model and Master Plan, June 2024, Urban Systems.
2. Golden Integrated Water Strategy Design Criteria, Aug. 8, 2024, Urban Systems.
3. Design Guidelines for Drinking Water Systems in British Columbia, Published March 2023, Revised January 2024, BC Ministry of Health.
4. MMCD Design Guidelines, 2022, Master Municipal Construction Documents Association.
5. Golden Integrated Water Strategy – Model Update and Validation, Aug. 6, 2024, Urban Systems.
6. Water Supply for Public Fire Protection, A Guide to Recommended Practice in Canada. FUS, 2020.
7. Email correspondence from FUS on 1990 and 2017 FUS hydrant testing results and required fire flows, Aug. 19, 2024.
8. 2013 Golden Water Distribution System Study, Revision 4, Aug. 2013, Urban Systems.

2.0 EXISTING WATER SYSTEM

The Town of Golden obtains its domestic water supply from five groundwater wells that tap buried sand and gravel deposits within the alluvium deposits of the Columbia River valley. The locations and pumping capacity of these wells are shown on Figure 2.2. The existing well capacities are summarized in Table 2.1.

Table 2.1: Existing Well Capacity

	Well Pump Capacity (L/s)	Total Production Over 18 Hour Pump Day (m^3/d)	Licensed Annual Water Allocation (m^3/year)
Well 2	9.5	616	105,000
Well 3	19	1,231	270,000
Well 4	37	2,398	408,354
Well 5	45	2,916	560,000
Well 7 (Note 2)	54	3,499	450,000
Total	164.5	10,660	1,793,354

Notes:

1. Wells are sized to produce the maximum day demands over an 18 hour pump day to allow time for shut downs for necessary maintenance work, repairs, or unplanned downtime.
2. Well 7 is currently under construction. Testing has shown that Well 7 has a sustainable capacity of 53 L/s, and a license has been requested for the volumes outlined in Table 2.1.

There are three pressure zones in the Town: the Northeast Bench (NE) pressure zone, the Southeast Bench (SE) pressure zone and the Townsite (Zone 1) pressure zone. All five of the groundwater wells are located within Zone 1, and supply water to the Gunite Reservoir. The Gunite reservoir in turn feeds the Hypalon reservoir though an automated valve chamber. The Hypalon Reservoir supplies water to Zone 1. The Gunite Reservoir, Hypalon reservoir, and the Selkirk Booster Station are all located on the same site in the SE Reservoir complex.

From Zone 1, water is lifted to the NE pressure zone and SE pressure zone via the Northeast Booster Station and the Selkirk Booster Station, respectively.

The NE Booster Station pumps water to the Lafontaine reservoir complex by one of two existing booster pumps. The Lafontaine reservoirs can provide fire protection storage to either the NE pressure zone or to lower elevations in the community through the NE bypass line (located within the NE Booster Station). It is important to note that the NE bypass line is manually operated and infrequently used currently, and Town's staff prefers the existing valve to be replaced before considering its use. The NE Booster pumps are on alternating winter and summer time duty. The NE "winter" booster pump has a capacity of 14 L/s, whereas the NE "summer" booster pump has a capacity of 17 L/s.

Water is boosted from the Gunite reservoir (located at the SE Reservoir Complex) into the Bear's Paw reservoir via the Selkirk Booster Station. There are two booster pumps in the Selkirk Booster station that run at 10 L/s each but are set to run concurrently, if necessary. It should be noted that, as indicated by SCADA data, when the two pumps run concurrently, the maximum MDD demand that the two pumps can supply when operating in parallel is 15.61 L/s. The Bear's Paw reservoir provides fire storage to the SE Bench only.

The NE bench has several buried pressure reducing valve stations in the community to reduce the pressures in the lower elevation portions of the community.

The Town also has a bulk water well, but that is not part of the potable water system. Well 6 has been abandoned and is no longer considered part of the potable water system.

Figure 2.1 shows a schematic of the existing water system. Figure 2.2 summarizes the existing water system infrastructure. Existing reservoir volumes and booster station capacities are summarized in Tables 2.2 and Table 2.3, respectively.

Table 2.2: Existing Reservoir Storage Volumes

Pressure Zone	Reservoir(s)	Total Storage Volume
Zone 1	Gunite	1,362 m^3
	Hypalon	2,270 m^3
SE Bench	Bears Paw	1,195 m^3
NE Bench	Lafontaine 1	760 m^3
	Lafontaine 2	1,362 m^3
	Total	6,949 m^3

Table 2.3: Existing Booster Station Capacity

Booster Station	Pump Capacity	Backup Generator
NE Booster Station	Winter Pump – 14 L/s Summer Pump – 17 L/s	Yes
SE Booster Station	Pump 1 – 10 L/s Pump 2 – 10 L/s	No Diesel Fire Pump – 70 L/s

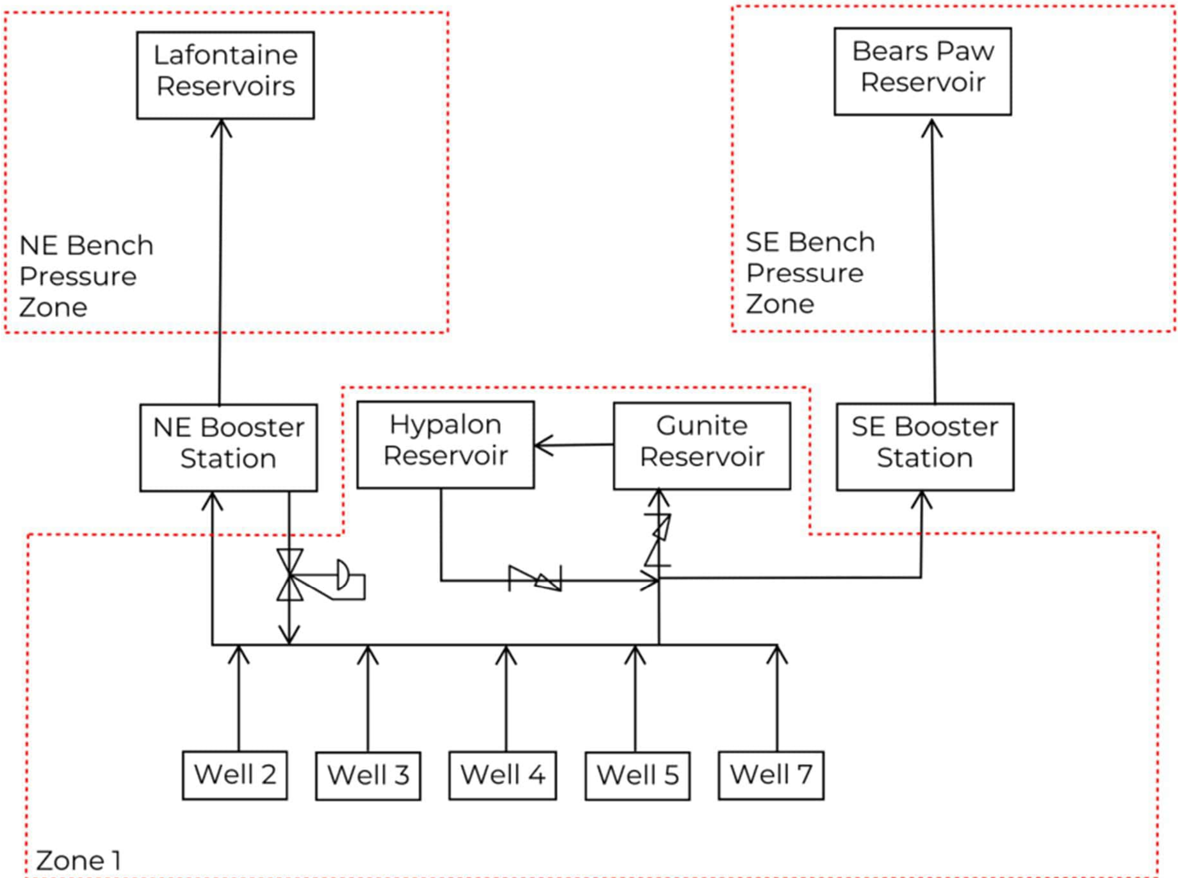
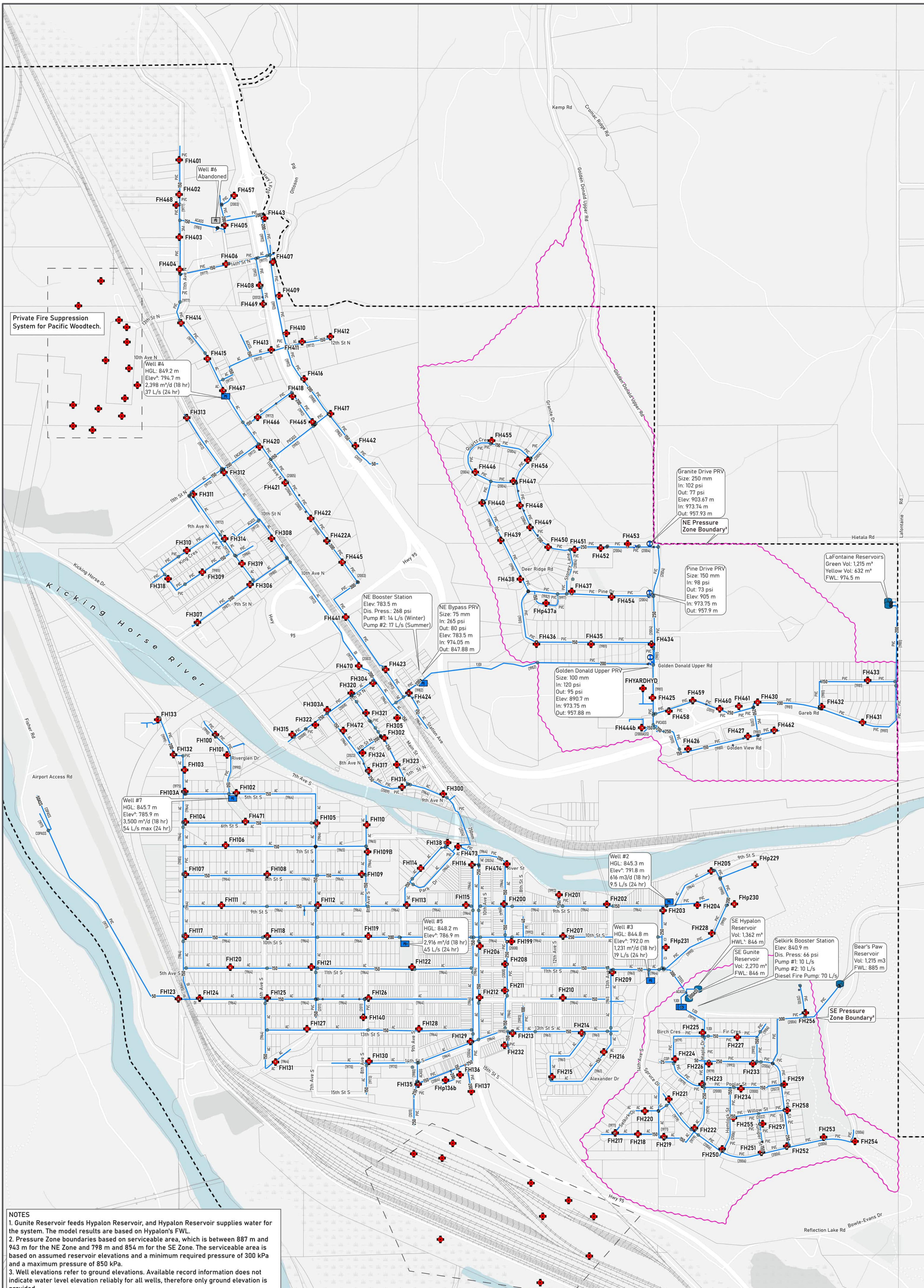


Figure 2.1: Existing Water System Schematic



NOTES
1. Gunite Reservoir feeds Hypalon Reservoir, and Hypalon Reservoir supplies water for the system. The model results are based on Hypalon's FWL.
2. Pressure Zone boundaries based on serviceable area, which is between 887 m and 943 m for the NE Zone and 798 m and 854 m for the SE Zone. The serviceable area is based on assumed reservoir elevations and a minimum required pressure of 300 kPa and a maximum pressure of 850 kPa.
3. Well elevations refer to ground elevations. Available record information does not indicate water level elevation reliably for all wells, therefore only ground elevation is provided.

URBAN SYSTEMS

Project #: 0404.0254.01
Author: BA
Checked: JC
Status:
Revision: A
Date: 2025 / 2 / 5

0 100 200 300 400 500
Metres

Coordinate System: NAD 1983 UTM Zone 11N

Scale: 1:6,000 (When plotted at 22"x34")

Data Sources:
- Village of Golden (Infrastructure); Urban Systems Ltd. (Infrastructure); Data BC (Cadastre PMBC, Municipalities); Esri (Basemap)

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

Hydrant
Water Node (Type)
- Hydrant Valve
- Valve
- Pressure Reducer Valve
- Air Release Valve
- Other

Water Pump (Active)
Water Pump (Abandoned)
Water Control Valve
- Pressure Reducer
Water Network Structure
- Reservoir
Water Pipe
Water Pressure Zone

Town Boundary

Town of Golden
Water Master Plan Update

Existing System

Figure 2.2

3.0 DESIGN CRITERIA

Appendix A outlines the design criteria used for this analysis. A summary of the key design criteria is included in this section.

3.1 POPULATION PROJECTIONS

Future population scenarios assume a population growth of 1.5% per year, as per the Town of Golden Transportation Plan (Urban Systems Ltd, 2023). This growth rate is applied to the base population from Golden's 2021 census data. The projected permanent population for the 10, and 25 year growth scenarios are summarized in Table 3.1.

Table 3.1: 10, 25, 50-Year Permanent Population Projections

Future Scenarios	Year	Population Projection
10-Year	2031	4,631
25-Year	2046	6,062

In addition, hotel, commercial, and industrial growth is anticipated. Table 3.2 summarizes the institutional, commercial, and industrial (ICI) growth projections, provided by the Town of Golden. As significant hotel growth is anticipated, hotels were separated from other ICI growth.

Table 3.2: Hotel, Commercial, and Industrial Growth Projections

Future Scenario	Year	Hotel (Bed unit)	Commercial (ha) [1]	Industrial / Institutional (ha)
Current	2021	956	31.0	46.4
10-Year	2031	1263	31.7	46.4
25-Year	2046	1516	32.8	46.4

Notes:

1. Hotels, zoned as commercial, represent an additional 14.3 ha. Hotel water usage was analyzed separately, as a result, this area was not included in the commercial area counts.

3.2 HISTORIC WATER USAGE

The Town provided historic water usage data from 2016 to 2022, which was used to calculate total annual water usage, average day demand (ADD), max day demand (MDD), and peak hour demand (PHD). The data shows that water usage is highest in the summer months. Figure 3.1 summarizes the monthly water usage from 2016 to 2022.

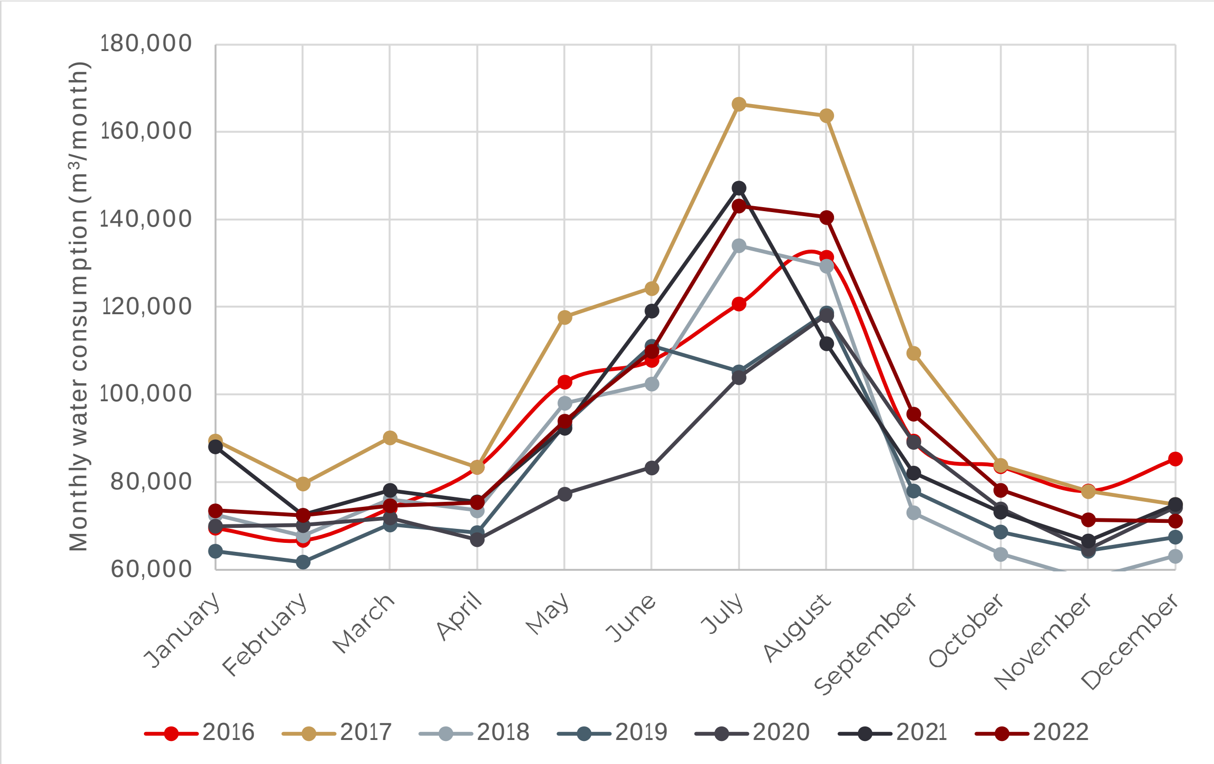


Figure 3.1: Total Well Volume Produced Per Month 2016-2022

Historic water usage was used to determine average day demands (ADD), maximum day demands (MDD), peak hour demands (PHD) and outdoor water usage. The proposed demands for the Integrated Water Plan are summarized in Table 3.3.

Table 3.3: Proposed Demands for Integrated Water Plan

	Residential	Hotel	ICI
Average Day Demand	460 L/cap/day (existing) 700 L/cap/day (growth)	350 L/BU/day	12,500 L/ha/day (existing) 21,500 L/ha/day (commercial growth)
Max Day Demand	1,000 L/cap/day (existing) 1,700 L/cap/day (growth)	700 L/BU/day	26,300 L/ha/day (existing) 45,000 L/ha/day (commercial growth)
Peak Hour Demand	1,500 L/cap/day (existing) 2,400 L/cap/day (growth)	1,100 L/BU/day	39,500 L/ha/day (existing) 67,500 L/ha/day (commercial growth)
Average Day Outdoor Demand	100 L/cap/day (existing)	N/A	8,000 L/ha/day (existing)

3.3 IMPACT OF CLIMATE CHANGE

In British Columbia, climate change scenarios indicate that average annual temperatures and precipitation amounts are projected to increase (Ministry of Health, 2024). However, even though precipitation is projected to increase annually, summer precipitation may decrease. Scenarios also indicate that the seasonal and regional variability will increase, such that some areas will receive significantly more precipitation and others will experience reduced recharge and more severe droughts.

The Design Guidelines for Drinking Water Systems in British Columbia outlines that climate change will likely cause increased demand on water systems, especially in summer months, due to:

1. Increased irrigation demands as a result of higher temperatures, reduced summer precipitation, and/or summer drought.
2. A lengthened growing season which would further increase irrigation demands.

To account for the impacts of climate change, we have allowed for an increased irrigation season in our annual water usage projections. The summer season is defined as the approximate length of the growing season during which there are no freezing temperatures to kill or damage plants.

It should also be noted that peak demands will likely coincide with periods of lowest precipitation. Therefore, to mitigate the impacts of climate change source studies as well as strategies incorporating increased monitoring, response planning, and community water conservation programs should be implemented to manage water demand. Table 3.4 shows the impacts of the anticipated lengthened growing season on water demands.

For the purpose of this study, we assumed the irrigation demand (i.e. 100 L/c/d for residential) will stay the same. Increases in demand due to higher temperatures and reduced precipitation could be mitigated by water conservation programs.

Table 3.4: Impacts of Lengthened Growing Season on Outdoor Water Usage

	Increase in Irrigation Length [1]	Irrigation Season (days)	Residential Outdoor Usage [2] (m^3/year)	ICI Outdoor Usage [3] (m^3/year)	Increase Due to Climate Change (m^3/year)
Current	-	153	60,986	33,672	-
10-Year	19%	182	84,317	40,371	30,030
25-Year	29%	197	114,415	44,285	64,042

Notes:

1. Average of increase in frost free days and increase in growing degree days data from Climatedata.ca, assuming the RCP-8.5 scenario.
2. Uses the calculated outdoor demand of 100 L/c/d, and the population growth of 1.5%
3. Uses the calculated outdoor demand of 8,000 L/ha/d, and the anticipated ICI growth provided by the Town.

3.4 EXISTING AND FUTURE WATER DEMANDS

The projected water demands for the existing, 10-Year, and 25-Year design horizons are summarized in Table 3.5.

Table 3.5: Estimated Water Demands for Integrated Water Plan

	Existing	10-Year	25-Year
Average Day Demand (m^3/d)	3,100	3,800	4,830
Maximum Day Demand (m^3/d)	6,700	8,150	10,850
Peak Hour Demand (L/s)	117	141	187

It is important to note that water conservation has not been considered in the future development projections. Water conservation measures and reduction targets could be evaluated in a future study (e.g., implementing a universal metering program).

3.5 REQUIRED FIRE FLOWS

Golden's Subdivision Servicing Bylaw stipulates fire flow requirements based on land use. These requirements are in line with the 2022 MMCD Design Guidelines.

The Town may want to consider lowering the industrial fire flow requirement. Industrial fire flows require extensive fire fighting personnel and equipment, and it should be confirmed if the Golden Fire Department has the resources to meet these requirements. Furthermore, industrial fire flows often drive infrastructure sizing for reservoirs and watermains. By not allowing future developments that require these fire flows, infrastructure sizing can be reduced. It is important to note that new buildings can be constructed with fire protection measures to meet the available fire flow in a given area (e.g. automated sprinklers, fire walls, better building materials, etc.).

Other than the industrial fire flow, no updates to the fire flow requirements stipulated in the Subdivision Servicing Bylaw are recommended for the Integrated Water Strategy.

Table 3.6: Recommended Fire Flows for Integrated Water Strategy

	Golden Subdivision Servicing Bylaw (2008)	Recommended Fire Flows for Integrated Water Strategy
Single Family Residential	60 L/s	60 L/s
Apartments/ townhouses	90 L/s	90 L/s
Commercial	150 L/s	150 L/s
Institutional	150 L/s	150 L/s
Industrial	225 L/s	150 L/s

Some existing locations have fire flow requirements that exceed the current bylaw. To assess existing fire flow performance, historic FUS reviews were consulted. The base required fire flow per zone is summarized in Table 3.7, see Section 5.0 for available fire storage.

Table 3.7: *Base Required Fire Flow Per Zone*

	Base Fire Flow Required (L/s)	Duration Fire Flow Required (min)[1]	Required Storage (m^3)
Townsite (Zone 1)	220 [2]	168	2,218
Northeast Bench (NE) Zone	183 [3]	135	1,482
Bear's Paw (SE) Zone	90 [4]	111	600
Total System	220 [2]	170	2,218

Notes:

1. Durations are taken from Water Supply for Public Fire Protection, A Guide to Recommended Practice in Canada. FUS, 2020.
2. Base fire flow from the 2017 FUS assessment completed for Golden. A max 150 L/s fire flow is recommended for future development.
3. FUS recommended fire flow for Days Inn Motel, from the 1990 FUS assessment. We are assuming this fire flow is the highest required fire flow in the NE zone. A max 150 L/s fire flow is recommended for future development.
4. Allows for apartments and townhouses to be developed within the Bear's Paw (SE) Zone. Proposed structures must be designed to limit their required fire flow to 90 L/s or less.

3.6 PERFORMANCE STANDARDS FOR NORMAL OPERATION

Normal operations are defined as all times when emergency operations, such as fire flow events, are not occurring. The following performance standards for normal operations are based on recommendations provided in the Master Municipal Construction Document (MMCD) Design Guideline Manual (2022). These design requirements are consistent with the 2008 Golden Subdivision Servicing Bylaw.

Maximum System Pressure:

A maximum water pressure of 850 kPa (123 psi) is recommended under static conditions. Where the maximum pressure exceeds 515 kPa (75 psi), service connections should be individually protected by pressure reducing valves located in the buildings being served.

It is worth noting that water pressures in excess of 515 kPa (75 psi) increase stress on plumbing fixtures and fittings, and that any leaks that may arise are exasperated by higher pressures.

Minimum System Pressure:

Under the peak hour demand scenario, the minimum residual pressure which should be maintained at street level is 300 kPa (44 psi).

4.0 SOURCE WATER ASSESSMENT

4.1 WATER SUPPLY

The Town relies on four water wells currently: Well 2, Well 3, Well 4, and Well 5. A fifth well (Well 7), was drilled in 2023 and design for the pump station and civil works to tie into the potable water system is ongoing. Well 7 has been sized to meet the projected water demands for the 25-year design horizon.

Table 4.1 summarizes the capacity of the existing well pumps to meet maximum day demands as well as the licensed annual allocation.

Table 4.1: Existing Well Capacity

	Well Pump Capacity (L/s)	Total Production Over 18 Hour Pump Day (m^3/d)	Licensed Annual Water Allocation ($m^3/year$)
Well 2	9.5	616	105,000
Well 3	19	1,231	270,000
Well 4	37	2,398	408,354
Well 5	45	2,916	560,000
Well 7	54	3,499 [1]	450,000 [1]
Total Without Well 7	110.5	7,160	1,343,354
Total With Well 7	164.5	10,660	1,793,354

Notes:

1. License request has been submitted to ENV, but not yet approved.

Well 7 was sized to meet the annual 25-year needs of Golden. With Well 7, the Town can supply the 25 Year MDD over an 18.3-hour period which is minor exceedance of the desired 18 hour daily operating time limit, and we expect the supply to be adequate. The required and available water supply once Well 7 is online is summarized in Table 4.2.

Table 4.2: Required & Available Water Supply for 25 Year Growth Horizon

	Water Supply Required	Water Supply Available with Well 7
Annual volume of water required – 25 Year Horizon (2046)	1,763,119 $m^3/year$	1,793,354 $m^3/year$
Maximum Day Demand – 25 Year Horizon (2046)	10,850 m^3/d	10,850 m^3/d (over 18.3 hours)

It is important to note that the system currently has a large reliance on the two larger capacity wells: Well #4 and #5. Should one of these wells fail, the Town would be unable to meet their MDD. The Town could still supply the average day demand if the highest capacity well was lost for any reason providing a reasonable amount of redundancy and we would expect the Town to implement water restrictions to limit use in such an event.

4.2 WATER SUPPLY RELIABILITY

Currently, Wells 3 and 5 have backup power. The Well 7 design includes a generator to allow operation in the event of a power outage. Installing a generator at Wells 2 and 4 is recommended to increase the reliability of the water supply system.

4.3 TREATMENT CONSIDERATIONS

Treatment upgrades have not been considered as part of this study. Testing is currently ongoing to confirm the presence of a confining layer at Well 7, if the confining layer is not found, UV and chlorine disinfection will be installed at this site to provide 3 log reduction of Cryptosporidium and Giardia and 4 log reduction of viruses. All other wells (i.e., 2, 3, 4 and 5) comply with Guidelines for Canadian Drinking Water Quality without treatment, have a confining layer and have been successfully operated for fifteen plus years without detecting total coliforms or E.coli. Wells 2, 3, 4 and 5 can provide secondary disinfection in an emergency.

It is possible that in the future regulations will change, and Interior Health could mandate continuous secondary disinfection or primary disinfection for 4 log reduction of viruses as is common for new construction. If this occurred, we would expect that costs related to this work would be eligible for grant funding. No allowance for treatment upgrades has been included in this study as it is not required at this time.

Summary of Recommended Water Supply Upgrades:

- Complete construction of Well 7
- Install generators at Wells 2 and 4

5.0 STORAGE ASSESSMENT

The Town has five existing reservoirs: two Lafontaine Reservoirs (NE Zone), the Bears Paw reservoir (SE Zone), and the Gunite and Hypalon reservoirs (Zone 1). Table 5.1 summarizes the recommend storage per zone for the 25-Year Design Horizon.

Table 5.1: Recommended Reservoir Storage

Parameter	Unit	Total System	Zone 1 (Gunite & Hypalon Reservoirs)	NE Zone (Lafontaine Reservoirs)	SE Zone (Bears Paw Reservoir)
A = Fire Storage	m^3	2,218	2,218	1,482	600
B = Equalization Storage	m^3	2,681	1,593	710	378
C = Emergency Storage	m^3	1,746	953	548	245
Recommended Reservoir size	m^3	6,645	4,764	2,740	1,223
Existing Reservoir Size	m^3	6,949	3,632	2,122	1,195
Storage Deficiency	m^3	N/A	-1,132	-618	-28

This storage does not need to be supplied solely by the reservoir for each zone. Additional credits for fire protection storage can be acquired by providing stand-by generators to ensure water from the source wells or booster stations supplying the zone can be pumped into the system even during a power outage, or by cascading water from a reservoir in a higher elevation pressure zone through pressure reducing valves.

It is important to note that relying on water cascaded from an upper zone increases the system risk. If a PRV fails during a fire event, the zone could have deficient fire flow. In addition, if there is insufficient looping in the zone, a watermain break could impact the ability to provide fire flows to lower zones.

Relying on water cascaded from an upper zone can also impact Fire Underwriters Survey (FUS) insurance ratings. Many factors go into computing a public fire protection classification (PFPC) score, including firefighting personnel, fire risk, building construction, and the water system itself. In general, the more redundancy in the water system, the higher the PFPC score.

It is important to minimize water age to reduce the risk of water quality issues occurring in the distribution system. As a result, upgrades to share storage between zones are recommended over constructing additional storage.

To share storage between zones, the following upgrades are recommended:

- Upgrades to the NE Booster Station are recommended. Oversizing the pumps by 11 L/s will provide 11 L/s of additional capacity to the NE zone. This could supplement MDD or emergency storage.
- Upgrades to the Selkirk Booster Station are recommended. The pump capacity needs to be increased to meet the existing MDD, therefore oversizing the pumps by 3 L/s will provide 3 L/s of additional storage capacity to the SE zone. This could supplement emergency storage. In addition, a generator is required for the SE Booster Station and pump capacity will need to be

further increased to address future water demands. See Section 6.0 for further discussion on the Selkirk Booster Station replacement.

- Install a PRV in the new NE Booster Station that will automatically open to supplement fire flows to Zone 1. We have assumed that only the fire flow volume (A volume) is available to cascade down to Zone 1, and that the B (MDD equalization) and C (emergency storage) must remain in the Lafontaine Reservoirs.
- Install a PRV in the Selkirk Booster Station that will automatically open to supplement fire flows to Zone 1. We have assumed that only the fire flow volume (A volume) is available to cascade down to Zone 1, and that the B (MDD equalization) and C (emergency storage) must remain in the Bears Paw reservoir.

With the above upgrades, the recommended storage volumes are as follows (Table 5.2).

Table 5.2: Recommended Storage Volumes Accounting for Pumping/Cascading

Parameter	Unit	Total System	Zone 1 (Gunite & Hypalon Reservoirs)	NE Zone (Lafontaine Reservoirs)	SE Zone (Bears Paw Reservoir)
Recommended Reservoir size	m^3	6,645	4,764	2,740	1,223
Existing Reservoir Size	m^3	6,949	3,632	2,122	1,195
Initial Surplus/Deficiency	m^3	304	-1,132	-618	-28
Volume available from other zones	m^3	N/A	1,436 [1]	832 [2]	151 [3]
Final Surplus/Deficiency	m^3	N/A	304	214	123

Notes:

1. Includes the NE and SE Zone's fire storage with deficient storage amounts subtracted as listed in Table 5.1
2. Includes the proposed additional 11 L/s oversizing of the NE Booster Pumps being utilized for 21 hours per day.
3. Includes the proposed additional 3 L/s oversizing of the SE Booster Pumps being utilized for 21 hours per day.

Summary of Recommended Storage Upgrades:

- Install automated cascading valves in NE Booster Station and Selkirk Booster Station.
- Oversize NE Booster Station pumps by 11 L/s to supplement emergency storage.
- Oversize Selkirk Pumps by 3 L/s to supplement emergency storage. See Section 6.0 for further discussion on the booster station water demand and emergency storage.

6.0 BOOSTER STATION ASSESSMENT

There are two existing booster station:

1. Northeast (NE) Booster Station: pumps water from Zone 1 to the Lafontaine Reservoirs.
2. Selkirk (SE) Booster Station: pumps water from Zone 1 to the Bears Paw Reservoir.

Table 6.1 summarizes the existing booster station capacity as well as capacity required to meet the 25-year demand projections. Note that the MDDs are expressed over a 21-hour pump day. Booster stations are commonly sized to meet MDD over 21 hours to allow time for maintenance.

Table 6.1: Booster Station Capacity Assessment

Parameter	Unit	NE Booster Station	Selkirk (SE) Booster Station
Pump 1 Capacity	L/s	14.0	10.0
Pump 2 Capacity	L/s	17.0	10.0
Capacity w/ largest pump out of service	L/s	14.0	10.0
Existing MDD - 21 hour operation day	L/s	13.0	12.2
Additional Capacity Required – Existing MDD	L/s	0.0	2.2
25 Year MDD - 21 hour operation day	L/s	37.6	20.0 [1]
Additional Capacity Required – 25 Year MDD	L/s	23.6	10.0

Notes:

1. The Bears Paw zone is close to build-out, which has been defined in previous planning (*Selkirk Booster Station – Water Model Verification and Pumping Requirements Review*, June 5, 2023, Urban Systems). To accommodate the 25-year buildout population (915 people), a booster station capacity of 20.0 L/s (provided over 21 hours) is required. Costs are based on the build-out capacity.

Both booster stations will require upgrades to meet the 25-year MDD:

- Significant growth is projected in the NE Zone, resulting in significant demand increases. A new NE booster station is proposed. As outlined in Section 4, oversizing the NE Booster pumps to defer reservoir volume upgrades is also recommended. A new booster station with 2 x 49 L/s pumps is recommended. The station will be equipped with a generator as well as a PRV to allow for cascading between the NE Zone and Zone 1
  - o Since 2022, Timber Ridge Phase 1, Golden Mountainside Campground Phase 1 and Skybridge and Cox Phase 2 were approved and constructed. Hence, the water demands from these developments were not included in the existing condition model but accounted for in the future/growth model results (10-year model). These developments are contributing to the water demand with 1.00 l/s, 4.36 l/s, and 0.08 l/s respectively under MDD conditions, for a total of an additional 5.44 l/s. Hence, considering pump 2 capacity of 17 l/s during summertime and the fact that Golden Mountainside Campground Phase 1 and Skybridge operate in summer, currently under MDD condition, there is no additional capacity remaining. Considering pump 1 capacity of 14 l/s during wintertime and the fact that Golden

Mountainside Campground Phase 1 and Skybridge do not operate in winter, currently under MDD condition, there is no additional capacity remaining.

- The existing MDD in the SE Zone exceeds the capacity of the Selkirk Booster Station with a single pump in operation. Originally, it was recommended to replace only the booster pumps and starters, with a condition assessment to evaluate additional building upgrades. However, further analysis revealed that intake velocity with the new pumps would be too high, and the current piping configuration in the slab prevents easy upgrades without significant service disruptions. Additionally, the fire pump requires manual operation and is nearing the end of its life, switching to an automated system presents less risk. Therefore, a new booster station with 2 x 23 L/s pumps with VFDs are recommended with a standby generator. Reuse of the generator from the NE Booster Station could be considered, however this should be reviewed by an electrical engineer in future design phases.
    - Since 2022, Bears Paw Phase 5 was approved and constructed. Hence, the water demands from this development were not included in the existing condition model but accounted for in the future/growth model results (10-year model). This development is contributing to the water demand with 1.42 L/s under MDD conditions. Hence, considering one pump only operating at any time, there is no additional capacity remaining; considering both pump 1 and pump 2 operating concurrently with a capacity of 15.61 L/s, there is an additional capacity of 1.99 L/s. It should be noted that it is not best practice to run booster station's pumps concurrently for 21-hour operation day at their maximum pump capacity output.

The recommended pump upgrades and their impact on shared fire storage between pressure zones are summarized in Table 6.2. As noted in Section 5.0, fire storage in one zone can be supplemented by pumping water from other zones. The booster station's capacity to supplement fire storage is defined as the largest pump's capacity with one well offline, minus the 25-year MDD.

Table 6.2: Summary of Pump Upgrades and Impacts on Shared Fire Storage

Parameter	NE Booster Station	Selkirk (SE) Booster Station
Proposed Number of Pumps and Capacity	2 x 49 L/s	2 x 23 L/s
Capacity w/ largest pump out of service	49 L/s	23 L/s
25 Year MDD - 21 hour operation day	38 L/s	20 L/s
Oversizing to Supplement Fire Storage	11 L/s	3 L/s

Summary of Recommended Booster Station Upgrades:

- Replace NE Booster Station.
- Replace SE Booster Station.

7.0 DISTRIBUTION SYSTEM ASSESSMENT

The Town has a water model, developed using Bentley WaterCAD. This model was used to assess the existing performance of Golden's water system. The water model is a representation of actual infrastructure and attempts to simulate the actual operation and flow demands in Golden. This model was validated as part of the infrastructure planning process and used to identify concerns related to the operation of the system under normal operating and fire-flow conditions. The water model was also updated with future development (as identified in the Design Criteria memorandum) to determine future distribution system requirements.

7.1 SYSTEM CHANGES AND IMPROVEMENTS SINCE 2013

Record drawings from system upgrades completed since 2013 and the Town's GIS data was the primary source of information used to update the pipe and node network topology model. The projects that altered the water distribution system are as follows:

- Well 6 was taken offline, and Well 7 is expected to be in service in fall 2025
- Watermain installations as part of the 2024 Kicking Horse River Bridge Replacement
- Watermain installations as part of the 2022 9th Avenue Improvements
- Watermain installations as part of the 2023 6th Street Underground Utilities

The most recent GIS data set was obtained from the Town's GIS portal on June 5, 2024. Attributes of the water mains, such as diameter and material, as well as node elevations were extracted from the GIS database. These attributes were compared to the model and updated as required.

Demands were updated to reflect the updated design criteria. In addition, model validation was completed to ensure the model was accurately representing real world conditions.

Additional details on the model update and validation can be found in the "*Golden Integrated Water Plan – Model Update and Validation"* memorandum (Appendix B).

7.2 WATER MODEL SCENARIOS

The system analysis was run with the scenarios outlined in Table 7.1. The model was initially run under existing MDD to evaluate the current system performance, and then under the 25-year MDD to evaluate the performance of the recommended upgrades at the design horizon. The scenarios are explained below:

- Pressures at ADD – Evaluates the system pressures under normal operating conditions with all booster stations and wells off. These pressures were compared to the minimum and maximum system operating pressures in the *2008 Subdivision and Development Servicing Bylaw*.
- Available fire flow at MDD – Evaluates the available fire flow. Nodes in Zone 1 show the available fire flow with the NE bypass closed (existing scenario), with NE bypass open (future scenario with upgrades) and the booster stations off as outlined in Table 7.1. The Town has noted that while the NE Booster Station currently has a bypass valve, it must be manually opened in the event of a fire. Staff have stated that they are unlikely to manually operate it during an emergency. The current configuration could also create system surging. The NE bypass valve has a significant

effect on available fire flows, however the Town has no immediate plans to replace the valve. As a result, we have assumed that the NE bypass valve is not operational in scenarios without upgrades.

For the NE and SE zone, nodes show the available fire flow with the existing NE bypass closed, the proposed SE bypass closed and pumps on as summarized in Table 7.1.

Figures 7.1 to 7.6 show the performance of the distribution system under normal operating conditions and fire flow events. Exports of the model performance are included as Appendix C.

Table 7.1: Operational Conditions for Water Model Result Figures

	Figure 7.1	Figure 7.2	Figure 7.3	Figure 7.4	Figure 7.5	Figure 7.6
Purpose	Static pressure under existing ADD	Static pressure under 25 year ADD	Available fire flow under existing MDD	Available fire flow under 25 year MDD without upgrades	Available fire flow under 25 year MDD with high priority upgrades	Available fire flow under 25 year MDD with all upgrades
Duty NE Booster Pump	Off	Off	On for NE pressure zone only	On for NE pressure zone only	On for NE pressure zone only	On for NE pressure zone only
NE Bypass	Closed	Closed	Closed	Closed	Open for Zone 1 only	Open for Zone 1 only
Duty Selkirk Booster Pump	Off	Off	Off	On for SE pressure zone only	On for SE pressure zone only	On SE pressure zone only
Well 2	Off	Off	Off	Off	On	On
Well 3	Off	Off	On	On	On	On
Well 4	Off	Off	Off	Off	On	On
Well 5	Off	Off	On	On	On	On
Well 7	Off	Off	Off	Off	Off	Off

7.3 RESULTS

Pressures in the distribution system during normal operation are within the recommended range. No upgrades are recommended related to improving system pressures.

Several upgrades are recommended to improve fire flow performance. These have been grouped into high and low priority upgrades. Additional information on proposed upgrades can be found in Appendix D.

High Priority Upgrades:

The high priority distribution system upgrades are to address deficiencies for upcoming development, increase system reliability, and provide significant fire flow improvements. The recommended upgrades are described as follows and shown in Figure 7.7.

- Fire flow performance is significantly improved when the groundwater wells are on. For the wells to be relied on in an emergency, they should have back up power. Installing a generator at Well 2 and 4 is recommended as a result.
- The model was run assuming one of the larger wells (either Well 7 or Well 4) was offline. This is a conservative approach and allows for a critical failure during the emergency response. This is in line with the approach that has been used since the 2013 water master plan update, which assumed all wells other than Well 6 were online.
- Fire flow performance is significantly improved in the northern portion of Zone 1 when there is a cascading valve in the NE booster station to supplement fire flows. A PRV that will automatically open to supplement fire flows is recommended and allowed for in NE Booster Station cost estimate.
- There is currently only one watermain crossing the Kicking Horse River. In addition, all but one of the groundwater wells are located south of the Kicking Horse. An additional watermain crossing is recommended for redundancy. The second watermain crossing also improves fire flow performance.
- There is small diameter piping feeding the Lafontaine Reservoirs. Replacing this piping improves not only the fires flows to the NE pressure zone, but to Zone 1 by improving the capacity of the NE Bypass valve. Replacing approximately 750 m of piping is recommended under current conditions to improve fire flow and increase residual pressures in the Gareb Road, Lafontaine Road, Granite Drive, and Golden View Road areas during fire flow events. Along with replacing the NE Booster Station, these upgrades are critical to supporting planned development and 25-year growth while ensuring sufficient storage and fire protection without expanding the existing reservoirs.

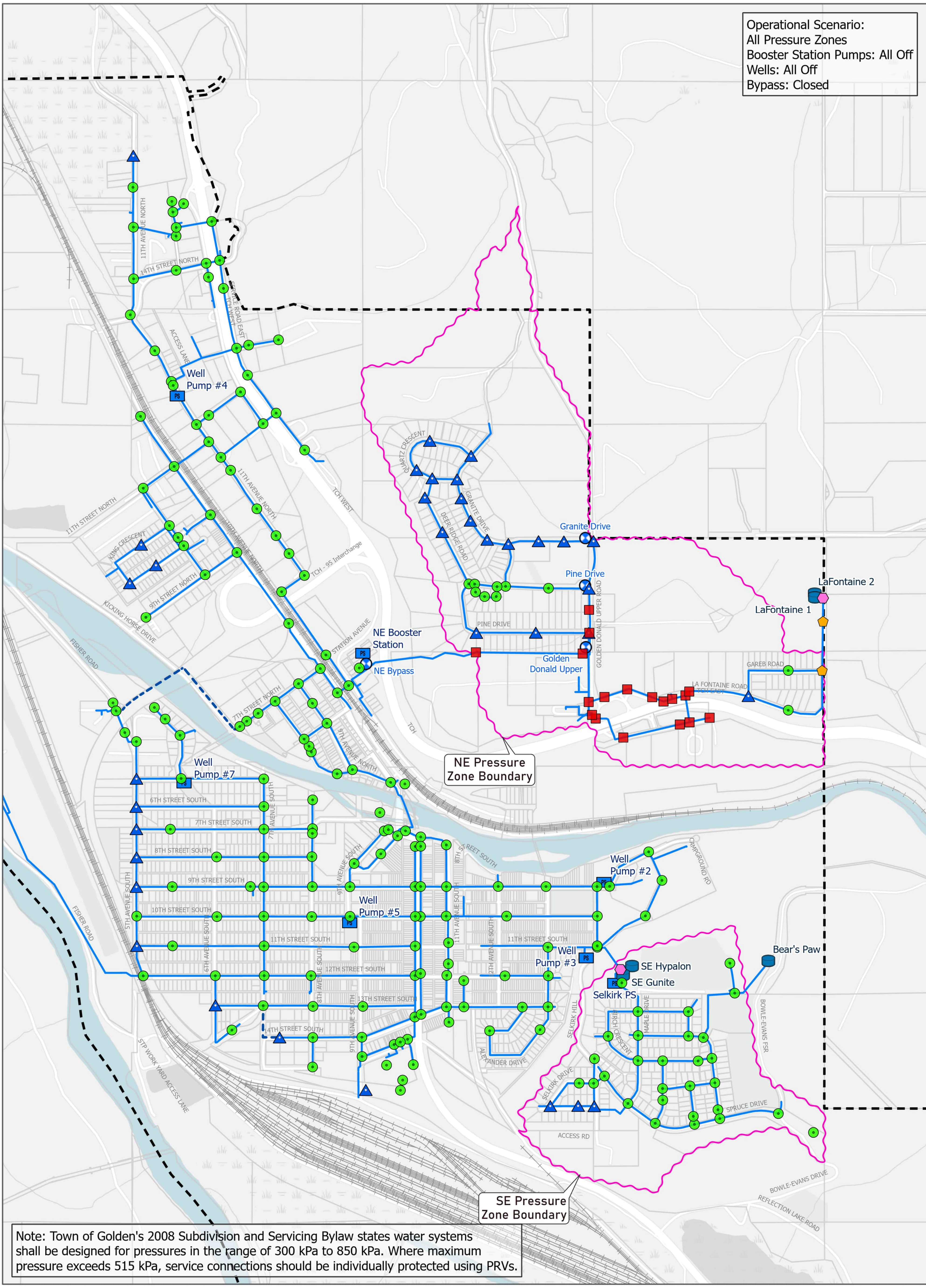
Low Priority Upgrades:

There are several areas with deficient fire flow currently. While we have identified upgrades (largely increasing pipe size) to improve fire flows to existing developments, the capital costs to rectify all deficiencies are high. Existing deficiencies are understood to have been considered in past FUS reviews for insurance grading and it possible that insurance costs could be lower with the proposed watermain upsizing. We recommend upsizing pipes to improve fire flow as funds allow and have identified the proposed works in Figure 7.7.

There are two areas that the model shows as having deficient fire flows, the NW industrial and highway commercial zone, and the southern industrial zone.

Additional information on the model results can be found in Appendix C.

The three PRVs along Golden Donald Upper Road require confined space entry to maintain, resulting in safety risks and higher maintenance costs. Modelling suggests that these PRVs are likely not functioning as intended currently; To achieve similar static pressures from the hydrant tests in the model, the PRVs in the model need to be set it open. The existing three PRV stations could be replaced with one above ground PRV station to reduce the confined space risk. However, as the system appears to be functioning adequately, these upgrades can be deferred until the infrastructure reaches the end of its service life or if significant service impacts arise. This work has not been included in current cost estimates and should be revisited in the next Water Strategy Update. The model results shown are based on design PRV set points.



URBAN SYSTEMS

Project #:	0404.0254.01
Author:	JW
Checked:	JR
Status:	Final
Revision:	A
Date:	2025 / 2 / 5

0 200 400 600 Metres

Coordinate System: NAD 1983 UTM Zone 11N

Scale: 1:12,500 (When plotted at 11"x17")

Data Sources:
- Data provided by ESRI, Town of Golden, BC Government

The accuracy & completeness of information shown on his drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

Legend

Pressure (kPa)
- < 150
- 150 - 300
- 300 - 550
- 550 - 700
- 700 - 850

- Water Pipe
- Future Water Pipe
- Water Pump
- Pressure Reducer
- Reservoir
- Water Pressure Zone
- Town Boundary

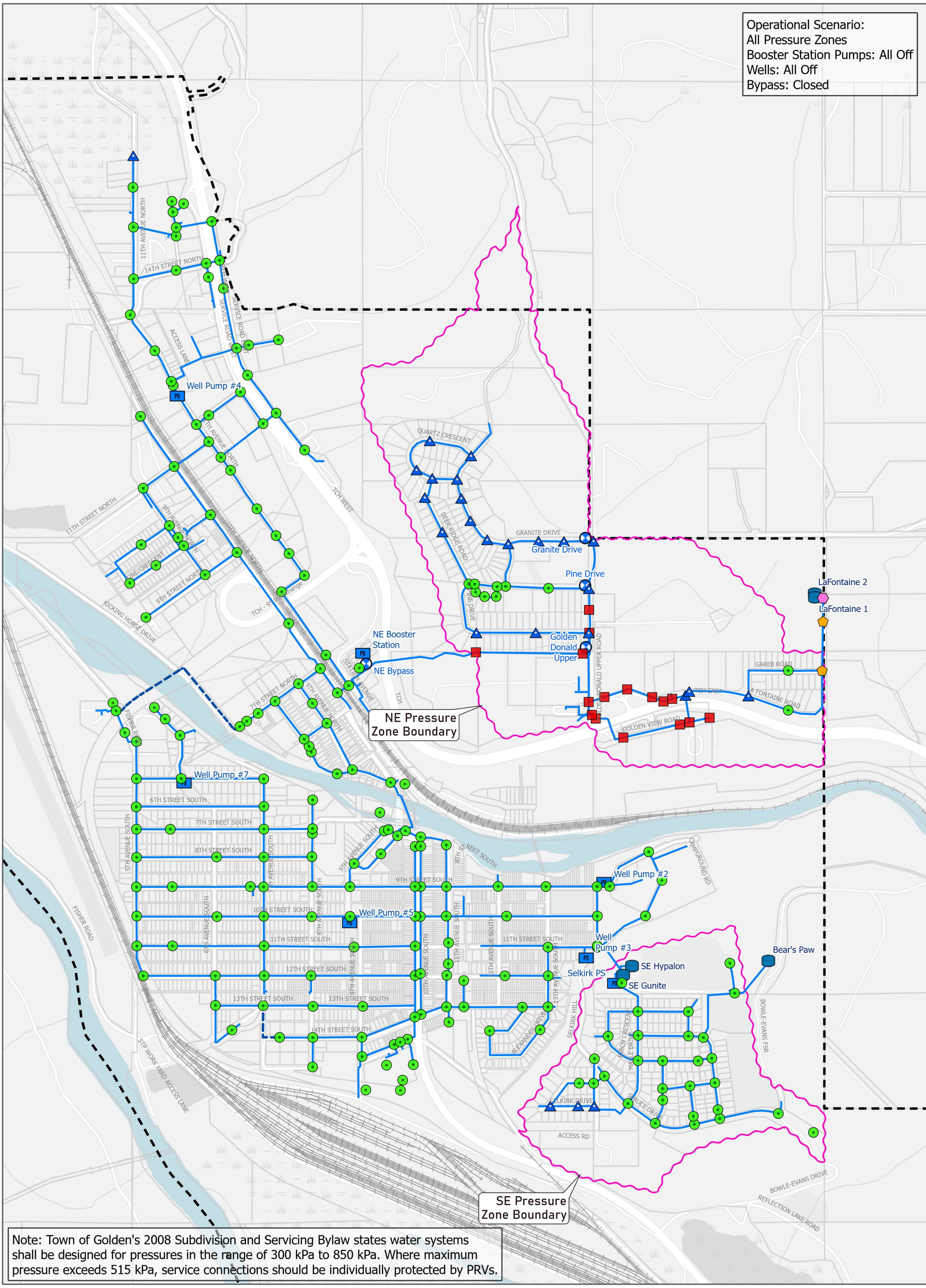
Town of Golden

Integrated Water Plan

Static Pressure (Under Existing ADD)

FIGURE 7.1

\\usl.urban-systems.com\projects\Projects_CAL\0404\0254\01\D-Design\GIS\Projects\Pro_Projects\0404_0254_01_Golden_Water_Update_20230921.aprx\Golden - WMP - Fig 7_1 - Static Pressure - Existing - 20250205



URBAN SYSTEMS

Project #: 0404.0254.01
Author: JW
Checked: JR
Status: **Final**
Revision: A
Date: 2025 / 2 / 5

0 200 400 600
Metres

Coordinate System: NAD 1983 UTM Zone 11N
Scale: 1:12,500 (When plotted at 11"x17")

Data Sources:
- Data provided by ESRI, Town of Golden, BC Government

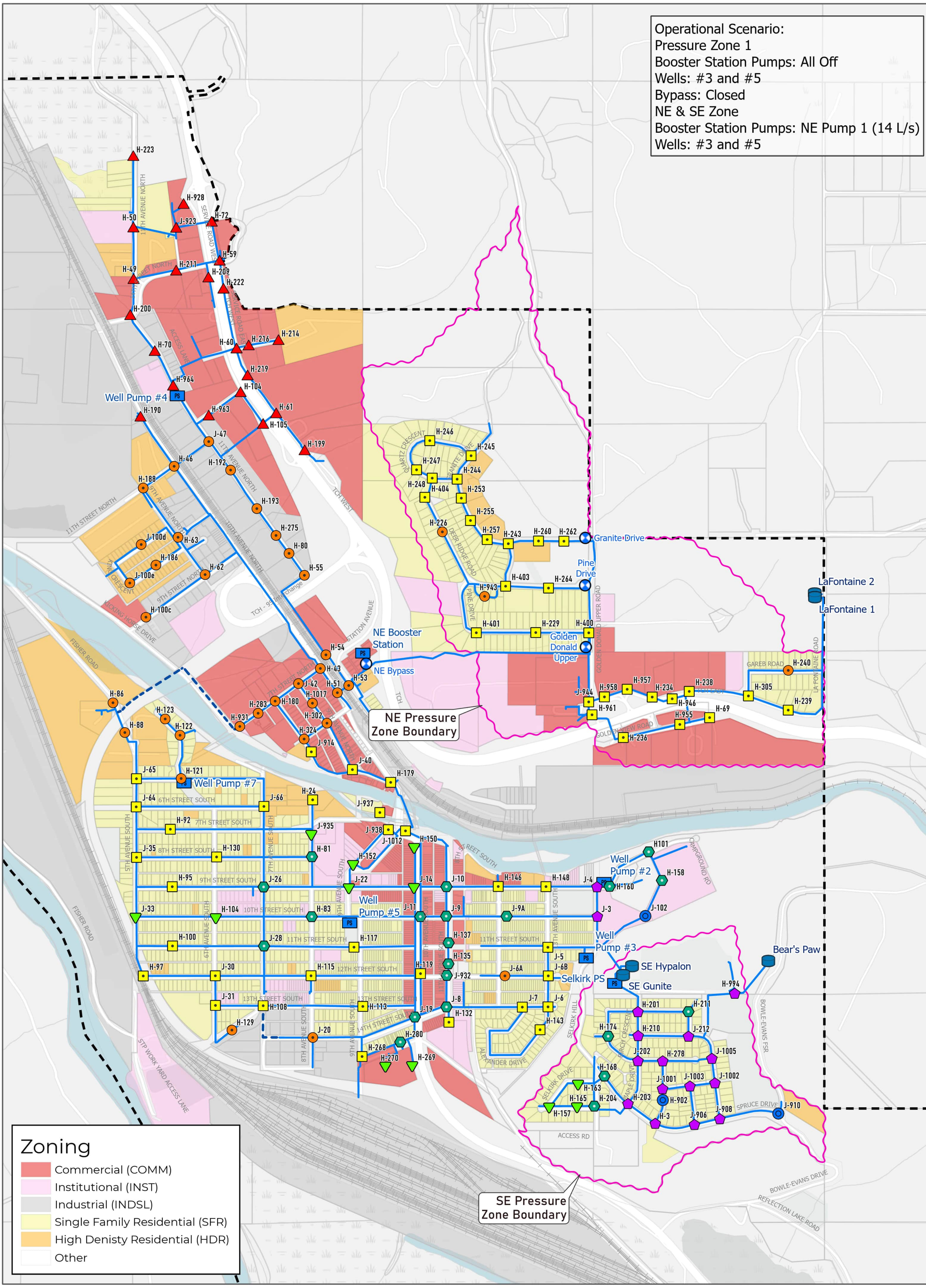
The accuracy & completeness of information shown on his drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

Legend
Pressure (kPa)
- 12 - 150
- 150 - 300
- 300 - 550
- 550 - 700
- 700 - 850

- Water Pipe
- Future Water Pipe
- Water Pump
- Pressure Reducer
- Reservoir
- Water Pressure Zone
- Town Boundary

Town of Golden
Integrated Water Plan
Static Pressure - Future (Under 25yr ADD)
FIGURE 7.2

\\usl.urban-systems.com\projects\Projects_CAL\0404\0254\01\D-Design\GIS\Projects\Pro_Projects\0404_0254_01_Golden_Water_Update_20230921.aprx\Golden - WMP - Fig 7_2 - Static Pressure - Future - 20250205



URBAN SYSTEMS

Project #: 0404.0254.01
Author: JW
Checked: JR
Status: Final
Revision: A
Date: 2025 / 4 / 22

0 200 400 600
Metres

Coordinate System: NAD 1983 UTM Zone 11N
Scale: 1:12,500 (When plotted at 11"x17")

Data Sources:
- Data provided by ESRI, Town of Golden, BC Government

The accuracy & completeness of information shown on his drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

Available Fire Flow (L/s)
- < 60
- 60 - 90 (SFR)
- 90 - 135 (HDR)
- 135 - 150 (HDR)
- 150 - 210 (COMM + INST)
- 210 - 225 (INDSL)
- 225 - 300 (INDSL)

- Water Pipe
- Future Water Pipe
- Water Pump
- Pressure Reducer
- Reservoir
- Water Pressure Zone
- Town Boundary

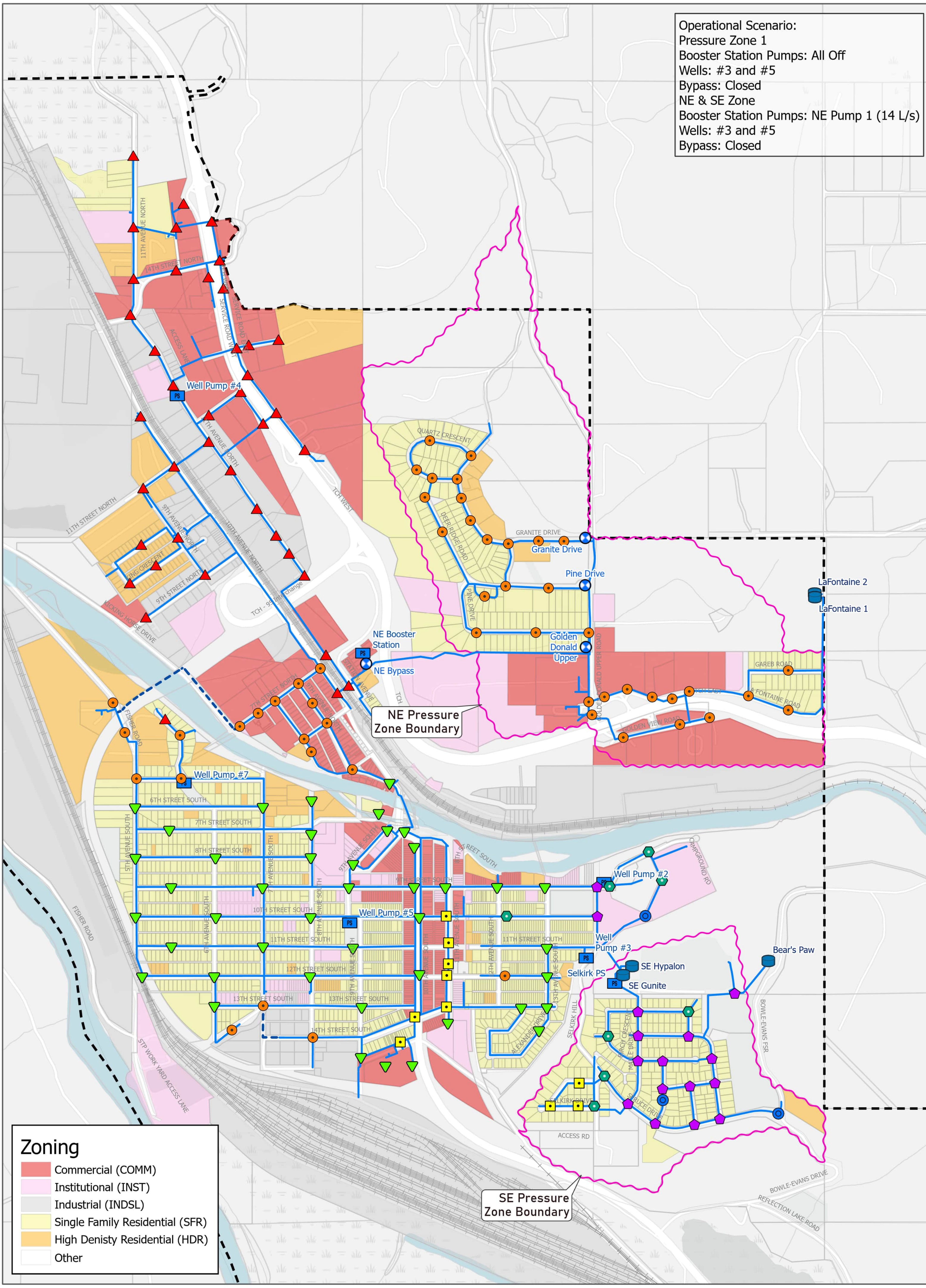
Town of Golden

Integrated Water Plan

Fire Flow (Under Existing MDD)

FIGURE 7.3

\\usl.urban-systems.com\projects\Projects_CAL\0404\0254\01\D-Design\GIS\Projects\Pro_Projects\0404_0254_01_Golden_Water_Update_20230921.aprx\Golden - WMP - Fig 7_3 - Fire Flow - Existing - 20250421



URBAN SYSTEMS

Project #:	0404.0254.01
Author:	JW
Checked:	JR
Status:	**Final**
Revision:	A
Date:	2025 / 5 / 8

0 200 400 600
Metres

Coordinate System: NAD 1983 UTM Zone 11N

Scale: 1:12,500 (When plotted at 11"x17")

Data Sources:
- Data provided by ESRI, Town of Golden, BC Government

The accuracy & completeness of information shown on his drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

Legend

Fire Flow (L/s)
- < 60
- 60 - 90
- 90 - 135 (HDR)
- 135 - 150 (HDR)
- 150 - 210 (COMM + INST)
- 210 - 225 (INDSL)
- 225 - 300 (INDSL)

- Water Pipe
- Future Water Pipe
- Water Pump
- Reservoir
- Pressure Reducer
- Water Pressure Zone
- Town Boundary

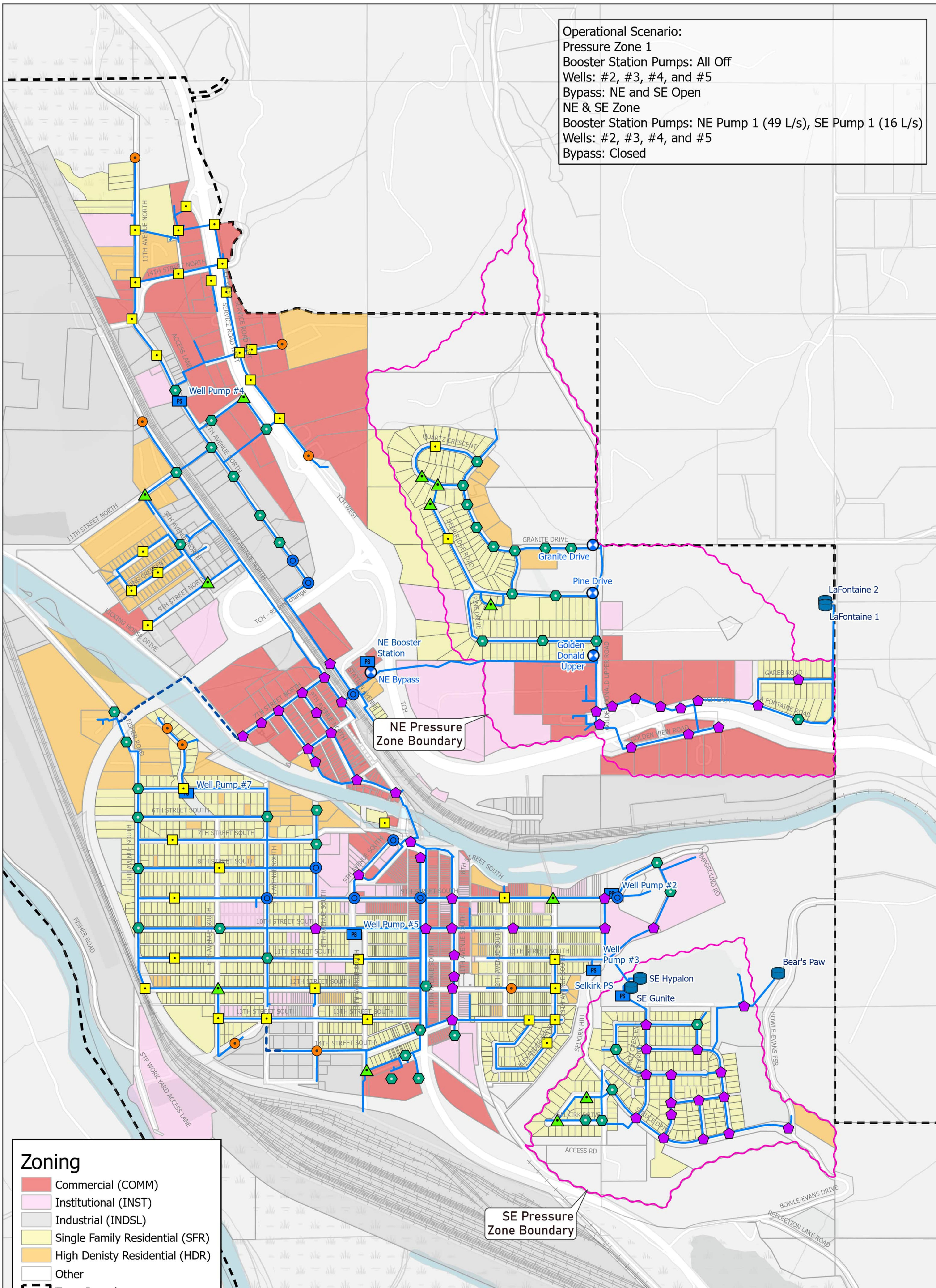
GOLDEN

Town of Golden

Integrated Water Plan

Fire Flow - Future
No Upgrades
(Under 25yr MDD)

FIGURE 7.4



URBAN SYSTEMS

Project #: 0404.0254.01
Author: JW
Checked: JR
Status: **Final**
Revision: A
Date: 2025 / 2 / 6

0 200 400 600
Metres

Coordinate System: NAD 1983 UTM Zone 11N
Scale: 1:12,500 (When plotted at 11"x17")

Data Sources:
- Data provided by ESRI, Town of Golden, BC Government

The accuracy & completeness of information shown on his drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

Legend

Fire Flow (L/s)
- 60 - 90 (SFR)
- 90 - 135 (HDR)
- 135 - 150 (HDR)
- 150 - 210 (COMM + INST)
- 210 - 225 (INDSL)
- 225 - 300 (INDSL)

- Water Pipe
- Future Water Pipe
- Water Pump
- Pressure Reducer
- Reservoir
- Water Pressure Zone
- Town Boundary

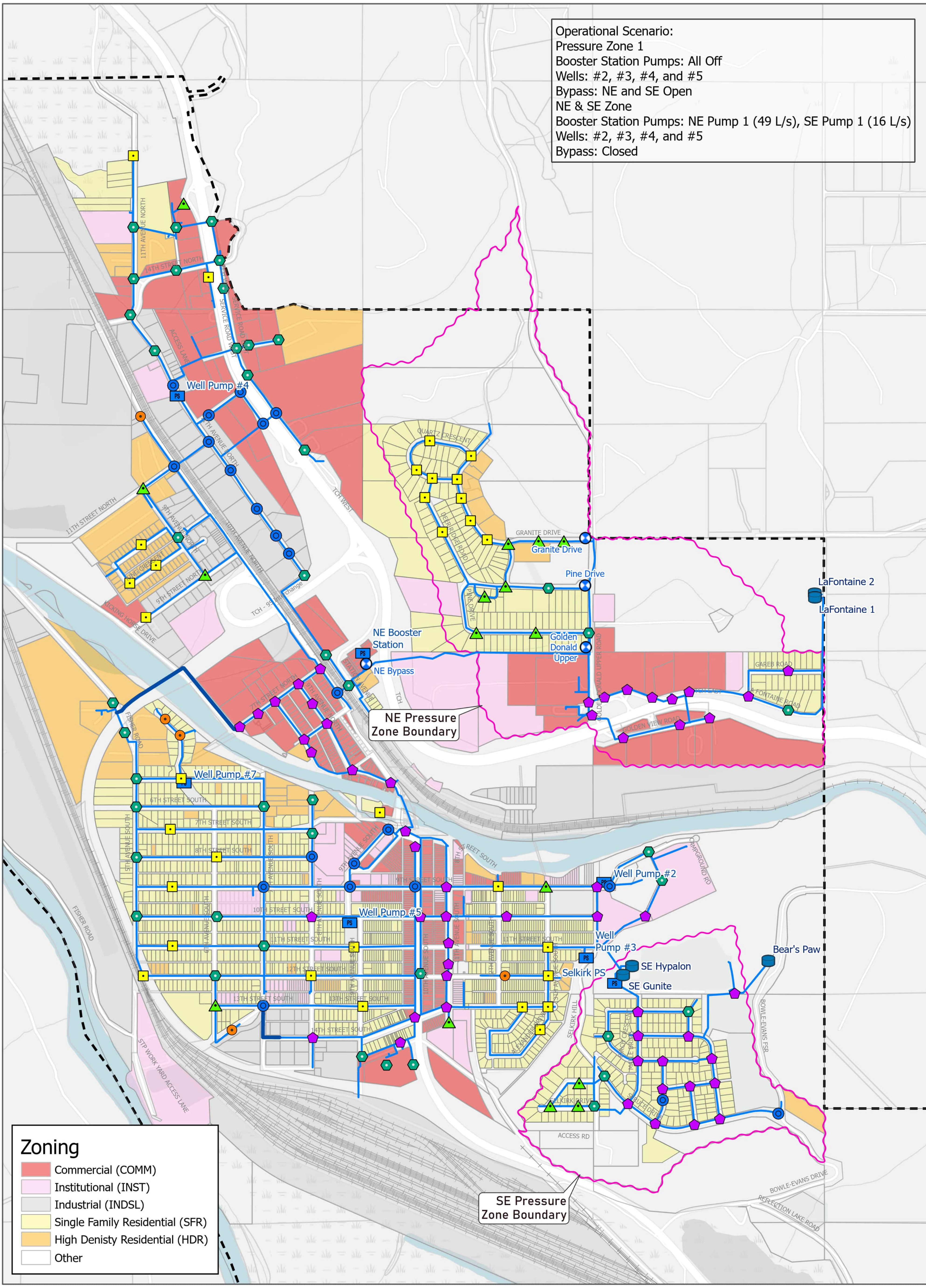
Town of Golden

Integrated Water Plan

Fire Flow - Future High Priority Upgrades (Under 25yr MDD)

FIGURE 7.5

\\usl.urban-systems.com\projects\Projects_CAL\0404\0254\01\D-Design\GIS\Projects\Pro_Projects\0404_0254_01_Golden_Water_Update_20230921.aprx\Golden - WMP - Fig 7_5 - Fire Flow (HP Upgrade) - Future - 20241120



URBAN SYSTEMS

Project #: 0404.0254.01
Author: JW
Checked: JR
Status: Final
Revision: A
Date: 2025 / 2 / 6

0 200 400 600
Metres

Coordinate System: NAD 1983 UTM Zone 11N

Scale: 1:12,500 (When plotted at 11"x17")

Data Sources:
- Data provided by ESRI, Town of Golden, BC Government

The accuracy & completeness of information shown on his drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

Legend

Fire Flow (L/s)
- 60 - 90 (SFR)
- 90 - 135 (HDR)
- 135 - 150 (HDR)
- 150 - 210 (COMM + INST)
- 210 - 225 (INDSL)
- 225 - 300 (INDSL)

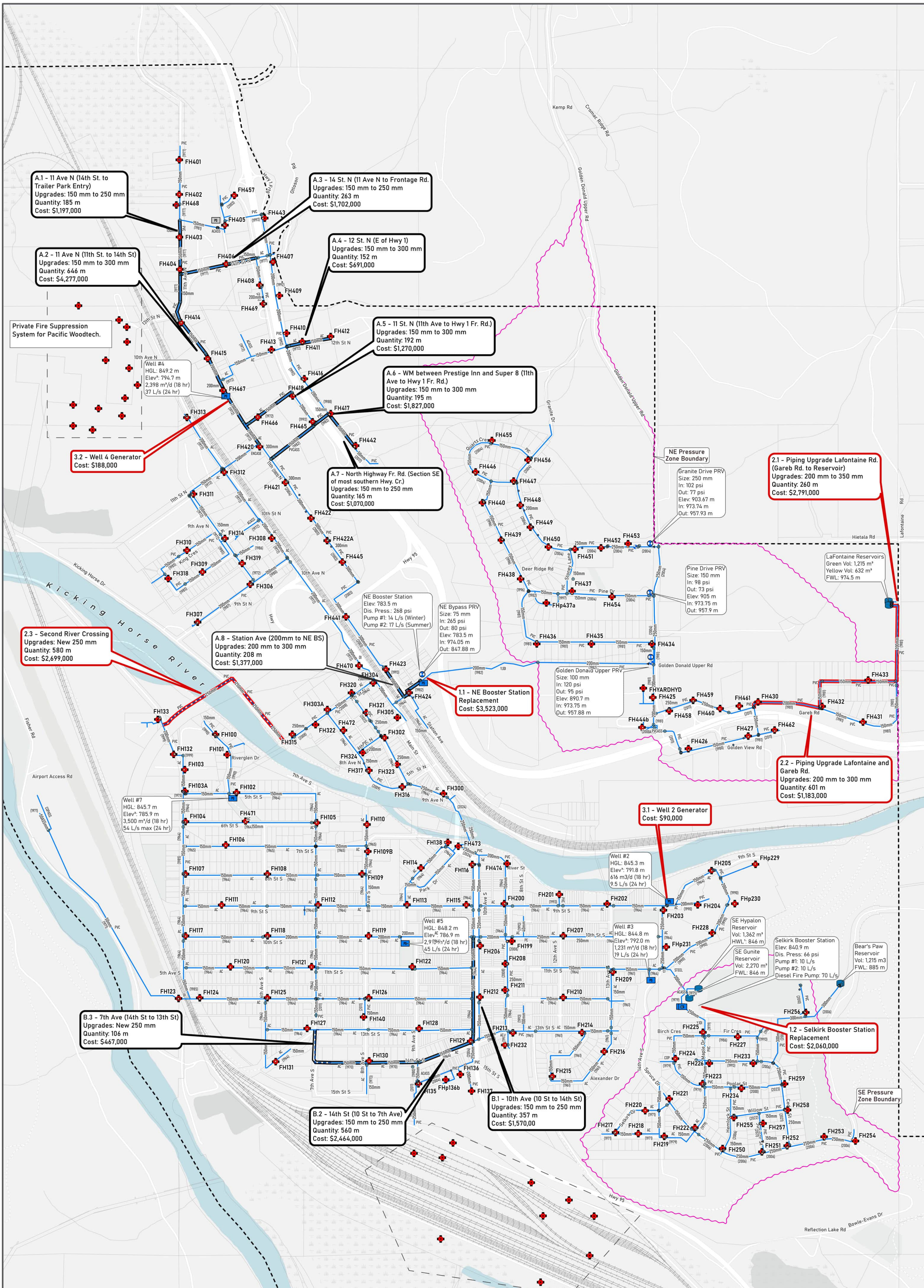
- Water Pipe
- Future Water Pipe
- Water Pump
- Reservoir
- Pressure Reducer
- Water Pressure Zone
- Town Boundary

Town of Golden

Integrated Water Plan

Fire Flow - Future All Upgrades (Under 25yr MDD)

FIGURE 7.6



URBAN SYSTEMS

Project #: 0404.0254.01
Author: BA
Checked: JC
Status:
Revision: A
Date: 2025 / 2 / 12

0 100 200 300 400 500
Metres

Coordinate System: NAD 1983 UTM Zone 11N
Scale: 1:6,000 (When plotted at 22"x34")

Data Sources:
- Village of Golden (Infrastructure); Urban Systems Ltd. (Infrastructure); Data BC (Cadastre PMBC, Municipalities); Esri (Basemap)

Hydrant

Water Node (Type)
- Hydrant Valve
- Valve
- Pressure Reducer Valve
- Air Release Valve
- Other

Water Pump (Active)
Water Pump (Abandoned)

Water Control Valve
- Pressure Reducer

Water Network Structure
- Reservoir

Water Pipe
Future Water Pipe

Priority Upgrade
- Low
- High

Water Pressure Zone
Town Boundary

Town of Golden
Water Master Plan Update

High and Low Priority Upgrades

Figure 7.7

8.0 COST ESTIMATES

The recommended upgrades have been classified as either high priority (needed to allow for growth, reliability, or to provide significant fire flow improvements) or as low priority (to be completed as funding allows). This section summarizes the recommended upgrades, upgrade trigger, and Class D capital cost estimates. Capital cost estimate breakdowns are included as Appendix E. The following assumptions were made to develop the cost estimates:

- Costs are Class D and include a 35% contingency for construction costs.
- Costs include a 15% allowance for engineering.
- The Selkirk booster station replacement includes a new building, power service, pumps, cascading valve, generator, and all necessary tie ins.
- The Northeast booster station replacement includes a new building, power service, pumps, cascading valve, generator, and all necessary tie ins.
- The second river crossing costs are based on the design package completed for this upgrade.
- Well 7 is currently in the detailed design phase. Costing for Well 7 is not included in this analysis, but is a critical upgrade to meet the 25 year demands for the Town.

The high and low priority upgrades are summarized in Tables 8.1 and 8.2, respectively. All low priority upgrades are triggered by improving fire flow performance. A breakdown of the cost estimate is included as Appendix E.

Table 8.1: Summary of High Priority Upgrades

Upgrade		Trigger				Class D Capital Cost
		Capacity - Existing	Capacity - Future	Fire Flow Improvement	System Reliability	
Booster Station Upgrades:						
1.1	NE Booster Station Replacement		X	X		$3,523,000
1.2	SE Booster Station Replacement	X	X	X	X	$2,060,000
Piping Upgrades						
2.1	350 mm Piping Upgrade Lafontaine Rd. (Gareb Rd. to Reservoir)			X		$2,791,000
2.2	300 mm Piping Upgrade Lafontaine and Gareb Rd.			X		$1,183,000
2.3	Second River Crossing		X	X	X	$2,699,000
Well Upgrades						
3.1	Well 2 Generator			X	X	$90,000
3.2	Well 4 Generator			X	X	$188,000
					Total High Priority Upgrades	$12,534,000

Table 8.2: Summary of Low Priority Upgrades

Upgrade		Trigger				Class D Capital Cost
		Capacity - Existing	Capacity - Future	Fire Flow Improvement	System Reliability	
NW Industrial Fire Flow Piping Upgrades						
A.1	11 Ave N (14th St. to Trailer Park Entry)			X		$1,197,000
A.2	11 Ave N (11th St. Rail Crossing to 14th St)			X		$4,277,000
A.3	14 St. N (11 Ave N to Frontage Rd.)			X		$1,702,000
A.4	12 St. N (E of Hwy 1)			X		$691,000
A.5	11 St. N (11th Ave to Hwy 1 Fr. Rd.)			X		$1,270,000
A.6	WM between Prestige Inn and Super 8 (11th Ave to Hwy 1 Fr. Rd.)			X		$1,827,000
A.7	North Highway Fr. Rd. (Section SE of most southern Hwy. Cr.)			X		$1,070,000
A.8	Station Ave (200mm to NE BS)			X		$1,377,000
S Industrial Fire Flow Piping Upgrades						
B.1	10th Ave S (10 St to 14th St)			X		$1,570,000
B.2	14th St S (10 St to 7th Ave)			X		$2,464,000
B.3	7th Ave S (14th St to 13th St)			X		$467,000
Total Low Priority Upgrades						$17,912,000

9.0 RISK ASSESSMENT AND PROJECTS PRIORITIZATION

A risk assessment and project prioritization were conducted to assist with the implementation order of the proposed system upgrades. High-priority upgrades focus on addressing deficiencies for upcoming development, improving system reliability, and significantly enhancing fire flow. Low-priority upgrades aim to address existing fire flow deficiencies. It should be noted that many of the low-priority upgrades were ranked the same due to their comparable impacts.

High-priority upgrades should be considered before additional development proceeds. Low-priority upgrades should be completed as funding permits and in alignment with asset renewal schedules (e.g., upsize when pipes reach end of life and require replacement).

Projects were prioritized based on the following:

- Risk:
  - Consequence of failure of infrastructure on fire flows.
  - Consequence of failure of infrastructure on water supply.
  - Likelihood of failure.
- Ability to meet existing demands, ability to meet future demands, and timing of anticipated growth.
- Number of connections benefitted by the upgrade.

The risk and prioritization for the high and low priority upgrades are summarized in Tables 9.1 and 9.2, respectively. Also listed in these tables is whether the project will be developer funded (required for a development to proceed), DCC funded (required due to growth), or asset management (required due to condition or age).

Table 9.1: Risk & Priority of High Priority Upgrades

Upgrade		Impact of not completing upgrade on:		Likelihood of failure if upgrade not completed	Risk	Priority[1]
		Water Supply	Fire Flows			
Booster Station Upgrades:						
1.1	NE Booster Station Replacement	High	Moderate	Moderate	High	1
1.2	SE Booster Station Replacement	High	Low	High	High	1
Piping Upgrades:						
2.1	350 mm Piping Upgrade Lafontaine Rd.	Low	High	Low	Moderate	2
2.2	300 mm Piping Upgrade Gareb Rd.	Low	High	Low	Moderate	2
2.3	Second River Crossing	High	High	Low[3]	Moderate	2
Well Upgrades:						
3.1	Well 2 Generator	Low	Moderate	Moderate	Low	3
3.2	Well 4 Generator	High	High	Moderate	High	1

Notes:

1. Priority ranking applicable for work described in Table 9.1 only (i.e., does not include low priority proposed upgrades)
2. The existing river crossing is scheduled to be replaced by the end of 2025, therefore the likelihood of failure in the near future is low once replaced. However, a second crossing provides critical redundancy, as well as two crossings provide significant fire flow benefits.

Table 9.2: Risk & Priority of Low Priority Upgrades

Upgrade		Impact of not completing upgrade on:		Likelihood of failure if upgrade not completed	Risk	Priority[1]
		Water Supply	Fire Flows			
Northwest Industrial Fire Flow Piping Upgrades						
A.1	11 Ave N (14th St. to Trailer Park Entry)	Low	Moderate	Low	Low	2
A.2	11 Ave N (11th St. Rail Crossing to 14th St)	Low	Moderate	Low	Low	5
A.3	14 St. N (11 Ave N to Frontage Rd.)	Low	Moderate	Low	Low	5
A.4	12 St. N (E of Hwy 1)	Low	Moderate	Low	Low	1
A.5	11 St. N (11th Ave to Hwy 1 Fr. Rd.)	Low	Moderate	Low	Low	5
A.6	WM between Prestige Inn and Super 8 (11th Ave to Hwy 1 Fr. Rd.)	Low	Moderate	Low	Low	5
A.7	North Highway Fr. Rd. (Section SE of most southern Hwy. Cr.)	Low	Moderate	Low	Low	5
A.8	Station Ave (200mm to NE BS)	Low	Moderate	Low	Low	5
South Industrial Fire Flow Piping Upgrades						
B.1	10th Ave (10 St to 14th St)	Low	Moderate	Low	Low	5
B.2	14th St (10 St to 7th Ave)	Low	Moderate	Low	Low	4
B.3	7th Ave (14th St to 13th St) – *New Pipe*	Low	Moderate	Low	Low	3

Notes:

1. Priority ranking applicable for work described in Table 9.2 only (i.e., does not include high priority proposed upgrades)

2. Many of the low priority upgrades have a similar impact on improving fire flows, and can be prioritized based on age, nearby replacement work, nearby development, or other triggers.

10.0 RECOMMENDATIONS & NEXT STEPS

This report summarizes the recommended water system upgrades to meet the 25-year MDD, including:

1. $12.5M high priority capital works have been identified to accommodate the 25-year growth projection, improve system reliability and/or address deficiencies. Refer to Figure 7.7 for the proposed works.
2. $17.9M low priority capital works have been identified to improve available fire flow throughout the distribution system that are recommended to be advanced as funding becomes available or as the applicable watermain is being replaced at the end of its service life. Refer to Figure 7.7 for the proposed works.

Going forward, we recommend that the Town complete the following:

1. Review and update the water conservation plan on a regular basis. Water reduction targets could be evaluated and incorporated into demand predictions if desired.
2. Update the subdivision servicing bylaw to reduce the industrial fire flow requirement to 150 L/s.
3. Update the DCC bylaw to account for the proposed projects required to support development in Golden.
4. Budget for and complete the recommended projects.
5. Review and update the Integrated Water Strategy every 5-10 years.

APPENDIX A

GOLDEN INTEGRATED WATER STRATEGY DESIGN CRITERIA

DATE: May 8, 2025
TO: Chris Cochran, Phil Armstrong, Jon Wilsgard | Town of Golden
CC: Sara Anderson
FROM: Robyn Cameron, Jill Reynolds, Jeremy Clowes | Urban Systems
FILE: 0404.0254.01
SUBJECT: Golden Integrated Water Plan Design Criteria

1.0 INTRODUCTION

The Town of Golden (Town) has engaged Urban Systems Ltd (Urban) to develop an Integrated Water Plan. The purpose of the Integrated Water Plan is to ensure an adequate level of service for existing and future conditions by collecting data to understand the variability of the water service demands, identifying key risks for established residential and commercial areas, proposing high-level solutions to ameliorate key risks, and evaluating the impacts of climate change on water level of service.

A critical component of the Integrated Water Plan is establishing the historic and projected water demands for the community. Urban has completed a preliminary review and analysis of background information to set design criteria. The following sections discuss the parameters and criteria that will be used for the Integrated Water Plan, including:

- Population projections.
- Historic water usage, including average day, max month, max day, and peak hour.
- Impact of climate change.
- Future water use.
- Fire flow requirements.

2.0 POPULATION PROJECTIONS

2.1 RESIDENTIAL POPULATION

Federal census population data was only available for the years 2016 and 2021 (shown in bold), therefore the population for the years between this range has been interpolated. These population numbers were then used to calculate the historic per capita water demands.

Table 2.1. Population data 2016-2021

Year	Population
2016	3,708
2017	3,764
2018	3,819
2019	3,875
2020	3,930
2021	3,986

2.2 INSTITUTIONAL, COMMERCIAL, INDUSTRIAL (ICI)

Golden is a popular tourist destination, and therefore has a large number of visitor accommodations. As of 2024, there are 956 hotel bed units, in addition to 211 short term rental accommodations. Tourism Golden reported an average monthly occupancy of 89% for hotel accommodations in 2023. As short-term rental accommodations are located in zoning areas that are typically residential, short term rental water usage was analyzed as a part of the residential water demands.

Based on the Town of Golden's land use map, and using aerial imagery to determine which sites were built out, the ICI land use area in the Town of Golden was calculated to be approximately 91.7 hectares, including hotels. The area calculated to be occupied by hotel accommodations is 14.3 hectares.

2.3 FUTURE POPULATION PROJECTIONS

Future population scenarios assume a population growth of 1.5% per year, as per the Town of Golden Transportation Plan (Urban Systems Ltd, 2023). This growth rate is applied to the base population from Golden's 2021 census data. The projected permanent population for the 10 and 25 year growth scenarios are summarized in Table 2.2.

Table 2.2: 10, 25, 50-Year Permanent Population Projections

Future Scenarios	Year	Population Projection
10-Year	2031	4,631
25-Year	2046	6,062

In addition, hotel, commercial, and industrial growth is anticipated. Table 2.3 summarizes the ICI growth projections, provided by the Town of Golden. As significant hotel growth is anticipated, hotels were separated from other ICI growth.

Table 2.3: Hotel, Commercial, and Industrial Growth Projections

Future Scenario	Year	Hotel (Bed unit)	Commercial (ha) [1]	Industrial / Institutional (ha)
Current	2021	956	31.0	46.4
10-Year	2031	1263	31.7	46.4
25-Year	2046	1516	32.8	46.4

Notes:

1. Hotels, zoned as commercial, represent an additional 14.3 ha. Hotel water usage was analyzed separately, as a result, this area was not included in the commercial area counts.

3.0 HISTORIC WATER USAGE

The Town provided the following historic water usage data from 2016 to 2022:

- Daily total water supplied from the wells.
- Quarterly water usage from metered industrial, commercial, and institutional (ICI) users.
- Yearly water usage for municipal irrigation.

This data was used to calculate the following parameters:

- Total annual water usage.
- Average day demand (ADD). The average day demands (ADD) represent the typical amount of water consumed by the community on an average day.
- Max day demand (MDD). The maximum day demand (MDD) is the day with the highest water usage per year.
- Peak hour demand (PHD). The peak hour demands are the hour with the highest water usage per year.

Water usage has also been analyzed based on land use (residential, ICI, and overall system performance) to calculate per capita/hectare water usage that will be used to estimate future water demands for the community.

3.1 TOTAL WATER USAGE

Using the well usage data provided by the Town, the total water usage was calculated for the entire system, ICI users, municipal irrigation and residential users.

The majority of residences are not metered, with the exception of a small test group and some multifamily units. Therefore, the residential usage is assumed to be the total well water usage minus the ICI and municipal irrigation. Consequently, the residential usage also includes any system losses and unaccounted for water usage (e.g. leaking watermains). The total yearly demands are summarized in Table 3.1. Figure 3.1 summarizes the annual usage from 2016 to 2022. As shown, water usage is highest in the summer months.

Table 3.1: Total Yearly Water Demands for All User Groups

Year	Total Well Water Usage (m^3)	ICI Metered Usage (m^3)	Municipal Irrigation metered Usage (m^3)	Residential Usage (m^3)
2016	1,092,985	371,894	22,358	698,733
2017	1,177,843	387,059	22,718	768,066
2018	1,011,252	393,398	20,793	597,060
2019	971,319	398,890	15,559	556,870
2020	963,833	364,396	15,114	584,323
2021	1,081,305	382,290	20,616	678,399
2022	1,099,541	415,431	18,454	665,657

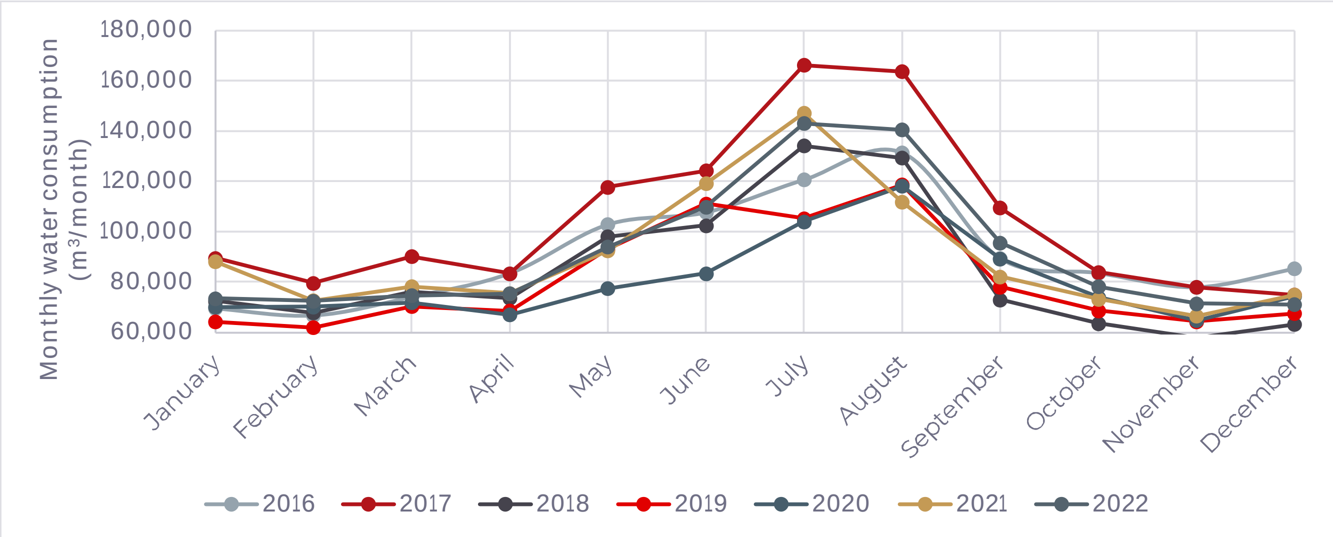


Figure 3.1: Total well volume produced per month 2016-2022

3.1.1 ADD to MDD Peaking Factor

The maximum day demand (MDD) is the day with the highest water usage per year. From the data provided by the Town, only the well data usage data was captured daily. Therefore, an ADD to MDD peaking factor was calculated for the total water demands and applied to the ICI and residential demands.

Table 3.2: ADD to MDD Peaking Factor

Year	Average Day Demand (m^3/d)	Maximum Day Demand (m^3/day)	ADD to MDD Peaking Factor
2016	2,994	5,402	1.80
2017	3,227	6,521	2.02
2018	2,771	5,659	2.04
2019	2,661	5,034	1.89
2020	2,641	5,122	1.94
2021	2,962	6,246	2.11
2022	3,012	5,649	1.88
	Maximum	6,521	2.1

3.1.2 MDD to PHD Peaking Factor

The peak hour demand is the hour with the highest water usage per year. Hourly water usage data was not available, therefore a factor of 1.5 from the Golden Subdivision Servicing Bylaw was applied to the MDD to calculate the peak hour demands.

Table 3.3: Factors used to convert ADD to MDD and Peak Hour

ADD to MDD Factor	MDD to Peak Hour Factor
2.1	1.5

3.2 INSTITUTIONAL, COMMERCIAL, INDUSTRIAL (ICI) DEMANDS

3.2.1 Industrial, Commercial, Institutional ADD

The Town of Golden supplied water meter records for ICI users from 2016-2022. Yearly and seasonal flow totals were calculated (excluding multi-family user flows) and used to calculate a per-hectare historical water usage rate, which will be used to project future flows. Four different parameters were analyzed:

- *Total ICI Water Usage* - This data was analyzed to determine a per hectare water usage that could be used to estimate future ICI demands. This data includes metered industrial, commercial, and industrial users, as well as irrigation and hotels.
- *Total ICI Water Usage, excluding hotels* – Hotel demands as well as hotel growth was analyzed based on bed units rather than area. As a result, the ICI usage was analyzed excluding hotel demands as well as hotel area. The per hectare water usage for future ICI demands is comparable when both including and excluding hotel usage.
- *Metered Irrigation* - This includes all ICI data that was classified as irrigation, as well as Municipal irrigation metered data. This value will be used to estimate the increased water demands as a result of climate change.
- *Hotel Water Usage* - Hotel water usage was separated from other ICI users as much of the future ICI growth is attributed to hotel development.

The calculated ICI ADD is summarized in Table 3.4.

Table 3.4: Average Day Demand for Industrial, Commercial, and Institutional Water Usage

Year	Total Average Day ICI		Total Average Day ICI Excluding Hotels		Metered Irrigation		Hotels	
	(m^3/d)	(L/ha/d)	(m^3/d)	(L/ha/d)	(m^3/d)	(L/ha/d)	(m^3/d)	(L/BU/d) [2]
2016	1,080	11,800	738	11,700	203	7,400	281	360
2017 [1]	1,123	12,200	764	12,100	248	9,000	297	380
2018	1,135	12,400	809	12,800	222	8,100	269	350
2019	1,135	12,400	799	12,700	179	6,500	293	380
2020	1,040	11,300	759	12,000	187	6,800	239	310
2021	1,104	12,000	809	12,800	256	9,300	238	310
2022	1,189	13,000	842	13,300	245	8,900	296	380
Average		12,200		12,500		8,000		350

Notes:

1. 2017 ICI was significantly higher than every other year. This was found to be due to significantly higher water usage at Mount 7 Taxi and Super Suds. This is assumed to be due to a water leak. As this is not representative of typical water usage, the water usage from Mount 7 Taxi in 2017 was excluded from the analysis.
2. Hotel water usage was calculated assuming an average occupancy of 90% and a total of 956 bed units which works out to 860 bed units in use.
3. Based on the Town of Golden's land use map, and using aerial imagery to determine which sites were built out, the ICI land use area in the Town of Golden was calculated to be approximately 91.7 hectares, with 14.3 hectares attributed to hotels. We have allowed for irrigating 30% of the total ICI area of 91.7 ha (27.5 ha irrigation area).

3.2.2 Summary and Comparison

The MDD and PHD for the ICI usage was calculated by applying the peaking factors summarized in Table 3.3 to the ADD.

Table 3.5: ICI Water Demands

Demands	ICI (excluding hotels) (L/ha/d)	Irrigation (L/ha/d)	Hotels (L/BU/d)
Average Day Demand	12,500	8,000	350
Max Day Demand	26,300	16,800	700
Peak Hour Demand	39,500	25,200	1,100

The calculated ICI ADD, MDD and Peak Hour values can be compared to criteria set out by the Town's Subdivision Servicing bylaw, other similar communities, and municipal design guidelines. Table 3.6 lists other values to assist the Town in selecting design criteria.

Table 3.6: ICI Design Criteria from Other Sources

	Zoning Density (ppl/ha)	ADD (L/ha/d)	MDD (L/ha/d)	Peak Hour (L/ha/d)	Notes
Calculated Values	-	12,500	26,300	39,500	-
Town of Golden Subdivision Servicing Bylaw (2008)					
Flow Base (L/c/d)		-	*See Notes*	-	In the absence of specific data, 600 L/p/d for commercial and institutional, and 100,000 L/ha/d for industrial. People/ha sourced from Table E.1 in the Bylaw.
Institutional	50	-	30,000	-	
Commercial	75	-	45,000	-	
Industrial	75	-	100,000	-	
MMCD Design Guidelines (2022)					
Flow Base (L/c/d)		300	600	900	Used in the absence of specific data. Assuming all users are metered. Does not include outdoor irrigation.
Institutional	50	15,000	30,000	45,000	
Commercial	90	27,000	54,000	81,000	
Industrial	90	27,000	54,000	81,000	
Regional District of East Kootenays Subdivision Servicing Bylaw (2016)					
Refers to the Design Guidelines for Rural Residential Community Water Systems published by the Ministry of Environment, which states metering records, or in the lack of that, conservative estimates should be used. The guidelines state that for recreational resorts, the MDD should be calculated for the 2 weeks over the holiday season at 100% occupancy rate with an indoor MDD of 230 L/d/BU.					
City of Revelstoke Subdivision Servicing Bylaw (2023)					
Flow Base (L/c/d)		900	2,400	4,000	Based off the residential demands and adjusted using zoning densities.
Institutional	50	45,000	120,000	200,000	
Commercial	75	67,500	180,000	300,000	
Industrial	50	45,000	120,000	200,000	
Salmon Arm Subdivision Servicing Bylaw (2023)					
Flow Base (L/c/d)		900	2,000	3,600	Based off the residential demands and adjusted using zoning densities.
Institutional	50	45,000	100,000	180,000	
Commercial	90	81,000	180,000	324,000	
Industrial	90	81,000	180,000	324,000	

Recommendations:

We recommend using the calculated values for estimating the existing ICI demands. However, for future demands it is recommended to use the Town's Subdivision Servicing Bylaw for commercial growth. The Town has indicated that most of the ICI growth will be in the Downtown and Highway Commercial zones, which contains a higher density of restaurants. Restaurants typically have a higher than average water usage, therefore the higher Subdivision Servicing Bylaw values are expected to be more representative of the anticipated growth.

Decision: calculated values will be used for existing ICI demands, Subdivision Servicing Bylaw values will be used for commercial growth.

3.3 RESIDENTIAL

3.3.1 Residential ADD

To calculate the average day demand per capita, the total residential demand was divided by the number of days in the year and the population estimate for that year. The average day demand includes both indoor and outdoor usage. The calculated residential average day demand is shown below in Table 3.7.

Table 3.7: Residential Average Day Demands

Year	Residential Water Usage [1] (m^3)	Population	Total ADD		ADD - Outdoor Usage [2]	
			(m^3/d)	(L/c/d)	(m^3/d)	(L/c/d)
2016	698,733	3,708	1,914	520	237	65
2017	768,066	3,764	2,104	560	858	230
2018	597,060	3,819	1,636	430	461	120
2019	556,870	3,875	1,526	400	409	100
2020	584,323	3,930	1,601	410	123	30
2021	678,399	3,986	1,859	460	252	60
2022	665,657	4,042	1,824	450	390	90
Average Per Capita Residential Water Use Per Day				460		100

Notes:

1. Residential water usage calculated by subtracting ICI and irrigation use from the total well usage.
2. Outdoor water usage calculated by subtracting winter (Oct. 1 – Apr. 30) from summer (May 1 – Sept. 30) usage. This value will be used to estimate the increased water demands as a result of climate change.

3.3.2 Residential Summary & Comparison

The MDD and Peak Hour demands for the residential usage was calculated by applying the peaking factors in Table 3.3 to the ADD.

Table 3.8: Residential Water Demands

Demands	Total Usage (L/c/d)
Average Day	460
Max Day = ADD x 2.1	1,000
Peak Hour = MDD x 1.5	1,500

The calculated residential demands can be compared to criteria set out by the Town's Subdivision Servicing bylaw, other similar communities, and guidelines. Table 3.9 lists other values to assist the Town in selecting design criteria.

Table 3.9: Residential Design Criteria from Other Sources

<table>
<tr><th colspan="2"></th><th>ADD (L/c/d)</th><th>MDD (L/c/d)</th><th>Peak Hour (L/c/d)</th></tr>
<tr><td colspan="2">Calculated Values</td><td>460</td><td>1,000</td><td>1,500</td></tr>
<tr><td colspan="2">Town of Golden Subdivision Servicing Bylaw (2008)</td><td>700</td><td>1,700</td><td>2,550</td></tr>
<tr><td rowspan="2">MMCD Design Guidelines (2022)</td><td>Metered</td><td>300</td><td>600</td><td>900</td></tr>
<tr><td>Unmetered</td><td>400</td><td>900</td><td>1,350</td></tr>
<tr><td colspan="2">Regional District of East Kootenays Subdivision Servicing Bylaw (2016)</td><td>115</td><td>230</td><td>-</td></tr>
<tr><td colspan="2">City of Revelstoke Subdivision Servicing Bylaw (2023)</td><td>900</td><td>2,400</td><td>4,000</td></tr>
<tr><td colspan="2">Salmon Arm Subdivision Servicing Bylaw (2023)</td><td>900</td><td>2,000</td><td>3,600</td></tr>
</table>

Recommendations

We recommend using the calculated parameters for existing users, and the Town's bylaw for future estimates except for bylaw's peak hour per capita flow value. The ADD and MDD per capita values in the Town's bylaw are reasonable for estimating future demands but the peak hour demand appears conservative. We recommend lowering the peak hour per capita flow rate to 2,400 L/d/c.

Decision: calculated values will be used for existing residential demands; Subdivision Servicing Bylaw values will be used for residential growth.

3.4 WATER DEMANDS FOR INTEGRATED WATER PLAN

The proposed demands for the Integrated Water Plan are summarized in Table 3.10.

Table 3.10: Proposed Demands for Integrated Water Plan

	Residential	Hotel	ICI
Average Day Demand	460 L/cap/day (existing) 700 L/cap/day (growth)	350 L/BU/day	12,500 L/ha/day (existing) 21,500 L/ha/day (commercial growth)
Max Day Demand	1,000 L/cap/day (existing) 1,700 L/cap/day (growth)	700 L/BU/day	26,300 L/ha/day (existing) 45,000 L/ha/day (commercial growth)
Peak Hour Demand	1,500 L/cap/day (existing) 2,400 L/cap/day (growth)	1,100 L/BU/day	39,500 L/ha/day (existing) 67,500 L/ha/day (commercial growth)
Average Day Outdoor Demand	100 L/cap/day (existing)	N/A	8,000 L/ha/day (existing)

4.0 IMPACT OF CLIMATE CHANGE

In British Columbia, climate change scenarios indicate that average annual temperatures and precipitation amounts are projected to increase (Ministry of Health, 2024). However, even though precipitation is projected to increase annually, summer precipitation may decrease. Scenarios also indicate that the seasonal and regional variability will increase, such that some areas will receive significantly more precipitation and others will experience reduced recharge and more severe droughts.

The Design Guidelines for Drinking Water Systems in British Columbia outlines that climate change will likely cause increased demand on water systems, especially in summer months, due to:

1. Increased irrigation demands as a result of higher temperatures, reduced summer precipitation, and/or summer drought.
2. A lengthened growing season which would further increase irrigation demands.

To account for the impacts of climate change, we have allowed for an increased irrigation season in our annual water usage projections. The summer season is defined as the approximate length of the growing season during which there are no freezing temperatures to kill or damage plants. This was evaluated from two lenses, the increase in frost free days and growing degree days (Table 4.1). The average of these two indicators were taken to be the increase in irrigation season. This increase in irrigation season is used with the outdoor demand to account for the impacts of climate change on water demand. Table 4.2 shows the impacts of the anticipated lengthened growing season on the water demand.

Table 4.1: Increase in Length of Irrigation Season from 2021 (Climatedata.ca)

	Increase in Frost Free Days [1]	Increase in Growing Degree Days (5ºC) [1]	Increase in Irrigation Season [2] Used for Integrated Water Plan
10 Year (2031)	12%	27%	19%
25 Year (2046)	29%	31%	30%

Notes:

1. Data from Climatedata.ca, assuming the RCP-8.5 scenario.
2. Irrigation season is defined as the approximate length of the growing season during which there are no freezing temperatures to kill or damage plants.

It should also be noted that peak demands will likely coincide with periods of lowest water supply. Therefore, to mitigate the impacts of climate change source studies as well as strategies incorporating increased monitoring, response planning, and community water conservation programs should be implemented to manage water demand.

For the purpose of this study, we assumed the irrigation demand (i.e. 100 L/c/d for residential) will stay the same. Increases in demand due to higher temperatures and reduced precipitation could be mitigated by water conservation programs.

Table 4.2: Impacts of Lengthened Growing Season on Outdoor Water Usage

	Increase in Irrigation Length	Irrigation Season (days)	Residential Outdoor Usage [1] (m^3/year)	ICI Outdoor Usage [2] (m^3/year)	Increase Due to Climate Change (m^3/year)
Current	-	153	60,986	33,672	-
10-Year	19%	182	84,317	40,371	30,030
25-Year	30%	197	114,415	44,285	64,042

Notes:

1. Uses the calculated outdoor demand of 100 L/c/d, and the population growth of 1.5%
2. Uses the calculated outdoor demand of 8,000 L/ha/d, and the anticipated ICI growth provided by the Town.

5.0 FUTURE WATER DEMANDS

The projected water demands for the 10-Year and 25-Year design horizons are summarized in Table 5.1. This table will be updated after review with the Town and finalization of the per capita/hectare/bed unit rates.

Table 5.1: Estimated Water Demands for Integrated Water Plan

	Unit	Current	10-Year	25-Year
Population/Area				
Residential	people	3,986	4,631	6,062
ICI (excluding hotels)	ha	77.4	78.1	79.2
Hotels	BU	956	1,263	1,516
Average Day Demand				
Residential	m^3/day	1,800	2,300	3,155
Hotel	m^3/day	300	400	500
ICI	m^3/day	1,000	1,000	1,000
Increase in outdoor usage due to climate change [1]	m^3/year	-	30,000	64,000
Total ADD	m^3/year	1,131,500	1,380,500	1,762,804
	m^3/day	3,100	3,800	4,830
Maximum day demand				
Residential	m^3/day	4,000	5,100	7,750
Hotel	m^3/day	700	900	1,100
ICI	m^3/day	2,000	2,000	2,000
Total MDD	m^3/day	6,700	8,000	10,850
Peak hour demand				
Residential	L/s	69	87	131
Hotel	L/s	12	16	19
ICI	L/s	35	36	37
Total PHD	L/s	117	139	187

Notes:

1. Increase in outdoor water usage due to climate change was calculated based on the outdoor water usage calculated in Section 3 (100 L/cap/day for residential, 8,000 for ICI irrigation), a current frost free season of 153 days, and the percent increases in the irrigation season summarized in Section 4.0.

It is important to note that water conservation has not been considered in the future development projections. This assumption should be reviewed with the Town, water conservation targets can be incorporated if desired.

6.0 LOCATION OF FUTURE GROWTH

The Town has prepared figures showing the location of future development. The location of future development will impact how future demands are allocated in the water model, as well as analysis of reservoir & booster station capacity.

For simplicity, as well as ease of future updates, the current water demands will be evenly allocated across each pressure zone. Future demands will be applied based on 10 and 25 year development figures provided by the Town (Attachment 1). All watermains required to service future development areas will be included in the water model.

7.0 REQUIRED FIRE FLOWS

Golden's Subdivision Servicing Bylaw stipulates fire flow requirements based on land use. These requirements are in line with the 2022 MMCD Design Guidelines.

The Town may want to consider lowering the industrial fire flow requirement. Industrial fire flows require extensive fire fighting personnel and equipment, and it should be confirmed if the Golden Fire Department has the resources to meet these requirements. Furthermore, industrial fire flows often drive infrastructure sizing for reservoirs and watermains. By not allowing future developments that require these fire flows, infrastructure sizing can be reduced. It is important to note that new buildings can be constructed with fire protection measures to meet the available fire flow in a given area (e.g. automated sprinklers, fire walls, better building materials, etc.).

Other than the industrial fire flow, no updates to the fire flow requirements stipulated in the Subdivision Servicing Bylaw are recommended for the Integrated Water Strategy.

Table 7.1: Recommended Fire Flows for Integrated Water Strategy

	Golden Subdivision Servicing Bylaw (2008)	Recommended Fire Flows for Integrated Water Strategy
Single Family Residential	60 L/s	60 L/s
Apartments/ townhouses	90 L/s	90 L/s
Commercial	150 L/s	150 L/s
Institutional	150 L/s	150 L/s
Industrial	225 L/s	150 L/s

8.0 SUMMARY AND NEXT STEPS

Table 8.1 summarizes the total system demands. This design criteria will form the basis for the Integrated Water Strategy analysis.

Table 8.1: Summary of Total System Demands

	Existing	10-Year	25-Year
Average Day Demand (m^3/d)	3,100	3,800	4,830
Maximum Day Demand (m^3/d)	6,700	8,150	10,850
Peak Hour Demand (L/s)	117	141	187

Sincerely,

URBAN SYSTEMS LTD.

Jill Reynolds, P.Eng., Project Engineer.

Jeremy Clowes, P.Eng., Principal
Water & Wastewater Engineer

/JR&RMC

cc: Sara Anderson

U:\Projects_CAL\0404\0254\01\Q-Quality-Records\Jeremy Clowes\11. Final WMP Report rev.2\4. Appendix A\2025-02-21-Golden Integrated Water Strategy Design Criteria R1.docx

Golden - Future Land Use 10 year GFA =m^2

Transportation Zone	Zoning	Residential Units	Downtown Commercial (GFA)	Highway Commercial (GFA)	Industrial (GFA)	Institutional (GFA)	Tourist Accommodation (Rooms) - (ie. Hotel, motel, resort housing, etc.)	Comment
1	M2 - (saw mill)							
2	R4, M2, C4 etc							
3	R5-R7							
4	C2,M1	40						40 TA Basecamp Lodge C2, 870 Kicking Horse, 850 Kicking Horse
5	C1-C3	51	918					Riverstone 51 dwellings 540 sq m com; 27 affordable DU Res 9th Ave / 6th St N/ 378 sq m com
6	M5-airport							airport hanger
7	R3	20						Fisher Road
8	R1/R2/R2A	22						Dogtooth (Burns/Lapka) 25 fee simple SDD sub and another 10 lots
9	R2/M2/I-1-3/C2/C5	0						Old Town Works Yard and others
10	R2/C2/C3/C5	13					0	Womens (13 dwelling units)
11	R2/R4/C2/P2/I2	0						
12	P1-2/I2	0						
13	R4	10						Bears Paw phase five and six SFD; sevens townhouses (32)
14	ER/P1	0						no w/s in this area.
15	ER/C3/M4	0						
16	C4/R6	0						
17	R1/R1-S	17						Asset townhouses 17 x 3 lots (17 in 10 year window) / 96 Westcor towhouses/apartments/ 129 campsites
18	CD1/12			0				Banner Rec addition to VIC (6 DU)
19	CD1/R5	0		6000			307	Lafontaine hotel (178 suites), restaurant, gas station & campground
20	C6	95					0	1410 Golden View (118)
Total		**268**	**918**	**6000**			307	

Golden - Future Land Use 25 year | **Zoning**: M2 - (saw mill) | GFA =m^2

Transportation Zone	Zoning	Residential Units	Downtown Commercial (GFA)	Highway Commercial (GFA)	Industrial (GFA)	Institutional (GFA)	Tourist Accommodation (Rooms) - (ie. Hotel, motel, resort housing, etc.)	Comment
1	M2 - (saw mill)							
2	R4, M2, C4 etc							
3	R5-R7	0						10th Ave N 3: King Cres 2; R5 rezoning required 100 res(code 50 to 20 year) - 30 of which STR;
4	C2,M1							Basecamp 80; apartment 24 on KH Drive
5	C1-C3						50	C3 7th St N / KH Drive
6	M5-airport	0						
7	R3	196						Fisher Road
8	R1/R2/R2A	20						20 units in lower
9	R2/M2/I-1-3/C2/C5							
10	R2/C2/C3/C5	70	1000					Imperial and Esso
11	R2/R4/C2/P2/I2							
12	P1-2/I2							
13	1/R1-S/R1-D/P1/R5/R	96						Bears Paw phase five and six SFD; sevens townhouses
14	ER/P1	0						
15	ER/C3/M4	0						
16	C4/R6	0						
17	R1/R1-S	40						Asset 17 and 17
18	CD1/12	50		4000				Highway yard redevelopment
19	CD1/R5	30		6000			178	Wesseinborn
20	C6	30					25	campsite redevelop into Dus / STR. Modest number to account for existing camp + estimated 50 Dus.
Total		**532**	**1000**	**10000**	**0**	**0**	253	

APPENDIX B

GOLDEN INTEGRATED WATER PLAN – MODEL UPDATE AND VALIDATION

MEMORANDUM

DATE: May 8, 2025
TO: Chris Cochran, Al Taylor, Ryan Robison, Bruce Forsyth | Town of Golden
CC: Sara Anderson
FROM: Robyn Cameron, Jill Reynolds, Jeremy Clowes | Urban Systems
FILE: 0404.0254.01
SUBJECT: Golden Integrated Water Plan – Model Update and Validation

1.0 INTRODUCTION

This memorandum outlines the model updates and the process used to validate Golden's hydraulic water model. WaterCAD version 23.0 computer modeling software created by Bentley is used for the analysis of the water distribution system in the Town of Golden. The water model from the 2013 Water Distribution Study was used as the base for the 2024 Integrated Water Plan.

2.0 MODEL UPDATES

The water model was last revised during the 2013 Water Distribution Study. To reflect current conditions, the infrastructure and water demands were updated.

2.1 DATA COLLECTION AND REVIEW

Prior to updating the model, information on the Town's water distribution system was compiled, collected and reviewed. This included reviewing the following information:

- Latest WaterCAD hydraulic model
- Updated GIS database
- PRV operations
- Pump station operations
- Storage reservoir operations
- Land-use and zoning maps
- Record drawings
- Previous reports
- Field data collected during 2024-06-18 site visit
- FUS fire flow calculations for developments
- Future population projections and growth zones

Urban Systems completed a site visit on June 18, 2024. During the site visit, a Town operator took Urban on a tour of the water system which included all reservoirs, booster stations, most wells, and PRV stations.

2.2 INFRASTRUCUTRE UPDATES

Record drawings from system upgrades completed since 2013 and the Town's GIS data was the primary source of information used to update the pipe and node network topology model. The projects that altered the water distribution system are as follows:

- Well 6 was taken offline, and Well 7 is expected to be in service in fall 2025
- Watermain installations as part of the 2024 Kicking Horse River Bridge Replacement

- Watermain installations as part of the 2022 9th Avenue Improvements
- Watermain installations as part of the 2023 6th Street Underground Utilities

The most recent GIS data set was obtained from the Town's GIS portal on June 5, 2024. Attributes of the water mains, such as diameter and material, as well as node elevations were extracted from the GIS database. These attributes were compared to the model and updated as required.

Since 2013, LiDAR data has significantly improved, and therefore the elevations were updated to reflect the best available information.

2.3 EXISTING DEMAND UPDATE

The Town provided historical water usage data from 2016 to 2022, and the 2024 *Golden Integrated Water Plan Design Criteria* memorandum outlines the total consumption for the water distribution system. The Town also provided flows from the Northeast (NE) Booster Station and Southeast (SE/Selkirk) Booster Station, which were used to determine the allocation of the water demands for each pressure zone. Table 1 summarizes the total system and zone demands under existing average day and maximum day demand conditions.

Table 1. Water Model System Existing Demand Summary

	Average Day Demand (ADD) (L/s)	Maximum Day Demand (MDD) (L/s)	Peak Hour Demand (PHD) (L/s)
Northeast (NE) Zone	5.4	11.4	17.1
Bear's Paw (SE) Zone	5.1	10.7	16.1
Townsite (Zone 1)	25.7	55.3	83.8
Total System	36.2	77.4	117.0

The demand update included applying a global multiplier to the previous model demands and adding demands to areas with growth since 2013 in order to match the updated data that the Town provided for the current existing demand scenarios.

2.4 FUTURE DEMAND UPDATE

Future population scenarios assume a population growth of 1.5% per year, as per the Town of Golden Transportation Plan (Urban Systems Ltd, 2023), and the Town provided ICI growth projects for the 10 and 25-Year horizons. The future residential and ICI growth are summarized in the 2024 Golden Integrated Water Plan Design Criteria memorandum. Figures are attached showing the locations of the anticipated growth. The demand associated with the anticipated growth is assigned to the nearest node in the water model. Tables 2 and 3 summarize the project growth for each pressure zone in the model.

Table 2. Water Model System Future Demand Summary – 10 Year Projects

	ADD (L/s)	MDD (L/s)	PHD (L/s)
Northeast (NE) Zone	9.9	21.6	31.9
Bear's Paw (SE) Zone	5.3	11.1	16.7
Townsite (Zone 1)	28.2	61.3	92.2
Total System Demand	43.3	93.9	140.8

Table 3. Water Model System Future Demand Summary – 25 Year Projects

	ADD (L/s)	MDD (L/s)	PHD (L/s)
Northeast (NE) Zone	14.7	32.9	48.2
Bear's Paw (SE) Zone	7.2	17.5	26.2
Townsite (Zone 1)	33.9	75.2	112.0
Total System Demand	55.8	125.6	186.4

2.5 RESERVOIR ELEVATIONS

The reservoir elevations used in the model are summarized in Table 4. To update the reservoir elevations, the model set points were compared to the record drawings, the SCADA data provided during hydrant testing, LiDAR information, and GPS ground points collected during the 2024-06-18 site visit. It should be noted that the GPS points collected during the site visit were not collected with survey equipment, and therefore were only used as reference.

Table 4. Reservoir Water Elevations Used in the Model

	Reservoir Water Elevation (m)
Lafontaine Reservoirs	973.7
Bear's Paw Reservoir	885.8
Gunite & Hypalon Reservoir [1]	842.2

Notes:

1. The wells feed the Gunite reservoir, which has a slightly higher elevation than the Hypalon Reservoir. The Gunite reservoir then feeds the Southeast/Selkirk Booster Station and the Hypalon Reservoir (through an automated valve that opens and closes to maintain level in the Hypalon reservoir). The Hypalon Reservoir supplies water to the main town pressure zone, which also feeds the Northeast Booster Station. For model simplicity, the Gunite and Hypalon are modeled as a single reservoir.

2.6 FIRE FLOW DEMAND UPDATE

The following sources of required fire flow data were utilized:

1. Golden's Subdivision Servicing Bylaw stipulates fire flow requirements based on land use (Table 5). These requirements are in line with the 2022 MMCD Design Guidelines. These values will be used where other data is not available. For future industrial developments, a required fire flow of 150 L/s will be considered, as per the Design Criteria memorandum.

2. Several recent developments have Fire Underwriters Survey (FUS) required fire flow calculations available. These values will be used in the place of the Subdivision Servicing Bylaw (Table 6).

3. A 1984 FUS assessment recommended a base fire flow of 210 L/s. While this fire flow is not required everywhere within the Town, we understand that the existing hotel developments in the Northeast zone and the industrial area in the Town zone will require these flows at minimum.

The available fire flows at each hydrant will be checked using WaterCAD's Fire Flow Analysis tool. The tool adds the Maximum Fire Flow to each node, then checks the residual pressure at that node, the Minimum Zone Pressure, and maximum velocity. If the Fire Flow Upper Limit can be delivered while maintaining the various constraints, that node will satisfy Fire Flow constraints. If one or more of the pressure constraints is not met while attempting to withdraw the Fire Flow Upper Limit, the program will iteratively assign lesser demands until it finds the maximum flow that can be provided while maintaining the pressure constraints.

Table 5. Recommended Fire Flows for Integrated Water Strategy.

	Golden Subdivision Servicing Bylaw (2008) (Existing Properties)	Recommended Fire Flows for Integrated Water Strategy (Future Developments)
Single Family Residential	60 L/s	60 L/s
Apartments/ townhouses	90 L/s	90 L/s
Commercial	150 L/s	150 L/s
Institutional	150 L/s	150 L/s
Industrial	225 L/s	150 L/s

Table 6. Development FUS Fire Flow Calculations that Exceed the Subdivision Servicing Bylaw

Address	Development Type	Required Fire Flow (L/s)	Zone
410 5th Ave	Apartment/Townhouses	133	Zone 1
8 - 1444 Granite Drive	Apartment/Townhouses	135	Zone 1
1410 Golden View Road	Apartment/Townhouses	183	NE Zone
801 9th Street North	Commercial	183	Zone 1
820 11th Avenue	Industerial/Residential	83	Zone 1
1145 10th Ave N	Residential/Commercial	167	Zone 1

As per MMCD guidelines, the following fire flow constraints were used:

- Velocities under fire flow conditions should be below 3.5 m/s
- Minimum pressure in system during MDD + fire flow is 150 kPa
- Minimum fire flow needed at each node is 60 L/s
- Fire flow upper limit is 225 L/s

Note that WaterCAD's Fire Flow analysis does not restrict the available fire flow based on hydrant capacity constraints. For instance, a 2.5-inch diameter fire hydrant port can only provide about 70 L/s, but the flow analysis might indicate available fire flow at nodes exceeding 100 L/s. Nevertheless, if more than 70 L/s is needed at that location, this suggests that the system can likely support multiple hydrants working together to provide the modelled flow.

2.7 PUMP CURVES

Where possible, the pump curves for the booster stations and wells were updated to match the manufacturer's curves. The manufacturer's curves were not available for all the pumps, this is in part due to the age of the pumps. As well, when model results with the manufacture's curves did not match the observed system performance, the curve was altered to match system observations. Table 7 outlines the updates made to the pump curves.

Table 7. Manufacturer Pump Curve Availability and Corresponding Model Update

System Component	Pump Curves Available	Pump Curve Update
Northeast Booster Pump 1 & 2	No manufacturer curves available, the original pumps were installed in 1982, and were rebuilt in 2000	Updated to match observed system performance
Selkirk (SE) Booster Pump 1 & 2	Manufacture pump curve available	Manufacture curve resulted in flows and pressures higher than the observed system performance. Could be due to decreased pump efficiency or hydraulic losses within booster station. Updated curve to match observations

System Component	Pump Curves Available	Pump Curve Update
Well Pump #2	Manufacture pump curve available	Updated to manufacturers curve
Well Pump #3	No manufacturer curves available	Updated to match observed system performance
Well Pump #4	Manufacture pump curve available	Updated to manufacturers curve
Well Pump #5	Manufacture pump curve available	Updated to manufacturers curve

2.8 PRV SET POINTS

The PRV setpoints from the 2013 Water Distribution Study were carried forward to the existing scenario in the model update, they are summarised in Table 8.

Table 8. Model Existing Scenario PRV Setpoints

Name	Size (mm)	Inlet Pressure	Outlet Pressure
Granite Drive PRV	250	102 psi	77 psi
Pine Drive PRV	150	98 psi	73 psi
Golden Donald Upper PRV	100 & 50	120 psi	95 psi
NE Bypass PRV	75	265 psi	80 psi

In conversation with the Town, we understand that the set points for the PRVs in the NE Zone (Granite Drive, Pine Drive, and Golden Donald Upper) were recommended as part of the 2013 Water Distribution Study. However, the PRVs have been adjusted in response to customer pressure complaints. The current PRV setpoints could not be confirmed as they are all in a confined space. Therefore, the model data in this area, likely does not represent actual conditions and the results should be used with caution. That said, this study will recommend PRV set points or infrastructure upgrades for this area, as a result, modelling can be completed considering the future recommended operational conditions and infrastructure.

3.0 MODEL CALIBRATION

3.1 INTENT/BACKGROUND

Calibration involves comparing model results to field observations and adjusting the system data as needed to ensure that the model's predicted performance aligns closely with measured system performance. This process may involve modifying pipe roughness, altering pump characteristics, changing reservoir elevations, and adjusting other model attributes that influence model results.

Measured field data (flows and pressures) are used to calibrate the water model from hydrant testing. Hydrant testing is the process of opening a hydrant and measuring the flow from it, while recording residual pressures at another hydrant in the area. These field measurements allow the same flow conditions to be simulated in the model while comparing pressures at two or more locations.

3.2 PREVIOUS MODEL CALIBRATION

The model was previously calibrated as part of the 2013 Water Distribution Study. During his process, the Hazen-Williams C factors were updated to match existing conditions at the time. These C factors in the model were reviewed to ensure they are reasonable and align with recommended values. In general, older parts of Golden have lower (worse) C factors when compared to newer parts. The average and range of Hazens-Williams C factors for each material type in the model is listed in Table 9.

Table 9. Average and Range of Hazens-Williams C Factors for Each Pipe Material in the Model

Material	Average	Minimum Value	Maximum Value
Asbestos Cement	117	110	140
Cast iron	110	110	110
Ductile Iron	130	120	130
PVC	130	100	150
Steel	110	90	130

3.3 STATIC PRESSURES

The static pressures were analyzed to confirm model elevations. Table 10 summarize the differences between the field data and the model results for the static pressures. With the exception of the PRV zones in the Northeast pressure zone, excellent agreement was observed between the modelled and the measured pressures.

Table 10. Summary of Model Calibration Results – Static Pressures

Test Number	Pressure Hydrant	Flushing Hydrant	Pressure Zone	Agreement	Comments
Test 1	4%	4%	Zone 1	Excellent (<5%)	Model predicts a lower pressure
Test 2	0%	1%	Zone 1	Excellent (<5%)	Model predicts a higher pressure
Test 3	0%	2%	Zone 1	Excellent (<5%)	Model predicts a higher pressure
Test 4	1%	1%	Zone 1	Excellent (<5%)	Model predicts a lower pressure
Test 5	3%	1%	Bear's Paw	Excellent (<5%)	Model predicts a lower pressure
Test 6	2%	2%	NE Zone	Excellent (<5%)	Model predicts a higher pressure
Test 7	18%	18%	NE Zone	Poor (>15%)	Test in PRV regulated area[1]
Average	4%	4%	-	-	-

Notes:

1. Modeled using the recommend PRV setpoints provided to the Town during the 2013 Water Distribution Study. In conversation with the Town operator, the PRVs have been adjusted in response to customer pressure complaints, and the current setpoints are unknown. To achieve the static pressure measured during testing in the model, with an error less than 5%, one of the PRVs need to be inactive (fully open).

3.4 FLOW TESTING DATA

Results from a total of seven (7) tests were provided by the Town, which were completed in April 2024. The complete fire flow test results used for the calibration process are attached. Key results are summarized below:

- The measured flows ranged from a low of 79 L/s to a high of 114 L/s
- The measured static pressures ranged from a low of 503 kPa to a high of 793 kPa
- The measured residual pressures ranged from a low of 262 kPa to a high of 558 kPa
- The measured pressure drops ranged from a low of 14 kPa to a high of 414 kPa
    - American Water Works Association (AWAA) recommends at least a 69 kPa (10 psi) pressure drop when conducting fire flow tests

When calibrating the model, the goal is to compare the measured values from the tests against the predicted results from the model, to show that the current model results agree with the observed field data.

However, when the hydrant testing flows were inputted into the model, the resulting residual pressures were physically impossible, indicating an issue with the flow data. Further inspection by the Town revealed that when the gauge was at atmospheric pressure, the needle was above zero, as shown in Figure 1. This confirms that the gauge is likely not calibrated, making the hydrant testing flows invalid.

Figure 1. *Gauge Used During Hydrant Testing at Atmospheric Pressure, Shows the Needle is Above Zero*

For Tests #1 to #4, a linear relationship was found between the measured flushing flows and the modeled flushing flows required to achieve the measured residual pressure. This relationship is illustrated in Figure 2. While this indicates that the model is performing in a predictable way that likely matches real world performance, the inaccuracies with the gauge cannot provide enough confidence to re-calibrate the model.

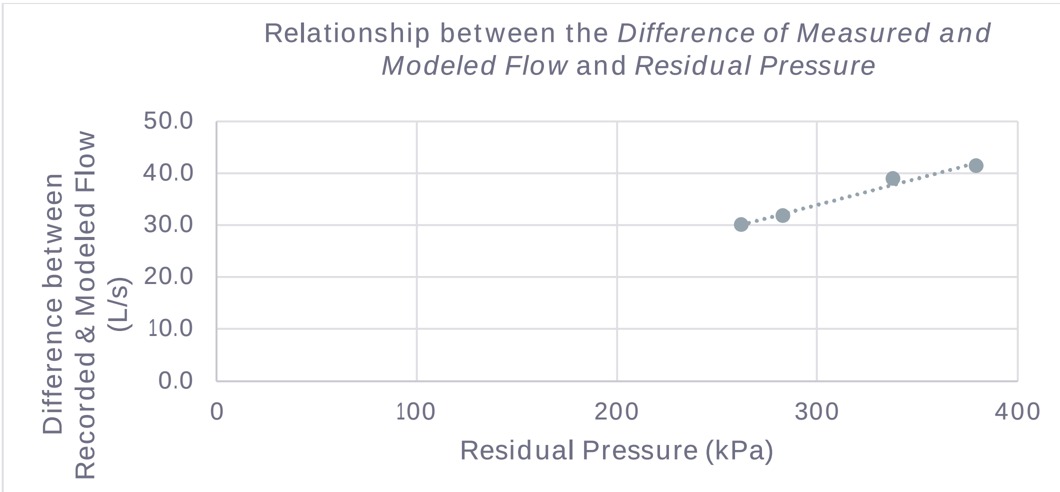


Figure 2. Graph comparing the difference between the measured flow and modeled flow required to achieve the measured residual pressure for Tests #1 to #4.

4.0 MODEL VALIDATION

It is important to note that the model was calibrated in 2013. While the April hydrant flow data is invalid and could not be used to re-calibrate the model, there is sufficient SCADA data available to validate the model. A description of calibration verses validation is below:

- Validation is the process of updating demands, physical attributes (e.g. pipe size), and other operational parameters to ensure the model matches real world conditions.
- Calibration is the process of adjusting model parameters, largely friction factors, to ensure that the model outputs match observed data as closely as possible.

There was a significant effort expended in 2013 to adjust friction factors to match real world performance at that time. Given that it has only been 10 years since that time, friction factors should not be significantly altered. We are additionally confident based on an analysis of model performance vs SCADA data.

To validate Golden's water model the actual pump discharge flows and pressures were compared to model outputs. The actual pump discharge flows and pressures are based on either SCADA data provided by the Town, or gauge readings collected during Urban's June 18th site visit. A summary of the results are provided in Table 8 and Table 9. These results are using the existing average day demand scenario, with all well pumps on and a duty booster station pump on.

Table 11. Comparison of System Performance to Model Results - Pump Discharge Flows

	SCADA / Gauge Discharge Flow (L/s)	Model Discharge Flow (L/s)	Percent Difference
NE Booster Pump 2	17.4	17.9	3%
NE Booster Pump 1	14.4	14.6	1%
Selkirk Booster Pump 1 & 2	9.63	9.3	3%
Well Pump #2	9.5	10	5%
Well Pump #3	19	18.8	1%
Well Pump #4	36.7	37.9	3%
Well Pump #5	45	44.2	2%
		Average	2%

Table 12. Comparison of System Performance to Model Results - Pump Discharge Pressures

	SCADA / Gauge Discharge Pressure (kPa)	Model Discharge Pressure (kPa)	Percent Difference
NE Booster Pump 2	1821	1862.5	2%
NE Booster Pump 1	1819	1851.5	2%
Selkirk Booster Pump 1 & 2	464.7	439.9	5%
Well Pump #2	529.7	508.6	4%
Well Pump #3	528.8	502.3	5%
Well Pump #4	527	513.9	2%
Well Pump #5	572.3	579.4	1%
		Average	2%

The average difference between system performance and model results is less than 5% which suggests that the model is reasonably predicting system behaviours. We are comfortable using the validated model for the Integrated Water Strategy Analysis.

5.0 MODEL RESULTS

Water model results for the system pressure demands for ADD & PHD, as well as the available fire flow with MDD is shown in Figures 3, 4, & 5. Our next step will be to complete an evaluation of the system and identify required upgrades.

5.1 SYSTEM PRESSURES AT ADD

<table>
<tr><th>Scenario</th><th>Setpoints</th><th>Color Coding Legend (kPa)</th></tr>
<tr><td>Demand</td><td>Average Day Demand</td><td rowspan="5">
<table>
<tr><th></th><th></th><th colspan="2">Pressure</th></tr>
<tr><th></th><th></th><th>(kPa)</th><th>(psi)</th></tr>
<tr><td>(pink)</td><td><=</td><td>150</td><td>22</td></tr>
<tr><td>(orange)</td><td><=</td><td>345</td><td>50</td></tr>
<tr><td>(green)</td><td><=</td><td>550</td><td>80</td></tr>
<tr><td>(blue)</td><td><=</td><td>700</td><td>102</td></tr>
<tr><td>(red)</td><td><=</td><td>850</td><td>123</td></tr>
<tr><td>(yellow)</td><td>></td><td>850</td><td>123</td></tr>
</table>
</td></tr>
<tr><td>Calculation Type</td><td>Hydraulics Only</td></tr>
<tr><td>Booster Station Pumps</td><td>All off</td></tr>
<tr><td>Well Pumps</td><td>All off</td></tr>
<tr><td>NE Bypass</td><td>Closed</td></tr>
</table>

Note: Black nodes represent future infrastructure that is not currently in service.

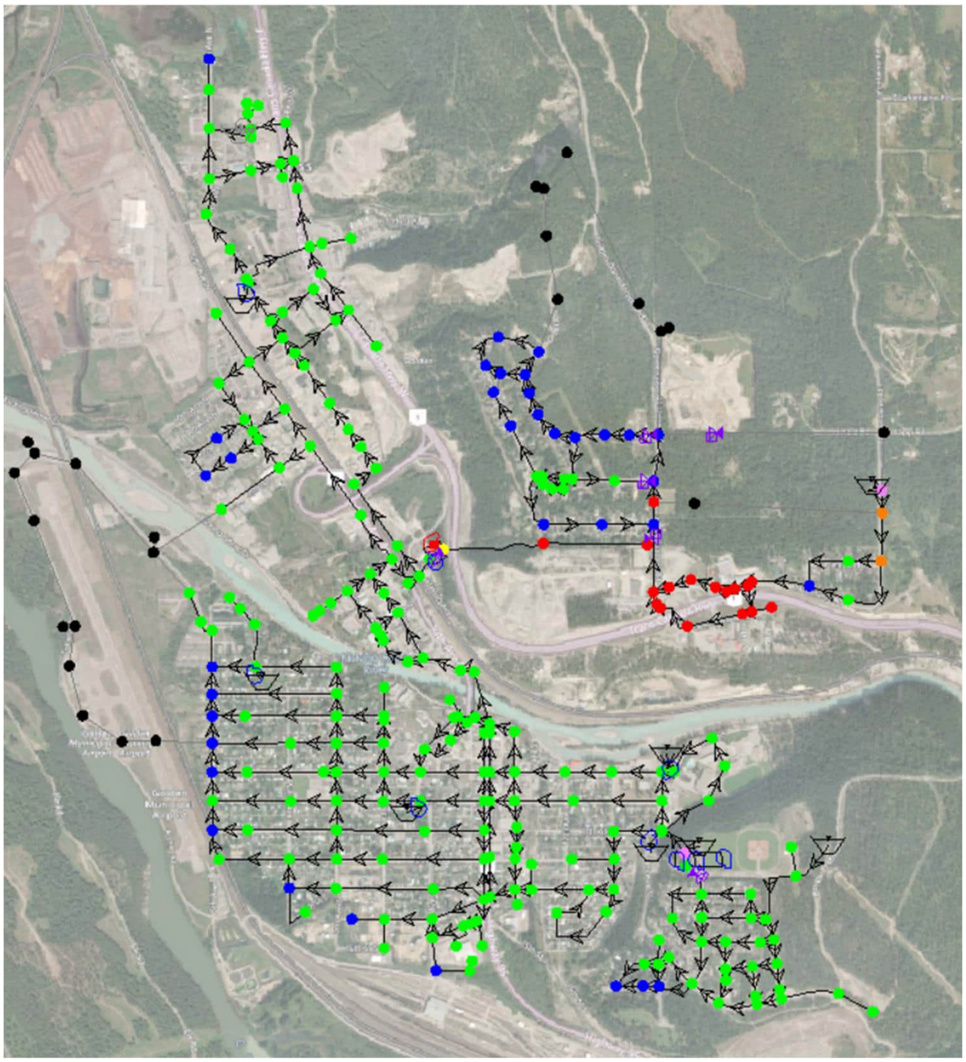


Figure 3. Pressures at the nodes under the existing average day demands, all pumps off

5.2 SYSTEM PRESSURES AT PHD

Scenario	Setpoints
Demand	Peak Hour Demand
Calculation Type	Hydraulics Only
Booster Station Pumps	Duty on, Standby off
Well Pumps	Wells 2, 3, 4, & 5 on
NE Bypass	Closed

Color Coding Legend (kPa)

		Pressure (kPa)	Pressure (psi)
Pink	<=	150	22
Orange	<=	345	50
Green	<=	550	80
Blue	<=	700	102
Red	<=	850	123
Yellow	>	850	123

Note: Black nodes represent future infrastructure that is not currently in service.

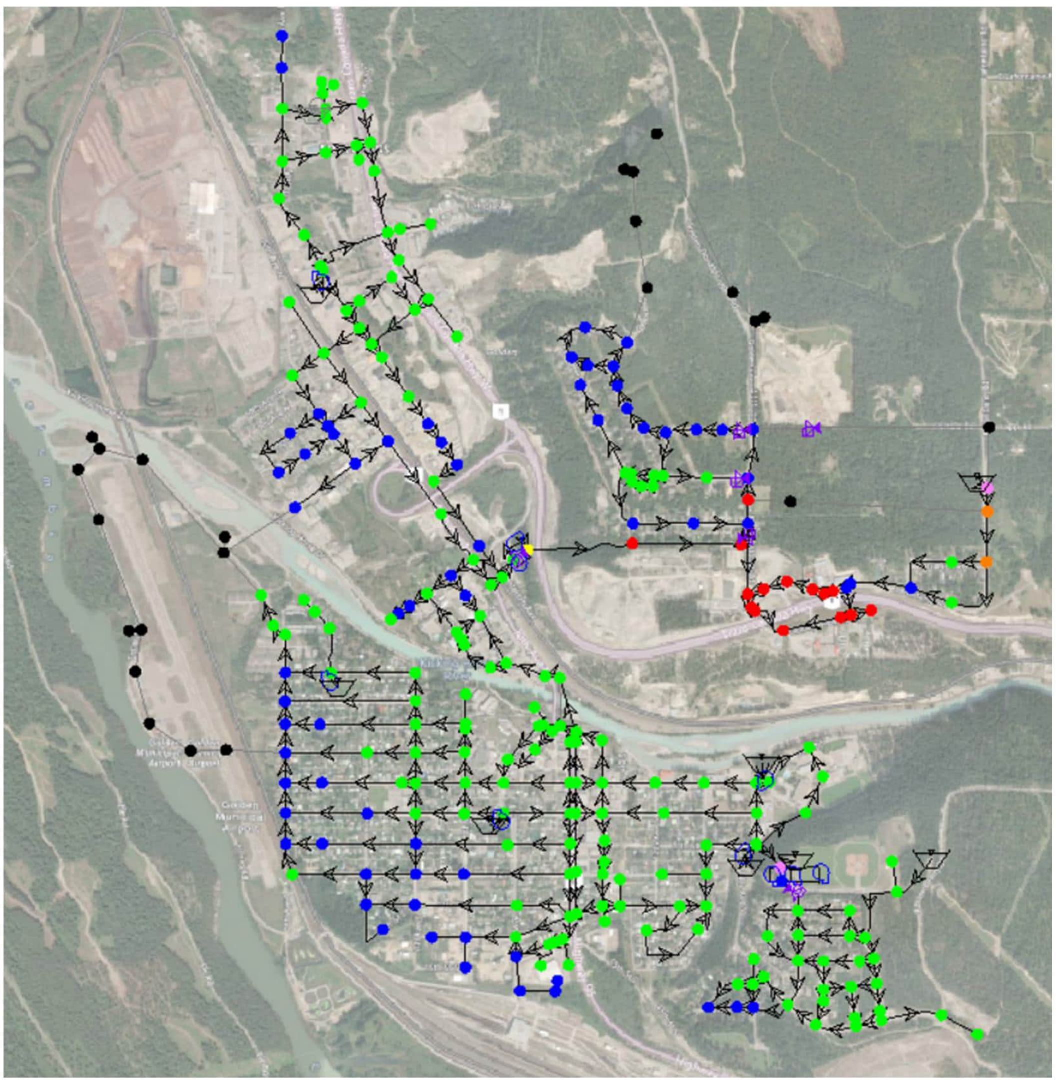


Figure 4. Pressures at the nodes under the existing peak hour demands, wells & booster stations on

5.3 AVAILABLE FIRE FLOWS AT MDD

Scenario	Setpoints
Demand	Maximum Day Demand
Calculation Type	Fire Flow
Booster Station Pumps	Duty on, Standby off
Well Pumps	3, 5, 7 on (wells with backup power)
NE Bypass	Closed

Color Coding Legend (L/s)

		Available Fire Flow	
		(L/s)	(USGPM)
	<=	50	793
	<=	60	951
	<=	90	1427
	<=	135	2140
	<=	151	2394
	<=	225	3567
	>	225	3567

Note: Black nodes represent nodes without a hydrant (for which fire flows are not calculated) or future infrastructure that is not currently in service.

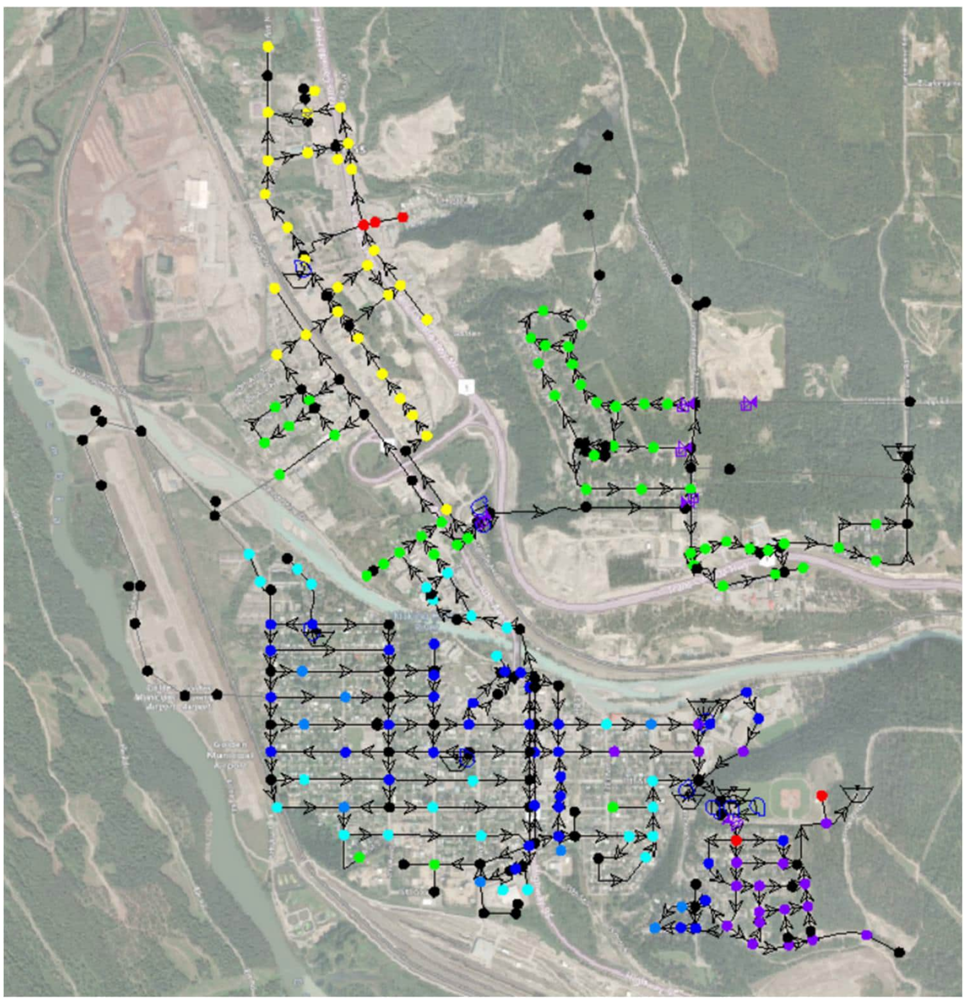


Figure 5. Available fire flows at hydrants under maximum day demands

6.0 CONCLUSION

Although the model calibration could not be updated using the 2024 hydrant testing results, the model was previously calibrated during the 2013 Water Distribution Study, and the model validation results give us confidence that it should still represent existing conditions accurately for evaluating system capacity in the 2024 Integrated Water System Plan.

The next steps for in preparing the 2024 Integrated Water System Plan as follows:

1. Confirm operational scenarios
2. Complete water system evaluation for existing and future conditions
3. Prepare recommendations for system upgrades
4. Finalize reporting

Sincerely,

URBAN SYSTEMS LTD.

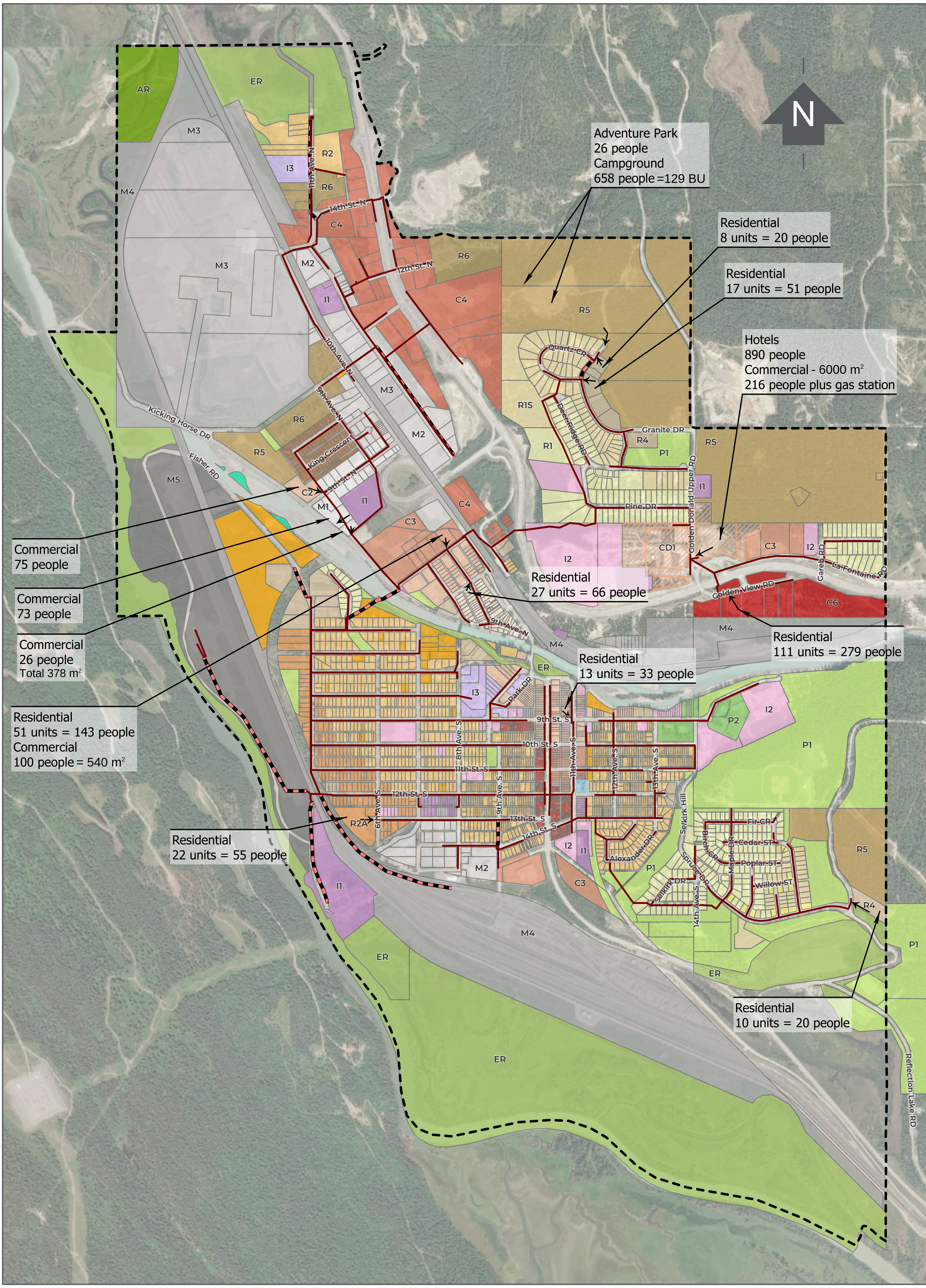
Jill Reynolds, P.Eng
Project Engineer

Robyn Cameron, EIT
Project Engineer-in-Training

cc: Sara Anderson

/JR&RMC
Enclosure

\\usl.urban-systems.com\projects\Projects_CAL\0404\0254\01\Q-Quality-Records\Jeremy Clowes\11. Final WMP Report rev.2\5. Appendix B\2024-08-06-Model Update and Validation.docx



URBAN SYSTEMS

Project #: 0404.0244.01
Author: SDF
Checked: CG
Status: Review
Revision: A
Date: 2024 / 5 / 21

0 100 200 300
Meters

Coordinate System:
NAD 1983 UTM Zone 11N

Scale: 1:15,000
(When plotted at 11"x17")

Data Sources:
- Data provided by government of B.C. and Town of Golden

The accuracy & completeness of information shown on his drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

Legend

- Future Sanitary Connection
- Sanitary Gravity Mains
- Sanitary Forcemains
- Town Boundary

Zoning

Residential: R1, R1D, R1S, R2, R2A, R3, R4, R5, R6, R7

Community: I1, I2, I3

Parks, Recreation, Environment: P1, P2, ER

Commercial: C1, C2, C3, C4, C5, C6

Industrial: M1, M2, M3, M4, M5

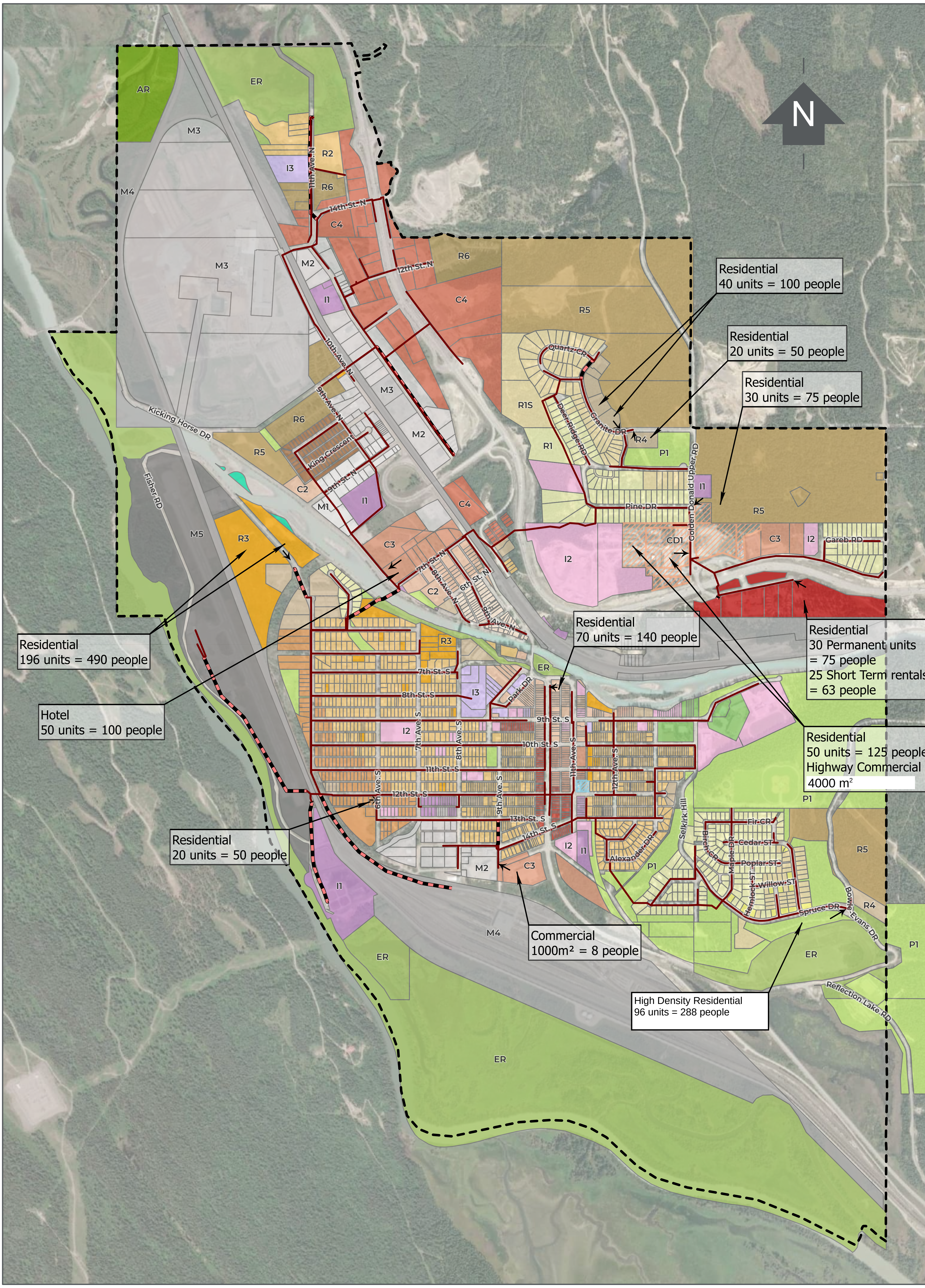
Other: CD1, CD2, CL, AR

TOWN OF GOLDEN
Kicking Horse Country

Sanitary Master Plan

10-year Growth Assumptions

FIGURE 11



URBAN SYSTEMS

Project #: 0404.0244.01
Author: SDF
Checked: CG
Status: Review
Revision: A
Date: 2024 / 6 / 21

0 100 200 300
Meters

Coordinate System: NAD 1983 UTM Zone 11N
Scale: 1:15,000 (When plotted at 11"x17")

Data Sources:
- Data provided by government of B.C. and Town of Golden

Notes:
- Based on 10 year projections

The accuracy & completeness of information shown on his drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

Legend

- Future Sanitary Connection
- Sanitary Gravity Mains
- Sanitary Forcemains
- Town Boundary

Zoning
- Residential: R1, R1D, R1S, R2, R2A, R3, R4, R5, R6, R7
- Community: I1, I2, I3
- Parks, Recreation, Environment: P1, P2, ER
- Commercial: C1, C2, C3, C4, C5, C6
- Industrial: M1, M2, M3, M4, M5
- Other: CD1, CD2, CL, AR

TOWN OF GOLDEN
Kicking Horse Country

Sanitary Master Plan

25-year Growth Assumptions

FIGURE 12

APPENDIX C

MODEL RESULTS

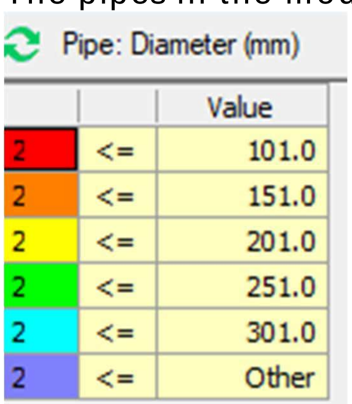
Model export tables are provided for Scenario 1.a and 2.a, the scenarios are described below. Screenshots of the model with the element labels are also provided for reference.

Scenario	Demand	Purpose	NE Booster Station			SE Booster Station			Well #2 10 L/s	Well #3 19 L/s	Well #4 38 L/s	Well #5 44 L/s	Well #7 55 L/s
			Pump 1 14 L/s	Pump 2 17 L/s	Bypass Valve	Pump 1 10 L/s	Pump 2 10 L/s	Fire Pump 70 L/s					
Scenario 1.a	Existing MDD	Determine fire flow for Zone 1								X		X	
Scenario 2.a	Existing MDD	Determine fire flow for NE & SE bench	X			x				X		X	

Notes:

- For fire flow analysis, it is assumed that only wells with backup power can provide fire flows. The largest well (Well #7) is assumed to be out of service.
- Only pumps with backup power are assumed operational for fire flow scenarios.
- The fire pump for the SE zone was installed prior to the construction of the Bears Paw reservoir. With the Bears Paw reservoir in place, the fire pump is not necessary to meet instantaneous fire flow requirements in the zone.

The pipes in the model screenshots are color coded by diameter, as described by the legend below.



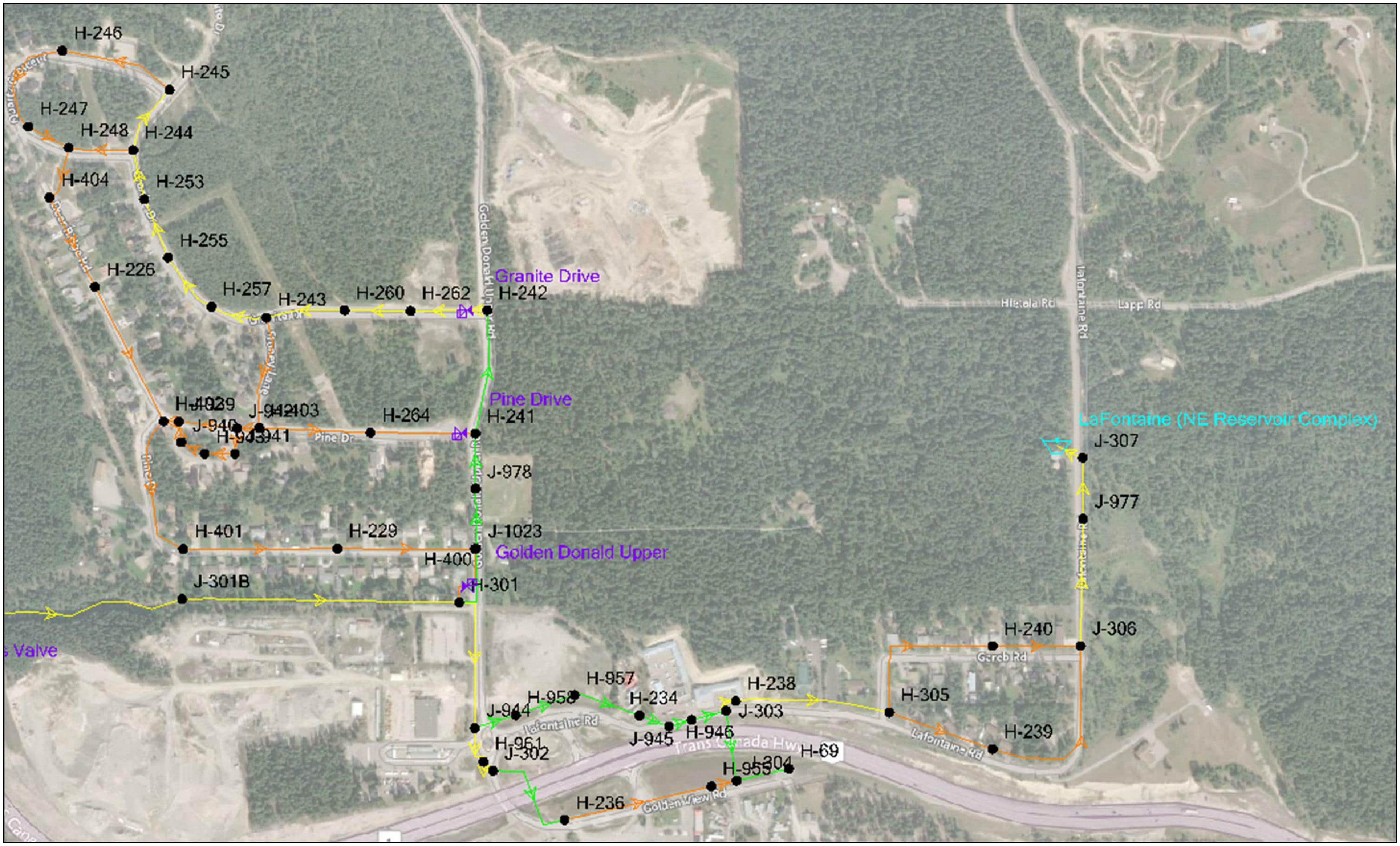


Figure 1 - NE Pressure Zone Model Labels

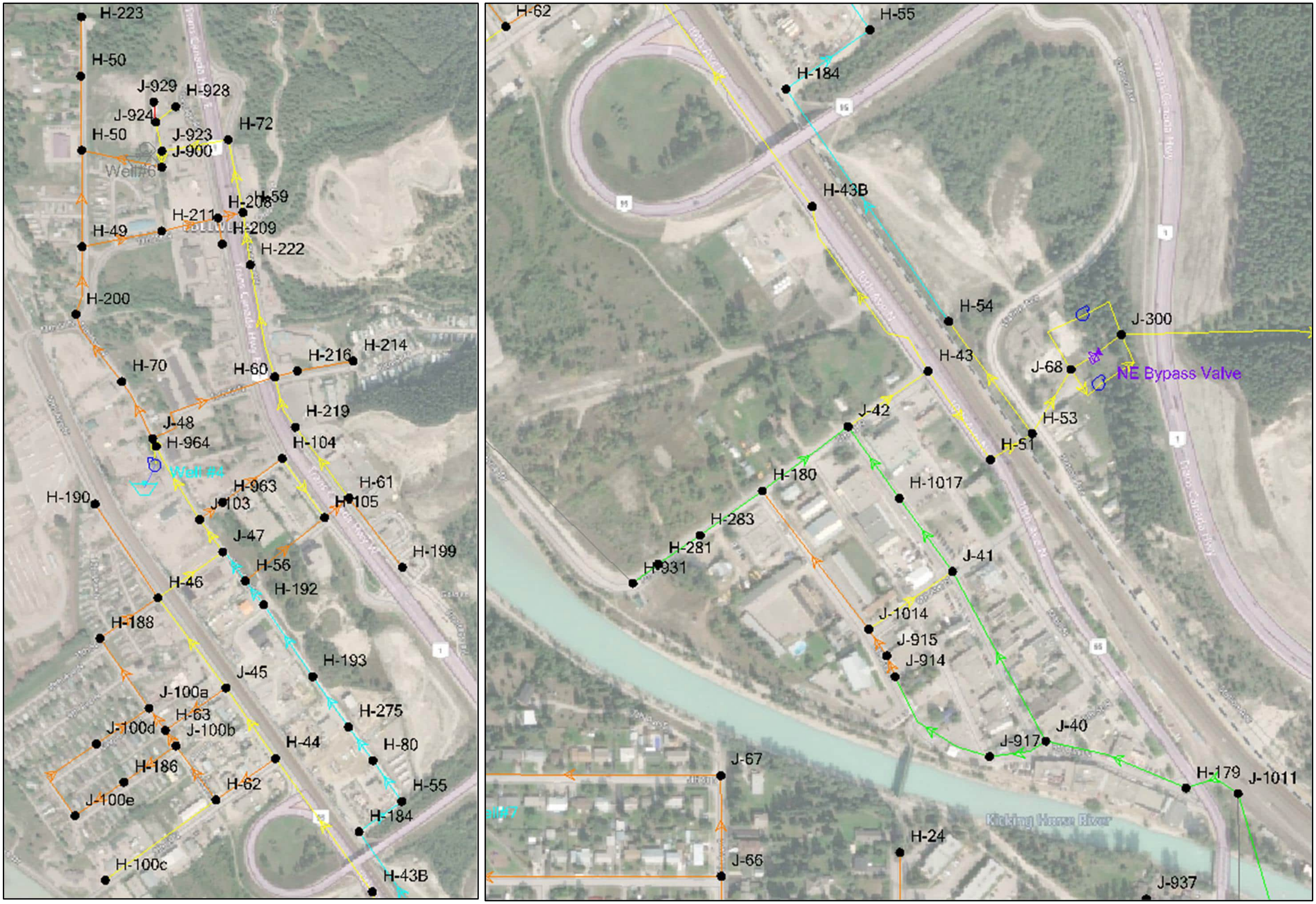


Figure 2: Left - Northwest Highway Commercial Area Model Labels, Right – North Industrial and Downtown Area

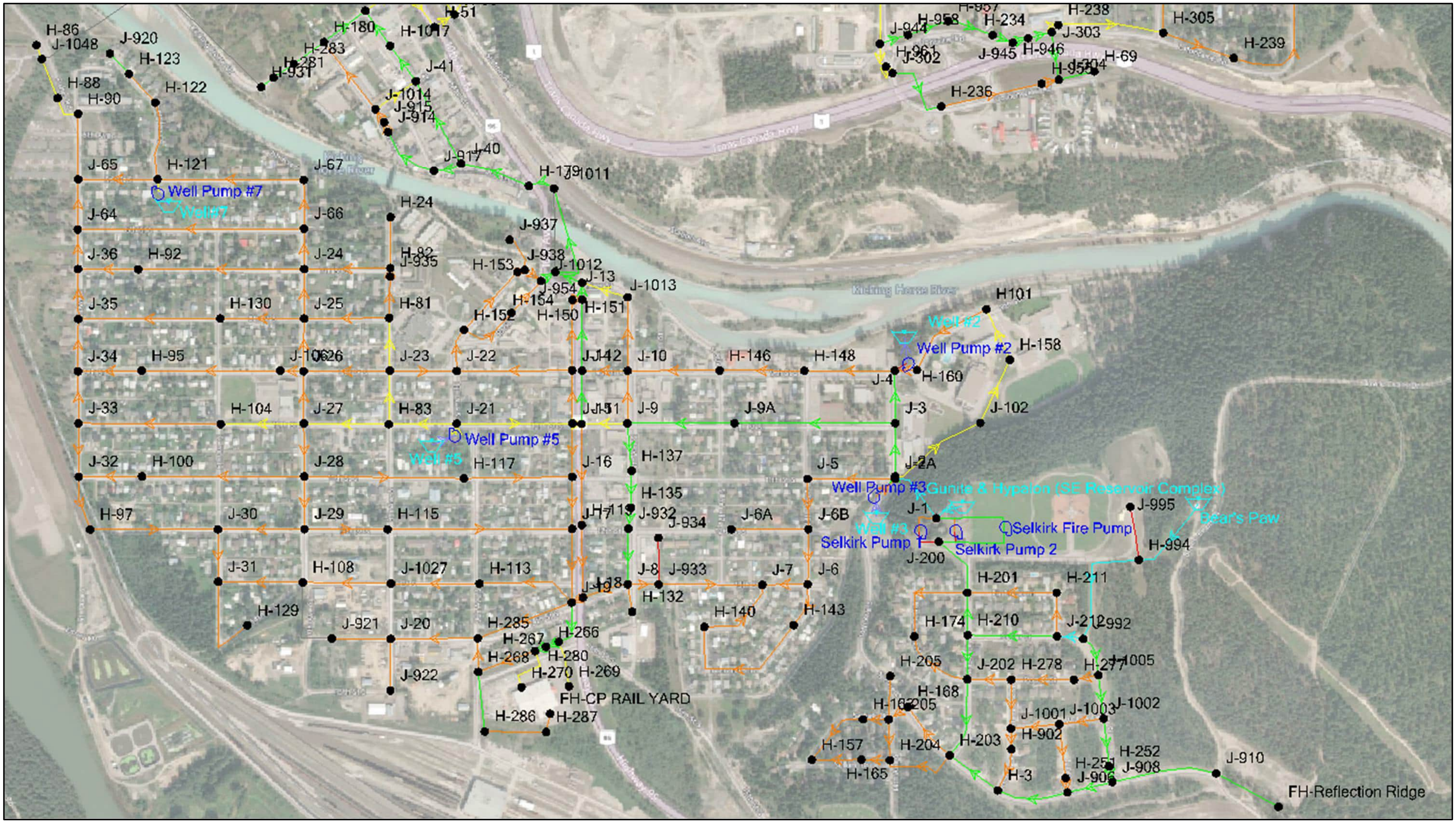


Figure 3: South Side and Bear's Paw Model Labels

Label	**Elevation (m)**	**Demand (L/s)**	**Pressure at MDD (kPa)**	**Pressure at MDD (psi)**	**Fire Flow (Available) (L/s)**
J-1	840.9	0.0	12.8	1.9	(N/A)
J-2A	791.97	0.0	491.9	71.3	(N/A)
J-3	791.84	1.2	493.1	71.5	61.2
J-2	791.79	0.0	493.6	71.6	(N/A)
J-4	791.8	0.1	493.4	71.6	60.1
J-5	791.15	1.7	499.1	72.4	61.7
J-6	791.13	1.8	499.1	72.4	61.8
J-7	790.39	2.1	506.4	73.4	62.1
J-8	787.21	0.3	538.2	78.1	60.3
J-9	788.47	0.7	525.9	76.3	60.7
J-10	789.51	0.6	515.5	74.8	60.6
J-11	787.76	0.3	532.9	77.3	60.3
J-12	788.88	0.0	521.6	75.7	(N/A)
J-13	789.43	0.4	515.6	74.8	(N/A)
J-14	788.92	0.2	521.3	75.6	60.2
J-15	787.81	0.3	532.9	77.3	(N/A)
J-16	787.33	0.9	537.3	77.9	(N/A)
J-17	787.15	0.9	538.8	78.1	(N/A)
J-18	786.6	0.3	544.1	78.9	(N/A)
J-19	786.64	1.6	543.7	78.9	61.7
J-20	785.45	0.9	555.2	80.5	60.9
J-21	786.9	0.7	550.1	79.8	(N/A)
J-22	787.35	0.7	536.6	77.8	60.7
J-23	787.06	1.2	540.7	78.4	(N/A)
J-24	786.9	1.1	541.6	78.6	(N/A)
J-25	786.63	1.2	544.4	79.0	(N/A)
J-26	786.89	0.7	542.1	78.6	60.7
J-27	786.44	0.6	546.9	79.3	(N/A)
J-28	785.76	1.1	552.7	80.2	61.1
J-29	785.44	0.6	555.7	80.6	(N/A)
J-30	785.36	0.7	556.3	80.7	60.7
J-31	784.98	0.4	560.0	81.2	60.4
J-32	784.88	1.4	561.1	81.4	(N/A)
J-33	785.29	0.9	557.2	80.8	60.9
J-34	784.98	1.0	560.3	81.3	(N/A)
J-35	784.97	1.0	560.3	81.3	61.0
J-36	784.89	1.0	561.0	81.4	(N/A)
J-40	788.13	1.0	523.7	76.0	61.0
H-302	786.43	0.7	539.4	78.2	60.7
J-42	785.61	0.5	546.3	79.2	60.5
H-43	786.37	0.2	536.5	77.8	60.2
H-44	786.09	0.3	536.6	77.8	(N/A)
J-45	787.25	0.0	524.8	76.1	(N/A)
H-46	790.01	2.0	497.6	72.2	62.0
J-47	793.09	0.2	467.5	67.8	60.2
J-103	794.19	0.3	456.3	66.2	(N/A)
J-48	794.69	0.0	451.1	65.4	(N/A)
H-49	789.68	0.6	499.4	72.4	60.6
H-59	796.73	0.8	430.3	62.4	60.8
H-60	800.66	4.9	391.9	56.8	64.9
H-61	797.67	0.2	421.5	61.1	60.2
H-105	797.38	0.2	424.8	61.6	60.2

H-104	799.43	1.3	404.8	58.7	61.3
J-300	802.05	0.0	1671.7	242.5	(N/A)
H-301	892.08	0.0	790.6	114.7	(N/A)
J-303	900.8	0.5	705.8	102.4	(N/A)
J-304	893.64	3.0	775.9	112.5	(N/A)
J-302	893.95	0.3	772.7	112.1	(N/A)
H-305	914.41	0.8	574.3	83.3	60.8
J-306	945.94	0.0	269.1	39.0	(N/A)
H101	792.23	1.2	489.3	71.0	61.2
J-102	792.88	0.0	482.9	70.0	60.0
J-66	786.79	0.7	542.3	78.7	60.7
J-67	786.89	1.0	541.2	78.5	(N/A)
J-65	784.98	1.8	559.9	81.2	61.8
J-64	785.12	0.9	558.6	81.0	60.9
H-51	786.07	0.1	538.4	78.1	60.1
J-68	786.5	0.0	533.8	77.4	(N/A)
J-307	960.17	0.0	132.0	19.1	(N/A)
J-200	840.9	0.0	438.9	63.7	(N/A)
H-201	840.48	1.2	443.1	64.3	61.2
H-211	843.27	0.6	415.7	60.3	60.6
J-212	842.95	0.5	418.9	60.8	60.5
H-210	839.99	0.6	447.8	65.0	60.6
J-202	839.28	0.8	454.7	66.0	60.9
H-203	834.36	0.5	502.9	72.9	60.5
H-204	829.3	1.1	552.4	80.1	61.1
J-205	833.78	0.8	508.5	73.7	(N/A)
H-63	785.61	4.5	540.6	78.4	64.5
H-62	785.27	0.1	544.3	78.9	60.1
H-50	787.49	2.3	520.6	75.5	62.3
J-301B	888.37	0.0	826.9	119.9	(N/A)
H-43B	786.91	0.0	530.2	76.9	(N/A)
H-205	835.16	0.0	494.9	71.8	(N/A)
H-24	787.41	0.0	536.6	77.8	60.0
H-50	785.46	0.0	540.5	78.4	(N/A)
J-900	791.58	0.6	480.6	69.7	(N/A)
H-400	894.9	0.9	615.8	89.3	60.9
H-401	888.92	0.9	674.5	97.8	61.0
H-402	904.84	0.7	518.9	75.3	(N/A)
H-403	904.55	0.1	521.8	75.7	60.1
H-404	896.32	0.6	602.3	87.4	60.6
H-53	786.08	0.0	537.9	78.0	60.0
H-54	785.5	0.0	542.7	78.7	60.0
H-55	785.49	0.0	542.4	78.7	60.0
H-56	792	0.0	478.1	69.3	(N/A)
J-9A	790.03	0.0	510.7	74.1	60.0
J-6A	789.31	0.0	517.1	75.0	60.0
J-6B	792.41	0.0	486.6	70.6	60.0
H-69	894.61	0.0	766.3	111.1	60.0
H-70	793.94	0.0	458.2	66.5	60.0
H-72	793.18	0.0	465.0	67.4	60.0
J-100b	785.62	0.0	540.6	78.4	(N/A)
J-100a	785.78	0.0	539.0	78.2	(N/A)
J-100d	784.83	0.0	548.3	79.5	60.0
H-100c	785.17	0.0	545.2	79.1	60.0
J-100e	784.85	0.0	548.2	79.5	60.0

H-80	785.77	0.0	539.6	78.3	60.0
H-81	787.06	0.0	540.4	78.4	60.0
H-82	787.33	0.0	537.4	78.0	(N/A)
H-83	787.11	0.0	542.0	78.6	60.0
H-86	785.38	0.0	556.0	80.6	60.0
H-88	785.47	0.0	555.1	80.5	60.0
H-90	785.41	0.0	555.7	80.6	(N/A)
H-92	785.65	0.0	553.6	80.3	60.0
H-95	785.37	0.0	556.5	80.7	60.0
H-97	786.05	0.0	549.7	79.7	60.0
H-100	785.23	0.0	557.7	80.9	60.0
H-104	785.78	0.0	553.2	80.2	60.0
J-106	786.71	0.0	543.8	78.9	(N/A)
H-108	785.91	0.0	550.9	79.9	60.0
H-113	786.35	0.0	546.6	79.3	60.0
H-115	785.54	0.0	554.6	80.4	60.0
H-117	786.84	0.0	542.1	78.6	60.0
H-119	787.3	0.0	537.3	77.9	60.0
H-121	785.89	0.0	551.0	79.9	60.0
H-122	786.08	0.0	549.1	79.6	60.0
H-123	786.06	0.0	549.4	79.7	60.0
H-130	786.26	0.0	547.8	79.5	60.0
H-129	785.73	0.0	552.7	80.2	60.0
H-132	787.45	0.0	535.8	77.7	60.0
H-135	787.91	0.0	531.3	77.1	60.0
H-137	787.82	0.0	532.2	77.2	60.0
H-140	788.41	0.0	525.7	76.3	(N/A)
H-143	789.71	0.0	513.0	74.4	60.0
H-146	790.88	0.0	502.2	72.8	60.0
H-148	790.89	0.0	502.2	72.8	60.0
H-150	788.98	0.0	520.3	75.5	60.0
H-151	789.35	0.0	516.6	74.9	(N/A)
H-152	787.35	0.0	536.0	77.7	60.0
H-153	788.37	0.0	525.8	76.3	(N/A)
H-154	787.85	0.0	530.9	77.0	(N/A)
H-158	793.75	0.0	474.4	68.8	60.0
H-160	792.34	0.0	488.2	70.8	60.0
H-157	822.59	0.4	618.0	89.6	60.4
H-163	831.27	0.0	533.0	77.3	60.0
H-165	826.17	0.0	583.0	84.6	60.0
H-168	834.73	0.0	499.2	72.4	60.0
H-174	837.59	0.4	471.2	68.3	60.4
H-179	788.32	0.0	523.6	75.9	60.0
H-180	786.07	0.0	541.8	78.6	60.0
H-184	786.33	0.0	534.2	77.5	(N/A)
H-186	784.5	0.0	551.5	80.0	60.0
H-188	787.48	0.0	522.4	75.8	60.0
H-190	790.88	0.0	489.1	70.9	60.0
H-192	790.98	0.0	488.1	70.8	60.0
H-193	786.98	0.0	527.5	76.5	60.0
H-199	795.47	0.0	443.1	64.3	60.0
H-200	790.61	0.0	490.5	71.1	60.0
H-208	796.15	0.0	436.0	63.2	(N/A)
H-209	797.06	0.0	427.1	61.9	60.0
H-211	794.03	0.0	456.7	66.2	60.0

H-214	804.49	0.0	354.5	51.4	60.0
H-216	801.68	0.0	381.9	55.4	60.0
H-219	800.49	0.0	393.7	57.1	60.0
H-222	799.54	0.0	402.8	58.4	60.0
H-223	783.52	0.0	559.4	81.1	60.0
H-226	898.55	0.0	580.5	84.2	60.0
H-229	891.61	0.0	648.1	94.0	60.0
H-234	894.12	0.7	771.0	111.8	60.7
H-236	891.04	0.0	801.1	116.2	60.0
H-238	901.66	0.0	697.6	101.2	60.0
H-239	929.24	0.0	430.4	62.4	60.0
H-240	938.83	0.4	337.5	48.9	60.4
H-241	907.18	0.0	642.7	93.2	(N/A)
H-242	908.49	0.0	629.8	91.3	(N/A)
H-243	899.07	0.0	575.7	83.5	60.0
H-244	892.11	0.0	643.6	93.4	60.0
H-245	889.71	0.4	667.1	96.8	60.4
H-246	890.92	0.4	655.2	95.0	60.4
H-247	894.04	0.0	624.7	90.6	60.0
H-248	893.62	0.0	628.8	91.2	60.0
H-253	892.88	0.0	636.1	92.3	60.0
H-255	896.42	0.3	601.5	87.2	60.3
H-257	898.32	0.0	583.0	84.6	60.0
H-260	896.14	0.0	604.5	87.7	60.0
H-262	899.79	0.0	569.0	82.5	60.0
H-264	905.21	0.3	515.3	74.7	60.3
H-266	786.23	0.0	547.7	79.4	(N/A)
H-267	786.06	0.0	549.4	79.7	(N/A)
H-268	785.56	0.0	554.3	80.4	60.0
H-269	786.03	0.0	549.7	79.7	60.0
H-270	786.54	0.0	544.7	79.0	60.0
H-275	786.12	0.0	536.0	77.7	60.0
H-277	841.43	0.4	433.7	62.9	(N/A)
H-278	840.08	0.0	446.9	64.8	60.0
H-280	786.16	0.0	548.4	79.5	60.0
H-281	785.84	0.0	544.0	78.9	(N/A)
H-283	785.81	0.0	544.3	79.0	60.0
H-285	786.15	0.0	548.5	79.6	(N/A)
H-286	785.05	0.0	559.2	81.1	(N/A)
H-287	785.46	0.0	555.2	80.5	(N/A)
FH-CP RAIL YA	785.62	0.0	553.7	80.3	(N/A)
FH-Reflection R	841.19	0.0	436.1	63.3	(N/A)
H-3	834.42	2.5	502.3	72.9	62.5
H-902	836.76	0.0	479.4	69.5	60.0
J-906	836.69	0.0	480.1	69.6	60.0
H-251	837.14	0.0	475.7	69.0	(N/A)
J-908	838.06	0.0	466.7	67.7	60.0
H-252	838.36	0.4	463.8	67.3	(N/A)
J-910	840.52	0.0	442.7	64.2	60.0
J-914	787.16	0.0	533.0	77.3	60.0
J-915	786.87	0.0	535.5	77.7	(N/A)
J-917	788.11	0.0	523.8	76.0	(N/A)
J-920	785.97	0.0	550.3	79.8	(N/A)
J-921	785.05	0.0	559.2	81.1	(N/A)
J-922	785.76	0.0	552.2	80.1	(N/A)

J-923	791.31	0.0	483.3	70.1	60.0
J-924	791.02	0.0	486.1	70.5	(N/A)
H-928	790.85	0.0	487.8	70.8	60.0
J-929	790.74	0.0	488.9	70.9	(N/A)
H-931	786.26	0.0	539.9	78.3	60.0
J-932	787.61	0.0	534.2	77.5	60.0
J-933	787.57	0.0	534.5	77.5	(N/A)
J-934	788.1	0.0	529.2	76.8	(N/A)
J-935	787.33	0.0	537.5	78.0	60.0
J-937	789.12	0.0	518.3	75.2	60.0
J-938	788.93	0.0	520.2	75.5	60.0
J-939	904.38	0.0	523.4	75.9	(N/A)
J-940	905.06	0.0	516.7	74.9	(N/A)
J-941	907.36	0.0	494.2	71.7	(N/A)
J-942	904.22	0.0	525.0	76.1	(N/A)
H-943	906.13	0.2	506.2	73.4	60.2
J-944	892.08	0.0	790.9	114.7	60.0
J-945	896.59	0.9	746.9	108.3	(N/A)
H-946	898.52	0.0	728.0	105.6	60.0
J-954	789.76	0.0	512.0	74.3	(N/A)
H-955	893.14	0.0	780.6	113.2	60.0
H-957	891.86	0.0	793.1	115.0	60.0
H-958	890.76	0.0	803.9	116.6	60.0
H-961	892.94	0.0	782.5	113.5	60.0
H-963	795.46	0.0	443.8	64.4	60.0
H-964	794.74	0.0	450.6	65.4	60.0
J-977	956.76	0.0	164.7	23.9	(N/A)
J-978	900.18	0.0	711.2	103.2	(N/A)
J-992	842.42	0.0	424.1	61.5	(N/A)
H-994	847.87	0.0	371.0	53.8	60.0
J-995	848.69	0.0	363.0	52.6	(N/A)
J-1001	837.93	0.0	468.0	67.9	60.0
J-1002	840.22	0.0	445.6	64.6	60.0
J-1003	839.12	0.4	456.4	66.2	60.4
J-1005	841.64	0.0	431.7	62.6	60.0
J-1011	788.39	0.0	523.6	75.9	(N/A)
J-1012	790.25	0.0	507.2	73.6	60.0
J-1013	789.35	0.0	516.4	74.9	(N/A)
H-324	786.67	0.0	537.1	77.9	60.0
H-1017	785.79	0.0	545.0	79.1	60.0
J-1023	896.46	0.0	747.7	108.4	(N/A)
J-1027	786.13	0.0	548.7	79.6	(N/A)
J-1048	785.41	0.0	555.7	80.6	(N/A)
J-1049	785.3	(N/A)	(N/A)	#VALUE!	(N/A)

Scenario 1.a: Bypass Closed, NE+SE BS Off, Wells 3+5 On, Well #7 Off

Existing System
Existing MDD + Fire Flow

Reservoir Information

Label	Assumed Water Level Elevation (m)	Hydraulic Grade (m)	Flow (Out net) (L/s)
Gunite & Hypalon (SE Reservoir Complex)	842.2	842.2	9.4
LaFontaine (NE Reservoir Complex)	973.7	973.7	-11.4
Well #2	769.24	769.2	0.0
Well #3	779.8	779.8	-19.1
Well #5	774.3	774.3	-45.5
Well #4	778.53	778.5	0.0
Bear's Paw	885.8	885.8	-10.7
Well#7	761.41	761.4	0.0

Note: Elevation information is the same for all scenarios

Scenario 1.a: Bypass Closed, NE+SE BS Off, Wells 3+5 On, Well #7 Off

Existing System
Existing MDD + Fire Flow

Pump Information

Label	**Assumed Elevation (m)**	**Status (Initial)**	**Hydraulic Grade (Suction) (m)**	**Hydraulic Grade (Discharge) (m)**	**Flow (Total) (L/s)**	**Pump Head (m)**
Well Pump #5	786.9	On	774.3	845.0	45.5	70.7
Well Pump #3	791.97	On	779.8	843.7	19.1	63.9
Well Pump #4	794.69	Off	778.5	840.8	0.0	0.0
Well Pump #2	791.8	Off	769.2	842.2	0.0	0.0
Well Pump #7	785.89	Off	761.4	842.2	0.0	0.0
NE Booster #2	786.5	Off	841.0	972.9	0.0	0.0
NE Booster #1	786.5	Off	841.0	972.9	0.0	0.0
Selkirk Pump 1	840.9	Off	842.2	885.7	0.0	0.0
Selkirk Pump 2	840.9	Off	842.2	885.7	0.0	0.0
Selkirk Fire Pump	840.9	Off	842.2	885.7	0.0	0.0

Scenario 1.a: Bypass Closed, NE+SE BS Off, Wells 3+5 On, Well #7 Off

Existing System
Existing MDD + Fire Flow

PRV Setting Information

Label	**Elevation (m)**	**Diameter (mm)**	**Status (Initial)**	**Pressure Setting (Initial) (kPa)**	**Hydraulic Grade Setting (Initial) (m)**	**Hydraulic Grade (From) (m)**	**Hydraulic Grade (To) (m)**	**Status (Calcul.)**
Golden Donald Upper	890.7	100	Active	655	957.6	972.9	957.8	Closed
Granite Drive	903.7	250	Active	530.9	957.9	972.8	957.9	Active
Pine Drive	905.0	150	Active	503.3	956.41	972.8	957.9	Closed
NE Bypass Valve	783.5	75	Closed	517.1	836.32	972.9	841.0	Closed

Note: "Status (Initial) - Active" means the valve will automatically open and close depending on set points.
"Status (Calculated) - Active" means that the valve is open based on system pressures

Label	Elevation (m)	Demand (L/s)	Pressure at MDD (kPa)	Pressure at MDD (psi)	Fire Flow (Available) (L/s)
J-1	840.9	0.0	12.7	1.8	(N/A)
J-2A	791.97	0.0	491.5	71.3	(N/A)
J-3	791.84	1.2	492.0	71.4	229.3
J-2	791.79	0.0	493.2	71.5	(N/A)
J-4	791.8	0.1	492.3	71.4	230.6
J-5	791.15	1.7	497.6	72.2	121.6
J-6	791.13	1.8	496.7	72.0	105.1
J-7	790.39	2.1	503.9	73.1	107.2
J-8	787.21	0.3	535.0	77.6	148.7
J-9	788.47	0.7	522.7	75.8	146.3
J-10	789.51	0.6	511.7	74.2	137.1
J-11	787.76	0.3	529.5	76.8	134.6
J-12	788.88	0.0	517.7	75.1	(N/A)
J-13	789.43	0.4	510.5	74.0	(N/A)
J-14	788.92	0.2	516.9	75.0	127.8
J-15	787.81	0.3	529.3	76.8	(N/A)
J-16	787.33	0.9	533.8	77.4	(N/A)
J-17	787.15	0.9	535.4	77.6	(N/A)
J-18	786.6	0.3	540.8	78.4	(N/A)
J-19	786.64	1.6	540.4	78.4	139.3
J-20	785.45	0.9	551.9	80.0	70.2
J-21	786.9	0.7	546.5	79.3	(N/A)
J-22	787.35	0.7	532.0	77.2	124.3
J-23	787.06	1.2	536.8	77.9	(N/A)
J-24	786.9	1.1	537.8	78.0	(N/A)
J-25	786.63	1.2	540.6	78.4	(N/A)
J-26	786.89	0.7	538.3	78.1	132.6
J-27	786.44	0.6	543.2	78.8	(N/A)
J-28	785.76	1.1	549.2	79.7	133.8
J-29	785.44	0.6	552.2	80.1	(N/A)
J-30	785.36	0.7	552.8	80.2	121.0
J-31	784.98	0.4	556.6	80.7	102.1
J-32	784.88	1.4	557.5	80.9	(N/A)
J-33	785.29	0.9	553.6	80.3	133.2
J-34	784.98	1.0	556.6	80.7	(N/A)
J-35	784.97	1.0	556.5	80.7	128.2
J-36	784.89	1.0	557.2	80.8	(N/A)
J-40	788.13	1.0	511.1	74.1	79.0
H-302	786.43	0.7	525.2	76.2	73.8
J-42	785.61	0.5	530.1	76.9	68.3
H-43	786.37	0.2	516.1	74.8	58.9
H-44	786.09	0.3	513.9	74.5	(N/A)
J-45	787.25	0.0	501.8	72.8	(N/A)
H-46	790.01	2.0	474.3	68.8	50.5
J-47	793.09	0.2	444.0	64.4	49.6
J-103	794.19	0.3	432.8	62.8	(N/A)
J-48	794.69	0.0	427.5	62.0	(N/A)
H-49	789.68	0.6	475.9	69.0	44.5
H-59	796.73	0.8	406.8	59.0	43.9
H-60	800.66	4.9	368.4	53.4	43.3
H-61	797.67	0.2	398.0	57.7	44.7
H-105	797.38	0.2	401.3	58.2	46.3

H-104	799.43	1.3	381.2	55.3	46.6
J-300	802.05	0.0	1691.0	245.3	(N/A)
H-301	892.08	0.0	801.0	116.2	(N/A)
J-303	900.8	0.5	714.1	103.6	(N/A)
J-304	893.64	3.0	784.3	113.7	(N/A)
J-302	893.95	0.3	781.6	113.4	(N/A)
H-305	914.41	0.8	580.7	84.2	98.8
J-306	945.94	0.0	271.8	39.4	(N/A)
H101	792.23	1.2	488.5	70.9	179.5
J-102	792.88	0.0	482.3	70.0	214.8
J-66	786.79	0.7	538.6	78.1	110.6
J-67	786.89	1.0	537.5	78.0	(N/A)
J-65	784.98	1.8	556.2	80.7	93.0
J-64	785.12	0.9	554.9	80.5	109.6
H-51	786.07	0.1	515.1	74.7	54.2
J-68	786.5	0.0	508.4	73.7	(N/A)
J-307	960.17	0.0	132.4	19.2	(N/A)
J-200	840.9	0.0	438.9	63.7	(N/A)
H-201	840.48	1.2	443.1	64.3	272.7
H-211	843.27	0.6	415.7	60.3	172.7
J-212	842.95	0.5	418.9	60.8	300.0
H-210	839.99	0.6	447.8	65.0	300.0
J-202	839.28	0.8	454.7	66.0	298.5
H-203	834.36	0.5	502.9	72.9	299.2
H-204	829.3	1.1	552.4	80.1	172.2
J-205	833.78	0.8	508.5	73.7	(N/A)
H-63	785.61	4.5	517.5	75.1	51.2
H-62	785.27	0.1	521.4	75.6	51.5
H-50	787.49	2.3	497.1	72.1	44.2
J-301B	888.37	0.0	841.8	122.1	(N/A)
H-43B	786.91	0.0	508.8	73.8	(N/A)
H-205	835.16	0.0	494.9	71.8	(N/A)
H-24	787.41	0.0	532.8	77.3	117.5
H-50	785.46	0.0	517.0	75.0	(N/A)
J-900	791.58	0.6	457.1	66.3	(N/A)
H-400	894.9	0.9	615.8	89.3	97.6
H-401	888.92	0.9	674.5	97.8	93.7
H-402	904.84	0.7	518.9	75.3	(N/A)
H-403	904.55	0.1	521.8	75.7	91.5
H-404	896.32	0.6	602.3	87.4	90.9
H-53	786.08	0.0	513.5	74.5	52.9
H-54	785.5	0.0	518.7	75.2	51.0
H-55	785.49	0.0	518.6	75.2	50.4
H-56	792	0.0	454.6	65.9	(N/A)
J-9A	790.03	0.0	508.3	73.7	165.6
J-6A	789.31	0.0	515.1	74.7	68.9
J-6B	792.41	0.0	484.7	70.3	106.9
H-69	894.61	0.0	774.7	112.4	99.6
H-70	793.94	0.0	434.7	63.0	45.5
H-72	793.18	0.0	441.5	64.0	44.0
J-100b	785.62	0.0	517.5	75.1	(N/A)
J-100a	785.78	0.0	515.8	74.8	(N/A)
J-100d	784.83	0.0	525.2	76.2	51.2
H-100c	785.17	0.0	522.3	75.8	51.5
J-100e	784.85	0.0	525.0	76.2	51.2

H-80	785.77	0.0	515.8	74.8	50.3
H-81	787.06	0.0	536.6	77.8	132.2
H-82	787.33	0.0	533.6	77.4	(N/A)
H-83	787.11	0.0	538.3	78.1	133.0
H-86	785.38	0.0	552.2	80.1	69.6
H-88	785.47	0.0	551.4	80.0	73.0
H-90	785.41	0.0	552.0	80.1	(N/A)
H-92	785.65	0.0	549.8	79.7	103.0
H-95	785.37	0.0	552.8	80.2	110.3
H-97	786.05	0.0	546.1	79.2	110.0
H-100	785.23	0.0	554.2	80.4	109.6
H-104	785.78	0.0	549.5	79.7	133.1
J-106	786.71	0.0	540.0	78.3	(N/A)
H-108	785.91	0.0	547.5	79.4	92.1
H-113	786.35	0.0	543.2	78.8	99.9
H-115	785.54	0.0	551.2	79.9	108.0
H-117	786.84	0.0	538.6	78.1	107.5
H-119	787.3	0.0	534.0	77.4	129.3
H-121	785.89	0.0	547.2	79.4	84.9
H-122	786.08	0.0	545.4	79.1	67.9
H-123	786.06	0.0	545.6	79.1	62.2
H-130	786.26	0.0	544.1	78.9	105.6
H-129	785.73	0.0	549.3	79.7	71.9
H-132	787.45	0.0	532.6	77.3	130.1
H-135	787.91	0.0	528.1	76.6	147.6
H-137	787.82	0.0	529.1	76.7	146.9
H-140	788.41	0.0	523.3	75.9	(N/A)
H-143	789.71	0.0	510.6	74.1	91.2
H-146	790.88	0.0	499.3	72.4	121.3
H-148	790.89	0.0	500.2	72.6	125.9
H-150	788.98	0.0	515.5	74.8	123.1
H-151	789.35	0.0	511.8	74.2	(N/A)
H-152	787.35	0.0	530.7	77.0	119.7
H-153	788.37	0.0	520.2	75.4	(N/A)
H-154	787.85	0.0	525.4	76.2	(N/A)
H-158	793.75	0.0	473.7	68.7	186.2
H-160	792.34	0.0	487.2	70.7	198.8
H-157	822.59	0.4	618.0	89.6	141.0
H-163	831.27	0.0	533.0	77.3	139.8
H-165	826.17	0.0	583.0	84.6	148.1
H-168	834.73	0.0	499.2	72.4	163.2
H-174	837.59	0.4	471.2	68.3	164.7
H-179	788.32	0.0	513.7	74.5	89.8
H-180	786.07	0.0	525.8	76.3	68.6
H-184	786.33	0.0	510.4	74.0	(N/A)
H-186	784.5	0.0	528.4	76.6	51.3
H-188	787.48	0.0	499.2	72.4	51.0
H-190	790.88	0.0	465.8	67.6	50.5
H-192	790.98	0.0	464.6	67.4	49.7
H-193	786.98	0.0	503.8	73.1	50.0
H-199	795.47	0.0	419.5	60.8	44.7
H-200	790.61	0.0	467.0	67.7	45.0
H-208	796.15	0.0	412.4	59.8	(N/A)
H-209	797.06	0.0	403.5	58.5	44.1
H-211	794.03	0.0	433.2	62.8	44.2

H-214	804.49	0.0	331.0	48.0	36.3
H-216	801.68	0.0	358.4	52.0	40.7
H-219	800.49	0.0	370.2	53.7	43.8
H-222	799.54	0.0	379.3	55.0	43.8
H-223	783.52	0.0	535.9	77.7	44.2
H-226	898.55	0.0	580.5	84.2	88.0
H-229	891.61	0.0	648.1	94.0	95.8
H-234	894.12	0.7	779.6	113.1	99.7
H-236	891.04	0.0	810.0	117.5	99.8
H-238	901.66	0.0	705.7	102.4	99.5
H-239	929.24	0.0	435.4	63.2	97.2
H-240	938.83	0.4	341.5	49.5	88.0
H-241	907.18	0.0	653.0	94.7	(N/A)
H-242	908.49	0.0	640.2	92.8	(N/A)
H-243	899.07	0.0	575.7	83.5	93.9
H-244	892.11	0.0	643.6	93.4	93.3
H-245	889.71	0.4	667.1	96.8	93.2
H-246	890.92	0.4	655.2	95.0	92.3
H-247	894.04	0.0	624.7	90.6	92.0
H-248	893.62	0.0	628.8	91.2	93.1
H-253	892.88	0.0	636.1	92.3	93.4
H-255	896.42	0.3	601.5	87.2	93.5
H-257	898.32	0.0	583.0	84.6	93.7
H-260	896.14	0.0	604.5	87.7	94.8
H-262	899.79	0.0	569.0	82.5	94.6
H-264	905.21	0.3	515.3	74.7	91.2
H-266	786.23	0.0	544.4	79.0	(N/A)
H-267	786.06	0.0	546.0	79.2	(N/A)
H-268	785.56	0.0	550.9	79.9	121.4
H-269	786.03	0.0	546.3	79.2	135.1
H-270	786.54	0.0	541.4	78.5	130.5
H-275	786.12	0.0	512.3	74.3	50.1
H-277	841.43	0.4	433.7	62.9	(N/A)
H-278	840.08	0.0	446.9	64.8	229.4
H-280	786.16	0.0	545.1	79.1	139.4
H-281	785.84	0.0	528.0	76.6	(N/A)
H-283	785.81	0.0	528.3	76.6	68.6
H-285	786.15	0.0	545.2	79.1	(N/A)
H-286	785.05	0.0	555.9	80.6	(N/A)
H-287	785.46	0.0	551.8	80.0	(N/A)
FH-CP RAIL YA	785.62	0.0	550.3	79.8	(N/A)
FH-Reflection R	841.19	0.0	436.1	63.3	(N/A)
H-3	834.42	2.5	502.3	72.9	297.8
H-902	836.76	0.0	479.4	69.5	216.5
J-906	836.69	0.0	480.1	69.6	286.7
H-251	837.14	0.0	475.7	69.0	(N/A)
J-908	838.06	0.0	466.7	67.7	277.2
H-252	838.36	0.4	463.8	67.3	(N/A)
J-910	840.52	0.0	442.7	64.2	218.4
J-914	787.16	0.0	520.1	75.4	77.1
J-915	786.87	0.0	522.1	75.7	(N/A)
J-917	788.11	0.0	511.2	74.1	(N/A)
J-920	785.97	0.0	546.5	79.3	(N/A)
J-921	785.05	0.0	555.9	80.6	(N/A)
J-922	785.76	0.0	548.9	79.6	(N/A)

J-923	791.31	0.0	459.8	66.7	44.1
J-924	791.02	0.0	462.6	67.1	(N/A)
H-928	790.85	0.0	464.3	67.3	44.1
J-929	790.74	0.0	465.4	67.5	(N/A)
H-931	786.26	0.0	523.9	76.0	68.6
J-932	787.61	0.0	531.0	77.0	147.9
J-933	787.57	0.0	531.5	77.1	(N/A)
J-934	788.1	0.0	526.2	76.3	(N/A)
J-935	787.33	0.0	533.6	77.4	132.3
J-937	789.12	0.0	512.7	74.4	106.8
J-938	788.93	0.0	514.6	74.6	116.3
J-939	904.38	0.0	523.4	75.9	(N/A)
J-940	905.06	0.0	516.7	74.9	(N/A)
J-941	907.36	0.0	494.2	71.7	(N/A)
J-942	904.22	0.0	525.0	76.1	(N/A)
H-943	906.13	0.2	506.2	73.4	88.5
J-944	892.08	0.0	799.8	116.0	99.8
J-945	896.59	0.9	755.4	109.6	(N/A)
H-946	898.52	0.0	736.5	106.8	99.6
J-954	789.76	0.0	506.3	73.4	(N/A)
H-955	893.14	0.0	789.1	114.5	99.6
H-957	891.86	0.0	801.8	116.3	99.8
H-958	890.76	0.0	812.7	117.9	99.8
H-961	892.94	0.0	791.4	114.8	99.8
H-963	795.46	0.0	420.3	61.0	47.5
H-964	794.74	0.0	427.1	61.9	46.1
J-977	956.76	0.0	165.9	24.1	(N/A)
J-978	900.18	0.0	721.5	104.7	(N/A)
J-992	842.42	0.0	424.1	61.5	(N/A)
H-994	847.87	0.0	371.0	53.8	300.0
J-995	848.69	0.0	363.0	52.6	(N/A)
J-1001	837.93	0.0	468.0	67.9	232.2
J-1002	840.22	0.0	445.6	64.6	296.0
J-1003	839.12	0.4	456.4	66.2	231.0
J-1005	841.64	0.0	431.7	62.6	300.0
J-1011	788.39	0.0	514.9	74.7	(N/A)
J-1012	790.25	0.0	501.5	72.7	115.0
J-1013	789.35	0.0	511.4	74.2	(N/A)
H-324	786.67	0.0	523.0	75.9	73.8
H-1017	785.79	0.0	529.9	76.9	70.7
J-1023	896.46	0.0	758.0	109.9	(N/A)
J-1027	786.13	0.0	545.3	79.1	(N/A)
J-1048	785.41	0.0	551.9	80.1	(N/A)
J-1049	785.3	(N/A)	(N/A)	#VALUE!	(N/A)

Scenario 2.a: Bypass Closed,
NE BS On, Wells 3+5 On, Well #7 Off

Existing System
Existing MDD + Fire Flow

Reservoir Information

Label	Assumed Water Level Elevation (m)	Hydraulic Grade (m)	Flow (Out net) (L/s)
Gunite & Hypalon (SE Reservoir Complex)	842.2	842.2	-4.3
LaFontaine (NE Reservoir Complex)	973.7	973.7	2.5
Well #2	769.24	769.2	0.0
Well #3	779.8	779.8	-19.1
Well #5	774.3	774.3	-45.7
Well #4	778.53	778.5	0.0
Bear's Paw	885.8	885.8	-10.7
Well#7	761.41	761.4	0.0

Note: Elevation information is the same for all scenarios

Scenario 2.a: Bypass Closed,
NE BS On, Wells 3+5 On, Well #7 Off

Existing System
Existing MDD + Fire Flow

Pump Information

Label	**Assumed Elevation (m)**	**Status (Initial)**	**Hydraulic Grade (Suction) (m)**	**Hydraulic Grade (Discharge) (m)**	**Flow (Total) (L/s)**	**Pump Head (m)**
Well Pump #5	786.9	On	774.3	844.6	45.7	70.3
Well Pump #3	791.97	On	779.8	843.6	19.1	63.8
Well Pump #4	794.69	Off	778.5	838.4	0.0	0.0
Well Pump #2	791.8	Off	769.2	842.1	0.0	0.0
NE Booster #22	786.5	Off	838.4	974.8	0.0	0.0
NE Booster #1	786.5	On	838.4	974.9	13.9	136.5
Selkirk Pump 1	840.9	Off	842.2	885.7	0.0	0.0
Selkirk Pump 2	840.9	Off	842.2	885.7	0.0	0.0
Selkirk Fire Pump	840.9	Off	842.2	885.7	0.0	0.0
Well Pump #7	785.89	Off	761.4	841.8	0.0	0.0

Scenario 2.a: Bypass Closed,
NE BS On, Wells 3+5 On, Well #7 Off

Existing System
Existing MDD + Fire Flow

PRV Setting Information

Label	**Elevation (m)**	**Diameter (mm)**	**Status (Initial)**	**Pressure Setting (Initial) (kPa)**	**Hydraulic Grade Setting (Initial) (m)**	**Hydraulic Grade (From) (m)**	**Hydraulic Grade (To) (m)**	**Status (Calcul.)**
Golden Donald Uppe	890.7	100	Active	655	957.6	973.9	957.8	Closed
Granite Drive	903.67	250	Active	530.9	957.9	973.9	957.9	Active
Pine Drive	905	150	Active	503.3	956.4	973.9	957.9	Closed
NE Bypass Valve	783.5	75	Closed	551.6	839.8	974.8	838.4	Closed

Note: "Status (Initial) - Active" means the valve will automatically open and close depending on set points.
"Status (Calculated) - Active" means that the valve is open based on system pressures

APPENDIX D

GOLDEN INTEGRATED WATER STRATEGY INFRASTRUCTURE UPGRADES SUMMARY

MEMORANDUM

DATE: May 8, 2025
TO: Chris Cochran, Al Taylor, Ryan Robison, Bruce Forsyth, Phil Armstrong, Town of Golden
CC: Sara Anderson, Urban Systems
FROM: Robyn Cameron, Jeremy Clowes, Jill Reynolds, Urban Systems
FILE: 0404.0254.01
SUBJECT: Golden Integrated Water Strategy Infrastructure Upgrades Summary

1.0 INTRODUCTION

This memorandum summarizes our review of the upgrades that are needed to the Town of Golden water system to accommodate the estimated 25-year growth projections. Our review included wells, reservoir storage, booster stations, and the overall distribution system. The contents of this memorandum will be incorporated into the Integrated Water Strategy report.

2.0 DESIGN CRITERIA

The design criteria used for the assessment are summarized in the following documents:

- Golden Integrated Water Strategy Design Criteria, May 8, 2025, Urban Systems.
- Golden Integrated Water Strategy – Model Update and Validation, May 8, 2025, Urban Systems.

The base required fire flow per zone is summarized in Table 2.1.

Table 2.1: Base Required Fire Flow Per Zone

	Base Fire Flow Required (L/s)	Duration Fire Flow Required (min)[1]	Required Storage (m^3)
Townsite (Zone 1)	220 [2]	168	2,218
Northeast Bench (NE) Zone	183 [3]	135	1,482
Bear's Paw (SE) Zone	90 [4]	111	600
Total System	220 [2]	168	2,218

Notes:

1. Durations are taken from Water Supply for Public Fire Protection, A Guide to Recommended Practice in Canada. FUS, 2020.
2. Base fire flow from the 2017 FUS assessment completed for Golden. A max 150 L/s fire flow is recommended for future development.
3. FUS recommended fire flow for Days Inn Motel, from the 1990 FUS assessment. We are assuming this fire flow is the highest required fire flow in the NE zone. A max 150 L/s fire flow is recommended for future development.
4. Allows for apartments and townhouses to be developed within the Bear's Paw (SE) Zone. Proposed structures must be designed to limit their required fire flow to 90 L/s or less.

The projected 25-year water demands are summarized in Table 2.2.

Table 2.2: 25-Year Water Demands

	Townsite (Zone 1)	NE Bench Zone	Bear's Paw (SE) Zone	Total System Demands
Average Day Demand (m^3/d)	2,930	1,270	630	4,830
Maximum Day Demand (m^3/d)	6,500	2,840	1,510	10,850
Peak Hour Demand (L/s)	112	48.2	26.2	187

To determine the required capacity-based upgrades for the water system components, the following was applied:

- Well Field – Must be able to supply the maximum day demand (MDD) in 18 hours,
- Reservoirs – Must be able to store:
  - A – Fire Flow Storage per Table 2.1,
  - B – Equalization Storage = 25% of MDD, and,
  - C – Emergency Storage = 25% of (A + B).
- Booster Stations must be able convey MDD over 21 hours, and,
- Watermains must be able to convey MDD plus fire flow with velocity < 4 m/s and minimum system pressure of 20 psi (140 kPa).

3.0 GROUNDWATER WELLS

The Town currently utilizes four groundwater wells (Wells 2, 3, 4 and 5) and has drilled another well (Well 7) that is currently planned to be brought online in 2025. The well field, including Well 7, can supply 10,660 m^3/18 hours which exceeds the 25-year projected MDD of 10,400 m^3/d. As such, no capacity-based upgrades have been included for the well field. Table 3.1 summarizes the well field capacity and identifies which wells have backup power.

Table 3.1: Well Field Capacity

Well	Back-up Power?	Capacity (L/s)	Capacity (m^3/d) [1]
2	No	9.5	616
3	Yes	19	1,231
4	No	37	2,398
5	Yes	45	2,916
7	Yes (planned)	54	3,499
	Total	164.5	10,660

Notes:

1. Well capacity is based on an 18 hour pump day.

Back-up power is recommended to be provided for Wells 2 and 4 as discussed in Section 6 to improve the available fire flow as well as the overall reliability of the water system.

Treatment upgrades have not been considered. Well 7 may include UV and chlorine disinfection to provide 3 log reduction of Cryptosporidium and Giardia and 4 log reduction of viruses as a confining layer was not found when the well was drilled. Further testing is planned for Well 7 to confirm the presence of a confining layer, if found, only emergency chlorination equipment will be provided for Well 7. All other wells (i.e., 2, 3, 4 and 5) comply with Guidelines for Canadian Drinking Water Quality without treatment, have a confining layer and have been successfully operated for fifteen plus years without detecting total coliforms or E.coli. Wells 2, 3, 4 and 5 can provide secondary disinfection in an emergency. It is possible that in the future regulations will change, and Interior Health could mandate continuous secondary disinfection or for 4 log reduction of viruses as is common for new construction. If this occurred, we would expect that costs related to this work would be eligible for grant funding. No allowance for treatment upgrades have been included as it is not required at this time.

4.0 STORAGE UPGRADES

The Town has five existing reservoirs: two Lafontaine Reservoirs (NE Zone), the Bears Paw reservoir (SE Zone), and the Gunite and Hypalon reservoirs (Zone 1). Table 4.1 summarizes the recommend storage per zone for the 25-Year Design Horizon.

Table 4.1: Recommended Reservoir Storage

Parameter	Unit	Total System	Zone 1 (Gunite & Hypalon Reservoirs)	NE Zone (Lafontaine Reservoirs)	SE Zone (Bears Paw Reservoir)
A	m^3	2,218	2,218	1,482	600
B	m^3	2,681	1,593	710	378
C	m^3	1,746	953	548	245
Recommended Reservoir size	m^3	6,645	4,764	2,740	1,223
Existing Reservoir Size	m^3	6,949	3,632	2,122	1,195
Storage Deficiency	m^3	N/A	-1,132	-618	-28

This storage does not need to be supplied solely by the reservoir for each zone. Additional credits for fire protection storage can be acquired by providing stand-by generators to ensure water from the source wells or booster stations supplying the zone can be pumped into the system even during a power outage, or by cascading water from a reservoir in a higher elevation pressure zone through pressure reducing valves (PRVs).

It is important to note that relying on water cascaded from an upper zone increases the system risk. If a PRV fails during a fire event, the zone could have deficient fire flow. In addition, if there is insufficient looping in the zone, a watermain break could impact the ability to provide fire flows to lower zones.

Relying on water cascaded from an upper zone can also impact Fire Underwriters Survey (FUS) insurance ratings. Many factors go into computing a public fire protection classification (PFPC) score, including firefighting personnel, fire risk, building construction, and the water system itself. In general, the more redundancy in the water system, the higher the PFPC score.

It is important to minimize water age to reduce the risk of water quality issues occurring in the distribution system. As a result, upgrades to share storage between zones are recommended over constructing additional storage. This should be reviewed with the fire department and the Town.

To share storage between zones, the following upgrades are recommended:

- Replacement and upsizing of the NE Booster Station is recommended. Oversizing the pumps by 11 L/s will provide 11 L/s of additional capacity to the NE zone. This could supplement MDD or emergency storage.
- Install a PRV in the new NE Booster Station that will automatically open to supplement fire flows to Zone 1. We have assumed that only the fire flow volume (A volume) is available to cascade down to Zone 1, and that the B (MDD equalization) and C (emergency storage) must remain in the Lafontaine Reservoirs.
- Install a PRV in the Selkirk Booster Station that will automatically open to supplement fire flows to Zone 1. We have assumed that only the fire flow volume (A volume) is available to cascade down to Zone 1, and that the B (MDD equalization) and C (emergency storage) must remain in the Bears Paw reservoir.

With the above upgrades, the recommended storage volumes are as follows (Table 4.2).

Table 4.2: Recommended Storage Volumes Accounting for Pumping/Cascading

Parameter	Unit	Total System	Zone 1 (Gunite & Hypalon Reservoirs)	NE Zone (Lafontaine Reservoirs)	SE Zone (Bears Paw Reservoir)
Recommended Reservoir Size	m^3	6,645	4,764	2,740	1,223
Existing Reservoir Size	m^3	6,949	3,632	2,122	1,195
Initial Surplus/Deficiency	m^3	304	-1,132	-618	-28
Volume available from other Zones	m^3	N/A	1,436[1]	832[2]	151[3]
Final Surplus/Deficiency	m^3	N/A	304	214	123

Notes:

1. Includes the NE and SE Zone's fire storage with the deficient storage amounts subtracted as listed in Table 4.1
2. Includes the proposed additional 11 L/s oversizing of the NE Booster Pumps being utilized for 21 hours per day.
3. Includes the proposed additional 3 L/s oversizing of the SE Booster Pumps being utilized for 21 hours per day.

5.0 BOOSTER STATION UPGRADES

There are two existing booster stations:

1. Northeast (NE) Booster Station: pumps water from Zone 1 to the Lafontaine Reservoirs.
2. Selkirk (SE) Booster Station: pumps water from Zone 1 to the Bears Paw Reservoir.

Table 5.1 summarizes the existing booster station capacity as well as capacity required to meet the 25-year demand projections. Note that the MDDs are expressed over a 21-hour pump day. Booster stations are commonly sized to meet MDD over 21 hours to allow time for maintenance.

Table 5.1: Booster Station Capacity Assessment

Parameter	Unit	NE Booster Station	Selkirk (SE) Booster Station
Pump 1 Capacity	L/s	14.0	10.0
Pump 2 Capacity	L/s	17.0	10.0
Capacity w/ largest pump out of service	L/s	14.0	10.0
Existing MDD - 21 hour operation day	L/s	13.0	12.2
Additional Capacity Required – Existing MDD	L/s	0.0	2.2
25 Year MDD - 21 hour operation day	L/s	37.6	20.0
Additional Capacity Required – 25 Year MDD	L/s	23.6	10.0

Both booster stations will require upgrades to meet the 25-year MDD:

- Significant growth is projected in the NE Zone, resulting in significant demand increases. A new NE booster station is proposed. As outlined in Section 4, oversizing the NE Booster pumps to defer reservoir volume upgrades is also recommended. A new booster station with 2 x 49 L/s pumps is recommended. The station will be equipped with a generator as well as a PRV to allow for cascading between the NE Zone and Zone 1.
- The existing MDD in the SE Zone exceeds the capacity of the Selkirk Booster Station with a single pump in operation. Originally, it was recommended to replace only the booster pumps and starters, with a condition assessment to evaluate additional building upgrades. However, further analysis revealed that intake velocity with the new pumps would be too high, and the current piping configuration in the slab prevents easy upgrades without significant service disruptions. Additionally, the fire pump is nearing the end of its life, and operations staff would prefer a less labor-intensive solution. Therefore, a new booster station with 2 x 23 L/s pumps with VFDs are recommended. In addition, a standby generator and a cascading PRV will be installed to allow for cascading storage between the SE Zone and Zone 1.

The recommended pump upgrades and their impact on shared fire storage between pressure zones are summarized in Table 5.2. As noted in Section 4.0, fire storage in one zone can be supplemented by pumping water from other zones. The booster station's capacity to supplement fire storage is defined as the largest pump's capacity with one well offline, minus the 25-year MDD.

Table 5.2: Summary of Pump Upgrades and Impacts on Shared Fire Storage

Parameter	NE Booster Station	Selkirk (SE) Booster Station
Proposed Number of Pumps and Capacity	2 x 49 L/s	2 x 23 L/s
Capacity w/ largest pump out of service	49 L/s	23 L/s
25 Year MDD - 21 hour operation day	38 L/s	20 L/s
Oversizing to Supplement Fire Storage	11 L/s	3 L/s

6.0 DISTRIBUTION SYSTEM UPGRADES

The Town has a water model, developed using Bentley WaterCAD. This model was used to assess the existing performance of Golden's water system. The water model is a representation of actual infrastructure and attempts to simulate the actual operation and flow demands in Golden. This model was validated as part of the infrastructure planning process and used to identify concerns related to the operation of the system under normal operating and fire-flow conditions. The water model was also updated with future development (as identified in the Design Criteria memorandum) to determine future distribution system requirements.

6.1 SYSTEM CHANGES & IMPROVEMENTS SINCE 2013

Record drawings from system upgrades completed since 2013 and the Town's GIS data was the primary source of information used to update the pipe and node network topology model. The projects that altered the water distribution system are as follows:

- Well 6 was taken offline, and Well 7 is expected to be in service in fall 2026
- Watermain installations as part of the 2024 Kicking Horse River Bridge Replacement
- Watermain installations as part of the 2022 9th Avenue Improvements
- Watermain installations as part of the 2023 6th Street Underground Utilities

The most recent GIS data set was obtained from the Town's GIS portal on June 5, 2024. Attributes of the water mains, such as diameter and material, as well as node elevations were extracted from the GIS database. These attributes were compared to the model and updated as required.

Demands were updated to reflect the updated design criteria. In addition, model validation was completed to ensure the model was accurately representing real world conditions.

Additional details on the model update and validation can be found in the "*Golden Integrated Water Plan – Model Update and Validation*" memorandum (Urban Systems, Aug. 6, 2024).

6.2 SCENARIOS

The system analysis was run with the scenarios outlined in Table 6.1 and Table 6.2. The model was initially run under existing MDD to evaluate the current system performance, and then under the 25-year MDD to evaluate the performance of the recommended upgrades at the design horizon. The scenarios are explained below:

- Scenario 1 – Evaluates the fire flow conditions in Zone 1. The NE bypass valve has a significant effect on available fire flows in Zone 1 in the north area of the community, however the Town has no immediate plans to replace the valve which is currently inoperable. As a result, we have assumed that the NE bypass valve is closed in the existing scenario as noted below.
    - For Scenario 1A, the NE and Selkirk Booster pumps are off, and the NE bypass is closed.
    - For Scenario 1B, the NE and Selkirk Booster pumps are off, and the NE bypass is open to convey water from the Lafontaine reservoirs to Zone 1. Only wells with backup power are on.
- Scenario 2 – Evaluates the fire flow conditions in the upper zones (NE and SE Zones). Therefore, booster stations are on to convey water to the higher zones, the existing NE bypass is closed and the proposed SE bypass is closed. Only wells with backup power are on.
- Scenario 3 – Evaluates the system pressures under normal operating conditions with all booster stations and wells off. These pressures were compared to the minimum and maximum system operating pressures in the *2008 Subdivision and Development Servicing Bylaw*.

Figures showing the performance of the distribution system under normal operating conditions and fire flow events will follow in the Integrated Water Strategy report. Exports of the model performance are included as Appendix C within the Integrated Water Strategy Report.

Table 6.1: Scenario Configuration for Existing System

Scenario	Demand	Purpose	NE Booster Station			SE Booster Station			Well #2 10 L/s	Well #3 19 L/s	Well #4 38 L/s	Well #5 44 L/s	Well #7 55 L/s
			Pump 1 14 L/s	Pump 2 17 L/s	Bypass Valve	Pump 1 10 L/s	Pump 2 10 L/s	Fire Pump 70 L/s					
Scenario 1.a	Existing MDD	Determine fire flow for Zone 1								X		X	
Scenario 2.a	Existing MDD	Determine fire flow for NE & SE bench	X			x				X		X	
Scenario 3.a	Existing ADD	Min pressures during normal operation											

Notes:

- For fire flow analysis, it is assumed that only wells with backup power can provide fire flows. The largest well (Well #7) is assumed to be out of service.
- Only pumps with backup power are assumed operational for fire flow scenarios.
- The fire pump for the SE zone was installed prior to the construction of the Bears Paw reservoir. With the Bears Paw reservoir in place, the fire pump is not necessary to meet instantaneous fire flow requirements in the zone.

Table 6.2: Scenario Configuration for Existing System with High Priority Upgrades

Scenario	Demand	Purpose	NE Booster Station		NE & SE Bypass Valves	SE Booster Station		Well #2 10 L/s	Well #3 19 L/s	Well #4 38 L/s	Well #5 44 L/s	Well #7 55 L/s
			Pump 1 49 L/s	Pump 2 49 L/s		Pump 1 23 L/s	Pump 2 23 L/s					
Scenario 1.b	25-Year MDD	Determine fire flow for Zone 1			X			X	X	X	X	
Scenario 2.b	25-Year MDD	Determine fire flow for NE & SE bench	X			X		X	X	X	X	
Scenario 3.b	25-Year ADD	Min pressures during normal operation										

Notes:

- For fire flow analysis, it is assumed that only wells with backup power can provide fire flows. The largest well (Well #7) is assumed to be out of service.
- Only pumps with backup power are assumed operational for fire flow scenarios.

6.3 RESULTS

The assessment found the following:

- Pressures in the distribution system during normal operation are within the recommended range. No upgrades are recommended related to improving system pressures.
- Fire flow performance is significantly improved when the groundwater wells are on. For the wells to be relied on in an emergency, they should have back up power. Installing a generator at Well 2 and 4 is recommended as a result.
    - Note that the model was ran assuming one of the larger wells (either Well 7 or Well 4) was offline. This is a conservative approach and allows for a critical failure during the emergency response. This is in line with the approach that has been used since the 2013 water master plan update, which assumed all wells other than Well 6 were online.
- Fire flow performance is significantly improved in the northern portion of Zone 1 when there is a cascading valve in the NE booster station to supplement fire flows. A PRV that will automatically open to supplement fire flows is recommended.
- There is currently only one watermain crossing the Kicking Horse River. In addition, all but one of the groundwater wells are located south of the Kicking Horse. An additional watermain crossing is recommended for redundancy. The second watermain crossing also improves fire flow performance.

We recommend upsizing pipes to improve fire flow as funds allow and have identified the proposed works in Figure 7.7 within the Integrated Water Strategy Report. Watermain upgrades that make a significant improvement are classified as “High Priority Upgrades". The high and low priority piping upgrades are further explained in Section 6.4 and Section 6.5, respectively. Modeling results are shown on Figures 7.1 to 7.6 within the Integrated Water Strategy Report.

6.4 HIGH PRIORITY DISTRIBUTION SYSTEM UPGRADES

The high priority distribution system upgrades are to address deficiencies for upcoming development, increase system reliability, and provide significant fire flow improvements. The recommended upgrades are described as follows and shown in Figure 7.7 within the Integrated Water Strategy Report.

6.4.1 NE Pressure Zone

Upgrades to the North-East Bench Pressure Zone (NE Zone) are required to accommodate the 25-year growth projection. The October 9, 2024, memorandum *“Golden Integrated Water Plan – North-East Bench Pressure Zone Upgrades_rev.1”* outlines the following recommended distribution system upgrades:

- Upgrade approximately 260 m of piping to 350 mm diameter along LaFontaine Road leading to the reservoir.
- Upgrade approximately 601 m of piping to 300 mm diameter along Gareb Road.

These upgrades are recommended under current conditions to improve fire flow and increase residual pressures in the Gareb Road, LaFontaine Road, and Golden View Road areas during fire flow events. Along with replacing the NE Booster Station, these upgrades are critical to supporting planned development and 25-year growth while ensuring sufficient storage and fire protection without expanding the existing reservoirs.

6.4.2 Second Kicking Horse River Crossing

Currently, there is only one watermain crossing the Kicking Horse River, with all but one groundwater supply well located on the south side. To improve system reliability and provide redundancy, an additional watermain crossing is recommended.

A second crossing would also address fire flow deficiencies on the north side of the river, particularly in the Highway corridor, where fire flow availability is currently insufficient. This upgrade was first proposed in the 2013 Water Distribution System Study and remains a priority in the 2024 Integrated Water Study.

Implementing this second crossing will enhance system resilience, ensure reliable water service, and improve fire protection for the northern areas of the system.

6.5 LOW PRIORITY SITRIBUTION SYSTEM UPGRADES

There are several areas with deficient fire flow currently. While we have identified upgrades (largely increasing pipe size) to improve fire flows to existing developments, the capital costs to rectify all deficiencies are high. Existing deficiencies are understood to have been considered in past FUS reviews for insurance grading and it possible that insurance costs could be lower with the proposed watermain upsizing. We recommend upsizing pipes to improve fire flow as funds allow and have identified the proposed works in Figure 7.7 within the Integrated Water Strategy Report.

There are two areas that the model shows as having deficient fire flows, the NW industrial and highway commercial zone, and the southern industrial zone, they are discussed in detail below:

6.5.1 NW Industrial & Commercial Areas

The purpose of the upgrades summarized in Table 6.3 is to provide adequate commercial and industrial fire flows to the existing commercial and industrial areas in Northwest Golden.

Table 6.3: Proposed Upgrades for South Industrial and Commercial Areas

Location	Length (m)	Existing Diameter (mm)	Proposed Diameter (mm)
11 Ave N (14th St. to Trailer Park Entry)	185	150	250
11 Ave N (11th St. Rail Crossing to 14th St)	646	150	300
14 St. N (11 Ave N to Frontage Rd.)	263	150	250
12 St. N (E of Hwy 1)	152	150	300
11 St. N (11th Ave to Hwy 1 Fr. Rd.)	192	150	300
WM between Prestige Inn and Super 8 (11th Ave to Hwy 1 Fr. Rd.)	195	150	300
North Highway Fr. Rd. (Section SE of most southern Hwy. Cr.)	165	150	250

Location	Length (m)	Existing Diameter (mm)	Proposed Diameter (mm)
Station Ave (200mm to NE BS)	208	200	300

Modeling indicates that the NE bypass valve is critical for providing fire protection to the NW Industrial and Highway Commercial Zone. However, even with the proposed bypass valve upgrade, additional distribution piping upgrades are necessary to improve conveyance to the area. *Table 6.4* below summarizes the fire flow requirements and available fire flow under various scenarios.

Table 6.4: Required and Available Fire Flows for the NW Industrial and Highway Commercial Areas

Required Fire Flow	Existing System with the Bypass Closed	High Priority Upgrades	Low Priority Upgrades
Industrial – 225 L/s Commercial – 150 L/s	Less than 60 L/s	Approximately 80 L/s	Maximum 220 L/s

It is important to note that even with all proposed upgrades, the industrial fire flow requirements outlined in the 2008 *Subdivision and Development Servicing Bylaw* cannot be fully met. To address this limitation, it is recommended that future developments in the area be restricted to a maximum fire flow demand of 150 L/s to ensure adequate fire protection within the system's capacity.

According to the most recent Fire Underwriters Survey (FUS) report, the maximum required fire flow for the area is 220 L/s. This requirement is met with all proposed upgrades, indicating that while the system may not align with the bylaw's higher standards, it satisfies the recognized FUS fire flow criteria for insurance and safety purposes.

6.5.2 South Industrial & Commercial Areas

The purpose of the upgrades summarized in Table 6.5: is to provide adequate commercial and industrial fire flows to the existing commercial and industrial areas in South Golden. These improvements were initially recommended in the *2013 Water Distribution System Study*.

Table 6.5: Proposed Upgrades for South Industrial and Commercial Areas

Location	Length (m)	Existing Diameter (mm)	Proposed Diameter (mm)
10th Ave (10 St to 14th St)	357	150	250
14th St (10 St to 7th Ave)	560	150	250
7th Ave (14th St to 13th St)	106	New	250

An additional segment of piping along 7th Avenue has been included in the recommendations to provide looping, which significantly increases the available fire flow to the area. Table 6.6 below summarizes the fire flow requirements and the available fire flow under various scenarios.

Table 6.6: Required and Available Fire Flows for the South Industrial and Commercial Areas

Required Fire Flow	Existing System with the Bypass Closed	High Priority Upgrades	High & Low Priority Upgrades	High & Low Priority Upgrades – No Looping
Industrial – 225 L/s Commercial – 150 L/s	70 L/s to 130 L/s	75 L/s to 150 L/s	Exceeds 225 L/s	100 L/s to 200 L/s

6.6 NE ZONE – GOLDEN DONALD UPPER ROAD PRVS

There are three parallel pressure reducing valves (PRVs) that service Golden Donald Upper Road neighbourhood in the NE pressure zone. PRVs operating in parallel are challenging to set because of how they interact with each other. PRV set points were recommended as part of the *2013 Golden Water Distribution System Study* and then implemented. Operations staff have noted that they have since adjusted the PRV set points due to pressure complaints from homeowners in the neighbourhood, however the current pressure setpoints are unknown.

All of the PRVs are located in confined spaces. Two of the PRVs are located in manholes that contain insufficient space within the manhole to complete maintenance work. The third is located within a vault that has sufficient space to complete work, but still requires confined space entry. Due to the safety risks associated with confined spaces, completing maintenance in these chambers will be time and labour intensive.

Modeling indicates that without PRVs, pressures in some locations exceed the 850 kPa maximum specified in the *2008 Subdivision and Development Servicing Bylaw*. Pressures across the pressure reducing valve supplied zone also exceed 515 kPa, necessitating individual property PRVs. Comparison of static pressures from hydrant testing to modeled pressures suggests that the PRVs may not be operating as intended, as hydrant testing results align more closely with PRVs being inactive compared to the previously recommended setpoints.

To improve operability and remove the safety risks associated with confined space entry, it is recommended to replace the three existing PRVs with a single PRV and complete minor pipe work as required to support the reconfiguration. This could include the following work:

- Replace the Granite Drive and Pine Drive Cul-de-sac PRVs with a spool of pipe
- Connect the Pine Drive and Golden Donald Upper Road watermains, abandon the existing PRV feedline at this location
- Install a new PRV on the Golden Donald Upper Road watermain that would supply the existing area fed by the three pressure reducing valves.

As the system appears to be functioning adequately, these upgrades can be deferred until the infrastructure reaches the end of its service life or if significant service impacts arise. This work has not been included in current cost estimates and should be revisited in the next Water Strategy Update.

7.0 UPGRADE SUMMARY & CLASS D COSTS

The recommended upgrades have been classified as either high priority (needed to allow for growth, reliability, or to provide significant fire flow improvements) or as low priority (to be completed as funding allows). This section summarizes the recommended upgrades, upgrade trigger, and Class D capital cost estimate. Capital cost estimate breakdowns are included in Appendix E within the Integrated Water Strategy Report. The following assumptions were made to develop the cost estimates:

- Costs are Class D and include a 35% contingency for construction costs.
- Costs include a 15% allowance for engineering.
- The Selkirk booster station replacement includes a new building, electrical service, pumps, cascading valve, generator, and all necessary tie ins.
- The Northeast booster station replacement includes a new building, electrical service, pumps, cascading valve, generator, and all necessary tie ins.
- The second river crossing costs are based on the design package completed for this upgrade.

The high and low priority upgrades are summarized in Tables 7.1 and 7.2, respectively. All low priority upgrades are triggered by improving fire flow performance. Figure 7.7 within the Integrated Water Strategy Report shows the location of the proposed high and low priority upgrades, respectively.

Table 7.1: Summary of High Priority Upgrades

Upgrade		Trigger				Class D Capital Cost Estimate
		Capacity - Existing	Capacity - Future	Fire Flow Improvement	System Reliability	
Booster Station Upgrades:						
1.1	NE Booster Station Replacement		X	X		$3,523,000
1.2	SE Booster Station Pumps	X	X	X	X	$2,060,000
Piping Upgrades:						
2.1	350 mm Piping Upgrade La Fontaine Rd. (Gareb Rd. to Reservoir)			X		$2,791,000
2.2	300 mm Piping Upgrade Lafontaine and Gareb Rd.			X		$1,183,000
2.3	Second River Crossing			X	X	$2,699,000
Well Upgrades:						
3.1	Well 2 Generator			X	X	$90,000
3.2	Well 4 Generator			X	X	$188,000
Total High Priority Upgrades						$12,534,000

Table 7.2: Summary of Low Priority Upgrades

Upgrade		Class D Capital Cost Estimate
A	NW Industrial Fire Flow Piping Upgrades	
A.1	11 Ave N (14th St. to Trailer Park Entry)	$1,197,000
A.2	11 Ave N (11th St. Rail Crossing to 14th St)	$4,277,000
A.3	14 St. N (11 Ave N to Frontage Rd.)	$1,702,000
A.4	12 St. N (E of Hwy 1)	$691,000
A.5	11 St. N (11th Ave to Hwy 1 Fr. Rd.)	$1,270,000
A.6	WM between Prestige Inn and Super 8 (11th Ave to Hwy 1 Fr. Rd.)	$1,827,000
A.7	North Highway Fr. Rd. (Section SE of most southern Hwy. Cr.)	$1,070,000
A.8	Station Ave (200mm to NE BS)	$1,377,000
B	S Industrial Fire Flow Piping Upgrades	
B.1	10th Ave (10 St to 14th St)	$1,570,000
B.2	14th St (10 St to 7th Ave)	$2,464,000
B.3	7th Ave (14th St to 13th St)	$467,000
	Total High Priority Upgrades	$17,912,000

8.0 REFERENCES

The following reports, studies, and references were consulted for this analysis:

1. Golden Integrated Water Strategy Design Criteria, Aug. 8, 2024, Urban Systems.
2. Golden Integrated Water Strategy – Model Update and Validation, Aug. 6, 2024, Urban Systems.
3. Water Supply for Public Fire Protection, A Guide to Recommended Practice in Canada. FUS, 2020.
4. Email correspondence from FUS on 1990 and 2017 FUS hydrant testing results and required fire flows, Aug. 19, 2024.
5. 2013 Golden Water Distribution System Study, Revision 4, Aug. 2013, Urban Systems.

9.0 CONCLUSION AND NEXT STEPS

This memorandum summarizes the recommended water system upgrades to meet the 25-year MDD.

$12.5M high priority capital works have been identified to accommodate the 25-year growth projection, improve system reliability and/or address deficiencies. Refer to Figure 7.7 within the Integrated Water Strategy Report for the proposed works.

$17.9 M low priority capital works have been identified to improve available fire flow throughout the distribution system that are recommended to be advanced as funding becomes available or as the applicable watermain is being replaced at the end of its service life. Refer to Figure 7.7 within the Integrated Water Strategy Report for the proposed works.

Our next steps will be to prepare the Integrated Water Strategy report, summarizing the work completed to date as well as an implementation plan for the Town.

Sincerely,

URBAN SYSTEMS LTD.

Robyn Cameron, EIT
Project Engineer

Jill Reynolds, P.Eng.
Project Engineer

Jeremy Clowes, P. Eng.
Principal, Water & Wastewater Engineer

/jr/jc

cc: Sara Anderson, P.Eng., Principal, Client Lead

\\usl.urban-systems.com\projects\Projects_CAL\0404\0254\01\Q-Quality-Records\Jeremy Clowes\11. Final WMP Report rev.2\7. Appendix D\2024-12-16 Golden Integrated Water Strategy Recommended Upgrades Summary - Final - REV1.docx

APPENDIX E

COST ESTIMATE OVERVIEW

High Priority Upgrades:

Engineering	15%
Contingency	35%

Date: 30-Sep-24
Prepared by: Jill Reynolds
Jeremy Clowes

Item	Description	Unit	Unit Cost	Quantity	Sub-Total	Engineering	Contingency	Total
1.0	**Booster Stations**							
1.1	NE Booster Station Replacement	LS	$2,349,000	1	$2,349,000	$352,000	$822,000	$3,523,000
1.2	Selkirk Booster Station Pump Upgrades and Cascading Valve	LS	$1,371,600	1	$1,372,000	$206,000	$480,000	$2,058,000
							Subtotal	**$5,581,000**
2.0	**Piping**							
2.1	350 mm Piping Upgrade La Fontaine Rd. (Gareb Rd. to Reservoir)	lm	$3,097	601	$1,861,000	$279,000	$651,000	$2,791,000
2.2	300 mm Piping Upgrade Lafontaine and Gareb Rd.	lm	$3,035	260	$789,000	$118,000	$276,000	$1,183,000
2.3	Second River Crossing	LS	$1,799,475	1	$1,799,000	$270,000	$630,000	$2,699,000
							Subtotal	**$6,673,000**
3.0	**Wells**							
3.1	Well 2 Generator (relocate Well 6 63 kVa generator)	LS	$60,000	1	$60,000	$9,000	$21,000	$90,000
3.2	Well 4 Generator (assume 80 kVa)	LS	$125,000	1	$125,000	$19,000	$44,000	$188,000
							Subtotal	**$278,000**
					Total High Priority Upgrades			**$12,532,000**

Low Priority Upgrades:

Item	Description	Unit	Unit Cost	Quantity	Sub-Total	Engineering	Contingency	Total
A	**NW Industrial Fire Flow Piping Upgrades**							
A.1	11 Ave N (14th St. to Trailer Park Entry)	lm	$4,311	185	$798,000	$120,000	$279,000	$1,197,000
A.2	11 Ave N (11th St. Rail Crossing to 14th St)	lm	$4,413	646	$2,851,000	$428,000	$998,000	$4,277,000
A.3	14 St. N (11 Ave N to Frontage Rd.)	lm	$4,311	263	$1,135,000	$170,000	$397,000	$1,702,000
A.4	12 St. N (E of Hwy 1)	lm	$3,035	152	$461,000	$69,000	$161,000	$691,000
A.5	11 St. N (11th Ave to Hwy 1 Fr. Rd.)	lm	$4,413	192	$847,000	$127,000	$296,000	$1,270,000
A.6	WM between Prestige Inn and Super 8 (11th Ave to Hwy 1 Fr. Rd.)	lm	$6,259	195	$1,218,000	$183,000	$426,000	$1,827,000
A.7	North Highway Fr. Rd. (Section SE of most southern Hwy. Cr.)	lm	$4,311	165	$713,000	$107,000	$250,000	$1,070,000
A.8	Station Ave (200mm to NE BS)	lm	$4,413	208	$918,000	$138,000	$321,000	$1,377,000
							Subtotal	**$13,411,000**
B	**S Industrial Fire Flow Piping Upgrades - UPDATED**							
B.1	10th Ave (10 St to 14th St)	lm	$2,933	357	$1,047,000	$157,000	$366,000	$1,570,000
B.2	14th St (10 St to 7th Ave)	lm	$2,933	560	$1,643,000	$246,000	$575,000	$2,464,000
B.3	7th Ave (14th St to 13th St)	lm	$2,933	106	$311,000	$47,000	$109,000	$467,000
							Subtotal	**$4,501,000**
					Total Low Priority Upgrades			**$17,912,000**

Notes:

1 Complete field investigations to refine costs (e.g., geotech and survey)
2 Costs for watermain installed within roadways developed based on unit rate sheet. Refer to attached.
3 Refer to breakdown for NE Booster Station Costs
4 Refer to breakdown for SE Booster Station Costs
5 Refer to breadown for river crossing cost estimate

WATERMAIN COST PER METRE (3 m depth, up to 400 mm) DERIVATION

ASSUMPTIONS: Open Cut Trench Size - 3 m cover, 1.00 m wide at base, 6.26 m wide at surface, side slope of 0.75H:1V = 8.4 m3/m of trench backfill

Item		Description	Unit	Quantity	Unit Price	Total
A.		**SITE PREPARATION**				
	1.01	Removal and disposal of unsuitable material (offsite disposal) + replace with import pit run (assume 25% of volume)	cu.m.	2.10	65.00	$136.50
	1.02	dewatering (assume 10% of length)	lin.m.	0.1	150.00	$15.00
	1.03	milling existing asphalt - approx 110 mm depth	sq.m	9.5	20.00	$190.00
		SUBTOTALS - SECTION A including dewatering				**$342**
B.		**ROAD WORK RESTORATION**				
	2.01	Granular subbase (400mm depth)	sq.m.	9.5	30.00	$285.00
	2.02	Granular base (75mm depth)	sq.m.	9.5	15.00	$142.50
	2.03	Asphalt (50mm)	sq.m.	9.5	50.00	$475.00
		SUBTOTALS - SECTION B				**$903**
C.		**Watermains**				
	3.01	Water services	ea.	0.089	3,500.00	$311.11
	3.02	Hydrants	ea.	0.011	15,000.00	$166.67
	3.03	Air Valves	ea.	0.003	40,000.00	$133.33
	3.04	Tie-ins	ea.	0.011	20,000.00	$222.22
		SUBTOTALS - SECTION C				**$833.33**
D.		**OTHER**				
	4.01	traffic control (150 to 400 pipe size)	lin.m.	1	30.00	$30.00
		SUBTOTALS - SECTION D				**$30.00**

Pipe Size (mm)	150	200	250	300	350	400
Pipe Cost (supply and install)	$450.00	$700.00	$800.00	$900.00	$950.00	$1,000.00
Extra Costs	$2,107.33	$2,107.33	$2,107.33	$2,107.33	$2,107.33	$2,107.33
Gate Valves	$8.40	$22.80	$26.00	$28.00	$40.00	$60.00
Subtotal	$2,565.73	$2,830.13	$2,933.33	$3,035.33	$3,097.33	$3,167.33
TOTAL UNIT COST	**$2,565.73**	**$2,830.13**	**$2,933.33**	**$3,035.33**	**$3,097.33**	**$3,167.33**
adder for 100 mm thick asphalt	$475.00	$475.00	$475.00	$475.00	$475.00	$475.00
	$902.50	$902.50	$902.50	$902.50	$902.50	$902.50
	$3,943.23	**$4,207.63**	**$4,310.83**	**$4,412.83**	**$4,474.83**	**$4,544.83**

Golden NE Booster Station - Upgrade to 49 L/s
Class D Cost Estimate

Job No. **0404.0254.01**
Prepared by: J.Clowes
Date: August 25, 2024

Replace Existing Station with Station Rated to 49 l/s
Provide ANSI 300# Flanges on Station Discharge

ITEM	DESCRIPTION	QTY	UNIT	$/UNIT	EXTENDED
1	**General**				
	Mobilization and demobilization	1	ls	$50,000	$50,000
	Insurance and bonding	1	ls	$35,000	$35,000
2	**Removals**				
	Existing Pump Station	1	ls	$50,000	$50,000
3	**Site Works**				
	200 mm C900 DR14 discharge pipe	30	lm	$450	$13,500
	200 mm Gate Valve - 350 psi rating	2	ea	$5,000	$10,000
	250 mm C900 DR18 suction pipe	30	lm	$550	$16,500
	250 mm Gate valve - 250 psi rating	4	ea	$5,500	$22,000
	Connect to Existing Watermain	2	ea	$10,000	$20,000
	Relief valve discharge piping and drywell	1	ls	$30,000	$30,000
	100 mm Sanitary Service and connection to existing	1	ls	$10,000	$10,000
	Access Road - 300 mm subbase, 100 mm base, 75 mm asphalt	36	sq.m	$100	$3,600
	Fencing	80	lm	$150	$12,000
	Landscaping	1	ls	$20,000	$20,000
4	**Pump Station**				
	Building	80	sq.m	$6,000	$480,000
	175 HP Canned Vertical turbine pump (49 L/s at 170 m TDH)	2	ea	$275,000	$550,000
	250 mm SS pump suction std wall type 304	20	lm	$1,800	$36,000
	200 mm SS pump discharge std wall type 304	20	lm	$1,600	$32,000
	200 mm 300# check valve	2	ea	$15,000	$30,000
	200 mm 300# butterfly valve	2	ea	$7,500	$15,000
	50mm combination air release and air/vac	4	ea	$5,000	$20,000
	200 mm flow meter 300#	1	ea	$12,500	$12,500
	Dual solenoid globe valve with ability to backfeed lower zone	1	ls	$25,000	$25,000
	150 mm pressure relief valve	1	ea	$15,000	$15,000
	pressure transmitter	2	ea	$5,000	$10,000
	pressure gauge	4	ea	$250	$1,000
	Electrical	1	ls	$425,000	$425,000
	Programming	1	ls	$100,000	$100,000
	Generator	1	ls	$275,000	$275,000
	Electrical service	1	ls	$30,000	$30,000
				Subtotal	$2,349,100
				Engineering (15%) & Contingency (35%)	$1,174,550
				Estimated Project Cost	$3,523,650

Golden SE Booster Station - Upgrade to 23 L/s
Class D Cost Estimate

Job No. 0404.0254.01
Prepared by: J.Reynolds

Date: August 25, 2024

ITEM	DESCRIPTION	QTY	UNIT	$/UNIT	EXTENDED
1	General				
	Mobilization and demobilization	1	ls	$10,000	$10,000
	Insurance and bonding	1	ls	$10,000	$10,000
2	Removals				
	Existing pumps and equipment	1	ls	$15,000	$15,000
3	Site Works				
	150 mm C900 DR14 discharge pipe	15	lm	$400	$6,000
	150 mm C900 DR18 suction pipe	15	lm	$500	$7,500
	150 mm Gate valve - 250 psi rating	4	ea	$5,000	$20,000
	Connect to Existing Watermain	2	ea	$10,000	$20,000
	Relief valve discharge piping and drywell	1	ls	$30,000	$30,000
	100 mm Sanitary Service and connection to existing	1	ls	$10,000	$10,000
	Access Road - 300 mm subbase, 100 mm base, 75 mm asphalt	36	sq.m	$100	$3,600
	Fencing		lm	$150	$0
	Landscaping	1	ls	$20,000	$20,000
4	Pump Station				
	Building	31	sq.m	$6,000	$186,000
	25 HP Canned Vertical turbine pump (23 L/s at 50 m TDH)	3	ea	$93,000	$279,000
	150 mm SS pump suction std wall type 304	15	lm	$1,800	$27,000
	150 mm SS pump discharge std wall type 304	15	lm	$1,600	$24,000
	150 mm 300# check valve	3	ea	$15,000	$45,000
	150 mm 300# butterfly valve	6	ea	$7,500	$45,000
	50mm combination air release and air/vac	4	ea	$5,000	$20,000
	150 mm flow meter 300#	1	ea	$12,500	$12,500
	Dual solenoid globe valve with ability to backfeed lower zone	1	ls	$25,000	$25,000
	150 mm pressure relief valve	1	ea	$15,000	$15,000
	pressure transmitter	2	ea	$5,000	$10,000
	pressure gauge	4	ea	$250	$1,000
	Electrical	1	ls	$270,000	$270,000
	Programming	1	ls	$100,000	$100,000
	Generator	1	ls	$130,000	$130,000
	Electrical service	1	ls	$30,000	$30,000
				Subtotal	$1,371,600
				Engineering (15%) & Contingency (35%)	$685,800
				Estimated Project Cost	$2,057,400