REGIONAL DISTRICT OF CENTRAL KOOTENAY

LISTER WATER SYSTEM

LONG-TERM INFRASTRUCTURE CAPACITY ASSESSMENT

NOVEMBER 04, 2019

FINAL

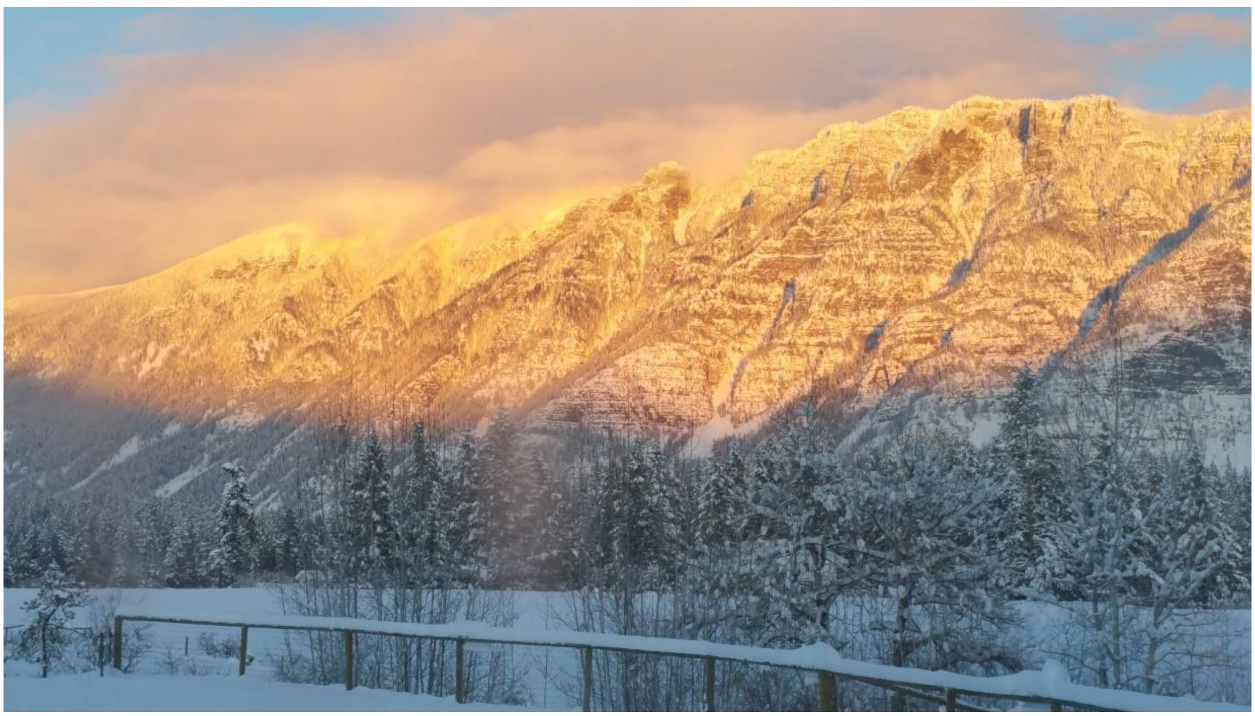

Photo Credit: Skimmerhorn Mountains - Leslie Payne

LISTER WATER SYSTEM

LONG-TERM INFRASTRUCTURE CAPACITY ASSESSMENT

REGIONAL DISTRICT OF CENTRAL KOOTENAY

SECOND ISSUE
FINAL

PROJECT NO.: 181-15710-01
CLIENT REF:06-2230-5700-65
DATE: NOVEMBER 04, 2019

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November 04, 2019

REGIONAL DISTRICT OF CENTRAL KOOTENAY
202 Lakeside Drive, PO Box 590
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Attention: Shari Imada, P.Eng. M.E.Des. Project Manager

Dear Madam:

Subject: Lister Water System – Long-Term Infrastructure Capacity Assessment
Client ref.: 06-2230-5700-65

We are pleased to submit the attached final Lister Water System – Long-Term Infrastructure Capacity Assessment. In the study we completed a desktop review of existing infrastructure studies and plans, updated the base plan and water model, assessed the existing conditions and then provided four options for updating the distribution systems to current regulatory standards and good engineering practice for future demands considering both domestic demand and potential for fire flow.

Thank you for this opportunity to work with the RDCK. If you have any questions, please feel free to contact us.

Kind regards,

Elise Paré, P.Eng.
Senior Project Manager

Encl.

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SECOND ISSUE - FINAL

October 31, 2019				
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1 INTRODUCTION

The Lister water system currently provides potable water to 129 active connections within a large rural community within Electoral Area B of the Regional District of Central Kootenay (RDCK). The water source for the Lister water system is a groundwater well which provides a reliable volume of good quality water to all its system users. Most of the land serviced by the Lister water system is within the ALR. The community is characterized by large lot agricultural parcels and further development is limited by ALR legislation, community values, and a requirement for adequate water supply for both domestic and fire protection purposes.[1]

The Regional District of Central Kootenay (RDCK) took over ownership of the Lister water system in 1982. An asset management plan completed for the system in 2018 indicates that approximately 75% of the total network has surpassed its service life or is scheduled for replacement within the next 15 years. Further to this, some of the network is undersized and some of the distribution lines are located on private property without secured rights of way. The system does not currently meet established guidelines for fire protection. The "Lister Water System Assessment: Current Boundary" report was completed by WSP in April 2019, and finalized in October 2019, to determine upgrade options for the Lister water system to improve the level of service of the system within its current boundaries.

There are several small water systems adjacent to the current Lister service area, including the Rykerts Irrigation District (Rykerts), Orde Creek Improvement District (Orde Creek), South Canyon Improvement District (South Canyon), and several individual properties adjacent to the existing Lister water system. There has been interest from these systems to connect to and receive water supply from the Lister water system. It is understood that significant distribution system improvements may be required to connect to these communities due to the distance between potential tie-in points, and upgrades to aging or undersized infrastructure.

WSP was commissioned to assess the feasibility of connecting these water systems to the Lister water system. This report summarizes WSP's findings on the long-term capacity of the existing Lister water system to service additional areas and includes the following items, as discussed in subsequent sections of this report:

- An overview of the existing systems and previously studies completed;
- An assessment of current and projected demands in the expansion areas;
- Updates to the Lister hydraulic water model to include the expansion areas;
- An assessment of the existing level of service provided in the expansion areas;
- Identification and assessment of potential connection options from the Lister water system to the expansion areas;
- Cost estimates to undertake the connections; and,
- Findings and recommendations.

[1] RDCK – Electoral Area B Comprehensive Land Use Bylaw No 2316, 2013, p19.

2 BACKGROUND INFORMATION

2.1 LISTER WATER SYSTEM

The current water source for Lister is a 250 mm diameter groundwater well drilled in 2010 and developed in 2012. The groundwater is disinfected via chlorination and the treatment contact time is achieved in an 885 m^3 above ground steel bolted reservoir. The reservoir has been designed to include domestic demands and fire flow storage from Lister, Rykerts and Orde Creek (Phase 1 Summary Report: Groundwater Source Assessment for the Lister Water System, WSA Engineering Ltd., 2010). Static pressures within the distribution system when the reservoir is 80% full range from 44 psi to 112 psi; the existing hydraulic model indicates similar results.

The Lister water system has approximately 24 kilometres of watermain within its service area for transmission and distribution. There are 196 active connections servicing a population of approximately 590 people. The Lister water system was upgraded during two major phases; the south end in the 1970s and the north end in the 1980s. Much of the distribution system consists of Series 160 PVC pipe with glued joints with diameters ranging from 50 to 150 mm, bedded in sand or pea gravel. Due to the age and construction year of the watermains, it is understood that much of the distribution system is undersized and was not designed to supply fire flows.

A concern for the distribution system includes dead-end mains, or the long "extended services" (mains less than 100mm in diameter) as they create potential for stagnation in the system. It is assumed that the regular daily use by the homeowners is sufficient to keep the water from stagnating in the pipes, however, this cannot be confirmed. There are small diameter blow offs throughout the system that the RDCK uses to flush the mains at least once a year.

The system is controlled via a basic controls system turning on the well pump when the reservoir level drops below 70% and stopping the pump at 80%. Free chlorine residual, flow, alarms, well level, raw water temp and reservoir level data is logged in the historian.

2.2 WATER SYSTEM ASSESSMENT - BASE STUDY

In April 2019, WSP completed the draft "Lister Water System Assessment: Current Boundary"[2] to assess the existing water system and identify upgrades for the system. From the assessment, it was found that much of the system was undersized and did not meet current engineering standards for the design of water systems. In particular, several areas of the existing system did not meet minimum available pressure criterion (minimum 40 psi or 276 kPa under Peak Hour Demand). The system is also unable to supply rural fire flows of at least 33 L/s (2,000 L/min). These deficiencies will be further exacerbated by future growth and the subsequent increased demands on the water utility in the future.

Upon request from the RDCK, three potential upgrade scenarios were developed for assessment to meet three different sets of future design criteria conditions:

- **Option 1** – the objective for Option 1 is to meet the available pressure criteria under Average Day Demand (ADD) and Peak Hour Demand (PHD) scenarios by upsizing watermains in the existing locations and securing rights-of-way in which the current watermains exist. Additional watermains

[2] The final version of the "Lister Water System Assessment: Current Boundary" was issued in October 2019.

are identified and located in roadways to service future developments. Upgrades to meet the fire flow requirements under Maximum Day Demand (MDD) are not considered under this option.

- **Option 2 –** The objective for Option 2 is to achieve the available pressure criteria under the ADD and PHD scenarios by abandoning watermains outside of secured rights-of-way and replacing them within existing roadways where applicable, upsizing existing watermains in existing roadways, and improving/adding looping to maintain water quality. Upgrades to meet the fire flow requirements under Maximum Day Demand (MDD) are not considered under this option.
  - **Option 2A -** An alternative scenario was created to upsize the transmission mains under Option 2 to provide the required fire flows to determine the incremental change and cost to meet rural fire flow demand requirements.
- **Option 3 –** Option 3 builds on Option 2 and includes additional future looping, relocation and addition of watermains where required, and pipe upsizing to provide the required fire flows under the MDD option.

Although any of the options can be considered for future upgrades depending on the desired level of service and available funding, only Options 1 and Option 2A are further considered for this Long-Term Infrastructure Capacity study. Option 1 is the lowest cost option due to the lower level of service criteria to be met. Although pressures will improve to the desired levels of service, fire flow requirements will not be met under this option and rights-of-way will need to be secured.

Option 2A is the lowest cost option of providing a fully fire protected water system. Option 2A provides a similar level of service as Option 2 while providing for and meeting fire flow requirements. The incremental cost of increasing the size of transmission mains and providing hydrants is only 25% more costly than Option 2. This option provides the minimum cost for the construction of a fully fire protected water system for Lister.

The estimated costs of implementing Option 1 and Option 2A are presented in the table below:

Table 2-1: Option 1 and Option 2A Cost Estimates

DESCRIPTION	ESTIMATED UPGRADE CONSTRUCTION COST	ENGINEERING (15%)	CONTINGENCY (50%)	TOTAL COST
Option 1 – Domestic Only	$3,520,000	$528,000	$1,760,000	$5,808,000
Option 2A – Domestic plus Rural Fire Flow	$9,530,000	$1,429,500	$4,765,000	$15,724,500

2.3 EXPANSION AREAS

This study arose due to expressed interest to the RDCK from adjacent smaller water systems and individual properties to join the Lister water system. Potential areas of expansion (“expansion areas”) include the Rykerts Irrigation District, the Orde Creek Improvement District, the South Canyon Improvement District, the Creston Valley Airport, and several individual properties adjacent to the existing Lister system boundary (“adjacent properties”). These potential expansion areas are currently supplied from creek intakes or private well systems and do not have functioning treatment systems. These systems are also currently under long-term boil water advisories and have ongoing maintenance and reliability challenges. The small water systems are operated by volunteer board members and all three boards have indicated it is very difficult to recruit new members, posing a high risk of discontinuation of this model due to lack of interest to replace aging or retired members.

From a connection point of view, significant upgrades may be required to connect these systems to the Lister water system, due to the distance between potential connection points, existing water quality concerns, and aged or undersized infrastructure.

Figure 2-1 shows the potential expansion areas relative to the existing Lister water system service boundary. Descriptions of the existing expansion area systems are provided in Section 3.

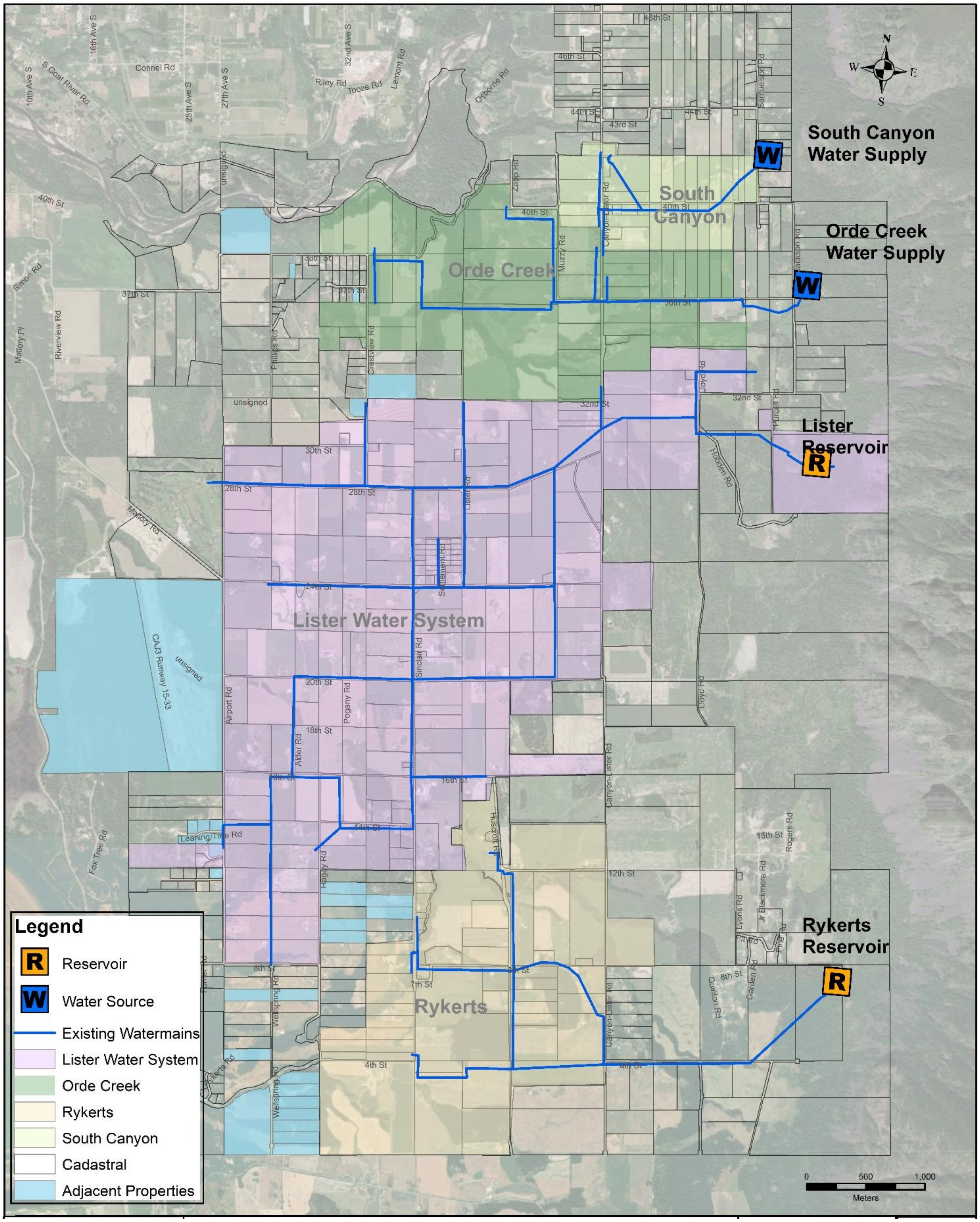


Figure 2-1: Lister Water System and Expansion Areas Boundaries

2.4 REFERENCE INFORMATION

During the preparation of this boundary expansion assessment, WSP conducted site visits of the potential expansion areas to collect reference information, interview representatives, and visually inspect existing water infrastructure. The following information was provided to WSP for review:

Rykerts Irrigation District

1. June 2019 communications and interview with Rykerts Irrigation District trustees and Chairman Glenn Mohr.
2. 2014-2018 Rykerts Irrigation District Financial Statements
3. 2019 Emergency Response and Contingency Plan
4. Rykerts Irrigation District - Water Line Diagram
5. Letters Patent R.I.D.

Orde Creek Improvement District

1. 2007 Orde Creek Water System Study, Pennco Engineering Ltd.
2. July 2019 communications and interview with Cody Peck, Orde Creek Improvement District member
3. Drawing showing existing distribution system and proposed connection points
4. Water system plan mapping - RDCK GIS

South Canyon Improvement District

1. June 2019 communications and interview with Katherine Goodchild and Rick Law, South Canyon Improvement District operators/representatives.
2. 2018 South Canyon Improvement District Financial Statements
3. 2018-2021 Financial Sources and Allocation of Funds
4. 2019 South Canyon Improvement District Annual General Meeting Minutes
5. 2019 Service connection details – contact information and financial information
6. 2019 MFLNRO Annual System Return
7. Water system plan mapping – RDCK GIS
8. 2005 Water Conservation Plan and Drought Contingency Plan, EBA Engineering Consultants Ltd.
9. Water System and service connection blueprint

3 EXPANSION AREAS - EXISTING SYSTEM

3.1 ADJACENT PROPERTIES

Twenty inquiries, totalling 31 properties, were submitted to the RDCK from adjacent properties to the existing service boundary requesting connection to the Lister water system. The adjacent properties surrounding the Lister water system service boundary primarily consist of rural and agricultural properties, which are responsible for providing and maintaining their private water supplies. These properties range from being located immediately adjacent to the existing Lister water system to approximately 1,600 m away from the closest watermain. The requests are to supply domestic water demands and domestic irrigation, similar to the majority of the existing properties in the Lister current service boundary.

A representative from the Creston Valley Regional Airport Society has also contacted the RDCK to request connection to the Lister water system. The airport's facilities is currently supplied by two groundwater wells, one of which supplies a 25,000 gallon tank used for fire suppression, and the other which services the Emergency Services building, resident house, and hangars. The Society are requesting a connection to the Lister water supply for limited use for the Emergency Services building (approximately 50 water users, maximum during search operations) and resident house (maximum 3 water users); the connection will not service the hangars or supply the fire suppression infrastructure[3].

The RDCK has provided a spreadsheet summarizing the properties to be considered for potential connection to the existing Lister water system. The majority of the properties are rural properties. The properties are summarized in the following table and are highlighted in blue on Figure 2-1.

Table 3-1: Adjacent Properties

NUMBER OF PROPERTIES	ADDRESS
1	2715 37th Street
1	2328 38th Street
1	2419 38th Street
6	(was 1241-1335) Airport Road
1	1201 Airport Road
Regional Airport	1993 Airport Road (Creston Valley Regional Airport)
1	(between 3115 & 3245) Crestview Road
1	3210 Hagey Road
1	950 Hagey Road

[3] Pers Comm. Mary Angus, Creston Valley Regional Airport Society Secretary/Treasurer, May 31, 2019 and October 8, 2019

NUMBER OF PROPERTIES	ADDRESS
1	645 Hagey Road
1	870 Hagey Road
1	1120 Hagey Road
1	1072 Hagey Road
1	1015 Sinclair Road
1	1075 Sinclair Road
1	649 Wellspring Rd
1	Wellspring Rd (south of Porthill Rd)
1	405 Wellspring Rd
8	Wellspring Rd

3.2 RYKERTS IRRIGATION DISTRICT

The Rykerts Irrigation District domestic water system is gravity-fed from a reservoir, supplied from an infiltration gallery fed from a spring at the head of South Rykerts Creek. The reservoir is a 50,000 USgal (190 m^3), dual cell concrete reservoir tank with concrete lid, re-constructed by the board members in the 2017. The reservoir tank is partially buried, with an approximate base elevation of 740 m geodetic. The reservoir tank is approximately 2.4 metres tall with the top water level of approximately 2 metres. Representatives have noted challenges with vandalism at the intake and reservoir site and access to the reservoir and intake during the winter season. Significant work has been completed by the board members to increase resilience at the site, by burying the infiltration gallery and installing a vandal resistant lock on the reservoir door. There is no permanent power to the reservoir site and the closest pole is approximately 1.5 km away on Fourth St.

Interior Health – Health Protection previously assessed the Rykerts water source as a Ground Water at Risk of Containing Pathogens (GARP) in February 2016 and as a result, the system is under a Boil Water Advisory. Although there is a chlorination system in place at the water source, it is currently not functional under the current system configuration due to lack of gravity head. No other treatment is provided by the system, aside from ground filtration at the buried infiltration gallery.

The majority of the water distribution system was installed in the 1970s and consists primarily of 50 to 75 mm diameter gasketed white PVC watermains. The reservoir outlet to the distribution system is 150 mm Schedule 40 PVC and was installed more recently in the 1990s. The majority of the system is not looped and there are several dead end watermains. This water system only supplies domestic demands; agricultural irrigation and commercial demands are supplied separately from individual creek intakes or private wells. Domestic irrigation is limited to a single sprinkler supplied from a 19 mm irrigation line per service connection. Agricultural irrigation and commercial demands are expected to remain as separate systems and is not considered for connection to the Lister water system in this study. There are no fire hydrants in the system but there is a single standpipe for flushing.

Representatives report there are currently 26 residential connections to be connected to the Lister water system with approximately two people per connection. A future subdivision, approximately 20 acres in area, is expected to accommodate the addition of three to four future residential connections.

There is a magnetic flow meter at the reservoir outlet, but the totalizer is not functional. The maximum instantaneous flow recorded from the flow meter is 12.3 L/s (280,000 US Gallons per day) and average demand is 3.3 L/s (75,000 Us gallons per day)[4]. The low demand season is in March and during the autumn months.

3.3 ORDE CREEK IMPROVEMENT DISTRICT

The domestic water supply for Orde Creek Improvement District is supplied from a low-head diversion structure which diverts fresh water from Orde Creek into a 7 m^3 settling tank. From the settling tank, a 100 mm asbestos concrete pipe supplies the distribution system by gravity. There is no treatment for this water supply and suspended solids and coliform levels are an ongoing water quality issue. As such, the system is under an ongoing Boil Water Advisory.

The distribution system consists of 50 mm carlon pipe (low density polyethylene tubing) and 75 mm PVC with gasketed-joint watermains installed in the early 1970s. The system is not looped and there are numerous dead ends. Generally, it has been reported that working pressures range between 50 to 110 psi in the improvement district. Previous studies have indicated that leakage is an ongoing issue in the system[5].

The system currently serves 22 homes, and the remaining homes in the area are serviced by private wells. Only domestic demands are supplied from the system, with agricultural irrigation and commercial demands supplied from separate systems. Domestic irrigation is limited to two sprinklers per service connection to irrigate lawns. Development within the Orde Creek Improvement District is limited by ALR regulations and no further development nor population growth is anticipated for the area. There are no fire hydrants and only one standpipe in the entire system for air release.

3.4 SOUTH CANYON IMPROVEMENT DISTRICT

The South Canyon Improvement District receives its water supply from an intake at Floyd Creek; there is no storage nor treatment in the current system. Prior to 2005, a provincial health inspector recommended treatment be provided for the system within five to seven years. Low levels of coliforms have been detected in the supply in the past and the system is under a permanent Boil Water Advisory since 2003. There have been concerns on source capacity in the past, including concerns that the nearby North Canyon Improvement District (NCID) groundwater wells were re-directing flow away from Floyd Creek. However, no interdependency has ever been established to corroborate this concern[6].

The supply main from Floyd Creek is 200 mm PVC, before decreasing to 100 mm, 75 mm, and 50 mm PVC distribution watermains. The majority of the system was installed between 1987-1988, with a newer section recently constructed on 40th Street. There is a single standpipe in the system, at the corner of Canyon-Lister Road and 40th Street. Supply pressures are low at certain connections due to gravity feed

[4] Pers Comm. Glenn Mohr, Rykerts Irrigation District Chariman, June 2019.
[5] Water System Study, Pennco Engineering Ltd., 2007
[6] Water Conservation Plan and Drought Contingency Plan, EBA Engineering Consultants Ltd., 2005

and these connections pay 10% lower fees as they must supplement pressure with private jet pumps. Service pressure at the corner of Canyon Lister Rd and 40th St is approximately 50 psi.

The water system provides domestic water supply to 36 residential connections, or approximately 70 people. Only domestic demands are supplied from the system with agricultural irrigation and commercial demands supplied from separate systems. The water supply permit owned by the improvement district allows irrigation supply of up to 54 acre-feet per year. There is no flow or consumption data available for the system. Further development of the area is limited by ALR regulations; hence the current population and demands are expected to remain similar in the future. Additional requests for new connections, including recent applications for irrigation for cherry orchards, have been denied due to the limited source capacity.

4 WATER MODEL UPDATES

4.1 OVERVIEW

The analysis for this study was completed using a water model developed from an EPANET water model (last updated June 2014) provided by RDCK and updated using elevations from recently collected LiDAR data. RDCK's model was first updated as part of the "Lister Water System Assessment: Current Boundary" completed by WSP in October 2019, and further developed with the following updates in this study:

1. The existing watermains for the expansion areas were added to the water model, based on sizes and locations indicated on base maps and blueprints provided by representatives for the expansion areas; no record drawings are available for the adjacent properties.
2. The node elevations for the watermains, including the existing Lister water system watermains, were updated using the LIDAR elevation data provided by the RDCK in July 2019.
   Note: the elevation data in the original water model provided by the RDCK varied by up to 30 metres in some locations (this has also updated current system results).
3. Water supply sources (reservoirs and intakes) for the expansion areas were added to the water model. The intake elevations and reservoir base elevations were estimated from LIDAR elevation data provided above; no record drawings or surveyed elevations/locations were available for the water supply sources.
4. Existing and Future demands for the expansion areas were added to the water model, further discussed in Section 4.3.
5. New scenarios were created to model future demands and connections to Lister water system. The proposed upgrade Options 1 and 2A, developed in the "Lister Water System Assessment: Current Boundary", were used as the base scenarios prior to connections.

4.2 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations were used during the water model updates:

1. The watermains lengths are approximated using real world geometric data from the modelling software.
2. No survey has been completed for watermains or the water sources, all elevation data is based on LIDAR elevation data provided by the RDCK (July 2019).
3. No updates have been made to the diameters, or C-factors in the EPANET model provided by RDCK.
4. The C-factors for the new watermains are 100 for watermains up to 150 mm diameter, and 110 for 200 mm watermain (*Design Guidelines for Rural Residential Community Water Systems, 2012).*
5. The model has not been calibrated.
6. The Lister Reservoir tank initial water level in steady state scenario is set to 8.78 metres above the base of the reservoir.
7. The elevation and settings of the water supply sources for the expansion areas are based on the approximate location of the sources and LIDAR elevation data:
   a. The Rykerts Irrigation District reservoir tank is modelled with a base elevation of 740 m geodetic. The initial water level in the steady state scenario is set to 2 metres above the base elevation, the top water level as estimated from field measurements.

b The Orde Creek Improvement District water source is modelled as an open reservoir supply which maintains an HGL of 745 m geodetic, the approximate elevation of the Orde Creek diversion structure.

c The South Canyon Improvement District water source is modelled as an open reservoir which maintains an HGL of 715 m geodetic, the approximate elevation of the Floyd Creek intake.

4.3 DEMAND DEVELOPMENT

4.3.1 DEMAND ESTIMATES

Where available, the demands for the expansion areas were developed using water consumption or flow meter data. In the absence of this data, demands were estimated in accordance to the *Design Guidelines for Rural Residential Community Water Systems (2012)*. The resulting ADD demands per connection is summarized in Table 4-1.

Table 4-1: Average Day Demand per Connection

DESCRIPTION		ADJACENT PROPERTIES	AIRPORT	RYKERTS	ORDE CREEK	SOUTH CANYON
Existing	Total Existing ADD (7)	0.226 L/s (8) (18,000 L/day)	0.064 L/s (5,600 L/day) (9)	0.825 L/s (71,000 L/day) (10)	0.57 L/s (49,000 L/day) (11)	1.02 L/s (88,000 L/day) (12)
	Number of Connections	31	1	26	22	36
Average Day Demand (Per Connection)		0.0073 L/s (630 L/day)	0.064 L/s (5,600 L/day)	0.0317 L/s (2,700 L/day)	0.0259 L/s (2,200 L/day)	0.0282 L/s (2,400 L/day)
Average Day Demand (Per Capita)[13]		0.0029 L/s (250 L/day)	0.001 L/s (105 L/day)	0.0127 L/s (1,080 L/day)	0.0104 L/s (880 L/day)	0.0113 L/s (960 L/day)

[7] Maximum Day Demand/2.5 Peaking Factor (*Design Guidelines for Rural Residential Community Water Systems, 2012)*

[8] Refer to Lister Water System Assessment: Current Boundary (WSP, October 2019)

[9] Maximum day demand based on 53 users and no irrigation demand. There is an estimated maximum of 50 water users at the Emergency Services building during search operations and 3 employees *(Communications with Creston Valley Regional Airport Society, October 2019).* We note this a conservative estimate because there are only currently two active bathrooms at the building.

[10] Average day demand based on maximum measured instantaneous flow of 3.3 L/s/4.0 Peaking Factor. Calculated ADD is 0.70 L/s (61 m^3/day) and is less conservative than the measured value.

[11] Based on allowance of two sprinklers per connection, with maximum overage of 1 acre per sprinkler.

[12] Based on permit allowance of 54 acre-feet per year. Calculated value is 1.89 L/s, and is less conservative than the permit allowance value.

[13] Assuming average 2.5 capita per connection

The ADD per capita for the expansion areas ranges from 880 L/capita/day to 1,080 L/capita/day, and is significantly higher than the estimated per capita demand in the Lister Water system. This can be attributed to the high leakage potential of the systems in expansion areas (resulting from the high ratio of watermain/service length per capita) and the conservative estimate of irrigation demands.

The evaluation completed in this study for future water usage assumes the per capita demands imposed on the system from existing water consumers will not increase or decrease. All demands are also inclusive of leakage, and historical information provided contains the totalized amount.

4.3.2 DEMAND SCENARIOS AND ALLOCATION

The following three demands scenarios were developed and evaluated:

1. **Average Day Demand (ADD) –** If available, ADD was estimated using water consumption data. In the absence of water consumption data, ADD per connection was determined using the *Design Guidelines for Rural Residential Community Water Systems, 2012*, where:
   - ADD = MDD/2.5 Peaking Factor
   - MDD = Indoor Usage + Water Loss Allowance + Irrigation Demand

   Refer to Section 4.3.1 for further information on Average Day Demand estimates.
2. **Maximum Day Demand + Fire Flow (MDD+FF)** – MDD was estimated as ADD x 2.5 Peaking Factor (*Design Guidelines for Rural Residential Community Water Systems, 2012*). Coincident to the MDD, each node in the water distribution system is evaluated for its ability to provide an additional fire flow while maintaining a residual pressure of 20 psi or 138 kPa. The minimum fire flow for this evaluation is 33 L/s as discussed and agreed with the RDCK.
   Refer to Section 4.4.2 for further information on fire flow requirements.
3. **Peak Hour Demand (PHD)** – PHD was estimated as ADD x 4.0 Peaking Factor (*Design Guidelines for Rural Residential Community Water Systems, 2012*).

The demands for the existing Lister water system were previously allocated as part of the "Lister Water System Assessment: Current Boundary". The demands for each connection in the expansion areas were allocated to the nearest model nodes in the water distribution system. The resulting demands are summarized in Table 4-2.

Table 4-2: Demand Scenarios

SYSTEM	EXISTING				FUTURE			
	NUMBER OF CONNECTIONS	AVERAGE DAY DEMAND	MAXIMUM DAY DEMAND	PEAK HOUR DEMAND	NUMBER OF CONNECTIONS	AVERAGE DAY DEMAND	MAXIMUM DAY DEMAND	PEAK HOUR DEMAND
Existing Lister Water System	196	8.70 L/s	21.75 L/s	34.80 L/s	250	9.09 L/s	22.73 L/s	36.36 L/s
Adjacent Properties	31	0.23 L/s	0.56 L/s	0.90 L/s	31	0.23 L/s	0.56 L/s	0.90 L/s
Airport	1	0.064 L/s	0.16 L/s	0.26 L/s	1	0.064 L/s	0.16 L/s	0.26 L/s

SYSTEM	EXISTING				FUTURE			
	NUMBER OF CONNECTIONS	AVERAGE DAY DEMAND	MAXIMUM DAY DEMAND	PEAK HOUR DEMAND	NUMBER OF CONNECTIONS	AVERAGE DAY DEMAND	MAXIMUM DAY DEMAND	PEAK HOUR DEMAND
Rykerts	26	0.83 L/s	2.06 L/s	3.30 L/s	30	0.95 L/s	2.38 L/s	3.80 L/s
Orde Creek	22	0.57 L/s	1.43 L/s	2.28 L/s	22	0.57 L/s	1.43 L/s	2.28 L/s
South Canyon	36	1.02 L/s	2.55 L/s	4.08 L/s	36	1.02 L/s	2.55 L/s	4.08 L/s
Total	**312**	**11.40 L/s**	**28.51 L/s**	**45.62 L/s**	**370**	**11.92 L/s**	**29.80 L/s**	**47.68 L/s**

4.4 DESIGN CRITERIA

4.4.1 AVAILABLE PRESSURES

Minimum service pressures are required to ensure an adequate flow and pressure of water at all serviced properties. There are, in most cases, two conditions under which systems should be analyzed or designed for minimum service pressures; these are the fire flow condition coincident to maximum day demand, and the peak hour demand condition. Furthermore, maximum service pressures in the system also need to be regulated to prevent over-pressurizing of the system, assessed under the average day demand condition.

Design Guidelines for Rural Residential Community Water System (2012) stipulates the service pressure requirements as presented in Table 4-3. These requirements have been reviewed in the hydraulic model under various demand conditions.

Table 4-3: Minimum and Maximum Pressures Criteria

SCENARIO	PRESSURE
Average Day Demand	120 psi; 827 kPa (maximum)
Fire Flow Condition Coincident to Maximum	20 psi;138 kPa (minimum)
Peak Hour Demand	40 psi; 276 kPa (minimum)

4.4.2 AVAILABLE FIRE FLOWS

None of the systems currently meet fire flow requirements. The RDCK is currently investigating provision of fire flow to the Lister water system, through a separate project. There are no plans to provide the properties outside of the existing Lister water system boundary with fire flow.

The base modelling scenarios are based on Option 1 and Option 2A which provide varying levels of fire protection within the Lister water system boundary (established in the "Lister Water System Assessment: Current Boundary" report). The modelling scenarios will assess the impact of expanding the service boundary to the available fire flows within the Lister water system boundary, whereas properties outside of the existing system boundary will not be assessed. Fire protection considerations are:

1. Only one fire will be fought at any one time;
2. To ensure pumper trucks obtain adequate water supplies from hydrants, a minimum residual pressure of 20 psi or 138 kPa on the street main is required during fires;
3. The area near the reservoir is not suitable for development and has been removed from consideration for maintaining the 20 psi or 138 kPa residual; and,
4. Fire flow is coincident with maximum day demand.
5. The minimum fire flow requirements vary based on the land use in the area. Due to the typical rural land use and the low density in the Lister water system, the least stringent water fire flow demand of 33 L/s (2,000 L/min) in *Table 6: FUS Fire Flow Requirements for Various Building*s in the Design Guidelines for Rural Residential Water Systems is used for the evaluation. This requirement is for buildings with a maximum 1300 sq.ft. area, brick/masonry construction type, with a minimum exposure distance of 45 m. It is understood the structures in Lister generally meet the characteristics above, with the exception of certain wood frame structures. This has been discussed with and accepted by the RDCK.

4.4.3 MAXIMUM VELOCITY

The recommended maximum acceptable velocity for flows in the water distribution system is 3.5 m/s during fire flow demand according to Master Municipal Construction Documents (MMCD) criteria.

5 BASE MODELLING SCENARIOS

The existing systems were modelled to assess the baseline conditions for the three demand scenarios discussed above. Appendix A contains figures illustrating the results from the analysis:

- Figure A-1: Existing Systems – Average Day Demand
- Figure A-2: Existing Systems – Peak Hour Demand
- Figure A-3: Existing Systems – Available Fire Flows coincident to Maximum Day Demand

Note: The results presented in this assessment supersedes results from the "Lister Water System Assessment: Current Boundary" submitted in April 2019; the results have been updated in the final issue submitted in October 2019. The elevation data in the water model was updated using LIDAR data, which resulted in the available pressures and fire flows to be lower than that provided in the April 2019 study.

5.1 EXISTING SYSTEMS

5.1.1 RYKERTS IRRIGATION DISTRICT

The existing available pressures under the ADD scenario range between 98 psi and 164 psi (676 kPa to 1131 kPa), exceeding the maximum pressure criterion of 120 psi or 827 kPa. The minimum pressure criterion under the PHD scenario was met throughout the system.

The available fire flow was not assessed for the Rykerts system.

5.1.2 ORDE CREEK IMPROVEMENT DISTRICT

Available pressures in the system under the ADD scenario range between 85 psi to 167 psi (586 kPa to 1151 kPa), due to the variation in ground elevation. This exceeds the maximum pressure criterion under the ADD scenario. The minimum pressure criterion under the PHD scenario was met throughout the system.

The available fire flow scenario was not assessed for the Orde Creek system.

5.1.3 SOUTH CANYON IMPROVEMENT DISTRICT

Available pressures under the ADD scenario range from 36 psi to 71 psi (248 kPa to 490 kPa), meeting the maximum pressure criterion. The majority of the system meets the minimum pressure criterion under the PHD scenario, with exception to several properties on the east side of the system, which are located at a higher elevation. The available pressure under this scenario are marginally deficient, at 35 psi or 241 kPa, compared to the minimum pressure criterion of 40 psi or 276 kPa under PHD.

The available fire flow was not assessed for the South Canyon system.

6 FUTURE MODELLING SCENARIOS

There are plans to upgrade the existing water system to improve the level of service, assessed as part of the “Lister Water System Assessment: Current Boundary” report. The future modelling scenarios for new connections assume one of the following two upgrade scenarios are carried out in the Lister water system prior to connecting to the system:

— Option 1 aims to meet PHD requirements throughout the system, by upsizing watermains in their existing locations. This will require obtaining ROWs for watermains that cross private properties. Watermain extensions are also provided to service future developments. Upgrades to meet fire flow requirements are not considered for this option.
— Option 2A aims to meet fire flow requirements for the majority of the system and relocate watermains outside of private properties. Watermain extensions are also provided to service future developments.

The following sections summarize the level of service that can be provided by the proposed connection of each system to the Lister water system. The “Lister Water System Assessment: Current Boundary” report provides additional detail on each upgrade scenario.

6.1 OPTION 1

The objective for Option 1 is to achieve the available pressure criteria under the ADD and PHD scenarios by upsizing watermains in the existing locations and secure with rights of way. Additional watermains are provided to service future developments.

Figures illustrating potential connections from the Lister water system under the Option 1 upgrade scenario, and incremental upgrades to meet the design criteria outlined in Section 4.4, are provided in Appendix B:

— Figure B-1: Option 1 Expansion – Average Day Demand Condition
— Figure B-2: Option 1 Expansion – Peak Hour Demand Condition

Figures B-1 and B-2 illustrate all connection and upgrades required to connect all adjacent properties and the three small utility systems simultaneously.

6.1.1 ADJACENT PROPERTIES

Connections to adjacent properties were provided from existing watermains from the Lister water system where possible. Where existing watermains were not available for connection, watermains were extended along public road allowances to the adjacent properties, to avoid acquisition of ROWs. Where this results in the addition of dead end watermains, blow offs or standpipes should be provided to allow for regular flushing of the dead ends.

The available pressure criterion under the ADD and PHD scenarios are met for all adjacent properties requesting connection to the Lister System, except the lower lying area near Phillips Road and 38th Street, which will exceed the ADD maximum available pressure criteria of 120 psi or 827 kPa. The watermain servicing this area should be designed for higher pressures, and individual pressure reducing valves (PRV) can be installed at the service connections to limit service pressures at the property to acceptable pressures.

6.1.2 RYKERTS

The existing Rykerts water system can be connected to the Lister water system via two new 100 mm diameter watermains on Huscroft Road and Sinclair Road. An additional loop is proposed for Canyon-Lister Road in the existing Lister water system to avoid limitations arising from supplying the Rykerts system from a dead end watermain. The existing 50 mm watermains in the Rykerts system are proposed to be upsized to 100 mm to improve system capacity. Although upsizing the existing 75 mm watermains will also improve the capacity of the system, the relative improvements to the level of service provided are insignificant and not critical for the connection to the Lister water system. Upsizing these 75 mm watermains to 100 mm can be undertaken as watermains age and require replacement.

The available pressure criterion under the ADD scenario is met throughout the Rykerts system. Under the PHD scenario, the three properties on Canyon-Lister Road, south of 8th Street, do not meet the minimum pressure criterion of 40 psi due to limitations on the static head available from Lister Reservoir. Further upsizing watermains will only marginally improve the available pressure in this area. A kiosk style booster station can be installed on the 100 mm proposed connection from the Lister Water System on Huscroft Road to meet pressure under PHD.

Maintaining the existing Rykerts Reservoir has been proposed as a possible solution to provide the required static head or as a backup source; this is not a reliable long-term solution and will present operational challenges. The existing reservoir is not an engineered structure and does not meet current health standards. Additionally, constructing and maintaining a treatment system for this reservoir will have an added cost and operational requirement. Furthermore, there is no permanent power to the reservoir site, with the nearest power pole approximately 1.5 km away. Finally, there is limited access to the reservoir during the winter season and there have been incidents of vandalism at the site, presenting a risk to the integrity of the overall water supply.

6.1.3 ORDE CREEK

The existing Orde Creek water system can be connected to the Lister water system from the existing Lister watermain north of 32nd Street and 36th Street, via a new 200 mm watermain on Lloyd Road. Although watermains are typically recommended to be a minimum of 150 mm for dead ends, the existing 50 mm watermains do not require upsizing to supply the required demands. Upsizing these watermains can be undertaken as watermains age and require replacement.

The available pressure criterion under the ADD scenario is exceeded on the west side of the system, due to the lower lying topography. The watermain servicing this area should be designed for higher pressures, and individual PRVs can be installed on the service connections to limit service pressures at the properties to acceptable pressures. Alternatively, the community could consider installation of a PRV on the watermain supplying the area experiencing high pressures.

The PHD minimum pressure criterion of 40 psi is not met on the east side of the system, due to the static head available at this location. However, this deficiency is marginal for most of the properties, except the property east of Lloyd Road, allowing lower pressures may be acceptable to the users. Alternatively, the community could consider installation of a booster station to supply the area experiencing low pressures.

6.1.4 SOUTH CANYON

Due to limitations caused by topography, the South Canyon water system cannot be connected to the Lister water system with watermains within the public road allowance without introducing negative pressures to the system. The proposed connection is a 150 mm connection which transverses private lots west of the Samuelson Road; this alignment can be refined based on available ROW acquisition.

Due to the static head provided by the Lister Reservoir, the minimum pressure criterion of 40 psi under the PHD scenario cannot be met throughout the majority system (approximately 20 of the 36 properties), except for the properties on west side of the system on Canyon-Lister Road. The available pressure criterion under the ADD scenario is met throughout the system. A booster station would be required to supply the area experiencing low pressures.

6.2 OPTION 2A

The objective for Option 2A is to meet service pressure requirements under ADD and PHD, as well as fire flow requirements under the MDD scenario and relocate all watermains located within private properties to the public road allowance. Additional watermains are provided to service future developments.

Figures illustrating potential connections from the Lister water system under the Option 2A upgrade scenario, and incremental upgrades to meet the design criteria outlined in Section 4.4, are provided in Appendix C:

- Figure C-1: Option 2A Expansion – Average Day Demand Condition
- Figure C-2: Option 2A Expansion – Peak Hour Demand Condition
- Figure C-3: Option 2A Expansion – Maximum Day Demand + Fire Flow Condition
- Figure C-3A: Option 2A Expansion – Maximum Day Demand + Fire Flow Condition (0 psi minimal residual pressure)

Figures C-1 to C-3 illustrates all connection and upgrades required to connect all adjacent properties and the three small utility systems simultaneously.

6.2.1 ADJACENT PROPERTIES

Connections to adjacent properties were provided from existing watermains from the Lister water system where possible. Where existing watermains were not available for connection, watermains were extended along public road allowances to the adjacent properties.

Connecting the adjacent properties under the Option 2A upgraded system produces similar results as Option 1; refer to Section 6.1.1 for further details.

6.2.2 RYKERTS

The connection point and upgrades required to connect the existing Rykerts water system to the Lister water system under the Option 2A upgraded system is similar to that of Option 1; refer to Section 6.1.2 for further details.

The available pressure criterion under the ADD scenario is met throughout the Rykerts system. Under the PHD scenario, the properties on the southeast end of the system, at Canyon-Lister Road and 8th Street, do not meet the minimum pressure criterion of 40 psi or 276 kPa due to limitations on the static head supplied from the Lister Reservoir. Further upsizing watermains will only marginally improve the available pressure in this area. Only one property is serviced in this area; providing a small booster station for the watermain servicing the property experiencing low pressures may be a cost-effective method of increasing the available pressure to this property, if desired.

6.2.3 ORDE CREEK

The connection points and resulting available pressures in Orde Creek under the Option 2A upgraded system produces similar results as Option 1; refer to Section 6.1.3 for further details.

6.2.4 SOUTH CANYON

The connection points and resulting available pressures in South Canyon under the Option 2A upgraded system produces similar results as Option 1; refer to Section 6.1.4 for further details.

6.2.5 IMPACT ON AVAILABLE FIRE FLOWS IN LISTER

Although the expansion areas will not be supplied with fire flow demands, expanding the service boundaries will subject the expansion areas to the criterion of maintain a minimum residual pressure of 20 psi or 138 kPa during fire flow events, impacting the available fire flow for the main Lister water system. This will reduce the available fire flows in the system to as low as 5 L/s in the system (Figure C-3), as opposed to the 12 L/s that could previously be supplied through the Option 2A scenario[14].

Through an assessment coincident to a reduced level of service, in case of emergency, the water system can likely be drawn down to residual pressures of 0 psi to maintain minimum fire flows of approximately 30 L/s for the majority of the system (Figure C-3A).

[14] Lister Water System Assessment: Current Boundary, WSP, October 2019

7 SOURCE CAPACITY

The water system will be supplied from the existing groundwater well from the existing Lister water supply. A high-level groundwater supply review was conducted as part of the "Lister Water System Assessment: Current Boundary" report. The review indicated that the theoretical safe yield of the aquifer is 31.5 L/s (500 USGPM), limited by pump size and well diameter and the potential for drawdown from the adjacent spring. Based on the record drawings for the 250 mm production well, the drawdown level at a flow rate of 500 USGPM is 3.7 mbgs (metres below ground surface) or (12.13 ft). The well pump currently installed in the 250 mm production well is designed to operate at approximately 26.0 L/s (425 USGPM). The pump screen is set at 23.6 mbgs (77.4 ft) at an elevation of 677.0 m. Under typical operations, the water level in the well varies from 21.3m to 23.48m (70 to 77 ft) above the pump.

The existing and future maximum day demand, including the existing Lister water system and all expansion areas, is estimated to be 28.5 L/s and 29.8 L/s, respectively, which are both within the theoretical safe yield of the aquifer but exceeding the current pump capacity of 26.0 L/s. If the Lister Reservoir capacity exceeds the required storage volume, high demands that cannot be met by the well pump can be provided by the reservoir. Alternatively, if the storage volume cannot accommodate excess demands, the RDCK can investigate using upgrading the well pump to supply higher flows. Instantaneous demands in excess of the source capacity may be equalized by the storage volume provided by Lister Reservoir.

Staff at the RDCK have noted that during previous well pump testing, the creek level has dropped. Prior to adding additional services area to the water system, additional drawdown testing should be conducted to confirm source capacity.

Refer to Section 8 for discussion on the storage capacity of Lister Reservoir.

8 STORAGE CAPACITY

The Lister Reservoir provides equalization of demand fluctuations, emergency flows, and fire flows. The existing Lister Reservoir was sized to accommodate domestic demands from Lister, Rykerts and Orde Creek, with a total storage capacity of 885 m^3 (Phase 1 Summary Report: Groundwater Source Assessment for the Lister Water System, WSA Engineering Ltd., 2010).

The total required storage is calculated as the sum of Balancing Storage, Fire Storage, and Emergency Storage (2014 Design Guidelines for Rural Residential Community Water Systems), where:

- **Balancing Storage** = 0.25 day x MDD
- **Fire Storage** is determined in accordance to Fire Underwriters Survey (FUS) guidelines. The required storage for Fire Flow for houses constructed of brick or masonry, with exposure distances of greater than 45 metres is 120 m^3. It is understood that the majority of the buildings serviced by the Lister water system meet these characteristics.
- **Emergency Storage** = 0.25 x (Balancing Storage + Fire Storage)

Tables 8-1 and 8-2 show the required storage volume for existing and future demands respectively, should the service boundary be expanded to service the potential expansion areas and adjacent properties. The required storage under existing and future demands is approximately 420 m^3 and 454 m^3 respectively, less than the existing Lister Reservoir storage capacity. This illustrates further that from a storage capacity point-of-view, the system reservoir is able to support larger and higher fire requirement properties.

Table 8-1: Required Storage Volumes – Existing Demands

AREA	FIRE STORAGE (M3)	EQUALIZATION STORAGE (M3)	EMERGENCY STORAGE (M3)	**REQUIRED STORAGE (M3)**
Lister Water System	120 m^3	77 m^3	49 m^3	**246 m^3**
Adjacent Properties	0 m^3	16 m^3	4 m^3	**20 m^3**
Rykerts Irrigation District	0 m^3	38 m^3	9 m^3	**47 m^3**
Orde Creek Improvement District	0 m^3	31 m^3	8 m^3	**38 m^3**
South Canyon Improvement District	0 m^3	55 m^3	14 m^3	**69 m^3**
Total	**120 m^3**	**216 m^3**	**84 m^3**	**420 m^3**

Table 8-2: Required Storage Volumes – Future Demands

AREA	FIRE STORAGE (M3)	EQUALIZATION STORAGE (M3)	EMERGENCY STORAGE (M3)	**REQUIRED STORAGE (M3)**
Lister Water System	120 m^3	98 m^3	55 m^3	**273 m^3**
Adjacent Properties	0 m^3	16 m^3	4 m^3	**20 m^3**
Rykerts Irrigation District	0 m^3	44 m^3	11 m^3	**55 m^3**
Orde Creek Improvement District	0 m^3	31 m^3	8 m^3	**38 m^3**
South Canyon Improvement District	0 m^3	55 m^3	14 m^3	**69 m^3**
Total	**120 m^3**	**243 m^3**	**91 m^3**	**454 m^3**

9 COST ESTIMATES

Class D cost estimates for connecting the adjacent properties and all three expansion areas to the Lister water system are shown in Table 9-1. The cost of the required upgrades and new watermains required for each system is shown separately. The base cost of the upgrades recommended as part of "Lister Water System Assessment: Current Boundary" (Option 1 and 2A) are not included in the costs below.

Table 9-1: Cost Estimate Summary

Watermain Upgrade Option	Construction	Engineering	Contingency	Total	Number of Future Connections	Cost per Connection
Option 1						
Adjacent Properties	$4,702,250	$705,338	$2,351,125	**$7,758,713**	29	$267,542
Rykerts Irrigation District	$2,268,750	$340,313	$1,134,375	**$3,743,438**	40	$93,586
Orde Creek Improvement District	$869,625	$130,444	$434,813	**$1,434,881**	22	$65,222
Orde Creek (Alternative Options)						
Shared Costs w/ South Canyon	*-$282,000*	*-$42,300*	*-$141,000*	*-$465,300*		
Community PRV Station	*$22,000*	*$3,300*	*$11,000*	*$36,300*		
Aboveground Reservoir (38 m3)	*$485,000*	*$72,750*	*$242,500*	*$800,250*		
South Canyon Improvement District	$1,537,845	$230,677	$768,923	**$2,537,444**	36	$70,485
South Canyon (Alternative Options)						
Shared Cost w/ Orde Creek	*-$282,000*	*-$42,300*	*-$141,000*	*-$465,300*		
Aboveground Reservoir (69 m3)	*$507,000*	*$76,050*	*$253,500*	*$836,550*		
Total Under Option 1 Upgrade Scenario (Excluding Alternative Options):				**$15,474,476**	127	$121,846
Option 1 Base Upgrade Costs				**$5,808,000**		
Grand Total				**$21,282,476**		
Option 2A						
Adjacent Properties	$3,539,750	$530,963	$1,769,875	**$5,840,588**	29	$201,400
Rykerts Irrigation District	$1,481,250	$222,188	$740,625	**$2,444,063**	40	$61,102
Orde Creek Improvement District	$564,000	$84,600	$282,000	**$930,600**	22	$42,300
Orde Creek (Alternative Options)						
Shared Costs w/ South Canyon	-$282,000	-$42,300	-$141,000	**-$465,300**		
Community PRV Station	*$22,000*	*$3,300*	*$11,000*	*$36,300*		
Aboveground Reservoir (38 m3)	*$485,000*	*$72,750*	*$242,500*	*$800,250*		
South Canyon Improvement District	$1,537,845	$230,677	$768,923	**$2,537,444**	36	$70,485
South Canyon (Alternative Options)						
Shared Cost w/ Orde Creek	-$282,000	-$42,300	-$141,000	**-$465,300**		
Aboveground Reservoir (69 m3)	*$507,000*	*$76,050*	*$253,500*	*$836,550*		
Total Under Option 2A Upgrade Scenario (Excluding Alternative Options):				**$11,752,694**	127	$92,541
Option 2A Base Upgrade Costs				**$15,724,500**		
Grand Total				**$27,477,194**		

Notes and Assumptions:

- After completing connections to the adjacent properties, the estimates above assume each connection to the expansion areas is undertaken separately. If Orde Creek and South Canyon both choose to connect, there is approximately 0.6 km of transmission main and a booster station that is common to both connections that can be shared between the two districts; this infrastructure is assumed to be split equally between the two districts under the Optional Item for the shared costs.
- The unit costs were developed from costs in similar projects within the RDCK and are in 2019 Dollars.
- Individual PRVs should be provided for connections in areas with available pressures exceeding 75 psi are seen on the frontage watermain; this is not shown separately in the cost estimate. Alternatively, there are Alternative Options provided above for a community PRV.
- Unless otherwise specified, new watermains will be installed within the road ROW, significantly increasing the cost of construction due to the cost of road restoration. The cost of construction can be reduced if the watermain can be constructed outside the road ROW. However, there are limitations construction outside of the road ROW due to conflicts with power poles and ditches. Alternatively, directional drilling can be considered to avoid the cost of road works.
- Costs for statutory right of way plans assume an explanatory plan would be feasible where the watermain parallels an existing legal boundary. Posting and reference plans will be required for other configurations.
- Costs for 6.0 m wide rights of way are included for the sections of existing and proposed watermain upgrades located on private property.
- The upgrade costs do not include the cost of providing services connections for future properties; only the cost of providing services to existing properties or re-instating existing service connections is included.
- Cross contamination control and disinfection may be required prior to connecting expansion areas to the Lister water system; these costs are not included.
- Costs only include the capital cost of construction, and do not consider the ongoing cost of operations and maintenance nor consumption.
- Engineering costs are estimated at 15% of construction costs. Actual engineering costs are subject to vary in percentage up or down, dependent on the size of the project. https://www.egbc.ca/getmedia/308d2e85-4d1d-4a1e-99f5-e1ed5485778f/Budget-Guidelines-for-Consulting-Engineering-Services-2009.pdf.aspx

The cost of connecting the expansion areas under the Option 2A upgrade scenario is approximately 23% lower than the cost of connections under Option 1, due to the improved level of service provided by Option 2A and availability of nearby connections. However, the RDCK would have spent more money initially to bring the water system to be constructed to Option 2A standards. A comparison of the overall costs is made in the following section of this report.

The average cost per connection is relatively high, due to the distances between the expansion areas and the existing system, and the low density in the expansion areas.

Detailed cost estimates are provided in Appendix D.

10 SUMMARY AND CONCLUSION

Rykerts Irrigation District, Orde Creek Improvement District and South Canyon District currently operate small water systems immediately adjacent to the Lister water system service boundary. These systems are under long-term Boil Water Advisories and face ongoing challenges maintaining the systems. There are also concerns on the reliability of the water sources. As such, the RDCK is exploring the feasibility of connecting these systems to the Lister water system. In addition, 31 additional properties adjacent to the utility, currently serviced by private water systems, have also requested connection the Lister water system.

Potential connections to Lister water system upgrade Options 1 and 2A (developed in the "Lister Water System Assessment: Current Boundary" report) were modelled. Due to topography and the static head supplied by the Lister Reservoir, it is not possible to meet minimum and maximum available pressure criteria for all areas within the expansion areas. In areas where minimum pressure criterion cannot be met, a booster station or constructing a reservoir can be provided to meet minimum pressure requirements. In particular, properties in the southeastern area of Rykerts, eastern area of Orde Creek, and the majority of South Canyon do not meet minimum available pressure criterion under PHD; and properties on the western side of Orde Creek and South Canyon exceed maximum pressure criterion under ADD. In areas that exceed maximum pressure, local PRVs can be supplied on the service connections or a community PRV can be constructed on the watermain to regulate the pressure to acceptable service pressures for residential use. Providing additional reservoirs may not be feasible for these systems due to challenges with topography and land acquisition. Both options would require more costly construction requirements and increase the cost of ongoing operations and maintenance of the water systems.

The groundwater well supplying the Lister water system has a theoretical safe yield of 31.5 L/s ("Lister Water System Assessment: Current Boundary" report) and is able to meet the future maximum day demand of 29.8 L/s, should all the expansion areas be connected to the Lister water system. However, staff at the RDCK have indicated that during previous well pump testing, the creek level has dropped. Prior to adding additional services area to the water system, additional drawdown testing should be conducted to confirm source capacity.

The current operating point of the well pump is 26.0 L/s and cannot meet the future maximum day demand. The excess storage capacity will likely be able to provide equalization of these flows. The Lister Reservoir was sized to accommodate domestic demands from Lister, Rykerts, and Orde Creek, with a total storage capacity of 885 m^3. This reservoir can accommodate the estimated future storage requirement of approximately 454 m^3.

The service areas outside of the existing Lister Water System are currently under long-term boil water advisories. If connecting the Lister Water System, disinfection of the existing systems should be considered to mitigate the risk of cross-contaminating the Lister Water System. Conversely, if the individual systems remain separate, the RDCK will need to monitor commitment to the ongoing Boil Water Advisories or obtaining treatment systems that will comply with Interior Health requirements.

Class D cost estimates were developed for separate connection requirements for each separate system. There may be opportunities to reduce these costs by sharing the construction costs of common upgrade requirements between the systems. The cost of connecting from Option 2A is approximately 23% lower than the cost of connections under Option 1, due to the improved level of service provided and closer watermain proximity provided by Option 2A. However, the RDCK would have spent more money initially to bring the water system to be constructed to Option 2A standards. When the cost of the initial upgrades is considered in the cost of connecting, the Option 1 is approximately 22% less than Option 2A.

Ultimately, the incremental cost from Option 1 to Option 2A would be due to the fire protection available from Option 2A in Lister.

Summaries of the estimated costs are presented in the tables below:

Table 10-1: Cost Estimate Summary

Description	**Total**
Costs Under Option 1	
Cost to Upgrade System to Option 1:	$5,808,000
Cost to Connect to Upgraded System:	$15,474,476
Total:	**$21,282,476**
Costs Under Option 2A	
Cost to Upgrade System to Option 2A:	$15,724,500
Cost to Connect to Upgraded System:	$11,752,694
Total:	**$27,477,194**

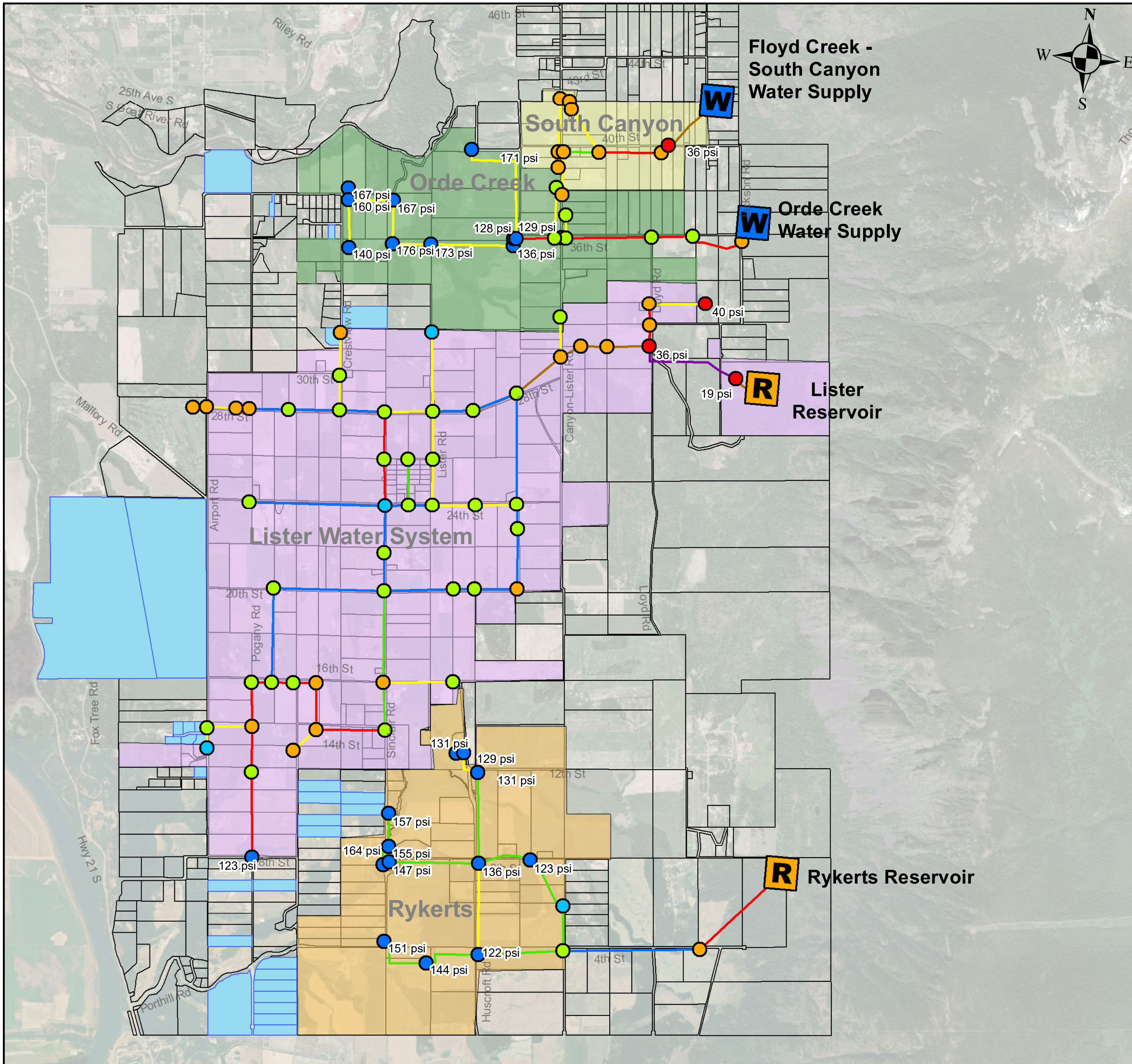
Table 10-2: Cost Estimate Summary with Alternative Options

Watermain Upgrade Option	Construction	Engineering	Contingency	Total	Number of Future Connections	Cost per Connection
Option 1						
Adjacent Properties	$4,702,250	$705,338	$2,351,125	**$7,758,713**	29	$267,542
Rykerts Irrigation District	$2,268,750	$340,313	$1,134,375	**$3,743,438**	40	$93,586
Orde Creek Improvement District	$869,625	$130,444	$434,813	**$1,434,881**	22	$65,222
Orde Creek (Alternative Options)						
Shared Costs w/ South Canyon	*-$282,000*	*-$42,300*	*-$141,000*	*-$465,300*		
Community PRV Station	*$22,000*	*$3,300*	*$11,000*	*$36,300*		
Aboveground Reservoir (38 m3)	*$485,000*	*$72,750*	*$242,500*	*$800,250*		
South Canyon Improvement District	$1,537,845	$230,677	$768,923	**$2,537,444**	36	$70,485
South Canyon (Alternative Options)						
Shared Cost w/ Orde Creek	*-$282,000*	*-$42,300*	*-$141,000*	*-$465,300*		
Aboveground Reservoir (69 m3)	*$507,000*	*$76,050*	*$253,500*	*$836,550*		
Total Under Option 1 Upgrade Scenario (Excluding Alternative Options):				**$15,474,476**	127	$121,846
Option 1 Base Upgrade Costs				**$5,808,000**		
Grand Total				**$21,282,476**		
Option 2A						
Adjacent Properties	$3,539,750	$530,963	$1,769,875	**$5,840,588**	29	$201,400
Rykerts Irrigation District	$1,481,250	$222,188	$740,625	**$2,444,063**	40	$61,102
Orde Creek Improvement District	$564,000	$84,600	$282,000	**$930,600**	22	$42,300
Orde Creek (Alternative Options)						
Shared Costs w/ South Canyon	-$282,000	-$42,300	-$141,000	**-$465,300**		
Community PRV Station	*$22,000*	*$3,300*	*$11,000*	*$36,300*		
Aboveground Reservoir (38 m3)	*$485,000*	*$72,750*	*$242,500*	*$800,250*		
South Canyon Improvement District	$1,537,845	$230,677	$768,923	**$2,537,444**	36	$70,485
South Canyon (Alternative Options)						
Shared Cost w/ Orde Creek	-$282,000	-$42,300	-$141,000	**-$465,300**		
Aboveground Reservoir (69 m3)	*$507,000*	*$76,050*	*$253,500*	*$836,550*		
Total Under Option 2A Upgrade Scenario (Excluding Alternative Options):				**$11,752,694**	127	$92,541
Option 2A Base Upgrade Costs				**$15,724,500**		
Grand Total				**$27,477,194**		

APPENDIX

A

Existing System | Water Modelling Figures



Legend

Area

- Lister Water System
- Orde Creek
- Rykerts
- South Canyon
- Adjacent Properties

Model Elements

- R Reservoir
- W Water Source

Average Day Demand (ADD)

Pressure

- <= 40 psi
- 40 psi - 80 psi
- 80 psi -100 psi
- 100 psi - 120 psi
- >= 120 psi

Existing Watermains

Diameter (mm)

- 50
- 75
- 100
- 150
- 200
- 250

Notes and Limitations:
1. No updates have been made to the diameters, or C-factors in the EPANET model provided by RDCK. (May 2019)
2. The elevations for all watermains, gravity intakes, and reservoirs (except for the Lister Reservoir) are estimated using LIDAR data provided by RDCK on July 24, 2019
3. The model has not been calibrated.

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CLIENT: Regional District Central Kootenay

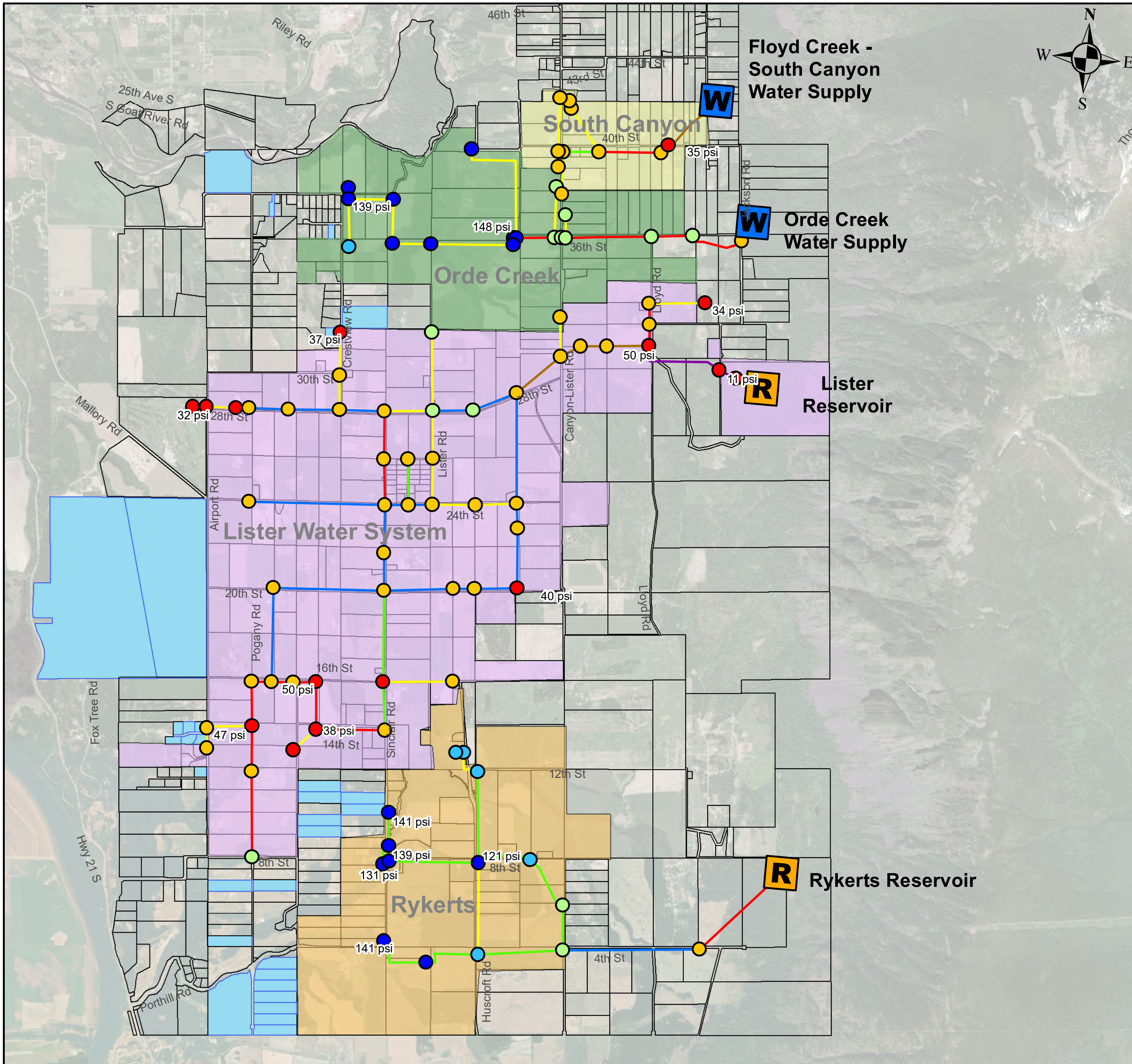
FIGURE A-1

EXISTING SYSTEMS AVERAGE DAY DEMAND CONDITION

Scale: 1:50,000 @ Letter
0 600 1,200
Meters

Project No.: 181-15710-01
Date: August 2019
Drawn: KK
Approved: SW/CL

Path: G:\opus_dk\municipal\Regional District of Columbia Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files\Figure A-1 Existing ADD.mxd



Legend

Area

- Lister Water System
- Orde Creek
- Rykerts
- South Canyon
- Adjacent Properties

Model Elements

- R Reservoir
- W Water Source

Peak Hour Demand (PHD)

Pressure

- < = 40 psi
- 40 psi - 80 psi
- 80 psi - 100 psi
- 100 psi - 120 psi
- > = 120 psi

Existing Watermains

Diameter (mm)

- 50
- 75
- 100
- 150
- 200
- 250

Notes and Limitations:
1. No updates have been made to the diameters, or C-factors in the EPANET model provided by RDCK. (May 2019)
2. The elevations for all watermains, gravity intakes, and reservoirs (except for the Lister Reservoir) are estimated using LIDAR data provided by RDCK on July 24, 2019
3. The model has not been calibrated.

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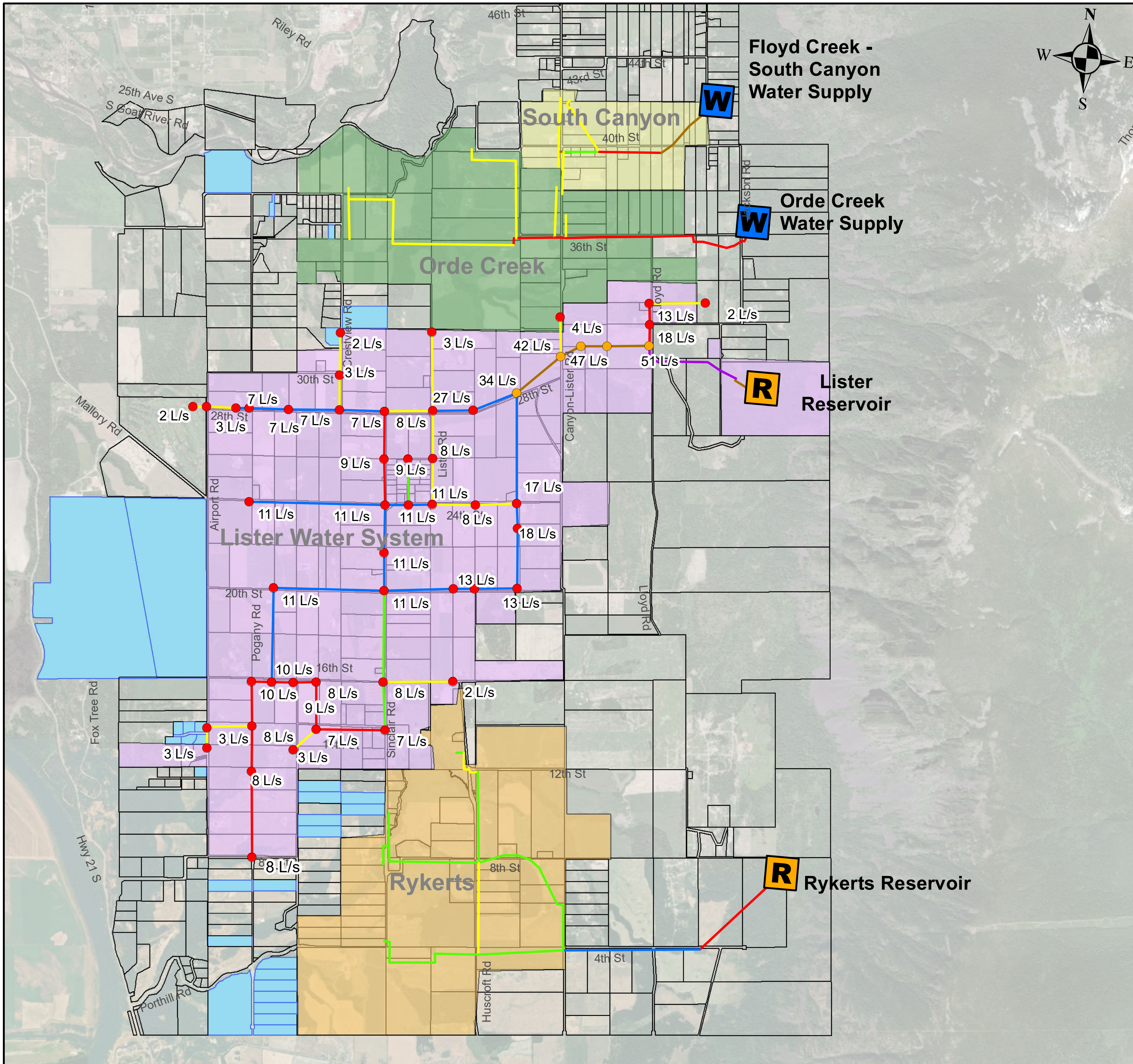
FIGURE A-2

EXISTING SYSTEMS
PEAK HOUR DEMAND CONDITION

Scale: 1:50,000 @ Letter
0 600 1,200
Meters

Project No.: 181-15710-01
Date: August 2019
Drawn: KK
Approved: SW/CL

Path: G:\opus_dk\municipal\Regional District of Columbia Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files\Figure A-2 Existing PHD.mxd



Legend

Area

- Lister Water System
- Orde Creek
- Rykerts
- South Canyon
- Adjacent Properties

Model Elements

- R — Reservoir
- W — Water Source

Available Fire Flow (MDD+FF)

Available Fire Flow

- FF < 33 L/s
- 33 L/s < FF < 60 L/s

Existing Watermains

Diameter (mm)

- 50
- 75
- 100
- 150
- 200
- 250

Notes and Limitations:
1. No updates have been made to the diameters, or C-factors in the EPANET model provided by RDCK. (May 2019)
2. The elevations for all watermains, gravity intakes, and reservoirs (except for the Lister Reservoir) are estimated using LIDAR data provided by RDCK on July 24, 2019
3. The model has not been calibrated.

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CLIENT: Regional District Central Kootenay

FIGURE A-3

EXISTING SYSTEMS- AVAILABLE FIRE FLOWS COINCIDENT TO MAXIMUM DAY DEMAND CONDITION

Scale: 1:50,000 @ Letter

0 600 1,200 Meters

Project No.: 181-15710-01

Date: August 2019

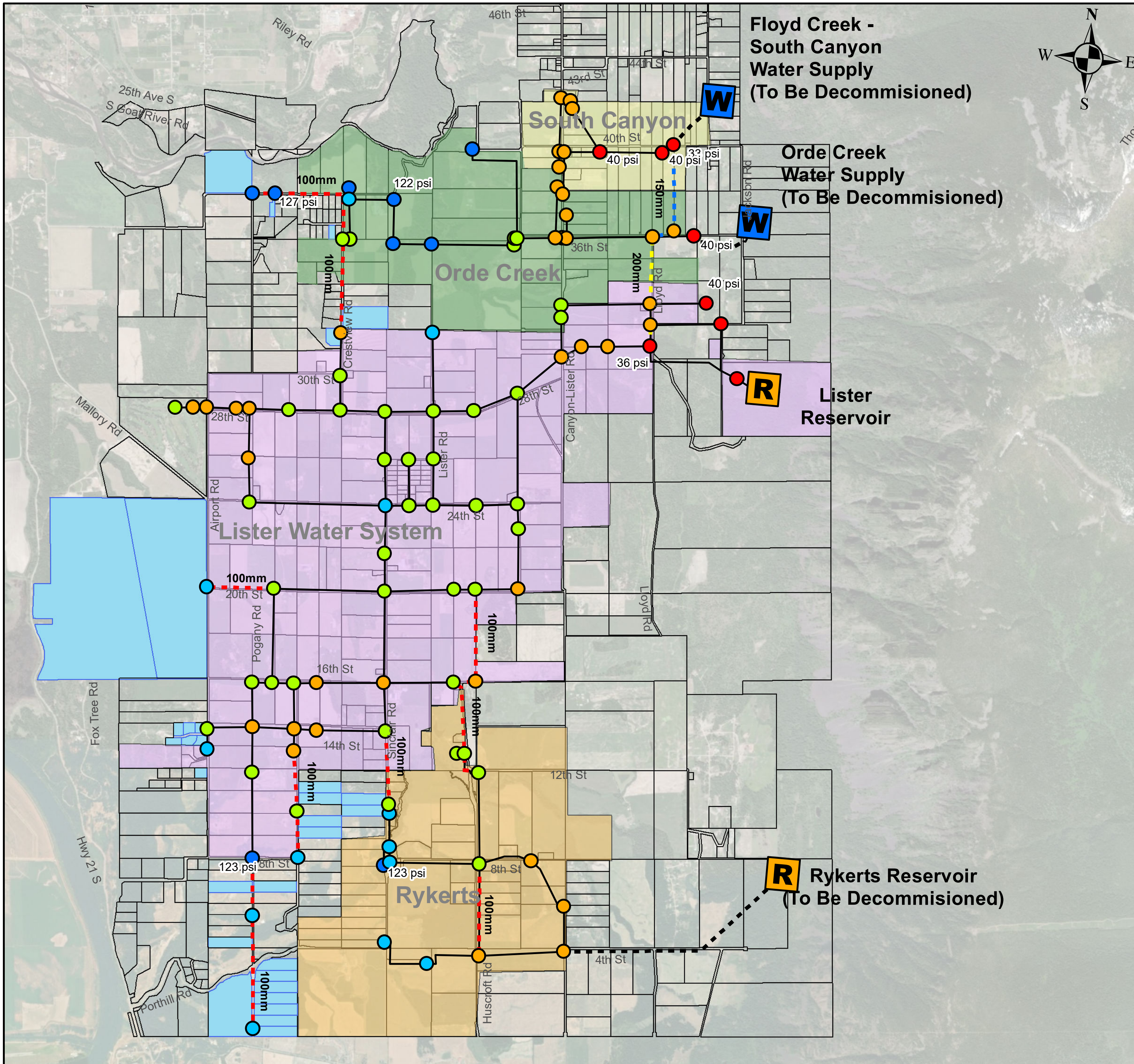
Drawn: KK

Approved: SW/CL

APPENDIX

B

Proposed System Option 1 | Water Modelling Figures



Legend

Area

- Lister Water System
- Orde Creek
- Rykerts
- South Canyon
- Adjacent Properties

Model Elements

- R Reservoir
- W Water Source

Average Day Demand (ADD)

Pressure

- <= 40 psi
- 40 psi - 80 psi
- 80 psi -100 psi
- 100 psi - 120 psi
- >= 120 psi
- Option 1 Existing Watermains
- Decommisioned Watermains

Proposed Watermains

Diameter (mm)

- 100
- 150
- 200

Notes and Limitations:
1. No updates have been made to the diameters, or C-factors in the EPANET model provided by RDCK. (May 2019)
2. The elevations for all watermains, gravity intakes, and reservoirs (except for the Lister Reservoir) are estimated using LIDAR data provided by RDCK on July 24, 2019
3. The model has not been calibrated.

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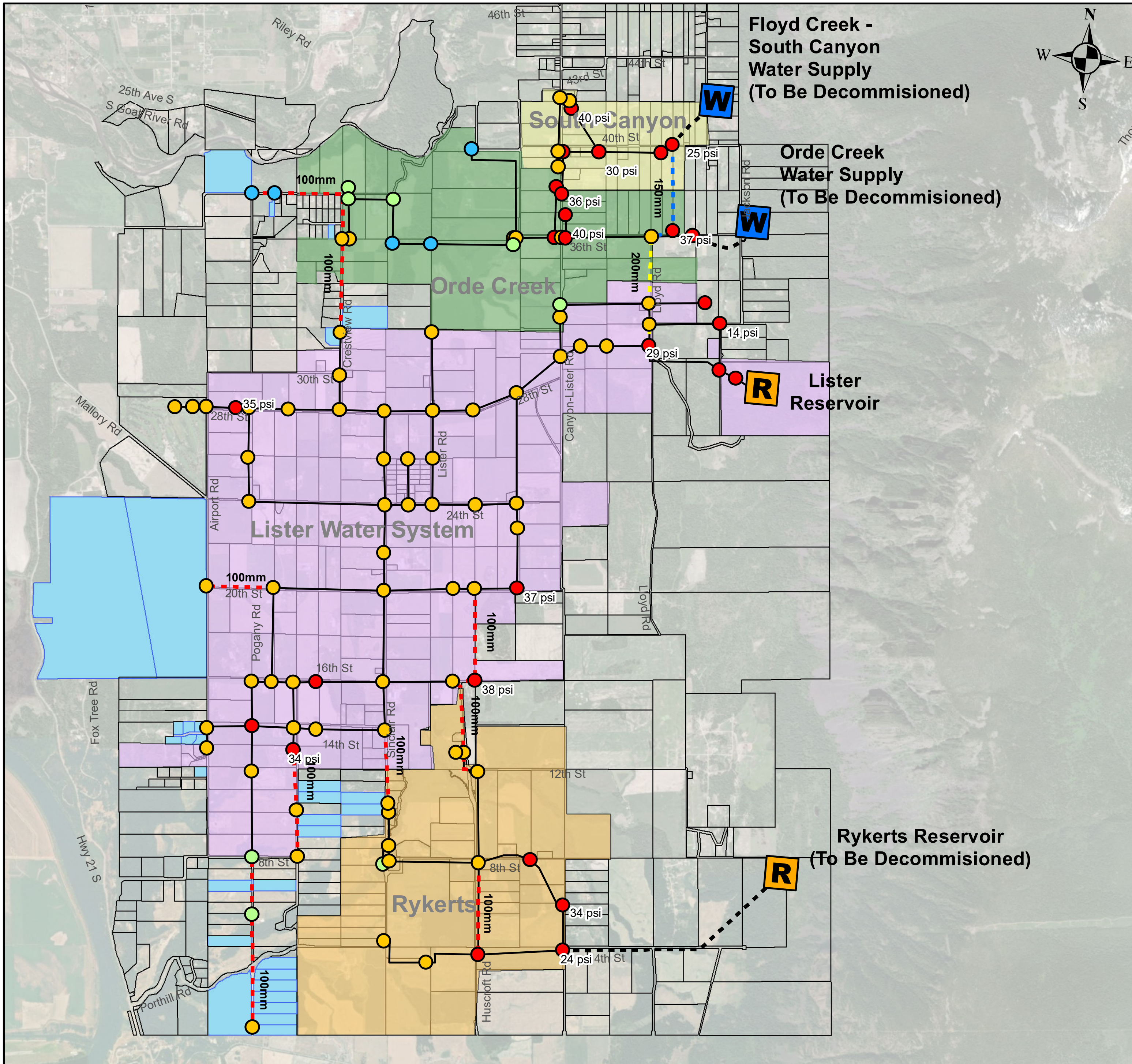
FIGURE B-1

OPTION 1 EXPANSION AVERAGE DAY DEMAND CONDITION

Scale:	1:50,000 @ Letter (0, 600, 1,200 Meters)
Project No.:	181-15710-01
Date:	August 2019
Drawn:	KK
Approved:	SW/CL

Path: G:\opus_dk\municipal\Regional District of Columbia Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files\Figure B-1 Expansion to include All Systems(ADD).mxd



Legend

Area

- Lister Water System
- Orde Creek
- Rykerts
- South Canyon
- Adjacent Properties

Model Elements

- R Reservoir
- W Water Source

Peak Hour Demand (PHD)

Pressure

- <= 40 psi
- 40 psi - 80 psi
- 80 psi - 100 psi
- 100 psi - 120 psi
- Option 1 Existing Watermains
- Decommisioned Watermains

Proposed Watermains

Diameter (mm)

- 100
- 150
- 200

Notes and Limitations:
1. No updates have been made to the diameters, or C-factors in the EPANET model provided by RDCK. (May 2019)
2. The elevations for all watermains, gravity intakes, and reservoirs (except for the Lister Reservoir) are estimated using LIDAR data provided by RDCK on July 24, 2019
3. The model has not been calibrated.

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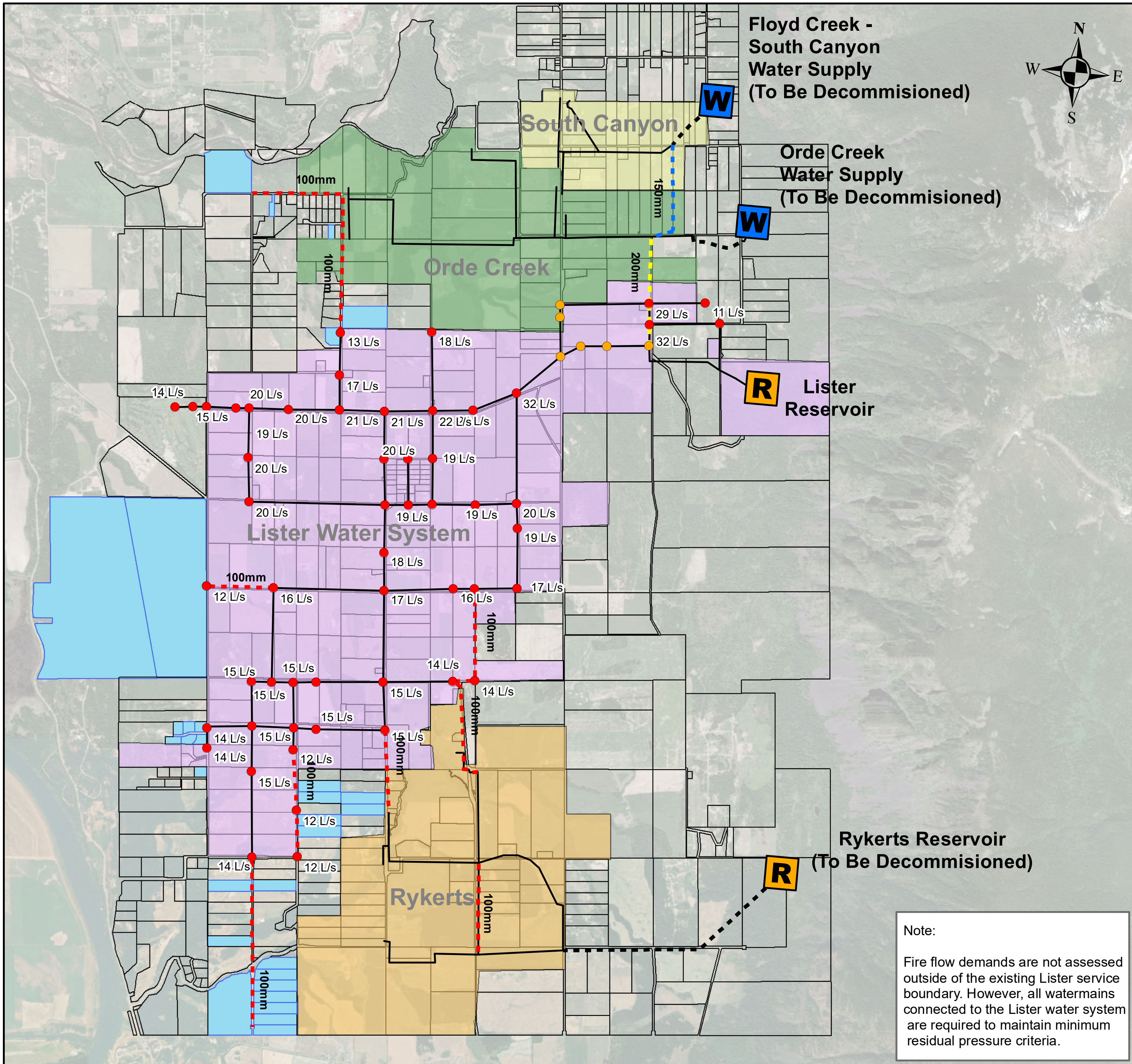
CLIENT: Regional District Central Kootenay

FIGURE B-2
OPTION 1 EXPANSION
PEAK HOUR DEMAND CONDITION

Scale:	1:50,000 @ Letter (0 – 600 – 1,200 Meters)
Project No.:	181-15710-01
Date:	August 2019
Drawn:	KK
Approved:	SW/CL

Path: G:\opus_dk\municipal\Regional District of Columbia Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files\Figure B-2 Expansion to include All Systems(PHD).mxd



Legend

Area

- Lister Water System
- Orde Creek
- Rykerts
- South Canyon
- Adjacent Properties

Model Elements

- R — Reservoir
- W — Water Source

Available Fire Flow (MDD+FF)

Available Fire Flow

- FF < 33 L/s
- 33 L/s < FF < 60 L/s
- Option 1 Existing Watermains
- Decommisioned Watermains

Proposed Watermains

Diameter (mm)

- 100
- 150
- 200

Notes and Limitations:
1. No updates have been made to the diameters, or C-factors in the EPANET model provided by RDCK. (May 2019)
2. The elevations for all watermains, gravity intakes, and reservoirs (except for the Lister Reservoir) are estimated using LIDAR data provided by RDCK on July 24, 2019
3. The model has not been calibrated.

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CLIENT: Regional District Central Kootenay

FIGURE B-3

OPTION 1 EXPANSION
AVAILABLE FIRE FLOWS COINCIDENT
TO MAXIMUM DAY DEMAND CONDITION

Scale:	1:50,000 @ Letter
Project No.:	181-15710-01
Date:	August 2019
Drawn:	KK
Approved:	SW/CL

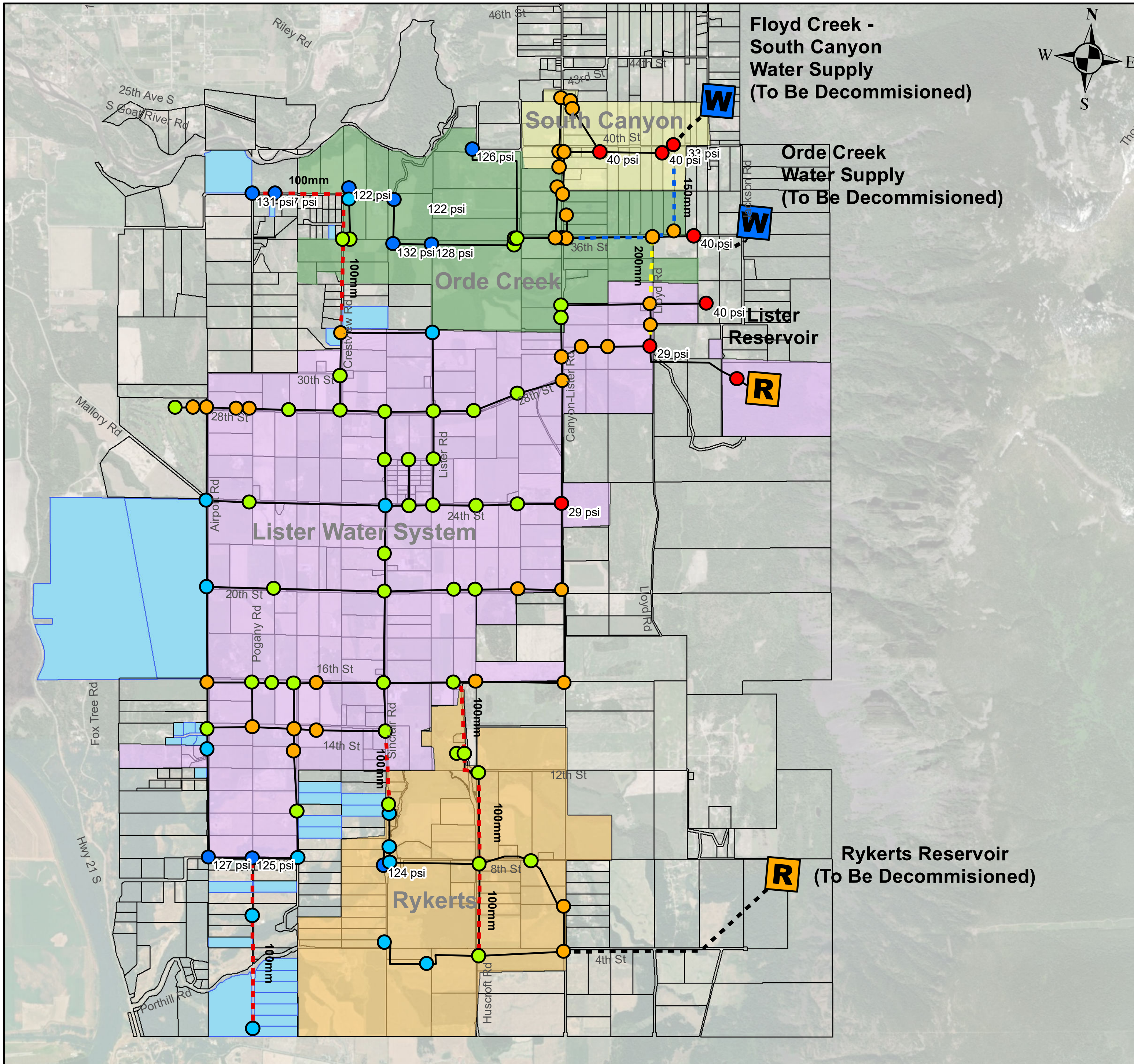
0 600 1,200 Meters

Path: G:\opus_dk\municipal\Regional District of Columbia Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files\Figure B-3 Expansion to include All Systems(MDD+FF).mxd

APPENDIX

C

Proposed System Option 2A | Water Modelling Figures



Legend

Area

- Lister Water System
- Orde Creek
- Rykerts
- South Canyon
- Adjacent Properties

Model Elements

- R Reservoir
- W Water Source

Average Day Demand (ADD)

Pressure

- <= 40 psi
- 40 psi - 80 psi
- 80 psi -100 psi
- 100 psi - 120 psi
- >= 120 psi
- Option 2A Watermains
- Decommisioned Watermains

Proposed Watermains

Diameter (mm)

- 100
- 150
- 200

Notes and Limitations:
1. No updates have been made to the diameters, or C-factors in the EPANET model provided by RDCK. (May 2019)
2. The elevations for all watermains, gravity intakes, and reservoirs (except for the Lister Reservoir) are estimated using LIDAR data provided by RDCK on July 24, 2019
3. The model has not been calibrated.

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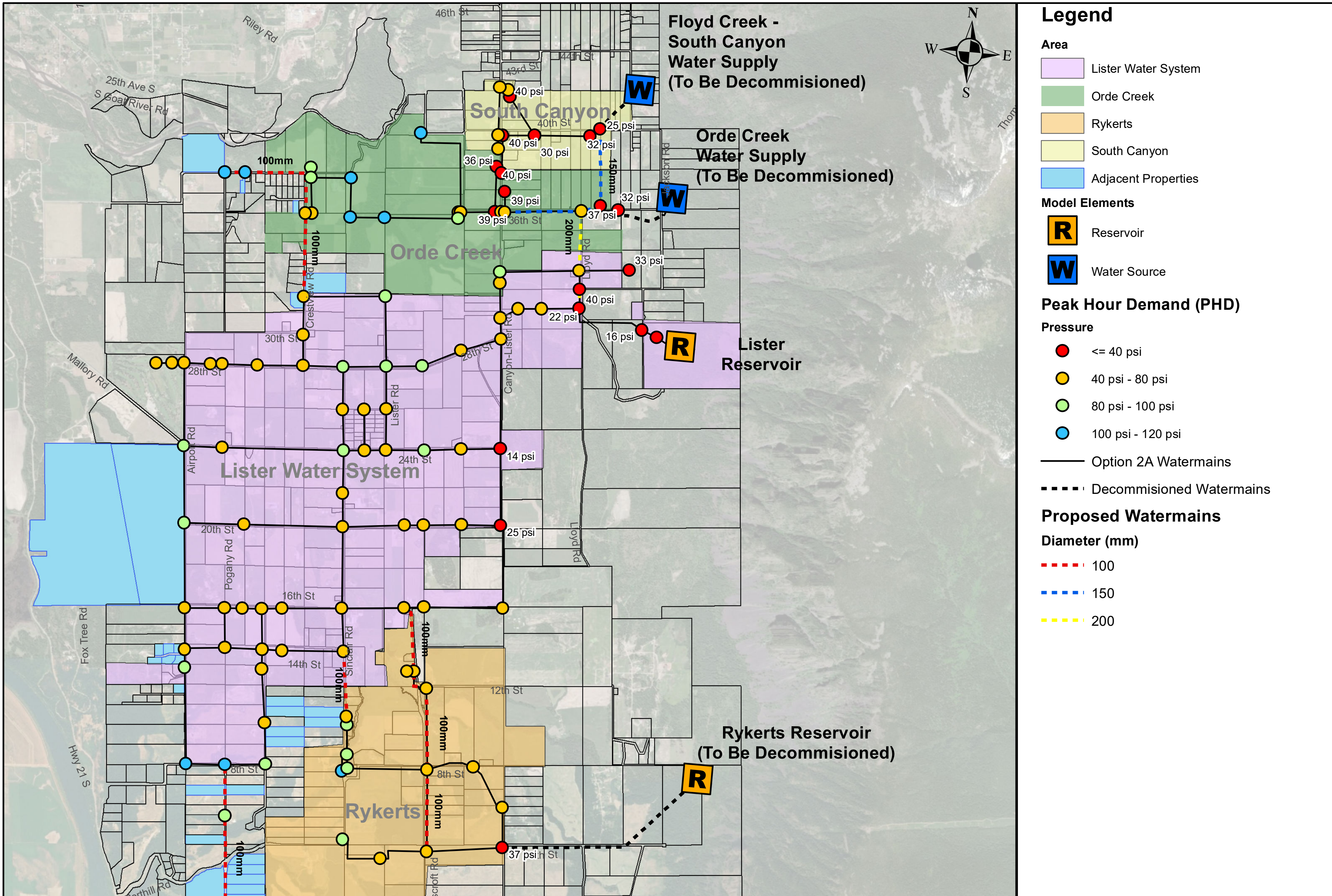
CLIENT: Regional District Central Kootenay

FIGURE C-1
OPTION 2A EXPANSION
AVERAGE DAY DEMAND CONDITION

Scale: 1:50,000 @ Letter
0 600 1,200
Meters

Project No.: 181-15710-01
Date: August 2019
Drawn: KK
Approved: SW/CL



Notes and Limitations:
1. No updates have been made to the diameters, or C-factors in the EPANET model provided by RDCK. (May 2019)
2. The elevations for all watermains, gravity intakes, and reservoirs (except for the Lister Reservoir) are estimated using LIDAR data provided by RDCK on July 24, 2019
3. The model has not been calibrated.

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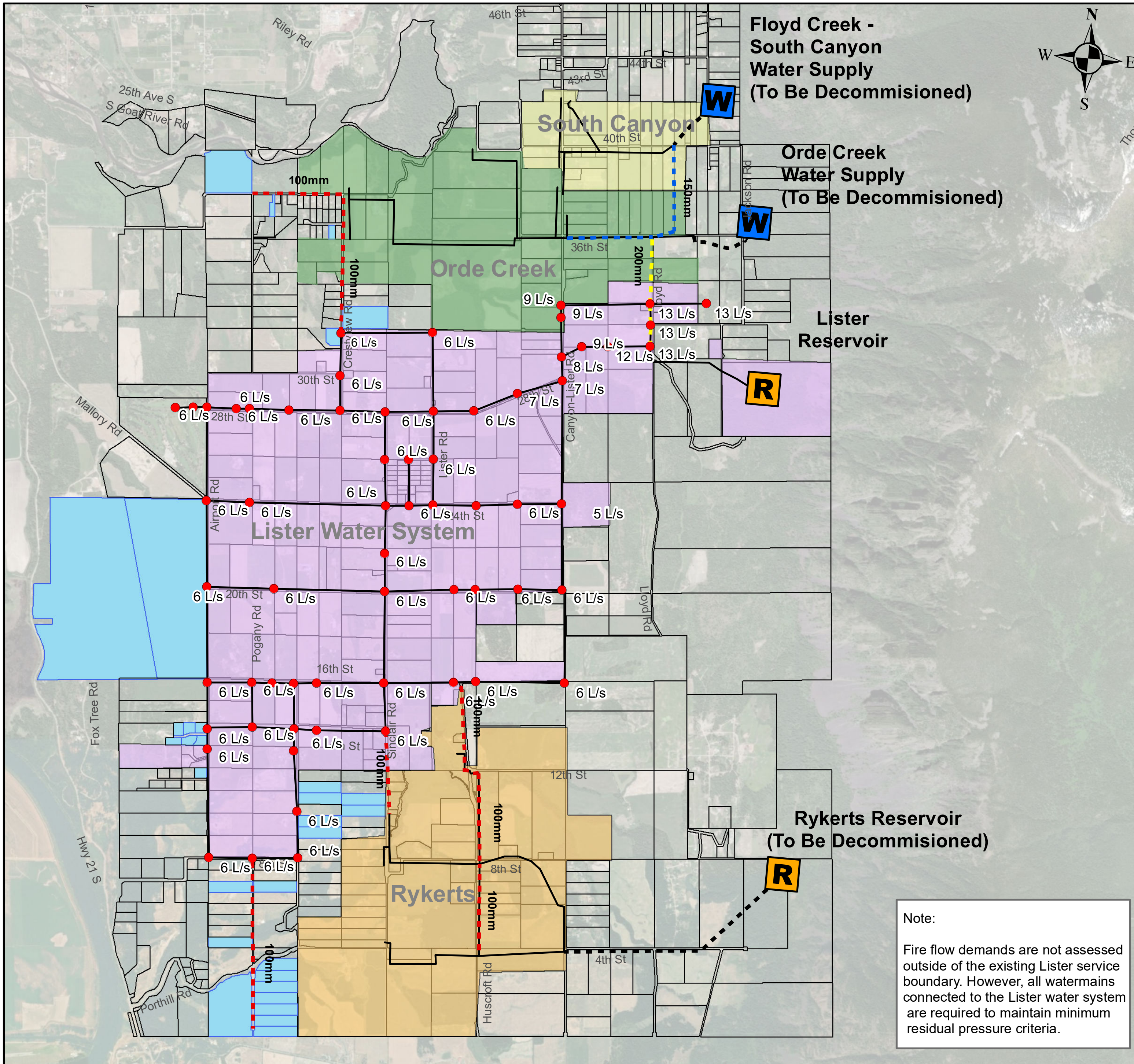
FIGURE C-2

OPTION 2A EXPANSION
PEAK HOUR DEMAND CONDITION

Scale: 1:50,000 @ Letter
0 600 1,200
Meters

Project No.: 181-15710-01
Date: August 2019
Drawn: KK
Approved: SW/CL



Legend

Area

- Lister Water System
- Orde Creek
- Rykerts
- South Canyon
- Adjacent Properties

Model Elements

- R Reservoir
- W Water Source

Available Fire Flow (MDD+FF)

Available Fire Flow

- FF < 33 L/s
- Option 2A Watermains
- Decommisioned Watermains

Proposed Watermains

Diameter (mm)

- 100
- 150
- 200

Notes and Limitations:
1. No updates have been made to the diameters, or C-factors in the EPANET model provided by RDCK. (May 2019)
2. The elevations for all watermains, gravity intakes, and reservoirs (except for the Lister Reservoir) are estimated using LIDAR data provided by RDCK on July 24, 2019
3. The model has not been calibrated.

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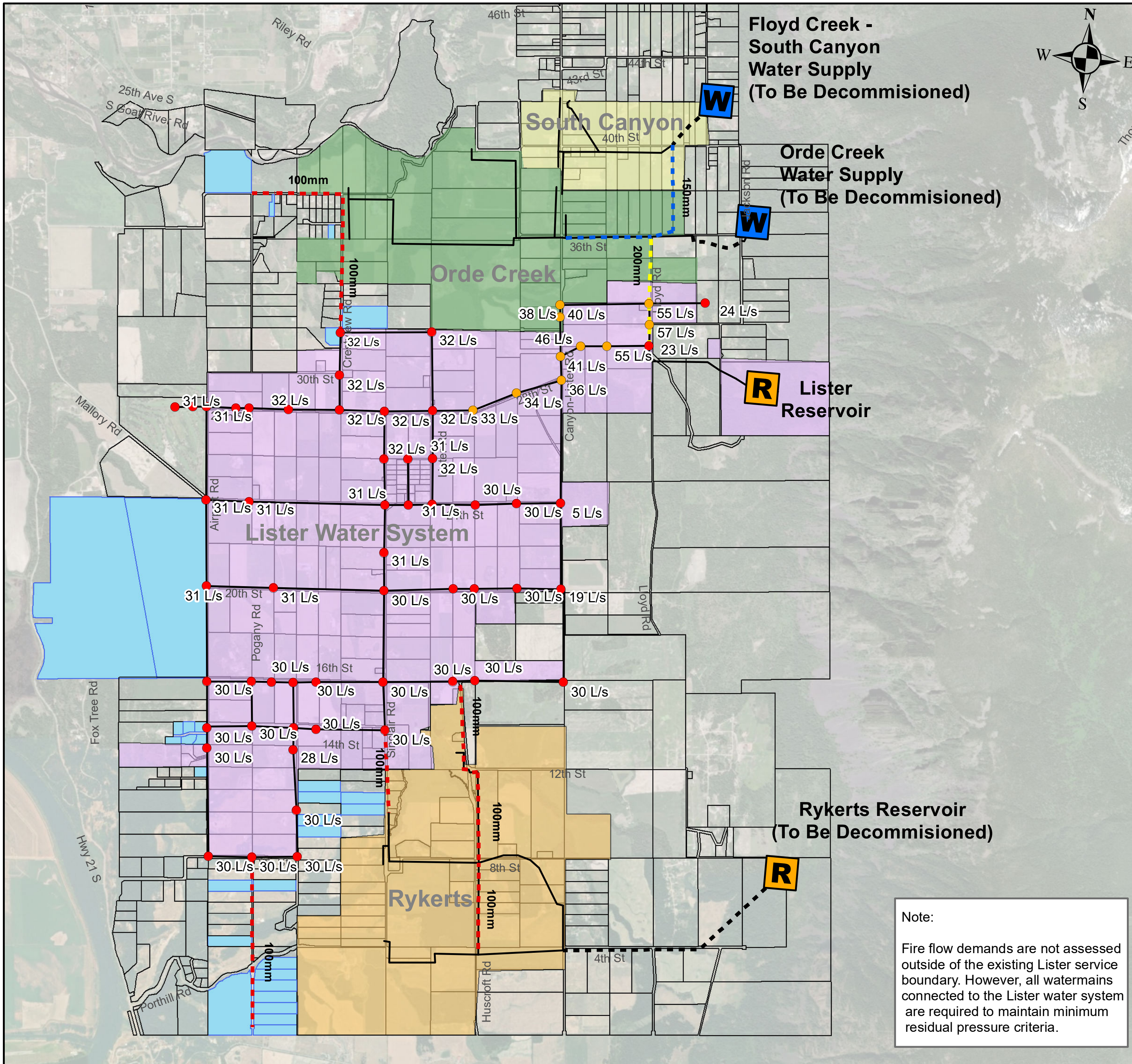
CLIENT: Regional District Central Kootenay

FIGURE C-3
OPTION 2A EXPANSION
AVAILABLE FIRE FLOWS COINCIDENT TO MAXIMUM DAY DEMAND CONDITION

Scale: 1:50,000 @ Letter
0 600 1,200
Meters

Project No.: 181-15710-01
Date: August 2019
Drawn: KK
Approved: SW/CL



Legend

Area

- Lister Water System
- Orde Creek
- Rykerts
- South Canyon
- Adjacent Properties

Model Elements

- R Reservoir
- W Water Source

Available Fire Flow (MDD+FF)

Available Fire Flow

- FF < 33 L/s
- 33 L/s < FF < 60 L/s
- Option 2A Watermains
- Decommisioned Watermains

Proposed Watermains

Diameter (mm)

- 100
- 150
- 200

Notes and Limitations:
1. No updates have been made to the diameters, or C-factors in the EPANET model provided by RDCK. (May 2019)
2. The elevations for all watermains, gravity intakes, and reservoirs (except for the Lister Reservoir) are estimated using LIDAR data provided by RDCK on July 24, 2019
3. The model has not been calibrated.

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CLIENT: Regional District Central Kootenay

FIGURE C-3A

OPTION 2A EXPANSION AVAILABLE FIRE FLOWS COINCIDENT TO MAXIMUM DAY DEMAND CONDITION (0 PSI MINIMAL RESIDUAL PRESSURE)

Scale: 1:50,000 @ Letter
0 600 1,200 Meters

Project No.: 181-15710-01
Date: August 2019
Drawn: KK
Approved: SW/CL

APPENDIX

D

Class D Cost estimates

Item	Description	Unit Cost	Unit	Quantity	Extension
Connection of Adjacent Properties Under Option 1					
1.1	**Install/Replace watermain (incl. fittings, valves, connecting to existing service connections)**				
	100Ø Watermain	$405	lineal metre	-	$0
	150Ø Watermain	$470	lineal metre	-	$0
	200Ø Watermain	$500	lineal metre	-	$0
	250Ø Watermain	$620	lineal metre	-	$0
	100Ø Watermain with road base and paving	$750	lineal metre	5,825	$4,368,750
	150Ø Watermain with road base and paving	$815	lineal metre	-	$0
	200Ø Watermain with road base and paving	$845	lineal metre	-	$0
	250Ø Watermain with road base and paving	$965	lineal metre	-	$0
1.2	Install new services (assuming average service length of 200 m per service)	$50	lineal metre	**5,800**	$290,000
1.3	Install new curb stops	$1,500	each	**29**	$43,500
1.4	Acquire ROW	$4	square metre	-	$0
1.5	Install kiosk-style booster station	$75,000	each	-	$0
				Sub-Total	**$4,702,250**
				Engineering & Design (15%)	$705,338
				Contingency (50%)	$2,351,125
				Grand Total	**$7,758,713**

Connection of Rykerts Under Option 1					
1.1	**Install/Replace watermain (incl. fittings, valves, connecting to existing service connections)**				
	100Ø Watermain	$405	lineal metre	-	$0
	150Ø Watermain	$470	lineal metre	-	$0
	200Ø Watermain	$500	lineal metre	-	$0
	250Ø Watermain	$620	lineal metre	-	$0
	100Ø Watermain with road base and paving	$750	lineal metre	2,925	$2,193,750
	150Ø Watermain with road base and paving	$815	lineal metre	-	$0
	200Ø Watermain with road base and paving	$845	lineal metre	-	$0
	250Ø Watermain with road base and paving	$965	lineal metre	-	$0
1.2	Install new services	$50	lineal metre	-	$0
1.3	Install new curb stops	$1,500	each	-	$0
1.4	Acquire ROW	$4	square metre	-	$0
1.5	Install kiosk-style booster station	$75,000	each	1	$75,000
				Sub-Total	**$2,268,750**
				Engineering & Design (15%)	$340,313
				Contingency (50%)	$1,134,375
				Grand Total	**$3,743,438**

Item	Description	Unit Cost	Unit	Quantity	Extension
Connection of Orde Creek Under Option 1					
1.1	**Install/Replace watermain (incl. fittings, valves, connecting to existing service connections)**				
	100Ø Watermain	$405	lineal metre	-	$0
	150Ø Watermain	$470	lineal metre	-	$0
	200Ø Watermain	$500	lineal metre	-	$0
	250Ø Watermain	$620	lineal metre	-	$0
	100Ø Watermain with road base and paving	$750	lineal metre	-	$0
	150Ø Watermain with road base and paving	$815	lineal metre	975	$794,625
	200Ø Watermain with road base and paving	$845	lineal metre	-	$0
	250Ø Watermain with road base and paving	$965	lineal metre	-	$0
1.2	Install new services	$50	lineal metre	-	$0
1.3	Install new curb stops	$1,500	each	-	$0
1.4	Acquire ROW	$4	square metre	-	$0
1.5	Install kiosk-style booster station	$75,000	each	1	$75,000
				Sub-Total	**$869,625**
				Engineering & Design (15%)	$130,444
				Contingency (50%)	$434,813
				Grand Total	**$1,434,881**

Item	Description	Unit Cost	Unit	Quantity	Extension
Connection of South Canyon Under Option 1					
1.1	**Install/Replace watermain (incl. fittings, valves, connecting to existing service connections)**				
	100Ø Watermain	$405	lineal metre	-	$0
	150Ø Watermain	$470	lineal metre	775	$364,250
	200Ø Watermain	$500	lineal metre	-	$0
	250Ø Watermain	$620	lineal metre	-	$0
	100Ø Watermain with road base and paving	$750	lineal metre	-	$0
	150Ø Watermain with road base and paving	$815	lineal metre	1,325	$1,079,875
	200Ø Watermain with road base and paving	$845	lineal metre	-	$0
	250Ø Watermain with road base and paving	$965	lineal metre	-	$0
1.2	Install new services	$50	lineal metre	-	$0
1.3	Install new curb stops	$1,500	each	-	$0
1.4	Acquire ROW	$4	square metre	4,680	$18,720
1.5	Install kiosk-style booster station	$75,000	each	1	$75,000
				Sub-Total	**$1,537,845**
				Engineering & Design (15%)	$230,677
				Contingency (50%)	$768,923
				Grand Total	**$2,537,444**

Item	Description	Unit Cost	Unit	Quantity	Extension
Connection of Adjacent Properties Under Option 2A					
1.1	**Install/Replace watermain (incl. fittings, valves, connecting to existing service connections)**				
	100Ø Watermain	$405	lineal metre	-	$0
	150Ø Watermain	$470	lineal metre	-	$0
	200Ø Watermain	$500	lineal metre	-	$0
	250Ø Watermain	$620	lineal metre	-	$0
	100Ø Watermain with road base and paving	$750	lineal metre	4,275	$3,206,250
	150Ø Watermain with road base and paving	$815	lineal metre	-	$0
	200Ø Watermain with road base and paving	$845	lineal metre	-	$0
	250Ø Watermain with road base and paving	$965	lineal metre	-	$0
1.2	Install new services (assuming average service length of 200 m per service)	$50	lineal metre	**5,800**	$290,000
1.3	Install new curb stops	$1,500	each	**29**	$43,500
1.4	Acquire ROW	$4	square metre	-	$0
1.5	Install kiosk-style booster station	$75,000	each	-	$0
				Sub-Total	**$3,539,750**
				Engineering & Design (15%)	$530,963
				Contingency (50%)	$1,769,875
				Grand Total	**$5,840,588**

Item	Description	Unit Cost	Unit	Quantity	Extension
Connection of Rykerts Under Option 2A					
1.1	**Install/Replace watermain (incl. fittings, valves, connecting to existing service connections)**				
	100Ø Watermain	$405	lineal metre	-	$0
	150Ø Watermain	$470	lineal metre	-	$0
	200Ø Watermain	$500	lineal metre	-	$0
	250Ø Watermain	$620	lineal metre	-	$0
	100Ø Watermain with road base and paving	$750	lineal metre	1,875	$1,406,250
	150Ø Watermain with road base and paving	$815	lineal metre	-	$0
	200Ø Watermain with road base and paving	$845	lineal metre	-	$0
	250Ø Watermain with road base and paving	$965	lineal metre	-	$0
1.2	Install new services	$50	lineal metre	-	$0
1.3	Install new curb stops	$1,500	each	-	$0
1.4	Acquire ROW	$4	square metre	-	$0
1.5	Install kiosk-style booster station	$75,000	each	1	$75,000
				Sub-Total	**$1,481,250**
				Engineering & Design (15%)	$222,188
				Contingency (50%)	$740,625
				Grand Total	**$2,444,063**

Item	Description	Unit Cost	Unit	Quantity	Extension
Connection of Orde Creek Under Option 2A					
1.1	**Install/Replace watermain (incl. fittings, valves, connecting to existing service connections)**				
	100Ø Watermain	$405	lineal metre	-	$0
	150Ø Watermain	$470	lineal metre	-	$0
	200Ø Watermain	$500	lineal metre	-	$0
	250Ø Watermain	$620	lineal metre	-	$0
	100Ø Watermain with road base and paving	$750	lineal metre	-	$0
	150Ø Watermain with road base and paving	$815	lineal metre	600	$489,000
	200Ø Watermain with road base and paving	$845	lineal metre	-	$0
	250Ø Watermain with road base and paving	$965	lineal metre	-	$0
1.2	Install new services	$50	lineal metre	-	$0
1.3	Install new curb stops	$1,500	each	-	$0
1.4	Acquire ROW	$4	square metre	-	$0
1.5	Install kiosk-style booster station	$75,000	each	1	$75,000
				Sub-Total	**$564,000**
				Engineering & Design (15%)	$84,600
				Contingency (50%)	$282,000
				Grand Total	**$930,600**

Item	Description	Unit Cost	Unit	Quantity	Extension
Connection of South Canyon Under Option 2A					
1.1	**Install/Replace watermain (incl. fittings, valves, connecting to existing service connections)**				
	100Ø Watermain	$405	lineal metre	-	$0
	150Ø Watermain	$470	lineal metre	775	$364,250
	200Ø Watermain	$500	lineal metre	-	$0
	250Ø Watermain	$620	lineal metre	-	$0
	100Ø Watermain with road base and paving	$750	lineal metre	-	$0
	150Ø Watermain with road base and paving	$815	lineal metre	1,325	$1,079,875
	200Ø Watermain with road base and paving	$845	lineal metre	-	$0
	250Ø Watermain with road base and paving	$965	lineal metre	-	$0
1.2	Install new services	$50	lineal metre	-	$0
1.3	Install new curb stops	$1,500	each	-	$0
1.4	Acquire ROW	$4	square metre	4,680	$18,720
1.5	Install kiosk-style booster station	$75,000	each	1	$75,000
				Sub-Total	**$1,537,845**
				Engineering & Design (15%)	$230,677
				Contingency (50%)	$768,923
				Grand Total	**$2,537,444**