REGIONAL DISTRICT OF CENTRAL KOOTENAY

# LISTER WATER SYSTEM ASSESSMENT

## CURRENT BOUNDARY

NOVEMBER 04, 2019

FINAL

# LISTER WATER SYSTEM ASSESSMENT

## CURRENT BOUNDARY

REGIONAL DISTRICT OF CENTRAL KOOTENAY

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WSP
5-2114 COLUMBIA AVENUE
ROSSLAND, BC, CANADA  V0G 1Y0

T: +1 250 362-5137
WSP.COM

November 04, 2019

FINAL

REGIONAL DISTRICT OF CENTRAL KOOTENAY
202 Lakeside Drive, PO Box 590
Nelson, BC V1L 5R4

**Attention: Shari Imada, P.Eng. M.E.Des. Environmental Services Coordinator**

Dear Madam:

**Subject: Lister Water System Assessment**
**Client ref.:** 06-2230-5700-65

We are pleased to submit the attached Lister Water System 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 system for future demand considering both domestic demand and potential for rural 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.

WSP ref.: 181-15710-00

5-2114 COLUMBIA AVENUE
ROSSLAND, BC, CANADA V0G 1Y0

T: 1(250)362-5137
F: 1(250)362-5284
wsp.com

# REVISION HISTORY

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| Prepared by | Prepared by | Reviewed by | Approved by | |
| Elise Paré | Stephenie Wong | Clive Leung | Elise Paré | |

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| Stephenie Wong | Elise Paré | Elise Paré | | |

# SIGNATURES

PREPARED BY

November 04, 2019

Stephenie Wong, EIT

Date

REVIEWED BY

November 04, 2019

Clive Leung, P.Eng.
Senior Project Engineer

Date

APPROVED BY

November 04, 2019

Elise Paré, P.Eng
Senior Project Manager

2019-11-04

Date

# CONTRIBUTORS

## CLIENT

| | |
|---|---|
| Environmental Services Coordinator | Shari Imada, P.Eng. |
| Utility Services Manager | Jason McDiarmid, Eng LL |
| Lead Water Operator | Robin Douville |

## WSP

| | |
|---|---|
| Project Manager | Elise Paré, P.Eng. |
| Water Modelling QA/QC | Clive Leung, P.Eng. |
| Water Modelling/Report Draft | Stephenie Wong, EIT |

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# 1 INTRODUCTION

The objective of this study is to provide a water system assessment and long-term asset replacement and upgrade schedule for the Lister water system.

WSP was commissioned to review and update the Lister water model and assess its current level of service provided, while also reviewing options to improve the system under future growth conditions.

The subsequent sections of this report provide the following:

- A desktop review of existing infrastructure studies and plans;
- A description of the existing water distribution system;
- Assessment of current and projected demands;
- Updated the base plan and water model;
- High level groundwater supply assessment;
- Future demand considering both domestic demand and potential for fire flow;
- Cost estimates; and
- Recommendations.

**Figure 1: Finished Storage Reservoir**

# 2 BACKGROUND INFORMATION

The community of Lister is located in Electoral Area B of the Creston Valley, in a rural area south of the Goat River and east of the Kootenay river with the Mount Thompson to the east. The majority of the land serviced by the Lister Water System is within the ALR, with an average parcel size of 20 acres. 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]

First developed in 1929, the Lister Water system currently services 196 active connections. The water system provides domestic water only, excluding agricultural use, except for a metered dairy connection and domestic service to the Creston Golf Clubhouse. The groundwater source is currently disinfected using chlorine prior to being stored in an above ground steel tank and then to distribution by gravity. The system is currently classified as a Small Water system under EOCP and a Large Water System by Interior Health.

The Regional District of Central Kootenay (RDCK) took over ownership of the Lister water system in 1982. The 2018 asset management plan indicates that approximately 75% of the total network has surpassed its service life or is scheduled for replacement within the next 15 years. 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.

## 2.1 REFERENCE INFORMATION

During the preparation of this assessment, the following information was provided to WSP for review:

1. 1980 EPEC Preliminary Report for the Lister Water Works System Upgrade
2. 1980 RDCK Project Financial Statement
3. 1982 Lister Waterworks Upgrading Project Summary, Alan R. Colby
4. 1991 Report on Lister Water Supply System, Kerr Wood Leidel
5. 1996 Lister Area Water Supply Study, Mould Engineering Services Ltd
6. 2003 Lister Water System Water Supply & Treatment Upgrade, Kerr Wood Leidel
7. 2010 Phase 1 Summary Report: Groundwater Source Assessment for the Lister Water System, WSA Engineering Ltd.
8. 2013 Phase 1 Groundwater Exploration and Testing Program Progress Report – Lister Water Service District, LC Topp Groundwater Consulting Services.
9. 2018 Funding Water Infrastructure for the Long Term – RDCK Lister, Econics
10. Flow data at source and for limited metered connections (2017/2018)
11. Current service accounts and GIS database for pipe network
12. 2014 EPANET water model
13. Record drawings for 1980 distribution system upgrades and 2013 supply, storage and treatment upgrades
14. Regulatory documents, 2014 Operating Permit Conditions
15. Water Quality data, 2018-06-13
16. 2017 Annual Report of Monitoring Lister Water System, RDCK

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

# 3 EXISTING SYSTEM

## 3.1 SUMMARY OF INFRASTRUCTURE

The water source for Lister is a 250mm diameter groundwater well drilled in 2010 and developed in 2012. The water is disinfected via chlorination and contact time is achieved in a 885 $m^3$ above ground steel bolted reservoir. The reservoir has been designed to include domestic demands plus fire flow storage for 66.6 L/s for 1.7 hours per the Design Guidelines for Rural Residential Water systems (2012). Static pressures within the distribution system when the reservoir is 80% full range from 44 psi to 112 psi.

The Lister water system has approximately 24 kilometres of watermain within its service area. There are 196 active connections servicing a population of approximately 590 people. The Lister water distribution system was upgraded during two major phases. The south end in the 1970s and the north end in the 1980s. Much of the distribution consists of Series 160 PVC pipe with glued joints with diameters ranging from 50 to 150mm bedded in sand or pea gravel. Crossings under the paved roads were completed in casings.[2] Sections of pipe were completed in bedrock, requiring blasting. The base plan provided to WSP has been reviewed against existing record drawings and confirmation of service locations with operations staff.[3] The updated plan has been converted to GIS format.

A concern for the distribution system include dead-end mains, or the long "extended services" (mains < 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 control and data acquisition system turning on the well pump when the reservoir level drops below 70% and stops at 80%. Free chlorine residual, flow, alarms, well level, raw water temp and reservoir level data is logged in the historian.

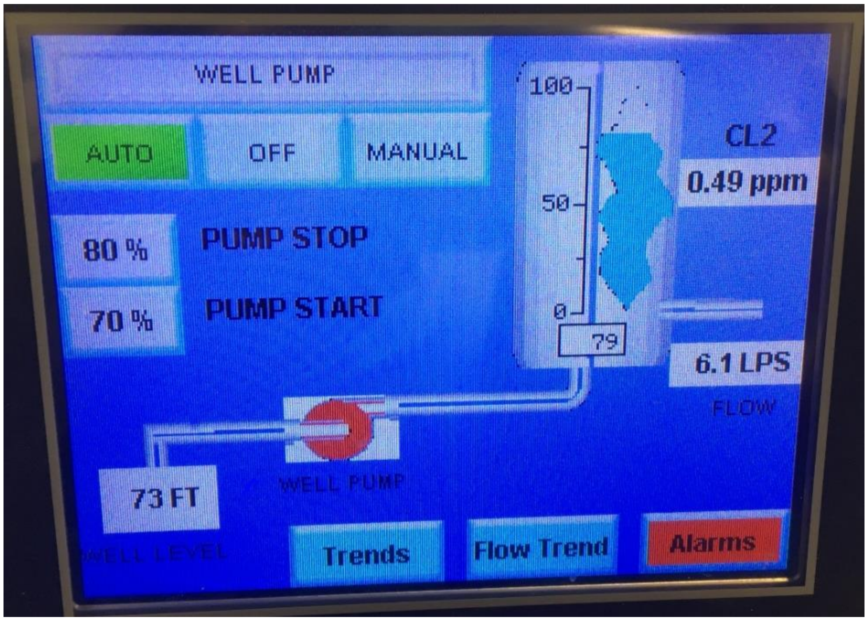


**Figure 2: SCADA HMI screen shot**

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[2] Lister Waterworks Upgrading Project, Alan R. Colby Consulting Engineer, 1982

[3] Pers Comm. Robin Douville, February 9, 2019

## 3.2 LEGAL AND REGULATORY COMPLIANCE

The Lister water system has approximately 25% of its watermains located outside of existing road rights of way and no statutory rights of way plans exist. The majority of these are located through agricultural fields or on the side of roads, presumably due to the ease of construction in the 1970s and 80s reducing the cost of road repair. While this was historically acceptable in a community where land ownership does not regularly change and the original handshake agreements are respected, this practice currently leaves the RDCK vulnerable in its legal rights to access lands to operate and maintain their linear infrastructure.

The system is classified as a Small Water System and all operators have their Level II certification for both water treatment and water distribution systems. The 2017 Annual report indicates the system is operating in compliance with the operating permit. A wellhead protection plan is recommended to ensure the continued water quality for the community.

The majority of lands within the Lister service area are classified under the Agricultural Land Reserve (ALR). Recent amendments to the Agricultural Land Commission (ALC) Act (Feb 22, 2019) limit development of non - farming uses and limit the size of principal residences to 500 square metres, without a variance or ALC approval and a maximum of one secondary suite within the principal residence. For the purposes of estimating water demand per parcel, this change does not materially affect the current land use bylaw for Lister.

The RDCK Water Bylaw No. 2577, 2017 includes seasonal water conservation measures which take effect between June 1$^{st}$ to September 30$^{th}$ every year. Additional stages of water conservation measures may be imposed during period of water shortages as necessary.

# 4 GROUNDWATER SUPPLY REVIEW

The 150mm diameter test well and 250mm diameter production well were drilled in October 2010 under the supervision of LC Topp Groundwater Consulting Services. A step drawdown test was performed on the test well at rates of 9.6 L/s (153 USGPM) to 22.1 L/s (351 USGPM) with maximum drawdown of 3.4m (11.13 ft) or 15.2% of total available drawdown. The constant rate pump test was conducted at 9.45 L/s (150 USGPM) with total drawdown at the end of 22 hours of 0.9m (2.98ft). 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.[4] Based on the record drawings for the 250mm production well, the drawdown level at a flow rate of 500 USGPM is 3.7 mbgs (metres below ground surface) or (12.13ft). The 10 HP pump (280 USGPM) installed in 2012 was replaced as it could not meet system demands.

The well pump currently installed in the 250mm production well is designed to operate 26L/s (425 USGPM). The pump screen is set at 23.6 mbgs (77.4ft) at an elevation of 677.0m. With the pump operating at a constant speed, the water level in the well varies from 21.3m to 23.48m (70 to 77 ft) above the pump.

Without completing additional pump tests, from a review of the well levels and system demand from 2017 and 2018, it appears that under normal operation, the drawdown does not exceed safe drawdown levels.

**Figure 3: 250mm Diameter Production Well**

[4] LC Topp Groundwater Consulting Services, Phase 1 Groundwater Exploration and Testing Program Progress Report – Lister Water Service District, August 13, 2013.

# 5 WATER MODEL UPDATES

RDCK provided an existing EPANET water distribution model (2014-06-20) to WSP for update, and for further analysis for the purposes of this assignment. As such, WSP completed the following model updates to improve the accurate representation of existing water infrastructure, and further updated the model for additional scenarios and detailed analysis for the system moving forwards:

1. The model was converted to a Bentley WaterCAD model, to allow for multiple scenarios development, including fire flow scenarios within one model, which expands on the functionality of the modelling tool while introducing new analysis features. The WaterCAD model or a simplified EPANET version of the water model may be returned to the RDCK upon request.
2. The physical scale of the existing model resulted in pipe lengths that did not match the actual length of the watermains in the system. Furthermore, many of the pipe lengths were using user-defined lengths. The scale of the system was adjusted such that the physical lengths of the pipes approximately matched the actual lengths of the watermains and cadastral provided by RDCK. The pipe lengths were updated to use scaled lengths automatically assigned based on geometry in the modelling software, rather than the user defined lengths originally defined in the model. However, user defined lengths used for the dedicated supply line from the reservoir to the water distribution system were kept, as pipe lengths in that area are purposefully manipulated for ease of reading and interpretation, as if actual lengths were to be used, the model elements for many different features would all be confined to a small area on the map.
3. Reservoir ID 2 does not exist in the Lister water supply system and was deleted from the model.
4. Reservoir ID 5 was converted from an open reservoir to a tank, to represent the Lister water tank, which receives from groundwater supply. The reservoir floor elevation was updated to 705 m (2012 Record Drawing by WSA Engineering Ltd.). The initial water level of the tank was updated to 8.78 m above the reservoir floor or 80% of top water level (10.97 m), which WSP understands is the elevation maintained by water operators to manage low pressures in certain areas of the system.
5. Updated demands were added to the water model, further discussed in Section 5.2.
6. New current demand scenarios were created for the model, further discussed in Section 6.
7. Anticipated future demands for growth and infill development were estimated and added to the model. Water system upgrade options and future demand scenarios were developed to determine future needs. This is further discussed in Section 7.
8. The node elevations for the watermains were updated using the LIDAR elevation data provided by the RDCK in July 2019; WSP understands that the original EPANET model provided by the RDCK used Google Earth elevations, which provides limited accuracy.

## 5.1 ASSUMPTIONS AND LIMITATIONS

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

1. The watermains for the reservoir supply and supply line from the reservoir, indicated by “Note 1” in the figures, have user defined lengths from the EPANET model provided by RDCK. The remaining lengths of all other water network infrastructure outside of this area are approximated using real world geometric data from the modelling software.
2. Furthermore, the watermains indicated through “Note 1” in the figures were not required to maintain minimum pressures/fire flows during fire flow demand scenarios.
3. No updates have been made to the diameters, or C-factors in the EPANET model provided by RDCK.
4. The available pressures and fire flows presented in this assessment are based on the elevation at which the existing watermain is located, and may not be representative of serviced properties which are at significantly different elevations.
5. The only updates made to the EPANET model are updates to the demands, lengths (outside of area marked in Note 1), and node elevations.

6 The model has not been calibrated.
7 The tank initial water level in steady state scenario is set to 8.78 m above the base of the reservoir.

## 5.2 DEMAND DEVELOPMENT AND ALLOCATION

### 5.2.1 DEMAND SCENARIOS

The following three demands scenarios were developed and evaluated for current and future demand scenarios:

1 **Average Day Demand (ADD) –** ADD were determined using the water consumption data available for the system. A summary of the ADDs is provided in the following sections.
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. The minimum fireflow for this evaluation is 33 L/s. This is discussed further in Section 5.3.2.
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 demand for the existing Lister water distribution system under the scenarios described above has been calculated from historical flow data provided by RDCK, and is summarized in the following table.

**Table 1: System Demand Summary**

| DEMAND SCENARIO | CURRENT | FUTURE |
|---|---|---|
| Average Day Demand | 8.7 L/s | 9.1 L/s |
| Maximum Day Demand | 21.8 L/s | 22.7 L/s |
| Peak Hour Demand | 34.8 L/s | 36.4 L/s |

The development of the current and future ADD is discussed in the following sub-sections.

### 5.2.2 CURRENT DEMAND AND ALLOCATION

The current system-wide ADD was estimated using the water intake flow data for the average and maximum total annual consumption in recent years, occurring in 2017. Water consumption data for the top two water consumers was also collected to estimate the anomalous demands imposed by these two consumers at their respective locations in the updated water model. The remaining demand on the system was then distributed evenly across all the water model nodes in the water distribution system. The estimated average day demands are summarized in Table 2 below.

**Table 2: Current Average Day Demand Distribution**

| DESCRIPTION | DEMAND | COMMENTS |
|---|---|---|
| Kootenay Meadows Dairy Farm (top water consumer) | 0.85 L/s | The highest annual consumption between 2013-2018 was recorded in 2017. The annual consumption in 2017 equated to an ADD of 0.85 L/s.<br><br>*Note: the estimated PHD of 3.4 L/s, calculated from the ADD x 4.0 peaking factor is significantly lower than the maximum instantaneous flow recorded at the Dairy Farm of 13.5 L/s. However, the maximum instantaneous flow was recorded during winter and not coincident to summertime peak flows from irrigation.* |
| Creston Golf Club (second highest water consumer) | 0.04 L/s | Consumption data was provided for 2018 only. The resulting ADD is 0.04 L/s.<br><br>*Note: Water usage was only recorded between April to October 2018 in the consumption data.* |
| Unit Demands Across the System | 7.79 L/s<br>(0.190 L/s per node x 41 nodes) | The highest annual consumption between 2014 to 2018 occurred in 2017. The annual consumption in 2017 equated to an ADD of 8.7 L/s. After accounting for the demands from the top two water consumers, discussed above, the remaining annual consumption is 7.79 L/s. This demand was distributed equally across the Lister water system.<br><br>*Note: Based on the population of 588, reported by RDCK, the equivalent ADD per capita is 1145 L/capita/day. This is generally higher than typical design values, although some rural systems are known to have similar high demands. These values may therefore be attributed to leakage in the aging system. Night time flow monitoring in January 2019 indicated approximately 4 L/s of system leakage after accounting for regular night time use and metered demand from the dairy.* |
| **Total Average Day Demand** | **8.70 L/s** | |

MDD was estimated as ADD x 2.5 Peaking Factor, the allocation for MDD follows the demands assigned to nodes during the ADD allocation phase as noted in the table above. PHD was estimated as ADD x 4.0 Peaking Factor and similarly allocated to the same nodes above.

### 5.2.3 FUTURE DEMANDS

Areas with potential for future development were identified based on the current zoning of the system and input from RDCK staff.[5] An estimated number of single family units and secondary suites were identified within the current limits of the water distribution system.

The ADD per unit was determined using guidelines from the Design Guidelines for Rural Residential Community Water Systems, 2012:

MDD = Indoor Usage + Water Loss Allowance + Irrigation Demand = 308 $m^3$/day

[5] Pers Comm Robin Douville, and Shari Imada February 27, 2019

*Where:*

- Indoor Usage = 135 $m^3$/day
- Water Loss Allowance = 160 $m^3$/day
- Irrigation Demand = 12.5 $m^3$/day

ADD = MDD / 2.5 PF = 123 $m^3$/day

ADD per unit = 123 m3/day / 196 units = 0.628 $m^3$/day = **0.0073 L/s/unit**

The water loss allowance is calculated as a function of system pressure and length of watermain/services. The high water loss can be attributed to the high proportion of watermain and service length relative to population.

The irrigation demand is based on an average of 0.4 ha (1 acre limit for residential irrigation) and an application of 0.4 $m^3$/ha/day for arid 1 region (Design Guidelines for Rural Residential Community Water Systems, 2012) for all existing parcels.

### 5.2.4 FUTURE DEMANDS ALLOCATION

The demands for 54 new single-family units were added to the model at an ADD of 0.0073 L/s/unit. The estimated future system-wide ADD is 9.09 L/s, a 0.39 L/s increase from the existing ADD of 8.70 L/s.

The evaluation completed in this study for future water usage also assumes the 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. As the RDCK intends to undertake upgrades to the Lister water system, the assumption for no increase/decrease in existing water usage provides a slightly conservative estimate as leakage is anticipated to decrease as watermains are replaced.

Future MDD and PHD were allocated in a similar manner as the current demands.

## 5.3 DESIGN CRITERIA

### 5.3.1 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.

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

**Table 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) |

### 5.3.2 AVAILABLE FIRE FLOWS

Water distribution systems must be able to deliver large volumes of water for fire protection in addition to domestic water demands. 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 (138 kPa) on the street main is required during fires, per the Design Guidelines for Rural Residential Water Systems;
3. The area near the reservoir is not suitable for development and has been removed from consideration for maintaining the 20 psi 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 utility, 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. (121 $m^2$) area, brick/masonry construction type, with a minimum exposure distance of 45 m. From discussions with the RDCK[6], it is understood the majority of structures in Lister generally meet the characteristics above, with the exception of certain wood frame structures. The RDCK have also confirmed

### 5.3.3 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.

[6] Pers Comm Jason McDiarmid and Shari Imada (RDCK) October 7, 2019

# 6 EXISTING MODELLING SCENARIOS

The existing system was modelled to assess the baseline conditions for the three demand scenarios discussed below. Figures illustrating the results from the analysis are enclosed in Appendix A.

## 6.1 AVERAGE DAY DEMAND

The available pressure criterion under the ADD scenario is met in all areas under the existing system, except for the supply line directly upstream and downstream of the reservoir and on 32nd Street at Lloyd Road. For the former, there is no demand in this section of the water system, therefore low pressures in this area is not a deficiency. For the latter, the available pressure is limited by the static head from the reservoir. The available pressure can only be improved marginally in the upgrade scenarios unless the water level in the reservoir can be increased.

Refer to Figure 7.1 for more details.

## 6.2 MAXIMUM DAY DEMAND

The only area in the water system able to receive the required fire flow of 33 L/s (2,000 L/min) under the MDD scenario is the 200 mm watermain on 32nd Street, between Lloyd Road and Canyon-Lister Road. The remainder of the system will not receive the theoretically required fire flow (i.e. if the utility were to be considered a fully fire protected utility) under the MDD scenario. The southwest area of section may receive flows as low as 3 L/s. This can be mainly attributed to the small diameter watermains which distribute water across and to the extents of the water system.

Refer to Figure 7.2 for more details.

## 6.3 PEAK HOUR DEMAND

Under the PHD scenario, several areas in the water system do not meet the minimum available pressure criterion of 40 psi. In general, the available pressure is limited by small diameter watermains and dead-ends in the system.

On 32nd Street, between Lloyd Road and Canyon-Lister Road, the available pressure is limited by the static head from the reservoir. The available pressure can only be improved marginally in the upgrade scenarios unless the water level in the reservoir can be increased.

Refer to Figure 7.3 for more details.

# 7 FUTURE MODELLING SCENARIOS

As described in Section 7, the current system does not meet the above applied and assessed design criteria under existing conditions and demands. This will be further exacerbated by future growth, and the resultant increased demands on the water utility in the future. As requested and further discussed with the RDCK, three potential upgrade scenarios to meet three different future design criteria conditions were developed to improve the level of service.

## 7.1 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. Upgrades to meet the fire flow requirements under MDD are not considered for this option.

### *7.1.1 AVERAGE DAY DEMAND*

Similar to the existing modelling scenario, the design criteria under the ADD scenario is met in all areas of the system, except for the supply line directly upstream and downstream of the reservoir and on 32nd Street at Lloyd Road and Purcell Road.

Refer to Figure 8.1.1 for more details for all watermain upgrade recommendations and the resulting level of service provided.

### *7.1.2 MAXIMUM DAY DEMAND*

Fire flow requirements cannot be met under Option 1, without increasing the watermain diameter for a significant portion of the system.

Refer to Figure 8.1.2 for more details.

### *7.1.3 PEAK HOUR DEMAND*

With exception to the area on 32nd Street which was similarly discussed in Section 7.3, adequate service pressures can be provided by upsizing several trunk mains and any dead-end watermains with diameters less than 150 mm.

Refer to Figure 8.1.3 for more details.

## 7.2 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, replacing existing watermains within existing road rights of way where applicable, upsizing existing watermains, and improving looping to maintain water quality.

However, an alternative scenario (herein called “Option 2A”) to upsize the trunk mains only under this option to provide the required fire flows is also assessed to determine the incremental change and cost required to meet rural fire flow demand requirements.

### 7.2.1 AVERAGE DAY DEMAND

Similar to the existing modelling scenario, the design criteria under the ADD scenario is met in all areas of the system, except for the supply line directly upstream and downstream of the reservoir and on 32nd Street at Lloyd Road. Options 2 and 2A provide similar results.

Refer to Figure 8.2.1 for results from Option 2.

### 7.2.2 MAXIMUM DAY DEMAND PLUS FIRE FLOW

Although this option improves the available fire flow significantly compared to the existing system, the majority of the system will not be able to meet the fire flow requirement due to the limited static head provided by the Lister Reservoir and the need to meet minimum residual pressure criteria of 20 psi at higher elevations near 32$^{nd}$ Street and Purcell Road, and along Canyon Lister Road.

Option 2A was created to determine the extents of the upgrades needed to increase available fire flow. In Option 2A, trunk watermains and dead ends from Option 2 were upsized. Again, due to the design criteria to maintain a minimum residual pressure of 20 psi at higher elevations, the system is unable to meet fire flow requirements.

Refer to Figure 8.2.2 and 8.2.2A for more details.

The fire flow analyses were run with a minimum residual pressure of 0 psi, to present a scenario where the system is drawn down to a minimum pressure of 0 psi in case of emergency. This scenario is not recommended due to the potential for water quality impacts related to negative pressure situations. Refer to Figure 8.2.2-1 and 8.2.2A-1 for additional details.

### 7.2.3 PEAK HOUR DEMAND

With exception to the area on 32$^{nd}$ Street, discussed in Section 7.3, and properties along Canyon Lister Road, adequate service pressures can be provided by improving looping in the system and upsizing dead-end watermains with diameters less than 150 mm. The available pressures in these areas are limited by the available static head in these areas and increasing watermain size will only marginally improve the available pressures.

Options 2 and 2A provide similar results.

Refer to Figure 8.2.3 for results from Option 2.

## 7.3 OPTION 3

Option 3 builds on Option 1 and includes additional future looping, relocation and addition of watermains where required, and pipe upsizing, to improve available pressures under the PHD scenario and provide the required fire flows under the MDD option.

### 7.3.1 AVERAGE DAY DEMAND

Similar to the existing modelling scenario, the design criteria under the ADD scenario is met in all areas of the system, except for the supply line directly upstream and downstream of the reservoir and on 32nd Street at Lloyd Road.

Refer to Figure 8.3.1 for more details.

### 7.3.2 MAXIMUM DAY DEMAND PLUS FIRE FLOW

Although this option improves the available fire flow significantly compared to the existing system, the majority of the system will not be able to meet the fire flow requirement due to the limited static head provided by the Lister Reservoir and the need to meet minimum residual pressure criteria of 20 psi at higher elevations near 32nd Street and Purcell Road, and along Canyon Lister Road.

Additionally, the dead end on the west end of 28th Street is also unable to provide the required fire flow. However, adequate fire flow can be provided within 150 m of the deficient node, so this area is not considered deficient.

The fire flow analyses were run with a minimum residual pressure of 0 psi, to present a scenario where the system is drawn down to a minimum pressure of 0 psi in case of emergency. This scenario is not recommended due to the potential for water quality impacts related to negative pressure situations.

Refer to Figure 8.3.2 and 8.3.2-1 for more details.

### 7.3.3 PEAK HOUR DEMAND

With exception to the area on 32nd Street, discussed in Section 7.3, adequate service pressures are provided under the upgrades suggested in Option 3.

Refer to Figure 8.3.3 for more details.

# 8 OPINIONS OF PROBABLE COST FOR UPGRADE OPTIONS

Class D cost estimates to complete the upgrade scenarios proposed in Section 8 were developed for comparison, summarized in Table 4 below.

**Table 4: Cost Estimate Summary**

| DESCRIPTION | ESTIMATED UPGRADE CONSTRUCTION COST | ENGINEERING (15%) | CONTINGENCY (50%) | TOTAL COST |
|---|---|---|---|---|
| Option 1 | $3,520,000 | $528,000 | $1,760,000 | $5,808,000 |
| Option 2 | $7,590,000 | $1,138,500 | $3,795,000 | $12,523,500 |
| Option 2A | $9,530,000 | $1,429,500 | $4,765,000 | $15,724,500 |
| Option 3 | $12,620,000 | $1,893,000 | $6,310,000 | $20,823,000 |

**Notes and Assumptions:**

- The unit costs were developed from costs in similar projects within the RDCK and are in 2019 Dollars.
- It is assumed based on record drawings and 1980s construction photos that all existing pipes are located outside of the road structure. Option 1 assumes pipe replacement outside of the road structure, using existing casings for road crossings.
- Options 2, 2A and 3 include replacement of road structure and asphalt in cost per lineal meter for pipe replacement.
- 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.
- The upgrade costs do not include the cost of providing services connections for future properties; only the cost of re-instating service connections to existing properties is included.
- Fire hydrants are provided for Options 2A and 3 only, because only fire flow requirements can be met under these options. One fire hydrant is provided for every 150 m length of watermain in the system, based on FUS Design Guidelines.

  RDCK have noted that FUS may accept 300 m spacing from hydrant to structures as an alternative design criteria. This design criteria should be confirmed by the RDCK prior to completing future designs and future designs should consider distance from existing structures as well as hydrant spacing along watermains.
- Costs for 6 m wide rights of way are included for the sections of existing and proposed watermain upgrades located on private property.
- 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

Meeting fire flows requirements while maintaining a minimum residual pressure of 20 psi is challenging due to the available static head in areas located at higher elevations, such as around 32nd Street and Purcell Road, and along Canyon Lister Road. Potential methods of is to exclude areas at higher elevations from the analysis or assessing an emergency scenario where the system is drawn down to a residual pressure of 0 psi. This scenario is not recommended due to the potential for water quality impacts related to negative pressure situations.

Option 1 is the lowest cost option due to the limited scope of upgrades. As discussed in Section 7, pressures will improve to the desired levels of service, but fire flow requirements will not be met under this option and rights of way will need to be secured.

Option 2 is approximately 120% more costly than Option 1 as it includes full road structure replacement and allows for watermains to be placed in more accessible rights-of-way and roadways for future maintenance and operation activities. Pressures will improve to the desired levels of service and theoretical fire flows would improve (if hydrants were to be installed). However, the fire flow requirement of 33 L/s (2,000 L/min) is not met across the system under this option.

Option 2A is approximately 25% or $3,200,000 more expensive than Option 2. Option 2A carries the same recommendations as Option 2, but increases the size of trunk mains to that which would be required in Option 3. The majority of the increased cost is due to the provision fire hydrants. The incremental cost to increase the size of the larger trunk watermains accounts for only 10% of the increase cost, or $300,000. This option improves the available fire flow to the system, albeit limited by the minimum residual pressure criteria. This scenario is not recommended due to the potential for water quality impacts related to negative pressure situations.

Option 3 is the most costly option due the extensive looping provided for full fire protection (as captured in Option 2A) and improved water quality, and the upgrade of existing watermains to meet design guidelines for minimum pipe diameters of 150mm throughout the network. Similar to Option 2A, this option significantly improves the available fire flow to the system, albeit limited by the minimum residual pressure criteria. This scenario is not recommended due to the potential for water quality impacts related to negative pressure situations.

Detailed cost estimates are provided in Appendix B.

# 9 SUMMARY AND CONCLUSIONS

Overall the water supply for the current service area is sufficient and has capacity for future buildout with improvements to the distribution system.

The existing water distribution system servicing the Lister water system does not meet the current engineering standards for water supply. In addition to low service pressures in some isolated areas, which may limit water supply, very little of the water system can provide adequate fire flows. This is understandable as the original system was never built to be full fire protection water utility. Potential causes of the current deficiencies include undersized watermains. Future development in the region will increase the demand on the existing system, exacerbating these deficiencies. However, recent changes to ALR land use requirements will help to minimize this impact.

As noted in the 2018 Econics report[7], the majority of the distribution system is either overdue for replacement for has no remaining service life. System leakage is high at approximately 5 L/s representing current real losses nine times greater than unavoidable real losses in the system. The future replacement options modelled include replacement of high and medium risk pipes as well as pipe upgrades to meet current design criteria for pressure and water quality. Pipe replacements identified in this report should be read in conjunction with the priority replacements identified in Econics report, updating the financial model as required.

As the costs for moving watermains within the road rights of way adds significant incremental costs due to the addition of road structure and repaving, it is recommended confirming the location of the road structure within the right of way and limiting placing watermains under the road. There may be other constraints to consider during detailed design, including separation required from the watermain to overhead power line poles and drainage ditches.

Three improvement options have been reviewed for future servicing options. Options 1 and 2 seek to improve water system pressure delivery to all customer connections to meet the level of service desired for rural water systems. If Option 1 is chosen, it is recommended the RDCK secure Statutory Rights of Way over the existing watermain alignments. Options 2A and 3 are designed similarly to meet the conditions above but also for providing a minimum available fire flow of 33 L/s (2,000 L/min) coincident to the maximum day demand condition. Option 3 consists of more extensive improvements to provide full coverage for fire protection, extensive looping for water quality purposes and to meet design guidelines for minimum pipe diameters of 150mm throughout the network and is therefore also the most costly.

The Creston Valley is already experiencing hotter, drier summers, warmer, wetter winters, and more extreme weather, and climate scientists are projecting these trends to continue into the future. To respond to the increasing risk of community interface fires hazards, a growing trend in the industry is moving towards implementing fire rated systems in rural areas.

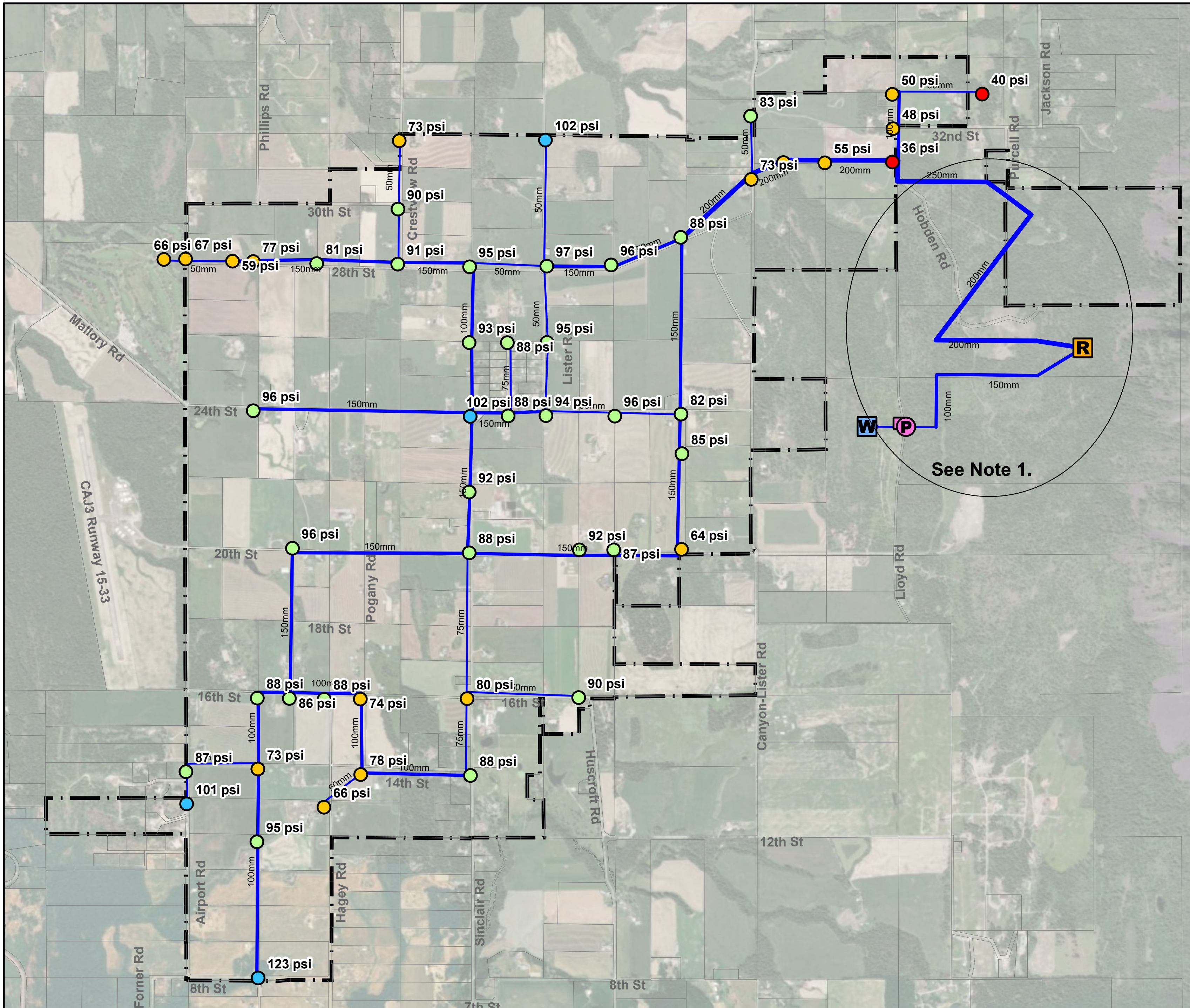
Based on the level of service that the RDCK desires for the Lister water system, the level of service desired by its connected customers, and the level of funding available, any of the options reviewed can and should be considered for the future upgrade of the Lister water system with long-term performance in mind.

[7] Econics, Funding Water Infrastructure for the Long Term, April 11, 2018

# APPENDIX

# A

# WATER MODELLING FIGURES




Client: Regional District of Central Kootenay

## Legend

**Available Pressures**

- <= 40 psi
- 40 psi - 80 psi
- 80 psi - 100 psi
- 100 psi - 127 psi
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:

1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.


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**FIGURE 7.1**

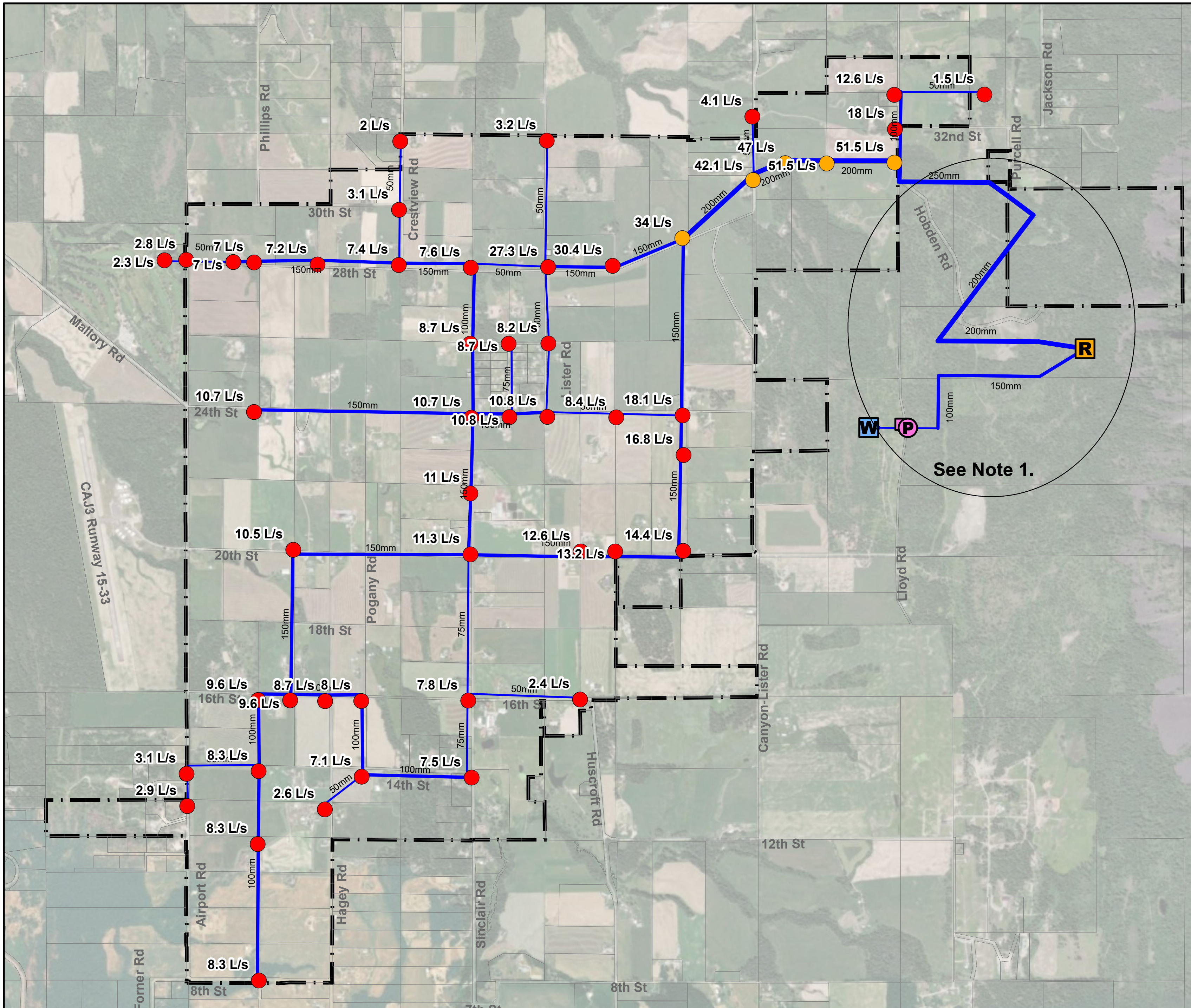
**LISTER WATER SYSTEM**
**EXISTING AVERAGE DAY DEMAND SCENARIO**
**SYSTEM PRESSURES**

Scale: 1:30,000 @ Letter
0 300 600
Meters

Project No.: 181-15710-00
Date: October 2019
Drawn: SW
Approved: CL

Path: \\ca-nvr-win01\vc_gen_g\opus_dk\municipal\Regional District of Central Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files - current boundary\7.1 Existing ADD.mxd

Client: Regional District of Central Kootenay

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## Legend

**Available Fire Flow**

- FF < 33 L/s
- 33 L/s < FF < 60 L/s
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:
1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.


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**FIGURE 7.2**

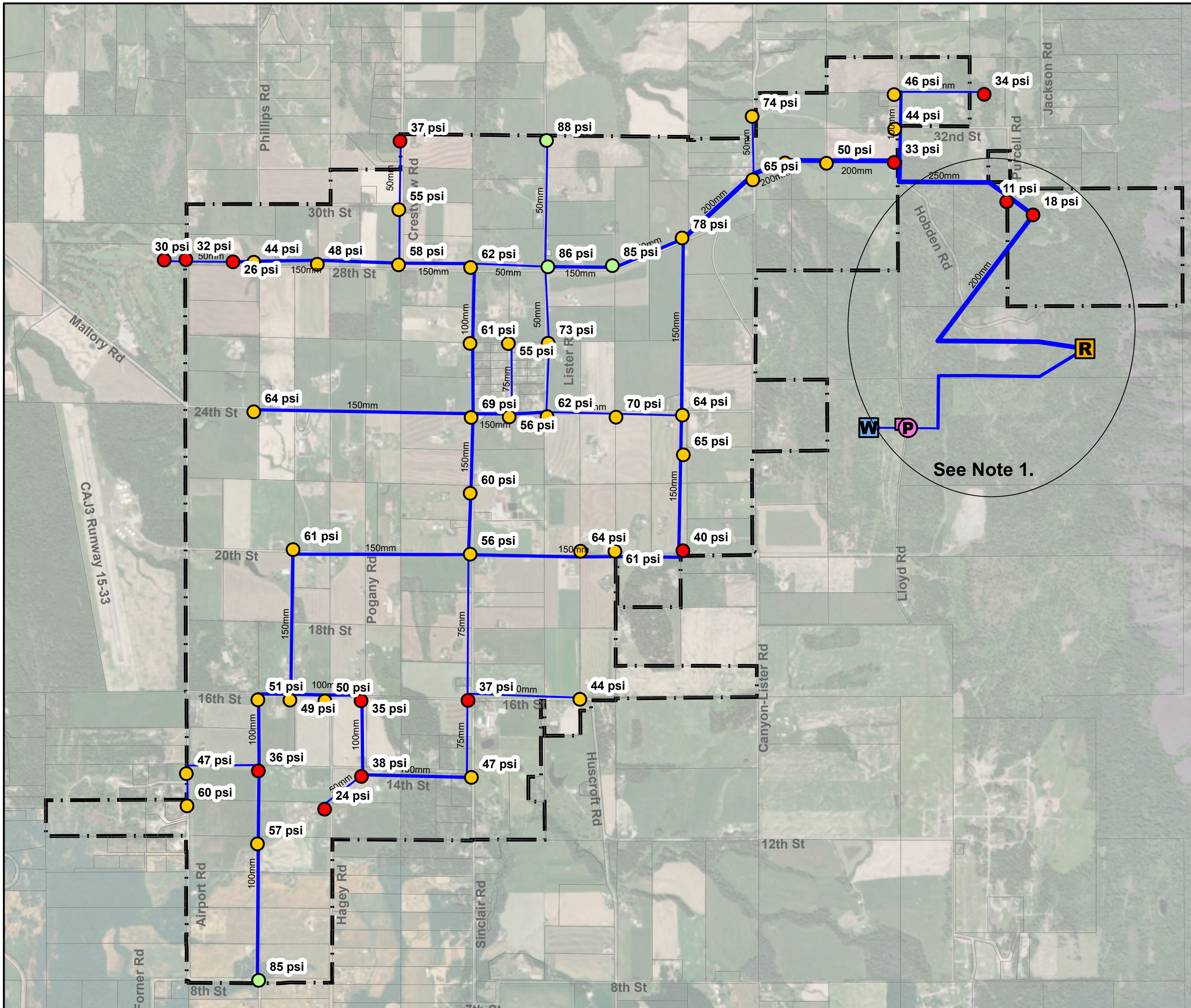
**LISTER WATER SYSTEM**
**EXISTING MAXIMUM DAY DEMAND SCENARIO**
**AVAILABLE FIRE FLOW**

Scale: 1:30,000 @ Letter
0 300 600
Meters

Project No.: 181-15710-00
Date: October 2019
Drawn: SW
Approved: CL


Path: \\ca-nvr-win01\vc_gen_g\opus_dk\municipal\Regional District of Central Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files - current boundary\7.2 Existing MDD.mxd

Client: Regional District of Central Kootenay




## Legend

### Available Pressures

- <= 40 psi
- 40 psi - 80 psi
- 80 psi - 100 psi
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:
1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.


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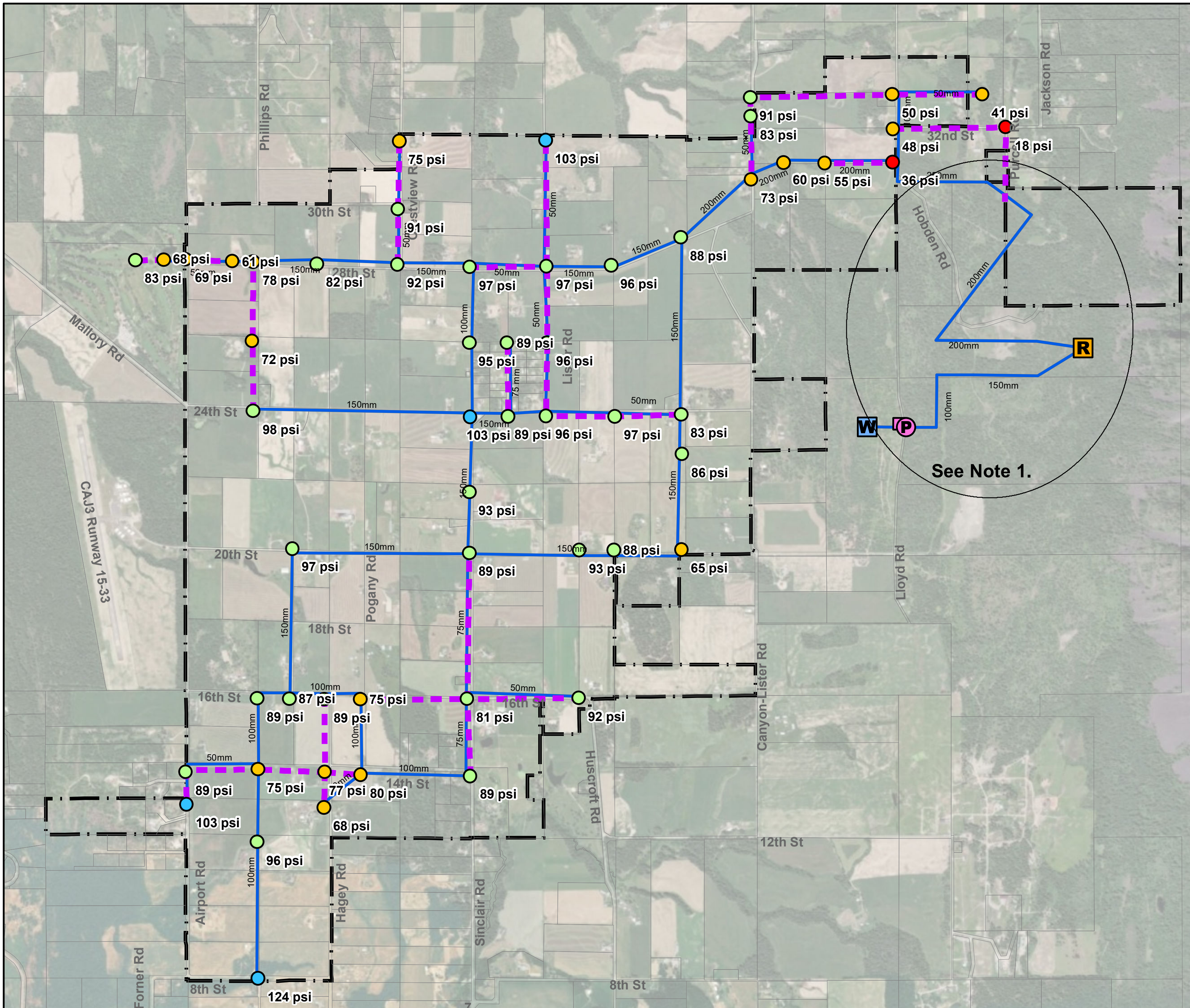
**FIGURE 7.3**

**LISTER WATER SYSTEM**
**EXISTING PEAK HOUR DEMAND SCENARIO**
**SYSTEM PRESSURES**

Scale: 1:30,000 @ Letter
0 300 600
Meters

Project No.: 181-15710-00
Date: October 2019
Drawn: SW
Approved: CL

Path: \\ca-nvr-win01\vc_gen_g\opus_dk\municipal\Regional District of Central Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files - current boundary\7.3 Existing PHD.mxd




Client: Regional District of Central Kootenay

## Legend

### Available Pressures

PSI

- <= 40 psi
- 40 psi - 80 psi
- 80 psi - 100 psi
- 100 psi - 127 psi
- Existing Watermains
- Watermain Upgrades
- Watermain to be Abandoned
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:
1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.


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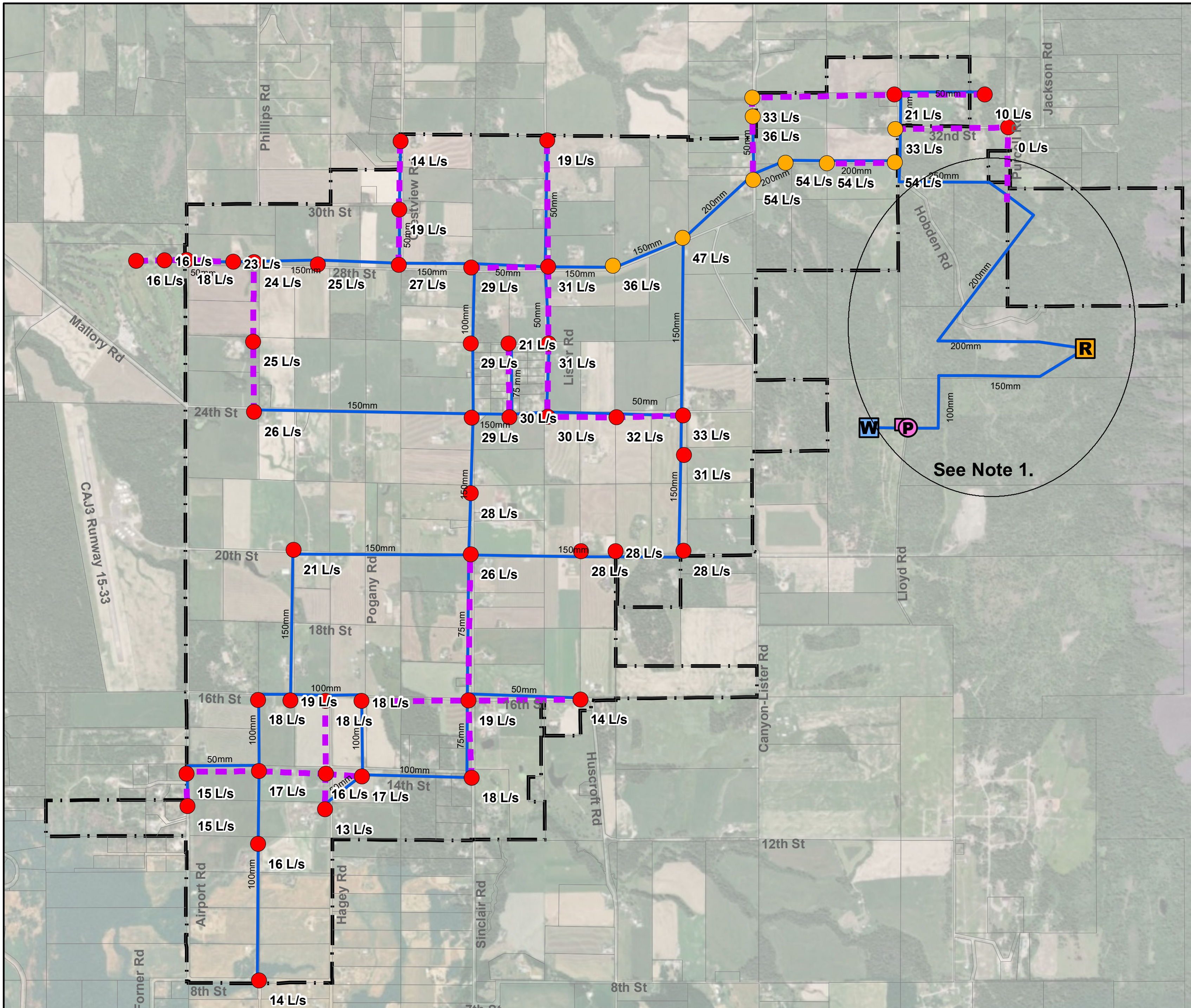
**FIGURE 8.1.1**

**LISTER WATER SYSTEM**
**OPTION 1 - FUTURE AVERAGE DAY DEMAND SCENARIO**
**AVAILABLE PRESSURES**

Scale: 1:30,000 @ Letter
0 300 600
Meters

| | |
|---|---|
| Project No.: | 181-15710-00 |
| Date: | October 2019 |
| Drawn: SW | Approved: CL |

Path: \\ca-nvr-win01\vc_gen_g\opus_dk\municipal\Regional District of Central Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files - current boundary\8.1.1 Option 1 - ADD.mxd




Client: Regional District of Central Kootenay

REGIONAL DISTRICT CENTRAL KOOTENAY

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## Legend

**Available Fire Flow**

- 33 L/s < FF
- 33 L/s < FF < 60 L/s
- Watermain Upgrades
- Existing Watermains
- Watermain to be Abandoned
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:

1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing elevations, diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for the proposed future watermain upgrades are estimated from the nearest node from the model provided by RDCK.
4. The model has not been calibrated.


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Fax (604) 990 4805

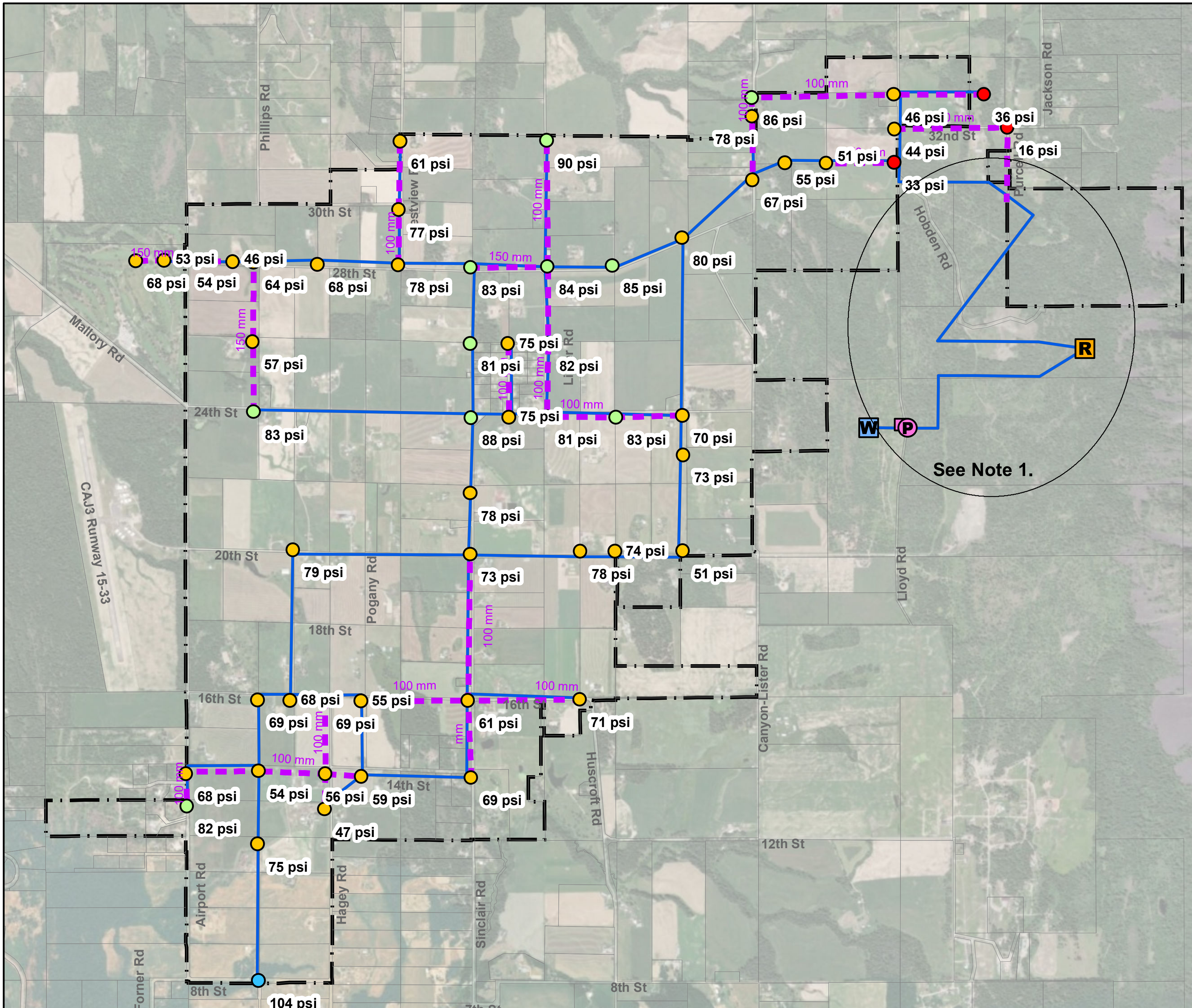



**FIGURE 8.1.2**

**LISTER WATER SYSTEM**
**OPTION 1 - FUTURE MAXIMUM DAY DEMAND SCENARIO**
**AVAILABLE FIRE FLOW**

| | |
|---|---|
| Scale: | 1:30,000 @ Letter (0 – 300 – 600 Meters) |
| Project No.: | 181-15710-00 |
| Date: | March 2019 |
| Drawn: | SW |
| Approved: | CL |

Path: \\ca-nvr-win01\vc_gen_g\opus_dk\municipal\Regional District of Central Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files - current boundary\8.1.2 Option 1 - MDD.mxd




Client: Regional District of Central Kootenay

## Legend

**Available Pressures**

- <= 40 psi
- 40 psi - 80 psi
- 80 psi - 100 psi
- 100 psi - 127 psi
- Watermain Upgrades
- Watermain to be Abandoned
- Existing Watermains
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:
1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.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Fax (604) 990 4805



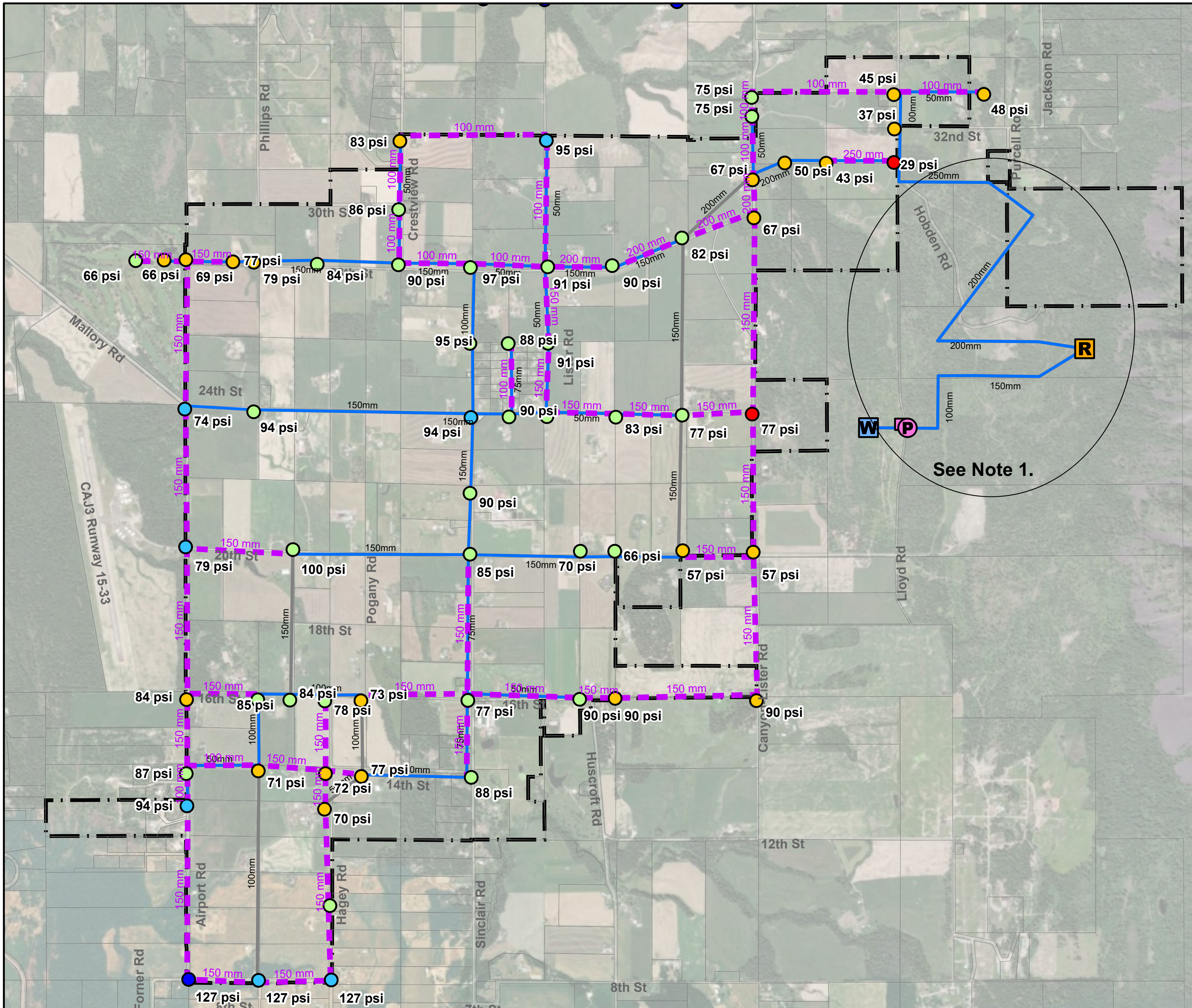

FIGURE 8.1.3

**LISTER WATER SYSTEM**
**OPTION 1 - FUTURE PEAK HOUR DEMAND SCENARIO**
**AVAILABLE PRESSURES**

Scale: 1:30,000 @ Letter
0 300 600
Meters

Project No.: 181-15710-00
Date: October 2019
Drawn: SW
Approved: CL

Path: \\ca-nvr-win01\vc_gen_g\opus_dk\municipal\Regional District of Central Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files - current boundary\8.1.3 Option 1 - PHD.mxd




Client: Regional District of Central Kootenay

REGIONAL DISTRICT CENTRAL KOOTENAY

## Legend

### Available Pressures

- <= 40 psi
- 40 psi - 80 psi
- 80 psi - 100 psi
- 100 psi - 127 psi
- > 127 psi
- Watermain Upgrades
- Existing Watermain
- Watermain to be Abandoned
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:
1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.


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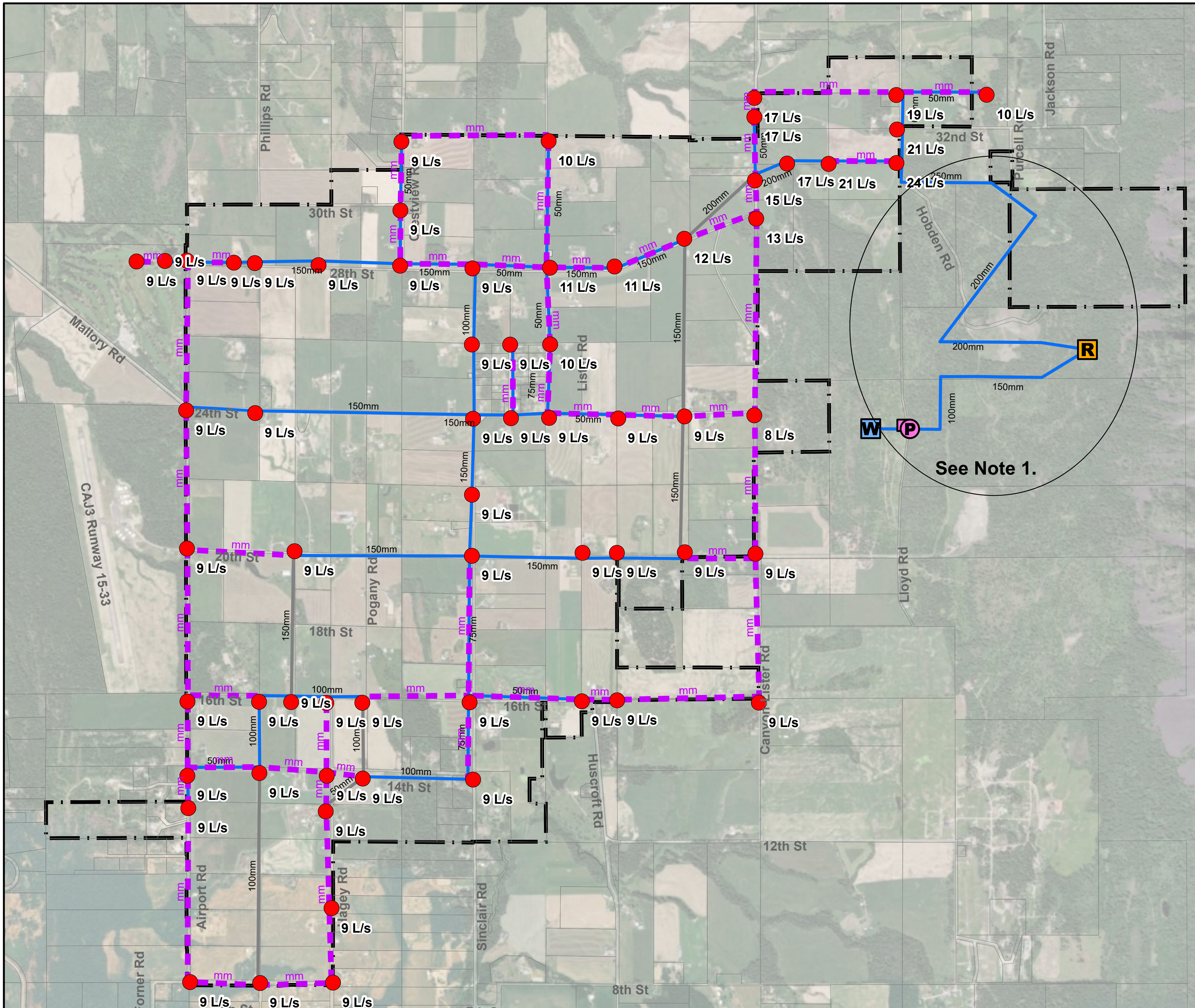
**FIGURE 8.2.1**

**LISTER WATER SYSTEM**
**OPTION 2 - FUTURE AVERAGE DAY DEMAND SCENRIO**
**AVAILABLE PRESSURES**

Scale: 1:30,000 @ Letter
0 300 600
Meters

Project No.: 181-15710-00
Date: October 2019
Drawn: SW
Approved: CL


Path: \\ca-nvr-win01\vc_gen_g\opus_dk\municipal\Regional District of Central Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files - current boundary\8.2.1 Option 2 - ADD.mxd




Client: Regional District of Central Kootenay

REGIONAL DISTRICT CENTRAL KOOTENAY

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# Legend

## Available Fire Flow

**Available Fire Flow**

- FF < 33 L/s
- Watermain Upgrades
- Existing Watermain
- Watermain to be Abandoned
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:
1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.


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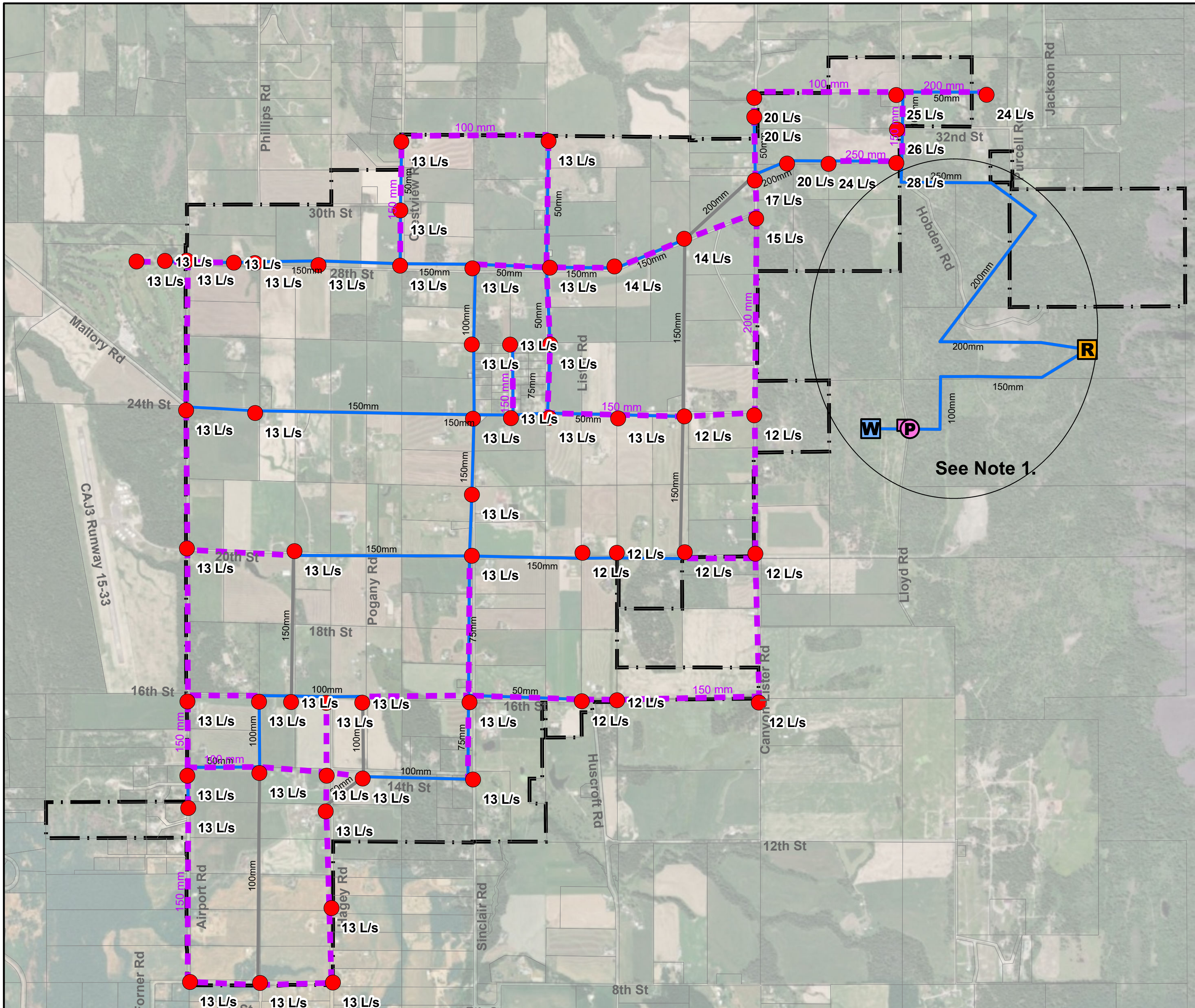
**FIGURE 8.2.2**

**LISTER WATER SYSTEM**
**OPTION 2 - FUTURE MAXIMUM DAY DEMAND SCENARIO**
**AVAILABLE FIRE FLOWS**

Scale:
1:30,000 @ Letter
0 300 600
Meters

Project No.: 181-15710-00
Date: October 2019
Drawn: SW
Approved: CL

Path: \\ca-nvr-win01\wc_gen_g\opus_dk\municipal\Regional District of Central Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files - current boundary\8.2.2 Option 2 - MDD.mxd




Client: Regional District of Central Kootenay

REGIONAL DISTRICT CENTRAL KOOTENAY

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## Legend

**Available Fire Flow**

FF < 33 L/s

**Watermain Upgrades**

Watermain Upgrades

Existing Watermain

Watermain to be Abandoned

Pump Station

Water Source

Storage Reservoir

Service Boundary

Notes and Limitations:

1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.


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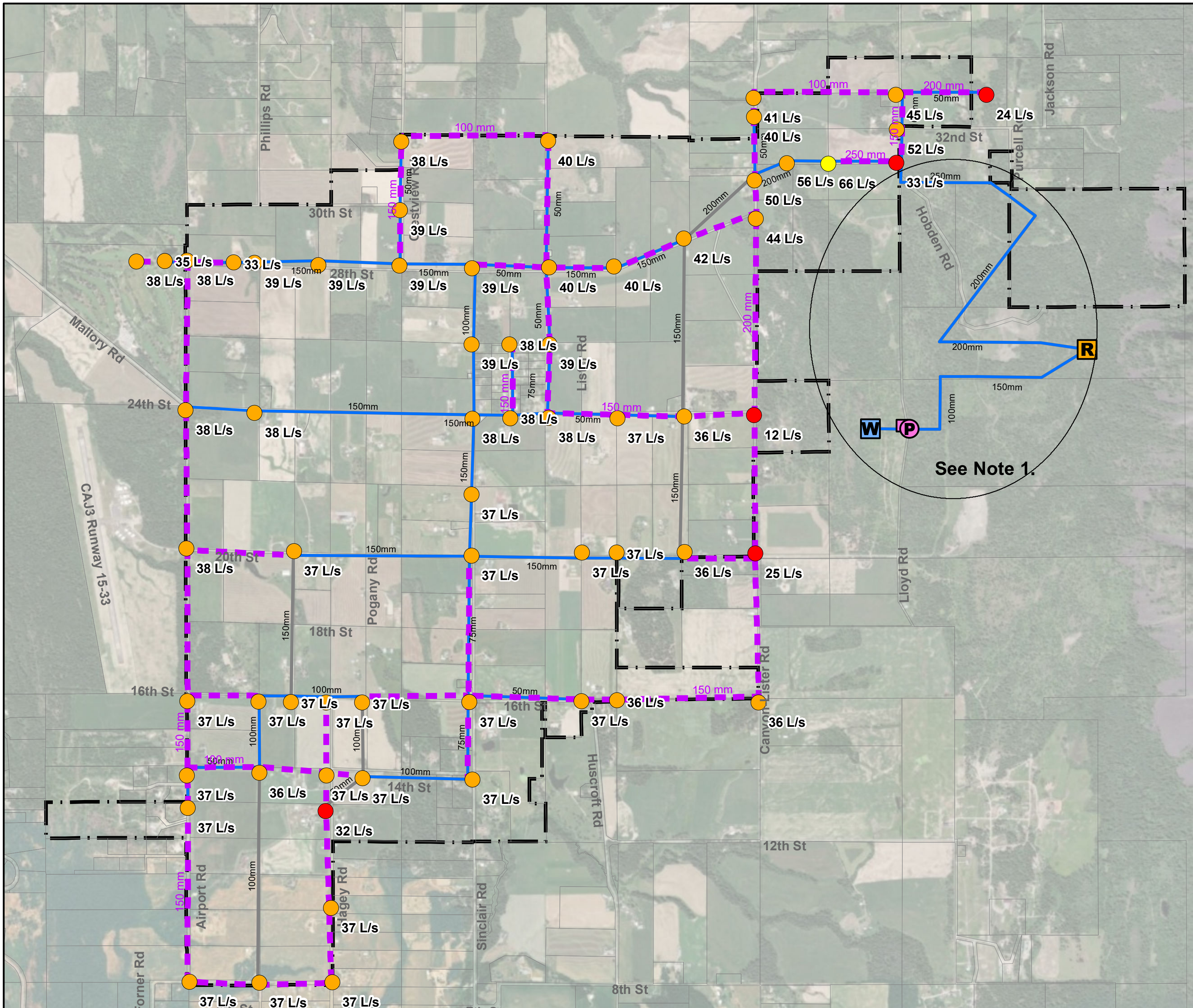
FIGURE 8.2.2A

**LISTER WATER SYSTEM**
**OPTION 2A - FUTURE MAXIMUM DAY DEMAND SCENARIO**
**AVAILABLE FIRE FLOWS**

Scale: 1:30,000 @ Letter
0 300 600
Meters

Project No.: 181-15710-00
Date: October 2019
Drawn: SW
Approved: CL




Client: Regional District of Central Kootenay

## Legend

**Available Fire Flow**

- FF < 33 L/s
- 33 L/s < FF < 60 L/s
- 60 L/s < FF < 90 L/s

**Watermain Upgrades**

- Watermain Upgrades
- Existing Watermain
- Watermain to be Abandoned
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:

1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.


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FIGURE 8.2.2A-1

# LISTER WATER SYSTEM
# OPTION 2A - FUTURE MAXIMUM DAY DEMAND SCENARIO
# AVAILABLE FIRE FLOWS (0 PSI MINIMUM RESIDUAL PRESSURE)

Scale: 1:30,000 @ Letter

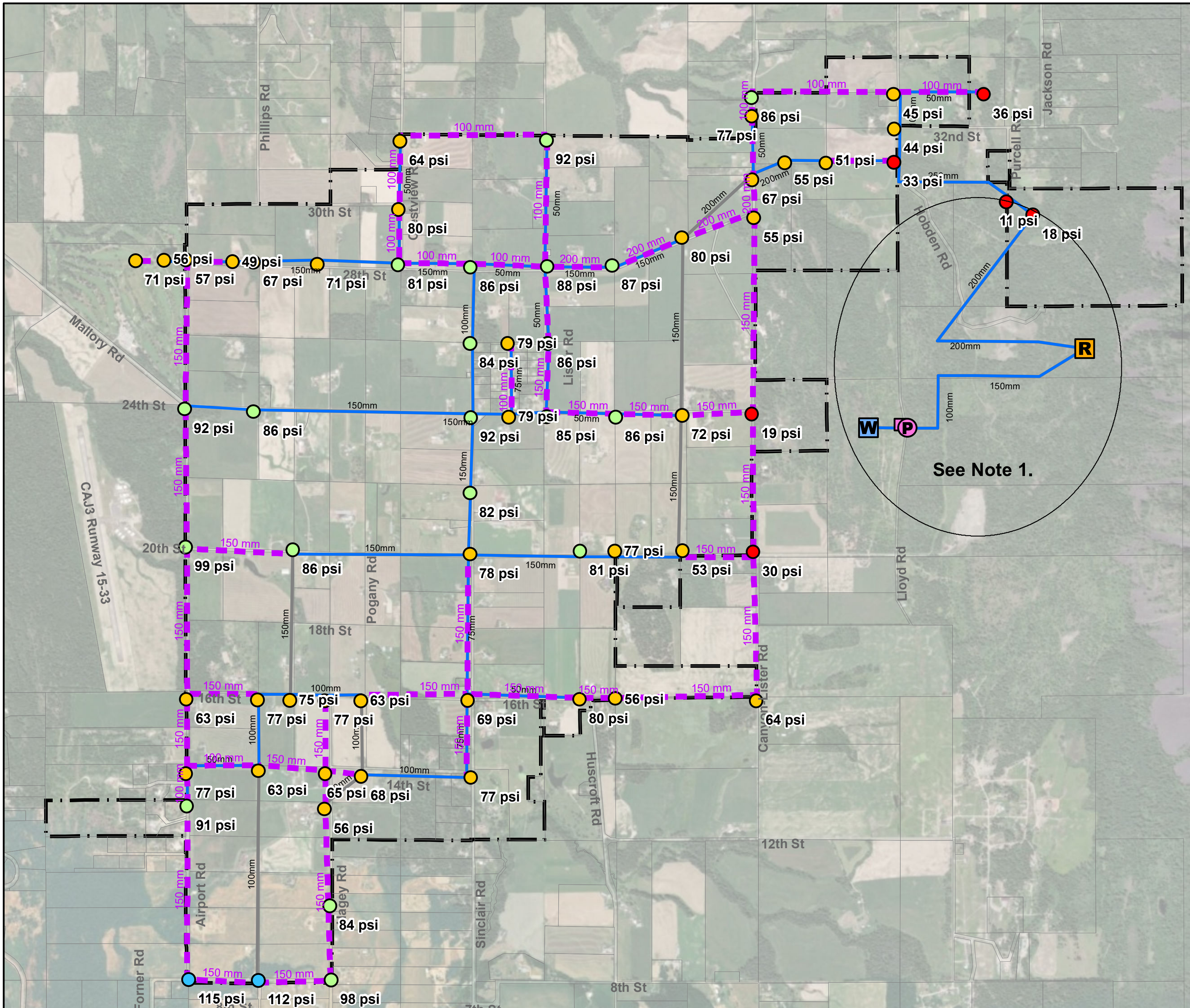
0 300 600 Meters

Project No.: 181-15710-00

Date: October 2019

Drawn: SW

Approved: CL




Client: Regional District of Central Kootenay

Regional District Central Kootenay

N
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## Legend

**Available Pressures**

- <= 40 psi
- 40 psi - 80 psi
- 80 psi - 100 psi
- 100 psi - 127 psi
- Watermain Upgrades
- Existing Watermain
- Watermain to be Abandoned
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:
1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.


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FIGURE 8.2.3

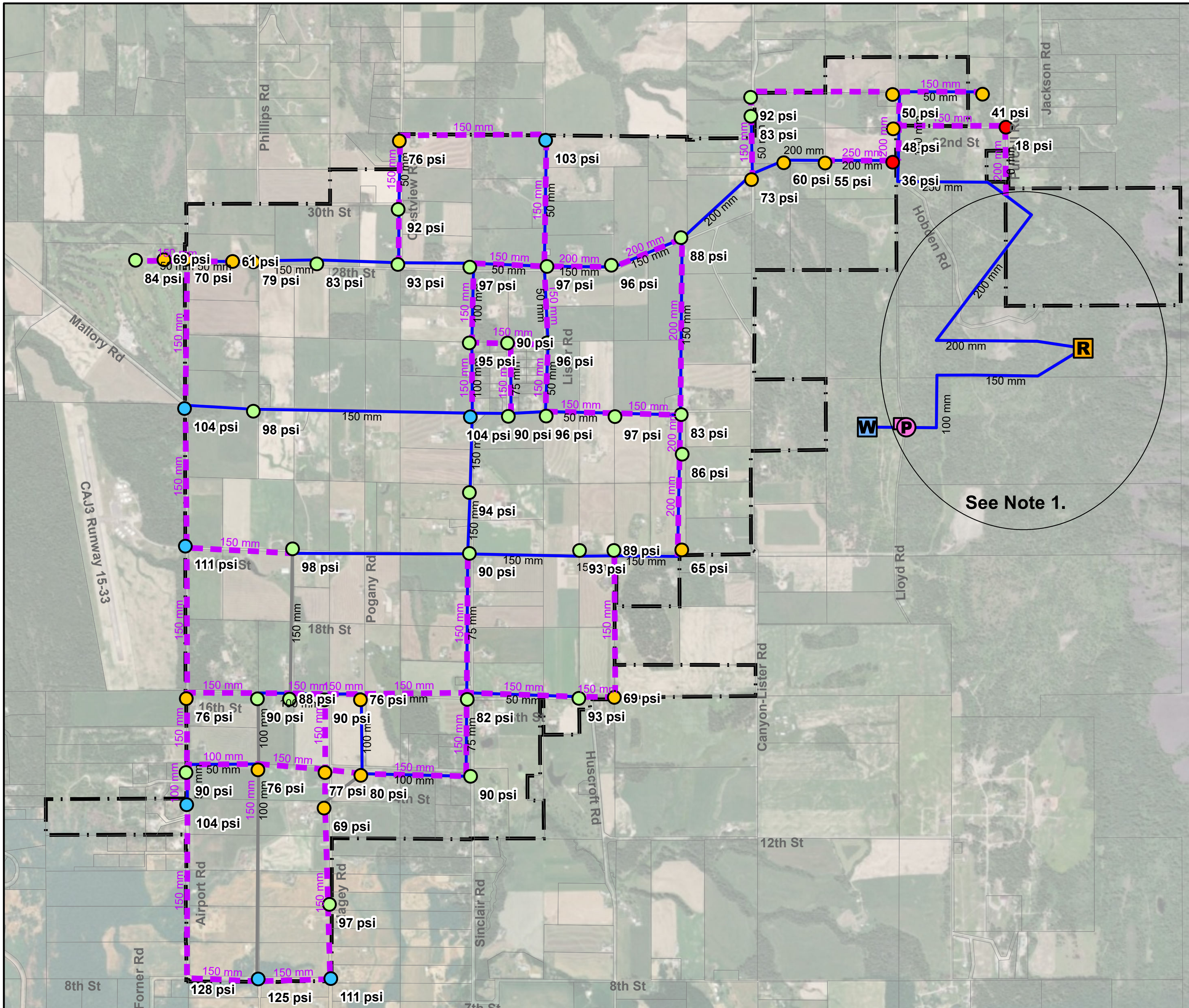
**LISTER WATER SYSTEM**
**OPTION 2 - FUTURE PEAK HOUR DEMAND SCENARIO**
**AVAILABLE PRESSURES**

Scale: 1:30,000 @ Letter
0 300 600
Meters

Project No.: 181-15710-00
Date: October 2019
Drawn: SW
Approved: CL


Path: \\ca-nvr-win01\vc_gen_g\opus_dk\municipal\Regional District of Central Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files - current boundary\8.2.3 Option 2 - PHD.mxd

Client: Regional District of Central Kootenay




## Legend

- Watermain Upgrades
- Existing Watermain
- Watermain to be Abandoned
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:

1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.

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#210 - 889 Harbourside Drive
Tel (604) 990 4800
Fax (604) 990 4805



**FIGURE 8.3.1**

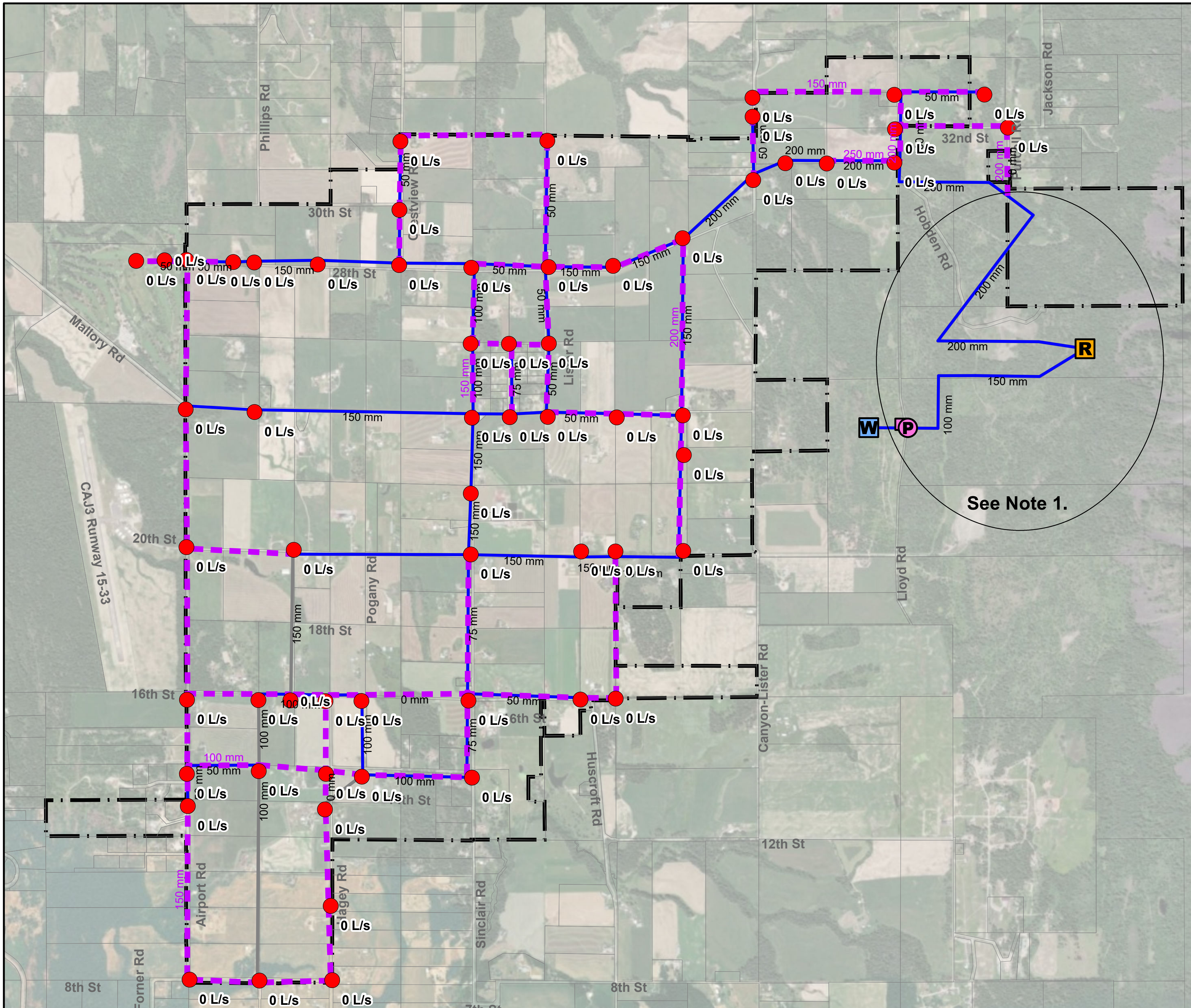
**LISTER WATER SYSTEM**
**OPTION 3 - FUTURE AVERAGE DAY DEMAND SCENARIO**
**AVAILABLE PRESSURE**

Scale: 1:30,000 @ Letter
0 300 600
Meters

Project No.: 181-15710-00
Date: October 2019
Drawn: SW
Approved: CL

Path: \\ca-nvr-win01\vc_gen_g\opus_dk\municipal\Regional District of Central Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files - current boundary\8.3.1 Option 3 - ADD.mxd

Client: Regional District of Central Kootenay




N
W
E
S

## Legend

**Available Fire Flow**

- FF < 33 L/s
- Watermain Upgrades
- Existing Watermain
- Watermain to be Abandoned
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:

1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.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Fax (604) 990 4805




**FIGURE 8.3.2**

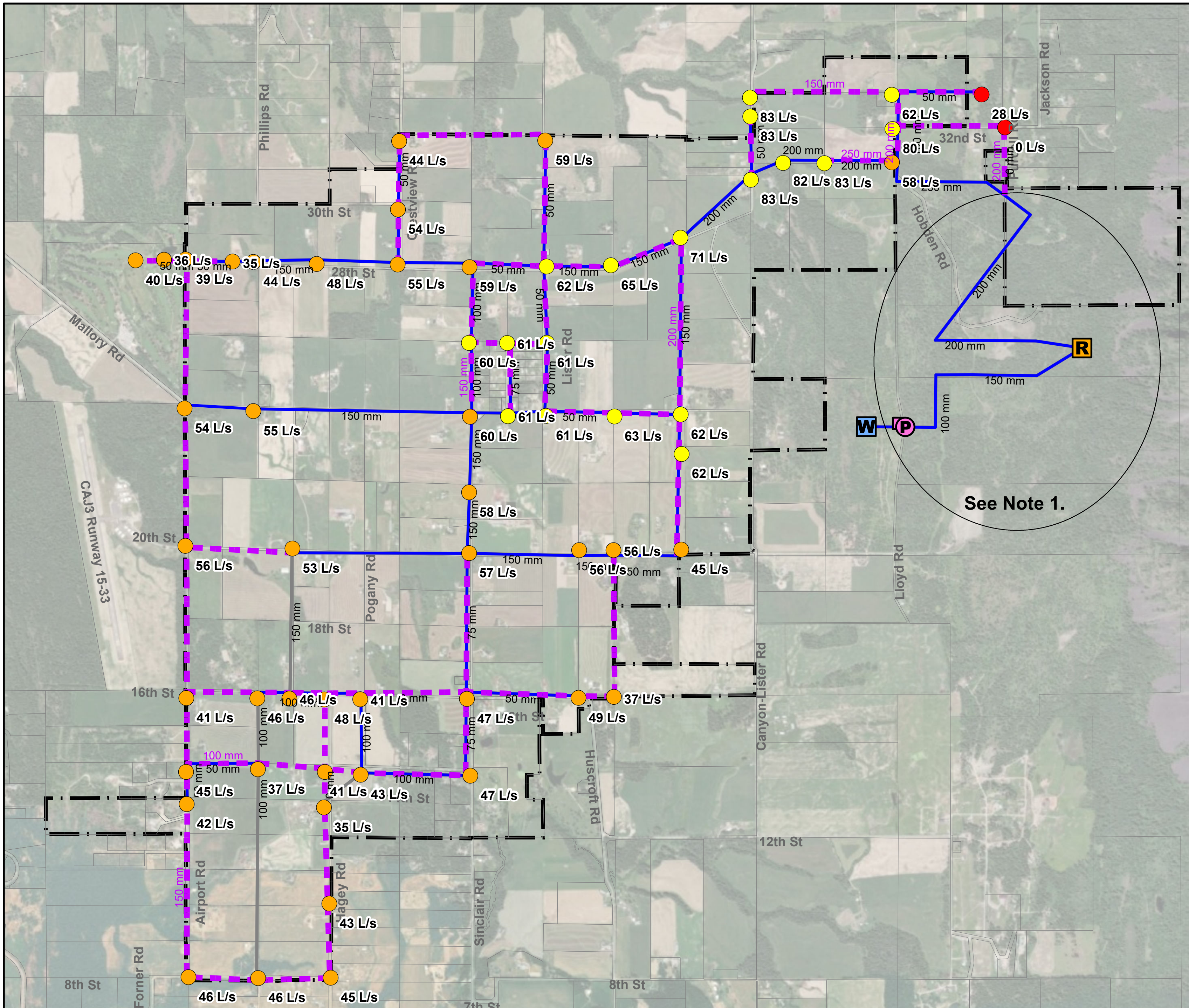
**LISTER WATER SYSTEM**
**OPTION 3 - FUTURE MAXIMUM DAY DEMAND SCENARIO**
**AVAILABLE FIRE FLOW**

Scale:
1:30,000 @ Letter
0 300 600
Meters

Project No.: 181-15710-00
Date: October 2019
Drawn: SW
Approved: CL

Path: \\ca-nvr-win01\vc_gen_g\opus_dk\municipal\Regional District of Central Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files - current boundary\8.3.2 Option 3 - MDD.mxd

Client: Regional District of Central Kootenay




## Legend

**Available Fire Flow**

- FF < 33 L/s
- 33 L/s < FF < 60 L/s
- 60 L/s < FF < 90 L/s
- Watermain Upgrades
- Existing Watermain
- Watermain to be Abandoned
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:

1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.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#210 - 889 Harbourside Drive
Tel (604) 990 4800
Fax (604) 990 4805



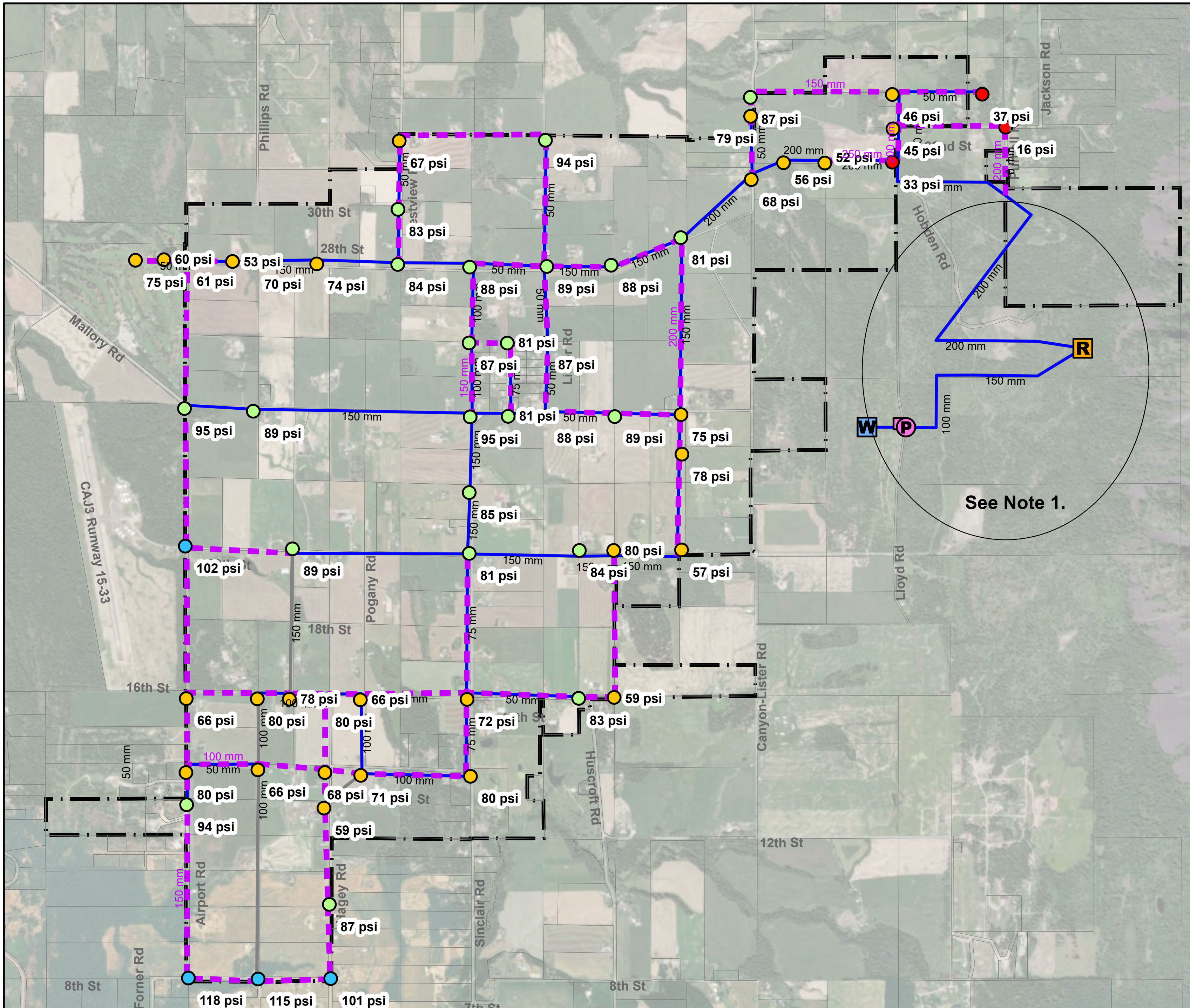

**FIGURE 8.3.2-1**

**LISTER WATER SYSTEM**
**OPTION 3 - FUTURE MAXIMUM DAY DEMAND SCENARIO**
**AVAILABLE FIRE FLOW (0 psi MINIMUM RESIDUAL PRESSURE)**

| | |
|---|---|
| Scale: | 1:30,000 @ Letter; 0 300 600 Meters |
| Project No.: | 181-15710-00 |
| Date: | October 2019 |
| Drawn: | SW |
| Approved: | CL |

Client: Regional District of Central Kootenay

REGIONAL DISTRICT CENTRAL KOOTENAY

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## Legend

**Available Pressures**

- <= 40 psi
- 40 psi - 80 psi
- 80 psi - 100 psi
- 100 psi - 127 psi
- Watermain Upgrades
- Existing Watermain
- Watermain to be Abandoned
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:
1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.

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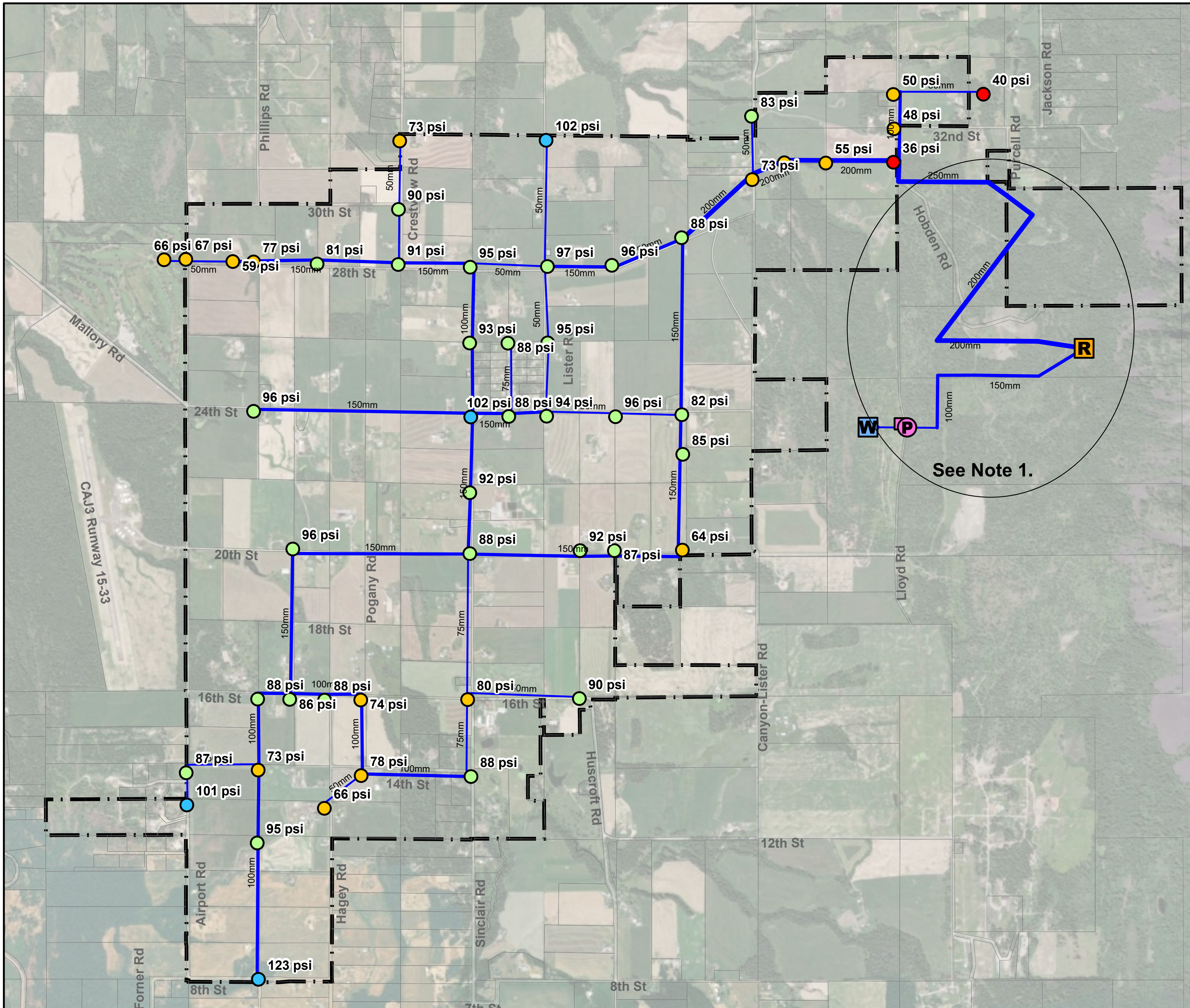
FIGURE 8.3.3

**LISTER WATER SYSTEM**
**OPTION 3 - FUTURE PEAK HOUR DEMAND SCENARIO**
**AVAILABLE PRESSURE**

Scale: 1:30,000 @ Letter
0 300 600
Meters

Project No.: 181-15710-00
Date: October 2019
Drawn: SW
Approved: CL




Client: Regional District of Central Kootenay

REGIONAL DISTRICT CENTRAL KOOTENAY

N
W E
S

# Legend

**Available Pressures**

- <= 40 psi
- 40 psi - 80 psi
- 80 psi - 100 psi
- 100 psi - 127 psi
- Pump Station
- Water Source
- Storage Reservoir
- Service Boundary

Notes and Limitations:
1. Watermains in the area indicated have user defined lengths from the EPANET model provided by RDCK.
2. No updates have been made to the existing diameters, or C-factors in the EPANET model provided by RDCK.
3. The elevations for all watermains are based on LIDAR data, provided by the RDCK (July 2019)
4. The model has not been calibrated.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#210 - 889 Harbourside Drive
Tel (604) 990 4800
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**FIGURE 7.1**

**LISTER WATER SYSTEM**
**EXISTING AVERAGE DAY DEMAND SCENARIO**
**SYSTEM PRESSURES**

Scale:
1:30,000 @ Letter
0 300 600
Meters

Project No.: 181-15710-00
Date: October 2019
Drawn: SW
Approved: CL


Path: \\ca-nvr-win01\vc_gen_g\opus_dk\municipal\Regional District of Central Kootenay\proj\181-15710-00 Lister Water System Assessment\400 Tech\GIS\mxd files - current boundary\7.1 Existing ADD.mxd

# B CLASS D COST ESTIMATES

| Item | Description | Unit Cost | Unit | Quantity | Extension |
|---|---|---|---|---|---|
| **Option 1: Improve pressure under PHD with watermains in existing locations, secure SRW, service vacant parcels.** | | | | | |
| 1.1 | **Install/Replace watermain (incl. fittings, valves, hydrants, connecting to existing service connections)** | | | | |
| | 100Ø Watermain | $405 | lineal metre | 7,130 | $2,887,650 |
| | 150Ø Watermain | $470 | lineal metre | 399 | $187,530 |
| | 200Ø Watermain | $500 | lineal metre | | $0 |
| | 250Ø Watermain | $620 | lineal metre | 406 | $251,720 |
| | 100Ø Watermain with road base and paving | $750 | lineal metre | | $0 |
| | 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 | 47,610 | $190,440 |
| 1.5 | Install new hydrants | $7,500 | each | - | $0 |
| | | | | **Sub-Total** | **$3,517,340** |
| | | | | Engineering & Design (15%) | $527,601 |
| | | | | Contingency (50%) | $1,758,670 |
| | | | | **Grand Total** | **$5,803,611** |

| Item | Description | Unit Cost | Unit | Quantity | Extension |
|---|---|---|---|---|---|
| **Option 2: Improve pressure under PHD, looping for water quality, move alignment to road ROW, service vacant parcels.** | | | | | |
| 1.1 | **Install/Replace watermain (incl. fittings, valves, hydrants, connecting to existing service connections)** | | | | |
| | 100Ø Watermain with road base and paving | $750 | lineal metre | 4,092 | $3,069,000 |
| | 150Ø Watermain with road base and paving | $815 | lineal metre | 3,860 | $3,145,900 |
| | 200Ø Watermain with road base and paving | $845 | each | 809 | $683,605 |
| | 250Ø Watermain with road base and paving | $965 | each | 406 | $391,790 |
| 1.2 | Install new services | $50 | lineal metre | 4,205 | $210,250 |
| 1.3 | Install new curb stops | $1,500 | each | 24 | $36,000 |
| 1.4 | Acquire ROW | $4 | square metre | 12,498 | $49,992 |
| 1.5 | Install new hydrants | $7,500 | each | - | $0 |
| | | | | **Sub-Total** | **$7,586,537** |
| | | | | Engineering & Design (15%) | $1,137,981 |
| | | | | Contingency (50%) | $3,793,269 |
| | | | | **Grand Total** | **$12,517,786** |

| Item | Description | Unit Cost | Unit | Quantity | Extension |
|---|---|---|---|---|---|
| **Option 2A: Improve pressure under PHD, looping for water quality, move alignment to road ROW, service vacant parcels. Upsize trunk mains for rural fire flow.** | | | | | |
| 1.1 | **Install/Replace watermain (incl. fittings, valves, hydrants, connecting to existing service connections)** | | | | |
| | 100Ø Watermain with road base and paving | $750 | lineal metre | 952 | $714,000 |
| | 150Ø Watermain with road base and paving | $815 | lineal metre | 6,503 | $5,299,945 |
| | 200Ø Watermain with road base and paving | $845 | each | 1,271 | $1,073,995 |
| | 250Ø Watermain with road base and paving | $965 | each | 406 | $391,790 |
| 1.2 | Install new services | $50 | lineal metre | 4,205 | $210,250 |
| 1.3 | Install new curb stops | $1,500 | each | 24 | $36,000 |
| 1.4 | Acquire ROW | $4 | square metre | 12,498 | $49,992 |
| 1.5 | Install new hydrants | $7,500 | each | 233 | $1,747,500 |
| | | | | **Sub-Total** | **$9,523,472** |
| | | | | Engineering & Design (15%) | $1,428,521 |
| | | | | Contingency (50%) | $4,761,736 |
| | | | | **Grand Total** | **$15,713,729** |

| Item | Description | Unit Cost | Unit | Quantity | Extension |
|---|---|---|---|---|---|
| **Option 3: Builds on Option 1 and includes additional future looping, relocation and addition of watermains where required, and pipe upsizing, to improve available pressures under the PHD scenario and provide the required fire flows under the MDD option.** | | | | | |
| 1.1 | **Install/Replace watermain (incl. fittings, valves, hydrants, connecting to existing service connections)** | | | | |
| | 100Ø Watermain with road base and paving | $750 | lineal metre | 595 | $446,250 |
| | 150Ø Watermain with road base and paving | $815 | lineal metre | 9,140 | $7,449,100 |
| | 200Ø Watermain with road base and paving | $845 | each | 2,799 | $2,365,155 |
| | 250Ø Watermain with road base and paving | $965 | each | 406 | $391,790 |
| 1.2 | Install new services | $50 | lineal metre | 2,280 | $114,000 |
| 1.3 | Install new curb stops | $1,500 | each | 13 | $19,500 |
| 1.4 | Acquire ROW | $4 | square metre | 23,112 | $92,448 |
| 1.5 | Install new hydrants | $7,500 | each | 232 | $1,740,000 |
| | | | | **Sub-Total** | **$12,618,243** |
| | | | | Engineering & Design (15%) | $1,892,736 |
| | | | | Contingency (50%) | $6,309,122 |
| | | | | **Grand Total** | **$20,820,101** |