JASPER WATER MODEL

MUNICIPALITY OF JASPER

REPORT

CONFIDENTIAL
JULY 2022

ISL

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July 7, 2022

Our Reference: 28026

Municipality of Jasper
303 Pyramid Lake Road, Box 520
Jasper, AB, T0E 1E0

Attention: Vidal Michaud, Utilities Manager, Operations Department

Dear V. Michaud:

Reference: Jasper Water Model –Report

Enclosed is the report for the Jasper Water Model project. We trust that it meets your expectations.

The Jasper Water Model project was initiated by the Municipality to develop a comprehensive water model to address existing conditions and limitations within the existing distribution system. The Jasper Water Model provides recommendations for areas where future development in the form of infills and densification can occur. It also provides recommendations for existing and future growth horizon upgrades.

This project was prompted by a lack of a hydraulic model and concerns of existing capacity limitations where densification is anticipated. This study will guide effective infrastructure implementation and assist the Municipality in understanding the existing water system and associated constraints that require upgrades.

We sincerely appreciate the opportunity to undertake this project on behalf of the Municipality of Jasper. Should you have any questions or concerns, please do not hesitate to contact the undersigned at 403.254.0544.

Sincerely,

Geoffrey Schulmeister, P.Eng., SCPM
General Manager, Water and Environment

Corporate Authorization

This document entitled “Jasper Water Model” has been prepared by ISL Engineering and Land Services Ltd. (ISL) for the use of the Municipality of Jasper. The information and data provided herein represent ISL’s professional judgment at the time of preparation. ISL denies any liability whatsoever to any other parties who may obtain this report and use it, or any of its contents, without prior written consent from ISL.

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Executive Summary

Background

The Municipality of Jasper (the Municipality) retained ISL Engineering and Land Services Ltd. (ISL) to develop a comprehensive water model to address existing conditions and limitations within the existing distribution system. The Municipality is currently operating a Level II water distribution system. Source water is supplied by three wells that are pumped to the Municipality's reservoir. Water from the reservoir is then fed to a common pressure zone for the entire community. Redevelopment is anticipated in the area by means of infilling vacant lots and converting single family homes to multi-family housing.

The Jasper Water Model was developed to meet the following objectives:
- Generate a comprehensive inventory of the existing water system and a hydraulic capacity assessment
- Develop a comprehensive water model for the service area using Bentley WaterCAD software that is compatible with the Municipality's current GIS software systems
- Calibrate the water model to represent real-life conditions more accurately
- Conduct an evaluation of the existing system and provide recommendations for upgrades and maintenance, including associated costs
- Identify upgrades required to service future development growth (targeting community housing availability), including associated costs
- Develop a condition rating system and prioritization plan for recommended upgrades

Cost Summary of Upgrades

Based upon the work process, a number of upgrades are recommended for the system. These are prioritized in Table 8.3 in the report, with cost summary as follows:
- $8.7 million in upgrades to the existing water system
- A further $1.3 million in upgrades to meet 25-year growth needs
- An annual spend of roughly $500,000 on average for roughly the next 20-25 years to meet these needs

Conclusions

Conclusions for the existing system are as follows:
1. Watermains near the river exhibit pressures greater than 800 kPa under Average Day Demand (ADD) and Maximum Day Demand (MDD) conditions and could become an issue under lower demand scenarios, particularly ADD, night-time, or off-season (i.e., winter) demands.
2. There are some isolated pressure constraints under Peak Hour Demand (PHD) conditions, though most of these pressure constraints are limited to smaller diameter dead-end mains and should not impact most of the distribution system.
3. The large variability in demands caused by seasonal tourists results in a big variance in pressures observed throughout the system. This coupled with the single pressure zone and reasonable degree of topographical changes could support the implementation of additional pressure zones to better control system pressures.
4. The hydrant with the smallest available fire flow occurs at the Jasper Inn & Suites, with other areas with significant fire flow deficiencies also occurring on dead-end small diameter watermains.
5. The reservoir is sufficiently filled under ADD, MDD, and fire flow parameters, with the caveat that chlorine contact time needs a separate review as it may increase the reservoir storage need.
6. The raw water supply flow rate is sufficient under ADD conditions. It is also sufficient under MDD conditions if there is some reserve capacity in the reservoir. If MDD conditions extend beyond a 24-hour duration, the reservoir would continue to be depleted, which could become a concern. The same concern would be apparent under PHD or fire flow conditions. Dialogue with AEP on supply rate required is recommended due to the drawdown under MDD conditions.

7. Areas most at risk for leakage are the industrial lands to the southeast and the developments to the north, where higher pressures are observed, and the areas are older.

Conclusions for the future system are as follows:
1. In the 10-year growth horizon, pressures are adequate under ADD and MDD conditions, however, drop below the recommended minimum pressure of 275 kPa under PHD conditions. This drop occurs in a significant portion of the townsite with watermains exhibiting the largest head loss predominantly along Bonhomme Street, Miette Avenue and Pine Avenue intersection.
2. Results from the 25-year growth horizon are generally like the 10-year, with ADD and MDD conditions performing adequately but PHD suggesting significant losses throughout the system. Areas with higher head losses also occur along Bonhomme Street, suggesting these areas would be good candidates for system improvements.
3. Fire flow contours are generally consistent in comparison to each other and the existing system upgrades results, with some incremental drops in available fire flow from existing to the 10-year growth horizon and from the 10-year to the 25-year growth horizon.
4. The reservoir is sufficiently filled under ADD, MDD, and fire flow parameters for the 10-year growth horizon, with a minimal deficiency of 8 m^3 for the 25-year growth horizon. There is not a substantial increase in the amount of storage needed from existing to future conditions.
5. Under ADD conditions, the reservoir is filling for both the 10- and 25-year growth horizons, though the 10-year growth horizon fills at a faster rate as there is a smaller demand required in the distribution system in comparison. The 10-year growth horizon is 95.2% full by the end of the day while the 25-year growth horizon is 86.6% full by the end of the day.
6. Under MDD conditions, there is more flow leaving the tank into the distribution system than there is flow filling the reservoir for most of the day. The reservoir is being depleting quicker than existing condition, with the 25-year growth horizon depleting quicker than the 10-year growth horizon. There is also the risk of depletion in the event of a fire, heightened for the future scenario particularly for the 25-year growth horizon under MDD conditions.

Recommendations

Recommendations for the existing system are as follows:
1. Upgrades are recommended to the existing system aim to reduce the high pressures in lower elevations under ADD and MDD conditions, increase pressures where deficiencies were noted under PHD conditions, and improve available fire flows at hydrants.
2. To reduce high pressures, implement three new pressure zones via eight new pressure reducing valves (PRVs). The first proposed pressure zone would be for the predominantly industrial lands with three PRVs added to the three watermains feeding the area. The second pressure zone is up north on Bonhomme Street, where four PRVs separate the lower terrain from the Main Pressure Zone. The final pressure zone is north of the second pressure zone, servicing only a few properties with one PRV.
3. To improve pressure and fire flow deficiencies, some looping and pipe upsizing is recommended. A 250 mm backbone is proposed in the industrial lands to provide additional fire flow protection. Two connections are proposed on Pyramid Lake Road. One connects the two sections of 300 mm watermains, and another connects the 50 mm cast iron watermain on the alley between Colin Crescent and Geikie Street to the 300 mm watermains. Smaller localized upgrades are also proposed on dead-end watermains to improve the pressures and fire flows.
4. Consideration for upgrading areas with small fire flow deficiencies could be made during roadworks programs. The recommendation in this case would be to replace watermains 150 mm or smaller with 200 mm to 300 mm mains to improve fire flows in Jasper. Dovetailing with roadworks programs is recommended to ensure efficient use of capital funds so if the road is already being re-done, the watermain can be replaced at an incremental cost relative to the overall road repair/replacement. This would offer a solution to improve the low roughness coefficients derived through the calibration process for smaller diameter cast iron pipes.
5. Remaining hydrants with a fire flow less than 76 L/s are on 150 mm mains and should be upgraded during roadworks programs or other capital projects.

6. To reduce the UFW throughout the system, several short-, medium-, and long-term solutions are proposed.
    a. Short-term solutions involve first differentiating between UFW due to irrigation vs leakage. Watermains with high normal operating pressures can also be reviewed to determine their watermain pressure rating.
    b. Medium-term solutions involve testing suspected watermains with high leakage in the field or by implementing leakage detection systems. Areas with higher pressures under normal operating pressures can also be divided into separate pressure zones through PRVs. This would reduce the pressures in the lower-lying areas.
    c. Long-term solutions would involve undertaking a replacement program to remove any watermains that are likely contributing to leakage. The replacement program can also be coupled with other capital projects, such as sewer replacements or roadway improvement projects. This will help to reduce the capital costs associated with these upgrades.
7. Review chlorine contact time requirements to confirm if some additional reservoir storage, or revisions such as baffles are required. A discussion with AEP is recommended in this case.
8. Confirm water supply rate requirements with AEP; while the reservoir retains capacity under the depletion modelling, the potential guide for a supply rate of two times MDD plus 10% does exist, though with Jasper's seasonality of demand, AEP may make an exception here. Dialogue with AEP is recommended to flesh this out.

Recommendations for the future system are as follows:

1. To improve pressures under peak hour demands, some watermain upgrades are recommended along Bonhomme Street. This includes upsizing the 150 mm bottleneck near the intersection of Bonhomme Street, Miette Avenue, and Pine Avenue to a 300 mm PVC watermain. As well, the source of significant pressure drops near the intersection of Bonhomme Street and Willow Avenue should be investigated and mitigated to also improve pressures.
2. Subject to the other recommendations for existing system upgrades and the pressure upgrade for the future system, no other specific watermain upgrades are recommended at this stage to improve fire flows throughout the network, however, smaller diameter watermains (150 mm and under) should be considered for upsizing if these align with any other capital upgrades or roadworks improvement programs.
3. Upgrades to the reservoir are not recommended in terms of storage capacity. Though there is a slight deficiency, this deficiency is very minimal. Instead, it is suggested that the Municipality confirms the exact reservoir sizing in the field, given that the reservoir storage was calculated from old record drawings. If there are discrepancies between the actual and calculated storage volumes, the actual volume should be compared to the required storage volume to ensure its adequacy. Review chlorine contact time requirements to confirm if some additional reservoir storage, or revisions such as baffles are required. A discussion with AEP is recommended in this case.

4. In terms of raw water supply, it was noted that there is a node with a negative pressure prior to reaching the reservoir. The pumping capacities of the three production wells should be investigated in the field, and updates to the WaterCAD model can be made accordingly. It is recommended to confirm water supply rate requirements with AEP; while the reservoir retains capacity under the depletion modelling, the potential guide for a supply rate of two times MDD plus 10% does exist, though with Jasper's seasonality of demand, AEP may make an exception here. Dialogue with AEP is recommended to flesh this out.

Table of Contents

APPENDICES

TABLES

FIGURES

ABBREVIATIONS

Abbreviation	Meaning
ACP	asbestos cement pipe
ADD	average day demand
AEP	Alberta Environment and Parks
CI	cast iron
CMP	composite material pipe
DI	ductile iron
EPS	extended period simulation
FF	fire flow
GIS	geographic information system
GP	galvanized Pipe
HDPE	high density polyethylene
HDR	high density residential
HGL	hydraulic grade line
ISL	ISL Engineering and Land Services Ltd.
LDR	low density residential
LiDAR	light detection and ranging
MDD	maximum day demand
MDR	medium density residential
the Municipality	the Municipality of Jasper
PHD	peak hour demand
PRV	pressure reducing valve
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
S	steel
UFW	unaccounted for water
WTP	Water Treatment Plant

UNITS

Unit	Meaning
$	dollars
%	percentage
ft^2	square feet
ft^2/unit	square feet per unit
ha	hectares
km	kilometre
kPa	kilopascals
L/p/d	litres per person per day
L/s	litres per second
L/s/ha	litres per second per hectare
m	metres
m^3	cubic metres
mm	millimetres
psi	pounds per square inch

GLOSSARY

ArcGIS – A program for mapping and spatial analysis.

Average Daily Demand – The average amount of water consumed in a community, city, or town, by a person in one day.

Calibrate – To adjust model parameters such that model results match known (measured) values.

Cast Iron – Comprised predominantly of a gray cast iron tube frequently used uncoated as a pressure pipe for transmission of water, gas, and sewage.

Commercial – Any development that is used for an activity with the purpose of generating a profit.

Density – A quantitative measure of the number of persons, families, or dwelling units per unit of area.

Developer – A registered owner, agent or any person, firm or company required to obtain or having obtained a development permit.

Development Type – Classification of urban areas into different categories.

Ductile Iron – A high strength graphite-rich cast iron material, often used for watermains.

Fire Flow – The quantity of water available for fire protection purposes in excess of that required for other purposes.

High Density Polyethylene – A synthetic plastic polymer that is tougher but heavier than polyvinyl chloride.

Head – The energy of a fluid expressed as the equivalent height of the fluid as a static column.

Hydrant Testing – A test conducted to determine the flow rate and pressure at a hydrant within a system. Often used for calibration or to determine water availability for firefighting.

Industrial – Any developments that are used for manufacturing, such as factories.

Institutional – Any developments that are used for the public’s interest, such as schools, hospitals, and recreation centres.

Junction – A calculation point in a network model – generally interchangeable with ‘node’.

Light Detection and Ranging (LiDAR) – Remote sensing method that uses a pulsed laser to measure ranges.

Main – An underground conduit for carrying potable water.

Maximum Day Demand – The maximum amount of water consumed in one day throughout the year.

Municipality – The governing body of Jasper.

Node – A calculation point in a network model – generally interchangeable with ‘junction’.

Parcel – The aggregate of the one or more areas of land described in a Certificate of Title or described in a Certificate of Title by reference to a plan filed or registered in a Land Titles Office.

Peak Hour Demand – The maximum amount of water consumed in one hour of maximum day during any month of the year.

Polyvinyl Chloride – A synthetic plastic polymer, often used for watermains.

Potable Water – Municipal water is water that has been processed and treated to meet drinking water standards of a given municipality.

Pump Curve – A relation of head and flow at which a pump is capable of operating.

Residential – Any developments that are used for housing a municipality’s population.

Roughness – The degree a surface will resist fluid flow. A main's roughness will depend on factors such as age and material.

Service Area – An area connected to a particular point of the distribution system.

Shapefile – An Esri-developed digital format for GIS data that carries both spatial and attribute information.

Spatial Analysis – Analysis of data based on location.

Topography – The terrain features in three dimensions.

Townsite – The legal subdivision of land.

Upgrade – To enable a section of the system to handle a greater capacity.

Water Treatment Plant – A facility that produces drinking water for public consumption. Treatment often involves some combination of filtering of sediment and disease-causing organisms and chemical treatment to remove excess minerals and other contaminants.

1.0 Introduction

1.1 Authorization

The Municipality of Jasper (the Municipality) retained ISL Engineering and Land Services Ltd. (ISL) to develop a comprehensive water model to address existing conditions and limitations within the existing distribution system. The Jasper Water Model (the Study) intends to provide recommendations for areas of expansion and upgrades to existing infrastructure.

By applying a comprehensive design, consistent approaches to issues, and sound engineering principles, while all the time protecting the natural and human environment, this study will guide effective infrastructure implementation and assist the Municipality in understanding the existing water system and associated constraints that require upgrades.

1.2 Background

The Municipality is currently operating a Level II water distribution system. Source water is supplied by three wells that are pumped to the Municipality's reservoir. Water from the reservoir is then fed to a common pressure zone for the entire community. Redevelopment is anticipated in the area by means of infilling vacant lots and converting single family homes to multi-family housing.

Areas of interest identified by the Municipality that triggered the need for this study include:

- The lack of a hydraulic model to evaluate the existing system;
- Concerns of limited system capacity under maximum day demand, peak hour demand, and fire flow conditions;
- The Municipality's unique topography that results in areas of high pressure based on a single pressure zone;
- The need for a water audit to identify losses attributed to unaccounted water, such as unmetered parcels or system leakage; and
- Restriction of development which prevents expansion of Municipality boundaries, with redevelopment of existing properties needed for growth to occur.

1.3 Purpose of Study

The Jasper Water Model will be developed to meet the following objectives:

- Generate a comprehensive inventory of the existing water system and a hydraulic capacity assessment
- Develop a comprehensive water model for the service area using Bentley WaterCAD software that is compatible with the Municipality's current GIS software systems
- Calibrate the water model to represent real-life conditions more accurately
- Conduct an evaluation of the existing system and provide recommendations for upgrades and maintenance, including associated costs
- Identify upgrades required to service future development growth, including associated costs
- Develop a condition rating system and prioritization plan for recommended upgrades

2.0 Study Area

2.1 Location

The Municipality of Jasper is situated in the Canadian Rocky Mountains on the mid-western border of Alberta. It is roughly 320 km from Edmonton and 345 km from Calgary. The Municipality is situated on the convergence between Highway 16 and the Icefields Parkway, which provide routes to both Calgary and Edmonton.

The overall study area of the Study includes all water infrastructure to conduct modelling of the existing system. The study area is bounded to the townsite. There is limited room for growth beyond the current boundary, so it is anticipated that future growth is mostly limited to densification and a few remaining undeveloped parcels within the townsite. The study area encompasses a total area of approximately 250 ha. Figure 2.1 highlights the area that was considered as part of this project.

The highest elevation in the townsite is northwest of Bonhomme Street, at an elevation of 1,090.25 m. The lowest elevation is in the northeast corner at an elevation of 1,033.66 m. Outside of the townsite, the elevation quickly drops to the east towards the Athabasca River, and raises significantly to the west towards the base of Cairngorm and Pyramid Mountain. The topography within the study area is shown in Figure 2.2.

2.2 Development Type

The development type influences water consumption rates, therefore obtaining an appropriate classification was vital in order to ensure that an accurate representation of the Municipality's water distribution system could be achieved. When determining development classification for existing areas in Jasper, a land use district shapefile provided by the Municipality was utilized.

A land use district map for the existing development is illustrated in Figure 2.3, while Table 2.1 summarizes all land use district codes and their corresponding descriptions. The land uses were compared to aerial maps and Google Street View to confirm that parcels were properly categorized. For the purposes of the project, many of these land use districts were grouped together to form an overall land use. In this manner, Jasper was classified more broadly by a number of unique development types, including residential, commercial, industrial, and institutional.

Table 2.1: Land Use District Descriptions

District Code	District Description	District Code	District Description
C1	Central Business District	NOS	Natural Open Space
C2	Tourist Commercial District	PS	Public Services
C3	Tourist Commercial Town Centre	R1	One-Family Dwelling District
C4	Automobile Service Station	R2	Two-Family Dwelling District
CCWa	Cabin Creek West One-Unit Dwelling	R2H	Old Town Jasper Historic
CCWb	Cabin Creek West Two-Unit Dwelling	R3a	Multi-Unit Small Lot Dwelling
CCWc	Cabin Creek West Multi-Unit Dwelling	R3b	Multi Dwelling
CR	Community Reserve	R4	Compact Lot
HS	Hostel	ROS	Recreational Open Space
I	Institutional	S	Storage and Services

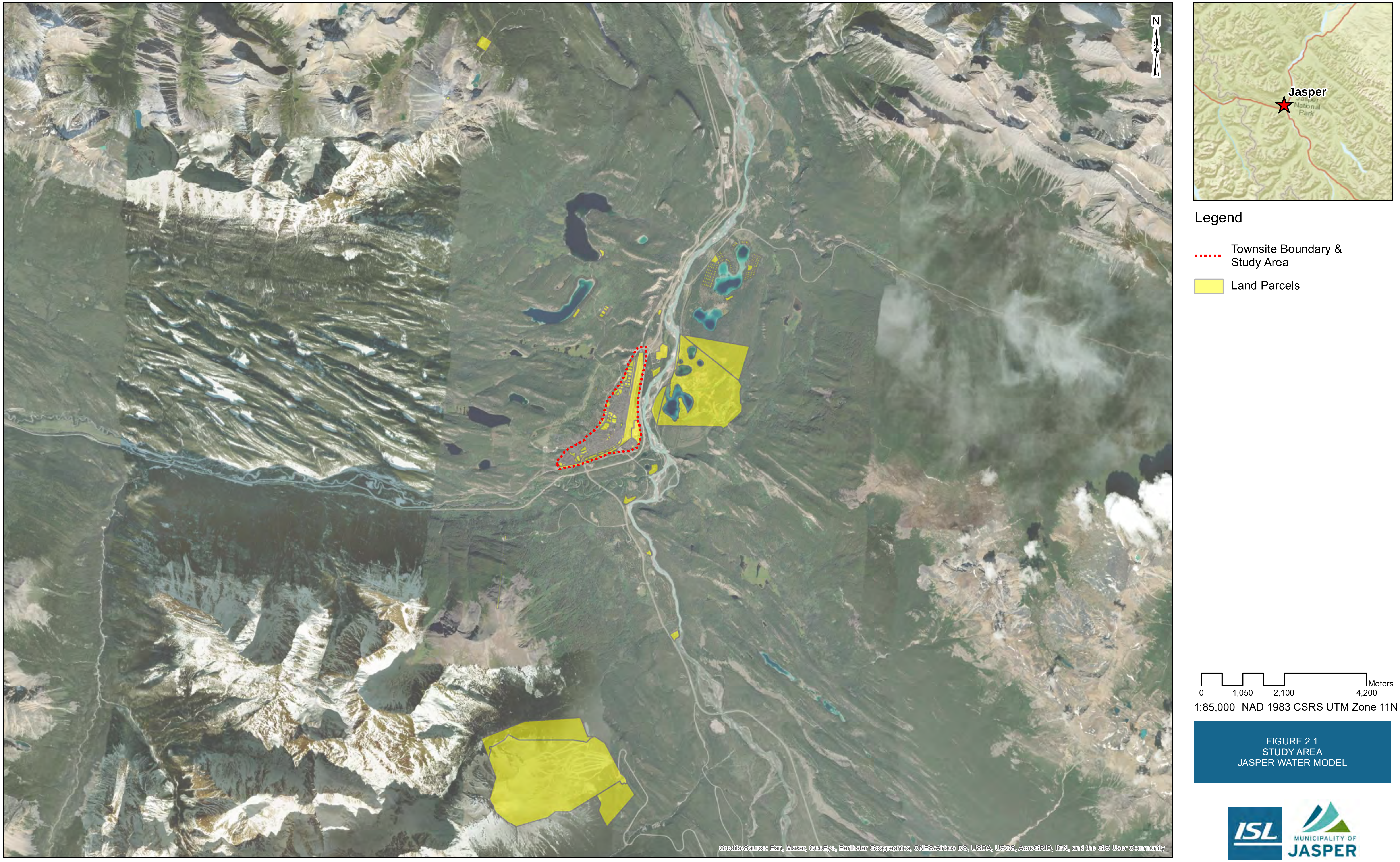

FIGURE 2.1
STUDY AREA
JASPER WATER MODEL

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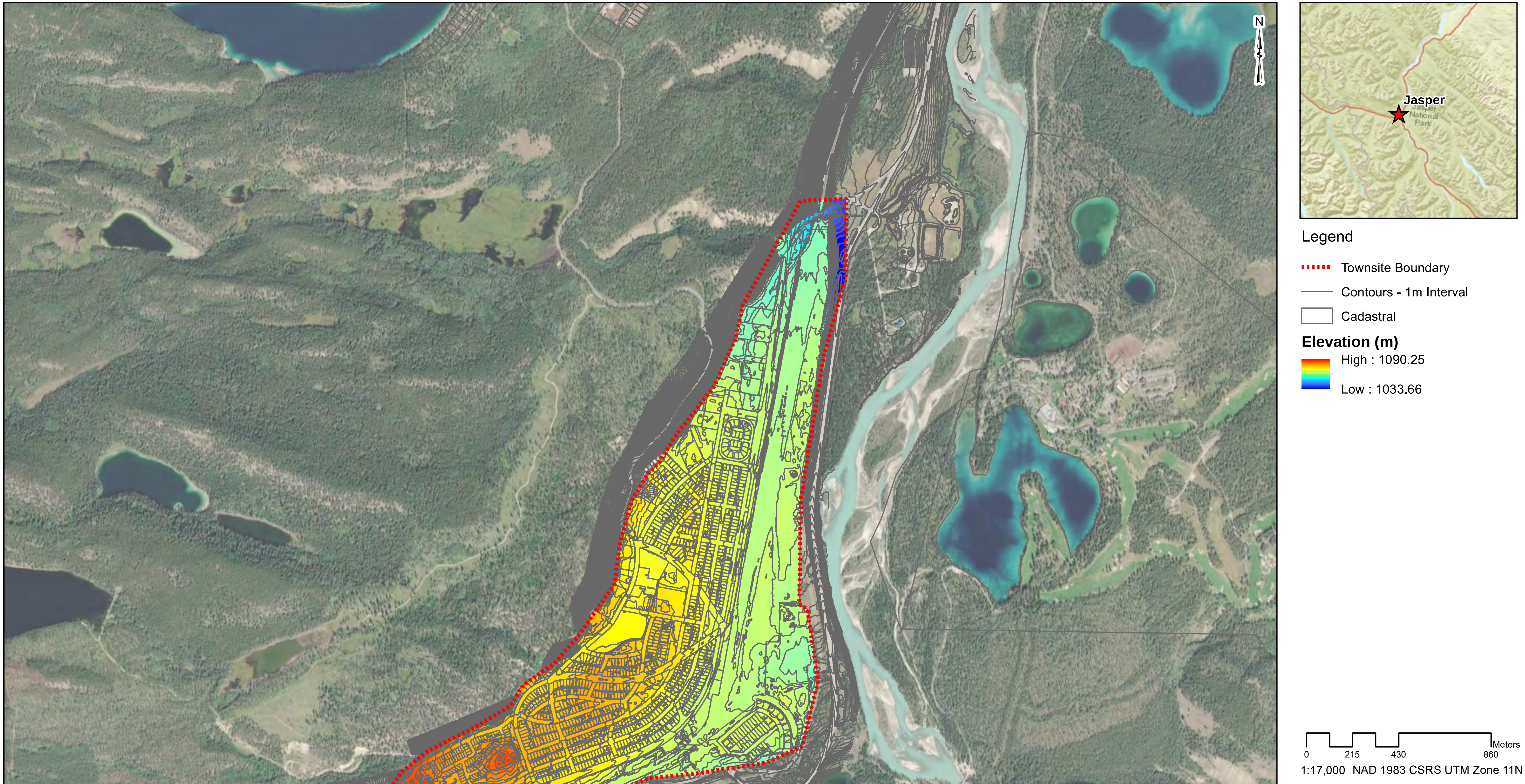

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 2.2
TOPOGRAPHY
JASPER WATER MODEL

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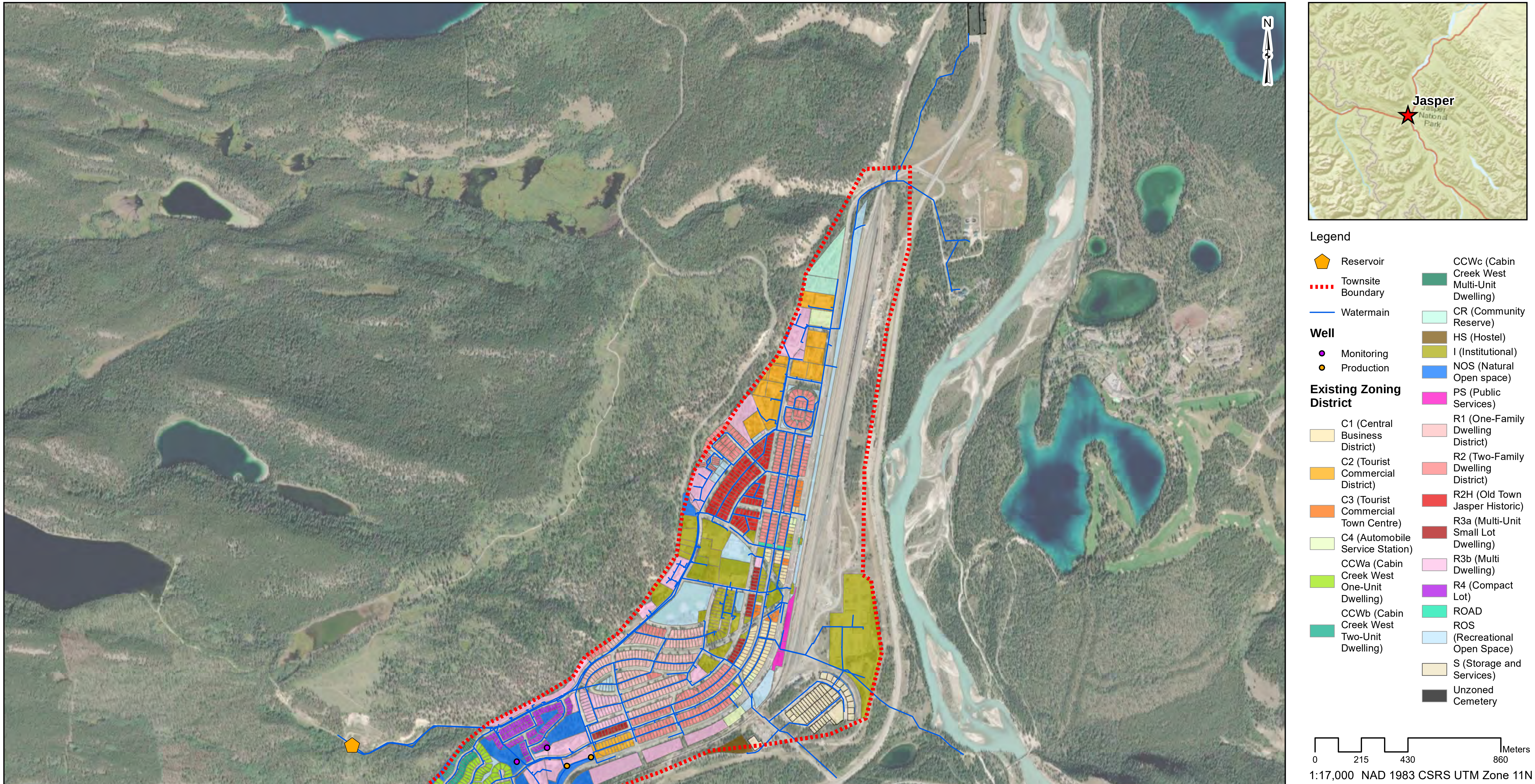

FIGURE 2.3
EXISTING ZONING DISTRICTS
JASPER WATER MODEL

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Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 2.3 - Existing Zoning Districts.mxd

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2.3 Population Horizons

The Municipality's water distribution system was assessed for three scenarios:

- Existing Conditions – Population of 4,738 based on the 2021 Census data
- 10-Year Growth (2032) – Population of 7,107
- 25-Year Growth (2047) – Population of 10,661

The Existing Conditions scenario has a population of 4,738 based on the 2021 Census data. This population was distributed across all residential parcels using various scaled residential densities. All residential land use districts stipulated in Table 2.1 were classified as low-, medium-, or high-density residential (LDR, MDR, and HDR, respectively). The number of units for each residential classification were estimated, either by counting the number of units from Google Earth/Street View, researching the residential complex online, or as a last resort assuming each unit is 1,000 ft^2 based on the Municipality's zoning regulations. Preliminary population per unit densities were applied for each residential classification, with the assumption that the higher density residential units will have smaller populations. The densities were then scaled uniformly to match the Municipality's population of 4,738. Table 2.2 summarizes these parameters.

Table 2.2: Existing Population Allocations

Parameter	LDR	MDR	HDR	Total
Original Density	3.5	3	2.5	N/A
Lots	434	706	893	2,033
Original Population	1,519	2,118	2,233	5,870
Scaled Density	2.83	2.42	2.02	N/A
Scaled Population	1,226	1,710	1,802	4,738

The 10- and 25-year growth populations were determined by applying an annual growth of 5% based on the baseline population of 4,738 applied to the Existing Conditions scenario. The townsite's footprint is not expected to grow given the geographical constraints of the area. There are also very few parcels that are undeveloped, meaning that most growth will occur through infills and densification. A map of all parcels that can potentially be redeveloped as infill properties with higher population densities was provided by the Municipality and is portrayed in Figure 2.4. This was used as a baseline to apply growth throughout the townsite.

The area of all parcels flagged for infill was calculated, and the total number of infill units were determined from the Municipality's Zoning Regulations. This states that for a row house, the lot area must contain at least 2,000 ft^2 for each internal dwelling unit or 2,500 ft^2 for each end dwelling unit. It also stipulates that multiple-family dwellings must have a lot area of at least 1,000 ft^2 for each dwelling unit. These criteria led to the development of two scenarios – MDR and HDR growth. Preliminary populations were determine based on the unit per area densities and the scaled densities applied in Table 2.2, which generally aligned with the 5% annual growth targets. The infill populations were subsequently scaled to match the 5% growth targets for the 10-Year and 25-Year scenarios. A summary of these calculations is provided below in Table 2.3 and illustrated graphically in Figure 2.5. A non-infill population of 1,996 was maintained from the Existing Conditions scenario.

Credits:Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 2.4
POTENTIAL INFILL LOTS
JASPER WATER MODEL

Table 2.3: Future Population Allocations

Parameter		Existing	Future – MDR	Future – HDR
Year		2022	2032	2047
Infill Area	ha	37.351	37.351	37.351
	ft^2	4,020,427	4,020,427	4,020,427
Infill Density	ft^2/unit	N/A	2,000	1,000
Infill Units		749	2,010	4,020
Infill Population		2,742	4,868	8,113
Total Population (Density)		4,738	6,864	10,109
Growth Based on Density			4.49%	4.53%
Targeted Total Population (5% Growth)		**4,738**	**7,107**	**10,661**
Difference			243	551
Infill Population (5% Growth)			5,111	8,665
Scaling Factor			1.05	1.07

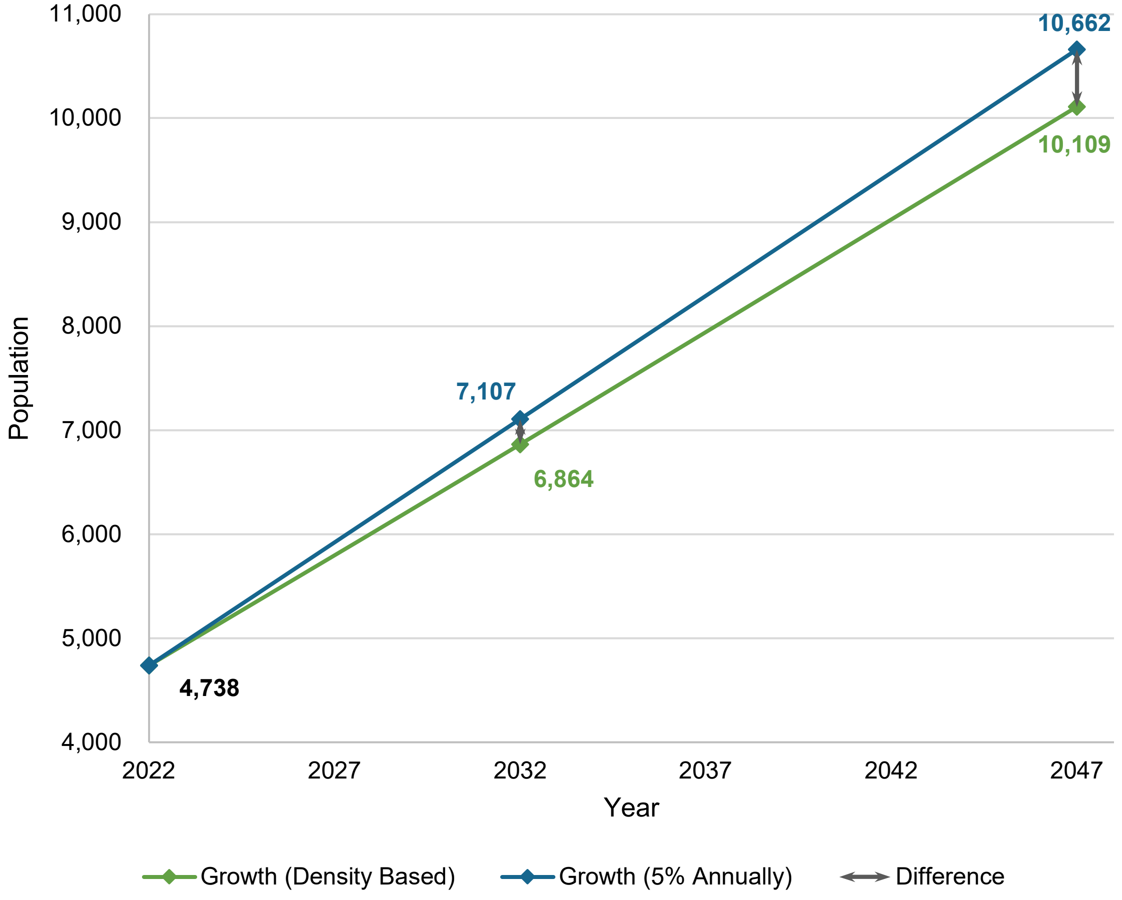

Figure 2.5: Population Growth

3.0 Design Criteria

The design criteria used to assess the Municipality's water distribution system was derived from past Water Servicing Studies, typical municipal servicing standards in the Province of Alberta, and fire flow requirements from the Fire Underwriters Survey. In addition, water consumption rates were derived based on the Municipality's population rates, service areas, and historic consumption and production data.

3.1 Assessment Scenarios

Model runs to analyze the water distribution system under existing and future conditions were undertaken. Scenarios reviewed included:

- Steady State:
  - Average day demand (ADD)
  - Maximum daily demand (MDD)
  - Peak hour demand (PHD)
- Steady State with Fire Flow Analysis:
  - Maximum day demand plus fire flow (MDD + FF)
- Extended period simulation (EPS)

3.2 Existing System Consumption Rates

The existing system consumption rates utilized in this analysis were derived through historic production and consumption data provided by the Municipality. Rates for residential, non-residential, irrigation, and unaccounted for water (UFW) were determined, in addition to the application of high-water users throughout the townsite.

The derivation of these rates is described in the subsequent sections and summarized below. Commercial consumption rates were applied for industrial and institutional areas as well as it was assumed that the commercial consumption data includes all non-residential demands.

- Residential Consumption Rate – 172 L/p/d
- Commercial Consumption Rate – 0.48 L/s/ha
- High-Water User Demand – Varies per High Water User
- Irrigation Consumption Rate – 0.41 L/s/ha
- UFW Rate – 0.11 L/s/ha

Production data, and residential and commercial consumption data was provided by the Municipality on a bi-monthly basis from 2017 to 2021. 2020 and 2021 experienced uncharacteristically low demands due to the Covid pandemic and a decrease in tourism as a result. This anomaly in the data is not representative of typical water consumption in Jasper, so the decision was made to exclude the data from 2020 and 2021 from the rate derivation process.

Jasper exhibits a high influx of seasonal workers and tourists during the summer months, so the water demands fluctuate rather significantly between the winter and summer months. Production and consumption water volumes were separated into peak and off-peak conditions. Peak conditions were assumed to be July and August, while all other months were considered as off-peak. The peak rates derived below were applied to the model to represent the system being loaded under the more significant peak conditions. Off-peak rates are included for information and a comparison.

3.2.1 Residential Consumption Rate Derivation

On an annual average, the residential consumption including high-water users ranged from 8.03 L/s to 8.28 L/s. These demands were divided by the populations in each year, to determine the consumption rate per year. Based on the three years of annual consumption data, an average peak conditions rate of 172 L/p/d was derived. Volumes from high-water users were deducted from the derivation as these were added into the model separately. The 2021 census population of 4,738 was used to derive per capita rates. This is summarized in Table 3.1.

Table 3.1: Residential Consumption Rate Derivation

Year	Overall Average Residential Consumption	Off-Peak Average Residential Consumption	Peak Average Residential Consumption	Off-Peak Residential Consumption Rate
	L/s	L/s	L/s	L/p/d
2017	8.03	7.29	11.65	216
2018	8.04	7.85	9.00	161
2019	8.28	8.34	7.99	140
Average	**8.12**	**7.83**	**9.54**	**172**

3.2.2 Commercial Consumption Rate Derivation

The commercial consumption is assumed to consist of all non-residential demands within the townsite. On an annual average, the commercial consumption including the high-water users ranged from 16.79 L/s to 17.81 L/s. Based on this, an average rate of 0.48 L/s/ha was derived. Volumes from high-water users were deducted from the derivation as these were added into the model separately. This is summarized in Table 3.2.

Table 3.2: Commercial Consumption Rate Derivation

Year	Overall Average Commercial Consumption	Off-Peak Average Commercial Consumption	Peak Average Commercial Consumption	Peak Commercial Consumption Rate
	L/s	L/s	L/s	L/p/d
2017	16.79	15.47	23.25	0.47
2018	16.92	15.71	22.82	0.45
2019	17.81	16.43	24.56	0.53
Average	**17.17**	**15.87**	**23.55**	**0.48**

3.2.3 High-Water Users Consumption

The total annual consumption data for the top 32 water users throughout the townsite was provided for 2019 and 2021. The locations of these high-water users are shown in Figure 3.1. To better represent these demands, these high-water users were deducted from the general consumption rate derivation. The demands from these users were assigned to the model individually through fixed demands at the nearest nodes to each property. This was completed to ensure proper demand allocations throughout the network, so that areas with higher water usage received a larger portion of the flows.

3.2.4 UFW Rate Derivation

In Jasper, UFW is either due to unmetered irrigation lines or leakage. The Municipality provided ISL with the locations of all unmetered parcels receiving potable water for irrigation, as shown in Figure 3.2. An irrigation rate of 25 mm per week was assumed. This rate is consistent with past studies performed by ISL for the Province of Alberta (the Province).

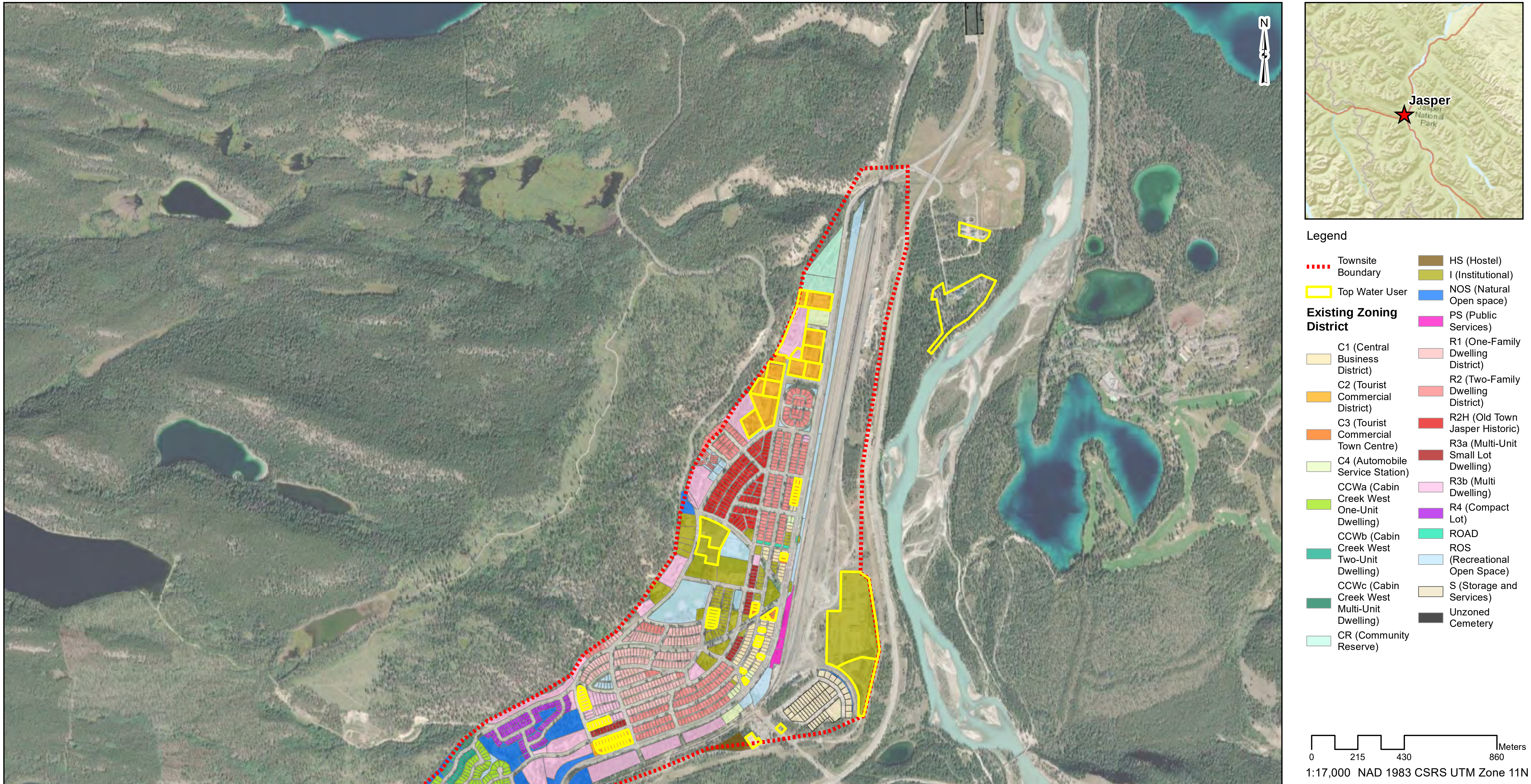

FIGURE 3.1
TOP WATER USERS
JASPER WATER MODEL

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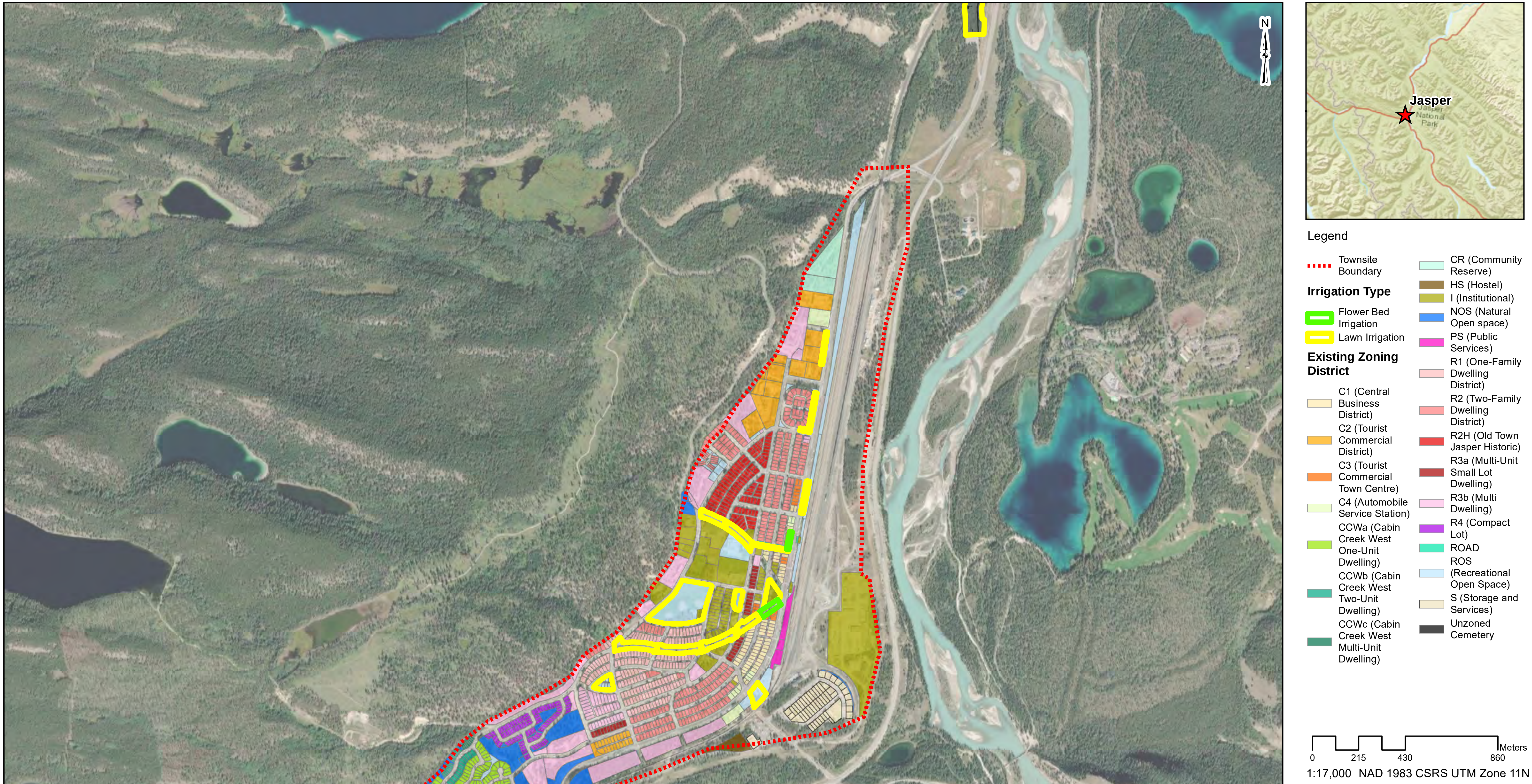


Credits:Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 3.2
IRRIGATION
JASPER WATER MODEL

Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 3.2 - Irrigation.mxd

It may be conservative as Jasper likely receives more rain than many other areas of the Province and is less reliant on irrigation. However, since one of Jasper's key industries is tourism, it is likely that lawn watering is more prevalent to increase the curb appeal of summer rental properties and hotels. The rate was therefore deemed adequate for this study, in lieu of historical data.

Leakage was assumed to be the difference between the UFW demand and the irrigation demand. This was applied uniformly across the model to account for potable water being lost throughout the network. The service area was based on those that were delineated during the development of the hydraulic model, as discussed in Section 5.2. The totaled 117 ha and was assumed to remain constant between years. An average rate of 0.11 L/s/ha was derived, as summarized in Table 3.3.

Table 3.3: Leakage Rate Derivation

Year	Leakage Area	Average Leakage Demand	Leakage Rate
	ha	L/s	L/s/ha
2017	117	10.41	0.09
2018	117	13.64	0.12
2019	117	16.00	0.14
Average	**117**	**13.35**	**0.11**

3.3 Future System Consumption Rates

For future developments, the following consumption rates were applied:

- Future Residential Consumption Rate – 172 L/p/d
- Future Non-Residential Consumption Rate – 0.48 L/s/ha

These rates are consistent with the existing consumption rates, given that these are unlikely to change significantly with densification of existing parcels. Given the unique characteristics of Jasper, in which the non-residential rate is higher than most municipalities due to the number of tourists using lodging (classified as commercial areas), decreasing this rate in the future is not warranted. The future residential rate is also generally lower than most municipalities, but aligns with current trends throughout Jasper, which are unlikely to deviate much in the future.

3.4 Peaking Factors

3.4.1 Steady State Simulations

The following factors were used to establish MDD and PHD for both the existing and future scenarios:

- MDD – 2.0 x ADD
- PHD – 5.0 x ADD

The MDD peaking factor is comparable to historic consumption data, noting that hourly consumption data was unavailable to perform a comparison of the PHD peaking factor. The factors are sufficient based on Alberta Environment and Parks' (AEP) guidelines.

For reference, AEP recommends an MDD that is 1.8 to 2.0 times the ADD and a PHD that is 2.0 to 5.0 times the MDD. Using a peaking factor of 2.0 times ADD is a conservative estimate for MDD. Using a PHD of 5.0 times ADD (i.e., 2.5 times MDD) is high compared to most municipalities but average in terms of AEP's guidelines. A higher PHD peaking factor was applied to account for the large influx of seasonal populations during the summer months. It is noted that a sensitivity analysis was performed under PHD between a factor of 5.0 to 7.0 times ADD.

At a peaking factor greater than 5.0 times ADD, there are substantial losses throughout the network, with most areas dropping below 275 kPa. This would not be sustainable for Jasper and given there are no observational accounts of pressures dropping this substantially under higher demand conditions, a higher peaking factor was not implemented.

3.4.2 Extended Period Simulation

The extended period simulation was run for a 24-hour duration, which required hourly peaking factors to formulate diurnal patterns for various land use types. As hourly consumption/production data was not available, typical diurnal patterns based on human behaviour were applied. Diurnals were assumed for residential and non-residential land use types. Irrigation and UFW were assigned constant diurnal patterns, assuming that these do not vary significantly during the course of a day. These diurnals are shown in Figures 3.3 and 3.4 below.

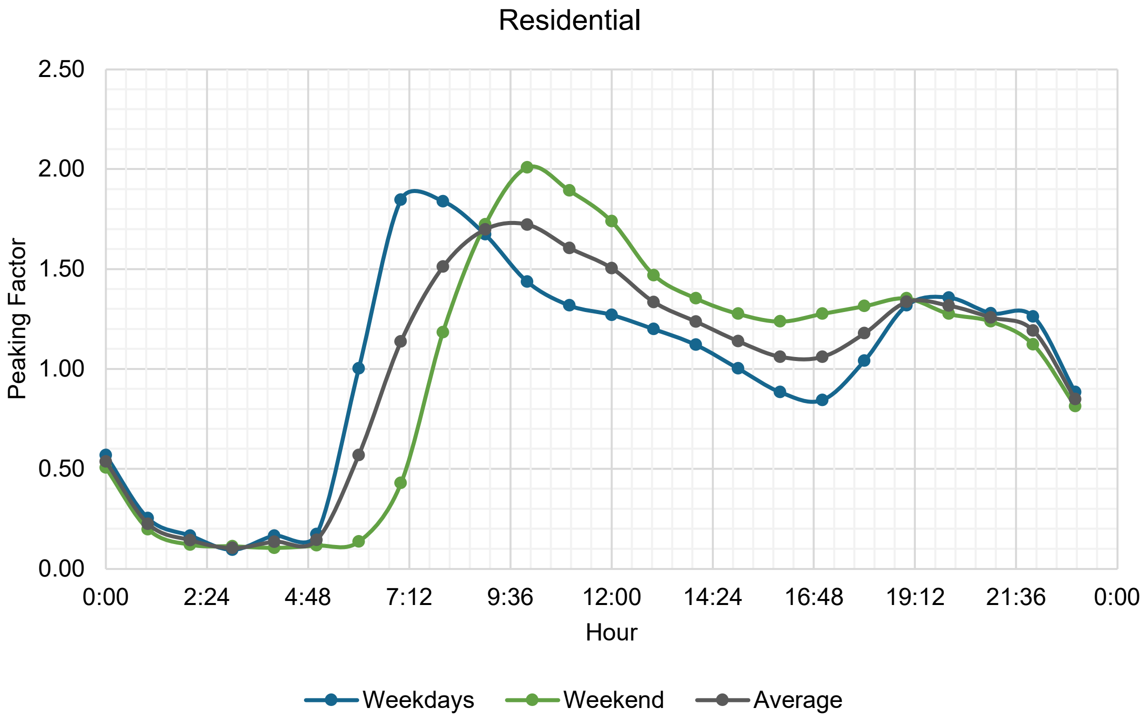


Figure 3.3: Residential Diurnal Pattern

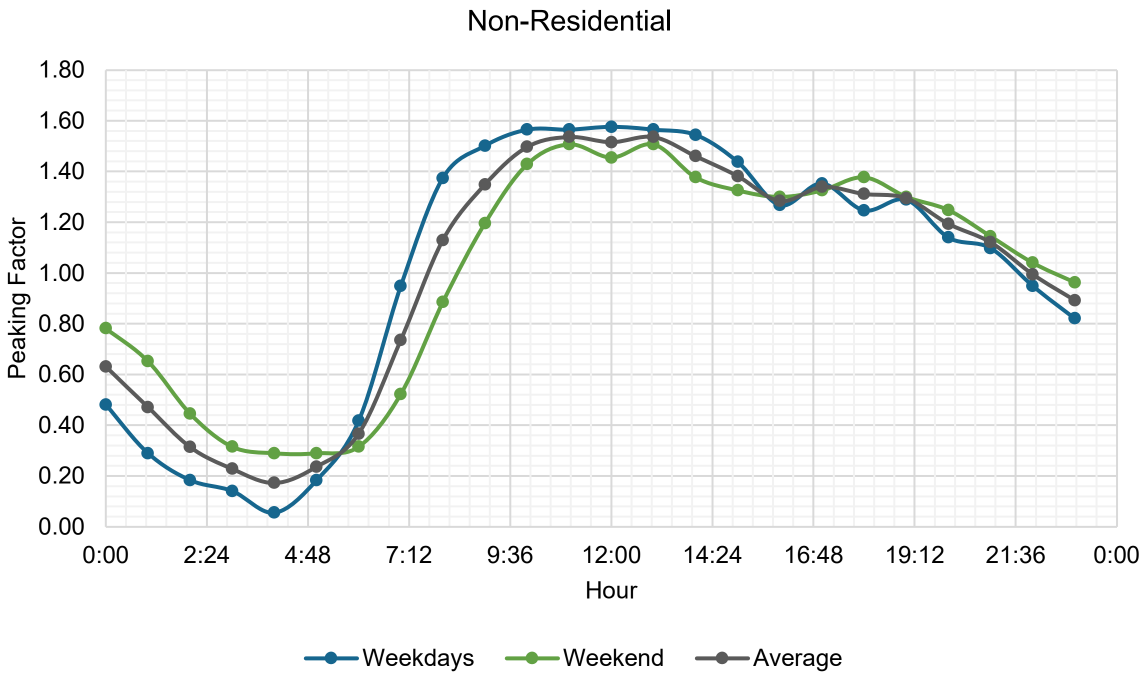


Figure 3.4: Non-Residential Diurnal Pattern

3.5 Operating Pressure Criteria

The Municipality's water system was assessed using the following criteria based on a variety of standards, including those stipulated by AEP:

1. Normal pressure range in the system under ADD of 350 kPa to 550 kPa
    - Pressures between 550 kPa and 670 kPa will be tolerated if individual PRVs are installed on all service connections within that pressure range.
    - Locations where the pressures are between 550 kPa and 670 kPa should be investigated to determine if a local PRV is installed, and if not, installation of a local service connection PRV should be investigated.
2. Minimum residual pressure in the system under PHD of 275 kPa
3. Minimum residual pressure in the system under MDD + FF of 140 kPa

3.6 Fire Flow Criteria

Fire flow criteria was based on the Fire Underwriters Survey recommendations (formerly the Insurer's Advisory Organization). Below are the fire flow rates for various development types:

1. Single Family Residential – 76 L/s
2. Multi-Family Residential / Institutional – 114 - 227 L/s
3. Industrial – 227 L/s
4. Commercial – 265 L/s

It is noted that typically fire flow requirements can be reduced by up to 50% for facilities equipped with sprinkler systems (i.e. reduce 50%, then add required sprinkler flow). This reduction is based on the Water Supply for Public Fire Protection (Fire Underwriters Survey, 1999), which states that fire flow may be reduced by up to 50% for facilities with adequately sized and designed automatic fire sprinkler protection systems.

3.7 Reservoir Storage

Reservoir storage volumes were calculated using the formula recommended by AEP.

Alberta Environment and Parks (Standards and Guidelines for Municipal Waterworks, Wastewater and Stormwater Drainage Systems):

$$S = A + B + (the\ greater\ of\ C\ or\ D)$$

Where,

S = Total storage requirement, m^3
A = Fire storage, m^3
B = Equalization storage (25% of MDD), m^3
C = Emergency storage (minimum of 15% of ADD), m^3
D = Disinfection contact time storage to meet CT requirements, m^3

In terms of fire storage, the fire flow rate of 265 L/s for 3.5 hours was selected. The rate and duration are in line with the criteria stipulated in the Water Supply for Public Fire Protection (Fire Underwriters Survey, 1999) document.

4.0 Existing Water System

4.1 Water Distribution System

Jasper is currently serviced by 33.4 km of potable water distribution mains. The water distribution system detailed with regards to diameter, material, and installation year are shown in Figures 4.1, 4.2, and 4.3, respectively. The watermains are predominantly polyvinyl chloride (PVC) or cast iron (CI). Pipe sizes range from 40 mm to 450 mm, with most being between 150 mm and 250 mm. Tables 4.1 to 4.3 below summarize the water distribution system based on diameter, material, and installation year.

Table 4.1: Potable Water Distribution Diameter Summary

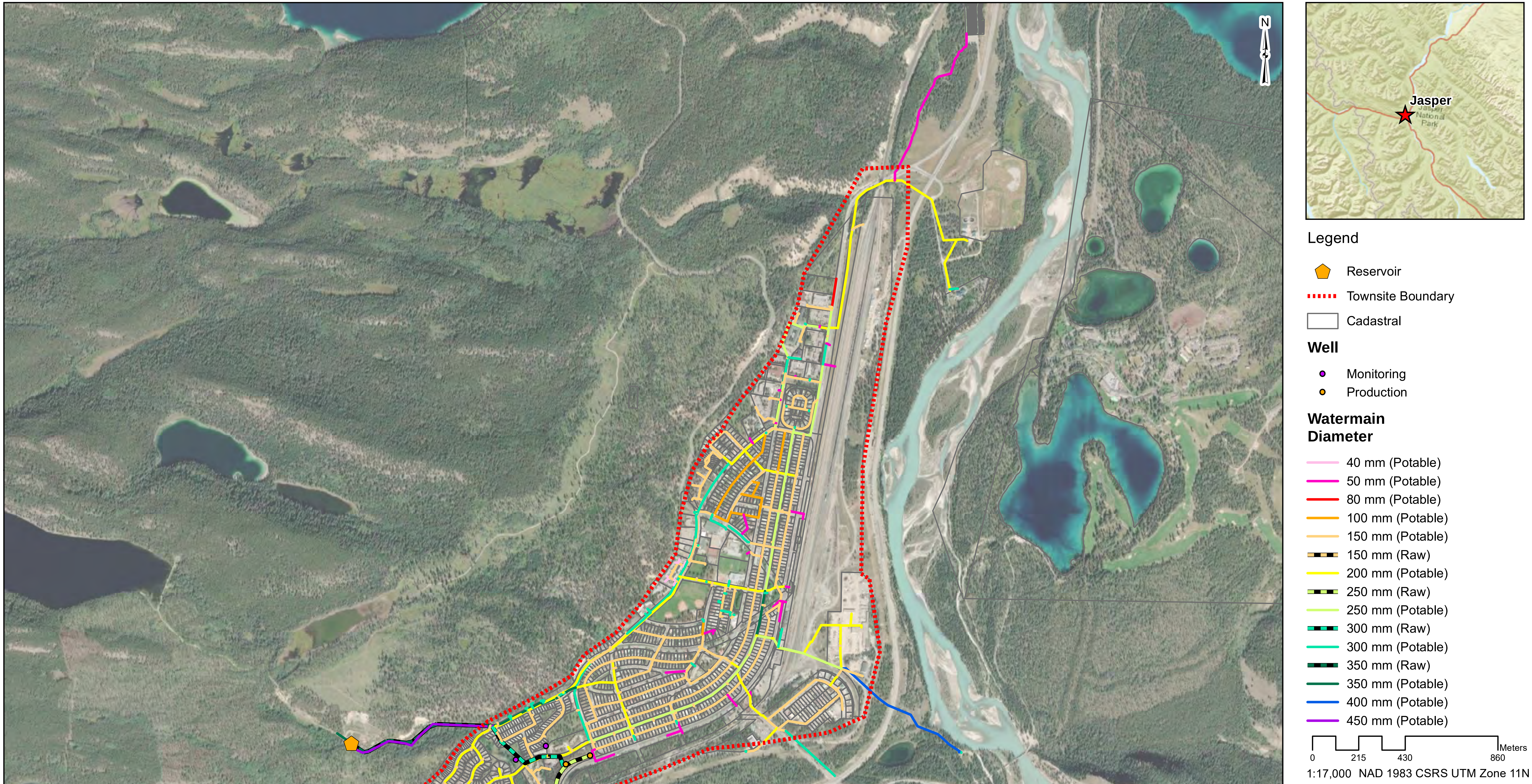
Diameter	Total Length	Percentage of Total Length
mm	m	%
40	139	0.41
50	1,903	5.70
80	132	0.40
100	1,268	3.79
150	13,533	40.49
200	8,063	24.13
250	3,269	9.78
300	2,915	8.72
350	715	2.14
400	701	2.10
450	785	2.35
Total	**33,423**	**100**

Table 4.2: Potable Water Distribution Material Summary

Material	Total Length	Percentage of Total Length
	m	%
Asbestos Cement (ACP)	17	0.05
Cast Iron (CI)	22,097	66.12
Composite Material (CMP)	2	0.01
Ductile Iron (DI)	26	0.08
Galvanized Pipe (GP)	17	0.05
High Density Polyethylene (HDPE)	720	2.15
Polyvinyl Chloride (PVC)	10,536	31.52
Steel (S)	7	0.02
Total	**33,423**	**100**

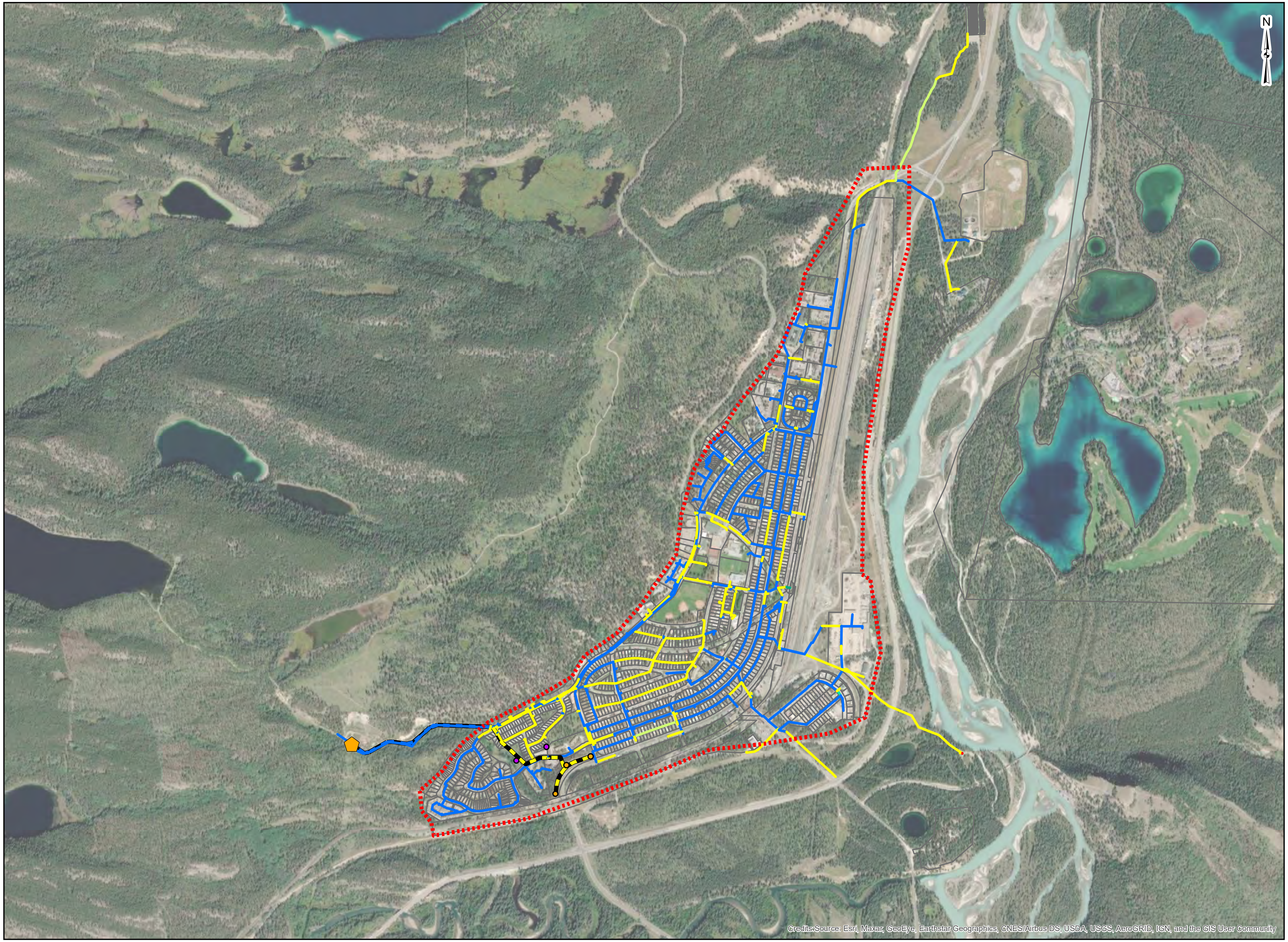
Table 4.3: Potable Water Distribution Installation Year Summary

Installation Year	Total Length	Percentage of Total Length
	m	%
Unknown	10	0.03
1900 - 1949	16,050	48.02
1950 - 1959	6,105	18.27
1960 - 1969	1,454	4.35
1970 - 1979	4,237	12.68
1980 - 1989	1,751	5.24
1990 - 1999	1,786	5.35
2000 - 2004	1,82	0.54
2005 - 2009	7,46	2.23
2010 - 2014	86	0.26
2015 - 2020	1,016	3.04
Total	**33,423**	**100**



Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 4.1
WATERMAIN DIAMETER
JASPER WATER MODEL



Legend

⬟ Reservoir
Townsite Boundary
☐ Cadastral

Well

● Monitoring
● Production

Watermain Material

Asbestos Cement (Potable)
Corrugated Metal (Potable)
Cast Iron (Potable)
Cast Iron (Raw)
Ductile Iron (Potable)
Galvanized Steel (Potable)
HDPE (Potable)
PVC (Potable)
PVC (Raw)
Steel (Potable)

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 4.2
WATERMAIN MATERIAL
JASPER WATER MODEL

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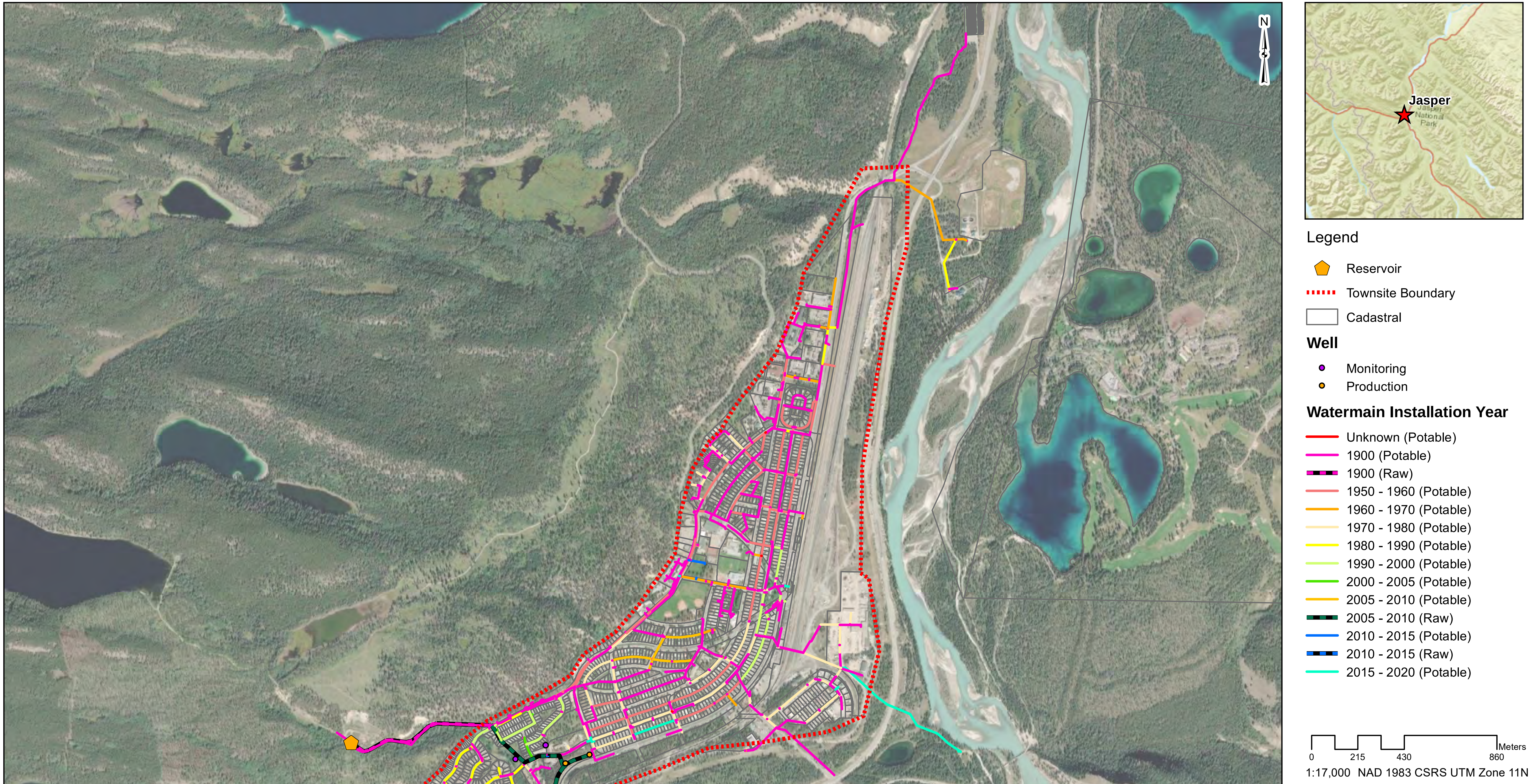

Credits:Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 4.3
WATERMAIN INSTALLATION YEAR
JASPER WATER MODEL

Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 4.3 - Watermain Installation Year.mxd

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Water is stored in a single reservoir adjacent to the water treatment plant (WTP) near the southwest end of the townsite boundary. The reservoir was upgraded in 1989, moving slightly to the southeast from its original location. Water is distributed via gravity, thus there are no pumps at this facility. Reservoir characteristics are summarized below in Table 4.4.

Table 4.4: Reservoir Characteristics

Parameter	Unit	Value
Capacity	m^3	6,877
Slab Elevation	m	Varies from 1111.90 to 1113.22
Top Elevation	m	1120.44
Hydraulic Grade Line[1]	m	1118.00

[1] *Hydraulic grade line determined through the calibration process.*

The reservoir storage volume was calculated from the record drawings provided for the reservoir. The record drawings titled Water Supply Improvements and Reservoir (1989) are included in Appendix A. Individual volumes for each section of the storage tank were calculated and summed to determine the overall storage capacity as identified above.

4.2 Water Supply System

Three wells supply water to Jasper. These wells are situated in the southwest end of the townsite boundary, near Connaught Drive. There are also two monitoring wells further north, however these are not used for water supply. A summary of these five wells is below in Table 4.5, and the well locations are shown on all water system figures.

Table 4.5: Summary of System Wells

Well Number	Location	Function
1	Adjacent to Parcel FZ off Patricia Street	Monitoring
2	Adjacent to Discovery Trail behind 1004 Walk Ups Parking Lot	Monitoring
3	Adjacent to Well Pump House – Behind Parcel CV-2 on the Connaught Drive Side	Production
4	Behind Parcel CV-2 Connaught Drive Side	Production
5	Behind Parcel CV-2 Connaught Drive Side	Production

Raw water from the three productions wells is pumped to the WTP via raw water supply lines ranging from 250 mm to 350 mm comprised of either PVC or CI. Tables 4.6 to 4.8 below summarize the raw water supply system based on diameter, material, and installation year, respectively.

Table 4.6: Raw Water Distribution Diameter Summary

Diameter	Total Length	Percentage of Total Length
mm	m	%
150	6	0.38
250	268	18.56
300	461	31.93
350	710	49.13
Total	**1,445**	**100**

Table 4.7: Raw Water Distribution Material Summary

Material	Total Length	Percentage of Total Length
	m	%
Cast Iron (CI)	702	48.54
Polyvinyl Chloride (PVC)	744	51.46
Total	**1,445**	**100**

Table 4.8: Raw Water Distribution Installation Year Summary

Installation Year	Total Length	Percentage of Total Length
	m	%
1900	710	49.13
2005 - 2009	730	50.49
2010 - 2014	6	0.38
Total	**1,445**	**100**

4.3 Water Consumption and Production

As mentioned in Section 3.0, historic water consumption and production data was provided in a spreadsheet format from the Municipality. Consumption data was provided on a bi-monthly basis between 2017 and 2021 while the production data was provided daily for approximately the same timeframe. Figure 4.4 illustrates the historic volumes for both production and consumption.

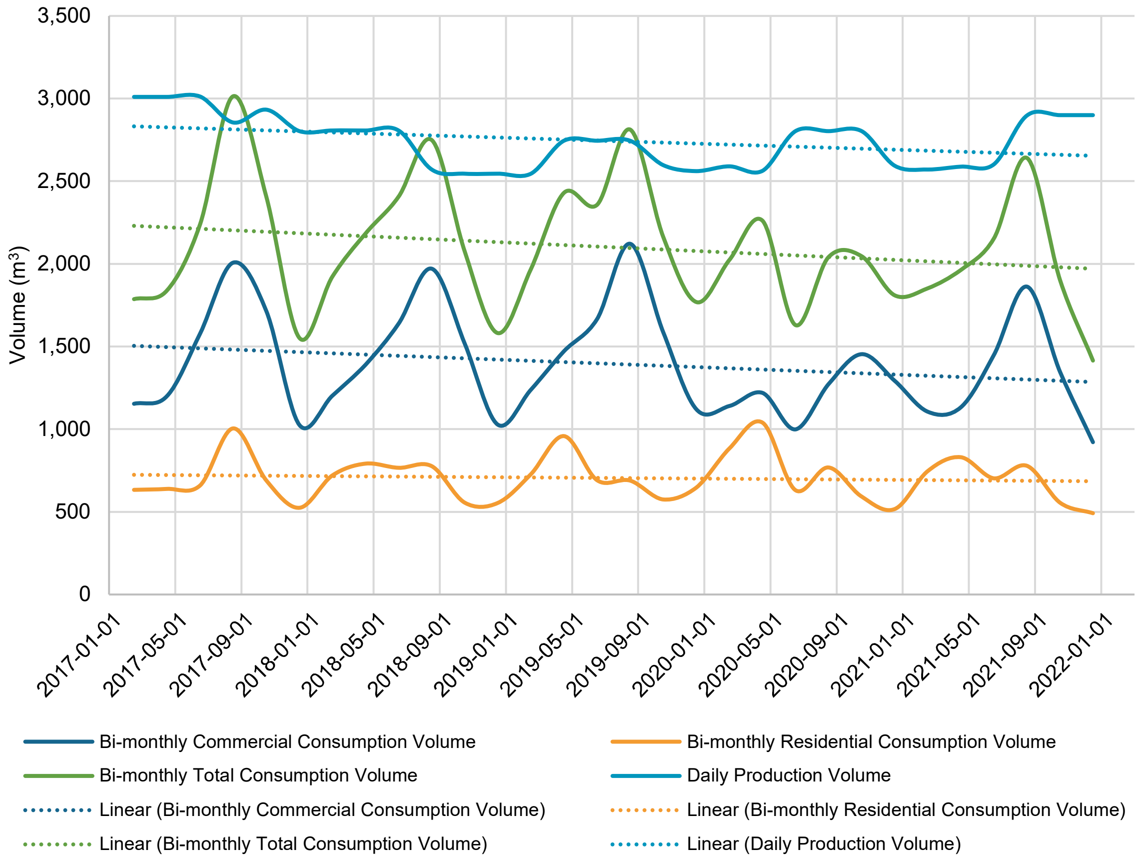


Figure 4.4: Historic Production and Consumption Volumes

Figure 4.4 suggests a slight downward trend in the amount of water usage from 2017 and 2022, suggesting that there could be some water conservation methods being applied. That said, since there is a strong correlation between water production and consumption and the number of visitors in Jasper, a decrease in water consumption is evident in 2020. This corresponds to the most significant lockdowns during Covid, when people were not able to travel as liberally. The decrease in tourists could result in the downward trends, which could offset any of the water conservation speculations.

Generally, consumption volumes peak during the summer months, which is consistent with when Jasper experiences an influx in tourists and the need for irrigation. Another notable distinction with the data is the difference between the consumption and production volumes. The difference supports assigning a rate for UFW in the water model to account for unmetered properties, irrigation, and system leakage.

5.0 Hydraulic Model Development

5.1 Model Set-up

Bentley OpenFlows WaterCAD Connect Edition Update 3 was used to assess Jasper's water distribution system. WaterCAD is a powerful analysis tool that utilizes pump curve data and routes flows through the physical distribution system. In this manner, pressure results are obtained, and available fire flow at any location in the water distribution system can be estimated. Modelling files will be appended to the final report submission of this document.

To develop the model, all available GIS data relevant to the water system in the study area received from the Municipality was reviewed in detail. Mains and junctions were then imported into the WaterCAD model using the provided shapefiles. The facility ids from the GIS data were applied as labels in the WaterCAD model along with an identification of the type of feature (e.g., "HYD" to represent a hydrant). This was done to ensure the features in the model could be easily referenced back to the GIS data.

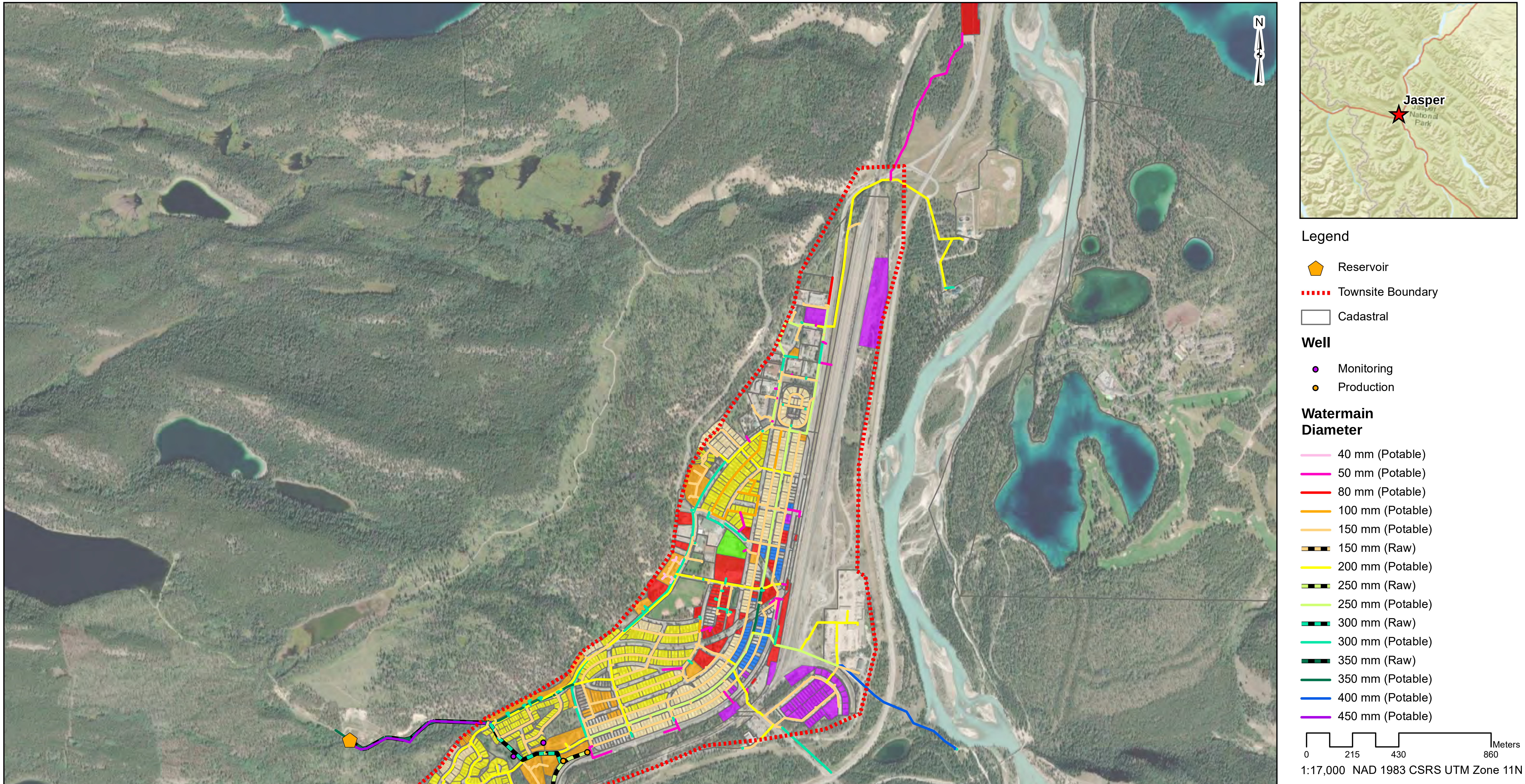
Junctions consist of hydrants, valves, and generalized nodes at intersections and main ends to ensure system connectivity. Notes associated with valves and hydrants from the GIS data were transferred to the model to provide additional context if needed. Similarly, pipe materials and installation years were added to the model. Once the data was imported it was inspected to ensure proper connectivity. Reservoir locations, elevations and settings were inputted based on the reservoir characteristics noted in Section 4.0.

Junction surface elevations were populated using the light detection and ranging (LiDAR) data that was obtained from the Municipality. This was accomplished by employing a powerful spatial analyst tool, which extracted the elevation from the LiDAR data at each targeted junction and assigned it as the surface elevation. The model was inspected one last time by performing a series of quality assurance/quality control (QA/QC) tasks to ensure that all data was detailed and accurate.

5.2 Service Area Delineation

Following the set-up of the physical water distribution system model, it was necessary to delineate the study area into service areas for the purpose of deriving populations and thus system demands. The service areas were delineated based on individual lots and the development type classifications mentioned in Section 2.2, including residential, commercial, industrial, and institutional. Parks labelled as being irrigated were also included for this purpose.

Populations were then spatially allocated to the individual lots using ArcGIS based on the method described in Section 2.3 for the three scenarios. Each lot was assigned to the nearest node in ArcGIS, and lots sharing the same node were merged together to formulate the final service area polygons. The populations associated with each development type on a per lot basis were summated during the merging process. A summary of the individual service areas is found in Table 5.1 below, while the merged service area polygons are illustrated in Figure 5.1.



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1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 5.1
SERVICE AREA POLYGONS
JASPER WATER MODEL

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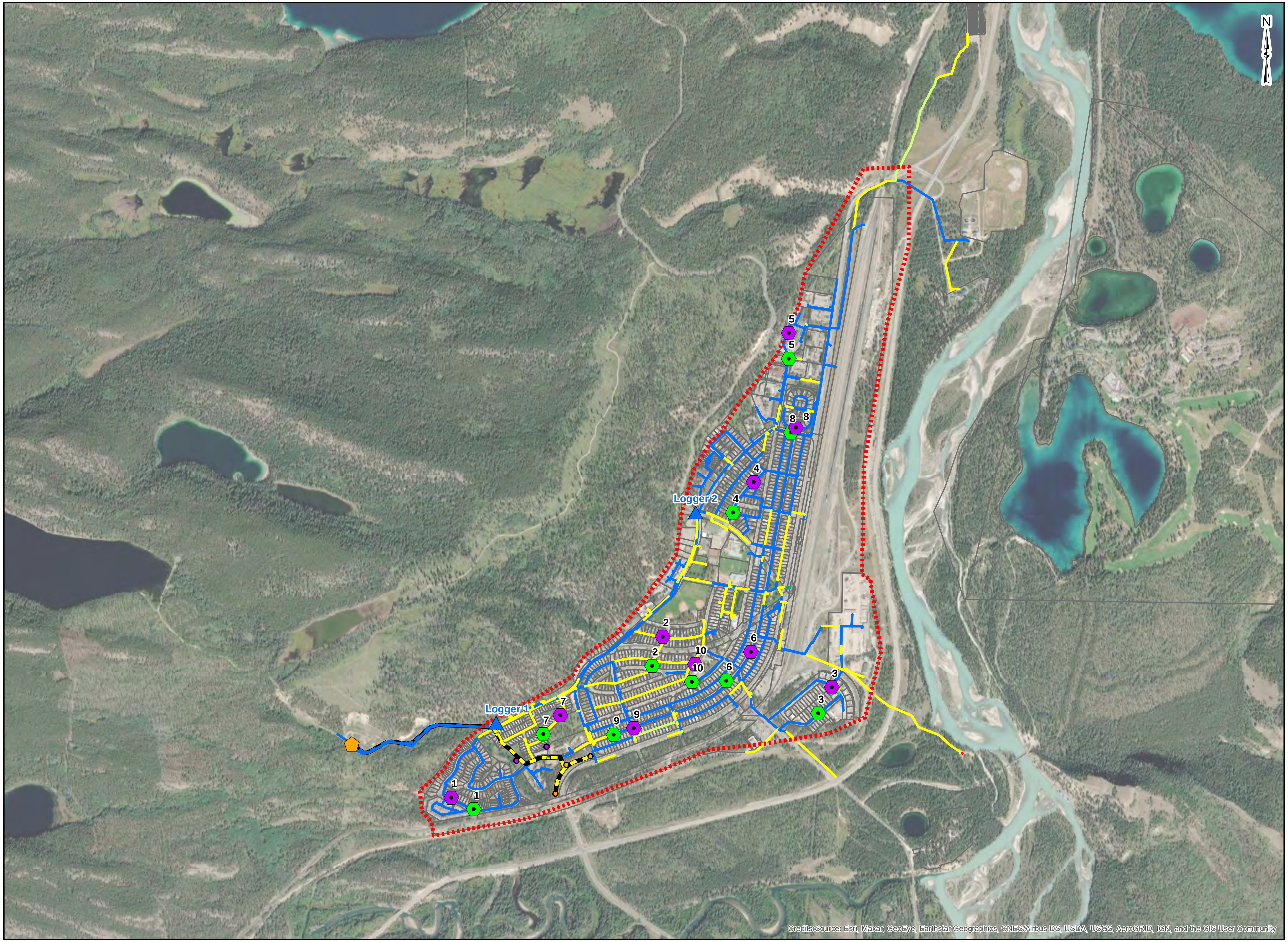
Date: 2022-06-03 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 5.1 - Service Area Polygons.mxd



Credits:Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

▭ Cadastral

▪▪▪ Townsite Boundary

Watermain Material

- Asbestos Cement (Potable)
- Corrugated Metal (Potable)
- Cast Iron (Potable)
- Cast Iron (Raw)
- Ductile Iron (Potable)
- Galvanized Steel (Potable)
- HDPE (Potable)
- PVC (Potable)
- PVC (Raw)
- Steel (Potable)

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 5.2
HYDRANT TEST LOCATIONS
JASPER WATER MODEL

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Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 5.2 - Actual Hydrant Locations.mxd

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Table 5.1: Summary of Service Areas

Land Use Type	Number of Lots	Total Area	Total Population		
		ha	Existing	10-Year Growth	25-Year Growth
Residential[1]	2,033	55.27	4,738	7,107	10,661
Commercial	115	17.98	-	-	-
Industrial	64	11.35	-	-	-
Institutional	69	23.06	-	-	-
Irrigation[2]	18	11.22	-	-	-
Total	**2,299**	**118.89**	**4,738**	**7,107**	**10,661**

[1] *Residential lots/populations linked to any of the high-water users were excluded from the model as these were added as straight demands rather than unit demands. This ensured that these demands were not double counted in the model. However, the table above documents the totals including the high-water user parcels.*

[2] *Some of the parcels with irrigation are on institutional properties, thus were divided in the model to ensure no areas were double counted.*

5.3 Hydrant Testing

SFE Global was requisitioned by ISL to complete hydrant tests at ten strategic locations throughout Jasper. The locations were selected to capture a variety of land use types and watermain materials, diameters, and installation years. Further to this, the Municipality identified areas within Jasper that were flagged as areas of concern or potential areas of concern to document as well. Two residual monitoring stations (loggers) were installed to supplement the hydrant flow test locations. The overall fire flow test reports can be found in Appendix B, and a map of the flow hydrants, residual hydrants and logger locations is illustrated in Figure 5.2.

The results of the hydrant testing are summarized below in Table 5.2. Observed pressures from hydrant testing were used to calibrate the water model, subsequently obtaining more accurate scenario results.

Table 5.2: Hydrant Flow Test Results

Hydrant Test	Time of Test	Residual Hydrant Elevation[1]	Test Type	Flow at Hydrant	Residual Hydrant Pressure		Logger No. 1 Pressure[2]		Logger No. 2 Pressure[2]	
		m		L/s	psi	kPa	psi	kPa	psi	kPa
1		1067.75	Static		70	483	70	483	77	531
	9:38		1 Port	100.74	50	345	61	420	69	474
2		1067.64	Static		70	483	70	483	77	531
	11:33		1 Port	83.91	61	421	66	453	65	449
3		1059.95	Static		80	552	70	483	77	531
	15:14		1 Port	68.37	60	414	63	435	63	432
4		1064.09	Static		72	496	70	483	77	531
	13:45		1 Port	56.62	56	386	68	468	68	470
5		1056.82	Static		82	565	70	483	77	531
	14:47		1 Port	97.86	65	448	62	427	57	394

Hydrant Test	Time of Test	Residual Hydrant Elevation[1]	Test Type	Flow at Hydrant	Residual Hydrant Pressure		Logger No. 1 Pressure[2]		Logger No. 2 Pressure[2]	
		m		L/s	psi	kPa	psi	kPa	psi	kPa
6		1060.93	Static		80	552	70	483	77	531
	10:55		1 Port	103.47	64	441	67	464	67	463
7		1070.52	Static		66	455	70	483	77	531
	10:04		1 Port	91.95	54	372	68	466	73	507
8		1059.64	Static		80	552	70	483	77	531
	14:04		1 Port	97.86	64	441	59	410	54	373
9		1064.74	Static		74	510	70	483	77	531
	10:33		1 Port	94.98	58	400	63	437	63	437
10		1066.11	Static		72	496	70	483	77	531
	12:11		1 Port	87.09	54	372	63	436	63	433

[1] *Elevations were obtained via the LiDAR data provided by Jasper.*

[2] *Static pressures at each logger were calculated by taking the averages of the overall logger data.*

5.4 Calibration

The ten hydrant test locations were used to calibrate the WaterCAD model. These hydrant test locations represent multiple physical locations and elevations within Jasper, as well as various development types and installation periods.

Model calibration was performed by using the resultant pressures and associated flow rates obtained from the hydrant testing. This was done to ensure proper Hazen-Williams ‘C’ values were used in the WaterCAD model to simulate pipe roughness and aging. The preliminary ‘C’ values represented common practice roughness values of the various materials seen throughout Jasper.

Following a review of the hydraulic grade lines (HGL) under static conditions based on the hydrant testing data, it was observed that there was a significant variation in HGLs suggesting more flow throughout the system than ADD conditions. An iterative process was undertaken by adjusting the peaking factor of the average day demands until sufficient head loss to match field conditions was observed in the model. A resulting peaking factor of 1.1 x ADD was thus applied to the model for the calibration process. This peaking factor applies solely to calibration and was removed for all subsequent analyses.

Another area of note was Logger 1, situated near the reservoir on Bonhomme Street. The elevation extracted from the LiDAR data plus the average pressure during the hydrant testing resulted in an HGL that was above the top of the reservoir, which is not possible considering the water distribution system is gravity fed. Upon review of historical imagery, it appears that a new development was constructed near the Logger 1 hydrant in 2015, around the same time that the LiDAR data was captured. It appears that the area was levelled to allow the development to occur, likely flattening and lowering the elevations compared to the LiDAR data. The Logger 1 hydrant elevation was therefore adjusted to roughly match the road elevation directly south to mitigate this.

That said, the elevation is an estimation, and may still vary. This could lead to larger pressure variances as the pressure is linked to the elevation of each node.

As most of the system is either PVC or CI and given that the roughness of PVC does not tend to vary significantly as calcification is not prevalent as it is in CI, it was decided to classify the CI watermains based on size. The intent was to allow for a smaller roughness coefficient (i.e., rougher watermain) for smaller diameter pipes, where the same thickness of calcification would more drastically increase head loss than a larger diameter pipe. This approach is supported through dialogue with the Municipality that leakage is more prevalent in services (i.e., smaller pipes). More leakage in smaller diameter pipes suggests that they are not aging as well as larger diameter pipes throughout the network, supporting lower ‘C’ values for smaller pipes.

In adjusting the ‘C’ values, it was determined that very good static pressure calibration could be achieved. All pressure errors are within ±20 kPa. The exception is Logger 1, which may have an inaccurate modelled elevation due to changes in topography since the LiDAR acquisition. In attempting to match the system pressures for the flowed tests, it was determined that most of the sites could be reasonably matched and are within ±30 kPa, except for two sites that are marginally outside of the threshold. The two sites include Hydrant Tests 5 and 10. At Hydrant Test 5, the modelled pressure is lower than the field pressure, while the opposite is true for Hydrant Test 10. For this reason, it is difficult to improve one without worsening the other unless calibrating on a micro scale, which would require location specific knowledge of the condition of watermains. This goes beyond the typical level of detail for a water model, thus was not undertaken. In addition, the Municipality has noted that their cast iron pipes are in excellent condition despite their age, so lowering the roughness too significantly would deviate from field observations of the pipe conditions.

For calibration under flowed conditions, an assumption was made that there is a system irregularity (either a closed valve, significant leakage, localized condition issues, etc.) at the intersection of Bonhomme Street and Willow Avenue. This likely does not represent the exact location in the field where the irregularity exists, however would likely occur in the vicinity. In the model this is represented by inactivating a small section of 300 mm watermain on Willow Avenue and was needed to reduce pressures at Hydrant Tests 9 and 10. This assumption was favoured over roughening the cast iron pipes further due to the Municipality’s field observations of cast iron conditions. As well, roughening these pipes would result in pressure drops throughout other areas of Jasper that would worsen the calibration results at several other hydrant test locations.

At this point it was deemed that reasonable calibration was achieved, allowing for system assessments. The Hazen-Williams ‘C’ values in Table 5.3 were determined for model calibration.

Table 5.3: Calibrated Hazen-Williams ‘C’ Values

Material	Percentage of All Distribution Mains	Roughness Coefficient
	%	
ACP	0.05	130
CI ≤ 100 mm	6.13	50
CI = 150 mm or 200 mm	44.48	80
CI ≥ 250 mm	15.50	120
CMP	0.01	100
DI	0.08	130
GP	0.05	130
HDPE	2.15	140
PVC	31.52	140
S	0.02	130

Table 5.4 and Figures 5.3 and 5.4 show the model calibration results obtained from using the ‘C’ values stipulated in Table 5.3.

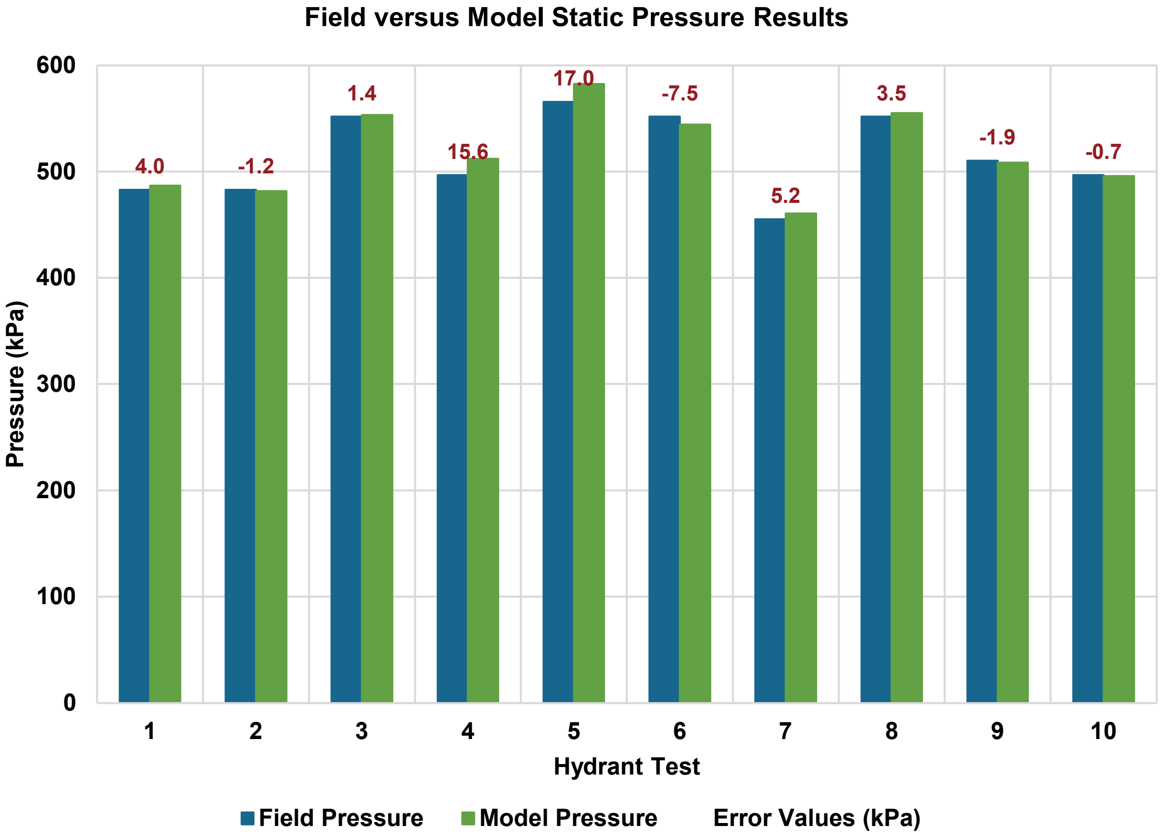


Figure 5.3: Static Pressure Calibration Results at Residual Hydrant

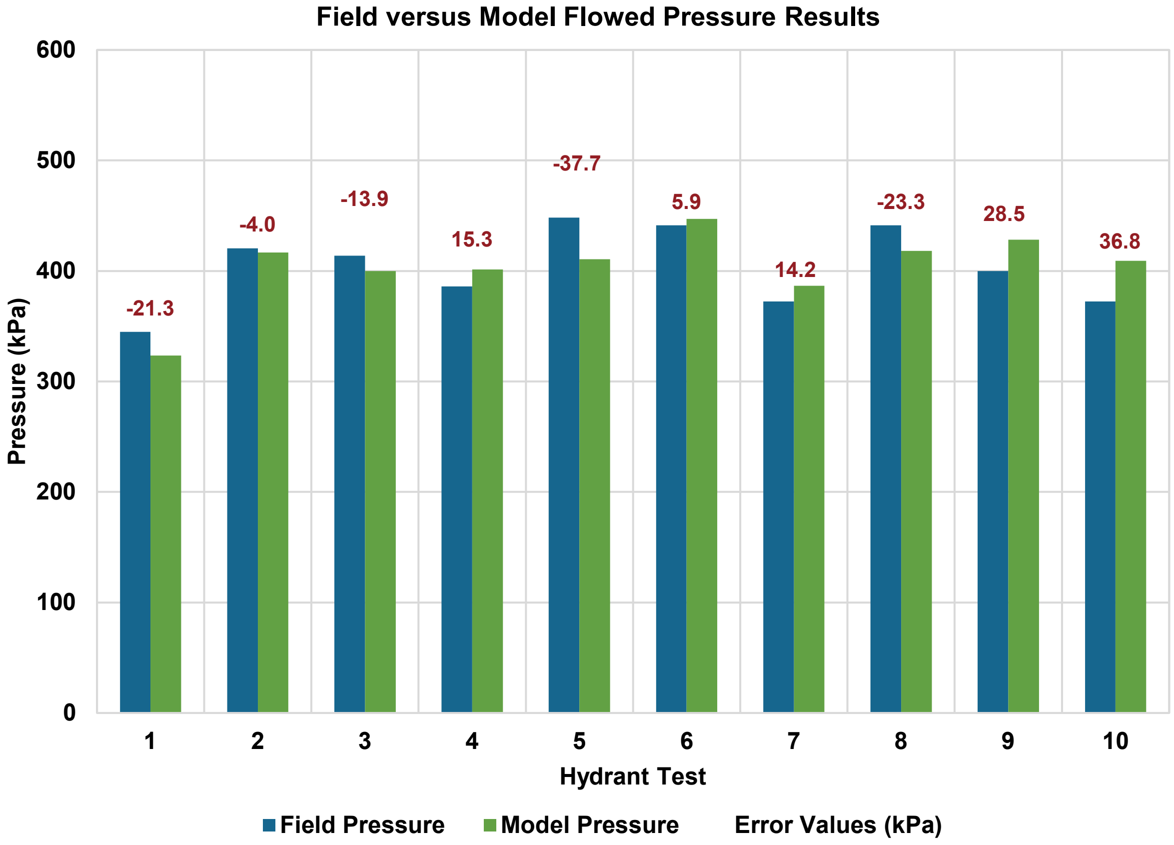


Figure 5.4: Flowed Pressure Calibration Results at Residual Hydrant

Table 5.4: Calibration Results

Hydrant Test	Test Type	Flow at Hydrant	Residual Hydrant			Logger 1			Logger 2		
			Field Pressure	Model Pressure	Model Error	Field Pressure	Model Pressure	Model Error	Field Pressure	Model Pressure	Model Error
		L/s	kPa	kPa	kPa	kPa	kPa	kPa	kPa	kPa	kPa
1	Static		482.6	486.6	4.0	482.8	461.9	-20.9	531.2	524.6	-6.6
	Flow	100.74	344.7	323.5	-21.3	420.0	442.7	22.6	474.3	490.2	15.9
2	Static		482.6	481.4	-1.2	482.8	461.9	-20.9	531.2	524.6	-6.6
	Flow	83.91	420.6	416.5	-4.0	452.6	449.3	-3.3	448.6	471.2	22.6
3	Static		551.6	553.0	1.4	482.8	461.9	-20.9	531.2	524.6	-6.6
	Flow	68.37	413.7	399.8	-13.9	435.2	452.2	17.0	431.6	474.1	42.5
4	Static		496.4	512.0	15.6	482.8	461.9	-20.9	531.2	524.6	-6.6
	Flow	56.62	386.1	401.4	15.3	468.2	454.4	-13.8	469.6	473.7	4.1
5	Static		565.4	582.4	17.0	482.8	461.9	-20.9	531.2	524.6	-6.6
	Flow	97.86	448.2	410.5	-37.7	426.9	446.2	19.3	393.6	423.5	29.9
6	Static		551.6	544.1	-7.5	482.8	461.9	-20.9	531.2	524.6	-6.6
	Flow	103.47	441.3	447.2	5.9	464.2	444.9	-19.3	463.1	436.9	-26.2
7	Static		455.1	460.3	5.2	482.8	461.9	-20.9	531.2	524.6	-6.6
	Flow	91.95	372.3	386.5	14.2	465.6	444.8	-20.8	506.5	490.4	-16.1
8	Static		551.6	555.1	3.5	482.8	461.9	-20.9	531.2	524.6	-6.6
	Flow	97.86	441.3	418.0	-23.3	409.9	446.2	36.3	372.6	424.5	51.9
9	Static		510.2	508.3	-1.9	482.8	461.9	-20.9	531.2	524.6	-6.6
	Flow	94.98	399.9	428.4	28.5	437.0	446.7	9.7	437.4	453.4	16.0
10	Static		496.4	495.8	-0.7	482.8	461.9	-20.9	531.2	524.6	-6.6
	Flow	87.09	372.3	409.1	36.8	436.0	448.6	12.6	432.7	465.6	32.9

6.0 Existing System Assessment and Upgrades

The existing water system was analyzed under six different scenarios to determine system conditions. As mentioned in Section 3.1, these scenarios included:

- Steady State:
  - Average day demand (ADD)
  - Maximum daily demand (MDD)
  - Peak hour demand (PHD)
- Steady State with Fire Flow Analysis:
  - Maximum day demand plus fire flow (MDD + FF)
- Extended period simulation (EPS)

Additionally, the reservoir was assessed in terms of reservoir storage under the existing system. Table 6.1 summarizes the demands that were used for input in the above-mentioned assessments.

Table 6.1: Existing System Demands

Scenario	Demand	
	L/s	m^3
ADD	51.58	4,457
MDD	103.16	8,913
PHD	257.9	22,283

6.1 Pressure Assessment

The highest and lowest pressures in addition to the locations at which these pressures occur are shown below in Table 6.2, for the ADD, MDD, and PHD scenarios.

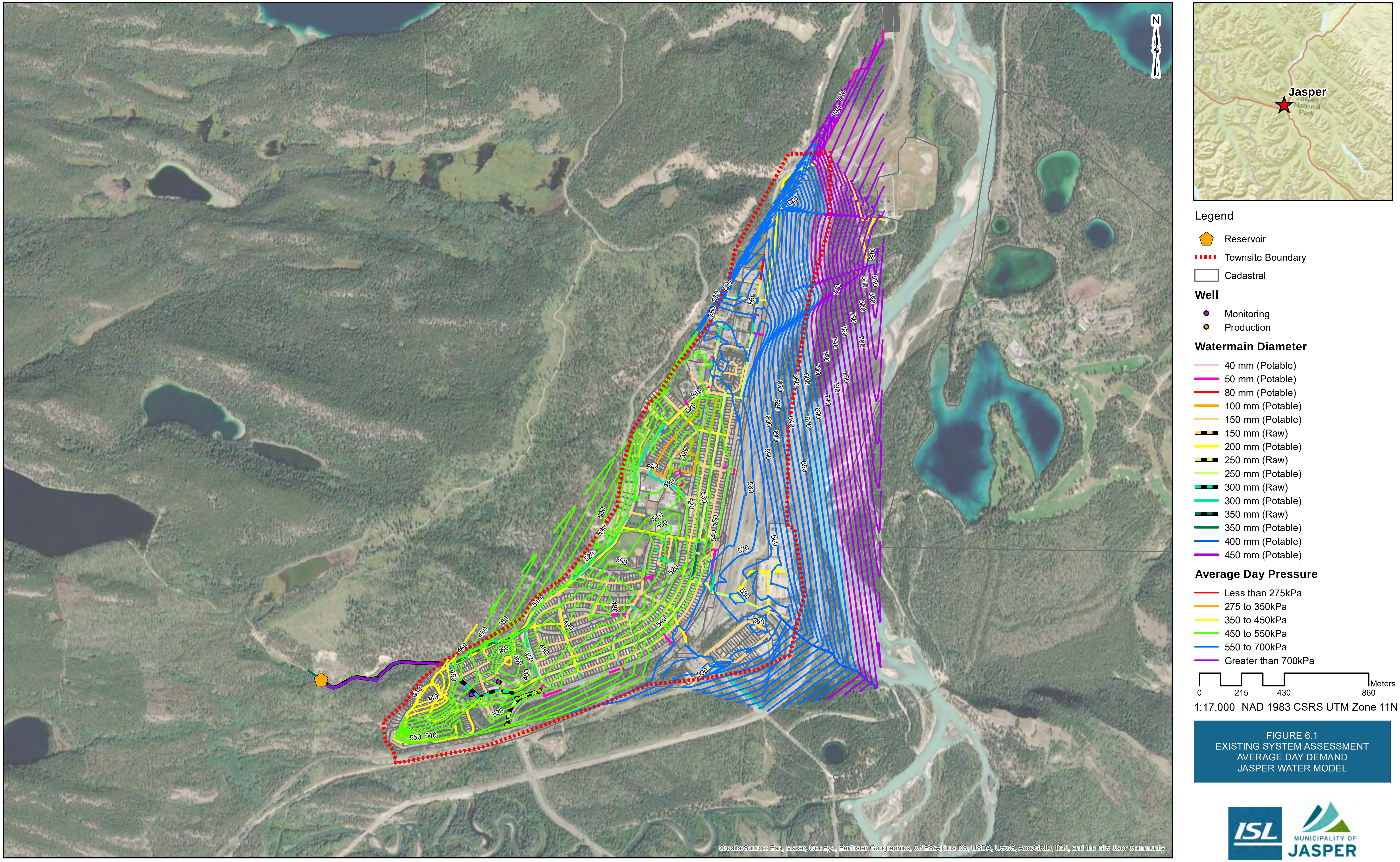
Table 6.2: Existing System Pressure Ranges

Scenario	Figure	Highest Pressure		Location	Lowest Pressure		Location
		kPa	psi		kPa	psi	
ADD	6.1	843.01	122.27	Pine Bungalows Resort	545.80	79.16	Jasper Inn & Suites
MDD	6.2	800.80	116.15		475.23	68.93	
PHD	6.3	540.75	78.43		40.38	5.86	

There is a wide range in pressures throughout Jasper under the three pressure assessment scenarios, which is expected given the system is on a single pressure zone. Higher pressures are exhibited to the east near the river in the lower terrain, while lower pressures are prevalent along the northwestern boundary of Jasper where the elevations are higher.

There are some isolated pressure constraints under PHD conditions due to large junction demands on small 50 mm diameter dead-end watermains with low ‘C’ values (i.e., higher pressure losses). One of these locations is near the Jasper Inn & Suites as indicated in Table 6.2. It is noted that most of these pressure constraints are limited to these smaller diameter dead-end mains and should not impact most of the distribution system. Most junctions in the PHD scenario are above the minimum pressure requirement of 275 kPa.

Watermains near the river exhibit pressures greater than 800 kPa under ADD and MDD conditions. This is quite substantial for a water system, given that the recommended maximum pressure is 550 kPa, or 670 kPa if localized PRVs are installed on services.



Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 6.1
EXISTING SYSTEM ASSESSMENT
AVERAGE DAY DEMAND
JASPER WATER MODEL

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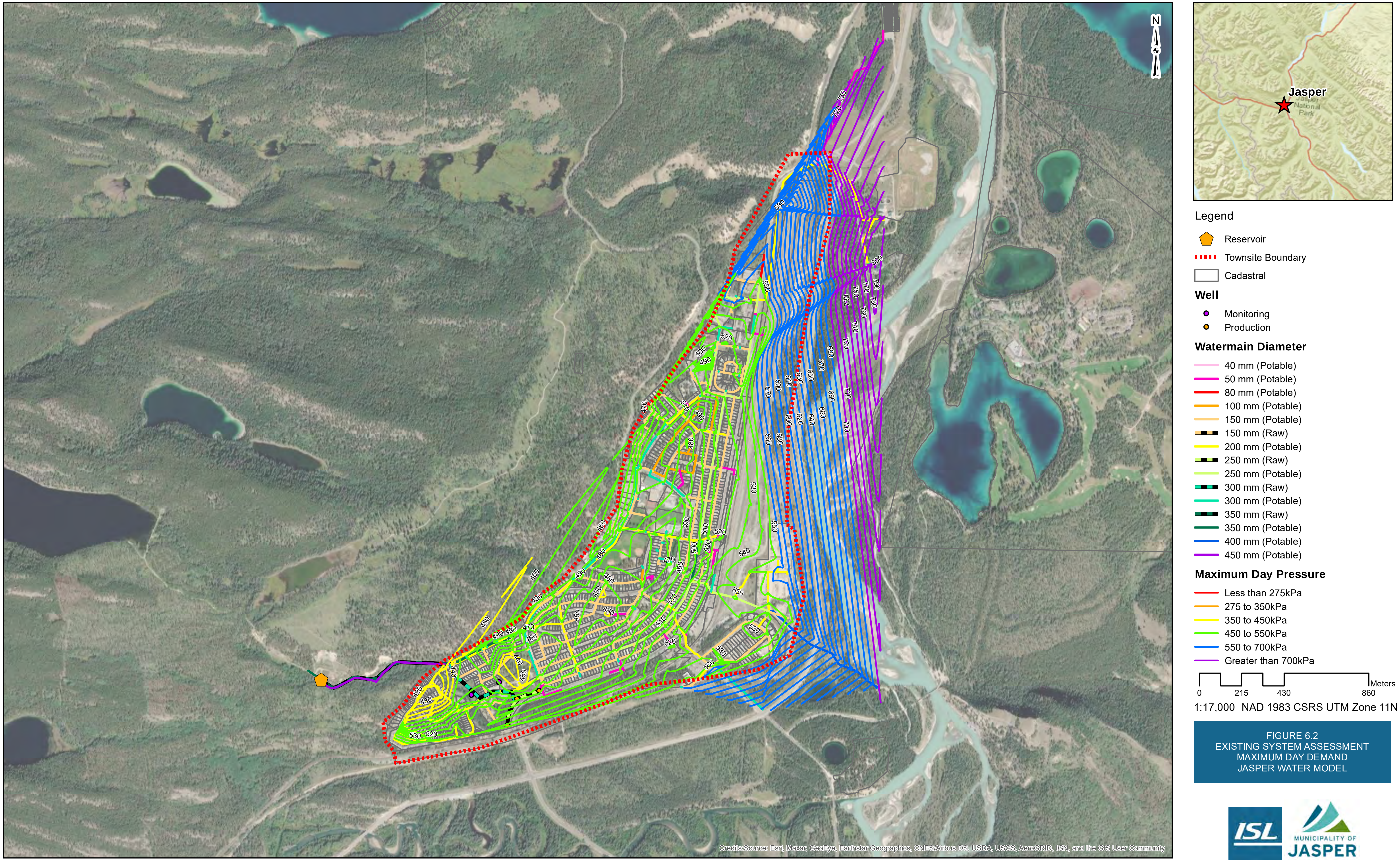

Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 6.2
EXISTING SYSTEM ASSESSMENT
MAXIMUM DAY DEMAND
JASPER WATER MODEL

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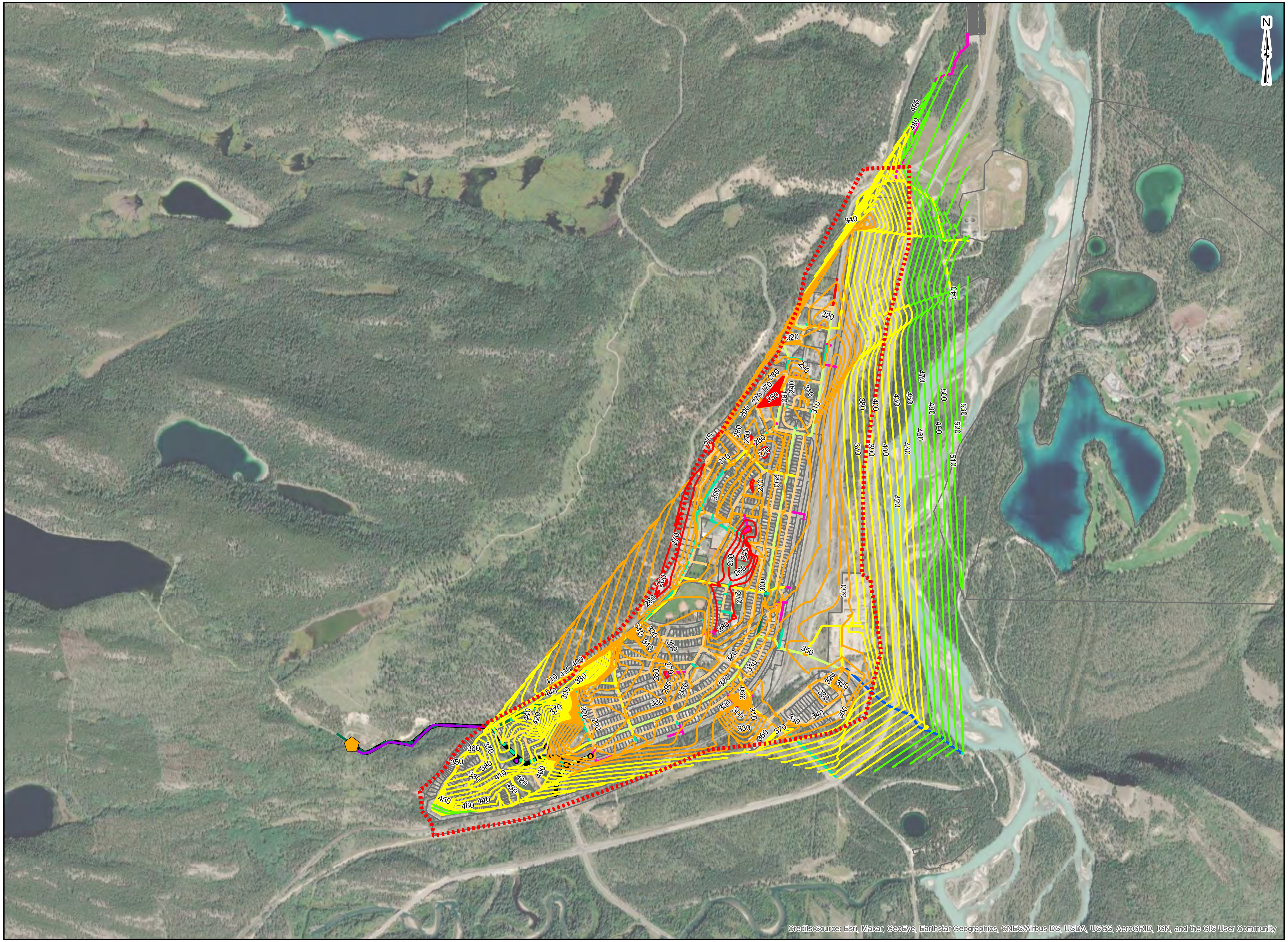

Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- ⬠ Reservoir
- ┅ Townsite Boundary
- ☐ Cadastral

Well

- ● Monitoring
- ● Production

Watermain Diameter

- — 40 mm (Potable)
- — 50 mm (Potable)
- — 80 mm (Potable)
- — 100 mm (Potable)
- — 150 mm (Potable)
- — 150 mm (Raw)
- — 200 mm (Potable)
- — 250 mm (Raw)
- — 250 mm (Potable)
- — 300 mm (Raw)
- — 300 mm (Potable)
- — 350 mm (Raw)
- — 350 mm (Potable)
- — 400 mm (Potable)
- — 450 mm (Potable)

Peak Hour Pressure

- — Less than 275kPa
- — 275 to 350kPa
- — 350 to 450kPa
- — 450 to 550kPa
- — 550 to 700kPa
- — Greater than 700kPa

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 6.3
EXISTING SYSTEM ASSESSMENT
PEAK HOUR DEMAND
JASPER WATER MODEL

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Higher pressures can lead to concerns with leakage if the watermains are not properly rated to accommodate these pressures. This could become an issue under lower demand scenarios, particularly ADD, night-time, or off-season (i.e., winter) demands.

The large variability in demands caused by seasonal tourists results in a big variance in pressures observed throughout the system. This coupled with the single pressure zone and reasonable degree of topographical changes could support the implementation of additional pressure zones to better control system pressures.

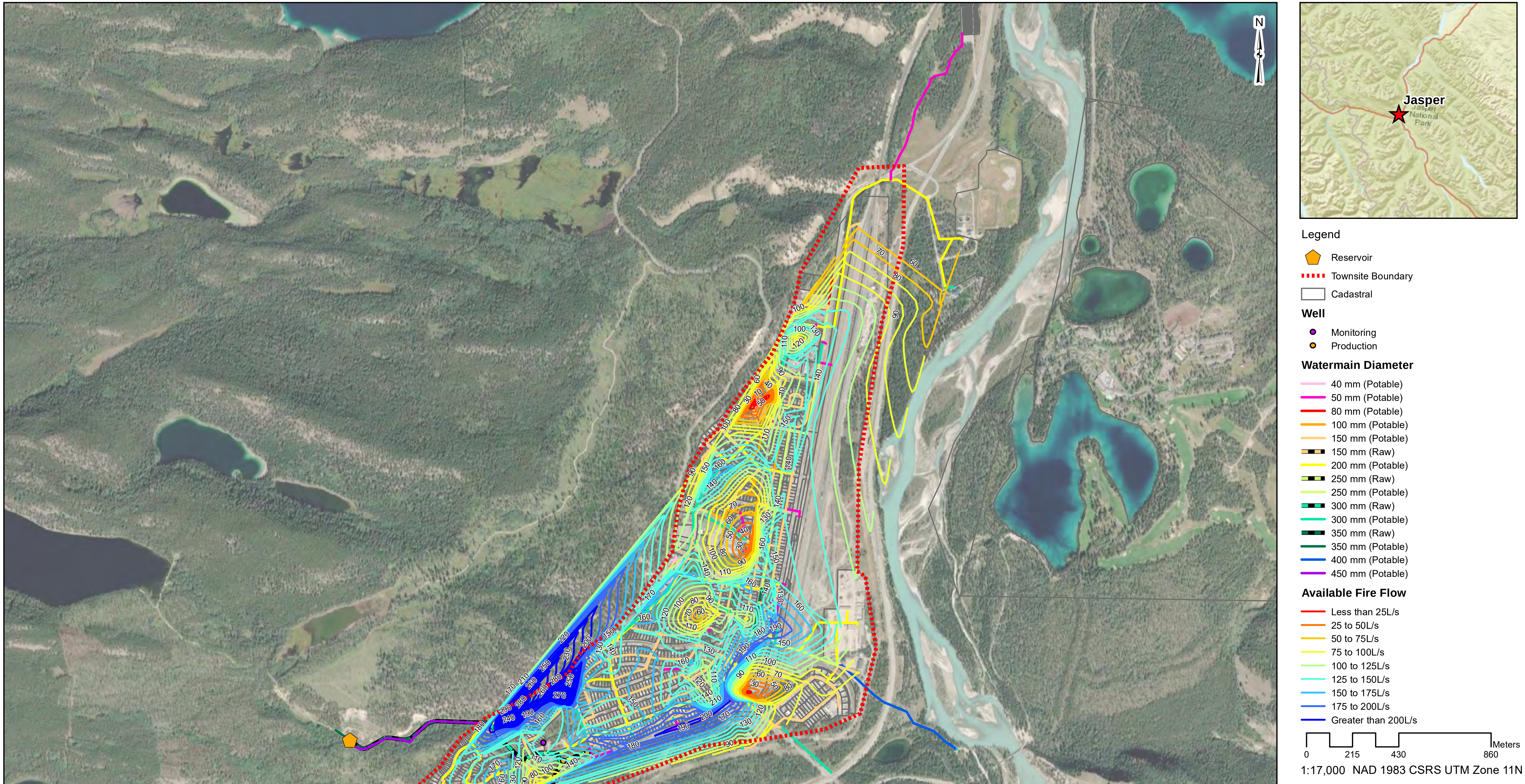
6.2 Fire Flow Assessment

Results of the MDD + FF assessment under existing conditions are shown in Figure 6.4. Available fire flow was determined only at hydrant locations (noting that the minimum pressure constraint requirement occurs at all nodes, not only the hydrants), with fire flows ranging from 8.24 L/s to 385.21 L/s. As expected, the hydrant with the smallest available fire flow occurs at the Jasper Inn & Suites as the minimum pressure constraint of 140 kPa under fire flow conditions occurs at a low flow due to the size and roughness of the connected main. Other areas with significant fire flow deficiencies also occur on dead-end small diameter watermains with a reduced ‘C’ value as determined through the calibration exercise.

Figure 6.5 compares the available fire flow under existing conditions to the current land use type for each parcel. Though some areas have fire flows in the 125 L/s to 150 L/s range, these mostly occur in low-density residential areas, thus is sufficient to meet the recommended criteria. However, this could become more of a concern as infill developments progress in the future, as these parcels will no longer be classified as low-density residential. Another area of note is the predominantly industrial lands to the south. These parcels have available fire flows in the 75 L/s to 100 L/s range, which is below the recommended criteria for industrial land use types.

The system level of service was calculated for Jasper based on the existing available fire flow. This process was accomplished by creating buffers around each hydrant to represent each hydrant’s coverage. Coverage criteria was obtained from the City of Calgary’s Design Guidelines for Subdivision Servicing 2020 in lieu of provincial guidelines as these standards are more conservative than those provided in EPCOR’s 2021 City of Edmonton Design and Construction Standards Volume 4: Water. Calgary’s guidelines stipulate that the maximum allowable fire hydrant spacing for low density residential properties is 300 m, suggesting a 150 m coverage. The maximum allowable fire hydrant spacing for institutional, commercial, industrial, and high-density residential developments is 150 m, suggesting a 75 m coverage. The outcome of this analysis is shown in Figure 6.6. This is intended to provide the Municipality a roadmap of which areas can be further densified prior to upgrades being required.

In Figure 6.6, it is important to note that this is not meant to entirely deter densification in certain areas. There are some options to allow growth to occur, but this must be made clear to developers. Firstly, fire flow criteria can be reduced by up to 50% if sprinklers are installed in buildings. The flow to supply the sprinklers (typically 20 to 30 L/s) must also be added to the required fire flow. For example, a commercial parcel has a fire flow requirement of 265 L/s without sprinklers. If sprinklers are installed in the building, the requirement is reduced to 162.5 L/s (half of 265 L/s plus 30 L/s for sprinkler flows). The second option, if sufficient fire flow still does not exist, is to stipulate in the development permit that an on-site fire suppression tank is required. The tank would be sized to provide sufficient fire flows for the required duration based on the Fire Underwriter’s Criteria. The developer would be responsible in ensuring this tank is installed and sufficient for the development to ensure public safety. The final solution would be to upgrade the Municipality’s existing water system to provide fire flows. Some existing system upgrade recommendations are proposed below, however these should be investigated on a case-by-case basis if fire flow criteria is not met otherwise.



Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 6.4
EXISTING SYSTEM ASSESSMENT
MAXIMUM DAY DEMAND PLUS FIRE FLOW
JASPER WATER MODEL

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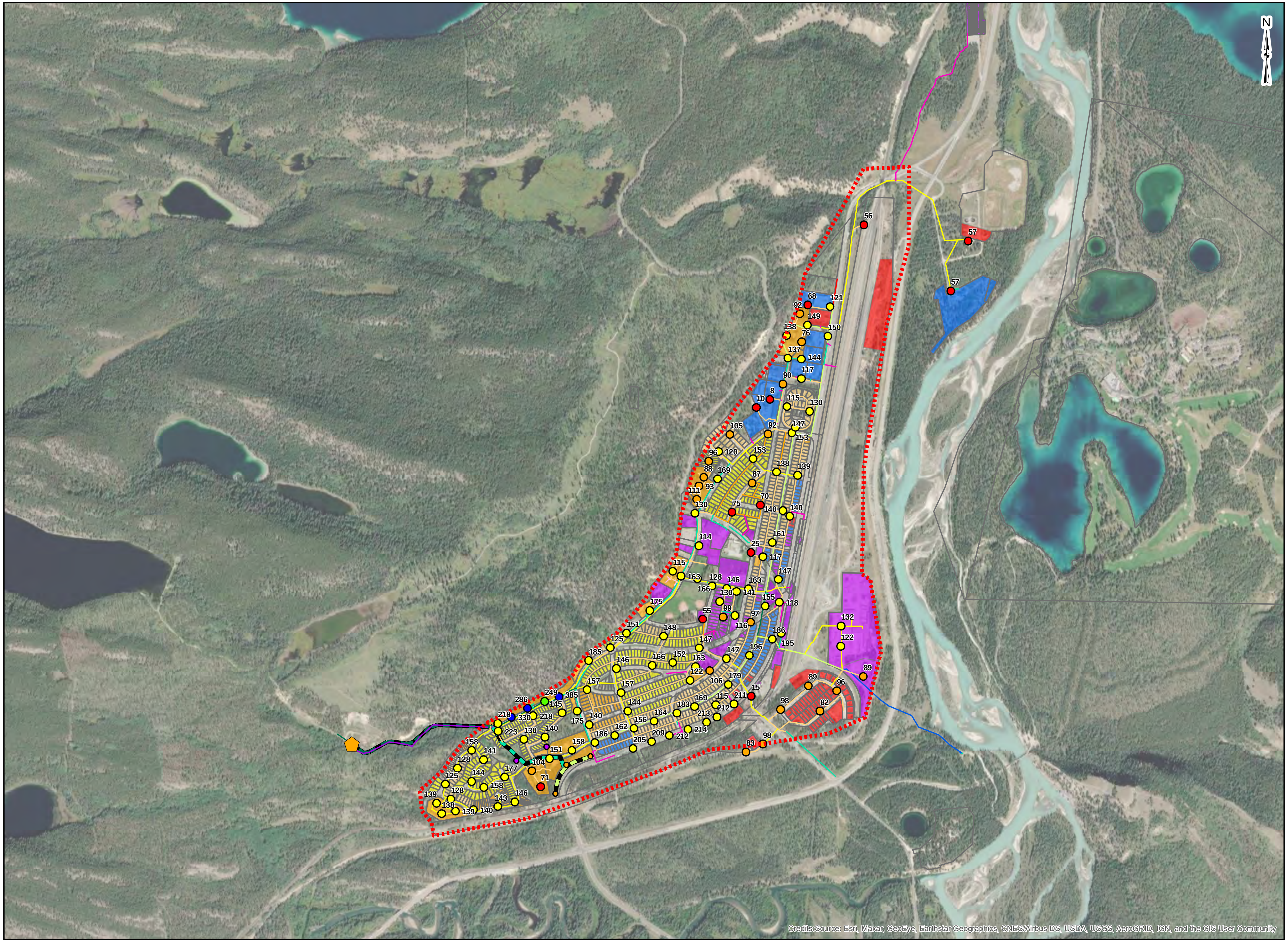
Date: 2022-05-24 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 6.4 - EX MDD + FF.mxd



Legend

- Reservoir
- Townsite Boundary
- Cadastral

Well

- ● Monitoring
- ● Production

Watermain Diameter

- 40 mm (Potable)
- 50 mm (Potable)
- 80 mm (Potable)
- 100 mm (Potable)
- 150 mm (Potable)
- 150 mm (Raw)
- 200 mm (Potable)
- 250 mm (Raw)
- 250 mm (Potable)
- 300 mm (Raw)
- 300 mm (Potable)
- 350 mm (Raw)
- 350 mm (Potable)
- 400 mm (Potable)
- 450 mm (Potable)

Available Fire Flow

- 🔴 Less than 76L/s (Fails All Criteria)
- 🟠 76 to 114L/s (Single Family Residential)
- 🟡 114 to 227L/s (Multi-Family Residential / Institutional)
- 🟢 227 to 265L/s (Industrial)
- 🔵 Greater than 265L/s (Commercial)

Land Use Type

- 🟦 Commercial
- 🟧 High Density Residential
- 🟥 Industrial
- 🟪 Institutional
- 🟨 Low Density Residential
- ▨ Medium Density Residential

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 6.5
EXISTING SYSTEM ASSESSMENT MAXIMUM DAY DEMAND PLUS FIRE FLOW COMPARISON TO LAND USE TYPES JASPER WATER MODEL

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Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 6.5 - EX MDD + FF versus Land Use.mxd

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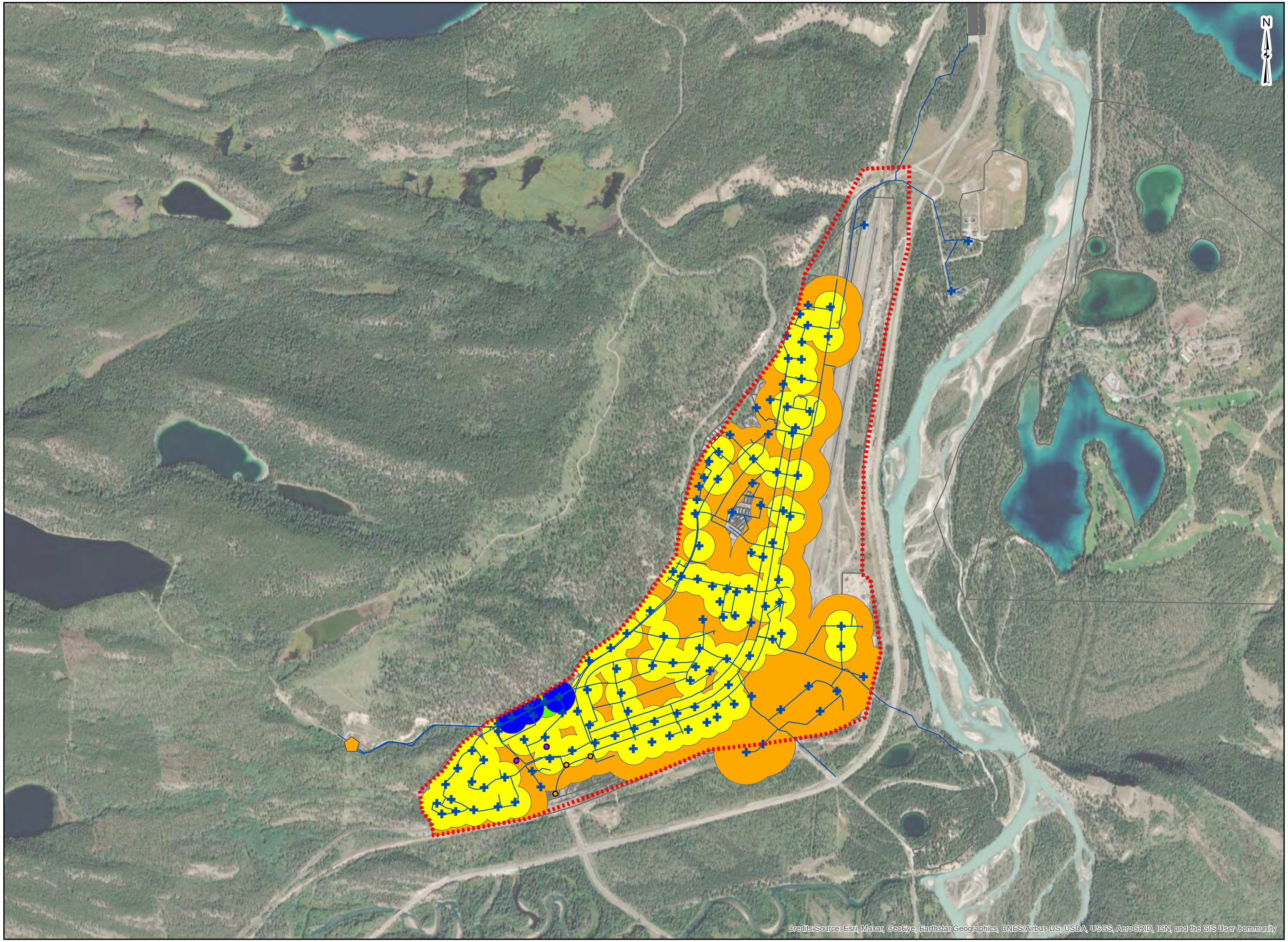

Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- ✚ Hydrant
- ⬟ Reservoir
- — Watermain
- ┅ Townsite Boundary
- ☐ Cadastral

Well

- ● Monitoring
- ● Production

Possible Land Use Type

- ☐ No Sufficient Fire Flow Coverage (Less than 76L/s)
- 🟧 Single Family Residential (76 to 114L/s)
- 🟨 Multi-Family Residential / Institutional (114 to 227L/s)
- 🟩 Industrial (227 to 265L/s)
- 🟦 Commercial (Greater than 265L/s)

Note: Hydrant coverage is based on the City of Calgary's Subdivision Servicing Design Guidelines.

Low Density Residential: 150m Radius
All Other Land Use Types: 75m Radius

This assumes no other hydrants are added to the system, which would also increase the hydrant coverage.

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 6.6
EXISTING SYSTEM ASSESSMENT
FIRE FLOW LEVEL OF SERVICE
JASPER WATER MODEL

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Date: 2022-07-06 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 6.6 - Possible Land Use Types.mxd

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6.3 Reservoir Capacity Assessment

The volume of water storage required in Jasper under existing conditions was determined using the formula for storage criteria provided by AEP noted in Section 3.7. A fire flow rate of 265 L/s for a 3.5-hour duration was chosen, as this represents the most conservative fire flow criteria for commercial developments based on the Fire Underwriters Survey recommendations. Table 6.3 summarizes the storage requirements.

Table 6.3: Existing Reservoir Storage Requirement

Parameter	Unit	Value	Factor	Total
ADD	m^3	4,457	15%	669
MDD	m^3	8,913	25%	2,228
Fire Flow	L/s	265	3.5 hours	3,339
			Total Storage Requirement (m^3)	**6,236**

There is an available storage capacity of 6,877 m^3 based on volume calculations performed using the 1989 record drawings. The existing storage requirement is less that the available storage capacity, meaning that there is sufficient storage under existing conditions. As such no water storage upgrading is required at this time. It is noted, however, that a detailed review of chlorine contact time was outside the scope of this exercise. It is suggested that the Municipality review this with operations and AEP, as this can affect the storage calculation in an upwards direction.

6.4 Well Supply Assessment

Water is supplied via three production wells north of Connaught Drive, and fed to the WTP through the 150 mm (very minor length), 250 mm, 300 mm, and 350 mm raw water supply lines noted in Section 4.2. A critical aspect of this project was to run an extended period simulation to compare the outflow of the reservoir to the inflow from the raw water supply lines based on well production.

The three wells operate at different pumping rates; however, a default flow rate of 75 L/s was used in this study. For this assessment scenario, the extended period simulation option was initiated. Diurnals for residential and non-residential land use types were assigned to each system demand, and the wells and raw water supply lines were activated in the model. A 'dummy' pump representing the pumps at the wells was added along the raw water supply line with a flow rate of 75 L/s to represent the assumed value for this study. A single design point with a flow of 75 L/s and head of 57.50 m was assumed for the model. To determine the head, a trial-and-error process was undertaken under ADD conditions to ensure that a rate of 75 L/s is being conveyed through the raw water supply lines. This is an approximation, resulting in slightly varying flow rates for the various scenarios that are assessed in this study. Having actual pump curves for the production wells would provide a more accurate representation, however, for the purposes of this study a single design point was deemed acceptable. If pump curves for the wells become available in the future, these can be updated in the model.

Results available at the reservoir were extracted from the model for the 24-hour simulation duration. It is noted that the reservoir was modelled as a tank in WaterCAD to provide more accurate results for water levels, flows, and volumes at the facility. The results include the following:

- Net flow leaving the tank
  - Represents the difference between the hourly network demands and the 75 L/s fill rate
- Percentage of the tank that is full
  - Represents the ratio of the tank active volume to the calculated tank full activated volume
- Water level within the tank
  - Represents the difference between the calculated hydraulic grade line and the base elevation of the tank

The following graphs in Figures 6.7 and 6.8 illustrate the results at the tank under ADD and MDD conditions. The PHD condition scenario was not simulated, given it would theoretically only be occurring for a one-hour duration. The tank begins at an HGL of 1118 m, which was determined through the static condition calibration exercise. This means that the tank is not empty at the beginning of the simulation, but rather its anticipated level under normal operating conditions.

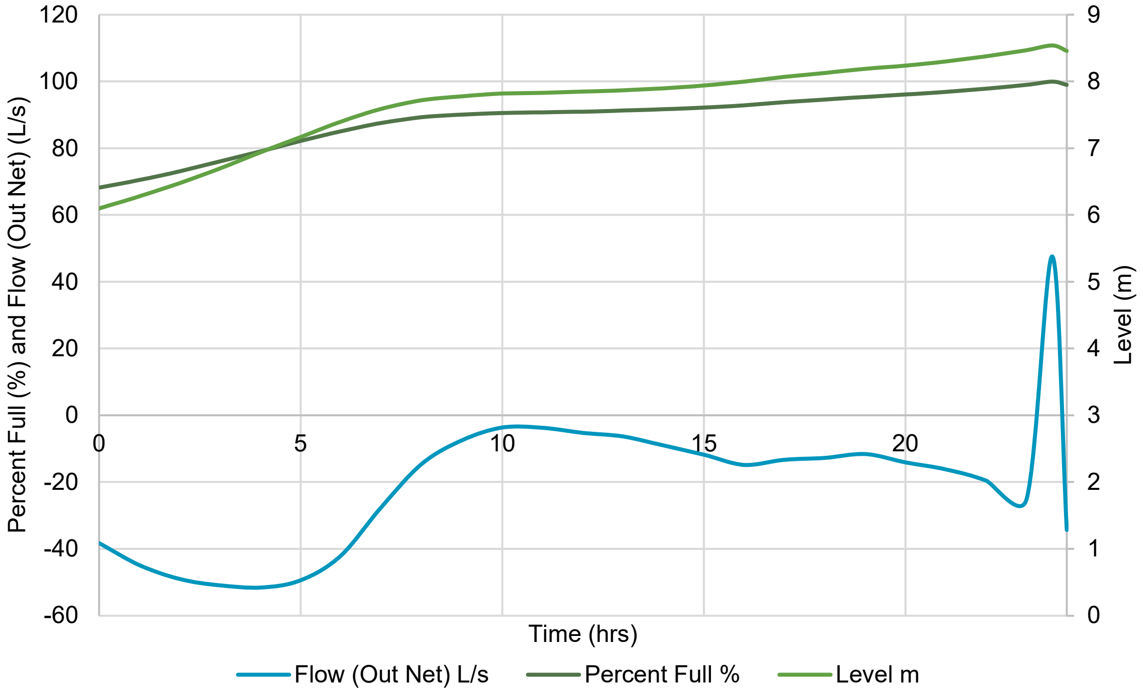


Figure 6.7: Existing ADD Condition Results at the Reservoir under an Extended Period Simulation

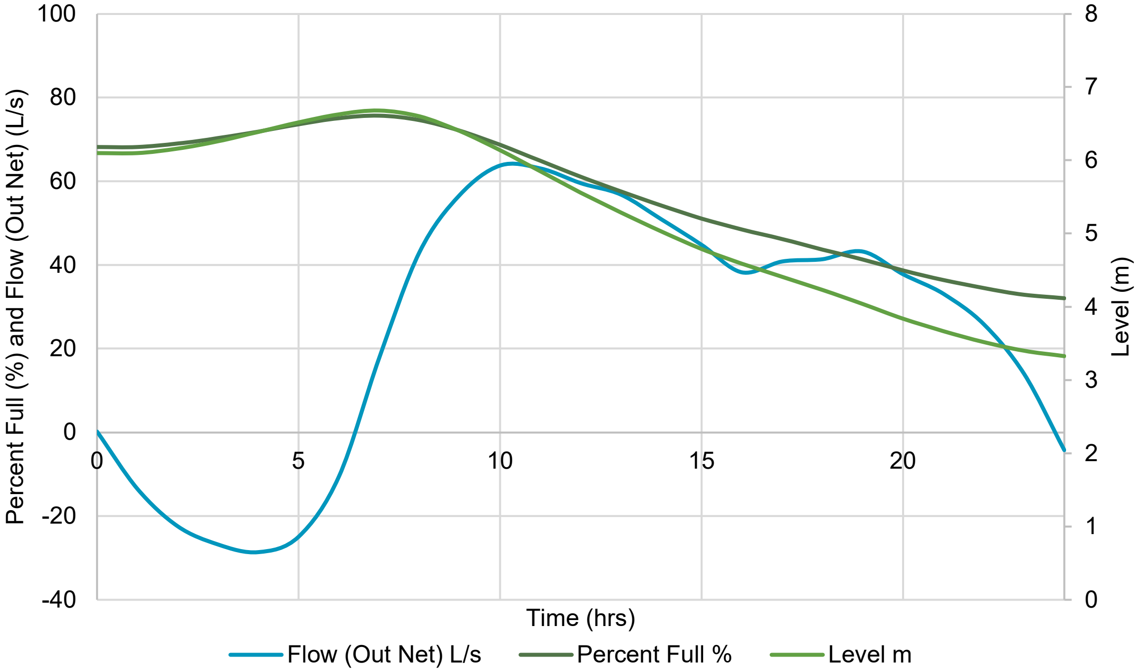


Figure 6.8: Existing MDD Condition Results at the Reservoir under an Extended Period Simulation

At a rate of 75 L/s, the reservoir is filling under ADD conditions (peaked based on the hourly diurnal factors stipulated in Section 3.4.2). This is because the total flow leaving the reservoir is less than the total flow entering the reservoir. Note that this assumes the pumps are running constantly for the duration of the extended period simulation. At about 23 hours into the simulation, the reservoir is full. This is evident on the 'Percent Full' time series above, and by the spike in the 'Flow (Out Net)' time series. Since the reservoir is full the excess water is being conveyed to the distribution system only while the reservoir depletes again.

Under MDD conditions, the reservoir becomes more depleted, which is evident on the 'Percent Full' time series, which drops to 32.1% full by the end of the 24-hour duration. It is also evident by the 'Flow (Out Net)' time series, illustrating that more flow is leaving the reservoir than entering it for most of the day. Note that since this also factors into diurnal peaking factors, the actual peak flow rate under these conditions will be greater than the steady-state MDD flow rate. This would still be less than the calculated PHD flow rate given that the maximum hourly peaking factor is less than the peaking factor from MDD to PHD conditions (PHD is 2.5 times MDD).

There is also the risk of depletion in the event of a fire as the volume of water leaving the reservoir to the distribution system will be substantially larger if there is a fire. Though the reservoir storage is adequate, the reservoir is not always full under the extended period simulation. There could be a concern with a lack of water under fire flow conditions if the required fire flow is greater (i.e., more than a single-family residential home) or if the fire occurs when the reservoir has been depleted.

From a steady-state review in terms of PHD conditions, the raw water fill rate of 75 L/s would be insufficient to meet the calculated PHD of 257.9 L/s. The reservoir would be required to operate on its reserve potable water supply to meet the needs of the system under these conditions.

The raw water supply flow rate is sufficient under ADD conditions. It is also sufficient under MDD conditions if there is some reserve capacity in the reservoir to supplement the deficiency if the design standard is reservoir depletion. It is noted that AEP typically recommends that water supply systems meet two times MDD conditions plus 10% (this would result in no depletion). If MDD conditions extend beyond a 24-hour duration, the reservoir would continue to be depleted, which could become a concern, hence the AEP guideline. That said, given the seasonality of Jasper's water demands, a discussion with AEP on this actual criterion is recommended as it may be less applicable in this case. The same concern would be apparent under PHD conditions. If the high demands continue for a substantial duration, the raw water supply flow rate and storage capacity of the reservoir will be unable to service the water distribution system. Note however that the reservoir storage capacity is sufficient under existing conditions based on AEP's criteria, as determined in Section 6.3 above.

6.5 Unaccounted for Water Assessment

As noted in Section 3.2, UFW includes unmetered irrigation lines and leakage losses throughout the distribution system. An irrigation rate was assumed based on industry standards and an understanding of the geographic and demographic characteristics of Jasper, while the leakage losses made up the difference. An average leakage of 26% of the total volume of water produced was calculated, which is substantial.

A desktop exercise was undertaken to identify areas of the system that are likely more susceptible to leakage. The critical factors that were considered in this exercise were watermain age, watermain material, and pressure under ADD conditions. These factors are shown in Figures 4.1, 4.2, and 6.1, respectively. Based on discussions with the Municipality, many galvanized service lines that were installed in the 1960s and 1970s have significant amounts of leakage. Also noted was that ductile iron watermains have experienced the most main breaks historically. It is also anticipated that watermains normally operating at higher pressures will also likely exhibit more leakage.

Based on the factors identified above, an assessment identifying the leakage potential for each section of watermain was performed. Watermains were ranked based on priority to consider further investigation and/or replacements. Three criteria were identified as follows:

- Watermains built before the 1980s received a score of 1
- Watermains comprising of ductile iron or steel received a score of 1
- Watermains with a pressure greater than 550 kPa under ADD conditions received a score of 1

The total scores were summated and used to prioritize leakage investigation, noting that the GIS data identified very limited sections of ductile iron or steel pipes. The GIS data also does not include any service lines; however, these should also be investigated if comprised of galvanized pipe. This analysis is shown in Figure 6.9, where higher priority watermains are shown as red and lower priority watermains are green. Areas of note are the industrial lands to the southeast and the developments to the north, where higher pressures are observed, and the areas are older.

6.6 Existing System Recommendations

6.6.1 Capacity-Based Upgrades

Upgrades to existing system infrastructure were added to the model to determine the system improvements. The focuses were to reduce the high pressures in lower elevations under ADD and MDD conditions, increase pressures where deficiencies were noted under PHD conditions, and improve available fire flows at hydrants. A figure illustrating the proposed upgrades are shown in Figure 6.10. The upgrades are also summarized as follows in Table 6.4.

Table 6.4: Summary of Recommended Upgrades

Upgrade ID	Location	Length	Proposed Size	Number of PRVs
		m	mm	
EX Upgrade 1	Near the intersection of Bonhomme Street and Geikie Street	149	200	N/A
EX Upgrade 2	Along Pyramid Lake Road between Bonhomme Street and Patricia Street	399	300	N/A
EX Upgrade 3	Near the intersection of Hazel Avenue and Connaught Drive	5	150	N/A
EX Upgrade 4	Along Turret Street between Larch Avenue and Tonquin Street	96	150	N/A
EX Upgrade 5	Along Turret Street south of Maligne Avenue and in the alley between Turret Street and Robson Street	189	150	N/A
EX Upgrade 6[1]	In the alley between Geikie Street and Patricia Street	1	150	N/A
EX Upgrade 7	Off Geikie Street, south of Pyramid Lake Road	20	150	N/A
EX Upgrade 8	Near the intersection of Pyramid Lake Road and Colin Crescent	11	200	N/A
EX Upgrade 9	Off Geikie Street, between Bonhomme Street and Juniper Street	59	150	N/A
EX Upgrade 10	Predominantly on Hazel Avenue and Stan Wright Drive	850	250	N/A
Industrial Pressure Zone	PRVs installed along Connaught Drive, between Miette Avenue and Hazel Avenue	N/A	N/A	3
North Pressure Zone	PRVs installed along Bonhomme Street, between Geikie Street and Connaught Drive	N/A	N/A	4
Low North Pressure Zone	PRV installed on Connaught Drive, near the northern townsite border	N/A	N/A	1

[1] *Very small portion of 50 mm watermain bottlenecking a hydrant service.*

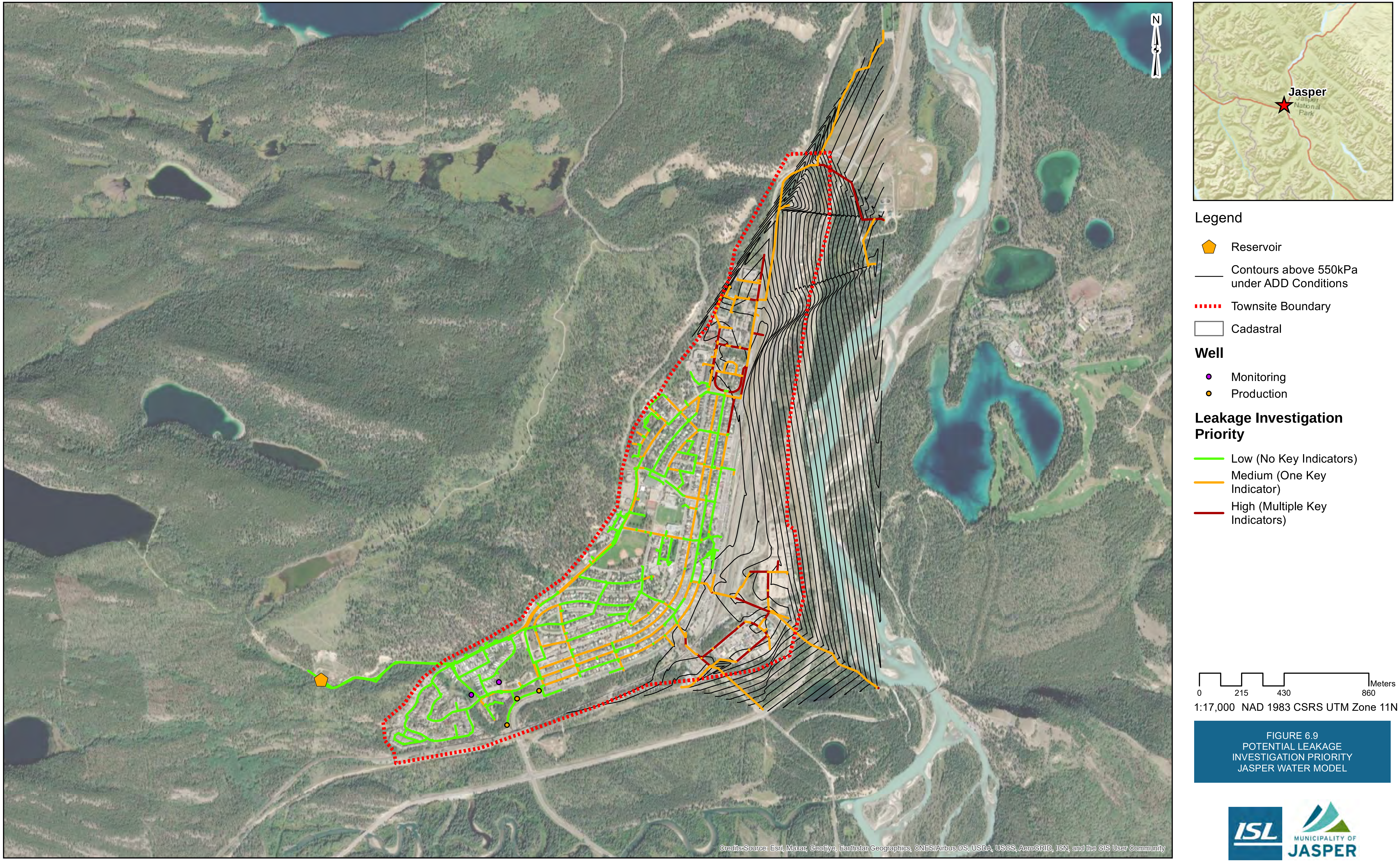
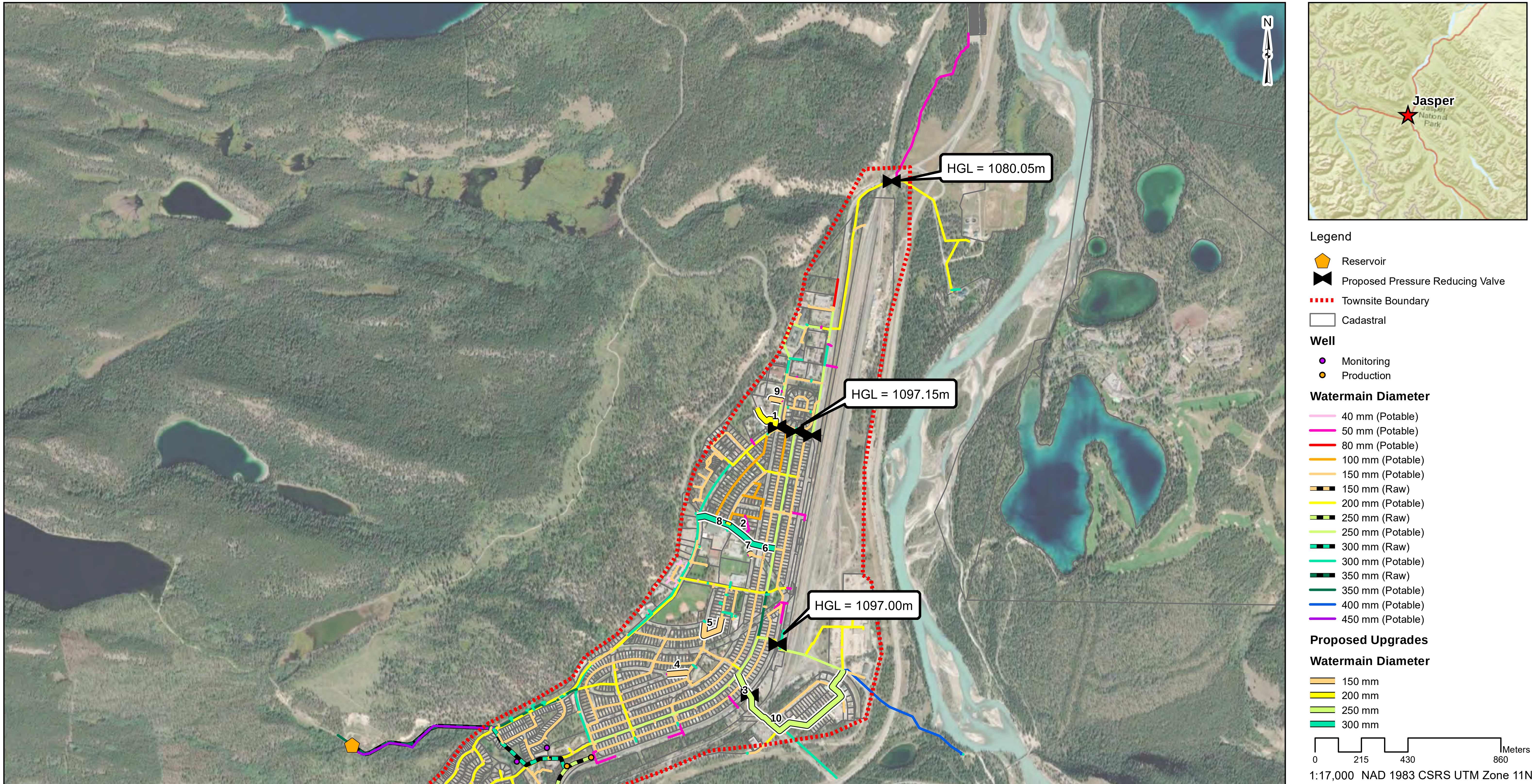


FIGURE 6.9
POTENTIAL LEAKAGE INVESTIGATION PRIORITY
JASPER WATER MODEL



Credits:Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 6.10
RECOMMENDED EXISTING
SYSTEM UPGRADES
JASPER WATER MODEL

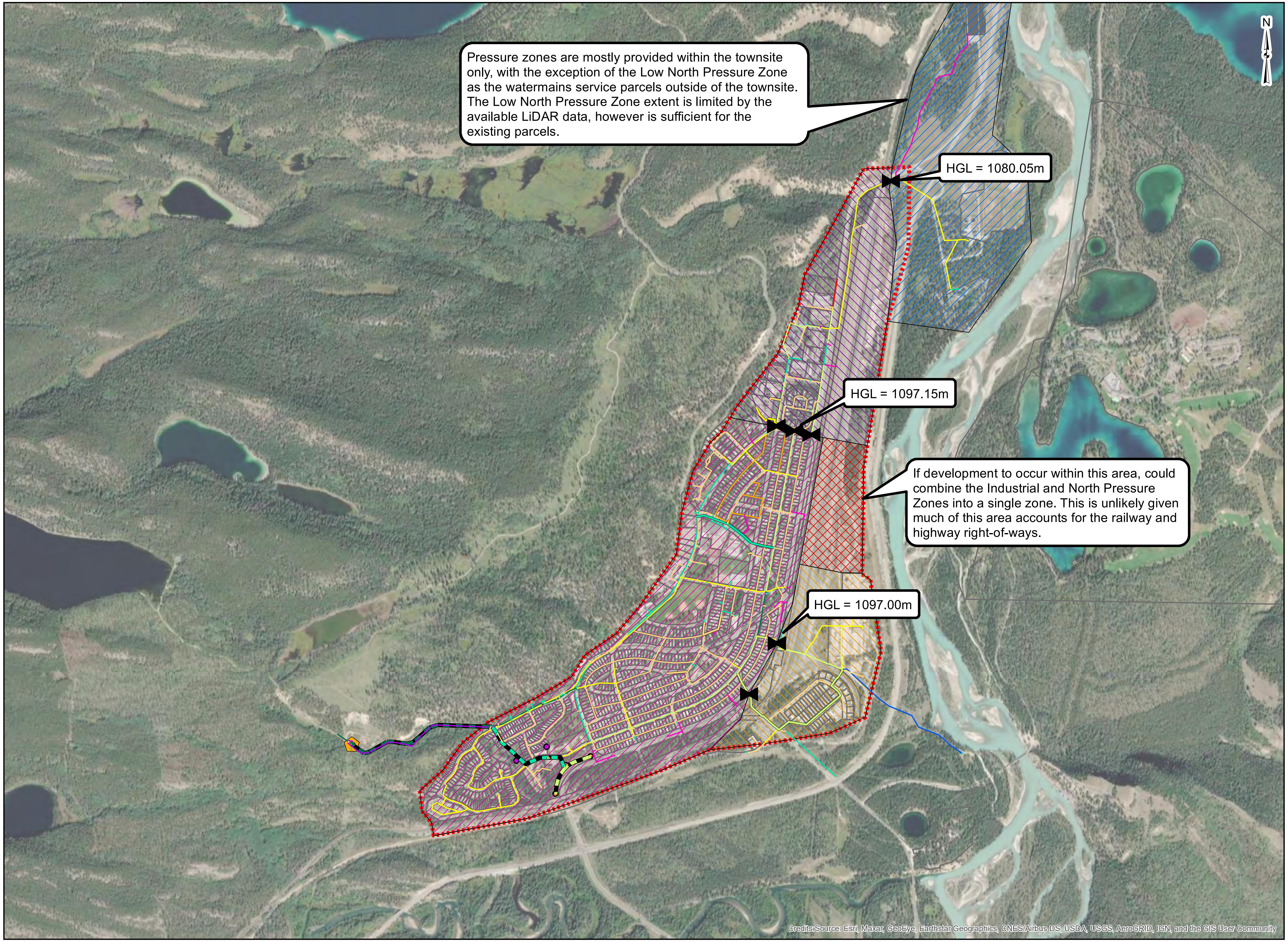
Date: 2022-06-03 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 6.10 - Existing System Upgrades.mxd

To reduce high pressures, three new pressure zones were implemented via eight new pressure reducing valves (PRVs). A map illustrating the three proposed pressure zones is shown in Figure 6.11. One pressure zone was created for the predominantly industrial lands by adding three PRVs to the three watermains feeding this area (noting two of these watermains on Connaught Drive are twinned). The proposed hydraulic grade line for this pressure zone is 1097 m. The second pressure zone is up north on Bonhomme Street, where four PRVs separate the lower terrain from the Main Pressure Zone. There are also twinned watermains with PRVs on Geikie Street. This pressure zone is proposed to have a hydraulic grade line of 1097.15 m. The final pressure zone is north of the second pressure zone, servicing only a few properties. The one PRV needed for this zone would be set at a hydraulic grade line of 1080.05 m. Since this final pressure zone would service a limited area, localized PRVs on laterals might be preferred.

To improve pressure and fire flow deficiencies, some looping and pipe upsizing is recommended. A 250 mm backbone is proposed in the industrial lands to provide additional fire flow protection. Two connections were added on Pyramid Lake Road. One connects the two sections of 300 mm watermains, and another connects the 50 mm cast iron watermain on the alley between Colin Crescent and Geikie Street to the 300 mm watermains. Smaller localized upgrades were also proposed on dead-end watermains to improve the pressures and fire flows.

Consideration for upgrading areas with small fire flow deficiencies could be made during roadworks programs. The recommendation in this case would be to replace watermains 150 mm or smaller with 200 mm to 300 mm mains, to improve fire flows in Jasper. That said, this would only make sense in conjunction with roadworks programs, given minor deficiencies in fire flow would make it difficult to justify larger capital expenditures. This will improve fire flows to meet standards over time. These programs should also contemplate replacement of any aging pipes with PVC piping. This would offer a solution to improve the low roughness coefficients derived through the calibration process for smaller diameter cast iron pipes.

The existing system conditions model was run again with the proposed upgrades (excluding any generalized upgrades during roadworks programs). Results are illustrated in Figures 6.12 to 6.15 for ADD, MDD, PHD, and MDD + FF, respectively. The results indicate that there are improvements across the townsite to better comply with operating pressure and fire flow criteria. Figure 6.16 illustrates the available fire flow compared to the current land use, and Figure 6.17 shows the maximum land use type that can be implemented with the upgrades in place to meet each fire flow level of service. Figure 6.16 assumes that no additional hydrants have been implemented, which would also improve the fire flow coverage. Remaining hydrants with a fire flow less than 76 L/s are on 150 mm mains and should be upgraded during roadworks programs or other capital projects.



Pressure zones are mostly provided within the townsite only, with the exception of the Low North Pressure Zone as the watermains service parcels outside of the townsite. The Low North Pressure Zone extent is limited by the available LiDAR data, however is sufficient for the existing parcels.

If development to occur within this area, could combine the Industrial and North Pressure Zones into a single zone. This is unlikely given much of this area accounts for the railway and highway right-of-ways.

Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

⬟ Reservoir
⧓ Proposed Pressure Reducing Valve
┅ Townsite Boundary
▭ Cadastral

Well

● Monitoring
● Production

Watermain Diameter

— 40 mm (Potable)
— 50 mm (Potable)
— 80 mm (Potable)
— 100 mm (Potable)
— 150 mm (Potable)
▬ 150 mm (Raw)
— 200 mm (Potable)
▬ 250 mm (Raw)
— 250 mm (Potable)
▬ 300 mm (Raw)
— 300 mm (Potable)
▬ 350 mm (Raw)
— 350 mm (Potable)
— 400 mm (Potable)
— 450 mm (Potable)

Proposed Upgrades

Watermain Diameter

═ 150 mm
═ 200 mm
═ 250 mm
═ 300 mm

Proposed Pressure Zone

▨ Industrial Pressure Zone
▨ Low North Pressure Zone
▨ Main Pressure Zone
▨ North Pressure Zone
▨ No Development Anticipated

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 6.11
RECOMMENDED PRESSURE ZONES
JASPER WATER MODEL

ISL MUNICIPALITY OF JASPER

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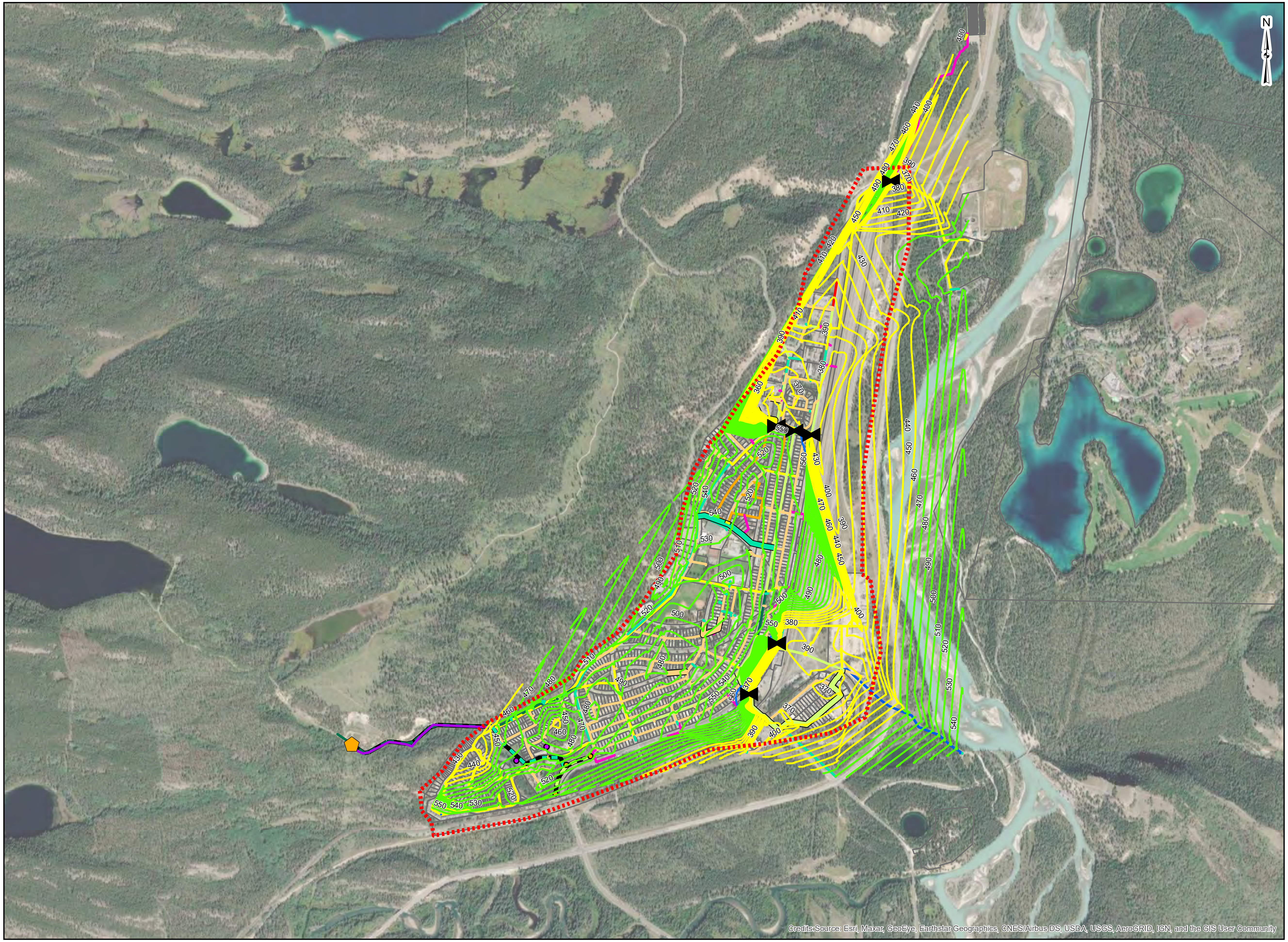
Date: 2022-06-15 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 6.11 - Existing System Upgrades - Pressure Zones.mxd



Legend

- Reservoir
- Proposed Pressure Reducing Valve
- Townsite Boundary
- Cadastral

Well

- Monitoring
- Production

Watermain Diameter

- 40 mm (Potable)
- 50 mm (Potable)
- 80 mm (Potable)
- 100 mm (Potable)
- 150 mm (Potable)
- 150 mm (Raw)
- 200 mm (Potable)
- 250 mm (Raw)
- 250 mm (Potable)
- 300 mm (Raw)
- 300 mm (Potable)
- 350 mm (Raw)
- 350 mm (Potable)
- 400 mm (Potable)
- 450 mm (Potable)

Proposed Upgrades

Watermain Diameter

- 150 mm
- 200 mm
- 250 mm
- 300 mm

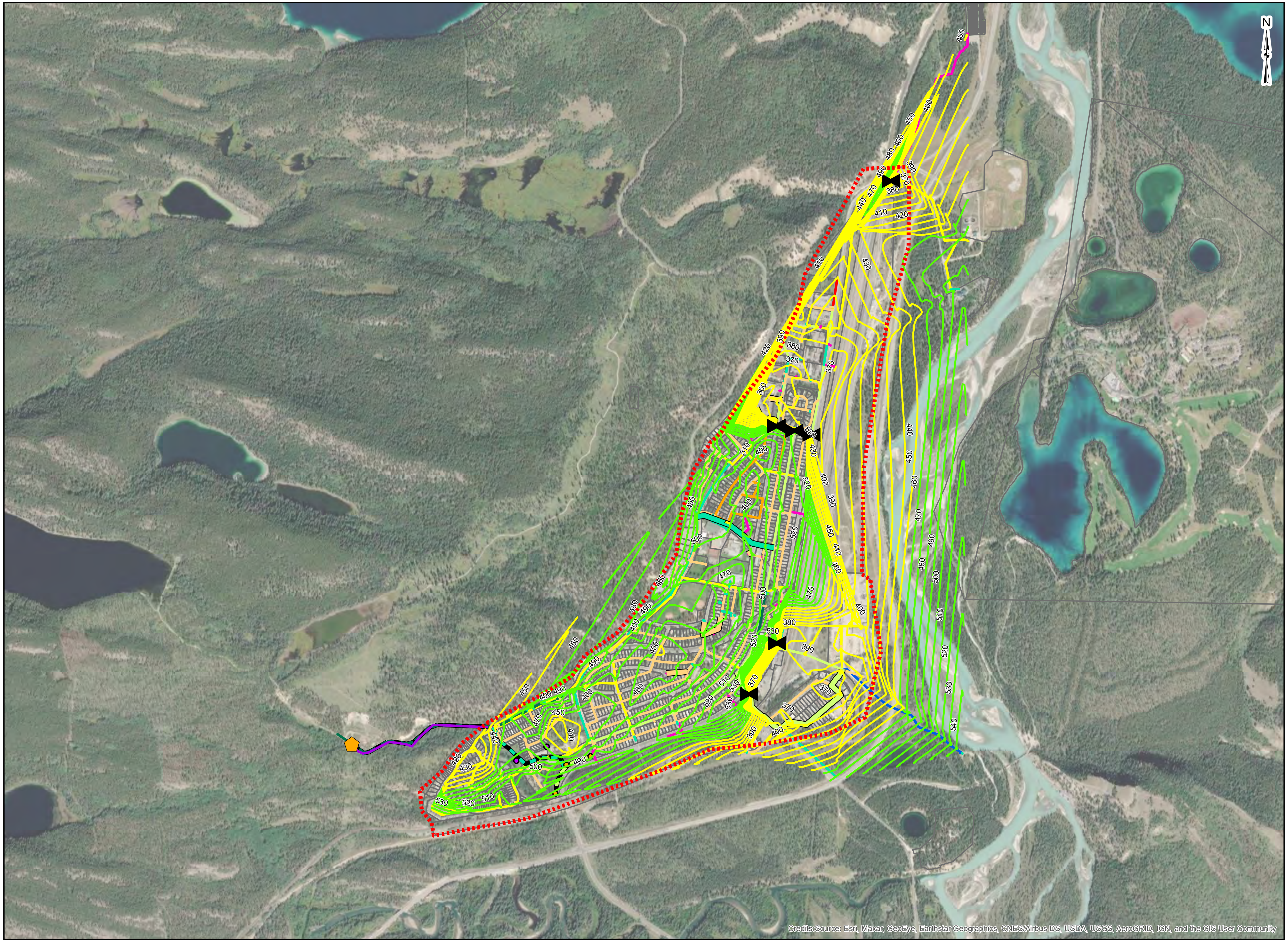
Average Day Pressure

- Less than 275kPa
- 275 to 350kPa
- 350 to 450kPa
- 450 to 550kPa
- 550 to 700kPa
- Greater than 700kPa

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 6.12
EXISTING SYSTEM ASSESSMENT
RECOMMENDED UPGRADES
AVERAGE DAY DEMAND
JASPER WATER MODEL



Legend

⬟ Reservoir
⧓ Proposed Pressure Reducing Valve
Townsite Boundary
☐ Cadastral

Well

● Monitoring
● Production

Watermain Diameter

40 mm (Potable)
50 mm (Potable)
80 mm (Potable)
100 mm (Potable)
150 mm (Potable)
150 mm (Raw)
200 mm (Potable)
250 mm (Raw)
250 mm (Potable)
300 mm (Raw)
300 mm (Potable)
350 mm (Raw)
350 mm (Potable)
400 mm (Potable)
450 mm (Potable)

Proposed Upgrades

Watermain Diameter

150 mm
200 mm
250 mm
300 mm

Maximum Day Pressure

Less than 275kPa
275 to 350kPa
350 to 450kPa
450 to 550kPa
550 to 700kPa
Greater than 700kPa

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 6.13
EXISTING SYSTEM ASSESSMENT RECOMMENDED UPGRADES MAXIMUM DAY DEMAND JASPER WATER MODEL

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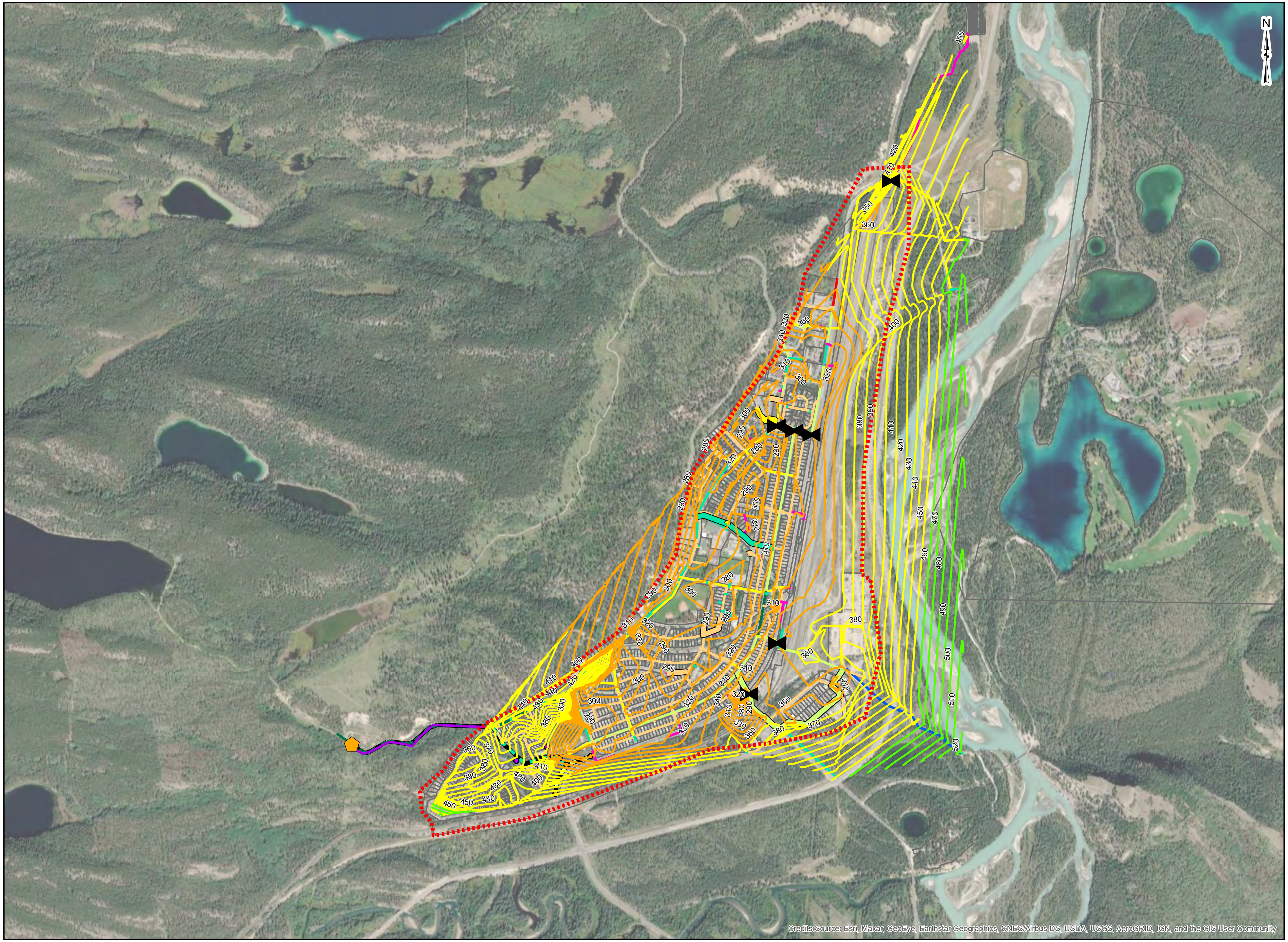

Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

⬟	Reservoir
⧓	Proposed Pressure Reducing Valve
⋯	Townsite Boundary
☐	Cadastral

Well

●	Monitoring
●	Production

Watermain Diameter

—	40 mm (Potable)
—	50 mm (Potable)
—	80 mm (Potable)
—	100 mm (Potable)
—	150 mm (Potable)
▬	150 mm (Raw)
—	200 mm (Potable)
▬	250 mm (Raw)
—	250 mm (Potable)
▬	300 mm (Raw)
—	300 mm (Potable)
▬	350 mm (Raw)
—	350 mm (Potable)
—	400 mm (Potable)
—	450 mm (Potable)

Proposed Upgrades

Watermain Diameter

▬	150 mm
▬	200 mm
▬	250 mm
▬	300 mm

Peak Hour Pressure

—	Less than 275kPa
—	275 to 350kPa
—	350 to 450kPa
—	450 to 550kPa
—	550 to 700kPa
—	Greater than 700kPa

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 6.14
EXISTING SYSTEM ASSESSMENT
RECOMMENDED UPGRADES
PEAK HOUR DEMAND
JASPER WATER MODEL

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Date: 2022-06-15 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 6.14 - EX PHD - Upgrades.mxd

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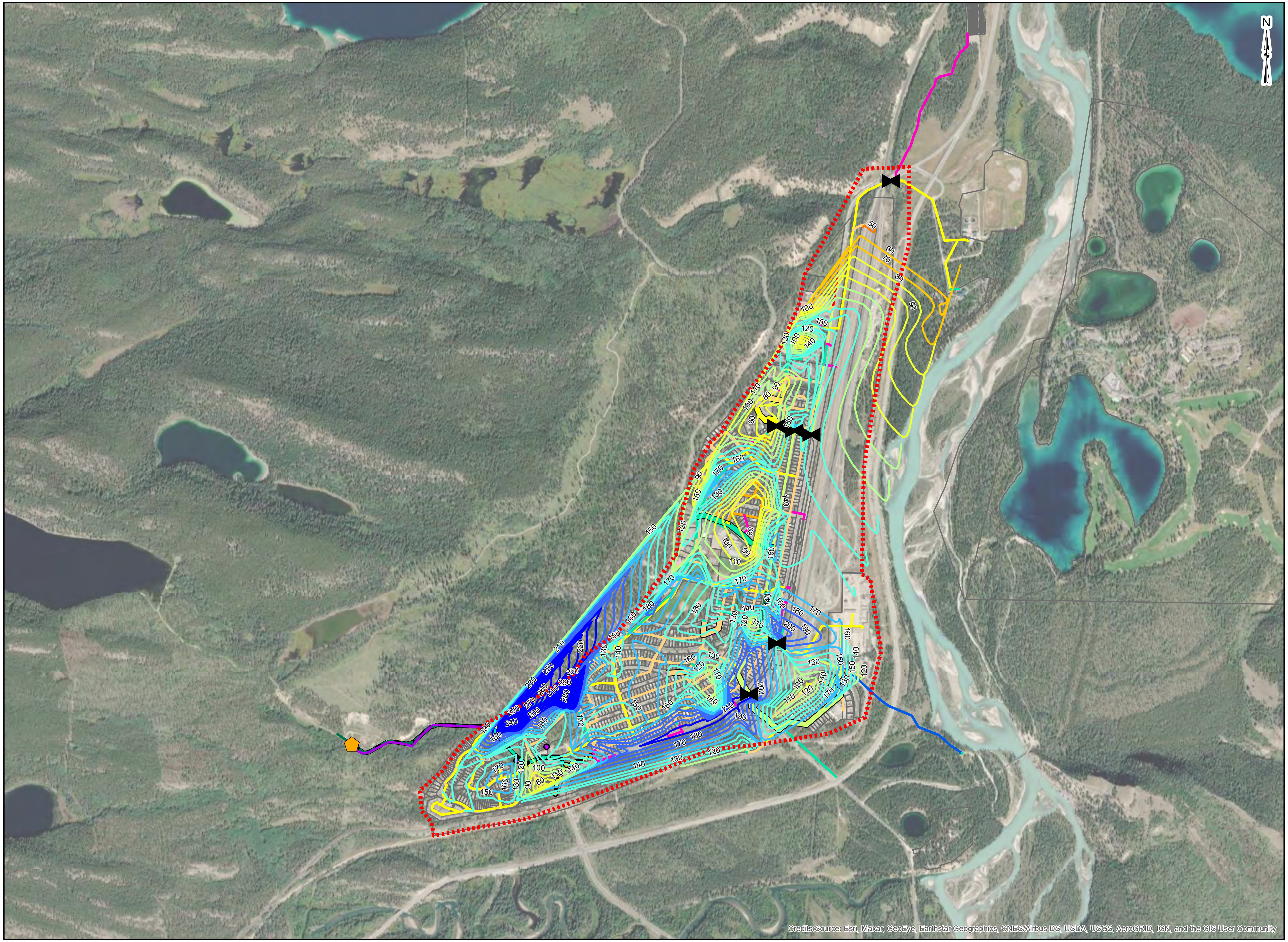

Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Reservoir
- Proposed Pressure Reducing Valve
- Townsite Boundary
- Cadastral

Well

- ● Monitoring
- ● Production

Watermain Diameter

- 40 mm (Potable)
- 50 mm (Potable)
- 80 mm (Potable)
- 100 mm (Potable)
- 150 mm (Potable)
- 150 mm (Raw)
- 200 mm (Potable)
- 250 mm (Raw)
- 250 mm (Potable)
- 300 mm (Raw)
- 300 mm (Potable)
- 350 mm (Raw)
- 350 mm (Potable)
- 400 mm (Potable)
- 450 mm (Potable)

Proposed Upgrades

Watermain Diameter

- 150 mm
- 200 mm
- 250 mm
- 300 mm

Available Fire Flow

- Less than 25L/s
- 25 to 50L/s
- 50 to 75L/s
- 75 to 100L/s
- 100 to 125L/s
- 125 to 150L/s
- 150 to 175L/s
- 175 to 200L/s
- Greater than 200L/s

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 6.15
EXISTING SYSTEM ASSESSMENT
RECOMMENDED UPGRADES
MAXIMUM DAY DEMAND PLUS FIRE FLOW
JASPER WATER MODEL

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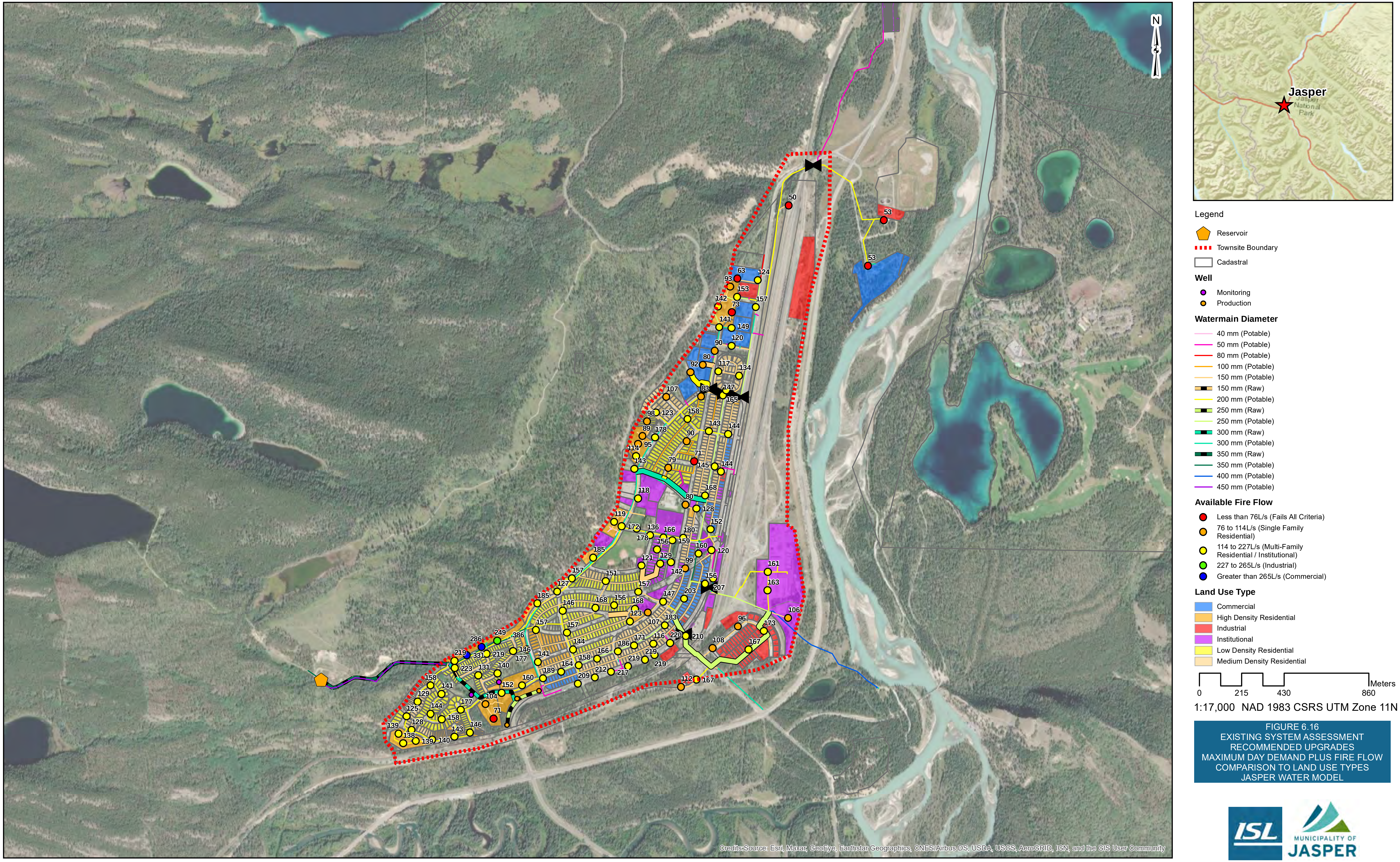
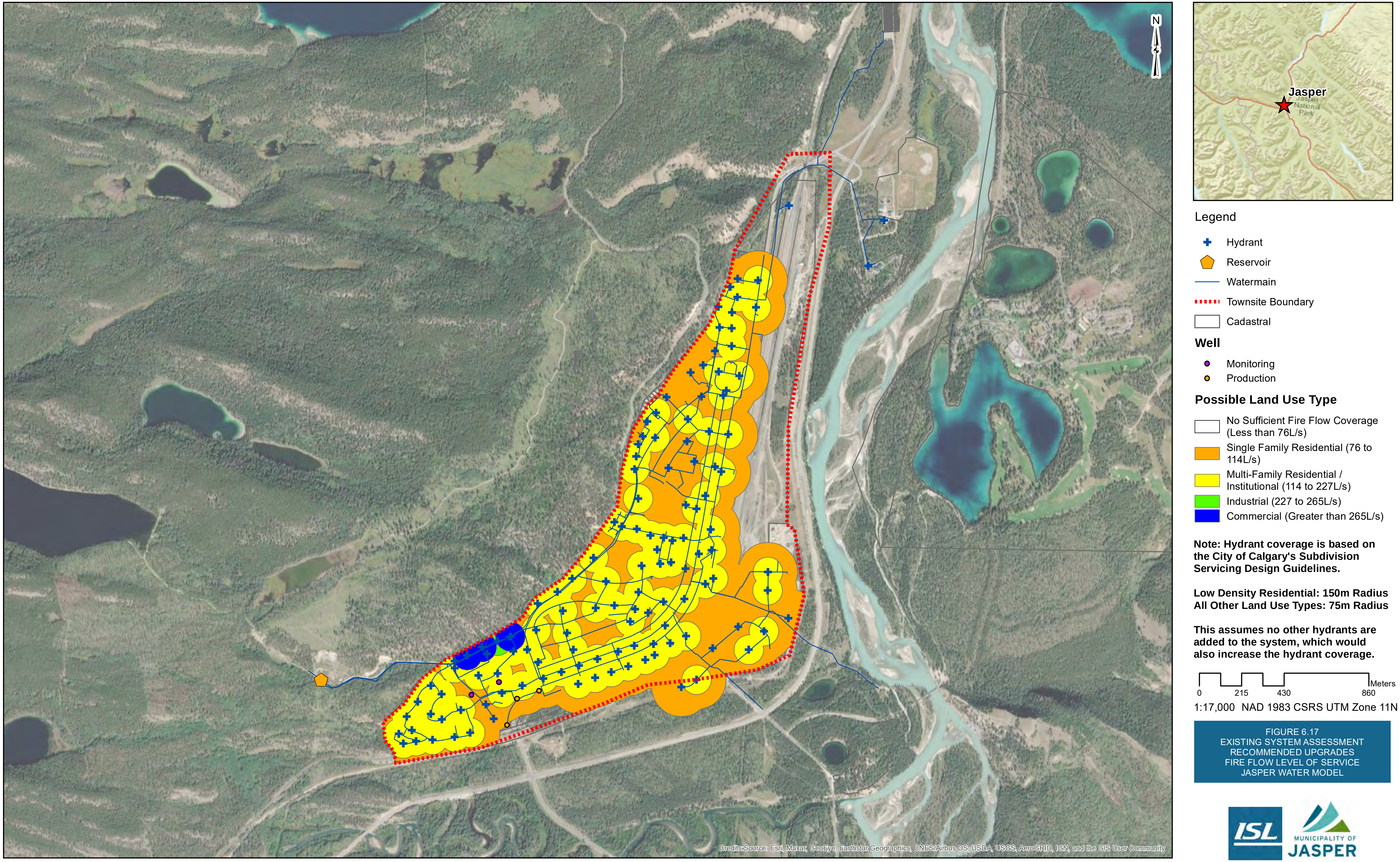
Date: 2022-06-15 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 6.15 - EX MDD + FF - Upgrades.mxd



Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 6.16
EXISTING SYSTEM ASSESSMENT
RECOMMENDED UPGRADES
MAXIMUM DAY DEMAND PLUS FIRE FLOW
COMPARISON TO LAND USE TYPES
JASPER WATER MODEL



Note: Hydrant coverage is based on the City of Calgary's Subdivision Servicing Design Guidelines.

Low Density Residential: 150m Radius
All Other Land Use Types: 75m Radius

This assumes no other hydrants are added to the system, which would also increase the hydrant coverage.

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 6.17
EXISTING SYSTEM ASSESSMENT
RECOMMENDED UPGRADES
FIRE FLOW LEVEL OF SERVICE
JASPER WATER MODEL

Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

6.6.2 Unaccounted for Water

To reduce the UFW throughout the system, several short-, medium-, and long-term solutions are proposed.

Short-Term Solutions

In the short-term, the first step would be to differentiate between UFW due to irrigation versus leakage. This could be accomplished by metering irrigation from potable water. As assumptions to the amount of irrigation were made in this study, metering these locations would provide actual potable water volume reports that could be deducted from the UFW volumes. The result of this would be that all UFW would be attributed to leakage, giving a more accurate depiction of the extent of leakage.

Watermains with high normal operating pressures can also be reviewed to determine their watermain pressure rating. This information may not be readily available in some instances; however, record drawings can be reviewed to determine if the watermains were installed to be able to handle the higher pressures. If the pressure ratings are insufficient for the system pressures, these watermains can be flagged for potential upgrades.

Medium-Term Solutions

Suspected watermains with higher leakage can be tested in the field. This would be accomplished by isolating sections of watermains through isolation valves and recording the pressure under normal operating conditions of a hydrant within the isolated section of pipes. If leakage is prevalent, a drop in pressure over time would be evident. It is recommended that this process is undertaken for any of the high priority sections of watermain identified in Figure 6.9.

Leakage detection systems could also be implemented; however, it is anticipated that this will have a limited benefit to the overall system versus the cost of installing these systems. The biggest concern with these systems is that leakage could get falsely detected when the groundwater table is high. This could lead to unnecessary replacements if this occurs. With the aging and older cast iron infrastructure, simply replacing the infrastructure rather than a complex leakage detection system is likely favourable.

Areas with higher pressures under normal operating pressures can also be divided into separate pressure zones through PRVs. This would reduce the pressures in the lower-lying areas. These areas include the far northeast, and the southeast within the predominantly industrial area. Both areas are near the river where the topography drops off. Figure 6.10 illustrates the potential PRVs that could be implemented to create new pressure zones and reduce the pressures within more reasonable tolerances (i.e., roughly below 550 kPa under average day demands).

Long-Term Solutions

A replacement program can be undertaken to remove any watermains that are likely contributing to leakage, as identified in Figure 6.9. This program can commence in the short-term, however the duration of this program will extend into the long-term. Replacements should be prioritized based on the severity noted in Figure 6.9. Replacing these watermains with PVC pipes will result in pipes with a greater life expectancy and improved hydraulics. The replacement program can also be coupled with other capital projects, such as sewer replacements or roadway improvement projects. This will help to reduce the capital costs associated with these upgrades.

6.7 Existing System Upgrades Cost Estimates

A summary of the costs associated with the recommended existing system upgrades are detailed below in Table 6.4. A full breakdown of the costs has been provided in Appendix C. It is noted that EX Upgrades 2, 6, 7, and 8 are all within proximity to each other, as are EX Upgrades 3 and 10. These would likely be coupled as a single upgrade during implementation.

Table 6.4: Cost Estimates for Recommended Upgrades to the Existing System

Item	Total Cost[3, 4]
EX Upgrade 1[1]	$660,000
EX Upgrade 2	$2,490,000
EX Upgrade 3[1]	$30,000
EX Upgrade 4[1]	$380,000
EX Upgrade 5	$460,000
EX Upgrade 6[1]	$20,000
EX Upgrade 7[1]	$40,000
EX Upgrade 8[2]	$60,000
EX Upgrade 9[1]	$230,000
EX Upgrade 10	$3,700,000
Industrial Pressure Zone	$240,000
North Pressure Zone	$320,000
Low North Pressure Zone	$80,000
Total	**$8,710,000**

[1] *These represent very minor/localized upgrades along hydrant services to reduce head losses directly to the hydrants. The upgrades generally consist of upsizing smaller watermains (i.e., less than 100 mm) or watermains with a lower roughness coefficient (smaller cast iron).*

[2] *Connection from newly proposed 300 mm watermain to the existing system at the intersection of Colin Crescent and Pyramid Lake Road.*

[3] *Note that costs assume water is done exclusively. Sanitary upgrades or storm upgrades could be carried at a lower incremental cost given the surface disturbance already occurring.*

[4] *Assumes minimal trenching is done – i.e. trench box installation.*

The costs associated with replacing all identified high priority watermains is summarized below in Table 6.5 and provided in detail in Appendix C. Watermains were assumed to be replaced with PVC pipe. The minimum inside diameter pipe size to carry fire flows stipulated by AEP is 150 mm. The pipe size was either maintained with existing or upsized to 150 mm, whichever governed.

Table 6.5: Capital Costs of a Replacement Program (High Priority Potential Leakage Watermains)

Item	Total Cost
150 mm Distribution Main	$2,950,000
200 mm Distribution Main	$2,150,000
250 mm Distribution Main	$,1210,000
300 mm Distribution Main	$920,000
Pavement Rehabilitation	$4,130,000
Total[1]	**$11,360,000**

[1] *Note that these costs are independent of the costs calculated for the existing system upgrades above in Table 6.4. Some overlap exists between the existing system upgrades and the high priority potential leakage watermains in the industrial lands (Upgrade 10), so there would be some cost savings where these overlaps exist.*

7.0 Future System Assessment and Upgrades

The future water system was analyzed under six different scenarios to determine system conditions. As mentioned in Section 3.1, these scenarios included:

- Steady State:
  - Average day demand (ADD)
  - Maximum daily demand (MDD)
  - Peak hour demand (PHD)
- Steady State with Fire Flow Analysis:
  - Maximum day demand plus fire flow (MDD + FF)
- Extended period simulation (EPS)

Additionally, the reservoir was assessed in terms of reservoir storage under future demands. The two growth horizons discussed in Section 2.3 were analyzed, including:

- 10-Year Growth (2032) – Population of 7,107
- 25-Year Growth (2047) – Population of 10,661

Table 7.1 summarizes the demands that were used for input in the above-mentioned assessments.

Table 7.1: Future System Demands

Scenario	10-Year Growth Demand		25-Year Growth Demand	
	L/s	m^3	L/s	m^3
ADD	56.05	4,843	63.14	5,455
MDD	112.10	9,685	126.28	10,911
PHD	280.25	24,214	315.70	27,276

In the assessments that follow, it is important to note that the existing system upgrades proposed in Section 6.6 are assumed to have been completed. Thus, it is recommended that these upgrades are implemented prior to any substantial densification in the 10- and 25- year growth horizons.

7.1 Pressure Assessment

The highest and lowest pressures in the 10-year growth horizon and the locations at which these pressures occur are shown below in Table 7.2, for the ADD, MDD, and PHD scenarios.

Table 7.2: 10-Year Growth Horizon Pressure Ranges

Scenario	Figure	Highest Pressure		Location	Lowest Pressure		Location
		kPa	psi		kPa	psi	
ADD	7.1	564.46	81.87	Connaught Drive, upstream of proposed twinned PRVs	350.37	50.82	Hydrant behind Jasper Inn & Suites
MDD	7.2	548.18	79.51	Service line near Old Fort Point Road	350.28	50.80	
PHD	7.3	488.27	70.82		237.52	34.45	Service near Bonhomme Street and Elm Avenue

The highest and lowest pressures in the 25-year growth horizon and the locations at which these pressures occur are shown below in Table 7.3, for the ADD, MDD, and PHD scenarios.

Table 7.3: 25-Year Growth Horizon Pressure Ranges

Scenario	Figure	Highest Pressure		Location	Lowest Pressure		Location
		kPa	psi		kPa	psi	
ADD	7.4	561.63	81.46	Connaught Drive, upstream of proposed twinned PRVs	350.37	50.82	Hydrant behind Jasper Inn & Suites
MDD	7.5	548.18	79.51	Service line near Old Fort Point Road	350.28	50.80	
PHD	7.6	459.53	66.65	Service line on Cottonwood Creek Road	177.77	25.78	Service near Petro Canada on Connaught Drive

In the 10-year growth horizon, pressures are adequate under ADD and MDD conditions, however, drop below the recommended minimum pressure of 275 kPa under PHD conditions. This drop occurs in a significant portion of the townsite. Watermains exhibiting the largest head loss are predominantly along Bonhomme Street, particularly in the 150 mm watermain bottleneck near the Bonhomme Street, Miette Avenue and Pine Avenue intersection. To the southwest at the intersection of Willow Avenue and Bonhomme Street the watermain that was closed during calibration is causing some head loss (70 kPa) in the adjacent 200 mm cast iron pipe. This pipe was closed during calibration to represent and area with higher head losses, either due to a closed valve, leakage, or localized condition issues.

Results from the 25-year growth horizon are generally like the 10-year, with ADD and MDD conditions performing adequately but PHD suggesting significant losses throughout the system. Areas with higher head losses also occur along Bonhomme Street near the locations noted above, suggesting these areas would be good candidates for system improvements. Recommendations to improve the future system are summarized in Section 7.5.

7.2 Fire Flow Assessment

The fire flow assessment results are shown in Figures 7.7 and 7.8 for the 10- and 25-year growth horizons, respectively. Fire flow contours are generally consistent in comparison to each other and the existing system upgrades results, with some incremental drops in available fire flow from existing to the 10-year growth horizon and from the 10-year to the 25-year growth horizon. Improvements to available fire flow will be apparent with the upgrades proposed to decrease the pressure losses noted in Section 7.1.

7.3 Reservoir Capacity Assessment

The volume of water storage required in Jasper under future conditions was also determined using the formula for storage criteria provided by AEP noted in Section 3.7. A fire flow rate of 265 L/s for a 3.5-hour duration was chosen, as this represents the most conservative fire flow criteria for commercial developments based on the Fire Underwriters Survey recommendations. Tables 7.4 and 7.5 summarize the storage requirements for the 10-year and 25-year growth horizons, respectively.

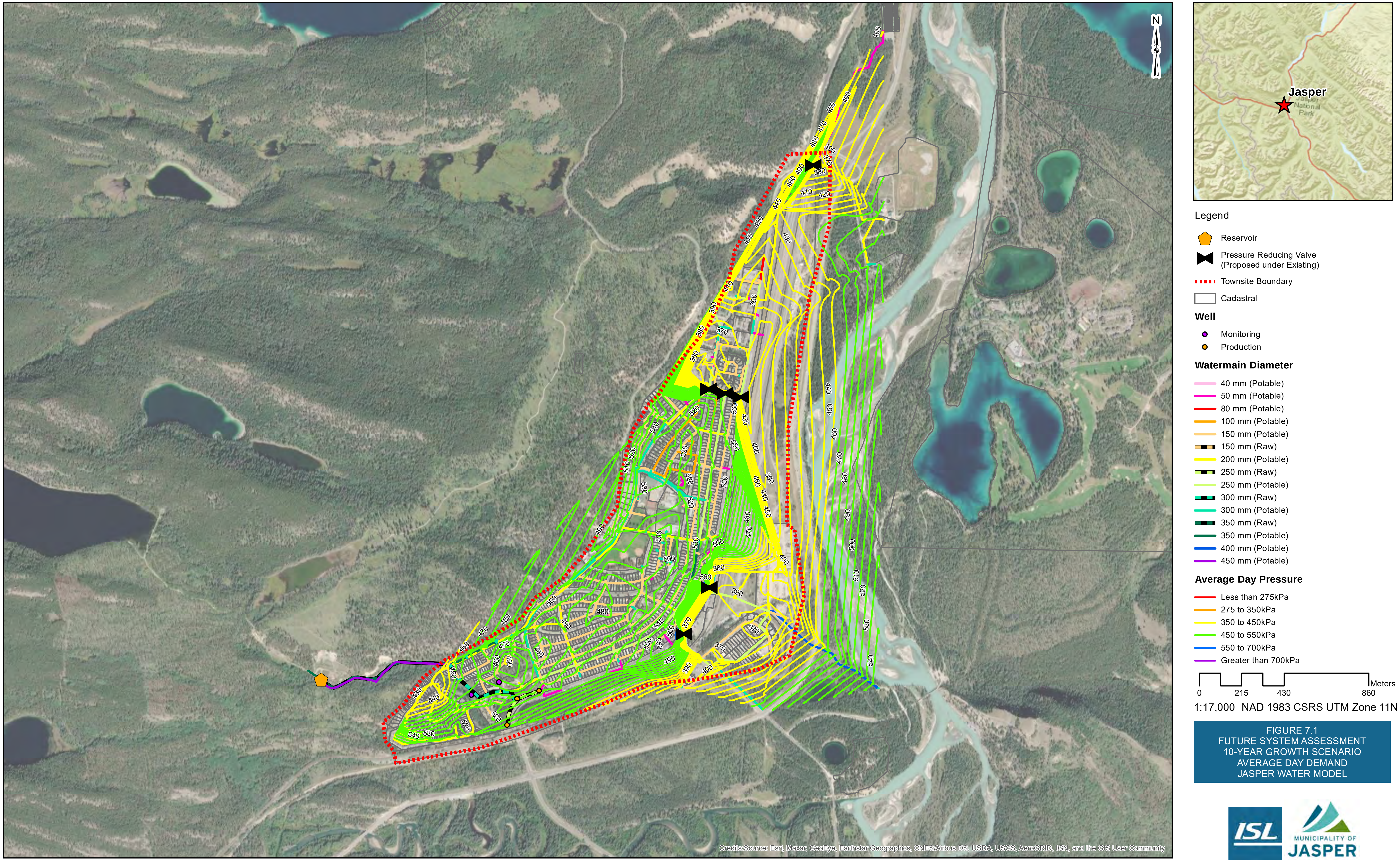


FIGURE 7.1
FUTURE SYSTEM ASSESSMENT
10-YEAR GROWTH SCENARIO
AVERAGE DAY DEMAND
JASPER WATER MODEL

Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 7.1 - FUT ADD 10-Year Growth Scenario.mxd

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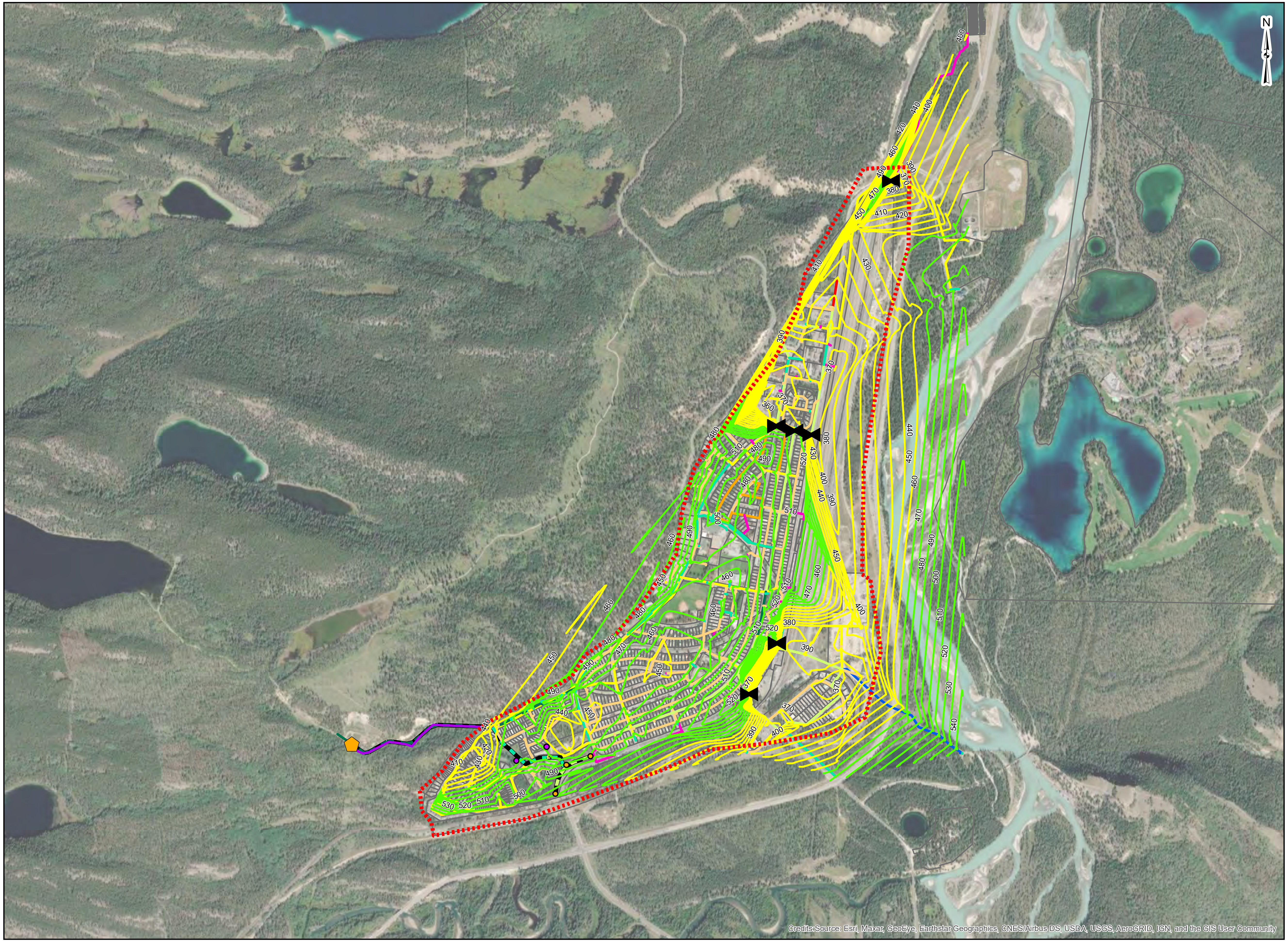

Legend

⬟ Reservoir

⧓ Pressure Reducing Valve (Proposed under Existing)

▪▪▪ Townsite Boundary

☐ Cadastral

Well

● Monitoring

● Production

Watermain Diameter

- 40 mm (Potable)
- 50 mm (Potable)
- 80 mm (Potable)
- 100 mm (Potable)
- 150 mm (Potable)
- 150 mm (Raw)
- 200 mm (Potable)
- 250 mm (Raw)
- 250 mm (Potable)
- 300 mm (Raw)
- 300 mm (Potable)
- 350 mm (Raw)
- 350 mm (Potable)
- 400 mm (Potable)
- 450 mm (Potable)

Maximum Day Pressure

- Less than 275kPa
- 275 to 350kPa
- 350 to 450kPa
- 450 to 550kPa
- 550 to 700kPa
- Greater than 700kPa

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 7.2
FUTURE SYSTEM ASSESSMENT
10-YEAR GROWTH SCENARIO
MAXIMUM DAY DEMAND
JASPER WATER MODEL

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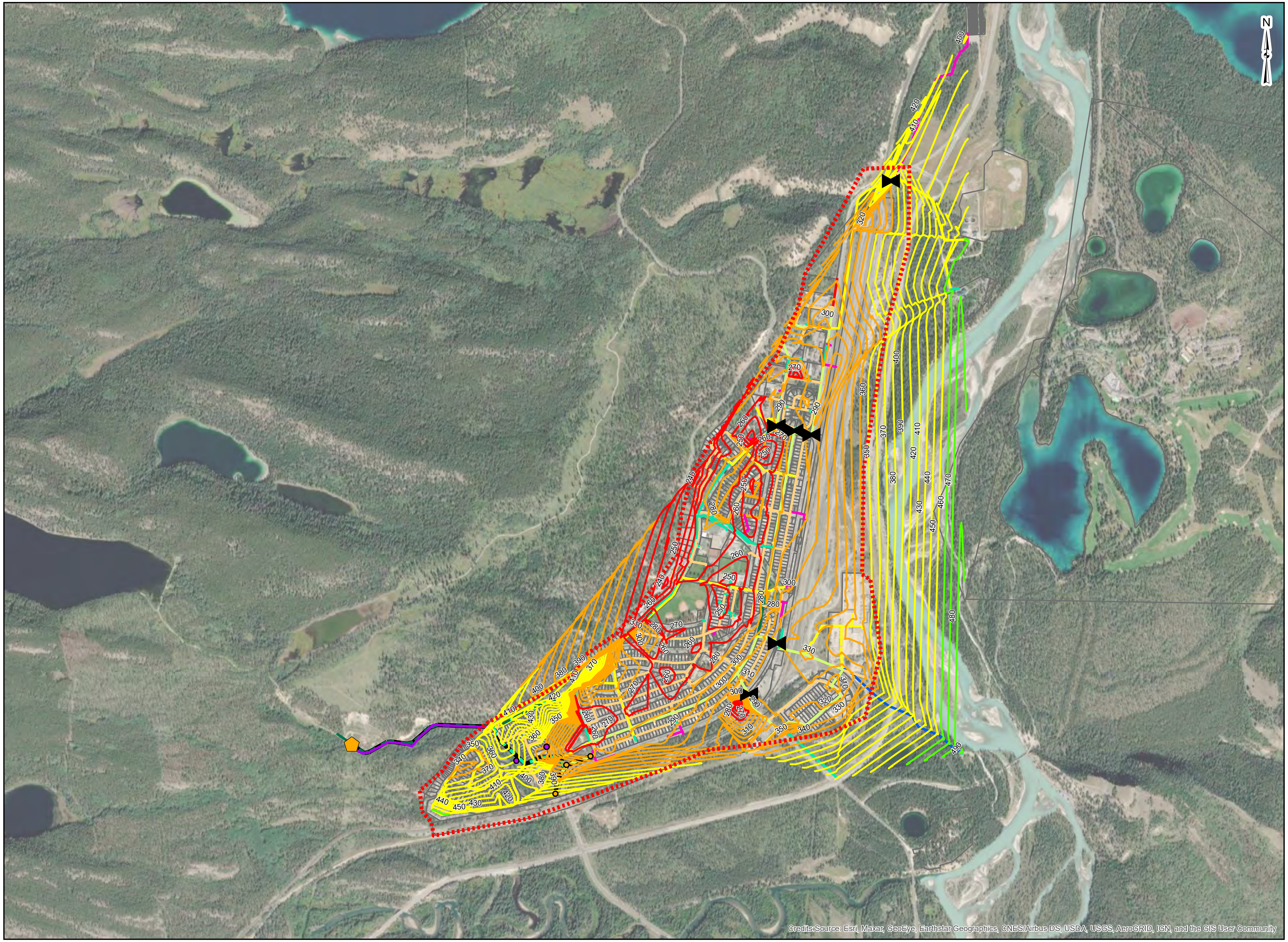
Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 7.2 - FUT MDD 10-Year Growth Scenario.mxd



Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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FIGURE 7.3
FUTURE SYSTEM ASSESSMENT
10-YEAR GROWTH SCENARIO
PEAK HOUR DEMAND
JASPER WATER MODEL

MUNICIPALITY OF JASPER

Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 7.3 - FUT PHD 10-Year Growth Scenario.mxd

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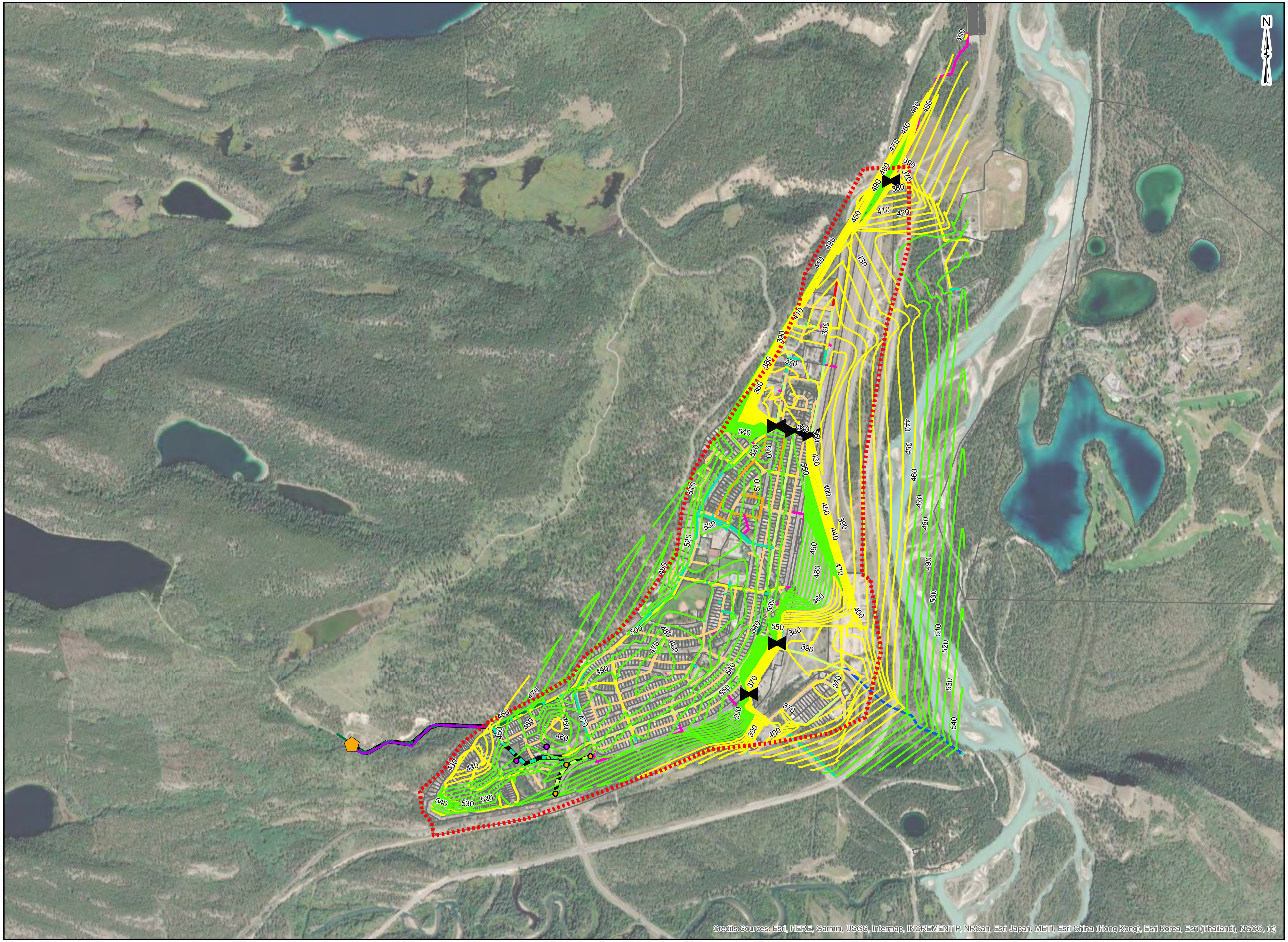

Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)

Legend

⬟ Reservoir

⧓ Pressure Reducing Valve (Proposed under Existing)

Townsite Boundary

☐ Cadastral

Well

● Monitoring

● Production

Watermain Diameter

- 40 mm (Potable)
- 50 mm (Potable)
- 80 mm (Potable)
- 100 mm (Potable)
- 150 mm (Potable)
- 150 mm (Raw)
- 200 mm (Potable)
- 250 mm (Raw)
- 250 mm (Potable)
- 300 mm (Raw)
- 300 mm (Potable)
- 350 mm (Raw)
- 350 mm (Potable)
- 400 mm (Potable)
- 450 mm (Potable)

Average Day Pressure

- Less than 275kPa
- 275 to 350kPa
- 350 to 450kPa
- 450 to 550kPa
- 550 to 700kPa
- Greater than 700kPa

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 7.4
FUTURE SYSTEM ASSESSMENT
25-YEAR GROWTH SCENARIO
AVERAGE DAY DEMAND
JASPER WATER MODEL

ISL

MUNICIPALITY OF JASPER

Date: 2022-06-09 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 7.4 - FUT ADD 25-Year Growth Scenario.mxd

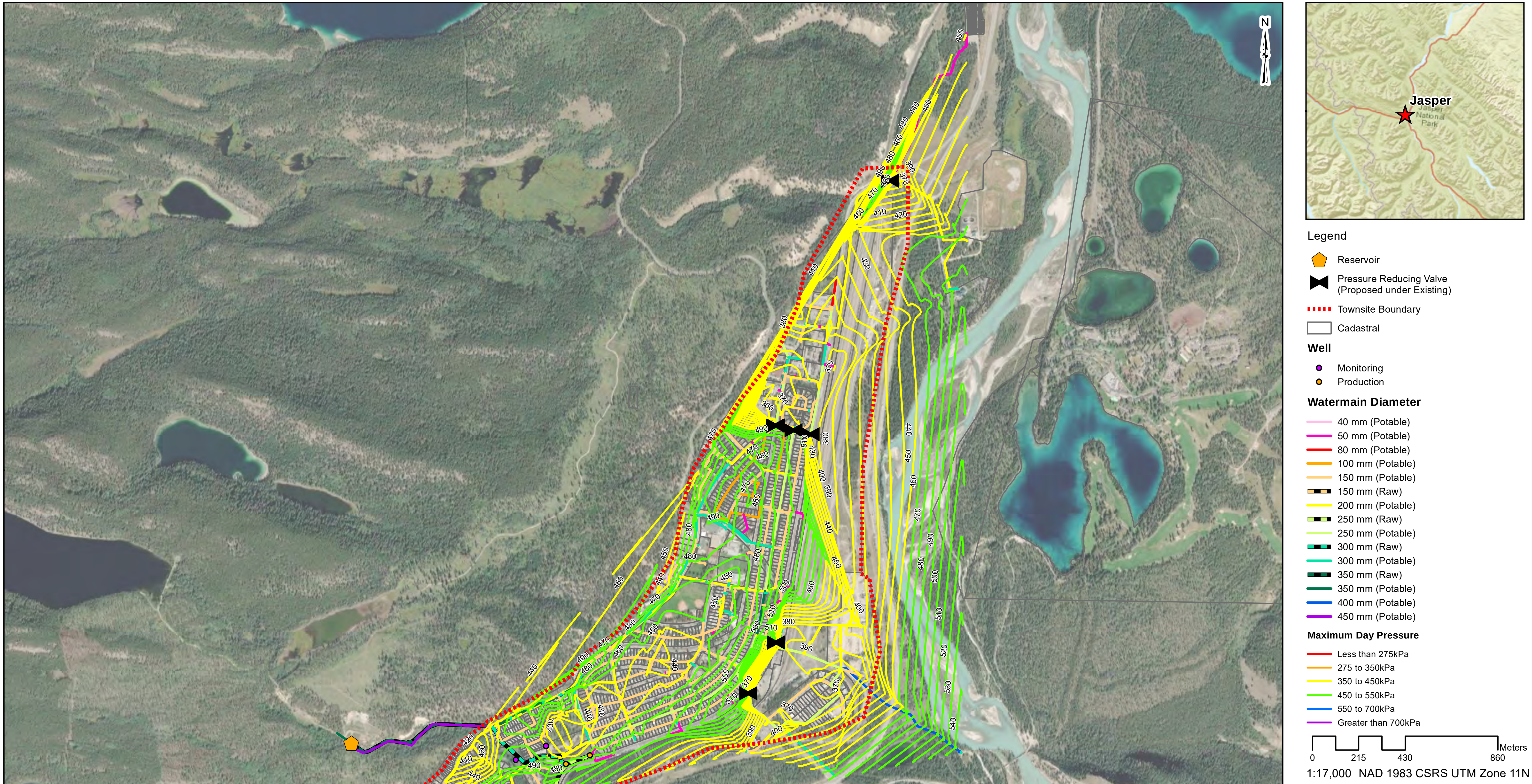

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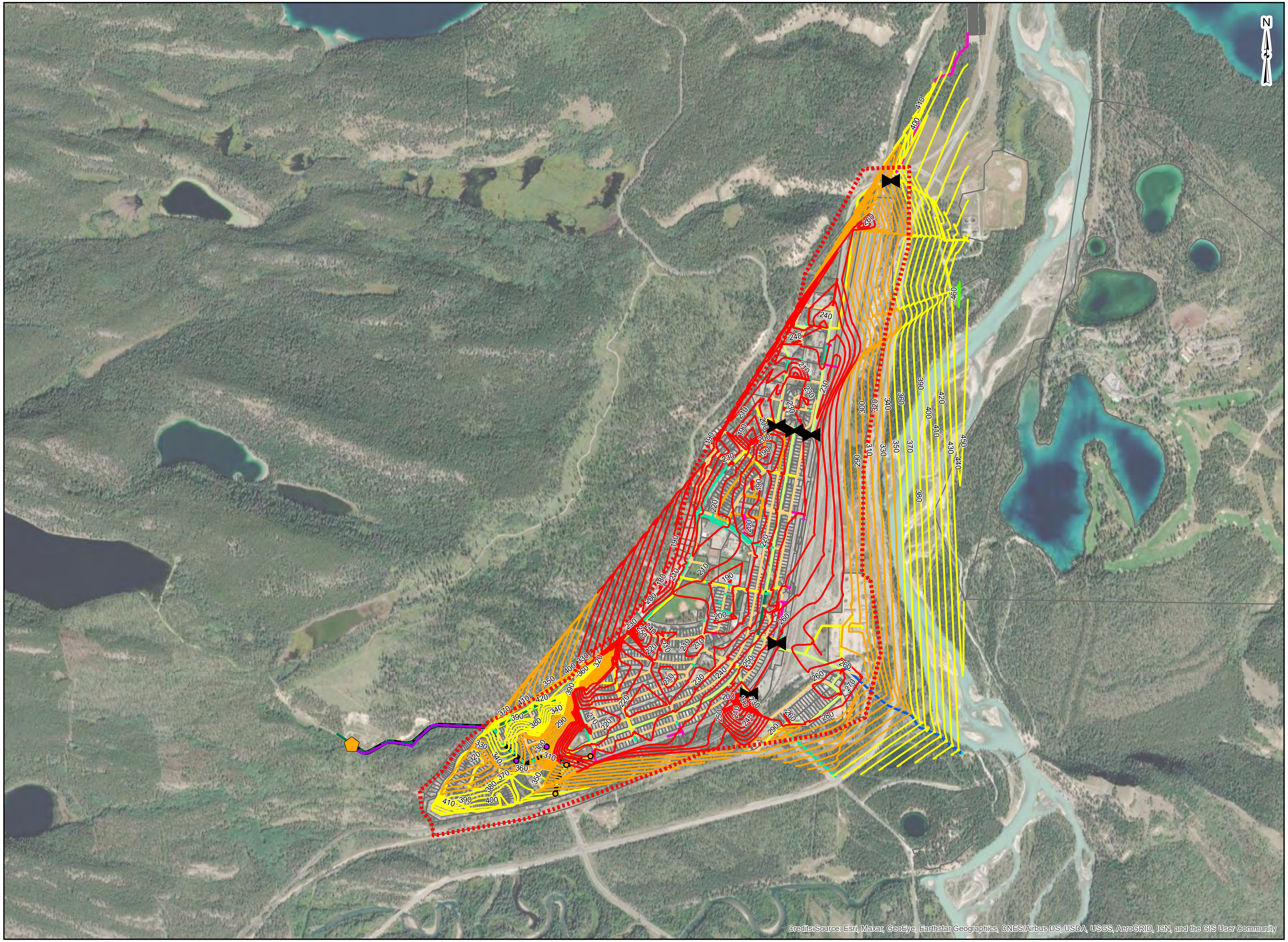
FIGURE 7.5
FUTURE SYSTEM ASSESSMENT
25-YEAR GROWTH SCENARIO
MAXIMUM DAY DEMAND
JASPER WATER MODEL

ISL

MUNICIPALITY OF JASPER



Legend

⬟ Reservoir

⧓ Pressure Reducing Valve (Proposed under Existing)

▪▪▪ Townsite Boundary

☐ Cadastral

Well

● Monitoring

● Production

Watermain Diameter

— 40 mm (Potable)
— 50 mm (Potable)
— 80 mm (Potable)
— 100 mm (Potable)
— 150 mm (Potable)
— 150 mm (Raw)
— 200 mm (Potable)
— 250 mm (Raw)
— 250 mm (Potable)
— 300 mm (Raw)
— 300 mm (Potable)
— 350 mm (Raw)
— 350 mm (Potable)
— 400 mm (Potable)
— 450 mm (Potable)

Peak Hour Pressure

— Less than 275kPa
— 275 to 350kPa
— 350 to 450kPa
— 450 to 550kPa
— 550 to 700kPa
— Greater than 700kPa

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 7.6
FUTURE SYSTEM ASSESSMENT
25-YEAR GROWTH SCENARIO
PEAK HOUR DEMAND
JASPER WATER MODEL

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MUNICIPALITY OF JASPER

Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 7.6 - FUT PHD 25-Year Growth Scenario.mxd

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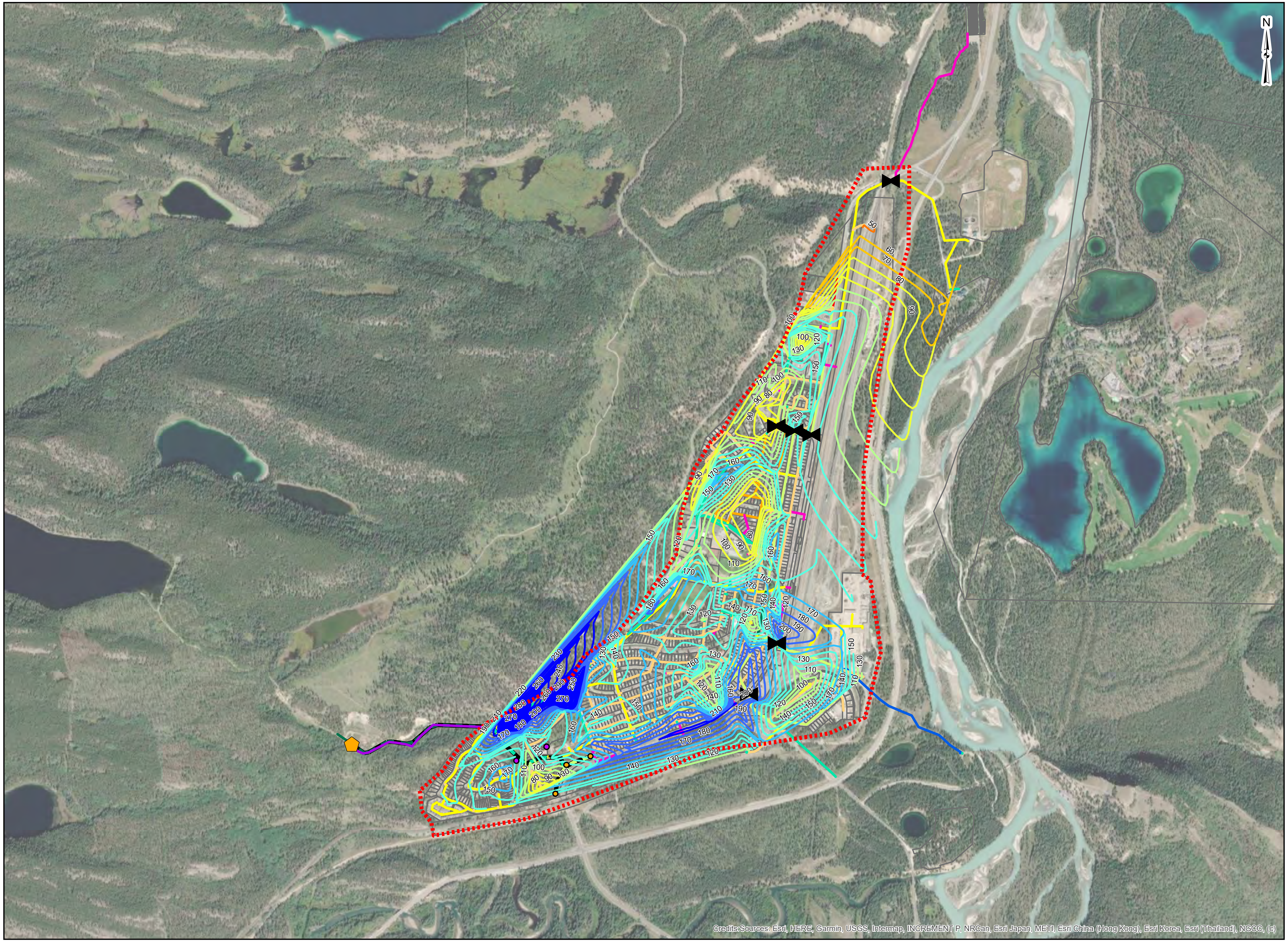

Credits:Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)

Legend

- ⬟ Reservoir
- ⧓ Pressure Reducing Valve (Proposed under Existing)
- ▪▪▪▪ Townsite Boundary
- ▭ Cadastral

Well

- ● Monitoring
- ● Production

Watermain Diameter

- 40 mm (Potable)
- 50 mm (Potable)
- 80 mm (Potable)
- 100 mm (Potable)
- 150 mm (Potable)
- 150 mm (Raw)
- 200 mm (Potable)
- 250 mm (Raw)
- 250 mm (Potable)
- 300 mm (Raw)
- 300 mm (Potable)
- 350 mm (Raw)
- 350 mm (Potable)
- 400 mm (Potable)
- 450 mm (Potable)

Available Fire Flow

- Less than 25L/s
- 25 to 50L/s
- 50 to 75L/s
- 75 to 100L/s
- 100 to 125L/s
- 125 to 150L/s
- 150 to 175L/s
- 175 to 200L/s
- Greater than 200L/s

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 7.7
FUTURE SYSTEM ASSESSMENT
10-YEAR GROWTH SCENARIO
MAXIMUM DAY DEMAND PLUS FIRE FLOW
JASPER WATER MODEL

ISL

MUNICIPALITY OF JASPER

Date: 2022-06-09 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 7.7 - FUT MDD + FF 10-Year Growth Scenario.mxd

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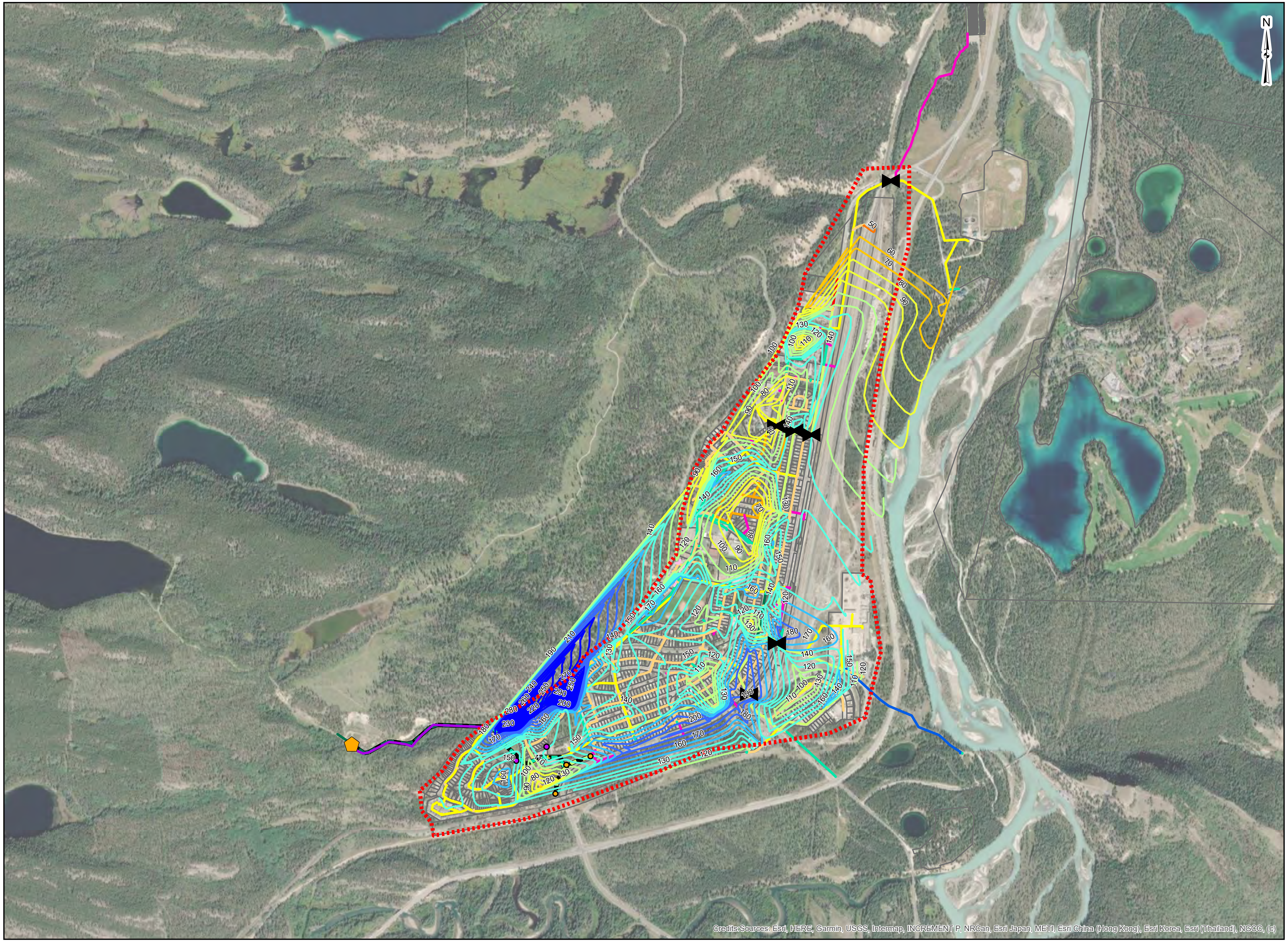


Legend

⬟ Reservoir

⧓ Pressure Reducing Valve (Proposed under Existing)

Townsite Boundary

☐ Cadastral

Well

● Monitoring

● Production

Watermain Diameter

- 40 mm (Potable)
- 50 mm (Potable)
- 80 mm (Potable)
- 100 mm (Potable)
- 150 mm (Potable)
- 150 mm (Raw)
- 200 mm (Potable)
- 250 mm (Raw)
- 250 mm (Potable)
- 300 mm (Raw)
- 300 mm (Potable)
- 350 mm (Raw)
- 350 mm (Potable)
- 400 mm (Potable)
- 450 mm (Potable)

Available Fire Flow

- Less than 25L/s
- 25 to 50L/s
- 50 to 75L/s
- 75 to 100L/s
- 100 to 125L/s
- 125 to 150L/s
- 150 to 175L/s
- 175 to 200L/s
- Greater than 200L/s

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 7.8
FUTURE SYSTEM ASSESSMENT
25-YEAR GROWTH SCENARIO
MAXIMUM DAY DEMAND PLUS FIRE FLOW
JASPER WATER MODEL

ISL

MUNICIPALITY OF JASPER

Table 7.4: 10-Year Growth Horizon Reservoir Storage Requirement

Parameter	Unit	Value	Factor	Total
ADD	m^3	4,843	15%	726
MDD	m^3	9,685	25%	2,421
Fire Flow	L/s	265	3.5	3,339
			Total Storage Requirement (m^3)	**6,487**

Table 7.5: 25-Year Growth Horizon Reservoir Storage Requirement

Parameter	Unit	Value	Factor	Total
ADD	m^3	5,455	15%	818
MDD	m^3	10,911	25%	2,728
Fire Flow	L/s	265	3.5	3,339
			Total Storage Requirement (m^3)	**6,885**

There is an available storage capacity of 6,877 m^3 based on volume calculations performed using the 1989 record drawings. The 10-year growth horizon storage requirement is less that the available storage capacity, meaning that there is sufficient storage for this scenario. The 25-year growth horizon is deficient by only 8 m^3, which is a minimal deficiency. The selected fire flow criterion is on the more conservative end as it assumes a commercial building without sprinklers for a longer duration. Depending on the Municipality's risk tolerance, the reservoir storage could be left as is, or alternatively upgraded to provide the total storage requirement of 6,885 m^3. If proposing upgrades, some additional redundancy could be factored into the design to justify the upgrade rather than the small amount of 8 m^3 that is needed.

Of note is that there is not a substantial increase in the amount of storage needed from existing to future conditions. This is because in smaller populations relative to number of reservoir scenarios, most of the required storage (in Jasper's case about half) comes from the required fire flow rather than system demands. The required fire flow storage also assumes that there is only one fire in Jasper at any given time. For added fire flow redundancy the available reservoir storage could be increased by 3,339 m^3, again noting that this would suggest simultaneous fires at two commercial buildings without sprinkler systems. It is noted again, however, that a detailed review of chlorine contact time was outside the scope of this exercise. It is suggested that the Municipality review this with operations and AEP, as this can affect the storage calculation in an upwards direction; this could be important to review under growth conditions (data on treatment system and exact well supply rates was not available for this model development so needs future review).

7.4 Well Supply Assessment

A similar methodology to that described in Section 6.4 was used to assess Jasper's well supply under future conditions. Figures 7.9 and 7.10 below illustrate the results at the tank under ADD and MDD conditions for both the 10- and 25-year growth horizons.

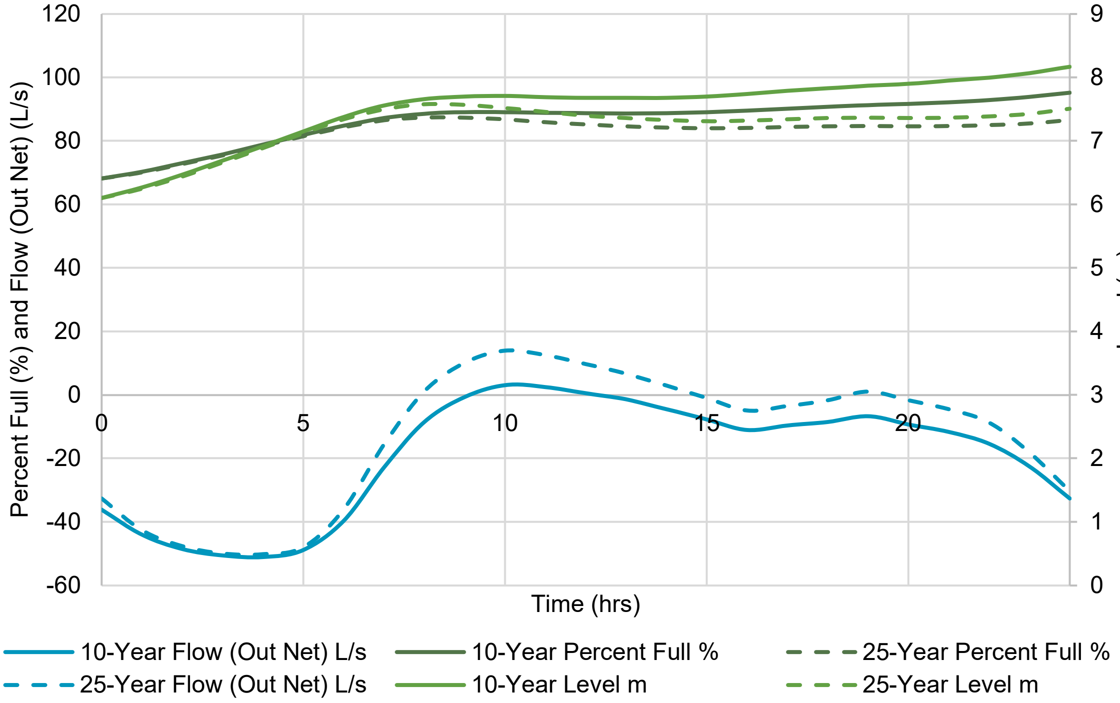


Figure 7.9: Future ADD Condition Results at the Reservoir under an Extended Period Simulation

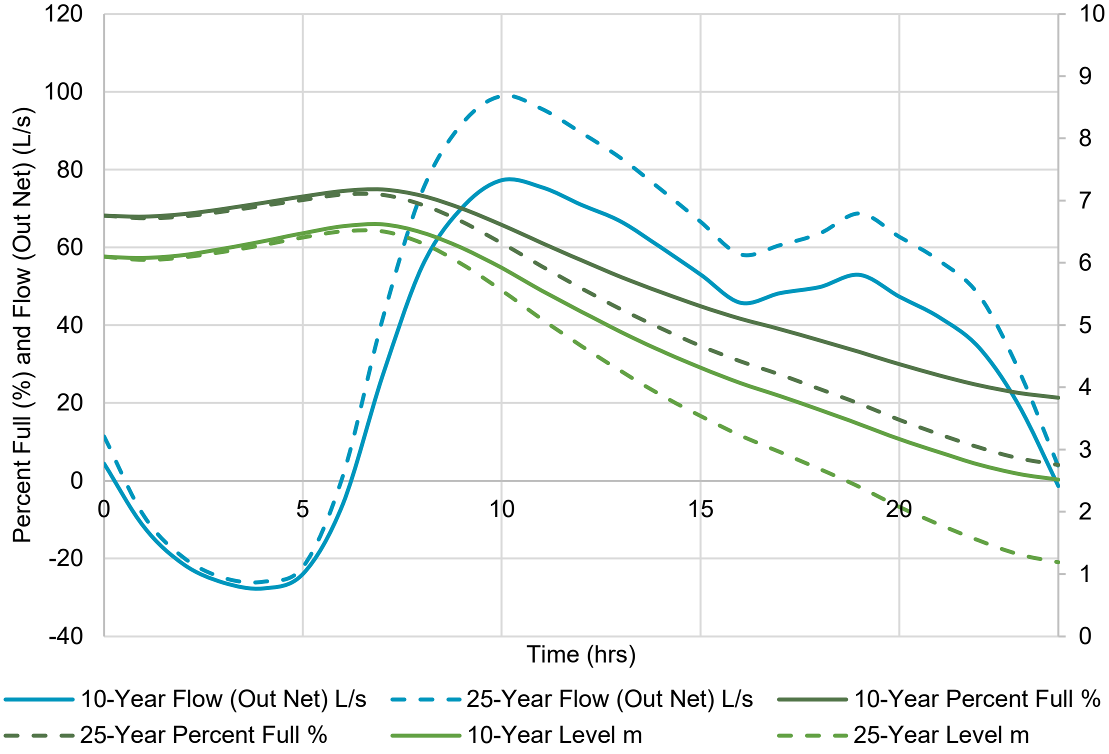


Figure 7.10: Future MDD Condition Results at the Reservoir under an Extended Period Simulation

Under ADD conditions, the reservoir is filling for both the 10- and 25-year growth horizons, evident from the ‘Percent Full’ and ‘Level’ time series in Figure 7.9. Both growth horizons start at the same level and percent full, but the 10-year growth horizon fills at a faster rate as there is a smaller demand required in the distribution system. The 10-year growth horizon is 95.2% full by the end of the day while the 25-year growth horizon is 86.6% full by the end of the day.

With the system operating under MDD conditions, a similar trend to existing conditions is observed in Figure 7.10. For most of the day (except for at night when the diurnal peaking factors are lower) the ‘Flow (Out Net)’ is positive, meaning there is more flow leaving the tank into the distribution system than there is flow filling the reservoir. As expected, the reservoir is being depleted quicker than existing conditions due to the extra flow required for the distribution system. Similarly, the 25-year growth horizon is depleted quicker than the 10-year growth horizon. Under MDD conditions there is a raw water supply junction near the reservoir where the pressure drops below zero, indicating that flow would not reach the reservoir. This could be a limitation of the assumed pump curve and single design point. A more in-depth review of the pump curves from the production wells should be undertaken prior to proposing any upgrades at the pumps to achieve sufficient pressure at the required flows under these future MDD conditions. It is again noted that this model is assessing reservoir drawdown and potential deficiency, whereas it is noted that AEP typically recommends that water supply systems meet two times MDD conditions plus 10% (this would result in no depletion). That said, given the seasonality of Jasper’s water demands, it is again noted that a discussion with AEP on this actual criterion is recommended as it may be less applicable in this case. The need to confirm exact well supply rate and pumping rate is also important to undertake.

There is also the risk of depletion in the event of a fire, which is heightened for the future scenarios, particularly for the 25-year growth horizon under MDD conditions. Though the reservoir storage is adequate, the extended period simulation begins when the reservoir is not completely full. This means that there could be a concern with a lack of water under fire flow conditions if the required fire flow is greater (i.e., more than a single-family residential home) or if the fire occurs when the reservoir has been depleted at the end of a maximum day demand.

7.5 Future System Recommendations

To improve pressures under peak hour demands, some watermain upgrades are recommended along Bonhomme Street. This includes upsizing the 150 mm bottleneck near the intersection of Bonhomme Street, Miette Avenue, and Pine Avenue to a 300 mm PVC watermain. As well, the source of significant pressure drops near the intersection of Bonhomme Street and Willow Avenue should be investigated and mitigated to also improve pressures. To simulate this in the model, the section of watermain that was originally inactivated during calibration was reactivated. Doing so allows several flow routes to the south, balancing the flows between multiple watermains and thus reducing pressure losses.

No specific watermain upgrades are recommended to improve fire flows throughout the network, however, smaller diameter watermains (150 mm and under) should be considered for upsizing if these align with any other capital upgrades or roadworks improvement programs.

Upgrades to the reservoir are not recommended in terms of storage capacity. Though there is a slight deficiency, this deficiency is very minimal. Instead, it is suggested that the Municipality confirms the exact reservoir sizing in the field, given that the reservoir storage was calculated from old record drawings. If there are discrepancies between the actual and calculated storage volumes, the actual volume should be compared to the required storage volume to ensure its adequacy.

In terms of raw water supply, it was noted that there is a node with a negative pressure prior to reaching the reservoir. The pumping capacities of the three production wells should be investigated in the field, and updates to the WaterCAD model can be made accordingly.

The recommended future system upgrades (i.e., 150 mm bottleneck upsizing and activating watermain previously closed during calibration) are illustrated in Figure 7.11. Assessment results with these upgrades are shown in Figures 7.12 to 7.19. The MDD + FF results, shown in Figures 7.18 and 7.19, indicate that the upgrades proposed under future system conditions also positively impact the available fire flow throughout the system, which further supports these upgrades.

As the upgrades are required for both the 10- and 25-year growth horizons, only the 25-year growth horizon was applied for the available fire flow versus land use and the maximum allowable land use type figures. These are shown in Figures 7.20 and 7.21, respectively. It is noted that the land use type shown on Figure 7.20 represents the existing land use with infill developments superimposed. Improved fire flow coverage can also be achieved by adding more hydrants to the system, as this approach assumes the existing hydrant assets only.

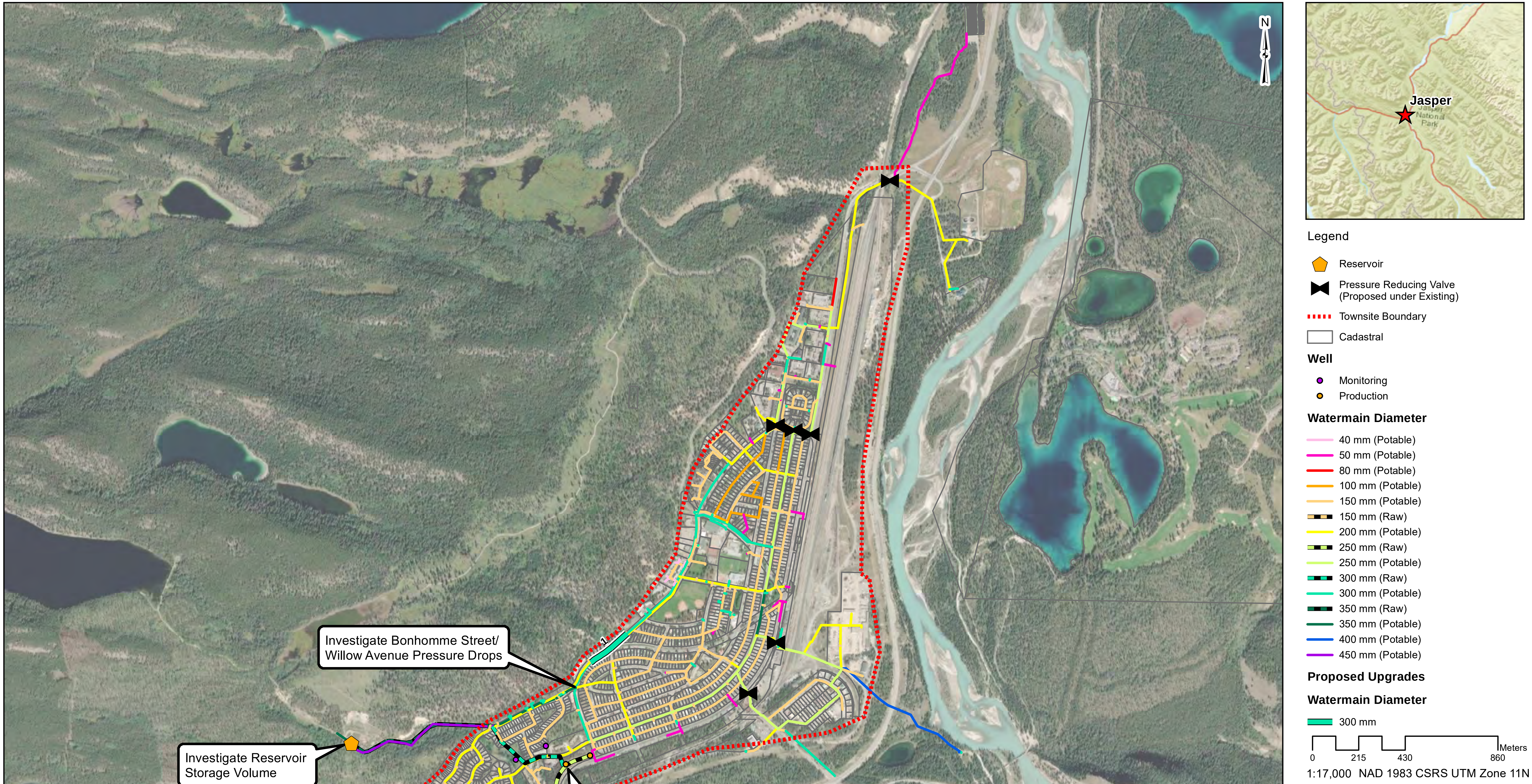
7.6 Future System Upgrades Cost Estimates

A summary of the costs associated with the recommended future system upgrades are detailed below in Table 7.6. A full breakdown of the costs has been provided in Appendix C.

Table 7.6: Cost Estimates for Recommended Upgrades to the Future System

Item	Total Cost
FUT Upgrade 1	$1,340,000
FUT Investigations	$50,000
Total	**$1,390,000**

It is noted that the 2022 Capital Projects – 5 Year Plan stipulates that a reservoir inspection is anticipated in 2026. Investigating the field storage volume could be completed during this inspection to save on costs.

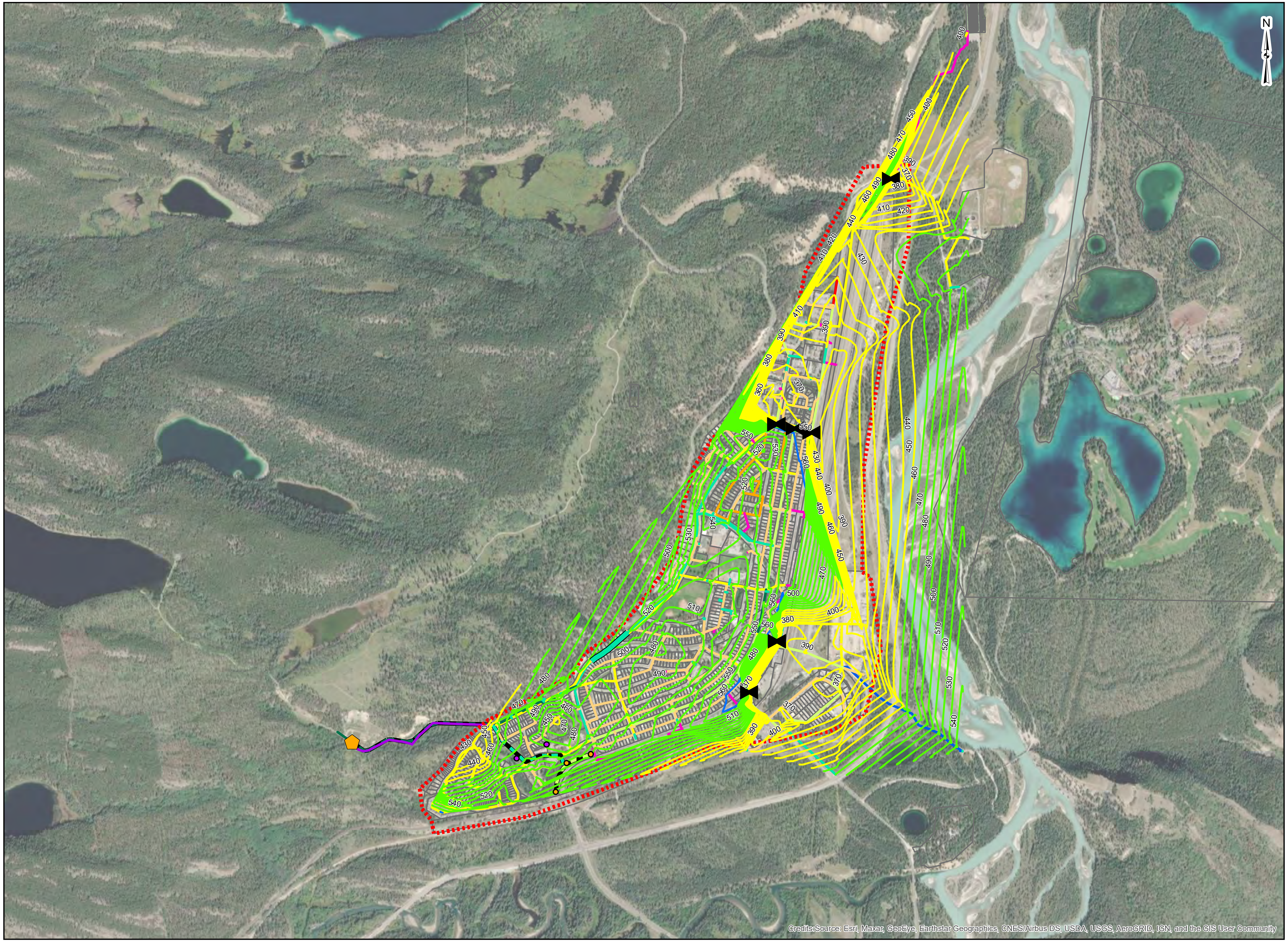


Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 7.11
RECOMMENDED FUTURE
SYSTEM UPGRADES
JASPER WATER MODEL

ISL
MUNICIPALITY OF JASPER

Date: 2022-06-09 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 7.11 - Future System Upgrades_v2.mxd



Legend

Reservoir
Pressure Reducing Valve (Proposed under Existing)
Townsite Boundary
Cadastral

Well

Monitoring
Production

Watermain Diameter

40 mm (Potable)
50 mm (Potable)
80 mm (Potable)
100 mm (Potable)
150 mm (Potable)
150 mm (Raw)
200 mm (Potable)
250 mm (Raw)
250 mm (Potable)
300 mm (Raw)
300 mm (Potable)
350 mm (Raw)
350 mm (Potable)
400 mm (Potable)
450 mm (Potable)

Average Day Pressure

Less than 275kPa
275 to 350kPa
350 to 450kPa
450 to 550kPa
550 to 700kPa
Greater than 700kPa

Proposed Upgrades

Watermain Diameter

300 mm

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 7.12
FUTURE SYSTEM ASSESSMENT
PROPOSED UPGRADES
10-YEAR GROWTH SCENARIO
AVERAGE DAY DEMAND
JASPER WATER MODEL

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MUNICIPALITY OF JASPER

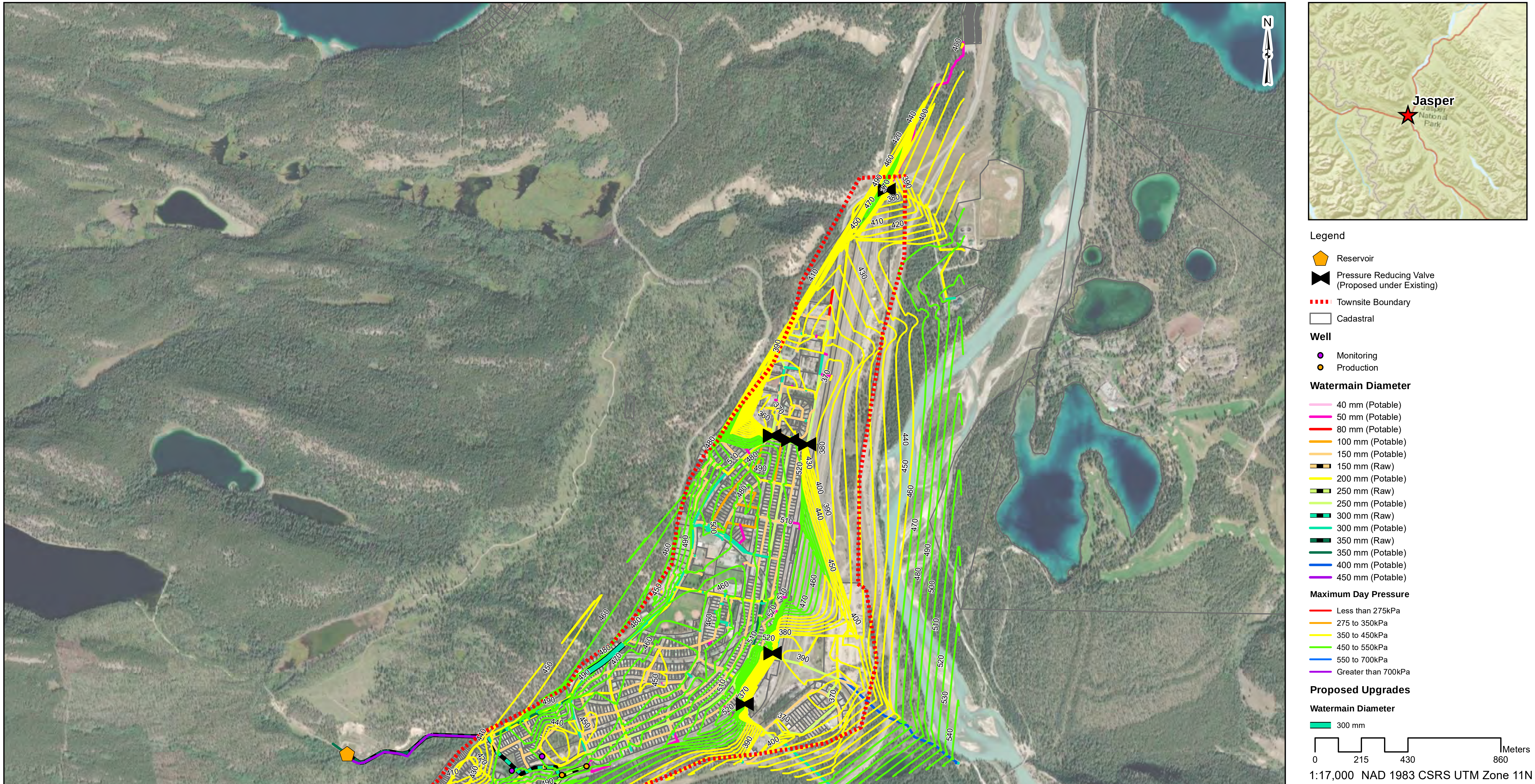

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FIGURE 7.13
FUTURE SYSTEM ASSESSMENT
PROPOSED UPGRADES
10-YEAR GROWTH SCENARIO
MAXIMUM DAY DEMAND
JASPER WATER MODEL

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MUNICIPALITY OF JASPER

Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 7.13 - FUT MDD 10-Year Growth Scenario - Upgrades.mxd

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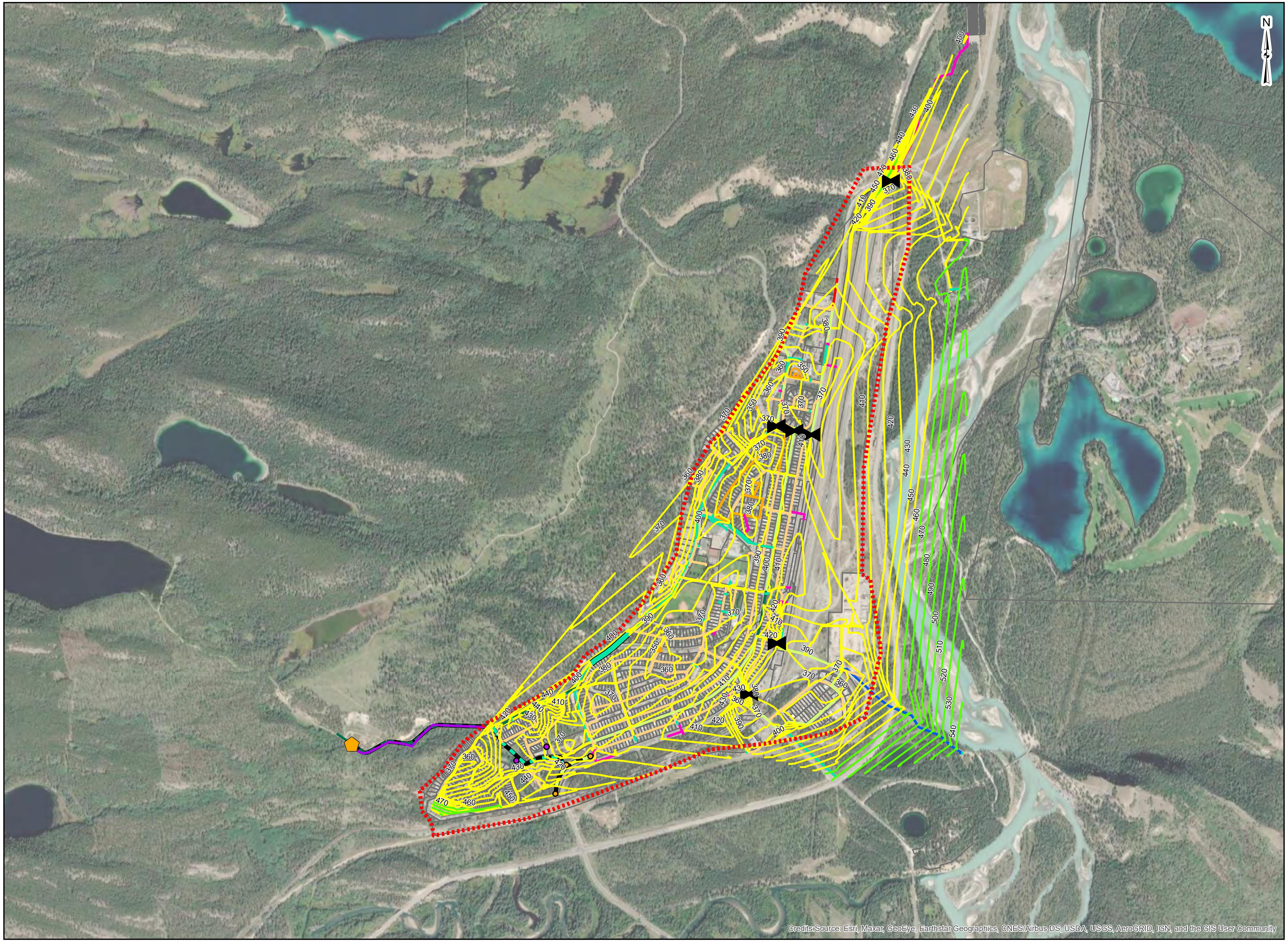

Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

⬟ Reservoir

⧓ Pressure Reducing Valve (Proposed under Existing)

Townsite Boundary

☐ Cadastral

Well

● Monitoring

● Production

Watermain Diameter

- 40 mm (Potable)
- 50 mm (Potable)
- 80 mm (Potable)
- 100 mm (Potable)
- 150 mm (Potable)
- 150 mm (Raw)
- 200 mm (Potable)
- 250 mm (Raw)
- 250 mm (Potable)
- 300 mm (Raw)
- 300 mm (Potable)
- 350 mm (Raw)
- 350 mm (Potable)
- 400 mm (Potable)
- 450 mm (Potable)

Peak Hour Pressure

- Less than 275kPa
- 275 to 350kPa
- 350 to 450kPa
- 450 to 550kPa
- 550 to 700kPa
- Greater than 700kPa

Proposed Upgrades

Watermain Diameter

- 300 mm

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 7.14
FUTURE SYSTEM ASSESSMENT
PROPOSED UPGRADES
10-YEAR GROWTH SCENARIO
PEAK HOUR DEMAND
JASPER WATER MODEL

ISL

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Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 7.14 - FUT PHD 10-Year Growth Scenario - Upgrades.mxd

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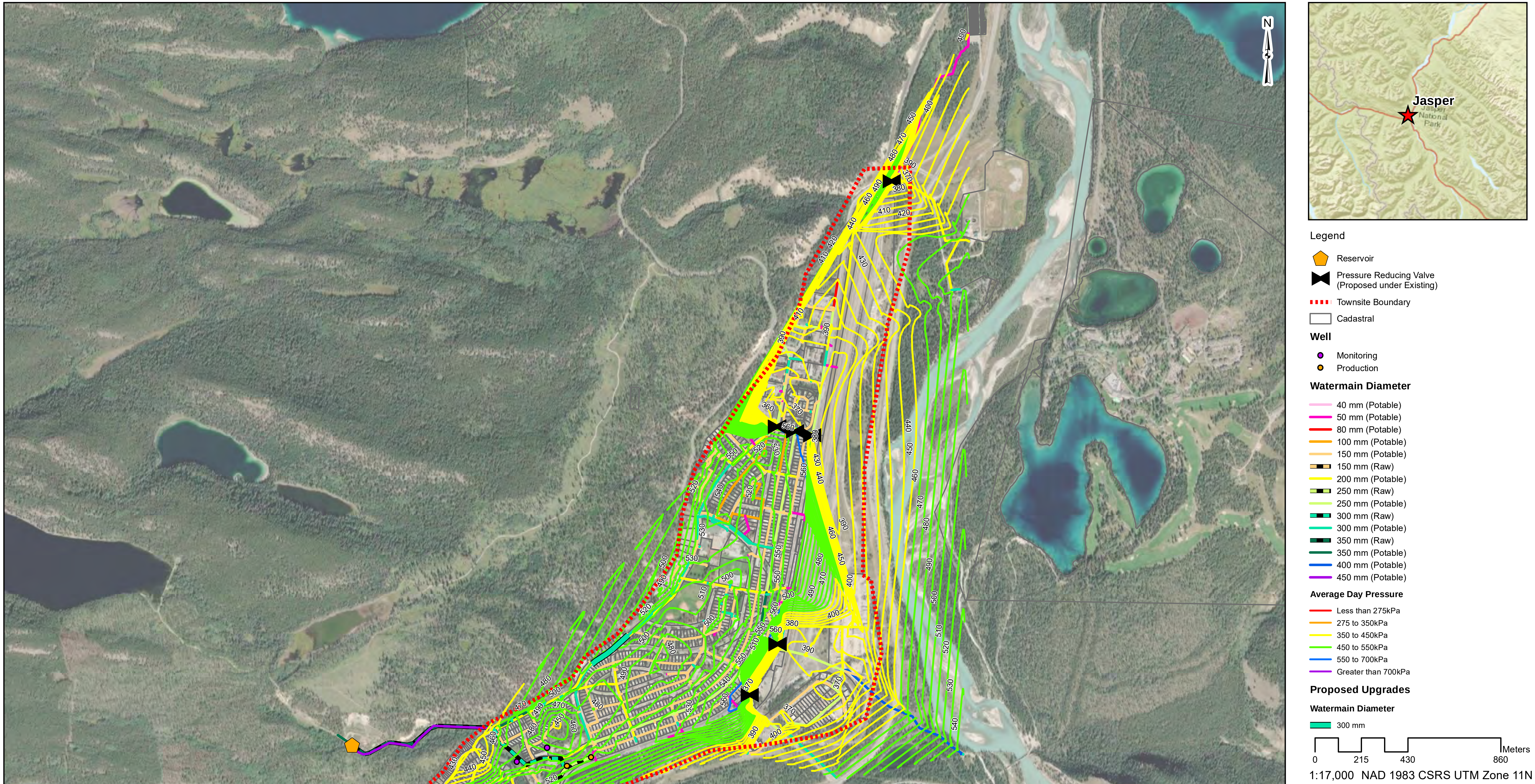
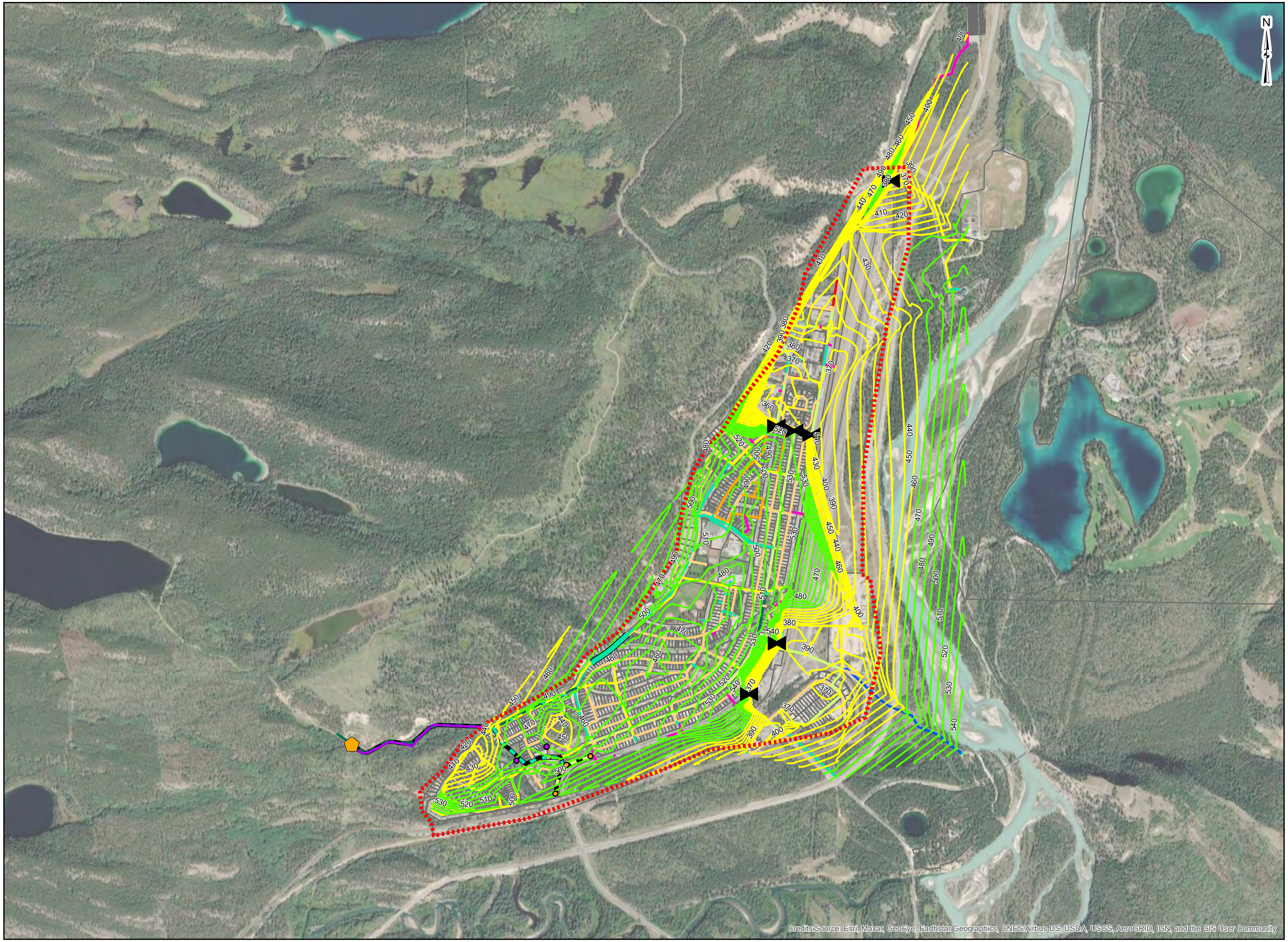


Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 7.15
FUTURE SYSTEM ASSESSMENT
PROPOSED UPGRADES
25-YEAR GROWTH SCENARIO
AVERAGE DAY DEMAND
JASPER WATER MODEL



Legend

- Reservoir
- Pressure Reducing Valve (Proposed under Existing)
- Townsite Boundary
- Cadastral

Well

- Monitoring
- Production

Watermain Diameter

- 40 mm (Potable)
- 50 mm (Potable)
- 80 mm (Potable)
- 100 mm (Potable)
- 150 mm (Potable)
- 150 mm (Raw)
- 200 mm (Potable)
- 250 mm (Raw)
- 250 mm (Potable)
- 300 mm (Raw)
- 300 mm (Potable)
- 350 mm (Raw)
- 350 mm (Potable)
- 400 mm (Potable)
- 450 mm (Potable)

Maximum Day Pressure

- Less than 275kPa
- 275 to 350kPa
- 350 to 450kPa
- 450 to 550kPa
- 550 to 700kPa
- Greater than 700kPa

Proposed Upgrades

Watermain Diameter

- 300 mm

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 7.16
FUTURE SYSTEM ASSESSMENT
PROPOSED UPGRADES
25-YEAR GROWTH SCENARIO
MAXIMUM DAY DEMAND
JASPER WATER MODEL

ISL
MUNICIPALITY OF JASPER

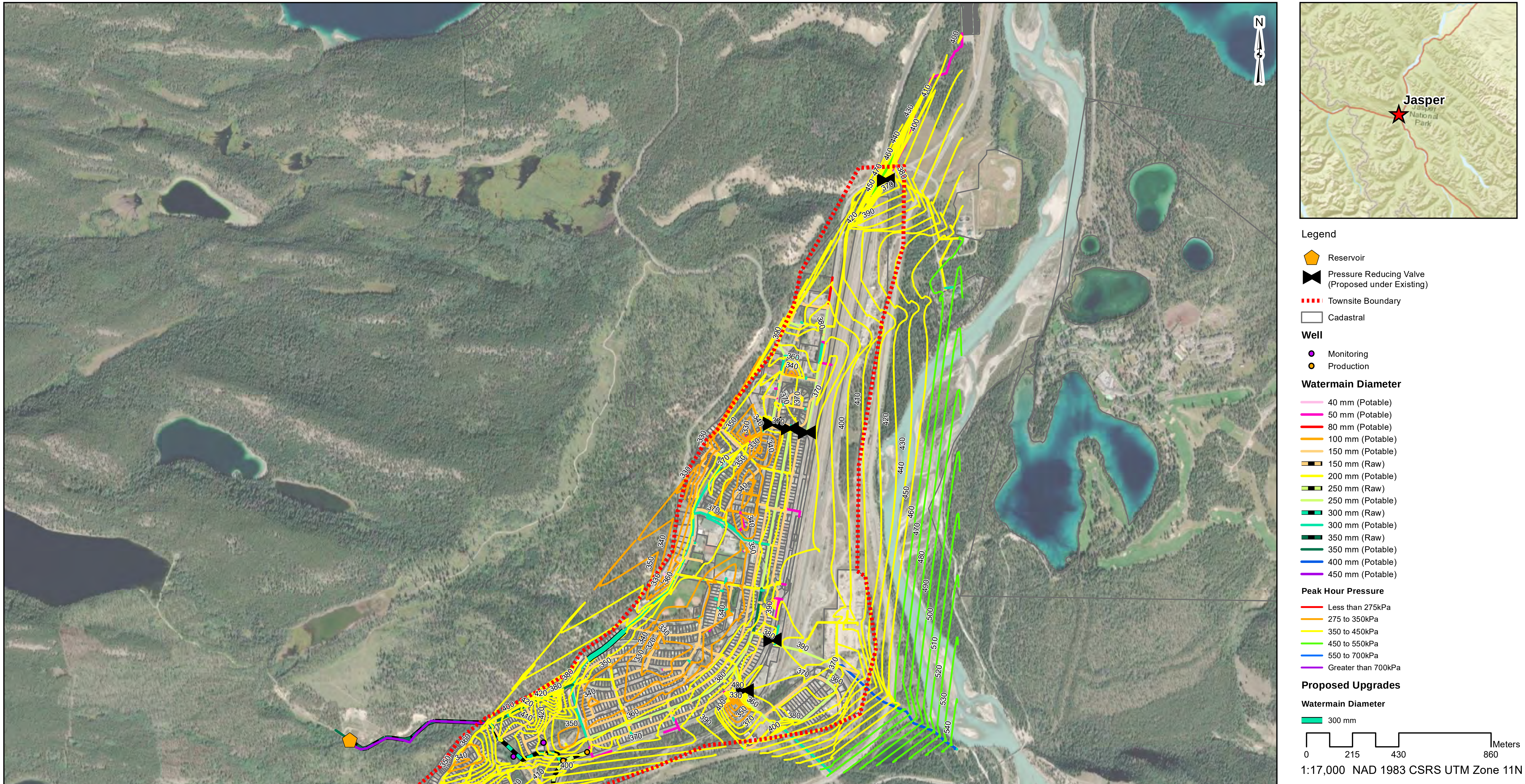


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FIGURE 7.17
FUTURE SYSTEM ASSESSMENT
PROPOSED UPGRADES
25-YEAR GROWTH SCENARIO
PEAK HOUR DEMAND
JASPER WATER MODEL

ISL

MUNICIPALITY OF JASPER

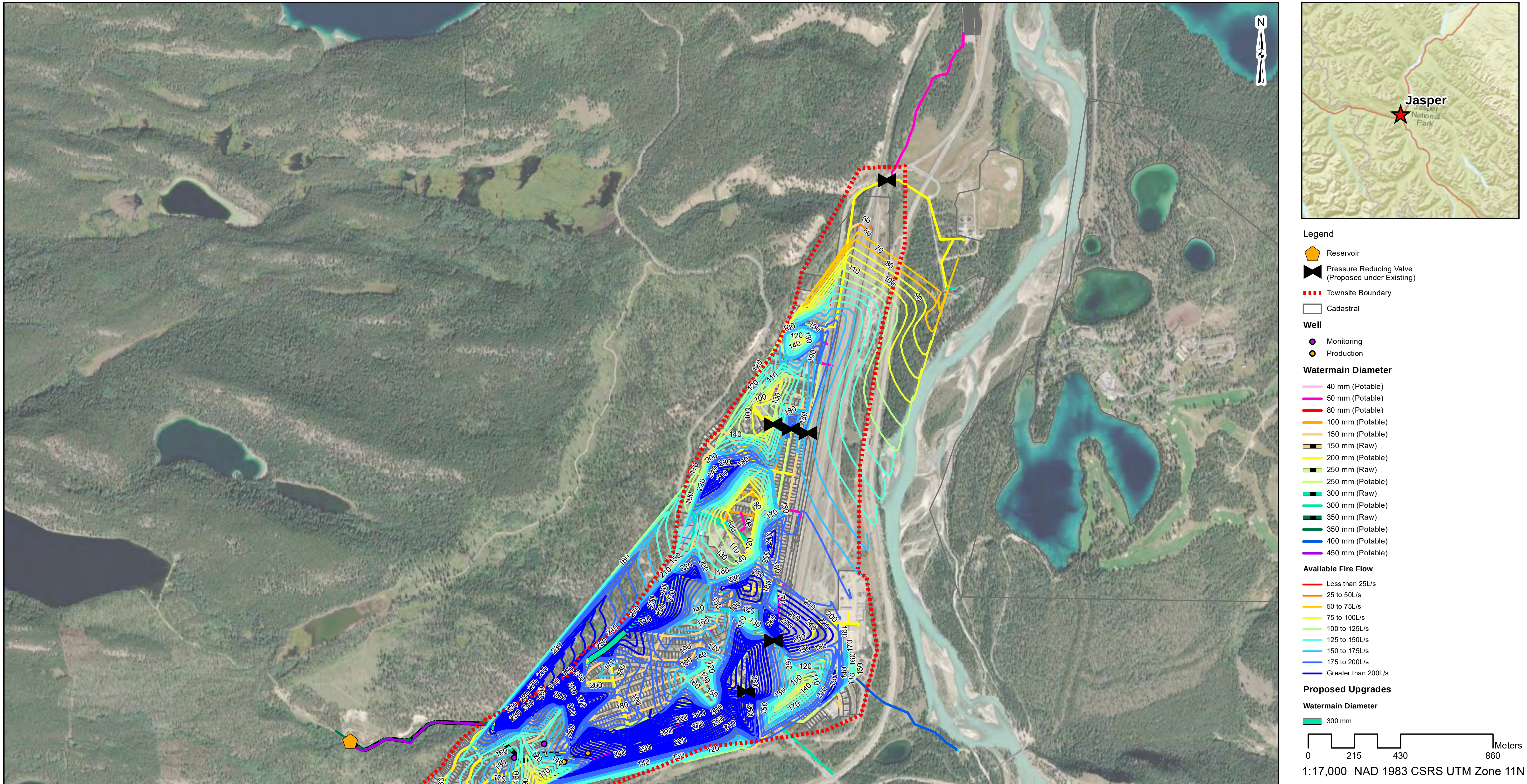

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FIGURE 7.18
FUTURE SYSTEM ASSESSMENT
PROPOSED UPGRADES
10-YEAR GROWTH SCENARIO
MAXIMUM DAY DEMAND PLUS FIRE FLOW
JASPER WATER MODEL

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Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 7.18 - FUT MDD + FF 10-Year Growth Scenario - Upgrades.mxd

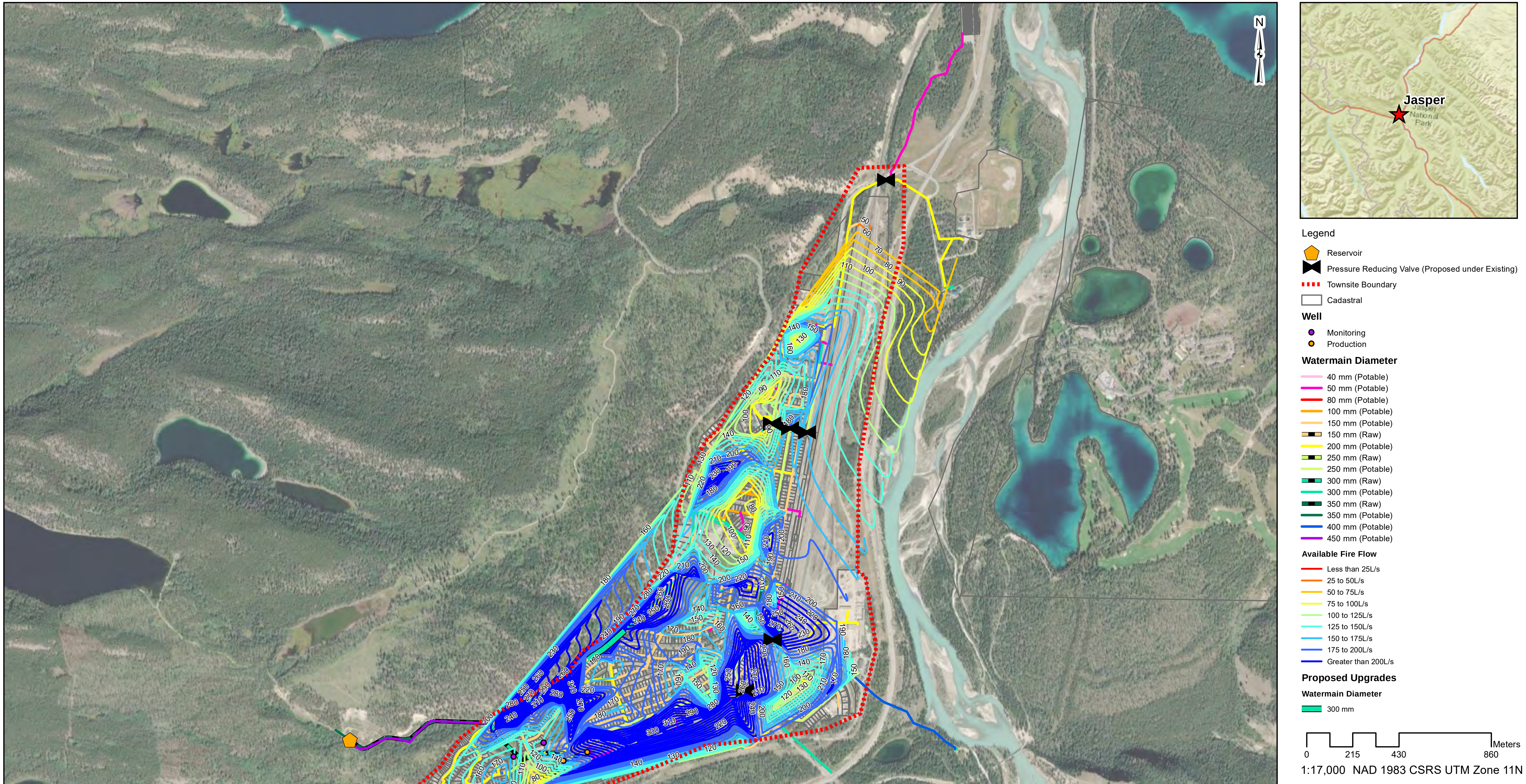

FIGURE 7.19
FUTURE SYSTEM ASSESSMENT
PROPOSED UPGRADES
25-YEAR GROWTH SCENARIO
MAXIMUM DAY DEMAND PLUS FIRE FLOW
JASPER WATER MODEL

Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 7.19 - FUT MDD + FF 25-Year Growth Scenario - Upgrades.mxd

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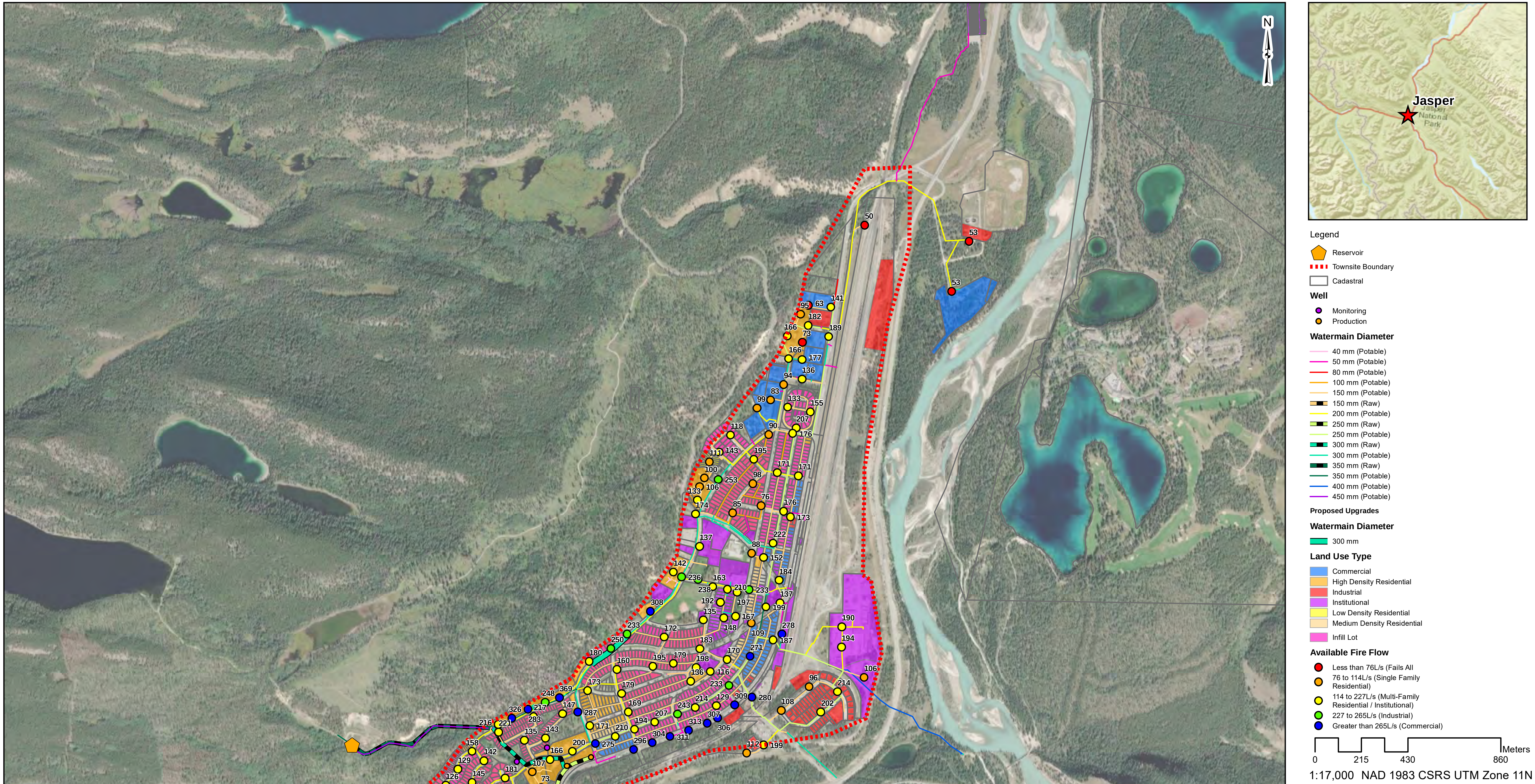


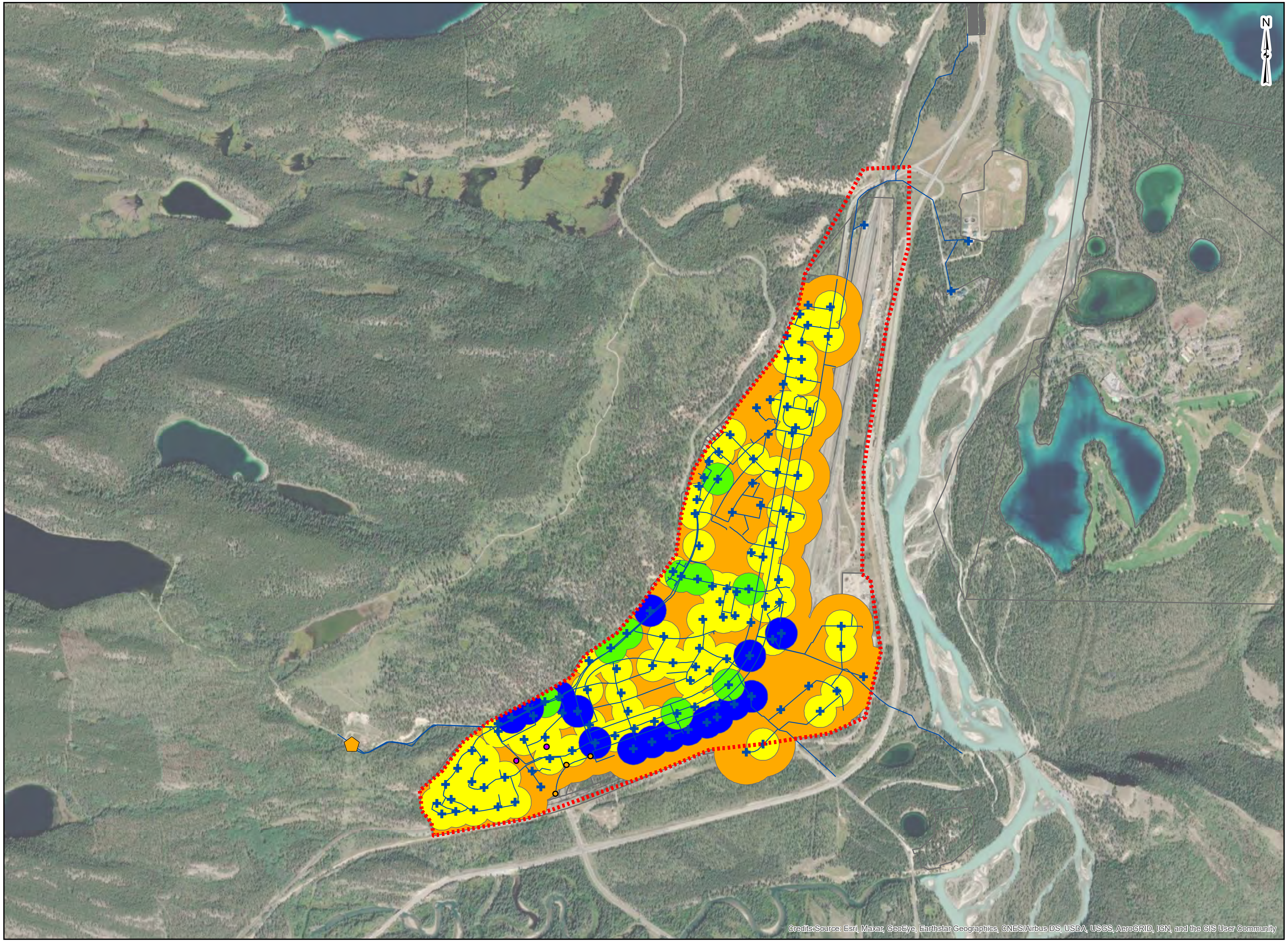
Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 7.20
FUTURE SYSTEM ASSESSMENT
RECOMMENDED UPGRADES
MAXIMUM DAY DEMAND PLUS FIRE FLOW
COMPARISON TO LAND USE TYPES
JASPER WATER MODEL

ISL

MUNICIPALITY OF JASPER

Date: 2022-06-10 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 7.20 - FUT MDD + FF 25-Year Growth Scenario versus Land Use.mxd



Credits:Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- ✚ Hydrant
- ⬟ Reservoir
- — Watermain
- ┅ Townsite Boundary
- ▭ Cadastral

Well

- ● Monitoring
- ● Production

Possible Land Use Type

- ☐ No Sufficient Fire Flow Coverage (Less than 76L/s)
- 🟧 Single Family Residential (76 to 114L/s)
- 🟨 Multi-Family Residential / Institutional (114 to 227L/s)
- 🟩 Industrial (227 to 265L/s)
- 🟦 Commercial (Greater than 265L/s)

Note: Hydrant coverage is based on the City of Calgary's Subdivision Servicing Design Guidelines.

Low Density Residential: 150m Radius
All Other Land Use Types: 75m Radius

This assumes no other hydrants are added to the system, which would also increase the hydrant coverage.

0 215 430 860 Meters

1:17,000 NAD 1983 CSRS UTM Zone 11N

FIGURE 7.21
FUTURE SYSTEM ASSESSMENT
RECOMMENDED UPGRADES
FIRE FLOW LEVEL OF SERVICE
JASPER WATER MODEL

Date: 2022-07-06 Document: Q:\Projects\28026_Jasper Water Model\25_GIS\251_Figures\3_Reporting\Figure 7.21 - Possible Land Use Types - FUT Upgrades.mxd

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8.0 Prioritization Plan

A total of seventeen recommendations were proposed between the existing and future system assessments. Thirteen of these were proposed for the existing system assessments and four were proposed for the future system assessments (noting this assumes recommended existing system upgrades have been implemented). A condition rating system was developed to prioritize the recommended upgrades. This essentially created a prioritization/staging plan that can be used as a roadmap for future capital planning.

The condition rating system classified five criteria:

- Growth horizon the upgrade was triggered (i.e., existing or future)
- Capital cost to complete the upgrade
- Age of the existing infrastructure
- The extent of system improvements that can be achieved by completing the upgrade
- Effort required by the Municipality to complete the upgrade

Each recommended upgrade was assigned a score from 1 to 5 for each of the above-mentioned criteria. High scores represent higher priorities for the given criteria. Score were assigned as follows for each of the criteria.

Growth Horizon

Recommended upgrades triggered under future conditions were assigned a score of 5. Recommended upgrades under existing conditions were assigned a score of 1.

Capital Cost

Recommended upgrades with the smallest capital costs were assigned a score of 1 while recommended upgrades with the highest capital costs were assigned a score of 5. Remaining upgrades were assigned a score of 2 to 4 depending on their capital costs relative to all other upgrades.

Age of Infrastructure

The age of existing infrastructure ranges from 1900 to 1973. It is anticipated that the infrastructure dated in 1900 was assigned this default year in lieu of actual installation year data, thus these were considered ‘unknown’ for this analysis. A score of 5 was assigned to the oldest infrastructure while a score of 1 was provided to the newest infrastructure. A score of 3 was assigned for watermains where the installation year was unknown or where infrastructure does not currently exist (i.e., PRVs to create the pressure zones or the three investigation items).

Extent of System Improvements

Recommended upgrades with a larger positive impact on the water system were assigned a 5, while those with a smaller impact were assigned a 1. Upgrades with an average impact were assigned a score of 2 to 4 based on a comparison with other upgrades. Generally, upgrades with a notable improvement in fire flows or pressures were assigned scores of 4 or 5 while upgrades with more localized improvements were assigned scores of 1 or 2.

Effort to Complete

Scores of 5 were assigned to recommended projects that are anticipated to be simpler to accomplish, such as the three investigation recommendations. The larger, more complex underground watermain upgrades were assigned scores of 1 or 2. PRV installations were assigned intermediate scores as they are underground, but rather localized.

Table 8.1 below summarizes the findings from this condition rating system.

Table 8.1: Condition Rating System Results

Criteria	Horizon	Cost	Age[1]	Extent of System Improvements	Effort to Complete	Total Score	Cost
EX Upgrade 1	5	3	3	4	3	**18**	**$660,000**
EX Upgrade 2	5	4	5	5	2	**21**	**$2,490,000**
EX Upgrade 3	5	1	3	1	4	**14**	**$30,000**
EX Upgrade 4	5	2	3	4	3	**17**	**$380,000**
EX Upgrade 5	5	2	4	4	3	**18**	**$460,000**
EX Upgrade 6	5	1	3	1	4	**14**	**$20,000**
EX Upgrade 7	5	1	3	2	4	**15**	**$40,000**
EX Upgrade 8	5	1	3	2	4	**15**	**$60,000**
EX Upgrade 9	5	2	4	3	3	**17**	**$230,000**
EX Upgrade 10	5	5	2	5	1	**18**	**$3,700,000**
Industrial PZ	5	2	3	4	3	**17**	**$240,000**
North PZ	5	3	3	4	3	**18**	**$320,000**
Low North PZ	5	2	3	1	3	**14**	**$80,000**
FUT Upgrade 1	1	4	5	5	2	**17**	**$1,340,000**
Investigate Bonhomme Street/Willow Avenue Pressure Drops	1	1	3	4	5	**14**	**$10,000**
Investigate Reservoir Storage Volume	1	1	3	1	5	**11**	**$10,000**
Investigate Well Pumping Capacity	1	1	3	2	5	**12**	**$30,000**

[1] *Cells highlighted grey represent those with either unknown installation years, an installation year of 1900, or upgrades where infrastructure does not currently exist.*

This condition rating system should be revisited after the completion of the Sanitary Modelling project to determine if there are any efficiencies if water and sanitary upgrades are done in conjunction. This would be updated as part of the Utility Master Plan, which is anticipated in 2023.

The scores were used to prioritize system upgrades, in conjunction with the projected annual capital budget. To determine the capital budget, ten years of historical and projected capital budgets for the Municipality were analyzed. The capital budgets ranged from 2016 to 2026, omitting 2018 due to missing information on the Municipality's website. Capital budgets for only water infrastructure were determined on an annual basis, then averaged and rounded to the nearest $10,000. It is noted that carry forward projects were included in the estimates, meaning that the same project may have been considered in more than one year. An average budget of $860,000 was determined, based on the summary shown in Table 8.2.

Table 8.2: Capital Budget Analysis

Year	Capital Budget
2026	$1,510,000
2025	$915,000
2024	$395,000
2023	$355,000
2022	$1,530,000
2021	$675,000
2020	$364,570
2019	$1,421,149
2017	$927,597
2016	$482,667
Average	**$860,000**

From this average budget, it is expected that a portion will be allocated to reoccurring projects, such as the annual valve replacement program, annual hydrant rebuilds, and other capital projects that are already being planned. Based on existing capital budgets, $205,000 is assigned to the annual valve replacement program and annual hydrant rebuilds. An additional $150,000 was assumed as a contingency for other capital projects. The remainder is $505,000 that is assumed to be the targeted budget for recommended upgrades outlined in this study. The following prioritization in Table 8.3 is therefore recommended, based on the targeted annual budget, condition rating score, and grouping of nearby projects. Exact years were not given, to allow flexibility with the Municipality's current capital projects, particularly those that are above the targeted budget such as the residential water meter upgrade and Colin Crescent deep services planning.

Table 8.3: Recommended Upgrade Prioritization

Year	Upgrade	Condition Rating Score	Cost	Total Cost
1 – 6	• EX Upgrade 2 • EX Upgrade 8 • EX Upgrade 7 • EX Upgrade 6	• 21 • 15 • 15 • 14	• $2,490,000 • $60,000 • $40,000 • $20,000	$2,610,000
7 – 14	• EX Upgrade 10 • Industrial PZ • EX Upgrade 3	• 18 • 17 • 14	• $3,700,000 • $240,000 • $30,000	$3,970,000
15 – 16	• North PZ • EX Upgrade 5	• 18 • 18	• $320,000 • $460,000	$780,000
17 – 19	• EX Upgrade 1 • EX Upgrade 4 • Investigate Bonhomme Street/Willow Avenue Pressure Drops • Investigate Well Pumping Capacity • Investigate Reservoir Storage Volume[1]	• 18 • 17 • 14 • 12 • 11	• $660,000 • $380,000 • $10,000 • $30,000 • $10,000	$1,090,000
20 – 23	• EX Upgrade 9 • FUT Upgrade 1	• 17 • 17	• $230,000 • $1,340,000	$1,570,000
24	• Low North PZ	• 14	• $80,000	$80,000

[1] *Potential to group this recommendation with the reservoir inspection project indicated in the 2022 Capital Projects – 5 Year Plan document.*

FUT Upgrade 1 and the Investigate Bonhomme Street/Willow Avenue Pressure Drops projects had a significant improvement to pressures and fire flows. The priority of these is lessened by being considered during the future system assessments. These projects can also be prioritized higher if there are more immediate development pressures in the areas where improvements are most prominent.

The projects that scored lower but were grouped with higher priority projects in the first years could be slid back to save budget in earlier years to try and advance other more critical projects sooner. However, due to the lower anticipated capital costs of these smaller projects, it is not expected that they will advance the larger projects much more quickly.

9.0 Conclusions and Recommendations

9.1 Conclusions

The Jasper Water Model was prepared to meet the following objectives:

- Generate a comprehensive inventory of the existing water system and a hydraulic capacity assessment
- Develop a comprehensive water model for the service area using Bentley WaterCAD software that is compatible with the Municipality's current GIS software systems
- Calibrate the water model to represent real-life conditions more accurately
- Conduct an evaluation of the existing system and provide recommendations for upgrades and maintenance, including associated costs
- Identify upgrades required to service future development growth, including associated costs
- Develop a condition rating system and prioritization plan for recommended upgrades

Conclusions for the existing system are as follows:

1. Watermains near the river exhibit pressures greater than 800 kPa under ADD and MDD conditions and could become an issue under lower demand scenarios, particularly ADD, night-time, or off-season (i.e., winter) demands.
2. There are some isolated pressure constraints under PHD conditions, though most of these pressure constraints are limited to smaller diameter dead-end mains and should not impact most of the distribution system.
3. The large variability in demands caused by seasonal tourists results in a big variance in pressures observed throughout the system. This coupled with the single pressure zone and reasonable degree of topographical changes could support the implementation of additional pressure zones to better control system pressures.
4. The hydrant with the smallest available fire flow occurs at the Jasper Inn & Suites, with other areas with significant fire flow deficiencies also occurring on dead-end small diameter watermains.
5. The reservoir is sufficiently filled under ADD, MDD, and fire flow parameters, with the caveat that chlorine contact time needs a separate review as it may increase the reservoir storage need.
6. The raw water supply flow rate is sufficient under ADD conditions. It is also sufficient under MDD conditions if there is some reserve capacity in the reservoir. If MDD conditions extend beyond a 24-hour duration, the reservoir would continue to be depleted, which could become a concern. The same concern would be apparent under PHD or fire flow conditions. Dialogue with AEP on supply rate required is recommended due to the drawdown under MDD conditions.
7. Areas most at risk for leakage are the industrial lands to the southeast and the developments to the north, where higher pressures are observed, and the areas are older.

Conclusions for the future system are as follows:

1. In the 10-year growth horizon, pressures are adequate under ADD and MDD conditions, however, drop below the recommended minimum pressure of 275 kPa under PHD conditions. This drop occurs in a significant portion of the townsite with watermains exhibiting the largest head loss predominantly along Bonhomme Street, Miette Avenue and Pine Avenue intersection.
2. Results from the 25-year growth horizon are generally like the 10-year, with ADD and MDD conditions performing adequately but PHD suggesting significant losses throughout the system. Areas with higher head losses also occur along Bonhomme Street, suggesting these areas would be good candidates for system improvements.
3. Fire flow contours are generally consistent in comparison to each other and the existing system upgrades results, with some incremental drops in available fire flow from existing to the 10-year growth horizon and from the 10-year to the 25-year growth horizon.
4. The reservoir is sufficiently filled under ADD, MDD, and fire flow parameters for the 10-year growth horizon, with a minimal deficiency of 8 m^3 for the 25-year growth horizon. There is not a substantial increase in the

amount of storage needed from existing to future conditions, with the caveat that chlorine contact time needs a separate review as it may increase the reservoir storage need.

5. Under ADD conditions, the reservoir is filling for both the 10- and 25-year growth horizons, though the 10-year growth horizon fills at a faster rate as there is a smaller demand required in the distribution system in comparison. The 10-year growth horizon is 95.2% full by the end of the day while the 25-year growth horizon is 86.6% full by the end of the day.
6. Under MDD conditions, there is more flow leaving the tank into the distribution system than there is flow filling the reservoir for most of the day. The reservoir is being depleting quicker than existing condition, with the 25-year growth horizon depleting quicker than the 10-year growth horizon. There is also the risk of depletion in the event of a fire, heightened for the future scenario particularly for the 25-year growth horizon under MDD conditions. Dialogue with AEP on supply rate required is recommended due to the drawdown under MDD conditions.

9.2 Recommendations

Recommendations for the existing system are as follows:

1. Upgrades to the existing system aim to reduce the high pressures in lower elevations under ADD and MDD conditions, increase pressures where deficiencies were noted under PHD conditions, and improve available fire flows at hydrants.
2. To reduce high pressures, implement three new pressure zones via eight new pressure reducing valves (PRVs). The first proposed pressure zone would be for the predominantly industrial lands with three PRVs added to the three watermains feeding the area. The second pressure zone is up north on Bonhomme Street, where four PRVs separate the lower terrain from the Main Pressure Zone. The final pressure zone is north of the second pressure zone, servicing only a few properties with one PRV.
3. To improve pressure and fire flow deficiencies, some looping and pipe upsizing is recommended. A 250 mm backbone is proposed in the industrial lands to provide additional fire flow protection. Two connections are proposed on Pyramid Lake Road. One connects the two sections of 300 mm watermains, and another connects the 50 mm cast iron watermain on the alley between Colin Crescent and Geikie Street to the 300 mm watermains. Smaller localized upgrades are also proposed on dead-end watermains to improve the pressures and fire flows.
4. Consideration for upgrading areas with small fire flow deficiencies could be made during roadworks programs. The recommendation in this case would be to replace watermains 150 mm or smaller with 200 mm to 300 mm mains, to improve fire flows in Jasper. Dovetailing with roadworks programs is recommended to ensure efficient use of capital funds so if the road is already being re-done, the watermain can be replaced at an incremental cost relative to the overall road repair/replacement.
5. Remaining hydrants with a fire flow less than 76 L/s are on 150 mm mains and should be upgraded during roadworks programs or other capital projects.
6. To reduce the UFW throughout the system, several short-, medium-, and long-term solutions are proposed.
   a. Short-term solutions involve first differentiating between UFW due to irrigation vs leakage. Watermains with high normal operating pressures can also be reviewed to determine their watermain pressure rating.
   b. Medium-term solutions involve testing suspected watermains with high leakage in the field or by implementing leakage detection systems. Areas with higher pressures under normal operating pressures can also be divided into separate pressure zones through PRVs. This would reduce the pressures in the lower-lying areas.
   c. Long-term solutions would involve undertaking a replacement program to remove any watermains that are likely contributing to leakage. The replacement program can also be coupled with other capital projects, such as sewer replacements or roadway improvement projects. This will help to reduce the capital costs associated with these upgrades.
7. Review chlorine contact time requirements to confirm if some additional reservoir storage, or revisions such as baffles are required. A discussion with AEP is recommended in this case.

8. Confirm water supply rate requirements with AEP; while the reservoir retains capacity under the depletion modelling, the potential guide for a supply rate of two times MDD plus 10% does exist, though with Jasper's seasonality of demand, AEP may make an exception here. Dialogue with AEP is recommended to flesh this out.

Recommendations for the future system are as follows:

1. To improve pressures under peak hour demands, some watermain upgrades are recommended along Bonhomme Street. This includes upsizing the 150 mm bottleneck near the intersection of Bonhomme Street, Miette Avenue, and Pine Avenue to a 300 mm PVC watermain. As well, the source of significant pressure drops near the intersection of Bonhomme Street and Willow Avenue should be investigated and mitigated to also improve pressures.
2. No specific watermain upgrades are recommended to improve fire flows throughout the network, however, smaller diameter watermains (150 mm and under) should be considered for upsizing if these align with any other capital upgrades or roadworks improvement programs.
3. Upgrades to the reservoir are not recommended in terms of storage capacity. Though there is a slight deficiency, this deficiency is very minimal. Instead, it is suggested that the Municipality confirms the exact reservoir sizing in the field, given that the reservoir storage was calculated from old record drawings. If there are discrepancies between the actual and calculated storage volumes, the actual volume should be compared to the required storage volume to ensure its adequacy. Review chlorine contact time requirements to confirm if some additional reservoir storage, or revisions such as baffles are required. A discussion with AEP is recommended in this case.

4. In terms of raw water supply, it was noted that there is a node with a negative pressure prior to reaching the reservoir. The pumping capacities of the three production wells should be investigated in the field, and updates to the WaterCAD model can be made accordingly. It is recommended to confirm water supply rate requirements with AEP; while the reservoir retains capacity under the depletion modelling, the potential guide for a supply rate of two times MDD plus 10% does exist, though with Jasper's seasonality of demand, AEP may make an exception here. Dialogue with AEP is recommended to flesh this out.

10.0 References

Alberta Environment. 2006. Standards and Guidelines for Municipal Waterworks, Wastewater, and Storm Drainage Systems.

City of Calgary. 2020. Design Guidelines for Subdivision Servicing 2020.

EPCOR Utilities Inc. 2021. City of Edmonton Design and Construction Standards Volume 4: Water

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Municipality of Jasper. Approved 2021-2024 Operating & 2022-2026 Capital Budgets.

Municipality of Jasper. Approved 2021 Capital.

Municipality of Jasper. Approved 2020 Operating and Capital Budget.

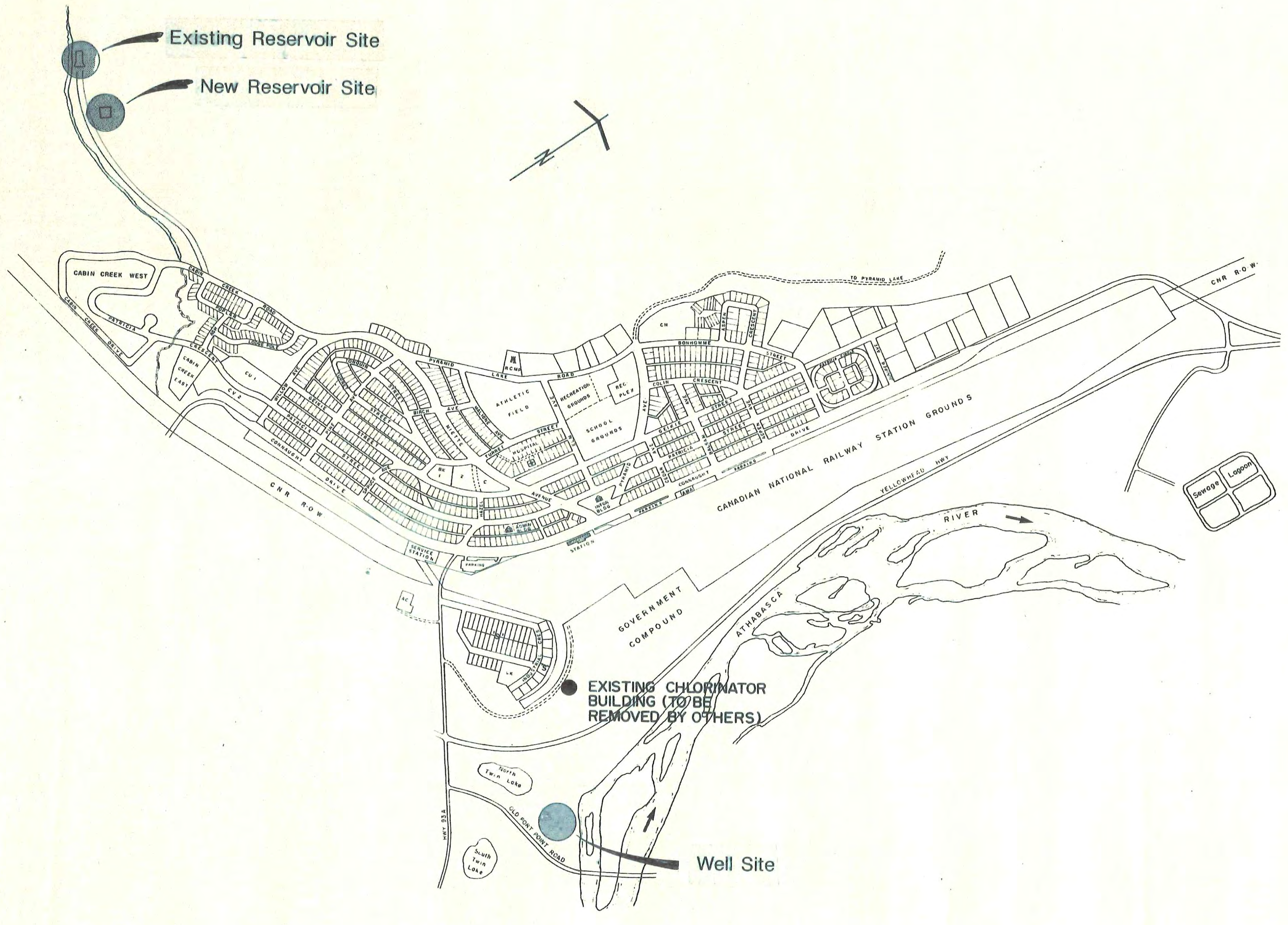
Municipality of Jasper. 2019 Capital Spending with Prior Year(s) Carry Forward.

Municipality of Jasper. 2017 Capital Budget Including carry forward projects from 2016, approved by Council.

Municipality of Jasper. 2016 Capital.

APPENDIX
Reservoir Record Drawings

A



LIST OF DRAWINGS

SITE DEVELOPMENT

C1	NEW RESERVOIR SITE PLAN
C2	NEW RESERVOIR SITE GABION PROFILES
C3	NEW RESERVOIR SITE GABION CROSS SECTIONS
C4	EXISTING RESERVOIR SITE PLAN A
C5	EXISTING RESERVOIR SITE PLAN B
C6	NEW WELL SITE PLAN
C7	SITE WORK DETAILS

ARCHITECTURAL & STRUCTURAL

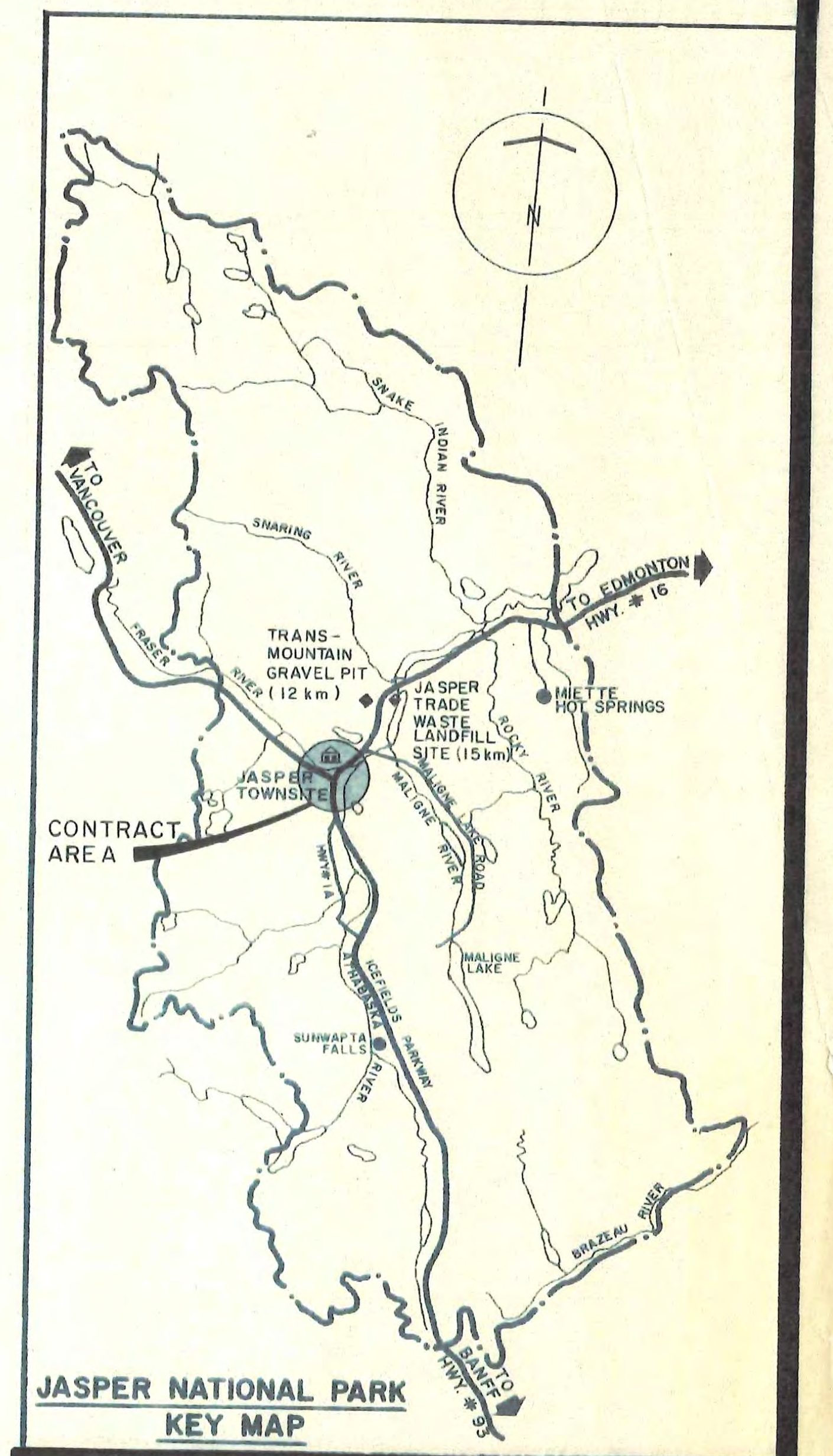
A1	FLOOR PLAN AND ELEVATIONS RESERVOIR CONTROL, METERING AND CHLORINATION FACILITY
A2	FLOOR PLAN AND ELEVATIONS WELL CONTROL METERING AND CHLORINATION FACILITY
A3	BUILDING SECTIONS AND DETAILS
S1	RESERVOIR BASE SLAB AND FOOTING PLAN
S2	CROSS SECTIONS AND SUBDRAIN PLAN
S3	WALL SECTIONS
S4	DETAILS AND SECTIONS
S5	RESERVOIR ROOF PLAN
S6	TYPICAL DETAILS
S7	ACCESS LADDER DETAILS

MECHANICAL

M1	MECHANICAL LEGEND
M2	WATER SYSTEM PROCESS AND INSTRUMENTATION
M3	WELL CONTROL, METERING AND
M4	RESERVOIR CONTROL, METERING AND CHLORINATION FACILITY
M5	MECHANICAL DETAILS
M6	MECHANICAL DETAILS
M7	PUMP VAULT DETAIL WATER WELL 1-89

ELECTRICAL

E1	WELL SITE PLAN UNDERGROUND CONDUIT AND CABLE LAYOUT
E2	WELL CONTROL FACILITY SINGLE LINE DIAGRAM MISC. SCHEDULE AND POWER DISTRIBUTION DETAIL
E3	WELL CONTROL FACILITY ELECTRICAL LAYOUTS
E4	WELL CONTROL FACILITY CONTROL SCHEMATICS H AND V CONTRACTOR ENCLOSURE DETAILS
E5	WELL CONTROL FACILITY CONTROL PANEL LAYOUT AND DETAILS
E6	WELL CONTROL FACILITY CONTROL PANEL TERMINAL BLOCKS WIRING DIAGRAM
E7	RESERVOIR CONTROL FACILITY SITE PLAN AND ELECTRICAL LAYOUT
E8	RESERVOIR CONTROL FACILITY CONTROL SCHEMATICS H AND V CONTRACTOR ENCLOSURE DETAILS
E9	RESERVOIR CONTROL FACILITY CONTROL PANEL LAYOUT AND DETAILS
E10	RESERVOIR CONTROL FACILITY CONTROL PANEL TERMINAL BLOCKS WIRING DIAGRAM
E11	ELECTRICAL PROGRAMMABLE LOGIC CONTROLLER BLOCK DIAGRAM
E12	WELL CONTROL FACILITY PLC RACK GROUPS 0, 1, 2, AND 3 WIRING DIAGRAM
E13	WELL CONTROL FACILITY PLC RACK GROUPS 4, 5, 6, AND 7 WIRING DIAGRAM
E14	RESERVOIR CONTROL FACILITY PLC RACK PLC RACK GROUPS 0, 1, 2, AND 3 WIRING DIAGRAM
E15	RESERVOIR CONTROL FACILITY PLC RACK GROUPS 4 AND 5 WIRING DIAGRAM



JASPER NATIONAL PARK KEY MAP

Water Supply Improvements and Reservoir

JASPER TOWNSITE

JASPER NATIONAL PARK

PERMIT TO PRACTICE
INFRASTRUCTURE SYSTEMS LTD.
Signature Bryan Berg
Date May 9/89
PERMIT NUMBER: P 4741
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Bryan Berg
May 9/89

approved by / approuve par — date / date
FEB 12 1990
Park Superintendent / Directeur du parc

no.	date	description	drawn by tracé par	app'd by appr. par
1	05/89	ISSUED FOR TENDER	W.C.	

revision / révision

A detail number / A numéro de détail
B location drawing number / B sur feuille no.
C drawing number / C numéro de feuille

Parks Canada / Parcs Canada
Engineering and Architecture / Génie et architecture

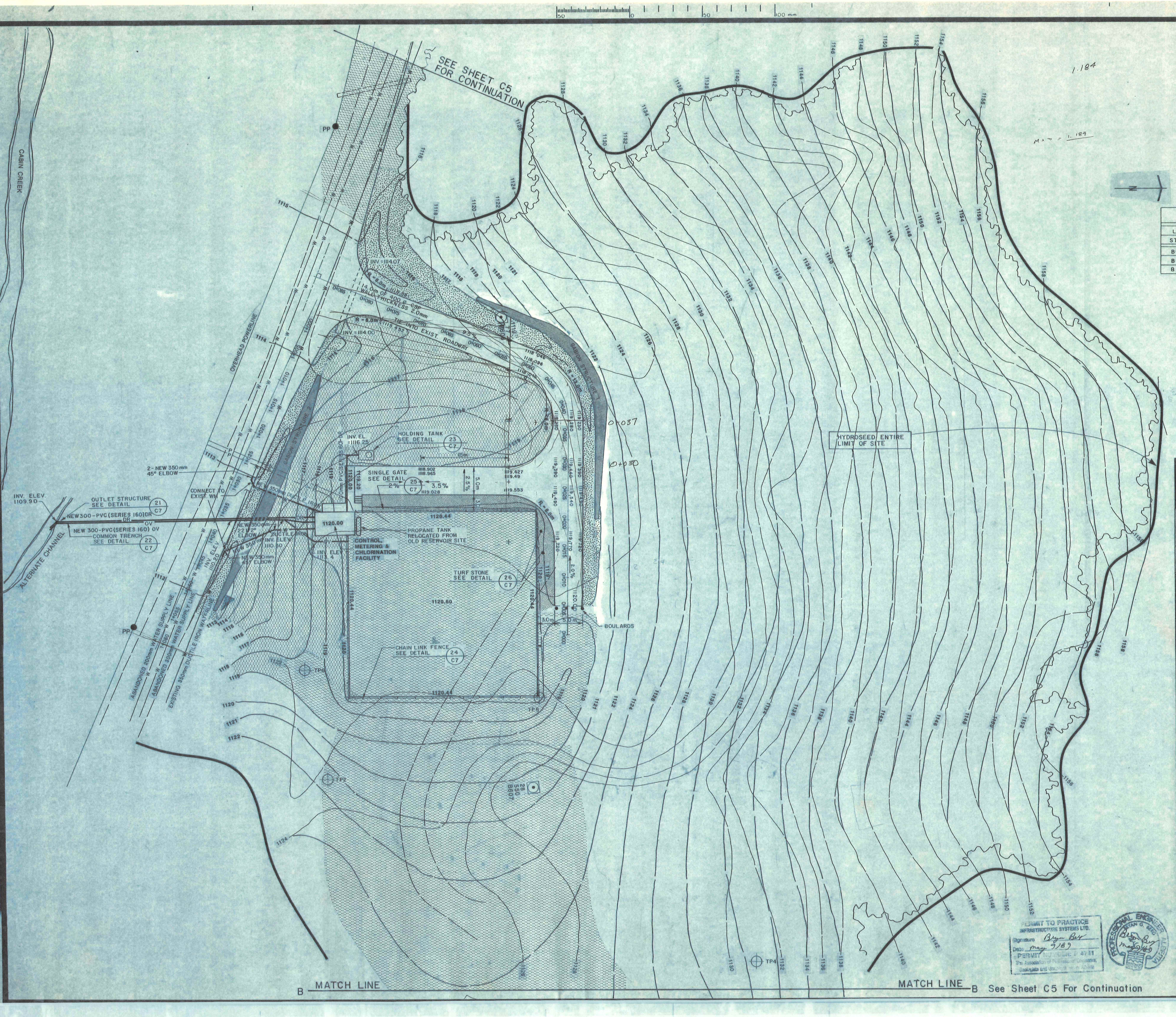
ISL Infrastructure Systems Ltd.
CONSULTING ENGINEERS

project title / titre du projet
WATER SUPPLY IMPROVEMENTS
AND RESERVOIR
JASPER TOWNSITE
Jasper National Park

drawing title / titre du dessin
COVER SHEET

designed by / conception par: B. MORRISON
approved by / approuvé par: Feb 26/90
drawn by / tracé par: W. J. CHEUNG
date / date: March, 1989
checked by / vérifié par: I.S.L. G.W.R. WARK; C. HIBBERT
scale / échelle
project asset number / numéro du projet d'immobilisation: 668516
sheet no. / feuille no.: 0
reference / drawing number / numéro de référence / dessin: NWJ 89 / R5

4-WS-014-002



PERMIT TO PRACTICE
INFRASTRUCTURE SYSTEMS LTD.
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The Association of Professional Engineers, Geologists and Geophysicists of Alberta

BRYAN G. BERG
May 9/89

NOTES

1. HYDROSEED ENTIRE LIMIT OF SITE.
2. SURVEY CONTROL POINTS TO BE REESTABLISHED AFTER CONSTRUCTION.
3. EXCESS CUT TO BE HAULED TO OLD RESERVOIR SITE FOR CUT/FILL BALANCE.

NEW RESERVOIR:

SE OUTSIDE CORNER	N—5 860 020.398 E— −74 582.523
NE OUTSIDE CORNER	N—5 860 052.563 E— −74 575.144

LATITUDE : 52°52'		LONGITUDE : 118°05'	
STATION	EASTING	NORTHING	ELEVATION
B607	− 74,560.107	5,860,047.668	1128.550
B608	− 74,640.396	5,860,060.171	1119.748
B609*	− 74,770.235	5,860,081.838	1123.697

* SHOWN ON DRAWING C5

LEGEND

⊕ TP2 TEST HOLES

EXISTING GROUND CONTOUR ELEVATIONS
— — 1122 — —

DESIGN GROUND CONTOUR ELEVATIONS
——— 1122 ———

▨ AREA TO RECEIVE 50mm TOPSOIL AND HYDROSEED
▨ TURF STONE
▨ TOPSOIL ENKAMAT AND HYDROSEED
━ LIMIT OF SITE
⊙ SURVEY CONTROL MONUMENT

approved by / approuve par — date/date
B. Heuton — FEB 12 1990
Park Superintendent / Directeur du parc

1	05/89	ISSUED FOR TENDER	W.C.	
no.	date	description	drawn by tracé par	app'd by appr. par

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Parks Canada — Parcs Canada
Engineering and Architecture — Génie et architecture

ISL Infrastructure Systems Ltd.
CONSULTING ENGINEERS

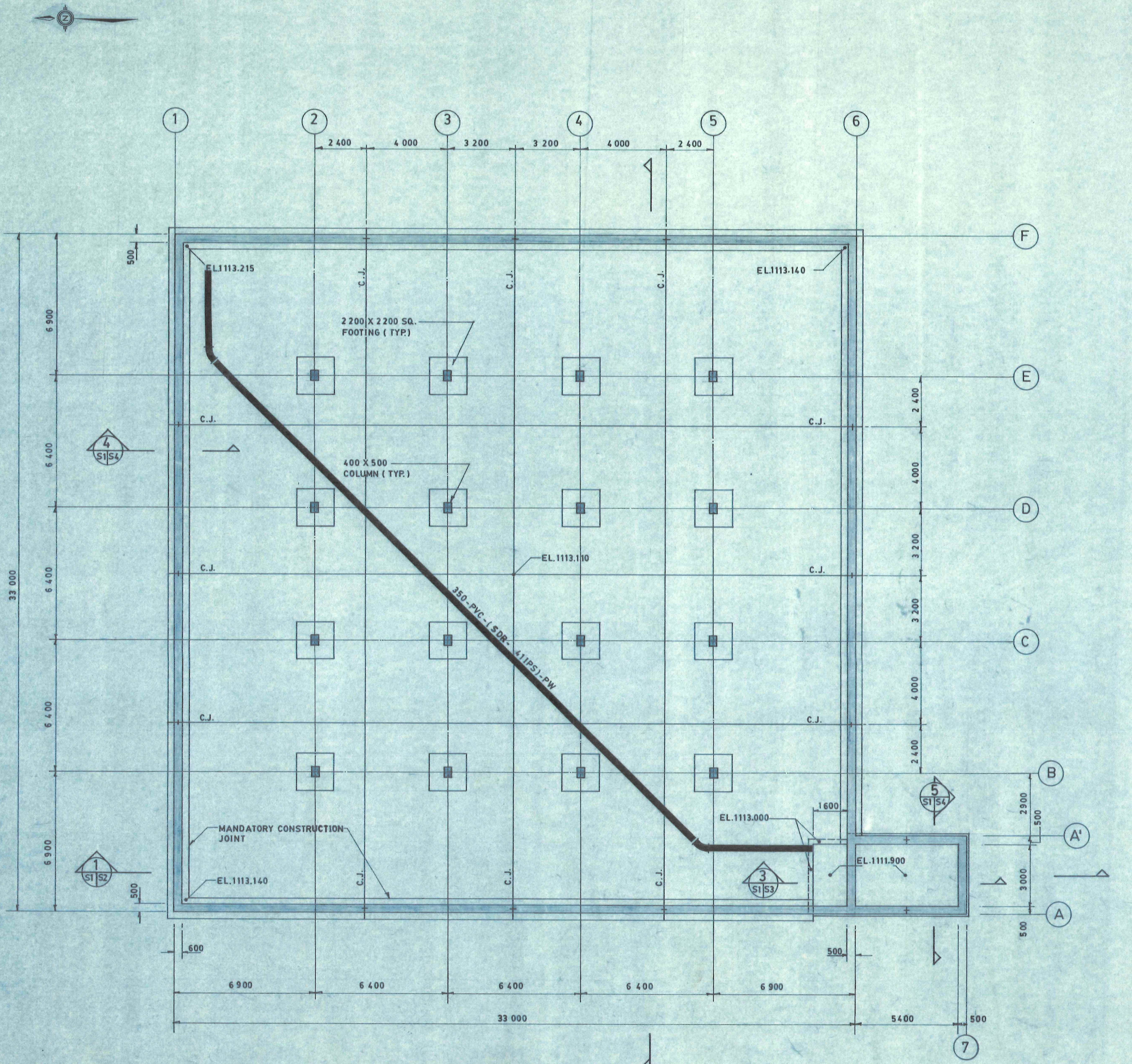
project title / titre du projet

WATER SUPPLY
IMPROVEMENTS
JASPER TOWNSITE
Jasper National Park

drawing title / titre du dessin

NEW RESERVOIR
SITE PLAN

designed by / conception par: B. MORRISON
approved by / approuvé par: Ron Howe Feb 26/90
drawn by / tracé par: W. J. CHEUNG
date /date: March, 1989
checked by/vérifié par: I.S.L. G.W.R. WARK Wark
scale / échelle: 1:250
project asset number / numéro du projet d'immobilisation: 668516
reference/drawing number /numéro de référence/dessin: NWJ 89 / R5
sheet no. / feuille no.: C1 1 OF 39



RESERVOIR BASE SLAB & FOOTING PLAN
1 : 100

C.J. INDICATES LOCATION OF CONSTRUCTION JOINTS. LOCATION OF SLAB C.J. AROUND PERIMETER NEXT TO FOOTING IS MANDATORY. ALL OTHER C.J. LOCATIONS MAY BE RELOCATED SUBJECT TO THE APPROVAL OF THE ENGINEER. SEE DWG NO. S6 FOR DETAILS.

Concrete

1. Provide concrete and perform work to CSA CAN3 -A23.1
2. Before any concrete pour the contractor shall verify all pipes, anchor bolts, sleeves, conduits and openings are located as shown on the drawings.
3. All reinforcing steel placement shall be inspected by the Engineer prior to each pour. Contractor shall check and confirm work is completed in accordance with Contract Documents prior to inspection.
4. Cement shall be Type 50, Sulphate Resistant.
5. Cast in place concrete shall have a minimum compressive strength of 30 MPa at 28 days.
6. Air entrainment shall be 4 - 7%.
7. Slump: 50 to 100mm.
8. The use of calcium chloride shall not be permitted.
9. Finishes:
   - i) Reservoir Floor - power trowel finish and sealed with Permaquik.
   - ii) Reservoir Walls and Columns - form finished and sealed with Permaquik - tolerance 8mm in 3m.
   - iii) Control Building Floors - steel trowel finish with hardener - tolerance 3mm in 3m.
   - iv) Reservoir Roof - steel trowel finish - tolerance 8mm in 3m.
   - v) Sidewalks - transverse broom finish with edges tooled and transverse surface grooves every 1.5 metres.
10. Superplasticized concrete shall be used for reservoir walls.
11. Concrete for walls shall be placed using pumps or vertical drop pipe, depositing to within 1.5M of final position.

Reinforcing Steel

1. Provide new deformed bars to CSA - G30.12, grade 400, except where specified otherwise.
2. Clear cover: (unless noted otherwise)
   - i) Surfaces poured against ground - 75mm.
   - ii) Formed surfaces - 50mm.
   - iii) Tops of Base Slabs - 50mm.
   - iv) Top of Control Building Slabs - 25mm
3. Lap splices: (Unless noted otherwise) to CSA CAN3 - A23.3 - M84.

   - all lap splices are Class C tension lap splices.

Miscellaneous Steel

1. Fabricate and erect steel to CAN3-S16.1-M84.
2. Perform welding to CSA W59-1984 by fabricators qualified to CSA W47.1 - 1983.
3. Provide steel to CSA CAN3-G40.21 - M81 with the following grades:

- W shape beams and columns	- 300 W
- HSS sections, class H	- 350 W
- channels and angles	- 300 W
- bars and plates	- 300 W

4. Provide anchor bolts to ASTM A307.
5. Submit shop drawings for review prior to fabrication. Shop drawings to show all details and material specifications.

Masonry

1. Interior walls to be 200mm standard weight block in stacked bond.
2. Mortar to be Type S.
3. Provide horizontal joint reinforcing every second course.
4. Walls are to be adequately braced until roof trusses and sheathing are securely in place

Waterstops

1. Waterstops of size indicated on drawings are to be securely wired in place prior to placing concrete.
2. All splices other than butt splices are to be shop fabricated.
3. All waterstops to be 225mm wide x 9.5mm bulb centre, ribbed, extruded PVC.

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Signature
Date May 9/89
PERMIT NUMBER: P 4741
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

H. SHUTTLEWORTH
May 9/89

approved by / approuve par — date/date
FEB 12 1990
Park Superintendent / Directeur du parc

no	date	description	drawn by tracé par	app'd by appr. par
1	05/89	ISSUED FOR TENDER	S.K.C.	

revision / révision

A detail number — A numéro de détail
B location drawing number — B sur feuille no.
C drawing number — C numéro de feuille

Parks Canada — Parcs Canada
Engineering and Architecture — Génie et architecture

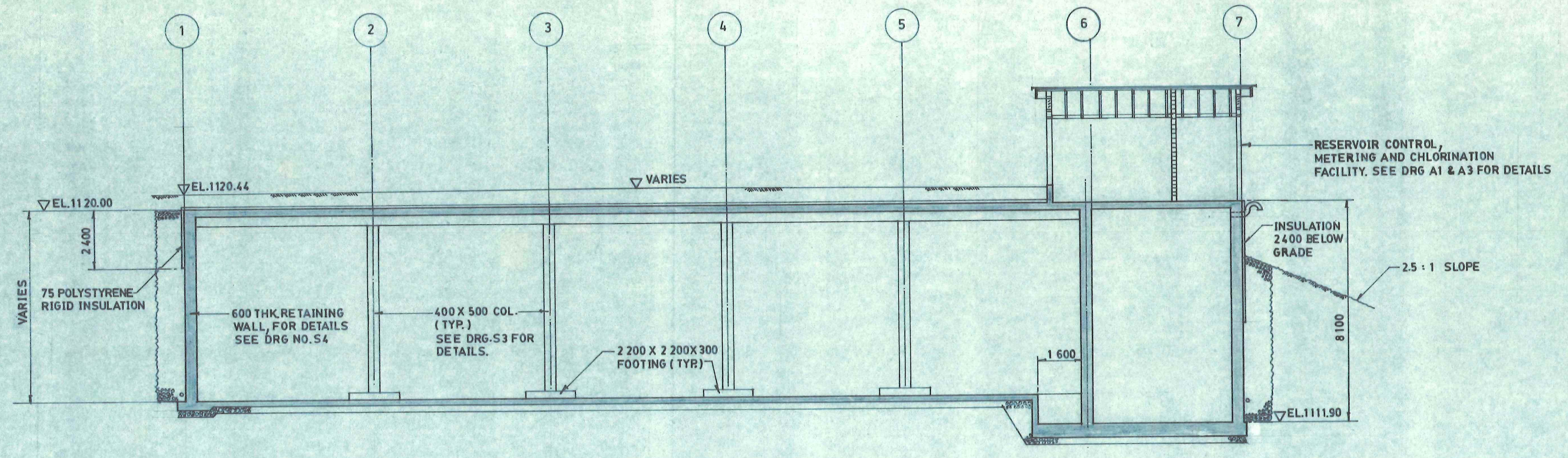
Infrastructure Systems Ltd.
CONSULTING ENGINEERS

project title / titre du projet
WATER SUPPLY
IMPROVEMENTS
JASPER TOWNSITE
Jasper National Park

drawing title / titre du dessin
RESERVOIR BASE SLAB AND
FOOTING PLAN

designed by / conception par: J.H.S
approved by / approuvé par: Feb 26/90
drawn by / tracé par: S.K.CHEN
date /date: March, 1989
checked by/vérifié par: I.S.L. G.W.R. WARK
scale / échelle: 1 : 100
project asset number / numéro du projet d'immobilisation: 668516
sheet no. / feuille no.: S1 11 OF 39
reference/drawing number /numéro de référence/dessin: NWJ 89 / R5

50 0 50 100 mm

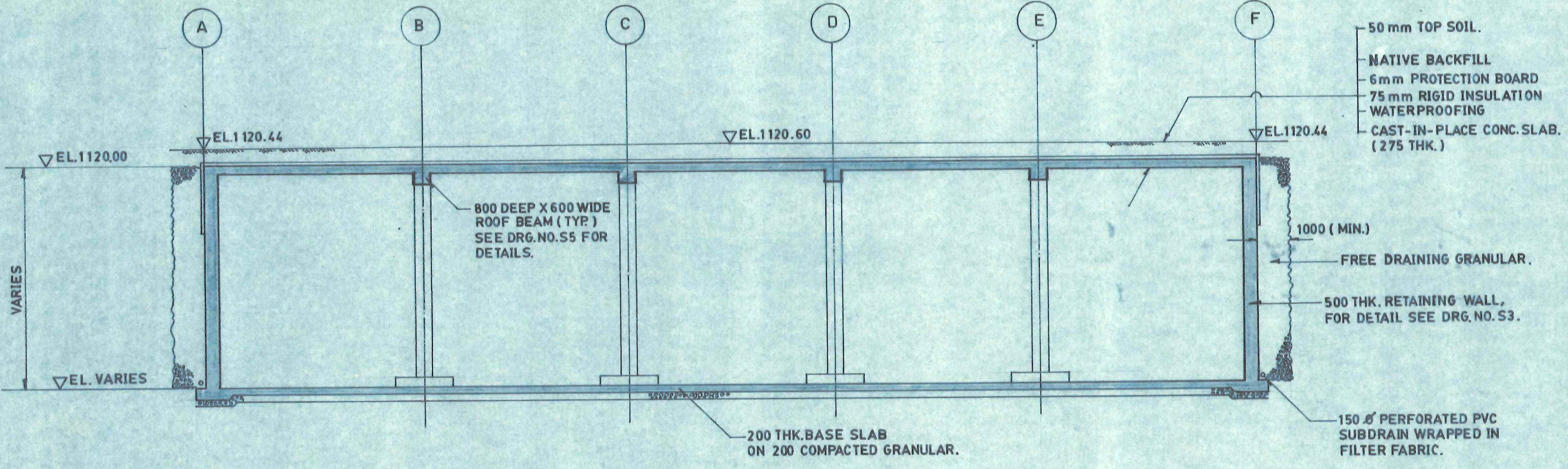


SECTION 1 S1 S2
1 : 100

~~18~~ 13
1111-90

13.215
11.900
1.315

8.180
1.315
6.785
275
6.510



SECTION 2 S1 S2
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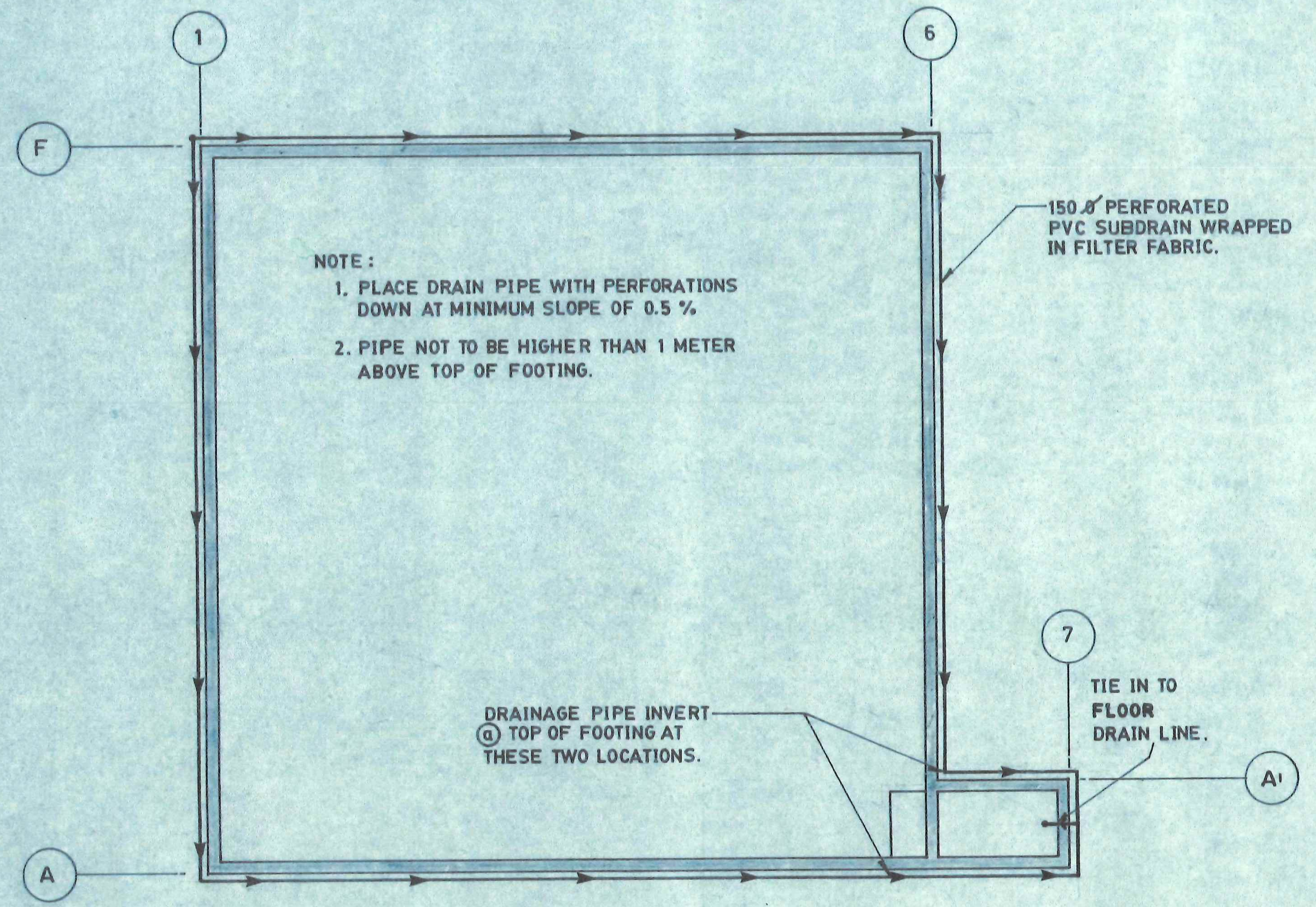

NOTE:
1. PLACE DRAIN PIPE WITH PERFORATIONS DOWN AT MINIMUM SLOPE OF 0.5 %
2. PIPE NOT TO BE HIGHER THAN 1 METER ABOVE TOP OF FOOTING.

SUBDRAIN PLAN
1 : 200

Foundation Preparation and Backfill

Well Site

1. Remove surficial organics and sand.
2. Compact subgrade to 98% of Standard Proctor Maximum Dry Density.
3. Provide well graded pit run gravel compacted to 98% of Standard Proctor Density as required to achieve design grades.

Reservoir

1. Excavate down 200mm below the underside of footings and base slab.
2. Geotechnical Engineer to inspect excavation and confirm suitability prior to continuing.
3. Compact subgrade using heavy vibratory equipment then proofroll.
4. Place 200mm of 50mm minus screened pit run or crushed gravel and compact using a vibrating roller weighing at least 10 tonnes, making at least four passes.
5. Carry out construction activities to minimize disturbance of compacted subgrade, and recompact any disturbed areas.
6. Place a minimum of 1 meter width of free draining gravel or sand around the perimeter of the reservoir. This material shall contain no more than 6% material by weight passing the 75 micron sieve.

Backfill on Top of Reservoir Roof

1. Backfill on top of the reservoir and surrounding excavation shall consist of 50-100mm of topsoil on native fill free from organics.
2. Backfill material shall not be piled on top of the reservoir. Material shall be deposited off the reservoir and spread using a Bobcat or similar lightweight vehicle. Compaction shall be carried out using Dynapac A36-PD or lighter compaction equipment.
3. Engineer's approval shall be required prior to the use of any equipment on the reservoir roof.
4. Backfill on top of and around the reservoir shall be lightly compacted to 92 - 95% of Standard Proctor Density.

Wall Protection

1. Place 75mm polystyrene rigid insulation around exterior face of all walls to a depth of 2400mm, unless noted otherwise.
2. Provide bituminous dampproofing on earth side face of exterior walls for their full height, except where noted.

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Signature
Date May 9/89
PERMIT NUMBER: P 4741
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

JAMES H. SHUTTLEWORTH
Jim Shuttleworth
May 9/89

approved by / approuve par | date/date
FEB 12 1990
Park Superintendent / Directeur du parc

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1	05/89	ISSUED FOR TENDER	S.K.C.	

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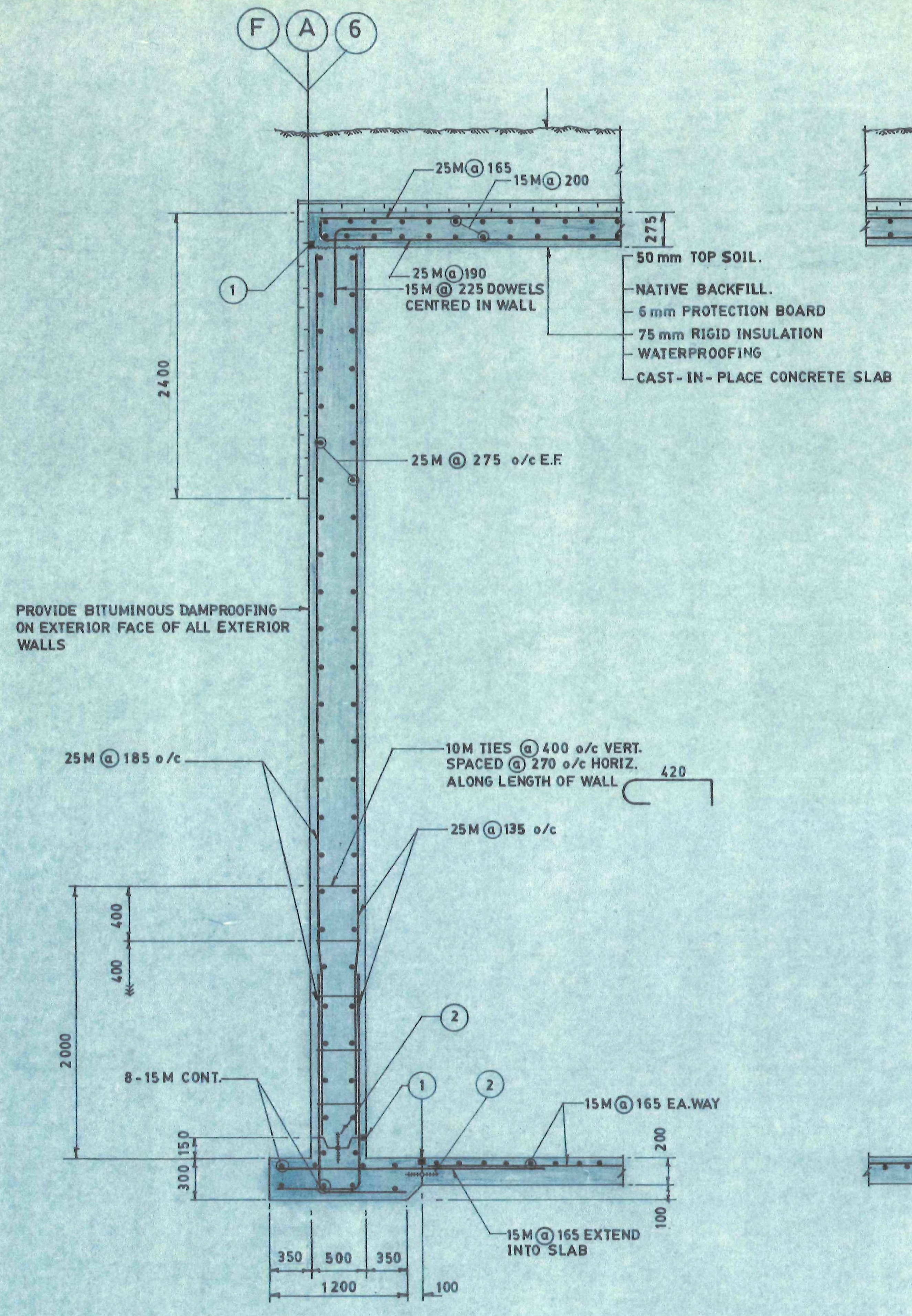
Parks Canada / Parcs Canada
Engineering and Architecture / Génie et architecture

ISL Infrastructure Systems Ltd.
CONSULTING ENGINEERS

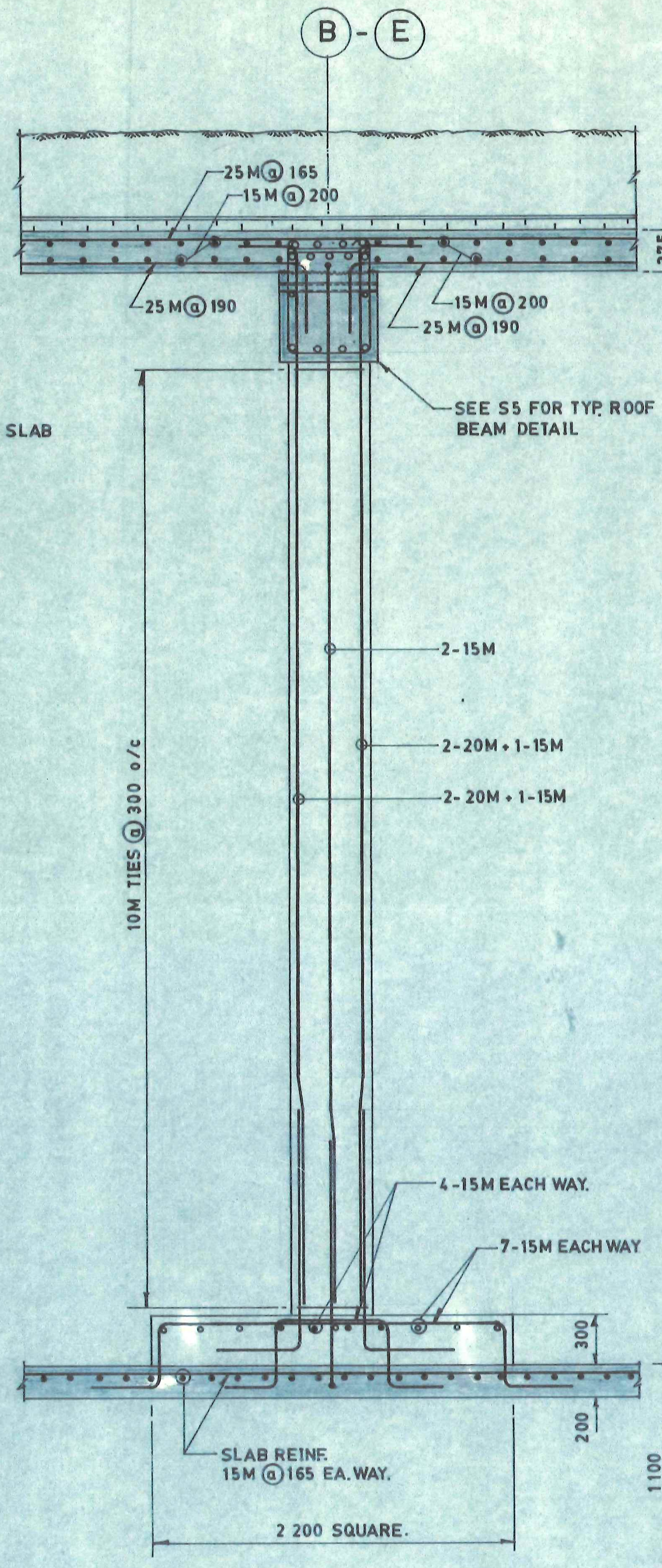
project title / titre du projet
WATER SUPPLY
IMPROVEMENTS
JASPER TOWNSITE
Jasper National Park

drawing title / titre du dessin
CROSS SECTIONS AND
SUBDRAIN PLAN

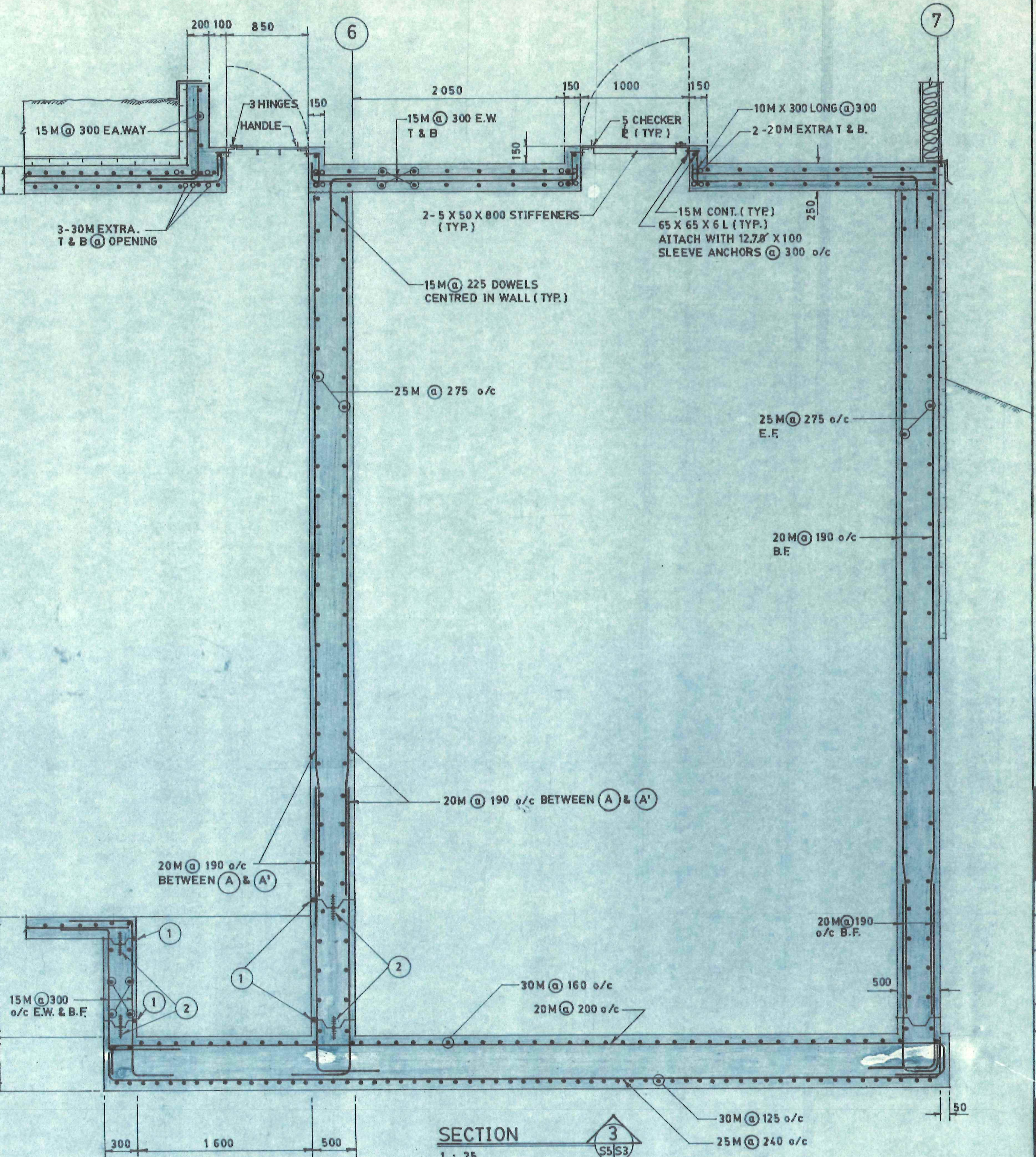
designed by / conception par: J.H.S
approved by / approuvé par: Feb 26/90
drawn by / tracé par: S.K.CHEN
date /date: March, 1989
checked by / vérifié par: I.S.L. G.W.R. WARK
scale / échelle: 1 : 100
project asset number / numéro du projet d'immobilisation: 668516
reference / drawing number / numéro de référence / dessin: NWJ 89 / R5
sheet no. / feuille no.: S2
12 OF 39



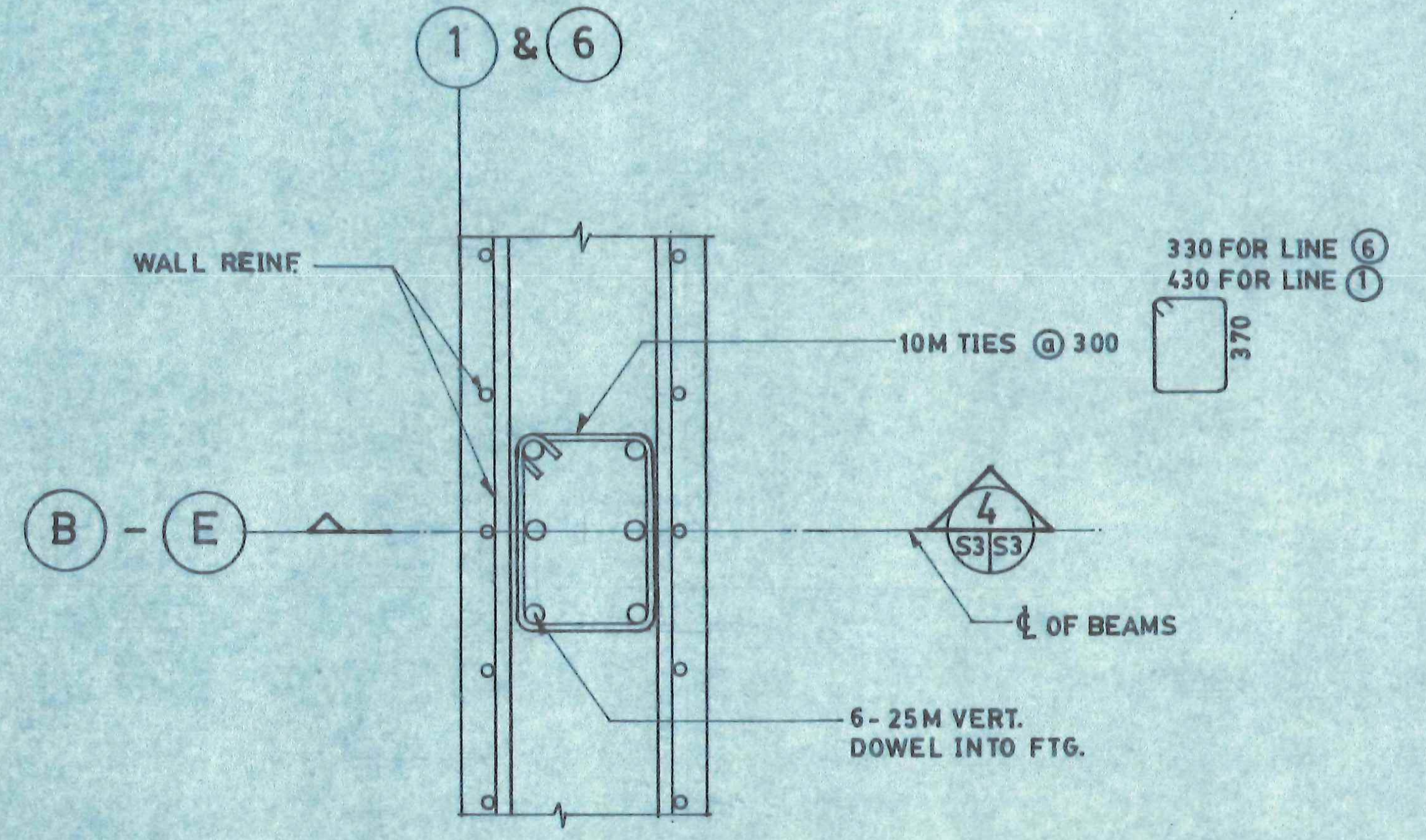
TYPICAL EXTERIOR WALL DETAIL
1 : 25



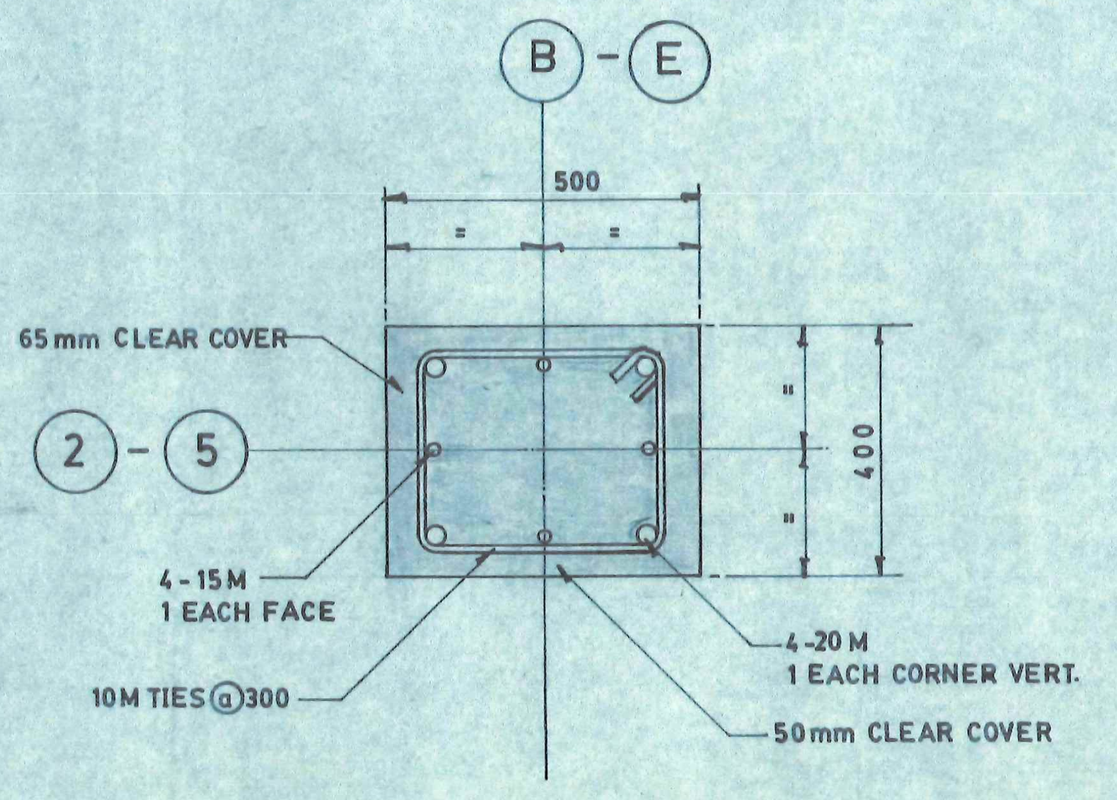
TYPICAL INTERIOR COLUMN & BEAM
1 : 25



SECTION 3 S5|S3
1 : 25



TYPICAL WALL COLUMN DETAIL
1 : 10



TYPICAL INTERIOR COLUMN DETAIL
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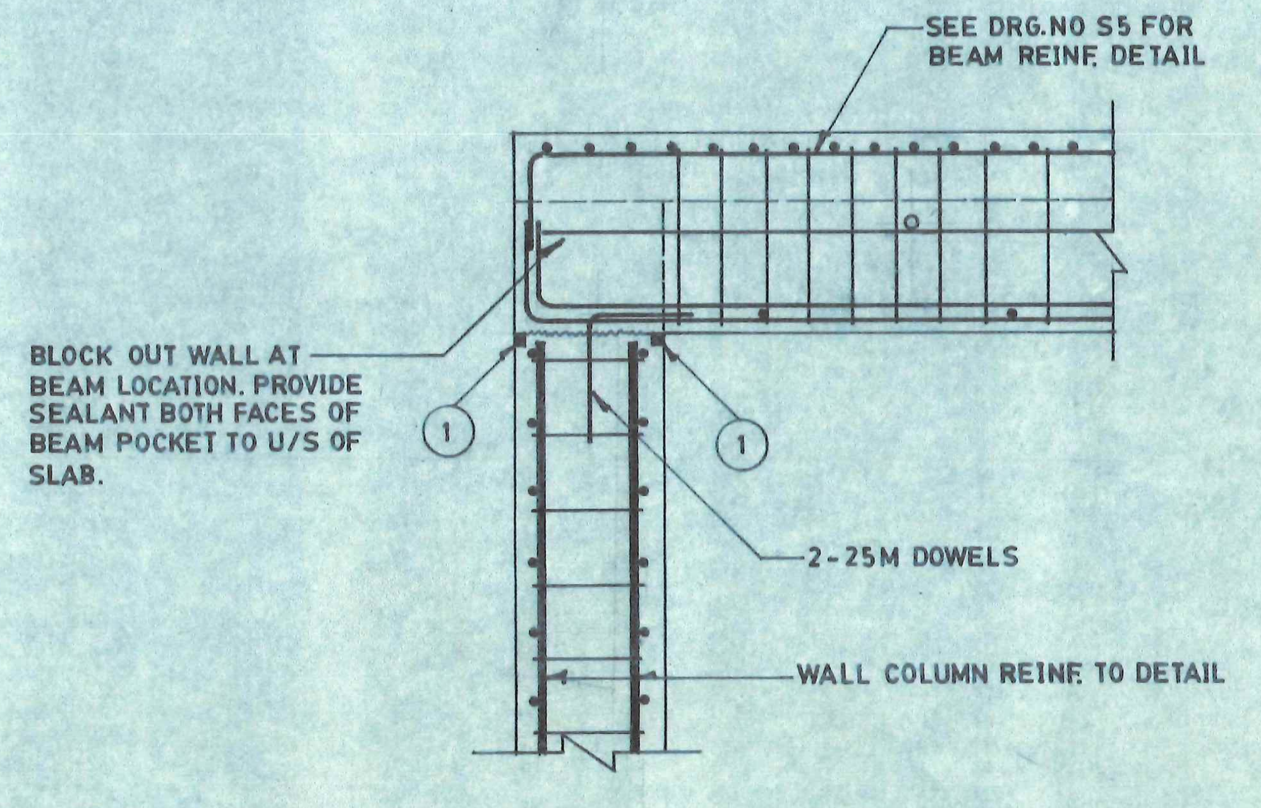

SECTION 4 S3|S3
1 : 25

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Date May 9/89
PERMIT NUMBER: P 4741
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

JAMES H. SHUTTLEWORTH
Jim Shuttleworth
May 9/89

DRAWING NOTES

1. Reservoir Sealant - Sika 1A or equivalent - See Det A (S6|S6)
2. Waterstop - 225mm Wide x 9.5mm Thick.

approved by / approuve par — date/date
G. Fenton FEB 12 1990
Park Superintendent / Directeur du parc

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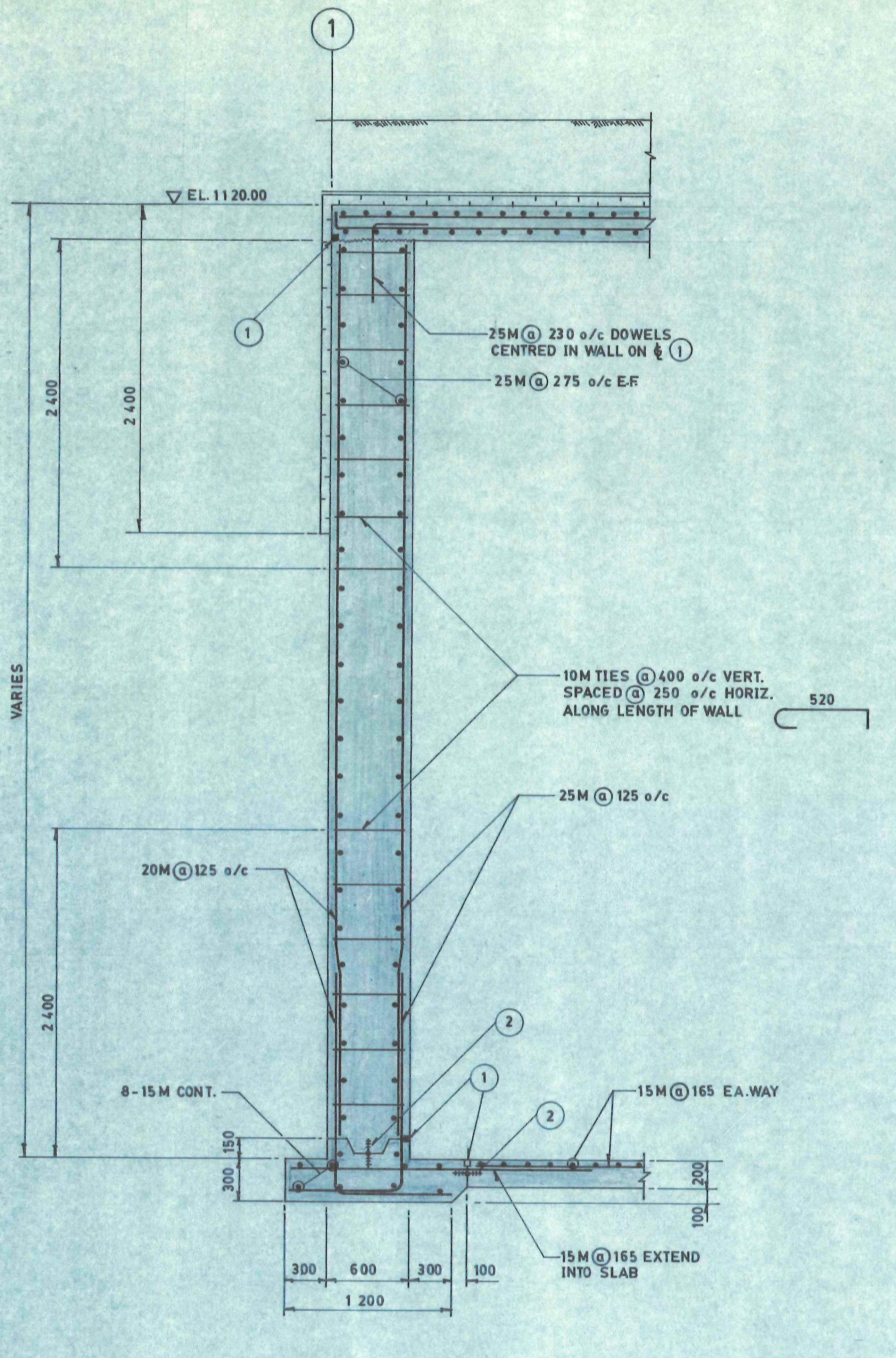
project title / titre du projet
WATER SUPPLY
IMPROVEMENTS
JASPER TOWNSITE
Jasper National Park

drawing title / titre du dessin
WALL SECTIONS

designed by / conception par: J.H.S
approved by / approuvé par: Rae Dave Feb 2nd/90
drawn by / tracé par: S.K.CHEN
date /date: March, 1989
checked by / vérifié par: I.S.L. G.W.R. WARK — Wark
scale / échelle: AS NOTED
project asset number / numéro du projet d'immobilisation: 668516
reference / drawing number / numéro de référence / dessin: NWJ 89 / R5
sheet no. / feuille no.: S3
13 OF 39



SECTION 4 S1 S4
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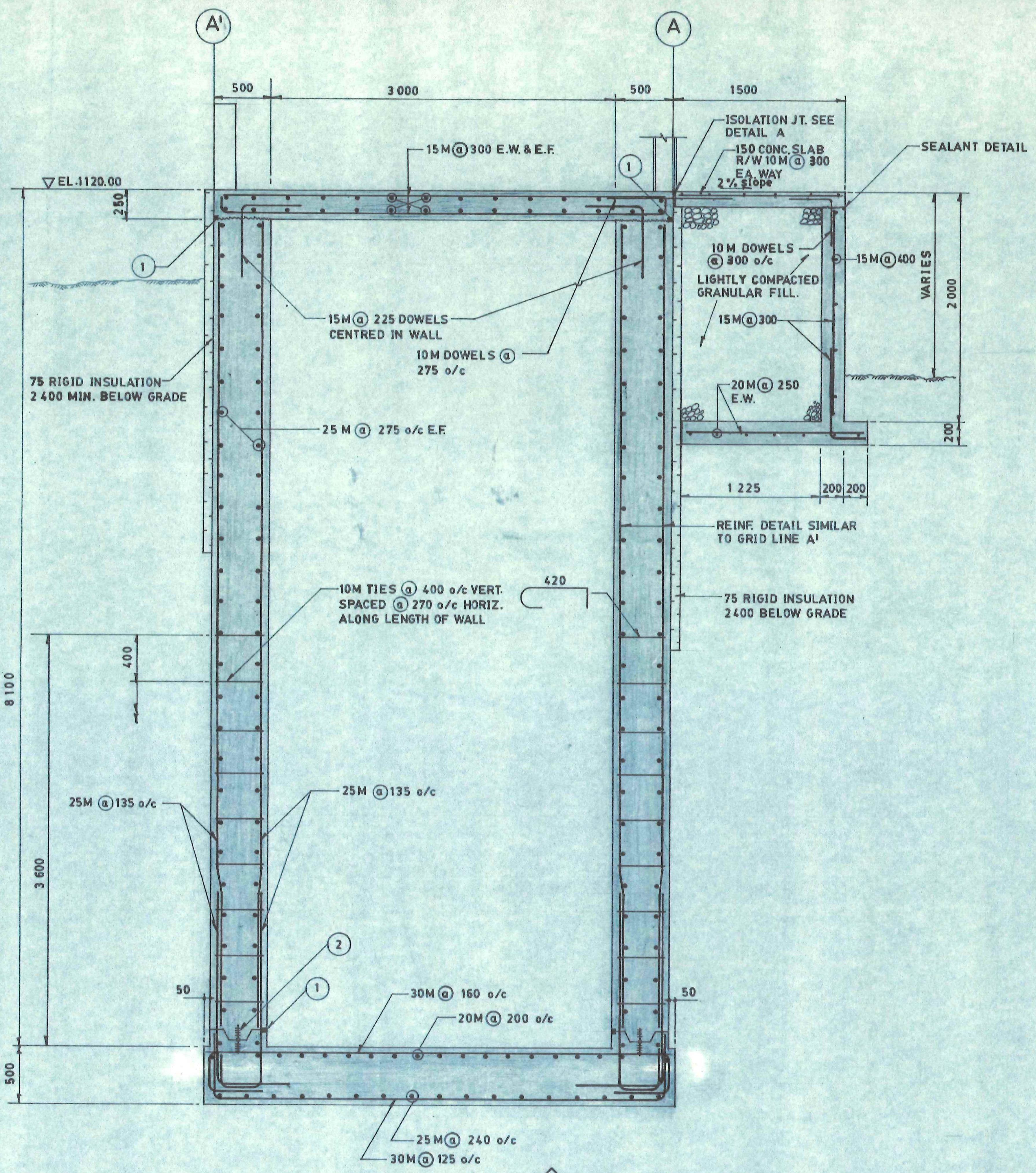

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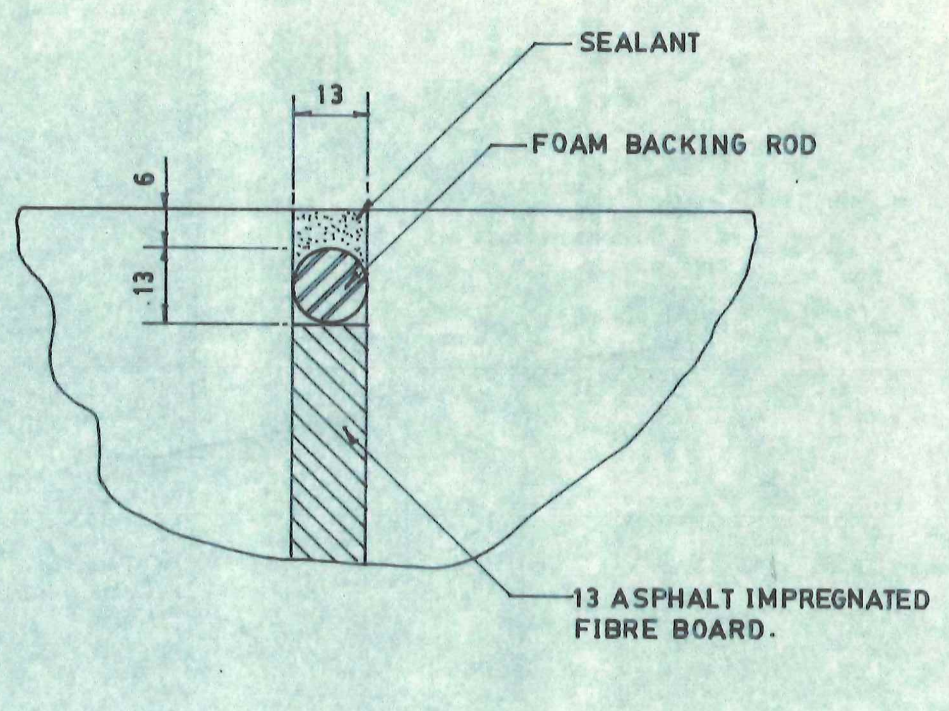

DETAIL A S4 S4
ISOLATION JT.
F. S.

DRAWING NOTES

1. Reservoir Sealant - Sika 1A or equivalent - See Det A S6 S6
2. Waterstop - 225mm Wide x 9.5mm Thick.

approved by / approuve par date/date
G. Fenton FEB 12 1990
Park Superintendent / Directeur du parc

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A
B C

A detail number
B location drawing number
C drawing number

A numéro de détail
B sur feuille no.
C numéro de feuille

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project title / titre du projet
WATER SUPPLY
IMPROVEMENTS
JASPER TOWNSITE
Jasper National Park

drawing title / titre du dessin
DETAILS AND SECTIONS

designed by / conception par: J.H.S
approved by / approuvé par: Ron Howe Feb 26/90
drawn by / tracé par: S.K.CHEN
date /date: March, 1989
checked by/vérifié par: I.S.L. G.W.R. WARK WH
scale / échelle: AS NOTED
project asset number / numéro du projet d'immobilisation: 668516
reference/drawing number /numéro de référence/dessin: NWJ 89 / R5
sheet no. / feuille no.: S4
14 OF 39

PERMIT TO PRACTICE
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Signature R. Pelkey
Date May 9/89
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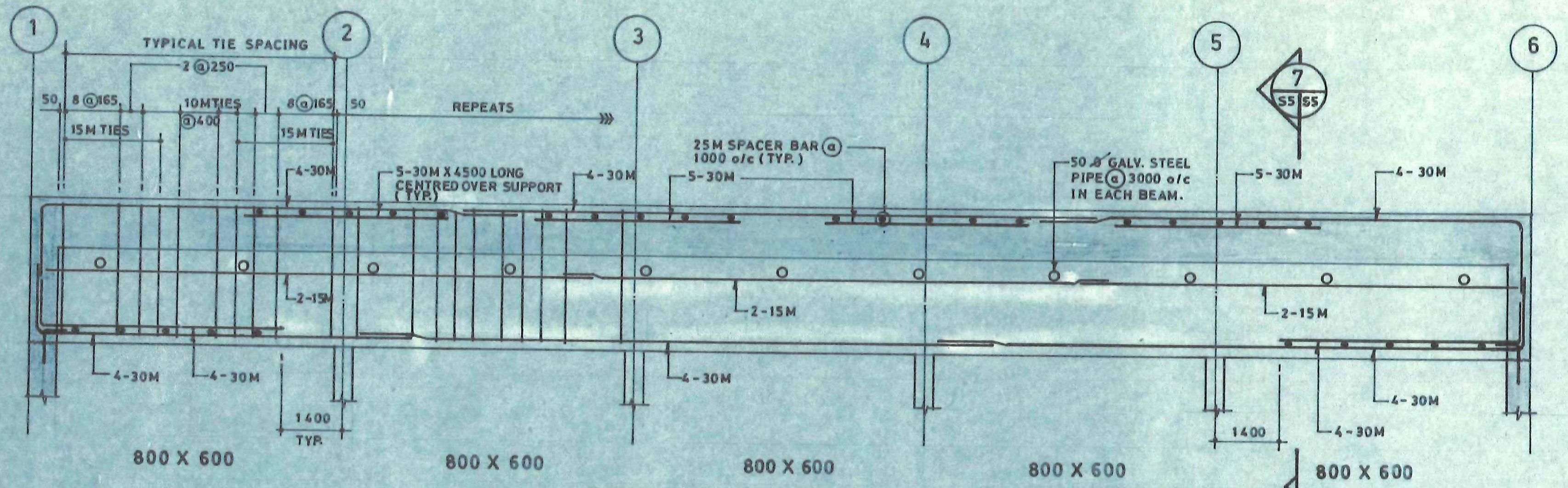
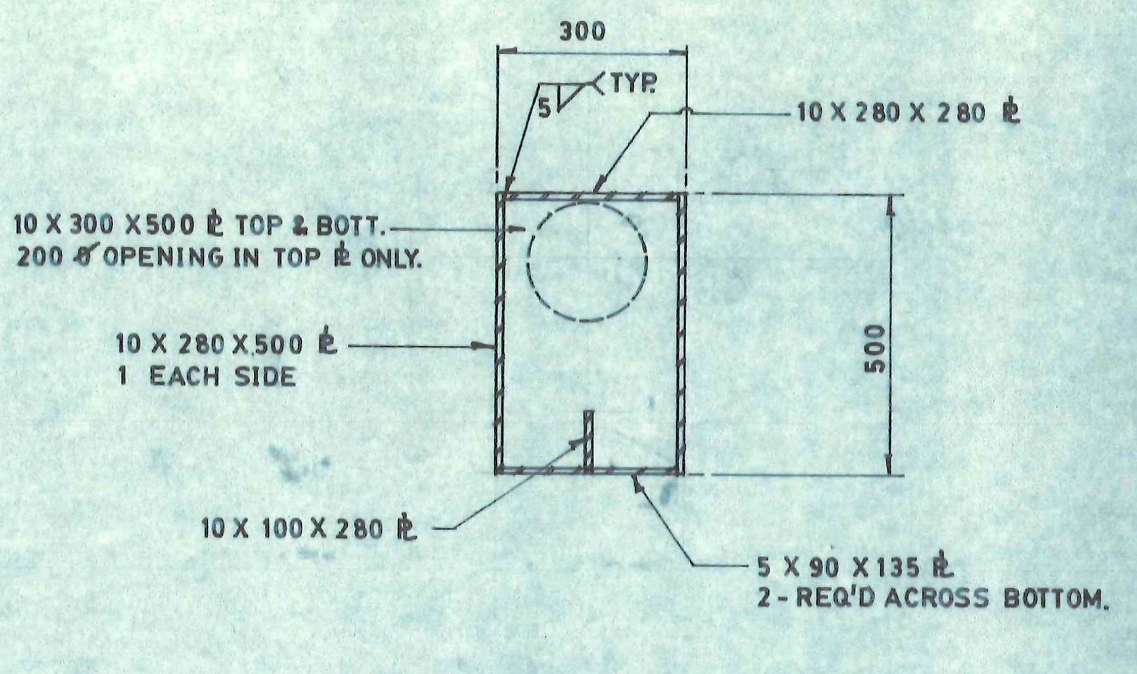
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

PROFESSIONAL ENGINEER ALBERTA
J. SHUTTLEWORTH
Jim Shuttleworth
May 9/89

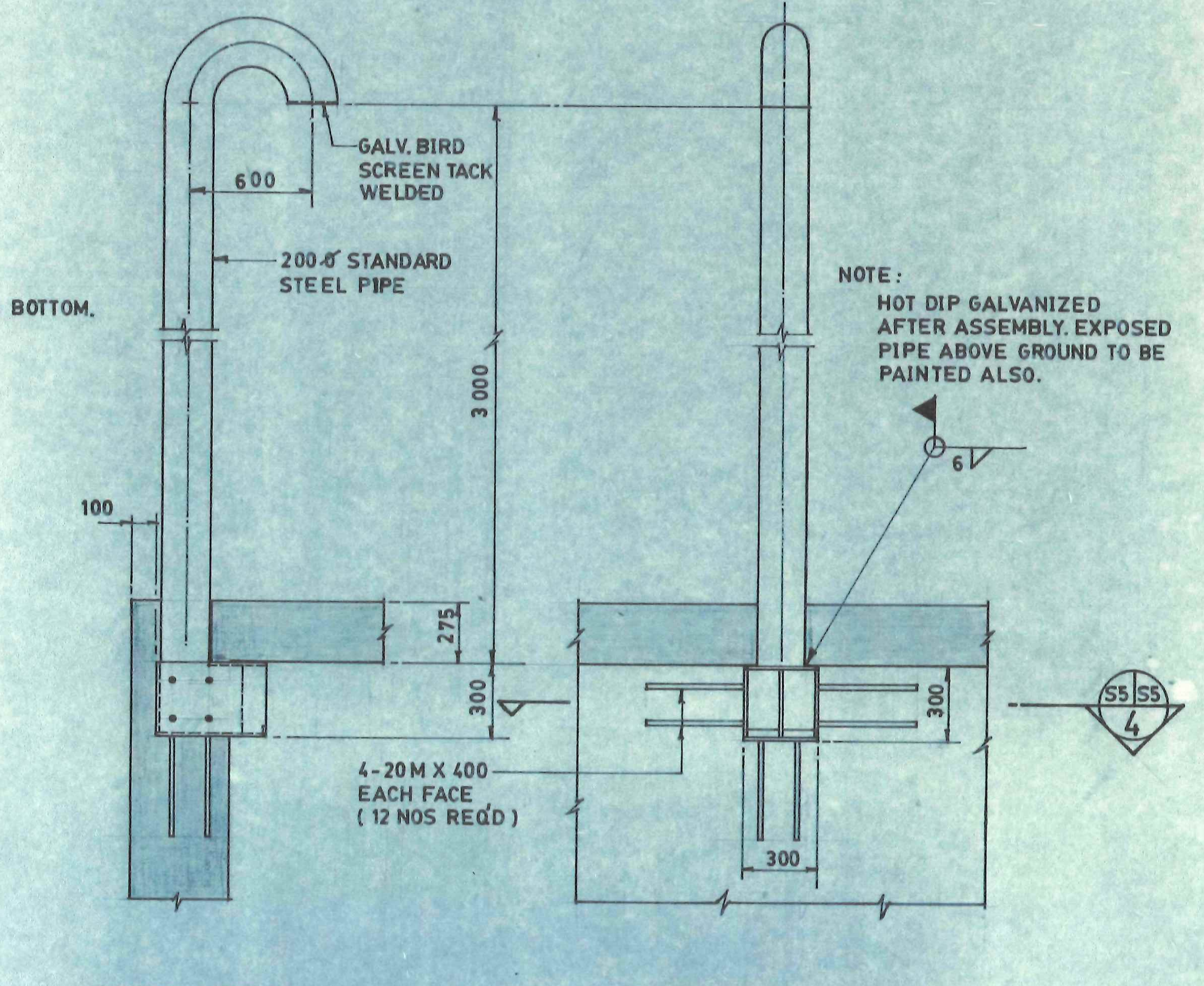
4-WS-014-015



TYPICAL ROOF BEAM DETAIL
SCALE :-
HORIZ : 1 : 100
VERT : 1 : 25



SECTION 4 S5 S5
1 : 10

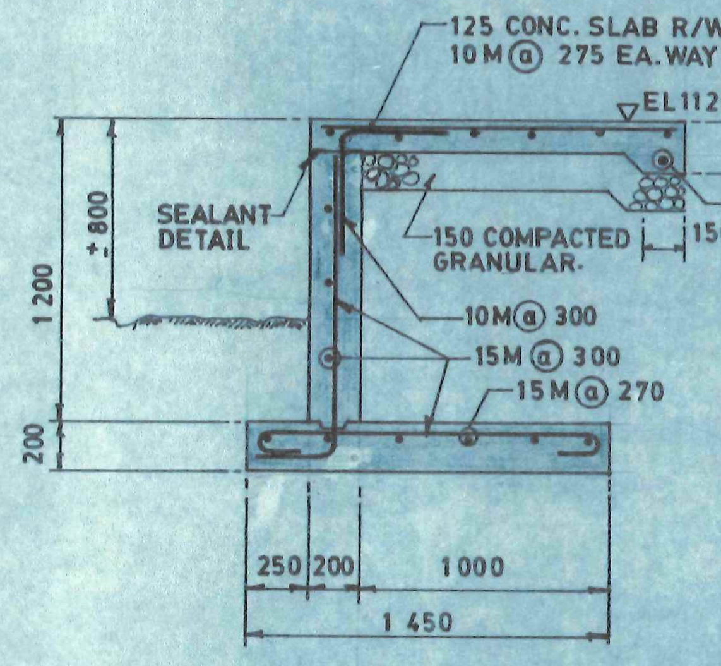


NOTE :
HOT DIP GALVANIZED AFTER ASSEMBLY. EXPOSED PIPE ABOVE GROUND TO BE PAINTED ALSO.

SIDE VIEW

FRONT VIEW

VENT PIPE DETAIL A S5 S5
1 : 20



SECTION 6 S5 S5
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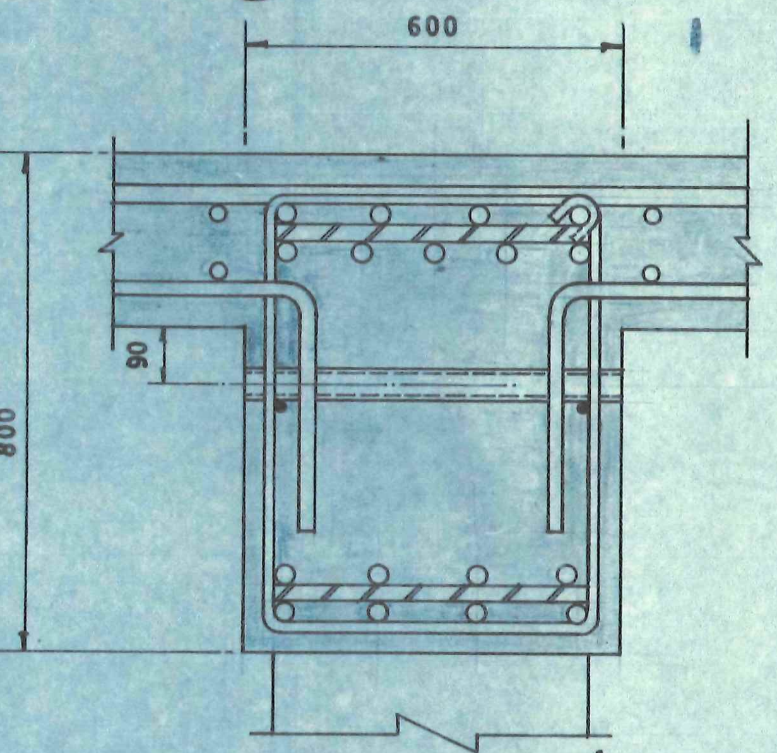
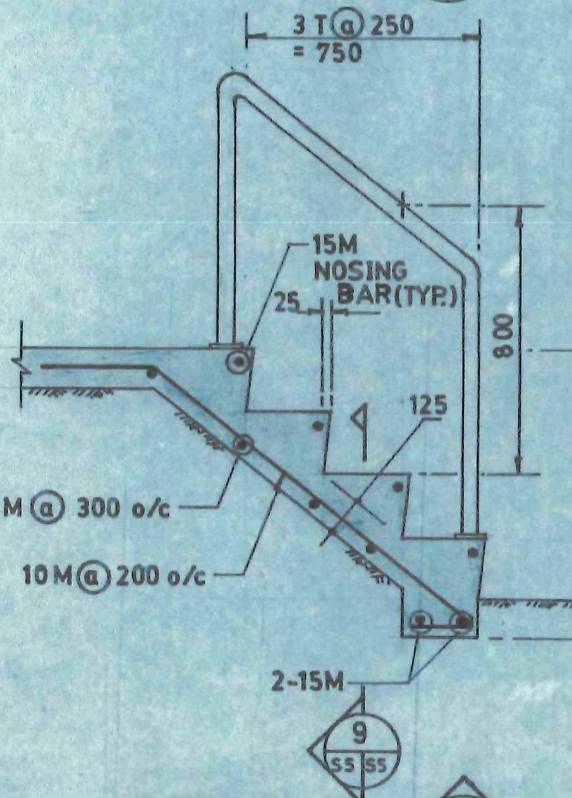


SECTION 7 S5 S5
1 : 10



SECTION 8 S5 S5
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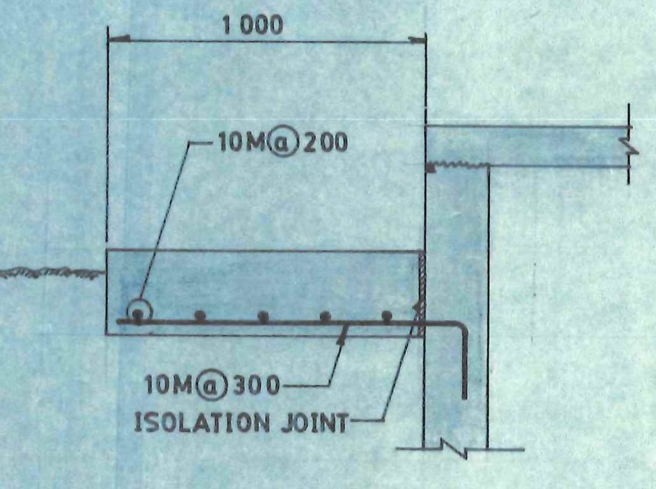

SECTION 9 S5 S5
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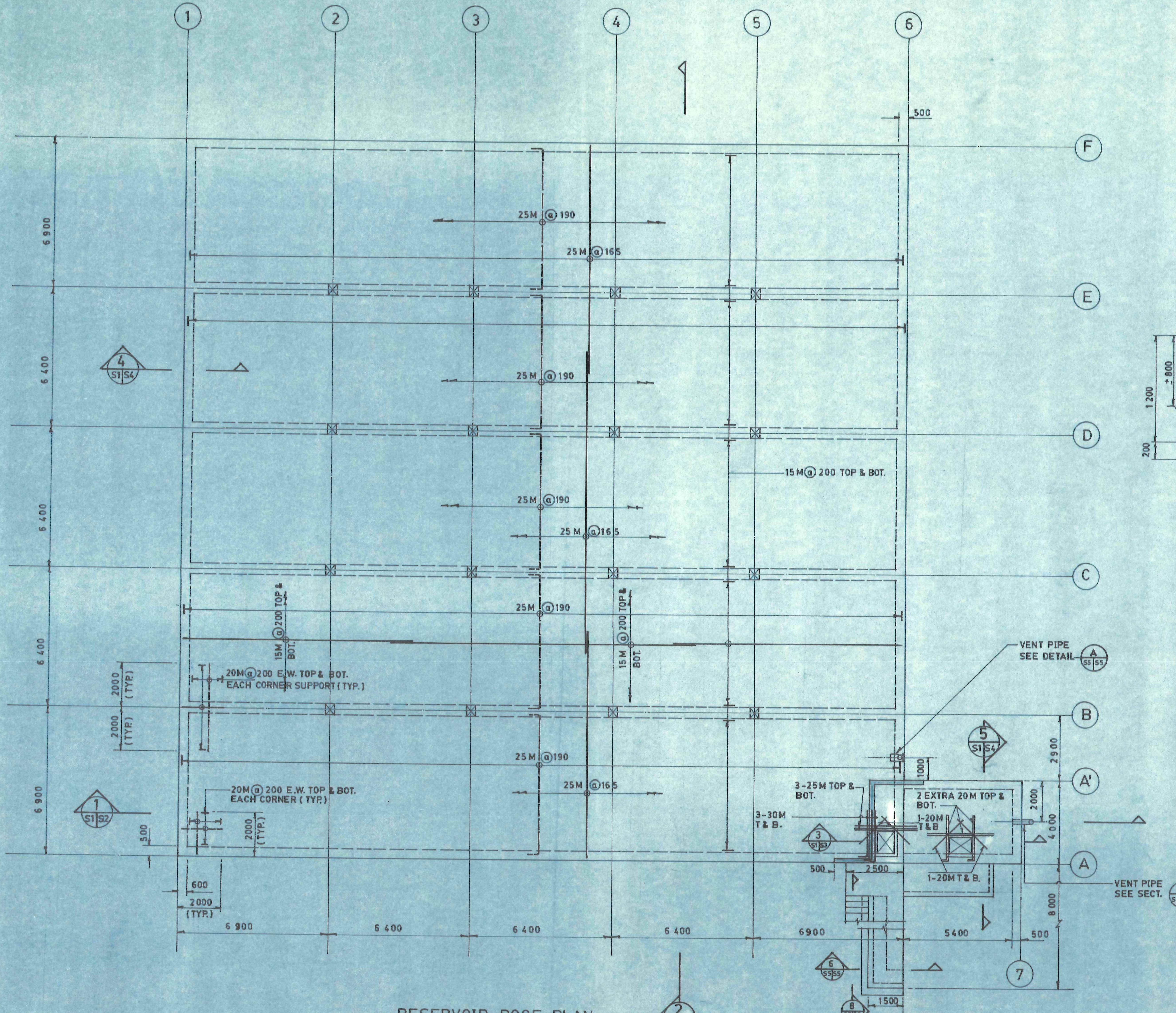

RESERVOIR ROOF PLAN
1 : 100

- - - - - - BOTTOM BAR SHOWN THUS
———— TOP BAR SHOWN THUS
TOP OF SLAB ELEVATION = 1120.00

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Date May 9/89
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PROFESSIONAL ENGINEER ALBERTA
JAMES H. SHUTTLEWORTH
Jim Shuttleworth
May 9/89

approved by / approuve par | date/date
B. Horton FEB 12 1990
Park Superintendent / Directeur du parc

no.	date	description	drawn by tracé par	app'd by appr. par
1	05/89	ISSUED FOR TENDER	S.K.C.	

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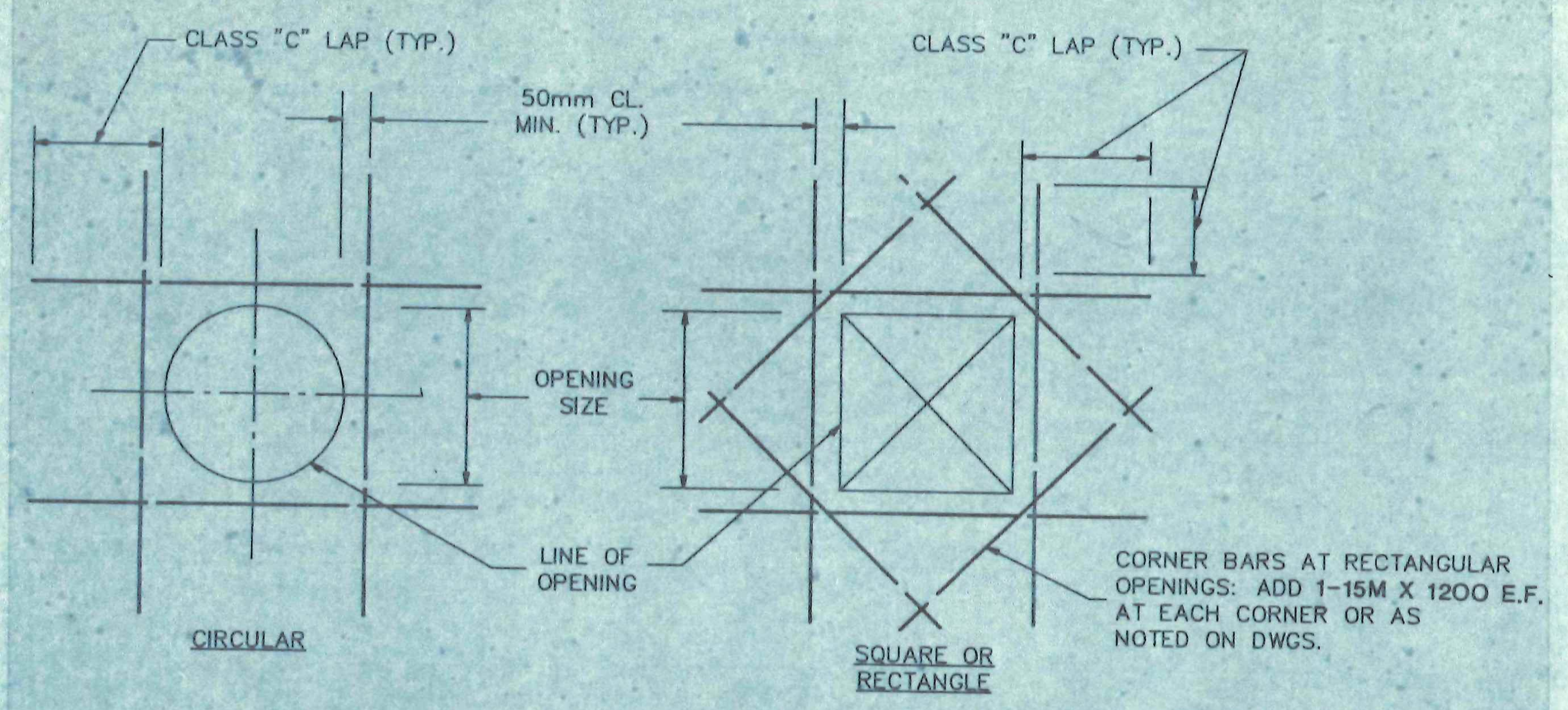
ISL Infrastructure Systems Ltd.
CONSULTING ENGINEERS

project title / titre du projet
WATER SUPPLY
IMPROVEMENTS
JASPER TOWNSITE
Jasper National Park

drawing title / titre du dessin
RESERVOIR ROOF PLAN

designed by / conception par: J.H.S
approved by / approuvé par: Rae Howe Feb 26/90
drawn by / tracé par: S.K.CHEN
date /date: March, 1989
checked by/vérifié par: I.S.L. G.W.R. WARK Watt
scale / échelle: AS NOTED
project asset number / numéro du projet d'immobilisation: 668516
reference/drawing number /numéro de référence/dessin: NWJ 89 / R5
sheet no. / feuille no.: S5
15 OF 39

4-WS-014-016

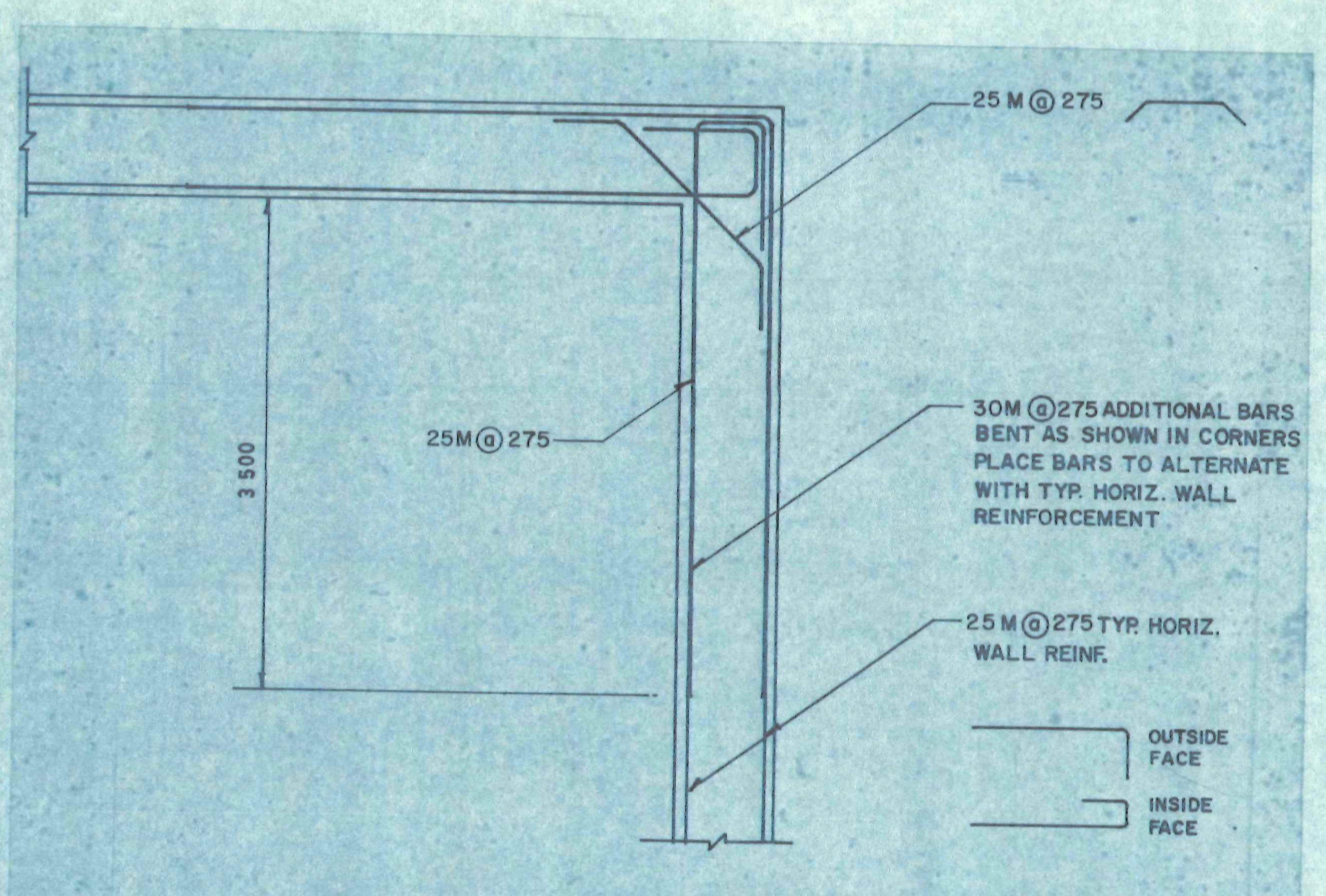


NOTES

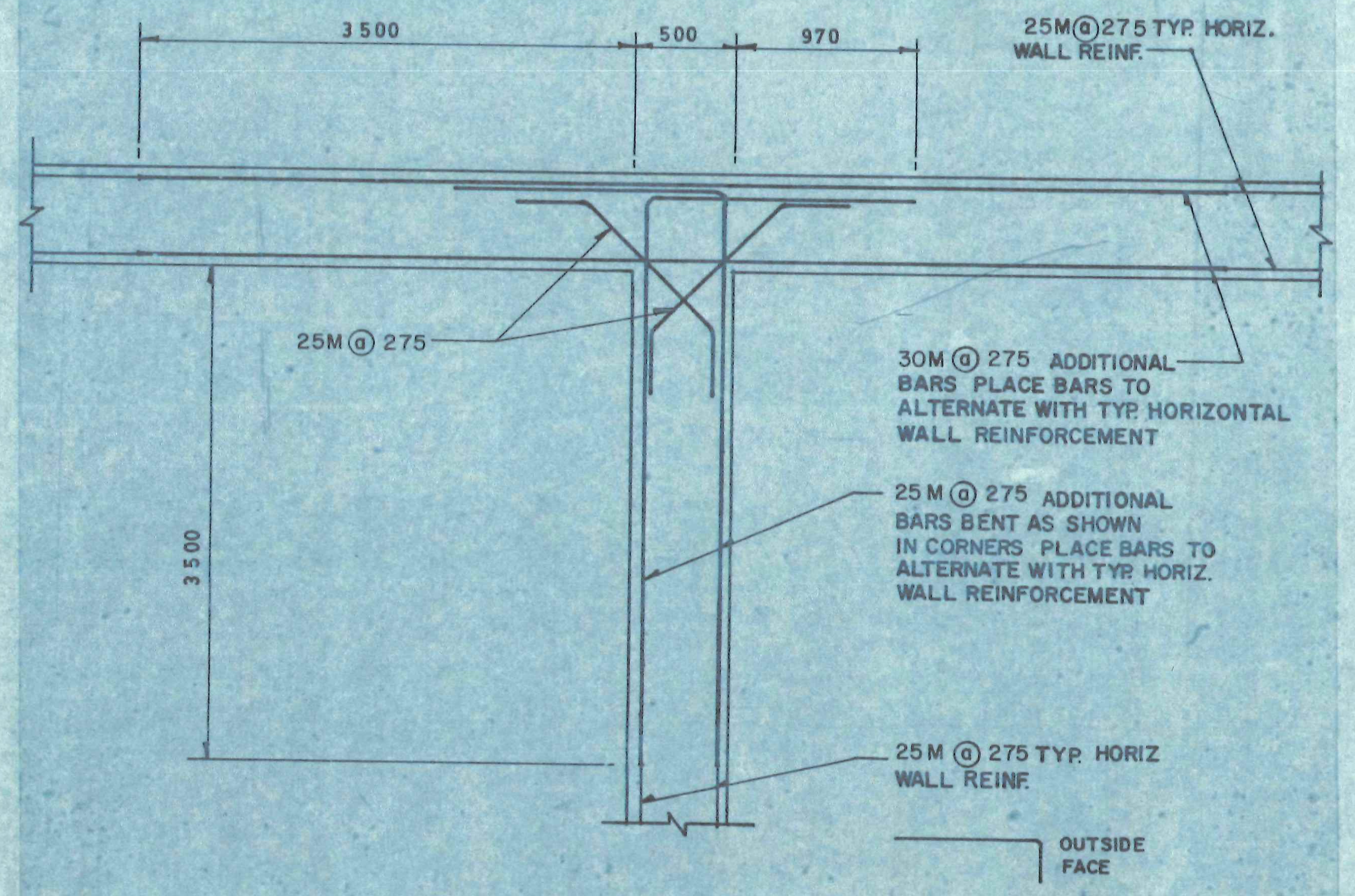
FOR OPENINGS 150mm OR LARGER ADD EXTRA BARS AS SHOWN EQUIVALENT IN AREA TO STEEL CUT BY OPENINGS UNLESS OTHERWISE NOTED ON DRAWINGS.

FOR OPENINGS UP TO 150mm NO EXTRA BARS ARE REQUIRED BUT BEND REGULAR REINFORCING AROUND OPENINGS.

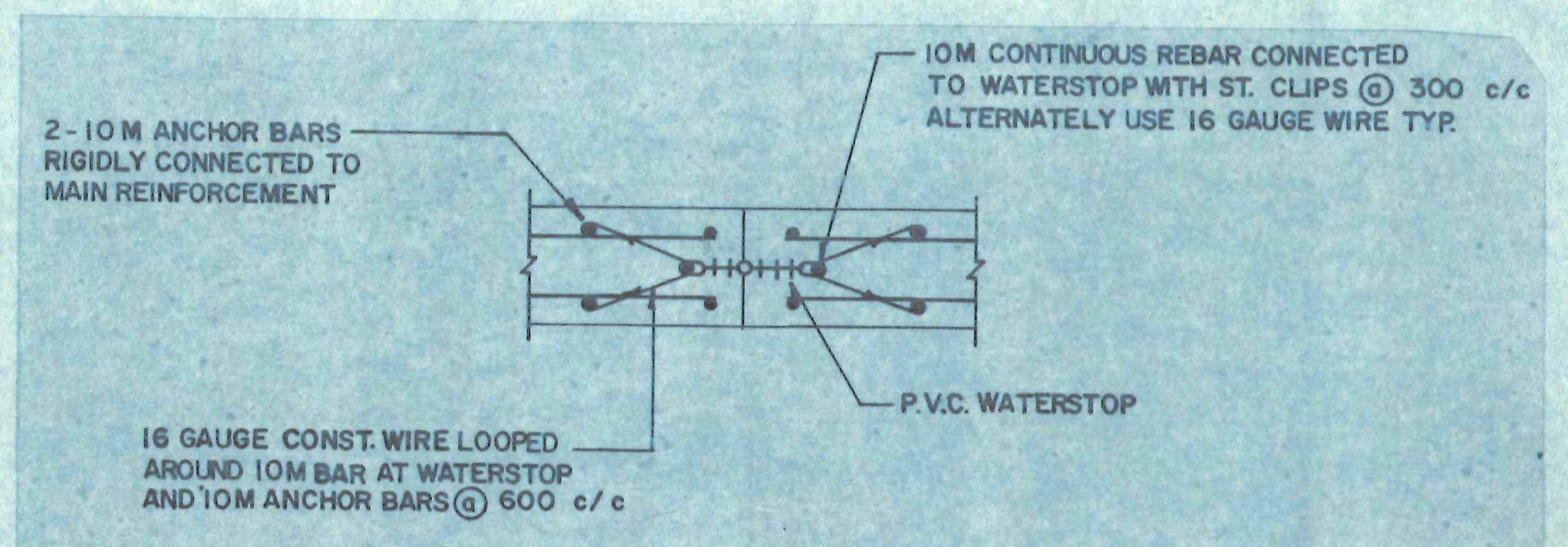
EXTRA STEEL REQUIREMENTS AT OPENINGS FORMED IN NEW CONCRETE WORK



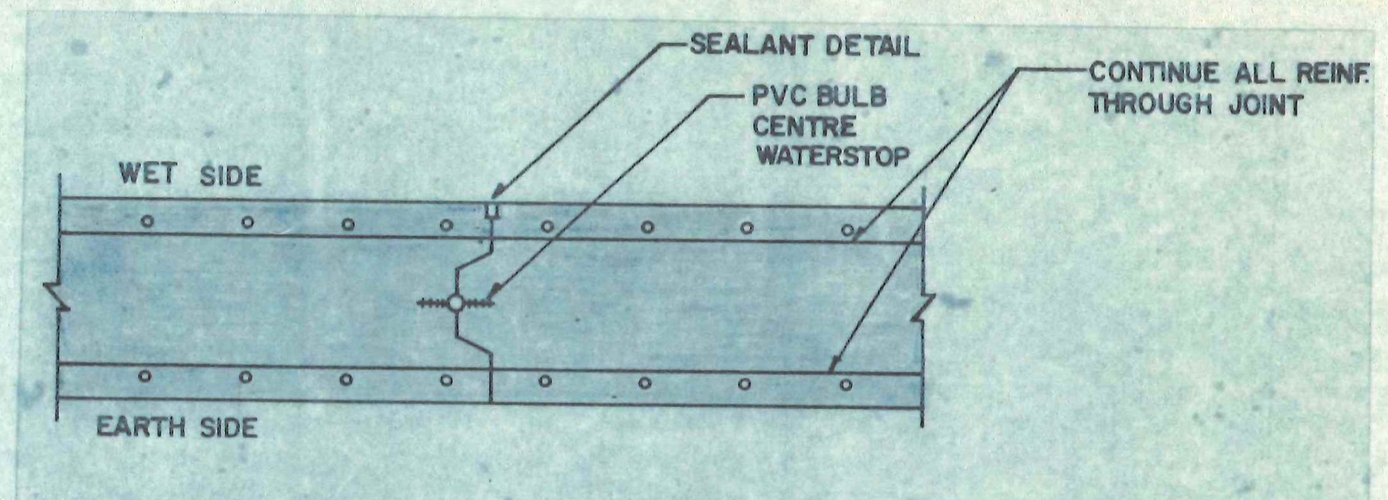
HORIZONTAL WALL REINFORCEMENT AT CORNERS



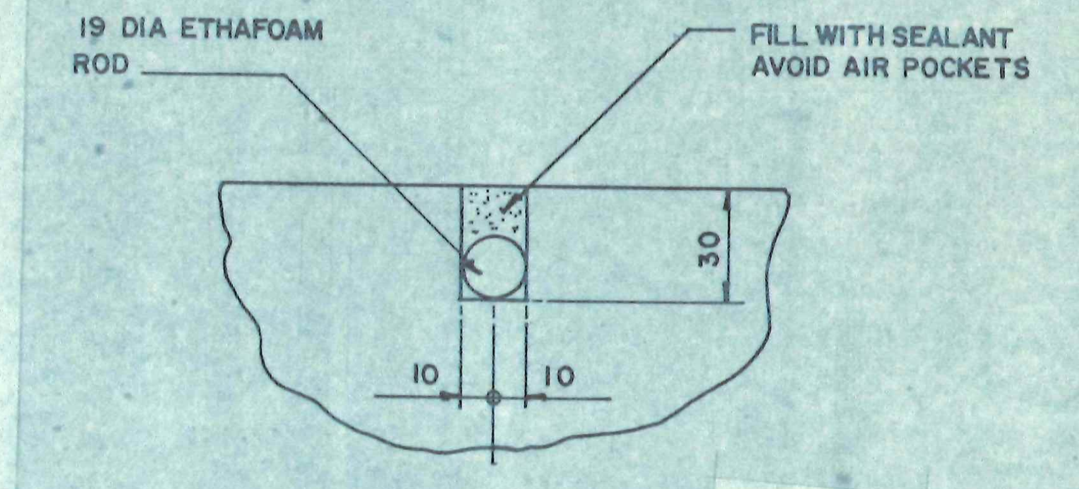
HORIZONTAL WALL REINFORCEMENT AT JUNCTION



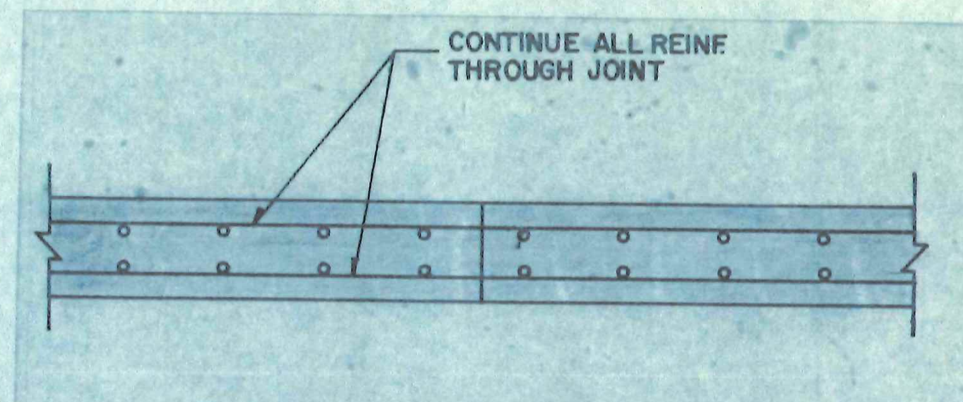
TYPICAL WATERSTOP ANCHORAGE DETAIL



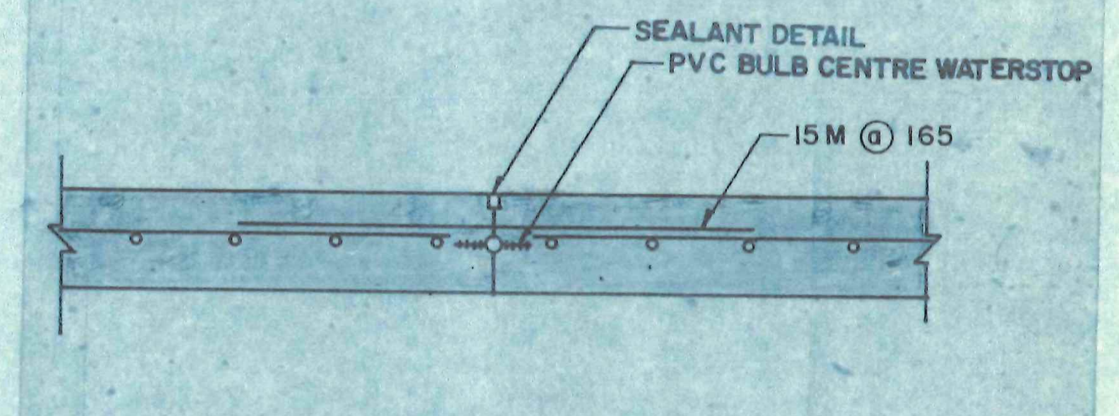
WALL CONSTRUCTION JOINT



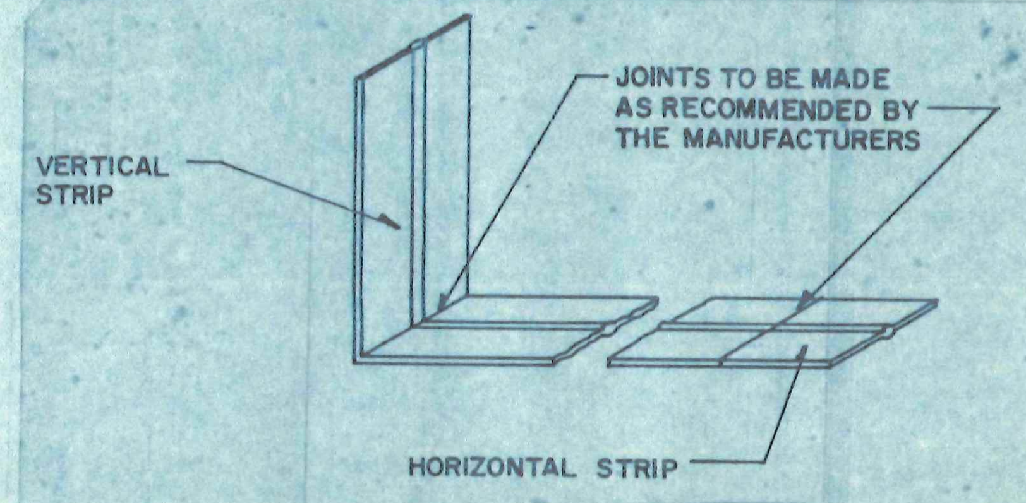
SEALANT DETAIL A S6 S6



ROOF SLAB CONSTRUCTION JOINT



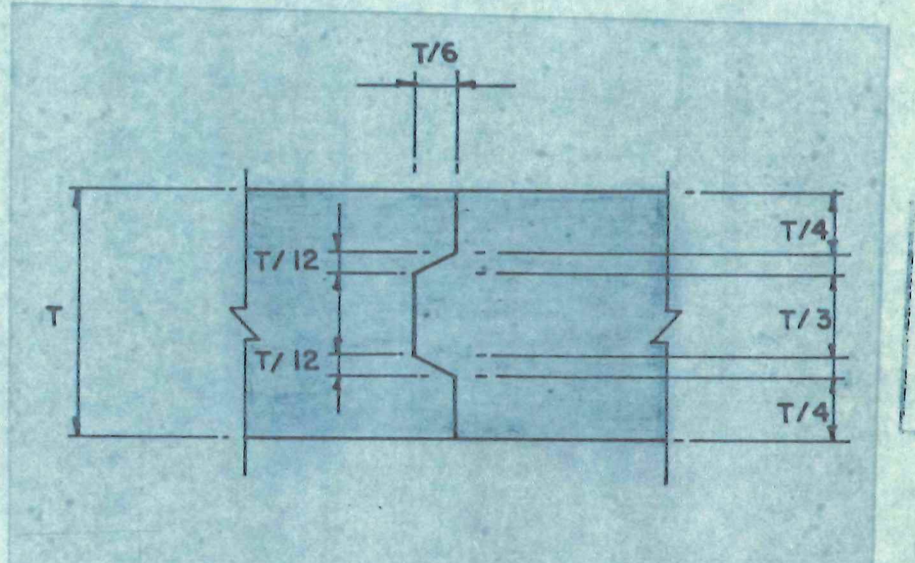
BASE SLAB CONSTRUCTION JOINT



NOTES

1. PVC WATERSTOPS SHALL BE JOINED TOGETHER AS RECOMMENDED BY MANUFACTURER AT ALL INTERSECTIONS AND JOINTS AND APPROVED BY THE ENGINEER BEFORE ANY CONCRETE IS PLACED
2. JOIN WATERSTOP TO FORM A CONTINUOUS UNBROKEN WATERSEAL IN ALL PARTS OF STRUCTURE AT EXPANSION JOINT
3. ALL TEES AND CROSSES AND OTHER SPECIAL INTERSECTIONS SHALL BE FACTORY-MADE ASSEMBLIES

P. V. C. WATERSTOP



TYPICAL CONSTRUCTION JOINT KEY DETAIL

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Signature PEPelkey
Date May 9/89
PERMIT NUMBER: P 4741
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

JAMES H. SHUTTLEWORTH
Jim Shuttleworth
May 9 /89

approved by / approuve par — date/date
FEB 1 2 1990
Park Superintendent / Directeur du parc

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ISL Infrastructure Systems Ltd.
CONSULTING ENGINEERS

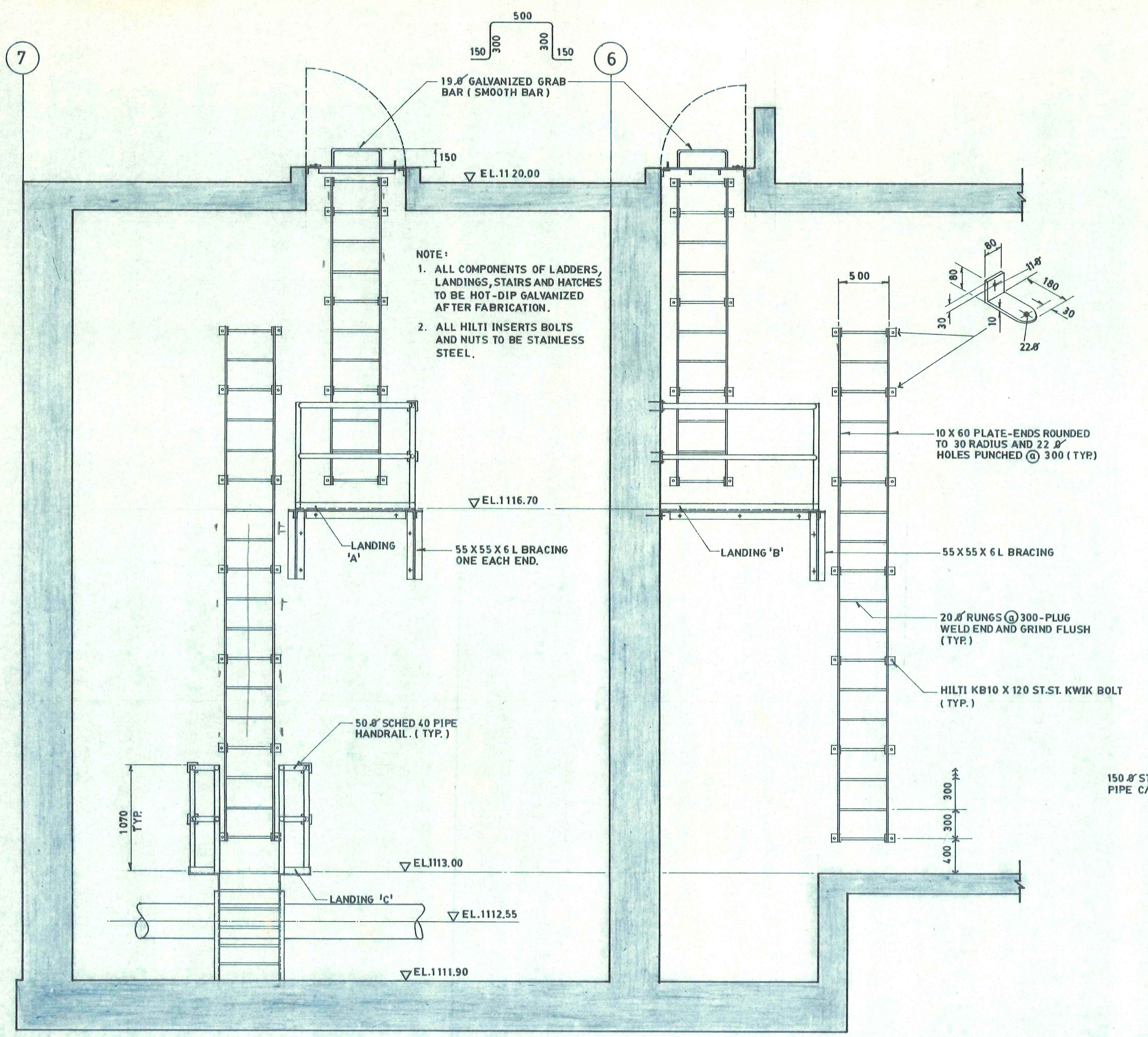
project title / titre du projet

WATER SUPPLY
IMPROVEMENTS
JASPER TOWNSITE
Jasper National Park

drawing title / titre du dessin

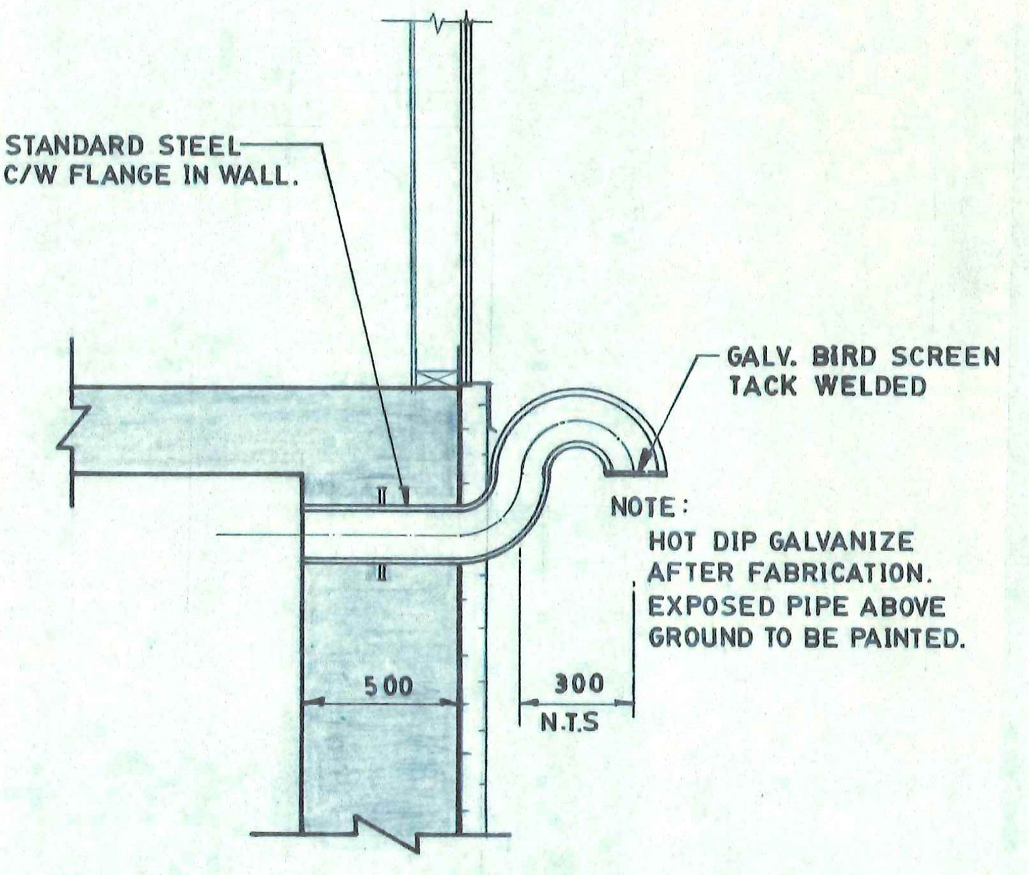
TYPICAL DETAILS

designed by / conception par: J.H.S
approved by / approuvé par: Ron Hove Feb 26/90
drawn by / tracé par: S.K.CHEN
date /date: March, 1989
checked by/vérifié par: I.S.L. G.W.R. WARK — WGH
scale / échelle: N.T.S
project asset number / numéro du projet d'immobilisation: 668516
reference/drawing number /numéro de référence/dessin: NWJ 89 / R5
sheet no. / feuille no.: S6
16 OF 39



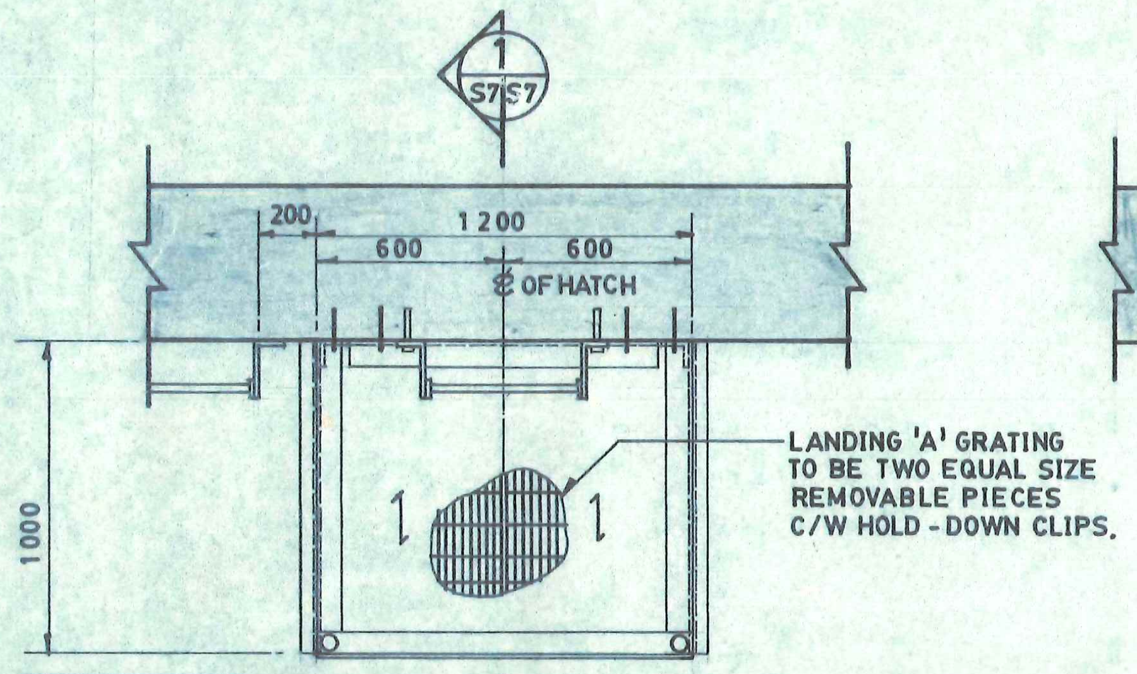
ACCESS LADDER DETAIL

1 : 25

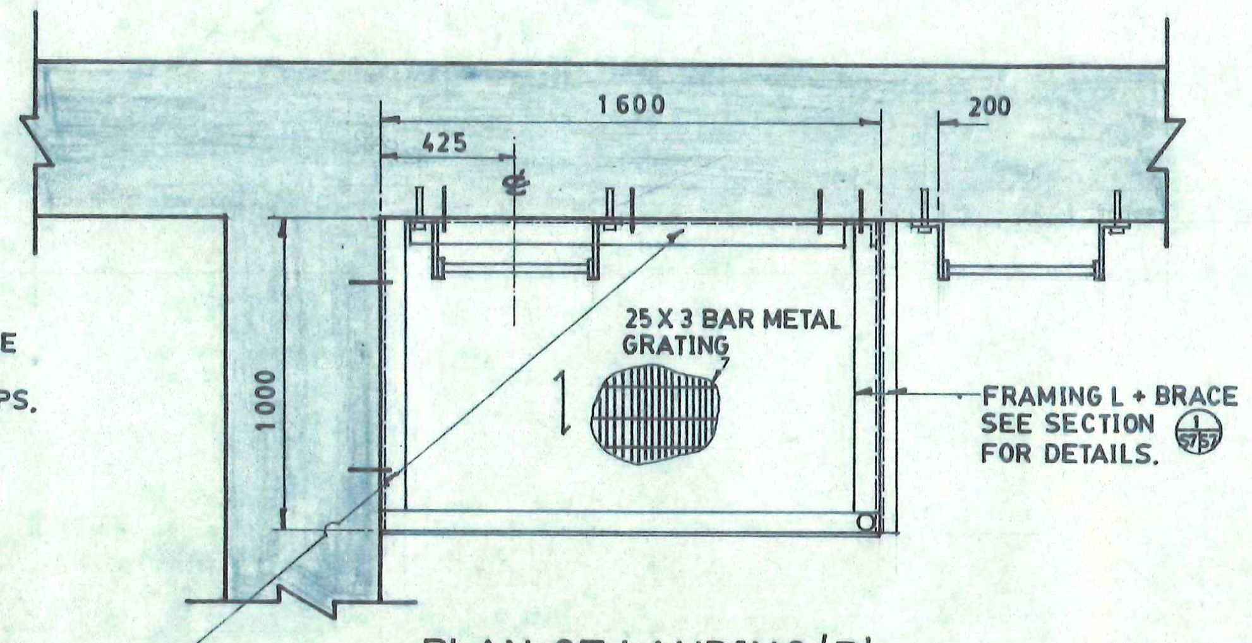


SECTION 9 S5 S7

1 : 20



PLAN OF LANDING 'A'



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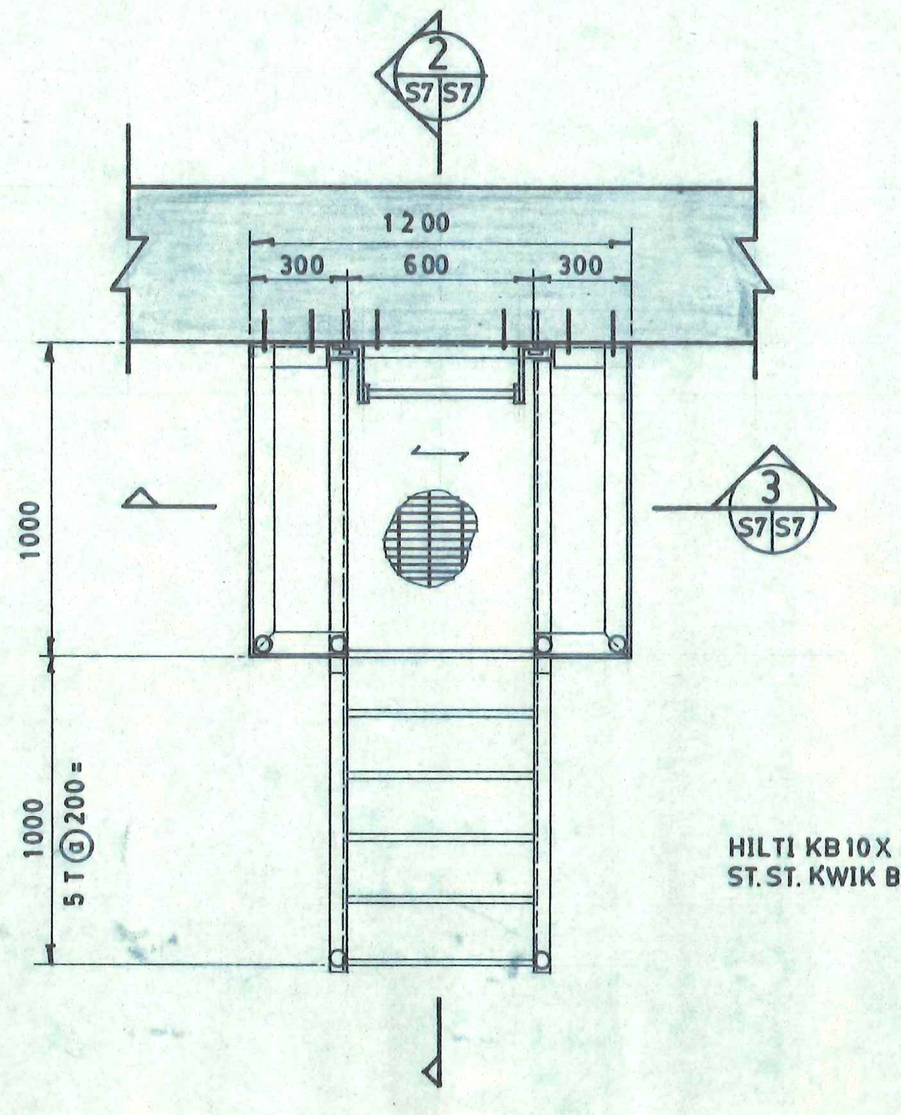
1 : 20



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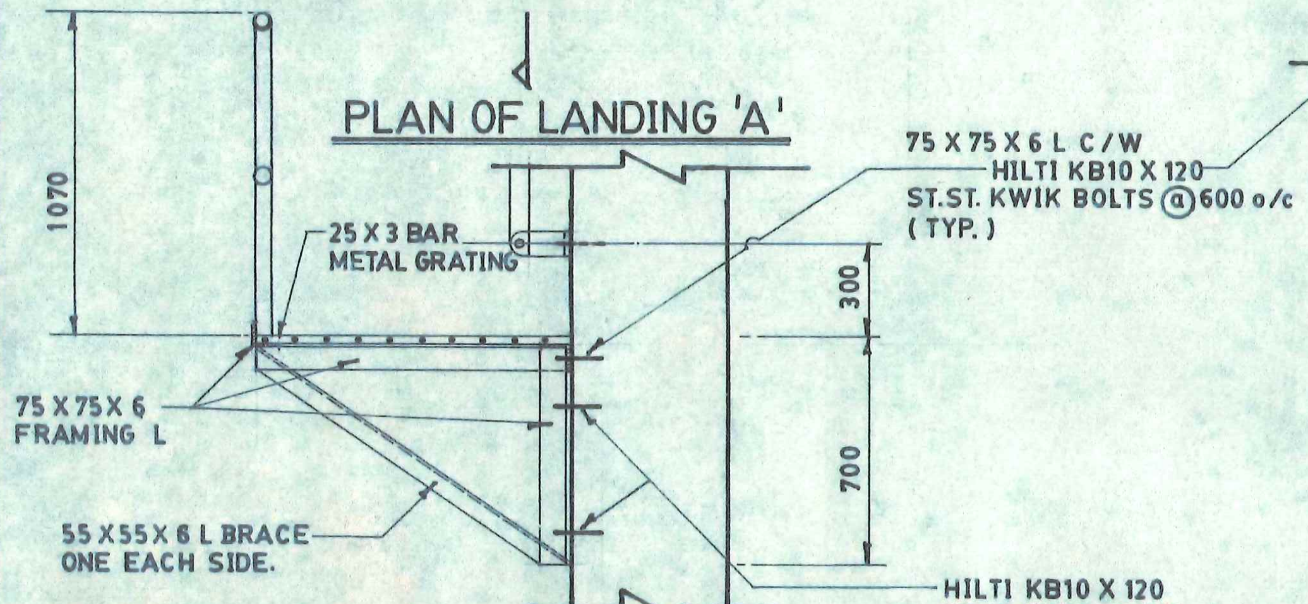
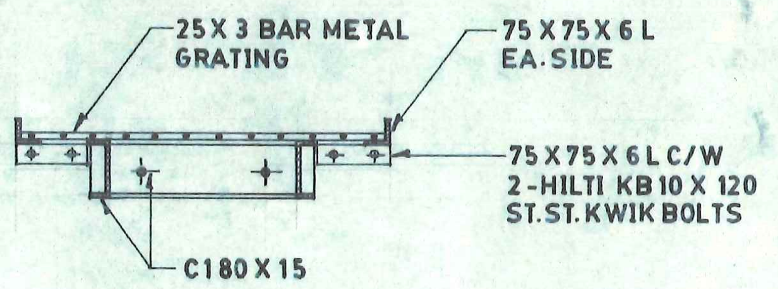
1 : 20



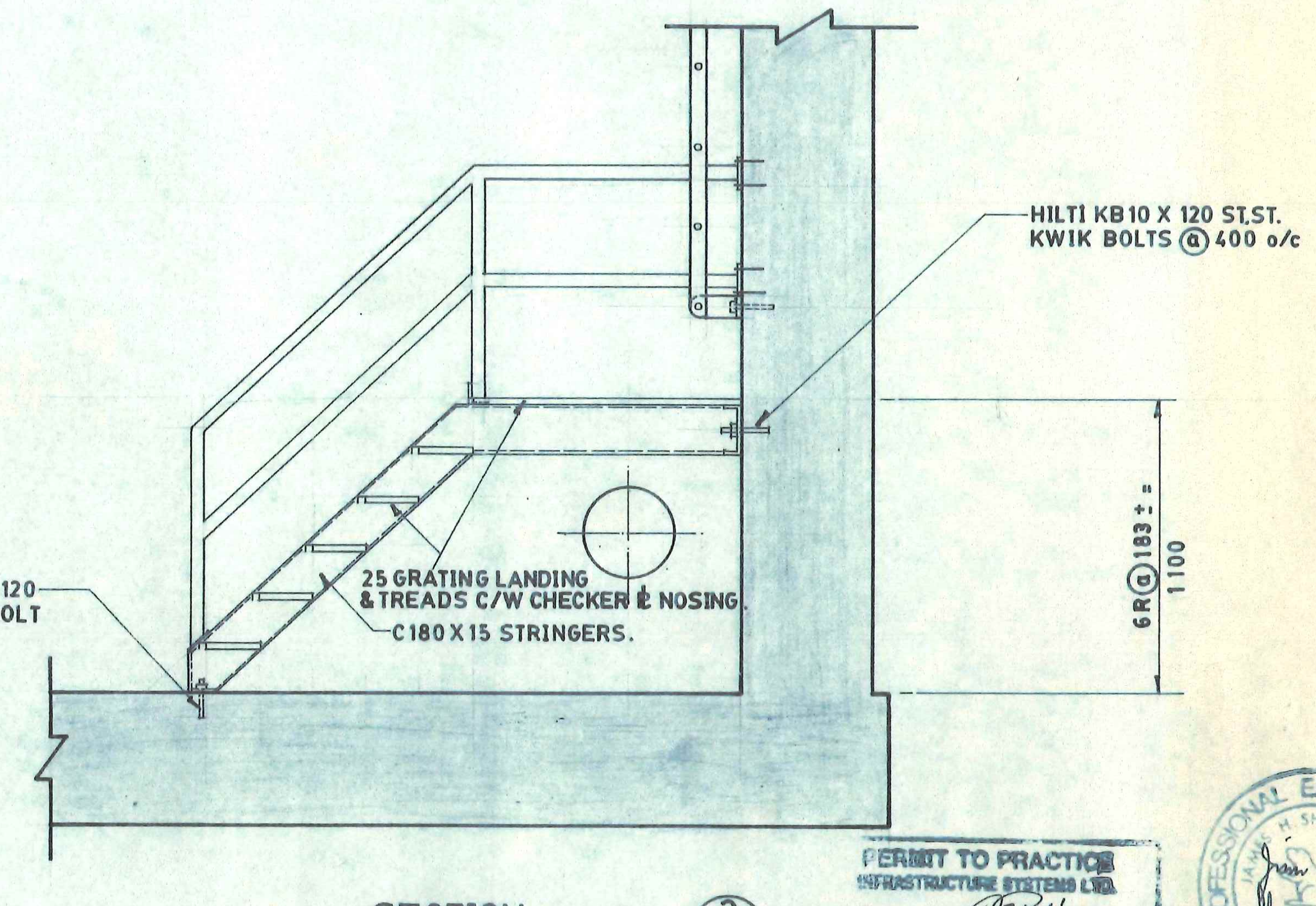
SECTION 1 S7 S7

1 : 20



SECTION 3 S7 S7

1 : 20



SECTION 2 S7 S7

1 : 20

PERMIT TO PRACTICE
INFRASTRUCTURE SYSTEMS LTD.
Signature AEPilkey
Date May 9/89
PERMIT NUMBER: P 4741
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

JAMES H. SHUTTLEWORTH
May 9/89

approved by / approuve par — date/date
G. Gertin — FEB 12 1990
Park Superintendent / Directeur du parc

no	date	description	drawn by tracé par	app'd by appr par
1	05/89	ISSUED FOR TENDER	S.K.C.	

revision / révision

A detail number — A numéro de détail
B location drawing number — B sur feuille no
C drawing number — C numéro de feuille

Parks Canada — Parcs Canada
Engineering and Architecture — Génie et architecture

Infrastructure Systems Ltd.
CONSULTING ENGINEERS

project title / titre du projet
WATER SUPPLY
IMPROVEMENTS
JASPER TOWNSITE
Jasper National Park

drawing title / titre du dessin
ACCESS LADDER DETAILS

designed by / conception par: J.H.S
approved by / approuvé par: Rae Howe Feb 26/90
drawn by / tracé par: S.K.CHEN
date /date: March, 1989
checked by / vérifié par: I.S.L. G.W.R. WARK Watt
scale / échelle: AS NOTED
project asset number / numéro du projet d'immobilisation: 668516
reference / drawing number / numéro de référence / dessin: NWJ 89 / R5
sheet no / feuille no: S7
17 OF 39

4-WS-014-018

APPENDIX
Hydrant Test Report
B

Final Report for

ISL Engineering and Land Services Ltd.

Attn: **Sarah Barbosa, P.Eng., ENV SP,** Municipal Engineer

Jasper, Alberta
Fire Hydrant Flow Testing
May 2022

Prepared and submitted by:

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Aldergrove, British Columbia V4W 3L1
Ph (604) 856-2220 *Fx* (604) 856-3003

May 4, 2022

Sarah Barbosa, P.Eng., ENV SP
Municipal Engineer

ISL Engineering and Land Services Ltd
4015 – 7th Street S.E.
Calgary, Alberta T2G 2Y9

FINAL REPORT: A22-100 - Fire Hydrant Flow Testing, Jasper, Alberta

Dear Sarah Barbosa.

Please find enclosed SFE's Final Report for the above-mentioned project. If you have any questions, comments, or concerns, please do not hesitate to contact us at your earliest convenience.

Thank you for having SFE conduct this work on your behalf. We are appreciative of the opportunity to work with you and your team on this project. We look forward to working together again soon.

Sincerely,
SFE Global

Kevin McMillan
Technical Services
(780) 461-0171
Kevin.McMillan@sfeglobal.com
www.sfeglobal.com

1. Executive Summary

This report provides details of the hydrant fire flow testing conducted in Jasper, Alberta. SFE Global was retained by ISL under the direction of Sarah Barbosa, P.Eng., ENV SP. Kevin McMillan represented SFE Global as Project Manager during this project.

As requested, SFE conducted ten fire hydrant fire flow tests on May 3rd, 2022. The flow hydrants and test hydrants were indicated to SFE by maps supplied by the client. The fire flow tests were conducted according to National Fire Protection Association (NFPA) 291 standards.

2. Summary of Testing

SFE Technicians met representatives of the Town of Jasper on-site to perform testing. The testing plan was discussed, and location maps reviewed by all participants.

Testing Equipment

Testing was performed on flow hydrants utilizing a Hydro Flow Products Hose Monster system with integral de-chlorinator. These are fixed pitot devices to measure flow, de-chlorinate and diffuse in one process. The benefit of this system is the ability to provide repeatable results and manage discharge water conditions.

The configuration for the Hose Monster System consisted of two-inch and four-inch hose monster devices depending on hydrant flow. To digitally log system pressure SFE Technicians installed two (2) Telog HPR hydrant pressure loggers. These devices were set to ten second logging intervals and one second sampling intervals. Each interval logs the minimum, maximum and average pressure for that time stamp.

Testing Procedure

The client selected all flow and residual hydrants for each test. SFE Technicians installed flow testing equipment on each flow hydrant and residual pressure measurement equipment on the residual hydrant.

The tests were performed by recording system static pressure then flowing the hydrant until flow and pressure stabilized. Residual and pitot(flow) pressures were then obtained. Upon closure of the flow hydrant, static pressure was obtained. Total flow and extrapolated flow to 20 psi residual pressure are calculated with system under normal conditions and using system static pressure.

Flow testing summary sheets are included in Appendix I.

3. Data

The testing reports included in Appendix I contain all test results and photos. All pressure readings are in psi and all flow values are reported in IGPM. All hydrants were returned to as found condition upon completion of testing.

4. Safety

A pre-job safety inspection and meeting was conducted by SFE personnel, and the following potential hazards were identified:

- Need for Personal Protective Equipment
- Working with water under pressure
- Pedestrian and vehicular traffic conditions
- Safe operation and shut down of fire hydrants
- COVID-19 Precautions

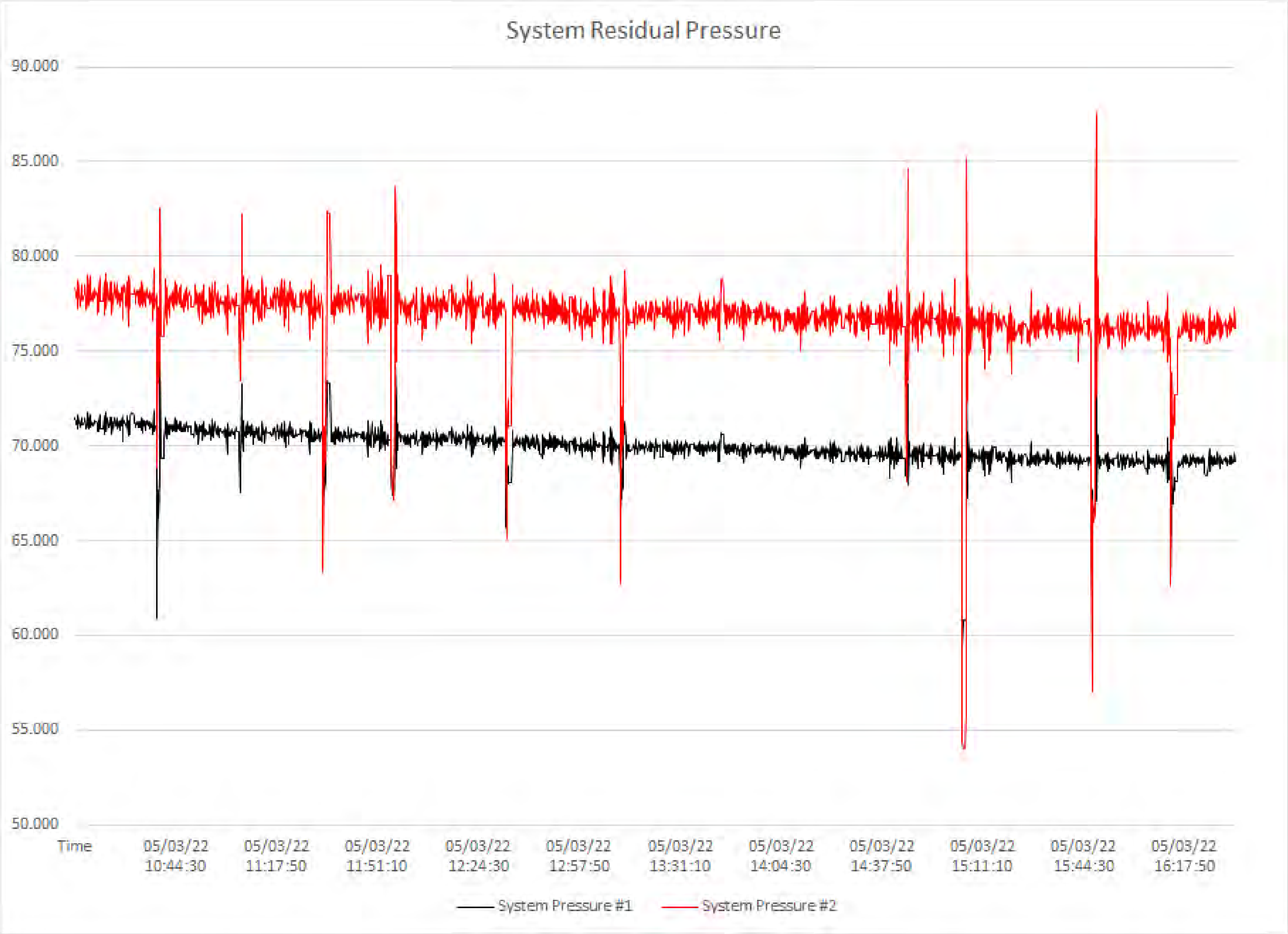
This project was conducted in accordance with the WCB and OSHA safety standards as documented in SFE's Safety Procedures Manual. The SFE crew reviewed the work to be completed and safety requirements at a tail-gate safety meeting held prior to commencing work.

Report End
May 2022

SFE Global
Project A22-100

Appendix I

Test Results


System Residual Pressure
90.000
85.000
80.000
75.000
70.000
65.000
60.000
55.000
50.000
Time
05/03/22 10:44:30
05/03/22 11:17:50
05/03/22 11:51:10
05/03/22 12:24:30
05/03/22 12:57:50
05/03/22 13:31:10
05/03/22 14:04:30
05/03/22 14:37:50
05/03/22 15:11:10
05/03/22 15:44:30
05/03/22 16:17:50
System Pressure #1
System Pressure #2

SFE GLOBAL

Fire Flow Test Report

Client Name:	ISL Engineering	Hyd 1 - #/Port Size	Four-Inch	System 1 Addr.	1084 Bonhomme
Project Location:	Jasper, AB	Hyd 2 - #/Port Size		System 2 Addr.	300 Bonhomme
SFE Project #:	A22-100	Hyd 1 - Pito Types	Four-Inch HM	Resid Hyd Addr.	
SFE Technicians:	KM/DU	Hyd 2 - Pito Types		Fire Pump Status	[✓ Auto]
		Test Procedure	NFPA 291	(circle one)	Force On

Test ID: System Hydrants Test : ______ of ______ Date: 04-May-22

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi

Flow Summary (igpm)	
Flow 1-1	
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	0
Flow @ 20 psi	#NUM!

Notes:

SYSTEM-1

GPS 52.87178 -118.09948

Flow Hydrant 2

GPS

SYSTEM-2

GPS 52.88068 -118.08595

Fire Flow Test Report

Client Name:	ISL Engineering	Hyd 1 - #/Port Size	Four-Inch	Flow Hyd 1 Addr	1132 Cabin Crk Drive	
Project Location:	Jasper, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr		
SFE Project #:	A22-100	Hyd 1 - Pito Types	Four-Inch HM	Resid Hyd Addr.	1148 Cabin Crk Drive	
SFE Technicians:	KM/DU	Hyd 2 - Pito Types		Fire Pump Status	[✓ N/A]	Gravity System
		Test Procedure	NFPA 291	(circle one)	Force On	

Test ID: 1 Test : 1 of 10 Date: 04-May-22

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
9:38	9:40	18				70	50	70

Flow Summary (igpm)	
Flow 1-1	1329
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	1329
Flow @ 20 psi	2180

Notes:

Flow Hydrant 1

GPS 52.86816 -118.10094

Flow Hydrant 2

GPS

Residual Hydrant

GPS 52.86862 -118.10249

Fire Flow Test Report

Client Name:	ISL Engineering	Hyd 1 - #/Port Size	Four-Inch	Flow Hyd 1 Addr	1028 Lodgepole Street	
Project Location:	Jasper, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr		
SFE Project #:	A22-100	Hyd 1 - Pito Types	Four-Inch HM	Resid Hyd Addr.	1010 Lodgepole Street	
SFE Technicians:	KM/DU	Hyd 2 - Pito Types		Fire Pump Status	[✓ N/A]	Gravity System
		Test Procedure	NFPA 291	(circle one)	Force On	

Test ID: 7

Test : 2 of 10

Date: 04-May-22

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
10:04	10:06	15				66	54	67

Flow Summary (igpm)	
Flow 1-1	1213
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	1213
Flow @ 20 psi	2506

Notes:

Flow Hydrant 1

GPS 52.87133 -118.09623

Flow Hydrant 2

GPS

Residual Hydrant

GPS 52.87214 -118.09506

SFE GLOBAL

Fire Flow Test Report

Client Name:	ISL Engineering	Hyd 1 - #/Port Size	Four-Inch	Flow Hyd 1 Addr	908 Patricia	
Project Location:	Jasper, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr		
SFE Project #:	A22-100	Hyd 1 - Pito Types	Four-Inch HM	Resid Hyd Addr.	823 Patricia	
SFE Technicians:	KM/DU	Hyd 2 - Pito Types		Fire Pump Status	N/A	Gravity System
		Test Procedure	NFPA 291	(circle one)	Force On	

Test ID: 9

Test : 3 of 10

Date: 04-May-22

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
10:33	10:34	16				74	58	74

Flow Summary (igpm)	
Flow 1-1	1253
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	1253
Flow @ 20 psi	2417

Notes:

Flow Hydrant 1

GPS 52.87135 -118.09137

Flow Hydrant 2

GPS

Residual Hydrant

GPS 52.87164 -118.08999

SFE GLOBAL

Fire Flow Test Report

Client Name:	ISL Engineering	Hyd 1 - #/Port Size	Four-Inch	Flow Hyd 1 Addr	706 Patricia	
Project Location:	Jasper, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr		
SFE Project #:	A22-100	Hyd 1 - Pito Types	Four-Inch HM	Resid Hyd Addr.	621 Patricia	
SFE Technicians:	KM/DU	Hyd 2 - Pito Types		Fire Pump Status	[✓ N/A]	Gravity System
		Test Procedure	NFPA 291	(circle one)	Force On	

Test ID: 6 Test : 4 of 10 Date: 04-May-22

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
10:55	10:57	19				80	64	80

Flow Summary (igpm)	
Flow 1-1	1365
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	1365
Flow @ 20 psi	2787

Notes:

Flow Hydrant 1

GPS 52.87368 -118.08367

Flow Hydrant 2

GPS

Residual Hydrant

GPS 52.87490 -118.08200

SFE GLOBAL

Fire Flow Test Report

Client Name:	ISL Engineering	Hyd 1 - #/Port Size	Four-Inch	Flow Hyd 1 Addr	Birch / Tonquin	
Project Location:	Jasper, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr		
SFE Project #:	A22-100	Hyd 1 - Pito Types	Four-Inch HM	Resid Hyd Addr.	Birch Ave Alley	
SFE Technicians:	KM/DU	Hyd 2 - Pito Types		Fire Pump Status	[✓ N/A]	Gravity System
		Test Procedure	NFPA 291	(circle one)	Force On	

Test ID: 2 Test : 5 of 10 Date: 04-May-22

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
11:33	11:35	12.5				70	61	70

Flow Summary (igpm)	
Flow 1-1	1107
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	1107
Flow @ 20 psi	2794

Notes: Note: Unable to shut off flow hydrant after testing. Hydrant failure. Locked out by client.

Flow Hydrant 1

GPS 52.87425 -118.08878

Flow Hydrant 2

GPS

Residual Hydrant

GPS 52.87547 -118.08808

SFE GLOBAL

Fire Flow Test Report

Client Name:	ISL Engineering	Hyd 1 - #/Port Size	Four-Inch	Flow Hyd 1 Addr	725 Larch	
Project Location:	Jasper, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr		
SFE Project #:	A22-100	Hyd 1 - Pito Types	Four-Inch HM	Resid Hyd Addr.	703 Turret	
SFE Technicians:	KM/DU	Hyd 2 - Pito Types		Fire Pump Status	N/A	Gravity System
		Test Procedure	NFPA 291	(circle one)	Force On	

Test ID: 10 Test : 6 of 10 Date: 04-May-22

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
12:11	12:13	13.5				72	54	72

Flow Summary (igpm)	
Flow 1-1	1149
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	1149
Flow @ 20 psi	2038

Notes:

Flow Hydrant 1

GPS 52.87360 -118.08604

Flow Hydrant 2

GPS

Residual Hydrant

GPS 52.87434 -118.08583

SFE GLOBAL

Fire Flow Test Report

Client Name:	ISL Engineering	Hyd 1 - #/Port Size	Four-Inch	Flow Hyd 1 Addr	230 Colin	
Project Location:	Jasper, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr		
SFE Project #:	A22-100	Hyd 1 - Pito Types	Four-Inch HM	Resid Hyd Addr.	205 Colin	
SFE Technicians:	KM/DU	Hyd 2 - Pito Types		Fire Pump Status	[✓ N/A]	Gravity System
		Test Procedure	NFPA 291	(circle one)	Force On	

Test ID: 4 Test : 7 of 10 Date: 04-May-22

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
13:45	13:47	5.5				72	56	72

Flow Summary (igpm)	
Flow 1-1	747
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	747
Flow @ 20 psi	1412

Notes:

Flow Hydrant 1

GPS 52.88069 -118.08339

Flow Hydrant 2

GPS

Residual Hydrant

GPS 52.88197 -118.08199

SFE GLOBAL

Fire Flow Test Report

Client Name:	ISL Engineering	Hyd 1 - #/Port Size	Four-Inch	Flow Hyd 1 Addr	101 Bonhomme
Project Location:	Jasper, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr	
SFE Project #:	A22-100	Hyd 1 - Pito Types	Four-Inch HM	Resid Hyd Addr.	1 Patricia Cres
SFE Technicians:	KM/DU	Hyd 2 - Pito Types		Fire Pump Status	🟩 N/A Gravity System
		Test Procedure	NFPA 291	(circle one)	Force On

Test ID: 8 Test : 8 of 10 Date: 04-May-22

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
14:04	14:06	17				80	64	80

Flow Summary (igpm)	
Flow 1-1	1291
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	1291
Flow @ 20 psi	2636

Notes: Note: Unable to shut off flow hydrant after testing. Hydrant failure. Locked out by client.

Flow Hydrant 1

GPS 52.88407 -118.07946

Flow Hydrant 2

GPS

Residual Hydrant

GPS 52.88428 -118.07913

Fire Flow Test Report

Client Name:	ISL Engineering	Hyd 1 - #/Port Size	Four-Inch	Flow Hyd 1 Addr	MPL Place	
Project Location:	Jasper, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr		
SFE Project #:	A22-100	Hyd 1 - Pito Types	Four-Inch HM	Resid Hyd Addr.	Behind Cavelle Appt.	
SFE Technicians:	KM/DU	Hyd 2 - Pito Types		Fire Pump Status	[✓ N/A]	Gravity System
		Test Procedure	NFPA 291	(circle one)	Force On	

Test ID: 5 Test : 9 of 10 Date: 04-May-22

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
14:47	14:49	17				82	65	83

Flow Summary (igpm)	
Flow 1-1	1291
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	1291
Flow @ 20 psi	2596

Notes:

Flow Hydrant 1

GPS 52.88714 -118.07969

Flow Hydrant 2

GPS

Residual Hydrant

GPS 52.88822 -118.07973

SFE GLOBAL

Fire Flow Test Report

Client Name:	ISL Engineering	Hyd 1 - #/Port Size	Four-Inch	Flow Hyd 1 Addr	Jasper Pet Outpost	
Project Location:	Jasper, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr		
SFE Project #:	A22-100	Hyd 1 - Pito Types	Four-Inch HM	Resid Hyd Addr.	#32 Stan Wright Dr.	
SFE Technicians:	KM/DU	Hyd 2 - Pito Types		Fire Pump Status	[✓ N/A]	Gravity System
		Test Procedure	NFPA 291	(circle one)	Force On	

Test ID: 3 Test : 10 of 10 Date: 04-May-22

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
15:14	15:16	8				80	60	80

Flow Summary (igpm)	
Flow 1-1	902
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	902
Flow @ 20 psi	1632

Notes:

Flow Hydrant 1

GPS 52.87238 -118.07729

Flow Hydrant 2

GPS

Residual Hydrant

GPS 52.87347 -118.07639

APPENDIX C
Detailed Cost Estimates

Table C.1: Detailed Existing System Upgrade Cost Estimates

ID	Items	Material	Quantity	Units	Unit Cost	Sub-Total	Contingency (30%)	Engineering (15%)	Total Cost
EX Upgrade 1	200 mm Watermain	PVC	149	Metres	$1,500	$223,350	$67,005	$33,503	$330,000
	Pavement Rehabilitation	N/A	149	Metres	$1,500	$223,500	$67,050	$33,525	$330,000
					EX Upgrade 1 Sub-Total:	**$446,850**	**$134,055**	**$67,028**	**$660,000**
EX Upgrade 2	300 mm Watermain	PVC	399	Metres	$2,800	$1,116,626	$334,988	$167,494	$1,620,000
	Pavement Rehabilitation	N/A	399	Metres	$1,500	$598,500	$179,550	$89,775	$870,000
					EX Upgrade 2 Sub-Total:	**$1,715,126**	**$514,538**	**$257,269**	**$2,490,000**
EX Upgrade 3	150 mm Watermain	PVC	5	Metres	$1,150	$6,245	$1,873	$937	$10,000
	Pavement Rehabilitation	N/A	5	Metres	$1,500	$7,500	$2,250	$1,125	$20,000
					EX Upgrade 3 Sub-Total:	**$13,745**	**$4,123**	**$2,062**	**$30,000**
EX Upgrade 4	150 mm Watermain	PVC	96	Metres	$1,150	$110,515	$33,155	$16,577	$170,000
	Pavement Rehabilitation	N/A	96	Metres	$1,500	$144,000	$43,200	$21,600	$210,000
					EX Upgrade 4 Sub-Total:	**$254,515**	**$76,355**	**$38,177**	**$380,000**
EX Upgrade 5	150 mm Watermain	PVC	189	Metres	$1,150	$216,890	$65,067	$32,534	$320,000
	Pavement Rehabilitation	N/A	60	Metres	$1,500	$90,000	$27,000	$13,500	$140,000
					EX Upgrade 5 Sub-Total:	**$306,890**	**$92,067**	**$46,034**	**$460,000**
EX Upgrade 6	150 mm Watermain	PVC	1	Metres	$1,150	$1,610	$483	$242	$10,000
	Pavement Rehabilitation	N/A	1	Metres	$1,500	$1,500	$450	$225	$10,000
					EX Upgrade 6 Sub-Total:	**$3,110**	**$933**	**$467**	**$20,000**
EX Upgrade 7	150 mm Watermain	PVC	20	Metres	$1,150	$23,460	$7,038	$3,519	$40,000
	Pavement Rehabilitation	N/A	0	Metres	$1,500	$0	$0	$0	$0
					EX Upgrade 7 Sub-Total:	**$23,460**	**$7,038**	**$3,519**	**$40,000**
EX Upgrade 8	200 mm Watermain	PVC	11	Metres	$1,500	$15,923	$4,777	$2,388	$30,000
	Pavement Rehabilitation	N/A	11	Metres	$1,500	$16,500	$4,950	$2,475	$30,000
					EX Upgrade 8 Sub-Total:	**$32,423**	**$9,727**	**$4,863**	**$60,000**
EX Upgrade 9	150 mm Watermain	PVC	59	Metres	$1,150	$67,275	$20,183	$10,091	$100,000
	Pavement Rehabilitation	N/A	59	Metres	$1,500	$88,500	$26,550	$13,275	$130,000
					EX Upgrade 9 Sub-Total:	**$155,775**	**$46,733**	**$23,366**	**$230,000**
EX Upgrade 10	250 mm Watermain	PVC	850	Metres	$1,900	$1,614,242	$484,273	$242,136	$2,350,000
	Pavement Rehabilitation	N/A	620	Metres	$1,500	$930,000	$279,000	$139,500	$1,350,000
					EX Upgrade 10 Sub-Total:	**$2,544,242**	**$763,273**	**$381,636**	**$3,700,000**
Industrial Pressure Zone	Pressure Reducing Valves	N/A	3	Items	$55,000	$165,000	$49,500	$24,750	$240,000
North Pressure Zone	Pressure Reducing Valves	N/A	4	Items	$55,000	$220,000	$66,000	$33,000	$320,000
Low North Pressure Zone	Pressure Reducing Valves	N/A	1	Items	$55,000	$55,000	$16,500	$8,250	$80,000
					New Pressure Zones Sub-Total:	**$440,000**	**$132,000**	**$66,000**	**$640,000**
					Existing System Upgrade Total:	**$5,936,136**	**$1,780,841**	**$890,420**	**$8,710,000**

Assumptions:
Costs herein are comparable to other municipalities.
Costs are representative of 2022.
The final total cost has been rounded to the nearest $10,000.

Table C.2: Detailed Replacement Program (High Priority Potential Leakage Watermains) Cost Estimates

Items	Material	Quantity	Units	Unit Cost	Sub-Total	Contingency (30%)	Engineering (15%)	Total Cost
150 mm Distribution Main	PVC	1,764	Metres	$1,150	$2,028,766	$608,630	$304,315	$2,950,000
200 mm Distribution Main	PVC	986	Metres	$1,500	$1,479,000	$443,700	$221,850	$2,150,000
250 mm Distribution Main	PVC	439	Metres	$1,900	$833,926	$250,178	$125,089	$1,210,000
300 mm Distribution Main	PVC	226	Metres	$2,800	$634,178	$190,253	$95,127	$920,000
Pavement Rehabilitation	N/A	1,897	Metres	$1,500	$2,845,628	$853,688	$426,844	$4,130,000
Replacement Program (High Priority Leakage Watermains) Total:					**$7,821,499**	**$2,346,450**	**$1,173,225**	**$11,360,000**

Assumptions:

Costs herein are comparable to other municipalities.
Costs are representative of 2022.
The final total cost has been rounded to the nearest $10,000.

Table C.3: Detailed Future System Upgrade Cost Estimates

ID	Items	Material	Quantity	Units	Unit Cost	Sub-Total	Contingency (30%)	Engineering (15%)	Total Cost
FUT Upgrade 1	300 mm Watermain	PVC	214	Metres	$2,800	$599,200	$179,760	$89,880	$870,000
	Pavement Rehabilitation	N/A	214	Metres	$1,500	$321,000	$96,300	$48,150	$470,000
FUT Upgrade 1 Sub-Total:						**$920,200**	**$276,060**	**$138,030**	**$1,340,000**
FUT Investigations	Investigate Bonhomme Street/Willow Avenue Pressure Drops	N/A	1	Items	$5,000	$5,000	$1,500	$750	$10,000
	Investigate Reservoir Storage Volume	N/A	1	Items	$5,000	$5,000	$1,500	$750	$10,000
	Investigate Well Pumping Capacity	N/A	3	Items	$5,000	$15,000	$4,500	$2,250	$30,000
FUT Investigations Sub-Total:						**$25,000**	**$7,500**	**$3,750**	**$50,000**
Future System Upgrade Total:						**$945,200**	**$283,560**	**$141,780**	**$1,390,000**

Assumptions:

Costs herein are comparable to other municipalities.
Costs are representative of 2022.
The final total cost has been rounded to the nearest $10,000.

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