TOWN OF BENTLEY SOUTHEAST ASP SERVICING STUDY

FINAL REPORT

June 21, 2022

Prepared for:
Town of Bentley

Prepared by:
Stantec Consulting Ltd.

Project Number:
110170054

Executive Summary

Stantec was retained by the Town of Bentley and Lacombe County to complete a servicing study for the proposed Southeast Area Structure Plan. The objective of the project was to evaluate the water, wastewater, and stormwater infrastructure that would be required to accommodate the future development. This required consideration of the Town's overall existing infrastructure networks as well as servicing of future residential identified on the north side of Bentley and providing water to the existing industrial land west of the CPR tracks.

Water and Wastewater Demands

Water and wastewater demands can be difficult to estimate for industrial and commercial developments and greatly depend on the nature of the businesses. This inherently makes it somewhat challenging to plan for the size of the infrastructure to construct that balances costs with desired levels of service. Unnecessary oversizing is costly and potable water could go stagnant if it remains in the watermains too long. Most municipal design volumes range from 0.10 l/s/ha to 0.69 l/s/ha. Lacombe County's Aspelund Business Park uses only approximately 0.02 l/s/ha. **For this study, 0.05 l/s/ha was selected as a reasonable design basis**. It is understood that the Town still wishes to attract some relatively high-volume water users such as seed-cleaning plants. The recommended infrastructure in this study has some residual capacity, so depending on the overall average that is built over time through future development, the Town's infrastructure can potentially take on above-average users.

Hydrogeology Summary

The groundwater supply in the area is above average for central Alberta. The Town is situated above the Paskapoo Formation. In this area, there are two distinct aquifers including the Lacombe and Haynes Members of the Paskapoo Formation at different depths. The Town's wells and most groundwater users in the area use the Lacombe Member, which indicated better groundwater yield in the area around Bentley than other areas of the province. However, the Haynes member is also known to be highly productive. This provides the opportunity for potential high-volume (i.e., industrial) water users are able to source their own non-potable groundwater wells following the Guide to Groundwater Authorization (Alberta Environment, 2011) without adding disproportionate stress to the Town's water supply. The Town of Bentley currently has three wells and two licenses authorizing the groundwater diversion to provide potable water for the residents. Key summary elements of the hydrogeological findings using available data are listed below with additional detail in the hydrogeology section of the report.

- The existing well residual capacity can accommodate approximately 3% annual growth for 21 years of the 25-year outlook with the likely need to add a fourth well to meet the 25-year projected demand.
- There is potential interference with local groundwater users if the Town install the future new well in the Lacombe Member of the Paskapoo Formation above the Haynes Member. The Haynes Member has higher aquifer potential than Lacombe Member and can avoid potential interference

with other groundwater users. The Town could consider a deep groundwater exploration program as there is significant aquifer potential in the Haynes Member of the Paskapoo Formation.

- Groundwater in the Town footprint and or just beyond, should be similar in water quality given the hydrogeological setting, and lack of observed variability and similar geological framework for the upper bedrock aquifer.
- The region as a whole indicates high groundwater yield rates and good groundwater quality, which is a good feature/advantage for future developments.
- Development of groundwater resources has some inherent uncertainty associated with the drilling costs, actual realized groundwater yield and potential for future changes to licensure process and groundwater allocations.
- Allocate capital to establish additional approved groundwater capacity early in the 25-year outlook and engage Alberta Environment and Parks to determine rationale needed to further develop the resource to accommodate growth without precluding others near Town from accessing/using the resource.

Water Servicing Summary

The Town's existing and future water distribution systems are shown on **Figure 2-1** and **Figure 2-2,** respectively. The Town currently has three concrete storage water reservoirs with total storage capacity of 1,671 m^3. At the existing water treatment plant, there are two Peerless distribution pumps and one fire pump. Based on the annual water consumption data from 2009 to 2020, the Average Daily Demand (ADD) is 264 Lcpd. The Southeast ASP mains are proposed to be sized to meet a minimum industrial fire flow of 150 l/s and residential fire flow of 75 l/s. Please note though that actual fire flow capacities modeled in this report range from approximately 160 l/s to 220 l/s. Below are the key summary of the future water servicing which detailed in the water section of the report.

- Water servicing for all future development can be accommodated by water mains up to 300 mm in diameter for the 0.05 L/s/ha scenario.
- To meet the future demand in the planned areas, three distribution pumps with one spare pump with a design capacity of 50 L/s at 42 m head will be.
- The existing water treatment plant and reservoirs have approximately 400 m^3 of residual capacity, which is enough to service the Town for approximately 30 more years at a consumption annual water demand growth rate of 3%.
- When the capacities are reached, the Town can either expand the reservoirs from 1,671 m^3 to 2,183 m^3, which may be challenging considering the constraints of the existing site, or construct a new water treatment plant and reservoir. For this study, it is proposed that a new water treatment plant be constructed east of the fire hall. The options should be further evaluated in the future as

decisions will factor on actual growth observed and the condition of the existing water treatment plant.

Wastewater Servicing Summary

The existing and future wastewater networks are shown on **Figure 3-1** and **Figure 3-2,** respectively. The existing lagoon is located southwest corner of the municipal limit, consisting of anaerobic cells, facultative cells, and storage cells. The existing storage cells have a total storage volume of 217,036 m^3 with a rated capacity of 595 m^3/day. Based on the average daily influent flow from the 2014 to 2021 influent meter records, the existing average daily sanitary flow is estimated to be 331 m^3/day (305 Lpcd). Below are the key summary of the future wastewater servicing which detailed in the wastewater section of the report.

- The proposed Southeast ASP area can be accommodated by a new gravity trunk that will extend to the lagoons. The sizes of the mains will vary from 250 mm to 450 mm. Although 200 mm diameter pipes can likely handle design flows for the 0.05 L/s/ha scenario, Stantec recommends that 250 mm mains be installed as the minimum size because they can provide much more capacity with only a minor increase in cost.

- To accommodate the ultimate future North Residential area growth, the existing 200 mm trunk along 50th Street from the lane to the north of 50 Avenue to 54 Avenue will need to upsized to 300 mm diameter sewer.

- The lagoons have capacity for more than 20 years with a 3% annual wastewater flow growth rate. For the ultimate build out of the proposed ASP and other Town's residential development, the lagoon volume would have to be increased from approximately 217,036 m^3 to 666,125 m^3 for the 0.05 L/s/ha scenario, which would require approximately 28 hectares (70 acres) of land to the west of the existing lagoons. The expansion is proposed to be on the west side of the existing lagoons because of the topographical constraints (i.e. the land is lower to the west).

Stormwater Servicing Summary

Stormwater management will be accommodated by a series of stormwater management facilities (ponds) as shown on **Figure 4-4** that cascade from east to west via ditches to the Blindman River. The plans in this report are based on the assumption that each development area / property would have its own stormwater management facility (storm pond). Below are the key summary of the future stormwater servicing which detailed in the stormwater management section of the report.

- A 1:100 pre-development release rate of 3.0 L/s/ha is proposed for the study area based on the Discharge Rate Control in Alberta. The existing Town and the relevant Highway 12 sub-catchments were previously approved in 2010 at a pre-development release rate of 4.0 L/s/ha; therefore, some of the proposed stormwater management facilities have a composite pre-development release rate.

- Wet stormwater management facilities are envisioned for the proposed study area. By following the water quality improvement recommendations outlined in this report, the study area will meet

This document entitled Town of Bentley Southeast ASP Servicing Study was prepared by Stantec Consulting Ltd. (“Stantec”) for the account of Town of Bentley (the “Client”). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec’s professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Project Engineer in Training
Francine Lei, EIT

PROFESSIONAL ENGINEER ALBERTA
BRADLEY J. VANDER HEYDEN
2022-06-21
Member No: 80305

Project Manager
Brad Vander Heyden, P. Eng.

PROFESSIONAL ENGINEER ALBERTA
JOHNNY QINGSHENG KE
ID#103082
21 Jun. 2022

Water and Wastewater Engineer
Johnny Ke, P.Eng.

PROFESSIONAL GEOLOGIST ALBERTA
JOSEPH T. E. RIDDELL
129072
2022-06-21

Hydrogeologist
Joseph Riddell, M.Sc., P.Geol.

PROFESSIONAL ENGINEER ALBERTA
BRAD DARDIS
2022-06-22

Stormwater Engineer
Brad Dardis, P.Eng.

PERMIT TO PRACTICE
STANTEC CONSULTING LTD.
Signature
Date 2022-06-21
PERMIT NUMBER: P 0258
The Association of Professional Engineers, Geologists and Geophysicists of Alberta
ID 65821

Permit to Practice

or exceed the necessary water quality improvement to meet the current Alberta Environment and Parks (AEP) criteria for removing 85% of Total Suspended Solids (TSS), for sediment particles 75 microns and larger.

- The existing CP railway and Range Road 12 culverts have sufficient conveyance capacity to facilitate development within the ASP area.
- At the time of detailed design, it is recommended onsite stormwater management criteria shall need to be defined to ensure that the public storm conveyance system is not overwhelmed.

  It is recommended that drainage easements/rights-of-way be retained from the Town limits to the Blindman River.

Opinions of Probable Costs

Opinions of probable costs were prepared and are included in Section 5 of this report. Please refer to that section for specific cost considerations.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Acronyms / Abbreviations

ADD	Average Daily Demand
AEP	Alberta Environment and Parks
AGS	Alberta Geological Survey
ASP	Area Structure Plan
AWWID	Alberta Water Well Information Database
BMPs	Best Management Practices
CHI	Computational Hydraulics Inc.
CSM	Conceptual Site Model
CP Railway	Canadian Pacific Railway
HGL	Hydraulic Grade Line
HP	Horsepower
HWL	High Water Level
IDF	Intensity-Duration-Frequency
I&I	Inflow and Infiltration
IPF	Instantaneous Peak Flow
Lpcd	Litres per Capita per Day
MDD	Maximum Daily Demand
MDF	Mean Daily Flow
NWL	Normal Water Level
OGS	Oil and Grit Separator
PCPS	Parkland Community Planning Services
PHD	Peak Hour Demand
PRV	Pressure Reducing Valves
ROW	Right-of-Way
SWSS	Stormwater Servicing Study
TSS	Total Suspended Solids
UARR	Unit Area Release Rates
VFD	Variable Frequency Drive
WSC	Water Survey of Canada
WWF	Wet Weather Flow

1 Introduction

Stantec Consulting Ltd. (Stantec) was retained by the Town of Bentley (the Town) to provide servicing planning to support the Town's Southeast Area Structure Plan (ASP) completed by Parkland Community Planning Services (PCPS). The goal of this servicing study is to ultimately provide recommendations for the water, wastewater, and stormwater required to accommodate the long-term development plans of the Southeast ASP area.

1.1 Study Objective

The objectives of this servicing study are to:

- Estimate the future water and wastewater demands of the study area;
- Review residual capacity of the current groundwater production system, and evaluate future potential for additional groundwater production;
- Model the existing and proposed future water infrastructure to identify water trunk routes and sizes, new reservoir and pump house locations, and connections to the existing Town's water distribution network;
- Model the proposed future wastewater infrastructure to identify gravity sewer sizes and locations, lift stations and force mains (if any), and connections to the existing Town's sanitary sewer system;
- Evaluate the existing wastewater lagoon capacity based on projected average wastewater flows from the existing and proposed developments;
- Prepare opinions of probable costs for the water, wastewater, and stormwater infrastructure.

1.2 Future Land Use Overview

1.2.1 SOUTHEAST ASP AREA

The Southeast ASP area is located southeast of the Town's existing municipal limits. It includes most of Section 23, Township 40, Range 40, W5M and is approximately 235 ha in total area. As shown on **Figure 1-1**, the future land use concept developed by PCPS, the Southeast ASP area consists of a mix of highway commercial, light and heavy industrial, public institutional, municipal reserve, and public utility lot development as detailed in **Table 1-1** below.

Table 1-1 Bentley Future SE Area Land Use

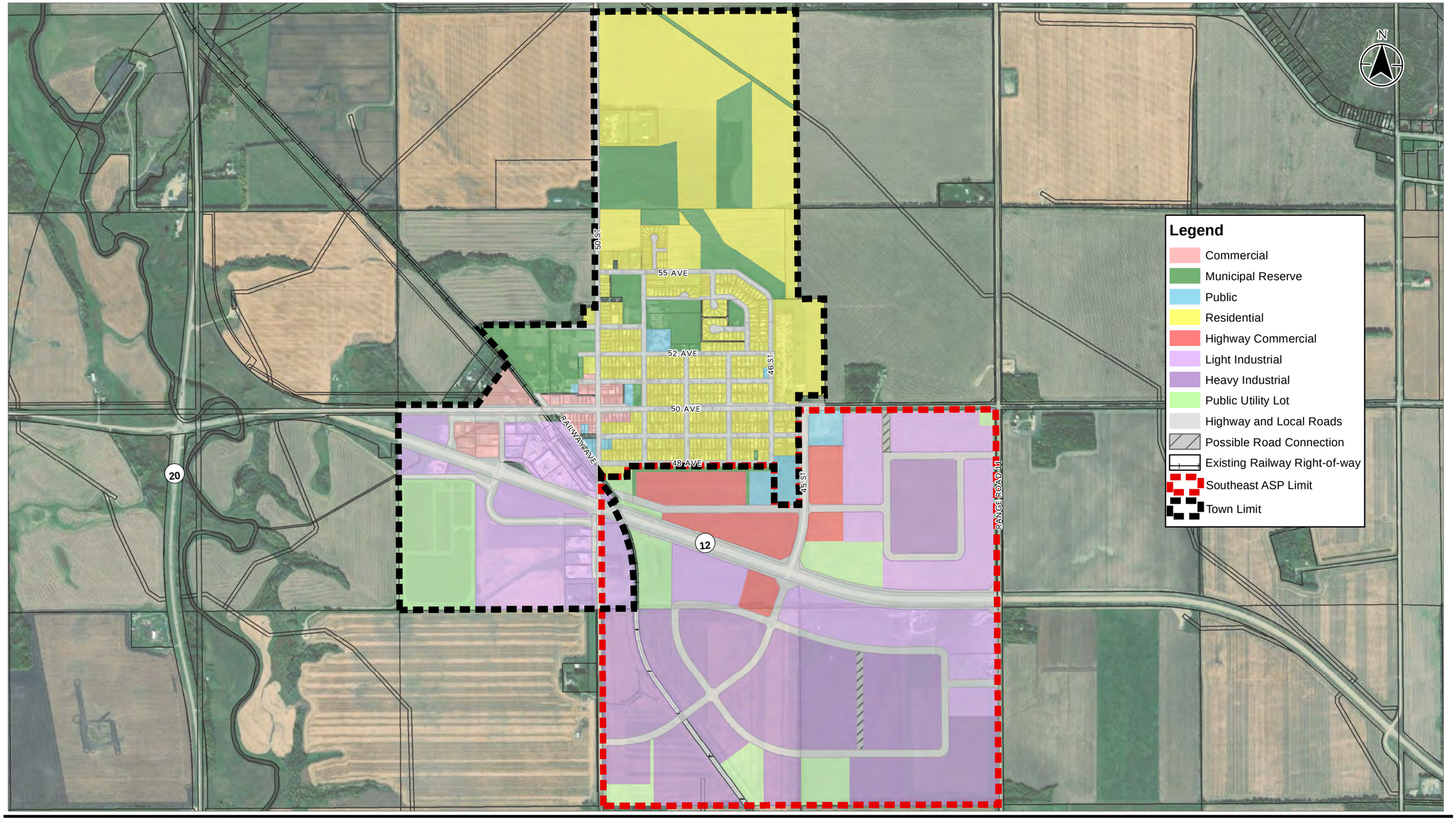
SE ASP Area Land Use	Area (Ha)	Percentage
Highway Commercial	19.6	8%
Light and Heavy Industrial	146.6	63%
Public Utility Lots	20.2	9%
Public Institutional	5.4	2%
Municipal Reserve	2.3	1%
Highway, Roads, Possible Road Connection, and Railway Right-of-Way	40.2	17%
Total	**234.3**	**100%**

1.2.2 FUTURE NORTH RESIDENTIAL AND SOUTHWEST INDUSTRIAL AREAS

The focus of this water and wastewater servicing study is to set alignments, sizing, and general locations of critical water and wastewater infrastructure for the Southeast ASP area. To do so, it is also important to assess the Town's existing capacity (and residual capacity) while also taking into account the Town's other future growth areas. **Table 1-2** summarized the future north residential area and SW industrial area used to examine the future demand based on Map 2 of the Town's *Land Supply and Future Growth Potential* study. Please note that if the development concepts change in the future, the models may need to be updated accordingly to confirm capacities.

Table 1-2 Future North Residential and SW Industrial Areas

Location	Land Use	Area (Ha)
Future North Area	Residential	75.5
Future SW Area	Industrial	26.3



Stantec

Town of Bentley

Lacombe County

Notes

1. Coordinate System: NAD 1983 UTM Zone 11N

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

0 200 400 600 800 metres

(At original document size of 11x17)
1:15,000

Client/Project

110170040 - REVA

Prepared by AL on 2022-04-05
TR by BVH on 2022-04-05

Town of Bentley
Servicing Assessment

Figure No.

1-1

Title

Overall Land Use

2 Water Servicing

2.1 Hydrogeology

2.1.1 INTRODUCTION

The Town of Bentley, Alberta (the Town) has retained Stantec Consulting Ltd (Stantec) to conduct an evaluation of the Town's current water supply, treatment, and distribution system with an objective of sustaining three percent growth over the next 25 years. As such, an evaluation of the current Alberta Environment Water Act Authorizations (Licenses, Permits and Approvals), the volumes associated with those authorizations, the regional setting, current wells and potential for additional groundwater development in the context of the Town's plan to grow is provided herein.

2.1.2 SCOPE OF WORK

The Town currently relies on three groundwater production wells for potable water supply, making groundwater quantity a critical factor in the Town's ability to grow. The scope of work summarized below uses available data sources to complete a desktop analysis of the current groundwater supply wells, the associated authorizations and assess the overall groundwater quantity outlook for the Town and its ability to expand its Industrial/commercial sectors to potentially include high-water demand and/or larger industrial facilities.

2.1.3 METHODS AND DATA SOURCES

Stantec has developed a workflow to leverage both publicly available geological/hydrogeological data and project- or site-specific data to assess groundwater potential for projects at a variety of scales. In this case, the Town has an extensive record of groundwater development, use, hydrogeological assessment and monitoring data to complete the desktop analysis. The methods are presented below for two parts of the overall desktop analysis.

The first component of the desktop study entailed the review of the Town's groundwater authorizations, hydrogeological assessment data and/or reports. The Town's current approvals are based on work completed by Stantec and others in the past, summarized in the following reports and Authorizations:

Reports

- MPE Engineering, May 2001. Town of Bentley: Water Supply and Shortage Assessment Final Report
- Stantec Consulting Ltd., 2011. Evaluation of Well NO. 3, Town of Bentley, Alberta.

Groundwater Authorizations

- Town of Bentley: groundwater diversion license 00033515-00-00, and amended license 00033515-00-03 describes the authorization of Wells 1 and 2.
- Town of Bentley: groundwater diversion license 00301866-00-00 describes the authorization of Well 3.

The second method that Stantec uses to assess groundwater potential entails developing a three-dimensional conceptual site model (3D CSM). A 3D CSM is a desktop/software-based approach to visualize various geospatial and thematic data both within the Town and surrounding area. This approach provides regional context for the hydrogeological setting of the Town, nearby water users and wells, flow rate analysis, aquifers currently used and potential for alternate aquifer sources aside from the upper bedrock aquifer described below.

The 3D CSM workflow integrates the following publicly available data:

- Alberta Water Well Information Database (AWWID): The AWWID is a well records database managed by Alberta Environment and Parks (AEP, 2022) that includes lithological, well completion, well testing, flow rates etc. (Appendix D). The well search encompassed the 6 sections surrounding Bentley and returned a total of 207 well records. The average depth of the borehole was 40 m below ground surface (m bgs) the minimum depth was 3.05 and the maximum depth was 287 m bgs.
- Alberta Geological Survey (AGS) Mapping:
  - Surficial Geology (Fenton *et al*., 2013)
  - Bedrock Geology (Prior *et al*., 2013)
  - AGS 3D Framework (AGS 2021)
- Alberta Research Council Hydrogeological Map Series NTS 83A (La Breton and Green 1971) and 83B (Tokarsky 1970) as the town lies close to the east edge of NTS 83B.

2.1.4 REGIONAL GEOLOGICAL/HYDROGEOLOGICAL SETTING

The Town is situated between Gull Lake to the east and the Blindman River to the west placing the Town between two groundwater discharge features. Gull Lake receives groundwater flow from the surrounding topographically defined basin, and the Blindman River is a semi-regional drainage feature that drains both runoff and baseflow (i.e., groundwater discharging to river) from its watershed area with groundwater springs that are observed along the Blindman River (Tokarsky 1970).

Surficial geology is mapped as either moraine or fluted moraine, composed of fine-grained till on top of bedrock in the Town and surrounding area, with fluvial deposits observed adjacent to the Blindman River, and glaciolacustrine deposits in the area surrounding Gull Lake (Fenton *et al.* 2013). Unconsolidated deposit thickness is approximately 20 m below the Town (AGS 2021).

The upper bedrock unit is the Paleogene aged Paskapoo Formation (Prior *et al*. 2013), characterized by a thick succession of non-marine siltstone, mudstone and sandstone. It is known that the Paskapoo Formation has three internal members including the Haynes, Lacombe and Sunchild Members (Lyster and Andriashek 2012). The Haynes and Sunchild Members are classified as sandstone-dominated regional aquifers, and the Lacombe is considered mudstone dominated regional aquitard. However, the Lacombe Member contains local-scale channelized sandstone beds that can perform well as a local aquifer. The Town lies east of the western extents of the Sunchild Member.

The Haynes Member, known as a high-yielding aquifer, is mapped as approximately 50 m thick under the Town (Lyster and Andriashek 2012). However, the Paskapoo is mapped as approximately 155 m thick (AGS 2021) meaning that the wells in the area, including the existing production wells are likely pumping from local-scale high-yielding sandstone beds in the Lacombe Member/Aquitard. Therefore, there is likely

even higher aquifer potential deeper within the Paskapoo Formation, specifically the Haynes Member Aquifer located approximately 100 m below the unconsolidated sediment/bedrock interface.

2.1.5 THREE-DIMENSIONAL CONCEPTUAL SITE MODEL (3D CSM)

The 3D CSM confirmed the interpretation of the regional setting as described above, particularly the Stantec (2011) interpretation that the Town's production wells, and most nearby well users are installed in the Lacombe Member. This is clearly visualized using the 3D CSM (Figure 1A, Appendix D) and comparison to the overall conceptual model for the internal members of the Paskapoo Formation (Figure 1B, Appendix E; Barker *et al*. 2011). The alternating thin beds of sandstone and mudstone are not typical of the Haynes Member, and likely constitutes a sand-rich interval and area within the Lacombe Member, which in many areas of Alberta, has limited aquifer potential.

The 3D CSM also mapped the recommended flow rates and screened intervals of the wells (including the Town's wells) from the AWWID (Figure 2; Appendix D). This demonstrates that the mapped groundwater yield potential beneath the Town, and the surrounding area is high, and perhaps higher than the potential groundwater yield polygons indicated by Lemay and Guha (2009), which were based on data ranging back to the 1970's. There appears to be a zone of good upper bedrock permeability trending east-west across the Town, though there could be some data bias with the Town simply developing larger capacity wells out of necessity relative to farm/domestic well applications.

The 3D CSM also shows that most well users are removing groundwater from the upper 10-20 m of the bedrock surface, likely because adequate supply is present in the upper sandstone beds. However, this also means that increasing pressure with new groundwater users or additional demand from the Town itself, that the uppermost bedrock beds may be under groundwater stress in the future depending on the rate, and density of new private and or public development.

2.1.6 SUMMARY OF CURRENT LICENSES

The Town has three wells and two licenses authorizing the groundwater diversion to provide potable water for the residents. Well 1 and Well 2 (Well IDs 1066506 and 1066508 respectively) were initially licensed in 1983 under license number 09174, which was later re-coded by Alberta Environment to 00033515-00-00, and amended to 00033515-00-02 which states a maximum annual diversion volume of 116,043 m^3, between the two wells and does not expire. License 0301866-00-00, which approves Well 3 (AWWID 1066506) to withdraw an annual maximum volume of 84,000 m^3 expires in 2037.

Table 2-1 Groundwater License Summary Table

Well	License No.	Max. Daily Withdrawal Rate (m^3/day)	Maximum Annual Withdrawal (m^3/year)
Well 1	00033515-00-01 & 00033515-00-02	490	116,043
Well 2	00033515-00-01 & 00033515-00-02	654	
Well 3	0301866-00-00	449	84,000
Total		**1,593**	**200,043**

A total of nine groundwater registrations are present within the six sections surrounding the Town, with three registrations in 40-1-27-W5M, five in 40-1-26-W5M and one in 40-1-22-W5M. All licenses/approvals and the respective amendments for the Town's groundwater wells are included in Appendix F.

2.1.7 GROUNDWATER DEVELOPMENT POTENTIAL ASSESSMENT

The Town's current average daily water demand is 290 m^3/day. The water is supplied by three wells that have a total capacity to supply 548 m^3/day and are licensed for the equivalent annual volume. The Town currently has 189% of the average daily demand, and capacity to refill reservoirs in the event that high demand for fire water or other temporary demand well in excess of the average daily demand is encountered. The Town currently utilizes 1,269 m^3 of the 1,671 m^3 total reservoir capacity for its typical daily consumption, emergency storage, and fire flow storage (assuming 150 L/s fire flow for two hours).

The three groundwater production wells have been pump tested and licensed to pump up to their sustainable long-term yield. Without adding a fourth production well, the Town has residual capacity to accommodate approximately 3% annual water demand growth for 21 years of the 25-year outlook. Even with the conservative growth rate applied for planning and design, the Town's current wells are capable of service into the future with the likely need to add a fourth well to meet the 25-year projected demand with a high level of confidence. Note that the individual wells also have higher allowable maximum diversion rates than the average daily rates as presented above which can be leveraged to calculate limitations of the wells to meet potential short-term high-demand situations such as reservoir filling or fire water demand. However, if maximum daily withdrawals are made, the overall annual volumetric approvals still apply.

2.1.8 CONCLUSIONS AND RECOMMENDATIONS

Based on the available data the following conclusions focused on planning and potential constraints are provided:

- The Town operates three production wells with a total licensed production capacity of 548 m^3/day.
- Under current projections (i.e., 3% water demand growth), the Town has enough capacity for 21 years of the 25-year outlook.
- Based on available data and current regulations, the Town should be able to supplement their water system with an additional well to achieve the 25-year growth/capacity objectives. However, previous studies (Stantec 2011) identified that there is potential for well interference with local groundwater users, and the approvals have provisos to accommodate impacts to other users.
- The Town's wells are likely installed in the Lacombe Member of the Paskapoo Formation above the Haynes Member Aquifer top located approximately 110-120 m below ground surface. The Haynes Member has significant aquifer potential. The Haynes is generally known to have similarly low TDS water quality as the shallower portions of the Paskapoo, especially close to the subcrop edge of the Haynes (near Red Deer, Alberta) as the Paskapoo Formation thins to the east. However, additional desktop study may be warranted to determine the Haynes groundwater chemistry if possible, in the vicinity of the Town.
- The three current production wells all have similar low total dissolved solids concentrations (i.e., 611-635 mg/L), sodium-bicarbonate type groundwater chemistry (Stantec 2011). Groundwater in the Town footprint and or just beyond, should be similar in water quality given the hydrogeological setting, and lack of observed variability and similar geological framework for the upper bedrock aquifer.

- The region as a whole indicates high groundwater yield rates and good groundwater quality, and the Town could develop the resource and/or market this to possible industrial developments as a feature/advantage associated with the area.
- Development of groundwater resources has some inherent uncertainty associated with the drilling costs, actual realized groundwater yield and potential for future changes to license process and groundwater allocations.

Recommendations based on the conclusions above include:

- With future development in mind, allocation of capital to establish additional approved groundwater capacity early in the 25-year outlook is likely prudent. As water authorizations are on a priority basis (i.e., first in time, first in right) it may be advisable to engage Alberta Environment and Parks to determine what, if any, rationale would be needed to further develop the resource to accommodate growth without precluding others near Town from accessing/using the resource. This would likely entail the installation and licensing/approval process to add a point of diversion and associated additional overall approved diversion volumes for the Town as per the Guide to Groundwater Authorization (Alberta Environment 2011).
- Consider a deep groundwater exploration program as there is significant aquifer potential in the Haynes Member of the Paskapoo Formation. If deep groundwater from the Haynes Member could be accessed, it would dramatically lower the chances of interference with other groundwater users and potentially open opportunities to attract high-water demand industrial residents.

2.2 Water Servicing Study Description

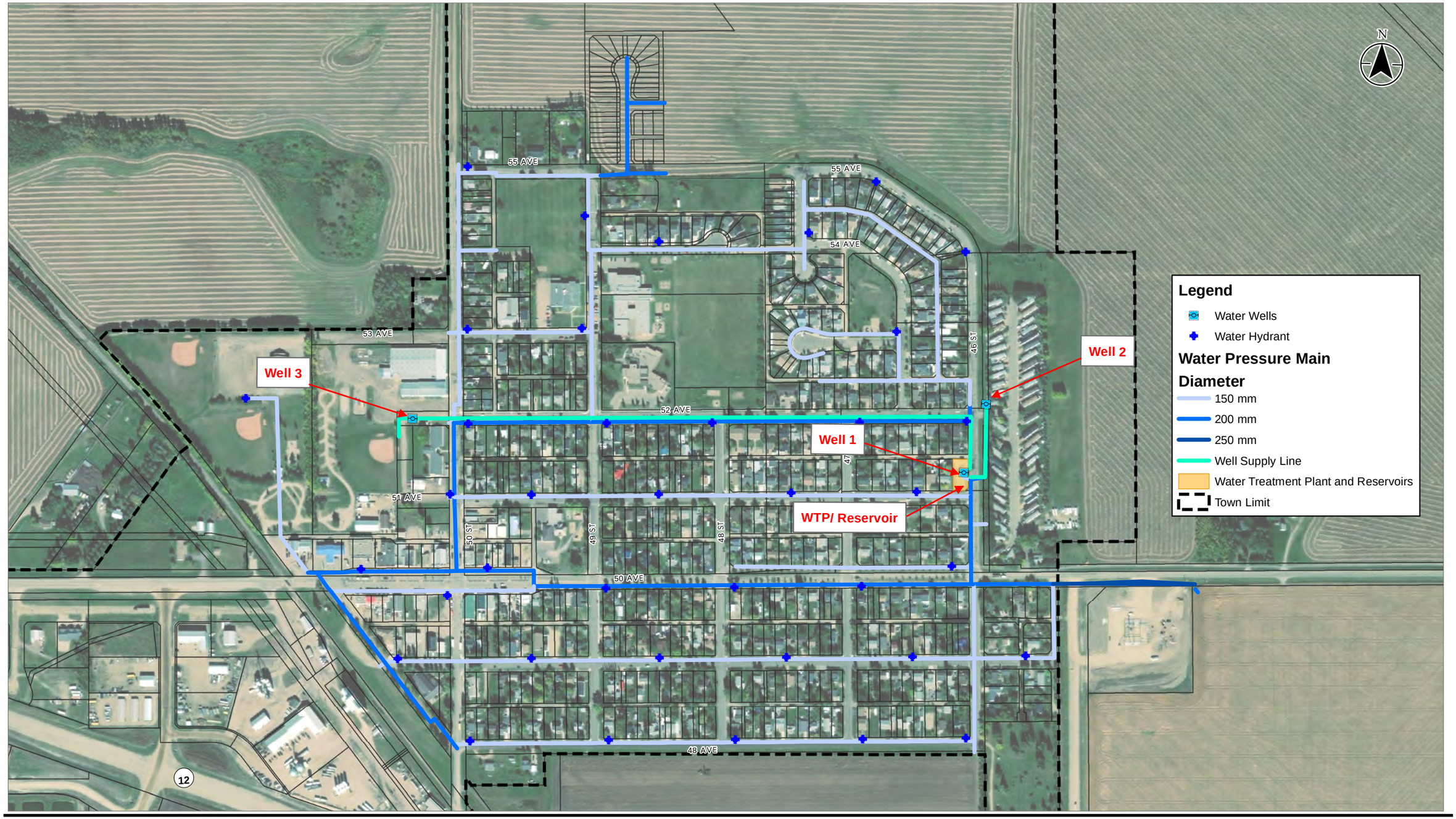
The water servicing infrastructure proposes to service the lands as set out in the future land uses as described in Section 1.2. The scope of work includes a review of the existing water distribution network, the extension of that network, and an estimate of the expansion required for the reservoirs based on the future development areas.

The hydraulic aspect of the system was analyzed using the WaterCAD model which includes all existing and future areas of the Town and the future Southeast ASP area.

2.3 Existing Infrastructure

2.3.1 EXISTING WATER NETWORK

The Town's existing water distribution system was constructed in a WaterCAD model using the existing waterlines included in the Town of Bentley 2011 Infrastructure Map Book, as well as Bentley Subdivision Phase 1 (April 12, 2021) and Bentley Fire Hall Site Servicing (June 12, 2013) as-builts. The existing water mains range from 150 mm to 250 mm in diameter as shown on **Figure 2-1**.



Stantec

Town of Bentley

Lacombe County

0 50 100 150 200 metres

(At original document size of 11x17)
1:5,000

Notes
1. Coordinate System: NAD 1983 UTM Zone 11N
2. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Client/Project
110170040 - REVA
Prepared by AL on 2022-04-05
TR by BVH on 2022-04-05
Town of Bentley
Servicing Assessment

Figure No.
2-1

Title
Water Servicing - Existing Conditions

2.3.2 RESERVOIR AND PUMPING FACILITIES

According to the Town of Bentley's Water Treatment Plant 2022 Map, the Town currently has three concrete storage water reservoirs with total storage capacity of 1,671 m^3.

Currently, the Town has two Peerless distribution pumps and one emergency standby Flowserve 14EM-2 fire pump at the water treatment plant. The Town provided the Peerless distribution pump curve, however, since the Flowserve 14EM-2 fire pump curve is not available, it is assumed in the model that the Flowserve fire pump curve is similar to another Flowserve fire pump14EMM provided by the supplier. The pumps are driven by Variable Frequency Drive (VFD) to maintain a discharge header pressure of 46 psi, which leads a Hydraulic Grade Line (HGL) at 966 m.

The two reservoirs' volumes and the pumping capacities are presented in **Table 2-2** and **Table 2-3,** respectively.

Table 2-2 Reservoir Volumes

Reservoir	Storage Capacity (m^3)
Reservoir 1	712
Reservoir 2	426
Reservoir 3	533
Total	**1,671**

Table 2-3 Existing Pump Capacities

Pump No.	Pump Model	Capacity
DP-01	Peerless 4x4x10c 7LB 7.5 HP	7 L/s at 39 m
DP-02	Peerless 4x4x10c 7LB 7.5 HP	7 L/s at 39 m
Fire pump-03	Flowserve 14EM-2 10.38in IMP. with Amarillo Right Angle Gear Drive	107 L/s at 46 m

*Note: The capacities of the distribution pumps are determined from the performance curve provided by the Town. The fire pump performance curve is not available, it is assumed that the Flowserve fire pump curve is similar to another Flowserve fire pump14EMM provided by the supplier

2.4 Design Criteria

To develop the hydraulic model, assumptions were made with respect to the following elements within the model:

- Water Demands;
- Fire Flows;
- Operating Pressures;

- Pipe Flow Velocities;
- Pipe Frictions; and
- Pumping Requirements.

The subsequent sections will describe the assumptions and criteria that were made for each of the elements listed above.

2.4.1 WATER DEMAND STANDARDS

The Town provided Stantec the Town's annual water consumption data from 2009 to 2020. Based on the annual water consumption provided and the Town's population between 2009 to 2020, the Average Daily Demand (ADD) is 264 Lcpd (liters/capita/day) which is within the normal range for Alberta municipalities with similar levels of development. The Maximum Daily Demand (MDD) is projected based on a MDD to ADD factor of 2. For Peak Hour Demand (PHD), the peaking factor is 4 times the ADD.

Industrial and commercial water demands can be difficult to predict and vary significantly even between municipalities and Alberta Environment and Parks' guidelines, and this can have a significant impact on the sizing of infrastructure required. A sensitivity analysis for alternative scenarios using 0.02 L/s/ha, 0.05 L/s/ha, and 0.1 L/s/ha was completed for consideration.

2.4.2 FIRE FLOW REQUIREMENTS

The requirement for fire flow is based on MPE's *Town of Bentley Water Distribution Analysis*, which is also in line with Lacombe County's fire flow standards. As shown in **Table 2-4**, for the residential areas, a fire flow of 75 L/s with a 2-hour storage is required. For the other non-residential areas, a fire flow of 150 L/s with a 2-hour storage is required.

Table 2-4 Fire Flow Requirements

Land Use Type	Required Fire Flow (L/s)	Required Duration (hours)
Residential	75	2
Non-Residential	150	2

For the Southeast ASP area, the high fire flow criterion (150 L/s) was selected and used in the model as the Southeast ASP mostly consists of commercial and industrial areas. All fire flow events were evaluated with a required duration time as per **Table 2-4**.

2.4.3 PRESSURE REQUIREMENTS

The minimum required pressure that the water network needs to maintain is 300 kPa (44 psi) at ground level under peak demand conditions. When there is a fire in the area, the minimum pressure at the watermain where the fire is occurring should be 140 kPa (22 psi) at ground level. The maximum allowable pressure at the end user water fixture should be less than 620 kPa (90 psi) at ground level.

2.4.4 FLOW VELOCITY

The maximum flow velocity within the distribution system is 1.5 m/s for normal operations (ADD, MDD, PHD). The allowances for higher velocities in water systems during fire flows are commonly made to prevent overdesign of watermains. For this hydraulic analysis, a maximum flow velocity of 2.5 m/s is set for available fire flow calculations under MDD scenario.

2.4.5 HYDRAULIC CALCULATIONS

In the WaterCAD simulation, the 'C' value in the Hazen-Williams equation for all existing and future pipes is set to 130 as an assumption in the model as the some of the existing water main pipe materials are unknown.

The water distribution networks were modeled to examine how the future development will affect the pipes, pumps and reservoir sizing. The model results are used to assist with sizing the pumps.

2.4.6 CRITERIA SUMMARY

The criteria used in the WaterCAD model are summarized in **Table 2-5**.

Table 2-5 Waterworks Design Criteria Summary

Parameter	Value	Unit
Average Daily Demand (ADD)	264	L/cp/d
MDD/ADD Peaking Factor	2	-
PHD/ADD Peaking Factor	4	-
Max. Velocity in pipe in daily flow condition	1.5	m/s
Max. Velocity in pipe in a fire flow condition	2.5	m/s
Hazen-William C	130	-
Minimum pressure during peak	280 (40)	kPa (PSI)
Maximum Desirable Pressure	620 (90)	kPa (PSI)
Minimum Fire Flow Pressure at Main	140 (20)	kPa (PSI)
Design Fire Flow for Residential Area	75	L/s
Design Fire Flow for Non-Residential Area	150	L/s

2.5 Water Demand Calculation

2.5.1 EXISTING WATER DEMAND

The existing water demand is calculated based on the annual water consumption between year 2009 to 2020. The existing water demands are summarized in **Table 2-6**. According to the Government of Alberta

Bentley population data, the Town's average population between 2009 to 2020 is 1,100, which equals to an average daily demand of 264 litres per capita per day (Lpcd).

Table 2-6 Existing Water Demands

Demand Scenarios	Existing Water Demand (L/s)	Existing Water Demand (m3/d)
Average Daily Demand (ADD)	3.36	290
Maximum Daily Demand (MDD)	6.72	580
Peak Hourly Demand (PHD)	13.44	1,161

2.5.2 FUTURE WATER DEMAND

The future water demands are estimated based on the future development areas suggested in the *Town of Bentley's Land Supply and Future Growth Potential* (2013) report for the future north residential and southwest industrial areas, as well as the Southeast ASP land use concept plan provided by PCPS. For the non-residential areas (Southeast ASP and Southwest Industrial areas), an average rate of 0.02 L/s/ha, 0.05 L/s/ha, and 0.1 L/s/ha was used for sensitivity analysis. For the north residential areas, the water demand is calculated based on the existing water demand of 264 Lpcd, and total population growth calculated based the Town of Bentley's *Land Supply and Future Growth Potential* (2013) report, which indicated the demand for the residential land is 12 units per gross developable hectare with the average number of 2.4 persons per dwelling unit. The future water demand is summarized in **Table 2-7** and

Table 2-8.

Table 2-7 Future Non-Residential Water Demand in Southeast and Southwest Areas

Future Non-Residential Development	Total Non-Residential Area (ha)	Q_{ave} Non-Residential (L/s/ha)	ADD (m^3/d)	MDD (m^3/d)	PHD (L/s)
Southeast ASP Area	166.24	0.02	287	575	13.28
		0.05	718	1436	33.24
		0.1	1436	2873	66.48
Southwest Industrial Area	26.32	0.02	45	91	2.12
		0.05	114	227	5.28
		0.1	227	455	10.52

The total PHD flow generated by the southeast and southwest areas ranges from 15.4 – 77 L/s at the fully built out stages, depending on the unit demand rate. The flows are significantly additions to the existing PHD of 13.44 L/s.

Table 2-8 Future Residential Water Demand In North

Future Residential Development	Estimated Total Residential Area (ha)	Estimated Total Population Growth	ADD (m^3/d)	MDD (m^3/d)	PHD (L/s)
North Residential	75.5	2,174	573	1,147	26.36

2.6 Water System Planning

2.6.1 STORAGE REQUIREMENT SENSITIVITY ANALYSIS

Based on the existing and future water demand calculated above, the existing reservoir volume of 1,671 m^3 is not enough to provide sufficient storage for the future demand. **Table 2-9** and **Table 2-10** below summarized the additional storage required using varies average flow rates.

Table 2-9 Additional Storage Required for Average Non-Residential Rate of 0.05 L/s/ha

Storage Type	Formula	Existing Demand	Future SW and SE Demand ($Q_{ave\_non\text{-}residential}$ = 0.05 L/s/ha)	Future North Residential Demand
ADD (m^3/d)		290	832	573
MDD (m^3/d)		580	1,664	1,147
A = Fire Storage (m^3)	Fire Storage (150 L/s for 2 hours)	1,080		
B = Equalization Storage (m^3)	0.25MDD	145	416	287
C = Emergency Storage (m^3)	0.15ADD	44	125	86
Total req. Storage for each area (m3)	S=A+B+C	1,269	1,621	1,453
Total Storage Required (m^3)	S=A+B+C	2,183		
Existing Reservoir Volumes (m^3)	V_{total}	1,671		
Additional Storage Volumes Required (m^3)	S - V_{total}	512		

The existing reservoir storage of 1,671 m^3 is more than the required total volume of 1,269 m^3 for the existing demand.

Based on the sensitivity analysis, another new reservoir with additional storage would be required to meet the demands in the future planned areas.

Table 2-10 Sensitivity Analysis with Various Average Flow Rates

Average Flow Rate Scenario (L/s/ha)	Total Additional Storage Required (m^3)
0.02	187
0.05	512
0.1	1,052

If the demand growth is 3% per year from the current demand of 290 m^3/day to a future demand of 667 m^3/day in the next 30 years, the total storage required would be 1,567 m^3. With a storage volume of 1,671 m^3, the existing reservoir volume can service the existing and future developments with the annual 3% demand increase. It is recommended for the Town to monitor the increasing demand with the new development areas and stage the storage at the new reservoir accordingly.

2.6.2 DISTRIBUTION PLANNING

The future north residential water distribution pipe diameters and network were added to the WaterCAD model and based on the water network shown in the *Summersault Area Structure Plan* (2014) and the *Town of Bentley Water Distribution Analysis* (2009) report. The Southeast ASP area distribution alignments follow the planned future roads shown in PCPS's land use concept plan. Based on the calculated water demands presented in **Table 2-7** and the hydraulic restrictions defined in the Design Criteria section, the future Southeast ASP mains are sized to be 200-300 mm diameter and Southwest Industrial pipes are sized to be 200 mm diameter for the 0.05 L/s/ha scenario. The demands are assigned to the nearest nodes in the distribution system model. It is good practice to loop the watermains when expanding the distribution system to increase the flows and prevent stagnant water or maintenance points.

Water demands can be difficult to estimate for industrial and commercial developments and greatly depend on the nature of the businesses. For example, an industrial storage site could use no water, while at the other end of the spectrum, a meat packing plant can use hundreds or thousands of cubic metres per day. Most municipal design volumes range from 0.10 l/s/ha to 0.69 l/s/ha. Lacombe County's Aspelund Business Park uses only approximately 0.02 l/s/ha. A reference of WaterCAD results with proposed pipe sizes to meet fire flow and pressure design criteria is included in **Appendix B** for 0.02 L/s/ha, 0.05 L/s/ha, and 0.1 L/s/ha scenarios. For this study, 0.05 l/s/ha was selected as a reasonable design basis.

The distribution network will divide into two pressure zones based on the existing ground elevations. The majority of the Town will be in the Upper Pressure Zone which will be operated at a hydraulic grade line (HGL) of 970.5m. Areas lower than 908.5m would have pressures that exceed the desired maximums, so Pressure Reducing Valves (PRV) are proposed to govern the pressures. The proposed ultimate distribution system for 0.05 L/s/ha scenario is presented on **Figure 2-2.**

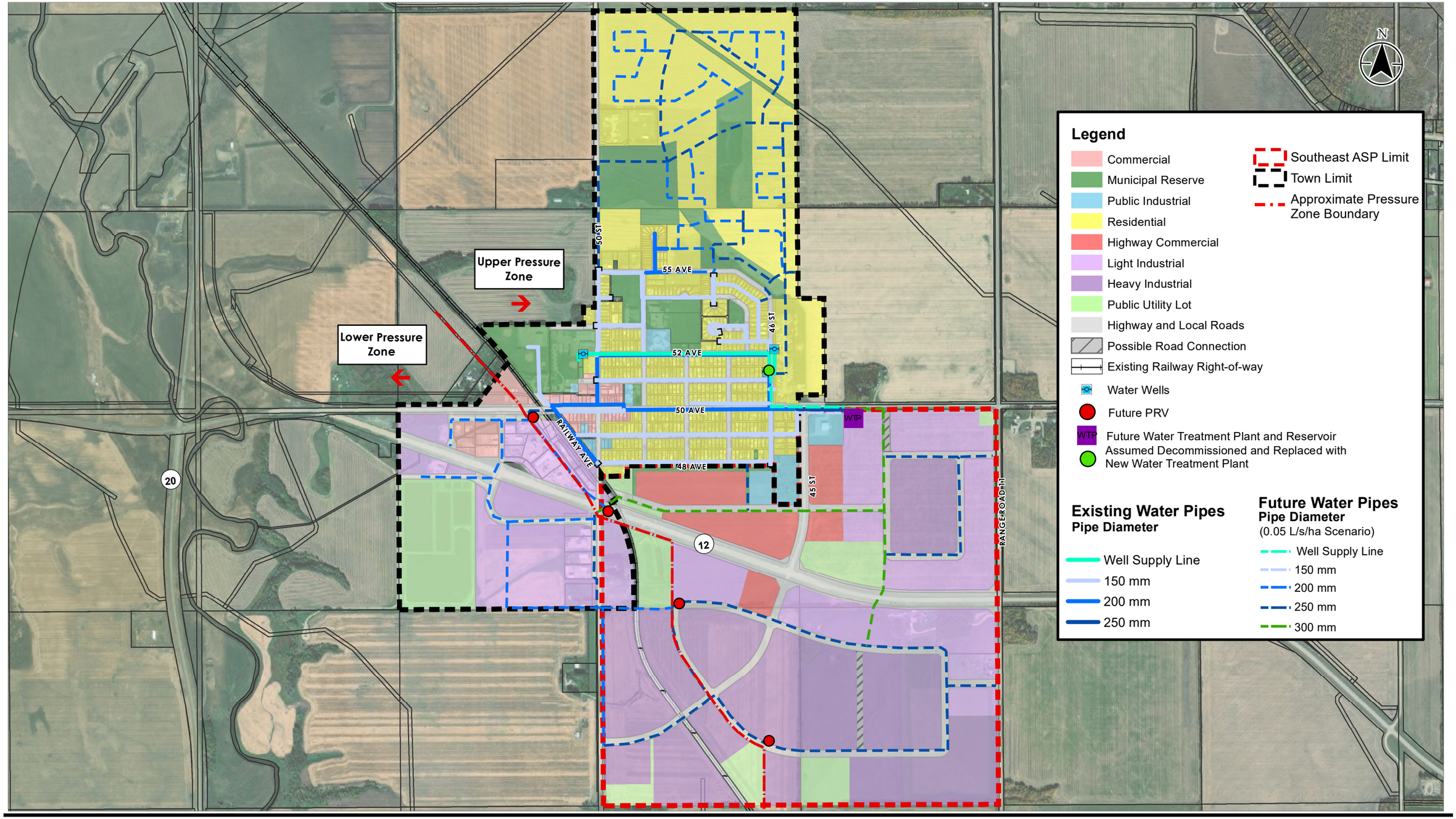
2.6.3 PUMP UPGRADES

To meet the future demand in the planned areas, a new reservoir with additional storage volume as shown in **Table 2-10** is required. Three distribution pumps with one spare distribution pump should be included at the new reservoir for 0.05 L/s/ha scenario with the design pump capacities presented in **Table 2-11**. The design pump capacities shown in **Table 2-11** below would be able to accommodate the pump capacities required for the ultimate buildout when the existing reservoir and pumps are decommissioned.

Table 2-11 Design Pump Capacities

	Each Pump Design Capacity
Distribution Pump (3 plus 1 spare pump)*	50 L/s at 42 m head (45 HP)

*Note that for 0.1 L/s/ha scenario, four distribution pumps plus one spare pump will be needed.



Stantec

Town of Bentley

Lacombe County

0 150 300 450 600 metres

(At original document size of 11x17)
1:15,000

Notes
1. Coordinate System: NAD 1983 UTM Zone 11N
2. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Client/Project
110170040 - REVA
Town of Bentley
Servicing Assessment

Prepared by AL on 2022-06-01
TR by BVH on 2022-06-01

Figure No.
2-2

Title
Water Servicing - Ultimate Conditions

V:\1101\active\110170054\drafting\figures\civil\110170054_fig2-2_bentley_ultimate_water_2022.mxd Revised: 2022-06-01 By: alieles

3 Wastewater Servicing

3.1 Wastewater Servicing Study Description

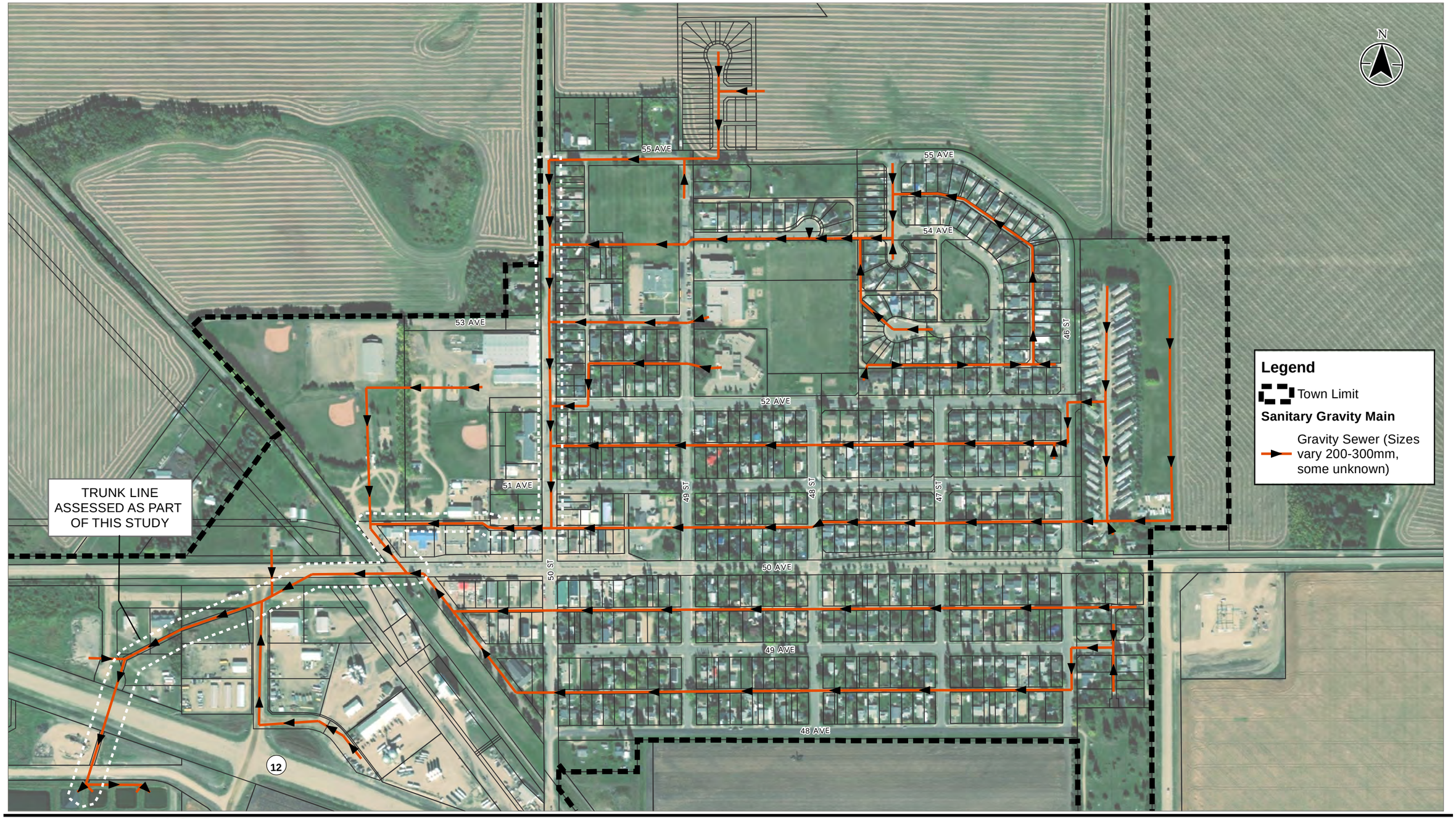
The wastewater servicing study is focused on the conceptual design of the sanitary sewer trunks (sizing and alignments) within the Southeast ASP boundary. This study also includes an evaluation of the existing wastewater lagoon capacity based on projected wastewater flows from the existing and proposed developments. The future north residential development also has been considered as part of this study to evaluate the need for upsizing the existing main trunk along 50th Street. The conceptual designs will provide a valuable guideline to be followed during for future planning and development activities. The Town and future developers will need to consider that the concept developed in this study represents a reasonable plan for the ultimate buildout of the proposed developments. For each individual development, depending on its specific location, interim facilities and infrastructures may be required to service the development.

The hydraulic aspect of the system was analyzed using the PCSWMM model which includes a small portion of the existing sewer trunk along 50th Street to the lagoon and the future Southeast ASP area.

3.2 Existing Conditions

3.2.1 EXISTING SANITARY SYSTEM

The Town's sanitary network generally flows by gravity from east to west. The flows are generally all directed into an important trunk that crosses the CP Railway tracks on 50th Avenue. The Town's existing sanitary sewer main trunk alignment along 50th Street to the lagoon was constructed in PCSWMM and based on the Town of Bentley 2011 Infrastructure Map Book and other record information. The existing sewer trunk between 51st Avenue and 50th Avenue west of the 50th Street is updated based on the Town's 2016 Capital Project Schedule A as-built drawing dated December 2016. As the 2011 Infrastructure Map book does not contain pipe invert elevations and manhole rim elevations, the existing sewer trunk along 50th Street is based on the existing manhole depths and pipe diameters were provided by the Town, the contour was provided by PCPS. Stantec also conducted a survey for the existing sewer trunks west of the railway track and updated pipe diameters and invert elevations based on the surveyed data. The existing sanitary network is presented on **Figure 3-1**.



Stantec

Town of Bentley

Lacombe County

0 50 100 150 200 metres

(At original document size of 11x17)
1:5,000

Notes
1. Coordinate System: NAD 1983 UTM Zone 11N
2. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Client/Project
110170040 - REVA
Prepared by AL on 2022-04-05
TR by BVH on 2022-04-05

Town of Bentley
Servicing Assessment

Figure No.
3-1

Title
Sanitary Servicing - Existing Conditions

3.2.2 EXISTING WASTEWATER LAGOON

The existing lagoon is located at the southwest corner of the municipal limits. According to the Town's Wastewater Treatment Facility Upgrade site plan (Dec 16, 1998), the existing lagoon has a passive lagoon configuration, consisting of anaerobic cells, facultative cells, and storage cells, as defined in Alberta Environment and Parks' design standards and guidelines. The parameters of the lagoon cells are presented in **Table 3-1**.

Table 3-1 Existing Bentley Lagoon System Cells

Cells	Number	Water depth (m)	Water volume (m^3)	Rated Capacity (m^3/d)
Anaerobic Cells	4	3.05	5,146	643
Facultative Cells	2	1.5	36,157	603
Storage Cells	2	2.44	217,036	595

The operation of the existing lagoon system is under the code of practice, which allows one discharge per year.

3.3 Design Criteria

The design criteria and assumptions for wastewater servicing are listed below:

- based on the average daily influent flow from the 2014 to 2021 influent meter records, the existing average daily sanitary flow is estimated to be 331 m^3/day. With the current population of 1085, the resulting per capita wastewater generation rate is 305 liters per capita per day. Note that is wastewater per capita generation rate is higher than the water consumption rate 264 Lcpd as in Section 2.3.1, which implies the Inflow and Infiltration flow to the sanitary sewer is high.
- An inflow and infiltration (I&I) allowance of 0.28 L/s/ha is applied to peak Wet Weather Flow (WWF).
- A peaking factor of 3.0 is used to determine the peak flow rate.

3.4 Wastewater Flow Calculation

3.4.1 EXISTING WASTEWATER FLOW

Based on the sewer areas that are contributing to the main sewer trunk manholes, the estimated existing wastewater flows are shown in **Table 3-2** below.

Table 3-2 Estimated Existing Wastewater Flow

MH ID	Existing Wastewater Flow (L/s)	Infiltration & Inflow Allowance (L/s/ha)	Peak DWF (L/s)	Peak WWF (L/s)
SA 90	0.09	0.28	0.26	0.69
SA 91	0.01		0.02	0.06
SA 86	0.43		1.28	3.39
SA 67	0.09		0.26	0.69
SA 64	0.14		0.41	1.10
SA 59	0.46		1.37	3.62
SA 41	0.64		1.93	5.11
SA 48	0.62		1.87	4.95
SA 16	0.40		1.19	3.15
SA 17	0.37		1.12	2.98
SA10	0.53		1.58	4.20
SA 3	0.06		0.19	0.49
		Total	**11.48**	**30.42**

3.4.2 FUTURE WASTEWATER FLOW

The future wastewater flows are calculated based on the future North Residential, Southeast ASP, and Southwest Industrial areas. Similar to the future water demand calculation, alternative average design flow rates of 0.02 L/s/ha, 0.05 L/s/ha, and 0.1 L/s/ha were analyzed for the sensitivity test. The future wastewater flows are summarized in **Table 3-3** and **Table 3-4** below.

Table 3-3 Future Non-Residential Wastewater Flow

Future Non-Residential Development	Total Non-Residential Area (ha)	Q_{ave} Non-Residential (L/s/ha)	Q ave Non-Resid (m^3/d)	Infiltration & Inflow Allowance (L/s/ha)	Peak DWF (L/s)	Peak WWF (L/s)
Southeast ASP (Industrial and Commercial Areas)	166.24	0.02	287	0.28	9.97	56.52
		0.05	718		24.94	71.48
		0.1	1,436		49.87	96.42
SW Industrial	26.32	0.02	45	0.28	1.58	8.95
		0.05	114		3.95	11.32
		0.1	227		7.90	15.27

Table 3-4 Future North Residential Wastewater Flow

Future Residential Development	Estimated Total Residential Area (ha)	Estimated Total Population Growth	Q ave Resid (m^3/d)	Infiltration & Inflow (I&I) Allowance (L/s/ha)	Peak DWF (L/s)	Peak WWF (L/s)
North Residential	75.5	2,174	663	0.28	23.01	44.14

Note that the project peak estimated wastewater flows are very high due to the estimated inflow and infiltration (I&I) allowance. The Town may want to consider completing flow monitoring to increase the accuracy of these estimates.

3.5 Future Sanitary Sewer System

3.5.1 LAGOON CAPACITY SENSITIVITY ANALYSIS

As the existing lagoon system's capacity is rated at 595 m^3/day, significant upgrades on the lagoons are needed to accommodate the projected flows in **Table 3-3** and **Table 3-4**. With a current average flow of 331 m^3/d, it is expected that the lagoon can support the future developments to up 2041 (20 years) if the developments lead to an annual wastewater flow growth rate of 3%. The existing surplus capacity 264 m^3/d is equivalent to 37% of the full average flow of the SE development area which is based on 0.05 L/s/ha.

The existing lagoon can support the existing and future growth beyond 20 years if:

- The annual wastewater flow growth rate is less than 3%
- The Town carry out an I&I reduction program, including a sanitary sewer flow monitoring program and sanitary sewer system integrity improvement program, to lower the existing I&I flows
- The actually I&I flow in the new sewers are less than the I&I allowance of 0.28 L/s/ha

Based on the existing and future average daily wastewater flows, the Town's existing lagoon would need to be expanded to accommodate the future development using average non-residential flow rates of 0.02 L/s/ha, 0.05 L/s/ha, and 0.1 L/s/ha as shown in **Table 3-5**.

Table 3-5 Lagoon Capacity Sensitivity Analysis

	$Q_{ave\_non\text{-}residential}$ = 0.02 L/s/ha Scenario	$Q_{ave\_non\text{-}residential}$ = 0.05 L/s/ha Scenario	$Q_{ave\_non\text{-}residential}$ = 0.1 L/s/ha Scenario
Existing Sanitary Average Daily Flow (m^3/day)	331		
Future North Residential Sanitary Average Daily Flow to Lagoon (m^3/day)	663		

	$Q_{ave\_non-residential}$ = 0.02 L/s/ha Scenario	$Q_{ave\_non-residential}$ = 0.05 L/s/ha Scenario	$Q_{ave\_non-residential}$ = 0.1 L/s/ha Scenario
Future Southwest and Southeast Sanitary Average Daily Flow to Lagoon (m^3/day)	333	832	1,664
Total Existing and Future Sanitary Average Daily Flow (m^3/day)	1,326	1,825	2,627

At full buildout, additional lagoon cells are needed to increase the lagoon's capacity. Based on the medium non-residential wastewater generation rate of 0.05 L/s/ha, the required lagoon cells volumes are presented in **Table 3-6**.

Table 3-6 Required Lagoon Cells Volumes for 0.05 L/s/ha Scenario

Cells	Existing Cell Water volume (m^3)	Ultimate required volume (m^3)	Proposed new cells volume (m^3)
Anaerobic Cells	5,146	14,600	9,454
Facultative Cells	36,157	109,500	73,343
Storage Cells	217,036	666,125	449,089

The estimated area for construction of the proposed new lagoon cells is 28 Ha. The proposed lagoon cells are presented on **Figure 3-2.**

3.5.2 FUTURE WASTEWATER NETWORK

3.5.2.1 Southeast ASP Area

Following the local road network included in the PCPS's conceptual future land use concept map, a schematic future Southeast ASP area sanitary sewer network is presented on **Figure 3-2**. To avoid the need to construct deep manholes, which can be costly and more challenging for maintenance, it is proposed to have the southwest portion to be under a low-pressure force main system. The rest of the Southeast ASP area is proposed to be under gravity system. In general, the sanitary sewers are proposed to be at the fronts of the lots for conceptual illustration. It is proposed to have the trunk north of Highway 12 join trunk the south of Highway 12 at 50th Street.

As noted in Section 2.6.2, the design water consumption rate is 0.05 l/s/ha. To supplement the decision and design considerations, a sensitivity analysis was completed for the 0.02 l/s/ha, 0.05 l/s/a, and 0.10 l/s/ha scenarios. The proposed pipe diameters are summarized in **Table 3-7**. The rest of the non-trunk sewers within the local roads would have adequate capacities with 200 mm pipes, but there is little cost difference to upsize those to be 250 mm, so 250 mm diameter pipes are recommended to accommodate potentially larger water consumers.

Table 3-7 Proposed Sewer Trunk Sizes in Southeast ASP Area

Future Sewer Pipe Location	Pipe Diameter (mm) $Q_{ave\_non\text{-}residential}$ = 0.02 L/s/ha Scenario	Pipe Diameter (mm) $Q_{ave\_non\text{-}residential}$ = 0.05 L/s/ha Scenario	Pipe Diameter (mm) $Q_{ave\_non\text{-}residential}$ = 0.1 L/s/ha Scenario
Trunks from 50th Street to Lagoon	375	450	450
Along 50 Street (South of Highway 12)	300	300	375
Remaining Sewer Trunks along Local Roads	250	250	250

3.5.2.2 Existing Network Upsizing

Based on the estimated future sanitary flows from the North Residential area, the model result shows that the existing 200 mm trunk along 50th Street, north of 50th Avenue, cannot accommodate the future north residential growth. It is recommended for the Town to upsize the existing 200 mm sewer trunks along 50 Street (from SA 90 to SA 41) to 300 mm. The proposed pipe diameters are summarized in **Table 3-8** to accommodate the future north residential growth.

Table 3-8 Proposed Existing Network Upsizing

Existing Sewer Pipe Location	Existing Pipe Diameter (mm)	Proposed Pipe Diameter (mm)
Along 50th Street (From SA 90 to SA 41)	200	300

EXISTING LINE TO BE UPSIZED TO 300MM DIAMETER

CAN BE A 250mm GRAVITY MAIN OR A 75MM LOW PRESSURE FORCE MAIN

50 ST
55 AVE
46 ST
52 AVE
50 AVE
RAILWAY AVE
48 AVE
45 ST
RANGE ROAD 11
20
12

N

Legend

- Manhole

Existing

- Gravity Sewer (Sizes vary 200-300mm, some unknown)
- Trunk Line (Assessed as part of this study)
- Manholes

Future

- (250mm)
- (300mm)
- (450mm)
- Future Lagoon Expansion (0.05 L/s/ha Scenario)

Boundaries

- Southeast ASP Limit
- Town Limit

Existing and Future Land Use

- Commercial
- Highway Commercial
- Heavy Industial
- Light Industrial
- Municipal Reserve
- Public
- Public Utility Lot
- Residential
- Roads
- Possible Road Connection
- Railway

Stantec

Town of Bentley

Lacombe County

0 150 300 450 600 metres

(At original document size of 11x17)
1:15,000

Notes
1. Coordinate System: NAD 1983 UTM Zone 11N
2. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Client/Project
110170040 - REVA
Town of Bentley
Servicing Assessment
Prepared by AL on 2022-06-01
TR by BVH on 2022-06-01

Figure No.
3-2

Title
Sanitary Servicing - Ultimate Conditions

V:\1101\active\110170054\drafting\figures\cad\110170054_fig3-2_bentley_ultimate_sanitary_2022.mxd Revised: 2022-06-01 By: aletee

4 Stormwater Management

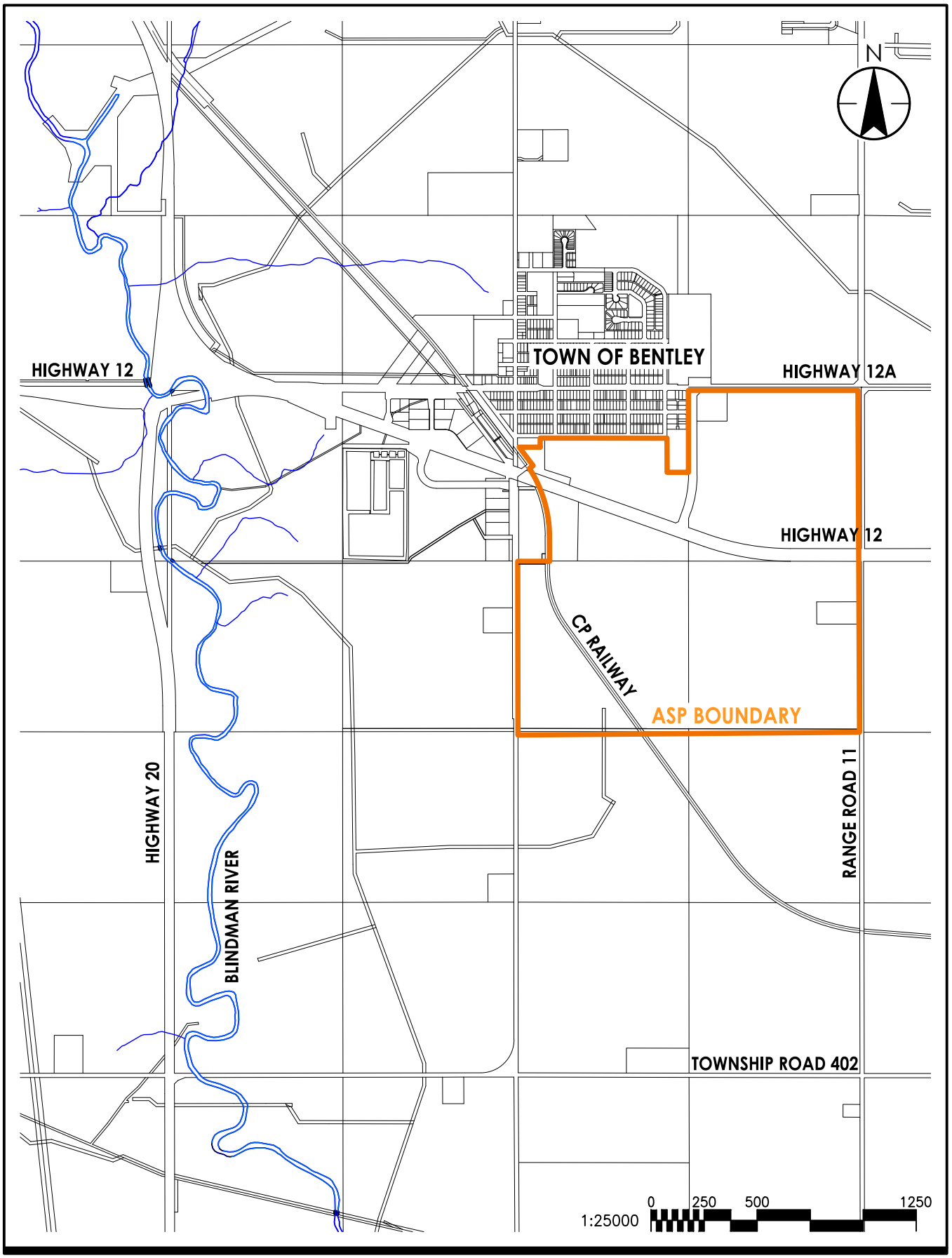
4.1 Introduction

4.1.1 STUDY DESCRIPTION

This stormwater servicing study (SWSS) was prepared by Stantec Consulting Ltd. (Stantec) on behalf of The Town of Bentley (Client) in support of the Southeast Area Structure Plan (ASP) being completed by Parkland Community Planning Services (PCPS). This storm servicing study is part of an overall servicing study that will ultimately provide recommendations for the water, wastewater, stormwater, and transportation infrastructure required to accommodate the long-term development of the ASP area. **Figure 4-1,** provided at the end of section 4.0 shows the ASP area relative to the existing Town of Bentley, and includes the bulk of Section 23, Range 40, Township 01, W5M.

4.1.2 EXISTING STUDIES

In 2010 Stantec was the consultant for the Bentley Roads Program which resulted in roadway and drainage improvements throughout a significant portion of the Town. In particular, a significant portion of the existing roadways were converted from ditch and culvert drainage systems to curb and gutters and storm sewers. That work also included the construction of a new storm pond located south of Highway 12 in the southwest corner of the NW quarter of Section 23, Range 40, Township 1, W5M. The stormwater analysis and design completed for that project was summarized in the report entitled “Bentley Roads Program Stormwater Management Plan Addendum 1, February 24, 2010”. The storm pond constructed in 2010 (P_NW_Interim) was configured to be expanded for future development in the area which has now evolved into the Southeast ASP.



\\Cd1044-f06\work_group\1101\active\110170054\drafting\drawings\current\figures\Figure.dwg
2021/11/10 11:13 PM By: Dardis, Brad

Stantec

FIGURE 4.1
LOCATION PLAN
BENTLEY SE ASP
STORMWATER SERVICING STUDY

4.1.3 EXISTING CONDITIONS

The ASP area is largely undeveloped and is utilized for small grain agricultural and hay production. It has the existing Town and 50 Avenue on its north border, Range Road 11 on its east border, Range Road 12 on its west border, and farm land on its south border. Please also see **Figure 4-4**. The study area largely drains from northeast to southwest at approximately 2%, and from 943 m to 898 m in elevation. The Blindman River is located approximately 1.3 km west of the west boundary of the study area. The recently constructed Highway 12 (year ~ 2011) runs southeast to northwest through the north half of Section 23, Range 40, Township 1, W5M, and the Canadian Pacific Railway runs southeast to northwest through the west half of Section 23.

The north half of the ASP area currently drains northeast to southwest through three existing culverts under the CP railway which are located in the southwest quadrant of the northwest quarter section of Section 23. The three CP railway culverts are 600 mm, 600 mm, and 900 mm in diameter and further drain east to west through existing 900 mm and 800 mm diameter culverts that drain under Range Road 12. The north half of the ASP area also drains north to south under Highway 12 through an existing 2400 mm diameter culvert that is located immediately north of the existing storm pond (P_NW).

The south half of the ASP area currently drains northeast to southwest through four existing culverts that drain under the CP railway line; 3 x 400 mm and 1 x 600 mm in diameter. However, the bulk of the south half of the ASP area drains through the existing 600 mm diameter culvert under the CP railway which is located on the south boundary of the southwest quarter section of Section 23. The 600 mm diameter CP railway culvert further drains east to west through an existing 900 mm diameter culvert located under Range Road 12.

The analysis completed as part of this study suggests that the existing CP railway and Range Road 12 culverts have sufficient conveyance capacity to facilitate development within the ASP area; however, drainage ROWs are proposed in later report sections to ensure that development runoff can access these existing culverts.

4.2 Methodology and Input Data

4.2.1 STUDY OBJECTIVES

The objective of this study is to demonstrate that the proposed future development will meet Alberta Environment and Parks (AEP) and Town of Bentley (Town) criteria for pre-development discharge rate and water quality improvement. It will also define several storm ponds located within the study area.

PCSWMM single event modeling was used to demonstrate that the proposed storm ponds will provide sufficient active storage volume to meet the pre-development release rate such that there is no uncontrolled spill for up to and including a 1:100 year design storm event.

4.2.2 COMPUTER MODEL

The PCSWMM computer model (Version 7.3.3080) was used in this study to perform single event analysis. PCSWMM has a proprietary graphical user interface developed by Computational Hydraulics, Inc. (CHI) in Guelph, Ontario, but is based on the EPA SWMM5 computational engine.

The PCSWMM can utilize steady state, kinematic wave or full dynamic wave routing methods which can take into account various hydrologic processes, such as precipitation, evaporation, snow accumulation and melting. By providing input data on rainfall and land use, the PCSWMM model can be used to generate runoff for specific catchments. Algorithms in PCSWMM can then be used to model the conveyance of runoff through pipes or in open channels, and reservoir routing can also be done to represent the attenuating effects of storage found in roadway traplows and/or stormwater management facilities.

4.2.3 DESIGN STORM

A Chicago design storm with a one in one-hundred (1:100) year return period, storm duration of 24 hours, and with a 5 minute time increment, was used to analyze the storm pond storage requirements.

Rainfall intensities for the Chicago distribution were determined from an intensity-duration-frequency (IDF) relationship that is described as

$$i = a / (t + b)^c \qquad [1]$$

where i is intensity (mm/hr), a, b and c are IDF parameters and t is the time duration (minutes). The time to storm peak is determined by

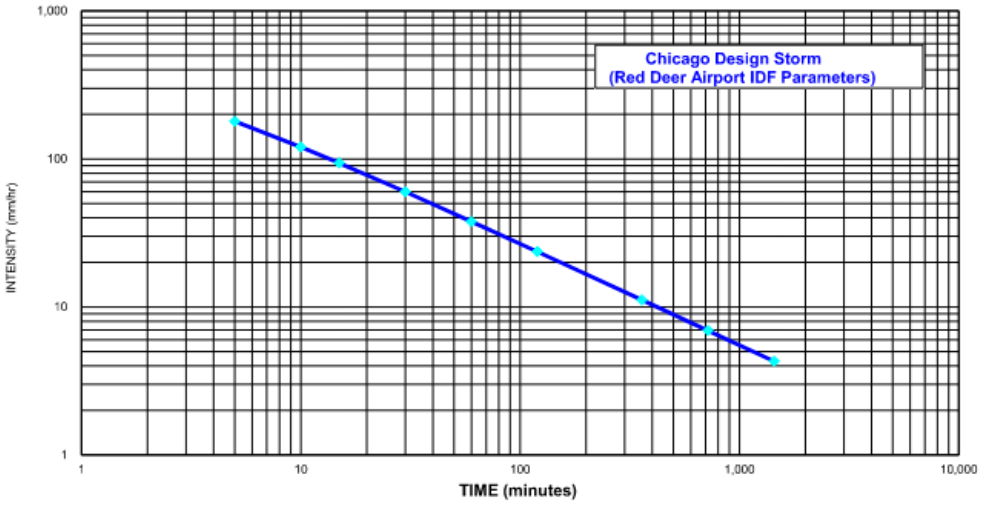
$$tp / td = r \quad \text{or} \quad tp = r(td) \qquad [2]$$

where tp is the time to peak and r is the ratio of time to peak versus storm duration, td.

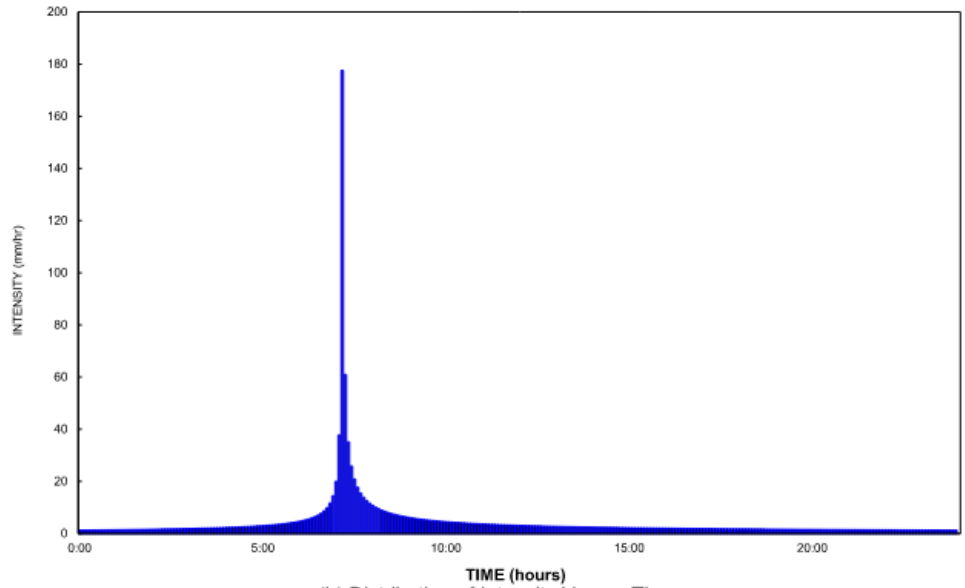
The following parameters were used to generate the Chicago design storm, and these parameters were developed from the Environment Canada IDF data for the Red Deer Regional Airport (3025481), with data from 1959 – 2012. Please see **Figure 4-2** on the following page for a graphical representation of the 1:100 year Chicago design storm utilized to design and analyze the proposed storm ponds.

a = 644.60 b = 1.41 c = 0.689 r = 0.30 (1:100 year)

Figure 4-2 Chicago Design Storm



(a) Intensity-Duration Relationship



(b) Distribution of Intensity Versus Time

A: 644.6
B: 1.41
C: 0.689
r: 0.3

Stantec

chicago_CRD_2012data.xls

Figure No.

Title

Chicago Design Storm
24 Hour, 1:100 Year

4.2.4 HYDROLOGIC PARAMETERS

The PCSWMM computer modeling estimated the infiltration over pervious surfaces based on Horton's Method. Horton's equation and the various parameters are as defined below:

$$f = fc + (fo - fc)e^{-k(t)} \text{ where,}$$

f = infiltration rate at time t (mm/hr)

fc = final infiltration rate (mm/hr)

fo = initial infiltration rate at the start of the storm (mm/hr)

k = decay rate (t^{-1})

t = time since initial infiltration rate

Based on Stantec's local knowledge, the study area is expected to have largely impervious sub-soils such as clays and/or tills. Therefore, the computer modeling has assumed relatively conservative Horton's infiltration parameters which result in relatively low stormwater infiltration rates. The utilized model infiltration parameters are as outlined in **Table 4-1** below.

Table 4-1 Hortons Parameters

Parameter	Unit	Value
Depression Storage		
Pervious Area	mm	5.0
Impervious Area	mm	2.0
Manning's Coefficient		
Pervious Area	n/a	0.250
Impervious Area	n/a	0.015
Infiltration		
Initial Rate	mm/hr	75
Final Rate	mm/hr	5.0
Decay Factor	1/hr	4.14

4.3 Proposed Stormwater Management

4.3.1 PRE-DEVELOPMENT RELEASE RATE

Pre-development flow rates were estimated by performing a regional frequency analysis on twelve gauged basins that are believed to have similar hydrologic characteristics to the study area. This

approach is considered more appropriate than determining pre-development flow rates through computer modeling alone because the later approach typically overestimates pre-development flow rates.

Table 4-2 below shows the selected gauged basin information including basin area and historical period of record. Frequency analysis was performed on Mean Daily Flow (MDF) annual maximum discharges. For some years of the available record MDF annual maxima were not available; therefore, a relationship with Instantaneous Peak Flow (IPF) annual maxima was developed, such that the missing MDF annual maxima could be infilled.

Table 4-2 Gauged Basins

Station #	Water Survey of Canada (WSC) Station	Basin Area (km^2)	Annual Maxima Count**
1	Raven River near Raven 05CB004	634.1	41
2	Blindman River near Blackfalds 05CC001	1459.1	59
3	Medicine River near Eckville 05CC007	1857.3	52
4	Lloyd Creek near Bluffton 05CC009	238.8	31
5	Block Creek near Leedale 05CC010	56.8	33
6	Waskasoo Creek at Red Deer 05CC011	250.0	24
7	Haynes Creek near Haynes 05CD006	165.0	32
8	Ray Creek near Innisfail 05CE010	44.4	35
9	Renwick Creek near Three Hills 05CE011	58.1	29
10	Threehills Creek below Ray Creek 05CE018	137.6	27
11	Battle River near Ponoka 05FA001	1551.4	64
12	Pipestone Creek near Wetaskiwin 05FA012	732.8	26

** Some Mean Daily Flow annual maxima were infilled using Instantaneous Peak Flow annual maxima

Statistical frequency analysis was performed using the HydroFreq software package. HydroFreq uses statistical analysis to predict hydrologic event magnitude and frequency based on historical data. HydroFreq performs statistical frequency analysis using the Extreme Value Type I (Gumbel), Log-Normal Type III, Log-Pearson Type III, and Pearson Type III distributions, to predict events with return periods of 2 to 100 years.

Table 4-3 and **Table 4-4** on the following pages show the results of the frequency analyses performed on the selected basins. In particular, **Table 4-4** shows the various return period flows as Unit Area Release Rates (UARR).

Table 4-3 Frequency Analysis Results

				Return Period Maximum (Mean Daily Flows)					
Station #	**Water Survey of Canada (WSC) Station**	**Basin Area (km^2)**	**Distribution & Fitting Method**	**1:2 (m^3/s)**	**1:5 (m^3/s)**	**1:10 (m^3/s)**	**1:25 (m^3/s)**	**1:50 (m^3/s)**	**1:100 (m^3/s)**
1	Raven River near Raven 05CB004	634.1	Gumbel (GEV) L-Moments	14.83	24.22	31.71	42.94	52.75	63.95
2	Blindman River near Blackfalds 05CC001	1459.1	Gumbel (GEV) L-Moments	48.45	91.01	127.58	186.21	240.90	306.93
3	Medicine River near Eckville 05CC007	1857.3	Gumbel (GEV) L-Moments	60.51	104.52	137.95	185.82	225.89	269.96
4	Lloyd Creek near Bluffton 05CC009	238.8	Gumbel (GEV) L-Moments	9.33	19.72	29.38	46.05	62.71	84.06
5	Block Creek near Leedale 05CC010	56.8	Gumbel (GEV) L-Moments	2.00	4.11	6.12	9.66	13.28	18.01
6	Waskasoo Creek at Red Deer 05CC011	250.0	Gumbel (GEV) L-Moments	7.29	14.13	19.36	26.90	33.26	40.30
7	Haynes Creek near Haynes 05CD006	165.0	Gumbel (GEV) L-Moments	2.21	5.05	7.67	12.16	16.61	22.28
8	Ray Creek near Innisfail 05CE010	44.4	Gumbel (GEV) L-Moments	1.16	2.51	3.70	5.67	7.56	9.91
9	Renwick Creek near Three Hills 05CE011	58.1	Gumbel (GEV) L-Moments	1.14	2.39	3.51	5.40	7.24	9.54
10	Threehills Creek below Ray Creek 05CE018	137.6	Gumbel (GEV) L-Moments	5.33	10.66	14.46	19.59	23.65	27.91
11	Battle River near Ponoka 05FA001	1551.4	Gumbel (GEV) L-Moments	28.07	54.49	75.15	105.52	131.60	160.92
12	Pipestone Creek near Wetaskiwin 05FA012	732.8	Gumbel (GEV) L-Moments	8.21	17.93	26.35	39.99	52.83	68.44

Table 4-4 Frequency Analysis Results (UARR)

				Unit Area Release Rates (UARR)					
Station #	**Water Survey of Canada (WSC) Station**	**Basin Area (km^2)**	**Distribution & Fitting Method**	**1:2 (m^3/s)**	**1:5 (m^3/s)**	**1:10 (m^3/s)**	**1:25 (m^3/s)**	**1:50 (m^3/s)**	**1:100 (m^3/s)**
1	Raven River near Raven 05CB004	634.1	Gumbel (GEV) L-Moments	0.23	0.38	0.50	0.68	0.83	1.01
2	Blindman River near Blackfalds 05CC001	1459.1	Gumbel (GEV) L-Moments	0.33	0.62	0.87	1.28	1.65	2.10
3	Medicine River near Eckville 05CC007	1857.3	Gumbel (GEV) L-Moments	0.33	0.56	0.74	1.00	1.22	1.45
4	Lloyd Creek near Bluffton 05CC009	238.8	Gumbel (GEV) L-Moments	0.39	0.83	1.23	1.93	2.63	3.52
5	Block Creek near Leedale 05CC010	56.8	Gumbel (GEV) L-Moments	0.35	0.72	1.08	1.70	2.34	3.17
6	Waskasoo Creek at Red Deer 05CC011	250.0	Gumbel (GEV) L-Moments	0.29	0.57	0.77	1.08	1.33	1.61
7	Haynes Creek near Haynes 05CD006	165.0	Gumbel (GEV) L-Moments	0.13	0.31	0.46	0.74	1.01	1.35
8	Ray Creek near Innisfail 05CE010	44.4	Gumbel (GEV) L-Moments	0.26	0.57	0.83	1.28	1.70	2.23
9	Renwick Creek near Three Hills 05CE011	58.1	Gumbel (GEV) L-Moments	0.20	0.41	0.60	0.93	1.25	1.64
10	Threehills Creek below Ray Creek 05CE018	137.6	Gumbel (GEV) L-Moments	0.39	0.77	1.05	1.42	1.72	2.03
11	Battle River near Ponoka 05FA001	1551.4	Gumbel (GEV) L-Moments	0.18	0.35	0.48	0.68	0.85	1.04
12	Pipestone Creek near Wetaskiwin 05FA012	732.8	Gumbel (GEV) L-Moments	0.11	0.24	0.36	0.55	0.72	0.93
	Average (L/s/ha)			0.27	0.5	0.7	1.1	1.4	**1.8**

The results from the individual station frequency analyses were plotted on a Discharge versus Basin Area graph, and an exponential regression analysis done for the 1:100 year return period, and this graph is provided as **Figure 4-3** on the following page. The result of the regression analysis generated the relationship shown in **Table 4-5** below which provides a method of calculating the regional pre-development release rate as a function of basin area. This relationship shows that the unit area release rate increases as basin areas decreases. However, there is a limit as to how small a basin can be made and still have these relationships hold up. For the study area we are proposing to use a representative basin area of 10 km^2, which results in the pre-development release rate shown in **Table 4-6** below.

Table 4-5 1:100 Year Regional Discharge as a Function of Basin Area

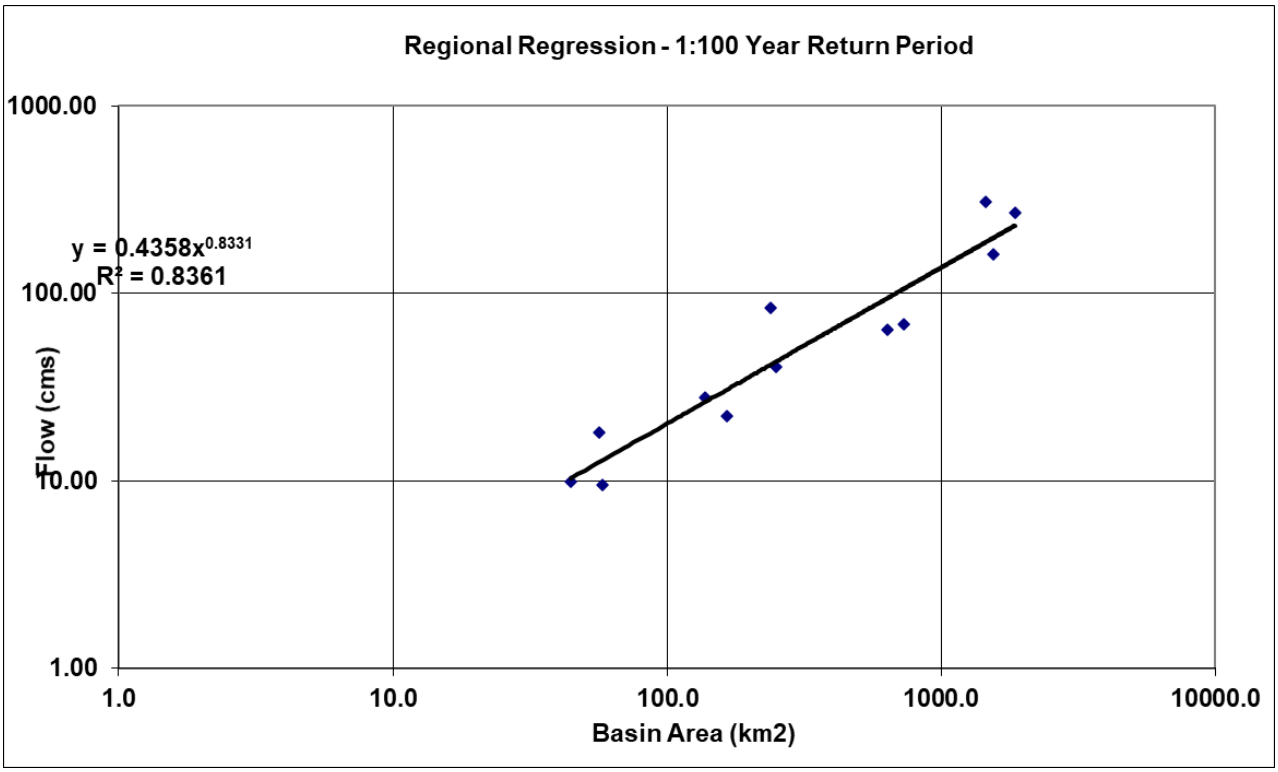
$Q_{100} = 0.4358 \times A^{0.8331}$	$R^2 = 0.8361$

Table 4-6 Estimated 1:100 Year Pre-Development Release Rate

Return Period (Years)	Unit Area Release Rate (L/s/ha)
100	3.0

Based on the results of the regional frequency analysis, a 1:100 year pre-development release rate of 3.0 L/s/ha is proposed for the study area. Providing Discharge Rate Control in Alberta is typically met through the use of stormwater management facilities, and this is the predominate type of treatment that is proposed for the study area. Please note that the existing Town and the relevant Highway 12 sub-catchments were previously approved (2010) at a pre-development release rate of 4.0 L/s/ha; therefore, some of the proposed stormwater management facilities have a composite pre-development release rate that will be outlined in later report sections.

Figure 4-3 Regional Analysis Regression 1:100 Year Return Period



4.3.2 STUDY AREA HYDROLOGY

The study area sub-catchments were delineated based upon LIDAR data provided by Parkland Community Planning Services, and as shown on **Figure 4-4**, provided at the end of this report sub-section. The proposed drainage paths and sub-catchment boundaries essentially match those found for existing conditions; therefore, **Figure 4-4** can be used to reference both existing and proposed configurations.

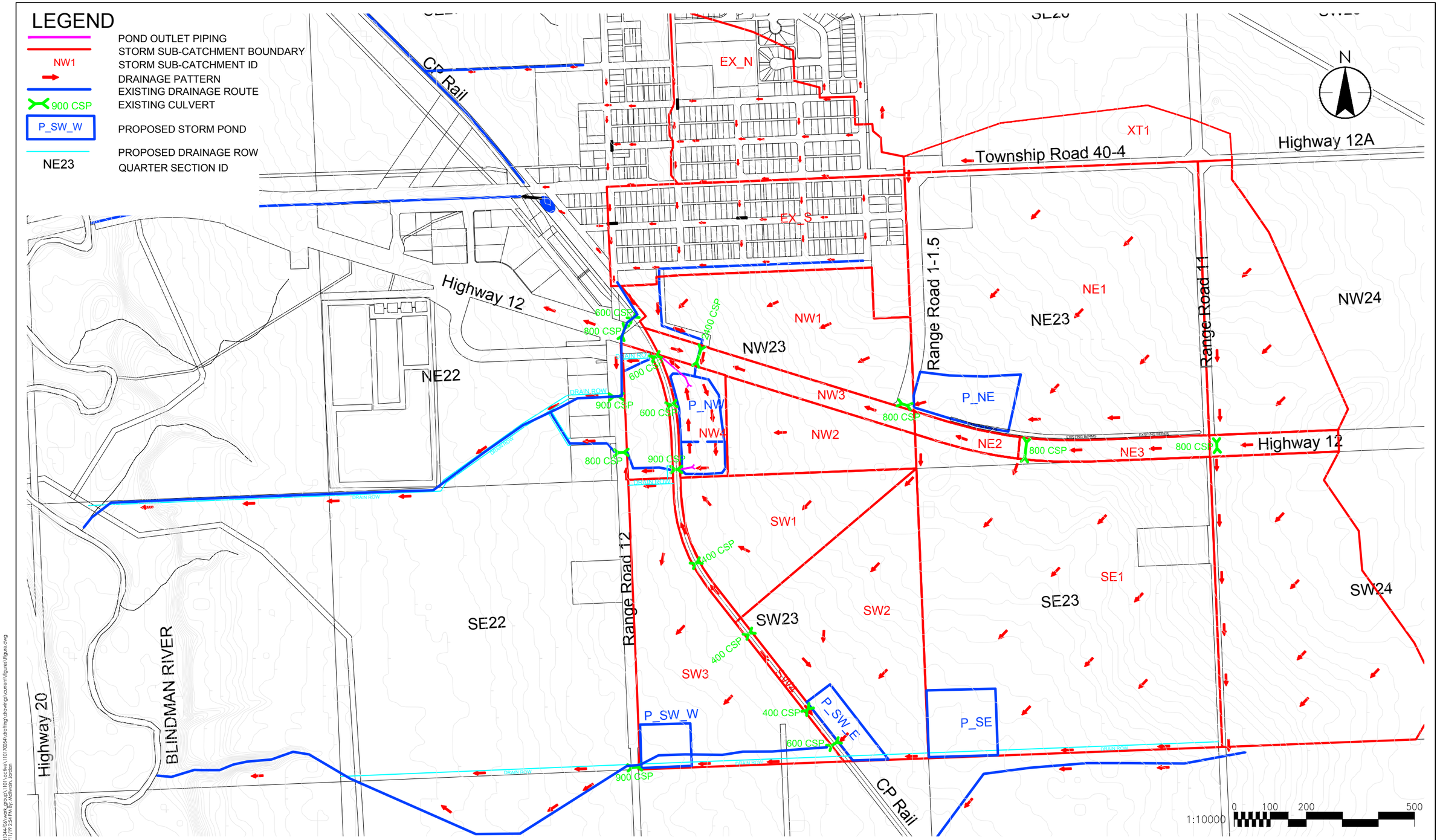
The two most significant characteristics that have an effect on peak flow generation and volume of stormwater runoff are the catchment area and the ratio of impervious to pervious surfaces (Impervious Ratio) within a catchment. The basin specific hydrologic characteristics used in the PCSWMM hydrologic analysis for post development conditions can be found in **Table 4-7** below, and the second last column shows the total runoff depth that was modeled for the 1:100 year, 24 hour duration storm.

Please note that the existing Town and the relevant Highway 12 sub-catchments were previously approved in 2010 at a pre-development release rate of 4.0 L/s/ha; therefore, some of the proposed stormwater management facilities have a composite pre-development release rate that will be outlined in

later report sections. The last column in **Table 4-7** shows the proposed pre-development release rate for each sub-catchment.

Table 4-7 Sub-Catchment Area Hydrology

Catchment ID	Catchment Area Description	Design Rainfall Event Return Period and Duration	Rainfall Depth (mm)	Catchment Area (ha)	Composite Impervious Ratio %	Runoff Depth (mm)	Pre-Dev. Rate (L/s/ha)
Ex_N	Existing Residential	1:100 yr, 24 hr	103.1	19.9	40	58.5	4
Ex_S	Existing Residential	1:100 yr, 24 hr	103.1	22.6	50	65.9	4
NE1	Industrial/Commercial	1:100 yr, 24 hr	103.1	60.3	80	87.7	3
NE2	Highway 12	1:100 yr, 24 hr	103.1	1.8	30	51.8	4
NE3	Highway 12	1:100 yr, 24 hr	103.1	3.2	30	51.8	4
NW1	Industrial/Commercial	1:100 yr, 24 hr	103.1	18.9	80	87.7	3
NW2	Industrial/Commercial	1:100 yr, 24 hr	103.1	9.7	80	87.7	3
NW3	Highway 12	1:100 yr, 24 hr	103.1	4.6	30	51.8	4
NW4	Storm Pond	1:100 yr, 24 hr	103.1	4.4	50	73.5	3
SE1	Industrial/Commercial	1:100 yr, 24 hr	103.1	67.2	80	87.7	3
SW1	Industrial/Commercial	1:100 yr, 24 hr	103.1	14.1	80	87.7	3
SW2	Industrial/Commercial	1:100 yr, 24 hr	103.1	24.6	80	87.7	3
SW3	Industrial/Commercial	1:100 yr, 24 hr	103.1	23.7	80	87.7	3
SW4	Railway ROW	1:100 yr, 24 hr	103.1	1.0	0	30.0	3
XT1	External Farm Land	1:100 yr, 24 hr	103.1	11.0	0	28.5	4



\\Cd1044-f06\work_groups\1101\active\110170054\drafting\drawings\current\figures\Figure.dwg
2021/11/19 2:54 PM By: Mullevan, Jordan

Stantec

FIGURE 4.4

STORMWATER MANAGEMENT PLAN

BENTLEY SE ASP

STORMWATER SERVICING STUDY

4.3.3 PUBLIC STORM SYSTEM CONVEYANCE

It is envisioned that drainage within the study area will largely be achieved with roadway ditches, and with culverts located at approaches and intersection locations. The combined ditch and culvert system shall be designed such that private property shall not be inundated for up to and including the 1:25 year event, and private infrastructure shall be protected for up to and including the 1:100 year event. Development roadways shall not be over toped for up to and including the 1:100 year design storm event. A minimum culvert diameter of 450 mm is recommended for approach culverts, and a minimum culvert diameter of 600 mm at development roadway crossings. At the time of detailed design the development roadway ditch/culvert system shall need to be analyzed to ensure that culverts and ditches are appropriately sized to meet the above criteria.

AEP provides several guide documents to the public to help with interpretation of a particular act or legislation, and one of these guides is the document, “Guide to the code of practice for water course crossings”. This Guide is intended to assist those responsible for watercourse crossing in meeting their obligations and the requirements of the Code of Practice; however, it is the legislation that is legally binding rather than any information provided within a guide. Therefore, the information provided in guides is more open to interpretation and evolution. The guide to water course crossings outlines the 1:25 year stream flow event as being a key level of service to design water course crossings (culverts) to; hence, the criteria outlined above.

Commercial areas could also potentially be serviced by a storm sewer system, in which case the storm sewer system would be designed such that there is essentially no surface ponding for up to and including the 1:5 year design storm event.

4.3.4 PRIVATE SITE STORMWATER MANAGEMENT

Commercial/Industrial areas often involve relatively large parcels with high impervious ratios, and this can result in very high peak flow rates that can potentially overwhelm the public storm conveyance system. Therefore, it is recommended that private sites be required to provide onsite short duration storage; however, the definition of specific onsite stormwater management criteria must be finalized at the detailed design stage. This criteria would likely take the form of providing sufficient onsite storage to meet a maximum discharge rate of approximately 100 L/s/ha (~1:5 year post development rate), and such that there is no overland spill from the site for up to and including the 1:100 year event. Where storm sewers are provided they would typically provide the outlet from the onsite short duration storage, and where storm sewers are not provided, onsite discharge rate control could be met with appropriately sized curb wall openings.

The **onsite** short duration storage is in addition to the storm ponds that are outlined later in this report. Please note that onsite short duration storage is a prudent and common measure that can typically be provided without significantly impairing development configurations or options. The required onsite short duration storage assuming an 80% impervious ratio and a maximum 100 L/s/ha discharge rate would be a minimum of 140 m^3/ha for the 1:100 year event; however, additional storage would be required if the

impervious ratio was higher. This works out to traplow ponding over approximately 11% of the private site, with a maximum 40 cm ponding depth and a 20 cm average ponding depth. The **onsite** stormwater management criteria shall need to be confirmed at the detailed design stage to ensure that the public storm system has adequate conveyance capacity to suit.

Please also note that the storm trunk modeling and design completed as part of this study assumed that there would be no unattenuated runoff contributing to the trunks/ditches; therefore, this will also need to be verified during detailed design.

4.3.5 PROPOSED STORM PONDS

The proposed storm ponds were universally assumed to have active depths of 1.5 m to 2.0 m, and 6:1 side slopes located above the normal water level (NWL). For estimating the facility parcel/footprint areas they were assumed to have an 8 m to 10 m buffer beyond the high water level (HWL) which provides for facility freeboard, berming and backsloping, and perimeter landscaping. Ponds are also envisioned to have piped outlets, including vaulted control structures containing appropriately sized orifices.

This is a relatively high level study; therefore, the configurations provided should not be considered as final. During the detailed design process, the developer's consultants could conceivably develop alternate drainage plans that work equally well, but would be subject to Town approval. Regardless, the provided stormwater management plan still provides valuable guidance for the required storage volume and parcel/footprint area for a given development area.

Table 4-8 below defines the serviced area, total area, composite discharge rate and unit area release rate (UARR) for each of the proposed storm ponds. The serviced area is the development area that a particular pond provides attenuation/storage for, and the total area includes "flow through" areas for which storage is provided in upstream storm ponds, or external areas for which attention is deemed unnecessary. Please also see the previously provided **Figure 4-4** which provides a visual representation of the ponds and sub-catchment areas outlined in the table below.

Table 4-8 Storm Pond Catchment Areas

Storm Pond ID	Serviced Sub-catchments	Serviced Catchment Area (ha)	Total Sub-catchments	Total Catchment Area (ha)	Composite Discharge Rate (L/s)	UARR (L/s/ha)
P_NW	NE2, EX_N, Ex_S, NW1, NW2, NW3, NW4, SW1	96.1	NE1, NE2, EX_N, Ex_S, NW1, NW2, NW3, NW4, SW1 XT1	167.3	561.8	3.36
P_NE	NE1	60.3	NE1	60.3	180.9	3.00
P_SW_W	SW3, SW4	24.7	SE1, SW2, NE3, SW3, SW4	119.6	362.0	3.03
P_SW_E	SW2	24.6	SE1, SW2, NE3	94.9	287.9	3.03
P_SE	SE1, NE3	70.3	SE1, NE3	70.3	214.2	3.05
	Total:	276.0				

Table 4-9 below summarizes the sub-catchment areas, permissible release rates, proposed active storage volumes, facility parcel/footprints, and preliminary design elevations of the proposed storm ponds that were preliminarily designed and analyzed for the study area. The tabulated permissible discharge rates and active storage volumes are for the 1:100 year design storm event, as determined by PCSWMM computer modeling.

Table 4-9 Storm Pond Sizing

Storm Pond ID	Serviced Catchment Area (ha)	Total Catchment Area (ha)	Permissible Discharge Rate (l/s)	Active Storage Volume (m^3)	Approximate Facility Parcel/Footprint (ha)	Preliminary NWL Elevation (m)	Preliminary HWL Elevation (m)
P_NW	96.06	167.30	561.8	53,300	4.38	904.60	906.60
P_NE	60.29	60.29	180.9	42,700	3.39	922.00	924.00
P_SW_W	24.70	119.62	362.0	16,600	1.69	897.50	899.00
P_SW_E	24.58	94.92	287.9	17,500	1.89	905.50	907.00
P_SE	70.35	70.35	214.2	49,100	3.55	910.00	912.00

4.3.6 NORTHWEST STORM POND PHASING

As previously mentioned, the 2010 Bentley Roads program also included the construction of a storm pond located south of Highway 12 in the southwest corner of the NW quarter of Section 23, Range 40, Township 1, W5M. This storm pond (P_NW_Interim) was constructed with an active volume of approximately 27,000 m^3, but was also configured to be expanded for future development in the area, which has now evolved into the Southeast ASP. This pond (P_NW) will ultimately be expanded to have an active storage volume of approximately 53,300 m^3, as shown in **Table 4-9** above, and will fill the majority of the current 4.38 ha parcel. Please see **Figure 4-5**, located at the end of this report sub-section.

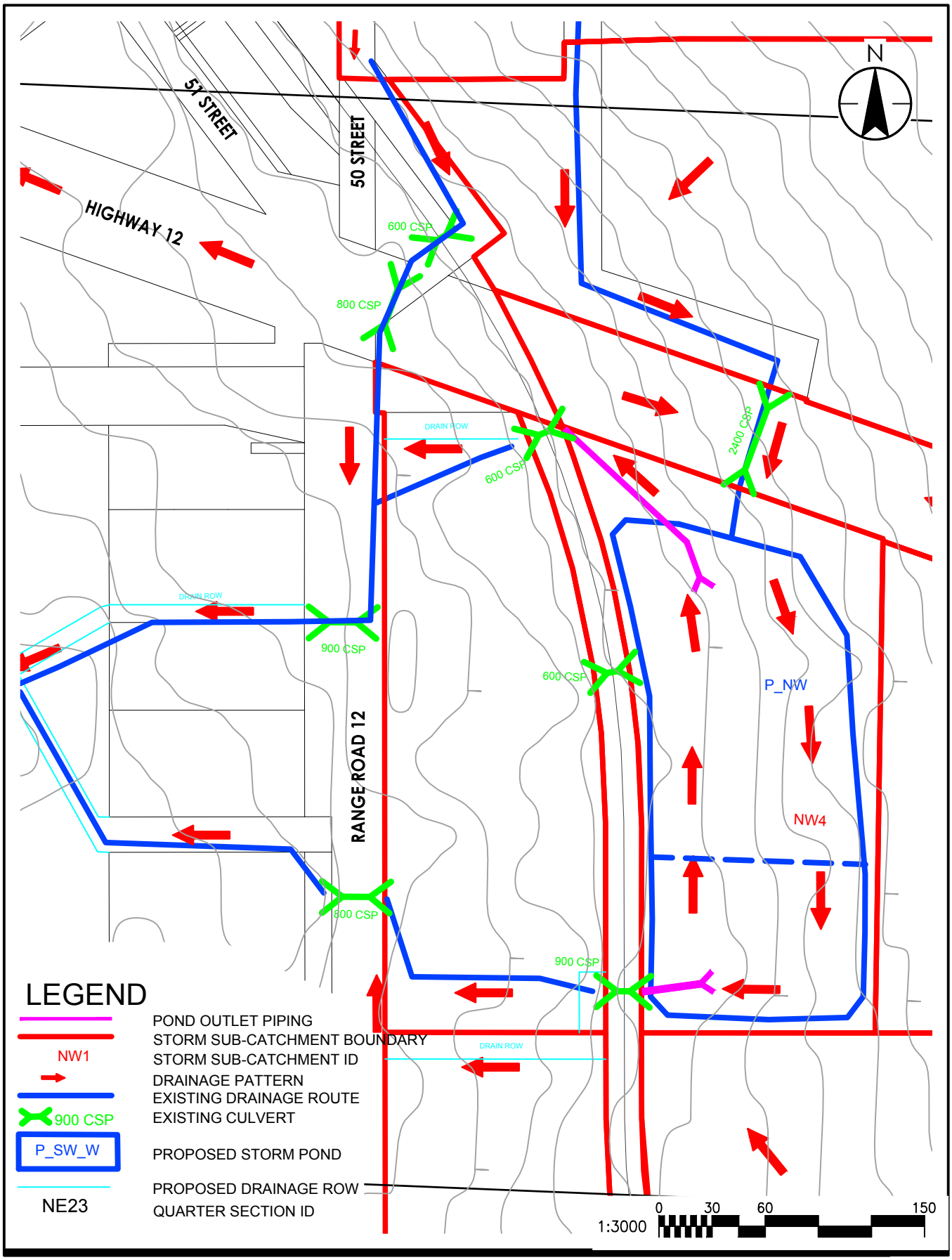
Storm pond P_NW_Interim was provided with 675\750 mm diameter outlet piping located in the NW corner of the facility and discharging to the existing 600 mm diameter culvert draining under the CP railway line. From there the pond discharge takes the natural drainage route draining southwest across the parcel located to the west. It was envisioned that the semi-recent construction of Highway 12 would have provided an offsite discharge route (south ditch line) from this existing 600 mm diameter culvert; however, CPR has installed an electrical pedestal in this location; thus, eliminating this option. Therefore, a drainage ROW is proposed on the north property line of the parcel located west of storm pond P_NW, such that the discharge from the 600 mm culvert can be channelized to flow straight west.

Outlet piping was previously provided in the northwest corner of the facility because it was believed that procurement of a drainage ROW could be avoided, and the existing 600 mm diameter culvert provided sufficient conveyance capacity for full development of only the NW quarter of Section 23. However, full development of the NE quarter of Section 23 is now also proposed, and this area must also discharge through storm pond P_NW. Therefore, we are now proposing a second set of 750 mm diameter outlet piping, and a control structure, be provided in the southwest corner of storm pond P_NW, which will drain to the existing 900 mm diameter culvert draining under the CP railway line. A second drainage ROW is also proposed located southwest of the exiting 900 mm diameter culvert, as shown on **Figure 4-5**; thus, permitting this portion of the pond discharge to be channelized rather than draining diffusely across the adjacent land parcel.

Once the second set of pond outlet piping (southwest) and discharge route are established, the existing northwest control structure will be modified to include an orifice plate that results in a controlled discharge of 200 L/s. This will be in addition to a controlled discharge of 362 L/s from the southwest control structure; thus, resulting in a total facility discharge rate of 562 L/s.

Alternatively, the proposed second set of outlet piping could be made the primary pond outlet and the existing outlet piping/structure could be made to discharge a trickle flow of only 20-30 L/s. The trickle flow would be small enough that a formal drainage ROW would likely not be required for the northwest pond outlet. However, this alternative concept may not work as well with the future development phasing.

Please also note that the current offsite discharge route from storm pond P_NW is through a 900 mm diameter culvert draining under Range Road 12, and then draining west in a ditch located between two existing lots. This existing ditch is believed to fall on a developed private lot; therefore, it would be prudent for the Town to procure a drainage ROW for this portion of the existing ditch.



\\Cd1044-f06\work_group\1101\active\101705\drafting\drawings\current\figures\Figure.dwg
2021/11/19 2:55 PM By: McElwain, Jordan

Stantec

FIGURE 4.5
NW STORM POND
BENTLEY SE ASP
STORMWATER SERVICING STUDY

4.3.7 DRAINAGE RIGHTS OF WAY

Drainage Rights of Way (ROW) are proposed in key locations where drainage connectivity is required to ensure that downstream landowners are not impacted. The previously provided **Figure 4-4** and **Figure 4-5** shows these drainage ROWs with cyan dashed lines. Three of the proposed ROWs are associated with the NW storm pond and were discussed in the previous report section.

The other proposed drainage ROWs are located on the south boundary of the study area and are required to contain the post development runoff and direct it to the proposed storm ponds. An additional drainage ROW is also proposed on the south boundary located west of Range Road 12 because the natural drainage pattern in this area takes runoff southwest towards existing farm infrastructure. The drainage ROW is proposed along the adjacent quarter section line such that the natural drainage route can be channelized and taken straight west so that it does not potentially impact the adjacent landowner(s).

The analysis completed as part of this study also suggests that the existing CP railway and Range Road 12 culverts have sufficient conveyance capacity to facilitate development within the ASP area.

4.3.8 WATER QUALITY IMPROVEMENT

Wet stormwater management facilities are envisioned for the storm ponds proposed for the study area. In terms of water quality improvement, wet stormwater management facilities are considered superior to dry facilities. Wet stormwater management facilities generally take the form of either wet ponds or constructed wetlands. Constructed wetlands are generally considered as providing better treatment than wet ponds, due to having a greater surface area for biological and chemical processes to occur on; thus, providing better treatment of nutrients and dissolved contaminants. However, typical wet ponds are still considered as providing sufficient treatment, and the decision between providing a constructed wetland or wet pond is generally contingent upon geotechnical conditions and earth balance requirements, and must be determined on a site by site basis.

Where dry facilities are desired by the developer, or are required due to site constraints, other Best Management Practices (BMPs) must also be considered and implemented to make up for the water quality performance limitations of dry facilities. The following BMPs should be considered for use in combination with dry stormwater facilities:

- Bio-retention areas – These are relatively small vegetated depressions that intercept and dispose of runoff on a local scale. They are ideally suited to being located in parking islands in commercial and industrial areas.

- Vegetated swales – These can be used to convey runoff through lower density developments instead of the more typical curb and gutter and storm sewers. They are effective at filtering and biologically treating runoff as it is conveyed.

- Storm facility wet cells – Effective water quality improvement can be facilitated by providing a much smaller wet cell (forebay) within an overall dry pond facility.

- Oil and grit separators (OGS) – These are below grade vaulted structures that are designed to provide enhanced sedimentation in a relatively small footprint. OGS units in Alberta have typically relied on sedimentation which due to the smaller footprint typically do not provide as high of performance as a full out wet stormwater management facility. However, OGS units can also be made to provide very high levels of treatment by utilizing filtration methods, but these units typically have very high operating costs and largely have not been utilized in Alberta.

By following the water quality improvement recommendations outlined in this report, the study area will meet or exceed the necessary water quality improvement to meet the current Alberta Environment and Parks (AEP) criteria for removing 85% of Total Suspended Solids (TSS), for sediment particles 75 microns and larger.

4.4 Conclusions and Recommendations

The following conclusions are drawn from the above analysis and study:

1. The objective of this study was to demonstrate that the proposed future development will meet Alberta Environment and Parks (AEP) and Town of Bentley (Town) criteria for pre-development discharge rate and water quality improvement. It also provides guidance on several storm ponds located within the study area.

2. Based on the results of the regional frequency analysis, a 1:100 year pre-development release rate of **3.0 L/s/ha** is proposed for the study area. Providing Discharge Rate Control in Alberta is typically met through the use of stormwater management facilities, and this is the predominate type of treatment that is proposed for the study area. Please note that the existing Town and the relevant Highway 12 sub-catchments were previously approved in 2010 at a pre-development release rate of 4.0 L/s/ha; therefore, some of the proposed stormwater management facilities have a composite pre-development release rate.

3. PCSWMM single event modeling was used to demonstrate that the proposed storm ponds will provide sufficient active storage volume to meet the pre-development release rate such that there is no uncontrolled spill for up to and including a 1:100 year design storm event.

4. Wet stormwater management facilities are envisioned for the storm ponds proposed for the study area. Wet stormwater management facilities generally take the form of either wet ponds or constructed wetlands. By following the water quality improvement recommendations outlined in this report, the study area will meet or exceed the necessary water quality improvement to meet the current Alberta Environment and Parks (AEP) criteria for removing 85% of Total Suspended Solids (TSS), for sediment particles 75 microns and larger.

5. The analysis completed as part of this study suggests that the existing CP railway and Range Road 12 culverts have sufficient conveyance capacity to facilitate development within the ASP area.

The following recommendations are drawn from the above analysis and study:

A. At the time of detailed design **onsite** stormwater management criteria shall need to be defined to ensure that the public storm conveyance system is not overwhelmed. This **onsite** short duration storage is in addition to the proposed storm ponds that are outlined in this report. Please note that onsite short duration storage is a prudent and common measure that can typically be provided without significantly impairing development configurations/options.

B. Drainage Rights of Way (ROW) are proposed in key locations where drainage connectivity is required to ensure that downstream landowners are not impacted. Three of the proposed ROWs are associated with the NW storm pond. The other proposed drainage ROWs are located on the south boundary of the study area and are required to contain the post development runoff and direct it to the proposed storm ponds. An additional drainage ROW is also proposed on the south boundary located west of Range Road 12. This drainage ROW is proposed along the

adjacent quarter section line such that the natural drainage route can be channelized and taken straight west so that it does not potentially impact the adjacent landowner(s).

C. The pond sizing and positioning as outlined in this report provides sufficient detail to complete the Town of Bentley Southeast ASP.

5 Opinion of Probable Costs

Opinions of probable costs have been prepared for the proposed infrastructure and are presented in the table below. Please refer Appendix A for detailed breakdowns.

Table 5-1 Opinion of Probable Costs

Item	Construction Costs	35% Contingency and Engineering	Total (Rounded to nearest $1,000)
Water Mains/Trunks			
New Water Treatment Plant	$ 5,783,000	$ 2,024,050	$ 7,807,000
NE22 40-1-5 (Existing Town Industrial Area)	$ 1,602,250	$ 560,788	$ 2,163,000
NW23 40-1-5 (North of Highway 12)	$ 843,750	$ 295,313	$ 1,139,000
NE23 40-1-5 (North of Highway 12)	$ 1,046,000	$ 366,100	$ 1,412,000
NW23&SW23 40-1-5 (South of Highway 12)	$ 1,663,250	$ 582,138	$ 2,245,000
SE23 40-1-5 (South of Highway 12)	$ 1,041,875	$ 364,656	$ 1,407,000
Sanitary Mains/Trunks			
Lagoons Expansion	$ 11,680,000	$ 4,088,000	$ 15,768,000
NE22 40-1-5 (Existing Town Industrial Area)	$ 663,650	$ 232,278	$ 896,000
NW23 40-1-5 (North of Highway 12)	$ 282,600	$ 98,910	$ 382,000
NE23 40-1-5 (North of Highway 12)	$ 704,800	$ 246,680	$ 951,000
NW23&SW23 40-1-5 (South of Highway 12, Forcemain Option for SW area)	$ 915,130	$ 320,296	$ 1,235,000
SE23 40-1-5 (South of Highway 12)	$ 519,380	$ 181,783	$ 701,000
50th Street Trunk Ugrade (Excludes Surface work and services)	$ 336,560	$ 117,796	$ 454,000
Stormwater Ponds and Outlet Ditches			
NE22 40-1-5 (Existing Town Industrial Area)	$ 152,500	$ 53,375	$ 206,000
NW23 40-1-5 (North of Highway 12)	$ 44,250.00	$ 15,488	$ 60,000
NE23 40-1-5 (North of Highway 12)	$ 1,024,800.00	$ 358,680	$ 1,383,000
NW23&SW23 40-1-5 (THREE PONDS)	$ 1,514,600.00	$ 530,110	$ 2,045,000
SE23 40-1-5 (South of Highway 12)	$ 1,473,000.00	$ 515,550	$ 1,989,000
SE22 40-1-5 (Off-Site Ditch)	$ 102,500.00	$ 35,875	$ 138,000

The opinion of probable costs was based on the following parameters and assumptions:

- Unit rates are based on recent similar projects constructed in Central Alberta in 2021/2022. The costs should be updated periodically, as required, in the future.
- All costs exclude GST
- The water and sewer quantities are based on the alignments illustrated in Figures 2-2 and 3-2.
- Land-associated costs are not included.
- Private lot services are not included the opinion of probable costs.
- Engineering and Contingency having a combined value of 35% of the construction value.

Also, please note that the southwestern most area is quite low. It is possible to service that by gravity, but it would require deepening of some of the trunk line to the north. The cost of servicing by gravity would be approximately $435,000 more than the force main option.

6 Hydrogeological Assessment Limitations

This hydrogeological assessment work that was performed in accordance with generally accepted professional standards at the time and location in which the services were provided. No other representations, warranties or guarantees are made concerning the accuracy or completeness of the data or conclusions contained within this report, including no assurance that this work has uncovered all potential liabilities associated with the identified property.

This assessment provides an evaluation of selected environmental conditions associated with the identified portion of the property that was assessed at the time the work was conducted and is based on information obtained by and/or provided to Stantec at that time. There are no assurances regarding the accuracy and completeness of this information. All information received from the client or third parties in the preparation of this report has been assumed by Stantec to be correct. Stantec assumes no responsibility for any deficiency or inaccuracy in information received from others.

The opinions in this report can only be relied upon as they relate to the condition of the portion of the identified property that was assessed at the time the work was conducted. Activities at the properties subsequent to Stantec's assessment may have significantly altered the property's condition. Stantec cannot comment on other areas of the property that were not assessed.

Conclusions made within this report consist of Stantec's professional opinion as of the time of the writing of this report and are based solely on the scope of work described in the report, the limited data available and the results of the work. They are not a certification of the property's environmental condition. This report should not be construed as legal advice.

This report has been prepared for the exclusive use of the client identified herein and any use by any third party is prohibited. Stantec assumes no responsibility for losses, damages, liabilities or claims, howsoever arising, from third party use of this report.

The locations of any utilities, buildings and structures, and property boundaries illustrated in or described within this report, if any, including pole lines, conduits, water mains, sewers and other surface or sub-surface utilities and structures are not guaranteed. Before starting work, the exact location of all such utilities and structures should be confirmed and Stantec assumes no liability for damage to them.

The conclusions are based on the site conditions encountered by Stantec at the time the work was performed at the specific testing and/or sampling locations, and conditions may vary among sampling locations. Factors such as areas of potential concern identified in previous studies, site conditions (e.g., utilities) and cost may have constrained the sampling locations used in this assessment. In addition, analysis has been carried out for only a limited number of chemical parameters, and it should not be inferred that other chemical species are not present. Due to the nature of the investigation and the limited data available, Stantec does not warrant against undiscovered environmental liabilities nor that the sampling results are indicative of the condition of the entire site. As the purpose of this report is to

identify site conditions which may pose an environmental risk; the identification of non-environmental risks to structures or people on the site is beyond the scope of this assessment.

Should additional information become available which differs significantly from our understanding of conditions presented in this report, Stantec specifically disclaims any responsibility to update the conclusions in this report.

7 References

Water and Wastewater Management

Town of Bentley Infrastructure Map Book, 2011.

Summersault Area Structure Plan, WSP, 2014.

Town of Bentley Water Distribution Analysis, MPE Engineering Ltd. and NorBen Development Ltd, 2002.

Bentley Industrial Area Structure Plan, PCPS, 2009.

Land Supply and Future Growth Potential, PCPS, 2013.

Southeast Bentley Area Structure Plan, Map 4: Future Land Use Concept, PCPS, 2022.

Town of Bentley Water Supply and Storage Assessment Final Report, MPE Engineering Ltd, 2001.

Water Treatment Plant Map, Town of Bentley, 2022.

Water Reservoir Expansion – Reservoir Piping Plan, MPE Engineering Ltd., May 2002.

Town of Bentley Wastewater Lagoon Report 2014 to 2021, Town of Bentley, 2022.

Lacombe County Standards Manual Edition 3, Lacombe County, May 2017.

Stormwater Management

PCWMM – Water System Models, User's Guide to SWMM5, CHI, Guelph, Ontario, Canada 2008.

Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, Part 5 Stormwater Management Guidelines, Alberta Government, March 2013.

Municipal Policies and Procedures Manual, Alberta Environmental Protection, April 2001.

The City of Red Deer – Engineering Services Design Guidelines, current edition.

The City of Calgary - Wastewater and Drainage - Stormwater Management and Design Manual, December 2011.

Bentley Roads Program Stormwater Management Plan Addendum 1, by Stantec Consulting Ltd., February 24, 2010.

Hydrogeology

Alberta Environment (AENV). 2006. Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems. ISBN: 0-7785-4394-3 (Printed Edition) ISBN: 0-7785-4395-1 (On-Line Edition)

AENV. 2011. Alberta Environment Guide to Groundwater Authorization. March 2011.

Alberta Environment and Parks (AEP), 1995. Ecodistricts of Alberta 1995 Polygons. vector digital data ISBN: 0-7732-1437-2.

Alberta Environment and Parks (AEP). 2022. Alberta Water Well Information Database (AWWID). Website Accessed April 2022. Website: http://groundwater.alberta.ca/WaterWells/d/.

Alberta Geological Survey (AGS). 2021. Geological Framework of Alberta, Version 3 (interactive app and map, methodology, model, dataset, StoryMaps, web maps); Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Interactive Application <https://gfa-v3-ags-aer.hub.arcgis.com>, [April 4, 2022]

Barker, A.A., Riddell, J.T.F., Slattery, S.R., Andriashek, L.D., Moktan, H., Wallace, S., Lyster, S., Jean, G., Huff, G.F., Stewart, S.A. and Lemay, T.G., 2011. Edmonton–Calgary Corridor groundwater atlas; Energy Resources Conservation Board, ERCB/AGS Information Series 140, 90 p.

Fenton, M.M., Waters, E.J., Pawley, S.M., Atkinson, N., Utting, D.J., and Mckay, K. 2013. Surficial geology of Alberta; Alberta Energy Regulator, AER/AGS Map 601, scale 1:1 000 000.

Grasby, S., Chen, Z., Hamblin, A., Wozniak, P., and Sweet, A. (2008). Regional characterization of the Paskapoo bedrock aquifer system, southern Alberta Geological Survey of Canada Contribution 2008-0479.. Canadian Journal of Earth Sciences. 45. 1501-1516. 10.1139/E08-069.

La Breton, E. and Green, R. 1971. Hydrogeological map of the Red Deer area, Alberta, NTS 83 Earth Science Report 1971-01: Hydrogeology of the Red Deer Area, Alberta

Lemay, T.G. and Guha, S. 2009. Compilation of Alberta groundwater information from existing maps and data sources; Energy Resources Conservation Board, ERCB/AGS Open File Report 2009-02, 43 p.

Lyster, S. and Andriashek, L.D. 2012. Geostatistical rendering of the architecture of hydrostratigraphic units within the Paskapoo Formation, central Alberta; Energy Resources Conservation Board, ERCB/AGS Bulletin 66, 115 p.

Prior, G.J., Hathway, B., Glombick, P.M., Pană, D.I., Banks, C.J., Hay, D.C., Schneider, C.L., Grobe, M., Elgr, R. and Weiss, J.A. 2013. Bedrock geology of Alberta; Alberta Energy Regulator, AER/AGS Map 600, scale 1:1 000 000.

Stantec Consulting Ltd. 2011. Evaluation of Well No. 3, Town of Bentley, Alberta. Project No.: 113928124.104

Tokarsky, O.1970. Hydrogeology of the Rocky Mountain House area, Alberta; Research Council of Alberta, RCA/AGS Earth Sciences Report 1971-03, 18 p

APPENDICES

Appendix A OPCs

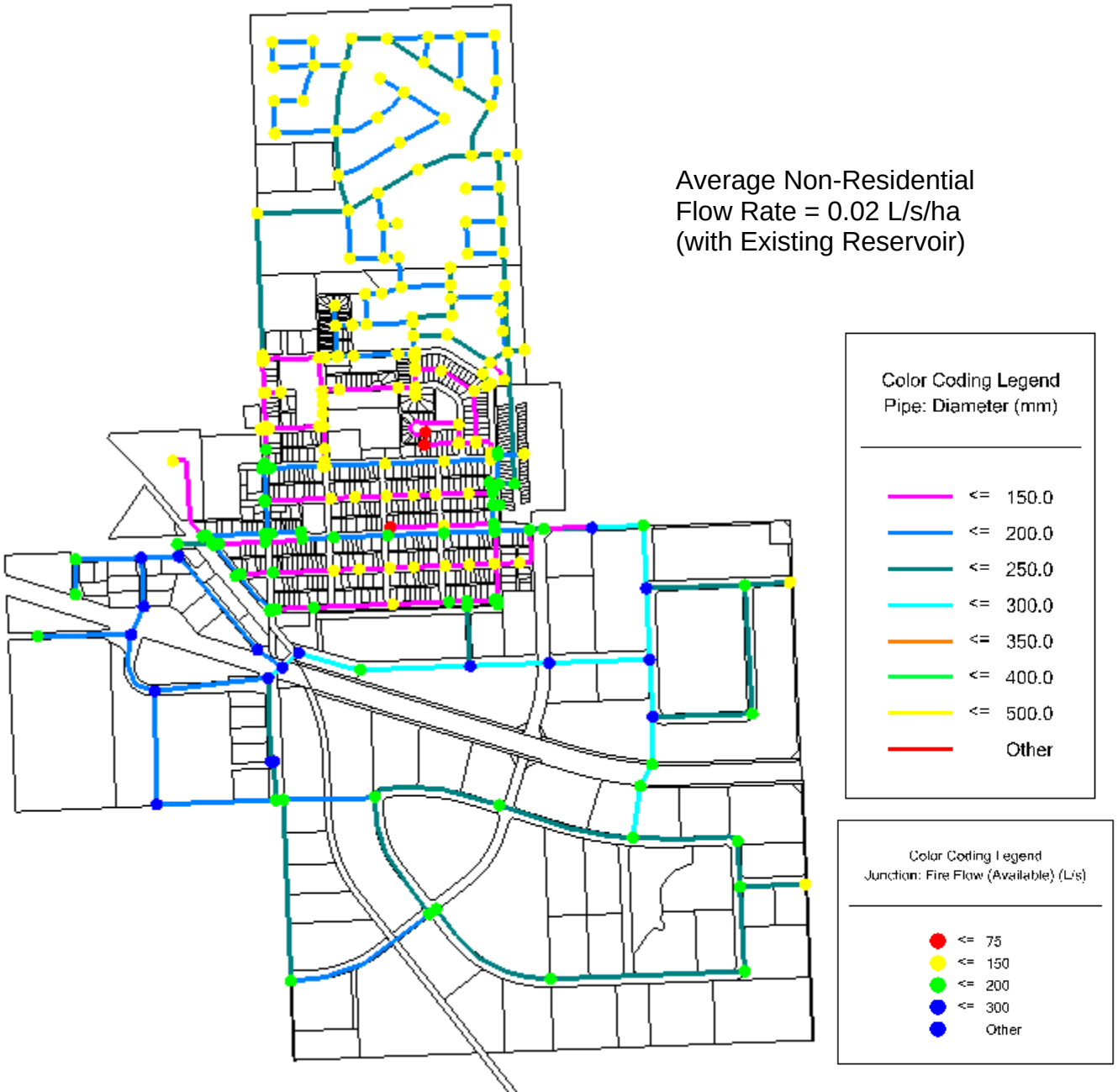
Item No.	Item of Work	Unit	Unit Price	Total Quantity	Total Cost
LAGOON UPGRADES					
0.1	Lagoon construction	l.s.	$11,600,000	1	$11,600,000.00
0.2	Outfall Piping and Upgrades (retrofit the existing)	l.s.	$80,000.00	1	$80,000.00
	Total Cost				$11,680,000.00
WATER TREATMENT PLANT AND WELLS					
0.1	New Water Treatment Plant-Reservoir	m^3	$4,000.00	512	$2,048,000
0.2	New WTP-Treatment and Pump Station	each	$3,000,000	1	$3,000,000
0.3	New Water Wells	each	$150,000.00	1	$150,000.00
0.4	Extend Old Well Supply Lines	m	$300.00	450	$135,000.00
0.5	Site Work	l.s.	$200,000.00	1	$200,000.00
0.6	Decommission Existing Water Treatment Plant and Restore Site	l.s.	$250,000.00	1	$250,000.00
	Total Cost				$5,783,000.00
NE22 40-1-5 (EXISTING TOWN INDUSTRIAL AREA)					
A. WATER TRUNKS (EXCLUDES LOT SERVICES AND NON-TRUNK LINES)					
0.1	200 mm watermain PVC DR18 c/w trench excavation to 3.0 m depth,valves and fittings.	m	$325.00	2900	$942,500.00
0.2	250 mm watermain PVC DR18 c/w trench excavation to 3.0 m	m	$375.00	535	$200,625.00
0.3	Hydrants including leads	each	$9,875.00	7	$69,125.00
0.4	Steel-Encased CPR Crossing	m	$4,000.00	60	$240,000.00
0.5	Pressure Reducing Vault	each	$150,000.00	1	$150,000.00
	Total Cost				$1,602,250.00
B. WASTEWATER TRUNKS					
0.1	Sanitary pipe PVC SDR 35 c/w bedding				
	a) 300 mm Dia	m	$120.00	375	$45,000.00
	b) 450 mm Dia	m	$250.00	725	$181,250.00
0.2	Trench excavation, backfill, and compaction to 95% S.P.D.				
	a) 3.0 m - 4.0 m Depth	m	$160.00	550	$88,000.00
	b) 4.0 m - 5.0 m Depth	m	$200.00	550	$110,000.00
0.3	1200 mm Dia. Manhole type 5A c/w frame & cover	v.m	$1,650.00	36	$59,400.00
0.4	Steel-Encased CPR Crossing	m	$3,000.00	60	$180,000.00
	Total Cost				$663,650.00
C. STORM OFFSITE					
0.1	Storm Ditch (northwest of 800 mm cul)	m^3	$25.00	1320	$33,000.00
0.2	800 CSP culvert replacement	m	$650.00	30	$19,500.00
0.3	Outfall to Blindman River	LS	$100,000.00	1	$100,000.00
	Total Cost				$152,500.00

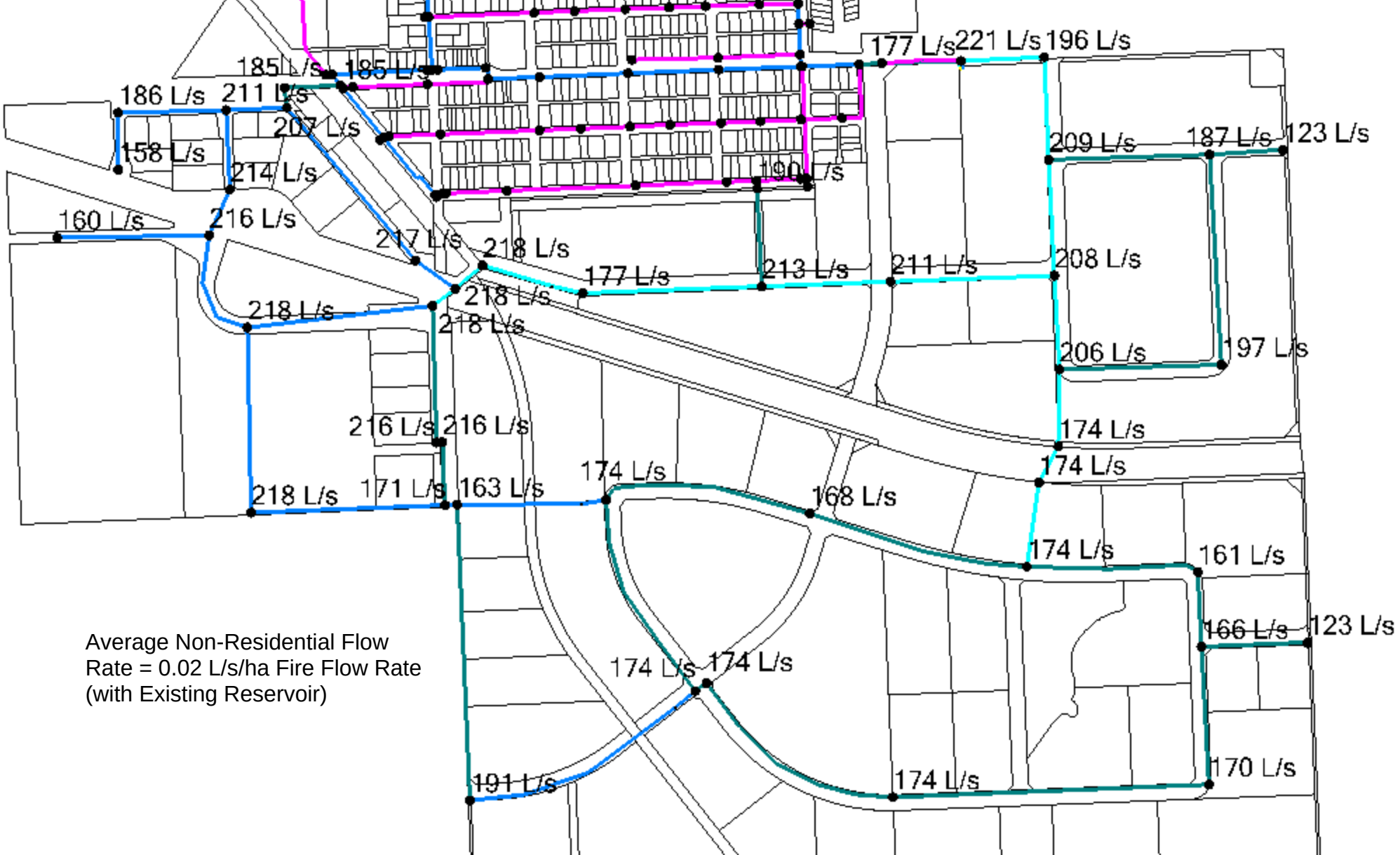
Item No.	Item of Work	Unit	Unit Price	Total Quantity	Total Cost
NW23 40-1-5 (NORTH OF HIGHWAY 12)					
A. WATER MAINS					
0.1	300 mm watermain PVC DR18 c/w trench excavation to 3.0 m	m	$425.00	780	$331,500.00
0.2	250 mm watermain PVC DR18 c/w trench excavation to 3.0 m	m	$375.00	200	$75,000.00
0.3	Hydrants including leads	each	$9,875.00	6	$59,250.00
0.4	Directional Drilled Highway 12 Crossing	m	$400.00	120	$48,000.00
0.5	Steel-Encased CPR Crossing	m	$3,000.00	60	$180,000.00
0.6	Pressure Reducing Vault	each	$150,000.00	1	$150,000.00
	Total Cost				$843,750.00
B. WASTEWATER TRUNKS					
0.1	Sanitary pipe PVC SDR 35 c/w bedding				
	a) 250 mm Dia	m	$110.00	780	$85,800.00
0.2	Trench excavation, backfill, and compaction to 95% S.P.D.				
	a) 3.0 m - 4.0 m Depth	m	$120.00	600	$72,000.00
	b) 4.0 m - 5.0 m Depth	m	$180.00	180	$32,400.00
0.3	1200 mm Dia. Manhole type 5A c/w frame & cover	v.m	$1,800.00	28	$50,400.00
0.4	Directional Drilled Highway 12 Crossing	m	$350.00	120	$42,000.00
	Total Cost				$282,600.00
C. STORM SERVICING					
0.1	Storm Ditch (NW of pond)	m^3	$25.00	440	$11,000.00
0.2	Storm Ditch (SW of pond);	m^3	$25.00	1330	$33,250.00
	Total Cost				$44,250.00
NE23 40-1-5 (NORTH OF HIGHWAY 12)					
A. WATER MAINS					
0.1	300 mm watermain PVC DR18 c/w trench excavation to 3.0 m	m	$425.00	1210	$514,250.00
0.2	250 mm watermain PVC DR18 c/w trench excavation to 3.0 m	m	$375.00	1150	$431,250.00
0.3	150 mm watermain PVC DR18 c/w trench excavation to 3.0 m	m	$275.00	150	$41,250.00
0.4	Hydrants including leads	each	$9,875.00	6	$59,250.00
	Total Cost				$1,046,000.00
B. WASTEWATER TRUNKS					
0.1	Sanitary pipe PVC SDR 35 c/w bedding				
	a) 250 mm Dia	m	$110.00	2200	$242,000.00
0.2	Trench excavation, backfill, and compaction to 95% S.P.D.				
	a) 3.0 m - 4.0 m Depth	m	$120.00	1100	$132,000.00
	b) 4.0 m - 5.0 m Depth	m	$180.00	1100	$198,000.00
0.3	1200 mm Dia. Manhole type 5A c/w frame & cover	v.m	$1,660.00	80	$132,800.00
	Total Cost				$704,800.00

Item No.	Item of Work	Unit	Unit Price	Total Quantity	Total Cost
C. STORM POND					
0.1	Storm Pond; based on active storage volume	m^3	$24.00	42700	$1,024,800.00
	Total Cost				$1,024,800.00
SW23 40-1-5 AND NW23 40-1-5 (SOUTH OF HIGHWAY 12)					
A. WATER MAINS					
0.1	250 mm watermain PVC DR18 c/w trench excavation to 3.0 m	m	$375.00	1570	$588,750.00
0.2	200 mm watermain PVC DR18 c/w trench excavation to 3.0 m	m	$325.00	850	$276,250.00
0.3	Hydrants including leads	each	$9,875.00	14	$138,250.00
0.4	Steel-Encased CPR Crossing	m	$3,000.00	120	$360,000.00
0.5	Pressure Reducing Vault	each	$150,000.00	2	$300,000.00
	Total Cost				$1,663,250.00
B. WASTEWATER TRUNKS					
0.1	Sanitary pipe PVC SDR 35 c/w bedding				
	a) 250 mm Dia	m	$110.00	1865	$205,150.00
0.2	Trench excavation, backfill, and compaction to 95% S.P.D.				
	a) 3.0 m - 4.0 m Depth	m	$120.00	935	$112,200.00
	b) 4.0 m - 5.0 m Depth	m	$180.00	930	$167,400.00
0.3	1200 mm Dia. Manhole type 5A c/w frame & cover	v.m	$1,660.00	68	$112,880.00
0.4	Steel-Encased CPR Crossing	m	$3,000.00	60	$180,000.00
	Total Cost				$777,630.00
C. STORM PONDS					
0.1	Storm Pond (NW2 Expansion); based on active storage volume	m^3	$24.00	26300	$631,200.00
0.2	Storm Pond (SW_W); based on active storage volume	m^3	$24.00	16600	$398,400.00
0.3	Storm Pond (SW_E); based on active storage volume	m^3	$24.00	17500	$420,000.00
0.4	Storm Ditch (south boundary)	m^3	$25.00	2600	$65,000.00
	Total Cost				$1,514,600.00
SE23 40-1-5 (SOUTH OF HIGHWAY 12)					
A. WATER MAINS					
0.1	300 mm watermain PVC DR18 c/w trench excavation to 3.0 m	m	$425.00	165	$70,125.00
0.2	250 mm watermain PVC DR18 c/w trench excavation to 3.0 m	m	$375.00	2200	$825,000.00
0.3	Hydrants including leads	each	$9,875.00	10	$98,750.00
0.4	Directional Drilled Highway 12 Crossing	m	$400.00	120	$48,000.00
	Total Cost				$1,041,875.00
B. WASTEWATER TRUNKS					

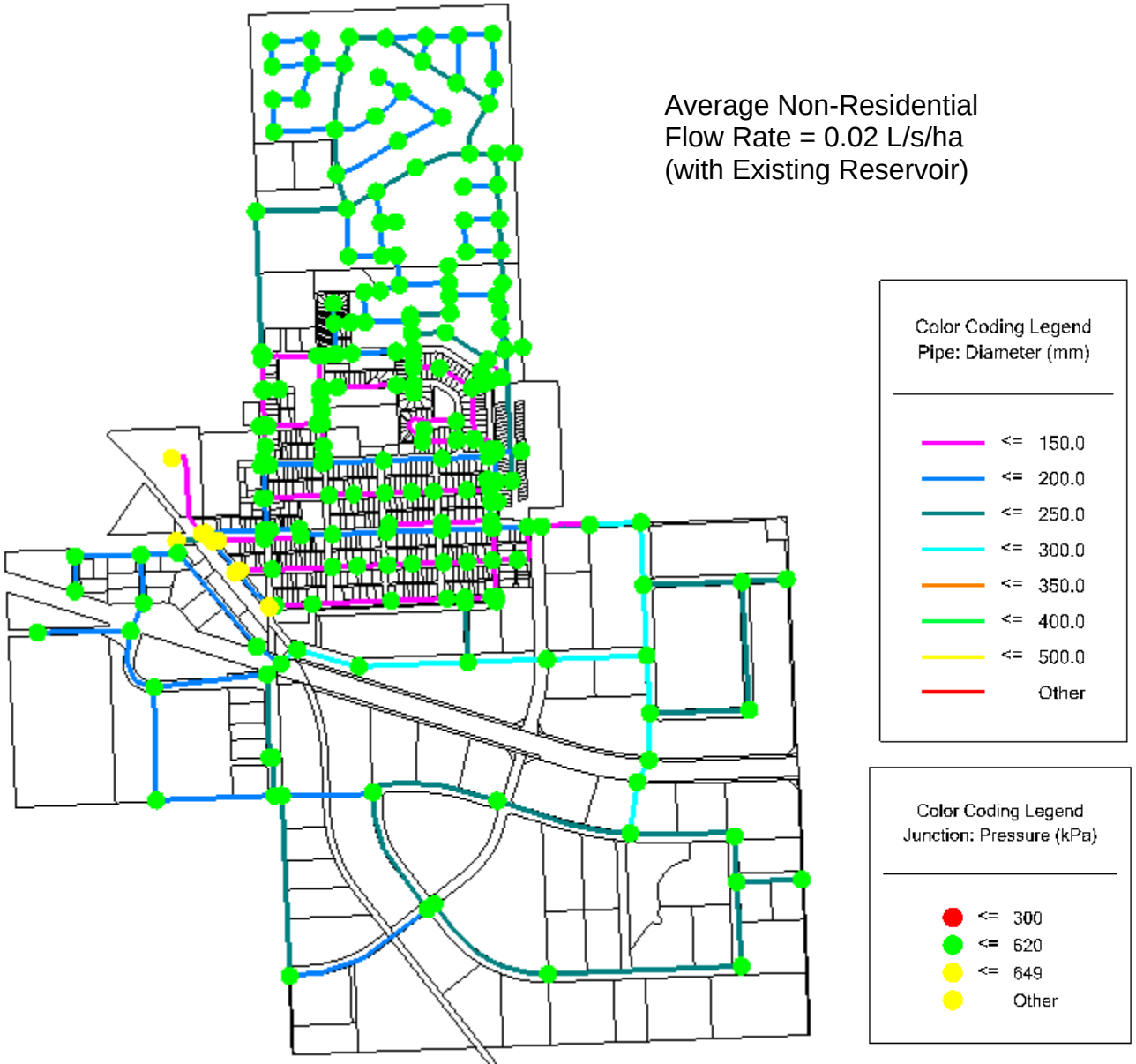
Item No.	Item of Work	Unit	Unit Price	Total Quantity	Total Cost
0.1	Sanitary pipe PVC SDR 35 c/w bedding				
	a) 250 mm Dia	m	$110.00	1650	$181,500.00
0.2	Trench excavation, backfill, and compaction to 95% S.P.D.				
	a) 3.0 m - 4.0 m Depth	m	$120.00	1200	$144,000.00
	b) 4.0 m - 5.0 m Depth	m	$180.00	450	$81,000.00
0.3	1200 mm Dia. Manhole type 5A c/w frame & cover	v.m	$1,660.00	68	$112,880.00
	Total Cost				$519,380.00
C. STORM POND					
0.1	Storm Pond; based on active storage volume	m^3	$30.00	49100	$1,473,000.00
	Total Cost				$1,473,000.00
SERVICING OF LOW AREA AT VERY SOUTHWEST CORNER OF AREA STRUCTURE PLAN					
OPTION A. LOW PRESSURE FORCE MAIN SYSTEM					
0.1	Supply and Directionally Drill 100mm HDPE DR11 Force Main	m	$170.00	750	$127,500.00
0.2	Flushout	each	$10,000.00	1	$10,000.00
	Total Cost				$137,500.00
OPTION B. GRAVITY TRUNK					
0.1	Sanitary pipe PVC SDR 35 c/w bedding				
	a) 250 mm Dia	m	$110.00	750	$82,500.00
0.2	Trench excavation, backfill, and compaction to 95% S.P.D.				
	a) 3.0 m - 4.0 m Depth	m	$120.00	120	$14,400.00
	b) 4.0 m - 5.0 m Depth	m	$180.00	630	$113,400.00
	c) Additional deepening to north to accommodate gravity connection	m	$200.00	675	$135,000.00
0.3	1200 mm Dia. Manhole type 5A c/w frame & cover	v.m	$1,660.00	68	$112,880.00
	Total Cost				$458,180.00
50th Street Trunk Upgrade (Excludes Surface Work and Service Connections)					
0.1	Sanitary pipe PVC SDR 35 c/w bedding				
	a) 300 mm Dia	m	$120.00	500	$60,000.00
0.2	Trench excavation, backfill, and compaction to 95% S.P.D.				
	a) 3.0 m - 4.0 m Depth	m	$300.00	500	$150,000.00
0.3	1200 mm Dia. Manhole type 5A c/w frame & cover	v.m	$1,660.00	16	$26,560.00
0.4	Hydrovacing, traffic accommodation, other misc.	l.s	$100,000.00	1	$100,000.00
	Total Cost				$336,560.00
SE22 40-1-5					
A. STORM OFFSITE					
0.1	Storm Ditch (south boundary)	m^3	$25.00	3200	$80,000.00
0.2	900 CSP culvert replacement	m	$750.00	30	$22,500.00
	Total Cost				$102,500.00

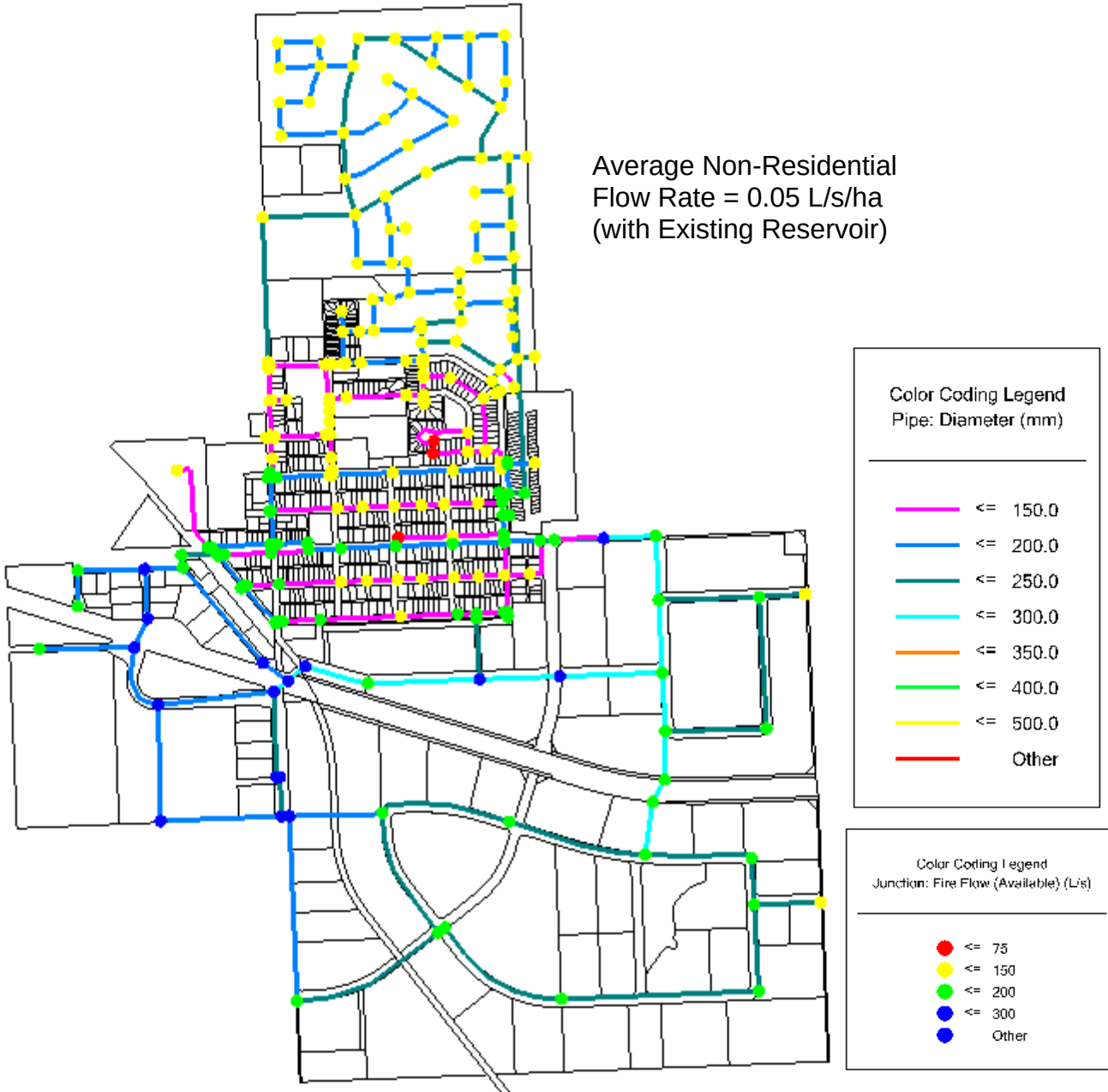
Appendix B WATERCAD FIGURES

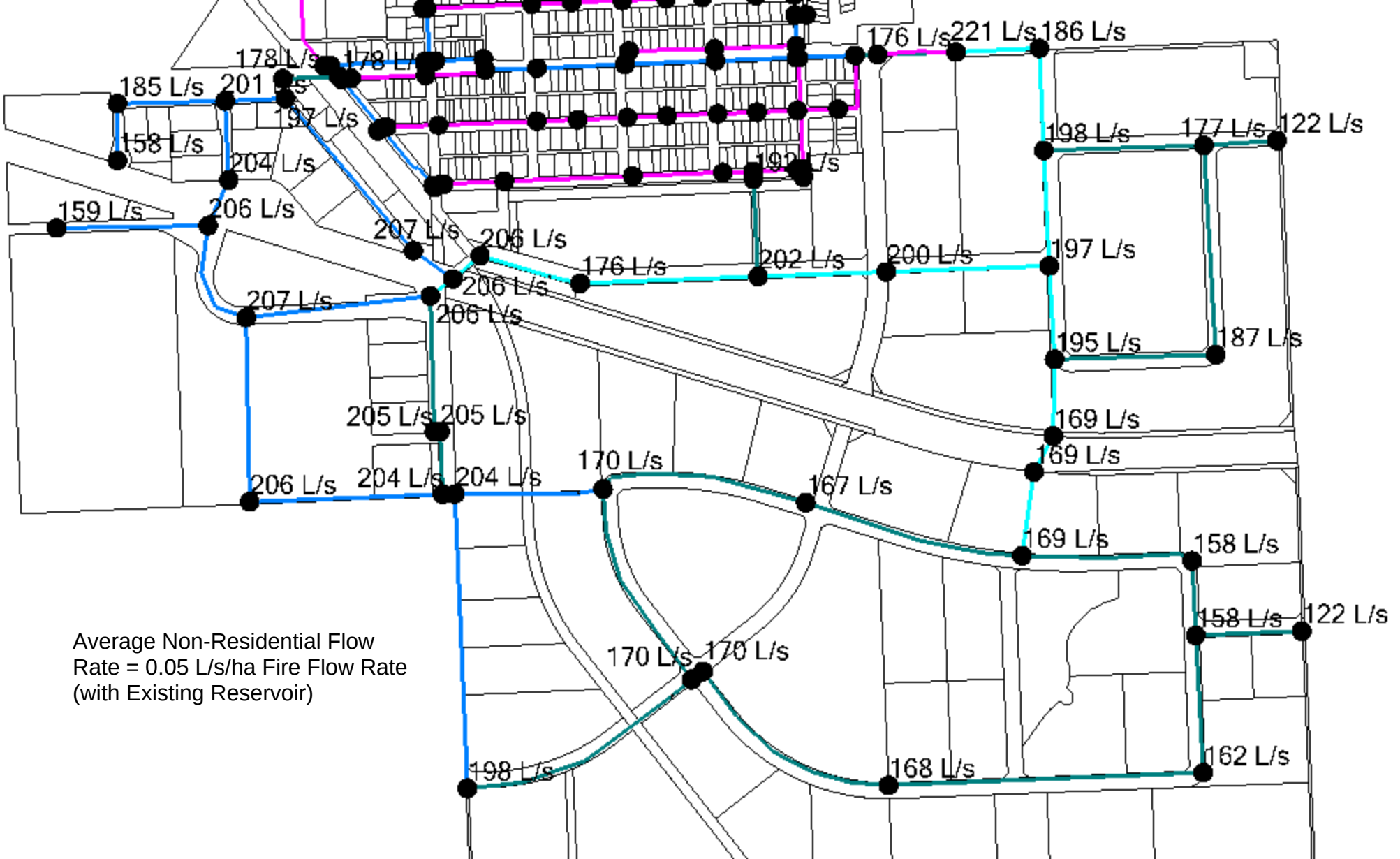

Average Non-Residential
Flow Rate = 0.02 L/s/ha
(with Existing Reservoir)
Color Coding Legend
Pipe: Diameter (mm)
<= 150.0
<= 200.0
<= 250.0
<= 300.0
<= 350.0
<= 400.0
<= 500.0
Other
Color Coding Legend
Junction: Fire Flow (Available) (L/s)
<= 75
<= 150
<= 200
<= 300
Other



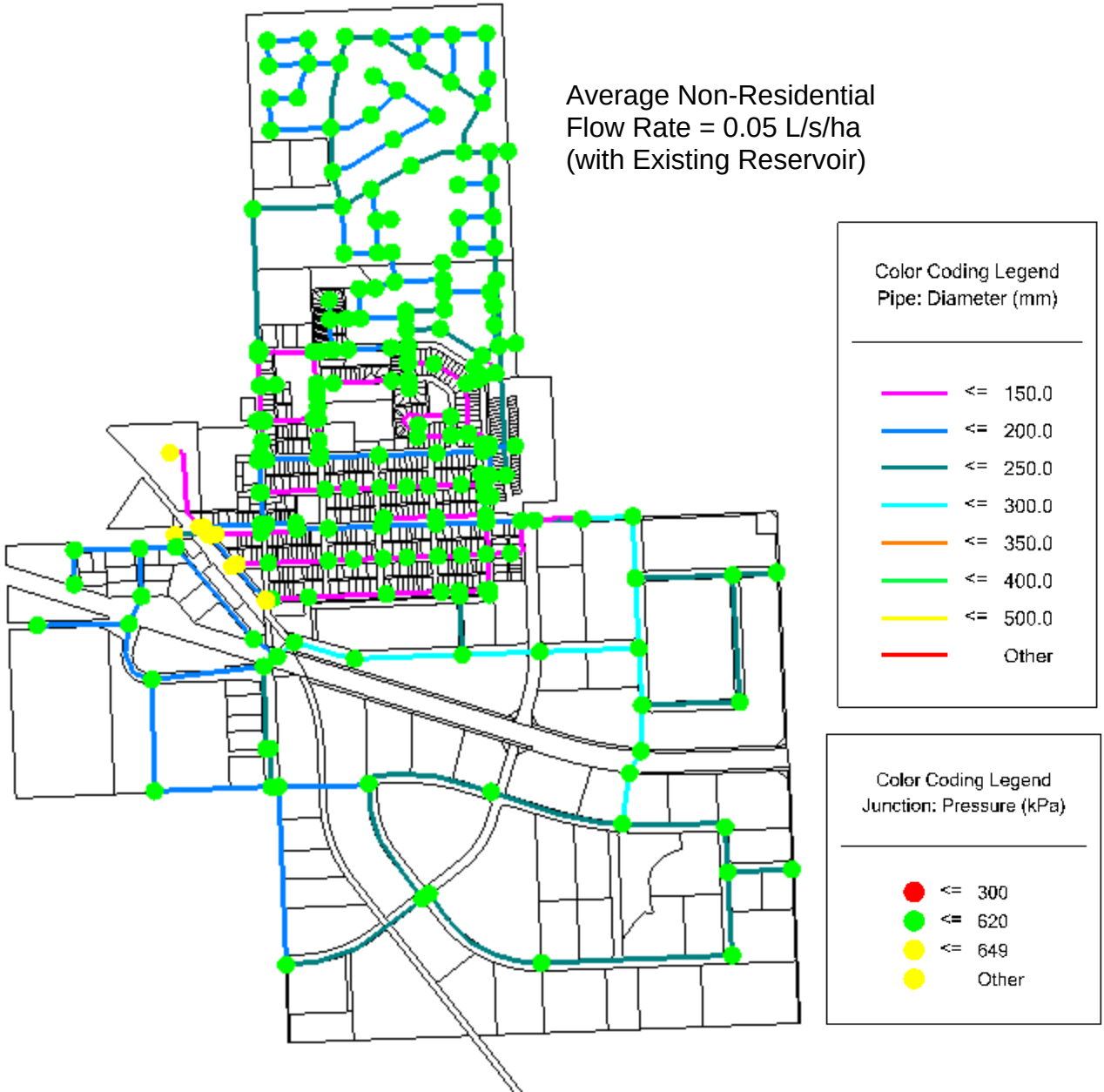
Average Non-Residential Flow Rate = 0.02 L/s/ha Fire Flow Rate (with Existing Reservoir)


Average Non-Residential
Flow Rate = 0.02 L/s/ha
(with Existing Reservoir)
Color Coding Legend
Pipe: Diameter (mm)
<= 150.0
<= 200.0
<= 250.0
<= 300.0
<= 350.0
<= 400.0
<= 500.0
Other
Color Coding Legend
Junction: Pressure (kPa)
<= 300
<= 620
<= 649
Other

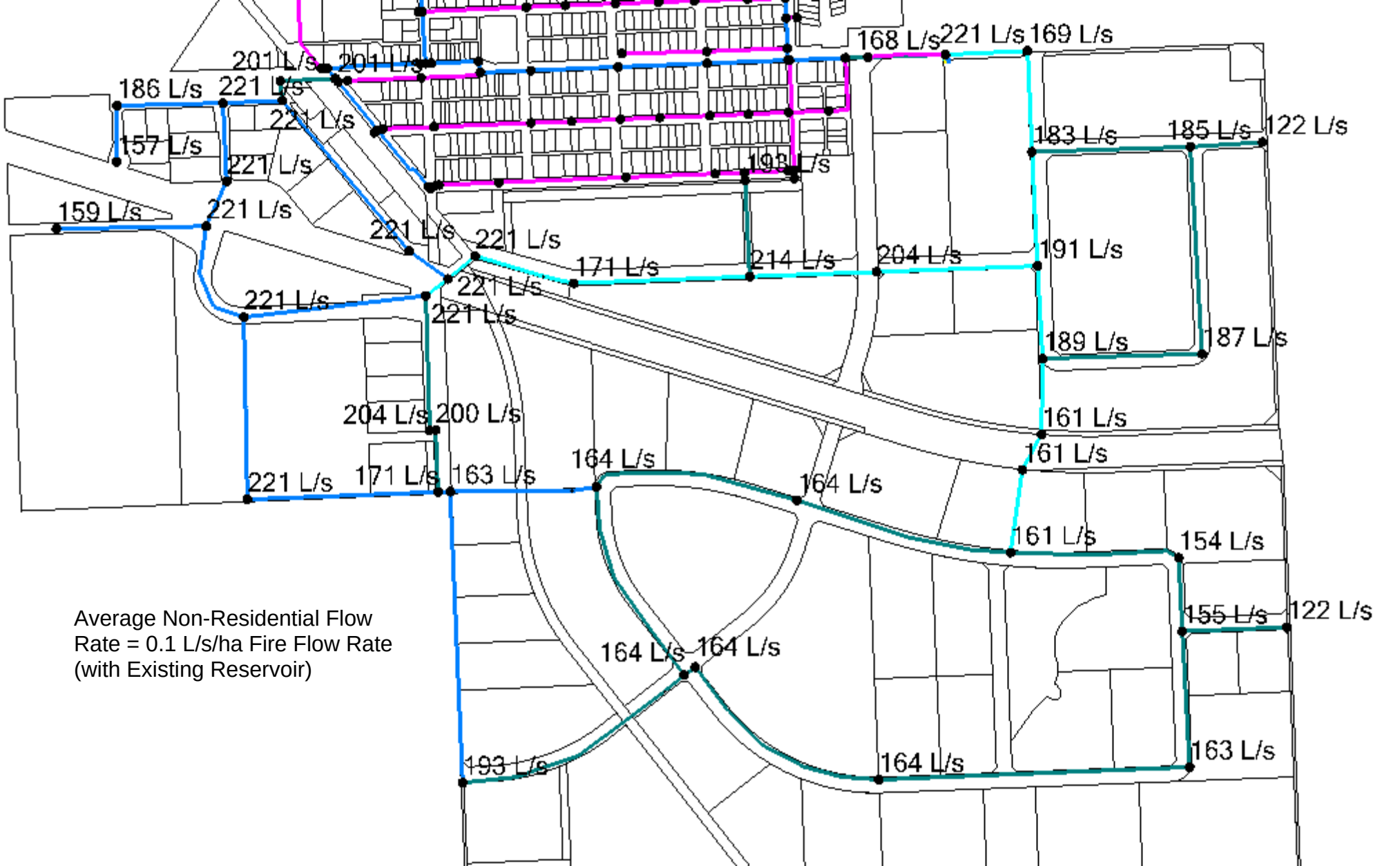

Average Non-Residential
Flow Rate = 0.05 L/s/ha
(with Existing Reservoir)
Color Coding Legend
Pipe: Diameter (mm)
<= 150.0
<= 200.0
<= 250.0
<= 300.0
<= 350.0
<= 400.0
<= 500.0
Other
Color Coding Legend
Junction: Fire Flow (Available) (L/s)
<= 75
<= 150
<= 200
<= 300
Other



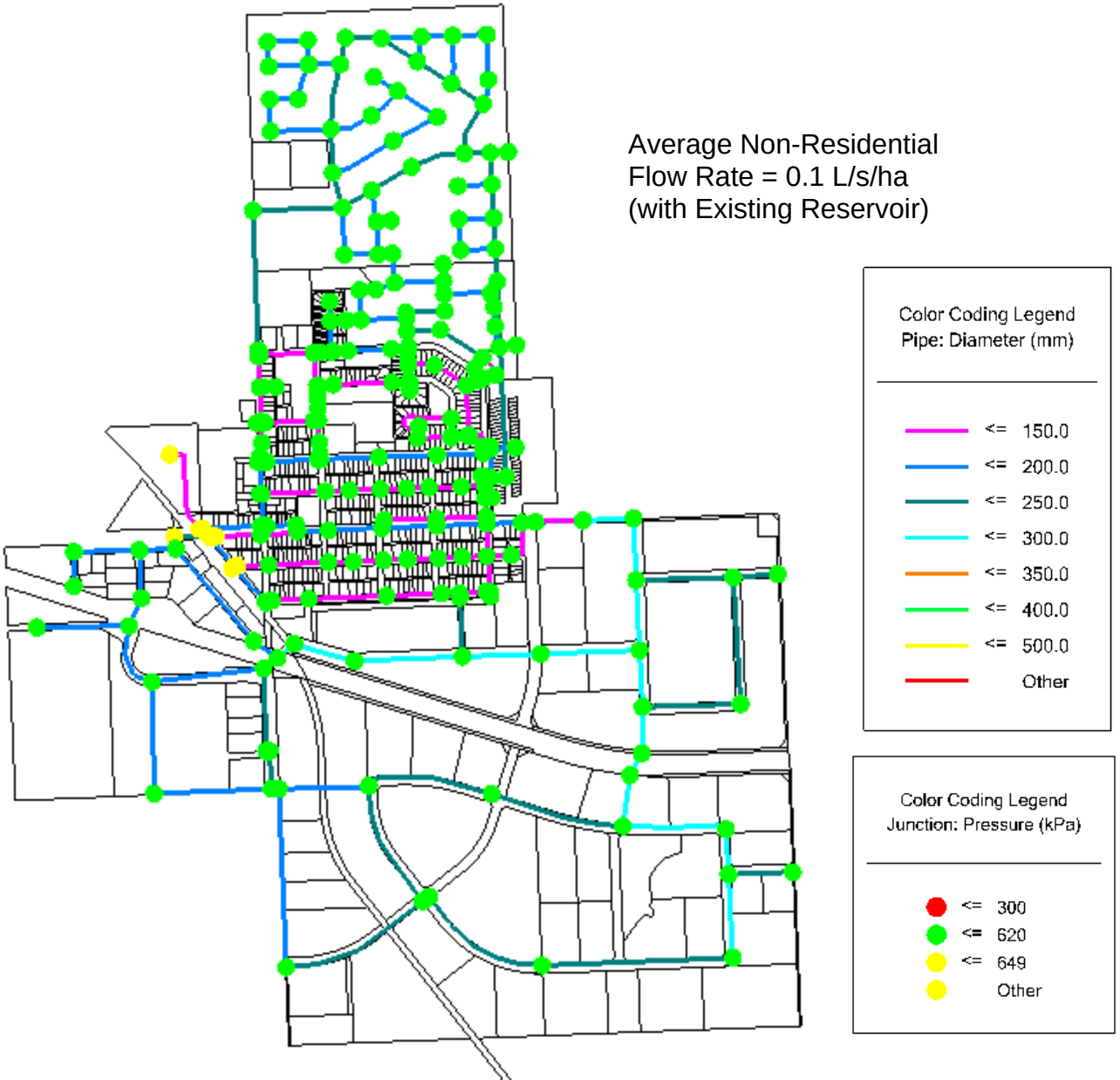
Average Non-Residential Flow Rate = 0.05 L/s/ha Fire Flow Rate (with Existing Reservoir)

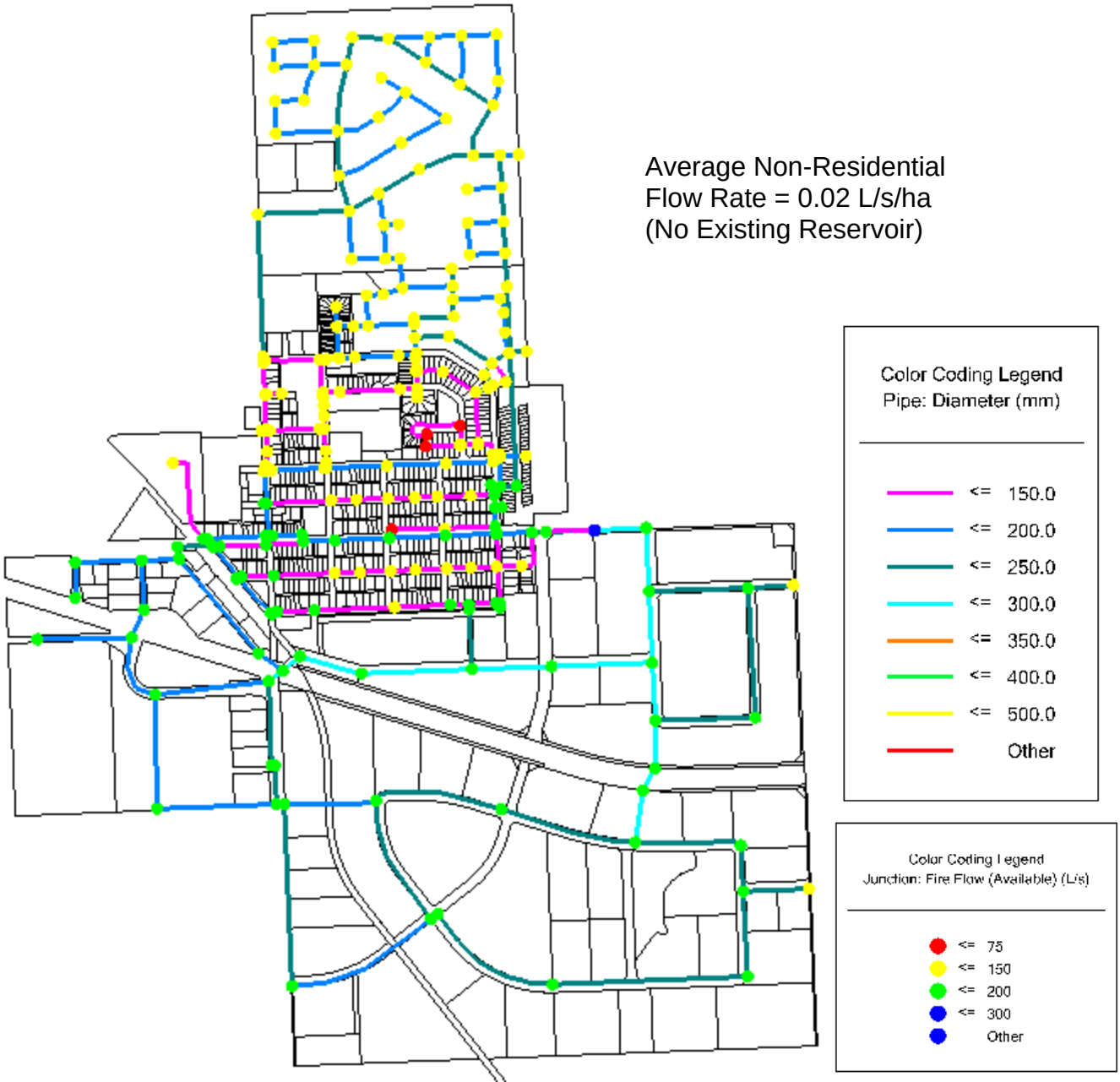

Average Non-Residential
Flow Rate = 0.05 L/s/ha
(with Existing Reservoir)
Color Coding Legend
Pipe: Diameter (mm)
<= 150.0
<= 200.0
<= 250.0
<= 300.0
<= 350.0
<= 400.0
<= 500.0
Other
Color Coding Legend
Junction: Pressure (kPa)
<= 300
<= 620
<= 649
Other

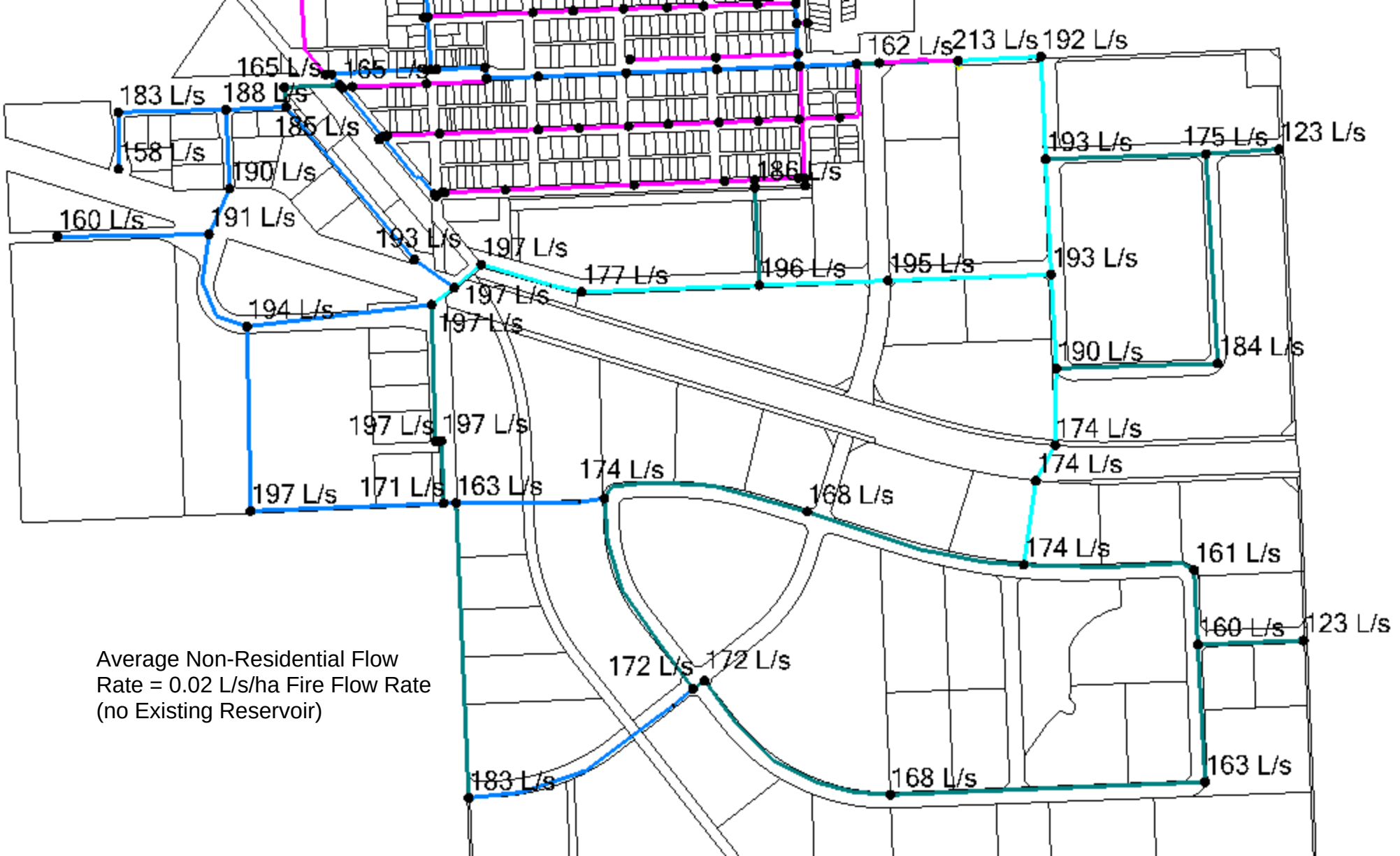

Average Non-Residential
Flow Rate = 0.1 L/s/ha
(with Existing Reservoir)
Color Coding Legend
Pipe: Diameter (mm)
<= 150.0
<= 200.0
<= 250.0
<= 300.0
<= 350.0
<= 400.0
<= 500.0
Other
Color Coding Legend
Junction: Fire Flow (Available) (L/s)
<= 75
<= 150
<= 200
<= 300
Other



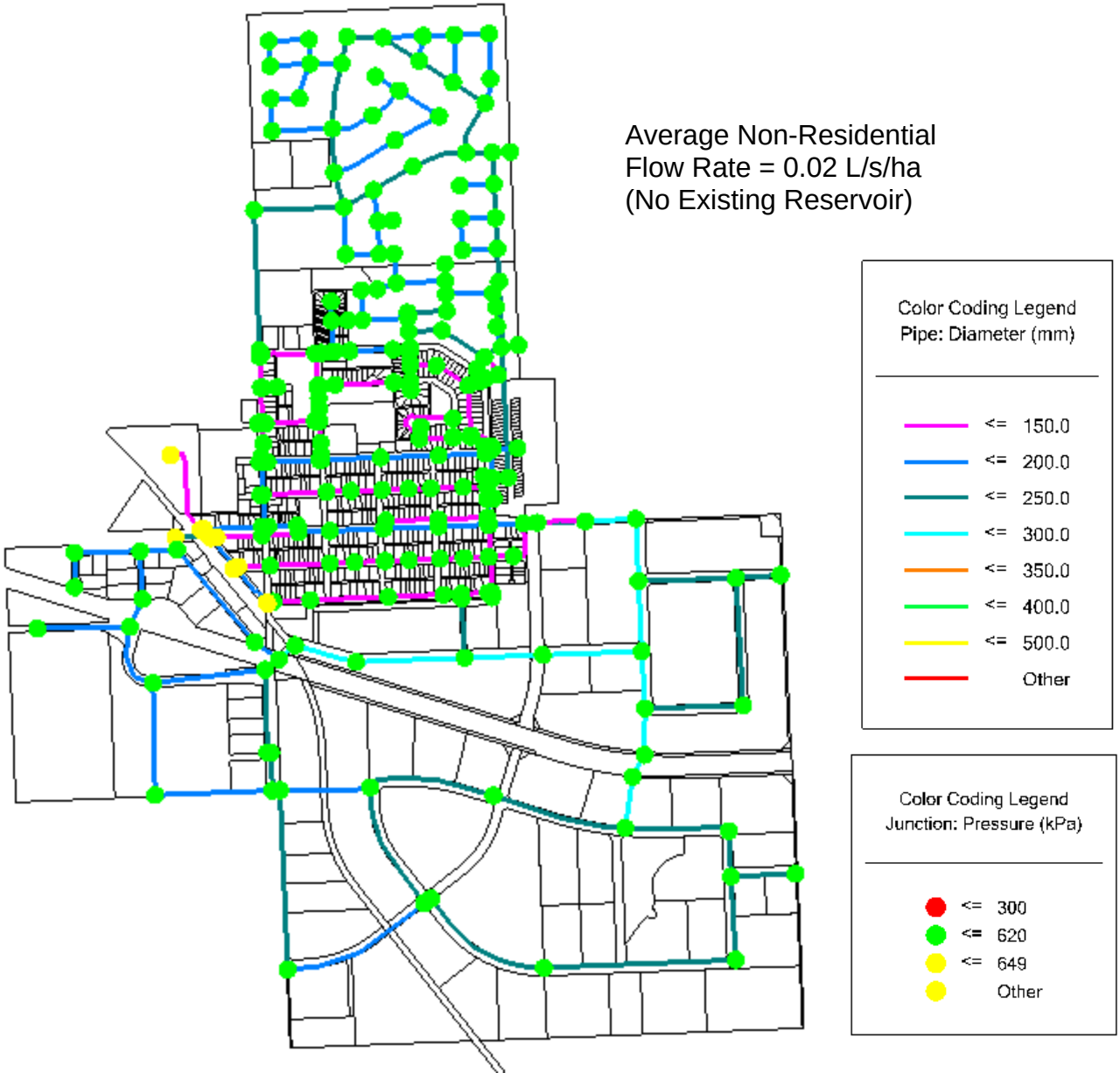
Average Non-Residential Flow Rate = 0.1 L/s/ha Fire Flow Rate (with Existing Reservoir)

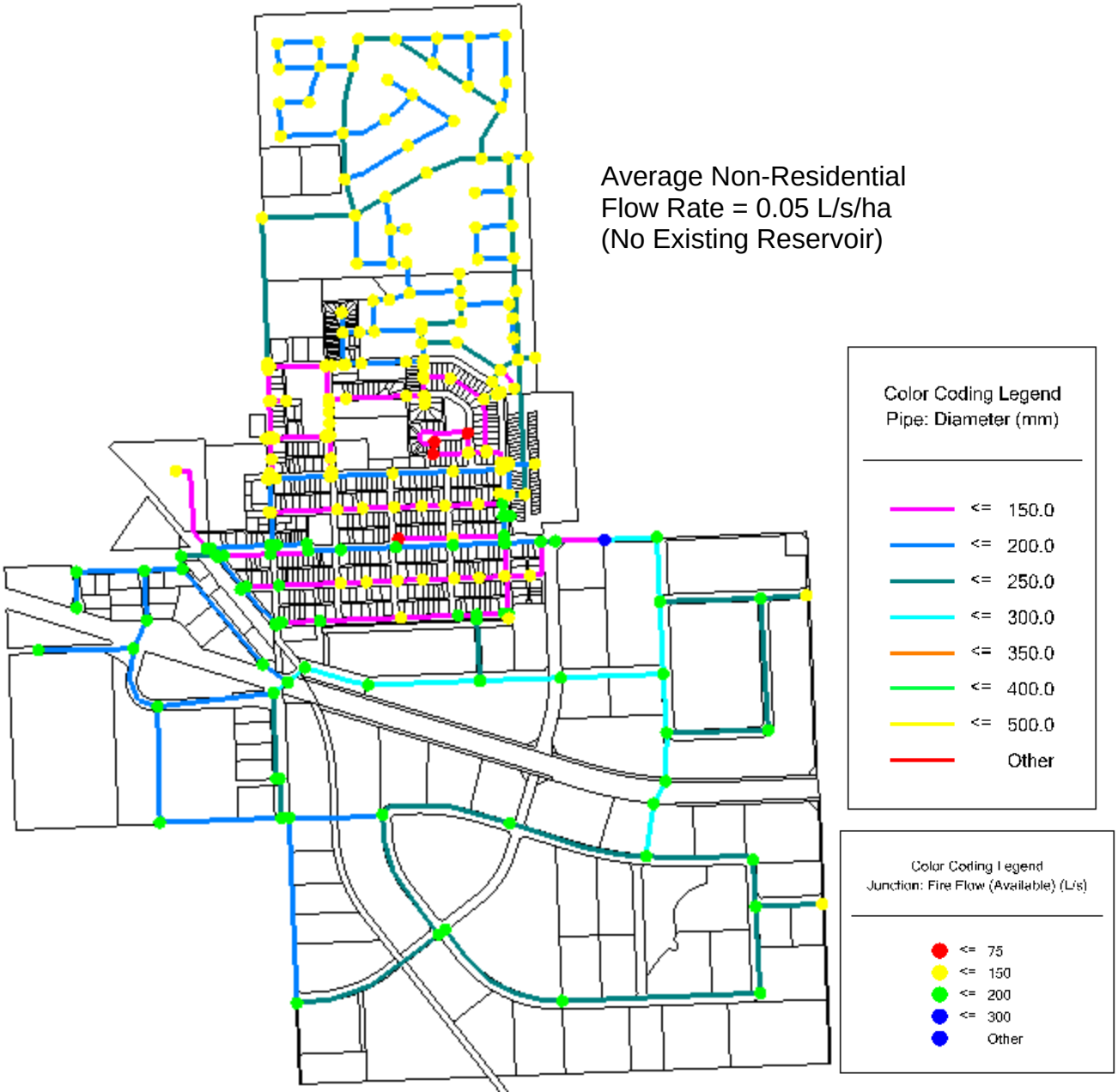

Average Non-Residential
Flow Rate = 0.1 L/s/ha
(with Existing Reservoir)
Color Coding Legend
Pipe: Diameter (mm)
<= 150.0
<= 200.0
<= 250.0
<= 300.0
<= 350.0
<= 400.0
<= 500.0
Other
Color Coding Legend
Junction: Pressure (kPa)
<= 300
<= 620
<= 649
Other

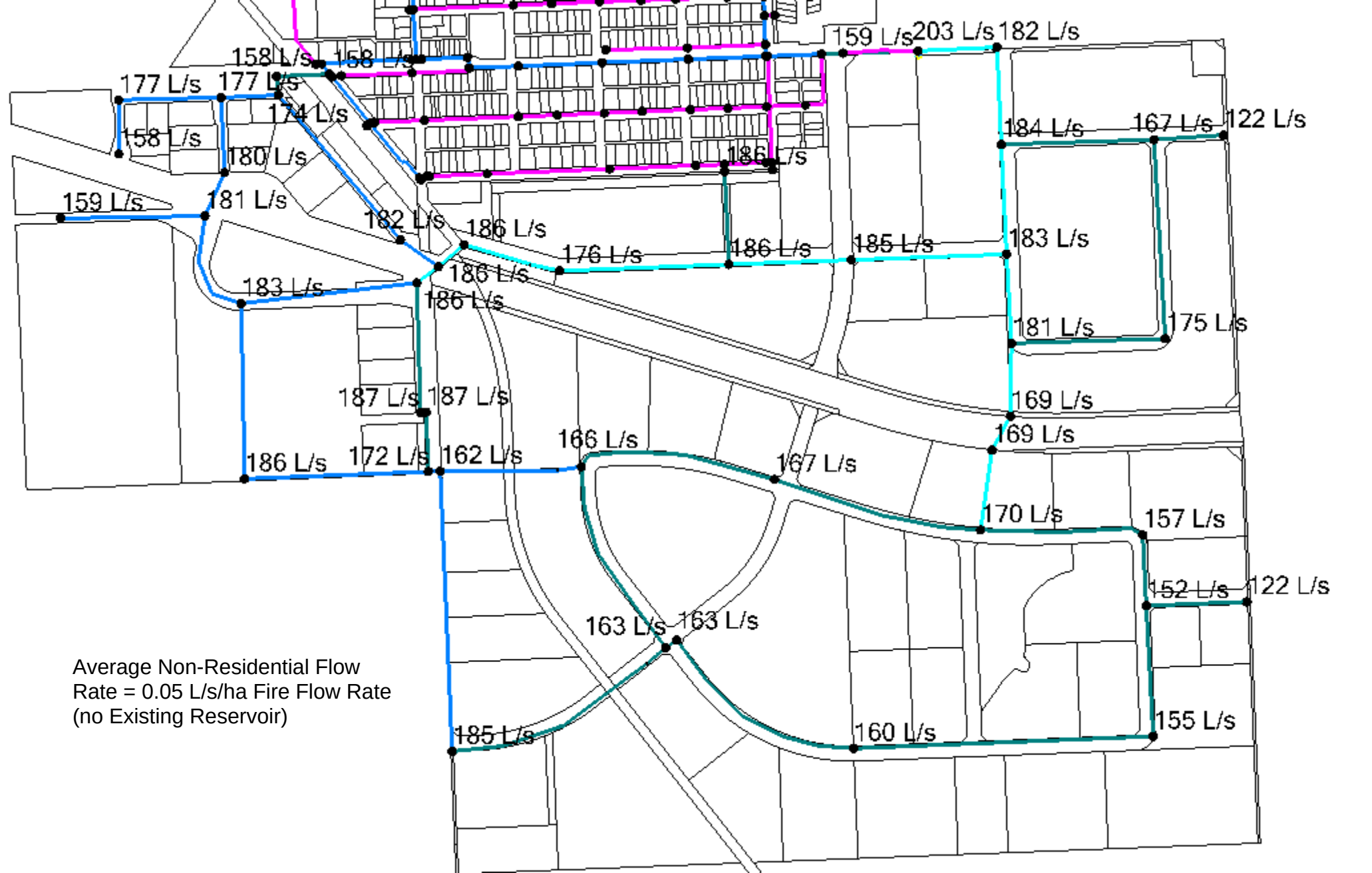

Average Non-Residential
Flow Rate = 0.02 L/s/ha
(No Existing Reservoir)
Color Coding Legend
Pipe: Diameter (mm)
<= 150.0
<= 200.0
<= 250.0
<= 300.0
<= 350.0
<= 400.0
<= 500.0
Other
Color Coding Legend
Junction: Fire Flow (Available) (L/s)
<= 75
<= 150
<= 200
<= 300
Other

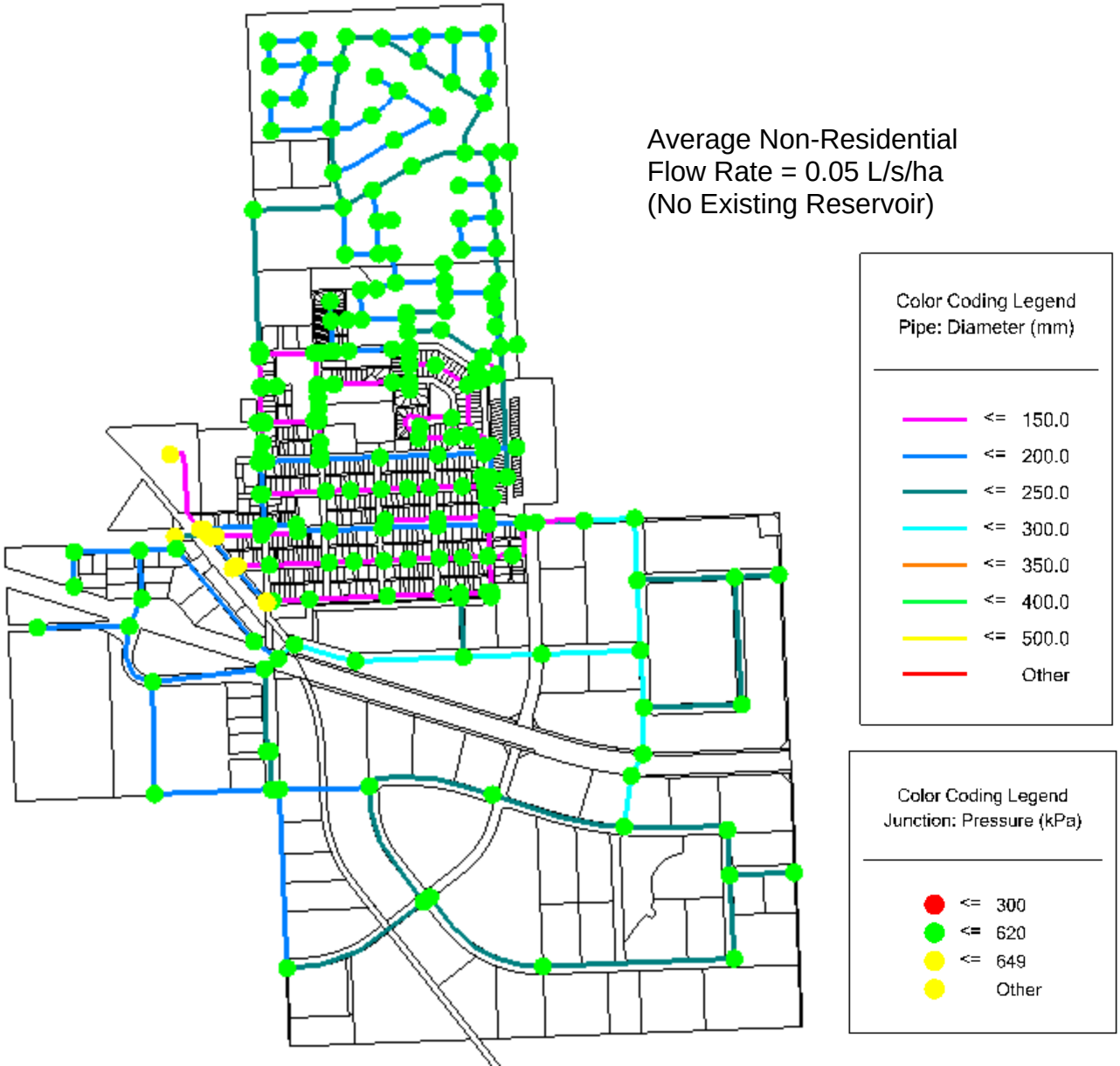


Average Non-Residential Flow Rate = 0.02 L/s/ha Fire Flow Rate (no Existing Reservoir)

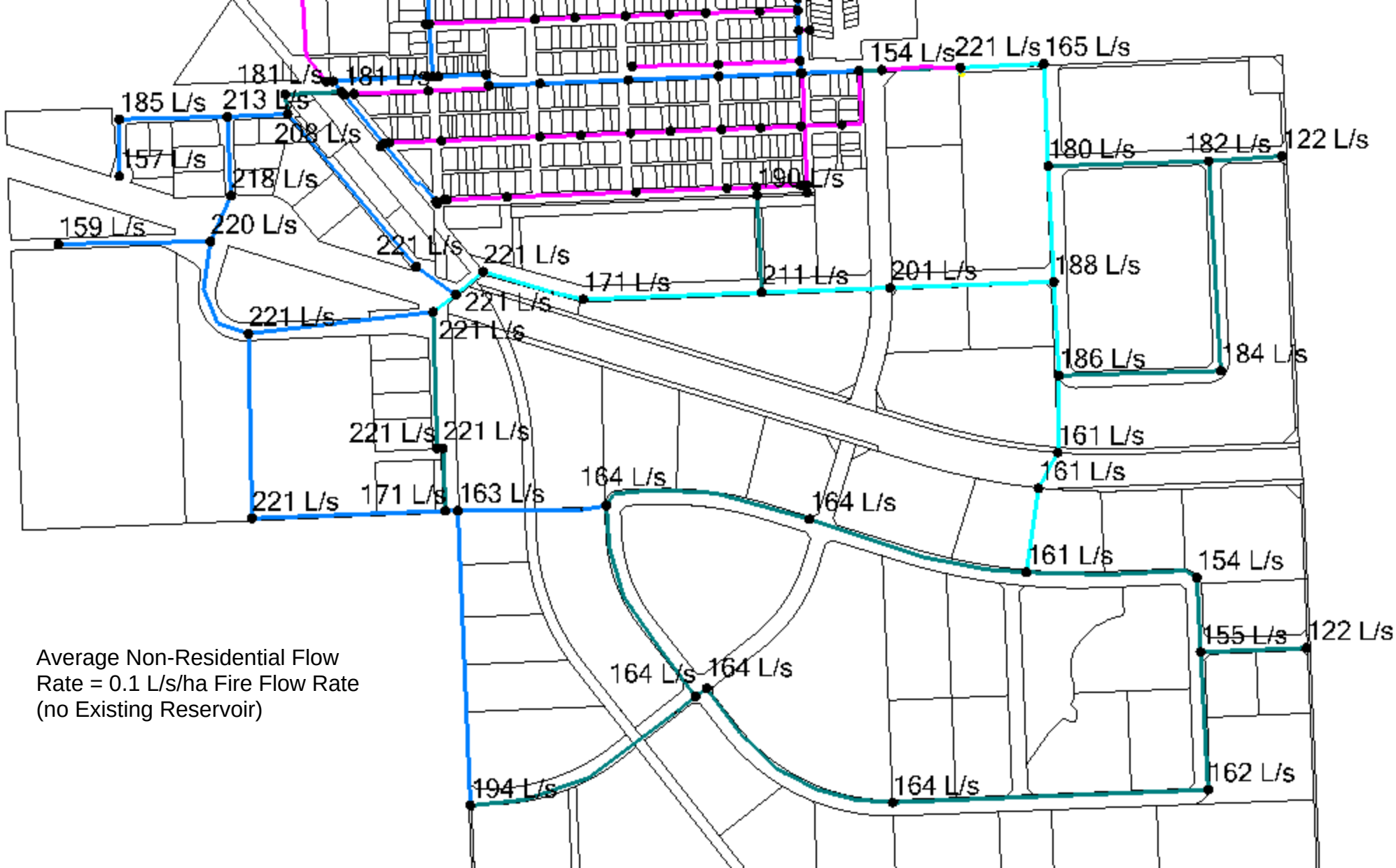

Average Non-Residential
Flow Rate = 0.02 L/s/ha
(No Existing Reservoir)
Color Coding Legend
Pipe: Diameter (mm)
<= 150.0
<= 200.0
<= 250.0
<= 300.0
<= 350.0
<= 400.0
<= 500.0
Other
Color Coding Legend
Junction: Pressure (kPa)
<= 300
<= 620
<= 649
Other


Average Non-Residential
Flow Rate = 0.05 L/s/ha
(No Existing Reservoir)
Color Coding Legend
Pipe: Diameter (mm)
<= 150.0
<= 200.0
<= 250.0
<= 300.0
<= 350.0
<= 400.0
<= 500.0
Other
Color Coding Legend
Junction: Fire Flow (Available) (L/s)
<= 75
<= 150
<= 200
<= 300
Other

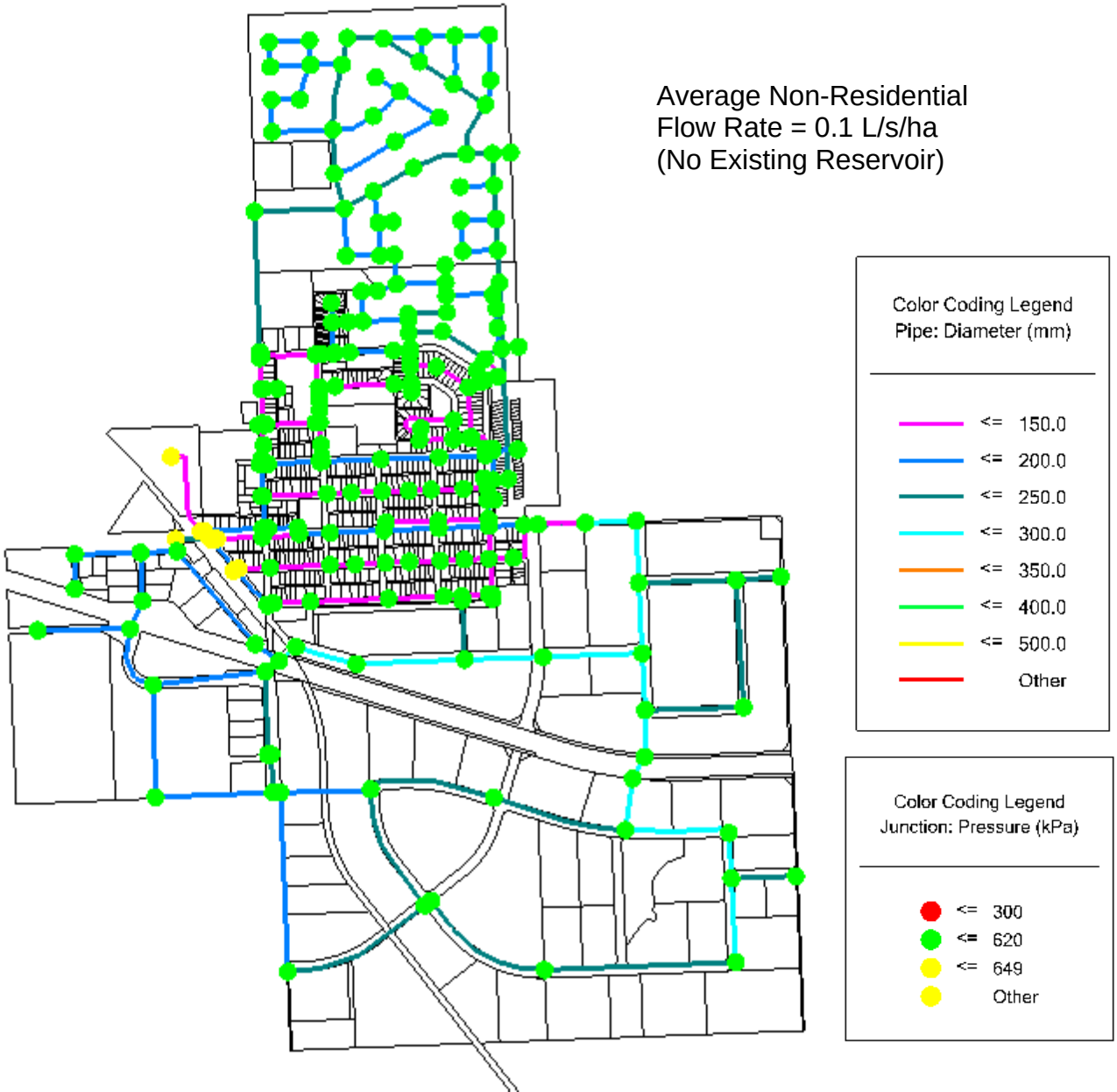

158 L/s
158 L/s
177 L/s
177 L/s
174 L/s
158 L/s
180 L/s
159 L/s
181 L/s
182 L/s
186 L/s
176 L/s
186 L/s
186 L/s
183 L/s
186 L/s
187 L/s
187 L/s
186 L/s
172 L/s
162 L/s
166 L/s
159 L/s
203 L/s
182 L/s
184 L/s
167 L/s
122 L/s
186 L/s
185 L/s
183 L/s
181 L/s
175 L/s
169 L/s
169 L/s
167 L/s
170 L/s
157 L/s
152 L/s
122 L/s
163 L/s
163 L/s
185 L/s
160 L/s
155 L/s
Average Non-Residential Flow Rate = 0.05 L/s/ha Fire Flow Rate (no Existing Reservoir)


Average Non-Residential
Flow Rate = 0.05 L/s/ha
(No Existing Reservoir)
Color Coding Legend
Pipe: Diameter (mm)
<= 150.0
<= 200.0
<= 250.0
<= 300.0
<= 350.0
<= 400.0
<= 500.0
Other
Color Coding Legend
Junction: Pressure (kPa)
<= 300
<= 620
<= 649
Other

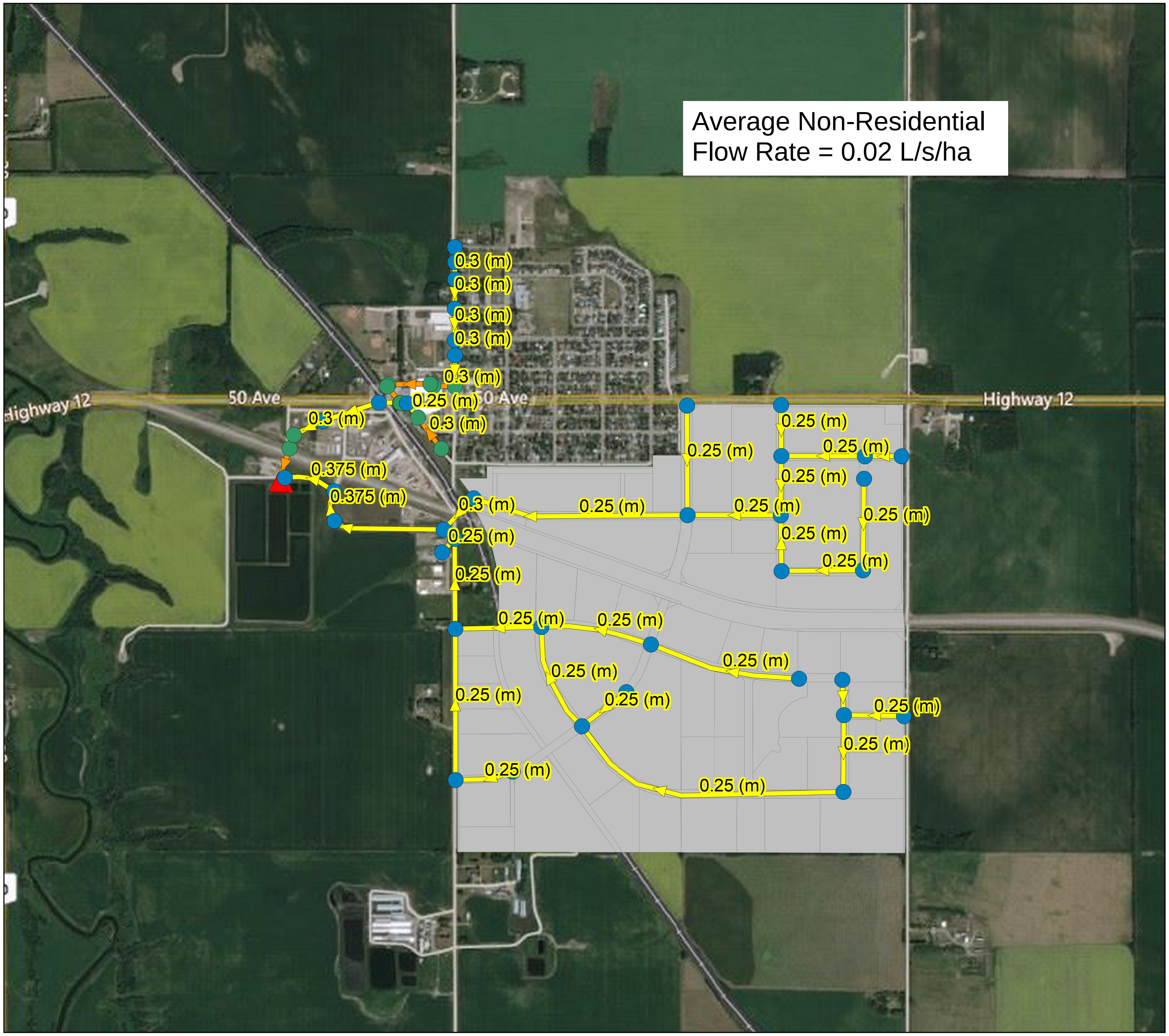

Average Non-Residential
Flow Rate = 0.1 L/s/ha
(No Existing Reservoir)
Color Coding Legend
Pipe: Diameter (mm)
<= 150.0
<= 200.0
<= 250.0
<= 300.0
<= 350.0
<= 400.0
<= 500.0
Other
Color Coding Legend
Junction: Fire Flow (Available) (L/s)
<= 75
<= 150
<= 200
<= 300
Other



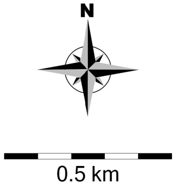
Average Non-Residential Flow Rate = 0.1 L/s/ha Fire Flow Rate (no Existing Reservoir)


Average Non-Residential
Flow Rate = 0.1 L/s/ha
(No Existing Reservoir)
Color Coding Legend
Pipe: Diameter (mm)
<= 150.0
<= 200.0
<= 250.0
<= 300.0
<= 350.0
<= 400.0
<= 500.0
Other
Color Coding Legend
Junction: Pressure (kPa)
<= 300
<= 620
<= 649
Other

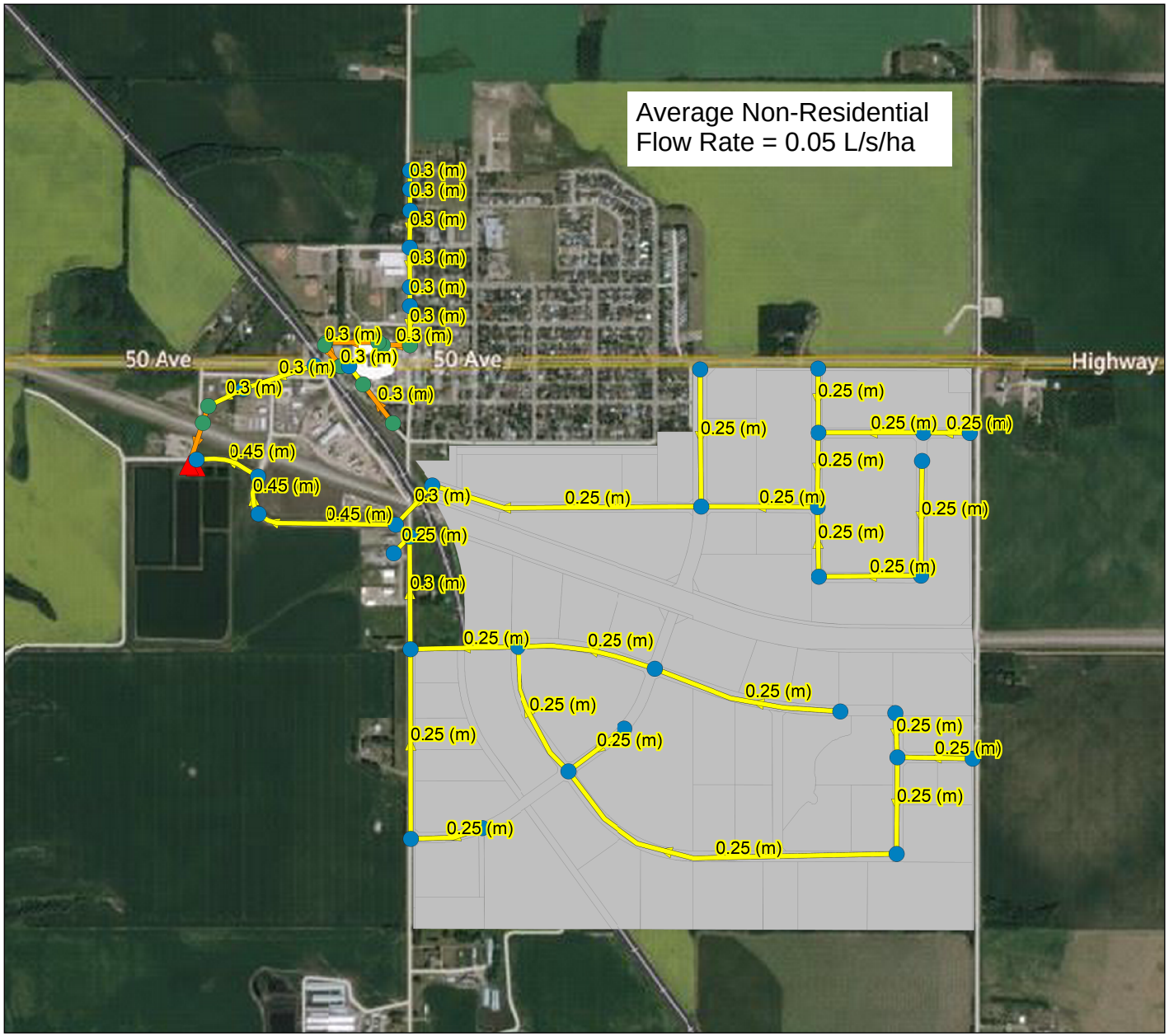
Appendix C PCSWMM FIGURES

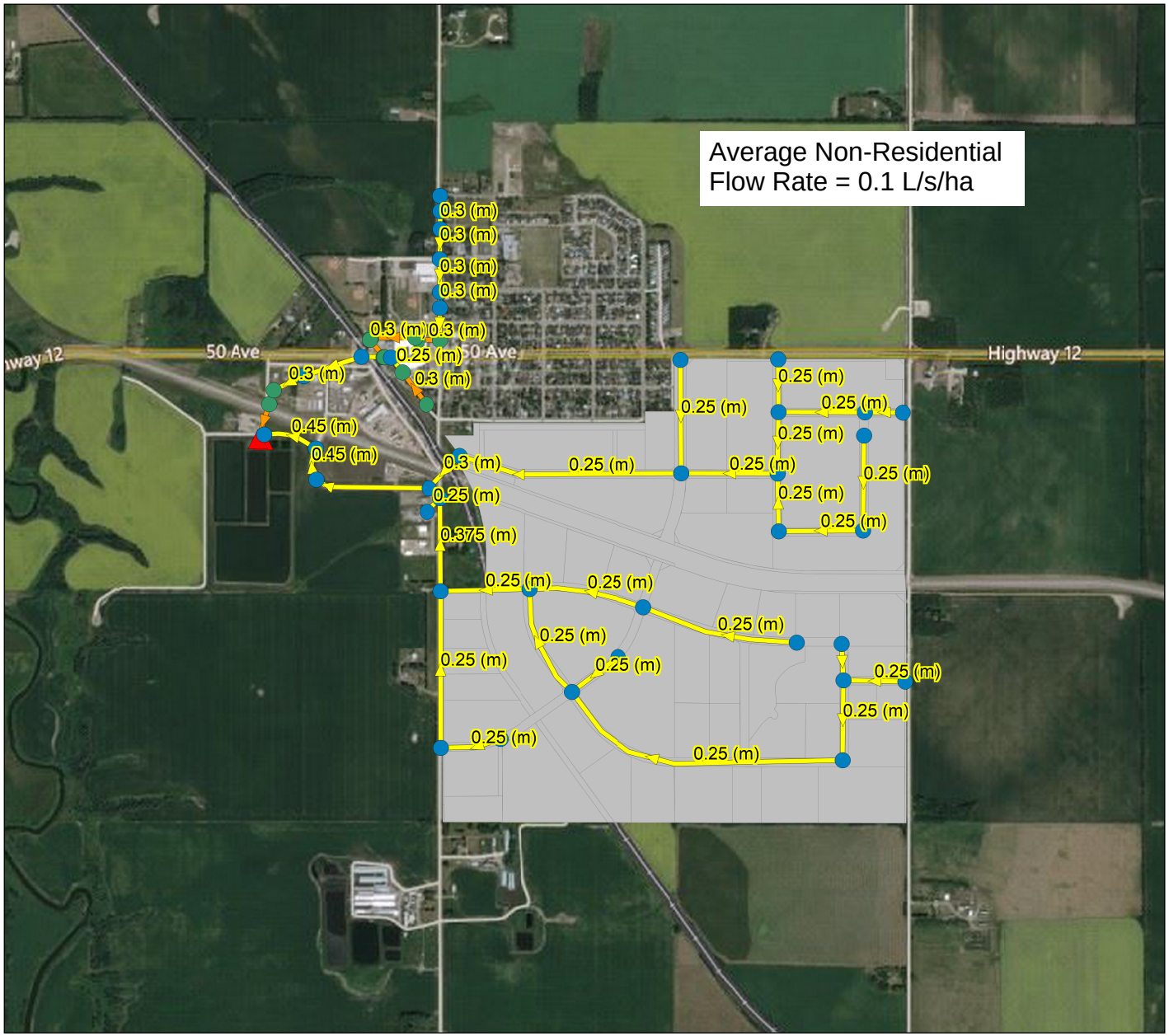


Average Non-Residential
Flow Rate = 0.02 L/s/ha
Highway 12
50 Ave
Highway 12
0.3 (m)
0.25 (m)
0.375 (m)



N
0.5 km


Average Non-Residential
Flow Rate = 0.05 L/s/ha
50 Ave
50 Ave
Highway
0.3 (m)
0.45 (m)
0.25 (m)
N
0.5 km


Average Non-Residential
Flow Rate = 0.1 L/s/ha
50 Ave
50 Ave
Highway 12
0.3 (m)
0.25 (m)
0.45 (m)
0.375 (m)
N
0.5 km

Appendix D AWWID WELL REPORT

Reconnaissance Report

View in Imperial

Export to Excel

Groundwater Wells

Please click the water Well ID to generate the Water Well Drilling Report.

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
247002	11	26	40	1	5	PETERSON C ENT LTD	1981-02-14	22.86	Dry Hole	Domestic		5		BENTLEY, TOWN OF			0.00
247005	11	26	40	1	5	PETERSON C ENT LTD	1981-02-14	22.86	Dry Hole	Domestic		3		BENTLEY, TOWN OF			0.00
247007	11	26	40	1	5	PETERSON C ENT LTD	1981-04-27	10.97	New Well	Domestic		4		BENTLEY, TOWN OF	7.01	1.14	60.96
247008	11	26	40	1	5	PETERSON C ENT LTD	1981-02-01	16.15	New Well	Domestic		6		BENTLEY, TOWN OF	14.63	1.14	60.96
352815	SE	23	40	1	5	ALKEN BASIN DRILLING LTD.	1990-11-06	48.77	New Well	Domestic		14		BERANEK, KENNY	33.53	45.46	13.97
361377	SE	27	40	1	5	ATSINGER KEN R	1977-09-24	36.58	New Well	Domestic		3		HERRICK, ED	10.67	45.46	14.12
369277	NE	22	40	1	5	ALKEN BASIN DRILLING LTD.	1993-05-20	24.38	New Well	Domestic		9		FREE NORTH HYDRAULIC SVC	4.57	68.19	13.97
369334	6	24	40	1	5	ALKEN BASIN DRILLING LTD.	1993-05-21	97.54	New Well-Decommissioned	Industrial		20		RUSTIN RES #SIMMON 18	0.00	45.46	0.00
396659	SW	27	40	1	5	FRASER, RON	1994-08-26	22.86	New Well	Domestic		5	25	COMMAND DRLG	9.45	54.55	0.00
437290	SE	22	40	1	5	RICHMOND WW DRLG	1979-07-27	18.29	New Well	Domestic & Stock		2		SZASZ, BOB	9.14	54.55	11.43
437292	SE	22	40	1	5	UNKNOWN DRILLER		19.81	Federal Well Survey	Domestic				SZASZ, L.			12.70
437294	SE	22	40	1	5	UNKNOWN DRILLER		19.81	Federal Well Survey	Stock				SZASZ, L.			12.70
437296	SE	22	40	1	5	ALKEN BASIN DRILLING LTD.	1989-01-11	77.72	New Well	Stock		4		SZASZ, ROBERT	15.24	45.46	13.97
437298	14	22	40	1	5	SATELLITE DRILLING LTD.	1978-07-17	30.48	New Well	Domestic	1	6		WECKER, DAN	5.18	34.10	11.43
437298	14	22	40	1	5	ALKEN BASIN DRILLING LTD.		28.00	Existing Well-Decommissioned	Unknown				WECKER, DAN			11.43
437301	NW	22	40	1	5	UNKNOWN DRILLER		10.67	Federal Well Survey	Domestic				WECKER, D.			15.24
437303	13	22	40	1	5	UNKNOWN DRILLER	1953-02-03	287.73	Structure Test Hole	Industrial				CALIFORNIA STANDARD #STH			0.00
437307	NE	22	40	1	5	ERICKSON ERNFRED	1958-07-29	34.44	New Well	Domestic		3		C.P.R.			5.08
437313	NE	22	40	1	5	SIEBLE ALLAN	1965-01-01	28.04	New Well	Domestic	1	3	3	SZASZ, L.	9.14	45.46	13.97
437320	NE	22	40	1	5	AB WATER WELL DRILLING	1977-08-12	16.46	New Well	Domestic		8		ALBERTA WHEAT POOL			14.12

Reconnaissance Report

View in Imperial

Export to Excel

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
437324	NE	22	40	1	5	RICHMOND WW DRLG	1979-10-04	21.34	New Well	Domestic & Stock		4		SZASZ, MRS	7.62	90.92	11.43
437443	NE	22	40	1	5	FORRESTER WATER WELL DRILLING (1981) LTD.	1980-07-18	25.91	New Well	Industrial	1	10		BENTLEY FARM SUPPLIES LTD	7.62	218.21	17.78
437450	NE	22	40	1	5	RICHMOND WW DRLG	1977-10-14	19.81	New Well	Domestic		2		BENTLY SEED CLEANING CO-OP	6.10	90.92	11.43
437452	NE	22	40	1	5	FORRESTER WATER WELL DRILLING (1981) LTD.	1982-07-30	32.00	New Well	Industrial		18		UNITED GRAIN GROWERS LTD	6.10	227.30	17.78
437458	NE	22	40	1	5	FORRESTER WATER WELL DRILLING (1981) LTD.	1982-11-24	27.43	New Well	Industrial		10		DUNCAN, DENNIS	3.05	136.38	17.78
437465	16	22	40	1	5	ERICKSON ERNFRED	1961-10-31	55.17	New Well	Domestic & Industrial		8	2	BENTLEY CREAMERY	11.28	109.11	17.78
437465	16	22	40	1	5	ERICKSON ERNFRED	1961-10-31	55.17	New Well	Domestic & Industrial		8	3	BENTLEY CREAMERY	12.50	109.11	17.78
437465	16	22	40	1	5	ALKEN BASIN DRILLING LTD.	2008-03-25	53.34	Dry Hole-Decommissioned	Unknown				BENTLEY, TOWN OF	10.67		17.78
437471	SE	23	40	1	5	NELSON DRILLING & PLUMBING	1974-08-31	54.86	New Well	Stock		7		BERANEK	33.83	45.46	10.16
437478	SE	23	40	1	5	UNKNOWN DRILLER		0.00	Federal Well Survey	Domestic & Stock				DAVEY, A.			6.35
437481	NW	23	40	1	5	ERICKSON & KANGAS	1965-09-02	30.48	New Well	Domestic		4		CALKINS, ELMER	17.68	45.46	11.43
437484	NW	23	40	1	5	NELSON DRILLING & PLUMBING	1964-06-30	45.72	New Well	Domestic		2		RIETMAN, NEIL	29.87	45.46	5.08
437489	NW	23	40	1	5	NELSON DRILLING & PLUMBING	1963-07-01	39.62	New Well	Domestic		2		HOLMES, BILL	29.26	45.46	5.08
437493	NW	23	40	1	5	NELSON DRILLING & PLUMBING	1964-06-30	45.72	New Well	Domestic		2		SEVIGNY, A.J.	29.87	45.46	5.08
437497	NW	23	40	1	5	UNKNOWN DRILLER		30.48	Chemistry	Domestic	1			ENGELBORTSON, SELMA			0.00
437502	NW	23	40	1	5	NELSON DRILLING & PLUMBING	1964-03-31	51.82	New Well	Domestic				WILKINS, J.	36.58	45.46	5.08
437504	NW	23	40	1	5	NELSON DRILLING & PLUMBING		42.67	New Well	Domestic		2		SWANSON, TONY	32.61	22.73	5.08
437507	NW	23	40	1	5	NELSON DRILLING & PLUMBING		39.62	New Well	Domestic		2		CASTLEMAN, SOPHIE	18.90	22.73	5.08
437510	3	26	40	1	5	NELSON DRILLING & PLUMBING		54.86	New Well	Domestic		2		BRANDON, M.	35.05	22.73	5.08
437510	3	26	40	1	5	ALKEN BASIN DRILLING LTD.		46.50	Existing Well-Decommissioned	Unknown				BRANDON, MERV			5.08

Reconnaissance Report

View in Imperial

Export to Excel

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
437514	NW	23	40	1	5	NELSON	1965-09-30	45.72	New Well	Domestic		4		ALBERTA PACIFIC GRAIN	32.00	45.46	10.16
437517	13	23	40	1	5	ERICKSON ERNFRED	1958-07-16	30.48	New Well	Domestic		3		BENTLEY COMMUNITY HALL	10.67	36.37	5.08
437519	14	23	40	1	5	ERICKSON ERNFRED		28.96	New Well	Domestic		7		STEPHENSON, W.			7.32
437523	NW	23	40	1	5	NELSON DRILLING & PLUMBING		39.62	New Well	Domestic		2		WHITHERALL, M.S.	18.90	22.73	5.08
437527	NW	23	40	1	5	UNKNOWN DRILLER		42.06	Chemistry	Domestic	1			STONESS, CHARLES/AGNES			0.00
437531	13	23	40	1	5	ERICKSON ERNFRED	1957-09-18	27.13	New Well	Domestic		9		SWANSON, J.	18.59	45.46	5.08
437535	14	23	40	1	5	ERICKSON ERNFRED	1958-10-17	37.80	New Well	Domestic		7		DICKAU, H.	28.96	36.37	5.08
437538	14	23	40	1	5	UNKNOWN DRILLER		42.37	Chemistry	Domestic	1	3		BROOKE, SIDNEY			5.08
437541	NW	23	40	1	5	RICHMOND WW DRLG	1976-05-13	33.53	New Well	Domestic		2		LECLERCQ, NORMAN	22.86	45.46	11.43
437543	15	23	40	1	5	ERICKSON & KANGAS	1963-06-11	39.62	New Well	Domestic		8	3	GRAY, A.	24.38	45.46	11.43
437547	SW	24	40	1	5	STAR DRLG CO	1977-06-24	68.58	New Well	Stock		2		SELTENRICH, W.A.	45.72	54.55	11.43
437551	SW	24	40	1	5	UNKNOWN DRILLER		60.96	Federal Well Survey	Domestic & Stock				SALTONRIDGE (SALTENRICH?)			0.00
437552	NW	24	40	1	5	UNKNOWN DRILLER		58.83	Federal Well Survey	Domestic & Stock				PIERSON, J.			5.08
437554	NW	24	40	1	5	UNKNOWN DRILLER		22.86	Chemistry	Domestic	1			GRAVATT, CALVIN			0.00
437562	13	25	40	1	5	ERICKSON & KANGAS	1967-07-14	41.76	New Well	Domestic		6	5	ALBERTA WHEAT POOL	11.58	36.37	11.43
438544	SE	26	40	1	5	FLINN DRILLING LTD.	1973-04-01	48.77	New Well	Domestic	1	6		BENTLEY HIGH SCHOOL	18.29	159.11	14.27
438548	SE	26	40	1	5	ERICKSON & KANGAS	1961-07-14	42.06	Deepened	Domestic	1	2		BENTLEY HOSPITAL	0.00		0.00
438554	SE	26	40	1	5	FORRESTER DRILLING	1974-06-14	44.20	New Well	Domestic		16		GARRIES, DON	30.48	90.92	13.97
438561	SE	26	40	1	5	NELSON	1947-01-01	42.67	Federal Well Survey	Domestic & Stock				MILES, R.C.			0.00
438564	SE	26	40	1	5	OTHER	1927-01-01	41.15	Federal Well Survey	Domestic & Stock				MILES, R.C.	41.15		5.08

Reconnaissance Report

View in Imperial

Export to Excel

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
438568	SE	26	40	1	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic				HOWES, WILLIAM			0.00
438570	SW	26	40	1	5	FORESTER, AUGUST R.	1973-07-04	57.91	Deepened	Domestic		14		ALBERTA WHEAT POOL	30.48	118.20	17.78
438570	SW	26	40	1	5	FORESTER, AUGUST R.	1973-07-04	57.91	Deepened	Domestic		14		ALBERTA WHEAT POOL	28.96	118.20	17.78
438586	SW	26	40	1	5	RICHMOND WW DRLG	1972-08-25	48.77	New Well	Domestic		2		MCLACHLAN, HELEN	32.92	18.18	10.16
438590	SW	26	40	1	5	BROWN JIM	1973-01-03	42.67	New Well	Domestic		3		STAN, AL	33.53	54.55	10.80
438592	SW	26	40	1	5	JOHANSON VICTOR	1954-01-01	27.43	New Well	Unknown		2		BERG, CARL	16.76	36.37	8.89
438659	SW	26	40	1	5	SCOTT HARVEY L	1954-10-01	24.69	New Well	Industrial		6		CAL STANDARD # RIG WELL	10.67	81.83	17.78
438660	SW	26	40	1	5	JOHANSON VICTOR	1954-04-01	25.60	New Well	Domestic		3			16.46	36.37	5.08
438661	SW	26	40	1	5	JOHANSON VICTOR	1954-08-01	33.53	New Well	Municipal		4			17.07	34.10	5.08
438662	SW	26	40	1	5	JOHANSON VICTOR	1954-08-01	29.26	New Well	Unknown		3		QUAST, JOHN	0.00	204.57	5.08
438665	SW	26	40	1	5	JOHANSON VICTOR	1954-04-01	28.96	New Well	Domestic		4			0.00	36.37	8.89
438666	SW	26	40	1	5	SIEBLE ALLAN	1965-05-01	39.62	New Well	Domestic		6		GORDON, J.T.	32.00	45.46	13.97
438668	SW	26	40	1	5	UNKNOWN DRILLER		0.00	Well Inventory	Domestic				GORDON, J.T.			0.00
438670	SW	26	40	1	5	FORESTER, AUGUST R.	1975-01-14	53.34	New Well	Municipal	1	16		BENTLEY, VILL OF	33.53	533.71	21.89
438670	SW	26	40	1	5	FORESTER, AUGUST R.	1975-01-14	53.34	New Well	Municipal	1	16	51	BENTLEY, VILL OF	33.65		21.89
438670	SW	26	40	1	5	FORESTER, AUGUST R.	1975-01-14	53.34	New Well	Municipal	1	16	23	BENTLEY, VILL OF	33.59	511.44	21.89
438670	SW	26	40	1	5	FORESTER, AUGUST R.	1975-01-14	53.34	New Well	Municipal	1	16	47	BENTLEY, VILL OF	33.53	533.71	21.89
438709	SW	26	40	1	5	UNKNOWN DRILLER		40.23	Chemistry	Domestic	1			CAPTON, GEORGE			0.00
438715	SW	26	40	1	5	UNKNOWN DRILLER		24.99	Chemistry	Domestic	1			CALDWELL, A			0.00
438721	SW	26	40	1	5	UNKNOWN DRILLER		38.10	Chemistry	Domestic	1			GEORGE, EDMUND			0.00

Reconnaissance Report

View in Imperial

Export to Excel

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
438725	SW	26	40	1	5	UNKNOWN DRILLER		32.00	Chemistry	Domestic	1			WOOLGAR, G			0.00
438732	SW	26	40	1	5	UNKNOWN DRILLER		36.58	Chemistry	Domestic	1			BALL, C.D.			0.00
438739	SW	26	40	1	5	UNKNOWN DRILLER		38.40	Chemistry	Domestic	1			STAN, AL			0.00
438746	SW	26	40	1	5	NELSON	1967-07-21	39.62	New Well	Domestic		3		PARKLAND BUILDERS	19.81	45.46	5.08
438748	SW	26	40	1	5	NELSON	1964-01-01	39.62	New Well	Domestic		2		WESTERN ALTA CONSTR LTD	18.90	22.73	5.08
438753	SW	26	40	1	5	UNKNOWN DRILLER		21.34	Chemistry	Domestic	1			GARRIES, R.H.			0.00
438760	SW	26	40	1	5	JOHANSON VICTOR		33.53	Chemistry	Domestic	1			GARRIES, G.H.			0.00
438774	SW	26	40	1	5	NELSON	1964-01-01	42.67	Deepened	Domestic				BERANAK, GORDON	26.82	45.46	11.43
438781	SW	26	40	1	5	NELSON	1964-04-01	42.67	New Well	Domestic				WILSON HOMES	23.77	45.46	5.08
438783	SW	26	40	1	5	NELSON	1963-06-01	39.62	New Well	Domestic		2		MIX, BILL	17.07	45.46	5.08
438787	SW	26	40	1	5	JOHANSON VICTOR	1955-07-01	35.05	New Well	Domestic		4			27.43		5.08
438791	SW	26	40	1	5	NELSON		45.72	New Well	Domestic		5		STAN, AL	32.00	45.46	11.43
438795	SW	26	40	1	5	NELSON	1967-10-06	42.67	New Well	Domestic		3		DAMERON, GERTRUDE	24.38	45.46	5.08
438798	SW	26	40	1	5	ALKEN BASIN DRILLING LTD.	1987-04-21	60.96	New Well	Municipal		18	11	BENTLEY, VILL OF	34.75	454.61	21.89
439027	SW	26	40	1	5	UNKNOWN DRILLER		23.16	Chemistry	Domestic				KISCHUK, JOSEPH			0.00
439029	3	26	40	1	5	ERICKSON & KANGAS	1965-12-02	39.62	New Well	Domestic		8		BAUNBACK	26.82	45.46	11.43
439034	4	26	40	1	5	DICKAU HOWARD F	1961-11-16	33.53	New Well	Domestic		8		BUTCHER, HELEN	28.65	22.73	5.08
439040	4	26	40	1	5	DICKAU HOWARD F	1968-11-13	28.65	New Well	Domestic		10		THEVENAZ, M	25.60	18.18	5.08
439047	4	26	40	1	5	ERICKSON & KANGAS	1963-07-09	39.62	New Well	Domestic		8	3	U.G.G.	25.91	45.46	11.43
439054	4	26	40	1	5	ERICKSON ERNFRED	1961-01-01	24.99	New Well	Domestic		5	2	SWANSON, TONY	15.24	45.46	11.43

Reconnaissance Report

View in Imperial

Export to Excel

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
439059	4	26	40	1	5	UNKNOWN DRILLER	1962-06-18	51.82	New Well	Industrial	1	3			13.72	104.56	12.70
439066	4	26	40	1	5	ERICKSON ERNFRED	1958-07-08	36.27	New Well	Domestic		8		JUTTE, CARL	26.82	36.37	5.08
439075	4	26	40	1	5	JOHANSON VICTOR	1956-11-29	32.31	Well Inventory	Domestic				LACOMBE SCHOOL DIV	19.51	31.82	5.08
439081	4	26	40	1	5	ERICKSON ERNFRED	1958-10-10	31.09	New Well	Domestic		5		JOHANSON, ART	18.29	36.37	5.08
439089	4	26	40	1	5	ERICKSON & KANGAS	1961-10-03	24.99	New Well	Domestic		4		SWANSON, TONY	12.19	45.46	10.16
439097	NW	26	40	1	5	FORESTER, AUGUST R.	1971-10-22	42.67	New Well	Domestic		12	49	ALTA LIQUOR CONTROL BOARD	12.01	112.61	0.00
439117	NW	26	40	1	5	UNKNOWN DRILLER		85.34	Chemistry	Domestic	1			HAARSTAD, HARVEY			0.00
439130	NW	26	40	1	5	UNKNOWN DRILLER		28.35	Federal Well Survey	Domestic & Stock				DAMRON, N.T.			0.00
439133	NW	26	40	1	5	ALKEN BASIN DRILLING LTD.	1988-07-06	103.63	New Well	Stock		23		HAARSTAD, HARVEY	36.58	136.38	13.97
439141		26	40	1	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic	1			RAWAY			0.00
439145	SE	26	40	1	5	FORRESTER DRILLING	1974-11-30	27.43	New Well	Domestic		5		MARTIN, WM	14.94	90.92	13.97
439152		26	40	1	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic	1			PACIFIC GRAIN			0.00
439455		26	40	1	5	UNKNOWN DRILLER		0.00	Chemistry	Domestic	1			DROST, ED			0.00
439457	SE	26	40	1	5	NELSON	1969-07-01	41.76	Deepened	Domestic		2		SPYCHER	16.15	45.46	5.08
439458	SE	26	40	1	5	NELSON	1969-07-01	33.53	New Well	Domestic		3		ROBERTSON	19.20	45.46	5.08
439460	SE	27	40	1	5	NELSON	1964-01-01	36.58	Deepened	Domestic				BENTLEY CURLING CLUB	14.94		11.43
439460	SE	27	40	1	5	NELSON	1964-01-01	36.58	Deepened	Domestic				BENTLEY CURLING CLUB	17.07	45.46	11.43
439461	SE	27	40	1	5	BROWN JIM	1971-01-10	30.48	New Well	Domestic		5		MCHENDRICK	15.24	27.28	10.16
439462	SE	27	40	1	5	UNKNOWN DRILLER		45.72	Chemistry	Domestic	1			WESTVIEW APTS			0.00
439463	SE	27	40	1	5	UNKNOWN DRILLER		41.15	Chemistry	Domestic	1			PETERSEN, WM			0.00

Reconnaissance Report

View in Imperial

Export to Excel

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
439464	SE	27	40	1	5	ALKEN BASIN DRILLING LTD.	1984-04-03	48.77	Deepened	Domestic	1	9		ELLWORTH, ELMORE	0.00	36.37	14.12
439464	SE	27	40	1	5	ALKEN BASIN DRILLING LTD.	1984-04-03	48.77	Deepened	Domestic	1	9		ELLWORTH, ELMORE	7.62	22.73	14.12
439465	1	27	40	1	5	ERICKSON & KANGAS	1963-03-21	31.09	New Well	Domestic		5		BENTLEY POST OFFICE	12.19	54.55	11.43
439466	SW	27	40	1	5	NELSON	1971-10-01	27.43	New Well	Stock		3		PEDERSON, ERVIN	5.49	45.46	5.08
439467	SW	27	40	1	5	BROWN JIM	1972-08-02	48.77	New Well	Domestic		6		TURNBULL, DAVID	33.53	90.92	10.16
439469	SW	27	40	1	5	BROWN JIM	1973-08-27	45.72	New Well	Domestic		7		BENTLEY SENIOR HOME	15.24	54.55	10.16
439475	SW	27	40	1	5	FREEMAN W J	1943-01-01	10.67	Federal Well Survey	Stock				WECKER, D	5.49		5.08
439478	SW	27	40	1	5	ALKEN BASIN DRILLING LTD.	1989-06-08	33.53	New Well	Stock		8		WECKER, DAN	5.49	54.55	13.97
439484	3	27	40	1	5	ERICKSON & KANGAS	1965-08-30	35.05	New Well	Domestic		7		ALTON BROS CONST	18.59	45.46	11.43
439489	4	27	40	1	5	UNKNOWN DRILLER	1954-03-31	0.00	Flowing Shot Hole	Industrial				SEABOARD OIL CO #SP 1864			0.00
439494	4	27	40	1	5	UNKNOWN DRILLER	1954-03-31	0.00	Flowing Shot Hole	Industrial				SEABOARD OIL CO#SP1864A			0.00
439496	NW	27	40	1	5	NELSON	1975-10-10	76.20	New Well	Domestic & Stock		6		BARGLALZ, KEN	7.62	45.46	10.16
439500	NW	27	40	1	5	UNKNOWN DRILLER		3.96	Federal Well Survey	Stock				WHILLIER, D	2.44		0.00
439504	NW	27	40	1	5	FREEMAN W J	1945-01-01	21.34	Federal Well Survey	Domestic & Stock				RAS, JOHN	12.19		5.08
439509	NW	27	40	1	5	UNKNOWN DRILLER		0.00	Spring	Stock				RAS, JOHN	0.03		0.00
439512	13	27	40	1	5	ALBERTA ENVIRONMENT	1971-06-01	8.53	Test Hole	Investigation		6		ALTA ENV #TH GLP 26 STN 20+00			0.00
439522	13	27	40	1	5	ALBERTA ENVIRONMENT	1971-06-01	3.05	Test Hole	Investigation		3		ALTA ENV #TH GLP 11 25+00			0.00
439526	13	27	40	1	5	ALBERTA ENVIRONMENT	1971-06-01	6.40	Test Hole	Investigation		5		ALTA ENV #TH GLP 12 29+81			0.00
439533	13	27	40	1	5	ALBERTA ENVIRONMENT	1971-06-01	3.05	Test Hole	Investigation		3		ALTA ENV #TH GLP 10 20+00			0.00
439543	14	27	40	1	5	OTHER	1984-10-04	5.49	New Well	Stock		4		BARGHOLZ, KEN	5.18	45.46	45.72

Reconnaissance Report

View in Imperial

Export to Excel

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
439553	NE	27	40	1	5	UNKNOWN DRILLER		36.58	Chemistry	Domestic	1			MORISON, J.B.			0.00
439563		27	40	1	5	JOHANSON VICTOR		32.61	New Well	Domestic		4		BENTLEY SCHOOL	26.82	90.92	15.24
439575	SE	27	40	1	5	GLEN JOHNSON WATER WELL DRILLING	1963-03-30	39.62	New Well	Domestic & Stock		4		GARRIES, RALPH G.	20.42	13.64	5.08
439581	SE	27	40	1	5	GLEN JOHNSON WATER WELL DRILLING	1963-03-19	42.67	New Well	Domestic		3		WOOLCER, C.R.	29.26	13.64	5.08
439588		27	40	1	5	FLINN DRILLING LTD.	1967-06-28	40.23	New Well	Domestic		4		BAYKO	35.05	59.10	13.97
439595	3	26	40	1	5	SIEBLE ALLAN	1965-08-23	40.23	New Well	Unknown		5		STARS, AL	30.48	36.37	13.97
439617	SE	27	40	1	5	GLEN JOHNSON WATER WELL DRILLING	1936-03-21	39.62	New Well	Domestic		4		CARRUTHERS, C	20.73	13.64	5.08
439621		27	40	1	5	UNKNOWN DRILLER		0.00	Flowing Shot Hole	Industrial				SEABOARD OIL CO#SP			0.00
439627	SE	27	40	1	5	NELSON	1969-11-01	45.72	New Well	Domestic		3		LEWIS, A.A.	31.09	45.46	5.08
439995	16	28	40	1	5	OTHER	1953-07-15	0.00	Flowing Shot Hole	Industrial				#SP			0.00
440139	2	34	40	1	5	SATELLITE DRILLING LTD.	1976-12-02	39.62	New Well	Domestic		9		BHADRENSA, G.	8.47	159.11	11.43
440148	2	34	40	1	5	ALBERTA ENVIRONMENT	1971-06-01	3.05	Test Hole	Investigation		2		ALTA ENV #TH GLP 5 STN 119+70			0.00
440155	2	34	40	1	5	SKY LINE DRLG LTD	1980-12-17	36.58	New Well	Domestic		4		SAWYER, DAVE	24.38	45.46	13.97
440217	3	34	40	1	5	ALBERTA ENVIRONMENT	1971-06-01	6.10	Test Hole	Investigation		6		ALTA ENV #TH GLP 27 STN 5+00			0.00
440229	3	34	40	1	5	ALBERTA ENVIRONMENT	1971-06-01	3.05	Test Hole	Investigation		4		ALTA ENV #GLP6 STN 0+00			0.00
440234	3	34	40	1	5	ALBERTA ENVIRONMENT	1971-06-01	3.05	Test Hole	Investigation		3		ALTA ENV #TH GLP 7 STN 5+00			0.00
440242	3	34	40	1	5	ALBERTA ENVIRONMENT	1971-06-01	3.05	Test Hole	Investigation		4		ALTA ENV #TH GLP 8 STN 10+00			0.00
440248	4	34	40	1	5	ALBERTA ENVIRONMENT	1971-06-01	3.05	Test Hole	Investigation		4		ALTA ENV #TH GLP 9 STN 15+00			0.00
442340	3	36	40	1	5	SKY LINE DRLG LTD	1981-02-27	35.05	New Well	Domestic	1	3		GALBRAITH, GORDON/ LOIS	9.14	68.19	14.12
443069	NW	23	40	1	5	TALL PINE DRILLING LTD.	1996-01-24	24.38	Old Well-Yield	Domestic				RAMSEY, DOUG	6.10	54.55	0.00

Reconnaissance Report

View in Imperial

Export to Excel

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
443828	NE	22	40	1	5	ALBERTA ENVIRONMENT	1974-06-19	89.92	Test Hole	Investigation		25		ALTA ENV #1210E			0.00
443829	SW	26	40	1	5	UNKNOWN DRILLER		115.82	Unknown	Unknown				ALTA ENV #1209E			0.00
466352	SW	22	40	1	5	ALKEN BASIN DRILLING LTD.	1996-06-27	25.30	New Well	Domestic		5	11	WILSON, DARREN	7.01	181.84	13.97
468041	6	24	40	1	5	ALKEN BASIN DRILLING LTD.	1997-05-16	97.54	New Well	Industrial		27	13	APL/CANTEX 4#RIG	18.29	68.19	13.97
469675	6	22	40	1	5	ALKEN BASIN DRILLING LTD.	1998-02-19	73.15	New Well	Industrial		26	13	OPAL/PD 390 C/O CODERO ENG#RIG	4.57	68.19	13.97
469676	6	22	40	1	5	ALKEN BASIN DRILLING LTD.	1998-02-19	73.15	New Well	Industrial		22	16	OPAL/PD 390 C/O CODERCO ENG	15.24	34.10	13.97
478901	12	26	40	1	5	AB WATER WELL DRILLING	1978-11-01	64.01	New Well	Stock	1	11		HAARSTAD, HARVEY	19.20	27.28	14.12
478902	NW	26	40	1	5	UNKNOWN DRILLER		53.34	Chemistry	Domestic	1			HAARSTAD, HARVEY			0.00
491578	SW	25	40	1	5	ALBERTA EAGLE DRILLING LTD.	1997-10-20	36.58	New Well	Domestic		8	9	KUIPERS, PETER	23.99	54.55	14.12
494628	NW	24	40	1	5	ALKEN BASIN DRILLING LTD.	1999-09-09	36.58	New Well	Domestic		13	5	VANGAAL, JOHN	14.02	113.65	13.97
496126	3	34	40	1	5	TALL PINE DRILLING LTD.	2000-05-02	79.25	Test Hole-Decommissioned	Industrial		11	14	FOUNDERS ENERGY	10.67	318.23	13.97
1035044	NE	22	40	1	5	AERO DRILLING & CONSULTING LTD.	2004-06-01	30.48	New Well	Industrial		14	19	TALSMA'S	12.50	22.73	14.13
1035045	NW	23	40	1	5	AERO DRILLING & CONSULTING LTD.	2004-05-28	24.38	New Well	Industrial		9	12	BENTLEY GARAGE	6.40	45.46	14.13
1035157	NE	22	40	1	5	AERO DRILLING & CONSULTING LTD.	2004-08-25	30.48	New Well	Industrial		11	14	CANADIAN COMPRSESSOR	7.32	90.92	14.13
1060226	SE	27	40	1	5	ALKEN BASIN DRILLING LTD.	2002-12-18	21.34	New Well	Domestic		6	7	PEDERSON, EVELYN	6.10	90.92	14.13
1060855	11	25	40	1	5	ALKEN BASIN DRILLING LTD.	2004-03-26	97.54	New Well	Industrial		18	12	PROGRESS	23.77	113.65	14.13
1060855	11	25	40	1	5	ALKEN BASIN DRILLING LTD.			Existing Well-Decommissioned	Other				PROGRESS / CHAMPION 19			
1060952	SE	26	40	1	5	ALKEN BASIN DRILLING LTD.	2005-02-28	60.96	New Well	Domestic		18	15	ANGUS, JEAN & JIM	43.28	136.38	14.13
1064835	2	35	40	1	5	ALKEN BASIN DRILLING LTD.	2006-11-02	48.77	New Well	Domestic		15	25	GOEHERING, RON	36.58	136.38	14.13
1064908	1	35	40	1	5	ALKEN BASIN DRILLING LTD.	2007-04-02	67.06	New Well	Domestic		20	8	MCKEEN, JOE & BRIDGETTE	23.16	136.38	14.13

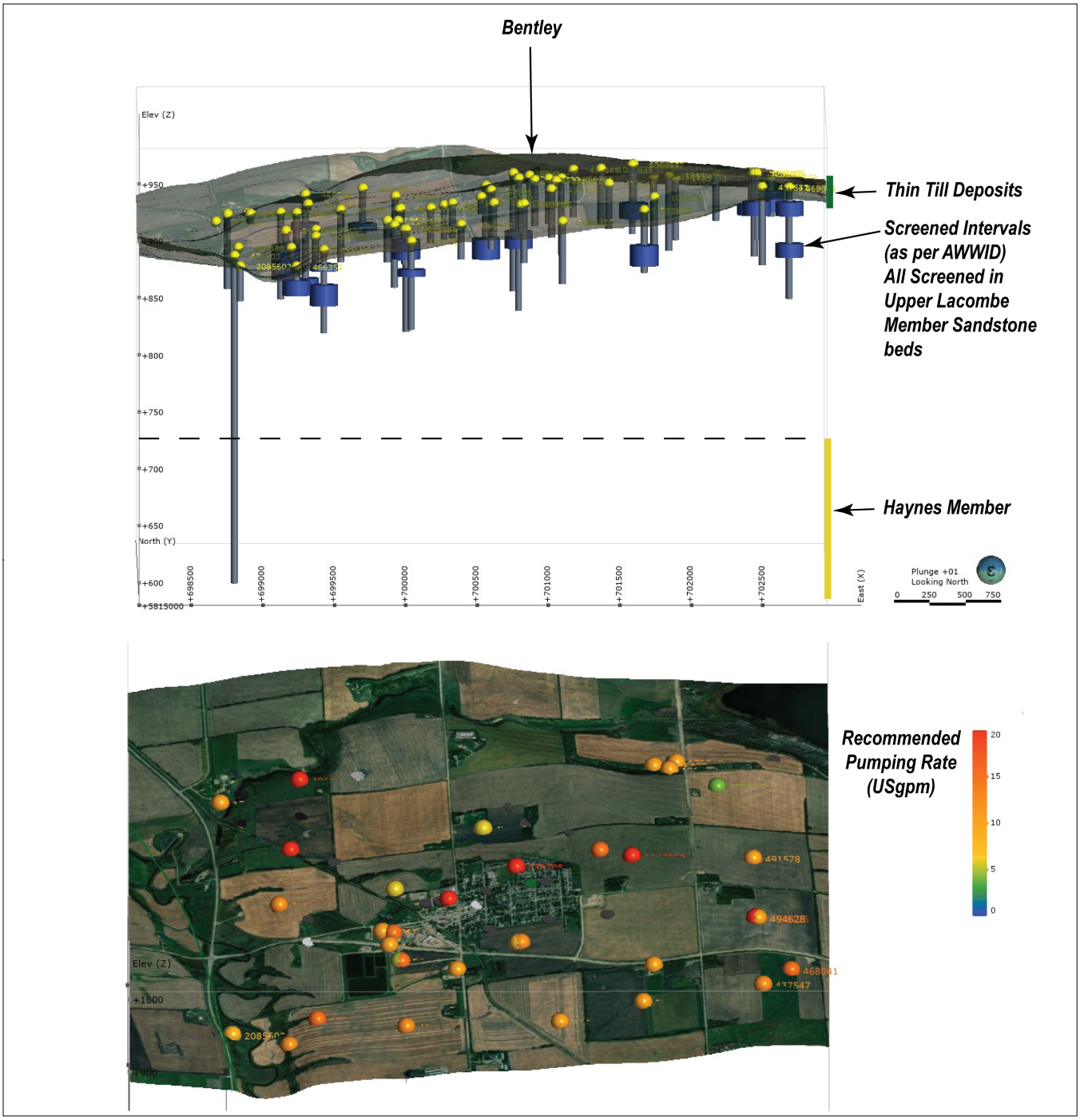
Reconnaissance Report

View in Imperial

Export to Excel

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
1065231	8	23	40	1	5	ALKEN BASIN DRILLING LTD.	2007-12-28	54.86	New Well	Domestic		14	12	BYZITHER, MARTIN	29.87	181.84	14.13
1065287	15	22	40	1	5	ALKEN BASIN DRILLING LTD.	2008-03-27	36.58	New Well	Domestic		9	17	GRAND DIAMOND ENTERPRISES	3.66	54.55	14.12
1066200	4	26	40	1	5	ALKEN BASIN DRILLING LTD.		15.24	Existing Well-Decommissioned	Unknown		1		BENTLEY, TOWN OF			3.81
1066326	15	22	40	1	5	ALKEN BASIN DRILLING LTD.	2011-03-08	54.86	New Well	Domestic		9	26	CROP PRODUCTION SERVICES	6.10	90.92	14.12
1066328	14	22	40	1	5	ALKEN BASIN DRILLING LTD.		19.00	Existing Well-Decommissioned	Unknown		1		WECKER, DAN			5.08
1066361	6	26	40	1	5	ALKEN BASIN DRILLING LTD.	2011-07-05	67.06	New Well-Decommissioned	Municipal		13	20	BENTLEY, TOWN OF	36.88	68.19	21.92
1066506	1	27	40	1	5	ALKEN BASIN DRILLING LTD.	2011-10-11	30.48	New Well	Municipal		6	16	BENTLEY, TOWN OF	12.34	681.91	21.92
1066508	1	27	40	1	5	ALKEN BASIN DRILLING LTD.	2011-10-13	30.48	New Well	Observation		6	15	BENTLEY, TOWN OF	11.89	454.61	13.97
1066629	9	22	40	1	5	ALKEN BASIN DRILLING LTD.	2012-06-18	30.48	New Well	Domestic		5	6	696263 ALBERTA LTD	4.88	181.84	14.12
1066810	3	23	40	1	5	ALKEN BASIN DRILLING LTD.	2012-10-31	54.86	New Well	Domestic		10	10	BALDWIN, DON & WILMA	7.62	90.92	14.12
1471151	15	22	40	1	5	LOUSANA WATER WELLS (1987) LTD.	2018-10-09	18.29	New Well	Industrial		5	12	1374570 ALBERTA LTD	3.97	227.30	14.13
1735003	11	27	40	1	5	TALL PINE DRILLING LTD.	2002-09-08	36.58	New Well	Industrial		4	7	PROGRESS ENERGY	4.27	227.30	14.13
1735125	NW	24	40	1	5	TALL PINE DRILLING LTD.	2002-10-19	73.15	New Well	Domestic		8	2	POGADL, ED	49.99	90.92	14.13
1735453	1	35	40	1	5	TALL PINE DRILLING LTD.	2007-06-22	54.86	New Well	Domestic		5	10	LAFFERTY, NATALIE	9.75	90.92	14.13
1735455	1	35	40	1	5	TALL PINE DRILLING LTD.	2007-05-30	60.96	New Well	Domestic		8	15	BAGEMA, JEFF	14.63	45.46	14.13
1735533	4	34	40	21	5	TALL PINE DRILLING LTD.	2009-11-20	65.53	New Well	Domestic		9	14	NEVERS, COREY	17.98	63.65	14.12
2085602	5	22	40	1	5	BLACK DOG DRILLING & ENV SERV. LTD.	2014-06-05	30.48	New Well	Domestic		8	11	PAKAY, ALBERT	5.49	118.20	14.13
2096870	3	26	40	1	5	UNKNOWNDRILLINGCOMP11			Existing Well-Decommissioned	Unknown				WHITTAKER, JAMES			

Appendix E THREE-DIMENSIONAL CONCEPTUAL SITE MODEL



Notes

1. Coordinate System: NAD 1983 UTM Zone 11N
2. Data Sources: Geogratis, ©Department of Natural Resources Canada, All rights reserved.
3. Background: .

Stantec

Project Location	Prepared by MKuhl on 2022-05-04
	TR by JRiddell on 2022-05-XX
Bentley, Alberta	IR by DRAFT on 2022-05-XX
Client/Project	110170054
Town of Bentley	
Bentley Water System Upgrade	
Figure No.	**DRAFT**
2	

Title

AWWID Screened Intervals and Flow Rates

V:\1102\active\gis_clients\STANTEC\110111017005 4\figures\fig_2_awwid_screened_intervals_and_flow_rates.mxd Revised: 2022-05-04 By: MKuhl

Figure 1a

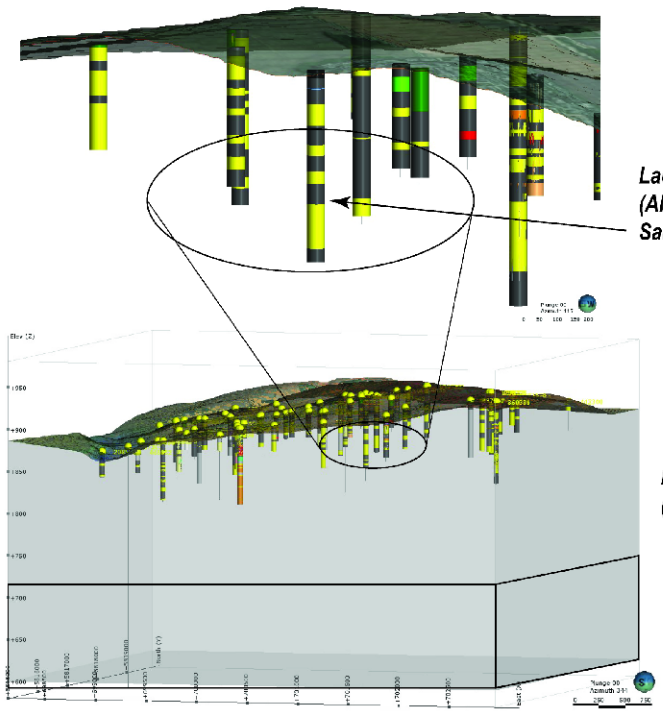
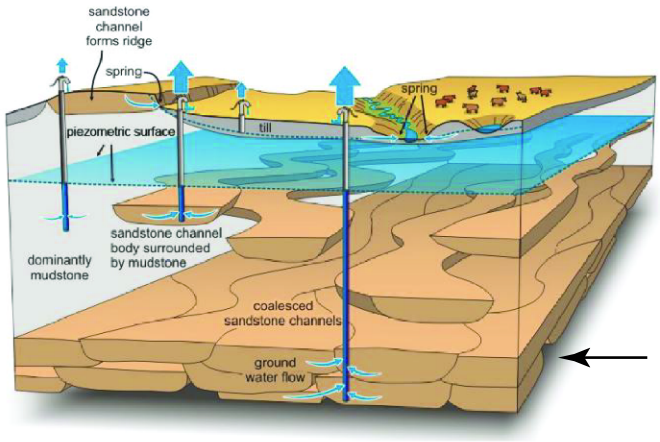


Figure 1b *(from Gratsby et al., 2008)*



Notes

1. Coordinate System: NAD 1983 UTM Zone 11N
2. Data Sources: Geogratis, ©Department of Natural Resources Canada, All rights reserved.
3. Background: .

Stantec

Project Location	Prepared by MKuhl on 2022-05-04
	TR by JRiddell on 2022-05-XX
Bentley, Alberta	IR by DRAFT on 2022-05-XX

Client/Project 110170054
Town of Bentley
Bentley Water System Upgrade

Figure No.
1 **DRAFT**

Title
Preliminary 3D CSM and Hydrogeological Interpretation

V:\1102\active\gis_clients\STANTEC\110111017005 4\figures\fig_1_prelim_3d_csm_and_hydro_interpret.mxd Revised: 2022-05-04 By: MKuhl

Appendix F TOWN'S GROUNDWATER WELLS LICENSES AND APPROVALS

Alberta Environment and Sustainable Resource Development

LICENCE AMENDMENT

PURSUANT TO THE PROVISIONS OF THE *WATER ACT*

LICENCE NO.: 1983 04 13
(EMS Approval ID 00033515-00-00)

FILE NO. 17780

PRIORITY NOs.: 1977-10-31-003
1977-10-31-011

AMENDMENT NO.: 00033515-00-03

LICENSEE: Town of Bentley

The Licence is amended as follows:

1. Correct the clerical error of legal land description for the well locations to read as follows:

Well Number	Legal Land Description for Well Location
77-10-31-03 (Well 1)	Plan 7521329, Lot 9, Block 23 SW 26-040-01-W5
77-10-31-11 (Well 2)	Plan 9323068, Lot 1MR, Block 22 SW 26-040-01-W5

Designated Director under the Act
Todd Aasen P.Eng.
District Approvals Manager
Central Region – Red Deer

2012 10 18
Dated (Y/M/D)

Alberta

ENVIRONMENT

LICENCE
to DIVERT AND USE WATER

Pursuant to Sections 11 and 33
THE WATER RESOURCES ACT

File No. 17780

Priority No. 1977-10-31-03
*1977-10-31-11

Purpose Municipal

Drainage Basin Red Deer River

First Issued 1983 04 13

Village of Bentley
Bentley, Alberta
T0C 0J0

* AMENDED
DATED
1992 07 27
by CONTROLLER

HAVING COMPLIED with the applicable provisions of The Water Resources Act and the regulations thereunder and Interim Licence No. 09174 , a copy of which is attached hereto and incorporated herein,

IS HEREBY GRANTED LICENCE to divert and use the quantities of water prescribed in the Interim Licence in accordance with and subject to all other applicable provisions of that Act and the regulations thereunder, and the terms and conditions attached hereto and incorporated herein, at locations described in the Interim Licence,

BY MEANS AND THROUGH works and undertakings described in the Interim Licence.

1983 04 13

Lewis D. Fahner
Controller of Water Resources

Alberta
ENVIRONMENT

INTERIM LICENCE

Pursuant to Section 16
THE WATER RESOURCES ACT
Nº 09174

Village of Bentley
Bentley, Alberta

File No. 17780

Priority No. 1977-10-31-03
*1977-10-31-11

having complied with the applicable provisions of the Water Resources Act and the regulations there under is hereby authorized, as soon as right-of-way is obtained:

A. To construct works as shown on plans and reports filed, approved and identified in departmental records as:

17780-1 Bentley Water Well Location Plan
17780-2 Bentley Reservoir & Pumphouse
17780-R2 Village of Bentley Waterwell No. 1
*17780-3 Approximate Point of Return Flow Village of Bentley

* AMENDED DATED 1992 07 27
CONTROLLER

B. To divert and use water as hereinafter specified and described subject to the terms and conditions attached hereto and incorporated herein.

PURPOSE: Municipal (urban water supply)

SOURCE OF SUPPLY: Aquifer

GROSS DIVERSION: Up to 94 acre-feet (~~25~~ *25.6 million Canadian gallons) per annum consisting of:

1. Estimated Consumptive Use: ~~25~~ *5.0 million gallons
2. Estimated Losses: Nil
3. Estimated Return Flow: ~~Nil~~ *20.6 million gallons to Blindman River at NW 22-40-1-W5

POINT OF DIVERSION	WELL NUMBER	PRODUCTION INTERVAL	MAXIMUM PUMP RATE	MAXIMUM ANNUAL DIVERSION
3-26-40-1-5	77-10-31-03	114'-170'	75 Cgpm	~~25~~ *12.8 mCg
*3-26-40-1-5	77-10-31-11	150'-200'	100 Cgpm	12.8 mCg

Date issued 13 April, 1978

Expiry Date 13 April, 1979

Controller of Water Resources

WR 2
Nov 77

File: 17780

TERMS AND CONDITIONS INTERIM LICENCE NO. 09174

1. The production well(s) shall meet the following criteria:

   (a) Constructed so as to permit water level readings to be taken once per month while the pump is operating.

   (b) Equipped with a cumulative meter which registers the number of gallons or cubic meters pumped.

2. If deemed necessary by the Controller of Water Resources the licensee shall obtain water samples for purposes of chemical analyses from the production well(s). The analyses must include total dissolved solids, pH, Ca, Mg, Na + K, CO_3, HCO_3, SO_4, Cl, Fe and NO_3.

3. If deemed necessary by the Controller of Water Resources, the licensee may be required to install an observation well or wells, completed in the same aquifer as the production well(s), to provide data for the evaluation of the effect of this withdrawal on the aquifer and the effect on other ground water users.

4. The licensee shall submit an annual return to the Controller of Water Resources on or before January 31 in each year for the preceding calendar year including:

   (a) Tables containing:

      (1) Monthly measurement of the water level in the pumping well(s) as per clause(s) 1(a). The dates and times at which readings were taken must be included.

      (2) Monthly readings of the number of Canadian gallons or cubic meters pumped from the well(s) as per clause(s) 1(b). The dates and times at which readings were taken must be included.

   (b) The total annual quantity pumped expressed in Canadian gallons and acre-feet or in cubic meters.

   and such other information as may from time to time be required.

5. Clause 4 may be waived upon completion of three years of production providing complete and accurate annual returns have been submitted as required by this clause.

6. The rights and privileges hereby granted are subject to periodic review and to modification to ensure the most beneficial use of the water in the public interest and more particularly to ensure preservation of the rights of other water users.

.../2

7. The rights and privileges hereby granted can only be extended, modified, transferred or assigned with the approval of the Controller of Water Resources and are subject to cancellation or modification as provided in the Water Resources Act.

8. This interim licence and its terms and conditions shall be attached to and become part of the licence to use water issued pursuant to Section 33 of the Water Resources Act.

*9. This interim licence together with the resulting licence remains valid only as long as the licensee continues to enjoy the right to occupy or otherwise affect the lands required in the operation of this project.

1983 04 13
Dated at Edmonton

for Lewis G. Fahlman
Controller of Water Resources

*AMENDED
DATED
1992 07 27
for CONTROLLER

Government of Alberta
Environment

LICENCE AMENDMENT

PURSUANT TO THE PROVISIONS
OF THE *WATER ACT*

LICENCE No. Dated 1983 04 13

FILE No. 17780

PRIORITY No. 1977-10-31-003
1977-10-31-011

EFFECTIVE DATE 2010 10 30

AMENDMENT No. 00033515-00-01

LICENSEE Town of Bentley

The licence is amended as follows:

1. Identify the diversions as follows:

WELL NUMBER	LEGAL LAND DESCRIPTION for WELL LOCATION	PRODUCTION INTERVAL (metres below grade)	MAXIMUM PUMP INTAKE DEPTH (metres below grade)	LIMITS	
				MAXIMUM RATE OF DIVERSION (cubic metres per day)	MAXIMUM ANNUAL DIVERSION (cubic metres per calendar year)
77-10-31-03 (well 1)	SW 26-040-01-W4, Plan 7521329, Lot 9, Block 23	34.7 – 51.8	34.4	490.0	23188.0 (16 acre feet)
77-10-31-11 (well 2)	SW 26-040-01-W4, Plan 9323068 (Municipal Reserve)	45.7 – 60.9	45.4	654.0	

2. Add the following Definition:

"Water Use Reporting System" means the secure internet website provided by Alberta Environment at http://www.environment.alberta.ca/1286.html for submitting measuring and monitoring results electronically to the Director.

3. Add Condition 1(c):

1. (c) The Licensee shall maintain the measuring device referred to in 1(b) at all times.

AMENDMENT

4. Delete Condition 2 and substitute with the following:

2.0 The Licensee shall, when requested in writing by the Director, ensure that the:

(a) collection;

(b) preservation;

(c) storage;

(d) handling; and

(e) analysis

of any sample required to be taken by this licence shall be conducted in accordance with the following:

(i) the *Standard Methods for the Examination of Water and Wastewater*, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation, 1998, as amended.

2.1 The Licensee shall, when requested in writing by the Director;

(a) obtain a representative sample of water being diverted from the production well; and

(b) analyze the water collected in 2.0 for the following parameters:

(i) Total Dissolved Solids, Hardness, Alkalinity, pH, Calcium, Magnesium, Sodium, Potassium, Carbonate (CO_3), Bicarbonate (HCO_3), Sulphate (SO_4), Chloride, Nitrate, and Iron, and

(ii) any other parameter required by the Director

on an annual basis.

5. Delete Condition 4 and substitute with the following:

4.0 The Licensee shall:

(a) monitor and measure the water levels in each production well; and

(b) record the water levels from the production well

on a monthly basis for each month thereafter, while water is being diverted.

AMENDMENT

4.1 The Licensee shall:

(a) monitor the total number of cubic metres of water diverted; and

(b) record the total number of cubic metres of water diverted

from each production well on a monthly basis.

4.2 The Licensee shall record and retain all of the following information for a minimum of 5 years after being collected:

(a) the place, date and time of all measuring; and

(b) the results obtained pursuant to 2.0, 2.1, 4.0, and 4.1; and

(c) the name of the individual who conducted the monitoring, measuring and sampling stipulated in (a) and (b).

4.3 The Licensee shall report to the Director the results of the measuring required in 4.2 using the "Water Use Reporting System" and any other information required in writing by the Director.

4.4 The Licensee shall submit the report required in 4.3 on or before the end of the month following the month in which the information is based upon was collected.

4.5 The licensee shall comply with the terms and conditions of the "Water Use Reporting System User Consent".

Designated Director under the Act
Todd Aasen, P. Eng.

2010 09 30
Dated (Y/M/D)

Government of Alberta
Environment

LICENCE AMENDMENT

PURSUANT TO THE PROVISIONS OF THE *WATER ACT*

LICENCE No.	Dated 1983 04 13
FILE No.	17780
PRIORITY No.	1977-10-31-003 1977-10-31-011
EFFECTIVE DATE	2010 10 20
AMENDMENT No.	00033515-00-02
LICENSEE	Town of Bentley

The licence is amended as follows:

1. Correct the clerical error of the Maximum Annual Diversion identified in the Diversion Table from 23188.0 m^3/yr to 116043.0 m^3/yr.

Designated Director under the Act
Todd Aasen, P. Eng.

2010 10 20
Dated (Y/M/D)