Town of Crossfield
Master Water Servicing Study
2020 Update

Prepared For: Town of Crossfield

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EXECUTIVE SUMMARY

The Town of Crossfield (the Town) commissioned Allnorth to prepare an updated Master Water Servicing Study (MWSS). This study includes evaluation of the existing water supply, storage, and distribution infrastructure, proposed upgrades to correct identified deficiencies and support upcoming developments, and a master servicing concept to service future developments.

Study Area

One of the main objectives of this study is to expand the master planning horizon to include a large proposed annexation of 22 quarter-sections, in addition to the current town area of 18 quarter-sections. The limits of the proposed annexation are illustrated in **Figure 2-1**, and include the Joint ASP lands currently split between the Town of Crossfield and Rocky View County.

Population Projection

The Town has indicated an expectation for 6% average annual growth, which has been used as the basis for population and demand projections as follows. The below projections are for residential population, and assume all residential units are occupied for design purposes. Note that since not all residential units are actually occupied, the existing (2018) population is higher than the 2018 Census population.

- Existing (2018): 3,895
- Five years (2023): 5,189
- Ten years (2028): 6,912
- Twenty years (2038): 11,609
- Thirty years (2048): 17,666
- Build-out (2062): 42,640

The expected areas of growth are the upcoming ASPs of Vista Crossing, Hawk's Landing, and Iron Landing to build-out over the next 20 years, the Joint ASP to build-out over the next 40 years, and development of other future lands to begin in 10-20 years, and proceed until the remainder of the study area is built out.

Water Demand

From the historical data the gross average daily demands has decreased steadily from 434 L/c/d (in 2017) to 382 L/c/d (June 2018-May 2019). The gross demand is calculated as the total water supplied by the pump station, less the bulk water total, divided by the residential population. This decrease is consistent with Statistics Canada per capita residential water use steady decrease for the households on metered water systems from 2011 to 2017.

Source Water Supply

The current water supply is obtained from the Mountain View Regional Water Services Commission (MVRWSC), which also supplies water to the Towns of Innisfail, Bowden, Olds, Didsbury, and Carstairs. The current design maximum for the MVRWSC water supply infrastructure is 27,400 m^3/d. Water is treated at the Anthony Henday Water Treatment Plant (AHWTP) near Innisfail, and pumped via transmission line to the Midline Pump Station at Olds. From the Midline Pump Station, there is a 400 mm transmission main to Didsbury, and a 250 mm transmission line from Didsbury to Crossfield. To accommodate future development, a second transmission main of 400 mm twinning the original main from Didsbury to Crossfield was approved in 2017.

The MVRWSC has a water diversion license for a total annual diversion to 10,658,600 m^3/yr (29,200 m^3/d). This licensed amount is intended to supply all six communities, including Crossfield, although there is no set amount allocated to each community. Currently, the MVRWSC supplies water to a population of approximately 30,000, for a total of approximately 11,500 m^3/d.

The current MVRWSC water supply infrastructure is anticipated to be sufficient for at least ten years, after which the 400 mm transmission main from the Midline Pump Station to Didsbury is expected to reach capacity and require twinning. The MVRWSC water license and treatment capacity is expected to be sufficient for at least 20 years, but depending on growth rates, may be adequate for 40 years or more. Allnorth recommends further evaluation to update remaining capacity and upgrade projections for each stage of the MVRWSC water supply system.

Water Storage

The current Town of Crossfield reservoir has a total capacity of 5,400 m^3, which is expected to be adequate for the next ten years (up to year 2028), after which Allnorth recommends constructing two additional storage cells of approximately 2,100 m^3 each at the existing main pump station, with an estimated cost of $2.8M each. These two cells do not have to be constructed together, and should provide ten years of further development each, bringing the town to the 30-year horizon. Beyond 30 years, it is difficult to predict the direction of development; however, to service the full build-out of the study area, a further 12,000 m^3 of storage will be required. This storage will likely be split evenly between two new pump stations, which are also required for the build-out of the study area.

Existing Distribution System

The existing water distribution system performs adequately under peak flow conditions at the demand nodes when no fire flow is required. However, under fire flow conditions, there are 49 demand nodes (hydrant locations) which cannot provide the required flow at the minimum required pressure, even when other nearby hydrants are utilized to supplement flow. This represents approximately 35% of all demand nodes in the Town of Crossfield. However, there is a major water main upgrade planned for 2020 along Railway Street, which will correct the deficiency for 24 of these demand nodes. For the remaining demand nodes, a series of six further water main upgrades are proposed, on Osler Avenue, Crossfield Estates, Strathcona Street, Chisholm Avenue, Elevator Road, and Laut Avenue. These upgrades will correct a further 17 deficient demand nodes. Allnorth recommends further investigation to confirm whether the Town fire-fighting equipment and spacing of hydrants provides adequate coverage and flow. The total estimated cost for these upgrades, excluding the Railway Street upgrade, is $5.57M.

The remaining eight deficient demand nodes are all located in the southern industrial area, and the remaining deficiencies are relatively small, with a shortfall of ~5-15% of required flow.

Servicing Upcoming ASPs

The upcoming ASPs include Vista Crossing, Iron Landing, and Hawk's Landing. Allnorth evaluated the detailed servicing plans provided by each developer to determine whether any modifications were required to either the servicing plans, or the existing town infrastructure. The results were as follows:

Vista Crossing: The proposed servicing strategy meets the performance criteria, assuming the 2020 Railway Street water main upgrade is in place.

Iron Landing: The proposed servicing strategy meets performance criteria for all areas, and fire flow criteria for all except the "Mixed Use" area, assuming the 2020 Railway Street water main upgrade is in place. In order to adequately service the Mixed Use area, either the site design must be constrained to meet the available fire flow of 7,600 L/min, or further upgrades will be required to the existing town infrastructure. Should the site design require more fire flow than is available, the Osler Avenue upgrade and/or the Laut Avenue upgrade already proposed to correct existing system fire flow deficiencies would provide additional fire flow up to 11,200 L/min.

Hawk's Landing: The proposed servicing strategy meets performance criteria for all areas, and fire flow criteria for all except the Commercial area and minor deficiencies for the Multi-family Residential areas, assuming the 2020 Railway Street water main upgrade is in place. In order to adequately service the Commercial area, either the site design must be constrained to meet the available fire flow of 7,400 L/min, or further upgrades will be required to the existing town infrastructure. Should the site design require more fire flow than is available, the Osler Avenue upgrade and/or the Laut Avenue upgrade already proposed to correct existing system fire flow deficiencies would provide additional fire flow up to the typical 12,000 L/min requirement for commercial land use. For the Multi-family Residential fire flow deficiencies, these deficiencies are small (available flow within 10% of required flow), and will be corrected when the upgrades proposed to correct existing town fire flow deficiencies are completed.

There are no additional upgrades required to the existing town infrastructure beyond the upgrades proposed to correct existing system fire flow deficiencies.

Ultimate Servicing Concept

The ultimate servicing concept consists of the existing town infrastructure (including proposed upgrades), the upcoming ASPs proposed servicing concepts, and the major distribution network for the remaining lands within the study area limits. The major distribution network is based on the City of Calgary grid system, and consists primarily of alternating 300 mm water mains along section boundaries, and 250 mm water mains along quarter-section boundaries. The remaining constraint will be water source being delivered through a single Transmission main, specifically if failure occurs. Therefore, future upgrades when the total demand for the MVRWSC exceed its design capacity water supply, additional transmission line should be considered.

The study area encompasses several areas requiring separate pressure zones due to elevation difference. The first new pressure zone includes approximately five quarter-sections of low elevation, which will require pressure reducing valves to prevent overpressure. A second pressure zone of very low elevation will be required, with additional pressure reducing valves, within the first low pressure zone to prevent overpressure of the lowest areas. The estimated cost for pressure reducing valves is dependent on the minor system design, and as such, no overall cost estimate has been provided. However, high level cost estimates per valve size have been included in **Section 11.3**.

The third new pressure zone includes approximately seven quarter-sections of high elevation, to the southeast of the existing town. This area will require an additional pump station of approximately the same capacity as the existing main pump station on Laut Avenue. A tentative location for this Southeast Pump Station has been identified on the south-east corner of the existing town boundary. The preliminary cost estimate for the Southeast Pump Station is $9.4M. A series of pressure-reducing valves will be required at the perimeter of this high elevation pressure zone to prevent overpressure of the main pressure zone.

An additional new pump station will be required to servicing the western and northern lands of the study area. This pump station is required primarily due to demand rather than elevation difference, and as such, will only need approximately one-third of the existing main pump station capacity. The preliminary cost estimate for the Southeast Pump Station is $8.4M. There is a second region of high elevation within this area, however it covers only one quarter-section. Due to the small size of the affected area, it has been assumed that the servicing of this area will be handled during development of this quarter-section and has been excluded from the master concept.

There is an option to upgrade the pump capacity of the existing main pump station, in order to delay the need to construct the Northwest Pump Station. This upgrade could service up to six of the thirteen total quarter sections in the north and west of the study area, as well as potentially reducing the capacity requirements of either the Northwest or Southeast pump stations. The preliminary cost estimate for the pump upgrade is $0.4M.

Conclusion

Master Waster Servicing Study update for the water servicing in the Town of Crossfield is completed. The updated master plan has incorporated ASP servicing plans for Vista Crossing, Iron Landing, Hawk's Landing and and Sunset Ridge. In addition, Joint ASP, and other future annexation areas (north, west and south of the existing town) have also been included in the updated master plan.

1 INTRODUCTION

The Town of Crossfield has an existing Master Water Servicing Study (MWSS) prepared in 2009 by Watt Consulting Group (D.A. Watt). Since the publication of this study, development direction and population growth for the Town has changed from the forecasts on which the study was based. As a result, many of the longer term water distribution upgrades and additions recommended by the 2009 MWSS may not meet the Town's current population and new growth needs. Notable changes since 2009 include:

- Addition of a Joint ASP between the Town and Rocky View County, covering approximately eleven quarter-sections. A MWSS specific to the Joint ASP was developed by MPE Engineering Ltd (MPE, 2017).
- New ASPs for several active new developments, including Vista Crossing (B&A et. al., June 2015), Iron Landing (Longview et. al, June 2011), Hawk's Landing (Creation Communities Inc, 2017), and Sunset Ridge (BSEI, 2007). A servicing assessment was conducted for these ASPs by Allnorth in 2017, including a new water model.
- Proposed new land for future annexation, covering approximately 22 further quarter-sections
- Changes to population growth projections
- New Municipal Development Plan (Bylaw No. 2018-15), adopted in November 2018.

This MWSS builds upon previous studies and provides an up-to-date assessment of the Town's water servicing needs, including a master servicing concept for key development stages and for build-out, proposed capital projects to service anticipated near and medium-term developments, and cost estimates.

1.1 Objectives

The objectives for the Master Waster Servicing Study update for the water servicing in the Town of Crossfield as follows:

- Define the study area water servicing requirements and assumptions in terms of existing and future land use, population and growth predictions.
- Define water demand assumptions for existing and future land uses based on recent Town metering data and typical servicing requirements per land use type.
- Develop the water servicing design basis based on previous studies, Crossfield bylaws, and typical design criteria for similar towns in Southern Alberta.
- Verify the existing model (developed by Allnorth in 2017) for the existing Town water distribution system, including calibration.
- Evaluate the existing water servicing infrastructure capacity, identify any deficiencies (areas that do not meet the design criteria), and propose upgrades to correct these deficiencies.
- Prepare a future servicing model to evaluate the Town water distribution system for upcoming ASPs, incorporating ASP servicing plans for Vista Crossing, Iron Landing, and Hawk's Landing. Identify system deficiencies, and propose upgrades to service these ASPs to build-out.
- Prepare a future servicing model to evaluate the Town water distribution system for the Joint ASP, and identify any significant differences from the previous Joint ASP MWSS (MPE, 2017). Evaluate the ability of the existing Crossfield water infrastructure to service the Joint ASP, and propose upgrades and/or additions to service Joint ASP build-out.

- Prepare a long-term future model to evaluate the ultimate development of the study area, including the existing town, upcoming ASPs, Joint ASP, and other future annexation areas (north, west and south of the existing town).
- Prepare costs estimates and a phasing plan for the proposed infrastructure upgrades and additions, including trigger conditions for each upgrade and estimated window for implementation.
- Provide a high level discussion of potential funding mechanisms.

2 STUDY AREA

The study area for the MWSS includes the following areas, and covers a total of 45 quarter-sections (see **Figure 2-1** and **Figure 3-1**). Within the study area, nine quarter-sections are developed, three have approved ASPs with development underway, and several further developments are expected to proceed in the near to medium term. The detailed land descriptions for the study area are as follows:

- **Within existing town boundary:**
  - Existing developed land: SE35-28-1-5 (residential/municipal), NW26-28-1-5 (Sunset Ridge, partially developed), NE26-28-1-5 (residential/downtown), SW26-28-1-5, SE26-28-1-5 (industrial), NE22-28-1-5 (wastewater storage cell), NW23-28-1-5 (golf course), NE23-28-1-5 (industrial);
  - Area Structure Plans (ASPs) under development:
    - Iron Landing (NE35 28-1 W5M, Bylaw No. 2011–11),
    - Vista Crossing (SW35 28-1 W5M, Bylaw No. 2015–07),
    - Hawks Landing (NW35 28-1 W5M, Bylaw No. 2016–12),
    - Sunset Ridge (NW26 28-1 W5M, partially developed, currently on hold);
  - Urban Reserve (Joint ASP): NW36-28-1-5, SW36-28-1-5, NW25-28-1-5, SW25-28-1-5, NW24-28-1-5;
  - Urban Reserve (no ASP): NE27-28-1-5, SE27-28-1-5;
- **Crossfield-Rocky View Joint ASP (2017):**
  - Five quarter-sections within the Town of Crossfield boundary (see above);
  - Six quarter-sections within Rocky View County: NE36-28-1-5, SE36-28-1-5, NE25-28-1-5, SE25-28-1-5, NE24-28-1-5, SW24-28-1-5, SE24-28-1-5;
- **Proposed future annexation areas, covering 22 quarter-sections:**
  - North of existing town: SW3-29-1-5, SE3-29-1-5, SW2-29-1-5, SE3-29-1-5, SW1-29-1-5, SE1-29-1-5;
  - West of existing town: NW34-28-1-5, NE34-28-1-5, SW34-28-1-5, SE34-28-1-5, NW27-28-1-5, SW34-28-1-5, NW22-28-1-5;
  - South of existing town: SW22-28-1-5, SE22-28-1-5, SW23-28-1-5, SE23-28-1-5, NE14-28-1-5, NW13-28-1-5, NE13-28-1-5, SW13-28-1-5, SE13-28-1-5.

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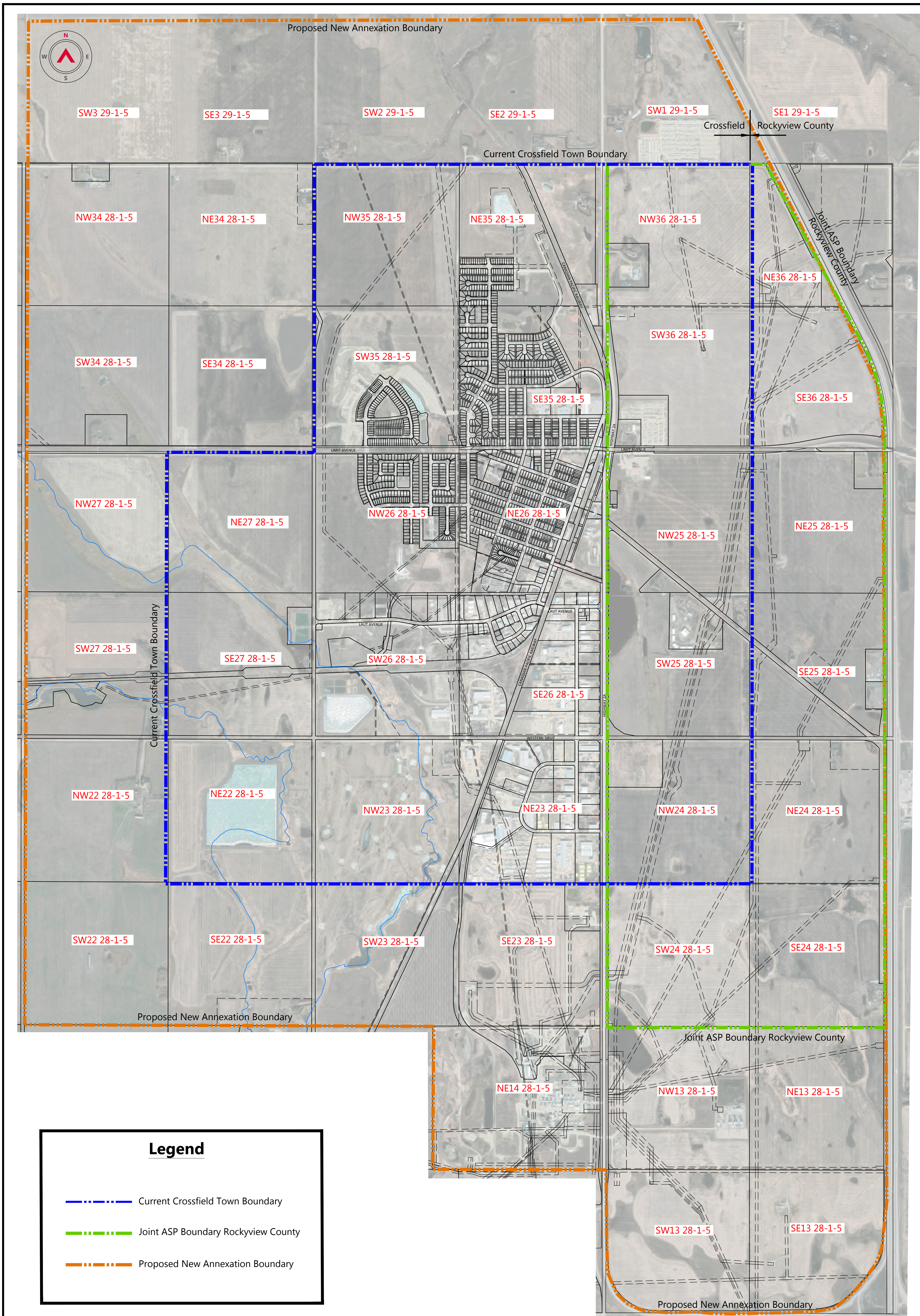


REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
A	17/01/06	ISSUED FOR REVIEW	JHC	FI

CLIENT: This is Crossfield EST 1907

Allnorth

TITLE: **New Crossfield Town Study Area**

CLIENT NO:	-	DRWN: LX	DATE: 18/11/06
PROJECT NO:	18CG0083	DSGN: AM	DATE: -
DRAWING SIZE:	ANSI "B"	CHKD: -	DATE: -
SCALE:	1:20000	APVD: -	DATE: -

PROJECT: **Master Sanitary Servicing Study**

DWG NO: **Figure 2-1**

REV: **A**

3 LAND USE AND STATISTICS

The MWSS is based on the Town of Crossfield Land Use Bylaw Map (September, 2018) and development objectives as presented in annexations agreements (2009), approved Crossfield-Rocky View Joint ASP (MPE, 2017) and Inter-municipal Development Plan (Rocky View and Town of Crossfield, June 2013), and the latest Master Development Plan (MDP) (Town of Crossfield, 2018).

Equivalent Population

In order to characterize the relative servicing demands of residential and non-residential areas, the concept of equivalent population has been utilized throughout this section. The residential equivalent populations are equal to the actual populations. The non-residential equivalent populations have been calculated as follows:

Non-Residential Existing Areas – Equivalent population density was calculated using the total areas and total metered volumes of residential, commercial, and industrial land uses. For industrial land use zones and commercial land use zones, the relative water use of residential, commercial, and industrial areas was compared for the year from June 2018 to May 2019. Using the demand per capita for the residential areas, equivalent population densities for non residential areas were determined. For commercial areas and industrial areas, the equivalent populations were calculated to be 6.5 and 7.8 persons/ha (c/ha) respectively. **Table 3-1** summarizes the relevant data used to determine equivalent population and population density for non-residential existing areas.

Table 3-1 – Equivalent Population Density for Non-Residential Existing Areas

Land Use	Total Area (ha)	Residential Population [1]	Metered Flow Rate (L/s/ha) [2]	(Equivalent) Population Density (c/ha)	(Equivalent) Population [3]
Residential	119.8	3,895	0.096	32.5	3,895
Commercial	59.7	N/A	0.019	6.5	386
Industrial	148.3	N/A	0.023	7.8	1,160

Notes:

1. Assuming all residential units are occupied by 2.7 residents
2. Based on June 2018 to May 2019 Town billing data (see Table 5-2)
3. Equivalent population density is calculated as the population density that would be required to generate the metered flow rate for the non-residential land use, given the metered flow rate and population density for residential land use.
4. c/ha = persons/ha

Non-Residential Future Areas – Equivalent population density was calculated using the future areas assumptions defined in **Section 5.6**, giving an equivalent population density of 27.4 c/ha.

Note that the assumption for equivalent population is much higher for future areas than existing areas. This is because the existing non-residential areas have a much lower water demand than is typical. For flexibility, the future area demand assumptions reflect typical demands, rather than existing demands.

Table 3-2 summarizes area, population, and land use for both existing and future development within the Town of Crossfield.

Table 3-2 – Summary of Land Use, Population & Area for Existing and Future Developments

Phase	Gross Area (ha)				Population		
	Residential	Industrial/ Commercial	Unserviced	Total	Actual Residential	Equivalent Non-residential	Total
Existing	120	225	90	**435**	3,895	1,613	**5,508**
Upcoming ASPs	120	5	21	**146**	6,365	131	**6,496**
Joint ASP	-	659	23	**681**	-	18,053	**18,053**
Balance of 2010 Annexation	167	28	65	**259**	6,602	776	**7,378**
Balance of Future Annexation	637	363	331	**1330**	25,778	9,946	**35,724**
Total (build-out to study horizon)	**1,043**	**1,280**	**530**	**2,852**	**42,640**	**30,520**	**73,159**

The following sections provide land use, population, area, and phasing statistics for each phase. Note that where the term “Gross Area” is used, this refers to the total area, including roads, allowances, and any other area not specifically listed in each summary table.

3.1 Existing Town

For the purpose of this study, “Existing Town” means the existing town areas currently being serviced as of 2018, excluding areas which are undeveloped or in development, as follows:

- Vista Crossing (beyond Phases 1 and 3)
- Iron Landing (beyond Phases 1, 2, and 3)
- Hawk’s Landing (full ASP)
- Sunset Ridge (beyond the current developed area as of 2018)
- Urban Reserve areas
- Unserviced land (e.g. majority of golf course, green spaces, etc.)

The population, area, and land use details for the existing town areas are presented in **Table 3-3**. The information presented is based on the latest Town of Crossfield land use bylaw map (Bylaw No. 2011-05, updated September 2018, see **Appendix A**).

Table 3-3 – Population and Area by Land Use Code for Existing Town Areas

Land Use Code	Fire Flow Type	Population Type	Gross Area (ha)	(Equivalent) Population[1]	(Equivalent) Residential Units
MHR	Single Family	Residential	5.6	187	69
RES-R1A	Single Family	Residential	48.3	1432	530
RES-R1B	Single Family	Residential	12.4	466	172
RES-R1C	Single Family	Residential	23.2	752	278
RES-R2	Multi-Family	Residential	20.9	734	270
RES-R3	Multi-Family	Residential	0.1	3	1
RES-R4	High-Density	Residential	1.9	71	26
BUS-C2	Commercial/Institutional	Non-Residential (Commercial)	14.6	94	35
COM-C3	Commercial/Institutional	Non-Residential (Commercial)	10.4	67	25
BUS-CBD	Commercial/Institutional	Non-Residential (Commercial)	5.1	33	12
BUS-EBD	Commercial/Institutional	Non-Residential (Commercial)	9.0	58	21
BUS-WBD[2]	Multi-Family	Residential	7.4	250	92
IND-I1	Industrial	Non-Residential (Industrial)	10.0	78	29
IND-I2	Industrial	Non-Residential (Industrial)	66.7	522	193
IND-I3	Industrial	Non-Residential (Industrial)	71.6	560	208
MUN (serviced)[3]	Commercial/Institutional	Non-Residential (Commercial)	31.1	201	74
MUN/DC (unserviced)	N/A	N/A	90.3	N/A – Unserviced	
Subtotal – Residential				**3,895**	**1,438**
Subtotal – Non-Residential				**1,613**	**597**
Total (Serviced)				**5,508**	**2,035**

Notes:

1. "Equivalent Population" means actual residents for residential zones (assuming all residential lots are occupied by an average of 2.7 residents), as well as equivalent population for non-residential zones (see **Section 3** and **Table 3-1**). It is used to characterize relative water demand, rather than total actual persons present in the town.
2. Although "BUS-WBD" stands for "Business-Western Business District", zones with this code are primarily residential at this time (2018). Since residential areas produce higher flows per unit area, this code has been classed as "Residential" for the purposes of flow demand estimation.
3. Municipal land use is very similar to commercial land use for water demand, and therefore is categorized with Commercial for the purpose of population equivalent calculation.

3.2 Upcoming Developments

Upcoming developments are summarized below, and include developments approved and in construction, or with construction planned within five years as of 2018.

3.2.1 Vista Crossing ASP (Town of Crossfield Bylaw No. 2015 – 07)

The Vista Crossing development is located at legal location SW1/4 35-28-01-W5M, and covers a gross area of 64.45 ha. For the purpose of water servicing, the land use for this ASP is largely single family residential, with some multi-family (medium density) residential. The population, area, and land use details for the Vista Crossing ASP are presented in **Table 3-4**. The information presented is based on the Vista Crossing ASP Bylaw 2015-07 (B&A et. al., 2015), the Vista Crossing 2017 Servicing Strategy Rev 2 (Exp, 2017), and the Vista Crossing Phase 4 2018 Servicing Strategy Rev 1 (Exp, 2018).

Table 3-4 – Vista Crossing ASP Summary

Description	Gross Area (ha)	Status	(Equivalent) Population[1]	(Equivalent) Residential Units[2]	Remarks
Developable Areas	**60.7**	**-**	**2,993**	**1,106**	
Catchment B Total	**24.6**	**-**	**1,117**	**412**	
Phase 1	10.9	Complete	407	150	Actual units constructed
Phase 3	2.5	Under Construction	141	52	Actual units to be constructed
MF.e	1.2	Future	171	63	Medium density residential - 22 units/acre (54.4 units/ha) as specified by ASP
Phase 2	5.6	Future	227	84	Low density residential - 6 units/acre (14.8 units/ha) as specified by ASP
Phase R	4.5	Future	171	63	Low density residential - 6 units/acre (14.8 units/ha) (estimated by Exp)[2]
Catchment C Total	**0.8**	**-**	**27**	**10**	
Catchment C	0.8	Future	27	10	Estimated maximum units (estimated by Exp)[2]
Catchment A Total	**32.4**	**-**	**1,849**	**684**	
Phase 4	5.0	Future	277	102	Actual units to be constructed
Catchment A excl. Phase 4	27.4	Future	1572	582	Medium density @ 22 units/acre (54.4 units/ha for 3.81 ha), low density @ 6 units/acre (14.8 units/ha for 23.61 ha)
Other	**2.8**	**-**	**-**	**-**	
Stormwater Facilities	2.8	-	-	-	Excluded from servicing area
Non-developable Areas	**3.8**	**-**	**N/A**	**N/A**	
Range Road 12 Area	1.6	-	-	-	Excluded from servicing area
Environmental Reserve / Wetland	2.2	-	-	-	Excluded from servicing area
Vista Crossing ASP Total	**64.5**	**-**	**2,993**	**1,106**	
Under construction / Complete as of 2018	13.3	Under Construction / Complete	548	202	Assumed complete as part of Existing System model
Future as of 2018	44.5	Future	2,445	904	
Non-developable/Other	6.6	-	-	-	

Notes:

1. Based on 2.7 persons per unit (National Census, Statistics Canada, 2016)
2. Unit density based on Vista Crossing Servicing Strategy (Exp, 2018). See Remarks for details.

3.2.2 Iron Landing ASP (Town of Crossfield Bylaw No. 2011-11)

The Iron Landing ASP is located at legal location NE1/4 35-28-1 W5M in the northern portion of the current boundaries of the Town of Crossfield and covers an area approximately 39.91 ha. The land use for this ASP is largely single family residential, with some multi-family (medium density) residential, and a mixed use/commercial zone. The population, area, and land use details for Iron Landing are presented in **Table 3-5.** The information presented is based on the Iron Landing ASP Bylaw 2011-11 (Longview et. al, June 2011), and the Iron Ridge construction drawings (Lee Maher, 2015).

Table 3-5 – Iron Landing ASP Summary

Description	Gross Area (ha)	Status	(Equivalent) Population[1]	(Equivalent) Residential Units[2]	Remarks
Developable Areas	**39.9**	**-**	**1618**	**598**	
Iron Landing Phase 1	**7.4**	**-**	**292**	**108**	
Iron Ridge Phase 1	1.8	Complete	68	25	Units constructed (low density residential)
Iron Ridge Phase 2	2.6	Complete	105	39	Units constructed (low density residential)
Iron Ridge Phase 3	3.0	Complete	119	44	Units constructed (low density residential)
Iron Landing Future	**25.6**	**-**	**1326**	**490**	
Low density Residential	21.5	Future	819	303	Based on ASP - Unit density equal to actual density of existing phases
Medium density Residential	3.5	Future	490	181	Based on ASP - Unit density to achieve total 592 residential lots
Commercial/Mixed Node	0.6	Future	17	6	Equivalent population based on 0.10 L/s/ha - see Section 3.0.
Other	**6.9**	**-**	**-**	**-**	
Open/Green Space	4.8	Future	-	-	Excluded from servicing area
Stormwater Facilities	2.1	-	-	-	Excluded from servicing area
Non-developable Areas	**0.0**	**-**	**N/A**	**N/A**	
N/A	0.0	-	-	-	
Iron Landing ASP Total	**39.9**	**-**	**1,618**	**598**	
Under construction / Complete as of 2018	7.4	Under Construction / Complete	292	108	Assumed complete as part of Existing System model
Future as of 2018	25.6	Future	1326	490	
Non-developable/Other	6.9	-	-	-	

Notes:

1. Based on 2.7 persons per unit (National Census, Statistics Canada, 2016), includes equivalent population for non-residential areas.
2. Unit density based on Iron Landing ASP - Bylaw No. 2011-11. See *Remarks* for details.

3.2.3 Hawk's Landing ASP (Town of Crossfield Bylaw No. 2016-12)

The Hawk's Landing ASP is located on legal location NW1/4 35-28-1 W5M, north of Vista Crossing and West of Iron Landing. Water servicing for this development will be via tie-ins to Iron Landing on Harrison Street, and McCaskill Drive. At build-out, Hawk's Landing will cover approximately 64.3 ha, and will contain approximately 962 residential units based on maximum density of 15 units per gross hectare. Estimated residential population for this area is 2,692 people based on the Hawk's Landing ASP. The population, area, and land use details for Hawk's Landing are presented in **Table 3-6**, below. The information presented is based on the Hawk's Landing ASP Bylaw 2016-12 (Creation Communities Inc, 2017).

Table 3-6 – Hawk's Landing ASP Summary

Description	Gross Area (ha)	Status	(Equivalent) Population[1]	(Equivalent) Residential Units[2]	Remarks
Developable Areas	**64.3**	**-**	**2,725**	**1,006**	
Residential Areas	**53.4**	**-**	**2,611**	**964**	
Single Detached	39.8	Future	1513	559	Based on ASP estimated units count for Single Detached
Street-Oriented Attached	12.9	Future	873	322	Based on ASP estimated units count for Street-Oriented Attached
Single Site Attached	0.8	Future	225	83	Based on ASP estimated units count for Single Site Attached
Commercial/Municipal Areas	**4.1**	**-**	**114**	**42**	
Commercial Area	0.5	Future	13	5	Equivalent population based on 0.10 L/s/ha - see Section 3.0.
School Reserve	3.7	Future	101	37	Equivalent population based on 0.10 L/s/ha - see Section 3.0.
Other	**6.7**	**-**	**-**	**-**	
Open/Green Space & MR	1.4	-	-	-	Excluded from servicing area
Stormwater Facilities	5.3	-	-	-	Excluded from servicing area
Non-developable Areas	**0.0**	**-**	**N/A**	**N/A**	
N/A	0.0	-	-	-	
Hawk's Landing ASP Total	**64.3**	**-**	**2,725**	**1,006**	
Under construction / Complete as of 2018	0.0	Under Construction / Complete	0	0	
Future as of 2018	57.6	Future	2,725	1,006	
Non-developable/Other	6.7	-	-	-	

Notes:

1. Based on 2.7 persons per unit (National Census, Statistics Canada, 2016), includes equivalent population for non-residential areas.
2. Unit density based on Hawk's Landing ASP - Bylaw No. 2016-12. See *Remarks* for details.

3.3 Ultimate Development

The ultimate development extents for this study include the Joint ASP, urban reserve areas within the current Town boundary and future annexation areas as defined in **Section 2.**

3.3.1 Crossfield-Rocky View Joint ASP (Joint ASP)

Based on the Rocky View County / Town of Crossfield Intermunicipal Development Plan (June 2013), MPE completed a Town of Crossfield / Rocky View County Joint Area Structure Plan (Joint ASP) - Water Servicing Study (August 2017). This study covers five quarter-sections within the Town of Crossfield boundary, and an additional six quarter-sections within the Rocky View County. The land use for the Joint ASP is summarized in **Table 3-7**, below.

The Joint ASP area is approximately 693 ha, of predominantly agricultural use, which is envisioned to be developed into commercial, industrial, municipal, and institutional land uses. At this time, there is no expected residential development east of Highway 2A, which includes the full Joint ASP area.

Table 3-7 – Crossfield / Rocky View Joint ASP – Land Use Summary

Legal Land Description	Gross Area (ha)						(Equivalent) Population[1]
	Residential	Industrial	Light Industrial	Commercial/ Institutional	MR/Green Space	Total	
Residential Areas	-	-	-	-	-	-	-
(None)							
Non-Residential Areas	**-**	**358**	**254**	**47**	**23**	**681**	**18,053**
NW 36-28-1-5	-	58.1	-	5.7	-	63.8	1,750
NE 36-28-1-5	-	-	22.5	-	-	22.5	617
SW 36-28-1-5	-	51.1	-	8.1	-	59.2	1,624
SE 36-28-1-5	-	-	50.3	-	-	50.3	1,380
NW 25-28-1-5	-	23.9	-	33.2	3.9	61	1,566
NE 25-28-1-5	-	56.4	-	-	3.4	59.8	1,547
SW 25-28-1-5	-	46.9	-	-	15.4	62.3	1,286
SE 25-28-1-5	-	57.1	-	-	-	57.1	1,566
NW 24-28-1-5	-	64.2	-	-	-	64.2	1,761
NE 24-28-1-5	-	-	58.8	-	-	58.8	1,613
SW 24-28-1-5	-	-	63.2	-	-	63.2	1,733
SE 24-28-1-5	-	-	58.7	-	-	58.7	1,610
Joint ASP Total	**-**	**357.7**	**253.5**	**47.0**	**22.7**	**680.9**	**18,053**

Notes:
1. Equivalent population based on 0.1 L/s/ha and future residential design criteria - see Section 3.0.

3.3.2 Remaining 2010 Annexation Build-out

There are several undeveloped areas within the existing town boundary that were annexed in 2010, but which are not part of the Upcoming Developments (see **Section 3.2**) or the Joint ASP (see **Section 3.3.1**). These remaining areas for build-out within the 2010 annexation boundary are summarized in **Table 3-8**, below.

Table 3-8 – Remaining 2010 Annexation Build-out – Land Use Summary

Legal Land Description	Gross Area (ha)						(Equivalent) Population[1]
	Residential	Industrial	Light Industrial	Commercial/ Institutional	MR/Green Space	Total	
Residential Areas	**163**	**-**	**-**	**-**	**3**	**166**	**6,602**
Sunset Ridge Future Area (within NE 26-28-1-5)	38.3	-	-	-	-	38.3	1,551
NE 27-28-1-5	62.6	-	-	-	-	62.6	2,535
SE 27-28-1-5	62.1	-	-	-	2.8	64.9	2,515
Non-Residential Areas	**-**	**28.3**	**-**	**-**	**-**	**93.2**	**776**
NE 22-28-1-5	-	-	-	-	64.9	64.9	-
NE 35-28-1-5	-	28.3	-	-	-	28.3	776
2010 Annexation Remaining Development Total[2]	**163.0**	**28.3**	**0.0**	**0.0**	**35.3**	**259.0**	**7,378**

Notes:
1. Population based on unit density of 15 units per gross developable hectare, and 2.7 persons per unit. Equivalent population based on 0.1 L/s/ha and future residential design criteria - see Section 3.0.
2. Excludes Joint ASP lands (see Section 3.3.1) and Upcoming ASPs (see Section 3.2)

3.3.3 Future Annexation Areas

Proposed future annexation areas, totalling 22 quarter-sections, will roughly double the current town area (see **Figure 3-1** and **Section 2** for detailed land descriptions). The future areas land use map includes the assumed land use for all undeveloped areas, both within the existing town boundary, and within the proposed future annexation areas. The assumed land uses and boundaries are based on the Joint ASP, Vista Crossing, Iron Landing, Hawk's Landing, and Sunset Ridge ASP land use maps for their respective areas, and on preliminary land use mapping provided by the Town for the remaining areas. These land use assumptions and boundaries include recent changes when compared to current MDP - Bylaw No. 2018-15 (Town of Crossfield, 2018), primarily due to the proposed new annexation and changes to land use within the Joint ASP, which are not included in the MDP.

These future annexation areas, excluding areas previously covered under the Joint ASP (see **Section 3.3.1**), are summarized in **Table 3-9**, below.

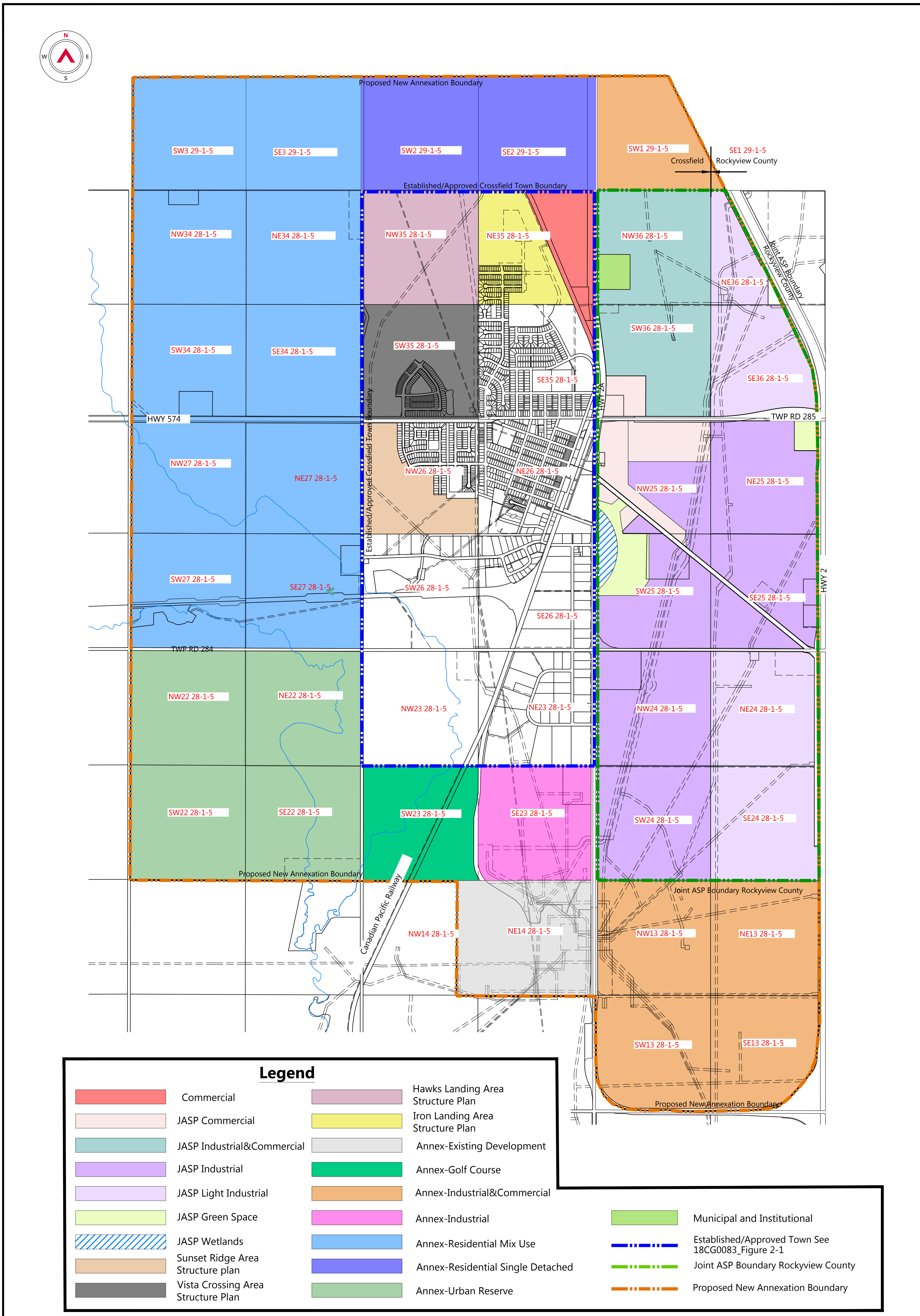
Table 3-9 – Future Annexation Areas Land Use Summary

Legal Land Description	Gross Area (ha)						(Equivalent) Population[1]
	Residential	Industrial	Light Industrial	Commercial/ Institutional	Reserve/ Unserviced	Total	
Residential Areas	**637**	**0**	**0**	**0**	**0**	**637**	**25,778**
SW 3-29-1-5	64.1	-	-	-	-	64.1	2,596
SE 3-29-1-5	64.3	-	-	-	-	64.3	2,604
SW 2-29-1-5	64.4	-	-	-	-	64.4	2,608
SE 2-29-1-5	61.1	-	-	-	-	61.1	2,475
NW 34-28-1-5	64.3	-	-	-	-	64.3	2,604
NE 34-28-1-5	64.4	-	-	-	-	64.4	2,608
SW 34-28-1-5	63.1	-	-	-	-	63.1	2,556
SE 34-28-1-5	63.3	-	-	-	-	63.3	2,564
NW 27-28-1-5	62.7	-	-	-	-	62.7	2,539
SW 27-28-1-5	64.8	-	-	-	-	64.8	2,624
Non-Residential Areas	**0.0**	**305.7**	**0.0**	**56.9**	**331.0**	**693.6**	**9,946**
SW 1-29-1-5	-	-	-	54.9	-	54.9	1,506
NW 22-28-1-5 [2]	-	-	-	-	64.8	64.8	-
SW 22-28-1-5 [2]	-	-	-	-	64.8	64.8	-
SE 22-28-1-5 [2]	-	-	-	-	64.8	64.8	-
SW 23-28-1-5	-	-	-	2	61.4	63.4	55
SE 23-28-1-5	-	63.1	-	-	-	63.1	1,731
NW 14-28-1-5 [3]	-	-	-	-	63.5	63.5	-
NE 14-28-1-5 [3]	-	-	-	-	11.7	11.7	-
NW 13-28-1-5	-	64.6	-	-	-	64.6	1,772
NE 13-28-1-5	-	62	-	-	-	62	1,701
SW 13-28-1-5	-	61.1	-	-	-	61.1	1,676
SE 13-28-1-5	-	54.9	-	-	-	54.9	1,506
Future Annexation Remaining Development Total	**636.5**	**305.7**	**0.0**	**56.9**	**331.0**	**1330.1**	**35,724**

Notes:

1. Residential Population based on unit density of 15 units per gross developable hectare and 2.7 persons per unit, non-residential equivalent population based on 0.1 L/s/ha - see Section 3.0
2. Legal locations NW/NE/SW 22-28-1-5 and SE 22-28-1-5 are expected to be developed beyond the horizon of this study.
3. Legal locations NW & NE 14-28-1-5 are an existing industrial development not serviced via the Town.

Date: 2019/09/11 | User: Annie Xu | File: P:\CG\2018\0-99\0-99 Active\18CG0083 - Crossfield - Water Master Plan\1000-Drawings\1011-Civil\01-Production\18CG0083_Figure 3-1 | Layout: Areas | Paper Size: 431.8mm x 558.8mm



REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
A	19/03/06	ISSUED FOR REVIEW	LX	AM

CLIENT: THIS is CROSSFIELD EST 1907

Allnorth

TITLE: **Town of Crossfield Land Use**

CLIENT NO: -	DRWN: LX	DATE: 18/11/06	
PROJECT NO: 18CG0083	DSGN: AM	DATE: -	
DRAWING SIZE: ANSI "B"	CHKD: -	DATE: -	
SCALE: 1:20000	APVD: -	DATE: -	

PROJECT: **Master Water Servicing Study**

DWG NO: **18CG0083 Figure 3-1**

REV: **A**

4 POPULATION GROWTH

The Town of Crossfield historical population data is presented in **Table 4-1**, based on Statistics Canada census data for 2001-2016, and on internal Crossfield census data for 2017-2018. During this historical period, annual growth was on average approximately 2% until 2017. Recently, growth has been much higher, with growth at 8.3% from 2017 to 2018. This recent increase in growth is likely due to new residential construction in the Iron Landing and Vista Crossing ASPs.

Table 4-1 – Historical Population Growth

Year	Population (Census)	Growth (Mean Annual %)
2001	2,399	-
2006	2,643	2.0%
2011	2,853	1.6%
2016	2,983	0.9%
2017	3,055	2.4%
2018	3,308	8.3%

For the purposes of population projection, this study follows the guidance of the 2018 Crossfield MDP, which references the growth study prepared in 2009 for the lands annexed to the Town in 2010. The 2009 growth study projected a residential population of 12,000 to 15,000 by the year 2040, which corresponds to an annual growth of approximately 6%. The actual growth which occurred between the publication of the growth study (2009) and the most recent census (2018) was approximately 2.0%. However, given the high rate of growth from 2017 to 2018, and the upcoming residential ASPs under active construction, 6% is reasonable for planning purposes. A growth rate of 6% as requested by the Town has therefore been assumed for the purposes of this study. Non-residential growth is expected to grow at the same rate, as defined by equivalent population (see **Section 3.0**). The projected population at the selected annual growth rate of 6% is summarized in **Table 4-2** and **Figure 4-1**, along with comparison rate of 2%, 4%, and 8%**.**

Table 4-2 – Population Projection

Year	Annual Growth				Remark
	2%	4%	6% (selected)	8%	
2018	3,308	3,308	3,308	3,308	2018 municipal census
2023	3,652	4,025	4,427	4,861	
2028	4,032	4,897	5,924	7,142	
2033	4,452	5,958	7,928	10,494	
2038	4,915	7,249	10,609	15,419	
2043	5,427	8,820	14,197	22,656	
2048	5,992	10,731	18,999	33,289	
2053	6,616	13,056	25,425	48,912	
2058	7,305	15,885	34,024	71,868	
2063	8,065	19,327	45,532	105,598	

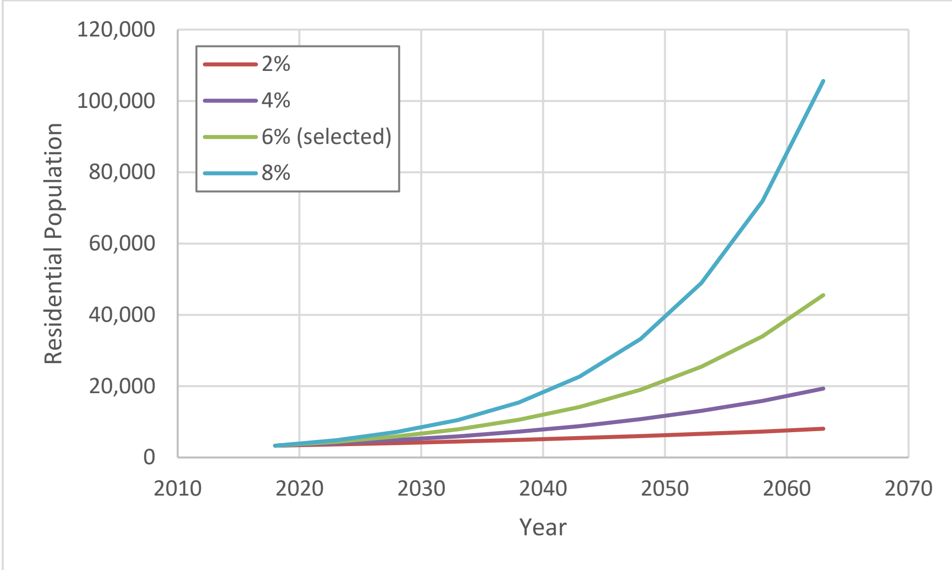


Figure 4-1 – Town of Crossfield Population Projections

4.1 Development Sequence

The prediction of development sequence, beyond areas already in negotiations with a specific developer, is subject to a great deal of uncertainty. For the purposes of this study, the assumed development sequence is based on the Town's best estimate for probable development of specific areas within the next 10 years. For the remainder, we have assumed development will proceed generally outwards, beginning with areas closest to major highways and the existing town. **Table 4-3** summarizes the assumed development sequence from the present to the study horizon.

In the near-term, we assume the majority of development will be focused on the upcoming ASPs for the next 10 years, with some development of the Joint ASP. For the range of 10-20 years from present, we assume the upcoming ASPs will be built out, with the remainder of development occurring in the Joint ASP and within the remaining undeveloped 2010 annexation lands. For the range of 20-30 years from present, there is more uncertainty, but we have assumed the lands within the existing (2010 annexation) town boundary will be built out, with the exception of quarter section NE22 28-1-5, which is assumed to be Urban Reserve at the study horizon. Finally, within the range of 30 years+, we expect the town to continue expansion in the Joint ASP lands, for the new annexation to be completed, and for expansion to progress throughout the newly annexed lands. The 6% growth estimate may become less appropriate as the town increases in size, due the exponential nature of a constant growth rate assumption. However, if the 6% growth rate is maintained, we expect build-out to the study horizon (all future annexation lands, less four quarter-sections) to occur in approximately 2062.

If higher or lower growth rate, the required infrastructure will simply be brought forward or delayed as required by whichever developments proceed at which time. Development sequence is also not strongly related to population totals, much more correlation to actual development locations when dealing with such a large area and potential development in any (or all) directions. Therefore, no detailed what-if scenarios are completed as the will very likely to be out of date within a couple of years, and so have been avoided in favour of refining plans at the time of development.

Table 4-3 – Assumed Development Sequence

Year Range	**Projected Population Growth** (Equivalent, All Land Use Types)								Total Equivalent Population	Total Residential Population
	Existing Town excl. Upcoming ASPs	Upcoming Developments: Vista Crossing	Upcoming Developments: Hawk's Landing	Upcoming Developments: Iron Landing	Joint ASP	Balance of 2010 Annexation Lands	Balance of Future Annexation Lands	Total Growth (= 6% P.A.)[1]		
Build-out Total	**4,668**	**2,993**	**2,725**	**1,618**	**18,053**	**7,378**	**35,724**	**N/A**	**73,159**	**42,640**
Existing (2018) Total	**4,668**	**548**	**0**	**292**	**0**	**0**	**0**	**N/A**	**5,508**	**3,895**
2019-2023	-	815	500	-	548	-	-	**1,863**	**7,371**	**5,189**
2024-2028	-	815	742	200	736	-	-	**2,493**	**9,864**	**6,912**
2029-2033	-	815	742	563	973	243	-	**3,336**	**13,201**	**9,212**
2034-2038	-	-	741	563	1,896	1,264	-	**4,465**	**17,666**	**11,609**
2039-2043	-	-	-	-	2,987	2,987	-	**5,975**	**23,641**	**14,282**
2044-2048	-	-	-	-	3,998	2,883	1,115	**7,996**	**31,636**	**17,666**
2049-2053	-	-	-	-	4,280	-	6,420	**10,700**	**42,337**	**22,299**
2054-2058	-	-	-	-	2,634	-	11,685	**14,319**	**56,656**	**30,731**
2059-2063	-	-	-	-	-	-	16,503	**16,503**	**73,159**	**42,640**

Notes:
1. P.A means per annum (annual growth rate)

5 WATER DEMAND

5.1 Demand Cases

Different model cases are required to evaluate different features of the water supply and distribution system. Water demand categories are most often specified based on land use, which include residential (single or multifamily), institutional, commercial and industrial. It is at the discretion of the modeller to select the most appropriate demand classifications for the water system being modelled and the data available to develop the demands. For this study, four cases have been modelled for each development scenario, as follows:

- **Average Daily Demand (ADD)** – This case represents the average (mean) derived from 24-hour water consumption over an annual period, and is used to evaluate the performance of the system under normal conditions.
- **Maximum Daily Demand (MDD)** – This case represents the highest water consumption occurring in a 24-hour day within an annual period, and is used to evaluate the performance of the system under high flow conditions, but without fire flow. Typically, this level of flow occurs during the hottest months of the year.
- **Peak Hourly Demand (PHD)** – This case represents the highest water consumption occurring in 1-hour within an annual period, and is used to evaluate the performance of the system under maximum normal flow conditions (i.e. without fire flow).
- **Maximum Daily Demand plus Fire Flow (MDD+FF)** – This case represents the MDD with concurrent fire flow at one or more locations. For this model, we consider fire flow at a single location, and repeat for all locations to determine the fire flow performance. This case is used to evaluate the system under fire flow conditions.

Under normal operations, the peak (maximum) hourly demand is the most extreme condition experienced by a water system on a single day and the maximum day demand is the most extreme condition that can be experienced during the year.

In the absence of usage data, Alberta Government (2012) suggests the use of peaking factors, as follows:

- Maximum Daily Demand = 1.8 to 2.0 times the Average Daily Demand
- Peak Hourly Demand = 2.0 to 5.0 times the Maximum Daily Demand depending on the design population.

In this study, a combination of historical data, analysis completed in the ASP and peaking factor approach was used.

5.2 Water Demands

The model water demand basis is summarized below in **Table 5-1**.

Table 5-1 – Water Demand Rates Summary

Item Description		Rate / Factor	Remark
Residential Gross Unit Density	Existing Areas	Varies	Based on lot count for each area, using most recent Town of Crossfield Land Use Map (2018)
	Future Areas	15 units/ha	See Section 5.5
Persons Per Residential Unit (all areas)		2.7	Based on most recent National Census (Statistics Canada, 2016 data), See Sections 5.4 & 5.5
Residential Average Daily Demand (ADD)	Existing Areas	254 L/c/d	See Section 5.4
	Future Areas	315 L/c/d	See Section 5.5
Industrial Average Daily Demand (ADD)	Existing Areas	0.023 L/s/ha	See Section 5.4
	Future Areas	0.10 L/s/ha	See Section 5.5
Commercial/Institutional Average Daily Demand (ADD)	Existing Areas	0.019 L/s/ha	See Section 5.4
	Future Areas	0.10 L/s/ha	See Section 5.5
Maximum Daily Demand (MDD, all areas)		2.0 * ADD	See Sections 5.3.1 and 5.5
Peak Hourly Demand (PHD)	Existing Areas & Upcoming ASPs	3.2 * ADD	See Sections 5.3.1 and 5.5
	Future Areas	2.6 * ADD	See Sections 5.3.1 and 5.5

5.3 Historical Water Usage Data

Historical water usage data for the Town of Crossfield by year over the period of January 2017 to May 2019 is presented in **Table 5-2**, including the percentage distribution across user types. The Town of Crossfield has performed several significant repairs to the water distribution piping in 2018, including meter upgrades to improve metering accuracy, and water leak repairs, it is important to use the most recent data available to capture the data most representative of the current conditions within the existing town network. For this reason, historical data is considered up until May 2019, rather than taking the demand trend over a period of several years, as the basis for current demand.

Table 5-2 – Historical Water Usage Data

Item	Water Quantity (m^3)				Data Source
	2017	2018	2019 (Jan-May)	2018-2019 (Jun-May)	
Total Pumped	532,839 (100%)	524,500 (100%)	213,966 (100%)	517,794 (100%)	Pump station meter records
Billed - Bulk Water	48,519 (9%)	55,763 (11%)	23,825 (11%)	56,805 (11%)	Bulk water (truck fill) station records
Billed - Residential	166,319 (31%)	173,223 (33%)	69,983 (33%)	174,331 (34%)	Consumer meter billing data
Billed - Commercial	41,746 (8%)	45,092 (9%)	16,281 (8%)	42,022 (8%)	
Billed - Industrial	105,561 (20%)	105,307 (20%)	46,952 (22%)	112,493 (22%)	
Unbilled	170,693 (32%)	145,114 (28%)	56,926 (27%)	132,143 (26%)	Remainder after deducting bulk water and consumer billed amounts

Table 5-2 shows a decrease in unbilled water usage from 32% in 2017 to 26% in the year from June 2018 to May 2019, most likely due to repairs conducted by the Town in 2018. The Town estimates that the majority of the remaining 26% unbilled water is due to older meters and potential further water leaks in the residential areas of town. As such, the unbilled water amount has been included with the residential water demand for the purposes of modelling the existing town.

The average daily demands (ADD) based on the historical data are summarised in **Table 5-3** by water user type. The residential usage shows a steady decreasing trend consistent with Statistics Canada information (https://www150.statcan.gc.ca/n1/pub/11-627-m/11-627-m2019022-eng.htm).

Table 5-3 – Historical Average Daily Demand

Water Demand Type	Unit	Average Daily Demand			
		2017	2018	2019 (Jan-May)	2018-2019 (Jun-May)
Bulk Water	L/d	132,929	152,775	158,832	155,631
Residential[1]	L/c/d	302	264	254	254
Commercial/Institutional	L/s/ha	0.019	0.020	0.018	0.019
Industrial	L/s/ha	0.022	0.022	0.024	0.023
Gross Demand[2]	L/c/d	434	388	381	382

Notes:
1. Assumed residential average daily demand includes unbilled amount
2. Gross Demand is calculated as the total water supplied by the pump station, less the bulk water total, divided by the residential population.

5.3.1 Demand Patterns

Municipal water demands vary on daily, weekly, and annual cycles. During a typical year, the peak daily water demands occur during the summer months due to irrigation, recreation, and seasonal agricultural/industrial demands. However, the variation between individual days greatly exceeds the variation between monthly averages. The following figure illustrates the variation in monthly averages for 2018/19, superimposed with the daily data for the same period. For this period, the maximum daily demand value was 2,430 m^3/d, which occurred on May 13, 2019. This maximum day demand is 1.7 times higher than the average demand for the year, which is slightly lower than the typical maximum daily demand design factor of 2.0.

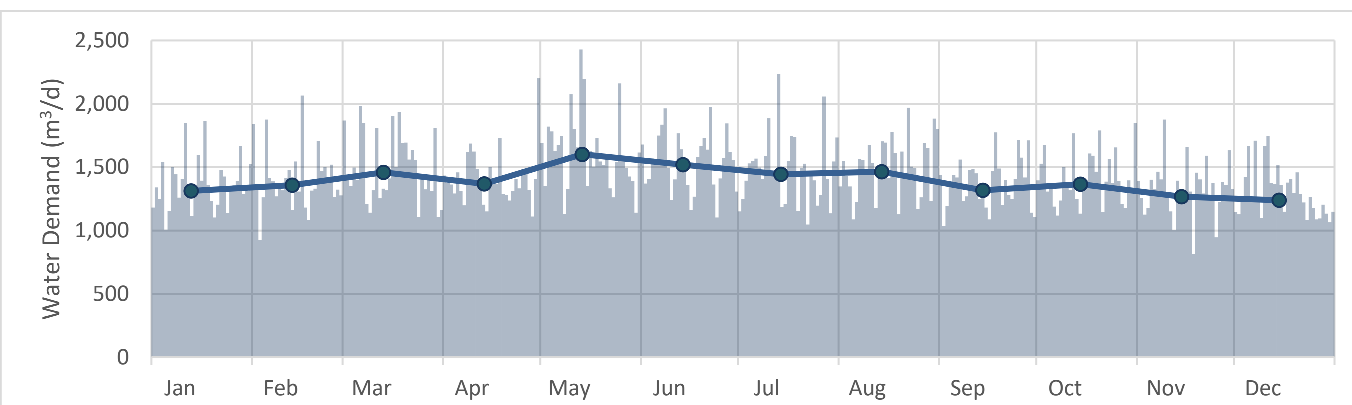


Figure 5-1 – Crossfield Historical Water Demand – 2018/19

There is also significant variation in water demand during a typical day, with two peaks: one in the morning, and one in the evening, coinciding with domestic use such as showers and washing machine/dishwasher cycles. The following figure illustrates the average daily variation in gross demand (i.e. diurnal data), and is based on *available* data at a five-minute resolution data for the period of Jan-May 2019 (no data was available at sufficient resolution prior to Jan 2019).

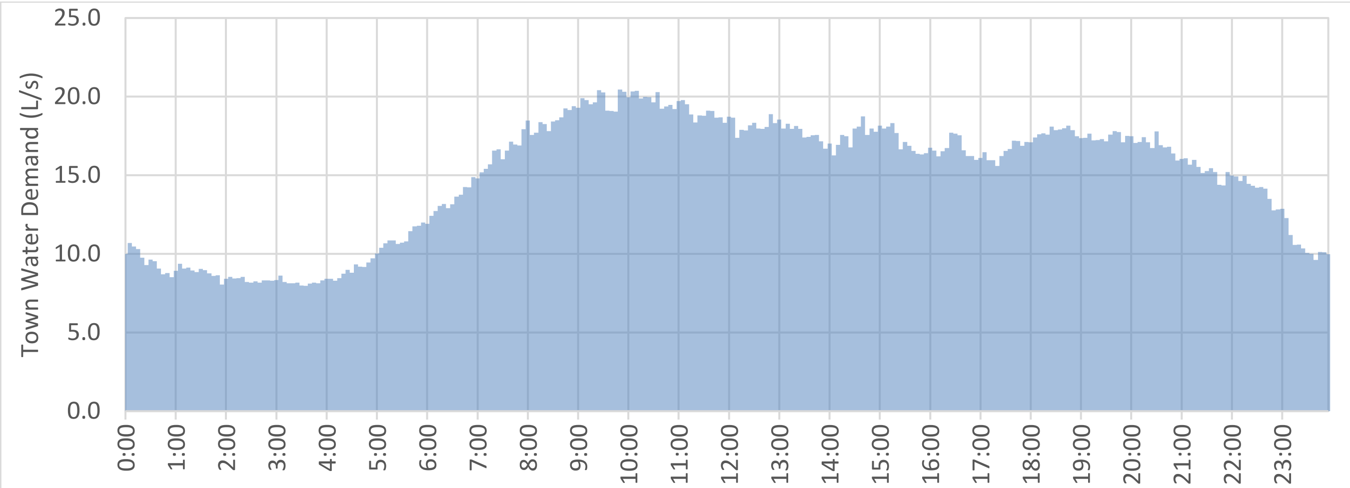


Figure 5-2 – Crossfield Gross Demand Diurnal Data

Figure 5-2 shows that for Crossfield, the highest peak occurs on average in the morning, at approximately 9:30 am, with a gross per capita demand of approximately 20 L/s. This peak demand is approximately 1.4 times higher than the daily average.

Without averaging, the peak hour for the same period (Jan-May 2019) is 52 L/s, which is 3.2 times higher than the daily average. This is consistent with the typical range for the peak hourly demand factor for towns of a similar size, which is 3.0 to 3.4 times the average daily demand (Diao et. al., 2010; MOE, 2008).

5.4 Existing Town Demand

The distribution of water users within the existing town was modelled by estimation of population or equivalent population for each land use zone as presented in **Table 3-3**.

For residential land use zones, a count of lots was made for each land use type, which was then converted to an estimated population density using the unit occupancy of 2.7 people per residential unit established in the 2016 National Census (Statistics Canada, 2016). This method of estimation gives a total residential population of 3,173, which assumes for design purposes that all lots are occupied, and with each lot containing one residential unit. This value is consistent with the 2018 Crossfield Census population of 3,055 (not all residential units are actually occupied).

The average daily demand (ADD) for existing areas is based on metered data for the period of June 2018 to May 2019, (see **Table 5-3** & **Section 5.2**). A comparison of the total water pumped for this period compared to annual totals from 2017 and 2018 indicates that this was a typical year for water demand. The unit water demands utilized are 254 L/c/d for residential areas, 0.019 L/s/ha for commercial/institutional areas, and 0.023 L/s/ha for industrial areas. These water demands have been based on a single year of data, as prior to this period, as there were significant water leaks affecting prior years' data.

Bulk water usage has added as a 500 L/min load at the truck fill station, based on utilizing the station's 2" connection to fill a 16 m^3 water truck, which typically takes 30 minutes. Although this is a high flow rate, it does not have a strong impact on the supply pressure for the rest of the town due to its proximity to the pump station, and its small magnitude compared to the design fire flow of 16,000 L/min.

5.5 Future Demand

For future expansion areas, as defined in **Sections 3.2 and 3.3**, historical data for the Town of Crossfield was compared with other Design Standards to establish reasonable design parameters for probable future water usage. **Table 5-4** provides a summary of key design criteria, including comparison to previous studies and the selected criteria for this MWSS.

Table 5-4 – Selection of Key Design Criteria for Future Developments

Criteria		Crossfield MWSS (DA Watt 2009)	Joint ASP MWSS (MPE 2017)	Rocky View County Standards (May 2013)	Selected Criteria for this MWSS	Selection Basis
Average persons per household		2.9	2.7	4.5	2.7	Equal to most recent national census value for Crossfield (Statistics Canada, 2016 data)
Residential Density (units/ha, gross)		-	16	-	15	Maximum allowable density per Crossfield Municipal Development Plan (2018)
Residential ADD (L/c/d)		357 [1]	315	340	315	Consistent with current Master Sanitary Servicing Study, sufficiently conservative for planning purposes [2]
Industrial/Commercial/ Institutional gross ADD (L/s/ha)		-	0.10	0.10	0.10	Consistent with typical planning assumptions to account for variability of potential development types
MDD Factor (compared to ADD)		2.0	2.0	2.0	2.0	Consistent with historical data (see Section 5.3.1), and with the typical assumption of 2.0
PHD Factor (compared to ADD)	Near-term[3]	-	-	3.82	3.2	Consistent with historical data (see Section 5.3.1), and with the typical range of 3.0-3.4
	Long-term[3]				2.6	Consistent with typical reductions in PHD factor with increasing population (see further discussion in this section).

Notes:

1. The Town of Crossfield Study (DA Watt, 2009) used the gross per capita demand in the place of residential average daily demand that was determined by gross usage and population without differentiating between land use types.
2. For comparison, the households on metered water systems and per capita residential water use in Canada, for 2011 to 2017, dropped from 251 L/c/d to 220 L/c/d (https://www150.statcan.gc.ca/n1/pub/11-627-m/11-627-m2019022-eng.htm , accessed on December 6, 2019).
3. The near-term future development phase is are assumed to include build-out of the Upcoming ASPs (see Section 8). The long-term future development phase includes development up to build-out at the study horizon (see Section 9).

The future water demand assumptions have been chosen to reflect conservative assumptions typically used for similar municipalities. The water demand assumptions for existing areas were not carried through as assumptions for future development, as the existing demands (particularly for non-residential areas) are significantly lower than is typical.

The peak hourly demand (PHD) and maximum daily demand (MDD) factors, compared to the average day demand factor, are dependent on the total population, with the factor reducing with increasing population. This is due to the reduced probability of the peak demands of each water user coinciding closely in time. Typically, for towns of a similar population to the existing Town of Crossfield, the factors range from 3.0-3.4 for PHD and from 2.0-2.3 for MDD (Diao et. al., 2010; MOE, 2019).

For near-term developments, including the upcoming ASPs, the assumed factors are 3.2 for PHD and 2.0 for MDD, to be consistent with the existing meter data. However, at build-out of the upcoming ASPs, the town will have a substantially larger population (10,000-15,000). At this stage, the expected PHD and MDD factors will fall, likely to the range of 2.7-2.9 for PHD and 1.8-1.9 for MDD (Diao et. al., 2010; MOE, 2019).

At the study horizon build-out, with a population of approximately 70,000 to 75,000, the PHD and MDD factors will fall further, likely to the range of 2.5-2.7 for PHD and 1.7-1.8 for MDD. Therefore, for the analysis of the ultimate servicing concept, a PHD factor of 2.6 and a MDD factor of 1.8 have been assumed.

5.6 Projected Demand Growth

The projected growth in average daily demand was calculated at five-year intervals based on the development sequence projections presented in **Table 4-3**. These demand projections are summarized in **Table 5-5**.

Table 5-5 – Projected Average Daily Demand Growth

Year	Projected Average Daily Demand (m^3/d)								Reference Population	
	Existing Town	Upcoming Developments			Joint ASP	Balance of 2010 Annexation Lands	Balance of Future Annexation Lands	Total	Total Equivalent	Residential Only
		Vista Crossing	Hawk's Landing	Iron Landing						
Build-out (~2062)	**1,186**	**942**	**859**	**510**	**5,687**	**2,324**	**11,253**	**22,760**	**73,158**	**42,639**
Existing (2018)	**1,186**	**173**	**-**	**92**	**-**	**-**	**-**	**1,450**	**5,508**	**3,895**
2023	1,186	429	158	92	173	-	-	**2,037**	**7,371**	**5,189**
2028	1,186	686	391	155	405	-	-	**2,823**	**9,864**	**6,912**
2033	1,186	942	625	332	712	77	-	**3,873**	**13,201**	**9,212**
2038	1,186	942	859	510	1,309	475	-	**5,280**	**17,666**	**11,609**
2043	1,186	942	859	510	2,250	1,416	-	**7,162**	**23,641**	**14,281**
2048	1,186	942	859	510	3,509	2,324	351	**9,681**	**31,636**	**17,666**
2053	1,186	942	859	510	4,857	2,324	2,374	**13,051**	**42,337**	**22,299**
2058	1,186	942	859	510	5,687	2,324	6,055	**17,562**	**56,656**	**30,731**
2063	1,186	942	859	510	5,687	2,324	11,253	**22,760**	**73,158**	**42,640**

5.7 Required Fire Flow

Fire flow is defined as the flow rate required and duration for which the fire flow must be supplied within the service area. The fire flow requirement is determined by land use, as defined in **Section 3**. **Table 5-6** compares fire flow requirement by land use for previous Town of Crossfield water servicing studies, as well as the Rocky View Servicing Standards (2013). It can be seen that the Rocky View County has higher requirements for residential areas, while the Town of Crossfield has higher requirements for Industrial and Commercial. The Town's current adopted fire flow standards have been utilized for this study, as the Town fire department will be the first responders for both existing and future areas. Additionally, for areas where the high fire flow for typical Commercial/Industrial is not feasible, a category has been added for "Light Industrial/Commercial", per the Rocky View County Fire Hydrant Water Suppression Bylaw (Bylaw C-7259-2013, 2013).

See **Section 9.3** for projected fire flow volume (storage) requirements.

Table 5-6 – Fire Flow Requirement by Land Use

Land Use	Crossfield MWSS (DA Watt, 2009)		Joint ASP MWSS (MPE, 2017)		Rocky View County Standards (2013)		Selected Criteria for this MWSS	
	Fire Flow (L/m)	Duration (hrs)	Fire Flow (L/m)	Duration (hrs)	Fire Flow (L/m)	Duration (hrs)	Fire Flow (L/m)	Duration (hrs)
Single Family Residential	4,500	1.75	N/A	N/A	6,000	2.0	4,500	1.75
Multi-Family Residential	7,500	2.0	N/A	N/A	10,000	2.0	7,500	2.0
Schools, Institutional Buildings	7,000	2.0	N/A	N/A	N/A	N/A	7,000	2.0
Light Industrial/Commercial	-	-	10,000	2.0	10,000	2.0	10,000	2.0
Commercial	12,000	2.5	12,000	2.5	15,000	3.5	12,000	2.5
Industrial	16,000	3.5	16,000	3.5	15,000	3.5	16,000	3.5
Notes: N/A = not applicable								

6 MODEL BASIS

The following sections define the model basis for all scenarios assessed as part of this study.

6.1 Model Cases

For this study, the following four cases have been modelled for each development scenario, as defined in **Section 5.1**.

- Average Daily Demand (ADD)
- Maximum Daily Demand (MDD)
- Peak Hourly Demand (PHD)
- Maximum Daily Demand plus Fire Flow (MDD+FF)

6.2 Performance Criteria

The following water system performance requirements have been used for this study, and are based upon the Rocky View County Servicing Standards (May 2013), the Town of Crossfield adopted standards (as specified by the previous Master Waster Servicing Study, DA Watt, 2009), and Alberta Environment Standards (April 2012).

- Minimum System pressures:
  - Maximum Daily Demand plus Fire Flow conditions or Maximum Hourly Demand, whichever is greater: ≥ 150 kPa (22 psi)
- Normal system operating pressure under maximum hourly demand: ≥ 350 kPa (51 psi) and ≤ 550 kPa (80 psi).
- Maximum system pressure without individual lot protection/testing: 550 kPa (80 psi)
- Maximum main line flow velocity: 3.0 m/s (excl. fire flow cases): Maximum pipe velocities can also be a major concern in a water distribution system. High pipe velocities can lead to high head loss conditions and possibly transient flow (water hammer) concerns, potentially causing damage to the water system (AWWA, 2012). Velocity restrictions are placed on normal flow cases only, to reduce wear on the pipe system. Under fire flow conditions, specifically at the fire hydrant velocities my reach 5 m/s. However, in order to prevent water hammer, operators must take care not to open or close a fire hydrant too quickly.
- Fire flow performance requirements per **Table 5-6**

6.2.1 Fire Flow Requirements

Required fire flows for each land use type are summarized in **Table 5-6**. Note that fire flows are in addition to the maximum day demand (MDD) flows for the case being analyzed, and therefore the required flow and volume will increase as development progresses. Given that the highest fire flow required is for industrial land use, the required volume for fire conditions will be 3,360 m^3 (16,000 L/m for 3.5 hrs) plus the case MDD for 3.5 hrs.

6.2.2 Limiting Cases

Of the four modelled cases, the PHD and MDD+FF cases are the limiting cases used to evaluate the overall system against the performance requirements, as follows:

- Maximum Daily Demand plus Fire Flow (MDD+FF) – This case has the highest flow demand of all cases up to the study horizon, but has a lower minimum design pressure than the normal flow cases, and no flow velocity restriction. As the Town continues to grow, the PHD case will exceed the demand of the MDD+FF case. This cross-over is expected to occur after the town's water demand has grown an additional 20% beyond the study horizon.
- Peak Hourly Demand (PHD) – This case has the highest flow demand of all normal flow cases, and is therefore required to evaluate whether the system meets the normal flow minimum pressure and maximum main line flow velocity.

6.3 Computational Methodology and Assumptions

The model was constructed using industry standard software Bentley WaterCAD, version 10.02.03.06, and in accordance with AWWA manual M32 (AWWA, 2012). Calculations have been based upon the Hazen-Williams formula, using a steady-state time analysis.

7 EXISTING SYSTEM EVALUATION

The objectives of the existing system evaluation are as follows:

- Prepare an existing town model
- Calibration of the existing town model using hydrant flow test data
- Evaluate the adequacy of the existing system using the performance criteria
- Identify areas that are deficient in one or more performance criteria
- Proposed upgrades for the existing town water distribution network to correct identified deficiencies, including preliminary alignment, sizing, and an implementation plan

The existing system to be evaluated is illustrated in **Figure 7-1**.

7.1 Physical Model Elements

7.1.1 Pipe Network

The modelled pipe network was assembled from record drawings and the Town AutoCAD base. In addition, Allnorth surveyed the town water valves and hydrants as part of the survey conducted in 2016 for the Master Sanitary Servicing Study. Specific data sources utilized are as follows:

- Existing water network elements present in 2009: Town AutoCAD base
- Additions to the water network from 2009 to 2016:
  - New pump station and reservoir added using construction drawings (2011)
  - 400 mm Laut Ave water line added using construction drawings (2011)
  - Iron Landing Phases 1 & 2 added using record drawings (2015)
  - Vista Crossing Phases 1 & 3 design drawings (2017-18)
  - Hammond Avenue, Stevens Place & Shantz Place added using Allnorth survey data (2016)
  - Osler Avenue upgrade added using record drawings (2017)
  - Chisholm Avenue upgrade added based on discussions with Town

The data sources used for each class of physical model element are as follows:

Pipes:

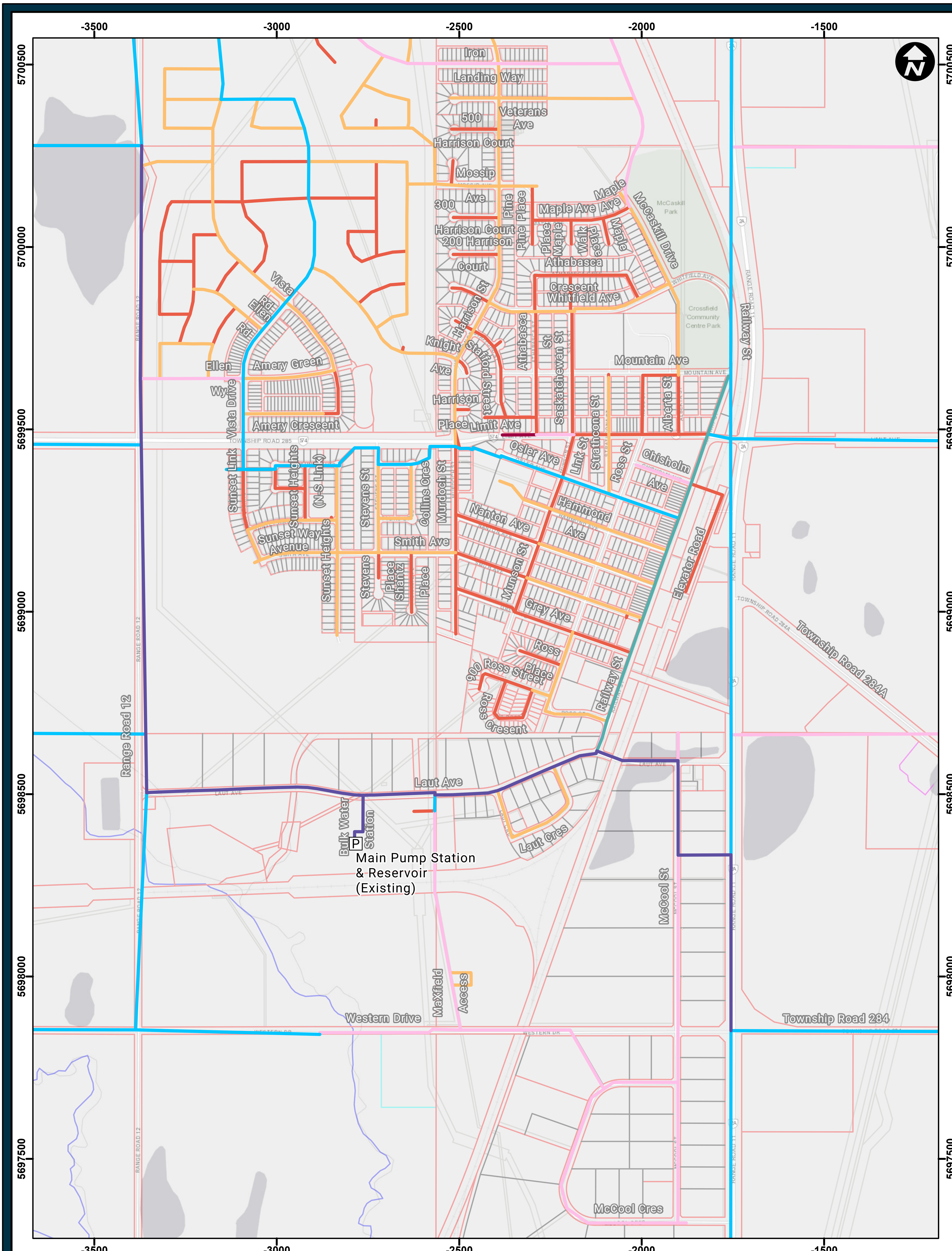
- Alignment, Material & Diameter - from record drawings, Town base map, and Allnorth survey
- Length - calculated automatically from pipe alignment
- Roughness - A Hazen-Williams C-factor was used to define pipe roughness, using typical material values: Polyvinyl Chloride (PVC): 130; Asbestos Cement (AC): 130; Ductile Iron (DI): 110
- Minor pipe losses - modelled using standard library values

Junctions (i.e. tees, crosses, stubs):

- Location - from record drawings, Town base map, and Allnorth survey
- Elevation - from LiDAR

Hydrants:

- Location - from record drawings, Town base map and Allnorth survey
- Elevation - from LiDAR
- Hydrant leads:
  - Alignment - from record drawings, valve locations, and/or proximity to nearest water main
  - Diameter and material - assumed to be 150 mm diameter PVC

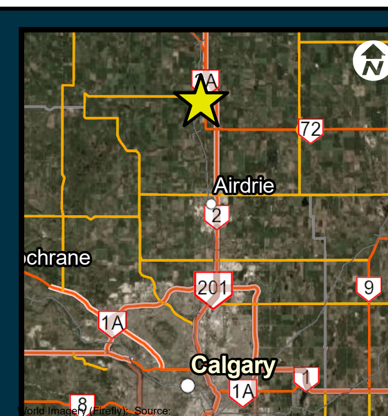


P Pump Station & Reservoir

Existing Water Pipe

Diameter

- 100 mm
- 150 mm
- 200 mm
- 250 mm
- 300 mm
- 350 mm
- 400 mm



THIS is CROSSFIELD EST 1907

Figure 7-1 – Existing Water Infrastructure

Date: 7/20/2020
Projection: NAD 1983 CSRS 3TM 114
Scale: 1:10,000
Author: ainglis
Last Modified By: ainglis
Checked By:
Revision #:

0 50 100 200 300 400
Metres

Allnorth

Path: E:\18CG0083 - Crossfield - Water Master Plan - Server\2400-GIS\2420-MXD\Crossfield - Water Master Plan.aprx

7.1.2 Pump Station & Reservoir

The Town of Crossfield water distribution pump station consists of three 50 HP pumps (normal supply, 40 L/s each), and three 150 HP pumps (fire flow supply, 135 L/s each), which draw water from the adjacent reservoir, and discharge to a common header feeding the distribution pipe network. The current design flow for this pump station is 400 L/s, which is obtained when the three 150 HP pumps are active, and the three 50 HP are inactive, but provide redundancy capacity. The pumps are vertical turbine type. The pumps are manufactured by Goulds Pumps, model 9TLC (50 HP) and 12FDLC (150 HP), with nameplate total dynamic head (TDH) of 550 kPa (56.1 metres of head, 79.7 psi).

The pump curves for each pump size were entered into the model, and are included in **Appendix B**. The reservoir minimum water level (elevation) is 1100.30 m, and the pump discharge elevation is 1106.15 m, as specified by the pump station construction drawings. These values were used to specify the reservoir outlet elevation and the pump discharge elevation respectively. The pump discharge pressure was set at 565 kPa (82 psi), which is the current discharge pressure per the pump station SCADA records.

7.1.3 Source Water Supply

The Town of Crossfield water supply is obtained from the Mountain View Regional Water Services Commission (MVRWSC), which also supplies water to the Towns of Innisfail, Bowden, Olds, Didsbury, and Carstairs. Raw water is obtained from the Red Deer River, and treated at the Anthony Henday Water Treatment Plant (AHWTP), located near Innisfail. The current design maximum for the MVRWSC water supply infrastructure is 27,400 m^3/d. From the AHWTP, there is a dedicated transmission line to the Midline Pump Station and Reservoir in Olds. From the Midline Pump Station, there is a 400 mm diameter transmission main to Didsbury, followed by a 250 mm transmission main from Didsbury via Carstairs to Crossfield. To accommodate future development, a second transmission main of 400 mm twinning the original main from Didsbury to Crossfield was approved in 2017. **Figure 7-2** illustrates the MVRWSC water supply infrastructure.

The current MVRWSC water diversion license was obtained in 2010, and brings the total annual diversion to 10,658,600 m^3/yr (29,200 m^3/d). This licensed amount is intended to supply all six communities, including Crossfield, although there is no set amount allocated to each community. Currently, the MVRWSC supplies water to a population of approximately 30,000, for a total of approximately 11,500 m^3/d, which is 2.5 times less than the licenced source water supply.

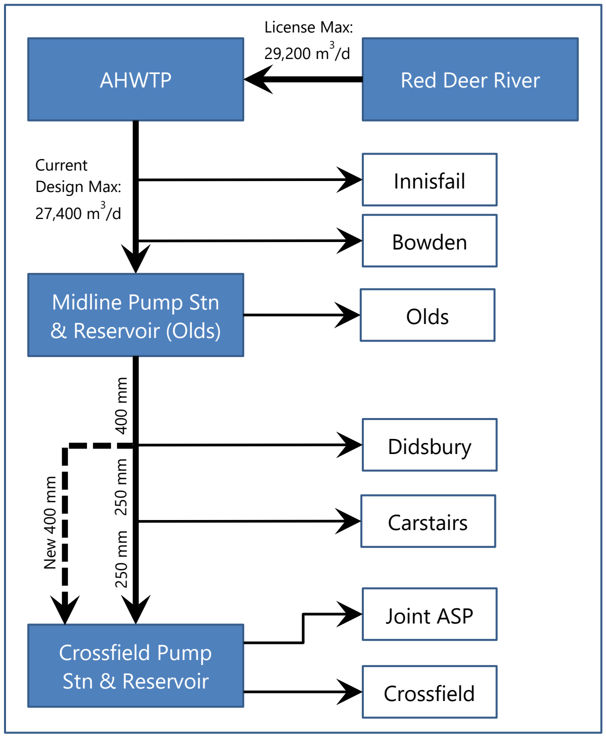


Figure 7-2 - MVRWSC Source Water Supply Flow Diagram

7.2 Water Demands

The water demands for the existing town areas were calculated using the Population/Land Use method of LoadBuilder utility within WaterCAD, which assigns water demands to the nearest network node. Water demands were specified using the Town Land Use Map shapefile (ESRI .shp), with demands assigned to each land use area per the assumptions summarized in **Table 5-1** Error! Reference source not found..

Fire flow demands were assigned to nodes at the location of each hydrant such that the fire flows specified in **Table 3-3** and **Table 5-6** were available for all existing serviced areas. Based on the hydrant flow test data, in locations where the required fire flow exceeds 5,000 L/min, it may be necessary to utilize more than one hydrant to meet the fire flow requirements. This is due to the inherent flow restriction of the hydrants and their connectors.

7.3 Model Calibration

The model performance was analyzed using hydrant flow testing data provided by the Town. The data included static pressure, dynamic pressure, and flow rate for the majority of hydrants. The time for testing was not recorded during the hydrant tests and including information for which hydrants were tested individually and which simultaneously.

The model as it exists performs fairly well compared to pressure test data. Comparison of the measured static pressure to the modelled static pressure showed that on average, the modelled pressures were 4% lower than the measured pressure, with 86% of hydrants having a modelled pressure within 10% of the measured static pressure.

Hydrant test data for available fire flow matches the model well in general, with 88% of hydrants supplying 80% or more of the modelled hydrant flow availability. This is expected, and consistent with the losses associated with the hydrant nozzle restriction and its elevation above the water main.

The current state of model calibration is sufficient for master planning purposes but should not be used as an operational level tool (e.g. for operating pump stations). Further data collection and testing conforming to AWWA Manual M17 (AWWA, 2006) would be required to increase the level of calibration during high demand periods.

Calibration was not performed as the hydrant test data did not conform to AWWA-M17 - Installation, Field Testing, and Maintenance of Fire Hydrants guidelines.

Allnorth recommends further investigation to confirm whether the Town fire-fighting equipment and spacing of hydrants provides adequate coverage and flow.

7.4 Existing System Performance

The following sections assess the performance of the existing water system for each of the design cases. Model results and figures are included in **Appendix D**.

7.4.1 Peak Hourly Demand (PHD)

Under normal flow conditions, the peak hourly demand model indicates that the existing water system meets the performance criteria as follows:

- **Normal Pressure Range**: The full existing network meets the normal pressure range of 350 kPa to 550 kPa.
- **Maximum Pressure**: The majority of the existing network meets the maximum pressure guideline of 550 kPa, with some areas of Laut Avenue and the McCool industrial area having elevated pressures up to 627 kPa. For future developments, these increased pressures would warrant either pressure reducing valves or individual lot testing/protection. However, given that much of areas are already developed, it is assumed that existing plumbing is adequate for the increased pressure. For any future development on Laut Avenue or within the existing industrial zones, Allnorth recommends notifying the developer of the elevated pressures, so that on-site plumbing may be designed accordingly.
- **Maximum Velocity**: The full existing network is operating below the maximum allowable main line velocity of 3.0 m/s. Maximum pipe velocities can also be a major concern in a water distribution system. High pipe velocities can lead to high head loss conditions and possibly transient flow (water hammer) concerns, potentially causing damage to the water system (AWWA, 2012). Because of this typical pipe velocities are limited to 3 m/s with exception during fire flows at the hydrant where the velocities may reach 5 m/s.

7.4.2 Maximum Daily Demand plus Fire Flow (MDD+FF)

In this analysis, the required fire flow was assigned to the demand nodes instead of the existing fire hydrants. Under normal practical case, a combination of hydrants are used for fire flow fighting and the guideline for hydrants spacing of 150 m is instituted for that purpose. Therefore, the premise is if the demand nodes meets or fail to meet the fire flow requirement, the surrounding combination of fire hydrants will be able or not able to deliver the fire flow.

The maximum daily demand plus fire flow case shows the modelled fire flow performance of the existing town water system. These model results are presented in **Figure 7-3** and **Table 7-1**, with hydrant locations colour coded by performance as follows:

- **Blue (pass with one hydrant utilized):** Hydrant flow test data exceeds the required fire flow (shown in blue)
- **Yellow (pass with two or more hydrants utilized):** Hydrant flow test data does not meet the required fire flow, but the local water network is able to supply sufficient flow (shown in yellow). For land uses other than single family residential, this is the expected condition, since a typical hydrant under normal conditions has a maximum supply between 5,000 L/min and 6,500 L/min. For municipal and multi-family land uses, (7,000-7,500 L/min), it may be possible to obtain sufficient flow from a single hydrant may be obtained using methods such utilizing the 4.5" and one or both 2.5" connections at the same time. For commercial and industrial land uses (12,000-16,000 L/min), multiple hydrants or special high flow hydrants will be required in all cases.
- **Red (fail – cannot supply required flow even with multiple hydrants utilized):** For these hydrants, an upgrade will be required for the existing water network.

The model results show that under fire flow conditions, the existing system cannot supply the fire flow requirements at many fire hydrant locations. This is due to insufficient flow availability from the water mains in near the hydrant, and therefore cannot be solved by utilizing multiple nearby hydrants. The areas especially affected are downtown Crossfield, as well as the northern and southern areas furthest from the pump station. See **Section 7.4.3** for a summary of underperforming hydrants and recommended upgrades.

For fire flow storage, the current reservoir volume is 5,400 m^3, which meets the required volume of 4,710 m^3 for the existing system (see **Section 10**).

7.4.3 Recommended Upgrades

The existing town system performs adequately under normal flow conditions, but has several deficiencies relating to the provision of fire flow. These deficiencies are caused by bottlenecks in the water main network, and must therefore be corrected by upgrading the affected mains. **Table 7-1** lists the deficient hydrant locations and Allnorth's recommendations to correct the deficiencies. Illustrative figures are also provided, with **Figure 7-3** showing existing hydrant and network performance, and **Figure 7-4** showing proposed upgrades.

Table 7-1 includes all existing underperforming hydrant locations, grouped by the upgrade required to address the deficiency. The "Local Network Available Fire Flows" section indicates the fire flow requirement for each hydrant location, as well as the available fire flow from the existing system, after the Railway Street Upgrade in 2020, after the proposed upgrade, and after all proposed upgrades. Yellow highlight indicates underperformance relative to the required fire flow.

The majority of underperforming hydrant locations are corrected by the upgrade of the Railway Street water main to 350 mm diameter, which the Town has planned for construction in 2020. The following six upgrades are concentrated in the downtown area, each targeting one or two hydrant locations through the upgrade of a local undersized water main. Allnorth recommends that the town upgrade each of these sections of water main as soon as practical.

Of the six proposed downtown upgrades, the Osler Ave upgrade will have the most impact in supporting future development in the north and northwest of town, as there is currently no adequately sized link between Railway Street and the existing 300 mm water main from Murdoch Street to Vista Drive.

The final upgrade consists of a new 400 mm water main from the east end of the existing 400 mm main (~200 m east of the existing pump station), west along Laut Avenue to McCool Street, and then south to the future tie-in with the Joint ASP, approximately 250 m south of Laut Avenue. In conjunction with the other proposed upgrades, this upgrade will resolve the fire flow deficiencies for nine hydrants, and will greatly improve (but not fully resolve) the deficiencies of a further eight hydrant locations (Town Hydrant IDs 57, 61, 62, 63, 64, 65 & 85). For these eight hydrant locations, all of which are in the McCool industrial area, there are two options – either extend the upsize of the water main further south along McCool Street, or evaluate whether the available fire flow is adequate for the existing properties. Allnorth recommends the latter, as an evaluation is likely to be more cost effective, and the available fire flow is close to the required flow (85% of required flow for the lowest performing hydrant out of the eight).

A preliminary review of the existing town hydrant distribution was also conducted. Several areas were identified which do not meet the spacing recommendations in Water Supply for Public Protection (Fire Underwriters Survey, 1999). Allnorth recommends a detailed review of hydrant spacing to determine where additional hydrants need to be installed.

Table 7-1 – Underperforming Demand Nodes (Hydrant Locations) and Recommended Upgrades

Upgrade Location	Pipe Diameter (mm) & Material		Approx. Length (m)	Affected Hydrant Locations			Local Network Available Fire Flows (L/min)[4]				
	Old	New		Town ID	Model ID	Land Use [2]	Required	Existing (2018)	Railway St Upgrade	This Upgrade	All Upgrades
Railway St, from Laut Ave to Limit Ave (planned for 2020)	150 AC, 200 & 250 PVC	350 PVC	1089	44	H-EX-027	Commercial	12,000	11,287	14,143	14,143	16,500
				41	H-EX-030	Commercial	12,000	10,265	12,730	12,730	15,710
				26	H-EX-031	Commercial	12,000	9,648	13,564	13,564	16,500
				27	H-EX-032	Commercial	12,000	9,551	12,578	12,578	15,742
				72	H-EX-037	MF Residential	7,500	6,870	10,201	10,201	13,710
				73	H-EX-038	MF Residential	7,500	6,862	10,087	10,087	13,739
				81	H-EX-048	Commercial	12,000	8,332	12,829	12,829	16,500
				82	H-EX-049	Commercial	12,000	8,761	12,554	12,554	15,637
				25	H-EX-050	Commercial	12,000	7,729	13,505	13,505	16,500
				24	H-EX-058	Commercial	12,000	7,159	13,261	13,261	16,500
				38	H-EX-060	Institutional	7,000	6,112	8,317	8,317	16,500
				21	H-EX-062	Commercial	12,000	6,501	13,028	13,028	16,500
				79	H-EX-063	Commercial	12,000	6,381	13,021	13,021	16,500
				4	H-EX-070	Institutional	7,000	5,683	7,729	7,729	9,235
				1	H-EX-073	Institutional	7,000	5,991	8,601	8,601	10,279
				28	H-EX-074	Institutional	7,000	6,260	9,663	9,663	12,941
				13	H-EX-078	MF Residential	7,500	5,906	7,794	7,794	9,166
				12	H-EX-080	Institutional	7,000	6,236	8,983	8,983	11,407
				19	H-EX-081	Institutional	7,000	6,380	9,931	9,931	12,337
				18	H-EX-082	MF Residential	7,500	6,412	9,873	9,873	12,200
				74	H-EX-090	Institutional	7,000	6,861	10,407	10,407	14,534
				New#7	H-VC1-006	MF Residential	7,500	6,827	9,542	9,542	13,007
Osler Ave[1]	150 & 200 PVC	300 PVC	749	23	H-EX-086	Commercial	12,000	6,875	11,229	12,926	16,500
				29	H-EX-059	Commercial	12,000	6,805	10,402	12,714	16,500
Crossfield Estates[1]	100 AC, 150 PVC	200 PVC	164	83	H-EX-055	MF Residential	7,500	2,784	2,990	8,778	10,239
				37	H-EX-056	MF Residential	7,500	3,104	3,373	10,457	12,519
Strathcona St[1]	150 AC	200 PVC	319	17	H-EX-084	MF Residential	7,500	4,172	4,911	7,661	9,701
Chisholm Ave[1]	150 PVC	250 PVC	160	22	H-EX-061	Commercial	12,000	5,044	6,693	12,274	14,589
Nanton Ave[1] from R'way St to Munson St	100 AC	200 PVC	337	?	H-EX-051	Commercial	12,000	3,936	4,334	12,895	16,500
Elevator Rd[1]	150 AC	250 PVC	394	23	H-EX-086	Commercial	12,000	6,263	9,141	14,430	16,500
				29	H-EX-059	Commercial	12,000	4,243	5,139	12,163	13,971
Laut Ave[1] from existing 400 mm main near Pump Station to Joint ASP	250 PVC	400 PVC	956	34	H-EX-033	MF Residential	7,500	6,057	7,055	7,625	7,795
				55	H-EX-014	Industrial	16,000	14,850	14,850	16,500	16,500
				20	H-EX-083	Commercial	12,000	6,579	10,414	12,355	12,781
				60	H-EX-005	Industrial	16,000	13,990	13,990	14,843	16,093
				58	H-EX-011	Industrial	16,000	13,396	13,396	14,493	16,313
				56	H-EX-013	Industrial	16,000	13,946	13,946	15,327	16,500
				59	H-EX-006	Industrial	16,000	13,689	13,689	14,980	16,410
				63	H-EX-002	Industrial	16,000	12,509	12,509	13,195	14,159
				62	H-EX-003	Industrial	16,000	12,990	12,990	13,705	14,721
				61	H-EX-004	Industrial	16,000	13,441	13,441	14,202	15,296
				66	H-EX-007	Industrial	16,000	12,813	12,813	13,673	14,945
				85	H-EX-008	Industrial	16,000	12,303	12,303	13,065	14,153
				65	H-EX-009	Industrial	16,000	12,113	12,113	12,824	13,820
				64	H-EX-010	Industrial	16,000	12,018	12,018	12,690	13,620
				57	H-EX-012	Industrial	16,000	12,256	12,256	13,135	14,507

Notes:
1. Assumed planned 2020 Railway St Upsize has occurred prior to this upgrade.
2. Abbreviations: SF = Single Family, MF = Multi-family
3. Highlighted cells indicate underperformance at the location of this hydrant relative to the required fire flow.
4. Available fire flows in this table are determined as the available flow from the water network at the location of each hydrant. Two or more hydrants may be required to supply this flow due to the inherent hydrant flow restriction (see Section 7.4.2).

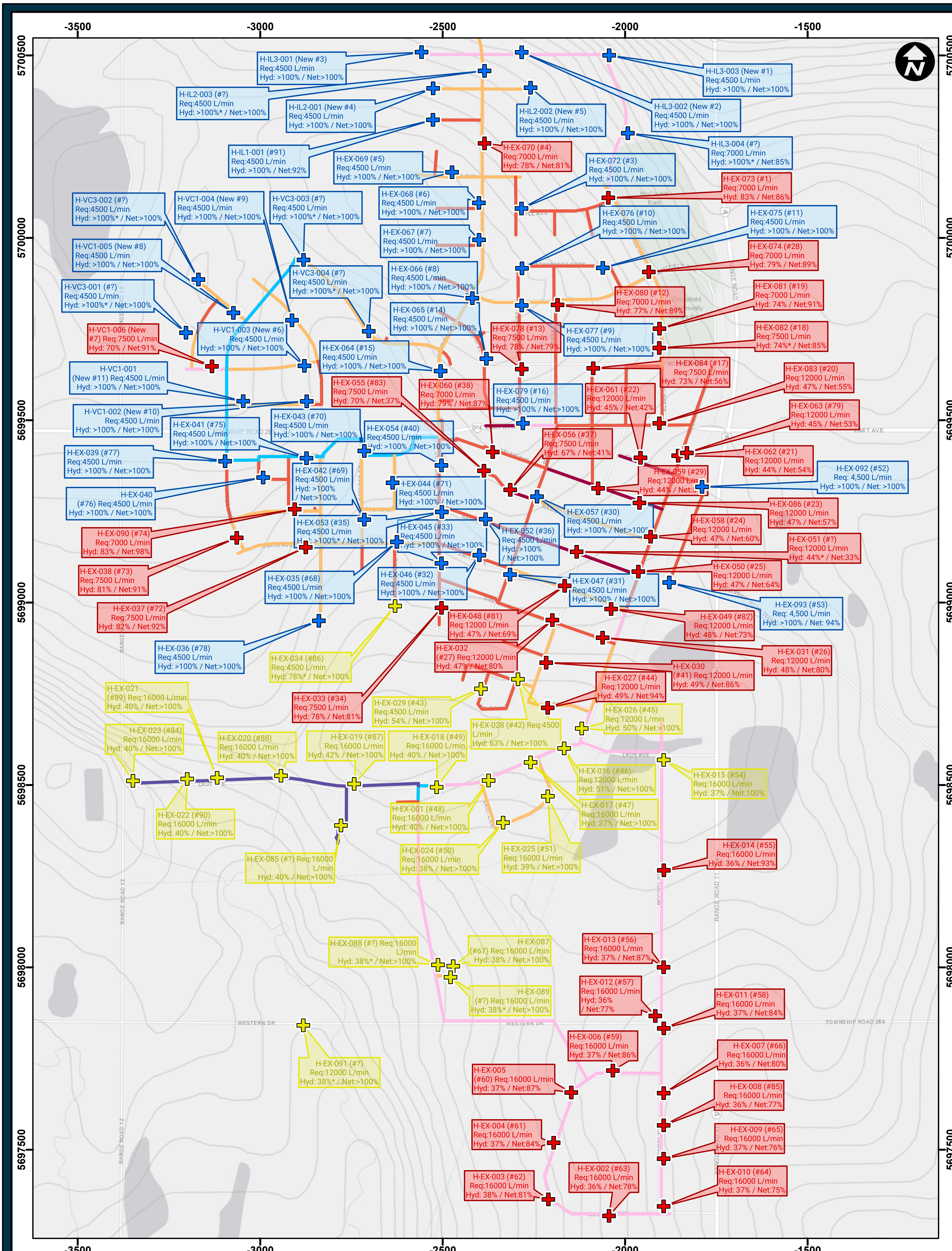


Figure 7-3 – Existing Town Fire Flow Performance for Demand Nodes

Water Pipe

Diameter

- 100 mm
- 150 mm
- 200 mm
- 250 mm
- 300 mm
- 350 mm
- 400 mm

- Pass (single hydrant)
- Pass (2+ hydrants required)
- Fail (network unable to supply required flow)
- Town Boundary

Label Legend

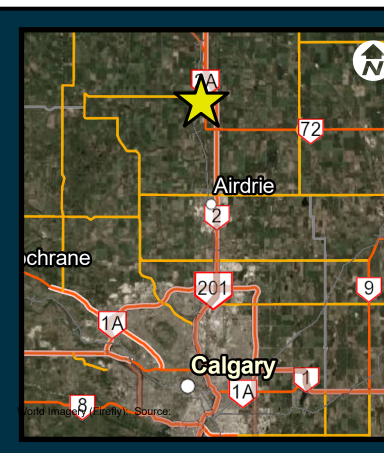
H-EX-001 (#48)	:	Hydrant Model ID (Hydrant Town ID)
Req: 16,000 L/min	:	Required fire flow at hydrant location
Hyd: 50%	:	Hydrant test flow (2018 data, single hydrant)
Net: >100%	:	Network fire flow for 1+ hydrants (as % of required fire flow)

Notes:

- An asterisk (*) indicates hydrant test data unavailable or hydrant not yet constructed – available hydrant flow estimated using nearby hydrants.
- A typical hydrant under normal conditions has a maximum supply between 5,000 L/min and 6,500 L/min. For municipal and multi-family land uses, (7,000-7,500 L/min), it may be possible to obtain sufficient flow from a single hydrant may be obtained using methods such utilizing the 4.5" and one or both 2.5" connections at the same time. For commercial and industrial land uses (12,000-16,000 L/min), multiple hydrants or special high flow hydrants will be required in all cases.

Date: 7/20/2020
Projection: NAD 1983 CSRS 3TM 114
Scale: 1:10,000
Author: ainglis
Last Modified By: ainglis
Checked By:
Revision #:

0 50 100 200 300 400
Metres



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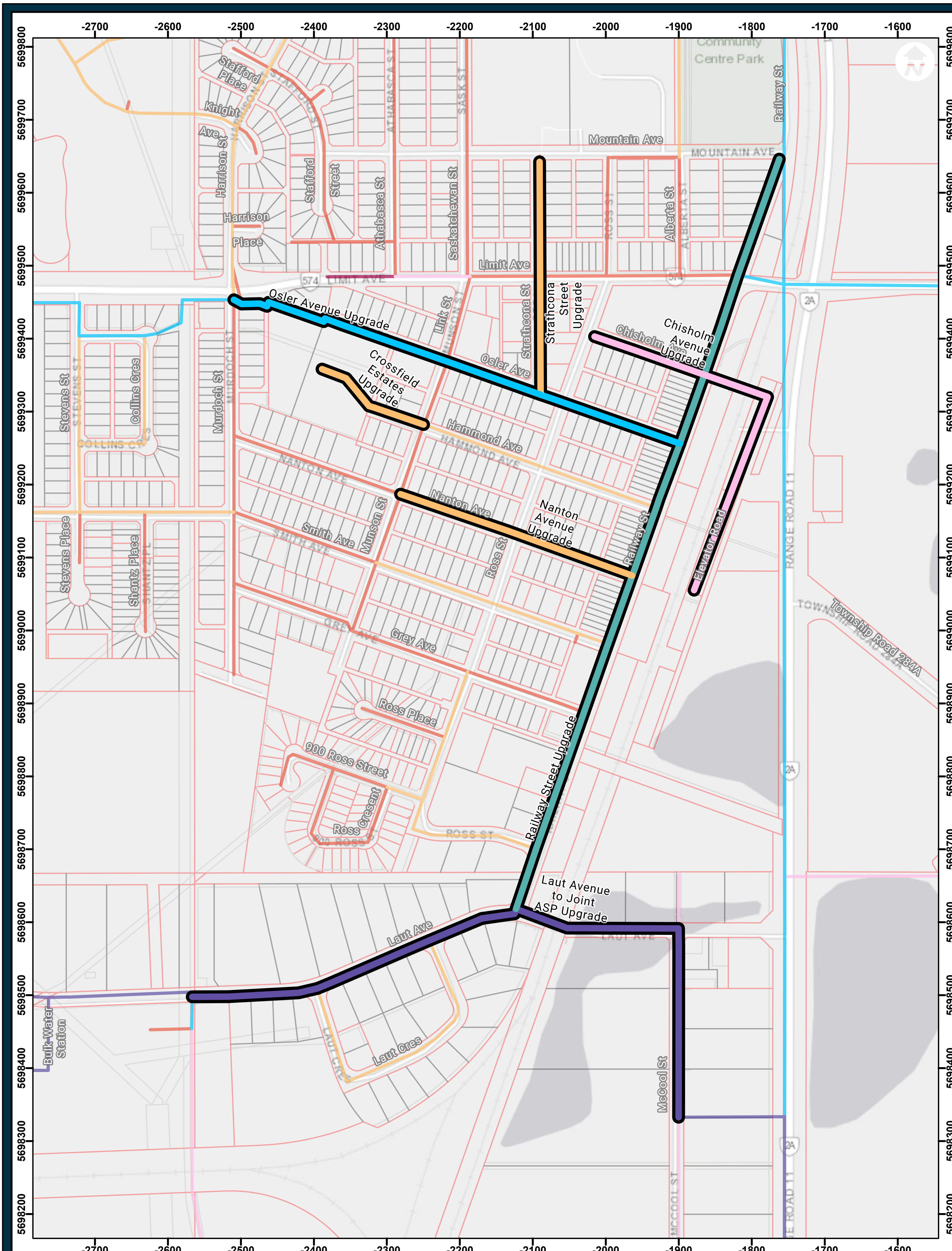

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Figure 7-4 – Proposed Fire Flow Upgrades for Existing Town

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Revision #:

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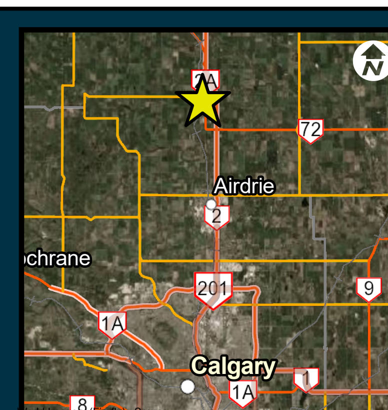
Metres

Pipe Upgrade Diameter	Existing Water Pipe Diameter
200 mm	100 mm
250 mm	150 mm
300 mm	200 mm
350 mm	250 mm
400 mm	300 mm
	350 mm
	400 mm



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8 SERVICING UPCOMING DEVELOPMENTS

The Town of Crossfield has approved three ASPs (Vista Crossing, Iron Landing, and Hawk's Landing), all of which are currently in development or expected to begin development in the near future. Detailed description of each ASP, including land use, phasing, and population estimates, is provided in **Section 3.2**.

In order to manage the servicing of these ASPs, the servicing needs of each ASP must be assessed in context with the needs of the other ASPs and the existing town servicing requirements. The objectives of this assessment are as follows:

- Addition of three developer-proposed ASP water servicing concepts to town water model, including piping, hydrants, and demands based on ASP population estimate and land use mapping
- Identification of required fire flow for each new ASP hydrant based on land use
- Evaluation of each ASP water servicing concept as compared to town water servicing performance criteria (see **Section 5.2**)
- Identification of any deficiencies within the ASP servicing strategies, including required modifications to meet the performance requirements
- Identification of any required upgrades to the existing water infrastructure to support upcoming ASPs

Water network and demands have been modelled based on the following:

- ASP documents and preliminary servicing designs as provided by each developer
- Population and land use assumptions as presented in **Section 3.2**
- Unit water demands for future developments as presented in **Table 5-1**Error! Reference source not found.
- Fire flow demands based on proposed hydrant locations (where available), minimum hydrant spacing (where specific hydrant locations were not provided), proposed land use, and fire flow requirements (see **Table 5-6**)
- The planned 2020 Railway Street upgrade to a 350 mm diameter water main is in place

The three servicing concepts are illustrated in **Figure 8-1**.

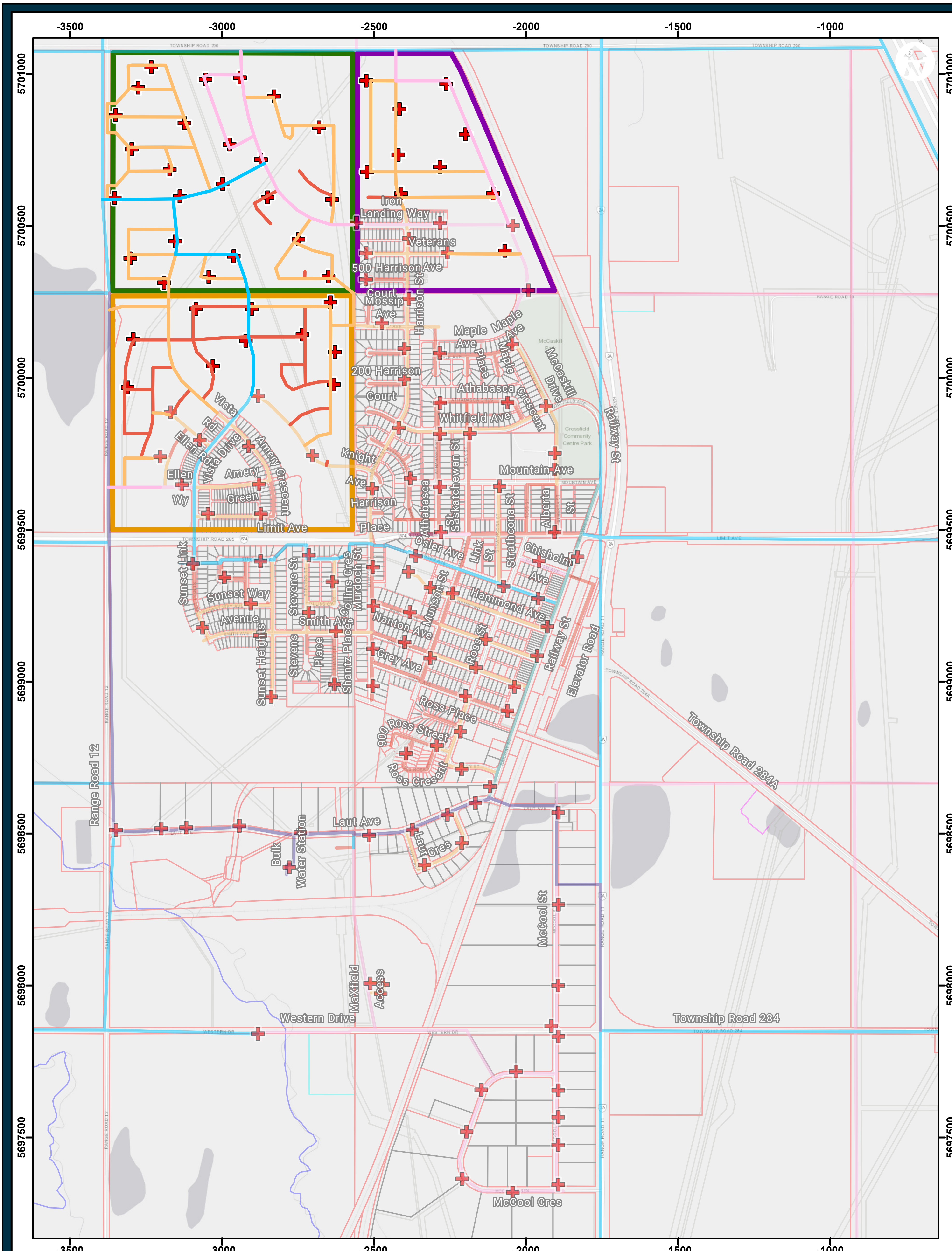

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Figure 8-1 - Upcoming ASPs Water Servicing Concepts

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Projection: NAD 1983 CSRS 3TM 114
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Author: ainglis
Last Modified By: ainglis
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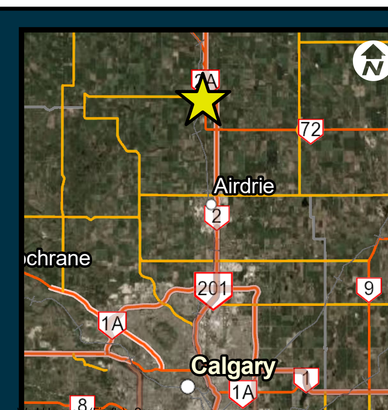
Revision #:

0 50 100 200 300 400 500
Metres

ASP Water Pipe Diameter (mm)	Existing Water Pipe Diameter (mm)	
150 mm	100 mm	Existing Hydrant
200 mm	150 mm	ASP Hydrant
250 mm	200 mm	Hawk's Landing
300 mm	250 mm	Iron Landing
	300 mm	Vista Crossing
	350 mm	Town Boundary
	400 mm	



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8.1 Vista Crossing

8.1.1 Servicing Strategy Overview

The proposed water servicing strategy for Vista Crossing is presented in the Vista Crossing ASP (Bylaw 2015-07), with additional details supplied in the Vista Crossing 2017 Servicing Strategy Rev 2 (Exp, 2017) and the Vista Crossing Phase 4 2018 Servicing Strategy Rev 1 (Exp, 2018). This strategy includes water network layout, pipe sizing, hydrant locations, and tie-in locations.

The preliminary water servicing layout includes three connections to the existing town water network. The first connection is a 300 mm connection at the intersection of Sunset Link and Highway 574 (Limit Avenue) from the south. This connection has been constructed and currently services Vista Crossing Phases 1 and 3. At build-out, this 300 mm water main will extend through the Vista Crossing ASP and connect to the future Hawk's Landing ASP in the north, and will serve as both the backbone of the water network for Vista Crossing, and one of the major servicing connections for Hawk's Landing. The design also includes a secondary 200 mm diameter northern connection to Hawk's Landing.

The second and third connections to the existing town are both 200mm diameter, and connect on the east boundary via Knight Avenue and Mossip Avenue. There are a further two water connections proposed to accommodate future adjacent developments to the west (250 mm and 200 mm). The remainder of the ASP is serviced by a network of 200 mm and 150 mm water mains, and is adequately looped for supply redundancy.

8.1.2 Performance Assessment

The model results indicate that for both normal flow (PHD model) and fire flow (MDD+FF model), the proposed Vista Crossing ASP water servicing design should meet all performance criteria with no further upgrades to the existing town water infrastructure beyond the planned 2020 Railway Street water main upgrade. Model results and figures are included in **Appendix D**.

8.2 Iron Landing

8.2.1 Servicing Strategy Overview

The Iron Landing ASP has been approved for the full development, which includes the conceptual water servicing plan. Phases 1, 2 and 3 are built out, and the model utilizes the record drawings for these areas. For the remainder of the ASP, there is no detailed servicing strategy. The ASP itself does provide a water network layout, but does not include hydrant locations or water main sizing. Hydrant locations have been assumed based on City of Calgary minimum hydrant spacing requirements. Water main sizing has been assumed based on the design of the previous phases, the proposed servicing design for the adjacent ASP of Hawk's Landing, and the demand requirements summarized in **Section 3.2.2**.

The assumed network design consists of a major system of 250 mm water mains, matching the connection sizing at Hawk's Landing in the west, and the existing Town in the South, as well as providing a 250 mm connection to future developments in the north. The majority of the remaining water network for Iron Landing has been assumed to be 200 mm diameter, with the exception of two cul-de-sacs, which are serviced by 150 mm diameter water mains. The ASP water network layout is adequately looped for supply redundancy.

8.2.2 Performance Assessment

The model results indicate that for normal flow (PHD model), the proposed Iron Landing ASP water servicing design should meet all performance criteria, with the exception of maximum static pressure. Due to low elevation, the east and northeast areas of the ASP have high static pressure, up to 620 kPa (compared to the design maximum of 550 kPa). As a result, pressure reducing valves may be required to maintain static pressure within an acceptable range. Allnorth recommends that at the time of development of the remainder of Iron Landing, the proposed water serving design undergoes detailed review using the town water model, to determine whether pressure reducing valves are required.

For the fire flow requirements (MDD+FF model), there is one deficient demand node (hydrant location), which is servicing the proposed commercial/mixed use zone in the north of the ASP. All other land use zones should have adequate fire flow servicing with no further upgrades to existing water system.

With the 2020 Railway Street upgrade in place, the deficient demand node is estimated to have ~7,600 L/min available, compared to the design criterion of 12,000 L/min. With the Osler Avenue upgrade also in place, the available fire flow at this location increases to ~9,000 L/min. With the upgrade of Laut Avenue upgrade in place in addition to Railway Street and Osler Avenue, the available fire flow further increases to ~11,200 L/min. Increasing the sizing of the servicing design within Iron Landing has minimal effect on available fire flow for this hydrant. Any further upgrades to the existing town water network would not be economically viable, due to the length of water main affected.

Based on the above findings, Allnorth recommends that a detailed fire flow assessment is conducted during preliminary approvals for the development of the commercial/mixed use zone of Iron Landing. This assessment should include specific fire flow calculations for the proposed buildings and site layout, to ensure that the fire flow available at the time of development is adequate for the proposed design.

Model results and figures are included in **Appendix D**.

8.3 Hawk's Landing

8.3.1 Servicing Strategy Overview

The proposed water servicing strategy for Vista Crossing is presented in the Hawk's Landing ASP (Bylaw 2016-12), with additional details supplied in the Proposed Water Distribution Layout Plan (2016). This strategy includes water network layout, pipe sizing, hydrant locations, and tie-in locations.

The preliminary water servicing layout includes one connection to the existing town water network, which is a 200 mm diameter connection to Mossip Avenue in the south-east corner of the ASP. The primary servicing connections will be via the Iron Landing (one 250 mm connection) and Vista Crossing (one 300 mm and one 200 mm connection) as discussed in previous sections. The major mains within Hawk's Landing consist of a 300 mm main running north from the Vista Crossing connection to a tee with a second 300 mm main, which runs from a future connection on the western boundary of the ASP in an approximately east-west orientation. This 300 mm main connects to the east with a 250 mm main, running from the Iron Landing connection to a future northern boundary connection.

The majority of the remaining water network for Hawk's Landing is 200 mm diameter, with the exception of three cul-de-sacs, which are serviced by 150 mm diameter water mains. The ASP water network layout is adequately looped for supply redundancy.

8.3.2 Performance Assessment

The model results indicate that for normal flow (PHD model), the proposed Hawk's Landing ASP water servicing design should meet all performance criteria. However, due to low elevation, in the north of the ASP, there is a somewhat elevated static pressure, up to 563 kPa (compared to the design maximum of 550 kPa). As a result, pressure reducing valves may be required to maintain static pressure within an acceptable range. As the modelled pressure is within 3% of the design maximum, it may be more cost effective for the developer to ensure the proposed plumbing is designed to handle this pressure. Additionally, the developer could monitor the static pressure of earlier phases of the development to assess whether actual peak pressures are likely to warrant pressure reducing valves.

For the fire flow requirements (MDD+FF model), with the Railway Street upgrade in place, there is one demand node (hydrant location) with major deficiency, which is the node servicing the proposed commercial zone in the north of the ASP. Additionally, there are multiple multi-family land use zone hydrants with minor deficiencies, all of which have an available fire flow within 10% of the required fire flow. All other land use zones should have adequate fire flow servicing with no further upgrades to existing water infrastructure.

With the 2020 Railway Street upgrade in place, the deficient commercial zone demand node is estimated to have ~7,400 L/min available, compared to the design criterion of 12,000 L/min. With the Osler Avenue upgrade also in place, the available fire flow for the commercial zone increases to ~8,800 L/min, and the fire flow available at all other demand nodes meets the performance requirement. With the upgrade of Laut Avenue upgrade in place in addition to Railway Street and Osler Avenue, the available fire flow for the commercial zone demand node also meets the performance requirement.

Based on the above findings, Allnorth recommends that a detailed fire flow assessment is conducted during preliminary approvals for the development of the commercial use zone of Hawk's Landing, if any the Railway Street, Osler Avenue, or Laut Avenue upgrades is not yet in place. This assessment should include specific fire flow calculations for the proposed buildings and site layout, to ensure that the fire flow available at the time of development is adequate for the proposed site design. For the multi-family land use zones, given that the available fire flow is within 10% of the required fire flow, this should be adequate for the temporary case before the Osler Avenue and/or Laut Avenue upgrades are completed.

Model results and figures are included in **Appendix D**.

8.4 Summary of Recommended Upgrades

In order to service the three upcoming ASPs, the following upgrades are recommended:

1. Planned 2020 Railway Street upgrade to 350 mm diameter
2. Osler Avenue Upgrade to 200 mm diameter, prior to commercial development in either Hawk's Landing or Iron Landing, if required by fire flow calculations for a specific site design
3. Laut Avenue Upgrade to 400 mm diameter, prior to commercial development in either Hawk's Landing or Iron Landing, if required by fire flow calculations for a specific site design

See **Section 7.4.3** for details of these upgrades, and **Section 11** for capital cost estimates.

9 ULTIMATE SERVICING CONCEPT

The ultimate water servicing concept is intended to provide a design for the major servicing network, encompassing build-out of all areas to the study horizon. The objectives for this concept are as follows:

- Develop water main layout for major servicing network
- Assess study area topography, identify significant regions of high and low elevation relative to the existing network, and delineate pressure zones
- Prepare model cases for the ultimate servicing concept
- Determine limits of study area which can be serviced by existing Laut Avenue pump station
- Determine limits of study area which can be serviced by upgraded Laut Avenue pump station
- Identify preliminary locations for future pump stations to service remaining study area beyond limits of Laut Avenue pump station
- Identify preliminary locations for pressure reducing valves to prevent overpressure of low elevation areas

Water network and demands have been modelled based on the following:

- City of Calgary major distribution system grid pattern (see **Section 9.1.1**)
- Population and land use assumptions as presented in **Section 3.3**
- Model basis (**Section 6**), including unit water demands for future developments as presented in **Table 5-1**Error! Reference source not found.
- Fire flow demands based on hydrant placement at quarter-section corners, proposed land use, and fire flow requirements (see **Table 5-6**), and assumption that future minor network will be adequately sized to supply similar hydrant flows within each quarter-section

Model results and figures are included in **Appendix D**.

9.1 Design Basis

9.1.1 Major System Layout

For future developments, a preliminary design for the major water servicing network must be assumed in order to analyse the servicing needs of the Town at each stage of development. Where a site servicing plan exists, this plan is used as the basis for analysis. Where no servicing plan exists, the City of Calgary water distribution system grid pattern (City of Calgary, August 2015) is adopted for this study. The City of Calgary grid pattern creates a logical layout of feeder, distribution and service mains. This layout provides many opportunities to loop the system creating redundancy so that service can be maintained in an emergency or during maintenance.

Continuity of main sizes should be maintained throughout the community while also adjusting the main size according to land use. However, for the purposes of evaluating the major network, only the water mains on quarter-section boundaries have been modelled. This allows the model to demonstrate the performance of the major network design without relying on additional capacity and looping provided by the minor water network within each quarter-section.

Although the grid system similar to Calgary is adopted, the remaining constraint will be water source being delivered through a single Transmission main, specifically if failure occurs. Therefore, future upgrades when the total demand for the MVRWSC exceed its design capacity Water supply, additional transmission line should be considered. It is projected that water demand for MVRWSC will exceed the water diversion license by 2034, see **Table 9-1**.

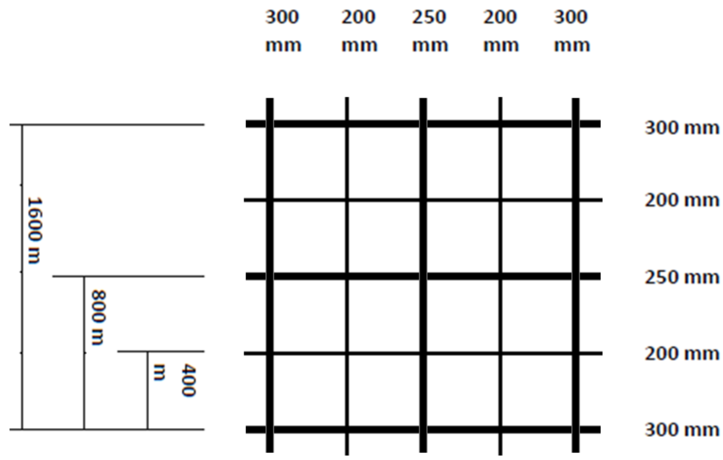

Figure 9-1 – Pipe Grid Pattern Network (*Source City of Calgary*)

9.1.2 Study Area Topography and Pressure Zone Servicing

While the existing town, upcoming ASPs, and majority of the Joint ASP lands are relatively flat, the further extents of the study area cover regions at very high and very low elevation relative to the existing town, as shown in **Figure 9-2**. Areas with similar elevation to the existing town will be serviced by the main pressure zone, Zone 1, having elevations between 1,100 m and 1,118 m.

In the northeast of the study area, the land slopes strongly downward to the north and east, towards Crossfield Creek. Although the slope does not follow quarter-section boundaries, the total area of low elevation covers approximately five quarter-sections, with elevation varying from 1,105 m to 1,069 m. This area will require two low elevation pressure zones due to the large range of elevation, with pressure reducing valves to isolate these zones and prevent overpressure. The first northeast pressure zone, Zone 2, is approximately 3.5 quarter section in area, with elevations between 1,105 m and 1,083 m. Beyond Zone 2, a second set of pressure reducing valves will create Zone 3, servicing the lowest elevations areas. Zone 3 will consist of 1.5 quarter sections, with elevations between 1,083 m and 1,069 m.

In the southeast of the study area, from the southeast region of the Joint ASP extending along the eastern boundary to the southern boundary of the study area, there is an area of high elevation covering approximately seven quarter-sections. This area is less steeply sloped than the low area in the northeast, but is still significantly higher than the existing town. This area will require one high elevation pressure zone, Zone 4, with elevation between 1,118 m and 1,129 m. The proposed Southeast Pump Station & Reservoir will be required to maintain adequate pressure and fire flow for future servicing. The major servicing concept includes a preliminary location for a Southeast Pump Station, as well as pressure reducing valves set at 350 kPa to prevent overpressure of the rest of the network at lower elevation.

In the northwest of the study area, there is a smaller region of high elevation, covering a single quarter-section. The major servicing concept includes a single high elevation pressure zone, Zone 5, and the proposed Northwest Pump Station & Reservoir. Zone 5 will have elevations between 1,120 m and 1,135 m, and will require pressure reducing valves to maintain pressure within this pressure zone and prevent overpressure of the surrounding areas. The Northwest Pump Station & Reservoir will be required to maintain adequate pressure and fire flow for future servicing of both Zone 5and the western annexation lands beyond the limits of the existing Laut Avenue pump station.

9.2 Concept Overview

The ultimate servicing concept is presented in **Figure 9-3**. The distribution network consists of the existing town infrastructure, upcoming ASPs proposed infrastructure, and grid pattern-based major system network described in **Section 9.1.1**.

The water distribution network used for Joint ASP is based on the City of Calgary grid, where 300 mm mains are placed on a 1,600 m grid (i.e. along section lines), with 250 mm mains at 800 m spacing (i.e. along internal quarter-section lines). The Joint ASP water network is proposed to connect to the existing Crossfield network at Limit Avenue (Highway 574), and at a new connection approximately 250 m south of Laut Avenue, on McCool Street.

As with the Joint ASP lands, the proposed water distribution network to service the future annexation areas is based on the City of Calgary grid, with 300 mm mains are placed on a 1,600 m grid and 250 mm mains at 800 m spacing. The future annexation areas are proposed to connect to the existing town water network as follows:

- **North of town** (along Township Road 290): connection(s) to Joint ASP lands (future), one 250 mm connection to the northern boundary of the Iron Landing development, one 250 mm connection to the northern boundary of the Hawk's Landing development.
- **West of town** (along Range Road 12): one 300 mm connection to the western boundary of the Hawk's Landing development, one 200 mm and one 250 mm connection to the western boundary of the Vista Crossing development.
- **South of town**: One 300 mm connection at the intersection of Range Road 12 and Laut Avenue, one 300 mm connection at the golf course entrance on Laut Avenue, connections to the Joint ASP areas (future).

The concept contains three proposed pump stations – the Laut Avenue main pump station (with optional pump upgrade), a new pump station in the northwest, and a further new pump station in the southeast. The supplementary pump stations will be supplied via a local reservoir at each pump station, which fills from main network during off-peak hours.

Water supply will continue to be via the MVRWSC transmission main, discharging into an upgraded reservoir at the main pump station for the near to medium term. In the long term, the total demand for the MVRWSC will exceed its design capacity. At this time, it is expected that a major study will be conducted to secure water supply for further development of all six MVRWSC communities, whether via further MVRWSC upgrades, or supplemented by a new water source.

The Town has indicated a preference for underground reservoirs at the new pump stations, rather than water towers. As such, the following description assumes underground reservoirs. However, water towers would still be a viable alternative.

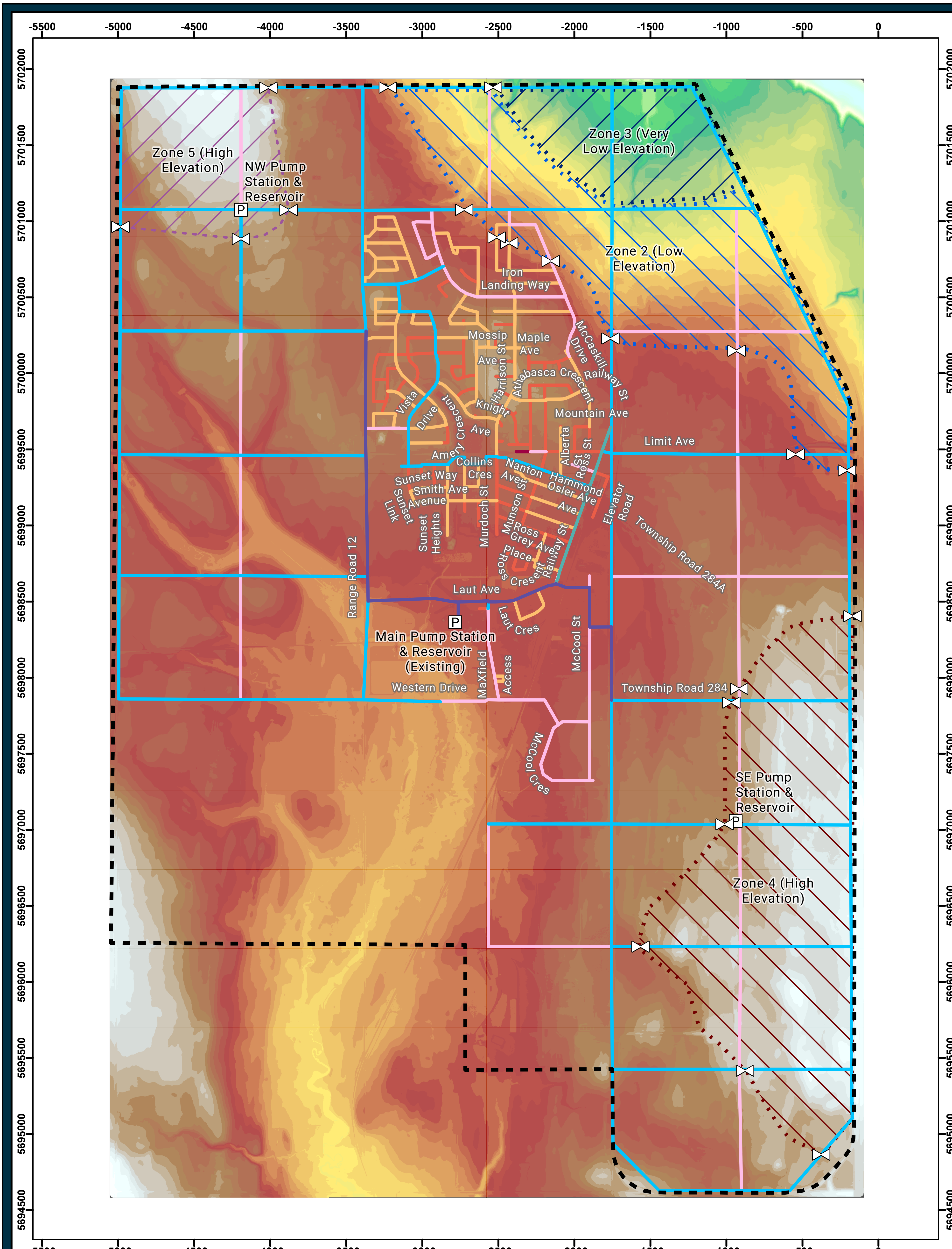

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Figure 9-2 – Ultimate Servicing Pressure Zone Map

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Last Modified By: ainglis
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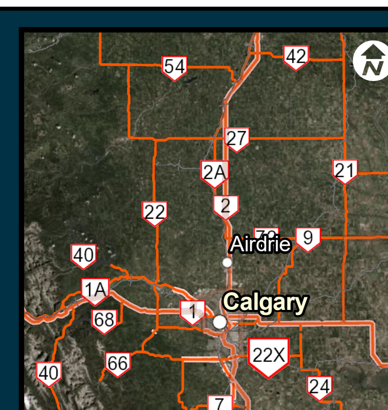
Revision #:

0 100 200 400 600 800 1,000
Metres

Water Pipe

- 100 mm
- 150 mm
- 200 mm
- 250 mm
- 300 mm
- 350 mm
- 400 mm

- Pressure Reducing Valves
- Pump Station & Reservoir
- Proposed Annexation Area
- Zone 2 (Low Elevation: 1083m-1105m)
- Zone 3 (Very Low Elevation: 1069m-1083m)
- Zone 4 (High Elevation: 1118m-1129m)
- Zone 5 (High Elevation: 1120m-1135m)



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9.3 Phasing

The phasing of the ultimate servicing concept is defined by the servicing limits of each pump station, as described in the following sections.

9.3.1 Existing Laut Avenue Pump Station

The existing Laut Avenue pump station has sufficient capacity for build-out of the three upcoming ASPs, the remainder of the Sunset Ridge ASP, and the majority of the Joint ASP. The excluded areas of the Joint ASP are four high elevation quarter-sections in the south and southeast, as shown in **Figure 9-4**. The total area that can be serviced by the existing main pump station is therefore the existing town, the three upcoming ASPs, plus approximately 10 additional quarter-sections.

There is some flexibility in which areas can be serviced by the existing pump station, as long as the total area remains approximately the same, and the alternative developments are both relatively close in distance and of similar elevation to the existing network.

Based on 6% growth, further pump station capacity (whether a pump upgrade or new pump station) will be required in approximately 2040 to 2045 (equivalent population of 19,000-25,000 / residential population of 12,000-15,000).

9.3.2 Upgraded Laut Avenue Pump Station

Upgrades may be required to the Laut Avenue pump station depending on the sequence of development of future lands. For example, should the town wish to service the majority of the Joint ASP (as described in **Section 9.3.2**), as well as new residential areas north and west of the upcoming ASPs, there will be two options to do so. The first option would be to construct the new Northwest Pump Station, which would provide capacity for all lands west and north of the existing town (13 quarter-sections). The second option would be to upgrade the existing pump station pump capacity. This would allow further development of up to six additional quarter-sections prior to the significant investment required for the new Northwest Pump Station.

While the ultimate servicing concept does not strictly require upgrades to the existing pump station, having these upgrades in place may allow the Northwest and/or the Southeast pump station pumps to be of smaller size.

Independent of whether the Laut Avenue Pump Station pump capacity is upgraded, there will be a requirement for the reservoir capacity to be upgraded. These required upgrades are estimated at an additional 4,200 m^3, for a total of 9,600 m^3. These upgrades would likely be constructed in two stages, as two cells of roughly 2,100 m^3 each. Alternatively, the storage capacity at the future Northwest and/or Southeast Pump Stations could be increased.

See **Section 10** for further discussion of storage requirements and staging.

9.3.3 Northwest Pump Station & Reservoir

The proposed Northwest Pump Station & Reservoir has been tentatively positioned at the southeast corner of the northwestern-most quarter-section in the study area. This location was chosen due its central location within the north and west areas to be serviced, and also due to the relatively high elevation. This pump station will meet all performance requirements to service all areas to the west and north of the existing town, within the future annexation boundary, for a total of approximately thirteen quarter-sections.

Model results indicate that this pump station will require approximately one third of the pump capacity of the existing Laut Avenue pump station (approximately one 50 HP pump and one 150 HP pump, plus redundancy as required).

This pump station would also require a new reservoir, which would be filled during off-peak hours via the existing network and main pump station supply. The ultimate capacity of this reservoir is estimated to be approximately 6,000 m^3, although this could be constructed in stages via multiple cells. See **Section 10** for further discussion of storage requirements and staging.

9.3.4 Southeast Pump Station & Reservoir

The proposed Southeast Pump Station & Reservoir has been tentatively positioned on the southeastern corner of the existing town boundary, within the Joint ASP. This location was chosen as the highest elevation location closest to the southern lands to be serviced, which receives adequate supply flow from the existing network. This pump station will meet all performance requirements to service all future annexation areas to the south and east of the existing town, beyond the limits of the Laut Avenue pump station, for a total of approximately nine quarter-sections.

Model results indicate that this pump station will require approximately the same pump capacity as the existing Laut Avenue pump station (approximately two 50 HP pumps and two 150 HP pumps, plus redundancy as required). The relatively high pump capacity compared to the serviced area is due to the high elevation of this area, which requires additional pump head.

This pump station would also require a new reservoir, which would be filled during off-peak hours via the existing network and main pump station supply. The ultimate capacity of this reservoir is estimated to be approximately 6,000 m^3, although this could be constructed in stages via multiple cells. See **Section 10** for further discussion of storage requirements and staging.

9.4 Source Water Supply

At build-out to the study horizon, the water supply required by Crossfield (based on ADD), is estimated to be 23,662 m^3/d. The current design capacity of the MVRWSC is 27,400 m^3/d, and that the current water diversion license is 29,200 m^3/d. At 6% annual population growth the projected water demand for MVRWSC will exceed the water diversion license by 2034. Given that the MVRWSC services five communities in addition to Crossfield, there will therefore need to be significant upgrades to the existing MVRWSC design capacity and a new diversion license, and/or an additional water supply source secured to facilitate build-out to the study horizon. Based on current MVRWSC servicing conditions, the following table provides high level projections for water demand across all MVRWSC communities, along with estimates for the probable window for these upgrades.

Table 9-1 – Source Water Supply Projections for MVRWSC Communities

Year	Projected Population			Projected Water Demand (m³/d)		
	2% Annual Growth	4% Annual Growth	6% Annual Growth	2% Annual Growth	4% Annual Growth	6% Annual Growth
Build-out[1] (~2062)	**71,702**	**168,495**	**389,564**	**27,486**	**64,590**	**149,333**
Existing (2018)	**30,000**	**30,000**	**30,000**	**11,500**	**11,500**	**11,500**
2023	33,122	36,500	40,147	12,697	13,992	15,390
2028	36,569	44,408	53,726	14,019	17,023	20,595
2033	40,375	54,029	71,898	15,478	20,711	27,561
2038	44,577	65,735	96,216	17,089	25,198	36,883
2043	49,217	79,977	128,759	18,868	30,657	49,358
2048	54,340	97,304	172,309	20,832	37,299	66,052
2053	59,996	118,385	230,588	23,000	45,380	88,392
2058	66,240	144,033	308,579	25,394	55,212	118,288
2063	73,134	175,238	412,948	28,037	67,174	158,296
Estimated Year Exceeding MVRWSC Design Capacity:				2062	2041	2033
Estimated Year Exceeding MVRWSC Diversion License:				2066	2042	2034

Notes:
1. Estimated build-out year for Crossfield, for reference.

The current MVRWSC design capacity does not guarantee that the existing transmission mains can supply an adequate share of the water supply to each community as development progresses. At some point between the current demand and the build-out demand at the study horizon, all transmission mains will need to be upgraded, as well as the Midline Pump Station at Olds.

It is anticipated that the first bottleneck in the transmission mains for Crossfield's water supply will occur in the 400 mm single line from the Midline Pump Station to Didsbury, given that the downstream capacity of the transmission main from Didsbury to Crossfield (including twinning) has higher capacity. This bottleneck will occur in this line well in advance of exceeding either the MVRWSC design capacity, or the current water license. Allnorth recommends further investigation to update estimates of current capacity in this line, calculation of remaining capacity based on demand projections for all three communities serviced, and projected timing for future twinning. Projected timing for upgrades of other infrastructure, including the transmission main from the AHWTP to the Midline Pump Station, and the Midline Pump Station and Reservoir, should also be revised based on the findings of this MWSS and equivalent studies for other MVRWSC communities.

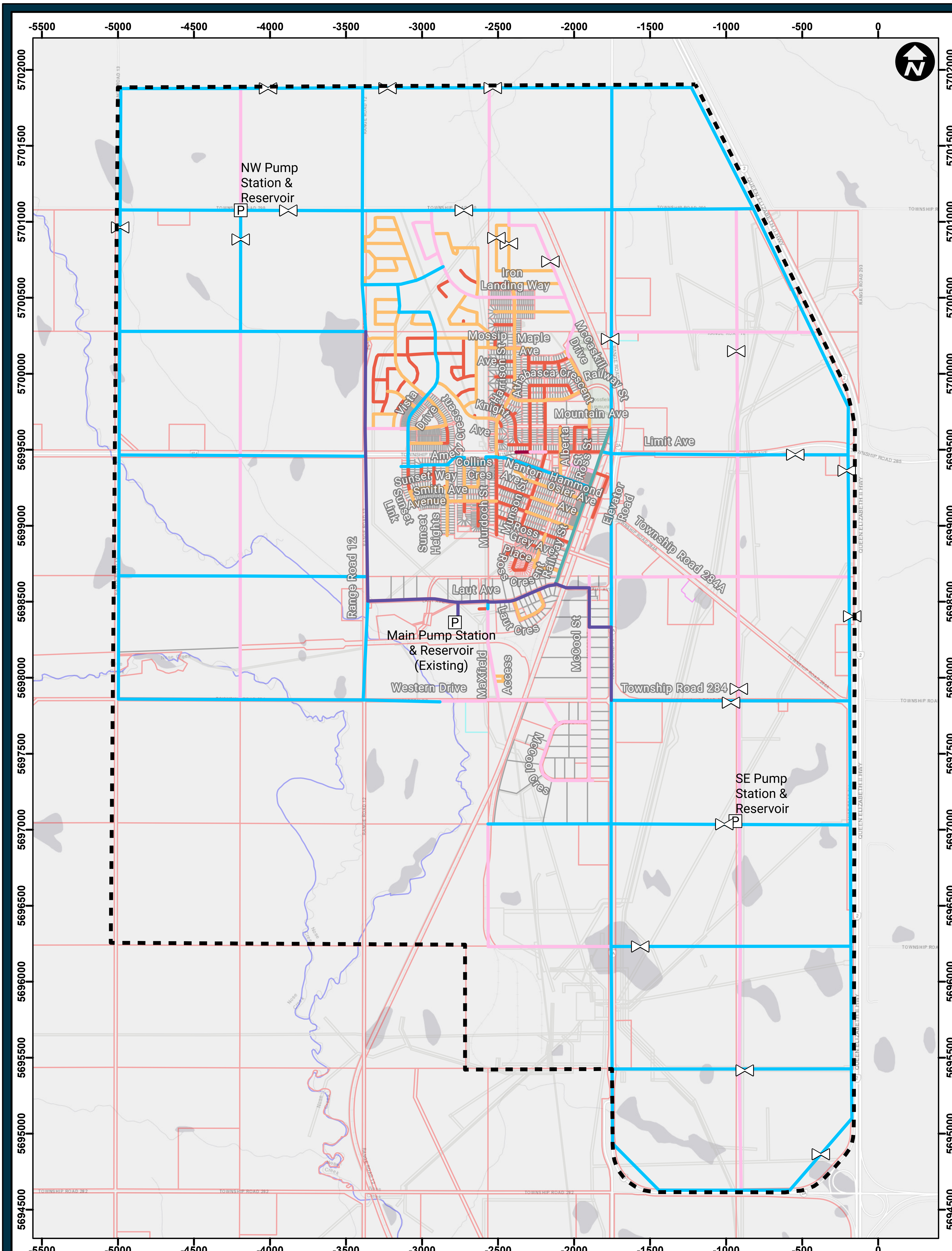


Figure 9-3 – Ultimate Servicing Concept

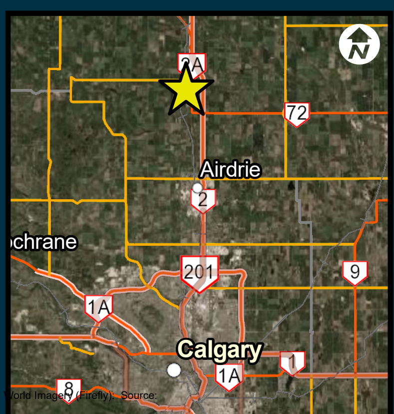
Date: 7/20/2020
Projection: NAD 1983 CSRS 3TM 114
Scale: 1:24,000
Author: ainglis
Last Modified By: ainglis
Checked By:
Revision #:

0 100 200 400 600 800 1,000
Metres

Water Pipe

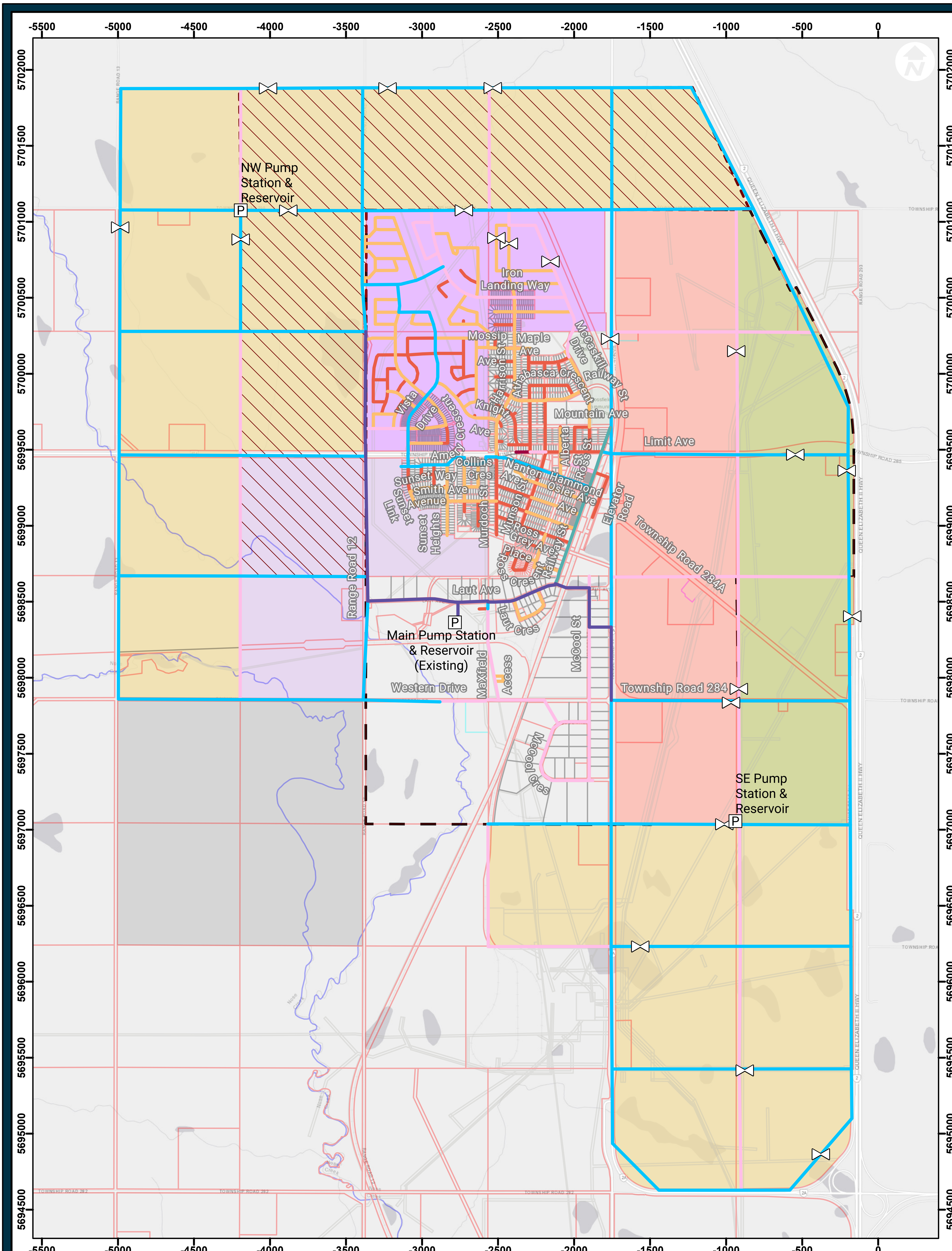
- 100 mm
- 150 mm
- 200 mm
- 250 mm
- 300 mm
- 350 mm
- 400 mm

- Pump Station
- Pressure Reducing Valves
- Proposed Annexation Area



Allnorth

Path: E:\18CG0083 - Crossfield - Water Master Plan - Server\2400-GIS\2420-MXD\Crossfield - Water Master Plan.aprx



Water Pipe
- 100 mm
- 150 mm
- 200 mm
- 250 mm
- 300 mm
- 350 mm
- 400 mm

Pressure Reducing Valves

P Pump Station

Limits of Servicing by Existing Main Pump Station

Limits of Servicing by Upgraded Main Pump Station

Existing Town Boundary Build-Out

Joint ASP - Existing Town Boundary

Joint ASP - Future Annexation

Upcoming ASPs

Future Development (beyond study horizon)

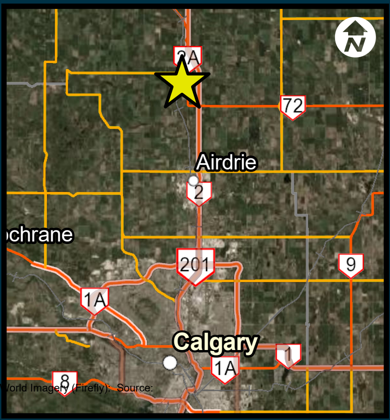
Study Horizon Build-Out

THIS is CROSSFIELD EST 1907

Figure 9-4 – Ultimate Servicing Concept - Phases

Date: 7/20/2020
Projection: NAD 1983 CSRS 3TM 114
Scale: 1:24,000
Author: ainglis
Last Modified By: ainglis
Checked By:
Revision #:

0 100 200 400 600 800 1,000 Metres



Allnorth

Path: E:\18CG0083 - Crossfield - Water Master Plan - Server\2400-GIS\2420-MXD\Crossfield - Water Master Plan.aprx

10 RESERVOIR STORAGE

The current Town of Crossfield reservoir has a total capacity of 5,400 m^3, including clearwell storage and two storage cells. An allowance for future expansion of two additional cells was made during initial design and construction.

The limiting factor for reservoir storage requirements is the provision of fire flow for the land use with the highest fire flow requirements, during maximum daily demand conditions. Alberta Environment recommends the following sizing procedure to determine minimum required reservoir storage:

$S = A + B + C$

Where: S = Total storage requirement, m^3
A = Fire storage, m^3
B = Equalization storage (approx. 25% of design MDD), m^3
C = Emergency storage (minimum of 15% of design ADD), m^3

For the Fire Storage (A), the required storage is based on the land use with the highest fire flow requirement (industrial, at 16,000 L/min fire flow for 3.5 hours). The total Fire Storage (A) is therefore 3,360 m^3.

The below table summarizes the projected reservoir storage requirements at five-yearly intervals based on the average daily demand growth projections presented in **Table 5-5** and fire flow requirements presented in **Table 5-6**. The below table also includes proposed reservoir upgrades to meet these projected storage requirements. See **Section 9.3** for discussion of reservoir locations and associated new pump stations.

Table 10-1 – Projected Reservoir Storage Requirements

Year	Required Storage (m^3)				Proposed Reservoir Upgrades	
	A	B	C	Total (S)	Description	Total Storage (m^3)
Build-out (~2062)	**3,360**	**11,380**	**3,414**	**18,154**	**Existing + two 2,000 m^3 cells + two 6,000 m^3 new reservoirs**	**21,600**
Existing (2018)	**3,360**	**725**	**218**	**4,303**	**Existing**	**5,400**
2023	3,360	1,019	306	4,684	Existing	5,400
2028	3,360	1,411	423	5,195	Existing	5,400
2033	3,360	1,937	581	5,878	Existing + one 2,100 m^3 cell	7,500
2038	3,360	2,640	792	6,792	Existing + one 2,100 m^3 cells	7,500
2043	3,360	3,581	1,074	8,015	Existing + two 2,100 m^3 cells	9,600
2048	3,360	4,840	1,452	9,652	Existing + two 2,100 m^3 cells	9,600
2053	3,360	6,526	1,958	11,843	Existing + two 2,100 m^3 cells + one 6,000 m^3 new reservoir	15,600
2058	3,360	8,781	2,634	14,775	Existing + two 2,100 m^3 cells + one 6,000 m^3 new reservoir	15,600
2063	3,360	11,380	3,414	18,154	Existing + two 2,000 m^3 cells + two 6,000 m^3 new reservoirs	21,600

11 CAPITAL COST ESTIMATES

The following capital cost estimates are provided for planning purposes, with all pricing given in 2019 Canadian Dollars.

11.1 Upgrades to Existing Water Mains

The following upgrades are recommended to correct the hydrant fire flow deficiencies within the existing town, and to support future development. For details of the impact of each project, refer to **Section 7.4.3** (existing town impact) and **Section 8.4** (upcoming ASPs servicing requirements). Note that a cost estimate for the Railway Street water main upgrade has not been included, as this project is already in progress.

All projects in this list are recommended to proceed as soon as practical, as the associated deficiencies are currently causing fire flow deficiencies in the existing town. Additionally, the Osler Ave and Laut Ave upgrades may be required to service the commercial/mixed use areas of Iron Landing and/or Hawk's Landing, depending on the fire flow requirements of the specific design for these areas.

Table 11-1 - Capital Cost Estimates - Upgrades to Existing Water Mains

<table>
<tr><th>Location</th><th>From/To</th><th>New Pipe Diameter (mm) & Material</th><th>Approx. Length (m)</th><th>Estimated Capital Cost</th><th>Estimated Timeline</th></tr>
<tr><td>Osler Ave</td><td>Full Length</td><td>300 PVC</td><td>749</td><td>$1,220,000</td><td rowspan="7"><u>All projects</u>: as soon as practical to correct hydrant deficiencies.
<u>Osler Ave & Laut Ave</u>: as required to service commercial/mixed use zones of upcoming ASPs</td></tr>
<tr><td>Crossfield Estates</td><td>Full Length</td><td>200 PVC</td><td>164</td><td>$260,000</td></tr>
<tr><td>Strathcona St</td><td>Full Length</td><td>200 PVC</td><td>319</td><td>$490,000</td></tr>
<tr><td>Chisholm Ave</td><td>Full Length</td><td>250 PVC</td><td>160</td><td>$250,000</td></tr>
<tr><td>Nanton Ave</td><td>Railway St to Munson St</td><td>200 PVC</td><td>337</td><td>$570,000</td></tr>
<tr><td>Elevator Rd</td><td>Full Length</td><td>250 PVC</td><td>394</td><td>$540,000</td></tr>
<tr><td>Laut Ave to Joint ASP</td><td>~200 m east of pump station to ~250 m south on McCool Street</td><td>400 PVC</td><td>1,300</td><td>$2,040,000</td></tr>
</table>

11.2 Pump Stations and Reservoirs

The following upgrades are part of the ultimate servicing concept, to service development once the capacity of the existing pump station and/or reservoir has been reached.

Table 11-2 - Capital Cost Estimates – Pump Stations & Reservoirs

Location	Project Details	Est. Capital Cost	Estimated Timeline
Existing Pump Station	Pump Upgrade (optional, to delay need for NW Pump Station)	$400,000	2040-2045, or when MDD exceeds 400 L/s design flow of existing pumps
Existing Pump Station	Reservoir extension – 1st additional 2,100 m^3 cell	$2,800,000	2030-2035, or when fire flow storage requirement exceeds existing storage of 5,400 m^3
Existing Pump Station	Reservoir extension – 2nd additional 2,100 m^3 cell	$2,800,000	2040-2045, or when fire flow storage requirement exceeds existing + first cell storage of 7,500 m^3
Proposed NW Pump Station	New Pump Station & Reservoir	$8,400,000	2050+, or as required to service western lands (see **Figure 9-4** for limits of main pump station servicing)
Proposed SE Pump Station	New Pump Station & Reservoir	$9,400,000	2050+, or as required to service south and eastern lands (see **Figure 9-4** for limits of main pump station servicing)

11.3 Future Major Water Mains

The pricing for future water mains is heavily dependent on the local site conditions, cost-sharing agreements with developers, specific design, and concurrent deep utilities projects along the same alignment. However, for high-level planning purposes, the following unit costs per linear metre of water main may be utilized.

Green-field installation of PVC water pipe, including one isolation valve per 100 m, excluding services and surface works (project complete at subgrade level):

- 400 mm water main: $ 850 / l.m.
- 300 mm water main: $ 600 / l.m.
- 250 mm water main: $ 520 / l.m.

Utility corridor crossing (railway/highway, etc.) PVC water pipe c/w casing, augering method:

- 400 mm water main: $ 1,700 / l.m.
- 300 mm water main: $ 1,400 / l.m.
- 250 mm water main: $ 1,200 / l.m.

Pressure reducing valves (PRVs):

- 150 mm Single PRV: $ 27,000 / each
- 200 mm Single PRV: $ 34,000 / each
- 250 mm Single PRV: $ 42,000 / each
- 150 mm Dual PRV: $ 39,000 / each
- 200 mm Dual PRV: $ 47,000 / each
- 250 mm Dual PRV: $ 56,000 / each

Hydrants c/w valve and 150 mm lead:

- Hydrant c/w valve & lead: $ 10,000 / each

12 CONCLUSIONS AND RECOMMENDATIONS

12.1 Conclusions

Master Waster Servicing Study update for the water servicing in the Town of Crossfield is completed. The updated master plan has incorporated ASP servicing plans for Vista Crossing, Iron Landing, Hawk's Landing and Sunset Ridge. In addition, Joint ASP, and other future annexation areas (north, west and south of the existing town) have also been included in the updated master plan.

The 2009 growth study projected a residential population of 12,000 to 15,000 by the year 2040 at an annual growth of approximately 6%. This Master Waster Servicing Study update has projected population growth using 6% growth rate at 42,640 people by 2062, which we expect build-out to the study horizon (all future annexation lands, less four quarter-sections) to occur (see **Table 4-3**).

From the historical data the gross average daily demands has decreased steadily from 434 L/c/d (in 2017) to 382 L/c/d (June 2018-May 2019), see **Table 5-3**. The gross demand is calculated as the total water supplied by the pump station, less the bulk water total, divided by the residential population. This decrease is consistent with Statistics Canada per capita residential water use steady decrease for the households on metered water systems from 2011 to 2017.

Selected fire flow requirement by land use for this study was derived from comparison of previous studies that include Crossfield MWSS (DA Watt, 2009), Joint ASP MWSS (MPE, 2017) and Rocky View County Standards (2013), as summarized in **Table 5-6**.

The existing system performance during the maximum daily demand plus fire flow indicates that many existing demand nodes are not able to meet the fire flow requirements, particularly in the downtown and northern areas furthest from the pump station (see **Figure 7-3**). For fire flow storage, the current reservoir volume is 5,400 m^3, which meets and exceeds the required volume of 4,710 m^3 for the existing system, up to year 2028.

The ultimate water-servicing concept was completed to provide a design for the major servicing network, encompassing build-out of all areas to the study horizon. A grid system similar to Calgary is adopted for the distribution system for the Joint ASP and other future annexation areas. The remaining constraint will be water source being delivered through a single Transmission main, specifically if failure occurs. Therefore, future upgrades when the total demand for the MVRWSC exceed its design capacity water supply, additional transmission line should be considered.

12.2 Recommendations

- The current water supply is obtained from the Mountain View Regional Water Services Commission (MVRWSC), and treated at the Anthony Henday Water Treatment Plant (AHWTP) near Innisfail. Midline Pump Station pumps the water from AHWTP is pumped via a 400 mm transmission line to Didsbury and a 250 mm transmission line from Didsbury to Crossfield. To accommodate future development, a second transmission main of 400 mm twinning the original main from Didsbury to Crossfield was approved in 2017. This will eliminate the constraint of water source being delivered through a single Transmission main, specifically if there is a failure. Allnorth recommends further evaluation to update remaining capacity and upgrade projections for each stage of the MVRWSC water supply system.

- The current Town of Crossfield reservoir has a total capacity of 5,400 m^3, which is expected to be adequate for the next ten years (up to year 2028). After which, Allnorth recommends constructing two additional storage cells of approximately 2,100 m^3 each (serving up to 30-year horizon) at the existing main pump station, with an estimated cost of $2.8M each. Beyond 30 years, it is difficult to predict the direction of development, however to service the full build-out of the study area, a further 12,000 m^3 of storage will be required.
- The existing system performance during the maximum daily demand plus fire flow indicates that many existing demand nodes are not able to meet the fire flow requirements. The major water main upgrade planned for 2020 along Railway Street will correct some of the deficiencies of the demand nodes. For the remaining demand nodes, a series of five further water main upgrades are proposed, on Osler Avenue, Crossfield Estates, Strathcona Street, Chisholm Avenue, and Laut Avenue. These upgrades will correct a further 17 deficient hydrants. In addition, Allnorth recommends a detailed review of hydrant spacing to determine where additional hydrants need to be installed. The total estimated cost for these upgrades, excluding the Railway Street upgrade, is $5.57M. It is expected these upgrades will also correct servicing deficiencies for the upcoming ASPs (Vista Crossing, Iron Landing and Hawk's Landing).
- The ultimate servicing concept consists of the existing town infrastructure (including proposed upgrades), the upcoming ASPs proposed servicing concepts, and the major distribution network for the remaining lands within the study area limits. The proposed major distribution network is based on the City of Calgary grid system, and consists primarily of alternating 300 mm water mains along section boundaries, and 250 mm water mains along quarter-section boundaries.
- To service ultimate concept pressure zones are proposed. The first new pressure zone includes approximately five quarter-sections of low elevation, which will require pressure reducing valves to prevent overpressure. A second pressure zone of very low elevation will be required, with additional pressure reducing valves, within the first low pressure zone to prevent overpressure of the lowest areas. The estimated cost for pressure reducing valves is dependent on the minor system design, and as such, no overall cost estimate has been provided. The third new pressure zone includes approximately seven quarter-sections of high elevation, to the southeast of the existing town. This area will require an additional pump station of approximately the same capacity as the existing main pump station on Laut Avenue. A tentative location for this Southeast Pump Station has been identified on the southeast corner of the existing town boundary. The preliminary cost estimate for the Southeast Pump Station is $9.4M. A series of pressure-reducing valves will be required at the perimeter of this high elevation pressure zone to prevent overpressure of the main pressure zone.
- An additional new pump station is recommended to servicing the western and northern lands of the study area. This pump station is required primarily due to demand rather than elevation difference, and as such, will only need approximately one-third of the existing main pump station capacity. The preliminary cost estimate for the Southeast Pump Station is $8.4M. There is a second region of high elevation within this area, however it covers only one quarter-section. Due to the small size of the affected area, it has been assumed that the servicing of this area will be handled during development of this quarter-section and has been excluded from the master concept.

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We trust this report satisfies your requirements at this time and thank you for the opportunity to work with you on the project. If you have questions or concerns do not hesitate to contact our office.

Yours truly,

ALLNORTH CONSULTANTS LIMITED

Allnorth Permit to Practice/Certificate of Authorization #:6366

Prepared By:

Mirren Turnbull
Project Manager

Reviewed By:

2020-07-22

Alex Mutasingwa, PhD, P.Eng
Sr. Civil Engineer

Appendix A Town of Crossfield Land Use Map

Town of Crossfield
Land Use Map

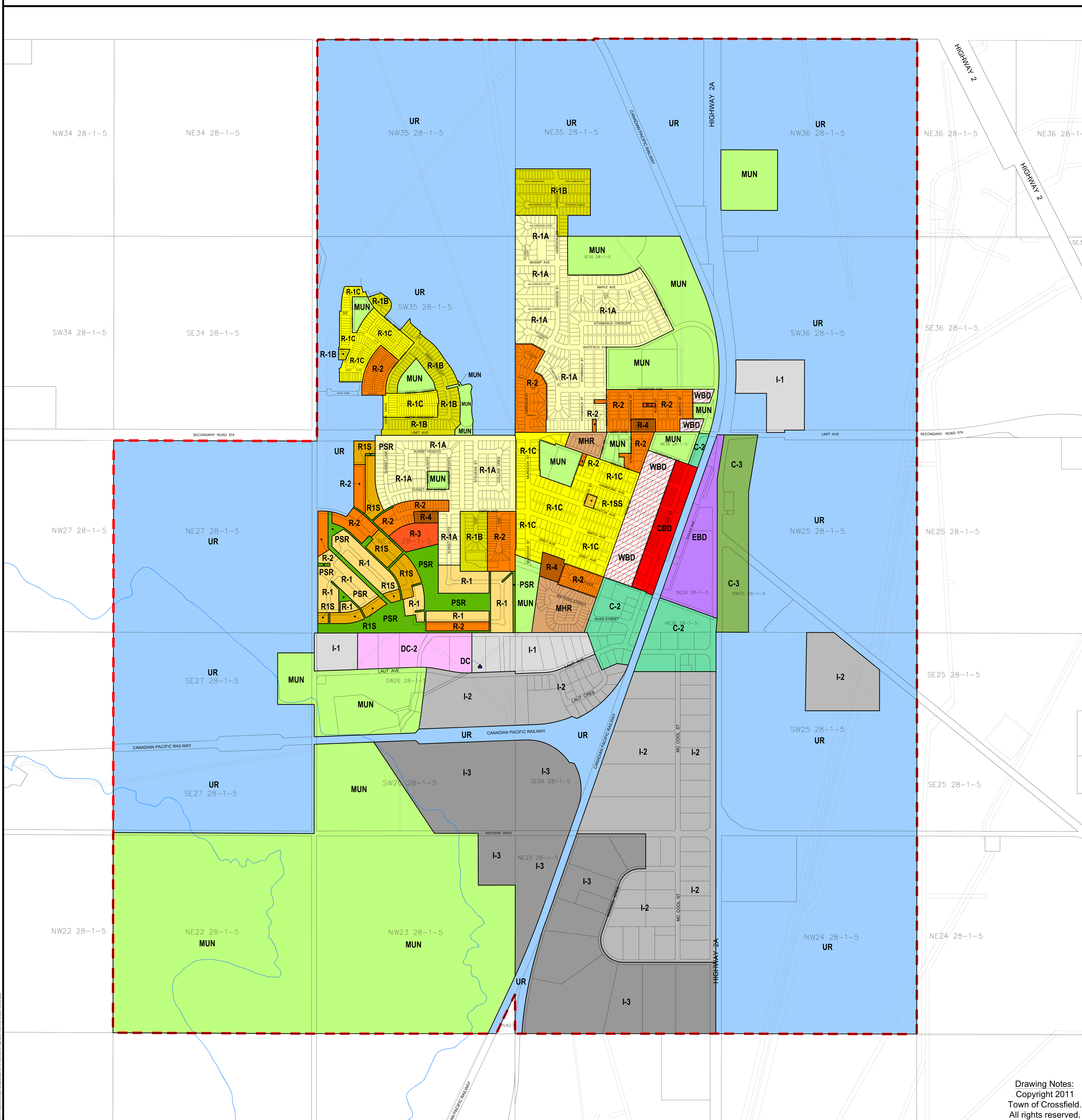
Scale 1:5,000

0 100 200 300 400 500m

Date Updated: September 21, 2018

LAND USE DISTRICTS

- Residential - Single Detached District............................R-1
- Residential - Single Detached Large Lot District...........R-1A
- Residential - Single Detached Medium Lot District.......R-1B
- Residential - Single Detached Small Lot District...........R-1C
- Residential - Single Detached Special District...............R1S
- Residential - Single Dwelling Secondary Suite and Carriage House District...................R-1SS
- Residential - Two Dwelling District.................................R-2
- Residential - Townhouse District....................................R-3
- Residential - Apartment District......................................R-4
- Residential - Manufactured Home District.....................MHR
- Central Business District...CBD
- West Downtown Business District................................WBD
- Elevator Road Business District....................................EBD
- Neighbourhood Commercial District...............................C-1
- Gateway and Entrance Business District.........................C-2
- Greenfield Commercial District.......................................C-3
- Light Industrial and Commercial District...........................I-1
- Medium Industrial District...I-2
- Heavy Industrial District..I-3
- Municipal and Institutional District................................MUN
- Public Service Right of Way District..............................PSR
- Urban Reserve District..UR
- Direct Control District...DC
- Direct Control District...DC-2
- Town Boundary

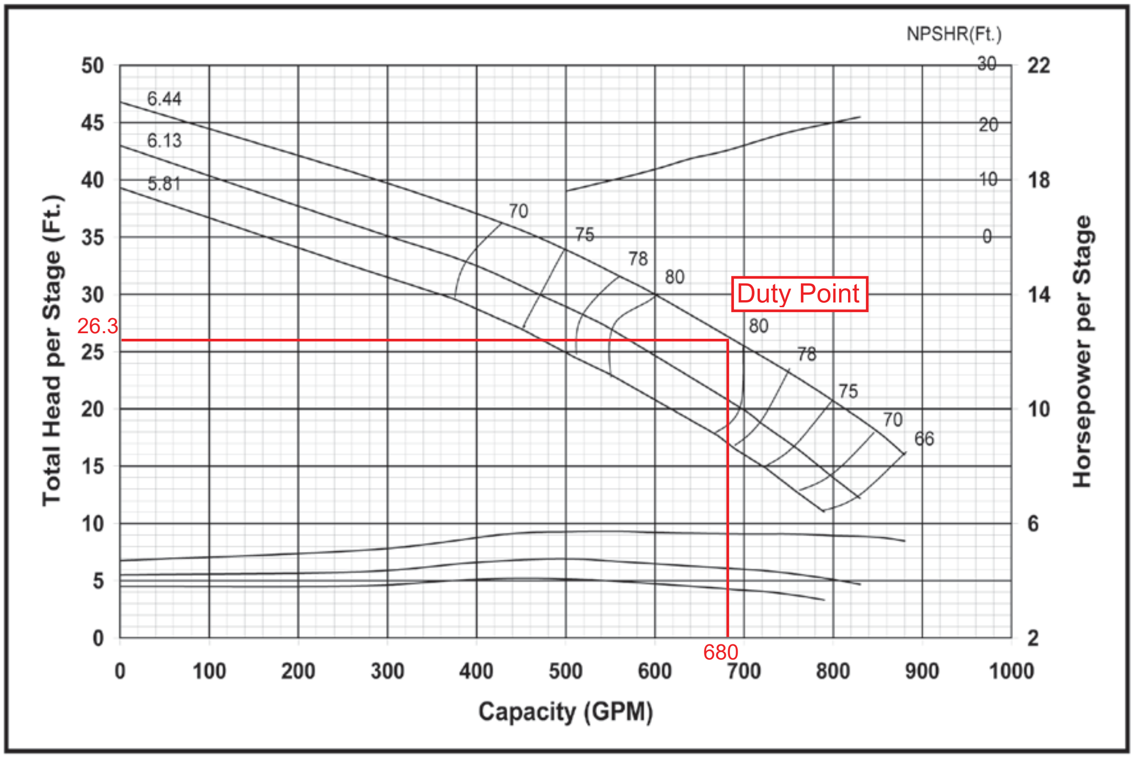


Drawing Notes:

Appendix B Pump Curves

MODEL 9TLC *(Effective June 1, 2006)*

GOULDS PROPOSAL NO.	GOULDS S.O. NO.	INQUIRY NO.	CUSTOMER P.O. NO.	P.O. DATE	ITEM NO.	CUSTOMER
PROJECT	SERVICE	GPM CAPACITY	FT. TDH	% EFFICIENCY	RPM	



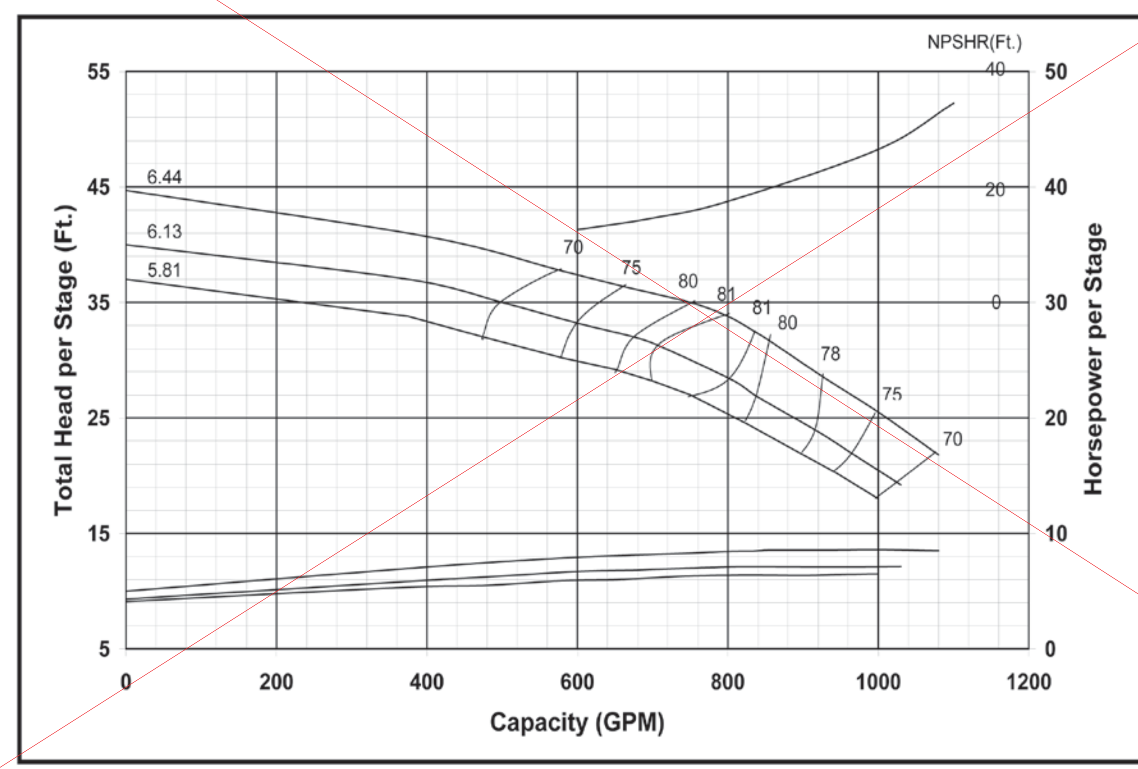
Curve No.	E6409TAPC1
Model	9TLC
RPM	1770
EFFICIENCY CORRECTION	
1-STAGE	
2-STAGE	
3-STAGE	
4-STAGE	
Impeller	ENCLOSED
Ns =	3740
K =	9.0 LBS/FT
K(Bal.)=	N/A
Bowl O.D.	9.25"
Bowl Lateral	0.75"
Max. PSI	530
Disch size	5", 6", 8"

TURBINE OPERATIONS
Lubbock, Texas

BOWL PERFORMANCE CURVE BASED ON PUMPING CLEAR, NON-AERATED WATER. RATED POINT ONLY IS GUARANTEED. CURVES REPRESENT SINGLE STAGE PERFORMANCE BASED ON TEST OF MULTI-STAGE BOWL ASSEMBLY. EFFICIENCY CORRECTION IS REQUIRED FOR LESSER STAGES.

MODEL 9THC *(Effective June 1, 2006)*

GOULDS PROPOSAL NO.	GOULDS S.O. NO.	INQUIRY NO.	CUSTOMER P.O. NO.	P.O. DATE	ITEM NO.	CUSTOMER
PROJECT	SERVICE	GPM CAPACITY	FT. TDH	% EFFICIENCY	RPM	



Curve No.	E6409TEPC1
Model	9THC
RPM	1770
EFFICIENCY CORRECTION	
1-STAGE	
2-STAGE	
3-STAGE	
4-STAGE	
Impeller	ENCLOSED
Ns =	3500
K =	9.0 LBS/FT
K(Bal.)=	N/A
Bowl O.D.	9.25"
Bowl Lateral	0.75"
Max. PSI	530
Disch size	5", 6", 8"

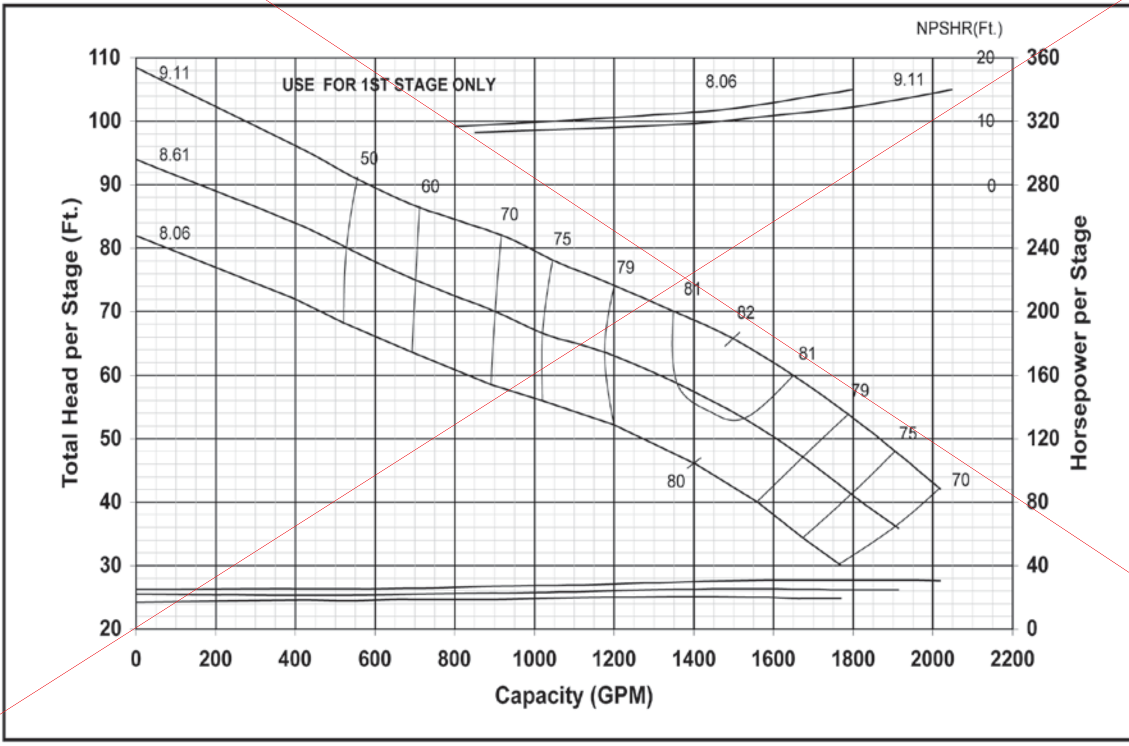
TURBINE OPERATIONS
Lubbock, Texas

BOWL PERFORMANCE CURVE BASED ON PUMPING CLEAR, NON-AERATED WATER. RATED POINT ONLY IS GUARANTEED. CURVES REPRESENT SINGLE STAGE PERFORMANCE BASED ON TEST OF MULTI-STAGE BOWL ASSEMBLY. EFFICIENCY CORRECTION IS REQUIRED FOR LESSER STAGES.

MODEL 12DXC *(Effective June 1, 2006)*

GOULDS PROPOSAL NO.	GOULDS S.O. NO.	INQUIRY NO.	CUSTOMER P.O. NO.	P.O. DATE	ITEM NO.	CUSTOMER

PROJECT	SERVICE	GPM CAPACITY	FT. TDH	% EFFICIENCY	RPM



Curve No.	E6412DMPC0
Model	12DXC
RPM	1770
EFFICIENCY CORRECTION	
1-STAGE	
2-STAGE	
3-STAGE	
4-STAGE	
Impeller	Enclosed
Ns =	4080
K =	17.2 LBS/FT
K(Bal.)=	N/A
Bowl O.D.	12.50"
Bowl Lateral	0.68"
Max. PSI	340
Min. Subm	24"

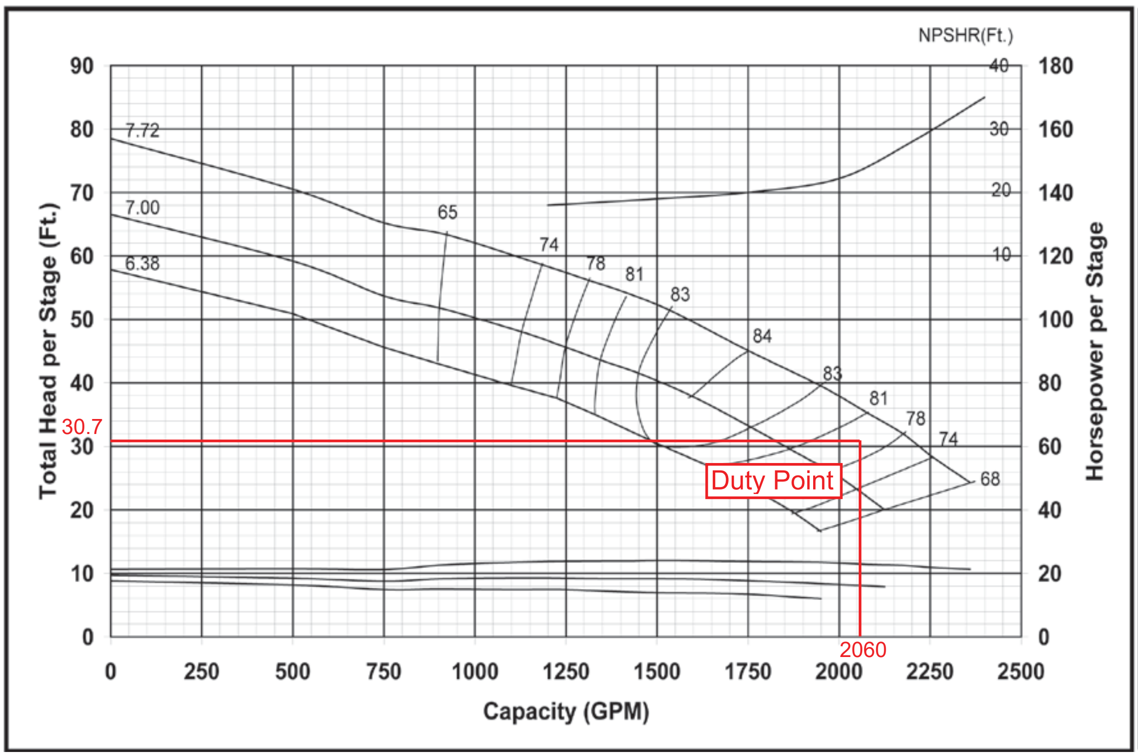
TURBINE OPERATIONS
Lubbock, Texas

BOWL PERFORMANCE CURVE BASED ON PUMPING CLEAR, NON-AERATED WATER. RATED POINT ONLY IS GUARANTEED. CURVES REPRESENT SINGLE STAGE PERFORMANCE BASED ON TEST OF MULTI-STAGE BOWL ASSEMBLY. EFFICIENCY CORRECTION IS REQUIRED FOR LESSER STAGES.

MODEL 12FDLC *(Effective June 1, 2006)*

GOULDS PROPOSAL NO.	GOULDS S.O. NO.	INQUIRY NO.	CUSTOMER P.O. NO.	P.O. DATE	ITEM NO.	CUSTOMER

PROJECT	SERVICE	GPM CAPACITY	FT. TDH	% EFFICIENCY	RPM



Curve No.	E6412FFPC0
Model	12FDLC
RPM	1770
EFFICIENCY CORRECTION	
1-STAGE	-3.0
2-STAGE	-1.5
3-STAGE	0.0
4-STAGE	0.0
Impeller	Enclosed
Ns =	4255
K =	15.0 LBS/FT
K(Bal.)=	N/A
Bowl O.D.	11.60"
Bowl Lateral	0.75"
Max. PSI	440
Disch Size	6", 8", 10"

TURBINE OPERATIONS
Lubbock, Texas

BOWL PERFORMANCE CURVE BASED ON PUMPING CLEAR, NON-AERATED WATER. RATED POINT ONLY IS GUARANTEED. CURVES REPRESENT SINGLE STAGE PERFORMANCE BASED ON TEST OF MULTI-STAGE BOWL ASSEMBLY. EFFICIENCY CORRECTION IS REQUIRED FOR LESSER STAGES.

Appendix C Cost Estimates

Osler Avenue Water Main Upgrade				
Description	**Unit**	**Est. Qty**	**Unit Price**	**Total Amt**
GENERAL				
Mobilization/Demobilization	L.S.	1	$ 35,957.62	$ 35,957.62
Shallow Utility Protection	ea.	22	$ 460.75	$ 10,136.50
Dewatering Allowance	L.S.	1	$ 11,989.73	$ 11,989.73
Tree Protection	L.S.	1	$ 2,349.28	$ 2,349.28
Hydrovac	hr	30	$ 493.11	$ 14,793.30
Traffic accommodation	L.S.	1	$ 17,470.87	$ 17,470.87
Quality control testing	L.S.	1	$ 32,945.06	$ 32,945.06
SITE WORK AND REMOVALS				
Saw cutting	l.m.	1,498	$ 9.26	$ 13,871.48
Road core incl. asphalt removal, base course and surplus material and disposal	m2	3,745	$ 11.84	$ 44,340.80
Removal & disposal - existing water main	l.m.	749	$ 27.38	$ 20,507.62
Removal & disposal - existing sidewalk and curb & gutter as required for water main installation	l.m.	135	$ 29.76	$ 4,017.60
WATER MAINS				
Temporary Water Service	L.S.	1	$ 21,082.37	$ 21,082.37
<u>Water main, incl. fittings:</u>				0.00
a) 300 mm PVC DR 18, 2.5-3.0m depth	l.m.	749	$ 285.00	$ 213,465.00
b) 150 mm PVC DR 18, 2.5-3.0m depth (hydrant leads)	l.m.	12	$ 261.46	$ 3,137.52
Gate Valves - 300 mm	ea.	3	$ 3,557.00	$ 10,671.00
Tie-in to existing	ea.	3	$ 4,328.70	$ 12,986.10
SERVICES				0.00
Replacement existing 20 mm water sewer services	ea.	45	$ 1,273.80	$ 57,321.00
SURFACE IMPROVEMENTS				0.00
Sub-grade preparation (150 mm worked depth)	m^2	3,745	$ 1.98	$ 7,415.10
Granular sub-base - 400 mm compacted depth	m^2	3,745	$ 23.29	$ 87,221.05
Granular base-course - 225 mm compacted depth	m^2	3,745	$ 15.23	$ 57,036.35
Sidewalk and Curb & Gutter Spot Repair	l.m.	135	$ 500.00	$ 67,500.00
<u>Surface Restoration</u>				0.00
Restoration of Topsoil & Landscaping	m^2	187	$ 24.67	$ 4,613.29
Restoration Asphalt Driveways & Misc Asphalt	m^2	187	$ 57.84	$ 10,816.08
Restoration Concrete Driveways & Misc Concrete	m^2	187	$ 118.35	$ 22,131.45
Asphalt pavement: 60 mm depth - Mix 'A'	m^2	3,745	$ 18.27	$ 68,421.15
Asphalt pavement: 40 mm depth - Mix 'B'	m^2	3,745	$ 18.27	$ 68,421.15
Adjustment of appurtenances - to finished grade c/w asphalt taper: Valves	ea.	3	$ 514.80	$ 1,544.40
Pavement markings	L.S.	1	$ 10,350.69	$ 10,350.69
			Project Subtotal:	**$ 932,513.56**
			30% Engineering & Contingency:	$ 279,754.07
			Project Total:	**$ 1,212,267.63**

Crossfield Estates Water Main Upgrade				
Description	**Unit**	**Est. Qty**	**Unit Price**	**Total Amt**
GENERAL				
Mobilization/Demobilization	L.S.	1	$ 7,873.23	$ 7,873.23
Shallow Utility Protection	ea.	5	$ 460.75	$ 2,303.75
Dewatering Allowance	L.S.	1	$ 2,625.25	$ 2,625.25
Tree Protection	L.S.	1	$ 514.39	$ 514.39
Hydrovac	hr	7	$ 493.11	$ 3,451.77
Traffic accommodation	L.S.	1	$ 3,825.40	$ 3,825.40
Quality control testing	L.S.	1	$ 7,213.61	$ 7,213.61
SITE WORK AND REMOVALS				
Saw cutting	l.m.	328	$ 9.26	$ 3,037.28
Road core incl. asphalt removal, base course and surplus material and disposal	m2	820	$ 11.84	$ 9,708.80
Removal & disposal - existing water main	l.m.	164	$ 27.38	$ 4,490.32
Removal & disposal - existing sidewalk and curb & gutter as required for water main installation	l.m.	27	$ 29.76	$ 803.52
WATER MAINS				
Temporary Water Service	L.S.	1	$ 4,616.17	$ 4,616.17
Water main, incl. fittings:				0.00
a) 200 mm PVC DR 18, 2.5-3.0m depth	l.m.	164	$ 225.00	$ 36,900.00
b) 150 mm PVC DR 18, 2.5-3.0m depth (hydrant leads)	l.m.	4	$ 261.46	$ 1,045.84
Gate Valves - 200 mm	ea.	1	$ 2,227.00	$ 2,227.00
Tie-in to existing	ea.	1	$ 4,328.70	$ 4,328.70
SERVICES				0.00
Replacement existing 20 mm water sewer services	ea.	9	$ 1,273.80	$ 11,464.20
SURFACE IMPROVEMENTS				0.00
Sub-grade preparation (150 mm worked depth)	m^2	820	$ 1.98	$ 1,623.60
Granular sub-base - 400 mm compacted depth	m^2	820	$ 23.29	$ 19,097.80
Granular base-course - 225 mm compacted depth	m^2	820	$ 15.23	$ 12,488.60
Sidewalk and Curb & Gutter Spot Repair	l.m.	27	$ 500.00	$ 13,500.00
Surface Restoration				0.00
Restoration of Topsoil & Landscaping	m^2	41	$ 24.67	$ 1,011.47
Restoration Asphalt Driveways & Misc Asphalt	m^2	41	$ 57.84	$ 2,371.44
Restoration Concrete Driveways & Misc Concrete	m^2	41	$ 118.35	$ 4,852.35
Asphalt pavement: 60 mm depth - Mix 'A'	m^2	820	$ 18.27	$ 14,981.40
Asphalt pavement: 40 mm depth - Mix 'B'	m^2	820	$ 18.27	$ 14,981.40
Adjustment of appurtenances - to finished grade c/w asphalt taper: Valves	ea.	1	$ 514.80	$ 514.80
Pavement markings	L.S.	1	$ 2,266.37	$ 2,266.37
			Project Subtotal:	**$ 194,118.46**
			30% Engineering & Contingency:	$ 58,235.54
			Project Total:	**$ 252,354.00**

Strathcona Street Water Main Upgrade				
Description	**Unit**	**Est. Qty**	**Unit Price**	**Total Amt**
GENERAL				
Mobilization/Demobilization	L.S.	1	$ 15,314.39	$ 15,314.39
Shallow Utility Protection	ea.	10	$ 460.75	$ 4,607.50
Dewatering Allowance	L.S.	1	$ 5,106.44	$ 5,106.44
Tree Protection	L.S.	1	$ 1,000.56	$ 1,000.56
Hydrovac	hr	13	$ 493.11	$ 6,410.43
Traffic accommodation	L.S.	1	$ 7,440.87	$ 7,440.87
Quality control testing	L.S.	1	$ 14,031.34	$ 14,031.34
SITE WORK AND REMOVALS				
Saw cutting	l.m.	638	$ 9.26	$ 5,907.88
Road core incl. asphalt removal, base course and surplus material and disposal	m2	1,595	$ 11.84	$ 18,884.80
Removal & disposal - existing water main	l.m.	319	$ 27.38	$ 8,734.22
Removal & disposal - existing sidewalk and curb & gutter as required for water main installation	l.m.	54	$ 29.76	$ 1,607.04
WATER MAINS				
Temporary Water Service	L.S.	1	$ 8,979.00	$ 8,979.00
<u>Water main, incl. fittings:</u>				0.00
a) 200 mm PVC DR 18, 2.5-3.0m depth	l.m.	319	$ 225.00	$ 71,775.00
b) 150 mm PVC DR 18, 2.5-3.0m depth (hydrant leads)	l.m.	4	$ 261.46	$ 1,045.84
Gate Valves - 200 mm	ea.	1	$ 2,227.00	$ 2,227.00
Tie-in to existing	ea.	1	$ 4,328.70	$ 4,328.70
SERVICES				0.00
Replacement existing 20 mm water sewer services	ea.	18	$ 1,273.80	$ 22,928.40
SURFACE IMPROVEMENTS				0.00
Sub-grade preparation (150 mm worked depth)	m^2	1,595	$ 1.98	$ 3,158.10
Granular sub-base - 400 mm compacted depth	m^2	1,595	$ 23.29	$ 37,147.55
Granular base-course - 225 mm compacted depth	m^2	1,595	$ 15.23	$ 24,291.85
Sidewalk and Curb & Gutter Spot Repair	l.m.	54	$ 500.00	$ 27,000.00
<u>Surface Restoration</u>				0.00
Restoration of Topsoil & Landscaping	m^2	80	$ 24.67	$ 1,973.60
Restoration Asphalt Driveways & Misc Asphalt	m^2	80	$ 57.84	$ 4,627.20
Restoration Concrete Driveways & Misc Concrete	m^2	80	$ 118.35	$ 9,468.00
Asphalt pavement: 60 mm depth - Mix 'A'	m^2	1,595	$ 18.27	$ 29,140.65
Asphalt pavement: 40 mm depth - Mix 'B'	m^2	1,595	$ 18.27	$ 29,140.65
Adjustment of appurtenances - to finished grade c/w asphalt taper: Valves	ea.	1	$ 514.80	$ 514.80
Pavement markings	L.S.	1	$ 4,408.37	$ 4,408.37
			Project Subtotal:	**$ 371,200.19**
			30% Engineering & Contingency:	$ 111,360.06
			Project Total:	**$ 482,560.25**

Chisholm Avenue Water Main Upgrade				
Description	**Unit**	**Est. Qty**	**Unit Price**	**Total Amt**
GENERAL				
Mobilization/Demobilization	L.S.	1	$ 7,681.20	$ 7,681.20
Shallow Utility Protection	ea.	5	$ 460.75	$ 2,303.75
Dewatering Allowance	L.S.	1	$ 2,561.22	$ 2,561.22
Tree Protection	L.S.	1	$ 501.85	$ 501.85
Hydrovac	hr	6	$ 493.11	$ 2,958.66
Traffic accommodation	L.S.	1	$ 3,732.10	$ 3,732.10
Quality control testing	L.S.	1	$ 7,037.66	$ 7,037.66
SITE WORK AND REMOVALS				
Saw cutting	l.m.	320	$ 9.26	$ 2,963.20
Road core incl. asphalt removal, base course and surplus material and disposal	m2	800	$ 11.84	$ 9,472.00
Removal & disposal - existing water main	l.m.	160	$ 27.38	$ 4,380.80
Removal & disposal - existing sidewalk and curb & gutter as required for water main installation	l.m.	24	$ 29.76	$ 714.24
WATER MAINS				
Temporary Water Service	L.S.	1	$ 4,503.58	$ 4,503.58
<u>Water main, incl. fittings:</u>				0.00
a) 250 mm PVC DR 18, 2.5-3.0m depth	l.m.	160	$ 260.00	$ 41,600.00
b) 150 mm PVC DR 18, 2.5-3.0m depth (hydrant leads)	l.m.	4	$ 261.46	$ 1,045.84
Gate Valves - 250 mm	ea.	1	$ 3,030.00	$ 3,030.00
Tie-in to existing	ea.	1	$ 4,328.70	$ 4,328.70
SERVICES				0.00
Replacement existing 20 mm water sewer services	ea.	8	$ 1,273.80	$ 10,190.40
SURFACE IMPROVEMENTS				0.00
Sub-grade preparation (150 mm worked depth)	m^2	800	$ 1.98	$ 1,584.00
Granular sub-base - 400 mm compacted depth	m^2	800	$ 23.29	$ 18,632.00
Granular base-course - 225 mm compacted depth	m^2	800	$ 15.23	$ 12,184.00
Curb & Gutter Spot Repair	l.m.	24	$ 230.70	$ 5,536.80
<u>Surface Restoration</u>				0.00
Restoration of Topsoil & Landscaping	m^2	40	$ 24.67	$ 986.80
Restoration Asphalt Driveways & Misc Asphalt	m^2	40	$ 57.84	$ 2,313.60
Restoration Concrete Driveways & Misc Concrete	m^2	40	$ 118.35	$ 4,734.00
Asphalt pavement: 60 mm depth - Mix 'A'	m^2	800	$ 18.27	$ 14,616.00
Asphalt pavement: 40 mm depth - Mix 'B'	m^2	800	$ 18.27	$ 14,616.00
Adjustment of appurtenances - to finished grade c/w asphalt taper: Valves	ea.	1	$ 514.80	$ 514.80
Pavement markings	L.S.	1	$ 2,211.10	$ 2,211.10
			Project Subtotal:	**$ 186,934.29**
			30% Engineering & Contingency:	$ 56,080.29
			Project Total:	**$ 243,014.58**

Nanton Avenue Water Main Upgrade				
Description	**Unit**	**Est. Qty**	**Unit Price**	**Total Amt**
GENERAL				
Mobilization/Demobilization	L.S.	1	$ 16,178.53	$ 16,178.53
Shallow Utility Protection	ea.	10	$ 460.75	$ 4,607.50
Dewatering Allowance	L.S.	1	$ 5,394.58	$ 5,394.58
Tree Protection	L.S.	1	$ 1,057.02	$ 1,057.02
Hydrovac	hr	13	$ 493.11	$ 6,410.43
Traffic accommodation	L.S.	1	$ 7,860.73	$ 7,860.73
Quality control testing	L.S.	1	$ 14,823.08	$ 14,823.08
SITE WORK AND REMOVALS				
Saw cutting	l.m.	674	$ 9.26	$ 6,241.24
Road core incl. asphalt removal, base course and surplus material and disposal	m2	1,685	$ 11.84	$ 19,950.40
Removal & disposal - existing water main	l.m.	337	$ 27.38	$ 9,227.06
Removal & disposal - existing sidewalk and curb & gutter as required for water main installation	l.m.	102	$ 29.76	$ 3,035.52
WATER MAINS				
Temporary Water Service	L.S.	1	$ 9,485.66	$ 9,485.66
Water main, incl. fittings:				0.00
a) 200 mm PVC DR 18, 2.5-3.0m depth	l.m.	337	$ 225.00	$ 75,825.00
b) 150 mm PVC DR 18, 2.5-3.0m depth (hydrant leads)	l.m.	8	$ 261.46	$ 2,091.68
Gate Valves - 200 mm	ea.	2	$ 2,227.00	$ 4,454.00
Tie-in to existing	ea.	1	$ 4,328.70	$ 4,328.70
SERVICES				0.00
Replacement existing 20 mm water sewer services	ea.	34	$ 1,273.80	$ 43,309.20
SURFACE IMPROVEMENTS				0.00
Sub-grade preparation (150 mm worked depth)	m^2	1,685	$ 1.98	$ 3,336.30
Granular sub-base - 400 mm compacted depth	m^2	1,685	$ 23.29	$ 39,243.65
Granular base-course - 225 mm compacted depth	m^2	1,685	$ 15.23	$ 25,662.55
Sidewalk and Curb & Gutter Spot Repair	l.m.	102	$ 500.00	$ 51,000.00
Surface Restoration				0.00
Restoration of Topsoil & Landscaping	m^2	84	$ 24.67	$ 2,072.28
Restoration Asphalt Driveways & Misc Asphalt	m^2	84	$ 57.84	$ 4,858.56
Restoration Concrete Driveways & Misc Concrete	m^2	84	$ 118.35	$ 9,941.40
Asphalt pavement: 60 mm depth - Mix 'A'	m^2	1,685	$ 18.27	$ 30,784.95
Asphalt pavement: 40 mm depth - Mix 'B'	m^2	1,685	$ 18.27	$ 30,784.95
Adjustment of appurtenances - to finished grade c/w asphalt taper: Valves	ea.	2	$ 514.80	$ 1,029.60
Pavement markings	L.S.	1	$ 4,657.12	$ 4,657.12
			Project Subtotal:	**$ 437,651.68**
			30% Engineering & Contingency:	$ 131,295.50
			Project Total:	**$ 568,947.18**

Elevator Road Water Main Upgrade				
Description	**Unit**	**Est. Qty**	**Unit Price**	**Total Amt**
GENERAL				
Mobilization/Demobilization	L.S.	1	$ 18,914.96	$ 18,914.96
Shallow Utility Protection	ea.	12	$ 460.75	$ 5,529.00
Dewatering Allowance	L.S.	1	$ 6,307.01	$ 6,307.01
Tree Protection	L.S.	1	$ 1,235.80	$ 1,235.80
Hydrovac	hr	16	$ 493.11	$ 7,889.76
Traffic accommodation	L.S.	1	$ 9,190.29	$ 9,190.29
Quality control testing	L.S.	1	$ 17,330.25	$ 17,330.25
SITE WORK AND REMOVALS				
Saw cutting	l.m.	788	$ 9.26	$ 7,296.88
Road core incl. asphalt removal, base course and surplus material and disposal	m2	1,970	$ 11.84	$ 23,324.80
Removal & disposal - existing water main	l.m.	394	$ 27.38	$ 10,787.72
WATER MAINS				
Temporary Water Service	L.S.	1	$ 11,090.06	$ 11,090.06
Water main, incl. fittings:				0.00
a) 250 mm PVC DR 18, 2.5-3.0m depth	l.m.	394	$ 260.00	$ 102,440.00
b) 150 mm PVC DR 18, 2.5-3.0m depth (hydrant leads)	l.m.	4	$ 261.46	$ 1,045.84
Gate Valves - 250 mm	ea.	1	$ 3,030.00	$ 3,030.00
Tie-in to existing	ea.	1	$ 4,328.70	$ 4,328.70
SERVICES				0.00
Replacement existing 20 mm water sewer services	ea.	8	$ 1,273.80	$ 10,190.40
SURFACE IMPROVEMENTS				0.00
Sub-grade preparation (150 mm worked depth)	m^2	1,970	$ 1.98	$ 3,900.60
Granular sub-base - 400 mm compacted depth	m^2	1,970	$ 23.29	$ 45,881.30
Granular base-course - 225 mm compacted depth	m^2	1,970	$ 15.23	$ 30,003.10
Surface Restoration				0.00
Restoration Asphalt Driveways & Misc Asphalt	m^2	99	$ 57.84	$ 5,726.16
Restoration Concrete Driveways & Misc Concrete	m^2	99	$ 118.35	$ 11,716.65
Asphalt pavement: 60 mm depth - Mix 'A'	m^2	1,970	$ 18.27	$ 35,991.90
Asphalt pavement: 40 mm depth - Mix 'B'	m^2	1,970	$ 18.27	$ 35,991.90
Adjustment of appurtenances - to finished grade c/w asphalt taper: Valves	ea.	1	$ 514.80	$ 514.80
Pavement markings	L.S.	1	$ 5,444.82	$ 5,444.82
			Project Subtotal:	**$ 415,102.69**
			30% Engineering & Contingency:	$ 124,530.81
			Project Total:	**$ 539,633.50**

Laut Avenue Water Main Upgrade						
Description	**Unit**	**Est. Qty**		**Unit Price**		**Total Amt**
GENERAL						
Mobilization/Demobilization	L.S.	1	$	62,409.75	$	62,409.75
Shallow Utility Protection	ea.	39	$	460.75	$	17,969.25
Dewatering Allowance	L.S.	1	$	20,809.95	$	20,809.95
Tree Protection	L.S.	1	$	4,077.52	$	4,077.52
Hydrovac	hr	52	$	493.11	$	25,641.72
Traffic accommodation	L.S.	1	$	30,323.28	$	30,323.28
Quality control testing	L.S.	1	$	57,181.02	$	57,181.02
SITE WORK AND REMOVALS						
Saw cutting	l.m.	2,600	$	9.26	$	24,076.00
Road core incl. asphalt removal, base course and surplus material and disposal	m2	6,500	$	11.84	$	76,960.00
Removal & disposal - existing water main	l.m.	1,300	$	27.38	$	35,594.00
Removal & disposal - existing sidewalk and curb & gutter as required for water main installation	l.m.	42	$	29.76	$	1,249.92
WATER MAINS						
Temporary Water Service	L.S.	1	$	36,591.56	$	36,591.56
Water main, incl. fittings:						0.00
a) 400 mm PVC DR 18, 2.5-3.0m depth	l.m.	1,300	$	400.00	$	520,000.00
b) 150 mm PVC DR 18, 2.5-3.0m depth (hydrant leads)	l.m.	8	$	261.46	$	2,091.68
Gate Valves - 400 mm	ea.	3	$	8,840.00	$	26,520.00
Tie-in to existing	ea.	3	$	4,328.70	$	12,986.10
SERVICES						0.00
Replacement existing 20 mm water sewer services	ea.	14	$	1,273.80	$	17,833.20
SURFACE IMPROVEMENTS						0.00
Sub-grade preparation (150 mm worked depth)	m^2	6,500	$	1.98	$	12,870.00
Granular sub-base - 400 mm compacted depth	m^2	6,500	$	23.29	$	151,385.00
Granular base-course - 225 mm compacted depth	m^2	6,500	$	15.23	$	98,995.00
Curb & Gutter Spot Repair	l.m.	42	$	230.70	$	9,689.40
Surface Restoration						0.00
Restoration of Topsoil & Landscaping	m^2	325	$	24.67	$	8,017.75
Restoration Asphalt Driveways & Misc Asphalt	m^2	325	$	57.84	$	18,798.00
Restoration Concrete Driveways & Misc Concrete	m^2	325	$	118.35	$	38,463.75
Asphalt pavement: 60 mm depth - Mix 'A'	m^2	6,500	$	18.27	$	118,755.00
Asphalt pavement: 40 mm depth - Mix 'B'	m^2	6,500	$	18.27	$	118,755.00
Adjustment of appurtenances - to finished grade c/w asphalt taper: Valves	ea.	3	$	514.80	$	1,544.40
Pavement markings	L.S.	1	$	17,965.16	$	17,965.16
				Project Subtotal:	**$**	**1,567,553.39**
				30% Engineering & Contingency:	$	470,266.02
				Project Total:	**$**	**2,037,819.41**

Appendix D Model Results

Phase	Pipe ID	Start Node	Stop Node	Material	Diameter (mm)	Length (m)	Hazen-Williams C	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Build-out) PHD	
								Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)
Existing	P-EX-001	J-EX-PUMP_JCT	J-EX-001	PVC	392.9	25	130	3,948	0.5	10,851	1.5	18,866	2.6	21,862	3.0	16,815	2.3	21,176	2.9
Existing	P-EX-002	J-EX-001	J-EX-002	PVC	392.9	130	130	3,923	0.5	10,810	1.5	18,840	2.6	21,829	3.0	16,790	2.3	21,143	2.9
Existing	P-EX-003	J-EX-002	J-EX-003	PVC	392.9	23	130	13	0.0	20	0.0	8,879	1.2	9,664	1.3	7,463	1.0	9,728	1.3
Existing	P-EX-004	J-EX-003	J-EX-004	PVC	392.9	103	130	12	0.0	19	0.0	8,878	1.2	9,663	1.3	7,462	1.0	9,726	1.3
Existing	P-EX-005	J-EX-004	J-EX-005	PVC	392.9	55	130	9	0.0	15	0.0	8,876	1.2	9,660	1.3	7,460	1.0	9,723	1.3
Existing	P-EX-006	J-EX-005	J-EX-006	PVC	392.9	55	130	9	0.0	14	0.0	8,875	1.2	9,659	1.3	7,459	1.0	9,723	1.3
Existing	P-EX-007	J-EX-006	J-EX-007	PVC	392.9	79	130	9	0.0	14	0.0	8,875	1.2	9,659	1.3	7,459	1.0	9,723	1.3
Existing	P-EX-008	J-EX-007	J-EX-008	PVC	392.9	40	130	8	0.0	13	0.0	8,875	1.2	9,658	1.3	7,458	1.0	9,722	1.3
Existing	P-EX-009	J-EX-008	J-EX-009	PVC	392.9	45	130	7	0.0	12	0.0	8,874	1.2	9,657	1.3	7,458	1.0	9,721	1.3
Existing	P-EX-010	J-EX-009	J-EX-010	PVC	392.9	37	130	7	0.0	12	0.0	8,874	1.2	9,657	1.3	7,458	1.0	9,721	1.3
Existing	P-EX-011	J-EX-010	J-EX-011	PVC	392.9	45	130	6	0.0	10	0.0	8,873	1.2	9,656	1.3	7,457	1.0	9,720	1.3
Existing	P-EX-012	J-EX-011	J-EX-012	PVC	392.9	81	130	4	0.0	6	0.0	8,870	1.2	9,653	1.3	7,454	1.0	9,716	1.3
Existing	P-EX-013	J-EX-012	J-EX-013	PVC	392.9	23	130	2	0.0	3	0.0	8,868	1.2	9,650	1.3	7,452	1.0	9,713	1.3
Existing	P-EX-014	J-EX-013	J-EX-014	PVC	392.9	8	130	1	0.0	1	0.0	8,867	1.2	9,649	1.3	7,451	1.0	9,712	1.3
Existing	P-EX-015	J-EX-002	J-EX-015	PVC	392.9	21	130	3,909	0.5	10,789	1.5	9,920	1.4	12,111	1.7	9,286	1.3	11,362	1.6
Existing	P-EX-016	J-EX-015	J-EX-016	PVC	392.9	9	130	3,909	0.5	10,789	1.5	9,920	1.4	12,111	1.7	9,285	1.3	11,361	1.6
Existing	P-EX-017	J-EX-016	J-EX-017	PVC	392.9	79	130	3,906	0.5	10,784	1.5	9,917	1.4	12,107	1.7	9,283	1.3	11,358	1.6
Existing	P-EX-018	J-EX-017	J-EX-018	PVC	392.9	88	130	3,902	0.5	10,777	1.5	9,912	1.4	12,101	1.7	9,278	1.3	11,352	1.6
Existing	P-EX-019	J-EX-018	J-EX-019	PVC	392.9	7	130	2,898	0.4	9,171	1.3	9,908	1.4	12,096	1.7	9,274	1.3	11,347	1.6
Existing	P-EX-020	J-EX-019	J-EX-020	PVC	392.9	50	130	2,252	0.5	6,907	1.5	8,148	1.1	10,427	1.4	7,995	1.1	9,377	1.2
Existing	P-EX-021	J-EX-020	J-EX-021	PVC	392.9	123	130	1,247	0.4	5,300	1.8	7,143	1.0	10,421	1.4	7,990	1.1	8,071	1.1
Existing	P-EX-022	J-EX-021	J-EX-022	PVC	392.9	20	130	914	0.3	3,904	1.3	6,469	0.9	9,438	1.3	7,236	1.0	7,307	1.0
Existing	P-EX-023	J-EX-022	J-EX-023	PVC	392.9	125	130	910	0.3	3,898	1.3	6,465	0.9	9,433	1.3	7,233	1.0	7,302	1.0
Existing	P-EX-024	J-EX-023	J-EX-024	PVC	392.9	22	130	907	0.3	3,893	1.3	6,461	0.9	9,429	1.3	7,229	1.0	7,298	1.0
Existing	P-EX-025	J-EX-024	J-EX-025	PVC	392.9	78	130	1,218	0.4	5,253	1.8	7,114	0.9	10,383	1.4	7,961	1.1	8,033	1.1
Existing	P-EX-026	J-EX-025	J-EX-026	PVC	392.9	52	130	1,216	0.4	5,250	1.8	7,112	0.9	10,380	1.4	7,959	1.1	8,030	1.1
Existing	P-EX-027	J-EX-026	J-EX-027	PVC	250	35	130	1,512	0.5	1,834	0.6	1,728	0.6	2,046	0.7	1,572	0.5	1,835	0.6
Existing	P-EX-028	J-EX-027	J-EX-028	PVC	250	51	130	1,511	0.5	1,832	0.6	1,726	0.6	2,045	0.7	1,570	0.5	1,833	0.6
Existing	P-EX-029	J-EX-028	J-EX-029	PVC	350	199	130	885	0.5	5,876	1.0	5,049	0.9	5,971	1.0	4,586	0.8	5,351	0.9
Existing	P-EX-030	J-EX-029	J-EX-030	PVC	350	92	130	975	0.3	5,671	1.0	5,152	0.9	6,074	1.1	4,662	0.8	5,453	0.9
Existing	P-EX-031	J-EX-030	J-EX-031	PVC	350	7	130	973	0.3	5,667	1.0	5,149	0.9	6,071	1.1	4,659	0.8	5,450	0.9
Existing	P-EX-032	J-EX-031	J-EX-032	PVC	350	99	130	469	0.4	4,268	0.7	4,532	0.8	5,308	0.9	4,066	0.7	4,812	0.8
Existing	P-EX-033	J-EX-032	J-EX-033	PVC	350	9	130	396	0.4	4,017	0.7	4,105	0.7	4,762	0.8	3,638	0.6	4,380	0.8
Existing	P-EX-034	J-EX-033	J-EX-034	PVC	350	90	130	391	0.4	393	0.7	4,099	0.7	4,754	0.8	3,631	0.6	4,371	0.8
Existing	P-EX-035	J-EX-034	J-EX-035	PVC	350	12	130	281	0.3	2,722	0.5	3,837	0.7	4,385	0.8	3,335	0.6	4,131	0.7
Existing	P-EX-036	J-EX-035	J-EX-036	PVC	350	82	130	278	0.3	2,717	0.5	3,833	0.7	4,380	0.8	3,331	0.6	4,126	0.7
Existing	P-EX-037	J-EX-036	J-EX-037	PVC	350	100	130	158	0.1	1,613	0.3	2,135	0.4	2,008	0.4	1,435	0.3	2,614	0.5
Existing	P-EX-038	J-EX-037	J-EX-038	PVC	350	52	130	119	0.1	1,549	0.3	2,117	0.4	1,985	0.3	1,417	0.3	2,591	0.5
Existing	P-EX-039	J-EX-038	J-EX-039	PVC	350	15	130	118	0.1	1,547	0.3	2,114	0.4	1,982	0.3	1,415	0.3	2,588	0.5
Existing	P-EX-040	J-EX-039	J-EX-040	PVC	350	77	130	116	0.1	1,545	0.3	2,112	0.4	1,978	0.3	1,412	0.2	2,584	0.5
Existing	P-EX-041	J-EX-040	J-EX-041	PVC	350	169	130	6	0.0	9	0.0	6	0.0	7	0.0	6	0.0	7	0.0
Existing	P-EX-042	J-EX-019	J-EX-042	PVC	309	44	130	646	0.1	2,263	0.5	1,760	0.4	1,669	0.4	1,279	0.3	1,969	0.4
Existing	P-EX-043	J-EX-042	J-EX-043	PVC	250	88	130	642	0.2	2,256	0.8	1,756	0.6	1,664	0.6	1,275	0.4	1,964	0.7
Existing	P-EX-044	J-EX-043	J-EX-044	PVC	250	360	130	632	0.2	2,241	0.8	1,746	0.6	1,651	0.6	1,265	0.4	1,951	0.7
Existing	P-EX-045	J-EX-044	J-EX-045	PVC	250	35	130	472	0.2	1,722	0.6	1,348	0.5	1,266	0.4	970	0.3	1,502	0.5
Existing	P-EX-046	J-EX-042	J-EX-046	PVC	155	57	130	3	0.0	4	0.0	3	0.0	3	0.0	3	0.0	3	0.0
Existing	P-EX-047	J-EX-044	J-EX-047	PVC	204	13	130	139	0.1	486	0.3	377	0.2	358	0.2	275	0.1	423	0.2
Existing	P-EX-048	J-EX-047	J-EX-048	PVC	204	52	130	137	0.1	482	0.3	375	0.2	355	0.2	272	0.1	420	0.2
Existing	P-EX-049	J-EX-048	J-EX-049	PVC	204	38	130	123	0.1	459	0.2	361	0.2	337	0.2	258	0.1	392.9.8	0.2
Existing	P-EX-050	J-EX-045	J-EX-049	PVC	204	41	130	119	0.1	454	0.2	357	0.2	332	0.2	255	0.1	397	0.2
Existing	P-EX-051	J-EX-050	J-EX-071	PVC	250	77	130	12	0.0	19	0.0	19	0.0	24	0.0	19	0.0	24	0.0

Phase	Pipe ID	Start Node	Stop Node	Material	Diameter (mm)	Length (m)	Hazen-Williams C	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Build-out) PHD	
								Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)
Existing	P-EX-052	J-EX-051	J-EX-227	PVC	392.9	236	150	322	0.1	1,745	0.6	1,172	0.2	3,342	0.4	2,552	0.3	1,716	0.2
Existing	P-EX-053	J-EX-052	J-EX-053	PVC	250	266	130	353	0.1	1,795	0.6	178	0.1	1,288	0.4	987	0.3	289	0.1
Existing	P-EX-054	J-EX-053	J-EX-054	PVC	250	133	130	377	0.1	1,833	0.6	201	0.1	1,319	0.5	1,011	0.3	320	0.1
Existing	P-EX-055	J-EX-054	J-EX-055	PVC	250	34	130	385	0.1	1,845	0.6	209	0.1	1,329	0.5	1,018	0.4	330	0.1
Existing	P-EX-056	J-EX-055	J-EX-056	PVC	250	123	130	390	0.1	1,854	0.6	214	0.1	1,336	0.5	1,024	0.4	337	0.1
Existing	P-EX-057	J-EX-056	J-EX-057	PVC	250	55	130	70	0.0	477	0.2	15	0.0	337	0.1	258	0.1	38	0.0
Existing	P-EX-058	J-EX-057	J-EX-058	PVC	250	89	130	74	0.0	484	0.2	20	0.0	343	0.1	263	0.1	44	0.0
Existing	P-EX-059	J-EX-058	J-EX-059	PVC	250	91	130	81	0.0	495	0.2	27	0.0	352	0.1	270	0.1	53	0.0
Existing	P-EX-060	J-EX-059	J-EX-060	PVC	250	131	130	90	0.0	509	0.2	35	0.0	363	0.1	278	0.1	64	0.0
Existing	P-EX-061	J-EX-056	J-EX-061	PVC	250	133	130	326	0.1	1,386	0.5	205	0.1	1,006	0.3	771	0.3	306	0.1
Existing	P-EX-062	J-EX-045	J-EX-226	PVC	250	125	130	583	0.2	2,161	0.7	1,697	0.6	1,586	0.5	1,216	0.4	1,887	0.6
Existing	P-EX-063	J-EX-062	J-EX-063	PVC	250	55	130	204	0.1	691	0.2	149	0.1	512	0.2	392	0.1	213	0.1
Existing	P-EX-064	J-EX-063	J-EX-064	PVC	250	146	130	193	0.1	674	0.2	138	0.1	497	0.2	381	0.1	198	0.1
Existing	P-EX-065	J-EX-064	J-EX-065	PVC	250	160	130	175	0.1	645	0.2	120	0.0	474	0.2	363	0.1	175	0.1
Existing	P-EX-066	J-EX-065	J-EX-066	PVC	250	174	130	132	0.0	577	0.2	78	0.0	419	0.1	321	0.1	120	0.0
Existing	P-EX-067	J-EX-066	J-EX-067	PVC	250	143	130	113	0.0	545	0.2	58	0.0	393	0.1	301	0.1	94	0.0
Existing	P-EX-068	J-EX-067	J-EX-068	PVC	250	23	130	14	0.0	22	0.0	14	0.0	18	0.0	14	0.0	18	0.0
Existing	P-EX-069	J-EX-021	J-EX-069	PVC	204	160	130	329	0.2	1,390	0.7	671	0.3	978	0.5	750	0.4	759	0.4
Existing	P-EX-070	J-EX-024	J-EX-070	PVC	204	120	130	313	0.2	1,363	0.7	655	0.3	957	0.5	733	0.4	738	0.4
Existing	P-EX-071	J-EX-051	J-EX-071	PVC	392.9	23	150	313	0.1	1,731	0.6	1,181	0.2	3,353	0.4	2,561	0.3	1,727	0.2
Existing	P-EX-073	J-EX-028	J-EX-073	PVC	204	119	130	622	0.3	1,070	0.6	854	0.4	1,019	0.5	783	0.4	915	0.5
Existing	P-EX-074	J-EX-073	J-EX-074	PVC	204	97	130	618	0.3	1,063	0.5	850	0.4	1,013	0.5	779	0.4	909	0.5
Existing	P-EX-075	J-EX-074	J-EX-075	PVC	204	48	130	54	0.0	86	0.0	54	0.0	70	0.0	54	0.0	70	0.0
Existing	P-EX-076	J-EX-075	J-EX-076	PVC	204	4	130	49	0.0	79	0.0	49	0.0	64	0.0	49	0.0	64	0.0
Existing	P-EX-077	J-EX-076	J-EX-077	PVC	155	78	130	27	0.0	43	0.0	27	0.0	35	0.0	27	0.0	35	0.0
Existing	P-EX-078	J-EX-077	J-EX-078	PVC	155	106	130	17	0.0	27	0.0	17	0.0	22	0.0	17	0.0	22	0.0
Existing	P-EX-079	J-EX-076	J-EX-079	PVC	155	207	130	16	0.0	26	0.0	16	0.0	21	0.0	16	0.0	21	0.0
Existing	P-EX-080	J-EX-074	J-EX-080	PVC	204	75	130	560	0.3	970	0.5	791	0.4	938	0.5	721	0.4	834	0.4
Existing	P-EX-081	J-EX-080	J-EX-081	PVC	204	16	130	555	0.3	961	0.5	786	0.4	931	0.5	716	0.4	827	0.4
Existing	P-EX-082	J-EX-081	J-EX-082	PVC	155	120	130	21	0.0	33	0.0	21	0.0	27	0.0	21	0.0	27	0.0
Existing	P-EX-083	J-EX-029	J-EX-083	PVC	155	35	130	95	0.1	198	0.2	107	0.1	109	0.1	80	0.1	108	0.1
Existing	P-EX-084	J-EX-081	J-EX-084	PVC	204	96	130	527	0.3	917	0.5	758	0.4	894	0.5	688	0.4	790	0.4
Existing	P-EX-085	J-EX-084	J-EX-085	PVC	155	12	130	416	0.4	1,089	1.0	635	0.6	765	0.7	592	0.5	662	0.6
Existing	P-EX-086	J-EX-085	J-EX-086	PVC	155	156	130	408	0.4	1,076	1.0	627	0.6	755	0.7	583	0.5	652	0.6
Existing	P-EX-087	J-EX-086	J-EX-087	AC	148.6	178	130	263	0.3	884	0.9	426	0.4	526	0.5	411	0.4	430	0.4
Existing	P-EX-088	J-EX-087	J-EX-088	PVC	155	79	130	16	0.0	26	0.0	16	0.0	21	0.0	16	0.0	21	0.0
Existing	P-EX-089	J-EX-088	J-EX-089	PVC	155	47	130	8	0.0	12	0.0	8	0.0	10	0.0	8	0.0	10	0.0
Existing	P-EX-090	J-EX-090	J-EX-215	PVC	204	49	130	41	0.0	315	0.2	46	0.0	73	0.0	49	0.0	143	0.1
Existing	P-EX-091	J-EX-030	J-EX-091	PVC	155	6	130	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Existing	P-EX-092	J-EX-031	J-EX-092	PVC	204	44	130	501	0.3	1,394	0.7	613	0.3	758	0.4	590	0.3	634	0.3
Existing	P-EX-093	J-EX-092	J-EX-093	PVC	155	13	130	4	0.0	7	0.0	4	0.0	6	0.0	4	0.0	6	0.0
Existing	P-EX-094	J-EX-092	J-EX-094	PVC	204	137	130	491	0.3	1,378	0.7	603	0.3	745	0.4	580	0.3	620	0.3
Existing	P-EX-095	J-EX-094	J-EX-095	PVC	204	156	130	475	0.2	1,353	0.7	588	0.3	725	0.4	564	0.3	600	0.3
Existing	P-EX-096	J-EX-086	J-EX-096	AC	148.6	84	130	130	0.1	168	0.2	186	0.2	209	0.2	158	0.2	202	0.2
Existing	P-EX-097	J-EX-095	J-EX-097	AC	148.6	93	130	276	0.3	980	0.9	454	0.4	565	0.5	442	0.4	455	0.4
Existing	P-EX-098	J-EX-097	J-EX-098	AC	148.6	114	130	264	0.3	962	0.9	443	0.4	551	0.5	431	0.4	440	0.4
Existing	P-EX-099	J-EX-087	J-EX-099	PVC	155	43	130	238	0.2	845	0.8	401	0.4	494	0.4	386	0.3	398	0.4
Existing	P-EX-100	J-EX-098	J-EX-100	PVC	204	116	130	419	0.2	1,734	0.9	821	0.4	1,025	0.5	805	0.4	802	0.4
Existing	P-EX-101	J-EX-100	J-EX-101	PVC	204	6	130	412	0.2	1,723	0.9	815	0.4	1,016	0.5	798	0.4	793	0.4
Existing	P-EX-102	J-EX-101	J-EX-102	PVC	204	89	130	380	0.2	1,671	0.9	782	0.4	974	0.5	766	0.4	751	0.4
Existing	P-EX-103	J-EX-102	J-EX-103	PVC	204	113	130	187	0.1	938	0.5	620	0.3	772	0.4	612	0.3	594	0.3

Phase	Pipe ID	Start Node	Stop Node	Material	Diameter (mm)	Length (m)	Hazen-Williams C	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Build-out) PHD	
								Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)
Existing	P-EX-104	J-EX-103	J-EX-104	PVC	204	41	130	72	0.0	364	0.2	263	0.1	328	0.2	260	0.1	258	0.1
Existing	P-EX-105	J-EX-104	J-EX-105	PVC	204	172	130	56	0.0	339	0.2	247	0.1	308	0.2	244	0.1	238	0.1
Existing	P-EX-106	J-EX-105	J-EX-106	PVC	204	19	130	0	0.0	0	0.0	278	0.1	362	0.2	278	0.1	362	0.2
Existing	P-EX-107	J-EX-090	J-EX-105	PVC	204	41	130	47	0.0	324	0.2	41	0.0	66	0.0	44	0.0	136	0.1
Existing	P-EX-108	J-EX-107	J-EX-108	PVC	204	156	130	43	0.1	203	0.4	396	0.2	505	0.3	397	0.2	391	0.2
Existing	P-EX-109	J-EX-108	J-EX-109	AC	148.6	110	130	154	0.2	827	0.8	361	0.4	461	0.4	363	0.4	354	0.3
Existing	P-EX-110	J-EX-109	J-EX-110	AC	148.6	132	130	142	0.1	808	0.8	350	0.3	446	0.4	351	0.3	338	0.3
Existing	P-EX-111	J-EX-110	J-EX-111	PVC	155	18	130	63	0.1	39	0.0	1	0.0	7	0.0	9	0.0	9	0.0
Existing	P-EX-112	J-EX-108	J-EX-112	AC	148.6	101	130	192	0.2	125	0.1	328	0.3	377	0.4	287	0.3	350	0.3
Existing	P-EX-113	J-EX-112	J-EX-113	AC	148.6	11	130	281	0.3	1,128	1.1	567	0.5	716	0.7	560	0.5	560	0.5
Existing	P-EX-114	J-EX-112	J-EX-114	PVC	204	70	130	8	0.0	13	0.0	8	0.0	11	0.0	8	0.0	11	0.0
Existing	P-EX-115	J-EX-114	J-EX-115	PVC	204	9	130	4	0.0	6	0.0	4	0.0	5	0.0	4	0.0	5	0.0
Existing	P-EX-116	J-EX-115	J-EX-116	PVC	204	85	130	2	0.0	4	0.0	2	0.0	3	0.0	2	0.0	3	0.0
Existing	P-EX-117	J-EX-103	J-EX-117	PVC	204	212	130	15	0.0	24	0.0	233	0.1	303	0.2	233	0.1	303	0.2
Existing	P-EX-118	J-EX-117	J-EX-118	PVC	204	14	130	2	0.0	3	0.0	220	0.1	286	0.2	220	0.1	286	0.2
Existing	P-EX-119	J-EX-036	J-EX-119	PVC	309	64	130	116	0.1	1,099	1.0	1,691	0.4	2,363	0.5	1,889	0.4	1,504	0.3
Existing	P-EX-120	J-EX-119	J-EX-120	PVC	309	120	130	104	0.1	1,080	1.0	1,680	0.4	2,348	0.5	1,878	0.4	1,488	0.3
Existing	P-EX-121	J-EX-120	J-EX-121	PVC	309	18	130	94	0.1	1,063	0.9	1,669	0.4	2,334	0.5	1,867	0.4	1,474	0.3
Existing	P-EX-122	J-EX-113	J-EX-122	AC	148.6	81	130	275	0.3	1,119	1.1	561	0.5	708	0.7	554	0.5	552	0.5
Existing	P-EX-123	J-EX-122	J-EX-123	PVC	309	153	130	74	0.1	769	0.7	1,378	0.3	1,857	0.4	1,489	0.3	1,208	0.3
Existing	P-EX-124	J-EX-123	J-EX-228	PVC	309	151	130	70	0.1	762	0.7	1,373	0.3	1,851	0.4	1,484	0.3	1,202	0.3
Existing	P-EX-125	J-EX-037	J-EX-125	PVC	250	104	130	13	0.0	20	0.0	13	0.0	17	0.0	13	0.0	16	0.0
Existing	P-EX-126	J-EX-125	J-EX-126	PVC	250	56	130	7	0.0	11	0.0	7	0.0	9	0.0	7	0.0	9	0.0
Existing	P-EX-127	J-EX-040	J-EX-127	PVC	155	80	110	102	0.1	1,523	1.4	355	0.3	602	0.5	490	0.4	210	0.2
Existing	P-EX-128	J-EX-127	J-EX-128	PVC	155	8	110	21	0.0	631	0.6	52	0.1	132	0.1	113	0.1	24	0.0
Existing	P-EX-129	J-EX-128	J-EX-129	PVC	155	93	110	16	0.0	623	0.6	47	0.0	125	0.1	108	0.1	31	0.0
Existing	P-EX-130	J-EX-121	J-EX-130	PVC	204	162	130	121	0.1	581	0.6	505	0.3	691	0.4	542	0.3	494	0.3
Existing	P-EX-131	J-EX-122	J-EX-131	AC	148.6	121	130	153	0.2	800	0.8	327	0.3	469	0.5	370	0.4	299	0.3
Existing	P-EX-132	J-EX-131	J-EX-132	PVC	250	4	130	188	0.1	1,475	0.5	624	0.2	911	0.3	724	0.3	538	0.2
Existing	P-EX-133	J-EX-132	J-EX-133	PVC	250	91	130	121	0.0	956	0.3	399	0.1	577	0.2	459	0.2	346	0.1
Existing	P-EX-134	J-EX-133	J-EX-134	PVC	250	8	130	116	0.0	948	0.3	394	0.1	571	0.2	454	0.2	340	0.1
Existing	P-EX-135	J-EX-134	J-EX-135	AC	101.6	93	130	6	0.0	10	0.0	6	0.0	8	0.0	6	0.0	8	0.0
Existing	P-EX-136	J-EX-110	J-EX-136	AC	148.6	109	130	197	0.2	834	0.8	342	0.3	427	0.4	333	0.3	336	0.3
Existing	P-EX-137	J-EX-136	J-EX-137	AC	148.6	77	130	186	0.2	818	0.8	332	0.3	414	0.4	323	0.3	323	0.3
Existing	P-EX-138	J-EX-124	J-EX-138	PVC	204	55	130	169	0.1	620	0.3	608	0.3	904	0.5	716	0.4	515	0.3
Existing	P-EX-139	J-EX-138	J-EX-139	PVC	204	80	130	158	0.1	603	0.3	597	0.3	890	0.5	705	0.4	501	0.3
Existing	P-EX-140	J-EX-139	J-EX-140	PVC	204	56	130	152	0.1	592	0.3	590	0.3	882	0.5	699	0.4	492	0.3
Existing	P-EX-141	J-EX-140	J-EX-141	PVC	204	92	130	181	0.1	354	0.2	126	0.1	277	0.1	209	0.1	139	0.1
Existing	P-EX-142	J-EX-141	J-EX-142	PVC	204	76	130	170	0.1	70	0.0	266	0.1	483	0.3	376	0.2	233	0.1
Existing	P-EX-143	J-EX-142	J-EX-143	PVC	204	12	130	165	0.1	62	0.0	262	0.1	476	0.2	371	0.2	227	0.1
Existing	P-EX-144	J-EX-143	J-EX-144	PVC	204	137	130	140	0.1	899	0.5	472	0.2	763	0.4	606	0.3	358	0.2
Existing	P-EX-145	J-EX-144	J-EX-145	PVC	204	16	130	120	0.1	867	0.4	452	0.2	737	0.4	586	0.3	332	0.2
Existing	P-EX-146	J-EX-145	J-EX-146	PVC	204	86	130	115	0.1	858	0.4	446	0.2	729	0.4	580	0.3	324	0.2
Existing	P-EX-147	J-EX-146	J-EX-147	PVC	204	16	130	98	0.1	832	0.4	430	0.2	708	0.4	564	0.3	303	0.2
Existing	P-EX-148	J-EX-147	J-EX-148	PVC	204	71	130	93	0.1	824	0.4	425	0.2	702	0.4	559	0.3	296	0.2
Existing	P-EX-149	J-EX-148	J-EX-149	PVC	204	92	130	48	0.0	482	0.3	296	0.2	567	0.3	446	0.2	223	0.1
Existing	P-EX-150	J-EX-149	J-EX-150	PVC	204	19	130	42	0.0	472	0.2	289	0.2	558	0.3	439	0.2	214	0.1
Existing	P-EX-151	J-EX-138	J-EX-151	PVC	155	38	130	5	0.0	8	0.0	5	0.0	7	0.0	5	0.0	7	0.0
Existing	P-EX-152	J-EX-140	J-EX-152	PVC	155	46	130	6	0.0	9	0.0	6	0.0	8	0.0	6	0.0	8	0.0
Existing	P-EX-153	J-EX-141	J-EX-153	PVC	155	73	130	4	0.0	448	0.4	156	0.1	226	0.2	182	0.2	113	0.1
Existing	P-EX-154	J-EX-153	J-EX-154	PVC	155	23	130	8	0.0	13	0.0	8	0.0	10	0.0	8	0.0	10	0.0

Phase	Pipe ID	Start Node	Stop Node	Material	Diameter (mm)	Length (m)	Hazen-Williams C	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Build-out) PHD	
								Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)
Existing	P-EX-155	J-EX-153	J-EX-155	PVC	155	61	130	15	0.0	467	0.4	168	0.2	241	0.2	194	0.2	129	0.1
Existing	P-EX-156	J-EX-143	J-EX-156	PVC	155	107	130	10	0.0	16	0.0	10	0.0	13	0.0	10	0.0	13	0.0
Existing	P-EX-157	J-EX-156	J-EX-157	PVC	155	4	130	5	0.0	7	0.0	5	0.0	6	0.0	5	0.0	6	0.0
Existing	P-EX-158	J-EX-143	J-EX-158	PVC	204	131	130	6	0.0	867	0.4	229	0.1	311	0.2	254	0.1	156	0.1
Existing	P-EX-159	J-EX-158	J-EX-159	PVC	204	2	130	17	0.0	763	0.4	237	0.1	338	0.2	273	0.1	177	0.1
Existing	P-EX-160	J-EX-159	J-EX-160	PVC	204	95	130	11	0.0	399	0.2	84	0.0	104	0.1	86	0.0	60	0.0
Existing	P-EX-161	J-EX-160	J-EX-161	PVC	204	4	130	12	0.0	495	0.3	130	0.1	169	0.1	138	0.1	101	0.1
Existing	P-EX-162	J-EX-161	J-EX-162	PVC	204	194	130	39	0.0	3	0.0	79	0.0	143	0.1	111	0.1	69	0.0
Existing	P-EX-163	J-EX-159	J-EX-163	AC	148.6	8	130	30	0.0	369	0.4	156	0.2	238	0.2	190	0.2	120	0.1
Existing	P-EX-164	J-EX-163	J-EX-164	AC	148.6	175	130	39	0.0	382	0.4	164	0.2	249	0.2	198	0.2	131	0.1
Existing	P-EX-165	J-EX-134	J-EX-165	AC	148.6	48	130	107	0.1	933	0.9	384	0.4	559	0.5	445	0.4	328	0.3
Existing	P-EX-166	J-EX-165	J-EX-166	PVC	155	83	130	38	0.0	503	0.4	190	0.2	271	0.2	217	0.2	158	0.1
Existing	P-EX-167	J-EX-166	J-EX-167	PVC	155	58	130	6	0.0	10	0.0	6	0.0	8	0.0	6	0.0	8	0.0
Existing	P-EX-168	J-EX-132	J-EX-168	AC	148.6	331	130	61	0.1	509	0.5	220	0.2	326	0.3	259	0.3	184	0.2
Existing	P-EX-169	J-EX-158	J-EX-169	PVC	155	110	130	18	0.0	111	0.1	3	0.0	21	0.0	14	0.0	15	0.0
Existing	P-EX-170	J-EX-160	J-EX-170	PVC	155	99	130	19	0.0	90	0.1	43	0.0	61	0.1	48	0.0	36	0.0
Existing	P-EX-171	J-EX-162	J-EX-171	PVC	155	92	130	1	0.0	78	0.1	10	0.0	36	0.0	27	0.0	5	0.0
Existing	P-EX-172	J-EX-130	J-EX-172	PVC	204	157	130	21	0.0	34	0.0	21	0.0	27	0.0	21	0.0	27	0.0
Existing	P-EX-173	J-EX-172	J-EX-173	AC	148.6	8	130	6	0.0	9	0.0	5	0.0	7	0.0	6	0.0	7	0.0
Existing	P-EX-174	J-EX-127	J-EX-174	PVC	155	162	130	76	0.1	883	0.8	298	0.3	463	0.4	371	0.3	227	0.2
Existing	P-EX-175	J-EX-174	J-EX-175	PVC	204	50	130	113	0.1	1,308	0.7	487	0.3	753	0.4	603	0.3	368	0.2
Existing	P-EX-176	J-EX-175	J-EX-176	PVC	204	53	130	111	0.1	1,305	0.7	485	0.3	750	0.4	601	0.3	365	0.2
Existing	P-EX-177	J-EX-176	J-EX-177	PVC	204	154	130	106	0.1	1,296	0.7	480	0.2	743	0.4	596	0.3	358	0.2
Existing	P-EX-178	J-EX-177	J-EX-178	PVC	204	10	130	132	0.1	1,194	0.6	556	0.3	904	0.5	720	0.4	414	0.2
Existing	P-EX-179	J-EX-178	J-EX-179	PVC	204	227	130	122	0.1	1,178	0.6	546	0.3	892	0.5	710	0.4	401	0.2
Existing	P-EX-180	J-EX-179	J-EX-180	PVC	204	44	130	8	0.0	13	0.0	8	0.0	11	0.0	8	0.0	11	0.0
Existing	P-EX-181	J-EX-141	J-EX-181	PVC	155	56	130	9	0.0	15	0.0	9	0.0	12	0.0	9	0.0	12	0.0
Existing	P-EX-182	J-EX-144	J-EX-182	PVC	155	126	130	11	0.0	18	0.0	11	0.0	15	0.0	11	0.0	15	0.0
Existing	P-EX-183	J-EX-146	J-EX-183	PVC	155	125	130	11	0.0	17	0.0	11	0.0	14	0.0	11	0.0	14	0.0
Existing	P-EX-184	J-EX-148	J-EX-184	PVC	204	83	130	21	0.0	443	0.2	133	0.1	100	0.1	93	0.1	40	0.0
Existing	P-EX-185	J-EX-184	J-EX-185	PVC	204	48	130	14	0.0	432	0.2	126	0.1	91	0.1	86	0.0	31	0.0
Existing	P-EX-186	J-EX-185	J-EX-186	PVC	204	45	130	0	0.0	410	0.2	112	0.1	72	0.0	72	0.0	13	0.0
Existing	P-EX-187	J-EX-140	J-EX-187	PVC	204	67	130	44	0.0	923	0.5	450	0.2	587	0.3	475	0.2	334	0.2
Existing	P-EX-188	J-EX-185	J-EX-188	PVC	155	67	130	8	0.0	14	0.0	8	0.0	11	0.0	8	0.0	11	0.0
Existing	P-EX-189	J-EX-148	J-EX-189	PVC	204	91	130	16	0.0	113	0.1	12	0.0	26	0.0	13	0.0	24	0.0
Existing	P-EX-190	J-EX-189	J-EX-190	PVC	204	13	130	4	0.0	6	0.0	4	0.0	5	0.0	4	0.0	5	0.0
Existing	P-EX-191	J-EX-189	J-EX-191	PVC	155	93	130	11	0.0	122	0.1	17	0.0	19	0.0	8	0.0	17	0.0
Existing	P-EX-192	J-EX-191	J-EX-192	PVC	155	65	130	8	0.0	12	0.0	8	0.0	10	0.0	8	0.0	10	0.0
Existing	P-EX-193	J-EX-191	J-EX-193	PVC	155	15	130	1	0.0	141	0.1	29	0.0	3	0.0	5	0.0	1	0.0
Existing	P-EX-194	J-EX-193	J-EX-194	PVC	155	90	130	6	0.0	149	0.1	34	0.0	3	0.0	9	0.0	5	0.0
Existing	P-EX-195	J-EX-194	J-EX-195	PVC	155	65	130	8	0.0	13	0.0	8	0.0	11	0.0	8	0.0	11	0.0
Existing	P-EX-196	J-EX-194	J-EX-196	PVC	155	88	130	23	0.0	176	0.2	51	0.0	25	0.0	26	0.0	27	0.0
Existing	P-EX-197	J-EX-196	J-EX-197	PVC	155	72	130	12	0.0	18	0.0	11	0.0	15	0.0	12	0.0	15	0.0
Existing	P-EX-198	J-EX-179	J-EX-198	PVC	155	12	130	46	0.0	213	0.2	74	0.1	55	0.1	49	0.0	57	0.1
Existing	P-EX-199	J-EX-196	J-EX-198	PVC	155	68	130	41	0.0	205	0.2	69	0.1	49	0.0	45	0.0	51	0.0
Existing	P-EX-200	J-EX-101	J-EX-200	PVC	155	70	130	28	0.0	44	0.0	28	0.0	36	0.0	28	0.0	36	0.0
Existing	P-EX-201	J-EX-200	J-EX-201	PVC	155	94	130	19	0.0	30	0.0	19	0.0	25	0.0	19	0.0	25	0.0
Existing	P-EX-202	J-EX-102	J-EX-202	PVC	155	69	130	14	0.0	23	0.0	14	0.0	19	0.0	14	0.0	19	0.0
Existing	P-EX-203	J-EX-102	J-EX-203	PVC	204	65	130	171	0.1	700	0.4	141	0.1	174	0.1	133	0.1	130	0.1
Existing	P-EX-204	J-EX-203	J-EX-204	PVC	204	29	130	166	0.1	691	0.4	136	0.1	167	0.1	127	0.1	123	0.1
Existing	P-EX-205	J-EX-204	J-EX-205	PVC	204	148	130	89	0.1	434	0.2	214	0.1	264	0.1	209	0.1	191	0.1

Phase	Pipe ID	Start Node	Stop Node	Material	Diameter (mm)	Length (m)	Hazen-Williams C	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Build-out) PHD	
								Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)
Existing	P-EX-206	J-EX-206	J-EX-222	PVC	309	172	130	193	0.0	1,556	0.4	1,174	0.3	1,451	0.3	1,160	0.3	1,056	0.2
Existing	P-EX-207	J-EX-206	J-EX-207	PVC	309	38	130	213	0.1	1,722	0.4	1,011	0.2	1,237	0.3	995	0.2	847	0.2
Existing	P-EX-208	J-EX-207	J-EX-208	PVC	309	49	130	207	0.1	1,714	0.4	1,005	0.2	1,231	0.3	990	0.2	840	0.2
Existing	P-EX-209	J-EX-208	J-EX-209	PVC	309	91	130	195	0.0	1,714	0.4	931	0.2	1,133	0.3	915	0.2	733	0.2
Existing	P-EX-210	J-EX-209	J-EX-210	PVC	155	65	130	21	0.0	219	0.2	108	0.1	129	0.1	106	0.1	62	0.1
Existing	P-EX-211	J-EX-210	J-EX-211	PVC	155	70	130	29	0.0	233	0.2	117	0.1	140	0.1	114	0.1	74	0.1
Existing	P-EX-212	J-EX-208	J-EX-211	PVC	155	62	130	4	0.0	13	0.0	66	0.1	88	0.1	67	0.1	97	0.1
Existing	P-EX-213	J-EX-212	J-EX-213	PVC	204	55	130	51	0.0	335	0.2	257	0.1	316	0.2	253	0.1	202	0.1
Existing	P-EX-214	J-EX-213	J-EX-214	PVC	204	17	130	49	0.0	332	0.2	255	0.1	313	0.2	251	0.1	199	0.1
Existing	P-EX-215	J-EX-214	J-EX-215	PVC	204	162	130	10	0.0	64	0.0	190	0.1	242	0.1	190	0.1	204	0.1
Existing	P-EX-216	J-EX-215	J-EX-216	PVC	155	165	130	41	0.0	362	0.3	134	0.1	155	0.1	130	0.1	48	0.0
Existing	P-EX-217	J-EX-209	J-EX-217	PVC	309	88	130	208	0.1	1,920	0.4	1,031	0.2	1,251	0.3	1,013	0.2	784	0.2
Existing	P-EX-218	J-EX-217	J-EX-218	PVC	309	5	130	242	0.1	2,271	0.5	866	0.2	1,017	0.2	844	0.2	444	0.1
Existing	P-EX-219	J-EX-217	J-EX-219	PVC	309	47	130	0	0.0	0	0.0	292	0.1	380	0.1	292	0.1	380	0.1
Existing	P-EX-220	J-EX-218	J-EX-220	PVC	309	57	130	239	0.1	2,267	0.5	864	0.2	1,014	0.2	841	0.2	440	0.1
Existing	P-EX-221	J-EX-212	J-EX-221	PVC	155	8	130	2	0.0	3	0.0	2	0.0	2	0.0	2	0.0	2	0.0
Existing	P-EX-222	J-EX-205	J-EX-222	PVC	309	12	130	200	0.0	1,566	0.4	1,181	0.3	1,459	0.3	1,166	0.3	1,065	0.2
Existing	P-EX-223	J-EX-204	J-EX-223	PVC	204	162	130	67	0.0	241	0.1	88	0.0	109	0.1	91	0.1	81	0.0
Existing	P-EX-224	J-EX-205	J-EX-224	PVC	309	90	130	118	0.0	1,144	0.3	974	0.2	1,205	0.3	965	0.2	883	0.2
Existing	P-EX-225	J-EX-103	J-EX-225	PVC	204	89	130	90	0.1	533	0.3	113	0.1	128	0.1	108	0.1	18	0.0
Existing	P-EX-226	J-EX-026	J-EX-071	PVC	392.9	227	130	299	0.1	1,707	0.6	1,202	0.2	3,381	0.5	2,582	0.3	1,755	0.2
Existing	P-EX-227	J-EX-032	J-EX-107	PVC	204	181	130	68	0.1	243	0.5	420	0.2	537	0.3	421	0.2	423	0.2
Existing	P-EX-228	J-EX-034	J-EX-112	PVC	204	338	130	104	0.1	1,277	0.7	254	0.1	359	0.2	288	0.2	230	0.1
Existing	P-EX-229	J-EX-060	J-EX-067	PVC	250	21	130	92	0.0	513	0.2	38	0.0	367	0.1	281	0.1	68	0.0
Existing	P-EX-230	J-EX-061	J-EX-062	PVC	250	76	130	333	0.1	1,397	0.5	212	0.1	1,015	0.3	778	0.3	315	0.1
Existing	P-EX-231	J-EX-069	J-EX-070	PVC	204	146	130	321	0.2	1,377	0.7	663	0.3	968	0.5	742	0.4	749	0.4
Existing	P-EX-232	J-EX-077	J-EX-079	PVC	155	52	130	1	0.0	2	0.0	1	0.0	2	0.0	1	0.0	1	0.0
Existing	P-EX-233	J-EX-083	J-EX-084	PVC	155	134	130	102	0.1	186	0.2	115	0.1	118	0.1	88	0.1	118	0.1
Existing	P-EX-234	J-EX-095	J-EX-108	AC	148.6	100	130	316	0.3	519	0.5	306	0.3	351	0.3	267	0.3	329	0.3
Existing	P-EX-235	J-EX-095	J-EX-096	AC	148.6	16	130	123	0.1	158	0.2	179	0.2	200	0.2	151	0.2	193	0.2
Existing	P-EX-236	J-EX-098	J-EX-111	PVC	155	87	130	70	0.1	51	0.0	8	0.0	2	0.0	2	0.0	18	0.0
Existing	P-EX-237	J-EX-098	J-EX-099	PVC	155	54	130	233	0.2	836	0.7	395	0.4	487	0.4	380	0.3	391	0.4
Existing	P-EX-238	J-EX-121	J-EX-122	PVC	309	135	130	38	0.0	466	0.4	1,154	0.3	1,630	0.4	1,314	0.3	967	0.2
Existing	P-EX-239	J-EX-124	J-EX-137	PVC	204	46	130	105	0.1	629	0.3	613	0.3	911	0.5	721	0.4	522	0.3
Existing	P-EX-240	J-EX-129	J-EX-130	PVC	155	91	110	48	0.0	156	0.1	169	0.2	198	0.2	150	0.1	205	0.2
Existing	P-EX-241	J-EX-129	J-EX-174	AC	148.6	260	130	51	0.1	447	0.4	204	0.2	308	0.3	246	0.2	159	0.2
Existing	P-EX-242	J-EX-130	J-EX-131	AC	148.6	96	130	40	0.0	684	0.7	303	0.3	449	0.4	359	0.4	246	0.2
Existing	P-EX-243	J-EX-137	J-EX-224	PVC	309	155	130	74	0.0	939	0.2	1,084	0.2	1,344	0.3	1,079	0.2	993	0.2
Existing	P-EX-244	J-EX-155	J-EX-166	PVC	155	138	130	25	0.0	482	0.4	177	0.2	254	0.2	203	0.2	141	0.1
Existing	P-EX-245	J-EX-161	J-EX-168	AC	148.6	7	130	55	0.1	499	0.5	213	0.2	318	0.3	253	0.2	176	0.2
Existing	P-EX-246	J-EX-162	J-EX-177	PVC	204	95	130	31	0.0	94	0.1	81	0.0	168	0.1	130	0.1	63	0.0
Existing	P-EX-247	J-EX-164	J-EX-165	AC	148.6	107	130	59	0.1	415	0.4	185	0.2	276	0.3	219	0.2	158	0.2
Existing	P-EX-248	J-EX-169	J-EX-170	PVC	155	87	130	7	0.0	128	0.1	8	0.0	7	0.0	3	0.0	1	0.0
Existing	P-EX-249	J-EX-170	J-EX-171	PVC	155	134	130	15	0.0	55	0.1	24	0.0	54	0.1	41	0.0	23	0.0
Existing	P-EX-250	J-EX-206	J-EX-225	PVC	204	149	130	30	0.0	184	0.1	153	0.1	200	0.1	154	0.1	195	0.1
Existing	P-EX-251	J-EX-211	J-EX-214	PVC	155	87	130	31	0.0	254	0.2	56	0.1	59	0.1	53	0.1	17	0.0
Existing	P-EX-252	J-EX-212	J-EX-225	PVC	204	15	130	54	0.0	340	0.2	260	0.1	320	0.2	256	0.1	206	0.1
Existing	P-EX-253	J-EX-216	J-EX-217	PVC	155	2	130	34	0.0	352	0.3	128	0.1	147	0.1	124	0.1	40	0.0
Existing	P-EX-254	J-EX-223	J-EX-224	PVC	204	76	130	55	0.0	221	0.1	100	0.1	125	0.1	103	0.1	97	0.1
Existing	P-EX-255	J-EX-227	J-EX-052	PVC	250	67	130	335	0.1	1,766	0.6	160	0.1	1,265	0.4	969	0.3	266	0.1
Existing	P-EX-256	J-EX-226	J-EX-062	PVC	250	486	130	547	0.2	2,104	0.7	371	0.1	1,539	0.5	1,180	0.4	540	0.2

Phase	Pipe ID	Start Node	Stop Node	Material	Diameter (mm)	Length (m)	Hazen-Williams C	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Build-out) PHD	
								Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)
Existing	P-EX-257	J-EX-228	J-EX-124	AC	148.6	62	130	70	0.1	-	-	-	-	-	-	-	-	-	-
Existing	P-EX-258	J-EX-229	J-EX-226	PVC	250	389	130	6	0.0	9	0.0	1,296	0.4	8	0.0	6	0.0	1,307	0.4
Existing	P-EX-259	J-EX-037	J-EX-230	AC	155	93	130	24	0.0	38	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Existing	P-EX-260	J-EX-230	J-EX-231	AC	155	301	130	12	0.0	19	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	P-HL-001	J-VC-016	J-HL-001	PVC	204	40	130	-	-	263	0.1	337	0.2	989	0.5	777	0.4	232	0.1
Near Term ASPs	P-HL-002	J-HL-001	J-HL-002	PVC	204	82	130	-	-	124	0.1	192	0.1	600	0.3	471	0.2	127	0.1
Near Term ASPs	P-HL-003	J-HL-003	J-HL-004	PVC	309	100	130	-	-	815	0.2	846	0.2	2,176	0.5	1,739	0.4	242	0.1
Near Term ASPs	P-HL-004	J-HL-006	J-HL-007	PVC	250	99	130	-	-	163	0.1	149	0.1	538	0.2	447	0.2	241	0.1
Near Term ASPs	P-HL-005	J-HL-009	J-HL-010	PVC	204	99	130	-	-	10	0.0	34	0.0	171	0.1	135	0.1	33	0.0
Near Term ASPs	P-HL-006	J-HL-012	J-HL-013	PVC	250	79	130	-	-	7	0.0	349	0.1	2,011	0.7	1,573	0.5	183	0.1
Near Term ASPs	P-HL-007	J-HL-012	J-HL-014	PVC	250	137	130	-	-	53	0.0	88	0.0	646	0.2	505	0.2	77	0.0
Near Term ASPs	P-HL-008	J-HL-014	J-HL-015	PVC	250	226	130	-	-	89	0.0	176	0.1	761	0.3	593	0.2	38	0.0
Near Term ASPs	P-HL-009	J-HL-015	J-HL-016	PVC	250	104	130	-	-	136	0.1	206	0.1	799	0.3	623	0.2	76	0.0
Near Term ASPs	P-HL-010	J-HL-016	J-HL-011	PVC	250	130	130	-	-	149	0.1	243	0.1	1,000	0.3	778	0.3	76	0.0
Near Term ASPs	P-HL-011	J-HL-005	J-HL-017	PVC	204	151	130	-	-	209	0.1	120	0.1	51	0.0	56	0.0	91	0.1
Near Term ASPs	P-HL-012	J-HL-017	J-HL-018	PVC	204	99	130	-	-	30	0.0	10	0.0	77	0.0	46	0.0	46	0.0
Near Term ASPs	P-HL-013	J-HL-018	J-HL-019	PVC	204	109	130	-	-	31	0.0	15	0.0	28	0.0	15	0.0	13	0.0
Near Term ASPs	P-HL-014	J-HL-019	J-HL-020	PVC	204	12	130	-	-	7	0.0	0	0.0	48	0.0	30	0.0	32	0.0
Near Term ASPs	P-HL-015	J-HL-020	J-HL-021	PVC	204	144	130	-	-	108	0.1	69	0.0	105	0.1	77	0.0	96	0.1
Near Term ASPs	P-HL-016	J-HL-021	J-HL-022	PVC	204	138	130	-	-	75	0.0	47	0.0	64	0.0	49	0.0	62	0.0
Near Term ASPs	P-HL-017	J-HL-022	J-HL-023	PVC	204	31	130	-	-	18	0.0	12	0.0	17	0.0	13	0.0	16	0.0
Near Term ASPs	P-HL-018	J-HL-023	J-HL-024	PVC	204	118	130	-	-	16	0.0	10	0.0	11	0.0	9	0.0	12	0.0
Near Term ASPs	P-HL-019	J-HL-024	J-HL-025	PVC	204	97	130	-	-	87	0.0	54	0.0	68	0.0	53	0.0	70	0.0
Near Term ASPs	P-HL-020	J-HL-025	J-HL-026	PVC	204	20	130	-	-	117	0.1	72	0.0	78	0.0	64	0.0	86	0.0
Near Term ASPs	P-HL-021	J-HL-026	J-HL-017	PVC	204	87	130	-	-	142	0.1	88	0.0	98	0.1	80	0.0	107	0.1
Near Term ASPs	P-HL-022	J-HL-018	J-HL-027	PVC	204	88	130	-	-	39	0.0	29	0.0	79	0.0	54	0.0	63	0.0
Near Term ASPs	P-HL-023	J-HL-027	J-HL-028	PVC	204	136	130	-	-	74	0.0	51	0.0	108	0.1	76	0.0	92	0.1
Near Term ASPs	P-HL-024	J-HL-028	J-HL-020	PVC	204	78	130	-	-	118	0.1	79	0.0	166	0.1	118	0.1	142	0.1
Near Term ASPs	P-HL-025	J-HL-028	J-HL-029	PVC	204	137	130	-	-	230	0.1	154	0.1	305	0.2	218	0.1	265	0.1
Near Term ASPs	P-HL-026	J-HL-029	J-HL-030	PVC	309	16	130	-	-	0	0.0	115	0.0	352	0.1	352	0.1	714	0.2
Near Term ASPs	P-HL-027	J-HL-029	J-HL-031	PVC	309	26	130	-	-	230	0.1	269	0.1	657	0.2	570	0.1	449	0.1
Near Term ASPs	P-HL-028	J-HL-031	J-HL-004	PVC	309	191	130	-	-	276	0.1	297	0.1	694	0.2	599	0.1	412	0.1
Near Term ASPs	P-HL-029	J-HL-004	J-HL-032	PVC	309	23	130	-	-	503	0.1	527	0.1	1,452	0.3	1,118	0.3	624	0.1
Near Term ASPs	P-HL-030	J-HL-032	J-HL-005	PVC	309	103	130	-	-	484	0.1	514	0.1	1,437	0.3	1,106	0.3	608	0.1
Near Term ASPs	P-HL-031	J-HL-007	J-HL-033	PVC	155	41	130	-	-	70	0.1	44	0.0	57	0.1	44	0.0	57	0.1
Near Term ASPs	P-HL-032	J-HL-033	J-HL-034	PVC	155	132	130	-	-	37	0.0	23	0.0	30	0.0	23	0.0	30	0.0
Near Term ASPs	P-HL-033	J-HL-002	J-HL-035	PVC	309	100	130	-	-	736	0.2	624	0.1	1,337	0.3	1,077	0.2	160	0.0
Near Term ASPs	P-HL-034	J-HL-035	J-HL-036	PVC	204	102	130	-	-	169	0.1	144	0.1	309	0.2	249	0.1	34	0.0
Near Term ASPs	P-HL-035	J-HL-036	J-HL-037	PVC	204	119	130	-	-	203	0.1	165	0.1	337	0.2	270	0.1	62	0.0
Near Term ASPs	P-HL-036	J-HL-037	J-VC-012	PVC	309	53	130	-	-	872	0.2	710	0.2	1,447	0.3	1,162	0.3	270	0.1
Near Term ASPs	P-HL-037	J-HL-037	J-HL-038	PVC	309	93	130	-	-	636	0.1	524	0.1	1,083	0.2	871	0.2	181	0.0
Near Term ASPs	P-HL-038	J-HL-038	J-HL-035	PVC	309	91	130	-	-	600	0.1	501	0.1	1,053	0.2	848	0.2	151	0.0
Near Term ASPs	P-HL-039	J-HL-001	J-HL-039	PVC	204	199	130	-	-	111	0.1	128	0.1	367	0.2	288	0.2	82	0.0
Near Term ASPs	P-HL-040	J-HL-039	J-HL-040	PVC	204	12	130	-	-	69	0.0	102	0.1	333	0.2	262	0.1	48	0.0
Near Term ASPs	P-HL-041	J-HL-040	J-HL-002	PVC	204	155	130	-	-	89	0.1	55	0.0	50	0.0	42	0.0	24	0.0
Near Term ASPs	P-HL-042	J-HL-040	J-HL-003	PVC	204	240	130	-	-	118	0.1	132	0.1	350	0.2	279	0.1	40	0.0
Near Term ASPs	P-HL-043	J-HL-008	J-HL-041	PVC	155	143	130	-	-	38	0.0	24	0.0	31	0.0	24	0.0	31	0.0
Near Term ASPs	P-HL-044	J-HL-022	J-HL-042	PVC	204	149	130	-	-	21	0.0	13	0.0	18	0.0	14	0.0	17	0.0
Near Term ASPs	P-HL-045	J-HL-042	J-HL-024	PVC	204	131	130	-	-	26	0.0	16	0.0	20	0.0	16	0.0	21	0.0
Near Term ASPs	P-HL-046	J-HL-005	J-HL-043	PVC	309	45	130	-	-	242	0.1	374	0.1	1,358	0.3	1,029	0.2	490	0.1
Near Term ASPs	P-HL-047	J-HL-043	J-HL-006	PVC	309	153	130	-	-	199	0.0	347	0.1	1,324	0.3	1,002	0.2	455	0.1

Phase	Pipe ID	Start Node	Stop Node	Material	Diameter (mm)	Length (m)	Hazen-Williams C	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Build-out) PHD	
								Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)
Near Term ASPs	P-HL-048	J-HL-044	J-HL-008	PVC	204	11	130	-	-	207	0.1	203	0.1	605	0.3	474	0.2	59	0.0
Near Term ASPs	P-HL-049	J-HL-008	J-HL-045	PVC	204	280	130	-	-	121	0.1	150	0.1	536	0.3	421	0.2	10	0.0
Near Term ASPs	P-HL-050	J-HL-045	J-HL-009	PVC	204	87	130	-	-	51	0.0	106	0.1	479	0.2	377	0.2	67	0.0
Near Term ASPs	P-HL-051	J-HL-010	J-HL-046	PVC	204	98	130	-	-	2	0.0	76	0.0	439	0.2	347	0.2	107	0.1
Near Term ASPs	P-HL-052	J-HL-046	J-HL-011	PVC	204	96	130	-	-	30	0.0	56	0.0	413	0.2	327	0.2	133	0.1
Near Term ASPs	P-HL-053	J-HL-002	J-HL-047	PVC	309	43	130	-	-	746	0.2	745	0.2	1,866	0.4	1,491	0.3	242	0.1
Near Term ASPs	P-HL-054	J-HL-047	J-HL-003	PVC	309	41	130	-	-	731	0.2	736	0.2	1,853	0.4	1,481	0.3	230	0.1
Near Term ASPs	P-HL-055	J-HL-009	J-HL-010	PVC	204	38	130	-	-	16	0.0	57	0.0	287	0.2	227	0.1	55	0.0
Near Term ASPs	P-HL-056	J-HL1-004	J-HL-044	PVC	204	35	130	-	-	216	0.1	209	0.1	613	0.3	480	0.2	67	0.0
Near Term ASPs	P-HL-057	J-HL-007	J-HL1-003	PVC	250	93	130	-	-	257	0.1	208	0.1	614	0.2	506	0.2	165	0.1
Near Term ASPs	P-HL-058	J-HL-011	J-HL-048	PVC	250	66	130	-	-	79	0.0	273	0.1	1,380	0.5	1,080	0.4	90	0.0
Near Term ASPs	P-HL-059	J-HL-048	J-HL-012	PVC	250	8	130	-	-	67	0.0	265	0.1	1,371	0.5	1,072	0.4	100	0.0
Near Term ASPs	P-HL-060	J-HL-025	J-HL-049	PVC	204	225	130	-	-	3	0.0	3	0.0	17	0.0	10	0.0	10	0.0
Near Term ASPs	P-HL-061	J-HL-049	J-HL-021	PVC	204	27	130	-	-	33	0.0	22	0.0	41	0.0	28	0.0	34	0.0
Near Term ASPs	P-HL-062	J-HL-016	J-HL-050	PVC	250	82	130	-	-	316	0.1	468	0.2	1,825	0.6	1,421	0.5	177	0.1
Near Term ASPs	P-HL-063	J-HL-050	J-HL-006	PVC	250	15	130	-	-	337	0.1	481	0.2	1,842	0.6	1,434	0.5	194	0.1
Near Term ASPs	P-HL1-001	J-HL1-001	J-IL3-001	PVC	250	74	130	-	-	319	0.1	262	0.1	746	0.3	601	0.2	90	0.0
Near Term ASPs	P-HL1-001	J-HL1-007	J-HL1-010	PVC	155	22	130	-	-	319	0.1	17	0.0	746	0.3	601	0.2	90	0.0
Near Term ASPs	P-HL1-002	J-HL1-002	J-HL1-001	PVC	250	69	130	-	-	42	0.0	15	0.0	84	0.0	83	0.0	206	0.1
Near Term ASPs	P-HL1-003	J-HL1-003	J-HL1-002	PVC	250	50	130	-	-	284	0.1	225	0.1	637	0.2	523	0.2	143	0.1
Near Term ASPs	P-HL1-004	J-HL1-001	J-HL1-004	PVC	204	49	130	-	-	232	0.1	219	0.1	626	0.3	490	0.3	80	0.0
Near Term ASPs	P-HL1-005	J-HL1-002	J-HL1-005	PVC	204	81	130	-	-	261	0.1	222	0.1	568	0.3	452	0.2	79	0.0
Near Term ASPs	P-HL1-006	J-HL1-005	J-HL1-006	PVC	204	16	130	-	-	279	0.1	234	0.1	583	0.3	464	0.2	94	0.1
Near Term ASPs	P-HL1-007	J-HL1-007	J-HL1-006	PVC	204	225	130	-	-	127	0.1	106	0.1	263	0.1	209	0.1	43	0.0
Near Term ASPs	P-HL1-008	J-HL1-008	J-HL1-007	PVC	204	78	130	-	-	180	0.1	139	0.1	306	0.2	242	0.1	86	0.0
Near Term ASPs	P-HL1-009	J-HL1-009	J-HL1-008	PVC	204	8	130	-	-	196	0.1	149	0.1	319	0.2	252	0.1	99	0.1
Near Term ASPs	P-HL1-010	J-HL1-009	J-EX-186	PVC	204	195	130	-	-	411	0.2	316	0.2	691	0.4	546	0.3	201	0.1
Near Term ASPs	P-HL1-012	J-HL1-006	J-HL1-009	PVC	204	209	130	-	-	179	0.1	144	0.1	342	0.2	271	0.1	72	0.0
Near Term ASPs	PH-VC-001	J-VC-018	H-VC-001	PVC	155	12	130	-	-	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC-002	H-VC-002	J-VC-030	PVC	155	8	130	-	-	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC-003	H-VC-003	J-VC-029	PVC	155	12	130	-	-	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC-004	H-VC-004	J-VC-028	PVC	155	5	130	-	-	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC-005	H-VC-005	J-VC-002	PVC	155	16	130	-	-	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC-006	H-VC-006	J-VC-011	PVC	155	13	130	-	-	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC-007	H-VC-007	J-VC-005	PVC	155	11	130	-	-	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC-008	H-VC-008	J-VC-032	PVC	155	15	130	-	-	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC-009	H-VC-009	J-VC-031	PVC	155	15	130	-	-	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC-010	J-VC-008	H-VC-010	PVC	155	15	130	-	-	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC-011	H-VC-011	J-HL-001	PVC	155	20	130	-	-	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC1-001	J-VC1-009	H-VC1-001	PVC	155	9	130	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC1-002	J-VC1-008	H-VC1-002	PVC	155	9	130	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC1-003	J-VC1-017	H-VC1-003	PVC	155	5	130	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC1-004	J-VC1-006	H-VC1-004	PVC	155	8	130	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC1-005	J-VC1-013	H-VC1-005	PVC	155	5	130	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC1-006	J-VC1-010	H-VC1-006	PVC	155	8	130	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC3-001	J-VC3-007	H-VC3-001	PVC	155	5	130	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC3-002	J-VC3-003	H-VC3-002	PVC	155	9	130	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC3-003	J-VC3-013	H-VC3-003	PVC	155	4	130	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	PH-VC3-004	J-VC3-010	H-VC3-004	PVC	155	5	130	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	P-IL-001	J-IL3-006	J-IL-001	PVC	250	94	130	-	-	498	0.2	197	0.1	349	0.1	275	0.1	199	0.1
Near Term ASPs	P-IL-002	J-IL-001	J-IL-002	PVC	250	92	130	-	-	384	0.1	117	0.0	191	0.1	150	0.1	132	0.0

Phase	Pipe ID	Start Node	Stop Node	Material	Diameter (mm)	Length (m)	Hazen-Williams C	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Build-out) PHD	
								Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)
Near Term ASPs	P-IL-003(1)	J-IL-002	PRV-66	PVC	250	21	130	-	-	-	-	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	P-IL-003(2)	PRV-66	J-IL-012	PVC	250	119	130	-	-	-	-	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	P-IL-004	J-IL-012	J-IL-016	PVC	250	185	130	-	-	202	0.1	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	P-IL-005	J-IL-016	J-IL-003	PVC	250	77	130	-	-	202	0.1	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	P-IL-006	J-IL-003	J-IL-004	PVC	250	97	130	-	-	35	0.0	104	0.0	136	0.1	104	0.0	136	0.1
Near Term ASPs	P-IL-007	J-IL-005	J-IL-011	PVC	204	146	130	-	-	97	0.1	64	0.0	122	0.1	97	0.1	63	0.0
Near Term ASPs	P-IL-008	J-IL-011	J-IL-002	PVC	204	154	130	-	-	97	0.1	64	0.0	122	0.1	97	0.1	63	0.0
Near Term ASPs	P-IL-009	J-IL-001	J-IL-006	PVC	204	324	130	-	-	77	0.0	57	0.0	127	0.1	102	0.1	36	0.0
Near Term ASPs	P-IL-010	J-IL-006	J-IL-007	PVC	155	102	130	-	-	32	0.0	20	0.0	26	0.0	20	0.0	26	0.0
Near Term ASPs	P-IL-011	J-IL-006	J-IL-005	PVC	204	86	130	-	-	257	0.1	84	0.0	70	0.0	50	0.0	129	0.1
Near Term ASPs	P-IL-012(1)	J-IL-004	PRV-68	PVC	204	70	130	-	-	-	-	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	P-IL-012(2)	PRV-68	J-IL-015	PVC	204	24	130	-	-	-	-	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	P-IL-013	J-IL-015	J-IL-008	PVC	204	149	130	-	-	43	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	P-IL-014	J-IL-008	J-IL-005	PVC	204	57	130	-	-	208	0.1	103	0.1	134	0.1	103	0.1	134	0.1
Near Term ASPs	P-IL-015	J-IL-004	J-IL-009	PVC	250	100	130	-	-	55	0.0	165	0.1	215	0.1	165	0.1	215	0.1
Near Term ASPs	P-IL-016	J-IL-004	J-IL-014	PVC	204	82	130	-	-	75	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	P-IL-017(1)	J-IL-014	PRV-67	PVC	204	30	130	-	-	-	-	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	P-IL-017(2)	PRV-67	J-IL-017	PVC	204	271	130	-	-	-	-	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	P-IL-018	J-IL-017	J-IL-005	PVC	204	81	130	-	-	75	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Near Term ASPs	P-IL-019	J-IL3-004	J-IL-006	PVC	204	41	130	-	-	238	0.1	63	0.0	10	0.0	15	0.0	139	0.1
Near Term ASPs	P-IL-020	J-IL2-005	J-IL-013	PVC	204	184	130	-	-	125	0.1	53	0.0	80	0.0	64	0.0	32	0.0
Near Term ASPs	P-IL-021	J-IL-013	J-IL3-009	PVC	204	51	130	-	-	125	0.1	53	0.0	80	0.0	64	0.0	32	0.0
Near Term ASPs	P-IL1-001	J-IL1-001	J-EX-150	PVC	204	45	130	38	0.0	465	0.2	285	0.2	553	0.3	435	0.2	209	0.1
Near Term ASPs	P-IL1-002	J-IL1-002	J-IL1-001	PVC	204	46	130	20	0.0	436	0.2	267	0.1	529	0.3	417	0.2	185	0.1
Near Term ASPs	P-IL1-003	J-IL1-001	J-IL-010	PVC	155	130	130	12	0.0	18	0.0	11	0.0	15	0.0	11	0.0	15	0.0
Near Term ASPs	P-IL2-001	J-IL2-001	J-IL1-002	PVC	204	40	130	12	0.0	424	0.2	260	0.1	520	0.3	410	0.2	176	0.1
Near Term ASPs	P-IL2-002	J-IL2-002	J-IL2-001	PVC	204	49	130	18	0.0	467	0.2	261	0.1	532	0.3	422	0.2	140	0.1
Near Term ASPs	P-IL2-003	J-IL2-001	J-IL2-003	PVC	204	132	130	14	0.0	23	0.0	14	0.0	18	0.0	14	0.0	18	0.0
Near Term ASPs	P-IL2-004	J-IL2-001	J-IL2-004	PVC	204	132	130	8	0.0	78	0.0	23	0.0	42	0.0	35	0.0	7	0.0
Near Term ASPs	P-IL2-005	J-IL2-004	J-IL2-005	PVC	204	4	130	0	0.0	91	0.1	31	0.0	52	0.0	43	0.0	4	0.0
Near Term ASPs	P-IL3-001	J-IL3-003	J-IL2-002	PVC	204	45	130	27	0.0	452	0.2	252	0.1	521	0.3	413	0.2	129	0.1
Near Term ASPs	P-IL3-002	J-IL3-003	J-IL3-004	PVC	204	53	130	0	0.0	250	0.1	70	0.0	1	0.0	8	0.0	149	0.1
Near Term ASPs	P-IL3-003	J-IL3-002	J-IL3-001	PVC	250	10	130	0	0.0	319	0.1	262	0.1	746	0.3	601	0.2	90	0.0
Near Term ASPs	P-IL3-004	J-IL3-003	J-IL3-002	PVC	250	165	130	10	0.0	335	0.1	272	0.1	759	0.3	611	0.2	77	0.0
Near Term ASPs	P-IL3-005	J-IL3-005	J-IL3-003	PVC	250	109	130	50	0.0	154	0.1	104	0.0	255	0.1	204	0.1	39	0.0
Near Term ASPs	P-IL3-006	J-IL3-007	J-IL3-005	PVC	250	225	130	61	0.0	211	0.1	140	0.1	302	0.1	240	0.1	7	0.0
Near Term ASPs	P-IL3-007	J-IL3-007	J-IL3-006	PVC	250	4	130	0	0.0	520	0.2	211	0.1	366	0.1	289	0.1	217	0.1
Near Term ASPs	P-IL3-008	J-IL3-008	J-IL3-007	PVC	250	8	130	61	0.0	733	0.3	352	0.1	669	0.2	530	0.2	226	0.1
Near Term ASPs	P-IL3-009	J-IL3-009	J-IL3-008	PVC	250	96	130	61	0.0	754	0.3	366	0.1	687	0.2	544	0.2	243	0.1
Near Term ASPs	P-IL3-010	J-IL3-010	J-IL3-009	PVC	250	120	130	61	0.0	921	0.3	444	0.2	800	0.3	633	0.2	309	0.1
Near Term ASPs	P-IL3-011	J-EX-179	J-IL3-010	PVC	250	190	130	61	0.0	941	0.3	457	0.2	816	0.3	646	0.2	325	0.1
JASP	P-JASP-001	J-ANN-003	J-ANN-002	PVC	309	819	130	-	-	-	-	290	0.1	632	0.1	736	0.2	16	0.0
JASP	P-JASP-002	J-ANN-001	J-ANN-003	PVC	309	112	130	-	-	-	-	615	0.1	90	0.0	357	0.1	418	0.1
JASP	P-JASP-003	J-ANN-002	J-ANN-004	PVC	309	805	130	-	-	-	-	385	0.1	623	0.1	283	0.1	87	0.0
JASP	P-JASP-004	J-ANN-003	J-ANN-005	PVC	250	809	130	-	-	-	-	85	0.0	247	0.1	152	0.1	99	0.0
JASP	P-JASP-005(2)	J-ANN-006	J-ANN-001	PVC	309	903	130	-	-	-	-	1,282	0.3	-	-	-	-	1,285	0.3
JASP	P-JASP-006	J-ANN-004	J-ANN-005	PVC	250	825	130	-	-	-	-	297	0.1	584	0.2	487	0.2	82	0.0
JASP	P-JASP-007	J-ANN-005	J-ANN-006	PVC	250	498	130	-	-	-	-	1,021	0.4	-	-	-	-	1,012	0.3
JASP	P-JASP-008(1)	J-ANN-004	PRV-27	PVC	309	37	130	-	-	-	-	0	0.0	2,093	0.5	1,451	0.3	891	0.2
JASP	P-JASP-008(2)	PRV-27	J-JASP-012	PVC	309	763	130	-	-	-	-	0	0.0	2,093	0.5	1,451	0.3	891	0.2
JASP	P-JASP-009(1)	J-ANN-005	PRV-28	PVC	250	40	130	-	-	-	-	0	0.0	0	0.0	0	0.0	0	0.0

Phase	Pipe ID	Start Node	Stop Node	Material	Diameter (mm)	Length (m)	Hazen-Williams C	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Build-out) PHD	
								Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)
JASP	P-JASP-009(2)	PRV-28	J-JASP-015	PVC	250	769	130	-	-	-	-	0	0.0	0	0.0	0	0.0	0	0.0
JASP	P-JASP-010	J-JASP-004	J-ANN-006	PVC	309	544	130	-	-	-	-	2,504	0.6	-	-	-	-	2,559	0.6
JASP	P-JASP-011(1)	J-JASP-011	J-426	PVC	309	58	130	-	-	-	-	2,671	0.6	-	-	-	-	2,775	0.6
JASP	P-JASP-011(2)	J-426	J-JASP-004	PVC	309	258	130	-	-	-	-	2,671	0.6	-	-	-	-	2,775	0.6
JASP	P-JASP-012	J-JASP-012	J-JASP-010	PVC	309	812	130	-	-	-	-	1,800	0.4	2,127	0.5	1,620	0.4	2,098	0.5
JASP	P-JASP-013	J-JASP-015	J-JASP-014	PVC	250	800	130	-	-	-	-	714	0.2	439	0.2	331	0.1	1,272	0.4
JASP	P-JASP-014(1)	J-JASP-009	PRV-37	PVC	309	692	130	-	-	-	-	0	0.0	-	-	-	-	0	0.0
JASP	P-JASP-014(2)	PRV-37	J-JASP-011	PVC	309	111	130	-	-	-	-	0	0.0	-	-	-	-	0	0.0
JASP	P-JASP-015	J-JASP-010	J-JASP-014	PVC	250	835	130	-	-	-	-	1,798	0.6	1,144	0.4	874	0.3	1,463	0.5
JASP	P-JASP-016	J-JASP-014	J-JASP-009	PVC	250	729	130	-	-	-	-	368	0.1	-	-	-	-	740	0.3
JASP	P-JASP-017	J-JASP-018	J-JASP-017	PVC	309	258	130	-	-	-	-	3,836	0.9	3,582	0.8	2,733	0.6	3,872	0.9
JASP	P-JASP-018(1)	J-JASP-014	PRV-21	PVC	250	748	130	-	-	-	-	0	0.0	-	-	-	-	0	0.0
JASP	P-JASP-018(2)	PRV-21	J-JASP-013	PVC	250	70	130	-	-	-	-	0	0.0	-	-	-	-	0	0.0
JASP	P-JASP-019(1)	J-JASP-007	PRV-47	PVC	309	525	130	-	-	-	-	0	0.0	-	-	-	-	1,219	0.3
JASP	P-JASP-019(2)	PRV-47	J-JASP-009	PVC	309	291	130	-	-	-	-	0	0.0	-	-	-	-	1,218	0.3
JASP	P-JASP-020(1)	J-JASP-008	PRV-29	PVC	309	771	130	-	-	-	-	0	0.0	-	-	-	-	0	0.0
JASP	P-JASP-020(2)	PRV-29	J-JASP-013	PVC	309	68	130	-	-	-	-	0	0.0	-	-	-	-	0	0.0
JASP	P-JASP-021	J-JASP-013	J-JASP-007	PVC	309	728	130	-	-	-	-	1,238	0.3	-	-	-	-	1,751	0.4
JASP	P-JASP-022	J-JASP-008	J-JASP-005	PVC	309	814	130	-	-	-	-	3,064	0.7	299	0.1	230	0.1	2,616	0.6
JASP	P-JASP-023	J-JASP-013	J-JASP-016	PVC	250	814	130	-	-	-	-	1,972	0.7	-	-	-	-	2,705	0.9
JASP	P-JASP-024	J-JASP-006	J-JASP-007	PVC	309	816	130	-	-	-	-	912	0.2	-	-	-	-	109	0.0
JASP	P-JASP-025(1)	J-JASP-005	PRV-30	PVC	309	787	130	-	-	-	-	0	0.0	-	-	-	-	0	0.0
JASP	P-JASP-025(2)	PRV-30	J-JASP-016	PVC	309	57	130	-	-	-	-	0	0.0	-	-	-	-	0	0.0
JASP	P-JASP-026	J-JASP-016	J-JASP-006	PVC	309	729	130	-	-	-	-	4,070	0.9	-	-	-	-	5,391	1.2
JASP	P-JASP-027	J-JASP-005	J-JASP-001	PVC	309	806	130	-	-	-	-	3,046	0.7	-	-	-	-	2,963	0.7
JASP	P-JASP-028	J-JASP-016	J-JASP-002	PVC	250	802	130	-	-	-	-	3,556	1.2	-	-	-	-	4,232	1.4
JASP	P-JASP-029	J-JASP-003	J-JASP-006	PVC	309	798	130	-	-	-	-	4,645	1.0	-	-	-	-	5,063	1.1
JASP	P-JASP-030(1)	J-JASP-001	PRV-31	PVC	309	310	130	-	-	-	-	0	0.0	-	-	-	-	0	0.0
JASP	P-JASP-030(2)	PRV-31	J-JASP-002	PVC	309	539	130	-	-	-	-	0	0.0	-	-	-	-	0	0.0
JASP	P-JASP-031	J-JASP-002	J-JASP-003	PVC	309	728	130	-	-	-	-	277	0.1	-	-	-	-	191	0.0
JASP	P-JASP-032(1)	J-JASP-017	J-416	PVC	392.9	469	110	-	-	-	-	2,665	0.4	817	0.1	629	0.1	2,098	0.3
JASP	P-JASP-032(2)	J-416	J-JASP-008	PVC	392.9	13	110	-	-	-	-	2,665	0.4	817	0.1	629	0.1	2,098	0.3
JASP	P-JASP-033	J-JASP-010	J-JASP-018	PVC	309	71	110	-	-	-	-	3,811	0.9	3,549	0.8	2,707	0.6	3,839	0.9
JASP	P-JASP-034	J-JASP-012	J-JASP-015	PVC	309	831	130	-	-	-	-	2,837	0.6	476	0.1	372	0.1	2,647	0.6
JASP	P-JASP-035(1)	J-JASP-015	PRV-25	PVC	309	375	130	-	-	-	-	2,848	0.6	-	-	-	-	3,005	0.7
JASP	P-JASP-035(2)	PRV-25	J-JASP-011	PVC	309	352	130	-	-	-	-	2,848	0.6	-	-	-	-	3,005	0.7
JASP	P-JASP-036	J-JASP-012	J-EX-040	PVC	309	64	130	-	-	-	-	1,740	0.4	1,355	0.3	906	0.2	2,353	0.5
JASP	P-JASP-037	J-EX-227	J-JASP-017	PVC	392.9	145	130	-	-	-	-	1,318	0.2	4,590	0.6	3,508	0.5	1,965	0.3
JASP	P-VC-001	J-VC-021	J-VC-001	PVC	204	92	130	-	-	240	0.1	200	0.1	302	0.2	244	0.1	99	0.1
JASP	P-VC-002	J-VC-001	J-VC-004	PVC	204	52	130	-	-	172	0.1	86	0.0	68	0.0	60	0.0	36	0.0
JASP	P-VC-003	J-VC3-002	J-VC-001	PVC	155	108	130	-	-	109	0.1	140	0.1	267	0.2	210	0.2	97	0.1
JASP	P-VC-004	J-VC-004	J-VC1-016	PVC	204	62	130	-	-	311	0.2	214	0.1	302	0.2	244	0.1	127	0.1
JASP	P-VC-005	J-VC-027	J-EX-186	PVC	204	76	130	-	-	2	0.0	204	0.1	618	0.3	474	0.2	189	0.1
JASP	P-VC-006	J-VC3-008	J-VC-022	PVC	204	38	130	-	-	128	0.1	79	0.0	260	0.1	194	0.1	130	0.1
JASP	P-VC-007	J-VC-015	J-VC3-006	PVC	250	118	130	-	-	339	0.1	609	0.2	1,453	0.5	1,106	0.4	730	0.3
JASP	P-VC-008	J-VC-014	J-VC3-003	PVC	204	55	130	-	-	164	0.1	69	0.0	32	0.0	31	0.0	32	0.0
JASP	P-VC-009	J-VC3-014	J-VC-002	PVC	309	193	130	-	-	859	0.2	757	0.2	1,465	0.3	1,161	0.3	474	0.1
JASP	P-VC-010	J-VC-003	J-VC-030	PVC	155	105	130	-	-	110	0.1	110	0.1	210	0.2	166	0.2	67	0.1
JASP	P-VC-011	J-VC-030	J-VC-004	PVC	155	125	130	-	-	110	0.1	110	0.1	210	0.2	166	0.2	67	0.1
JASP	P-VC-012	J-VC-002	J-VC-005	PVC	155	186	130	-	-	10	0.0	60	0.1	135	0.1	103	0.1	68	0.1
JASP	P-VC-013	J-VC-005	J-VC-006	PVC	155	92	130	-	-	88	0.1	37	0.0	60	0.1	51	0.0	7	0.0

Phase	Pipe ID	Start Node	Stop Node	Material	Diameter (mm)	Length (m)	Hazen-Williams C	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Build-out) PHD	
								Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)
JASP	P-VC-014	J-VC-006	J-VC-007	PVC	155	219	130	-	-	43	0.0	20	0.0	31	0.0	25	0.0	8	0.0
JASP	P-VC-015	J-VC-007	J-VC-008	PVC	155	84	130	-	-	154	0.1	78	0.1	114	0.1	92	0.1	47	0.0
JASP	P-VC-016	J-VC-008	J-VC-009	PVC	204	89	130	-	-	423	0.2	286	0.2	550	0.3	434	0.2	209	0.1
JASP	P-VC-017	J-VC-009	J-VC3-012	PVC	155	148	130	-	-	98	0.1	95	0.1	201	0.2	157	0.1	80	0.1
JASP	P-VC-018	J-VC-005	J-VC-010	PVC	155	100	130	-	-	39	0.0	72	0.1	163	0.1	129	0.1	30	0.0
JASP	P-VC-019	J-VC-010	J-VC-032	PVC	204	85	130	-	-	167	0.1	59	0.0	263	0.1	195	0.1	108	0.1
JASP	P-VC-020	J-VC-032	J-VC-027	PVC	204	61	130	-	-	167	0.1	59	0.0	263	0.1	195	0.1	108	0.1
JASP	P-VC-021	J-VC-027	J-VC-031	PVC	204	89	130	-	-	228	0.1	182	0.1	404	0.2	316	0.2	129	0.1
JASP	P-VC-022	J-VC-031	J-VC-008	PVC	204	95	130	-	-	228	0.1	182	0.1	404	0.2	316	0.2	129	0.1
JASP	P-VC-023	J-VC-009	J-VC3-011	PVC	204	179	130	-	-	376	0.2	222	0.1	390	0.2	308	0.2	170	0.1
JASP	P-VC-024	J-VC-003	J-VC-029	PVC	155	110	130	-	-	41	0.0	73	0.1	193	0.2	151	0.1	51	0.0
JASP	P-VC-025	J-VC-029	J-VC-011	PVC	155	184	130	-	-	41	0.0	73	0.1	193	0.2	151	0.1	51	0.0
JASP	P-VC-026	J-VC-011	J-VC-002	PVC	309	100	130	-	-	731	0.2	690	0.2	1,440	0.3	1,143	0.3	384	0.1
JASP	P-VC-027	J-VC-011	J-VC-010	PVC	204	185	130	-	-	165	0.1	13	0.0	133	0.1	91	0.1	112	0.1
JASP	P-VC-028	J-VC-011	J-VC-012	PVC	309	40	130	-	-	901	0.2	728	0.2	1,471	0.3	1,180	0.3	294	0.1
JASP	P-VC-029	J-VC-003	J-VC-013	PVC	155	80	130	-	-	70	0.1	41	0.0	204	0.2	155	0.1	73	0.1
JASP	P-VC-030	J-VC-013	J-VC-028	PVC	155	112	130	-	-	78	0.1	97	0.1	180	0.2	143	0.1	50	0.0
JASP	P-VC-031	J-VC-028	J-VC-018	PVC	155	169	130	-	-	78	0.1	97	0.1	180	0.2	143	0.1	50	0.0
JASP	P-VC-032	J-VC-018	J-VC-019	PVC	155	229	130	-	-	89	0.1	102	0.1	193	0.2	151	0.1	78	0.1
JASP	P-VC-033	J-VC-019	J-VC-014	PVC	155	69	130	-	-	7	0.0	95	0.1	237	0.2	182	0.2	91	0.1
JASP	P-VC-034	J-VC-014	J-VC-020	PVC	155	76	130	-	-	144	0.1	148	0.1	248	0.2	197	0.2	102	0.1
JASP	P-VC-035	J-VC-020	J-VC-021	PVC	155	140	130	-	-	62	0.1	94	0.1	186	0.2	147	0.1	55	0.1
JASP	P-VC-036	J-VC-021	J-VC-013	PVC	204	93	130	-	-	273	0.1	276	0.1	463	0.2	373	0.2	130	0.1
JASP	P-VC-037	J-VC-022	J-VC-019	PVC	155	86	130	-	-	140	0.1	224	0.2	466	0.4	360	0.3	205	0.2
JASP	P-VC-038	J-VC-022	J-VC-015	PVC	204	149	130	-	-	76	0.0	343	0.2	778	0.4	594	0.3	387	0.2
JASP	P-VC-039	J-VC-015	J-VC-023	PVC	250	54	130	-	-	83	0.0	1,064	0.4	2,377	0.8	1,813	0.6	1,263	0.4
JASP	P-VC-040	J-VC-013	J-VC-024	PVC	204	110	130	-	-	374	0.2	303	0.2	401	0.2	331	0.2	69	0.0
JASP	P-VC-041	J-VC-024	J-VC-016	PVC	204	51	130	-	-	291	0.2	354	0.2	1,012	0.5	795	0.4	255	0.1
JASP	P-VC-042	J-VC-024	J-VC-025	PVC	204	197	130	-	-	40	0.0	79	0.0	646	0.3	491	0.3	221	0.1
JASP	P-VC-043	J-VC-018	J-VC-020	PVC	155	93	130	-	-	59	0.1	39	0.0	43	0.0	36	0.0	28	0.0
JASP	P-VC-044	J-VC-006	J-VC-007	PVC	155	67	130	-	-	81	0.1	38	0.0	58	0.1	48	0.0	14	0.0
JASP	P-VC-045	J-VC3-009	J-VC-026	PVC	155	14	130	-	-	26	0.0	16	0.0	21	0.0	16	0.0	21	0.0
JASP	P-VC-046	J-VC-002	J-VC-017	PVC	155	84	130	-	-	86	0.1	25	0.0	152	0.1	118	0.1	21	0.0
JASP	P-VC-047	J-VC-017	J-VC-003	PVC	155	98	130	-	-	41	0.0	54	0.1	189	0.2	146	0.1	58	0.1
JASP	P-VC1-001	J-EX-220	J-VC1-001	PVC	309	41	130	234	0.1	2,259	0.5	859	0.2	1,008	0.2	836	0.2	434	0.1
JASP	P-VC1-002	J-VC1-001	J-VC1-002	PVC	309	50	130	231	0.1	2,219	0.5	834	0.2	975	0.2	811	0.2	401	0.1
JASP	P-VC1-003	J-VC1-002	J-VC1-003	PVC	309	97	130	169	0.0	1,883	0.4	648	0.1	700	0.2	595	0.1	231	0.1
JASP	P-VC1-004	J-VC1-003	J-VC1-004	PVC	309	148	130	89	0.0	978	0.2	838	0.2	1,506	0.3	1,192	0.3	580	0.1
JASP	P-VC1-005	J-VC1-004	J-VC1-005	PVC	309	100	130	55	0.0	669	0.2	751	0.2	1,533	0.3	1,202	0.3	548	0.1
JASP	P-VC1-006	J-VC1-005	J-VC1-006	PVC	204	99	130	2	0.0	255	0.1	213	0.1	404	0.2	320	0.2	132	0.1
JASP	P-VC1-007	J-VC1-006	J-VC1-007	PVC	204	136	130	11	0.0	276	0.1	227	0.1	421	0.2	333	0.2	150	0.1
JASP	P-VC1-008	J-VC1-007	J-VC1-008	PVC	155	160	130	10	0.0	196	0.2	98	0.1	161	0.1	129	0.1	57	0.1
JASP	P-VC1-009	J-VC1-008	J-VC1-009	PVC	204	174	130	37	0.0	239	0.1	125	0.1	196	0.1	156	0.1	92	0.1
JASP	P-VC1-010	J-VC1-009	J-VC1-002	PVC	204	46	130	58	0.0	273	0.1	147	0.1	223	0.1	177	0.1	119	0.1
JASP	P-VC1-011	J-VC1-003	J-VC1-010	PVC	250	40	130	40	0.0	757	0.3	361	0.1	1,121	0.4	844	0.3	497	0.2
JASP	P-VC1-012	J-VC1-010	J-VC1-011	PVC	250	11	130	37	0.0	740	0.3	372	0.1	1,135	0.4	855	0.3	511	0.2
JASP	P-VC1-013	J-VC1-011	J-VC1-012	PVC	250	6	130	36	0.0	731	0.3	378	0.1	1,142	0.4	860	0.3	518	0.2
JASP	P-VC1-014	J-VC1-013	J-VC1-004	PVC	204	40	130	22	0.0	290	0.2	75	0.0	43	0.0	22	0.0	16	0.0
JASP	P-VC1-015	J-VC1-014	J-VC1-013	PVC	204	17	130	16	0.0	281	0.1	69	0.0	50	0.0	28	0.0	9	0.0
JASP	P-VC1-016	J-VC1-015	J-VC1-005	PVC	204	15	130	3	0.0	342	0.2	233	0.1	327	0.2	263	0.1	152	0.1
JASP	P-VC1-017	J-VC1-015	J-VC1-016	PVC	204	42	130	0	0.0	331	0.2	226	0.1	318	0.2	256	0.1	143	0.1

Phase	Pipe ID	Start Node	Stop Node	Material	Diameter (mm)	Length (m)	Hazen-Williams C	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Build-out) PHD	
								Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)
JASP	P-VC1-018	J-VC1-003	J-VC1-017	PVC	204	213	130	26	0.0	120	0.1	153	0.1	292	0.2	229	0.1	125	0.1
JASP	P-VC1-019	J-VC1-017	J-VC1-007	PVC	204	39	130	13	0.0	99	0.1	140	0.1	275	0.1	216	0.1	108	0.1
JASP	P-VC3-001	J-VC3-001	J-VC1-014	PVC	204	39	130	10	0.0	271	0.1	63	0.0	59	0.0	34	0.0	1	0.0
JASP	P-VC3-002	J-VC3-002	J-VC3-001	PVC	204	67	130	0	0.0	293	0.2	222	0.1	316	0.2	254	0.1	145	0.1
JASP	P-VC3-003	J-VC3-003	J-VC3-002	PVC	204	7	130	0	0.0	179	0.1	79	0.0	44	0.0	41	0.0	44	0.0
JASP	P-VC3-004	J-VC3-001	J-VC3-004	PVC	155	120	130	8	0.0	50	0.0	177	0.2	397	0.4	306	0.3	167	0.2
JASP	P-VC3-005	J-VC3-005	J-VC3-004	PVC	204	94	130	30	0.0	227	0.1	128	0.1	177	0.1	143	0.1	77	0.0
JASP	P-VC3-006	J-VC3-005	J-VC1-012	PVC	250	38	130	33	0.0	713	0.2	389	0.1	1,156	0.4	871	0.3	533	0.2
JASP	P-VC3-007	J-VC3-006	J-VC3-005	PVC	250	14	130	0	0.0	458	0.2	534	0.2	1,356	0.5	1,032	0.4	633	0.2
JASP	P-VC3-008	J-VC3-004	J-VC3-007	PVC	204	28	130	6	0.0	151	0.1	65	0.0	241	0.1	179	0.1	111	0.1
JASP	P-VC3-009	J-VC3-007	J-VC3-008	PVC	204	26	130	0	0.0	141	0.1	71	0.0	249	0.1	186	0.1	119	0.1
JASP	P-VC3-010	J-VC3-009	J-EX-187	PVC	204	89	130	44	0.0	923	0.5	450	0.2	587	0.3	475	0.2	334	0.2
JASP	P-VC3-011	J-VC3-010	J-VC3-009	PVC	204	58	130	44	0.0	894	0.5	432	0.2	563	0.3	457	0.2	311	0.2
JASP	P-VC3-012	J-VC3-011	J-VC3-010	PVC	204	42	130	44	0.0	880	0.5	423	0.2	552	0.3	448	0.2	299	0.2
JASP	P-VC3-013	J-VC3-011	J-VC3-012	PVC	204	83	130	44	0.0	482	0.3	188	0.1	143	0.1	126	0.1	112	0.1
JASP	P-VC3-014	J-VC3-012	J-VC3-013	PVC	204	141	130	44	0.0	349	0.2	70	0.0	87	0.0	54	0.0	3	0.0
JASP	P-VC3-015	J-VC3-013	J-VC3-014	PVC	204	22	130	44	0.0	317	0.2	50	0.0	113	0.1	73	0.0	23	0.0
JASP	P-VC3-016	J-VC1-005	J-VC3-014	PVC	309	119	130	44	0.0	568	0.1	723	0.2	1,599	0.4	1,250	0.3	518	0.1
Ultimate	P-ANN-001	J-ANN-040	J-ANN-028	PVC	309	795	130	-	-	-	-	814	0.2	-	-	-	-	537	0.1
Ultimate	P-ANN-002	J-JASP-001	J-ANN-011	PVC	309	806	130	-	-	-	-	4,940	1.1	-	-	-	-	5,056	1.1
Ultimate	P-ANN-003(1)	J-JASP-002	PRV-59	PVC	250	746	130	-	-	-	-	3,073	1.0	-	-	-	-	3,052	1.0
Ultimate	P-ANN-003(2)	PRV-59	J-ANN-012	PVC	250	60	130	-	-	-	-	3,073	1.0	-	-	-	-	3,052	1.0
Ultimate	P-ANN-004(1)	J-ANN-010	J-418	PVC	309	3	130	-	-	-	-	4,010	0.9	-	-	-	-	4,789	1.1
Ultimate	P-ANN-004(2)	J-418	J-JASP-003	PVC	309	805	130	-	-	-	-	4,010	0.9	-	-	-	-	4,789	1.1
Ultimate	P-ANN-006	J-ANN-011	J-ANN-012	PVC	309	836	130	-	-	-	-	3,924	0.9	-	-	-	-	3,418	0.8
Ultimate	P-ANN-007(1)	J-ANN-012	PRV-58	PVC	309	54	130	-	-	-	-	3,529	0.8	-	-	-	-	2,194	0.5
Ultimate	P-ANN-007(2)	PRV-58	J-ANN-010	PVC	309	681	130	-	-	-	-	3,529	0.8	-	-	-	-	2,194	0.5
Ultimate	P-ANN-008	J-ANN-011	J-ANN-007	PVC	309	706	130	-	-	-	-	1,391	0.3	-	-	-	-	2,125	0.5
Ultimate	P-ANN-009	J-ANN-012	J-ANN-008	PVC	250	798	130	-	-	-	-	1,919	0.7	-	-	-	-	842	0.3
Ultimate	P-ANN-010	J-ANN-009	J-ANN-010	PVC	309	620	130	-	-	-	-	116	0.0	-	-	-	-	2,121	0.5
Ultimate	P-ANN-011	J-ANN-007	J-ANN-008	PVC	309	758	130	-	-	-	-	1,558	0.4	-	-	-	-	2,342	0.5
Ultimate	P-ANN-012(1)	J-ANN-008	PRV-35	PVC	309	628	130	-	-	-	-	0	0.0	-	-	-	-	1,970	0.4
Ultimate	P-ANN-012(2)	PRV-35	J-ANN-009	PVC	309	22	130	-	-	-	-	0	0.0	-	-	-	-	1,970	0.4
Ultimate	P-ANN-013	J-ANN-024	J-ANN-035	PVC	309	788	130	-	-	-	-	1,424	0.3	-	-	-	-	2,033	0.5
Ultimate	P-ANN-014(1)	J-ANN-035	PRV-43	PVC	309	192	130	-	-	-	-	2,750	0.6	-	-	-	-	3,941	0.9
Ultimate	P-ANN-014(2)	PRV-43	J-ANN-036	PVC	309	610	130	-	-	-	-	2,751	0.6	0	0.0	0	0.0	3,940	0.9
Ultimate	P-ANN-015(1)	J-ANN-036	PRV-2	PVC	309	228	130	-	-	-	-	2,178	0.5	2,335	0.5	2,206	0.5	2,329	0.5
Ultimate	P-ANN-015(2)	PRV-2	J-ANN-038	PVC	309	605	130	-	-	-	-	2,178	0.5	2,335	0.5	2,206	0.5	2,329	0.5
Ultimate	P-ANN-016(1)	J-ANN-038	PRV-13	PVC	309	18	130	-	-	-	-	0	0.0	0	0.0	0	0.0	0	0.0
Ultimate	P-ANN-016(2)	PRV-13	J-ANN-039	PVC	309	788	130	-	-	-	-	0	0.0	0	0.0	0	0.0	0	0.0
Ultimate	P-ANN-017	J-ANN-039	J-ANN-025	PVC	309	523	130	-	-	-	-	398	0.1	0	0.0	287	0.1	517	0.1
Ultimate	P-ANN-018	J-ANN-023	J-ANN-024	PVC	309	798	130	-	-	-	-	1,714	0.4	-	-	-	-	2,410	0.5
Ultimate	P-ANN-019	J-ANN-022	J-ANN-035	PVC	250	802	130	-	-	-	-	1,895	0.6	-	-	-	-	2,647	0.9
Ultimate	P-ANN-020	J-ANN-034	J-ANN-036	PVC	309	809	130	-	-	-	-	10	0.0	3,068	0.7	2,769	0.6	879	0.2
Ultimate	P-ANN-021(1)	J-ANN-037	J-439	PVC	250	15	130	-	-	-	-	1,633	0.6	1,627	0.6	1,661	0.6	1,621	0.6
Ultimate	P-ANN-021(2)	J-439	J-ANN-038	PVC	250	790	130	-	-	-	-	1,633	0.6	1,627	0.6	1,661	0.6	1,621	0.6
Ultimate	P-ANN-022(1)	J-ANN-002	PRV-14	PVC	309	12	130	-	-	-	-	0	0.0	373	0.1	0	0.0	0	0.0
Ultimate	P-ANN-022(2)	PRV-14	J-ANN-039	PVC	309	790	130	-	-	-	-	0	0.0	373	0.1	0	0.0	0	0.0
Ultimate	P-ANN-023(1)	J-ANN-025	PRV-15	PVC	309	679	130	-	-	-	-	594	0.1	-	-	287	0.1	772	0.2
Ultimate	P-ANN-023(2)	PRV-15	J-ANN-001	PVC	309	216	130	-	-	-	-	594	0.1	-	-	287	0.1	772	0.2
Ultimate	P-ANN-024	J-ANN-023	J-ANN-022	PVC	309	792	130	-	-	-	-	2,286	0.5	-	-	-	-	3,153	0.7

Phase	Pipe ID	Start Node	Stop Node	Material	Diameter (mm)	Length (m)	Hazen-Williams C	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Build-out) PHD	
								Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)	Flow (L/min)	Max Vel. (m/s)
Ultimate	P-ANN-025(1)	J-ANN-022	PRV-44	PVC	309	253	130	-	-	-	-	0	0.0	-	-	-	-	1,541	0.3
Ultimate	P-ANN-025(2)	PRV-44	J-ANN-034	PVC	309	547	130	-	-	-	-	0	0.0	0	0.0	0	0.0	1,541	0.3
Ultimate	P-ANN-026	J-ANN-034	J-HL-013	PVC	309	455	130	-	-	-	-	14	0.0	1,043	0.2	1,079	0.2	926	0.2
Ultimate	P-ANN-027(1)	J-IL-009	J-440	PVC	309	12	130	-	-	-	-	863	0.2	1,160	0.3	1,051	0.2	929	0.2
Ultimate	P-ANN-027(2)	J-440	J-ANN-002	PVC	309	664	130	-	-	-	-	863	0.2	1,160	0.3	1,051	0.2	929	0.2
Ultimate	P-ANN-028(1)	J-ANN-023	PRV-46	PVC	309	29	130	-	-	-	-	0	0.0	-	-	-	-	0	0.0
Ultimate	P-ANN-028(2)	PRV-46	J-ANN-026	PVC	309	770	130	-	-	-	-	0	0.0	-	-	-	-	0	0.0
Ultimate	P-ANN-029(1)	J-ANN-022	PRV-45	PVC	309	124	130	-	-	-	-	0	0.0	-	-	-	-	1,591	0.4
Ultimate	P-ANN-029(2)	PRV-45	J-ANN-027	PVC	309	673	130	-	-	-	-	0	0.0	0	0.0	0	0.0	1,590	0.4
Ultimate	P-ANN-030	J-ANN-026	J-ANN-027	PVC	309	794	130	-	-	-	-	31	0.0	-	-	-	-	530	0.1
Ultimate	P-ANN-031	J-ANN-027	J-ANN-043	PVC	309	823	130	-	-	-	-	679	0.2	597	0.1	468	0.1	499	0.1
Ultimate	P-ANN-032	J-ANN-026	J-ANN-040	PVC	309	813	130	-	-	-	-	608	0.1	-	-	-	-	220	0.1
Ultimate	P-ANN-033	J-ANN-027	J-ANN-041	PVC	250	816	130	-	-	-	-	415	0.1	1,235	0.4	959	0.3	98	0.0
Ultimate	P-ANN-034	J-VC-025	J-ANN-043	PVC	392.9	56	110	-	-	-	-	1,821	0.3	2,743	0.4	2,152	0.3	1,385	0.2
Ultimate	P-ANN-035	J-VC-023	J-VC-025	PVC	392.9	583	110	-	-	-	-	1,925	0.3	3,421	0.5	2,667	0.4	1,639	0.2
Ultimate	P-ANN-036	J-ANN-040	J-ANN-041	PVC	309	797	130	-	-	-	-	366	0.1	-	-	-	-	427	0.1
Ultimate	P-ANN-037	J-ANN-041	J-ANN-042	PVC	309	824	130	-	-	-	-	1,277	0.3	535	0.1	415	0.1	1,327	0.3
Ultimate	P-ANN-038	J-ANN-041	J-ANN-029	PVC	250	793	130	-	-	-	-	638	0.2	1,348	0.5	1,042	0.4	477	0.2
Ultimate	P-ANN-039	J-ANN-028	J-ANN-029	PVC	255	800	130	-	-	-	-	494	0.2	-	-	-	-	458	0.2
Ultimate	P-ANN-040	J-ANN-029	J-ANN-032	PVC	255	836	130	-	-	-	-	1,576	0.5	1,690	0.6	1,305	0.4	1,719	0.6
Ultimate	P-ANN-041	J-ANN-028	J-ANN-030	PVC	309	811	130	-	-	-	-	890	0.2	-	-	-	-	820	0.2
Ultimate	P-ANN-042	J-ANN-029	J-ANN-031	PVC	250	813	130	-	-	-	-	703	0.2	-	-	-	-	706	0.2
Ultimate	P-ANN-043	J-ANN-030	J-ANN-031	PVC	309	801	130	-	-	-	-	1,179	0.3	-	-	-	-	1,196	0.3
Ultimate	P-ANN-044	J-ANN-031	J-ANN-033	PVC	309	809	130	-	-	-	-	2,456	0.6	-	-	-	-	2,648	0.6
Ultimate	P-ANN-045	J-ANN-033	J-EX-229	PVC	309	505	130	-	-	-	-	1,290	0.3	-	-	-	-	1,300	0.3
Ultimate	P-ANN-046	J-ANN-043	J-HL-030	PVC	309	309	130	-	-	-	-	818	0.2	2,917	0.7	2,294	0.5	463	0.1
Ultimate	P-ANN-047	J-HL-030	J-ANN-034	PVC	309	487	130	-	-	-	-	597	0.1	2,833	0.6	2,312	0.5	686	0.2
Ultimate	P-ANN-052(1)	J-ANN-021	J-415	PVC	309	549	130	-	-	-	-	632	0.1	-	-	-	-	451	0.1
Ultimate	P-ANN-052(2)	J-415	J-JASP-005	PVC	309	261	130	-	-	-	-	632	0.1	-	-	-	-	451	0.1
Ultimate	P-ANN-056	J-ANN-021	J-ANN-014	PVC	250	807	130	-	-	-	-	971	0.3	-	-	-	-	892	0.3
Ultimate	P-ANN-060(1)	J-ANN-014	J-414	PVC	250	350	130	-	-	-	-	1,331	0.5	-	-	-	-	1,360	0.5
Ultimate	P-ANN-060(2)	J-414	J-JASP-001	PVC	250	459	130	-	-	-	-	1,331	0.5	-	-	-	-	1,360	0.5
Ultimate	P-ANN-061	J-EX-014	J-ANN-032	PVC	392.9	161	130	-	-	-	-	7,153	1.0	9,648	1.3	7,450	1.0	7,651	1.0
Ultimate	P-ANN-062	J-ANN-032	J-ANN-042	PVC	392.9	793	130	-	-	-	-	5,109	0.7	7,428	1.0	5,738	0.8	5,324	0.7
Ultimate	P-ANN-063	J-ANN-042	J-VC-023	PVC	392.9	182	130	-	-	-	-	3,448	0.5	6,393	0.9	4,938	0.7	3,498	0.5
Ultimate	P-ANN-064	J-ANN-037	J-IL-009	PVC	309	129	130	-	-	-	-	1,431	0.3	1,897	0.4	1,618	0.4	1,666	0.4
Ultimate	P-ANN-065(1)	J-HL-013	PRV-71	PVC	309	119	130	-	-	-	-	0	0.0	533	0.1	159	0.0	308	0.1
Ultimate	P-ANN-065(2)	PRV-71	J-ANN-037	PVC	309	261	130	-	-	-	-	0	0.0	533	0.1	159	0.0	308	0.1
Ultimate	P-ANN-066	J-EX-014	J-ANN-033	PVC	309	651	130	-	-	-	-	1,415	0.3	-	-	-	-	1,672	0.4

Phase	Junction ID	Elevation (m)	X (m)	Y (m)	Hydraulic Grade (m)	Demand (L/min)	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Build-out) PHD	
							Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)
Existing	J-EX-001	1,105.4	-2,787	5,698,389	1,163.2	25	567	57.9	566	57.8	566	57.9	565	57.7	566	57.8	565	57.7
Existing	J-EX-002	1,105.4	-2,764	5,698,497	1,161.3	41	563	57.5	556	56.8	551	56.3	540	55.2	547	55.9	542	55.4
Existing	J-EX-003	1,105.9	-2,787	5,698,498	1,161.2	1	562	57.5	556	56.8	546	55.8	534	54.6	541	55.3	536	54.8
Existing	J-EX-004	1,105.0	-2,889	5,698,515	1,160.9	2	572	58.4	565	57.7	552	56.4	539	55.1	547	55.9	541	55.3
Existing	J-EX-005	1,104.3	-2,943	5,698,520	1,160.7	0	579	59.1	572	58.5	558	57.0	544	55.6	552	56.4	546	55.8
Existing	J-EX-006	1,104.3	-2,998	5,698,518	1,160.5	0	575	58.8	569	58.1	557	56.9	542	55.4	550	56.2	543	55.5
Existing	J-EX-007	1,105.0	-3,078	5,698,515	1,160.2	1	573	58.5	566	57.9	547	55.9	531	54.3	540	55.2	533	54.5
Existing	J-EX-008	1,104.3	-3,118	5,698,513	1,160.0	1	579	59.2	573	58.5	553	56.5	536	54.8	545	55.7	538	54.9
Existing	J-EX-009	1,104.0	-3,162	5,698,511	1,159.9	0	581	59.4	575	58.7	555	56.7	538	54.9	547	55.9	539	55.1
Existing	J-EX-010	1,103.6	-3,200	5,698,510	1,159.7	1	585	59.8	579	59.1	558	57.0	540	55.2	549	56.1	541	55.3
Existing	J-EX-011	1,102.7	-3,245	5,698,509	1,159.6	3	595	60.8	588	60.1	565	57.8	547	55.9	557	56.9	548	56.0
Existing	J-EX-012	1,102.2	-3,326	5,698,506	1,159.3	2	620	63.4	614	62.7	568	58.1	548	56.0	559	57.1	550	56.2
Existing	J-EX-013	1,102.4	-3,349	5,698,505	1,159.2	1	626	64.0	620	63.3	566	57.8	545	55.7	556	56.8	547	55.9
Existing	J-EX-014	1,102.4	-3,357	5,698,504	1,159.2	300	627	64.1	621	63.4	565	57.8	545	55.7	556	56.8	546	55.8
Existing	J-EX-015	1,105.0	-2,743	5,698,497	1,161.2	0	571	58.4	564	57.6	555	56.7	543	55.5	550	56.2	545	55.7
Existing	J-EX-016	1,105.0	-2,734	5,698,497	1,161.2	3	571	58.4	564	57.6	554	56.6	542	55.4	550	56.2	544	55.6
Existing	J-EX-017	1,104.4	-2,655	5,698,501	1,160.8	5	577	58.9	566	57.8	557	56.9	544	55.5	553	56.5	546	55.8
Existing	J-EX-018	1,104.3	-2,566	5,698,504	1,160.4	4	574	58.6	559	57.1	554	56.6	538	55.0	549	56.1	541	55.3
Existing	J-EX-019	1,104.5	-2,567	5,698,498	1,160.4	0	572	58.5	557	56.9	552	56.4	536	54.8	547	55.9	539	55.1
Existing	J-EX-020	1,104.8	-2,517	5,698,498	1,160.3	1005	570	58.3	552	56.4	548	56.0	531	54.3	543	55.4	535	54.6
Existing	J-EX-021	1,104.9	-2,395	5,698,509	1,160.0	4	573	58.5	541	55.3	545	55.6	526	53.7	540	55.2	531	54.3
Existing	J-EX-022	1,104.9	-2,376	5,698,517	1,160.0	4	573	58.6	540	55.1	544	55.6	525	53.6	539	55.1	530	54.2
Existing	J-EX-023	1,105.0	-2,262	5,698,567	1,159.7	3	568	58.0	527	53.8	540	55.2	519	53.0	536	54.7	526	53.8
Existing	J-EX-024	1,105.0	-2,242	5,698,575	1,159.7	2	568	58.0	525	53.7	539	55.1	518	53.0	535	54.7	526	53.7
Existing	J-EX-025	1,105.0	-2,170	5,698,605	1,159.5	2	566	57.9	515	52.6	537	54.9	515	52.6	534	54.5	524	53.5
Existing	J-EX-026	1,105.7	-2,123	5,698,618	1,159.4	3	560	57.2	502	51.3	529	54.1	506	51.7	526	53.7	516	52.7
Existing	J-EX-027	1,105.5	-2,112	5,698,652	1,159.4	1	558	57.0	501	51.2	531	54.3	507	51.9	528	53.9	517	52.9
Existing	J-EX-028	1,105.6	-2,096	5,698,700	1,159.3	4	559	57.2	502	51.3	529	54.1	505	51.6	526	53.7	515	52.7
Existing	J-EX-029	1,106.5	-2,030	5,698,888	1,158.9	4	549	56.1	488	49.8	517	52.8	490	50.1	512	52.4	502	51.3
Existing	J-EX-030	1,107.6	-1,999	5,698,975	1,158.6	2	537	54.8	474	48.4	504	51.5	476	48.7	499	51.0	488	49.9
Existing	J-EX-031	1,107.8	-1,997	5,698,982	1,158.6	4	536	54.7	472	48.3	503	51.3	475	48.5	498	50.9	487	49.7
Existing	J-EX-032	1,108.6	-1,964	5,699,075	1,158.4	7	527	53.8	463	47.3	493	50.4	465	47.5	488	49.9	477	48.7
Existing	J-EX-033	1,108.6	-1,961	5,699,083	1,158.4	7	527	53.8	463	47.3	493	50.4	464	47.5	488	49.9	477	48.7
Existing	J-EX-034	1,108.4	-1,931	5,699,168	1,158.3	8	528	54.0	464	47.4	494	50.5	465	47.5	489	49.9	477	48.8
Existing	J-EX-035	1,108.4	-1,927	5,699,179	1,158.3	4	527	53.9	463	47.4	494	50.5	465	47.5	489	49.9	477	48.8
Existing	J-EX-036	1,108.0	-1,898	5,699,256	1,158.2	6	531	54.2	467	47.7	497	50.7	467	47.7	491	50.2	479	49.0
Existing	J-EX-037	1,108.6	-1,865	5,699,350	1,158.1	5	524	53.6	460	47.0	490	50.1	460	47.0	484	49.5	473	48.3
Existing	J-EX-038	1,108.8	-1,848	5699392.9.03	1,158.1	2	522	53.4	458	46.8	488	49.9	458	46.8	482	49.3	470	48.1
Existing	J-EX-039	1,108.9	-1,843	5,699,414	1,158.1	3	522	53.3	458	46.8	488	49.9	458	46.8	482	49.3	470	48.0
Existing	J-EX-040	1,110.0	-1,819	5,699,487	1,158.1	10	511	52.2	447	45.6	476	48.7	446	45.6	470	48.1	458	46.8
Existing	J-EX-041	1,109.4	-1,762	5,699,646	1,158.1	6	515	52.6	451	46.1	483	49.3	452	46.2	477	48.7	464	47.5
Existing	J-EX-042	1,106.0	-2,567	5,698,454	1,160.4	1	560	57.2	544	55.6	537	54.9	521	53.3	532	54.4	524	53.6
Existing	J-EX-043	1,107.0	-2,567	5,698,366	1,160.3	10	550	56.2	533	54.4	527	53.9	511	52.2	521	53.3	513	52.4
Existing	J-EX-044	1,104.6	-2,525	5,698,011	1,159.7	20	573	58.6	547	55.9	548	56.0	530	54.1	540	55.1	530	54.2
Existing	J-EX-045	1,104.6	-2,519	5,697,977	1,159.6	9	573	58.5	547	55.8	547	55.9	528	54.0	538	55.0	529	54.1
Existing	J-EX-046	1,105.3	-2,624	5,698,453	1,160.4	3	564	57.6	549	56.1	545	55.6	528	54.0	539	55.1	531	54.3
Existing	J-EX-047	1,105.0	-2,513	5,698,010	1,159.7	2	569	58.1	543	55.5	543	55.5	525	53.6	535	54.7	526	53.7
Existing	J-EX-048	1,105.7	-2,467	5,698,004	1,159.7	14	565	57.8	540	55.1	537	54.8	518	53.0	528	54.0	519	53.0

Phase	Junction ID	Elevation (m)	X (m)	Y (m)	Hydraulic Grade (m)	Demand (L/min)	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Build-out) PHD	
							Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)
Existing	J-EX-049	1,105.4	-2,478	5,697,977	1,159.7	3	568	58.0	542	55.4	540	55.2	521	53.3	531	54.3	522	53.3
Existing	J-EX-050	1,105.9	-1,900	5,698,668	1,159.4	19	566	57.9	512	52.3	526	53.8	502	51.3	524	53.5	513	52.4
Existing	J-EX-051	1,106.0	-1,900	5,698,569	1,159.4	9	558	57.0	504	51.5	525	53.7	502	51.3	523	53.4	512	52.3
Existing	J-EX-052	1,106.0	-1,900	5,698,266	1,159.4	18	557	57.0	508	51.9	525	53.7	501	51.2	523	53.4	512	52.3
Existing	J-EX-053	1,108.6	-1,901	5,698,000	1,159.4	24	532	54.4	487	49.8	501	51.2	478	48.9	497	50.8	487	49.7
Existing	J-EX-054	1,110.4	-1,901	5,697,867	1,159.4	8	515	52.6	472	48.2	485	49.5	462	47.2	480	49.1	470	48.0
Existing	J-EX-055	1,110.7	-1,901	5,697,832	1,159.4	5	512	52.3	469	47.9	481	49.2	459	46.9	477	48.7	466	47.6
Existing	J-EX-056	1,111.6	-1,901	5,697,710	1,159.4	5	502	51.3	462	47.2	473	48.4	451	46.1	468	47.8	457	46.7
Existing	J-EX-057	1,111.9	-1,901	5,697,655	1,159.4	5	499	51.0	459	46.9	470	48.1	448	45.8	465	47.5	455	46.4
Existing	J-EX-058	1,112.0	-1,901	5,697,567	1,159.4	7	499	51.0	459	46.9	470	48.0	448	45.7	464	47.4	454	46.4
Existing	J-EX-059	1,111.5	-1,901	5,697,475	1,159.4	8	503	51.4	463	47.3	475	48.5	453	46.3	469	47.9	459	46.9
Existing	J-EX-060	1,110.7	-1,901	5,697,345	1,159.4	3	512	52.3	472	48.2	482	49.3	460	47.0	477	48.7	466	47.6
Existing	J-EX-061	1,109.0	-2,034	5,697,710	1,159.4	7	529	54.0	489	50.0	500	51.1	478	48.9	494	50.5	484	49.4
Existing	J-EX-062	1,107.9	-2,104	5,697,692	1,159.4	10	539	55.1	501	51.2	511	52.2	489	50.0	505	51.6	494	50.5
Existing	J-EX-063	1,107.0	-2,142	5,697,655	1,159.4	11	548	56.0	510	52.1	519	53.0	498	50.8	513	52.4	503	51.4
Existing	J-EX-064	1,105.8	-2,190	5,697,517	1,159.4	18	560	57.2	521	53.2	531	54.2	509	52.0	525	53.6	514	52.5
Existing	J-EX-065	1,106.2	-2,205	5,697,365	1,159.4	42	556	56.8	517	52.8	527	53.8	505	51.6	521	53.2	510	52.2
Existing	J-EX-066	1,108.1	-2,044	5,697,324	1,159.4	20	538	54.9	498	50.9	508	51.9	486	49.7	503	51.3	492	50.3
Existing	J-EX-067	1,110.6	-1,901	5,697,324	1,159.4	7	513	52.4	473	48.3	483	49.4	461	47.1	477	48.8	467	47.7
Existing	J-EX-068	1,111.1	-1,878	5,697,324	1,159.4	14	508	51.9	468	47.8	479	48.9	457	46.7	473	48.3	462	47.3
Existing	J-EX-069	1,105.6	-2,332	5,698,391	1,159.9	8	559	57.1	522	53.4	536	54.7	516	52.7	531	54.3	522	53.4
Existing	J-EX-070	1,105.1	-2,208	5,698,465	1,159.8	9	566	57.8	526	53.8	539	55.1	519	53.0	535	54.7	526	53.7
Existing	J-EX-071	1,106.0	-1,900	5,698,592	1,159.4	3	559	57.1	505	51.6	525	53.7	502	51.3	523	53.4	512	52.4
Existing	J-EX-073	1,105.0	-2,212	5,698,719	1,159.2	4	565	57.7	506	51.7	534	54.5	509	52.0	530	54.2	519	53.1
Existing	J-EX-074	1,105.0	-2,251	5,698,768	1,159.0	4	565	57.8	505	51.6	533	54.4	508	51.9	529	54.0	518	53.0
Existing	J-EX-075	1,105.0	-2,296	5,698,784	1,159.0	5	564	57.7	504	51.5	533	54.4	508	51.9	529	54.0	518	53.0
Existing	J-EX-076	1,105.0	-2,300	5,698,785	1,159.0	6	564	57.7	504	51.5	533	54.4	508	51.9	529	54.0	518	53.0
Existing	J-EX-077	1,105.0	-2,373	5,698,811	1,159.0	9	564	57.7	504	51.5	533	54.4	508	51.9	529	54.0	518	53.0
Existing	J-EX-078	1,105.0	-2,445	5,698,788	1,159.0	17	564	57.6	504	51.5	533	54.4	508	51.9	529	54.0	518	53.0
Existing	J-EX-079	1,105.0	-2,390	5,698,762	1,159.0	17	564	57.7	504	51.5	533	54.4	508	51.9	529	54.0	518	53.0
Existing	J-EX-080	1,105.6	-2,226	5,698,839	1,159.0	5	559	57.1	498	50.9	527	53.8	501	51.2	523	53.4	512	52.3
Existing	J-EX-081	1,106.0	-2,221	5,698,854	1,159.0	7	555	56.7	494	50.5	523	53.4	497	50.8	519	53.0	508	51.9
Existing	J-EX-082	1,106.0	-2,334	5,698,893	1,159.0	21	554	56.6	493	50.4	522	53.4	497	50.7	518	53.0	508	51.9
Existing	J-EX-083	1,107.0	-2,063	5,698,900	1,158.9	7	544	55.6	483	49.3	512	52.3	485	49.6	508	51.9	497	50.8
Existing	J-EX-084	1,107.7	-2,189	5,698,944	1,158.9	8	537	54.9	475	48.6	505	51.6	479	48.9	501	51.2	490	50.1
Existing	J-EX-085	1,107.8	-2,200	5,698,948	1,158.8	8	536	54.7	473	48.4	504	51.4	477	48.8	499	51.0	488	49.9
Existing	J-EX-086	1,109.0	-2,348	5,698,999	1,158.5	15	523	53.4	452	46.2	489	49.9	460	47.0	484	49.5	473	48.3
Existing	J-EX-087	1,108.4	-2,509	5,699,065	1,158.2	8	527	53.8	447	45.7	492	50.3	462	47.2	487	49.8	476	48.6
Existing	J-EX-088	1,107.9	-2,510	5,698,986	1,158.2	8	537	54.9	458	46.8	497	50.8	467	47.7	492	50.3	481	49.1
Existing	J-EX-089	1,106.5	-2,510	5,698,939	1,158.2	8	546	55.8	466	47.6	511	52.2	481	49.1	506	51.7	495	50.5
Existing	J-EX-090	1,110.9	-3,061	5,699,179	1,157.8	5	502	51.3	409	41.8	464	47.4	432	44.2	459	46.9	448	45.8
Existing	J-EX-091	1,107.7	-2,005	5,698,977	1,158.6	0	537	54.8	473	48.4	504	51.5	476	48.7	499	51.0	488	49.9
Existing	J-EX-092	1,108.0	-2,038	5,698,996	1,158.6	6	533	54.5	469	47.9	500	51.1	473	48.3	496	50.6	485	49.5
Existing	J-EX-093	1,107.8	-2,042	5,698,984	1,158.6	4	535	54.7	471	48.1	502	51.3	474	48.5	497	50.8	486	49.7
Existing	J-EX-094	1,108.8	-2,167	5,699,041	1,158.5	15	523	53.4	456	46.6	491	50.2	463	47.3	487	49.7	475	48.6
Existing	J-EX-095	1,109.8	-2,315	5,699,093	1,158.4	7	513	52.4	442	45.1	481	49.2	453	46.3	476	48.7	465	47.5
Existing	J-EX-096	1,109.5	-2,320	5,699,078	1,158.4	7	513	52.4	442	45.1	483	49.4	455	46.5	479	48.9	467	47.8
Existing	J-EX-097	1,110.0	-2,402	5,699,124	1,158.3	11	512	52.3	436	44.5	477	48.8	448	45.8	472	48.3	461	47.1

Phase	Junction ID	Elevation (m)	X (m)	Y (m)	Hydraulic Grade (m)	Demand (L/min)	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Build-out) PHD	
							Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)
Existing	J-EX-098	1,110.0	-2,509	5,699,162	1,158.1	8	511	52.3	428	43.7	476	48.6	445	45.5	471	48.1	460	47.0
Existing	J-EX-099	1,109.0	-2,509	5,699,108	1,158.2	6	521	53.2	439	44.9	486	49.7	456	46.6	481	49.2	470	48.0
Existing	J-EX-100	1,109.6	-2,625	5,699,162	1,158.0	7	511	52.2	423	43.3	478	48.9	447	45.7	473	48.4	462	47.2
Existing	J-EX-101	1,109.5	-2,632	5,699,162	1,158.0	5	511	52.2	423	43.2	479	49.0	448	45.8	474	48.5	463	47.3
Existing	J-EX-102	1,109.0	-2,721	5,699,162	1,157.9	7	521	53.2	429	43.9	483	49.4	452	46.2	478	48.9	467	47.8
Existing	J-EX-103	1,109.0	-2,834	5,699,162	1,157.8	11	521	53.2	428	43.7	483	49.3	451	46.1	478	48.8	467	47.7
Existing	J-EX-104	1,109.2	-2,875	5,699,162	1,157.8	15	518	52.9	425	43.4	481	49.2	449	45.9	476	48.6	465	47.5
Existing	J-EX-105	1,110.0	-3,044	5,699,143	1,157.8	10	511	52.2	418	42.7	473	48.3	441	45.0	468	47.8	457	46.7
Existing	J-EX-106	1,110.0	-3,061	5,699,134	1,157.8	278	511	52.2	418	42.7	473	48.3	441	45.0	468	47.8	457	46.7
Existing	J-EX-107	1,109.8	-2,134	5,699,136	1,158.4	25	514	52.5	445	45.5	480	49.1	452	46.2	475	48.6	464	47.4
Existing	J-EX-108	1,110.8	-2,281	5,699,187	1,158.4	13	503	51.4	431	44.0	471	48.1	442	45.2	466	47.6	455	46.5
Existing	J-EX-109	1,111.0	-2,385	5,699,223	1,158.2	12	502	51.3	425	43.4	467	47.7	438	44.7	462	47.2	451	46.1
Existing	J-EX-110	1,111.0	-2,510	5,699,267	1,158.1	8	502	51.2	418	42.7	466	47.6	436	44.5	461	47.1	450	46.0
Existing	J-EX-111	1,111.0	-2,510	5,699,249	1,158.1	7	502	51.3	418	42.7	466	47.6	436	44.5	461	47.1	450	46.0
Existing	J-EX-112	1,111.0	-2,250	5,699,282	1,158.3	7	502	51.3	430	43.9	468	47.8	438	44.8	463	47.3	451	46.1
Existing	J-EX-113	1,111.0	-2,245	5,699,292	1,158.2	6	501	51.2	429	43.8	467	47.8	438	44.7	462	47.2	451	46.1
Existing	J-EX-114	1,112.0	-2,316	5,699,305	1,158.3	5	492	50.3	420	42.9	458	46.8	428	43.8	453	46.3	441	45.1
Existing	J-EX-115	1,112.0	-2,324	5,699,308	1,158.3	1	492	50.3	420	42.9	458	46.8	428	43.8	453	46.3	441	45.1
Existing	J-EX-116	1,112.6	-2,389	5,699,358	1,158.3	2	488	49.9	417	42.6	452	46.1	422	43.1	446	45.6	435	44.5
Existing	J-EX-117	1,110.0	-2,835	5,698,950	1,157.8	13	511	52.2	418	42.7	473	48.3	441	45.0	468	47.8	457	46.7
Existing	J-EX-118	1,110.0	-2,835	5,698,936	1,157.8	220	511	52.2	418	42.7	473	48.3	441	45.0	468	47.8	457	46.7
Existing	J-EX-119	1,108.9	-1,959	5,699,278	1,158.1	12	523	53.5	455	46.5	487	49.8	457	46.7	482	49.2	470	48.1
Existing	J-EX-120	1,111.4	-2,073	5,699,318	1,158.1	11	498	50.8	421	43.1	463	47.3	432	44.2	457	46.7	446	45.6
Existing	J-EX-121	1,111.7	-2,089	5,699,323	1,158.1	10	494	50.5	417	42.6	459	46.9	428	43.8	453	46.3	442	45.2
Existing	J-EX-122	1,111.9	-2,217	5,699,368	1,158.0	10	492	50.3	413	42.2	456	46.6	426	43.5	451	46.1	440	44.9
Existing	J-EX-123	1,113.0	-2,361	5,699,419	1,158.0	4	481	49.2	396	40.5	445	45.5	414	42.3	440	45.0	429	43.8
Existing	J-EX-124	1,112.0	-2,512	5,699,499	1,157.9	6	491	50.2	399	40.8	454	46.4	423	43.2	449	45.9	438	44.8
Existing	J-EX-125	1,109.9	-1,963	5,699,385	1,158.1	6	512	52.3	448	45.8	478	48.9	448	45.8	473	48.3	461	47.1
Existing	J-EX-126	1,111.0	-2,015	5,699,403	1,158.1	7	501	51.2	437	44.7	467	47.7	437	44.7	461	47.1	449	45.9
Existing	J-EX-127	1,110.6	-1,898	5,699,486	1,158.0	6	505	51.6	427	43.6	469	47.9	438	44.8	464	47.4	452	46.2
Existing	J-EX-128	1,110.7	-1,906	5,699,486	1,158.0	5	504	51.5	426	43.5	468	47.8	437	44.7	463	47.3	451	46.1
Existing	J-EX-129	1,111.4	-1,999	5,699,486	1,158.0	12	496	50.6	415	42.4	461	47.1	430	43.9	455	46.5	444	45.4
Existing	J-EX-130	1,112.9	-2,090	5,699,486	1,158.0	12	481	49.2	392.9	40.9	447	45.6	416	42.5	441	45.1	430	43.9
Existing	J-EX-131	1,112.5	-2,186	5,699,485	1,157.9	6	486	49.6	401	41.0	449	45.9	418	42.7	444	45.4	433	44.3
Existing	J-EX-132	1,112.5	-2,189	5,699,485	1,157.9	6	486	49.7	402	41.0	450	45.9	418	42.7	445	45.4	434	44.3
Existing	J-EX-133	1,112.0	-2,280	5,699,485	1,157.9	5	491	50.2	406	41.5	454	46.4	423	43.2	449	45.9	438	44.8
Existing	J-EX-134	1,112.0	-2,288	5,699,485	1,157.9	4	491	50.2	406	41.5	454	46.4	423	43.2	449	45.9	438	44.8
Existing	J-EX-135	1,112.0	-2,382	5,699,485	1,157.9	6	491	50.2	406	41.5	454	46.4	423	43.2	449	45.9	438	44.8
Existing	J-EX-136	1,111.0	-2,510	5,699,376	1,158.0	10	501	51.2	413	42.2	465	47.5	434	44.3	460	47.0	449	45.9
Existing	J-EX-137	1,111.7	-2,510	5,699,453	1,157.9	8	491	50.2	399	40.8	457	46.7	426	43.5	452	46.2	441	45.0
Existing	J-EX-138	1,112.5	-2,512	5,699,554	1,157.9	6	484	49.5	392	40.1	449	45.9	417	42.6	444	45.4	433	44.3
Existing	J-EX-139	1,113.8	-2,512	5,699,635	1,157.8	6	472	48.2	379	38.7	435	44.5	403	41.2	431	44.0	420	42.9
Existing	J-EX-140	1,115.7	-2,504	5,699,690	1,157.8	8	454	46.4	361	36.9	416	42.5	384	39.2	411	42.0	401	41.0
Existing	J-EX-141	1,118.0	-2,461	5,699,771	1,157.8	6	432	44.2	339	34.7	394	40.2	361	36.9	389	39.8	379	38.7
Existing	J-EX-142	1,118.9	-2,424	5,699,838	1,157.8	5	422	43.2	330	33.7	385	39.3	353	36.0	381	38.9	370	37.8
Existing	J-EX-143	1,118.7	-2,418	5,699,848	1,157.8	9	422	43.2	330	33.7	387	39.5	354	36.2	382	39.1	372	38.0
Existing	J-EX-144	1,118.4	-2,390	5,699,979	1,157.7	9	428	43.7	333	34.0	389	39.8	356	36.4	385	39.3	375	38.3
Existing	J-EX-145	1,118.1	-2,391	5,699,995	1,157.7	6	431	44.0	336	34.3	391	40.0	358	36.6	387	39.6	377	38.5

Phase	Junction ID	Elevation (m)	X (m)	Y (m)	Hydraulic Grade (m)	Demand (L/min)	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Build-out) PHD	
							Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)
Existing	J-EX-146	1,117.4	-2,391	5,700,080	1,157.7	6	438	44.7	342	35.0	398	40.7	365	37.3	394	40.3	384	39.2
Existing	J-EX-147	1,117.2	-2,391	5,700,096	1,157.7	5	439	44.9	343	35.1	400	40.9	367	37.5	396	40.5	386	39.4
Existing	J-EX-148	1,117.0	-2,391	5,700,167	1,157.7	7	442	45.2	345	35.3	401	41.0	368	37.6	398	40.7	388	39.6
Existing	J-EX-149	1,117.0	-2,392	5,700,259	1,157.6	6	442	45.2	345	35.3	401	41.0	368	37.6	398	40.6	388	39.6
Existing	J-EX-150	1,117.0	-2,392	5,700,278	1,157.6	5	442	45.2	345	35.3	401	41.0	368	37.6	398	40.6	387	39.6
Existing	J-EX-151	1,112.9	-2,474	5,699,554	1,157.9	5	482	49.3	390	39.8	445	45.4	413	42.2	440	44.9	429	43.8
Existing	J-EX-152	1,114.7	-2,479	5,699,654	1,157.8	6	464	47.4	371	37.9	426	43.6	394	40.3	422	43.1	411	42.0
Existing	J-EX-153	1,117.4	-2,405	5,699,726	1,157.8	4	439	44.8	347	35.4	393	40.9	368	37.6	396	40.4	385	39.3
Existing	J-EX-154	1,117.8	-2,387	5,699,740	1,157.8	8	434	44.4	342	35.0	396	40.5	364	37.2	392	40.0	381	38.9
Existing	J-EX-155	1,115.5	-2,386	5,699,669	1,157.8	10	456	46.6	365	37.3	418	42.7	386	39.5	414	42.3	403	41.2
Existing	J-EX-156	1,120.0	-2,516	5,699,887	1,157.8	6	413	42.2	320	32.7	374	38.2	341	34.9	370	37.8	359	36.7
Existing	J-EX-157	1,120.0	-2,520	5,699,887	1,157.8	5	413	42.2	320	32.7	374	38.2	341	34.9	370	37.8	359	36.7
Existing	J-EX-158	1,117.4	-2,293	5,699,823	1,157.8	4	438	44.8	347	35.5	400	40.9	368	37.6	396	40.4	385	39.3
Existing	J-EX-159	1,117.4	-2,290	5,699,823	1,157.8	3	439	44.8	347	35.5	400	40.9	368	37.6	396	40.4	385	39.3
Existing	J-EX-160	1,117.3	-2,195	5,699,823	1,157.8	4	438	44.8	347	35.5	393	40.9	368	37.6	396	40.4	385	39.3
Existing	J-EX-161	1,117.2	-2,191	5,699,823	1,157.8	4	439	44.8	348	35.5	401	41.0	369	37.7	397	40.5	386	39.4
Existing	J-EX-162	1,112.6	-2,009	5,699,858	1,157.8	8	484	49.5	393	40.2	446	45.6	414	42.3	442	45.2	431	44.1
Existing	J-EX-163	1,117.2	-2,290	5,699,815	1,157.8	8	440	45.0	349	35.7	402	41.1	370	37.8	398	40.6	387	39.5
Existing	J-EX-164	1,113.5	-2,289	5,699,640	1,157.8	21	471	48.2	382	39.1	438	44.7	406	41.5	433	44.3	422	43.2
Existing	J-EX-165	1,113.0	-2,289	5,699,533	1,157.9	9	484	49.4	396	40.5	444	45.3	412	42.1	439	44.9	428	43.7
Existing	J-EX-166	1,113.8	-2,372	5,699,533	1,157.8	7	475	48.6	386	39.5	436	44.5	404	41.3	431	44.1	420	43.0
Existing	J-EX-167	1,113.7	-2,430	5,699,532	1,157.8	6	474	48.4	385	39.3	436	44.6	404	41.3	432	44.1	421	43.0
Existing	J-EX-168	1,117.1	-2,191	5,699,816	1,157.8	7	440	45.0	349	35.7	403	41.1	370	37.8	398	40.7	387	39.6
Existing	J-EX-169	1,118.0	-2,283	5,699,922	1,157.8	11	432	44.2	341	34.9	394	40.2	361	36.9	389	39.8	378	38.7
Existing	J-EX-170	1,117.0	-2,195	5,699,923	1,157.8	11	442	45.2	351	35.9	403	41.2	371	37.9	399	40.8	388	39.7
Existing	J-EX-171	1,114.3	-2,061	5,699,923	1,157.8	14	468	47.8	377	38.5	430	43.9	398	40.6	426	43.5	415	42.4
Existing	J-EX-172	1,115.4	-2,091	5,699,642	1,158.0	16	457	46.7	376	38.4	422	43.1	391	39.9	417	42.6	405	41.4
Existing	J-EX-173	1,115.6	-2,091	5,699,650	1,158.0	5	455	46.5	374	38.3	420	42.9	389	39.8	415	42.4	403	41.2
Existing	J-EX-174	1,110.8	-1,899	5,699,649	1,157.9	14	502	51.3	417	42.6	465	47.5	433	44.3	460	47.0	449	45.9
Existing	J-EX-175	1,111.0	-1,899	5,699,698	1,157.9	2	501	51.2	415	42.4	463	47.3	431	44.1	459	46.9	447	45.7
Existing	J-EX-176	1,110.5	-1,900	5,699,751	1,157.8	5	501	51.2	413	42.3	468	47.8	436	44.5	463	47.3	452	46.2
Existing	J-EX-177	1,109.7	-1,924	5,699,900	1,157.8	5	514	52.5	423	43.2	475	48.6	443	45.3	471	48.1	460	47.0
Existing	J-EX-178	1,109.8	-1,929	5,699,909	1,157.8	10	512	52.3	421	43.0	474	48.4	441	45.1	469	48.0	459	46.9
Existing	J-EX-179	1,111.4	-2,033	5,700,111	1,157.7	7	497	50.8	402	41.0	456	46.6	423	43.2	453	46.2	442	45.2
Existing	J-EX-180	1,111.1	-2,058	5,700,147	1,157.7	8	499	51.0	403	41.2	459	46.9	426	43.5	455	46.5	445	45.5
Existing	J-EX-181	1,119.3	-2,510	5,699,798	1,157.8	9	420	42.9	327	33.4	381	39.0	349	35.7	377	38.5	366	37.4
Existing	J-EX-182	1,120.0	-2,517	5,699,980	1,157.7	11	413	42.2	318	32.5	373	38.1	340	34.8	369	37.7	359	36.6
Existing	J-EX-183	1,119.7	-2,516	5,700,081	1,157.7	11	415	42.4	320	32.7	375	38.4	342	35.0	372	38.0	361	36.9
Existing	J-EX-184	1,117.0	-2,474	5,700,167	1,157.6	7	442	45.1	345	35.3	401	41.0	368	37.6	398	40.6	388	39.6
Existing	J-EX-185	1,118.0	-2,522	5,700,170	1,157.6	6	432	44.2	335	34.3	392	40.0	358	36.6	388	39.6	378	38.6
Existing	J-EX-186	1,119.1	-2,566	5,700,173	1,157.6	0	422	43.2	325	33.2	381	38.9	347	35.5	377	38.5	367	37.5
Existing	J-EX-187	1,115.5	-2,568	5,699,708	1,157.8	0	458	46.8	364	37.2	418	42.7	386	39.4	414	42.3	403	41.2
Existing	J-EX-188	1,118.6	-2,517	5,700,237	1,157.6	8	425	43.4	328	33.5	386	39.4	353	36.0	382	39.1	372	38.0
Existing	J-EX-189	1,114.9	-2,300	5,700,167	1,157.7	1	462	47.2	366	37.4	422	43.2	389	39.7	419	42.8	408	41.7
Existing	J-EX-190	1,114.4	-2,287	5,700,167	1,157.7	4	467	47.7	370	37.9	427	43.6	393	40.2	423	43.2	413	42.2
Existing	J-EX-191	1,115.4	-2,299	5,700,073	1,157.7	4	457	46.7	361	36.9	417	42.7	384	39.2	414	42.3	404	41.2
Existing	J-EX-192	1,116.6	-2,300	5,700,008	1,157.7	8	446	45.6	350	35.7	405	41.4	372	38.0	402	41.0	391	40.0
Existing	J-EX-193	1,115.0	-2,284	5,700,073	1,157.7	5	461	47.1	365	37.3	421	43.0	387	39.6	417	42.6	407	41.6

Phase	Junction ID	Elevation (m)	X (m)	Y (m)	Hydraulic Grade (m)	Demand (L/min)	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Build-out) PHD	
							Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)
Existing	J-EX-194	1,114.2	-2,194	5,700,074	1,157.7	8	469	47.9	373	38.1	429	43.8	396	40.4	426	43.5	415	42.4
Existing	J-EX-195	1,115.8	-2,193	5,700,008	1,157.7	8	453	46.3	357	36.5	413	42.2	380	38.8	410	41.9	399	40.8
Existing	J-EX-196	1,113.0	-2,106	5,700,079	1,157.7	7	481	49.2	385	39.4	441	45.0	407	41.6	437	44.7	427	43.6
Existing	J-EX-197	1,113.8	-2,090	5,700,008	1,157.7	11	473	48.3	377	38.5	433	44.2	393	40.8	429	43.9	419	42.8
Existing	J-EX-198	1,111.7	-2,043	5,700,104	1,157.7	5	495	50.6	399	40.8	454	46.4	420	42.9	450	46.0	440	44.9
Existing	J-EX-200	1,109.4	-2,632	5,699,093	1,158.0	9	516	52.7	428	43.7	480	49.1	449	45.9	475	48.6	464	47.4
Existing	J-EX-201	1,108.0	-2,631	5,698,998	1,158.0	19	535	54.6	447	45.6	494	50.5	463	47.3	489	50.0	478	48.8
Existing	J-EX-202	1,109.0	-2,721	5,699,093	1,157.9	14	524	53.5	433	44.2	483	49.4	452	46.2	478	48.9	467	47.8
Existing	J-EX-203	1,109.6	-2,722	5,699,227	1,157.9	6	511	52.2	419	42.8	478	48.8	446	45.6	473	48.3	462	47.2
Existing	J-EX-204	1,110.0	-2,722	5,699,256	1,157.9	9	511	52.2	419	42.8	474	48.4	442	45.2	469	47.9	458	46.8
Existing	J-EX-205	1,111.0	-2,722	5,699,404	1,157.9	7	501	51.2	409	41.8	464	47.4	432	44.2	459	46.9	448	45.7
Existing	J-EX-206	1,113.6	-2,835	569,939,209	1,157.8	11	476	48.6	383	39.1	437	44.7	406	41.4	432	44.2	421	43.1
Existing	J-EX-207	1,113.5	-2,873	569,939,209	1,157.8	5	477	48.7	384	39.2	439	44.8	407	41.6	434	44.3	423	43.2
Existing	J-EX-208	1,113.0	-2,922	569,939,209	1,157.8	8	481	49.2	388	39.6	443	45.3	412	42.1	438	44.8	428	43.7
Existing	J-EX-209	1,114.0	-3,004	5,699,391	1,157.8	8	472	48.2	378	38.6	434	44.3	402	41.0	428	43.8	418	42.7
Existing	J-EX-210	1,113.1	-2,992	5,699,338	1,157.8	9	473	48.3	379	38.7	442	45.2	410	41.9	437	44.6	426	43.5
Existing	J-EX-211	1,112.1	-2,922	5,699,338	1,157.8	5	489	49.9	395	40.4	452	46.2	420	42.9	447	45.7	436	44.6
Existing	J-EX-212	1,111.0	-2,850	5,699,251	1,157.8	2	501	51.2	408	41.7	463	47.3	431	44.1	458	46.8	447	45.7
Existing	J-EX-213	1,111.0	-2,905	5,699,251	1,157.8	2	501	51.2	408	41.7	463	47.3	431	44.1	458	46.8	447	45.7
Existing	J-EX-214	1,111.0	-2,922	5,699,251	1,157.8	9	501	51.2	408	41.7	463	47.3	431	44.1	458	46.8	447	45.7
Existing	J-EX-215	1,111.0	-3,080	5,699,224	1,157.8	10	501	51.2	408	41.7	463	47.3	431	44.0	458	46.8	447	45.7
Existing	J-EX-216	1,113.0	-3,092	5,699,388	1,157.8	6	481	49.2	387	39.5	443	45.3	411	42.0	438	44.8	427	43.7
Existing	J-EX-217	1,113.0	-3,092	5,699,390	1,157.8	0	481	49.2	387	39.5	443	45.3	411	42.0	438	44.8	427	43.7
Existing	J-EX-218	1,113.0	-3,092	5,699,395	1,157.8	3	481	49.2	387	39.5	443	45.3	411	42.0	438	44.8	427	43.7
Existing	J-EX-219	1,112.0	-3,138	5,699,390	1,157.8	292	491	50.2	397	40.5	453	46.3	421	43.0	448	45.8	437	44.7
Existing	J-EX-220	1,113.0	-3,092	5,699,452	1,157.8	5	481	49.2	386	39.5	443	45.3	411	42.0	438	44.8	427	43.7
Existing	J-EX-221	1,111.0	-2,850	5,699,259	1,157.8	2	501	51.2	408	41.7	463	47.3	431	44.1	458	46.8	447	45.7
Existing	J-EX-222	1,111.0	-2,722	5,699,416	1,157.9	6	501	51.2	409	41.8	464	47.4	432	44.2	459	46.9	448	45.7
Existing	J-EX-223	1,111.0	-2,632	5,699,328	1,157.9	12	501	51.2	409	41.8	464	47.4	432	44.2	459	46.9	448	45.8
Existing	J-EX-224	1,111.0	-2,632	5,699,404	1,157.9	10	501	51.2	409	41.8	464	47.4	432	44.2	459	46.9	448	45.8
Existing	J-EX-225	1,111.0	-2,835	5,699,251	1,157.8	6	501	51.2	408	41.7	463	47.3	431	44.1	458	46.8	447	45.7
Existing	J-EX-226	1,103.3	-2,496	5,697,853	1,159.5	30	585	59.8	557	56.9	559	57.1	540	55.2	550	56.2	540	55.2
Existing	J-EX-227	1,105.6	-1,900	5,698,333	1,159.4	13	561	57.3	510	52.1	529	54.0	505	51.6	526	53.8	516	52.7
Existing	J-EX-228	1,111.5	-2,499	5,699,448	1,157.9	0	491	50.2	399	40.8	460	47.0	429	43.8	455	46.5	444	45.3
Existing	J-EX-229	1,101.6	-2,882	5,697,846	1,159.1	3	637	65.1	609	62.2	576	58.9	557	56.9	563	57.5	553	56.5
Existing	J-EX-230	1,108.2	-1,775	5,699,325	1,158.1	0	529	54.0	465	47.5	495	50.5	465	47.5	489	50.0	477	48.7
Existing	J-EX-231	1,107.0	-1,870	5,699,039	1,158.1	0	540	55.2	476	48.7	506	51.7	476	48.7	500	51.1	489	49.9
Existing	J-EX-PUMP_JCT	1,105.8	-2,787	5,698,364	1,163.5	0	565	57.7	565	57.7	565	57.7	565	57.7	565	57.7	565	57.7
Near Term ASPs	J-HL-001	1,113.6	-3,175	5,700,325	1,157.6	18	-	-	378	38.6	435	44.5	402	41.1	431	44.1	421	43.1
Near Term ASPs	J-HL-002	1,114.5	-3,153	5,700,405	1,157.6	16	-	-	369	37.7	426	43.5	392	40.1	422	43.1	412	42.1
Near Term ASPs	J-HL-003	1,113.9	-3,151	5,700,488	1,157.6	21	-	-	375	38.3	431	44.0	397	40.6	428	43.7	418	42.7
Near Term ASPs	J-HL-004	1,113.5	-3,161	5,700,588	1,157.6	23	-	-	378	38.6	434	44.4	393	40.9	431	44.1	422	43.1
Near Term ASPs	J-HL-005	1,111.7	-3,038	5,700,615	1,157.6	21	-	-	396	40.5	452	46.2	418	42.7	450	45.9	440	44.9
Near Term ASPs	J-HL-006	1,110.0	-2,861	5,700,704	1,157.6	15	-	-	412	42.1	468	47.8	433	44.3	465	47.6	456	46.6
Near Term ASPs	J-HL-007	1,111.6	-2,817	5,700,616	1,157.6	15	-	-	397	40.6	453	46.3	419	42.8	450	46.0	441	45.0
Near Term ASPs	J-HL-008	1,110.6	-2,633	5,700,596	1,157.6	29	-	-	407	41.6	462	47.2	428	43.7	460	47.0	450	46.0
Near Term ASPs	J-HL-009	1,106.7	-2,767	5,700,829	1,157.6	16	-	-	445	45.5	500	51.0	465	47.5	498	50.9	488	49.9
Near Term ASPs	J-HL-010	1,107.7	-2,805	5,700,829	1,157.6	15	-	-	435	44.5	490	50.0	455	46.5	488	49.9	479	48.9

Phase	Junction ID	Elevation (m)	X (m)	Y (m)	Hydraulic Grade (m)	Demand (L/min)	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Build-out) PHD	
							Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)
Near Term ASPs	J-HL-011	1,107.7	-2,927	5,700,922	1,157.6	26	-	-	435	44.5	489	50.0	454	46.4	488	49.9	479	48.9
Near Term ASPs	J-HL-012	1,106.1	-2,936	5,700,996	1,157.6	4	-	-	451	46.1	504	51.5	469	47.9	504	51.5	494	50.5
Near Term ASPs	J-HL-013	1,104.9	-2,938	5,701,075	1,157.6	334	-	-	463	47.3	516	52.7	479	49.0	516	52.7	506	51.7
Near Term ASPs	J-HL-014	1,108.3	-3,057	5,700,979	1,157.6	89	-	-	429	43.8	483	49.3	447	45.7	482	49.3	473	48.3
Near Term ASPs	J-HL-015	1,109.8	-2,980	5,700,767	1,157.6	29	-	-	414	42.3	469	47.9	433	44.3	467	47.8	458	46.8
Near Term ASPs	J-HL-016	1,109.0	-2,895	5,700,795	1,157.6	20	-	-	422	43.1	477	48.7	442	45.1	475	48.6	466	47.6
Near Term ASPs	J-HL-017	1,111.3	-3,089	5,700,757	1,157.6	23	-	-	392.9	40.9	456	46.6	422	43.1	453	46.3	443	45.3
Near Term ASPs	J-HL-018	1,112.6	-3,187	5,700,758	1,157.6	23	-	-	387	39.5	443	45.2	409	41.8	440	45.0	430	44.0
Near Term ASPs	J-HL-019	1,114.0	-3,297	5,700,758	1,157.6	15	-	-	373	38.1	429	43.8	395	40.4	426	43.6	417	42.6
Near Term ASPs	J-HL-020	1,114.0	-3,308	5,700,757	1,157.6	10	-	-	374	38.2	430	43.9	395	40.4	427	43.6	417	42.6
Near Term ASPs	J-HL-021	1,112.0	-3,377	5,700,857	1,157.6	0	-	-	393	40.1	449	45.9	415	42.4	446	45.6	436	44.6
Near Term ASPs	J-HL-022	1,110.5	-3,307	5,700,951	1,157.6	23	-	-	408	41.7	464	47.4	430	43.9	461	47.1	451	46.1
Near Term ASPs	J-HL-023	1,109.7	-3,276	5,700,948	1,157.6	21	-	-	415	42.4	471	48.2	437	44.7	469	47.9	459	46.9
Near Term ASPs	J-HL-024	1,110.3	-3,159	5,700,948	1,157.6	28	-	-	409	41.8	465	47.5	431	44.0	462	47.2	453	46.3
Near Term ASPs	J-HL-025	1,110.5	-3,125	5,700,857	1,157.6	20	-	-	408	41.6	464	47.4	429	43.9	461	47.1	451	46.1
Near Term ASPs	J-HL-026	1,110.6	-3,119	5,700,839	1,157.6	16	-	-	407	41.6	463	47.3	429	43.8	460	47.0	451	46.0
Near Term ASPs	J-HL-027	1,113.2	-3,172	5,700,680	1,157.6	22	-	-	381	38.9	437	44.6	403	41.2	434	44.4	425	43.4
Near Term ASPs	J-HL-028	1,115.2	-3,308	5,700,679	1,157.6	24	-	-	362	37.0	418	42.7	384	39.2	415	42.4	406	41.4
Near Term ASPs	J-HL-029	1,115.4	-3,378	5,700,586	1,157.6	0	-	-	360	36.8	416	42.5	382	39.0	413	42.2	403	41.2
Near Term ASPs	J-HL-030	1,115.1	-3,394	5,700,586	1,157.6	335	-	-	363	37.1	419	42.8	385	39.3	416	42.5	406	41.5
Near Term ASPs	J-HL-031	1,115.8	-3,352	5,700,586	1,157.6	29	-	-	356	36.4	412	42.1	378	38.6	409	41.8	392.9	40.9
Near Term ASPs	J-HL-032	1,112.9	-3,138	5,700,590	1,157.6	12	-	-	384	39.2	440	45.0	406	41.5	437	44.7	428	43.7
Near Term ASPs	J-HL-033	1,111.7	-2,853	5,700,597	1,157.6	21	-	-	396	40.5	452	46.2	417	42.6	449	45.9	439	44.9
Near Term ASPs	J-HL-034	1,112.5	-2,841	5,700,506	1,157.6	23	-	-	388	39.6	444	45.3	409	41.8	441	45.1	431	44.1
Near Term ASPs	J-HL-035	1,113.4	-3,052	5,700,405	1,157.6	20	-	-	379	38.8	436	44.6	403	41.2	433	44.2	423	43.2
Near Term ASPs	J-HL-036	1,112.9	-3,044	5,700,326	1,157.6	21	-	-	385	39.3	442	45.1	408	41.7	438	44.7	428	43.7
Near Term ASPs	J-HL-037	1,113.1	-2,924	5,700,326	1,157.6	21	-	-	382	39.1	439	44.9	406	41.5	436	44.5	426	43.5
Near Term ASPs	J-HL-038	1,112.8	-2,961	5,700,405	1,157.6	23	-	-	386	39.4	443	45.2	409	41.8	439	44.9	429	43.8
Near Term ASPs	J-HL-039	1,117.5	-3,308	5,700,393	1,157.6	26	-	-	339	34.7	396	40.5	363	37.1	392	40.1	383	39.1
Near Term ASPs	J-HL-040	1,118.0	-3,308	5,700,405	1,157.6	25	-	-	334	34.2	391	40.0	358	36.5	388	39.6	378	38.6
Near Term ASPs	J-HL-041	1,109.6	-2,746	5,700,680	1,157.6	24	-	-	417	42.6	472	48.3	438	44.7	470	48.0	460	47.0
Near Term ASPs	J-HL-042	1,109.5	-3,233	5,701,028	1,157.6	29	-	-	418	42.7	474	48.4	440	44.9	471	48.1	461	47.1
Near Term ASPs	J-HL-043	1,110.9	-2,996	5,700,632	1,157.6	27	-	-	404	41.3	460	47.0	425	43.5	457	46.7	447	45.7
Near Term ASPs	J-HL-044	1,110.9	-2,633	5,700,586	1,157.6	6	-	-	404	41.3	459	46.9	425	43.4	457	46.7	447	45.7
Near Term ASPs	J-HL-045	1,105.6	-2,681	5,700,829	1,157.6	44	-	-	455	46.5	510	52.1	475	48.6	509	52.0	499	51.0
Near Term ASPs	J-HL-046	1,106.2	-2,831	5,700,923	1,157.6	20	-	-	450	45.9	504	51.5	469	47.9	503	51.4	493	50.4
Near Term ASPs	J-HL-047	1,114.4	-3,147	5,700,447	1,157.6	10	-	-	370	37.8	427	43.6	393	40.2	423	43.3	414	42.3
Near Term ASPs	J-HL-048	1,106.0	-2,935	5,700,987	1,157.6	7	-	-	452	46.1	505	51.6	470	48.0	505	51.6	495	50.6
Near Term ASPs	J-HL-049	1,111.6	-3,350	5,700,858	1,157.6	19	-	-	397	40.5	453	46.2	418	42.8	450	46.0	440	45.0
Near Term ASPs	J-HL-050	1,109.9	-2,867	5,700,718	1,157.6	13	-	-	414	42.3	469	47.9	435	44.4	467	47.7	457	46.7
Near Term ASPs	J-HL1-001	1,112.5	-2,642	5,700,503	1,157.6	28	-	-	388	39.6	444	45.3	409	41.8	441	45.1	431	44.1
Near Term ASPs	J-HL1-002	1,112.7	-2,708	5,700,525	1,157.6	12	-	-	386	39.5	442	45.2	408	41.7	440	44.9	430	43.9
Near Term ASPs	J-HL1-003	1,112.7	-2,751	5,700,550	1,157.6	17	-	-	386	39.5	442	45.2	408	41.7	440	44.9	430	43.9
Near Term ASPs	J-HL1-004	1,111.7	-2,635	5,700,551	1,157.6	10	-	-	396	40.4	451	46.1	417	42.6	449	45.9	439	44.9
Near Term ASPs	J-HL1-005	1,114.2	-2,754	5,700,458	1,157.6	11	-	-	372	38.0	428	43.7	394	40.3	425	43.4	415	42.4
Near Term ASPs	J-HL1-006	1,114.3	-2,764	5,700,445	1,157.6	17	-	-	371	37.9	427	43.6	392	40.1	424	43.3	414	42.3
Near Term ASPs	J-HL1-007	1,115.7	-2,728	5,700,326	1,157.6	16	-	-	357	36.5	413	42.2	379	38.7	410	41.9	392.9	40.9
Near Term ASPs	J-HL1-008	1,116.7	-2,650	5,700,326	1,157.6	10	-	-	347	35.5	403	41.2	369	37.7	393	40.9	390	39.9

Phase	Junction ID	Elevation (m)	X (m)	Y (m)	Hydraulic Grade (m)	Demand (L/min)	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Build-out) PHD	
							Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)
Near Term ASPs	J-HL1-009	1,116.7	-2,642	5,700,326	1,157.6	23	-	-	347	35.5	403	41.2	369	37.8	393	40.9	390	39.9
Near Term ASPs	J-HL1-010	1,115.7	-2,728	5,700,348	1,157.6	17	-	-	357	36.5	413	42.2	379	38.7	410	41.9	392.9	40.9
Near Term ASPs	J-IL-001	1,104.0	-2,094	5,700,594	1,157.6	23	-	-	471	48.2	528	53.9	494	50.5	525	53.6	515	52.6
Near Term ASPs	J-IL-002	1,103.0	-2,130	5,700,678	1,157.6	53	-	-	485	49.6	538	54.9	504	51.5	534	54.6	524	53.6
Near Term ASPs	J-IL-003	1,099.8	-2,332	5,700,977	1,139.1	104	-	-	512	52.3	384	39.2	383	39.2	384	39.3	384	39.2
Near Term ASPs	J-IL-004	1,102.1	-2,429	5,700,977	1,139.1	61	-	-	490	50.1	362	37.0	361	36.9	362	37.0	362	36.9
Near Term ASPs	J-IL-005	1,107.3	-2,429	5,700,678	1,157.6	44	-	-	439	44.9	496	50.7	462	47.2	493	50.3	483	49.3
Near Term ASPs	J-IL-006	1,110.1	-2,418	5,700,593	1,157.6	16	-	-	412	42.1	469	47.9	435	44.4	465	47.6	455	46.5
Near Term ASPs	J-IL-007	1,110.8	-2,520	5,700,593	1,157.6	20	-	-	405	41.4	461	47.1	427	43.6	458	46.8	448	45.8
Near Term ASPs	J-IL-008	1,105.4	-2,430	5,700,734	1,157.6	103	-	-	457	46.7	514	52.5	480	49.0	511	52.2	500	51.1
Near Term ASPs	J-IL-009	1,099.4	-2,429	5,701,076	1,139.1	402	-	-	516	52.7	388	39.6	387	39.6	388	39.7	388	39.6
Near Term ASPs	J-IL-010	1,118.0	-2,521	5,700,323	1,157.6	11	427	43.6	330	33.7	391	40.0	357	36.5	388	39.6	378	38.6
Near Term ASPs	J-IL-011	1,106.2	-2,283	5,700,677	1,157.6	0	-	-	450	46.0	506	51.7	472	48.2	503	51.4	493	50.4
Near Term ASPs	J-IL-012	1,100.4	-2,184	5,700,807	1,139.1	0	-	-	507	51.8	378	38.6	378	38.6	379	38.7	378	38.6
Near Term ASPs	J-IL-013	1,108.8	-2,071	5,700,407	1,157.6	0	-	-	425	43.4	481	49.1	447	45.7	477	48.8	467	47.8
Near Term ASPs	J-IL-014	1,101.6	-2,511	5,700,977	1,139.1	0	-	-	495	50.6	366	37.4	366	37.4	367	37.5	366	37.4
Near Term ASPs	J-IL-015	1,103.8	-2,429	5,700,883	1,157.6	0	-	-	473	48.4	530	54.1	496	50.7	527	53.8	517	52.8
Near Term ASPs	J-IL-016	1,099.4	-2,255	5,700,977	1,139.1	0	-	-	517	52.8	388	39.7	388	39.6	389	39.7	388	39.6
Near Term ASPs	J-IL-017	1,108.0	-2,511	5,700,677	1,157.6	0	-	-	433	44.2	489	50.0	455	46.5	486	49.6	476	48.6
Near Term ASPs	J-IL1-001	1,116.6	-2,392	5,700,323	1,157.6	6	447	45.7	350	35.8	405	41.4	372	38.0	402	41.1	392	40.0
Near Term ASPs	J-IL1-002	1,116.4	-2,391	5,700,368	1,157.6	7	448	45.8	351	35.8	407	41.6	373	38.2	404	41.3	394	40.2
Near Term ASPs	J-IL2-001	1,115.0	-2,391	5,700,408	1,157.6	8	467	47.7	370	37.8	420	43.0	387	39.5	417	42.6	407	41.6
Near Term ASPs	J-IL2-002	1,112.6	-2,391	5,700,458	1,157.6	9	489	49.9	391	40.0	443	45.3	409	41.8	440	45.0	430	44.0
Near Term ASPs	J-IL2-003	1,116.0	-2,523	5,700,409	1,157.6	14	453	46.3	356	36.4	411	41.9	377	38.5	407	41.6	397	40.6
Near Term ASPs	J-IL2-004	1,111.6	-2,259	5,700,408	1,157.6	8	502	51.3	405	41.4	454	46.4	420	42.9	451	46.1	441	45.0
Near Term ASPs	J-IL2-005	1,111.3	-2,255	5,700,408	1,157.6	21	504	51.5	407	41.6	456	46.6	422	43.2	453	46.3	443	45.3
Near Term ASPs	J-IL3-001	1,112.5	-2,568	5,700,503	1,157.6	0	485	49.5	387	39.5	444	45.3	409	41.8	441	45.1	431	44.0
Near Term ASPs	J-IL3-002	1,112.7	-2,558	5,700,503	1,157.6	10	483	49.4	386	39.4	443	45.2	408	41.7	440	44.9	430	43.9
Near Term ASPs	J-IL3-003	1,112.0	-2,393	5,700,503	1,157.6	13	495	50.6	397	40.6	449	45.9	415	42.4	446	45.6	436	44.6
Near-term ASPs	J-IL3-004	1,111.3	-2,403	5,700,555	1,157.6	7	502	51.3	405	41.4	456	46.6	422	43.1	453	46.3	443	45.2
Near-term ASPs	J-IL3-005	1,110.0	-2,284	5,700,502	1,157.6	36	513	52.4	415	42.4	469	47.9	435	44.5	466	47.6	456	46.6
Near-term ASPs	J-IL3-006	1,104.9	-2,060	5,700,507	1,157.6	14	579	59.2	481	49.2	519	53.0	485	49.6	516	52.7	506	51.7
Near-term ASPs	J-IL3-007	1,105.0	-2,058	5,700,503	1,157.6	1	579	59.2	481	49.2	518	52.9	484	49.4	515	52.6	505	51.6
Near-term ASPs	J-IL3-008	1,105.0	-2,055	5,700,496	1,157.6	14	579	59.2	481	49.2	518	52.9	484	49.5	515	52.6	505	51.6
Near-term ASPs	J-IL3-009	1,105.5	-2,019	5,700,407	1,157.6	26	572	58.4	475	48.5	513	52.5	480	49.0	510	52.1	500	51.1
Near-term ASPs	J-IL3-010	1,107.7	-2,005	5,700,292	1,157.6	12	534	54.5	437	44.6	492	50.3	458	46.8	489	49.9	478	48.9
Near-term ASPs	J-VC-001	1,113.5	-3,104	5,699,962	1,157.7	26	-	-	379	38.7	437	44.6	404	41.3	432	44.2	422	43.1
Near-term ASPs	J-VC-002	1,114.3	-2,913	5,700,134	1,157.7	33	-	-	372	38.0	429	43.8	396	40.5	425	43.4	415	42.4
Near-term ASPs	J-VC-003	1,114.7	-3,095	5,700,124	1,157.7	24	-	-	368	37.6	425	43.5	392	40.1	421	43.0	411	42.0
Near-term ASPs	J-VC-004	1,114.0	-3,065	5,699,927	1,157.7	18	-	-	374	38.3	432	44.2	393	40.8	428	43.7	417	42.6
Near-term ASPs	J-VC-005	1,116.0	-2,727	5,700,134	1,157.7	24	-	-	355	36.3	412	42.1	379	38.7	408	41.7	398	40.7
Near-term ASPs	J-VC-006	1,116.4	-2,727	5,700,042	1,157.7	22	-	-	351	35.8	408	41.7	375	38.3	404	41.2	393	40.2
Near-term ASPs	J-VC-007	1,116.1	-2,726	5,699,976	1,157.7	19	-	-	354	36.2	411	42.0	378	38.6	407	41.6	397	40.5
Near-term ASPs	J-VC-008	1,117.9	-2,644	5,699,988	1,157.7	25	-	-	336	34.4	393	40.2	360	36.8	389	39.8	379	38.7
Near-term ASPs	J-VC-009	1,117.7	-2,644	5,699,900	1,157.7	31	-	-	338	34.6	395	40.4	362	37.0	391	39.9	381	38.9
Near-term ASPs	J-VC-010	1,116.3	-2,727	5,700,234	1,157.7	26	-	-	352	36.0	409	41.8	376	38.4	405	41.4	395	40.4
Near-term ASPs	J-VC-011	1,114.1	-2,912	5,700,234	1,157.7	22	-	-	373	38.2	431	44.0	397	40.6	427	43.6	416	42.6
Near-term ASPs	J-VC-012	1,114.3	-2,913	5,700,274	1,157.6	18	-	-	371	37.9	428	43.8	395	40.4	424	43.4	414	42.3

Phase	Junction ID	Elevation (m)	X (m)	Y (m)	Hydraulic Grade (m)	Demand (L/min)	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Build-out) PHD	
							Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)
Near-term ASPs	J-VC-013	1,115.4	-3,175	5,700,124	1,157.7	29	-	-	360	36.8	418	42.7	385	39.4	413	42.2	403	41.2
Near-term ASPs	J-VC-014	1,114.0	-3,227	5,699,884	1,157.7	16	-	-	374	38.3	433	44.2	393	40.9	428	43.7	417	42.6
Near-term ASPs	J-VC-015	1,113.7	-3,320	5,699,639	1,157.8	113	-	-	377	38.5	437	44.6	406	41.5	431	44.0	421	43.0
Near-term ASPs	J-VC-016	1,113.6	-3,175	5,700,285	1,157.6	17	-	-	378	38.6	435	44.5	402	41.1	431	44.1	421	43.0
Near-term ASPs	J-VC-017	1,113.0	-2,997	5,700,131	1,157.7	28	-	-	384	39.2	441	45.1	408	41.7	437	44.7	427	43.6
Near-term ASPs	J-VC-018	1,112.2	-3,321	5,699,961	1,157.7	43	-	-	392	40.0	450	46.0	417	42.7	445	45.5	435	44.4
Near-term ASPs	J-VC-019	1,114.0	-3,238	5,699,816	1,157.7	27	-	-	374	38.3	433	44.2	393	40.9	428	43.7	417	42.7
Near-term ASPs	J-VC-020	1,114.0	-3,228	5,699,960	1,157.7	15	-	-	374	38.2	432	44.2	393	40.9	428	43.7	417	42.6
Near-term ASPs	J-VC-021	1,113.3	-3,161	5,700,033	1,157.7	18	-	-	381	39.0	439	44.9	407	41.5	435	44.4	424	43.4
Near-term ASPs	J-VC-022	1,115.0	-3,267	5,699,735	1,157.7	40	-	-	365	37.3	424	43.3	392	40.0	418	42.7	408	41.7
Near-term ASPs	J-VC-023	1,113.0	-3,374	5,699,639	1,157.8	458	-	-	384	39.3	445	45.5	414	42.3	438	44.8	428	43.8
Near-term ASPs	J-VC-024	1,113.9	-3,176	5,700,234	1,157.6	27	-	-	375	38.3	433	44.2	393	40.9	428	43.8	418	42.7
Near-term ASPs	J-VC-025	1,112.0	-3,371	5,700,222	1,157.7	25	-	-	393	40.2	452	46.2	420	42.9	447	45.7	437	44.6
Near-term ASPs	J-VC-026	1,112.2	-2,653	5,699,725	1,157.7	16	-	-	394	40.3	450	46.0	417	42.7	446	45.5	435	44.5
Near-term ASPs	J-VC-027	1,118.5	-2,642	5,700,172	1,157.7	37	-	-	330	33.8	387	39.6	354	36.2	383	39.2	373	38.1
Near-term ASPs	J-VC-028	1,112.0	-3,288	5,700,124	1,157.7	0	-	-	394	40.2	452	46.1	419	42.8	447	45.7	437	44.6
Near-term ASPs	J-VC-029	1,114.0	-3,095	5,700,234	1,157.7	0	-	-	374	38.2	432	44.1	399	40.7	427	43.7	417	42.6
Near-term ASPs	J-VC-030	1,113.1	-3,038	5,700,039	1,157.7	0	-	-	383	39.1	441	45.0	408	41.7	436	44.6	426	43.5
Near-term ASPs	J-VC-031	1,118.2	-2,643	5,700,084	1,157.7	0	-	-	333	34.0	390	39.9	357	36.5	386	39.4	376	38.4
Near-term ASPs	J-VC-032	1,118.5	-2,643	5,700,233	1,157.7	0	-	-	331	33.8	388	39.6	354	36.2	384	39.2	373	38.2
Near-term ASPs	J-VC1-001	1,113.7	-3,092	5,699,493	1,157.7	25	476	48.6	380	38.8	436	44.6	404	41.3	431	44.0	420	43.0
Near-term ASPs	J-VC1-002	1,114.5	-3,092	5,699,542	1,157.7	40	472	48.2	376	38.4	428	43.7	396	40.4	423	43.2	412	42.1
Near-term ASPs	J-VC1-003	1,114.5	-3,092	5,699,639	1,157.7	18	462	47.2	365	37.3	428	43.8	396	40.5	423	43.2	413	42.2
Near-term ASPs	J-VC1-004	1,114.5	-3,039	5,699,773	1,157.7	12	463	47.3	366	37.5	428	43.7	395	40.4	423	43.2	412	42.1
Near-term ASPs	J-VC1-005	1,114.6	-2,975	5,699,849	1,157.7	8	480	49.0	383	39.1	427	43.6	394	40.3	422	43.2	412	42.1
Near-term ASPs	J-VC1-006	1,115.0	-2,906	5,699,779	1,157.7	13	482	49.3	386	39.4	423	43.2	390	39.9	418	42.7	408	41.6
Near-term ASPs	J-VC1-007	1,113.6	-2,842	5,699,662	1,157.7	12	486	49.7	390	39.8	436	44.6	404	41.3	432	44.1	421	43.0
Near-term ASPs	J-VC1-008	1,114.6	-2,873	5,699,543	1,157.7	27	472	48.2	375	38.4	427	43.6	395	40.3	422	43.1	411	42.0
Near-term ASPs	J-VC1-009	1,115.0	-3,046	5,699,543	1,157.7	21	468	47.8	372	38.0	423	43.3	391	40.0	418	42.7	408	41.7
Near-term ASPs	J-VC1-010	1,115.0	-3,132	5,699,639	1,157.7	11	472	48.2	375	38.3	423	43.3	391	40.0	418	42.7	408	41.7
Near-term ASPs	J-VC1-011	1,115.0	-3,144	5,699,639	1,157.7	5	475	48.5	378	38.6	423	43.3	391	40.0	418	42.7	408	41.7
Near-term ASPs	J-VC1-012	1,115.0	-3,149	5,699,640	1,157.7	11	476	48.7	379	38.8	423	43.3	392	40.0	418	42.7	408	41.7
Near-term ASPs	J-VC1-013	1,115.0	-3,070	5,699,798	1,157.7	6	459	46.9	362	37.0	423	43.2	390	39.9	418	42.7	408	41.6
Near-term ASPs	J-VC1-014	1,115.0	-3,083	5,699,810	1,157.7	7	461	47.1	364	37.2	423	43.2	390	39.9	418	42.7	408	41.6
Near-term ASPs	J-VC1-015	1,114.4	-2,986	5,699,860	1,157.7	7	482	49.2	385	39.3	428	43.8	396	40.4	424	43.3	413	42.2
Near-term ASPs	J-VC1-016	1,114.5	-3,018	5,699,886	1,157.7	12	473	48.3	376	38.4	427	43.6	395	40.3	422	43.2	412	42.1
Near-term ASPs	J-VC1-017	1,114.0	-2,880	5,699,654	1,157.7	13	482	49.2	385	39.3	433	44.2	401	40.9	428	43.7	417	42.7
Near-term ASPs	J-VC3-001	1,115.0	-3,113	5,699,834	1,157.7	17	459	46.9	362	37.0	423	43.2	390	39.9	418	42.7	408	41.6
Near-term ASPs	J-VC3-002	1,115.0	-3,166	5,699,875	1,157.7	3	450	45.9	352	36.0	423	43.2	390	39.9	418	42.7	408	41.6
Near-term ASPs	J-VC3-003	1,115.0	-3,173	5,699,877	1,157.7	9	447	45.7	350	35.8	423	43.2	390	39.9	418	42.7	408	41.6
Near-term ASPs	J-VC3-004	1,115.0	-3,175	5,699,733	1,157.7	16	471	48.1	374	38.2	424	43.3	392	40.0	418	42.7	408	41.7
Near-term ASPs	J-VC3-005	1,115.0	-3,188	5,699,640	1,157.7	18	484	49.5	387	39.6	424	43.3	392	40.0	418	42.7	408	41.7
Near-term ASPs	J-VC3-006	1,114.8	-3,202	5,699,639	1,157.7	75	484	49.5	387	39.6	426	43.5	394	40.3	421	43.0	410	41.9
Near-term ASPs	J-VC3-007	1,115.0	-3,203	5,699,735	1,157.7	6	467	47.8	370	37.9	424	43.3	392	40.0	418	42.7	408	41.7
Near-term ASPs	J-VC3-008	1,115.0	-3,229	5,699,734	1,157.7	8	462	47.2	365	37.3	424	43.3	392	40.0	418	42.7	408	41.7
Near-term ASPs	J-VC3-009	1,114.0	-2,657	5,699,711	1,157.7	2	493	50.4	398	40.7	432	44.2	393	40.9	428	43.7	417	42.7
Near-term ASPs	J-VC3-010	1,116.0	-2,706	5,699,741	1,157.7	9	487	49.7	391	39.9	413	42.2	380	38.8	408	41.7	398	40.6
Near-term ASPs	J-VC3-011	1,116.0	-2,728	5,699,777	1,157.7	14	484	49.5	388	39.7	412	42.1	380	38.8	408	41.7	398	40.6

Phase	Junction ID	Elevation (m)	X (m)	Y (m)	Hydraulic Grade (m)	Demand (L/min)	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Build-out) PHD	
							Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)
Near-term ASPs	J-VC3-012	1,115.4	-2,776	5,699,845	1,157.7	22	484	49.5	387	39.6	418	42.7	385	39.4	413	42.2	403	41.2
Near-term ASPs	J-VC3-013	1,114.5	-2,883	5,699,936	1,157.7	20	484	49.5	387	39.6	427	43.7	395	40.3	423	43.2	413	42.2
Near-term ASPs	J-VC3-014	1,114.0	-2,903	5,699,944	1,157.7	16	483	49.4	386	39.4	432	44.2	393	40.8	428	43.7	417	42.7
JASP	J-JASP-001	1,113.0	-1,757	5,696,232	1,162.2	563	-	-	-	-	-	-	-	-	482	49.2	466	47.6
JASP	J-JASP-002	1,123.4	-907	5,696,232	1,171.1	760	-	-	-	-	-	-	-	-	467	47.7	447	45.7
JASP	J-JASP-003	1,129.0	-179	5,696,233	1,171.1	358	-	-	-	-	-	-	-	-	412	42.1	393	40.1
JASP	J-JASP-004	1,095.2	-196	5,699,782	1,139.9	166	-	-	-	-	-	-	-	-	438	44.7	437	44.6
JASP	J-JASP-005	1,114.9	-1,756	5,697,038	1,160.9	614	-	-	-	-	436	44.6	411	42.0	450	46.0	436	44.5
JASP	J-JASP-006	1,129.0	-183	5,697,031	1,173.9	336	-	-	-	-	-	-	-	-	439	44.9	425	43.4
JASP	J-JASP-007	1,124.0	-188	5,697,848	1,174.0	326	-	-	-	-	-	-	-	-	490	50.0	473	48.4
JASP	J-JASP-008	1,110.8	-1,755	5,697,852	1,159.6	399	-	-	-	-	477	48.7	452	46.2	478	48.8	466	47.6
JASP	J-JASP-009	1,115.3	-191	5,698,663	1,157.1	368	-	-	-	-	-	-	-	-	408	41.7	405	41.4
JASP	J-JASP-010	1,106.0	-1,755	5,698,663	1,158.5	214	-	-	-	-	519	53.1	492	50.2	514	52.5	503	51.4
JASP	J-JASP-011	1,100.9	-198	5,699,467	1,140.3	177	-	-	-	-	-	-	-	-	386	39.4	385	39.4
JASP	J-JASP-012	1,109.1	-1,756	5,699,475	1,158.0	703	-	-	-	-	485	49.5	455	46.5	479	48.9	466	47.6
JASP	J-JASP-013	1,118.6	-916	5,697,848	1,174.2	734	-	-	-	-	-	-	-	-	545	55.7	531	54.2
JASP	J-JASP-014	1,113.0	-921	5,698,666	1,157.1	716	-	-	-	-	448	45.7	418	42.7	432	44.2	426	43.5
JASP	J-JASP-015	1,110.0	-925	5,699,466	1,156.9	703	-	-	-	-	476	48.6	446	45.5	459	46.9	448	45.8
JASP	J-JASP-016	1,118.9	-912	5,697,034	1,175.9	763	-	-	-	-	-	-	-	-	557	56.9	556	56.8
JASP	J-JASP-017	1,106.5	-1,755	5,698,333	1,159.4	147	-	-	-	-	519	53.1	494	50.5	518	52.9	507	51.8
JASP	J-JASP-018	1,106.0	-1,755	5,698,591	1,158.8	25	-	-	-	-	521	53.2	494	50.5	516	52.8	505	51.7
Ultimate	J-ANN-001	1,087.0	-821	5,701,086	1,139.0	73	-	-	-	-	507	51.8	506	51.7	509	52.0	508	51.9
Ultimate	J-ANN-002	1,084.2	-1,752	5,701,079	1,139.0	769	-	-	-	-	535	54.7	534	54.6	536	54.8	535	54.7
Ultimate	J-ANN-003	1,086.0	-933	5,701,084	1,139.0	410	-	-	-	-	517	52.8	516	52.7	519	53.0	518	52.9
Ultimate	J-ANN-004	1,102.8	-1,754	5,700,274	1,138.9	681	-	-	-	-	353	36.1	353	36.0	353	36.1	353	36.1
Ultimate	J-ANN-005	1,100.0	-929	5,700,275	1,139.0	639	-	-	-	-	379	38.8	379	38.7	382	39.0	381	38.9
Ultimate	J-ANN-006	1,094.1	-432	5,700,272	1,139.3	202	-	-	-	-	-	-	-	-	443	45.2	442	45.1
Ultimate	J-ANN-007	1,118.3	-1,595	5,694,784	1,165.6	167	-	-	-	-	-	-	-	-	463	47.4	452	46.2
Ultimate	J-ANN-008	1,114.0	-901	5,694,628	1,166.0	362	-	-	-	-	-	-	-	-	508	52.0	501	51.2
Ultimate	J-ANN-009	1,125.8	-360	5,694,866	1,169.0	116	-	-	-	-	-	-	-	-	423	43.2	391	39.9
Ultimate	J-ANN-010	1,128.6	-180	5,695,426	1,169.0	365	-	-	-	-	-	-	-	-	395	40.4	367	37.5
Ultimate	J-ANN-011	1,115.5	-1,751	5,695,426	1,165.3	375	-	-	-	-	-	-	-	-	488	49.8	474	48.4
Ultimate	J-ANN-012	1,121.9	-915	5,695,426	1,167.5	758	-	-	-	-	-	-	-	-	446	45.6	427	43.6
Ultimate	J-ANN-014	1,106.5	-2,565	5,696,231	1,161.4	360	-	-	-	-	-	-	-	-	538	55.0	522	53.3
Ultimate	J-ANN-021	1,100.7	-2,566	5,697,038	1,161.0	339	-	-	-	-	-	-	-	-	591	60.3	575	58.8
Ultimate	J-ANN-022	1,121.5	-4,193	5,701,075	1,177.7	1115	-	-	-	-	-	-	-	-	550	56.2	550	56.2
Ultimate	J-ANN-023	1,112.4	-4,985	5,701,078	1,177.0	572	-	-	-	-	-	-	-	-	632	64.6	626	64.0
Ultimate	J-ANN-024	1,121.2	-4,981	5,701,876	1,176.5	290	-	-	-	-	-	-	-	-	542	55.4	532	54.4
Ultimate	J-ANN-025	1,071.0	-1,229	5,701,883	1,120.7	196	-	-	-	-	487	49.8	477	48.7	487	49.7	486	49.7
Ultimate	J-ANN-026	1,111.0	-4,988	5,700,279	1,157.6	577	-	-	-	-	-	-	-	-	456	46.6	446	45.5
Ultimate	J-ANN-027	1,119.0	-4,193	5,700,278	1,157.6	1124	-	-	-	-	384	39.2	352	35.9	377	38.6	368	37.6
Ultimate	J-ANN-028	1,109.0	-4,995	5,698,671	1,157.7	570	-	-	-	-	-	-	-	-	477	48.7	466	47.6
Ultimate	J-ANN-029	1,111.1	-4,195	5,698,669	1,157.8	1147	-	-	-	-	470	48.1	444	45.3	458	46.8	447	45.6
Ultimate	J-ANN-030	1,110.0	-4,997	5,697,860	1,157.9	289	-	-	-	-	-	-	-	-	468	47.9	457	46.7
Ultimate	J-ANN-031	1,107.3	-4,196	5,697,856	1,158.1	574	-	-	-	-	-	-	-	-	497	50.8	486	49.7
Ultimate	J-ANN-032	1,105.9	-3,359	5,698,665	1,158.8	468	-	-	-	-	528	53.9	505	51.6	518	52.9	509	52.0
Ultimate	J-ANN-033	1,102.3	-3,387	5,697,854	1,158.9	249	-	-	-	-	-	-	-	-	554	56.6	544	55.6
Ultimate	J-ANN-034	1,111.0	-3,393	5,701,073	1,157.6	621	-	-	-	-	454	46.4	418	42.7	456	46.6	447	45.7

Phase	Junction ID	Elevation (m)	X (m)	Y (m)	Hydraulic Grade (m)	Demand (L/min)	Existing (2018) MDD+FF		Existing (2018) PHD		Ultimate (Phase 1) MDD+FF		Ultimate (Phase 1) PHD		Ultimate (Build-out) MDD+FF		Ultimate (Build-out) PHD	
							Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)	Pressure (kPa)	Head (m)
Ultimate	J-ANN-035	1,125.1	-4,193	5,701,877	1,176.2	569	-	-	-	-	-	-	-	-	500	51.1	488	49.9
Ultimate	J-ANN-036	1,108.1	-3,391	5,701,882	1,157.6	564	-	-	-	-	473	48.3	434	44.4	484	49.5	477	48.7
Ultimate	J-ANN-037	1,100.0	-2,558	5,701,076	1,139.1	202	-	-	-	-	383	39.1	383	39.1	383	39.2	383	39.1
Ultimate	J-ANN-038	1,082.9	-2,558	5,701,881	1,140.3	545	-	-	-	-	561	57.3	561	57.3	561	57.3	561	57.3
Ultimate	J-ANN-039	1,069.1	-1,752	5,701,882	1,120.7	398	-	-	-	-	505	51.6	495	50.6	505	51.6	504	51.5
Ultimate	J-ANN-040	1,106.7	-4,992	5,699,466	1,157.6	572	-	-	-	-	-	-	-	-	498	50.9	488	49.8
Ultimate	J-ANN-041	1,104.3	-4,195	5,699,462	1,157.6	1135	-	-	-	-	532	54.4	502	51.3	522	53.4	512	52.3
Ultimate	J-ANN-042	1,115.0	-3,371	5,699,457	1,157.9	384	-	-	-	-	427	43.7	398	40.7	420	42.9	410	41.9
Ultimate	J-ANN-043	1,113.7	-3,370	5,700,278	1,157.6	325	-	-	-	-	435	44.4	402	41.1	430	43.9	420	42.9

Colour Legend (Available Fire Flow as % of Required):

0,000 (00%)	>100%	0,000 (00%)	90-100%	0,000 (00%)	75-90%	0,000 (00%)	50-75%	0,000 (00%)	<50%

Phase	Model Hydrant ID	Town Hydrant ID	X (m)	Y (m)	Required Fire Flow	2018 Hydrant Test Data [L/min (% of Required)]	Local Network Fire Flow Available [L/min (% of Required)]					
							Existing System (2018)	Existing System (with Railway St upgrade)	ASPs Build-out (with Osler Ave upgrade)	Existing System (with all upgrades)	Ultimate (Phase 1)	Ultimate (Build-out)
Existing	H-EX-001	#48	-2,374	5,698,512	16,000	6,469 (40%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-002	#63	-2,044	5,697,319	16,000	5,822 (36%)	12,509 (78%)	12,509 (78%)	14,159 (88%)	14,159 (88%)	13,156 (82%)	15,010 (94%)
Existing	H-EX-003	#62	-2,210	5,697,364	16,000	6,023 (38%)	12,990 (81%)	12,990 (81%)	14,721 (92%)	14,721 (92%)	13,725 (86%)	15,711 (98%)
Existing	H-EX-004	#61	-2,196	5,697,519	16,000	5,992 (37%)	13,441 (84%)	13,441 (84%)	15,296 (96%)	15,296 (96%)	14,270 (89%)	16,000+ (>100%)
Existing	H-EX-005	#60	-2,148	5,697,657	16,000	5,943 (37%)	13,990 (87%)	13,990 (87%)	16,000+ (>100%)	16,000+ (>100%)	14,978 (94%)	16,000+ (>100%)
Existing	H-EX-006	#59	-2,034	5,697,717	16,000	5,905 (37%)	13,689 (86%)	13,689 (86%)	15,881 (99%)	16,000+ (>100%)	14,724 (92%)	16,000+ (>100%)
Existing	H-EX-007	#66	-1,894	5,697,655	16,000	5,735 (36%)	12,813 (80%)	12,813 (80%)	14,945 (93%)	14,945 (93%)	13,758 (86%)	16,000+ (>100%)
Existing	H-EX-008	#85	-1,894	5,697,567	16,000	5,735 (36%)	12,303 (77%)	12,303 (77%)	14,153 (88%)	14,153 (88%)	13,025 (81%)	15,082 (94%)
Existing	H-EX-009	#65	-1,894	5,697,476	16,000	5,871 (37%)	12,113 (76%)	12,113 (76%)	13,820 (86%)	13,820 (86%)	12,757 (80%)	14,653 (92%)
Existing	H-EX-010	#64	-1,895	5,697,345	16,000	5,992 (37%)	12,018 (75%)	12,018 (75%)	13,620 (85%)	13,620 (85%)	12,576 (79%)	14,352 (90%)
Existing	H-EX-011	#58	-1,894	5,697,833	16,000	5,905 (37%)	13,396 (84%)	13,396 (84%)	16,000+ (>100%)	16,000+ (>100%)	15,077 (94%)	16,000+ (>100%)
Existing	H-EX-012	#57	-1,917	5,697,867	16,000	5,822 (36%)	12,256 (77%)	12,256 (77%)	14,507 (91%)	14,507 (91%)	13,465 (84%)	15,260 (95%)
Existing	H-EX-013	#56	-1,895	5,698,000	16,000	5,943 (37%)	13,946 (87%)	13,946 (87%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-014	#55	-1,894	5,698,266	16,000	5,822 (36%)	14,850 (93%)	14,850 (93%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-015	#54	-1,894	5,698,569	16,000	5,992 (37%)	15,960 (100%)	15,960 (100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-016	#46	-2,167	5,698,600	12,000	6,125 (51%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-017	#47	-2,259	5,698,562	16,000	5,992 (37%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-018	#49	-2,516	5,698,494	16,000	6,352 (40%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-019	#87	-2,743	5,698,503	16,000	6,655 (42%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-020	#88	-2,943	5,698,525	16,000	6,412 (40%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-021	#89	-3,118	5,698,520	16,000	6,394 (40%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-022	#90	-3,200	5,698,517	16,000	6,394 (40%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-023	#84	-3,349	5,698,511	16,000	6,394 (40%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-024	#50	-2,334	5,698,397	16,000	6,125 (38%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-025	#51	-2,212	5,698,469	16,000	6,193 (39%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-026	#45	-2,119	5,698,655	12,000	5,992 (50%)	14,167 (>100%)	15,387 (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-027	#44	-2,212	5,698,712	12,000	5,905 (49%)	11,287 (94%)	14,143 (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-028	#42	-2,294	5,698,790	4,500	2,824 (63%)	10,657 (>100%)	12,058 (>100%)	14,527 (>100%)	14,527 (>100%)	13,642 (>100%)	14,957 (>100%)
Existing	H-EX-029	#43	-2,395	5,698,763	4,500	2,445 (54%)	8,543 (>100%)	9,200 (>100%)	10,296 (>100%)	10,296 (>100%)	9,611 (>100%)	10,148 (>100%)
Existing	H-EX-030	#41	-2,216	5,698,835	12,000	5,905 (49%)	10,265 (86%)	12,730 (>100%)	15,710 (>100%)	15,710 (>100%)	14,809 (>100%)	16,000+ (>100%)
Existing	H-EX-031	#26	-2,062	5,698,904	12,000	5,765 (48%)	9,648 (80%)	13,564 (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-032	#27	-2,199	5,698,952	12,000	5,686 (47%)	9,551 (80%)	12,578 (>100%)	15,742 (>100%)	15,742 (>100%)	14,855 (>100%)	16,000+ (>100%)
Existing	H-EX-033	#34	-2,503	5,698,986	7,500	5,822 (78%)	6,057 (81%)	7,055 (94%)	7,795 (>100%)	7,795 (>100%)	7,270 (97%)	7,630 (>100%)
Existing	H-EX-034	#86	-2,630	5,698,991	4,500	5,822* (78%)	5,199 (>100%)	5,968 (>100%)	6,542 (>100%)	6,542 (>100%)	6,082 (>100%)	6,347 (>100%)
Existing	H-EX-035	#68	-2,625	5,699,166	4,500	5,905 (>100%)	7,040 (>100%)	11,162 (>100%)	15,495 (>100%)	15,495 (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-036	#78	-2,839	5,698,950	4,500	5,905 (>100%)	6,348 (>100%)	7,980 (>100%)	9,582 (>100%)	9,582 (>100%)	9,146 (>100%)	10,006 (>100%)
Existing	H-EX-037	#72	-2,875	5,699,151	7,500	6,155 (82%)	6,870 (92%)	10,201 (>100%)	13,710 (>100%)	13,710 (>100%)	14,487 (>100%)	16,000+ (>100%)
Existing	H-EX-038	#73	-3,064	5,699,178	7,500	6,072 (81%)	6,862 (91%)	10,087 (>100%)	13,739 (>100%)	13,739 (>100%)	14,658 (>100%)	16,000+ (>100%)
Existing	H-EX-039	#77	-3,096	5,699,388	4,500	5,822 (>100%)	6,838 (>100%)	10,280 (>100%)	14,888 (>100%)	14,888 (>100%)	16,000+ (>100%)	16,000+ (>100%)

Colour Legend (Available Fire Flow as % of Required):

0,000 (00%)	>100%	0,000 (00%)	90-100%	0,000 (00%)	75-90%	0,000 (00%)	50-75%	0,000 (00%)	<50%

Phase	Model Hydrant ID	Town Hydrant ID	X (m)	Y (m)	Required Fire Flow	2018 Hydrant Test Data [L/min (% of Required)]	Local Network Fire Flow Available [L/min (% of Required)]					
							Existing System (2018)	Existing System (with Railway St upgrade)	ASPs Build-out (with Osler Ave upgrade)	Existing System (with all upgrades)	Ultimate (Phase 1)	Ultimate (Build-out)
Existing	H-EX-040	#76	-2,992	5,699,343	4,500	5,905 (>100%)	6,708 (>100%)	9,064 (>100%)	11,939 (>100%)	11,939 (>100%)	12,630 (>100%)	14,900 (>100%)
Existing	H-EX-041	#75	-2,873	5,699,396	4,500	5,822 (>100%)	6,847 (>100%)	10,511 (>100%)	15,729 (>100%)	15,729 (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-042	#69	-2,715	5,699,228	4,500	5,905 (>100%)	6,881 (>100%)	10,814 (>100%)	15,441 (>100%)	15,441 (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-043	#70	-2,715	5,699,416	4,500	5,905 (>100%)	6,851 (>100%)	10,718 (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-044	#71	-2,637	5,699,329	4,500	5,905 (>100%)	6,858 (>100%)	10,578 (>100%)	15,101 (>100%)	15,101 (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-045	#33	-2,503	5,699,108	4,500	5,905 (>100%)	7,391 (>100%)	10,068 (>100%)	12,400 (>100%)	12,400 (>100%)	11,998 (>100%)	13,328 (>100%)
Existing	H-EX-046	#32	-2,400	5,699,130	4,500	5,992 (>100%)	7,594 (>100%)	9,780 (>100%)	11,802 (>100%)	11,802 (>100%)	11,258 (>100%)	12,409 (>100%)
Existing	H-EX-047	#31	-2,315	5,699,077	4,500	5,561 (>100%)	7,970 (>100%)	11,924 (>100%)	15,386 (>100%)	15,386 (>100%)	15,127 (>100%)	16,000+ (>100%)
Existing	H-EX-048	#81	-2,166	5,699,046	12,000	5,686 (47%)	8,332 (69%)	12,829 (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-049	#82	-2,038	5,698,983	12,000	5,765 (48%)	8,761 (73%)	12,554 (>100%)	15,637 (>100%)	15,637 (>100%)	15,811 (>100%)	16,000+ (>100%)
Existing	H-EX-050	#25	-1,964	5,699,085	12,000	5,686 (47%)	7,729 (64%)	13,505 (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-051	#?	-2,133	5,699,139	12,000	5,284* (44%)	3,936 (33%)	4,334 (36%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-052	#36	-2,382	5,699,229	4,500	5,905 (>100%)	6,987 (>100%)	9,026 (>100%)	10,931 (>100%)	10,931 (>100%)	10,401 (>100%)	11,393 (>100%)
Existing	H-EX-053	#35	-2,502	5,699,249	4,500	5,735* (>100%)	7,195 (>100%)	10,004 (>100%)	12,782 (>100%)	12,782 (>100%)	12,535 (>100%)	14,206 (>100%)
Existing	H-EX-054	#40	-2,503	5,699,376	4,500	5,735 (>100%)	7,031 (>100%)	9,284 (>100%)	11,737 (>100%)	11,737 (>100%)	11,494 (>100%)	12,914 (>100%)
Existing	H-EX-055	#83	-2,387	5,699,362	7,500	5,235 (70%)	2,784 (37%)	2,990 (40%)	10,239 (>100%)	10,239 (>100%)	9,600 (>100%)	10,464 (>100%)
Existing	H-EX-056	#37	-2,315	5,699,309	7,500	4,993 (67%)	3,104 (41%)	3,373 (45%)	12,519 (>100%)	12,519 (>100%)	12,057 (>100%)	13,552 (>100%)
Existing	H-EX-057	#30	-2,241	5,699,291	4,500	5,322 (>100%)	7,127 (>100%)	11,646 (>100%)	15,223 (>100%)	15,223 (>100%)	15,217 (>100%)	16,000+ (>100%)
Existing	H-EX-058	#24	-1,930	5,699,181	12,000	5,625 (47%)	7,159 (60%)	13,261 (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-059	#29	-2,074	5,699,313	12,000	5,284 (44%)	6,805 (57%)	10,402 (87%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-060	#38	-2,363	5,699,413	7,000	5,561 (79%)	6,112 (87%)	8,317 (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-061	#22	-1,958	5,699,397	12,000	5,375 (45%)	5,044 (42%)	6,693 (56%)	14,589 (>100%)	14,589 (>100%)	14,768 (>100%)	16,000+ (>100%)
Existing	H-EX-062	#21	-1,855	5,699,403	12,000	5,284 (44%)	6,501 (54%)	13,028 (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-063	#79	-1,831	5,699,410	12,000	5,375 (45%)	6,381 (53%)	13,021 (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-064	#15	-2,506	5,699,635	4,500	5,375 (>100%)	6,668 (>100%)	10,135 (>100%)	14,056 (>100%)	14,056 (>100%)	14,978 (>100%)	16,000+ (>100%)
Existing	H-EX-065	#14	-2,380	5,699,669	4,500	5,375 (>100%)	5,800 (>100%)	7,695 (>100%)	9,125 (>100%)	9,125 (>100%)	8,774 (>100%)	9,797 (>100%)
Existing	H-EX-066	#8	-2,419	5,699,835	4,500	5,375 (>100%)	6,212 (>100%)	9,158 (>100%)	12,077 (>100%)	12,077 (>100%)	13,250 (>100%)	16,000+ (>100%)
Existing	H-EX-067	#7	-2392.9.35	5,699,995	4,500	5,375 (>100%)	5,809 (>100%)	8,080 (>100%)	9,929 (>100%)	9,929 (>100%)	11,216 (>100%)	13,723 (>100%)
Existing	H-EX-068	#6	-2392.9.76	5,700,096	4,500	5,375 (>100%)	5,721 (>100%)	7,989 (>100%)	9,679 (>100%)	9,679 (>100%)	11,944 (>100%)	14,798 (>100%)
Existing	H-EX-069	#5	-2,474	5,700,180	4,500	5,470 (>100%)	5,354 (>100%)	7,007 (>100%)	8,142 (>100%)	8,142 (>100%)	11,715 (>100%)	14,603 (>100%)
Existing	H-EX-070	#4	-2,385	5,700,259	7,000	5,470 (78%)	5,683 (81%)	7,729 (>100%)	9,235 (>100%)	9,235 (>100%)	12,242 (>100%)	15,464 (>100%)
Existing	H-EX-072	#3	-2,284	5,700,080	4,500	5,470 (>100%)	5,397 (>100%)	6,909 (>100%)	7,903 (>100%)	7,903 (>100%)	8,597 (>100%)	9,716 (>100%)
Existing	H-EX-073	#1	-2,046	5,700,110	7,000	5,822 (83%)	5,991 (86%)	8,601 (>100%)	10,279 (>100%)	10,279 (>100%)	12,658 (>100%)	15,208 (>100%)
Existing	H-EX-074	#28	-1,935	5,699,907	7,000	5,515 (79%)	6,260 (89%)	9,663 (>100%)	12,941 (>100%)	12,941 (>100%)	14,864 (>100%)	16,000+ (>100%)
Existing	H-EX-075	#11	-2,061	5,699,918	4,500	5,186 (>100%)	6,033 (>100%)	8,145 (>100%)	9,714 (>100%)	9,714 (>100%)	9,765 (>100%)	11,058 (>100%)
Existing	H-EX-076	#10	-2,283	5,699,916	4,500	5,186 (>100%)	5,653 (>100%)	7,683 (>100%)	9,223 (>100%)	9,223 (>100%)	9,130 (>100%)	10,424 (>100%)
Existing	H-EX-077	#9	-2,283	5,699,815	4,500	5,648 (>100%)	6,208 (>100%)	8,911 (>100%)	11,300 (>100%)	11,300 (>100%)	11,880 (>100%)	14,357 (>100%)
Existing	H-EX-078	#13	-2,283	5,699,640	7,500	5,822 (78%)	5,906 (79%)	7,794 (>100%)	9,166 (>100%)	9,166 (>100%)	8,946 (>100%)	9,901 (>100%)
Existing	H-EX-079	#16	-2,280	5,699,491	4,500	5,561 (>100%)	6,558 (>100%)	10,286 (>100%)	13,447 (>100%)	13,447 (>100%)	13,828 (>100%)	16,000+ (>100%)

Colour Legend (Available Fire Flow as % of Required):	0,000 (00%)	>100%	0,000 (00%)	90-100%	0,000 (00%)	75-90%	0,000 (00%)	50-75%	0,000 (00%)	<50%

Phase	Model Hydrant ID	Town Hydrant ID	X (m)	Y (m)	Required Fire Flow	2018 Hydrant Test Data [L/min (% of Required)]	Local Network Fire Flow Available [L/min (% of Required)]					
							Existing System (2018)	Existing System (with Railway St upgrade)	ASPs Build-out (with Osler Ave upgrade)	Existing System (with all upgrades)	Ultimate (Phase 1)	Ultimate (Build-out)
Existing	H-EX-080	#12	-2,185	5,699,816	7,000	5,375 (77%)	6,236 (89%)	8,983 (>100%)	11,407 (>100%)	11,407 (>100%)	11,843 (>100%)	14,334 (>100%)
Existing	H-EX-081	#19	-1,906	5,699,751	7,000	5,186 (74%)	6,380 (91%)	9,931 (>100%)	12,337 (>100%)	12,337 (>100%)	13,052 (>100%)	15,244 (>100%)
Existing	H-EX-082	#18	-1,907	5,699,698	7,500	5,186* (74%)	6,412 (85%)	9,873 (>100%)	12,200 (>100%)	12,200 (>100%)	12,658 (>100%)	14,664 (>100%)
Existing	H-EX-083	#20	-1,906	5,699,492	12,000	5,648 (47%)	6,579 (55%)	10,414 (87%)	12,781 (>100%)	12,781 (>100%)	12,824 (>100%)	14,681 (>100%)
Existing	H-EX-084	#17	-2,087	5,699,642	7,500	5,470 (73%)	4,172 (56%)	4,911 (65%)	9,701 (>100%)	9,701 (>100%)	9,213 (>100%)	10,196 (>100%)
Existing	H-EX-085	N/A	-2,779	5,698,389	16,000	6,352 (40%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-086	#23	-1,961	5,699,273	12,000	5,686 (47%)	6,875 (57%)	11,229 (94%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-087	#67	-2,471	5,698,003	16,000	6,023 (38%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-088	N/A	-2,513	5,698,007	16,000	6,023* (38%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-089	N/A	-2,478	5,697,973	16,000	6,023* (38%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-090	#74	-2,906	5,699,256	7,000	5,822 (83%)	6,861 (98%)	10,407 (>100%)	14,534 (>100%)	14,534 (>100%)	16,000+ (>100%)	16,000+ (>100%)
Existing	H-EX-091	N/A	-2,882	5,697,841	12,000	6,023* (38%)	12,614 (>100%)	12,614 (>100%)	13,137 (>100%)	13,137 (>100%)	11,874 (99%)	16,000+ (>100%)
Existing	H-EX-092	#52	-1,789	5,699,317	4,500	5,091 (>100%)	6,263 (>100%)	9,141 (>100%)	9,145 (>100%)	16,000+ (>100%)	14,806 (>100%)	16,000+ (>100%)
Existing	H-EX-093	#53	-1,882	5,699,041	4,500	5,235 (>100%)	4,243 (94%)	5,139 (>100%)	5,139 (>100%)	13,971 (>100%)	11,277 (>100%)	12,333 (>100%)
Near-term ASPs	H-HL-001	-	-2,639	5,700,586	7,500	5,000* (>100%)	-	-	-	-	13,569 (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-002	-	-2,850	5,700,593	7,500	5,000* (>100%)	-	-	-	-	9,826 (>100%)	11,606 (>100%)
Near-term ASPs	H-HL-003	-	-2,681	5,700,823	4,500	5,000* (>100%)	-	-	-	-	12,953 (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-004	-	-2,829	5,700,926	4,500	5,000* (>100%)	-	-	-	-	14,993 (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-005	-	-2,941	5,700,987	12,000	5,000* (>100%)	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-006	-	-3,054	5,700,981	7,500	5,000* (>100%)	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-007	-	-2,975	5,700,767	4,500	5,000* (>100%)	-	-	-	-	15,890 (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-008	-	-2,872	5,700,717	7,500	5,000* (>100%)	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-009	-	-2,998	5,700,637	7,500	5,000* (>100%)	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-010	-	-3,139	5,700,597	7,500	5,000* (>100%)	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-011	-	-3,172	5,700,685	4,500	5,000* (>100%)	-	-	-	-	12,278 (>100%)	15,891 (>100%)
Near-term ASPs	H-HL-012	-	-3,353	5,700,591	7,500	5,000* (>100%)	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-013	-	-3,297	5,700,752	4,500	5,000* (>100%)	-	-	-	-	12,496 (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-014	-	-3,124	5,700,837	4,500	5,000* (>100%)	-	-	-	-	12,563 (>100%)	15,993 (>100%)
Near-term ASPs	H-HL-015	-	-3,350	5,700,864	7,500	5,000* (>100%)	-	-	-	-	11,682 (>100%)	14,545 (>100%)
Near-term ASPs	H-HL-016	-	-3,276	5,700,954	7,500	5,000* (>100%)	-	-	-	-	11,218 (>100%)	13,603 (>100%)
Near-term ASPs	H-HL-017	-	-3,233	5,701,022	7,500	5,000* (>100%)	-	-	-	-	10,620 (>100%)	12,664 (>100%)
Near-term ASPs	H-HL-018	-	-2,962	5,700,399	4,500	5,000* (>100%)	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-019	-	-3,044	5,700,331	4,500	5,000* (>100%)	-	-	-	-	15,296 (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-020	-	-3,302	5,700,392	4,500	5,000* (>100%)	-	-	-	-	13,584 (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL-021	-	-3,154	5,700,449	4,500	5,000* (>100%)	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL1-001	-	-2,749	5,700,456	4,500	5,000* (>100%)	-	-	-	-	13,405 (>100%)	16,000+ (>100%)
Near-term ASPs	H-HL1-002	-	-2,650	5,700,332	4,500	5,000* (>100%)	-	-	-	-	12,014 (>100%)	15,291 (>100%)
Near-term ASPs	H-IL-001	-	-2,411	5,700,605	4,500	5,000* (>100%)	-	-	-	-	12,487 (>100%)	14,969 (>100%)
Near-term ASPs	H-IL-002	-	-2,523	5,700,677	4,500	5,000* (>100%)	-	-	-	-	9,965 (>100%)	11,268 (>100%)

Appendix D - WaterCAD Model Inputs and Results - Hydrant Tables

Colour Legend (Available Fire Flow as % of Required):

0,000 (00%)	>100%	0,000 (00%)	90-100%	0,000 (00%)	75-90%	0,000 (00%)	50-75%	0,000 (00%)	<50%

Phase	Model Hydrant ID	Town Hydrant ID	X (m)	Y (m)	Required Fire Flow	2018 Hydrant Test Data [L/min (% of Required)]	Local Network Fire Flow Available [L/min (% of Required)]					
							Existing System (2018)	Existing System (with Railway St upgrade)	ASPs Build-out (with Osler Ave upgrade)	Existing System (with all upgrades)	Ultimate (Phase 1)	Ultimate (Build-out)
Near-term ASPs	H-IL-003	-	-2,526	5,700,977	12,000	5,000* (>100%)	-	-	-	-	14,040 (>100%)	14,879 (>100%)
Near-term ASPs	H-IL-004	-	-2,417	5,700,883	4,500	5,000* (>100%)	-	-	-	-	8,882 (>100%)	9,723 (>100%)
Near-term ASPs	H-IL-005	-	-2,421	5,700,732	7,500	5,000* (>100%)	-	-	-	-	11,209 (>100%)	12,817 (>100%)
Near-term ASPs	H-IL-006	-	-2,283	5,700,693	7,500	5,000* (>100%)	-	-	-	-	11,663 (>100%)	13,447 (>100%)
Near-term ASPs	H-IL-007	-	-2,199	5,700,801	4,500	5,000* (>100%)	-	-	-	-	14,964 (>100%)	12,377 (>100%)
Near-term ASPs	H-IL-008	-	-2,263	5,700,966	7,500	5,000* (>100%)	-	-	-	-	16,000+ (>100%)	15,263 (>100%)
Near-term ASPs	H-IL-009	-	-2,109	5,700,606	4,500	5,000* (>100%)	-	-	-	-	13,402 (>100%)	15,798 (>100%)
Near-term ASPs	H-IL-010	-	-2,070	5,700,417	4,500	5,000* (>100%)	-	-	-	-	13,498 (>100%)	16,000+ (>100%)
Near-term ASPs	H-IL1-001	#91	-2,527	5,700,324	4,500	5,375 (>100%)	4,120 (92%)	4,904 (>100%)	5,351 (>100%)	5,351 (>100%)	5,391 (>100%)	5,802 (>100%)
Near-term ASPs	H-IL2-001	New #4	-2,526	5,700,410	4,500	5,186 (>100%)	5,264 (>100%)	6,725 (>100%)	7,680 (>100%)	7,680 (>100%)	9,158 (>100%)	10,590 (>100%)
Near-term ASPs	H-IL2-002	New #5	-2,259	5,700,412	4,500	5,417 (>100%)	5,660 (>100%)	7,283 (>100%)	8,286 (>100%)	8,286 (>100%)	12,930 (>100%)	15,862 (>100%)
Near-term ASPs	H-IL2-003	-	-2,385	5,700,458	4,500	5,000* (>100%)	5,700 (>100%)	7,901 (>100%)	9,633 (>100%)	9,633 (>100%)	14,125 (>100%)	16,000+ (>100%)
Near-term ASPs	H-IL3-001	New #3	-2,558	5,700,509	4,500	5,765 (>100%)	5,734 (>100%)	7,582 (>100%)	8,762 (>100%)	8,762 (>100%)	15,050 (>100%)	16,000+ (>100%)
Near-term ASPs	H-IL3-002	New #2	-2,284	5,700,509	4,500	5,822 (>100%)	5,764 (>100%)	8,054 (>100%)	9,895 (>100%)	9,895 (>100%)	14,670 (>100%)	16,000+ (>100%)
Near-term ASPs	H-IL3-003	New #1	-2,044	5,700,501	4,500	5,735 (>100%)	5,836 (>100%)	8,233 (>100%)	10,210 (>100%)	10,210 (>100%)	14,985 (>100%)	16,000+ (>100%)
Near-term ASPs	H-IL3-004	-	-1,993	5,700,287	7,000	5,000* (>100%)	5,916 (85%)	8,435 (>100%)	10,561 (>100%)	10,561 (>100%)	13,872 (>100%)	16,000+ (>100%)
Near-term ASPs	H-VC-001	-	-3,311	5,699,968	4,500	5,000* (>100%)	-	-	-	-	10,978 (>100%)	12,774 (>100%)
Near-term ASPs	H-VC-002	-	-3,030	5,700,038	4,500	5,000* (>100%)	-	-	-	-	10,399 (>100%)	12,051 (>100%)
Near-term ASPs	H-VC-003	-	-3,086	5,700,226	4,500	5,000* (>100%)	-	-	-	-	9,389 (>100%)	10,723 (>100%)
Near-term ASPs	H-VC-004	-	-3,292	5,700,126	4,500	5,000* (>100%)	-	-	-	-	10,219 (>100%)	11,698 (>100%)
Near-term ASPs	H-VC-005	-	-2,922	5,700,121	4,500	5,000* (>100%)	-	-	-	-	14,120 (>100%)	16,000+ (>100%)
Near-term ASPs	H-VC-006	-	-2,902	5,700,226	4,500	5,000* (>100%)	-	-	-	-	14,949 (>100%)	16,000+ (>100%)
Near-term ASPs	H-VC-007	-	-2,736	5,700,141	4,500	5,000* (>100%)	-	-	-	-	10,902 (>100%)	13,115 (>100%)
Near-term ASPs	H-VC-008	-	-2,643	5,700,248	4,500	5,000* (>100%)	-	-	-	-	11,269 (>100%)	14,064 (>100%)
Near-term ASPs	H-VC-009	-	-2,629	5,700,084	4,500	5,000* (>100%)	-	-	-	-	11,000 (>100%)	13,576 (>100%)
Near-term ASPs	H-VC-010	-	-2,633	5,699,977	4,500	5,000* (>100%)	-	-	-	-	11,086 (>100%)	13,659 (>100%)
Near-term ASPs	H-VC-011	-	-3,191	5,700,312	4,500	5,000* (>100%)	-	-	-	-	12,744 (>100%)	15,968 (>100%)
Near-term ASPs	H-VC1-001	New #11	-3,047	5,699,552	4,500	5,235 (>100%)	6,715 (>100%)	9,165 (>100%)	12,224 (>100%)	12,224 (>100%)	13,865 (>100%)	16,000+ (>100%)
Near-term ASPs	H-VC1-002	New #10	-2,873	5,699,552	4,500	5,515 (>100%)	6,379 (>100%)	8,389 (>100%)	10,609 (>100%)	10,609 (>100%)	11,140 (>100%)	13,054 (>100%)
Near-term ASPs	H-VC1-003	New #6	-2,879	5,699,649	4,500	5,235 (>100%)	6,826 (>100%)	9,385 (>100%)	12,497 (>100%)	12,497 (>100%)	14,434 (>100%)	16,000+ (>100%)
Near-term ASPs	H-VC1-004	New #9	-2,913	5,699,774	4,500	5,561 (>100%)	6,807 (>100%)	9,225 (>100%)	12,176 (>100%)	12,176 (>100%)	13,655 (>100%)	16,000+ (>100%)
Near-term ASPs	H-VC1-005	New #8	-3,073	5,699,794	4,500	5,515 (>100%)	6,685 (>100%)	9,217 (>100%)	12,478 (>100%)	12,478 (>100%)	16,000+ (>100%)	16,000+ (>100%)
Near-term ASPs	H-VC1-006	New #7	-3,132	5,699,648	7,500	5,235 (70%)	6,827 (91%)	9,542 (>100%)	13,007 (>100%)	13,007 (>100%)	16,000+ (>100%)	16,000+ (>100%)
Near-term ASPs	H-VC3-001	-	-3,203	5,699,740	4,500	5,000* (>100%)	6,389 (>100%)	8,466 (>100%)	10,809 (>100%)	10,809 (>100%)	15,610 (>100%)	16,000+ (>100%)
Near-term ASPs	H-VC3-002	-	-3,169	5,699,886	4,500	5,000* (>100%)	5,896 (>100%)	7,644 (>100%)	9,473 (>100%)	9,473 (>100%)	14,182 (>100%)	16,000+ (>100%)
Near-term ASPs	H-VC3-003	-	-2,881	5,699,939	4,500	5,000* (>100%)	6,813 (>100%)	9,924 (>100%)	13,671 (>100%)	13,671 (>100%)	16,000+ (>100%)	16,000+ (>100%)
Near-term ASPs	H-VC3-004	-	-2,703	5,699,744	4,500	5,000* (>100%)	6,726 (>100%)	9,621 (>100%)	12,752 (>100%)	12,752 (>100%)	13,927 (>100%)	16,000+ (>100%)
JASP	H-JASP-001	-	-1,707	5,701,122	16,000	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
JASP	H-JASP-002	-	-903	5,701,113	16,000	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)

Colour Legend (Available Fire Flow as % of Required):	0,000 (00%)	>100%	0,000 (00%)	90-100%	0,000 (00%)	75-90%	0,000 (00%)	50-75%	0,000 (00%)	<50%

Phase	Model Hydrant ID	Town Hydrant ID	X (m)	Y (m)	Required Fire Flow	2018 Hydrant Test Data [L/min (% of Required)]	Local Network Fire Flow Available [L/min (% of Required)]					
							Existing System (2018)	Existing System (with Railway St upgrade)	ASPs Build-out (with Osler Ave upgrade)	Existing System (with all upgrades)	Ultimate (Phase 1)	Ultimate (Build-out)
JASP	H-JASP-003	-	-795	5,701,112	16,000	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
JASP	H-JASP-004	-	-405	5,700,296	16,000	-	-	-	-	-	-	16,000+ (>100%)
JASP	H-JASP-005	-	-900	5,700,304	16,000	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
JASP	H-JASP-006	-	-1,722	5,700,305	16,000	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
JASP	H-JASP-007	-	-1,728	5,699,508	16,000	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
JASP	H-JASP-008	-	-893	5,699,500	16,000	-	-	-	-	-	14,036 (88%)	16,000+ (>100%)
JASP	H-JASP-009	-	-166	5,699,497	16,000	-	-	-	-	-	-	16,000+ (>100%)
JASP	H-JASP-010	-	-167	5,698,687	16,000	-	-	-	-	-	-	16,000+ (>100%)
JASP	H-JASP-011	-	-884	5,698,705	16,000	-	-	-	-	-	11,407 (71%)	16,000+ (>100%)
JASP	H-JASP-012	-	-1,709	5,698,706	16,000	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
JASP	H-JASP-013	-	-1,711	5,697,903	16,000	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
JASP	H-JASP-014	-	-868	5,697,891	16,000	-	-	-	-	-	-	16,000+ (>100%)
JASP	H-JASP-015	-	-145	5,697,883	16,000	-	-	-	-	-	-	16,000+ (>100%)
JASP	H-JASP-016	-	-148	5,697,069	16,000	-	-	-	-	-	-	16,000+ (>100%)
JASP	H-JASP-017	-	-880	5,697,070	16,000	-	-	-	-	-	-	16,000+ (>100%)
JASP	H-JASP-018	-	-1,719	5,697,079	16,000	-	-	-	-	-	10,583 (66%)	16,000+ (>100%)
JASP	H-JASP-019	-	-1,707	5,696,282	16,000	-	-	-	-	-	-	16,000+ (>100%)
JASP	H-JASP-020	-	-867	5,696,275	16,000	-	-	-	-	-	-	16,000+ (>100%)
JASP	H-JASP-021	-	-142	5,696,272	16,000	-	-	-	-	-	-	14,561 (91%)
Ultimate	H-FUT-001	-	-4,953	5,701,906	7,500	-	-	-	-	-	-	13,427 (>100%)
Ultimate	H-FUT-002	-	-4,165	5,701,907	7,500	-	-	-	-	-	-	13,992 (>100%)
Ultimate	H-FUT-003	-	-3,360	5,701,916	4,500	-	-	-	-	-	11,605 (>100%)	16,000+ (>100%)
Ultimate	H-FUT-004	-	-2,516	5,701,921	4,500	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Ultimate	H-FUT-005	-	-1,721	5,701,920	16,000	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Ultimate	H-FUT-006	-	-1,201	5,701,917	16,000	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Ultimate	H-FUT-007	-	-2,505	5,701,132	4,500	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Ultimate	H-FUT-008	-	-3,333	5,701,127	4,500	-	-	-	-	-	14,329 (>100%)	16,000+ (>100%)
Ultimate	H-FUT-009	-	-4,164	5,701,107	7,500	-	-	-	-	-	-	16,000+ (>100%)
Ultimate	H-FUT-010	-	-4,960	5,701,103	7,500	-	-	-	-	-	-	16,000+ (>100%)
Ultimate	H-FUT-011	-	-4,949	5,700,310	7,500	-	-	-	-	-	-	16,000+ (>100%)
Ultimate	H-FUT-012	-	-4,157	5,700,312	7,500	-	-	-	-	-	12,415 (>100%)	16,000+ (>100%)
Ultimate	H-FUT-013	-	-3,349	5,700,300	7,500	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Ultimate	H-FUT-014	-	-3,322	5,699,504	7,500	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Ultimate	H-FUT-015	-	-4,156	5,699,500	7,500	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Ultimate	H-FUT-016	-	-4,952	5,699,499	7,500	-	-	-	-	-	-	16,000+ (>100%)
Ultimate	H-FUT-017	-	-4,942	5,698,726	7,500	-	-	-	-	-	-	16,000+ (>100%)
Ultimate	H-FUT-018	-	-4,138	5,698,724	7,500	-	-	-	-	-	13,917 (>100%)	16,000+ (>100%)
Ultimate	H-FUT-019	-	-3,315	5,698,702	7,500	-	-	-	-	-	16,000+ (>100%)	16,000+ (>100%)
Ultimate	H-FUT-020	-	-3,340	5,697,892	7,500	-	-	-	-	-	-	16,000+ (>100%)

Colour Legend (Available Fire Flow as % of Required):	0,000 (00%)	>100%	0,000 (00%)	90-100%	0,000 (00%)	75-90%	0,000 (00%)	50-75%	0,000 (00%)	<50%

Phase	Model Hydrant ID	Town Hydrant ID	X (m)	Y (m)	Required Fire Flow	2018 Hydrant Test Data [L/min (% of Required)]	Local Network Fire Flow Available [L/min (% of Required)]					
							Existing System (2018)	Existing System (with Railway St upgrade)	ASPs Build-out (with Osler Ave upgrade)	Existing System (with all upgrades)	Ultimate (Phase 1)	Ultimate (Build-out)
Ultimate	H-FUT-021	-	-4,156	5,697,895	7,500	-	-	-	-	-	-	16,000+ (>100%)
Ultimate	H-FUT-022	-	-4,963	5,697,895	7,500	-	-	-	-	-	-	16,000+ (>100%)
Ultimate	H-FUT-023	-	-2,509	5,697,090	16,000	-	-	-	-	-	-	16,000+ (>100%)
Ultimate	H-FUT-024	-	-2,494	5,696,310	16,000	-	-	-	-	-	-	15,364 (96%)
Ultimate	H-FUT-025	-	-1,710	5,695,470	16,000	-	-	-	-	-	-	16,000+ (>100%)
Ultimate	H-FUT-026	-	-874	5,695,469	16,000	-	-	-	-	-	-	16,000+ (>100%)
Ultimate	H-FUT-027	-	-143	5,695,465	16,000	-	-	-	-	-	-	10,017 (63%)
Ultimate	H-FUT-028	-	-399	5,694,891	16,000	-	-	-	-	-	-	9,729 (61%)
Ultimate	H-FUT-029	-	-859	5,694,674	16,000	-	-	-	-	-	-	16,000+ (>100%)
Ultimate	H-FUT-030	-	-1,547	5,694,819	16,000	-	-	-	-	-	-	15,012 (94%)

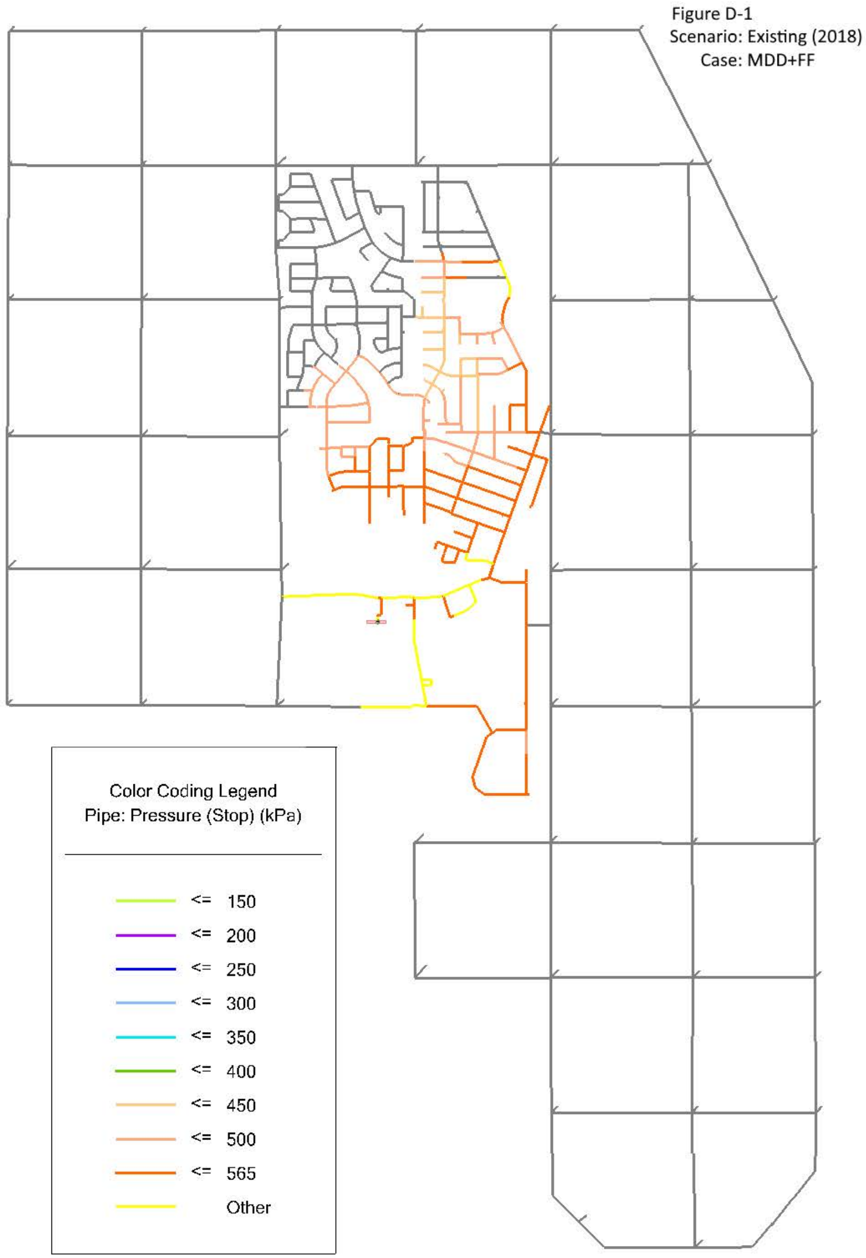


Figure D-1
Scenario: Existing (2018)
Case: MDD+FF
Color Coding Legend
Pipe: Pressure (Stop) (kPa)
<= 150
<= 200
<= 250
<= 300
<= 350
<= 400
<= 450
<= 500
<= 565
Other

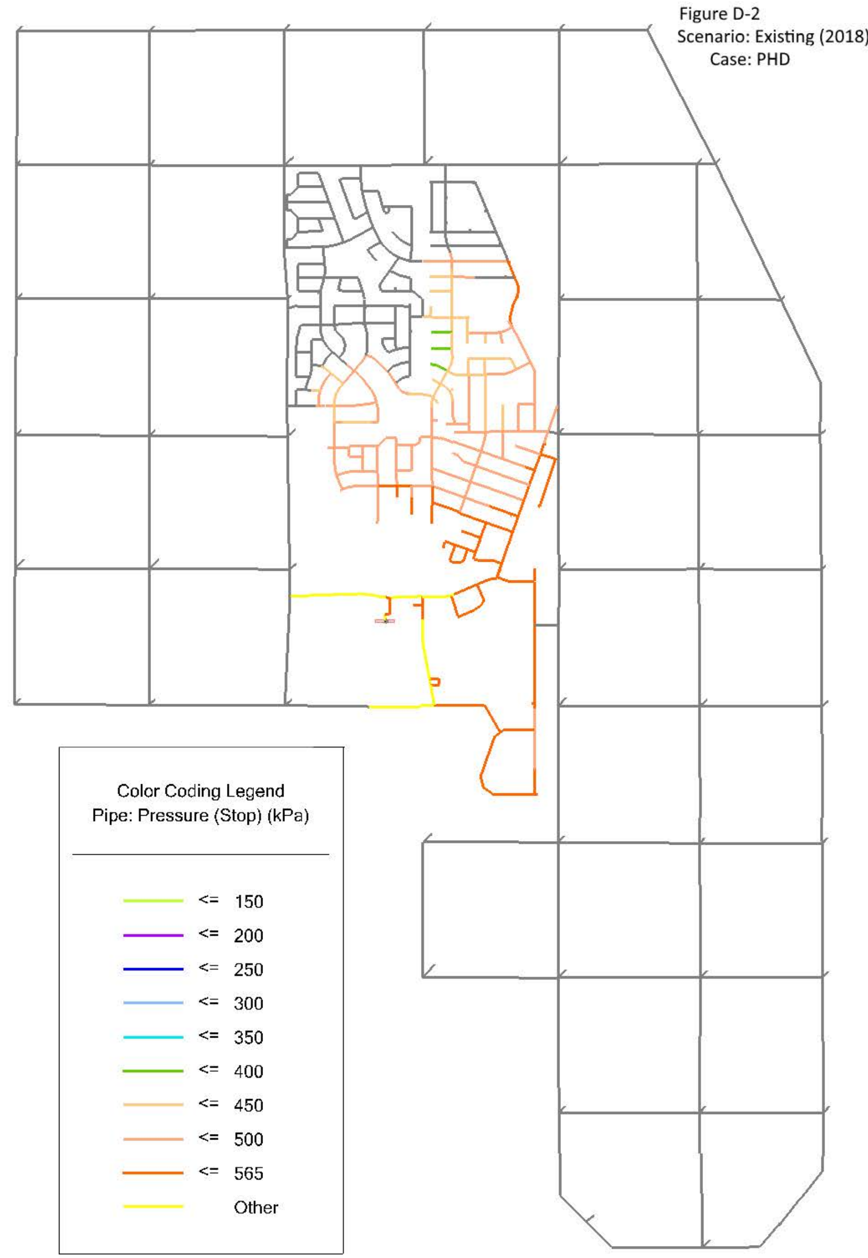


Figure D-2
Scenario: Existing (2018)
Case: PHD
Color Coding Legend
Pipe: Pressure (Stop) (kPa)
<= 150
<= 200
<= 250
<= 300
<= 350
<= 400
<= 450
<= 500
<= 565
Other

Figure D-3
Scenario: Ultimate (Phase 1)
Case: MDD+FF

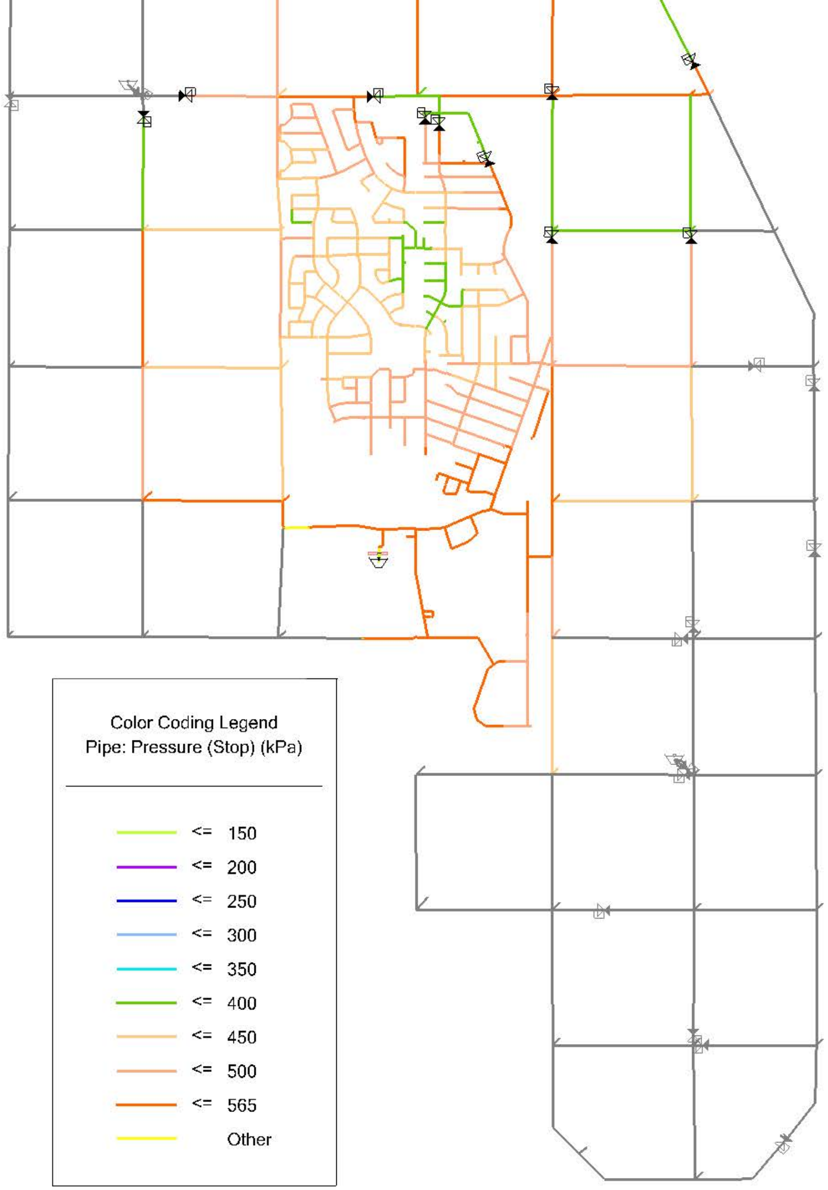
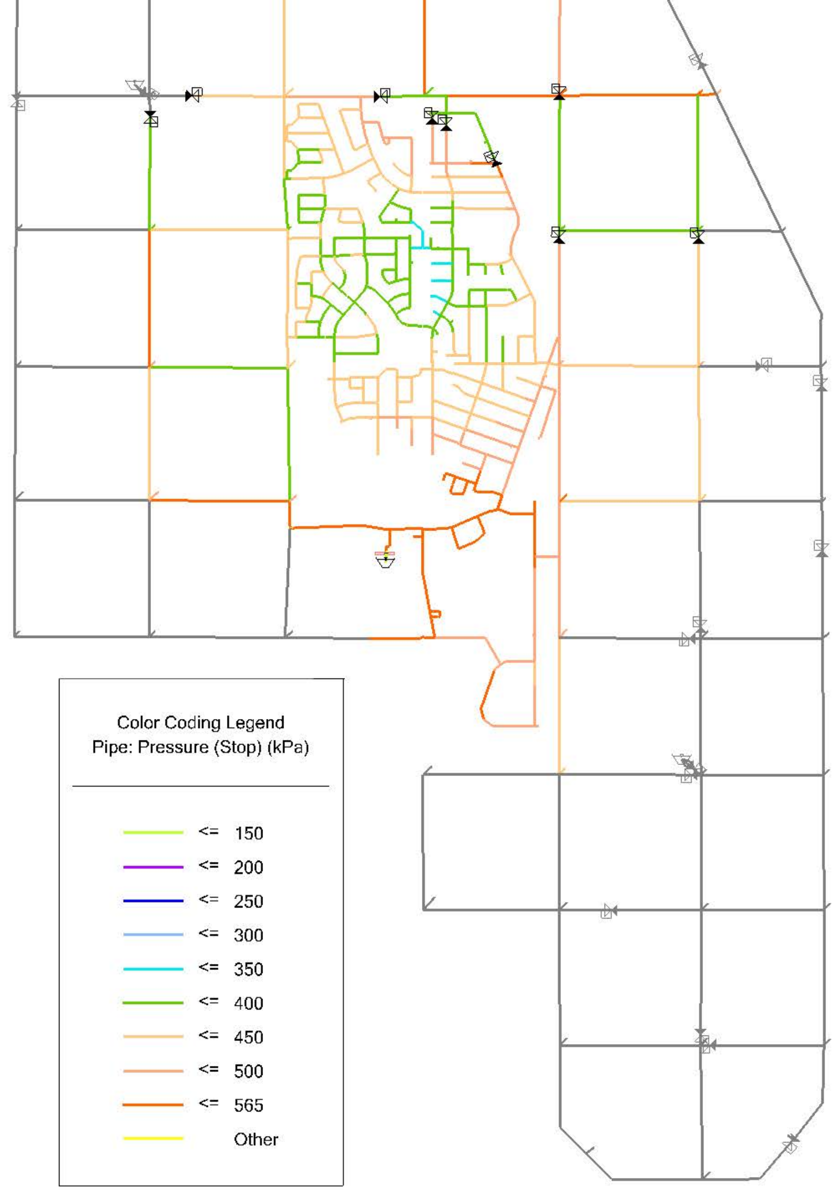


Figure D-4
Scenario: Ultimate (Phase 1)
Case: PHD



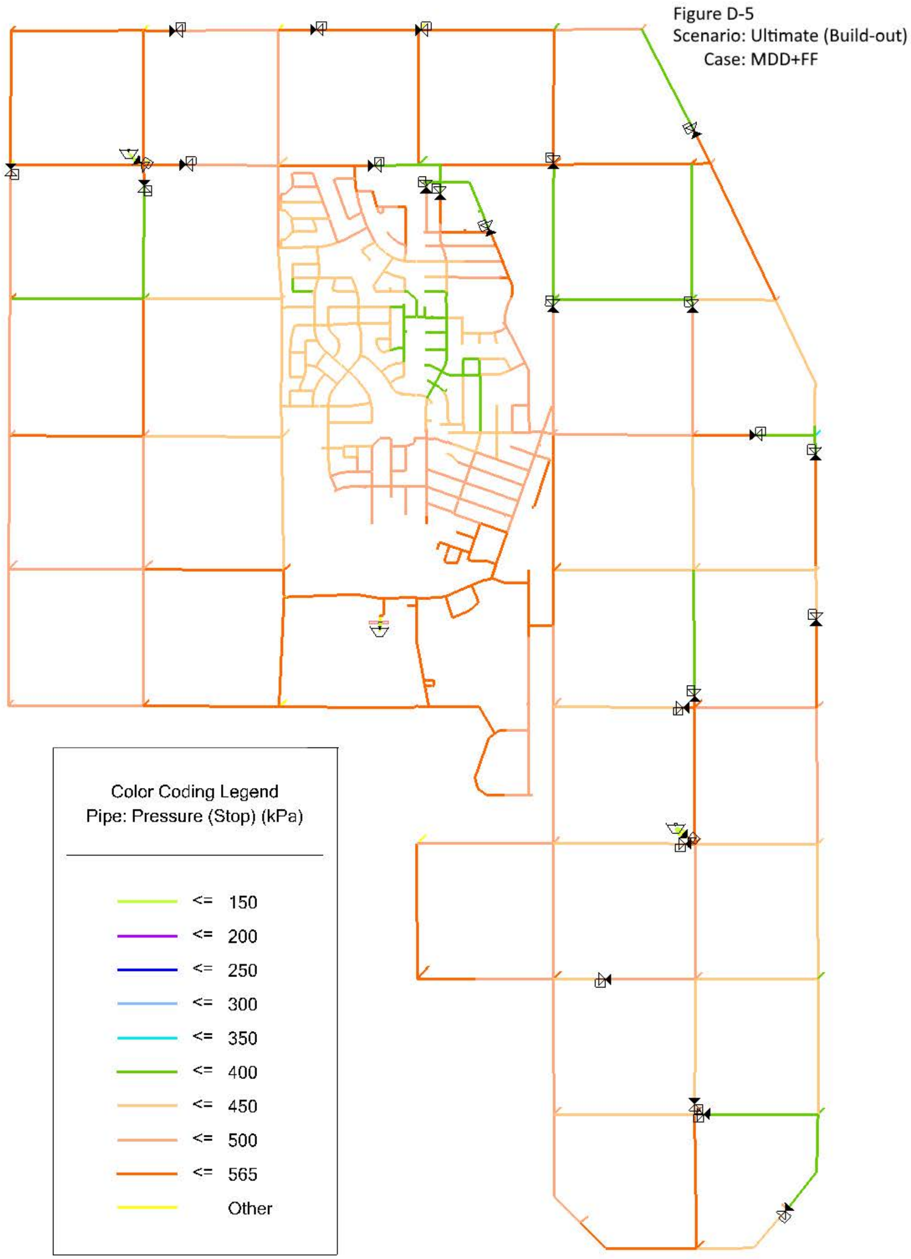


Figure D-5
Scenario: Ultimate (Build-out)
Case: MDD+FF
Color Coding Legend
Pipe: Pressure (Stop) (kPa)
<= 150
<= 200
<= 250
<= 300
<= 350
<= 400
<= 450
<= 500
<= 565
Other

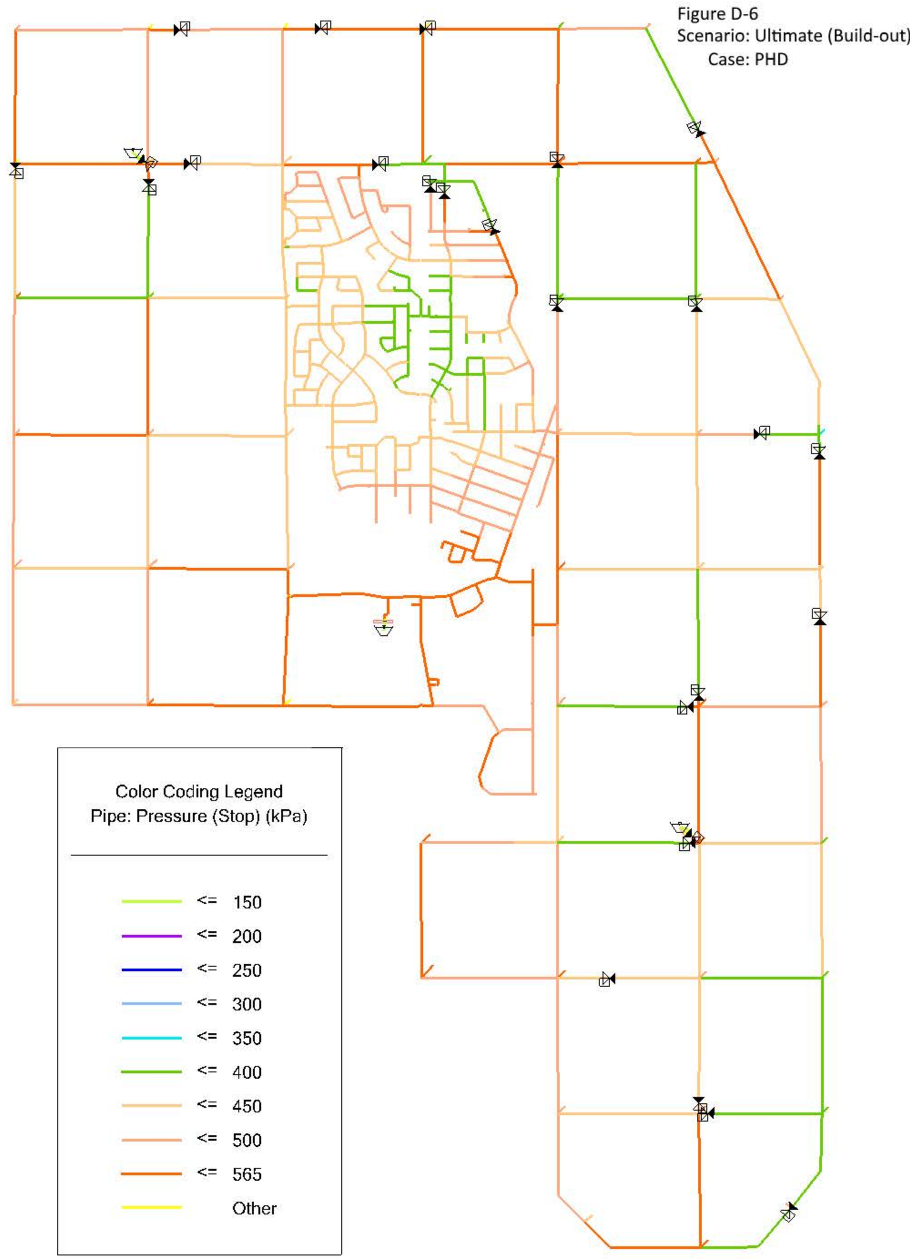


Figure D-6
Scenario: Ultimate (Build-out)
Case: PHD
Color Coding Legend
Pipe: Pressure (Stop) (kPa)
<= 150
<= 200
<= 250
<= 300
<= 350
<= 400
<= 450
<= 500
<= 565
Other