Report

Associated Engineering
GLOBAL PERSPECTIVE. LOCAL FOCUS.

Town of Redwater

Master Services Plan Update

August 2010

Executive Summary

In 2003, the Town of Redwater retained Associated Engineering to undertake an analysis of the existing water distribution, sanitary sewerage, storm drainage and transportation systems. The analyses of these systems were compiled in a Master Services Plan. Since then, Redwater has doubled its corporate boundary by annexation. Due to the substantial increase to the Town's land area, the existing Master Services Plan needed to be updated.

In 2009, the Town retained Associated Engineering to update the 2003 Master Services Plan. As with the original Master Services Plan, the update is intended to assist administration and Council in planning and budgeting infrastructure upgrading and expansion, to achieve orderly and coordinated development.

1 OBJECTIVES

The objective of this report is to update the existing Master Services Plan that addresses the expansion and capacity upgrading of the existing water, sanitary, storm and transportation systems. This report will determine upgrading requirements to satisfy existing and future growth and provide a cost estimate of recommended upgrades.

2 STUDY AREA

The study area is the newly annexed town boundary. This area is comprised of approximately 31 quarter sections.

3 DESIGN POPULATIONS AND DENSITIES

The design populations used in this report are based on a 2% linear growth projection from 2009 on. This growth projection is based on the Town's Municipal Development Plan.

Population densities are used to estimate the population or equivalent population for different land uses. These values are used in conjunction with the per capita daily consumption rates to estimate the demands on the water and sewer systems.

The following are population densities and equivalent population densities used in this report:

Table E1
Equivalent Population Densities

Description	Population Density Persons/ha
Residential (Single family)	35
Residential (Multi family)	85
Residential (Apartment)	175
Commercial	30
Industrial	25

For specific information on other design criteria used for analyzing the infrastructure systems, please refer to Section 2 - Design Criteria.

4 WATERWORKS SYSTEM

The Town of Redwater's water system consists of:

- Treated Water Supply Line
- Reservoir and Pumphouse
- Water Distribution System

4.1 Treated Water Supply Line

City of Edmonton treated water is supplied from the Capital Region Northeast Water Services Commission via a 250 mm diameter main at the Redwater Connection. The supply pressures and reservoir levels are monitored by CRNWSC staff at the On-Line Station. The Commission assesses the capacity of the line, and the ability to serve the various communities and industrial users.

4.2 Reservoir and Pumphouse

The pumphouse currently consists of three distribution pumps and two stand-by pumps with natural gas engines. These pumps supply water to the distribution system, truck fill, and the ARC plant (formerly ESSO) which is located east of Redwater.

4.3 Water Distribution System

The existing distribution system is comprised mainly of steel and asbestos cement (AC) pipe, except for the industrial area on the east side of town which is constructed of polyvinyl chloride (PVC) pipe. Most of the distribution system was constructed in the 1960's and 1970's, and the system has not grown significantly since this time. The pipe sizes range in diameter from 75 mm to 450 mm.

4.4 Existing Water System Assessment

The existing distribution system was analyzed based on satisfying peak hour pressures and peak day plus fire flow requirements. The following conclusions were drawn:

- All pressures within the existing distribution system are within those recommended in the design criteria.
- Some locations in the distribution system do not satisfy Fire flow demands.
- The distribution system has 100% redundancy in the distribution pumping, in order to allow for pump maintenance and repair.
- The existing fire pumps are adequate to provide for the maximum of 200 L/s fire flow and peak day demand (excluding the truck fill demand).
- The existing reservoir has significant available storage.
- Some areas of the Town do not have adequate hydrant coverage.

4.5 Waterworks Upgrading Costs (2010 Dollars)

• Existing Distribution System Upgrades	$ 3,845,700
• Ultimate Distribution System Upgrades (to Year 2020)	$ 5,512,300
• New Booster Pumphouse	$ 800,000
Total Water System Upgrades	$10,158,000

5 SANITARY SEWERAGE SYSTEM

The Town's sanitary system consists of:

- Collection System
- Lift Stations and Forcemains
- Lagoons (non-aerated and mechanically aerated)

5.1 Collection System

The existing collection system is comprised of 200 mm diameter laterals and trunk mains which range in size from 250 to 600 mm in diameter. The system is divided into two separate major catchments, each serviced by an outfall sewer. The majority of the town's sewerage, from one catchment, is directed to a mechanically aerated lagoon system via a lift station and forcemain. After the aerated lagoon, much of the treated sewage returns to a trunk sewer where it is transported to the stabilization lagoons. The remainder of the treated sewage is pumped to the golf course for irrigation purposes. The industrial area, the second catchment, is located on the eastern edge of Redwater and is serviced by a separate 375 to 600 mm diameter outfall which discharges to the stabilization lagoons.

5.2 Lift Stations and Forcemains

There is one main lift station which intercepts flow from the majority of the town and directs it to the mechanically aerated lagoon, as described above.

5.3 Lagoons

The Town of Redwater has two lagoon treatment systems. The first is an aerated lagoon system which receives flow from the majority of the town. A portion of the effluent flow from the aerated lagoons is used for golf course irrigation during summer months. The remainder is discharged to the storage ponds described below.

The non-aerated lagoon system is comprised of four anaerobic cells and three storage cells. The anaerobic cells receive raw sewage flow from the industrial area. The storage cells receive all of the anaerobic lagoon effluent as well as all of the flow from the aerated lagoons (except the portion used for golf course irrigation).

5.4 Existing Sewerage System Assessment

The existing sanitary system has been modeled based on the population densities and flows outlined in the design criteria. The flows identified in the design criteria took the Town's flow monitoring into consideration. A sensitivity analysis was performed to compare model results with flow monitoring. This comparison acknowledged that the model results may be conservative. However, since this only affects the existing system, it will allow for future densification of existing development. From the analysis of the sanitary system, the following conclusions were drawn:

- The existing sewage pumps in the Sewage Lift Station are currently undersized for Peak Wet Weather Flow based on one pump operating continuously.
- The existing wet well capacity is approximately 3.2 m^3 .
- The existing forcemain is adequately sized for the current pumps, however will be undersized if the pumps are to be increased to handle the peak flows.

- Some existing sanitary sewers will surcharge during Peak Wet Weather Flow conditions.
- The number of aerated cells is adequate. Three (3) cells are provided (standards require 1 complete mix cell followed by two partial mix cells).
- The energy input to the complete mix cell appears adequate. AENV's guideline for complete mix cells calls for an energy input of 6 to 10 W/m^3 . The available energy input is estimated to be at the upper limit of this range.
- The retention time through the complete mix cell is inadequate. AENV's standards indicate complete mix to have at least 2 days retention. The existing retention time appears to be approximately 1.5 days.
- The retention time through the partial mix cells is inadequate. AENV's standards indicate the partial mix cells should have at least 28 days retention. The Town's lagoons provide approximately 22 days of retention.
- The anaerobic lagoons provide more than sufficient capacity for initial treatment of the industrial flows. AENV requires four anaerobic cells with 2 days retention time in each cell (8 days total). The available retention in the anaerobic cells is well above this (about 36 days currently and 27 days for 20-year projection).
- Utilizing the design flows, the storage lagoons do not appear to provide adequate storage (estimated at 150 days currently) to limit the frequency of discharge to the Redwater River to twice per year, in accordance with the current AENV approval. AENV typically accepts twice per year discharge where proper aerated lagoon treatment precedes storage.
- In the future, AENV may require that the industrial component of the flow receive at least one year retention. One-year storage is generally required with conventional treatment lagoons. In addition, facultative lagoon treatment may be required for this component of the flow.
- According to Public Works staff actual discharge frequency for the storage lagoons is twice every year. Since the theoretical discharge frequency is greater than twice per year, this discrepancy may indicate that the design flows are higher than actual, or that there is significant evaporation.
- The use of aerated lagoon effluent for golf course irrigation is most likely acceptable. The Town takes responsibility for effluent disinfection to ensure the effluent meets acceptable bacteria levels (total coliforms <1000/100 mL and fecal coliforms <200/100 mL).
- The overall yearly storage volume utilized at the lagoon appears to be quite variable from year to year.

5.5 Sanitary System Upgrading Costs (2010 Dollars)

• Existing Sanitary Sewer System Upgrades	$1,413,000
• Existing L.S., Forcemain and Lagoon Upgrades	$2,110,000
Total Sanitary System Upgrades	$3,523,000

6 STORM DRAINAGE SYSTEM

The Town of Redwater generally slopes gently in the northeast direction toward the Redwater River except for portions along the south town boundary which slope to the southeast. The Town has a limited storm sewer system, with runoff mostly being handled on the streets and in roadside ditches. The construction of houses, commercial buildings, paved roads and parking lots increases the imperviousness of a watershed and reduces the infiltration of rainwater. This means that a much larger portion of the rainfall will run off. This increases the volume and rate of runoff and produces larger peak flood discharges in developed watersheds than would have occurred before development.

Water quality issues, such as sedimentation and pollution associated with stormwater runoff from urban areas, also need to be dealt with before the flows are discharged into natural water courses.

6.1 Existing Drainage System

The existing drainage system for the developed areas within the existing town boundary rely primarily on surface drainage facilities (roadways and paved surfaces, drainage swales, and culverts) which discharge into nearby ditches and sloughs that eventually flow into the Redwater River. There is a short section of storm sewer on 46th Avenue, in the southeast portion of the town.

In addition to the flows generated within the town limits, there is a rural area on the west side of the town which drains overland into the Town's drainage system through the ditches along the railway and Highway 38. Runoff from this rural area needs to be accommodated in the Town's drainage system or directed around the town.

6.2 Existing Drainage System Assessment

A brief reconnaissance was conducted on September 26, 2009 to confirm the initial drainage assessment and to note any development that has occurred since 2005. Associated Engineering also reviewed the record drawings of the newly constructed storm sewers and design drawings for proposed developments. Through the assessment of the drainage system, the following conclusions were drawn:

- There are locations where the length of runs on the street exceeds current design standards.
- The existing drainage system does not provide for future development.
- Future development areas will require stormwater management to control peak flows and urban runoff water quality.

6.3 Drainage System Upgrading Costs (2010 Dollars)

• Surface Improvements	$ 25,000
• Underground Construction	$ 15,000
• Stormwater Management Facility (Pond D)	$2,100,000
• Other Assessments	$ 215,000
Total Storm System Upgrades	$2,355,000

7 TRANSPORTATION SYSTEM

As part of the Master Services Plan Update, Associated Engineering completed a capacity analysis of existing and future traffic volumes to identify upgrades required prior to 2020 to accommodate the projected traffic volumes along 48 Avenue. Associated Engineering also developed an ultimate road network that will support growth in the lands recently annexed by the town.

7.1 Existing Transportation Network Analysis

The existing transportation consists of a number of arterial an collector roads, these roads and the classification of each have been listed below.

• 44 Street	Arterial
• 48 Street	Collector (Arterial between 48 Ave and 49 Avenue)
• 53 Street	Collector
• 58 Street	Arterial
• 65 Street	Collector
• 44 Avenue	Arterial
• 49 Avenue	Arterial
• 53 Avenue	Arterial

Associated Engineering completed a capacity analysis of the intersections on 48 Avenue to determine the existing level of service (LOS) and to identify the need for intersection improvements. It was determined that the intersections have sufficient capacity to accommodate the existing traffic volumes.

	LOS (AM/PM)
• Highway 28/48 Avenue	A/A
• 48 Avenue/65 Street	A/A
• 48 Avenue/58 Street	A/A
• 48 Avenue/53 Street	A/A
• 48 Avenue/49 Avenue	A/A
• 48 Avenue/48th Street	A/A
• 48 Avenue/44th Street	A/A

7.2 Future Transportation Network Analysis

The anticipated growth in the Town of Redwater over the next ten years will lead to an increase in the traffic volumes on the major roadways of the town as well. To identify what upgrades are required to accommodate the increased traffic volumes, Associated Engineering developed traffic projections and completed a capacity analysis of the projected volumes.

It was determined that upgrades were required at four intersections with 48 Avenue.

- Highway 28 (traffic signals)
- 58 Street (traffic signals and geometric improvements)
- 48 Street (traffic signals)
- 44 Street (geometric improvements)

With recommended improvements, the study intersections are expected to operate at the following level of service:

	LOS (AM/PM)
• Highway 28/48 Avenue	A/B
• 48 Avenue/65 Street	A/A
• 48 Avenue/58 Street	B/B
• 48 Avenue/53 Street	C/C
• 48 Avenue/49 Avenue	C/C
• 48 Avenue/48th Street	B/B
• 48 Avenue/44th Street	A/A

7.3 Transportation System Upgrading Costs (2010 Dollars)

• Intersection Improvements	$1,063,000
Total Transportation System Upgrades	**$1,063,000**

Table of Contents

1 Introduction

1.1 BACKGROUND

The Town of Redwater is located along Highway 38, east of Highway 28, approximately 40 kilometres northeast of the City of Edmonton. Refer to Figure 1.1 for a location plan.

The Town of Redwater has retained Associated Engineering to update the 2005 Master Services Plan including an analysis of the existing water distribution system, sanitary sewerage system, storm drainage system and transportation system. The update includes approximately 1300 ha of land annexed by the Town in 2007. It incorporates any new or updated utilities, proposed developments as well the extensive additional annexed lands. The updated analysis, along with recommended upgrades and estimated costs has been compiled in a Master Services Plan Update report. This document will assist the Town to plan for infrastructure upgrading, to meet both existing and future needs.

1.2 STUDY AREA

The study area is comprised of the current town boundary, which incorporates the 2005 town boundary with the annexed lands in 2007. The annexed lands expanded the Town area in all directions of the previous boundary.

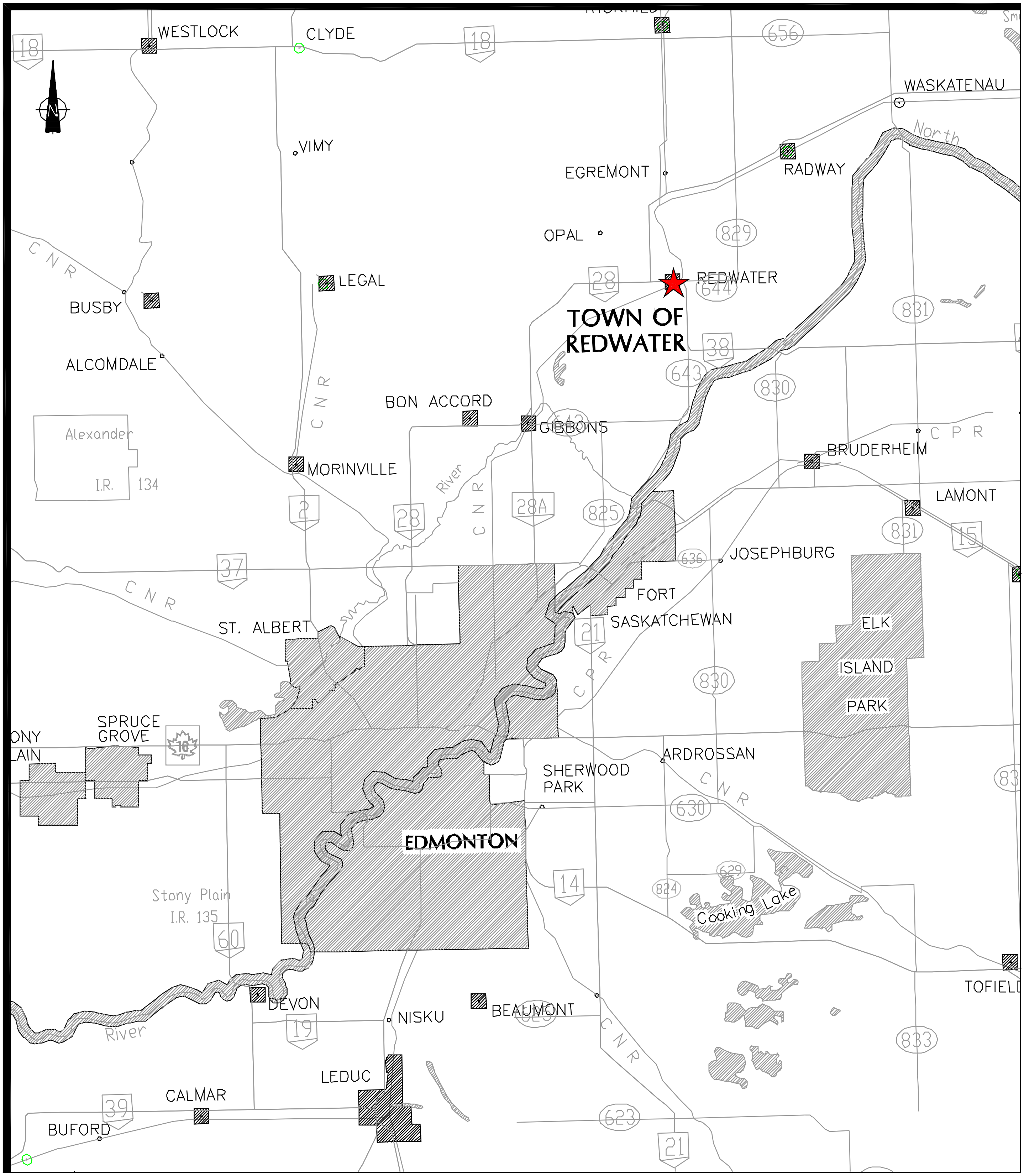
The topography of the Town generally falls northeast toward the Redwater River. The highest elevations are located in the southwest in lands identified as future residential areas. The lowest elevations are located in the northeast adjacent to the Redwater River.

1.3 REPORT OBJECTIVES AND SCOPE

The scope of work is to address the existing capacity, recommend upgrades, and propose future expansion of the water distribution system, sanitary sewerage system, storm drainage system and transportation system.

The objectives of this report are as follows:

- Review the existing water, sanitary, storm and transportation systems
- Determine the system demands
- Analyse the capability of the existing systems to handle the current and projected demands
- Determine the upgrading requirements to satisfy existing and future growth
- Assess possible future growth locations and phasing options to service these locations
- Provide a cost estimate of recommended upgrades



Town *of* Redwater

MASTER SERVICES PLAN UPDATE

LOCATION PLAN

Associated Engineering

FIGURE 1.1

Time: 7:49am
Date: Sep 08, 2010
File: P:\20093796\00_MasterServPlanUpd\Working_Dwgs\100_Civil\FINAL-REPORT-2010-05\3796-FG-11.dwg by

1.4 REFERENCES

1. Town of Redwater, Master Services Plan - Associated Engineering, May, 2005.
2. Town of Redwater, Sanitary Sewer System 2008 Flow Monitoring Program, September 2009
3. Town of Redwater, Municipal Development Plan, 2009.
4. Town of Redwater Water records.

1.5 ACKNOWLEDGEMENTS

Associated Engineering would like to thank the staff of the Town of Redwater for their assistance in completing this project.

1.6 ABBREVIATIONS

AC	asbestos cement
km	kilometre
L/s	Litres per second
L	Litre
Lpcd	Litres per capita day
m	metre
m/s	metres per second
m^3/s	cubic metres per second
m^3	cubic metres
mm	millimetre
PRV	Pressure reducing valve
PVC	polyvinyl chloride
AEAL	Associated Engineering Alberta Ltd.
USGPM	United States Gallons per Minute
W/m^3	Watts per cubic metre

1.7 METRIC CONVERSIONS

To Convert From	To	Multiple By
cubic metres (m^3)	cubic feet (ft^3)	35.31
cubic metres (m^3)	imp gal (ig)	219.97
cubic metres/hour (m^3/hr)	igpm	3.667
kilopascals (kPa)	psi	0.145
kilowatts (kw)	horsepower (hp)	1.341
litres/sec (L/s)	igpm	13.2
megalitres (ML)	imp gal (ig)	219974
metres (m)	ft	3.281
millimetres (mm)	inches	0.0394

2 Design Criteria

2.1 GENERAL

2.1.1 Population

One of the main variables in assessing a community's municipal servicing components is the population.

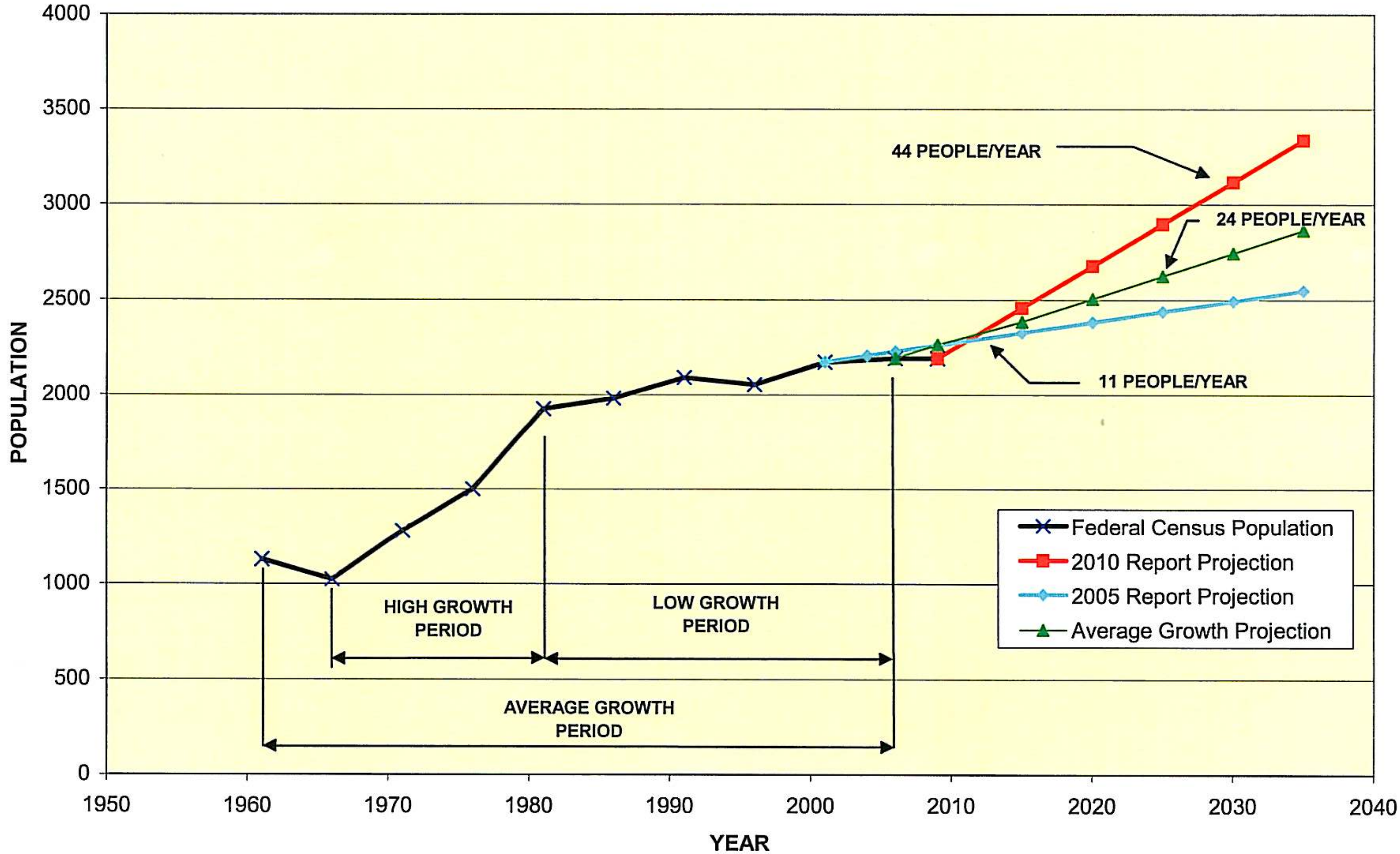
Historical populations have been provided by Statistics Canada or have been taken from the 2005 Master Services Plan, and are shown below in Table 2.1. In addition, the Town of Redwater has indicated that the population for 2009 has remained unchanged at 2192.

Table 2.1: Historical Populations

YEAR	POPULATION
1961	1130
1966	1025
1971	1280
1976	1500
1981	1925
1986	1980
1991	2090
1996	2053
2001	2172
2006	2192

The population growth analysis is shown in Figure 2.1. This figure identifies three comparative growth projections; the 2005 report projection (11 people/year), the average growth projection (24 people/year from 1961 to 2006) and the proposed 2010 report projection of 44 people/year (2% linear growth rate using the 2009 population). The actual growth rate from 2001 and 2006 was 4 people per year. This growth rate was not used to project the future population, as it may not be reflective of long term growth in the area.

FIGURE 2.1
TOWN OF REDWATER
POPULATION GROWTH PROJECTION



N:\033514\ProjMan\Population ProjectionsREV.xls

The growth projections based on 44 people per year are shown below up to the year 2035.

Table 2.2: Population Growth Projections

YEAR	POPULATION	YEAR	POPULATION
2006	2192	2021	2720
2007	2192	2022	2764
2008	2192	2023	2808
2009	2192	2024	2852
2010	2236	2025	2896
2011	2280	2026	2940
2012	2324	2027	2984
2013	2368	2028	3028
2014	2412	2029	3072
2015	2456	2030	3116
2016	2500	2031	3160
2017	2544	2032	3204
2018	2588	2033	3248
2019	2632	2034	3292
2020	2676	2035	3336

2.1.2 Population Density

Population Densities are utilized to estimate the population or equivalent population based on different land uses. These values are used in conjunction with the per capita daily consumption rates to estimate the demands on the water and sewer systems.

The following population densities, and equivalent population densities were adopted in the 2005 Master Services Plan, and have been used in this report update as well:

Table 2.3
Equivalent Population Densities

Description	Population Density
	persons/ha
Residential (Single family)	35
Residential (Multi family)	85
Residential (Apartment)	175
Commercial	30
Industrial	25

In the 2005 report, a small sampling of family residential densities was taken, using average areas and an average of 2.7 people per lot, calculated from Statistics Canada information (based on 810 dwellings and 2172 people in 2001). The densities ranged from 27 to 37 people per hectare.

The 2006 Statistics Canada information indicates 866 occupied dwellings with 2192 people. This equates to a somewhat smaller value of 2.5 people per dwelling unit, or densities ranging from 25 to 34 people per hectare. This likely relates to occupants moving to new housing developments within the town and a relatively small overall growth rate. For the purposes of this report, it is proposed that the values established in 2005 be applied in order to be conservative regarding future planning.

As such, a value of 35 people per hectare is proposed to be used for both existing and future residential densities.

Values for all of the above population densities were established in 2005 by comparing values used by other communities, and those used in the 1980 Municipal Servicing Report.

2.1.3 Land Use

Existing and proposed future land use information has been provided by the Town of Redwater from the 2009 Town of Redwater Municipal Development Plan, and the Zoning Bylaw. These plans are enclosed as Figures 2.2 and 2.3. The equivalent population densities established above are applied in conjunction with the zoning map in order to establish equivalent populations.

The study area is limited to the existing Town Boundaries as shown on Figure 2.3.

2.1.4 Design Horizon

For Municipal waterworks and sewerage master planning, a design horizon of 20 years is considered reasonable. Design horizons rely on predictions of population growth that could be substantially affected by economic conditions, population migration and changes in life styles.


Town of Redwater
Land Use Bylaw
Map 1.1
Map 1.2
Map 1.3
Map 1.4
Legend
R1 Residential Single Family (R1) District
R2 Residential Single Family Large Dwelling and Large Lot (R2) District
R3 Residential Single Family Compact Lot (R3) District
R4 Residential Two Family (R4) District
R5 Residential Medium Density (R5) District
R6 Residential High Density (R6) District
RMHS Residential Manufactured Home Subdivision (RMHS) District
RMHP Residential Manufactured Home Park Residential (RMHP) District
C1 Primary Commercial (C1) District
C2 General Commercial (C2) District
C3 Highway Commercial (C3) District
M1 Industrial (M1) District
SP Semi-Public (SP) District
UR Urban Reserve (UR) District
N
August 12, 2010
0
800m
NW35 57-22-4
NE35 57-22-4
NW36 57-22-4
NE36 57-22-4
NW31 57-21-4
NE31 57-21-4
NW32 57-21-4
NE32 57-21-4
NW33 57-21-4
SW35 57-22-4
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SE32 57-21-4
SW33 57-21-4
NW26 57-22-4
NE26 57-22-4
NW25 57-22-4
NE25 57-22-4
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NE30 57-21-4
NW29 57-21-4
NE29 57-21-4
NW28 57-21-4
SW26 57-22-4
SE26 57-22-4
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SE25 57-22-4
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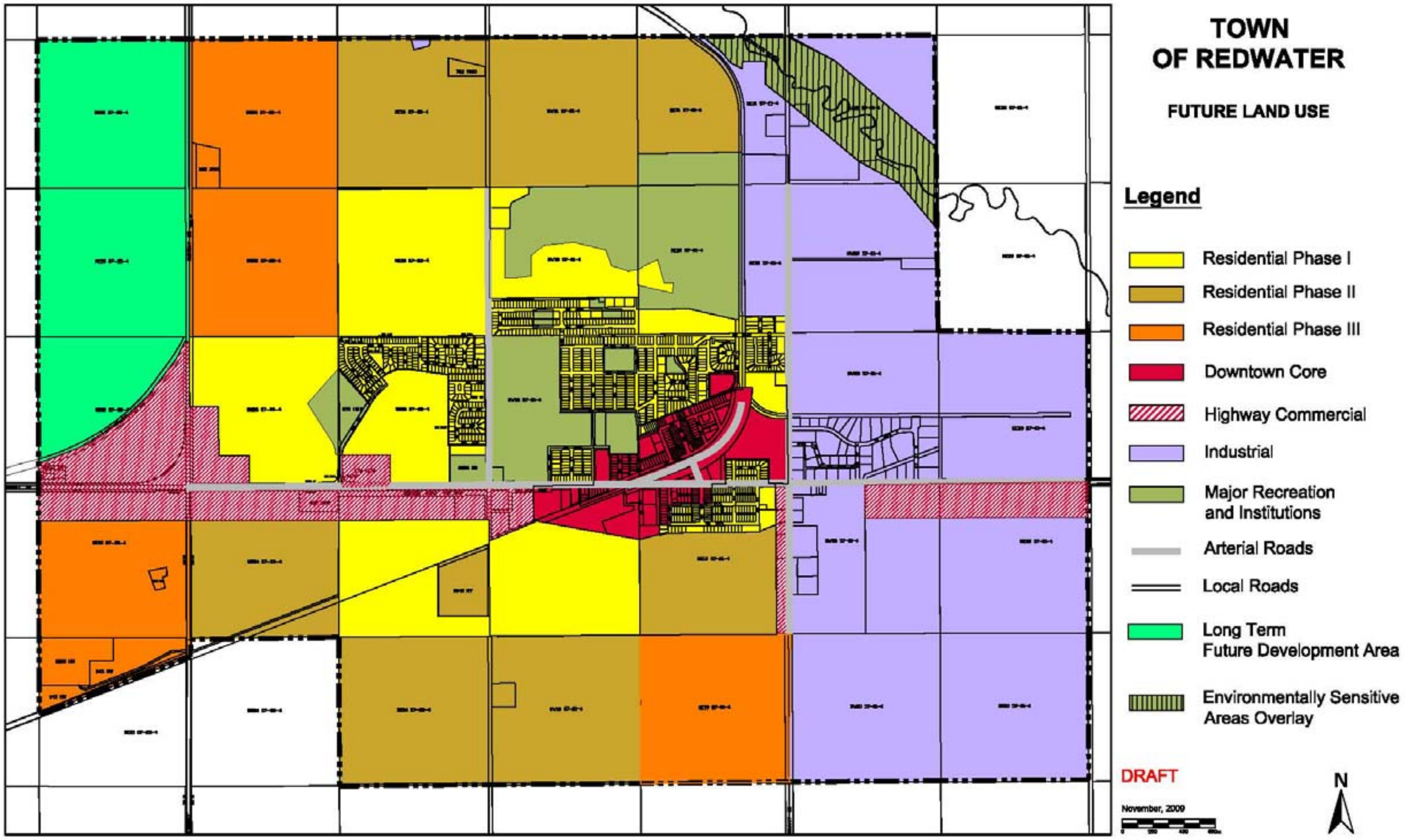
SW29 57-21-4
SE29 57-21-4
SW28 57-21-4
NW23 57-22-4
NE23 57-22-4
NW24 57-22-4
LOT 85
NW19 57-21-4
NE19 57-21-4
NW20 57-21-4
NE20 57-21-4
NW21 57-21-4
SW23 57-22-4
SE23 57-22-4
SW24 57-22-4
SE24 57-22-4
SW19 57-21-4
SE19 57-21-4
SW20 57-21-4
SE20 57-21-4
SW21 57-21-4
NW14 57-22-4
NE14 57-22-4
NW13 57-22-4
NE13 57-22-4
NW18 57-21-4
NE18 57-21-4
NW17 57-21-4
NE17 57-21-4
NW16 57-21-4
HIGHWAY 28
HIGHWAY 38
HIGHWAY 644
UR
M1
R1
SP
R5
R6
C3
C1
C2
R2
R3
R4
RMHS

Figure 2.3 - Future Land Use Map - Town of Redwater 2009 MDP



A 10 year design horizon is reasonable for water and sewage pumping equipment. These components can be readily increased to meet the population growth or replaced to provide operating reliability.

A 20 to 25 year design horizon is reasonable for many major facilities. It allows the facilities to be expanded, upgraded or upsized in an orderly staging. This will reduce the initial capital cost (from over sizing), incorporate allowance for expansion which will avoid future costly replacement.

A much longer design period is used to identify the various system components such as water storage reservoir, water transmission mains, sanitary collection trunk and treatment facilities and stormwater management facilities to serve the Study Area lands. The Study Area defines the lands to be considered in the long term or ultimate development requiring infrastructure servicing. This long term planning allows for the orderly growth and development of the town.

The typical design life expectancy of various infrastructure components are:

Waterworks System:

- Pump Station 50 years
- Pumping Equipment 10-15 years
- Control Systems 5-10 years
- Reservoir 50 years
- Water Distribution Main 50-100 years

Sanitary Sewerage System:

- Pumping Equipment 10 years
- Controls 5-10 years
- Lift Station 25-50 years
- Gravity Sewer 50-100 years
- Sewage Lagoon 20-25 years

Storm Drainage System:

- Gravity Sewer 50-100 years
- Culverts 25-50 years
- Stormwater Management Facilities 50-100 years

Transportation System:

•	Road Pavement Structures	20 years (typical)
•	Concrete Flatworks (Sidewalks, Curb & Gutter)	30 years +(varies according to use of de-icing salts/chlorides and damage caused by snow clearing equipment

2.2 WATER SYSTEM

2.2.1 Water Demand

Water demand is critical in determining the distribution network, pumping capability and storage required for a water system. Three critical rates of demand, Average Day, Peak Day and Peak Hour Flow are normally used. Fire flows, in conjunction with the Peak Day flows are also used to test the system's capability to deliver water and meet system demands.

The following briefly describes each of the critical flow conditions:

2.2.1.1 Average Day

The Average Day demand is determined by dividing the total annual consumption by 365 days. By dividing this rate by the population served, the per capita per day demand is derived. This rate is used primarily as a basis for the projection of the total water demand.

2.2.1.2 Peak Day

The Peak Day demand is determined by the single day of maximum consumption observed in the distribution system. In using the single day maximum flow, one must ensure that the record is not distorted by fire fighting demand, equipment malfunction or watermain breaks. The peaking factor is determined by comparing the peak consumption day to the average day demand. The Peak Day demand is used in determining the delivery capacity required of supply mains, treatment facilities, storage facilities and pumping facilities. In conjunction with the fire flow, it is used to test the water system's capacity to supply the fire and peak day demand.

2.2.1.3 Peak Hour

The Peak Hour demand is the expected maximum demand observed during a short period of the day. Usually, most facilities are not equipped to record peak hour demands in such detail. Therefore, the rate is established based on experience and judgement. The Peak Hour rate is used in determining watermain sizing and pumping requirement.

2.2.1.4 Historical Water Demands

The Town of Redwater has provided water consumption records for the past seven years. They have been calculated as follows:

Table 2.4
Water Demand

	2002	2003	2004	2005	2006	2007	2008	Average
Average Day Demand (L/s)	9	8.3	8.3	8.0	8.4	8.1	8.7	**8.4**
Average Day Per Capita (L/c/d)	357	329	327	317	329	320	341	332
Peak Day Demand (L/s)	20.9	15.5	12.3	10.6	11.4	10.9	12.6	13.5
Population (assumed)	2176	2180	2184	2188	2192	2192	2192	
Peak Day Ratio	2.3	1.9	1.5	1.3	1.4	1.3	1.5	1.6

For the purpose of this report, it is recommended that the Average per Capita water consumption be assumed at 330 L/cap/day. This is lower that the value used in the 2005 report of 360 L/cap/day, and is reflective of five years worth of additional data.

2.2.1.5 Peaking Factor

The average ratio of the peak flow to the average day flow is 1.6. However, a more conservative value of 1.8 is recommended for use within this report. This is lower than the peak day factor of 2.0 which was utilized in the 2005 report, but is more reflective of the additional data analyzed (2004 through 2008 water data).

The existing facilities within the Town of Redwater do not measure Peak Hour flows. A Peak Hour factor of 3 times the Average Daily Demand has been observed in similar communities and will be adopted for this report.

2.2.1.6 Existing Water Demands

The water consumption demands to be used in this study will be as shown in Table 2.5. This is based on a population of 2192 in 2009 and 330 L/cap/day.

Table 2.5
Existing System Demands (2010 Estimated Population 2236)

	Peaking Factor (Times Average Day)	Redwater (L/s)	Truck fill (L/s)	Handfill (L/s)	ARC (L/s)	TOTAL (L/s)
Average Day Demand	1	8.5	30	2	0.55	41.1
Peak Day Demand	1.8	15.4	30	2	4.3	51.7
Peak Hour Demand	3	25.6	30	2	4.3	61.9

In addition to the town demands, the flows shown in the above table also include columns for the truckfill, handfill and the water sold to the ARC plant (formerly ESSO). The town does not appear to have an agreement regarding the quantity of water to be sold to ARC, but that they will provide as required except when experiencing a shortage. Based on daily records for 2009, the average day rate sold to ARC was 0.55 L/s, and the peak day (occurred in July) was 4.3 L/s. This is equivalent to the Peak Day Factor of nearly 8 times the average day flow, and far exceeds the normal flows used by ARC. As such, this number will also be used as the design value for the Peak Hour flows. Also, ARC has an existing 48,000 US gal tank which they endeavour to keep full. This tank can buffer peak conditions greater than the 4.3 L/s assumed.

The truckfill average supply rate has been estimated to be approximately 30 L/s, however this has not been verified. A flow rate of 2 L/s was indicated by Town staff as the capacity of the handfill. A peaking factor does not get applied to the truckfill and handfill demands as they are either in operation, or not.

2.2.2 Fire Flow

The following table presents the fire flows recommended by the Guidelines of the Insurance Bureau of Canada.

Table 2.6
Fire Flows

Description	Recommended Fire Flow litres/minute
1. Single Family Residential	
Wood frame construction, two stories or less	
100 m^3 to 150 m^2	5,000 (83 L/s)
150 m^2 to 275 m^2	6,000 (100 L/s)
2. Multi Family Residential	
Wood frame construction c/w fire separator	
four units up to 100 m^2 each	8,000 (133 L/s)
3. Walk-up Apartments	
Ordinary construction up to 3,200 m^2 (10-20 m separation)	12,000 (200 L/s)
4. Schools	
Non-combustible construction	
up to 3,300 m^2	10,000 (167 L/s)
up to 4,000 m^2	11,000 (183 L/s)
up to 12,000 m^2	19,000 (317 L/s)
5. Institutional, Churches	
Ordinary construction (15% exposure) up to 850 m^2	6,000 (100 L/s)
6. Commercial	
Non-combustible construction (50% exposure)	
up to 2,900 m^2	11,000 (183 L/s)
up to 4,200 m^2	14,000 (233 L/s)
7. Light Industry	
Non-combustible construction	
up to 2,900 m^2 (25% exposure)	9,000 (150 L/s)
up to 2,900 m^2 (50% exposure)	11,000 (183 L/s)
8. Low Density Rural Residential	
2 stories or less over 30 m separation	2,000 (33 L/s)
9. High Density Rural Residential	3,000 (50 L/s)
2 stories or less 10.1 to 30 m separation	

The preceding flows, based on Fire Underwriter's Guidelines, are determined as follows:

F = $220 C\sqrt{A}$ where

F = required fire flow in litres per minute
C = 1.5 for wood frame construction

= 1.0 for ordinary construction
= 0.8 for non-combustible construction
= 0.6 for fire flow resistant construction (fully protected frame, floors, roof)
A = total floor area in square metres (including all storeys)

Other considerations when determining fire flow requirements are:

- occupancy hazard
- automatic sprinkler protection
- exposure within 45 metres

The following fire flows are recommended to be adopted by this study based on the table provided above:

Residential	Single Family	83 L/s
	Multi-family	133 L/s
	High Density	200 L/s
Commercial	(standard)	183 L/s
	(large)	233 L/s
Industrial		183 L/s
Schools		167 L/s
Institutional		100 L/s

The higher value of 183 L/s for neighbourhood commercial areas will be applied to all new residential locations. This will allow for additional fire flow flexibility for these developments.

2.2.3 Operating Pressures

The recommended normal operating system pressures are:

- absolute minimum pressure at peak demand 280 kPa (40 psi)
- target minimum pressure 345 kPa (50 psi)
- maximum system pressure 551 kPa (80 psi)

The minimum system pressures during a fire event are:

- residual pressure at demand hydrant 140 kPa (20 psi)
- zone pressure 280 kPa (40 psi)

2.2.4 Pipe Roughness Coefficient (“C” Value)

The following "C" values for various pipes, are recommended to be used in the hydraulic model.

- PVC 130
- Asbestos Cement 120
- Steel 110
- Ductile Iron 120

Any new proposed pipes will be assumed to be either PVC or HDPE pipe, and will have a “C” factor of 130 applied.

2.2.5 Pipe Sizes

Minimum recommended pipe sizes per land use are as follows:

- Residential 200 mm diameter
- Commercial/Industrial 250 mm diameter or greater (location dependant)

2.3 SANITARY SEWERAGE SYSTEM

2.3.1 Sewage Flow

2.3.1.1 Dry Weather Flows (DWF)

- Domestic Sanitary Flows:
  - Daily per capita flow: 330 L/c/d

This is based on 100% of the average day water consumption. The average day flow in the winter months was compared to average water consumption, however the winter month sewage generation exceeded the current level of water consumption. This would suggest that a portion of the sewage is due to Base infiltration (groundwater). The 2008 flow monitoring report establishes an overall Base Dry Weather Flow rate which is a total of the Average Dry Weather Flow and Base Infiltration. This equalled 10.55 L/s for Gauge Site 4 which includes all but the southeast industrial component. Using a population of 2192 people for 2008, this equates to a total of 416 L/c/d (or 86 L/c/d greater than the water consumption rates).

It is therefore recommended that 100% of the water consumption rate be used as an assumed per capita sewage generation rate, and the excess flows be included as Base infiltration.

Peaking Factor:

- Existing System: Peaking Factor of 2.5 based on results from the 2008 Sanitary Sewer System Flow Monitoring Program.

- Future Development: Peaking Factor to a maximum of 3.8 based on Harmon's Formula.

$$\text{Peak Factor} = 1 + \frac{14}{(4 + p^{0.5})}$$

Where p = equivalent population in 1000's.

2.3.1.2 Wet Weather Flows (WWF)

Rainfall related Infiltration/Inflows (I/I) for existing development areas are based on results from the 2008 Flow Monitoring Program. I/I rates for the 1:25 year storm were used to analyze the existing system and to design proposed upgrades. Wet Weather Flows for future development areas are based on current standards. Wet weather flows for both the existing and future systems are comprised of the dry weather flows and rainfall related I/I. I/I design criteria recommended are as follows:

Existing Development Areas

- General Infiltration Allowance:
  - Residential Areas: 0.85 L/s/ha (1:25 year storm)
  - Industrial/Commercial: 0.60 L/s/ha (1:25 year storm)

- Base I/I 0.013 L/s/ha

As the sewage generation rates are assumed to be approximately 100% of the average day water consumption rate (or 330 L/c/d), the Base I/I is therefore assumed to be the difference of 86 L/c/d (or 1.85 L/s in total). Applied to the contributing area of 144 ha (in Gauge 4) and population of 2192 this equates to 0.013 L/s/ha.

Future and New Development Areas:

- General Infiltration Allowance:
  - Residential Areas: 0.28 L/s/ha
  - Other Areas: 0.28 L/s/ha

- Foundation Drain: No allowance (not allowed)

- Sag Manhole Allowance: No allowance (not allowed)

2.3.2 Pipe Roughness

For gravity sewers, the coefficient of roughness in the Manning's formula shall be 0.015 for old pipes regardless of material type. The majority of the pipes appear to be VCT pipe, although the material type is not fully known throughout the system. New pipes (PVC or HDPE) and proposed pipes will use a value of 0.013.

2.3.3 Velocity

The suggested range of velocities for the sanitary system are as follows:

Table 2.7: Suggested Minimum Velocities

Gravity Main	Minimum 0.6 m/s	Maximum 3 m/s
Forcemains	Minimum 0.76 m/s	Maximum 1.5 m/s

2.3.4 Pipe Slope

Minimum slopes, as recommended by Alberta Environment, are required to achieve a 0.6 m/s minimum scour velocity. The minimum pipe slopes are as follows:

Table 2.8: Minimum Pipe Slopes

Sewer Diameter (mm)	Minimum Design Slope (m/100 m)
200	0.40
250	0.28
300	0.22
375	0.15
450	0.12
600	0.10

2.3.5 Pipe Cover

The Alberta Environment Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems state that a minimum pipe cover above the crown of pipe be 2.5 m, or based on historical frost penetration data. For the purpose of the Master Plan Update, a minimum depth of cover of 3.0 m above the proposed pipes has been applied.

2.3.6 Lagoon Flows

Aerated lagoons are typically designed for peak month flows and the typical long retention lagoons are designed for retention of annual average flows. For the Town of Redwater, the average flows for the mechanically aerated lagoon are based on the average peak month flows from 2004 through 2008 which were provided by the Town of Redwater. The pertinent information is provided below in Table 2.9.

Table 2.9: Raw Wastewater Flows

	2004	2005	2006	2007	2008	Average
Population	2,184	2,188	2,192	2192	2192	
Peak Month Flow (m^3 /day)	71,059	50,096	46,131	85,573	50,427	60,657
Average Day (in peak month) (m^3 /day)	2,292	1,670	1,488	2,760	1,627	1,967
Average Sewage Generation (in peak month) L/c/d	1,050	763	679	1,259	742	899

As shown in the Table, the average sewage generation is calculated using the average peak months and estimated populations equals 899 L/c/d. A value of 900 L/c/d will be used to analyze the aerated lagoon.

The existing cells in the non-aerated lagoon have been analyzed based on the following:

- Average Dry Weather Flow 330 L/c/d
- Base Infiltration Allowance (Ex. System) 86 L/c/d
- General I/I/ Allowance 30 L/c/d

The 2008 Flow Monitoring Program shows the average dry weather flow at Gauge 4 to be 10.55 L/s which is estimated to be 330 L/c/d sewage generation and 86 L/c/d base Infiltration using the estimated 2008 population. An additional 30 L/c/d (approximately 10% of sewage generation) has been included to estimate the accumulation of the wet weather contributions.

In order to analyze the storage ponds, an additional flow allowance from the industrial area must be included. As the flow monitoring program did not include a location along the industrial outfall sewer, an assumption must be made regarding this contribution. In the 2005 report, this was assumed to make up 13% of the overall flows, based on existing model results (related to area and equivalent population density). This is unchanged in the current analysis, and therefore an additional 13% (based on the above flow calculation) will be added in order to account for the industrial contribution to the storage ponds.

Table 2.10 shows the resulting flow projections over the next 20 years (2010, 2020 and 2030). It has been assumed that the industrial area will continue to contribute approximately 13% of the total flows into the future. In the future projections the base infiltration value will not be applied to expansion areas, as it has been established based on the existing development though flow monitoring. Ideally, new sewer systems will not be designed to permit a significant quantity of base I/I.

Table 2.10: Lagoon System Flow Projections

	Year		
Description	**2010**	**2020**	**2030**
Time Period	Existing	10 – yr.	20 – yr.
Population	2,236	2,676	3,116
Peak Month Flow - Aerated Lagoons • Peak Month Flow, m^3 /day	2,012	2,408	2,804
Average Annual Flow - Anaerobic to Storage Cells • Total Flow, m^3 /day • Residential Flow @ 87% (from aerated lagoons) • Industrial Area Flow @ 13% (from anaerobic lagoons)	1,146 997 149	1,328 1,156 173	1,510 1,314 196

The above projected flows for the aerated lagoons do not include the industrial area contribution. If the industrial area is diverted to the aerated lagoons in the future, then the above flows will need to be modified.

2.4 STORM DRAINAGE SYSTEM

The following is a summary of the principal design criteria for storm drainage design. The storm system was assessed and conceptually designed using the modified rational method for the calculation of runoff volumes and Manning's formula to determine the capacity of conduits. This study was conducted at a conceptual level.

2.4.1 Design Storms

The following return periods were used for the drainage systems:

- Minor drainage systems (pipes) shall be designed for the 1:5 year storm event
- Major drainage systems (stormwater management ponds, ditches, culverts etc.) shall be designed for the 1:100 year storm event.

The meteorological data used was generated from the City of Edmonton Municipal Airport. The following table summarizes the rainfall intensity parameters for storms of duration 1 to 24 hours for this station.

2.4.2 Rainfall Intensity Parameters

Table 2.11: Rainfall Intensity Parameters

Coefficients	**Return Period**	
	1:5 year	1:100 year
a (t in hours)	23.4	43.9
b	-0.654	-0.661
c (t in hours)	0.00	0.00

Rainfall intensity in mm per hour $= a \times (t + c)^b$
t = storm duration in hours
a, b, & c are constants

2.4.3 Runoff Coefficients

A runoff coefficient expresses the ratio of runoff to the rate of rainfall and is dependent on the land use and the condition of the soil. Paved areas, such as roadways and parking lots, have impervious surfaces and therefore a high runoff coefficient. Natural areas, such as parks and agricultural lands, have lower runoff coefficients because most of the rainfall infiltrates into the ground.

The following runoff coefficients were used in the 2005 Master Plan and have been adopted for this Master Plan Update:

Table 2.12: Runoff Coefficients

	1:5 Year	1:100 Year
Commercial Areas	0.90	0.95
Industrial Areas	0.60	0.80
Residential Areas		
Single Family Residences	0.40	0.60
Multi-Family Residences	0.60	0.70
Agricultural Lands and Parks	0.10	0.30

Capacity of Conduits

Manning's formula will be used to determine the capacity the open channel and storm sewers:

$$Q = \frac{1}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

where:

Q = discharge in cubic metres per sec (m^3/s)
A = cross sectional area of flow in square metres (m^2)
R = hydraulic radius in metres (m)
S = slope of the conduit in metres per metre (m/m)
n = Manning's roughness coefficient

As a general rule, the storm sewers will be sized to have a minimum diameter of 300 mm.

2.4.4 Manning's Roughness Coefficient "n"

Table 2.13: Roughness Coefficient

Type of Conduit	Manning's "n"
PVC Pipes	0.013
Concrete Pipes / Culverts	0.013
Corrugated Steel Pipe	0.024
Grassed Ditches	0.05

2.4.5 Velocity of Flow

It is important to maintain a minimum velocity in storm sewers to prevent the deposition and build-up of sediments and other debris. This build-up could lead to blockages of flow and reduced capacity.

In open channels, it is also important to keep velocities low to reduce erosion and to promote infiltration and settling of pollutants which enhances the quality of the runoff.

The following velocity limits are general guidelines set according to the Alberta Environment Stormwater Management Guidelines:

Table 2.14: Velocity Limits

Type of Conduit	Minimum Velocity (m/s)	Maximum Velocity (m/s)
Open channel	no limit	0.5-1.0*
Storm Trunks	0.6	3.0

* If velocities exceed 0.5 m/s, check dams can be used to promote infiltration and settling of pollutants.

In the case of open channels, increased velocities can also put the public at risk (especially small children). Alberta Environment has guidelines for permissible depths in open channels for varying velocities to mitigate the risk to the public.

Table 2.15: Permissible Depths in Open Channels

Permissible Depths for Submerged Objects	
Water Velocity (m/s)	Permissible Depth (m)
0.5	0.80
1.0	0.32
2.0	0.21
3.0	0.09
Note: Based on a 20-kg child and concrete lined channels. Larger persons may be able to withstand deeper flows.	

2.4.6 Pipe Cover

The Alberta Environment Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems state that the minimum depth of cover to pipe crown shall be 1.2 m. This is to protect storm sewers from adverse weather conditions and from loads applied on the surface (traffic, buildings etc.).

2.4.7 Culvert Design

There are two main types of culvert flows:

- *Inlet Control*
  In this case, the cross-sectional area of the barrel, the inlet configuration or geometry, and the headwater elevation or the amount of ponding upstream of the inlet are of primary importance. Inlet control occurs when the flow through the culvert is limited by culvert entrance characteristics (i.e. the barrel can carry more flow than the entrance will allow).

- *Outlet Control*
  The outlet control flow occurs when the culvert barrel is not capable of conveying as much flow as the inlet opening will accept. In this case, the tailwater elevation in the outlet channel, the barrel slope, the barrel roughness and the length of the barrel are the factors of importance.

The design criteria for culvert design are as follows:

- The culvert shall convey the 1:5 year runoff, with water levels below crown of pipe.
- The culvert shall convey the 1:100 year runoff, utilizing the maximum static head available at the inlet end of the culvert (to top of road or 1.5 x diameter, whichever is lower).

- The capacity of the culverts shall be determined for inlet and outlet control conditions and the lesser of the two shall be used as the discharge capacity.

2.4.8 Stormwater Management Facilities

The storage required to control runoff to pre-development rates can be achieved by many small control facilities (building roofs, parking lots, landscaped depressions) or by larger centralized facilities (large urban retention ponds and/or detention ponds) in parks and open spaces. Large centralized storage facilities called stormwater management ponds have been found to be the most efficient means to control urban runoff.

2.4.9 Wet Ponds

Retention facilities, or wet ponds, are man-made water bodies that retain a pre-selected minimum amount of water throughout the year in a natural type setting. The purpose of a wet pond is to provide a temporal storage of stormwater runoff in order to enhance water quality and restrict discharge to pre-development levels.

Wet ponds have the following characteristics:

- Design storage volume 1:100 year 24 hour storm
- Minimum water surface area 2.0 ha at normal water level
- Depth of permanent pool 2.5 m below normal water level.
- Maximum active storage depth 2.0 m above normal water level
- Minimum freeboard 1.0 m above the design high water level
- Maximum sideslopes 7:1 above the normal water level

2.4.10 Constructed Wetlands

Constructed wetlands retain runoff to improve water quality and control peak discharge rates. Sedimentation is provided by permanent deep pools at the inlets, outlet and along the flow path. Relatively shallow areas with extensive plantings provide filtration and biological processes that account for the water quality benefits of constructed wetlands.

Constructed wetlands have the following characteristics:

- Design storage volume: 1:100 year 24 hour storm
- Wetland size approximately 5% of watershed area
- Forebay ~10% of wetland surface area
- Average storage depth 1.0 m to 2.0 m

2.4.11 Dry Ponds

Detention storage facilities, or dry ponds, are man-made facilities intended to hold runoff for a limited time only and as such are usually free of ponding for the majority of time. The purpose of a dry pond is to temporarily store storm water runoff during major storm events in order to attenuate peak flows to pre-development levels. They also provide some improvements to runoff water quality due to settling of suspended solids, but to a lesser degree than wet ponds or wetlands.

The design criteria which were used for dry ponds are as follows:

- Design storage volume 1:100 year 24 hour storm
- Maximum active storage depth 2.0 m
- Interior side slope 5:1
- Minimum freeboard 1.0 m above the design high water level
- Minimum bottom slope 1%.

2.4.12 Pond Storage Volumes

The storage volume for the stormwater management ponds is based on the land use/zoning of the area draining to the facility. Stormwater management ponds usually have their outlets installed with flow control devices, such as orifice plates or weirs, which restrict flows from the ponds to a pre-determined maximum release discharge. The Alberta Environment guidelines require the regulation of post-development flows to pre-development levels, therefore, a maximum stormwater management pond release rate of 2.5 l/s/ha has been adopted for the study area.

The required pond storage volumes for the 1:100 year, 24 hour duration storm and a maximum release rate of 2.5 L/s/ha, were determined using the Modified Rational Method as follows:

- Commercial areas 1120 m^3/ha
- Industrial areas 920 m^3/ha
- Single Family Residential 670 m^3/ha
- Multi-Family Residential 740 m^3/ha
- Parks and Natural areas 280 m^3/ha

2.5 TRANSPORTATION SYSTEM

The design criteria for the components of the Transportation System include:

- Geometric Design Guide for Canadian Roads, Transportation Association of Canada
- Manual of Uniform Traffic Control Devices, Transportation Association of Canada
- Guide for the Design of Roadway Lighting, Transportation Association of Canada

3 Waterworks System

3.1 EXISTING FACILITIES

The Town of Redwater's water system consists of:

- Treated Water Supply Line
- Reservoir and Pumphouse
- Water Distribution System

3.2 TREATED WATER SUPPLY LINE

City of Edmonton treated water is supplied from the Capital Region Northeast Water Services Commission via a 250 mm diameter main at the Redwater Connection. The supply pressures and reservoir levels are monitored by CRNWSC staff at the On-Line Station. The Commission assesses the capacity of the line, and the ability to serve the various communities and industrial users.

3.3 RESERVOIR AND PUMPHOUSE

The pumphouse has recently been upgraded and consists of three new distribution pumps and two stand-by pumps with natural gas engines. These pumps supply water to the distribution system, truck fill, bucket fill and the ARC plant which is located east of Redwater.

The existing pumps are as follows:

- There are two 40 HP Vertiline vertical turbine pumps, model 11 EM. They are 3 stage variable speed pumps. They are rated at 41 L/s (650 USGPM) and 500 kPa (72 psi) each.
- There is one 50 HP Vertiline vertical turbine pump. It is a 4 stage model 12 RI. The pump is rated at 60 L/s (950 USGPM) and 500 kPa (72 psi).
- The two stand-by pumps are identical Johnston vertical turbine pumps, 3 stage, model 14CC with a 10 inch impeller. They are each rated for 122 L/s (1937 USGPM) at 503 kPa (73 psi).

The outgoing pumphouse pressure is controlled by a PRV which is set at 82 psi. One of the 40 HP pumps acts as the duty pump. If it cannot meet target pressure the second 40 HP pump is activated (40 HP + 40 HP). If this is not sufficient then the non duty 40 HP pump is replaced by the 50 HP pump (40 HP + 50 HP). If this is still not sufficient the non duty 40 HP pump is turned on (40 HP + 50 HP + 40 HP).

The truckfill and bucketfill are supplied directly off of the system discharge header of the distribution and stand-by pumps, as there is not a separate truckfill pump. The ESSO supply line is also fed by the distribution pumps directly off of the main header.

The existing reservoir storage capacity is 9,092 m^3.

3.4 DISTRIBUTION SYSTEM

The existing distribution system is comprised mainly of steel and asbestos cement (AC) pipe. The industrial area on the east side of town and new extensions to the system are constructed of polyvinyl chloride (PVC) pipe. Most of the distribution system was constructed in the 1960's and 1970's, and the system has not grown significantly since this time. The pipe sizes range in diameter from 75 mm to 450 mm. Figure 3.1 shows the pipe sizes of the distribution system.

The 2005 Master Services Plan recommended dividing the Town into two separate pressure zones in order to boost pressures to allow for expansion in the west. As such, a 400 mm diameter waterline has been constructed from 58 Street to 52 Avenue in order to supply water from the future booster pumphouse to future development areas. This will split the system into two zones, at a location east of 58th Street. The pumphouse has been designed, but has not been built to date.

3.5 EXISTING SYSTEM ASSESSMENT

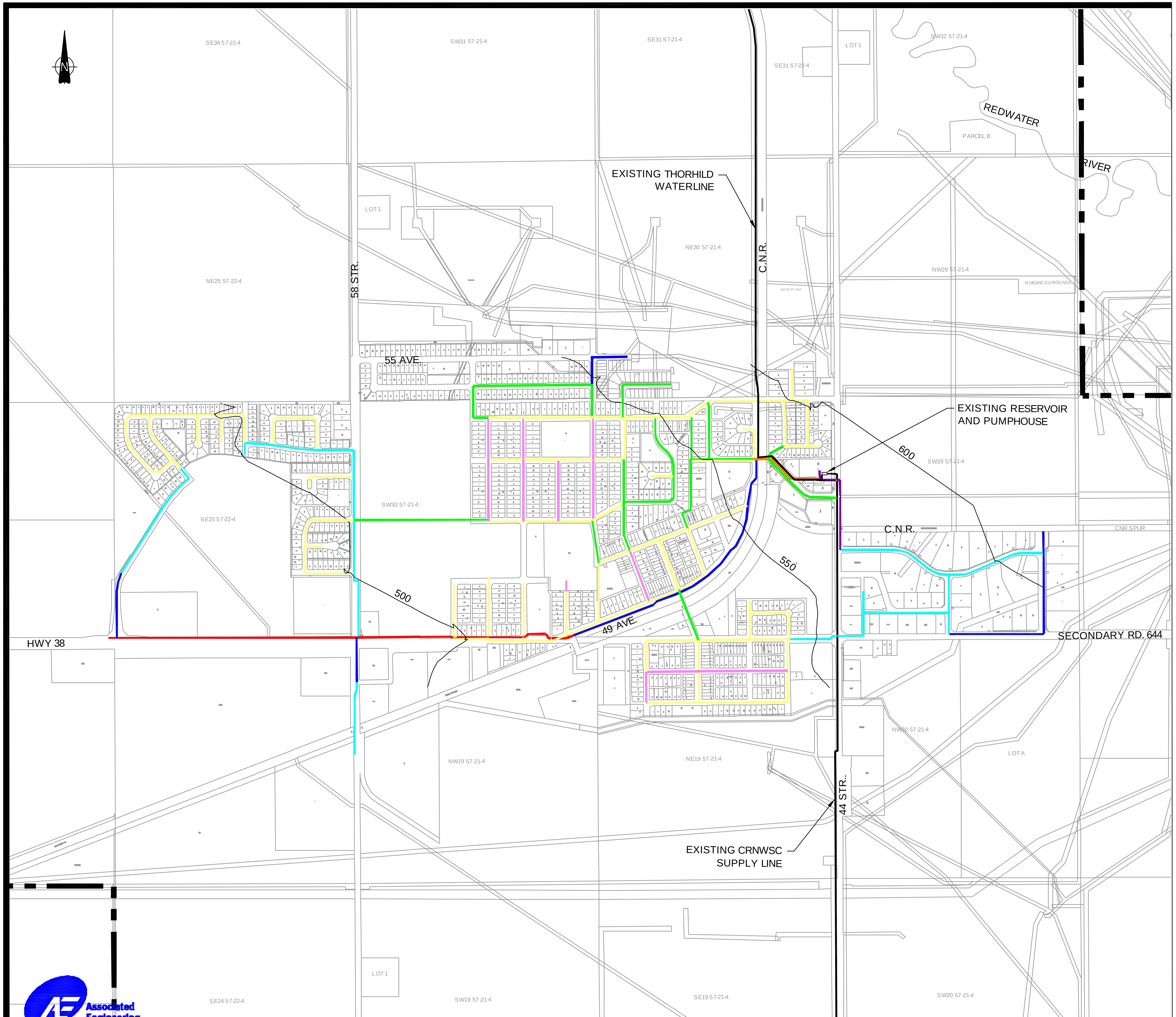
The existing distribution system was analyzed using the computer modelling software WaterCAD by Bentley. The model was updated to include new pump curves and watermain extensions to reflect recent upgrades. The distribution system was analysed based on satisfying peak hour pressures and peak day plus fire flow requirements. Although the average day run is not generally used in analyzing the capacity of the system, it is included in this section to illustrate how the system may currently be functioning. The following describes each scenario in detail:

3.5.1 Average Day

There are two scenarios to be analyzed during the average day run; with and without the truckfill operating. Due to the insignificant flow rate of the bucketfill, it has not been modelled.

During the average day scenario, with the truckfill not in operation, only one 40 HP pump is required to run in order to satisfy the system demands. Under these conditions the pressure at the pumphouse is 469 kPa (68 psi). The resulting minimum system pressure occurs in the southwest at 350 kPa (51 psi) and the maximum pressure occurs at the north end of the Industrial Park at 525 kPa (76 psi). The system pressures during this scenario fall within the design criteria identified in this report.

With the truckfill in operation, only one 40 HP pump is required to satisfy the system demands. As the pump has a variable speed control (or variable frequency drive - VFD) set to maintain a pressure of 496 kPa (72 psi), the system pressures are not affected by the truckfill operation. In all scenarios the outgoing pressures are reduced to a maximum of 469 kPa (68 psi) by the pressure reducing valve.



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3796-RP01-BASE-3TM-GRID_2009

Town of Redwater

MASTER SERVICES PLAN UPDATE

EXISTING WATER DISTRIBUTION SYSTEM

LEGEND:

EXISTING 100mm WATERMAIN
EXISTING 150mm WATERMAIN
EXISTING 200mm WATERMAIN
EXISTING 250mm WATERMAIN
EXISTING 300mm WATERMAIN
EXISTING 350mm WATERMAIN
EXISTING 400mm WATERMAIN
EXISTING 450mm WATERMAIN
TOWN BOUNDARY
450 PRESSURE CONTOURS (PEAK HOUR DEMAND)

SCALE: 1 : 12,500

AUGUST, 2010

FIGURE 3.1

3.5.2 Peak Hour

Under peak hour demands and if the truckfill is not operating, only one 40 HP pump is required. This results in a pumphouse pressure of 468 kPa (68 psi) due to the PRV setting, a maximum system pressure of 525 kPa (76 psi) and a minimum pressure of 349 kPa (51 psi). The system pressures during this scenario are within those outlined in the design criteria section of this report. Figure 3.1 shows the pressure contours which result from this scenario.

If the truckfill is in operation (assumed to supply 30 L/s), both 40 HP pumps are required. The maximum system pressure would be 523 kPa (76 psi) and the minimum pressure would be 343 kPa (50 psi).

3.5.3 Peak Day plus Fire

Figure 3.2 shows the ability of the distribution system to meet the recommended fire flows under existing conditions. The Peak Day plus Fire scenario assumes that both stand-by pumps are operating. Due to the VFD, there is not a significant difference in results based on whether or not the truckfill is in operation.

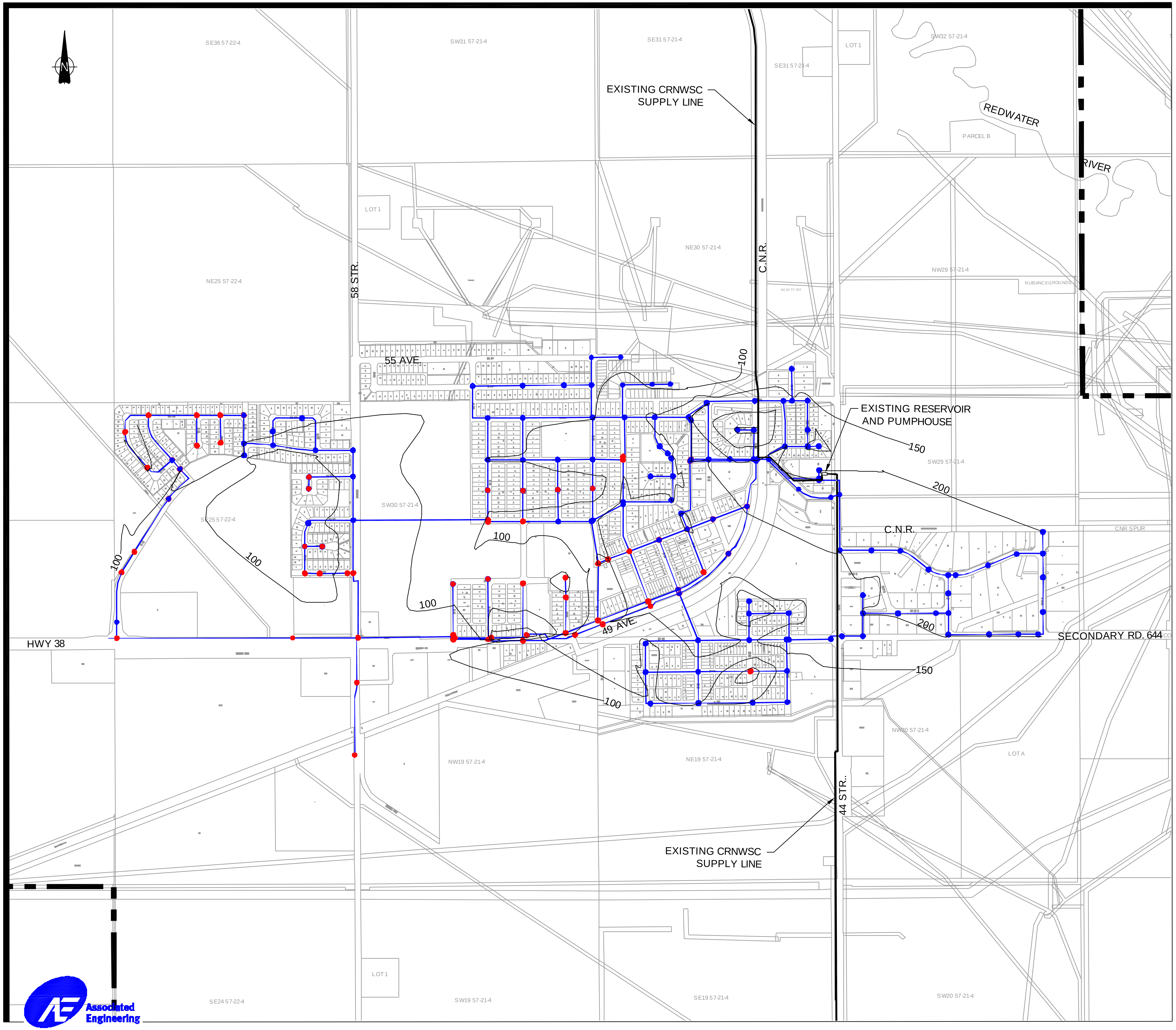
Those nodes which do not meet the recommended fire flow levels are still capable of drawing water, however it may not be at the quantity or pressure identified within the design criteria identified in this report. Figure 3.2 also identifies the fire flow available (while maintaining minimum pressure requirements) in the form of available fire flow contours.

3.5.4 Pump Capacity

As shown in the design criteria section of the report, it is assumed that the average truck fill supply rate is approximately 30 L/s. This has been estimated from the existing system model scenarios. Conversations with the pumphouse operator suggest that the current supply rate is considered adequate by the majority of truckfill customers. Therefore, a required supply rate of 30 L/s will be assumed. A common value used for many truckfills is a supply rate of 3,000 gpm or 19 L/s.

According to the model results, the peak hour demand (including truckfill and ARC) is satisfied with one 40 HP pump operating.

The existing stand-by pumps are adequate to supply the maximum fire flow of 200 L/s and the existing peak day demand of 19.7 L/s (which excludes the truckfill and handfill demands but includes ARC). The total flow required is therefore is 219.7 L/s. The existing pumps can each produce approximately 122 L/s at 503 kPa (73 psi), and more than satisfy the requirements. The pumps may be slightly undersized if the truck fill is in operation which would bring the total anticipated flow requirements to 249.7 L/s (versus pump capacity of 244 L/s, however at a fairly high pressure). The stand-by pumps should be adequate to supply the fire flow demands for some time, as it may not be imperative that the truck fill operate at full flow during fire periods.



Town of Redwater

MASTER SERVICES PLAN UPDATE

EXISTING WATER DISTRIBUTION SYSTEM FIRE FLOW ANALYSIS

LEGEND:

- SATISFIES FIRE FLOW CRITERIA
- FAILS FIRE FLOW CRITERIA
- 60 L/s AVAILABLE FIRE FLOW CONTOURS
- STUDY BOUNDARY

NOTE:

MINIMUM FIRE FLOW CRITERIA USED IN ANALYSIS

83 L/s	RESIDENTIAL
183 L/s	COMMERCIAL/INDUSTRIAL
167 L/s	SCHOOLS

SCALE: 1 : 12,500

AUGUST, 2010

FIGURE 3.2

3.6 WATER STORAGE

There are two methods of calculating water storage requirements:

.1 Alberta Environment Guidelines require:

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

Where,
S = Total storage requirement, m^3
A = Fire storage, m^3
B = Equalization storage (approximately 25% of projected maximum daily design flow), m^3
C = Emergency storage (minimum of 15% of projected average daily design flow), m^3
D = Disinfection contact time (T10) storage to meet the CT requirements, m^3

.2 Supply System based criteria (systems dependent on long supply lines):

- 1 Peak Day
- Fire Storage

For systems dependent on long supply lines, it is recommended that the second method of calculating storage requirements be applied. As such, Table 3.1 calculates the available and required storage based on 1 Peak Day plus Fire storage requirements.

The fire storage is the largest demand allowed for in the distribution system, which in this study is 200 L/s as recommended for the high density residential land use. A fire flow of 200 L/s is required to be maintained for 2.5 hours, in accordance with the Fire Underwriters Survey guidelines.

A peak day fill rate of 115 m^3 for the truckfill occurred in June 2009. Although this is the peak recorded rate, it is possible that significantly more water could be required in the future, due to emergency situations or additional users. As such, it is recommended that a storage capacity of 870 m^3 be retained for truckfill purposes. This is equivalent to 16 straight hours (6 am to 10 pm) of filling at a rate of 30 l/s. The trucks are estimated to hold 13.6 m^3/load (3,602 USgal/load). Based on the average existing filling rate of 30 L/s (460 USGPM), it would take 7.8 minutes to fill each truck. Assuming on the average it takes about 15 minutes to load a 13.6 m^3 truck (complete cycle of parking, hose adjustment and fill), 4 trucks could be filled per hour. Over 16 hours this could result in an estimated total of 64 loads, which at 13.6 m^3 per load totals 870 m^3.

The quantity of storage required for the bucketfill was set at 11 m^3. This peak day demand was recorded by the Town's water meter and occurred in June 2009.

The existing total available storage is 9,092 m^3 . From the attached Table 3.1. it is apparent that there is significant remaining storage. In 2010 it is estimated that there is 4,711 m^3 of remaining storage which

Table 3.1
Town of Redwater
Master Services Plan

Storage Requirements - Based on One Peak Day Plus Fire

	Existing Storage (m^3)	Population	Redwater Peak Day Flow (L/s)	ARC Peak Day Flow (L/s)	Truckfill Peak Day Flow (m^3/day)	Handfill Peak Day Flow (m^3/day)	TOTAL Peak Day Flow (m^3/day)	Fire Flow (200 L/s for 2.5 hours) (m^3)	Total Required Storage (m^3)	Remaining Storage (Surplus) (m^3)
2010	**9092**	2236	15.4	4.3	870.0	11.0	2581	1800	**4381**	4711
2015	**9092**	2456	16.9	4.3	870.0	11.0	2711	1800	**4511**	4581
2020	**9092**	2676	18.4	4.3	870.0	11.0	2842	1800	**4642**	4450
2025	**9092**	2896	19.9	4.3	870.0	11.0	2973	1800	**4773**	4319
2030	**9092**	3116	21.4	4.3	870.0	11.0	3103	1800	**4903**	4189

could be made available for future growth. This equates to an additional population of approximately 7,900 people.

3.7 HYDRANT COVERAGE

Figure 3.3 indicates the current level of hydrant coverage within the town. The coverage is based on a 75 m radius for hydrants within single family residential areas, and 60 m for all other locations. The figure also recommends locations of future hydrants in areas without sufficient coverage. Most of the areas which require additional hydrants can be easily serviced off of existing watermains. The exception is the industrial area, where hydrants are adequately placed along the existing waterline, however may not extend deep enough into the existing properties in order to provide protection to all buildings.

3.8 UPGRADES TO EXISTING SYSTEM

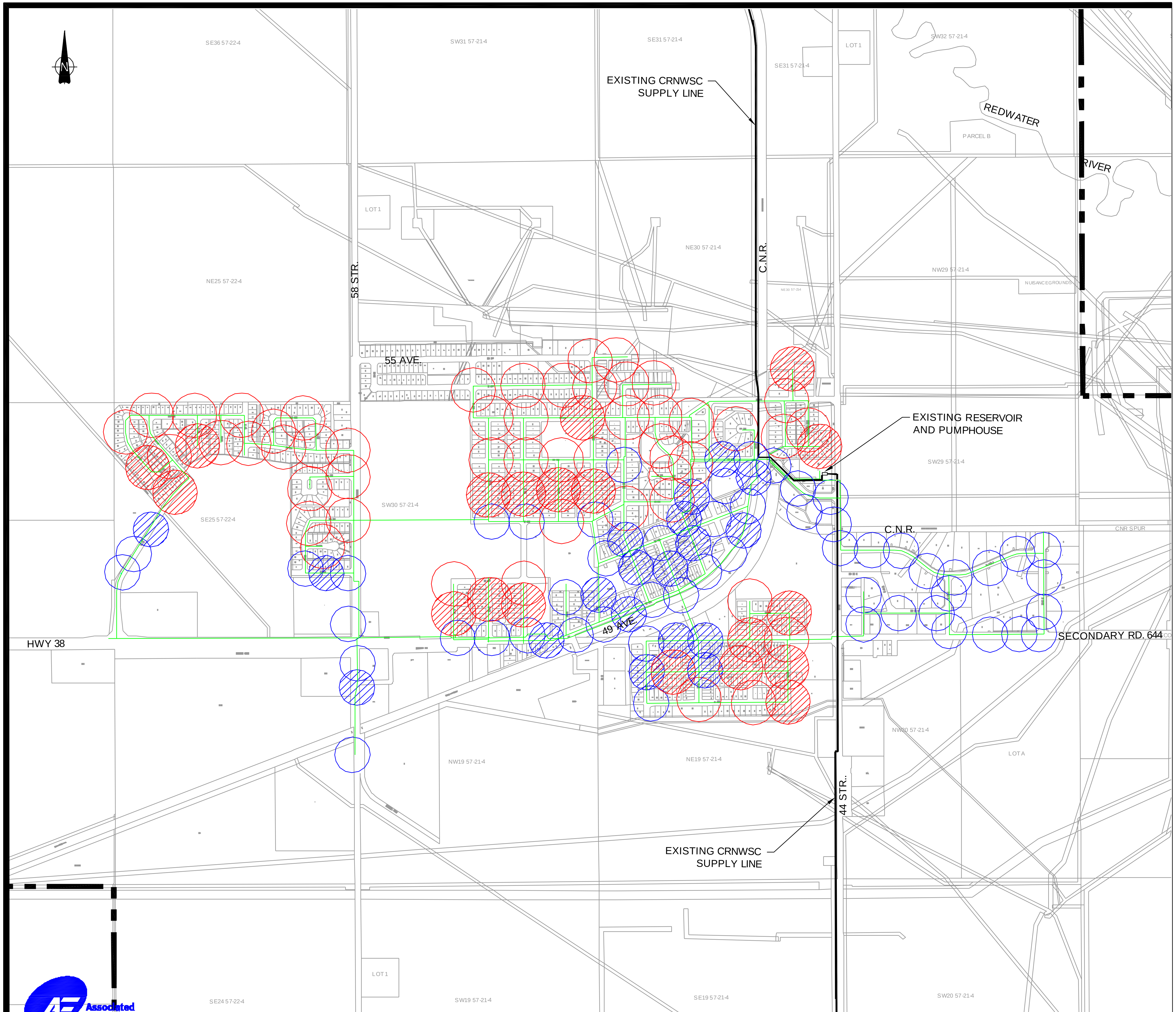
The existing water distribution system requires upgrading in order to satisfy the peak day plus fire flow scenario. Recommended upgrades are identified in Figure 3.4. The upgrades are shown in two categories, initial and long term upgrades. The initial upgrades relate to satisfying local fire flow recommendations, while the long term upgrades relate to providing additional water to the booster pumphouse for re-pumping of fire flows to the proposed western (upper) zone.

The initial upgrades include the construction of the booster pumphouse (already designed) and PRV, which will create two separate pressure zones. A pressure reducing valve is recommended to be installed on the existing 200 mm diameter line which crosses the golf course. This is recommended in order to establish the pressure zones, and yet it will allow for the upper zone to assist the lower zone during fire flow conditions. It should be noted that the PRV will only allow the upper zone to cascade down to the lower zone under extreme low pressure conditions (i.e. fire conditions). The PRV is estimated to be set at 310 kPa (45 psi).

The booster pumphouse will be required in order to satisfy the fire flow recommendations for the existing western area. The implementation of the initial upgrades with the booster pumphouse and PRV will satisfy nearly all of the recommended fire flows in the entire existing distribution system. However, if the PRV is not installed, a significant portion of the central area will not satisfy fire flows (related to low pressures near eastern connection of proposed PRV line). The PRV will not be required following the construction of all of the proposed upgrades to the existing system.

The booster pumphouse will house both distribution and standby pumps. However, a sufficient water supply must be insured in order to operate a booster pumphouse. Such a pumphouse relies on the water from the distribution system, and pumps it to a higher hydraulic gradeline. With the existing piping and the existing fire pumps operating, the proposed booster can receive up to 158 L/s, maintaining a minimum pressure of 280 KPa (40 psi) in the system during a peak day without the truck fill operating.

With the booster station supplying 78 psi above the floor elevation of 634.35 m the peak day demand plus fire flow is satisfied (with the north PRV closed). The lowest pressure in the west system occurs in the



Town of Redwater

MASTER SERVICES PLAN UPDATE

EXISTING WATER DISTRIBUTION SYSTEM HYDRANT ANALYSIS

LEGEND:

- EXISTING HYDRANT COVERAGE IN RESIDENTIAL AREAS (75m RADIUS)
- PROPOSED HYDRANT COVERAGE IN RESIDENTIAL AREAS
- EXISTING HYDRANT COVERAGE IN ALL OTHER AREAS (60m RADIUS)
- PROPOSED HYDRANT COVERAGE IN ALL OTHER AREAS
- TOWN BOUNDARY

SCALE: 1 : 12,500

AUGUST, 2010

FIGURE 3.3

Time: 7:49am
Date: Sep 08, 2010
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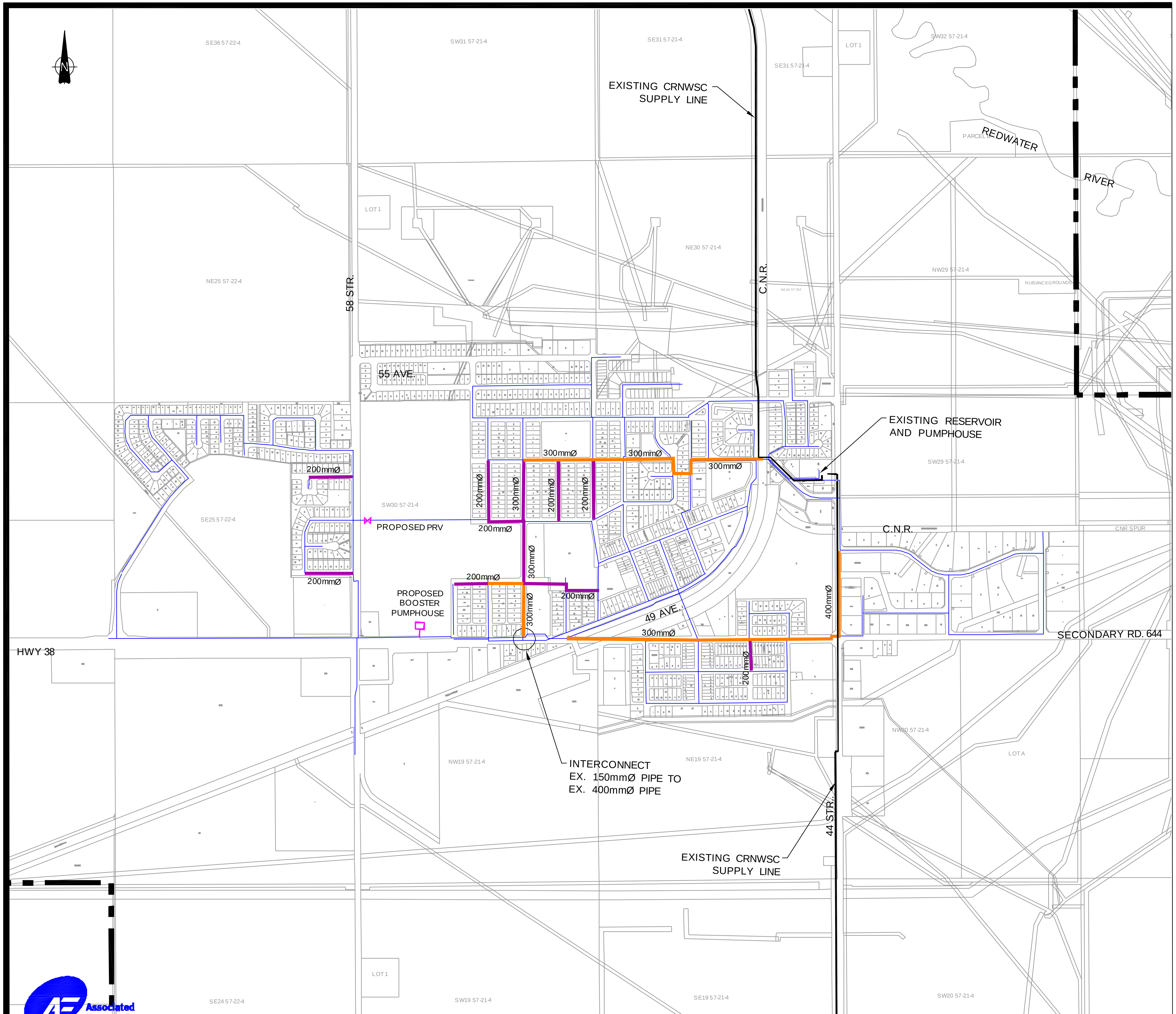
Xrefs: 3796-RT01-TIT-AE-RPT
3796-RP01-BASE-3TM-GRID_2009



Town of Redwater

MASTER SERVICES PLAN UPDATE

EXISTING WATER DISTRIBUTION SYSTEM WITH UPGRADES

LEGEND:

- INITIAL UPGRADES TO EXISTING SYSTEM
- LONG TERM UPGRADES TO EXISTING SYSTEM
- TOWN BOUNDARY

SCALE: 1 : 12,500

AUGUST, 2010

FIGURE 3.4

Time: 7:49am
Date: Sep 08, 2010
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south west corner and is 467 KPa (68 psi). The highest pressure occurs on the north of the system and is 547 KPa (79 psi)

Other upgrades shown in the figure are based on satisfying fire flow criteria. Significant upgrades are shown, many located adjacent to Provident Place. This is in part due to the arena, and high density fire flow requirements in the area, but is also due to existing dead end lines. The existing 100 mm diameter steel lines are not sufficient to supply fire flow demands. In order to satisfy fire flow requirements throughout the system, these 100 mm lines must be replaced.

Although not immediately required, it is recommended that the town establish several supply options to the booster pumphouse. The booster pumps can only operate with an adequate water supply. Without this supply, fire flow demands cannot be ensured. Therefore, it is in the Town's best interest to establish the trunk mains shown in Figure 3.4. The construction of these lines will provide an alternate supply route if a main line requires repair (i.e. at a rail crossing). Installing these lines will also assist in supplying additional water to the booster pumphouse, which will allow for continued development in the proposed upper zone.

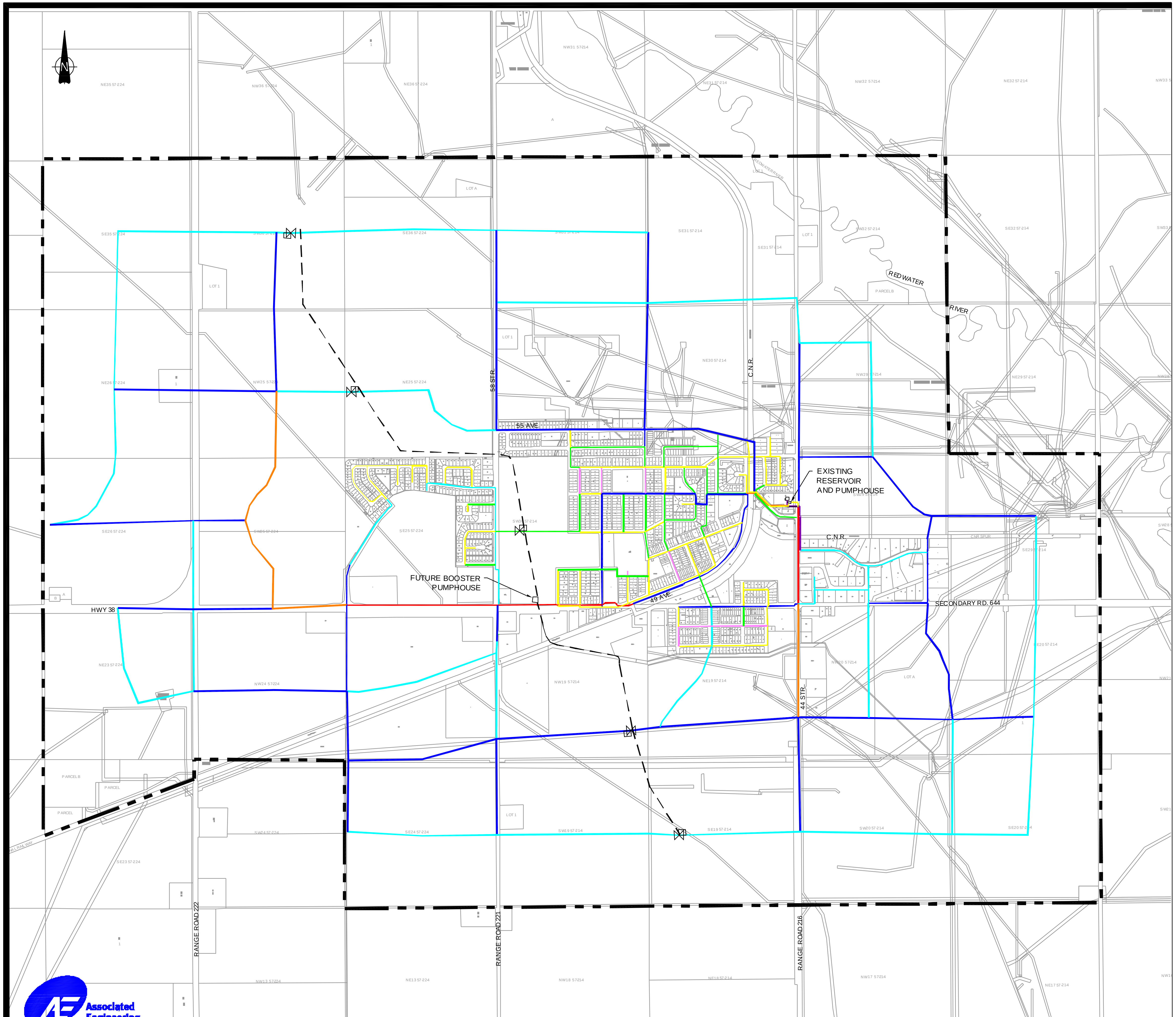
Following the construction the recommended upgrades, and with the existing fire pumps operating, it is possible to get 235 L/s at the booster pumphouse, maintaining a minimum pressure of 280 KPa (40 psi) in the system. This is calculated during a peak day without the truck fill operating. These upgrades will provide the 183 L/s commercial fire flows to the upper zone (based on FUS), and continue to supply peak day flow. If the Fire pumps were upgraded, a potential flow of 285 L/s could be achieved.

3.9 ULTIMATE WATER DISTRIBUTION SYSTEM

The Ultimate Servicing Plan for the water system involves large diameter mains looping into the expansion areas. The upgrades shown in Figure 3.5 have been based on the assumption that all of the recommended upgrades to the existing system have been undertaken. It is also recommended that mains in the residential areas be upsized to 200 mm diameter and those in commercial/industrial areas to 250 mm or greater as they require replacement over time.

Several pressure reducing valves are identified throughout the system along the proposed pressure zone break (elevation of 635). This is recommended to allow the upper zone to assist the lower zone during fire conditions. However, it should be noted that it is not intended that the upper zone will cascade down to the lower zone other than during extreme conditions (PRV's set to open at a Hydraulic Gradeline of 635 m or approximately 45 psi at the PRV north of the proposed Booster Pumphouse location).

To service the ultimate area in the west zone, significant additional water will be required to be supplied to the proposed booster pumphouse and maintain minimum pressures. During the Peak Hour scenario, the system would need to supply approximately 192 L/s to the booster pumphouse. This has been established based on the estimated future population (based on future residential land use) and has been distributed throughout the future lands based on equivalent population densities. In order to maintain velocities of less than 1.5 m/s during normal operating periods, this will require that the header and distribution piping from the main pumphouse to the distribution system be upsized to a 600 mm diameter main. Also, the piping



Town of Redwater

MASTER SERVICES PLAN UPDATE

ULTIMATE WATER DISTRIBUTION SYSTEM

LEGEND:

- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- FUTURE ZONE BOUNDARY (APPROX. ELEVATION 635m)
- TOWN BOUNDARY

NOTE:

MINIMUM RECOMMENDED PIPE SIZES IN RESIDENTIAL AREAS IS 200mmø, IN COMMERCIAL/INDUSTRIAL AREAS IS 250mmø OR GREATER.

SCALE: 1 : 20,000

AUGUST, 2010

FIGURE 3.5

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3796-RP01-BASE-3TM-GRID_2009

along 48th Avenue will be required to be upsized to at least a 450 mm diameter from 55th Street to 58th Street in order to reduce velocities to below 1.5 m/s.

During Peak Day demands it is estimated that this would be in the order of 115 L/s. During the Peak Day plus Fire scenario, 183 L/s would be required at the booster pumphouse in order to supply the fire pump, and 115 L/s in order to provide for the peak day demands. The above upgrades will be sufficient to supply these flows to the booster pumphouse.

The commercial fire flow of 183 L/s has been based on the current size of commercial buildings within the Town. In the future, larger buildings such as large big box stores or a mall may be constructed within Redwater. The large buildings could require a recommended fire flow of 233 L/s. In the Ultimate scenario shown in Figure 3.5, commercial developments situated along the highway will be able to access these large fire flows from the proposed ultimate distribution system.

4 Sanitary Sewerage System

4.1 EXISTING FACILITIES

The sanitary system consists of:

- Collection System
- Lift Station and Forcemain
- Lagoons (stabilization and mechanically aerated)

4.1.1 Collection System

The existing collection system is comprised of 200 mm diameter collection mains, and 250 mm to 600 mm diameter trunk mains (refer to Figure 4.1). The system is divided into two separate major catchments. An upgraded trunk system was installed in 2008 to handle the majority of the town's sewage. This new trunk main connects to the existing lift station which directs the sewage through the existing 250 mm forcemain to the mechanically aerated lagoon. After treatment in the lagoon, the majority of the discharged sewage is transported to the stabilization lagoon. A portion of the treated sewage is pumped to the golf course for irrigation purposes. The industrial area located on the southeast corner of the Town is serviced by a separate trunk system that discharges directly to the stabilization lagoons.

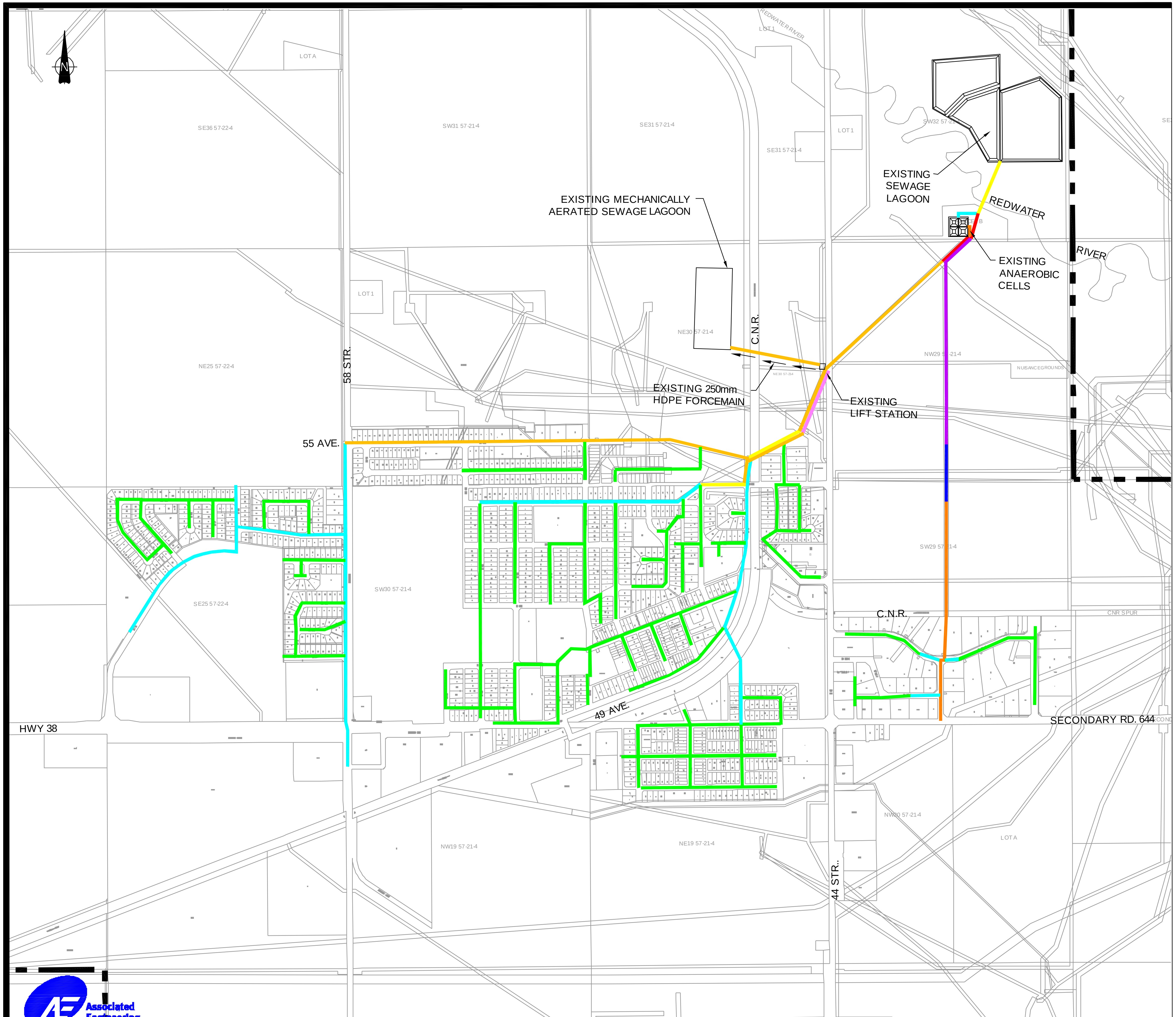
4.1.2 Lift Stations and Forcemains

There is one main lift station which intercepts flow from the 525 mm outfall sewer, and directs the flow to the mechanically aerated lagoon.

The sewage lift station is outfitted with two identical Hydromatic submersible sewage pumps. These pumps are 3 phase, model S4M, 15 HP pumps and are rated at 44.2 L/s at 15.2 m TDH. The lift station barrel is 1.83 m in diameter (6 ft) and is 6 m in depth. The base elevation is 615 m and the top elevation is 621 m. The 525 mm diameter inlet pipe is at 616.46 m and the 250 mm diameter forcemain discharge elevation is at 616.6 m. The wet well capacity is approximately 3.2 m^3 .

The forcemain is a 250 mm diameter HDPE DR 11 pipe, and is approximately 400 m long. The discharge elevation appears to be approximately 622 m.

A portion of the aerated sewage is pumped to the golf course via an existing lift station and forcemain. This system has not been analysed within this report.



Town of Redwater

MASTER SERVICES PLAN UPDATE

EXISTING SANITARY SEWER SYSTEM

LEGEND:

- EXISTING 200mm SANITARY
- EXISTING 250mm SANITARY
- EXISTING 300mm SANITARY
- EXISTING 375mm SANITARY
- EXISTING 400mm SANITARY
- EXISTING 450mm SANITARY
- EXISTING 525mm SANITARY
- EXISTING 600mm SANITARY
- TOWN BOUNDARY

SCALE: 1 : 12,500

AUGUST, 2010

FIGURE 4.1

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Date: Sep 08, 2010
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3796-RP01-BASE-3TM-GRID_2009

4.1.3 Lagoons

The Town of Redwater has two wastewater treatment systems identified on Figure 4.1:

- Aerated lagoon system which receives flow from the 525 mm trunk sewer, lift station and forcemain. A portion of the effluent flow from the aerated lagoons is used for golf course irrigation during summer months. The remainder is discharged to the storage ponds (see below).
- Non-aerated lagoon system comprised of four anaerobic cells and three storage cells. The anaerobic cells receive raw sewage flow (estimated at 13% of the total flow) via the 375 mm/600 mm outfall from the industrial area. The storage cells receive all of the anaerobic lagoon effluent as well as all of the flow from the aerated lagoons (except the portion used for golf course irrigation).

Table 4.1 summarizes information on the two lagoon systems.

Lagoon Cells	Depth m	Volume m^3	Air Flow m^3 /min
Aerated Cells (residential flow)			
Cell 1 (complete mix)	5.00	3,000	12.50
Cell 2 (partial mix)	5.00	22,500	12.50
Cell 3 (partial mix)	5.00	22,500	6.20
Total		48,000	31.20
Anaerobic Cells (industrial flow)			
Cell 1		1,360	
Cell 2		1,360	
Cell 3		1,360	
Cell 4		1,360	
Total		5,440	
Storage Cells (residential & Industrial flow)*			
Cell 1	1.68	75,800	
Cell 2	2.29	42,250	
Cell 3	2.29	54,340	
Total		172,390	

4.2 EXISTING SYSTEM ASSESSMENT

4.2.1 Design Basis

Flow Monitoring was performed on the sanitary sewer at 4 locations. The results indicate that the actual dry weather contributions are lower than the design densities would generate. However, the population densities have not been adjusted in order to model flows closer to the existing scenario. In order to come close to the monitored flow, the densities and equivalent densities would have to be significantly reduced (i.e. residential density to 15 p/ha or less). These densities were thought to be far too low to apply to either existing or future development areas and could potentially result in undersized mains.

As such, the existing sanitary system has been modelled based on the population densities outlined in the design criteria and a per capita sewage generation rate of 330 L/c/d. A base I/I rate has been included in the model to account for the flow monitoring results at the furthest downstream gauge (Gauge 4) where the Average Dry Weather Flow was 10.55 L/s (416 L/c/d).

In addition, the inflow/infiltration rates for the existing area have been estimated from the 2008 Flow Monitoring program. These I/I rates are based on the 1:25 year storm.

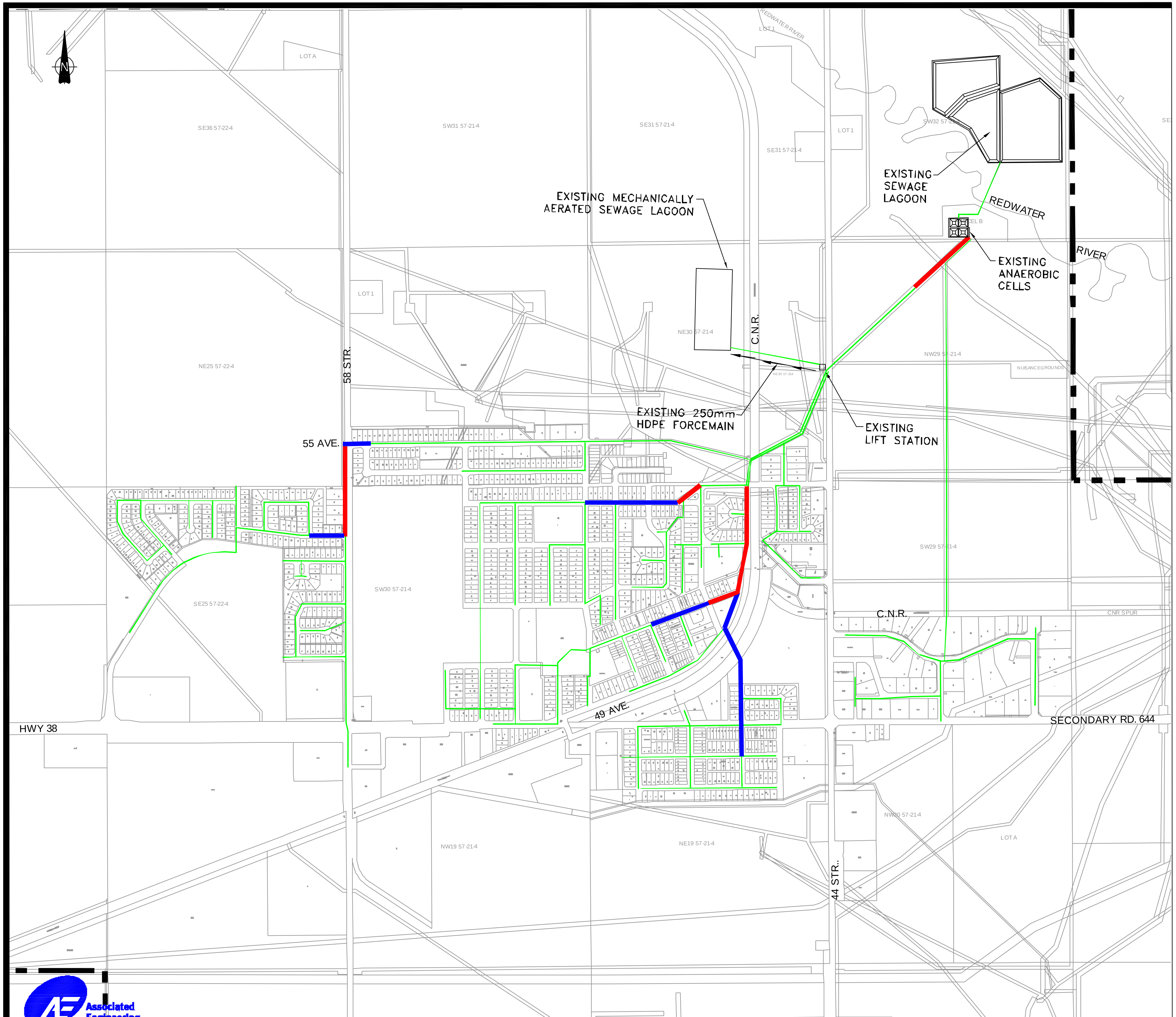
Future development areas have been modelled using a typical I/I design rate of 0.28 L/s.

A sensitivity analysis was performed in order to establish how conservative the spreadsheet model is in comparison to the flow monitoring results. The suggested 1:25 year I/I rates and the monitored peak DWF from Gauge 4 (totals 130.1 L/s) were compared to the suggested 1:25 year I/I rates and the modelled peak DWF at gauge 4 (totals 169.7 L/s). This results in an additional 30% of flow based on using the design densities and the peaking factor of 2.5 (as recommended in the monitoring report). It is acknowledged that this may be a conservative approach, however mainly affects the existing system, and will allow for future densification of the area.

4.2.2 Collection System Assessment

Overall the sanitary system appears to function well in most locations. The system was analyzed and separated into three major categories: pipes with greater than 20% spare capacity, pipes with greater than 0% but less than 20% spare capacity, and pipes without spare capacity (therefore undersized to handle peak flows). Figure 4.2 identifies the sections of pipes without spare capacity (pipes are undersized) or less than 20% spare capacity.

As shown on the figure, there are three locations where sewer mains appear to be undersized: on 58th Street, from MH174 to MH172; on 50th Avenue and 49th Avenue/46th Street, from MH131 to MH110; and on 53rd Avenue, from MH100 to MH10. A portion of the outfall sewer may also be undersized, however this is difficult to quantify as described below. The spreadsheet model of the existing sanitary system is included as Table 4.2.



Town of Redwater

MASTER SERVICES PLAN UPDATE

EXISTING SANITARY SEWER SYSTEM HYDRAULIC ASSESSMENT

LEGEND:

- EXISTING SANITARY SEWER SYSTEM
- PIPES WITH LESS THAN 20% REMAINING CAPACITY
- SURCHARGED PIPES (ZERO REMAINING CAPACITY)
- TOWN BOUNDARY

SCALE: 1 : 12,500

AUGUST, 2010

FIGURE 4.2

TABLE 4.2

TOWN OF REDWATER

MASTER SERVICES PLAN
EXISTING SANITARY SEWER
HYDRAULIC ANALYSIS

General	Existing Areas
Per Capita Flow Generation	330 L/c/day
Peaking Factor	Harmons
Commercial/Industrial Infiltration	0.60 L/s/ha
Residential Infiltration (Older homes)	0.85 L/s/ha
Future/New Development Infiltration	0.28 L/s/ha
Manning's n Old Pipe	0.015
New Pipe	0.013

Other	Single Family Residential	Multy Family Residential	High Density Residential	Commercial	Industrial
Population Density	35 people/ha	85 people/ha	175 people/ha	30 people/ha	25 people/ha
Area Flow Generation	0.13 L/s/ha	0.32 L/s/ha	0.67 L/s/ha	0.11 L/s/ha	0.10 L/s/ha

Less than 20% spare capacity	10.00
No spare capacity (Pipe Full)	0.00

From MH	To MH	Design Flows: Total DWF (L/s)	Accum DWF (L/s)	Harmon's Peaking Factor	Peak DWF (L/s)	Residential I/I (L/s)	Other I/I (L/s)	Base I/I* (L/s)	Total I/I (L/s)	Accum I/I (L/s)	Accum WWF (L/s)	Pipe Data: Length	Diameter	Slope	Velocity	Capacity	Spare Capacity: (L/s)	(%)
89.3	89.2	1.444	1.444	2.500	3.611	1.658	4.248	0.117	6.023	6.023	9.634	115.00	250	0.34%	0.615	31.150	21.52	69.07
89.2	89.1	0.000	1.444	2.500	3.611	0.000	0.000	0.000	0.000	6.023	9.634	40.00	250	0.29%	0.574	29.079	19.45	66.87
89.1	181	0.069	1.513	2.500	3.783	0.000	0.360	0.008	0.368	6.391	10.173	105.00	250	0.23%	0.510	25.866	15.69	60.67
181	180	0.000	1.513	2.500	3.783	0.000	0.000	0.000	0.000	6.391	10.173	55.00	250	0.36%	0.640	32.423	22.25	68.62
180	179	0.000	1.513	2.500	3.783	0.000	0.000	0.000	0.000	6.391	10.173	60.00	250	0.35%	0.628	31.809	21.64	68.02
179	178	0.388	1.901	2.500	4.754	0.816	2.562	0.068	3.446	9.837	14.590	116.00	250	0.28%	0.557	28.240	13.65	48.33
178	177	0.188	2.090	2.500	5.225	1.199	0.000	0.018	1.217	11.054	16.278	60.00	250	0.35%	0.628	31.809	15.53	48.82
177	176	0.324	2.413	2.500	6.034	2.057	0.000	0.031	2.088	13.142	19.175	102.00	250	0.14%	0.393	19.920	0.74	3.74
176	175	0.000	2.413	2.500	6.034	0.000	0.000	0.000	0.000	13.142	19.175	45.00	250	0.67%	0.866	43.901	24.73	56.32
175	174	0.416	2.829	2.500	7.073	2.644	0.000	0.040	2.684	15.826	22.899	81.00	250	0.40%	0.667	33.795	10.90	32.24
106X	105X	1.243	1.243	2.500	3.108	7.905	0.000	0.121	8.026	8.026	11.134	82.00	200	0.29%	0.495	16.043	4.91	30.60
105X	104X	0.111	1.354	2.500	3.385	0.706	0.000	0.011	0.716	8.742	12.128	91.00	250	0.22%	0.497	25.206	13.08	51.89
82.7	82-6	0.270	0.270	2.500	0.675	0.000	2.052	0.044	2.096	2.096	2.771	50.00	250	0.32%	0.600	30.415	27.64	90.89
82.6	82.5	0.000	0.270	2.500	0.675	0.000	0.000	0.000	0.000	2.096	2.771	120.00	250	0.28%	0.565	28.620	25.85	90.32
82.5	82.4	0.094	0.364	2.500	0.909	0.595	0.000	0.009	0.604	2.701	3.610	100.00	250	0.65%	0.855	43.348	39.74	91.67
82.4	82.3	0.000	0.364	2.500	0.909	0.000	0.000	0.000	0.000	2.701	3.610	120.00	250	0.57%	0.805	40.771	37.16	91.15
82.3	82.2	0.000	0.364	2.500	0.909	0.000	0.000	0.000	0.000	2.701	3.610	85.00	250	0.59%	0.814	41.237	37.63	91.25
82.2	82.1	0.000	0.364	2.500	0.909	0.000	0.000	0.000	0.000	2.701	3.610	30.00	250	0.40%	0.671	34.005	30.40	89.39
82.1	104X	0.053	0.417	2.500	1.043	0.340	0.000	0.005	0.345	3.046	4.088	52.00	250	0.46%	0.721	36.527	32.44	88.81
104X	103X	0.053	1.825	2.500	4.562	0.340	0.000	0.005	0.345	12.133	16.695	90.00	250	0.26%	0.536	27.181	10.49	38.58
103X	102X	0.329	2.154	2.500	5.384	2.091	0.000	0.032	2.123	14.256	19.640	110.00	250	0.39%	0.663	33.617	13.98	41.58
102X	101X	0.000	2.154	2.500	5.384	0.000	0.000	0.000	0.000	14.256	19.640	47.00	250	0.28%	0.558	28.277	8.64	30.54
101X	174	0.362	2.516	2.500	6.290	2.304	0.000	0.035	2.339	16.595	22.884	125.00	250	0.23%	0.509	25.786	2.90	11.25
174	173	0.063	5.408	2.500	13.520	0.400	0.000	0.006	0.406	32.826	46.346	100.60	250	0.27%	0.550	27.855	0.00	0.00
173	172	0.063	5.471	2.500	13.677	0.400	0.000	0.006	0.406	33.232	46.909	100.60	250	0.28%	0.560	28.366	0.00	0.00
172	171	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	33.232	46.909	102.10	250	0.69%	0.879	44.520	0.00	0.00
171	170	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	33.232	46.909	86.00	300	0.33%	0.684	49.888	2.98	5.97
170	169	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	33.232	46.909	95.00	300	0.40%	0.758	55.296	8.39	15.17
169	168	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	33.232	46.909	106.40	300	0.34%	0.697	50.856	3.95	7.76
168	167	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	33.232	46.909	115.00	375	0.19%	0.608	69.335	22.43	32.35
167	166	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	33.232	46.909	107.00	375	0.20%	0.616	70.228	23.32	33.21
166	165	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	33.232	46.909	96.00	375	0.20%	0.619	70.523	23.61	33.49
165	164	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	33.232	46.909	103.00	375	0.19%	0.613	69.854	22.94	32.85
164	163	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	33.232	46.909	95.00	375	0.23%	0.669	76.285	29.38	38.51
7G	200	0.028	0.028	2.500	0.070	0.059	0.000	0.003	0.062	0.062	0.132	31.86	200	0.80%	0.942	30.551	30.42	99.57
200	163	0.068	0.096	2.500	0.241	0.434	0.000	0.007	0.440	0.502	0.742	96.00	200	0.40%	0.578	18.755	18.01	96.04
163	162	0.531	6.098	2.500	15.244	3.375	0.000	0.052	3.426	37.160	52.404	93.00	375	0.18%	0.594	67.776	15.37	22.68
Plug	162	0.393	0.393	2.500	0.982	0.339	0.000	0.016	0.355	0.355	1.337	11.00	250	1.32%	1.406	71.228	69.89	98.12
162	161	0.070	6.560	2.500	16.400	0.442	0.000	0.007	0.449	37.963	54.363	91.00	375	0.20%	0.618	70.503	16.14	22.89
161	160	0.075	6.635	2.500	16.587	0.476	0.000	0.007	0.483	38.446	55.033	101.00	375	0.51%	0.998	113.745	58.71	51.62
160	159	0.072	6.707	2.500	16.767	0.459	0.000	0.007	0.466	38.912	55.680	91.00	375	2.58%	2.234	254.745	199.06	78.14

		Design Flows										Pipe Data					Spare Capacity	
From MH	To MH	Total DWF (L/s)	Accum DWF (L/s)	Harmon's Peaking Factor	Peak DWF (L/s)	Residential I/I (L/s)	Other I/I (L/s)	Base I/I* (L/s)	Total I/I (L/s)	Accum I/I (L/s)	Accum WWF (L/s)	Length	Diameter	Slope	Velocity	Capacity	(L/s)	(%)
1G	2G	0.044	0.044	2.500	0.110	0.092	0.000	0.004	0.097	0.097	0.207	34.00	200	2.50%	1.668	54.101	53.89	99.62
2G	3G	0.136	0.180	2.500	0.451	0.286	0.000	0.013	0.299	0.396	0.847	101.26	200	0.40%	0.667	21.639	20.79	96.09
3G	4G	0.132	0.313	2.500	0.782	0.277	0.000	0.013	0.290	0.686	1.468	113.85	200	0.40%	0.668	21.655	20.19	93.22
4G	5G	0.111	0.424	2.500	1.059	0.232	0.000	0.011	0.243	0.929	1.988	72.50	200	0.40%	0.667	21.640	19.65	90.81
5G	6G	0.476	0.900	2.500	2.249	0.997	0.000	0.046	1.043	1.972	4.221	74.74	200	1.00%	1.055	34.207	29.99	87.66
159	6G	0.000	6.707	2.500	16.767	0.000	0.000	0.000	0.000	38.912	55.680	95.00	375	0.65%	1.123	128.064	72.38	56.52
6G	158	0.000	7.607	2.500	19.017	0.000	0.000	0.000	0.000	40.884	59.901	83.03	375	0.62%	1.095	124.847	64.95	52.02
158	08-4	0.000	7.607	2.500	19.017	0.000	0.000	0.000	0.000	40.884	59.901	68.86	375	0.41%	0.891	101.625	41.72	41.06
08-4	9	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	13.72	375	0.41%	0.888	101.291	101.29	100.00
08-4	08-3	0.000	7.607	2.500	19.017	0.000	0.000	0.000	0.000	40.884	59.901	18.18	375	0.30%	0.882	100.606	40.71	40.46
18	17	1.331	1.331	2.500	3.328	4.777	1.200	0.099	6.076	6.076	9.404	69.00	200	0.35%	0.539	17.489	8.08	46.23
17	16	0.187	1.518	2.500	3.796	1.190	0.000	0.018	1.208	7.284	11.080	117.00	250	0.28%	0.564	28.555	17.47	61.20
20	16	0.504	0.504	2.500	1.260	3.205	0.000	0.049	3.254	3.254	4.513	67.00	200	0.36%	0.547	17.748	13.23	74.57
16	15	0.124	2.147	2.500	5.367	0.791	0.000	0.012	0.803	11.340	16.707	116.00	250	0.29%	0.574	29.109	12.40	42.60
15	14	0.104	2.251	2.500	5.628	0.663	0.000	0.010	0.673	12.014	17.641	118.00	250	0.31%	0.594	30.108	12.47	41.41
23	14	0.958	0.958	2.500	2.394	5.313	0.000	0.081	5.394	5.394	7.788	70.00	200	0.44%	0.609	19.734	11.95	60.54
14	13	0.107	3.316	2.500	8.289	0.680	0.000	0.010	0.690	18.098	26.387	101.00	250	0.30%	0.578	29.303	2.92	9.95
22	13	0.782	0.782	2.500	1.955	2.933	0.000	0.045	2.977	2.977	4.932	67.00	200	0.45%	0.612	19.843	14.91	75.14
13	12	0.174	4.271	2.500	10.679	1.105	0.000	0.017	1.122	22.197	32.876	113.00	250	0.49%	0.740	37.511	4.64	12.36
12	11	0.203	4.475	2.500	11.187	1.292	0.000	0.020	1.312	23.509	34.695	94.00	250	0.78%	0.935	47.382	12.69	26.78
11	100	0.000	4.475	2.500	11.187	0.000	0.000	0.000	0.000	23.509	34.695	28.00	250	0.43%	0.695	35.199	0.50	1.43
101	100	0.686	0.686	2.500	1.714	4.361	0.000	0.067	4.427	4.427	6.142	63.00	200	0.56%	0.682	22.103	15.96	72.21
100	10	0.000	5.160	2.500	12.901	0.000	0.000	0.000	0.000	27.936	40.837	60.00	250	0.52%	0.763	38.647	0.00	0.00
32	10	0.602	0.602	2.500	1.504	2.805	0.000	0.043	2.848	2.848	4.352	85.00	200	0.36%	0.552	17.909	13.56	75.70
10	08-1	0.000	5.762	2.500	14.405	0.000	0.000	0.000	0.000	30.784	45.189	15.83	300	1.88%	1.644	119.967	74.78	62.33
08-1	08-2	0.000	5.762	2.500	14.405	0.000	0.000	0.000	0.000	30.784	45.189	140.33	300	1.31%	1.580	115.266	70.08	60.80
115	114	0.286	0.286	2.500	0.716	0.000	1.500	0.033	1.533	1.533	2.249	140.00	200	0.39%	0.573	18.587	16.34	87.90
127A	127	0.355	0.355	2.500	0.888	1.020	1.020	0.038	2.078	2.078	2.966	95.00	200	0.39%	0.571	18.507	15.54	83.97
125	127	2.251	2.251	2.500	5.628	10.829	1.092	0.189	12.110	12.110	17.738	105.00	200	0.45%	0.612	19.840	2.10	10.59
127	46A	0.307	2.914	2.500	7.285	1.955	0.000	0.030	1.985	16.173	23.458	86.00	250	0.26%	0.537	27.194	3.74	13.74
46A	146	0.334	3.248	2.500	8.120	2.125	0.000	0.033	2.158	18.330	26.451	20.00	250	0.45%	0.712	36.068	9.62	26.66
146	145	0.000	3.248	2.500	8.120	0.000	0.000	0.000	0.000	18.330	26.451	104.00	250	0.32%	0.598	30.287	3.84	12.67
145	114	0.000	3.248	2.500	8.120	0.000	0.000	0.000	0.000	18.330	26.451	116.60	250	0.29%	0.573	29.034	2.58	8.90
114	113	0.000	3.535	2.500	8.836	0.000	0.000	0.000	0.000	19.863	28.699	143.00	250	0.30%	0.582	29.484	0.78	2.66
155	134	1.844	1.844	2.500	4.611	4.446	3.150	0.136	7.732	7.732	12.342	110.00	200	0.31%	0.508	16.487	4.14	25.14
134	133	0.367	2.211	2.500	5.527	0.255	0.870	0.023	1.148	8.879	14.407	105.00	200	0.40%	0.578	18.755	4.35	23.18
133	132	0.241	2.452	2.500	6.129	0.000	1.260	0.027	1.287	10.167	16.296	104.70	200	0.44%	0.606	19.656	3.36	17.10
132	131	0.241	2.692	2.500	6.730	0.000	1.260	0.027	1.287	11.454	18.184	105.30	200	0.38%	0.564	18.277	0.09	0.51
131	113	0.147	2.839	2.500	7.098	0.000	0.924	0.020	0.944	12.398	19.496	114.80	200	0.40%	0.579	18.771	0.00	0.00
113	112	0.000	6.374	2.500	15.934	0.000	0.000	0.000	0.000	32.261	48.195	78.60	250	0.27%	0.548	27.792	0.00	0.00
112	75	0.000	6.374	2.500	15.934	0.000	0.000	0.000	0.000	32.261	48.195	75.00	250	0.28%	0.561	28.451	0.00	0.00
75	111	0.312	6.686	2.500	16.715	0.459	0.900	0.027	1.386	33.647	50.361	75.00	250	0.28%	0.561	28.451	0.00	0.00
111	76	0.000	6.686	2.500	16.715	0.000	0.000	0.000	0.000	33.647	50.361	31.00	250	0.19%	0.467	23.654	0.00	0.00
76	110	0.187	6.873	2.500	17.183	1.190	0.000	0.018	1.208	34.855	52.037	75.00	250	0.40%	0.671	34.005	0.00	0.00
110	08-2	0.000	6.873	2.500	17.183	0.000	0.000	0.000	0.000	34.855	52.037	10.98	300	1.00%	1.384	100.974	48.94	48.46
08-2	08-3	0.000	12.635	2.500	31.588	0.000	0.000	0.000	0.000	65.638	97.226	66.04	375	2.36%	2.464	280.944	183.72	65.39
08-3	08-5	0.000	20.242	2.500	50.604	0.000	0.000	0.000	0.000	106.523	157.127	143.98	375	1.20%	1.757	200.325	43.20	21.56
110	9	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	82.00	250	3.30%	1.929	97.745	97.74	100.00
9	152	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	130.00	300	1.95%	1.675	122.211	122.21	100.00

		Design Flows										Pipe Data					Spare Capacity	
From MH	To MH	Total DWF (L/s)	Accum DWF (L/s)	Harmon's Peaking Factor	Peak DWF (L/s)	Residential I/I (L/s)	Other I/I (L/s)	Base I/I* (L/s)	Total I/I (L/s)	Accum I/I (L/s)	Accum WWF (L/s)	Length	Diameter	Slope	Velocity	Capacity	(L/s)	(%)
153	08-5	1.404	1.404	2.500	3.509	8.925	0.000	0.137	9.062	9.062	12.571	39.46	200	0.93%	0.882	28.598	16.03	56.04
08-5	08-6	0.000	21.645	2.500	54.113	0.000	0.000	0.000	0.000	115.584	169.698	62.34	375	1.35%	1.866	212.701	43.00	20.22
08-6	08-7	0.000	21.645	2.500	54.113	0.000	0.000	0.000	0.000	115.584	169.698	145.00	525	0.24%	0.993	221.996	52.30	23.56
08-7	08-8	0.000	21.645	2.500	54.113	0.000	0.000	0.000	0.000	115.584	169.698	84.91	525	0.30%	1.098	245.387	75.69	30.84
08-8	LS	0.000	21.645	2.500	54.113	0.000	0.000	0.000	0.000	115.584	169.698	7.07	525	0.30%	1.094	244.520	74.82	30.60
08-5	152	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.61	200	0.93%	1.016	32.937	32.94	100.00
152	8	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	63.00	300	1.94%	1.667	121.668	121.67	100.00
8	LS	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	223.00	375	0.37%	0.848	96.712	96.71	100.00
2A	1A						Estimated maximum existing discharge at 76 L/s				76.000	150.00	375	unknown				
1A	7										76.000	136.00	375	unknown				
7	6										76.000	175.00	375	0.43%	0.916	104.467	28.47	27.25
6	5										76.000	180.00	375	0.39%	0.867	98.856	22.86	23.12
5	4										76.000	180.00	375	0.21%	0.639	72.836	0.00	0.00
4	3										76.000	100.00	400	0.21%	0.665	86.287	10.29	11.92
3	5A										76.000	118.00	300	unknown				
82-26	82-24	0.697	0.697	2.500	1.743	0.000	4.380	0.095	4.475	4.475	6.218	103.00	250	0.64%	0.849	43.040	36.82	85.55
82-25	82-24	0.115	0.115	2.500	0.286	0.000	0.720	0.016	0.736	0.736	1.022	85.00	375	0.41%	0.892	101.722	100.70	99.00
82-24	82-18	0.044	0.856	2.500	2.139	0.000	0.276	0.006	0.282	5.492	7.631	120.00	375	0.41%	0.889	101.298	93.67	92.47
82-19	82-18	0.659	0.659	2.500	1.647	0.000	4.140	0.090	4.230	4.230	5.877	70.00	250	0.94%	1.030	52.208	46.33	88.74
82-18	82-10	0.000	1.514	2.500	3.786	0.000	0.000	0.000	0.000	9.722	13.508	16.00	375	25.75%	7.056	804.416	790.91	98.32
82-11	82-10	1.308	1.308	2.500	3.270	0.000	8.220	0.178	8.398	8.398	11.668	52.00	250	0.44%	0.706	35.758	24.09	67.37
82-10	82-9	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	70.00	375	0.43%	0.910	103.778	78.60	75.74
82-9	82-8	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	60.00	375	0.37%	0.842	95.990	70.81	73.77
82-8	81-11	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	45.00	375	0.16%	0.548	62.522	37.35	59.73
81-11	81-10	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	125.00	375	0.22%	0.646	73.675	48.50	65.83
81-10	81-9	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	120.00	375	0.18%	0.595	67.875	42.70	62.91
81-9	81-8	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	120.00	375	0.17%	0.568	64.717	39.54	61.10
81-8	81-7	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	129.00	450	0.20%	0.705	115.727	90.55	78.24
81-7	81-6	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	148.00	600	0.18%	0.797	232.685	207.51	89.18
81-6	81-5	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	150.00	600	0.18%	0.807	235.531	210.35	89.31
81-5	81-4	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	150.00	600	0.20%	0.851	248.271	223.09	89.86
81-4	81-3	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	95.00	600	0.19%	0.828	241.650	216.47	89.58
81-3	81-2	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	111.00	600	0.14%	0.722	210.771	185.59	88.05
81-2	81-1	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	82.00	600	0.18%	0.814	237.438	212.26	89.40
81-1	3	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	15.00	600	0.73%	1.629	475.404	450.23	94.70
3	2	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	32.00	375	0.03%	0.246	28.023	2.85	10.16
2	1	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	43.00	375	1.12%	1.469	167.486	142.31	84.97
1	anaerobic	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177		375					
anaerobic	5A	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	101.177	90.00	250	unknown				
5A	Storage	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	101.177	230.00	300	unknown				

The required capacity of the outfall sewer (from the aerated sewage lagoons to the anaerobic cells) can be difficult to establish. The lagoon outlet configuration and operation is not known, nor is the outlet invert. Although the inflow rate could increase considerably if a new lift station is constructed, the discharge rate is likely buffered significantly due to the large area of the pond. As such, it is not likely an issue at this time, however should be investigated further at such time as the Lift Station is upgraded.

As further described in the following section; the maximum anticipated outflow from the lift station is estimated at 76 L/s with both pumps operating. If (at a worst case), this flow was transported through the outfall sewer, it would result in the outfall pipe sections from Manhole 5 through Manhole 2 requiring upsizing.

An analysis of the physical condition of the collection system is outside the scope of this report. This type of analysis would require a complete CCTV program, and a condition assessment to interpret and present the results. The results of the CCTV may indicate other problem areas which may need to be addressed. If the condition assessment were to indicate areas with potential reduced capacity, these areas could be repaired or replaced along with those which are shown to have structural deficiencies.

4.2.3 Lift Stations and Forcemain Assessment

There are various methods in which the required capacity of the existing lift station could be calculated:

1. A typical method would be to determine the existing contributing wet weather flows and add the peak dry weather flow (calculated using the population, sewage generation rate of 330 L/c/d and Harmon's peaking factor). This would result in a total flow to the lift station of 144.9 L/s.

2. A second method would be to utilize the existing contributing wet weather flows and add the peak dry weather flow based on the results of the flow monitoring data (calculated using a sewage generation rate of 330 L/c/d and a peaking factor of 2.5 – base I/I included in total I/I value). This would result in a total flow to the lift station of 136.3 L/s.

3. A third method would be to utilize the total wet weather flow calculated using the spreadsheet model. This would result in a total flow to the lift station of 169.7 L/s.

As previously discussed, the spreadsheet model (Method 3) is somewhat conservative in nature, which may be a benefit when installing sewer mains (ideally have very long service lives). Method 1 is often utilized, and was used in the 2005 Master Services Plan in the absence of flow monitoring data. The analysis of the existing sewage lift station has therefore been performed based on Method 2, and a likely wet weather contributing flow of 136.3 L/s for existing conditions.

The lift station pumps appear to be able to handle the peak dry weather flows (each pump setpoint of 44.2 L/s). However, the lift station may be significantly undersized under wet weather conditions (flow into lift station identified as 136.3 L/s in method 2). The operator of the lift station has observed that it has flooded in the past due to extreme flows.

A system curve was developed for the 2005 Master Services Plan in order to establish the actual capacity of the pumps and forcemain. Figure 4.3 shows the system curve. Several assumptions were made to create the system due to lack of information: the pump shut off elevation is 0.5 m above the lift station floor at 615.5m; the high water level in the lagoon is 625 m, therefore the static head is 9.5 m. The system curve was developed using the static head and the pump curve information provided by the Town of Redwater. The system curve identifies the flows and related total pumping head associated with these flows. Figure 4.3 shows that if the assumptions in the static head are correct then one single pump will actually pump 52 L/s and two pumps will pump 76 L/s. These are both based on a pipe roughness "C" factor of 130 for HDPE pipe, which may be conservative. Public Works staff have observed that the pump shutoff may actually be lower than assumed. This does not significantly effect the enclosed system curve.

At the existing pump capacity of 44.2 L/s, the velocity through the forcemain would be 1.16 m/s. With two pumps operating the velocity increases to 2.0 m/s which surpasses the recommended maximum velocity of 1.5 m/s.

The existing wet well capacity is approximately 3.2 m^3, based on information provided by Public Works staff.

4.2.4 Lagoon System Assessment

Table 4.3 summarizes the calculated retention capacities of the lagoon systems assuming:

- per capita flows and population levels as presented in Table 2.9, Section 2.3.1.6.
- no aerated lagoon effluent utilized for golf course irrigation (this is a conservative assumption which may be realized during an extremely wet year).
- no leakage from any of the lagoon cells.

It should be noted that the contributing flows identified in Table 2.10 are significantly higher than identified in the 2005 Master Services Plan. This is directly related to the results and recommendations of the 2008 Flow Monitoring Program, as well as recorded raw wastewater flow data at the aerated lagoon. Again, there is no information on the contribution from the Industrial site, and best estimates have been made (based on areas and design equivalent population densities).

Figure 4.3
Town of Redwater - Master Services Plan
System Curve

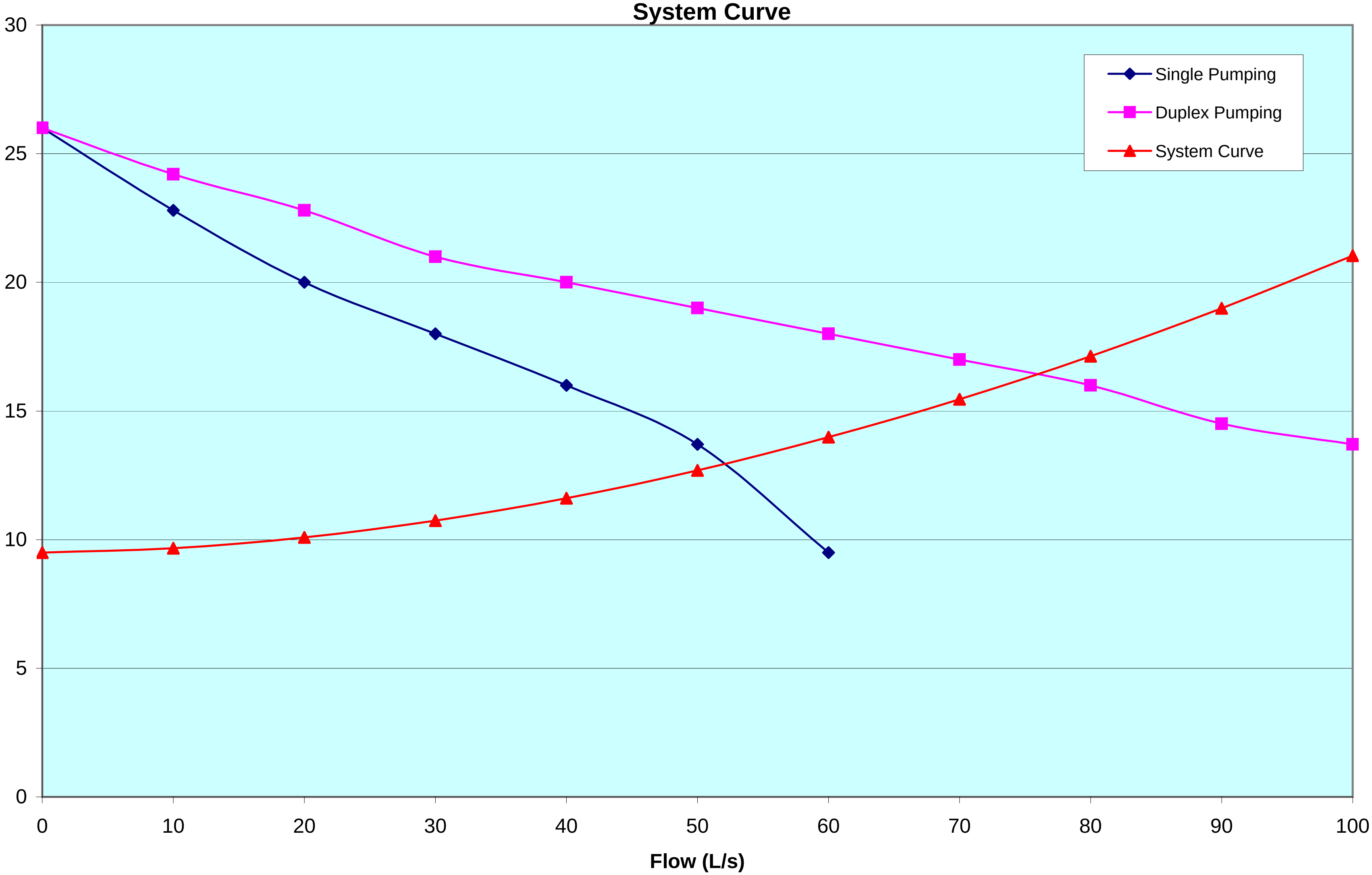


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Table 4.3
Lagoon Capacity Analysis

Lagoon Cells	Volume m^3	Retention (days)		
		Existing	10 year	20 year
Aerated Cells				
Cell 1 (Complete Mix)	3,000	1.5	1.2	1.1
Cell 2 (Partial Mix)	22,500	11.2	9.3	8.0
Cell 3 (Partial Mix)	22,500	11.2	9.3	8.0
Total	48,000	23.9	19.9	17.1
Anaerobic Cells (Industrial Flow)				
Cell 1	1,360			
Cell 2	1,360			
Cell 3	1,360			
Cell 4	1,360			
Total	5,440	36.5	31.5	27.7
Storage Cells (Residential & Industrial Flow)*				
Cell 1	75,800			
Cell 2	42,250			
Cell 3	54,340			
Total	172,390	150	130	114

* Indicated retention times assume no golf course irrigation flow.
Actual retention times would increase due to utilization of aerated lagoon effluent for irrigation during summer months.

Review of this information relative to AENV's standards and guidelines leads to the following conclusions:

- The aerated lagoons have nearly sufficient aeration capacity for the 20 year period (have capacity for up to 3100 people), as the required air supply is 31.4 m^3 /min. and the available is 31.2 m^3 /min.
- The number of aerated cells is adequate. Three (3) cells are provided (standards require one complete mix cell followed by two partial mix cells).
- The energy input to the complete mix cell appears adequate. AENV's guideline for complete mix cells calls for an energy input of 6 to 10 W/m^3. The available energy input is estimated to be at the upper limit of this range.

- The retention time through the complete mix cell is inadequate. AENV's standards indicate complete mix cells to have at least 2 days retention. The existing retention time appears to be approximately 1.5 days.

- The retention time through the partial mix cells is inadequate. AENV's standards indicate the partial mix cells should have at least 28 days retention. The existing retention time appears to be approximately 22 days.

- The anaerobic lagoons provide more than sufficient capacity for initial treatment of the industrial flows. AENV requires four anaerobic cells with 2 days retention time in each cell (8 days total). The available retention in the anaerobic cells is well above this (about 36 days currently and 27 days for 20-year projection).

- Currently the storage lagoons may not provide adequate storage (estimated at 150 days) to limit the frequency of discharge to the Redwater River to twice per year, in accordance with the current AENV approval. AENV typically accepts twice per year discharge where proper aerated lagoon treatment precedes storage.

- In the future, AENV may require that the industrial component of the flow receive at least one year retention as it is typical with conventional treatment lagoons. In addition, facultative lagoon treatment may be required for this component of the flow.

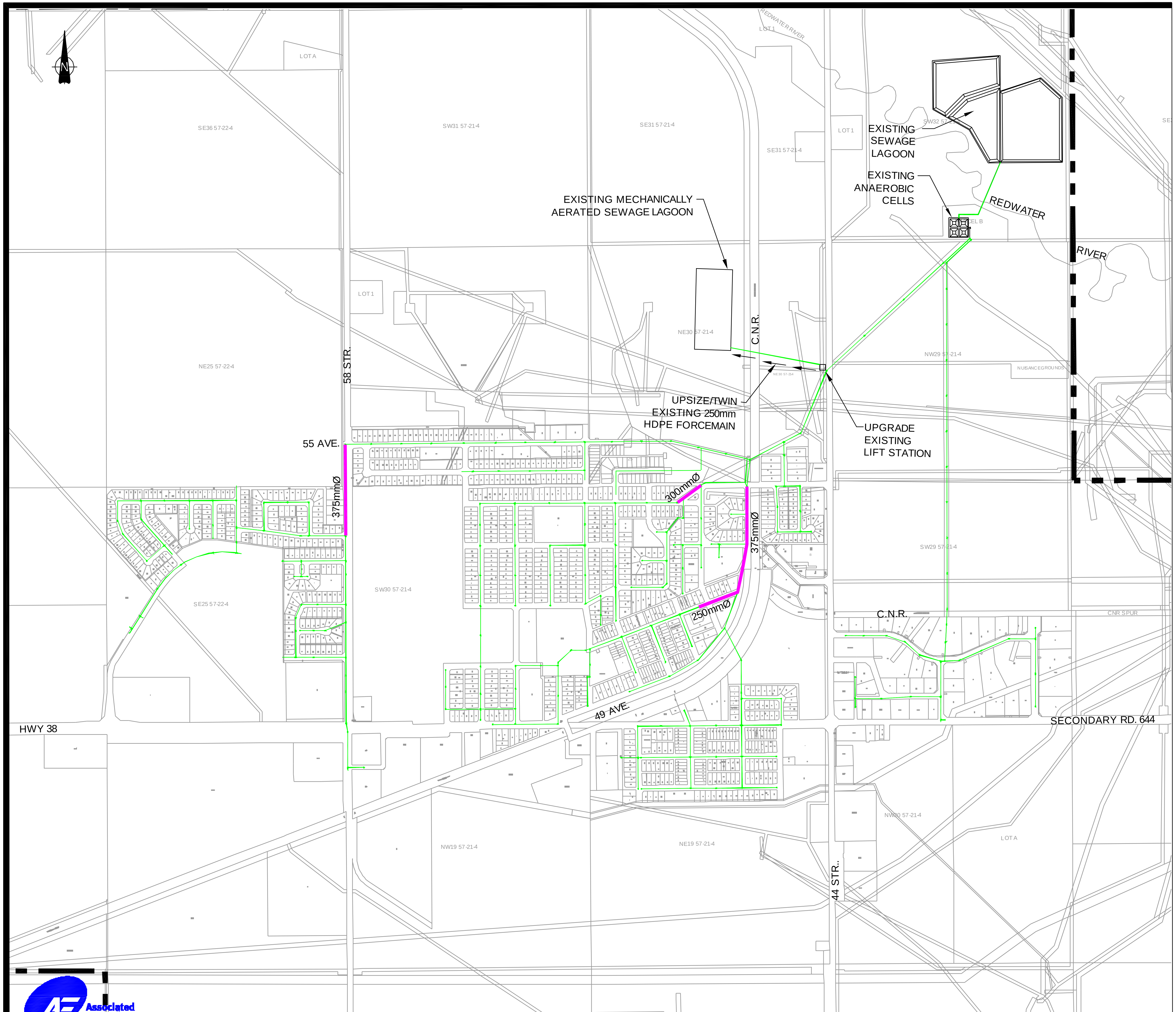
- According to the operator, the discharge frequency for the storage lagoons is typically twice per year, as per the existing approval. Since the theoretical discharge frequency is greater than twice per year, this discrepancy could be due to:
  - Design flows which are larger than actual.
  - Significant evaporation from the lagoon.

- The 2005 Master Plan indicated that the lagoons were generally discharged once every two years. Information provided by the operator has indicated that this is not accurate. The previous Master Plan therefore concluded that there was a possibility that the lagoon was leaking. This no longer appears likely due to information provided by operator. This includes twice yearly lagoon discharge, a previous occasion of an additional emergency discharge, as well as the lack of physical evidence of leaking.

- The use of aerated lagoon effluent for golf course irrigation is acceptable. The Town takes responsibility for effluent disinfection to ensure the effluent meets acceptable bacteria levels (total coliforms <1000/100 mL and fecal coliforms <200/100 mL).

4.3 UPGRADES TO EXISTING SYSTEM

The recommended upgrades to the collection system are identified in Figure 4.4. Those areas recommended for upgrading are limited to the pipes from Figure 4.2 with zero remaining capacity. The



Town of Redwater

MASTER SERVICES PLAN UPDATE

EXISTING SANITARY SEWER SYSTEM WITH UPGRADES

LEGEND:

- PROPOSED UPGRADES
- EXISTING SYSTEM
- TOWN BOUNDARY

NOTE: PIPE UPGRADES INDICATED ARE SIZED FOR ULTIMATE SCENARIO

SCALE: 1 : 12,500

AUGUST, 2010

FIGURE 4.4

Associated Engineering

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proposed pipes shown on the figure are in locations required to satisfy the existing system but sized to satisfy the ultimate system.

As discussed in the previous section, there is a potential that the outfall pipe may be undersized if both of the lift station pumps are operating (refer to Table 4.2). Further analysis is recommended in order to determine the appropriate outfall size considering a lift station and pumping upgrade as well as future growth considerations.

According to the hydraulic analysis, the sewage lift station will likely be undersized during periods of Peak Wet Weather Flow. The pumps will require upsizing upon confirming the assumed flows. If the design flows are applied and the pumps suitable sized for a minimum of 159.7 L/s (estimated 25 year system flows), then the velocity through the forcemain would be approximately 4.2 m/s based on a 220 mm internal diameter. This velocity greatly exceeds the recommended velocity; therefore the forcemain would require twinning or upsizing.

The wet well capacity for projected 25 year flows has been estimated to be 24.0 m^3 and is based on storing one half of the peak wet weather flow for 5 minutes. The estimated 10 year pumping rate is 145.7 L/s for which the lift station pumps should be designed to accommodate. These estimated future pumping and storage rates will require further analysis during detailed design of the sewage lift station, and they do not include an allowance for the addition of industrial flows. At this discharge rate, the entire outfall downstream of the aerated lagoons could require upsizing. Further detailed analysis is recommended.

A spreadsheet model of the existing system with upgrades is enclosed in Appendix B.

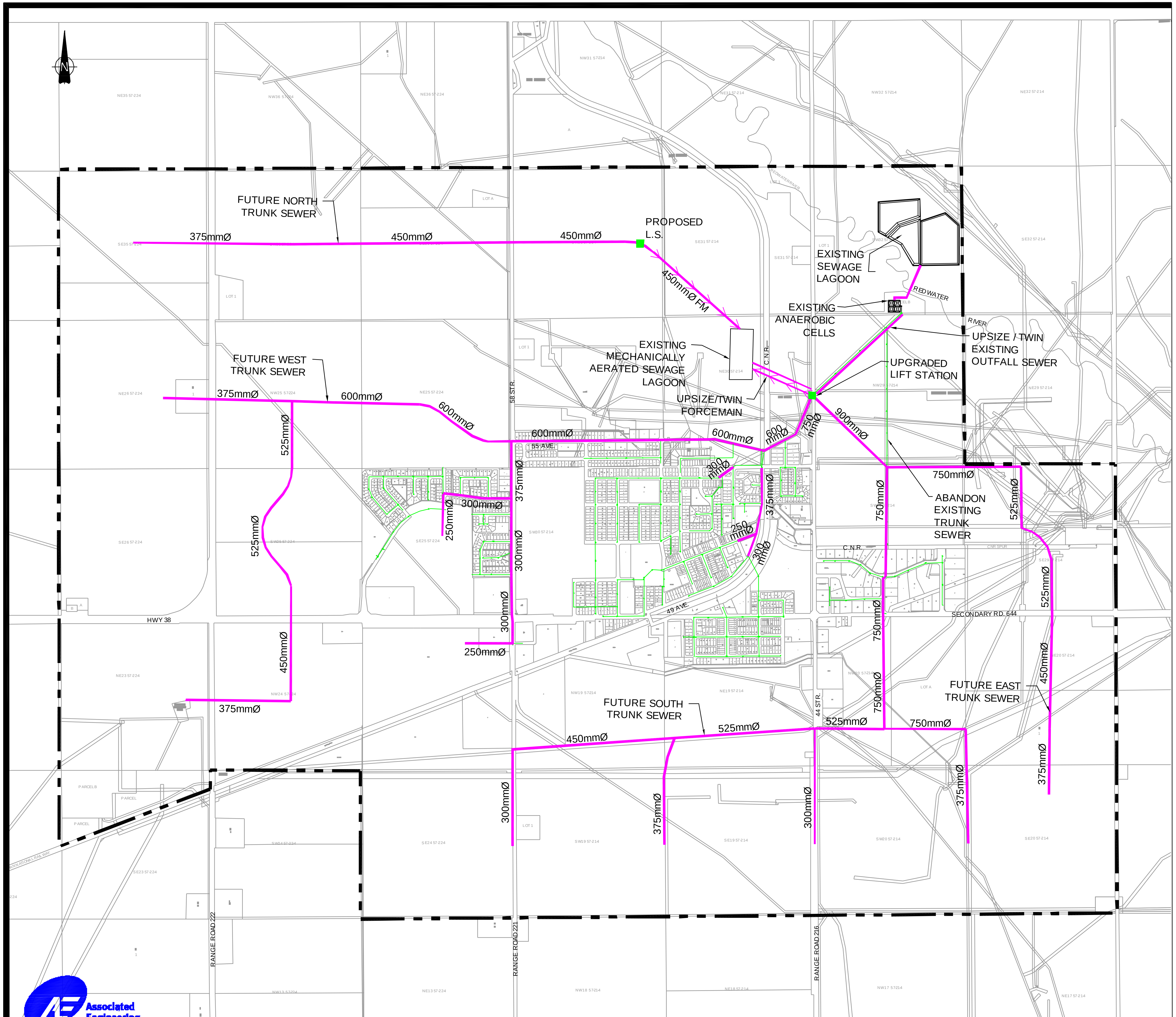
A letter sent to the Town of Redwater from Associated Engineering dated May 5, 2008, provides some conceptual wastewater servicing options to the Town for future consideration.

For capital planning purposes, we recommend the following upgrades for consideration:

- Divert all of the industrial flow to the aerated lagoons. This will eliminate the possible need for facultative lagoon treatment and one-year storage for the industrial flow prior to discharge. Before undertaking this modification, we recommend sampling of the industrial wastewater to confirm acceptable quality for aerated lagoon treatment and subsequent irrigation. In addition, the need for this modification should be reviewed with AENV in view of the additional costs and likely marginal benefits in terms of quality of water discharged from the storage pond.
- Expand the existing aerated lagoons to accommodate the anticipated 20 year sewage volumes as well as the industrial flows.

4.4 ULTIMATE SANITARY SEWERAGE SYSTEM

The concept for the ultimate sanitary sewerage system is shown in Figure 4.5. It identifies major trunk sewers to be constructed in order to expand the existing service area. The tributary area of each of these



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Town of
Redwater

MASTER SERVICES PLAN UPDATE

ULTIMATE SANITARY SEWER SYSTEM

LEGEND:

PROPOSED UPGRADES/NEW PIPES

EXISTING SYSTEM

TOWN BOUNDARY

SCALE: 1 : 20,500

AUGUST, 2010

FIGURE 4.5

major sanitary sewers is also identified in the figure. The spreadsheet model of the ultimate system and manhole numbering reference drawing are enclosed in Appendix B.

As shown in Figure 4.5, the future development would be serviced as follows;

- Future West Trunk Sewer
  - The west area of the Town will be serviced through a trunk system that connects to the existing system at Manhole 171. The existing system will accommodate approximately 18 ha (residential) before pipe upgrades are required.

- Future South Trunk Sewer
  - The southwest area and the area directly south of the industrial area of the Town will be serviced through a trunk system that connects to the existing sewer system at Manhole 82-25. Approximately 68 ha of industrial land use or 58 ha residential land use can be connected to the existing system before upgrades are required.

- Future East Trunk Sewer
  - The southeast area of Town will be serviced through a trunk system that connects to the industrial area and ultimately discharges to the aerated lagoon after being pumped through the upgraded lift station. The existing lift station will have to be upgraded or replaced in order to accommodate the additional flows.

- Future North Trunk Sewer
  - The area northwest of the Town will be serviced through a separate trunk system directed to the aerated lagoon through a new lift station and forcemain.

- The area immediately west of Manhole 89.3 (west of 58th Street) and north of the CN Railway will connect to the existing system. Upgrades to the existing system will be required when this area is developed.

- There is an area immediately south of MH 89.3 and the CN Railway (west of 58th Street) that has recently been developed. The Town is analyzing the possibility that the area connect temporarily to the existing sanitary system through MH 89.3. Ultimately, the development concept identifies this area connecting to the future south trunk sewer system which will flow through the existing industrial area.

The existing lift station and forcemain is undersized and will require significant upgrading in the future scenario.

This report assumes that all flows will ultimately be directed towards the aerated lagoon. In the future, the existing lagoons will require upgrading in order to accommodate for an increase in population. An increase in the area directed to the aerated lagoon would likely also significantly increase the future lagoon discharge rate. This would have to be considered during the analysis of the outfall sewer, when information on the mechanically aerated lagoon outlet is provided.

The ultimate scenario was also analyzed based on the estimated 1 in 100 year storm return period (versus 1 in 25 years). Utilizing this storm return period did not significantly change the model results. Overall, the system can hand the increased wet weather flows quite well, with an additional two pipes in the existing system being marginally undersized in this scenario.

The presence of active pipelines shown on the map indicates that there may be design constraints in some cases for trunk sewers. The final trunk sewer alignments will be subject to review when the locations and elevations of the pipeline crossings are known.

5 Storm Drainage System

5.1 GENERAL

Since the completion of the Town of Redwater's Master Services Plan in 2005, the Town has annexed a large amount of land to the west, north and east of its previous town boundary. The corporate boundary has changed in size from approximately 700 ha to approximately 2000 ha (Figure 2.3). The addition of this area requires an update to the storm drainage concept provided in the earlier report so that orderly and coordinated development can occur. The Town has also recently completed a Municipal Development Plan (MDP) (December, 2009) that will help guide the community as it develops and matures in the years to come. The MDP indicates that the Town's intention is to support urban development within the town and to discourage Country Residential development in the area surrounding the town.

The construction of houses, commercial buildings, paved roads and parking lots increases the imperviousness of a watershed and reduces the infiltration of rainwater. This means that a much larger portion of the rainfall will run off. The increased volume and rate of runoff produces larger peak flood discharges in developed watersheds than would have occurred before development.

The function of the storm drainage system is to collect the surface-water runoff generated in an urban area and convey it safely to the receiving water course in a manner which minimizes the disruption to land use and impact to the environment. In conjunction with the conveyance system, stormwater management facilities (storage ponds) are generally used in most modern stormwater drainage systems to control the rate of flow and to minimize the potential downstream impacts.

Water quality issues, such as sedimentation and pollution associated with stormwater runoff from urban areas, also needs to be dealt with before the flows are discharged into natural water courses. Vegetated swales, rain gardens and storm water management ponds all help to remove sediments and other pollutants from the runoff, reducing the loading to receiving water bodies.

5.2 TOPOGRAPHY

The Town of Redwater is located above the valley of the Redwater River. The terrain generally slopes gently in the northeast direction toward the Redwater River except for portions along the south town boundary which slope to the southeast. The elevation within the existing town ranges from approximately 645.0 m on the west to 615.0 m on the east side of the town, for a general slope of approximately 0.5%. There are a number of interconnected sloughs which carry runoff from the northern part of the town to the Redwater River. The Redwater River flows in a southeasterly direction, discharging to the North Saskatchewan River.

5.3 EXISTING SYSTEM

Figure 5.1 shows the existing drainage system for the Town (full size drawing included as Storm 1 in Appendix C). The developed areas within the existing town boundary rely primarily on surface drainage facilities (roadways and paved surface, drainage swales, and culverts), which discharge into nearby ditches that eventually flow to the Redwater River.

Sections of storm sewer exist along 46 Avenue, from 49 Street to 46 Street, and in the lane west of 47 Street, from 52 Avenue to 54 Avenue. A new storm sewer has recently been constructed in the lane north of 50 Avenue, which connects to the existing sewer in the lane west of 47 Street. There are catch basin manholes along the commercial strip on the northwest side of 49 Avenue that direct drainage to the ditch that runs along the southwest side of 49 Avenue.

Due to the limited storm sewer system in the Town of Redwater, runoff is mostly being handled on the streets and in roadside ditches. This results in long runs of on-street drainage, to a length of 800 m or more, to the closest ditch. A brief analysis of the expected depths of flow and velocities in the streets, associated with a 1:5 year, 1:25 year and 1:100 year storm events, was conducted. As outlined in Section 2.4.5, Alberta Environment has guidelines regarding acceptable depths for varying velocities to mitigate the risk to the public. The rational method was used to determine the allowable drainage area and corresponding length of street section, that would result in flows acceptable under this guideline. The following table shows the results of this analysis for an average 11 m wide street section, having a gutter depth of approximately 0.15 m, for a longitudinal slope of 0.5% and 1.0%.

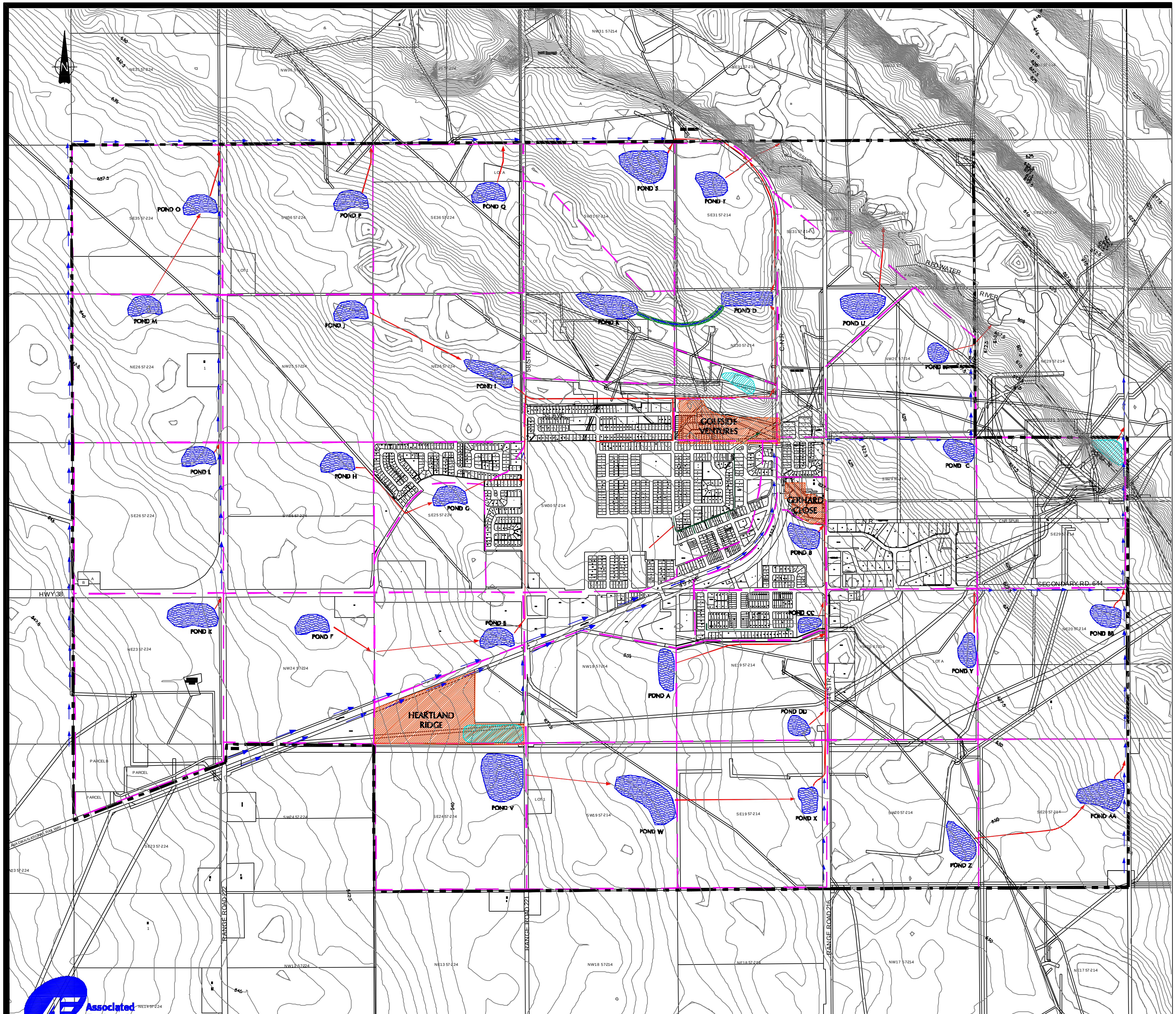
Table 5.1 Acceptable Drainage Area and Street Length for Various Return Periods based on AENV Guidelines of Permissible Depths for Submerged Objects

Longitudinal Slope of Street Section	Return Period					
	1:5 Yr		1:25 Yr		1:100 Yr	
	Drainage Area (ha)	Street Length (m)	Drainage Area (ha)	Street Length (m)	Drainage Area (ha)	Street Length (m)
0.50%	30	1095	20	894	10	632
1.00%	20	894	10	632	5	447

The critical conditions indicate that long runs of street drainage should be limited to approximately 400 m for safety issues. This will result in an approximate depth of flow of 0.1 m with a velocity of 2.0 to 2.5 m/s.

Three new developments are currently under construction and will include storm servicing. Stormwater management facilities (storm ponds) are being implemented in conjunction with these developments.

- Heartland Ridge is located in the south half of NE 24-57-22-W4, just west of 58 Street.
- Golfside is located just north of 54 Avenue and east of 51 Street.



Town of Redwater

MASTER SERVICES PLAN UPDATE

PROPOSED STORM DRAINAGE SYSTEM

LEGEND:

- TOWN BOUNDARY
- SUB-CATCHMENT BOUNDARY
- EXISTING POND (OR UNDER DEVELOPMENT)
- PROPOSED POND
- DITCH
- PROPOSED STORM SEWER
- EXISTING STORM SEWER
- PROPOSED DRAINAGE PARKWAY
- PROPOSED/UNDER DEVELOPMENT

SCALE: 1 : 20,000

AUGUST, 2010

FIGURE 5.3

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- Gerhard Close subdivision is proposed for development and includes a short section of storm pipe and a dry pond. Gerhard Close will be located just east of the CNR, north of 48 Avenue.

Figure 5.1 shows the locations of these developments. Two additional Area Structure Plans for Westland Village and Sunrise are under review

In addition to the flows generated within the town limits, there are rural areas to the west of Redwater that drain overland into the Town's drainage system through the ditches along the railway and Highway 38. Runoff from these rural areas needs to be accommodated in the Town's drainage system or directed around the town.

The project area is broadly divided into five drainage basins as shown in Figure 5.2 and described below:

North Drainage Basin

The north drainage basin is comprised of the lands north of 54 Avenue and between Highway 28 and 46 Street. The majority of this area is used for agricultural purposes with the exception of the country residential homes in the southeast corner of NE 25-57-22 W4. Golfside Ventures, under development in the south portion of NE 30-57-21 W4, is bordered by 46 Street on the east and 54 Avenue on the south.

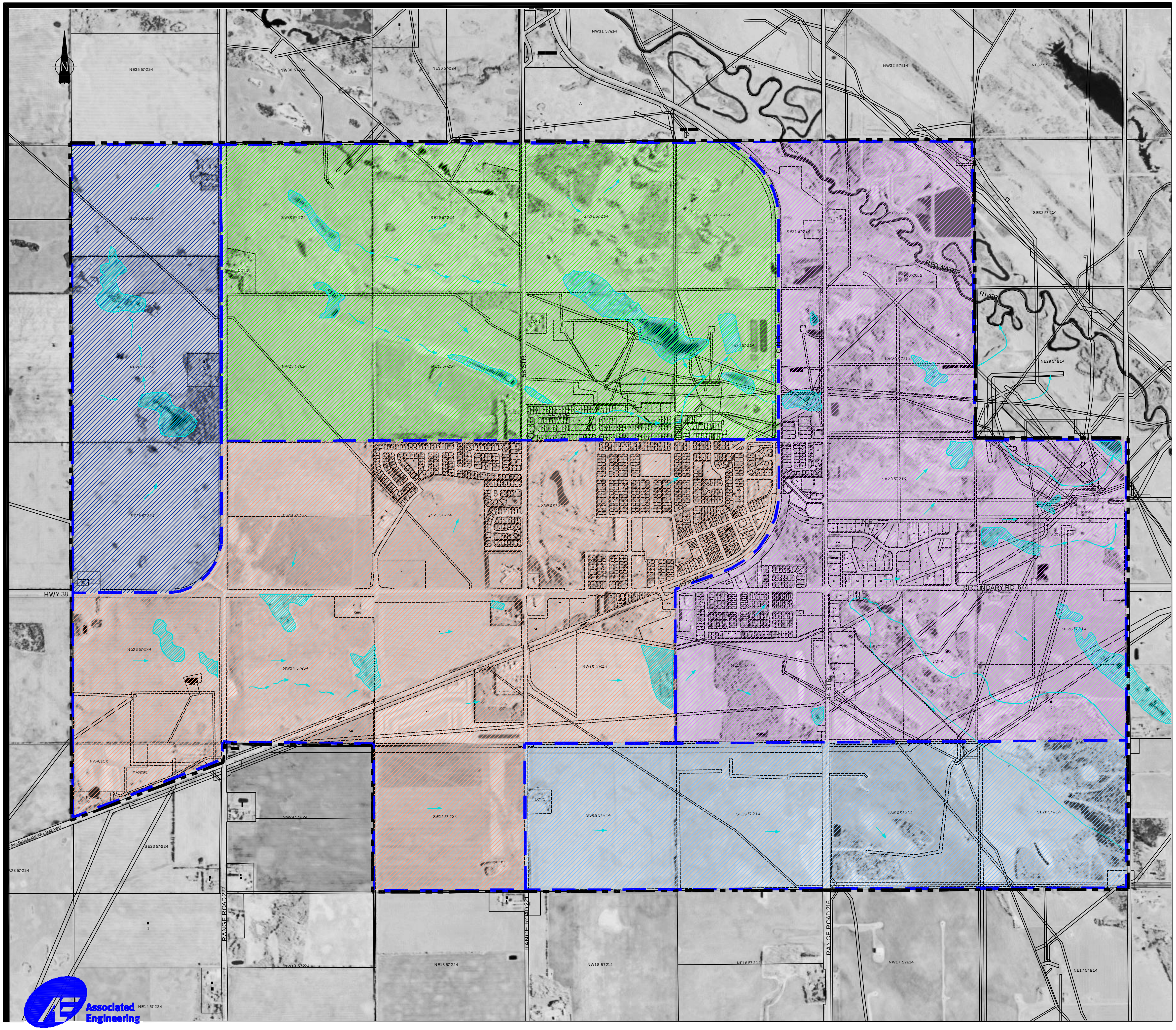
The south half of NW 30-57-21 W4 is planned as single family residential homes. To date, approximately half of this development is complete. The runoff from this development is conveyed by gutter flows, over a distance of 800 m, to catch basins on 51 Street, near 54 Avenue. Currently, it is understood that the CB's drain through the sewer system of Golfside development. This storm sewer will eventually discharge to a stormwater management pond that is proposed for Golfside development.

The ditches on both sides of the Canadian National Railway (CNR) collect runoff from adjacent commercial areas as well as external flows from beyond the existing town limits to the west. The north ditch joins the natural water course north of 54 Avenue.

The north drainage area has several depression zones or sloughs which trend northwest to southeast and drain to the east. These depression zones provide storage and conveyance that allow the external flows to flow through the Town to the Redwater River.

Northwest Drainage Area

Three quarter sections on the west side of Highway 28 drain northward through these lands and to ditches along Highway 28. Runoff from this area drains overland to the Redwater River.



Town of Redwater

MASTER SERVICES PLAN UPDATE

STORM DRAINAGE BASINS

LEGEND:

- TOWN BOUNDARY
- DRAINAGE BOUNDARY
- EXISTING WETLAND/DEPRESSION AREA
- DIRECTION OF NATURAL DRAINAGE
- NORTH
- WEST
- SOUTH
- EAST
- NORTHWEST

SCALE: 1 : 20,000

AUGUST, 2010

FIGURE 5.2

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Associated Engineering

West Drainage Area

The west drainage area is from one quarter section west of Highway 28 to 46 Street/49 Avenue and from 54 Avenue south to 800 m (1/2 mile) south of Highway 38. It also includes the SE ¼ 24-57-22-W4, west of Range Road 221.

Key features of this basin are as follows:

- Contains nine quarter sections, including most of the developed area of Redwater
- Drainage is predominantly overland along the streets towards the northeast
- A limited storm sewer system was constructed in 2003 along the lane west of 47 Street, from 52 Avenue to 54 Avenue, and discharges to a slough north of Golfside. This system was recently expanded south and west in the lane north of 50 Avenue to pick up drainage from the high school area.
- The Redwater Golf Course, which drains overland to the northeast to a shallow ditch in the alley north of 53 Avenue.
- The east half of the alley north of 53 Avenue was recently paved and CB's were installed to accommodate the runoff. It is understood that this drainage connects to the sewer system in Golfside.
- The Downtown area, which is bounded by the CNR on the east and 51 Street on the west, 54 Avenue on the north and 48 Street (Highway 38) on the south.
- Ditches between 49 Avenue/Railway carry runoff from the commercial area along 49 Avenue and the rural area to the west. The flows join the natural water course immediately north of 54 Avenue before it crosses the railway tracks.
- A ditch along 58 Street carries the runoff from the quarter section to the west which includes the hospital and approximately 29 ha of residential development.
- Heartland Ridge drains through a storm pond and discharges to the ditch along 58 Street.

The remaining land in the west drainage area, west of 58 Street, is currently used for agricultural purposes except for a section of industrial development and a new residential development in the south half of NE 24-57-22 W4. Drainage is collected by the railway ditches. There are depression zones in NW 24-57-22 W4 that discharge to ditches along Highway 38 or along the railway. Future plans for this basin include predominantly residential land use with a strip of highway commercial along Highway 38 from the town boundary east to 58 Street.

East Drainage Area

This area includes the industrial area east of 44 Street and two small residential areas east of 46 Street and south of 49 Avenue, and extends east to the Town boundary and the Redwater River.

The residential area south of 49 Avenue drains to the storm sewer along 46 Avenue that drains to ditches along 46 Street and Secondary Road 644.

The industrial strip is drained with roadside ditches to the northeast and eventually overland to the Redwater River. The path this runoff takes is not apparent on the airphoto.

The south railway ditch joins the south ditch of the CNR spur line and drains eastward along the northside of the industrial area.

The newly annexed areas to the southeast are agricultural lands with low, depressed areas running from the northwest to southeast through the middle of the area. The natural drainage path for this area is to the southeast. This area is poorly drained, as is the area in the north of this basin. Significant drainage improvements will be required when this area is developed. The general direction of drainage is toward the northeast, but it is impeded by glacial landforms that trend to the southeast.

Future land use plans for this area are predominantly industrial.

South Drainage Area

The town boundary has been extended one-half mile to the south to include four quarter sections that drain to the east or southeast through the low, poorly drained area and eventually discharging to the Redwater River. These lands are currently used for agricultural purposes and are planned to be developed into residential and industrial uses.

5.4 ASSESSMENT OF EXISTING SYSTEM

Associated Engineering completed a Master Services Plan in 2005, which included an assessment of the existing system. A site reconnaissance was conducted at that time (April 2004) during the snowmelt runoff period and noted a number of areas that exhibited ponding.

A brief reconnaissance was conducted on September 26, 2009 to confirm the initial drainage assessment and to note any development that has occurred since 2005. Observations from this reconnaissance are included in the assessment which follows. Associated Engineering also reviewed the record drawings of the newly constructed storm sewers and design drawings for proposed developments.

The following is a brief assessment of the existing system, which includes the observations in April 2004 and September 2009. A number of improvements have been made since 2004, as recommended in the 2005 report, and these will also be discussed below.

Street Drainage

- A new 1050 mm diameter sewer was constructed in the lane west of 47 Street as part of the recommendations from the 2005 Master Plan.
- The majority of the lane north of 53 Avenue has been paved in conjunction with the development of Golfside subdivision. Catch basin MH’s are located in the lane to accommodate drainage. Drainage from 51 Street crosses 54 Avenue and is collected by the new catch basin MH’s. It is

understood that these catch basins connect to the storm system constructed as part of the Golfside development. Currently, this system outlets to the natural drainage path, north along 46 Street, but will discharge to the proposed stormwater management pond for that area once constructed. The recommendation in 2005 to improve the ditch in this lane is no longer required.

- A grassed swale carries runoff from 47 Street in the lane north of 50 Avenue eastward to the railway ditch. The swale is shallow and poorly graded to the extent that much of the runoff spills onto the lawn of the senior citizens lodge. Photos 5.1 and 5.2 the flooding that occurred during the 2004 spring runoff and the existing swale.
- Catch basins have been installed along 51 Street north of 53 Avenue. These should reduce the ponding observed at 51 Street and 54 Avenue witnessed in 2004.
- 49 Avenue slopes toward the west end of the high school. A new storm sewer was constructed in 2010 in the lane north of 50 Avenue as part of the recommendation from the 2005 Master Plan.
- Drainage problems were observed at the Sobey's (formerly IGA) and in front of the Hospital during the April 2004 site visit. A catch basin manhole has been installed in the Sobey's parking lot and in 49 Avenue in front of Sobey's, which will direct the drainage to the ditch on the south side of 49 Avenue. The hospital site was re-graded in conjunction with the water line project that was completed in 2005. See photos 5.3 through 5.6.
- A general concern with the street drainage system is the long runs on the street. As shown in Figure 5.1, there are locations where the surface drainage runs on the street surface or in gutters for 400 m or more. Most urban design standards limit the street drainage to 120-200 m to control the depth and flow of water on the street surface. A brief analysis of the flows on a typical street section, outlined in Section 5.3, indicate street drainage should be limited to a maximum of 400 m to meet the guidelines for depth and velocity.

Ditches

- The railway ditches along 49 Avenue, from 51 Street to 46 Street, have well defined channels and are well-vegetated as shown in Photos 5.7 and 5.8. These ditches drain part of the central business area and an area west of 51 Street. Culverts along these ditches should be maintained regularly to ensure adequate capacity. Some of the culverts are damaged and should be replaced.
- The ditch along 49 Avenue was partly blocked with weed growth and debris during the 2009 site visit, and was also noted in the 2004 report. The ditches should be maintained regularly to ensure the culverts are clear of weeds and/or debris.
- The ditch system at the back alley of 53 Avenue, between 51 Street and 46 Street, has been replaced with a paved lane with catch basin manholes connected to the underground system of the Golfside development. The lane receives runoff from the area between 46 Street and 51 Street on the south, as well as the golf course. Further east, from 49th Street to the railway crossing, the ditch has a clearly defined channel. See photos 5.9 through 5.11.
- Ditches along 58th Street have clearly defined, grassed channels as shown in Photo 5.12.

Culverts

- Some of the culverts have traffic damage to the inlet that should be repaired. Photo 5.13 shows a damaged culvert in the 49 Avenue ditch, near 47 Street.
- The inlet and outlets of the culverts should be maintained regularly to keep them clear of debris and other blockages (Photo 5.14).

PHOTO 5.1 Flooding of the lawn of the Senior Citizens Lodge (2004)

PHOTO 5.2 Swale in lane north of 50 Avenue (2009)

PHOTO 5.3 Ponding on 49 Avenue in front of Sobey's (formerly IGA) (2004)

PHOTO 5.4 New catchbasin installed, which should alleviate ponding witnessed in 2004. (2009)

PHOTO 5.5 Ponding in front of Hospital (2004)

PHOTO 5.6 Hospital site re-graded in conjunction with the water line project. (2009)

PHOTO 5.7 Ditch along 49 Avenue (2004)

PHOTO 5.8 Ditch along 49 Avenue (2009)

PHOTO 5.9 Back alley of 53 Avenue (2004)

PHOTO 5.10 Back alley of 53 Avenue, now paved. (2009)

PHOTO 5.11 Swale on North side of 54 Avenue (2004)

PHOTO 5.12 Ditch along 58 Street (2009)

PHOTO 5.13 Damaged culvert in 49 Avenue ditch, near 47 Street (2009)

PHOTO 5.14 Culverts require maintenance to keep clear of weeds and debris (2009)

Stormwater Management Ponds

- The Town of Redwater has two stormwater management ponds under development. One pond is part of the Heartland Ridge development and one is part of the Golfside Ventures development. There is also a proposed dry pond as part of the Gerhard Close development.

- As part of the advisory services provided to the Town of Redwater, AE previously reviewed the Heartland Ridge, Golfside Ventures, and Gerhard Close development drawings.

- The design details for Heartland Ridge are as follows:
  - Service Area: 22.8 ha
  - Design Volume (live storage): 17,900 m^3
  - Design NWL: 633.7 m
  - Design HWL: 635.7 m
  - Design Peak Outflow: 57 L/s

- The design details for Golfside Ventures are as follows:
  - Ultimate Service Area: 8.44 ha
  - Interim Design Volume (live storage): 5,200 m^3
  - Ultimate Design Volume (live storage): 10,730 m^3
  - Design NWL: 621.50 m
  - Design HWL: 623.50 m
  - Design Peak Flow (based on contributing area * 2.5 L/s/ha) = 54.9 L/s

  The pond proposed for the Golfside Ventures Subdivision has an ultimate design volume of 10,730 m^3. Note that a larger pond, Pond D with a capacity of 125,000 m^3, was recommended in the 2005 Master Services Plan to accommodate runoff from the existing town area as well as some of the proposed development to the south and west. Pond D is now recommended to be located north of the aerated sewage lagoon, which is farther north than previously recommended.

- Gerhard Close Subdivision proposes a dry pond with a storage capacity of 2510 m^3 and a HWL level of 626.60 m. The discharge from the dry pond is proposed to be carried north in a 200 mm diameter pipe before discharging to an existing ditch along 44 Street, near 54 Avenue. This ditch flows north along 44 Street, where it follows the natural drainage routes and eventually flows east to the Redwater River

Wetlands

- There are a number of existing wetlands in and around the Town that help to provide storage and treatment of runoff from the Town and upstream. These should be preserved and, if possible, integrated into the stormwater drainage system in the future. Otherwise, Alberta Environment may require mitigation (replacement with larger wetlands elsewhere).

5.5 UPGRADES TO THE EXISTING SYSTEM

The existing drainage facilities that should be considered for upgrading are:

- **The Back Alley of 50th Avenue from 47 Street to 46 Street.**

  The 2005 report recommended that the swale at this location be re-graded to carry the flow from 47 Street eastward to the railway ditch. The poorly graded swale has caused flooding of the neighbouring lawns at the Senior Citizen Lodge. The swale at this location still appears to have little capacity to deal with large storm events or snowmelt runoff events. This swale should be re-graded to carry the flow from 47 Street eastward to the railway ditch along 49 Avenue/ 46 Street

- **Pond D**

  Pond D is recommended to accept drainage from the majority of the existing Town area, but is located farther north than originally planned in 2005. This is recommended as it appears that the pond being constructed northeast of Golfside Estates has been sized only for this development, and will not be large enough to handle the conceptual flows for the entire contributing area of Pond D. It is proposed to be located in NE 30-57-21-4, immediately north of the mechanically aerated lagoons. In addition, the various pipelines located in this area could pose a constructability constraint to enlarging the pond at the current site. Future ponds will also flow through Pond D for enhanced water treatment prior to discharging to Redwater River. Conceptual sizing and drainage paths are included in Section 5.6.

- **Regular Maintenance Of The Ditches And Culverts**

  Damaged CSP culverts were noticed during a site visit on September 26, 2009. All damaged CSP culverts should be repaired or replaced in order to restore the capacity of the existing conveyance systems.

  Site visits in 2004 and 2009 noted debris and weed growth in the ditch along the railway at the central business area. To ensure adequate capacity the culverts and ditches should be cleaned regularly.

- **Annual Cleaning Of Streets/Catchbasins**

  Catchbasin manholes in the central business area were partly blocked with sediments, leaves and trash at the time of the 2009 site visit. Catchbasin manholes should be kept clear of debris to allow drainage of the street.

- **Wetlands**

  Assessments of the existing wetlands by a Qualified Aquatic Environmental Specialist (QAES) be conducted to determine whether replacement or compensation might be required if they are disturbed.

- **School Site Drainage**

  A detailed survey and assessment of options to improve drainage at the west side of the high school site should be conducted.

5.6 FUTURE/ULTIMATE STORM DRAINAGE SYSTEM

The MDP outlines the preferred plan for the phasing of new residential, commercial and industrial areas and identifies the anticipated land uses (enclosed as Figure 2.2). Drainage systems will need to be extended upstream to serve future development of the Town. In addition, Alberta Environment requires that runoff from all new development areas be controlled so that there is no increase in peak flows downstream and that the runoff from urban areas be treated so as to remove 80% of the suspended sediments larger than 75 μm. This means that future development areas will require stormwater management facilities (wet ponds or constructed wetlands).

The proposed stormwater management concept plan for ultimate development is shown in Figure 5.3. The plan includes the recently annexed areas to the south, north and west.

The stormwater drainage concept incorporates the present principles of stormwater management. The approach includes:

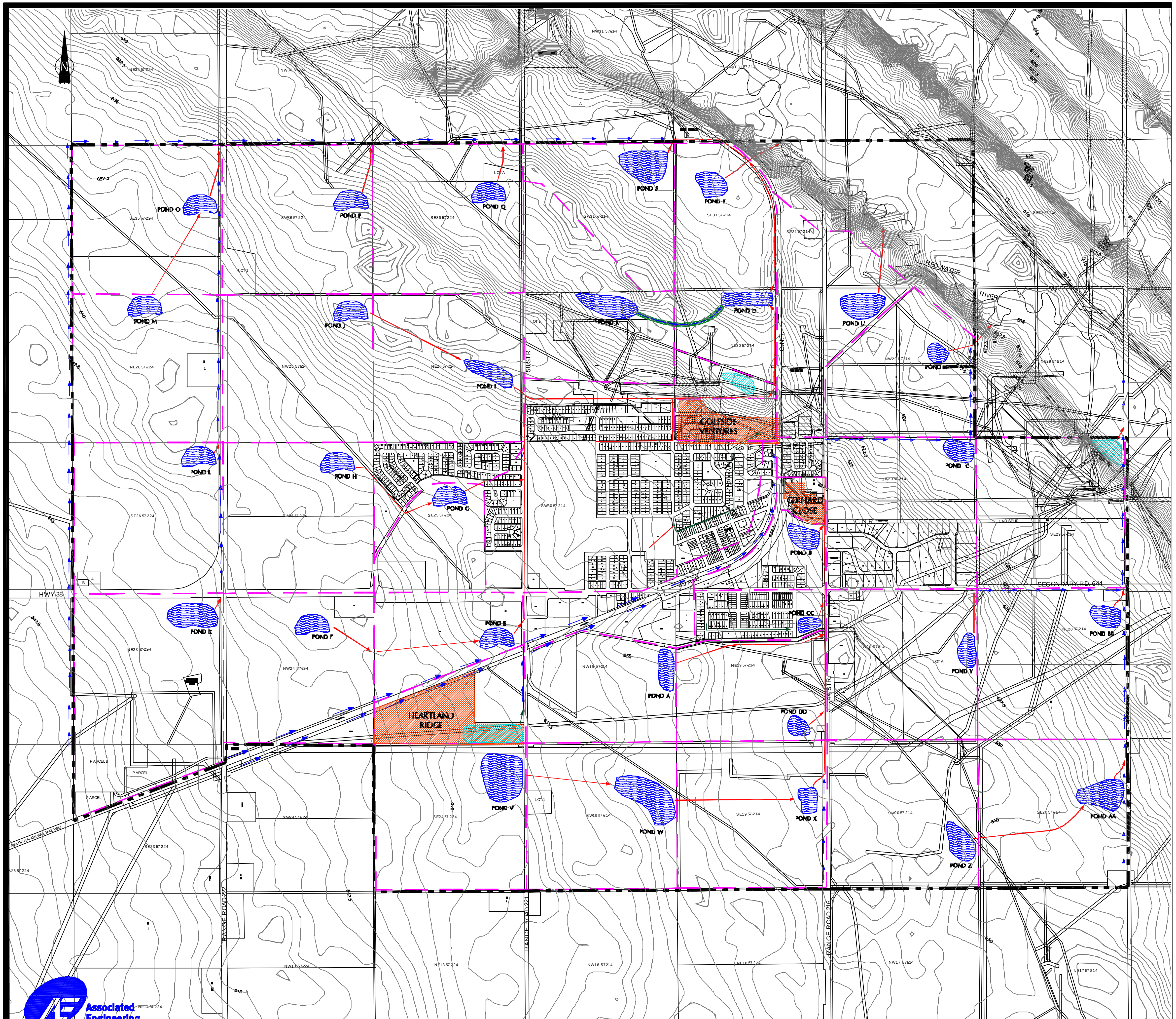
- Following existing topography and drainage.
- Preserving and incorporating natural wetlands into the drainage systems wherever possible.
- Controlling post-development runoff to pre-development levels by using stormwater management ponds
- Enhancing stormwater quality using wet or dry ponds where possible.
- Enhancing neighbourhood amenity values with a variety of stormwater management ponds.

The proposed location and configuration of the ponds is shown on Figure 5.3 (full size drawing included as Storm 2 in Appendix C). A conceptual design of the stormwater management facilities was completed for this report. The designs were determined using the Modified Rational Method for the 1:100 year, 24 hour duration storm. Table 5.2 summarizes the pond sizes, outflow requirements and outlet sizing. Connecting pipes have been conceptually sized for pond outflows only. These will likely form a part of the local collection system and may be larger, with oversize costs to be shared between developments. The concept presented in Figure 5.3 provides storm sewer connections between stormwater management ponds.

TABLE 5.2 PRELIMINARY POND STORAGE AND OUTFLOW RATES

Name	Catchment Area (ha)					Storage Volume (m3)	Area at Top of Bank (ha)	Outflow Rate (m^3/s)	Cumulative Outflow Rate (m^3/s)	Orifice Diameter (mm)
	Single Family Residential	Commercial	Industrial	Park or Undeveloped	Total					
Pond A	46.0				46.0	30,600	2.7	0.12	0.12	200
Pond B	3.2	15.1			18.3	19,000	1.9	0.05	0.05	120
Pond C	6.4		65.0		71.4	64,300	4.9	0.17	0.22	270
Pond D	102.8	26.7	10.6	60.2	200.3	124,800	8.5	0.50	1.46	700
Pond E	20.4	13.6			34.0	28,800	2.6	0.09	0.25	290
Pond F	51.8	13.2			65.0	49,200	4.0	0.16	0.16	230
Pond G	26.6	4.0			30.6	22,200	2.2	0.08	0.23	280
Pond H	52.3	8.9		3.8	65.0	44,700	3.6	0.15	0.15	230
Pond I	65.0				65.0	43,300	3.6	0.16	0.32	330
Pond J	65.0				65.0	43,300	3.6	0.16	0.16	230
Pond K	66.4	20.0			86.4	66,500	5.0	0.22	0.22	270
Pond L	34.7	30.3			65.0	57,000	4.4	0.16	0.16	230
Pond M	65.0				65.0	43,300	3.6	0.16	0.16	230
Pond N			65.0		65.0	60,000	4.6	0.16	0.16	230
Pond O	65.0				65.0	43,300	3.6	0.16	0.32	330
Pond P	65.0				65.0	43,300	3.6	0.16	0.16	230
Pond Q	65.0				65.0	43,300	3.6	0.16	0.16	230
Pond R	38.5				38.5	25,600	2.4	0.10	0.10	180
Pond S	65.0				65.0	43,300	3.6	0.16	0.16	230
Pond T	31.2			32.8	64.0	29,900	2.7	0.16	0.16	230
Pond U	50.5				50.5	33,600	2.9	0.13	0.13	210
Pond V	65.0				65.0	43,300	3.6	0.16	0.16	230
Pond W	65.0				65.0	43,300	3.6	0.16	0.32	330
Pond X	65.0				65.0	43,300	3.6	0.16	0.48	400
Pond Y		7.3	57.7		65.0	61,400	4.7	0.16	0.16	230
Pond Z			65.0		65.0	60,000	4.6	0.16	0.16	230
Pond AA			65		65.0	60,000	4.6	0.16	0.32	330
Pond BB			65		65.0	60,000	4.6	0.16	0.48	400
Pond CC	53.5	9.8			63.3	46,600	3.8	0.16	0.16	230
Pond DD	41.3	4.5			45.8	32,500	2.8	0.11	0.11	190

NOTE: Pond sizes are preliminary and subject to review in detailed design.
Catchment areas are approximate.



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3796-RP01-BASE-3TM-GRID_2009
3796-RP03-contour-3TM-RPT

Town of Redwater

MASTER SERVICES PLAN UPDATE

PROPOSED STORM DRAINAGE SYSTEM

LEGEND:

- TOWN BOUNDARY
- SUB-CATCHMENT BOUNDARY
- EXISTING POND (OR UNDER DEVELOPMENT)
- PROPOSED POND
- DITCH
- PROPOSED STORM SEWER
- EXISTING STORM SEWER
- PROPOSED DRAINAGE PARKWAY
- PROPOSED/UNDER DEVELOPMENT

SCALE: 1 : 20,000

AUGUST, 2010

FIGURE 5.3

Sewers were assumed for ultimate development as per the Town's intention to support urban development. In the interim, however, there may be areas where it will make sense to convey stormwater using ditches/swales until development progresses. Some advantages of using ditches/swales in the interim are:

- Lower development costs. Subdivisions with larger land parcels mean there is less opportunity for developers to re-coup servicing costs which could make the cost of developing prohibitive.
- Vegetated ditches and swales can promote infiltration and can help to reduce the sediments and other pollutants in stormwater runoff, thereby reducing pollutant loads to receiving water bodies. If designed appropriately, they can also provide storage to replace stormwater management ponds.

Pond D has been relocated north of the sewage lagoon, compared to the proposed location in the 2005 Master Servicing Plan. The existing Town area will route through Pond D via a storm trunk system. A drainage parkway from proposed Pond R to Pond D could be considered, which could add to the aesthetics of the community and if properly landscaped can create a passive park space and buffers between land uses.

Trunk sewers will drain the proposed ponds south of Highway 38 (Secondary Highway 644), to the east and then north to Redwater River.

Ponds west of Highway 28 will drain to the ditches along Highway 28, then to a new ditch along the north edge of Town to the Redwater River. Ditches should suffice except for the last, steep section to the river where erosion may be an issue. A storm pipe should be constructed to discharge down the bank to the river. However, the ditches along Highway 28 may need to be lowered to accommodate drainage from the ponds. In this case, the ditches may be converted to a piped system.

Existing ditches along the railway and 46 Avenue will be left in place to drain the railway, undeveloped upstream areas and a small portion of the downtown commercial area.

Historically, the Town was developed with on-street (gutter) drainage to defined swales or ditches. In some places, there are long runs on the street, as long as 800 m, which can result in large on-street flows, frequent ponding, and flooding of private property where lot grades are low. Ditches and swales are not always maintained and this may affect their capacity to carry flow during in a major storm event.

The design of the ponds and sewers is conceptual only and is subject to review during the subdivision design stage based on the most current planning information and the design of the tributary drainage system in each catchment.

The presence of active pipelines shown on the map indicates that there may be design constraints in some cases for trunk sewers. The final trunk sewer alignments will be subject to review when the locations and elevations of the pipeline crossings are known.

6 Transportation System

6.1 BACKGROUND

Included as part of the 2005 Master Services Plan was a review of the existing transportation network within the Town of Redwater and a long term transportation network that would accommodate population growth to 6,100. The long term network included the following:

- the widening of 48 Avenue to a four lane undivided arterial from 44 Street west to Highway 28 (beyond year 2035)
- the widening of 44 Street to a four lane undivided arterial from the proposed 44 Avenue north to 48 Avenue (beyond year 2035)
- the eastward extension of 55 Avenue to tie directly to 54 Avenue thereby providing a continuous east-west collector roadway from 44 Street to 58 Street (beyond year 2035)
- the extension of existing and/or the construction of new two lane collector roadways to provide access to proposed residential or industrial communities
- control of access along 48 Avenue and the portion of 44 Street that is proposed for a future four lane undivided arterial roadway (ongoing)
- protection of right-of-way and acquisition of property along 48 Avenue and the portion of 44 Street that is proposed for a future four lane undivided arterial roadway (ongoing)
- protection of right-of-way and acquisition of property along 48 Avenue and the portion of 44 Street that is proposed for a future four lane undivided arterial roadway (ongoing)
- installation of traffic signals along 48 Avenue at 44 Street, 48 Street, 49 Avenue, and 58 Street (as warrants dictate, but not anticipated prior to year 2035)
- protection of right-of-way for the east-west extension of 55 Avenue as a two lane undivided collector for the fundamental provision of an additional east-west roadway between 44 Street and 58 Street (ongoing)

As the town boundaries have changed significantly since the 2005 study was completed, it is necessary to update the study to include all town lands in the identification of a road network that would be needed to address the future travel demand.

Currently, Highway 28 is located approximately 2 km west of the Town of Redwater. Alberta Transportation plans to ultimately relocate Highway 28 such that it is located approximately 10 km west of Redwater. The timeline for the relocation of the highway has not been established and could occur beyond the 20-year horizon established for this study. Therefore, the relocation of the highway and the impact on traffic was not considered in this study.

6.2 STUDY METHODOLOGY

The Master Services Plan update was completed using the following methodology:

- data collection and review
- identify the study intersections
- establish capacity analysis horizons
- generate background, site, and total traffic forecasts for the analysis horizons
- distribute and assign traffic forecasts to the study intersections for the analysis horizons
- analyze the capacity of the study intersections for the analysis horizons
- complete traffic signal warrants at the study intersections for the analysis horizons
- develop a unit cost estimate for construction of new roadway

The following intersections were studied for the Master Services Plan update and are presented in Figure 6.1:

- Highway 28 and 48 Avenue
- 48 Avenue and 65 Street/Ochre Park Road
- 48 Avenue and 58 Street
- 48 Avenue and 53 Street
- 48 Avenue and 49 Avenue
- 48 Avenue and 48 Street
- 48 Avenue and 44 Street

Both the morning (AM) and afternoon (PM) peak hour traffic volumes were used to complete the capacity analysis. The capacity analysis was completed for two horizons: existing (2010) and long-term (2020).

6.3 LAND USE

The Town of Redwater provided Associated Engineering with the Future Land Use Map from the 2009 Municipal Development Plan, which is enclosed as Figure 2.3.

Conceptual development plans were provided to Associated Engineering for new developments proposed within the new town boundaries. These developments included, from west to east:

- Westland Village Subdivision, located in SW25-57-22-4
- Triple 5 Development, located in NW24-57-22-4
- Heartland Ridge Subdivision, located NE24-57-22-4 (between the railway tracks and the oil pipeline right-of-way)
- Horizon Heights Subdivision, located in SE24-57-22-4
- BDRC Development, located in SW31-57-51-4
- Golf Course Subdivision, located in SW30-57-21-4 and NE30-57-21-4 (west of the railway tracks)

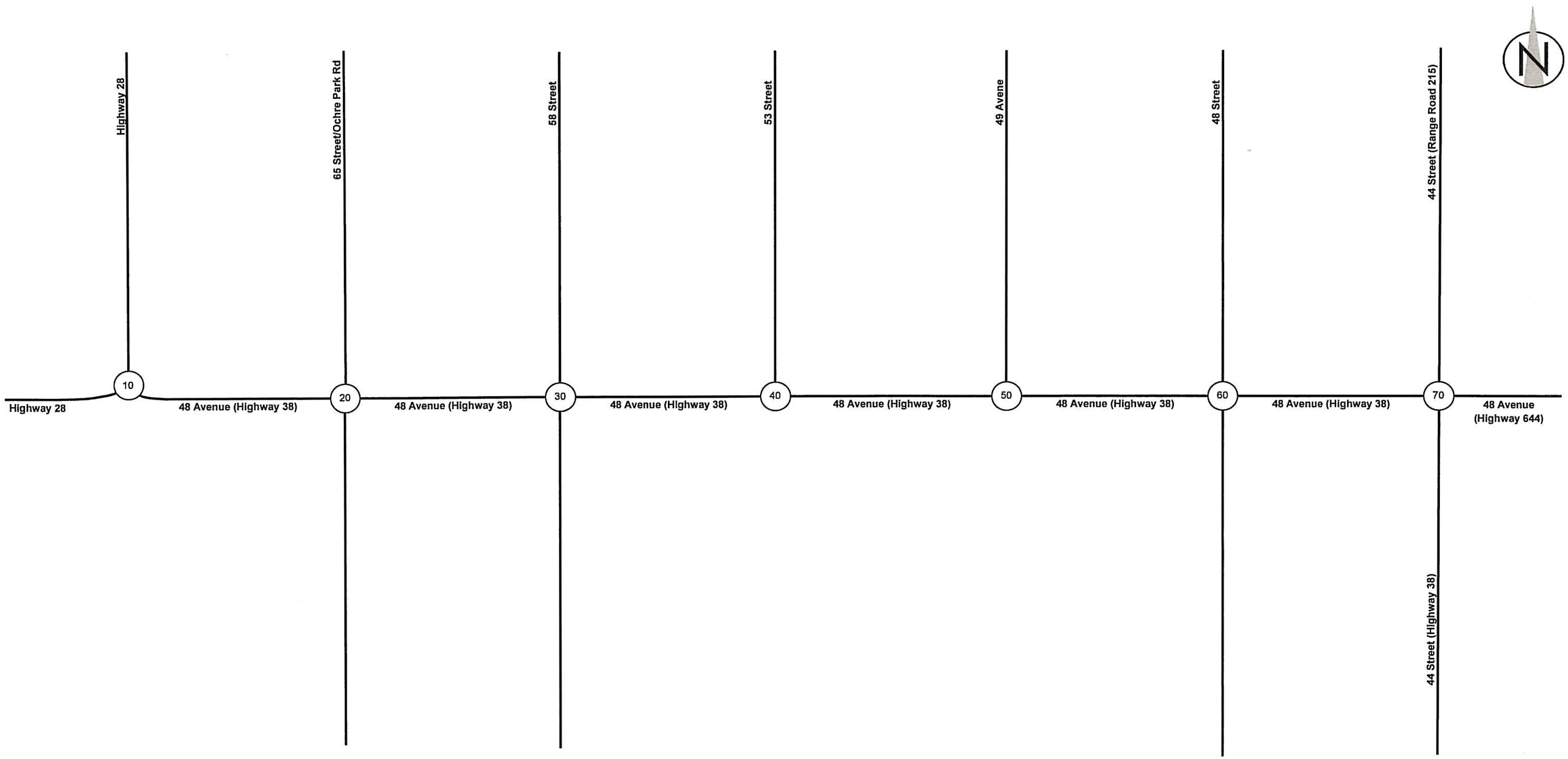

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Figure 6.1

Town of Redwater - Existing Road Network

Master Service Plan Update

2009-3796 Town of Redwater

P:\20093796\00_MasterServPlanUpd\Engineering\03.00_Conceptual_Feasibility_Design\Transportation\Revised Analysis\Report\June 2010 Revisions\Figures.xls\Figures.xls\Fig 6.1

- Sunrise Estates I Subdivision, located in NW19-57-21-4 (between the railway tracks and oil pipeline right-of-ways)
- Sunrise Estates II Subdivision, located in SW19-57-21-4
- Riverbank Subdivision, located in SE31-57-21-4
- Golfside Estates Subdivision, located in the south portion of NE30-57-21-4 (south of well site)

The conceptual development plans discussed above have not been approved by the Town of Redwater. However, for completion of the Master Services Plan update, Associated Engineering has used these plans for the determination of travel demand and the resulting town road network.

6.3.1 Future Land Use

For this study it has been assumed that the land use bounded by the previous town boundaries will be developed by the 2020 horizon. Several of the conceptual development plans discussed above are located within the previous town boundaries, including:

- South half of the Westland Village Subdivision
- Heartland Ridge Subdivision
- Sunrise Estates I Subdivision
- Golfside Estates Subdivision

6.4 2008 TRAFFIC CONDITIONS

Traffic volume information for the study area was collected from the Alberta Transportation website. The information collected included the Traffic Volume History (1999-2008) for Highway 28, Highway 38, and Highway 644 and 2008 Turning Movement Diagrams for the Highway 28/Highway 38, Highway 38/58 Street, and Highway 38/44 Street intersections.

This traffic count information was supplemented with information from the 1981 Redwater Transportation Study. That study contained PM peak hour counts at a number of key intersections within the town including the 48 Avenue/49 Avenue and 48 Avenue/48 Street intersections. Since development in the downtown core has not changed significantly since those counts were completed, it was assumed that the volumes turning to and from 49 Avenue and 48 Street are similar today to the counts completed previously; as such these volumes of turning vehicles have been used in this study as well.

To estimate the turning movements for the remaining intersections along the corridor, a volume balancing exercise was completed. The balancing of the traffic volumes was undertaken by:

- considering adjoining intersection directional link volumes and developing consistent directional link volumes for the network
- considering a higher traffic distribution to/from of the Central Business District (accessed by 49th Avenue and 48th Street) in the AM and PM peak hours, respectively

- developing turning volumes based on the consistent link volume and looking at the original ratio of movement split at the major intersections.

6.5 TRAFFIC FORECASTS

6.5.1 Background Traffic Volumes

To account for traffic growth on 48 Avenue independent of additional development in the Town of Redwater, an annual growth rate of 2.5% was assumed for the traffic volumes along the corridor; this growth rate is consistent with the provincial average growth rate for highways throughout Alberta. The growth rate was applied, non-compounded, to all of the turning movements at the study intersections.

6.5.2 Development Traffic Volumes

The proposed developments presented in the conceptual development plans will generate additional traffic, above and beyond the background traffic volumes. The summation of the background traffic and the development traffic is commonly used to forecast total travel demand. Associated Engineering has assumed that the developments detailed in Section 6.2.1 will be built out by the 2020 analysis horizon. A three-step process was undertaken to determine the traffic volumes generated by the future developments proposed in the 2020 horizon. The steps included:

- trip generation: estimate of the number of trips generated to/from the development sites during the AM and PM peak hours
- trip distribution: estimate of the origin of trips to the development sites and destinations of the trips from the development sites. Essentially this estimates the to-and-from work trips along with additional major trip purposes.
- trip assignment: selecting the routes used by trips to/from the development sites and assignment of the traffic volumes to the study intersections

The trip generation, distribution and assignment process was not undertaken for Westland Village since a traffic impact assessment was already completed for the development. The traffic impact assessment accomplished the trip generation, distribution and assignment as part of the study. The traffic impact assessment was completed for the 2011, 2018 and 2028 time horizons. The volumes developed for the 2011 horizon was assumed for the 2020 analysis horizon for the Master Services Plan update.

The Institute of Transportation Engineers Trip Generation (7th Edition) handbook was referenced to determine the appropriate trip generation rates to/from the proposed developments. Areas for the different land uses were estimated using the conceptual development plans provided by the Town. The Town’s Land Use Bylaw was referenced to obtain the maximum density and minimum site area needed for calculating the number of residential units for a given land parcel. Table 6.1 presents the land use statistics for the 2020 analysis horizon.

Table 6.1
Land Use Statistics

Development	Land Use	Independent Variable Unit	2020 Horizon	
			Area Ha (Acre)	Unit
Heartland Ridge Subdivision	Residential - Low Density	Dwelling Unit	-	204
Sunrise Estates I Subdivision	Residential - Low Density	Dwelling Unit	-	342
	Residential - Medium Density	Dwelling Unit	3.4 (8.3)	101(1)
	Commercial	Gross Leasable Area (1000 ft^2)	2.4 (5.9)	38.6
Golfside Estates Subdivision	Residential - Low Density	Dwelling Unit	5.1 (12.5)	109(2)
	Residential - Medium Density	Dwelling Unit	1.2 (3.0)	36
	Park	Acres	0.2 (0.4)	0.4

The traffic patterns from the AT turning movement diagrams were used to distribute the development traffic at Highway 38 and 38 Street, and Highway 38 and 44 Street. For the remaining intersections, the development traffic was distributed by considering the land uses at the origin and destination, and the land uses adjacent to the study intersections, on a case-by-case scenario for each development.

6.5.3 Total Traffic Volumes

The total traffic volumes were generated by combining the background traffic volumes with the development traffic volumes from the developments for common time horizons. Since no developments were assumed for the existing (2010) horizon, the total traffic volumes comprise of the background traffic volumes only. Figures 6.2 and 6.3 present the existing (2010) total traffic volumes in the AM and PM peak hours, respectively. Figures 6.4 and 6.5 present the total traffic volumes for the 2020 horizon in the AM and PM peak hours, respectively.

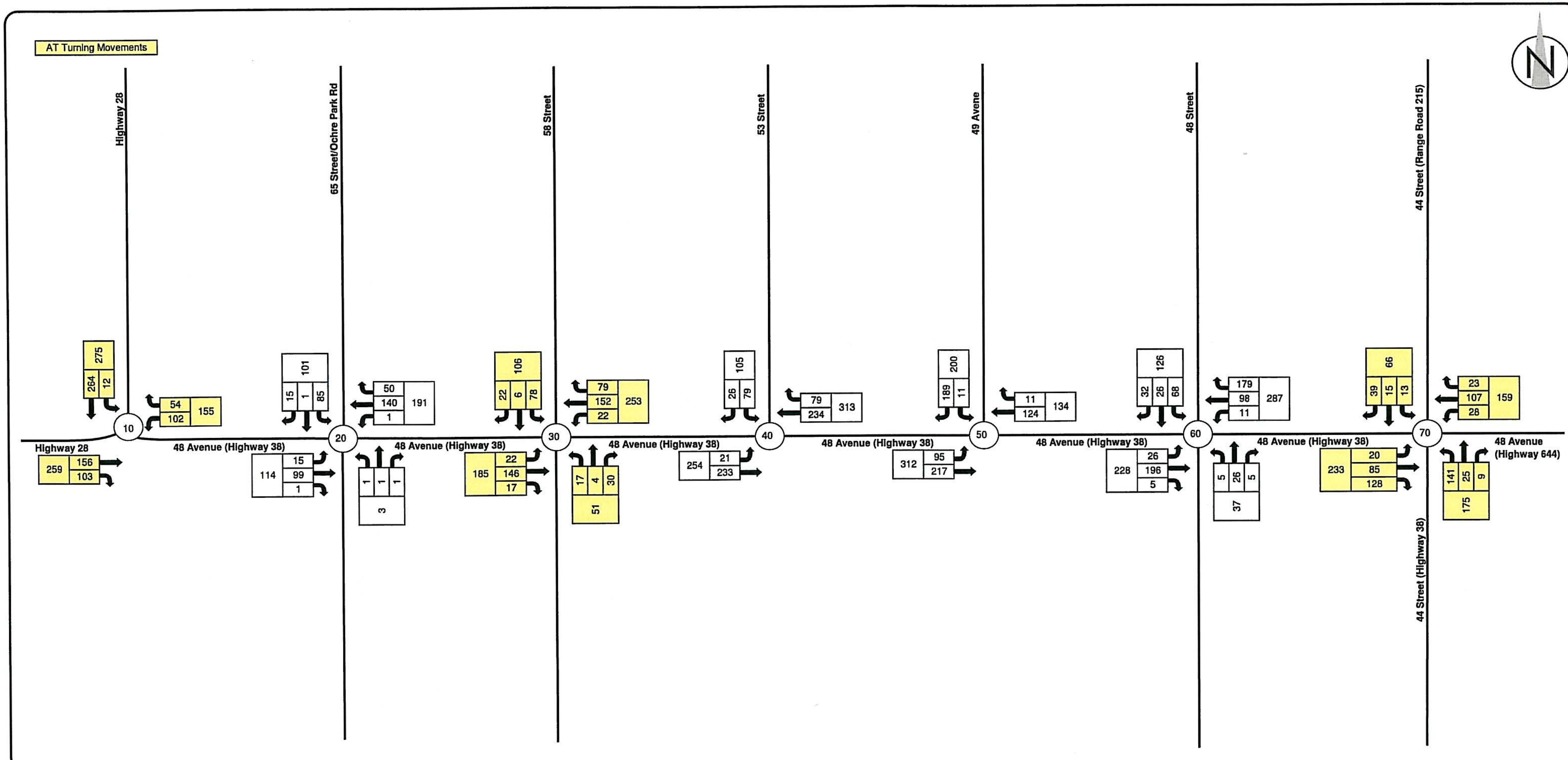

Figure 6.2

2010 AM Peak Hour Traffic Volumes

Master Service Plan Update

2009-3796 Town of Redwater

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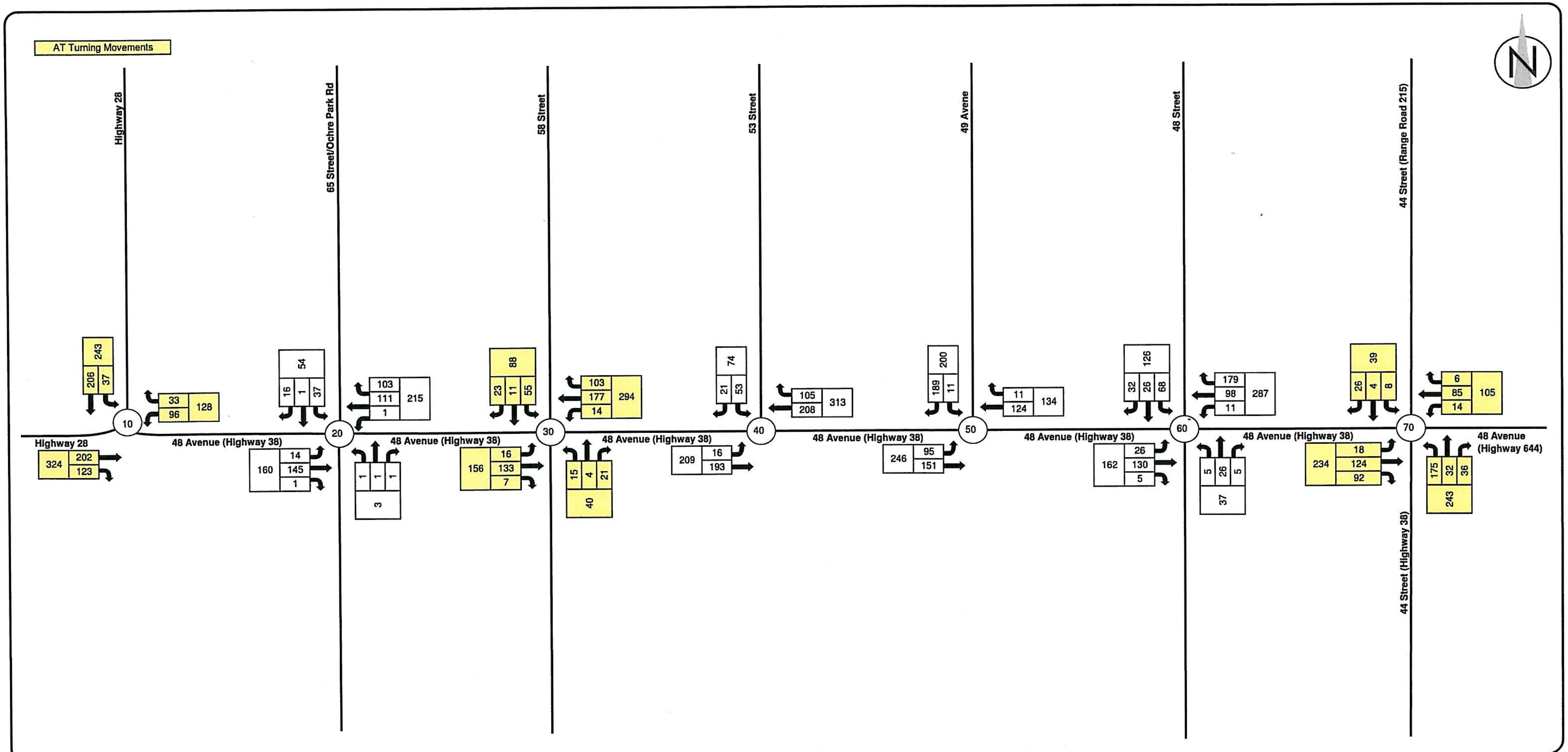

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Figure 6.3

2010 PM Peak Hour Traffic Volumes

Master Service Plan Update

2009-3796 Town of Redwater

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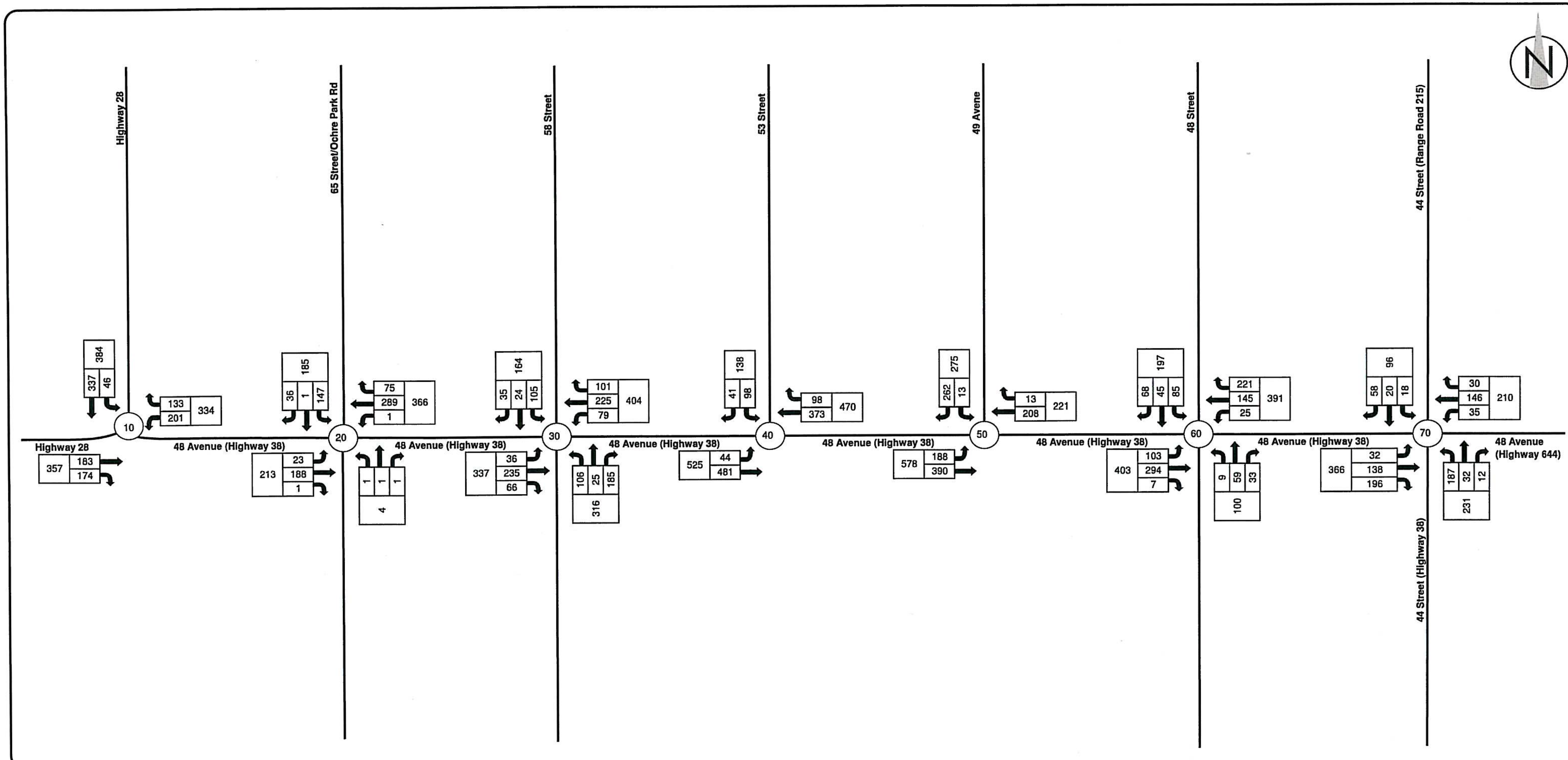

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Figure 6.4

2020 AM Peak Hour Traffic Volumes

Master Service Plan Update

2009-3796 Town of Redwater

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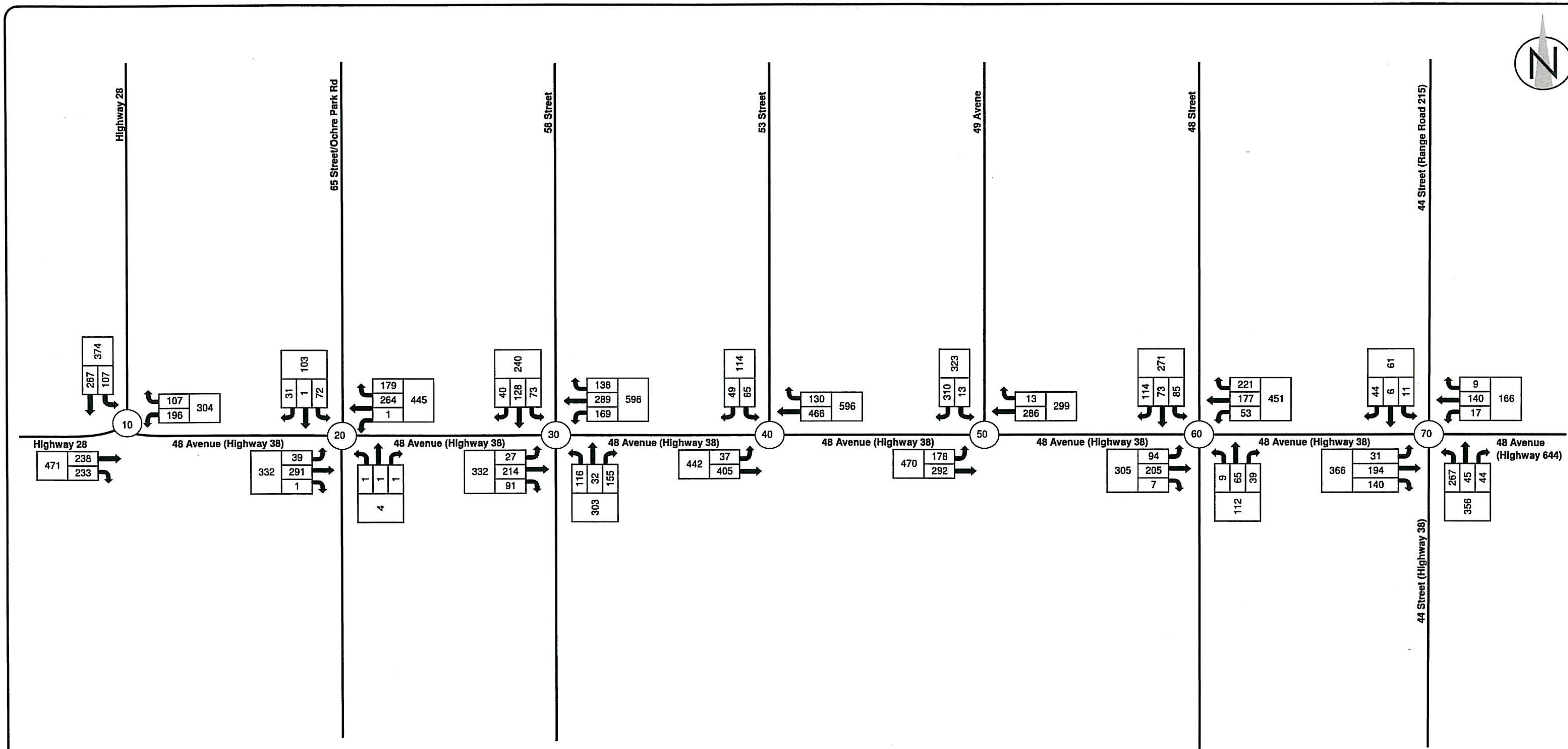

Figure 6.5

2020 PM Peak Hour Traffic Volumes

Master Service Plan Update

2009-3796 Town of Redwater

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6.6 TRANSPORTATION NETWORK

The Synchro/Sim Traffic 7 traffic analysis program, which is based on the Institute of Transportation Engineers Highway Capacity Manual (HCM), was used to analyze the capacity of the study intersections and determine the need for any improvements. Synchro 7 applies the methodology established by the HCM to output a level of service for a study intersection, given the lane designations, vehicular volumes, signal timing and heavy vehicle percentages.

Level of service for signalized and stop-controlled intersections is defined as the average wait time for approaching vehicles. Table 6.2 presents the average vehicle delay times for each level of service.

Table 6.2
Level of Service Criteria

Level of Service	Average Stop Control Delay per Vehicle (seconds)	Average Signalized Delay per Vehicle (seconds)
A	less than 10	less than 10
B	10 – 15	10 – 20
C	15 – 25	20 – 35
D	25 – 35	35 – 55
E	35 – 50	55 – 80
F	more than 50	more than 80

For the purpose of this assessment a minimum LOS of D was required for the intersection; this is in accordance with the section U.D.6 of the Alberta Infrastructure and Transportation Highway Geometric Design Guide Urban Supplement (Urban Design Guide).

As part of the analysis Associated Engineering also investigated the volume to capacity ratio (V/C) on each approach. The V/C ratio is a measurement of actual volume to theoretical capacity of each lane or approach to an intersection. V/C ratios less than 0.9 are preferred, v/c ratios between 0.9 and 1.0 indicate the volumes are nearing capacity, and v/c ratios greater than 1.0 indicate potential breakdown of vehicular flow, and should be avoided if possible. The Table 6.3 provides a brief description of critical V/C values.

Table 6.3
Volume to Capacity Ratio Descriptions

Volume to Capacity Ratio	Description
< 0.9	Traffic volumes are less than theoretical capacity
0.9 to 1.0	Traffic volumes are approaching capacity
> 1.0	Traffic volumes exceed capacity

The following sections provide a summary of the capacity analysis completed for the intersections being investigated as part of this study. Detailed results of the capacity analysis are included in Appendix D.

6.6.1 Existing (2010) Network

The analysis of the 2010 traffic volumes was intended to identify existing deficiencies at the intersections along the Highway 38 corridor. The results of the analysis found that each of the intersections along Highway 38 operates acceptably with a minimum approach level of service C during the AM and PM peak hours. As all of the intersections operate acceptably there are no immediate improvements required.

6.6.2 2020 Transportation Network

Based on the analysis of the projected 2020 traffic volumes it was determined that the intersections of 49 Avenue, 53 Street, and 65 Street will operate at a minimum level of service C during the AM and PM peak hours. The analysis identified capacity issues at the other four study intersections that will require additional improvements.

At the intersection of 48 Avenue and 44 Street it was found that the delays on 44 Street would increase past acceptable limits; the northbound approach is reduced to a level of service E during the PM peak hour. To provide additional capacity at this intersection, left turn lanes should be constructed for north and southbound traffic. With these improvements, the level of service for all movements will increase to a minimum of C during the AM peak hour and D in the PM peak hours

The increased traffic volumes projected for the 48 Avenue/48 Street intersection result in significant delays on the southbound leg. Associated Engineering looked at geometric improvements that would increase the capacity of the intersection but it was not possible to increase capacity enough to reach an acceptable level of service for the intersection with geometric improvements alone. Therefore, Associated Engineering recommends that traffic signals be installed at this location to accommodate the future traffic volumes.

The 58 Street intersection with 48 Avenue will serve as a major access point for developments on both sides of Highway 38. As a result, significant traffic volumes have been projected for this intersection. The capacity analysis found that the existing intersection treatment will not have capacity to accommodate these traffic volumes; both the north and southbound approaches will fail during the AM and PM peak hour without improvements. To provide sufficient capacity to accommodate these traffic volumes, the following improvements will be required:

- installation of traffic signals
- construction of a dedicated left turn lane for westbound traffic
- construction of channelized right turns on all corners of the intersection

The intersection of Highway 28 and 48 Avenue will also see increased delays on the minor leg of the intersection (Highway 38) at the 2020 analysis horizon. During the PM peak hour this approach is reduced to a level of service E. Associated Engineering has looked at geometric improvements that could be completed in order to increase the capacity, but while level of service on the right turn could be improved, the left turn would continue to operate at E. With 196 vehicles making this left turn, Associated Engineering does not feel that this delay is acceptable. Therefore, to provide additional capacity, traffic signals should be installed at this intersection.

6.6.3 Ultimate Road Network

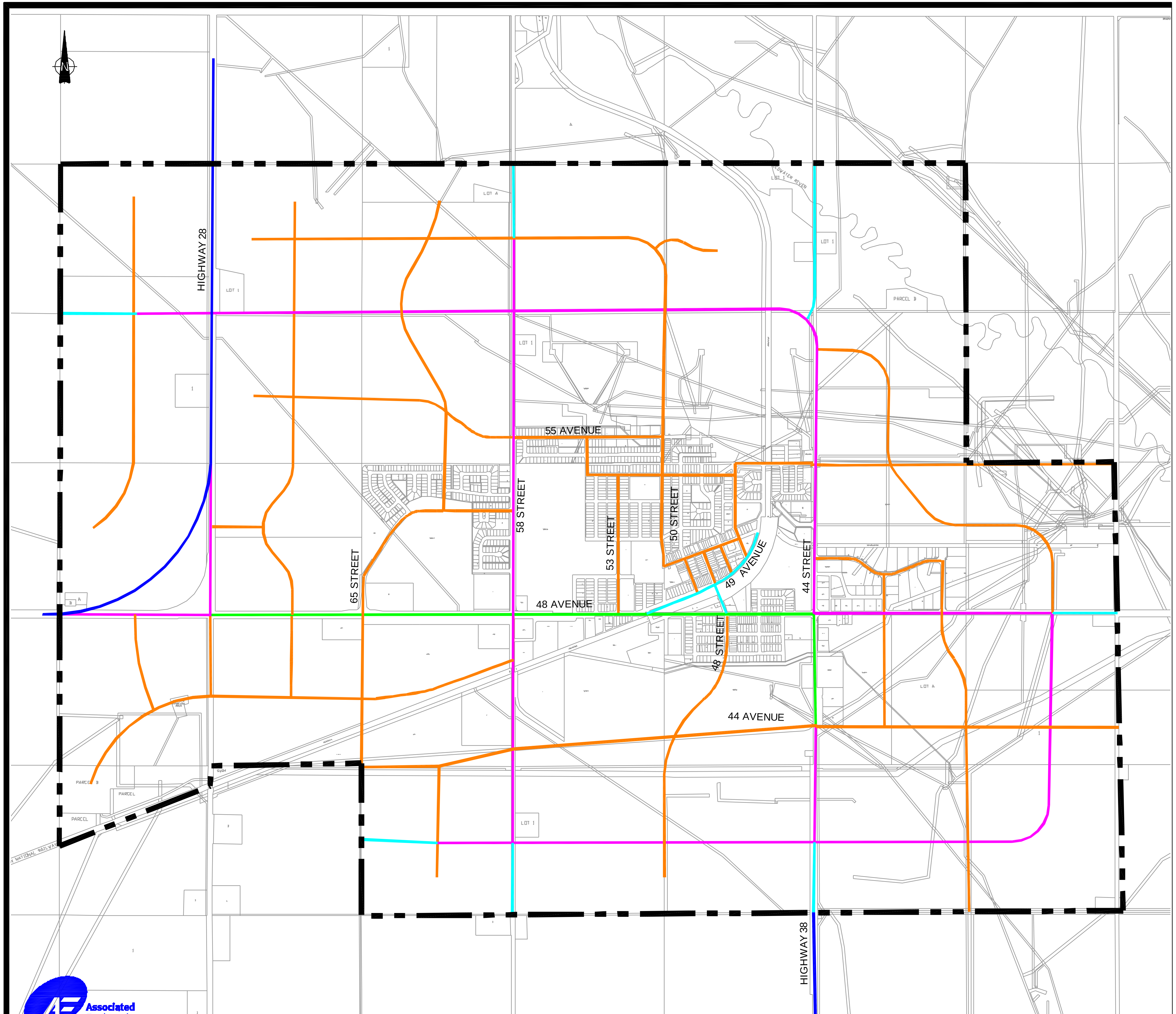
The ultimate road network presented in Figure 6.6 represents a road network that will accommodate growth within the new boundaries of the Town of Redwater. This road network builds on the road network that was previously identified in the 2005 Master Services Plan.

There are three types of arterial roadways contained in the plan - five-lane undivided, four-lane undivided, and two-lane undivided. The five lane sections will include 48 Avenue from Highway 28 to 44 Street and 44 Street between 48 Avenue and 44 Avenue. These roadways will have two through lanes of travel in each direction and a two-way left turn in the centre of the roadway.

Additional four-lane arterials have been identified at approximately 1,600 m (1 mi) spacing throughout the town. This spacing corresponds to the existing range road right-of-ways in the town and will provide for sufficient capacity for vehicles traveling within the town.

As these arterials approach the town limits they transition from a four-lane to a two-lane cross section. This reflects the reduced development that will be adjacent to the roadway and the resulting lower traffic volumes. To provide the option to upgrade these facilities to four lanes in the future (should development plans change or the town boundaries be expanded again), the right-of-way for a four-lane arterial should be protected at this time.

Collector roads have been shown on the long term network with a spacing of approximately 600 - 800 m from the arterial roadways. Additional collector roads could be developed if required to facilitate denser residential or large scale commercial developments as long as the minimum intersection spacing identified in the previous section is maintained.



Town of Redwater

MASTER SERVICES PLAN UPDATE

ULTIMATE ROAD NETWORK

LEGEND:

- HIGHWAY
- ARTERIAL - 2 LANE UNDIVIDED (URBAN)
- ARTERIAL - 4 LANE UNDIVIDED (URBAN)
- ARTERIAL - 5 LANE UNDIVIDED (URBAN)
- MAJOR COLLECTOR - 2 LANE UNDIVIDED (URBAN)
- TOWN BOUNDARY

SCALE: 1 : 20,500

AUGUST, 2010

FIGURE 6.6

Time: 7:50am
Date: Sep 08, 2010
File: P:\20093796\00_MasterServPlanUpd\Working_Dwgs\100_Civil\FINAL-REPORT-2010-05\3796-FG-66.dwg by
Xrefs: 3796RP01_BASE_10TM_2009_Updated
3796-RT01-TIT-AE-RPT

6.7 ROAD CLASSIFICATIONS AND GEOMETRIC STANDARDS

Associated Engineering has reviewed the existing road network in the Town of Redwater and has identified the appropriate classification of the roadways based on the function that they serve. Future roadways have also been identified that will provide the capacity required to accommodate future growth within the town.

The following sections outline these roadway types. Table 6.4 provides a summary of the standards associated with each roadway classification.

6.7.1 Arterial Road

The arterial road network typically connects major development areas within a town. This can include central business districts, industrial centres, residential communities, and other activity centres. Arterial roads also provide connections to the collector road network; however, local road connections are typically not provided. Because the primary function of an arterial roadway is to carry traffic, on street parking is often discouraged.

6.7.2 Collector Road

Collector roads provide land access and also carry traffic volumes through residential, industrial, and commercial developments. Collector roads gather traffic from the local road network and provide a connection to the arterial road network. Collector roads can intersect with arterial road, other collector road, and local roads. Parking may be permitted on these streets.

Table 6.4
Road Classifications and Standards

	Arterial Roadway	Collector Roadway
Traffic Service Function	Traffic movement major/primary consideration	Traffic movement and land use access of equal importance
Traffic Volume (Vehicle per day)	5000 - 20000 (minor) 10000 - 30000 (major)	<8000 (residential) 1000 - 12000 (indust./comm.)
Flow Characteristics	Uninterrupted flow except at signals and crosswalks	Interrupted flow
Design Speed (km/h)	50 - 80	60
Posted Speed (km/h)	50 - 70	50
Vehicle Type	All types	Passenger and all service vehicles (residential) All types (indust./comm.)
Desirable Connections	Collectors, arterials, expressways, freeways	Locals, collectors, arterials
Transit Service	Express and local buses permitted	Permitted
Accommodation of Cyclists	Lane widening or separate facilities desirable	No restrictions or special facilities
Accommodations of Pedestrians	Sidewalks may be provided, separation from traffic lanes preferred	Sidewalks provided both sides
Parking	Restricted	Permitted
Minimum Intersection Spacing (m)	200 (minimum) 400 (desirable)	60
Right-of-way Width (m)	45	24

7 Cost Estimates

Cost estimates are only provided for upgrades which are recommended for the existing system to satisfy present servicing standards. The estimates presented include an allowance for engineering (15%) and contingency (15%), but do not include G.S.T. The costs are based on 2010 construction dollars.

7.1 WATER SYSTEM UPGRADES

Unit costs for the estimates for Water System Upgrades are provided in Appendix A.

7.1.1 Water Distribution System

Minimum Recommended Upgrades		
• 47 Street - 47 to 48 Avenue	$ 203,500	
• 49 Avenue - 58 to 59 Street	$ 314,900	
• 52 Avenue - 58 to 59 Street	$ 284,200	
• 49 Avenue - 54 to 55 Street	$ 226,600	
• 53 Street - 49 to 52 Avenue	$ 871,500	
• 51 Avenue - 53 to 54 Street	$ 226,600	
• 54 Street - 51 to 52 Avenue	$ 401,300	
• 49 Avenue - 51 to 53 Street	$ 526,100	
• 51 Street - 51 to 52 Avenue	$ 393,600	
• 52 Street - 51 to 52 Avenue	$ 397,400	
Total Minimum Recommended Upgrades		**$ 3,845,700**
Long-Term Upgrades (to year 2020)		
• 49 Avenue - 53 to 54 Street	$ 226,600	
• 52 Avenue - 50 to 53 Street	$ 1,855,900	
• 52 Avenue Crossing	$ 66,000	
• 44 Street - 48 to 51 Avenue	$ 653,100	
• 48 Avenue - 44 to 51 Street	$ 1,935,300	
• 53 Street - 48 to 49 Avenue	$ 380,400	
• Additional hydrants (38)	$ 380,000	
• 150 mm by 400 m Cross Connections	$ 15,000	
Total Long-Term Upgrades		**$ 5,512,300**
Total Distribution System		**$ 9,358,000**

7.1.2 Booster Pumphouse

• Booster Pumphouse	$ 800,000		
Total: Booster Pumphouse and Related Works		**$**	**800,000**
TOTAL: WATER SYSTEMS UPGRADES			**$10,158,000**

7.2 SANITARY SYSTEMS UPGRADES

Unit costs for the estimates for Sanitary System Upgrades are provided in Appendix B.

7.2.1 Sanitary Collection System

• Condition Assessment CCTV and Study	$ 110,000		
• 58th Street Sewer Replacement	$ 370,000		
• 50th Avenue Sewer Replacement	$ 110,000		
• Central Trunk System Sewer Replacement	$ 823,000		
Total: Sanitary Collection System Upgrades		**$**	**1,413,000**

7.2.2 Lift Station/Forcemain/Sewage Lagoon Upgrades

• Lift Station	$ 1,500,000		
• Forcemain	$ 560,000		
• Sewage Lagoon Expansion Study	$ 50,000		
Total: Lift Station/Forcemain/Sewage Lagoon Upgrades		**$**	**2,110,000**
TOTAL: SANITARY SYSTEM UPGRADES		**$**	**3,523,000**

7.3 STORM DRAINAGE SYSTEM UPGRADES

7.3.1 Surface Improvements

• Grassed Swale in Lane North of 50th Avenue	$ 25,000		
Total: Surface Improvements		**$**	**25,000**

7.3.2 Underground Construction

• Repair/Replace Culverts	$ 15,000		
Total: Underground Construction		**$**	**15,000**

7.3.3 Ponds (for Existing System)

• Pond D (not including land costs)	$ 2,100,000	
Total: Ponds		**$ 2,100,000**

7.3.4 Other Assessments

• Annual Catchbasin/Street Cleaning	$ 175,000	
• Wetland Assessment	$ 15,000	
• School Site Drainage	$ 25,000	
Total: Other Assessments		**$ 215,000**
TOTAL: STORM DRAINAGE SYSTEM		**$ 2,355,000**

7.4 TRANSPORTATION SYSTEM UPGRADES

Associated Engineering did not identify any deficiencies with the Town's existing roadway network. As development occurs within the town it will be the responsibility of the developers to construct the new roadways required for the development; however, these developments will also increase traffic volumes on existing roadways resulting in additional delays and the need for roadway upgrades. The following upgrades are anticipated to be required by the year 2020.

• 48 Avenue and 44 Street		
Left turn lane northbound traffic	$ 86,000	
Left turn lane southbound traffic	$ 86,000	
• 48 Avenue and 48 Street		
Installation of traffic signals	$ 230,000	
• 48 Avenue and 55 Street		
Installation of traffic signals	$ 230,000	
Left turn lane for westbound traffic	$ 86,000	
Channelization of all right turns	$ 115,000	
• Highway 28 and 48 Avenue		
Installation of traffic signals	$ 230,000	
TOTAL: TRANSPORTATION SYSTEM UPGRADES		**$ 1,063,000**

8 Conclusions

8.1 WATER SYSTEM

- All pressures within the existing distribution system are within those recommended in the design criteria.
- Some locations in the distribution system do not satisfy Fire flow demands.
- The distribution system has 100% redundancy in the distribution pumping, in order to allow for pump maintenance and repair.
- The existing standby pumps are adequate to provide for the maximum of 200 L/s fire flow and peak day demand (excluding the truck fill demand).
- The existing reservoir has significant available storage.
- Some areas of the Town do not have adequate hydrant coverage.

8.2 SANITARY SYSTEM

- The existing sewage pumps in the Sewage Lift Station are currently undersized for Peak Wet Weather Flow based on one pump operating continuously.
- The existing wet well capacity is approximately 3.2 m^3 , and is undersized for the estimated peak flows.
- The existing forcemain is adequately sized for the current pumps, however will be undersized if the pumps are to be increased to handle the peak flows.
- Some existing sanitary sewers may surcharge during Peak Wet Weather Flow conditions.
- The number of aerated cells is adequate. Three (3) cells are provided (standards require 1 complete mix cell followed by two partial mix cells).
- The energy input to the complete mix cell appears adequate. AENV's guideline for complete mix cells calls for an energy input of 6 to 10 W/m^3. The available energy input is estimated to be at the upper limit of this range.
- The retention time through the complete mix cell is inadequate. AENV's standards indicate complete mix cells to have at least 2 days retention. The existing retention time appears to be approximately 1.5 days.
- The retention time through the partial mix cells is inadequate. AENV's standards indicate the partial mix cells should have at least 28 days retention. The Town's lagoons provide approximately 22 days of retention.
- The anaerobic lagoons provide more than sufficient capacity for initial treatment of the industrial flows. AENV requires four anaerobic cells with 2 days retention time in each cell (8 days total). The available retention in the anaerobic cells is well above this (about 36 days currently and 27 days for 20-year projection).
- Utilizing the design flows, the storage lagoons do not appear to provide adequate storage (estimated at 150 days currently) to limit the frequency of discharge to the Redwater River to twice per year, in accordance with the current AENV approval. AENV typically accepts twice per year discharge where proper aerated lagoon treatment precedes storage.

- In the future, AENV may require that the industrial component of the flow receive at least one year retention. One-year storage is generally required with conventional treatment lagoons. In addition, facultative lagoon treatment may be required for this component of the flow.
- According to Public Works staff actual discharge frequency for the storage lagoons is twice every year. Since the theoretical discharge frequency is greater than twice per year, this discrepancy may indicate that the design flows are higher than actual, that there is significant evaporation, and/or that irrigation water use is significant.
- The use of aerated lagoon effluent for golf course irrigation is most likely acceptable. The Town takes responsibility for effluent disinfection to ensure the effluent meets acceptable bacteria levels (total coliforms <1000/100 mL and fecal coliforms <200/100 mL).
- The overall yearly storage volume utilized at the lagoon appears to be quite variable from year to year.

8.3 STORM SYSTEM

- The existing ditch along 49 Avenue and the railway was partly blocked with weed growth, sediments and debris.
- There are some damaged culverts that should be replaced/repaired.
- The grassed swale north of 50 Avenue is poorly graded and contributes to ponding in the area.
- There are locations where the length of runs on the street exceeds current design standards.
- The existing drainage system does not provide for future development.
- Future development areas will require stormwater management to control peak flows and urban runoff water quality.

8.4 TRANSPORTATION SYSTEM

- There are existing deficiencies in the Town's roadway network. The existing transportation system is sufficient to accommodate the daily traffic volumes in the Town of Redwater.
- As development progresses, delays on the existing roadway network will occur. Upgrades to accommodate these traffic volumes will be required at the intersections of 48 Avenue with Highway 28, and 44 Street, 48 Street, and 55 Street prior to 2020.

9 Recommendations

9.1 WATER SYSTEM

- Construct a booster pumphouse east of 58th Street along 48th Avenue.
- Install both distribution pumps and a stand-by pump at the booster pumphouse. The STAND-BY pump may be staged to initially provide a portion of the ultimate commercial fire flow.
- Install a PRV on the 200 mm line which crosses the golf course.
- Construct the initial upgrades as indicated in Figure 3.4.
- Plan to undertake the remainder of the upgrades shown in Figure 3.4.
- New watermains in residential locations and commercial/industrial are recommended to be a minimum of 200 mm and 250 mm in diameter, respectively. It is recommended that as older pipes are repaired or replaced, that they be increased to at least these sizes.
- Future expansion to occur in accordance with Figure 3.5.

9.2 SANITARY SYSTEM

- A Condition Assessment of the existing sanitary collection system is recommended to be undertaken, to consist of CCTV investigation and a study.
- Upgrading to sanitary sewers is recommended in accordance to Figure 4.4, due to Peak Wet Weather Flows.
- Replacement of the Lift Station in order to accommodate the Peak Wet Weather Flows.
- New pumps should be specified so that one pump operating continuously can handle the peak flows.
- Twin or upsize the existing sewage forcemain upon upsizing of the sewage pumps.
- Future expansion to occur in accordance to Figure 4.5.
- Undertake a lagoon expansion study to fully assess the capacity of the lagoons. The outfall sewer can also be better assessed at this time.
- Subject to confirmation of the need for lagoon expansion:
  - Divert all of the industrial flow to the aerated lagoons. This will eliminate the possible need for additional facultative lagoon treatment and one-year storage for the industrial flow prior to discharge. Before undertaking this modification, we recommend sampling of the industrial wastewater be undertaken to confirm acceptable quality for aerated lagoon treatment and subsequent irrigation. In addition, the need for this modification should be reviewed with AENV in view of the additional costs and likely marginal benefits in terms of quality of water discharged from the storage pond.
  - Expand the aerated lagoons to accommodate the industrial area and 20 year flows.

9.3 STORM SYSTEM

- The proposed future stormwater management facilities will control peak flows and enhance urban runoff water quality. The majority of the ponds are proposed to have storm pipes convey the flows downstream. Conceptual sizes have been provided, but detailed design of these systems will be required at the time of development. Ditches could be used to drain these facilities if required, prior to the development of downstream areas.

- The ditch along the railway will be left as is to drain the railway and undeveloped areas upstream as well as a small portion of the downtown commercial area.
- Some ditches that will receive runoff from the proposed storm trunks or storm ponds will require improvement. Site studies should therefore be completed to confirm the location of all the underground utilities and pipelines before preliminary design is completed. More detailed topographic data (surveys or LIDAR) should be acquired and used to develop preliminary elevations and grades of the ponds, pipes, and ditches.
- Existing wetlands should be preserved and incorporated into the stormwater management system where possible. An assessment should be conducted by a Qualified Aquatic Environmental Specialist to determine if these wetlands will need to be preserved or compensated, along with the preliminary hydraulic design/grades and elevations of the proposed stormwater management system.

9.4 TRANSPORTATION SYSTEM

In addition to the upgrades identified in this report, Associated Engineering recommends the following:

- Periodic monitoring of intersection traffic volumes through intersection turning movement counts to identify the need for upgrades
- Require traffic impact assessment for all area structure plans in order to identify the appropriate intersection treatment at access points to the development form the arterial road network.
- Control and consolidate access points to the arterial road network to accommodate future arterial road upgrades
- Continue to protect/acquire the right-of-way to accommodate future arterial road upgrades

REPORT

Closure

This report was prepared for the Town of Redwater for the purpose of providing a Master Services Plan Update.

The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering Alberta Ltd.

Sept 1, 2010
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Sept 1, 2010
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Project Engineer

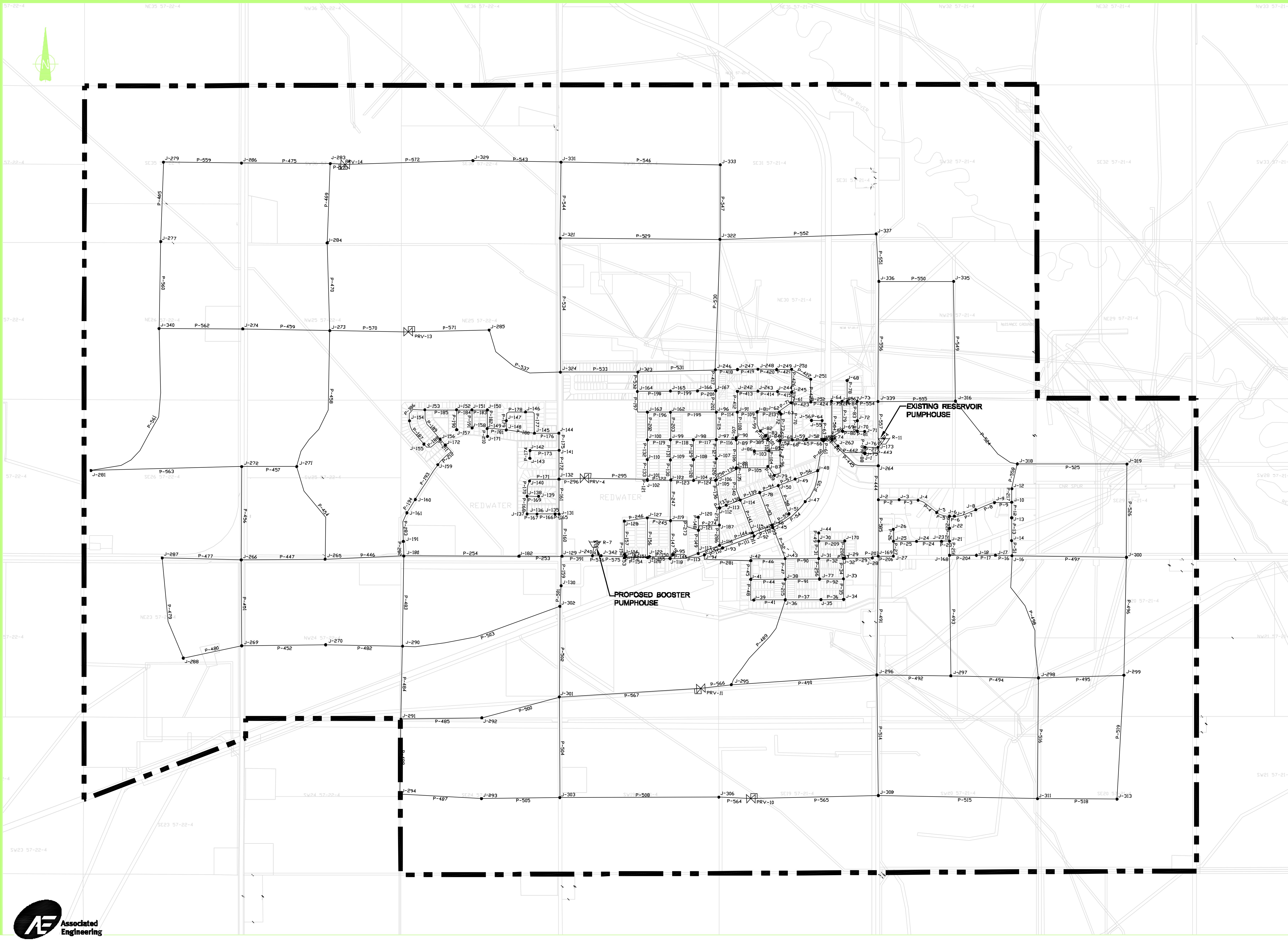
ASSOCIATED ENGINEERING
QUALITY MANAGEMENT SIGN-OFF
Signature:
Date: September 2, 2010

APEGGA Permit to Practice P 3979

Permit Stamp

A

Appendix A - Water Distribution System - Numbering Plan, Unit Costs and WaterCAD Model Reports



TOWN OF REDWATER

MASTER SERVICES PLAN UPDATE

WATER SYSTEM

SCALE: 1 : 15 000

AUGUST, 2010

WATER INDEX

Associated Engineering

Town of Redwater - Master Plan Update
Estimated Costs - Water Distribution System

Recommended Upgrades to Existing System

1.0 Distribution System

Location	From	To	Type	Length (m)	Diameter (mm)	Unit Price ($)	Amount ($)
Initial Upgrades to Existing System							
49 Avenue	58 Street	59 Street	Developed	164	200	$1,920	**$ 314,900**
52 Avenue	58 Street	59 Street	Developed	148	200	$1,920	**$ 284,200**
49 Avenue	51 Street	53 Street	Developed	274	200	$1,920	**$ 526,100**
49 Avenue	54 Street	55 Street	Developed	118	200	$1,920	**$ 226,600**
53 Street	49 Avenue	52 Avenue	Developed	417	300	$2,090	**$ 871,500**
51 Avenue	53 Street	54 Street	Developed	118	200	$1,920	**$ 226,600**
54 Street	51 Avenue	52 Avenue	Developed	209	200	$1,920	**$ 401,300**
51 Street	51 Avenue	52 Avenue	Developed	205	200	$1,920	**$ 393,600**
52 Street	51 Avenue	52 Avenue	Developed	207	200	$1,920	**$ 397,400**
47 Street	47 Avenue	48 Avenue	Developed	106	200	$1,920	**$ 203,500**
						Total	**$ 3,845,700**
Long Term Upgrades to Existing System							
49 Avenue	53 Street	54 Street	Developed	118	200	$1,920	**$ 226,600**
53 Street	48 Avenue	49 Avenue	Developed	182	300	$2,090	**$ 380,400**
48 Avenue	44 Street	52 Street	Developed	926	300	$2,090	**$ 1,935,300**
44 Street	48 Avenue	51 Avenue	Developed	289	400	$2,260	**$ 653,100**
52 Avenue	46 Street	53 Street	Developed	888	300	$2,090	**$ 1,855,900**
52 Avenue	Crossing Railway		Developed	30	350	$2,200	**$ 66,000**
Cross Correction (150x400mm)							**$ 15,000**
						Total	**$ 5,132,300**
						Total	**$ 8,978,000**

2.0 Hydrants

38 hydrants* including leads, valves, installation and restoration at $10,000 per hydrant — **$ 380,000**

*(the cost of proposed hydrants along proposed watermains identified above are not included)

3.0 Booster Pumphouse

Booster Pumphouse — **$ 800,000**

Total Recommended Upgrades to Existing System = $ 10,158,000

Town of Redwater - Water Distribution System Unit Costs

Cost Estimates

Watermains

Undeveloped Land

Item	Pipe Diameter 200	250	300	350	400	450	500	600
Topsoil Stripping and Stockpile (assume depth of 0.4m)	17.5	17.5	17.5	17.5	20.0	20.0	20.0	20.0
Trenching and backfilling	270	270	270	270	315	315	315	315
Pipe Zone Material	25	25	25	25	50	50	50	50
Supply and Install DR 18 Pipe	80	110	155	210	275	350	430	600
Place Topsoil, compact and seed	35	35	35	35	40	40	40	40
Fire Hydrant (1 every 90m)	100	100	100	100	100	100	100	100
Gate Valve (1 per 100m 300 mm down, 1 per 200 m 400 mm and up)	30	50	70	90	60	75	100	125
Fittings (Tees, Bends, Reducers, Plugs)	10	12	14	16	20	24	26	30
Miscellaneous (Mob/De-Mob, Survey, Signage) (10%)	57	62	69	76	88	97	108	128
Engineering and Contingency (add 30%)	187	204	227	252	290	321	357	422
Total	812	886	982	1092	1258	1393	1546	1830
Total (rounded)	**$810**	**$890**	**$980**	**$1,090**	**$1,260**	**$1,390**	**$1,550**	**$1,830**

Developed Land

Item	Pipe Diameter 200	250	300	350	400	450	500	600
Asphalt Pavement Removal	45	45	45	45	67.5	67.5	67.5	67.5
Granular Base Removal and Disposal	30	30	30	30	45	45	45	45
Curb, Gutter, sidewalk Removal	50	50	50	50	50	50	50	50
Trenching and Backfilling	370	370	370	370	415	415	415	415
Pipe Zone Material	25	25	25	25	50	50	50	50
Supply and Install DR 18 Pipe	80	110	155	210	275	350	430	600
Monolithic Sidewalk Curb and Gutter	190	190	190	190	190	190	190	190
Existing Pavement Repair	200	200	200	200	300	300	300	300
Fire Hydrant (1 every 90m)	100	100	100	100	100	100	100	100
Gate Valve (1 per 100m 300 mm down, 1 per 200 m 400 mm and up)	30	50	70	90	60	75	100	125
Fittings (Tees, Bends, Reducers, Plugs)	10	12	14	16	20	24	26	30
Reconnect services	200	200	200	200	0	0	0	0
Manhole/Valve/Catch Basin Adjustments	10	10	10	10	10	10	10	10
Miscellaneous (Mob/De-Mob, Survey, Signage) (10%)	134	139	146	154	158	168	178	198
Engineering and Contingency (add 30%)	442	459	481	507	522	553	589	654
Total	1916	1991	2086	2196	2263	2397	2550	2835
Total (rounded)	**$1,920**	**$1,990**	**$2,090**	**$2,200**	**$2,260**	**$2,400**	**$2,550**	**$2,830**

Active Scenario: Existing Peak Hour

Current Time: 0.000 hours

Label	Elevation (m)	Demand (L/s)	Pressure (kPa)	Hydraulic Grade (m)	Is Active?
J-1	625.40	0.000	486.7	675.13	True
J-2	627.60	0.000	465.1	675.12	True
J-3	627.00	0.240	470.8	675.11	True
J-4	626.20	0.390	478.5	675.09	True
J-5	625.80	0.000	482.3	675.08	True
J-6	625.00	0.330	490.0	675.07	True
J-7	624.90	0.000	491.0	675.07	True
J-8	624.30	0.360	496.9	675.07	True
J-9	623.30	0.000	506.6	675.07	True
J-10	621.50	0.660	524.2	675.07	True
J-12	621.40	0.000	525.2	675.07	True
J-13	623.50	0.000	504.7	675.07	True
J-14	625.00	0.300	490.0	675.07	True
J-16	625.50	0.000	485.1	675.07	True
J-17	625.40	0.000	486.1	675.07	True
J-18	626.40	0.210	476.3	675.06	True
J-21	625.70	0.300	483.1	675.06	True
J-22	625.30	0.000	487.1	675.07	True
J-23	625.90	0.000	481.1	675.06	True
J-24	626.50	0.210	475.2	675.05	True
J-25	627.60	0.000	464.3	675.05	True
J-26	627.40	0.240	466.3	675.05	True
J-27	628.00	0.240	460.4	675.04	True
J-28	628.50	0.000	455.4	675.04	True
J-29	630.00	0.180	440.7	675.03	True
J-30	630.00	0.240	440.6	675.02	True
J-31	630.50	0.750	435.7	675.01	True
J-32	630.00	0.000	440.7	675.02	True
J-33	629.70	0.300	443.5	675.01	True
J-34	629.70	0.120	443.4	675.01	True
J-35	630.30	0.270	437.5	675.00	True
J-36	630.40	0.180	436.5	675.00	True
J-38	631.00	0.150	430.6	675.00	True
J-39	631.50	0.480	425.7	675.00	True
J-41	631.50	0.660	425.7	675.00	True
J-42	631.40	0.270	426.7	675.00	True
J-43	631.20	0.390	428.7	675.00	True
J-44	629.40	0.000	446.4	675.02	True
J-45	631.00	0.000	430.6	675.00	True
J-46	631.00	0.180	430.6	675.00	True
J-47	629.70	0.000	443.5	675.01	True
J-48	628.60	0.210	454.4	675.03	True
J-49	629.40	0.000	446.5	675.02	True
J-50	629.90	0.240	441.5	675.01	True
J-51	630.30	0.210	437.5	675.00	True
J-52	627.90	0.000	461.4	675.04	True
J-53	627.90	0.000	461.4	675.05	True

Active Scenario: Existing Peak Hour

Current Time: 0.000 hours

Label	Elevation (m)	Demand (L/s)	Pressure (kPa)	Hydraulic Grade (m)	Is Active?
J-54	627.90	0.000	461.4	675.04	True
J-55	627.30	0.000	467.3	675.04	True
J-56	627.40	0.210	466.3	675.04	True
J-57	629.20	0.000	448.5	675.03	True
J-58	628.50	0.270	455.4	675.04	True
J-59	629.10	0.510	449.5	675.03	True
J-60	629.20	0.000	448.5	675.03	True
J-61	627.60	0.000	464.2	675.03	True
J-62	628.50	0.390	455.3	675.02	True
J-63	628.50	0.000	455.3	675.02	True
J-64	626.40	0.000	476.3	675.07	True
J-65	624.20	0.210	498.0	675.08	True
J-67	623.90	0.000	500.9	675.08	True
J-68	622.40	0.210	515.6	675.08	True
J-69	626.40	0.180	476.6	675.10	True
J-70	625.40	0.210	486.3	675.09	True
J-71	625.40	0.000	486.3	675.09	True
J-72	625.40	0.000	486.3	675.09	True
J-73	623.60	0.240	503.8	675.08	True
J-74	627.30	0.000	467.8	675.10	True
J-75	625.40	0.000	486.7	675.13	True
J-76	626.82	0.000	472.8	675.13	True
J-77	630.50	0.300	435.5	675.00	True
J-78	630.30	0.180	437.4	675.00	True
J-79	629.70	0.000	443.5	675.02	True
J-81	629.10	0.210	449.0	674.98	True
J-82	629.30	0.000	447.0	674.97	True
J-83	629.30	0.270	447.0	674.97	True
J-84	629.40	0.000	446.0	674.97	True
J-85	629.50	0.000	445.0	674.97	True
J-86	629.70	0.120	443.1	674.97	True
J-87	629.70	0.210	443.1	674.97	True
J-88	630.50	0.000	435.2	674.97	True
J-89	630.30	0.600	437.1	674.97	True
J-90	630.30	0.000	437.1	674.97	True
J-91	629.70	0.210	443.0	674.96	True
J-92	631.20	0.000	428.6	674.99	True
J-93	632.20	0.000	418.7	674.99	True
J-94	632.70	0.000	413.8	674.98	True
J-95	633.20	0.000	408.9	674.98	True
J-96	630.00	0.210	440.0	674.96	True
J-97	630.30	0.210	437.1	674.96	True
J-98	630.90	0.210	431.2	674.96	True
J-99	631.50	0.450	425.3	674.96	True
J-100	632.00	0.330	420.4	674.96	True
J-101	632.50	0.210	415.6	674.96	True
J-102	632.50	0.000	415.6	674.96	True

Active Scenario: Existing Peak Hour

Current Time: 0.000 hours

Label	Elevation (m)	Demand (L/s)	Pressure (kPa)	Hydraulic Grade (m)	Is Active?
J-103	631.90	0.210	421.4	674.96	True
J-104	631.50	0.210	425.4	674.96	True
J-105	630.90	0.000	431.3	674.97	True
J-106	630.90	0.420	431.3	674.97	True
J-107	630.80	0.000	432.2	674.96	True
J-108	630.90	0.000	431.2	674.96	True
J-109	631.80	0.000	422.4	674.96	True
J-110	632.30	0.000	417.5	674.96	True
J-111	630.50	0.330	435.2	674.97	True
J-112	632.20	0.000	418.6	674.97	True
J-113	631.50	0.000	425.4	674.97	True
J-114	630.90	0.630	431.3	674.97	True
J-115	631.20	0.210	428.5	674.98	True
J-116	632.20	0.090	418.6	674.97	True
J-117	632.70	0.090	413.7	674.97	True
J-118	633.20	0.330	408.8	674.97	True
J-119	632.70	0.210	413.7	674.97	True
J-120	632.20	0.510	418.5	674.96	True
J-121	632.20	0.240	418.5	674.96	True
J-122	633.60	0.000	405.0	674.98	True
J-123	634.30	0.000	398.1	674.98	True
J-124	634.30	0.090	398.1	674.98	True
J-125	634.30	0.000	398.1	674.97	True
J-126	633.60	0.330	404.9	674.97	True
J-127	632.80	0.210	412.7	674.97	True
J-128	633.20	0.120	408.9	674.98	True
J-129	635.20	0.300	389.3	674.97	True
J-130	634.90	0.000	392.2	674.97	True
J-131	634.00	0.000	400.9	674.97	True
J-132	634.00	0.000	400.9	674.96	True
J-135	634.00	0.000	400.9	674.97	True
J-136	634.70	0.480	394.1	674.96	True
J-137	635.20	0.000	389.2	674.96	True
J-138	634.90	0.120	392.1	674.96	True
J-139	634.50	0.180	396.0	674.96	True
J-140	634.60	0.300	395.0	674.96	True
J-141	634.00	0.000	400.9	674.96	True
J-142	634.00	0.510	400.9	674.96	True
J-143	634.00	0.000	400.9	674.96	True
J-144	633.40	0.240	406.8	674.96	True
J-145	634.10	0.210	399.9	674.96	True
J-146	633.30	0.420	407.7	674.96	True
J-147	634.00	0.000	400.9	674.96	True
J-148	634.00	0.180	400.9	674.96	True
J-149	633.70	0.120	403.8	674.96	True
J-150	634.00	0.120	400.9	674.96	True
J-151	634.00	0.120	400.9	674.96	True

Active Scenario: Existing Peak Hour

Current Time: 0.000 hours

Label	Elevation (m)	Demand (L/s)	Pressure (kPa)	Hydraulic Grade (m)	Is Active?
J-152	634.30	0.210	397.9	674.96	True
J-153	635.20	0.270	389.2	674.96	True
J-154	635.80	0.210	383.3	674.96	True
J-155	636.40	0.210	377.4	674.96	True
J-156	635.80	0.000	383.3	674.97	True
J-157	634.90	0.150	392.1	674.96	True
J-158	634.60	0.090	395.0	674.96	True
J-159	637.00	0.000	371.6	674.97	True
J-160	637.80	0.300	363.8	674.97	True
J-161	638.00	0.000	361.8	674.97	True
J-162	630.80	0.330	432.2	674.96	True
J-163	631.50	0.240	425.3	674.96	True
J-164	630.90	0.330	431.2	674.96	True
J-165	630.30	0.000	437.1	674.96	True
J-166	629.70	0.300	442.9	674.96	True
J-167	629.10	0.060	448.8	674.96	True
J-168	627.20	0.000	468.4	675.06	True
J-169	628.50	0.000	455.5	675.04	True
J-170	630.00	0.210	440.6	675.02	True
J-171	634.00	0.000	400.9	674.96	True
J-172	635.90	0.240	382.4	674.97	True
J-173	626.82	0.000	472.8	675.13	True
J-174	627.30	0.000	468.1	675.13	True
J-175	627.30	0.000	468.1	675.13	True
J-176	627.30	0.000	468.1	675.13	True
J-177	627.30	0.000	468.1	675.13	True
J-178	627.30	0.000	468.1	675.13	True
J-180	639.30	0.000	349.1	674.97	True
J-182	637.00	0.000	371.6	674.97	True
J-191	638.50	0.000	357.0	674.97	True
J-242	628.00	0.120	459.6	674.96	True
J-243	628.00	0.120	459.6	674.96	True
J-244	628.00	0.120	459.6	674.96	True
J-246	628.50	0.060	454.7	674.96	True
J-247	628.50	0.090	454.7	674.96	True
J-252	627.00	0.000	470.3	675.05	True
J-253	628.40	0.000	458.0	675.20	True
J-254	628.40	0.000	457.4	675.14	True
J-255	628.40	0.000	457.6	675.16	True
J-260	628.40	0.000	458.0	675.20	True
J-261	628.40	0.000	458.0	675.20	True
J-263	627.40	0.000	466.9	675.11	True
J-264	627.90	0.000	462.2	675.12	True
J-346	627.90	0.000	462.2	675.12	True
J-347	627.60	0.000	465.0	675.12	True
J-348	635.60	0.000	385.3	674.97	True

Active Scenario: Existing Peak Hour

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-2	J-2	J-3	106.93	250.0	130.0	8.039	0.16	True
P-3	J-3	J-4	97.63	250.0	130.0	7.799	0.16	True
P-4	J-4	J-5	115.44	250.0	130.0	7.409	0.15	True
P-5	J-5	J-6	70.20	250.0	130.0	7.409	0.15	True
P-6	J-6	J-7	24.79	250.0	130.0	2.547	0.05	True
P-7	J-7	J-8	115.24	250.0	130.0	2.547	0.05	True
P-8	J-8	J-9	104.24	250.0	130.0	2.187	0.04	True
P-9	J-9	J-10	88.84	250.0	130.0	2.187	0.04	True
P-12	J-10	J-13	79.95	297.0	130.0	1.527	0.02	True
P-13	J-13	J-14	117.53	297.0	130.0	1.527	0.02	True
P-16	J-16	J-17	84.93	297.0	130.0	1.227	0.02	True
P-17	J-17	J-18	98.70	297.0	130.0	1.227	0.02	True
P-21	J-21	J-22	66.47	250.0	130.0	-4.532	0.09	True
P-22	J-22	J-6	61.64	250.0	130.0	-4.532	0.09	True
P-23	J-21	J-23	41.90	250.0	130.0	5.249	0.11	True
P-24	J-23	J-24	128.04	250.0	130.0	5.249	0.11	True
P-25	J-24	J-25	118.50	250.0	130.0	5.039	0.10	True
P-26	J-25	J-26	61.18	250.0	130.0	0.240	0.00	True
P-27	J-25	J-27	76.75	250.0	130.0	4.799	0.10	True
P-29	J-28	J-29	141.74	254.0	120.0	4.559	0.09	True
P-31	J-30	J-31	89.35	148.6	120.0	0.738	0.04	True
P-32	J-31	J-32	126.05	148.6	120.0	-1.411	0.08	True
P-33	J-32	J-29	7.68	148.6	120.0	-3.191	0.18	True
P-34	J-32	J-33	106.05	148.6	120.0	1.780	0.10	True
P-35	J-33	J-34	105.22	148.6	120.0	0.998	0.06	True
P-36	J-34	J-35	116.79	148.6	120.0	0.878	0.05	True
P-37	J-35	J-36	183.19	148.6	120.0	0.608	0.04	True
P-41	J-36	J-39	162.23	148.6	120.0	0.578	0.03	True
P-44	J-41	J-38	177.19	100.3	120.0	-0.221	0.03	True
P-45	J-41	J-42	96.01	148.6	120.0	-0.341	0.02	True
P-46	J-42	J-43	185.64	148.6	120.0	-0.611	0.04	True
P-47	J-43	J-38	106.28	148.6	120.0	0.340	0.02	True
P-48	J-39	J-41	122.16	100.3	120.0	0.098	0.01	True
P-49	J-30	J-44	41.81	148.6	120.0	0.000	0.00	True
P-51	J-14	J-16	77.49	297.0	130.0	1.227	0.02	True
P-52	J-43	J-45	171.22	199.4	120.0	0.059	0.00	True
P-53	J-45	J-46	12.16	199.4	120.0	1.663	0.05	True
P-54	J-45	J-47	215.91	297.0	130.0	-8.322	0.12	True
P-55	J-47	J-48	176.76	297.0	130.0	-8.322	0.12	True
P-56	J-48	J-49	122.46	148.6	120.0	1.148	0.07	True
P-57	J-49	J-50	93.42	148.6	120.0	1.148	0.07	True
P-58	J-50	J-51	155.68	148.6	120.0	1.179	0.07	True
P-59	J-51	J-46	111.82	148.6	120.0	0.969	0.06	True
P-60	J-48	J-52	162.13	293.9	120.0	-9.679	0.14	True
P-61	J-52	J-53	10.35	293.9	120.0	-11.018	0.16	True
P-62	J-53	J-54	12.22	199.4	120.0	3.401	0.11	True

Active Scenario: Existing Peak Hour

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-63	J-54	J-55	99.16	148.6	120.0	0.210	0.01	True
P-64	J-55	J-56	54.92	148.6	120.0	0.210	0.01	True
P-65	J-52	J-57	224.06	148.6	120.0	1.338	0.08	True
P-66	J-54	J-58	80.36	199.4	120.0	3.191	0.10	True
P-67	J-58	J-59	72.02	199.4	120.0	2.921	0.09	True
P-68	J-59	J-60	59.02	199.4	120.0	2.835	0.09	True
P-69	J-60	J-57	8.12	199.4	120.0	0.962	0.03	True
P-70	J-59	J-61	192.84	199.4	120.0	-0.423	0.01	True
P-71	J-61	J-62	80.81	148.6	120.0	1.719	0.10	True
P-72	J-62	J-63	17.67	199.4	120.0	-1.873	0.06	True
P-73	J-63	J-60	132.46	199.4	120.0	-1.873	0.06	True
P-75	J-64	J-65	49.29	148.6	120.0	-2.142	0.12	True
P-78	J-67	J-68	107.29	148.6	120.0	0.210	0.01	True
P-79	J-65	J-69	153.75	148.6	120.0	-1.657	0.10	True
P-80	J-69	J-70	76.94	148.6	120.0	1.355	0.08	True
P-81	J-70	J-71	37.15	148.6	120.0	0.000	0.00	True
P-82	J-70	J-72	55.29	148.6	120.0	1.145	0.07	True
P-83	J-72	J-73	98.87	148.6	120.0	1.145	0.07	True
P-84	J-73	J-67	52.64	148.6	120.0	0.905	0.05	True
P-85	J-53	J-74	38.46	199.4	120.0	-14.419	0.46	True
P-86	J-74	J-69	78.15	200.0	130.0	3.192	0.10	True
P-88	J-75	J-1	5.51	268.7	120.0	10.713	0.19	True
P-89	J-75	J-76	28.01	392.4	120.0	-25.650	0.21	True
P-90	J-43	J-31	172.61	148.6	120.0	-1.400	0.08	True
P-91	J-38	J-77	176.47	100.3	120.0	-0.181	0.02	True
P-92	J-77	J-33	123.06	100.3	120.0	-0.481	0.06	True
P-93	J-46	J-78	180.21	148.6	120.0	0.550	0.03	True
P-94	J-78	J-50	101.47	148.6	120.0	-2.029	0.12	True
P-95	J-50	J-79	56.87	199.4	120.0	-2.300	0.07	True
P-96	J-79	J-57	199.03	199.4	120.0	-2.300	0.07	True
P-99	J-81	J-82	101.91	199.4	120.0	1.467	0.05	True
P-100	J-82	J-83	35.79	199.4	120.0	1.467	0.05	True
P-101	J-83	J-84	20.87	199.4	120.0	1.197	0.04	True
P-102	J-84	J-85	61.14	199.4	120.0	1.197	0.04	True
P-103	J-85	J-86	75.17	148.6	120.0	0.120	0.01	True
P-104	J-85	J-87	82.74	199.4	120.0	1.077	0.03	True
P-105	J-87	J-88	165.41	199.4	120.0	0.867	0.03	True
P-106	J-88	J-89	143.22	199.4	120.0	1.560	0.05	True
P-107	J-89	J-90	10.12	148.6	120.0	0.179	0.01	True
P-108	J-90	J-91	138.31	148.6	120.0	0.179	0.01	True
P-109	J-91	J-81	101.88	152.4	110.0	-1.524	0.08	True
P-110	J-45	J-92	108.08	297.0	130.0	6.718	0.10	True
P-111	J-92	J-93	172.48	297.0	130.0	6.718	0.10	True
P-112	J-93	J-94	99.72	297.0	130.0	6.718	0.10	True
P-113	J-94	J-95	175.01	392.4	120.0	6.718	0.06	True
P-114	J-91	J-96	107.82	152.4	110.0	1.133	0.06	True

Active Scenario: Existing Peak Hour

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-115	J-96	J-97	141.69	101.6	110.0	-0.248	0.03	True
P-116	J-97	J-89	102.40	152.4	110.0	-0.781	0.04	True
P-117	J-97	J-98	117.55	152.4	110.0	0.575	0.03	True
P-118	J-98	J-99	117.76	152.4	110.0	0.565	0.03	True
P-119	J-99	J-100	118.53	152.4	110.0	0.209	0.01	True
P-121	J-101	J-102	6.88	101.6	110.0	-0.006	0.00	True
P-122	J-102	J-103	118.39	152.4	110.0	-0.006	0.00	True
P-123	J-103	J-104	119.05	152.4	110.0	-0.437	0.02	True
P-124	J-104	J-105	112.74	152.4	110.0	-0.846	0.05	True
P-125	J-105	J-106	4.88	152.4	110.0	0.238	0.01	True
P-126	J-106	J-107	108.20	101.6	110.0	0.253	0.03	True
P-127	J-107	J-97	97.52	101.6	110.0	0.253	0.03	True
P-128	J-104	J-108	107.06	101.6	110.0	0.200	0.02	True
P-129	J-108	J-98	101.07	101.6	110.0	0.200	0.02	True
P-130	J-103	J-109	103.99	101.6	110.0	0.221	0.03	True
P-131	J-109	J-99	103.57	101.6	110.0	0.221	0.03	True
P-132	J-100	J-110	102.53	101.6	110.0	-0.233	0.03	True
P-133	J-110	J-101	99.72	101.6	110.0	-0.233	0.03	True
P-134	J-106	J-111	115.87	152.4	110.0	-0.435	0.02	True
P-135	J-111	J-88	7.36	199.4	120.0	0.693	0.02	True
P-136	J-105	J-112	144.16	199.4	120.0	-1.084	0.03	True
P-137	J-112	J-113	35.89	148.6	120.0	-0.733	0.04	True
P-138	J-113	J-114	77.15	148.6	120.0	-0.733	0.04	True
P-139	J-114	J-78	107.19	148.6	120.0	-2.399	0.14	True
P-140	J-114	J-111	162.88	199.4	120.0	1.457	0.05	True
P-141	J-114	J-115	179.70	100.3	120.0	-0.422	0.05	True
P-142	J-115	J-46	107.72	148.6	120.0	-1.902	0.11	True
P-143	J-112	J-116	192.46	148.6	120.0	-0.351	0.02	True
P-144	J-116	J-115	181.60	148.6	120.0	-1.270	0.07	True
P-145	J-116	J-117	117.02	148.6	120.0	0.829	0.05	True
P-146	J-117	J-118	148.95	148.6	120.0	-0.011	0.00	True
P-147	J-118	J-119	193.47	148.6	120.0	0.210	0.01	True
P-148	J-120	J-121	66.74	100.3	120.0	-0.510	0.06	True
P-149	J-121	J-117	119.91	148.6	120.0	-0.750	0.04	True
P-150	J-95	J-122	123.48	392.4	120.0	6.718	0.06	True
P-151	J-122	J-123	122.81	392.4	120.0	6.718	0.06	True
P-152	J-123	J-124	16.44	155.0	130.0	1.301	0.07	True
P-153	J-124	J-125	15.83	148.6	120.0	1.091	0.06	True
P-154	J-125	J-126	118.07	148.6	120.0	1.091	0.06	True
P-155	J-126	J-118	123.36	148.6	120.0	0.551	0.03	True
P-156	J-126	J-127	203.67	148.6	120.0	0.210	0.01	True
P-157	J-124	J-128	171.29	148.6	120.0	0.120	0.01	True
P-158	J-123	J-129	328.21	392.4	120.0	5.417	0.04	True
P-159	J-129	J-130	156.10	297.0	130.0	0.000	0.00	True
P-160	J-129	J-131	234.41	250.0	130.0	3.349	0.07	True
P-161	J-131	J-132	178.61	254.0	120.0	2.555	0.05	True

Active Scenario: Existing Peak Hour

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-162	J-132	J-101	454.24	199.4	120.0	0.437	0.01	True
P-165	J-131	J-135	19.74	148.6	120.0	0.793	0.05	True
P-166	J-135	J-136	93.25	148.6	120.0	0.793	0.05	True
P-167	J-136	J-137	50.58	148.6	120.0	0.313	0.02	True
P-168	J-137	J-138	90.89	148.6	120.0	0.313	0.02	True
P-169	J-138	J-139	58.95	148.6	120.0	0.180	0.01	True
P-170	J-138	J-140	80.62	148.6	120.0	0.013	0.00	True
P-171	J-140	J-132	157.69	148.6	120.0	-0.287	0.02	True
P-172	J-132	J-141	147.53	254.0	120.0	1.832	0.04	True
P-173	J-141	J-142	148.36	148.6	120.0	0.510	0.03	True
P-174	J-142	J-143	39.78	148.6	120.0	0.000	0.00	True
P-175	J-141	J-144	88.56	254.0	120.0	1.322	0.03	True
P-176	J-144	J-145	125.87	254.0	120.0	1.082	0.02	True
P-177	J-145	J-146	149.54	148.6	120.0	0.249	0.01	True
P-178	J-146	J-147	137.37	148.6	120.0	-0.171	0.01	True
P-179	J-147	J-148	46.58	148.6	120.0	-0.171	0.01	True
P-180	J-148	J-145	144.72	254.0	120.0	-0.622	0.01	True
P-181	J-148	J-149	98.53	254.0	120.0	0.272	0.01	True
P-182	J-149	J-150	95.50	148.6	120.0	0.151	0.01	True
P-183	J-150	J-151	79.49	148.6	120.0	0.031	0.00	True
P-184	J-151	J-152	79.27	148.6	120.0	-0.179	0.01	True
P-185	J-152	J-153	162.79	148.6	120.0	-0.539	0.03	True
P-186	J-153	J-154	125.41	148.6	120.0	-0.187	0.01	True
P-187	J-154	J-155	145.37	148.6	120.0	-0.397	0.02	True
P-188	J-155	J-156	105.12	148.6	120.0	-0.607	0.04	True
P-189	J-156	J-153	178.12	148.6	120.0	0.621	0.04	True
P-190	J-152	J-157	102.41	148.6	120.0	0.150	0.01	True
P-191	J-151	J-158	92.50	148.6	120.0	0.090	0.01	True
P-193	J-159	J-160	213.11	250.0	130.0	-1.469	0.03	True
P-194	J-160	J-161	81.42	250.0	130.0	-1.769	0.04	True
P-195	J-96	J-162	235.63	152.4	110.0	0.316	0.02	True
P-196	J-162	J-163	118.42	152.4	110.0	0.113	0.01	True
P-197	J-163	J-164	158.19	204.0	130.0	-0.015	0.00	True
P-198	J-164	J-165	168.74	204.0	130.0	-0.345	0.01	True
P-199	J-165	J-166	139.26	204.0	130.0	-0.345	0.01	True
P-200	J-166	J-167	93.06	204.0	130.0	-0.645	0.02	True
P-201	J-167	J-96	113.33	204.0	130.0	-0.855	0.03	True
P-202	J-163	J-100	141.26	101.6	110.0	-0.112	0.01	True
P-203	J-162	J-99	141.83	101.6	110.0	-0.126	0.02	True
P-204	J-18	J-168	138.25	297.0	130.0	1.017	0.01	True
P-206	J-27	J-169	77.84	250.0	130.0	4.559	0.09	True
P-207	J-169	J-28	38.91	250.0	130.0	4.559	0.09	True
P-208	J-29	J-170	89.58	148.6	120.0	1.188	0.07	True
P-209	J-170	J-30	133.92	148.6	120.0	0.978	0.06	True
P-210	J-149	J-171	40.04	254.0	120.0	0.000	0.00	True
P-211	J-156	J-172	40.48	148.6	120.0	-1.229	0.07	True

Active Scenario: Existing Peak Hour

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-212	J-172	J-159	140.22	250.0	130.0	-1.469	0.03	True
P-213	J-62	J-81	113.97	152.4	110.0	3.202	0.18	True
P-214	J-67	J-65	29.20	148.6	120.0	0.695	0.04	True
P-215	J-38	J-36	105.65	148.6	120.0	0.150	0.01	True
P-216	J-21	J-168	72.60	250.0	130.0	-1.017	0.02	True
P-217	J-12	J-10	72.67	297.0	130.0	0.000	0.00	True
P-219	J-173	J-76	67.53	406.4	110.0	25.650	0.20	True
P-221	J-174	J-175	21.81	406.4	110.0	0.000	0.00	True
P-222	J-176	J-175	23.90	406.4	110.0	0.000	0.00	True
P-223	J-176	J-177	23.90	406.4	110.0	0.000	0.00	True
P-224	J-177	J-178	22.20	406.4	110.0	0.000	0.00	True
P-226	PMP- Fire Pump	J-178	47.25	254.0	110.0	0.000	0.00	True
P-228	PMP-Fire Pump	J-176	43.24	254.0	110.0	0.000	0.00	True
P-231	J-173	PRV-1	25.26	406.4	110.0	-25.650	0.20	True
P-232	PRV-1	J-174	31.89	406.4	110.0	-25.650	0.20	True
P-233	T-1	PMP-40 HP	41.97	152.4	110.0	0.000	0.00	True
P-234	T-1	PMP-50 HP	26.22	152.4	110.0	0.000	0.00	True
P-235	T-1	PMP-Fire Pump	24.02	203.2	110.0	0.000	0.00	True
P-236	T-1	PMP- 40 HP	42.27	152.4	110.0	25.651	1.41	True
P-237	T-1	PMP-Fire Pump	51.55	203.2	110.0	0.000	0.00	True
P-253	J-129	J-182	220.97	400.0	130.0	1.769	0.01	True
P-254	J-182	J-180	591.83	400.0	130.0	1.769	0.01	True
P-282	J-180	J-191	75.02	300.0	130.0	1.769	0.03	True
P-283	J-191	J-161	151.36	300.0	130.0	1.769	0.03	True
P-412	J-91	J-242	106.89	200.0	130.0	0.360	0.01	True
P-413	J-242	J-243	104.98	200.0	130.0	0.240	0.01	True
P-414	J-243	J-244	101.17	200.0	130.0	0.120	0.00	True
P-417	J-167	J-246	107.63	300.0	130.0	0.150	0.00	True
P-418	J-246	J-247	113.84	300.0	130.0	0.090	0.00	True
P-423	J-61	J-252	101.86	148.6	120.0	-2.142	0.12	True
P-424	J-252	J-64	109.10	148.6	120.0	-2.142	0.12	True
P-428	J-254	J-174	19.60	200.0	110.0	25.651	0.82	True
P-430	J-253	J-255	45.28	150.0	110.0	25.651	1.45	True
P-431	J-255	J-254	27.93	200.0	110.0	25.651	0.82	True
P-434	J-261	J-260	21.74	200.0	110.0	0.000	0.00	True
P-435	J-260	J-253	61.88	200.0	110.0	0.000	0.00	True
P-436	PMP-40 HP	J-261	20.74	150.0	110.0	0.000	0.00	True

Active Scenario: Existing Peak Hour

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-437	PMP-50 HP	J-260	18.28	200.0	110.0	0.000	0.00	True
P-438	PMP- 40 HP	J-253	24.66	150.0	110.0	25.651	1.45	True
P-441	J-74	J-263	44.33	343.9	120.0	-17.611	0.19	True
P-442	J-263	J-75	152.97	343.9	120.0	-14.937	0.16	True
P-443	J-1	J-264	131.05	479.6	120.0	10.713	0.06	True
P-444	J-264	J-2	174.53	479.6	120.0	8.039	0.04	True
P-587	J-346	J-264	50.86	200.0	130.0	-2.674	0.09	True
P-588	J-263	J-347	90.77	200.0	130.0	-2.674	0.09	True
P-589	J-347	J-346	116.69	200.0	130.0	-2.674	0.09	True
P-590	J-130	J-348	244.95	239.0	130.0	0.000	0.00	True

Active Scenario: Existing Peak Hour

Current Time: 0.000 hours

Id	Label	Elevation (m)	Pump Definition	Status	Intake Grade (m)	Discharge Grade (m)	Discharge (L/s)
395	PMP-Fire Pump	627.30	Fire Pump	Off	624.00	675.13	0.000
396	PMP- 40 HP	627.30	40 HP Distribution Pump	On	623.92	675.23	25.651
397	PMP- Fire Pump	627.30	Fire Pump	Off	624.00	675.13	0.000
400	PMP-40 HP	627.30	40 HP Distribution Pump	On	624.00	675.20	0.000
401	PMP-50 HP	627.30	50 HP Distribution Pump	Off	624.00	675.20	0.000

Pump Head (m)	Is Active?
0.00	True
51.31	True
0.00	True
0.00	True
0.00	True

Active Scenario: Existing Peak Day plus Fire

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-1	True	83.000	201.000	0.000	138.0	491.2	276.0	355.9	True
J-2	True	183.001	201.000	0.000	138.0	462.7	276.0	354.4	True
J-3	True	183.001	201.000	0.144	138.0	424.3	276.0	348.9	True
J-4	True	183.001	201.000	0.234	138.0	399.9	276.0	345.2	True
J-5	True	183.001	201.000	0.000	138.0	371.7	276.0	341.4	True
J-6	True	183.001	201.000	0.198	138.0	362.4	276.0	339.3	True
J-7	True	183.001	201.000	0.000	138.0	353.7	276.0	339.2	True
J-8	True	183.001	201.000	0.216	138.0	332.6	276.0	336.0	True
J-9	True	183.001	201.000	0.000	138.0	330.7	276.0	331.6	True
J-10	True	183.001	201.000	0.396	138.0	344.8	276.0	323.2	True
J-12	True	183.001	201.000	0.000	138.0	328.3	276.0	323.2	True
J-13	True	183.001	201.000	0.000	138.0	325.3	276.0	318.9	True
J-14	True	183.001	201.000	0.180	138.0	312.1	276.0	313.4	True
J-16	True	183.001	201.000	0.000	138.0	309.2	276.0	316.4	True
J-17	True	183.001	201.000	0.000	138.0	313.2	276.0	312.8	True
J-18	True	183.001	201.000	0.126	138.0	308.1	276.0	315.0	True
J-21	True	183.001	201.000	0.180	138.0	340.7	276.0	328.3	True
J-22	True	183.001	201.000	0.000	138.0	348.3	276.0	336.7	True
J-23	True	183.001	201.000	0.000	138.0	330.2	276.0	322.2	True
J-24	True	183.001	201.000	0.126	138.0	301.1	276.0	297.4	True
J-25	True	183.001	199.887	0.000	138.0	274.2	276.0	276.0	True
J-26	True	183.001	198.891	0.144	138.0	244.6	276.0	276.0	True
J-27	True	183.001	191.965	0.144	138.0	275.1	276.0	276.0	True
J-28	False	183.001	180.875	0.000	138.0	279.1	276.0	276.0	True
J-29	True	83.000	171.706	0.108	138.0	270.7	276.0	276.0	True
J-30	True	83.000	107.514	0.144	138.0	270.1	276.0	276.0	True
J-31	True	83.000	144.390	0.450	138.0	243.1	276.0	276.0	True
J-32	True	83.000	173.159	0.000	138.0	255.8	276.0	276.0	True
J-33	True	83.000	117.136	0.180	138.0	249.3	276.0	276.0	True
J-34	True	83.000	99.695	0.072	138.0	236.6	276.0	276.0	True
J-35	True	83.000	102.969	0.162	138.0	194.1	276.0	276.0	True
J-36	True	83.000	99.187	0.108	138.0	273.5	276.0	276.0	True
J-38	True	83.000	127.495	0.090	138.0	243.2	276.0	276.0	True
J-39	True	83.000	94.761	0.288	138.0	138.0	276.0	312.0	True
J-41	True	83.000	92.413	0.396	138.0	218.4	276.0	276.0	True
J-42	True	83.000	90.706	0.162	138.0	246.1	276.0	276.0	True
J-43	True	83.000	172.384	0.234	138.0	274.2	276.0	276.0	True
J-44	True	83.000	105.579	0.000	138.0	178.1	276.0	276.0	True
J-45	False	183.001	176.632	0.000	138.0	356.7	276.0	276.0	True
J-46	False	183.001	178.560	0.108	138.0	346.8	276.0	276.0	True
J-47	True	183.000	190.987	0.000	138.0	362.3	276.0	276.0	True
J-48	True	183.000	201.000	0.126	138.0	376.5	276.0	279.9	True
J-49	True	183.000	194.007	0.000	138.0	138.0	276.0	284.0	True
J-50	True	183.001	201.000	0.144	138.0	282.5	276.0	278.5	True

Active Scenario: Existing Peak Day plus Fire

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-51	False	183.001	174.672	0.126	138.0	138.0	276.0	287.3	True
J-52	True	83.000	201.000	0.000	138.0	402.4	276.0	293.9	True
J-53	True	83.000	201.000	0.000	138.0	404.2	276.0	295.1	True
J-54	True	160.000	201.000	0.000	138.0	388.8	276.0	294.0	True
J-55	True	83.000	89.307	0.000	138.0	277.0	276.0	276.0	True
J-56	True	83.000	89.545	0.126	138.0	174.6	276.0	276.0	True
J-57	True	200.000	201.000	0.000	138.0	331.4	276.0	289.4	True
J-58	True	160.000	201.000	0.162	138.0	338.7	276.0	293.5	True
J-59	True	160.000	201.000	0.306	138.0	335.3	276.0	292.2	True
J-60	True	200.000	201.000	0.000	138.0	333.7	276.0	289.8	True
J-61	True	83.000	201.000	0.000	138.0	286.3	276.0	297.0	True
J-62	True	83.000	201.000	0.234	138.0	286.6	276.0	287.3	True
J-63	True	83.000	201.000	0.000	138.0	286.2	276.0	287.5	True
J-64	True	83.000	185.610	0.000	138.0	138.0	276.0	279.1	True
J-65	True	83.000	175.988	0.126	138.0	258.6	276.0	276.1	True
J-67	True	83.000	156.756	0.000	138.0	261.3	276.0	276.0	True
J-68	True	83.000	105.621	0.126	138.0	138.0	276.0	349.3	True
J-69	True	83.000	201.000	0.108	138.0	369.5	276.0	335.5	True
J-70	True	83.000	145.095	0.126	138.0	276.0	276.0	276.0	True
J-71	True	83.000	139.540	0.000	138.0	138.0	276.0	291.2	True
J-72	True	83.000	162.814	0.000	138.0	168.5	276.0	276.0	True
J-73	True	83.000	165.801	0.144	138.0	179.2	276.0	276.0	True
J-74	True	83.000	201.000	0.000	138.0	454.8	276.0	337.5	True
J-75	True	83.000	201.000	0.000	138.0	493.4	276.0	356.8	True
J-76	True	83.000	201.000	0.000	138.0	481.8	276.0	359.1	True
J-77	False	83.000	63.263	0.180	138.0	138.0	276.0	350.6	True
J-78	True	183.001	188.686	0.108	138.0	230.3	276.0	276.0	True
J-79	True	83.000	201.000	0.000	138.0	269.7	276.0	280.7	True
J-81	True	83.000	157.504	0.126	138.0	262.9	276.0	276.0	True
J-82	True	83.000	143.209	0.000	138.0	268.9	276.0	276.0	True
J-83	True	83.000	139.890	0.162	138.0	272.4	276.0	276.0	True
J-84	True	83.000	140.521	0.000	138.0	268.3	276.0	276.0	True
J-85	True	83.000	135.416	0.000	138.0	278.0	276.0	276.0	True
J-86	True	83.000	108.675	0.072	138.0	138.0	276.0	325.5	True
J-87	True	83.000	145.218	0.126	138.0	258.7	276.0	276.0	True
J-88	True	83.000	161.928	0.000	138.0	272.6	276.0	276.0	True
J-89	False	200.000	141.507	0.360	138.0	273.6	276.0	276.0	True
J-90	False	200.000	142.909	0.000	138.0	251.3	276.0	276.0	True
J-91	True	83.000	132.753	0.126	138.0	259.4	276.0	276.0	True
J-92	False	183.001	161.366	0.000	138.0	354.0	276.0	276.0	True
J-93	False	183.001	145.399	0.000	138.0	344.2	276.0	276.0	True
J-94	False	183.001	138.577	0.000	138.0	339.7	276.0	276.0	True
J-95	False	183.001	135.449	0.000	138.0	335.1	276.0	276.0	True
J-96	True	83.000	99.177	0.126	138.0	280.1	276.0	276.0	True

Active Scenario: Existing Peak Day plus Fire

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-97	True	83.000	129.687	0.126	138.0	235.3	276.0	276.0	True
J-98	True	83.000	116.337	0.126	138.0	221.2	276.0	276.0	True
J-99	True	83.000	100.877	0.270	138.0	256.3	276.0	276.0	True
J-100	True	83.000	100.209	0.198	138.0	186.3	276.0	276.0	True
J-101	False	183.000	113.066	0.126	138.0	257.0	276.0	276.0	True
J-102	False	183.000	115.606	0.000	138.0	218.9	276.0	276.0	True
J-103	False	183.000	118.871	0.126	138.0	213.0	276.0	276.0	True
J-104	True	83.000	127.461	0.126	138.0	214.6	276.0	276.0	True
J-105	True	133.000	145.227	0.000	138.0	272.6	276.0	276.0	True
J-106	True	133.000	145.836	0.252	138.0	266.4	276.0	276.0	True
J-107	False	83.000	72.218	0.000	138.0	138.0	276.0	340.9	True
J-108	False	83.000	70.278	0.000	138.0	138.0	276.0	340.6	True
J-109	False	83.000	68.814	0.000	138.0	138.0	276.0	340.4	True
J-110	False	83.000	68.653	0.000	138.0	138.0	276.0	339.3	True
J-111	True	83.000	161.761	0.198	138.0	274.0	276.0	276.0	True
J-112	False	183.000	150.614	0.000	138.0	248.2	276.0	276.0	True
J-113	False	200.000	149.407	0.000	138.0	229.0	276.0	276.0	True
J-114	False	200.000	171.619	0.378	138.0	255.4	276.0	276.0	True
J-115	False	183.001	170.676	0.126	138.0	153.6	276.0	276.0	True
J-116	False	183.001	120.969	0.054	138.0	254.2	276.0	276.0	True
J-117	False	183.001	85.733	0.054	138.0	271.1	276.0	276.0	True
J-118	False	183.001	79.371	0.198	138.0	271.1	276.0	276.0	True
J-119	False	183.000	63.463	0.126	138.0	138.0	276.0	320.1	True
J-120	False	183.000	41.090	0.306	138.0	138.0	276.0	334.9	True
J-121	False	183.000	53.804	0.144	138.0	276.0	276.0	276.0	True
J-122	False	183.001	133.396	0.000	138.0	331.3	276.0	276.0	True
J-123	False	183.001	131.463	0.000	138.0	324.7	276.0	276.0	True
J-124	False	183.001	134.124	0.054	138.0	291.0	276.0	276.0	True
J-125	False	200.000	136.691	0.000	138.0	249.2	276.0	276.0	True
J-126	False	183.001	87.189	0.198	138.0	268.2	276.0	276.0	True
J-127	False	83.000	64.104	0.126	138.0	138.0	276.0	330.4	True
J-128	False	83.000	77.027	0.072	138.0	138.0	276.0	327.2	True
J-129	False	183.000	125.421	0.180	138.0	316.1	276.0	276.0	True
J-130	False	183.000	125.420	0.000	138.0	303.4	276.0	276.0	True
J-131	False	160.000	128.814	0.000	138.0	297.7	276.0	276.0	True
J-132	True	83.000	130.533	0.000	138.0	284.1	276.0	276.0	True
J-135	False	160.000	116.071	0.000	138.0	274.9	276.0	276.0	True
J-136	False	160.000	82.645	0.288	138.0	270.1	276.0	276.0	True
J-137	False	160.000	83.757	0.000	138.0	245.5	276.0	276.0	True
J-138	False	83.000	73.756	0.072	138.0	272.1	276.0	276.0	True
J-139	False	83.000	72.518	0.108	138.0	207.0	276.0	276.0	True
J-140	False	83.000	82.765	0.180	138.0	255.6	276.0	276.0	True
J-141	True	83.000	121.525	0.000	138.0	276.0	276.0	276.0	True
J-142	False	83.000	52.985	0.306	138.0	276.0	276.0	276.0	True

Active Scenario: Existing Peak Day plus Fire

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-143	False	83.000	52.985	0.000	138.0	248.4	276.0	276.0	True
J-144	True	83.000	115.584	0.144	138.0	281.9	276.0	276.0	True
J-145	True	83.000	109.252	0.126	138.0	274.2	276.0	276.0	True
J-146	True	83.000	96.728	0.252	138.0	211.4	276.0	276.0	True
J-147	True	83.000	97.833	0.000	138.0	240.5	276.0	276.0	True
J-148	True	83.000	104.591	0.108	138.0	275.1	276.0	276.0	True
J-149	True	83.000	100.676	0.072	138.0	278.9	276.0	276.0	True
J-150	False	83.000	82.611	0.072	138.0	264.1	276.0	276.0	True
J-151	False	83.000	71.144	0.072	138.0	281.9	276.0	276.0	True
J-152	False	83.000	68.587	0.126	138.0	281.9	276.0	276.0	True
J-153	False	83.000	77.539	0.162	138.0	267.5	276.0	276.0	True
J-154	False	83.000	72.114	0.126	138.0	242.4	276.0	276.0	True
J-155	False	83.000	73.542	0.126	138.0	241.1	276.0	276.0	True
J-156	False	83.000	82.687	0.000	138.0	279.4	276.0	276.0	True
J-157	False	83.000	70.344	0.090	138.0	150.5	276.0	276.0	True
J-158	False	83.000	72.925	0.054	138.0	154.8	276.0	276.0	True
J-159	True	83.000	105.243	0.000	138.0	264.4	276.0	276.0	True
J-160	False	167.000	112.321	0.180	138.0	267.3	276.0	276.0	True
J-161	False	167.000	113.899	0.000	138.0	273.8	276.0	276.0	True
J-162	True	83.000	93.694	0.198	138.0	232.2	276.0	276.0	True
J-163	True	83.000	88.572	0.144	138.0	258.2	276.0	276.0	True
J-164	True	83.000	86.907	0.198	138.0	268.6	276.0	276.0	True
J-165	True	83.000	89.098	0.000	138.0	270.9	276.0	276.0	True
J-166	True	83.000	92.158	0.180	138.0	275.0	276.0	276.0	True
J-167	True	83.000	95.512	0.036	138.0	280.0	276.0	276.1	True
J-168	True	183.001	201.000	0.000	138.0	309.6	276.0	321.0	True
J-169	True	183.001	184.359	0.000	138.0	276.1	276.0	276.0	True
J-170	True	83.000	135.532	0.126	138.0	191.6	276.0	276.0	True
J-171	True	83.000	101.895	0.000	138.0	266.3	276.0	276.0	True
J-172	True	83.000	99.378	0.144	138.0	274.8	276.0	276.0	True
J-173	True	83.000	201.000	0.000	138.0	481.9	276.0	359.2	True
J-174	True	83.000	201.000	0.000	138.0	519.5	276.0	359.2	True
J-175	True	83.000	201.000	0.000	138.0	519.6	276.0	359.2	True
J-176	True	83.000	201.000	0.000	138.0	519.8	276.0	359.2	True
J-177	True	83.000	201.000	0.000	138.0	519.8	276.0	359.2	True
J-178	True	83.000	201.000	0.000	138.0	519.8	276.0	359.2	True
J-180	False	183.000	119.075	0.000	138.0	268.2	276.0	276.0	True
J-182	False	183.000	121.517	0.000	138.0	298.5	276.0	276.0	True
J-191	True	83.000	113.421	0.000	138.0	278.7	276.0	276.0	True
J-242	True	83.000	109.175	0.072	138.0	276.0	276.0	276.0	True
J-243	True	83.000	94.877	0.072	138.0	276.0	276.0	276.0	True
J-244	True	83.000	94.878	0.072	138.0	234.4	276.0	276.0	True
J-246	True	83.000	95.503	0.036	138.0	279.7	276.0	276.1	True
J-247	True	83.000	95.502	0.054	138.0	273.1	276.0	276.1	True

Active Scenario: Existing Peak Day plus Fire

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-252	True	83.000	181.367	0.000	138.0	138.0	276.0	295.2	True
J-253	True	83.000	201.000	0.000	138.0	478.8	276.0	359.2	True
J-254	True	83.000	201.000	0.000	138.0	505.4	276.0	359.2	True
J-255	True	83.000	201.000	0.000	138.0	497.0	276.0	359.2	True
J-260	True	83.000	201.000	0.000	138.0	472.0	276.0	359.2	True
J-261	True	83.000	201.000	0.000	138.0	468.6	276.0	359.2	True
J-263	True	83.000	201.000	0.000	138.0	459.2	276.0	342.8	True
J-264	True	83.000	201.000	0.000	138.0	464.0	276.0	355.1	True
J-346	True	200.000	201.000	0.000	140.0	424.4	280.0	450.5	True
J-347	True	200.000	201.000	0.000	140.0	411.6	180.0	449.5	True
J-348	False	183.000	125.414	0.000	138.0	225.6	276.0	276.0	True

Active Scenario: Full Upgrades with Booster (PD + F)

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-2	J-2	J-3	106.93	250.0	130.0	1.531	0.03	True
P-3	J-3	J-4	97.63	250.0	130.0	1.387	0.03	True
P-4	J-4	J-5	115.44	250.0	130.0	1.153	0.02	True
P-5	J-5	J-6	70.20	250.0	130.0	1.153	0.02	True
P-6	J-6	J-7	24.79	250.0	130.0	0.519	0.01	True
P-7	J-7	J-8	115.24	250.0	130.0	0.519	0.01	True
P-8	J-8	J-9	104.24	250.0	130.0	0.303	0.01	True
P-9	J-9	J-10	88.84	250.0	130.0	0.303	0.01	True
P-12	J-10	J-13	79.95	297.0	130.0	-0.093	0.00	True
P-13	J-13	J-14	117.53	297.0	130.0	-0.093	0.00	True
P-16	J-16	J-17	84.93	297.0	130.0	-0.273	0.00	True
P-17	J-17	J-18	98.70	297.0	130.0	-0.273	0.00	True
P-21	J-21	J-22	66.47	250.0	130.0	-0.436	0.01	True
P-22	J-22	J-6	61.64	250.0	130.0	-0.436	0.01	True
P-23	J-21	J-23	41.90	250.0	130.0	-0.143	0.00	True
P-24	J-23	J-24	128.04	250.0	130.0	-0.143	0.00	True
P-25	J-24	J-25	118.50	250.0	130.0	-0.269	0.01	True
P-26	J-25	J-26	61.18	250.0	130.0	0.144	0.00	True
P-27	J-25	J-27	76.75	250.0	130.0	-0.413	0.01	True
P-29	J-28	J-29	141.74	297.0	130.0	4.269	0.06	True
P-31	J-30	J-31	89.35	148.6	120.0	0.150	0.01	True
P-32	J-31	J-32	126.05	297.0	130.0	-3.187	0.05	True
P-33	J-32	J-29	7.68	297.0	130.0	-3.741	0.05	True
P-34	J-32	J-33	106.05	148.6	120.0	0.554	0.03	True
P-35	J-33	J-34	105.22	148.6	120.0	0.394	0.02	True
P-36	J-34	J-35	116.79	148.6	120.0	0.322	0.02	True
P-37	J-35	J-36	183.19	148.6	120.0	0.160	0.01	True
P-41	J-36	J-39	162.23	148.6	120.0	0.260	0.01	True
P-44	J-41	J-38	177.19	100.3	120.0	-0.104	0.01	True
P-45	J-41	J-42	96.01	148.6	120.0	-0.320	0.02	True
P-46	J-42	J-43	185.64	297.0	130.0	-1.710	0.02	True
P-47	J-43	J-38	106.28	148.6	120.0	0.255	0.01	True
P-48	J-39	J-41	122.16	100.3	120.0	-0.028	0.00	True
P-49	J-30	J-44	41.81	148.6	120.0	0.000	0.00	True
P-51	J-14	J-16	77.49	297.0	130.0	-0.273	0.00	True
P-52	J-43	J-45	171.22	199.4	120.0	0.341	0.01	True
P-53	J-45	J-46	12.16	199.4	120.0	0.616	0.02	True
P-54	J-45	J-47	215.91	297.0	130.0	-1.836	0.03	True
P-55	J-47	J-48	176.76	297.0	130.0	-1.836	0.03	True
P-56	J-48	J-49	122.46	148.6	120.0	0.393	0.02	True
P-57	J-49	J-50	93.42	148.6	120.0	0.393	0.02	True
P-58	J-50	J-51	155.68	148.6	120.0	0.029	0.00	True
P-59	J-51	J-46	111.82	148.6	120.0	-0.097	0.01	True
P-60	J-48	J-52	162.13	293.9	120.0	-2.354	0.03	True
P-61	J-52	J-53	10.35	293.9	120.0	-5.401	0.08	True
P-62	J-53	J-54	12.22	199.4	120.0	1.427	0.05	True

Active Scenario: Full Upgrades with Booster (PD + F)

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-63	J-54	J-55	99.16	148.6	120.0	0.126	0.01	True
P-64	J-55	J-56	54.92	148.6	120.0	0.126	0.01	True
P-65	J-52	J-57	224.06	300.0	130.0	3.046	0.04	True
P-66	J-54	J-58	80.36	199.4	120.0	1.301	0.04	True
P-67	J-58	J-59	72.02	199.4	120.0	1.139	0.04	True
P-68	J-59	J-60	59.02	199.4	120.0	0.238	0.01	True
P-69	J-60	J-57	8.12	300.0	120.0	-2.549	0.04	True
P-70	J-59	J-61	192.84	199.4	120.0	0.595	0.02	True
P-71	J-61	J-62	80.81	148.6	120.0	-0.156	0.01	True
P-72	J-62	J-63	17.67	199.4	120.0	-0.603	0.02	True
P-73	J-63	J-60	132.46	199.4	120.0	-0.603	0.02	True
P-75	J-64	J-65	49.29	148.6	120.0	-0.455	0.03	True
P-78	J-67	J-68	107.29	148.6	120.0	0.126	0.01	True
P-79	J-65	J-69	153.75	148.6	120.0	-0.506	0.03	True
P-80	J-69	J-70	76.94	148.6	120.0	0.471	0.03	True
P-81	J-70	J-71	37.15	148.6	120.0	0.000	0.00	True
P-82	J-70	J-72	55.29	148.6	120.0	0.345	0.02	True
P-83	J-72	J-73	98.87	148.6	120.0	0.345	0.02	True
P-84	J-73	J-67	52.64	148.6	120.0	0.201	0.01	True
P-85	J-53	J-74	38.46	343.9	120.0	-6.828	0.07	True
P-86	J-74	J-69	78.15	199.4	120.0	1.085	0.03	True
P-88	J-75	J-1	5.51	268.7	120.0	7.431	0.13	True
P-89	J-75	J-76	28.01	392.4	120.0	-14.270	0.12	True
P-90	J-43	J-31	172.61	297.0	130.0	-2.540	0.04	True
P-91	J-38	J-77	176.47	100.3	120.0	-0.146	0.02	True
P-92	J-77	J-33	123.06	100.3	120.0	0.020	0.00	True
P-93	J-46	J-78	180.21	148.6	120.0	0.179	0.01	True
P-94	J-78	J-50	101.47	148.6	120.0	-0.220	0.01	True
P-96	J-79	J-57	199.03	199.4	120.0	-0.497	0.02	True
P-99	J-81	J-82	101.91	199.4	120.0	-0.147	0.00	True
P-100	J-82	J-83	35.79	199.4	120.0	-0.147	0.00	True
P-101	J-83	J-84	20.87	199.4	120.0	-0.309	0.01	True
P-102	J-84	J-85	61.14	300.0	120.0	-1.871	0.03	True
P-103	J-85	J-86	75.17	148.6	120.0	0.072	0.00	True
P-104	J-85	J-87	82.74	199.4	120.0	0.241	0.01	True
P-105	J-87	J-88	165.41	199.4	120.0	0.612	0.02	True
P-106	J-88	J-89	143.22	199.4	120.0	0.030	0.00	True
P-107	J-89	J-90	10.12	148.6	120.0	-0.103	0.01	True
P-108	J-90	J-91	138.31	152.4	110.0	-0.103	0.01	True
P-109	J-91	J-81	101.88	152.4	110.0	-0.234	0.01	True
P-110	J-45	J-92	108.08	297.0	130.0	1.561	0.02	True
P-111	J-92	J-93	172.48	297.0	130.0	1.309	0.02	True
P-112	J-93	J-94	99.72	297.0	130.0	1.309	0.02	True
P-113	J-94	J-95	175.01	392.4	120.0	2.537	0.02	True
P-114	J-91	J-96	107.82	152.4	110.0	0.173	0.01	True
P-115	J-96	J-97	141.69	101.6	110.0	0.043	0.01	True

Active Scenario: Full Upgrades with Booster (PD + F)

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-116	J-97	J-89	102.40	297.0	130.0	-1.335	0.02	True
P-117	J-97	J-98	117.55	297.0	130.0	1.083	0.02	True
P-118	J-98	J-99	117.76	297.0	130.0	0.841	0.01	True
P-119	J-99	J-100	118.53	152.4	110.0	0.122	0.01	True
P-121	J-101	J-102	6.88	200.0	130.0	-0.189	0.01	True
P-122	J-102	J-103	118.39	204.0	130.0	-0.189	0.01	True
P-123	J-103	J-104	119.05	152.4	110.0	-0.133	0.01	True
P-124	J-104	J-105	112.74	152.4	110.0	-0.143	0.01	True
P-125	J-105	J-106	4.88	152.4	110.0	-0.117	0.01	True
P-126	J-106	J-107	108.20	200.0	130.0	-0.169	0.01	True
P-127	J-107	J-97	97.52	200.0	130.0	-0.169	0.01	True
P-128	J-104	J-108	107.06	200.0	130.0	-0.117	0.00	True
P-129	J-108	J-98	101.07	200.0	130.0	-0.117	0.00	True
P-130	J-103	J-109	103.99	297.0	130.0	-0.416	0.01	True
P-131	J-109	J-99	103.57	297.0	130.0	-0.416	0.01	True
P-132	J-100	J-110	102.53	204.0	130.0	-0.063	0.00	True
P-133	J-110	J-101	99.72	204.0	130.0	-0.063	0.00	True
P-134	J-106	J-111	115.87	152.4	110.0	-0.200	0.01	True
P-135	J-111	J-88	7.36	199.4	120.0	-0.582	0.02	True
P-136	J-105	J-112	144.16	199.4	120.0	-0.026	0.00	True
P-137	J-112	J-113	35.89	148.6	120.0	-0.175	0.01	True
P-138	J-113	J-114	77.15	148.6	120.0	-0.175	0.01	True
P-139	J-114	J-78	107.19	148.6	120.0	-0.290	0.02	True
P-140	J-114	J-111	162.88	199.4	120.0	-0.184	0.01	True
P-141	J-114	J-115	179.70	100.3	120.0	-0.079	0.01	True
P-142	J-115	J-46	107.72	148.6	120.0	-0.232	0.01	True
P-144	J-116	J-115	181.60	148.6	120.0	-0.279	0.02	True
P-145	J-116	J-117	117.02	148.6	120.0	0.164	0.01	True
P-146	J-117	J-118	148.95	148.6	120.0	0.009	0.00	True
P-147	J-118	J-119	193.47	297.0	130.0	0.365	0.01	True
P-148	J-120	J-121	66.74	100.3	120.0	-0.306	0.04	True
P-149	J-121	J-117	119.91	148.6	120.0	-0.102	0.01	True
P-150	J-95	J-122	123.48	392.4	120.0	1.798	0.01	True
P-151	J-122	J-123	122.81	392.4	120.0	1.798	0.01	True
P-152	J-123	J-124	16.44	155.0	130.0	-0.070	0.00	True
P-153	J-124	J-125	15.83	148.6	120.0	-0.053	0.00	True
P-154	J-125	J-126	118.07	148.6	120.0	-0.053	0.00	True
P-155	J-126	J-118	123.36	148.6	120.0	-0.185	0.01	True
P-156	J-126	J-127	203.67	148.6	120.0	-0.067	0.00	True
P-157	J-124	J-128	171.29	148.6	120.0	-0.070	0.00	True
P-159	J-129	J-130	156.10	297.0	130.0	0.000	0.00	True
P-160	J-129	J-131	234.41	250.0	130.0	1.798	0.04	True
P-161	J-131	J-132	178.61	254.0	120.0	1.214	0.02	True
P-165	J-131	J-135	19.74	204.0	130.0	0.584	0.02	True
P-166	J-135	J-136	93.25	204.0	130.0	0.584	0.02	True
P-167	J-136	J-137	50.58	204.0	130.0	0.296	0.01	True

Active Scenario: Full Upgrades with Booster (PD + F)

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-168	J-137	J-138	90.89	148.6	120.0	0.296	0.02	True
P-169	J-138	J-139	58.95	148.6	120.0	0.108	0.01	True
P-170	J-138	J-140	80.62	148.6	120.0	0.116	0.01	True
P-171	J-140	J-132	157.69	148.6	120.0	-0.064	0.00	True
P-172	J-132	J-141	147.53	254.0	120.0	1.150	0.02	True
P-173	J-141	J-142	148.36	204.0	130.0	0.306	0.01	True
P-174	J-142	J-143	39.78	148.6	120.0	0.000	0.00	True
P-175	J-141	J-144	88.56	254.0	120.0	0.844	0.02	True
P-176	J-144	J-145	125.87	254.0	120.0	0.700	0.01	True
P-177	J-145	J-146	149.54	148.6	120.0	0.154	0.01	True
P-178	J-146	J-147	137.37	148.6	120.0	-0.098	0.01	True
P-179	J-147	J-148	46.58	148.6	120.0	-0.098	0.01	True
P-180	J-148	J-145	144.72	254.0	120.0	-0.421	0.01	True
P-181	J-148	J-149	98.53	254.0	120.0	0.214	0.00	True
P-182	J-149	J-150	95.50	148.6	120.0	0.142	0.01	True
P-183	J-150	J-151	79.49	148.6	120.0	0.070	0.00	True
P-184	J-151	J-152	79.27	148.6	120.0	-0.056	0.00	True
P-185	J-152	J-153	162.79	148.6	120.0	-0.272	0.02	True
P-186	J-153	J-154	125.41	148.6	120.0	-0.091	0.01	True
P-187	J-154	J-155	145.37	148.6	120.0	-0.217	0.01	True
P-188	J-155	J-156	105.12	148.6	120.0	-0.343	0.02	True
P-189	J-156	J-153	178.12	148.6	120.0	0.343	0.02	True
P-190	J-152	J-157	102.41	148.6	120.0	0.090	0.01	True
P-191	J-151	J-158	92.50	148.6	120.0	0.054	0.00	True
P-193	J-159	J-160	213.11	250.0	130.0	-0.830	0.02	True
P-194	J-160	J-161	81.42	250.0	130.0	-1.010	0.02	True
P-195	J-96	J-162	235.63	152.4	110.0	0.193	0.01	True
P-196	J-162	J-163	118.42	152.4	110.0	0.028	0.00	True
P-197	J-163	J-164	158.19	204.0	130.0	-0.130	0.00	True
P-198	J-164	J-165	168.74	204.0	130.0	-0.328	0.01	True
P-199	J-165	J-166	139.26	204.0	130.0	-0.328	0.01	True
P-200	J-166	J-167	93.06	204.0	130.0	-0.508	0.02	True
P-201	J-167	J-96	113.33	204.0	130.0	0.189	0.01	True
P-202	J-163	J-100	141.26	101.6	110.0	0.014	0.00	True
P-203	J-162	J-99	141.83	101.6	110.0	-0.033	0.00	True
P-204	J-18	J-168	138.25	297.0	130.0	-0.399	0.01	True
P-206	J-27	J-169	77.84	250.0	130.0	-0.557	0.01	True
P-207	J-169	J-28	38.91	250.0	130.0	-0.557	0.01	True
P-208	J-29	J-170	89.58	148.6	120.0	0.420	0.02	True
P-209	J-170	J-30	133.92	148.6	120.0	0.294	0.02	True
P-210	J-149	J-171	40.04	254.0	120.0	0.000	0.00	True
P-211	J-156	J-172	40.48	148.6	120.0	-0.686	0.04	True
P-212	J-172	J-159	140.22	250.0	130.0	-0.830	0.02	True
P-213	J-62	J-81	113.97	152.4	110.0	0.214	0.01	True
P-214	J-67	J-65	29.20	148.6	120.0	0.075	0.00	True
P-215	J-38	J-36	105.65	148.6	120.0	0.208	0.01	True

Active Scenario: Full Upgrades with Booster (PD + F)

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-216	J-21	J-168	72.60	250.0	130.0	0.399	0.01	True
P-217	J-12	J-10	72.67	297.0	130.0	0.000	0.00	True
P-219	J-173	J-76	67.53	406.4	110.0	14.270	0.11	True
P-221	J-174	J-175	21.81	406.4	110.0	-14.270	0.11	True
P-222	J-176	J-175	23.90	406.4	110.0	14.270	0.11	True
P-223	J-176	J-177	23.90	406.4	110.0	-4.716	0.04	True
P-224	J-177	J-178	22.20	406.4	110.0	-4.716	0.04	True
P-225	J-178	Esso	51.57	152.4	110.0	4.838	0.27	True
P-226	PMP- Fire Pump	J-178	47.25	254.0	110.0	9.554	0.19	True
P-228	PMP-Fire Pump	J-176	43.24	254.0	110.0	9.554	0.19	True
P-231	J-173	PRV-1	25.26	406.4	110.0	-14.270	0.11	True
P-232	PRV-1	J-174	31.89	406.4	110.0	-14.270	0.11	True
P-233	T-1	PMP-40 HP	41.97	152.4	110.0	0.000	0.00	True
P-234	T-1	PMP-50 HP	26.22	152.4	110.0	0.000	0.00	True
P-235	T-1	PMP-Fire Pump	24.02	203.2	110.0	9.554	0.29	True
P-236	T-1	PMP- 40 HP	42.27	152.4	110.0	0.000	0.00	True
P-237	T-1	PMP-Fire Pump	51.55	203.2	110.0	9.554	0.29	True
P-245	J-119	J-127	119.45	200.0	130.0	0.335	0.01	True
P-246	J-127	J-128	119.21	200.0	130.0	0.142	0.00	True
P-247	J-103	J-119	209.03	300.0	130.0	0.234	0.00	True
P-253	J-129	J-182	220.97	392.9	130.0	1.010	0.01	True
P-254	J-182	J-180	591.83	392.9	130.0	1.010	0.01	True
P-256	J-31	J-77	105.65	200.0	130.0	0.347	0.01	True
P-273	J-119	J-121	176.72	204.0	130.0	0.138	0.00	True
P-274	J-121	J-187	127.08	152.4	130.0	-0.210	0.01	True
P-275	J-187	J-112	87.86	152.4	130.0	-0.150	0.01	True
P-281	J-42	J-94	260.80	297.0	130.0	1.227	0.02	True
P-282	J-180	J-191	75.02	297.0	130.0	1.010	0.01	True
P-283	J-191	J-161	151.36	297.0	130.0	1.010	0.01	True
P-285	J-2	J-28	300.88	392.9	130.0	4.826	0.04	True
P-286	J-116	J-187	104.63	152.4	130.0	0.061	0.00	True
P-295	J-101	PRV-4	323.66	199.4	120.0	0.000	0.00	True
P-296	PRV-4	J-132	130.67	199.4	120.0	0.000	0.00	True
P-309	J-87	J-79	55.90	204.0	130.0	-0.497	0.02	True
P-311	J-92	J-115	18.47	152.4	130.0	0.251	0.01	True
P-312	J-118	J-95	22.95	297.0	130.0	-0.739	0.01	True
P-385	J-89	J-84	163.21	297.0	130.0	-1.562	0.02	True
P-391	J-240	J-129	155.87	392.4	130.0	2.988	0.02	True

Active Scenario: Full Upgrades with Booster (PD + F)

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-392	R-7	J-240	61.02	392.4	130.0	2.988	0.02	True
P-410	J-85	J-60	108.45	300.0	130.0	-2.184	0.03	True
P-412	J-91	J-242	106.89	200.0	130.0	-0.167	0.01	True
P-413	J-242	J-243	104.98	200.0	130.0	-0.239	0.01	True
P-414	J-243	J-244	101.17	200.0	130.0	-0.311	0.01	True
P-415	J-244	J-245	72.91	200.0	130.0	-0.383	0.01	True
P-416	J-245	J-61	54.30	200.0	130.0	-0.599	0.02	True
P-417	J-167	J-246	107.63	300.0	130.0	-0.733	0.01	True
P-418	J-246	J-247	113.84	300.0	130.0	-0.769	0.01	True
P-419	J-247	J-248	105.02	300.0	130.0	-0.823	0.01	True
P-420	J-248	J-249	96.09	300.0	130.0	-0.823	0.01	True
P-421	J-249	J-250	77.01	300.0	130.0	-0.823	0.01	True
P-422	J-250	J-251	110.79	300.0	130.0	-0.607	0.01	True
P-423	J-61	J-252	101.86	148.6	120.0	0.152	0.01	True
P-424	J-252	J-64	109.10	148.6	120.0	-0.455	0.03	True
P-425	J-251	J-252	117.12	300.0	130.0	-0.607	0.01	True
P-426	J-250	J-245	117.62	200.0	130.0	-0.216	0.01	True
P-428	J-254	J-174	19.60	200.0	110.0	0.000	0.00	True
P-430	J-253	J-255	45.28	150.0	110.0	0.000	0.00	True
P-431	J-255	J-254	27.93	200.0	110.0	0.000	0.00	True
P-433	J-254	J-259	47.59	80.0	110.0	0.000	0.00	True
P-434	J-261	J-260	21.74	200.0	110.0	0.000	0.00	True
P-435	J-260	J-253	61.88	200.0	110.0	0.000	0.00	True
P-436	PMP-40 HP	J-261	20.74	150.0	110.0	0.000	0.00	True
P-437	PMP-50 HP	J-260	18.28	200.0	110.0	0.000	0.00	True
P-438	PMP- 40 HP	J-253	24.66	150.0	110.0	0.000	0.00	True
P-441	J-74	J-263	44.33	343.9	120.0	-7.913	0.09	True
P-442	J-263	J-75	152.97	343.9	120.0	-6.839	0.07	True
P-443	J-1	J-264	131.05	479.6	120.0	7.431	0.04	True
P-444	J-264	J-2	174.53	479.6	120.0	6.357	0.04	True
P-575	J-123	J-342	125.34	392.4	120.0	1.867	0.02	True
P-576	J-342	J-240	45.43	392.4	120.0	0.000	0.00	True
P-587	J-346	J-264	50.86	200.0	130.0	-1.074	0.03	True
P-588	J-263	J-347	90.77	200.0	130.0	-1.074	0.03	True
P-589	J-347	J-346	116.69	200.0	130.0	-1.074	0.03	True
P-590	J-130	J-348	244.95	239.0	130.0	0.000	0.00	True

Active Scenario: Full Upgrades with Booster (PD + F)

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
Esso	True	83.000	201.000	4.838	138.0	440.7	276.0	408.6	True
J-1	True	83.000	201.000	0.000	138.0	491.4	276.0	405.0	True
J-2	True	183.001	201.000	0.000	138.0	464.2	276.0	402.6	True
J-3	True	183.001	201.000	0.144	138.0	434.5	276.0	402.3	True
J-4	True	183.001	201.000	0.234	138.0	423.4	276.0	402.2	True
J-5	True	183.001	201.000	0.000	138.0	413.8	276.0	402.0	True
J-6	True	183.001	201.000	0.198	138.0	417.2	276.0	401.8	True
J-7	True	183.001	201.000	0.000	138.0	409.7	276.0	401.2	True
J-8	True	183.001	201.000	0.216	138.0	390.5	276.0	395.2	True
J-9	True	183.001	201.000	0.000	138.0	389.3	276.0	391.4	True
J-10	True	183.001	201.000	0.396	138.0	404.0	276.0	383.0	True
J-12	True	183.001	201.000	0.000	138.0	387.6	276.0	383.0	True
J-13	True	183.001	201.000	0.000	138.0	384.9	276.0	378.9	True
J-14	True	183.001	201.000	0.180	138.0	372.4	276.0	374.1	True
J-16	True	183.001	201.000	0.000	138.0	370.0	276.0	378.2	True
J-17	True	183.001	201.000	0.000	138.0	374.7	276.0	375.0	True
J-18	True	183.001	201.000	0.126	138.0	370.6	276.0	378.7	True
J-21	True	183.001	201.000	0.180	138.0	408.5	276.0	395.0	True
J-22	True	183.001	201.000	0.000	138.0	408.5	276.0	399.6	True
J-23	True	183.001	201.000	0.000	138.0	406.7	276.0	401.1	True
J-24	True	183.001	201.000	0.126	138.0	406.5	276.0	401.3	True
J-25	True	183.001	201.000	0.000	138.0	409.1	276.0	400.9	True
J-26	True	183.001	201.000	0.144	138.0	377.0	276.0	400.9	True
J-27	True	183.001	201.000	0.144	138.0	418.9	276.0	400.6	True
J-28	True	183.001	201.000	0.000	138.0	447.7	276.0	399.6	True
J-29	True	83.000	201.000	0.108	138.0	421.4	276.0	394.2	True
J-30	True	83.000	144.751	0.144	138.0	270.1	276.0	276.0	True
J-31	True	83.000	201.000	0.450	138.0	411.3	276.0	390.9	True
J-32	True	83.000	201.000	0.000	138.0	420.9	276.0	393.9	True
J-33	True	83.000	160.895	0.180	138.0	233.7	276.0	276.0	True
J-34	True	83.000	124.353	0.072	138.0	214.4	276.0	276.0	True
J-35	True	83.000	129.269	0.162	138.0	155.3	276.0	276.0	True
J-36	True	83.000	127.544	0.108	138.0	263.6	276.0	276.0	True
J-38	True	83.000	195.705	0.090	138.0	197.5	276.0	276.0	True
J-39	True	83.000	106.456	0.288	138.0	138.0	276.0	347.7	True
J-41	True	83.000	170.987	0.396	138.0	138.0	276.0	339.0	True
J-42	True	83.000	201.000	0.162	138.0	394.6	276.0	381.0	True
J-43	True	83.000	201.000	0.234	138.0	403.0	276.0	385.9	True
J-44	True	83.000	134.134	0.000	138.0	138.0	276.0	293.8	True
J-45	True	183.001	201.000	0.000	138.0	404.4	276.0	382.9	True
J-46	True	183.001	201.000	0.108	138.0	392.7	276.0	382.9	True
J-47	True	183.000	201.000	0.000	138.0	410.8	276.0	386.3	True
J-48	True	183.000	201.000	0.126	138.0	427.3	276.0	388.4	True
J-49	True	183.000	197.398	0.000	138.0	138.0	276.0	319.5	True

Active Scenario: Full Upgrades with Booster (PD + F)

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-50	True	183.000	201.000	0.144	138.0	211.9	276.0	309.1	True
J-51	True	183.001	183.167	0.126	138.0	138.0	276.0	359.7	True
J-52	True	83.000	201.000	0.000	138.0	450.6	276.0	391.2	True
J-53	True	83.000	201.000	0.000	138.0	452.0	276.0	392.0	True
J-54	True	160.000	201.000	0.000	138.0	436.3	276.0	391.5	True
J-55	True	83.000	92.370	0.000	138.0	277.0	276.0	276.0	True
J-56	True	83.000	92.580	0.126	138.0	168.4	276.0	276.1	True
J-57	True	200.000	201.000	0.000	138.0	425.9	276.0	388.1	True
J-58	True	160.000	201.000	0.162	138.0	392.8	276.0	390.1	True
J-59	True	160.000	201.000	0.306	138.0	404.5	276.0	389.0	True
J-60	True	200.000	201.000	0.000	138.0	425.8	276.0	388.0	True
J-61	True	83.000	201.000	0.000	138.0	395.9	276.0	385.5	True
J-62	True	83.000	201.000	0.234	138.0	360.2	276.0	369.0	True
J-63	True	83.000	201.000	0.000	138.0	360.1	276.0	369.0	True
J-64	True	83.000	201.000	0.000	138.0	184.9	276.0	317.0	True
J-65	True	83.000	193.854	0.126	138.0	256.7	276.0	276.0	True
J-67	True	83.000	166.131	0.000	138.0	261.3	276.0	276.0	True
J-68	True	83.000	107.511	0.126	138.0	138.0	276.0	398.6	True
J-69	True	83.000	201.000	0.108	138.0	369.5	276.0	385.3	True
J-70	True	83.000	146.676	0.126	138.0	276.0	276.0	276.0	True
J-71	True	83.000	140.409	0.000	138.0	138.0	276.0	293.0	True
J-72	True	83.000	165.348	0.000	138.0	168.6	276.0	276.0	True
J-73	True	83.000	171.225	0.144	138.0	179.6	276.0	276.0	True
J-74	True	83.000	201.000	0.000	138.0	460.4	276.0	394.0	True
J-75	True	83.000	201.000	0.000	138.0	493.5	276.0	406.3	True
J-76	True	83.000	201.000	0.000	138.0	481.8	276.0	408.5	True
J-77	True	83.000	201.000	0.180	138.0	298.1	276.0	390.5	True
J-78	True	183.001	201.000	0.108	138.0	255.7	276.0	359.0	True
J-79	True	83.000	201.000	0.000	138.0	360.6	276.0	387.1	True
J-81	True	83.000	201.000	0.126	138.0	344.3	276.0	387.0	True
J-82	True	83.000	201.000	0.000	138.0	367.7	276.0	386.7	True
J-83	True	83.000	201.000	0.162	138.0	394.1	276.0	386.6	True
J-84	True	83.000	201.000	0.000	138.0	417.0	276.0	386.5	True
J-85	True	83.000	201.000	0.000	138.0	418.3	276.0	387.1	True
J-86	True	83.000	136.137	0.072	138.0	138.0	276.0	397.6	True
J-87	True	83.000	201.000	0.126	138.0	385.1	276.0	386.7	True
J-88	True	83.000	201.000	0.000	138.0	378.2	276.0	380.6	True
J-89	True	200.000	201.000	0.360	138.0	406.9	276.0	385.0	True
J-90	True	200.000	201.000	0.000	138.0	354.7	276.0	385.3	True
J-91	True	83.000	201.000	0.126	138.0	339.6	276.0	373.6	True
J-92	True	183.000	201.000	0.000	138.0	399.6	276.0	380.5	True
J-93	True	183.000	201.000	0.000	138.0	387.5	276.0	375.9	True
J-94	True	183.001	201.000	0.000	138.0	386.7	276.0	372.6	True
J-95	True	183.000	201.000	0.000	138.0	378.8	276.0	368.1	True

Active Scenario: Full Upgrades with Booster (PD + F)

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-96	True	83.000	201.000	0.126	138.0	306.4	276.0	338.8	True
J-97	True	83.000	201.000	0.126	138.0	404.6	276.0	383.4	True
J-98	True	83.000	201.000	0.126	138.0	394.7	276.0	381.5	True
J-99	True	83.000	201.000	0.270	138.0	385.4	276.0	380.1	True
J-100	True	83.000	201.000	0.198	138.0	237.3	276.0	281.4	True
J-101	True	183.000	201.000	0.126	138.0	284.2	276.0	290.1	True
J-102	True	183.000	201.000	0.000	138.0	288.0	276.0	289.2	True
J-103	True	183.000	201.000	0.126	138.0	382.7	276.0	377.7	True
J-104	True	83.000	201.000	0.126	138.0	311.8	276.0	361.0	True
J-105	True	133.000	201.000	0.000	138.0	353.6	276.0	365.4	True
J-106	True	133.000	201.000	0.252	138.0	355.7	276.0	365.0	True
J-107	True	83.000	201.000	0.000	138.0	347.6	276.0	382.8	True
J-108	True	83.000	201.000	0.000	138.0	330.0	276.0	353.1	True
J-109	True	83.000	201.000	0.000	138.0	380.4	276.0	378.9	True
J-110	True	83.000	201.000	0.000	138.0	250.4	276.0	280.8	True
J-111	True	83.000	201.000	0.198	138.0	375.7	276.0	381.3	True
J-112	True	183.000	201.000	0.000	138.0	311.7	276.0	342.6	True
J-113	True	200.000	201.000	0.000	138.0	246.8	276.0	344.6	True
J-114	True	200.000	201.000	0.378	138.0	329.8	276.0	371.4	True
J-115	True	183.001	201.000	0.126	138.0	361.0	276.0	380.8	True
J-116	True	183.001	201.000	0.054	138.0	237.4	276.0	343.5	True
J-117	True	183.001	201.000	0.054	138.0	227.0	276.0	347.1	True
J-118	True	183.001	201.000	0.198	138.0	377.6	276.0	369.1	True
J-119	True	183.000	201.000	0.126	138.0	379.1	276.0	372.5	True
J-120	False	183.000	49.891	0.306	138.0	138.0	276.0	405.5	True
J-121	True	183.000	201.000	0.144	138.0	307.3	276.0	307.3	True
J-122	True	183.000	201.000	0.000	138.0	367.9	276.0	361.2	True
J-123	True	183.000	201.000	0.000	138.0	355.0	276.0	357.6	True
J-124	True	183.001	201.000	0.054	138.0	313.5	276.0	318.2	True
J-125	True	200.000	201.000	0.000	138.0	251.1	276.0	324.6	True
J-126	True	183.001	201.000	0.198	138.0	208.2	276.0	335.3	True
J-127	True	83.000	201.000	0.126	138.0	299.6	276.0	305.2	True
J-128	True	83.000	201.000	0.072	138.0	213.8	276.0	318.7	True
J-129	True	183.000	201.000	0.180	138.0	517.6	276.0	456.0	True
J-130	True	183.000	201.000	0.000	138.0	483.0	276.0	456.0	True
J-131	True	160.000	201.000	0.000	138.0	424.9	276.0	413.2	True
J-132	True	83.000	201.000	0.000	138.0	372.0	276.0	374.6	True
J-135	True	160.000	201.000	0.000	138.0	399.7	276.0	389.8	True
J-136	True	160.000	201.000	0.288	138.0	300.7	276.0	299.0	True
J-137	True	160.000	201.000	0.000	138.0	256.2	276.0	301.9	True
J-138	True	83.000	142.210	0.072	138.0	272.1	276.0	276.0	True
J-139	True	83.000	123.857	0.108	138.0	138.0	276.0	330.3	True
J-140	True	83.000	166.641	0.180	138.0	163.0	276.0	276.0	True
J-141	True	83.000	201.000	0.000	138.0	319.7	276.0	319.7	True

Active Scenario: Full Upgrades with Booster (PD + F)

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-142	True	83.000	151.645	0.306	138.0	276.0	276.0	276.0	True
J-143	True	83.000	141.424	0.000	138.0	138.0	276.0	307.8	True
J-144	True	83.000	201.000	0.144	138.0	296.6	276.0	293.3	True
J-145	True	83.000	192.893	0.126	138.0	272.1	276.0	276.0	True
J-146	True	83.000	154.683	0.252	138.0	138.0	276.0	301.6	True
J-147	True	83.000	162.358	0.000	138.0	196.1	276.0	276.0	True
J-148	True	83.000	182.340	0.108	138.0	272.8	276.0	276.0	True
J-149	True	83.000	173.467	0.072	138.0	278.9	276.0	276.0	True
J-150	True	83.000	140.418	0.072	138.0	231.8	276.0	276.0	True
J-151	True	83.000	116.750	0.072	138.0	281.9	276.0	276.0	True
J-152	True	83.000	113.290	0.126	138.0	281.9	276.0	276.0	True
J-153	True	83.000	138.407	0.162	138.0	239.3	276.0	276.0	True
J-154	True	83.000	128.971	0.126	138.0	165.8	276.0	276.0	True
J-155	True	83.000	129.156	0.126	138.0	187.7	276.0	276.0	True
J-156	True	83.000	155.988	0.000	138.0	273.8	276.0	276.0	True
J-157	True	83.000	94.997	0.090	138.0	138.0	276.0	352.5	True
J-158	True	83.000	99.338	0.054	138.0	138.0	276.0	348.2	True
J-159	True	83.000	201.000	0.000	138.0	309.2	276.0	322.9	True
J-160	True	167.000	201.000	0.180	138.0	358.8	276.0	385.8	True
J-161	True	167.000	201.000	0.000	138.0	385.5	276.0	391.1	True
J-162	True	83.000	170.798	0.198	138.0	138.0	276.0	294.1	True
J-163	True	83.000	156.578	0.144	138.0	227.5	276.0	276.0	True
J-164	True	83.000	152.379	0.198	138.0	253.1	276.0	276.0	True
J-165	True	83.000	167.411	0.000	138.0	257.8	276.0	276.0	True
J-166	True	83.000	196.468	0.180	138.0	267.3	276.0	276.0	True
J-167	True	83.000	201.000	0.036	138.0	340.1	276.0	333.8	True
J-168	True	183.001	201.000	0.000	138.0	373.8	276.0	384.5	True
J-169	True	183.001	201.000	0.000	138.0	434.0	276.0	400.1	True
J-170	True	83.000	195.164	0.126	138.0	138.0	276.0	309.2	True
J-171	True	83.000	174.514	0.000	138.0	254.7	276.0	276.0	True
J-172	True	83.000	201.000	0.144	138.0	276.5	276.0	292.9	True
J-173	True	83.000	201.000	0.000	138.0	481.9	276.0	408.6	True
J-174	True	83.000	201.000	0.000	138.0	511.1	276.0	408.6	True
J-175	True	83.000	201.000	0.000	138.0	511.2	276.0	408.6	True
J-176	True	83.000	201.000	0.000	138.0	511.4	276.0	408.6	True
J-177	True	83.000	201.000	0.000	138.0	511.4	276.0	408.6	True
J-178	True	83.000	201.000	0.000	138.0	511.4	276.0	408.6	True
J-180	True	183.000	201.000	0.000	138.0	412.3	276.0	417.4	True
J-182	True	183.000	201.000	0.000	138.0	487.3	276.0	443.3	True
J-187	True	183.000	201.000	0.000	138.0	276.6	276.0	345.8	True
J-191	True	183.000	201.000	0.000	0.0	403.0	0.0	413.2	True
J-240	True	83.000	201.000	0.000	138.0	537.4	276.0	408.6	True
J-242	True	83.000	201.000	0.072	138.0	315.8	276.0	351.1	True
J-243	True	83.000	201.000	0.072	138.0	310.5	276.0	352.1	True

Active Scenario: Full Upgrades with Booster (PD + F)

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-244	True	83.000	201.000	0.072	138.0	336.1	276.0	358.7	True
J-245	True	83.000	201.000	0.000	138.0	385.6	276.0	379.2	True
J-246	True	83.000	201.000	0.036	138.0	349.4	276.0	340.1	True
J-247	True	83.000	201.000	0.054	138.0	354.2	276.0	346.9	True
J-248	True	83.000	201.000	0.000	138.0	369.4	276.0	353.1	True
J-249	True	83.000	201.000	0.000	138.0	380.2	276.0	358.9	True
J-250	True	83.000	201.000	0.000	138.0	385.6	276.0	363.6	True
J-251	True	83.000	201.000	0.000	138.0	379.6	276.0	366.8	True
J-252	True	83.000	201.000	0.000	138.0	374.8	276.0	369.7	True
J-253	True	83.000	201.000	0.000	138.0	470.4	276.0	408.6	True
J-254	True	83.000	201.000	0.000	138.0	497.0	276.0	408.6	True
J-255	True	83.000	201.000	0.000	138.0	488.7	276.0	408.6	True
J-259	False	83.000	0.000	0.000	138.0	762.4	276.0	408.6	True
J-260	True	83.000	201.000	0.000	138.0	463.6	276.0	408.6	True
J-261	True	83.000	201.000	0.000	138.0	460.3	276.0	408.6	True
J-263	True	83.000	201.000	0.000	138.0	462.7	276.0	396.9	True
J-264	True	83.000	201.000	0.000	138.0	464.5	276.0	403.8	True
J-342	True	83.000	201.000	1.867	138.0	338.9	276.0	466.2	True
J-346	True	200.000	201.000	0.000	140.0	424.5	280.0	396.2	True
J-347	True	200.000	201.000	0.000	140.0	412.5	180.0	394.1	True
J-348	True	183.000	201.000	0.000	138.0	306.3	276.0	408.6	True

Active Scenario: Future PH

Current Time: 0.000 hours

Label	Elevation (m)	Demand (L/s)	Pressure (kPa)	Hydraulic Grade (m)	Is Active?
J-1	625.40	0.000	495.7	676.05	True
J-2	627.60	0.000	468.5	675.47	True
J-3	627.00	0.240	472.4	675.27	True
J-4	626.20	0.390	478.4	675.08	True
J-5	625.80	0.000	480.3	674.87	True
J-6	625.00	0.330	486.9	674.75	True
J-7	624.90	0.000	487.7	674.73	True
J-8	624.30	0.360	493.0	674.68	True
J-9	623.30	0.000	502.3	674.63	True
J-10	621.50	0.660	519.5	674.59	True
J-12	621.40	6.300	520.5	674.59	True
J-13	623.50	0.000	499.9	674.57	True
J-14	625.00	0.300	485.0	674.56	True
J-16	625.50	6.540	480.0	674.55	True
J-17	625.40	0.000	481.1	674.56	True
J-18	626.40	0.210	471.5	674.57	True
J-21	625.70	0.300	479.4	674.68	True
J-22	625.30	0.000	483.6	674.72	True
J-23	625.90	0.000	477.5	674.69	True
J-24	626.50	0.210	472.0	674.73	True
J-25	627.60	0.000	461.5	674.76	True
J-26	627.40	0.240	463.5	674.76	True
J-27	628.00	0.240	457.8	674.78	True
J-28	628.50	6.660	451.9	674.68	True
J-29	630.00	0.180	433.7	674.32	True
J-30	630.00	0.240	432.0	674.14	True
J-31	630.50	0.750	426.5	674.08	True
J-32	630.00	0.000	433.5	674.30	True
J-33	629.70	0.300	435.0	674.15	True
J-34	629.70	0.120	434.2	674.07	True
J-35	630.30	0.270	427.5	673.99	True
J-36	630.40	0.180	425.4	673.87	True
J-38	631.00	0.150	419.0	673.81	True
J-39	631.50	0.480	413.8	673.78	True
J-41	631.50	0.660	410.6	673.46	True
J-42	631.40	0.270	410.6	673.36	True
J-43	631.20	0.390	416.5	673.75	True
J-44	629.40	0.000	437.9	674.14	True
J-45	631.00	0.000	416.6	673.57	True
J-46	631.00	0.180	416.6	673.57	True
J-47	629.70	0.000	432.4	673.88	True
J-48	628.60	0.210	445.7	674.14	True
J-49	629.40	0.000	435.4	673.89	True
J-50	629.90	0.240	428.6	673.69	True
J-51	630.30	0.210	423.9	673.62	True
J-52	627.90	0.000	456.3	674.53	True
J-53	627.90	0.000	457.1	674.61	True

Active Scenario: Future PH

Current Time: 0.000 hours

Label	Elevation (m)	Demand (L/s)	Pressure (kPa)	Hydraulic Grade (m)	Is Active?
J-54	627.90	0.000	456.9	674.58	True
J-55	627.30	0.000	462.7	674.58	True
J-56	627.40	0.210	461.8	674.58	True
J-57	629.20	0.000	440.6	674.22	True
J-58	628.50	0.270	449.4	674.42	True
J-59	629.10	0.510	442.2	674.28	True
J-60	629.20	0.000	440.5	674.21	True
J-61	627.60	0.000	456.6	674.26	True
J-62	628.50	0.390	447.3	674.20	True
J-63	628.50	0.000	447.3	674.21	True
J-64	626.40	0.000	471.8	674.61	True
J-65	624.20	0.210	494.6	674.74	True
J-67	623.90	0.000	497.9	674.78	True
J-68	622.40	0.210	512.6	674.78	True
J-69	626.40	0.180	473.6	674.79	True
J-70	625.40	0.210	483.6	674.81	True
J-71	625.40	0.000	483.6	674.81	True
J-72	625.40	0.000	483.7	674.82	True
J-73	623.60	0.240	501.6	674.85	True
J-74	627.30	0.000	464.8	674.79	True
J-75	625.40	0.000	495.7	676.05	True
J-76	626.82	0.000	482.3	676.10	True
J-77	630.50	0.300	426.5	674.08	True
J-78	630.30	0.180	424.1	673.64	True
J-79	629.70	0.000	434.3	674.07	True
J-81	629.10	0.210	439.6	674.02	True
J-82	629.30	0.000	437.5	674.00	True
J-83	629.30	0.270	437.4	673.99	True
J-84	629.40	0.000	436.4	673.99	True
J-85	629.50	0.000	436.1	674.06	True
J-86	629.70	0.120	434.2	674.06	True
J-87	629.70	0.210	434.0	674.04	True
J-88	630.50	0.000	423.4	673.76	True
J-89	630.30	0.600	425.4	673.77	True
J-90	630.30	0.000	425.4	673.77	True
J-91	629.70	0.210	433.7	674.01	True
J-92	631.20	0.000	412.4	673.33	True
J-93	632.20	0.000	398.6	672.93	True
J-94	632.70	0.000	391.4	672.70	True
J-95	633.20	0.000	382.4	672.27	True
J-96	630.00	0.210	430.2	673.96	True
J-97	630.30	0.210	423.7	673.60	True
J-98	630.90	0.210	416.2	673.43	True
J-99	631.50	0.450	409.0	673.29	True
J-100	632.00	0.330	403.1	673.19	True
J-101	632.50	0.210	397.4	673.11	True
J-102	632.50	0.000	397.4	673.10	True

Active Scenario: Future PH

Current Time: 0.000 hours

Label	Elevation (m)	Demand (L/s)	Pressure (kPa)	Hydraulic Grade (m)	Is Active?
J-103	631.90	0.210	402.8	673.06	True
J-104	631.50	0.210	410.1	673.40	True
J-105	630.90	0.000	417.2	673.53	True
J-106	630.90	0.420	417.2	673.53	True
J-107	630.80	0.000	418.5	673.57	True
J-108	630.90	0.000	416.1	673.42	True
J-109	631.80	0.000	404.9	673.17	True
J-110	632.30	0.000	399.8	673.15	True
J-111	630.50	0.330	423.3	673.75	True
J-112	632.20	0.000	403.8	673.45	True
J-113	631.50	0.000	411.2	673.51	True
J-114	630.90	0.630	418.2	673.63	True
J-115	631.20	0.210	412.4	673.34	True
J-116	632.20	0.090	398.9	672.95	True
J-117	632.70	0.090	391.9	672.74	True
J-118	633.20	0.330	382.7	672.31	True
J-119	632.70	0.210	390.7	672.62	True
J-120	632.20	0.510	397.0	672.76	True
J-121	632.20	0.240	397.1	672.77	True
J-122	633.60	0.000	372.9	671.70	True
J-123	634.30	0.000	360.5	671.14	True
J-124	634.30	0.090	361.3	671.21	True
J-125	634.30	0.000	361.5	671.24	True
J-126	633.60	0.330	376.0	672.02	True
J-127	632.80	0.210	386.8	672.32	True
J-128	633.20	0.120	381.5	672.18	True
J-129	635.20	2.850	523.5	688.69	True
J-130	634.90	2.550	520.9	688.12	True
J-131	634.00	0.000	534.5	688.61	True
J-132	634.00	0.000	534.1	688.57	True
J-135	634.00	0.000	534.5	688.61	True
J-136	634.70	0.480	527.6	688.61	True
J-137	635.20	0.000	522.7	688.60	True
J-138	634.90	0.120	525.5	688.59	True
J-139	634.50	0.180	529.4	688.59	True
J-140	634.60	0.300	528.3	688.58	True
J-141	634.00	0.000	533.6	688.53	True
J-142	634.00	0.510	533.6	688.53	True
J-143	634.00	0.000	533.6	688.53	True
J-144	633.40	0.240	539.3	688.50	True
J-145	634.10	0.210	532.1	688.47	True
J-146	633.30	0.420	539.8	688.45	True
J-147	634.00	0.000	532.8	688.44	True
J-148	634.00	0.180	532.8	688.44	True
J-149	633.70	0.120	535.6	688.42	True
J-150	634.00	0.120	529.9	688.14	True
J-151	634.00	0.120	527.6	687.91	True

Active Scenario: Future PH

Current Time: 0.000 hours

Label	Elevation (m)	Demand (L/s)	Pressure (kPa)	Hydraulic Grade (m)	Is Active?
J-152	634.30	0.210	524.2	687.86	True
J-153	635.20	0.270	511.3	687.44	True
J-154	635.80	0.210	504.8	687.38	True
J-155	636.40	0.210	498.4	687.32	True
J-156	635.80	0.000	503.9	687.28	True
J-157	634.90	0.150	518.3	687.86	True
J-158	634.60	0.090	521.8	687.91	True
J-159	637.00	0.000	491.7	687.24	True
J-160	639.50	0.300	466.9	687.21	True
J-161	640.00	0.000	461.9	687.20	True
J-162	630.80	0.330	421.4	673.86	True
J-163	631.50	0.240	414.6	673.87	True
J-164	630.90	0.330	420.8	673.90	True
J-165	630.30	0.000	426.9	673.92	True
J-166	629.70	0.300	433.0	673.95	True
J-167	629.10	0.060	439.1	673.96	True
J-168	627.20	4.020	463.8	674.59	True
J-169	628.50	4.680	453.1	674.80	True
J-170	630.00	0.210	433.0	674.24	True
J-171	634.00	0.000	532.6	688.42	True
J-172	635.90	0.240	502.7	687.26	True
J-173	626.82	0.000	482.4	676.11	True
J-180	641.50	3.060	447.1	687.19	True
J-182	637.00	2.550	501.7	688.27	True
J-187	632.20	0.000	398.8	672.95	True
J-191	641.00	0.510	452.1	687.19	True
J-240	634.25	0.000	537.5	689.18	True
J-242	628.00	0.120	450.9	674.07	True
J-243	628.00	0.120	451.5	674.13	True
J-244	628.00	0.120	452.1	674.19	True
J-245	627.50	0.000	457.4	674.24	True
J-246	628.50	0.060	445.4	674.01	True
J-247	628.50	0.090	446.0	674.08	True
J-248	627.50	0.000	456.4	674.14	True
J-249	627.00	0.000	461.9	674.20	True
J-250	627.00	5.880	462.3	674.24	True
J-251	627.00	0.000	463.4	674.35	True
J-252	627.00	0.000	464.5	674.46	True
J-263	627.40	0.000	467.2	675.14	True
J-264	627.90	0.000	468.4	675.77	True
J-265	641.50	2.550	439.2	686.37	True
J-266	642.50	2.550	428.6	686.29	True
J-269	643.50	6.660	419.9	686.41	True
J-270	642.00	6.660	437.4	686.69	True
J-271	641.00	5.880	437.5	685.70	True
J-272	641.50	2.550	432.6	685.70	True
J-273	638.50	5.880	455.4	685.03	True

Active Scenario: Future PH

Current Time: 0.000 hours

Label	Elevation (m)	Demand (L/s)	Pressure (kPa)	Hydraulic Grade (m)	Is Active?
J-274	640.50	5.880	434.2	684.87	True
J-277	638.50	12.600	450.2	684.50	True
J-279	638.00	12.600	454.8	684.47	True
J-281	644.00	12.600	403.5	685.23	True
J-283	632.70	5.880	508.8	684.69	True
J-284	634.50	5.880	492.4	684.81	True
J-285	634.00	5.880	389.6	673.81	True
J-286	636.50	5.880	470.0	684.52	True
J-287	644.00	2.550	413.9	686.29	True
J-288	644.00	6.660	414.2	686.32	True
J-290	641.50	6.660	446.0	687.07	True
J-291	641.50	6.660	445.9	687.06	True
J-292	639.50	6.660	465.8	687.09	True
J-293	640.00	6.660	460.2	687.03	True
J-294	642.00	6.660	440.7	687.03	True
J-295	634.50	6.660	388.1	674.15	True
J-296	633.00	11.340	405.8	674.47	True
J-297	630.70	4.020	428.4	674.47	True
J-298	628.00	4.020	454.8	674.47	True
J-299	625.50	4.020	479.2	674.46	True
J-300	619.50	6.540	538.2	674.49	True
J-301	638.00	6.660	481.4	687.19	True
J-302	637.50	6.660	492.1	687.78	True
J-303	639.30	6.660	467.3	687.05	True
J-306	635.20	6.660	506.6	686.97	True
J-308	632.30	10.680	412.2	674.42	True
J-311	631.00	4.020	425.0	674.43	True
J-313	629.00	4.020	444.6	674.43	True
J-316	621.50	6.300	521.3	674.77	True
J-318	620.00	6.300	534.2	674.59	True
J-319	617.50	6.300	558.1	674.52	True
J-321	628.00	5.880	448.7	673.85	True
J-322	624.50	0.000	484.5	674.01	True
J-323	632.00	5.880	410.0	673.90	True
J-324	624.50	5.880	483.0	673.85	True
J-329	627.70	5.880	451.3	673.81	True
J-331	625.50	5.880	473.2	673.85	True
J-333	620.50	0.000	523.4	673.98	True
J-335	619.00	6.300	545.2	674.71	True
J-336	618.70	6.300	548.2	674.71	True
J-337	619.00	6.300	542.8	674.46	True
J-339	623.50	6.300	505.2	675.12	True
J-340	640.50	12.600	433.4	684.78	True
J-342	635.00	192.000	346.2	670.37	True
J-346	627.90	0.000	467.2	675.64	True
J-347	627.60	0.000	467.4	675.36	True

Active Scenario: Future PH

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-2	J-2	J-3	106.93	250.0	130.0	31.956	0.65	True
P-3	J-3	J-4	97.63	250.0	130.0	31.716	0.65	True
P-4	J-4	J-5	115.44	250.0	130.0	31.326	0.64	True
P-5	J-5	J-6	70.20	250.0	130.0	31.326	0.64	True
P-6	J-6	J-7	24.79	250.0	130.0	15.519	0.32	True
P-7	J-7	J-8	115.24	250.0	130.0	15.519	0.32	True
P-8	J-8	J-9	104.24	250.0	130.0	15.159	0.31	True
P-9	J-9	J-10	88.84	250.0	130.0	15.159	0.31	True
P-12	J-10	J-13	79.95	297.0	130.0	12.402	0.18	True
P-13	J-13	J-14	117.53	297.0	130.0	12.402	0.18	True
P-16	J-16	J-17	84.93	297.0	130.0	-12.143	0.18	True
P-17	J-17	J-18	98.70	297.0	130.0	-12.143	0.18	True
P-21	J-21	J-22	66.47	250.0	130.0	-15.477	0.32	True
P-22	J-22	J-6	61.64	250.0	130.0	-15.477	0.32	True
P-23	J-21	J-23	41.90	250.0	130.0	-10.583	0.22	True
P-24	J-23	J-24	128.04	250.0	130.0	-10.583	0.22	True
P-25	J-24	J-25	118.50	250.0	130.0	-10.793	0.22	True
P-26	J-25	J-26	61.18	250.0	130.0	0.240	0.00	True
P-27	J-25	J-27	76.75	250.0	130.0	-11.033	0.22	True
P-29	J-28	J-29	141.74	300.0	130.0	60.709	0.86	True
P-31	J-30	J-31	89.35	148.6	120.0	4.342	0.25	True
P-32	J-31	J-32	126.05	300.0	130.0	-49.362	0.70	True
P-33	J-32	J-29	7.68	297.0	130.0	-55.738	0.80	True
P-34	J-32	J-33	106.05	148.6	120.0	6.376	0.37	True
P-35	J-33	J-34	105.22	148.6	120.0	4.600	0.27	True
P-36	J-34	J-35	116.79	148.6	120.0	4.480	0.26	True
P-37	J-35	J-36	183.19	148.6	120.0	4.210	0.24	True
P-41	J-36	J-39	162.23	148.6	120.0	3.794	0.22	True
P-44	J-41	J-38	177.19	101.6	120.0	-2.835	0.35	True
P-45	J-41	J-42	96.01	148.6	120.0	5.489	0.32	True
P-46	J-42	J-43	185.64	300.0	130.0	-55.186	0.78	True
P-47	J-43	J-38	106.28	250.0	130.0	-15.973	0.33	True
P-48	J-39	J-41	122.16	101.6	120.0	3.314	0.41	True
P-49	J-30	J-44	41.81	148.6	120.0	0.000	0.00	True
P-51	J-14	J-16	77.49	297.0	130.0	12.102	0.17	True
P-52	J-43	J-45	171.22	199.4	120.0	12.065	0.39	True
P-53	J-45	J-46	12.16	199.4	120.0	1.605	0.05	True
P-54	J-45	J-47	215.91	297.0	130.0	-43.545	0.63	True
P-55	J-47	J-48	176.76	297.0	130.0	-43.545	0.63	True
P-56	J-48	J-49	122.46	148.6	120.0	7.837	0.45	True
P-57	J-49	J-50	93.42	148.6	120.0	7.837	0.45	True
P-58	J-50	J-51	155.68	148.6	120.0	3.659	0.21	True
P-59	J-51	J-46	111.82	148.6	120.0	3.449	0.20	True
P-60	J-48	J-52	162.13	293.9	120.0	-51.592	0.76	True
P-61	J-52	J-53	10.35	293.9	120.0	-95.050	1.40	True
P-62	J-53	J-54	12.22	199.4	120.0	17.030	0.55	True

Active Scenario: Future PH

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-63	J-54	J-55	99.16	148.6	120.0	0.210	0.01	True
P-64	J-55	J-56	54.92	148.6	120.0	0.210	0.01	True
P-65	J-52	J-57	224.06	300.0	130.0	43.458	0.61	True
P-66	J-54	J-58	80.36	199.4	120.0	16.820	0.54	True
P-67	J-58	J-59	72.02	199.4	120.0	16.550	0.53	True
P-68	J-59	J-60	59.02	199.4	120.0	12.326	0.39	True
P-69	J-60	J-57	8.12	300.0	130.0	-33.669	0.48	True
P-70	J-59	J-61	192.84	199.4	120.0	3.714	0.12	True
P-71	J-61	J-62	80.81	148.6	120.0	4.186	0.24	True
P-72	J-62	J-63	17.67	199.4	120.0	-2.503	0.08	True
P-73	J-63	J-60	132.46	199.4	120.0	-2.503	0.08	True
P-75	J-64	J-65	49.29	148.6	120.0	-8.917	0.51	True
P-78	J-67	J-68	107.29	148.6	120.0	0.210	0.01	True
P-79	J-65	J-69	153.75	148.6	120.0	-2.858	0.16	True
P-80	J-69	J-70	76.94	148.6	120.0	-2.565	0.15	True
P-81	J-70	J-71	37.15	148.6	120.0	0.000	0.00	True
P-82	J-70	J-72	55.29	148.6	120.0	-2.775	0.16	True
P-83	J-72	J-73	98.87	148.6	120.0	-2.775	0.16	True
P-84	J-73	J-67	52.64	148.6	120.0	6.479	0.37	True
P-85	J-53	J-74	38.46	343.9	120.0	-112.080	1.21	True
P-86	J-74	J-69	78.15	199.4	120.0	0.474	0.02	True
P-88	J-75	J-1	5.51	600.0	120.0	175.097	0.62	True
P-89	J-75	J-76	28.01	600.0	120.0	-301.999	1.07	True
P-90	J-43	J-31	172.61	300.0	130.0	-51.668	0.73	True
P-91	J-38	J-77	176.47	101.6	120.0	-2.461	0.30	True
P-92	J-77	J-33	123.06	101.6	120.0	-1.476	0.18	True
P-93	J-46	J-78	180.21	148.6	120.0	-3.190	0.18	True
P-94	J-78	J-50	101.47	148.6	120.0	-3.938	0.23	True
P-96	J-79	J-57	199.03	199.4	120.0	-9.789	0.31	True
P-99	J-81	J-82	101.91	199.4	120.0	4.911	0.16	True
P-100	J-82	J-83	35.79	199.4	120.0	4.911	0.16	True
P-101	J-83	J-84	20.87	199.4	120.0	4.641	0.15	True
P-102	J-84	J-85	61.14	300.0	120.0	-37.661	0.53	True
P-103	J-85	J-86	75.17	148.6	120.0	0.120	0.01	True
P-104	J-85	J-87	82.74	199.4	120.0	5.710	0.18	True
P-105	J-87	J-88	165.41	199.4	120.0	15.289	0.49	True
P-106	J-88	J-89	143.22	199.4	120.0	-1.365	0.04	True
P-107	J-89	J-90	10.12	200.0	120.0	-6.644	0.21	True
P-108	J-90	J-91	138.31	148.6	110.0	-6.644	0.38	True
P-109	J-91	J-81	101.88	148.6	110.0	-1.178	0.07	True
P-110	J-45	J-92	108.08	297.0	130.0	54.006	0.78	True
P-111	J-92	J-93	172.48	297.0	130.0	56.489	0.82	True
P-112	J-93	J-94	99.72	297.0	130.0	56.489	0.82	True
P-113	J-94	J-95	175.01	400.0	120.0	116.895	0.93	True
P-114	J-91	J-96	107.82	148.6	110.0	3.512	0.20	True
P-115	J-96	J-97	141.69	101.6	110.0	2.977	0.37	True

Active Scenario: Future PH

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-116	J-97	J-89	102.40	297.0	130.0	-46.981	0.68	True
P-117	J-97	J-98	117.55	297.0	130.0	43.145	0.62	True
P-118	J-98	J-99	117.76	297.0	130.0	39.069	0.56	True
P-119	J-99	J-100	118.53	148.6	110.0	4.436	0.26	True
P-121	J-101	J-102	6.88	200.0	130.0	8.076	0.26	True
P-122	J-102	J-103	118.39	204.0	130.0	8.076	0.25	True
P-123	J-103	J-104	119.05	148.6	110.0	-8.739	0.50	True
P-124	J-104	J-105	112.74	148.6	110.0	-5.084	0.29	True
P-125	J-105	J-106	4.88	200.0	110.0	-13.002	0.41	True
P-126	J-106	J-107	108.20	200.0	130.0	-6.603	0.21	True
P-127	J-107	J-97	97.52	200.0	130.0	-6.603	0.21	True
P-128	J-104	J-108	107.06	200.0	130.0	-3.865	0.12	True
P-129	J-108	J-98	101.07	200.0	130.0	-3.865	0.12	True
P-130	J-103	J-109	103.99	297.0	130.0	-37.989	0.55	True
P-131	J-109	J-99	103.57	297.0	130.0	-37.989	0.55	True
P-132	J-100	J-110	102.53	204.0	130.0	8.286	0.25	True
P-133	J-110	J-101	99.72	204.0	130.0	8.286	0.25	True
P-134	J-106	J-111	115.87	148.6	110.0	-6.819	0.39	True
P-135	J-111	J-88	7.36	199.4	120.0	-16.654	0.53	True
P-136	J-105	J-112	144.16	199.4	120.0	7.919	0.25	True
P-137	J-112	J-113	35.89	148.6	120.0	-6.858	0.40	True
P-138	J-113	J-114	77.15	148.6	120.0	-6.858	0.40	True
P-139	J-114	J-78	107.19	148.6	120.0	-0.568	0.03	True
P-140	J-114	J-111	162.88	199.4	120.0	-9.505	0.30	True
P-141	J-114	J-115	179.70	101.6	120.0	2.584	0.32	True
P-142	J-115	J-46	107.72	148.6	120.0	-8.064	0.46	True
P-144	J-116	J-115	181.60	148.6	120.0	-7.955	0.46	True
P-145	J-116	J-117	117.02	148.6	120.0	7.303	0.42	True
P-146	J-117	J-118	148.95	148.6	120.0	9.535	0.55	True
P-147	J-118	J-119	193.47	297.0	130.0	-46.106	0.67	True
P-148	J-120	J-121	66.74	101.6	120.0	-0.510	0.06	True
P-149	J-121	J-117	119.91	148.6	120.0	2.322	0.13	True
P-150	J-95	J-122	123.48	400.0	120.0	163.762	1.30	True
P-151	J-122	J-123	122.81	400.0	120.0	163.762	1.30	True
P-152	J-123	J-124	16.44	200.0	130.0	-28.238	0.90	True
P-153	J-124	J-125	15.83	200.0	120.0	-14.751	0.47	True
P-154	J-125	J-126	118.07	148.6	120.0	-14.751	0.85	True
P-155	J-126	J-118	123.36	148.6	120.0	-8.443	0.49	True
P-156	J-126	J-127	203.67	148.6	120.0	-6.638	0.38	True
P-157	J-124	J-128	171.29	148.6	120.0	-13.577	0.78	True
P-159	J-129	J-130	156.10	297.0	130.0	71.467	1.03	True
P-160	J-129	J-131	234.41	250.0	130.0	12.303	0.25	True
P-161	J-131	J-132	178.61	254.0	120.0	9.890	0.20	True
P-165	J-131	J-135	19.74	204.0	130.0	2.412	0.07	True
P-166	J-135	J-136	93.25	204.0	130.0	2.412	0.07	True
P-167	J-136	J-137	50.58	204.0	130.0	1.932	0.06	True

Active Scenario: Future PH

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-168	J-137	J-138	90.89	148.6	120.0	1.932	0.11	True
P-169	J-138	J-139	58.95	200.0	120.0	0.180	0.01	True
P-170	J-138	J-140	80.62	148.6	120.0	1.632	0.09	True
P-171	J-140	J-132	157.69	148.6	120.0	1.332	0.08	True
P-172	J-132	J-141	147.53	254.0	120.0	11.223	0.22	True
P-173	J-141	J-142	148.36	204.0	130.0	0.510	0.02	True
P-174	J-142	J-143	39.78	148.6	120.0	0.000	0.00	True
P-175	J-141	J-144	88.56	254.0	120.0	10.713	0.21	True
P-176	J-144	J-145	125.87	254.0	120.0	10.473	0.21	True
P-177	J-145	J-146	149.54	148.6	120.0	1.623	0.09	True
P-178	J-146	J-147	137.37	148.6	120.0	1.203	0.07	True
P-179	J-147	J-148	46.58	200.0	120.0	1.203	0.04	True
P-180	J-148	J-145	144.72	254.0	120.0	-8.640	0.17	True
P-181	J-148	J-149	98.53	254.0	120.0	9.663	0.19	True
P-182	J-149	J-150	95.50	148.6	120.0	9.543	0.55	True
P-183	J-150	J-151	79.49	148.6	120.0	9.423	0.54	True
P-184	J-151	J-152	79.27	200.0	120.0	9.213	0.29	True
P-185	J-152	J-153	162.79	148.6	120.0	8.853	0.51	True
P-186	J-153	J-154	125.41	148.6	120.0	3.554	0.20	True
P-187	J-154	J-155	145.37	148.6	120.0	3.344	0.19	True
P-188	J-155	J-156	105.12	148.6	120.0	3.134	0.18	True
P-189	J-156	J-153	178.12	148.6	120.0	-5.029	0.29	True
P-190	J-152	J-157	102.41	148.6	120.0	0.150	0.01	True
P-191	J-151	J-158	92.50	148.6	120.0	0.090	0.01	True
P-193	J-159	J-160	213.11	250.0	130.0	7.923	0.16	True
P-194	J-160	J-161	81.42	250.0	130.0	7.623	0.16	True
P-195	J-96	J-162	235.63	148.6	110.0	3.037	0.18	True
P-196	J-162	J-163	118.42	148.6	110.0	-1.099	0.06	True
P-197	J-163	J-164	158.19	204.0	130.0	-5.518	0.17	True
P-198	J-164	J-165	168.74	204.0	130.0	-4.910	0.15	True
P-199	J-165	J-166	139.26	204.0	130.0	-4.910	0.15	True
P-200	J-166	J-167	93.06	204.0	130.0	-5.210	0.16	True
P-201	J-167	J-96	113.33	204.0	130.0	2.711	0.08	True
P-202	J-163	J-100	141.26	101.6	110.0	4.180	0.52	True
P-203	J-162	J-99	141.83	101.6	110.0	3.805	0.47	True
P-204	J-18	J-168	138.25	297.0	130.0	-12.353	0.18	True
P-206	J-27	J-169	77.84	250.0	130.0	-11.273	0.23	True
P-207	J-169	J-28	38.91	300.0	130.0	67.369	0.95	True
P-208	J-29	J-170	89.58	148.6	120.0	4.792	0.28	True
P-209	J-170	J-30	133.92	148.6	120.0	4.582	0.26	True
P-210	J-149	J-171	40.04	254.0	120.0	0.000	0.00	True
P-211	J-156	J-172	40.48	200.0	120.0	8.163	0.26	True
P-212	J-172	J-159	140.22	250.0	130.0	7.923	0.16	True
P-213	J-62	J-81	113.97	148.6	110.0	6.299	0.36	True
P-214	J-67	J-65	29.20	148.6	120.0	6.269	0.36	True
P-215	J-38	J-36	105.65	250.0	130.0	-16.497	0.34	True

Active Scenario: Future PH

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-216	J-21	J-168	72.60	250.0	130.0	25.760	0.52	True
P-217	J-12	J-10	72.67	297.0	130.0	-2.096	0.03	True
P-219	J-173	J-76	67.53	600.0	110.0	301.999	1.07	True
P-245	J-119	J-127	119.45	200.0	130.0	20.545	0.65	True
P-246	J-127	J-128	119.21	200.0	130.0	13.697	0.44	True
P-247	J-103	J-119	209.03	300.0	130.0	54.593	0.77	True
P-253	J-129	J-182	220.97	392.9	130.0	105.381	0.87	True
P-254	J-182	J-180	591.83	392.9	130.0	102.831	0.85	True
P-256	J-31	J-77	105.65	200.0	130.0	1.285	0.04	True
P-273	J-119	J-121	176.72	204.0	130.0	-12.267	0.38	True
P-274	J-121	J-187	127.08	200.0	130.0	-15.339	0.49	True
P-275	J-187	J-112	87.86	148.6	130.0	-14.777	0.85	True
P-281	J-42	J-94	260.80	300.0	130.0	60.405	0.85	True
P-282	J-180	J-191	75.02	297.0	130.0	-7.113	0.10	True
P-283	J-191	J-161	151.36	297.0	130.0	-7.623	0.11	True
P-286	J-116	J-187	104.63	148.6	130.0	0.562	0.03	True
P-295	J-101	PRV-4	323.66	199.4	120.0	0.000	0.00	True
P-296	PRV-4	J-132	130.67	199.4	120.0	0.000	0.00	True
P-309	J-87	J-79	55.90	204.0	130.0	-9.789	0.30	True
P-311	J-92	J-115	18.47	200.0	130.0	-2.483	0.08	True
P-312	J-118	J-95	22.95	297.0	130.0	46.867	0.68	True
P-385	J-89	J-84	163.21	297.0	130.0	-42.302	0.61	True
P-391	J-240	J-129	155.87	450.0	130.0	192.000	1.21	True
P-392	R-7	J-240	61.02	450.0	130.0	192.000	1.21	True
P-410	J-85	J-60	108.45	300.0	130.0	-43.492	0.62	True
P-412	J-91	J-242	106.89	200.0	130.0	-9.188	0.29	True
P-413	J-242	J-243	104.98	200.0	130.0	-9.308	0.30	True
P-414	J-243	J-244	101.17	200.0	130.0	-9.428	0.30	True
P-415	J-244	J-245	72.91	200.0	130.0	-9.548	0.30	True
P-416	J-245	J-61	54.30	200.0	130.0	-7.283	0.23	True
P-417	J-167	J-246	107.63	300.0	130.0	-7.982	0.25	True
P-418	J-246	J-247	113.84	300.0	130.0	-27.621	0.39	True
P-419	J-247	J-248	105.02	300.0	130.0	-27.711	0.39	True
P-420	J-248	J-249	96.09	300.0	130.0	-27.711	0.39	True
P-421	J-249	J-250	77.01	300.0	130.0	-27.711	0.39	True
P-422	J-250	J-251	110.79	300.0	130.0	-35.857	0.51	True
P-423	J-61	J-252	101.86	148.6	120.0	-7.754	0.45	True
P-424	J-252	J-64	109.10	300.0	130.0	-43.611	0.62	True
P-425	J-251	J-252	117.12	300.0	130.0	-35.857	0.51	True
P-426	J-250	J-245	117.62	200.0	130.0	2.265	0.07	True
P-441	J-74	J-263	44.33	343.9	120.0	-147.247	1.59	True
P-442	J-263	J-75	152.97	343.9	120.0	-126.902	1.37	True
P-443	J-1	J-264	131.05	479.6	120.0	175.097	0.97	True
P-444	J-264	J-2	174.53	479.6	120.0	154.752	0.86	True
P-446	J-180	J-265	405.08	350.0	130.0	80.158	0.83	True
P-447	J-265	J-266	430.86	300.0	130.0	14.836	0.21	True

Active Scenario: Future PH

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-451	J-266	J-269	441.05	250.0	130.0	-11.030	0.22	True
P-452	J-269	J-270	431.41	300.0	130.0	-29.042	0.41	True
P-454	J-265	J-271	522.00	350.0	130.0	62.772	0.65	True
P-456	J-272	J-266	479.51	250.0	130.0	-25.458	0.52	True
P-457	J-271	J-272	282.71	300.0	130.0	4.925	0.07	True
P-458	J-271	J-273	746.44	350.0	130.0	51.967	0.54	True
P-459	J-273	J-274	447.19	300.0	130.0	21.116	0.30	True
P-465	J-277	J-279	408.28	250.0	130.0	5.269	0.11	True
P-469	J-283	J-284	407.93	300.0	130.0	-19.091	0.27	True
P-470	J-284	J-273	450.73	300.0	130.0	-24.971	0.35	True
P-475	J-283	J-286	456.47	250.0	130.0	13.211	0.27	True
P-477	J-266	J-287	406.08	300.0	130.0	-2.142	0.03	True
P-479	J-287	J-288	531.51	250.0	130.0	-4.692	0.10	True
P-480	J-288	J-269	306.89	250.0	130.0	-11.352	0.23	True
P-482	J-270	J-290	395.36	300.0	130.0	-35.702	0.51	True
P-483	J-290	J-180	463.35	350.0	130.0	-26.726	0.28	True
P-484	J-290	J-291	375.15	300.0	130.0	5.095	0.07	True
P-485	J-291	J-292	416.23	300.0	130.0	-10.047	0.14	True
P-487	J-293	J-294	419.29	250.0	130.0	-1.822	0.04	True
P-488	J-294	J-291	385.20	300.0	130.0	-8.482	0.12	True
P-489	J-36	J-295	525.08	250.0	130.0	-16.261	0.33	True
P-490	J-295	J-296	750.01	300.0	130.0	-22.921	0.32	True
P-491	J-296	J-169	610.35	350.0	130.0	-39.474	0.41	True
P-492	J-296	J-297	379.67	300.0	130.0	-3.661	0.05	True
P-493	J-297	J-168	619.22	250.0	130.0	-9.387	0.19	True
P-494	J-297	J-298	451.01	300.0	130.0	1.706	0.02	True
P-495	J-298	J-299	439.07	300.0	130.0	3.979	0.06	True
P-496	J-299	J-300	605.92	250.0	130.0	-4.654	0.09	True
P-497	J-300	J-16	588.59	250.0	130.0	-6.179	0.13	True
P-498	J-16	J-298	663.80	300.0	130.0	11.527	0.16	True
P-500	J-301	J-292	412.89	300.0	130.0	16.707	0.24	True
P-501	J-130	J-302	106.08	250.0	130.0	68.917	0.97	True
P-502	J-302	J-301	465.34	250.0	130.0	41.525	0.59	True
P-503	J-302	J-290	840.59	250.0	130.0	20.732	0.42	True
P-504	J-301	J-303	517.08	300.0	130.0	18.158	0.26	True
P-505	J-303	J-293	402.71	250.0	130.0	4.838	0.10	True
P-508	J-303	J-306	817.19	250.0	130.0	6.660	0.14	True
P-514	J-296	J-308	619.58	300.0	130.0	8.873	0.13	True
P-515	J-308	J-311	818.12	250.0	130.0	-1.807	0.04	True
P-516	J-311	J-298	620.70	250.0	130.0	-5.235	0.11	True
P-518	J-311	J-313	408.70	250.0	130.0	-0.592	0.01	True
P-519	J-313	J-299	637.79	250.0	130.0	-4.612	0.09	True
P-524	J-316	J-318	462.29	300.0	130.0	21.819	0.31	True
P-525	J-318	J-319	563.29	300.0	130.0	11.315	0.16	True
P-526	J-319	J-300	478.79	250.0	130.0	5.015	0.10	True
P-529	J-321	J-322	820.72	250.0	130.0	-9.277	0.19	True

Active Scenario: Future PH

Current Time: 0.000 hours

Label	Start Node	Stop Node	Scaled Length (m)	Diameter (mm)	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Is Active?
P-530	J-322	J-246	670.51	300.0	130.0	-1.208	0.02	True
P-531	J-246	J-323	398.69	300.0	130.0	18.372	0.26	True
P-532	J-323	J-164	98.47	250.0	130.0	0.938	0.02	True
P-533	J-323	J-324	397.85	300.0	130.0	11.554	0.16	True
P-534	J-324	J-321	688.45	300.0	130.0	-0.206	0.00	True
P-537	J-324	J-285	482.30	250.0	130.0	5.880	0.12	True
P-543	J-329	J-331	452.43	250.0	130.0	-5.880	0.12	True
P-544	J-331	J-321	390.74	300.0	130.0	-3.191	0.05	True
P-546	J-331	J-333	818.51	250.0	130.0	-8.569	0.17	True
P-547	J-333	J-322	383.34	300.0	130.0	-8.569	0.12	True
P-549	J-316	J-335	615.57	250.0	130.0	6.207	0.13	True
P-550	J-335	J-336	384.31	250.0	130.0	-0.093	0.00	True
P-551	J-336	J-337	244.04	250.0	130.0	22.938	0.47	True
P-552	J-337	J-322	803.65	250.0	130.0	16.638	0.34	True
P-554	J-73	J-339	105.02	148.6	130.0	-9.494	0.55	True
P-555	J-339	J-316	398.43	300.0	130.0	34.326	0.49	True
P-556	J-339	J-336	617.43	300.0	130.0	29.331	0.41	True
P-557	J-339	J-173	235.53	300.0	130.0	-79.451	1.12	True
P-558	J-12	J-318	127.44	300.0	130.0	-4.204	0.06	True
P-559	J-286	J-279	401.04	250.0	130.0	7.331	0.15	True
P-560	J-277	J-340	447.00	250.0	130.0	-17.869	0.36	True
P-561	J-340	J-281	933.64	250.0	130.0	-15.233	0.31	True
P-562	J-274	J-340	430.78	300.0	130.0	15.236	0.22	True
P-563	J-272	J-281	774.66	300.0	130.0	27.833	0.39	True
P-564	J-306	PRV-10	164.66	250.0	130.0	0.000	0.00	True
P-565	PRV-10	J-308	655.50	250.0	130.0	0.000	0.00	True
P-566	J-295	PRV-11	157.43	300.0	130.0	0.000	0.00	True
P-567	PRV-11	J-301	728.73	300.0	130.0	0.000	0.00	True
P-570	J-273	PRV-13	402.85	250.0	130.0	0.000	0.00	True
P-571	PRV-13	J-285	415.96	250.0	130.0	0.000	0.00	True
P-572	J-329	PRV-14	656.86	250.0	130.0	0.000	0.00	True
P-573	PRV-14	J-283	76.78	250.0	130.0	0.000	0.00	True
P-574	J-173	R-11	44.78	600.0	130.0	-381.450	1.35	True
P-575	J-123	J-342	125.34	400.0	120.0	192.000	1.53	True
P-576	J-342	J-240	45.43	392.4	120.0	0.000	0.00	True
P-584	J-74	J-64	195.77	300.0	130.0	34.694	0.49	True
P-585	J-2	J-169	289.80	400.0	130.0	122.796	0.98	True
P-587	J-346	J-264	50.86	200.0	130.0	-20.345	0.65	True
P-588	J-263	J-347	90.77	200.0	130.0	-20.345	0.65	True
P-589	J-347	J-346	116.69	200.0	130.0	-20.345	0.65	True

Active Scenario: Future PD plus Fire

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-1	True	83.000	201.000	0.000	138.0	495.3	276.0	389.7	True
J-2	True	183.001	201.000	0.000	138.0	460.8	276.0	383.8	True
J-3	True	183.001	201.000	0.144	138.0	437.7	276.0	381.8	True
J-4	True	183.001	201.000	0.234	138.0	435.3	276.0	381.0	True
J-5	True	183.001	201.000	0.000	138.0	439.3	276.0	380.1	True
J-6	True	183.001	201.000	0.198	138.0	453.4	276.0	379.5	True
J-7	True	183.001	201.000	0.000	138.0	449.2	276.0	379.4	True
J-8	True	183.001	201.000	0.216	138.0	443.2	276.0	379.1	True
J-9	True	183.001	201.000	0.000	138.0	455.5	276.0	379.0	True
J-10	True	183.001	201.000	0.396	138.0	485.8	276.0	378.9	True
J-12	True	183.001	201.000	3.780	138.0	484.4	276.0	379.0	True
J-13	True	183.001	201.000	0.000	138.0	463.2	276.0	378.8	True
J-14	True	183.001	201.000	0.180	138.0	449.1	276.0	378.7	True
J-16	True	183.001	201.000	3.924	138.0	447.5	276.0	378.5	True
J-17	True	183.001	201.000	0.000	138.0	444.6	276.0	378.5	True
J-18	True	183.001	201.000	0.126	138.0	433.6	276.0	378.5	True
J-21	True	183.001	201.000	0.180	138.0	448.1	276.0	378.7	True
J-22	True	183.001	201.000	0.000	138.0	447.7	276.0	379.1	True
J-23	True	183.001	201.000	0.000	138.0	438.9	276.0	378.5	True
J-24	True	183.001	201.000	0.126	138.0	423.1	276.0	378.1	True
J-25	True	183.001	201.000	0.000	138.0	416.8	276.0	377.8	True
J-26	True	183.001	201.000	0.144	138.0	384.7	276.0	377.8	True
J-27	True	183.001	201.000	0.144	138.0	423.4	276.0	377.6	True
J-28	True	183.001	201.000	3.996	138.0	434.5	276.0	373.6	True
J-29	True	83.000	201.000	0.108	138.0	407.7	276.0	366.0	True
J-30	True	83.000	138.610	0.144	138.0	270.1	276.0	276.0	True
J-31	True	83.000	201.000	0.450	138.0	397.6	276.0	362.0	True
J-32	True	83.000	201.000	0.000	138.0	407.2	276.0	365.6	True
J-33	True	83.000	163.593	0.180	138.0	225.9	276.0	276.0	True
J-34	True	83.000	134.188	0.072	138.0	191.7	276.0	276.0	True
J-35	True	83.000	137.802	0.162	138.0	164.3	276.0	276.0	True
J-36	True	83.000	201.000	0.108	138.0	368.8	276.0	361.7	True
J-38	True	83.000	201.000	0.090	138.0	373.8	276.0	359.4	True
J-39	True	83.000	119.142	0.288	138.0	138.0	276.0	374.6	True
J-41	True	83.000	170.514	0.396	138.0	138.0	276.0	353.0	True
J-42	True	83.000	201.000	0.162	138.0	374.5	276.0	347.8	True
J-43	True	83.000	201.000	0.234	138.0	389.2	276.0	356.5	True
J-44	True	83.000	130.968	0.000	138.0	138.0	276.0	286.8	True
J-45	True	183.001	201.000	0.000	138.0	384.9	276.0	351.7	True
J-46	True	183.001	201.000	0.108	138.0	373.3	276.0	352.0	True
J-47	True	183.000	201.000	0.000	138.0	394.3	276.0	356.6	True
J-48	True	183.000	201.000	0.126	138.0	413.1	276.0	360.5	True
J-49	True	183.000	191.734	0.000	138.0	138.0	276.0	309.4	True
J-50	True	183.000	201.000	0.144	138.0	194.9	276.0	293.1	True

Active Scenario: Future PD plus Fire

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-51	False	183.001	177.356	0.126	138.0	138.0	276.0	348.4	True
J-52	True	83.000	201.000	0.000	138.0	439.2	276.0	368.9	True
J-53	True	83.000	201.000	0.000	138.0	441.0	276.0	370.3	True
J-54	True	160.000	201.000	0.000	138.0	425.3	276.0	370.0	True
J-55	True	83.000	89.915	0.000	138.0	277.0	276.0	276.0	True
J-56	True	83.000	90.165	0.126	138.0	173.3	276.0	276.0	True
J-57	True	200.000	201.000	0.000	138.0	415.2	276.0	363.4	True
J-58	True	160.000	201.000	0.162	138.0	382.2	276.0	368.4	True
J-59	True	160.000	201.000	0.306	138.0	395.2	276.0	366.3	True
J-60	True	200.000	201.000	0.000	138.0	415.2	276.0	363.3	True
J-61	True	83.000	201.000	0.000	138.0	405.2	276.0	366.8	True
J-62	True	83.000	201.000	0.234	138.0	351.3	276.0	360.0	True
J-63	True	83.000	201.000	0.000	138.0	351.0	276.0	360.1	True
J-64	True	83.000	201.000	0.000	138.0	444.7	276.0	371.0	True
J-65	True	83.000	201.000	0.126	138.0	380.2	276.0	374.2	True
J-67	True	83.000	201.000	0.000	138.0	331.9	276.0	346.6	True
J-68	True	83.000	116.041	0.126	138.0	138.0	276.0	383.0	True
J-69	True	83.000	201.000	0.108	138.0	390.4	276.0	374.4	True
J-70	True	83.000	166.755	0.126	138.0	276.0	276.0	276.0	True
J-71	True	83.000	150.089	0.000	138.0	138.0	276.0	313.4	True
J-72	True	83.000	201.000	0.000	138.0	162.0	276.0	278.1	True
J-73	True	83.000	201.000	0.144	138.0	355.3	276.0	377.6	True
J-74	True	83.000	201.000	0.000	138.0	451.0	276.0	373.4	True
J-75	True	83.000	201.000	0.000	138.0	495.4	276.0	389.7	True
J-76	True	83.000	201.000	0.000	138.0	482.3	276.0	390.2	True
J-77	True	83.000	201.000	0.180	138.0	286.6	276.0	361.8	True
J-78	True	183.001	201.000	0.108	138.0	238.3	276.0	342.1	True
J-79	True	83.000	201.000	0.000	138.0	348.8	276.0	361.2	True
J-81	True	83.000	201.000	0.126	138.0	331.3	276.0	361.8	True
J-82	True	83.000	201.000	0.000	138.0	356.1	276.0	360.7	True
J-83	True	83.000	201.000	0.162	138.0	382.8	276.0	360.0	True
J-84	True	83.000	201.000	0.000	138.0	405.3	276.0	359.3	True
J-85	True	83.000	201.000	0.000	138.0	407.0	276.0	360.5	True
J-86	True	83.000	133.031	0.072	138.0	138.0	276.0	373.5	True
J-87	True	83.000	201.000	0.126	138.0	372.9	276.0	360.4	True
J-88	True	83.000	201.000	0.000	138.0	362.9	276.0	356.9	True
J-89	True	200.000	201.000	0.360	138.0	393.1	276.0	355.4	True
J-90	True	200.000	201.000	0.000	138.0	379.1	276.0	355.9	True
J-91	True	83.000	201.000	0.126	138.0	336.1	276.0	363.8	True
J-92	True	183.000	201.000	0.000	138.0	378.0	276.0	347.8	True
J-93	True	183.000	201.000	0.000	138.0	360.9	276.0	341.1	True
J-94	True	183.001	201.000	0.000	138.0	356.8	276.0	337.3	True
J-95	True	183.000	201.000	0.000	138.0	344.9	276.0	330.4	True
J-96	True	83.000	201.000	0.126	138.0	327.5	276.0	348.6	True

Active Scenario: Future PD plus Fire

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-97	True	83.000	201.000	0.126	138.0	388.5	276.0	352.1	True
J-98	True	83.000	201.000	0.126	138.0	376.1	276.0	348.9	True
J-99	True	83.000	201.000	0.270	138.0	365.3	276.0	346.7	True
J-100	True	83.000	201.000	0.198	138.0	228.8	276.0	276.9	True
J-101	True	183.000	201.000	0.126	138.0	303.3	276.0	307.5	True
J-102	True	183.000	201.000	0.000	138.0	303.8	276.0	306.1	True
J-103	True	183.000	201.000	0.126	138.0	359.6	276.0	342.7	True
J-104	True	83.000	201.000	0.126	138.0	286.8	276.0	338.7	True
J-105	True	133.000	201.000	0.000	138.0	338.3	276.0	341.8	True
J-106	True	133.000	201.000	0.252	138.0	339.0	276.0	341.5	True
J-107	True	83.000	201.000	0.000	138.0	330.7	276.0	351.4	True
J-108	True	83.000	201.000	0.000	138.0	308.7	276.0	330.3	True
J-109	True	83.000	201.000	0.000	138.0	358.9	276.0	344.8	True
J-110	True	83.000	201.000	0.000	138.0	253.5	276.0	280.0	True
J-111	True	83.000	201.000	0.198	138.0	360.2	276.0	356.7	True
J-112	True	183.000	201.000	0.000	138.0	294.8	276.0	326.2	True
J-113	True	200.000	201.000	0.000	138.0	230.0	276.0	327.1	True
J-114	True	200.000	201.000	0.378	138.0	313.5	276.0	353.7	True
J-115	True	183.001	201.000	0.126	138.0	363.9	276.0	348.2	True
J-116	True	183.001	201.000	0.054	138.0	210.8	276.0	314.3	True
J-117	True	183.001	201.000	0.054	138.0	199.8	276.0	320.9	True
J-118	True	183.001	201.000	0.198	138.0	344.5	276.0	331.1	True
J-119	True	183.000	201.000	0.126	138.0	350.6	276.0	335.5	True
J-120	False	183.000	49.935	0.306	138.0	138.0	276.0	381.2	True
J-121	True	183.000	201.000	0.144	138.0	297.4	276.0	297.4	True
J-122	True	183.000	201.000	0.000	138.0	326.7	276.0	318.4	True
J-123	True	183.000	201.000	0.000	138.0	307.2	276.0	309.1	True
J-124	True	183.001	201.000	0.054	138.0	294.9	276.0	295.8	True
J-125	True	200.000	201.000	0.000	138.0	276.3	276.0	297.3	True
J-126	True	183.001	201.000	0.198	138.0	180.5	276.0	315.2	True
J-127	True	83.000	197.976	0.126	138.0	271.3	276.0	276.0	True
J-128	True	83.000	201.000	0.072	138.0	181.9	276.0	287.3	True
J-129	True	183.000	201.000	1.710	138.0	516.0	276.0	415.9	True
J-130	True	183.000	201.000	1.530	138.0	486.9	276.0	402.0	True
J-131	True	160.000	201.000	0.000	138.0	424.0	276.0	411.3	True
J-132	True	83.000	201.000	0.000	138.0	372.7	276.0	375.4	True
J-135	True	160.000	201.000	0.000	138.0	398.9	276.0	388.9	True
J-136	True	160.000	201.000	0.288	138.0	299.9	276.0	298.2	True
J-137	True	160.000	201.000	0.000	138.0	255.4	276.0	301.1	True
J-138	True	83.000	141.369	0.072	138.0	272.1	276.0	276.0	True
J-139	True	83.000	140.184	0.108	138.0	221.9	276.0	276.0	True
J-140	True	83.000	165.945	0.180	138.0	164.0	276.0	276.0	True
J-141	True	83.000	201.000	0.000	138.0	322.3	276.0	322.3	True
J-142	True	83.000	151.390	0.306	138.0	276.0	276.0	276.0	True

Active Scenario: Future PD plus Fire

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-143	True	83.000	141.159	0.000	138.0	138.0	276.0	307.2	True
J-144	True	83.000	201.000	0.144	138.0	300.6	276.0	297.7	True
J-145	True	83.000	195.294	0.126	138.0	271.3	276.0	276.0	True
J-146	True	83.000	159.937	0.252	138.0	138.0	276.0	333.2	True
J-147	True	83.000	182.232	0.000	138.0	231.7	276.0	276.0	True
J-148	True	83.000	183.874	0.108	138.0	274.8	276.0	276.0	True
J-149	True	83.000	175.755	0.072	138.0	278.9	276.0	276.0	True
J-150	True	83.000	147.642	0.072	138.0	220.5	276.0	276.0	True
J-151	True	83.000	122.208	0.072	138.0	281.9	276.0	276.0	True
J-152	True	83.000	120.841	0.126	138.0	281.9	276.0	276.0	True
J-153	True	83.000	153.346	0.162	138.0	229.4	276.0	276.0	True
J-154	True	83.000	142.190	0.126	138.0	141.2	276.0	276.0	True
J-155	True	83.000	142.319	0.126	138.0	172.8	276.0	276.0	True
J-156	True	83.000	186.597	0.000	138.0	272.9	276.0	276.0	True
J-157	True	83.000	97.443	0.090	138.0	138.0	276.0	362.5	True
J-158	True	83.000	101.166	0.054	138.0	138.0	276.0	355.2	True
J-159	True	83.000	201.000	0.000	138.0	305.9	276.0	320.1	True
J-160	True	167.000	201.000	0.180	138.0	352.7	276.0	377.2	True
J-161	True	167.000	201.000	0.000	138.0	378.7	276.0	375.8	True
J-162	True	83.000	173.765	0.198	138.0	138.0	276.0	345.4	True
J-163	True	83.000	201.000	0.144	138.0	235.4	276.0	315.7	True
J-164	True	83.000	201.000	0.198	138.0	330.9	276.0	323.4	True
J-165	True	83.000	201.000	0.000	138.0	282.6	276.0	331.1	True
J-166	True	83.000	201.000	0.180	138.0	310.5	276.0	333.2	True
J-167	True	83.000	201.000	0.036	138.0	375.6	276.0	338.7	True
J-168	True	183.001	201.000	2.412	138.0	429.8	276.0	378.5	True
J-169	True	183.001	201.000	2.808	138.0	440.3	276.0	377.0	True
J-170	True	83.000	190.407	0.126	138.0	138.0	276.0	301.4	True
J-171	True	83.000	176.843	0.000	138.0	254.2	276.0	276.0	True
J-172	True	83.000	201.000	0.144	138.0	275.3	276.0	280.6	True
J-173	True	83.000	201.000	0.000	138.0	482.3	276.0	390.3	True
J-180	True	183.000	201.000	1.836	138.0	404.9	276.0	373.6	True
J-182	True	183.000	201.000	1.530	138.0	479.5	276.0	402.1	True
J-187	True	183.000	201.000	0.000	138.0	282.0	276.0	327.5	True
J-191	True	183.000	201.000	0.306	0.0	395.7	0.0	374.4	True
J-240	True	83.000	201.000	0.000	138.0	537.3	276.0	390.4	True
J-242	True	83.000	201.000	0.072	138.0	318.9	276.0	357.6	True
J-243	True	83.000	201.000	0.072	138.0	318.6	276.0	357.1	True
J-244	True	83.000	201.000	0.072	138.0	348.9	276.0	366.3	True
J-245	True	83.000	201.000	0.000	138.0	402.1	276.0	367.0	True
J-246	True	83.000	201.000	0.036	138.0	390.3	276.0	337.4	True
J-247	True	83.000	201.000	0.054	138.0	392.9	276.0	344.4	True
J-248	True	83.000	201.000	0.000	138.0	407.1	276.0	350.8	True
J-249	True	83.000	201.000	0.000	138.0	417.8	276.0	356.9	True

Active Scenario: Future PD plus Fire

Current Time: 0.000 hours

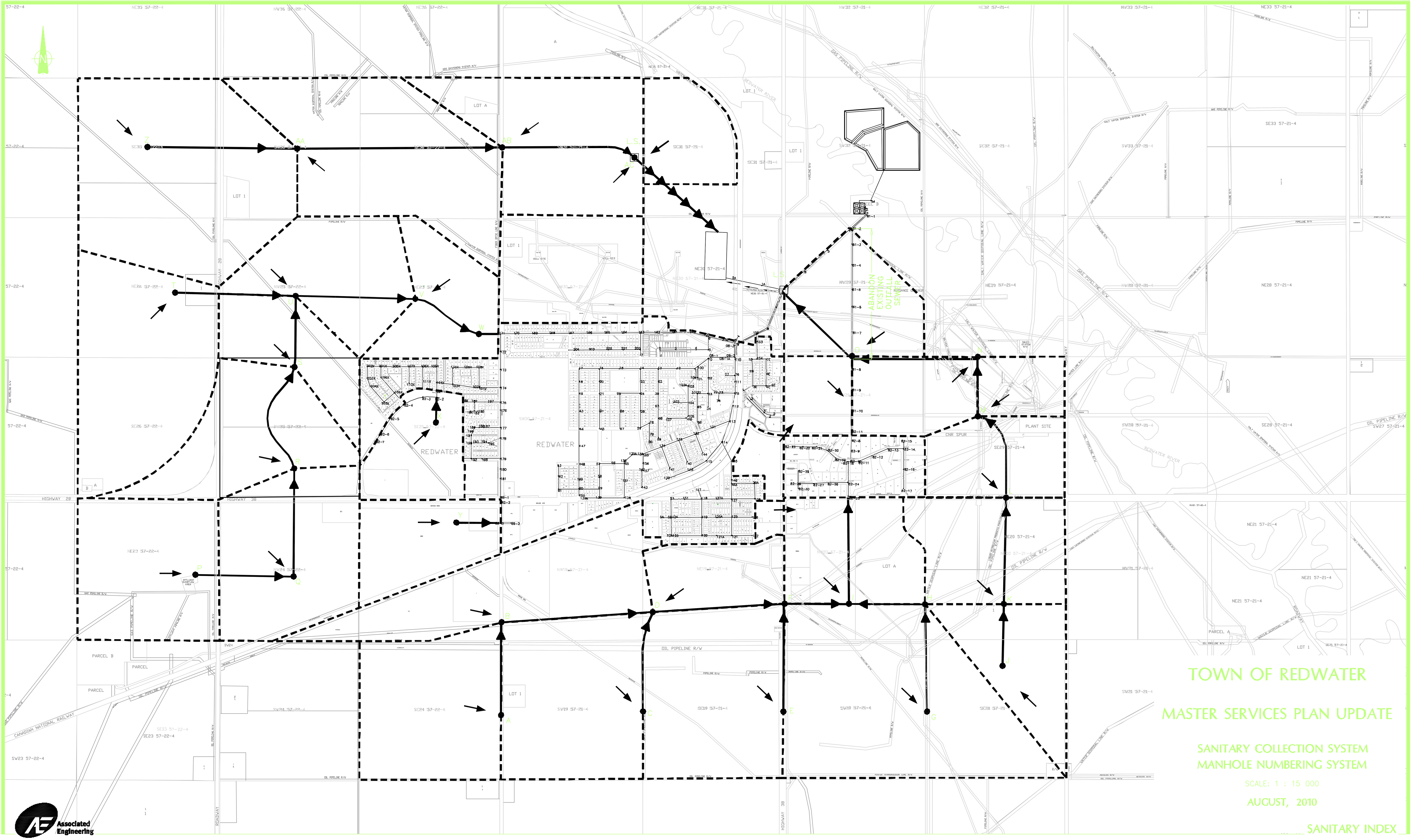
Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-250	True	83.000	201.000	3.528	138.0	424.0	276.0	362.1	True
J-251	True	83.000	201.000	0.000	138.0	426.4	276.0	366.7	True
J-252	True	83.000	201.000	0.000	138.0	432.8	276.0	369.9	True
J-263	True	83.000	201.000	0.000	138.0	455.2	276.0	377.6	True
J-264	True	83.000	201.000	0.000	138.0	464.6	276.0	386.7	True
J-265	True	183.000	201.000	1.530	0.0	363.0	0.0	335.3	True
J-266	True	183.000	201.000	1.530	0.0	336.0	0.0	323.8	True
J-269	True	183.000	201.000	3.996	0.0	317.4	0.0	319.1	True
J-270	True	183.000	201.000	3.996	0.0	347.0	0.0	342.5	True
J-271	True	183.000	201.000	3.528	0.0	322.7	0.0	295.1	True
J-272	True	183.000	201.000	1.530	0.0	305.1	0.0	281.3	True
J-273	True	183.000	201.000	3.528	0.0	278.0	0.0	260.4	True
J-274	True	183.000	201.000	3.528	0.0	219.9	0.0	235.2	True
J-277	True	183.000	201.000	7.560	0.0	150.3	0.0	189.7	True
J-279	True	183.000	201.000	7.560	0.0	140.1	0.0	205.7	True
J-281	True	183.000	201.000	7.560	0.0	190.9	0.0	285.3	True
J-283	True	183.000	201.000	3.528	0.0	329.9	0.0	304.3	True
J-284	True	183.000	201.000	3.528	0.0	304.6	0.0	296.1	True
J-285	True	183.000	201.000	3.528	0.0	265.6	0.0	380.0	True
J-286	True	183.000	201.000	3.528	0.0	186.9	0.0	211.1	True
J-287	True	183.000	201.000	1.530	0.0	277.9	0.0	310.4	True
J-288	True	183.000	201.000	3.996	0.0	256.1	0.0	312.5	True
J-290	True	183.000	201.000	3.996	0.0	392.4	0.0	370.6	True
J-291	True	183.000	201.000	3.996	0.0	317.1	0.0	315.6	True
J-292	True	183.000	201.000	3.996	0.0	318.8	0.0	321.4	True
J-293	True	183.000	201.000	3.996	0.0	224.3	0.0	263.8	True
J-294	True	183.000	201.000	3.996	0.0	223.3	0.0	279.4	True
J-295	True	183.000	201.000	3.996	0.0	304.7	0.0	370.7	True
J-296	True	183.000	201.000	6.804	0.0	377.3	0.0	367.5	True
J-297	True	183.000	201.000	2.412	0.0	388.5	0.0	373.5	True
J-298	True	183.000	201.000	2.412	0.0	412.4	0.0	376.5	True
J-299	True	183.000	201.000	2.412	0.0	412.8	0.0	377.4	True
J-300	True	183.000	201.000	3.924	0.0	463.0	0.0	378.6	True
J-301	True	183.000	201.000	3.996	0.0	346.8	0.0	323.9	True
J-302	True	183.000	201.000	3.996	0.0	436.1	0.0	390.5	True
J-303	True	183.000	201.000	3.996	0.0	273.8	0.0	290.3	True
J-306	False	183.000	172.740	3.996	0.0	0.0	0.0	318.4	True
J-308	True	183.000	201.000	6.408	0.0	331.6	0.0	374.6	True
J-311	True	183.000	201.000	2.412	0.0	329.1	0.0	371.5	True
J-313	True	183.000	201.000	2.412	0.0	307.6	0.0	357.4	True
J-316	True	183.000	201.000	3.780	0.0	488.0	0.0	380.5	True
J-318	True	183.000	201.000	3.780	0.0	498.4	0.0	379.2	True
J-319	True	183.000	201.000	3.780	0.0	473.5	0.0	378.9	True
J-321	True	183.000	201.000	3.528	0.0	337.5	0.0	319.0	True

Active Scenario: Future PD plus Fire

Current Time: 0.000 hours

Label	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Demand (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Pressure (Zone Lower Limit) (kPa)	Calculated Minimum Zone Pressure (kPa)	Is Active?
J-322	True	183.000	201.000	0.000	0.0	402.6	0.0	332.0	True
J-323	True	83.000	201.000	3.528	138.0	334.9	276.0	320.0	True
J-324	True	183.000	201.000	3.528	0.0	400.8	0.0	313.7	True
J-329	True	183.000	201.000	3.528	0.0	45.4	0.0	319.7	True
J-331	True	183.000	201.000	3.528	0.0	327.2	0.0	305.5	True
J-333	True	183.000	201.000	0.000	0.0	395.2	0.0	328.6	True
J-335	True	183.000	201.000	3.780	0.0	441.2	0.0	379.8	True
J-336	True	183.000	201.000	3.780	0.0	491.3	0.0	379.0	True
J-337	True	183.000	201.000	3.780	0.0	442.0	0.0	369.6	True
J-339	True	183.000	201.000	3.780	0.0	486.6	0.0	382.0	True
J-340	True	183.000	201.000	7.560	0.0	210.3	0.0	236.5	True
J-342	True	83.000	201.000	115.200	138.0	281.4	276.0	464.1	True
J-346	True	200.000	201.000	0.000	140.0	423.2	280.0	374.9	True
J-347	True	200.000	201.000	0.000	140.0	408.7	180.0	371.9	True

B Appendix B - Sanitary Sewerage System - Numbering Plan, Unit Costs, and Spreadsheet Models


REDWATER
REDWATER
HIGHWAY 28
OIL PIPELINE R/V
PLANT SITE
LOT A
LOT 1
PARCEL A
PARCEL B
TOWN OF REDWATER
MASTER SERVICES PLAN UPDATE
SANITARY COLLECTION SYSTEM
MANHOLE NUMBERING SYSTEM
SCALE: 1 : 15 000
AUGUST, 2010
SANITARY INDEX
Associated Engineering

Town of Redwater - Master Plan Update
Estimated Costs - Sanitary Collection System

Recommended Upgrades to Existing System

1.0 58th Street Replacement

	Location	Type	Length (m)	Diameter (mm)	Unit Price ($)	Amount ($)
A	*MH174 to MH173*	Developed	100.6	375	$1,840	**$185,104**
B	*MH173 to MH172*	Developed	100.6	375	$1,840	**$185,104**
					Total	**$370,208**

2.0 50th Avenue Replacement

	Location	Type	Length (m)	Diameter (mm)	Unit Price ($)	Amount ($)
C	*MH100 to MH10*	Developed	60	300	$1,810	**$108,600**
					Total	**$108,600**

3.0 Central Trunk System

	Location	From	To	Type	Length (m)	Diameter (mm)	Unit Price ($)	Amount ($)
D	***50th Avenue***	***MH131***	***MH113***	Developed	114.8	250	$1,800	**$206,640**
E	***49th Avenue***	***MH113***	***MH112***	Developed	78.6	375	$1,840	**$144,624**
F	***49th Avenue***	***MH112***	***MH75***	Developed	75	375	$1,840	**$138,000**
G	***46th Street***	***MH75***	***MH111***	Developed	75	375	$1,840	**$138,000**
H	***46th Street***	***MH111***	***MH76***	Developed	31	375	$1,840	**$57,040**
I	***46th Street***	***MH76***	***MH110***	Developed	75	375	$1,840	**$138,000**
							Total	**$822,304**

Town of Redwater- Sanitary Sewer System Unit Costs

Cost Estimates

Sanitary Sewer

Undeveloped Land

	Pipe Diameter								
Item	**200**	**250**	**300**	**375**	**450**	**525**	**600**	**750**	**900**
Topsoil Stripping and Stockpile (assume depth of 0.4m)	17.5	17.5	17.5	20.0	20.0	20.0	20.0	25.0	30.0
Trenching and backfilling	270	270	270	315	315	315	315	360	360
Pipe Zone Material	25	25	25	50	50	50	50	75	100
Supply and Install DR 35 Pipe	45	50	55	60	85	115	145	215	300
Place Topsoil, compact and seed	35	35	35	40	40	40	40	45	50
Manholes (1 every 100 m)	100	100	100	100	100	100	100	100	200
Miscellaneous (Mob/De-Mob, Survey, Signage) (10%)	49	50	50	59	61	64	67	82	104
Engineering and Contingency (add 30%)	163	164	166	193	201	211	221	271	343
Total	704	711	719	837	872	915	958	1173	1487
Total (rounded)	**$700**	**$710**	**$720**	**$840**	**$870**	**$920**	**$960**	**$1,170**	**$1,490**

Developed Land

	Pipe Diameter								
Item	**200**	**250**	**300**	**375**	**450**	**525**	**600**	**750**	**900**
Asphalt Pavement Removal	45	45	45	75	75	75	75	100	125
Granular Base Removal and Disposal	30	30	30	50	50	50	50	75	100
Curb, Gutter, sidewalk Removal	50	50	50	50	50	50	50	50	50
Trenching and Backfilling	370	370	370	415	415	415	415	460	500
Pipe Zone Material	25	25	25	50	50	50	50	75	100
Supply and Install DR 35 Pipe	45	50	55	60	85	115	145	215	300
Monolithic Sidewalk Curb and Gutter	190	190	190	190	190	190	190	190	190
Existing Pavement Repair	200	200	200	300	300	300	300	400	500
Reconnect services	200	200	200	0	0	0	0	0	0
Manholes (1 every 100 m)	100	100	100	100	100	100	100	100	200
Miscellaneous (Mob/De-Mob, Survey, Signage) (10%)	126	126	127	129	132	135	138	167	207
Engineering and Contingency (add 30%)	414	416	417	426	434	444	454	549	681
Total	1795	1802	1809	1845	1880	1923	1966	2381	2953
Total (rounded)	**$1,790**	**$1,800**	**$1,810**	**$1,840**	**$1,880**	**$1,920**	**$1,970**	**$2,380**	**$2,950**

Crossing

	Pipe Diameter		
Item	**600**	**750**	**900**
Supply and Install Sewer	1850	2200	2650
Miscellaneous (Mob/De-Mob, Survey, Signage) (10%)	185	220	265
Engineering and Contingency (add 30%)	611	726	875
Total	$2,645.5	$3,146.0	$3,789.5
Total (rounded)	**$2,650**	**$3,150**	**$3,790**

TOWN OF REDWATER
MASTER PLAN
EXISTING SANITARY SEWER
HYDRAULIC ANALYSIS - WITH UPGRADES

General	Existing Areas
Per Capita Flow Generation	330 L/c/day
Peaking Factor	Harmons
Commercial/Industrial Infiltration	0.60 L/s/ha
Residential Infiltration (Older homes)	0.85 L/s/ha
Future/New Development Infiltration	0.28 L/s/ha
Manning's n Old Pipe	0.015
New Pipe	0.013

Other	Single Family Residential	Multy Family Residential	High Density Residential	Commercial	Industrial
Population Density	35 people/ha	85 people/ha	175 people/ha	30 people/ha	25 people/ha
Area Flow Generation	0.13 L/s/ha	0.32 L/s/ha	0.67 L/s/ha	0.11 L/s/ha	0.10 L/s/ha

Less than 20% spare capacity	10.00
No spare capacity (Pipe Full)	0.00

		Design Flows										Pipe Data					Spare Capacity	
From MH	To MH	Total DWF (L/s)	Accum DWF (L/s)	Harmon's Peaking Factor	Peak DWF (L/s)	Residential I/I (L/s)	Other I/I (L/s)	Base I/I* (L/s)	Total I/I (L/s)	Accum I/I (L/s)	Accum WWF (L/s)	Length	Diameter	Slope	Velocity	Capacity	(L/s)	(%)
89.3	89.2	1.444	1.444	2.500	3.611	1.658	4.248	0.117	6.023	6.023	9.634	115.00	250	0.34%	0.615	31.150	21.52	69.07
89.2	89.1	0.000	1.444	2.500	3.611	0.000	0.000	0.000	0.000	6.023	9.634	40.00	250	0.29%	0.574	29.079	19.45	66.87
89.1	181	0.069	1.513	2.500	3.783	0.000	0.360	0.008	0.368	6.391	10.173	105.00	250	0.23%	0.510	25.866	15.69	60.67
181	180	0.000	1.513	2.500	3.783	0.000	0.000	0.000	0.000	6.391	10.173	55.00	250	0.36%	0.640	32.423	22.25	68.62
180	179	0.000	1.513	2.500	3.783	0.000	0.000	0.000	0.000	6.391	10.173	60.00	250	0.35%	0.628	31.809	21.64	68.02
179	178	0.388	1.901	2.500	4.754	0.816	2.562	0.068	3.446	9.837	14.590	116.00	250	0.28%	0.557	28.240	13.65	48.33
178	177	0.188	2.090	2.500	5.225	1.199	0.000	0.018	1.217	11.054	16.278	60.00	250	0.35%	0.628	31.809	15.53	48.82
177	176	0.324	2.413	2.500	6.034	2.057	0.000	0.031	2.088	13.142	19.175	102.00	250	0.14%	0.393	19.920	0.74	3.74
176	175	0.000	2.413	2.500	6.034	0.000	0.000	0.000	0.000	13.142	19.175	45.00	250	0.67%	0.866	43.901	24.73	56.32
175	174	0.416	2.829	2.500	7.073	2.644	0.000	0.040	2.684	15.826	22.899	81.00	250	0.40%	0.667	33.795	10.90	32.24
106X	105X	1.243	1.243	2.500	3.108	7.905	0.000	0.121	8.026	8.026	11.134	82.00	200	0.29%	0.495	16.043	4.91	30.60
105X	104X	0.111	1.354	2.500	3.385	0.706	0.000	0.011	0.716	8.742	12.128	91.00	250	0.22%	0.497	25.206	13.08	51.89
82.7	82-6	0.270	0.270	2.500	0.675	0.000	2.052	0.044	2.096	2.096	2.771	50.00	250	0.32%	0.600	30.415	27.64	90.89
82.6	82.5	0.000	0.270	2.500	0.675	0.000	0.000	0.000	0.000	2.096	2.771	120.00	250	0.28%	0.565	28.620	25.85	90.32
82.5	82.4	0.094	0.364	2.500	0.909	0.595	0.000	0.009	0.604	2.701	3.610	100.00	250	0.65%	0.855	43.348	39.74	91.67
82.4	82.3	0.000	0.364	2.500	0.909	0.000	0.000	0.000	0.000	2.701	3.610	120.00	250	0.57%	0.805	40.771	37.16	91.15
82.3	82.2	0.000	0.364	2.500	0.909	0.000	0.000	0.000	0.000	2.701	3.610	85.00	250	0.59%	0.814	41.237	37.63	91.25
82.2	82.1	0.000	0.364	2.500	0.909	0.000	0.000	0.000	0.000	2.701	3.610	30.00	250	0.40%	0.671	34.005	30.40	89.39
82.1	104X	0.053	0.417	2.500	1.043	0.340	0.000	0.005	0.345	3.046	4.088	52.00	250	0.46%	0.721	36.527	32.44	88.81
104X	103X	0.053	1.825	2.500	4.562	0.340	0.000	0.005	0.345	12.133	16.695	90.00	250	0.26%	0.536	27.181	10.49	38.58
103X	102X	0.329	2.154	2.500	5.384	2.091	0.000	0.032	2.123	14.256	19.640	110.00	250	0.39%	0.663	33.617	13.98	41.58
102X	101X	0.000	2.154	2.500	5.384	0.000	0.000	0.000	0.000	14.256	19.640	47.00	250	0.28%	0.558	28.277	8.64	30.54
101X	174	0.362	2.516	2.500	6.290	2.304	0.000	0.035	2.339	16.595	22.884	125.00	250	0.22%	0.493	24.989	2.10	8.42
174	173	0.063	5.408	2.500	13.520	0.132	0.000	0.006	0.138	32.558	46.078	100.60	300	0.27%	0.716	52.263	6.19	11.83
173	172	0.063	5.471	2.500	13.677	0.132	0.000	0.006	0.138	32.696	46.373	100.60	300	0.28%	0.729	53.222	6.85	12.87
172	171	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	32.696	46.373	102.10	300	0.69%	1.145	83.531	37.16	44.48
171	170	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	32.696	46.373	86.00	300	0.33%	0.684	49.888	3.52	7.05
170	169	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	32.696	46.373	95.00	300	0.40%	0.758	55.296	8.92	16.14
169	168	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	32.696	46.373	106.40	300	0.34%	0.697	50.856	4.48	8.82
168	167	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	32.696	46.373	115.00	375	0.19%	0.608	69.335	22.96	33.12
167	166	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	32.696	46.373	107.00	375	0.20%	0.616	70.228	23.86	33.97
166	165	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	32.696	46.373	96.00	375	0.20%	0.619	70.523	24.15	34.24
165	164	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	32.696	46.373	103.00	375	0.19%	0.613	69.854	23.48	33.61
164	163	0.000	5.471	2.500	13.677	0.000	0.000	0.000	0.000	32.696	46.373	95.00	375	0.23%	0.669	76.285	29.91	39.21
7G	200	0.028	0.028	2.500	0.070	0.059	0.000	0.003	0.062	0.062	0.132	31.86	200	0.80%	0.942	30.551	30.42	99.57
200	163	0.068	0.096	2.500	0.241	0.434	0.000	0.007	0.440	0.502	0.742	96.00	200	0.40%	0.578	18.755	18.01	96.04
163	162	0.531	6.098	2.500	15.244	3.375	0.000	0.052	3.426	36.624	51.868	93.00	375	0.18%	0.594	67.776	15.91	23.47
Plug	162	0.393	0.393	2.500	0.982	0.339	0.000	0.016	0.355	0.355	1.337	11.00	250	1.32%	1.406	71.228	69.89	98.12
162	161	0.070	6.560	2.500	16.400	0.442	0.000	0.007	0.449	37.427	53.827	91.00	375	0.20%	0.618	70.503	16.68	23.65
161	160	0.075	6.635	2.500	16.587	0.476	0.000	0.007	0.483	37.911	54.498	101.00	375	0.51%	0.998	113.745	59.25	52.09
160	159	0.072	6.707	2.500	16.767	0.459	0.000	0.007	0.466	38.377	55.144	91.00	375	2.58%	2.234	254.745	199.60	78.35

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From MH	To MH	Design Flows: Total DWF (L/s)	Accum DWF (L/s)	Harmon's Peaking Factor	Peak DWF (L/s)	Residential I/I (L/s)	Other I/I (L/s)	Base I/I* (L/s)	Total I/I (L/s)	Accum I/I (L/s)	Accum WWF (L/s)	Pipe Data: Length	Diameter	Slope	Velocity	Capacity	Spare Capacity: (L/s)	(%)
1G	2G	0.044	0.044	2.500	0.110	0.092	0.000	0.004	0.097	0.097	0.207	34.00	200	2.50%	1.668	54.101	53.89	99.62
2G	3G	0.136	0.180	2.500	0.451	0.286	0.000	0.013	0.299	0.396	0.847	101.26	200	0.40%	0.667	21.639	20.79	96.09
3G	4G	0.132	0.313	2.500	0.782	0.277	0.000	0.013	0.290	0.686	1.468	113.85	200	0.40%	0.668	21.655	20.19	93.22
4G	5G	0.111	0.424	2.500	1.059	0.232	0.000	0.011	0.243	0.929	1.988	72.50	200	0.40%	0.667	21.640	19.65	90.81
5G	6G	0.476	0.900	2.500	2.249	0.997	0.000	0.046	1.043	1.972	4.221	74.74	200	1.00%	1.055	34.207	29.99	87.66
159	6G	0.000	6.707	2.500	16.767	0.000	0.000	0.000	0.000	38.377	55.144	95.00	375	0.65%	1.123	128.064	72.92	56.94
6G	158	0.000	7.607	2.500	19.017	0.000	0.000	0.000	0.000	40.348	59.365	83.03	375	0.62%	1.095	124.847	65.48	52.45
158	08-4	0.000	7.607	2.500	19.017	0.000	0.000	0.000	0.000	40.348	59.365	68.86	375	0.41%	0.891	101.625	42.26	41.58
08-4	9	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	13.72	375	0.41%	0.888	101.291	101.29	100.00
08-4	08-3	0.000	7.607	2.500	19.017	0.000	0.000	0.000	0.000	40.348	59.365	18.18	375	0.30%	0.882	100.606	41.24	40.99
18	17	1.331	1.331	2.500	3.328	4.777	1.200	0.099	6.076	6.076	9.404	69.00	200	0.35%	0.539	17.489	8.08	46.23
17	16	0.187	1.518	2.500	3.796	1.190	0.000	0.018	1.208	7.284	11.080	117.00	250	0.28%	0.564	28.555	17.47	61.20
20	16	0.504	0.504	2.500	1.260	3.205	0.000	0.049	3.254	3.254	4.513	67.00	200	0.36%	0.547	17.748	13.23	74.57
16	15	0.124	2.147	2.500	5.367	0.791	0.000	0.012	0.803	11.340	16.707	116.00	250	0.29%	0.574	29.109	12.40	42.60
15	14	0.104	2.251	2.500	5.628	0.663	0.000	0.010	0.673	12.014	17.641	118.00	250	0.31%	0.594	30.108	12.47	41.41
23	14	0.958	0.958	2.500	2.394	5.313	0.000	0.081	5.394	5.394	7.788	70.00	200	0.44%	0.609	19.734	11.95	60.54
14	13	0.107	3.316	2.500	8.289	0.680	0.000	0.010	0.690	18.098	26.387	101.00	250	0.30%	0.578	29.303	2.92	9.95
22	13	0.782	0.782	2.500	1.955	2.933	0.000	0.045	2.977	2.977	4.932	67.00	200	0.45%	0.612	19.843	14.91	75.14
13	12	0.174	4.271	2.500	10.679	1.105	0.000	0.017	1.122	22.197	32.876	113.00	250	0.49%	0.740	37.511	4.64	12.36
12	11	0.203	4.475	2.500	11.187	1.292	0.000	0.020	1.312	23.509	34.695	94.00	250	0.78%	0.935	47.382	12.69	26.78
11	100	0.000	4.475	2.500	11.187	0.000	0.000	0.000	0.000	23.509	34.695	28.00	250	0.43%	0.695	35.199	0.50	1.43
101	100	0.686	0.686	2.500	1.714	4.361	0.000	0.067	4.427	4.427	6.142	63.00	200	0.56%	0.682	22.103	15.96	72.21
100	10	0.000	5.160	2.500	12.901	0.000	0.000	0.000	0.000	27.936	40.837	60.00	300	0.52%	0.994	72.513	31.68	43.68
32	10	0.602	0.602	2.500	1.504	2.805	0.000	0.043	2.848	2.848	4.352	85.00	200	0.36%	0.552	17.909	13.56	75.70
10	08-1	0.000	5.762	2.500	14.405	0.000	0.000	0.000	0.000	30.784	45.189	15.83	300	1.88%	1.644	119.967	74.78	62.33
08-1	08-2	0.000	5.762	2.500	14.405	0.000	0.000	0.000	0.000	30.784	45.189	140.33	300	1.31%	1.580	115.266	70.08	60.80
115	114	0.286	0.286	2.500	0.716	0.000	1.500	0.033	1.533	1.533	2.249	140.00	200	0.39%	0.573	18.587	16.34	87.90
127A	127	0.355	0.355	2.500	0.888	1.020	1.020	0.038	2.078	2.078	2.966	95.00	200	0.39%	0.571	18.507	15.54	83.97
125	127	2.251	2.251	2.500	5.628	10.829	1.092	0.189	12.110	12.110	17.738	105.00	200	0.45%	0.612	19.840	2.10	10.59
127	46A	0.307	2.914	2.500	7.285	1.955	0.000	0.030	1.985	16.173	23.458	86.00	250	0.26%	0.537	27.194	3.74	13.74
46A	146	0.334	3.248	2.500	8.120	2.125	0.000	0.033	2.158	18.330	26.451	20.00	250	0.45%	0.712	36.068	9.62	26.66
146	145	0.000	3.248	2.500	8.120	0.000	0.000	0.000	0.000	18.330	26.451	104.00	250	0.32%	0.598	30.287	3.84	12.67
145	114	0.000	3.248	2.500	8.120	0.000	0.000	0.000	0.000	18.330	26.451	116.60	250	0.29%	0.573	29.034	2.58	8.90
114	113	0.000	3.535	2.500	8.836	0.000	0.000	0.000	0.000	19.863	28.699	143.00	250	0.30%	0.582	29.484	0.78	2.66
155	134	1.844	1.844	2.500	4.611	4.446	3.150	0.136	7.732	7.732	12.342	110.00	200	0.31%	0.508	16.487	4.14	25.14
134	133	0.367	2.211	2.500	5.527	0.255	0.870	0.023	1.148	8.879	14.407	105.00	200	0.40%	0.578	18.755	4.35	23.18
133	132	0.241	2.452	2.500	6.129	0.000	1.260	0.027	1.287	10.167	16.296	104.70	200	0.44%	0.606	19.656	3.36	17.10
132	131	0.241	2.692	2.500	6.730	0.000	1.260	0.027	1.287	11.454	18.184	105.30	200	0.38%	0.564	18.277	0.09	0.51
131	113	0.147	2.839	2.500	7.098	0.000	0.431	0.020	0.451	11.905	19.003	114.80	250	0.40%	0.775	39.271	20.27	51.61
113	112	0.000	6.374	2.500	15.934	0.000	0.000	0.000	0.000	31.768	47.702	78.60	375	0.27%	0.829	94.545	46.84	49.55
112	75	0.000	6.374	2.500	15.934	0.000	0.000	0.000	0.000	31.768	47.702	75.00	375	0.28%	0.849	96.787	49.08	50.71
75	111	0.312	6.686	2.500	16.715	0.151	0.420	0.027	0.598	32.366	49.081	75.00	375	0.21%	0.741	84.483	35.40	41.90
111	76	0.000	6.686	2.500	16.715	0.000	0.000	0.000	0.000	32.366	49.081	31.00	375	0.19%	0.706	80.470	31.39	39.01
76	110	0.187	6.873	2.500	17.183	0.392	0.000	0.018	0.410	32.776	49.959	75.00	375	0.40%	1.015	115.683	65.72	56.81
110	08-2	0.000	6.873	2.500	17.183	0.000	0.000	0.000	0.000	32.776	49.959	10.98	300	1.00%	1.384	100.974	51.01	50.52
08-2	08-3	0.000	12.635	2.500	31.588	0.000	0.000	0.000	0.000	63.560	95.148	66.04	375	2.36%	2.464	280.944	185.80	66.13
08-3	08-5	0.000	20.242	2.500	50.604	0.000	0.000	0.000	0.000	103.908	154.513	143.98	375	1.20%	1.757	200.325	45.81	22.87
110	9	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	82.00	250	3.30%	1.929	97.745	97.74	100.00
9	152	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	130.00	300	1.95%	1.675	122.211	122.21	100.00

n:\004628\Civil\rev3_existing san+upgrades_Report.xls (Model)

From MH	To MH	Design Flows										Pipe Data					Spare Capacity	
		Total DWF (L/s)	Accum DWF (L/s)	Harmon's Peaking Factor	Peak DWF (L/s)	Residential I/I (L/s)	Other I/I (L/s)	Base I/I* (L/s)	Total I/I (L/s)	Accum I/I (L/s)	Accum WWF (L/s)	Length	Diameter	Slope	Velocity	Capacity	(L/s)	(%)
153	08-5	1.404	1.404	2.500	3.509	8.925	0.000	0.137	9.062	9.062	12.571	39.46	200	0.93%	0.882	28.598	16.03	56.04
08-5	08-6	0.000	21.645	2.500	54.113	0.000	0.000	0.000	0.000	112.970	167.083	62.34	375	1.35%	1.866	212.701	45.62	21.45
08-6	08-7	0.000	21.645	2.500	54.113	0.000	0.000	0.000	0.000	112.970	167.083	145.00	525	0.24%	0.993	221.996	54.91	24.74
08-7	08-8	0.000	21.645	2.500	54.113	0.000	0.000	0.000	0.000	112.970	167.083	84.91	525	0.30%	1.098	245.387	78.30	31.91
08-8	LS	0.000	21.645	2.500	54.113	0.000	0.000	0.000	0.000	112.970	167.083	7.07	525	0.30%	1.094	244.520	77.44	31.67
08-5	152	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.61	200	0.93%	1.016	32.937	32.94	100.00
152	8	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	63.00	300	1.94%	1.667	121.668	121.67	100.00
8	LS	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	223.00	375	0.37%	0.848	96.712	96.71	100.00
2A	1A			Further analysis required to establish/verify the estimated outfall sewer discharge rate							141.700	150.00	375	unknown				
1A	7										141.700	136.00	375	unknown				
7	6										141.700	175.00	375	0.43%	0.916	104.467	0.00	0.00
6	5										141.700	180.00	375	0.39%	0.867	98.856	0.00	0.00
5	4										141.700	180.00	375	0.21%	0.639	72.836	0.00	0.00
4	3										141.700	100.00	400	0.21%	0.665	86.287	0.00	0.00
3	5A										141.700	118.00	300	unknown				
82-26	82-24	0.697	0.697	2.500	1.743	0.000	4.380	0.095	4.475	4.475	6.218	103.00	250	0.64%	0.849	43.040	36.82	85.55
82-25	82-24	0.115	0.115	2.500	0.286	0.000	0.720	0.016	0.736	0.736	1.022	85.00	375	0.41%	0.892	101.722	100.70	99.00
82-24	82-18	0.044	0.856	2.500	2.139	0.000	0.276	0.006	0.282	5.492	7.631	120.00	375	0.41%	0.889	101.298	93.67	92.47
82-19	82-18	0.659	0.659	2.500	1.647	0.000	4.140	0.090	4.230	4.230	5.877	70.00	250	0.94%	1.030	52.208	46.33	88.74
82-18	82-10	0.000	1.514	2.500	3.786	0.000	0.000	0.000	0.000	9.722	13.508	16.00	375	25.75%	7.056	804.416	790.91	98.32
82-11	82-10	1.308	1.308	2.500	3.270	0.000	8.220	0.178	8.398	8.398	11.668	52.00	250	0.44%	0.706	35.758	24.09	67.37
82-10	82-9	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	70.00	375	0.43%	0.910	103.778	78.60	75.74
82-9	82-8	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	60.00	375	0.37%	0.842	95.990	70.81	73.77
82-8	81-11	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	45.00	375	0.16%	0.548	62.522	37.35	59.73
81-11	81-10	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	125.00	375	0.22%	0.646	73.675	48.50	65.83
81-10	81-9	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	120.00	375	0.18%	0.595	67.875	42.70	62.91
81-9	81-8	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	120.00	375	0.17%	0.568	64.717	39.54	61.10
81-8	81-7	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	129.00	450	0.20%	0.705	115.727	90.55	78.24
81-7	81-6	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	148.00	600	0.18%	0.797	232.685	207.51	89.18
81-6	81-5	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	150.00	600	0.18%	0.807	235.531	210.35	89.31
81-5	81-4	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	150.00	600	0.20%	0.851	248.271	223.09	89.86
81-4	81-3	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	95.00	600	0.19%	0.828	241.650	216.47	89.58
81-3	81-2	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	111.00	600	0.14%	0.722	210.771	185.59	88.05
81-2	81-1	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	82.00	600	0.18%	0.814	237.438	212.26	89.40
81-1	3	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	15.00	600	0.73%	1.629	475.404	450.23	94.70
3	2	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	32.00	375	0.03%	0.246	28.023	2.85	10.16
2	1	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177	43.00	375	1.12%	1.469	167.486	142.31	84.97
1	anaerobic	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	25.177							
anaerobic	5A	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	166.877	90.00	250	unknown				
5A	Storage	0.000	2.823	2.500	7.056	0.000	0.000	0.000	0.000	18.120	166.877	230.00	300	unknown				

TOWN OF REDWATER
MASTER PLAN
ULTIMATE SANITARY SEWER
HYDRAULIC ANALYSIS

1:25 Year Storm Data

General	Existing Areas
Per Capita Flow Generation	330 L/c/day
Peaking Factor	Harmons
Commercial/Industrial Infiltration	0.60 L/s/ha
Residential Infilitration (Older homes)	0.85 L/s/ha
Future/New Development Infiltration	0.28 L/s/ha
Manning's n Old Pipe	0.015
New Pipe	0.013

Other	Single Family Residential	Multy Family Residential	High Density Residential	Commercial	Industrial
Population Density	35 people/ha	85 people/ha	175 people/ha	30 people/ha	25 people/ha
Area Flow Generation	0.13 L/s/ha	0.32 L/s/ha	0.67 L/s/ha	0.11 L/s/ha	0.10 L/s/ha

Less than 20% spare capacity	10.00
No spare capacity (Pipe Full)	0.00

		Design Flows										Pipe Data					Spare Capacity	
From MH	To MH	Total DWF (L/s)	Accum DWF (L/s)	Harmon's Peaking Factor	Peak DWF (L/s)	Residential I/I (L/s)	Other I/I (L/s)	Base I/I* (L/s)	Total I/I (L/s)	Accum I/I (L/s)	Accum WWF (L/s)	Length	Diameter	Slope	Velocity	Capacity	(L/s)	(%)
Y	89.3	4.782	4.782	3.735	17.860	5.936	4.760	0.000	10.696	10.696	28.556	259.22	250	1.19%	1.156	58.551	29.99	51.23
89.3	89.2	1.444	6.226	2.500	15.566	1.658	4.248	0.117	6.023	16.719	32.285	115.00	300	0.34%	0.801	58.446	26.16	44.76
89.2	89.1	0.000	6.226	2.500	15.566	0.000	0.000	0.000	0.000	16.719	32.285	40.00	300	0.29%	0.748	54.560	22.28	40.83
89.1	181	0.069	6.295	2.500	15.738	0.000	0.360	0.008	0.368	17.087	32.824	105.00	300	0.23%	0.665	48.531	15.71	32.36
181	180	0.000	6.295	2.500	15.738	0.000	0.000	0.000	0.000	17.087	32.824	55.00	300	0.36%	0.834	60.834	28.01	46.04
180	179	0.000	6.295	2.500	15.738	0.000	0.000	0.000	0.000	17.087	32.824	60.00	300	0.35%	0.818	59.683	26.86	45.00
179	178	0.388	6.683	2.500	16.708	0.816	2.562	0.068	3.446	20.533	37.241	116.00	300	0.28%	0.726	52.986	15.74	29.71
178	177	0.188	6.872	2.500	17.180	1.199	0.000	0.018	1.217	21.750	38.929	60.00	300	0.25%	0.691	50.441	11.51	22.82
177	176	0.324	7.195	2.500	17.988	2.057	0.000	0.031	2.088	23.838	41.826	102.00	300	0.20%	0.612	44.671	2.84	6.37
176	175	0.000	7.195	2.500	17.988	0.000	0.000	0.000	0.000	23.838	41.826	45.00	300	0.67%	1.129	82.370	40.54	49.22
175	174	0.416	7.611	2.500	19.028	2.644	0.000	0.040	2.684	26.522	45.550	81.00	300	0.40%	0.869	63.408	17.86	28.16
106X	105X	1.243	1.243	2.500	3.108	7.905	0.000	0.121	8.026	8.026	11.134	82.00	200	0.29%	0.495	16.043	4.91	30.60
105X	104X	0.111	1.354	2.500	3.385	0.706	0.000	0.011	0.716	8.742	12.128	91.00	250	0.22%	0.497	25.206	13.08	51.89
82.7	82-6	0.270	0.270	2.500	0.675	0.000	2.052	0.044	2.096	2.096	2.771	50.00	250	0.32%	0.600	30.415	27.64	90.89
82.6	82.5	0.000	0.270	2.500	0.675	0.000	0.000	0.000	0.000	2.096	2.771	120.00	250	0.28%	0.565	28.620	25.85	90.32
82.5	82.4	0.094	0.364	2.500	0.909	0.595	0.000	0.009	0.604	2.701	3.610	100.00	250	0.65%	0.855	43.348	39.74	91.67
82.4	82.3	0.000	0.364	2.500	0.909	0.000	0.000	0.000	0.000	2.701	3.610	120.00	250	0.57%	0.805	40.771	37.16	91.15
82.3	82.2	0.000	0.364	2.500	0.909	0.000	0.000	0.000	0.000	2.701	3.610	85.00	250	0.59%	0.814	41.237	37.63	91.25
X	82.2	5.107	5.107	3.715	18.972	10.696	0.000	0.000	10.696	10.696	29.668	143.76	200	1.75%	1.394	45.213	15.55	34.38
82.2	82.1	0.000	5.470	2.500	13.675	0.000	0.000	0.000	0.000	2.701	16.376	30.00	250	0.40%	0.774	39.237	22.86	58.26
82.1	104X	0.053	5.524	2.500	13.809	0.112	0.000	0.000	0.112	2.813	16.622	52.00	250	0.46%	0.832	42.147	25.53	60.56
104X	103X	0.053	6.931	2.500	17.328	0.112	0.000	0.000	0.112	11.667	28.995	90.00	300	0.26%	0.699	50.998	22.00	43.15
103X	102X	0.329	7.260	2.500	18.150	0.689	0.000	0.000	0.689	12.356	30.506	110.00	300	0.39%	0.864	63.074	32.57	51.63
102X	101X	0.000	7.260	2.500	18.150	0.000	0.000	0.000	0.000	12.356	30.506	47.00	300	0.28%	0.727	53.056	22.55	42.50
101X	174	0.362	7.622	2.500	19.056	0.759	0.000	0.000	0.759	13.114	32.170	125.00	300	0.22%	0.643	46.886	14.72	31.39
174	173	0.063	15.296	2.500	38.241	0.132	0.000	0.000	0.132	39.768	78.009	100.60	375	0.27%	0.831	94.759	16.75	17.68
173	172	0.063	15.359	2.500	38.398	0.132	0.000	0.000	0.132	39.899	78.297	100.60	375	0.28%	0.846	96.498	18.20	18.86
172	171	0.000	15.359	2.500	38.398	0.000	0.000	0.000	0.000	39.899	78.297	102.10	375	0.69%	1.328	151.452	73.15	48.30
P	Q	11.682	11.682	3.435	40.130	20.580	4.536	0.000	25.116	25.116	65.246	547.65	375	0.37%	0.970	110.536	45.29	40.97
Q	R	9.572	21.253	3.202	68.045	15.512	5.292	0.000	20.804	45.920	113.965	621.38	450	0.29%	0.973	159.728	45.76	28.65
R	S	7.394	28.648	3.078	88.165	9.800	6.636	0.000	16.436	41.552	129.717	560.24	525	0.25%	1.007	224.921	95.20	42.33
S	U	4.772	33.420	3.012	100.663	9.996	0.000	0.000	9.996	51.548	152.211	438.67	525	0.87%	1.869	417.580	265.37	63.55
T	U	12.150	12.150	3.421	41.560	21.560	4.536	0.000	26.096	26.096	67.656	705.12	375	0.62%	1.267	144.489	76.83	53.18
U	V	7.072	52.641	2.815	148.198	14.812	0.000	0.000	14.812	92.456	240.654	676.53	600	0.20%	0.980	286.143	45.49	15.90
V	W	5.187	38.607	2.950	113.892	10.864	0.000	0.000	10.864	62.412	176.304	429.71	600	0.12%	0.749	218.503	42.20	19.31
W	171	0.000	38.607	2.950	113.892	0.000	0.000	0.000	0.000	62.412	176.304	124.74	600	0.53%	1.596	465.937	289.63	62.16

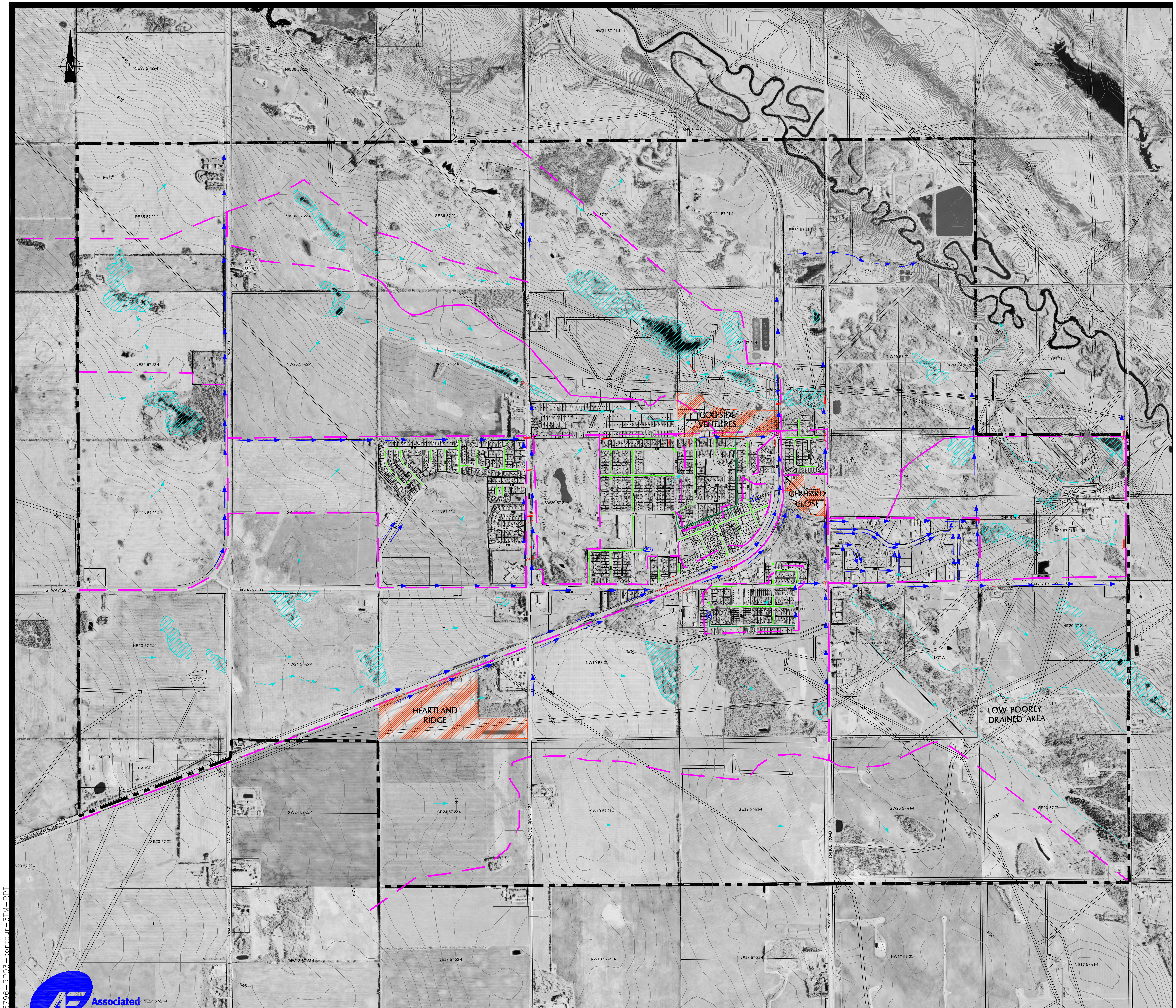
		Design Flows										Pipe Data					Spare Capacity	
From MH	To MH	Total DWF (L/s)	Accum DWF (L/s)	Harmon's Peaking Factor	Peak DWF (L/s)	Residential I/I (L/s)	Other I/I (L/s)	Base I/I* (L/s)	Total I/I (L/s)	Accum I/I (L/s)	Accum WWF (L/s)	Length	Diameter	Slope	Velocity	Capacity	(L/s)	(%)
171	170	0.000	53.966	2.500	134.915	0.000	0.000	0.000	0.000	102.311	237.227	86.00	600	0.33%	1.252	365.502	128.28	35.10
170	169	0.000	53.966	2.500	134.915	0.000	0.000	0.000	0.000	102.311	237.227	95.00	600	0.40%	1.388	405.126	167.90	41.44
169	168	0.000	53.966	2.500	134.915	0.000	0.000	0.000	0.000	102.311	237.227	106.40	600	0.34%	1.277	372.598	135.37	36.33
168	167	0.000	53.966	2.500	134.915	0.000	0.000	0.000	0.000	102.311	237.227	115.00	600	0.19%	0.960	280.170	42.94	15.33
167	166	0.000	53.966	2.500	134.915	0.000	0.000	0.000	0.000	102.311	237.227	107.00	600	0.20%	0.972	283.777	46.55	16.40
166	165	0.000	53.966	2.500	134.915	0.000	0.000	0.000	0.000	102.311	237.227	96.00	600	0.20%	0.976	284.971	47.74	16.75
165	164	0.000	53.966	2.500	134.915	0.000	0.000	0.000	0.000	102.311	237.227	103.00	600	0.19%	0.967	282.264	45.04	15.96
164	163	0.000	53.966	2.500	134.915	0.000	0.000	0.000	0.000	102.311	237.227	95.00	600	0.23%	1.056	308.254	71.03	23.04
7G	200	0.028	0.028	2.500	0.070	0.059	0.000	0.000	0.059	0.059	0.129	31.86	200	0.80%	0.942	30.551	30.42	99.58
200	163	0.068	0.096	2.500	0.241	0.434	0.000	0.007	0.440	0.499	0.740	96.00	200	0.40%	0.578	18.755	18.02	96.06
163	162	0.531	54.593	2.500	136.483	1.112	0.000	0.052	1.163	103.974	240.456	93.00	600	0.19%	0.966	281.809	41.35	14.67
Plug	162	0.393	0.393	2.500	0.982	1.029	0.000	0.016	1.044	1.044	2.026	11.00	250	1.32%	1.406	71.228	69.20	97.16
162	161	0.070	55.055	2.500	137.639	0.146	0.000	0.007	0.152	105.170	242.809	91.00	600	0.20%	0.976	284.889	42.08	14.77
161	160	0.075	55.130	2.500	137.826	0.157	0.000	0.007	0.164	105.334	243.160	101.00	600	0.51%	1.575	459.622	216.46	47.10
160	159	0.072	55.202	2.500	138.006	0.151	0.000	0.007	0.158	105.492	243.499	91.00	600	2.58%	3.527	1029.374	785.87	76.34
1G	2G	0.044	0.044	2.500	0.110	0.092	0.000	0.000	0.092	0.092	0.203	34.00	200	2.50%	1.668	54.101	53.90	99.63
2G	3G	0.136	0.180	2.500	0.451	0.286	0.000	0.000	0.286	0.378	0.829	101.26	200	0.40%	0.667	21.639	20.81	96.17
3G	4G	0.132	0.313	2.500	0.782	0.277	0.000	0.000	0.277	0.655	1.437	113.85	200	0.40%	0.668	21.655	20.22	93.36
4G	5G	0.111	0.424	2.500	1.059	0.232	0.000	0.000	0.232	0.888	1.947	72.50	200	0.40%	0.667	21.640	19.69	91.00
5G	6G	0.476	0.900	2.500	2.249	0.997	0.000	0.000	0.997	1.884	4.134	74.74	200	1.00%	1.055	34.207	30.07	87.92
159	6G	0.000	55.202	2.500	138.006	0.000	0.000	0.000	0.000	105.492	243.499	95.00	600	0.65%	1.773	517.480	273.98	52.95
6G	158	0.000	56.102	2.500	140.255	0.000	0.000	0.000	0.000	107.377	247.632	83.03	600	0.62%	1.728	504.482	256.85	50.91
158	08-4	0.000	56.102	2.500	140.255	0.000	0.000	0.000	0.000	107.377	247.632	68.86	600	0.41%	1.407	410.648	163.02	39.70
08-4	9	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	13.72	375	0.41%	0.888	101.291	101.29	100.00
08-4	08-3	0.000	56.102	2.500	140.255	0.000	0.000	0.000	0.000	107.377	247.632	18.18	600	0.30%	1.207	352.326	104.69	29.71
18	17	1.331	1.331	2.500	3.328	4.777	1.200	0.099	6.076	6.076	9.404	69.00	200	0.35%	0.539	17.489	8.08	46.23
17	16	0.187	1.518	2.500	3.796	1.190	0.000	0.018	1.208	7.284	11.080	117.00	250	0.28%	0.564	28.555	17.47	61.20
20	16	0.504	0.504	2.500	1.260	3.205	0.000	0.049	3.254	3.254	4.513	67.00	200	0.36%	0.547	17.748	13.23	74.57
16	15	0.124	2.147	2.500	5.367	0.791	0.000	0.012	0.803	11.340	16.707	116.00	250	0.29%	0.574	29.109	12.40	42.60
15	14	0.104	2.251	2.500	5.628	0.663	0.000	0.010	0.673	12.014	17.641	118.00	250	0.31%	0.594	30.108	12.47	41.41
23	14	0.958	0.958	2.500	2.394	5.313	0.000	0.081	5.394	5.394	7.788	70.00	200	0.44%	0.609	19.734	11.95	60.54
14	13	0.107	3.316	2.500	8.289	0.680	0.000	0.010	0.690	18.098	26.387	101.00	250	0.30%	0.578	29.303	2.92	9.95
22	13	0.782	0.782	2.500	1.955	2.933	0.000	0.045	2.977	2.977	4.932	67.00	200	0.45%	0.612	19.843	14.91	75.14
13	12	0.174	4.271	2.500	10.679	1.105	0.000	0.017	1.122	22.197	32.876	113.00	250	0.49%	0.740	37.511	4.64	12.36
12	11	0.203	4.475	2.500	11.187	1.292	0.000	0.020	1.312	23.509	34.695	94.00	250	0.78%	0.935	47.382	12.69	26.78
11	100	0.000	4.475	2.500	11.187	0.000	0.000	0.000	0.000	23.509	34.695	28.00	250	0.43%	0.695	35.199	0.50	1.43
101	100	0.686	0.686	2.500	1.714	4.361	0.000	0.067	4.427	4.427	6.142	63.00	200	0.56%	0.682	22.103	15.96	72.21
100	10	0.000	5.160	2.500	12.901	0.000	0.000	0.000	0.000	27.936	40.837	60.00	300	0.52%	0.861	62.845	22.01	35.02
32	10	0.602	0.602	2.500	1.504	2.805	0.000	0.043	2.848	2.848	4.352	85.00	200	0.36%	0.552	17.909	13.56	75.70
10	08-1	0.000	5.762	2.500	14.405	0.000	0.000	0.000	0.000	30.784	45.189	15.83	300	1.88%	1.644	119.967	74.78	62.33
08-1	08-2	0.000	5.762	2.500	14.405	0.000	0.000	0.000	0.000	30.784	45.189	140.33	300	1.31%	1.580	115.266	70.08	60.80
115	114	0.286	0.286	2.500	0.716	0.000	1.500	0.033	1.533	1.533	2.249	140.00	200	0.39%	0.573	18.587	16.34	87.90

		Design Flows										Pipe Data					Spare Capacity	
From MH	To MH	Total DWF (L/s)	Accum DWF (L/s)	Harmon's Peaking Factor	Peak DWF (L/s)	Residential I/I (L/s)	Other I/I (L/s)	Base I/I* (L/s)	Total I/I (L/s)	Accum I/I (L/s)	Accum WWF (L/s)	Length	Diameter	Slope	Velocity	Capacity	(L/s)	(%)
127A	127	0.355	0.355	2.500	0.888	1.020	1.020	0.038	2.078	2.078	2.966	95.00	200	0.39%	0.571	18.507	15.54	83.97
125	127	2.251	2.251	2.500	5.628	10.829	1.092	0.189	12.110	12.110	17.738	105.00	200	0.45%	0.612	19.840	2.10	10.59
127	46A	0.307	2.914	2.500	7.285	1.955	0.000	0.030	1.985	16.173	23.458	86.00	250	0.26%	0.537	27.194	3.74	13.74
46A	146	0.334	3.248	2.500	8.120	2.125	0.000	0.033	2.158	18.330	26.451	20.00	250	0.45%	0.712	36.068	9.62	26.66
146	145	0.000	3.248	2.500	8.120	0.000	0.000	0.000	0.000	18.330	26.451	104.00	250	0.32%	0.598	30.287	3.84	12.67
145	114	0.000	3.248	2.500	8.120	0.000	0.000	0.000	0.000	18.330	26.451	116.60	250	0.29%	0.573	29.034	2.58	8.90
114	113	0.000	3.535	2.500	8.836	0.000	0.000	0.000	0.000	19.863	28.699	143.00	300	0.30%	0.758	55.320	26.62	48.12
155	134	1.844	1.844	2.500	4.611	4.446	3.150	0.136	7.732	7.732	12.342	110.00	200	0.31%	0.508	16.487	4.14	25.14
134	133	0.367	2.211	2.500	5.527	0.255	0.870	0.023	1.148	8.879	14.407	105.00	200	0.40%	0.578	18.755	4.35	23.18
133	132	0.241	2.452	2.500	6.129	0.000	1.260	0.027	1.287	10.167	16.296	104.70	200	0.44%	0.606	19.656	3.36	17.10
132	131	0.241	2.692	2.500	6.730	0.000	1.260	0.027	1.287	11.454	18.184	105.30	200	0.38%	0.564	18.277	0.09	0.51
131	113	0.147	2.839	2.500	7.098	0.000	0.431	0.020	0.451	11.905	19.003	114.80	250	0.40%	0.775	39.271	20.27	51.61
113	112	0.000	6.374	2.500	15.934	0.000	0.000	0.000	0.000	31.768	47.702	78.60	375	0.27%	0.829	94.545	46.84	49.55
112	75	0.000	6.374	2.500	15.934	0.000	0.000	0.000	0.000	31.768	47.702	75.00	375	0.28%	0.849	96.787	49.08	50.71
75	111	0.312	6.686	2.500	16.715	0.151	0.420	0.027	0.598	32.366	49.081	75.00	375	0.28%	0.849	96.787	47.71	49.29
111	76	0.000	6.686	2.500	16.715	0.000	0.000	0.000	0.000	32.366	49.081	31.00	375	0.19%	0.706	80.470	31.39	39.01
76	110	0.187	6.873	2.500	17.183	0.392	0.000	0.018	0.410	32.776	49.959	75.00	375	0.40%	1.015	115.683	65.72	56.81
110	08-2	0.000	6.873	2.500	17.183	0.000	0.000	0.000	0.000	32.776	49.959	10.98	300	1.00%	1.384	100.974	51.01	50.52
08-2	08-3	0.000	12.635	2.500	31.588	0.000	0.000	0.000	0.000	63.560	95.148	66.04	375	2.36%	2.464	280.944	185.80	66.13
08-3	08-5	0.000	68.737	2.500	171.843	0.000	0.000	0.000	0.000	170.937	342.780	143.98	600	1.20%	2.404	701.544	358.76	51.14
110	9	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	82.00	250	3.30%	1.929	97.745	97.74	100.00
9	152	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	130.00	300	1.95%	1.675	122.211	122.21	100.00
153	08-5	1.404	1.404	2.500	3.509	8.925	0.000	0.137	9.062	9.062	12.571	39.46	200	0.93%	0.882	28.598	16.03	56.04
08-5	08-6	0.000	70.141	2.500	175.352	0.000	0.000	0.000	0.000	179.998	355.350	62.34	600	1.35%	2.552	744.887	389.54	52.29
08-6	08-7	0.000	70.141	2.500	175.352	0.000	0.000	0.000	0.000	179.998	355.350	145.00	750	0.24%	1.260	574.667	219.32	38.16
08-7	08-8	0.000	70.141	2.500	175.352	0.000	0.000	0.000	0.000	179.998	355.350	84.91	750	0.30%	1.393	635.220	279.87	44.06
08-8	LS	0.000	70.141	2.500	175.352	0.000	0.000	0.000	0.000	179.998	355.350	7.07	750	0.16%	1.005	458.114	102.76	22.43
08-5	152	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.61	200	0.93%	1.016	32.937	32.94	100.00
152	8	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	63.00	300	1.94%	1.667	121.668	121.67	100.00
8	LS	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	223.00	375	0.37%	0.848	96.712	96.71	100.00
Z	AA	16.790	16.790	3.296	55.346	35.168	0.000	0.000	35.168	35.168	90.514	865.11	375	0.40%	1.020	116.342	25.83	22.20
AA	AB	13.435	30.225	3.055	92.334	28.140	0.000	0.000	28.140	63.308	155.642	1178.23	450	0.75%	1.566	257.049	101.41	39.45
AB	AC	10.186	40.412	2.930	118.418	21.336	0.000	0.000	21.336	84.644	203.062	821.96	450	0.73%	1.548	254.121	51.06	20.09
AC	Forcemain	6.170	46.582	2.869	133.625	6.664	8.764	0.000	15.428	100.072	233.697	651.33						
2A	1A			Further analysis required to establish/verify the estimated outfall sewer discharge rate							979.684	150.00	375	unknown				
1A	7										979.684	136.00	375	unknown				
7	6										979.684	175.00	375	0.43%	0.916	104.467	0.00	0.00
6	5										979.684	180.00	375	0.39%	0.867	98.856	0.00	0.00
5	4										979.684	180.00	375	0.21%	0.639	72.836	0.00	0.00
4	3										979.684	100.00	400	0.21%	0.665	86.287	0.00	0.00
3	5A										979.684	118.00	300	unknown				
5A	Storage										979.684	230.00	300	unknown				
A	B	8.338	8.338	3.556	29.649	16.556	0.000	0.000	16.556	16.556	46.206	520.02	300	0.38%	0.857	62.563	16.36	26.15
B	D	8.997	17.335	3.284	56.922	18.844	0.000	0.000	18.844	35.400	92.323	877.91	450	0.34%	1.054	173.057	80.73	46.65
C	D	10.059	10.059	3.490	35.103	19.113	0.260	0.000	19.373	19.373	54.476	587.34	375	0.25%	0.803	91.569	37.09	40.51
D	F	4.692	32.085	3.029	97.201	7.442	3.181	0.000	10.623	65.397	162.598	757.49	525	0.28%	1.064	237.800	75.20	31.62
E	F	10.577	10.577	3.472	36.719	21.680	0.552	0.000	22.232	22.232	58.951	624.96	300	0.48%	0.958	69.895	10.94	15.66
F	I	0.000	42.662	2.907	124.009	0.000	0.000	0.000	0.000	87.629	211.638	375.74	525	0.75%	1.733	387.304	175.67	45.36
G	H	11.649	11.649	3.436	40.030	0.000	34.160	0.000	34.160	34.160	74.190	619.99	375	0.32%	0.911	103.888	29.70	28.59
H	I	0.000	54.311	2.802	152.157	0.000	0.000	0.000	0.000	121.789	273.946	439.15	750	0.18%	1.087	495.706	221.76	44.74
I	82-25	4.599	47.260	2.862	135.273	0.000	13.132	0.000	13.132	100.761	236.034	612.08	750	0.11%	0.830	378.477	142.44	37.64

n:\004628\Civil\rev3_ultimate_Report.xls (Model)

From MH	To MH	Design Flows										Pipe Data					Spare Capacity		
		Total DWF (L/s)	Accum DWF (L/s)	Harmon's Peaking Factor	Peak DWF (L/s)	Residential I/I (L/s)	Other I/I (L/s)	Base I/I* (L/s)	Total I/I (L/s)	Accum I/I (L/s)	Accum WWF (L/s)	Length	Diameter	Slope	Velocity	Capacity	(L/s)	(%)	
82-26	82-24	0.697	0.697	2.500	1.743	0.000	4.380	0.095	4.475	4.475	6.218	103.00	250	0.64%	0.849	43.040	36.82	85.55	
82-25	82-24	0.753	48.013	2.500	120.032	0.608	0.706	0.061	1.374	102.135	222.167	85.00	750	0.41%	1.634	745.266	523.10	70.19	
82-24	82-18	0.044	48.754	2.500	121.885	0.000	0.129	0.006	0.135	106.745	228.629	120.00	750	0.41%	1.627	742.154	513.52	69.19	
82-19	82-18	0.659	0.659	2.500	1.647	0.000	4.140	0.090	4.230	4.230	5.877	70.00	250	0.94%	1.030	52.208	46.33	88.74	
82-18	82-10	0.000	49.413	2.500	123.532	0.000	0.000	0.000	0.000	110.974	234.506	16.00	375	25.75%	7.056	804.416	569.91	70.85	
82-11	82-10	1.308	1.308	2.500	3.270	0.000	8.220	0.178	8.398	8.398	11.668	52.00	250	0.44%	0.706	35.758	24.09	67.37	
82-10	82-9	0.000	50.721	2.500	126.802	0.000	0.000	0.000	0.000	119.372	246.175	70.00	750	0.43%	1.667	760.323	514.15	67.62	
82-9	82-8	0.000	50.721	2.500	126.802	0.000	0.000	0.000	0.000	119.372	246.175	60.00	750	0.37%	1.542	703.270	457.10	65.00	
82-8	81-11	0.000	50.721	2.500	126.802	0.000	0.000	0.000	0.000	119.372	246.175	45.00	750	0.16%	1.004	458.067	211.89	46.26	
81-11	81-10	0.000	50.721	2.500	126.802	0.000	0.000	0.000	0.000	119.372	246.175	125.00	750	0.22%	1.184	539.776	293.60	54.39	
81-10	81-9	2.735	53.456	2.500	133.639	2.268	4.844	0.330	7.442	126.815	260.454	120.00	750	0.18%	1.090	497.287	236.83	47.63	
81-9	81-8	0.000	53.456	2.500	133.639	0.000	0.000	0.000	0.000	126.815	260.454	120.00	750	0.17%	1.040	474.145	213.69	45.07	
81-8	O	0.000	53.456	2.500	133.639	0.000	0.000	0.000	0.000	126.815	260.454	55.38	750	1.93%	3.540	1614.395	1353.94	83.87	
J	K	4.115	4.115	3.779	15.552	0.000	12.068	0.000	12.068	12.068	27.620	357.62	375	1.20%	1.755	200.103	172.48	86.20	
K	L	5.447	9.562	3.508	33.543	0.000	15.008	0.000	15.008	27.076	60.619	613.30	450	0.62%	1.426	234.124	173.50	74.11	
L	M	3.447	13.009	3.395	44.166	0.000	10.108	0.000	10.108	37.184	81.350	549.66	525	0.22%	0.938	209.633	128.28	61.19	
M	N	1.652	14.661	3.349	49.104	0.000	4.844	0.000	4.844	42.028	91.132	330.13	525	0.30%	1.105	246.930	155.80	63.09	
N	O	2.989	56.444	2.785	157.183	0.000	8.764	0.000	8.764	135.579	292.762	723.23	750	0.10%	0.792	361.325	68.56	18.98	
O	LS	4.297	75.402	2.658	200.430	0.000	12.600	0.000	12.600	190.207	390.637	560.85	900	0.10%	0.901	591.416	200.78	33.95	
O	81-7	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	129.00	450	0.20%	0.705	115.727	115.73	100.00	Abaondon
81-7	81-6	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	148.00	600	0.18%	0.797	232.685	232.68	100.00	Abaondon
81-6	81-5	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	150.00	600	0.18%	0.807	235.531	235.53	100.00	Abaondon
81-5	81-4	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	150.00	600	0.20%	0.851	248.271	248.27	100.00	Abaondon
81-4	81-3	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	95.00	600	0.19%	0.828	241.650	241.65	100.00	Abaondon
81-3	81-2	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	111.00	600	0.14%	0.722	210.771	210.77	100.00	Abaondon
81-2	81-1	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	82.00	600	0.18%	0.814	237.438	237.44	100.00	Abaondon
81-1	3	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	15.00	600	0.73%	1.629	475.404	475.40	100.00	Abaondon
3	2	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	32.00	375	0.03%	0.246	28.023	28.02	100.00	Abaondon
2	1	0.000	0.000	2.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	43.00	375	1.12%	1.469	167.486	167.49	100.00	Abaondon
1	anaerobic										0.000								

C Appendix C - Storm Drainage System - Pond D Concept Design with Costs



Town of Redwater

MASTER SERVICES PLAN UPDATE

EXISTING STORM DRAINAGE SYSTEM

LEGEND:

- TOWN BOUNDARY
- SUB-CATCHMENT BOUNDARY
- EXISTING DRAINAGE FEATURE
- PONDING ISSUES
- DIRECTION OF NATURAL DRAINAGE
- DIRECTION OF STREET DRAINAGE
- EXISTING DITCH
- EXISTING PIPE
- EXISTING CULVERT

SCALE: 1 : 10,000

AUGUST, 2010

STORM_1

Time: 7:56am
Date: Sep 08, 2010
File: P:\20093796\00_MasterServPlanUpd\Working_Dwgs\100_Civil\FINAL-REPORT-2010-05\STORM_1.dwg by
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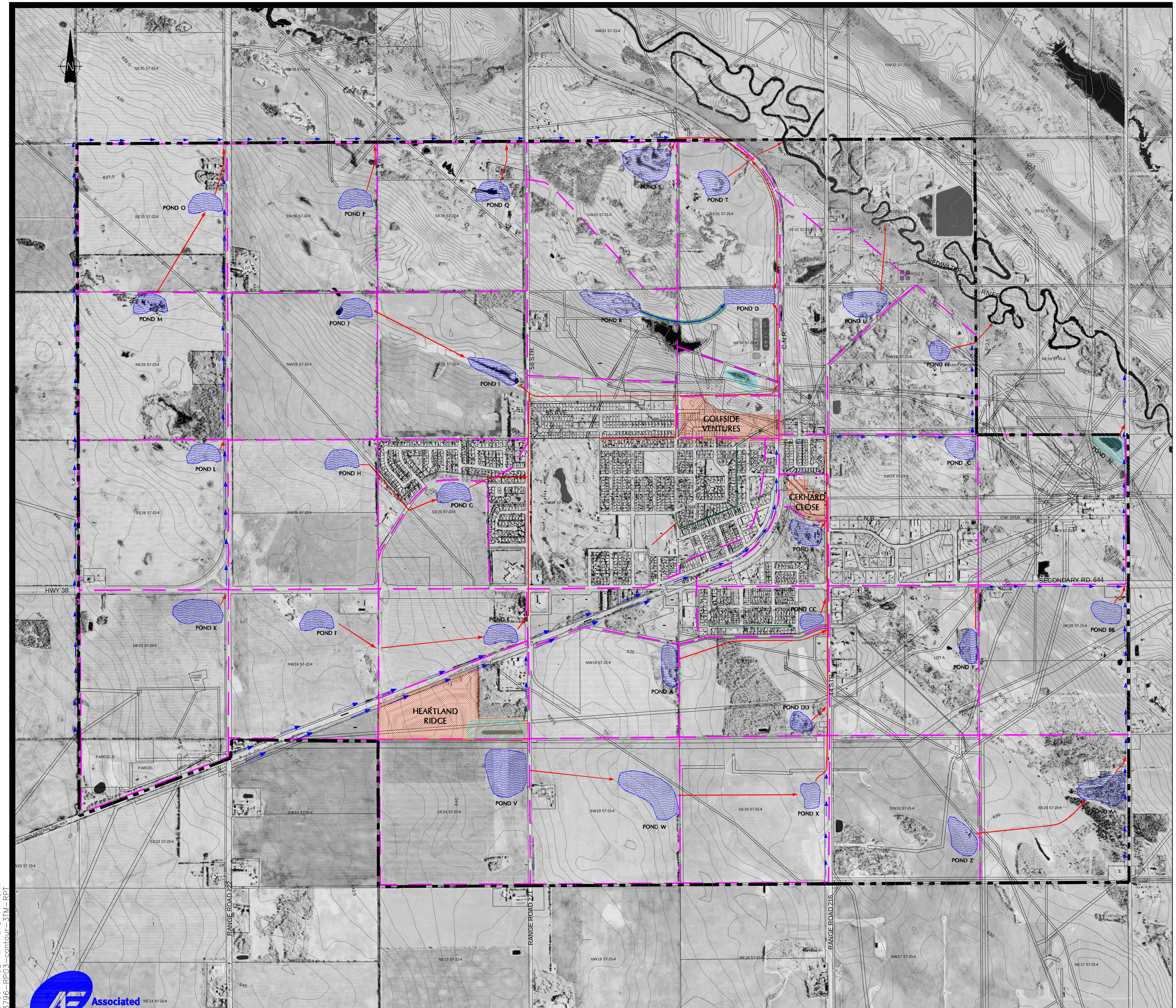
3796-RP02-AIRPHOTO-TIF-3TM
3796-RP03-contour-3TM-RPT



Town of Redwater

MASTER SERVICES PLAN UPDATE

PROPOSED STORM DRAINAGE SYSTEM

LEGEND:

- TOWN BOUNDARY
- SUB-CATCHMENT BOUNDARY
- EXISTING POND (OR UNDER DEVELOPMENT)
- PROPOSED POND
- DITCH
- PROPOSED STORM SEWER
- EXISTING STORM SEWER
- PROPOSED DRAINAGE PARKWAY
- PROPOSED/UNDER DEVELOPMENT

SCALE: 1 : 10,000

AUGUST, 2010

STORM_2

Time: 7:56am
Date: Sep 08, 2010
File: P:\20093796\00_MasterServPlanUpd\Working_Dwgs\100_Civil\FINAL-REPORT-2010-05\STORM_3.dwg by
Xrefs: 3796-RT01-TIT-AE-RPT
3796-RP01-BASE-3TM-GRID_2009
3796-RP02-AIRPHOTO-TIF-3TM
3796-RP03-contour-3TM-RPT

D Appendix D - Transportation System

Movement	NBT	NBR	SBL	SBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	256	103	12	264	102	54
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	278	112	13	287	111	59
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			390		591	278
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			390		591	278
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			99		75	92
cM capacity (veh/h)			1142		450	739

Direction, Lane #	NB 1	NB 2	SB 1	SB 2	NW 1
Volume Total	278	112	13	287	170
Volume Left	0	0	13	0	111
Volume Right	0	112	0	0	59
cSH	1700	1700	1142	1700	520
Volume to Capacity	0.16	0.07	0.01	0.17	0.33
Queue Length 95th (m)	0.0	0.0	0.3	0.0	11.2
Control Delay (s)	0.0	0.0	8.2	0.0	15.2
Lane LOS			A		C
Approach Delay (s)	0.0		0.4		15.2
Approach LOS					C

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	29.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	3	110	1	2	147	42	1	0	1	74	1	7
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	120	1	2	160	46	1	0	1	80	1	8
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	205			121			299	336	120	291	291	160
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	205			121			299	336	120	291	291	160
tC, single (s)	4.2			4.2			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.3			2.3			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	88	100	99
cM capacity (veh/h)	1314			1413			645	582	931	658	617	885

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	3	121	162	46	2	89
Volume Left	3	0	2	0	1	80
Volume Right	0	1	0	46	1	8
cSH	1314	1700	1413	1700	762	672
Volume to Capacity	0.00	0.07	0.00	0.03	0.00	0.13
Queue Length 95th (m)	0.1	0.0	0.0	0.0	0.1	3.6
Control Delay (s)	7.7	0.0	0.1	0.0	9.7	11.2
Lane LOS	A		A		A	B
Approach Delay (s)	0.2		0.1		9.7	11.2
Approach LOS					A	B

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	23.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	22	146	17	22	152	79	17	4	30	78	6	22
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	24	159	18	24	165	86	18	4	33	85	7	24
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	251			177			447	505	159	454	438	165
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	251			177			447	505	159	454	438	165
tC, single (s)	4.2			4.2			7.4	6.8	6.5	7.2	6.6	6.3
tC, 2 stage (s)												
tF (s)	2.3			2.3			3.7	4.2	3.5	3.6	4.1	3.4
p0 queue free %	98			98			96	99	96	82	99	97
cM capacity (veh/h)	1242			1341			452	421	827	466	482	859

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	183	18	189	86	55	115
Volume Left	24	0	24	0	18	85
Volume Right	0	18	0	86	33	24
cSH	1242	1700	1341	1700	612	516
Volume to Capacity	0.02	0.01	0.02	0.05	0.09	0.22
Queue Length 95th (m)	0.5	0.0	0.4	0.0	2.4	6.8
Control Delay (s)	1.2	0.0	1.1	0.0	11.5	14.0
Lane LOS	A		A		B	B
Approach Delay (s)	1.1		0.8		11.5	14.0
Approach LOS					B	B

Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	40.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	2	252	251	2	1	2
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	274	273	2	1	2
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	275				552	274
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	275				552	274
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	100
cM capacity (veh/h)	1271				494	765

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	276	275	3
Volume Left	2	0	1
Volume Right	0	2	2
cSH	1271	1700	647
Volume to Capacity	0.00	0.16	0.01
Queue Length 95th (m)	0.0	0.0	0.1
Control Delay (s)	0.1	0.0	10.6
Lane LOS	A		B
Approach Delay (s)	0.1	0.0	10.6
Approach LOS			B

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	24.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	9	244	252	16	1	1
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	10	265	274	17	1	1
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	291				567	283
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	291				567	283
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				100	100
cM capacity (veh/h)	1253				481	756

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	275	291	2
Volume Left	10	0	1
Volume Right	0	17	1
cSH	1253	1700	588
Volume to Capacity	0.01	0.17	0.00
Queue Length 95th (m)	0.2	0.0	0.1
Control Delay (s)	0.4	0.0	11.1
Lane LOS	A		B
Approach Delay (s)	0.4	0.0	11.1
Approach LOS			B

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	30.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	9	233	2	5	266	16	1	0	0	0	0	1
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	10	253	2	5	289	17	1	0	0	0	0	1
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	307			255			584	591	254	583	584	298
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	307			255			584	591	254	583	584	298
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			100	100	100	100	100	100
cM capacity (veh/h)	1237			1292			419	414	784	420	419	742

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	265	312	1	1
Volume Left	10	5	1	0
Volume Right	2	17	0	1
cSH	1237	1292	419	742
Volume to Capacity	0.01	0.00	0.00	0.00
Queue Length 95th (m)	0.2	0.1	0.1	0.0
Control Delay (s)	0.4	0.2	13.6	9.9
Lane LOS	A	A	B	A
Approach Delay (s)	0.4	0.2	13.6	9.9
Approach LOS			B	A

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	27.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	28	107	23	20	85	128	141	25	9	13	15	39
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	30	116	25	22	92	139	153	27	10	14	16	42
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	232			141			364	452	116	336	338	92
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	232			141			364	452	116	336	338	92
tC, single (s)	4.1			4.1			7.2	6.6	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.1	3.4	3.5	4.0	3.3
p0 queue free %	98			98			71	94	99	97	97	96
cM capacity (veh/h)	1319			1429			528	475	920	562	556	957

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	147	25	114	139	190	73
Volume Left	30	0	22	0	153	14
Volume Right	0	25	0	139	10	42
cSH	1319	1700	1429	1700	531	737
Volume to Capacity	0.02	0.01	0.02	0.08	0.36	0.10
Queue Length 95th (m)	0.6	0.0	0.4	0.0	12.9	2.6
Control Delay (s)	1.8	0.0	1.5	0.0	15.5	10.4
Lane LOS	A		A		C	B
Approach Delay (s)	1.5		0.7		15.5	10.4
Approach LOS					C	B

Intersection Summary			
Average Delay	6.0		
Intersection Capacity Utilization	36.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	NBT	NBR	SBL	SBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	202	123	37	206	96	33
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	220	134	40	224	104	36
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			353		524	220
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			353		524	220
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			97		78	96
cM capacity (veh/h)			1178		481	798

Direction, Lane #	NB 1	NB 2	SB 1	SB 2	NW 1
Volume Total	220	134	40	224	140
Volume Left	0	0	40	0	104
Volume Right	0	134	0	0	36
cSH	1700	1700	1178	1700	536
Volume to Capacity	0.13	0.08	0.03	0.13	0.26
Queue Length 95th (m)	0.0	0.0	0.8	0.0	8.3
Control Delay (s)	0.0	0.0	8.2	0.0	14.1
Lane LOS			A		B
Approach Delay (s)	0.0		1.2		14.1
Approach LOS					B

Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	31.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	17	142	1	1	126	88	1	1	2	13	0	1
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	18	154	1	1	137	96	1	1	2	14	0	1
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	233			155			332	427	155	333	332	137
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	233			155			332	427	155	333	332	137
tC, single (s)	4.2			4.2			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.3			2.3			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			100	100	100	98	100	100
cM capacity (veh/h)	1284			1372			613	512	891	611	579	912

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	18	155	138	96	4	15
Volume Left	18	0	1	0	1	14
Volume Right	0	1	0	96	2	1
cSH	1284	1700	1372	1700	686	625
Volume to Capacity	0.01	0.09	0.00	0.06	0.01	0.02
Queue Length 95th (m)	0.4	0.0	0.0	0.0	0.2	0.6
Control Delay (s)	7.8	0.0	0.1	0.0	10.3	10.9
Lane LOS	A		A		B	B
Approach Delay (s)	0.8		0.0		10.3	10.9
Approach LOS					B	B

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	26.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	16	133	7	14	177	103	15	4	21	55	11	23
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	17	145	8	15	192	112	16	4	23	60	12	25
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	304			152			433	514	145	427	410	192
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	304			152			433	514	145	427	410	192
tC, single (s)	4.2			4.2			7.4	6.8	6.5	7.2	6.6	6.3
tC, 2 stage (s)												
tF (s)	2.3			2.3			3.7	4.2	3.5	3.6	4.1	3.4
p0 queue free %	99			99			96	99	97	88	98	97
cM capacity (veh/h)	1186			1370			461	420	843	496	506	829

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	162	8	208	112	43	97
Volume Left	17	0	15	0	16	60
Volume Right	0	8	0	112	23	25
cSH	1186	1700	1370	1700	597	555
Volume to Capacity	0.01	0.00	0.01	0.07	0.07	0.17
Queue Length 95th (m)	0.4	0.0	0.3	0.0	1.9	5.0
Control Delay (s)	1.0	0.0	0.7	0.0	11.5	12.9
Lane LOS	A		A		B	B
Approach Delay (s)	0.9		0.4		11.5	12.9
Approach LOS					B	B

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	35.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	1	208	289	1	2	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	226	314	1	2	5
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	315				543	315
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	315				543	315
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	99
cM capacity (veh/h)	1228				500	726

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	227	315	8
Volume Left	1	0	2
Volume Right	0	1	5
cSH	1228	1700	643
Volume to Capacity	0.00	0.19	0.01
Queue Length 95th (m)	0.0	0.0	0.3
Control Delay (s)	0.0	0.0	10.7
Lane LOS	A		B
Approach Delay (s)	0.0	0.0	10.7
Approach LOS			B

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	25.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	1	209	287	1	12	3
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	227	312	1	13	3
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	313				542	312
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	313				542	312
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				97	100
cM capacity (veh/h)	1230				501	728

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	228	313	16
Volume Left	1	0	13
Volume Right	0	1	3
cSH	1230	1700	534
Volume to Capacity	0.00	0.18	0.03
Queue Length 95th (m)	0.0	0.0	0.8
Control Delay (s)	0.0	0.0	11.9
Lane LOS	A		B
Approach Delay (s)	0.0	0.0	11.9
Approach LOS			B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	25.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	1	218	1	1	285	1	0	0	4	12	0	3
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1	237	1	1	310	1	0	0	4	13	0	3
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	311			238			555	553	238	557	553	310
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	311			238			555	553	238	557	553	310
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	99	97	100	100
cM capacity (veh/h)	1233			1311			439	440	801	438	440	730

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	239	312	4	16
Volume Left	1	1	0	13
Volume Right	1	1	4	3
cSH	1233	1311	801	476
Volume to Capacity	0.00	0.00	0.01	0.03
Queue Length 95th (m)	0.0	0.0	0.1	0.8
Control Delay (s)	0.0	0.0	9.5	12.8
Lane LOS	A	A	A	B
Approach Delay (s)	0.0	0.0	9.5	12.8
Approach LOS			A	B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	29.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	18	124	92	14	85	6	175	32	36	8	4	26
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	20	135	100	15	92	7	190	35	39	9	4	28
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	99			235			327	303	135	353	397	92
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	99			235			327	303	135	353	397	92
tC, single (s)	4.1			4.1			7.2	6.6	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.1	3.4	3.5	4.0	3.3
p0 queue free %	99			99			67	94	96	98	99	97
cM capacity (veh/h)	1475			1321			582	585	898	534	523	957

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	154	100	108	7	264	41
Volume Left	20	0	15	0	190	9
Volume Right	0	100	0	7	39	28
cSH	1475	1700	1321	1700	614	763
Volume to Capacity	0.01	0.06	0.01	0.00	0.43	0.05
Queue Length 95th (m)	0.3	0.0	0.3	0.0	17.3	1.4
Control Delay (s)	1.0	0.0	1.2	0.0	15.2	10.0
Lane LOS	A		A		C	A
Approach Delay (s)	0.6		1.1		15.2	10.0
Approach LOS					C	A

Intersection Summary			
Average Delay	7.0		
Intersection Capacity Utilization	43.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	NBT	NBR	SBL	SBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	183	174	46	337	201	133
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	199	189	50	366	218	145
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			388		665	199
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			388		665	199
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			96		44	82
cM capacity (veh/h)			1144		393	820

Direction, Lane #	NB 1	NB 2	SB 1	SB 2	NW 1
Volume Total	199	189	50	366	363
Volume Left	0	0	50	0	218
Volume Right	0	189	0	0	145
cSH	1700	1700	1144	1700	496
Volume to Capacity	0.12	0.11	0.04	0.22	0.73
Queue Length 95th (m)	0.0	0.0	1.1	0.0	48.1
Control Delay (s)	0.0	0.0	8.3	0.0	29.6
Lane LOS			A		D
Approach Delay (s)	0.0		1.0		29.6
Approach LOS					D

Intersection Summary			
Average Delay	9.6		
Intersection Capacity Utilization	43.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	9	203	1	3	298	65	1	0	1	133	1	27
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	10	221	1	3	324	71	1	0	1	145	1	29
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	395			222			601	642	221	572	572	324
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	395			222			601	642	221	572	572	324
tC, single (s)	4.2			4.2			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.3			2.3			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			100	100	100	66	100	96
cM capacity (veh/h)	1117			1296			391	388	818	427	425	717

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	10	222	327	71	2	175
Volume Left	10	0	3	0	1	145
Volume Right	0	1	0	71	1	29
cSH	1117	1700	1296	1700	529	458
Volume to Capacity	0.01	0.13	0.00	0.04	0.00	0.38
Queue Length 95th (m)	0.2	0.0	0.1	0.0	0.1	14.1
Control Delay (s)	8.3	0.0	0.1	0.0	11.8	17.6
Lane LOS	A		A		B	C
Approach Delay (s)	0.3		0.1		11.8	17.6
Approach LOS					B	C

Intersection Summary			
Average Delay	4.0		
Intersection Capacity Utilization	39.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	36	235	66	79	225	101	106	25	185	105	24	35
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	39	255	72	86	245	110	115	27	201	114	26	38
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	354			327			801	860	255	965	822	245
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	354			327			801	860	255	965	822	245
tC, single (s)	4.2			4.2			7.4	6.8	6.5	7.2	6.6	6.3
tC, 2 stage (s)												
tF (s)	2.3			2.3			3.7	4.2	3.5	3.6	4.1	3.4
p0 queue free %	97			93			49	89	72	17	90	95
cM capacity (veh/h)	1136			1178			224	241	728	138	269	775

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	295	72	330	110	343	178
Volume Left	39	0	86	0	115	114
Volume Right	0	72	0	110	201	38
cSH	1136	1700	1178	1700	380	183
Volume to Capacity	0.03	0.04	0.07	0.06	0.90	0.97
Queue Length 95th (m)	0.9	0.0	1.9	0.0	74.4	62.9
Control Delay (s)	1.4	0.0	2.7	0.0	58.6	111.3
Lane LOS	A		A		F	F
Approach Delay (s)	1.1		2.0		58.6	111.3
Approach LOS					F	F

Intersection Summary			
Average Delay	31.1		
Intersection Capacity Utilization	59.6%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	2	252	251	2	1	11
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	274	273	2	1	12
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	275				552	274
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	275				552	274
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	98
cM capacity (veh/h)	1271				494	765

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	276	275	13
Volume Left	2	0	1
Volume Right	0	2	12
cSH	1271	1700	731
Volume to Capacity	0.00	0.16	0.02
Queue Length 95th (m)	0.0	0.0	0.4
Control Delay (s)	0.1	0.0	10.0
Lane LOS	A		B
Approach Delay (s)	0.1	0.0	10.0
Approach LOS			B

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	24.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	83	423	367	20	1	29
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	90	460	399	22	1	32
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	421				1050	410
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	421				1050	410
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	92				100	95
cM capacity (veh/h)	1123				231	642

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	550	421	33
Volume Left	90	0	1
Volume Right	0	22	32
cSH	1123	1700	606
Volume to Capacity	0.08	0.25	0.05
Queue Length 95th (m)	2.1	0.0	1.4
Control Delay (s)	2.2	0.0	11.3
Lane LOS	A		B
Approach Delay (s)	2.2	0.0	11.3
Approach LOS			B

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	60.7%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	82	340	3	19	353	20	3	26	26	0	12	30
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	89	370	3	21	384	22	3	28	28	0	13	33
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	405			373			1024	996	371	1028	987	395
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	405			373			1024	996	371	1028	987	395
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	92			98			98	87	96	100	94	95
cM capacity (veh/h)	1137			1169			180	221	675	171	224	655

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	462	426	60	46
Volume Left	89	21	3	0
Volume Right	3	22	28	33
cSH	1137	1169	318	423
Volume to Capacity	0.08	0.02	0.19	0.11
Queue Length 95th (m)	2.0	0.4	5.4	2.9
Control Delay (s)	2.3	0.6	18.9	14.5
Lane LOS	A	A	C	B
Approach Delay (s)	2.3	0.6	18.9	14.5
Approach LOS			C	B

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	32	138	196	35	146	30	187	32	12	18	20	58
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	35	150	213	38	159	33	203	35	13	20	22	63
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	191			363			528	487	150	485	667	159
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	191			363			528	487	150	485	667	159
tC, single (s)	4.1			4.1			7.2	6.6	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.1	3.4	3.5	4.0	3.3
p0 queue free %	97			97			47	92	99	95	94	93
cM capacity (veh/h)	1364			1185			382	445	881	432	354	879

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	185	213	197	33	251	104
Volume Left	35	0	38	0	203	20
Volume Right	0	213	0	33	13	63
cSH	1364	1700	1185	1700	402	585
Volume to Capacity	0.03	0.13	0.03	0.02	0.62	0.18
Queue Length 95th (m)	0.6	0.0	0.8	0.0	32.8	5.2
Control Delay (s)	1.6	0.0	1.8	0.0	27.7	12.5
Lane LOS	A		A		D	B
Approach Delay (s)	0.8		1.5		27.7	12.5
Approach LOS					D	B

Intersection Summary			
Average Delay	9.1		
Intersection Capacity Utilization	48.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	NBT	NBR	SBL	SBT	NWL	NWR
Lane Configurations						
Volume (veh/h)	238	233	107	267	196	107
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	259	253	116	290	213	116
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			512		782	259
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			512		782	259
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			89		32	85
cM capacity (veh/h)			1028		311	759

Direction, Lane #	NB 1	NB 2	SB 1	SB 2	NW 1
Volume Total	259	253	116	290	329
Volume Left	0	0	116	0	213
Volume Right	0	253	0	0	116
cSH	1700	1700	1028	1700	393
Volume to Capacity	0.15	0.15	0.11	0.17	0.84
Queue Length 95th (m)	0.0	0.0	3.1	0.0	62.6
Control Delay (s)	0.0	0.0	8.9	0.0	46.9
Lane LOS			A		E
Approach Delay (s)	0.0		2.6		46.9
Approach LOS					E

Intersection Summary			
Average Delay	13.2		
Intersection Capacity Utilization	45.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	43	288	1	1	282	161	1	1	3	42	0	12
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	47	313	1	1	307	175	1	1	3	46	0	13
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	482			314			729	891	314	719	716	307
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	482			314			729	891	314	719	716	307
tC, single (s)	4.2			4.2			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.3			2.3			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	95			100			100	100	100	86	100	98
cM capacity (veh/h)	1036			1197			321	269	727	329	339	733

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	47	314	308	175	5	59
Volume Left	47	0	1	0	1	46
Volume Right	0	1	0	175	3	13
cSH	1036	1700	1197	1700	456	375
Volume to Capacity	0.05	0.18	0.00	0.10	0.01	0.16
Queue Length 95th (m)	1.1	0.0	0.0	0.0	0.3	4.4
Control Delay (s)	8.6	0.0	0.0	0.0	13.0	16.4
Lane LOS	A		A		B	C
Approach Delay (s)	1.1		0.0		13.0	16.4
Approach LOS					B	C

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	49.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	27	214	91	169	289	138	116	32	155	73	128	40
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	29	233	99	184	314	150	126	35	168	79	139	43
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	464			332			1086	1123	233	1159	1072	314
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	464			332			1086	1123	233	1159	1072	314
tC, single (s)	4.2			4.2			7.4	6.8	6.5	7.2	6.6	6.3
tC, 2 stage (s)												
tF (s)	2.3			2.3			3.7	4.2	3.5	3.6	4.1	3.4
p0 queue free %	97			84			0	77	78	14	20	94
cM capacity (veh/h)	1032			1174			49	152	751	92	175	708

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	262	99	498	150	329	262
Volume Left	29	0	184	0	126	79
Volume Right	0	99	0	150	168	43
cSH	1032	1700	1174	1700	110	153
Volume to Capacity	0.03	0.06	0.16	0.09	3.01	1.72
Queue Length 95th (m)	0.7	0.0	4.4	0.0	Err	151.0
Control Delay (s)	1.2	0.0	4.2	0.0	Err	400.1
Lane LOS	A		A		F	F
Approach Delay (s)	0.9		3.3		Err	400.1
Approach LOS					F	F

Intersection Summary			
Average Delay	2125.2		
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	18	423	567	1	3	30
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	20	460	616	1	3	33
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	617				1116	617
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	617				1116	617
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				99	93
cM capacity (veh/h)	948				225	490

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	479	617	36
Volume Left	20	0	3
Volume Right	0	1	33
cSH	948	1700	443
Volume to Capacity	0.02	0.36	0.08
Queue Length 95th (m)	0.5	0.0	2.1
Control Delay (s)	0.6	0.0	13.8
Lane LOS	A		B
Approach Delay (s)	0.6	0.0	13.8
Approach LOS			B

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	46.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	62	364	488	1	14	80
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	67	396	530	1	15	87
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	532				1061	531
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	532				1061	531
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	93				93	84
cM capacity (veh/h)	1021				231	548

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	463	532	102
Volume Left	67	0	15
Volume Right	0	1	87
cSH	1021	1700	455
Volume to Capacity	0.07	0.31	0.22
Queue Length 95th (m)	1.7	0.0	6.8
Control Delay (s)	1.9	0.0	15.2
Lane LOS	A		C
Approach Delay (s)	1.9	0.0	15.2
Approach LOS			C

Intersection Summary			
Average Delay	2.2		
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	62	314	1	41	408	1	2	32	37	14	40	79
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	67	341	1	45	443	1	2	35	40	15	43	86
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	445			342			1117	1010	342	1067	1010	444
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	445			342			1117	1010	342	1067	1010	444
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	94			96			98	84	94	90	80	86
cM capacity (veh/h)	1100			1200			125	217	701	153	217	614

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	410	489	77	145
Volume Left	67	45	2	15
Volume Right	1	1	40	86
cSH	1100	1200	328	329
Volume to Capacity	0.06	0.04	0.24	0.44
Queue Length 95th (m)	1.6	0.9	7.2	17.2
Control Delay (s)	1.9	1.1	19.3	24.3
Lane LOS	A	A	C	C
Approach Delay (s)	1.9	1.1	19.3	24.3
Approach LOS			C	C

Intersection Summary			
Average Delay	5.7		
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	31	194	140	17	140	9	267	45	44	11	6	44
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	34	211	152	18	152	10	290	49	48	12	7	48
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	162			363			518	477	211	540	620	152
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	162			363			518	477	211	540	620	152
tC, single (s)	4.1			4.1			7.2	6.6	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.1	3.4	3.5	4.0	3.3
p0 queue free %	98			98			30	89	94	97	98	95
cM capacity (veh/h)	1399			1185			415	459	814	376	384	886

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	245	152	171	10	387	66
Volume Left	34	0	18	0	290	12
Volume Right	0	152	0	10	48	48
cSH	1399	1700	1185	1700	448	645
Volume to Capacity	0.02	0.09	0.02	0.01	0.86	0.10
Queue Length 95th (m)	0.6	0.0	0.4	0.0	70.6	2.7
Control Delay (s)	1.2	0.0	1.0	0.0	46.2	11.2
Lane LOS	A		A		E	B
Approach Delay (s)	0.8		0.9		46.2	11.2
Approach LOS					E	B

Intersection Summary			
Average Delay	18.5		
Intersection Capacity Utilization	56.7%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	NBT	NBR	SBL	SBT	NWL	NWR
Lane Configurations						
Volume (vph)	183	174	46	337	201	133
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.85	1.00	1.00	0.95	
Flt Protected	1.00	1.00	0.95	1.00	0.97	
Satd. Flow (prot)	1779	1512	1706	1795	1590	
Flt Permitted	1.00	1.00	0.63	1.00	0.97	
Satd. Flow (perm)	1779	1512	1136	1795	1590	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	199	189	50	366	218	145
RTOR Reduction (vph)	0	113	0	0	60	0
Lane Group Flow (vph)	199	76	50	366	303	0
Heavy Vehicles (%)	8%	8%	7%	7%	11%	11%
Turn Type		Perm	Perm			
Protected Phases	4			8	2	
Permitted Phases		4	8			
Actuated Green, G (s)	16.0	16.0	16.0	16.0	16.0	
Effective Green, g (s)	16.0	16.0	16.0	16.0	16.0	
Actuated g/C Ratio	0.40	0.40	0.40	0.40	0.40	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	
Lane Grp Cap (vph)	712	605	454	718	636	
v/s Ratio Prot	0.11			c0.20	c0.19	
v/s Ratio Perm		0.05	0.04			
v/c Ratio	0.28	0.12	0.11	0.51	0.48	
Uniform Delay, d1	8.1	7.6	7.5	9.0	8.9	
Progression Factor	1.00	1.00	1.00	1.00	0.53	
Incremental Delay, d2	1.0	0.4	0.5	2.6	2.4	
Delay (s)	9.1	8.0	8.0	11.6	7.1	
Level of Service	A	A	A	B	A	
Approach Delay (s)	8.6			11.2	7.1	
Approach LOS	A			B	A	

Intersection Summary			
HCM Average Control Delay	9.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	43.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	9	203	1	3	298	65	1	0	1	133	1	27
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	10	221	1	3	324	71	1	0	1	145	1	29
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	395			222			601	642	221	572	572	324
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	395			222			601	642	221	572	572	324
tC, single (s)	4.2			4.2			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.3			2.3			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			100	100	100	66	100	96
cM capacity (veh/h)	1117			1296			391	388	818	427	425	717

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	10	222	327	71	2	175
Volume Left	10	0	3	0	1	145
Volume Right	0	1	0	71	1	29
cSH	1117	1700	1296	1700	529	458
Volume to Capacity	0.01	0.13	0.00	0.04	0.00	0.38
Queue Length 95th (m)	0.2	0.0	0.1	0.0	0.1	14.1
Control Delay (s)	8.3	0.0	0.1	0.0	11.8	17.6
Lane LOS	A		A		B	C
Approach Delay (s)	0.3		0.1		11.8	17.6
Approach LOS					B	C

Intersection Summary			
Average Delay	4.0		
Intersection Capacity Utilization	39.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	36	235	66	79	225	101	106	25	185	105	24	35
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00	1.00		1.00			1.00	
Frt		1.00	0.85	1.00	1.00	0.85		0.92			0.97	
Flt Protected		0.99	1.00	0.95	1.00	1.00		0.98			0.97	
Satd. Flow (prot)		1660	1420	1630	1715	1458		1381			1644	
Flt Permitted		0.94	1.00	0.56	1.00	1.00		0.84			0.71	
Satd. Flow (perm)		1569	1420	953	1715	1458		1179			1205	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	39	255	72	86	245	110	115	27	201	114	26	38
RTOR Reduction (vph)	0	0	43	0	0	66	0	121	0	0	23	0
Lane Group Flow (vph)	0	294	29	86	245	44	0	222	0	0	155	0
Heavy Vehicles (%)	15%	15%	15%	12%	12%	12%	26%	26%	26%	10%	10%	10%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		16.0	16.0	16.0	16.0	16.0		16.0			16.0	
Effective Green, g (s)		16.0	16.0	16.0	16.0	16.0		16.0			16.0	
Actuated g/C Ratio		0.40	0.40	0.40	0.40	0.40		0.40			0.40	
Clearance Time (s)		4.0	4.0	4.0	4.0	4.0		4.0			4.0	
Lane Grp Cap (vph)		628	568	381	686	583		472			482	
v/s Ratio Prot					0.14							
v/s Ratio Perm		c0.19	0.02	0.09		0.03		c0.19			0.13	
v/c Ratio		0.47	0.05	0.23	0.36	0.08		0.47			0.32	
Uniform Delay, d1		8.9	7.3	7.9	8.4	7.4		8.9			8.3	
Progression Factor		1.18	1.54	1.00	1.00	1.00		1.00			1.00	
Incremental Delay, d2		2.5	0.2	1.4	1.5	0.3		3.4			1.8	
Delay (s)		13.0	11.5	9.3	9.9	7.7		12.2			10.0	
Level of Service		B	B	A	A	A		B			B	
Approach Delay (s)		12.7			9.2			12.2			10.0	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	11.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	2	252	251	2	1	11
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	274	273	2	1	12
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	275				552	274
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	275				552	274
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	98
cM capacity (veh/h)	1271				494	765

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	276	275	13
Volume Left	2	0	1
Volume Right	0	2	12
cSH	1271	1700	731
Volume to Capacity	0.00	0.16	0.02
Queue Length 95th (m)	0.0	0.0	0.4
Control Delay (s)	0.1	0.0	10.0
Lane LOS	A		B
Approach Delay (s)	0.1	0.0	10.0
Approach LOS			B

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	24.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	83	423	367	20	1	29
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	90	460	399	22	1	32
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	421				1050	410
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	421				1050	410
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	92				100	95
cM capacity (veh/h)	1123				231	642

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	550	421	33
Volume Left	90	0	1
Volume Right	0	22	32
cSH	1123	1700	606
Volume to Capacity	0.08	0.25	0.05
Queue Length 95th (m)	2.1	0.0	1.4
Control Delay (s)	2.2	0.0	11.3
Lane LOS	A		B
Approach Delay (s)	2.2	0.0	11.3
Approach LOS			B

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	60.7%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	82	340	3	19	353	20	3	26	26	0	12	30
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	89	370	3	21	384	22	3	28	28	0	13	33
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	405			373			1024	996	371	1028	987	395
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	405			373			1024	996	371	1028	987	395
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	92			98			98	87	96	100	94	95
cM capacity (veh/h)	1137			1169			180	221	675	171	224	655

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	462	426	60	46
Volume Left	89	21	3	0
Volume Right	3	22	28	33
cSH	1137	1169	318	423
Volume to Capacity	0.08	0.02	0.19	0.11
Queue Length 95th (m)	2.0	0.4	5.4	2.9
Control Delay (s)	2.3	0.6	18.9	14.5
Lane LOS	A	A	C	B
Approach Delay (s)	2.3	0.6	18.9	14.5
Approach LOS			C	B

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	32	138	196	35	146	30	187	32	12	18	20	58
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	35	150	213	38	159	33	203	35	13	20	22	63
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	191			363			528	487	150	485	667	159
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	191			363			528	487	150	485	667	159
tC, single (s)	4.1			4.1			7.2	6.6	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.1	3.4	3.5	4.0	3.3
p0 queue free %	97			97			47	92	99	95	94	93
cM capacity (veh/h)	1364			1185			382	445	881	432	354	879

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	185	213	197	33	203	48	20	85
Volume Left	35	0	38	0	203	0	20	0
Volume Right	0	213	0	33	0	13	0	63
cSH	1364	1700	1185	1700	382	515	432	637
Volume to Capacity	0.03	0.13	0.03	0.02	0.53	0.09	0.05	0.13
Queue Length 95th (m)	0.6	0.0	0.8	0.0	24.0	2.4	1.1	3.7
Control Delay (s)	1.6	0.0	1.8	0.0	24.6	12.7	13.7	11.5
Lane LOS	A		A		C	B	B	B
Approach Delay (s)	0.8		1.5		22.3		11.9	
Approach LOS					C		B	

Intersection Summary			
Average Delay	7.6		
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	NBT	NBR	SBL	SBT	NWL	NWR
Lane Configurations						
Volume (vph)	238	233	107	267	196	107
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.85	1.00	1.00	0.95	
Flt Protected	1.00	1.00	0.95	1.00	0.97	
Satd. Flow (prot)	1779	1512	1706	1795	1597	
Flt Permitted	1.00	1.00	0.60	1.00	0.97	
Satd. Flow (perm)	1779	1512	1073	1795	1597	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	259	253	116	290	213	116
RTOR Reduction (vph)	0	152	0	0	49	0
Lane Group Flow (vph)	259	101	116	290	280	0
Heavy Vehicles (%)	8%	8%	7%	7%	11%	11%
Turn Type		Perm	Perm			
Protected Phases	4			8	2	
Permitted Phases		4	8			
Actuated Green, G (s)	16.0	16.0	16.0	16.0	16.0	
Effective Green, g (s)	16.0	16.0	16.0	16.0	16.0	
Actuated g/C Ratio	0.40	0.40	0.40	0.40	0.40	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	
Lane Grp Cap (vph)	712	605	429	718	639	
v/s Ratio Prot	0.15			c0.16	c0.18	
v/s Ratio Perm		0.07	0.11			
v/c Ratio	0.36	0.17	0.27	0.40	0.44	
Uniform Delay, d1	8.4	7.7	8.1	8.6	8.7	
Progression Factor	1.00	1.00	1.00	1.00	0.72	
Incremental Delay, d2	1.4	0.6	1.5	1.7	2.0	
Delay (s)	9.9	8.3	9.6	10.3	8.3	
Level of Service	A	A	A	B	A	
Approach Delay (s)	9.1			10.1	8.3	
Approach LOS	A			B	A	

Intersection Summary			
HCM Average Control Delay	9.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	45.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	43	288	1	1	282	161	1	1	3	42	0	12
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	47	313	1	1	307	175	1	1	3	46	0	13
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	482			314			729	891	314	719	716	307
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	482			314			729	891	314	719	716	307
tC, single (s)	4.2			4.2			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.3			2.3			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	95			100			100	100	100	86	100	98
cM capacity (veh/h)	1036			1197			321	269	727	329	339	733

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	47	314	308	175	5	59
Volume Left	47	0	1	0	1	46
Volume Right	0	1	0	175	3	13
cSH	1036	1700	1197	1700	456	375
Volume to Capacity	0.05	0.18	0.00	0.10	0.01	0.16
Queue Length 95th (m)	1.1	0.0	0.0	0.0	0.3	4.4
Control Delay (s)	8.6	0.0	0.0	0.0	13.0	16.4
Lane LOS	A		A		B	C
Approach Delay (s)	1.1		0.0		13.0	16.4
Approach LOS					B	C

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	49.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	27	214	91	169	289	138	116	32	155	73	128	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00	1.00		1.00			1.00	
Frt		1.00	0.85	1.00	1.00	0.85		0.93			0.98	
Flt Protected		0.99	1.00	0.95	1.00	1.00		0.98			0.99	
Satd. Flow (prot)		1661	1420	1630	1715	1458		1393			1682	
Flt Permitted		0.95	1.00	0.59	1.00	1.00		0.81			0.84	
Satd. Flow (perm)		1580	1420	1019	1715	1458		1155			1432	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	29	233	99	184	314	150	126	35	168	79	139	43
RTOR Reduction (vph)	0	0	59	0	0	90	0	94	0	0	18	0
Lane Group Flow (vph)	0	262	40	184	314	60	0	235	0	0	243	0
Heavy Vehicles (%)	15%	15%	15%	12%	12%	12%	26%	26%	26%	10%	10%	10%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		16.0	16.0	16.0	16.0	16.0		16.0			16.0	
Effective Green, g (s)		16.0	16.0	16.0	16.0	16.0		16.0			16.0	
Actuated g/C Ratio		0.40	0.40	0.40	0.40	0.40		0.40			0.40	
Clearance Time (s)		4.0	4.0	4.0	4.0	4.0		4.0			4.0	
Lane Grp Cap (vph)		632	568	408	686	583		462			573	
v/s Ratio Prot					c0.18							
v/s Ratio Perm		0.17	0.03	0.18		0.04		c0.20			0.17	
v/c Ratio		0.41	0.07	0.45	0.46	0.10		0.51			0.42	
Uniform Delay, d1		8.6	7.4	8.8	8.8	7.5		9.0			8.7	
Progression Factor		1.04	1.10	1.00	1.00	1.00		1.00			1.00	
Incremental Delay, d2		2.0	0.2	3.6	2.2	0.4		4.0			2.3	
Delay (s)		10.9	8.4	12.4	11.0	7.9		13.0			11.0	
Level of Service		B	A	B	B	A		B			B	
Approach Delay (s)		10.2			10.7			13.0			11.0	
Approach LOS		B			B			B			B	

Intersection Summary			
HCM Average Control Delay	11.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	63.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	18	423	567	1	3	30
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	20	460	616	1	3	33
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	617				1116	617
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	617				1116	617
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				99	93
cM capacity (veh/h)	948				225	490

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	479	617	36
Volume Left	20	0	3
Volume Right	0	1	33
cSH	948	1700	443
Volume to Capacity	0.02	0.36	0.08
Queue Length 95th (m)	0.5	0.0	2.1
Control Delay (s)	0.6	0.0	13.8
Lane LOS	A		B
Approach Delay (s)	0.6	0.0	13.8
Approach LOS			B

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	46.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	62	364	488	1	14	80
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	67	396	530	1	15	87
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	532				1061	531
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	532				1061	531
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	93				93	84
cM capacity (veh/h)	1021				231	548

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	463	532	102
Volume Left	67	0	15
Volume Right	0	1	87
cSH	1021	1700	455
Volume to Capacity	0.07	0.31	0.22
Queue Length 95th (m)	1.7	0.0	6.8
Control Delay (s)	1.9	0.0	15.2
Lane LOS	A		C
Approach Delay (s)	1.9	0.0	15.2
Approach LOS			C

Intersection Summary			
Average Delay	2.2		
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	62	314	1	41	408	1	2	32	37	14	40	79
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	67	341	1	45	443	1	2	35	40	15	43	86
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	445			342			1117	1010	342	1067	1010	444
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	445			342			1117	1010	342	1067	1010	444
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	94			96			98	84	94	90	80	86
cM capacity (veh/h)	1100			1200			125	217	701	153	217	614

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	410	489	77	145
Volume Left	67	45	2	15
Volume Right	1	1	40	86
cSH	1100	1200	328	329
Volume to Capacity	0.06	0.04	0.24	0.44
Queue Length 95th (m)	1.6	0.9	7.2	17.2
Control Delay (s)	1.9	1.1	19.3	24.3
Lane LOS	A	A	C	C
Approach Delay (s)	1.9	1.1	19.3	24.3
Approach LOS			C	C

Intersection Summary			
Average Delay	5.7		
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	31	194	140	17	140	9	267	45	44	11	6	44
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	34	211	152	18	152	10	290	49	48	12	7	48
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	162			363			518	477	211	540	620	152
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	162			363			518	477	211	540	620	152
tC, single (s)	4.1			4.1			7.2	6.6	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.1	3.4	3.5	4.0	3.3
p0 queue free %	98			98			30	89	94	97	98	95
cM capacity (veh/h)	1399			1185			415	459	814	376	384	886

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	245	152	171	10	290	97	12	54
Volume Left	34	0	18	0	290	0	12	0
Volume Right	0	152	0	10	0	48	0	48
cSH	1399	1700	1185	1700	415	586	376	766
Volume to Capacity	0.02	0.09	0.02	0.01	0.70	0.17	0.03	0.07
Queue Length 95th (m)	0.6	0.0	0.4	0.0	41.8	4.7	0.8	1.8
Control Delay (s)	1.2	0.0	1.0	0.0	31.5	12.4	14.9	10.1
Lane LOS	A		A		D	B	B	B
Approach Delay (s)	0.8		0.9		26.7		10.9	
Approach LOS					D		B	

Intersection Summary			
Average Delay	11.2		
Intersection Capacity Utilization	51.7%	ICU Level of Service	A
Analysis Period (min)	15		