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Introduction

1.1 Background

At present, the area to the south and to the east of the City of Grande Prairie is serviced in the following manners:

- ***Water:***
  The sources of water are either from wells constructed on individual lots or from a water truck that supplies water on a regular basis.
- ***Wastewater:***
  Wastewater is either disposed of by septic fields on each lot by holding tanks that will be pumped out at a regular interval.

The County of Grande Prairie wishes to increase the servicing level by providing water and wastewater municipal services to these areas. In 2003, Aquatera Utilities Inc. commissioned Infrastructure Systems Ltd. (ISL) to carry out the study.

1.2 Scope of Work

The scope of work is to provide water distribution and wastewater collection systems to the existing and potential developments in the study as shown on Figure 2.1.1 in Section 2. The scope of work for this assignment included the following tasks.

- Collected and reviewed data;
- Established design criteria;
- Carried out population, water demand and wastewater flow projections;
- Investigated potential water distribution system options;

- Investigated potential wastewater collection system options;
- Prepared construction cost estimates; and,
- Prepared report.

2

Study Area

2.1 Location

The study area consists of approximately 43 sections of land bounded to the north by 100 Avenue and to the south by the Wapiti River. The east boundary is approximately 9 km (5.5 miles) east of the east boundary of the City of Grande Prairie. The west boundary follows the east and south boundaries of the City and Highway 40. The boundary of the study area is shown in Figure 2.1.1.

As shown in Figure 2.1.1, existing developments are scattered in the areas north of Bear Creek and east of the City's boundary, as well as areas between Resources Road and Highway 40, north of Wapiti River. The existing developments south of Bear Creek and east of Resources Road, are the Weyerhaeuser Pulp Mill and Sterling's Pulp Chemicals which are developed at the north bank of the Wapiti River.

2.2 Topography

As shown in Figure 2.1.1, the area south of Bear Creek and east of Resources Road consists of numerous sloughs and generally is not suitable for developments due to high costs associated with poor ground conditions for the construction of underground utilities. There is a knoll in the vicinity of 100 Avenue, immediately east of the City's boundary. The land north of Bear Creek generally slopes in a south-easterly direction toward Bear Creek. The area west of Resources Road generally slopes in a southerly direction toward Wapiti River.

The contours were prepared based on spot elevations obtained from the Provincial government through Altalis Ltd. The accuracy of the contours is unknown. Verification

of the contours will be required when carrying out the preliminary and detailed design.

2.3 Existing Developments

The study area has 30 developments. The location, size, and type of developments are shown in Table 2.1 and Figure 2.1.1.

Table 2.1 Existing Developments

DEVELOPMENTS	NUMBER OF LOTS/UNITS
1. Residential Development	
• Brookside	10
• Sunnybrook	19
• Eastland Acres	12
• Arthur Lane	37
• Sunridge Estates	9
• Aspen Ridge	52
• Lawra Estates	32
• Woodlake Estates	8
• Green Acres	18
• Windwood Lane	11
• Bear Ridge Estates	27
• Sandy Ridge Estates	30
• Eagle Estates	34
• Willowood Estates	27
• Maple Grove	13
• Pinebrooke Estates	19
• Pine Valley Estates	24
• Sandy Lane	19
• Pine Valley South	5
• Tamarack Estates	20
• The Dunes	45
• Borstad/Carlson/Barker	8
• Tink Estates	7
• Meckena Estates	220
2. Mobile Home Parks	
• Eldoes Mobile Home Park	85
• Swan City Trailer Park	65
• Triple L Mobile Home Park	92
3. Industrial Developments	
• County Industrial Park	47
• Hwy 40 Industrial Park	15
• Correctional Line Industrial Park	15

4. RV Park	
• Camp Tamarack	87 stalls
5. Parks	
• Evergreen Park	6

3

Proposed Design Criteria

3.1 Water Distribution

The proposed design criteria for the water distribution system is described as follows:

Water Demand:

Standard Water Distribution System

- Residential Developments: 275 L/capita/day
- Industrial Developments: 625 L/capita/day or 10,000 L/ha/day
- Residential Development

  Maximum Day Factor = 2.0

  Peak Hour Factor = 3.0
- Industrial Development

  Maximum Day Factor = 1.5

  Peak Hour Factor = 2.0
- Fire flow to be provided to urban reserve residential areas only
- Hazen Williams Coefficient = 110

Trickle Water Distribution Systems

- Residential Developments = 0.076 L/s/lot
- Industrial Developments = 0.152 L/s/lot
- Minimum pressure = 69 Kpa

3.2 Wastewater Collection System

The proposed design criteria for the wastewater collection system are described as follows:

Wastewater Flow:

Gravity Sewer System

- Residential Developments: 275 L/capita/day
- Industrial Developments: 625L/capita/day or 10,000 L/ha/day
- Residential Developments - Peaking Factor = 2.6(p) ^ -0.1 < 4.5 (p = population in thousand)
- Industrial Developments Peaking Factor = 6.659 (Q avg) -0.168 < 5
- Infiltration = 0.28 L/s/hectare
- Required Design Flow for gravity sewer = Peak Flow/0.864
- Manning N Factor = 0.013
- Hazen Williams Coefficient = 110.

Lift Station

- The storage of a lift station shall be designed to have a minimum cycling time of ten minutes plus the storage required at the pump shutoff water level.
- Bypass pumping facilities shall be provided at the lift station for emergency pumping during power failure.

Low Pressure Sewer System

- Flow to be determined on the basis of the number of lots and a chart to establish the design flow attached in Appendix A. The chart is provided by Engineering Pump Systems Ltd. and was developed using data collected from existing low pressure sewer systems.

4

Design Population

4.1 Population for Existing Developments

The County of Grande Prairie has the following planning standards with respect to the population density.

Residential Development: 3 persons/lot

Industrial Development: Equivalent population of 16 persons/hectare

Since the area to the east and to the south of the City are to be connected into Aquatera's water distribution and wastewater systems at different locations, the existing populations were estimated for each of the areas. The existing population for the areas to the east and to the south of the City of Grande Prairie are shown in Tables 4.1.1 and 4.1.2.

Table 4.1.1 Eastern Area Population

Developments	Number of Lots/Units	Existing Population
1. Residential Developments		
• Brookside	10	30
• Sunnybrook	19	57
• Eastland Acres	12	36
• Arthur Lane	37	111
• Sunridge Estates	9	27
• Aspen Ridge	52	156
• Lawra Estates	32	96
• Woodlake Estates	8	24
• Green Acres	18	54
• Lindwood Lane	11	33
• Bear Ridge Estates	27	81
• Sandy Ridge Estates	30	90
• Eagle Estates	34	102
• Willowood Estates	27	81
• Maple Grove	13	39
• Pinebrooke Estates	19	57
• Pine Valley Estates	24	72
• Pine Valley South	5	15
• Borstad/Carlson/Barker	8	24
• Mekena Estates	220	660
2. Mobile Home Parks		
• Eldoes Mobile Home Park	85	255
• Swan City Trailer Park	65	195
• Triple L Mobile Home Park	92	276
TOTAL	857	2571

Table 4.1.2 Southern Area Population

Developments	Number of Lots/Units	Existing Population Equivalent
1. Residential Developments		
• Sandy Lane	19	57
• Tamarack Estates	20	60
• The Dunes	45	135
• Tink Estates	7	21
2. Industrial developments		
• Hwy 40 Industrial Park	15 (129.4 Ha)	2070
• County Industrial Park	47 (52.8 Ha)	845
• Correctional Line Industrial Park	15 (77.2 Ha)	1235
3. RV PARKS		
• Camp Tamarack	87	261
4. PARKS		
• Evergreen Park	6	19
TOTAL	261	4703

4.2 Population for Future Developments

It is assumed that all lands with an agricultural land use be developed into Country Residential subdivisions with a minimum size of lot to be one hectare. The population of each lot is three persons. Also, urban reserve residential land use has six lots per hectare. The population of each lot is also three persons.

5

Wastewater System

The study area will have the following two separate wastewater drainage areas:

- ***Eastern Area*** Area to the east of the City of Grande Prairie.
  The wastewater system for this area will be drained into the 88 Street sanitary trunk sewer.

- ***Southern Area*** Area to the south of the City of Grande Prairie.
  The wastewater system will be connected into the wastewater treatment plant. The provision of wastewater service to Weyerhaeuser Pulp Mill will not be considered.

5.1 Design Wastewater Flow

The design wastewater flow will be calculated on the basis of the population of existing and ultimate developments within the servicing area and the design criteria as stated in Section 3. The design flow for the gravity and low pressure sewer system is attached in Appendix B.

5.2 Wastewater Systems Options

The following two potential options were evaluated for the wastewater system.

- Gravity sewer system with lift stations at strategic locations
- Low pressure sewer system with lift stations at strategic locations

A low pressure sewer system is especially cost effective to service developments throughout an undulating terrain. A low pressure system consists of a network of

pressurized sewer mains just like a water distribution system. The wastewater from a dwelling will be discharged directly into a storage tank and then pumped into the pressurized sewer main by a grinder pump. Also, a shut off valve will be installed at the property line. A sketch of a low pressure sewer system is depicted in Figure 5.2.1.

Since the head for grinder pumps is generally less than 30 m, a lift station with regular sewage pumps will be required when the point of discharge is far away from the developments. The number of lift stations required depends on the distance between the point of discharge and the development.

One of the advantages of a low pressure sewer system is that the size of the majority of sewers is generally smaller ($\leq$150 mm) and can be installed about 3 m below ground surface. It would therefore be possible to utilize a ploughing technique for the installation of the sewer pipe, reducing the construction cost substantially.

The existing septic tank and holding tank can be converted to a chamber which will house the grinder pump if these tanks are in good condition.

5.3 Proposed Wastewater System

5.3.1 Eastern Area

The wastewater from this basin will be drained into the existing 900 mm ⌀ sanitary trunk sewer at 88 Street and 60 Avenue. The invert elevation of the 88 Street sanitary sewer at the point of connection is approximately 645.61 m.

- ***Gravity Sewer System***

  The study area was divided into three sub-basins as follows:

  - **Sub-basin 1** - Area to the east of the blind line of Sections 9 ,16, and 21 and north of Bear Creek. The wastewater in this sub-basin will be drained into the proposed lift station #2 at the southeast corner of the SE 1/4 Section 14.
  - **Sub-basin 2** - Area to the west of the blind line of Sections 9, 16, and 21 and north of Bear Creek excluding Pine Valley Estates and Pine Brook Estates.

- **Sub-basin 3** - Pine Valley Estates and Pine Brook Estates.

The layout of the gravity sewer system is shown in Figure 5.3.1.1. In order to minimize the depth of the sewer, six lift stations were required to service existing and future developments in this area because the topography of the land slopes in a south and east direction. The size of the gravity sanitary sewers range from 200 mm to 900 mm in diameter and the forcemains range from 150 mm to 750 mm in diameter.

Eldoes and Swan City Mobile Home Parks Eagle Estates and the Borstad/Carlson/Barkers were considered in the design of the trunk sewers. As an alternate these developments could be serviced into the future 88 Street sanitary trunk sewer because the future trunk sewer will be installed along the west boundary of these developments. The estimated construction cost of the gravity sewer system is $ 57,240,713 as shown in Section 7.

- ***Low Pressure Sewer System***

  The layout of the low pressure sewer system is shown on Figure 5.3.1.2. The size of the sewer pipes range from 100 mm to 250 mm in diameter. The system also requires the construction of three lift stations to overcome the limited head of the grinder pumps. The estimated construction cost is $ 8,361,430 as shown in Section 7. The Pine Valley South subdivision could be serviced either into the eastern or the southern low pressure sewer systems. It would be more cost effective to service this subdivision into the southern low pressure system because the construction of a river crossing will be required if it is to be serviced into the eastern low pressure sewer system.

5.3.2 Southern Area

The wastewater for this area will be drained into the existing wastewater treatment plant. The invert elevation of the sanitary sewer at the wastewater treatment plant is approximately 642.00 m.

- ***Gravity Sewer System***

  This area was divided into four sub-basins as follows:

- **Sub-basin 1** - Areas east of 100 Street including Highway 40 Industrial Park correction line Industrial park, the Evergreen Park, Pine Valley South and areas within the service boundary east of Resources Road and south of Bear Creek.

  The wastewater in this basin will be drained into the proposed Lift Station A and then through a 450 mm ⌀ forcemain into the gravity sewer along 100 Street.

- **Sub-basin 2** - Area west of 100 Street along SH688.
  The wastewater from this area will be drained directly into the gravity sewer along 100 Street.

- **Sub-basin 3** - Area south of SH688 except the Dunes.
  The wastewater from this area will be drained into the proposed Lift Station B and then through a 375 mm ⌀ forcemain into the gravity sewer along 100 Street.

- **Sub-basin 4 - The Dunes**
  The wastewater from this area will be drained into the proposed Lift Station C and then through a 150 mm diameter forcemain into Lift Station B.

  The layout of the gravity sewer system is shown in Figure 5.3.1.1. The estimated construction cost is $ 30,080,401 as shown in Section 7.

- ***Low Pressure Sewer System***

  The layout of the low pressure sewer system is shown in Figure 5.3.1.2. The system consists of 100 mm ⌀ to 200 mm ⌀ pressure sewer pipes. The estimated construction cost is $ 2,323,854 s shown in Section 7.

5.4 Preferred Option

As stated in Sections 5.3.1 and 5.3.2, the low pressure sewer system has the lowest construction cost. Also, the number of lift stations in the low pressure sewer system is less than the gravity sewer system and hence the low pressure sewer system has a lower operation and maintenance costs. Therefore the low pressure sewer system is the preferred option.

6

Water Distribution System

There will be two water distribution systems for the study area. The area to the east of the City of Grande Prairie will be connected into the trunk watermain at 100 Avenue near 90 Street and 68 Avenue at 90th Street. The second distribution system is for the area to the south of the City of Grande Prairie and will be connected into the water treatment plant. The supply of water to Weyerhaeuser will be considered in the design of the water distribution system. The maximum flow to Weyerhaeuser will be 9.46 L/s (150USGPM) at a minimum pressure of 276 Kpa (40psi).

A separate cost comparison evaluation was done for the water servicing of The Dunes, Tamarack Estates, and Weyerhaeuser. The evaluation compares the cost of providing a trickle water distribution system to The Dunes and Tamarack Estates only vs a combined system which feeds Weyerhaeuser, The Dunes, and Tamarack Estates. The evaluation is included in Appendix C.

6.1 Design Water Demand

The design water demands for the water distribution system were calculated on the basis of the population of the existing and ultimate developments within the servicing areas and the design criteria stated in Section 3.

6.2 Water Distribution System Options

The following water distribution systems potential options were investigated.

- Direct feed water distribution system with fire flow for UR land use areas only.
- Trickle water distribution system with fire flow to UR land use areas only.

A trickle water distribution system consists of a cistern, level control float valve, flow control valve, pressure tank, a jet pump and a shut off valve at the property line as shown in Figure 6.2.1. The operation is described as follows:

- Water is supplied to the cistern from the distribution main by pressure in the main.
- Water is supplied to the plumbing fixtures of the dwelling from the cistern through the pressure tank and jet pump.
- When the water level drops, the float valve will open to fill the cistern through the flow control valve at a control rate of 5 L/minute.

6.3 Proposed Water Distribution System

6.3.1 Eastern Area

- ***Direct Feed Water Distribution System with Fire Flow to UR Land Use Area***

The proposed water distribution system is a looped system which consists of watermains along 68 Avenue and 100 Avenue and along county roads. The system would be connected into the City of Grande Prairie water distribution system at 100 Avenue to an existing 200 mm ⌀ watermain and 68 Avenue to an existing 300 mm ⌀ watermain and will be serviced from the zone 1 reservoir. The layout of the system is shown in Figure 6.3.1.1. The construction cost is estimated to be $9,702,000 as shown in Section 7.

P ***Trickle Water Distribution System***

As shown on Figure 6.3.1.2, the proposed trickle water distribution system is identical to a standard water distribution system, except that the size of some of the watermain is smaller because the water is supplied at a controlled rate to the cistern for each dwelling instead of directly feeding into the plumbing fixtures of a dwelling. The estimated construction cost is $5,403,000 as shown in Section 7.

6.3.2 Southern Area

- ***Standard Water Distribution System***

The system is connected into the existing watermain at the water treatment plant. Since this system has only a single feed line it is not as reliable as a system with

two feed lines. The estimated construction cost is $3,631,000 as shown in Section 7.

- ***Trickle Water Distribution System***

  The layout of this system is identical to the standard water distribution system. However, the size of water is smaller than the standard water distribution system. This system consists of a trickle water distribution system for the existing and future developments in the study area and a water supply line to the reservoir of Weyerhaeuser at a rate of 150 US G/PM. The estimated construction cost is $2,540,000 as shown in Section 7.

6.3.3 Preferred Option

As shown in Section 6.3.1. and 6.3.2, the trickle water distribution has a lower construction cost than the direct feed water distribution. Although a direct feed water distribution system has the following benefits, the difference in the construction costs of these two systems is very significant ($5,390,000):

- There is no need for the installation of a cistern and associated control fixtures and pressurized plumbing system for each dwelling.
- There will be no operation costs associated with the operation of pressurized plumbing systems.

It is therefore the trickle water supply system that would be the preferred option.

7

Construction Cost Estimates

7.1 Assumptions

The construction costs presented below were estimated on the basis of the following assumptions:

- 2004 unit prices;
- Normal ground condition;
- Gravity sanitary sewer pipe shall be PVC pipes SDR35;
- Low pressure sewer pipe shall be HDPE pipes;
- Watermain shall be HDPE pipes;
- Sewer pipes and watermains with diameters of 150 mm ⌀ and smaller will be installed by a trencher;
- Sewer pipes deeper than 8 m will be installed by tunneling method
- Lift station has a back-up pump
- Alarm, PLC and SCADA control systems and standby power supply were excluded for a lift station
- All road crossings will be installed by augering method with steel casing pipes; and,
- 10% for engineering and contingencies;
- 30% for contingencies.

The summary of the construction cost estimates is shown in Sections 7.2 and 7.3. The detailed cost estimate is shown in Appendix E.

7.2 Wastewater Systems Construction Cost Estimates

7.2.1 Eastern Area

7.2.1.1 Gravity Sewer System

Sewer Pipes	$	27,507,638.00
Forcemains	$	3,520,974.00
Lift Stations	$	2,232,000.00
Road Crossings	$	140,000.00
Appurtenances	$	6,205,722.00
Engineering	$	3,960,633.00
Contingencies	$	13,070,090.00
Total	**$**	**56,637,057.00**

7.2.1.2 Low Pressure System

Sewer Pipes	$	2,593,418.00
Forcemains	$	604,280.00
Lift Stations	$	1,014,000.00
Road Crossings	$	140,000.00
Fittings	$	870,340.00
Engineering	$	1,044,408.00
Contingencies	$	1,879,934.00
Total	**$**	**8,146,380.00**

7.2.2 Southern Area

7.2.2.1 Gravity Sewer System

Sewer Pipes	$	15,557,943.00
Forcemains	$	1,138,095.00
Lift Stations	$	950,000.00
Road Crossings	$	50,000.00
Appurtenances	$	3,339,208.00
Engineering	$	2,103,525.00
Contingencies	$	6,941,631.00
Total	**$**	**30,080,402.00**

7.2.2.2 Low Pressure Sewer System

Sewer Pipes	$	1,191,375.00
Road Crossings	$	50,000.00
Fittings	$	248,275.00
Engineering	$	297,930.00
Contingencies	$	536,274.00
Total	**$**	**2,323,854.00**

7.3 Water Distribution System Construction Cost Estimates

7.3.1 Eastern Areas

7.3.1.1Standard Water Distribution System

Watermain and Fittings	$	7,163,000.00
Road Crossings	$	300,000.00
Engineering and Contingencies	$	2,239,000.00
Total	**$**	**9,702,000.00**

7.3.1.2 Trickle Water Distribution System

Watermain and Fittings	$	3,856,000.00
Road Crossings	$	300,000.00
Engineering and Contingencies	$	1,247,000.00
Total	**$**	**5,403,000.00**

7.3.2 Southern Areas

7.3.2.1 Standard Water Distribution System

Watermain and Fittings	$	2,633,000.00
Road Crossings	$	160,000.00
Engineering and Contingencies	$	838,000.00
Total	**$**	**3,631,000.00**

7.3.2.2 Trickle Water Distribution System

Watermain and Fittings	$	1,794,000.00
Road Crossings	$	160,000.00
Engineering and Contingencies	$	586,000.00
Total	**$**	**2,540,000.00**

8

Conclusions

The study has the following conclusions:

- The conventional gravity sanitary sewer and water distribution system are not cost- effective to service the existing and future developments in the study area because of the following reasons:
  - The study area is large and consists of approximately 43 sections
  - The topography of the study area is generally sloping in a south-easterly direction, with a mild slope from the point of connection for these two systems.
  - The existing developments are scattered in the study area.

- The study area will have two distinct low pressure sewer and trickle water distribution systems, one for the area east of the City of Grande Prairie and one for the area south of the City of Grande Prairie.

- The most suitable wastewater system to service the study area is a low pressure sewer system. The existing septic tank and holding tank can be used to house the grinder pump and hence reduce the construction costs.

- The most suitable water distribution system to service the study area is a trickle water system.

  The trickle water supply system provides water to the cistern installed for each lot within the study area at a controlled rate of 5 L/min. The existing cisterns can be converted into the storage component of the system and hence reduce the construction costs. The design of the trunk watermain also considered the

supply of water to the reservoir of Weyerhaeuser at a rate of 150USGPM. The estimated construction costs for the study area is $7,943,000.

- The low pressure sewer system for the area east of the City will be connected into the 900 mm ⌀ sanitary trunk sewer at 88 Street and 60 Avenue. The low pressure sewer system for the area south of the City will be connected into the existing wastewater treatment plant. The estimated construction cost for both areas of low pressure sewer system for both areas is $ 10,470,232.00.
- The standard or trickle water distribution systems for the areas east of the City will be connected into the existing watermains on 100 Avenue and 68 Avenue. The trickle water system for the area south of the City will be connected into the existing watermain at the water treatment plant.

- The low pressure sanitary sewer system and the trickle water supply system were designed on the basis of an ultimate development scenario within the servicing areas. All lands currently having an agricultural land use were assumed to be developed into Country Residential subdivisions.

- The design of the water and wastewater systems did not allow for any conversion of existing Country Residential subdivisions to Rural Residential subdivisions.

9

Recommendations

The study has the following recommendations:

- Implement a low pressure sewer system for the study area and use the existing septic tanks and holding tanks as the storage tank for the grinder pumps.

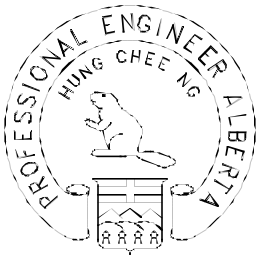
- Implement a trickle water supply system for the study area and convert the existing cisterns into the storage component of the system.

- A geotechnical investigation and engineering survey should be carried out for the preliminary / detailed design of the proposed systems.

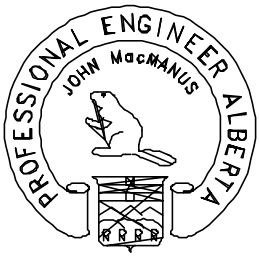
Corporate Authorization

This document entitled “Areas Southeast of City of Grande Prairie - Servicing Study Report”

was prepared by Infrastructure Systems Ltd.



Herman H.C. Ng, M.A.Sc., P.Eng.
Senior Municipal/ Environmental Engineer



John MacManus, P.Eng.
Vice President/Manager of Municipal Engineering

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Date _____
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The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Appendix A

Chart to Establish Pipe Flow

Appendix B

Wastewater System Design Flow Calculations

Appendix C

Water Supply to the Dunes and Tamarack Estate

Appendix D

Water Distribution System Model

Appendix E

Detailed Cost Estimates