Preliminary Design Report

NORTH RED DEER RIVER WATER SERVICES COMMISSION

Water Transmission Pipeline

ASSOCIATED
ENGINEERING

June
2003

Creating value through service and innovation

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June 12, 2003
File: 2003-3333 - 3.1

Mr. John Van Doesburg, Manager
North Red Deer Water Services Commission
c/o Town of Lacombe
5432 - 56 Avenue
Lacombe, AB
T4L 1E9

Re: NORTH RED DEER RIVER WATER TRANSMISSION PIPELINE PRELIMINARY DESIGN REPORT

Associated
Engineering
Alberta Ltd.

1000 Pacific Plaza
10909 Jasper Avenue
Edmonton, Alberta
T5J 5B9

Tel 780.451.7666
Fax 780.454.7698
www.ae.ca

Dear Sir:

Associated Engineering is pleased to submit our Preliminary Design Report, for the subject project.

This report is the culmination of alignment analysis, hydraulic analysis, geotechnical, archaeological, historical, agricultural and environmental reviews and input received from the Technical Committee.

We trust you will find this report comprehensive and complete and you can now proceed with the next phase of this project.

We sincerely appreciated this opportunity to work with the Technical Committee and yourself in the execution of this preliminary design.

Yours truly,

B.G. Birch, P. Eng.
Project Manager

BGB/ja
cc Mr. Ray Kerber, Town of Blackfalds
Mr. Dave Powell, Town of Lacombe
Mr. Gerald Matichuk, Town of Ponoka
Mr. Terry Hager, County of Lacombe
Mr. Charlie Cutforth, County of Ponoka
Mr. Paul Goranson, City of Red Deer
Mr. Terrence Kozmech, Descon Eng. Services Ltd. (Montana First Nations)
Mr. Leonard Standing on the Road, Montana Tribal Administration
Mr. Phil Simpson, Samson First Nations
Mr. Garry van Kiepma, Ermineskin First Nations
Mr. Harvey Roasting, Louis Bull First Nations

Mr. Sidney Lam, Public Works and Government Services Canada
Mr. Hugo Buttau, Public Works and Government Services Canada
Mr. Gray Waters, Public Works and Government Services Canada
Ms. Crystal Stamp, Indian and Northern Affairs Canada
Mr. Alvin Beier, Alberta Environment, Parkland Region

TABLE OF CONTENTS

SECTION **PAGE NO.**

TABLE OF CONTENTS **i**

1 INTRODUCTION 1-1

1.1 Background 1-1
1.2 Scope 1-1
1.3 Acknowledgments 1-2
1.4 References 1-2
1.5 Abbreviations 1-3
1.6 Metric Conversion Factors 1-4

2 EXISTING FACILITIES 2-1

2.1 Red Deer 2-1
2.2 Town of Blackfalds 2-1
2.3 Town of Lacombe 2-1
2.4 Town of Ponoka 2-2
2.5 First Nations Facilities 2-2

3 DESIGN CRITERIA 3-1

3.1 Historical Population 3-1
3.2 Population Projections 3-2
3.3 Historical Water Demands 3-3
3.4 Per Capita Water Consumption 3-5
3.5 Peaking Factors 3-5
3.6 Projected Water Demands 3-6
3.7 Velocities 3-6
3.8 Pressures 3-6
3.9 Pipe Roughness 3-7
3.10 Storage 3-7
3.11 Fire Flow 3-8

4 WATER SUPPLY CONCEPT 4-1

4.1 Mode of Operation 4-1
4.2 SCADA System 4-3
4.3 Delivery 4-8

5 ANALYSIS 5-1

5.1 Hydraulic Analysis 5-1
5.2 Materials 5-5
5.3 Diurnal Analysis 5-5
5.4 Chlorine Analysis 5-6
5.5 Transient Analysis 5-7

6 ALIGNMENT 6-1

6.1 Topography 6-1
6.2 Geotechnical 6-1
6.3 Environmental, Archaeological, Historical 6-2
6.4 Tie-Ins 6-3
6.5 Meter Station 6-4
6.6 Booster Station 6-4

7 CONSTRUCTION ISSUES 7-1

7.1 Environmental Issues 7-1
7.2 Crossings 7-2
7.3 Land Acquisition (Right-of-Ways) 7-2
7.4 Temporary Fencing 7-2
7.5 Traffic Management 7-3
7.6 Safety 7-3
7.7 Supply of Water for Testing 7-3
7.8 Isolation Valves 7-3
7.9 Flushouts 7-4

7.10 Pigging Stations 7-4
7.11 Combination Air Release Valves 7-4
7.12 Disposal of Super Chlorinated Water 7-4
7.13 Wash Stations 7-4
7.14 Land Issues 7-5
7.15 Approvals 7-5

8 SCHEDULE 8-1

9 COST ESTIMATES 9-1

10 CONCLUSIONS 10-1

11 RECOMMENDATIONS 11-1

12 CLOSURE 12-1

APPENDIX A ESTIMATED COST BREAKDOWNS
APPENDIX B PEDOCAN LAND EVALUATION LTD. - REPORT
APPENDIX C PARKLAND GEOTECHNICAL LTD. - REPORT
APPENDIX D TYPICAL CONSTRUCTION DETAILS
APPENDIX E WORK COPIES OF HYDRAULIC GRADELINES
APPENDIX F STORAGE VOLUME VS. TIME

INTRODUCTION

SECTION 1

1.1 BACKGROUND

A regional waterline has been proposed to serve the Towns of Blackfalds, Lacombe and Ponoka, the counties of Lacombe and Ponoka and the First Nations communities of Montana, Samson, Ermineskin and Louis Bull. This corridor along Highway 2 and 2A, north of Red Deer has been experiencing significant growth in recent years. The rapid growth, along with depleting aquifers, has contributed to the need for water restrictions during peak demand periods. As well, many of these communities have indicated that they will require additional sources of water (i.e. new well sources) for continued growth.

A Regional Water Study was completed in September 2001 which investigated the viability and associated costs of constructing and operating the proposed waterline. An application was made to Alberta Environment to draw water from the Red Deer River (part of the South Saskatchewan River Basin) with the intention of treating and piping it to the above communities. As all of the communities (except for Blackfalds) are located in the North Saskatchewan River Basin, the transmission of the water was identified as being an inter-basin transfer. Subsequently Bill 33, North Red Deer Water Authorization Act, was passed in the Alberta Legislature allowing the transfer of water from one basin to another.

The North Red Deer River Water Services Commission was proposed to build, own and operate the waterline. The Commission has been actively involved in the preliminary design of the waterline through their Technical Committee.

1.2 SCOPE

This preliminary report examines and evaluates several parameters in order to identify a water supply line that will satisfy the long term needs of the noted communities. These parameters include population and water use projections; overall system concept; pipeline alignment; pipe material, pipe diameter; capital costs; operating and maintenance costs; and construction staging.

1.3 ACKNOWLEDGMENTS

Associated Engineering is pleased to have prepared this pre-design report. Assistance and understanding of the following Technical Committee members is gratefully acknowledged;

- John Van Doesburg - North Red Deer River Water Services Commission
- Charlie Cutforth - Ponoka County
- Ray Kerber - Town of Blackfalds
- Curtis Herzberg - Town of Ponoka
- Gerald Matichuk - Town of Ponoka
- Dave Powell - Town of Lacombe
- Paul Goranson - City of Red Deer
- Terry Hager - Lacombe County
- Terrence Kozmech - Descon Eng. Services Ltd. (Representing the Montana First Nations Band)
- Leonard Standing on the Road - Montana First Nations
- Gray Waters - Public Works and Government Services Canada
- Hugo Buttau - Public Works and Government Services Canada
- Sidney Lam - Public Works and Government Services Canada, Indian and Northern Affairs Canada

The assistance and cooperation of staff of the Towns of Blackfalds, Lacombe and Ponoka, as well as the City of Red Deer, are also sincerely appreciated.

1.4 REFERENCES

.1 “Regional Water Study”, prepared for the Communities of Blackfalds, Lacombe and Ponoka; the First Nations of Montana, Samson, Ermineskin and Louis Bull, by UMA Engineering Ltd., dated September, 2001.

.2 “North Water Group, Water Supply Study”, by Earth Tech and Hydroconsult EN3 Services Ltd., dated September, 2001.

1.5 ABBREVIATIONS

AC	asbestos cement
fps	feet per second
ft^3/s	cubic feet per second
ft^3	cubic feet
ig	imperial gallons
igpcd	imperial gallons per capita day
igpm	imperial gallons per minute
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
mig	million imperial gallons
mm	millimetre
PRV	Pressure reducing valve
PVC	polyvinyl chloride
AEAL	Associated Engineering Alberta Ltd.
USGPM	United States Gallons per Minute

1.6 METRIC CONVERSION FACTORS

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

EXISTING FACILITIES

2.1 RED DEER

The water source for the North Red Deer River Water Services Commission (NRDRWSC) will be from the City of Red Deer water distribution system. The tie in is proposed at the intersection of Gaetz Avenue and Highway 11A, to an existing 500 mm diameter line. This tie in connection will be made directly to the distribution system.

The City of Red Deer Water Treatment plant is presently undergoing upgrades. The extent and staging of the planned upgrade is impacted by the NRDRWSC requirements. Similarly, the City of Red Deer is presently analyzing its water distribution system, with the intent of supplying the projected demand of the NRDRWSC. The City has, in consultation with NRDRWSC, developed a program to upgrade the treatment plant in stages.

2.2 TOWN OF BLACKFALDS

Immediately to the north of Red Deer is the Town of Blackfalds. The Town has one water treatment plant/reservoir and pumphouse on Railway Street. It has a storage capacity of 2450 m^3. The Town utilizes wells for its current water supply.

A recent study anticipates a new reservoir and pumphouse will be required in the very near future due to the high growth rate. The proposed reservoir will add 2,500 m^3 of storage.

2.3 TOWN OF LACOMBE

The Town of Lacombe also utilizes wells for its water supply system. It has three (3) existing Reservoirs and Pumphouses, and has a total storage volume of 13,140 m^3. They are:

- North Distribution Pumping Station (Pumphouse A)
- South Distribution Pumping Station (Pumphouse B)
- College Heights Pumping Station (Pumphouse C)

Lacombe’s only treatment at present is chlorination at each reservoir. The chlorinated water is then pumped into the distribution system.

2.4 TOWN OF PONOKA

As in the case of Blackfalds and Lacombe, Ponoka is also on a well supply system. Ponoka has two (2) water treatment plants and two other reservoir/pumphouses. Total existing storage capacity is 5,690 m³. The water treatment plants are located at:

- Ponoka Water Treatment Plant - North of 61st Avenue and West of 61st Street
- Central Pump Station - Southeast Corner of Highway 2A and 43rd Avenue

The reservoirs/pumphouses are:

- Lucas Heights Pump Station and Reservoir at the northeast corner of 63rd Street and 55th Avenue;
- East Reservoir and Pumphouse - The pumphouse is located along 48th Avenue, east of 40th Street. It is connected to the reservoir to the east of 38th Street near 48th Avenue.

2.5 FIRST NATIONS FACILITIES

Four First Nations reserves have been considered in this study:

- Ermineskin Band
- Louis Bull Band
- Montana Band
- Samson Band

All four of these bands currently receive water from groundwater wells.

The proposed regional pipeline is to deliver water to Montana, Samson and Ermineskin reservoirs. Louis Bull would in turn receive water off the regional pipeline, near the Ermineskin lateral. The respective storage capacity of these three Bands’ reservoirs are as follows:

•	Ermineskin	2,900 m^3
•	Montana	845 m^3
•	Samson	1,364 m^3

SECTION 3

DESIGN CRITERIA

The North Red Deer River Water Services Commission has adopted the water demands identified in the Act passed by the Alberta Legislature. The fifty year total demands have been utilized in this report; however, some adjustment has been made for the intervening years.

3.1 HISTORICAL POPULATION

The historical populations presented below were supplied by the municipalities or collected from Statistics Canada. Population statistics for the First Nations are derived from the previous Regional Water Study by UMA Engineering Ltd.

Table 3.1 Historical Populations

YEAR	BLACKFALDS	LACOMBE	PONOKA
1981	1488	5591	5221
1986	1688	6080	5473
1991	1769	6934	5864
1996	2001	8018	6149
2001	3144	9384	6330
2002	3540		

- Montana Band
  On-Reserve Population, 2001: 564-102 urban, 462 rural
- Samson Band
  On-Reserve Population, 2001: 4,845-1,453 urban, 3,392 rural
- Ermineskin Band
  On-Reserve Population, 2001: 2,282-500 urban, 1,782 rural
- Louis Bull Band
  On-Reserve Population, 2001: 1,201-673 urban, 528 rural

Table 3.2 Annual Population Change (in percent)

YEAR	BLACKFALDS	LACOMBE	PONOKA
1981-1986	2.55	1.69	0.95
1986-1991	0.94	2.66	1.39
1991-1996	2.5	2.95	0.95
1996-2001	9.46	3.2	0.58
AVERAGE	**3.86**	**2.63**	**0.97**

Note: Above table uses the formula:

Future population = Existing Population * (1 + annual percent growth)^n
(n = years)

3.2 POPULATION PROJECTIONS

Population projections were discussed in meetings with the Technical Committee. Although it was decided that the populations associated with the water demand as identified in Bill 33 would be used in the design of the pipeline, the Committee wished to compare these values to their own growth projections.

A growth of 3.0 % was identified in Bill 33 for the Town of Blackfalds, which has averaged 3.86% growth from 1981 to 2001, and 9.46% over the past five years.

The Town of Lacombe chose to remain with the projections provided in the Regional Water Study, as their council had passed these projections. These projections were based on a 3% growth for 10 years, followed by 41 years of 1.5% growth. The Town of Lacombe grew an average of 2.63% over the past 20 years, 3.2 % over the past five years.

The Town of Ponoka has anticipated higher growth rate than the historical rates, therefore requested that a growth factor of 1.8% be used for population projections. They have averaged 0.97 % over the past 20 years, and 0.58 % over the past 5 years.

The four First Nations are all assumed to have an on-reserve population growth of 3.0% for 50 years with 80% of the population urban, 20% rural.

3.3 HISTORICAL WATER DEMANDS

Flow data was provided from the various municipalities in order to develop the historical water demand tables shown below.

3.3.1 Town of Blackfalds

Table 3.3.1 Blackfalds Water Consumption

	2001	2002	AVERAGE
Average Day Consumption (L/s)	11.6	11.6	
Population	3144	3540	
Per Capita Consumption (L/c/d)	318.9	282.8	**300.9**
Peak Day Consumption(L/s)	25.1	28.1	
Peak Day Factor	2.2	2.4	**2.3**
Peak 5 Day (L/s)	16.1	22.8	
Peak 5 Day Factor (L/s)	1.4	2	**1.7**

3.3.2 Town of Lacombe

Table 3.3.2 Lacombe Water Consumption

	1998	**1999**	**2000**	**2001**	**2002**	**AVERAGE**
Average Day Consumption (L/s)	31.9	31.5	34.8	37.5	35.3	
Population	8270	8517	9128	9384		
Per Capita Consumption (L/c/d)	332.9	319.5	329.8	345.7		**332**
Peak Day Factor			1.6	1.6		**1.6**

3.3.3 Town of Ponoka

Table 3.3.3 Ponoka Water Consumption

	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**AVERAGE**
Average Day Consumption (L/s)	27.3	28	27.7	28.3	28.1	28.2	
Population	**6185**	**6221**	**6257**	**6293**	6330		
Per Capita Consumption (L/c/d)	382	389	382	389	384		**385**
Peak Day Consumption (L/s)	53.2	49.1	42	44.5	48	49.7	
Peak Day Factor	2	1.8	1.5	1.6	1.7	1.8	**1.7**
Peak 5 Day (L/s)	39.2	42.8	36.5	38.6	39.6	45	
Peak 5 Day Factor (L/s)	1.4	1.5	1.3	1.4	1.4	1.6	**1.4**

Note: Bolded populations have been interpolated from known populations

3.4 PER CAPITA WATER CONSUMPTION

The per capita water consumption values extracted from the preceding tables are summarized below:

Table 3.4 Per Capita Water Consumption

	Blackfalds	**Lacombe**	**Ponoka**	**AVERAGE**
Average Day Consumption (L/c/d)	301	332	385	339.3
Peak Day Factor	2.3	1.6	1.7	1.9
Peak 5 Day Factor	1.7		1.4	1.6
Peak Hour Factor		3		

The per capita water consumption of 370 L/c/day for all urban areas, which was developed in the preceding conceptual report, will be adopted for this report. A value of 180 L/c/day will be used for all of the First Nations rural areas.

3.5 PEAKING FACTORS

The pipeline design will be based on supplying Peak Day Flows. These peak flows have been calculated using a multiplier of 1.8 times the Average Day Demand. The concept study suggested a Peak Day factor of 1.5 times the Average Day Flow. However, this report recommends the use of the 1.8 multiplier, which is a common design value for the Regional Water Commissions around Alberta. The 1.8 Peak Day factor also compares with the average peak day factor for the three municipalities shown in Table 3.4.

North Red Deer River
Water Transmission Line

Table 3.5
Water Demand

	Actual Ave Day Demands (m^3/day)	AVERAGE DAY WATER DEMANDS (m^3/day)					PEAK DAY WATER DEMANDS (m^3/day)				
	2002	**2003**	**2006**	**2011**	**2021**	**2051**	**2003**	**2006**	**2011**	**2021**	**2051**
Blackfalds	1158	1480	1833	2220	2960	5184	2664	3263	3996	5328	9331
Lacombe	3240	3137	3875	7822	9571	13392	5647	6975	14080	15200	21352
Ponoka	2436	2729	2940	3167	3674	5702	4912	5292	5701	6613	10264
Montana		88	101	178	241	605	158	182	321	434	1089
Samson		929	1077	1696	2282	5530	1672	1938	3053	4108	9953
Ermineskin		381	441	748	1003	2419	685	794	1346	1805	4355
Louis Bull		326	378	510	685	1642	587	681	917	1233	2955
Other Res./Indus.		0	1005	1126	1326	2160	0	1810	2027	2387	3888
TOTAL		**9069**	**11650**	**17467**	**21742**	**36634**	**16324**	**20935**	**31440**	**37108**	**63187**

Note: Peak Day Demands are calculated using a 1.8 times Average Day Peaking Factor
However industrial consumption at Lacombe has **NOT** been peaked

3.6 PROJECTED WATER DEMANDS

Projected water demands depend greatly on the projected growth rates for the region. Although growth rates have been developed for this report, the Technical Committee has recommended to adopt the demands identified in the Water Licence. The average day demands which are identified in the licence are shown in Table 3.5.

These average day values are shown in Table 3.5 along with Peak Day demands calculated using the 1.8 times average day factor. The 2003 values shown were originally identified as 2001 values. They have been repeated for 2003 and are believed to still be reasonable values when compared to actual average day demands.

3.7 VELOCITIES

One of the main criteria in a pipeline design is its velocity. High velocities can have serious effect on the pipeline when there is a sudden change in the velocity. This sudden change in velocity creates pressure surges, and possibly negative pressures, which, if not mitigated, can cause severe pipe (and equipment) damage. As velocities increase, higher pumping heads are required, hence higher energy costs.

The recommended maximum operating velocity is 1.5 m/s for plastic (polyvinyl chloride and polyethylene) pipes. Higher velocities can be safely used in steel and ductile iron pipelines, provided proper surge allowance and surge suppression is provided

3.8 PRESSURES

3.8.1 Supply Pressure

The supply pressure from the Red Deer distribution system will be between 345 kPa (50 psi) and 414 kPa (60 psi). This represents a supply elevation between 912 metres and 919 metres at the City boundary.

3.8.2 Delivery Pressure

At each delivery point (to the customer's reservoir), a minimum pressure of 10 m (14 psi) will be maintained.

3.8.3 Pipe Operating Pressure

.1 One of the options is to use the Red Deer distribution pressure for the entire 50 year projected demands. Due to this pressure constraint, larger pipe diameters are required.

.2 With smaller pipe diameters, higher head losses will require much higher pressure at the source. Operating pressure as high as 4000 kPa (580 psi) has been considered. Booster pumps are required for these options.

3.9 PIPE ROUGHNESS

The pipe roughness coefficient "C" factor used in the Hazen-Williams equation, to size the pipeline will be:

• Polyvinylchloride (PVC)	130
• Polyethylene (PE)	130
• Steel (Epoxy or Cement Mortar Lined)	130
• Ductile Iron (Cement Mortar Lined)	130

3.10 STORAGE

Alberta Environment Guidelines suggest a minimum municipal storage volume consisting of the following:

- Equalization storage (peak hour demand): 25 % of Peak Day flow.
- Emergency storage (in event of supply interruption): 15% of Average Day flow.
- Fire Storage: suggested minimum 220 L/s for a 3 hour duration.

For long supply lines, a common criteria is to provide storage equal to two (2) Average Day demands plus Fire Storage. This criteria mitigates against supply interruption and also addresses disinfection criteria (CT - chlorine residuals and contact time are met). This

North Red Deer River
Water Transmission Line

Table 3.6(a)
Water Storage Requirements

Reservoir Storage Requirements - 2003

	Current Storage (m^3)	Future Storage (m^3)	Total Storage (m^3)	Ave Day Demand (m^3)	2 x Ave Day (m^3)	Fire Flow (m^3)	Total Required Storage (m^3)	Storage (+/-) (m^3)
Blackfalds	2450							
		2500						
	2450	2500	**4950**	1343	**2686**	**2376**	**5062**	**-2612**
	539,000	550,000	1,089,000	295,460	590,920	522,720	1,113,640	-574,640
Lacombe	4540							
	2270							
	6330							
	13140		**13140**	3416	**6832**	**2376**	**9208**	**3932**
	2,890,800		2,890,800	751,520	1,503,040	522,720	2,025,760	865,040
Ponoka	4550							
	910							
	230							
		4620						
	5690	4620	**10310**	2729	**5458**	**2376**	**7834**	**-2144**
	1,251,800	1,016,400	2,268,200	600,380	1,200,760	522,720	1,723,480	-471,680
Montana								
	845		**845**	88	**176**	**523**	**699**	**146**
	185,900		185,900	19,360	38,720	115,060	153,780	32,120
Samson								
	1,364		**1,364**	929	**1,858**	**2,376**	**4,234**	**-2,870**
	300,080		300,080	204,380	408,760	522,720	931,480	-631,400
Ermineskin								
	2,900		**2,900**	381	**762**	**2,376**	**3,138**	**-238**
	638,000		638,000	83,820	167,640	522,720	690,360	-52,360

Storage +/- is based on existing reservoir capacity

* Average Day Demand is based on a per capita consumption of 370 L/cap/day.
* Fire Flow Requirements are based on 220 L/s demand for a 3 hour duration, except Monana: 83 L/s for a 1.75 hour duration.

North Red Deer River
Water Transmission Line

Table 3.6(b)
Water Storage Requirements

Reservoir Storage Requirements - 2011

	Current Storage (m^3)	Future Storage (m^3)	Total Storage (m^3)	Ave Day Demand (m^3)	2 x Ave Day (m^3)	Fire Flow (m^3)	Total Required Storage (m^3)	Storage (+/-) (m^3)
Blackfalds	2450							
		2500						
	2450	2500	**4950**	2058	**4116**	**2376**	**6492**	**-4042**
	539,000	550,000	1,089,000	452,760	905,520	522,720	1,428,240	-889,240
Lacombe	4540							
	2270							
	6330							
	13140		**13140**	5485	**10970**	**2376**	**13346**	**-206**
	2,890,800		2,890,800	1,206,700	2,413,400	522,720	2,936,120	-45,320
Ponoka	4550							
	910							
	230							
		4620						
	5690	4620	**10310**	3167	**6334**	**2376**	**8710**	**-3020**
	1,251,800	1,016,400	2,268,200	696,740	1,393,480	522,720	1,916,200	-664,400
Montana								
	845		**845**	178	**356**	**523**	**879**	**-34**
	185,900		185,900	39,160	78,320	115,060	193,380	-7,480
Samson								
	1,364		**1,364**	1,696	**3,392**	**2,376**	**5,768**	**-4,404**
	300,080		300,080	373,120	746,240	522,720	1,268,960	-968,880
Ermineskin								
	2,900		**2,900**	748	**1,496**	**2,376**	**3,872**	**-972**
	638,000		638,000	164,560	329,120	522,720	851,840	-213,840

Storage +/- is based on existing reservoir capacity

* Average Day Demand is based on a per capita consumption of 370 L/cap/day.

* Fire Flow Requirements are based on 220 L/s demand for a 3 hour duration, except Monana: 83 L/s for a 1.75 hour duration.

🟦 imperial gallons

criteria has been adopted for the purpose of this report. The resulting storage requirements for years 2003 and 2011 are shown on the enclosed Tables 3.6(a) and Table 3.6(b) - Water Storage Requirements, respectively.

County connections will be required to provide storage and re-pump. This is both to ensure that they are not drawing peak demand flows directly off of the supply line, as well as ensuring adequate supply pressures. This also provides an effective safeguard against backflow (potential contamination) and over pressuring customer systems.

3.11 FIRE FLOW

The supply line is not intended to supply water for a fire flow demand. Each community is responsible to provide adequate storage for fire demand and other emergencies and related pumping and distribution system capacity.

WATER SUPPLY CONCEPT

4.1 MODE OF OPERATION

4.1.1 Central Control Philosophy

A single, central point of monitoring and control of all of the major reservoir fill points is required. Through discussions with the Technical Committee, it appears that the central control will be located at the City of Red Deer, Water Treatment Plant.

Regardless of where this central control is located, continuous monitoring of each major fill point is required. This does not require 24 hour/7 day per week manned monitoring at a single site. With modems, portable laptops, 24 hour/7 days per week can be achieved, using "on call" operators when the site is not manned.

An alarm signal system, from each fill point (and meter station) to the central control site, then via dial-out to "on call" operator numbers provides alarm monitoring.

The regional system operators must have emergency contact numbers for each member.

A meter station is proposed at the "custody transfer" point. This meter station could be at the City of Red Deer boundary or at another agreed upon site. All customers between the point of tie-in and the meter vault will be the responsibility of the City of Red Deer, if the meter vault is at or close to the City boundary. If the meter vault is located closer to the Blindman River, an agreement between the city of Red Deer, County of Red Deer and NRDRWSC will be required, regarding any customers located within the County of Red Deer. All customers downstream of the meter vault would be the responsibility of the respective municipality, to receive and process applications, monthly meter readings and billings.

Water billing by the City of Red Deer will be to the NRDRWSC based on flow through the meter vault. The NRDRWSC would then bill each municipality for its respective water consumption. Each respective municipality would then bill each of its customers.

It is also required that any line customers be approved by the Commission. Therefore, a water service application by a prospective customer would be to the member municipality in which the customer's property is located. This application would then be submitted by the municipality to the Commission for review and approval.

4.1.2 Uniform Flow Vs. Peak Flow

The recommended (and preferred) mode of operation is for the City of Red Deer to supply water on a relatively uniform, constant flow, daily basis. The flow rate will be dependent on the previous day's water consumption and each member's reservoir levels.

If this criteria is adopted for projected flow demands, pipeline sizing and supply requirements; in the short-term operation, the system would have capacity to deliver at higher flow rates for shorter supply periods, depending on the City of Red Deer's supply capabilities.

4.1.3 "Air Gap" Policy

An "air gap" policy is recommended for all customers. Even small customers can be served this way using a customer owned cistern and customer owned pressure system.

An "air gap" policy has many advantages:

- The supply and transmission system can be operated at a relatively uniform flow rate, thereby economizing on sizing of system components.
- Peak factors are reduced.
- Operating pressures are reduced.
- Customer systems are protected from high surge pressures as well as low pressures.
- A cost effective backflow/cross-connection protection is provided.

A proposed minimum pressure of 10 metres (14 psi) is proposed at each delivery point.

4.1.4 Monitoring and Control

Each major fill station is proposed to include the following:

- Flow metering
- Flow control valve
- Pressure relief/pressure sustaining valve
- Reservoir level monitoring
- Pressure sensing

Flow, pressure and reservoir level monitoring would be provided, from each major fill point to the central control site.

Flow control would be provided at the central control site.

Other information which can be transferred to a central site are illegal entry alarms, low building temperature alarm, fire/smoke alarm, if desired.

4.2 SCADA SYSTEM

4.2.1 SCADA Master System

The SCADA System will comprise a SCADA Master at the Red Deer Water Treatment Plant (WTP) or another agreed location for a central operating centre. The SCADA Master will be separate and independent of any other co-located control systems serving process control needs (e.g. at the WTP). The SCADA Master will retrieve pipeline data continuously via the communications system from Remote Terminal Units (RTUs) at the fill stations. Operations personnel will view this data and send flow rate setpoints to remote fill stations as required for pipeline operations. In response to alarm conditions, personnel will be dispatched to investigate remote sites via an alarm dispatch system.

The SCADA Master will comprise a programmable controller (PLC) , a redundant Human Machine Interface (HMI), a printer and an uninterruptible power supply. The PLC will provide the interface to the telecommunications system, govern data communications to the remote PLCs, provide alarm handling functions, and maintain a uniform set of pipeline data such that the same information will be displayed on both HMIs. Each HMI will be identical in terms of equipment, software platform and applications software and will access data from the PLC via an isolated data communications network.

During normal operation, operations personnel will designate one of the HMIs for automatically printing reports at a specified time of day. In the event of failure of this HMI, the remaining on-line HMI will need to be designated for automatic printouts. Operations personnel will periodically ensure clocks in each HMI are set the same. When both HMIs are on-line, all features and functionality of the SCADA Master will be available to operations personnel at each HMI. All information available on HMI screens will be available for print out on demand by operations personnel.

Each HMI will provide graphical displays of the pipeline with current values of instrumentation signals from remote sites. It will exchange data with the PLC and display alarm status, and provide event logging, reporting, and trending functions. Historical trends will be available on disk for later retrieval and review by operations personnel. Applications software will be provided to record and log aggregate inflows to the pipeline (meter vault) and aggregate outflows from the pipeline on a daily basis.

If located at the Red Deer WTP, the manufacturer of equipment and software for the SCADA Master will be the same as that utilized by the WTP control system, i.e. Allen Bradley PLCs and Intellution iFix HMI.

The estimated construction cost of the SCADA Master includes equipment, software licenses and programming, and excluding any interfaces to the Internet. The cost is highly dependent upon the extent of functions incorporated into the design.

Design functions and features of the RTUs are discussed in the Instrumentation and Control System section below.

4.2.2 Instrumentation and Controls System Design

A Control System cabinet is required at each fill station and the meter vault to house a PLC (RTU). An HMI associated with the PLC is not required. The PLC will transfer instrumentation signals back to the SCADA Master and will control fill valves based on flow rate setpoints entered by operations personnel at the SCADA master. Indicating transmitters at fill stations will allow operations and maintenance personnel at remote sites to view values of instrument signals.

The PLC will interface to the following instrumentation:

- Red Deer Meter Vault - flowmeter (flowrate and pulse signal), flow control valve, pressure sustaining valve, pressure transmitter
- Fill Stations - flowmeter (flowrate and pulse signal), ultrasonic level transmitter, pressure transmitter (upstream of the pressure sustaining valve), flow control valve, pressure sustaining valve
- Building Systems - As existing reservoir facilities at the fill stations may already provide for building security and temperature, provisions for building security and temperature alarms will be addressed on a case by case basis.

The control systems at fill stations will be designed for unattended operation and will be independent of any existing instrumentation and controls systems governing water distribution from reservoir sites. In the event of communications failure to the SCADA Master, the control system will continue to operate on the basis of the last flow rate setpoint received from the SCADA Master. When the prevailing level in the reservoir approaches its overflow point, the fill valve will automatically close. Fill valves will be equipped such that the flow control signal from the PLC can be manually overridden.

Signals sent to the SCADA Master from remote sites will include:

- pressure, reservoir level (except meter vault), flowrate, aggregate flow (running total)
- flow control valve position
- UPS alarm
- building security and temperature alarms (if required)

Signals sent to the fill station control system from the SCADA Master will be:

- flow rate control

The estimated construction cost of the local control systems at the meter vault and the fill stations includes PLC equipment, software and programming, and electronic instrumentation. Provisions for chemical feeds and respective analytical instruments, if required, have not been included in the estimate.

4.2.3 Telecommunications

Communications between the SCADA Master at the Red Deer WTP and the remote sites may be either wireless radio or leased line services from Telus.

Leased Line Services - 4 wire leased line services, arranged in a point to multi-point configuration are available from Telus. The communications bandwidth is adequate for data throughput required to transmit data between the WTP and the remote sites. Overall availability of leased line services are expected to be adequate, however, response time to repair in the event of outage may be high.

Wireless telecommunications may be Private (licenced) Radio, Unlicenced (Spread Spectrum) Radio, or Unlicenced Ethernet Radio. All these options are capable of providing adequate bandwidth for transmission of the data volumes required for pipeline operations.

Unlicenced radio operates in radio spectrum shared by publicly available wireless services and hence is susceptible to periodic congestion. While the likelihood of congestion may be low due to smaller populations in the communities being served by the pipeline, this may increase over time as unlicenced wireless services proliferate. The bandwidth available by the Ethernet Radios is higher, offering the potential to deploy applications requiring higher bandwidth in the future. Private Licenced Radio is not susceptible to congestion and offers the potential to provide better coverage if lower frequencies can be used. Radio spectrum requires approval from Industry Canada.

All these wireless options are considered feasible for the majority of the pipeline route based on preliminary evaluation of ground profiles. Repeaters are likely required to provide radio signal coverage over the 70 km. length of the pipeline, subject to confirmation by a path study based on GPS or legal land coordinates. Leased line service may be required for the link to the Red Deer WTP and the meter vault due to possible location in the river valley. Budgetary estimates for radio systems include supporting 20m towers, antenna and radio equipment at each of the fill stations and the meter vault.

A preliminary cost comparison of leased lines to radio systems suggests the 20 year net present value for a radio system to be lower.

Subject to confirmation by radio path study and Industry Canada's approval for radio spectrum, private (licenced) radio supplemented by leased line (if required to Red Deer WTP) is preferred, to provide SCADA communications for pipeline operation due to:

- being less susceptible to congestion and having the potential to provide better availability through use of lower operating frequencies than alternative radio technologies;
- being only marginally more expensive than alternative radio technologies with the potential to reduce costs through use of lower operating frequencies which may yield reduced requirements for tower heights and signal repeaters.

4.2.4 Other Considerations

Construction of the Alberta SuperNet is underway, providing high speed data communications services to municipalities across Alberta. However this medium is not currently judged viable for the North Red Deer Pipeline, given the uncertainty of its completion schedule and the costs of deploying radio equipment at both the pipeline termination point and the nearest SuperNet termination point within a given municipality.

4.2.5 Electrical System Design

North Red Deer River Meter Vault will require electrical service from the utility, 120 VAC distribution and lighting, plus battery backed UPS to power instrumentation, controls and telecommunications equipment.

Two 120 VAC circuit feeds from existing distribution panels will be required at the fill stations. One circuit is required for an uninterruptible power supply (UPS) which will provide power to instrumentation, controls and telecommunications equipment plus another 120 VAC circuit to power an electrically actuated fill valve.

It is assumed that two spare 120 VAC circuits are available at each of the fill station sites. The need to increase 120 VAC circuit capacity in existing 120 VAC distribution will be evaluated on a case by case basis.

4.3 DELIVERY

4.3.1 Point of Delivery

As noted, the proposed point of tie-in to the city of Red Deer distribution system is at Gaetz Avenue and the north City boundary. The point of custody transfer could be either at the City boundary or at some location further north. We suggest the meter vault (point of custody transfer) be near the north boundary of Sec. 10-39-27-W4 (just south of the railway). This means that the portion of the NRDRWSC pipeline upstream of the meter vault would be in Red Deer County.

With the existing (and proposed) development within Red Deer County, north of the City of Red Deer, it is highly likely that these developments will seek (require) water service from the City of Red Deer. Even though Red Deer County is not proposing to be a member of the Commission, they could request service off the transmission main.

It is quite conceivable that a distribution system could be incorporated into this portion of the transmission main.

Appropriate agreements and connection contributions would be required between the NRDRWSC, City of Red Deer and Red Deer County for the use of this main and water service.

This portion of water consumption should not be considered part of the Inter-basin transfer.

At some point in the future, ownership of this pipeline could conceivably be sold to either the County or the City of Red Deer.

Similarly, if smaller diameter pipe options are adopted, requiring a booster pump station at Red Deer, this same location should be considered for the pump station. Metering would then occur within the pump station. With the potential of the Red Deer distribution system extending north in the future, that portion of the transmission main from the City boundary to south of the Blindman River could be downsized. Ultimate delivery capacity could be achieved through a looped, distribution main system.

4.3.2 Customers Delivery Points

It was proposed at the Technical Committee meeting, that each of the urban members (Blackfalds, Lacombe, Ponoka) be provided with a maximum of two connections by the Commission. Provision has also been made for Lacombe and Ponoka Counties to each be provided with up to two connections by the Commission. Additional connections could be provided, but this cost would be the responsibility of each respective municipality.

One connection is proposed for each of the Ermineskin, Montana and Samson Band water reservoirs. A stub-out is also proposed for future connections to the Louis Bull Band water system.

ANALYSIS

5.1 HYDRAULIC ANALYSIS

The hydraulic analysis compared five basic scenarios:

.1 PVC pipe - gravity option
.2 PVC pipe - pumped at year 2028 option
.3 Steel pipe option (pumped once)
.4 Ductile iron pipe - pumped at year 2028
.5 Ductile iron pipe - pumped once at Red Deer

The two plastic pipe options assumed that the proposed pipeline would tie directly onto the Red Deer distribution line, and use the available distribution pressure. The steel pipe option assumed that pumping would be required at the point of tie-in, immediately. The first ductile iron pipe option utilizes the City pressures until year 2028; the second ductile iron pipe option requires booster pumping at Red Deer immediately.

5.1.1 Option 1 - PVC Pipe - Gravity Option

This option assumes that the pipeline would not require any pumping to meet the 2051 demand flows. A minimum delivery pressure of 345 kPa (50 psi) from the City of Red Deer is assumed. The nominal pipe diameter at the tie-in would be a 900 mm pipe (see Figure 5.1). This pipe size would be required up to Lacombe where it would decrease to a 750 mm diameter pipe. At Ponoka the pressure would be cut down at a reservoir or through the use of a PRV so as not to require an increase in the pressure class of the pipe. A 600 mm diameter pipe would be required, from Ponoka to the Montana Lateral. After this, the pipe would decrease to a 500 mm nominal pipe to the Samson Lateral, and further decrease to a 350 mm diameter pipe to the Ermineskin Reservoir.

This Option allows for the greatest flexibility for the future. It has the lowest velocities and can be expanded by adding booster pumping in the future. It is the highest capital cost option, however, and also has a high life cycle cost.

Refer to attached Figure 5.1 for a Hydraulic Gradeline of this option.

NORTH RED DEER RIVER WATER TRANSMISSION PIPELINE

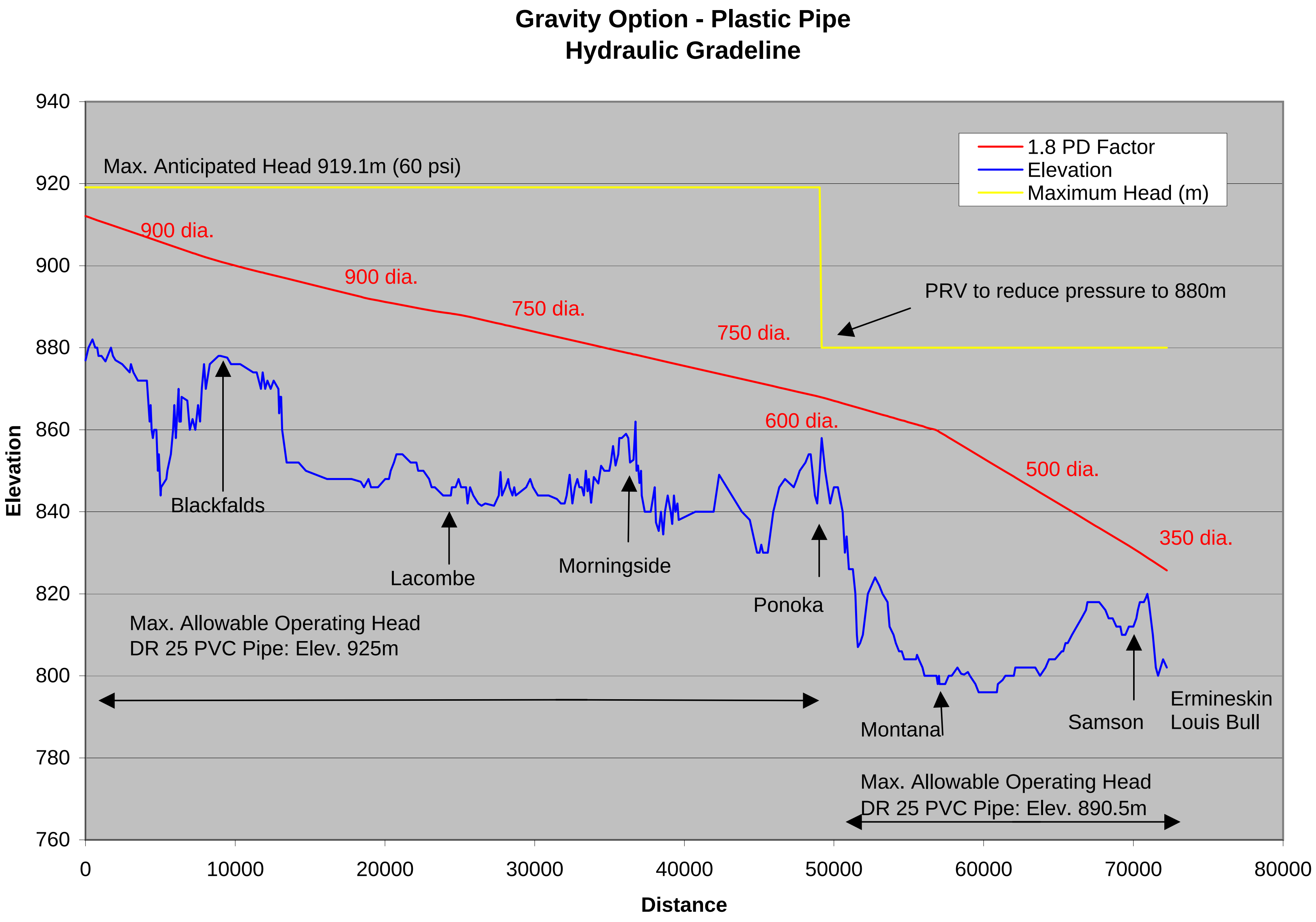

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Figure 5.1

5.1.2 Option 2 - PVC Pipe - Pumped at Year 2028 Option

The second option assumed that the ultimate design flows would require pumping at Lacombe. The pipe size at the tie-in would be a 750 mm nominal diameter pipe (see Figure 5.2). This 750 mm pipe would continue up to Lacombe, where a pumping station would be required in approximately year 2028. From Lacombe, the 750 mm diameter continues to Morningside where it would decrease to a 600 mm pipe. The pipe would further be reduced to a 500 mm diameter from Ponoka to Samson. From Samson to Ermineskin the pipe would be a 350 mm diameter pipe.

By year 2028 a pumping station would be required to raise the hydraulic gradeline to an elevation of 917 m. This pumping station is proposed downstream of the most northerly lateral to Lacombe.

This option is less flexible than the gravity option. In order to use a 750 mm pipe from Red Deer to Lacombe, the velocity, at ultimate flow reaches 1.67 m/s, slightly above the 1.5 m/s which is recommended. Consequently, no additional flow beyond the 2051 design flows could be forced through the pipe without significantly increasing the velocities.

This option is a lower capital cost than the gravity option, however, will involve significantly higher operating and maintenance costs, due to the pumping station, in the future.

Refer to Figure 5.2 for a Hydraulic Gradeline of this option.

5.1.3 Option 3 - Steel Pipe Option

The third option has been developed using steel pipe. Steel pipe can withstand much higher operating pressures (and velocities) than can plastic pipe and allows pumping at higher pressure, hence reducing overall pipe diameters.

The steel pipe option is based on a cement mortar, interior lining and polyethylene exterior coating. Cathodic protection is also included. The steel option looked at two basic scenarios - pump once or twice. If only pumping once, the pumping station

NORTH RED DEER RIVER WATER TRANSMISSION PIPELINE

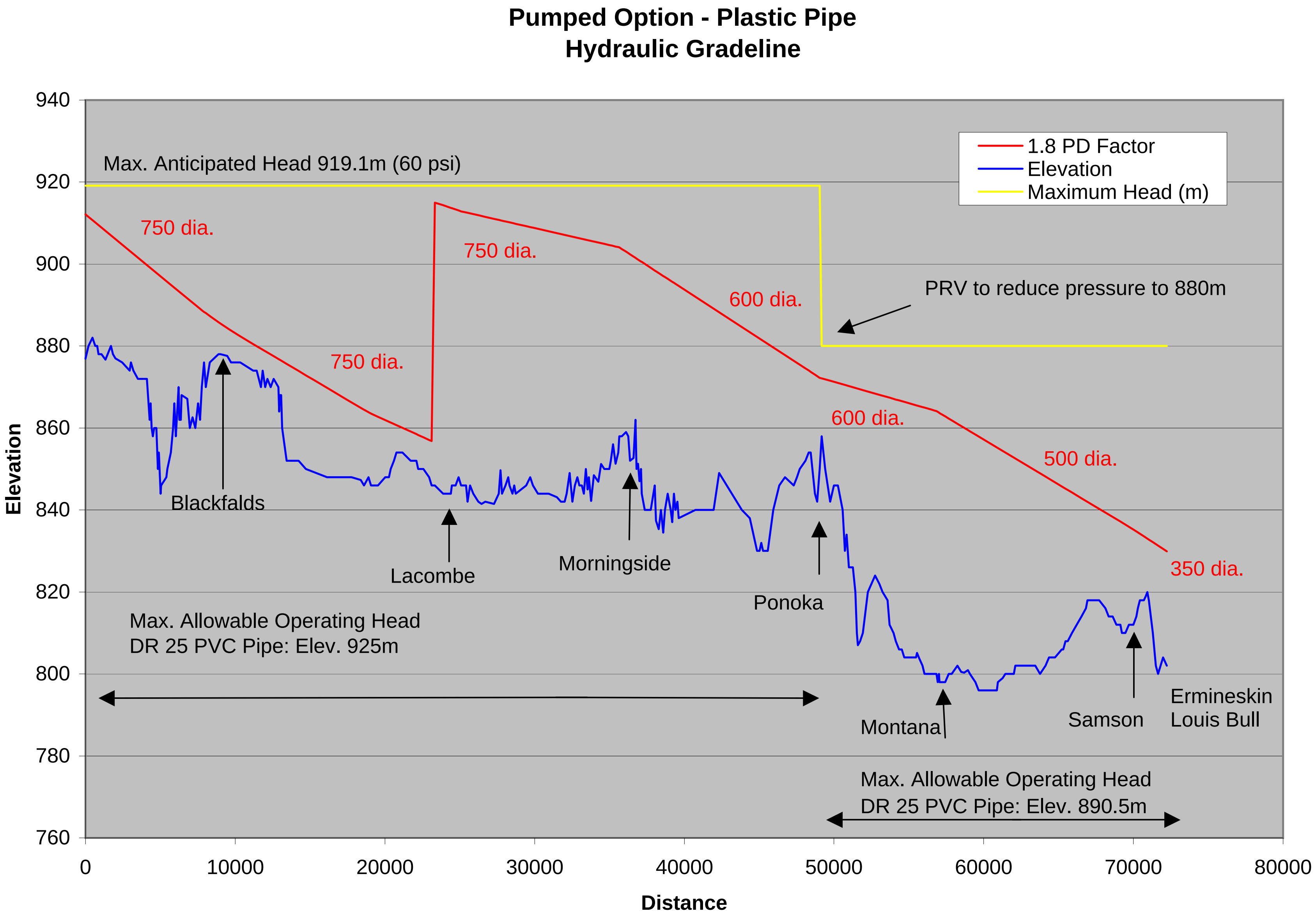

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Figure 5.2

would be required at the Red Deer tie-in (See Figure 5.3). The station would be required to raise the hydraulic gradeline by approximately 3,930 kPa (570 psi) to an elevation of approximately 1,315 m, at ultimate flow. The pipe diameters required would be 600 mm from Red Deer to Lacombe, 500 mm diameter from Lacombe to Ponoka, 400 mm diameter from Ponoka to Samson and 300 mm diameter to the Ermineskin Reservoir.

If two pumping stations were to be constructed, the first would be at Red Deer and the second is proposed at Morningside. The pipe sizes would remain the same. The purpose of two pumping stations is to reduce the pumping heads at the first station. Alternatively, the first pumping station could remain at very high pressures and reduce pipe sizes to 600 mm from Red Deer past Blackfalds, 500 mm past Blackfalds to Lacombe, and 450 mm diameter from Lacombe to Morningside. This option was assessed but rejected due to a high life cycle cost (due to capital cost of two pump stations and related operating and maintenance costs).

5.1.4 Option 4 - Ductile Iron Pipe - Pumped at Year 2028

This option is comparable to Option 2. The pipeline would operate in a “gravity” mode until Year 2028, then a pump station is proposed at Lacombe. A 750 mm diameter pipe (see Figure 5.4) would be constructed from Red Deer to Lacombe; 600 mm from Lacombe to Ponoka; 500 mm from Ponoka to Samson and 350 mm from Samson to Ermineskin.

The ductile iron pipe option is based on a cement mortar interior lining and polyethylene exterior wrap. An impressed current cathodic protection system is also included.

Ductile iron pipe has an advantage over PVC and steel pipe in that the inside diameter of the same nominal pipe size, is greater. Therefore, ductile iron pipe has a greater hydraulic capacity for the same velocity of flow.

Ductile iron pipe has the advantage over PVC pipe also, in that in larger diameters, the material cost is lower. Ductile iron pipe also has advantages over PVC in that

NORTH RED DEER RIVER WATER TRANSMISSION PIPELINE

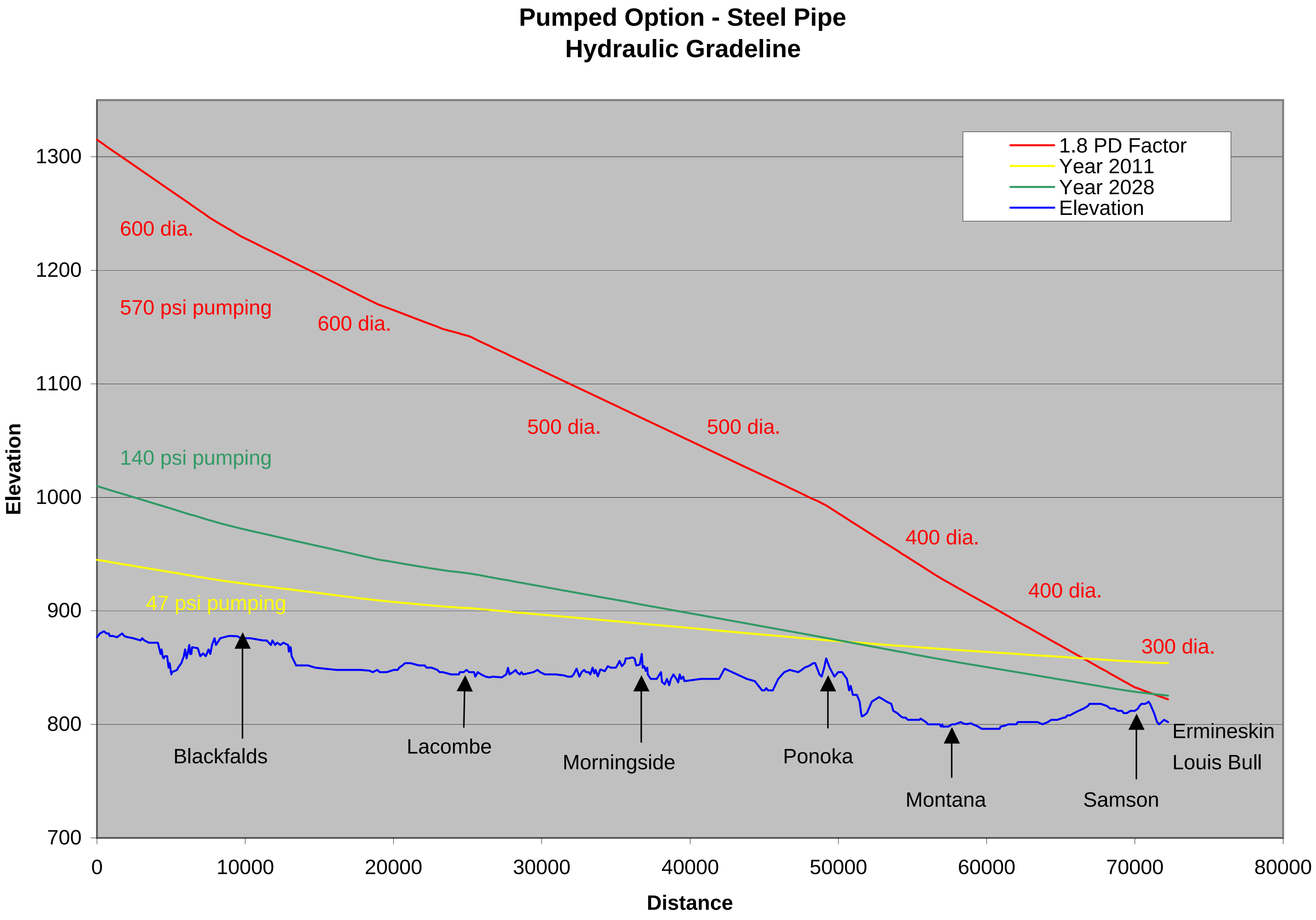

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Figure 5.3

NORTH RED DEER RIVER WATER TRANSMISSION PIPELINE

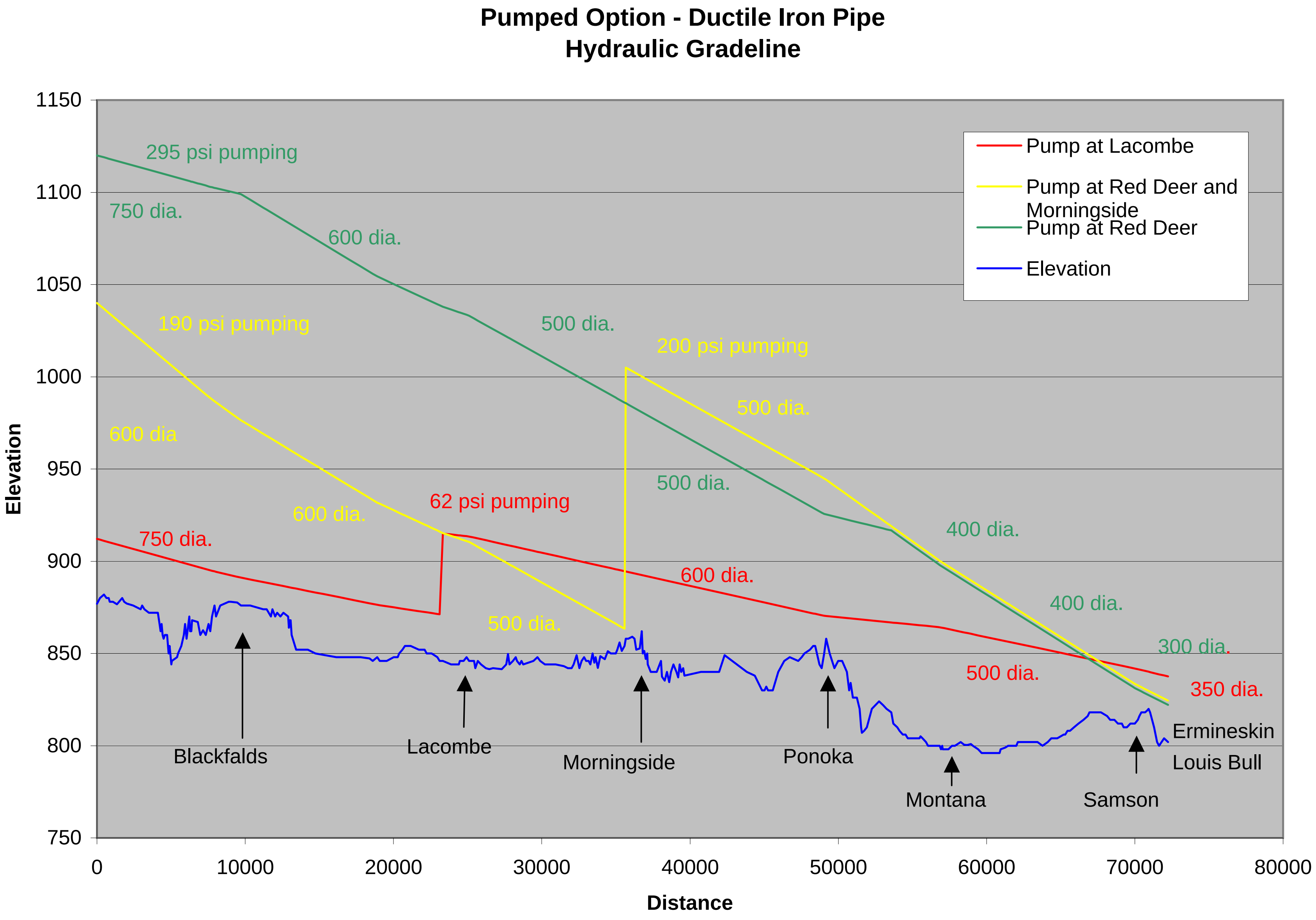

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Figure 5.4

higher operating pressures and velocities can be achieved with the range of pressure classes available.

The major disadvantage of ductile iron pipe (as with steel) is its susceptibility to corrosion. Mitigative measures to inhibit corrosion are very critical, to protect the integrity of ductile iron pipe.

5.1.5 Option 5 - Ductile Iron Pipe - Pump at Red Deer

This option is comparable to Option 3 - Steel pipe. Smaller diameter pipes require pumping immediately at Red Deer.

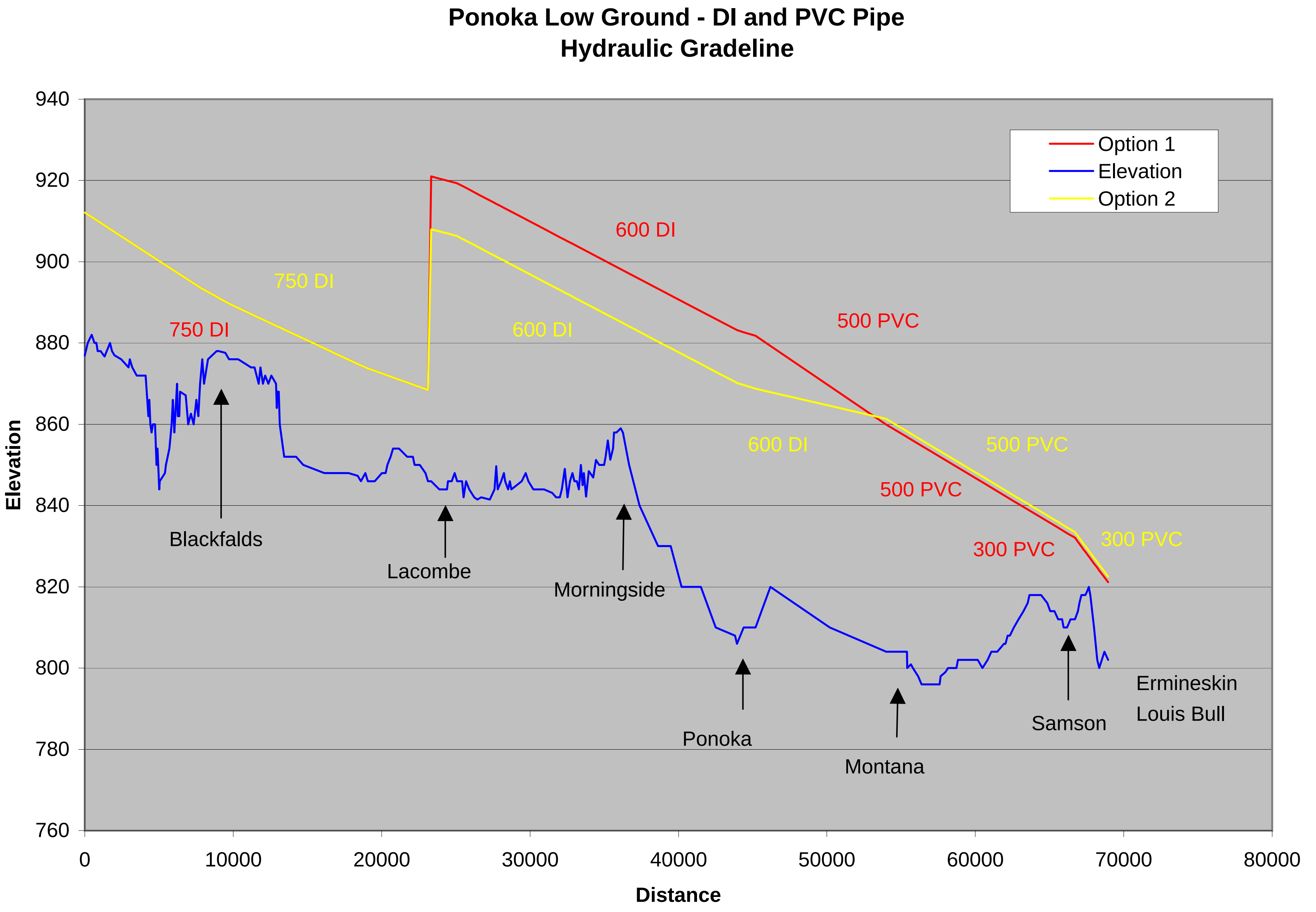
A 750 mm pipe is required between Red Deer and Blackfalds (see Figure 5.4); 600 mm Blackfalds to Lacombe, 500 mm Lacombe to Ponoka; 400 mm Ponoka to Samson and 350 mm Samson to Ermineskin.

5.1.6 Option 6 - Ductile Iron Pipe and PVC Pipe - Pump at Lacombe

This option uses a combination of pipe materials in order to maximize the benefits of each. From Red Deer to Lacombe a 750 mm Ductile Iron Pipe is proposed (see Figure 5.5). The Ductile Iron Pipe has a larger inside diameter than both the steel pipe and DR 25 PVC Pipe, and increases the pressure at the tie-in locations in both Blackfalds and Lacombe. At Lacombe, a future pumping station raises the hydraulic gradeline to approximately 920 m. From Lacombe to Ponoka, the pipe decreases to a 600 mm Ductile Iron Pipe. At Ponoka the pipe changes to a 500 mm diameter PVC pipe up to the Samson First Nations. From Samson to the Ermineskin First Nations, the pipe is a 300 mm diameter PVC pipe.

This option is based on an alignment to the west of Ponoka, referred to as the Ponoka Low Ground alignment. This option will require geotechnical confirmation of potential construction issues to verify its viability and any cost implications.

NORTH RED DEER RIVER WATER TRANSMISSION PIPELINE



n:\033333\Report\Report Excel Files\HGLCharts(PonokaLowGround)\Ponoka LG PVC chart

Figure 5.5

5.1.7 Other Options

The scenarios presented in Figures 5.1 to 5.4 have been based on an easterly route around Ponoka. Although the route is slightly longer, it will avoid a high water table area, and potentially reduce the class of pipe. As discussed in Option 6, the route to the west of Ponoka may still be suitable depending on geotechnical confirmation. Additional information for the alignment west of Ponoka is included in the Appendix.

The results of applying a Peak Day factor of 1.5 times average day flow is also provided as a reference in the appendix.

5.2 MATERIALS

Several materials were considered to be suitable for construction of this pipeline. The hydraulic analysis modelled the specific materials by using appropriate C-factors and pressure ratings. Those materials considered were:

- Polyvinyl Chloride (PVC)
- Polyethylene (PE)
- Steel pipe with both interior and exterior coatings.
- Ductile iron with cement mortar lining and polyethylene wrap

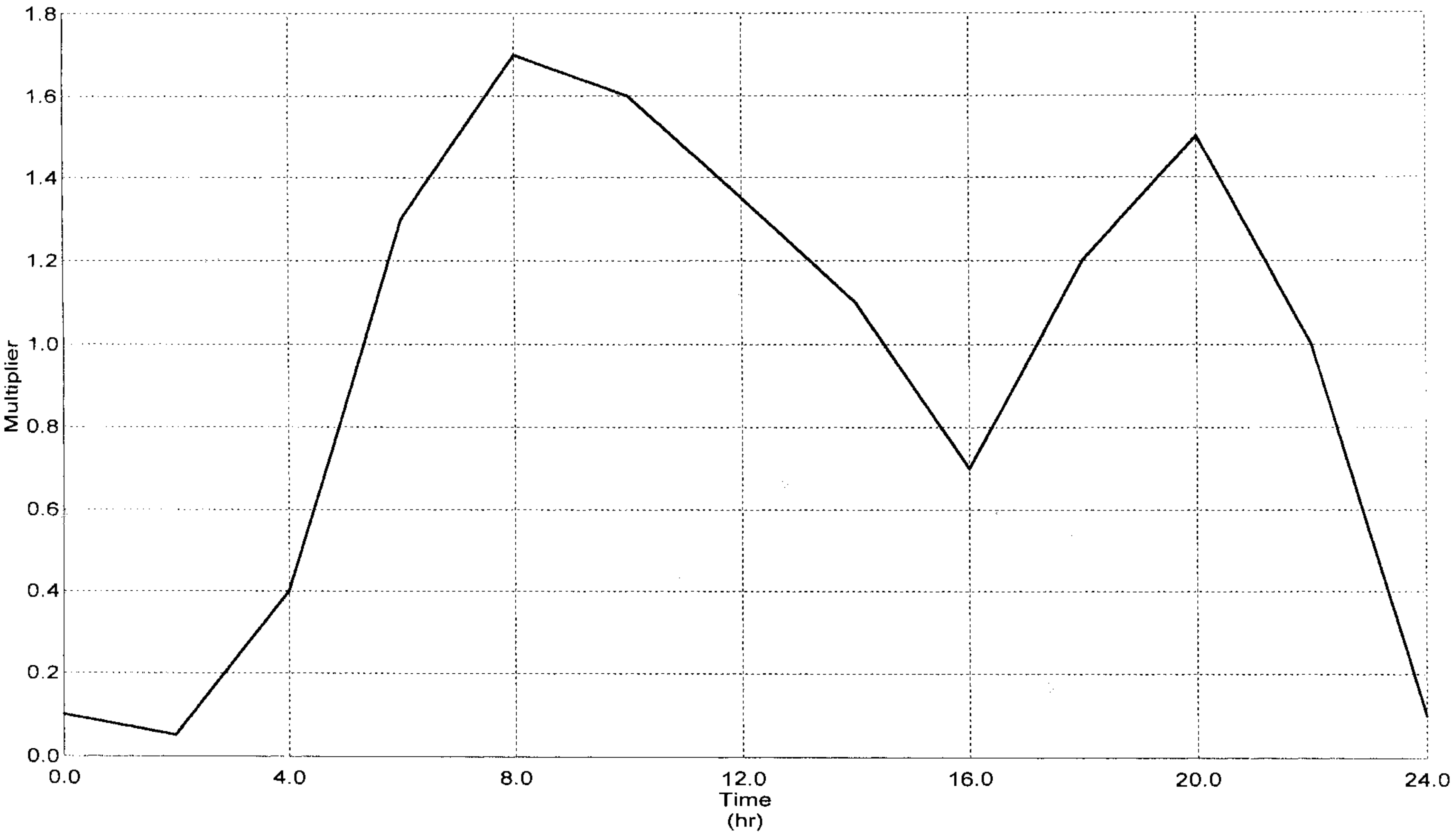
The material recommended within this report has been done so mainly based on the cost estimates developed. As all of the materials are considered to be acceptable, capital costs and maintenance costs become the basis for the recommendation.

5.3 DIURNAL ANALYSIS

An analysis was performed on the capacity of the reservoirs during peak day scenarios. This simulation used a diurnal curve adapted from flow data recorded by the Town of Lacombe. The diurnal curve represents the pattern of water usage throughout the day. The curve used for the purpose of this report represented a large peak in water demand at 8:00 am, and a smaller peak after supper at 8:00 pm. The curve is attached as Figure 5.6. This pattern was used as a demand, while required supply rate was simulated as an inflow.

NORTH RED DEER RIVER WATER TRANSMISSION PIPELINE

Figure 5.6 - Diurnal Pattern



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Associated Engineering
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Project Engineer: Kai Ch'ng
WaterCAD v5.0 [5.0037]
Page 1 of 1

The main purpose of running this analysis is to identify if fire storage would be compromised during peak demand periods. The fire storage required for each community has been identified as 2376 m^3 except for Montana. The fire flow storage for Montana is proposed as 523 m^3.

This analysis was performed for Blackfalds, Lacombe and Ponoka. It was not done for the First nations reservoirs. Each community was analyzed based on 2003, 2011 and 2051 demands. The resulting graphs are appended to the end of this report (Appendix F).

The Town of Blackfalds currently has 2450 m^3 of storage. Running a peak day demand of 28 l/s significantly interferes with the required fire storage. Blackfalds was also analyzed using a 2011 demand, assuming that storage was increased to 6492 m^3 as recommended. Analyzing this situation shows that fire flow storage is not impacted.

The Town of Lacombe currently has 13, 140 m^3 of storage. A peak day demand of 71 l/s does not interfere with the fire storage of 2376 m^3. In fact, as the demands are increased in 2011 and 2051, fire storage is not compromised, even without increasing the storage capacity. However, as demand increases, additional storage will still be required as security against supply interruption.

The Town of Ponoka currently has 5690 m^3 of storage (they are currently in the process of adding increased storage capacity). In all three runs, 2003, 2011 and 2051, there is enough storage capacity such that fire storage will not be compromised.

5.4 CHLORINE ANALYSIS

The City of Red Deer currently uses chloramines as a residual disinfectant in their distribution system. Chloramines have been found to have a very slow decay rate when compared to free chlorine.

Experience on other large regional systems, demonstrates that chlorine residual can be maintained for extended periods using chloramine as a disinfectant.

5.5 TRANSIENT ANALYSIS

5.5.1 Introduction

A new treated water pipeline is to be constructed to supply a number of municipal water systems from the City of Red Deer water distribution system. The pipeline is to travel north of Red Deer and supply the communities of Blackfalds, Lacombe, Ponoka, Montana, Samson and Ermineskin.

As part of the preliminary design, a hydraulic transient analysis was completed to identify potential risks to the water supply system resulting from pipeline transient pressures. These risks include over-pressure and potential damage to the pipeline or the attached equipment. However, since this is a treated water pipeline, there are risks to water quality associated with vacuum conditions in the pipeline resulting from pressure down-surge.

A number of pipeline routes are still under consideration. As a result, the final system configuration and pipeline routing may differ from the cases analysed here, but there is sufficient detail to provide guidance for the detailed design.

5.5.2 Analysis Assumptions

Two pipeline materials are considered for this analysis: standard steel pipe and DR25 PVC pipe. The operating conditions for each pipeline system are significantly different.

For the steel pipeline, a booster pump station is to located in Red Deer and connect directly to the Red Deer Water distribution system. The operating pressure of the steel pipeline is much higher than for PVC. Consequently, a relatively high pressure pump station is required. At peak flow rates, the booster pump maintains approximately 200 kPa at Ermineskin.

In contrast, the system using larger diameter PVC pipe has a more gradually sloped hydraulic grade line. For this system, it is proposed that the City of Red Deer distribution system would supply part of the pipeline directly, and a booster pump would be installed at Lacombe to meet downstream demands.

The pipeline characteristics and demand point flow rates used in this analysis are given in Table 5.1. The distribution of demands along the pipeline has a significant influence on the steady-state operating conditions and the resulting hydraulic transients. The demand distribution used here is representative of peak flow conditions.

Table 5.1: Pipeline and Node Summary

Station (m)	Node Elevation (m)	Node Description	Demand (L/s)	Pipe Description
0	875.0	Red Deer	-732	
				600 mm Steel or 750 mm PVC
8 700	881.0	Blackfalds	119	
				600 mm Steel or 750 mm PVC
22 700	847.0	Lacombe	247	
				500 mm Steel or 750 mm PVC
51 000	830.0	Ponoka	132	
				500 mm Steel or 500 mm PVC
71 500	800.0	Samson	126	
				500 mm Steel or 500 mm PVC
73 500	791.0	Ermineskin	93	
		Branch pipeline		300 mm Steel or 350 mm PVC
3 900	711.0	Montana	15	

Data used to describe the specific pipe used in this analysis are summarized in Table 5.2. The friction factor has been selected to correspond the steady state simulations of the pipeline. Note that transmit time for a pressure wave to travel the full length of the pipeline is approximately 1 minute for steel pipe and approximately 3.5 minutes for PVC pipe.

Table 5.2: Pipe Data

Pipe Material	Pipe ID (mm)	Friction Factor (HW)	Wave Speed (m/s)
600 mm Steel	590.6	135	1150
500 mm Steel	489.0	135	1185
400 mm Steel	387.4	135	1225
300 mm Steel	285.8	135	1225
750 mm SDR 25 PVC	747.8	135	350
500 mm SDR 25 PVC	504.7	135	350
350 mm SDR 25 PVC	357.5	135	350

(Note: Ductile iron pipe ha not been analyzed for hydraulic transient in this preliminary design stage. The wave speed for ductile iron pipe is 1,420 m/s.)

For this analysis, typical pump characteristics were used in the pump station models, since specific pumps have not been selected. Each pump station included two centrifugal pumps and a check valve piped in parallel between suction and discharge headers. The check valves allow free flow from the suction to discharge headers if the pumps are not required or shut-down unexpectedly. The data used to model booster pump stations at Red Deer and at Lacombe are summarized in Table 5.3.

Table 5.3: Booster Pump Data

Pump Data	Red Deer	Lacombe
Rated Discharge (L/s)	366	183
Rated Head (m)	396	30.0
Rated Speed (rpm)	1800	1800
Rated Efficiency	0.80	0.80
Rotational Inertia (kg m^2)	125	1.3

The City of Red Deer distribution system has been modelled as a constant head reservoir. It is assumed that distribution pressure remains constant, irrespective of flow rate into the pipeline.

Flow out of the pipeline at demand points is modelled using atmospheric discharge valves. Based on the steady state pipeline pressure, a valve discharge coefficient is specified to model the desired demand flow rate as a discharge to atmosphere. Under transient conditions, flow out of valve varies based on the pipeline pressure. This valve model also includes a check function to disallow flow into pipeline. Specific demand flow rates are given Table 5.1.

At the high points in the pipeline, combination air valves have been modelled. There valve coefficient for air inflow and outflow are assumed to be equal. The valve coefficients selected correspond to 75 mm or 50 mm combination air valves, the locations of each valve type depend on the steady state pipe flow rate.

5.5.3 Scenarios

Seven scenarios have been examined in this analysis. These are described below.

5.5.3.1 Steel Pipeline Configuration

- Power failure at the Red Deer booster pump station occurs 50 sec. into the simulation. The downstream demands, modelled as atmospheric discharge valves, remain open.
- Accidental closure of the reservoir fill valve at Lacombe. The valve is assumed to close within 1 sec. The downstream demands and booster pump station remain in operation.
- Simultaneous accidental closure of the reservoir fill valves at both Samson and Ermineskin. The valves are assumed to close within 1 sec. The downstream demands and booster pump station remain in operation.

5.5.3.2 PVC Pipeline Configuration

- Power failure at the Lacombe booster pump station occurs 50 sec into the simulation. The supply from the City of Red Deer, the downstream demands, modelled as atmospheric discharge valves, remain open.
- Accidental closure of the reservoir fill valve at Lacombe. The valve is assumed to close within 1 sec. The downstream demands and booster pump station remain in operation.
- Simultaneous accidental closure of the reservoir fill valves at both Samson and Ermineskin. The valves are assumed to close within 1 sec. All other demands and booster pump station remain in operation.
- Accidental closure of the supply valve from the City of Red Deer distribution system. The valve is assumed to close within 1 sec. The downstream demands and booster pump station remain in operation.

5.5.4 Computer Model

The hydraulic transient analysis was completed using TransAM, a computer code developed by Professor Bryan Karney of the University of Toronto and HydraTek Associates. The code models simple and complex hydraulic systems including a wide range of boundary devices, such as pumpstations, valves, reservoirs, etc. It can also simulate the effect of various surge mitigation devices. Simulation results can be viewed in a number of formats including system maximum and minimum pressure envelopes, as well as time histories of individual component parameters.

Simulation of system transient behaviour begins from an initial steady-state condition. The steady state condition can be determined using an external computation of the of the pipeline flow rates and hydraulic grade line, or using the steady state prediction capabilities of TransAM. For this analysis, the steady-state hydraulic grade lines have been predicted using a spreadsheet using the pipeline flow rates and pump characteristics as input. The pipeline flow rates are dependent on magnitude and distribution of demands. The hydraulic grade line has also been confirmed using a TransAM computation.

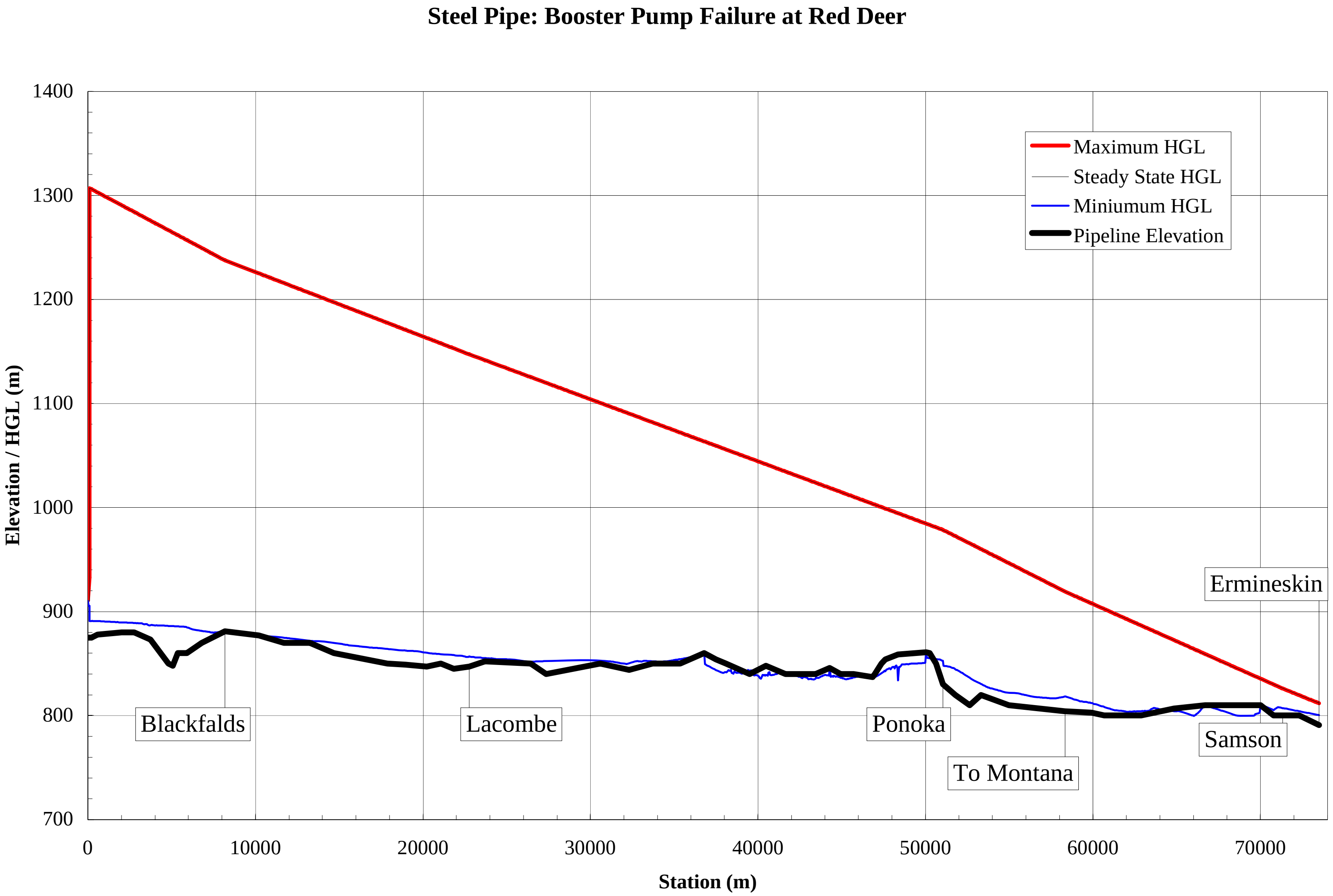
5.5.5 Results and Discussion

The results of this analysis are presented as a series of plots showing maximum and minimum hydraulic grade lines (HGLs) along the pipeline path. Also plotted are the steady state HGL and the pipeline profile. The steady state HGL represents the initial condition prior to initiation of the transient event. During the course of the transient simulation, the computer program stores the maximum and minimum hydraulic grade line valves at every location along the pipeline. These HGL extremes are plotted in the following figures.

5.5.5.1 Steel Pipeline

The maximum-minimum HGL envelope for a power failure at the Red Deer booster station is plotted in Figure 5.7. In this figure, the maximum and steady state HGLs are coincident. The minimum HGL dips below the pipeline profile at several locations, indicating that intermittent subatmospheric pressures have developed at some locations along the pipeline. There appears to be regions of column separation near Ponoka and Samson. Combination air valves are somewhat effective in controlling column separation. Since the maximum HGL is coincident with the steady state HGL, unacceptably high pressures resulting from vapour column

Figure 5.7


Steel Pipe: Booster Pump Failure at Red Deer
Maximum HGL
Steady State HGL
Miniumum HGL
Pipeline Elevation
Elevation / HGL (m)
1400
1300
1200
1100
1000
900
800
700
0
10000
20000
30000
40000
50000
60000
70000
Station (m)
Blackfalds
Lacombe
Ponoka
To Montana
Samson
Ermineskin

collapse are not apparent. The risk of in-leakage of ground water during periods of subatmospheric pressure is low since the integrity of welded steel pipe is typically high.

Since the booster pump station is connected directly to the City of Red Deer distribution system, the initial down surge following pump failure is mitigated by flow through the parallel check valve. The distribution system behaves like a surge tank and reduces the magnitude of the down surge. As a result, the possibility of column separation is reduced.

The HGL at the end of the simulation is plotted in Figure 5.8. In spite of the booster pump shut down, the reservoir fill valves at all of the downstream demand point remain open. Figure 5.8 shows that the HGL has a much lower slope, indicating that the flow rate is much lower. The final HGL is also attached to the pipeline profile, and changes slope, near Ponoka and Samson. At these locations, the combination air valves have opened and the pipeline is filling with air.

The resulting maximum-minimum HGL envelope for an accidental reservoir fill valve closure at Lacombe is plotted in Figure 5.9. In this figure, the minimum and steady state HGLs are coincident. As a result of the sudden valve closure at Lacombe, the flow rate in the pipeline decreases. As the transient pressure waves dissipate, the HGL increases in elevation and its slope decreases upstream of Lacombe. Since the flow has been reduced, the pressure at the booster pump station increases as a result of the pumps running further to the left on their pump curves. The maximum pressures observed in this scenario can be accommodated through standard pipeline design.

To test the potential for high up surge pressures at the downstream end of the pipeline, it has been assumed that the reservoir fill valves at both Samson and Ermineskin simultaneously within 1 sec. This scenario is quite unlikely, and therefore, the results of this simulation conservatively bound more probable scenarios. The results are plotted in Figure 5.10. In this plot the maximum HGL is significantly higher than the steady state. The

Figure 5.8

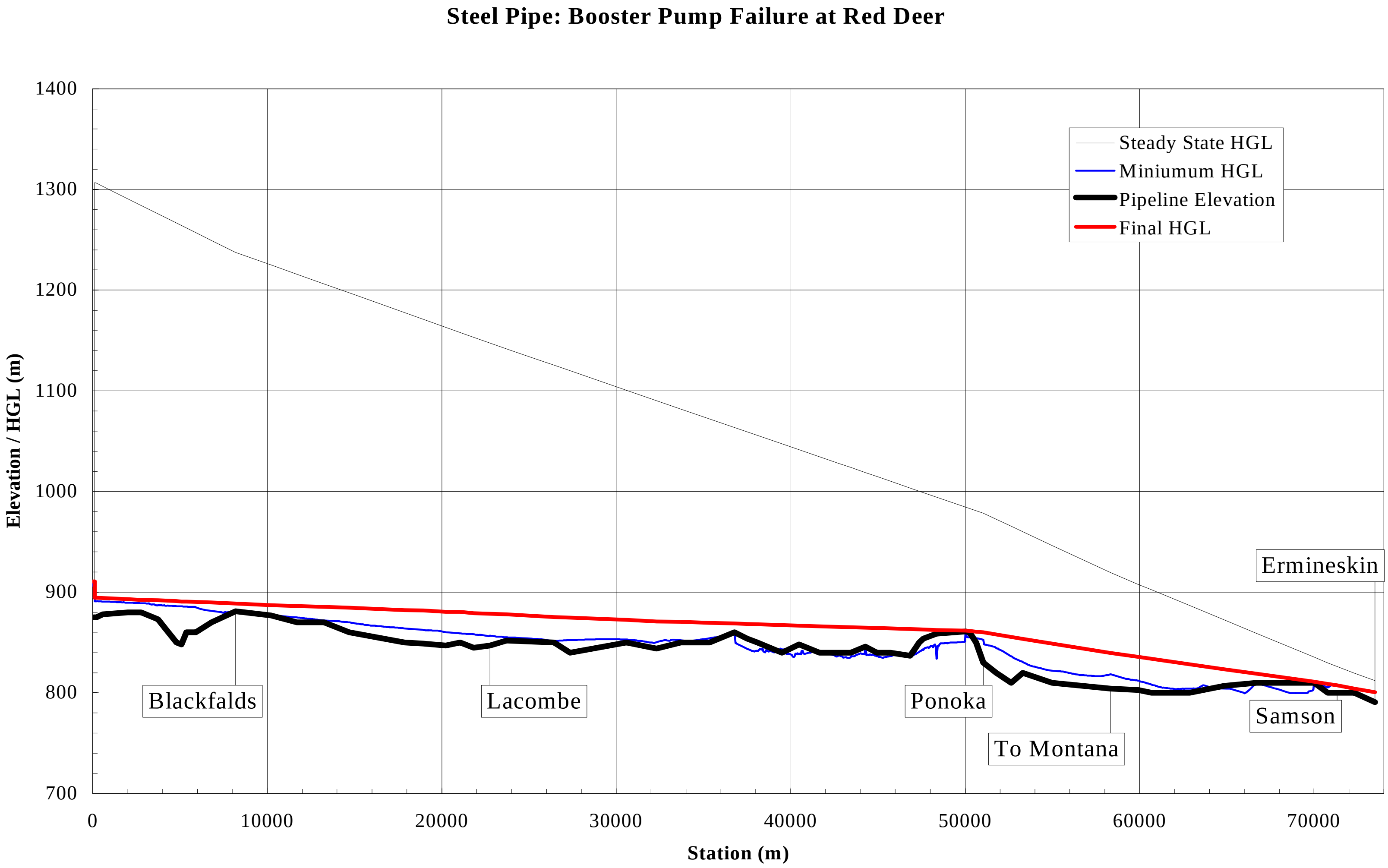

Steel Pipe: Booster Pump Failure at Red Deer
Elevation / HGL (m)
1400
1300
1200
1100
1000
900
800
700
0
10000
20000
30000
40000
50000
60000
70000
Station (m)
Steady State HGL
Miniumum HGL
Pipeline Elevation
Final HGL
Ermineskin
Blackfalds
Lacombe
Ponoka
To Montana
Samson

Figure 5.9

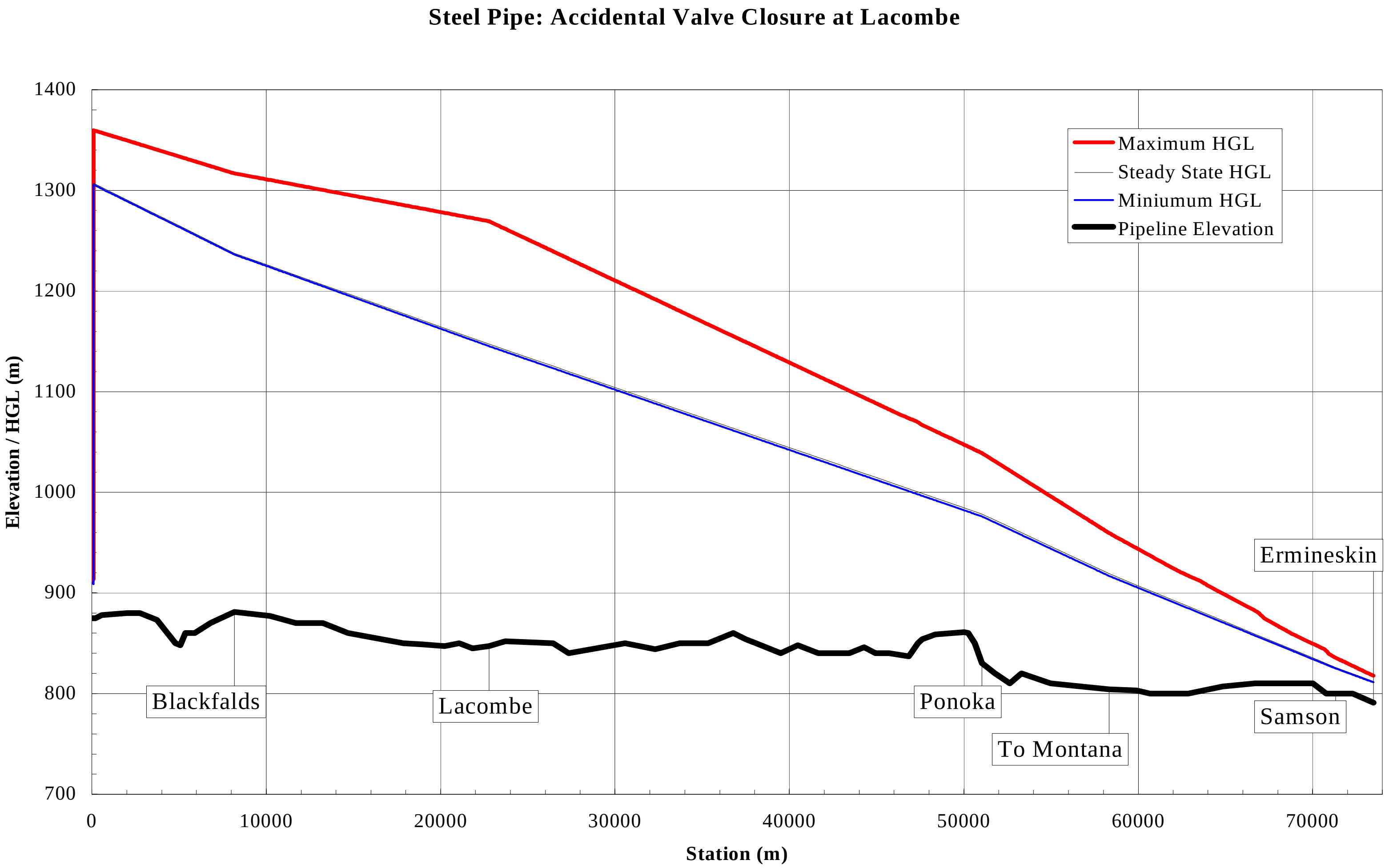
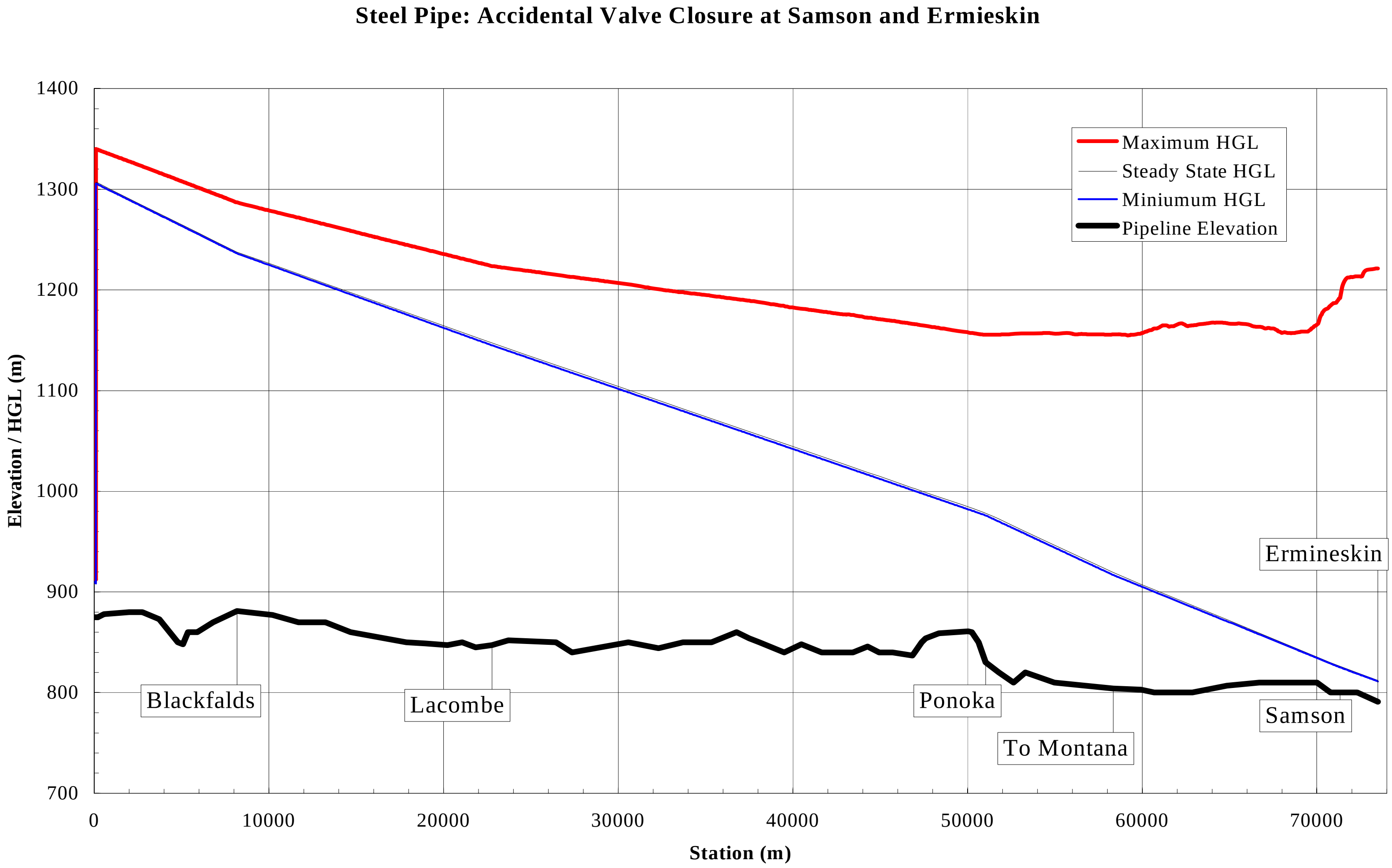

Steel Pipe: Accidental Valve Closure at Lacombe
Elevation / HGL (m)
1400
1300
1200
1100
1000
900
800
700
0
10000
20000
30000
40000
50000
60000
70000
Station (m)
Maximum HGL
Steady State HGL
Miniumum HGL
Pipeline Elevation
Blackfalds
Lacombe
Ponoka
To Montana
Ermineskin
Samson

Figure 5.10



Steel Pipe: Accidental Valve Closure at Samson and Ermieskin
1400
1300
1200
1100
1000
900
800
700
Elevation / HGL (m)
0
10000
20000
30000
40000
50000
60000
70000
Station (m)
Maximum HGL
Steady State HGL
Miniumum HGL
Pipeline Elevation
Blackfalds
Lacombe
Ponoka
To Montana
Ermineskin
Samson

maximum pipeline pressure at Ermineskin is approximately 430 m (300 psi). In this case, the pressure rating or the downstream pipeline should be approximately the same as the pipeline immediately downstream of the booster station.

5.5.5.2 PVC Pipeline

In the PVC pipeline configuration, the reservoir fill station is assumed to be just upstream of the booster pump station. In Figure 5.11, the maximum-minimum HGL envelop for a power failure at the booster pump station is plotted. In this case, the steady state HGL is coincident with the maximum HGL downstream of the booster station and the minimum HGL upstream of the booster station. The combination air valve at the high point in the pipeline profile near Ponoka opens momentarily during the transient event. After pump shut down, a lower flow is established in the pipeline downstream of the booster station. Pipeline integrity is not challenged in this scenario.

Pipeline integrity is challenged as a result of column separation if the pipeline supply valve at Red Deer is suddenly closed. Upon closure of this valve, a pressure down surge of sufficient magnitude to cause column separation progresses downstream of the valve. Figure 5.12 shows that combination air valves at high points in the pipeline mitigate the down surge somewhat. However, due to the topography downstream of the connection to the City of Red Deer distribution system, combination air valves are not completely effective in preventing subatmospheric pipeline pressures. Because of the combination air valves, regions of subatmospheric pressure are limited to the pipeline upstream of Blackfalds.

In this scenario, the valve is assumed to close from a fully open position in 1 sec. The magnitude of the initial down surge, and the probability of column separation, could be reduced through the use of slow closing isolation valves at Red Deer.

Figure 5.11

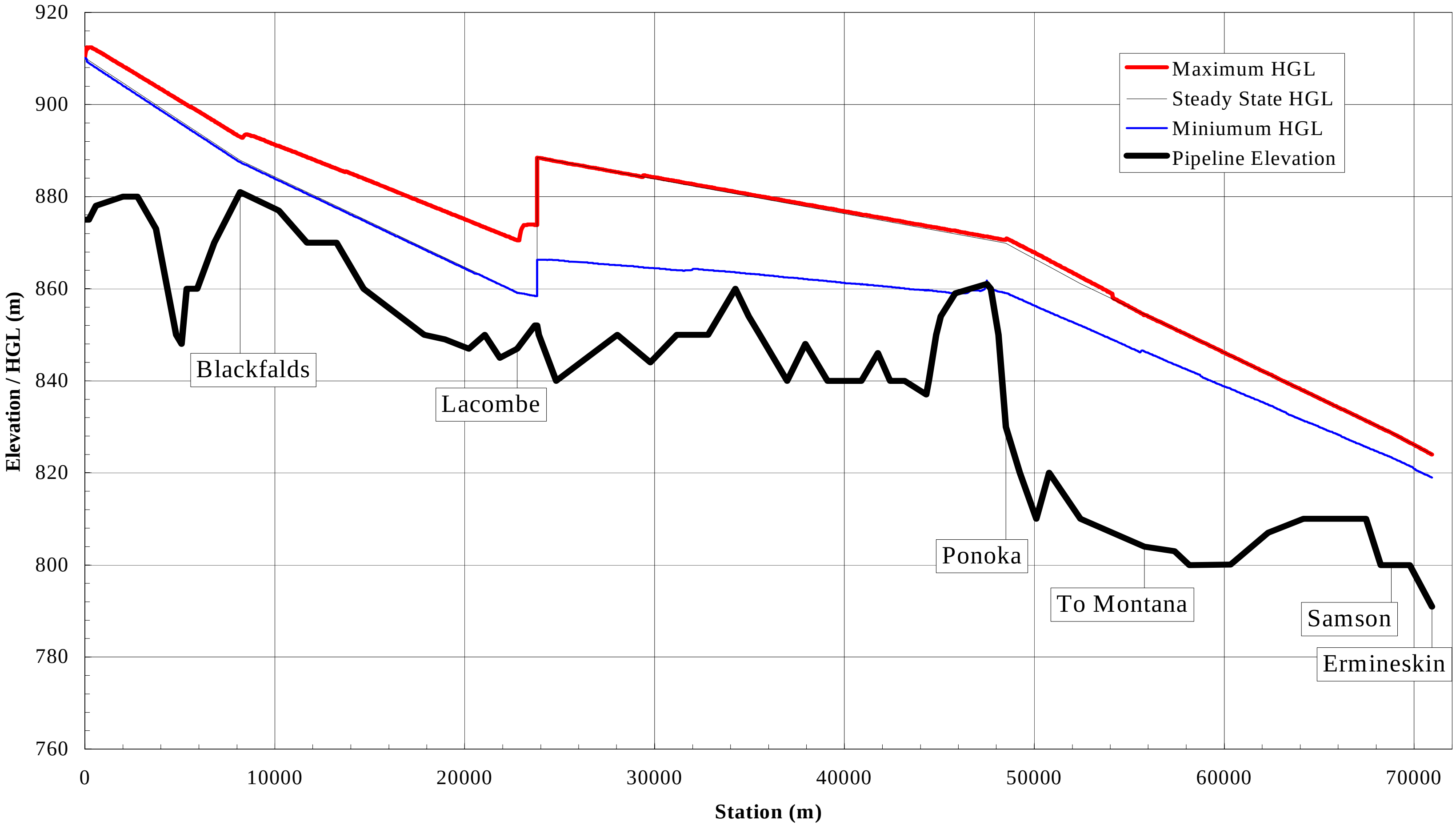
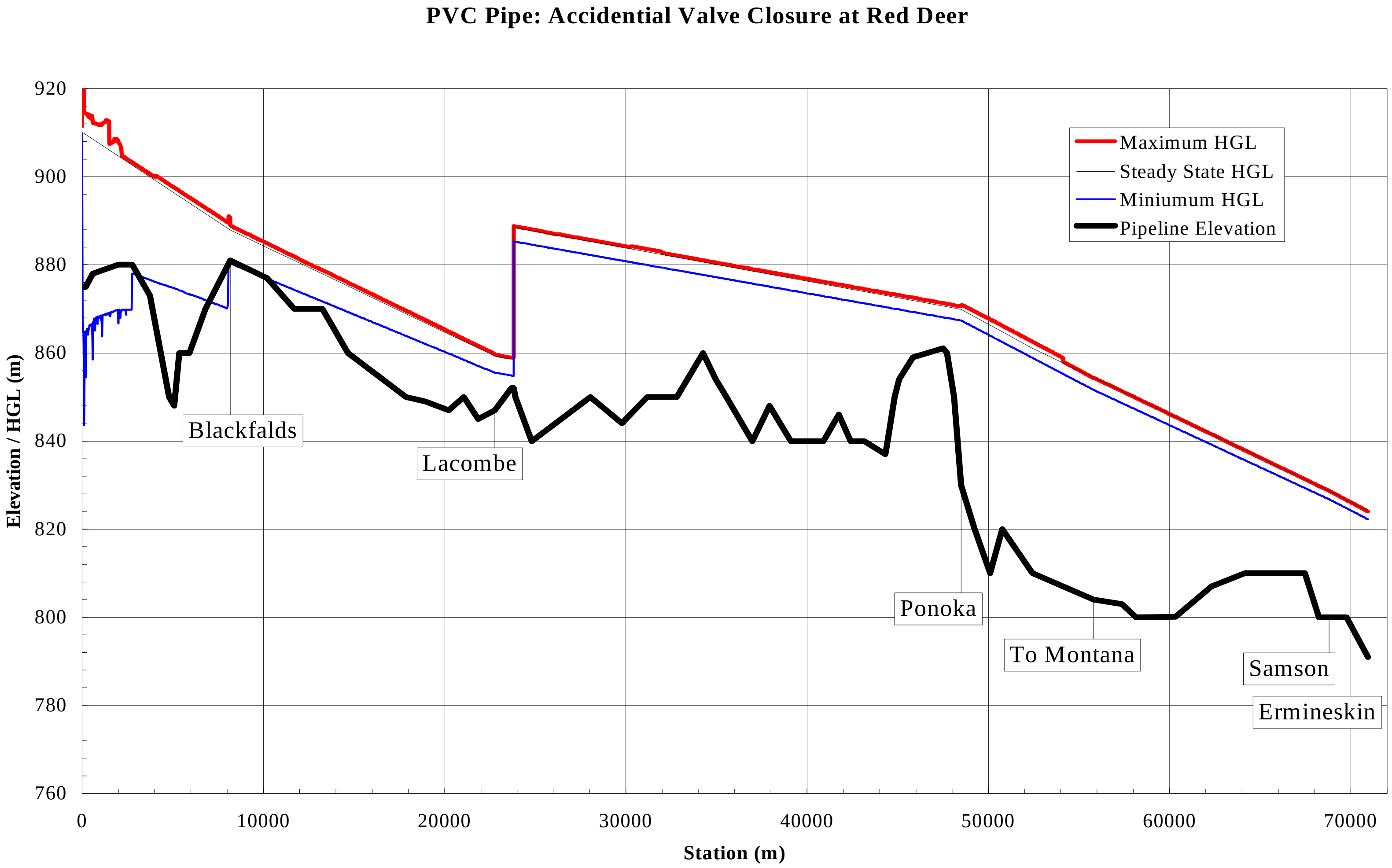

PVC Pipe: Booster Pump Failure
Maximum HGL
Steady State HGL
Miniumum HGL
Pipeline Elevation
Elevation / HGL (m)
Station (m)
920
900
880
860
840
820
800
780
760
0
10000
20000
30000
40000
50000
60000
70000
Blackfalds
Lacombe
Ponoka
To Montana
Samson
Ermineskin

Figure 5.12


PVC Pipe: Accidential Valve Closure at Red Deer
Maximum HGL
Steady State HGL
Miniumum HGL
Pipeline Elevation
Elevation / HGL (m)
920
900
880
860
840
820
800
780
760
Station (m)
0
10000
20000
30000
40000
50000
60000
70000
Blackfalds
Lacombe
Ponoka
To Montana
Samson
Ermineskin

The effect of an accidental valve closure at Lacombe is plotted in Figure 5.13. In this case the minimum HGL is coincident with the steady state HGL, and the maximum HGL is displaced upward by approximately 20 m. The transient pressures developed during this scenario are well within the pipeline capabilities.

The results for simultaneous reservoir fill valve closure at Samson and Ermineskin are plotted in Figure 5.14. The maximum HGL along the pipeline is highest at the downstream end. Since the pipeline elevation is lowest at this point, the resulting transient pressure will be highest. The peak pressure at Ermineskin is approximately 115 m (80 psi).

5.5.6 Conclusions

A preliminary hydraulic transient analysis has been completed of two proposed 70 km pipeline systems, supplying treated water from the City of Red Deer to six communities. For both cases, the pipelines are reasonably well protected through the use of booster station by-pass check valves and combination air valves.

In one case, the accidental closure of the supply valve at Red Deer with a PVC pipeline, there is a risk of column separation upstream of Blackfalds. With socket joint pipe, or leaky pipelines, there is the possibility of pipeline contamination during periods of subatmospheric pressure. This particular scenario can be avoided by installing a slow closing valve at the pipeline supply connection to the City of Red Deer.

A hydraulic transient analysis of the system should be repeated when final pipeline routing, pipeline properties and equipment selections have been completed, to confirm adequacy of surge protection measures.

Figure 5.13

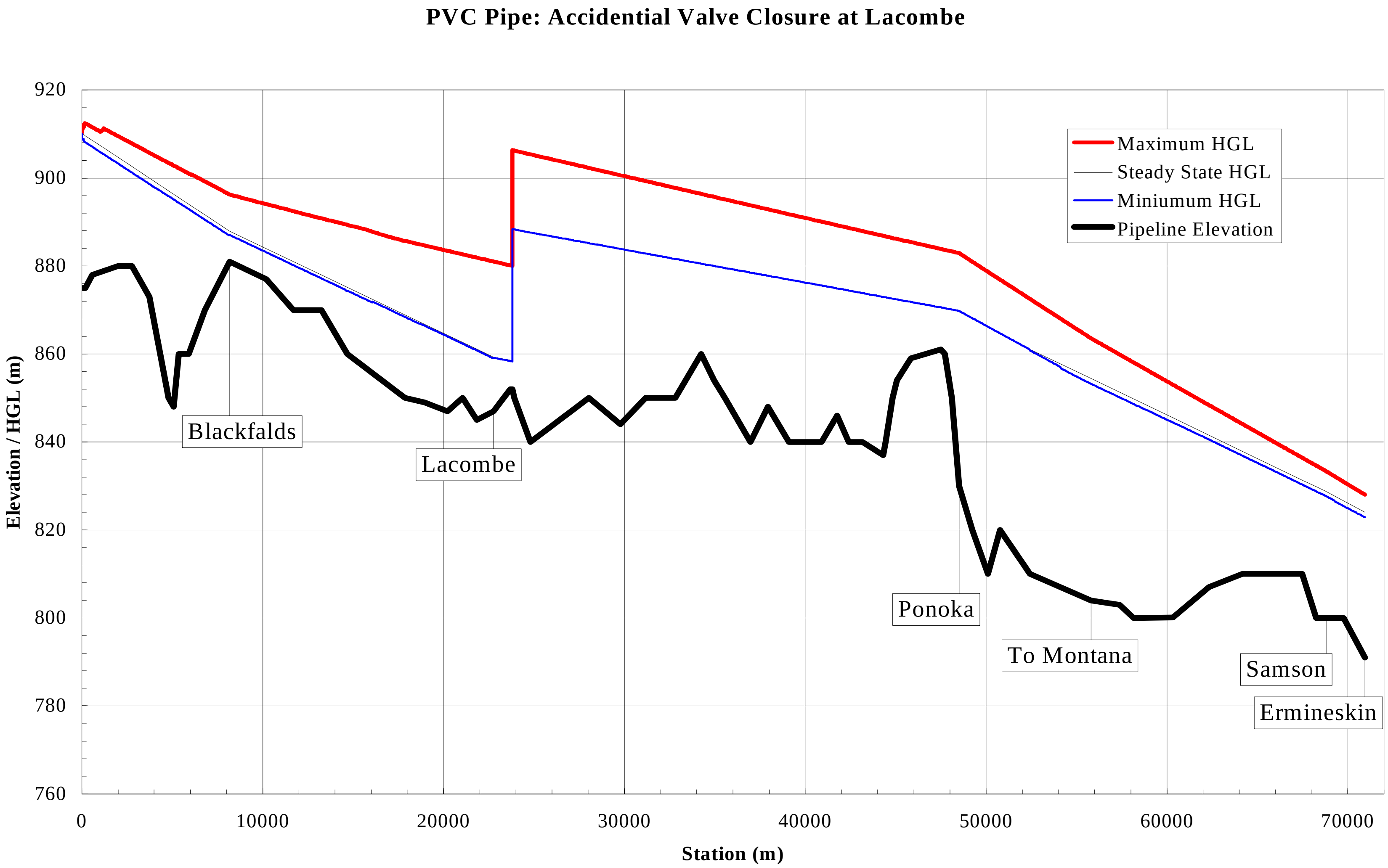
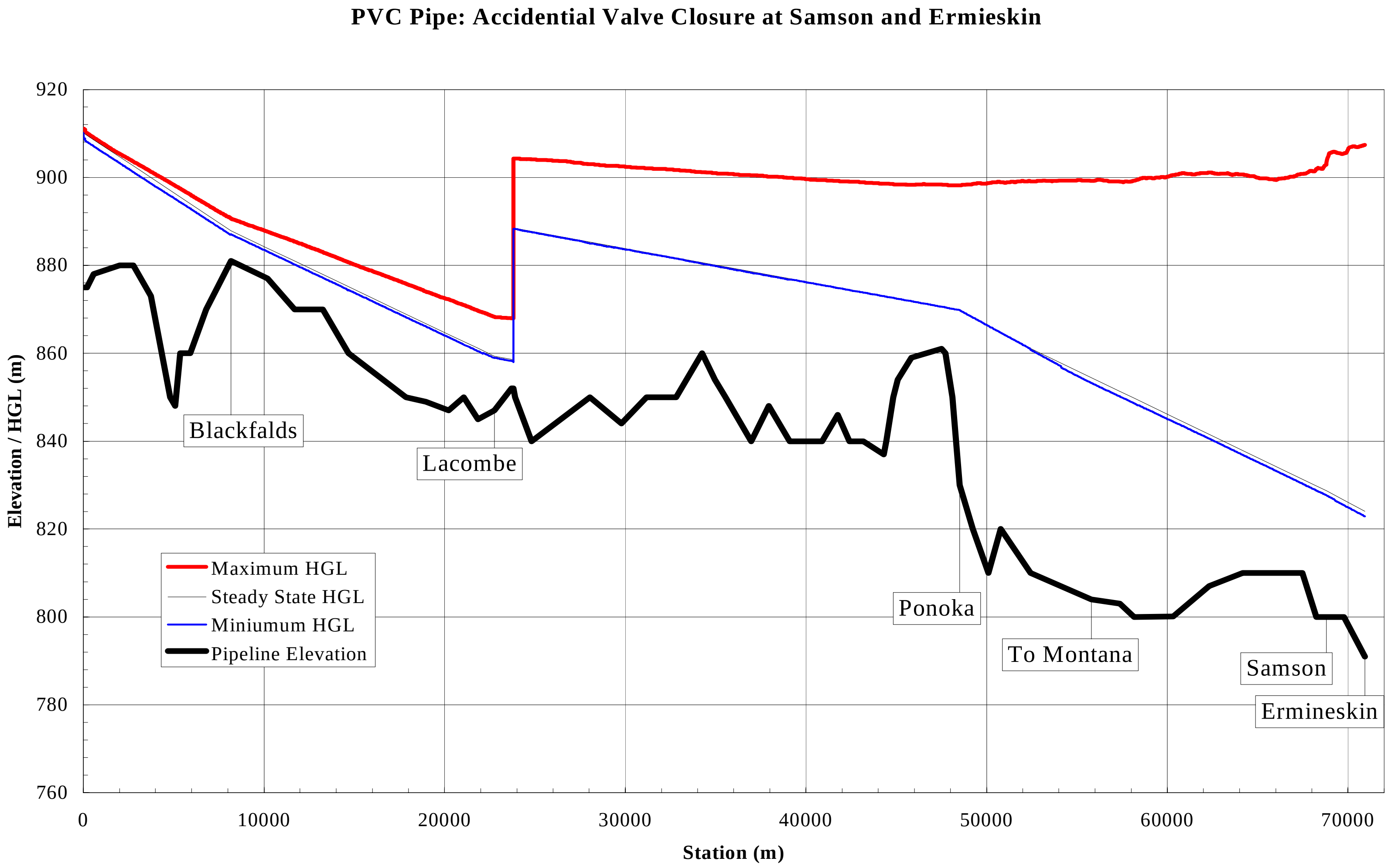

PVC Pipe: Accidential Valve Closure at Lacombe
Elevation / HGL (m)
920
900
880
860
840
820
800
780
760
Station (m)
0
10000
20000
30000
40000
50000
60000
70000
Maximum HGL
Steady State HGL
Miniumum HGL
Pipeline Elevation
Blackfalds
Lacombe
Ponoka
To Montana
Samson
Ermineskin

Figure 5.14


PVC Pipe: Accidental Valve Closure at Samson and Ermieskin
Elevation / HGL (m)
920
900
880
860
840
820
800
780
760
0
10000
20000
30000
40000
50000
60000
70000
Station (m)
Blackfalds
Lacombe
Ponoka
To Montana
Samson
Ermineskin
Maximum HGL
Steady State HGL
Miniumum HGL
Pipeline Elevation

ALIGNMENT

6.1 TOPOGRAPHY

The topography of the proposed alignment generally falls from Red Deer to Ermineskin in elevation. The ground elevation varies from approximately 875 m at Red Deer, plunging to 848 m at the Blindman River, and rising to 881 m at Blackfalds. From Blackfalds the elevation falls to Lacombe, and generally rises to 860 m at the community of Morningside. From Morningside the ground falls then rises to pass Ponoka on the east side at an elevation of 860 m. From Ponoka the ground falls continually to Ermineskin.

The tie in at Red Deer is located in a light industrial/commercial area at the north end of Red Deer. The proposed alignment generally travels north along Highway 2A, and crosses several railways and pipelines. The land use between Red Deer and Blackfalds is a combination of both light industrial and agricultural lands.

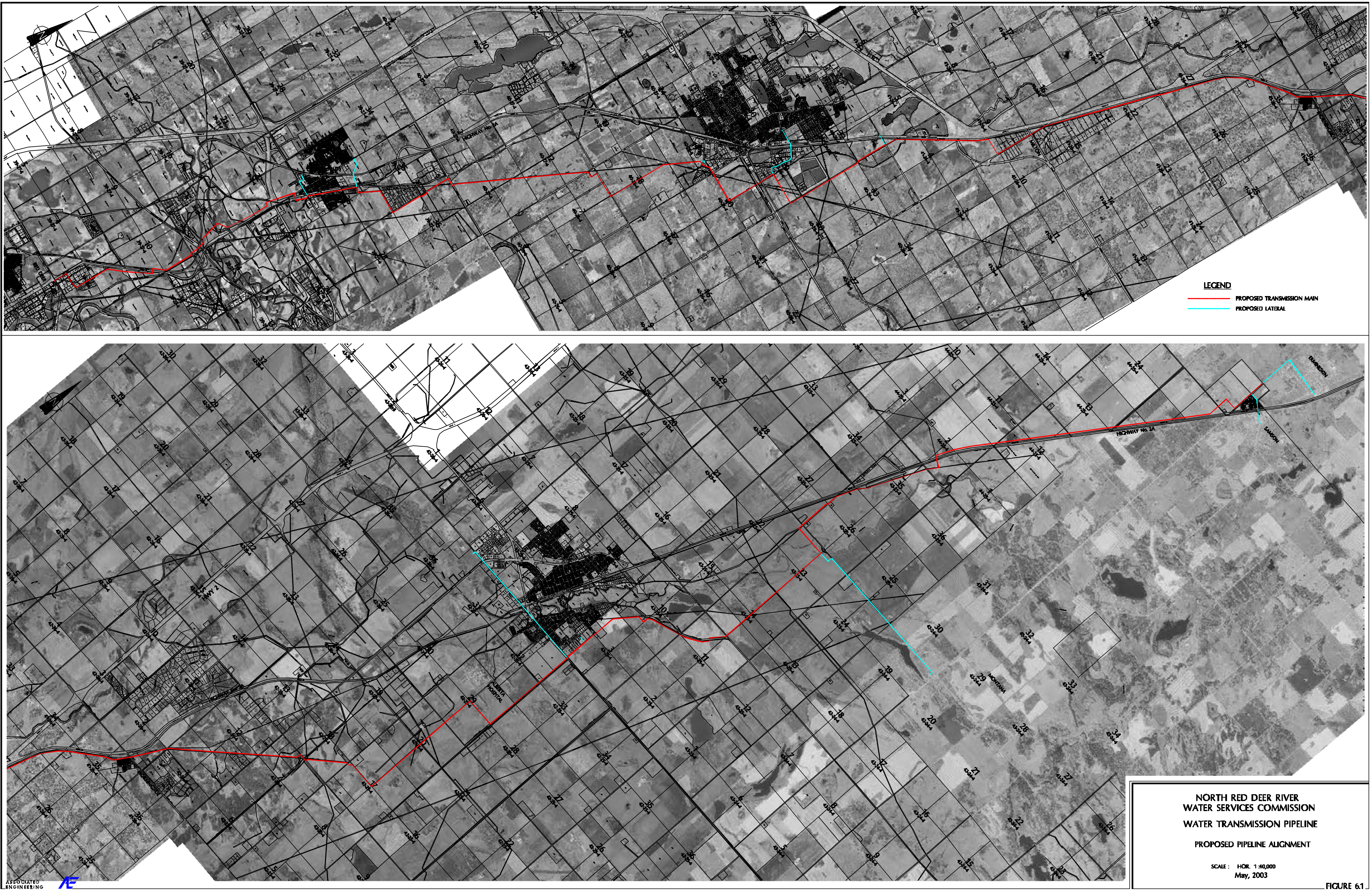
Once past Blackfalds, the alignment follows an existing ATCO high pressure gas pipeline ROW, through agricultural lands. The alignment passes to the east of Lacombe, around the town lagoons. The alignment heads north along Highway 2A until it passes the community of Morningside. It then heads across country, along the edge of the “sand dunes”, to the east of Alberta Hospital. The alignment passes to the east of Ponoka and heads north until it reaches the east/west access road to the Montana Pumphouse (Bobtail Road). The alignment then turns west to meet up with Highway 2A. The proposed alignment follows Highway 2A the remaining distance to the Ermineskin reservoir. The majority of the alignment is situated within and adjacent to agricultural lands.

An alternative alignment may be a route to the west of Ponoka, following geotechnical confirmation.

The proposed alignment is shown on Figure 6.1.

6.2 GEOTECHNICAL

Enclosed in Appendix C is a geotechnical report prepared by Parkland Geotechnical Consulting Ltd.



LEGEND

🟥	PROPOSED TRANSMISSION MAIN
🟦	PROPOSED LATERAL

NORTH RED DEER RIVER
WATER SERVICES COMMISSION
WATER TRANSMISSION PIPELINE

PROPOSED PIPELINE ALIGNMENT

SCALE : HOR. 1:40,000
May, 2003

FIGURE 6.1

ASSOCIATED ENGINEERING

As a result of this preliminary geotechnical evaluation, the following design and construction issues are noted:

- high groundwater is anticipated in many areas, necessitating flatter trench side slopes and seepage control measures;
- the sand and gravel deposits in the Blindman River area appear to preclude horizontal direction drilling methods (unless bedrock material can be encountered at reasonable depths, drilling fluid frac out cannot be prevented);
- the east (high ground) alignment at Ponoka is anticipated to be a lower unit cost construction route than the west (low ground) route, however, subject to geotechnical confirmation, the low ground (west) route may be lower total due to a shorter length.

Detailed geotechnical and geophysical investigations must be conducted at both the Blindman and Battle River crossings. Also, geotechnical investigations along the pipeline route in areas of suspected high groundwater table and sloughing soils are recommended.

Geotechnical investigations can be integrated with the agricultural soils investigation where applicable, prior to detailed design.

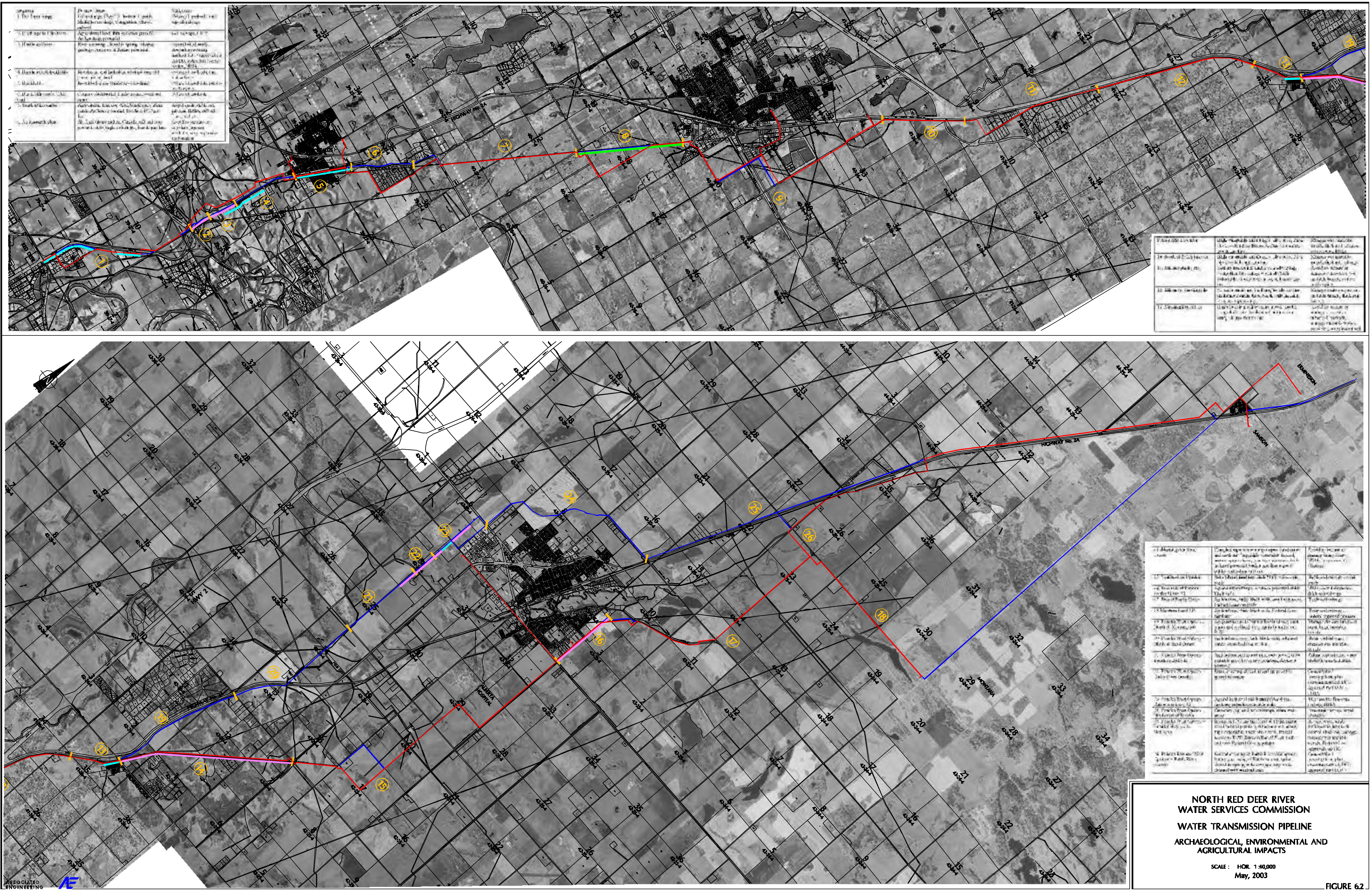
6.3 ENVIRONMENTAL, ARCHAEOLOGICAL, HISTORICAL

Enclosed in Appendix B is a report entitled "Environmental Review of Proposed Routes", prepared by Pedocan Land Evaluation Ltd.

The enclosed Figure 6.2 summarizes the findings of this preliminary investigation.

The selected alignment takes into account Pedocan's report. Where feasible, the alignment has been altered to avoid identified "significant sites".

High potential areas near the Blindman River, Lacombe, Morningside and Ponoka require further investigation to confirm the presence of historical and/or archaeological resources. A complete listing of sites requiring an archaeological investigation is included in Pedocan's



NORTH RED DEER RIVER
WATER SERVICES COMMISSION

WATER TRANSMISSION PIPELINE

ARCHAEOLOGICAL, ENVIRONMENTAL AND
AGRICULTURAL IMPACTS

SCALE : HOR. 1 :40,000
May, 2003

FIGURE 6.2

report (Table 1). A final alignment review may identify other sites requiring a Historical Resource Impact Assessment (HRIA).

A Fish and Fish Habitat Assessment will be required at the Blindman (and Battle) River if open cut installation methods are determined to be the most feasible method.

A Soil Survey and Soil Conservation Plan will be required for the Construction and Reclamation Permit Application.

A summary of Environmental Factors and Issues is provided in Table 2 in Pedocan's report.

6.4 TIE-INS

The tie in at Red Deer will be to the existing 500 mm PVC distribution main at Gaetz Avenue. A meter station will be located downstream of the tie in at a location suitable to both the City of Red Deer and the NRDRWSC (and County of Red Deer if in County lands).

At each of the tie in connections to reservoirs, a fill station will be required. In the existing pump stations, modifications to existing fill piping is required to provide flow control, pressure transmission and other data acquisitions.

The tie-ins have been sized based on the ultimate demand which has been divided between the number of tie-ins requested by each Town. During the detailed design stage, if the allocation of flow is altered, the tie-ins can be resized to accommodate the change.

Ultimately two tie-ins are planned for Blackfalds, as the Town is planning for an additional storage reservoir. Each of these tie-ins is proposed to be 250 mm nominal diameter and will handle 59.5 l/s per connection.

The Town of Lacombe has requested that three tie-ins be used. Each connection is proposed to handle 69 l/s (one third of the ultimate demand for Lacombe) and will be sized at 250 mm nominal diameter.

Two tie-ins are proposed for the Town of Ponoka. Based on the proposed east alignment, a 300 mm lateral to the proposed new reservoir is proposed (92 l/s capacity) and a 200 mm lateral to the east reservoir (39 l/s capacity). If only one connection is planned, then it would handle the entire ultimate demand of 131 l/s and be 350 mm in diameter.

Each of the First Nations has been allotted one connection. The Montana lateral will be approximately 4 kilometers and will require a 150 mm nominal diameter pipe to handle the 13 l/s demand. Samson will require one 350 mm diameter connection to handle the 115 l/s demand. The connection to Ermineskin is proposed at 250 mm diameter, to accommodate 50 L/s demand. The stub-out connection for Louis Bull is to handle 34 L/s.

An allowance has been made for both Lacombe and Ponoka Counties for 1 kilometre of 150 mm diameter lateral, each to be located where specified by the County.

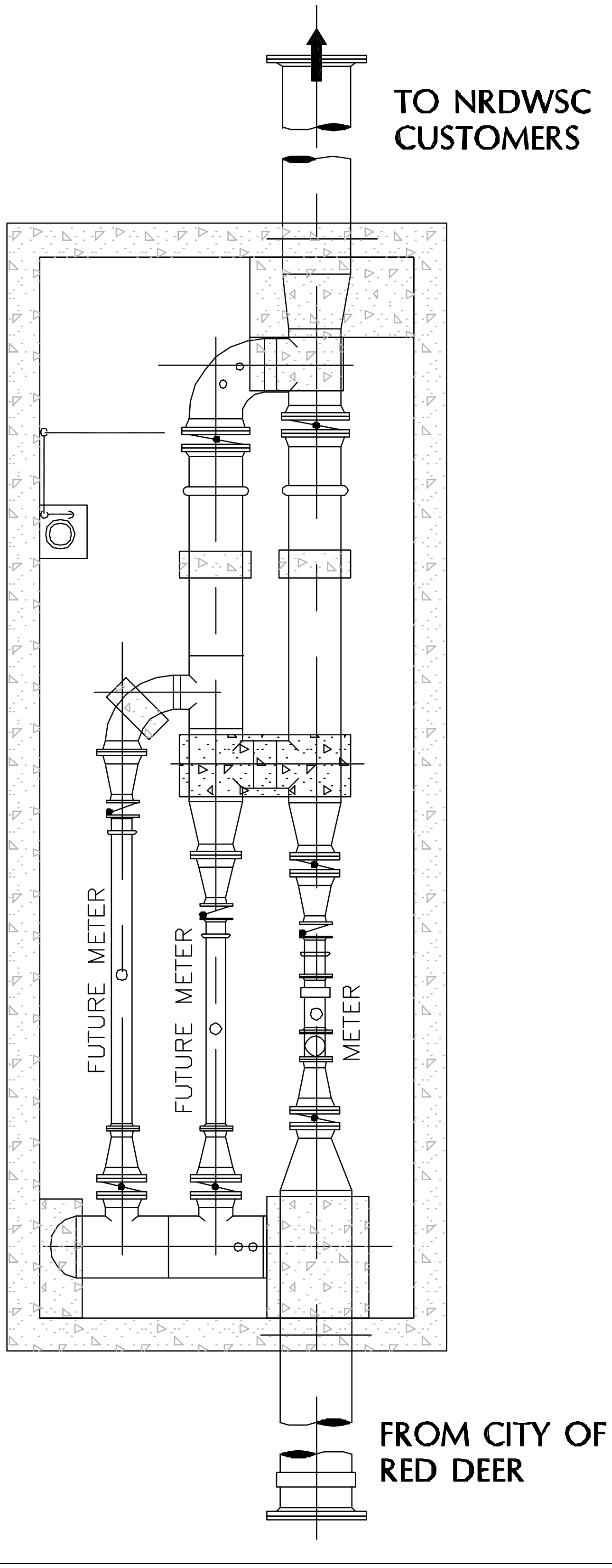
6.5 METER STATION

A typical meter station is shown in Figure 6.3 The meter station will be housed in a waterproof concrete vault. The structure will be below ground. Initially, only one meter will be installed while the others are left for future connection when demand dictates. The station will have the ability to communicate with the control centre.

The concept proposed allows for a turbine or positive displacement type meter. We understand the City of Red Deer will accept a magmeter for flow measurement. Space requirements can be reduced, as the need for pipe diameter reduction can be eliminated. Detailed design will table these options into consideration.

6.6 BOOSTER STATION

Some of the options discussed require the boosting of the supply pressure. A typical booster station layout is shown in Figure 6.4. The booster station will be equipped to communicate with the control centre. Two, variable frequency drive pumps are proposed in the first stage. Provision is proposed in the pumphouse to accommodate four pumps at the ultimate stage. An emergency generator capable of operating a minimum of two of the pumps is recommended.



NORTH RED DEER RIVER WATER SERVICES COMMISSION

METER STATION

FIGURE 6.3

ASSOCIATED ENGINEERING

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Date: 2003/5/14
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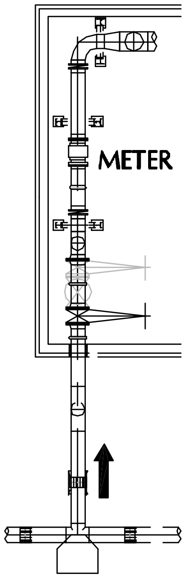
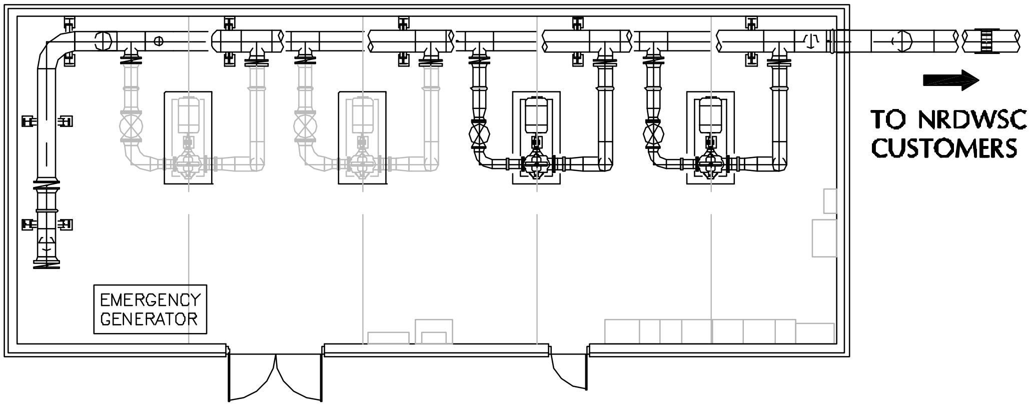
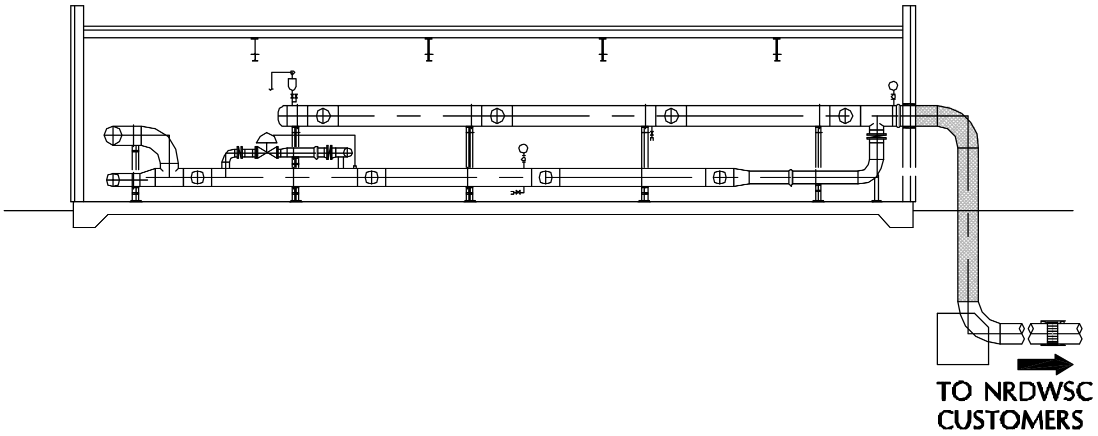


SUPPLY LINE PLAN



BOOSTER STATION PLAN



PIPE SECTION

NORTH RED DEER RIVER
WATER SERVICES COMMISSION

IN - LINE BOOSTER STATION

ASSOCIATED
ENGINEERING

FIGURE 6.4

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Date: 2003/5/14
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Xrefs: 3333RT03

CONSTRUCTION ISSUES

7.1 ENVIRONMENTAL ISSUES

The detail design and construction of the pipeline must also consider environmental factors. Namely creek crossings and top soil reclamation.

Detailed drawings and applications for creek crossings will need to be submitted to Alberta Environment and the Federal Department of Fisheries and Oceans. Crossing approvals will be obtained prior to construction. It is important that the creek crossings are designed such that construction will have minimal to no impact on the creek beds. Horizontal Directional Drilling (HDD) construction methods are proposed to minimize the impact on the environment.

A preliminary geotechnical information suggests that HDD of the Blindman River may not be feasible, due to the gravel formations. If bedrock is not present, at reasonable depth, open cut excavation may be the only option.

Construction will proceed using methods such that top soil is kept separated from the spoil excavation and the topsoil and natural drainage patterns are re-established after construction.

7.1.1 Regulated Pipeline

The Environmental Protection and Enhancement Act (EPEA) and the activities designation regulation require pipelines identified as Class 1 to obtain Conservation and Reclamation approval prior to any surface restoration.

“Class 1 pipelines are directed by the terms and conditions of the approval, as well as the Environment Guidelines. They are subject to Environmental Protection Orders and must also meet the criteria for reclamation certification.” “Http://www.gov.ab.ca/env/protenf/landrec/index.html”.

Class 1 lines are those lines with an "index" of 2690 or greater. The index for the proposed line is calculated as follows:

Pipe OD (mm) x Length of Line (km) $\geq$ 2690
600 mm x 20 km = 12,000 > 2690
500 mm x 18 km = 9,000 > 2690
400 mm x 10 km = 4,000 > 2690

Therefore based on the definition, the proposed pipeline is identified as a Class 1 pipeline.

7.2 CROSSINGS

The proposed pipeline will cross numerous gas pipeline easements, high voltage power lines, telecommunication lines, Highway 2A and county roads. Detailed drawings for crossings will be required for each of these crossings and crossing agreements established prior to construction.

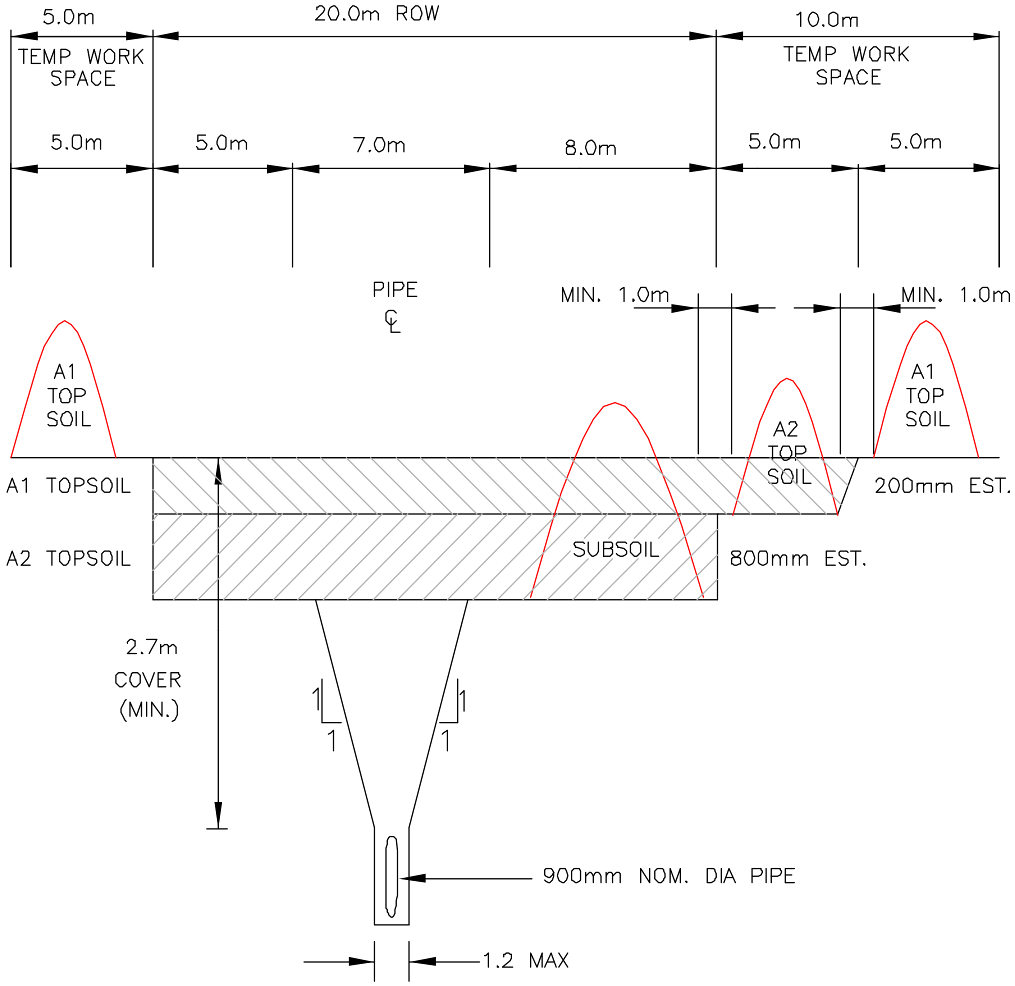
7.3 LAND ACQUISITION (RIGHT-OF-WAYS)

The Right-of-Way proposed is a 20 m permanent right-of-way, and 15 m temporary working space. The attached Figures 7.1 and 7.2 shows a conceptual cross section of how the right-of-way could be proportioned and organized. As a regulated pipeline, the required space will depend on the findings of the Environmental Protection Plan, to appropriately separate the excavated material. The proposed pipeline right-of-ways are shown in Figure 7.3 and 7.4.

The 20 m permanent right-of-way is premised on a lower cost of compensation for the additional 15 m working space. If the landowner compensation for both permanent and working space land is the same, a permanent 35 m right-of-way should be acquired.

7.4 TEMPORARY FENCING

Temporary fencing is required in some locations in order to keep livestock out of construction zones and planted areas. The period this temporary fence has to remain on site

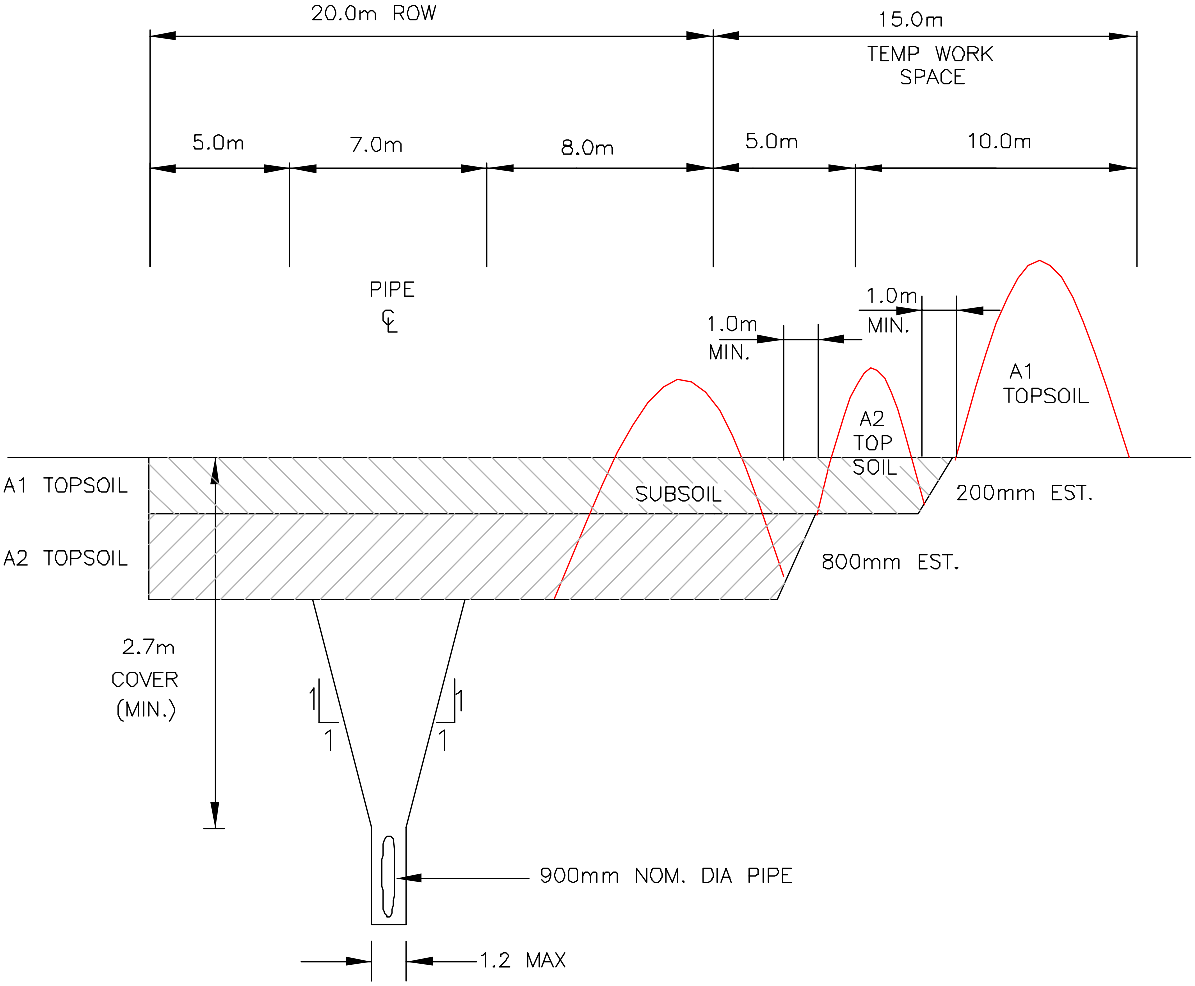


NORTH RED DEER RIVER WATER SERVICES COMMISSION

LAND REQUIREMENT
TEMPORARY WORK SPACE ON BOTH SIDES

FIGURE 7.1

ASSOCIATED ENGINEERING



NORTH RED DEER RIVER WATER SERVICES COMMISSION

LAND REQUIREMENT
TEMPORARY WORK SPACE ON ONE SIDE

ASSOCIATED ENGINEERING

FIGURE 7.2

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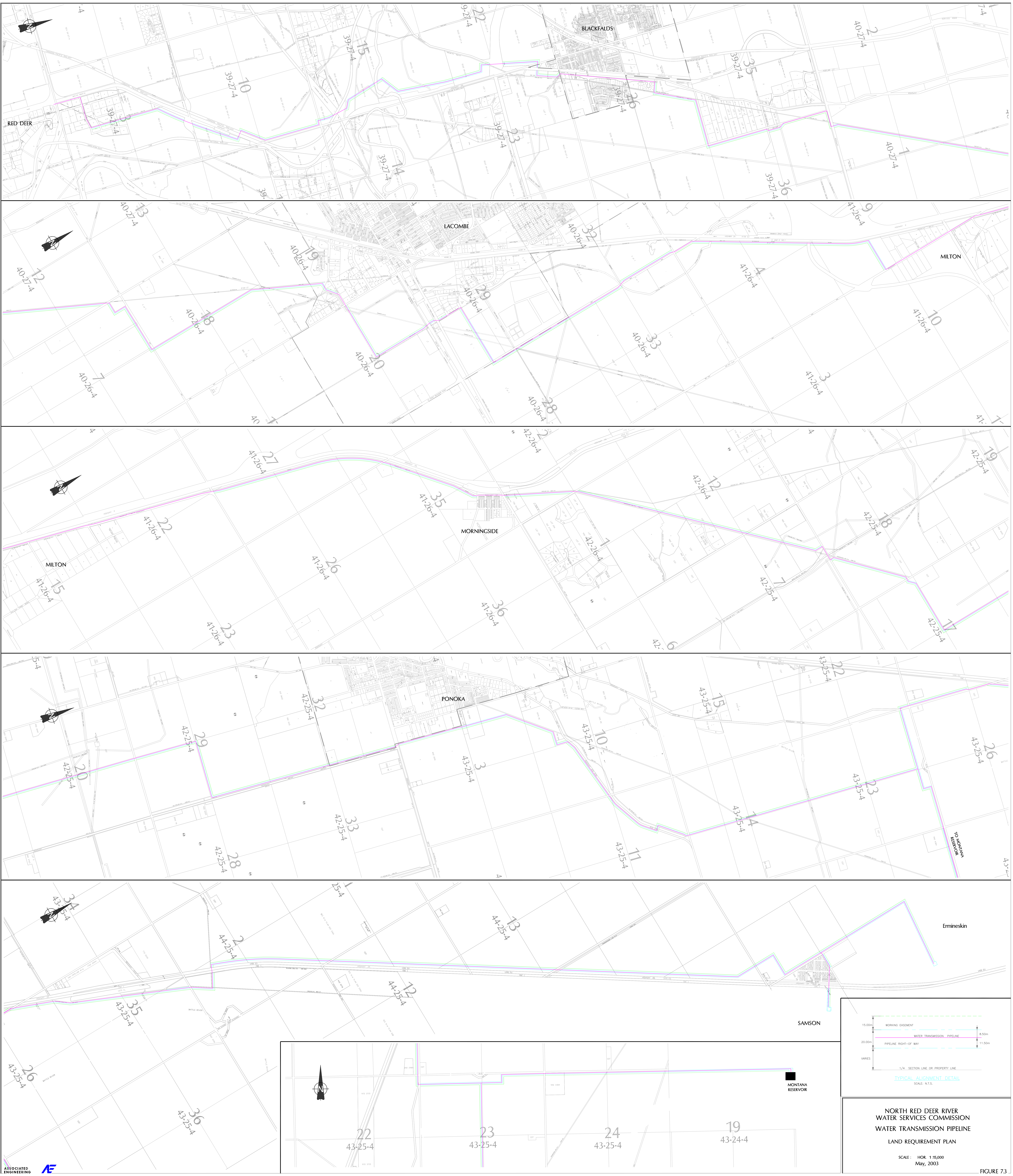
Xrefs: 3333RT03



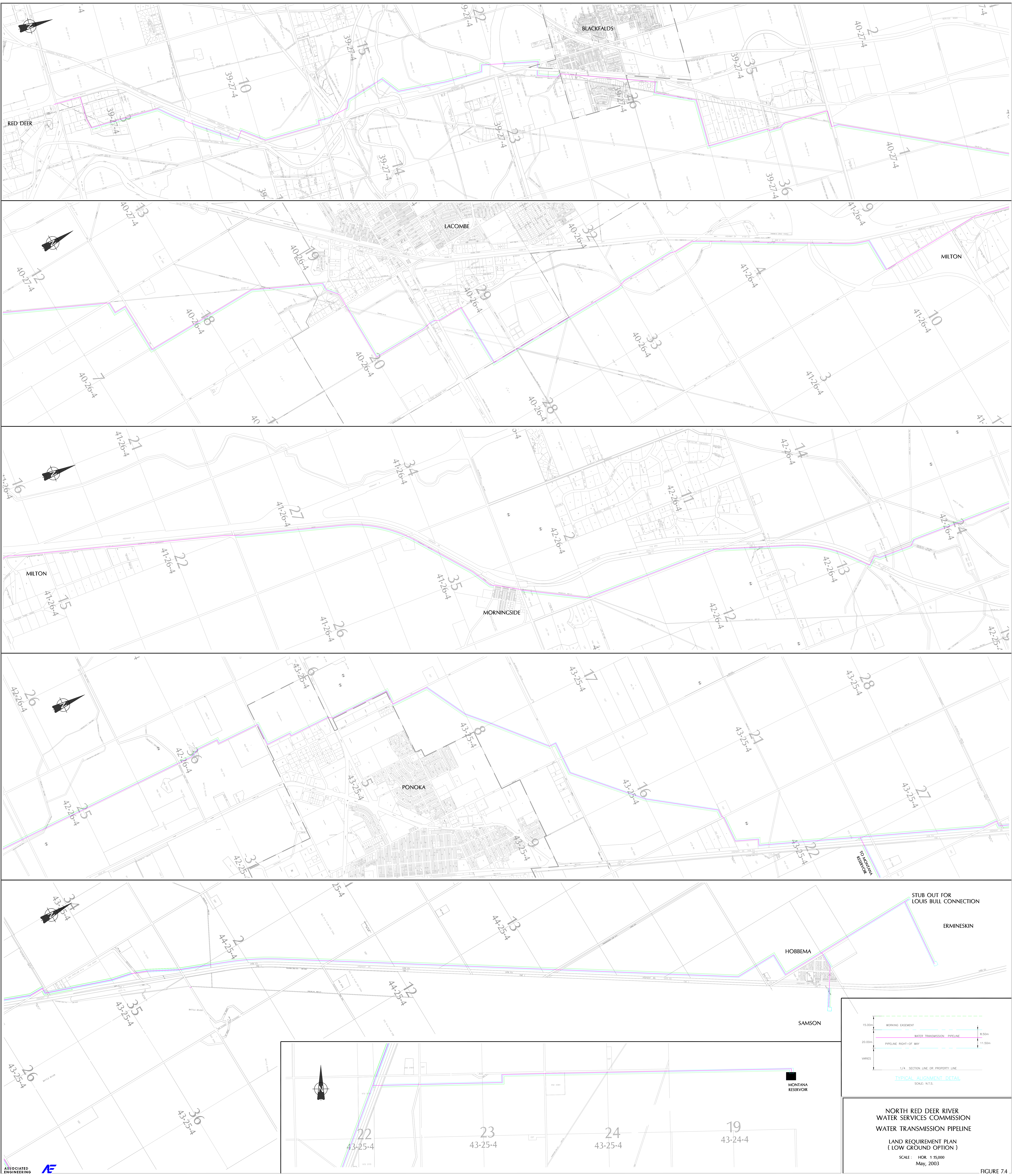
NORTH RED DEER RIVER
WATER SERVICES COMMISSION

WATER TRANSMISSION PIPELINE

LAND REQUIREMENT PLAN

SCALE : HOR. 1 :15,000
May, 2003

FIGURE 7.3



NORTH RED DEER RIVER
WATER SERVICES COMMISSION

WATER TRANSMISSION PIPELINE

LAND REQUIREMENT PLAN
(LOW GROUND OPTION)

SCALE : HOR. 1 :15,000
May, 2003

FIGURE 7.4

depends on how soon the affected area is restored to its original condition. The Environmental Protection Plan will indicate the locations which will require temporary fencing. This will be refined following discussions with land owners.

7.5 TRAFFIC MANAGEMENT

A Traffic Management plan will likely be required by Provincial Authorities. The plan will indicate possible hazards, and required signage and personnel needed for work adjacent to highways and during highway crossings. The Construction Contractor will be required to develop their own traffic management plan as a requirement of the contract.

7.6 SAFETY

Safety issues will need to be identified and addressed. Examples of safety issues are;

- work adjacent to highways, roads, creeks and rivers
- work adjacent to pipelines, powerlines
- ground conditions (ie. soft soils)
- urban settings, rural residences

The safety of both the contractor and the public must be ensured at all times. All regulatory guidelines by Occupational Health and Safety and Workers' Compensation Board will be enforced.

7.7 SUPPLY OF WATER FOR TESTING

It will be prudent to assume the source of water for testing will be from the City of Red Deer. However, due to the large volume required (due to large diameter pipe), short test sections are recommended. This will avoid taxing the Red Deer Treatment Plant to produce water and also minimize wastage.

7.8 ISOLATION VALVES

Isolation valves are recommended along the pipeline as a means to isolate a section of the pipeline for servicing, repair or regular pipeline maintenance. Due to the high capital cost and minimal requirement for isolation valves, they are proposed at approximately 6.4 kilometre (4 mile) spacings.

7.9 FLUSHOUTS

Flushouts are recommended along the pipelines for the ease of draining, testing disinfecting and flushing, the line. Low points, adjacent to creeks and rivers are proposed flushout points.

7.10 PIGGING STATIONS

Pig sending and receiving stations are proposed at the beginning and end of each change in pipe diameter. These facilities are essential for the initial cleaning and disinfection of the pipeline. They also assist for future operation and maintenance, recognizing that the need for future pigging is normally very infrequent (approximately every 15 years).

7.11 COMBINATION AIR RELEASE VALVES

These valve assemblies help to safeguard the pipeline from either entrapped air (causing air lock) during normal operation or a vacuum (pipe collapse) within the line during pipe break or when draining the line.

7.12 DISPOSAL OF SUPER CHLORINATED WATER

Disposal of super chlorinated water used to disinfect the pipeline must be to AEP standards, before discharging.

7.13 WASH STATIONS

Wash stations are required to combat the spread of noxious weeds. The Environmental Plan will indicate locations where all equipment, vehicles and tools will be required to be completely washed down, before moving onto the next land area.

7.14 LAND ISSUES

Estimated Costs for Land Compensation were developed directly from the values recently experienced by the County of Lacombe. Estimated costs are based on compensating temporary working space at the same rate as the permanent working space, adhering to a recent EUB ruling. As noted previously, a 35 metre wide permanent right-of-way should be acquired if compensation is the same for working space as for permanent right-of-way.

7.15 APPROVALS

- Alberta Environmental Protection
  - approval to construct
  - River and Creek Crossings
  - Licence of Occupation (LOC)
  - amendments to existing Municipal licences

- Department of Fisheries and Oceans
  - River and Creek Crossings

- Canadian Coast Guard
  - River and Creek Crossings

- Alberta Transportation
  - Highway Crossings
  - Secondary Highway Crossings

- Gasline Crossings
  - ATCO
  - CNRL
  - Addison Energy
  - Glencoe Resources

  - Enermark Inc.
  - Northrock Resources
  - Alta Gas
  - Dow Chemical
  - BP Canada

- Utilities Crossings
  - telephone
  - cables
  - buried power cables
  - buried gas service lines
  - high voltage, overhead power transmission lines.

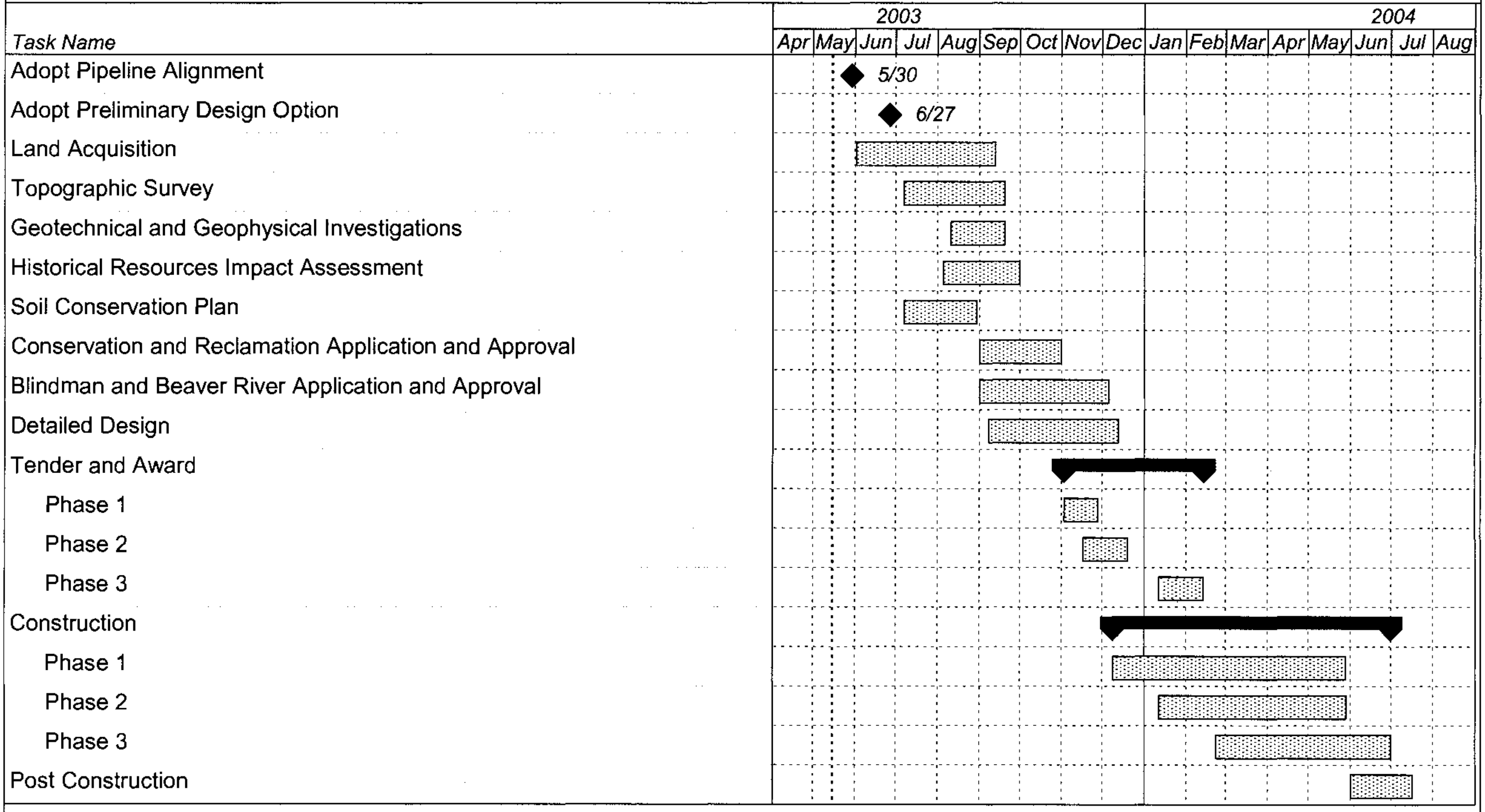
SCHEDULE

SECTION

8

A tentative land acquisition, approvals, design and construction schedule is attached as Figure 8.1. It considers timing restrictions such as those imposed by river crossings, as well as preferred seasons for trenching specific locations. It has been assumed that approvals can be obtained in a timely manner. If the approval process takes longer than expected and/or a full scale environmental impact study is required, the schedule will be impacted accordingly.

North Red Deer River Water Transmission Pipeline
Proposed Project Implementation Schedule



Thu 5/15/03

Figure 8.1

ASSOCIATED ENGINEERING

COST ESTIMATES

Cost Estimates have been developed for the various options. Capital Costs have been estimated for the gravity and pumped plastic pipe options, as well as for the steel and ductile iron pipe options. These capital costs, together with estimated operating and maintenance costs, have then been used to calculate the respective life cycle costs.

Cost estimates include construction and non-construction elements. Non-construction elements include:

- engineering
- geotechnical, geophysical and materials testing
- legal and topographic survey
- land agent
- right-of-way
- solicitor
- environmental, historical, archaeological

The estimated costs are intended to allow for projected 2004 construction costs. The following tables summarize the respective estimated capital and life cycle costs. Detailed breakdowns of these estimated costs are included in the Appendices.

Table 9.1
North Red Deer River Water Transmission Pipeline

Capital Cost Breakdown

From	To	PVC Gravity Option	PVC Pumped Option Pump at Lacombe	Steel Option Pump at Red Deer	Ductile Iron Pump at Lacombe	Ductile Iron Pump at Red Deer
		1.8 PF	**1.8 PF**	**1.8 PF**	**1.8 PF**	**1.8 PF**
Red Deer	Blackfalds	10,753,430	8,416,892	7,189,030	7,436,203	8,632,017
Blackfalds	Lacombe	14,280,821	10,762,287	9,118,497	9,270,122	8,087,157
Lacombe	Morningside	7,244,410	7,244,410	5,373,490	4,762,071	4,308,465
Morningside	Ponoka	10,043,487	7,686,844	7,759,020	6,901,261	6,409,625
Ponoka	Montana	4,496,562	3,668,534	3,953,346	4,040,265	3,045,622
Montana	Samson	5,718,998	5,708,108	6,181,035	5,501,740	4,623,075
Samson	Ermineskin	683,189	683,189	882,403	732,103	711,328
Sub-Total For Pipe		53,220,897	44,170,264	40,456,821	38,643,767	35,817,288
METERING STATION		468,000	468,000		468,000	
BOOSTER STATION(S)			Future	1,535,400	Future	1,535,400
TOTAL		**$53,688,897**	**$44,638,264**	**$41,992,221**	**$39,111,767**	**$37,352,688**

Note: Above costs include Engineering and Contingency
They do not include G.S.T.

Table 9.2
NORTH RED DEER RIVER WATER TRANSMISSION PIPELINE

Ponoka Alignment Cost Comparison For PVC and DI Pipe

From	To	Ponoka High Ground Pump at Lacombe	Ponoka Low Ground Pump at Lacombe
		1.8 PF	**1.8 PF**
Red Deer	Blackfalds	7,436,203	7,436,203
Blackfalds	Lacombe	9,270,122	9,270,122
Lacombe	Morningside	4,762,071	4,762,071
Morningside	Ponoka	6,949,661	5,752,388
Ponoka	Montana	3,704,834	3,456,310
Montana	Samson	5,682,698	5,422,286
Samson	Ermineskin	683,189	617,413
Sub-Total For Pipe		38,488,779	36,716,792
METERING STATION		468,000	468,000
BOOSTER STATION(S)		Future	Future
	TOTAL	**$38,956,779**	**$37,184,792**

Note: Above costs include Engineering and Contingency
They do not include G.S.T.

Table 9.3
North Red Deer River Water Transmission Pipeline

Life Cycle Costs

	PVC Gravity Option	PVC Pumped Option Pump at Lacombe	Steel Option Pump at Red Deer	Ductile Iron Pump at Lacombe	Ductile Iron Pump at Red Deer	Ductile Iron and PVC Option Pump at Lacombe (High Ground Option)
	1.8 PF	1.8 PF	1.8 PF	1.8 PF	1.8 PF	1.8 PF
PIPELINE	71,706,500	59,640,551	55,821,660	52,282,520	48,504,690	52,066,217
METERING STATION	982,614	982,614		982,614		
BOOSTER STATION(S)		2,381,183	12,347,052	2,110,381	12,059,580	2,110,381
TOTAL	$72,689,114	$63,004,348	$68,168,712	$55,375,515	$60,564,270	$54,176,598

CONCLUSIONS

Conclusions derived from the preliminary design of the North Red Deer River Water Transmission Pipeline are as follows:

.1 Long term (50 year) water demand projections for all the proposed members are as per the figures adopted for the inter-basin transfer application.

.2 Short term (10 year) water demand projections have been adjusted slightly, for Blackfalds and Lacombe, from the figures adopted for the inter-basin transfer application.

.3 A peak day demand factor of 1.8 has been adopted for design purposes.

.4 Additional storage capacity is required at Blackfalds and the Ermineskin and Samson Bands to meet the recommended design criteria.

.5 The final alignment proposed is a culmination of assessing the shortest route; agricultural, environmental and historical issues; hydraulic advantages; constructability issues and financial considerations.

.6 A radio spectrum, private (licensed) radio system is the preferred SCADA communication system, subject to confirmation via path studies and Industry Canada approval.

.7 A meter station located south of the Blindman River offers some long term advantages. The NRDRWSC and City of Red Deer, in consultation with the County of Red Deer, need to review options and decide on the optimum long term location.

.8 Policies regarding “air gap” mode of operation and central control location needs to be adopted.

.9 The lowest life cycle cost alternative is as follows:

- Ductile iron pipe from Red Deer to Ponoka;
- PVC pipe from Ponoka to Hobbema;
- Future booster pump station at Lacombe (in approximately 25 years).

.10 A 50-year “gravity” system option was considered but it has the highest capital cost as well as a high life cycle cost, of the options analyzed.

.11 The capital costs for the various material options presented are all within a range of 15%. Many factors, but particularly actual material costs and contractor workload can influence actual construction costs. It would be prudent for the Commission to design and tender the various pipeline material options to ensure true construction industry prices are obtained.

.12 Hydraulic transient analysis shows that under various scenarios (pump/power failures, rapid valve closures), surge suppression can be mitigated with conventional surge protection and negative pressure devices. The most critical event is a sudden valve close at Samson or Ermineskin. This event can be mitigated with surge protection at Ponoka.

(Note: Hydraulic transient analysis performed on PVC and steel in this preliminary design. If ductile iron pipe is adopted, a hydraulic transient analysis of this material should be undertaken as part of detailed design.)

.13 Diurnal flow analysis confirms that fire storage will not be compromised in any of the three urban municipalities, provided storage levels meet the proposed criteria. Blackfalds will be impacted with their current level of storage and proposed peak day design flows. Further analysis is required to assess the impact of higher flows to Blackfalds, during emergency events, if storage addition is deferred.

.14 As the City of Red Deer uses choramine disinfection, it is anticipated that chloramine residuals can be maintained to the system extremities, based on experience in other regional systems. Rechlorination is not anticipated.

.15 The next phase of this project is to proceed with land acquisition, environmental approvals, historical assessments, topographic surveys and soils investigations.

.16 The implementation schedule provided is subject to decisions on the service envelope and confirmation of funding. To achieve water delivery by spring, 2004, the next phase of implementation must proceed immediately.

RECOMMENDATIONS

SECTION 11

We respectfully recommend the following:

.1 The Commission adopt the design criteria presented in this report for detailed design.

.2 The Commission adopt proposed pipeline alignment for implementation.

.3 The Commission authorize proceeding with land acquisition for the proposed pipeline alignment.

.4 The Commission adopt a regional pipeline option, for purposes of detailed design and construction. The recommended option is a booster station at Lacombe in the future, with ductile iron pipe upstream of Ponoka and PVC pipe downstream of Ponoka.

.5 The Commission authorize the next phase of implementation, as soon as the service envelope and pipeline option have been adopted.

.6 If ductile iron pipe material or a combination of ductile iron pipe and PVC pipe is adopted, a hydraulic transient analysis based on actual materials, pressure classes, diameters and alignments be undertaken.

.7 The Commission design and tender up to three pipe options: PVC, Steel and Ductile Iron/PVC Combination. This will ensure the Commission obtains the true market cot for all options and hence the ability to select the optimum value option.

CLOSURE

This report was prepared for the North Red Deer River Water Services Commission. This report is a preliminary design report to establish a proposed pipeline alignment and assess options and costs for a regional water transmission pipeline.

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.

BLAIR G. BIRCH

B.G. Birch, P.Eng.
Project Manager

KAI Y. CH'NG

Kai Ch'ng, P.Eng
Project Engineer

CANDICE E. RITCHIE

Candice Ritchie, P.Eng.
Design Engineer

ROBERT R. TURNER

Bob Turner, P. Eng.
Electrical Controls Engineer

PERMIT TO PRACTICE
ASSOCIATED ENGINEERING ALBERTA LTD.
Signature ________________________
Date ____________________________
PERMIT NUMBER: P 3979
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ESTIMATED COST BREAKDOWNS

APPENDIX

A

NORTH RED DEER RIVER WATER TRANSMISSION PIPELINE

Pipe Material and Installation Costs

Nominal Diameter	TOTAL COST					
	PVC **DR25**	**HDPE** **DR 17** **(1 Pipe Size Larger)**	**STEEL** X42	**DUCTILE IRON** **PC 350**	**DUCTILE IRON** **PC Varies**	
250	$123	$132	$237			
300	$134		$258	$169		
350	$158	$176	$286	$185	$176	PC 250
400	$188	$209	$313	$213	$200	PC 250
450	$223	$249	$338	$241	$225	PC 250
500	$274	$323	$363	$280	$260	PC 250
600	$348		$405	$347	$306	PC 200
750	$488			$501	$405	PC 150
900	$661			$754	$589	PC 150

NOTE: Installation costs includes topsoil, stripping, trench excavation, pipe installation, pipe zone material, backfilling, topsoil replacement and misc. fittings, equipment and washdown stations, fencing, signage, hydrostatic testing and disinfecting and pigging.

N:\033333\Report\Report Excel Files\Pipe Material Costs_Unit Costs

NORTH RED DEER RIVER WATER TRANSMISSION PIPELINE

Pipe Material and Installation Costs

	PIPE MATERIAL COST			INSTALLATION COST	MARKUP	TOTAL COST	
Material	**Nominal Diameter**	**Internal Diameter**	**Unit Cost**	**Labour**	**15% (on Material)**	**(inc. 5% infl. for year 2004)**	
PVC							
DR 25	**250**	260	41	$70.00	6.15	**123**	
DR 25	**300**	309	50	$70.00	7.5	**134**	Material Costs Estimated
DR 25	**350**	357.5	65.75	$75.00	9.8625	**158**	
DR 25	**400**	406.6	85.8	$80.00	12.87	**188**	
DR 25	**450**	455.7	108.1	$88.00	16.215	**223**	
DR 25	**500**	504.7	140	$100.00	21	**274**	Material Costs Estimated
DR 25	**600**	602.9	192.9	$110.00	28.935	**348**	
DR 25	**750**	747.8	299.8	$120.00	44.97	**488**	
DR 25	**900**	895	430	$135.00	64.5	**661**	Material Costs Estimated
DR 18	**250**	250	54.35	$70.00	8.1525	**139**	
DR 18	**350**	345.4	104.55	$75.00	15.6825	**205**	
DR 18	**400**	392.9	118.2	$80.00	17.73	**227**	
DR 18	**450**	440.3	148.75	$88.00	22.3125	**272**	
DR 18	**600**	582.5	263.35	$110.00	39.5025	**433**	
DR 26	**250**	250.79	31.5	$70.00	4.725	**112**	
DR 26	**300**	297.61	40	$70.00	6	**122**	Material Costs Estimated
DR 26	**350**	326.56	53.35	$75.00	8.0025	**143**	
DR 26	**400**	373.33	70.3	$80.00	10.545	**169**	
DR 26	**450**	419.89	89.5	$88.00	13.425	**200**	
DR 26	**600**	559.78	160.95	$110.00	24.1425	**310**	
HDPE							
DR 17	**300**	283.46	48.59	$70.00	7.2885	**132**	
DR 17	**400**	355.73	76.45	$80.00	11.4675	**176**	
DR 17	**450**	400.18	96.82	$88.00	14.523	**209**	
DR 17	**500**	444.68	119.46	$100.00	17.919	**249**	
DR 17	**600**	533.58	172.12	$110.00	25.818	**323**	
DR 11	**300**	261.44	72.31	$70.00	10.8465	**161**	
DR 11	**450**	369.11	144.1	$88.00	21.615	**266**	
DR 11	**500**	410.1	177.96	$100.00	26.694	**320**	
DR 11	**600**	492.1	256.34	$110.00	38.451	**425**	
DR 9	**750**	582.52	478	$120.00	71.7	**703**	

NORTH RED DEER RIVER WATER TRANSMISSION PIPELINE

Pipe Material and Installation Costs

Material	PIPE MATERIAL COST Nominal Diameter	Internal Diameter	Unit Cost			INSTALLATION COST Labour	MARKUP 15% (on Material)	TOTAL COST (inc. 5% infl. for year 2004)
STEEL			**MATERIAL**	**INTERNAL COATING**	**EXTERNAL COATING**			
	250	260.3	49.83	12.81	7.96	145	10.59	**237.00**
	300		57	17	9.5	150	12.525	**258.00**
	350	342.8	65.25	21.15	10.99	160	14.6085	**286.00**
	400	393.6	74.75	24.11	12.74	170	16.74	**313.00**
	450	444.4	84.23	27.25	16.08	175	19.134	**338.00**
	500		95	31	18	180	21.6	**363.00**
	600	597.2	112.78	36.12	21.35	190	25.5375	**405.00**
				Cement Mortar Lining				
DUCTILE IRON			**MATERIAL PC 350**					**PC 350**
	300		70			80	10.5	**169**
	350		79			85	11.85	**185**
	400		98			90	14.7	**213**
	450		114			98	17.1	**241**
	500		136			110	20.4	**280**
	600		183			120	27.45	**347**
	750		302			130	45.3	**501**
	900		498			145	74.7	**754**
			MATERIAL					**various PC**
	350		72	**PC 250**		85	10.8	**176**
	400		87	**PC 250**		90	13.05	**200**
	450		101	**PC 250**		98	15.15	**225**
	500		120	**PC 250**		110	18	**260**
	600		149	**PC 200**		120	22.35	**306**
	750		222	**PC 150**		130	33.3	**405**
	900		362	**PC 150**		145	54.3	**589**

NOTE: Installation costs includes topsoil, stripping, trench excavation, pipe installation, pipe zone material, backfilling, topsoil replacement and misc. fittings, equipment and washdown stations, fencing, signage, hydrostatic testing and disinfecting and pigging.

NORTH RED DEER RIVER WATER TRANSMISSION PIPELINE

PEAK DAY = 1.8 * AVERAGE DAY

COST BREAKDOWN

PVC Option

GRAVITY SYSTEM - PONOKA HIGH GROUND
OPTION 1

		Length	Diameter	Material	Pipe/Constr.	Sub Total	# Valves	Valve	Total	PRV, CAV's	Unit	Total	Pig Launch	Tie-in	Tie-in	Easements		River	Clearing	Highway		Total	Railway		Total	Pipeline		Total	County Rd		Total	Creeks		Total	TOTAL	Non-Construction	Eng, Mat Testing	Contingency	GRAND TOTAL
					Unit Cost	Pipe/Constr.	(mainline)	Unit Cost	Valves		cost			Red Deer	Connections	Land	Crop	Crossing	Grubbing	Crossing	Unit Price	Highway	Crossing	Unit Price	Railway	Crossing	Unit Price	Pipeline	Crossing	Unit Price	County Rd	Crossing	Unit Price	Creeks		Costs (1%)	Geotech. (10%)	10%	
Red Deer	Blackfalds	9713	900	DR 25	661	6,420,050	2	120,000	$240,000	3	20,000	60,000	55,000	50,000	420,000	210,772	30,596	600,000	75,000	160	2,500	400,000	120	2,500	300,000	7	5,000	35,000	3	10,000	30,000	1	25,000	25,000	9,136,714				
Blackfalds	Lacombe	15378	900	DR 25	661	10,164,474	3	120,000	$360,000	3	20,000	60,000	55,000		470,000	333,703	48,441			40	2,500	100,000	30	2,500	75,000	4	5,000	20,000	8	10,000	80,000	1	25,000	25,000	11,976,706				
Lacombe	Morningside	10569	750	DR 25	488	5,157,762	2	75,000	$150,000	3	20,000	60,000	50,000			229,347	33,292			120	2,000	240,000				2	4,000	8,000	6	8,000	48,000				6,085,534				
Morningside	Ponoka	13391	750	DR 25	488	6,534,922	3	75,000	$225,000	3	20,000	60,000	50,000		887,000	290,585	42,182			40	2,000	80,000				7	4,000	28,000	6	8,000	48,000	2	22,000	44,000	8,420,749				
Ponoka	Montana	7789	600	DR 25	348	2,713,896	2	50,000	$100,000	3	20,000	60,000	80,000		470,000	169,021	24,535									2	3,500	7,000	3	7,000	21,000	3	20,000	60,000	3,805,966				
Montana	Samson	13154	500	DR 25	274	3,604,854	3	35,000	$105,000	2	15,000	30,000	60,000		300,000	285,442	41,435	100,000		40	1,200	48,000	30	1,200	36,000	3	3,000	9,000	7	6,000	42,000	3	18,000	54,000	4,795,219				
Samson	Ermineskin	2240	350	DR 25	158	354,241	1	10,000	$10,000	1	10,000	10,000	40,000		75,000	48,608	7,056												3	3,000	9,000				576,910				
	TOTAL	72234			SUB-TOTAL	34,950,198			1,190,000			340,000	390,000	50,000	2,622,000	1,567,478	227,537	700,000	75,000			868,000			411,000			107,000			278,000			208,000	43,984,213	439,842	$4,398,421	$4,398,421	$53,220,897

Note : mainline valves assumed 1 every 6 km

PUMPED SYSTEM - PONOKA HIGH GROUND

PUMP AT LACOMBE

OPTION B

		Length	Diameter	Material	Pipe/Constr.	Sub Total	# Valves	Valve	Total	PRV, CAV's	Unit	Total	Pig Launch	Tie-in	Tie-in	Easements		River	Clearing	Highway		Total	Railway		Total	Pipeline		Total	County Rd		Total	Creeks		Total	TOTAL	Non-Construction	Eng, Mat Testing	Contingency	GRAND TOTAL
					Unit Cost	Pipe/Constr.	(mainline)	Unit Cost	Valves		cost			Red Deer	Connections	Land	Crop	Crossing	Grubbing	Crossing	Unit Price	Highway	Crossing	Unit Price	Railway	Crossing	Unit Price	Pipeline	Crossing	Unit Price	County Rd	Crossing	Unit Price	Creeks		Costs (1%)	Geotech. (10%)	10%	
Red Deer	Blackfalds	9713	750	DR 25	488	4,740,027	2	75,000	$150,000	3	20,000	60,000	50,000	50,000	420,000	210,772	30,596	600,000	75,000	160	2,000	320,000	120	2,000	240,000	7	4,000	28,000	3	8,000	24,000	1	22,000	22,000					
Blackfalds	Lacombe	15378	750	DR 25	488	7,504,595	3	75,000	$225,000	3	20,000	60,000			470,000	333,703	48,441			40	2,000	80,000	30	2,000	60,000	4	4,000	16,000	8	8,000	64,000	1	22,000	22,000					
Lacombe	Morningside	10569	750	DR 25	488	5,157,762	2	75,000	$150,000	3	20,000	60,000	50,000			229,347	33,292			120	2,000	240,000				2	4,000	8,000	6	8,000	48,000								
Morningside	Ponoka	13391	600	DR 25	348	4,665,783	3	50,000	$150,000	3	20,000	60,000	80,000		887,000	290,585	42,182			40	1,500	60,000				7	3,500	24,500	6	7,000	42,000	2	20,000	40,000					
Ponoka	Montana	7789	500	DR 25	274	2,134,575	2	35,000	$70,000	3	15,000	45,000	30,000		470,000	169,021	24,535									2	3,000	6,000	3	6,000	18,000	3	18,000	54,000					
Montana	Samson	13154	500	DR 25	274	3,604,854	3	35,000	$105,000	2	15,000	30,000	30,000		300,000	285,442	41,435	100,000		40	1,500	60,000	30	1,500	45,000	3	3,000	9,000	7	6,000	42,000	3	18,000	54,000					
Samson	Ermineskin	2240	350	DR 25	158	354,241	1	10,000	$10,000	1	10,000	10,000	40,000		75,000	48,608	7,056												3	3,000	9,000								
	TOTAL	72234			SUB-TOTAL	28,161,835		SUB-TOTAL	860,000			325,000	280,000	50,000	2,622,000	1,567,478	227,537	700,000	75,000			760,000			345,000			91,500			247,000	TOTAL		192,000	36,504,350	365,044	$3,650,435	$3,650,435	$44,170,264

Note : mainline valves assumed 1 every 6 km

Steel Option

PUMPED SYSTEM - PONOKA HIGH GROUND

PUMP AT Red Deer

OPTION A

		Length	Diameter	Material	Pipe/Constr.	Sub Total	# Valves	Valve	Total	PRV, CAV's	Unit	Total	Pig Launch	Tie-in	Tie-in	Easements		River	Clearing	Highway		Total	Railway		Total	Pipeline		Total	County Rd		Total	Creeks		Total	TOTAL	Non-Construction	Eng, Mat Testing	Contingency	GRAND TOTAL
					Unit Cost	Pipe/Constr.	(mainline)	Unit Cost	Valves		cost			Red Deer	Connections	Land	Crop	Crossing	Grubbing	Crossing	Unit Price	Highway	Crossing	Unit Price	Railway	Crossing	Unit Price	Pipeline	Crossing	Unit Price	County Rd	Crossing	Unit Price	Creeks		Costs (1%)	Geotech. (10%)	10%	
Red Deer	Blackfalds	9713	600	STEEL	405	3,933,765	2	50,000	$100,000	3	20,000	60,000	40,000	50,000	420,000	210,772	30,596	600,000	75,000	160	1,500	240,000	120	1,500	180,000	7	3,500	24,500	3	7,000	21,000	1	20,000	20,000					
Blackfalds	Lacombe	15378	600	STEEL	405	6,228,090	3	50,000	$150,000	3	20,000	60,000	40,000		470,000	333,703	48,441			40	1,500	60,000	30	1,500	45,000	4	3,500	14,000	8	7,000	56,000	1	20,000	20,000					
Lacombe	Morningside	10569	500	STEEL	363	3,836,547	2	35,000	$70,000	3	15,000	45,000	30,000			229,347	33,292			120	1,200	144,000				2	3,000	6,000	6	6,000	36,000								
Morningside	Ponoka	13391	500	STEEL	363	4,860,933	3	35,000	$105,000	3	15,000	45,000	30,000		887,000	290,585	42,182			40	1,200	48,000				7	3,000	21,000	6	6,000	36,000	2	18,000	36,000					
Ponoka	Montana	7789	400	STEEL	313	2,437,957	2	20,000	$40,000	3	10,000	30,000	20,000		470,000	169,021	24,535									2	2,500	5,000	3	4,000	12,000	3	16,000	48,000					
Montana	Samson	13154	400	STEEL	313	4,117,202	3	20,000	$60,000	2	10,000	20,000	20,000		300,000	285,442	41,435	100,000		40	1,000	40,000	30	1,000	30,000	3	2,500	7,500	7	4,000	28,000	3	16,000	48,000					
Samson	Ermineskin	2240	300	STEEL	237	530,880	1	8,000	$8,000	1	10,000	10,000	30,000		75,000	48,608	7,056												3	3,000	9,000								
	TOTAL	72234			SUB-TOTAL	25,945,374		SUB-TOTAL	533,000			270,000	210,000	50,000	2,622,000	1,567,478	227,537	700,000	75,000			532,000			255,000			78,000			198,000	TOTAL		172,000	33,435,389	334,354	$3,343,539	$3,343,539	$40,456,821

Note : mainline valves assumed 1 every 6 km

Ductile Iron Option

PUMPED SYSTEM - PONOKA HIGH GROUND

PUMP AT Lacombe

		Length	Diameter	Material	Pipe/Constr.	Sub Total	# Valves	Valve	Total	PRV, CAV's	Unit	Total	Pig Launch	Tie-in	Tie-in	Easements		River	Clearing	Highway		Total	Railway		Total	Pipeline		Total	County Rd		Total	Creeks		Total	TOTAL	Non-Construction	Eng, Mat Testing	Contingency	GRAND TOTAL
					Unit Cost	Pipe/Constr.	(mainline)	Unit Cost	Valves		cost			Red Deer	Connections	Land	Crop	Crossing	Grubbing	Crossing	Unit Price	Highway	Crossing	Unit Price	Railway	Crossing	Unit Price	Pipeline	Crossing	Unit Price	County Rd	Crossing	Unit Price	Creeks		Costs (1%)	Geotech. (10%)	10%	
Red Deer	Blackfalds	9713	750	DI	405	3,929,540	2	75,000	$150,000	3	20,000	60,000	50,000	50,000	420,000	210,772	30,596	600,000	75,000	160	2,000	320,000	120	2,000	240,000	7	4,000	28,000	3	8,000	24,000	1	22,000	22,000					
Blackfalds	Lacombe	15378	750	DI	405	6,221,401	3	75,000	$225,000	3	20,000	60,000	50,000		470,000	333,703	48,441			40	2,000	80,000	30	2,000	60,000	4	4,000	16,000	8	8,000	64,000	1	22,000	22,000					
Lacombe	Morningside	10569	600	DI	306	3,233,242	2	50,000	$100,000	3	20,000	60,000	40,000			229,347	33,292			120	1,500	180,000				2	3,500	7,000	6	7,000	42,000								
Morningside	Ponoka	13391	600	DI	306	4,096,541	3	50,000	$150,000	3	20,000	60,000	0		887,000	290,585	42,182			40	1,500	60,000				7	3,500	24,500	6	7,000	42,000	2	20,000	40,000					
Ponoka	Montana	7789	600	DI	306	2,382,791	2	50,000	$100,000	3	20,000	60,000	40,000		470,000	169,021	24,535									2	3,500	7,000	3	7,000	21,000	3	18,000	54,000					
Montana	Samson	13154	500	DI	260	3,425,302	3	35,000	$105,000	2	15,000	30,000	60,000		300,000	285,442	41,435	100,000		40	1,200	48,000	30	1,200	36,000	3	3,000	9,000	7	6,000	42,000	3	18,000	54,000					
Samson	Ermineskin	2240	350	DI	176	394,666	1	10,000	$10,000	1	10,000	10,000	40,000		75,000	48,608	7,056												3	3,000	9,000								
	TOTAL	72234			SUB-TOTAL	23,683,482		SUB-TOTAL	840,000			340,000	280,000	50,000	2,622,000	1,567,478	227,537	700,000	75,000			688,000			336,000			91,500			244,000	TOTAL		192,000	31,936,997	319,370	$3,193,700	$3,193,700	$38,643,767

Note : mainline valves assumed 1 every 6 km

PUMPED SYSTEM - PONOKA HIGH GROUND

PUMP AT Red Deer

		Length	Diameter	Material	Pipe/Constr.	Sub Total	# Valves	Valve	Total	PRV, CAV's	Unit	Total	Pig Launch	Tie-in	Tie-in	Easements		River	Clearing	Highway		Total	Railway		Total	Pipeline		Total	County Rd		Total	Creeks		Total	TOTAL	Non-Construction	Eng, Mat Testing	Contingency	GRAND TOTAL
					Unit Cost	Pipe/Constr.	(mainline)	Unit Cost	Valves		cost			Red Deer	Connections	Land	Crop	Crossing	Grubbing	Crossing	Unit Price	Highway	Crossing	Unit Price	Railway	Crossing	Unit Price	Pipeline	Crossing	Unit Price	County Rd	Crossing	Unit Price	Creeks		Costs (1%)	Geotech. (10%)	10%	
Red Deer	Blackfalds	9713	750	DI	501	4,867,816	2	75,000	$150,000	3	20,000	60,000	100,000	50,000	420,000	210,772	30,596	600,000	75,000	160	2,000	320,000	120	2,000	240,000	7	4,000	28,000	3	8,000	24,000	1	22,000	22,000					
Blackfalds	Lacombe	15378	600	DI	347	5,335,743	3	50,000	$150,000	3	20,000	60,000	80,000		470,000	333,703	48,441			40	1,500	60,000	30	1,500	45,000	4	3,500	14,000	8	7,000	56,000	1	20,000	20,000					
Lacombe	Morningside	10569	500	DI	280	2,956,361	2	35,000	$70,000	3	15,000	45,000	30,000			229,347	33,292			120	1,200	144,000				2	3,000	6,000	6	6,000	36,000								
Morningside	Ponoka	13391	500	DI	280	3,745,731	3	35,000	$105,000	3	15,000	45,000	30,000		887,000	290,585	42,182			40	1,200	48,000				7	3,000	21,000	6	6,000	36,000	2	18,000	36,000					
Ponoka	Montana	7789	400	DI	213	1,657,772	2	25,000	$50,000	3	15,000	45,000	25,000		470,000	169,021	24,535									2	2,500	5,000	3	4,000	12,000	3	16,000	48,000					
Montana	Samson	13154	400	DI	213	2,799,632	3	25,000	$75,000	2	15,000	30,000	25,000		300,000	285,442	41,435	100,000		40	1,000	40,000	30	1,000	30,000	3	2,500	7,500	7	4,000	28,000	3	16,000	48,000					
Samson	Ermineskin	2240	300	DI	169	377,496	1	10,000	$10,000	1	10,000	10,000	40,000		75,000	48,608	7,056												3	3,000	9,000								
	TOTAL	72234			SUB-TOTAL	21,740,549		SUB-TOTAL	610,000			295,000	330,000	50,000	2,622,000	1,567,478	227,537	700,000	75,000			612,000			315,000			81,500			201,000	TOTAL		174,000	29,601,064	296,011	$2,960,106	$2,960,106	$35,817,288

Note : mainline valves assumed 1 every 6 km

Ductile Iron and PVC Option

PUMPED SYSTEM - PONOKA HIGH GROUND

PUMP AT Lacombe

		Length	Diameter	Material	Pipe/Constr.	Sub Total	# Valves	Valve	Total	PRV, CAV's	Unit	Total	Pig Launch	Tie-in	Tie-in	Easements		River	Clearing	Highway		Total	Railway		Total	Pipeline		Total	County Rd		Total	Creeks		Total	TOTAL	Non-Construction	Eng, Mat Testing	Contingency	GRAND TOTAL
					Unit Cost	Pipe/Constr.	(mainline)	Unit Cost	Valves		cost			Red Deer	Connections	Land	Crop	Crossing	Grubbing	Crossing	Unit Price	Highway	Crossing	Unit Price	Railway	Crossing	Unit Price	Pipeline	Crossing	Unit Price	County Rd	Crossing	Unit Price	Creeks		Costs (1%)	Geotech. (10%)	10%	
Red Deer	Blackfalds	9713	750	DI	405	3,929,540	2	75,000	$150,000	3	20,000	60,000	50,000	50,000	420,000	210,772	30,596	600,000	75,000	160	2,000	320,000	120	2,000	240,000	7	4,000	28,000	3	8,000	24,000	1	22,000	22,000					
Blackfalds	Lacombe	15378	750	DI	405	6,221,401	3	75,000	$225,000	3	20,000	60,000	50,000		470,000	333,703	48,441			40	2,000	80,000	30	2,000	60,000	4	4,000	16,000	8	8,000	64,000	1	22,000	22,000					
Lacombe	Morningside	10569	600	DI	306	3,233,242	2	50,000	$100,000	3	20,000	60,000	40,000			229,347	33,292			120	1,500	180,000				2	3,500	7,000	6	7,000	42,000								
Morningside	Ponoka	13391	600	DI	306	4,096,541	3	50,000	$150,000	3	20,000	60,000	40,000		887,000	290,585	42,182			40	1,500	60,000				7	3,500	24,500	6	7,000	42,000	2	20,000	40,000					
Ponoka	Montana	5878	500	PVC	274	1,610,866	1	50,000	$50,000	3	20,000	60,000	30,000		470,000	127,553	18,516									2	3,000	6,000	3	6,000	18,000	3	18,000	54,000					
		1911	500	PVC	274	523,710	1	35,000	$35,000							41,469	6,020																						
Montana	Samson	13154	500	PVC	274	3,604,854	3	35,000	$105,000	2	15,000	30,000	30,000		300,000	285,442	41,435	100,000		40	1,200	48,000	30	1,200	36,000	3	3,000	9,000	7	6,000	42,000	3	18,000	54,000					
Samson	Ermineskin	2240	350	PVC	158	354,241	1	10,000	$10,000	1	10,000	10,000	40,000		75,000	48,608	7,056												3	3,000	9,000								
	TOTAL	72234			SUB-TOTAL	23,574,393		SUB-TOTAL	825,000			340,000	280,000	50,000	2,622,000	1,567,478	227,537	700,000	75,000			688,000			336,000			90,500			241,000	TOTAL		192,000	31,808,908	318,089	$3,180,891	$3,180,891	$38,488,779

Note : mainline valves assumed 1 every 6 km

PUMPED SYSTEM - PONOKA LOW GROUND

PUMP AT Lacombe

		Length	Diameter	Material	Pipe/Constr.	Sub Total	# Valves	Valve	Total	PRV, CAV's	Unit	Total	Pig Launch	Tie-in	Tie-in	Easements		River	Clearing	Highway		Total	Railway		Total	Pipeline		Total	County Rd		Total	Creeks		Total	TOTAL	Non-Construction	Eng, Mat Testing	Contingency	GRAND TOTAL
					Unit Cost	Pipe/Constr.	(mainline)	Unit Cost	Valves		cost			Red Deer	Connections	Land	Crop	Crossing	Grubbing	Crossing	Unit Price	Highway	Crossing	Unit Price	Railway	Crossing	Unit Price	Pipeline	Crossing	Unit Price	County Rd	Crossing	Unit Price	Creeks		Costs (1%)	Geotech. (10%)	10%	
Red Deer	Blackfalds	9713	750	DI	405	3,929,540	2	75,000	$150,000	3	20,000	60,000	50,000	50,000	420,000	210,772	30,596	600,000	75,000	160	2,000	320,000	120	2,000	240,000	7	4,000	28,000	3	8,000	24,000	1	22,000	22,000					
Blackfalds	Lacombe	15378	750	DI	405	6,221,401	3	75,000	$225,000	3	20,000	60,000	50,000		470,000	333,703	48,441			40	2,000	80,000	30	2,000	60,000	4	4,000	16,000	8	8,000	64,000	1	22,000	22,000					
Lacombe	Morningside	10569	600	DI	306	3,233,242	2	50,000	$100,000	3	20,000	60,000	40,000			229,347	33,292			120	1,500	180,000				2	3,500	7,000	6	7,000	42,000								
Morningside	Ponoka	12150	600	DI	306	3,716,898	2	50,000	$100,000	3	20,000	60,000	40,000		298,000	263,655	38,273			80	1,500	120,000	30	1,500		7	3,500	24,500	6	7,000	42,000	2	20,000	40,000					
Ponoka	Montana	6600	500	PVC	274	1,808,730	2	50,000	$100,000	3	15,000	45,000	30,000		620,000	143,220	20,790									2	3,000	6,000	3	6,000	18,000	3	18,000	54,000					
Montana	Samson	12715	500	PVC	274	3,484,546	3	35,000	$105,000	2	15,000	30,000	30,000		300,000	275,916	40,052	100,000		0	1,200	0	0	1,200	0	3	3,000	9,000	7	6,000	42,000	3	18,000	54,000					
Samson	Ermineskin	2240	300	PVC	134	299,880	1	10,000	$10,000	1	10,000	10,000	40,000		75,000	48,608	7,056												3	3,000	9,000								
	TOTAL	69365			SUB-TOTAL	22,694,236		SUB-TOTAL	790,000			325,000	280,000	50,000	2,183,000	1,505,221	218,500	700,000	75,000			700,000			300,000			90,500			241,000	TOTAL		192,000	30,344,456	303,445	$3,034,446	$3,034,446	$36,716,792

Note : mainline valves assumed 1 every 6 km

North Red Deer Water Services Commission

Phase	Item	Quantity	Unit	Rate	Extension	Subtotal
Red Deer Metering Station	1.Site Work					
	- Excavation				3000	
	- Access Road / Parking				10000	
	-Site grading/topsoil/seeding				3000	
	- Fence				5000	
						21000
	2.Structure					
	-Meter vault				80000	
	- Building				15000	
						95000
	3. Mechanical					
	- Piping/Valves				110000	
	- Meter				10000	
	-Ventilation/Heating				5000	
	-Misc.				5000	
						130000
	4. Electrical					
	- Power to site				10000	
	- Wiring / Fixtures				6000	
	- Ventilation/Heating				6000	
						22000
	5. Instrumentation					
	- Equipment/gauges				50000	
	- Upgrade Red Deer SCADA/Programming				25000	
	- PLC/Telemetry/Tower				50000	
	- Telephone to site				1000	
	- Misc.				5000	
						81000
Contingency (20%)						69800
Engineering (15%)						49200
						468000

Capital Costs (Present Value)	$ 468,000
Yearly Capital Debt Service	$ 37,484
Years	25
Interest	6.25%

Assumptions:

North Red Deer Water Services Commission
Metering Station

Unit Cost For Power per kWh	**$0.10**
Incremental Cost In Percent	**2.5%**

Year						**Net Cost**	**Net Present Value**
	Capital Yearly Costs	**Operation and Maintenace**	**Annual Power Consumption kWh**	**Unit Rate**	**Power Cost**	**Cost per Year**	**Cost per Year**
1	37484	5000	24000	$0.10	2,400	44884	44884
2	37484	5125	24600	$0.11	2,585	45194	43560
3	37484	5253	25215	$0.11	2,715	45453	42226
4	37484	5384	25845	$0.11	2,853	45722	40941
5	37484	5519	26492	$0.11	2,997	46001	39702
6	37484	5657	27154	$0.12	3,149	46290	38508
7	37484	5798	27833	$0.12	3,308	46591	37357
8	37484	5943	28528	$0.12	3,476	46904	36248
9	37484	6092	29242	$0.12	3,652	47228	35180
10	37484	6244	29973	$0.13	3,837	47565	34151
11	37484	6400	30722	$0.13	4,031	47916	33159
12	37484	6560	31490	$0.13	4,235	48280	32203
13	37484	6724	32277	$0.14	4,449	48658	31282
14	37484	6893	33084	$0.14	4,675	49052	30395
15	37484	7065	33911	$0.14	4,911	49461	29541
16	37484	7241	34759	$0.15	5,160	49886	28718
17	37484	7423	35628	$0.15	5,421	50328	27925
18	37484	7608	36519	$0.16	5,696	50788	27162
19	37484	7798	37432	$0.16	5,984	51267	26427
20	37484	7993	38368	$0.16	6,287	51765	25719
21	37484	8193	39327	$0.17	6,605	52283	25038
22	37484	8398	40310	$0.17	6,940	52822	24382
23	37484	8608	41318	$0.18	7,291	53383	23750
24	37484	8823	42351	$0.18	7,660	53967	23142
25	37484	9044	43409	$0.19	8,048	54576	22557
26		9270	44495	$0.19	8,455	17725	7061
27		9501	45607	$0.19	8,883	18385	7059
28		9739	46747	$0.20	9,333	19072	7059
29		9982	47916	$0.20	9,806	19788	7059
30		10232	49114	$0.21	10,302	20534	7060
31		10488	50342	$0.22	10,823	21311	7063
32		10750	51600	$0.22	11,371	22121	7066
33		11019	52890	$0.23	11,947	22966	7071
34		11294	54212	$0.23	12,552	23846	7076
35		11577	55568	$0.24	13,187	24764	7083
36		11866	56957	$0.24	13,855	25721	7091
37		12163	58381	$0.25	14,556	26719	7100
38		12467	59840	$0.26	15,293	27760	7110
39		12778	61336	$0.26	16,068	28846	7121
40		13098	62870	$0.27	16,881	29979	7133
41		13425	64442	$0.28	17,736	31161	7146
42		13761	66053	$0.28	18,633	32394	7161
43		14105	67704	$0.29	19,577	33682	7176
44		14458	69396	$0.30	20,568	35025	7193
45		14819	71131	$0.30	21,609	36428	7210
46		15190	72910	$0.31	22,703	37893	7229
47		15569	74732	$0.32	23,852	39422	7249
48		15958	76601	$0.33	25,060	41018	7270
49		16357	78516	$0.34	26,329	42686	7292
50		16766	80479	$0.34	27,661	44428	7315
							$ 982,614

Interest Rate	6.25%
Inflation Rate	2.50%
	6.25%
Present Value Discount Rate	3.75%

North Red Deer Water Services Commission

Phase	Item	Quantity	Unit	Rate	Extension	Subtotal
Steel Pipe - Red Deer Booster Station + Metering Station	1.Site Work					
	- Excavation				5000	
	- Access Road / Parking				10000	
	-Site grading/topsoil/seeding				10000	
	- Fence				8000	
						33000
	2.Structure					
	- Concrete				300000	
	- Building				80000	
						380000
	3. Mechanical					
	- Piping/Valves				250000	
	- Meter				10000	
	- Pumps				70000	
	-Ventilation/Heating				10000	
	-Misc.				5000	
						345000
	4. Electrical					
	- Power to site				10000	
	- Wiring / Fixtures				15000	
	- Ventilation/Heating				12000	
						37000
	5. Instrumentation					
	- Equipment/gauges				80000	
	- Variable Speed Drive				40000	
	- Upgrade Red Deer SCADA/Programming				25000	
	- PLC/Telemetry/Tower				50000	
	- Telephone to site				1000	
	- Misc.				5000	
						201000
	6. Meter Station					
	- Structure				40000	
	- Mechanical				80000	
	- Electrical				10000	
	- Instrumentation				10000	
	- Misc.				5000	
						145000
Contingency (20%)						228200
Engineering (15%)						166200
						1535400

Capital Costs (Present Value)	$1,535,400
Yearly Capital Debt Service	$ 122,977
Years	25
Interest	6.25%

Assumptions:

North Red Deer Water Services Commission
Red Deer Booster Station (@ 390 m head) - Pump At Red Deer (Steel Pipe)

Unit Cost for Power per kWh	**$0.10**
Incremental Unit Cost In Percent	**2.5%**

Year							**Net Cost**	**Net Present Value**
	Capital Yearly Costs	**Operation and Maintenace**	**Pump Replacement / Upgrade**	**Annual Power Consumption kWh**	**Unit Rate**	**Power Cost**	**Cost per Year**	**Cost per Year**
1	122,977	35,000		146,670	$0.10	14,667	172,644	172,644
2	122,977	35,875		160,507	$0.11	16,863	175,716	169,364
3	122,977	36,772		175,649	$0.11	18,915	178,665	165,983
4	122,977	37,691		192,220	$0.11	21,217	181,886	162,868
5	122,977	38,633		210,354	$0.11	23,800	185,410	160,023
6	122,977	39,599		230,199	$0.12	26,696	189,273	157,452
7	122,977	40,589		251,916	$0.12	29,945	193,511	155,159
8	122,977	41,604		275,681	$0.12	33,589	198,170	153,152
9	122,977	42,644		301,689	$0.12	37,677	203,298	151,436
10	122,977	43,710	20,000	330,150	$0.13	42,262	208,950	150,020
11	122,977	44,803		361,297	$0.13	47,405	215,185	148,913
12	122,977	45,923		395,381	$0.13	53,174	222,075	148,126
13	122,977	47,071		432,682	$0.14	59,646	229,694	147,670
14	122,977	48,248		473,501	$0.14	66,904	238,130	147,560
15	122,977	49,454		518,171	$0.14	75,047	247,478	147,810
16	122,977	50,690		567,055	$0.15	84,180	257,847	148,437
17	122,977	51,958		620,551	$0.15	94,424	269,359	149,459
18	122,977	53,257		679,094	$0.16	105,916	282,149	150,897
19	122,977	54,588		743,160	$0.16	118,805	296,371	152,774
20	122,977	55,953	150,000	813,270	$0.16	133,264	312,194	155,114
21	122,977	57,352		889,993	$0.17	149,482	329,811	157,944
22	122,977	58,785		973,955	$0.17	167,673	349,436	161,294
23	122,977	60,255		1,065,838	$0.18	188,079	371,311	165,196
24	122,977	61,761		1,166,389	$0.18	210,968	395,707	169,686
25	122,977	63,305		1,276,427	$0.19	236,642	422,925	174,803
26		64,888		1,396,845	$0.19	265,441	330,329	131,597
27		66,510		1,528,623	$0.19	297,745	364,255	139,867
28		68,173		1,672,833	$0.20	333,980	402,153	148,838
29		69,877		1,830,648	$0.20	374,625	444,503	158,565
30		71,624	30,000	2,003,352	$0.21	420,217	491,841	169,110
31		73,415		2,192,348	$0.22	471,356	544,771	180,539
32		75,250		2,399,174	$0.22	528,720	603,970	192,923
33		77,131		2,625,512	$0.23	593,064	670,196	206,339
34		79,060		2,873,203	$0.23	665,239	744,299	220,872
35		81,036		3,144,261	$0.24	746,198	827,234	236,610
36		83,062		3,440,891	$0.24	837,009	920,071	253,652
37		85,139		3,765,504	$0.25	938,872	1,024,010	272,102
38		87,267		4,120,742	$0.26	1,053,131	1,140,398	292,076
39		89,449		4,509,493	$0.26	1,181,295	1,270,744	313,697
40		91,685	200,000	4,934,918	$0.27	1,325,057	1,416,742	337,097
41		93,977		5,400,478	$0.28	1,486,315	1,580,292	362,421
42		96,327		5,909,960	$0.28	1,667,197	1,763,523	389,824
43		98,735		6,467,505	$0.29	1,870,092	1,968,827	419,476
44		101,203		7,077,650	$0.30	2,097,680	2,198,883	451,558
45		103,733		7,745,355	$0.30	2,352,964	2,456,697	486,267
46		106,327		8,476,052	$0.31	2,639,316	2,745,643	523,817
47		108,985		9,275,683	$0.32	2,960,517	3,069,502	564,436
48		111,709		10,150,751	$0.33	3,320,807	3,432,517	608,376
49		114,502		11,108,372	$0.34	3,724,945	3,839,447	655,903
50		117,365	40,000	12,156,336	$0.34	4,178,265	4,295,630	707,310
								$ 12,347,052

Incremental Energy	9%

Interest Rate	6.25%
Inflation Rate	2.50%
	6.25%
Present Value Discount Rate	3.75%

North Red Deer Water Services Commission

Red Deer Booster Station (@ 208 m head) - Pump At Red Deer (Ductile)

Unit Cost for Power per kWh	**$0.10**
Incremental Unit Cost In Percent	**2.5%**

Year							Net Cost	Net Present Value
	Capital Yearly Costs	Operation and Maintenace	Pump Replacement / Upgrade	Annual Power Consumption kWh	Unit Rate	Power Cost	Cost per Year	Cost per Year
1	122,977	35,000		146,670	$0.10	14,667	172,644	172,644
2	122,977	35,875		160,368	$0.11	16,849	175,701	169,350
3	122,977	36,772		175,346	$0.11	18,883	178,632	165,952
4	122,977	37,691		191,722	$0.11	21,163	181,831	162,818
5	122,977	38,633		209,628	$0.11	23,718	185,328	159,952
6	122,977	39,599		229,206	$0.12	26,581	189,157	157,356
7	122,977	40,589		250,613	$0.12	29,790	193,357	155,035
8	122,977	41,604		274,019	$0.12	33,387	197,968	152,995
9	122,977	42,644		299,611	$0.12	37,417	203,039	151,243
10	122,977	43,710	20,000	327,593	$0.13	41,935	208,622	149,785
11	122,977	44,803		358,189	$0.13	46,997	214,778	148,631
12	122,977	45,923		391,642	$0.13	52,671	221,572	147,790
13	122,977	47,071		428,219	$0.14	59,031	229,079	147,275
14	122,977	48,248		468,213	$0.14	66,157	237,382	147,097
15	122,977	49,454		511,942	$0.14	74,144	246,576	147,271
16	122,977	50,690		559,754	$0.15	83,096	256,764	147,813
17	122,977	51,958		612,033	$0.15	93,128	268,063	148,740
18	122,977	53,257		669,193	$0.16	104,371	280,605	150,071
19	122,977	54,588		731,693	$0.16	116,972	294,537	151,829
20	122,977	55,953	150,000	800,029	$0.16	131,094	310,024	154,036
21	122,977	57,352		874,748	$0.17	146,921	327,250	156,717
22	122,977	58,785		956,445	$0.17	164,659	346,421	159,902
23	122,977	60,255		1,045,772	$0.18	184,538	367,770	163,621
24	122,977	61,761		1,143,442	$0.18	206,817	391,556	167,906
25	122,977	63,305		1,250,234	$0.19	231,786	418,069	172,796
26		64,888		1,367,000	$0.19	259,770	324,658	129,337
27		66,510		1,494,671	$0.19	291,132	357,642	137,328
28		68,173		1,634,265	$0.20	326,280	394,453	145,988
29		69,877		1,786,897	$0.20	365,672	435,549	155,371
30		71,624	30,000	1,953,785	$0.21	409,820	481,444	165,535
31		73,415		2,136,258	$0.22	459,297	532,712	176,542
32		75,250		2,335,774	$0.22	514,748	589,998	188,460
33		77,131		2,553,924	$0.23	576,893	654,025	201,361
34		79,060		2,792,448	$0.23	646,542	725,601	215,323
35		81,036		3,053,248	$0.24	724,598	805,635	230,432
36		83,062		3,338,406	$0.24	812,079	895,141	246,779
37		85,139		3,650,197	$0.25	910,121	995,260	264,463
38		87,267		3,991,107	$0.26	1,020,000	1,107,267	283,591
39		89,449		4,363,857	$0.26	1,143,145	1,232,594	304,279
40		91,685	200,000	4,771,419	$0.27	1,281,156	1,372,842	326,651
41		93,977		5,217,046	$0.28	1,435,830	1,529,808	350,843
42		96,327		5,704,292	$0.28	1,609,178	1,705,505	376,999
43		98,735		6,237,044	$0.29	1,803,454	1,902,189	405,278
44		101,203		6,819,553	$0.30	2,021,185	2,122,388	435,849
45		103,733		7,456,465	$0.30	2,265,202	2,368,935	468,896
46		106,327		8,152,861	$0.31	2,538,679	2,645,006	504,617
47		108,985		8,914,298	$0.32	2,845,174	2,954,159	543,227
48		111,709		9,746,849	$0.33	3,188,671	3,300,381	584,956
49		114,502		10,657,156	$0.34	3,573,639	3,688,141	630,055
50		117,365	40,000	11,652,481	$0.34	4,005,084	4,122,449	678,794
								$ 12,059,580

Incremental Energy	9%

Interest Rate	6.25%
Inflation Rate	2.50%
	6.25%
Present Value Discount Rate	3.75%

North Red Deer Water Services Commission

Phase	Item	Quantity	Unit	Rate	Extension	Subtotal
Lacombe Booster (2028)	1.Site Work					
	- Excavation	1		3000	3000	
	- Access Road / Parking	1		8000	8000	
	-Site grading/topsoil/seeding	1		8000	8000	
	- Fence	1		5000	5000	
						24000
	2.Structure					
	- Concrete	1		180000	180000	
	- Building	1		50000	50000	
						230000
	3. Mechanical					
	- Piping/Valves	1		150000	150000	
	- Meter	1		10000	10000	
	- Pumps	1		70000	70000	
	-Ventilation/Heating	1		8000	8000	
	-Misc.	1		5000	5000	
						243000
	4. Electrical					
	- Power to site	1		10000	10000	
	- Wiring / Fixtures	1		10000	10000	
	- Ventilation/Heating	1		8000	8000	
						28000
	5. Instrumentation					
	- Equipment/gauges	1		50000	50000	
	- Variable Speed Drive	1		30000	30000	
	- Upgrade Red Deer SCADA/Programming	1		14000	14000	
	- PLC/Telemetry/Tower	1		30000	30000	
	- Telephone to site	1		1000	1000	
	- Misc.	1		5000	5000	
						130000
Contingency (20%)						131000
Engineering (15%)						94650
						880650

Capital Costs (Present Value)	$	880,650
Future Cost (inflation 2.5% over 25 years)	$	1,632,676
Yearly Capital Debt Service	$	130,769
Years		25
Interest		6.25%

Assumptions:

Operation & Maintenance (Present)	$	35,000
Future Value	$	64,888
Pump Upgrade / Replacement (Present)	$	20,000
Future Value	$	37,079
Pump Replacement (Present)	$	100,000
Future Value	$	185,394

North Red Deer Water Services Commission
Lacombe Booster - Year 2028 For PVC Pipe

Unit Cost For Power per kWh	**$0.10**
Incremental Unit Cost In Percent	**2.50%**

Year							**Net Cost**	**Net Present Value**
	Capital Yearly Costs	**Operation and Maintenace**	**Pump Replacement / Upgrade**	**Annual Power Consumption kWh**	**Unit Rate**	**Power Cost**	**Cost per Year**	**Cost per Year**
1	0	0		0			0	0
2	0	0		0			0	0
3	0	0		0			0	0
4	0	0		0			0	0
5	0	0		0			0	0
6	0	0		0			0	0
7	0	0		0			0	0
8	0	0		0			0	0
9	0	0		0			0	0
10	0	0		0			0	0
11	0	0		0			0	0
12	0	0		0			0	0
13	0	0		0			0	0
14	0	0		0			0	0
15	0	0		0			0	0
16	0	0		0			0	0
17	0	0		0			0	0
18	0	0		0			0	0
19	0	0		0			0	0
20	0	0		0			0	0
21	0	0		0			0	0
22	0	0		0			0	0
23	0	0		0			0	0
24	0	0		0			0	0
25	0	0		0			0	0
26	130,769	64,888		171,760	$0.19	31,843	227,500	90,631
27	130,769	66,510		188,089	$0.19	35,742	233,021	89,476
28	130,769	68,173		205,969	$0.19	40,119	239,060	88,477
29	130,769	69,877		225,550	$0.20	45,031	245,677	87,639
30	130,769	71,624		246,992	$0.20	50,545	252,937	86,968
31	130,769	73,415		270,473	$0.21	56,733	260,917	86,469
32	130,769	75,250		296,186	$0.22	63,680	269,699	86,149
33	130,769	77,131		324,343	$0.22	71,477	279,377	86,015
34	130,769	79,060		355,177	$0.23	80,229	290,057	86,075
35	130,769	81,036		388,942	$0.23	90,053	301,857	86,339
36	130,769	83,062	37,000	425,917	$0.24	101,079	314,910	86,816
37	130,769	85,139		466,407	$0.24	113,455	329,362	87,519
38	130,769	87,267		510,747	$0.25	127,347	345,383	88,459
39	130,769	89,449		559,301	$0.26	142,940	363,157	89,649
40	130,769	91,685		612,472	$0.26	160,442	382,895	91,105
41	130,769	93,977		670,697	$0.27	180,086	404,832	92,843
42	130,769	96,327		734,458	$0.28	202,137	429,232	94,881
43	130,769	98,735		804,280	$0.28	226,887	456,390	97,238
44	130,769	101,203		880,739	$0.29	254,668	486,639	99,935
45	130,769	103,733		964,468	$0.30	285,850	520,352	102,996
46	130,769	106,327	185,000	1,056,156	$0.30	320,850	557,945	106,445
47	130,769	108,985		1,156,560	$0.31	360,136	599,889	110,311
48	130,769	111,709		1,266,510	$0.32	404,232	646,709	114,622
49	130,769	114,502		1,386,912	$0.33	453,727	698,997	119,412
50	130,769	117,365		1,518,760	$0.34	509,282	757,415	124,715
								$ 2,381,183

Incremental Energy	10%

Interest Rate	6.25%
Inflation Rate	2.50%
	6.25%
Present Value Discount Rate	3.75%

North Red Deer Water Services Commission
Lacombe Booster (@ 44 m head) - Pump at Lacombe For Ductile Iron Pipe

Unit Cost For Power per kWh	**$0.10**
Incremental Unit Cost In Percent	**2.50%**

Year							Net Cost	Net Present Value
	Capital Yearly Costs	Operation and Maintenace	Pump Replacement / Upgrade	Annual Power Consumption kWh	Unit Rate	Power Cost	Cost per Year	Cost per Year
1	0	0		0			0	0
2	0	0		0			0	0
3	0	0		0			0	0
4	0	0		0			0	0
5	0	0		0			0	0
6	0	0		0			0	0
7	0	0		0			0	0
8	0	0		0			0	0
9	0	0		0			0	0
10	0	0		0			0	0
11	0	0		0			0	0
12	0	0		0			0	0
13	0	0		0			0	0
14	0	0		0			0	0
15	0	0		0			0	0
16	0	0		0			0	0
17	0	0		0			0	0
18	0	0		0			0	0
19	0	0		0			0	0
20	0	0		0			0	0
21	0	0		0			0	0
22	0	0		0			0	0
23	0	0		0			0	0
24	0	0		0			0	0
25	0	0		0			0	0
26	130,769	64,888		171,760	$0.19	31,843	227,500	90,631
27	130,769	66,510		184,041	$0.19	34,973	232,252	89,180
28	130,769	68,173		197,200	$0.19	38,411	237,352	87,844
29	130,769	69,877		211,301	$0.20	42,186	242,832	86,624
30	130,769	71,624		226,409	$0.20	46,333	248,725	85,519
31	130,769	73,415		242,598	$0.21	50,887	255,070	84,531
32	130,769	75,250		259,944	$0.22	55,888	261,907	83,660
33	130,769	77,131		278,531	$0.22	61,381	269,281	82,906
34	130,769	79,060		298,446	$0.23	67,415	277,243	82,272
35	130,769	81,036		319,786	$0.23	74,041	285,845	81,759
36	130,769	83,062	37,000	342,651	$0.24	81,318	295,149	81,369
37	130,769	85,139		367,151	$0.24	89,311	305,218	81,103
38	130,769	87,267		393,403	$0.25	98,089	316,125	80,965
39	130,769	89,449		421,532	$0.26	107,730	327,948	80,957
40	130,769	91,685		451,673	$0.26	118,319	340,773	81,083
41	130,769	93,977		483,968	$0.27	129,949	354,694	81,345
42	130,769	96,327		518,573	$0.28	142,721	369,816	81,747
43	130,769	98,735		555,652	$0.28	156,749	386,253	82,295
44	130,769	101,203		595,382	$0.29	172,156	404,128	82,991
45	130,769	103,733		637,953	$0.30	189,077	423,579	83,841
46	130,769	106,327	185,000	683,568	$0.30	207,661	444,757	84,851
47	130,769	108,985		732,445	$0.31	228,072	467,826	86,026
48	130,769	111,709		784,816	$0.32	250,489	492,967	87,373
49	130,769	114,502		840,932	$0.33	275,110	520,381	88,898
50	130,769	117,365		901,060	$0.34	302,150	550,284	90,609
								$ 2,110,381

Incremental Energy 7%

Interest Rate	6.25%
Inflation Rate	2.50%
	6.25%
Present Value Discount Rate	3.75%

North Red Deer Water Services Commission
Gravity PVC

Year			Net Cost	Net Present Value
	Capital Yearly Costs	Operation and Maintenace	Cost per Year	Cost per Year
1	4,262,707	20,000	4,282,707	4,282,707
2	4,262,707	20,500	4,283,207	4,128,393
3	4,262,707	21,013	4,283,720	3,979,650
4	4,262,707	21,538	4,284,245	3,836,277
5	4,262,707	22,076	4,284,784	3,698,082
6	4,262,707	22,628	4,285,336	3,564,875
7	4,262,707	23,194	4,285,901	3,436,478
8	4,262,707	23,774	4,286,481	3,312,716
9	4,262,707	24,368	4,287,076	3,193,422
10	4,262,707	24,977	4,287,685	3,078,434
11	4,262,707	25,602	4,288,309	2,967,598
12	4,262,707	26,242	4,288,949	2,860,762
13	4,262,707	26,898	4,289,605	2,757,783
14	4,262,707	27,570	4,290,278	2,658,521
15	4,262,707	28,259	4,290,967	2,562,841
16	4,262,707	28,966	4,291,673	2,470,615
17	4,262,707	29,690	4,292,398	2,381,718
18	4,262,707	30,432	4,293,140	2,296,028
19	4,262,707	31,193	4,293,901	2,213,432
20	4,262,707	31,973	4,294,680	2,133,815
21	4,262,707	32,772	4,295,480	2,057,072
22	4,262,707	33,592	4,296,299	1,983,099
23	4,262,707	34,431	4,297,139	1,911,794
24	4,262,707	35,292	4,298,000	1,843,062
25	4,262,707	36,175	4,298,882	1,776,810
26		37,079	37,079	14,771
27		38,006	38,006	14,594
28		38,956	38,956	14,418
29		39,930	39,930	14,244
30		40,928	40,928	14,072
31		41,951	41,951	13,903
32		43,000	43,000	13,735
33		44,075	44,075	13,570
34		45,177	45,177	13,406
35		46,306	46,306	13,245
36		47,464	47,464	13,085
37		48,651	48,651	12,928
38		49,867	49,867	12,772
39		51,114	51,114	12,618
40		52,391	52,391	12,466
41		53,701	53,701	12,316
42		55,044	55,044	12,167
43		56,420	56,420	12,021
44		57,830	57,830	11,876
45		59,276	59,276	11,733
46		60,758	60,758	11,591
47		62,277	62,277	11,452
48		63,834	63,834	11,314
49		65,430	65,430	11,178
50		67,066	67,066	11,043
				$ 71,706,500

Interest Rate	6.25%
Inflation Rate	2.50%
	6.25%
Present Value Discount Rate	3.75%

Debenture

Capital Cost	$	53,220,897
Yearly Capital Debt Service	$	4,262,707
Year		25
Interest		6.25%

North Red Deer Water Services Commission
PVC - Pumped At Lacombe

Year			Net Cost	Net Present Value
	Capital Yearly Costs	Operation and Maintenace	Cost per Year	Cost per Year
1	3,537,800	20,000	3,557,800	3,557,800
2	3,537,800	20,500	3,558,300	3,429,687
3	3,537,800	21,013	3,558,813	3,306,199
4	3,537,800	21,538	3,559,338	3,187,168
5	3,537,800	22,076	3,559,877	3,072,434
6	3,537,800	22,628	3,560,429	2,961,841
7	3,537,800	23,194	3,560,994	2,855,240
8	3,537,800	23,774	3,561,574	2,752,487
9	3,537,800	24,368	3,562,169	2,653,442
10	3,537,800	24,977	3,562,778	2,557,972
11	3,537,800	25,602	3,563,402	2,465,947
12	3,537,800	26,242	3,564,042	2,377,244
13	3,537,800	26,898	3,564,698	2,291,741
14	3,537,800	27,570	3,565,371	2,209,324
15	3,537,800	28,259	3,566,060	2,129,880
16	3,537,800	28,966	3,566,766	2,053,303
17	3,537,800	29,690	3,567,491	1,979,489
18	3,537,800	30,432	3,568,233	1,908,338
19	3,537,800	31,193	3,568,994	1,839,755
20	3,537,800	31,973	3,569,773	1,773,645
21	3,537,800	32,772	3,570,573	1,709,920
22	3,537,800	33,592	3,571,392	1,648,494
23	3,537,800	34,431	3,572,232	1,589,283
24	3,537,800	35,292	3,573,093	1,532,208
25	3,537,800	36,175	3,573,975	1,477,192
26		37,079	37,079	14,771
27		38,006	38,006	14,594
28		38,956	38,956	14,418
29		39,930	39,930	14,244
30		40,928	40,928	14,072
31		41,951	41,951	13,903
32		43,000	43,000	13,735
33		44,075	44,075	13,570
34		45,177	45,177	13,406
35		46,306	46,306	13,245
36		47,464	47,464	13,085
37		48,651	48,651	12,928
38		49,867	49,867	12,772
39		51,114	51,114	12,618
40		52,391	52,391	12,466
41		53,701	53,701	12,316
42		55,044	55,044	12,167
43		56,420	56,420	12,021
44		57,830	57,830	11,876
45		59,276	59,276	11,733
46		60,758	60,758	11,591
47		62,277	62,277	11,452
48		63,834	63,834	11,314
49		65,430	65,430	11,178
50		67,066	67,066	11,043
				$ 59,640,551

Interest Rate	6.25%
Inflation Rate	2.50%
	6.25%
Present Value Discount Rate	3.75%

Debenture

Capital Cost	$	44,170,264
Yearly Capital Debt Service	$	3,537,800
Year		25
Interest		6.25%

North Red Deer Water Services Commission
Steel Pipe - Pumped At Red Deer

Year			Net Cost	Net Present Value
	Capital Yearly Costs	Operation and Maintenace	Cost per Year	Cost per Year
1	3,240,374	50,000	3,290,374	3,290,374
2	3,240,374	51,250	3,291,624	3,172,649
3	3,240,374	52,531	3,292,905	3,059,166
4	3,240,374	53,845	3,294,218	2,949,769
5	3,240,374	55,191	3,295,564	2,844,313
6	3,240,374	56,570	3,296,944	2,742,654
7	3,240,374	57,985	3,298,358	2,644,656
8	3,240,374	59,434	3,299,808	2,550,186
9	3,240,374	60,920	3,301,294	2,459,118
10	3,240,374	62,443	3,302,817	2,371,328
11	3,240,374	64,004	3,304,378	2,286,697
12	3,240,374	65,604	3,305,978	2,205,113
13	3,240,374	67,244	3,307,618	2,126,464
14	3,240,374	68,926	3,309,299	2,050,646
15	3,240,374	70,649	3,311,022	1,977,555
16	3,240,374	72,415	3,312,789	1,907,094
17	3,240,374	74,225	3,314,599	1,839,168
18	3,240,374	76,081	3,316,455	1,773,684
19	3,240,374	77,983	3,318,357	1,710,555
20	3,240,374	79,933	3,320,306	1,649,697
21	3,240,374	81,931	3,322,304	1,591,026
22	3,240,374	83,979	3,324,353	1,534,465
23	3,240,374	86,079	3,326,452	1,479,936
24	3,240,374	88,231	3,328,604	1,427,367
25	3,240,374	90,436	3,330,810	1,376,687
26		92,697	92,697	36,929
27		95,015	95,015	36,484
28		97,390	97,390	36,044
29		99,825	99,825	35,610
30		102,320	102,320	35,181
31		104,878	104,878	34,757
32		107,500	107,500	34,338
33		110,188	110,188	33,925
34		112,943	112,943	33,516
35		115,766	115,766	33,112
36		118,660	118,660	32,713
37		121,627	121,627	32,319
38		124,667	124,667	31,930
39		127,784	127,784	31,545
40		130,979	130,979	31,165
41		134,253	134,253	30,789
42		137,610	137,610	30,418
43		141,050	141,050	30,052
44		144,576	144,576	29,690
45		148,190	148,190	29,332
46		151,895	151,895	28,979
47		155,693	155,693	28,630
48		159,585	159,585	28,285
49		163,574	163,574	27,944
50		167,664	167,664	27,607
				$ 55,821,660

Interest Rate	6.25%
Inflation Rate	2.50%
	6.25%
Present Value Discount Rate	3.75%

Debenture

Capital Cost	$ 40,456,821
Yearly Capital Debt Service	$ 3,240,374
Year	25
Interest	6.25%

North Red Deer Water Services Commission
Ductile Iron - Pump At Lacombe

Year			Net Cost	Net Present Value
	Capital Yearly Costs	Operation and Maintenace	Cost per Year	Cost per Year
1	3,095,739	20,000	3,115,739	3,115,739
2	3,095,739	20,500	3,116,239	3,003,604
3	3,095,739	21,013	3,116,752	2,895,516
4	3,095,739	21,538	3,117,277	2,791,329
5	3,095,739	22,076	3,117,816	2,690,903
6	3,095,739	22,628	3,118,367	2,594,100
7	3,095,739	23,194	3,118,933	2,500,791
8	3,095,739	23,774	3,119,513	2,410,849
9	3,095,739	24,368	3,120,107	2,324,153
10	3,095,739	24,977	3,120,717	2,240,585
11	3,095,739	25,602	3,121,341	2,160,032
12	3,095,739	26,242	3,121,981	2,082,385
13	3,095,739	26,898	3,122,637	2,007,540
14	3,095,739	27,570	3,123,310	1,935,395
15	3,095,739	28,259	3,123,999	1,865,853
16	3,095,739	28,966	3,124,705	1,798,819
17	3,095,739	29,690	3,125,429	1,734,203
18	3,095,739	30,432	3,126,172	1,671,918
19	3,095,739	31,193	3,126,932	1,611,880
20	3,095,739	31,973	3,127,712	1,554,006
21	3,095,739	32,772	3,128,512	1,498,220
22	3,095,739	33,592	3,129,331	1,444,446
23	3,095,739	34,431	3,130,171	1,392,611
24	3,095,739	35,292	3,131,032	1,342,644
25	3,095,739	36,175	3,131,914	1,294,480
26		37,079	37,079	14,771
27		38,006	38,006	14,594
28		38,956	38,956	14,418
29		39,930	39,930	14,244
30		40,928	40,928	14,072
31		41,951	41,951	13,903
32		43,000	43,000	13,735
33		44,075	44,075	13,570
34		45,177	45,177	13,406
35		46,306	46,306	13,245
36		47,464	47,464	13,085
37		48,651	48,651	12,928
38		49,867	49,867	12,772
39		51,114	51,114	12,618
40		52,391	52,391	12,466
41		53,701	53,701	12,316
42		55,044	55,044	12,167
43		56,420	56,420	12,021
44		57,830	57,830	11,876
45		59,276	59,276	11,733
46		60,758	60,758	11,591
47		62,277	62,277	11,452
48		63,834	63,834	11,314
49		65,430	65,430	11,178
50		67,066	67,066	11,043
				$ 52,282,520

Interest Rate	6.25%
Inflation Rate	2.50%
	6.25%
Present Value Discount Rate	3.75%

Debenture

Capital Cost	$	38,651,027
Yearly Capital Debt Service	$	3,095,739
Year		25
Interest		6.25%

North Red Deer Water Services Commission
Ductile Iron - Pump At Red Deer

			Net Cost	**Net Present Value**
Year	**Capital Yearly Costs**	**Operation and Maintenace**	**Cost per Year**	**Cost per Year**
1	2,868,772	20,000	2,888,772	2,888,772
2	2,868,772	20,500	2,889,272	2,784,841
3	2,868,772	21,013	2,889,785	2,684,660
4	2,868,772	21,538	2,890,310	2,588,094
5	2,868,772	22,076	2,890,848	2,495,013
6	2,868,772	22,628	2,891,400	2,405,291
7	2,868,772	23,194	2,891,966	2,318,807
8	2,868,772	23,774	2,892,546	2,235,442
9	2,868,772	24,368	2,893,140	2,155,086
10	2,868,772	24,977	2,893,749	2,077,629
11	2,868,772	25,602	2,894,374	2,002,966
12	2,868,772	26,242	2,895,014	1,930,996
13	2,868,772	26,898	2,895,670	1,861,623
14	2,868,772	27,570	2,896,342	1,794,752
15	2,868,772	28,259	2,897,032	1,730,293
16	2,868,772	28,966	2,897,738	1,668,159
17	2,868,772	29,690	2,898,462	1,608,266
18	2,868,772	30,432	2,899,204	1,550,533
19	2,868,772	31,193	2,899,965	1,494,882
20	2,868,772	31,973	2,900,745	1,441,238
21	2,868,772	32,772	2,901,544	1,389,527
22	2,868,772	33,592	2,902,364	1,339,682
23	2,868,772	34,431	2,903,203	1,291,633
24	2,868,772	35,292	2,904,064	1,245,317
25	2,868,772	36,175	2,904,947	1,200,670
26		37,079	37,079	14,771
27		38,006	38,006	14,594
28		38,956	38,956	14,418
29		39,930	39,930	14,244
30		40,928	40,928	14,072
31		41,951	41,951	13,903
32		43,000	43,000	13,735
33		44,075	44,075	13,570
34		45,177	45,177	13,406
35		46,306	46,306	13,245
36		47,464	47,464	13,085
37		48,651	48,651	12,928
38		49,867	49,867	12,772
39		51,114	51,114	12,618
40		52,391	52,391	12,466
41		53,701	53,701	12,316
42		55,044	55,044	12,167
43		56,420	56,420	12,021
44		57,830	57,830	11,876
45		59,276	59,276	11,733
46		60,758	60,758	11,591
47		62,277	62,277	11,452
48		63,834	63,834	11,314
49		65,430	65,430	11,178
50		67,066	67,066	11,043
				$ 48,504,690

Interest Rate	6.25%
Inflation Rate	2.50%
	6.25%
Present Value Discount Rate	3.75%

Debenture

Capital Cost	$ 35,817,288
Yearly Capital Debt Service	$ 2,868,772
Year	25
Interest	6.25%

North Red Deer Water Services Commission
Ductile Iron and PVC - Pump At Lacombe

Year			Net Cost	Net Present Value
	Capital Yearly Costs	Operation and Maintenace	Cost per Year	Cost per Year
1	3,082,744	20,000	3,102,744	3,102,744
2	3,082,744	20,500	3,103,244	2,991,079
3	3,082,744	21,013	3,103,757	2,883,443
4	3,082,744	21,538	3,104,282	2,779,693
5	3,082,744	22,076	3,104,820	2,679,687
6	3,082,744	22,628	3,105,372	2,583,290
7	3,082,744	23,194	3,105,938	2,490,372
8	3,082,744	23,774	3,106,518	2,400,806
9	3,082,744	24,368	3,107,112	2,314,473
10	3,082,744	24,977	3,107,721	2,231,255
11	3,082,744	25,602	3,108,346	2,151,039
12	3,082,744	26,242	3,108,986	2,073,717
13	3,082,744	26,898	3,109,642	1,999,186
14	3,082,744	27,570	3,110,314	1,927,343
15	3,082,744	28,259	3,111,004	1,858,091
16	3,082,744	28,966	3,111,710	1,791,338
17	3,082,744	29,690	3,112,434	1,726,993
18	3,082,744	30,432	3,113,176	1,664,968
19	3,082,744	31,193	3,113,937	1,605,181
20	3,082,744	31,973	3,114,717	1,547,550
21	3,082,744	32,772	3,115,516	1,491,997
22	3,082,744	33,592	3,116,336	1,438,448
23	3,082,744	34,431	3,117,176	1,386,829
24	3,082,744	35,292	3,118,036	1,337,072
25	3,082,744	36,175	3,118,919	1,289,109
26		37,079	37,079	14,771
27		38,006	38,006	14,594
28		38,956	38,956	14,418
29		39,930	39,930	14,244
30		40,928	40,928	14,072
31		41,951	41,951	13,903
32		43,000	43,000	13,735
33		44,075	44,075	13,570
34		45,177	45,177	13,406
35		46,306	46,306	13,245
36		47,464	47,464	13,085
37		48,651	48,651	12,928
38		49,867	49,867	12,772
39		51,114	51,114	12,618
40		52,391	52,391	12,466
41		53,701	53,701	12,316
42		55,044	55,044	12,167
43		56,420	56,420	12,021
44		57,830	57,830	11,876
45		59,276	59,276	11,733
46		60,758	60,758	11,591
47		62,277	62,277	11,452
48		63,834	63,834	11,314
49		65,430	65,430	11,178
50		67,066	67,066	11,043
				$ 52,066,217

Interest Rate	6.25%
Inflation Rate	2.50%
	6.25%
Present Value Discount Rate	3.75%

Debenture

Capital Cost	$	38,488,779	High Ground Estimate
Yearly Capital Debt Service	$	3,082,744	
Year		25	
Interest		6.25%	

PEDOCAN LAND EVALUATION LTD. - REPORT

NORTH RED DEER WATER PIPELINE

PRE-DESIGN PHASE

ENVIRONMENTAL REVIEW OF PROPOSED ROUTES

Prepared by:

Pedocan Land Evaluation Ltd.

May 2003

Table of Contents

Table of Contents ii

List of Tables iii

List of Appendices iv

1. INTRODUCTION 1

2. ENVIRONMENTAL SCREENING OF ROUTES 1

    2.1 Scoping Issues of Concern 1
    2.2 Historical Resources Overview 2
    2.3 Watercourse Crossings and Fish 8
    2.4 Soils, Conservation and Effects on Construction 10
    2.5 Land Use 11

3. Summary 13

4. Requirements for Detailed Design Phase 15

5. Literature Cited 15

6. Personal Communications 15

7. Appendices 16

List of Tables

Table 1. Areas of proposed rights-of-way alignment alternatives recommended for inspection of Historical Resources. 6

Table 2. Summary of Environmental Features and Issues along Proposed Route. 13

List of Appendices

Appendix 1. Archaeological Features (Map 1 of 4). 16

Appendix 2. Archaeological Features (Map 2 of 4).**Error! Bookmark not defined.**

Appendix 3. Archaeological Features (Map 3 of 4).**Error! Bookmark not defined.**

Appendix 4. Archaeological Features (Map 4 of 4).**Error! Bookmark not defined.**

Appendix 5. Environmental Features and Issues Map.**Error! Bookmark not defined.**

1. INTRODUCTION

The proposed North Red Deer Water Pipeline will carry potable water from Red Deer to Blackfalds, Lacombe, Ponoka, and Hobbema. This will be a large pipe (500 to 750 or 900mm diameter) for most of its length. It will typically be built using open trench construction methods. The trench will be 2.5 to 3m deep, and will be approximately 6m wide at the top (wider in unstable soils). The typical right of way work space will be in the order of 35m wide.

This report is part of the pre-design engineering study conducted by Associated Engineering. This report provides direction for conservation and reclamation planning and detailed design.

This report was prepared by Pedocan Land Evaluation Ltd., with input from FMA Historical Resources Consultants Inc., Westworth Associates Environmental Ltd., and Don James and Associates Ltd.

2. ENVIRONMENTAL SCREENING OF ROUTES

2.1 Scoping Issues of Concern

A scoping exercise was undertaken to identify valued environmental components and issues that are directly relevant to the pipeline routes. The environmental review and screening focused on the relevant features and issues. Multiple route options were examined. The relevant features and issues identified included:

- Historical resources (archaeological and palaeontological)
- Watercourses and fish
- Soils (conservation of agricultural soils and soil limitations for construction)
- Land Use and potential conflicts (including Natural Areas)

A screening for rare species of plants and animals, nesting sites or dens, and critical habitat was deferred to the detailed design stage, and the summer season.

Field investigation and inventory of historical resources, fish habitat and soils will be done during the detailed design phase.

2.2 Historical Resources Overview

Prepared by FMA Historical Resources Consultants Inc.

Introduction

With respect to the historical resource issues associated with the water lines, it is noted that large portions of all the proposed rights-of-way parallel a large amount of existing highway and railway disturbance throughout their lengths. Areas that do not lie within these disturbed regions fall largely within cultivated terrain or pasture. As a result of this, for the majority of the length of all the right-of-way alternatives, the potential for identifying intact historical resource deposits is generally low. There are, however, exceptions to this that occur on three levels. These include:

- sites and locations identified on the *Listing of Significant Historical Sites and Areas (third edition)*;
- areas that cross the known locations of identified historical resource sites; and
- areas which, as the result of their environmental characteristics, possess a higher potential for the identification of historical resource sites.

Listed Significant Sites

In terms of historical resource regulations, those areas identified on the *Listing of Significant Historical Sites and Areas (third edition)* are the most important, as this document forms the basis for the cultural resource management program of Alberta Community Development with respect to smaller scale projects. Four areas of land identified on the *Listing of Historical Sites and Areas (third edition)* are found within one kilometre of the proposed right-of-way alternatives. Two of these areas (LSD 15, Section 19-40-26-W4M and LSD 2, Section 30-40-26-W4M and LSD 11 & 12, Section 4-43-25-W4M) consist of historic buildings associated with Lacombe and Ponoka, and will not be affected by the proposed development. Two other areas (Section 14-39-27-W4M and LSDs 9 to 16, Section 29-42-25-W4M) lie immediately adjacent to the areas of the development (see attached figure). The area of Section 14-39-27-W4M is considered to be the Red Deer River Palaeontological zone, and carries with it an Historical Resource Value (HRV) of “4”, which indicates the necessity for “…*avoidance and/or the conduct of additional historical resource studies”* (Alberta Community

Development 2002). As a result, palaeontological assessment of the portion of the right-of-way that crosses this area will have to be examined to ensure that no significant palaeontological resources are impacted as the result of the development. The area within the N1/2-29-42-25-W4M is identified as part of the region associated with the historic “Building 1” of the Alberta Hospital. It carries with an HRV ranking of “1”, indicating that it is a “Provincial Historic Resource” which ”…*is not to be impacted*” (Alberta Community Development 2002). The requirement for the avoidance of impact applies to the building, rather than to all the lands that surround it. As it is identified on the *Listing of Significant Historical Sites and Areas (third edition)*, however, an assessment will be required by Alberta Community Development to ensure that no significant impact occurs to either the building or any feature specifically associated with that building.

Known Site Locations

In addition to localities that are important through their listing on the *Listing of Significant Historical Sites and Areas (third edition),* there are a number of known and recorded archaeological site locations that lie immediately adjacent to, or are crossed by, one or more of the right-of-way alternatives. These areas have been identified through disturbance that has occurred to the regions as the result of previous construction and cultivation. They lie east of Ponoka, east of Lacombe, and are found plentifully in the section of the rights-of-way between the Blindman River and Lacombe (in the area surrounding Blackfalds) (see attached figure). Eleven sites or artifact collection locations have been identified within one kilometre of the rights-of-way. These include one isolated find site (FcPk 20), two lithic workshop sites (FcPk 18, FcPk 19) and eight artifact collection locations (FcPj 4, FcPk 1, FcPk 2, FcPk 29, FcPk 32, FcPk 36, FcPk 37, FePj 2). Most of the sites have been identified in cultivated or otherwise disturbed contexts. Although these sites are not of the nature that permits their inclusion on the *Listing of Significant Historical Sites and Areas (third edition),* they are important as they have yielded a wide variety of diagnostic lithic artifacts associated with Middle and Late Prehistoric periods (*c*. 5,000 to 500 years ago). As a result, despite the disturbed contexts of these sites, areas of the proposed development rights-of-way that either cross or run immediately adjacent to theses sites should be inspected to ensure that they will not be impacting intact cultural deposits associated with these sites. These locations would specifically include areas along the edges of Sections 23, 26, 27 and 35 of Twp 39-27-W4M (adjacent to FcPk 18, 19, 29 and 36 and crossing FcPk 1), the edges of Sections 1 and 11 of Twp 40-27-W4M (adjacent to sites FcPk 2 and FcPk 37), the edges of Sections 28 and 33 (adjacent to sites FcPj 4 and FcPk 32) and Section 3, Twp 43-25-W4M (crossing site FePj 2) (see attached figure).

“High Potential” Areas

Although the *Listing of Significant Historical Sites and Areas (third edition)* and the known locations of archaeological sites identified in the Alberta Archaeological Site Inventory database provide an indication of the historical resource potential of the region, they do not represent all the possible archaeological sites that may be within the development zone. As a result, based on airphoto analysis or the proximity of a number of areas to environmental features such as watercourses, there are a number of locations that are considered to have potential for the identification of historical resource sites. These include portions of the rights-of-way that cross or lie immediately adjacent to the main watercourses of the region (including the Blindman River, Wolf Creek and small seasonal or permanent lakes in the region), areas of which may not have been subject to ground disturbance, or areas of unique undisturbed landforms. In most cases, the areas selected as being of “high potential” for historical resource sites based on their environmental characteristics also lie immediately adjacent to areas identified as candidates for investigation based on their proximity to known archaeological site locations (see attached figure). Areas of potential for the identification of historical resources which should be subject to investigation include NW-4-39-27-W4M, N1/2-39-27-W4M, N1/2-20-40-26-W4M, Sections 1, 2, 12-42-26-W4M, Section 34-42-26-W4M; S1/2-6-43-25-W4M, S1/2-3-43-25-W4M, Sections 6-44-24-W4M and N1/2, Section 32/33-43-24-W4M (see attached figure). As a measure of risk management to avoid inadvertently impacting historical resources that have not yet been identified within the areas of the development, it is recommended that these areas be investigated for the presence of historical resource sites.

Summary of Historical Resource Issues

Based on the results of the overview, it is recommended that a highly targeted ***Historical Resource Impact Assessment (HRIA)*** be conducted of the right-of-way alternative selected for construction. The target areas for HRIA investigation, identified in Table 1, would consist of those that contain known historical resource constraints (such as those sites identified on the *Listing of Significant Historical Sites and Areas* or those that contain recorded historical resource site locations), as well as those areas that should be examined for the purpose of managing risk with respect to historical resource site locations (“high potential” archaeological site locations). With the exception of Section 14-39-27-W4M (the Red Deer River Palaeontological locale), the remainder of the areas of concern are all archaeological in nature. To minimize impact on historical resource site areas of concern, it is strongly recommended that the right-of-way chosen incorporate as much area of previous disturbance as possible for the alignment used. Such areas would include the use of previously disturbed ditchlines or other areas disrupted through highway and railway construction or disturbance. Where this is achieved, the need for historical resource assessment will be minimized, as the threat of development to intact archaeological deposits would be reduced.

Table 1. Areas of proposed rights-of-way alignment alternatives recommended for inspection of Historical Resources.

Twp & Rge	Section	Criteria for Historical Resource Impact Assessment	Type of assessment recommended
Twp 39-27-W4M	NW, Section 4	crosses "high potential" area adjacent to small lake	archaeological
	Section 14	Red Deer River Palaeontological zone, Identified on the *Listing of Significant Historical Sites and Areas (third edition)* as possessing an HRV 4 rating	palaeontological
	Sections 23, 26 & 27	adjacent to sites FcPk 18, FcPk 19, FcPk 29, FcPk 36	archaeological
	Section 35	crosses site FcPk 35	archaeological
	N1/2, Section 39	crosses "high potential" area Based on the results of the overview, it is recommended that an highly targeted Historical Resource Impact Assessment be conducted of the selected right-of-way alternative. The areas that would be selected would consist of those within Table 1 which are applicable to the specific routing. These areas consist of those that contain known historical resource constraints (such as those sites identified on the *Listing of Significant Historical Sites and Areas* or those that contain recorded historical resource site locations), as well as those areas that should be examined for the purpose of managing risk with respect to historical resource site locations ("high potential" archaeological site locations). With the exception of Section 14-39-27-W4M, the Red Deer River Palaeontological locale, the remainder of the areas of concern are all archaeological in nature. To minimize impact on historical resource site areas of concern, it is recommended that the right-of-way employed incorporate as much area of previous disturbance as possible for the alignment used. As a result, preferable areas would include ditchline disturbance of highways or areas previously disturbed through highway and railway construction or disturbance. Where this is achieved, the need for historical resource assessment will be minimized, as the threat of development to intact archaeological deposits will be minimized. of Blindman River	archaeological
Twp 40-26-W4M	N1/2, Section 20	crosses "high potential" area of Wolf Creek	archaeological
	Sections 28 & 33	adjacent to sites FcPj 4 and FcPk 32	archaeological
Twp 40-27-W4M	Sections 1, 11 & 12	adjacent to sites FcPk 2 and FcPk 37; crosses "high potential" area	archaeological
Twp 42-25-W4M	N1/2, Section-29	Historic Building 1 of the Alberta hospital, Identified on the *Listing of Significant Historical Sites and Areas (third edition)* as possessing an HRV 1 rating	archaeological
Twp 42-26-W4M	Sections 1, 2 & 12-	crosses "high potential" areas adjacent to Morningside	archaeological
	Section 34	crosses "high potential" area of Battle River	archaeological

Twp & Rge	Section	Criteria for Historical Resource Impact Assessment	Type of assessment recommended
Twp 43-24-W4M	Sections 32/33	crosses “high potential” area of Battle River	archaeological
Twp 43-25-W4M	Section 3	crosses site FePj 2; crosses “high potential” area	archaeological
	S1/2, Section 6	crosses “high potential” area of small lakes north of Battle River	archaeological
Twp 44-24-W4M	Section 6	crosses “high potential” area of Battle River	archaeological

2.3 Watercourse Crossings and Fish

The proposed pipeline will cross the Blindman River immediately downstream of Highway 2A, on the east side of the old bridge.

The “Ponoka East route option” crosses the Battle River north of Ponoka in township 43. The “Ponoka West route option” crosses the Battle River twice; south of Ponoka and at the township 43 location north of Ponoka to supply water to the Montana Band Indian Reserve.

The Battle River and the Blindman River in the vicinity of the proposed waterline crossings may support a variety of sport fish and forage fish species including northern pike, yellow perch, burbot, longnose sucker, white sucker, lake chub, brook stickleback, pearl dace, northern redbelly dace, and longnose dace. No species of special concern are expected to occur near the proposed waterline crossings. All of these species are spring spawners. Although fall spawning species such as the mountain whitefish are known to occur in the Red Deer River, these fish species are not expected to spawn in the Blindman River system (V. Buchwald, Area Fisheries Biologist, Alberta Sustainable Resource Development, personal communication).

Because of the likelihood that both waterline crossing locations support fish, the Battle River and Blindman River waterline crossings are designated as Class C watercourses (Red Deer Management Area Mapsheet) as defined under the Alberta *Water Act-Code of Practice for Watercourse Crossings* (Alberta Environment 2001). Although the potential location of the Blindman River crossing is relatively close to the Red Deer River, which has a Class B designation with a Restricted Activity period of September 16 – June 30, the Class C designation for the Blindman River still applies (V. Buchwald, Area Fisheries Biologist, Alberta Sustainable Resource Development, personal communication). Class C watercourses in this area have a Restricted Activity Period of April 16 – June 30 for construction activity.

The preferred crossing method for the pipeline at the Battle River and Blindman River sites is by *horizontal directional drilling*. The geology at the Blindman River needs to be investigated but appears to be a sequence of bedded sands and gravels overlying sandstone. Conditions may not be favorable for directional drilling of a large diameter hole. The option would be to use a *trench with flow isolation* method. An authorization from DFO for instream work would be required.

If construction of the proposed waterline occurs outside of the Restricted Activity Period and horizontal directional drilling is used as the crossing method, potential impacts on the aquatic resources of the Battle River and Blindman River are expected to be negligible. A trench with isolation crossing causes a short term disruption but the effects are mitigable.

A ***Fish and Fish Habitat Assessment*** should be done at the selected crossing locations to support the DFO application and the Code of Practice for Watercourse Crossings. Designs for habitat restoration and possibly mitigation measures will be required for a trench with isolation crossing.

Contingency plans for dealing with frac-out of drilling fluids must be in place for a directional drilling project. Effective erosion and sediment control must be in place at river crossings during and after construction.

2.4 Soils, Conservation and Effects on Construction

The soils along the proposed routes are typically thick black Chernozemic soils (Agrasid soil inventory database). These are some of the best agricultural soils in Alberta. The black topsoil (A horizon) can be as much as 1m thick, but thinner soils on sands and gravels are also present. Wet soils (Gleysols) with a high watertable are common along the route, especially near Lacombe and Ponoka.

Conservation of topsoil, and replacement of overall soil quality, is required during pipeline construction. Salvage, storage and replacement of very thick topsoil requires planning and allowance for sufficient space and use of appropriate equipment and methods.

The pipeline trench is expected to about 6m wide at the top. The right of way and work space will have to be in the order of 35m wide to accommodate topsoil storage, spoil storage, trench, equipment space and traffic. Additional space is required at crossings and in areas of unstable soils. A large volume of topsoil will be salvaged, stored and replaced. Lack of space commonly results in soil handling problems and mixing of topsoil and subsoil.

Soil handling methods and right of way design should change to match changes in construction methods due to steep topography (grading); for wet, unstable soils; for crossings of foreign pipelines; at road crossings; at watercourse crossings; at side bends; and sometimes at landowner request.

Wet soils and non-cohesive soils result in unstable trench walls. Special procedures such as wider trench and less steep backslope, or use of boxes or shoring are required to protect workers in the trench. Wet soils may restrict traffic to tracked vehicles only. Wet ditches must be pumped to allow construction and backfill. There are several wet soil landscapes along the proposed route.

A ***Soil Survey and a Soil Conservation Plan*** for the selected route are required for the ***Conservation and Reclamation Permit Application***. In addition to normal soil sampling the soils in industrial areas and soils adjacent to old gas stations should be sampled and tested for presence of gasoline, diesel and other contaminants. Contaminated soils should be avoided or cleaned-up.

2.5 Land Use

The land use adjacent to the pipeline route determines many environmental and social issues and affects construction methods and often the construction schedule. This pipeline route goes through urban / suburban areas; country residential and small farm holdings; and large holding agricultural lands.

Urban and suburban residential or commercial areas will have land and right of way (RoW) issues to resolve. They also have issues related to: congested space; numerous road and utility crossings; issues of construction traffic interrupting business and commuter traffic; construction noise and hours of work; public safety / barriers / fencing / security; and localized potential for contaminated soils near old fuel storage tank sites. These areas require effective communication and planning, and urban pipeline construction methods (narrow work space, vertical trench with shoring, compacted backfill, use of fillcrete, replacement of pavement or landscaped areas).

Country residential and small farm owners may be reluctant to provide easements, and will have several land and RoW issues to negotiate. They may have concerns related to proximity to houses and encroachment on landscaped yards and natural green areas; blocked access to their driveway; control of dogs; fencing for horses; protection of shallow water wells from drilling frac-out; crossings of private u/g utilities; construction traffic and safety; construction noise and hours of work; and open excavations and public safety. These areas also require effective communication and planning and some fine-tuning of the route. Pipeline construction methods should be modified to reduce the footprint and perhaps the hours of work. These areas require aggressive safety measures including barriers, fencing, and security patrols. Some areas will require site-specific procedures and designs for every stage from survey to construction, clean-up and reclamation, and restoration of landscaping and fences.

Appropriate planning and specifications are required for:

- Disposal of slash (no burning; logs, firewood, chips)
- Disposal of hydrovac mud
- Pipe storage
- Contractor yards

In areas of large holding agricultural land use there will also be land and RoW issues and probably some reluctance to routing. Pre-construction planning should

- avoid yards and livestock facilities,
- identify private u/g utilities,
- identify requirements for temporary fences and gates,
- specify replacement fences,
- preserve or replace shelter belts,
- specify weed control requirements,
- maintain surface drainage,
- go under subsurface drains,
- identify constraints to scheduling of survey, construction and clean-up
- identify farm and field access,
- obtain landowner input to, rock disposal, tree clearing / slash piling / disposal, dewatering of ponds and wet ditch, and choice of revegetation species.

3. Summary

We have subdivided the pipeline route into 26 segments based on land use, biophysical features, and environmental issues or constraints (see attached Route Map drawing and the following table). Table 2 identifies environmental features and issues and suggests possible mitigation measures. More detailed examination of the route will be done in the detailed design phase of this project, and specific mitigation measures will be identified as part of the Conservation and Reclamation Plan.

A Conservation and Reclamation Permit will be applied for, and the permit is required prior to construction as this is a Class 1 pipeline under AEPEA regulations.

Table 2. Summary of Environmental Features and Issues along Proposed Route.

Pre-Design Phase (May 6, 2003)

Segment	Feature / Issue	Mitigation
1. Red Deer fringe	Urban fringe, Hwy 2A, Industrial yards, Multiple crossings, Congestion, Gravel subsoil	Urban p/l methods, thin topsoil salvage
2. RD fringe to Blindman	Agricultural land, thin soil over gravel?, Archaeology potential	Soil salvage, HRIA
3. Blindman River	River crossing, closed in spring, adverse geology, Archaeo & Palaeo potential	Geotechnical study, determine crossing method, DFO approval for HADD, sched fall / early winter, HRIA
4. Blindman to Blackfalds	Residential and Industrial obstructions, old gravel pit, ag land	Urban p/l methods, thin soil salvage
5. Blackfalds	Restricted space (landscaped median)	Urban p/l methods, restore landscaping
6. Blackfalds north, C&E trail	Country Residential, landscaping, restricted space	Urban p/l methods
7. South of Lacombe	Agricultural land use, thick black soils, Farm yards, Archaeo potential, beside ATCO gas line	Avoid yards, thick soil salvage, HRIA, setback from gas line
8. Ag Research Sites	Ab Agriculture and Ag Canada soil and crop research plots, high watertable, beside gas line	Avoid by reroute or negotiate, special methods, very expensive reclamation
9. East side Lacombe	High watertable and sloughs, silty soils, thick black soils, urban fringe, Archaeo potential, beside gas line	Manage wet, unstable trench, thick soil salvage, refine route, HRIA
10. South of 2/ 2A junction	High watertable and sloughs, silty soils, thick black soils, beside gas line	Manage wet unstable trench, thick soil salvage
11. Milton country res.	Country residential land use, landscaping, congestion for routing, wetlands, high	Avoid by reroute or manage congestion, wet unstable

Segment	Feature / Issue	Mitigation
	watertable, thick blacks on sand, beside gas line	trench, restore landscaping
12. Milton to Morningside	Ag and country res land use, beside gas line, landscaped yards, thick black soils on sand, complex topography	Manage route congestion, unstable trench, thick soil salvage
13. Morningside village	Route beside gas line under paved street?, congested route, landscaped, mature trees, sand, old gas station site	Avoid by reroute or manage congestion , urban p/l methods, manage unstable trench, possible contaminated soil
14. Morningside Sand Dunes	Complex topo, some steep slopes, sand dunes and wetland / bog, high watertable in sand, mature spruce trees, country residences, high archaeo potential, beside gas line, expect public opposition to route	Avoid by reroute or manage many issues, HRIA; expensive to construct
15. Southeast of Ponoka	Agricultural land use, thick black soils, farm yards	Thick soil salvage, avoid yards
16. East side of Ponoka, north of Hwy 53	Ag and urban fringe, Archaeo potential, thick black soils	HRIA, avoid obstacles, thick soil salvage
17. East of Battle River	Ag land use, thick black soils, small wet areas, limited access to RoW	Thick soil salvage
18.Montana Band I.R.	Ag land use, thick black soils, Federal Gov. regulator	Thick soil salvage, Federal approval process
19. Ponoka West Option – North of Morningside	Ag (pasture) and Country Res land use; sand dunes and wetland/ bog, limits to traffic on RoW	Manage dry sand and wet sand, bogs, unstable trench
20. Ponoka West Option – North of Sand Dunes	Ag land use, very thick black soils, silts and sands, some high watertable	Thick soil salvage, manage wet unstable trench
21. Ponoka West Option – South of Battle R	Ag land use and gravel pits, soils are variable, possible gravel resource isolation, Archaeo potential	Adjust soil salvage, some unstable trench, HRIA
22. Ponoka West Option – Battle River (south)	River crossing, closed in spring, possible gravel substrate	Geotechnical investigation, plan crossing method, DFO approval for HADD, HRIA
23. Ponoka West Option – Battle R to Hwy 53	Ag and industrial (oil battery?) land use, Archaeo potential; variable soils	May need to fine-tune routing, HRIA
24. Ponoka West Option – Northwest of Ponoka	Cemetery, ag land, urban fringe, some wet areas	Fine-tune routing, avoid obstacles
25. Ponoka West Option – Parallel Hwy 2A to Hobbema	Beside ATCO gas line (east of CPR), major weed control problem, numerous wet areas, high watertable, thick black soils, limited access to RoW, Samson Band I.R. at north end with Federal Gov. regulator	Several weed wash stations and long term control, thick soil salvage, manage wet unstable trench, Federal Gov approvals on I.R.
26. Ponoka East and West Options – Battle River (north)	Second crossing of Battle R on west option but only crossing of Battle on east option, closed in spring, unknown geology, wide channel with wetland area	Geotechnical investigation, plan crossing method, DFO approval for HADD

4. Requirements for Detailed Design Phase

1. Participate in public communication and finalize the route
2. Conduct a targetted Historical Resources Impact Assessment (HRIA)
3. Conduct a soil survey and prepare a Soil Conservation Plan
4. Assess Fish and Fish Habitat at river crossings. Design contingency and protection plans for drilled crossings, and design habitat restoration and mitigation for trenched crossings.
5. Screen the route for rare species of plants and animals and critical habitat and identify any mitigation required.
6. Identify specific landowner environmental issues and mitigation.
7. Prepare environmental and reclamation specifications and annotate the alignment sheets.
8. Prepare Conservation and Reclamation (C&R) permit application and respond to regulatory queries.

5. Literature Cited

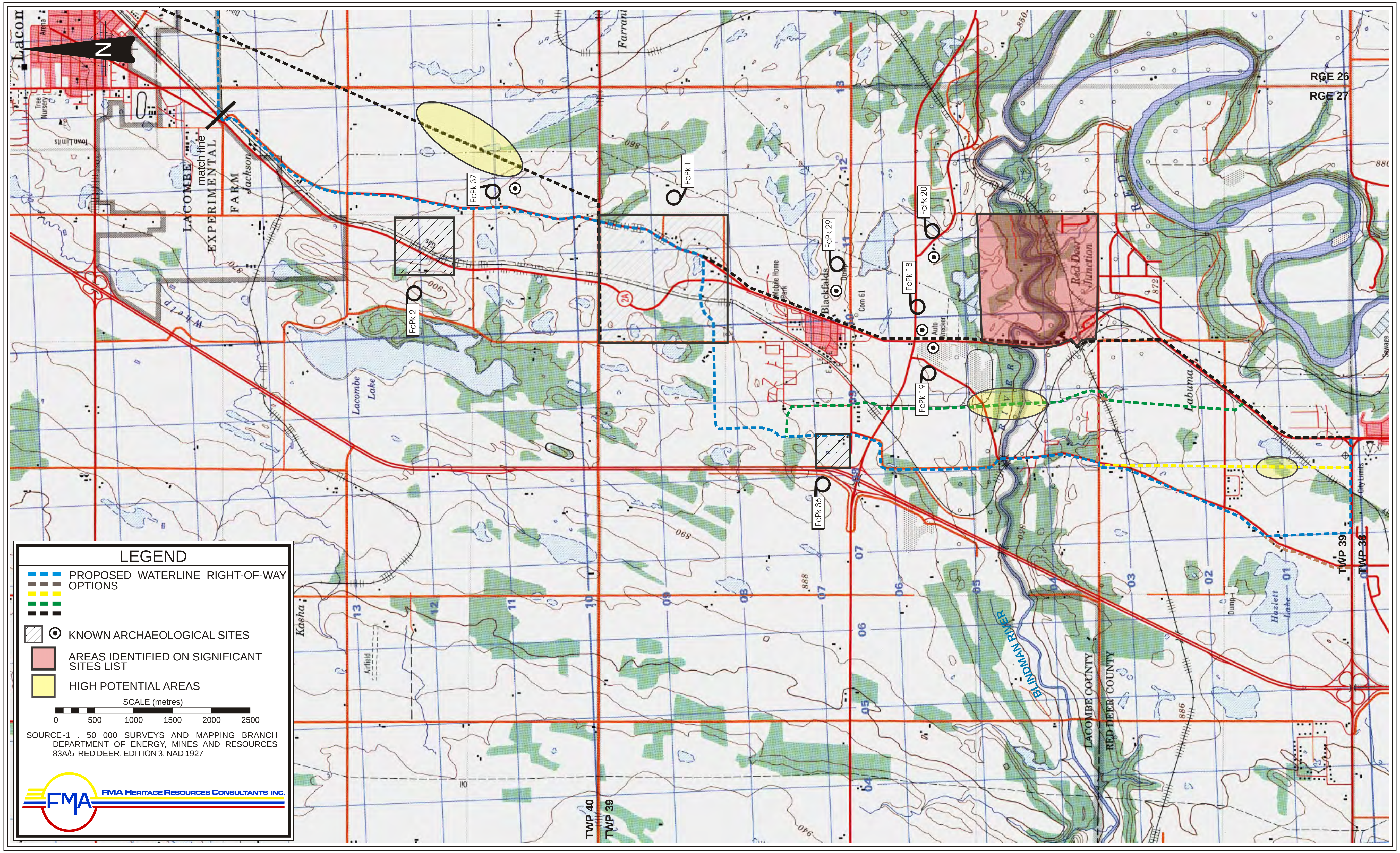
Alberta Environment. 2001. Guide to the Code of Practice for Pipelines and Telecommunication Lines crossing a waterbody including guidelines for complying with the Code of Practice. Alberta Environment, Edmonton, Alberta, Canada.

6. Personal Communications

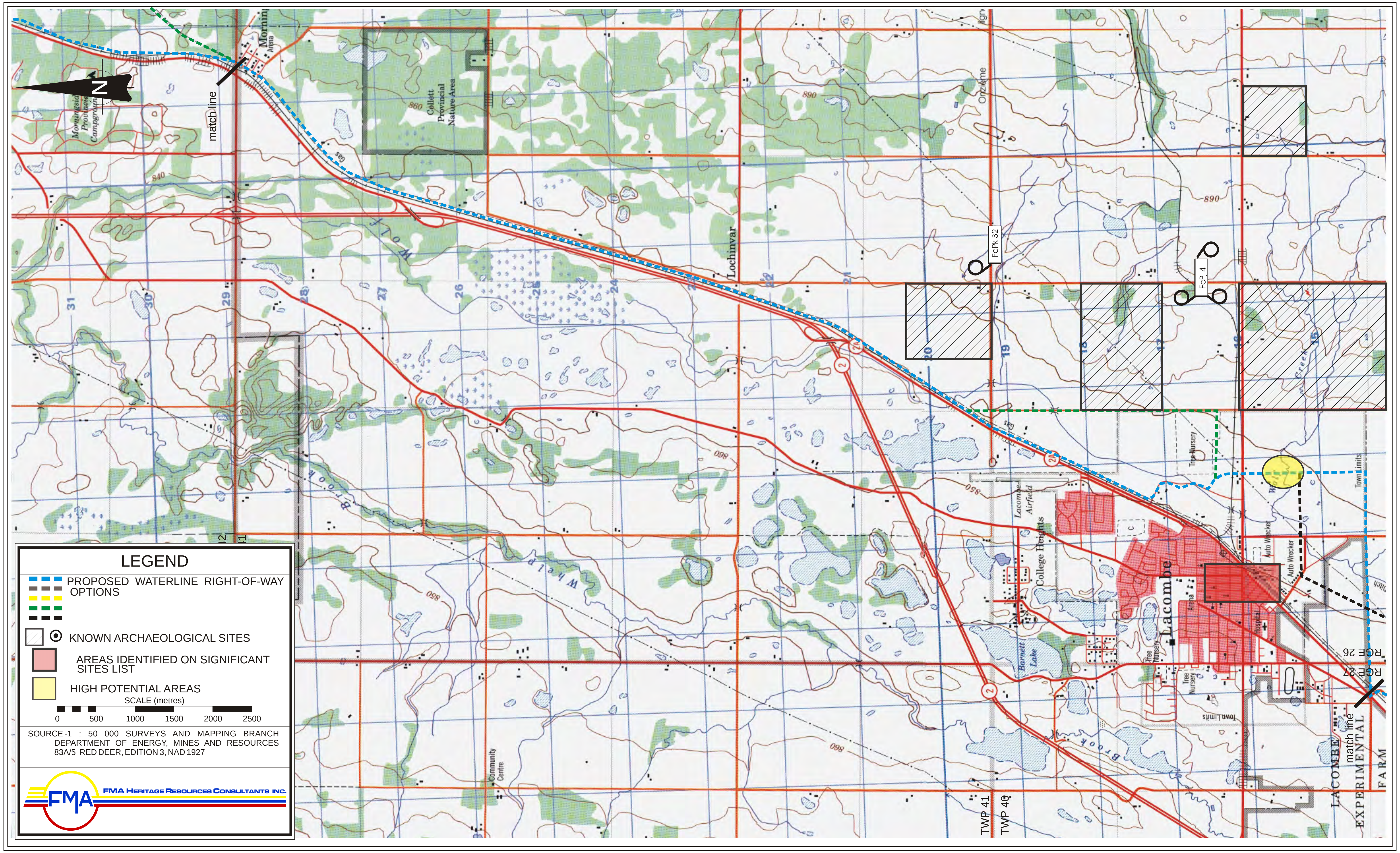
Vance Buchwald, Area Fisheries Biologist, Fisheries Management, Fish and Wildlife Division, Southeast Region, Red Deer, Alberta.

7. Appendices

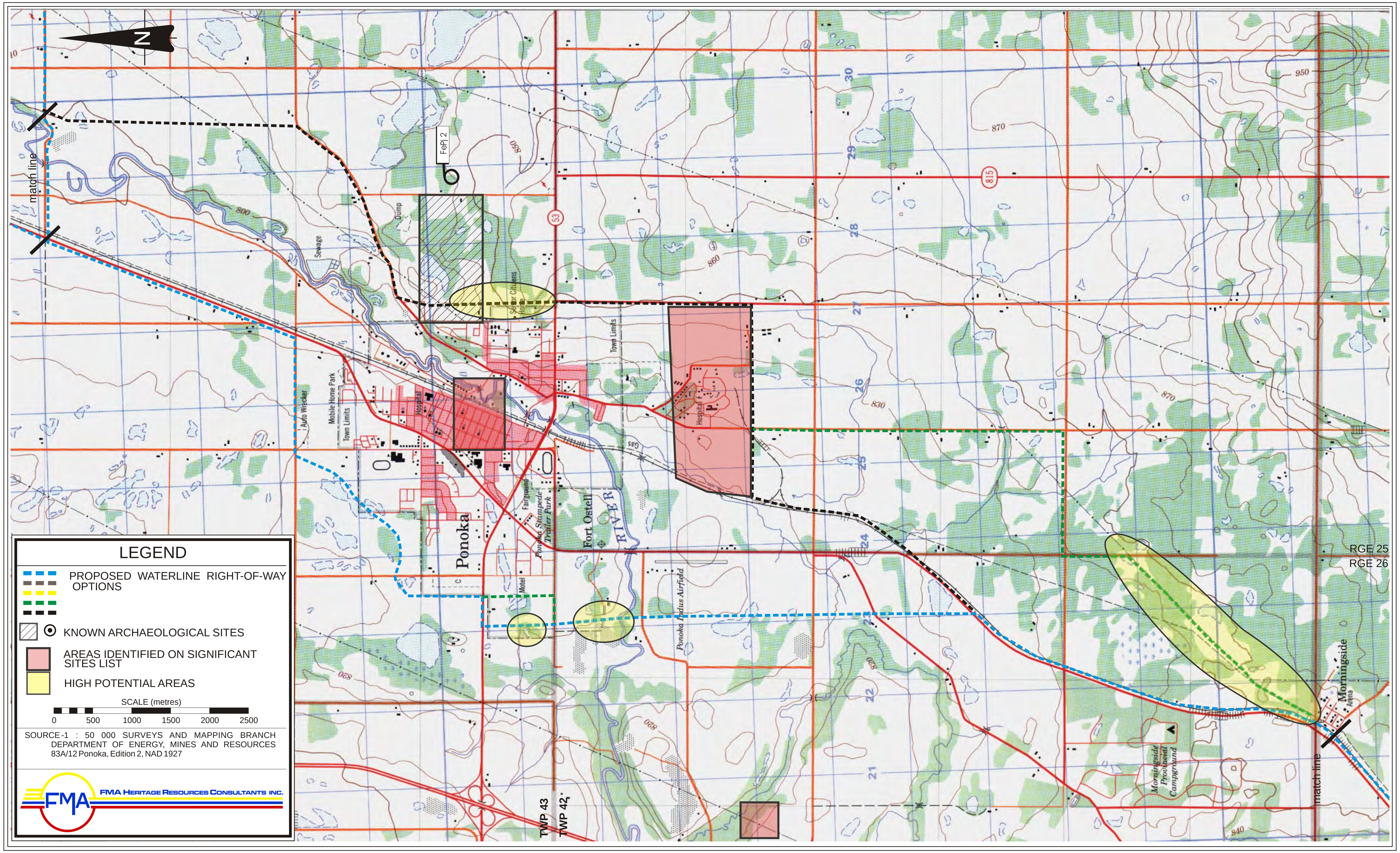
Appendix 1. Archaeological Features (Map 1 of 4).



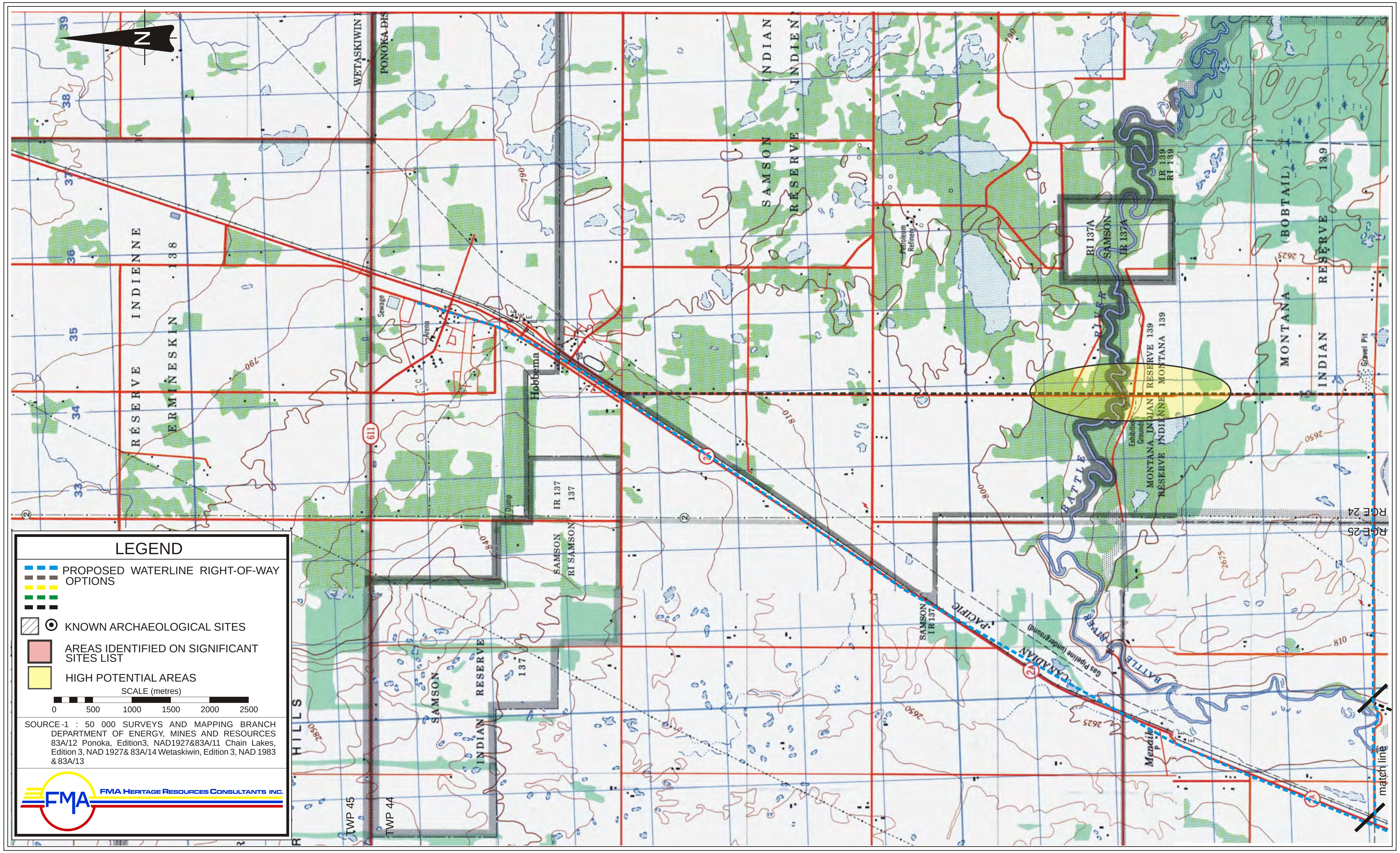
Proposed development options (1 of 4)



Proposed development options (2 of 4)



Proposed development options (3 of 4)



Proposed development options (4 of 4)

APPENDIX C

PARKLAND GEOTECHNICAL LTD. - REPORT

GEOTECHNICAL REVIEW
PROPOSED RED DEER NORTH WATER LINE
HIGHWAY 2A CORRIDOR
RED DEER TO HOBBEMA, ALBERTA

Submitted To:

ASSOCIATED ENGINEERING ALBERTA LTD.
Edmonton, Alberta

Submitted by:

Parkland Geotechnical Consulting Ltd.
Red Deer, Alberta

MAY 2003

File # RD0888

TABLE OF CONTENTS

Page
TABLE OF CONTENTS I

1.0 INTRODUCTION 1

2.0 OFFICE REVIEW 1

3.0 SITE DESCRIPTION 2

3.1 GEOGRAPHIC FEATURES 2
3.2 SURFICIAL GEOLOGY 2
3.3 GEOTECHNICAL INFORMATION 3

4.0 TYPICAL SOILS 3

4.1 TOPSOIL 3
4.2 GLACIO-FLUVIAL DEPOSITS 3
4.3 EOLIAN SAND 3
4.4 LACUSTRINE SOILS 4
4.5 TILL 4
4.6 BEDROCK 4

5.0 GEOTECHNICAL EVALUATION 4

5.1 NORTH RED DEER/ RED DEER COUNTY 4
5.2 BLINDMAN RIVER VALLEY 5
5.3 BLACKFALDS 5
5.4 BLACKFALDS/ CP RAIL OVERPASS TO MORNINGSIDE TURN-OFF 5
5.5 MORNINGSIDE 5
5.6 PONOKA 6
5.7 BOBTAIL ROAD TO SAMSON TOWNSITE 6
5.8 MONTANA BAND/ EASTSIDE ROAD 6
5.9 RECOMMENDATIONS FOR FUTURE INVESTIGATION 6

6.0 GENERAL RECOMMENDATIONS FOR BURIED SERVICE INSTALLATIONS 7

6.1 SITE PREPARATION 7
6.2 BURIED SERVICE EXCAVATIONS 7
6.3 PIPE BEDDING 8
6.4 TRENCH BACKFILL 8
6.5 TRENCH SETTLEMENT 9
6.6 DIRECTIONAL DRILLING 9
6.5 CONCRETE FOR UNDERGROUND STRUCTURES 10

7.0 LIMITATIONS 10

TABLE OF CONTENTS (CON'T)

APPENDIX A

FIGURE 1 - KEY PLAN
FIGURE 2 - SITE PLAN
FIGURE 3 - SURFICIAL GEOLOGY
FIGURE 4 - GEOTECHNICAL DATA POINTS - NORTH AREA
FIGURE 5 - GEOTECHNICAL DATA POINTS - SOUTH AREA
FIGURE 6 - AERIAL PHOTOGRAPH - BATTLE RIVER - NORTH CROSSING
FIGURE 7 - AERIAL PHOTOGRAPH - BATTLE RIVER - SOUTH CROSSING
FIGURE 8 - AERIAL PHOTOGRAPH - BLINDMAN RIVER VALLEY
TABLE A1 - GEOTECHNICAL DATA POINT SUMMARY
TABLE A2 - WATER WELL SUMMARY
COMPOSITE BOREHOLE LOGS (51)
EXPLANATION SHEETS

1.0 INTRODUCTION

A regional water line is being proposed between the City of Red Deer and the Ermineskin Band Reserve at Hobbema, Alberta. The project is a joint effort between various levels of government including the municipalities along the proposed route including the City of Red Deer, the Towns of Blackfalds, Lacombe and Ponoka; the Counties of Lacombe and Ponoka; and the Samson, Ermineskin, Louis Bull and Montana Band Indian Reserves. The proposed water line follows the approximate alignment of Highway 2A and will include about 70 km of pressurized water pipeline, two river crossings, numerous other road and stream crossings and possible structures along the proposed route. Parkland Geotechnical Consulting Ltd. (Parkland) has undertaken a preliminary geotechnical review for this project. The scope of the approved work was provided in Parkland's proposal letter (PRO515) dated January 28, 2003. Authorization to proceed with this review was given by Mr. Blair Birch, P.Eng. of Associated Engineering Alberta Ltd., acting on behalf of the project committee.

This geotechnical review study was conducted to provide a summary of the geotechnical data gathered to identify geotechnical issues related to construction of the proposed water line and discuss general recommendations for various construction techniques which may be required along the proposed routes. It is expected that detailed and site specific investigation will be undertaken to determine the engineering properties of the site soils with respect to design and installation of underground services for this project. This review provides recommendations regarding future investigation along the proposed alignment.

2.0 OFFICE REVIEW

This study was an overview or desk-top review of the available information for the areas along the proposed pipeline routes identified by AEAL. The primary components of this office review would include:

1. A review of aerial photography and geological data for the proposed alignment.

2. A selection of relevant historical geotechnical data has been compiled along the proposed routes based on available file records known to Parkland. Parkland personnel contacted several municipalities and their engineering consultants who have worked along the proposed routes to supplement the information in Parkland files.

3. Parkland has reviewed local water well records on file and publically available over the Internet through Alberta Environment's Groundwater Information System.

This information was compiled and used to identify areas of limited information and locations of concern relative to proposed crossings or unusual landforms to guide in planning a cost effective geotechnical drilling program.

The information which has been complied has come from a number of sources related to both public and private projects. In general, file information from public projects undertaken for various municipalities has been taken as fully available for this study. Whereas, Parkland has not undertaken to obtain releases of geotechnical data from private files so the information available is in terms of general experience of Parkland personnel. The complied information is also subject to a wide range of detail and accuracy from very accurate boreholes to water well records which can be suspect terms of both log description and location. To acknowledge this situation, all geotechnical data has been assigned an accuracy rating of low, medium, high and very high as described below.

Low:	These would include percolation test data and water well records which are often logged very poorly.
Medium:	These would include geotechnical information provided or available to Parkland without supporting logs (eg. text from a geotechnical report or verbal descriptions provided by others).
High:	These would include unsurveyed borehole information which is available on file and could be produced for this project; and surveyed borehole information from private files that is not presently available for this project (without obtaining a release from the Owner).
Very High:	These would include borehole logs at surveyed location and elevation that are available on file and could be produced for this project.

3.0 SITE DESCRIPTION

The proposed water line follows the approximate alignment of Highway 2A from the north end of the City of Red Deer to the Ermineskin Town-site at Hobbema. The subject area for the proposed water line is shown on the Key Plan, provided on Figure 1, in Appendix A. The proposed routes selected for consideration were forwarded to Parkland On March 19, 2003,in the form of coloured lines overlain on an aerial photograph mosaic. For the purposes of this report the proposed alignments are named and discussed in terms of colours, with Blue, Red and Green alignments being the most prominent. The main routes are shown on the Site Plan, Figure 2 in Appendix A.

3.1 GEOGRAPHIC FEATURES

The study area runs through three counties, crossing both the Blindman and Battle River valleys. Grade changes through the area are generally gradual, with exception of the river valleys. Slopes along the river valley are generally considered to be stable with a few localized exceptions. Based on a cursory review of aerial photographs obvious signs of major instability were not noted where proposed water line alignments cross these river valleys. Several low lying sloughs are present along the alignment, but these sloughs were generally small and localized. The majority of the local topography outside of the two river valleys was considered to be gently rolling except for: the area west of Morningside which was rolling; and the large hill/ridge on the west side of Highway 2A just south of Lacombe.

The three main proposed alignments skirt around Blackfalds, Lacombe and Ponoka; and all alignments follow Highway 2Afor extended lengths such as Lacombe to Morningside and Ponoka to Hobbema. The proposed alignments split around either side of Blackfalds and Ponoka, but all three proposals loop around the east side of Lacombe where they pass by the Lacombe sewage lagoons. Only the Red alignment passes the sewage lagoons northeast of Ponoka.

3.2 SURFICIAL GEOLOGY

The Highway 2A corridor generally follows the axis of the Glacial Lake Red Deer Basin which existed between Ponoka and Innisfail and ran through Lacombe, Blackfalds and Red Deer. The surficial geology of the study area can be broadly described as glacial lake sediments in a depression carved out of the moraine (till) sheet. The lake basin crossed two pre-glacial river beds denoted by extensive coarse sand and gravel deposits. The Blindman and Battle Rivers have down cut the old river channels and re-exposed the gravel and bedrock which pre-existed the last period of glaciation. The lake deposits have since been overlain in several locations by thin eolian (dune) sediments blown down from the northwest. A insert from the Alberta Research Council Quaternary Geology report (Shetson 1990), is shown on Figure 3, in Appendix A.

3.3 GEOTECHNICAL INFORMATION

Parkland has reviewed a total of 51 relevant sites in the study area, which were defined as a site within 2 km of a proposed water line alignments. The locations of the geotechnical data points are shown on Figures 4 and 5, in Appendix A. For areas of the proposed alignment where geotechnical data was not available or limited Parkland reviewed the Alberta Environment Groundwater Information System for available water well records. The surficial geology of 55 water well records was reviewed and summarized in Table A1. The relevant water well locations are also indicated on Figures 4 and 5.

4.0 TYPICAL SOILS

The soil profile along the alignment varies and will be discussed in general terms by area in the following section. The following is a brief description of the soil types encountered and typical characteristics which might impact the proposed water line project.

4.1 TOPSOIL

Topsoil is generally considered to be abundant in Central Alberta. The topsoil is typically moderately organic and is considered to be relatively weak and highly compressible. Transitions to underlying inorganic soils are usually distinct. There are a few typical exceptions like areas around sloughs such as north Blackfalds and in the Samson Band Town-site.

4.2 GLACIO-FLUVIAL DEPOSITS

Local river valley flood-plains are usually covered or terraced with water deposited granular sediments. These glacio-fluvial deposits generally become coarser with depth. The typical profile consists of a layer of medium fine sand overlying thicker deposits of dense, cobbley sand and gravel. The sands are usually clean and non plastic, but occasionally have some silty fines. Sand and gravel deposits are usually well graded with aggregate sizes up to 300 mm in diameter.

4.3 EOLIAN SAND

Eolian or “wind-deposited” sand is found in a number of areas along the proposed water line route. The typical sand was comprised of medium grained sand with a trace of silt and clay fines (typically less than 15 percent combined silt and clay). In most cases the transition into wet, siltier soils was not well defined. The upper sand was damp to moist with typical moisture contents in the 5 to 10 percent range above the groundwater table. Below the groundwater table the sand was saturated with moisture content up to 25 percent. This type of material is used widely through the Red Deer area as borrow and bedding sand. The sand is considered to be compactable and stable, except under very wet conditions. The Optimum Moisture Content (OMC) is usually about 12 percent and the CBR value for this sand is typically around 5 in the soaked condition.

4.4 LACUSTRINE SOILS

Local lacustrine soils are usually interbedded silt, sand and clay deposits. The proportions of silt and clay vary randomly with depth and as a result the plasticity can range from non to high plastic. The most predominant lacustrine soil has over 50 percent silt by grain size, but has over 20 percent clay particles which causes the soil to behave like a medium plastic clay. Sandy layers, where encountered have high proportions of clay and silt which greatly reduce the engineering properties of these deposits. The relative density of the sandy soil was medium dense (compact), and the consistency of the cohesive soils was stiff. The moisture contents in these deposits range from approximately 15 to 25 percent in the sandy soils to slightly over 40 percent in the silty clay soils. In general, the silty deposits are considered to be wet, soft, sensitive and highly frost susceptible. The OMC is usually between 15 and 20 percent and the soaked CBR values range from 2.5 to 5 which is relatively low.

4.5 TILL

Till deposits are glacial materials which are usually pre-consolidated by glacial action. The local till is a mixture of sand, silt and clay with inclusions of pebbles, cobbles, coal fragments and bedrock nodules. Both clay and sand tills are found in the area, but clay tills are generally more common. The common clay till is usually medium plastic with a consistency ranging from stiff to hard. A sand till will have less than 10 percent clay particles and the resulting soil is non plastic. The moisture content of a local clay till is typically about 18 percent and sand till is about 14 percent. Cobbles, large boulders and wet sand layers are commonly encountered within the till in the Central Alberta.

4.6 BEDROCK

The typical local formation consists of inter-bedded silt-stone and clay shale with occasional layers of sandstone. The upper zone of the local formation is usually considered to be weak, weathered rock which has the consistency of a very stiff to very hard soil. The local bedrock weathers very quickly, breaking down into the constituent materials (ie. silt and clay). The upper formation has a tendency to be very fractured which makes the bedrock much more permeable than the constituent materials would normally suggest. The competency of bedrock generally increases with depth. Excavation into the upper zone of local bedrock formation is generally possible with larger equipment. However, occasional slabs of intact rock may be encountered, in which case specialized hammer equipment or blasting may be required.

5.0 GEOTECHNICAL EVALUATION

In general, Parkland believes that most of the alignment will encounter soil conditions compatible with conventional open trench servicing methods. Whether the subgrade is sensitive wet, silty clay; stable till, hard bedrock or saturated gravel, open cut trench construction methods can be adapted to deal with a wide range of conditions assuming right-of-way allowances are not restricted. Based on past experience in the area the following comments are provided regarding alignment options for selected areas. For reference aerial photographs of the Blindman and Battle River valleys are shown on Figures 6, 7 and 8.

5.1 NORTH RED DEER/RED DEER COUNTY

The subsurface conditions in this area is considered to be fair to good for buried service installation, depending on the thickness of wind-blown sands overlying the sensitive glacio-lacustrine deposits. The surficial clean sand is considered to be suitable for use as trench backfill. The silty clay are considered to be marginal for use as trench backfill because of high moisture contents, but it may be possible to mix in drier soils to improve compaction characteristics. Excavations will generally require relatively flat side-slopes and seepage control measures due to shallow groundwater. All three of the proposed routes to the Blindman River are expected to encounter similar conditions.

5.2 BLINDMAN RIVER VALLEY

The Blindman River valley is known for extensive sand and gravel deposits which extend north past SH 597. For many years, these gravel have been mined for commercial use. Groundwater levels in the gravel can range from very shallow (near Blackfalds Sewage Lagoons) to very deep (near Burbank). These gravels are very permeable and seepage flows in the gravel will be very high in areas of shallow groundwater. For example, in the early 1990's AGT installed a new cable in the northeast corner of the intersection between Highway 2A and SH 597 and were not able to control the seepage flows to a level which would allow dry placement of the service. Similar conditions are expected along the toe of the north valley wall where groundwater from Blackfalds moves towards the river. The western-most approach is higher ground and may have slightly better conditions closer to the highway for directional drilling. The river crossing is expected to be based in gravel underlain by till and/or shale. Water well logs suggest that gravel at the river may be about 5 to 10 m deep.

5.3 BLACKFALDS

The near surface soils throughout most of the Town of Blackfalds are relatively dry fine to medium grained sand. Conditions for shallow service installations in the sand native to this area are very good, but service installations into the groundwater table at depths of 3 to 5 m below grade quickly deteriorate and will result in very unstable and flat side-wall slopes.

5.4 BLACKFALDS/CP RAIL OVERPASS TO MORNINGSIDE TURN-OFF

North of Blackfalds the predominant near surface soils are interbedded lacustrine silt, sand and clay soils. These local lacustrine soils are extensive in depth and proportions of silt, sand and clay vary randomly with depth. The one area of possible exception is Highway 2A beside the hill area about 3 km south of Lacombe which may be the result of a shallow bedrock outcrop. The groundwater table through this section is generally expected to be shallow at 2 to 4 m below grade. Some areas around the east sides of Lacombe with have seasonal groundwater peaks within 1.5 m of grade. Low areas to the north of Milton Road on the west side of Highway 2, also have shallow groundwater tables. This marginal farmland area required extensive regrading and de-watering into Wolf Creek to increase the useable pasture area. High ground to the east of the highway north of Lacombe will be slightly better in terms of groundwater conditions.

5.5 MORNINGSIDE

The near surface soils throughout most of the Morningside area are relatively dry fine to medium grained sand from several dune formations in the area. Conditions for shallow service installations in the sand native to this area are very good, but service installations into the groundwater table at depths of 3 to 5 m below grade will result in very unstable side-wall slopes.

5.6 PONOKA

Two alignment options are proposed near Ponoka; one around the west side of Town and one around the east edge of Town. The soil conditions in the Ponoka area are probably the widest ranging including, gravel river flats, silty lacustrine deposits, glacial out-wash soils and glacial (till) soils with significant inclusions of coarse gravel and wet sand. The Battle River valley is characterized by gravel flats with shallow groundwater conditions that extend up through the Southwest Industrial Park to Highway 53. Through east Ponoka, the river valley is a mixture of till and glacially deposited sand and gravel. The ridge to the east of the river valley has thin clay deposits overlying clay till. The upland area on the west side of Town has thicker lacustrine soils overlying till up to between Highway 2A and 63rd Street where the till becomes shallower.

With the west alignment option the Battle River will be crossed south of the Southwest Industrial Park area where coarse wet gravel and shallow groundwater conditions will be encountered. North of Highway 53 the soil conditions which consist of potentially sensitive wet silty lacustrine clay over till. Subdivision work in the north part of Ponoka have encountered some very wet soils which increase the sensitivity of these soils.

The east alignment option is expected to encounter drier lacustrine soils over shallow till. Subdivision servicing in this area of Ponoka has generally been very reasonable. This alignment crosses the Battle River at Bob-tail Road about 3 km north of Town. Based on surficial geology information for this area it is expected that the river crossing will encounter gravel through the flood-plain but the slopes on either side should be till with a possible thin covering of sand or clay.

5.7 BOBTAIL ROAD TO SAMSON TOWN-SITE

The soil profile commonly found through most of this area is lacustrine clay overlying extensive clay till deposits. The silt content in the clay varies, but the clay is generally more stable and less sensitive than some of the lacustrine soils found in southern sections of the subject area (ie. Lacombe). The depth to till generally decreases closer to Hobbema. The till is considered to be well suited to trenching and backfill operations.

5.8 MONTANA BAND/EASTSIDE ROAD

One of the alignments considered for the water line, but likely dropped from consideration ran north through the Montana Band Reserve along Eastside Road. The conditions in this area are predominantly till with both sand and clay till present along the route. The overlying soils vary from wet sand to lacustrine clay. Several low lying areas were common and the groundwater table is relatively shallow and commonly found perched in the sand layers above the till. The Battle River valley and the Eastside Road crossing appears to be cut into glacial (till) deposits with some gravel, but the gravel deposits appear to be less extensive than found south of Ponoka.

5.9 RECOMMENDATIONS FOR FUTURE INVESTIGATION

It is expected that a geotechnical field investigation will be part of the next design phase of the project. It is believed that it will not be cost effective to drill the entire alignment on a tight enough spacing to identify all possible conditions and problems. Parkland recommend an intuitive and opportunistic approach to the drilling program followed by an observational approach to handle issues as they arise during construction. Based on information from this review, site specific investigation is recommended for the following sites:

- the possible Blindman and Battle River crossings near Blackfalds and Ponoka, respectively;
- possible crossings sites for primary Highways 11A, 12, 53 and Secondary Highway 597.
- slopes along the Blindman River south of Blackfalds, particularly the south escarpment of around the C & E Trail in Red Deer County.
- and the east escarpment of the Battle River northeast of Ponoka.
- the possible bedrock ridge along Highway 2A halfway between Blackfalds and Lacombe.

In addition to these sites, it is recommended to undertake general drilling along county road right-of-ways at periodic intervals along the preferred route. Please note, it is expected that information may come to our attention through review of this report resulting in identification of other potential problem sites that might require further investigation.

6.0 GENERAL RECOMMENDATIONS FOR BURIED SERVICE INSTALLATIONS

6.1 SITE PREPARATION

Topsoil and organic soils will need to be stripped from the proposed alignment. It is expected that the alignment will be reclaimed so topsoil materials should be stockpiled for re-use. Care should be taken to minimize cross-contamination of inorganic and organic soils during and after stripping.

6.2 BURIED SERVICE EXCAVATIONS

It is expected that water line services will be installed to depths of 3 to 6 m below finished grade depending on changes in local topography. Conventional trenched excavations with sloping sides are considered to be feasible provided measures are taken to control groundwater in areas. Trench side-slope stability will be a concern since the trenches will intercept the groundwater table in several locations.

Excavations should be carried out in accordance with Alberta Occupational Health and Safely Regulations. The side-slopes of conventional unsupported trench excavations would be dependent on the local soil conditions. In general, for excavations deeper than 1.5 m, it is recommended side-slopes for short term excavations should be cut back to a minimum 1H:1V. According to OH&S regulations steeper side-slopes may be used in areas with “hard” soils, however, the only soils which might meet this classification will be found in the tills near Hobbema. Soil above seepage zones and saturated silty soils may require flatter side-slopes (required cuts may vary from about 1H:1V in stiff clay and dry sand to as shallow as 4H:1V in saturated silt deposits). If required side-slopes cannot be provided the use of temporary shoring is recommended in the working area of the trench.

The degree of stability of a steeply cut excavated trench wall decreases directly with time and, therefore, construction should be directed at minimizing the length of time service trenches remain open. Groundwater seepage from the sides of the trenches and from the base of the excavation is to be expected in many areas. Denaturing of excavated slopes may be necessary for trenches extending through granular deposits below the groundwater table. Monitoring and maintenance of the slopes should be carried out on a regular basis. Base heave and/or boiling of the trench bottom may occur, particularly in less cohesive silty soils. If large, wet silt or sand lenses are encountered within the cut, denaturing using well points or other pressure relief measures may be required. Stiff clay soils may not be subject to boiling, but disturbance from excavation may cause loss of strength and subgrade support.

Installation of underground services and utilities requires an observational approach be adopted which should combine past experience, contractor's experience and geotechnical input. It would be desirable for the selected excavation contractor(s) to be experienced in a wide range of soil conditions. Quality workmanship is essential.

6.3 PIPE BEDDING

Minor deflections of the trench bedding is expected. Underground utility pipes should be of a type which will maintain watertight joints (i.e. rubber gasket) after minor shifting has occurred. Bedding requirements are a function of the class of pipe and trench configuration, as well as site specific geotechnical considerations. In general, granular pipe bedding should be relatively well graded sand or sand/gravel mixture which can be readily compacted around the pipe to achieve high frictional strength. Bedding materials must have an appropriate gradation so that migration of natural soils into the granular system is restricted. Uniform gravels or gap-graded sands and gravels should not be used as bedding materials unless adequate provision is made to surround such soils with a filter fabric. In the likely event of significant seepage and wet base conditions, a free draining gravel layer may be required across the trench base to act as working base and assist in denaturing the working surface of the trench base. The thickness of gravel required will be dependent on the ability to provide a safe working surface.

6.4 TRENCH BACKFILL

It is expected that native soils will be used at the site. Ideally, backfill should be low to medium plastic, inorganic clay; well graded sand; or select coarse graded gravel. Typically the native surficial soils are expected to be relatively loose sand soils in a dry to moist condition or relatively wet, stiff lacustrine soils. Granular soils such as sand or gravel, or clay till are generally considered to be suitable for backfill and typical lacustrine soils are generally considered marginally suitable, provided they can be dried to a lower moisture content.

To minimize fill settlement under self-weight, excavated soil with a water content exceeding the plastic limit of the soil by more than 5 percent should not be used as fill unless the moisture content is lowered. Wet fill material should be dried or blended with drier material prior to use as trench backfill. If this is not practical, the wet material should be wasted. If required, suitable replacement soils would include imported clay with an appropriate moisture content relative to its optimum for compaction or imported sand materials suitable for compaction.

Good compaction of backfill is important to minimize future potential trench settlement. Backfill should be placed and uniformly compacted in thin lifts to at least 95 percent . Uniformity of compaction is most important. The lift thicknesses should be governed by the ability of the selected compaction equipment to uniformly achieve the recommended density. It is recommended to use lifts with a maximum thickness of 200 mm for granular fill and 150 mm for clay fill. To reduce combative effort needed to achieve maximum density in engineered fills it is recommended to place granular fill at moisture contents 0 to 2 percent below OMC and clay fill at moisture contents about two percent above OMC.

If backfill materials are wet of OMC and a slightly higher risk of settlement is acceptable it may be practical to compact the backfill above the pipe bedding to a density of at least 100 percent of One Point Proctor density at natural moisture content. Any further reduction in specifications due to weather or soil conditions should be reviewed by the geotechnical engineer. The final density results should be reviewed to allow for design modifications to surface development, if required. In the event that the trench footprint extends into areas that may be subject to housing, the backfill below footing depth (nominally below 0.6 m of existing grade) should be compacted to at least 100 percent SPMDD. To minimize harmful differential settlement uniformity of compaction is most important. Frequent compaction inspection and testing of backfill placement is recommended to encourage attention to quality workmanship in placement.

6.5 TRENCH SETTLEMENT

Settlement of the compacted backfill in trenches under self-weight will occur at this site. The magnitude and rate of settlement will be dependent on the backfill soil type, the moisture condition of the backfill at the time of placement, the depth of the service trench, drainage conditions and the initial density achieved during compaction. Based on experience, total settlement of 1.5 - 2.5 percent of fill depth is expected for soils compacted to 95 percent of SPMDD. If the alternative One-Point compaction standard described above is used for wetter backfill, the estimated total settlement potential is about 2.5 percent of fill depth (up to 300 mm). It should be noted localized differential settlement is considered to be a greater concern than uniform settlement of a large area. Assuming uniform placement of fill, the greatest potential for non-uniformity is the depth of trench across the alignment. Surface development in fill to native subgrade transition areas will be subject to the most harmful settlement if transitions are not gradual.

The time rate of settlement is most dependent on the type of backfill. Generally, granular soils settle within a much shorter period than fine grained silt and clays. The expected period for the majority of total settlement (90 percent) on this project will be governed by the characteristics of the native silty clay and is estimated to require a period of 1 to 2 years. It should be noted that frozen soils will not settle significantly until after thawing. For wetter soils compacted to reduced density standards in wet subgrade conditions, there is a potential of future post construction settlements in event of significant downward movement of the groundwater table. Settlement is expected to have any impact on both surface development and buried service connections within the fill. Foundations for permanent structures should not be placed on trench backfill without further site specific geotechnical and structural review. Settlement will affect final grading and drainage of overlying pavements, therefore road construction should be delayed until a significant percentage of the expected settlement has occurred. The use of gradual transitions will be important for roads and other surface development. For underground services crossing through the fill, the potential for down-drag acting on the pipes will increase depending on how high the service is within the fill.

6.6 DIRECTIONAL DRILLING

Directional drilling is expected to be considered for major crossings of the Blindman and Battle Rivers and many of the road crossing along the route. Soil conditions for directional drilling will vary along the route. Typical silty clay and till subgrades common to large sections of the alignment will be well suited for directional drilling. Drilling conditions in sand subgrades will be dependent on the soil moisture and groundwater levels within the deposits, but most of the sands encountered are expected to be less than saturated and above the groundwater table. Difficult “hard” drilling conditions may be encountered in shallow bedrock formations. Usually wet “mud” drilling technics are used to deal with these harder conditions.

The most difficult anticipated conditions along the proposed routes will be through the cobbley gravel deposits which are expected to be relatively deep at all three of the proposed river crossing sites. Specialized cutting bits are available which can handle coarse gravel and cobble sized aggregate, but larger boulders may cause difficulties. The two options anticipated for river crossing are to cut through gravel or to bore under the gravel through till or bedrock. If boring below the gravel is selected then it will be essential to determine the depth of gravel and the condition of the material below the gravel. If lines are drilled below the gravel it should be expected that the upper 3 to 5 m of the soil or bedrock formation will be significantly fractured due to the valley rebound effect in the base of each river valley. As a result, the seepage volumes from these below gravel materials, may be much higher than expected based on the constituent clay and silt materials. This situation is particularly common in local bedrock. It is highly recommended to undertake test bores by drilling pilot holes at the selected river crossing locations. Pilot holes will provide cost effective information regarding feasibility of directional drilling at each location.

For preliminary purposes the profile constraints for direction drilling should be taken as a maximum directional change of 15^{O} per 15 m of length and a maximum practical total length of 500 m. Longer drill shots and slight curvature variations are possible depending on the equipment available to different contractors.

6.7 CONCRETE FOR UNDERGROUND STRUCTURES

The water soluble sulphate concentration will range from negligible to severe along the alignment. Areas which characteristically have severe potential for chemical attack of subsurface concrete include North Red Deer, areas of Blackfalds, Lacombe and areas of Ponoka. Sulphate Resisting (Type 50) Portland cement is required for concrete in contact with high sulphate soils.

7.0 CLOSURE

This preliminary report is based on an office review of available topographic, hydrogeological, geological and geotechnical data. This report has been prepared for the exclusive use of the Red Deer North Water Line Project Committee, Associated Engineering Alberta Ltd. and their approved agents for specified application to the proposed Red Deer North Water Transmission Line Project between the City of Red Deer and Hobbema, Alberta. This report has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

Respectfully submitted,
Parkland Geotechnical Consulting Ltd.

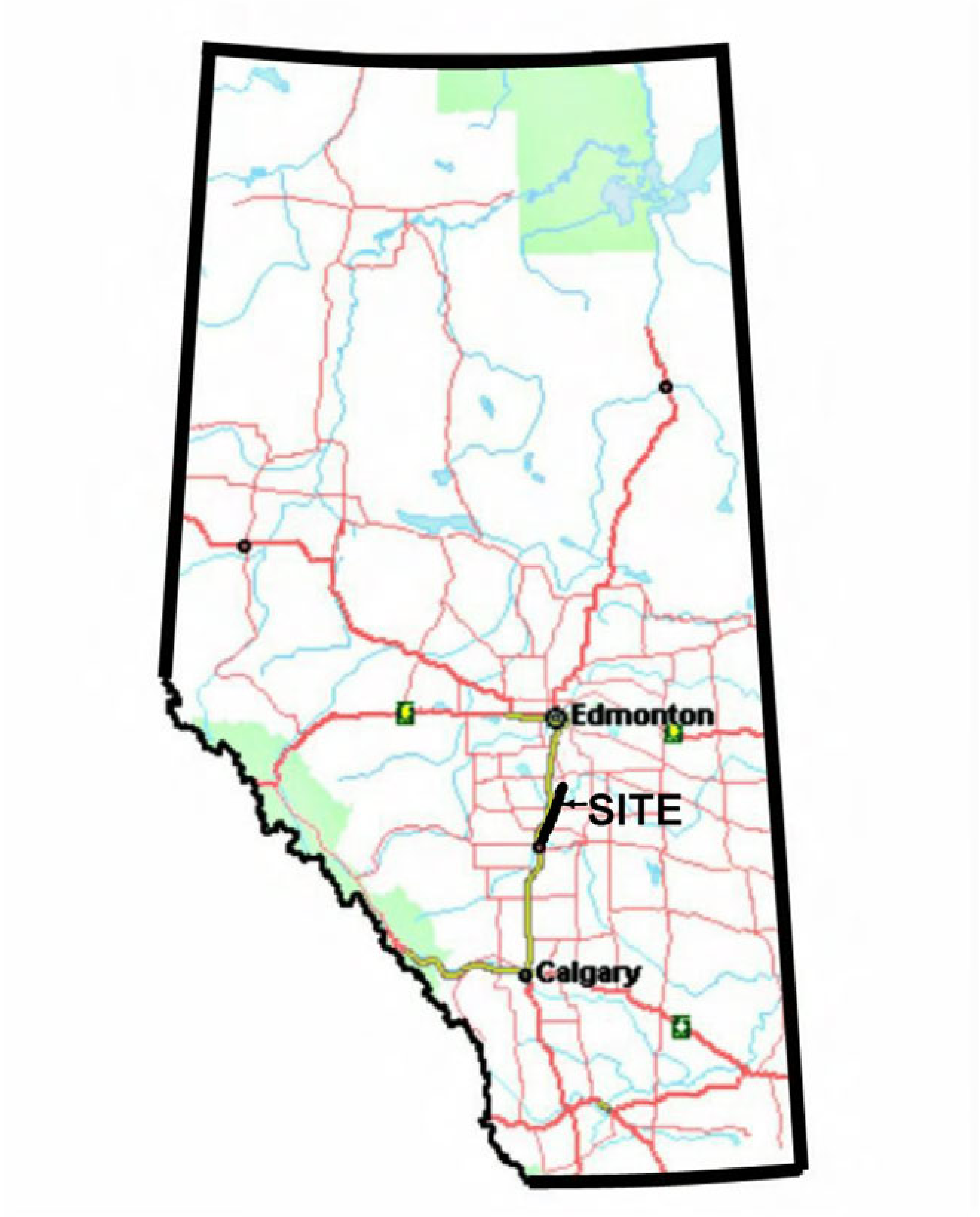
Mark D. Brotherton, P. Eng.
Principal Geotechnical Engineer

RD0888FULL REPORT.wpd

A.P.E.G.G.A. Permit #07312

APPENDIX A

FIGURE 1 - KEY PLAN
FIGURE 2 - SITE PLAN
FIGURE 3 - SURFICIAL GEOLOGY
FIGURE 4 - GEOTECHNICAL DATA POINTS - NORTH AREA
FIGURE 5 - GEOTECHNICAL DATA POINTS - SOUTH AREA
FIGURE 6 - AERIAL PHOTOGRAPH - BATTLE RIVER - NORTH CROSSING
FIGURE 7 - AERIAL PHOTOGRAPH - BATTLE RIVER - SOUTH CROSSING
FIGURE 8 - AERIAL PHOTOGRAPH - BLINDMAN RIVER VALLEY
TABLE A1 - GEOTECHNICAL DATA POINT SUMMARY
TABLE A2 - WATER WELL SUMMARY
COMPOSITE BOREHOLE LOGS (51)
EXPLANATION SHEETS



N.T.S.

FIGURE #1

Parkland
GEOTECHNICAL
CONSULTING LIMITED

KEY PLAN

RED DEER NORTH WATER LINE
HIGHWAY 2A CORRIDOR
BLINDMAN RIVER VALLEY, ALBERTA

MAY 2003

PROJECT RD0888

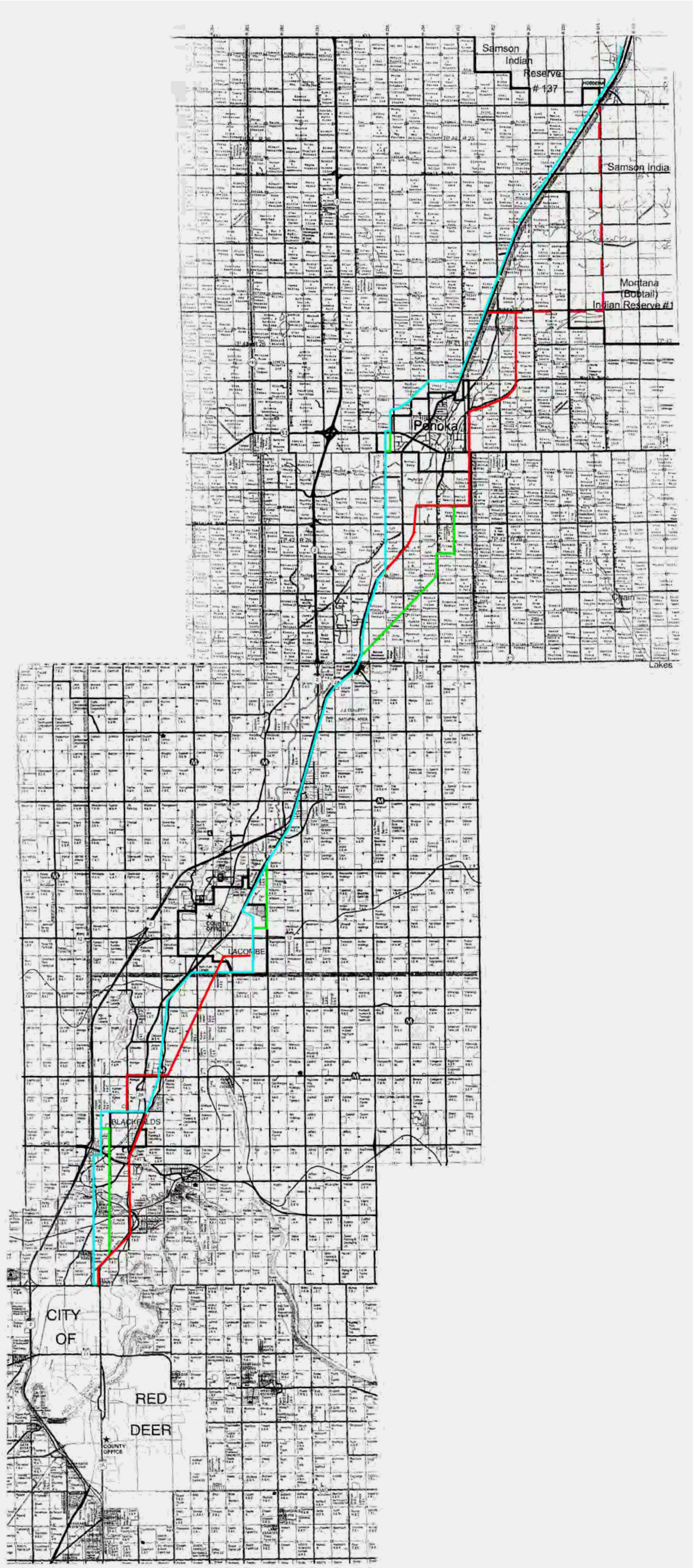


FIGURE #2

Parkland
GEOTECHNICAL
CONSULTING LIMITED

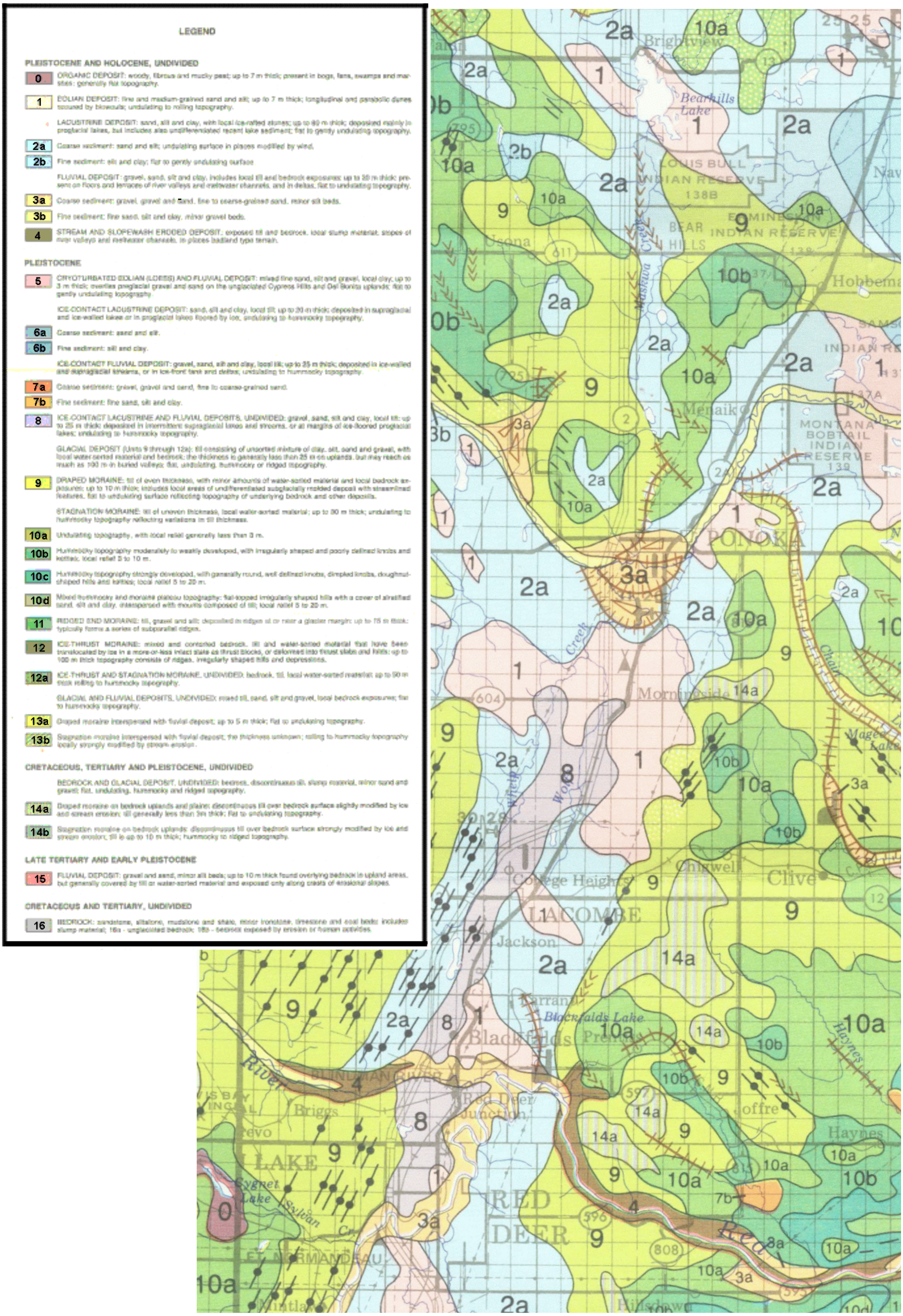
SITE PLAN

RED DEER NORTH WATER LINE
HIGHWAY 2A CORRIDOR
RED DEER TO HOBBEMA, ALBERTA

N.T.S.

MAY 2003

PROJECT RD0888



LEGEND

PLEISTOCENE AND HOLOCENE, UNDIVIDED

0 ORGANIC DEPOSIT: woody, fibrous and mucky peat; up to 7 m thick; present in bogs, fens, swamps and marshes; generally flat topography.

1 EOLIAN DEPOSIT: fine and medium-grained sand and silt; up to 7 m thick; longitudinal and parabolic dunes scoured by blowouts; undulating to rolling topography.

LACUSTRINE DEPOSIT: sand, silt and clay, with local ice-rafted stones; up to 60 m thick; deposited mainly in proglacial lakes, but includes also undifferentiated recent lake sediment; flat to gently undulating topography.

2a Coarse sediment: sand and silt; undulating surface in places modified by wind.

2b Fine sediment: silt and clay; flat to gently undulating surface.

FLUVIAL DEPOSIT: gravel, sand, silt and clay, includes local till and bedrock exposures; up to 30 m thick; present on floors and terraces of river valleys and meltwater channels, and in deltas; flat to undulating topography.

3a Coarse sediment: gravel, gravel and sand, fine to coarse-grained sand, minor silt beds.

3b Fine sediment: fine sand, silt and clay, minor gravel beds.

4 STREAM AND SLOPEWASH ERODED DEPOSIT: exposed till and bedrock, local slump material; slopes of river valleys and meltwater channels, in places badland type terrain.

PLEISTOCENE

5 CRYOTURBATED EOLIAN (LOESS) AND FLUVIAL DEPOSIT: mixed fine sand, silt and gravel, local clay; up to 3 m thick; overlies preglacial gravel and sand on the unglaciated Cypress Hills and Del Bonita uplands; flat to gently undulating topography.

ICE-CONTACT LACUSTRINE DEPOSIT: sand, silt and clay, local till; up to 20 m thick; deposited in supraglacial and ice-walled lakes or in proglacial lakes floored by ice; undulating to hummocky topography.

6a Coarse sediment: sand and silt.

6b Fine sediment: silt and clay.

ICE-CONTACT FLUVIAL DEPOSIT: gravel, sand, silt and clay, local till; up to 25 m thick; deposited in ice-walled and supraglacial streams, or in ice-front fans and deltas; undulating to hummocky topography.

7a Coarse sediment: gravel, gravel and sand, fine to coarse-grained sand.

7b Fine sediment: fine sand, silt and clay.

8 ICE-CONTACT LACUSTRINE AND FLUVIAL DEPOSITS, UNDIVIDED: gravel, sand, silt and clay, local till; up to 25 m thick; deposited in intermittent supraglacial lakes and streams, or at margins of ice-floored proglacial lakes; undulating to hummocky topography.

GLACIAL DEPOSIT (Units 9 through 12a): till consisting of unsorted mixture of clay, silt, sand and gravel, with local water-sorted material and bedrock; the thickness is generally less than 25 m on uplands, but may reach as much as 100 m in buried valleys; flat, undulating, hummocky or ridged topography.

9 DRAPED MORAINE: till of even thickness, with minor amounts of water-sorted material and local bedrock exposures; up to 10 m thick; includes local areas of undifferentiated subglacially molded deposit with streamlined features; flat to undulating surface reflecting topography of underlying bedrock and other deposits.

STAGNATION MORAINE: till of uneven thickness, local water-sorted material; up to 30 m thick; undulating to hummocky topography reflecting variations in till thickness.

10a Undulating topography, with local relief generally less than 3 m.

10b Hummocky topography moderately to weakly developed, with irregularly shaped and poorly defined knobs and kettles; local relief 3 to 10 m.

10c Hummocky topography strongly developed, with generally round, well defined knobs, dimpled knobs, doughnut-shaped hills and kettles; local relief 5 to 20 m.

10d Mixed hummocky and moraine plateau topography: flat-topped irregularly shaped hills with a cover of stratified sand, silt and clay, interspersed with mounds composed of till; local relief 5 to 20 m.

11 RIDGED END MORAINE: till, gravel and silt; deposited in ridges at or near a glacier margin; up to 75 m thick; typically forms a series of subparallel ridges.

12 ICE-THRUST MORAINE: mixed and contorted bedrock, till and water-sorted material that have been translocated by ice in a more-or-less intact state as thrust blocks, or deformed into thrust slabs and folds; up to 100 m thick topography consists of ridges, irregularly shaped hills and depressions.

12a ICE-THRUST AND STAGNATION MORAINE, UNDIVIDED: bedrock, till, local water-sorted material; up to 90 m thick rolling to hummocky topography.

GLACIAL AND FLUVIAL DEPOSITS, UNDIVIDED: mixed till, sand, silt and gravel, local bedrock exposures; flat to hummocky topography.

13a Draped moraine interspersed with fluvial deposit; up to 5 m thick; flat to undulating topography.

13b Stagnation moraine interspersed with fluvial deposit; the thickness unknown; rolling to hummocky topography locally strongly modified by stream erosion.

CRETACEOUS, TERTIARY AND PLEISTOCENE, UNDIVIDED

BEDROCK AND GLACIAL DEPOSIT, UNDIVIDED: bedrock, discontinuous till, slump material, minor sand and gravel; flat, undulating, hummocky and ridged topography.

14a Draped moraine on bedrock uplands and plains; discontinuous till over bedrock surface slightly modified by ice and stream erosion; till generally less than 3m thick; flat to undulating topography.

14b Stagnation moraine on bedrock uplands; discontinuous till over bedrock surface strongly modified by ice and stream erosion; till is up to 10 m thick; hummocky to ridged topography.

LATE TERTIARY AND EARLY PLEISTOCENE

15 FLUVIAL DEPOSIT: gravel and sand, minor silt beds; up to 10 m thick found overlying bedrock in upland areas, but generally covered by till or water-sorted material and exposed only along crests of erosional slopes.

CRETACEOUS AND TERTIARY, UNDIVIDED

16 BEDROCK: sandstone, siltstone, mudstone and shale, minor ironstone, limestone and coal beds; includes slump material; 16a - unglaciated bedrock; 16b - bedrock exposed by erosion or human activities.

FIGURE #2

NOTES:
REF: "ALBERTA RESEARCH COUNCIL, QUATERNARY GEOLOGY",
I. SHETSON, 1990.

N.T.S.

Parkland
GEOTECHNICAL
CONSULTING LIMITED

SURFICIAL GEOLOGY
RED DEER NORTH WATER LINE
HIGHWAY 2A CORRIDOR
RED DEER TO HOBBEMA, ALBERTA

MAY 2003
PROJECT RD0888

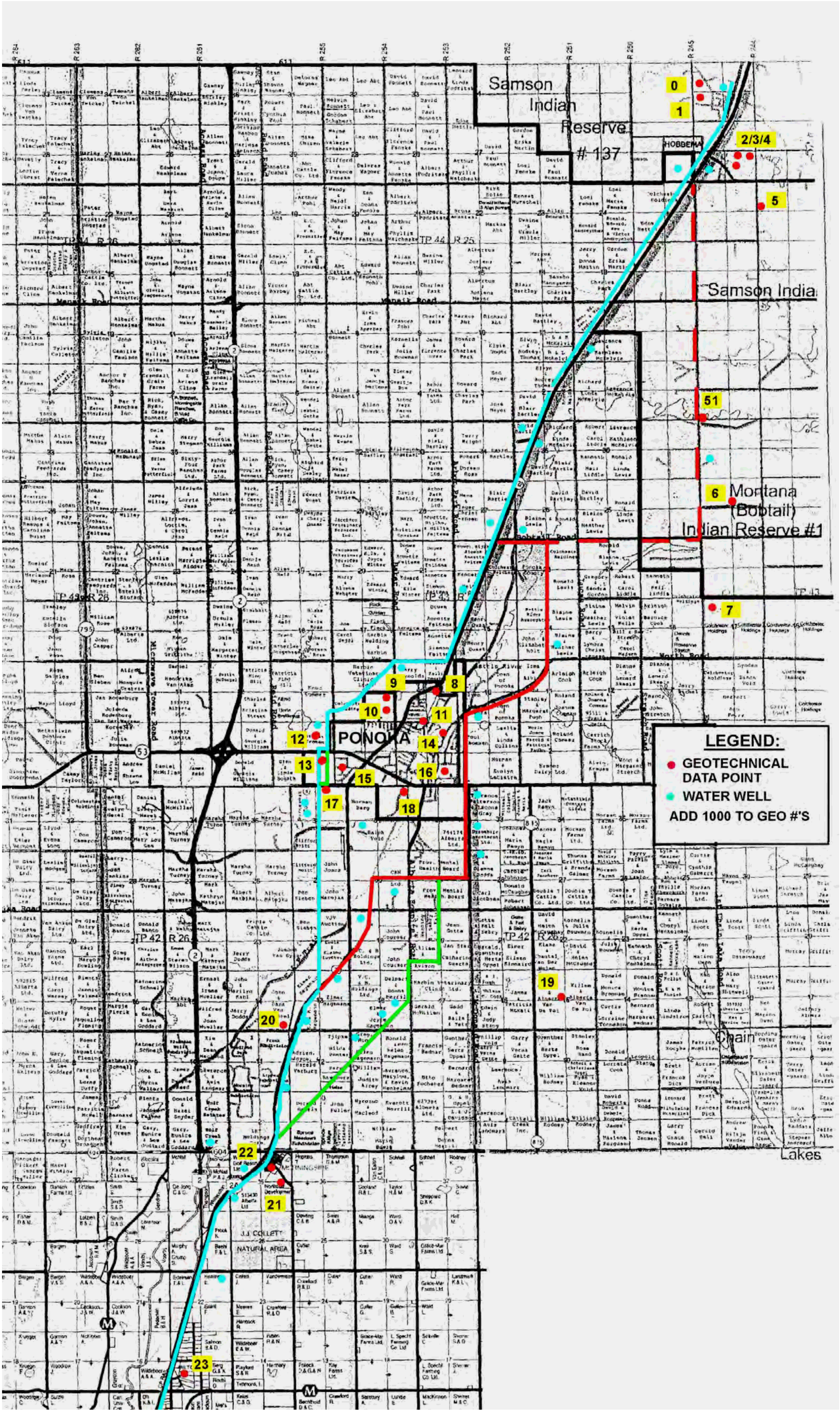


FIGURE #4

Parkland GEOTECHNICAL CONSULTING LIMITED

DATA POINTS - NORTH

RED DEER NORTH WATER LINE
HIGHWAY 2A CORRIDOR
LACOMBE TO HOBBEMA, ALBERTA

MAY 2003 PROJECT RD0888

N.T.S.

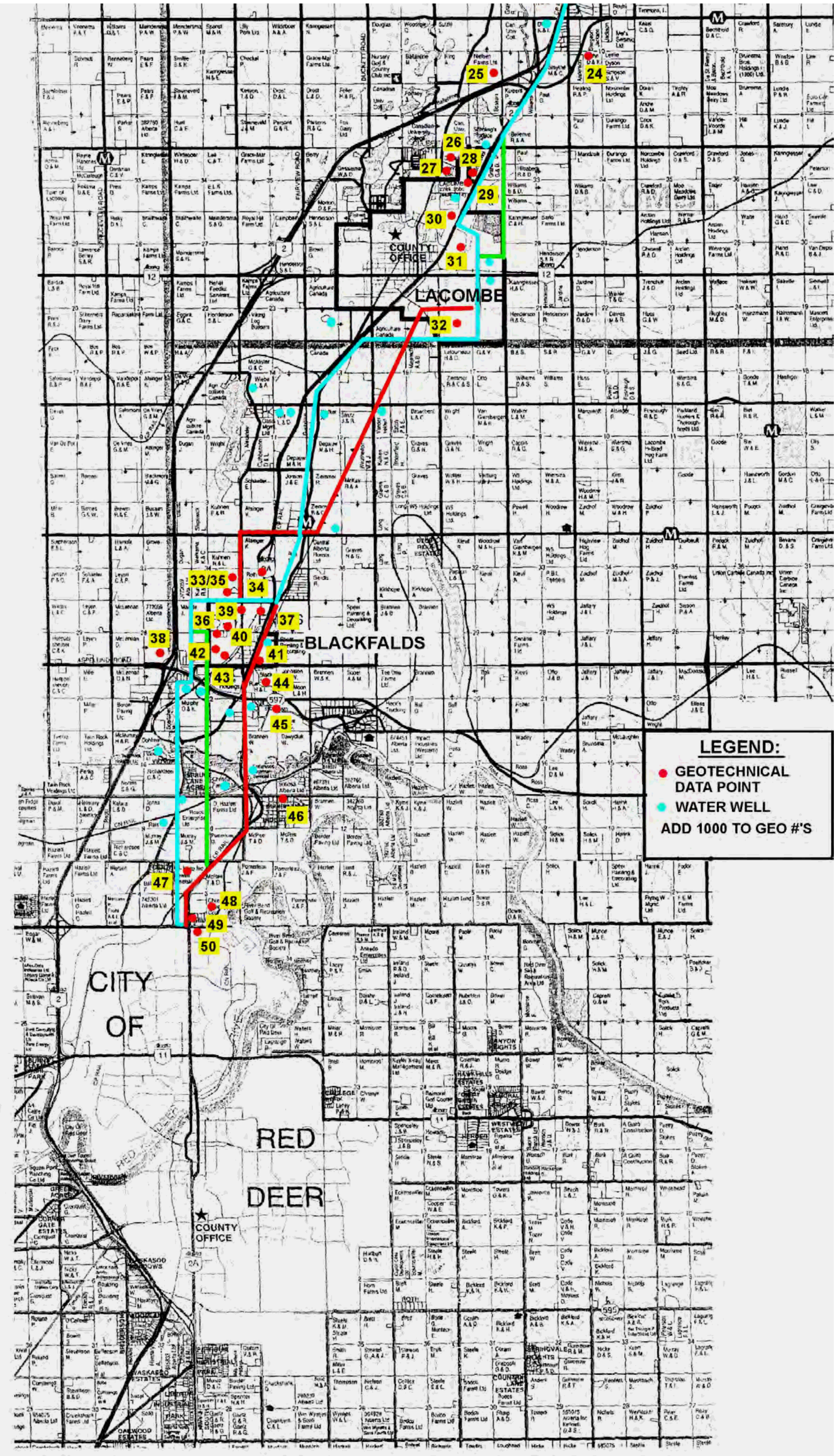


FIGURE #5

Parkland
GEOTECHNICAL
CONSULTING LIMITED

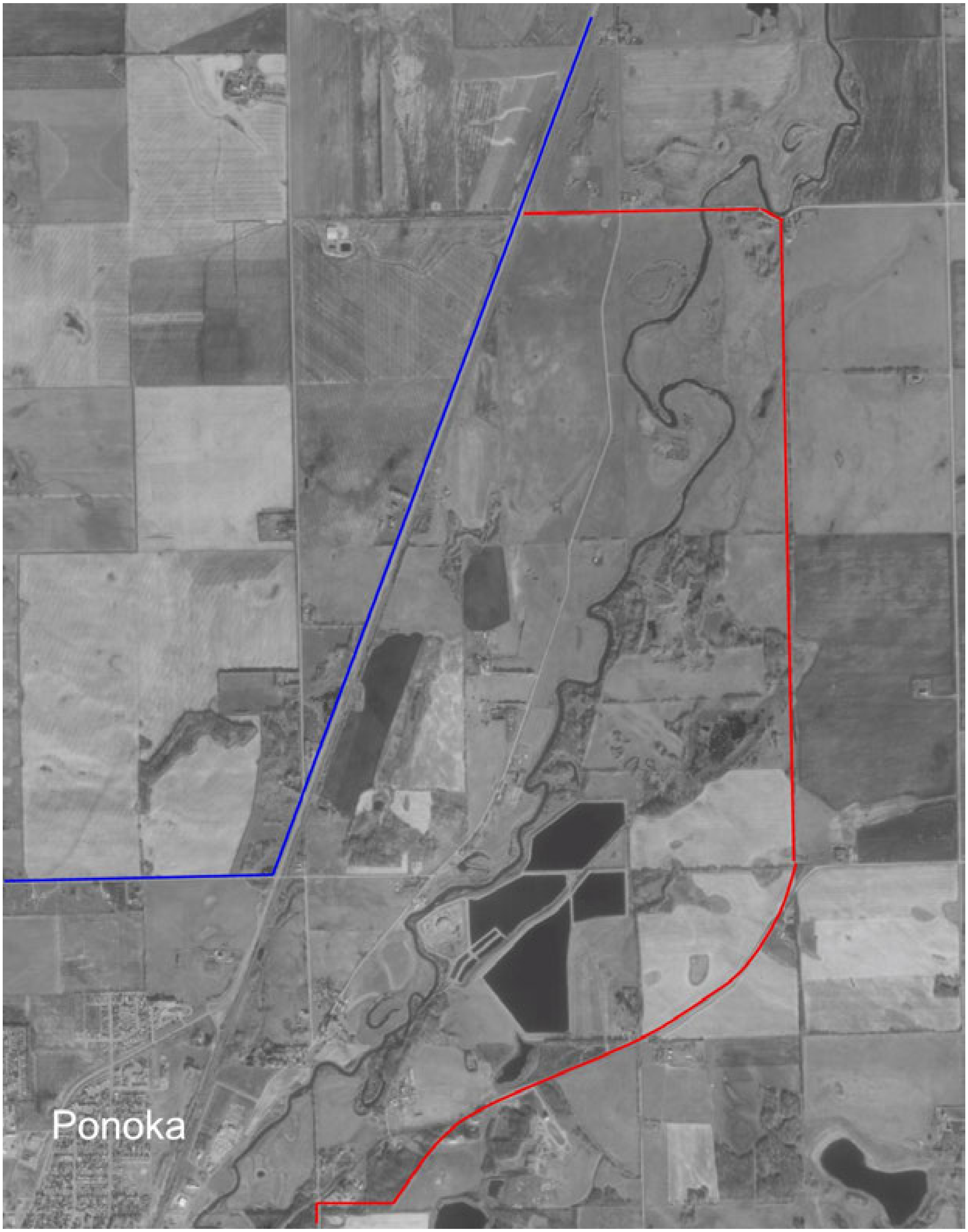
DATA POINTS - SOUTH

RED DEER NORTH WATER LINE
HIGHWAY 2A CORRIDOR
RED DEER TO LACOMBE, ALBERTA

N.T.S.

MAY 2003

PROJECT RD0888



N.T.S.

FIGURE #6

Parkland GEOTECHNICAL CONSULTING LIMITED

2002 AERIAL PHOTOGRAPH

RED DEER NORTH WATER LINE
HIGHWAY 2A CORRIDOR
BATTLE RIVER (N. OF PONOKA), ALBERTA

MAY 2003

PROJECT RD0888

N.T.S.

FIGURE #7

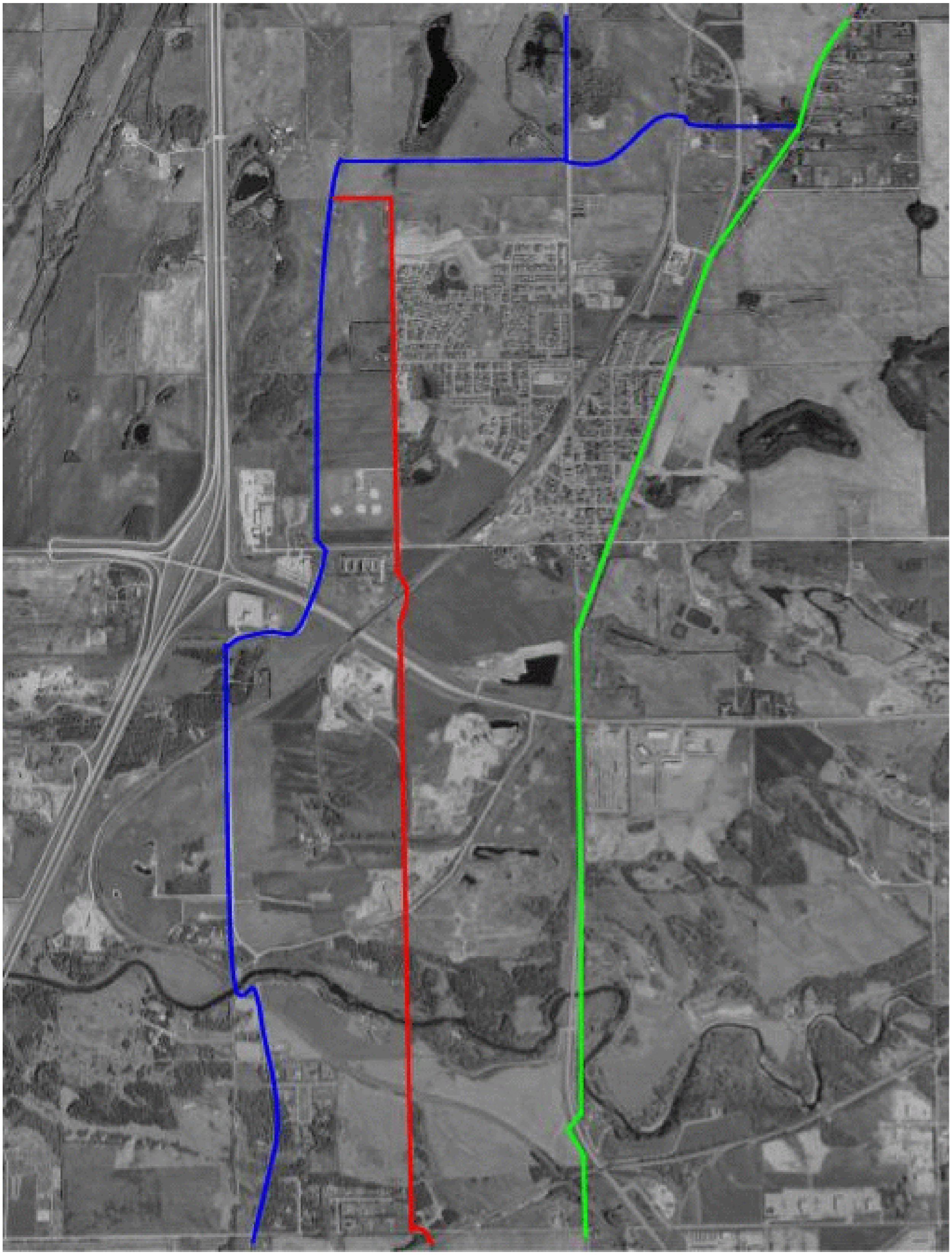
Parkland GEOTECHNICAL CONSULTING LIMITED

2002 AERIAL PHOTOGRAPH

RED DEER NORTH WATER LINE
HIGHWAY 2A CORRIDOR
BATTLE RIVER (S. OF PONOKA), ALBERTA

MAY 2003

PROJECT RD0888



N.T.S.

FIGURE #8

Parkland GEOTECHNICAL CONSULTING LIMITED

2002 AERIAL PHOTOGRAPH

RED DEER NORTH WATER LINE
HIGHWAY 2A CORRIDOR
BLINDMAN RIVER VALLEY, ALBERTA

MAY 2003

PROJECT RD0888

TABLE A1
RED DEER NORTH WATER TRANSMISSION LINE PROJECT
SUMMARY OF GEOTECHNICAL DATA

REF #	RATE	PROJECT	LOCATION	MUNICIPALITY	SOURCE	FILE #	DATE	TYPE	LOG
1000	MED.	ERMINESKIN SCHOOL TRACK	LSD 12-32-44-24-W4M	ERMINESKIN RESERVE	DES	RX03990	1990	BH	N
1001	MED.	RES. SUBDIVISION	LSD 6-32-44-24-W4M	ERMINESKIN RESERVE	DES	RX03990	1990	BH	N
1002	MED.	SAMSON LIFT STATION	29-44-24-W4M	SAMSON RESERVE	DES	RX08016	1990	BH	N
1003	MED.	SAMSON HIGH SCHOOL	LSD 7-29-44-24-W4M	SAMSON RESERVE	GRP 2	RX05532	1996	BH	N
1004	MED.	SAMSON MIDDLE SCHOOL	LSD 8-29-44-25-W4M	SAMSON RESERVE	GRP 2	RX05982	1998	BH	N
1005	LOW-MED	SAMSON LAGOON/FORCE MAIN	21-44-24-W4M	SAMSON RESERVE	DES	RX04016	1990	BH	N
1006	MED.	MONTANA SEWAGE LAGOON	28-43-24-W4M	MONTANA RESERVE	AEE	RX05408	1996	BH	N
1007	MED.	BORROW SITE	17-43-24-W4M	PONOKA COUNTY	AEE	RX05408	1996	BH	N
1008	MED.	PONOKA CHRISTIAN SCHOOL	LSD 10-9-43-25-W4M	T. OF PONOKA	HBT	RX04449	1992	BH	N
1009	HIGH	LAEBON SUBDIVISION	LSD 8-8-43-25-W4M	T. OF PONOKA	PGEO	RD0733	2002	BH	N/A
1010	HIGH	PONOKA HIGH SCHOOL ADD.	LSD 1-8-43-25-W4M	T. OF PONOKA	PGEO	RD0497	2001	BH	N/A
1011	HIGH	57 AVE FORCE MAIN	LSD 14-4-43-25-W4M	T. OF PONOKA	HBT	RX04835	1994	BH	Y
1012	HIGH	63 STREET PONOKA	LSD 9/16-5-43-25-W4M	T. OF PONOKA	SAB	E9912-534	2000	BH	Y
1013	MED.	SW IND. PARK EXPANSION	LSD 8-6-43-25-W4M	T. OF PONOKA	AEE	RX05616	1997	BH	N/A
1014	HIGH	ROWLAND SUBDIVISION	LSD 7-4-43-25-W4M	T. OF PONOKA	PGEO	RD0302	2001	BH	N/A
1015	MED.	SW IND. PARK ROADS	LSD 4/5-5-43-25-W4M	T. OF PONOKA	AEE	RX05578	1996	BH	N/A
1016	HIGH	RES. SUBDIVISION	LSD 2-4-43-25-W4M	T. OF PONOKA	PGEO	RD0599	2002	BH	N/A
1017	HIGH	SW PONOKA RESERVOIR	LSD 15-36-42-25-W4M	T. OF PONOKA	PGEO	RD0752	2002	BH	Y
1018	HIGH	S. PONOKA LIFT STATION	LSD 13-32-42-25-W4M	T. OF PONOKA	PGEO	RD0111	2000	BH	Y
1019	LOW	SITE INVESTIGATION	15-42-25-W4M	PONOKA COUNTY	AEE	RX04885	1994	BH	N
1020	MED.	PARKLAND CR CHURCH	LSD 1-14-42-26-W4M	PONOKA COUNTY	AEE	RX06350	1999	BH	N
1021	MED.	RURAL SUBDIVISION	NE 35-41-26-W4M	LACOMBE COUNTY	AEE	RX05703	1987	PERC	N/A
1022	LOW	PHASE 2 ESA	LSD 10-35-41-26-W4M	LACOMBE COUNTY	AEE	N/A	1996	BH	N
1023	LOW	PRIVATE RESIDENCE	SW 15-41-26-W4M	LACOMBE COUNTY	AEE	PRIVATE	1994	PERC	N
1024	MED.	PRIVATE RESIDENCE	LSD 6-10-41-26-W4M	LACOMBE COUNTY	PGEO	RD0206	2000	PERC	N/A
1025	LOW	FARM DEVELOPMENT	SE 8-41-26-W4M	LACOMBE COUNTY	AEE	RX05714	1997	PIT	N
1026	HIGH	TERRACE HEIGHTS	LSD 12-31-40-46-W4M	LACOMBE COUNTY	PGEO	RD0386	2000	BH	N/A
1027	HIGH	LACOMBE K-8 SCHOOL	LSD 12-32-40-26-W4M	LACOMBE COUNTY	PGEO	RD0593	2002	BH	N/A
1028	MED.	CHURCH	LSD 6-32-40-26-W4M	T. OF LACOMBE	HBT	RX04471	1992	BH	N/A
1029	HIGH	MEDICAL CLINIC	LSD 3-32-40-26-W4M	T. OF LACOMBE	PGEO	RD0196	2000	BH	N/A
1030	HIGH	COOP SHOPPING MALL	LSD 14-27-40-26-W4M	LACOMBE COUNTY	PGEO	RD0250	2000	BH	N/A
1031	HIGH	COMMERCIAL SITE	LSD 6-29-40-26-W4M	T. OF LACOMBE	PGEO	RD0512	2001	BH	N/A
1032	HIGH	RES. SUBDIVISION	SW 20-40-26-W4M	T. OF LACOMBE	PGEO	RD0120	2000	BH	N/A
1033	HIGH	RUTTEN SUBDIVSION	LSD 9/16-34-39-27-W4M	LACOMBE COUNTY	PGEO	RD0814		BH	N/A
1034	MED.	HIGHWAY 2A/CP OVERPASS	LSD 6-35-39-27-W4M	LACOMBE COUNTY	AEE	RX05605	1997	BH	N/A
1035	HIGH	RUTTEN SUBDIVSION	LSD 1 TO 4-34-39-27-W4M	LACOMBE COUNTY	PGEO	RD0814	2002	BH	N/A
1036	HIGH	WATERMAIN EXTENSION	LSD 14-27-39-27-W4M	LACOMBE COUNTY	PGEO	RD0289	2001	BH	Y
1037	LOW-MED	UCCL LOAD OUT	LSD 16-26-39-27-W4M	LACOMBE COUNTY	HBT	RX04071	1990	BH	N/A
1038	MED.	PRELIM. INVESTIGATION	28-39-27-W4M	LACOMBE COUNTY	AEE	RX05474	1996	BH	N/A
1039	HIGH	BLACKFALDS BROADWAY AVE	LSD 16-27-39-27-W4M	T. OF BLACKFALDS	PGEO	RD0290	2001	BH	Y
1040	HIGH	NW LIFT STATION	LSD 10-27-39-27-W4M	T. OF BLACKFALDS	PGEO	RD0110	2000	BH	Y
1041	HIGH	BLACKFALDS SE POND	SW 26-39-27-W4M	T. OF BLACKFALDS	PGEO	RDO109	2000	BH	Y
1042	HIGH	ROLLING HILLS SUBDIVISION.	SE 27-39-27-W4M	T. OF BLACKFALDS	PGEO	RD0680	2002	BH	N/A
1043	HIGH	WATER RESERVOIR EXPANSION	LSD 2-27-39-27-W4M	T. OF BLACKFALDS	HBT	RX03536	1988	UNKNOWN	N/A
1044	LOW	SEWAGE LAGOON EXPANSION	LSD 6-23-39-27-W4M	T. OF BLACKFALDS	HBT	RX03376	1987	REVIEW	N/A
1045	HIGH	COMMERCIAL DEVEL.	LSD 6-17-39-27-W4M	RED DEER COUNTY	PGEO	RD0589	2002	BH	N/A
1046	HIGH	TANIC DEVELOPMENT	LSD 16-3-38-28-W4M	RED DEER COUNTY	PGEO	RD0117	2000	BH	N/A
1047	HIGH	IPSCO WAREHOUSE	LSD 14-3-39-27-W4M	RED DEER COUNTY	PGEO	RD0191	2000	BH	N/A
1048	HIGH	CHILES IND. SUBDIVISION	LSD 2-3-39-27-W4M	RED DEER COUNTY	AEE	RX06193	1999	BH	N/A
1049	MED.	COMMERCIAL SITE	LSD 3-3-39-27-W4M	RED DEER COUNTY	AEE	RX05400	1996	BH	N/A
1050	HIGH	COMMERICAL SITE	LSD 12-33-38-27-W4M	CITY OF RED DEER	PGEO	RD0101	2000	BH	N/A
1051	MED.	EASTSIDE ROAD BRIDGE	LSD 4-5-44-24-W4M	MONTANA RESERVE	DES	UNKNOWN	1996	BH	N

LEGEND:
PGEO - PARKLAND GEOTECHNICAL CONSULTING LTD.
AEE - AGRA EARTH & ENVIRONMENTAL LIMITED
HBT - HBT AGRA LIMITED
DES - DESCON ENGINEERING LTD.
GRP2 - GROUP 2 ARCHITECTURE
SAB - SABATINI GEOTECHNICAL INC.

TABLE A2
RED DEER NORTH WATER TRANSMISSION LINE PROJECT
SUMMARY OF WATER WELL DATA

WELL#	WELL OWNER	LOCATION	MUNICIPALITY	DATE	VERIFIED	SURFICIAL SOIL
282574	MAURICE STRABEL	NE 16-39-27-W4M	RED DEER COUNTY	1972	NO	GRAVEL TO 25 FT
156362	KELLY COUPLAND	LSD 4-15-39-27-W4M	RED DEER COUNTY	1991	NO	SAND/SILT TO 45 FT
285388	STAN STEWART	SE 9-39-27-W4M	RED DEER COUNTY	1996	NO	CLAY TO 39, GRAVEL TO 45 FT
95004	WALTER TRITHART	LSD 12-22-39-27-W4M	LACOMBE COUNTY	1979	MAP	SAND & GRAVEL TO 80 FT
290727	EASTCOTT LAND & CATTLE	22-39-27-W4M	LACOMBE COUNTY	1998	NO	SANDY CLAY TO 87 FT
95009	C. SPIERS	SE-22-39-27-W4M	LACOMBE COUNTY	1968	NO	GRAVEL & SAND TO 55 FT
95257	TOWN OF BLACKFALDS #8	LSD 13-23-39-27-W4M	T. OF BLACKFALDS	1987	MAP	SAND TO 23 FT
259030	NORTHWEST PIPE	LSD 5-23-39-27-W4M	LACOMBE COUNTY	1995	MAP	SAND & GRAVEL TO 67 FT
290212	KELLY COUPLAND	LSD 15-39-27-W4M	RED DEER COUNTY	1998	NO	SANDY TILL TO 43 FT
293579	SILVERADO OILFIELD	LSD 5-14-39-27-W4M	RED DEER COUNTY	2000	NO	SAND TO 15 FT, CLAY TO 55 FT
285417	CASE SPELT	SW 14-40-27-W4M	LACOMBE COUNTY	1996	NO	SAND/CLAY TO 24 FT, GRAVEL TO 68
280677	DOUG WILL	LSD 16-11-40-27-W4M	LACOMBE COUNTY	1996	MAP	CLAY TO 20 FT, TILL TO 56 FT
273567	DAVE WILL	NE 11-40-27-W4M	LACOMBE COUNTY	1988	MAP	SAND/CLAY TO 54 FT
292475	DON GUSTAFSON	NW 12-40-27-W4M	LACOMBE COUNTY	1995	MAP	CLAY & TILL TO 60 FT
200758	MIKE RIX	LSD 1-2-40-27-W4M	LACOMBE COUNTY	1993	NO	SAND TO 26 FT, CLAY TO 68 FT
273749	BOYNES RANCH	NW 7-40-26-W4M	LACOMBE COUNTY	1976	NO	CLAY TO 47
274514	GOV'T RESEARCH STATION	SW 24-40-27-W4M	LACOMBE COUNTY	1970	NO	SAND TO 36 FT, TILL TO 91 FT
284343	LACOMBE NURSERIES	SE 29-40-26-W4M	T. OF LACOMBE	1969	YES	CLAY & SILT TO 22 FT
294979	PENTINGON FARM CENTRE	NE 20-40-26-W4M	T. OF LACOMBE	2000	NO	CLAY TO 40 FT, TILL TO 65 FT
274619	LACOMBE NURSERIES	SW 32-40-26-W4M	T. OF LACOMBE	1971	NO	CLAY TO 20 FT, BEDROCK
93390	LEROY HIRSCHKORN	LSD 15-9-41-26-W4M	LACOMBE COUNTY	1976	NO	SAND TO 56 FT
296810	T. OF LACOMBE WELL #11-01	LSD 16-32-40-26-W4M	LACOMBE COUNTY	2001	NO	SAND TO 16 FT, TILL TO 82 FT
93491	R. HEALING	LSD 16-22-41-26-W4M	LACOMBE COUNTY	1968	YES	SAND TO 38 FT, TILL TO 63 FT
242428	D. TRENCHUK	NW 35-41-26-W4M	LACOMBE COUNTY	1979	NO	SAND TO 16 FT, CLAY TO 157
93561	J. WELYGAN	LSD 5-35-41-26-W4M	LACOMBE COUNTY	1966	MAP	SAND TO 20 FT, CLAY TO 85 FT
275185	WOLF CREEK GOLF COURSE	LSD 1-3-42-26-W4M	PONOKA COUNTY	1984	MAP	CLAY TO 18 FT, SAND TO 61 FT
298689	ELMER HAGEMANN	NE 13-42-26-W4M	PONOKA COUNTY	2001	MAP	SAND TO 26 FT, CLAY TO 55 FT
275850	VIC COURSER	SW 13-42-26-W4M	PONOKA COUNTY	1981	NO	SAND TO 48 FT
275551	JOHN WOLCOTT	LSD 1-11-42-26-W4M	PONOKA COUNTY	1960	MAP	SAND TO 12 FT, SANDSTONE
290271	RON HAGMANN	NW 7-42-25-W4M	PONOKA COUNTY	1998	MAP	SAND TO 30 FT, TILL TO 65 FT
94013	NEIL TURNER	LSD 8-42-25-W4M	PONOKA COUNTY	1982	MAP	CLAY/SAND TO 14 FT, SHALE/COAL
94014	ABT CATTLE COMPANY	SE 18-42-25-W4M	PONOKA COUNTY	1981	NO	SAND TO 8, SANDSTONE
291875	I. JONES	SE 36-42-26-W4M	PONOKA COUNTY	1999	MAP	TILL WITH GRAVEL LAYERS TO 83 FT
238439	LLOYD BIRNEY	NW 19-42-25-W4M	PONOKA COUNTY	1994	NO	SAND TO 9 FT, CLAY TO 55 FT
94101	SUNRISE CRC (CHURCH)	SE 30-42-25-W4M	PONOKA COUNTY	1986	NO	SAND TO 6 FT, CLAY WITH GRAV TO 95 FT
94156	E.F. KROGER	LSD 5-33-42-25-W4M	PONOKA COUNTY	1964	MAP	SAND TO 6 FT, CLAY TO 25, TILL
94079	HERMAN ABT	LSD 13-28-42-25-W4M	PONOKA COUNTY	1964	MAP	TILL TO 74 FT WITH SAND
41195	JIM THORESON	NE 6-43-25-W4M	T. OF PONOKA	2002	NO	TILL TO 20 FT, GRAVEL TO 29 FT, TILL
285482	T. OF PONOKA #12	NW 36-42-26-W4M	PONOKA COUNTY	1996	NO	GRAVEL TO 14 FT, TILL WITH SAND/GR
276676	JOLIN ROCK PRODUCTS	LSD 11-36-42-26-W4M	PONOKA COUNTY	1979	NO	GRAVEL TO 64 FT
294112	DAVE FLORIZOONE	SW 10-43-25-W4M	PONOKA COUNTY	2000	NO	TILL TO 28 FT, GRAVEL
94158	VERN HENDERSON	LSD 13-33-42-25-W4M	PONOKA COUNTY	1968	NO	TILL TO 31 FT
86561	ECONOMY AUTO PARTS	LSD 13-9-43-25-W4M	PONOKA COUNTY	1980	NO	TILL WITH SAND & CLAY
287530	ROD CARRICK	SW 22-43-25-W4M	PONOKA COUNTY	1997	NO	CLAY TILL TO 55 FT.
290295	ARBUTUS NUSERY	SE 14-43-25-W4M	PONOKA COUNTY	1998	NO	TILL TO 30 FT, GRAVEL
86754	AMOS SWEET	LSD 13-43-25-W4M	PONOKA COUNTY	1977	MAP	CLAY TO 13 FT, TILL TO 95 FT
86753	R.H. BOARDMAN	LSD 11-35-43-25-W4M	PONOKA COUNTY	1983	MAP	TILL WITH GRAVEL TO 61 FT
290765	DON MORROW	SE 27-43-25-W4M	PONOKA COUNTY	1998	NO	TILLTO 60 FT, BEDROCK
86702	P. BROSSEUR	LSD 4-26-43-25-W4M	PONOKA COUNTY	1964	MAP	TILL TO 53 FT, GRAVEL
97993	MONTANA BAND	SE 31-43-24-W4M	MONTANA RESERVE	1986	NO	SAND TO 25 FT, CLAY TO 55 FT
295964	SAMSON MAINTENANCE	SE 6-44-24-W4M	SAMSON RESERVE	2001	NO	TILL TO 134 FT W. GRAVEL, BEDROCK
92820	F & E ENT	SW 12-44-25-W4M	PONOKA COUNTY	1986	NO	GRAVEL TO 15 FT, TILL TO 73
285538	SAMSON MAINTENANCE	SE 30-44-24-W4M	PONOKA COUNTY	1996	NO	TILL TO 68 FT
285537	SAMSON MAINTENANCE	SW 29-44-24-W4M	SAMSON RESERVE	1996	NO	TILL TO 46 FT, GRAVEL
277187	MURRAY POTTS	NE 32-44-24-W4M	SAMSON RESERVE	1986	NO	TILL TO 27 FT, GRAVEL

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1000

PROJECT: ERMINESKIN SCHOOL TRACK

TYPE OF HOLE(S): BOREHOLES (5)

LOCATION: LSD 12-32-44-24-W4M

SOURCE: DESCON

TYPE OF LOG: ESTIMATE

ELEVATION:

LOGGED BY: HBT AGRA

ACCURACY: MEDIUM

DATE: 1990

FILE #: RX03990

FILE ORIGINALS: NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	FILL OR ORGANICS	ORG			
1m	CLAY: SILTY, TRACE ORGANIC.	CI-OH			
2m	CLAY TILL: SILTY, SANDY, MEDIUM PLASTIC, STIFF TO VERY STIFF.	CI	AVG. 18%		
3m					
4m	TYPICAL END OF HOLE AT 4.0 M. NO STANDPIPE.				
5m					
6m					
7m					
8m					
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1002	PROJECT: SAMSON LIFT STATION	TYPE OF HOLE(S): BOREHOLES
LOCATION: 29-44-24-W4M	SOURCE: FYN ENGINEERING	TYPE OF LOG: ESTIMATE
ELEVATION:	LOGGED BY: HBT AGRA	ACCURACY: MEDIUM
DATE: JUNE 1990	FILE #: RX04016	FILE ORIGINALS: NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL	ORG			
	CLAY: SILTY, MEDIUM PLASTIC.	CI	UP TO 30%		
1m					
2m	SAND: FINE GRAINED, NON PLASTIC, WET.	SA	TYP. 20%		
3m	CLAY TILL: SILTY, SANDY, MEDIUM PLASTIC, STIFF TO VERY STIFF.	CI	AVG. 17%		
4m					
5m					
6m	▽	@ ~5.9 M			
7m					
8m	ESTIMATED END OF HOLE.				
9m					
10m					

END OF HOLE UNKNOWN (EST. 8 - 10 M).

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1003

PROJECT: SAMSON HIGH SCHOOL

TYPE OF HOLE(S): BOREHOLES (10)

LOCATION: LSD 7-29-44-24-W4M

SOURCE: GROUP 2 ARCH.

TYPE OF LOG: ESTIMATE

ELEVATION:

LOGGED BY: AGRA E & E

ACCURACY: MEDIUM

DATE: DECEMBER 1996

FILE #: RX05532

FILE ORIGINALS: NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL: 300 - 600 MM	ORG			
	CLAY TILL: SILTY, SANDY, MEDIUM PLASTIC, STIFF.	CI	AVG. 20%		
1m				16 40	MIN. MAX.
2m					
3m					
	▽	@ ~3.5 M			
4m					
5m					
6m					
	- STIFF TO HARD			13 40	MIN. MAX.
7m					
8m					
9m					
10m					

END OF DEEPEST HOLE AT 10.5 M.

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1004	PROJECT: SAMSON MIDDLE SCHOOL	TYPE OF HOLE(S): BOREHOLES (11)
LOCATION: LSD 8-29-44-25-W4M	SOURCE: GROUP 2 ARCH.	TYPE OF LOG: ESTIMATE
ELEVATION:	LOGGED BY: AGRA E & E	ACCURACY: MEDIUM
DATE: APRIL 1998	FILE #: RX05982	FILE ORIGINALS: NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL: 200 - 500 MM	ORG			
	CLAY TILL: SILTY, SANDY, MEDIUM PLASTIC, FIRM TO STIFF.	CI	TYP. 20%		
1m				6 15	MIN. MAX.
2m	▽	@ ~2.0 M			
3m					
4m					
5m					
	- STIFF TO HARD			11 38	MIN. MAX.
6m					
7m					
	END OF DEEPEST HOLE AT 7.6 M.				
8m					
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1005
PROJECT: SAMSON LAGOON/FORCE MAIN
TYPE OF HOLE(S): BOREHOLES
LOCATION: 21-44-24-W4M
SOURCE: FYN ENGINEERING
TYPE OF LOG: ESTIMATE
ELEVATION:
LOGGED BY: HBT AGRA
ACCURACY: LOW - MEDIUM
DATE: JUNE 1990
FILE #: RX04016
FILE ORIGINALS: NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL: UP TO 750 MM	ORG			NATIVE PROFILE NOT INCLUDING LAGOON BERMS.
	SAND: FINE GRAINED, WET. ▽	SA @ ~1.0 M			
1m	CLAY TILL: SILTY, SANDY, MEDIUM PLASTIC, STIFF, MOIST TO WET.	CI	TYP. 20%		
2m					
3m					
4m					
5m					
6m	ESTIMATED END OF HOLE.				
7m					
8m					
9m					
10m					

END OF HOLE UNKNOWN (EST. 6.0 M BELOW GRADE).

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1006
PROJECT: MONTANA SEWAGE LAGOON
TYPE OF HOLE(S): BOREHOLES (6)
LOCATION: 28-43-24-W4M
SOURCE: DESCON
TYPE OF LOG: ESTIMATE
ELEVATION:
LOGGED BY: AGRA E & E
ACCURACY: MEDIUM
DATE: MAY 1996
FILE #: RX05408
FILE ORIGINALS: NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL: 100 - 700 MM	ORG			
	SAND: FINE GRAINED, LOOSE TO COMPACT.	SA	5 - 8%		GRAIN SIZE ESTIMATE: SAND 90%, SILT/CLAY 10%
1m					
2m					
3m	▽	@ 2-4 M	AVG. 20%		
4m					
5m					
	CLAY TILL: SILTY, SANDY, MEDIUM PLASTIC, STIFF.	CI	AVG. 22%		
6m	TYPICAL END OF HOLE AT 6.0 M.				
7m					
8m					
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1007	PROJECT: BORROW SITE	TYPE OF HOLE(S): BOREHOLES (3)
LOCATION: 17-43-24-W4M	SOURCE: DESCON	TYPE OF LOG: ESTIMATE
ELEVATION:	LOGGED BY: AGRA E & E	ACCURACY: MEDIUM
DATE: MAY 1996	FILE #: RX05408	FILE ORIGINALS: NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL: 200 - 500 MM	ORG			
1m	CLAY TILL: SILTY, SANDY, MEDIUM PLASTIC, STIFF.	CI	AVG. 15%		
2m	- SAND LAYERS, WET.				
3m					
4m	SAND: FINE GRAINED, TRACE SILT.	SA			
5m					
6m	END OF HOLE AT 6.0 M.				
7m					
8m					
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

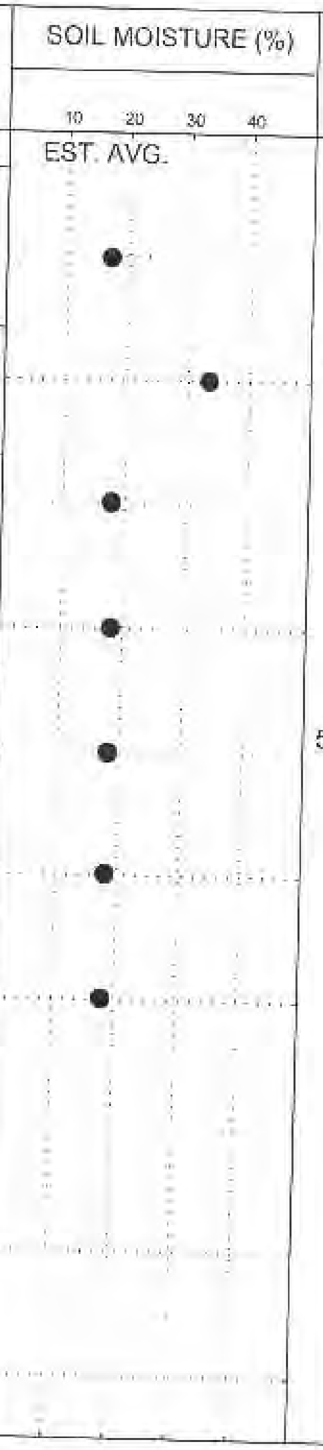
REF. POINT #:	1008	PROJECT:	PONOKA CHRISTIAN SCHOOL	TYPE OF HOLE(S):	BOREHOLES
LOCATION:	LSD 10-9-43-25-W4M	SOURCE:	PRIVATE FILE	TYPE OF LOG:	ESTIMATE
ELEVATION:		LOGGED BY:	HBT AGRA	ACCURACY:	MEDIUM
DATE:	MAY 1992	FILE #:	RX04449	FILE ORIGINALS:	NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL	ORG			
	SAND TILL	SI	TYP: 15%		
1m					
	▽	@ ~1.5 M			
2m					
	CLAY TILL: SILTY, SANDY, MEDIUM PLASTIC, VERY STIFF.	CI	TYP: 18%		
3m					
4m				25	AVG.
5m					
	SAND: MEDIUM GRAINED, DENSE.	SA			
6m					
	ESTIMATED END OF HOLE.				
7m					
8m					
9m					
10m					

END OF HOLE UNKNOWN (EST. 6 - 8 M).

NORTH RED DEER WATER LINE PROJECT

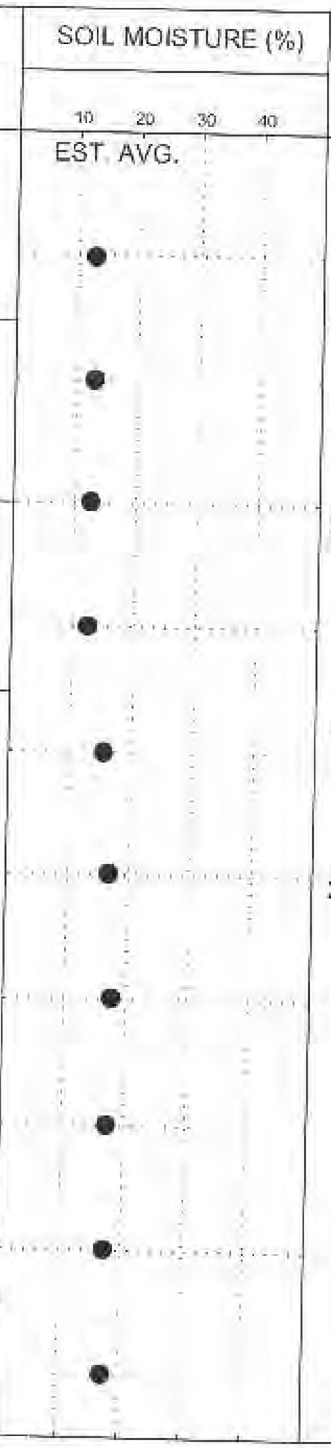
REF. POINT #: 1009
PROJECT: LAEBON SUBDIVISION
TYPE OF HOLE(S): BOREHOLES (8)
LOCATION: LSD 8-8-43-29-W4M
SOURCE: PRIVATE FILES
TYPE OF LOG: COMPOSITE
ELEVATION: NOT GEODETIC
LOGGED BY: PARKLAND GEO
ACCURACY: HIGH
DATE: SEPTEMBER 2002
FILE #: RD0733
FILE ORIGINALS: N/A



DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: 200 - 400 MM	ORG		
1m	SAND: AND SILT, NON PLASTIC, LOOSE, BROWN, DAMP.	SM		
2m	CLAY: SILTY, TRACE SAND, FIRM, BROWN, MOIST. 1.5 TO 3.2 M	CL-ML	12	
3m 4m 5m 6m 7m	CLAY TILL: SILTY, SANDY, STIFF, MEDIUM PLASTIC, GREY, GREY, BROWN, OCC. GRAVEL, MOIST TO WET. ▽	CI @ 3.5 M	50+	GRAIN SIZE ANALYSIS: SAND 20%, SILT 40%, CLAY 40%
8m 9m 10m	DEEPEST HOLE TO 7.3 M.			

NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1010	PROJECT:	PONOKA HIGH SCHOOL ADD	TYPE OF HOLE(S):	BOREHOLES (2)
LOCATION:	LSD 1-8-43-28-W4M	SOURCE:	PRIVATE FILE	TYPE OF LOG:	COMPOSITE
ELEVATION:		LOGGED BY:	PARKLAND GEO	ACCURACY:	HIGH
DATE:	OCTOBER 2001	FILE #:	RD0497	FILE ORIGINALS:	N/A



DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
0m–1.5m	FILL: SANDY CLAY	FILL SC		
1.5m–3m	SAND: SILTY, TRACE GRAVEL, COMPACT, BROWN, MOIST.	SM	9	
3m–4.5m	CLAY: AND SAND, SILTY, TRACE GRAVEL, VERY STIFF, BROWN, MOIST.	SC	22	
4.5m–9.4m	CLAY TILL: SILTY, SANDY, TRACE GRAVEL, HARD, GREY, MOIST. - FREE WATER	CI	43 27	
9.4m	END OF HOLE AT 9.4 M.			

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1011

PROJECT: 57 AVE FORCE MAIN

TYPE OF HOLE(S): BOREHOLES (3)

LOCATION: LSD 14-4-43-25-W4M

SOURCE: FILE FOR T. PONOKA

TYPE OF LOG: COMPOSITE

ELEVATION:

LOGGED BY: HBT AGRA

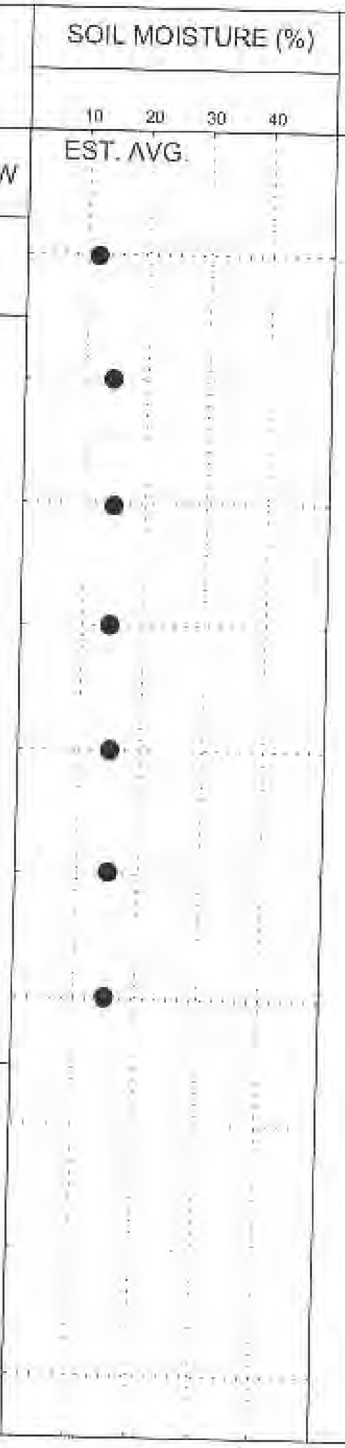
ACCURACY: HIGH

DATE: MARCH 1994

FILE #: RX04835

FILE ORIGINALS: YES (PG #RD0111)

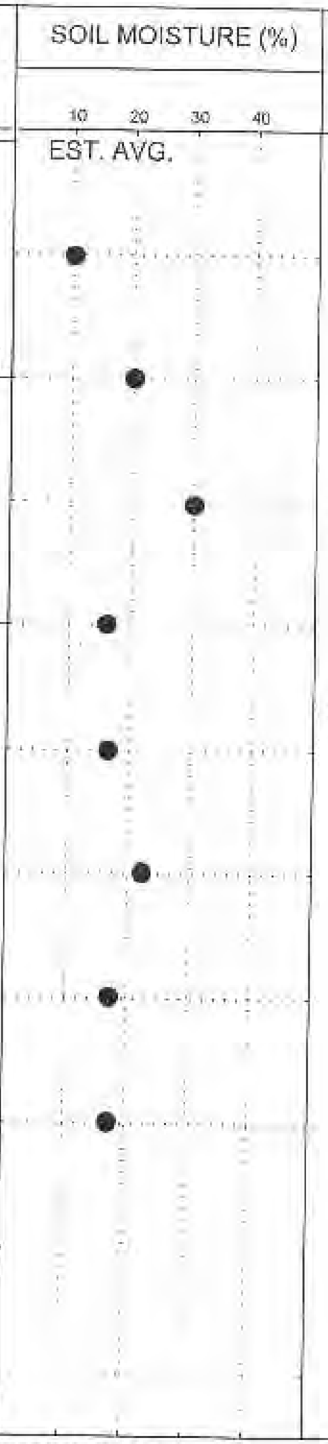
DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	FILL: SAND AND GRAVEL	FILL SA-GW		
1m	SAND: FINE GRAINED, SILTY, TRACE GRAVEL, LOOSE, BROWN, DAMP.	SM		
2m 3m 4m 5m 6m 7m	CLAY TILL: SILTY, SANDY, STIFF, OCC. GRAVEL, MEDIUM PLASTIC, BROWN, DAMP.	CI		
8m 9m 10m	END OF HOLE AT 7.6 M. NO STANDPIPE.			



NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1012	PROJECT:	63 STREET PONOKA	TYPE OF HOLE(S):	BOREHOLES (4)
LOCATION:	LSD 9/16-5-43-25-W4M	SOURCE:	FILE FOR T. PONOKA	TYPE OF LOG:	COMPOSITE
ELEVATION:	812 M	LOGGED BY:	SABATINI	ACCURACY:	HIGH
DATE:	JANUARY 2000	FILE #:	E9912-534	FILE ORIGINALS:	YES (PG #RD0294)

DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: 50 MM			
	SAND: FINE GRAINED, TRACE SILT, LOOSE TO COMPACT, LT. BROWN, DAMP.	SM		
1m				
				SO4 = SEVERE
2m	▽	@ 2.0 M		
	CLAY: SILTY, FIRM, LOW PLASTIC, BROWN.	CL-ML		
3m			17	
4m				
	CLAY TILL: SANDY, HARD, LOW PLASTIC, GREY.	CI		
			21	
5m				
6m	- FREE WATER			
7m				
8m				
	END OF HOLE AT 8.0 M.			
9m				
10m				



NOTES: ONE HOLE HAD SHALLOW ORGANIC CLAY (MC = 52%).

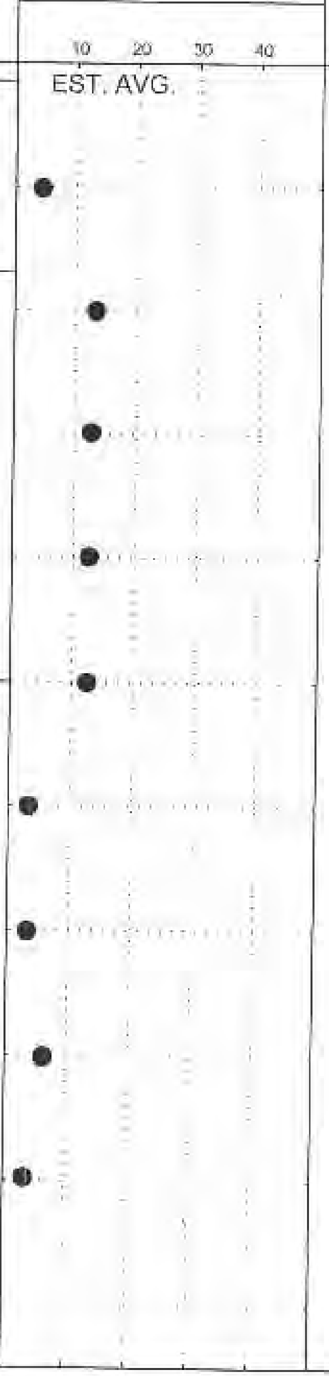
NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1013
PROJECT: S.W. IND. PARK EXPANSION
TYPE OF HOLE(S): BOREHOLES (7)
LOCATION: LSD 8-6-43-25-W4M
SOURCE: FILES FOR T. PONOKA
TYPE OF LOG: COMPOSITE
ELEVATION:
LOGGED BY: AGRA E & E
ACCURACY: MEDIUM
DATE: JANUARY 1997
FILE #: RX05616
FILE ORIGINALS: N/A

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL: 200 - 400 MM	ORG			
1m	SAND: MEDIUM GRAINED, SILTY, TRACE CLAY, NON TO LOW PLASTIC, LOOSE.	SM	TYP. 8%		
2m	SAND AND GRAVEL: COARSE, WELL GRADED, COMPACT TO DENSE. ▽	GW TYP 2.5 M	5 - 15%		S04 = MODERATE
3m					
4m					
5m	CLAY TILL: SILTY, SANDY, MEDIUM PLASTIC, STIFF (SOME SAND TILL PRESENT).	CI	TYP. 15 - 19%		
6m	END OF HOLE AT 6.1 M.				
7m					
8m					
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1014	PROJECT: ROWLAND SUBDIVISION	TYPE OF HOLE(S): BOREHOLES (3)
LOCATION: LSD 7-4-43-25-W4M	SOURCE: PRIVATE FILE	TYPE OF LOG: COMPOSITE
ELEVATION: 824 M	LOGGED BY: PARKLAND GEO	ACCURACY: HIGH
DATE: MARCH 2001	FILE #: RD0302	FILE ORIGINALS: N/A



DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%)	SPT N	COMMENTS
	TOPSOIL: 100 - 200 MM				
1m	SAND: FINE GRAINED, TRACE SILT, TRACE CLAY, COMPACT, BROWN, DAMP.	SA			S04 = SEVERE GRAIN SIZE ANALYSIS: SAND 80%, SILT 10%, CLAY 10%
2m 3m 4m	CLAY TILL: SILTY, SANDY, VERY STIFF TO HARD, MEDIUM PLASTIC, BROWN, OCC. GRAVEL, MOIST.	CI			PLASTICITY - CI (LL = 35) GRAIN SIZE ANALYSIS: SAND 40%, SILT 25%, CLAY 35%
5m 6m 7m 8m 9m 10m	BEDROCK: SANDSTONE, DENSE.	BDRK			

END OF HOLE AT 10.4 M.

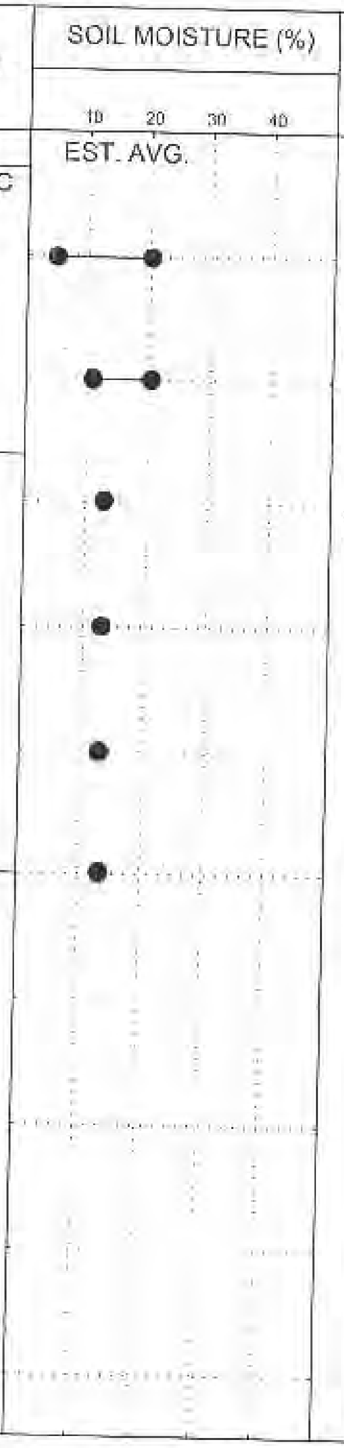
NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1015
PROJECT: SAMSON LAGOON/FORCE MAIN
TYPE OF HOLE(S): BOREHOLES
LOCATION: LSD 4/5-5-43-25-W4M
SOURCE: FILES FOR T. PONOKA
TYPE OF LOG: ESTIMATE
ELEVATION:
LOGGED BY: AGRA E & E
ACCURACY: MEDIUM
DATE: NOVEMBER 1996
FILE #: RX05578
FILE ORIGINALS: N/A

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	PAVEMENT FILL	FILL			
1m	SAND: (POSSIBLE FILL)	SA			
2m	CLAY TILL: SILTY, SANDY.	CI			
3m	END OF HOLE AT 2.4 M. NO WATER LEVELS.				
4m					
5m					
6m					
7m					
8m					
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

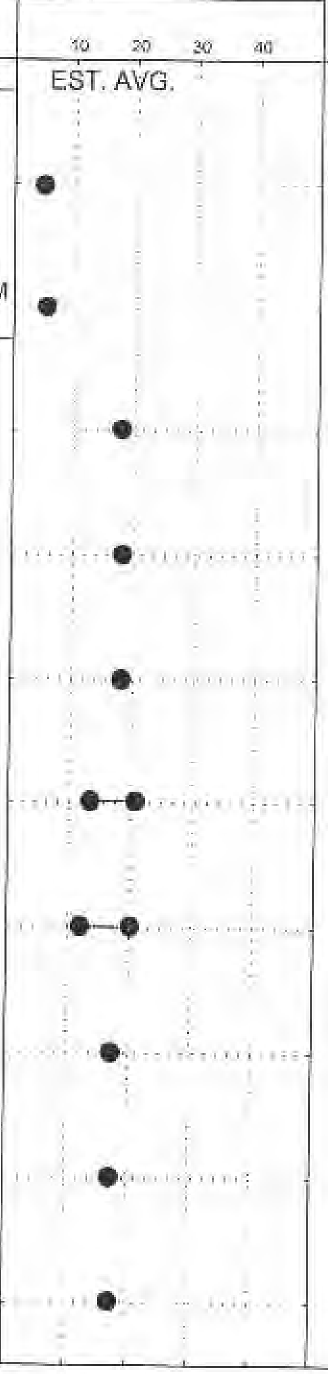
REF. POINT #: 1016
PROJECT: RES. SUBDIVISION
TYPE OF HOLE(S): BOREHOLES (4)
LOCATION: LSD 2-4-43-25-W4M
SOURCE: PRIVATE FILE
TYPE OF LOG: COMPOSITE
ELEVATION: NOT GEODETIC
LOGGED BY: PARKLAND GEO
ACCURACY: HIGH
DATE: APRIL 2002
FILE #: RD0599
FILE ORIGINALS: N/A



DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: 200 - 300 MM	ORG		
1m 2m	SAND: AND SILT, SOME CLAY, INTERBEDDED, COMPACT, NON TO LOW PLASTIC, BROWN, MOIST. 1.4 TO 3.5 M	SM-SC	18	GRAIN SIZE ANALYSIS: SAND 35%, SILT 35%, CLAY 30% PLASTICITY: 20/36/16 (CI)
3m 4m 5m	CLAY TILL: SILTY, SANDY, VERY STIFF, MEDIUM PLASTIC, BROWN, OCC. GRAVEL, MOIST.	CI	50+	
6m 7m 8m 9m 10m	END OF HOLE AT 6.0 M.			

NORTH RED DEER WATER LINE PROJECT

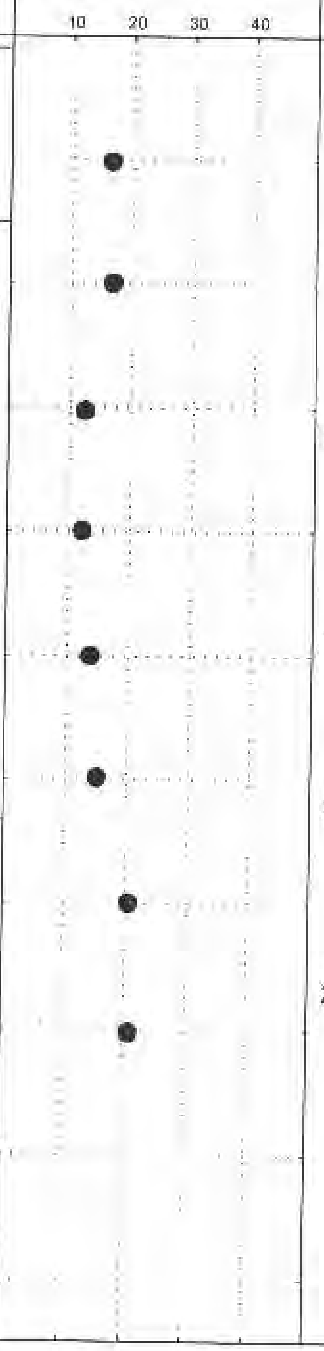
REF. POINT #: 1017	PROJECT: SW PONOKA RESERVOIR	TYPE OF HOLE(S): BOREHOLES (4)
LOCATION: LSD 15-36-42-25-W4M	SOURCE: FILE FOR T. PONOKA	TYPE OF LOG: COMPOSITE
ELEVATION: 809 M	LOGGED BY: PARKLAND GEO	ACCURACY: HIGH
DATE: AUGUST 2002	FILE #: RD0752	FILE ORIGINALS: YES

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%)	SPT N	COMMENTS
	TOPSOIL: 200 - 300 MM				
1m	SAND AND GRAVEL: WELL GRADED, COARSE, DENSE, BROWN, MOIST.	GW			
2m	▽	@ ~2.0 M			
	CLAY TILL: SILTY, SANDY, VERY STIFF, MEDIUM PLASTIC, BROWN, OCC. GRAVEL, MOIST.	CI			
3m					SO4 = NEGLIGIBLE
4m					
5m					
	- SAND LAYER OR SAND TILL 1 - 2 M THICK, WET.				
6m					
7m					
8m					
9m					
10m	END OF HOLE AT 10.0 M.				

NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1018	PROJECT:	S. PONOKA LIFT STATION	TYPE OF HOLE(S):	BOREHOLES (1)
LOCATION:	LSD 13-32-42-25-W4M	SOURCE:	FILE FOR PONOKA	TYPE OF LOG:	ACTUAL
ELEVATION:	883.5 M	LOGGED BY:	PARKLAND GEO	ACCURACY:	HIGH
DATE:	JUNE 2000	FILE #:	RD0111	FILE ORIGINALS:	YES

SOIL MOISTURE (%)



DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: 100 MM			
1m	SAND: COMPACT, MEDIUM GRAINED, BROWN, MOIST.	SW		
2m	CLAY TILL: SILTY, SANDY, TRACE GRAVEL, MEDIUM PLASTIC, STIFF, BROWN/ GREY, MOIST.	CI ▽ @ 2.3 M	10	
3m			28	
4m				
5m			32	
6m			30	
7m	SAND AND GRAVEL: SOME SILT, DENSE, BROWN, WET.	SW		
8m			24	
9m	END OF HOLE AT 8.95 M.			
10m				

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1019

PROJECT: SITE INVESTIGATION

TYPE OF HOLE(S): BOREHOLES

LOCATION: 15-42-25-W4M

SOURCE: FILES FOR PONOKA COUNTY

TYPE OF LOG: ESTIMATE

ELEVATION:

LOGGED BY: AGRA E & E

ACCURACY: LOW

DATE: JUNE 1994

FILE #: RX04885

FILE ORIGINALS: NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	SAND: FINE GRAINED, NON PLASTIC, DRY.	SW			
1m					
	CLAY: SILTY, MEDIUM PLASTIC.	CL-ML			
2m					
3m					
4m					
5m					
6m					
7m					
8m					
	ESTIMATED END OF HOLE.				
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1020	PROJECT:	PARKLAND CR CHURCH	TYPE OF HOLE(S):	BOREHOLES
LOCATION:	LSD 1-14-42-26-W4M	SOURCE:	PRIVATE FILE	TYPE OF LOG:	ESTIMATE
ELEVATION:		LOGGED BY:	AGRA E&E	ACCURACY:	MEDIUM
DATE:	JULY 1999	FILE #:	RX06350	FILE ORIGINALS:	NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL:	ORG			
	SAND: SILTY, FINE GRAINED, COMPACT	SA	AVG 10%		
1m	▽	~ 1.0m			
			AVG 20%		
2m					
3m					
4m					
	CLAY: SILTY, FIRM TO STIFF, MED. PLASTIC, WET.	CL-ML	AVG 30%		
5m					
6m					
7m			AVG 20%		
8m					
	ESTIMATED END OF HOLE.				
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1021	PROJECT: RURAL SUBDIVISION	TYPE OF HOLE(S): PERC TESTS
LOCATION: NE 35-41-26-W4M	SOURCE: PRIVATE FILE	TYPE OF LOG: ESTIMATE
ELEVATION:	LOGGED BY: AGRA E&E	ACCURACY: MEDIUM
DATE: JULY 1997	FILE #: RX05703	FILE ORIGINALS: NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL	ORG			
	SAND: FINE GRAINED, TRACE SILT.	SA			
1m					
2m					
3m	END OF HOLE @ 3.0m. NO GROUNDWATER.				
4m					
5m					
6m					
7m					
8m					
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1022

PROJECT: PHASE 2 ESA

TYPE OF HOLE(S): BOREHOLES

LOCATION: LSD 10-35-41-26-W4M

SOURCE: PRIVATE FILE

TYPE OF LOG: ESTIMATE

ELEVATION:

LOGGED BY: AGRA E&E

ACCURACY: LOW

DATE: MARCH 1996

FILE #: N/A

FILE ORIGINALS: NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	PAVEMENT FILL:	FILL			
	SAND: SILTY, FINE GRAINED	SA.SM			
1m					
2m					
3m					
4m	EST. ▽	~4m			
	CLAY: SILTY	CL-ML			
5m					
6m					
	EST.				
	CLAYTILL	CI			
7m					
	EST.				
8m					
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1023
PROJECT: PRIVATE RESIDENCE
TYPE OF HOLE(S): PERC.
LOCATION: SW 15-41-26-W4M
SOURCE: PRIVATE FILE
TYPE OF LOG: ESTIMATE
ELEVATION:
LOGGED BY: AGRA E & E
ACCURACY: LOW
DATE: 1994
FILE #: PRIVATE
FILE ORIGINALS: NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL	ORG			
	CLAY: SILTY, MEDIUM PLASTIC.	CL-ML			
1m					
	▽	@ ~1.5 M			
2m					
3m	END OF HOLE AT 3.0 M.				
4m					
5m					
6m					
7m					
8m					
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1024

PROJECT: PRIVATE RESIDENCE

TYPE OF HOLE(S): PERC. TEST (1)

LOCATION: LSD 6-10-41-26-W4M

SOURCE: PRIVATE FILE

TYPE OF LOG: ESTIMATE

ELEVATION:

LOGGED BY: PARKLAND GEO

ACCURACY: MODERATE

DATE: OCTOBER 2000

FILE #: RD0206

FILE ORIGINALS: N/A

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL: 300 MM	ORG			
	SAND: MEDIUM GRAINED, TRACE SILT, BROWN, MOIST TO WET.	SW			
1m					
	∇	@ 1.4 M			
2m					
3m					
	END OF HOLE AT 3.0 M.				
4m					
5m					
6m					
7m					
8m					
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

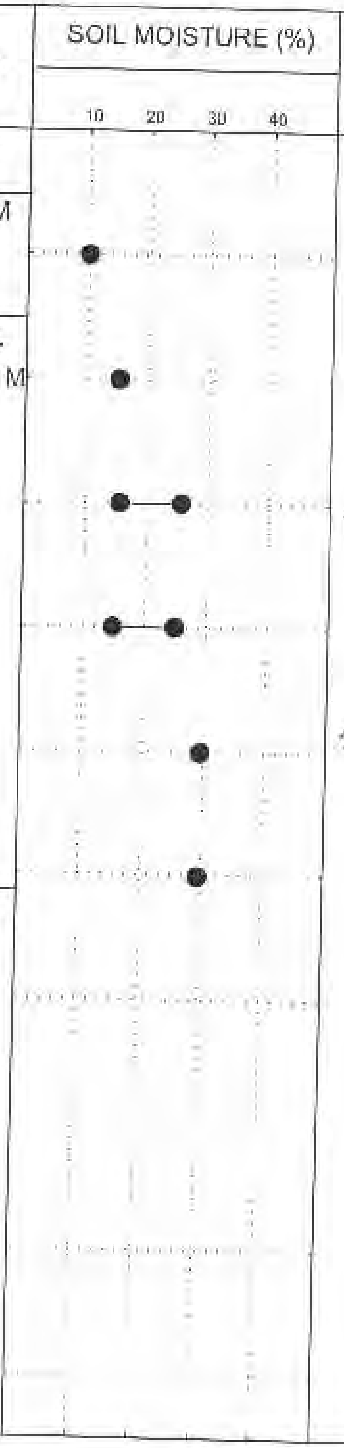
REF. POINT #: 1025
PROJECT:
TYPE OF HOLE(S): TESTPITS
LOCATION: SE 8-41-26-W4M
SOURCE: FILES FOR LACOMBE COUNTY
TYPE OF LOG: ESTIMATE
ELEVATION:
LOGGED BY: AGRA E & E
ACCURACY: LOW
DATE: JUNE 1997
FILE #: RX05714
FILE ORIGINALS: NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL	ORG			
	CLAY: SILTY, DRY OF OMC.	CL-ML			PLASTICITY - CI (LL = 41%)
1m					
2m					
3m					
4m					
5m	END OF HOLE AT 4.8 M.				
6m					
7m					
8m					
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1026
PROJECT: TERRACE HEIGHTS SUBD.
TYPE OF HOLE(S): BOREHOLES (5)
LOCATION: LSD 12-31-40-26-W4M
SOURCE: PRIVATE FILE
TYPE OF LOG: COMPOSITE
ELEVATION: 855 - 865 M
LOGGED BY: PARKLAND GEO
ACCURACY: HIGH
DATE: MAY 2000
FILE #: RD0386
FILE ORIGINALS: N/A

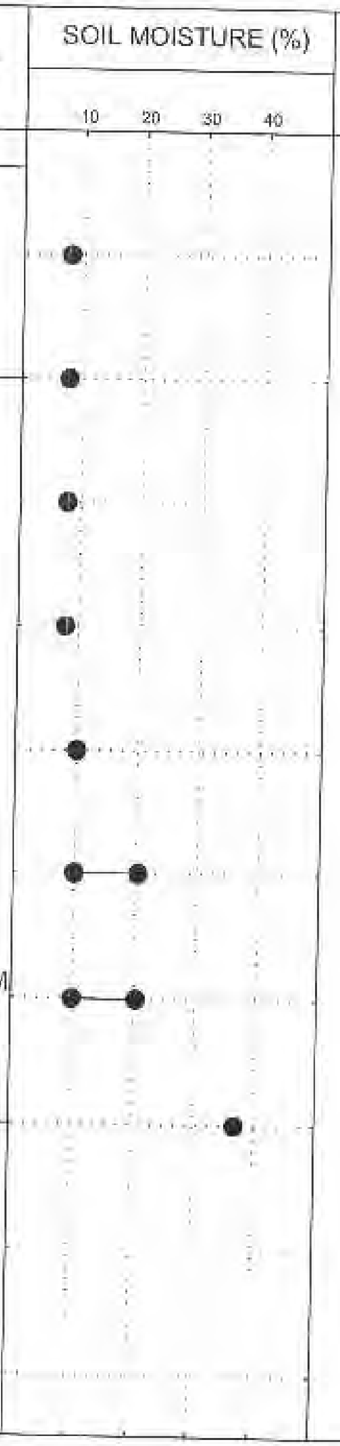
DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: 0.3 TO 1.1 M	ORG		
1m	SAND AND SILT: TRACE CLAY, FINE GRAINED, LOOSE.	SA-SM		PLASTICITY - CL (LL = 26%) GRAIN SIZE ANALYSIS: SAND 65%, SILT 10%, CLAY 25%
2m	SILT AND CLAY: TRACE FINE SAND, STIFF, MEDIUM PLASTIC, WET. ▽	CL-ML @ ~2.1 M		PLASTICITY - CL (LL = 47%) GRAIN SIZE ANALYSIS: SAND 18%, SILT 27%, CLAY 55%
3m			10	
4m				
5m			10	
6m	END OF HOLE AT 6.1 M.			
7m				
8m				
9m				
10m				



NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1027	PROJECT: LACOMBE K - 8 SCHOOL	TYPE OF HOLE(S): BOREHOLES (16)
LOCATION: LSD 12-32-40-26-W4M	SOURCE: PRIVATE FILE	TYPE OF LOG: COMPOSITE
ELEVATION: 856 M	LOGGED BY: PARKLAND GEO	ACCURACY: HIGH
DATE: APRIL 2002	FILE #: RD0593	FILE ORIGINALS: N/A

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%)	SPT N	COMMENTS
	TOPSOIL: 100 - 400 MM	ORG			
1m	SAND: SOME SILT, TRACE CLAY, COMPACT, BROWN, MOIST.	SM			
2m	SILT: SOME FINE SAND, LITTLE, CLAY, COMPACT, LOW PLASTIC, BROWN, DAMP.	ML			
3m					
4m					
5m					
6m	- OCC. CLAY LAYERS				GRAIN SIZE ANALYSIS: SAND 30%, SILT 60%, CLAY 10%
7m	▽ @ ~848 M				
8m	END OF HOLE AT 8.0 M.				
9m					
10m					



NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1028
PROJECT: CHURCH
TYPE OF HOLE(S): BOREHOLES
LOCATION: LSD 6-32-40-26-W4M
SOURCE: PRIVATE FILE
TYPE OF LOG: ESTIMATE
ELEVATION:
LOGGED BY: HBT AGRA
ACCURACY: MEDIUM
DATE: JUNE 1992
FILE #: RX04471
FILE ORIGINALS: N/A

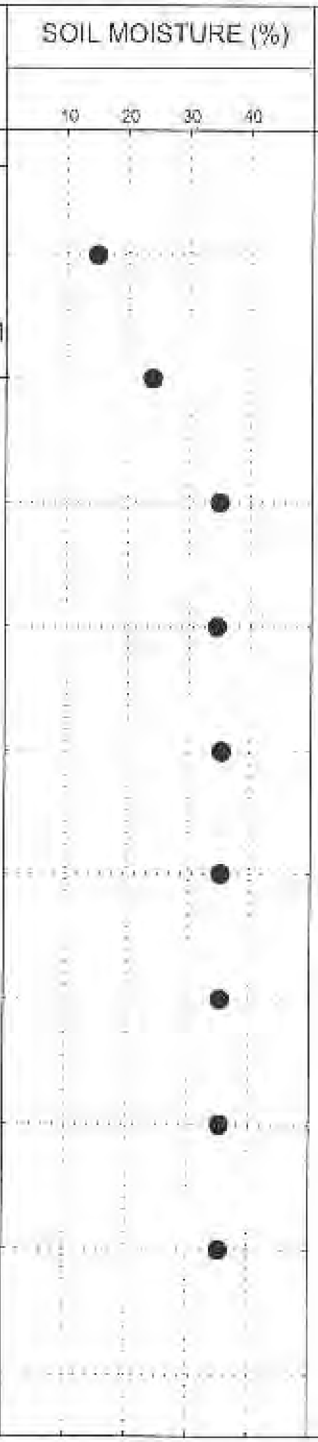
DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL	ORG		
1m	SAND: FINE GRAINED, SILTY, LOOSE, NON PLASTIC.	SM		
2m				
	SILT AND CLAY: TRACE FINE SANDS, STIFF, MEDIUM PLASTIC, WET.	CL-ML		
3m				
4m				
5m				
6m				
7m				
8m				
9m				
10m				

PROFILE BELOW 10m: CLAY TILL AT 10.4 M.

END OF DEEPEST HOLE AT 10.9 M.

NORTH RED DEER WATER LINE PROJECT

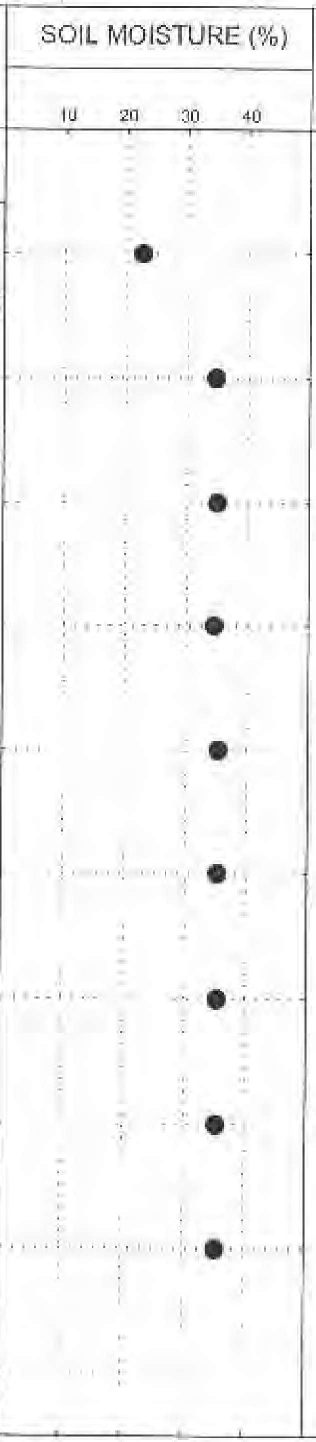
REF. POINT #: 1029	PROJECT: MEDICAL CLINIC	TYPE OF HOLE(S): BOREHOLES (5)
LOCATION: LSD 3-32-40-26-W4M	SOURCE: PRIVATE FILE	TYPE OF LOG: COMPOSITE
ELEVATION:	LOGGED BY: PARKLAND GEO	ACCURACY: HIGH
DATE: SEPTEMBER 2000	FILE #: RD0196	FILE ORIGINALS: N/A



DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: 300 - 700 MM	ORG		
	SAND: AND SILT, TRACE CLAY, MEDIUM GRAINED, COMPACT, BROWN, DAMP.	SM-SC		
1m				
	▽	@ ~1.7 M		
2m	SILT AND CLAY: TRACE SAND, FIRM, GREY, WET.	ML-CL		
3m			6	
4m				
5m				
6m			6	
7m				
8m				
9m	END OF HOLE AT 9.0 M.			
10m				

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1030	PROJECT: COOP SHOPPING MALL	TYPE OF HOLE(S): BOREHOLES (14)
LOCATION: LSD 14-27-40-26-W4M	SOURCE: PRIVATE FILE	TYPE OF LOG: COMPOSITE
ELEVATION: 846 M	LOGGED BY: PARKLAND GEO	ACCURACY: HIGH
DATE: NOVEMBER 2000	FILE #: RD0250	FILE ORIGINALS: N/A

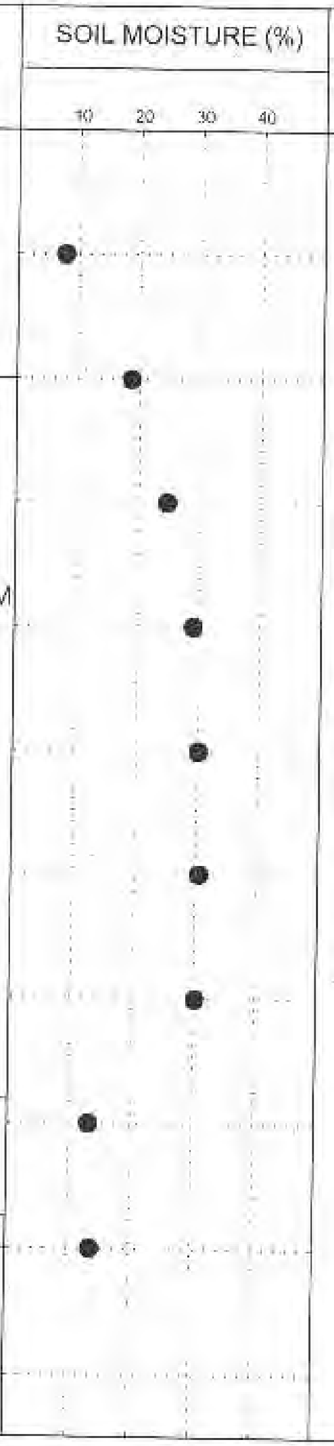


DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: 50 - 600 MM	ORG		
1m	CLAY: AND SILT, MEDIUM PLASTIC, FIRM, BROWN, MOIST. ▽	CL-ML @ ~1.5 M		PLASTICITY - CL (LL = 48%) SO4 = SEVERE GRAIN SIZE ANALYSIS: SAND 10%, SILT 60%, CLAY 30%
2m			7	
3m			7	
4m				
5m			7	
6m	- STIFF		9	
7m				
8m			9	
9m				GRAIN SIZE ANALYSIS: SAND 10%, SILT 55%, CLAY 35%
10m	END OF DEEPEST HOLE AT 9.5 M.			

NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1031	PROJECT:	COMMERCIAL SITE	TYPE OF HOLE(S):	BOREHOLES (5)
LOCATION:	LSD 6-29-40-26-W4M	SOURCE:	PRIVATE FILE	TYPE OF LOG:	COMPOSITE
ELEVATION:		LOGGED BY:	PARKLAND GEO	ACCURACY:	HIGH
DATE:	OCTOBER 2001	FILE #:	RD0512	FILE ORIGINALS:	N/A

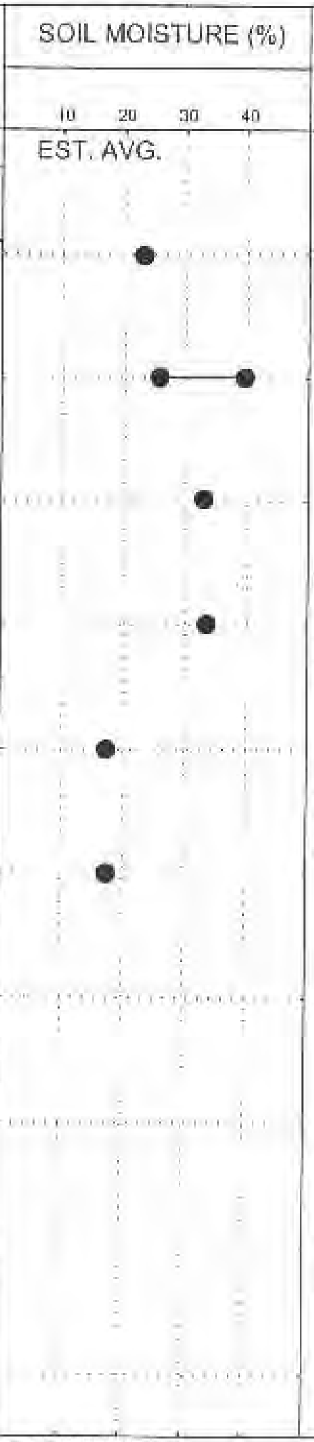
DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	FILL: SAND, TRACE GRAVEL, BROWN.	FILL SW		
1m				
2m	SILT AND CLAY: TRACE SAND, STIFF, MEDIUM PLASTIC, BROWN, MOIST.	CL-ML	10	
3m			15	
4m	▽	@ ~3.8 M		
5m			15	
6m				
7m			12	
8m	CLAY TILL: SILTY, SANDY, STIFF, MEDIUM PLASTIC.	CI		
9m	BEDROCK	BDRK		
	END OF HOLE AT 9.0 M.			
10m				



NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1032	PROJECT: RES. SUBDIVISION	TYPE OF HOLE(S): BOREHOLES (25)
LOCATION: SW 20-40-26-W4M	SOURCE: PRIVATE FILE	TYPE OF LOG: COMPOSITE
ELEVATION: 845 - 850 M	LOGGED BY: PARKLAND GEO	ACCURACY: HIGH
DATE: AUGUST 2000	FILE #: RD0120	FILE ORIGINALS: N/A

DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: 100 - 550 MM	ORG		
	SILT AND CLAY: TRACE SAND, MEDIUM PLASTIC, FIRM, BROWN, MOIST.	CL-ML		
1m	∇	@ ~ 845 M		
2m			15	PLASTICITY - CL (LL = 38%) OMC = 19 % GRAIN SIZE ANALYSIS: SAND 5%, SILT 65%, CLAY 30%
3m				
4m	- SAND LAYERS 2.9 TO 5.8 M			
	CLAY TILL: SILTY, SANDY, VERY STIFF, MEDIUM PLASTIC, BROWN, OCC. OCC. GRAVEL, MOIST.	CI		
5m				
6m			25	GRAIN SIZE ANALYSIS: GRAVEL 5%, SAND 30%, SILT 35%, CLAY 30%
	END OF HOLE AT 6.0 M.			
7m				
8m				
9m				
10m				

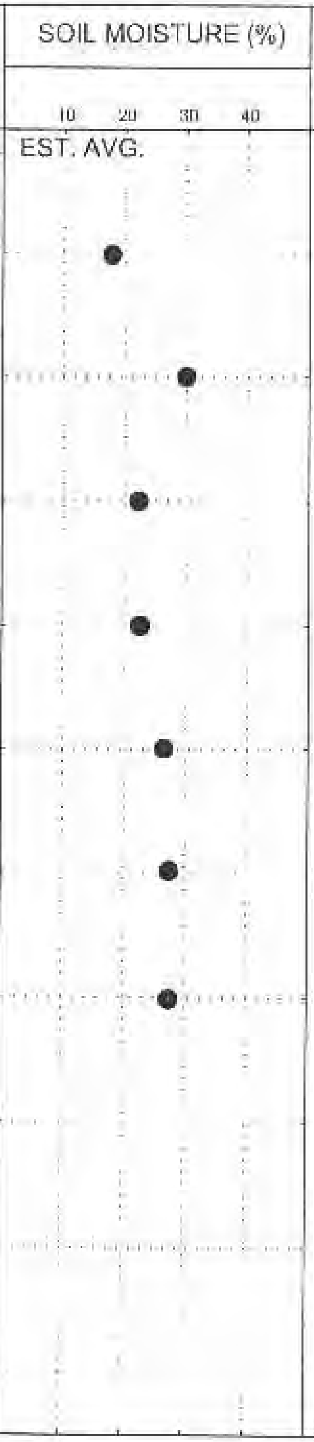


NOTE: TILL IS GENERALLY SHALLOWER TO THE EAST.

NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1033	PROJECT:	RUTTEN SUBDIVISION	TYPE OF HOLE(S):	BOREHOLES (5)
LOCATION:	LSD 9/16-34-39-27-W4M	SOURCE:	PRIVATE FILE	TYPE OF LOG:	COMPOSITE
ELEVATION:	869 - 870 M	LOGGED BY:	PARKLAND GEO	ACCURACY:	HIGH
DATE:		FILE #:	RD0814	FILE ORIGINALS:	N/A

DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: 200 MM			
1m	SAND: MEDIUM GRAINED, SILTY, TRACE CLAY, COMPACT, BROWN, MOIST. ▽	SM @ 1 M ~ 868 M		
2m	CLAY: SILTY, FIRM, LOW PLASTIC, GREY, WET.	CL		
			6	
3m	- SANDY			
4m			7	
	- LITTLE SAND			
5m				
			7	
6m				
7m	END OF HOLE AT 7.0 M.			
8m				
9m				
10m				



NOTE: PROFILE NEAR LOW LYING SLOUGH.

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1034	PROJECT: HIGHWAY 2A/CP OVERPASS	TYPE OF HOLE(S): BOREHOLES (6)
LOCATION: LSD 6-35-39-27-W4M	SOURCE: FILE FOR ALTA TRANS.	TYPE OF LOG: ESTIMATE
ELEVATION: 881.5 M	LOGGED BY: AGRA E & E	ACCURACY: MEDIUM
DATE: APRIL 1997	FILE #: RX05605	FILE ORIGINALS: N/A

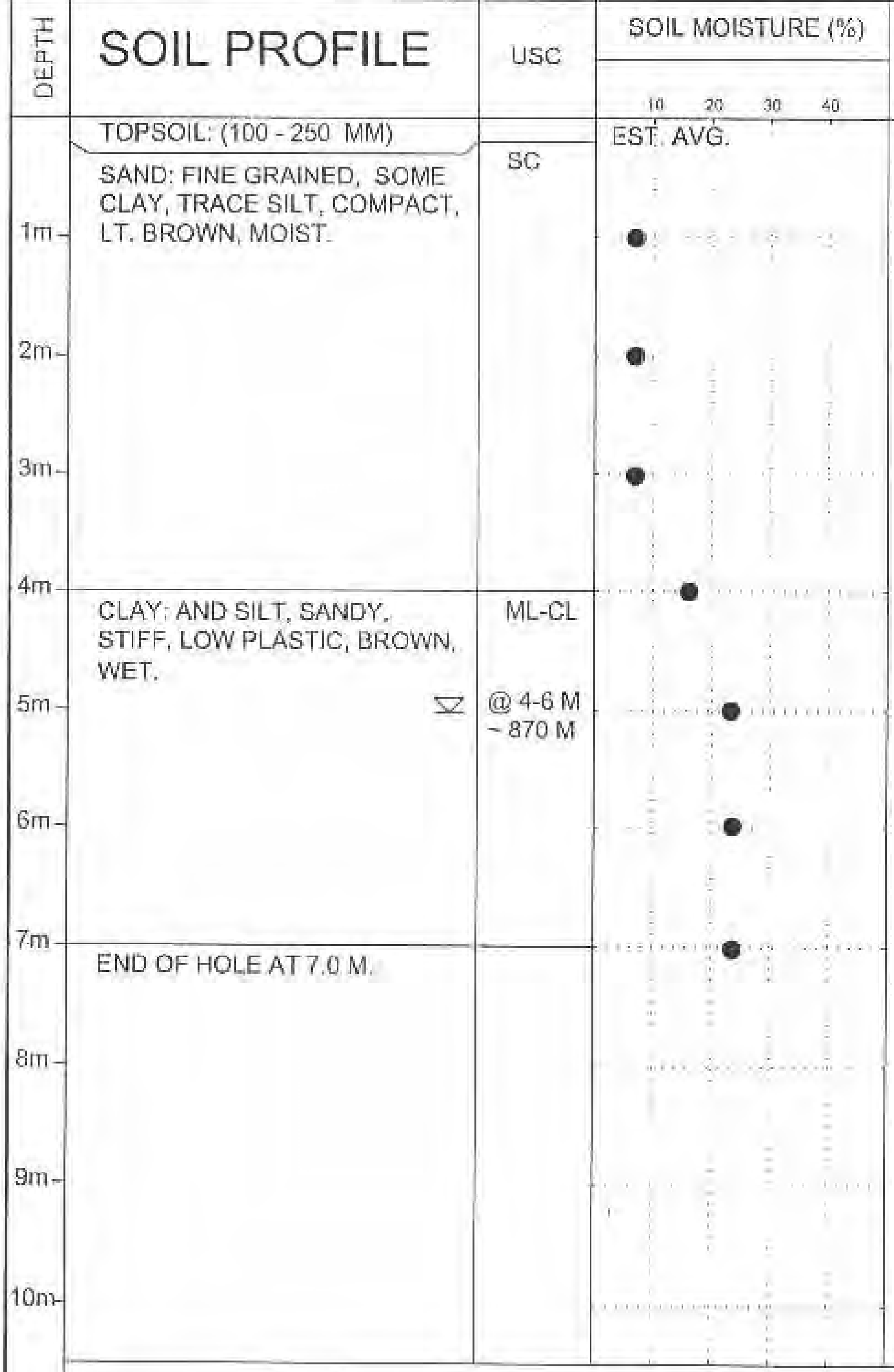
DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	SAND: SILTY, TRACE CLAY, NON TO LOW PLASTIC, LOOSE TO COMPACT.	SM-ML	TYP. 8 - 15%		NOT INCLUDING EMBANKMENT FILL.
1m					
2m					
3m					
4m	SILT AND CLAY: SOME SAND, INTERBEDDED, FIRM TO STIFF, LOW TO MEDIUM PLASTIC.	CL-ML	TYP. 20%		
5m					
6m	▽	@ ~6.5 M	TYP. 25 - 30%		
7m					
8m					
9m					
10m					

PROFILE BELOW 10m: CLAY TO 19 M (~862 M); TILL TO 26 M (~ 853 M); BEDROCK.

NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1035	PROJECT:	RUTTEN SUBDIVISION	TYPE OF HOLE(S):	BOREHOLES (5)
LOCATION:	LSD 1 TO 4 - 34-39-27-W4M	SOURCE:	PRIVATE FILES	TYPE OF LOG:	COMPOSITE
ELEVATION:	873 - 877 M	LOGGED BY:	PARKLAND GEO	ACCURACY:	HIGH
DATE:	NOVEMBER 2002	FILE #:	RD0814	FILE ORIGINALS:	N/A

DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: (100 - 250 MM)			
	SAND: FINE GRAINED, SOME CLAY, TRACE SILT, COMPACT, LT. BROWN, MOIST.	SC		SO4 = SEVERE GRAIN SIZE ANALYSIS: SAND 74%, SILT 9%, CLAY 17%
4m	CLAY: AND SILT, SANDY, STIFF, LOW PLASTIC, BROWN, WET. ▽	ML-CL @ 4-6 M ~ 870 M		
7m	END OF HOLE AT 7.0 M.			

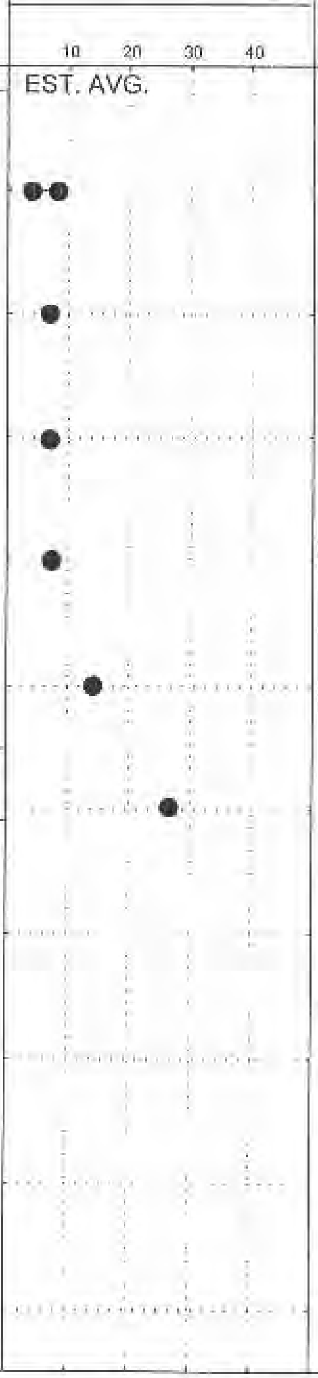


NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1036	PROJECT: WATERMAIN EXTENSION	TYPE OF HOLE(S): BOREHOLES (3)
LOCATION: LSD 14-27-39-27-W4M	SOURCE: FILE FOR BLACKFALDS	TYPE OF LOG: COMPOSITE
ELEVATION: 877 M	LOGGED BY: PARKLAND GEO	ACCURACY: HIGH
DATE: FEBRUARY 2001	FILE #: RD0289	FILE ORIGINALS: YES

DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: (100 - 200 MM)			
	SAND: SILTY, TRACE CLAY, FINE GRAINED, COMPACT, BROWN.	SM		
1m				
2m			25	
3m			10	
4m				
5m			12	
	CLAY: SILTY, FIRM, MEDIUM PLASTIC, BROWN.	CL-ML		GRAIN SIZE ANALYSIS: SAND 5%, SILT 65%, CLAY 30%
6m				
	END OF HOLE AT 6.1 M. HOLE DRY.			
7m				
8m				
9m				
10m				

SOIL MOISTURE (%)



NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1037	PROJECT: UCCL LOAD OUT	TYPE OF HOLE(S): BOREHOLES
LOCATION: LSD 16-26-39-27-W4M	SOURCE: PRIVATE FILES	TYPE OF LOG: ESTIMATE
ELEVATION:	LOGGED BY: HBT AGRA	ACCURACY: LOW TO MEDIUM
DATE: 1988/1990	FILE #: RX03582/RX04071	FILE ORIGINALS: N/A

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	FILL	FILL			
1m	SILT AND CLAY	ML-CL			
2m	SAND: FINE GRAINED, TRACE SILT, LOOSE TO COMPACT.	SA			
3m					
4m					
5m					
6m					
7m					
8m					
9m					
10m					

PROFILE BELOW 10m: TILL ESTIMATED AT ~ 15 M.

END OF DEEPEST HOLES AT 20 M.

NORTH RED DEER WATER LINE PROJECT

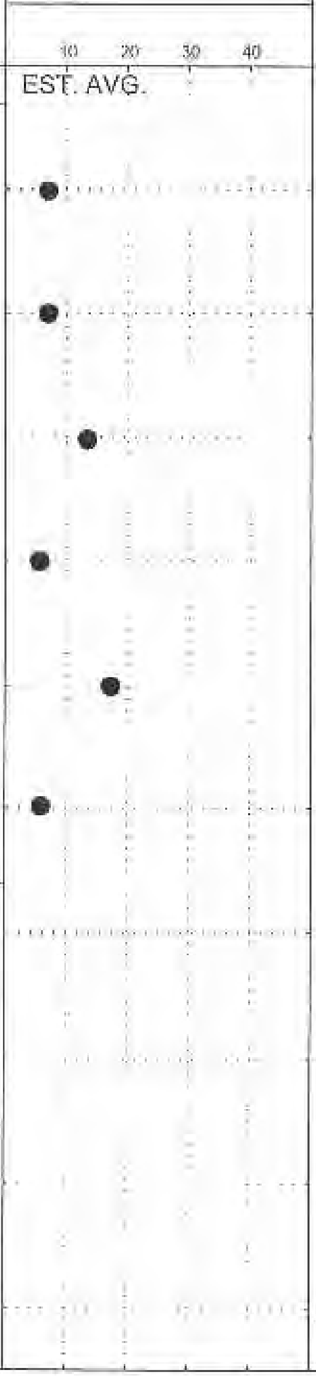
REF. POINT #: 1038
PROJECT: PRELIM. INVESTIGATION
TYPE OF HOLE(S): BOREHOLES
LOCATION: 28-39-27-W4M
SOURCE: PRIVATE FILE
TYPE OF LOG: ESTIMATE
ELEVATION:
LOGGED BY: AGRA E & E
ACCURACY: MEDIUM
DATE: JULY 1996
FILE #: RX05474
FILE ORIGINALS: N/A

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL: 300 MM	FILL			
	SAND: FINE GRAINED, TRACE SILT, TRACE CLAY, LOOSE TO COMPACT.	SA	TYP. 10%		
1m				10	AVG.
2m					
3m					
4m					
5m	- SAND TILL.				
6m	BEDROCK: CLAYSHALE.	BDRK			
7m					
8m					
9m					
10m					
	ESTIMATED END OF HOLE.				

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1039
PROJECT: BLACKFALDS BROADWAY AVE.
TYPE OF HOLE(S): BOREHOLES (5)
LOCATION: LSD 16-27-39-27-W4M
SOURCE: FILE FOR BLACKFALDS
TYPE OF LOG: TYPICAL (#5)
ELEVATION: 880 M
LOGGED BY: PARKLAND GEO
ACCURACY: HIGH
DATE: FEBRUARY 2001
FILE #: RD0290
FILE ORIGINALS: YES

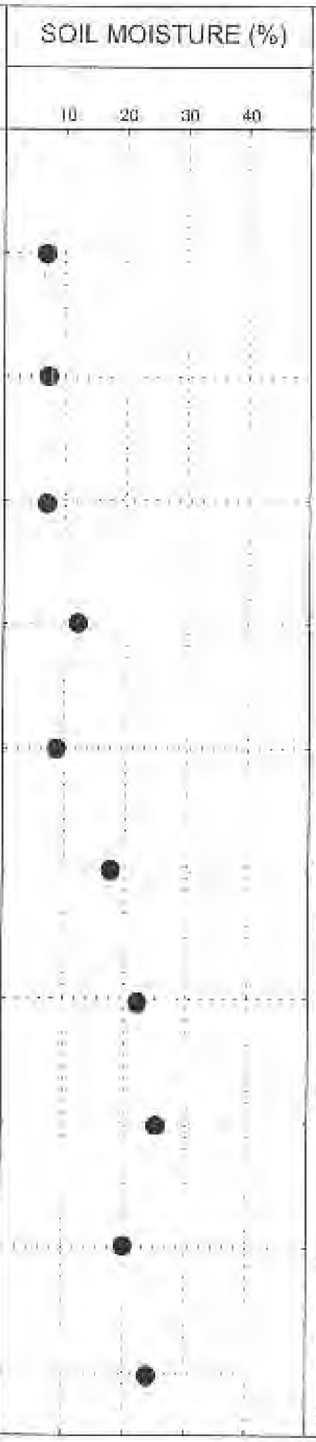
SOIL MOISTURE (%)



DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: PEATY (300 MM)	ORG		
	SAND: SILTY, SOME CLAY, NON PLASTIC, COMPACT, BROWN, DAMP.	SM		
1m				GRAIN SIZE ANALYSIS: SAND 65%, SILT 15%, CLAY 20%
2m				
3m	- CLAYEY		13	
4m				
5m	- SILTY CLAY LAYER			
6m	▽	@ 874 M	16	
7m	END OF HOLE AT 6.6 M.			
8m				
9m				
10m				

NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1040	PROJECT:	NW LIFT STATION	TYPE OF HOLE(S):	BOREHOLES (1)
LOCATION:	LSD 10-27-39-27-W4M	SOURCE:	FILE FOR BLACKFALDS	TYPE OF LOG:	ACTUAL
ELEVATION:	873 M	LOGGED BY:	PARKLAND GEO	ACCURACY:	HIGH
DATE:	JUNE 2000	FILE #:	RD0110	FILE ORIGINALS:	YES



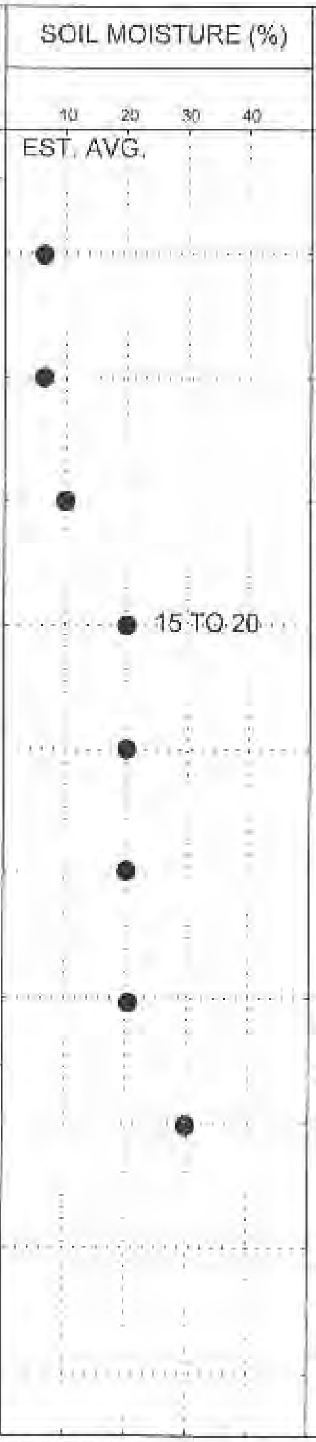
DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	SAND: SOME SILT, MEDIUM COARSE, NON PLASTIC, COMPACT, BROWN, MOIST.	SA-SM		
1m				
2m	- GREY			
3m			6	GRAIN SIZE ANALYIS: SAND 85 %, SILT 10 %, CLAY 5 %
4m	▽	@ 4.3 M		
5m	- WET		6	
6m			8	
7m				
8m	- COARSE GRAINED		11	GRAIN SIZE ANALYIS: SAND 73 %, SILT 17 %, CLAY 10 %
9m			9	
10m			16	

PROFILE BELOW 10m: SAME

END OF HOLES AT 11.1 M

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1041	PROJECT: BLACKFALDS SE POND	TYPE OF HOLE(S): BOREHOLES (4)
LOCATION: SW 26-39-27-W4M	SOURCE: PRIVATE FILE	TYPE OF LOG: TYPICAL (#2)
ELEVATION: 874 M (EST. HIGH)	LOGGED BY: PARKLAND GEO	ACCURACY: HIGH
DATE: JUNE 2000	FILE #: RD0109	FILE ORIGINALS: YES



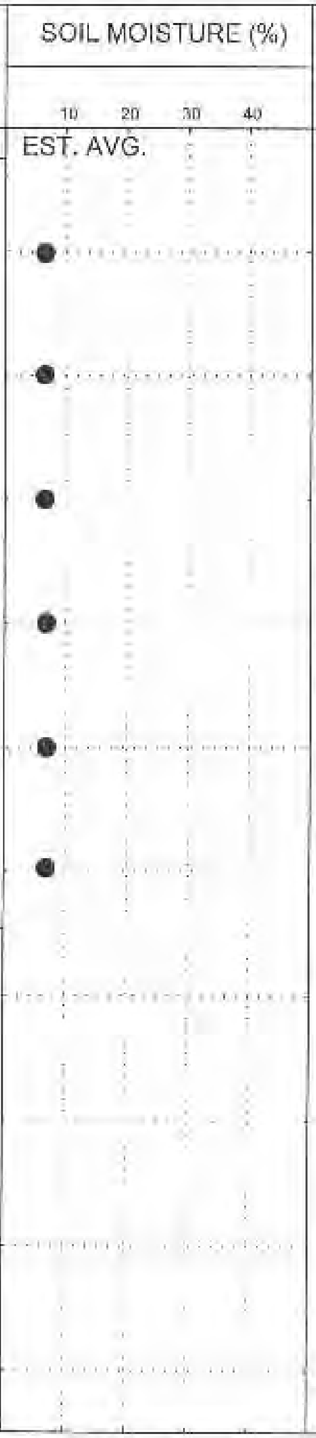
DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: 400 MM	ORG		
1m	SAND: TRACE SILT, TRACE CLAY, NON PLASTIC, COMPACT, LT. BROWN, DRY - DAMP.	SW		
2m				GRAIN SIZE ANALYIS: SAND 60%, SILT 35 %, CLAY 5 %
3m				
4m	- WET ▽	@4.0 M 870 M	15	
5m				GRAIN SIZE ANALYIS: SAND 85 %, SILT 10%, CLAY 5 %
6m				
7m				
8m	SILT: AND CLAY, STIFF, MEDIUM PLASTIC, GREY, WET.	ML-CL		
9m	END OF HOLE AT 865 M.			
10m				

NOTE: ORIGINAL SITE WAS ON A SIDE HILL BESIDE A DEPRESSION (SLOUGH).

NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1042	PROJECT:	ROLLING HILLS SUBD.	TYPE OF HOLE(S):	BOREHOLES (13)
LOCATION:	SE 27-39-27-W4M	SOURCE:	PRIVATE FILE	TYPE OF LOG:	COMPOSITE
ELEVATION:	869 - 877 M	LOGGED BY:	PARKLAND GEO	ACCURACY:	HIGH
DATE:	AUGUST 2002	FILE #:	RD0680	FILE ORIGINALS:	N/A

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%)	SPT N	COMMENTS
	TOPSOIL: 125 - 250 MM	ORG	EST. AVG.		
1m	SAND: LITTLE SILT, MEDIUM TO COARSE GRAINED, COMPACT, BROWN, DAMP.	SW			
2m					TYPICAL GRAIN SIZE: SAND 85%, SILT 15 %
3m					
4m					
5m					
6m					GROUNDWATER @ ~ 865 M. MOISTURES RISE TO 15 - 20%.
7m					
8m					
9m					
10m					



NOTE: SOME SILTY SURFICIAL SOILS (POSSIBLE FILL).
SILTY CLAY (MC 30 - 35%) BELOW ELEV. 869 M.

END OF HOLES AT 6.0 - 6.5 M

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1043

PROJECT: RESERVOIR EXPANSION

TYPE OF HOLE(S):

LOCATION: LSD 2-27-39-27-W4M

SOURCE: FILES FOR T. BLACKFALDS

TYPE OF LOG:

ELEVATION:

LOGGED BY: HBT AGRA

ACCURACY:

DATE: MAY 1988

FILE #: RX03536

FILE ORIGINALS:

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	FILL	FILL			
	ORGANICS	ORG			
1m	SAND: FINE GRAINED, UNIFORM, TRACE SILT, COMPACT.	SP	AVG. 8%	13 22	MIN MAX
2m					
3m					
4m					
5m					
6m					
7m	EST.				
8m	CLAY: SILTY, STIFF, MEDIUM TO HIGH PLASTIC.	CI-CH	●		
9m	SAND: FINE GRAINED, DENSE.	SA			
10m	▽	TRACE			
	ESTIMATED END OF HOLE.				

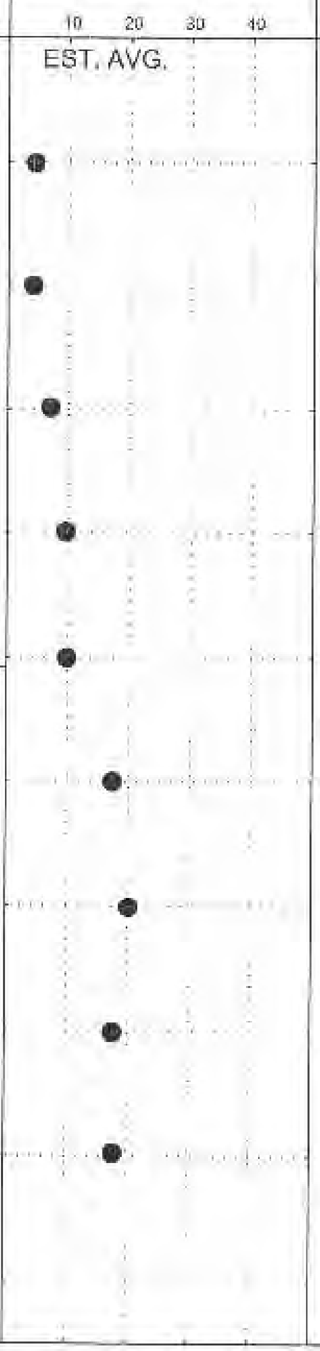
NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1044	PROJECT:	SEWAGE LAGOON EXP.	TYPE OF HOLE(S):	REVIEW
LOCATION:	LSD 6-23-39-27-W4M	SOURCE:	FILES FOR T. BLACKFALDS	TYPE OF LOG:	ESTIMATE
ELEVATION:		LOGGED BY:	HBT AGRA	ACCURACY:	LOW
DATE:	JULY 1987	FILE #:	RX03376	FILE ORIGINALS:	N/A

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	SAND: MEDIUM GRAINED, TRACE SILT, LOOSE.	SW			
1m					
2m	SAND: SOME GRAVEL, TRACE SILT, COMPACT.	SW-GW			
3m					
4m					
5m					
6m	▽	@ ~6.0 M			
7m					
8m	ESTIMATED END OF HOLE.				
9m					
10m					

NORTH RED DEER WATER LINE PROJECT

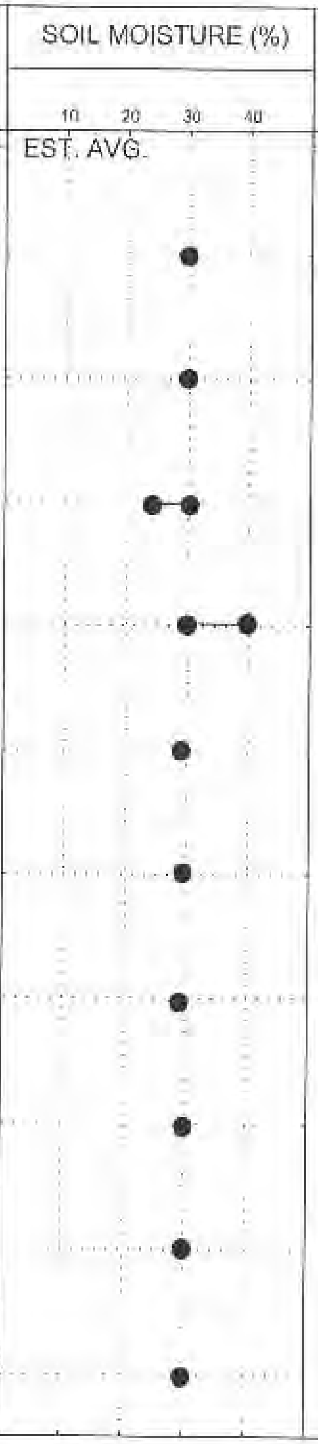
REF. POINT #: 1045	PROJECT: COMMERCIAL DEV.	TYPE OF HOLE(S): BOREHOLES (2)
LOCATION: LSD 6-14-39-27-W4M	SOURCE: PRIVATE FILE	TYPE OF LOG: COMPOSITE
ELEVATION:	LOGGED BY: PARKLAND GEO	ACCURACY: HIGH
DATE: MARCH 2002	FILE #: RD0589	FILE ORIGINALS: N/A

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%)	SPT N	COMMENTS
	SAND: SOME SILT, TRACE CLAY, COMPACT, NON PLASTIC, BROWN, MOIST.	SA			
1m					
2m					
3m					
4m					
5m				15	GRAIN SIZE ANALYSIS: SAND 65%, SILT 20%, CLAY 15%
	CLAY TILL: SILTY, SANDY, STIFF, MEDIUM PLASTIC, BROWN, MOIST. ▽	CI @ 5.5 M			
6m					PLASTICITY - CI (LL = 31%)
7m				10	
8m					
9m				11	
	END OF HOLE AT ~ 9.0 M.				
10m					

NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1046	PROJECT:	TANIC DEVELOPMENT	TYPE OF HOLE(S):	BOREHOLES (3)
LOCATION:	LSD 16-11-39-27-W4M	SOURCE:	PRIVATE FILE	TYPE OF LOG:	COMPOSITE
ELEVATION:	874 M (AVG)	LOGGED BY:	PARKLAND GEO	ACCURACY:	HIGH
DATE:	JUNE 2000	FILE #:	RD0177	FILE ORIGINALS:	NA

DEPTH	SOIL PROFILE	USC	SPT N	COMMENTS
	TOPSOIL: 100 - 200 MM			
	SILT: SOME CLAY, STIFF, LOW PLASTIC, BROWN.	ML		
1m				
			17	GRAIN SIZE ANALYIS: SAND 13 %, SILT 65 %, CLAY 22 %
2m				
3m				
			17	
	▽	@3.6 M		
4m				
			11	GRAIN SIZE ANALYIS: SAND 4 %, SILT 66 %, CLAY 30 %
5m	- CLAYEY	ML-CL		
6m				
			17	
7m				
			9	
8m				
9m				
10m				

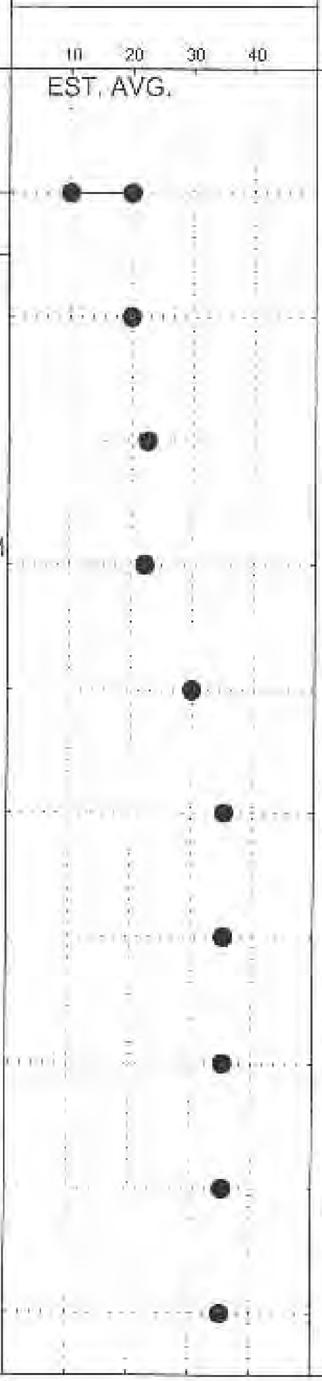


PROFILE BELOW 10m:

END OF HOLES @ 10.5 M

NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1047	PROJECT:	IPSCO WAREHOUSE	TYPE OF HOLE(S):	BOREHOLES (4)
LOCATION:	LSD 14-3-39-27-W4M	SOURCE:	PRIVATE FILE	TYPE OF LOG:	COMPOSITE
ELEVATION:		LOGGED BY:	PARKLAND GEO	ACCURACY:	HIGH
DATE:	SEPTEMBER 2000	FILE #:	RD0191	FILE ORIGINALS:	N/A

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%)	SPT N	COMMENTS
	FILL: GRAVEL	FILL			
1m	SAND: SOME SILT	SM			
	SILT AND CLAY: FIRM, MEDIUM PLASTIC, BROWN, MOIST TO WET.	ML-CL		15	
2m					
3m				6	
4m	▽	@ ~3.9 M			
5m				6	
6m				6	
7m					
8m				6	
9m				6	
10m					

PROFILE BELOW 10m: CLAY TILL AT 14.6 M.

END OF DEEPEST HOLE AT 15.8 M.

NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1048	PROJECT:	CHILES IND. SUBDIV.	TYPE OF HOLE(S):	BOREHOLES
LOCATION:	LSD 2-3-39-27-W4M	SOURCE:	PRIVATE FILE	TYPE OF LOG:	COMPOSITE
ELEVATION:	876m (EST.)	LOGGED BY:	AGRA E&E	ACCURACY:	HIGH
DATE:	JUNE 1999	FILE #:	RX06193 (PG #RD0133)	FILE ORIGINALS:	NA

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	TOPSOIL:	ORG			
1m 2m	SAND: FINE TO MED. GRAINED, SOME SILT TO SILTY, LOOSE	SM	AVG 15%		
3m 4m 5m 6m	CLAY: SILTY, TRACE SAND, FIRM TO STIFF, MED. PLASTIC, WET	CL-ML	AVG 30%		
7m 8m 9m 10m	CLAY TILL: SILTY, SANDY, MED. PLASTIC, VERY STIFF	CI	TYP. 20%		

PROFILE BELOW 10m: TILL TO END OF HOLE

END OF DEEPEST HOLE: ABOUT 19.7m

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1049	PROJECT: COMMERCIAL SITE	TYPE OF HOLE(S): BOREHOLES
LOCATION: LSD 3-3-39-27-W4M	SOURCE: PRIVATE FILE	TYPE OF LOG: ESTIMATE
ELEVATION:	LOGGED BY: AGRA E&E	ACCURACY: MEDIUM
DATE: MAY 1996	FILE #: RX05400	FILE ORIGINALS: NA

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	FILL: SAND, GRAVEL, CLAY.	FILL			
1m					
	- BURIED ORGANIC LAYER. ▽	@ ~ 2.0 M			
2m	SILT: AND FINE SAND, CLAY, LOOSE.	ML-SA	TYP. 25%		
3m					
4m					
5m					
6m	SILT AND CLAY: TRACE SAND, MEDIUM PLASTIC, FIRM TO STIFF.	ML-CL	TYP. 30%		
7m					
8m					
9m					
10m					

PROFILE BELOW 10m: SAME

END OF DEEPEST HOLE AT 15m.

NORTH RED DEER WATER LINE PROJECT

REF. POINT #:	1050	PROJECT:	COMMERCIAL SITE	TYPE OF HOLE(S):	BOREHOLES (7)
LOCATION:	LSD 12-33-38-27-W4M	SOURCE:	PRIVATE	TYPE OF LOG:	COMPOSITE
ELEVATION:	876 m	LOGGED BY:	PARKLAND GEO	ACCURACY:	HIGH
DATE:	2000	FILE #:	RD0101	FILE ORIGINALS:	N/A

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	FILL OR ORGANICS	FILL	EST. RANGE		
1m	CLAY: AND SILT, MEDIUM PLASTIC, STIFF, MOIST	CI-ML	20 - 30 %		
2m					PLASTICITY: CI (LL = 36 %) GRAIN SIZE ANALYSIS: SAND 5 %, SILT 65 %, CLAY 30 %
3m					
4m	▽	@ 3 TO 8 M			GROUNDWATER DEEPER NEAR CREST OF ESCARPMENT
5m					
6m					
7m					
8m	- VERY STIFF.				
9m					
10m					

PROFILE BELOW 10 M: SAME TO 20.5 M, TILL BELOW

END OF DEEPEST HOLE TO 22.5 M.

NORTH RED DEER WATER LINE PROJECT

REF. POINT #: 1051	PROJECT: EASTSIDE ROAD BRIDGE	TYPE OF HOLE(S): BOREHOLES (7)
LOCATION: LSD 4-5-44-24-W4M	SOURCE: DESCON (PROFILE DWG)	TYPE OF LOG: ESTIMATE
ELEVATION: 791 M	LOGGED BY: AGRA E & E	ACCURACY: LOW - MEDIUM
DATE: 1998	FILE #: UNKNOWN	FILE ORIGINALS: NO

DEPTH	SOIL PROFILE	USC	SOIL MOISTURE (%) 10 20 30 40	SPT N	COMMENTS
	FILL: CLAY TO 2.5 M	FILL			
1m	CLAY TILL: SILTY, SANDY, MEDIUM PLASTIC, FIRM TO STIFF.	CI			
2m	- FREQ. SAND LAYERS				
3m					
4m					
5m					
6m					
	▽	@ ~6.5 M			WATER LEVEL AT THE BRIDGE
7m	EST. DEEPEST HOLE AT 7 M				
8m					
9m					
10m					

NOTE: 2.5 M OF SAND AT SURFACE ABOUT 75 M TO THE SOUTH OF THE BRIDGE. SAND POCKETS UP TO 1 M THICK IN THE TILL.

EXPLANATION OF TERMS AND SYMBOLS

The terms and symbols used on the borehole logs to summarize the results of the field investigation and subsequent laboratory testing are described on the following two pages.

The borehole logs are a graphical representation summarizing the soil profile as determined during site specific field investigation. The borehole logs may include test data from laboratory soil testing, if applicable. The materials, boundaries and conditions have been established only at the borehole locations at the time of drilling. The soil conditions shown on the borehole logs are not necessarily representative of the subsurface conditions elsewhere across the site. The transitions in soil profile usually have gradual rather than distinct unit boundaries as shown on this graphical representation.

- **PRINCIPAL SOIL TYPE -** The major soil type by weight of material or by behavior.

Material	Grain Size
Boulders	Larger than 300 mm
Cobbles	75 mm to 300 mm
Coarse Gravel	19 mm to 75 mm
Fine Gravel	5 mm to 19 mm
Coarse Sand	2 mm to 5 mm
Medium Sand	0.425 mm to 2 mm
Fine Sand	0.75 mm to 0.425 mm
Silt & Clay	Smaller than 0.075 mm

- **DESCRIPTION OF MINOR SOIL TYPE -** Minor soil types are identified by weight of minor component.

Percent	Descriptor
35 to 50	and
20 to 35	some
10 to 20	little
1 to 10	trace

- **RELATIVE STRENGTH OF COARSE GRAINED SOIL -** The following terms are used relative to Standard Penetration Test (SPT), ASTM D1586, N value for blows per 300 mm.

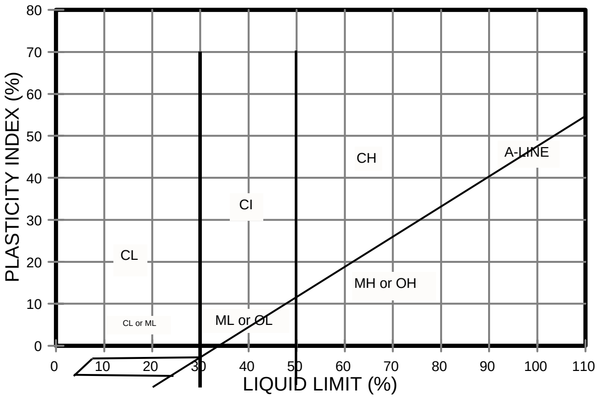
Description	N Value
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Over 50

- **CONSISTENCY OF FINED GRAINED SOIL -** The following terms are used relative to unconfined strength in kPa and Standard Penetration Test (SPT), ASTM D1586, N value for blows per 300 mm.

Description	Unconfined Compressive Strength (kPa)	N Value
Very Soft	less than 25	Less than 2
Soft	25 to 50	2 to 4
Firm	50 to 100	4 to 8
Stiff	100 to 200	8 to 15
Very Stiff	200 to 380	15 to 30
Hard	Over 380	Over 30

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	▨	WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			GP	▨	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO	NOT MEETING ALL OF THE ABOVE REQUIREMENTS	
		DIRTY GRAVELS (WITH SOME FINES)	GM	▨	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12 %	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			GC	▨	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE OR P.I. MORE THAN
	SANDS MORE THAN HALF FINE GRAINS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	SW	░	WELL GRADED SANDS, GRAVELLY SANDS WITH LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			SP	░	POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ALL OF THE ABOVE REQUIREMENTS	
		DIRTY SANDS (WITH SOME FINES)	SM	▥	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12 %	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			SC	▨	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE OR P.I. MORE THAN
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES NO. 200 SIEVE)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 50\%$	ML	▥	INORGANIC SILTS & VERY FINE SANDS, ROCK FLUOR, SILTY SANDS OF SLIGHT	CLASSIFICATION IS BASED ON THE PLASTICITY CHART BELOW	
		$W_L > 50\%$	MH	▥	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY		
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART NEGLIGIBLE ORGANIC CONTENT	$W_L < 30\%$	CL	▨	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR		
		$30\% < W_L < 50\%$	CI	▨	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50\%$	CH	▨	INORGANIC CLAYS OF HIGH PLASTICITY		
	ORGANIC SILTS & CLAYS BELOW "A" LINE ON CHART	$W_L < 50\%$	OL	▥	ORGANIC SILT, AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
		$W_L > 50\%$	OH	▨	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt	■	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE	



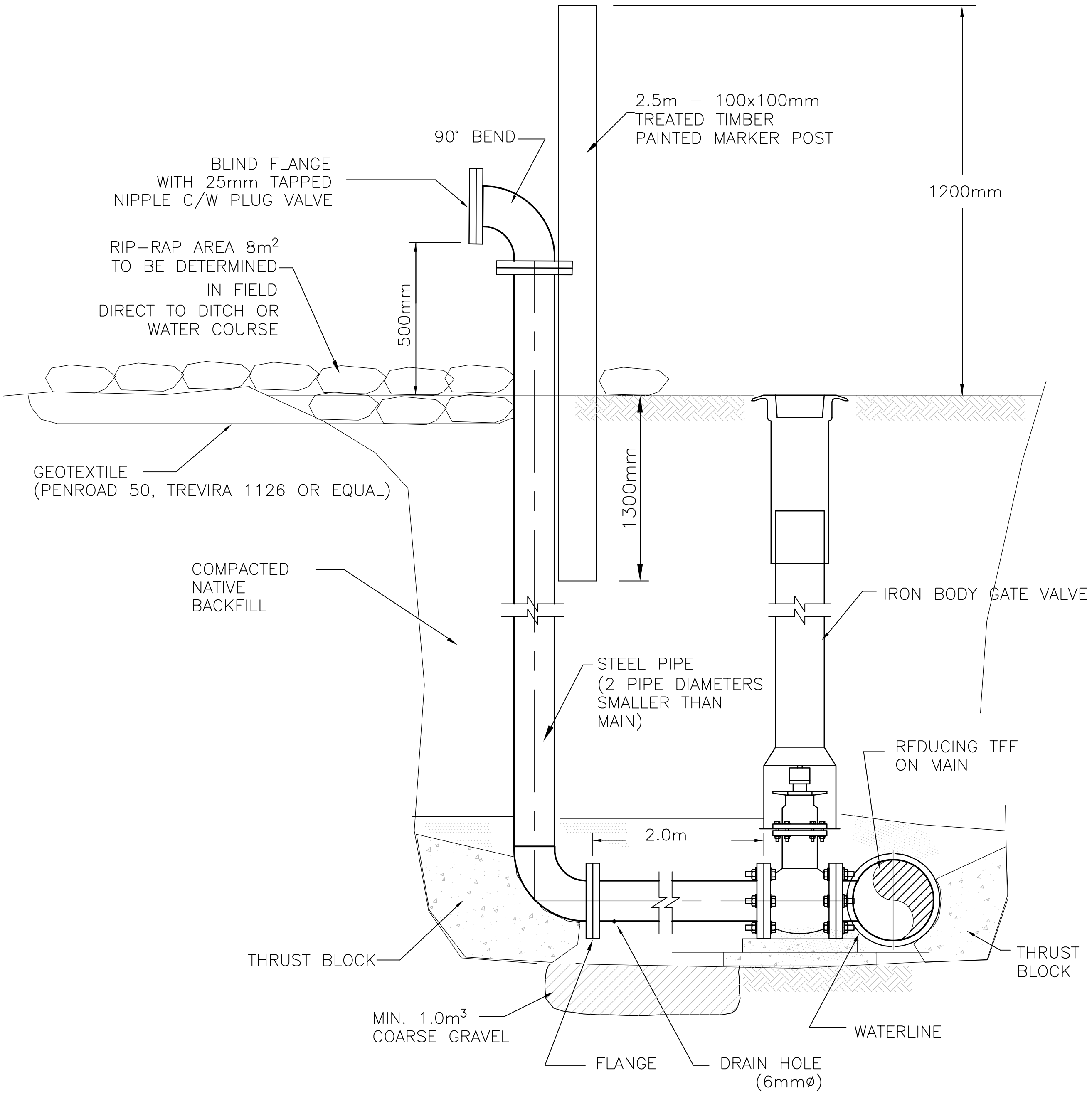
NOTES ON SOIL CLASSIFICATION AND DESCRIPTION:

10. Soils are classified and described according to their engineering properties and behaviour.
11. Boundary classifications for soils with characteristics of two groups are given combined group symbols, eg. GW-GC is a well graded gravel-sand mixture with clay binder between 5 and 12 %.
12. Soil classification is in accordance with the Unified Soil Classification System, with the exception that an inorganic clay of medium plasticity (CI) is recognized.
13. The use of modifying adjectives may be employed to define the estimated percentage range by weight of minor components.

Parkland GEOTECHNICAL
CONSULTING LIMITED

TYPICAL CONSTRUCTION DETAILS

APPENDIX D



NORTH RED DEER RIVER
WATER SERVICES COMMISSION

TYPICAL FLUSH OUT ASSEMBLY

ASSOCIATED ENGINEERING

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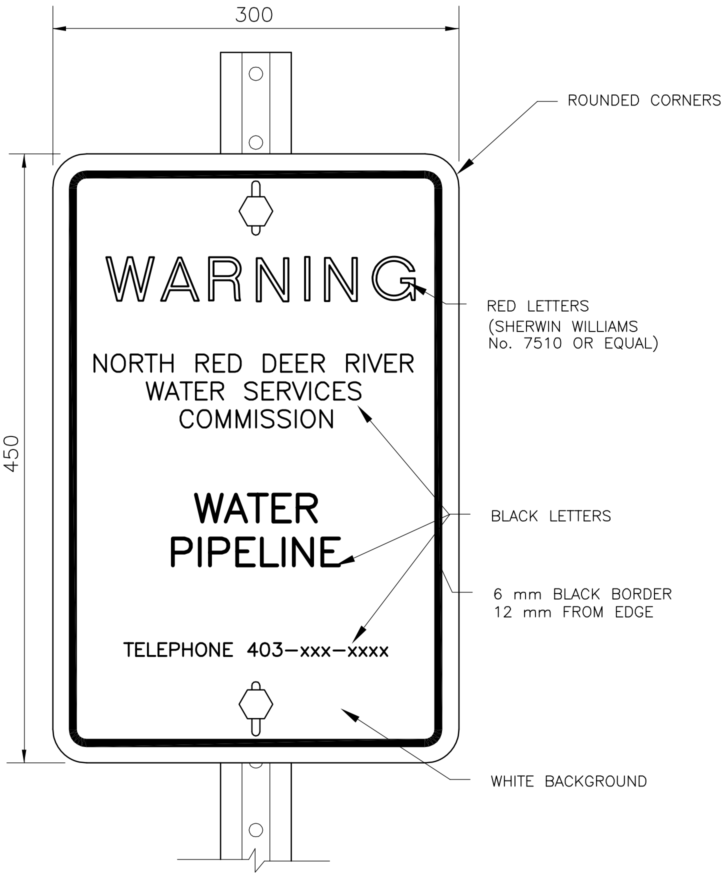
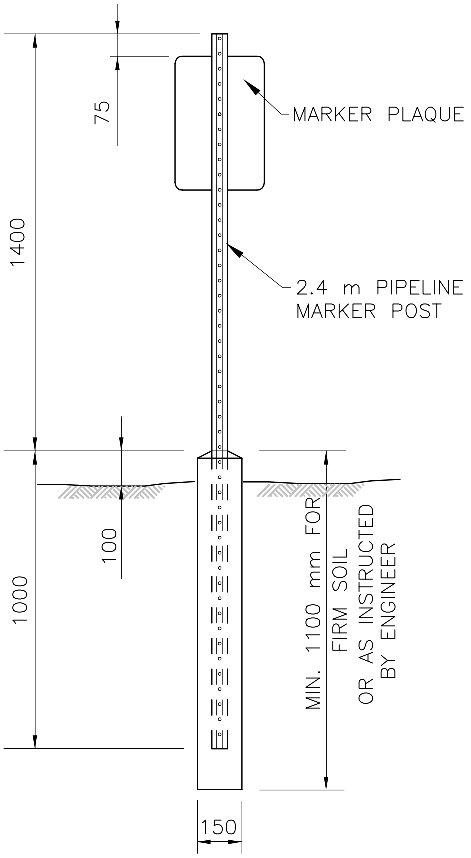


PIPELINE WARNING MARKER



WARNING MARKER POST

NOTES

1 PLAQUE TO BE MADE OF 12 GA STEEL OR 2 mm ALUMINUM, ACCORDING TO E.R.C.B. REGULATIONS, OR AS SUPPLIED BY "ALBERTA TRAFFIC SUPPLY LTD." REMOVE ALL SHARP EDGES.

2 MARKER POST AND FRAME EXPOSED STEEL PARTS SHALL BE GALVANIZED.

3 ALL MARKINGS ON PLAQUE SHALL BE PERMANENT WEATHER RESISTANT AND AS APPROVED BY ENGINEER.

4 PLAQUE SHALL BE ATTACHED TO MARKER POST WITH SUITABLE CADMIUM PLATED H.D. MACHINE BOLTS C/W NUTS & WASHERS.

5 CONCRETE SHALL BE 21 kPa COMPRESSIVE STRENGTH AFTER 28 DAYS.

6 MARKER POST SHALL BE INSTALLED IN COMPACTED SOIL AND FULLY TAMPED AROUND CONCRETE BASE, TO THE SATISFACTION OF FIELD ENGINEER.

7 MARKER POSTS ARE TO BE INSTALLED ON BOTH SIDES OF CROSSED RIGHT OF WAY, AS CLOSE TO FENCE AS POSSIBLE.
PLAQUES SHALL BE FACING RIGHT OF WAY.
PLAQUES SHALL BE PLACED ABOVE PIPE AND NOT TO THE SIDE..

NORTH RED DEER RIVER
WATER SERVICES COMMISSION

WARNING SIGN

ASSOCIATED
ENGINEERING

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Date: 2003/5/14
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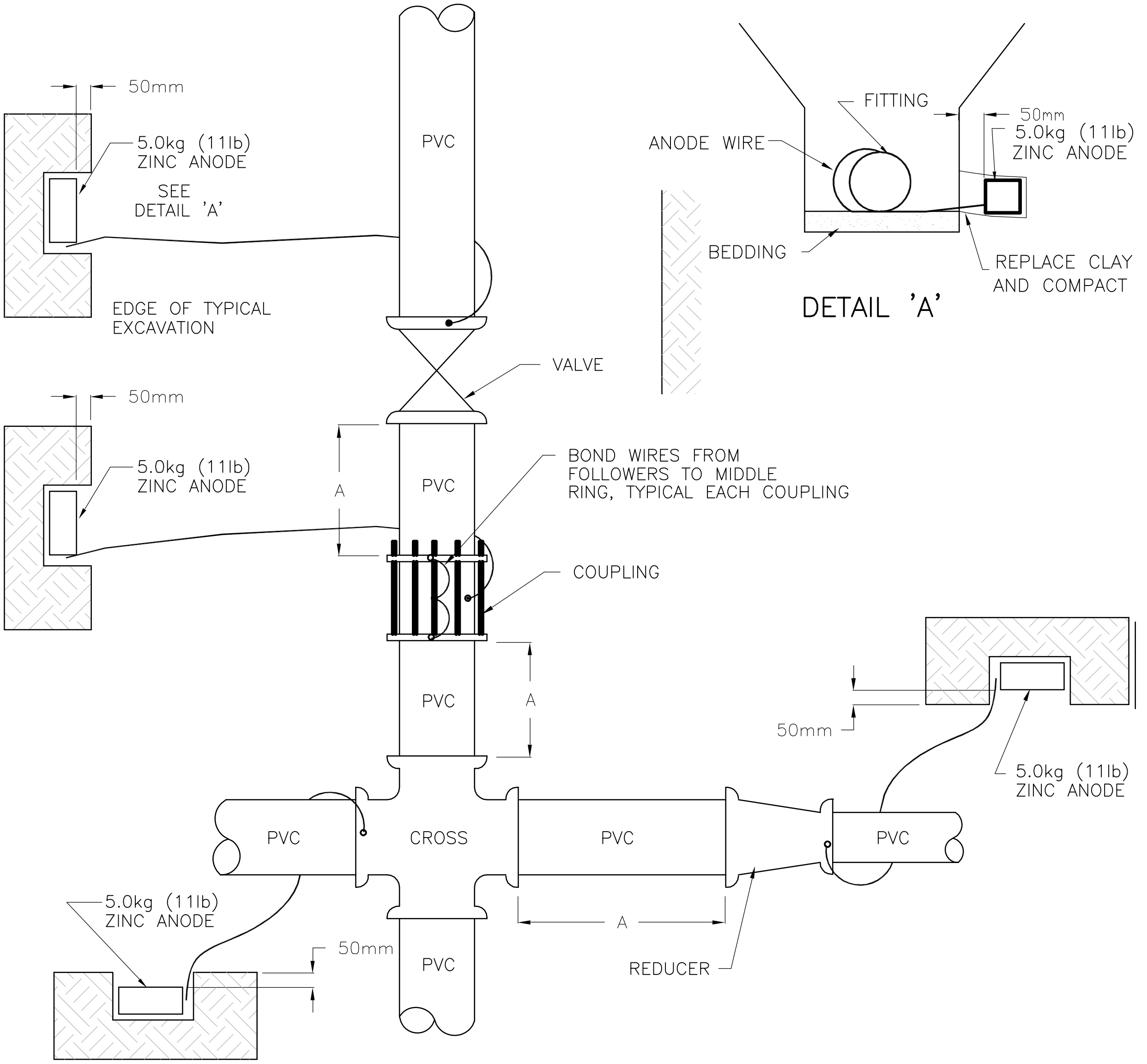

NOTES:

1. MINIMUM DISTANCE FROM ANODE TO PIPE, FITTING, VALVE, OR HYDRANT IS 150mm.
2. INSTALL ANODE AT APPROX. PIPE DEPTH IN NATIVE SOIL.
3. BOND WIRES MAY BE USED TO PROTECT UP TO TWO FITTINGS WITH ONE ANODE WHEN DIMENSION 'A' DOES NOT EXCEED ONE (1) METER.
4. ALL ZINC ANODES ON FITTINGS AND VALVES ARE 5.0kg (11lb).
5. ZINC ANODES TO BE EMBEDDED INTO TRENCH WALL TO PROVIDE FOR A MINIMUM OF 50mm OF NATIVE CLAY COMPLETELY SURROUNDING THE ANODE.
6. ANODES TO BE AT LEAST 300mm CLEAR OF THRUST BLOCK.

NORTH RED DEER RIVER
WATER SERVICES COMMISSION

TYPICAL ANODE INSTALLATION

ASSOCIATED ENGINEERING

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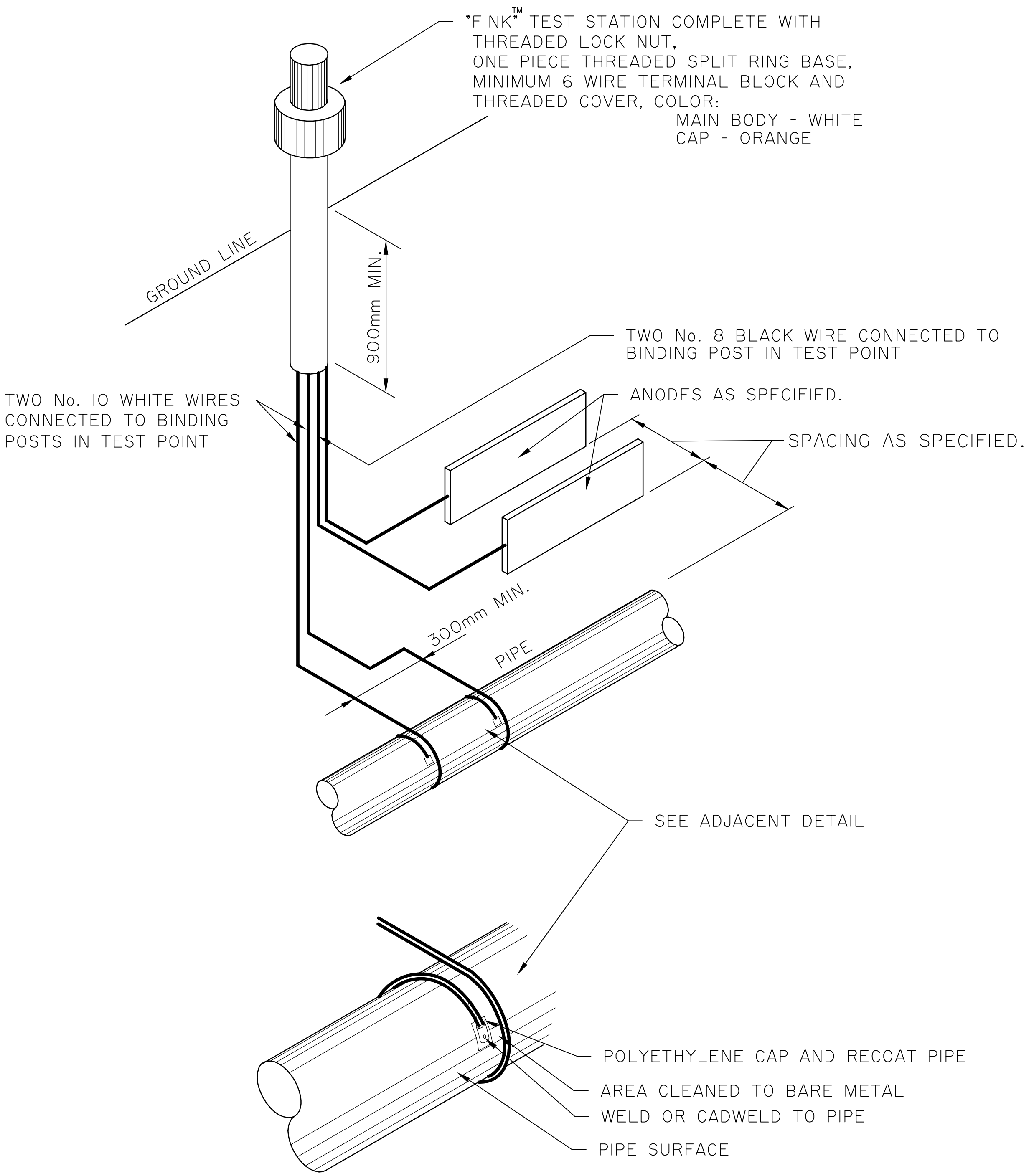

NORTH RED DEER RIVER
WATER SERVICES COMMISSION

TEST POINT DETAIL (STEEL PIPE)

ASSOCIATED ENGINEERING

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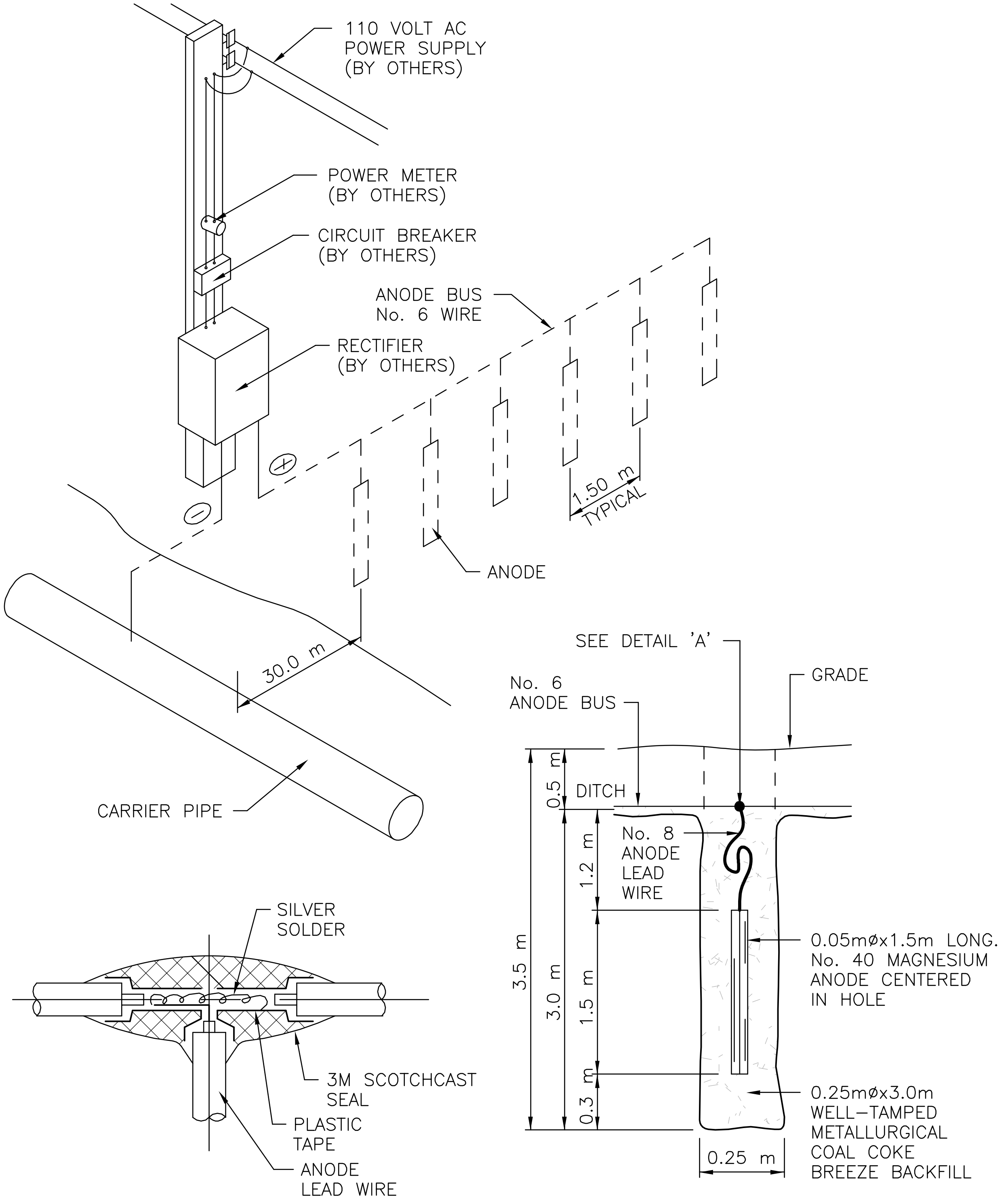

NORTH RED DEER RIVER
WATER SERVICES COMMISSION

TYPICAL RECTIFIER GROUND BED CATHODIC PROTECTION
SYSTEM INSTALLATION (STEEL PIPE)

Time: 14:46
Date: 2003/5/14
Plot Scale: 1=1 (Paper Space)
AutoCAD File: 033333\REPORT\3333FG12.DWG (BW)
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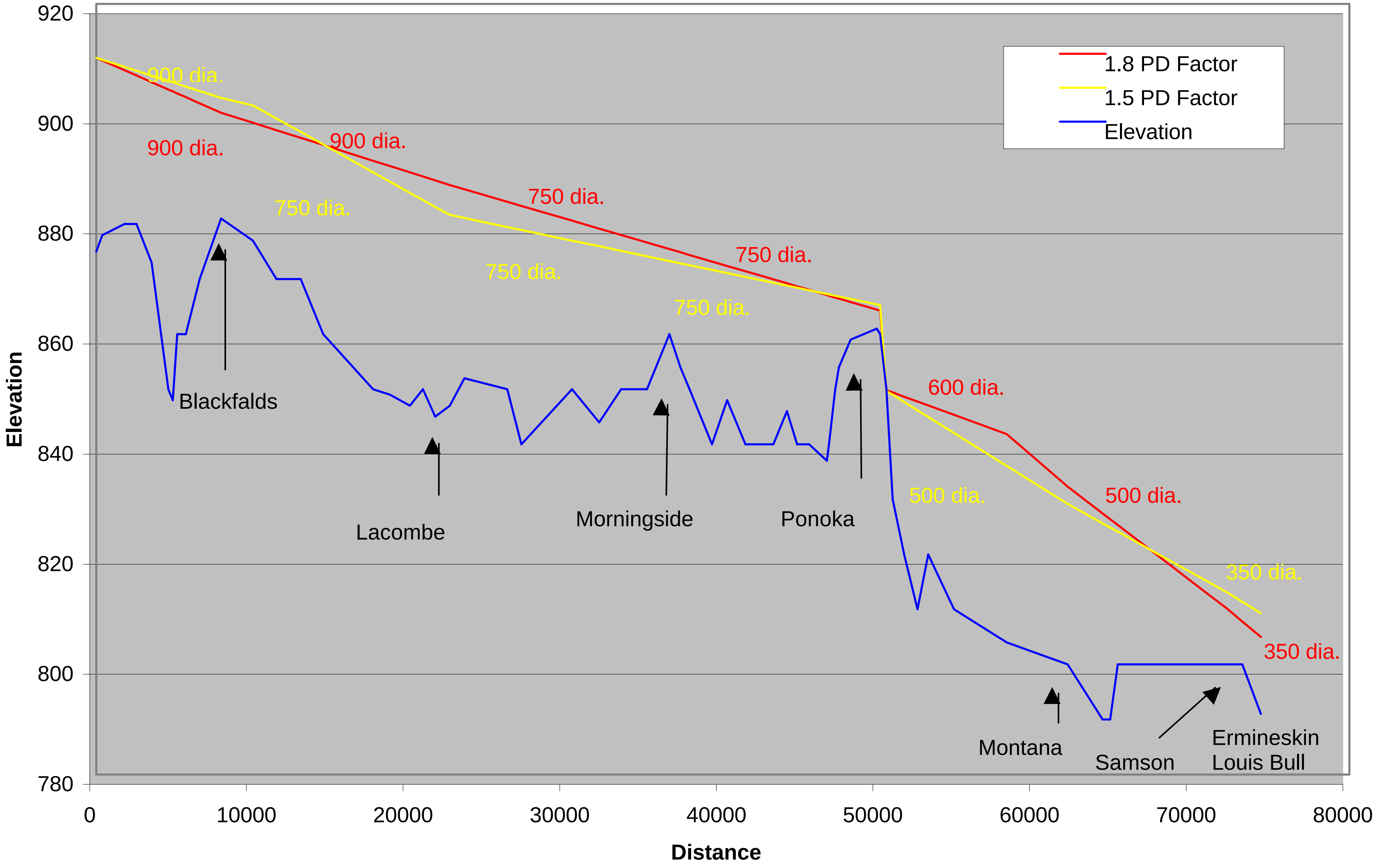
ASSOCIATED
ENGINEERING

WORK COPIES OF HYDRAULIC GRADELINES

APPENDIX

E

Gravity System - Ponoka High Ground
Hydraulic Gradeline



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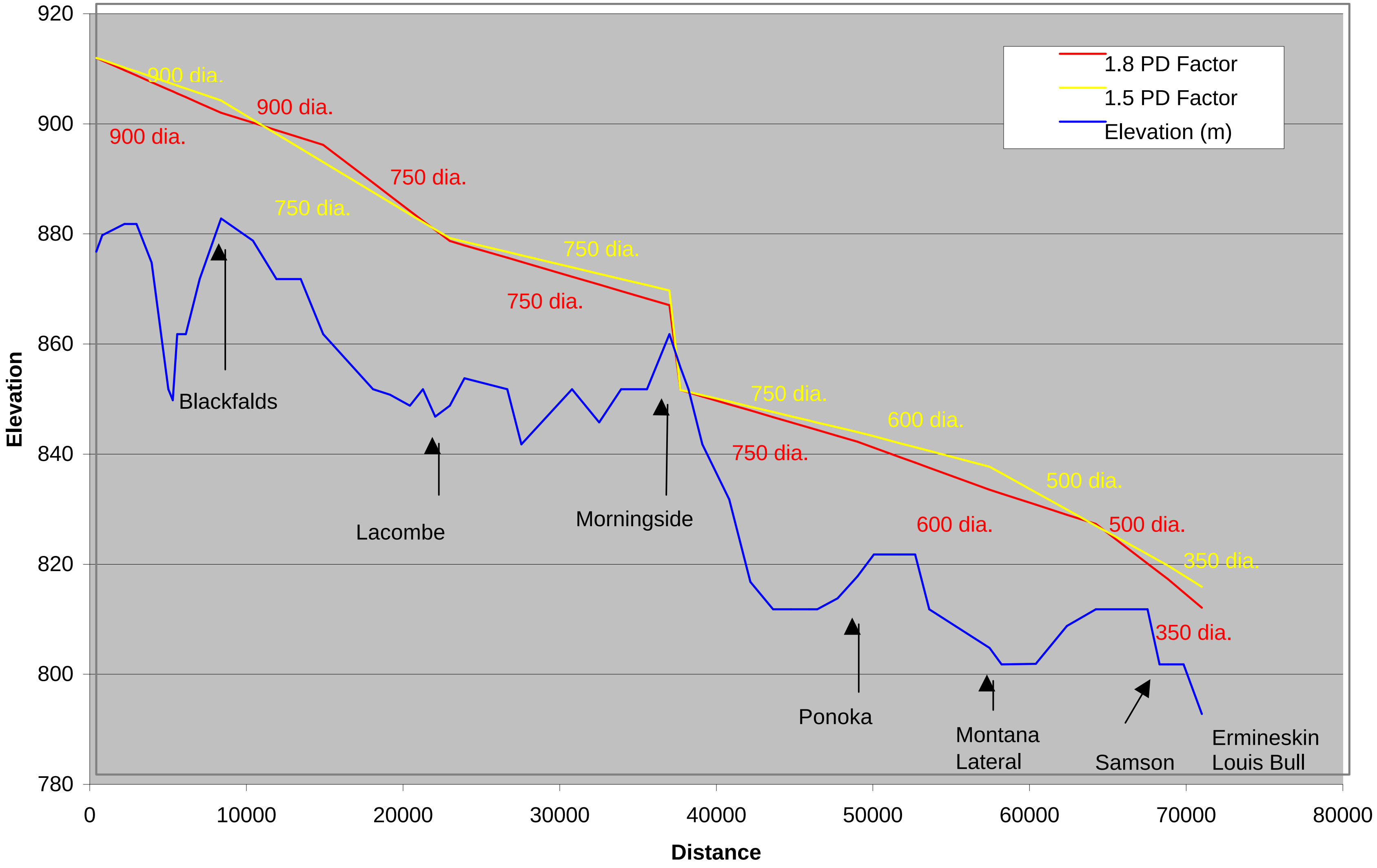
Gravity System - Ponoka Low Ground
Hydraulic Gradeline



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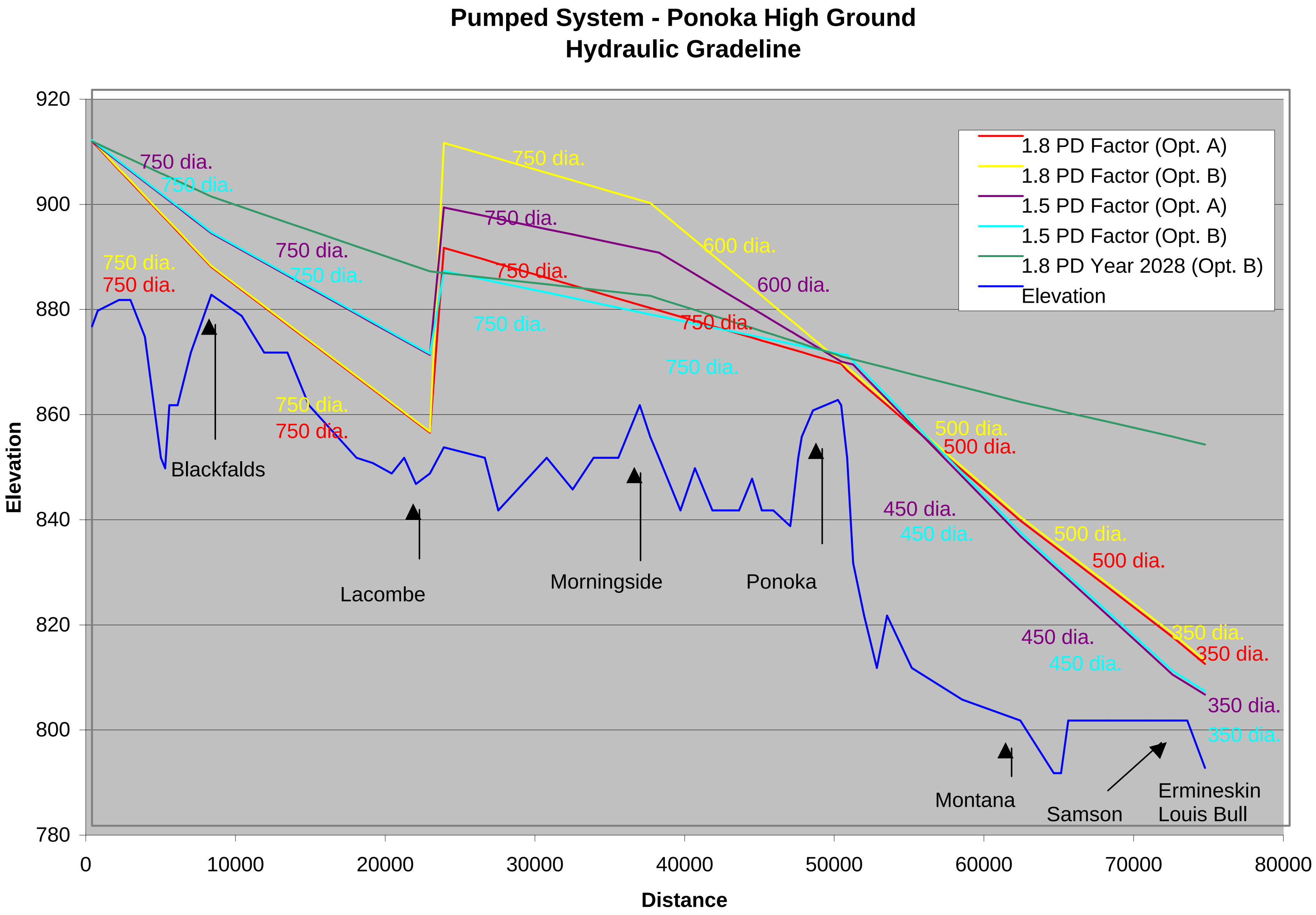

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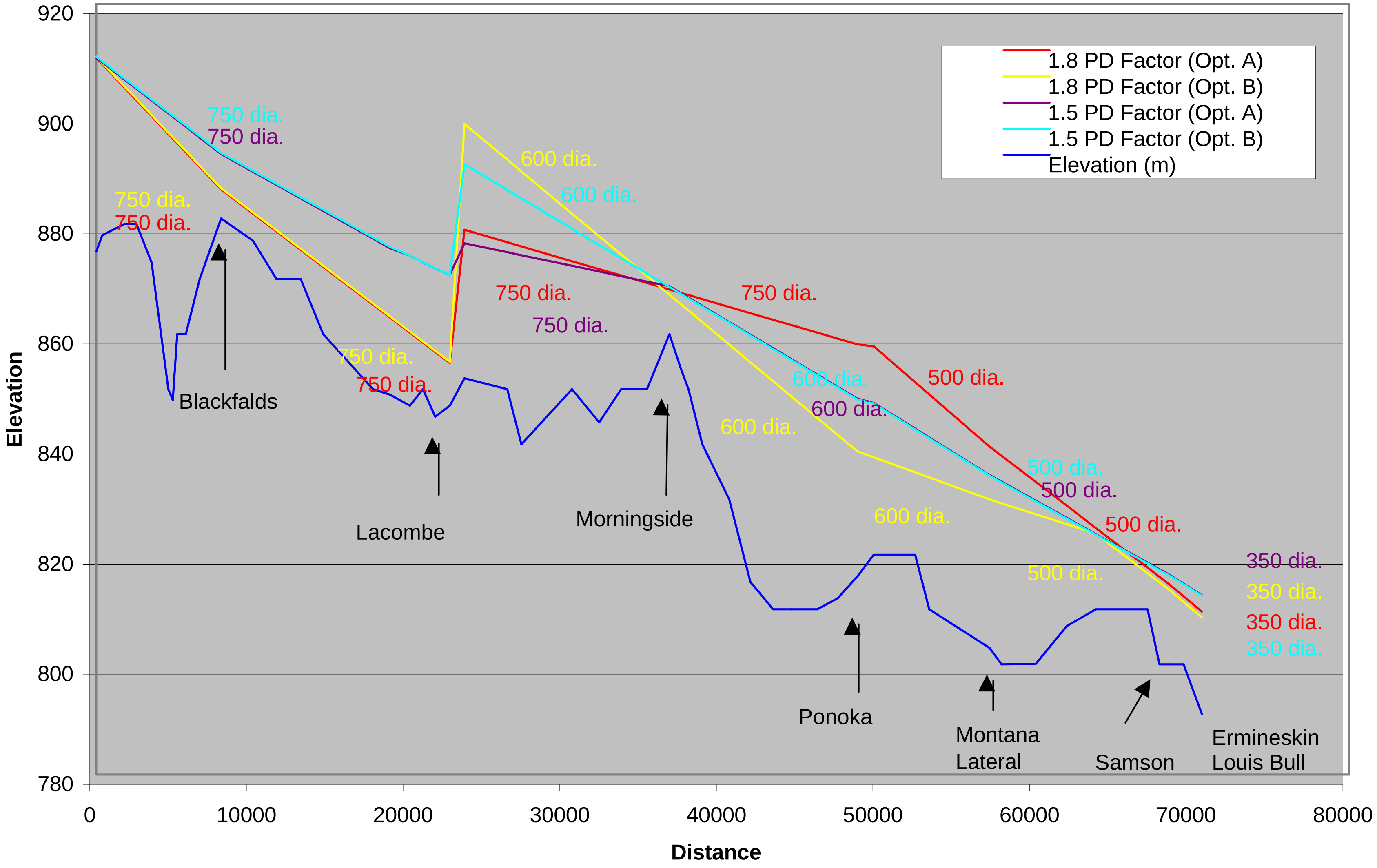
Pumped System - Ponoka Low Ground
Hydraulic Gradeline



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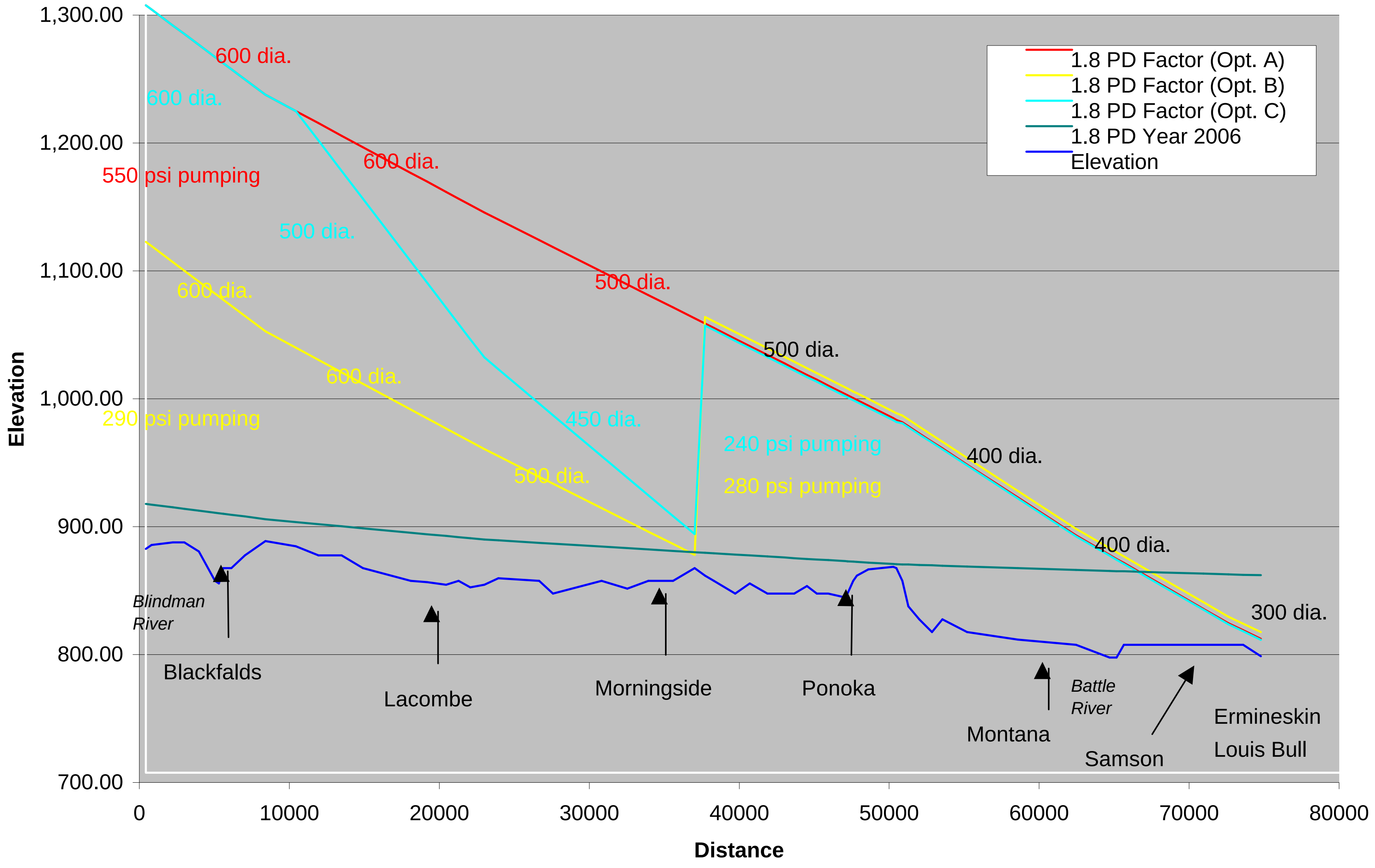
Pumped System - Ponoka High Ground
Hydraulic Gradeline - Steel Pipe



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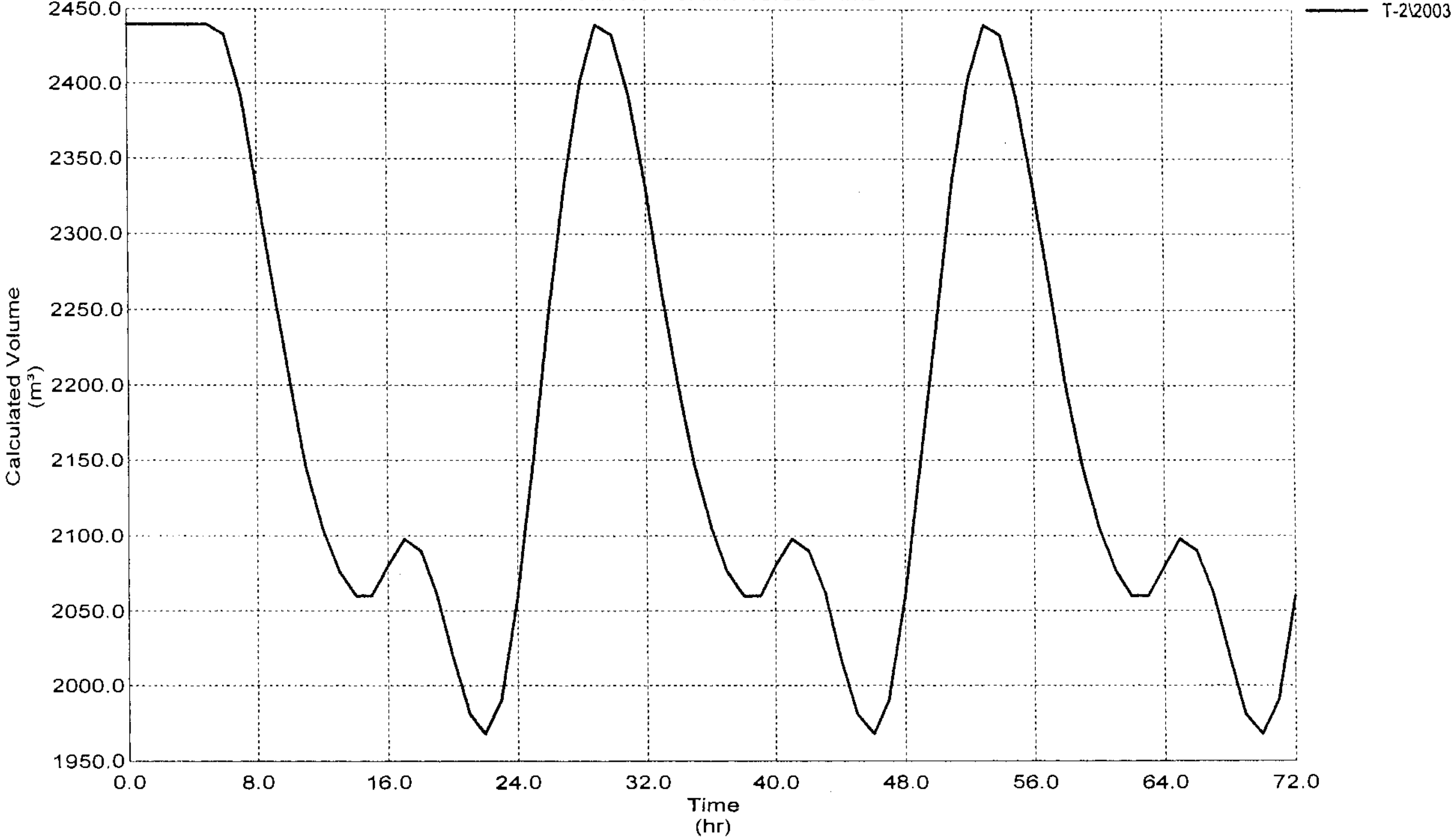
STORAGE VOLUME VS. TIME

Graph

TOWN OF BLACKFALDS
YEAR 2003 EXISTING STORAGE 2450 m^3
(Short of required Storage)

Uses portion of the 2376 m^3
required Fire Storage

Tank: T-2
Calculated Volume versus Time



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05/06/03 06:30:04 PM

Associated Engineering
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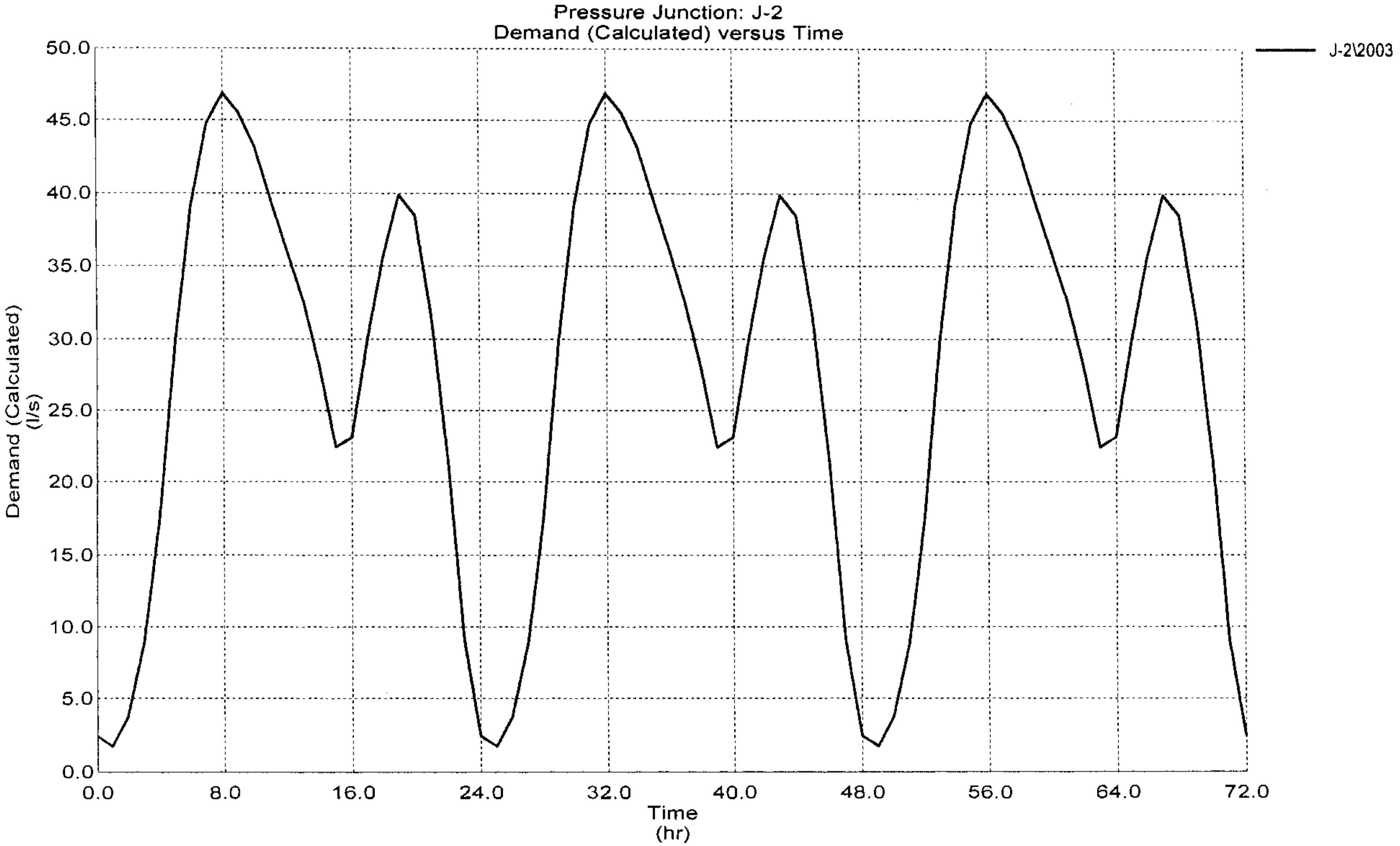
Project Engineer: Kai Ch'ng
WaterCAD v5.0 [5.0037]
Page 1 of 1

Graph

Demand Pattern



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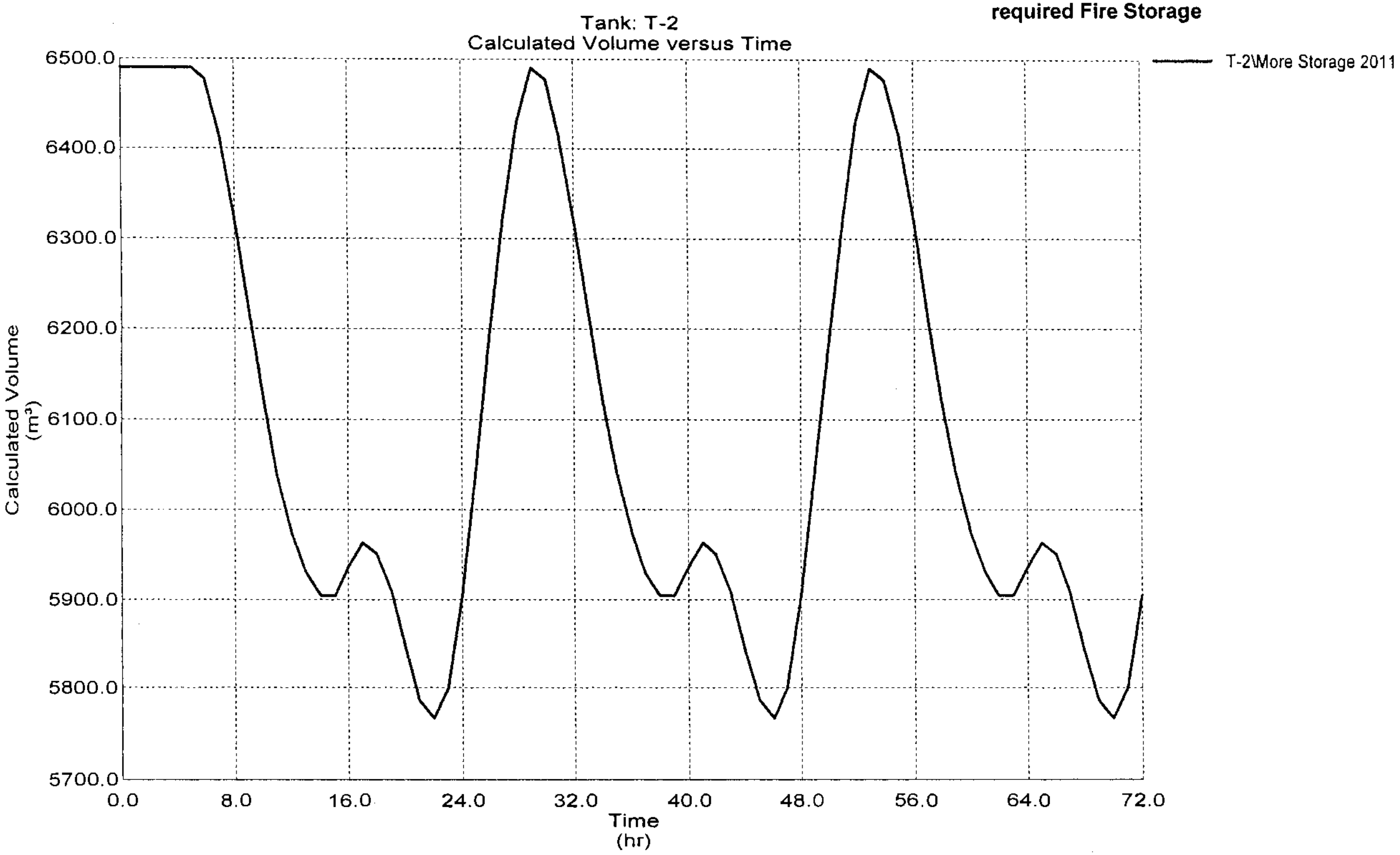
Associated Engineering

Project Engineer: Kai Ch'ng
WaterCAD v5.0 [5.0037]

Graph

TOWN OF BLACKFALDS
YEAR 2011 STORAGE
(Increased to 6492 m^3 as recommended

Does not use the 2376 m^3
required Fire Storage



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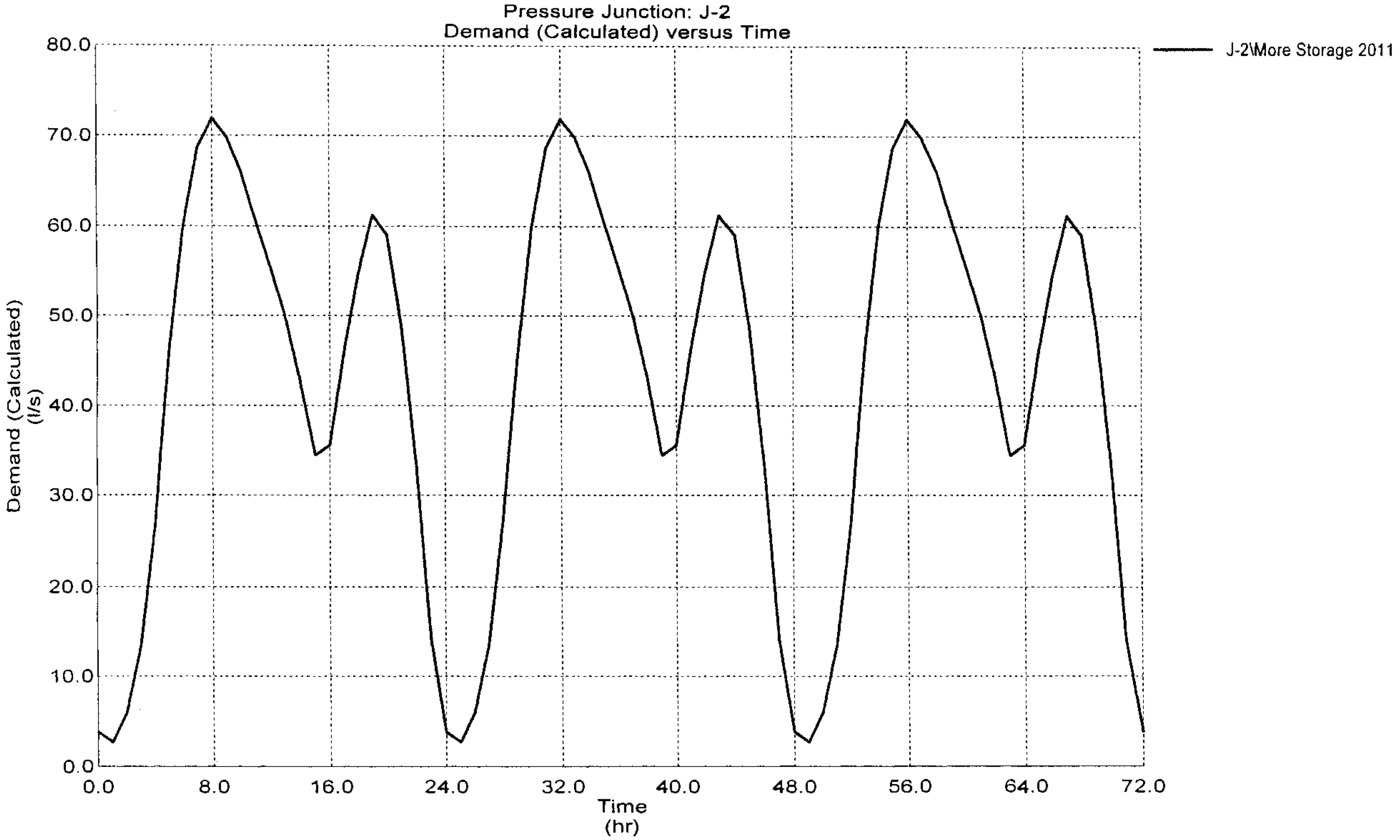
Graph

TOWN OF BLACKFALDS
YEAR 2011 STORAGE
(Increased to 6492 m^3 as recommended

Demand Pattern



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Associated Engineering

Project Engineer: Kai Ch'ng
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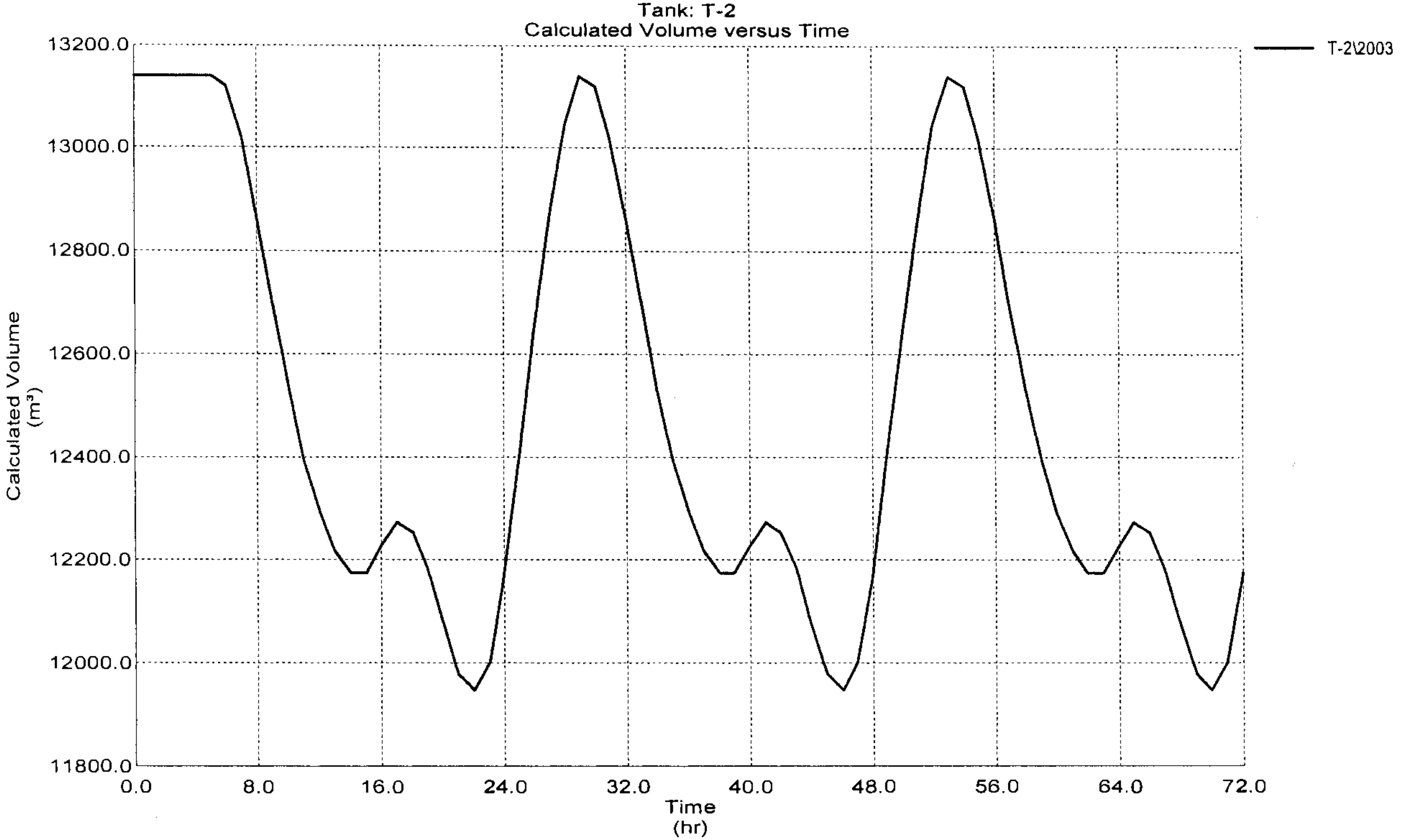
TOWN OF LACOMBE
YEAR 2003 EXISTING STORAGE 13,140 m^3

Graph

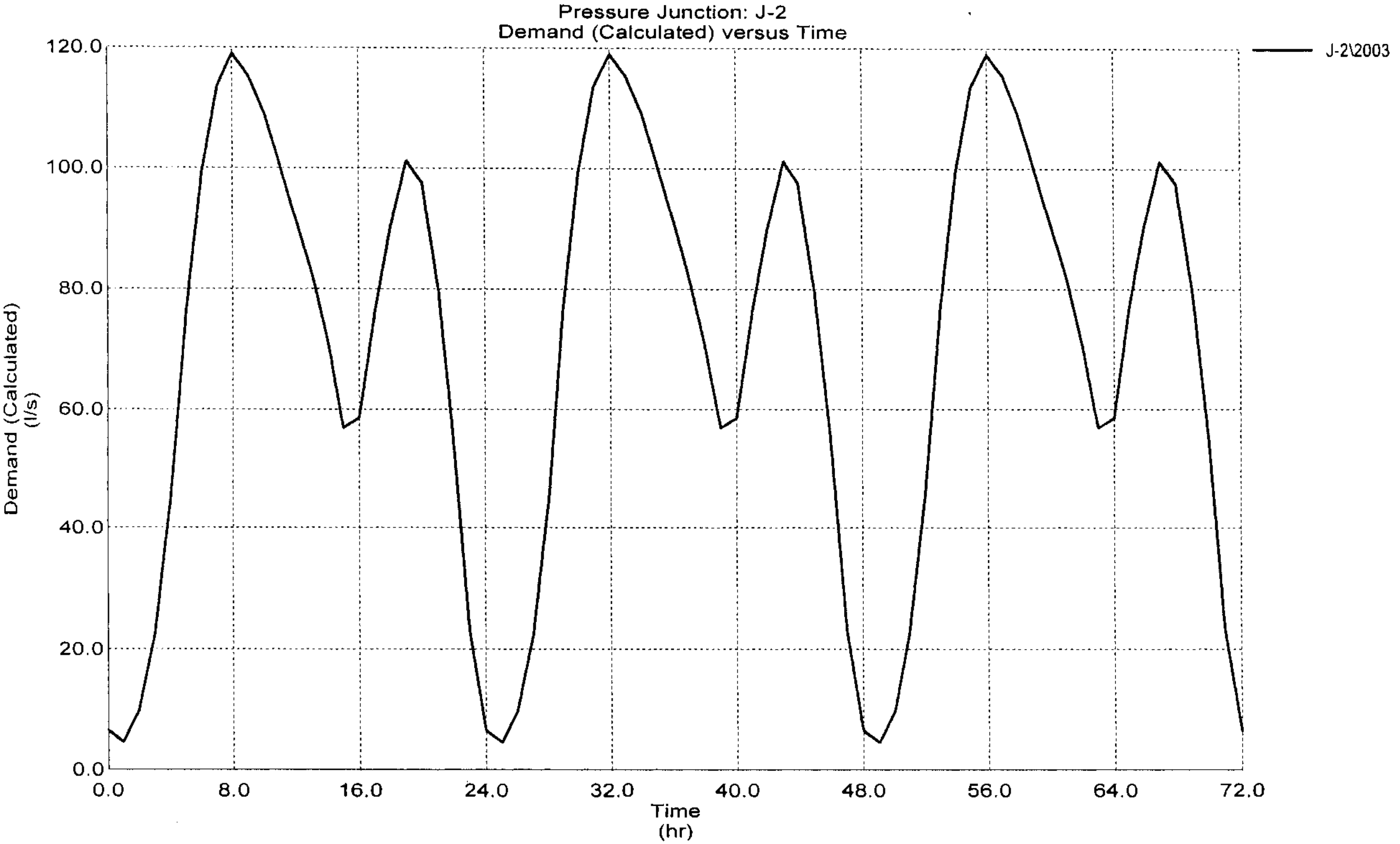
Does not use the 2376 m^3
required Fire Storage



Graph

TOWN OF LACOMBE
YEAR 2003 EXISTING STORAGE

Demand Pattern



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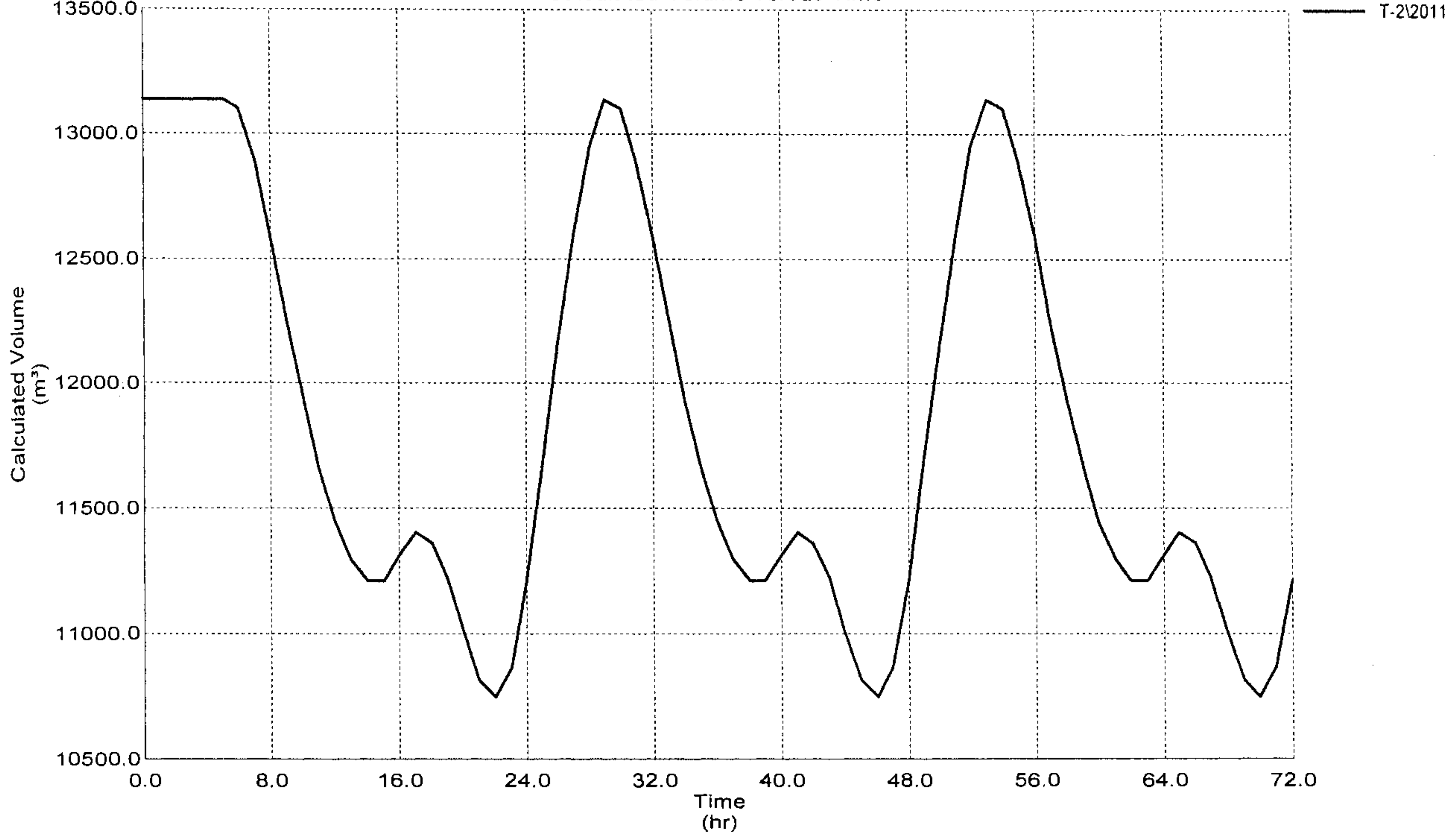
TOWN OF LACOMBE
YEAR 2011 EXISTING STORAGE 13,140 m^3
(Short of required Storage)

Does not use the 2376 m^3
required Fire Storage

Graph

Tank: T-2
Calculated Volume versus Time



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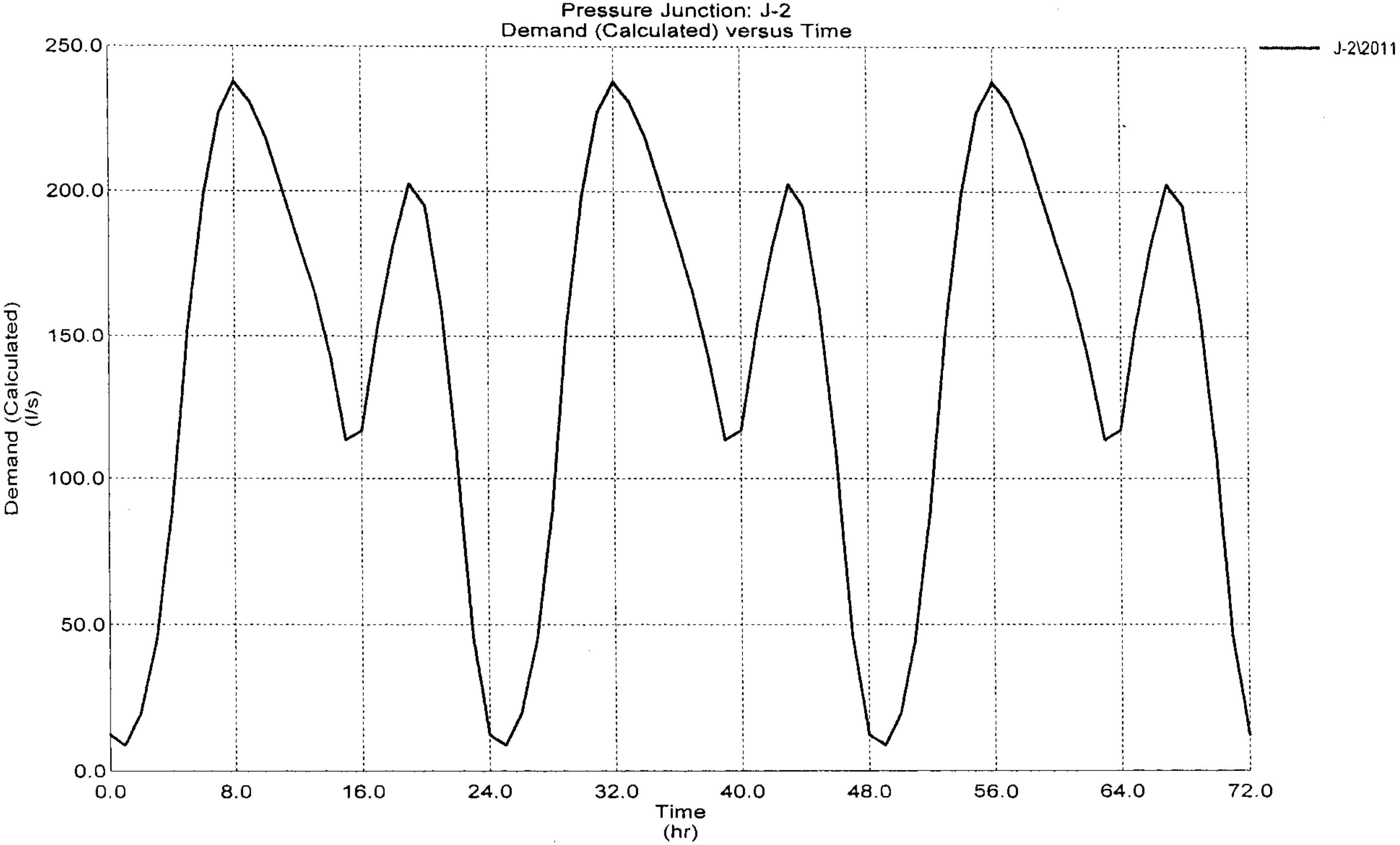
WaterCAD v5.0 [5.0037]
Page 1 of 1

Graph

TOWN OF LACOMBE
YEAR 2011 EXISTING STORAGE

Demand Pattern



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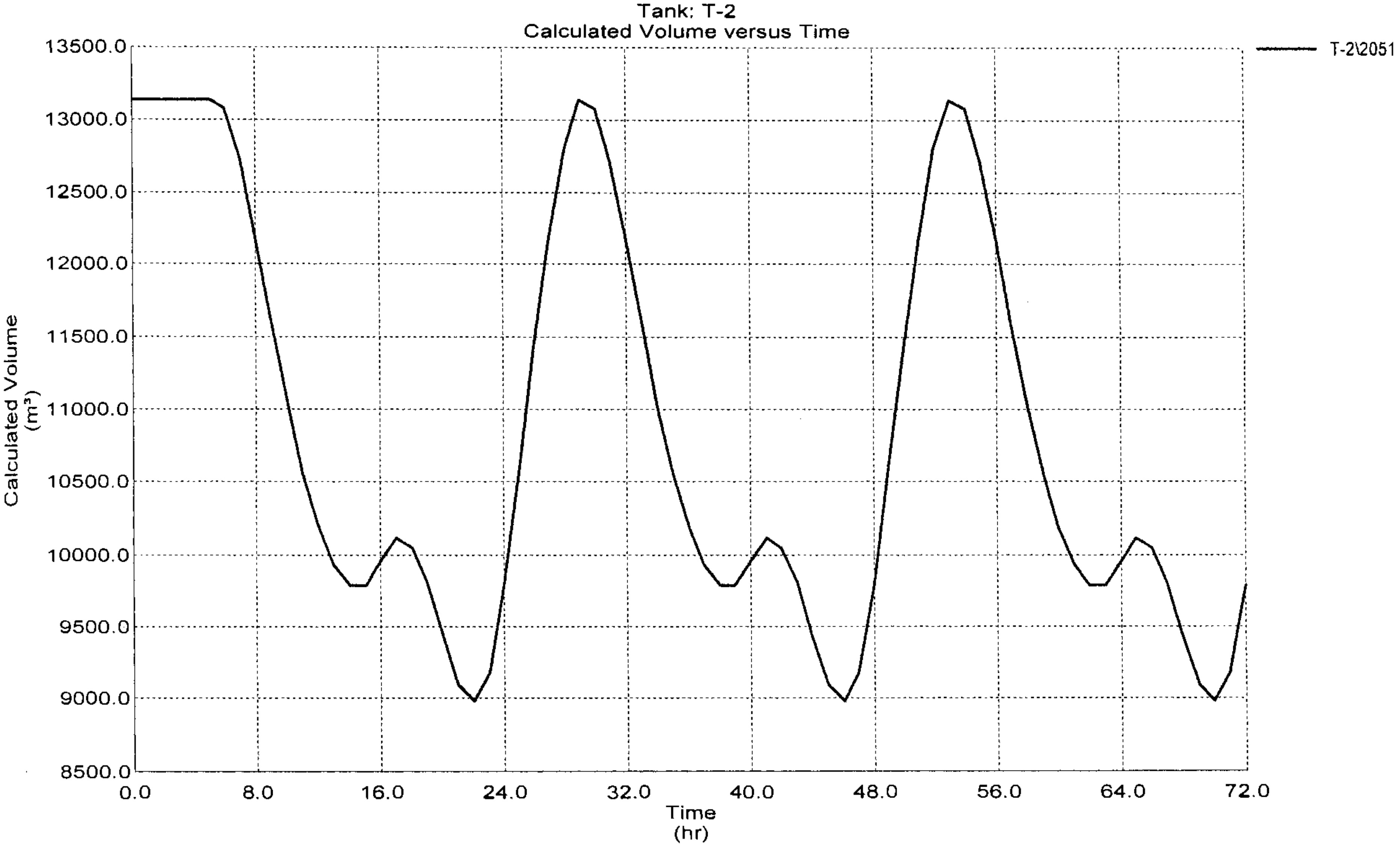
Graph

TOWN OF LACOMBE
YEAR 2051 EXISTING STORAGE 13,140 m^3
(Short of required Storage)

Does not use the 2376 m^3
required Fire Storage



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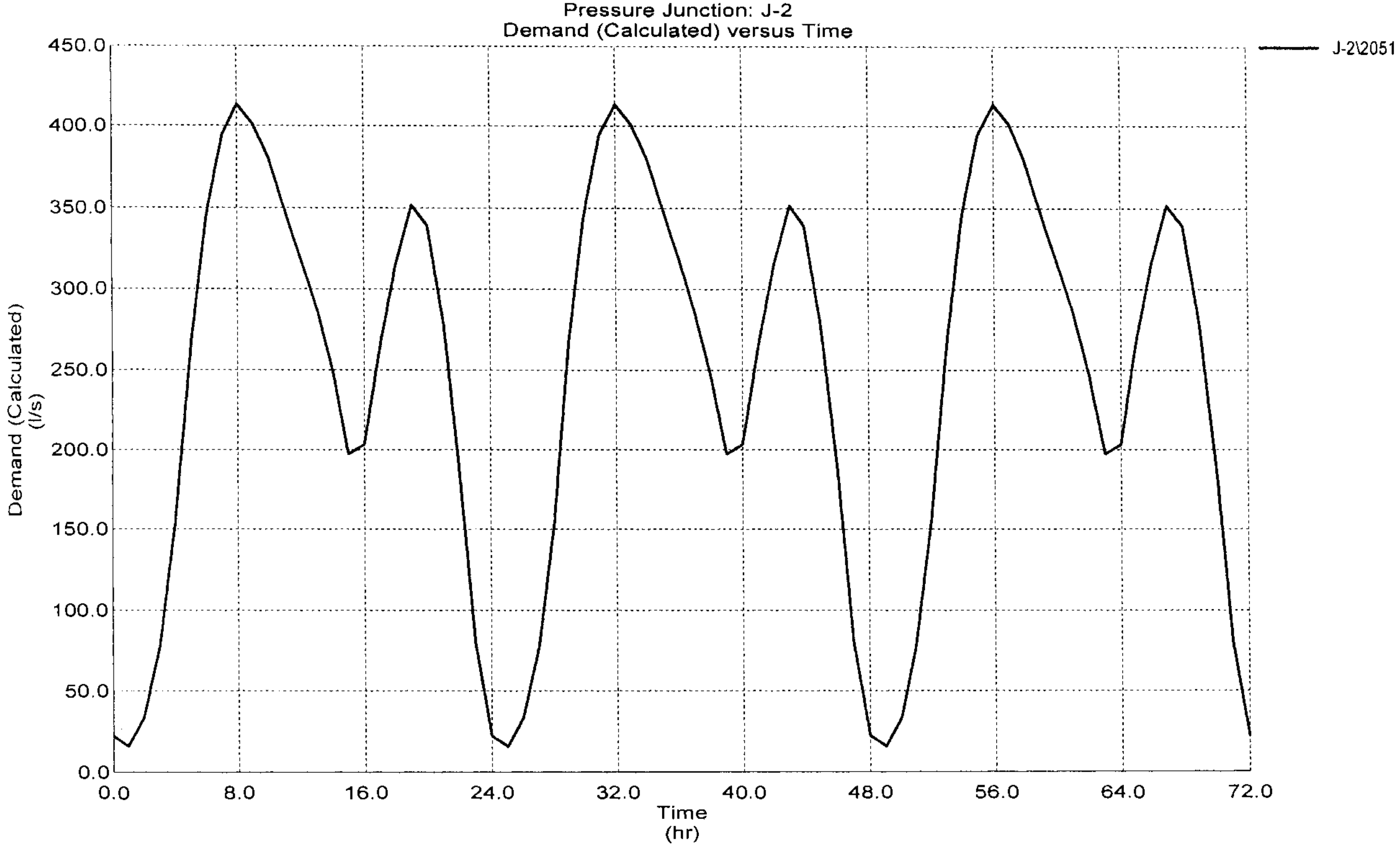
Associated Engineering

Project Engineer: Kai Ch'ng
WaterCAD v5.0 [5.0037]

Graph

TOWN OF LACOMBE
YEAR 2051 EXISTING STORAGE

Demand Pattern



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05/06/03 06:50:03 PM

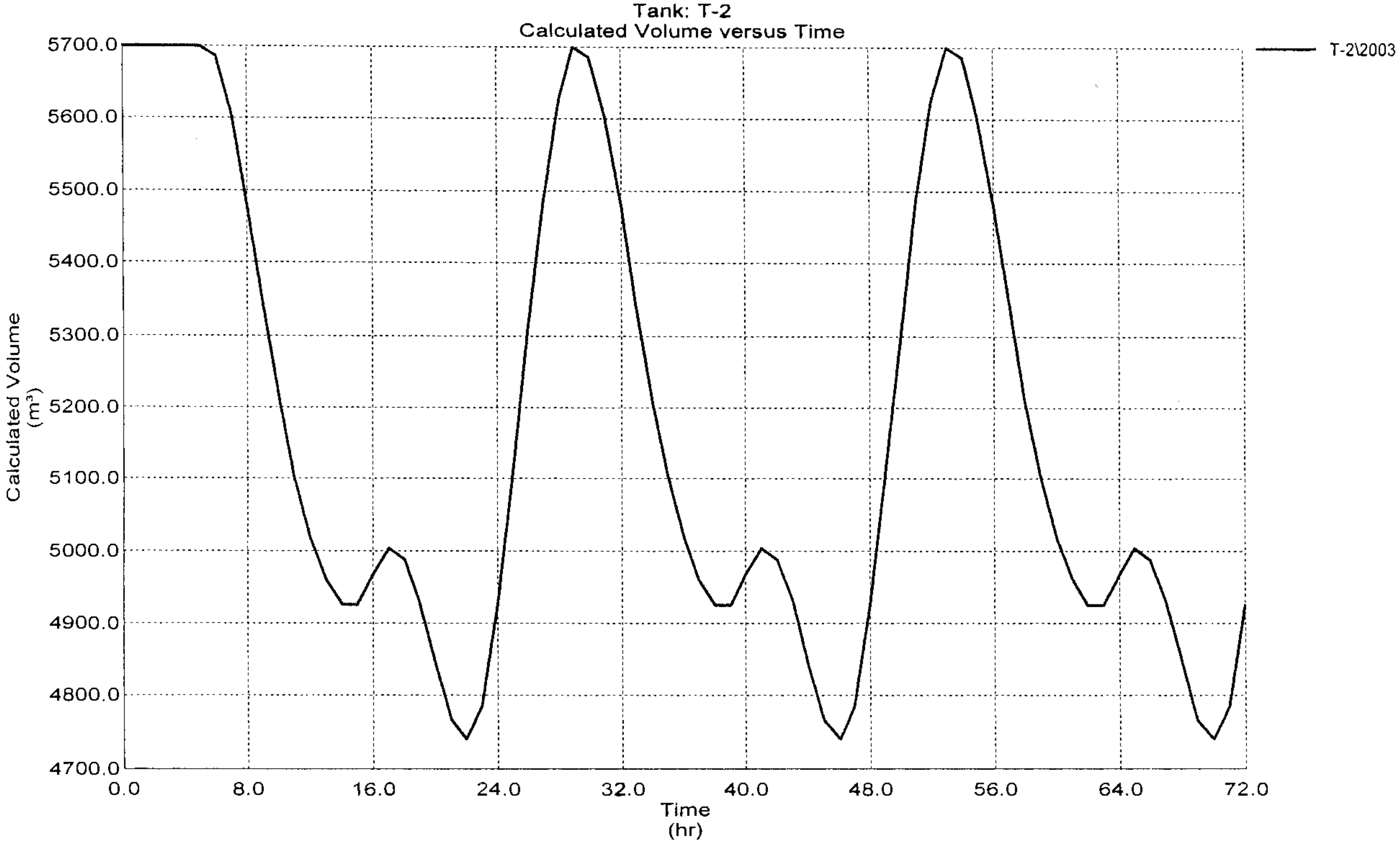
Associated Engineering

Project Engineer: Kai Ch'ng
WaterCAD v5.0 [5.0037]

Graph

TOWN OF PONOKA
YEAR 2003 EXISTING STORAGE 5,690 m^3
(Short of required Storage)

Does not use the 2376 m^3
required Fire Storage



Title: North Red Deer River Water Transmission Pipeline
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05/06/03 06:54:41 PM

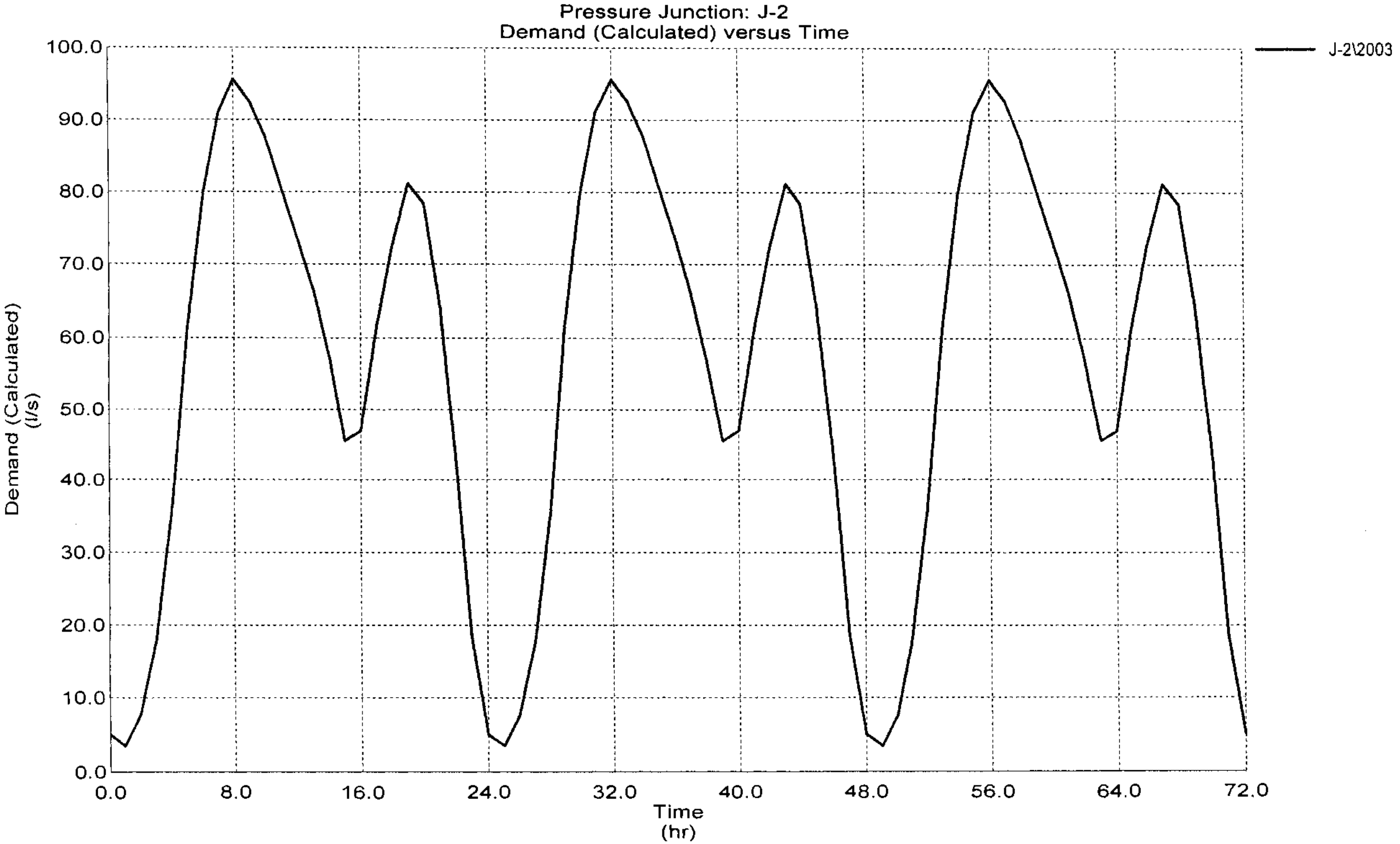
Associated Engineering

Project Engineer: Kai Ch'ng
WaterCAD v5.0 [5.0037]

Graph

TOWN OF PONOKA
YEAR 2003 EXISTING STORAGE

Demand Pattern



Title: North Red Deer River Water Transmission Pipeline
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05/06/03 06:54:51 PM

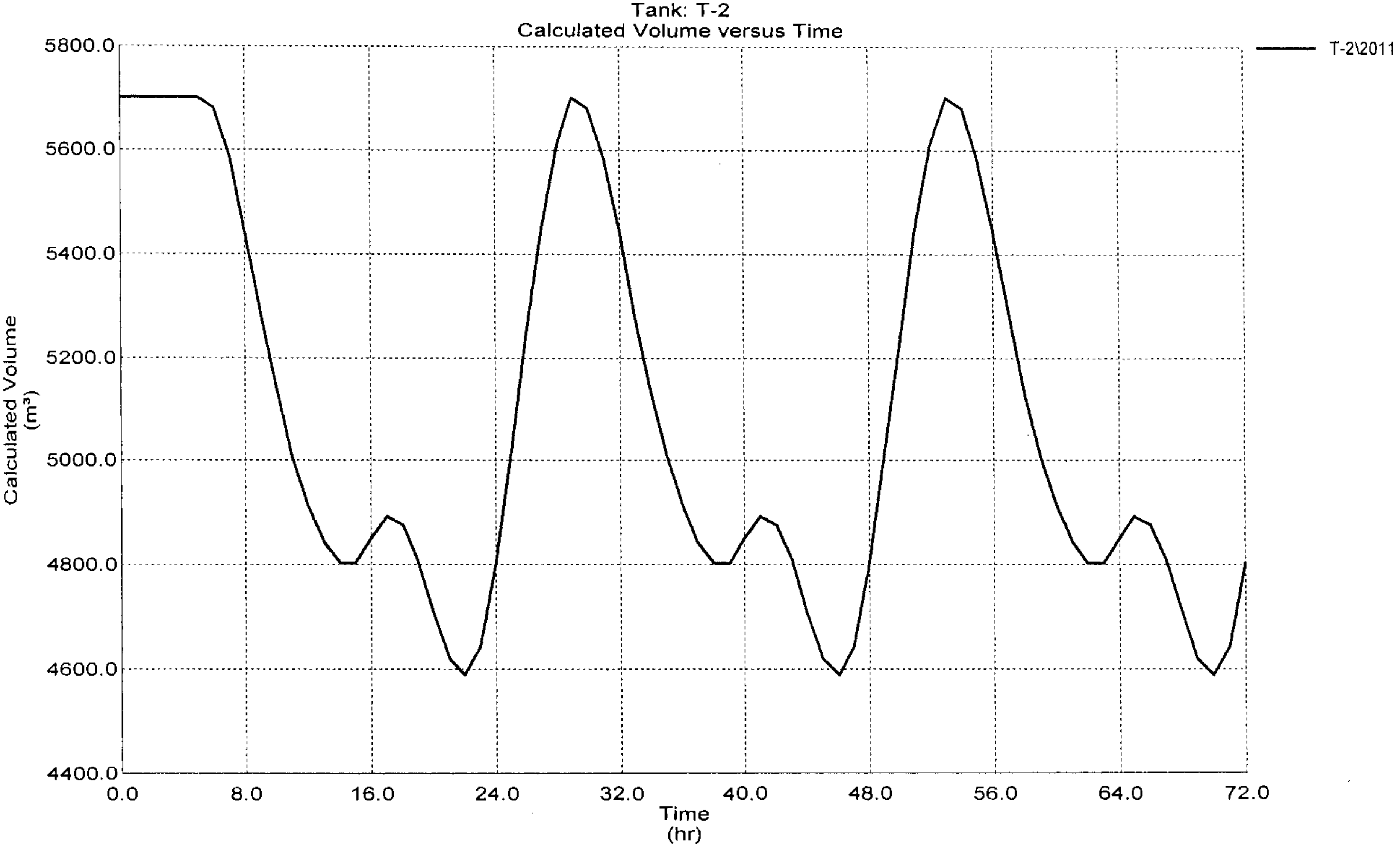
Associated Engineering

Project Engineer: Kai Ch'ng
WaterCAD v5.0 [5.0037]

Graph

TOWN OF PONOKA
YEAR 2011 EXISTING STORAGE 5,690 m³
(Short of required Storage)

Does not use the 2376 m³
required Fire Storage



Title: North Red Deer River Water Transmission Pipeline
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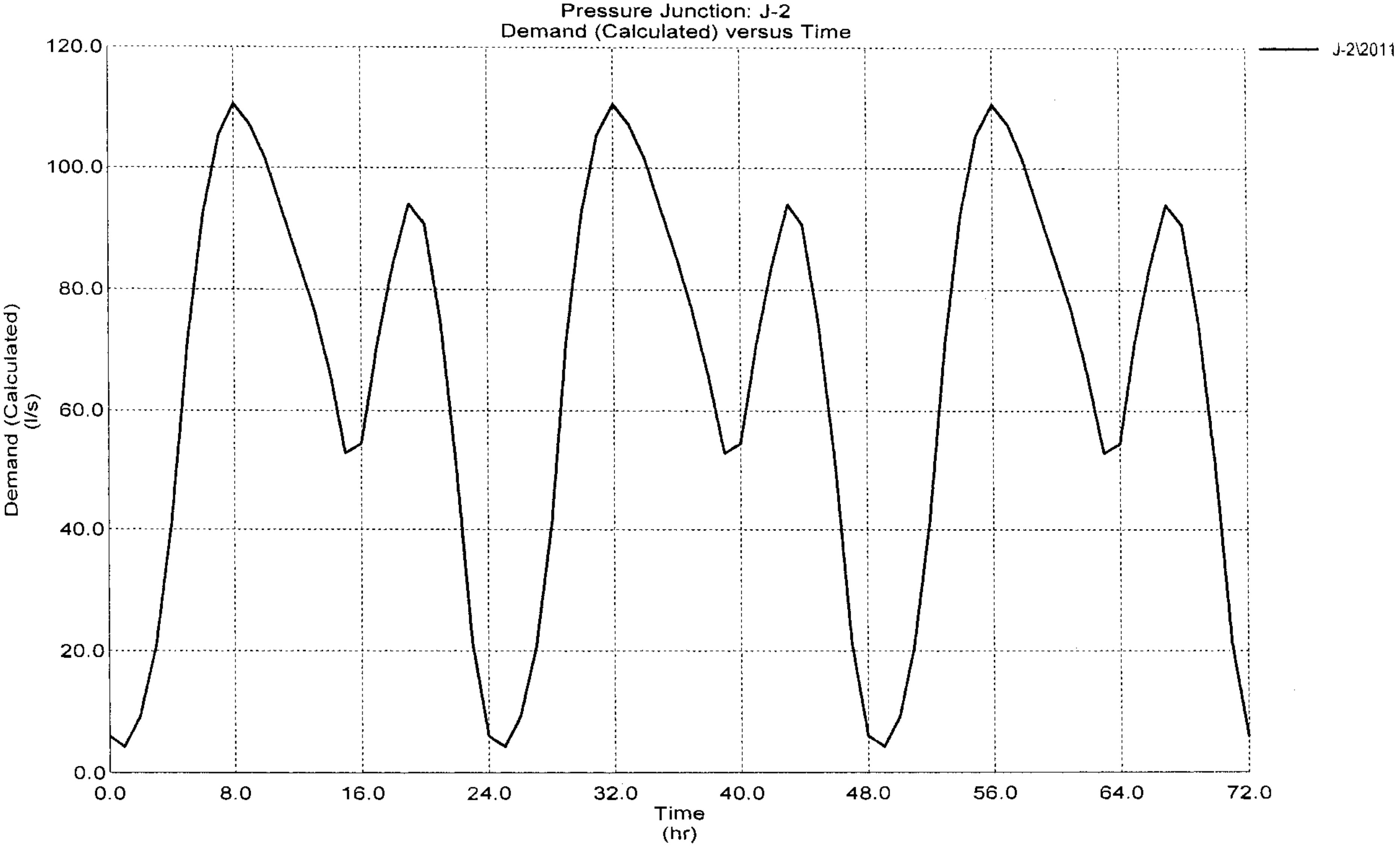
Project Engineer: Kai Ch'ng
WaterCAD v5.0 [5.0037]

TOWN OF PONOKA
YEAR 2011 EXISTING STORAGE

Graph

Demand Pattern



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05/06/03 06:57:19 PM

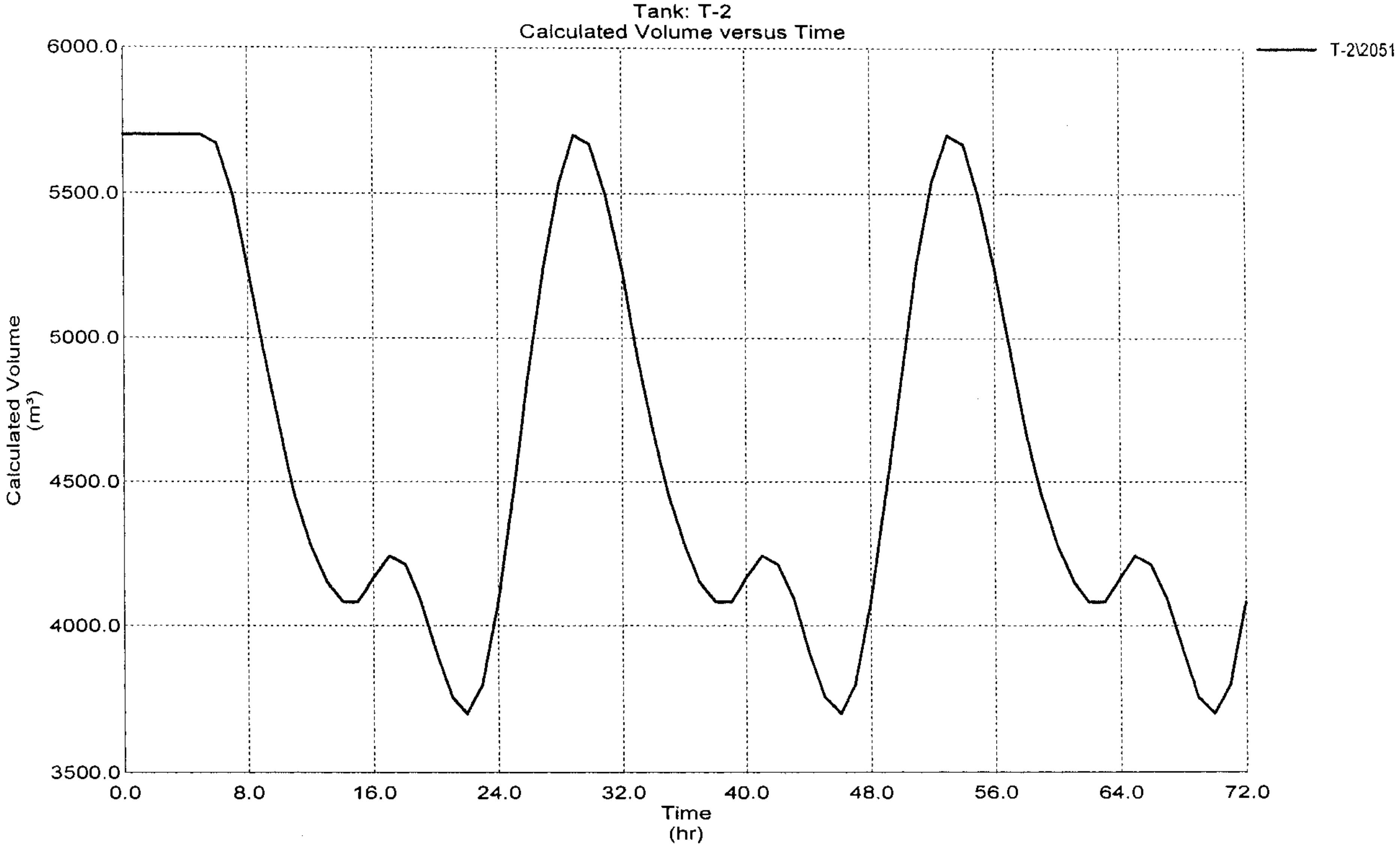
Associated Engineering

Project Engineer: Kai Ch'ng
WaterCAD v5.0 [5.0037]

TOWN OF PONOKA
YEAR 2051 EXISTING STORAGE 5,690 m^3
(Short of required Storage)

Does not use the 2376 m^3
required Fire Storage

Graph



Title: North Red Deer River Water Transmission Pipeline
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05/06/03 06:57:55 PM

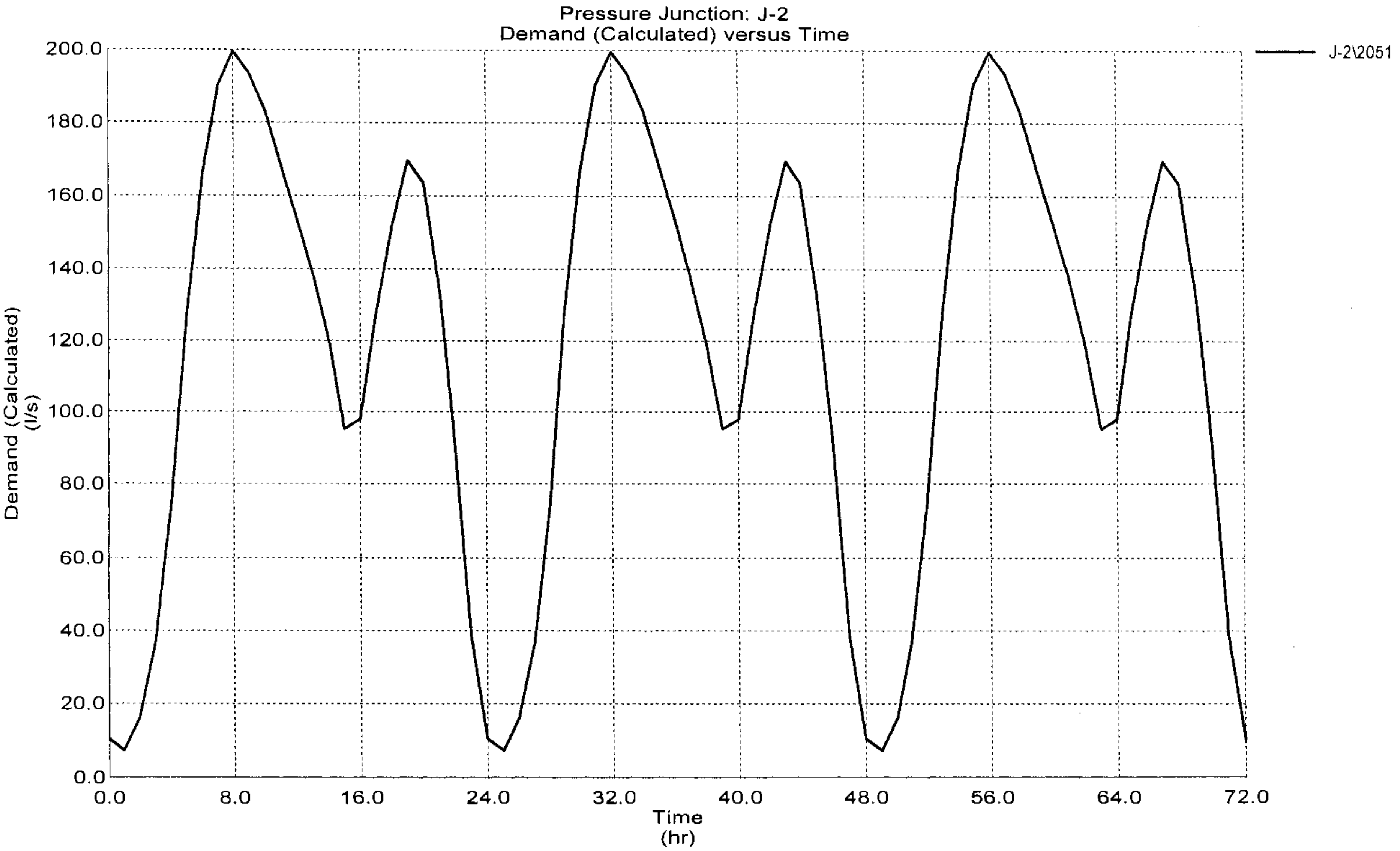
Associated Engineering

Project Engineer: Kai Ch'ng
WaterCAD v5.0 [5.0037]

Graph

TOWN OF PONOKA
YEAR 2051 EXISTING STORAGE

Demand Pattern



Title: North Red Deer River Water Transmission Pipeline
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05/06/03 06:58:10 PM

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