MPE Engineering Ltd.

Final Report for:

TOWN OF COALHURST

STORM WATER MANAGEMENT PLAN

Date: June 19, 2017
Project #: 1450-051

Proud of Our Past… Building the Future

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MPE Engineering Ltd.

Town of Coalhurst
P.O. Box 456
100 – 51st Avenue
Coalhurst, AB T0L 0V0

June 19, 2017
File: 14\50\051\R04

Attention: Mr. R. Kim Hauta
Chief Administrative Officer

Dear Kim:

Re: Town of Coalhurst
Storm Water Management Plan

We are pleased to submit the final copy of the above noted report. We thank you for the opportunity to be of service and to have prepared this report on your behalf. We look forward to assisting you in implementing the recommendations within this report.

If you have any inquiries regarding our report or if clarification is required, please contact the undersigned.

Yours truly,

MPE ENGINEERING LTD.

Matt Harker, P.Eng.
Project Manager

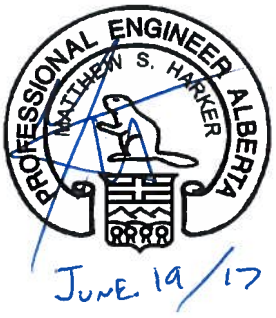
:mh
Enclosure

CORPORATE AUTHORIZATION

This report has been prepared by MPE Engineering Ltd. under authorization of the Town of Coalhurst. The material in this report represents the best judgment of MPE Engineering Ltd. given the available information. Any use that a third party makes of this report, or reliance on or decisions made based upon it is the responsibility of the third party. MPE Engineering Ltd. accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions taken based upon this report.

MPE ENGINEERING LTD.

Prepared by:



Project Manager

PERMIT TO PRACTICE
MPE ENGINEERING LTD.
PERMIT NUMBER: P 3680
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

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1.0 INTRODUCTION

1.1 Evaluation Background

The Town of Coalhurst retained MPE Engineering Ltd. to complete a study of the Town's storm water management system. The objective of the study was to evaluate the existing storm water infrastructure and overland flow paths, with a view to identifying deficiencies and developing plans for any required upgrades. Figure 1.1 is a location plan showing the Town of Coalhurst in relation to other communities in southern Alberta. Figure 1.2 illustrates the study area included in the storm water evaluation.

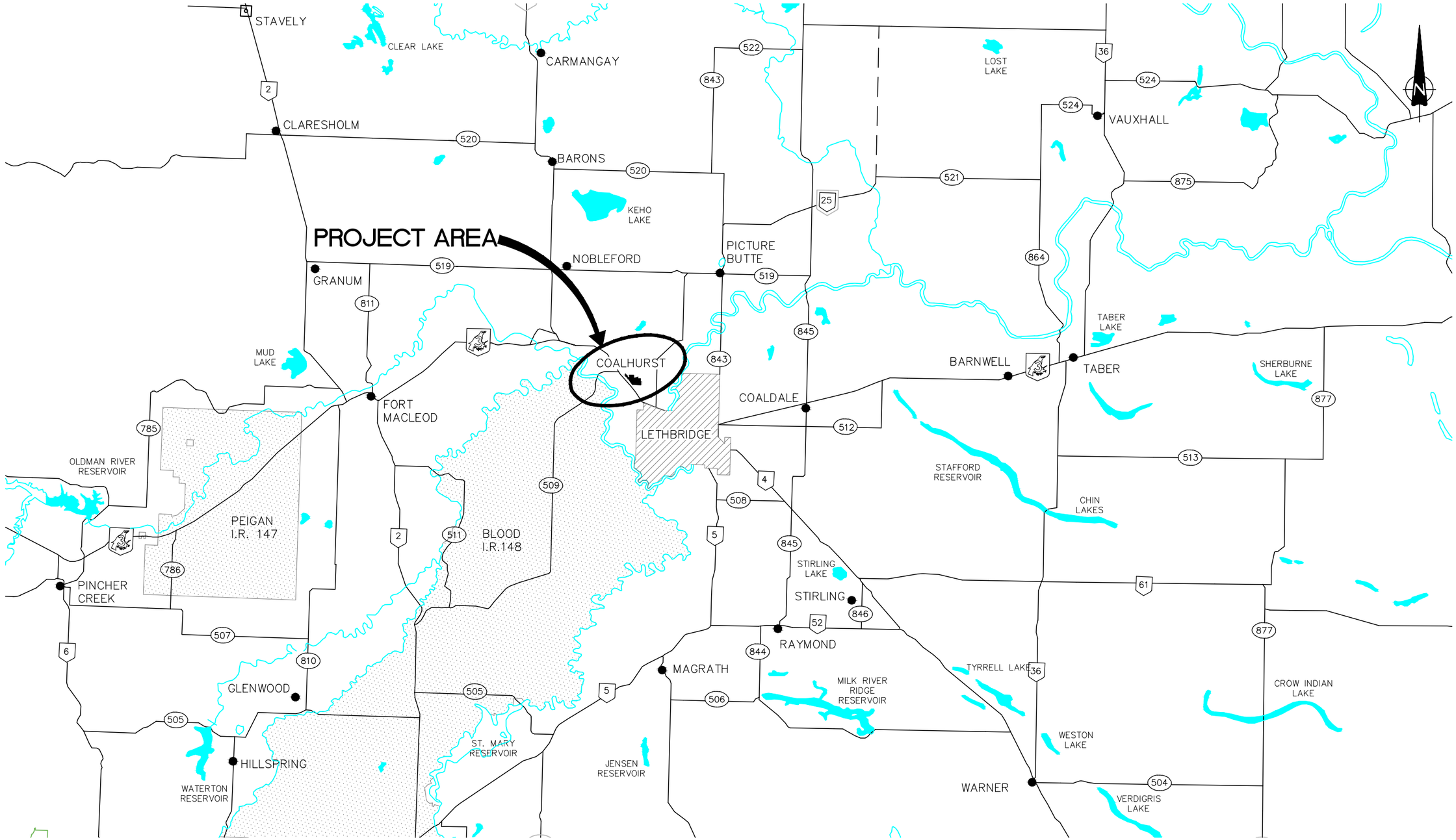
1.2 Scope of Work

In general, the tasks included in this study are the following:

- Review available information on the storm water drainage system, including catchment areas and storm water management facilities (SWMF's).
- Develop a computer model of the existing storm water drainage system.
- Develop an overall master drainage plan for the Town of Coalhurst which aims at addressing and minimizing the current drainage problems.
- Prepare cost estimates for proposed storm water management improvements.

1.3 Site Investigations

As an integral part of this study, a number of site visits were undertaken by MPE personnel. These site visits were conducted to become familiar with the Town, its existing storm water infrastructure and to identify issues requiring review and analysis. Topographic surveys were undertaken of key infrastructure components relative to storm water management by the Town to determine storm water runoff drainage patterns.

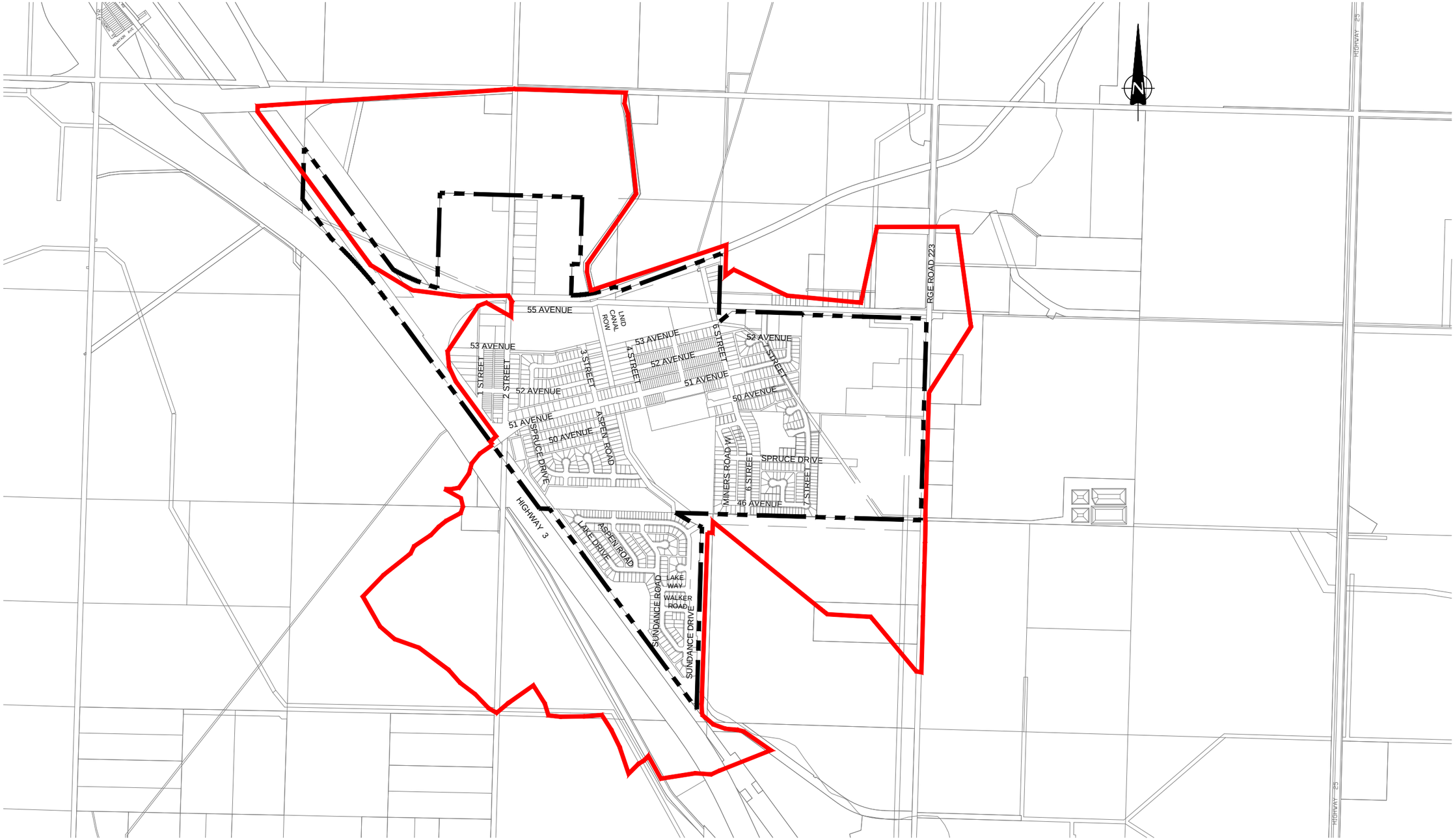


Engineering Ltd.

TOWN OF COALHURST

STORM WATER MANAGEMENT PLAN
LOCATION PLAN

SCALE: 1:500 000	DATE: JUNE 2017	JOB: 1450-051-00	FIGURE: 1.1



LEGEND

TOWN BOUNDARY

STUDY AREA BOUNDARY

MPE Engineering Ltd.

TOWN OF COALHURST

STORM WATER MANAGEMENT PLAN
STUDY AREA

SCALE: 1:15 000	DATE: JUNE 2017	JOB: 1450-051-00	FIGURE: 1.2

2.0 STORM WATER MANAGEMENT

2.1 Location

The Town is located approximately 10 kilometers west of the City of Lethbridge on Highway No. 3 and the CP Rail Tracks. This study focuses on the drainage within the Town limits and the immediate surrounding areas.

2.2 Background

Storm water drainage has been a concern in Coalhurst over the years due to a number of factors. In the past the Town has been subjected to a number of severe storm events which have caused wide spread surface flooding within the Town. Storm water management was addressed in the Infrastructure Master Plan (MPE, 2006). This plan provides an update to that report and offers some additional direction on implementing a storm water management system.

The analysis of the study area included conducting surveys and field observations of the storm water systems and drainage patterns, as well as developing a computer model to determine pre-development and post-development runoff and storm water storage requirements. The survey data and contour map provided by the Town were used to determine existing overland flow paths included in the study area. Discussions with the Town of Coalhurst personnel also helped to determine problem areas, such as those that experience recurring ponding or flooding.

2.3 Storm Water System

2.3.1 Major (Overland) Drainage

Much of Coalhurst is reliant on overland drainage to remove storm water runoff. The overland drainage or major drainage system typically relies on surface drainage along curb and gutters, swales, ditches, and culverts. As its name implies, the major drainage system is designed to carry runoff from larger less frequent storms. Typically major systems are designed for the 1:100 year storm event.

The Town has one outfall line located along 45th Avenue that drains the storm water runoff east to the Oldman River. The first 700 m of the outfall line is 400 mm diameter PVC pipe. The next 1,600 m is 300 mm diameter Series 100 PVC pipe that is rated for 100 psi pressure operation. The final 250 m section

of pipe is 200 mm HDPE from the top of riverbank down to the outlet structure into the river. This outfall line currently operates under gravity flow with a capacity of 52.5 l/s.

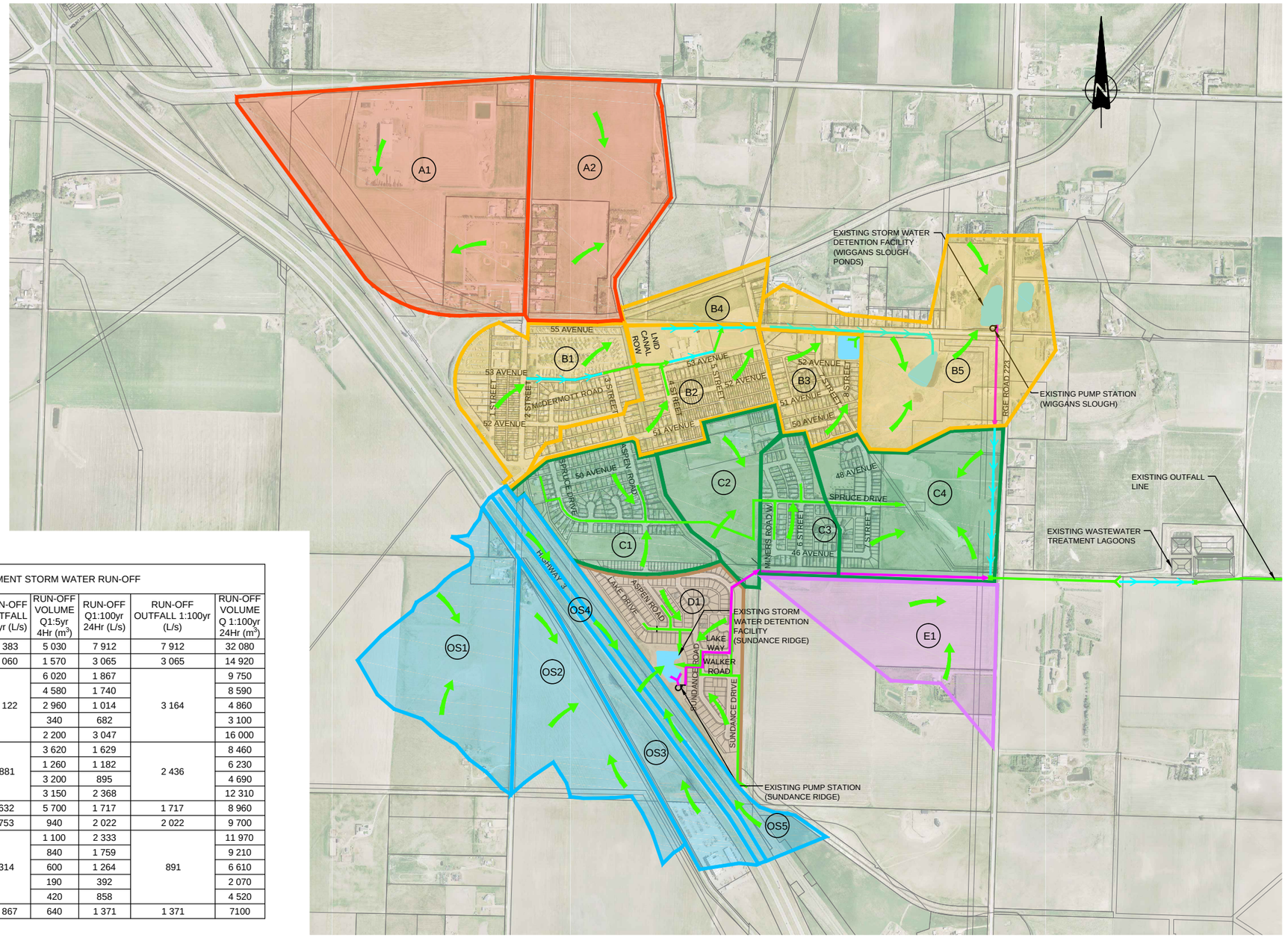
The existing drainage patterns and facilities are illustrated in Figure 2.1. The study area is divided into eighteen catchment areas.

Catchments A1 and A2 are located in the northwest section of the study area. Although these areas are largely undeveloped, catchment A1 includes a large recreational area and catchment A2 includes a small section of residential development. Storm water runoff drains by overland flow to the respective low areas in each of the catchments.

Catchments B1, B2, and B3 are developed areas that include the industrial area and the north portion of the existing residential area. Storm water runoff for these areas is largely overland flow by way of the curb and gutter system. Catchments B4 and B5 are largely undeveloped with a small portion of country residential located along 55th Avenue. Storm water runoff for these areas flow by overland drainage. The runoff for all five of these catchments moves east eventually draining to the Wiggins Slough located within catchment B5.

Catchments C1, C3, and C4 are largely made up of residential developments although the east portion of catchment C4 remains undeveloped. The school is located within catchment C2 with the rest of the catchment remaining undeveloped. These catchments are bounded by 50th Avenue on the north, the town boundary on the east, 45th Avenue on the south and Highway 3 on the west. In the developed areas the storm water runoff flows by way of the curb and gutter system while the undeveloped locations rely on the natural topography to convey the storm water east. In catchment C1 any storm water that is not intercepted by the minor underground system flows into the canal that borders the east side of the catchment. The runoff for the remaining catchments flows east eventually ponding in the natural low area found near the center of catchment C4.

Catchment area D1 is confined to the Sundance residential development. Storm water runoff flows via the curb and gutter system and minor underground system to the SWMF at the west side of the catchment area. The storm water from this pond is pumped to the outfall line on the east side of the Town.



PRE-DEVELOPMENT STORM WATER RUN-OFF

CATCHMENT AREA	AREA (ha)	RUN-OFF Q1:5yr 4Hr (L/s)	RUN-OFF OUTFALL 1:5yr (L/s)	RUN-OFF VOLUME Q1:5yr 4Hr (m^3)	RUN-OFF Q1:100yr 24Hr (L/s)	RUN-OFF OUTFALL 1:100yr (L/s)	RUN-OFF VOLUME Q 1:100yr 24Hr (m^3)
A	55.96	2 383	2 383	5 030	7 912	7 912	32 080
A2	33.09	1 060	1 060	1 570	3 065	3 065	14 920
B1	22.18	687	1 122	6 020	1 867	3 164	9 750
B2	18.64	636		4 580	1 740		8 590
B3	10.44	360		2 960	1 014		4 860
B4	6.59	241		340	682		3 100
B5	36.78	1 112		2 200	3 047		16 000
C1	19.10	603	881	3 620	1 629	2 436	8 460
C2	14.39	429		1 260	1 182		6 230
C3	10.73	328		3 200	895		4 690
C4	27.85	876		3 150	2 368		12 310
D1	20.40	632	632	5 700	1 717	1 717	8 960
E1	21.11	753	753	940	2 022	2 022	9 700
OS1	26.63	912	314	1 100	2 333	891	11 970
OS2	21.08	644		840	1 759		9 210
OS3	15.08	464		600	1 264		6 610
OS4	4.81	141		190	392		2 070
OS5	10.44	311		420	858		4 520
POND	15.95	509	1 867	640	1 371	1 371	7100

LEGEND

- EXISTING GRAVITY STORM SEWER
- EXISTING STORM SEWER FORCEMAIN
- EXISTING DRAINAGE SWALE
- DRAINAGE FLOW ARROWS
- EXISTING STORM WATER MANAGEMENT FACILITY
- A1 CATCHMENT AREA LABEL

MPE Engineering Ltd.

TOWN OF COALHURST

STORM WATER MANAGEMENT PLAN
EXISTING DRAINAGE

SCALE: 1:15 000	DATE: JUNE 2017	JOB: 1450-051-00	FIGURE: 2.1

Catchment area E1 is an undeveloped area found on the south side of 45th Avenue. This catchment relies on overland drainage to convey the storm water runoff northeast.

Catchment areas OS1, OS2, OS3, OS4, and OS5 are the offsite areas west of Coalhurst that flow into catchment D1. The area consists of Canadian Pacific Railway, Alberta Transportation, and Lethbridge County lands that are largely agricultural with some commercial development. This catchment relies on overland drainage to convey drainage east into Coalhurst.

2.3.2 Minor (Underground) Drainage

The existing underground storm water collection system can be split into three main sections:

- The north portion of the system extends through Catchment B. This system consists of a series of underground pipes and swales that direct the runoff to the natural low area found in catchment B5. During periods that the levels of the natural pond are high the Town currently pumps the water to the Wiggins slough. An existing pump station located at the Wiggins slough has a capacity of 40 l/s and pumps the storm water to a ditch along Range Road 223. The ditch outlets to the main storm water outfall line at 45th Avenue. The total volume of storage available in the natural pond and Wiggins slough is unknown.

- The center portion of the system extends through catchment C. This system of underground pipes collects the storm water runoff which flows east to the natural low area found in catchment C4.

- The south portion of the underground system is found within the Sundance residential subdivision. Runoff is collected through a series of catch basins and pipes which then flows to the Sundance SWMF that has a storage capacity of 20,300 m^3. There is a pump station with a capacity of 70 l/s that pumps the storm water to the main outfall line on 45th Avenue.

2.4 Storm Water Conveyance Analysis

2.4.1 Definitions

Pre-development in this document refers to the set of hydrologic conditions that existed before any development in the Town of Coalhurst had occurred.

Post-development in this document refers to the set of hydrologic conditions that reasonably may be expected or anticipated to exist after completion of future developments throughout the Town of Coalhurst.

2.4.2 Storm Water Management Principles

The general principle for storm water management is that runoff from a developed area cannot exceed the runoff that occurred prior to development. The post development 1:5 year runoff rate cannot exceed the pre-development 1:5 year runoff rate. Any runoff in excess of this must be stored for later release at a controlled rate at a SWMF. Storage is typically required for runoff from all storms up to the 1:100 year design storm. The SWMF provides storage of runoff water as well as the required level of treatment. The outlet from the SWMF is designed to limit the release of storm water into the downstream system or receiving watercourse to no more than the 1:5 year pre-development runoff.

2.4.3 Design Storms

The City of Lethbridge design storms were adopted for the present analysis as the weather patterns are similar to those experienced in Coalhurst. The following formula defines the intensity-duration-frequency (IDF) curves for various storms, with the coefficients varying according to the return period (frequency), the storm intensity, and the storm duration. Rainfall intensity is calculated as:

$$i = \frac{a}{(t+b)^c}$$

Where:

i is the rainfall intensity (mm/hour).

t is time (minutes).

a, b and ***c*** are the constants for the respective design storm return period.

The design storms used in this analysis are the 4-hour 1:5 year storm and the 24-hour 1:100 year storm. The coefficients for the City of Lethbridge design storms which were used in this study are presented in Table 2.1.

Table 2.1 – IDF Equation Coefficients

Return Period	*a*	*b*	*c*
1 in 5 Year	440.69	0	0.696
1 in 100 Year	1019.20	0	0.731

The 4-hour, 1:5 year design storm for the City of Lethbridge produces approximately 39 mm of precipitation. The 24 hour, 1:100 year design storm produces approximately 120 mm of precipitation.

2.4.4 Computer Modeling

A storm water analysis of the Town was undertaken using the hydrologic modeling program PCSWMM. The model was used to aid in determination of runoff volumes, peak flow rates, and to size SWMF's for conveyance and storage of runoff.

The following modeling parameters and assumptions were incorporated into the analysis:

1. Specific modeling parameters used for the existing conditions can be found in Appendix A.
2. For pre-development conditions all catchments were assumed to be undeveloped.
3. Existing development conditions were reviewed from site visits, recent air photos, and relevant documents.
4. To generate peak flows and storm water runoff volumes, a Chicago storm was used in the analysis with a peak skew of 0.33.
5. All runoff is assumed to be stored within the Town by a SWMF, and then released at pre-development release rates to the main outfall line.
6. Capacities of the existing drainage channels and culverts were assumed to be physical limitations to the drainage system.

The peak flow rates calculated from the hydrologic modeling for the existing scenario are presented in Table 2.2.

Table 2.2 – Storm Water Run Off (Existing)					
Catchment Area	Area (Ha)	Run-Off Q 1:5yr 4Hr (l/s)	Run-Off Volume 1:5yr 4Hr (m^3)	Run-Off Q 1:100yr 24Hr (l/s)	Run-Off Volume 1:100yr 24Hr (m^3)
A1	55.96	2,383	5,030	7,912	32,080
A2	33.09	1,060	1,570	3,065	14,920
B1	22.18	2,105	6,020	7,834	22,540
B2	18.64	2,538	4,580	8,231	18,030
B3	10.44	1,718	2,960	5,564	10,860
B4	6.59	241	340	682	3,100
B5	36.78	1,497	2,200	4,314	18,310
C1	19.10	1,642	3,620	5,583	16,240
C2	14.39	731	1,260	2,259	8,380
C3	10.73	1,062	3,200	3,899	11,410
C4	27.85	1,816	3,150	5,627	18,260
D1	20.40	1,977	5,700	7,347	21,040
E1	21.11	753	940	2,191	9,700
OS1	26.63	912	1,100	2,333	11,970
OS2	21.08	644	840	1,759	9,210
OS3	15.08	464	600	1,264	6,610
OS4	4.81	141	190	392	2,070
OS5	10.44	311	420	858	4,520

2.5 Proposed Drainage Work

From this analysis and a review of previous studies, the overall solution to the Town's drainage problems will involve a combination of two major components. For an overview of the proposed upgrades refer to Figure 2.2:

1. **Construct a new outfall line:** The capacity of the outfall line largely determines the amount of storage required at the individual ponds. Currently, the outfall system for the entire Town relies on one main outlet with a capacity of 52.5 l/s. Due to this limited release rate, a large amount of storage is required to retain the runoff volume from storm events.

REQUIRED STORAGE POST-DEVELOPMENT		
CATCHMENT AREA	RELEASE RATE (L/s)	STORAGE VOLUME 1:100yr (m^3)
SWMF A1	0	34 000
SWMF A2	0	16 000
SWMF B2	645	16 000
SWMF B5A	0	23 000
SWMF B5B	40	--
SWMF C2A	280	4 000
SWMF C2B	150	5 300
SWMF C4	1460	40 000
SWMF D1	70	22 000
SWMF E1	750	6 000
SWMF OS3	0	30 000

POST DEVELOPMENT STORM WATER RUN-OFF							
CATCHMENT AREA	AREA (ha)	RUN-OFF Q1:5yr 4Hr (L/s)	RUN-OFF OUTFALL 1:5yr (L/s)	RUN-OFF VOLUME Q1:5yr 4Hr (m^3)	RUN-OFF Q1:100yr 24Hr (L/s)	RUN-OFF OUTFALL 1:100yr (L/s)	RUN-OFF VOLUME Q 1:100yr 24Hr (m^3)
A	55.96	2 383	2 383	5 030	7 912	7 912	32 080
A2	33.09	1 060	1 060	1 570	3 065	3 065	14 920
B1	22.18	2 105	2 881	6 020	7 834	9 993	22 540
B2	18.64	2 538		4 580	8 231		18 030
B3	10.44	1 718	3 083	2 960	5 564	10 490	10 860
B4	6.59	3 20		530	975		3 800
B5	36.78	2 750		6 530	9 537		30 030
C1	19.10	1 642	1 829	3 620	5 583	7 903	16 240
C2	14.39	1 241		3 720	4 535		14 280
C3	10.73	1 062	2 978	3 200	3 899		11 410
C4	27.85	2 705		7 110	9 809	9 809	27 440
D1	20.40	1 977	1 977	5 700	7 347	7 347	21 040
E1	21.11	1 858	1 858	3 310	5 845	5 845	16 250
OS1	26.63	912	314	1 100	2 333	891	11 970
OS2	21.08	644		840	1 759		9 210
OS3	15.08	464		600	1 264		6 610
OS4	4.81	141		190	392		2 070
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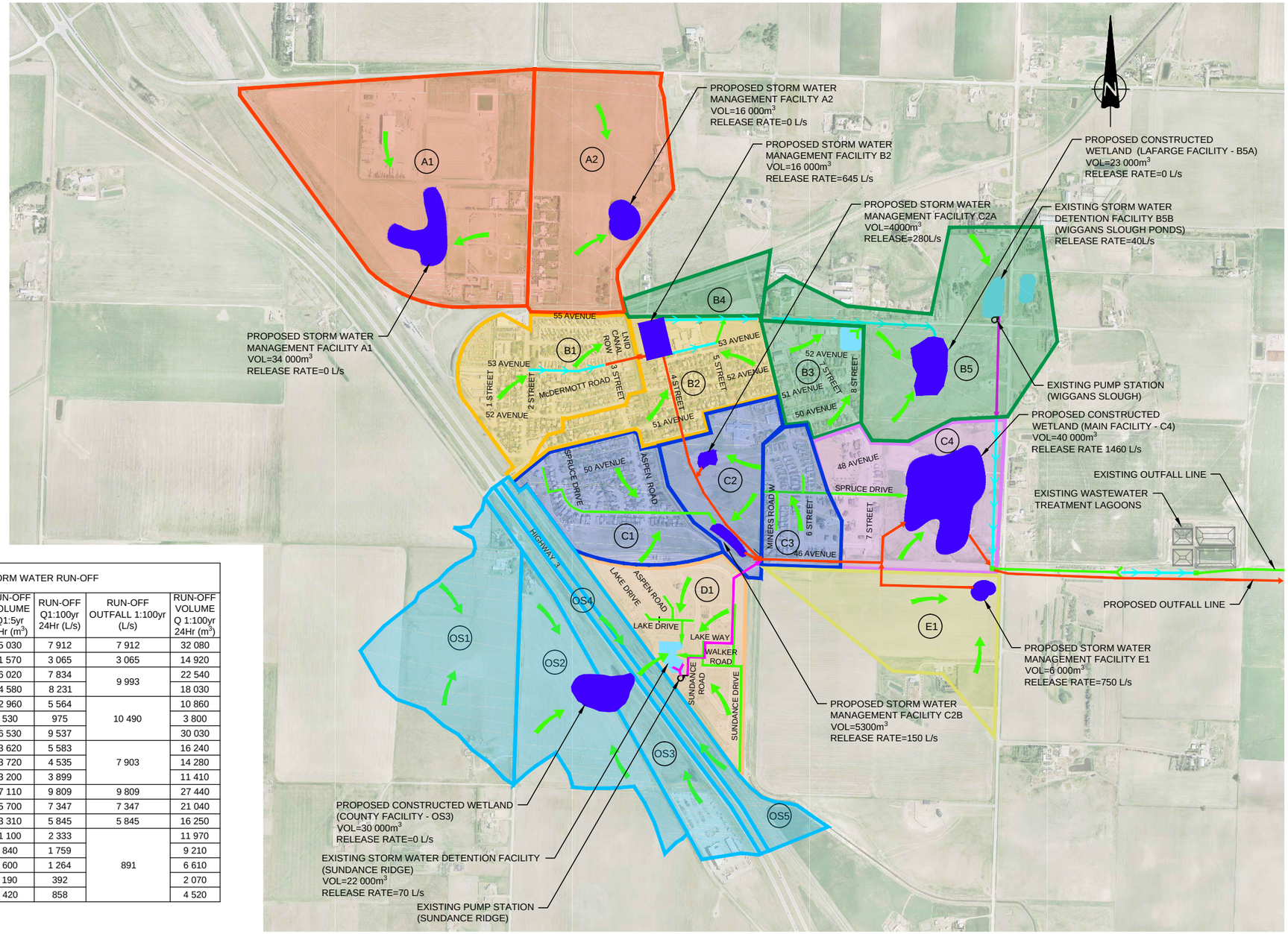


LEGEND

- EXISTING GRAVITY STORM SEWER
- EXISTING STORM SEWER FORCEMAIN
- EXISTING DRAINAGE SWALE
- EXISTING STORM WATER MANAGEMENT FACILITY
- DRAINAGE FLOW ARROWS
- PROPOSED STORM WATER MANAGEMENT FACILITY
- PROPOSED GRAVITY STORM SEWER
- PROPOSED STORM SEWER FORCEMAIN
- A1 CATCHMENT AREA LABEL

MPE Engineering Ltd.

TOWN OF COALHURST

STORM WATER MANAGEMENT PLAN
PROPOSED DRAINAGE

SCALE: 1:15 000	DATE: JUNE 2017	JOB: 1450-051-00	FIGURE: 2.2

It is proposed that a 900 mm outfall line be constructed with a slope of 0.6% to increase the outfall capacity to the river from 52.5 l/s to approximately 1,460 l/s. Constructing a new outfall line with much greater capacity allows the Town to construct future ponds with lower volume requirements.

2. **Create Storage:** SWMF's store the water during a major storm event and release the runoff at a controlled rate. The SWMF's also provide treatment of the runoff as sediment is able to settle out of the water in these areas. Constructed wetlands can provide additional treatment due to the wetland plantings and improved design elements.

   Intermediate storm water ponds at key locations throughout the Town will manage the volume of runoff from major storm events. Flow from the intermediate ponds will be directed to the proposed storm trunk and eventually enter the main constructed wetland located in catchment C4 where the storm water will be treated before entering the outfall line to the river.

   Where possible, it is recommended that constructed wetlands be utilized as SWMF's to provide greater treatment of the storm water runoff.

   - Constructed Wetlands

   As mentioned above, constructed wetlands add improved treatment of the storm water runoff when compared to traditional storm ponds. There are three SWMF's that are proposed to be created as constructed wetlands.

   - Main Facility – This constructed wetland will receive the runoff from the other intermediate SWMF's and will serve as the final treatment before being directed to the outfall at the river. The proposed outfall line will provide this constructed wetland with a release rate of approximately 1,460 l/s. With this release rate the constructed wetland will require 40,000 m^3 of active storage.

   - Lafarge Facility – This constructed wetland will receive the runoff from the majority of catchment area B. It is proposed that this constructed wetland have a zero release rate during storm events and be released into the main facility post storm

events. A zero release rate from this constructed wetland would require 23,000 m^3 of active storage.

- o County Facility – Recent events have located a culvert that crosses the CP Rail tracks just west of the Sundance subdivision. In a 1:00 year event, there is potentially 34,000 m^3 of storm water runoff that would flow across the CP Rail tracks into the Sundance SWMF. It is recommended that a constructed wetland be built on the west side of the highway to collect and detain the majority of the storm water runoff before it enters into the subdivision. Catchment OS4 and OS5 would still continue to flow into Sundance unrestricted which the computer model shows that the Sundance SWMF will flood by approximately 2,000 m^3 above the designed FSL. The constructed wetlands would be designed to release runoff post storm event to minimize impact to the Sundance SWMF operations. The post storm event release rate from the constructed wetlands would require 30,000 m^3 of active storage.

- Facilities For Future Development (SWMF's A1, A2, E1) – Future development is expected in catchments A1, A2, and E1. As this development occurs, SWMF's will be constructed to manage the runoff from major storm events. It is possible that the new developments might change the catchment areas which would change the volume of storage required. Without access to the storm trunk, Catchments A1, A2, and B5 have been restricted to a post storm event discharge. Catchment E1 has been assigned a pre development discharge rate into the main pond of 750 l/s.

- School Facility (SWMF B2) – Adding intermediate ponds to the existing system will provide further protection against flooding in major storm events. The first pond would be located west of the high school and would collect storm water runoff from catchments B1 and B2. The runoff that comes from catchment B1 is restricted to the existing ditch capacity of 1,440 l/s.

  With a pre-development 1:5 release rate of 645 l/s a pond with 16,000 m^3 of storage would be necessitated.

- SWMF C2A & C2B – The runoff from catchment C2 would flow to these ponds as well as the 1:100 year overflow volumes from catchments C1 and C3. The Overflow from catchment C1 would flow to the C2B pond while the overflow from C3 would flow to the C2A pond. Catchment C2 has a predevelopment release rate of 430 l/s. Dividing this release rate between the two ponds based on area gives the C2A pond a release rate of 280 l/s and the C2B pond a release rate of 150 l/s. The storage required for these ponds changes depending on the type of catchment C2 development. Pre-development flows for C2A and C2B ponds require 3,200m^3 and 4,700 m^3 of storage respectively. Post-development flows require storage for the C2A and C2B ponds to increase to 4,000 m^3 and 5,300 m^3 respectively.

2.6 Cost Estimates

Order of Magnitude cost estimates have been prepared for the Storm Water Management Improvements outlined above. Table 2.3 presents the estimated cost for each of the improvements including construction, contingency allowance and engineering services. Details of the estimates are included in Appendix B.

Table 2.3 – Proposed Storm Water Management Improvements

Infrastructure Improvements	Estimated Cost
Storm Outfall Upgrades	$ 4,914,000
Constructed Wetland – Main Facility	$ 3,970,000
Constructed Wetland – County Facility	$ 3,020,000
Constructed Wetland – Lafarge Facility	$ 1,930,000
Storm Trunk	$ 5,769,000
School Storm Water Management Facility	$ 911,000
Total	**$ 20,514,000**

2.7 Conclusions and Recommendations

The following conclusions and recommendations can be made:

- Design and construction of the proposed storm water management works should proceed with the overall development of the Town of Coalhurst. Storm water management planning for new development must be designed to accommodate development run-off from a 1 in 100 year design storm event with a 1 in 5 year pre-development release rate.

- Additional storm water runoff storage is needed in key areas to alleviate flooding in major events. Where possible these facilities should be created as constructed wetlands to enhance storm water treatment.

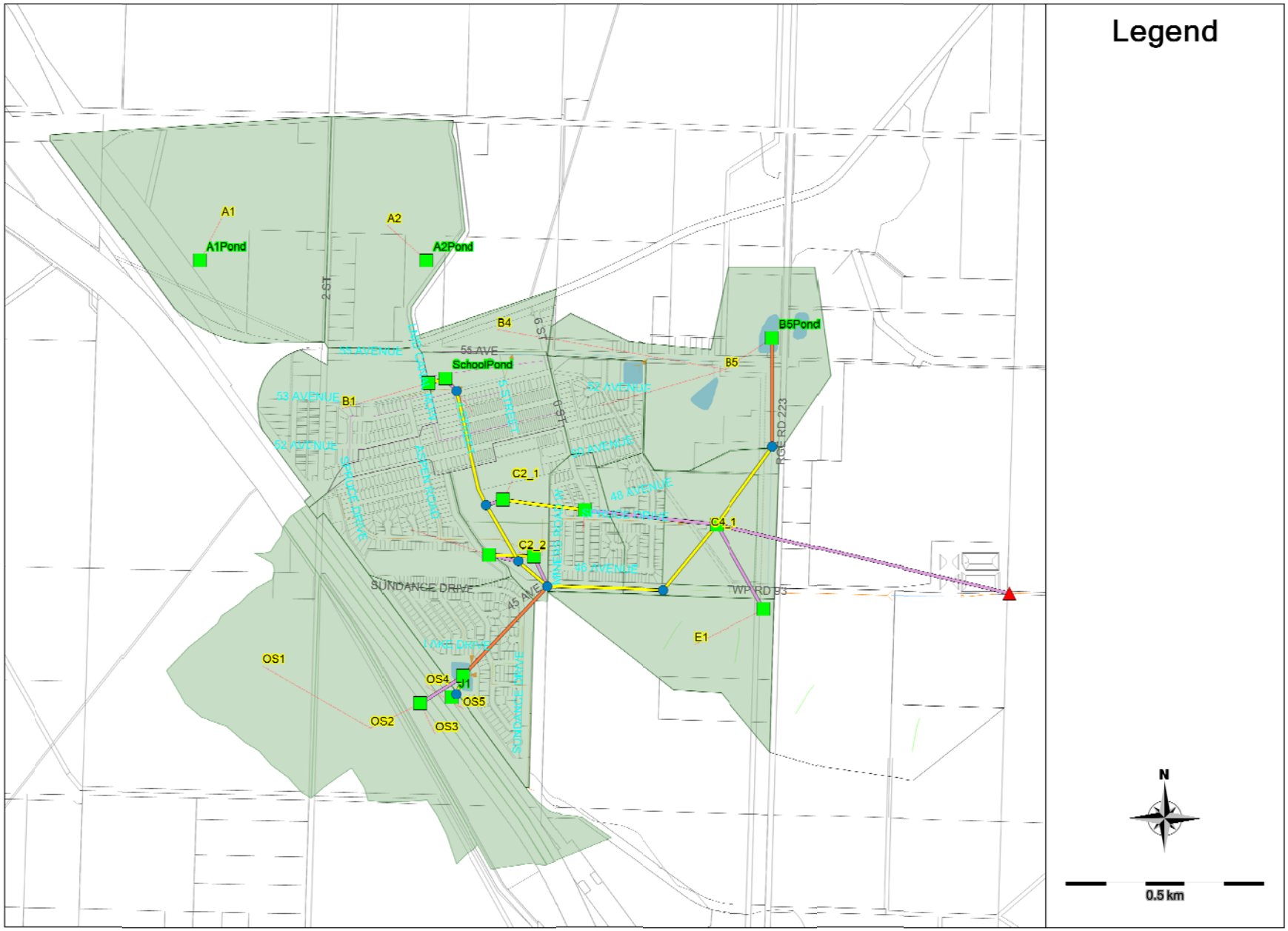
- A significant amount of storm water runoff enters the Sundance subdivision through a culvert under the CP Rail tracks causing the existing Sundance pond to flood in storm events. It is recommended that a constructed wetland be constructed to help mitigate the potential flooding of the Sundance subdivision from off-site storm water runoff.

- The existing minor underground system is not capable of handling the release rates from SWMF's. It is recommended that a new storm trunk be constructed to handle these flows along with an upgraded outfall line to the Oldman River.

- As the existing undeveloped areas are developed, consideration will have to be given to developing surface drainage systems, which limit the storm water flows to meet Alberta Environment and Parks (AEP) guidelines. Where possible, an underground storm sewer system that ties into the proposed storm trunk is desirable to convey minor storm events rather than along roadway curb/gutters and swales.

- It is recommended that an operations plan be created for the management of the SWMF's. This plan will require coordination with Lethbridge County for the management of the County facility and the Wiggins slough area. An operations plan will help ensure that the SWMF's are being utilized in major storm events.

Appendix A – Computer Model Data


Legend
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A2
A2Pond
B4
B5
B5Pond
B1
SchoolPond
C2_1
C2_2
C4_1
E1
J1
OS1
OS2
OS3
OS4
OS5
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53 AVENUE
52 AVENUE
50 AVENUE
48 AVENUE
46 AVENUE
45 AVE
SUNDANCE DRIVE
ASPEN RIDGE DRIVE
ASPEN RIDGE ROAD
RGE RD 223
WP RD 63
2 ST
6 ST
N
0.5 km

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  EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
  --------------------------------------------------------------

  ***********************************************************
  NOTE: The summary statistics displayed in this report are
  based on results found at every computational time step,
  not just on results from each reporting time step.
  ***********************************************************

  ****************
  Analysis Options
  ****************
  Flow Units ............... LPS
  Process Models:
    Rainfall/Runoff ........ YES
    Snowmelt ............... NO
    Groundwater ............ NO
    Flow Routing ........... YES
    Ponding Allowed ........ NO
    Water Quality .......... NO
  Infiltration Method ...... CURVE_NUMBER
  Flow Routing Method ...... DYNWAVE
  Starting Date ............ MAY-14-2014 00:00:00
  Ending Date .............. MAY-30-2014 00:00:00
  Antecedent Dry Days ...... 0.0
  Report Time Step ......... 00:01:00
  Wet Time Step ............ 00:05:00
  Dry Time Step ............ 00:05:00
  Routing Time Step ........ 5.00 sec


  *************
  Element Count
  *************
  Number of rain gages ...... 2
  Number of subcatchments ... 20
  Number of nodes ........... 22
  Number of links ........... 21
  Number of pollutants ...... 0
  Number of land uses ....... 0


  ****************
  Raingage Summary
  ****************
                                          Data        Recording
  Name                Data Source         Type        Interval
  ----------------------------------------------------------
  Chicago_24hr_1:100yrChicago_24hr        INTENSITY     5 min.
  Chicago_4hr_1:5yr   Chicago_4hr         INTENSITY     5 min.


  ********************
  Subcatchment Summary
  ********************
  Name                        Area     Width   %Imperv    %Slope    Rain Gage            Outlet
  ------------------------------------------------------------------------------------------
--------
  A1                        55.96    590.00     23.00    0.6000    Chicago_24hr_1:100yr A1Pond
  A2                        33.09    530.00     12.00    0.4000    Chicago_24hr_1:100yr A2Pond
  B1                        22.18    470.00     66.00    0.5000    Chicago_24hr_1:100yr J111
  B2                        18.64    390.00     58.00    2.7000    Chicago_24hr_1:100yr SchoolPond
```

B3	10.44	300.00	67.00	2.4000	Chicago_24hr_1:100yr B5
B4	6.59	110.00	20.00	0.6000	Chicago_24hr_1:100yr B5
B5	36.78	400.00	44.00	1.5000	Chicago_24hr_1:100yr B5Pond
C1	19.10	410.00	68.00	0.6000	Chicago_24hr_1:100yr C1Storage
C2_1	4.89	180.00	63.00	1.0000	Chicago_24hr_1:100yr C2APond
C2_2	2.48	180.00	63.00	1.0000	Chicago_24hr_1:100yr C2BPond
C3	10.73	180.00	73.00	0.7000	Chicago_24hr_1:100yr C3Storage
C4_1	6.73	240.00	100.00	0.2000	Chicago_24hr_1:100yr C4Pond
C4_2	7.53	280.00	62.00	1.5000	Chicago_24hr_1:100yr C4Pond
D1	20.40	250.00	68.00	1.5000	Chicago_24hr_1:100yr SundancePond
E1	21.11	460.00	58.00	1.0000	Chicago_24hr_1:100yr E1Pond
OS1	26.63	350.00	10.00	2.5000	Chicago_24hr_1:100yr OS2
OS2	21.08	250.00	10.00	1.4000	Chicago_24hr_1:100yr OS3Pond
OS3	15.08	200.00	10.00	1.2000	Chicago_24hr_1:100yr OS3Pond
OS4	4.81	60.00	10.00	0.9000	Chicago_24hr_1:100yr OS5
OS5	10.44	120.00	10.00	1.2000	Chicago_24hr_1:100yr J1

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J10	JUNCTION	925.86	5.24	0.0	
J2	JUNCTION	927.94	1.00	0.0	
J3	JUNCTION	926.30	5.10	0.0	
J4	JUNCTION	925.83	5.27	0.0	
J5	JUNCTION	925.74	4.26	0.0	
J6	JUNCTION	926.21	4.79	0.0	
J7	JUNCTION	929.00	1.00	0.0	
OF1	OUTFALL	920.00	0.00	0.0	
A1Pond	STORAGE	0.00	2.00	0.0	
A2Pond	STORAGE	0.00	2.00	0.0	
B5Pond	STORAGE	929.00	2.50	0.0	
C1Storage	STORAGE	928.00	3.00	0.0	
C2APond	STORAGE	927.00	4.00	0.0	
C2BPond	STORAGE	927.50	2.00	0.0	
C3Storage	STORAGE	929.00	1.00	0.0	
C4Pond	STORAGE	925.00	1.90	0.0	
E1Pond	STORAGE	927.50	2.00	0.0	
J1	STORAGE	928.50	1.50	0.0	
J111	STORAGE	930.50	2.50	0.0	
OS3Pond	STORAGE	929.00	2.00	0.0	
SchoolPond	STORAGE	928.00	2.00	0.0	
SundancePond	STORAGE	920.00	4.50	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C10	J10	J4	CONDUIT	97.6	0.0307	0.0130
C11	C1Storage	C2BPond	CONDUIT	113.3	0.4414	0.0160
C2	J2	SundancePond	CONDUIT	49.4	9.0258	0.0300
C3	J3	J6	CONDUIT	299.8	0.0310	0.0130
C4	J4	J5	CONDUIT	290.3	0.0310	0.0130
C5	J5	C4Pond	CONDUIT	50.0	0.4720	0.0130
C6	J6	J10	CONDUIT	164.2	0.0311	0.0130
C7	J7	C4Pond	CONDUIT	75.0	4.0032	0.0300
C8	C3Storage	C2APond	CONDUIT	209.3	0.7168	0.0160
OL1	J111	SchoolPond	CONDUIT	43.9	1.1395	0.0300
OL8	B5Pond	J7	TYPE1 PUMP			
SundancePump	SundancePond	J4	TYPE1 PUMP			
C1	J1	J2	OUTLET			

C9	C1Storage	J10	OUTLET
OL2	E1Pond	C4Pond	OUTLET
OL3	C4Pond	OF1	OUTLET
OL4	C2APond	J6	OUTLET
OL5	C2BPond	J4	OUTLET
OL6	SchoolPond	J3	OUTLET
OL7	OS3Pond	SundancePond	OUTLET
OL9	C3Storage	C4Pond	OUTLET

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C10	CIRCULAR	1.50	1.77	0.38	1.50	1	1239.46
C11	TRAPEZOIDAL	1.00	14.00	0.77	18.00	1	48724.60
C2	TRAPEZOIDAL	1.00	10.00	0.66	15.00	1	75762.83
C3	CIRCULAR	1.20	1.13	0.30	1.20	1	686.72
C4	CIRCULAR	1.50	1.77	0.38	1.50	1	1244.75
C5	CIRCULAR	1.50	1.77	0.38	1.50	1	4856.79
C6	CIRCULAR	1.20	1.13	0.30	1.20	1	687.21
C7	TRAPEZOIDAL	1.00	4.00	0.55	7.00	1	17824.66
C8	TRAPEZOIDAL	1.00	14.00	0.77	18.00	1	62090.49
OL1	TRAPEZOIDAL	1.00	8.00	0.61	13.00	1	20389.87

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	42.614	120.145
Evaporation Loss	0.000	0.000
Infiltration Loss	15.501	43.702
Surface Runoff	26.767	75.467
Final Surface Storage	0.478	1.347
Continuity Error (%)	-0.309	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	26.767	267.674
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	21.841	218.408
Internal Outflow	0.000	0.000
Storage Losses	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	4.930	49.297
Continuity Error (%)	-0.011	

****
Highest Continuity Errors
****
Node C2APond (-1.70%)

****
Time-Step Critical Elements
****
None

****
Highest Flow Instability Indexes
****
Link OL6 (26)
Link C9 (19)
Link C10 (9)
Link C6 (6)
Link OL9 (6)

****
Routing Time Step Summary
****
Minimum Time Step : 5.00 sec
Average Time Step : 5.00 sec
Maximum Time Step : 5.00 sec
Percent in Steady State : 0.00
Average Iterations per Step : 2.07

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
A1	120.15	0.00	0.00	59.04	60.03	33.59	7911.82	0.500
A2	120.15	0.00	0.00	71.56	47.46	15.70	3065.49	0.395
B1	120.15	0.00	0.00	16.13	103.13	22.88	7833.97	0.858
B2	120.15	0.00	0.00	21.81	97.63	18.19	8231.07	0.813
B3	120.15	0.00	0.00	14.85	104.70	10.93	5563.86	0.871
B4	120.15	0.00	0.00	59.41	59.69	3.94	975.49	0.497
B5	120.15	40.43	0.00	36.06	123.54	45.43	10489.90	0.769
C1	120.15	0.00	0.00	14.59	104.71	20.00	7216.20	0.872
C2_1	120.15	0.00	0.00	17.96	101.53	4.97	2352.58	0.845
C2_2	120.15	0.00	0.00	17.85	101.66	2.52	1394.59	0.846
C3	120.15	0.00	0.00	11.35	107.89	11.57	3899.05	0.898
C4_1	120.15	0.00	0.00	0.00	119.24	8.03	2843.76	0.992
C4_2	120.15	0.00	0.00	19.04	100.47	7.57	3771.67	0.836
D1	120.15	0.00	0.00	14.62	104.65	21.35	7347.27	0.871
E1	120.15	0.00	0.00	21.97	97.39	20.56	8026.53	0.811
OS1	120.15	0.00	0.00	72.70	46.28	12.32	2332.88	0.385
OS2	120.15	58.46	0.00	74.83	102.61	21.63	1904.83	0.575
OS3	120.15	0.00	0.00	73.37	45.59	6.88	1264.16	0.379
OS4	120.15	0.00	0.00	73.89	45.11	2.17	391.87	0.375
OS5	120.15	20.79	0.00	74.60	65.18	6.80	880.33	0.462

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days	hr:min
J10	JUNCTION	0.18	1.22	927.08	0	08:47
J2	JUNCTION	0.00	0.05	927.99	0	08:06
J3	JUNCTION	0.05	0.97	927.27	0	08:48
J4	JUNCTION	0.19	1.18	927.00	0	08:47
J5	JUNCTION	0.11	0.95	926.69	0	15:02
J6	JUNCTION	0.06	0.98	927.18	0	08:47
J7	JUNCTION	0.04	0.05	929.05	0	03:10

OF1	OUTFALL	0.00	0.00	920.00	0	00:00
A1Pond	STORAGE	1.62	1.68	1.68	16	00:00
A2Pond	STORAGE	1.51	1.57	1.57	16	00:00
B5Pond	STORAGE	0.70	1.66	930.66	1	02:46
C1Storage	STORAGE	0.00	1.31	929.31	0	08:00
C2APond	STORAGE	0.02	1.56	928.56	0	08:56
C2BPond	STORAGE	0.02	1.05	928.55	0	08:41
C3Storage	STORAGE	0.00	0.68	929.68	0	08:01
C4Pond	STORAGE	0.07	1.69	926.69	0	15:01
E1Pond	STORAGE	0.01	1.12	928.62	0	08:56
J1	STORAGE	0.00	0.03	928.53	0	08:05
J111	STORAGE	0.01	0.34	930.84	0	08:30
OS3Pond	STORAGE	0.19	1.16	930.16	1	02:31
SchoolPond	STORAGE	0.03	1.12	929.12	0	11:25
SundancePond	STORAGE	0.56	1.34	921.34	4	16:22

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr
J10	JUNCTION	0.00	1865.00	0	08:47	0.000	65.022
J2	JUNCTION	0.00	318.07	0	08:05	0.000	6.801
J3	JUNCTION	0.00	645.00	0	07:56	0.000	41.067
J4	JUNCTION	0.00	2085.00	0	08:47	0.000	128.768
J5	JUNCTION	0.00	2085.00	0	08:47	0.000	128.799
J6	JUNCTION	0.00	939.08	0	08:51	0.000	49.561
J7	JUNCTION	0.00	40.00	0	01:51	0.000	45.433
OF1	OUTFALL	0.00	1460.00	0	07:46	0.000	218.407
A1Pond	STORAGE	7905.14	7905.14	0	08:00	33.591	33.591
A2Pond	STORAGE	3062.16	3062.16	0	08:00	15.702	15.702
B5Pond	STORAGE	10485.25	10485.25	0	08:00	45.433	45.433
C1Storage	STORAGE	7211.29	7211.29	0	08:00	20.004	20.004
C2APond	STORAGE	2350.31	5143.56	0	08:01	4.968	8.356
C2BPond	STORAGE	1393.04	7293.50	0	08:00	2.521	7.059
C3Storage	STORAGE	3896.75	3896.75	0	08:00	11.575	11.575
C4Pond	STORAGE	6609.99	9519.14	0	08:00	15.595	218.423
E1Pond	STORAGE	8019.85	8019.85	0	08:00	20.558	20.558
J1	STORAGE	879.41	879.41	0	08:00	6.801	6.801
J111	STORAGE	7828.86	7828.86	0	08:00	22.877	22.877
OS3Pond	STORAGE	3165.91	3165.91	0	08:00	28.507	28.507
SchoolPond	STORAGE	8223.14	8858.90	0	08:00	18.194	41.064
SundancePond	STORAGE	7342.56	7582.92	0	08:00	21.347	56.656

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
A1Pond	STORAGE	384.00	1.680	0.320
A2Pond	STORAGE	384.00	1.570	0.430
B5Pond	STORAGE	384.00	1.658	0.842
E1Pond	STORAGE	384.00	1.119	0.881
J1	STORAGE	384.00	0.029	1.471

OS3Pond STORAGE 384.00 1.155 0.845

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	E&I Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
A1Pond	32.468	81	0	33.591	84	16 00:00	0.00
A2Pond	15.148	76	0	15.702	79	16 00:00	0.00
B5Pond	17.447	28	0	41.452	66	1 02:46	40.00
C1Storage	0.000	0	0	0.013	44	0 08:00	7000.17
C2APond	0.045	0	0	3.907	39	0 08:56	280.00
C2BPond	0.094	1	0	5.258	53	0 08:41	150.00
C3Storage	0.000	0	0	0.007	68	0 08:01	3491.62
C4Pond	1.482	4	0	33.787	89	0 15:01	1550.03
E1Pond	0.049	0	0	5.594	56	0 08:56	750.00
J1	0.005	0	0	0.289	2	0 08:05	318.07
J111	0.159	0	0	6.728	13	0 08:30	1440.00
OS3Pond	3.722	9	0	23.101	58	1 02:31	70.00
SchoolPond	0.413	1	0	15.690	56	0 11:25	645.00
SundancePond	11.263	13	0	26.819	30	4 16:22	70.00

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow LPS	Max. Flow LPS	Total Volume 10^6 ltr
OF1	83.90	188.30	1460.00	218.407
System	83.90	188.30	1460.00	218.407

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C10	CONDUIT	1865.00	0 08:47	1.23	1.50	0.80
C11	CONDUIT	6060.17	0 08:00	1.76	0.12	0.31
C2	CONDUIT	317.92	0 08:06	1.27	0.00	0.05
C3	CONDUIT	659.08	0 08:51	0.89	0.96	0.81
C4	CONDUIT	2085.00	0 08:47	1.81	1.68	0.66
C5	CONDUIT	2085.00	0 08:47	2.64	0.43	0.71
C6	CONDUIT	960.48	0 08:50	1.23	1.40	0.79

C7	CONDUIT	40.02	0	09:51	0.78	0.00	0.37
C8	CONDUIT	3161.62	0	08:01	1.62	0.05	0.30
OL1	CONDUIT	1440.00	0	08:06	1.29	0.07	0.29
OL8	PUMP	40.00	0	01:51		1.00	
SundancePump	PUMP	70.00	0	02:59		1.00	
C1	DUMMY	318.07	0	08:05			
C9	DUMMY	940.00	0	07:51			
OL2	DUMMY	750.00	0	07:54			
OL3	DUMMY	1460.00	0	07:46			
OL4	DUMMY	280.00	0	07:56			
OL5	DUMMY	150.00	0	07:58			
OL6	DUMMY	645.00	0	07:56			
OL7	DUMMY	70.00	0	08:03			
OL9	DUMMY	330.00	0	07:47			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
C10	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.06	0.0000
C11	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
C2	1.00	0.77	0.00	0.00	0.00	0.00	0.00	0.23	0.24	0.0000
C3	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.11	0.0000
C4	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.31	0.0000
C5	1.00	0.00	0.00	0.00	0.04	0.00	0.00	0.96	0.80	0.0000
C6	1.00	0.00	0.00	0.00	0.05	0.00	0.00	0.95	0.20	0.0000
C7	1.00	0.16	0.00	0.00	0.04	0.00	0.00	0.80	0.98	0.0000
C8	1.00	0.99	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
OL1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.37	0.0000

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Upstream	Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
C10	0.01	0.01	0.01	2.66	0.01
C4	0.01	0.01	0.01	6.87	0.01
C6	0.01	0.01	0.01	7.53	0.01

****
Pumping Summary
****

Pump	Percent Utilized	Number of Start-Ups	Min Flow LPS	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr	Power Usage Kw-hr	% Time Off Pump Curve: Low	High
OL8	82.50	1	0.00	39.84	40.00	45.433	99.73	0.0	0.0
SundancePump	59.04	2	0.00	69.42	70.00	56.656	800.84	0.0	46.0

Analysis begun on: Fri Mar 03 13:26:11 2017
Analysis ended on: Fri Mar 03 13:26:17 2017

Appendix B – Detailed Cost Estimates

Town of Coalhurst

Storm Water Management Plan

Gravity Pipe Storm Outfall to Oldman River

ORDER OF MAGNITUDE COST ESTIMATE

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
General Items					
1	General Requirements	1	L.S.	$ 329,000.00	$ 329,000
				SUBTOTAL	$ 329,000
Storm Water Collection System					
1	Topsoil - Strip, Stockpile and Replace	85,000	m^2	$ 3.50	$ 297,500
2	1800mm Manhole	58	v.m.	$ 3,800.00	$ 220,400
3	1500mm Manhole	42	v.m.	$ 3,000.00	$ 126,000
4	1050mm Sanitite Storm Pipe (Average Depth= 3.0m)	720	m	$ 690.00	$ 496,800
5	900mm Sanitite Storm Pipe (Average Depth= up to 3m)	1,100	m	$ 520.00	$ 572,000
6	900mm Sanitite Storm Pipe (Average Depth= up to 4m)	890	m	$ 580.00	$ 516,200
7	900mm Sanitite Storm Pipe (Average Depth= up to 5m)	310	m	$ 660.00	$ 204,600
8	900mm Sanitite Storm Pipe (Average Depth= up to 6m)	140	m	$ 770.00	$ 107,800
9	900mm SDR35 PVC Storm Pipe	120	m	$ 750.00	$ 90,000
10	450mm HDPE Storm Pipe Down Coulee	250	m	$ 525.00	$ 131,250
11	Highway 25 Crossing 1200mm Steel Casing	1	L.S.	$ 250,000.00	$ 250,000
12	Road Restoration - Range Road 23-3 Crossing	1	L.S.	$ 20,000.00	$ 20,000
13	Overland Spill CSO - Range Road 22-3 Crossing	1	L.S.	$ 25,000.00	$ 25,000
14	High Pressure Gas Line Crossing Allowance	2	L.S.	$ 15,000.00	$ 30,000
15	Overland Spill Channel Grading	1,500	m^3	$ 8.00	$ 12,000
16	Barb Wire Fencing	2,700	m	$ 15.00	$ 40,500
17	River Outlet Structure Upgrades	1	L.S.	$ 100,000.00	$ 100,000
18	Additional bedding materials	1,000	t	$ 40.00	$ 40,000
				SUBTOTAL	$ 3,280,050
				GRAND SUBTOTAL	**$ 3,609,000**
				EXTRA WORK ALLOWANCE (15%)	$ 542,000
				ENGINEERING SERVICES	$ 416,000
				GEOTECHNICAL SERVICES	$ 104,000
				LAND ACQUISTIONS/RIGHT OF WAY	$ 243,000
				GRAND TOTAL	**$ 4,914,000**

Assumptions

Unit prices are an opinion of probable costs and is a function of many factors that can change with time and hence must not be relied upon as the actual cost.

No allowance for land agent fees.

No allowance for phasing of work.

No allowance for the relocation/modification of existing shallow utilities.

No allowance for crop damage, work to be completed after harvest.

Allowance of for 0.3 ha of permanent right of way @ $90,000 per ha. (new right of way)

Allowance of for 4.8 ha of temporary work right of way @ $45,000 per ha. (approximately 10m along existing right of ways)

Topsoil - strip, stockpile and replace allow for 30m of topsoil restoration along open cut installation.

Any required seeding included with the pipe installation costs

Town of Coalhurst

Storm Water Management Plan

Constructed Wetland - Lethbridge County Facility

ORDER OF MAGNITUDE COST ESTIMATE

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
General Items					
1	General Requirements	1	L.S.	$ 167,000.00	$ 167,000
2	Hydro Excavation	8	hrs.	$ 350.00	$ 2,800
				SUBTOTAL	$ 169,800
Underground Utility Works					
1	Flow Control Structure - Discharge to Sundance SWMF	1	L.S.	$ 45,000.00	$ 45,000
2	Flow Control Structure - Intermediate Structure between Wetland Areas	1	L.S.	$ 20,000.00	$ 20,000
3	Outlet Structure into Sundance SWMF	1	L.S.	$ 10,000.00	$ 10,000
4	Forebay Berm Maintenance Assembly	1	each	$ 10,000.00	$ 10,000
5	Storm Pipe				
	a) 300 mm PVC Pipe	100	m	$ 250.00	$ 25,000
	b) 600 mm PVC Pipe	50	m	$ 350.00	$ 17,500
	c) 300mm HDPE Pipe - Installed by Horizontal Directional Drill	175	m	$ 375.00	$ 65,625
6	CP Rail Crossing - 450mm Steel Casing	1	L.S.	$ 100,000.00	$ 100,000
7	Eldorado Storm Pond Pipe Modification	1	L.S.	$ 3,000.00	$ 3,000
8	Makeup Water Supply from LNID	1	L.S.	$ 25,000.00	$ 25,000
				SUBTOTAL	$ 321,100
Site Grading Works					
1	Strip and Stockpile Topsoil	58,000	m^2	$ 1.00	$ 58,000
2	Common Excavation	15,000	m^3	$ 8.00	$ 120,000
3	Waste Excavation	30,500	m^3	$ 15.00	$ 457,500
4	Compacted Native Clay Liner Below FSL	28,000	m^2	$ 5.00	$ 140,000
5	Natural Grass Swale	500	m	$ 40.00	$ 20,000
6	Topsoil Restoration				
	a) Emergent Wetland Vegetation	12,000	m^2	$ 12.50	$ 150,000
	b) Upland Riparian Vegetation	5,600	m^2	$ 7.50	$ 42,000
	c) Native Prairie Vegetation	24,000	m^2	$ 3.50	$ 84,000
	d) Park Vegetation - Sundance SWMF	200	m^2	$ 20.00	$ 4,000
7	Shrub Mulch Beds	6,000	m^2	$ 12.00	$ 72,000
8	Plantings				
	a) Trees	120	each	$ 500.00	$ 60,000
	b) Shrubs	360	each	$ 60.00	$ 21,600
9	4.0m Gravel Access Road				
	a) Site Access Road	400	m^2	$ 22.00	$ 8,800
	b) Wetland Perimeter Road	2,800	m^2	$ 22.00	$ 61,600
10	Gravel Road Restoration - Lethbridge County Road	60	m^2	$ 35.00	$ 2,100
11	Asphalt Road Restoration - Lethbridge County Road	50	m^2	$ 70.00	$ 3,500
12	Asphalt Path Restoration - Sundance SWMF	1	L.S.	$ 1,000.00	$ 1,000
12	Facility Signage	7	each	$ 350.00	$ 2,450
13	Wildlife Friendly Fencing	1,500	m	$ 25.00	$ 37,500
				SUBTOTAL	$ 1,346,100
				GRAND SUBTOTAL	**$ 1,837,000**
				EXTRA WORK ALLOWANCE (15%)	$ 275,600
				ENGINEERING AND QUALIFIED WETLAND PRACTICIONER SERVICES (15%)	$ 316,900
				QUALITY ASSURANCE SERVICES (2.5%)	$ 52,800
				LAND ACQUISTIONS	$ 540,000
				GRAND TOTAL	**$ 3,020,000**

Assumptions

- Land purchased at $35,000/acre. No allowance for purchase of crown owned land (Alberta Transportation).
- Unit prices are an opinion of probable costs and is a function of many factors that can change with time and hence must not be relied upon as the actual cost.
- No allowance for geotechnical or environmental site assessments.
- No allowance for phasing of work.
- No allowance for the relocation/modification of existing shallow utilities.
- No allowance for additional site improvements; such as, turf irrigation, pathways, site programming, site servicing etc.

- Pond allows for approximately 25,000m^3 of active storage and 10,000m^3 of sediment forebay/permanent ponding volume.
- Flow control structure includes precast concrete vault, weir wall, and sluice gate as necessary.
- Sundance outlet structure includes modifications and restoration work to Sundance SWMF.
- Forebay berm maintenance assembly includes pipe and plug valve.
- Make up water system will be LNID domestic turnout.
- CP Rail crossing includes steel casing, HDPE pipe, casing spacers, and restoration work.
- All waste excavation to be hauled offsite. No allowance for disposal/tipping fees.
- Natural grass swale work includes waste excavation, grading, topsoil placement and seed.
- Emergent wetland vegetation to be placed within aquatic bench and shallow wetland areas.
- Upland riparian vegetation to be placed along full supply level.
- Native prairie vegetation to be placed above flood fringe area.
- 40 trees/ha. and 3 shrubs/tree.
- Gravel access road includes waste excavation, subgrade preparation and 200mm granular material.
- Gravel road restoration includes waste excavation, subgrade preparation and 400mm granular material.
- Asphalt road restoration includes waste excavation, subgrade preparation, 400mm granular material and 100mm asphalt.
- Asphalt path restoration includes asphalt removal, waste excavation, subgrade preparation, 100mm base granular material, prime coat and 50mm asphalt
- Signage to be placed every 100m around perimeter of facility.

Town of Coalhurst
Storm Water Management Plan

Constructed Wetland - Lafarge Site Facility

ORDER OF MAGNITUDE COST ESTIMATE

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
General Items					
1	General Requirements	1	L.S.	$ 123,000.00	$ 123,000
2	Hydro Excavation	8	hrs.	$ 350.00	$ 2,800
3	High Pressure Gas Line Construction Crossings	2	each	$ 25,000.00	$ 50,000
				SUBTOTAL	$ 175,800
Underground Utility Works					
1	Outlet Structure	1	L.S.	$ 45,000.00	$ 45,000
2	Inlet Structure	1	L.S.	$ 45,000.00	$ 45,000
3	Forebay Berm Maintenance Assembly	1	each	$ 10,000.00	$ 10,000
4	Outlet Structure into Main SWMF	1	L.S.	$ 15,000.00	$ 15,000
5	Storm Manhole to Main SWMF	3	each	$ 7,500.00	$ 22,500
6	300mm PVC Storm Pipe to Main SWMF	250	m	$ 250.00	$ 62,500
7	Makeup Water Supply from LNID	1	L.S.	$ 25,000.00	$ 25,000
				SUBTOTAL	$ 225,000
Site Grading Works					
1	Strip and Stockpile Topsoil	50,000	m^2	$ 1.00	$ 50,000
2	Common Excavation	5,000	m^3	$ 8.00	$ 40,000
3	Waste Excavation	40,000	m^3	$ 5.00	$ 200,000
4	Unsuitable Waste Excavation	1,000	m^3	$ 20.00	$ 20,000
5	Compacted Native Clay Liner Below FSL	25,000	m^2	$ 5.00	$ 125,000
6	De-watering and De-sludging of Existing SWMF	1	L.S.	$ 15,000.00	$ 15,000
7	Natural Grass Swale	500	m	$ 40.00	$ 20,000
8	Topsoil Restoration				
	a) Emergent Wetland Vegetation	10,000	m^2	$ 12.50	$ 125,000
	b) Upland Riparian Vegetation	2,500	m^2	$ 7.50	$ 18,750
	c) Native Prairie Vegetation	20,000	m^2	$ 3.50	$ 70,000
9	Shrub Mulch Beds	5,000	m^2	$ 12.00	$ 60,000
10	Plantings				
	a) Trees	100	each	$ 500.00	$ 50,000
	b) Shrubs	300	each	$ 60.00	$ 18,000
11	4.0m Gravel Access Road				
	a) Site Access Road	500	m^2	$ 22.00	$ 11,000
	b) Wetland Perimeter Road	3,000	m^2	$ 22.00	$ 66,000
12	Facility Signage	10	each	$ 350.00	$ 3,500
				SUBTOTAL	$ 892,300
Naturalized Overland Emergency Spill Path					
1	49 Avenue Culvert Crossing	1	L.S.	$ 15,000.00	$ 15,000
2	Strip and Stockpile Topsoil	5,500	m^2	$ 1.00	$ 5,500
3	Waste Excavation	6,000	m^3	$ 5.00	$ 30,000
4	Native Prairie Vegetation Restoration	5,000	m^2	$ 3.50	$ 17,500
5	Turf Reinforcement Matting	500	m^2	$ 15.00	$ 7,500
6	Rock Check Dams	3	each	$ 1,500.00	$ 4,500
7	Plantings				
	a) Trees	20	each	$ 500.00	$ 10,000
	b) Shrubs	60	each	$ 60.00	$ 3,600
8	4.0m Gravel Maintenance Road	1,000	m^2	$ 22.00	$ 22,000
				SUBTOTAL	$ 115,600
				GRAND SUBTOTAL	**$ 1,408,700**
				EXTRA WORK ALLOWANCE (15%)	$ 211,300
				ENGINEERING AND QUALIFIED WETLAND PRACTICIONER SERVICES (15%)	$ 243,000
				QUALITY ASSURANCE SERVICES (2.5%)	$ 40,500
				LAND ACQUISTIONS	$ 22,500
				GRAND TOTAL	**$ 1,930,000**

Assumptions

- Land purchased at $35,000/acre.
- Unit prices are an opinion of probable costs and is a function of many factors that can change with time and hence must not be relied upon as the actual cost.
- No allowance for geotechnical or environmental site assessments.
- No allowance for phasing of work.
- No allowance for the relocation/modification of existing shallow utilities.
- No allowance for additional site improvements; such as, turf irrigation, pathways, site programming, site servicing etc.

- Pond allows for approximately 20,000m^3 of active storage and 10,000m^3 of sediment forebay/permanent ponding volume.
- Outlet/inlet structure includes precast concrete vault, sluice gate, pipe and flared end.
- Forebay berm maintenance assembly includes pipe and plug valve.
- Make up water system will be LNID domestic turnout from nearby canal.
- All waste excavation to be placed/stockpiled on-site.
- Natural grass swale work includes waste excavation, grading, topsoil placement and seed.
- Emergent wetland vegetation to be placed within aquatic bench and shallow wetland areas.
- Upland riparian vegetation to be placed along full supply level.
- Native prairie vegetation to be placed above flood fringe area.
- 40 trees/ha. and 3 shrubs/tree.
- Gravel access road includes waste excavation, subgrade preparation and 200mm granular material.
- Signage to be placed every 100m around perimeter of facility.
- Emergency spill allows for 1.0m^3/s of flow from SW corner of facility to main SWMF site (approximately 250m).

Town of Coalhurst
Storm Water Management Plan

Constructed Wetland - Main Facility

ORDER OF MAGNITUDE COST ESTIMATE

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
General Items					
1	General Requirements	1	L.S.	$ 263,000.00	$ 263,000
2	Hydro Excavation	8	hrs.	$ 350.00	$ 2,800
3	High Pressure Gas Line Construction Crossings	2	each	$ 25,000.00	$ 50,000
				SUBTOTAL	$ 315,800
Underground Utility Works					
1	Outlet Structure	1	L.S.	$ 120,000.00	$ 120,000
2	Inlet Structure	1	L.S.	$ 120,000.00	$ 120,000
3	Forebay Berm Maintenance Assembly	1	each	$ 10,000.00	$ 10,000
4	Makeup Water Supply from LNID	1	L.S.	$ 25,000.00	$ 25,000
				SUBTOTAL	$ 275,000
Site Grading Works					
1	Strip and Stockpile Topsoil	120,000	m^2	$ 1.00	$ 120,000
2	Common Excavation	20,000	m^3	$ 8.00	$ 160,000
3	Waste Excavation	140,000	m^3	$ 5.00	$ 700,000
4	Compacted Native Clay Liner Below FSL	40,000	m^2	$ 5.00	$ 200,000
5	Topsoil Restoration				
	a) Emergent Wetland Vegetation	15,000	m^2	$ 12.50	$ 187,500
	b) Upland Riparian Vegetation	4,500	m^2	$ 7.50	$ 33,750
	c) Native Prairie Vegetation	64,000	m^2	$ 3.50	$ 224,000
6	Shrub Mulch Beds	16,000	m^2	$ 12.00	$ 192,000
7	Plantings				
	a) Trees	320	each	$ 500.00	$ 160,000
	b) Shrubs	960	each	$ 60.00	$ 57,600
8	4.0m Gravel Access Road				
	a) Site Access Road	2,500	m^2	$ 22.00	$ 55,000
	b) Wetland Perimeter Road	4,500	m^2	$ 22.00	$ 99,000
9	Site Approach Upgrades	1	L.S.	$ 2,500.00	$ 2,500
10	Asphalt Site Parking and Storage c/w 8.0m Wide Access Road	2,000	m^2	$ 45.00	$ 90,000
11	Facility Signage	12	each	$ 350.00	$ 4,200
				SUBTOTAL	$ 2,285,600
Naturalized Overland Emergency Spill Path					
1	Range Road 233 Culvert Crossing	1	L.S.	$ 15,000.00	$ 15,000
2	Strip and Stockpile Topsoil	6,500	m^2	$ 1.00	$ 6,500
3	Waste Excavation	2,000	m^3	$ 5.00	$ 10,000
4	Native Prairie Vegetation Restoration	6,000	m^2	$ 3.50	$ 21,000
5	Turf Reinforcement Matting	500	m^2	$ 15.00	$ 7,500
6	Rock Check Dams	3	each	$ 1,500.00	$ 4,500
				SUBTOTAL	$ 64,500
				GRAND SUBTOTAL	**$ 2,940,900**
				EXTRA WORK ALLOWANCE (15%)	$ 441,100
				ENGINEERING AND QUALIFIED WETLAND PRACTICIONER SERVICES (15%)	$ 507,300
				QUALITY ASSURANCE SERVICES (2.5%)	$ 84,600
				LAND ACQUISTIONS	-
				GRAND TOTAL	**$ 3,970,000**

Assumptions

- Unit prices are an opinion of probable costs and is a function of many factors that can change with time and hence must not be relied upon as the actual cost.
- No allowance for geotechnical or environmental site assessments.
- No allowance for phasing of work.
- No allowance for the relocation/modification of existing shallow utilities.
- No allowance for additional site improvements; such as, turf irrigation, plantings, pathways, site programming, site servicing etc.

- Pond allows for approximately 40,000m^3 of active storage and 25,000m^3 of sediment forebay/permanent ponding volume.
- Outlet/inlet structure includes precast concrete vault, sluice gate, pipe and flared end.
- Forebay berm maintenance assembly includes pipe and plug valve.
- Make up water system will be LNID domestic turnout into the existing storm system through Imperial Meadows.
- All waste excavation to be placed/stockpiled on-site.
- Natural grass swale work includes waste excavation, grading, topsoil placement and seed.
- Emergent wetland vegetation to be placed within aquatic bench and shallow wetland areas.
- Upland riparian vegetation to be placed along full supply level.
- Native prairie vegetation to be placed above flood fringe area.
- 40 trees/ha. and 3 shrubs/tree.
- Gravel access road includes waste excavation, subgrade preparation and 200mm granular material.
- Asphalt road includes City of Lethbridge Local Road Structure.
- Signage to be placed every 100m around perimeter of facility.
- Emergency spill allows for 1.0m^3/s of flow from SE corner of facility past Range Road 223.

MPE Engineering Ltd.

Town of Coalhurst

Storm Water Management Plan

Storm Trunk

ORDER OF MAGNITUDE COST ESTIMATE

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
Range Road 22-3 to Sundance Drive Corner					
1	General Requirements	1	L.S.	$ 139,000.00	$ 139,000
2	Temporary Construction Easement	0.8	ha	$ 35,000.00	$ 28,000
3	Connection to Existing Storm Forcemain	1	L.S.	$ 5,000.00	$ 5,000
4	1500mm Storm Pipe - Depth = 3.5m to 6.5m	670	m	$ 1,650.00	$ 1,105,500
5	2400mm Manhole	25	v.m	$ 3,500.00	$ 87,500
6	Remove and Dispose of Existing Storm Forcemain	650	m	$ 150.00	$ 97,500
7	6 Street Road Crossing	1	L.S.	$ 25,000.00	$ 25,000
8	Barbed Wire Fence Replacement	250	m	$ 15.00	$ 3,750
9	Topsoil and Seed Restoration	16,750	m^2	$ 3.50	$ 58,625
				SUBTOTAL	$ 1,550,000
Sundance Drive Corner to 4th Street, South of 51 Avenue					
1	General Requirements	1	L.S.	$ 86,000.00	$ 86,000
2	Temporary Construction Easement	1.2	ha	$ 35,000.00	$ 42,000
3	Connection to Existing Storm Main	1	L.S.	$ 10,000.00	$ 10,000
4	1200mm Storm Pipe - Depth = 4.5m to 6.5m	575	m	$ 1,250.00	$ 718,750
5	2400mm Manhole	21	v.m	$ 3,500.00	$ 73,500
6	Topsoil and Seed Restoration	14,375	m^2	$ 3.50	$ 50,313
				SUBTOTAL	$ 981,000
4th Street, South of 51 Avenue to 53 Avenue (School SWMF)					
1	General Requirements	1	L.S.	$ 122,000.00	$ 122,000
2	Traffic Accommodation	1	L.S.	$ 20,000.00	$ 20,000
3	Connection to Existing Water Distribution System	3	each	$ 5,000.00	$ 15,000
4	Temporary Water Supply	1	L.S.	$ 20,000.00	$ 20,000
5	200mm Water Pipe	240	m	$ 250.00	$ 60,000
6	200mm Isolation Valve	2	each	$ 2,500.00	$ 5,000
7	Fire Hydrant c/w Isolation Valve	1	each	$ 9,000.00	$ 9,000
8	Water Service Replacement	10	each	$ 3,000.00	$ 30,000
9	Sanitary By-Pass Pumping	1	L.S.	$ 20,000.00	$ 20,000
10	Connection to Existing Sanitary Collection System	3	each	$ 3,500.00	$ 10,500
11	Sanitary Manhole	3	v.m	$ 2,000.00	$ 6,000
12	Water Tight Manhole Insert	2	each	$ 2,000.00	$ 4,000
13	250mm Sanitary Pipe	260	m	$ 250.00	$ 65,000
14	Sanitary Pipe Frost Shielding	260	m	$ 100.00	$ 26,000
15	Sanitary Service Replacement	10	each	$ 2,000.00	$ 20,000
16	1200mm Storm Pipe - Depth = 3.5m to 5.0m	275	m	$ 1,250.00	$ 343,750
17	2400mm Manhole	8	v.m	$ 3,500.00	$ 28,000
18	Catch Basin c/w ICD	9	each	$ 3,500.00	$ 31,500
19	300mm Catch Bain Lead	100	m	$ 200.00	$ 20,000
20	Asphalt Removal	3,500	m^2	$ 10.00	$ 35,000
21	Concrete Sidewalk/Curb and Gutter Removal	1,225	m^2	$ 15.00	$ 18,375
22	Waste Excavation	1,900	m^3	$ 15.00	$ 28,500
23	Tile Drain	825	m	$ 15.00	$ 12,375

24	Geotextile Fabric	4,725	m^2	$ 4.50	$ 21,263
25	300mm Base Granular	4,725	m^2	$ 18.00	$ 85,050
26	75mm Asphalt c/w Prime Coat	3,500	m^2	$ 23.00	$ 80,500
27	Curb and Gutter Monolithic Sidewalk	600	m	$ 150.00	$ 90,000
28	Curb and Gutter	225	m	$ 90.00	$ 20,250
29	Landscape Retaining Wall	250	m	$ 200.00	$ 50,000
30	Concrete Driveway Restoration	175	m^2	$ 135.00	$ 23,625
31	Asphalt Driveway Restoration	75	m^2	$ 50.00	$ 3,750
32	Gravel Driveway and Lane Restoration	225	m^2	$ 35.00	$ 7,875
33	Topsoil and Sod Restoration	1,000	m^2	$ 20.00	$ 20,000
				SUBTOTAL	$ 1,352,000
3rd Steet to 4th Street (Through School Site and Under LNID Canal)					
1	General Requirements	1	L.S.	$ 39,000.00	$ 39,000
2	1200mm Storm Pipe - Depth = 2.5m to 4.0m	120	m	$ 1,250.00	$ 150,000
3	900mm Storm Pipe - Depth = 3.0m to 3.5m	90	m	$ 850.00	$ 76,500
4	750mm Storm Pipe - Depth = 2.0m to 2.5m	75	m	$ 600.00	$ 45,000
5	Pond Inlet/Bypass Structure, Pipe, Flared End and Slide Gate	1	L.S.	$ 30,000.00	$ 30,000
6	Flared End Ditch Inlet	1	L.S.	$ 5,000.00	$ 5,000
7	LNID Canal Crossing	1	L.S.	$ 30,000.00	$ 30,000
8	Catch Basin	5	each	$ 3,500.00	$ 17,500
9	300mm Catch Basin Lead	25	m	$ 200.00	$ 5,000
10	Inlet/Outlet - Riprap Armour	100	tonne	$ 75.00	$ 7,500
11	3 Street Road Crossing	1	L.S.	$ 12,500.00	$ 12,500
12	Topsoil and Seed Restoration	2,000	m^2	$ 5.00	$ 10,000
				SUBTOTAL	$ 428,000
53rd Avenue, 3 Street to 2 Street (In Front of School)					
1	General Requirements	1	L.S.	$ 14,000.00	$ 14,000
2	900mm Storm Pipe in Existing Ditch	170	m	$ 600.00	$ 102,000
3	School Approach Crossing	2	each	$ 3,500.00	$ 7,000
4	Catch Basin	3	each	$ 3,500.00	$ 10,500
5	300mm Catch Basin Lead	30	m	$ 200.00	$ 6,000
6	Topsoil and Seed Restoration	1,500	m^2	$ 5.00	$ 7,500
				SUBTOTAL	$ 147,000
				GRAND SUBTOTAL	**$ 4,458,000**
				EXTRA WORK ALLOWANCE (15%)	$ 669,000
				ENGINEERING SERVICES	$ 513,000
				GEOTECHNICAL SERVICES	$ 129,000
				LAND ACQUISTIONS	$ -
				GRAND TOTAL	**$ 5,769,000**

Assumptions

Unit prices are an opinion of probable costs and is a function of many factors that can change with time and hence must not be relied upon as the actual cost.

No allowance for land agent fees.

No allowance for phasing of work.

No allowance for the relocation/modification of existing shallow utilities.

No allowance for any additional permanent land acquisitions.

No allowance for additional pipe bedding and haunching.

Range Road 22-3 to Sundance Drive

Allowance for a 30m wide temporary construction easement throughout the undeveloped land within the SE 21-9-22-4.

6 Street road crossing includes; 150m^2 of asphalt and 25m of monolithic sidewalk restoration.

Sundance Drive to 4 Street south of 51 Avenue

Allowance for a 20m wide temporary construction easement within Lot 15, Block 2, Plan 061 4136.

4 Street, south of 51 Avenue to 53 Avenue (School)

Allowance for replacement of all deep utilities and water/sanitary services within restoration area.

Allowance for water tight manhole inserts to be installed on all sanitary manholes within trapped lows.

Inlet control devices to be installed on all catch basins tied directly into the storm trunk line.

Waste excavation includes all road waste excavation, and a allowance for additional waste material resulting from road re-grading.

Allowance for tile drain along all restored gutters.

Landscape retaining wall allowance for landscaping tie ins in areas of significant road re-grading.

Driveway and lane restoration costs include all additional waste excavation resulting from road re-grading.

3 Steet to 4 Street (Under LNID Canal)

Inlet/Outlet riprap armour allows for both pipe inlet and pond outlet erosion protection.

3 Street road crossing includes; 100m^2 of asphalt and 20m of monolithic sidewalk restoration.

Assumed LNID crossing to be completed by open cut excavation.

53 Avenue, 3 Street to 2 Street

No allowance for any road restoration.

Town of Coalhurst

Storm Water Management Plan

School Facility

ORDER OF MAGNITUDE COST ESTIMATE

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
General Items					
1	General Requirements	1	L.S.	$ 64,000.00	$ 64,000
				SUBTOTAL	$ 64,000
Storm Water Management Facility					
1	Topsoil - Strip and Stockpile	42,500	m^2	$ 1.00	$ 42,500
2	Waste Excavation	32,000	m^3	$ 12.00	$ 384,000
3	300mm Compacted Clay Liner	14,000	m^2	$ 3.00	$ 42,000
4	Perimeter Tile Drain	375	m	$ 40.00	$ 15,000
5	Landscape Catch Basin	6	each	$ 1,300.00	$ 7,800
6	Inlet/Outlet - Riprap Armour	50	tonne	$ 75.00	$ 3,750
7	Pond InOutlet Structure, Pipe, Flared End and Slide Gate	1	L.S.	$ 30,000.00	$ 30,000
8	Irrigation System	1	L.S.	$ 70,000.00	$ 70,000
9	Topsoil and Seed	17,500	m^2	$ 2.50	$ 43,750
				SUBTOTAL	$ 638,800
				GRAND SUBTOTAL	**$ 703,000**
				EXTRA WORK ALLOWANCE (15%)	$ 106,000
				ENGINEERING SERVICES	$ 81,000
				GEOTECHNICAL SERVICES	$ 21,000
				LAND ACQUISTIONS	$ -
				GRAND TOTAL	**$ 911,000**

Assumptions

Unit prices are an opinion of probable costs and is a function of many factors that can change with time and hence must not be relied upon as the actual cost.

No allowance for land agent fees.

No allowance for phasing of work.

No allowance for the relocation/modification of existing shallow utilities.

No allowance for any additional permanent land acquisitions.

Pond allows for approximately 16,000m^3 of storage.

Waste excavation to be trucked offsite.

Clay liner below full service level only.