MARTIN
GEOMATIC CONSULTANTS LTD.

SITE DRAINANGE ANALYSIS
ENERCLEAN THOMSON SUBDIVISION
SW-1-9-21-W4M
LETHBRIDGE COUNTY
ALBERTA

Prepared for:	Hypervac Technologies
File Number:	166543CE
Dated:	August 2016

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I. PROJECT BACKGROUND AND DRAINAGE FEATURES

The Enerclean Thomson Subdivision is a proposed group country residential subdivision located 3 km east of Highway#4 (43rd St. S) and 1 km south of Highway #3 in Lethbridge County. The legal property description is Southwest Quarter of Section 1, Township 9, Range 21 West of the 4th Meridian. The property is bound by Range Road 21-1 to the west, the St. Mary River Irrigation District (SMRID) Northeast Lateral Canal to the east, and farmland/ homestead to the north and south. See Figure 1 – Project Location. This drainage report is being submitted in support of The Enerclean Thomson Area Structure Plan (ASP) and rezoning application, for consideration by the Lethbridge County. The plan area is +/- 9.43 ha which includes two lots. The landowner is proposing to subdivide into a total of 4 lots and rezone the land from Lethbridge Urban Fringe (LUF) to Group Country Residential (GCR). The proposed lot layout is shown on Figure 2 – Proposed Subdivision. The purpose of this report is to provide stormwater management strategies to guide the future development of the Enerclean Thomson Subdivision.

A. Existing Features

The area presently includes two parcels (LUF) with one dwelling and one shop. The land is generally flat with ground slopes of 0.5% to 2.0%. The site is presently split in to two catchment areas which define the overland drainage boundaries. The south catchment (4.04 ha) drains to an existing low area along the east property line, which drains through an uncontrolled 300mm culvert to the SMRID Northeast Lateral Canal. The north catchment (5.41 ha) drains to a natural channel which is released through a manually operated sluice gate and 450mm culvert to the SMRID canal. The Northeast Lateral Canal flows northeasterly to the SMRID Northeast Reservoir (approximately 10 km north of Coaldale).

Offsite runoff is directed across the site from west to east along the natural channel. A 450mm culvert under Range Road 21-1 conveys surface water from the west along a grass swale. The swale extends about 1.5km southwest from a lake adjacent to the Lethbridge Correctional Center. The outlet of this lake has a sluice gate which would discharge to the grass swale when opened and ultimately flow across the natural channel at the Enerclean Thomson site and to the SMRID canal.

Existing soil descriptions for the area include loam and silt loam (L, SiL) Orthic Dark Brown Chernozem on medium textured sediments deposited by wind and water (LET), as defined in soil polygon 5865 and 5861[a]. Soil classifications are used to determine infiltration rates for the purpose of this report. Furthermore, four boreholes[b] have been completed on site to determine soil conditions for the purpose geotechnical investigations and general suitability of the proposed development. The four boreholes generally found 100mm topsoil above clay, with groundwater depths ranging from 1.5m to 4.5m. Soil reports are included in Appendix B – Soil Information. A topographical site survey has been completed by Martin Geomatic Consultants Ltd[c] and an existing surface terrain model has been created to define drainage boundaries, storage depressions and flow conveyance routes as shown in Figure 3 – Existing Site Features.

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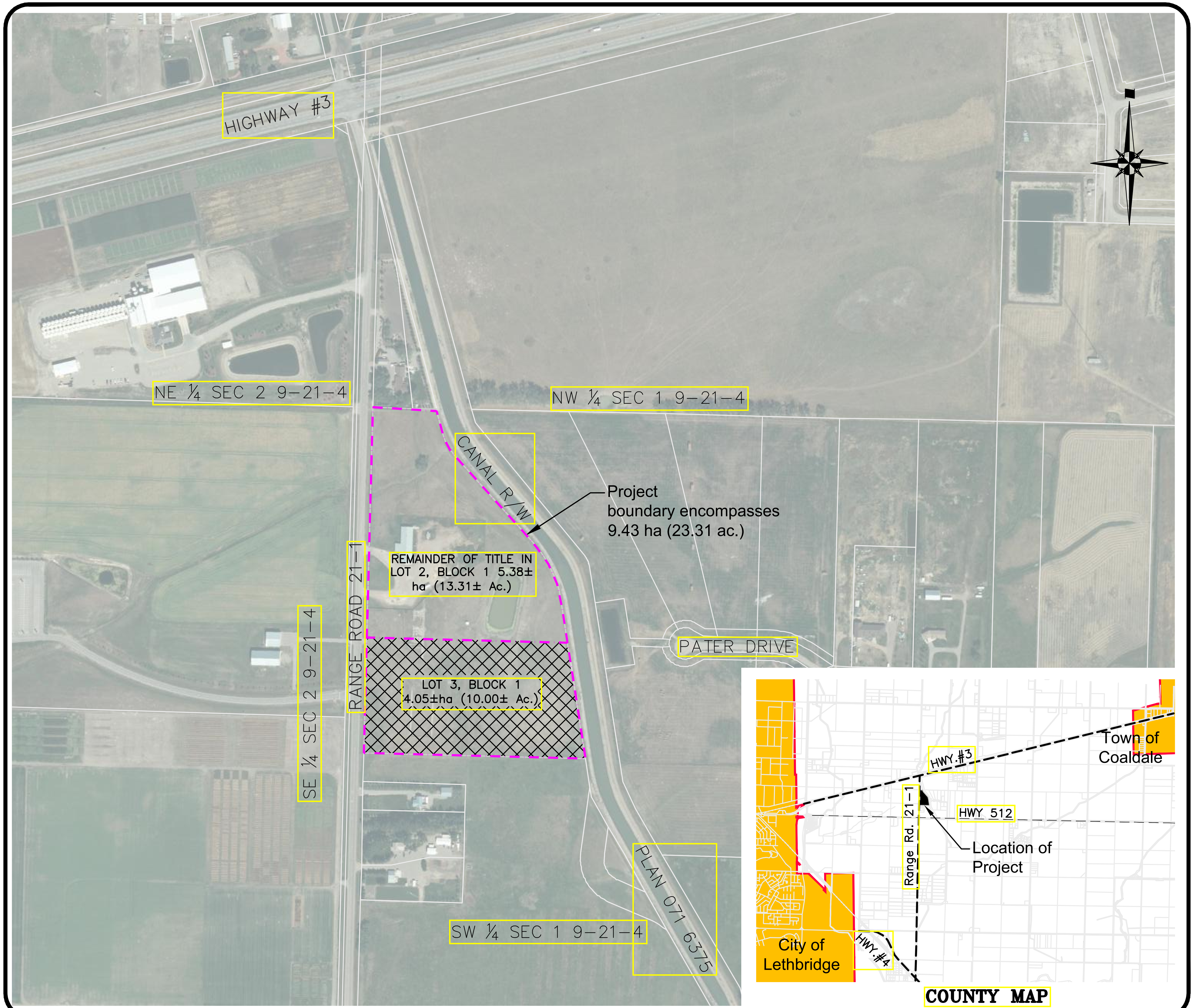
[a] Alberta Soil Information Viewer, Alberta Agriculture and Forestry, http://www4.agric.gov.ab.ca/agrasidviewer

[b] Geotechnical Investigation, Propsed Rural Subdivision, Part of SW-1-9-21-W4, Range Rd 21-1, near Lethbridge, A, Amec Foster Wheeler, August 2016.

[c] MGCL topographical site survey, May 2016.



LEGEND:

▬ ▬ ▬ PROJECT BOUNDARY

EnerClean/Thomson

STORM WATER MANAGEMENT PLAN

PROJECT LOCATION

FIGURE 1

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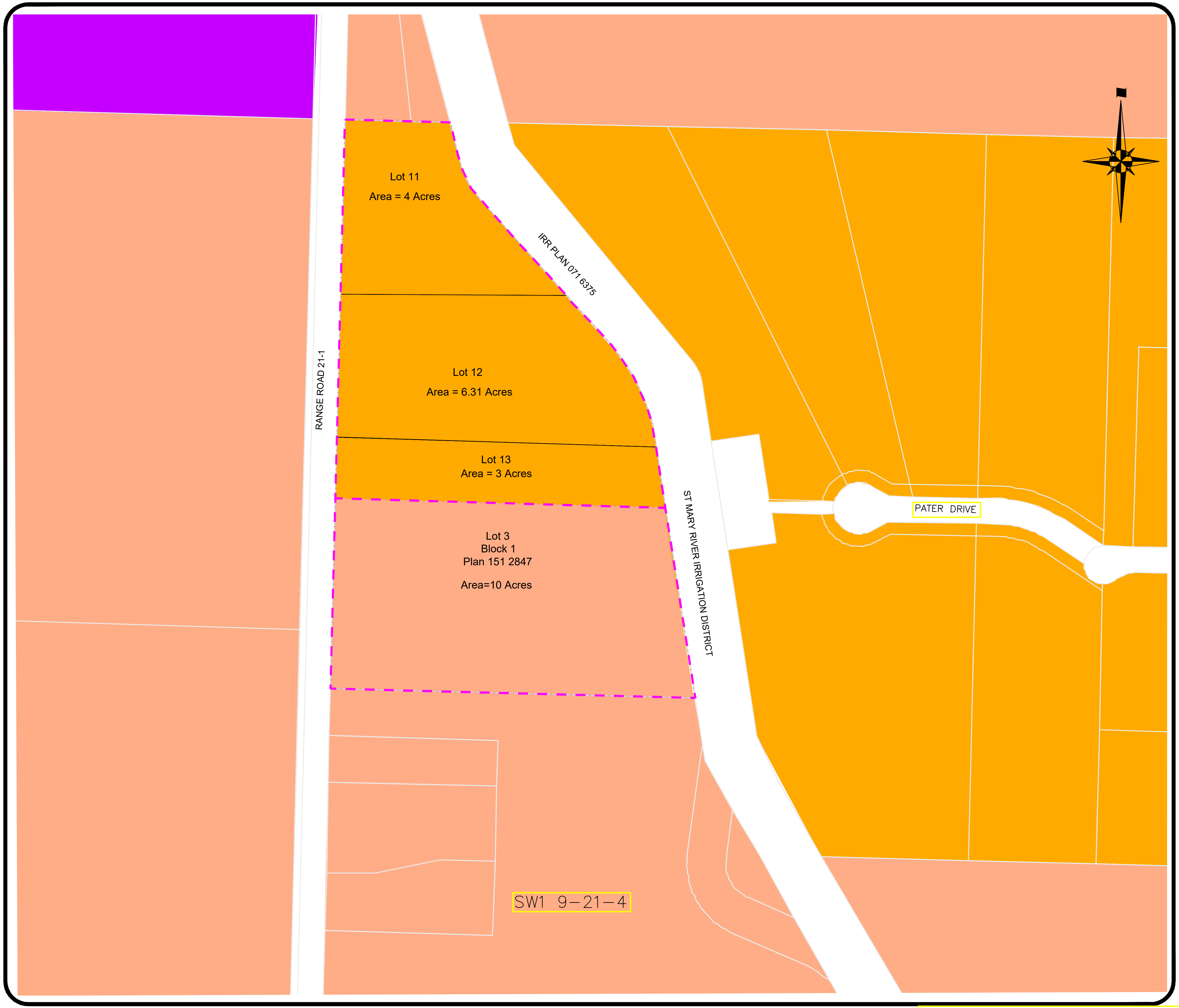

LEGEND:

- - - - PROJECT BOUNDARY

■ LETHBRIDGE URBAN FRINGE (LUF)
■ GROUPED COUNTRY RESIDENTIAL (GCR)
■ RURAL GENERAL INDUSTRIAL (RGI)

EnerClean/Thomson

STORM WATER MANAGEMENT PLAN

PROPOSED SUBDIVISION

FIGURE 2

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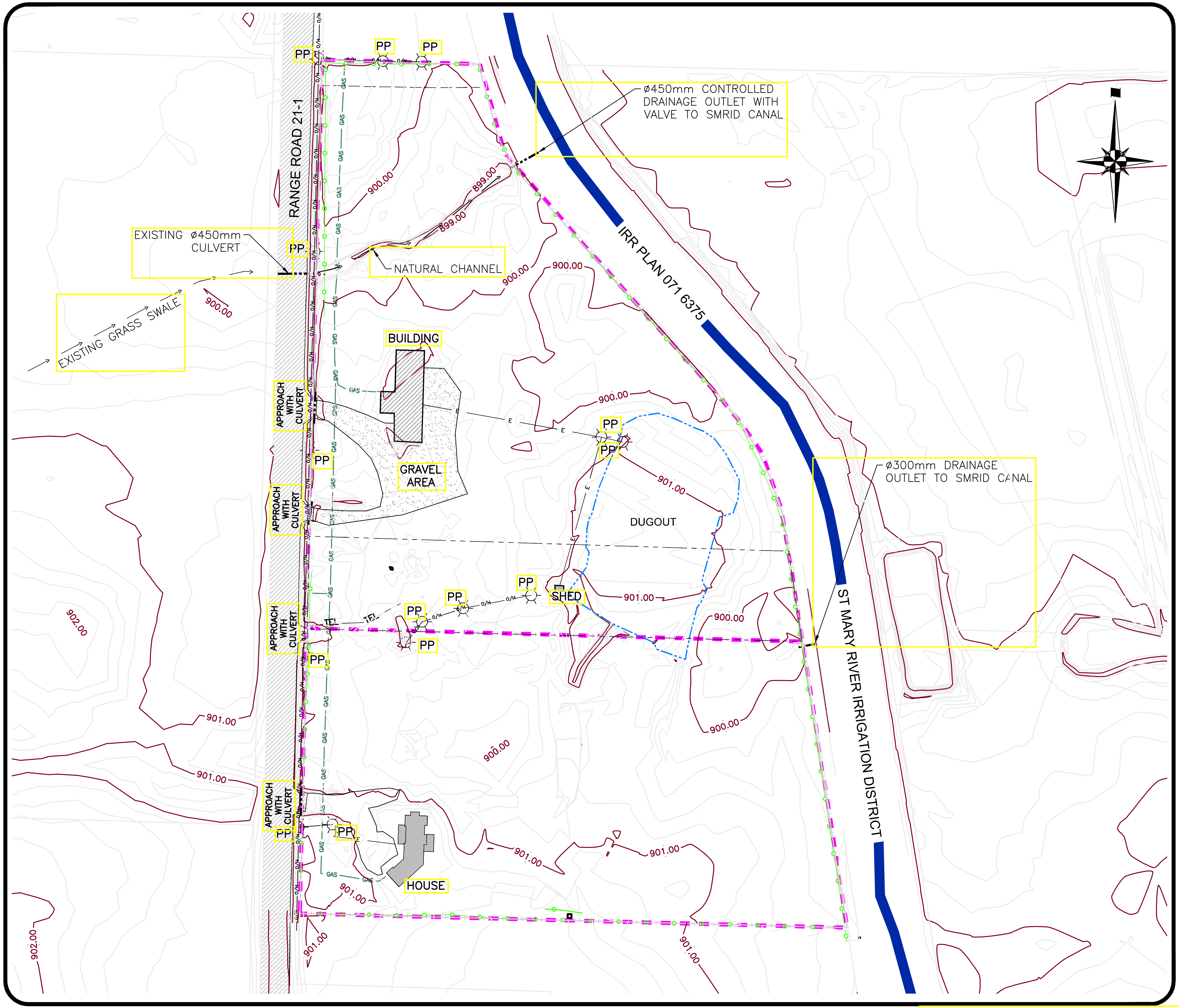

LEGEND:

— · — · —	PROJECT BOUNDARY
PP	POWER POLE w/ OH LINE
▨	EX.HOUSES/STRUCTURES
— · · —	EX. C.S.P.
— GAS — GAS —	EX. GAS LINE
—○—	EX. FENCE LINE
900.00	EX. MAJOR CONTOUR LINE
— O/H —	EX. OH POWER LINE
— E —	EX. ELECTRICAL LINE
→ →	EX. SWALE
- - -	EX. DUGOUT
- - - - - -	EX. WATER LINE

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STORM WATER MANAGEMENT PLAN

EXISTING SITE FEATURES

FIGURE 3

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B. Proposed Development

The proposed development will subdivide the existing parcels into 4 Group Country Residential lots ranging in size from about 1 ha to 4 ha. All of the 4 proposed lots have frontage and direct access on to Range Road 21-1 with approaches. There are no internal access or circulation roads proposed within the development. From a drainage perspective, the runoff discharge rates and volumes will be affected as a result of the development, due to an increase in the amount of impervious areas for the plan area with the addition of hard surfaces including building roofs and driveways. To mitigate this, the development will include detention storage on site with controlled release which is designed to not exceed the pre-development levels. The detention storage areas are located at the low areas of the site and adjacent to the existing drainage outlet locations which release to the SMRID Northeast Lateral Canal. The detention ponds will be built with shallow depressions and berms that are designed to minimize the earthwork efforts and to provide a usable lawn space for residents when the pond is dry. Grass swales will be created to direct runoff away from the buildings and to the designated storage areas. Figure 4 – Proposed Stormwater Upgrades shows the location of proposed detention ponds.

II. METHODOLOGY

Drainage analysis of the proposed development has been completed to determine runoff, storage, and discharge rates for pre and post-development conditions. Existing site analysis (pre-development) has been analyzed to determine a benchmark for allowable release rates at the post development conditions. A stormwater management model[d] has been built to assist with the analysis. The following parameters are included in the modeling:

1. Synthetic Design Storm – Chicago Method: 24-hour duration, 100-year return period, (IDF Parameters A = 1019.20, B = 0, C = 0.731)[e]
2. Rainfall time step = 5 minutes
3. Simulation duration = 24 hrs
4. Routing Method: Dynamic Wave
5. No effect of Evaporation and Groundwater
6. Total Catchment area = 9.45ha
7. Infiltration Method: Green Ampt
8. Manning's N Impervious = 0.015
9. Manning's N Pervious = 0.15 (undeveloped), 0.1 (developed)
10. Depression Storage Pervious = 5mm (undeveloped), 3.8mm (developed)
11. Depression Storage Impervious = $0.77*(S\%)^{-0.49}$

A. Sub-Catchments

The existing (pre-development) and proposed site (post-development) models have been developed to simulate drainage patterns in response to a single event 100yr synthetic design storm. The following tables show the sub catchment parameters assumed in the pre and post-development models:

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[d] EPA Storm Water Management Model – Version 5.0 (Build 5.0.22)

[e] 2016 Design Standards, City of Lethbridge.

Table 1 – Pre Development Sub-Catchment Parameters							
Sub-Catchment ID	Area (ha)	Flow Path (m)	Slope (%)	Soil	H.Con (mm/hr)	S.Head (mm)	IMD
Pre-1	5.41	228	0.6	L, SiL	10.0	127.9	0.36
Pre-2	4.04	234	0.5	L, SiL	10.0	127.9	0.36

Table 2 – Post Development Sub-Catchment Parameters							
Sub-Catchment ID	Area (ha)	Flow Path (m)	Slope (%)	Soil	H.Con (mm/hr)	S.Head (mm)	IMD
Post-1a	4.64	90	1.3	L, SiL	10.0	127.9	0.36
Post-1b	0.77	228	0.6	L, SiL	10.0	127.9	0.36
Post-2	4.04	365	0.71	L, SiL	10.0	127.9	0.36

The source information for the above tables includes:

Area (ha) & Flow Path (m): measured

Slope (%): calculated from field survey

Soil Texture: Alberta Soil Viewer & boreholes

Hydraulic Conductivity (mm/hr) & Suction Head (mm): Soil properties[f]

Initial Moisture Deficit: Typical soil characteristics[g]

Pre-development impervious area: 5%[h]

Post-development impervious area: 20% (estimated)

III. RESULTS

The model results are presented in the following tables. Details of the rainfall runoff modeling are included in Appendix B – SWMM Model Results.

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[f] Rawls, W.J. et al., (1983). J. Hyd. Engr., 109:1316

[g] XP SWMM Soultions, http://help.xpsolutions.com/display/xps2015/Infiltration

[h] 2016 Design Standards, City of Lethbridge.

A. Pre and Post Development Runoff

Table 3 presents the pre-development model results for the sub-catchment runoff generated from a 24 hour duration 100 year storm. Existing subcatchment areas are shown in the attached Appendix.

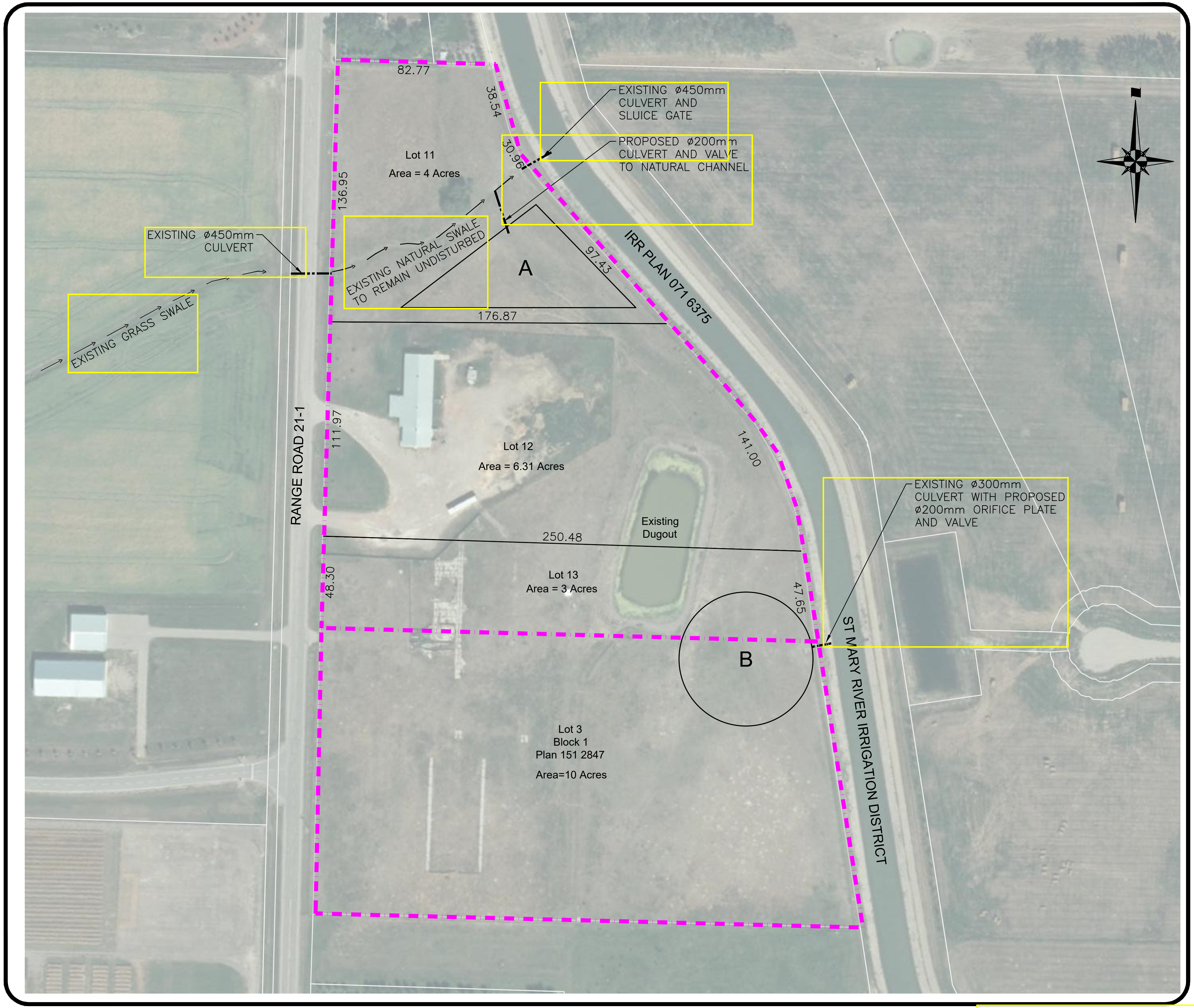
Table 3 – Pre-Development Runoff

Sub Catchment ID	Pre-1	Pre-2	TOTAL
Desc.	North	South	-
Area (ha)	5.41	4.04	9.45
Precipitation (mm)	120.15	120.15	120.15
Infiltration (mm)	92.43	93.15	92.64
Runoff Depth (mm)	27.84	27.09	27.51
Runoff Volume (m^3)	1,510	1,090	2,600
Peak Runoff (m^3/s)	0.39	0.28	-

Table 4 presents the sub-catchment model results for the post-development runoff generated from a 24 hour duration 100 year storm. Proposed subcatchment areas are shown in the attached Appendix.

Table 4 – Post-Development Runoff

Sub Catchment ID	Post-1a	Post-1b	Post-2	TOTAL
Desc.	Center	North	South	-
Area (ha)	4.64	0.77	4.04	9.45
Precipitation (mm)	120.15	120.15	120.15	120.15
Infiltration (mm)	74.65	70.79	75.15	74.45
Runoff Depth (mm)	45.64	50.05	45.09	45.71
Runoff Volume (m^3)	2,120	380	1,820	4,320
Peak Runoff (m^3/s)	0.92	0.25	0.77	-



LEGEND:

- - - PROJECT BOUNDARY

Ⓐ Retention Pond 'A' (Prop. N)
V_{HWL} = 1,300m^3
A_{HWL} = 3,300m^2
d_{HWL} = 0.42m

Ⓑ Retention Pond 'B' (Prop. S)
V_{HWL} = 1,000m^3
A_{HWL} = 3,700m^2
d_{HWL} = 0.56m

EnerClean/Thomson
STORM WATER MANAGEMENT PLAN

PROPOSED STORM WATER UPGRADES

FIGURE 4

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B. Proposed Storage Units

Table 5 displays the proposed detention ponds in response to the 100 year event as shown on Figure 4 – Proposed Stormwater Upgrades.

Table 5 – Proposed Storage Units

Storage Unit	Outlet	Max. Depth (m)	Invert El. NWL (m)	Max. HGL El. (m)	Area bottom (m^2)	Area HWL (m^2)	Max. Volume (m^3)	Min. FF El. (m)
Prop.N	200mm	0.42	899.00	899.42	2,900	3,300	1,292	900.42
Prop.S	200mm	0.56	899.65	900.21	15	3,700	984	901.21
TOTAL	-	-	-	-	-	-	2,276	-

NWL = Normal water level

HWL = High water level

HGL = Hydraulic grade line

Min. FF El. = Minimum finished floor of buildings adjacent to ponds

FF = Finished floor

C. Pre and Post Development Runoff

The pre and post development discharge rates to the SMRID canal are shown below.

Table 6 – Release Rates

Outlet Description	Qpeak (m^3/s)		
	Pre - Development	Post - Development	Net Change
North 450mm Culvert to SMRID Canal	0.264	0.189	-0.075
South 300mm Culvert to SMRID Canal	0.094	0.061	-0.033

IV. RECOMMENDATIONS

It is recommended that the developer(s) provide a combined total of 2,300 m^3 of active stormwater storage to retain the runoff on-site and release at or below the pre-development rates generated from a 1 in 100 year 24 hour storm as outlined in this report. The piped outlets from the ponds will include isolation valves which will be normally open, but can be closed as required by Lethbridge County and SMRID. Detailed designs including detention ponds, outlets, swales and grading plans are recommended prior to construction, which should generally follow the preliminary concepts outlined in this report. The high-water (HWL) level of such detention ponds shall be a minimum of 1.0 m below finished floor (FF) elevations of adjacent buildings. Emergency escape routes shall be provided for a suitable outlet from each pond in the event of flooding.

V. CLOSING

We trust that this report meets the requirements of the Area Structure Plan. Should you require any further information, please contact the undersigned.

Per:	Reviewed by:
(Original signed and sealed August 25, 2016)	(Original signed and sealed August 25, 2016)
Matt Redgrave, P.Eng. Project Manager	Ray Martin, P.Eng. Vice-President

MARTIN GEOMATIC CONSULTANTS LTD.
Association of Professional Engineers and Geoscientists of Alberta
Permit to Practice P05852

Description for Soil Polygon: 5861

LET4/U1h

Orthic Dark Brown Chernozem on medium textured (L, SiL) sediments deposited by wind and water (LET).

The polygon includes soils with Rego profiles (4).

Undulating, high relief landform with a limiting slope of 4% (U1h).

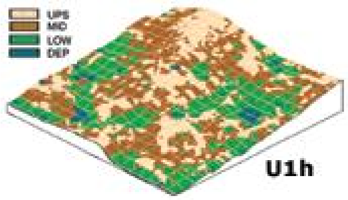
Example site picture(s)

There may be more than one example since different field locations may all fall into the same landform classification.

Click on picture(s) above for larger image.

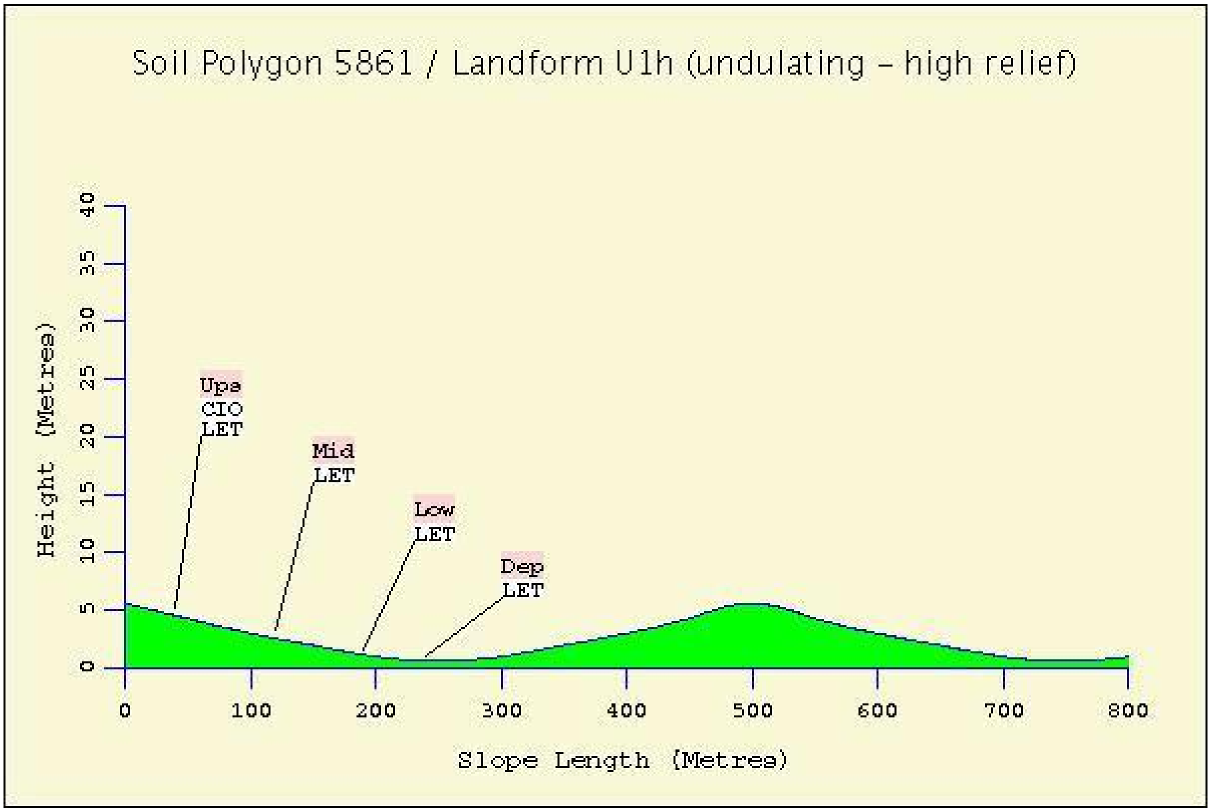
Example 3D picture

Digital elevation picture showing slope distribution.



Click on picture(s) above for larger image.

Landform profile and soil distribution



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Description for Soil Polygon: 5865

LET5/U1l

Orthic Dark Brown Chernozem on medium textured (L, SiL) sediments deposited by wind and water (LET).

The polygon includes soils that are finer textured than the dominant or co-dominant soils (5).

Undulating, low relief landform with a limiting slope of 2% (U1l).

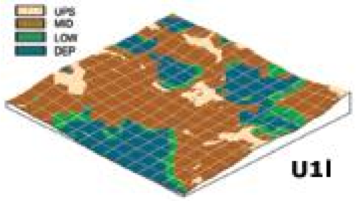
Example site picture(s)

There may be more than one example since different field locations may all fall into the same landform classification.

Click on picture(s) above for larger image.

Example 3D picture

Digital elevation picture showing slope distribution.



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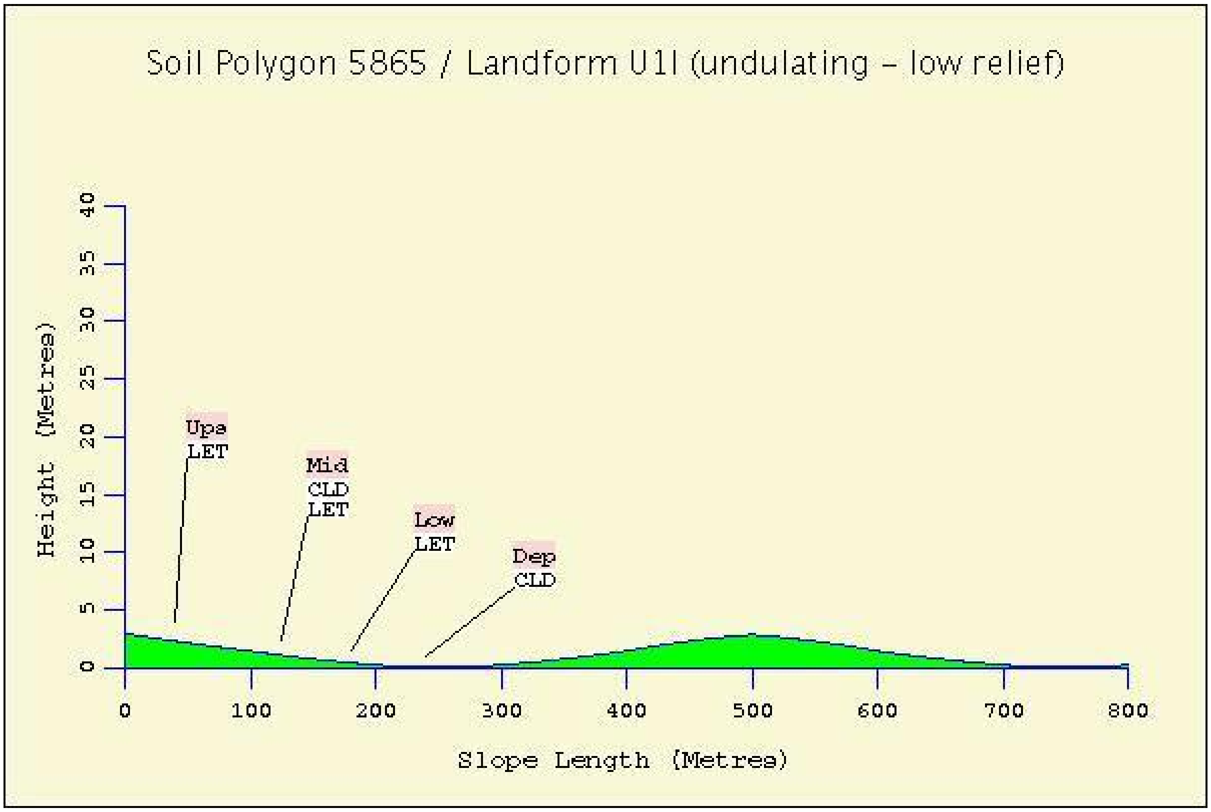
Landform profile and soil distribution



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August 22, 2016

Amec Foster Wheeler File: BX30428

Martin Geomatic Consultants Ltd.
255 – 31 Street North
Lethbridge, AB, T1H 3Z4

Attention: Mr. Ed Martin, P.Eng.

RE: GEOTECHNICAL INVESTIGATION
Proposed Rural Subdivision
Part of SW-1-9-21-W4, Range Rd 21-1, near Lethbridge, AB

1.0 INTRODUCTION

At the request of Martin Geomatic Consultants Ltd., Amec Foster Wheeler Environment & Infrastructure (Amec Foster Wheeler) has carried out a geotechnical investigation to support the development of a rural residential subdivision at the above-captioned site.

Based on information provided to Amec Foster Wheeler, it is understood that the subject land area encompasses about 9.3 ha, and is currently made of up two parcels. It is understood that the north parcel (about 5.4 ha) will be subdivided into three rural residential building lots, as illustrated on Figure 1, attached. The three new lots will range in area between about 1.2 ha and 2.6 ha.

It is understood that the current geotechnical investigation will be used to support the proposed subdivision application.

2.0 METHODOLOGY AND RESULTS

2.1 Methodology

In order to assess the subsurface soil and groundwater conditions at the site, Amec Foster Wheeler visited the site on August 3, 2016 and monitored the drilling a series of four boreholes at the locations denoted on Figure 1 as BH16-01 to BH16-04, inclusive.

The boreholes were advanced using a truck-mounted drill equipped with continuous flight solid stem augers, and extended to depths of 4.5 m to 5.0 m below existing grade. During the drilling, disturbed soil samples were collected from the auger flights. In addition, Standard Penetration Tests (SPTs) were also carried out at regular intervals to assess the soil consistency/compactness, and obtain to representative samples for identification.

Upon completion of the drilling, 25 mm diameter hand-slotted standpipes were inserted into three of the boreholes (BH16-01, BH16-02, and BH16-04) to facilitate measurement of the depth to the groundwater table. The annular space was backfilled with the auger cuttings with a bentonite cap at the surface. The remaining boreholes were backfilled with the auger cuttings.

The drilling was carried out under the supervision of an Amec Foster Wheeler technician, who collected the soil samples and logged the subsurface conditions. The recovered soil samples were transported to Amec Foster Wheeler's Lethbridge laboratory for further review by a geotechnical engineer and selected laboratory classification testing. Laboratory testing for this project consisted of routine moisture content determinations and Atterberg Limits testing, with results presented on the appended borehole logs.

Samples remaining will be stored for a period of three months following this report at which time they will be discarded unless we are requested otherwise by the Client.

2.2 Soil and Groundwater Conditions

The subsurface conditions encountered are detailed on the attached borehole logs and summarized in the following paragraphs. It must be noted that boundaries of soil indicated on the borehole logs are inferred from non-contiguous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purposes of geotechnical design, and should not be interpreted as exact planes of geological change.

The boreholes were each surfaced with a 100 mm thick layer of topsoil.

Underlying the topsoil a 0.65 m thick layer of clay fill was observed at borehole BH16-01. The clay fill was described as medium plastic, silty and sandy, mottled, brown, and moist. The consistency of the clay fill was described as firm (based on tactile observations, and observed drill resistance).

The predominant natural mineral soil encountered underlying the topsoil was clay becoming clay till at depth. The clay and clay till was described as medium plastic, silty and sandy with trace gravel, oxide and coal inclusions, and brown. The consistency of the clay and clay till was described as firm to very stiff (based on tactile observations, observed drill resistance, and SPT N-values ranging between 6 and 28 blows per 300 mm of sampler penetration and pocket penetrometer readings ranging between about 2 kg/cm^2 and 2.5 kg/cm^2). In general, the lower N-values (6 to 16) were observed at depths of 1.5 m and 3 m, with higher N-values (16 to 28) recorded beginning at and below the 3 m test depth.).

Based on laboratory testing, the *in situ* water content of the clay and clay till ranged between about 16.5 percent and 24 percent, generally indicative of moist soil conditions.

The results of Atterberg Limits testing carried out on two representative samples of the clay till are provided on the borehole logs, and detailed in the following table. The results of the Atterberg Limits testing indicated that the clay till is of medium plasticity.

Table 1: Atterberg Limits

Borehole / Sample No.	Liquid Limit, w_L	Plasticity Index, I_P	Moisture Content, w
BH16-02/S2	33%	18%	23.4%
BH16-04/S2	38%	22%	23.1%

The boreholes were each terminated in the clay till stratum.

Details of groundwater seepage are provided on the borehole logs. As noted on the logs, slight groundwater seepage was observed in boreholes BH16-01 and BH16-02 from a depth of about 1.5 m to 2.0 m below existing grade while the remaining boreholes were open and dry upon completion of the drilling.

As indicated previously, 25 mm diameter hand-slotted standpipes were installed in three boreholes (BH16-01 BH16-02 and BH16-04) to facilitate measurement of the depth to groundwater. The standpipes were monitored on August 18, 2016, (about two weeks following the drilling) at which time groundwater was measured at depths of about 2.1 m and 4.5 m below grade at boreholes BH16-01 and BH16-04, respectively. While the remaining standpipe was dry.

It is noted that groundwater conditions are expected to fluctuate seasonally in response to spring thaw and periods of heavy precipitation, and may differ at the time of construction.

3.0 GEOTECHNICAL DISCUSSION AND RECOMMENDATIONS

Based on information provided to Amec Foster Wheeler, it is understood that the subject land area encompasses about 9.3 ha, and is currently made of up two parcels. It is understood that the north parcel (about 5.4 ha) will be subdivided into three rural residential building lots, as illustrated on Figure 1, attached. The three new lots will range in area between about 1.2 ha and 2.6 ha.

Based on the results of the current investigation, the subject site is considered generally suitable for the proposed subdivision and rural residential development.

Based on our understanding of the proposed development as discussed above and in conjunction with the results of the current investigation, the following paragraphs provide preliminary geotechnical discussion and recommendations pertaining to residential construction and onsite sanitary sewage disposal.

3.1 Residential Construction – Preliminary Comments

For preliminary design purposes, the following general discussion and recommendations are offered to support the development of single family residential and related ancillary structures within the study area site. Specific, detailed geotechnical investigations are required for non-residential developments in the subdivision, and may be needed for some residential structures if there are unusual design features associated with the residence.

Conventional Strip and Spread Footing Foundations

Based on AMECs review of the soil conditions within the widely spaced boreholes at the site, the natural occurring clay and clay till encountered within the boreholes is generally considered suitable for the support of conventional strip and spread footings for proposed single family residences. For preliminary design, a Serviceability Limit States (SLS) bearing pressure of 75 kPa is recommended, with a corresponding unfactored Ultimate Limit States (ULS) bearing pressure of 225 kPa. A geotechnical resistance factor of 0.5 should be applied to the ULS bearing pressure, per current building code requirements.

As indicated above, further investigation and/or review of the bearing soils associated with any non-residential structures will be required to support detailed design of the various proposed structures.

For protection against frost action, perimeter footings in heated areas should be extended to provide at least 1.5 m of soil cover. For any unheated buildings or portions of the building, footings should have at least 2.1 m of soil cover. Alternatively, insulation can be used to reduce the thickness of soil cover required.

Damp-Proofing and Drainage

While only minor groundwater was encountered during the current investigation, the installation of weeping tile around residences is still recommended, regardless of groundwater elevation. The requirements for weeping tile installation are outlined in Section 9.14 of the Alberta Building Code. Weeping tiles must discharge to either a gravity outlet, or to a pumped sump, in accordance with local regulatory requirements.

In conjunction with installation of weeping tile, below grade foundation walls around basements require damp proofing, in accordance with the current Alberta Building Code.

Weeping tile flow due to surface water infiltration along foundation walls can be minimized by providing a modest amount of compaction to the exterior foundation wall backfill, thus minimizing future settlement of the backfill. The backfill within two metres of the residence foundation should be graded away from the foundation at approximately a ten percent slope. Downspout roof leaders should discharge onto splash pads at least a metre from the foundation walls.

Construction of Slabs-on-Grade

In general, it is anticipated that engineered fill or the natural clay till at the site will provide adequate support for grade supported basement floors, concrete garage slabs, driveways and parking slabs, provided the subgrade is adequately prepared by stripping topsoil and fill, and reconstruction to achieve design elevations by placement of thin lifts compacted to a minimum of 98 percent of Standard Proctor Maximum Dry Density (SPMDD).

Following preparation of the subgrade surface, a levelling course of 25 mm nominal size well graded crushed gravel at least 150 mm in compacted thickness is recommended directly beneath the slabs. The gravel should also be compacted to at least 98 percent of SPMDD.

For the basement floor slabs, a 150 mm minimum thickness of 25 mm crushed washed rock should be used instead of the well graded crushed gravel.

The excavated subgrade for the slabs on grade should be protected at all times from rain, snow, freezing temperatures, excessive drying and the ingress of free water. To minimize the potential negative effects of settlement or heave in soil below the slabs, it would be preferable to allow slabs to float with no rigid connections to walls or foundation elements except at doorways.

Some relative movement between the slabs-on-grade and adjacent walls or foundations and differential movements within the slabs should be anticipated. Where recommendations outlined in this report are followed, these movements are expected to be within tolerable limits.

3.2 Concrete Mix Considerations

In general, the natural mineral soil deposits in the Lethbridge area contain high levels of water soluble sulphates, indicating severe to very severe potential for sulphate attack on concrete in contact with native mineral soil deposits. Based on the CSA Standard A23.1-09 the Class of Exposure for concrete elements in contact with the clay soils is S-2. Accordingly, sulphate resisting cement (i.e., Type HS, formerly Type 50) should be used in the manufacture of concrete in contact with soil at this site. For durability purposes the concrete must have a maximum water to cementitious materials ratio of 0.45, and a minimum 56 day compressive strength of 32 MPa. Air entrainment and curing should follow CSA A23.1-09 Table 2 requirements.

An air entrainment agent is recommended for concrete exposed to cyclic freeze-thaw action. In addition to the improved durability, the air entraining will provide improved workability of the plastic concrete.

3.3 Onsite Sanitary Sewage Disposal

It is understood that the subject lots will be serviced by private sewage systems which will be developed by the buyer of the individual lots in conjunction the design and construction of proposed residences.

The design and construction of private onsite sanitary sewage disposal systems in Alberta is subject to the requirements of the *Alberta Private Sewage Systems Standard of Practise 2015* (hereafter referred to as the *2015 Standard*).

One of the most significant changes recent changes encompassed in the 2015 Standard compared to prior to the 2009 standard of practice is a shift from a design based on percolation testing to a design based on soil profile and textural classification. Percolation rates can only be used to support a design based on soil profile.

In accordance with *2015 Standard*, a site (i.e., lot) specific evaluation and report is required to support the detailed design and construction of individual private sewage systems. Detailed requirements for the Site Evaluation are provided in Part 7 of the *2015 Standard*.

Using the results of the Site Evaluation, a type of private sewage system best suited for the site is proposed. Selection of the type of system is based on various factors including soil profile, vertical separation between groundwater or impervious layer and point of effluent infiltration, design effluent volume and anticipated effluent strength.

The typical and most cost efficient private sewage system for a single family residential lot generally involves primary treatment of effluent using a septic tank with discharge to a conventional treatment field. The treatment field typically utilizes perforated piping laid in a bed of gravel in trenches which distributes the effluent within a series of trenches to the natural subsurface soils.

Where there are limits imposed by proximity to water table or very low permeable soils, a treatment mound can be considered as an alternative to a conventional treatment field. A treatment mound generally refers to a system where effluent from a septic tank is distributed onto an imported sand layer that is constructed above grade. In this case, the effluent must be discharged into the treatment mound using a pressurized system. Accordingly, the costs associated with importing sand for the treatment mound and operation of a discharge pump make this style of treatment system more costly than the conventional treatment field.

As an alternative, secondary treatment of the effluent can be considered. Secondary treatment of the effluent, as outlined in Part 5 of the *2015 Standard*, can be carried out by means of a sand filter, a re-circulating gravel filter, or a Packaged Sewage Treatment Plant. Where effluent quality meets Level 2 or better (as outlined in Table 5.1.1.1 of the 2015 Standard), the options for disposal of the effluent are less restrictive, and effluent may even be used for sub-surface drip dispersal and irrigation (subject to Section 8.5 of the 2015 Standard).

For the proposed lots, groundwater was measured at depths ranging between about 2.1 m and 4.5 m below existing grades, as detailed in the previous Section 2.2. The groundwater depths observed generally satisfy the vertical separation requirements for soil-based treatment as outlined in Paragraph 8.1.1.4 of the *2015 Standard*.

Based on the current investigation and visual review of samples recovered from boreholes at the site, the soils indicate a textural classification ranging between about SiCL (silty clay loam) to C (clay). Based on the results of the textural classification, the site is considered marginally suitable for effluent discharge using a conventional treatment field, and a treatment mound or secondary treatment of the effluent may be warranted.

It is noted that the detailed design of each proposed discharge field must be based on a soil profile assessment and textural classification of test pits within the footprint of the proposed discharge fields, and that these textural classifications will vary somewhat from the classification indicated above.

4.0 CLOSURE

The recommendations given in the above sections are based upon interpreted conditions found within the four boreholes advanced at this site. Should subsurface conditions other than those presented in this report be encountered during construction, the Client should notify our office so that these recommendations can be reviewed.

Soil conditions, by their nature, can be highly variable across a site. A contingency should be included in the construction budget to allow for the possibility of variations in soil conditions, which may result in modification of the design, and/or changes in the construction procedures.

It is noted that the recommendations outlined herein are considered 'preliminary' relative to the actual design, development and construction of proposed residences within the subject site. Further investigation and analyses may be required to support detailed design and construction of the proposed development.

This report has been prepared for the exclusive use of Martin Geomatic Consultants Ltd. and their designers for the specific application to the development described in this report. Any use that a third party makes of this report, or any reliance or decisions based on this report are the sole responsibility of those parties. This report has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made.

We trust that this report satisfies your present requirements, and we look forward to assisting you in the completion of this project. Should you have any questions, please contact the undersigned at your convenience.

Yours truly,

Amec Foster Wheeler Environment & Infrastructure
A division of Amec Foster Wheeler Americas Ltd.

JOHN LOBBEZOO
Aug 22, 2016

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APEGA PERMIT P04546

Attachments:
Figure 1 Borehole Location Plan
Borehole Logs
Explanation of Symbols and Terms

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Fax (403) 327-7682

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Martin Geomatics Consultants Ltd.

TITLE: BOREHOLE LOCATION PLAN

DWN BY: BJ

DATUM: NA

DATE: AUGUST 2016

PROJECT:
Proposed Rural Residential Subdivision
SW1-9-21-W4M
near Lethbridge, Alberta

CHK'D BY: JS

PROJECT NO: BX30428

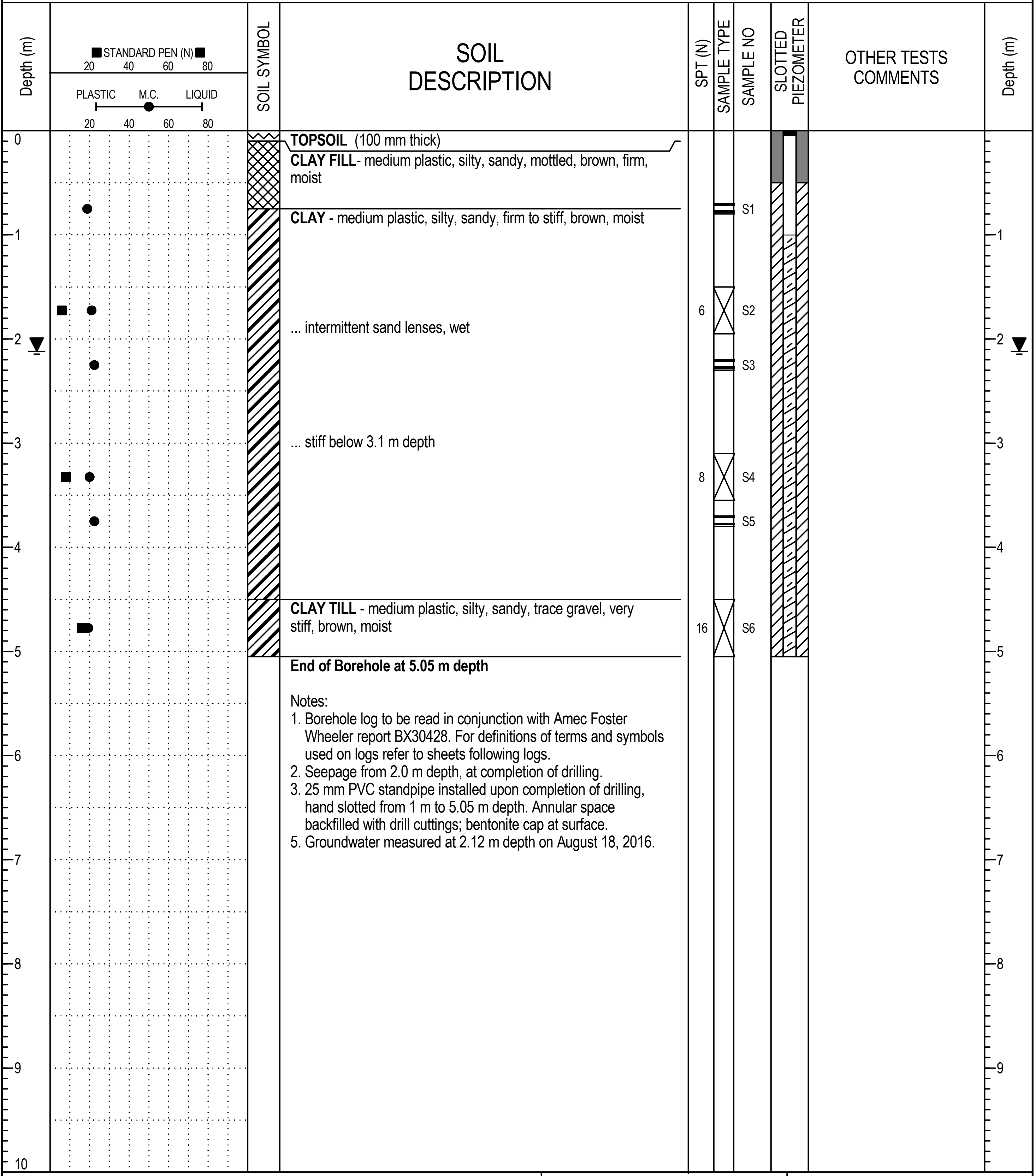
SCALE: NTS

FIGURE 1

PROJECT: Proposed Rural Residential Subdivision	DRILLER: Chilako Drilling Services Ltd.	BOREHOLE NO: **BH16-01**
CLIENT: Martin Geomatic Consultants Ltd.	DRILL/METHOD: Truck Mounted C-1150 Drill/ SSA	PROJECT NO: BX30428
LOCATION: South of the proposed development area. Refer to Figure 1		ELEVATION: --

SAMPLE TYPE ■ Shelby Tube ◪ No Recovery ☒ SPT Test (N) ☰ Grab Sample ▥ Split-Pen ◧ Core

BACKFILL TYPE ▩ Bentonite ⁚ Pea Gravel ▥ Slough ⁘ Grout ▨ Drill Cuttings ⁙ Sand



SOIL DESCRIPTION

TOPSOIL (100 mm thick)

CLAY FILL- medium plastic, silty, sandy, mottled, brown, firm, moist

CLAY - medium plastic, silty, sandy, firm to stiff, brown, moist

... intermittent sand lenses, wet

... stiff below 3.1 m depth

CLAY TILL - medium plastic, silty, sandy, trace gravel, very stiff, brown, moist

End of Borehole at 5.05 m depth

Notes:

1. Borehole log to be read in conjunction with Amec Foster Wheeler report BX30428. For definitions of terms and symbols used on logs refer to sheets following logs.
2. Seepage from 2.0 m depth, at completion of drilling.
3. 25 mm PVC standpipe installed upon completion of drilling, hand slotted from 1 m to 5.05 m depth. Annular space backfilled with drill cuttings; bentonite cap at surface.
5. Groundwater measured at 2.12 m depth on August 18, 2016.

SPT (N)	SAMPLE NO
	S1
6	S2
	S3
8	S4
	S5
16	S6

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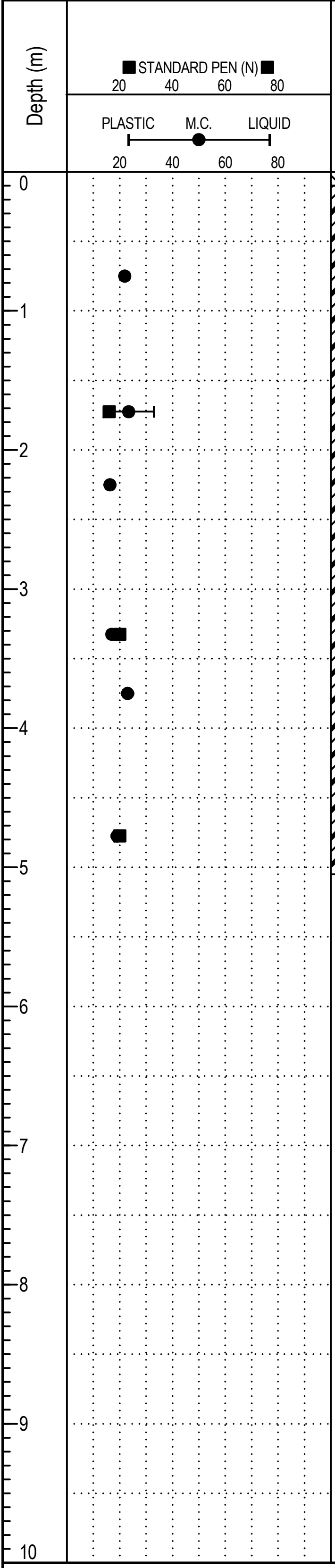
Environment & Infrastructure

LOGGED BY: SR	COMPLETION DEPTH: 5.05 m
REVIEWED BY: JL	COMPLETION DATE: 3/8/16

PROJECT: Proposed Rural Residential Subdivision	DRILLER: Chilako Drilling Services Ltd.	BOREHOLE NO: **BH16-02**
CLIENT: Martin Geomatic Consultants Ltd.	DRILL/METHOD: Truck Mounted C-1150 Drill/ SSA	PROJECT NO: BX30428
LOCATION: Centre of the proposed development area. Refer to Figure 1		ELEVATION: --

SAMPLE TYPE	■ Shelby Tube	▨ No Recovery	☒ SPT Test (N)	☰ Grab Sample	▥ Split-Pen	▮ Core
BACKFILL TYPE	▩ Bentonite	⁘ Pea Gravel	▥ Slough	⁖ Grout	▨ Drill Cuttings	⁙ Sand



SOIL SYMBOL

SOIL DESCRIPTION

TOPSOIL (100 mm thick)

CLAY TILL - medium plastic, silty, sandy, trace gravel, very stiff, brown, moist

... intermittent thin sand stringers, wet

End of Borehole at 5.05 m depth

Notes:
1. Borehole log to be read in conjunction with Amec Foster Wheeler report BX30428. For definitions of terms and symbols used on logs refer to sheets following logs.
2. Seepage from 1.5 m depth, at completion of drilling.
3. 25 mm PVC standpipe installed upon completion of drilling, hand slotted from 1 m to 5.05 m depth. Annular space backfilled with drill cuttings; bentonite cap at surface.
5. Standpipe was dry on August 18, 2016.

SPT (N)	SAMPLE TYPE	SAMPLE NO
	☰	S1
16	☒	S2
	☰	S3
20	☒	S4
	☰	S5
20	☒	S6

SLOTTED PIEZOMETER

OTHER TESTS COMMENTS

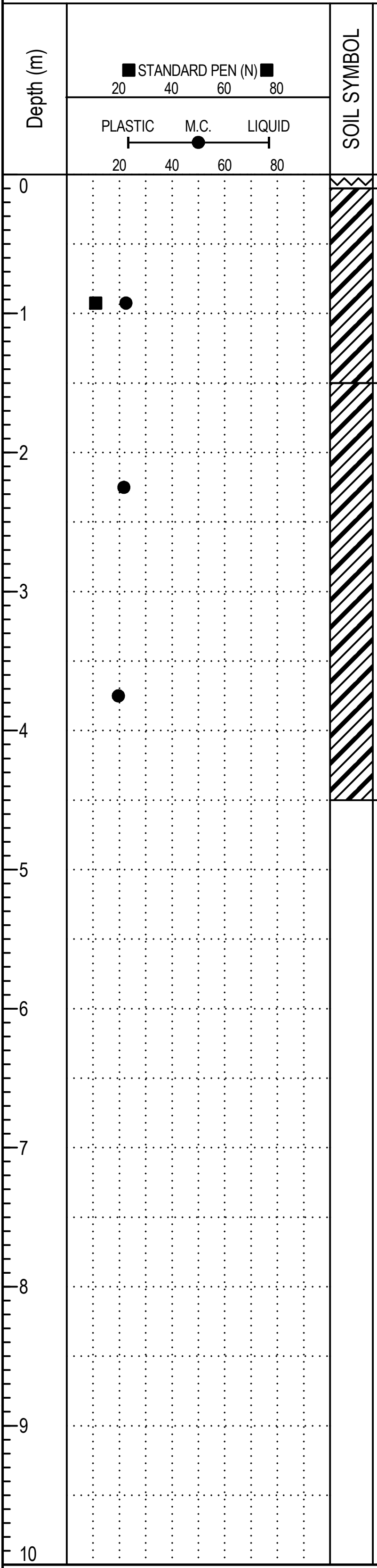
Depth (m)

Amec Foster Wheeler Environment & Infrastructure	LOGGED BY: SR	COMPLETION DEPTH: 5.05 m
	REVIEWED BY: JL	COMPLETION DATE: 3/8/16
		Page 1 of 1

PROJECT: Proposed Rural Residential Subdivision	DRILLER: Chilako Drilling Services Ltd.	BOREHOLE NO: **BH16-03**
CLIENT: Martin Geomatic Consultants Ltd.	DRILL/METHOD: Truck Mounted C-1150 Drill/ SSA	PROJECT NO: BX30428
LOCATION: Proposed dugout/berm area. Refer to Figure 1		ELEVATION: --

SAMPLE TYPE ■ Shelby Tube ▨ No Recovery ☒ SPT Test (N) ☰ Grab Sample ▥ Split-Pen ◨ Core

BACKFILL TYPE ■ Bentonite ⁘ Pea Gravel ▥ Slough ⁘ Grout ▨ Drill Cuttings ⁘ Sand



SOIL DESCRIPTION	SPT (N)	SAMPLE TYPE	SAMPLE NO	OTHER TESTS COMMENTS
TOPSOIL (100 mm thick)				
CLAY - medium plastic, silty, sandy, stiff, brown, moist to very moist	11	☒	S1	
CLAY TILL - medium plastic, silty, sandy, trace gravel, coal & oxide inclusions, very stiff, brown, moist		☰	S2	PP = 2.0 kg/cm².
		☰	S3	PP = 2.5 kg/cm².

End of Borehole at 4.5 m depth

Notes:

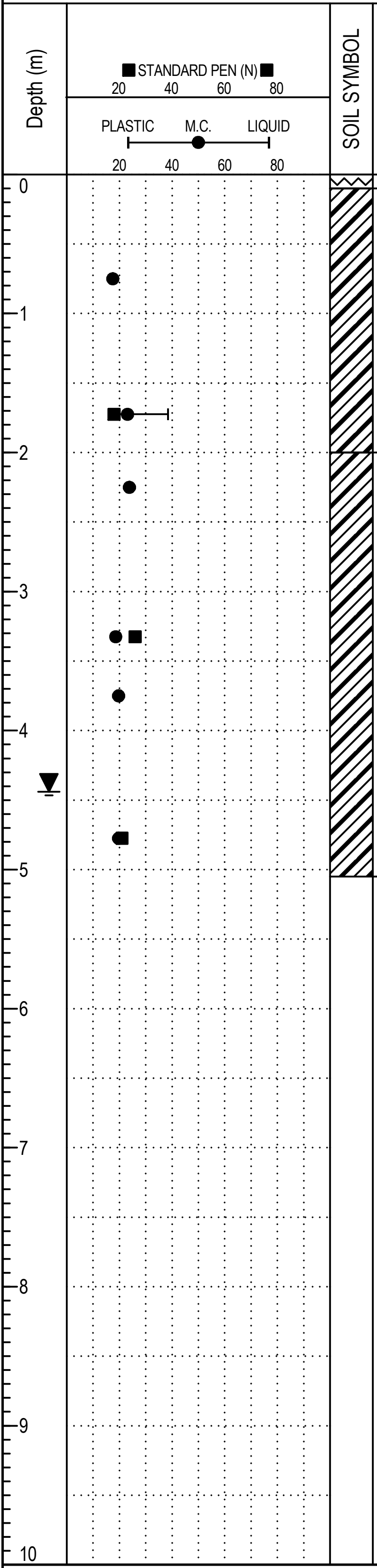
1. Borehole log to be read in conjunction with Amec Foster Wheeler report BX30428. For definitions of terms and symbols used on logs refer to sheets following logs.
2. Borehole open and dry at completion of drilling.
3. Borehole backfilled with drill cuttings.

Amec Foster Wheeler Environment & Infrastructure	LOGGED BY: SR	COMPLETION DEPTH: 4.50 m
	REVIEWED BY: JL	COMPLETION DATE: 3/8/16
		Page 1 of 1

PROJECT: Proposed Rural Residential Subdivision	DRILLER: Chilako Drilling Services Ltd.	BOREHOLE NO: **BH16-04**
CLIENT: Martin Geomatic Consultants Ltd.	DRILL/METHOD: Truck Mounted C-1150 Drill/ SSA	PROJECT NO: BX30428
LOCATION: North of the proposed development area. Refer to Figure 1		ELEVATION: --

SAMPLE TYPE ■ Shelby Tube ▨ No Recovery ☒ SPT Test (N) ☰ Grab Sample ▥ Split-Pen ◧ Core

BACKFILL TYPE ■ Bentonite ⁘ Pea Gravel ▥ Slough ⁘ Grout ▨ Drill Cuttings ⁘ Sand



SOIL DESCRIPTION

TOPSOIL (100 mm thick)

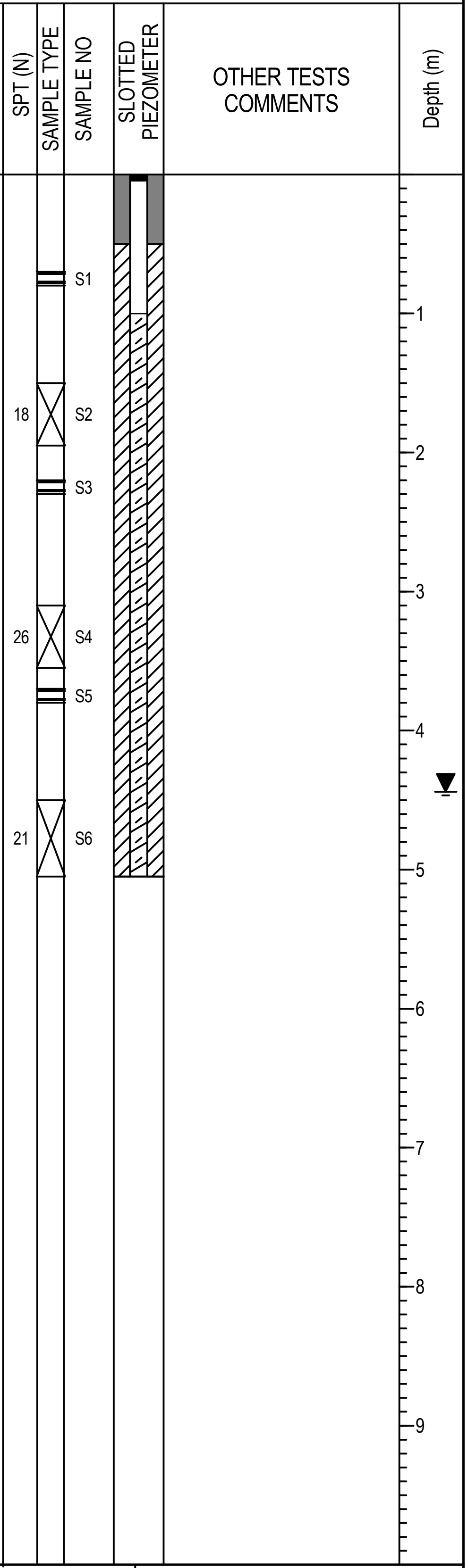
CLAY - medium plastic, silty, sandy, trace gravel, stiff to very stiff, brown, damp to moist

... very stiff below 1.5 m depth

CLAY TILL - medium plastic, silty, sandy, trace gravel, coal & oxide inclusions, very stiff, brown, moist

End of Borehole at 5.05 m depth

Notes:
1. Borehole log to be read in conjunction with Amec Foster Wheeler report BX30428. For definitions of terms and symbols used on logs refer to sheets following logs.
sheets following logs.
2. Borehole open and dry at completion of drilling.
3. 25 mm PVC standpipe installed upon completion of drilling, hand slotted from 1 m to 5.05 m depth. Annular space backfilled with drill cuttings; bentonite cap at surface.
5. Groundwater measured at 4.44 m depth on August 18, 2016.



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Environment & Infrastructure

LOGGED BY: SR	COMPLETION DEPTH: 5.05 m
REVIEWED BY: JL	COMPLETION DATE: 3/8/16
	Page 1 of 1

EXPLANATION OF TERMS AND SYMBOLS

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

It should be noted that materials, boundaries and conditions have been established only at the borehole locations at the time of investigation and are not necessarily representative of subsurface conditions elsewhere across the site.

TEST DATA

Data obtained during the field investigation and from laboratory testing are shown at the appropriate depth interval.

Abbreviations, graphic symbols, and relevant test method designations are as follows:

*C	Consolidation test	*ST	Swelling test
D_R	Relative density	TV	Torvane shear strength
*k	Permeability coefficient	VS	Vane shear strength
*MA	Mechanical grain size analysis	w	Natural Moisture Content (ASTM D2216)
	and hydrometer test	w_l	Liquid limit (ASTM D 423)
N	Standard Penetration Test (CSA A119.1-60)	w_p	Plastic Limit (ASTM D 424)
N_d	Dynamic cone penetration test	E_f	Unit strain at failure
NP	Non plastic soil	γ	Unit weight of soil or rock
pp	Pocket penetrometer strength (kg/cm^2)	γ_d	Dry unit weight of soil or rock
*q	Triaxial compression test	ρ	Density of soil or rock
q_u	Unconfined compressive strength	ρ_d	Dry Density of soil or rock
*SB	Shearbox test	C_u	Undrained shear strength
SO_4	Concentration of water-soluble sulphate	→	Seepage
		▼	Observed water level

* The results of these tests are usually reported separately

Soils are classified and described according to their engineering properties and behaviour.

The soil of each stratum is described using the Unified Soil Classification System[1] modified slightly so that an inorganic clay of "medium plasticity" is recognized.

The modifying adjectives used to define the actual or estimated percentage range by weight of minor components are consistent with the Canadian Foundation Engineering Manual[2].

Relative Density and Consistency:

Cohesionless Soils		Cohesive Soils		
Relative Density	SPT (N) Value	Consistency	Undrained Shear Strength c_u (kPa)	Approximate SPT (N) Value
Very Loose	0-4	Very Soft	0-12	0-2
Loose	4-10	Soft	12-25	2-4
Compact	10-30	Firm	25-50	4-8
Dense	30-50	Stiff	50-100	8-15
Very Dense	>50	Very Stiff	100-200	15-30
		Hard	>200	>30

Standard Penetration Resistance ("N" value)
The number of blows by a 63.6kg hammer dropped 760 mm to drive a 50 mm diameter open sampler attached to "A" drill rods for a distance of 300 mm.

---

[1] "Unified Soil Classification System", Technical Memorandum 36-357 prepared by Waterways Experiment Station, Vicksburg, Mississippi, Corps of Engineers, U.S. Army. Vol. 1 March 1953.

[2] "Canadian Foundation Engineering Manual", 4th Edition, Canadian Geotechnical Society, 2006.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	COLOUR CODE	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75µm)	GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75mm	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	△	RED	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			GP	▲	RED	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY GRAVELS (WITH SOME FINES)	GM	▥	YELLOW	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12 %	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			GC	▨	YELLOW	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
	SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75mm	CLEAN SANDS (LITTLE OR NO FINES)	SW	⁘	RED	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{60})^2}{D_{10} \times D_{60}} = 1$ to 3	
			SP	○	RED	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY SANDS (WITH SOME FINES)	SM	▥	YELLOW	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12 %	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			SC	▨	YELLOW	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75µm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	W_L< 50%	ML	▥	GREEN	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)	
		W_L< 50%	MH	▥	BLUE	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDS OR SILTY SOILS		
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	W_L< 30%	CL	▨	GREEN	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS		
		30% <W_L< 50%	CI	▨	GREEN-BLUE	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		W_L> 50%	CH	▨	BLUE	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS BELOW "A" LINE	W_L< 50%	OL	┆	GREEN	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	WHENEVER THE NATURE OF THE FINES CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER "F", E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY	
		W_L> 50%	OH	╱	BLUE	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt	〰	ORANGE	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBEROUS TEXTURE	

SPECIAL SYMBOLS

LIMESTONE	▦	OILSAND	▨
SANDSTONE	⁘	SHALE	☰
SILTSTONE	┅	FILL (UNDIFFERENTIATED)	▩

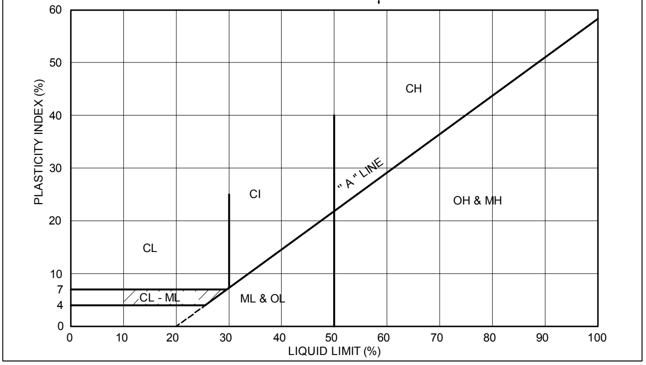
SOIL COMPONENTS

FRACTION	U.S. STANDARD SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
GRAVEL	PASSING	RETAINED	PERCENT	DESCRIPTOR
COARSE	76mm	19mm		
FINE	19mm	4.75mm	35-50	AND
SAND				
COARSE	4.75mm	2.00mm	20-35	Y/EY
MEDIUM	2.00mm	425µm		
FINE	425µm	75µm	10-20	SOME
FINES (SILT OR CLAY BASED ON PLASTICITY)	75µm		1-10	TRACE

OVERSIZED MATERIAL

ROUNDED OR SUBROUNDED:	NOT ROUNDED:
COBBLES 76mm TO 200mm	ROCK FRAGMENTS > 76mm
BOULDERS > 200mm	ROCKS > 0.76 CUBIC METRE IN VOLUME

PLASTICITY CHART FOR SOILS PASSING 425 µm SIEVE



NOTES:

1. ALL SIEVE SIZES MENTIONED ON THIS CHART ARE U.S. STANDARD A.S.T.M. E.11
2. COARSE GRAIN SOILS WITH 5 TO 12% FINES GIVEN COMBINED GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL SAND MIXTURE WITH CLAY BINDER BETWEEN 5 AND 12% FINES.

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APPENDIX B

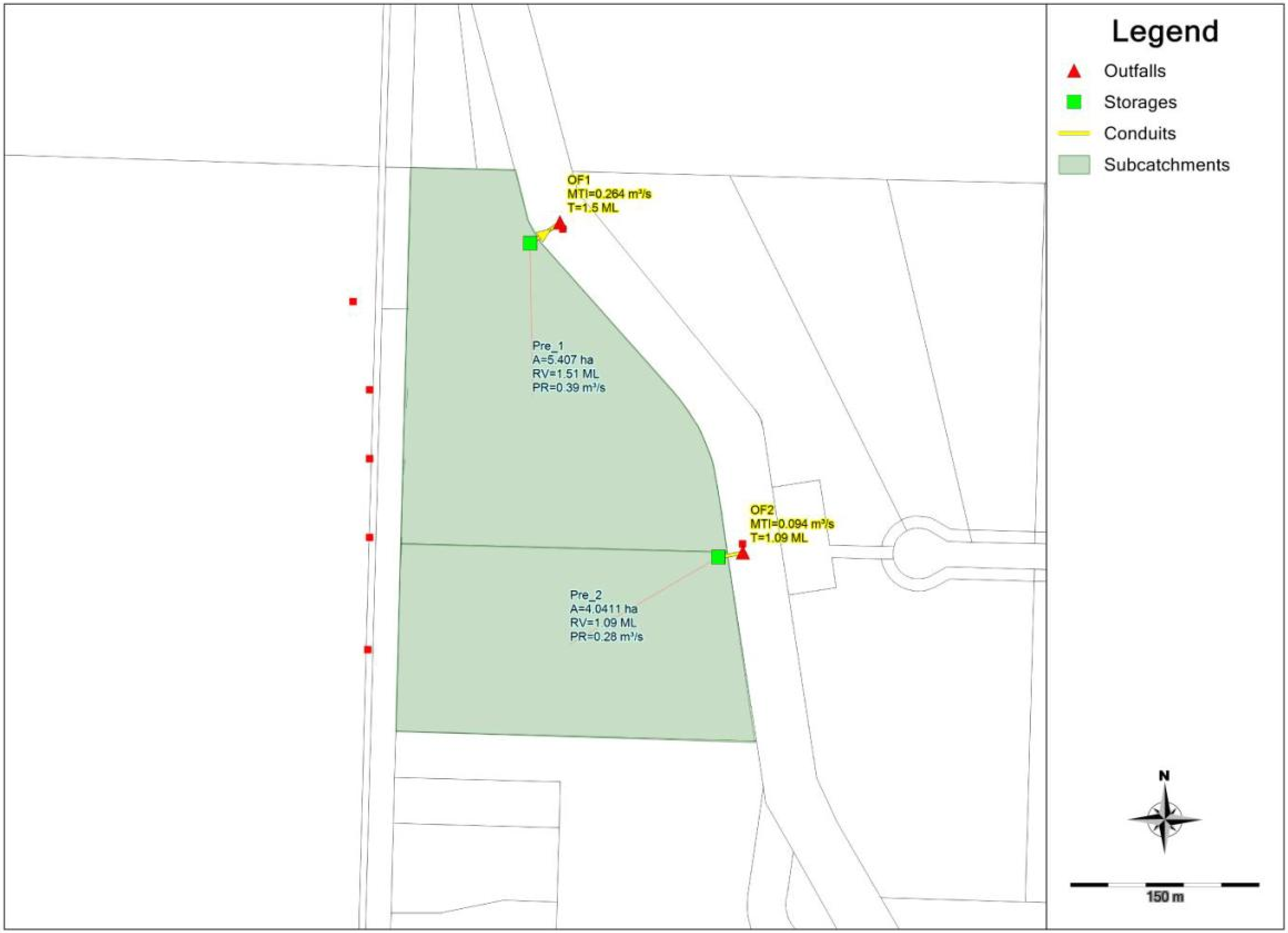
SWMM MODEL RESULTS

SITE DRAINANGE ANALYSIS
ENERCLEAN THOMSON SUBDIVISION
SW-1-9-21-WM4
LETHBRIDGE COUNTY
ALBERTA

Pre-Development

Runoff Analysis

EPA SWMM 5.1


Legend
Outfalls
Storages
Conduits
Subcatchments
OF1
MTI=0.264 m³/s
T=1.5 ML
Pre_1
A=5.407 ha
RV=1.51 ML
PR=0.39 m³/s
OF2
MTI=0.094 m³/s
T=1.09 ML
Pre_2
A=4.0411 ha
RV=1.09 ML
PR=0.28 m³/s
N
150 m

```
[TITLE]

[OPTIONS]
;;Options            Value
;;------------------ ------------
FLOW_UNITS           CMS
INFILTRATION         GREEN_AMPT
FLOW_ROUTING         DYNWAVE
START_DATE           06/30/2016
START_TIME           00:00:00
REPORT_START_DATE    06/30/2016
REPORT_START_TIME    00:00:00
END_DATE             07/01/2016
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:01:00
WET_STEP             00:05:00
DRY_STEP             00:05:00
ROUTING_STEP         5
ALLOW_PONDING        YES
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[EVAPORATION]
;;Type          Parameters
;;------------- ----------
CONSTANT     0.0
DRY_ONLY     NO

[RAINGAGES]
;;                    Rain      Time   Snow   Data
```

```
;;Name                Type      Intrvl Catch  Source
;;------------------- --------- ------ ------ ----------
Lethbridge_100yr_24hr INTENSITY 0:05   1.0    TIMESERIES Lethbridge_100yr_24hr

[SUBCATCHMENTS]
;;                                                 Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
Pre_1            Lethbridge_100yr_24hr J1          5.407    5        237.149  0.6      0
Pre_2            Lethbridge_100yr_24hr J2          4.0411   5        172.697  0.5      0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
Pre_1            0.015      0.15       1.28       5          0          OUTLET
Pre_2            0.015      0.15       1.4        5          0          OUTLET

[INFILTRATION]
;;Subcatchment   Suction    HydCon     IMDmax
;;-------------- ---------- ---------- ----------
Pre_1            127.85     10         0.357
Pre_2            127.85     10         0.357

[OUTFALLS]
;;               Invert     Outfall      Stage/Table      Tide
;;Name           Elev.      Type         Time Series      Gate Route To
;;-------------- ---------- ------------ ---------------- ---- ----------------
OF1              898.52     FREE                          NO
OF2              899.59     FREE                          NO

[STORAGE]
;;               Invert   Max.     Init.    Storage    Curve                      Ponded   Evap.
;;Name           Elev.    Depth    Depth    Curve      Params                     Area     Frac.    Infiltration parameters
;;-------------- -------- -------- -------- ---------- -------- -------- -------- -------- -------- -----------------------
J1               898.54   2.46     0        TABULAR    ex.north_channel           0        0
J2               899.65   1.35     0        TABULAR    ex.south_depression           0     0

[CONDUITS]
;;               Inlet            Outlet                      Manning    Inlet      Outlet     Init.      Max.
;;Name           Node             Node             Length     N          Offset     Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- ----------
C1               J1               OF1              17.6       0.022      0          0          0          0
C2               J2               OF2              8          0.022      0          0          0          0

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels
```

```
;;-------------- ------------ ---------------- ---------- ---------- ---------- ----------
C1               CIRCULAR     0.45             0          0          0          1
C2               CIRCULAR     0.3              0          0          0          1

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
ex.north_channel Storage    0          2
ex.north_channel            .2         33
ex.north_channel            .4         105
ex.north_channel            .6         333
ex.north_channel            .8         545

ex.south_depression Storage    0          15
ex.south_depression            0.2        750
ex.south_depression            0.4        2387

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
;Chicago design storm, a = 1019.2, b = 0, c = 0.731, Duration = 1440 minutes, r = 0.35, rain units = mm/hr.
Lethbridge_100yr_24hr            0:00       1.352
Lethbridge_100yr_24hr            0:05       1.361
Lethbridge_100yr_24hr            0:10       1.372
Lethbridge_100yr_24hr            0:15       1.382
Lethbridge_100yr_24hr            0:20       1.392
Lethbridge_100yr_24hr            0:25       1.403
Lethbridge_100yr_24hr            0:30       1.414
Lethbridge_100yr_24hr            0:35       1.425
Lethbridge_100yr_24hr            0:40       1.436
Lethbridge_100yr_24hr            0:45       1.448
Lethbridge_100yr_24hr            0:50       1.459
Lethbridge_100yr_24hr            0:55       1.471
Lethbridge_100yr_24hr            1:00       1.483
Lethbridge_100yr_24hr            1:05       1.496
Lethbridge_100yr_24hr            1:10       1.509
Lethbridge_100yr_24hr            1:15       1.521
Lethbridge_100yr_24hr            1:20       1.535
Lethbridge_100yr_24hr            1:25       1.548
Lethbridge_100yr_24hr            1:30       1.562
Lethbridge_100yr_24hr            1:35       1.576
Lethbridge_100yr_24hr            1:40       1.59
```

Lethbridge_100yr_24hr	1:45	1.605
Lethbridge_100yr_24hr	1:50	1.62
Lethbridge_100yr_24hr	1:55	1.635
Lethbridge_100yr_24hr	2:00	1.651
Lethbridge_100yr_24hr	2:05	1.667
Lethbridge_100yr_24hr	2:10	1.683
Lethbridge_100yr_24hr	2:15	1.7
Lethbridge_100yr_24hr	2:20	1.717
Lethbridge_100yr_24hr	2:25	1.735
Lethbridge_100yr_24hr	2:30	1.753
Lethbridge_100yr_24hr	2:35	1.771
Lethbridge_100yr_24hr	2:40	1.79
Lethbridge_100yr_24hr	2:45	1.809
Lethbridge_100yr_24hr	2:50	1.829
Lethbridge_100yr_24hr	2:55	1.85
Lethbridge_100yr_24hr	3:00	1.871
Lethbridge_100yr_24hr	3:05	1.892
Lethbridge_100yr_24hr	3:10	1.914
Lethbridge_100yr_24hr	3:15	1.937
Lethbridge_100yr_24hr	3:20	1.961
Lethbridge_100yr_24hr	3:25	1.985
Lethbridge_100yr_24hr	3:30	2.009
Lethbridge_100yr_24hr	3:35	2.035
Lethbridge_100yr_24hr	3:40	2.061
Lethbridge_100yr_24hr	3:45	2.089
Lethbridge_100yr_24hr	3:50	2.117
Lethbridge_100yr_24hr	3:55	2.146
Lethbridge_100yr_24hr	4:00	2.176
Lethbridge_100yr_24hr	4:05	2.206
Lethbridge_100yr_24hr	4:10	2.238
Lethbridge_100yr_24hr	4:15	2.272
Lethbridge_100yr_24hr	4:20	2.306
Lethbridge_100yr_24hr	4:25	2.341
Lethbridge_100yr_24hr	4:30	2.378
Lethbridge_100yr_24hr	4:35	2.416
Lethbridge_100yr_24hr	4:40	2.456
Lethbridge_100yr_24hr	4:45	2.498
Lethbridge_100yr_24hr	4:50	2.541
Lethbridge_100yr_24hr	4:55	2.585
Lethbridge_100yr_24hr	5:00	2.632
Lethbridge_100yr_24hr	5:05	2.681
Lethbridge_100yr_24hr	5:10	2.732
Lethbridge_100yr_24hr	5:15	2.785
Lethbridge_100yr_24hr	5:20	2.841
Lethbridge_100yr_24hr	5:25	2.9
Lethbridge_100yr_24hr	5:30	2.961

Lethbridge_100yr_24hr	5:35	3.026
Lethbridge_100yr_24hr	5:40	3.094
Lethbridge_100yr_24hr	5:45	3.166
Lethbridge_100yr_24hr	5:50	3.242
Lethbridge_100yr_24hr	5:55	3.323
Lethbridge_100yr_24hr	6:00	3.408
Lethbridge_100yr_24hr	6:05	3.499
Lethbridge_100yr_24hr	6:10	3.596
Lethbridge_100yr_24hr	6:15	3.699
Lethbridge_100yr_24hr	6:20	3.81
Lethbridge_100yr_24hr	6:25	3.929
Lethbridge_100yr_24hr	6:30	4.057
Lethbridge_100yr_24hr	6:35	4.195
Lethbridge_100yr_24hr	6:40	4.346
Lethbridge_100yr_24hr	6:45	4.509
Lethbridge_100yr_24hr	6:50	4.688
Lethbridge_100yr_24hr	6:55	4.885
Lethbridge_100yr_24hr	7:00	5.102
Lethbridge_100yr_24hr	7:05	5.344
Lethbridge_100yr_24hr	7:10	5.615
Lethbridge_100yr_24hr	7:15	5.921
Lethbridge_100yr_24hr	7:20	6.269
Lethbridge_100yr_24hr	7:25	6.67
Lethbridge_100yr_24hr	7:30	7.139
Lethbridge_100yr_24hr	7:35	7.693
Lethbridge_100yr_24hr	7:40	8.361
Lethbridge_100yr_24hr	7:45	9.186
Lethbridge_100yr_24hr	7:50	10.234
Lethbridge_100yr_24hr	7:55	11.619
Lethbridge_100yr_24hr	8:00	13.551
Lethbridge_100yr_24hr	8:05	16.477
Lethbridge_100yr_24hr	8:10	21.566
Lethbridge_100yr_24hr	8:15	33.491
Lethbridge_100yr_24hr	8:20	286.165
Lethbridge_100yr_24hr	8:25	92.134
Lethbridge_100yr_24hr	8:30	42.664
Lethbridge_100yr_24hr	8:35	30.072
Lethbridge_100yr_24hr	8:40	23.803
Lethbridge_100yr_24hr	8:45	19.955
Lethbridge_100yr_24hr	8:50	17.317
Lethbridge_100yr_24hr	8:55	15.38
Lethbridge_100yr_24hr	9:00	13.889
Lethbridge_100yr_24hr	9:05	12.7
Lethbridge_100yr_24hr	9:10	11.728
Lethbridge_100yr_24hr	9:15	10.915
Lethbridge_100yr_24hr	9:20	10.224

Lethbridge_100yr_24hr	9:25	9.629
Lethbridge_100yr_24hr	9:30	9.109
Lethbridge_100yr_24hr	9:35	8.652
Lethbridge_100yr_24hr	9:40	8.245
Lethbridge_100yr_24hr	9:45	7.881
Lethbridge_100yr_24hr	9:50	7.553
Lethbridge_100yr_24hr	9:55	7.255
Lethbridge_100yr_24hr	10:00	6.984
Lethbridge_100yr_24hr	10:05	6.736
Lethbridge_100yr_24hr	10:10	6.507
Lethbridge_100yr_24hr	10:15	6.296
Lethbridge_100yr_24hr	10:20	6.101
Lethbridge_100yr_24hr	10:25	5.919
Lethbridge_100yr_24hr	10:30	5.75
Lethbridge_100yr_24hr	10:35	5.592
Lethbridge_100yr_24hr	10:40	5.444
Lethbridge_100yr_24hr	10:45	5.304
Lethbridge_100yr_24hr	10:50	5.173
Lethbridge_100yr_24hr	10:55	5.049
Lethbridge_100yr_24hr	11:00	4.932
Lethbridge_100yr_24hr	11:05	4.822
Lethbridge_100yr_24hr	11:10	4.717
Lethbridge_100yr_24hr	11:15	4.617
Lethbridge_100yr_24hr	11:20	4.522
Lethbridge_100yr_24hr	11:25	4.431
Lethbridge_100yr_24hr	11:30	4.345
Lethbridge_100yr_24hr	11:35	4.263
Lethbridge_100yr_24hr	11:40	4.184
Lethbridge_100yr_24hr	11:45	4.109
Lethbridge_100yr_24hr	11:50	4.036
Lethbridge_100yr_24hr	11:55	3.967
Lethbridge_100yr_24hr	12:00	3.901
Lethbridge_100yr_24hr	12:05	3.837
Lethbridge_100yr_24hr	12:10	3.775
Lethbridge_100yr_24hr	12:15	3.716
Lethbridge_100yr_24hr	12:20	3.659
Lethbridge_100yr_24hr	12:25	3.604
Lethbridge_100yr_24hr	12:30	3.55
Lethbridge_100yr_24hr	12:35	3.499
Lethbridge_100yr_24hr	12:40	3.449
Lethbridge_100yr_24hr	12:45	3.401
Lethbridge_100yr_24hr	12:50	3.355
Lethbridge_100yr_24hr	12:55	3.31
Lethbridge_100yr_24hr	13:00	3.267
Lethbridge_100yr_24hr	13:05	3.224
Lethbridge_100yr_24hr	13:10	3.183

Lethbridge_100yr_24hr	13:15	3.144
Lethbridge_100yr_24hr	13:20	3.105
Lethbridge_100yr_24hr	13:25	3.068
Lethbridge_100yr_24hr	13:30	3.031
Lethbridge_100yr_24hr	13:35	2.996
Lethbridge_100yr_24hr	13:40	2.961
Lethbridge_100yr_24hr	13:45	2.928
Lethbridge_100yr_24hr	13:50	2.895
Lethbridge_100yr_24hr	13:55	2.863
Lethbridge_100yr_24hr	14:00	2.832
Lethbridge_100yr_24hr	14:05	2.802
Lethbridge_100yr_24hr	14:10	2.773
Lethbridge_100yr_24hr	14:15	2.744
Lethbridge_100yr_24hr	14:20	2.716
Lethbridge_100yr_24hr	14:25	2.689
Lethbridge_100yr_24hr	14:30	2.662
Lethbridge_100yr_24hr	14:35	2.636
Lethbridge_100yr_24hr	14:40	2.61
Lethbridge_100yr_24hr	14:45	2.585
Lethbridge_100yr_24hr	14:50	2.561
Lethbridge_100yr_24hr	14:55	2.537
Lethbridge_100yr_24hr	15:00	2.514
Lethbridge_100yr_24hr	15:05	2.491
Lethbridge_100yr_24hr	15:10	2.469
Lethbridge_100yr_24hr	15:15	2.447
Lethbridge_100yr_24hr	15:20	2.425
Lethbridge_100yr_24hr	15:25	2.404
Lethbridge_100yr_24hr	15:30	2.384
Lethbridge_100yr_24hr	15:35	2.364
Lethbridge_100yr_24hr	15:40	2.344
Lethbridge_100yr_24hr	15:45	2.325
Lethbridge_100yr_24hr	15:50	2.306
Lethbridge_100yr_24hr	15:55	2.287
Lethbridge_100yr_24hr	16:00	2.269
Lethbridge_100yr_24hr	16:05	2.251
Lethbridge_100yr_24hr	16:10	2.233
Lethbridge_100yr_24hr	16:15	2.216
Lethbridge_100yr_24hr	16:20	2.199
Lethbridge_100yr_24hr	16:25	2.183
Lethbridge_100yr_24hr	16:30	2.166
Lethbridge_100yr_24hr	16:35	2.15
Lethbridge_100yr_24hr	16:40	2.134
Lethbridge_100yr_24hr	16:45	2.119
Lethbridge_100yr_24hr	16:50	2.104
Lethbridge_100yr_24hr	16:55	2.089
Lethbridge_100yr_24hr	17:00	2.074

Lethbridge_100yr_24hr	17:05	2.059
Lethbridge_100yr_24hr	17:10	2.045
Lethbridge_100yr_24hr	17:15	2.031
Lethbridge_100yr_24hr	17:20	2.017
Lethbridge_100yr_24hr	17:25	2.004
Lethbridge_100yr_24hr	17:30	1.99
Lethbridge_100yr_24hr	17:35	1.977
Lethbridge_100yr_24hr	17:40	1.964
Lethbridge_100yr_24hr	17:45	1.951
Lethbridge_100yr_24hr	17:50	1.939
Lethbridge_100yr_24hr	17:55	1.926
Lethbridge_100yr_24hr	18:00	1.914
Lethbridge_100yr_24hr	18:05	1.902
Lethbridge_100yr_24hr	18:10	1.89
Lethbridge_100yr_24hr	18:15	1.879
Lethbridge_100yr_24hr	18:20	1.867
Lethbridge_100yr_24hr	18:25	1.856
Lethbridge_100yr_24hr	18:30	1.845
Lethbridge_100yr_24hr	18:35	1.834
Lethbridge_100yr_24hr	18:40	1.823
Lethbridge_100yr_24hr	18:45	1.812
Lethbridge_100yr_24hr	18:50	1.802
Lethbridge_100yr_24hr	18:55	1.791
Lethbridge_100yr_24hr	19:00	1.781
Lethbridge_100yr_24hr	19:05	1.771
Lethbridge_100yr_24hr	19:10	1.761
Lethbridge_100yr_24hr	19:15	1.751
Lethbridge_100yr_24hr	19:20	1.741
Lethbridge_100yr_24hr	19:25	1.732
Lethbridge_100yr_24hr	19:30	1.722
Lethbridge_100yr_24hr	19:35	1.713
Lethbridge_100yr_24hr	19:40	1.704
Lethbridge_100yr_24hr	19:45	1.695
Lethbridge_100yr_24hr	19:50	1.686
Lethbridge_100yr_24hr	19:55	1.677
Lethbridge_100yr_24hr	20:00	1.668
Lethbridge_100yr_24hr	20:05	1.659
Lethbridge_100yr_24hr	20:10	1.651
Lethbridge_100yr_24hr	20:15	1.642
Lethbridge_100yr_24hr	20:20	1.634
Lethbridge_100yr_24hr	20:25	1.626
Lethbridge_100yr_24hr	20:30	1.617
Lethbridge_100yr_24hr	20:35	1.609
Lethbridge_100yr_24hr	20:40	1.601
Lethbridge_100yr_24hr	20:45	1.593
Lethbridge_100yr_24hr	20:50	1.586

```
Lethbridge_100yr_24hr            20:55      1.578
Lethbridge_100yr_24hr            21:00      1.57
Lethbridge_100yr_24hr            21:05      1.563
Lethbridge_100yr_24hr            21:10      1.555
Lethbridge_100yr_24hr            21:15      1.548
Lethbridge_100yr_24hr            21:20      1.541
Lethbridge_100yr_24hr            21:25      1.534
Lethbridge_100yr_24hr            21:30      1.526
Lethbridge_100yr_24hr            21:35      1.519
Lethbridge_100yr_24hr            21:40      1.512
Lethbridge_100yr_24hr            21:45      1.506
Lethbridge_100yr_24hr            21:50      1.499
Lethbridge_100yr_24hr            21:55      1.492
Lethbridge_100yr_24hr            22:00      1.485
Lethbridge_100yr_24hr            22:05      1.479
Lethbridge_100yr_24hr            22:10      1.472
Lethbridge_100yr_24hr            22:15      1.466
Lethbridge_100yr_24hr            22:20      1.459
Lethbridge_100yr_24hr            22:25      1.453
Lethbridge_100yr_24hr            22:30      1.447
Lethbridge_100yr_24hr            22:35      1.441
Lethbridge_100yr_24hr            22:40      1.434
Lethbridge_100yr_24hr            22:45      1.428
Lethbridge_100yr_24hr            22:50      1.422
Lethbridge_100yr_24hr            22:55      1.416
Lethbridge_100yr_24hr            23:00      1.411
Lethbridge_100yr_24hr            23:05      1.405
Lethbridge_100yr_24hr            23:10      1.399
Lethbridge_100yr_24hr            23:15      1.393
Lethbridge_100yr_24hr            23:20      1.387
Lethbridge_100yr_24hr            23:25      1.382
Lethbridge_100yr_24hr            23:30      1.376
Lethbridge_100yr_24hr            23:35      1.371
Lethbridge_100yr_24hr            23:40      1.365
Lethbridge_100yr_24hr            23:45      1.36
Lethbridge_100yr_24hr            23:50      1.355
Lethbridge_100yr_24hr            23:55      1.349
Lethbridge_100yr_24hr            24:00      0

[REPORT]
INPUT      YES
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL
```

```
[TAGS]

[MAP]
DIMENSIONS       374973.372412022 5506834.08572354 375286.108381399 5507333.95913518
UNITS            Meters

[COORDINATES]
;;Node           X-Coord          Y-Coord
;;-------------- ---------------- ----------------
OF1              375117.804       5507267.712
OF2              375262.343       5507006.782
J1               375093.931       5507251.073
J2               375242.971       5507003.138

[VERTICES]
;;Link           X-Coord          Y-Coord
;;-------------- ---------------- ----------------

[POLYGONS]
;;Subcatchment   X-Coord          Y-Coord
;;-------------- ---------------- ----------------
Pre_1            375249.931       5507006.959
Pre_1            374991.411       5507013.633
Pre_1            374999.09        5507311.238
Pre_1            375082.132       5507309.321
Pre_1            375092.317       5507269.396
Pre_1            375102.537       5507251.51
Pre_1            375212.407       5507127.729
Pre_1            375227.738       5507105.017
Pre_1            375238.242       5507079.466
Pre_1            375245.056       5507040.287
Pre_1            375249.931       5507006.959
Pre_2            374991.411       5507013.633
Pre_2            375249.931       5507006.959
Pre_2            375271.893       5506856.807
Pre_2            374987.588       5506865.488
Pre_2            374991.411       5507013.633

[SYMBOLS]
;;Gage           X-Coord          Y-Coord
;;-------------- ---------------- ----------------
```

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)
---------------------------------------------------------------


*************
Element Count
*************
Number of rain gages ...... 1
Number of subcatchments ... 2
Number of nodes ........... 4
Number of links ........... 2
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                     Data       Recording
Name                 Data Source                     Type       Interval
-------------------------------------------------------------------------
Lethbridge_100yr_24hr Lethbridge_100yr_24hr           INTENSITY    5 min.


********************
Subcatchment Summary
********************
Name                           Area     Width   %Imperv    %Slope Rain Gage            Outlet
-------------------------------------------------------------------------------------------------------------
Pre_1                          5.41    237.15      5.00    0.6000 Lethbridge_100yr_24hr J1
Pre_2                          4.04    172.70      5.00    0.5000 Lethbridge_100yr_24hr J2


************
Node Summary
************
                                          Invert      Max.    Ponded    External
Name                 Type                  Elev.     Depth      Area    Inflow
--------------------------------------------------------------------------------
OF1                  OUTFALL              898.52      0.45       0.0
OF2                  OUTFALL              899.59      0.30       0.0
J1                   STORAGE              898.54      2.46       0.0
J2                   STORAGE              899.65      1.35       0.0
```

```
************
Link Summary
************
Name             From Node        To Node          Type            Length    %Slope Roughness
---------------------------------------------------------------------------------------------
C1               J1               OF1              CONDUIT           17.6    0.1136    0.0220
C2               J2               OF2              CONDUIT            8.0    0.7500    0.0220


*********************
Cross Section Summary
*********************
                                      Full     Full     Hyd.     Max.   No. of     Full
Conduit          Shape               Depth     Area     Rad.    Width  Barrels     Flow
---------------------------------------------------------------------------------------
C1               CIRCULAR             0.45     0.16     0.11     0.45        1     0.06
C2               CIRCULAR             0.30     0.07     0.07     0.30        1     0.05



*********************************************************
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 ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... DYNWAVE
Starting Date ............ JUN-30-2016 00:00:00
Ending Date .............. JUL-01-2016 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
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         1.135       120.145
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.876        92.738
Surface Runoff ...........         0.260        27.517
Final Storage ............         0.001         0.078
Continuity Error (%) .....        -0.156


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.260         2.598
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.260         2.596
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.002
Continuity Error (%) .....        -0.005


***************************
Time-Step Critical Elements
***************************
Link C2 (33.41%)


********************************
Highest Flow Instability Indexes
********************************
All links are stable.
```

```
*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     1.78 sec
Average Time Step           :     4.09 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00


***************************
Subcatchment Runoff Summary
***************************

--------------------------------------------------------------------------------------------------------
                          Total      Total      Total      Total      Total       Total     Peak  Runoff
                         Precip      Runon       Evap      Infil     Runoff      Runoff   Runoff   Coeff
Subcatchment                 mm         mm         mm         mm         mm    10^6 ltr      CMS
--------------------------------------------------------------------------------------------------------
Pre_1                    120.15       0.00       0.00      92.43      27.84        1.51     0.39   0.232
Pre_2                    120.15       0.00       0.00      93.15      27.09        1.09     0.28   0.225


******************
Node Depth Summary
******************

---------------------------------------------------------------------------------
                               Average  Maximum  Maximum  Time of Max    Reported
                                 Depth    Depth      HGL   Occurrence   Max Depth
Node                 Type       Meters   Meters   Meters  days hr:min      Meters
---------------------------------------------------------------------------------
OF1                  OUTFALL      0.08     0.36   898.88     0  08:50        0.11
OF2                  OUTFALL      0.08     0.24   899.83     0  09:34        0.07
J1                   STORAGE      0.16     0.78   899.32     0  08:50        0.24
J2                   STORAGE      0.13     0.40   900.05     0  09:34        0.12


*******************
Node Inflow Summary
*******************

-------------------------------------------------------------------------------------------------
                                Maximum  Maximum                  Lateral       Total        Flow
```

```
                                Lateral    Total  Time of Max      Inflow      Inflow     Balance
                                 Inflow   Inflow   Occurrence      Volume      Volume       Error
Node                 Type           CMS      CMS  days hr:min    10^6 ltr    10^6 ltr     Percent
-------------------------------------------------------------------------------------------------
OF1                  OUTFALL      0.000    0.264     0  08:50           0         1.5       0.000
OF2                  OUTFALL      0.000    0.094     0  09:34           0        1.09       0.000
J1                   STORAGE      0.391    0.391     0  08:25         1.5         1.5       0.001
J2                   STORAGE      0.278    0.278     0  08:25        1.09        1.09       0.001


**********************
Node Surcharge Summary
**********************

Surcharging occurs when water rises above the top of the highest conduit.
---------------------------------------------------------------------
                                             Max. Height   Min. Depth
                                 Hours       Above Crown    Below Rim
Node                 Type      Surcharged         Meters       Meters
---------------------------------------------------------------------
J1                   STORAGE         1.21          0.326        1.684
J2                   STORAGE         2.33          0.103        0.947


*********************
Node Flooding Summary
*********************

No nodes were flooded.


**********************
Storage Volume Summary
**********************

--------------------------------------------------------------------------------------------------
                       Average     Avg  Evap Exfil       Maximum     Max    Time of Max    Maximum
                        Volume    Pcnt  Pcnt  Pcnt        Volume    Pcnt     Occurrence    Outflow
Storage Unit           1000 m3    Full  Loss  Loss       1000 m3    Full    days hr:min        CMS
--------------------------------------------------------------------------------------------------
J1                       0.011       0     0     0         0.136       5       0  08:50      0.264
J2                       0.082       1     0     0         0.397       6       0  09:34      0.094


***********************
Outfall Loading Summary
```

```
***********************

-----------------------------------------------------------
                       Flow       Avg       Max       Total
                       Freq      Flow      Flow      Volume
Outfall Node           Pcnt       CMS       CMS    10^6 ltr
-----------------------------------------------------------
OF1                   96.58     0.036     0.264       1.504
OF2                   95.75     0.026     0.094       1.092
-----------------------------------------------------------
System                96.17     0.062     0.348       2.596


********************
Link Flow Summary
********************

-----------------------------------------------------------------------------
                               Maximum  Time of Max   Maximum    Max/    Max/
                                |Flow|   Occurrence   |Veloc|    Full    Full
Link                 Type          CMS  days hr:min     m/sec    Flow   Depth
-----------------------------------------------------------------------------
C1                   CONDUIT     0.264     0  08:50      1.75    4.64    0.90
C2                   CONDUIT     0.094     0  09:34      1.41    1.90    0.90


***************************
Flow Classification Summary
***************************

-------------------------------------------------------------------------------------
                    Adjusted    ---------- Fraction of Time in Flow Class ----------
                     /Actual         Up    Down  Sub   Sup   Up    Down  Norm  Inlet
Conduit               Length    Dry  Dry   Dry   Crit  Crit  Crit  Crit  Ltd   Ctrl
-------------------------------------------------------------------------------------
C1                      1.00   0.03  0.00  0.00  0.97  0.00  0.00  0.00  0.00  0.00
C2                      1.00   0.03  0.00  0.00  0.97  0.00  0.00  0.00  0.00  0.00


*************************
Conduit Surcharge Summary
*************************

----------------------------------------------------------------------------
                                                         Hours        Hours
                       --------- Hours Full --------   Above Full   Capacity
```

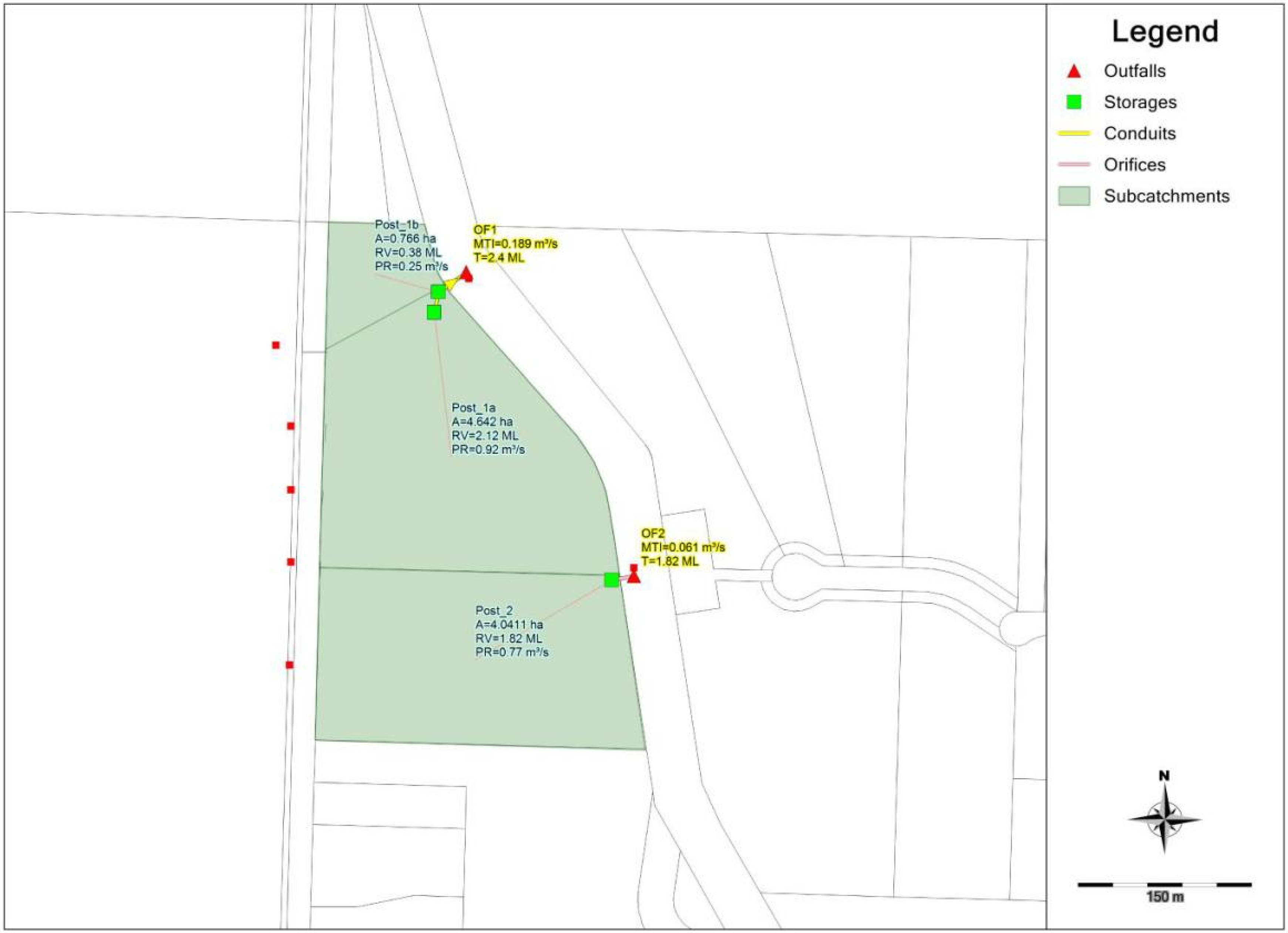
```
Conduit                 Both Ends  Upstream  Dnstream   Normal Flow   Limited
----------------------------------------------------------------------------
C1                           0.01      1.21      0.01      1.91          0.01
C2                           0.01      2.33      0.01      3.03          0.01


Analysis begun on:  Tue Jul 26 16:08:03 2016
Analysis ended on:  Tue Jul 26 16:08:03 2016
Total elapsed time: < 1 sec
```

Post-Development

Runoff Analysis

EPA SWMM 5.1


Legend
Outfalls
Storages
Conduits
Orifices
Subcatchments
Post_1b
A=0.766 ha
RV=0.38 ML
PR=0.25 m³/s
OF1
MTI=0.189 m³/s
T=2.4 ML
Post_1a
A=4.642 ha
RV=2.12 ML
PR=0.92 m³/s
OF2
MTI=0.061 m³/s
T=1.82 ML
Post_2
A=4.0411 ha
RV=1.82 ML
PR=0.77 m³/s
N
150 m

```
[TITLE]

[OPTIONS]
;;Options            Value
;;------------------ ------------
FLOW_UNITS           CMS
INFILTRATION         GREEN_AMPT
FLOW_ROUTING         DYNWAVE
START_DATE           06/30/2016
START_TIME           00:00:00
REPORT_START_DATE    06/30/2016
REPORT_START_TIME    00:00:00
END_DATE             07/01/2016
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:01:00
WET_STEP             00:05:00
DRY_STEP             00:05:00
ROUTING_STEP         5
ALLOW_PONDING        YES
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[EVAPORATION]
;;Type          Parameters
;;------------- ----------
CONSTANT     0.0
DRY_ONLY     NO

[RAINGAGES]
;;                    Rain      Time   Snow   Data
```

```
;;Name                Type      Intrvl Catch  Source
;;------------------- --------- ------ ------ ----------
Lethbridge_100yr_24hr INTENSITY 0:05   1.0    TIMESERIES Lethbridge_100yr_24hr

[SUBCATCHMENTS]
;;                                                 Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
Post_1a          Lethbridge_100yr_24hr Prop.N      4.642    20       203.596  0.6      0
Post_1b          Lethbridge_100yr_24hr ex.N        0.766    20       85.111   1.3      0
Post_2           Lethbridge_100yr_24hr prop.S      4.0411   20       172.697  0.5      0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
Post_1a          0.015      0.1        1.3        3.8        0          OUTLET
Post_1b          0.015      0.1        0.88       3.8        0          OUTLET
Post_2           0.015      0.1        1.4        3.8        0          OUTLET

[INFILTRATION]
;;Subcatchment   Suction    HydCon     IMDmax
;;-------------- ---------- ---------- ----------
Post_1a          127.9      10         0.36
Post_1b          127.9      10         0.36
Post_2           127.9      10         0.36

[OUTFALLS]
;;               Invert     Outfall      Stage/Table      Tide
;;Name           Elev.      Type         Time Series      Gate Route To
;;-------------- ---------- ------------ ---------------- ---- ----------------
OF1              898.52     FREE                          NO
OF2              899.59     FREE                          NO

[STORAGE]
;;               Invert   Max.     Init.    Storage    Curve                      Ponded   Evap.
;;Name           Elev.    Depth    Depth    Curve      Params                     Area     Frac.    Infiltration parameters
;;-------------- -------- -------- -------- ---------- -------- -------- -------- -------- -------- -----------------------
ex.N             898.54   2.46     0        TABULAR    ex.north_channel           0        0
Prop.N           899      1        0        TABULAR    prop_north_depression           0   0
prop.S           899.65   1.35     0        TABULAR    propsouth_depression           0    0

[CONDUITS]
;;               Inlet            Outlet                      Manning    Inlet      Outlet     Init.      Max.
;;Name           Node             Node             Length     N          Offset     Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- ----------
C1               ex.N             OF1              17.6       0.022      0          0          0          0
```

```
C3               Prop.N           ex.N             18.13      0.01       0          0          0          0

[ORIFICES]
;;               Inlet            Outlet           Orifice      Crest      Disch.     Flap Open/Close
;;Name           Node             Node             Type         Height     Coeff.     Gate Time
;;-------------- ---------------- ---------------- ------------ ---------- ---------- ---- ----------
C2               prop.S           OF2              SIDE         0          0.65       NO   0

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels
;;-------------- ------------ ---------------- ---------- ---------- ---------- ----------
C1               CIRCULAR     0.45             0          0          0          1
C3               CIRCULAR     0.2              0          0          0          1
C2               CIRCULAR     0.2              0          0          0

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
ex.north_channel Storage    0          2
ex.north_channel            .2         33
ex.north_channel            .4         105
ex.north_channel            .6         333
ex.north_channel            .8         545

prop_north_depression Storage    0          2900
prop_north_depression            0.5        3350
prop_north_depression            1          3890

propsouth_depression Storage    0          15
propsouth_depression            0.2        750
propsouth_depression            0.4        3000
propsouth_depression            .6         4000

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
;Chicago design storm, a = 1019.2, b = 0, c = 0.731, Duration = 1440 minutes, r = 0.35, rain units = mm/hr.
Lethbridge_100yr_24hr            0:00       1.352
Lethbridge_100yr_24hr            0:05       1.361
Lethbridge_100yr_24hr            0:10       1.372
Lethbridge_100yr_24hr            0:15       1.382
Lethbridge_100yr_24hr            0:20       1.392
```

Lethbridge_100yr_24hr	0:25	1.403
Lethbridge_100yr_24hr	0:30	1.414
Lethbridge_100yr_24hr	0:35	1.425
Lethbridge_100yr_24hr	0:40	1.436
Lethbridge_100yr_24hr	0:45	1.448
Lethbridge_100yr_24hr	0:50	1.459
Lethbridge_100yr_24hr	0:55	1.471
Lethbridge_100yr_24hr	1:00	1.483
Lethbridge_100yr_24hr	1:05	1.496
Lethbridge_100yr_24hr	1:10	1.509
Lethbridge_100yr_24hr	1:15	1.521
Lethbridge_100yr_24hr	1:20	1.535
Lethbridge_100yr_24hr	1:25	1.548
Lethbridge_100yr_24hr	1:30	1.562
Lethbridge_100yr_24hr	1:35	1.576
Lethbridge_100yr_24hr	1:40	1.59
Lethbridge_100yr_24hr	1:45	1.605
Lethbridge_100yr_24hr	1:50	1.62
Lethbridge_100yr_24hr	1:55	1.635
Lethbridge_100yr_24hr	2:00	1.651
Lethbridge_100yr_24hr	2:05	1.667
Lethbridge_100yr_24hr	2:10	1.683
Lethbridge_100yr_24hr	2:15	1.7
Lethbridge_100yr_24hr	2:20	1.717
Lethbridge_100yr_24hr	2:25	1.735
Lethbridge_100yr_24hr	2:30	1.753
Lethbridge_100yr_24hr	2:35	1.771
Lethbridge_100yr_24hr	2:40	1.79
Lethbridge_100yr_24hr	2:45	1.809
Lethbridge_100yr_24hr	2:50	1.829
Lethbridge_100yr_24hr	2:55	1.85
Lethbridge_100yr_24hr	3:00	1.871
Lethbridge_100yr_24hr	3:05	1.892
Lethbridge_100yr_24hr	3:10	1.914
Lethbridge_100yr_24hr	3:15	1.937
Lethbridge_100yr_24hr	3:20	1.961
Lethbridge_100yr_24hr	3:25	1.985
Lethbridge_100yr_24hr	3:30	2.009
Lethbridge_100yr_24hr	3:35	2.035
Lethbridge_100yr_24hr	3:40	2.061
Lethbridge_100yr_24hr	3:45	2.089
Lethbridge_100yr_24hr	3:50	2.117
Lethbridge_100yr_24hr	3:55	2.146
Lethbridge_100yr_24hr	4:00	2.176
Lethbridge_100yr_24hr	4:05	2.206
Lethbridge_100yr_24hr	4:10	2.238

Lethbridge_100yr_24hr	4:15	2.272
Lethbridge_100yr_24hr	4:20	2.306
Lethbridge_100yr_24hr	4:25	2.341
Lethbridge_100yr_24hr	4:30	2.378
Lethbridge_100yr_24hr	4:35	2.416
Lethbridge_100yr_24hr	4:40	2.456
Lethbridge_100yr_24hr	4:45	2.498
Lethbridge_100yr_24hr	4:50	2.541
Lethbridge_100yr_24hr	4:55	2.585
Lethbridge_100yr_24hr	5:00	2.632
Lethbridge_100yr_24hr	5:05	2.681
Lethbridge_100yr_24hr	5:10	2.732
Lethbridge_100yr_24hr	5:15	2.785
Lethbridge_100yr_24hr	5:20	2.841
Lethbridge_100yr_24hr	5:25	2.9
Lethbridge_100yr_24hr	5:30	2.961
Lethbridge_100yr_24hr	5:35	3.026
Lethbridge_100yr_24hr	5:40	3.094
Lethbridge_100yr_24hr	5:45	3.166
Lethbridge_100yr_24hr	5:50	3.242
Lethbridge_100yr_24hr	5:55	3.323
Lethbridge_100yr_24hr	6:00	3.408
Lethbridge_100yr_24hr	6:05	3.499
Lethbridge_100yr_24hr	6:10	3.596
Lethbridge_100yr_24hr	6:15	3.699
Lethbridge_100yr_24hr	6:20	3.81
Lethbridge_100yr_24hr	6:25	3.929
Lethbridge_100yr_24hr	6:30	4.057
Lethbridge_100yr_24hr	6:35	4.195
Lethbridge_100yr_24hr	6:40	4.346
Lethbridge_100yr_24hr	6:45	4.509
Lethbridge_100yr_24hr	6:50	4.688
Lethbridge_100yr_24hr	6:55	4.885
Lethbridge_100yr_24hr	7:00	5.102
Lethbridge_100yr_24hr	7:05	5.344
Lethbridge_100yr_24hr	7:10	5.615
Lethbridge_100yr_24hr	7:15	5.921
Lethbridge_100yr_24hr	7:20	6.269
Lethbridge_100yr_24hr	7:25	6.67
Lethbridge_100yr_24hr	7:30	7.139
Lethbridge_100yr_24hr	7:35	7.693
Lethbridge_100yr_24hr	7:40	8.361
Lethbridge_100yr_24hr	7:45	9.186
Lethbridge_100yr_24hr	7:50	10.234
Lethbridge_100yr_24hr	7:55	11.619
Lethbridge_100yr_24hr	8:00	13.551

Lethbridge_100yr_24hr	8:05	16.477
Lethbridge_100yr_24hr	8:10	21.566
Lethbridge_100yr_24hr	8:15	33.491
Lethbridge_100yr_24hr	8:20	286.165
Lethbridge_100yr_24hr	8:25	92.134
Lethbridge_100yr_24hr	8:30	42.664
Lethbridge_100yr_24hr	8:35	30.072
Lethbridge_100yr_24hr	8:40	23.803
Lethbridge_100yr_24hr	8:45	19.955
Lethbridge_100yr_24hr	8:50	17.317
Lethbridge_100yr_24hr	8:55	15.38
Lethbridge_100yr_24hr	9:00	13.889
Lethbridge_100yr_24hr	9:05	12.7
Lethbridge_100yr_24hr	9:10	11.728
Lethbridge_100yr_24hr	9:15	10.915
Lethbridge_100yr_24hr	9:20	10.224
Lethbridge_100yr_24hr	9:25	9.629
Lethbridge_100yr_24hr	9:30	9.109
Lethbridge_100yr_24hr	9:35	8.652
Lethbridge_100yr_24hr	9:40	8.245
Lethbridge_100yr_24hr	9:45	7.881
Lethbridge_100yr_24hr	9:50	7.553
Lethbridge_100yr_24hr	9:55	7.255
Lethbridge_100yr_24hr	10:00	6.984
Lethbridge_100yr_24hr	10:05	6.736
Lethbridge_100yr_24hr	10:10	6.507
Lethbridge_100yr_24hr	10:15	6.296
Lethbridge_100yr_24hr	10:20	6.101
Lethbridge_100yr_24hr	10:25	5.919
Lethbridge_100yr_24hr	10:30	5.75
Lethbridge_100yr_24hr	10:35	5.592
Lethbridge_100yr_24hr	10:40	5.444
Lethbridge_100yr_24hr	10:45	5.304
Lethbridge_100yr_24hr	10:50	5.173
Lethbridge_100yr_24hr	10:55	5.049
Lethbridge_100yr_24hr	11:00	4.932
Lethbridge_100yr_24hr	11:05	4.822
Lethbridge_100yr_24hr	11:10	4.717
Lethbridge_100yr_24hr	11:15	4.617
Lethbridge_100yr_24hr	11:20	4.522
Lethbridge_100yr_24hr	11:25	4.431
Lethbridge_100yr_24hr	11:30	4.345
Lethbridge_100yr_24hr	11:35	4.263
Lethbridge_100yr_24hr	11:40	4.184
Lethbridge_100yr_24hr	11:45	4.109
Lethbridge_100yr_24hr	11:50	4.036

Lethbridge_100yr_24hr	11:55	3.967
Lethbridge_100yr_24hr	12:00	3.901
Lethbridge_100yr_24hr	12:05	3.837
Lethbridge_100yr_24hr	12:10	3.775
Lethbridge_100yr_24hr	12:15	3.716
Lethbridge_100yr_24hr	12:20	3.659
Lethbridge_100yr_24hr	12:25	3.604
Lethbridge_100yr_24hr	12:30	3.55
Lethbridge_100yr_24hr	12:35	3.499
Lethbridge_100yr_24hr	12:40	3.449
Lethbridge_100yr_24hr	12:45	3.401
Lethbridge_100yr_24hr	12:50	3.355
Lethbridge_100yr_24hr	12:55	3.31
Lethbridge_100yr_24hr	13:00	3.267
Lethbridge_100yr_24hr	13:05	3.224
Lethbridge_100yr_24hr	13:10	3.183
Lethbridge_100yr_24hr	13:15	3.144
Lethbridge_100yr_24hr	13:20	3.105
Lethbridge_100yr_24hr	13:25	3.068
Lethbridge_100yr_24hr	13:30	3.031
Lethbridge_100yr_24hr	13:35	2.996
Lethbridge_100yr_24hr	13:40	2.961
Lethbridge_100yr_24hr	13:45	2.928
Lethbridge_100yr_24hr	13:50	2.895
Lethbridge_100yr_24hr	13:55	2.863
Lethbridge_100yr_24hr	14:00	2.832
Lethbridge_100yr_24hr	14:05	2.802
Lethbridge_100yr_24hr	14:10	2.773
Lethbridge_100yr_24hr	14:15	2.744
Lethbridge_100yr_24hr	14:20	2.716
Lethbridge_100yr_24hr	14:25	2.689
Lethbridge_100yr_24hr	14:30	2.662
Lethbridge_100yr_24hr	14:35	2.636
Lethbridge_100yr_24hr	14:40	2.61
Lethbridge_100yr_24hr	14:45	2.585
Lethbridge_100yr_24hr	14:50	2.561
Lethbridge_100yr_24hr	14:55	2.537
Lethbridge_100yr_24hr	15:00	2.514
Lethbridge_100yr_24hr	15:05	2.491
Lethbridge_100yr_24hr	15:10	2.469
Lethbridge_100yr_24hr	15:15	2.447
Lethbridge_100yr_24hr	15:20	2.425
Lethbridge_100yr_24hr	15:25	2.404
Lethbridge_100yr_24hr	15:30	2.384
Lethbridge_100yr_24hr	15:35	2.364
Lethbridge_100yr_24hr	15:40	2.344

Lethbridge_100yr_24hr	15:45	2.325
Lethbridge_100yr_24hr	15:50	2.306
Lethbridge_100yr_24hr	15:55	2.287
Lethbridge_100yr_24hr	16:00	2.269
Lethbridge_100yr_24hr	16:05	2.251
Lethbridge_100yr_24hr	16:10	2.233
Lethbridge_100yr_24hr	16:15	2.216
Lethbridge_100yr_24hr	16:20	2.199
Lethbridge_100yr_24hr	16:25	2.183
Lethbridge_100yr_24hr	16:30	2.166
Lethbridge_100yr_24hr	16:35	2.15
Lethbridge_100yr_24hr	16:40	2.134
Lethbridge_100yr_24hr	16:45	2.119
Lethbridge_100yr_24hr	16:50	2.104
Lethbridge_100yr_24hr	16:55	2.089
Lethbridge_100yr_24hr	17:00	2.074
Lethbridge_100yr_24hr	17:05	2.059
Lethbridge_100yr_24hr	17:10	2.045
Lethbridge_100yr_24hr	17:15	2.031
Lethbridge_100yr_24hr	17:20	2.017
Lethbridge_100yr_24hr	17:25	2.004
Lethbridge_100yr_24hr	17:30	1.99
Lethbridge_100yr_24hr	17:35	1.977
Lethbridge_100yr_24hr	17:40	1.964
Lethbridge_100yr_24hr	17:45	1.951
Lethbridge_100yr_24hr	17:50	1.939
Lethbridge_100yr_24hr	17:55	1.926
Lethbridge_100yr_24hr	18:00	1.914
Lethbridge_100yr_24hr	18:05	1.902
Lethbridge_100yr_24hr	18:10	1.89
Lethbridge_100yr_24hr	18:15	1.879
Lethbridge_100yr_24hr	18:20	1.867
Lethbridge_100yr_24hr	18:25	1.856
Lethbridge_100yr_24hr	18:30	1.845
Lethbridge_100yr_24hr	18:35	1.834
Lethbridge_100yr_24hr	18:40	1.823
Lethbridge_100yr_24hr	18:45	1.812
Lethbridge_100yr_24hr	18:50	1.802
Lethbridge_100yr_24hr	18:55	1.791
Lethbridge_100yr_24hr	19:00	1.781
Lethbridge_100yr_24hr	19:05	1.771
Lethbridge_100yr_24hr	19:10	1.761
Lethbridge_100yr_24hr	19:15	1.751
Lethbridge_100yr_24hr	19:20	1.741
Lethbridge_100yr_24hr	19:25	1.732
Lethbridge_100yr_24hr	19:30	1.722

Lethbridge_100yr_24hr	19:35	1.713
Lethbridge_100yr_24hr	19:40	1.704
Lethbridge_100yr_24hr	19:45	1.695
Lethbridge_100yr_24hr	19:50	1.686
Lethbridge_100yr_24hr	19:55	1.677
Lethbridge_100yr_24hr	20:00	1.668
Lethbridge_100yr_24hr	20:05	1.659
Lethbridge_100yr_24hr	20:10	1.651
Lethbridge_100yr_24hr	20:15	1.642
Lethbridge_100yr_24hr	20:20	1.634
Lethbridge_100yr_24hr	20:25	1.626
Lethbridge_100yr_24hr	20:30	1.617
Lethbridge_100yr_24hr	20:35	1.609
Lethbridge_100yr_24hr	20:40	1.601
Lethbridge_100yr_24hr	20:45	1.593
Lethbridge_100yr_24hr	20:50	1.586
Lethbridge_100yr_24hr	20:55	1.578
Lethbridge_100yr_24hr	21:00	1.57
Lethbridge_100yr_24hr	21:05	1.563
Lethbridge_100yr_24hr	21:10	1.555
Lethbridge_100yr_24hr	21:15	1.548
Lethbridge_100yr_24hr	21:20	1.541
Lethbridge_100yr_24hr	21:25	1.534
Lethbridge_100yr_24hr	21:30	1.526
Lethbridge_100yr_24hr	21:35	1.519
Lethbridge_100yr_24hr	21:40	1.512
Lethbridge_100yr_24hr	21:45	1.506
Lethbridge_100yr_24hr	21:50	1.499
Lethbridge_100yr_24hr	21:55	1.492
Lethbridge_100yr_24hr	22:00	1.485
Lethbridge_100yr_24hr	22:05	1.479
Lethbridge_100yr_24hr	22:10	1.472
Lethbridge_100yr_24hr	22:15	1.466
Lethbridge_100yr_24hr	22:20	1.459
Lethbridge_100yr_24hr	22:25	1.453
Lethbridge_100yr_24hr	22:30	1.447
Lethbridge_100yr_24hr	22:35	1.441
Lethbridge_100yr_24hr	22:40	1.434
Lethbridge_100yr_24hr	22:45	1.428
Lethbridge_100yr_24hr	22:50	1.422
Lethbridge_100yr_24hr	22:55	1.416
Lethbridge_100yr_24hr	23:00	1.411
Lethbridge_100yr_24hr	23:05	1.405
Lethbridge_100yr_24hr	23:10	1.399
Lethbridge_100yr_24hr	23:15	1.393
Lethbridge_100yr_24hr	23:20	1.387

```
Lethbridge_100yr_24hr            23:25      1.382
Lethbridge_100yr_24hr            23:30      1.376
Lethbridge_100yr_24hr            23:35      1.371
Lethbridge_100yr_24hr            23:40      1.365
Lethbridge_100yr_24hr            23:45      1.36
Lethbridge_100yr_24hr            23:50      1.355
Lethbridge_100yr_24hr            23:55      1.349
Lethbridge_100yr_24hr            24:00      0

[REPORT]
INPUT      YES
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS       374973.372412022 5506834.08572354 375286.108381399 5507333.95913518
UNITS            Meters

[COORDINATES]
;;Node           X-Coord          Y-Coord
;;-------------- ---------------- ----------------
OF1              375117.804       5507267.712
OF2              375262.343       5507006.782
ex.N             375093.931       5507251.073
Prop.N           375090.103       5507233.356
prop.S           375242.971       5507003.138

[VERTICES]
;;Link           X-Coord          Y-Coord
;;-------------- ---------------- ----------------

[POLYGONS]
;;Subcatchment   X-Coord          Y-Coord
;;-------------- ---------------- ----------------
Post_1a          374996.255       5507201.356
Post_1a          375099.315       5507257.148
Post_1a          375102.537       5507251.51
Post_1a          375212.407       5507127.729
Post_1a          375227.738       5507105.017
Post_1a          375238.242       5507079.466
Post_1a          375245.056       5507040.287
Post_1a          375249.931       5507006.959
```

```
Post_1a          374991.411       5507013.633
Post_1a          374996.255       5507201.356
Post_1b          375099.315       5507257.148
Post_1b          374996.255       5507201.356
Post_1b          374999.09        5507311.238
Post_1b          375082.132       5507309.321
Post_1b          375092.317       5507269.396
Post_1b          375099.315       5507257.148
Post_2           374991.411       5507013.633
Post_2           375249.931       5507006.959
Post_2           375271.893       5506856.807
Post_2           374987.588       5506865.488
Post_2           374991.411       5507013.633

[SYMBOLS]
;;Gage           X-Coord          Y-Coord
;;-------------- ---------------- ----------------
```

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)
--------------------------------------------------------------


*************
Element Count
*************
Number of rain gages ...... 1
Number of subcatchments ... 3
Number of nodes ........... 5
Number of links ........... 3
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                     Data       Recording
Name                 Data Source                     Type       Interval 
------------------------------------------------------------------------
Lethbridge_100yr_24hr Lethbridge_100yr_24hr           INTENSITY    5 min.


********************
Subcatchment Summary
********************
Name                       Area     Width   %Imperv    %Slope Rain Gage            Outlet
-----------------------------------------------------------------------------------------------------------
Post_1a                    4.64    203.60     20.00    0.6000 Lethbridge_100yr_24hr Prop.N
Post_1b                    0.77     85.11     20.00    1.3000 Lethbridge_100yr_24hr ex.N
Post_2                     4.04    172.70     20.00    0.5000 Lethbridge_100yr_24hr prop.S


************
Node Summary
************
                                         Invert      Max.    Ponded    External
Name                 Type                 Elev.     Depth      Area    Inflow  
-------------------------------------------------------------------------------
OF1                  OUTFALL             898.52      0.45       0.0
OF2                  OUTFALL             899.59      0.00       0.0
ex.N                 STORAGE             898.54      2.46       0.0
Prop.N               STORAGE             899.00      1.00       0.0
prop.S               STORAGE             899.65      1.35       0.0
```

```
************
Link Summary
************
Name             From Node        To Node          Type            Length    %Slope Roughness
---------------------------------------------------------------------------------------------
C1               ex.N             OF1              CONDUIT           17.6    0.1136    0.0220
C3               Prop.N           ex.N             CONDUIT           18.1    2.5380    0.0100
C2               prop.S           OF2              ORIFICE


*********************
Cross Section Summary
*********************
                                        Full     Full     Hyd.     Max.   No. of     Full
Conduit          Shape                 Depth     Area     Rad.    Width  Barrels     Flow
---------------------------------------------------------------------------------------
C1               CIRCULAR               0.45     0.16     0.11     0.45        1     0.06
C3               CIRCULAR               0.20     0.03     0.05     0.20        1     0.07



*********************************************************
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 ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... DYNWAVE
Starting Date ............ JUN-30-2016 00:00:00
Ending Date .............. JUL-01-2016 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
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         1.135       120.145
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.704        74.550
Surface Runoff ...........         0.432        45.759
Final Storage ............         0.003         0.364
Continuity Error (%) .....        -0.439


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.432         4.321
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.421         4.212
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.011         0.110
Continuity Error (%) .....        -0.001


***************************
Time-Step Critical Elements
***************************
Link C3 (9.96%)
Link C1 (2.52%)


********************************
```

```
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.67 sec
Average Time Step           :     4.86 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00


***************************
Subcatchment Runoff Summary
***************************

--------------------------------------------------------------------------------------------------------
                          Total      Total      Total      Total      Total       Total     Peak  Runoff
                         Precip      Runon       Evap      Infil     Runoff      Runoff   Runoff   Coeff
Subcatchment                 mm         mm         mm         mm         mm    10^6 ltr      CMS
--------------------------------------------------------------------------------------------------------
Post_1a                  120.15       0.00       0.00      74.65      45.64        2.12     0.92   0.380
Post_1b                  120.15       0.00       0.00      70.79      50.05        0.38     0.25   0.417
Post_2                   120.15       0.00       0.00      75.15      45.09        1.82     0.77   0.375


******************
Node Depth Summary
******************

---------------------------------------------------------------------------------
                               Average  Maximum  Maximum  Time of Max    Reported
                                 Depth    Depth      HGL   Occurrence   Max Depth
Node                 Type       Meters   Meters   Meters  days hr:min      Meters
---------------------------------------------------------------------------------
OF1                  OUTFALL      0.09     0.31   898.83     0  08:31        0.09
OF2                  OUTFALL      0.00     0.00   899.59     0  00:00        0.00
ex.N                 STORAGE      0.16     0.54   899.08     0  08:31        0.17
Prop.N               STORAGE      0.11     0.42   899.42     0  09:48        0.13
prop.S               STORAGE      0.19     0.56   900.21     0  09:53        0.17
```

```
*******************
Node Inflow Summary
*******************

-------------------------------------------------------------------------------------------------
                                Maximum  Maximum                  Lateral       Total        Flow
                                Lateral    Total  Time of Max      Inflow      Inflow     Balance
                                 Inflow   Inflow   Occurrence      Volume      Volume       Error
Node                 Type           CMS      CMS  days hr:min    10^6 ltr    10^6 ltr     Percent
-------------------------------------------------------------------------------------------------
OF1                  OUTFALL      0.000    0.189     0  08:31           0         2.4       0.000
OF2                  OUTFALL      0.000    0.061     0  09:53           0        1.82       0.000
ex.N                 STORAGE      0.250    0.278     0  08:25       0.383         2.4       0.018
Prop.N               STORAGE      0.925    0.925     0  08:25        2.12        2.12       0.003
prop.S               STORAGE      0.772    0.772     0  08:25        1.82        1.82       0.000


**********************
Node Surcharge Summary
**********************

Surcharging occurs when water rises above the top of the highest conduit.
---------------------------------------------------------------------
                                             Max. Height   Min. Depth
                                 Hours       Above Crown    Below Rim
Node                 Type     Surcharged          Meters       Meters
---------------------------------------------------------------------
ex.N                 STORAGE         0.31          0.094        1.916
Prop.N               STORAGE         5.02          0.218        0.582
prop.S               STORAGE         8.12          0.357        0.793


*********************
Node Flooding Summary
*********************

No nodes were flooded.


**********************
Storage Volume Summary
**********************

--------------------------------------------------------------------------------------------------
                       Average     Avg  Evap Exfil       Maximum     Max    Time of Max    Maximum
                        Volume    Pcnt  Pcnt  Pcnt        Volume    Pcnt     Occurrence    Outflow
```

```
Storage Unit           1000 m3    Full  Loss  Loss       1000 m3    Full    days hr:min         CMS
--------------------------------------------------------------------------------------------------
ex.N                     0.004       0     0     0         0.044       2       0  08:31       0.189
Prop.N                   0.326      10     0     0         1.292      38       0  09:48       0.076
prop.S                   0.205       4     0     0         0.984      18       0  09:53       0.061


***********************
Outfall Loading Summary
***********************

-----------------------------------------------------------
                       Flow       Avg       Max       Total
                       Freq      Flow      Flow      Volume
Outfall Node           Pcnt       CMS       CMS    10^6 ltr
-----------------------------------------------------------
OF1                   96.90     0.030     0.189       2.395
OF2                   95.62     0.023     0.061       1.817
-----------------------------------------------------------
System                96.26     0.053     0.237       4.212


********************
Link Flow Summary
********************

-----------------------------------------------------------------------------
                               Maximum  Time of Max   Maximum    Max/    Max/
                                |Flow|   Occurrence   |Veloc|    Full    Full
Link                 Type          CMS  days hr:min     m/sec    Flow   Depth
-----------------------------------------------------------------------------
C1                   CONDUIT     0.189     0  08:31      1.32    3.32    0.84
C3                   CONDUIT     0.076     0  09:57      2.41    1.11    1.00
C2                   ORIFICE     0.061     0  09:53                      1.00


***************************
Flow Classification Summary
***************************

-------------------------------------------------------------------------------------
                    Adjusted    ---------- Fraction of Time in Flow Class ----------
                     /Actual         Up    Down  Sub   Sup   Up    Down  Norm  Inlet
Conduit               Length    Dry  Dry   Dry   Crit  Crit  Crit  Crit  Ltd   Ctrl
-------------------------------------------------------------------------------------
C1                      1.00   0.02  0.00  0.00  0.98  0.00  0.00  0.00  0.00  0.00
```

```
C3                       1.00   0.02  0.02  0.00  0.83  0.13  0.00  0.00  0.69  0.00


*************************
Conduit Surcharge Summary
*************************

----------------------------------------------------------------------------
                                                          Hours        Hours
                       --------- Hours Full --------   Above Full   Capacity
Conduit                Both Ends  Upstream  Dnstream   Normal Flow   Limited
----------------------------------------------------------------------------
C1                          0.01      0.31      0.01      6.08         0.01
C3                          5.02      5.02      7.23      3.24         3.24


Analysis begun on:  Tue Aug 02 15:04:17 2016
Analysis ended on:  Tue Aug 02 15:04:17 2016
Total elapsed time: < 1 sec
```