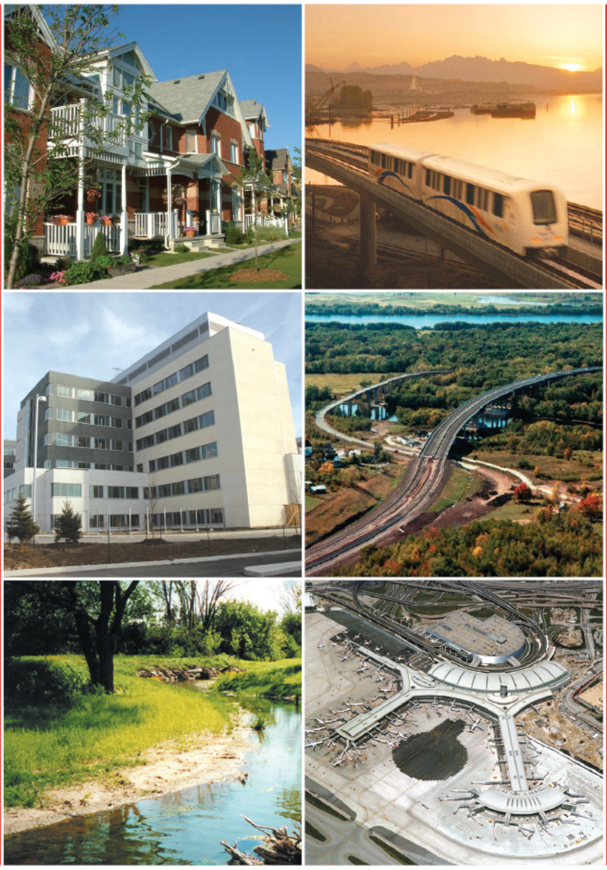
MMM Group Limited



Town of Mayerthorpe
Master Drainage Plan Update

COMMUNITIES
TRANSPORTATION
BUILDINGS
INFRASTRUCTURE

MMM GROUP

JUNE 2014 | 5311012000E04

Town of Mayerthorpe

MASTER DRAINAGE PLAN UPDATE

Prepared by

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Originally Prepared December 2011

Revised June 2014

MAYERTHORPE MASTER DRAINAGE PLAN UPDATE
Model Calibration and Adjustments for AESRD Comments
Completed on behalf of the Town of Mayerthorpe

Respectfully Submitted,

Prepared By:

PROFESSIONAL ENGINEER
ALBERT ZHENGJI ZHUGE
ALBERTA

June 13th, 2014

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Reviewed By:

PROFESSIONAL ENGINEER
JOSHUA A. MAXWELL
ALBERTA

June 13, 2014

Josh Maxwell, M.Sc., P. Eng.

PERMIT TO PRACTICE
MMM GROUP LIMITED

Signature ____________

Date June 13/14

PERMIT NUMBER: P 8845

The Association of Professional Engineers, Geologists and Geophysicists of Alberta

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STANDARD LIMITATIONS

This report was prepared by MMM Group Limited (MMM) for the client in accordance with the agreement between MMM and the client. This report is based on information provided to MMM which has not been independently verified.

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This Standard Limitations statement is considered part of this report.

VERSION HISTORY

REV	DATE	REASON FOR ISSUE	PREPARED BY	REVIEWED BY	SENIOR REVIEWED BY
00	June 21, 2011	Preview for the Client	Nedal Barbar	Kessie Govender	Jon Heisler
01	June 22, 2011	1st Draft Submission to Client	Nedal Barbar	Kessie Govender	Jon Heisler
02	August 4, 2011	2nd Draft Submission to Client	Nedal Barbar	Kessie Govender	
03	December 15, 2011	Final Submission	Kessie Govender	Kessie Govender	Jon Heisler
04	June 6, 2014	Updated with Calibration Results	Lisa Maruska	Alberta Zhuge Joshua Maxwell	Ryan Olson

1.0 INTRODUCTION

1.1 General

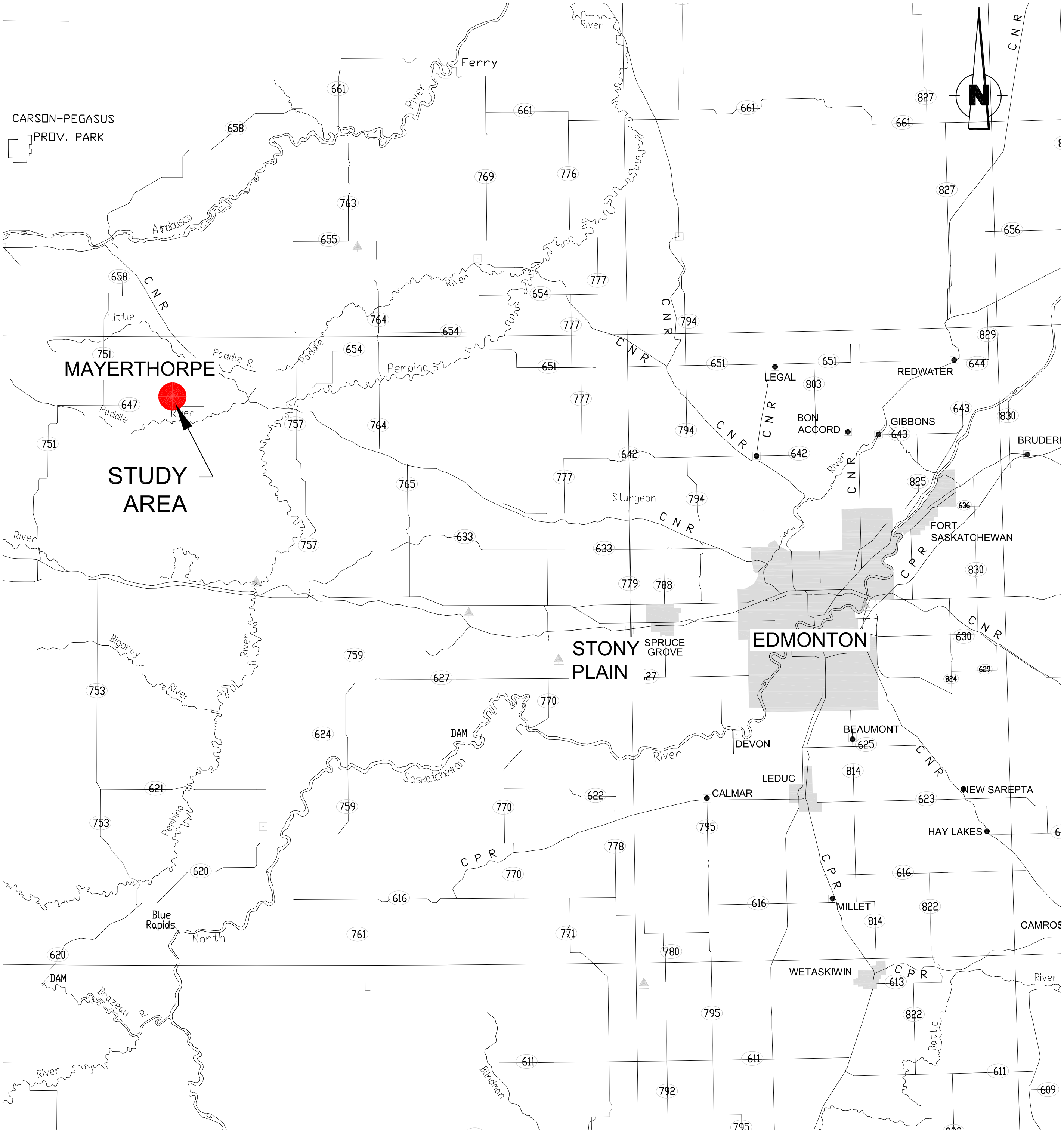
The Town of Mayerthorpe identified a need for a overall stormwater management plan in their community and retained MMM Group Limited to prepare this Stormwater Management Plan. The Water Act and Alberta Environmental Protection and Enhancement Act, requires municipal authorities to provide a framework to deal with stormwater in their communities. This report presents the findings of the existing storm drainage system including future stormwater requirements and provides an overall stormwater management conceptual plan for the Town. In addition, this study provides technical support for the proposed system of managing storm water and is intended to be guiding document for development applications and capital infrastructure upgrades. The subject study area is shown on **Figure 1.1**.

1.2 Study Area

The Town is located approximately 140 kilometres northwest of Edmonton and shares its drainage boundaries with Lac Ste. Anne County. This Town is bounded in the north by the Little Paddle River, Range Road 83 to the east, and Highway 43 in the south and west. The CN Rail line bisects the northern portion of the Town in the east-west direction and Hwy 22 in the north-south direction. The study area including the Town boundary is shown in **Figure 1.2**.

1.3 Scope of Work

- Review existing information available such as as-built drawings and reports.
- Determine a pre-development discharge rate for the area based on available hydrometric station flow data available in Little Paddle River.
- Develop a stormwater management plan within the Town/Corporate limits and surrounding lands in accordance with Alberta Environment Protection Stormwater Management Guidelines.
- Assess the capacity of the storm drainage system for the present conditions and future requirements.
- Recommend practices, policies, and priorities for stormwater management.



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S:\Projects\5311012000 Mayerthorpe SWM Plan\CAD\Drawings\FIGURES\2011 Master Drainage Plan E04\01-5311012e04 Fig 1.1 Loc Plan.dwg

TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

LOCATION PLAN
FIGURE 1.1

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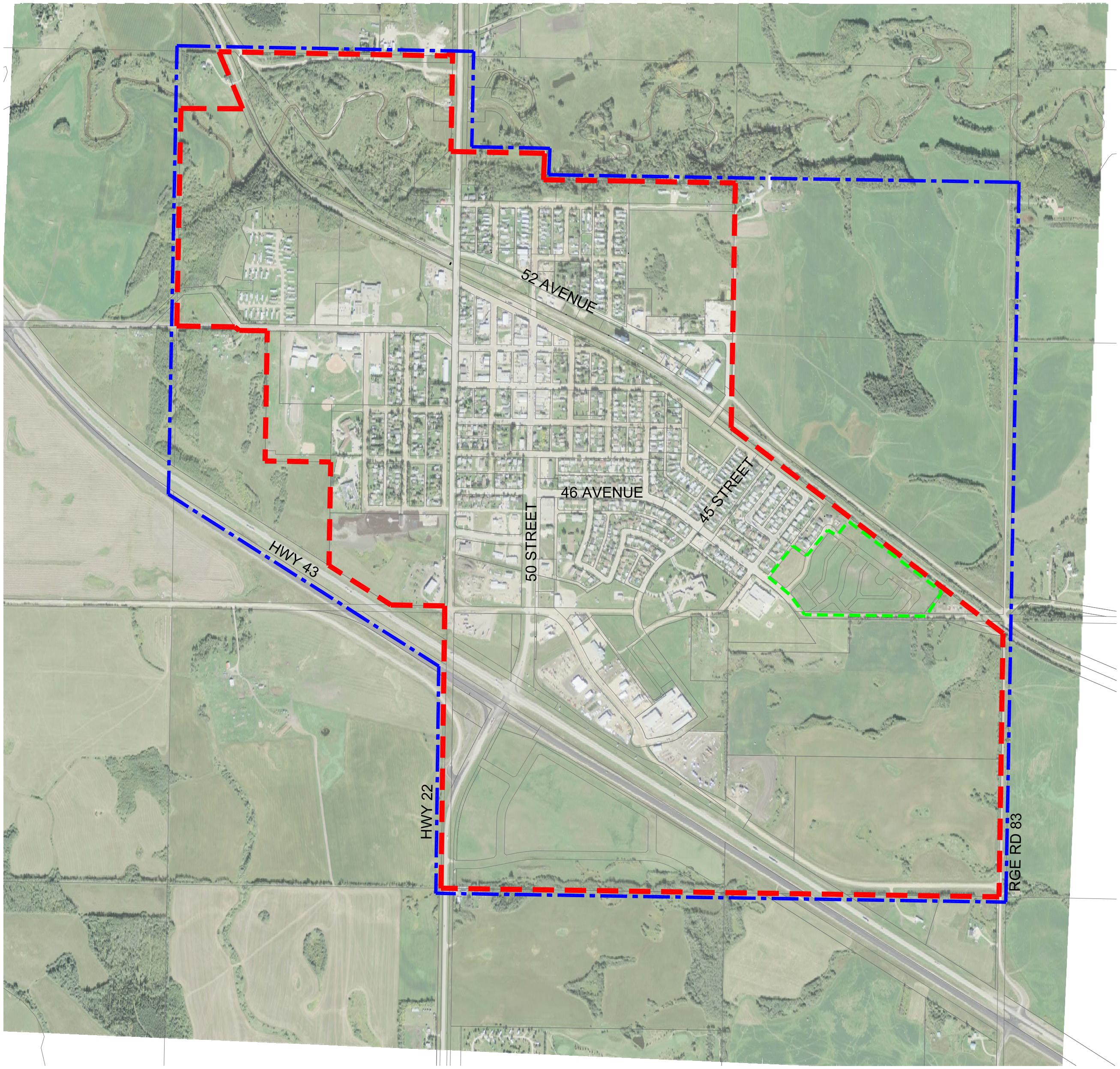

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TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

SCALE 1:12 500

TOWN BOUNDARY
APPROX. STUDY AREA BOUNDARY
PROPOSED MILLS ACRES SUB-DIVISION

STUDY PLAN

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FIGURE 1.2

2.0 WATERSHED DRAINAGE PLAN

2.1 General

The Town study area including its upstream sub-basin headwaters drain into the Little Paddle River just north of study area. The Little Paddle River watershed forms part of the Paddle River basin which ultimately discharges into the Pembina River. The Town is located approximately 16 km upstream of the Little Paddle River and Paddle River confluence.

The Town of Mayerthorpe is located within the boundaries of Lac Ste. Anne County and has urbanized setting in rural Alberta. Currently no pre-development rate has been established for the Little Paddle River near the Town of Mayerthorpe or within the Lac Ste. Anne County. There are no stormwater management controls that limit the discharge of stormwater runoff from the Town into the Little Paddle River. As part of this study, frequency analysis of recorded flood flows in the Little Paddle River was used to determine the pre-development flow rate.

2.2 Hydrometric Station

In order to conduct a frequency analysis, flood flow data is required in the Little Paddle River. Recorded flow data was available from the Water Survey of Canada website at Hydrometric Station 07BB005, which is the nearest station available to the Town with a total gross drainage area of 295.1 km^2. 39 years of peak flow data from 1963 to 2010 are available at this Station, however approximately 5 years of maximum instantaneous flow data were missing. **Table 2.1** shows the maximum instantaneous and maximum daily peak flows utilized in our analysis. The Hydrometric Station is located just upstream of the Town at the intersection of Highway 43 and Little Paddle River as shown on **Figure 2.1**.

TABLE 2.1 - AVAILABLE PEAK FLOW DATA AT HYDROMETRIC STATION		
Year	Maximum Instantaneous Peak Flow (m^3/s)	Maximum Daily Peak Flow (m^3/s)
1963	34.8	missing
1971	84.4	missing
1972	21	missing
1973	16.8	missing
1974	54.9	missing
1975	34.5	missing
1977	51	missing
1978	29.2	missing
1979	32.4	missing
1980	35.7	missing
1981	7.14	missing
1982	31.9	missing
1983	31	missing
1984	17.6	missing

TABLE 2.1 - AVAILABLE PEAK FLOW DATA AT HYDROMETRIC STATION		
Year	Maximum Instantaneous Peak Flow (m^3/s)	Maximum Daily Peak Flow (m^3/s)
1985	38.9	missing
1986	45.9	missing
1988	48.8	missing
1989	150	missing
1990	68.5	48
1991	33.5	28.9
1992	missing	2.6
1993	missing	14.6
1994	21.6	16.7
1995	25.9	19.4
1996	30.3	26.3
1997	50	40
1998	missing	3.56
1999	23.8	16.6
2000	10.9	8.18
2001	49.5	39.6
2002	15	12.3
2003	missing	7.2
2004	3.05	2.27
2005	16.2	11.8
2006	missing	0.61
2007	61.7	48.8
2008	2.02	1.56
2009	4.7	4.09
2010	0.408	0.191

2.3 Pre-development Rate

The 2, 5, 10, 20, 25, 50, and 100 year return period discharge in Little Paddle River were determined using the maximum instantaneous discharge data available at Hydrometric Station 07BB005. Linear regression was used to estimate 5 years of missing peak instantaneous flow data from the available maximum daily peak discharge. **Table 2.2** below shows a summary of the frequency analysis results. The Log-Normal distribution was the best fit curve and was utilized to establish the discharges for each return period.

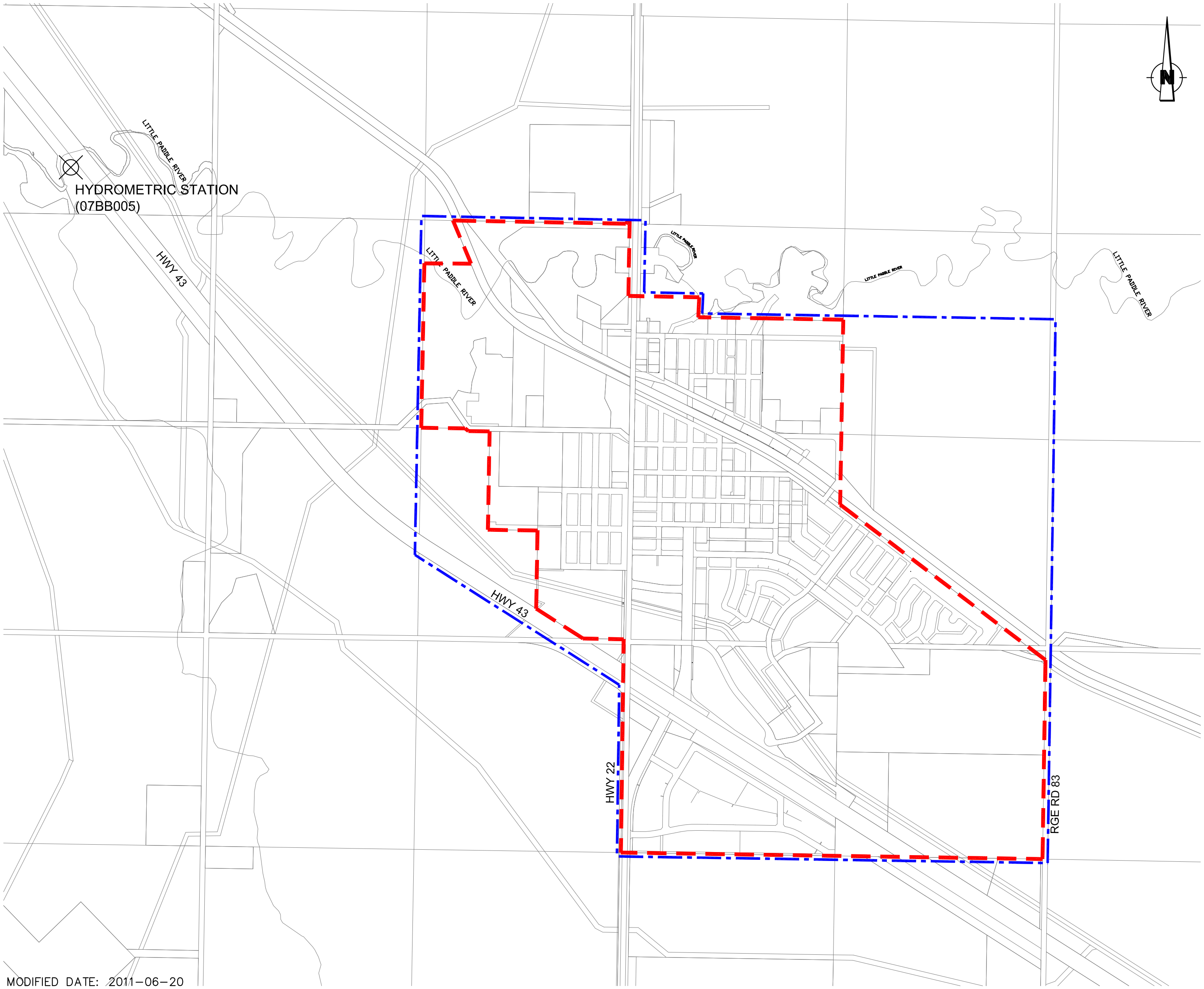
TABLE 2.2 – SUMMARY OF PEAK DISCHARGE AT STATION 07BB005							
DATA TYPE	RETURN PERIOD DISCHARGE (M^3/S)						
	2	5	10	20	25	50	100
Maximum Instantaneous (m^3/s)	30.0	48.3	67.9	89.2	96.4	120.2	150.0
Maximum Instantaneous (L/s/ha)	1.0	1.6	2.3	3.0	3.3	4.1	5.1

As shown in **Table 2.2**, the maximum allowable rate for a 100 Year return frequency is 5.1 L/s/ha. It is recommended that the discharge rates from the subject area will be controlled to this maximum allowable rate. The watershed area of Little Paddle River just upstream of the Town was determined utilizing the National Topographic System (NTS) of Canada maps of 1:40,000 scale located on the Natural Resources Canada website. The delineated watershed boundary of the Little Paddle River up to the Town of Mayerthorpe is shown on **Figure 2.2**. A total watershed area of 322.1 km^2 drains into the Little Paddle River near the Town. **Table 2.3** shows the calculated maximum instantaneous 1:100 year flood flow in Little Paddle River at the proposed site based on this drainage area and the maximum allowable rate of 5.1 L/s/ha.

TABLE 2.3 – SUMMARY OF 1-100 YEAR PEAK DISCHARGE AT SITE			
FLOW DATA	DRAINAGE AREA AT SITE (KM^2)	MAXIMUM ALLOWABLE (L/S/HA)	1:100 YEAR MAXIMUM INSTANTANEOUS DISCHARGE (M^3/S)
Maximum Instantaneous	322.1	5.1	164

Based on the above calculations, a maximum instantaneous flow of 164 m^3/s occurs in the River at the site during the 1:100 year flood event based on frequency analysis of Hydrometric Station 07BB005.

The predevelopment rate of 5.1 L/s/ha is applicable to the study area boundary. Please refer to **Figure 2.1** for the approximate study area boundary.



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TOWN OF
MAYERTHORPE

MASTER
DRAINAGE PLAN

SCALE 1:15000

TOWN BOUNDARY
APPROX. STUDY AREA BOUNDARY

LOCATION OF
HYDROMETRIC STATION

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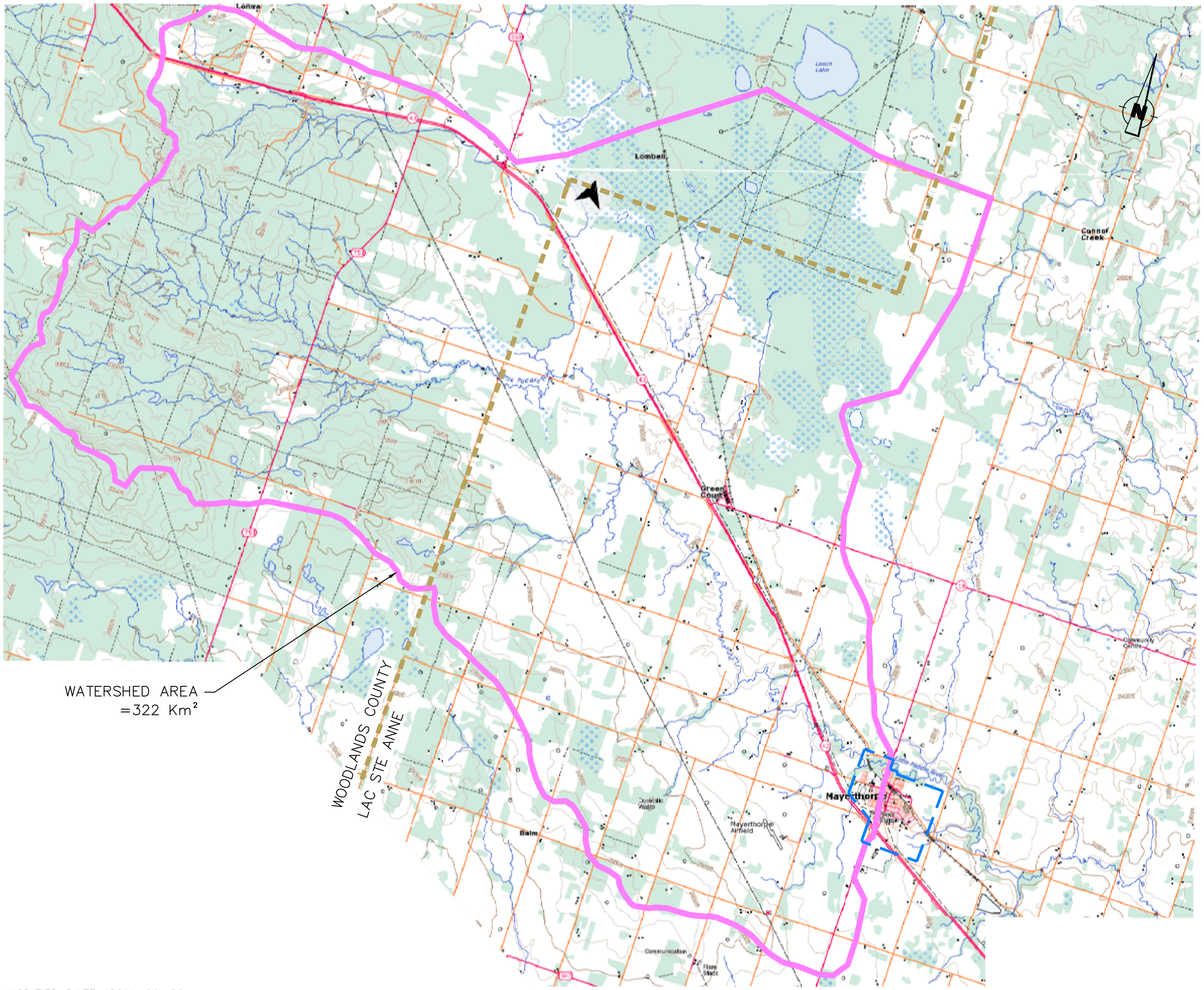
FIGURE 2.1



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S:\Projects\5311012000 Mayerthorpe SWM Plan\CAD\Drawings\FIGURES\2011 Master Drainage Plan E04\04-5311012e04 Fig 2.2 Watershed.dwg

TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

SCALE 1:100 000

WATERSHED BOUNDARY
APPROX. STUDY AREA BOUNDARY
COUNTY BOUNDARY

LITTLE PADDLE RIVER WATERSHED BOUNDARY AT STUDY AREA

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FIGURE 2.2

3.0 BIOPHYSICAL FRAMEWORK

3.1 General

MMM Group Limited was retained by the Town of Mayerthorpe to prepare a Stormwater Management Plan for the entire Town located in Lac Ste. Anne County, Alberta. As part of the stormwater management, a basic framework for a biophysical is being prepared. The Town of Mayerthorpe will conduct a detailed biophysical assessment once funding is available.

3.2 Study Area

The Town is located 140 kilometres northwest of Edmonton within Lac Ste. Anne County. This Town is bounded on the north by the Little Paddle River, Range Road 83 to the east, and Highway 43 in the south and west. The CN rail line bisects the northern portion of the Town in the east-west direction. The study area for the Biophysical Assessment will include the Little Paddle River and floodplain area within the Town boundary and is shown in **Figure 3.1**.

3.3 Scope of Work

The scope work for Biophysical Assessment Frame work for the proposed development includes:

- Regulatory consideration for a Biophysical Assessment and Potential Outfall development along the Little Paddle River.
- Preliminary desktop review of existing information and presentation.
- Recommendations.

3.4 REGULATORY CONSIDERATIONS

The following federal, provincial and municipal acts, regulations, or policies may be relevant to certain aspects of the Biophysical Assessment for the establishment of a Stormwater Management Network for the Town of Mayerthorpe:

3.4.1 Federal Legislation

- Migratory Bird Convention Act.
- Fisheries Act
- Navigable Waters Protection Act
- Species at Risk Act

3.4.2 Provincial Legislation

- Environmental Protection and Enhancement Act
- Public Lands Act
- Water Act
- Weed Control Act
- Wildlife Act
- Alberta Land Stewardship Act

3.4.3 Municipal Legislation

- Town of Mayerthorpe Municipal Development Plan, North Star Planning, July 2006.
- Southeast-Highway No. 43 Area Structure Plan, Town of Mayerthorpe with Assistance from New Era Municipal Services, April 1999.
- Lac Ste. Anne County – Municipal Development Plan – No. 17-08 Section 3.11 Rural-Urban Municipal Fringe.
- Lac Ste. Anne County - Municipal Development Plan – No. 17-08 Section 3.13 Environment.

3.4.4 Additional Regulations for Outfall establishment along Little Paddle River

- Government of Alberta, Water Act, Code of Practice for Outfall Structures on Water Bodies, September, 2003.
- Government of Alberta, Water Act, Guide to Requirements for Outfall Structures on Water Bodies, December, 2004.

The code of practice requires that a Professional Engineer (P.Eng.) prepare plans and a Qualified Aquatics Environmental Specialist (QAES) provides written specification before an outfall structure can be approved for construction.

3.5 Biophysical Assessment Preliminary Results

3.5.1 Study Area Location

The preliminary study area was established as the NE 29-57-8 W5M and the N1/2 28-57-8- W5M and contains the Little Paddle River and flood plain area. As it has not been determined if any outfall structures will be established or not, a final study area will not be established until after the Stormwater Management Plan has been approved.

3.5.2 Climate

In general, the climate of Mayerthorpe and surrounding area is continental, being characterized by long, cold winters and short, cool summers. Mean daily temperature at Mayerthorpe (based on the closest station at Whitecourt) ranges from -16.4 in January to 15.1 in July and averages 2.6˚C year-round. On average the frost-free season is up to 164 days. Precipitation follows a summer-high, winter-low pattern and averages 577 mm annually of which 71 % falls as rain.

3.5.3 Physiographic Description

Mayerthorpe is in the Dry Mixedwood subregion, which is a component of the Boreal Forest Region of Alberta. While still predominantly agricultural, this area has significant aspen forests with fens occupying the low-lying areas. This area is intermediate between the Central Parkland subregion to the southeast and the Central Mixedwood subregion to the northwest.

3.5.4 Historical Aerial Photographs

Historical aerial photographs indicate continuous development of the townsite since the 1950's which residential development radiating out from the 50th Street area and up the Little Paddle River valley. Industrial and commercial development closer to the Highway 43 corridor has been ongoing since the 1980's.

3.5.5 Field Reconnaissance, Sampling and Surveys

Field surveys and reconnaissance of the Mayerthorpe area indicated typical transition mixed parkland aspen forest with boreal vegetation.

3.5.6 Topography

The Mayerthorpe area is in an area of gently rolling topography which grades gently toward the Little Paddle River valley which is typical of central Alberta.

3.5.7 Geology

Local geology consists of glaciolacustrine deposits of clay to silty clay varying from 2 metres to 15 metres in thickness. This is underlain by bedrock of the Paskapoo Formation consisting of grey feldspathic sandstone, dark bentonitic mudstone and thick coal beds.

Surficial soils in the vicinity of the Study area were reviewed using the Government of Alberta Agriculture and Food Soil Information Viewer (AGRASID) Version 3.0 (Alberta Soil Information Centre 2001). Four soil classification polygons were reported to intersect the Study area. The northwest portion of the study area contains Orthic Dark Gray Chernozen on very fine textured (HC) water-laid sediments and includes poorly drained soils. This area is described as hummocky, low relief landforms with a limiting slope of 6% (polygon 19292). In the centre of the study area is a valley with floodplain with low relief landforms with slopes ranging from 1-5% on the floodplain and up to 15 % on the side slopes with undifferentiated mineral soils (polygon 19339). In the central south west portion of the study area is the disturbed lands where the Town of Mayerthorpe is located (polygon 19337). The soils in the southeast portion of the study site are Orthic Dark Gray Chernozems on very fine textured (Heavy Clay) water-laid sediments and Dark Gray Luvisols on very fine textured (Heavy Clay) water-laid sediments, the area includes poorly drained soils and has hummocky, low relief landforms with a limiting slope of 6% (polygon 19287).

A copy of the AGRASID search results is included in **Appendix A**.

3.5.8 Hydrology

The Little Paddle River drains east to join the Paddle River north of Rochfort Bridge, which is itself a tributary of the Pembina River. The North Saskatchewan River drainage basin is just south of the area. There are also many small, shallow lakes. About 15 percent of the surrounding area is covered by wetlands, with organic accumulations underlying 10 percent and shallow peats or wet mineral soils underlying the remaining 5 percent.

3.5.9 Vegetation

The Study area is in the Boreal Dry Mixedwood Natural Subregion of the Boreal Forest Natural Region (ASRD 2005). The subregion represents a transition zone between the conifer-dominated boreal mixedwood forest, and the deciduous-dominated aspen parkland. Native vegetation in the area consists of aspen forests with mixed understories of rose, low-bush cranberry, beaked hazelnut and Canada buffaloberry. Treed, shrubby or sedge-dominated fens occupy about 15 percent of the area. Jack pine stands occur on dry, well to rapidly drained glaciofluvial and eolian parent materials.

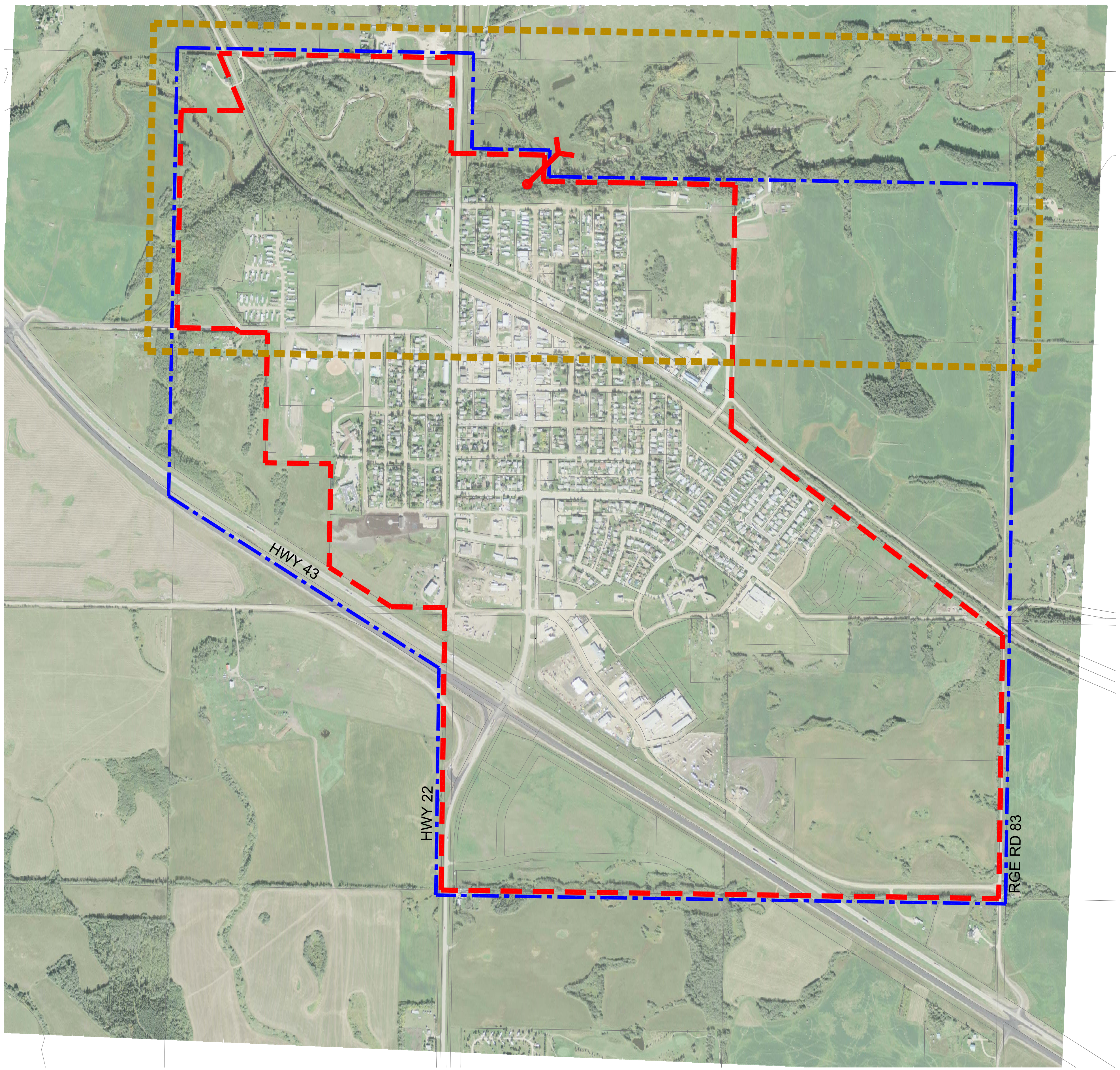
3.5.10 Wildlife

Animals of the area include a mixture of grassland species and boreal forest species. Characteristic species of the parkland include red-eyed vireo, red-tailed hawk, least flycatcher, yellow warbler, white-tailed deer, coyote, porcupine, northern pocket-gopher, voles and snowshoe hare. The permanent and intermittent wetlands common in the area support a variety of birds and amphibians as well. A search for records of fish species was run through the Fisheries and Wildlife Information System (FWMIS) for the study area. The search was conducted for a 2 km radius from the centre of the study area to determine what species have been observed on in the area. Records of fish were retrieved for the Little Paddle River along Highway 43 and include: Brook Stickleback, Fathead Minnow, Lake Chub, Longnose Sucker, and White Sucker.

Copies of the occurrences reports are included in **Appendix B**.

3.5.11 Conservation Recommendations

It is recommended that a long term monitoring program and Watershed Stewardship program be established.



MODIFIED DATE: 2011-06-20
S:\Projects\5311012000 Mayerthorpe SWM Plan\CAD\Drawings\FIGURES\2011 Master Drainage Plan E04\05-5311012e04 Fig 3.1 Study Area.dwg

TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

SCALE 1:12 500

TOWN BOUNDARY
APPROX. STUDY AREA BOUNDARY
PRELIMINARY BIO-PHYSICAL ASSESSMENT AREA
EXISTING OUTFALL

BIOPHYSICAL STUDY PLAN

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FIGURE 3.1

4.0 MASTER DRAINAGE PLAN

4.1 Data Collection and Review

A comprehensive review of existing information was conducted by MMM Group Limited. Information obtained from the Town, Alberta Environment, Alberta Transportation, Lac Ste. Anne County, DCL Siemens, North Star Planning, and from current land owners and developers were reviewed. This included existing reports, as-built drawings and available LIDAR (Light Detection and Ranging) information.

4.1.1 Available Reports

The following available reports were utilized for this Study:

- Town of Mayerthorpe Municipal Development Plan, North Star Planning, July 2006.
- Southeast-Highway No. 43 Area Structure Plan, Town of Mayerthorpe with Assistance from New Era Municipal Services, April 1999.
- Infrastructure Assessment, DCL Siemens Engineering Ltd., July 2009.
- Geotechnical Site Investigation, Proposed Mayerthorpe Exhibition Centre and Outdoor Swimming Pool, Sabatini Earth Technologies Inc., October 2009.

4.1.2 As-Built Drawings

In addition to the provided reports, available drawings completed for the Town were utilized to gain an understanding of the drainage patterns, as well as, existing drainage infrastructure within the Town boundary limits. These drawings were very supportive in the evaluation of the existing storm infrastructure. The following drawings were utilized in this study:

- 1979 Underground Utilities – Highway Commercial III Subdivision, Underwood McLellan (1977) Ltd., October 1979.
- 1979 Underground Utilities – Mills Acres Stage 1, Underwood McLellan (1977) Ltd., July 1979.
- Mill's Acres Subdivision – 42nd Street Drainage Extension, Associated Engineering, March 1995.
- Town of Mayerthorpe Storm Drainage, Underwood McLellan and Associates Limited, August 1974.
- HI VU Subdivision – Stage 2, Underwood McLellan and Associates Limited, December 1976 and May 1977.
- 1998 Roads to Resources Program – 52 Avenue From 52 Street to 45 Street, Merge Consulting Ltd., May 1998.
- ARA Engineering – Culvert Information along Highway 43 from East of the Town of Mayerthorpe to West of Sangudo.
- Seniors Lodge – DCL Siemens/Wilson Architects.

4.1.3 LIDAR Information

LIDAR (Light Detection and Ranging) is an optical remote sensing technology that can measure the distance to, or other properties of a target by illuminating the target with light, often using pulses from a laser.

Airborne Imaging was retained by MMM Group Limited to obtain LIDAR contours over the entire area of the Town including surrounding areas. These contours were given in 0.25 m, 0.50 m, and 1.0 m contours. The 0.25 m contours were utilized to delineate the watershed and sub-basins within Study area. **Figure 4.1** shows the 2.0 m contours provided by Airborne Imaging.

4.1.4 Stakeholder Survey

A survey was conducted via mail out questionnaire to various stakeholders regarding storm drainage on their properties, historical drainage information and if there are any intended land used changes that are intended in the future etc. A summarized response from the survey can be found in **Appendix D**.

4.2 Design Criteria

The Alberta Environmental Protection Stormwater Management Guidelines, January 1999, were utilized for the design criteria of the minor and major systems. Lac Ste. Anne County Standards were also used where applicable.

4.2.1 Minor System

The minor system consists of those drainage works that convey runoff from minor storm events that range from the 1:2 year to 1:10 year storm events. Although return periods varying from 2 to 10 years are used as design standards in different municipalities, the 1:5 year design storm is the most common for the design of the minor system. Based on the Lac Ste. Anne County Standards, the 5-year rainfall intensity shall be taken from climatic design values obtained from Atmospheric Environment Services (AES). The nearest IDF data from AES is located in Edson, Alberta and will be utilized for the analysis of the 1:2 Year and 1:5 Year events. The minor components can consist of the following:

- Roof leaders
- Foundation drains
- Manholes, junctions and outfalls
- Outfalls
- Catch basins, inlets and leads
- Underground pipe system
- Ditches
- Swales
- Erosion protection and energy dissipators

- Receiving waters

4.2.2 Major System

The major system consists of those drainage works that convey runoff from major storm events up to the 1:100 year storm event. During a major storm event the capacity of the minor system is exceeded and overland flow conveyance commences. Surcharge in the minor system should not exceed more than 300 mm during a major storm event. The major system can consist of the following components:

- Ditches or channels
- Swales
- Culverts
- Outfall channels
- Stormwater Management Facilities (SWMFs)
- Overland drainage (lot drainage, roads, gutters, etc.)
- Receiving waters

The maximum allowable discharge rate from SWMFs is set to the pre-development rate of 5.1 L/s/ha, calculated in Section 2.0. In general, the pre-development flow rate is achieved by the installation of a control structure at the outlet of each SWMF, including a spillway for emergency that allows each SWMF to spill into the drainage channel if flows exceed the 1:100 Year level.

4.2.3 Water Quality

Alberta Environment requires the removal of 85% of sediments with a particle size of 75µm or greater from developments before discharging into a watercourse.

The Alberta Environment Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems (1997) identify the following requirements for storm water quality.

- Storing a 25 mm storm event over the contributing area: and,
- Detaining the runoff for the duration of 24 hours.

4.3 Field Reconnaissance

Two site visits were conducted in the Town. A site visit was conducted on April 7, 2011 and another followed on May 6, 2011. A number of drainage issues were noted within the Town drainage infrastructure. A number of culverts and pipes have been found clogged, damaged at the inlet/outlets, and frozen creating backups.

In addition, it was noted that a large amount of silt is being deposited in existing catch basins due to unpaved roads within the Town. This may be causing an excess amount of sediment build-up in the storm pipes therefore limiting the flow capacity in the storm sewer system. In addition, the sediment from the gravel roads may be impacting the habitat along the watercourses and Little Paddle River. During the site visit, catch basins just east of the intersection of 42A Avenue and 50 Street were found to be filled with sediments. A few other areas were seen to be collected in areas such as residential yards and few ditches due to water backing up from these frozen or plugged culverts. The existing major system culverts were also inspected and found to be plugged with debris and erosion has occurred upstream and downstream of most culverts. Erosion protection measures are recommended at these culverts to prevent any further damage caused by erosion.

4.4 Geotechnical Information

Geotechnical information for the Town was limited to one report that was available to be used at the time of preparing this Study. The report was limited to a small site located in Lot R, Block 5, Plan 1655MC in SE 29-57-8-W5M and comprised of approximately 6.5 hectares. Sabatini Earth Technologies Inc. prepared this report on October 2009 for the proposed Mayerthorpe Exhibition Centre and Outdoor Swimming Pool.

Ten (10) boreholes were drilled at the above mentioned site at depths ranging from 3.0 to 10.5 m. The soil consisted of a layer of fill, topsoil, organic clay over clay, which extended to the maximum depth of the boreholes. Organic clay and/or topsoil and organic inclusions were observed within the fill layer.

The report describes the topsoil as “silty with traces of sand, greyish brown in colour, compressible with occasional small roots, organics and wood pieces”. The fill consisted of gravel and clay. Clay fill was described as “silty with traces of sand, greyish brown in colour, moist, high plastic and stiff in consistency with occasional admixing of topsoil, traces of salt and rust stains and concrete and gravel bits”. The gravel fill was defined as “damp and compact”.

The ground water conditions at this small site were observed during drilling and 27 days after. Ground water levels ranged in depth from 0.9 m to 9.8 m below ground.

4.5 Existing Drainage System

4.5.1 Existing Land Uses and Topography

The Study area topography is undulating in elevation but ultimately drains north into the Little Paddle River. Elevations on the site range from approximately 705 m to 725 m. The Study area currently consists of residential, institutional, commercial, industrial, recreational, and undeveloped areas as shown on **Figure 4.2** and forms part of the Municipal Development Plan, prepared in July 2006.

4.5.2 Drainage Basins

The total watershed basin including sub-basin areas draining towards the Study area is shown on **Figure 4.2**. A total area of 899.9 ha drains into the Little Paddle River at Mayerthorpe. The watershed area was divided into 10 major basins and consists of 45 sub-basins to account for flows draining into the existing storm sewer system, as well as, areas draining towards the River and major culverts. **Table 4.1** summarizes the basin areas, as well as, the approximated runoff coefficients based on the existing Land Use Plan provided by the Town. The runoff coefficients were determined based on the Lac Ste. Anne County General Municipal Servicing Standards, January 2008. Note that the runoff coefficients for the existing land uses as shown in **Table 4.1** are un-calibrated values. These values have been subsequently subjected to a calibration, which is documented in Section 4.5.6 discusses the model calibration and adjusted runoff coefficients based on the calibration results.

TABLE 4.1 – EXISTING SUB-BASIN AREAS AND RUNOFF COEFFICIENTS

Sub-Basin	Area (ha)	Existing Weighted Runoff Coefficient *
1	13.1	0.22
2	15.9	0.11
3	45.8	0.20
4 (A/B)	30.3	0.32
5	4.2	0.72
6	1.1	0.69
7	1.4	0.39
8	3.4	0.45
9	1.5	0.42
10	1.2	0.48
11	1.1	0.49
12	1.9	0.41
13	1.8	0.46
14	7.3	0.45
15	8.6	0.48
16	4.2	0.43
17 (A/B)	12.1	0.46
18	33.4	0.13
19	18.9	0.10
20	27.2	0.10
21	13.5	0.25
22	13.5	0.52
23	12.6	0.52
24	0.8	0.35
25	4.6	0.65
26	3.6	0.41
27	1.1	0.57
28	1.4	0.45
29	0.9	0.44
30	4.2	0.42
31	4.7	0.48
32	3.7	0.71
33	10.7	0.60
34	17.4	0.50
35	2.8	0.37

TABLE 4.1 – EXISTING SUB-BASIN AREAS AND RUNOFF COEFFICIENTS		
Sub-Basin	Area (ha)	Existing Weighted Runoff Coefficient *
36	4.5	0.38
37	13.3	0.27
38	1.7	0.50
39	22.7	0.29
40 (A/B)	3	0.42
41 (A/B)	2.9	0.57
42	3.3	0.21
43	67	0.11
44	28.8	0.11
45	422.8	0.10
Total	899.90	

* Un-calibrated values

As shown on **Figure 4.3**, there are upstream basins draining towards the Town (Basins 1, 44, and 45) that drain through several culverts under Highway 43 including the service road south of Highway 43. These basins are not within the Town boundary and will need to be diverted east along the service road or along Highway 43 ditch across Range Road 83 and ultimately into the Little Paddle River. This will lessen the possibility of flooding in the southeast area from these upstream basins, as well as, lower the impact on the water quality of these upstream basins. The existing drainage patterns are also shown on **Figure 4.3**.

4.5.3 Drainage Issues and Constraints

The Infrastructure Assessment Report prepared by DCL Siemens (July 2009), outlined drainage issues noted in **Table 4.2.1**. Additional issues were noted during the site visits in April and May 2011 by MMM Group.

TABLE 4.2.1 – DRAINAGE ISSUES IN EXISTING SYSTEM		
Location	Issue	Possible Cause
South Side of 50 Ave West of 53 St	Slow Draining - No Grade to CB (Catch Basin)	Poor Grading to CB or Clogged CB since there is a lot of gravel and mud in area draining towards CB.
North Side of 42A Ave West of 45 St	Slow Draining	This may be due to the 42A Avenue cutting off flow from upstream; it appears that no culvert or CB exists.
East Side of 51 St - 49 Ave to 50 Ave	Frequent Storm Back-ups	No CB's exist and it appears to be a low point. Road needs to be graded to slope north or a CB needs to be added.
South Side - Intersection of 49 Ave & 51 St	Frequent Storm Back-ups - No CB's	
North Side - Intersection of 49 Ave & 51 St	Frequent Storm Back-ups - No CB's	
Intersection of 52 St & 53 Ave	High Swale - No Drainage North	Possibility of gravel building up near paved road on 52 St, therefore blocking flow from 52 St in gutter flowing north. This shouldn't

TABLE 4.2.1 – DRAINAGE ISSUES IN EXISTING SYSTEM		
Location	Issue	Possible Cause
		be a major problem as the slope of 52 St appears to be steep at this location.
Intersection of 54 St & 48 Ave	Slow Draining - No Grade to CB	Poor Grading to CB or Clogged CB since there is a lot of gravel and mud in area draining towards CB.
Southwest Quadrant of the Intersection of 50 St and 42A Ave	Slow Draining	Runoff backing up due to frozen culvert under 50 St.
Catch basins on 42A Ave and 42 Ave	Clogged Catch Basins or undersized storm pipes.	Possible frozen pipes causing runoff to back up into streets. Pipes are not buried deep enough. Approx. 0.9 m of cover based on as- built drawings.

Possible causes of these drainage issues have been examined utilizing the existing LIDAR contours, during site visit, and Google Earth in street view. Additional issues were noted during the site visit such as debris and sediment build-up at the upstream end of major culverts and distortion at the culvert ends. Erosion has occurred at some culverts and it is recommended that erosion and sediment control measures be implemented at these locations. Erosion was noted during the site visit at a depth of approximately 1.5m at one culvert location. The location of existing culverts as well as an analysis of the existing storm system is discussed in Section 4.5.5.

4.5.4 Precipitation (IDF) Data Assessment

The precipitation data (or Intensity-Duration-Frequency, e.g., IDF data) essentially determines the maximum intensities and total rainfall depths of design storms (e.g., 2-year, 5-year, 100-year, etc.), which influences the Town design standards and is a key to assess and evaluate the Town's infrastructures. A comparison of the precipitation data from different precipitation gauges located within the vicinity of the Town of Mayerthorpe was carried out. **Table 4.2.2** provides a summary of the precipitation gauges investigated.

TABLE 4.2.2 - PRECIPITATION GAUGES WITHIN THE VICINITY OF THE TOWN OF MAYERTHORPE						
Gauge Name	Gauge #	Operated by	Latitude	Longitude	Altitude	Available Data
Mayerthorpe	07BB809	Alberta Environment	53°51'30.0"N	115°21'20.0"W	N/A	Precipitation Depth: May 1 to September 30, 2012 and May 1 to September 30, 2013
Edson	3062244	Environment Canada	53° 35' N	116° 28' W	927	Precipitation Depth: IDF Data based on 1970 - 1992
Whitecourt	3067372	Environment Canada	54° 8' N	115° 47' W	782	Precipitation Depth: IDF Data based on 1982 - 2006

*Note that the precipitation depth obtained from EC's Whitecourt location is not available for the selected time periods.

A brief comparison of the results is included in Figure 1 in the Appendix E-1, Tables 4.2.3 and 4.2.4. The detailed results can also be found in Appendix E-1.

TABLE 4.2.3 - PRECIPITATION DATA COMPARISON BASED ON MAY 1 TO SEPTEMBER 30 2012 AND 2013		
Total Depth (mm)	Mayerthorpe	Edson
May 1 to Sep 30, 2012	426.8	325.8
May 1 to Sep 30, 2013	352.8	262.8

TABLE 4.2.4 - PRECIPITATION DATA COMPARISON BASED ON 100-YEAR IDF INFORMATION					
Duration		100-Year Rainfall Amounts (mm)		100-Year Rainfall Intensity (mm/hr)	
		Edson	Whitecourt	Edson	Whitecourt
5	min	17.5	11.6	210.6	139.6
10	min	22.4	17.4	134.3	104.2
15	min	25.9	21	103.4	83.9
30	min	31.3	31.4	62.6	62.8
1	h	36.9	38.8	36.9	38.8
2	h	45.2	50.6	22.6	25.3
6	h	48.9	75.4	8.2	12.6
12	h	69.1	85	5.8	7.1
24	h	92.4	109.9	3.9	4.6

The above information indicates the following:

1) Based on rainfall depth recorded during 2012 and 2013 summer seasons (May 1 to September 30), the Mayerthorpe gauge collected more rainfall amounts than those from Edson gauge;

2) Based on IDF data, for 100-year event with storm duration less than 1 hour, the Edson gauge provides more rainfall amount and higher rainfall intensity than those from Whitecourt location; and

3) Based on IDF data, for 100-year event with storm duration more than 1 hour, however, the Edson gauge provides less rainfall amount and lower rainfall intensity than those from Whitecourt location.

Consequently, for purposes of prudent design, it is recommend to use precipitation data obtained from Environment Canada Atmospheric Environment Services (EC-AES) Whitecourt gauge for this Master Drainage Plan study. This includes

1) Rational Method Assessment – Existing and Future Storm Sewer System Design: IDF parameter Coefficient "*a*" and Exponent "*b*" for 1:2 Year and 1:5 Year storm events;

2) XPSWMM Model – Existing and Future Minor System Model: The 1:5 Year design storm determined by adjusting the City of Edmonton 4 hour Chicago design storm distribution by a correction factor to obtain a total 1:5 Year-4 hour rainfall amount of 34.9 mm provided by the Whitecourt IDF data; and

3) XPSWMM Model – Existing and Future Major System Model: The 1:100 Year-24 hour Huff design storm determined by adjusting the City of Edmonton 1:100 Year - 24 hour design storm distribution by a correction factor to obtain a total rainfall amount of 109.9 mm provided by the Whitecourt IDF data.

4.5.5 Existing Minor System Assessment

The existing minor storm sewer system has been assessed for the subject area using the rational method and XP-SWMM modeling software. **Figure 4.4** illustrates the existing storm sewer system which was created based on available information from as-built drawings provided by the Town. The delineated areas draining into system were determined from LIDAR data. Some areas of the watershed discharge into swales or ditches and ultimately into the Little Paddle River.

4.5.5.1 Rational Method Assessment

The existing storm sewer system design and analysis details for the 1:2 Year and 1:5 Year storm events are shown on **Tables 4.3** and **Table 4.4**, respectively. The physical information in the tables such as pipe diameter, slope, pipe invert and ground elevations were determined from the existing as-built drawings provided. The IDF Coefficient "*a*" and Exponent "*b*" are obtained from EC-AES IDF data at Whitecourt gauge.

It appears that the storm sewer system may be surcharging but possibly below the ground elevation as no flooding has been reported by the Town except upstream of MH 79-122 which occurred during spring snowmelt in April 2011. In order to confirm that surcharging is occurring and to determine the elevation of surcharge during the 1:5 Year for that area, a model was completed for the minor system located between 42^{nd} and 50^{th} Street and 42^{nd} to 43^{rd} Avenue.

Further evaluation is needed to better understand the functioning of the minor system. "Ground Truthing" of the data is required to confirm the analysis of the spreadsheet and further a dynamic model should be created to verify those results.

Section 4.5.6 discusses the calibration of the hydrology model established for study area by using the flow monitoring data of the minor system and how the calibrated parameters (e.g., runoff coefficients assigned for the existing land uses) were applied in producing a reliable peak flow rates and representative conditions of the Town STM sewer system.

4.5.5.2 XP-SWMM Modeling

To assess the capacity of existing minor system, the 1-5 Year 4hr return period storm event was determined based on the Whitecourt IDF Curve data provided by Atmospheric Environment Services (AES) and modeled using XP-SWMM 2010 (Version 12.0), a recognized stormwater management modeling software. The 1:5 Year design storm was determined by adjusting the City of Edmonton 4 hour

Chicago design storm distribution by a correction factor to obtain a total 1:5 Year-4 hour rainfall amount of 34.9 mm provided by the Whitecourt IDF data.

XP-SWMM was utilized to assess the existing minor system located between 42nd and 50th Street and 42nd to 43rd Avenue. The following hydrological parameters were utilized in the model as shown in **Table 4.5.1**.

TABLE 4.5.1 – SUMMARY OF THE EXISTING MINOR SYSTEM MODELING HYDROLOGIC PARAMETERS				
Description		Unit		Value
Manning's Coefficient				
Pervious Area				0.25
Impervious Area				0.015
Depression Storage				
Pervious Area		mm		6.4
Impervious Area		mm		3.2
Infiltration				
Initial Rate		mm/hr		25.4
Final Rate		mm/hr		1.3
Decay Factor		1/s		0.00115
Basin	Total Drainage Area (ha)	Imperviousness * (%)	Catchment Width (m)	Catchment Slope (%)
33	10.7	62	295	0.8
6	1.1	69	64	0.6
5	4.2	74	156	1.9

*__Note__: The imperviousness numbers shown in Table 4.5.1 are un-calibrated values. The Section 4.5.6 discusses the model calibration in details.

The physical information such as the pipe diameter, slope, pipe invert and ground elevations were imported from **Table 4.3** or **4.4**. Results indicate that the minor system in this area does surcharge during the 5 Year event as shown on **Figures 4.5A** and **4.5B**. From MH 79-122 to CB-MH1, the system surcharged above the road elevation as shown by the hydraulic grade line on **Figure 4.5A**. It appears that the minor system is over capacity and surcharging during the 1:5 Year event and it is recommended that no additional areas in the future be conveyed through the existing system until upgrades be implemented. Additional modeling of the rest of the minor system is recommended as the rational method does not determine if the system has surcharged above the existing road or ground elevations. The rational method is a conservative approach that indicates the flow rate in this pipe system and therefore modeling of the minor system is recommended along with flow monitoring of the minor system. Consequently, the following section discusses the calibration of the established XPSWMM model.

4.5.6 Model Calibration and Parameter Adjustment

4.5.6.1 General

As an important step in producing a reliable and representative model of the Town STM sewer system, a calibration of the established XP-SWMM model was performed. The calibration was based on the observed data recorded for the study area. The following generally summarizes the calibration procedures.

- Review and analysis the recorded data (e.g., stream flow monitoring data, rain data, etc.) for the area; select a total of three most significant events for calibration and validation.
- Calibration of the XPSWMM model established for the existing conditions for the study area based on the selected events.
- Once the calibration was completed, the design storms were simulated to produce a calibrated design flows (for 2-year, 5-year return periods, etc.). Such flows were then used to adjust the runoff coefficients used in the existing storm sewer system design (Rational Method).

4.5.6.2 Continuous Monitoring Stream flows and Precipitation Data

The available rain data was provided by Alberta Environment at its rain gauge of Mayerthorpe (#07BB809) for 2012 and 2013 summer seasons (i.e., May 1, 2012 to September 30, 2012 and May 1, 2013 to September 30, 2013). The streamflow data was obtained for the same time periods from three flow monitoring gauges:

1) Gauge #1 at 48th Ave and 52nd Street;
2) Gauge #2 at 51st Street and 51st Avenue; and
3) Gauge #3 at the Culvert under the Railway Tracks.

The locations of these gauges are shown in Figures 4.4 and 4.6 in the Appendix E-2.

Based on the review and analysis of these rain and flow data correspondingly, three significant rainfall events were selected:

1) 17/07/2012 21:00 – 18/07/2012 2:50
2) 23/07/2012 5:00 – 24/07/2012 1:50
3) 21/07/2013 23:00 – 22/07/2013 6:55

Table 4.5.2 summarizes these selected rainfall events which were used for the model calibration.

TABLE 4.5.2 – SELECTED RAINFALL EVENTS

Event #	Date/Time	Duration	Mayerthorpe Rainfall Gauge		
			Total Rain Depth (mm)	Total Rain Volume (m3)	Max. Intensity (mm/hr)
1	17/07/2012 9:00:00 PM to 18/07/2012 2:50:00 AM	6 hr 50 min	27	8662	25.5
2	23/07/2012 5:00:00 AM to 24/07/2012 1:50:00 AM	20 hr 50 min	63	19814	14.8
3	21/07/2013 10:00:00 PM to 22/07/2013 6:55:00 AM	8 hr 55 min	20	6206	17.7

4.5.6.3 Model Calibration

For the calibration purposes, a XPSWMM model was established by a single 31.5 ha catchment which lumps all sub-catchments upstream of Flow Gauge #2 (i.e., Catchments 25, 26, 27, 28, 29, 30, 31, 32, 35 and 36 as shown in Figure 4.4 in Appendix E-2). The following parameters were investigated for the calibration.

- Imperviousness,
- The Horton minimum asymptotic final infiltration, and
- Depression storage parameter.

The calibration was targeted to match the resulting runoff volumes and peak flow rates with those observed. For all three selected events, the runoff volumes and peak flows from the un-calibrated XPSWMM model were generally 1.5 to 2 times higher than those observed. Consequently, the parameters were adjusted in order to reduce the runoff volumes and peak flows to a reasonable level as compared to the observed. The following summarizes the results:

- Imperviousness: Reduce the imperviousness from 0.42 to 0.35 (e.g., 16.7% reduction)
- Fc: Increase the Horton Infiltration minimum asymptotic final infiltration (Fc) from 1.3 to 5.0.
- Depression Storage: By adjusting the depression storage for both impervious and pervious areas, little changes to the peak flows and volumes were obtained. As such, this parameter was not sensitive and was therefore left unchanged.

Comparisons of un-calibrated, calibrated and observed hydrographs for all three selected events and all other related information are included in Appendix E-3. Table 4.5.3 provides a summary of the calibration results.

TABLE 4.5.3 – CALIBRATION RESULTS AT FLOW GAUGE #2

Event #	Runoff Volume					Peak Flow				
	Observed (m^3)	Un-calibrated		Calibrated		Observed (m^3/s)	Un-calibrated		Calibrated	
		Volume (m^3)	Difference to Observed	Volume (m^3)	Difference to Observed		Peak Flow Rate (m^3/s)	Difference to Observed	Peak Flow Rate (m^3/s)	Difference to Observed
1	1908	3432	+80%	2690	+41%	0.74	0.95	+29%	0.78	+6%
2	10857	14680	+35%	9092	-16%	0.87	1.43	+64%	1.02	+17%
3	736	2285	+210%	1805	+145%	0.22	0.64	+193%	0.53	+142%

As shown in the comparison hydrographs in Appendix E-2 and the above table, the calibration successfully reduces the differences of the peak flows and runoff volumes between those from the models and observation data, while the calibrated model still provides relatively conservative results.

4.5.6.4 Model Validation

For the model validation, a XPSWMM model was established for Catchment #30 (with a drainage area of 4.2 ha) to validate the calibrated model based on the data from Flow Gauge #1. Major system model (used for culvert assessment as discussed later in Section 4.5.6) was used to validate the calibration results based on the data recorded at Gauge #3. Note that, since such major system model doesn't reflect the performance of the minor system (storm sewer system), the results were only used for the reference purpose.

The validation provides a rigorous check on the "soundness" of the calibrated model. The validation hydrographs and detailed results are provided in Appendix E-4. Summaries of validation results for Gauges #1 and #3 are provided in Tables 4.5.4 and 4.5.5 respectively.

TABLE 4.5.4 – VALIDATION RESULTS AT FLOW GAUGE #1

Event #	Runoff Volume					Peak Flow				
	Observed (m^3)	Un-calibrated		Calibrated		Observed (m^3/s)	Un-calibrated		Calibrated	
		Volume (m^3)	Difference to Observed	Volume (m^3)	Difference to Observed		Peak Flow Rate (m^3/s)	Difference to Observed	Peak Flow Rate (m^3/s)	Difference to Observed
1	260	512	97%	469	80%	0.05	0.13	147%	0.11	118%
2	621	1930	211%	1126	81%	0.08	0.22	173%	0.15	89%
3	114	254	122%	183	60%	0.03	0.07	159%	0.06	104%

TABLE 4.5.5 – VALIDATION RESULTS AT FLOW GAUGE #3

Event #	Runoff Volume					Peak Flow				
	Observed (m^3)	Un-calibrated		Calibrated		Observed (m^3/s)	Un-calibrated		Calibrated	
		Volume (m^3)	Difference to Observed	Volume (m^3)	Difference to Observed		Peak Flow Rate (m^3/s)	Difference to Observed	Peak Flow Rate (m^3/s)	Difference to Observed
1	1908	4892	156%	3689	93%	0.74	0.85	15%	0.72	-1%
2	10852	17121	58%	10882	0%	0.87	1.09	25%	0.95	9%
3	734	2790	280%	2285	211%	0.19	0.51	169%	0.45	135%

The validation results generally agree with the calibration results. The validation confirms that the calibrated model results lower runoff volumes and peak flow rates from those simulated by the un-calibrated model, while it still provides conservative results by comparing with the observed data.

4.5.6.5 Revised Rational Method Assessment based on Calibration Results

As previously discussed, once the calibration was completed, the design storms were simulated to produce a calibrated design flows (for 2-year, 5-year return periods, etc.). The resulting hydrographs flows were then used to adjust the runoff coefficients used in the existing storm sewer system design (as previously discussed in Section 4.5.5.1).

Consistently, the 2-year and 5-year design storms based on Whitecourt IDF data are simulated by calibrated XPSWMM model for existing conditions. In order to match the 2-year and 5-year peak flow rates calculated from the existing storm sewer system design (Rational Method) with those from the calibrated XPSWMM model, the existing runoff coefficient values need to be reduced by 10%~20%.

Table 4.5.6 shows a comparison of the original runoff coefficient and adjusted runoff coefficient based on the XPSWMM model calibration for existing conditions. In the case of high imperviousness landuses, the runoff coefficients were not reduced, as these areas were not the focus of the calibration exercise.

TABLE 4.5.6 – COMPARISON BETWEEN ORIGINAL AND ADJUSTED RUNOFF COEFFICIENT FOR EXISTING CONDITIONS

Existing Land Use	Runoff Coefficient	
	Original Runoff Coeff.	Adjusted Runoff Coeff.
Residential	0.50	0.40
Commercial	0.90	0.75
Industrial	0.70	0.60
Recreation	0.25	0.20
Institutional	0.50	0.40
Reserves	0.10	0.10
Undeveloped	0.10	0.10
Highway	0.90	0.90
Paved Road	0.90	0.90
Gravel Road	0.30	0.25

Consequently, the adjusted existing storm sewer system design and analysis details for the 1:2 Year and 1:5 Year storm events are shown on **Tables 4.5.7** and **Table 4.5.8.**

Results confirm that the existing storm sewer system is undersized for both the 1:2 Year, as well as, the 1:5 Year events. Substantial sections in the minor system are surcharging well in excess of the pipe network flowing 100% full. Some sections in the minor system network indicate to have high velocities exceeding the maximum allowable 3m/s.

Furthermore, the imperviousness values associated with different existing land uses were also adjusted based on the calibration results. Table 4.5.9 presents a comparison of the original imperviousness values with those adjusted for existing conditions. These adjusted imperviousness values were further applied for the existing major system assessment as described in the following sections.

TABLE 4.5.9 – COMPARISON BETWEEN ORIGINAL AND ADJUSTED IMPERVIOUSNESS FOR EXISTING CONDITIONS*		
Existing Land Use	Imperviousness (%)	
	Original Impveriousness (%)	Adjusted Impveriousness (%)
Residential	50	40
Commercial	95	75
Industrial	80	70
Recreation	13	10
Institutional	50	40
Reserves	10	10
Undeveloped	10	10
Highway	95	95
Paved Road	95	95
Gravel Road	13	10

Note that these values are intended for existing landuses only and should not be applied to any future or proposed landuses.

4.5.7 Existing Major System Assessment

The existing major system consists of a series of culverts and interconnected ditches and an evaluation was conducted for the complete drainage system within the Town. An analysis was completed to determine if the existing major culverts were able to accommodate the existing 1:100 Year flows. Culverts conveying flow across Highway 43, the Canadian National Railway track, 47 Avenue, Range Road 83 and the service road north of Highway 43 were the only culverts analyzed. **Figure 4.6** shows the existing culverts analyzed including their drainage basins. XP-SWMM was utilized to assess the existing major system. As mentioned previously, the imperviousness values assigned for the existing land uses were based on the calibration results as shown in Table 4.5.9. The hydrological input parameters (e.g., calibrated runoff coefficients for existing land uses) as shown in **Tables 4.5.7** and **4.5.8** were utilized in the model. **Table 4.6** summarizes the catchment input parameters utilized for modeling.

TABLE 4.6 – SUMMARY OF EXISTING MAJOR SYSTEM HYDROLOGICAL PARAMETERS				
Catchment	Total Drainage Area (ha)	Calibrated Imperviousness (%)	Catchment Width (m)	Catchment Slope (%)
1	16.2	11	269	0.8%
2	50.8	11	575	0.9%
3	45.8	17	362	1.3%
4	40.1	32	321	1.0%
5	37.7	37	318	1.0%
6	40.2	29	348	1.2%
7	13.5	43	239	0.7%
8	5.6	54	114	1.4%
9	4.2	34	158	1.9%
10	2.6	38	133	1.5%
11	33.4	13	317	1.3%
12	15.9	11	236	1.0%
13	7.8	23	272	1.4%
14	422.8	10	1104	0.7%
15	28.8	11	336	0.7%
16	5.3	23	457	2.6%
17	2.2	51	107	1.0%
18	4.0	51	146	1.1%

The 1:100 Year-24 hour Huff design storm was determined by adjusting the City of Edmonton 1:100 Year - 24 hour design storm distribution by a correction factor to obtain a total rainfall amount of 109.9 mm provided by the Whitecourt IDF data.

Culverts should be designed to convey the 1:100 year - 24 hour peak flows without overtopping the railway or highway. All culverts and natural drainage courses were assumed to have a Manning's roughness coefficient of 0.024 and 0.050, respectively. The majority of culvert inverts were surveyed and imported into the model. Missing inverts were determined from available LIDAR data. The ditch and road elevations were also determined from LIDAR data; however, a few ditch and edge of road elevations were surveyed such as areas along the railway line. The natural drainage courses or ditch cross-section profiles were created utilizing the LIDAR data at their specific locations.

The model was simulated for the 1:100 Year event and a few locations found to be undersized as shown on **Figure 4.7**. The following culverts are undersized:

- The 525 mm culvert across Range Road 83 just north of the Township Road 574A appears to be undersized. Range Road 83 was overtopped at this location and appears to be on a low spot along the Range Road 83 profile. The culverts just upstream of this culvert are 1300 mm and 750 mm in diameter and are placed across Township Road 574A and the railway line.
- A 450 mm culvert exists across 47 Avenue as shown on **Figure 4.6** and discharges north into the 1300 mm diameter culvert under the railway line. The model indicates that this culvert is undersized and overtopping of the road occurs.

- In addition, the 525 mm diameter culvert across Range Road 83 just south of the railway could not accommodate the 1:100 Year flood flows. In a 1:100 Year storm event, the stormwater will flood at this location and spill on the east side of Range Road 83.
- The 600 mm culvert near the intersection of Range Road 83 and the service road at the southeast corner of the Study area appears to be undersized for the 1:100 Year event. Flooding also occurs at this location.

It is recommended that these culverts be upgraded to accommodate the 1:100 Year flow. The upgraded sizes were determined in the servicing plan in Section 6.0.

As an additional part of the storm water management plan we have evaluated the capacity of the culverts under the CN Railway (1300 mm and 900 mm in diameter) and TWP Road 547A (900 mm and 750 mm in diameter) just 230 m and 500 m northwest of Range Road 83. These culverts currently convey the runoff from the Mills Acres Subdivision and upstream of it. It was determined that these culverts have enough capacity to handle future development upstream. **Table C.1** contains a summary of the assessment results for all culverts across Township Road 574A and the CN Railway.

4.5.8 Water Quality

Stormwater management facilities do not only collect and control the runoff generated from developments, they are also utilized for water quality enhancement. Alberta Environment requires that for particle sizes 75 μm or greater, 85% of suspended solids settle in storm events that are 25 mm (1 inch) or less.

The Alberta Environment Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems (1997) identify the following requirements for storm water quality:

- Storing a 25 mm storm event over the contributing area; and,
- Detaining the runoff for the duration of 24 hours.

Stormwater quality enhancement can be implemented by the construction of wetlands and wet or dry ponds. In addition, oil and grit separators can be utilized to improve the water quality before discharging into the natural waters downstream. The existing major system appears to not contain any water quality controls to improve the runoff quality from Study area before discharge into the River. It is recommended that necessary water quality controls such as stormwater management facilities be developed, as well as, necessary Best Management Practices (BMPs).

4.6 Future Drainage System

4.6.1 Future Land Use

Planned future land uses are described in the Municipal Development Plan, July 2006. A major change is an increase in residential and industrial land uses and a decrease in reserves. **Figure 4.8** shows the proposed future land uses.

4.6.2 Drainage Basins

The total watershed basin draining towards the Study area is shown on **Figure 4.2** in Section 4.5.2. These 45 basin areas were overlapped with the future land use plan to determine the increase in runoff coefficient. The change in runoff from future developments is expected to increase by an average of approximately 41% based on the total weighted runoff coefficient. **Table 4.7.1** summarizes the basin areas, as well as, the approximated runoff coefficients based on the future land use plan provided by the Town. Again, the runoff coefficients and imperviousness values used for the existing land uses were determined based on the calibration results (as shown in Tables 4.5.6 and 4.5.7 respectively). While the runoff coefficients and imperviousness values used for future development areas (where the landuse will be changed) were obtained based the on the Stormwater Management Guidelines for the Province of Alberta, dated January 1999. Table 4.7.2 provides a summary of the final/adjusted runoff coefficients and imperviousness values used for both existing (calibrated) and future land uses.

TABLE 4.7.1 – FUTURE SUB-BASIN AREAS AND RUNOFF COEFFICIENTS			
Sub-Basin	Area (ha)	Existing Weighted Runoff Coefficient	Future Weighted Runoff Coefficient
1	13.1	0.22	0.29
2	15.9	0.11	0.70
3	45.8	0.19	0.49
4 (A/B)	30.3	0.27	0.50
5	4.2	0.60	0.64
6	1.1	0.58	0.72
7	1.4	0.32	0.36
8	3.4	0.38	0.44
9	1.5	0.34	0.43
10	1.2	0.38	0.46
11	1.1	0.42	0.49
12	1.9	0.35	0.49
13	1.8	0.38	0.51
14	7.3	0.38	0.44
15	8.6	0.41	0.47
16	4.2	0.36	0.46
17 (A/B)	12.1	0.39	0.48
18	33.4	0.13	0.15
19	18.9	0.10	0.10

TABLE 4.7.1 – FUTURE SUB-BASIN AREAS AND RUNOFF COEFFICIENTS			
Sub-Basin	Area (ha)	Existing Weighted Runoff Coefficient	Future Weighted Runoff Coefficient
20	27.2	0.10	0.10
21	13.5	0.23	0.59
22	13.5	0.44	0.56
23	12.6	0.44	0.54
24	0.8	0.29	0.50
25	4.6	0.55	0.66
26	3.6	0.35	0.43
27	1.1	0.49	0.56
28	1.4	0.37	0.49
29	0.9	0.38	0.42
30	4.2	0.35	0.46
31	4.7	0.40	0.47
32	3.7	0.61	0.61
33	10.7	0.51	0.53
34	17.4	0.43	0.41
35	2.8	0.31	0.45
36	4.5	0.31	0.44
37	13.3	0.22	0.23
38	1.7	0.40	0.90
39	22.7	0.24	0.24
40 (A/B)	3	0.34	0.44
41 (A/B)	2.9	0.49	0.52
42	3.3	0.18	0.43
43	67	0.11	0.35
44	28.8	0.11	0.11
45	422.8	0.10	0.10
TOTAL AREA (HA)	899.90		
TOTAL WEIGHTED RUNOFF COEFFICIENT		0.17	0.25

TABLE 4.7.2 – Summary of Adjusted Runoff Coefficients and Imperviousness for Existing and Future Land Uses				
Land Uses	Runoff Coefficient		Imperviousness Value (%)	
	Existing Landuse (Calibrated)	Future Landuse (Standard)	Existing Landuse (Calibrated)	Future Landuse (Standard)
Residential	0.40	0.50	40	50
Commercial	0.75	0.90	75	80
Industrial	0.60	0.70	70	70
Recreation	0.20	0.25	10	20
Institutional	0.40	0.50	40	50
Reserves	0.10	0.10	10	-
Undeveloped	0.10	0.10	10	-
Highway	0.90	0.90	80	80
Paved Road	0.90	0.90	90	90
Gravel Road	0.25	0.30	10	30

4.6.3 Future Land Use Minor System Assessment

The existing minor storm sewer system has been assessed for the subject area using the rational method and the 1:2 and 1:5 Year rainfall intensities and based on the weighted future runoff coefficients.

Evaluation of the existing storm sewer system for the 1:2 Year and 1:5 Year storm events based on proposed future development are shown on **Table 4.8** and **Table 4.9**, respectively. As-built drawings provided by the Town were utilized for determining the physical information such as pipe diameter, slope, pipe invert and ground elevations.

The minor system will collect runoff up to the 1:5 Year storm event and discharge into proposed Storm Water Management Facilities (SWMFs). Runoff from events greater than the 1:5 Year storm event will flow overland and ultimately into the SWMFs. Analysis results for the future condition have indicated that the minor storm sewer system is still undersized for both the 1:2 Year, as well as, the 1:5 Year events and the existing system condition has worsened. The existing minor system has performed poorly due to an increase in runoff from future developments as the total weighted runoff coefficient increased from 0.17 to 0.25, an average increase of approximately 41%. The existing minor system can be replaced but with larger pipes but this will be very costly. It may be possible to connect the existing system to new set of storm trunks which convey flows to the SWMFs and ultimately into the Little Paddle River. MMM Group Limited can re-analyze the system and propose options to ensure that the pipes do not surcharge and that the minimum requirements set by Lac Ste. Anne County are met, however, this is outside of the scope of this Study.

4.6.4 Proposed Major System Design

Flows in excess of the 1-5 Year storm are usually conveyed through a series of ditches and culverts or by overland flow known as the major drainage system. These flows need to be routed to SWMF's to control the runoff and promote water quality enhancement before discharging into the Little Paddle River at a maximum allowable discharge rate. Ten (10) SWMFs have been proposed for the entire Study area as shown on **Figure 4.9**. The proposed SWMF's will be designed in accordance with the Lac Ste. Anne County Standards and the Alberta Stormwater Management Guidelines. A few alterations to the existing drainage patterns might be required to minimize the number of SWMFs required. **Figure 4.9** shows the proposed SWMF basin boundaries as well as proposed ditches that will be required convey runoff into the SWMFs.

4.6.4.1 Hydrologic and Hydraulic Analysis

To determine the required capacity of each SWMF for the proposed future land use, the 4 and 24 hour storms of return period 1-100 Year, 1-25 Year and 1-5 Year were determined based on the Whitecourt IDF Curve data provided by Atmospheric Environment Services (AES) and modeled using XP-SWMM 2010 (version 12.0), a recognized stormwater management modeling software.

To determine the runoff volumes, and peak flows the following hydrological parameters shown in **Table 4.10** were utilized in the model.

TABLE 4.10 – SUMMARY OF FUTURE MAJOR SYSTEM MODELING HYDROLOGIC PARAMETERS

Description	Unit	Value
Manning's Coefficient		
Pervious Area		0.25
Impervious Area		0.015
Depression Storage		
Pervious Area	mm	6.4
Impervious Area	mm	3.2
Infiltration		
Initial Rate	mm/hr	25.4
Final Rate	mm/hr	1.3
Decay Factor	1/s	0.00115

SWMF	Sub-Basin	Total Drainage Area (ha)	Imperviousness (%)	Catchment Width (m)	Catchment Slope (%)
1	3,4,5,6,33,43	153.7	42	873	1.1
2	4,7,8,9,10,11,12,13,14, 15,16,17,18	83.3	34	609	1.0
3	19	18.9	10	320	0.8
4	20	27.2	10	538	1.0
5	21,23,42	29.4	57	677	0.5
6	25,26,27,28,29,30,31, 32,35,36,37,41,22	59.3	44	550	1.1
7	39	22.7	20	261	1.3
8	41,24,40,38	7.4	56	233	0.2
9	34	17.4	41	365	1.9
10	2	15.9	70	263	1.2

The 5 Year, 25 Year, and 100 Year - 4 hour Chicago distributions, as well as, the 100 Year - 24 hour Huff distribution were simulated. These design storms were determined by adjusting the City of Edmonton

4 hour and 24 hour design storm distributions by a correction factor to obtain the total rainfall amounts for each storm event provided on the Whitecourt IDF data. For all facilities, the 1:100 Year - 24 hour storm was determined to be the most critical event. A summary of the modeling results for all storm events are shown in **Table 4.11**. **Table 4.12** below provides a summary of the maximum storage volume requirement for each SWMF, as well as, the maximum allowable rate. All SWMFs will be controlled to the maximum allowable discharge rate of 5.1 L/s/ha.

TABLE 4.11 – XP-SWMM MODELING STORAGE RESULTS					
SWMF	Total Drainage Area (ha)	Required Storage Volume (m^3)			
		1:5 Year 4 Hour	1:25 Year 4 Hour	1:100 Year 4 Hour	1:100 Year 24 Hour
1	153.7	20,000	34,400	47,800	75,800
2	83.3	9,200	16,600	23,600	38,100
3	18.9	1,300	3,000	4,700	8,000
4	27.2	2,200	4,900	7,500	12,200
5	29.4	5,400	9,100	12,300	17,300
6	59.3	8,600	15,100	21,000	32,600
7	22.7	2,000	4,200	6,300	10,400
8	7.4	1,300	2,200	3,000	4,400
9	17.4	2,800	5,000	6,900	9,900
10	15.9	3,400	5,500	7,400	10,100

TABLE 4.12 – XP-SWMM 1:100 YEAR 24 HOUR STORAGE RESULTS						
SWMF	Total Drainage Area (ha)	Maximum Discharge Rate (m^3/s)	Rainfall (mm)	Runoff (mm)	Runoff/Rainfall Ratio (%)	Required Storage Volume (m^3)
1	153.7	0.78	109.9	77.5	71	75,800
2	96.8	0.44	109.9	74.3	68	38,100
3	18.9	0.09	109.9	66.1	60	8,000
4	27.2	0.13	109.9	67.3	61	12,200
5	29.4	0.16	109.9	87.3	79	17,300
6	45.8	0.28	109.9	80.5	73	32,600
7	22.7	0.11	109.9	70.2	64	10,400
8	7.4	0.04	109.9	86.7	79	4,400
9	17.4	0.08	109.9	81.5	74	9,900
10	15.9	0.09	109.9	92.6	84	10,100

As shown in **Table 4.12**, the SWMF volumes require a storage volume ranging from 4,400 m^3 to 75,800 m^3.

4.6.4.2 Proposed SWM Facilities

The typical concept section of a SWMF is provided on **Figure 4.10**. All SWMFs shall be designed in accordance with Alberta Environment Stormwater Management Guidelines and the Lac Ste. Anne County Standards.

For SWMFs where the main inlet does not have adequate hydraulic separation from the outlet, and the potential for “short-circuiting” of water exists, a submerged flow directing barrier between the inlet and outlet to be designed to ensure adequate detention is achieved.

Emergency Overflows routes to Little Paddle River will be designed for all SWMFs as most are immediately adjacent to River. As such, these facilities will be required to provide a minimum freeboard of 0.3 m. For SWMFs without a major overflow route the freeboard should be increased to 0.6 m

The feasibility of reducing the number of SWMFs has been carefully considered. The SWMF location was determined based on the low areas within each basin and also dependant on the natural topography. All SWMFs should be kept at least 100m away from the bank of the Little Paddle River to ensure the banks are stable from water seepage from the SWMFs. A geotechnical investigation is recommended for the SWMFs and any new developments along the banks of the River.

4.6.4.3 Control Structures and Outfalls

Each SWMF will include a control structure and outfall to the Little Paddle River or watercourse. The outlet structure will be designed to limit discharge from the critical storm event to a maximum of 5.1 l/s/ha.

One of the benefits of utilizing 10 SWMF outfalls to facilitate post-development drainage is that it will better mimic the predevelopment flows to Little Paddle River with multiple natural inlet locations. Outfalls will be designed to minimize impacts to existing vegetation and to limit erosion. Prior to detail design an Environmental Impact Assessment must be conducted to ensure the outfall locations are acceptable and to defined design parameters for the outfall. Further details of the outlet control structure configurations and outfalls will be provided at the detailed design stage. A typical outfall control structure has been included as **Figure 4.11**.

4.6.4.4 Operation and Maintenance

There will be minimal requirements to operate the proposed stormwater facility. Maintenance of the facility should include the following:

- Removal of any build-up material or obstructions at the outlet or inlets. Build-up of materials is anticipated to be highest during the initial development stages.
- Inspection of the inlet areas and the sediment removal of sediment if required.
- Inspection and removal of debris within the pond.
- Inspection to ensure no algae blooms are present.

Further details on Operations and Maintenance to be provided at the Subdivision Approval Stage.

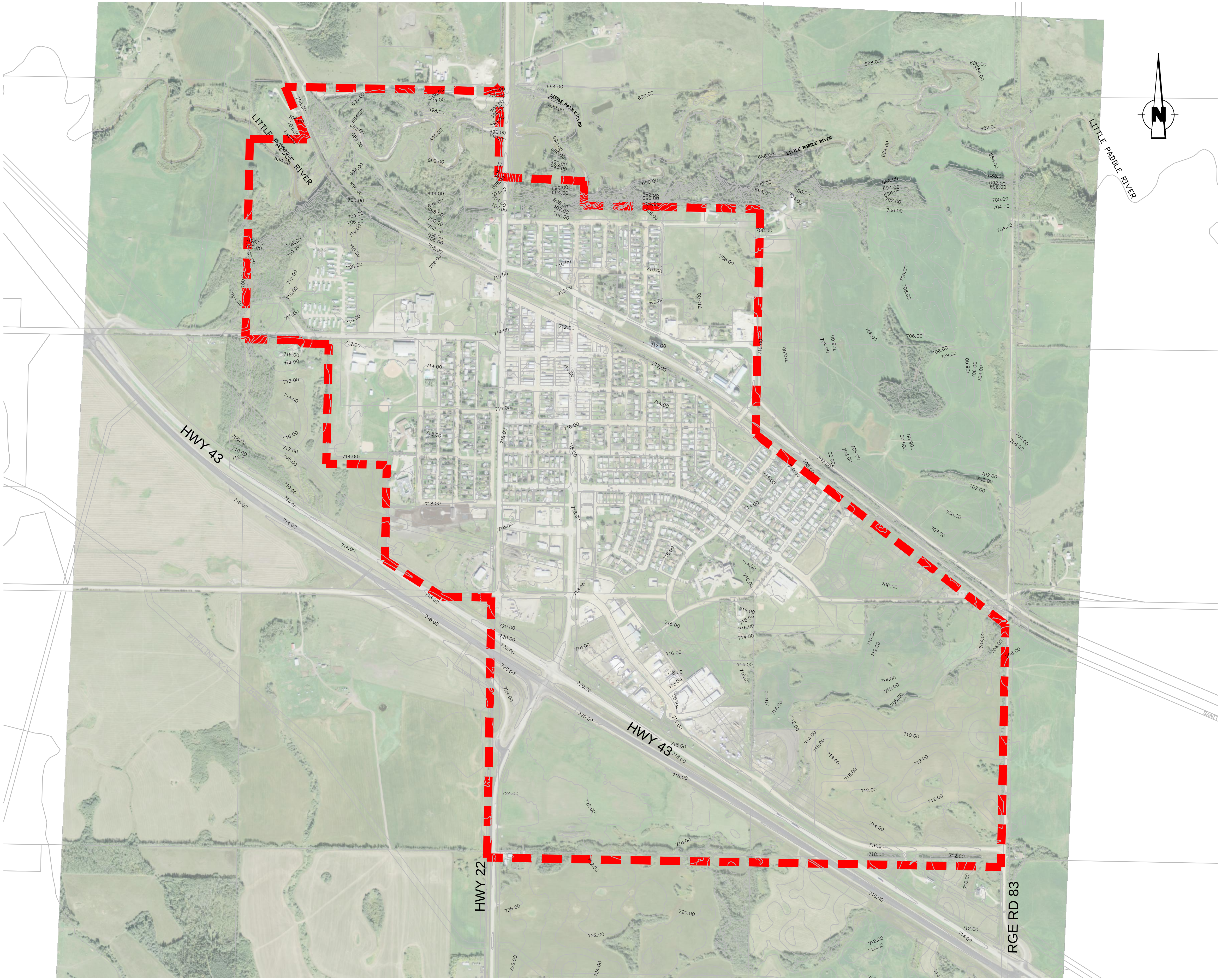
4.6.4.5 Water Quality

As SWMFs are constructed, the water quality into Little Paddle River will be enhanced lessening the total impact and improving the water quality on the Athabasca Watershed. The proposed SWMFs will be designed to achieve 85% removal of particles sized 75 μm or greater as required by Alberta Environment. Additional details can be provided in the detail design stage.

4.6.4.6 Best Management Practices (BMPs)

The following BMPs should be implemented as part of the Master Drainage Plan:

- Street sweeping, catch basin cleaning and anti-litter regulations should be a component of specific drainage plans.
- Implement sediment and erosion controls during construction to limit the amount of sediment into receiving waters. Temporary perimeter drainage swales directed to temporary ponds, silt fences, check dams, infiltration catch basins, timed staging of excavation are some good BMPs during construction.
- Reducing the amount of impervious surfaces by utilizing permeable pavement, porous turf, and paving blocks
- Implementing green infrastructure such as green roofs, vegetated road dividers, bioswales, preserving existing vegetation, and rain water harvesting.



MODIFIED DATE: 2011–06–20
S:\Projects\5311012000 Mayerthorpe SWM Plan\CAD\Drawings\FIGURES\2011 Master Drainage Plan E04\07–5311012e04 Fig 4.1 2.0m LIDAR CONTOURS.dwg

TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

SCALE 1:12500
0 200 400m

LEGEND

TOWN BOUNDARY

722.00 2.0m CONTOURS

2.0m LIDAR CONTOURS

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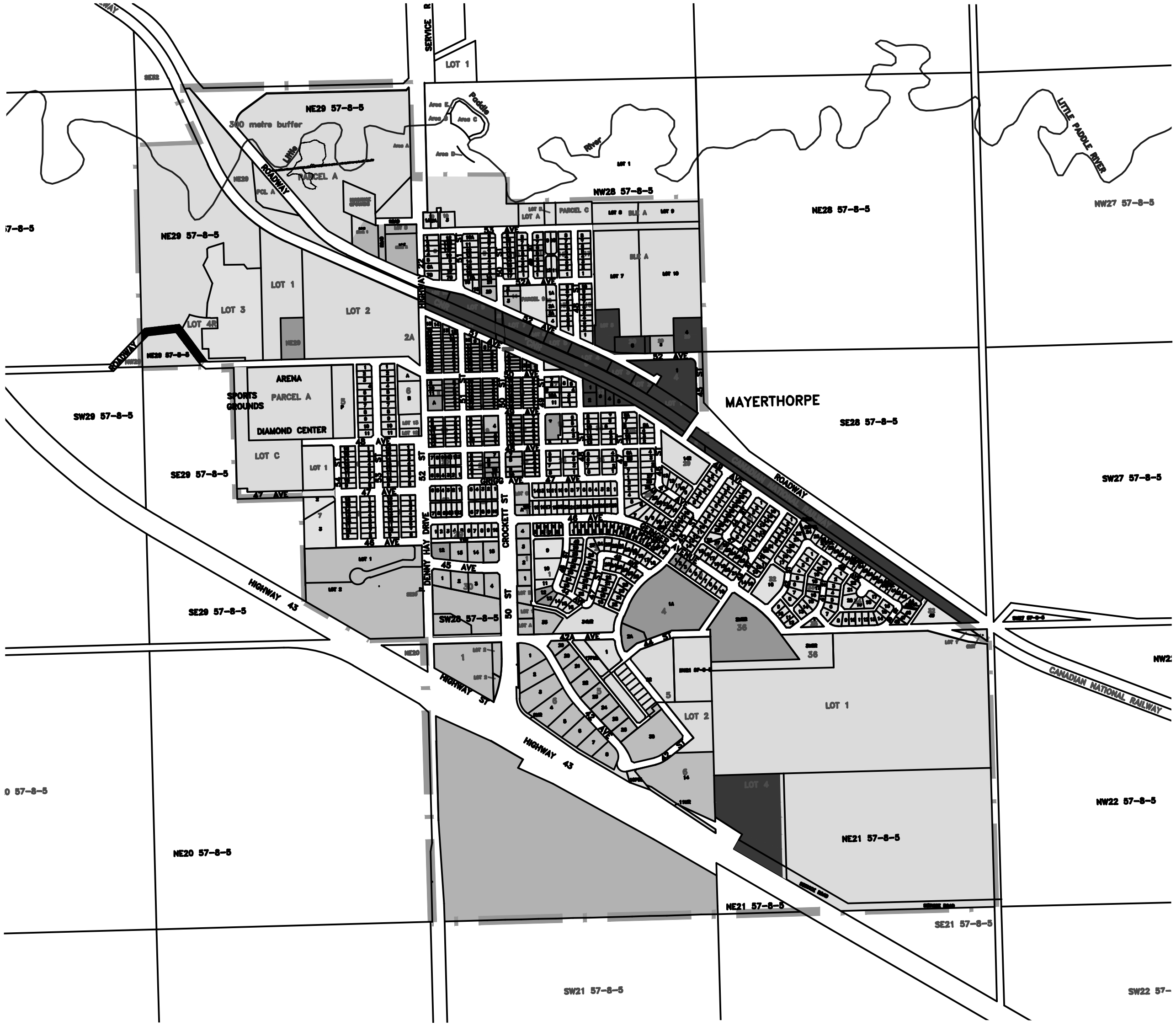
FIGURE 4.1



Residential
Commercial
Industrial
Institutional
Recreation
Direct Control
Reserve

REFERENCE: TOWN OF MAYERTHORPE
(NORTH STAR PLANNING, JULY 2006)

MODIFIED DATE: 2011-08-04
S:\Projects\5311012000 Mayerthorpe SWM Plan\CAD\Drawings\FIGURES\2011 Master Drainage Plan E04\08-5311012e04 Fig 4.2 Ex Landuse Plan.dwg

TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

EXISTING LAND USE PLAN
FIGURE 4.2

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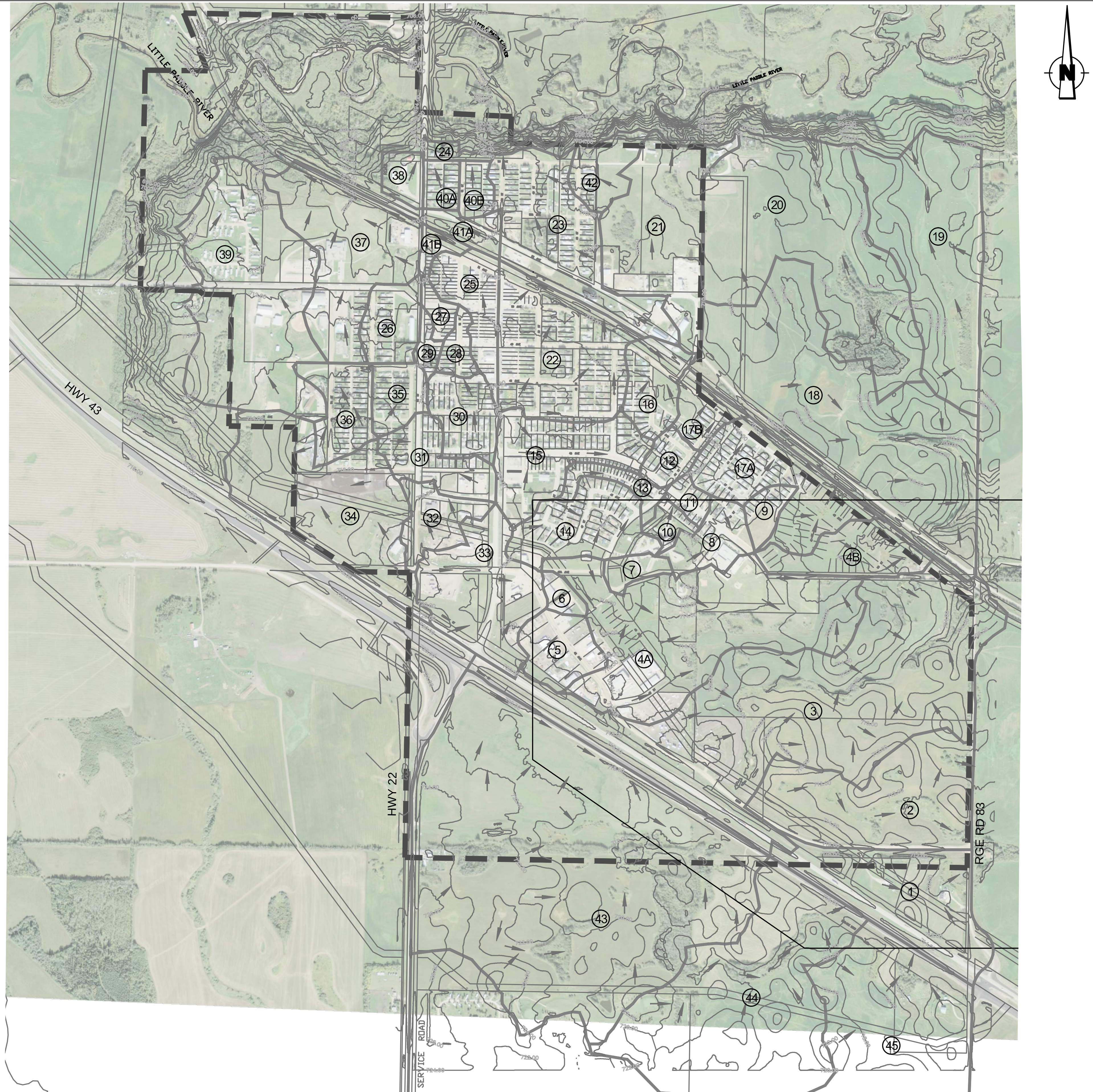
WATERSHED BOUNDARIES

SUB-BASIN	AREA (ha)
1	13.1
2	15.9
3	45.8
4A	24.9
4B	5.4
5	4.2
6	1.1
7	1.4
8	3.4
9	1.5
10	1.2
11	1.1
12	1.9
13	1.8
14	7.3
15	8.6
16	4.2
17A	9.5
17B	2.6
18	33.4
19	18.9
20	27.2
21	13.5
22	13.5
23	12.6
24	0.8
25	4.6
26	3.6
27	1.1
28	1.4
29	0.9
30	4.2
31	4.7
32	3.7
33	10.7
34	17.4
35	2.8
36	4.5
37	13.3
38	1.7
39	22.7
40A	1.5
40B	1.5
41A	1.9
41B	1.0
42	3.3
43	67.0
44	28.8
45	422.8



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S:\Projects\5311012000 Mayerthorpe SWM Plan\CAD\Drawings\FIGURES\2011 Master Drainage Plan E04\09–5311012e04 Fig 4.3 Watershed subbasin.dwg

TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

SCALE 1:12 500
0 200 400m

LEGEND

TOWN BOUNDARY
SUB–BASIN BOUNDARY
EXISTING DRAINAGE DIRECTION
3 SUB–BASIN NUMBER

WATERSHED SUB-BASIN BOUNDARIES

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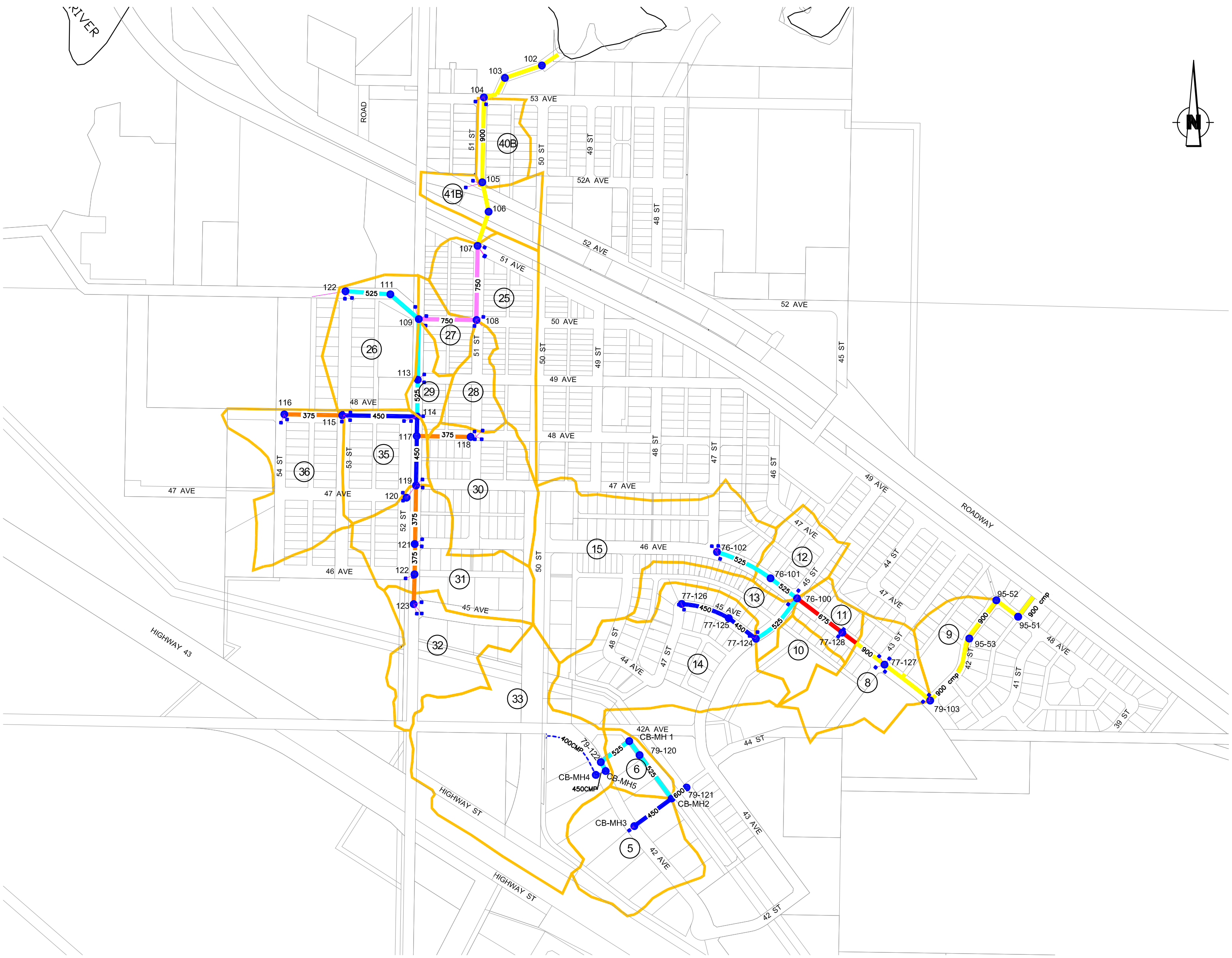
FIGURE 4.3



TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

SCALE 1: 7500

0 100 200m

LEGEND

- 76-101 STORM MANHOLE AND NUMBER
- CATCH BASIN
- CMP CULVERT
- 375 STORM
- 450 STORM
- 525 STORM
- 600 STORM
- 675 STORM
- 750 STORM
- 900 STORM
- 5 MINOR SYSTEM DRAINAGE BOUNDARIES AND NUMBER

EXISTING MINOR STORM SYSTEM

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FIGURE 4.4

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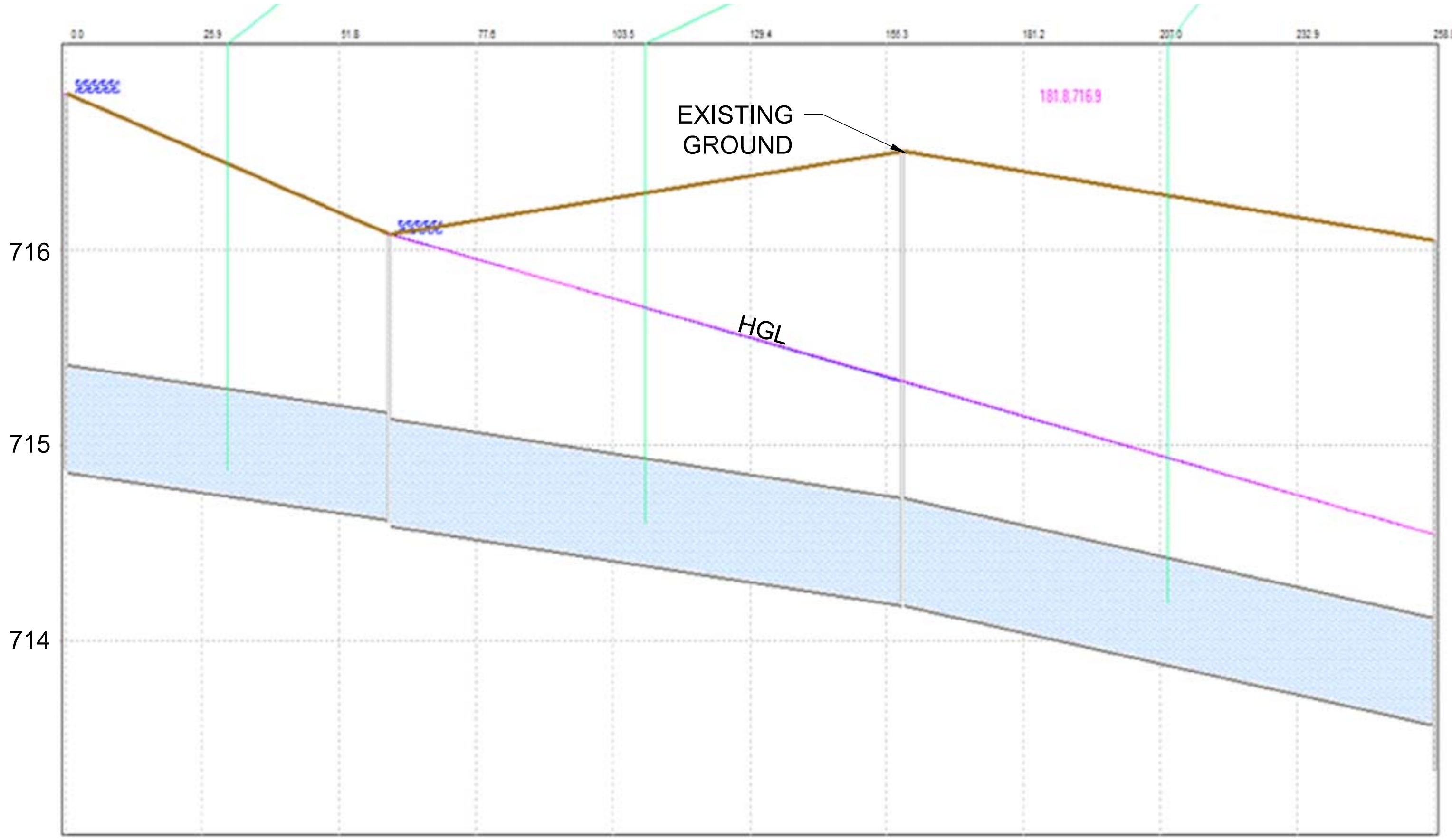
Upstream Manhole	79-122	CBMH1	79-120
Downstream Manhole	CBMH1	79-120	CBMH2
Diameter (mm)	525.000	525.000	525.000
Roughness	0.013	0.013	0.013
Length (m)	61.300	97.0	100.5
Conduit Slope (%)	0.396	0.418	0.614



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TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

XP - SWMM PROFILE FROM MH 79-122 TO CB-MH2
FIGURE 4.5a

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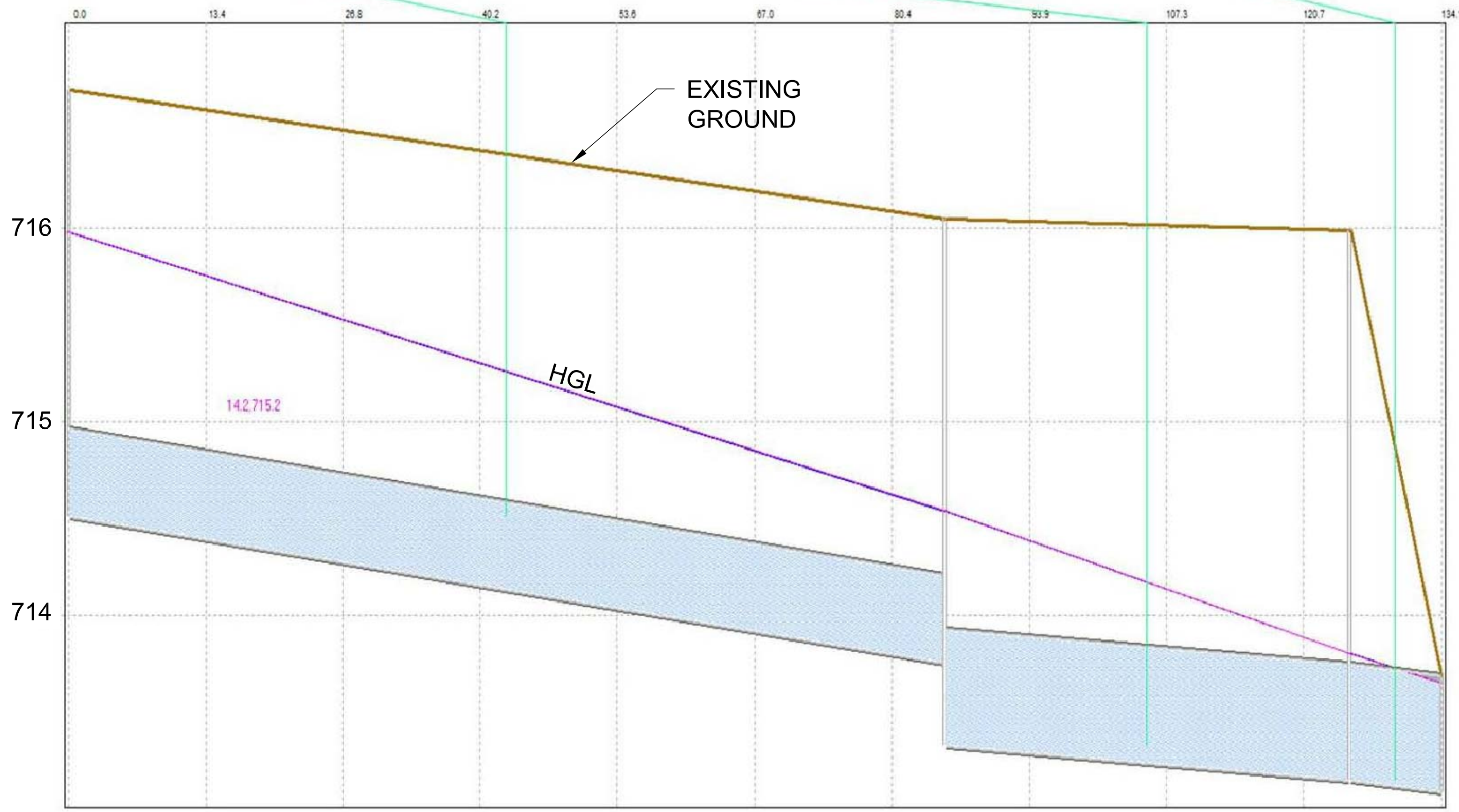
Upstream Manhole	CBMH3	CBMH2	79–120
Downstream Manhole	CBMH2	79–121	Ditch (Drainage Course)
Diameter (mm)	450.000	600.000	600.000
Roughness	0.013	0.013	0.013
Length (m)	85.600	39.5	9.0
Conduit Slope (%)	0.883	0.451	0.667



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S:\Projects\5311012000 Mayerthorpe SWM Plan\CAD\Drawings\FIGURES\2011 Master Drainage Plan E04\12–5311012e04 Fig 4.5b XP–SWMM OUTLET.dwg

TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

XP - SWMM PROFILE FROM CB-MH3 TO OUTLET
FIGURE 4.5b

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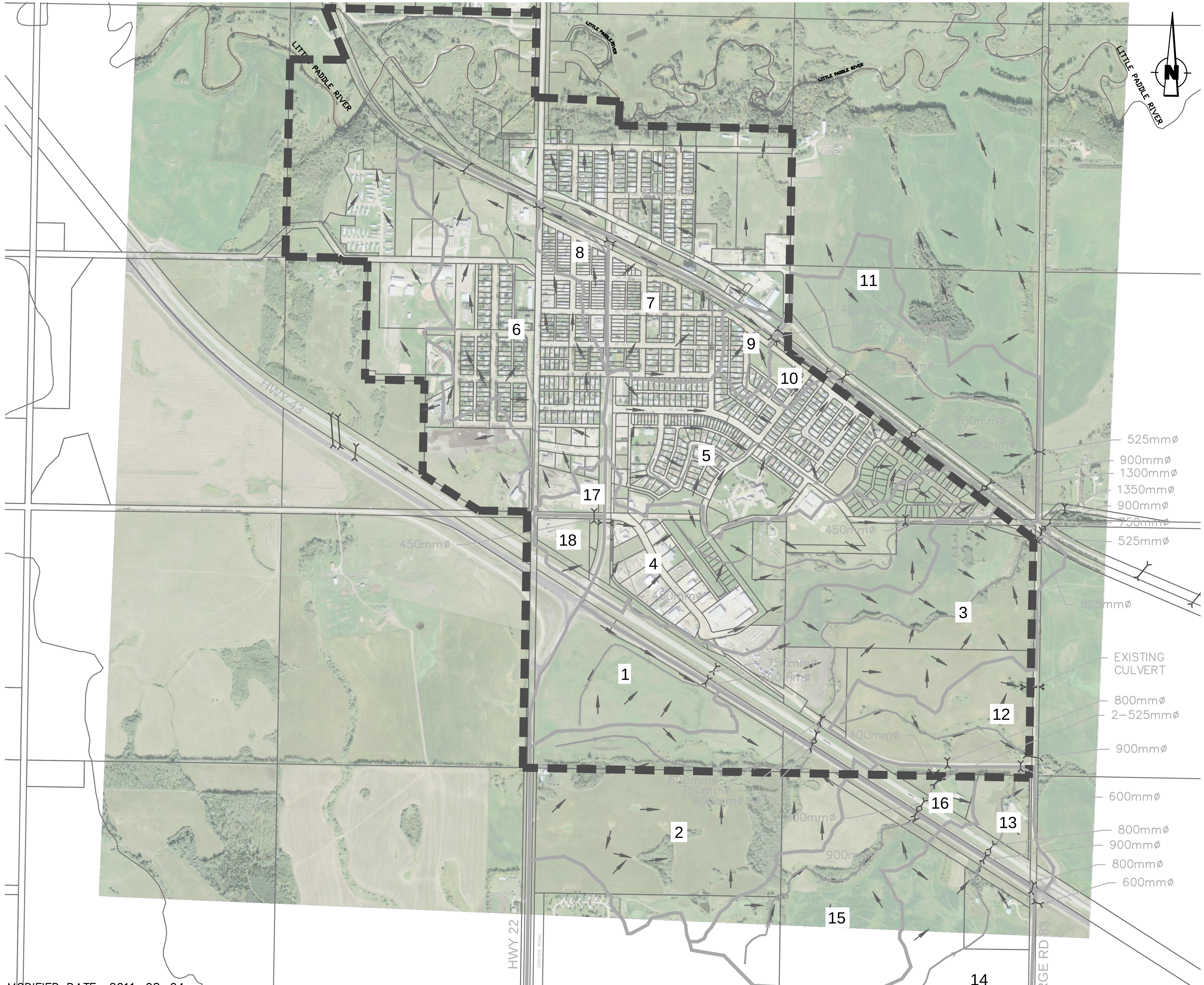

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S:\Projects\5311012000 Mayerthorpe SWM Plan\CAD\Drawings\FIGURES\2011 Master Drainage Plan E04\13–5311012e04 Fig 4.6 Major Culvert.dwg

TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

SCALE 1:12 500
0 200 400m

LEGEND

- TOWN BOUNDARY
- DRAINAGE DIRECTION
- CULVERT BASIN BOUNDARY
- EXISTING CULVERTS
- 2 CULVERT CATCHMENT NUMBER
- DRAINAGE COURSE
- EXISTING CULVERT (LOCATION, SIZE, AND INVERT TO BE OBTAINED BY TOWN)

MAJOR CULVERT DRAINAGE BOUNDARIES

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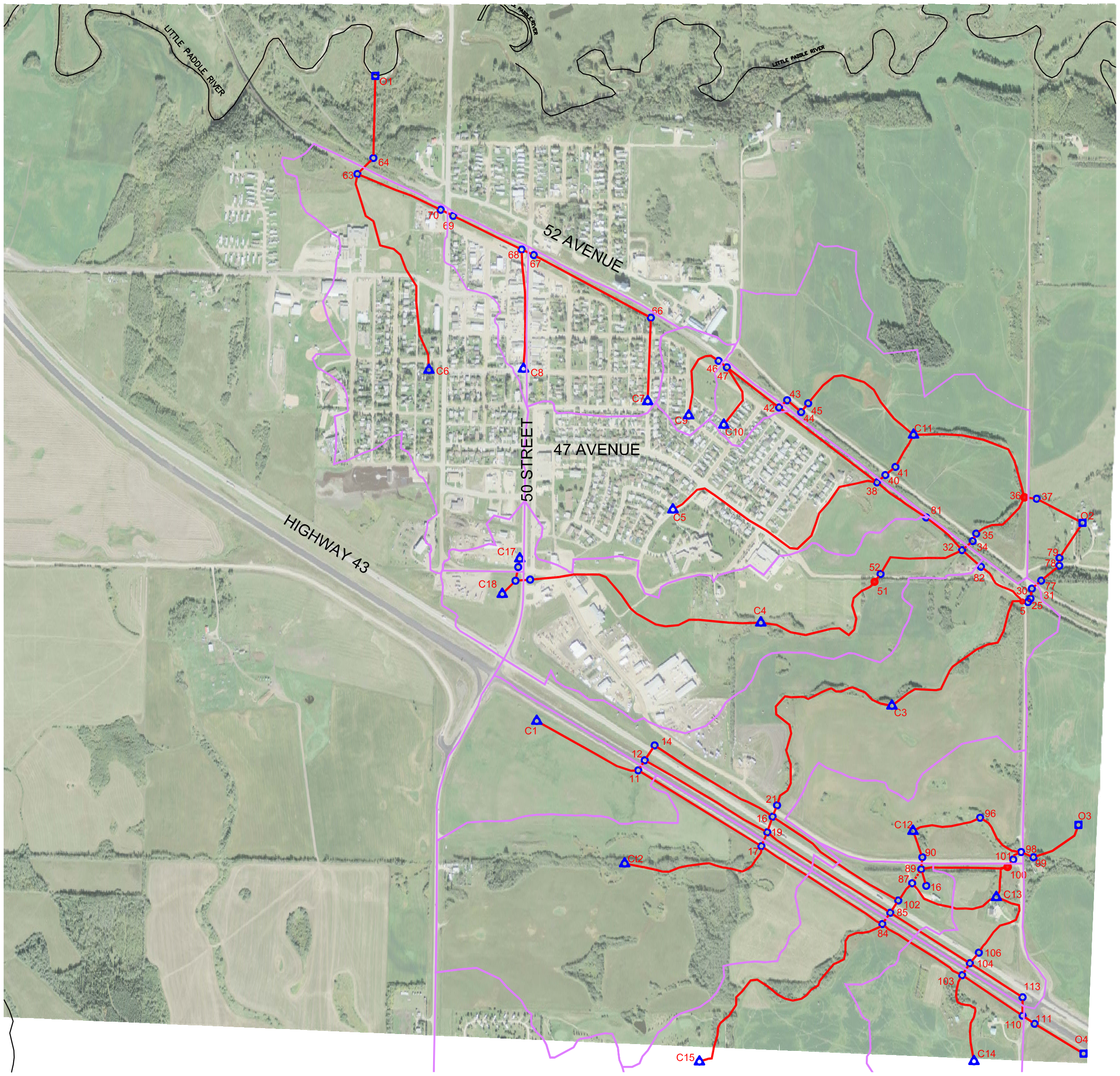
FIGURE 4.6



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TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

SCALE 1:12500
0 200 400m

LEGEND

- FLOODING OCCURRED
- MODEL LINK
- 51 MODEL NODE AND LABEL
- C4 MODEL CATCHMENT AND LABEL
- O2 MODEL OUTLET AND LABEL
- CULVERT BASIN BOUNDARY

EXISTING MAJOR SYSTEM MODELING RESULTS

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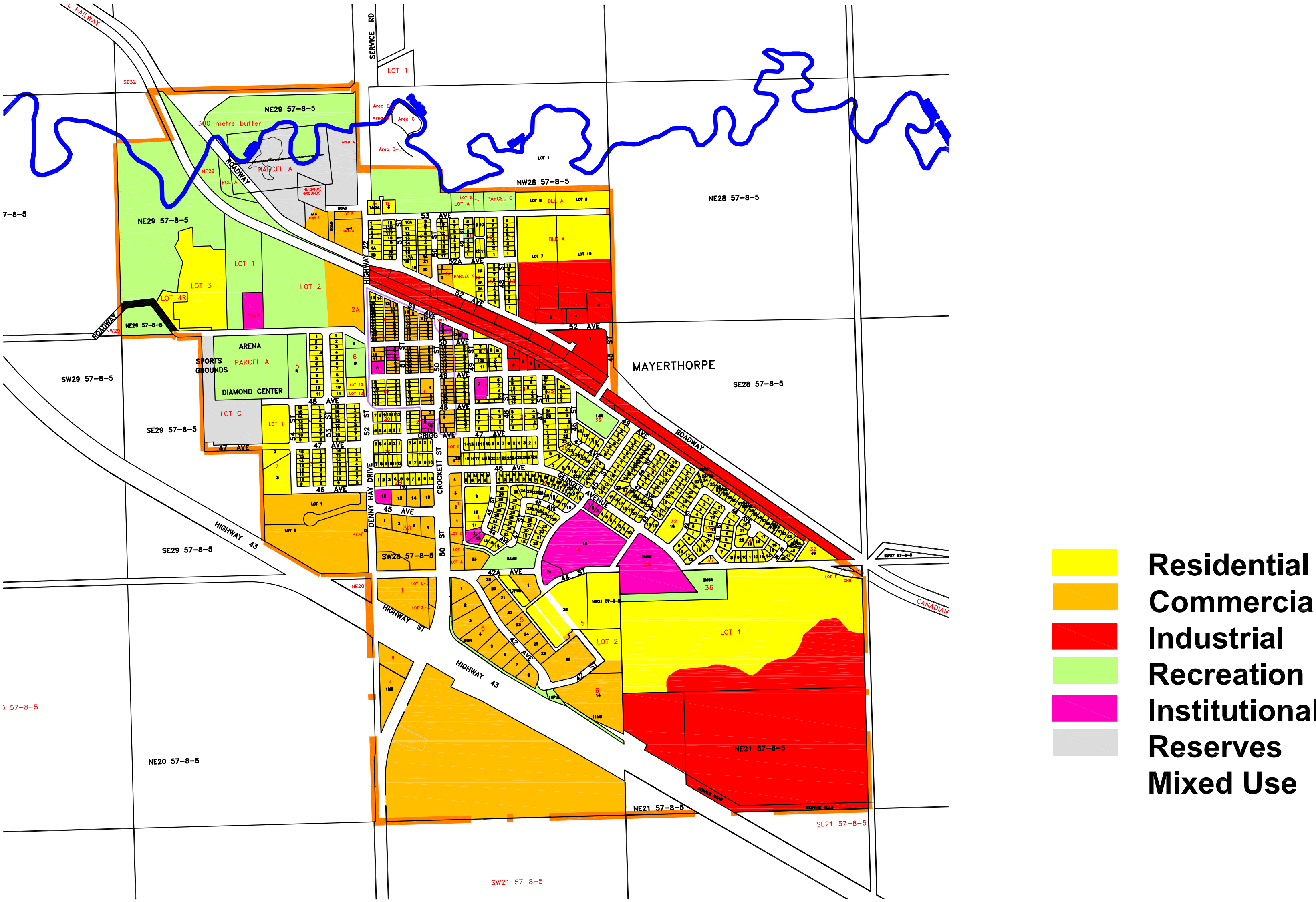
FIGURE 4.7



MODIFIED DATE: 20110620

REFERENCE: TOWN OF MAYERTHORPE

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TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

FUTURE LAND USE PLAN
FIGURE 4.8

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f: 780.426.0659
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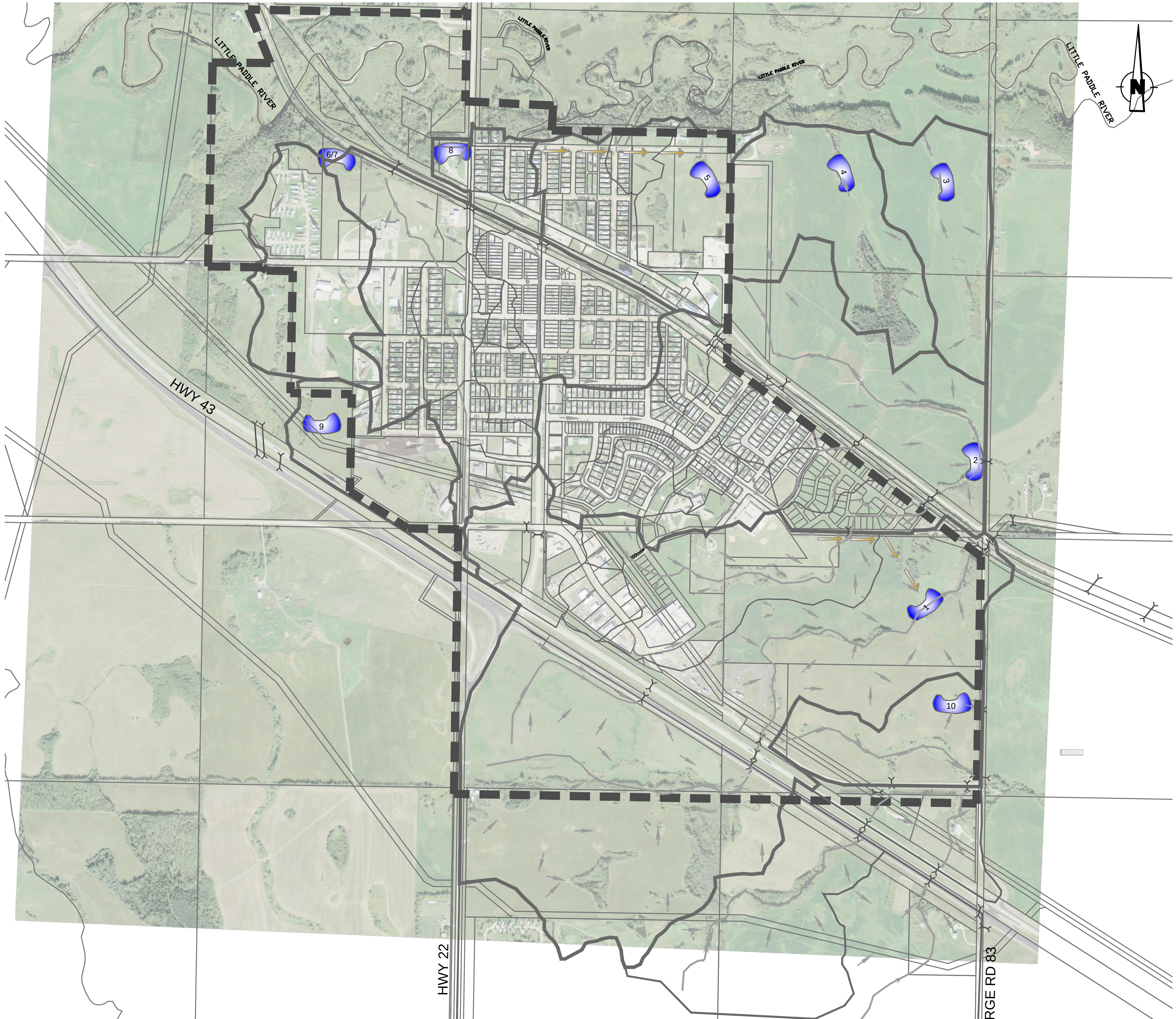


MODIFIED DATE: 2011–08–04
S:\Projects\5311012000 Mayerthorpe SWM Plan\CAD\Drawings\FIGURES\2011 Master Drainage Plan E04\16–5311012e04 Fig 4.9 Major Drainage.dwg

TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

SCALE 1:12500
0 200 400m

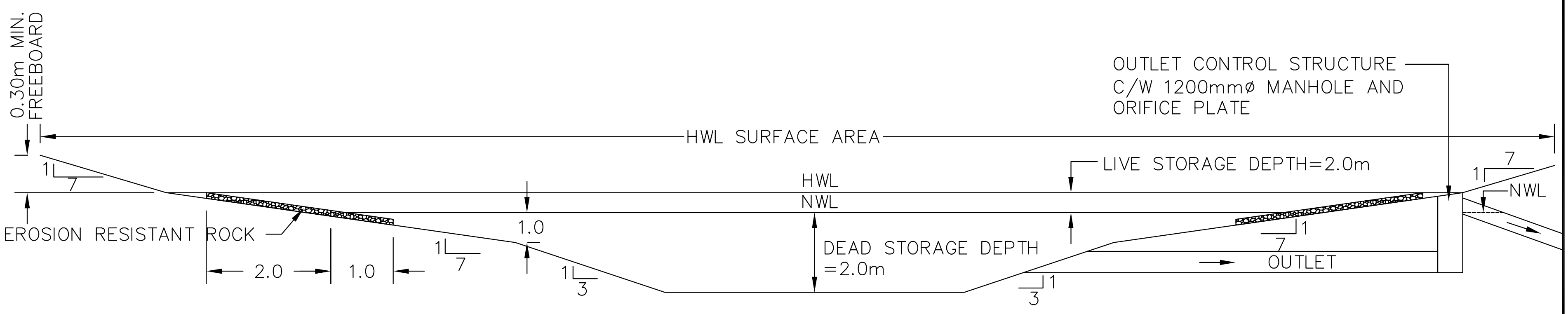
LEGEND

- TOWN BOUNDARY
- SUB–BASIN BOUNDARY
- SWMF BASIN BOUNDARY
- EXISTING DRAINAGE DIRECTION
- EXISTING CULVERTS
- PROPOSED SWMF
- DRAINAGE COURSE
- PROPOSED DITCH

STORMWATER FACILITY MAJOR BASIN BOUNDARY

MMM GROUP
#200, 10576 - 113 Street
Edmonton, AB T5H 3H5
t: 780.423.4123
f: 780.426.0659
www.mmm.ca

FIGURE 4.9



MODIFIED DATE: 2011-05-18
S:\Projects\5311012000 Mayerthorpe SWM Plan\CAD\Drawings\FIGURES\2011 Master Drainage Plan E04\17-5311012e04 Fig 4.10 Typ X-Section.dwg

TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

TYPICAL CROSS-SECTON OF STORMWATER MANAGEMENT FACILITY
FIGURE 4.10

MMM GROUP

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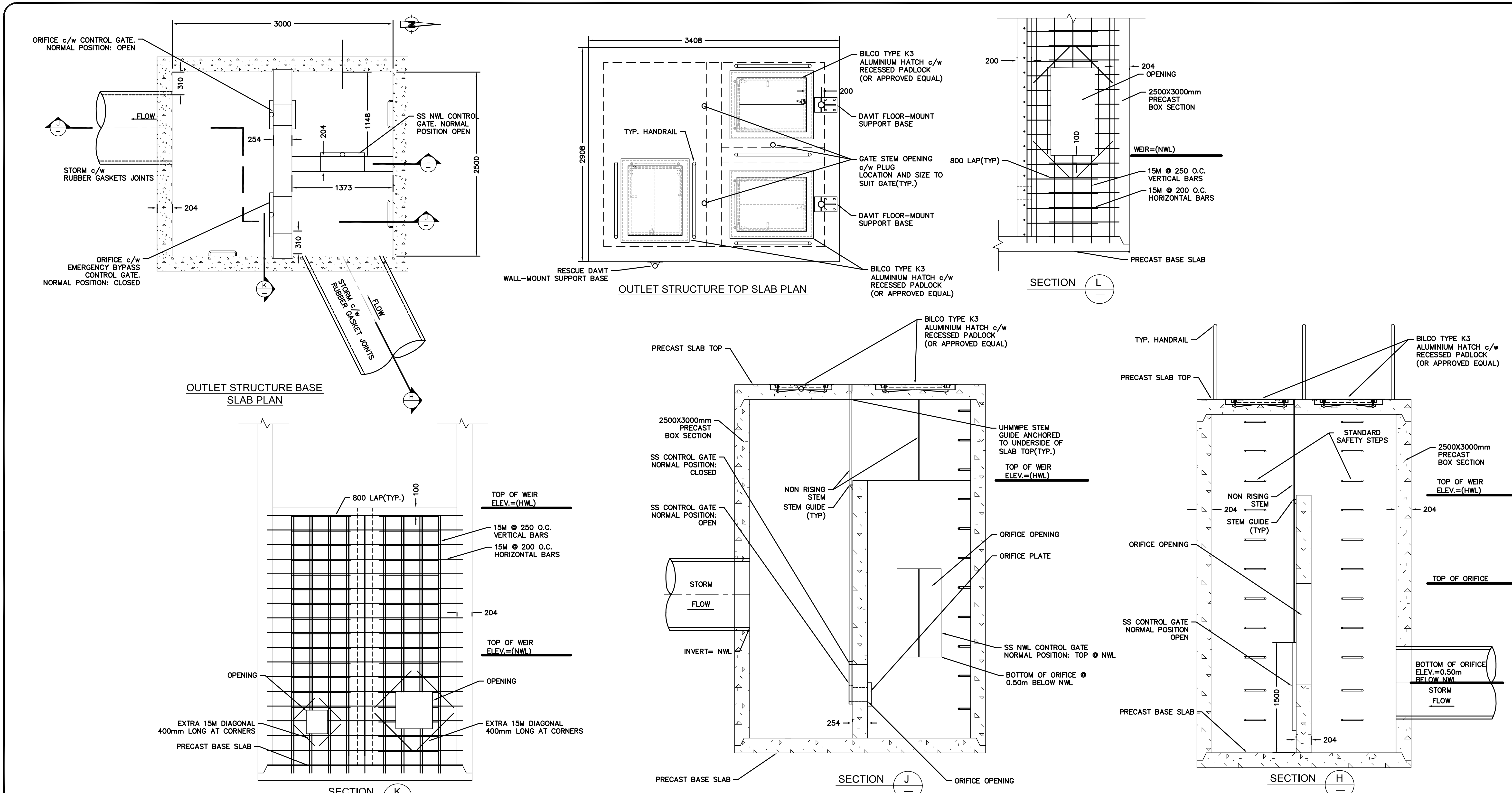

MODIFIED DATE: 20110620
S:\Projects\5311012000 Mayerthorpe SWM Plan\CAD\Drawings\FIGURES\2011 Master Drainage Plan E04\18-5311012e04 Fig 4.11 Control Structure.dwg

MMM GROUP
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TOWN OF MAYERTHORPE
MASTER DRAINAGE PLAN

TYPICAL CROSS-SECTON OF STORMWATER MANAGEMENT CONTROL STRUCTURE
FIGURE 4.11

TABLE 4.3: EXISTING MINOR STORM SYSTEM 2 YEAR STORM EVALUATION WITH UN-CALIBRATED LANDUSE RUNOFF COEFFICIENTS
NEIGHBOURHOOD DESIGN REPORT
Town of Mayerthorpe

Manning's "n"	0.013
Initial Time of Concentration	8.00
A	15.2
B	-0.644

Manhole Drop 90deg	0.06
Manhole Drop 0deg	0.03

Consultant: MMM Group
Project: Town of Mayerthorpe SWM Plan
Project No.: 5311012-000
Date: 01/04/2014

Sub-Basin Area Draining Into MH	From MH	To MH	Area Added Ha	Total Area Ha	Runoff Coef. C	Area x Runoff C.	Total A x C	Total Time of Con. min	* Intensity I mm/hr	Q Design m^3/s	Safety Factor	Q Required m^3/s	Pipe Size Diameter mm	Slope of Pipe %	Length of Pipe m	Q Capacity m^3/s	Percent Full %	Velocity Full m/s	Time of Q in Pipe min	U/S Inv. m	D/S Inv. m	Drop m	Ground U/S m	Ground D/S m	Depth to U/S Inv. m	Depth to D/S Inv. m	Depth to U/S Obv. m	Depth to D/S Obv. m	Notes
32	123	122	3.70	3.70	0.71	2.63	2.63	8.00	55.64	0.407	1.00	0.407	375	0.45	56.327	0.118	344%	1.07	0.88	715.052	714.796	0.00	717.63	717.07	2.6	2.3	2.2	1.9	
31	122	121	4.70	8.40	0.48	2.24	4.88	8.88	52.03	0.705	1.00	0.705	375	0.56	56.998	0.131	536%	1.19	0.80	714.796	714.476	0.01	717.07	716.67	2.3	2.2	1.9	1.8	
	121	119	0.00	8.40	0.00	0.00	4.88	9.68	49.23	0.705	1.00	0.705	375	0.60	111.557	0.136	520%	1.23	1.51	714.466	713.799	0.00	716.67	717.25	2.2	3.5	1.8	3.1	
	120	119	0.00	0.00	0.00	0.00	0.00	8.00	55.64	0.000	1.00	0.000	300	1.76	29.261	0.128	0%	1.82	0.27	714.841	714.326	0.53	717.48	717.25	2.6	2.9	2.3	2.6	
	119	117	0.00	8.40	0.00	0.00	4.88	11.19	44.83	0.705	1.00	0.705	450	1.20	92.934	0.312	226%	1.96	0.79	713.799	712.683	0.05	717.25	717.09	3.5	4.4	3.0	4.0	
30	118	117	4.20	4.20	0.42	1.77	1.77	8.00	55.64	0.274	1.00	0.274	375	0.42	111.923	0.113	242%	1.02	1.82	713.573	713.107	0.48	715.67	717.09	2.1	4.0	1.7	3.6	
	117	114	0.00	12.60	0.00	0.00	6.65	11.98	42.90	0.979	1.00	0.979	450	1.50	36.820	0.349	280%	2.19	0.28	712.628	712.077	0.01	717.09	716.16	4.5	4.1	4.0	3.6	
36	116	115	4.50	4.50	0.38	1.72	1.72	8.00	55.64	0.265	1.00	0.265	375	0.40	111.953	0.111	239%	1.00	1.86	713.384	712.936	0.07	715.33	716.03	1.9	3.1	1.6	2.7	
	115	114	0.00	4.50	0.00	0.00	1.72	9.86	48.64	0.265	1.00	0.265	450	0.35	137.831	0.169	158%	1.06	2.17	712.866	712.385	0.32	716.03	716.16	3.2	3.8	2.7	3.3	
35	114	113	2.80	19.90	0.37	1.03	9.40	12.26	42.27	1.104	1.00	1.104	525	2.06	67.848	0.618	179%	2.85	0.40	712.068	710.669	0.04	716.16	713.81	4.1	3.1	3.6	2.6	
29	113	109	0.90	20.80	0.44	0.40	9.80	12.65	41.41	1.127	1.00	1.127	525	1.89	114.666	0.591	191%	2.73	0.70	710.626	708.462	0.21	713.81	711.98	3.2	3.5	2.7	3.0	
26	112	111	3.60	3.60	0.41	1.49	1.49	8.00	55.64	0.230	1.00	0.230	525	0.46	43.282	0.293	78%	1.35	0.53	708.785	708.584	0.02	710.76	711.07	2.0	2.5	1.4	2.0	
	111	109	0.00	3.60	0.00	0.00	1.49	8.53	53.38	0.230	1.00	0.230	525	0.16	106.101	0.169	136%	0.78	2.26	708.569	708.404	0.16	711.07	711.98	2.5	3.6	2.0	3.1	
27	109	108	1.10	25.50	0.57	0.63	11.91	13.35	40.00	1.323	1.00	1.323	750	0.56	111.923	0.832	159%	1.88	0.99	708.249	707.624	0.03	711.98	712.90	3.7	5.3	3.0	4.5	
28	108	107	1.40	26.90	0.45	0.63	12.54	14.35	38.20	1.330	1.00	1.330	750	0.61	139.263	0.872	153%	1.97	1.18	707.593	706.740	0.07	712.90	710.86	5.3	4.1	4.6	3.4	
25	107	106	4.60	31.50	0.65	3.01	15.54	15.52	36.31	1.568	1.00	1.568	900	0.87	68.702	1.692	93%	2.66	0.43	706.667	706.066	0.02	710.86	710.15	4.2	4.1	3.3	3.2	
	106	105	0.00	31.50	0.00	0.00	15.54	15.95	35.67	1.568	1.00	1.568	900	0.59	57.516	1.388	113%	2.18	0.44	706.042	705.703	0.09	710.15	709.64	4.1	3.9	3.2	3.0	
41	105	104	1.90	33.40	0.57	1.07	16.62	16.39	35.06	1.618	1.00	1.618	900	0.99	159.868	1.801	90%	2.83	0.94	705.612	704.030	0.32	709.64	708.48	4.0	4.5	3.1	3.6	
40	104	103	1.50	34.90	0.42	0.63	17.25	17.33	33.82	1.621	1.00	1.621	700	8.92	63.216	2.765	59%	7.19	0.15	703.707	698.071	-0.06	708.48	702.66	4.8	4.6	4.1	3.9	
	103	102	0.00	34.90	0.00	0.00	17.25	17.48	33.63	1.621	1.00	1.621	700	8.62	68.489	2.720	60%	7.07	0.16	698.135	692.228	-0.01	702.66	694.39	4.5	2.2	3.8	1.5	
	102	CREEK	0.00	34.90	0.00	0.00	17.25	17.64	33.44	1.621	1.00	1.621	700	6.62	37.338	2.383	68%	6.19	0.10	692.234	689.762		694.39		2.2		1.5		
33	79-122	CBMH1	10.70	10.70	0.60	6.39	6.39	8.00	55.64	0.988	1.00	0.988	525	0.40	61.300	0.271	365%	1.25	0.82	714.875	714.632	0.03	716.800	716.080	1.9	1.4	1.4	0.9	
	CBMH1	79-120	0.00	10.70	0.00	0.00	6.39	8.82	52.26	0.988	1.00	0.988	525	0.42	97.000	0.278	356%	1.28	1.26	714.600	714.195	0.00	716.00	716.51	1.4	2.3	0.9	1.8	
	79-120	CBMH2	0.00	10.70	0.00	0.00	6.39	10.08	47.96	0.988	1.00	0.988	525	0.61	100.500	0.337	293%	1.56	1.08	714.195	713.578	0.25	716.51	716.05	2.3	2.5	1.8	1.9	
5	CBMH3	CBMH2	4.20	4.20	0.72	3.02	3.02	8.00	55.64	0.467	1.00	0.467	450	0.88	85.600	0.268	174%	1.68	0.85	714.517	713.761	0.43	716.72	716.05	2.2	2.3	1.7	1.8	
6	CBMH2	79-121	1.10	16.00	0.69	0.76	10.18	11.15	44.92	1.270	1.00	1.270	600	0.45	39.480	0.412	308%	1.46	0.45	713.328	713.150	0.00	716.05	715.99	2.7	2.8	2.1	2.2	
	79-121	DITCH 1	0	16.00	0.00	0.00	10.1798	11.60	43.79	1.270	1.00	1.270	600	0.67	9.00	0.501	253%	1.77	0.08	713.150	713.090		715.985		2.8		2.2		
14	77-126	77-125	7.30	7.30	0.45	3.28	3.28	8.00	55.64	0.507	1.00	0.507	450	0.55	80.123	0.211	240%	1.33	1.01	712.656	712.217	0.00	714.93	714.38	2.3	2.2	1.8	1.7	
	77-125	77-124	0.00	7.30	0.00	0.00	3.28	9.01	51.55	0.507	1.00	0.507	450	0.37	82.296	0.174	292%	1.09	1.26	712.217	711.912	0.04	714.38	714.14	2.2	2.2	1.7	1.8	
13	77-124	76-100	1.80	9.10	0.46	0.83	4.11	10.26	47.39	0.541	1.00	0.541	525	0.41	110.072	0.275	197%	1.27	1.44	711.876	711.425	0.10	714.14	713.78	2.3	2.4	1.7	1.8	
15	76-102	76-101	8.60	8.60	0.48	4.14	4.14	8.00	55.64	0.640	1.00	0.640	525	0.67	119.512	0.351	182%	1.62	1.23	712.738	711.943	0.00	714.90	715.59	2.2	3.6	1.6	3.1	
	76-101	76-100	0.00	8.60	0.00	0.00	4.14	9.23	50.75	0.640	1.00	0.640	525	0.61	62.667	0.337	190%	1.56	0.67	711.943	711.559	0.23	715.59	713.78	3.6	2.2	3.1	1.7	
12	76-100	77-128	1.90	19.60	0.41	0.79	9.04	11.71	43.54	1.093	1.00	1.093	675	1.17	105.461	0.911	120%	2.55	0.69	711.324	710.086	0.10	713.78	712.48	2.5	2.4	1.8	1.7	
11	77-128	77-127	1.10	20.70	0.49	0.54	9.58	12.40	41.96	1.117	1.00	1.117	900	0.51	98.146	1.296	86%	2.04	0.80	709.989	709.486	0.10	712.48	712.02	2.5	2.5	1.6	1.6	
8, 10	77-127	79-103	4.60	25.30	*0.46*	2.10	11.68	13.20	40.30	1.308	1.00	1.308	900	0.41	108.380	1.165	112%	1.83	0.99	709.387	708.938	0.05	712.02	711.45	2.6	2.5	1.7	1.6	
	79-103	95-S3	0.00	25.30	0.00	0.00	11.68	14.19	38.47	1.308	1.00	1.308	900	1.06	139.940	1.864	70%	2.93	0.80	708.890	707.400	0.00	711.45	709.90	2.6	2.5	1.7	1.6	
	95-S3	95-S2	0.00	25.30	0.00	0.00	11.68	14.98	37.15	1.308	1.00	1.308	900	1.11	92.780	1.907	69%	3.00	0.52	707.400	706.370	0.00	709.90	708.38	2.5	2.0	1.6	1.1	
9	95-S2	95-S1	1.50	26.80	0.42	0.63	12.31	15.50	36.34	1.243	1.00	1.243	900	1.03	57.980	1.837	68%	2.89	0.33	706.370	705.770	0.00	708.38	707.98	2.0	2.2	1.1	1.3	
	95-S1	DITCH2	0.00	26.80	0.00	0.00	12.31	15.83	35.85	1.243	1.00	1.243	1200	0.44	49.610	2.586	48%	2.29	0.36	705.770	705.550		707.98	706.62	2.2	1.1	1.0		

*Note: The Whitecourt, AB IDF data were utilized to determine the intensity.

TABLE 4.4: EXISTING MINOR STORM SYSTEM 5 YEAR STORM EVALUATION WITH UN-CALIBRATED LANDUSE RUNOFF COEFFICIENTS
NEIGHBOURHOOD DESIGN REPORT
Town of Mayerthorpe

Manning's "n"	0.013
Initial Time of Concentration	8.00
A	20.7
B	-0.631

Manhole Drop 90deg	0.06
Manhole Drop 0deg	0.03

Consultant: MMM Group
Project: Town of Mayerthorpe SWM Plan
Project No.: 5311012-000
Date: 01/04/2014

Sub-Basin Area Draining Into MH	From MH	To MH	Area Added Ha	Total Area Ha	Runoff Coef. C	Area x Runoff C.	Total A x C	Total Time of Con. min	* Intensity I mm/hr	Q Design m^3/s	Safety Factor	Q Required m^3/s	Pipe Size Diameter mm	Slope of Pipe %	Length of Pipe m	Q Capacity m^3/s	Percent Full %	Velocity Full m/s	Time of Q in Pipe min	U/S Inv. m	D/S Inv. m	Drop m	Ground U/S m	Ground D/S m	Depth to U/S Inv. m	Depth to D/S Inv. m	Depth to U/S Obv. m	Depth to D/S Obv. m	Notes
32	123	122	3.70	3.70	0.71	2.63	2.63	8.00	73.81	0.540	1.00	0.540	375	0.45	56.327	0.118	457%	1.07	0.88	715.052	714.796	0.00	717.63	717.07	2.6	2.3	2.2	1.9	
31	122	121	4.70	8.40	0.48	2.24	4.88	8.88	69.12	0.936	1.00	0.936	375	0.56	56.998	0.131	713%	1.19	0.80	714.796	714.476	0.01	717.07	716.67	2.3	2.2	1.9	1.8	
	121	119	0.00	8.40	0.00	0.00	4.88	9.68	65.47	0.936	1.00	0.936	375	0.60	111.557	0.136	690%	1.23	1.51	714.466	713.799	0.00	716.67	717.25	2.2	3.5	1.8	3.1	
	120	119	0.00	0.00	0.00	0.00	0.00	8.00	73.81	0.000	1.00	0.000	300	1.76	29.261	0.128	0%	1.82	0.27	714.841	714.326	0.53	717.48	717.25	2.6	2.9	2.3	2.6	
	119	117	0.00	8.40	0.00	0.00	4.88	11.19	59.73	0.936	1.00	0.936	450	1.20	92.934	0.312	300%	1.96	0.79	713.799	712.683	0.05	717.25	717.09	3.5	4.4	3.0	4.0	
30	118	117	4.20	4.20	0.42	1.77	1.77	8.00	73.81	0.363	1.00	0.363	375	0.42	111.923	0.113	321%	1.02	1.82	713.573	713.107	0.48	715.67	717.09	2.1	4.0	1.7	3.6	
	117	114	0.00	12.60	0.00	0.00	6.65	11.98	57.22	1.300	1.00	1.300	450	1.50	36.820	0.349	372%	2.19	0.28	712.628	712.077	0.01	717.09	716.16	4.5	4.1	4.0	3.6	
36	116	115	4.50	4.50	0.38	1.72	1.72	8.00	73.81	0.352	1.00	0.352	375	0.40	111.953	0.111	317%	1.00	1.86	713.384	712.936	0.07	715.33	716.03	1.9	3.1	1.6	2.7	
	115	114	0.00	4.50	0.00	0.00	1.72	9.86	64.70	0.352	1.00	0.352	450	0.35	137.831	0.169	209%	1.06	2.17	712.866	712.385	0.32	716.03	716.16	3.2	3.8	2.7	3.3	
35	114	113	2.80	19.90	0.37	1.03	9.40	12.26	56.39	1.472	1.00	1.472	525	2.06	67.848	0.618	238%	2.85	0.40	712.068	710.669	0.04	716.16	713.81	4.1	3.1	3.6	2.6	
29	113	109	0.90	20.80	0.44	0.40	9.80	12.65	55.27	1.504	1.00	1.504	525	1.89	114.666	0.591	255%	2.73	0.70	710.626	708.462	0.21	713.81	711.98	3.2	3.5	2.7	3.0	
26	112	111	3.60	3.60	0.41	1.49	1.49	8.00	73.81	0.305	1.00	0.305	525	0.46	43.282	0.293	104%	1.35	0.53	708.785	708.584	0.02	710.76	711.07	2.0	2.5	1.4	2.0	
	111	109	0.00	3.60	0.00	0.00	1.49	8.53	70.87	0.305	1.00	0.305	525	0.16	106.101	0.169	180%	0.78	2.26	708.569	708.404	0.16	711.07	711.98	2.5	3.6	2.0	3.1	
27	109	108	1.10	25.50	0.57	0.63	11.91	13.35	53.42	1.767	1.00	1.767	750	0.56	111.923	0.832	212%	1.88	0.99	708.249	707.624	0.03	711.98	712.90	3.7	5.3	3.0	4.5	
28	108	107	1.40	26.90	0.45	0.63	12.54	14.35	51.06	1.778	1.00	1.778	750	0.61	139.263	0.872	204%	1.97	1.18	707.593	706.740	0.07	712.90	710.86	5.3	4.1	4.6	3.4	
25	107	106	4.60	31.50	0.65	3.01	15.54	15.52	48.58	2.098	1.00	2.098	900	0.87	68.702	1.692	124%	2.66	0.43	706.667	706.066	0.02	710.86	710.15	4.2	4.1	3.3	3.2	
	106	105	0.00	31.50	0.00	0.00	15.54	15.95	47.75	2.098	1.00	2.098	900	0.59	57.516	1.388	151%	2.18	0.44	706.042	705.703	0.09	710.15	709.64	4.1	3.9	3.2	3.0	
41	105	104	1.90	33.40	0.57	1.07	16.62	16.39	46.94	2.167	1.00	2.167	900	0.99	159.868	1.801	120%	2.83	0.94	705.612	704.030	0.32	709.64	708.48	4.0	4.5	3.1	3.6	
40	104	103	1.50	34.90	0.42	0.63	17.25	17.33	45.32	2.172	1.00	2.172	700	8.92	63.216	2.765	79%	7.19	0.15	703.707	698.071	-0.06	708.48	702.66	4.8	4.6	4.1	3.9	
	103	102	0.00	34.90	0.00	0.00	17.25	17.48	45.08	2.172	1.00	2.172	700	8.62	68.489	2.720	80%	7.07	0.16	698.135	692.228	-0.01	702.66	694.39	4.5	2.2	3.8	1.5	
	102	CREEK	0.00	34.90	0.00	0.00	17.25	17.64	44.82	2.172	1.00	2.172	700	6.62	37.338	2.383	91%	6.19	0.10	692.234	689.762		694.39		2.2		1.5		
33	79-122	CBMH1	10.70	10.70	0.60	6.39	6.39	8.00	73.81	1.311	1.00	1.311	525	0.40	61.300	0.271	484%	1.25	0.82	714.875	714.632	0.03	716.800	716.080	1.9	1.4	1.4	0.9	
	CBMH1	79-120	0.00	10.70	0.00	0.00	6.39	8.82	69.42	1.311	1.00	1.311	525	0.42	97.000	0.278	472%	1.28	1.26	714.600	714.195	0.00	716.00	716.51	1.4	2.3	0.9	1.8	
	79-120	CBMH2	0.00	10.70	0.00	0.00	6.39	10.08	63.81	1.311	1.00	1.311	525	0.61	100.500	0.337	389%	1.56	1.08	714.195	713.578	0.25	716.51	716.05	2.3	2.5	1.8	1.9	
5	CBMH3	CBMH2	4.20	4.20	0.72	3.02	3.02	8.00	73.81	0.619	1.00	0.619	450	0.88	85.600	0.268	231%	1.68	0.85	714.517	713.761	0.43	716.72	716.05	2.2	2.3	1.7	1.8	
6	CBMH2	79-121	1.10	16.00	0.69	0.76	10.18	11.15	59.85	1.693	1.00	1.693	600	0.45	39.480	0.412	411%	1.46	0.45	713.328	713.150	0.00	716.05	715.99	2.7	2.8	2.1	2.2	
	79-121	DITCH 1	0	16.00	0.00	0.00	10.18	11.60	58.38	1.693	1.00	1.693	600	0.67	9.00	0.501	338%	1.77	0.08	713.150	713.090		715.985		2.8		2.2		
14	77-126	77-125	7.30	7.30	0.45	3.28	3.28	8.00	73.81	0.673	1.00	0.673	450	0.55	80.123	0.211	319%	1.33	1.01	712.656	712.217	0.00	714.93	714.38	2.3	2.2	1.8	1.7	
	77-125	77-124	0.00	7.30	0.00	0.00	3.28	9.01	68.50	0.673	1.00	0.673	450	0.37	82.296	0.174	388%	1.09	1.26	712.217	711.912	0.04	714.38	714.14	2.2	2.2	1.7	1.8	
13	77-124	76-100	1.80	9.10	0.46	0.83	4.11	10.26	63.07	0.720	1.00	0.720	525	0.41	110.072	0.275	262%	1.27	1.44	711.876	711.425	0.10	714.14	713.78	2.3	2.4	1.7	1.8	
15	76-102	76-101	8.60	8.60	0.48	4.14	4.14	8.00	73.81	0.849	1.00	0.849	525	0.67	119.512	0.351	242%	1.62	1.23	712.738	711.943	0.00	714.90	715.59	2.2	3.6	1.6	3.1	
	76-101	76-100	0.00	8.60	0.00	0.00	4.14	9.23	67.45	0.849	1.00	0.849	525	0.61	62.667	0.337	252%	1.56	0.67	711.943	711.559	0.23	715.59	713.78	3.6	2.2	3.1	1.7	
12	76-100	77-128	1.90	19.60	0.41	0.79	9.04	11.71	58.05	1.457	1.00	1.457	675	1.17	105.461	0.911	160%	2.55	0.69	711.324	710.086	0.10	713.78	712.48	2.5	2.4	1.8	1.7	
11	77-128	77-127	1.10	20.70	0.49	0.54	9.58	12.40	55.99	1.490	1.00	1.490	900	0.51	98.146	1.296	115%	2.04	0.80	709.989	709.486	0.10	712.48	712.02	2.5	2.5	1.6	1.6	
8, 10	77-127	79-103	4.60	25.30	*0.46*	2.10	11.68	13.20	53.82	1.746	1.00	1.746	900	0.41	108.380	1.165	150%	1.83	0.99	709.387	708.938	0.05	712.02	711.45	2.6	2.5	1.7	1.6	
	79-103	95-S3	0.00	25.30	0.00	0.00	11.68	14.19	51.42	1.746	1.00	1.746	900	1.06	139.940	1.864	94%	2.93	0.80	708.890	707.400	0.00	711.45	709.90	2.6	2.5	1.7	1.6	
	95-S3	95-S2	0.00	25.30	0.00	0.00	11.68	14.98	49.68	1.746	1.00	1.746	900	1.11	92.780	1.907	92%	3.00	0.52	707.400	706.370	0.00	709.90	708.38	2.5	2.0	1.6	1.1	
9	95-S2	95-S1	1.50	26.80	0.42	0.63	12.31	15.50	48.63	1.663	1.00	1.663	900	1.03	57.980	1.837	91%	2.89	0.33	706.370	705.770	0.00	708.38	707.98	2.0	2.2	1.1	1.3	
	95-S1	DITCH2	0.00	26.80	0.00	0.00	12.31	15.83	47.98	1.663	1.00	1.663	1200	0.44	49.610	2.586	64%	2.29	0.36	705.770	705.550		707.98	706.62	2.2	1.1	1.0		

*Note: The Whitecourt, AB IDF data were utilized to determine the intensity.

251%

TABLE 4.5.7: EXISTING MINOR STORM SYSTEM 2 YEAR STORM EVALUATION WITH EXISTING LANDUSE WITH CALIBRATED RUNOFF C
NEIGHBOURHOOD DESIGN REPORT
Town of Mayerthorpe

Manning's "n" 0.013
Initial Time of Concentration 8.00

Manhole Drop 90deg	0.06
Manhole Drop 0deg	0.03

Consultant: MMM Group
Project: Town of Mayerthorpe SWM Plan
Project No.: 5311012-000
Date: Apr-14

Sub-Basin Area Draining Into MH	From MH	To MH	Area Added Ha	Total Area Ha	Runoff Coef. C	Area x Runoff C.	Total A x C	Total Time of Con. min	* Intensity I mm/hr	Q Design m^3/s	Safety Factor	Q Required m^3/s	Pipe Size Diameter mm	Slope of Pipe %	Length of Pipe m	Q Capacity m^3/s	Percent Full %	Velocity Full m/s	Time of Q in Pipe min	U/S Inv. m	D/S Inv. m	Drop m	Ground U/S m	Ground D/S m	Depth to U/S Inv. m	Depth to D/S Inv. m	Depth to U/S Obv. m	Depth to D/S Obv. m	Notes
32	123	122	3.70	3.70	0.61	2.25	2.25	8.00	55.64	0.347	1.00	0.347	375	0.45	56.327	0.118	294%	1.07	0.88	715.052	714.796	0.00	717.63	717.07	2.6	2.3	2.2	1.9	
31	122	121	4.70	8.40	0.40	1.88	4.13	8.88	52.03	0.597	1.00	0.597	375	0.56	56.998	0.131	455%	1.19	0.80	714.796	714.476	0.01	717.07	716.67	2.3	2.2	1.9	1.8	
	121	119	0.00	8.40	0.00	0.00	4.13	9.68	49.23	0.597	1.00	0.597	375	0.60	111.557	0.136	440%	1.23	1.51	714.466	713.799	0.00	716.67	717.25	2.2	3.5	1.8	3.1	
	120	119	0.00	0.00	0.00	0.00	0.00	8.00	55.64	0.000	1.00	0.000	300	1.76	29.261	0.128	0%	1.82	0.27	714.841	714.326	0.53	717.48	717.25	2.6	2.9	2.3	2.6	
	119	117	0.00	8.40	0.00	0.00	4.13	11.19	44.83	0.597	1.00	0.597	450	1.20	92.934	0.312	191%	1.96	0.79	713.799	712.683	0.05	717.25	717.09	3.5	4.4	3.0	4.0	
30	118	117	4.20	4.20	0.35	1.49	1.49	8.00	55.64	0.230	1.00	0.230	375	0.42	111.923	0.113	203%	1.02	1.82	713.573	713.107	0.48	715.67	717.09	2.1	4.0	1.7	3.6	
	117	114	0.00	12.60	0.00	0.00	5.62	11.98	42.90	0.827	1.00	0.827	450	1.50	36.820	0.349	237%	2.19	0.28	712.628	712.077	0.01	717.09	716.16	4.5	4.1	4.0	3.6	
36	116	115	4.50	4.50	0.31	1.40	1.40	8.00	55.64	0.216	1.00	0.216	375	0.40	111.953	0.111	195%	1.00	1.86	713.384	712.936	0.07	715.33	716.03	1.9	3.1	1.6	2.7	
	115	114	0.00	4.50	0.00	0.00	1.40	9.86	48.64	0.216	1.00	0.216	450	0.35	137.831	0.169	128%	1.06	2.17	712.866	712.385	0.32	716.03	716.16	3.2	3.8	2.7	3.3	
35	114	113	2.80	19.90	0.31	0.88	7.90	12.26	42.27	0.927	1.00	0.927	525	2.06	67.848	0.618	150%	2.85	0.40	712.068	710.669	0.04	716.16	713.81	4.1	3.1	3.6	2.6	
29	113	109	0.90	20.80	0.38	0.34	8.23	12.65	41.41	0.947	1.00	0.947	525	1.89	114.666	0.591	160%	2.73	0.70	710.626	708.462	0.21	713.81	711.98	3.2	3.5	2.7	3.0	
26	112	111	3.60	3.60	0.35	1.26	1.26	8.00	55.64	0.195	1.00	0.195	525	0.46	43.282	0.293	67%	1.35	0.53	708.785	708.584	0.02	710.76	711.07	2.0	2.5	1.4	2.0	
	111	109	0.00	3.60	0.00	0.00	1.26	8.53	53.38	0.195	1.00	0.195	525	0.16	106.101	0.169	115%	0.78	2.26	708.569	708.404	0.16	711.07	711.98	2.5	3.6	2.0	3.1	
27	109	108	1.10	25.50	0.49	0.54	10.03	13.35	40.00	1.115	1.00	1.115	750	0.56	111.923	0.832	134%	1.88	0.99	708.249	707.624	0.03	711.98	712.90	3.7	5.3	3.0	4.5	
28	108	107	1.40	26.90	0.37	0.52	10.55	14.35	38.20	1.120	1.00	1.120	750	0.61	139.263	0.872	128%	1.97	1.18	707.593	706.740	0.07	712.90	710.86	5.3	4.1	4.6	3.4	
25	107	106	4.60	31.50	0.55	2.55	13.10	15.52	36.31	1.322	1.00	1.322	900	0.87	68.702	1.692	78%	2.66	0.43	706.667	706.066	0.02	710.86	710.15	4.2	4.1	3.3	3.2	
	106	105	0.00	31.50	0.00	0.00	13.10	15.95	35.67	1.322	1.00	1.322	900	0.59	57.516	1.388	95%	2.18	0.44	706.042	705.703	0.09	710.15	709.64	4.1	3.9	3.2	3.0	
41	105	104	1.90	33.40	0.49	0.94	14.04	16.39	35.06	1.367	1.00	1.367	900	0.99	159.868	1.801	76%	2.83	0.94	705.612	704.030	0.32	709.64	708.48	4.0	4.5	3.1	3.6	
40	104	103	1.50	34.90	0.34	0.51	14.56	17.33	33.82	1.367	1.00	1.367	700	8.92	63.216	2.765	49%	7.19	0.15	703.707	698.071	-0.06	708.48	702.66	4.8	4.6	4.1	3.9	
	103	102	0.00	34.90	0.00	0.00	14.56	17.48	33.63	1.367	1.00	1.367	700	8.62	68.489	2.720	50%	7.07	0.16	698.135	692.228	-0.01	702.66	694.39	4.5	2.2	3.8	1.5	
	102	CREEK	0.00	34.90	0.00	0.00	14.56	17.64	33.44	1.367	1.00	1.367	700	6.62	37.338	2.383	57%	6.19	0.10	692.234	689.762		694.39		2.2		1.5		
33	79-122	CBMH1	10.70	10.70	0.51	5.49	5.49	8.00	55.64	0.848	1.00	0.848	525	0.40	61.300	0.271	313%	1.25	0.82	714.875	714.632	0.03	716.800	716.080	1.9	1.4	1.4	0.9	
	CBMH1	79-120	0.00	10.70	0.00	0.00	5.49	8.82	52.26	0.848	1.00	0.848	525	0.42	97.000	0.278	305%	1.28	1.26	714.600	714.195	0.00	716.00	716.51	1.4	2.3	0.9	1.8	
	79-120	CBMH2	0.00	10.70	0.00	0.00	5.49	10.08	47.96	0.848	1.00	0.848	525	0.61	100.500	0.337	252%	1.56	1.08	714.195	713.578	0.25	716.51	716.05	2.3	2.5	1.8	1.9	
5	CBMH3	CBMH2	4.20	4.20	0.60	2.53	2.53	8.00	55.64	0.390	1.00	0.390	450	0.88	85.600	0.268	146%	1.68	0.85	714.517	713.761	0.43	716.72	716.05	2.2	2.3	1.7	1.8	
6	CBMH2	79-121	1.10	16.00	0.58	0.64	8.65	11.15	44.92	1.080	1.00	1.080	600	0.45	39.480	0.412	262%	1.46	0.45	713.328	713.150	0.00	716.05	715.99	2.7	2.8	2.1	2.2	
	79-121	DITCH 1	0	16.00	0.00	0.00	8.65215	11.60	43.79	1.080	1.00	1.080	600	0.67	9.00	0.501	215%	1.77	0.08	713.150	713.090		715.985		2.8		2.2		
14	77-126	77-125	7.30	7.30	0.38	2.80	2.80	8.00	55.64	0.433	1.00	0.433	450	0.55	80.123	0.211	205%	1.33	1.01	712.656	712.217	0.00	714.93	714.38	2.3	2.2	1.8	1.7	
	77-125	77-124	0.00	7.30	0.00	0.00	2.80	9.01	51.55	0.433	1.00	0.433	450	0.37	82.296	0.174	250%	1.09	1.26	712.217	711.912	0.04	714.38	714.14	2.2	2.2	1.7	1.8	
13	77-124	76-100	1.80	9.10	0.38	0.69	3.49	10.26	47.39	0.460	1.00	0.460	525	0.41	110.072	0.275	167%	1.27	1.44	711.876	711.425	0.10	714.14	713.78	2.3	2.4	1.7	1.8	
15	76-102	76-101	8.60	8.60	0.41	3.55	3.55	8.00	55.64	0.548	1.00	0.548	525	0.67	119.512	0.351	156%	1.62	1.23	712.738	711.943	0.00	714.90	715.59	2.2	3.6	1.6	3.1	
	76-101	76-100	0.00	8.60	0.00	0.00	3.55	9.23	50.75	0.548	1.00	0.548	525	0.61	62.667	0.337	163%	1.56	0.67	711.943	711.559	0.23	715.59	713.78	3.6	2.2	3.1	1.7	
12	76-100	77-128	1.90	19.60	0.35	0.66	7.69	11.71	43.54	0.930	1.00	0.930	675	1.17	105.461	0.911	102%	2.55	0.69	711.324	710.086	0.10	713.78	712.48	2.5	2.4	1.8	1.7	
11	77-128	77-127	1.10	20.70	0.42	0.46	8.15	12.40	41.96	0.950	1.00	0.950	900	0.51	98.146	1.296	73%	2.04	0.80	709.989	709.486	0.10	712.48	712.02	2.5	2.5	1.6	1.6	
8, 10	77-127	79-103	4.60	25.30	*0.38*	1.75	9.90	13.20	40.30	1.108	1.00	1.108	900	0.41	108.380	1.165	95%	1.83	0.99	709.387	708.938	0.05	712.02	711.45	2.6	2.5	1.7	1.6	
	79-103	95-S3	0.00	25.30	0.00	0.00	9.90	14.19	38.47	1.108	1.00	1.108	900	1.06	139.940	1.864	59%	2.93	0.80	708.890	707.400	0.00	711.45	709.90	2.6	2.5	1.7	1.6	
	95-S3	95-S2	0.00	25.30	0.00	0.00	9.90	14.98	37.15	1.108	1.00	1.108	900	1.11	92.780	1.907	58%	3.00	0.52	707.400	706.370	0.00	709.90	708.38	2.5	2.0	1.6	1.1	
9	95-S2	95-S1	1.50	26.80	0.34	0.51	10.41	15.50	36.34	1.051	1.00	1.051	900	1.03	57.980	1.837	57%	2.89	0.33	706.370	705.770	0.00	708.38	707.98	2.0	2.2	1.1	1.3	
	95-S1	DITCH2	0.00	26.80	0.00	0.00	10.41	15.83	35.85	1.051	1.00	1.051	1200	0.44	49.610	2.586	41%	2.29	0.36	705.770	705.550		707.98	706.62	2.2	1.1	1.0		

*Note: The Whitecourt, AB IDF data were utilized to determine the intensity.

TABLE 4.5.8: EXISTING MINOR STORM SYSTEM 5 YEAR STORM EVALUATION WITH EXISTING LANDUSE WITH CALIBRATED RUNOFF C
NEIGHBOURHOOD DESIGN REPORT
Town of Mayerthorpe

Manning's "n"	0.013
Initial Time of Concentration	8.00
A	20.7
B	-0.631

Manhole Drop 90deg	0.06
Manhole Drop 0deg	0.03

Consultant: MMM Group
Project: Town of Mayerthorpe SWM Plan
Project No.: 5311012-000
Date: Apr-14

Sub-Basin Area Draining Into MH	From MH	To MH	Area Added Ha	Total Area Ha	Runoff Coef. C	Area x Runoff C.	Total A x C	Total Time of Con. min	* Intensity I mm/hr	Q Design m^3/s	Safety Factor	Q Required m^3/s	Pipe Size Diameter mm	Slope of Pipe %	Length of Pipe m	Q Capacity m^3/s	Percent Full %	Velocity Full m/s	Time of Q in Pipe min	U/S Inv. m	D/S Inv. m	Drop m	Ground U/S m	Ground D/S m	Depth to U/S Inv. m	Depth to D/S Inv. m	Depth to U/S Obv. m	Depth to D/S Obv. m	Notes
32	123	122	3.70	3.70	0.61	2.25	2.25	8.00	73.81	0.461	1.00	0.461	375	0.45	56.327	0.118	390%	1.07	0.88	715.052	714.796	0.00	717.63	717.07	2.6	2.3	2.2	1.9	
31	122	121	4.70	8.40	0.40	1.88	4.13	8.88	69.12	0.793	1.00	0.793	375	0.56	56.998	0.131	604%	1.19	0.80	714.796	714.476	0.01	717.07	716.67	2.3	2.2	1.9	1.8	
	121	119	0.00	8.40	0.00	0.00	4.13	9.68	65.47	0.793	1.00	0.793	375	0.60	111.557	0.136	585%	1.23	1.51	714.466	713.799	0.00	716.67	717.25	2.2	3.5	1.8	3.1	
	120	119	0.00	0.00	0.00	0.00	0.00	8.00	73.81	0.000	1.00	0.000	300	1.76	29.261	0.128	0%	1.82	0.27	714.841	714.326	0.53	717.48	717.25	2.6	2.9	2.3	2.6	
	119	117	0.00	8.40	0.00	0.00	4.13	11.19	59.73	0.793	1.00	0.793	450	1.20	92.934	0.312	254%	1.96	0.79	713.799	712.683	0.05	717.25	717.09	3.5	4.4	3.0	4.0	
30	118	117	4.20	4.20	0.35	1.49	1.49	8.00	73.81	0.305	1.00	0.305	375	0.42	111.923	0.113	269%	1.02	1.82	713.573	713.107	0.48	715.67	717.09	2.1	4.0	1.7	3.6	
	117	114	0.00	12.60	0.00	0.00	5.62	11.98	57.22	1.098	1.00	1.098	450	1.50	36.820	0.349	315%	2.19	0.28	712.628	712.077	0.01	717.09	716.16	4.5	4.1	4.0	3.6	
36	116	115	4.50	4.50	0.31	1.40	1.40	8.00	73.81	0.287	1.00	0.287	375	0.40	111.953	0.111	259%	1.00	1.86	713.384	712.936	0.07	715.33	716.03	1.9	3.1	1.6	2.7	
	115	114	0.00	4.50	0.00	0.00	1.40	9.86	64.70	0.287	1.00	0.287	450	0.35	137.831	0.169	170%	1.06	2.17	712.866	712.385	0.32	716.03	716.16	3.2	3.8	2.7	3.3	
35	114	113	2.80	19.90	0.31	0.88	7.90	12.26	56.39	1.237	1.00	1.237	525	2.06	67.848	0.618	200%	2.85	0.40	712.068	710.669	0.04	716.16	713.81	4.1	3.1	3.6	2.6	
29	113	109	0.90	20.80	0.38	0.34	8.23	12.65	55.27	1.264	1.00	1.264	525	1.89	114.666	0.591	214%	2.73	0.70	710.626	708.462	0.21	713.81	711.98	3.2	3.5	2.7	3.0	
26	112	111	3.60	3.60	0.35	1.26	1.26	8.00	73.81	0.259	1.00	0.259	525	0.46	43.282	0.293	88%	1.35	0.53	708.785	708.584	0.02	710.76	711.07	2.0	2.5	1.4	2.0	
	111	109	0.00	3.60	0.00	0.00	1.26	8.53	70.87	0.259	1.00	0.259	525	0.16	106.101	0.169	153%	0.78	2.26	708.569	708.404	0.16	711.07	711.98	2.5	3.6	2.0	3.1	
27	109	108	1.10	25.50	0.49	0.54	10.03	13.35	53.42	1.489	1.00	1.489	750	0.56	111.923	0.832	179%	1.88	0.99	708.249	707.624	0.03	711.98	712.90	3.7	5.3	3.0	4.5	
28	108	107	1.40	26.90	0.37	0.52	10.55	14.35	51.06	1.497	1.00	1.497	750	0.61	139.263	0.872	172%	1.97	1.18	707.593	706.740	0.07	712.90	710.86	5.3	4.1	4.6	3.4	
25	107	106	4.60	31.50	0.55	2.55	13.10	15.52	48.58	1.768	1.00	1.768	900	0.87	68.702	1.692	104%	2.66	0.43	706.667	706.066	0.02	710.86	710.15	4.2	4.1	3.3	3.2	
	106	105	0.00	31.50	0.00	0.00	13.10	15.95	47.75	1.768	1.00	1.768	900	0.59	57.516	1.388	127%	2.18	0.44	706.042	705.703	0.09	710.15	709.64	4.1	3.9	3.2	3.0	
41	105	104	1.90	33.40	0.49	0.94	14.04	16.39	46.94	1.831	1.00	1.831	900	0.99	159.868	1.801	102%	2.83	0.94	705.612	704.030	0.32	709.64	708.48	4.0	4.5	3.1	3.6	
40	104	103	1.50	34.90	0.34	0.51	14.56	17.33	45.32	1.832	1.00	1.832	700	8.92	63.216	2.765	66%	7.19	0.15	703.707	698.071	-0.06	708.48	702.66	4.8	4.6	4.1	3.9	
	103	102	0.00	34.90	0.00	0.00	14.56	17.48	45.08	1.832	1.00	1.832	700	8.62	68.489	2.720	67%	7.07	0.16	698.135	692.228	-0.01	702.66	694.39	4.5	2.2	3.8	1.5	
	102	CREEK	0.00	34.90	0.00	0.00	14.56	17.64	44.82	1.832	1.00	1.832	700	6.62	37.338	2.383	77%	6.19	0.10	692.234	689.762		694.39		2.2		1.5		
33	79-122	CBMH1	10.70	10.70	0.51	5.49	5.49	8.00	73.81	1.125	1.00	1.125	525	0.40	61.300	0.271	416%	1.25	0.82	714.875	714.632	0.03	716.800	716.080	1.9	1.4	1.4	0.9	
	CBMH1	79-120	0.00	10.70	0.00	0.00	5.49	8.82	69.42	1.125	1.00	1.125	525	0.42	97.000	0.278	405%	1.28	1.26	714.600	714.195	0.00	716.00	716.51	1.4	2.3	0.9	1.8	
	79-120	CBMH2	0.00	10.70	0.00	0.00	5.49	10.08	63.81	1.125	1.00	1.125	525	0.61	100.500	0.337	334%	1.56	1.08	714.195	713.578	0.25	716.51	716.05	2.3	2.5	1.8	1.9	
5	CBMH3	CBMH2	4.20	4.20	0.60	2.53	2.53	8.00	73.81	0.518	1.00	0.518	450	0.88	85.600	0.268	193%	1.68	0.85	714.517	713.761	0.43	716.72	716.05	2.2	2.3	1.7	1.8	
6	CBMH2	79-121	1.10	16.00	0.58	0.64	8.65	11.15	59.85	1.439	1.00	1.439	600	0.45	39.480	0.412	349%	1.46	0.45	713.328	713.150	0.00	716.05	715.99	2.7	2.8	2.1	2.2	
	79-121	DITCH 1	0	16.00	0.00	0.00	8.65	11.60	58.38	1.439	1.00	1.439	600	0.67	9.00	0.501	287%	1.77	0.08	713.150	713.090		715.985		2.8		2.2		
14	77-126	77-125	7.30	7.30	0.38	2.80	2.80	8.00	73.81	0.575	1.00	0.575	450	0.55	80.123	0.211	272%	1.33	1.01	712.656	712.217	0.00	714.93	714.38	2.3	2.2	1.8	1.7	
	77-125	77-124	0.00	7.30	0.00	0.00	2.80	9.01	68.50	0.575	1.00	0.575	450	0.37	82.296	0.174	331%	1.09	1.26	712.217	711.912	0.04	714.38	714.14	2.2	2.2	1.7	1.8	
13	77-124	76-100	1.80	9.10	0.38	0.69	3.49	10.26	63.07	0.612	1.00	0.612	525	0.41	110.072	0.275	222%	1.27	1.44	711.876	711.425	0.10	714.14	713.78	2.3	2.4	1.7	1.8	
15	76-102	76-101	8.60	8.60	0.41	3.55	3.55	8.00	73.81	0.727	1.00	0.727	525	0.67	119.512	0.351	207%	1.62	1.23	712.738	711.943	0.00	714.90	715.59	2.2	3.6	1.6	3.1	
	76-101	76-100	0.00	8.60	0.00	0.00	3.55	9.23	67.45	0.727	1.00	0.727	525	0.61	62.667	0.337	216%	1.56	0.67	711.943	711.559	0.23	715.59	713.78	3.6	2.2	3.1	1.7	
12	76-100	77-128	1.90	19.60	0.35	0.66	7.69	11.71	58.05	1.240	1.00	1.240	675	1.17	105.461	0.911	136%	2.55	0.69	711.324	710.086	0.10	713.78	712.48	2.5	2.4	1.8	1.7	
11	77-128	77-127	1.10	20.70	0.42	0.46	8.15	12.40	55.99	1.268	1.00	1.268	900	0.51	98.146	1.296	98%	2.04	0.80	709.989	709.486	0.10	712.48	712.02	2.5	2.5	1.6	1.6	
8, 10	77-127	79-103	4.60	25.30	*0.38*	1.75	9.90	13.20	53.82	1.480	1.00	1.480	900	0.41	108.380	1.165	127%	1.83	0.99	709.387	708.938	0.05	712.02	711.45	2.6	2.5	1.7	1.6	
	79-103	95-S3	0.00	25.30	0.00	0.00	9.90	14.19	51.42	1.480	1.00	1.480	900	1.06	139.940	1.864	79%	2.93	0.80	708.890	707.400	0.00	711.45	709.90	2.6	2.5	1.7	1.6	
	95-S3	95-S2	0.00	25.30	0.00	0.00	9.90	14.98	49.68	1.480	1.00	1.480	900	1.11	92.780	1.907	78%	3.00	0.52	707.400	706.370	0.00	709.90	708.38	2.5	2.0	1.6	1.1	
9	95-S2	95-S1	1.50	26.80	0.34	0.51	10.41	15.50	48.63	1.406	1.00	1.406	900	1.03	57.980	1.837	77%	2.89	0.33	706.370	705.770	0.00	708.38	707.98	2.0	2.2	1.1	1.3	
	95-S1	DITCH2	0.00	26.80	0.00	0.00	10.41	15.83	47.98	1.406	1.00	1.406	1200	0.44	49.610	2.586	54%	2.29	0.36	705.770	705.550		707.98	706.62	2.2	1.1	1.0		
																	212%												

*Note: The Whitecourt, AB IDF data were utilized to determine the intensity.

TABLE 4.8: EXISTING MINOR STORM SYSTEM 2 YEAR STORM EVALUATION WITH FUTURE LANDUSE
NEIGHBOURHOOD DESIGN REPORT
Town of Mayerthorpe

Manning's "n"	0.013
Initial Time of Concentration	8.00
A	15.2
B	-0.644

Manhole Drop 90deg	0.06
Manhole Drop 0deg	0.03

Consultant: MMM Group
Project: Town of Mayerthorpe SWM Plan
Project No.: 5311012-000
Date: Apr-14

Sub-Basin Area Draining Into MH	From MH	To MH	Area Added Ha	Total Area Ha	Runoff Coef. C	Area x Runoff C.	Total A x C	Total Time of Con. min	* Intensity I mm/hr	Q Design m^3/s	Safety Factor	Q Required m^3/s	Pipe Size Diameter mm	Slope of Pipe %	Length of Pipe m	Q Capacity m^3/s	Percent Full %	Velocity Full m/s	Time of Q in Pipe min	U/S Inv. m	D/S Inv. m	Drop m	Ground U/S m	Ground D/S m	Depth to U/S Inv. m	Depth to D/S Inv. m	Depth to U/S Obv. m	Depth to D/S Obv. m	Notes
32	123	122	3.70	3.70	0.61	2.25	2.25	8.00	55.64	0.347	1.00	0.347	375	0.45	56.327	0.118	294%	1.07	0.88	715.052	714.796	0.00	717.63	717.07	2.6	2.3	2.2	1.9	
31	122	121	4.70	8.40	0.47	2.21	4.45	8.88	52.03	0.644	1.00	0.644	375	0.56	56.998	0.131	490%	1.19	0.80	714.796	714.476	0.01	717.07	716.67	2.3	2.2	1.9	1.8	
	121	119	0.00	8.40	0.00	0.00	4.45	9.68	49.23	0.644	1.00	0.644	375	0.60	111.557	0.136	475%	1.23	1.51	714.466	713.799	0.00	716.67	717.25	2.2	3.5	1.8	3.1	
					0.00																								
	120	119	0.00	0.00	0.00	0.00	0.00	8.00	55.64	0.000	1.00	0.000	300	1.76	29.261	0.128	0%	1.82	0.27	714.841	714.326	0.53	717.48	717.25	2.6	2.9	2.3	2.6	
					0.00																								
	119	117	0.00	8.40	0.00	0.00	4.45	11.19	44.83	0.644	1.00	0.644	450	1.20	92.934	0.312	206%	1.96	0.79	713.799	712.683	0.05	717.25	717.09	3.5	4.4	3.0	4.0	
					0.00																								
30	118	117	4.20	4.20	0.46	1.95	1.95	8.00	55.64	0.301	1.00	0.301	375	0.42	111.923	0.113	266%	1.02	1.82	713.573	713.107	0.48	715.67	717.09	2.1	4.0	1.7	3.6	
					0.00																								
	117	114	0.00	12.60	0.00	0.00	6.40	11.98	42.90	0.944	1.00	0.944	450	1.50	36.820	0.349	271%	2.19	0.28	712.628	712.077	0.01	717.09	716.16	4.5	4.1	4.0	3.6	
					0.00																								
36	116	115	4.50	4.50	0.44	1.99	1.99	8.00	55.64	0.308	1.00	0.308	375	0.40	111.953	0.111	278%	1.00	1.86	713.384	712.936	0.07	715.33	716.03	1.9	3.1	1.6	2.7	
	115	114	0.00	4.50	0.00	0.00	1.99	9.86	48.64	0.308	1.00	0.308	450	0.35	137.831	0.169	183%	1.06	2.17	712.866	712.385	0.32	716.03	716.16	3.2	3.8	2.7	3.3	
					0.00																								
35	114	113	2.80	19.90	0.45	1.27	9.66	12.26	42.27	1.134	1.00	1.134	525	2.06	67.848	0.618	184%	2.85	0.40	712.068	710.669	0.04	716.16	713.81	4.1	3.1	3.6	2.6	
29	113	109	0.90	20.80	0.42	0.37	10.03	12.65	41.41	1.154	1.00	1.154	525	1.89	114.666	0.591	195%	2.73	0.70	710.626	708.462	0.21	713.81	711.98	3.2	3.5	2.7	3.0	
					0.00																								
26	112	111	3.60	3.60	0.43	1.54	1.54	8.00	55.64	0.239	1.00	0.239	525	0.46	43.282	0.293	81%	1.35	0.53	708.785	708.584	0.02	710.76	711.07	2.0	2.5	1.4	2.0	
	111	109	0.00	3.60	0.00	0.00	1.54	8.53	53.38	0.239	1.00	0.239	525	0.16	106.101	0.169	141%	0.78	2.26	708.569	708.404	0.16	711.07	711.98	2.5	3.6	2.0	3.1	
					0.00																								
27	109	108	1.10	25.50	0.56	0.61	12.19	13.35	40.00	1.355	1.00	1.355	750	0.56	111.923	0.832	163%	1.88	0.99	708.249	707.624	0.03	711.98	712.90	3.7	5.3	3.0	4.5	
28	108	107	1.40	26.90	0.49	0.68	12.87	14.35	38.20	1.366	1.00	1.366	750	0.61	139.263	0.872	157%	1.97	1.18	707.593	706.740	0.07	712.90	710.86	5.3	4.1	4.6	3.4	
25	107	106	4.60	31.50	0.66	3.03	15.90	15.52	36.31	1.604	1.00	1.604	900	0.87	68.702	1.692	95%	2.66	0.43	706.667	706.066	0.02	710.86	710.15	4.2	4.1	3.3	3.2	
	106	105	0.00	31.50	0.00	0.00	15.90	15.95	35.67	1.604	1.00	1.604	900	0.59	57.516	1.388	116%	2.18	0.44	706.042	705.703	0.09	710.15	709.64	4.1	3.9	3.2	3.0	
41	105	104	1.90	33.40	0.52	0.99	16.89	16.39	35.06	1.645	1.00	1.645	900	0.99	159.868	1.801	91%	2.83	0.94	705.612	704.030	0.32	709.64	708.48	4.0	4.5	3.1	3.6	
40	104	103	1.50	34.90	0.44	0.66	17.55	17.33	33.82	1.649	1.00	1.649	700	8.92	63.216	2.765	60%	7.19	0.15	703.707	698.071	-0.06	708.48	702.66	4.8	4.6	4.1	3.9	
	103	102	0.00	34.90	0.00	0.00	17.55	17.48	33.63	1.649	1.00	1.649	700	8.62	68.489	2.720	61%	7.07	0.16	698.135	692.228	-0.01	702.66	694.39	4.5	2.2	3.8	1.5	
	102	CREEK	0.00	34.90	0.00	0.00	17.55	17.64	33.44	1.649	1.00	1.649	700	6.62	37.338	2.383	69%	6.19	0.10	692.234	689.762		694.39		2.2		1.5		
					0.00																								
33	79-122	CBMH1	10.70	10.70	0.53	5.63	5.63	8.00	55.64	0.870	1.00	0.870	525	0.40	61.300	0.271	321%	1.25	0.82	714.875	714.632	0.03	716.800	716.080	1.9	1.4	1.4	0.9	
	CBMH1	79-120	0.00	10.70	0.00	0.00	5.63	8.82	52.26	0.870	1.00	0.870	525	0.42	97.000	0.278	313%	1.28	1.26	714.600	714.195	0.00	716.00	716.51	1.4	2.3	0.9	1.8	
	79-120	CBMH2	0.00	10.70	0.00	0.00	5.63	10.08	47.96	0.870	1.00	0.870	525	0.61	100.500	0.337	258%	1.56	1.08	714.195	713.578	0.25	716.51	716.05	2.3	2.5	1.8	1.9	
					0.00																								
5	CBMH3	CBMH2	4.20	4.20	0.64	2.67	2.67	8.00	55.64	0.413	1.00	0.413	450	0.88	85.600	0.268	154%	1.68	0.85	714.517	713.761	0.43	716.72	716.05	2.2	2.3	1.7	1.8	
					0.00																								
6	CBMH2	79-121	1.10	16.00	0.72	0.79	9.10	11.15	44.92	1.135	1.00	1.135	600	0.45	39.480	0.412	275%	1.46	0.45	713.328	713.150	0.00	716.05	715.99	2.7	2.8	2.1	2.2	
	79-121	DITCH 1	0	16.00	0.00	0.00	9.09567	11.60	43.79	1.135	1.00	1.135	600	0.67	9.00	0.501	226%	1.77	0.08	713.150	713.090		715.985		2.8		2.2		
					0.00																								
14	77-126	77-125	7.30	7.30	0.44	3.18	3.18	8.00	55.64	0.491	1.00	0.491	450	0.55	80.123	0.211	233%	1.33	1.01	712.656	712.217	0.00	714.93	714.38	2.3	2.2	1.8	1.7	
	77-125	77-124	0.00	7.30	0.00	0.00	3.18	9.01	51.55	0.491	1.00	0.491	450	0.37	82.296	0.174	283%	1.09	1.26	712.217	711.912	0.04	714.38	714.14	2.2	2.2	1.7	1.8	
13	77-124	76-100	1.80	9.10	0.51	0.92	4.10	10.26	47.39	0.539	1.00	0.539	525	0.41	110.072	0.275	196%	1.27	1.44	711.876	711.425	0.10	714.14	713.78	2.3	2.4	1.7	1.8	
					0.00																								
15	76-102	76-101	8.60	8.60	0.47	4.03	4.03	8.00	55.64	0.622	1.00	0.622	525	0.67	119.512	0.351	177%	1.62	1.23	712.738	711.943	0.00	714.90	715.59	2.2	3.6	1.6	3.1	
	76-101	76-100	0.00	8.60	0.00	0.00	4.03	9.23	50.75	0.622	1.00	0.622	525	0.61	62.667	0.337	185%	1.56	0.67	711.943	711.559	0.23	715.59	713.78	3.6	2.2	3.1	1.7	
					0.00																								
12	76-100	77-128	1.90	19.60	0.49	0.94	9.06	11.71	43.54	1.096	1.00	1.096	675	1.17	105.461	0.911	120%	2.55	0.69	711.324	710.086	0.10	713.78	712.48	2.5	2.4	1.8	1.7	
11	77-128	77-127	1.10	20.70	0.49	0.54	9.60	12.40	41.96	1.119	1.00	1.119	900	0.51	98.146	1.296	86%	2.04	0.80	709.989	709.486	0.10	712.48	712.02	2.5	2.5	1.6	1.6	
8, 10	77-127	79-103	4.60	25.30	*0.44*	2.03	11.63	13.20	40.30	1.302	1.00	1.302	900	0.41	108.380	1.165	112%	1.83	0.99	709.387	708.938	0.05	712.02	711.45	2.6	2.5	1.7	1.6	
	79-103	95-S3	0.00	25.30	0.00	0.00	11.63	14.19	38.47	1.302	1.00	1.302	900	1.06	139.940	1.864	70%	2.93	0.80	708.890	707.400	0.00	711.45	709.90	2.6	2.5	1.7	1.6	
	95-S3	95-S2	0.00	25.30	0.00	0.00	11.63	14.98	37.15	1.302	1.00	1.302	900	1.11	92.780	1.907	68%	3.00	0.52	707.400	706.370	0.00	709.90	708.38	2.5	2.0	1.6	1.1	
9	95-S2	95-S1	1.50	26.80	0.43	0.64	12.27	15.50	36.34	1.238	1.00	1.238	900	1.03	57.980	1.837	67%	2.89	0.33	706.370	705.770	0.00	708.38	707.98	2.0	2.2	1.1	1.3	
	95-S1	DITCH2	0.00	26.80	0.00	0.00	12.27	15.83	35.85	1.238	1.00	1.238	1200	0.44	49.610	2.586	48%	2.29	0.36	705.770	705.550		707.98	706.62	2.2	1.1	1.0		

*Note: The Whitecourt, AB IDF data were utilized to determine the intensity.

181%

TABLE 4.9: EXISTING MINOR STORM SYSTEM 5 YEAR STORM EVALUATION WITH FUTURE LANDUSE
NEIGHBOURHOOD DESIGN REPORT
Town of Mayerthorpe

Manning's "n"	0.013
Initial Time of Concentration	8.00
A	20.7
B	-0.631

Manhole Drop 90deg	0.06
Manhole Drop 0deg	0.03

Consultant: MMM Group
Project: Town of Mayerthorpe SWM Plan
Project No.: 5311012-000
Date: Apr-14

Sub-Basin Area Draining Into MH	From MH	To MH	Area Added Ha	Total Area Ha	Runoff Coef. C	Area x Runoff C.	Total A x C	Total Time of Con. min	* Intensity I mm/hr	Q Design m^3/s	Safety Factor	Q Required m^3/s	Pipe Size Diameter mm	Slope of Pipe %	Length of Pipe m	Q Capacity m^3/s	Percent Full %	Velocity Full m/s	Time of Q in Pipe min	U/S Inv. m	D/S Inv. m	Drop m	Ground U/S m	Ground D/S m	Depth to U/S Inv. m	Depth to D/S Inv. m	Depth to U/S Obv. m	Depth to D/S Obv. m	Notes
32	123	122	3.70	3.70	0.61	2.25	2.25	8.00	73.81	0.461	1.00	0.461	375	0.45	56.327	0.118	390%	1.07	0.88	715.052	714.796	0.00	717.63	717.07	2.6	2.3	2.2	1.9	
31	122	121	4.70	8.40	0.47	2.21	4.45	8.88	69.12	0.855	1.00	0.855	375	0.56	56.998	0.131	651%	1.19	0.80	714.796	714.476	0.01	717.07	716.67	2.3	2.2	1.9	1.8	
	121	119	0.00	8.40	0.00	0.00	4.45	9.68	65.47	0.855	1.00	0.855	375	0.60	111.557	0.136	631%	1.23	1.51	714.466	713.799	0.00	716.67	717.25	2.2	3.5	1.8	3.1	
	120	119	0.00	0.00	0.00	0.00	0.00	8.00	73.81	0.000	1.00	0.000	300	1.76	29.261	0.128	0%	1.82	0.27	714.841	714.326	0.53	717.48	717.25	2.6	2.9	2.3	2.6	
	119	117	0.00	8.40	0.00	0.00	4.45	11.19	59.73	0.855	1.00	0.855	450	1.20	92.934	0.312	274%	1.96	0.79	713.799	712.683	0.05	717.25	717.09	3.5	4.4	3.0	4.0	
30	118	117	4.20	4.20	0.46	1.95	1.95	8.00	73.81	0.399	1.00	0.399	375	0.42	111.923	0.113	352%	1.02	1.82	713.573	713.107	0.48	715.67	717.09	2.1	4.0	1.7	3.6	
	117	114	0.00	12.60	0.00	0.00	6.40	11.98	57.22	1.254	1.00	1.254	450	1.50	36.820	0.349	359%	2.19	0.28	712.628	712.077	0.01	717.09	716.16	4.5	4.1	4.0	3.6	
36	116	115	4.50	4.50	0.44	1.99	1.99	8.00	73.81	0.409	1.00	0.409	375	0.40	111.953	0.111	369%	1.00	1.86	713.384	712.936	0.07	715.33	716.03	1.9	3.1	1.6	2.7	
	115	114	0.00	4.50	0.00	0.00	1.99	9.86	64.70	0.409	1.00	0.409	450	0.35	137.831	0.169	243%	1.06	2.17	712.866	712.385	0.32	716.03	716.16	3.2	3.8	2.7	3.3	
35	114	113	2.80	19.90	0.45	1.27	9.66	12.26	56.39	1.513	1.00	1.513	525	2.06	67.848	0.618	245%	2.85	0.40	712.068	710.669	0.04	716.16	713.81	4.1	3.1	3.6	2.6	
29	113	109	0.90	20.80	0.42	0.37	10.03	12.65	55.27	1.540	1.00	1.540	525	1.89	114.666	0.591	261%	2.73	0.70	710.626	708.462	0.21	713.81	711.98	3.2	3.5	2.7	3.0	
26	112	111	3.60	3.60	0.43	1.54	1.54	8.00	73.81	0.317	1.00	0.317	525	0.46	43.282	0.293	108%	1.35	0.53	708.785	708.584	0.02	710.76	711.07	2.0	2.5	1.4	2.0	
	111	109	0.00	3.60	0.00	0.00	1.54	8.53	70.87	0.317	1.00	0.317	525	0.16	106.101	0.169	187%	0.78	2.26	708.569	708.404	0.16	711.07	711.98	2.5	3.6	2.0	3.1	
27	109	108	1.10	25.50	0.56	0.61	12.19	13.35	53.42	1.809	1.00	1.809	750	0.56	111.923	0.832	217%	1.88	0.99	708.249	707.624	0.03	711.98	712.90	3.7	5.3	3.0	4.5	
28	108	107	1.40	26.90	0.49	0.68	12.87	14.35	51.06	1.826	1.00	1.826	750	0.61	139.263	0.872	209%	1.97	1.18	707.593	706.740	0.07	712.90	710.86	5.3	4.1	4.6	3.4	
25	107	106	4.60	31.50	0.66	3.03	15.90	15.52	48.58	2.146	1.00	2.146	900	0.87	68.702	1.692	127%	2.66	0.43	706.667	706.066	0.02	710.86	710.15	4.2	4.1	3.3	3.2	
	106	105	0.00	31.50	0.00	0.00	15.90	15.95	47.75	2.146	1.00	2.146	900	0.59	57.516	1.388	155%	2.18	0.44	706.042	705.703	0.09	710.15	709.64	4.1	3.9	3.2	3.0	
41	105	104	1.90	33.40	0.52	0.99	16.89	16.39	46.94	2.202	1.00	2.202	900	0.99	159.868	1.801	122%	2.83	0.94	705.612	704.030	0.32	709.64	708.48	4.0	4.5	3.1	3.6	
40	104	103	1.50	34.90	0.44	0.66	17.55	17.33	45.32	2.210	1.00	2.210	700	8.92	63.216	2.765	80%	7.19	0.15	703.707	698.071	-0.06	708.48	702.66	4.8	4.6	4.1	3.9	
	103	102	0.00	34.90	0.00	0.00	17.55	17.48	45.08	2.210	1.00	2.210	700	8.62	68.489	2.720	81%	7.07	0.16	698.135	692.228	-0.01	702.66	694.39	4.5	2.2	3.8	1.5	
	102	CREEK	0.00	34.90	0.00	0.00	17.55	17.64	44.82	2.210	1.00	2.210	700	6.62	37.338	2.383	93%	6.19	0.10	692.234	689.762		694.39		2.2		1.5		
33	79-122	CBMH1	10.70	10.70	0.53	5.63	5.63	8.00	73.81	1.154	1.00	1.154	525	0.40	61.300	0.271	426%	1.25	0.82	714.875	714.632	0.03	716.800	716.080	1.9	1.4	1.4	0.9	
	CBMH1	79-120	0.00	10.70	0.00	0.00	5.63	8.82	69.42	1.154	1.00	1.154	525	0.42	97.000	0.278	415%	1.28	1.26	714.600	714.195	0.00	716.00	716.51	1.4	2.3	0.9	1.8	
	79-120	CBMH2	0.00	10.70	0.00	0.00	5.63	10.08	63.81	1.154	1.00	1.154	525	0.61	100.500	0.337	342%	1.56	1.08	714.195	713.578	0.25	716.51	716.05	2.3	2.5	1.8	1.9	
5	CBMH3	CBMH2	4.20	4.20	0.64	2.67	2.67	8.00	73.81	0.548	1.00	0.548	450	0.88	85.600	0.268	205%	1.68	0.85	714.517	713.761	0.43	716.72	716.05	2.2	2.3	1.7	1.8	
6	CBMH2	79-121	1.10	16.00	0.72	0.79	9.10	11.15	59.85	1.512	1.00	1.512	600	0.45	39.480	0.412	367%	1.46	0.45	713.328	713.150	0.00	716.05	715.99	2.7	2.8	2.1	2.2	
	79-121	DITCH 1	0	16.00	0.00	0.00	9.09567	11.60	58.38	1.512	1.00	1.512	600	0.67	9.00	0.501	302%	1.77	0.08	713.150	713.090		715.985		2.8		2.2		
14	77-126	77-125	7.30	7.30	0.44	3.18	3.18	8.00	73.81	0.652	1.00	0.652	450	0.55	80.123	0.211	309%	1.33	1.01	712.656	712.217	0.00	714.93	714.38	2.3	2.2	1.8	1.7	
	77-125	77-124	0.00	7.30	0.00	0.00	3.18	9.01	68.50	0.652	1.00	0.652	450	0.37	82.296	0.174	376%	1.09	1.26	712.217	711.912	0.04	714.38	714.14	2.2	2.2	1.7	1.8	
13	77-124	76-100	1.80	9.10	0.51	0.92	4.10	10.26	63.07	0.718	1.00	0.718	525	0.41	110.072	0.275	261%	1.27	1.44	711.876	711.425	0.10	714.14	713.78	2.3	2.4	1.7	1.8	
15	76-102	76-101	8.60	8.60	0.47	4.03	4.03	8.00	73.81	0.826	1.00	0.826	525	0.67	119.512	0.351	235%	1.62	1.23	712.738	711.943	0.00	714.90	715.59	2.2	3.6	1.6	3.1	
	76-101	76-100	0.00	8.60	0.00	0.00	4.03	9.23	67.45	0.826	1.00	0.826	525	0.61	62.667	0.337	245%	1.56	0.67	711.943	711.559	0.23	715.59	713.78	3.6	2.2	3.1	1.7	
12	76-100	77-128	1.90	19.60	0.49	0.94	9.06	11.71	58.05	1.461	1.00	1.461	675	1.17	105.461	0.911	160%	2.55	0.69	711.324	710.086	0.10	713.78	712.48	2.5	2.4	1.8	1.7	
11	77-128	77-127	1.10	20.70	0.49	0.54	9.60	12.40	55.99	1.492	1.00	1.492	900	0.51	98.146	1.296	115%	2.04	0.80	709.989	709.486	0.10	712.48	712.02	2.5	2.5	1.6	1.6	
8, 10	77-127	79-103	4.60	25.30	*0.44*	2.03	11.63	13.20	53.82	1.738	1.00	1.738	900	0.41	108.380	1.165	149%	1.83	0.99	709.387	708.938	0.05	712.02	711.45	2.6	2.5	1.7	1.6	
	79-103	95-S3	0.00	25.30	0.00	0.00	11.63	14.19	51.42	1.738	1.00	1.738	900	1.06	139.940	1.864	93%	2.93	0.80	708.890	707.400	0.00	711.45	709.90	2.6	2.5	1.7	1.6	
	95-S3	95-S2	0.00	25.30	0.00	0.00	11.63	14.98	49.68	1.738	1.00	1.738	900	1.11	92.780	1.907	91%	3.00	0.52	707.400	706.370	0.00	709.90	708.38	2.5	2.0	1.6	1.1	
9	95-S2	95-S1	1.50	26.80	0.43	0.64	12.27	15.50	48.63	1.657	1.00	1.657	900	1.03	57.980	1.837	90%	2.89	0.33	706.370	705.770	0.00	708.38	707.98	2.0	2.2	1.1	1.3	
	95-S1	DITCH2	0.00	26.80	0.00	0.00	12.27	15.83	47.98	1.657	1.00	1.657	1200	0.44	49.610	2.586	64%	2.29	0.36	705.770	705.550		707.98	706.62	2.2	1.1	1.0		
																	241%												

*Note: The Whitecourt, AB IDF data were utilized to determine the intensity.

5.0 APPROVALS AND AGREEMENTS

Identified approvals/agreements that will be required for the storm system are as follows:

- Alberta Environment Letter of Authorization for the Storm Water Management Facilities.
- Alberta Environment approval under the Water Act and Environmental Protection and Enhancement Act.
- Alberta Sustainable Resources License of Occupation.
- Department of Fisheries and Oceans Act.
- Transport Canada Navigable Waters Protection Act.
- Town of Mayerthorpe Approval of the detail design.
- A Servicing Agreement between the Developer and the Town will be required.
- Lot Grading Plan Approval.

6.0 SERVICING PLAN

As part of the Master Drainage Plan, a pre-development flow rate was determined for the Town to provide guidance for development within the Study area as well as to evaluate the drainage issues within the Town. As development proceeds enhancements and upgrades are required to the major system because no controls were in place to address the increase in runoff generated from the Study area. A servicing plan was created for the major drainage system in which upgrades are required.

Stormwater Management Facilities (SWMFs), upsizing of culverts and ditches and re-alignment of certain drainage paths will have to be considered. As the Town addresses the proposed upgrades for the major system, runoff into the Little Paddle River and water quality will be improved. At the time preparing this report no Biophysical assessment has been conducted, other than preliminary desk top study. Please refer to **Table 6.1** below that lists a number of issues within each SWMF basin, as well as, proposed upgrade options and measures.

Some of the stormwater facility drainage basins straddles the Town and County jurisdictional boundaries. Various scenarios exist for addressing area boundaries and have suggested scenarios for future upgrades. Depending on the scenarios selected will determine the type of upgrades required.

Three options were considered for Stormwater Facility Basin 1. (For details on the proposed upgrades see **Table 6.1**).

- Scenario 1.0 considers maintaining the existing drainage path with an increase in size of SWMF #2.
- Scenario 1.1 considers modifying a drainage path and diverting flows via a ditch on the south side of 47th Avenue to the proposed SWMF #1.
- Scenario 1.2 considers modifying the drainage path as noted in Scenario 1.1 and diverting flows from Phase 2 of Mills Acres Subdivision along the PUL along CN Rail right-of-way and re-directing the flows to SWMF #1.
- Scenario 2.0 considers maintaining the existing drainage path with a SWMF #2 on private property with upgrading existing culverts under RR83.
- Scenario 3.0 relates to SWMF basin 3 should development occur within this basin.
- Scenario 4.0 relates to SWMF basin 4 should development occur within this basin.
- Scenario 5.0 relates to SWMF basin 5 should development occur within this basin.
- Scenario 6.0/7.0 relates to basin 6&7 with a combined SWMF connecting both basins with one stormwater management facility.
- Scenario 8.0 relates to basin 8 should development occur.
- Scenario 9.0 relates to basin 9 and the Fallen Four Memorial Park.

- Scenario 10.0 relates to basin 10 and considers maintaining existing drainage paths and modifying drainage paths by diverting flows from basins 1, 44 & 45.

TABLE 6.1 – MAJOR SYSTEM DRAINAGE SERVICING					
Scenario	SWMF Basin #	Issues	Upgrades	Upgrade Measures	Possible Results of Upgrade
1.0	1	450 mm diameter culvert under 47 Avenue undersized	Upsize the 450 mm culvert to 4-450 mm culverts to accommodate the addition runoff from the upstream basins (sub-basins 4A, 5, 6, 33).	1) Erosion protection upstream and downstream of each culvert accommodating runoff. 2) Lots in the Mills Acres subdivision are to be graded above the freeboard elevation. 3) Construct a diversion ditch along the north side of 47 Avenue to accommodate the additional flows and prevent upstream basin runoff from entering subdivision.	Stormwater Management Facility (SWMF) #1 decreases in size but SWMF #2 increases to accommodate the additional flow.
1.1		525 mm diameter culvert under Range Road 83 is undersized	Remove/plug 450 mm culvert and divert upstream basin flows along a ditch on the south side of 47 Avenue into SWMF #1 and upsize the 525 mm culvert under Range Road 83 to 2-750 mm culverts.	Erosion protection on proposed ditch and upstream and downstream of each culvert accommodating runoff.	Stormwater Management Facility #1 volume stays as proposed. Improved water quality as well as improved flow through culvert with no overtopping. SWMF #2 decreases in size.
1.2		Drainage of the Town's land into a private land owner's property which is outside Town of Mayerthorpe boundary limits.	Divert Phase 2 of Mills Acres to SWMF #1	Phase 2 of Mills Acres needs to be re-graded to drain south or a diversion ditch needs to be constructed to divert the flows in SWMF #1. In addition, installation of a culvert under 47 Avenue will need to be completed.	This will increase the size of SWMF #1 and decrease the size of SWMF #2.
2.0	2	525 mm diameter culvert under Range Road 83 is undersized	Construct SWMF# 2 to control the discharge up to the maximum allowable discharge rate of 5.1 L/s/ha. Upsize the 525 mm culvert to 2-525 mm culverts to accommodate 1:100 Year runoff	Erosion protection upstream and downstream of culvert	Improved water quality as well as improved flow through culvert with no overtopping.
3.0	3	Runoff discharging directly into Little Paddle River and not controlled	Construct SWMF#3 to control the discharge up to the maximum allowable rate.	Erosion protection at the outfall	Water quality improved and runoff controlled to the maximum allowable rate.
4.0	4	Runoff discharging directly into Little Paddle River and not controlled	Construct SWMF#4 to control the discharge up to the maximum allowable rate.	Erosion protection at the outfall	Water quality improved and runoff controlled to the maximum allowable rate.
5.0	5	Runoff from developed land discharging directly into Little Paddle River without treatment or control to pre-development rate.	Construct a ditch on the south side of 53rd Avenue to divert runoff into SWMF #5.	Erosion protection at the outfall	Water quality improved and runoff controlled to the maximum allowable rate.
6.0	6	Runoff from developed land discharging directly into Little Paddle River without treatment or control to pre-development rate.	Construct SWMF#6 to control the discharge up to the maximum allowable rate. Divert flows in the minor system into SWMF#6 instead of directly at Little Paddle River.	Erosion protection at the outfall	Water quality improved and runoff controlled to the maximum allowable rate.
6.1		The two 450 mm culverts along the railway are damaged	Replace culverts to allow for full capacity flow	Erosion protection upstream and downstream of each culvert.	Increased flow through the culverts and less back-ups
7.0	7	Runoff discharging directly into Little Paddle River and not controlled	Construct SWMF#7 to control the discharge up to the maximum allowable rate.	Erosion protection at the outfall	Water quality improved and runoff controlled to the maximum allowable rate.
8.0	8	Runoff discharging directly into Little Paddle River and not controlled	Construct SWMF#8 to control the discharge up to the maximum allowable rate. Install culvert to divert flows under Highway 22 from the east side of basin to the west side into the proposed stormwater management facility.	Erosion protection at the outfall	Water quality improved and runoff controlled to the maximum allowable rate.
9.0	9	Runoff discharging directly into Little Paddle River and not controlled	Construct SWMF#9 to control the discharge up to the maximum allowable rate.	Erosion protection at the outfall	Water quality improved and runoff controlled to the maximum allowable rate.
10.0	10	Runoff discharging directly into Little Paddle River and not controlled	Construct SWMF#10 to control the discharge up to the maximum allowable rate and allow upstream basins to pass through.	Erosion protection at the outfall	Water quality improved and runoff controlled to the maximum allowable rate.
10.1			Construct SWMF#10 to control the discharge up to the maximum allowable rate and divert upstream basins (sub-basins 1, 44, & 45) by constructing a ditch along the service road with a culvert installed across Range Road 83 just south of service road.	1) Erosion protection at the outfall	Water quality improved and runoff controlled to the maximum allowable rate.
10.2				2) Erosion Protection upstream and downstream of each culvert accommodating runoff.	Reduced impact of upstream basins on development downstream by diverting runoff.

The costs associated with these upgrades were evaluated at a conceptual level. The approximate cost of construction of the SWMFs is shown below in **Table 6.2**. A total cost of construction of the SWMFs is approximately $8.75 mil (assuming $40 construction cost per m^3 storage volume). Other costs such as ditch and culvert construction have not been included in cost estimate as they vary depending on the depth of ditch and size of culvert replacement.

TABLE 6.2 – SWMF CONSTRUCTION COST ESTIMATE

SWMF	Live Storage Volume (m^3)	Estmated Cost ($) - Class 'D'
1	75,800	$3,032,000
2	38,100	$1,524,000
3	8,000	$320,000
4	12,200	$488,000
5	17,300	$692,000
6	32,600	$1,304,000
7	10,400	$416,000
8	4,400	$176,000
9	9,900	$396,000
10	10,100	$404,000
	TOTAL	$8,752,000

It should also be noted that property requirements for the stormwater management facilities are to be acquired where required. Further to the live storage volumes are preliminary estimated values based on the model analysis. Once the model has been calibrated the live storage volumes will be adjusted accordingly.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the Study the following conclusions were drawn:

1. Precipitation Data Analysis indicates that the precipitation data obtained from Environment Canada Atmospheric Environment Services (EC-AES) Whitecourt gauge give more conservative values (e.g., rainfall depths and intensities) than those from EC-AES Edson gauge, and were used for the Master Drainage Plan study.
2. A pre-development rate of 5.1 L/s/ha was established and should be utilized for the Town to control post-development runoff up to a maximum allowable rate which will prevent flooding downstream.
3. A total area of 899.9 ha drains towards site. The watershed area was divided into 45 sub-basins to account for flows draining into the existing storm sewer system, as well as, areas draining towards the River, major culverts and proposed ponds.
4. As an important step in producing a reliable and representative model of the Town stormwater sewer system, a hydrological model calibration was successfully performed based on the observed data recorded for the study area. The calibration results in the adjustment of the runoff coefficients and imperviousness values applied for the existing land use areas.
5. There may be possible issues with the existing overall minor system that need to be corrected by maintaining and improving the minor system. The minor system appears to be undersized as it surcharges during the 1:2 Year storm event where it should be able to accommodate the 1:5 Year storm event without surcharging. Flow monitoring at specific points in the system to be considered to understand and analyze the minor system before any upgrades are considered.
6. In addition, some improvements to the existing major system conveyance system are recommended. Four (4) culverts were determined to be undersized and others were noted to be damaged during the site visit.
7. The current drainage patterns have shown erosion is being experienced at many culvert locations.

Based on the Study conducted and the conclusions drawn, the following is recommended:

1. The rainfall data used for the MDP study was based on the EC-AES’s Whitecourt gauge where the published data is available from 1982 to 2006. We believe it is important to understand the overall trend of the changes for the precipitation data recorded after 2006, which may also reflect the factor of climate changes. As such, we recommend that once the most recent precipitation data from this gauge is available, the rainfall data (e.g., 2- to 100- year design storm rainfall depths, maximum intensities, etc.) should also be updated and re-applied by the established minor and major system models to confirm their reliability.
2. It is recommended that a preliminary analysis of possible options for improvement of the minor system be conducted as the existing minor system surcharges during the 1:2 Year storm event. Lac Ste. Anne

County Standards indicated that minor system should be able to convey the 1:5 Year storm event without surcharging. Additional modeling of the rest of the minor system is recommended as the rational method cannot determine if the system has surcharged above the existing road or ground elevations. The rational method is a conservative approach and therefore modeling of the minor system is recommended along with flow monitoring of the minor system. Recorded data was applied to calibrate and verify the results of the minor system.

3. Ten (10) SWMFs are proposed for the entire Study area to control runoff to the maximum allowable rate of 5.1 L/s/ha. The SWMF volumes require a storage volume ranging from 3,100 m^3 to 53,500 m^3. With the implementation of SWMFs, the water quality into Little Paddle River will be enhanced, lessening the total impact and improving the water quality on the Athabasca Watershed. The proposed SWMFs will be designed to achieve 85 % removal of particles sized 75 µm or greater as required by Alberta Environment.
4. The basins will need be diverted east along the service road or along Highway 43 ditch across Range Road 83 and ultimately into Little Paddle River. This will lessen the possibility of flooding in the southeast area from these upstream basins, as well as, lower the impact on the water quality of these upstream basins.
5. Intersection at 51 Street and 49 Avenue needs to be graded to slope north or a CB needs to be added.
6. Subdivision applications request storm drainage designs be submitted and approved by the Town.
7. Lot Grading Drawings to be submitted as part of the subdivision application.
8. BMPs should be implemented as part of the Master Drainage Plan such as:
   - Street sweeping, catch basin cleaning and anti-litter regulations should be a component of specific drainage plans.
   - Implement sediment and erosion controls during construction to limit the amount of sediment into receiving waters. Temporary perimeter drainage swales directed to temporary ponds, silt fences, check dams, infiltration catch basins, timed staging of excavation are some good BMPs during construction.
   - Reducing the amount of impervious surfaces by utilizing permeable pavement, porous turf, and paving blocks
   - Implementing green infrastructure such as green roofs, vegetated road dividers, bioswales, preserving existing vegetation, and rain water harvesting.
9. The Town adopts the Storm Drainage Report.
10. Cost Sharing Agreement to be developed for the construction of the stormwater management facilities.
11. Maintenance of drainage infrastructure is required and erosion protection measures are required to protect the drainage and surrounding infrastructure including improving water quality within the watershed.

12. That AEW recommendations for hydraulic analyses using Whitecourt IDF data be implemented; or if IDF data closer to Mayerthorpe becomes available in 2012, this should be used for the hydraulic analysis to obtain a more accurate analysis for the model.
13. The Town allocate funding to conduct flow monitoring in order to calibrate the model.
14. The Town allocate funding to conduct the hydraulic analysis as recommended above in point 11.
15. The Town incorporates the stormwater upgrades into their 25 year Capital Plan.

7.1 Biophysical Conclusions and Recommendations

Based on the preliminary biophysical assessment the following conclusions were drawn:

1. The final Study area should be established once the SWMP in reviewed and with consultation with the Town.
2. Preliminary analysis of surficial geology indicated a mix Chernozens and Luvisols in the upland area outside of the Little Paddle River Valley. In the river valley area the soils are mixed undifferentiated mineral soils dominated by low relief floodplains and steeper valley sides.
3. Vegetation in the Study area is dominated by a mix of conifer mixedwood forest, and the deciduous-dominated aspen forests.

Based on the assessment conducted, the following is recommended:

1. A detailed Biophysical Assessment is to be conducted upon the Town securing funding for this section of the work.
2. The establishment of a local Stewardship that would facilitate long term monitoring for the Little Paddle River.

8.0 REFERENCES

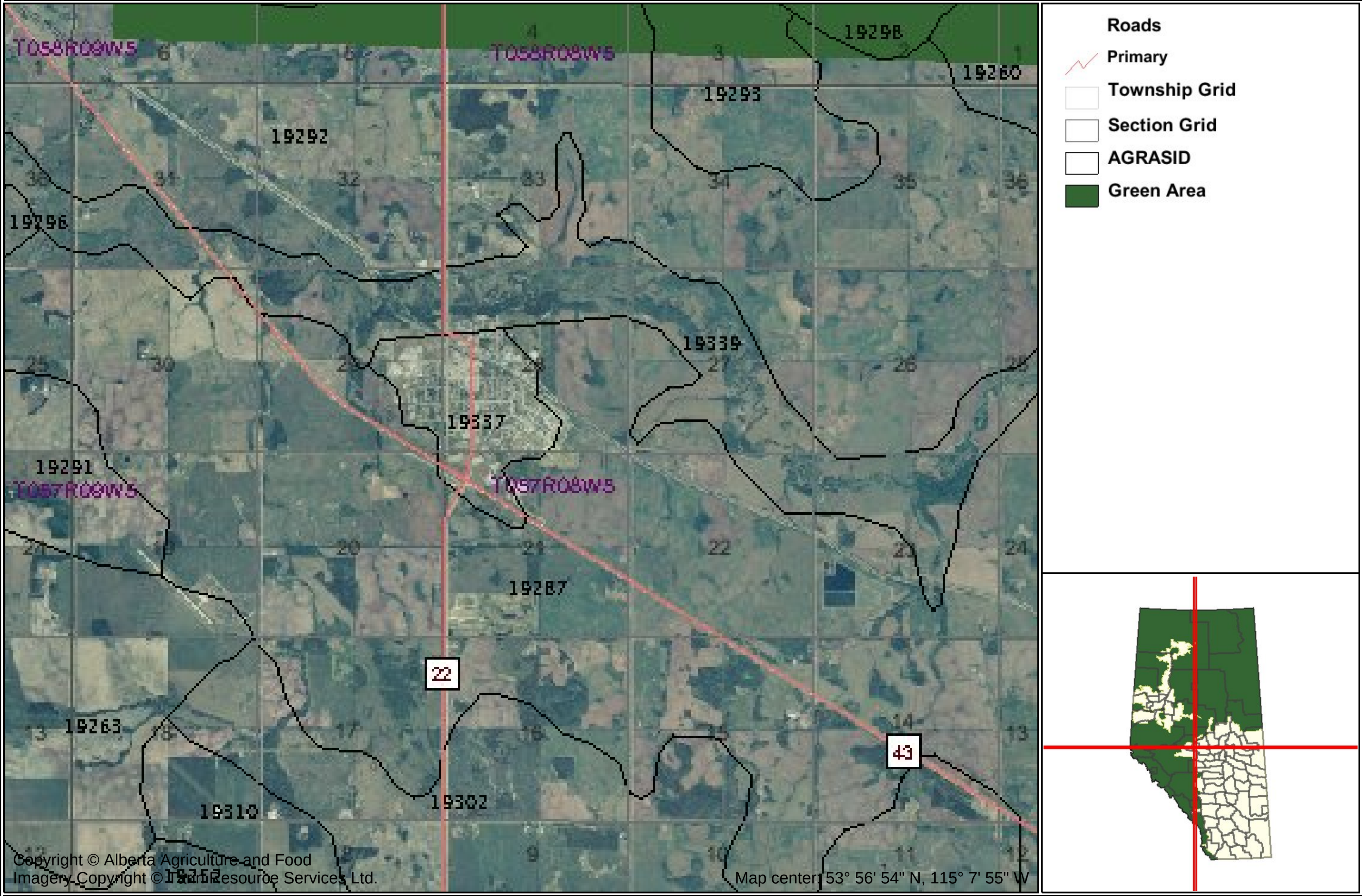
Alberta Soil Information Centre. 2001. AGRASID 3.0: Agricultural Region of Alberta Soil Inventory Database (Version 3.0). Edited by J.A. Brierley, T.C. Martin, and D.J. Spiess. Agriculture and Agri-Food Canada, Research Branch; Alberta Agriculture, Food and Rural Development, Conservation and Development Branch. Accessed May 17, 2011.

Alberta Sustainable Resource Development (ASRD). 2005. 2005 Natural Regions and Subregions of Alberta [map]. Alberta Environment. [online resource] http://www.tpr.alberta.ca/parks/heritageinfocentre/docs/nsr2005_final_letter.pdf

Fisheries and Wildlife Information System (FWMIS). 2011. Government of Alberta [online resource]. http://xnet.env.gov.ab.ca/imf/imf.jsp?site=fw_mis_pub Accessed May 16, 2011.

APPENDIX A – AGRASID Search Response

Mayerthorpe Soils



Information presented here is from AGRASID, the Agricultural Region of Alberta Soil Inventory Database. It contains soil and landscape information with defining spatial polygons for the agricultural region of Alberta.

Scale 1:45,158

Alberta Agriculture and Food

Printed: Jun 27, 2011 3:10:29 PM

Identify Results

Metadata

Soil Polygon Information	
POLYNUMB	19339
HECTARES	766
LSRSRATING	4T(10)
MUNAME	ZUN1/SC1l
Soil Components	
NEW_SYMBOL	ZUN
PERCENT	100
SERIES	MISC.UNDIFF.MINERAL
DRAINAGE	W
MAS_PM	U0
SG	O.R
COMPONENT	1

Coordinate Position

Geographic: 53° 57' 33" N, 115° 8' 47" W

Click on the button to the right to get textual and visual landscape information for the currently identified soil polygon.

More Info

Click on the button to the right to print Identify Results.

Print Results

Identify Results

Metadata

Soil Polygon Information			
POLYNUMB	19292		
HECTARES	3271		
LSRSRATING	4HT(8) - 5W(2)		
MUNAME	MCO2/H1I		
Soil Components			
NEW_SYMBOL	MCO	MLA	ZGW
PERCENT	60	20	20
SERIES	MICO	MACOLA	MISC.GLEYSOL
DRAINAGE	MW	MW	P
MAS_PM	F2	F2	U0
SG	O.DGC	D.GL	O.HG
COMPONENT	1	2	3

Coordinate Position

Geographic: 53° 57' 40" N, 115° 5' 51" W

Click on the button to the right to get textual and visual landscape information for the currently identified soil polygon.

More Info

Click on the button to the right to print Identify Results.

Print Results

Identify Results

Metadata

Soil Polygon Information	
POLYNUMB	19337
HECTARES	162
LSRSRATING	DL
MUNAME	ZUN1/DL
Soil Components	
NEW_SYMBOL	ZUN
PERCENT	0
SERIES	MISC.UNDIFF.MINERAL
DRAINAGE	W
MAS_PM	U0
SG	O.R
COMPONENT	null

Coordinate Position

Geographic: 53° 57' 1" N, 115° 8' 17" W

Click on the button to the right to get textual and visual landscape information for the currently identified soil polygon.

More Info

Click on the button to the right to print Identify Results.

Print Results

Identify Results

Metadata

Soil Polygon Information			
POLYNUMB	19287		
HECTARES	4190		
LSRSRATING	4HT(8) - 5W(2)		
MUNAME	MCML2/H1l		
Soil Components			
NEW_SYMBOL	MLA	MCO	ZGW
PERCENT	40	40	20
SERIES	MACOLA	MICO	MISC.GLEYSOL
DRAINAGE	MW	MW	P
MAS_PM	F2	F2	U0
SG	D.GL	O.DGC	O.HG
COMPONENT	1	2	3

Coordinate Position

Geographic: 53° 57' 13" N, 115° 7' 8" W

Click on the button to the right to get textual and visual landscape information for the currently identified soil polygon.

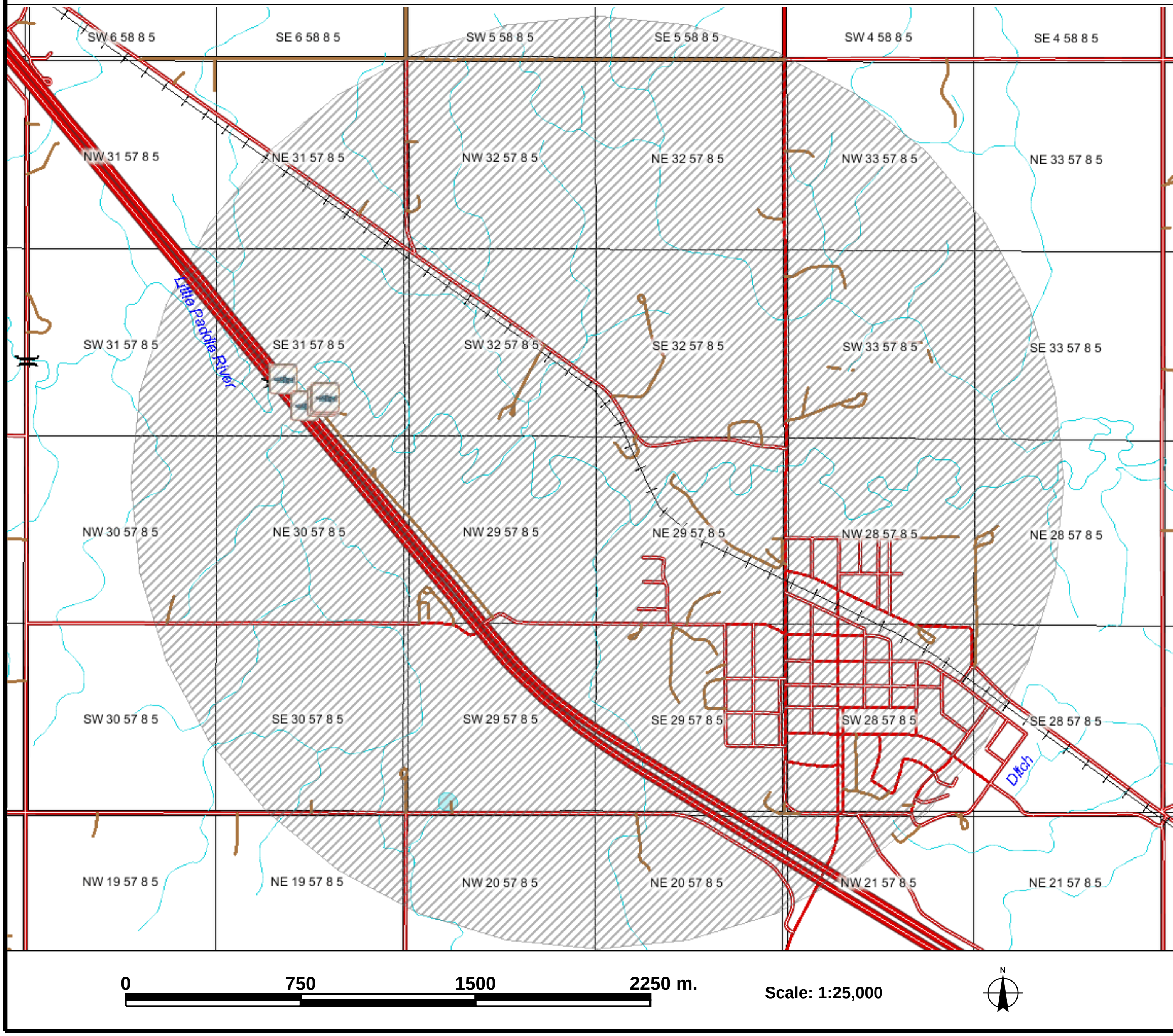
More Info

Click on the button to the right to print Identify Results.

Print Results

APPENDIX B – FWMIS Search Results

Created Tue May 17 12:01:37 MDT 2011



Legend

- Tertiary Watershed Units
- PFRA Watersheds
- Stocked Lake - 10 Year Summary
- Fish Inventory
- Bridges
  - Bridges
- Railways
- Cutlines & Trails
  - Clearing Trail
  - ATV Trail
  - ATV Indefinite Trail
  - Cutline Trail
- Other Roads
  - Unclassified Road
  - Unimproved Road
  - Winter Road
  - Truck Trail
  - Ferry Route
  - Ford Winter Crossing
  - Interchange Ramp
- Gravel Roads
  - 1 Lane Road
  - 2 Lane Road
- Paved Roads
  - Undivided 1L Road
  - Undivided 2L Road
  - Undivided 4L Road
  - Divided Road
- Hydrography Carto Anno Points
- Hydrography Points
- FWMIS Waterbody Arcs
  - Aquaduct

Notes: Little Paddle River at Mayerthorpe

Species Summary Report

Species present within the current buffer extent:

Wildlife Inventory	
No records found.	
Fish Inventory	
BROOK STICKLEBACK	
FATHEAD MINNOW	
LAKE CHUB	
LONGNOSE SUCKER	
WHITE SUCKER	
Buffer extent	
Centroid (X,Y):	489863, 5976764
Central Meridian:	-115.0
Centroid (Qtr Sec Twp Rng Mer):	NE 29 57 8 5
Buffer radius:	2 kilometers

APPENDIX C – Culvert Analysis Submitted to AENV

Lorraine MacNeil

From: Kessie Govender
Sent: June-02-11 6:00 PM
To: Mayerthorpe CAO [cao@mayerthorpe.ca] (cao@mayerthorpe.ca)
Cc: Nedal Barbar
Subject: Mayerthorpe Culvert Analysis near the Mills Acres Subdivision Under CNR and Township Road 574A
Attachments: DOC060211.pdf

Hi Karen,

As part of the storm water management report we have evaluated the capacity of the culverts under the CN Railway and TWP Rd 547A.

The assessment of the existing culverts under Township Road 574A and CN Railroad near the proposed Mills Acres Subdivision has been based on Lidar information and existing data obtained during the study.

Both culverts (1300 mm and 900 mm) under the CN Railway and the culverts under Township Road 574A currently convey the runoff from the Mills Acres Subdivision area and upstream of the Mills Acres Sub division. Please refer to the attachment. An assessment was completed utilizing the 1:100 Year storm event for three conditions described below.

Condition 1:
We evaluated the capacity of the existing system.
Results: Our evaluation indicates that the 450 mm culvert along 47 Avenue as shown on attachment was undersized causing runoff to back-up upstream, therefore runoff is either constricted or restricted the flow at this point. The downstream culverts north of 47 Ave **have capacity for condition 1**. Please refer to the table below and refer to the results shaded in yellow.

Condition 2:
We evaluated the capacity of the existing system (with current land use with the existing developed land) and allowed adequate upsizing of the storm culvert under 47 Ave.
Results: Assuming the 450mm culvert is upsized in the future and allowing unrestricted flow under the 47 Ave (that is no backup of stormwater flows at the proposed 47 Ave culvert). Please refer to the table below and refer to the results shaded in blue. The downstream culverts north of 47 Ave **have capacity for condition 2**. Under condition 2, the velocities were very high at the 900 mm culvert under Township Road 574A. During our site visit on May 2011, a significant amount of erosion occurred downstream of this culvert eroding the ditch or watercourse at a depth of 1.2m.

Condition 3:
We evaluated the capacity of the existing system (with the future land use with the future developments, including for the flows from the Mills Acres sub division)and allowed adequate upsizing of the storm culvert under 47 Ave. Future development will increase runoff into these culverts at an average of 18% based on our model results. The downstream culverts north of 47 **Ave have capacity for condition 3**. Please refer to the table below and refer to the results shaded in green. Culverts north of 47 Ave were less than 60% full. During our site visit on May 2011, a significant amount of erosion occurred downstream of this culvert eroding the ditch or watercourse at a depth of 1.2m. Note that the velocity in the 900 mm culvert under Township road 574A has increased.

Existing Culvert	Output Parameter	Existing Condition with Back-up upstream of 47 Ave 450 mm culvert	Existing Condition with 47 Ave 450 mm culvert Upsized	Future Condition with 47 Ave 450 mm culvert Upsized
1300 mm under CNR approx. 230 m northwest of Range Road 83	**Slope (%)**		**0.7**	
	Max. Flow (m^3/s)	0.26	0.82	1.02
	Velocity (m/s)	1.1	1.6	1.8
	Depth (m)	0.2	0.4	0.4
	***Clearance (m)**	1.1	0.9	0.9
900 mm under Township Road 574A approx. 230 m northwest of Range Road 83	**Slope (%)**		**5.1**	
	Max. Flow (m^3/s)	0.26	0.82	1.02
	Velocity (m/s)	2.3	3.2	3.4
	Depth (m)	0.2	0.4	0.4
	***Clearance (m)**	0.7	0.5	0.5
900 mm under CNR approx. 500 m northwest of Range Road 83	**Slope (%)**		**1.84**	
	Max. Flow (m^3/s)	0.68	0.68	0.76
	Velocity (m/s)	2.1	2.1	2.2
	Depth (m)	0.5	0.5	0.5
	***Clearance (m)**	0.4	0.4	0.4
750 mm under Township Road 574 approx. 500 m northwest of Range Road 83	**Slope (%)**		**1.1**	
	Max. Flow (m^3/s)	0.68	0.68	0.76
	Velocity (m/s)	2	2	2.1
	Depth (m)	0.3	0.3	0.3
	***Clearance (m)**	0.45	0.45	0.45

**Note: Clearance is the distance from culvert obvert to water level.*

We have also calculated the pre development flow rate to be 5.1 L/s/ha which based on the 1:100 year maximum instantaneous discharge of 164m^3/s. We suggest using a pre development flow rate between 4.5 to 5.1 L/s/ha for any proposed developments.

If you have any questions please call at your earliest convenience.

Regards,

Kessie Govender, P.Eng
Senior Project Manager
Infrastructure

MMM Group Limited
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Edmonton, Alberta, Canada T5H 3H5
t: 780.423.4123 x 4716 | f: 780.426.0659 l c: 780.860.8568
GovenderK@mmm.ca | www.mmm.ca

HWY 22
HWY 43
47 Ave
Mills Acres
CN Rail
TWP RD 574A
900mm ϕ
450mm ϕ
750mm ϕ
Drainage Basin Boundaries
1300mm ϕ
900mm ϕ
N

Table C.1: Assessment of All Culverts Across Township Road 574A and the CN Railway

Modelled by XPSWMM with Whitecourt IDF data and Calibrated/Adjusted Imperviousness

Updated Date: April 2014

Existing Culvert	Output Parameter	Existing Condition with Back-up upstream of 47 Ave 450 mm culvert	Existing Condition with 47 Ave 450 mm culvert Upsized	Future Condition with 47 Ave 450 mm culvert Upsized	% Culvert Full - For Future Condition
1300 mm under CNR approx. 230 m northwest of Range Road 83	Slope (%)	**0.7**			
	Max. Flow (m^3/s)	0.3	1.00	1.25	
	Velocity (m/s)	1.2	1.8	1.9	
	Depth (m)	0.2	0.4	0.5	
	Clearance (m)	1.1	0.9	0.8	38%
900 mm under Township Road 574A approx. 230 m northwest of Range Road 83	Slope (%)	**5.1**			
	Max. Flow (m^3/s)	0.3	1.00	1.25	
	Velocity (m/s)	2.4	3.4	3.6	
	Depth (m)	0.2	0.4	0.5	
	Clearance (m)	0.7	0.5	0.4	56%
900 mm under CNR approx. 500 m northwest of Range Road 83	Slope (%)	**1.84**			
	Max. Flow (m^3/s)	0.85	0.85	0.97	
	Velocity (m/s)	2.2	2.2	2.2	
	Depth (m)	0.5	0.5	0.7	
	Clearance (m)	0.4	0.4	0.2	78%
750 mm under Township Road 574 Aapprox. 500 m northwest of Range Road 83	Slope (%)	**1.1**			
	Max. Flow (m^3/s)	0.85	0.85	0.97	
	Velocity (m/s)	2.1	2.1	2.2	
	Depth (m)	0.3	0.3	0.3	
	Clearance (m)	0.44	0.44	0.43	40%
750 mm under CNR approx 200 m southeast of 45 Street	Max. Flow (m^3/s)	N/A	N/A	0.25	
	Velocity (m/s)	N/A	N/A	1.3	
	Depth (m)	N/A	N/A	0.43	
	Clearance (m)	N/A	N/A	0.32	57%
525 mm under Township Road 574 approx 250 m southeast of 45 Street	Max. Flow (m^3/s)	N/A	N/A	0.25	
	Velocity (m/s)	N/A	N/A	1.51	
	Depth (m)	N/A	N/A	0.33	
	Clearance (m)	N/A	N/A	0.19	63%

Note: Clearance is the distance from pipe obvert to water level in culvert.

APPENDIX D – Stakeholder Survey

TOWN OF MAYERTHORPE - STORMWATER MANAGEMENT PLAN STAKEHOLDER CONSULTATION

Question #	Question	Respondent #1	Respondent #2	Respondent #3	Respondent #4	Respondent #5	Respondent #6	Respondent #7	TOTALS
1	Please circle your property on the attached map or provide a legal land description	4902-50 St 373CL-5-1-3 373CL-5-14-18 4201-52 St SW5/-57-8-5-/1024305-1-1	SE 29 57 8 W5 8416 TWP RD 574A	Plan: 832 2769 Block: A (Crossroads at HWY 22 & 43 Intersection)	PT. NW 54 57 8 W5 4461-42A Ave	Mayerthorpe Sr. Jr. High School	Answered on behalf of Chamber	4407-42A Ave	
2, 3, 4	Have you had any problems in the past with stormwater drainage? If yes, when did the problems occur? Please describe the issue.	No	15 years ago - Spring 10 years ago - Spring 5 years ago - Spring 2 years ago - Spring 1 years ago - Spring Less than 1 year ago - Spring "The town lets the drain freeze and then won't thaw it out until my property/road is flooded"	Not Sure	20 years ago - Spring, Summer "There was no problem until the Town dug a huge drainage ditch and pumped the water through it which ran into my property, causing a ditch. The ditch remains but the pump has been removed."	20 years ago "No drainage"	20 years ago - Spring, Summer, Fall, Winter "Main Street on West side always has water accumulate due to no storm sewer outlets. Water has to go uphill to reach storm sewer outlets in many parts of the town. Visual inspection will confirm this."	Less than 1 year ago "New PUL Lodge - water accumulation to the west of site"	No: 1 Not Sure: 1 Yes: 5
5	Do you have any stormwater drainage information? If yes, please specify.	Not Sure	Yes (Does not Specify)	Not Sure (Draft ASP & Topography showing low points)	Yes, sewer proposal.	No	Not Sure	No	No: 2 Not Sure: 3 Yes: 2
6	Are there any watercourses or protected wetlands on or bordering your property?	No	Yes, see attached Map.	Not Sure	Yes, Low Land	Yes, at Mayerthorpe High (see attached Map)	Not Sure	Not Sure	No: 1 Not Sure: 3 Yes: 3
7	If 'yes' to Question 6, have there been any erosion issues or stormwater quality concerns?		Yes		No	Yes			No: 1 Yes: 2
8	What is the current use of the property?	Food Services & Restaurants	Agricultural Residential, Single Family	Raw Land	Residential, Single Family	Public Education		Seniors Lodge	
9, 10	Do you have short-term intentions of upgrading/enhancing/changing/subdividing your property? If yes, please describe.	No	Yes, additions to building; relocate approach; possible subdivisions	Yes, subdivide into (~40x) smaller parcels for truck stop, motel, highway commercial and light industrial developments.	Not Sure	No		Not Sure	No: 2 Not Sure: 2 Yes: 2
11, 12	Do you have mid-term intentions of upgrading/enhancing/changing/subdividing your property? If yes, please describe.	No	Yes, additions to building; relocate approach; possible subdivisions	Yes, subdivide into (~40x) smaller parcels for truck stop, motel, highway commercial and light industrial developments.	Not Sure	No		Yes, landscaping	No: 2 Not Sure: 1 Yes: 3
13, 14	Do you have long-term intentions of upgrading/enhancing/changing/subdividing your property? If yes, please describe.	Not Sure	Yes, additions to building; relocate approach; possible subdivisions	Yes, subdivide into (~40x) smaller parcels for truck stop, motel, highway commercial and light industrial developments. Proposing phase development. Possibly 25% every two years.	Not Sure	No		Not Sure	No: 1 Not Sure: 3 Yes: 2
15	What is your age group?		31-49	31-49	65+	50-65		65+	31-49: 2 50-65: 1 65+: 2
16	Which of the following best describes your interest?		Country Residential Acreage	Commercial Business Industrial Business	Country Residential Acreage Single Family Residential	Public Education	All	Seniors Lodge	
17	Male or Female		Male	Male	Female	Male			Male: 3 Female: 1
18	Landowner, Tenant or Other (Please Specify)	Landowner	Landowner	Landowner	Landowner	Landowner		Operator	Landowner: 4 Other: 1
19	Where do you live?		County of Lac Ste. Anne	Edmonton	Town of Mayerthorpe	County of Lac Ste. Anne	Town of Mayerthorpe	Town of Mayerthorpe	County of Lac Ste. Anne: 2 Town of Mayerthorpe: 3 Other: 1
20	Is this your first time submitting this survey?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No: 0 Yes: 7

APPENDIX E1 – Precipitation Gauge Comparison

idf_v2-10_2011_05_17_306_AB_3062244_EDSON_A
Environment Canada/Environnement Canada

Short Duration Rainfall Intensity-Duration-Frequency Data
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

Gumbel - Method of moments/Méthode des moments

2011/05/17

==

EDSON A AB 3062244

Latitude: 53 35'N Longitude: 116 28'W Elevation/Altitude: 927 m

Years/Années : 1970 - 1992 # Years/Années : 23

==

****

Table 1 : Annual Maximum (mm)/Maximum annuel (mm)

****

Year Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1970	8.9	16.3	19.6	22.9	35.6	46.0	46.2	54.4	59.2
1971	5.3	10.2	13.0	16.3	17.0	20.8	33.8	47.8	54.9
1972	5.1	7.9	11.4	12.2	14.2	15.0	27.7	40.9	66.5
1973	7.6	13.2	16.5	18.0	18.3	18.5	23.4	29.2	31.5
1974	6.3	8.4	11.2	14.7	16.3	17.0	32.5	45.5	64.3
1975	13.0	14.2	16.0	17.0	17.5	32.3	32.3	32.5	41.4
1976	10.2	13.0	16.3	24.4	27.4	28.2	28.2	28.2	39.9
1977	8.1	10.4	11.9	15.0	18.0	19.0	26.9	33.0	49.8
1978	7.6	15.2	18.0	24.3	24.3	24.4	32.1	45.7	58.2
1979	11.8	14.1	15.1	15.3	15.3	19.3	19.6	26.4	48.8
1980	15.8	17.3	18.2	18.2	18.3	18.3	25.1	45.6	51.2
1981	6.8	10.9	13.2	13.7	16.8	17.5	17.7	17.7	28.4
1982	4.5	5.8	8.3	12.2	23.1	27.7	36.8	43.0	57.2
1983	5.6	9.6	10.8	12.0	14.0	14.0	21.3	28.5	50.6
1984	6.8	9.0	11.3	13.6	14.0	20.9	25.3	38.2	48.5
1985	3.4	4.9	5.7	8.2	11.5	14.6	16.7	30.3	45.0
1986	4.0	7.8	7.8	7.8	9.3	14.2	31.9	51.8	74.1
1987	5.4	7.9	12.0	16.5	17.4	18.8	21.7	29.9	38.2
1988	12.1	16.0	16.7	16.7	16.7	23.8	24.7	25.3	28.0
1989	4.9	6.3	8.1	10.0	10.5	12.8	24.7	46.0	69.3
1990	6.7	8.9	11.4	13.2	13.4	15.6	31.1	46.7	60.7
1991	7.6	13.4	20.2	25.8	26.5	29.4	29.4	37.5	40.2
1992	3.9	5.8	8.3	10.3	12.9	13.7	18.9	19.8	23.4
# Yrs. Années	23	23	23	23	23	23	23	23	23
Mean Moyenne	7.5	10.7	13.1	15.6	17.8	20.9	27.3	36.7	49.1
Std. Dev. Écart-type	3.2	3.7	4.1	5.0	6.1	7.7	6.9	10.3	13.8
Skew. Dissymétrie	1.08	0.20	0.08	0.59	1.34	1.75	0.73	-0.09	-0.14
Kurtosis	3.98	2.21	2.43	3.13	5.37	7.00	4.37	2.32	2.66

*-99.9 Indicates Missing Data/Données manquantes

Warning: annual maximum amount greater than 100-yr return period amount
Avertissement : la quantité maximale annuelle excède la quantité
pour une période de retour de 100 ans

Year/Année	Duration/Durée	Data/Données	100-yr/ans
1970	2 h	46.0	45.2

****

Table 2a : Return Period Rainfall Amounts (mm)
Quantité de pluie (mm) par période de retour

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	6.9	9.8	11.7	14.0	15.8	17.5	23
10 min	10.1	13.4	15.6	18.3	20.4	22.4	23
15 min	12.4	16.0	18.4	21.4	23.6	25.9	23
30 min	14.8	19.2	22.1	25.8	28.6	31.3	23
1 h	16.8	22.1	25.7	30.2	33.6	36.9	23
2 h	19.7	26.5	31.0	36.7	41.0	45.2	23
6 h	26.2	32.3	36.3	41.4	45.2	48.9	23
12 h	35.0	44.1	50.2	57.8	63.5	69.1	23
24 h	46.8	59.0	67.1	77.3	84.9	92.4	23

****

Table 2b :

Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	83.1	117.2	139.8	168.4	189.5	210.6	23
	+/- 14.5	+/- 24.4	+/- 33.0	+/- 44.4	+/- 53.2	+/- 61.9	23
10 min	60.6	80.4	93.4	109.9	122.1	134.3	23
	+/- 8.4	+/- 14.1	+/- 19.0	+/- 25.7	+/- 30.7	+/- 35.8	23
15 min	49.7	64.1	73.6	85.6	94.5	103.4	23
	+/- 6.1	+/- 10.3	+/- 13.9	+/- 18.7	+/- 22.4	+/- 26.1	23
30 min	29.5	38.4	44.2	51.7	57.2	62.6	23
	+/- 3.8	+/- 6.3	+/- 8.6	+/- 11.5	+/- 13.8	+/- 16.1	23
1 h	16.8	22.1	25.7	30.2	33.6	36.9	23
	+/- 2.3	+/- 3.9	+/- 5.2	+/- 7.0	+/- 8.4	+/- 9.8	23
2 h	9.8	13.3	15.5	18.4	20.5	22.6	23
	+/- 1.4	+/- 2.4	+/- 3.3	+/- 4.4	+/- 5.3	+/- 6.2	23
6 h	4.4	5.4	6.0	6.9	7.5	8.2	23
	+/- 0.4	+/- 0.7	+/- 1.0	+/- 1.3	+/- 1.6	+/- 1.8	23
12 h	2.9	3.7	4.2	4.8	5.3	5.8	23
	+/- 0.3	+/- 0.5	+/- 0.7	+/- 1.0	+/- 1.2	+/- 1.4	23
24 h	2.0	2.5	2.8	3.2	3.5	3.9	23
	+/- 0.2	+/- 0.4	+/- 0.5	+/- 0.7	+/- 0.8	+/- 0.9	23

****

Table 3 : Interpolation Equation / Équation d'interpolation: R = A*T^B

R = Interpolated Rainfall rate (mm/h)/Intensité interpolée de la pluie (mm/h)
RR = Rainfall rate (mm/h) / Intensité de la pluie (mm/h)
T = Rainfall duration (h) / Durée de la pluie (h)

****

Statistics/Statistiques	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans
Mean of RR/Moyenne de RR	28.7	38.5	45.0	53.2	59.3	65.3
Std. Dev. /Écart-type (RR)	29.3	40.5	47.9	57.3	64.3	71.2
Std. Error/Erreur-type	5.1	5.0	4.9	4.9	4.8	4.8
Coefficient (A)	16.8	22.0	25.4	29.7	32.9	36.0
Exponent/Exposant (B)	-0.697	-0.713	-0.719	-0.725	-0.729	-0.732
Mean % Error/% erreur moyenne	6.7	5.7	5.4	5.5	5.5	5.5

idf_v2-10_2011_05_17_306_AB_3067372_WHITECOURT_A
Environment Canada/Environnement Canada

Short Duration Rainfall Intensity-Duration-Frequency Data
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

Gumbel - Method of moments/Méthode des moments

2011/05/17

==

WHITECOURT A AB 3067372

Latitude: 54 8'N Longitude: 115 47'W Elevation/Altitude: 782 m

Years/Années : 1982 - 2006 # Years/Années : 24

==

****

Table 1 : Annual Maximum (mm)/Maximum annuel (mm)

****

Year Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1982	9.0	9.8	10.7	13.4	15.7	15.8	29.1	45.0	57.9
1983	4.1	8.2	12.3	17.3	21.4	27.5	39.2	44.0	51.7
1984	7.0	12.4	16.4	20.0	21.8	27.7	27.7	36.0	43.9
1985	6.3	7.7	7.9	8.2	11.1	18.7	48.1	65.8	85.5
1986	7.5	10.3	11.7	13.6	17.2	17.9	22.2	35.5	54.1
1987	8.2	10.2	12.8	21.5	31.6	32.8	32.8	32.8	33.5
1988	4.7	9.3	11.1	14.6	20.0	27.8	41.5	55.4	67.0
1989	7.0	8.8	11.4	19.4	26.9	47.2	75.8	76.0	98.6
1990	3.9	5.3	7.0	9.2	10.9	18.2	28.6	43.7	69.4
1991	5.6	8.5	9.6	10.1	17.0	24.0	29.6	35.7	42.8
1992	4.5	6.3	9.4	15.4	18.1	18.7	19.0	27.6	33.2
1993	9.1	12.5	13.6	14.3	14.5	18.3	38.5	48.6	52.4
1994	7.4	11.0	12.5	18.2	19.2	19.6	22.8	31.7	34.7
1996	7.4	13.4	14.1	20.6	28.9	37.9	56.0	56.2	65.1
1997	6.5	12.0	17.5	26.0	26.2	26.4	30.7	34.4	41.6
1998	5.3	5.5	5.6	7.8	10.9	13.7	21.4	31.1	37.5
1999	3.6	6.0	9.0	10.6	12.0	12.6	27.6	31.8	37.2
2000	2.8	5.2	6.5	7.8	13.0	24.3	24.3	29.1	34.0
2001	4.4	5.8	7.4	12.6	20.0	25.7	31.0	46.9	59.9
2002	6.4	7.4	7.9	7.9	7.9	9.3	13.0	14.4	16.2
2003	4.4	5.3	5.9	6.4	6.8	6.8	8.5	9.5	12.7
2004	3.8	4.6	5.7	7.2	10.8	14.2	19.7	28.8	37.1
2005	7.7	11.9	12.5	20.7	24.6	25.3	25.3	29.4	37.2
2006	3.7	4.2	5.3	7.8	11.6	15.4	32.0	32.8	40.9
# Yrs. Années	24	24	24	24	24	24	24	24	24
Mean Moyenne	5.8	8.4	10.2	13.8	17.4	21.9	31.0	38.4	47.7
Std. Dev. Écart-type	1.8	2.9	3.4	5.6	6.8	9.1	14.2	14.9	19.8
Skew. Dissymétrie	0.15	0.19	0.35	0.43	0.42	0.89	1.49	0.62	0.75
Kurtosis	2.17	2.06	2.70	2.44	2.65	4.59	6.66	4.26	4.19

idf_v2-10_2011_05_17_306_AB_3067372_WHITECOURT_A
*-99.9 Indicates Missing Data/Données manquantes

Warning: annual maximum amount greater than 100-yr return period amount
Avertissement : la quantité maximale annuelle excède la quantité
pour une période de retour de 100 ans

Year/Année	Duration/Durée	Data/Données	100-yr/ans
1989	6 h	75.8	75.4

****

Table 2a : Return Period Rainfall Amounts (mm)
Quantité de pluie (mm) par période de retour

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	5.5	7.2	8.3	9.6	10.6	11.6	24
10 min	7.9	10.5	12.1	14.2	15.8	17.4	24
15 min	9.6	12.6	14.7	17.2	19.1	21.0	24
30 min	12.9	17.8	21.1	25.3	28.3	31.4	24
1 h	16.3	22.3	26.3	31.4	35.1	38.8	24
2 h	20.4	28.5	33.8	40.6	45.6	50.6	24
6 h	28.7	41.2	49.5	60.0	67.7	75.4	24
12 h	36.0	49.1	57.8	68.8	76.9	85.0	24
24 h	44.4	61.9	73.5	88.2	99.1	109.9	24

****

Table 2b :

Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	66.5	86.1	99.0	115.4	127.5	139.6	24
	+/- 8.1	+/- 13.7	+/- 18.5	+/- 24.9	+/- 29.8	+/- 34.8	24
10 min	47.6	62.7	72.8	85.5	94.9	104.2	24
	+/- 6.3	+/- 10.6	+/- 14.3	+/- 19.3	+/- 23.1	+/- 26.9	24
15 min	38.4	50.6	58.6	68.8	76.4	83.9	24
	+/- 5.1	+/- 8.5	+/- 11.5	+/- 15.5	+/- 18.6	+/- 21.7	24
30 min	25.7	35.6	42.2	50.5	56.7	62.8	24
	+/- 4.1	+/- 6.9	+/- 9.4	+/- 12.7	+/- 15.1	+/- 17.6	24
1 h	16.3	22.3	26.3	31.4	35.1	38.8	24
	+/- 2.5	+/- 4.2	+/- 5.7	+/- 7.7	+/- 9.2	+/- 10.7	24
2 h	10.2	14.2	16.9	20.3	22.8	25.3	24
	+/- 1.7	+/- 2.8	+/- 3.8	+/- 5.1	+/- 6.2	+/- 7.2	24
6 h	4.8	6.9	8.2	10.0	11.3	12.6	24
	+/- 0.9	+/- 1.5	+/- 2.0	+/- 2.7	+/- 3.2	+/- 3.7	24
12 h	3.0	4.1	4.8	5.7	6.4	7.1	24
	+/- 0.5	+/- 0.8	+/- 1.0	+/- 1.4	+/- 1.7	+/- 1.9	24
24 h	1.9	2.6	3.1	3.7	4.1	4.6	24
	+/- 0.3	+/- 0.5	+/- 0.7	+/- 0.9	+/- 1.1	+/- 1.3	24

****

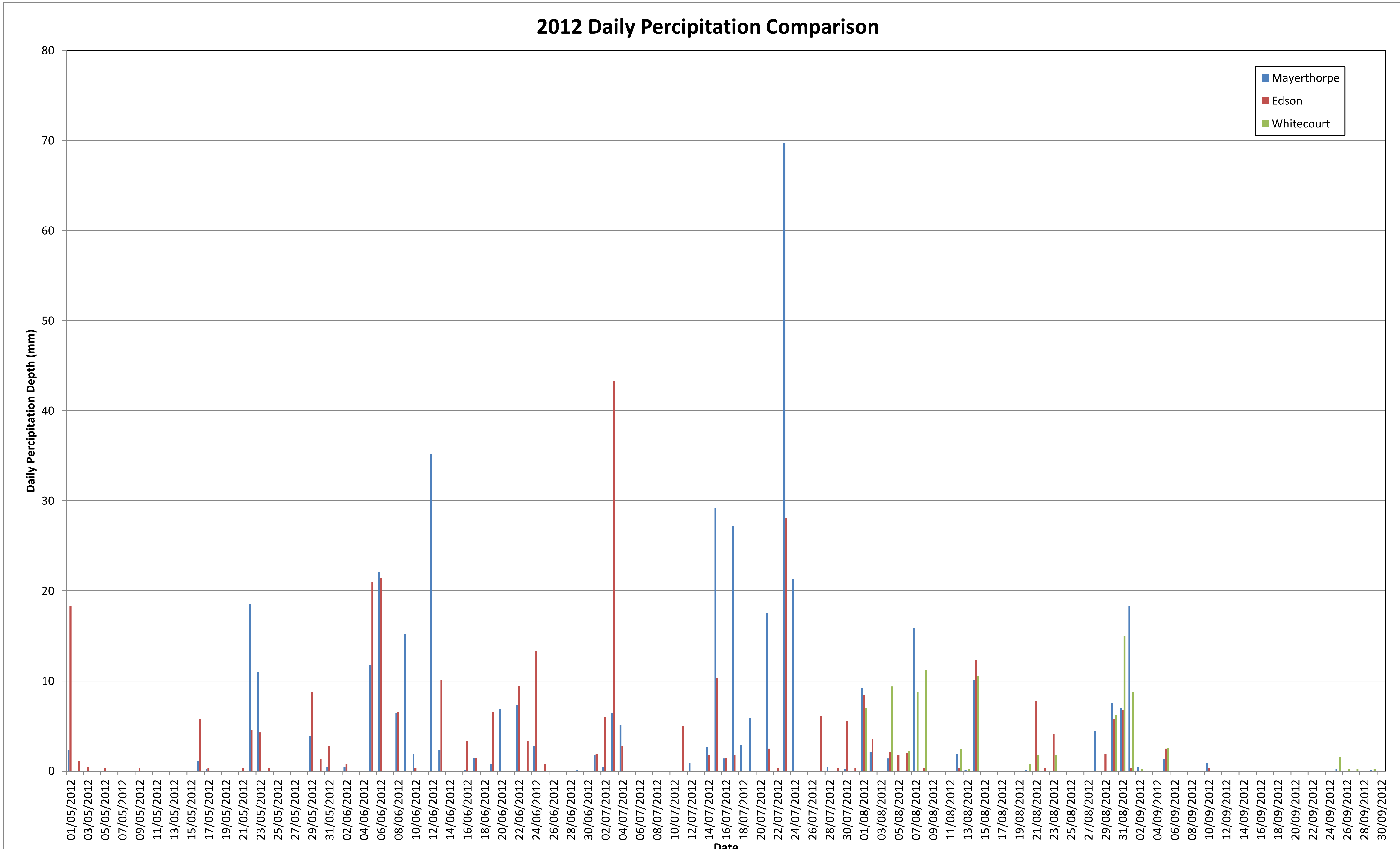
Table 3 : Interpolation Equation / Équation d'interpolation: R = A*T^B

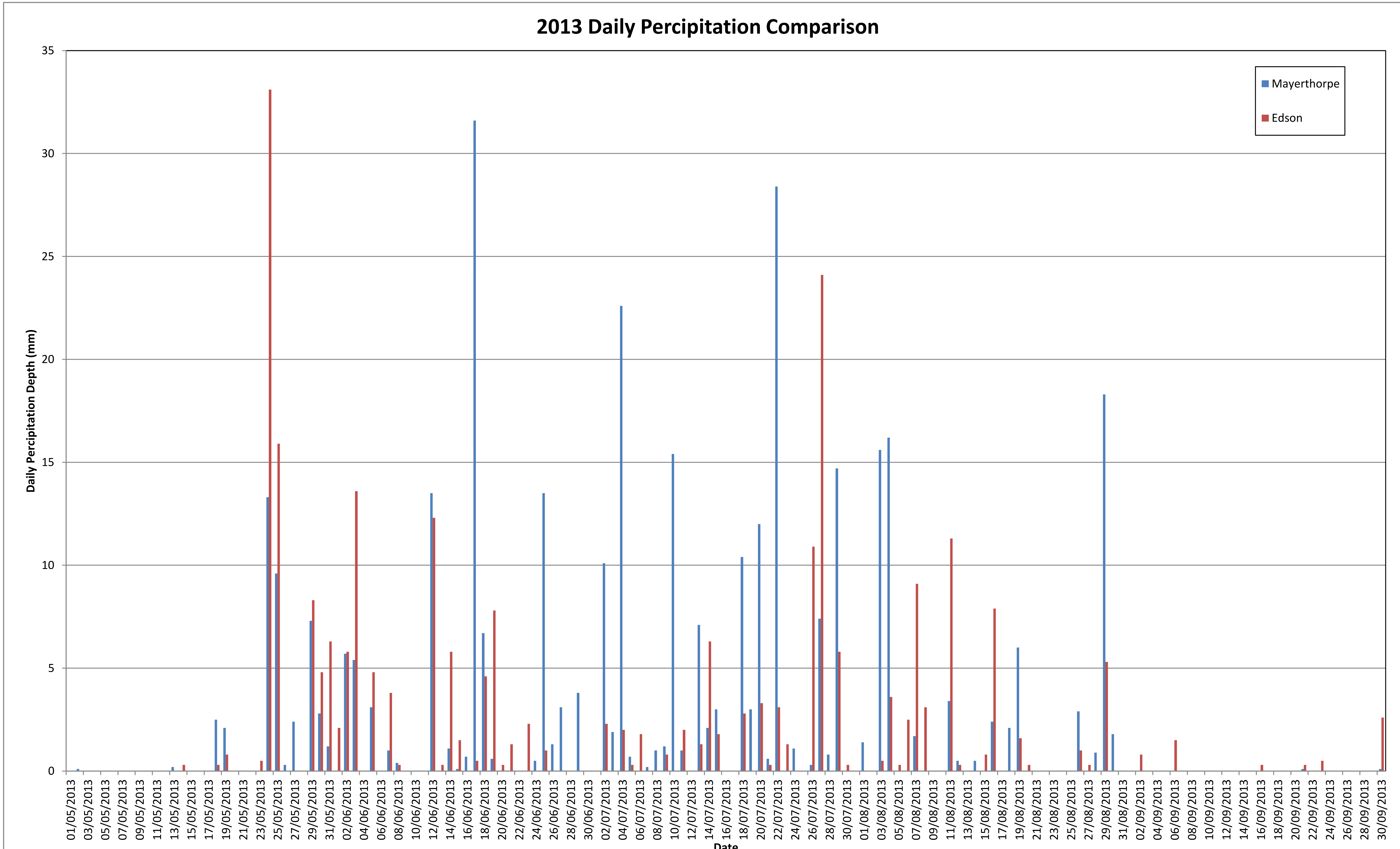
R = Interpolated Rainfall rate (mm/h)/Intensité interpolée de la pluie (mm/h)
RR = Rainfall rate (mm/h) / Intensité de la pluie (mm/h)

T = Rainfall duration (h) / Durée de la pluie (h)

****

Statistics/Statistiques	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans
Mean of RR/Moyenne de RR	23.8	31.7	36.9	43.5	48.4	53.2
Std. Dev. /Écart-type (RR)	22.7	29.4	33.8	39.4	43.6	47.7
Std. Error/Erreur-type	3.5	5.2	6.4	7.8	8.9	10.0
Coefficient (A)	15.2	20.7	24.3	28.9	32.3	35.6
Exponent/Exposant (B)	-0.644	-0.631	-0.625	-0.620	-0.617	-0.615
Mean % Error/% erreur moyenne	5.1	6.6	7.2	7.8	8.1	8.4


2012 Daily Percipitation Comparison
Daily Percipitation Depth (mm)
Date
Mayerthorpe
Edson
Whitecourt
0
10
20
30
40
50
60
70
80
01/05/2012
30/09/2012



2013 Daily Percipitation Comparison
Daily Percipitation Depth (mm)
Date
Mayerthorpe
Edson
0
5
10
15
20
25
30
35
01/05/2013
30/09/2013

Duration		100-Year Rainfall Amounts (mm)		100-Year Rainfall Intensity (mm/hr)	
		Edson	Whitecourt	Edson	Whitecourt
5	min	17.5	11.6	210.6	139.6
10	min	22.4	17.4	134.3	104.2
15	min	25.9	21	103.4	83.9
30	min	31.3	31.4	62.6	62.8
1	h	36.9	38.8	36.9	38.8
2	h	45.2	50.6	22.6	25.3
6	h	48.9	75.4	8.2	12.6
12	h	69.1	85	5.8	7.1
24	h	92.4	109.9	3.9	4.6

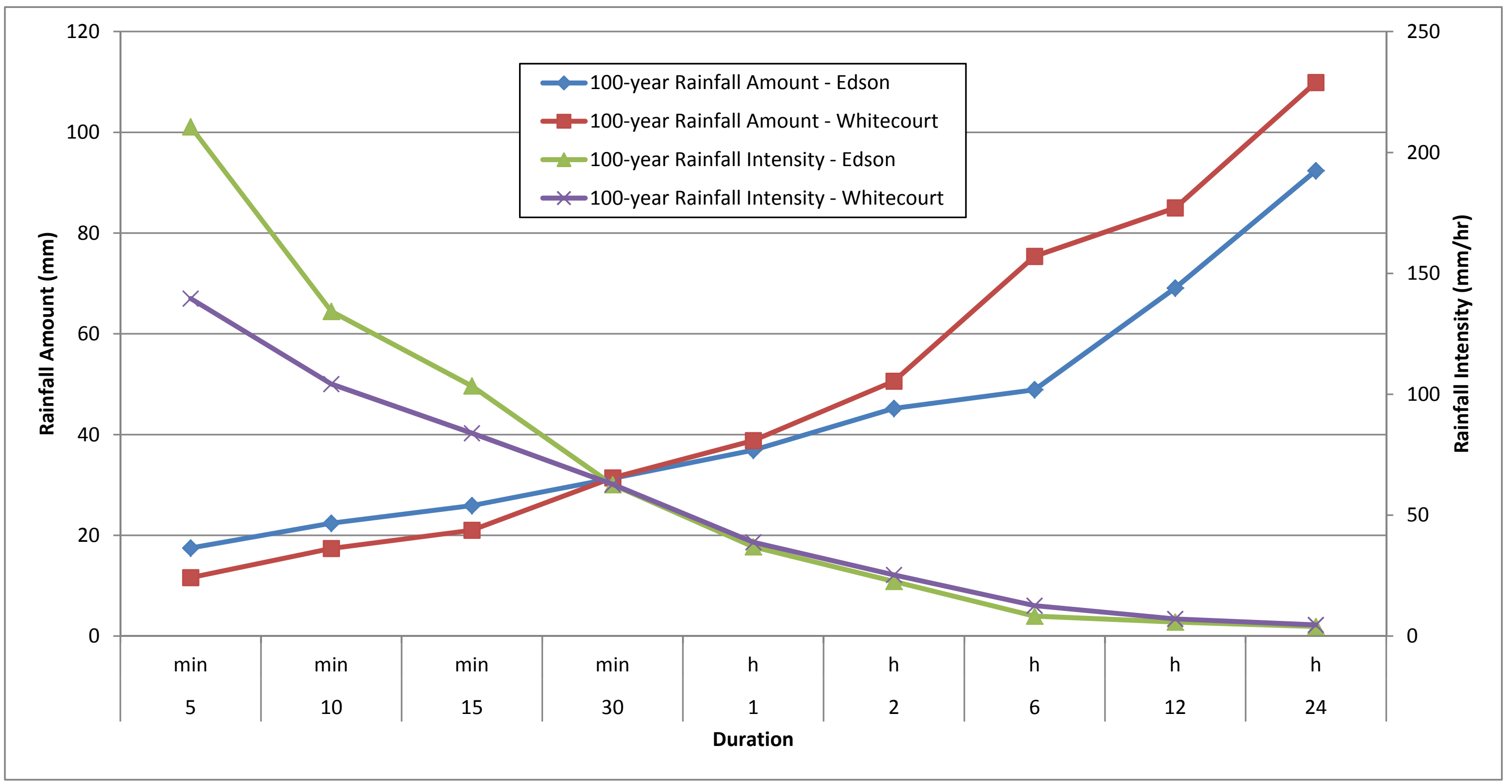
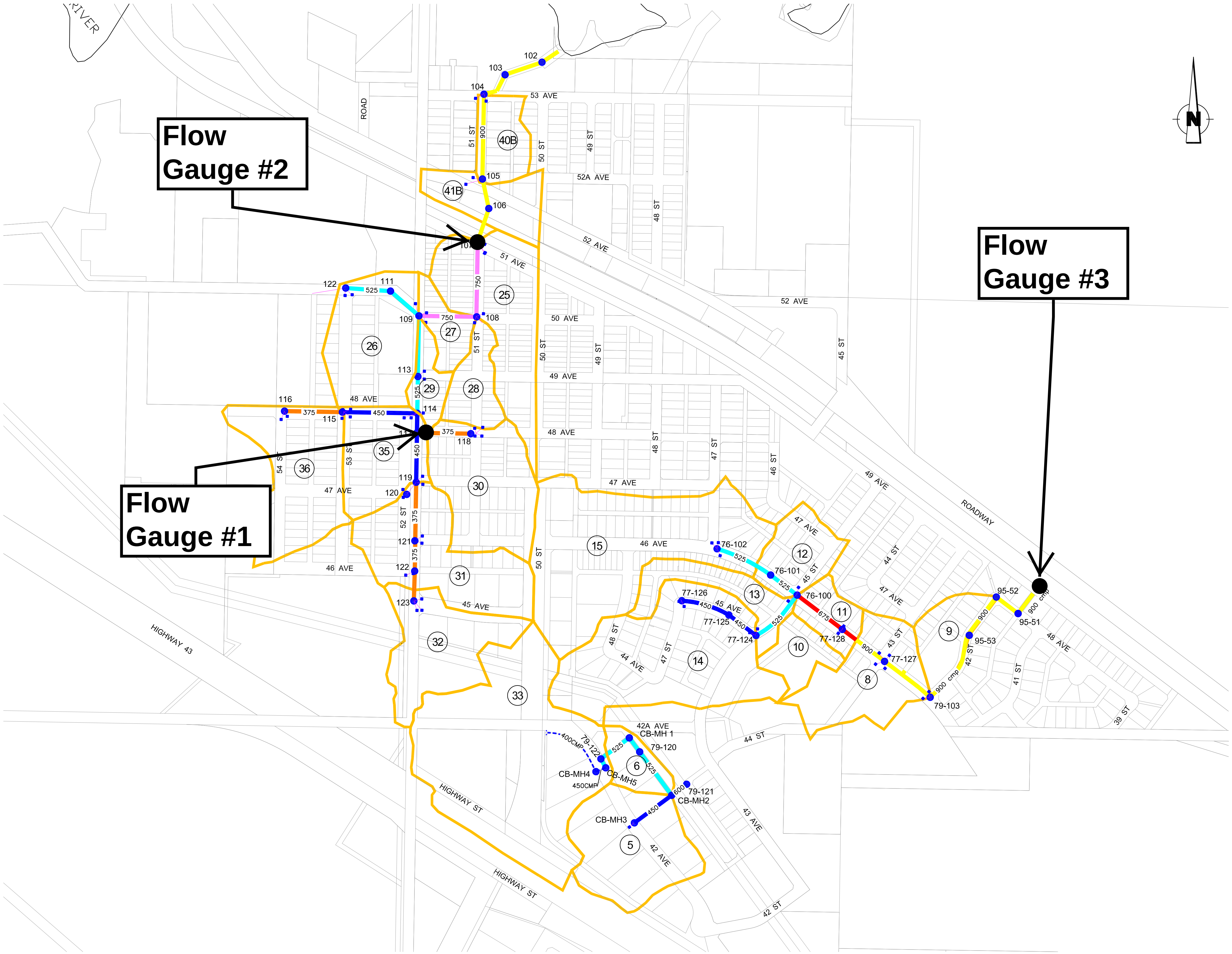


Figure 1

APPENDIX E2 – Hydrological Model Calibration and Validation - Figures



TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

SCALE 1: 7500

0 100 200m

LEGEND

76-101	STORM MANHOLE AND NUMBER
	CATCH BASIN
	CMP CULVERT
375	375 STORM
450	450 STORM
525	525 STORM
600	600 STORM
675	675 STORM
750	750 STORM
900	900 STORM
5	MINOR SYSTEM DRAINAGE BOUNDARIES AND NUMBER

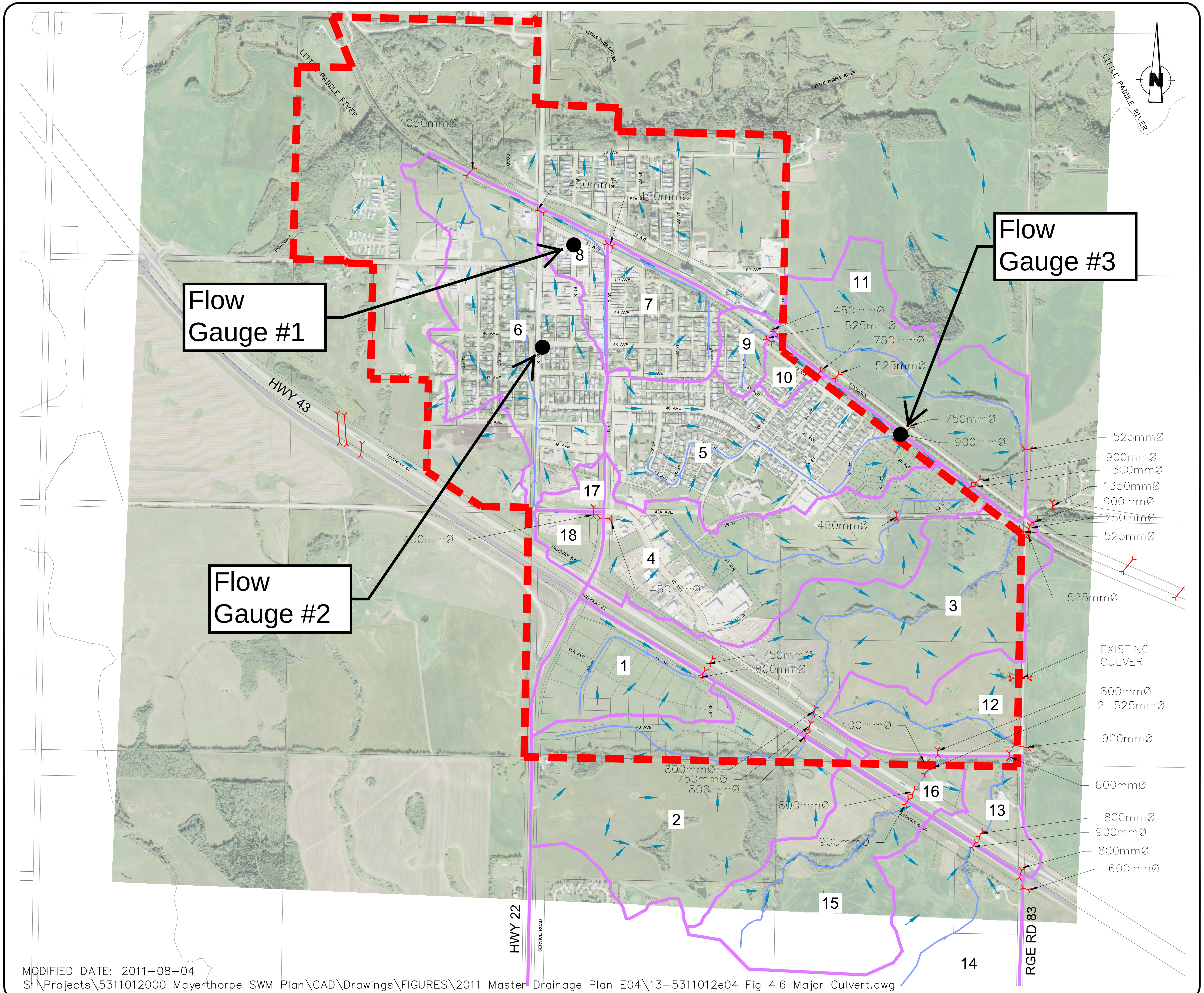
EXISTING MINOR STORM SYSTEM

MMM GROUP

#200, 10576 - 113 Street
Edmonton, AB T5H 3H5
t: 780.423.4123
f: 780.426.0659
www.mmm.ca

FIGURE 4.4

MODIFIED DATE: 2011-08-04
S:\Projects\5311012000 Mayerthorpe SWM Plan\CAD\Drawings\FIGURES\2011 Master Drainage Plan E04\10-5311012e04 Fig 4.4 Ex Minor System.dwg



TOWN OF MAYERTHORPE

MASTER DRAINAGE PLAN

SCALE 1:12 500
0 200 400m

LEGEND

TOWN BOUNDARY
DRAINAGE DIRECTION
CULVERT BASIN BOUNDARY
EXISTING CULVERTS
2 CULVERT CATCHMENT NUMBER
DRAINAGE COURSE
EXISTING CULVERT (LOCATION, SIZE, AND INVERT TO BE OBTAINED BY TOWN)

MAJOR CULVERT DRAINAGE BOUNDARIES

MMM GROUP
#200, 10576 - 113 Street
Edmonton, AB T5H 3H5
t: 780.423.4123
f: 780.426.0659
www.mmm.ca

FIGURE 4.6

APPENDIX E-3 – Hydrological Model Calibration and Validation – Calibration Results

Project: Town of Mayerthorpe SWM Plan
Project No: 5311012-000
Date: 19-Dec-13
Author: Lisa Maruska
Checked By: Albert Zhuge
Title: **Runoff Coefficient Data from Table 4.3 - Existing Minor Storm System 2 Year and 5 Year Storm Evalulation with Current Landuse**

SUB-BASIN AREA DRAINING INTO MH	FROM MH	TO MH	AREA ADDED (ha)	TOTAL AREA (ha)	TOTAL AREA (ha)	RUNOFF COEFFICIENT (C.)	AREA X RUNOFF C.	TOTAL A X C	Q DESIGN 2 year (m3/s)	Q DESIGN 5 year (m3/s)
32	123	122	3.7	3.7	3.7	0.71	2.63	2.63	0.501	0.677
31	122	121	4.7	8.4	8.4	0.48	2.24	2.24	0.862	1.164
	121	119	0	8.4	8.4	0	0.00	0	0.862	1.164
	120	119	0	0	8.4	0	0.00	0	0	
	119	117	0	8.4	0	0	0.00	0	0.862	1.164
30	118	117	4.2	4.2	12.6	0.42	1.77	1.77	0.337	0.456
	117	114	0	12.6	4.2	0	0.00	0	1.199	1.619
36	116	115	4.5	4.5	17.1	0.38	1.72	1.72	0.326	0.441
	115	114	0	4.5	4.5	0	0.00	0	0.326	0.441
35	114	113	2.8	19.9	7.3	0.37	1.03	1.03	1.327	1.782
29	113	109	0.9	20.8	20.8	0.44	0.40	0.4	1.352	1.816
26	112	111	3.6	3.6	24.4	0.41	1.49	1.49	0.283	0.382
	111	109	0	3.6	3.6	0	0.00	0	0.283	
27	109	108	1.1	25.5	4.7	0.57	0.63	0.63	1.584	2.125
28	108	107	1.4	26.9	26.9	0.45	0.63	0.63	1.586	2.125
25 - 900 mm pipe - Flow Monitoring Gauge	107	106	4.6	31.5	31.5	0.65	3.01	3.01	1.862	2.491
						15.512				
					Weighted C	**0.49**				

AREA TOTAL to FLOW MONITORING GAUGE #2
31.5 ha

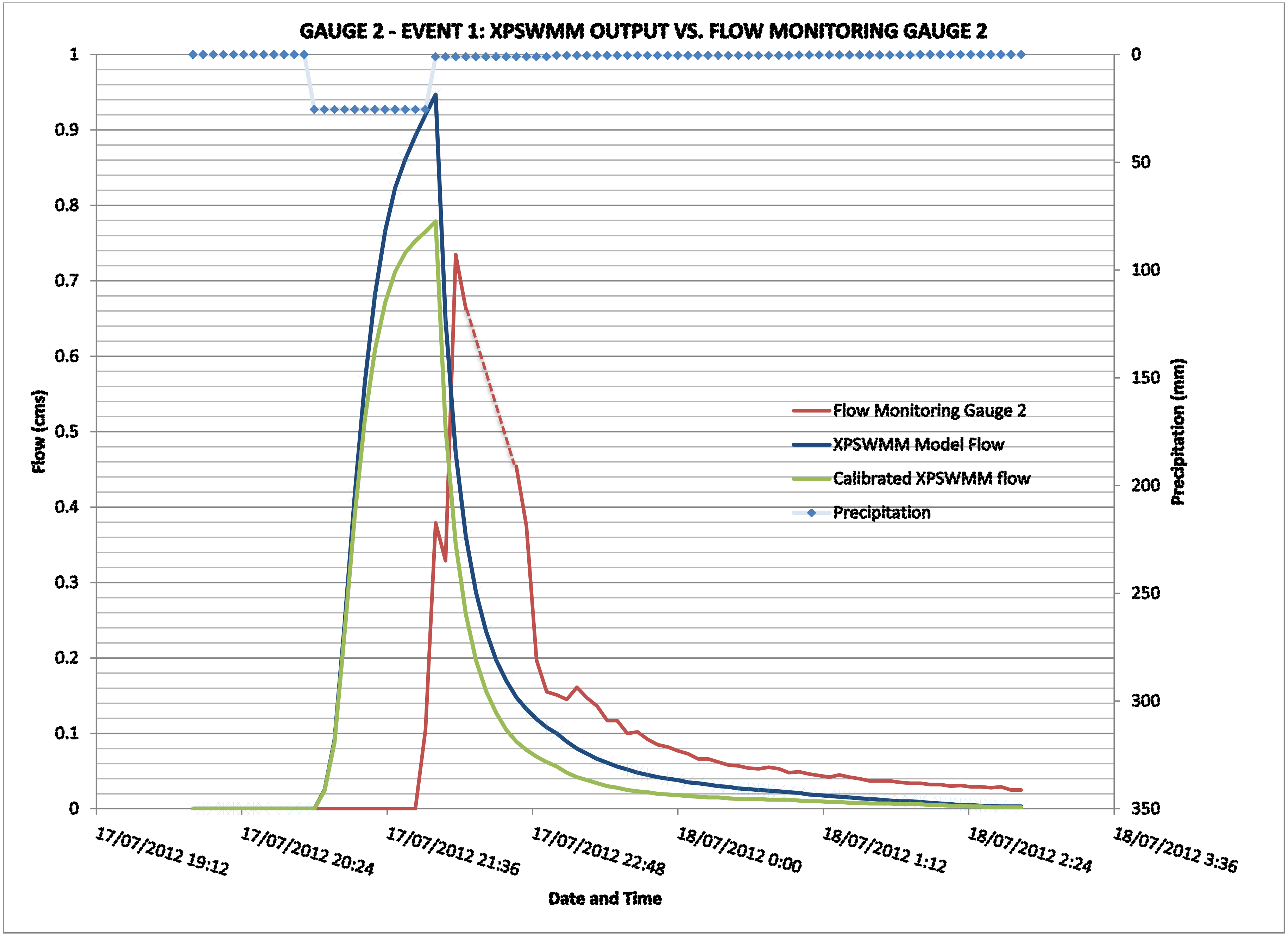
Weighted RC = 0.49

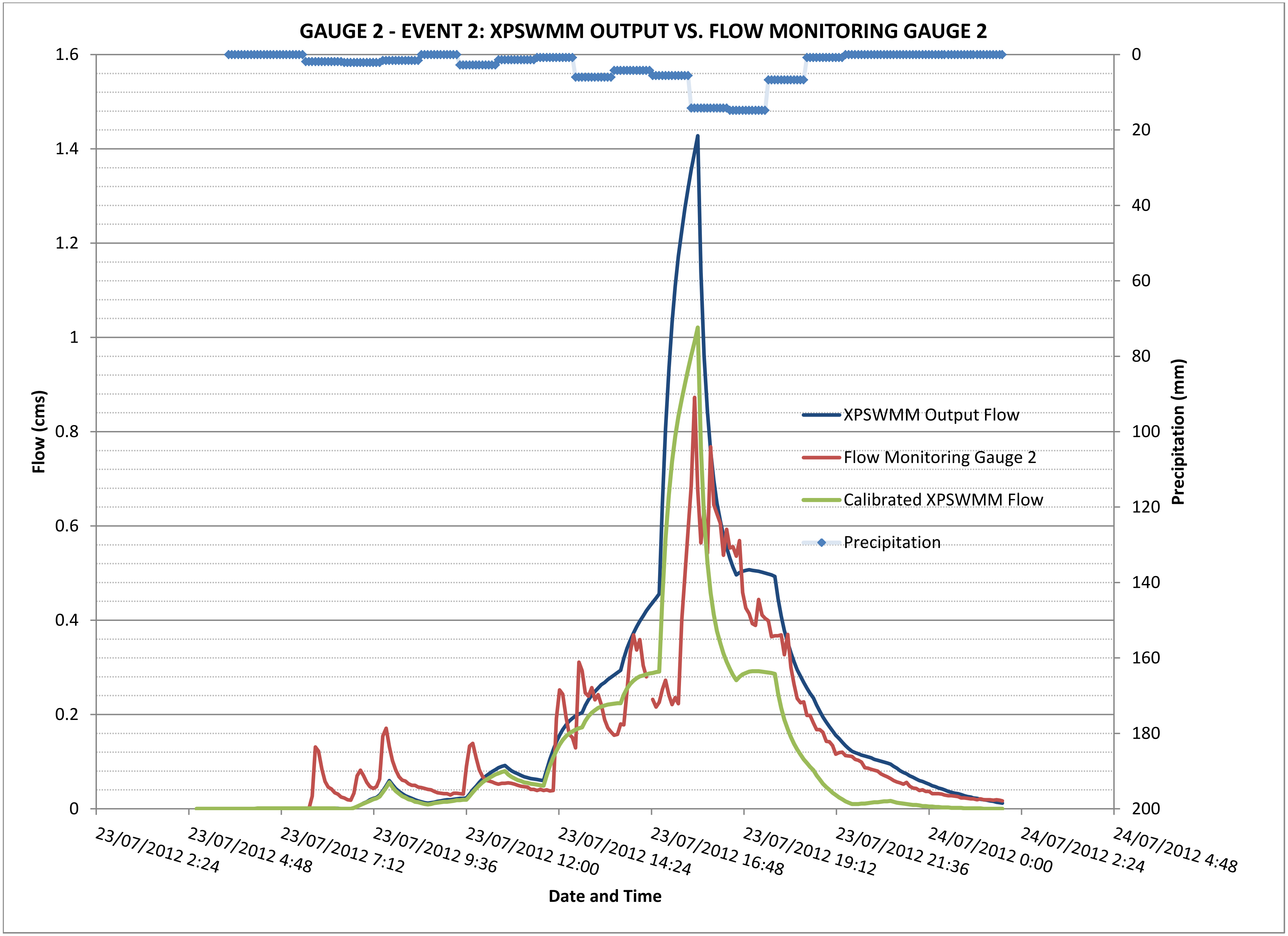
FLOW GAUGE 2

Converted RC to Imperviousness I:
C=0.7I+0.2
0.42

Slope - South end of drainage area to North end
=(715.39 m - 710 m)/973 m
0.006

[Aside - East to West Slope - not used in model: From 54st and 48 ave end to 50st and btw 48 ave and 49 ave]
0.000853242


GAUGE 2 - EVENT 1: XPSWMM OUTPUT VS. FLOW MONITORING GAUGE 2
Flow (cms)
Precipitation (mm)
Date and Time
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
50
100
150
200
250
300
350
17/07/2012 19:12
17/07/2012 20:24
17/07/2012 21:36
17/07/2012 22:48
18/07/2012 0:00
18/07/2012 1:12
18/07/2012 2:24
18/07/2012 3:36
Flow Monitoring Gauge 2
XPSWMM Model Flow
Calibrated XPSWMM flow
Precipitation



GAUGE 2 - EVENT 2: XPSWMM OUTPUT VS. FLOW MONITORING GAUGE 2
Flow (cms)
Precipitation (mm)
Date and Time
XPSWMM Output Flow
Flow Monitoring Gauge 2
Calibrated XPSWMM Flow
Precipitation
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
0
20
40
60
80
100
120
140
160
180
200
23/07/2012 2:24
23/07/2012 4:48
23/07/2012 7:12
23/07/2012 9:36
23/07/2012 12:00
23/07/2012 14:24
23/07/2012 16:48
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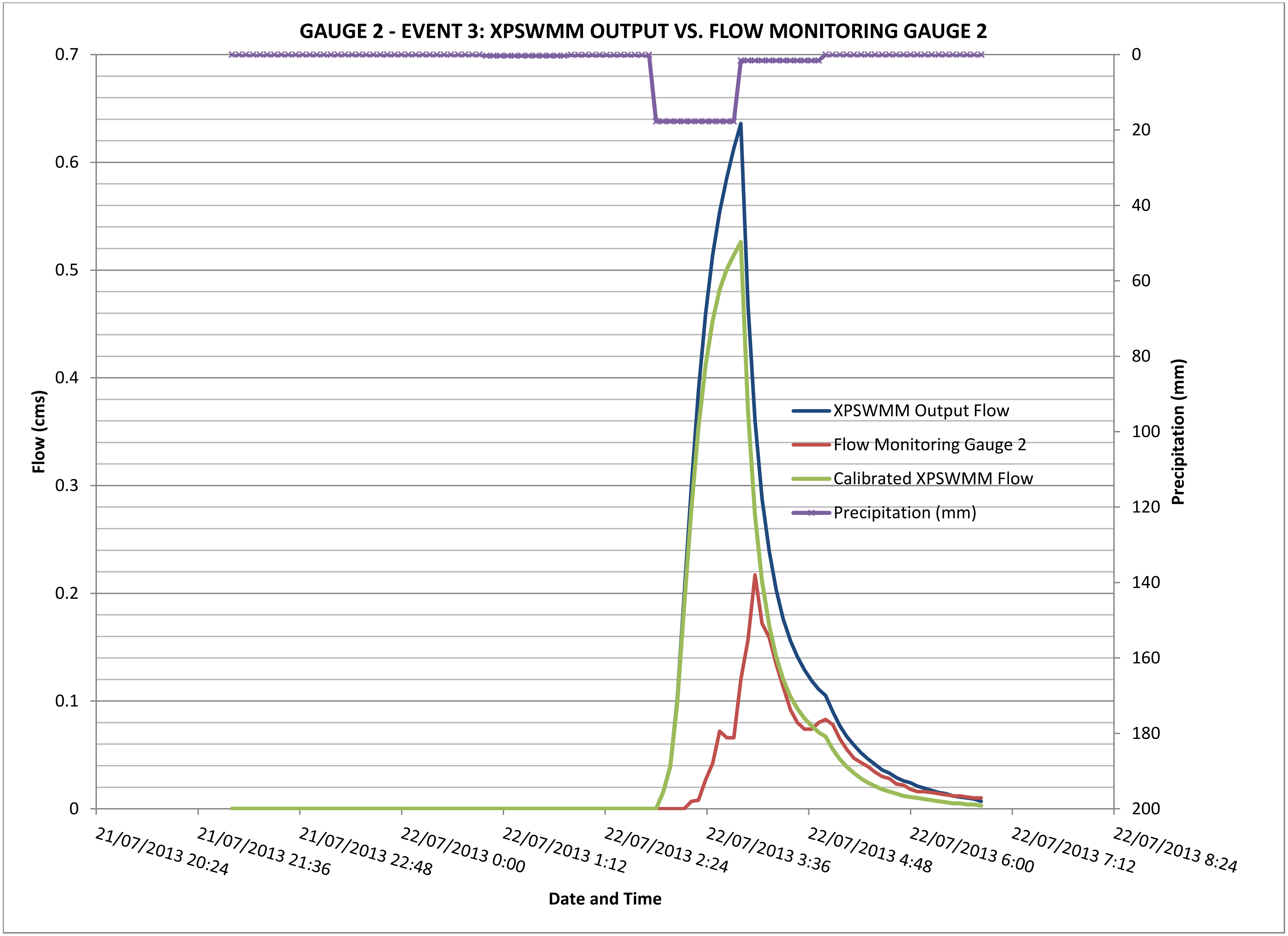
24/07/2012 4:48



GAUGE 2 - EVENT 3: XPSWMM OUTPUT VS. FLOW MONITORING GAUGE 2
Flow (cms)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Precipitation (mm)
0
20
40
60
80
100
120
140
160
180
200
XPSWMM Output Flow
Flow Monitoring Gauge 2
Calibrated XPSWMM Flow
Precipitation (mm)
21/07/2013 20:24
21/07/2013 21:36
21/07/2013 22:48
22/07/2013 0:00
22/07/2013 1:12
22/07/2013 2:24
22/07/2013 3:36
22/07/2013 4:48
22/07/2013 6:00
22/07/2013 7:12
22/07/2013 8:24
Date and Time

Feb. 11, 2014

Event #	Date/Time	Duration	Rain (Paddle Dam)			Runoff Volume					Peak Flow				
			Total Rain Depth (mm)	Total Rain Volume (m^3)	Max. Intensity (mm/hr)	Observed (m^3)	Un-calibrated (m3)		Calibrated (m3)		Observed (m^3/s)	Un-calibrated (m3)		Calibrated (m3)	
							Volume (m^3)	Difference to Observed	Volume (m^3)	Difference to Observed		Peak Flow Rate (m^3/s)	Difference to Observed	Peak Flow Rate (m^3/s)	Difference to Observed
1	17/07/2012 9:00:00 PM to 18/07/2012 2:50:00 AM	6 hr 50 min	27	8662	25.5	1908	3432	80%	2690	41%	0.74	0.95	29%	0.78	6%
2	23/07/2012 5:00:00 AM to 24/07/2012 1:50:00 AM	20 hr 50 min	63	19814	14.8	10857	14680	35%	9092	-16%	0.87	1.43	64%	1.02	17%
3	21/07/2013 10:00:00 PM to 22/07/2013 6:55:00 AM	8 hr 55 min	20	6206	17.7	736	2285	210%	1805	145%	0.22	0.64	193%	0.53	142%

APPENDIX E-4 – Hydrological Model Calibration and Validation – Validation Results

Project: Town of Mayerthorpe SWM Plan
Project No: 5311012-000
Date: 12-Feb-14
Author: Lisa Maruska
Title: **Runoff Coefficient Data from Table 4.3 - Existing Minor Storm System 2 Year and 5 Year Storm Evalulation with Current Landuse**

SUB-BASIN AREA DRAINING INTO MH	FROM MH	TO MH	AREA ADDED (ha)	TOTAL AREA (ha)	TOTAL AREA (ha)	RUNOFF COEFFICIENT (C.)	AREA X RUNOFF C.	TOTAL A X C	Q DESIGN 2 year (m3/s)	Q DESIGN 5 year (m3/s)
32	123	122	3.7	3.7	3.7	0.71	2.63	2.63	0.501	0.677
31	122	121	4.7	8.4	8.4	0.48	2.24	2.24	0.862	1.164
	121	119	0	8.4	8.4	0	0.00	0	0.862	1.164
	120	119	0	0	8.4	0	0.00	0	0	
	119	117	0	8.4	0	0	0.00	0	0.862	1.164
30	118	117	4.2	4.2	12.6	0.42	1.77	1.77	0.337	0.456
	117	114	0	12.6	4.2	0	0.00	0	1.199	1.619
36	116	115	4.5	4.5	17.1	0.38	1.72	1.72	0.326	0.441
	115	114	0	4.5	4.5	0	0.00	0	0.326	0.441
35	114	113	2.8	19.9	7.3	0.37	1.03	1.03	1.327	1.782
29	113	109	0.9	20.8	20.8	0.44	0.40	0.4	1.352	1.816
26	112	111	3.6	3.6	24.4	0.41	1.49	1.49	0.283	0.382
	111	109	0	3.6	3.6	0	0.00	0	0.283	
27	109	108	1.1	25.5	4.7	0.57	0.63	0.63	1.584	2.125
28	108	107	1.4	26.9	26.9	0.45	0.63	0.63	1.586	2.125
25 - 900 mm pipe - Flow Monitoring Gauge	107	106	4.6	31.5	31.5	0.65	3.01	3.01	1.862	2.491
						15.512				
					Weighted C	**0.49**				

AREA TOTAL to FLOW MONITORING GAUGE #2
31.5 ha

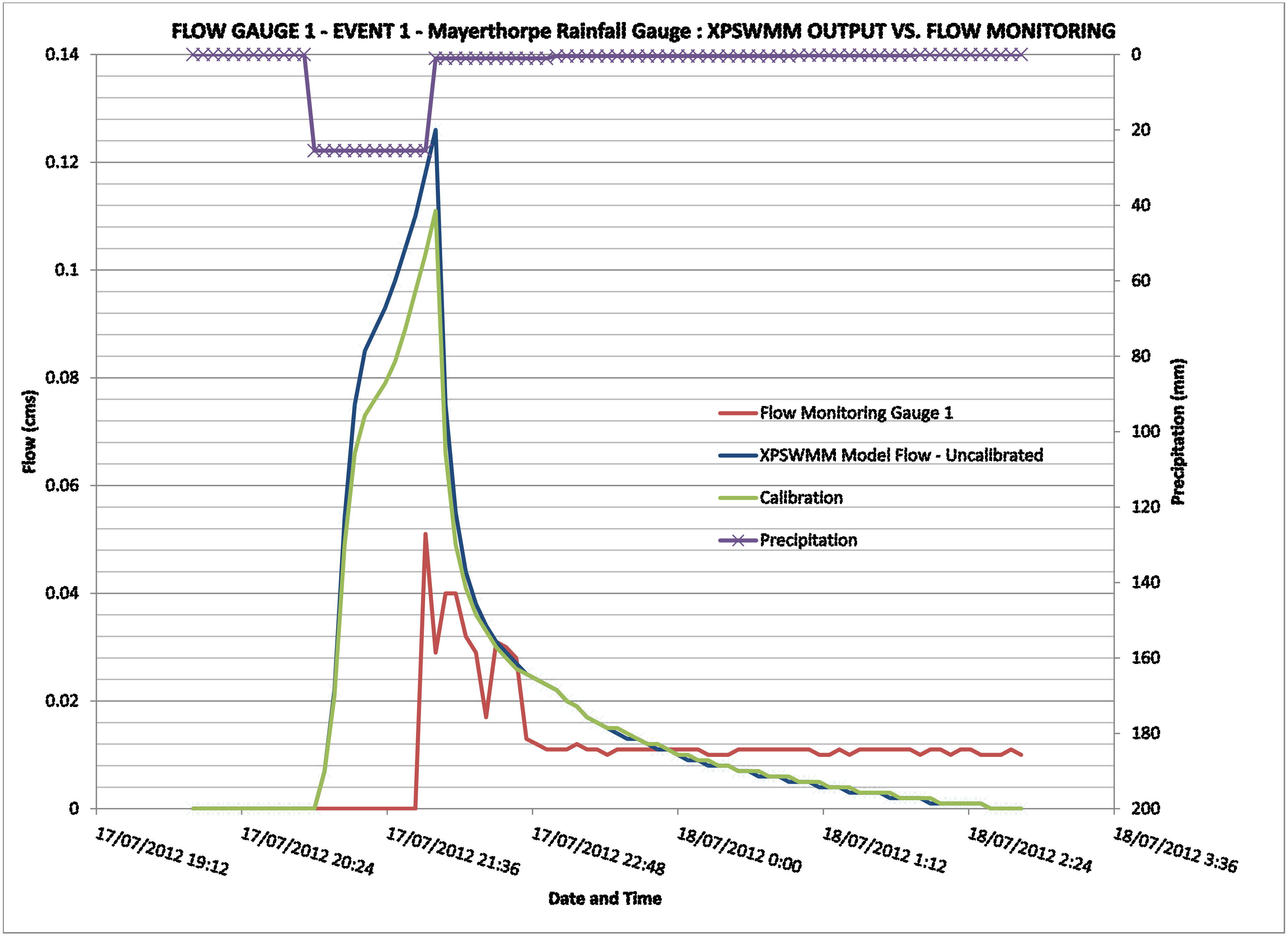
Weighted RC = 0.49

Converted RC to Imperviousness I:
C=0.7I+0.2
0.42

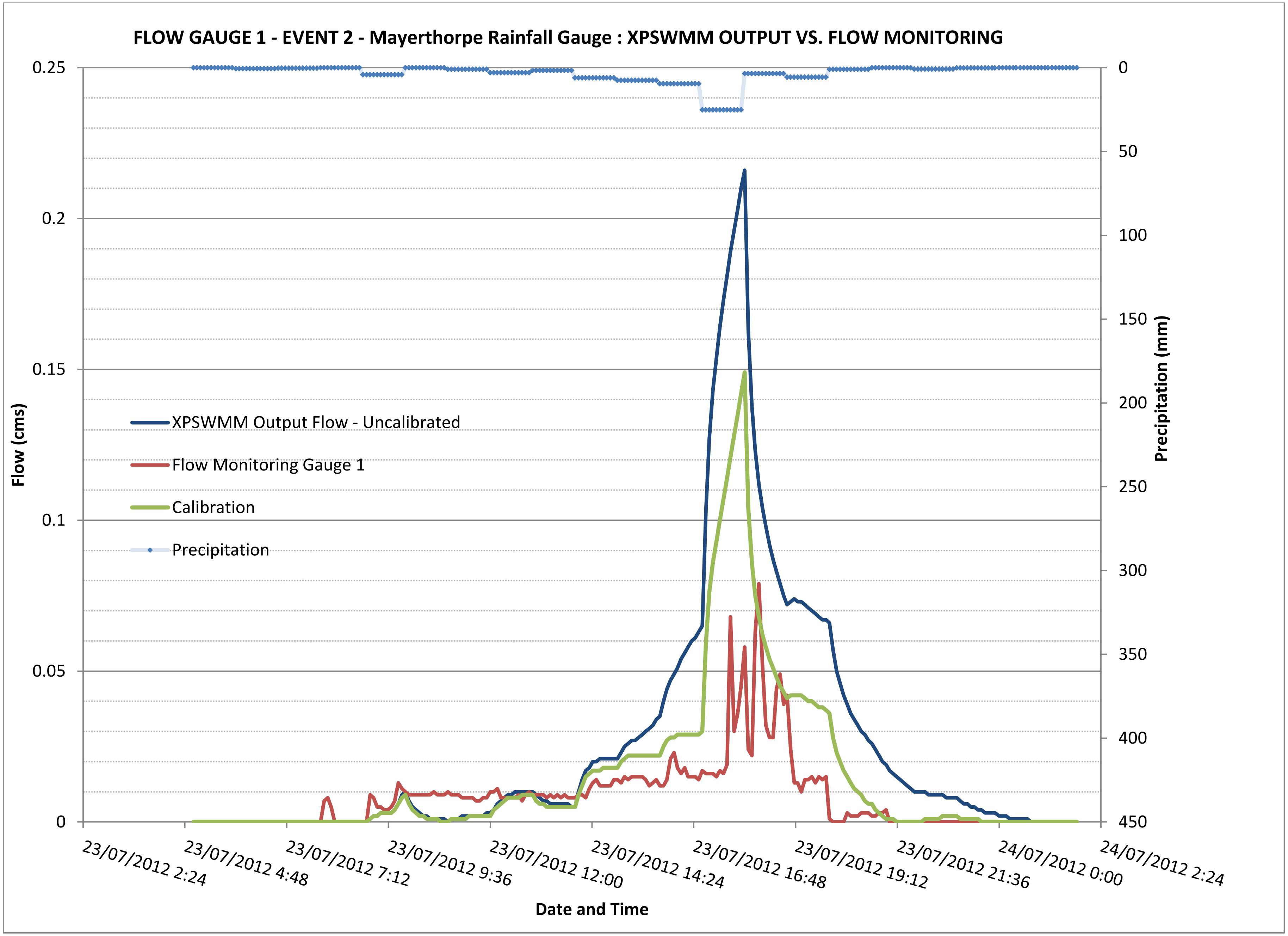
FLOW MONITORING GAUGE 1
Catchment 30 - MH 118 -> 117
Area : 4.2 ha
RC: 0.42
Converted RC to Imperviousness I:
C=0.7I+0.2
0.31 Imperv % uncalibrated
0.26 Imperv % calibrated

Slope - South end of drainage area to North end
=(715.39 m - 710 m)/973 m
0.006

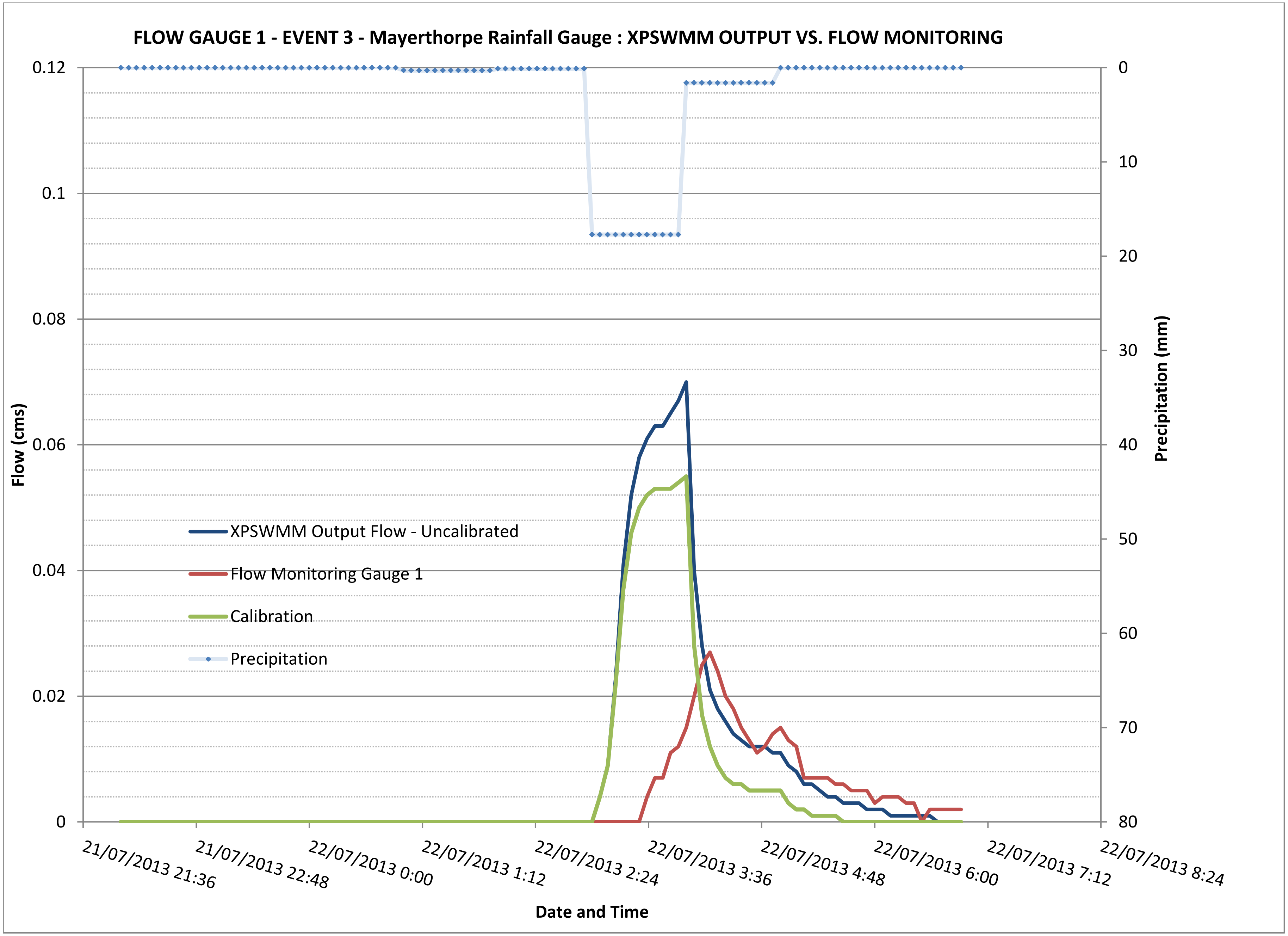
[Aside - East to West Slope - not used in model: From 54st and 48 ave end to 50st and btw 48 ave and 49 ave]
0.000853242



FLOW GAUGE 1 - EVENT 1 - Mayerthorpe Rainfall Gauge : XPSWMM OUTPUT VS. FLOW MONITORING
Flow (cms)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Precipitation (mm)
0
20
40
60
80
100
120
140
160
180
200
Flow Monitoring Gauge 1
XPSWMM Model Flow - Uncalibrated
Calibration
Precipitation
17/07/2012 19:12
17/07/2012 20:24
17/07/2012 21:36
17/07/2012 22:48
18/07/2012 0:00
18/07/2012 1:12
18/07/2012 2:24
18/07/2012 3:36
Date and Time

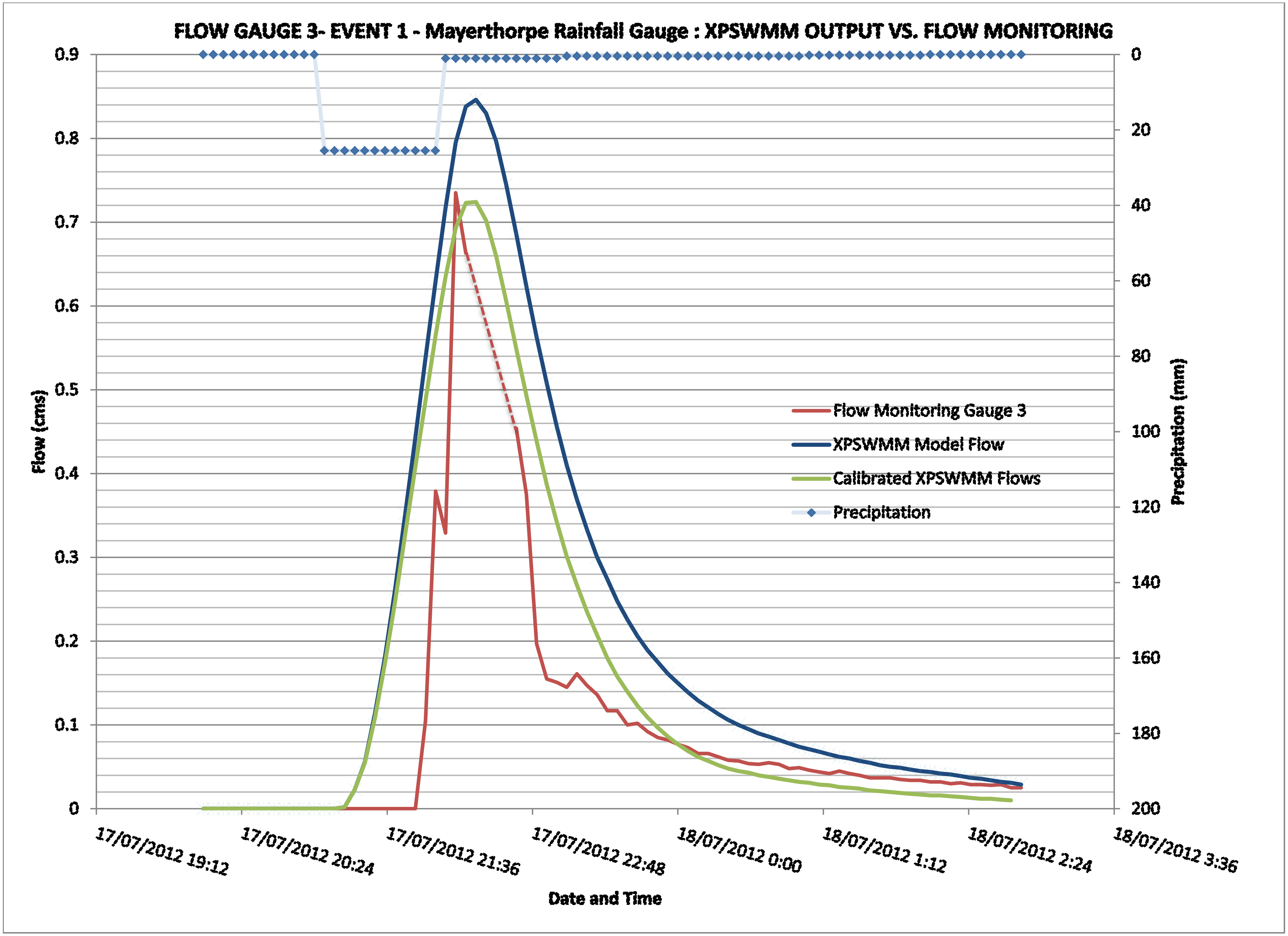


FLOW GAUGE 1 - EVENT 2 - Mayerthorpe Rainfall Gauge : XPSWMM OUTPUT VS. FLOW MONITORING
Flow (cms)
0.25
0.2
0.15
0.1
0.05
0
Precipitation (mm)
0
50
100
150
200
250
300
350
400
450
XPSWMM Output Flow - Uncalibrated
Flow Monitoring Gauge 1
Calibration
Precipitation
23/07/2012 2:24
23/07/2012 4:48
23/07/2012 7:12
23/07/2012 9:36
23/07/2012 12:00
23/07/2012 14:24
23/07/2012 16:48
23/07/2012 19:12
23/07/2012 21:36
24/07/2012 0:00
24/07/2012 2:24
Date and Time

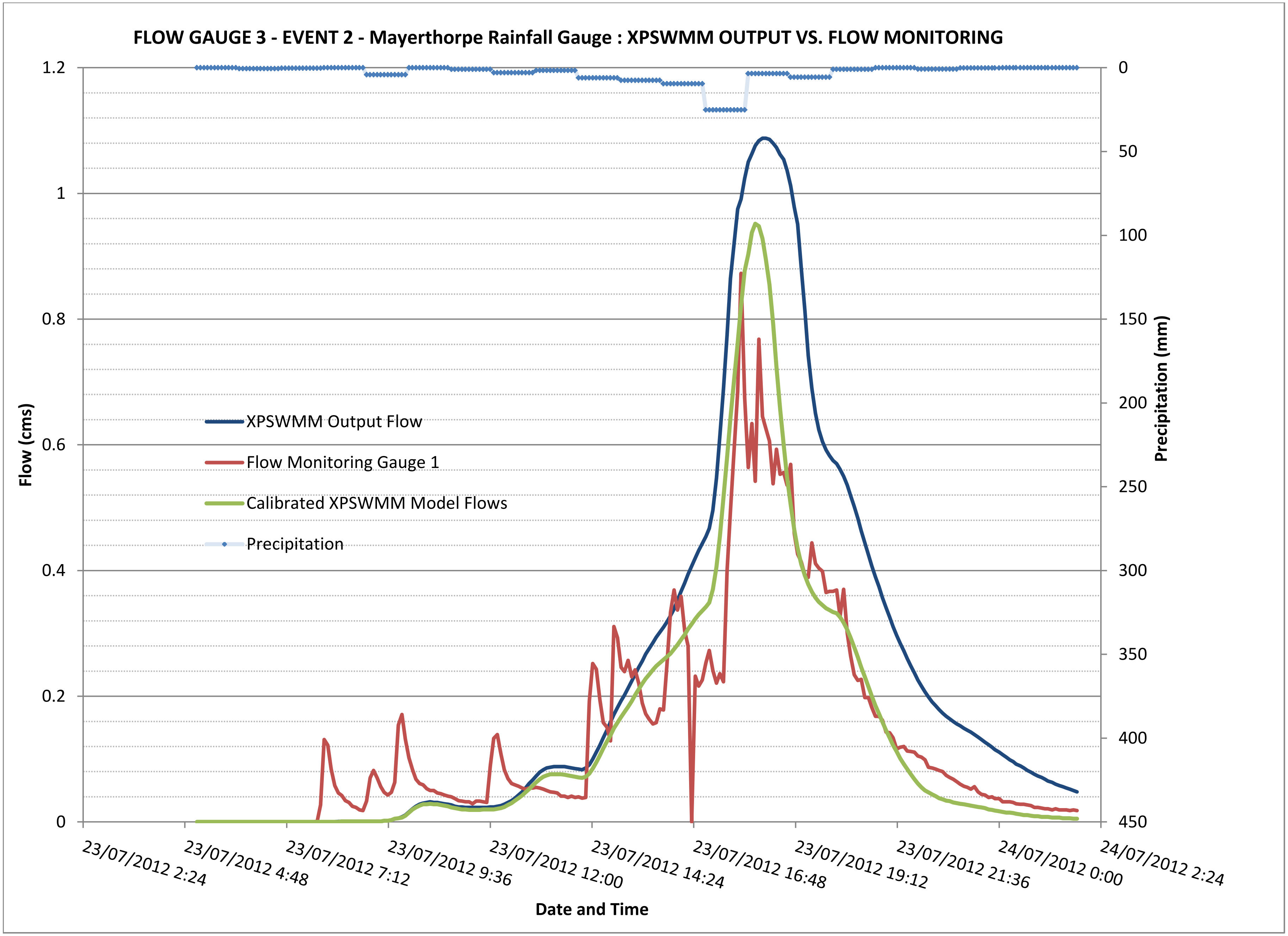

FLOW GAUGE 1 - EVENT 3 - Mayerthorpe Rainfall Gauge : XPSWMM OUTPUT VS. FLOW MONITORING
Flow (cms)
Precipitation (mm)
Date and Time
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40
50
60
70
80
21/07/2013 21:36
21/07/2013 22:48
22/07/2013 0:00
22/07/2013 1:12
22/07/2013 2:24
22/07/2013 3:36
22/07/2013 4:48
22/07/2013 6:00
22/07/2013 7:12
22/07/2013 8:24
XPSWMM Output Flow - Uncalibrated
Flow Monitoring Gauge 1
Calibration
Precipitation

Feb 11, 2014

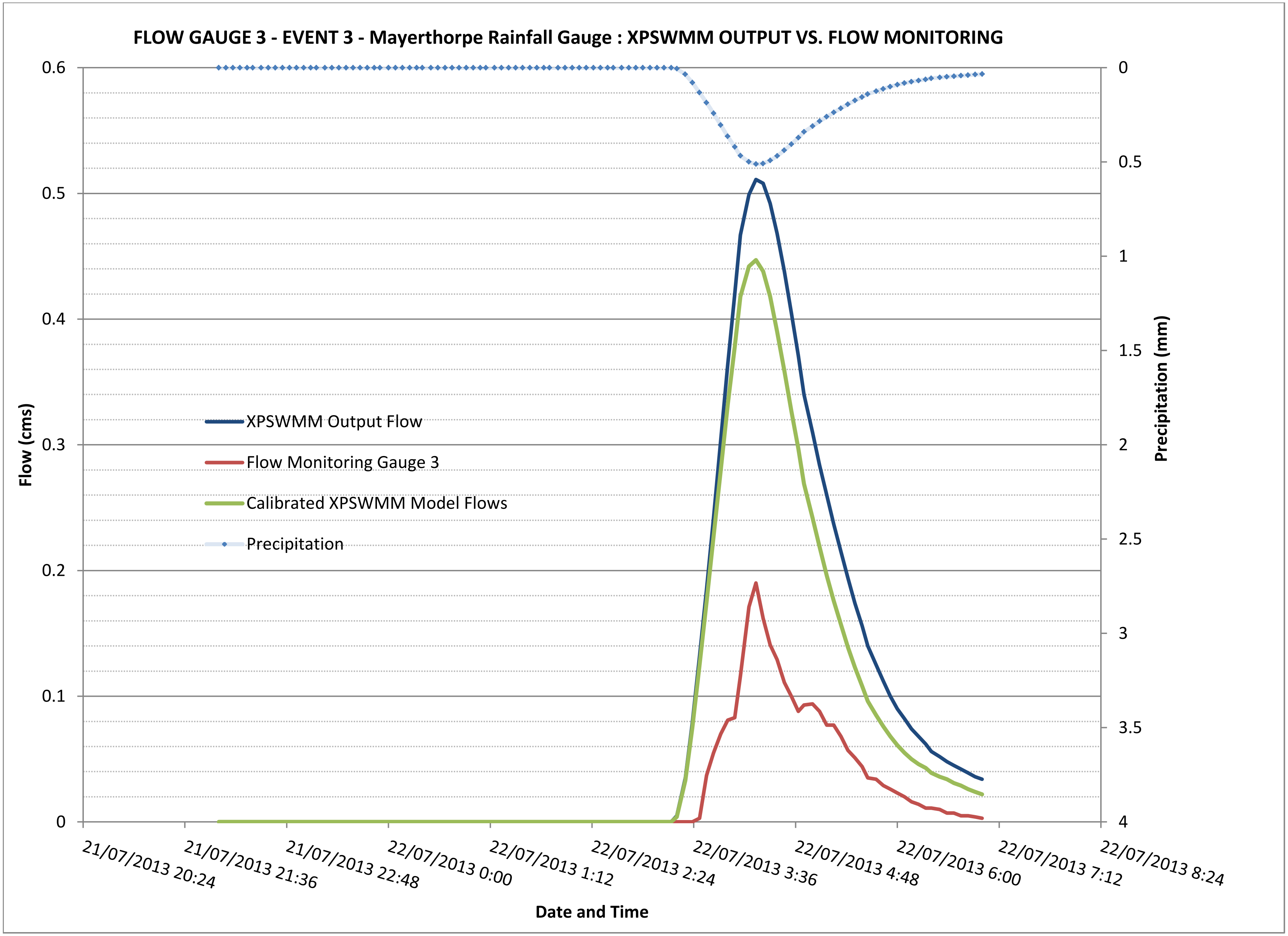
Event #	Date/Time	Duration	Rain (Mayerthorpe)			Runoff Volume					Peak Flow				
			Total Rain Depth (mm)	Total Rain Volume (m^3)	Max. Intensity (mm/hr)	Observed (m^3)	Un-calibrated (m3)		Calibrated (m3)		Observed (m^3/s)	Un-calibrated (m3)		Calibrated (m3)	
							Volume (m^3)	Difference to Observed	Volume (m^3)	Difference to Observed		Peak Flow Rate (m^3/s)	Difference to Observed	Peak Flow Rate (m^3/s)	Difference to Observed
1	17/07/2012 9:00:00 PM to 18/07/2012 2:50:00 AM	6 hr 50 min	27	1155	25.5	260	512	97%	469	80%	0.05	0.13	147%	0.11	118%
2	23/07/2012 5:00:00 AM to 24/07/2012 1:50:00 AM	20 hr 50 min	70	2927	25.2	621	1930	211%	1126	81%	0.08	0.22	173%	0.15	89%
4	21/07/2013 10:00:00 PM to 22/07/2013 6:55:00 AM	8 hr 55 min	20	827	17.7	114	254	122%	183	60%	0.03	0.07	159%	0.06	104%



FLOW GAUGE 3- EVENT 1 - Mayerthorpe Rainfall Gauge : XPSWMM OUTPUT VS. FLOW MONITORING
Flow (cms)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Precipitation (mm)
0
20
40
60
80
100
120
140
160
180
200
Flow Monitoring Gauge 3
XPSWMM Model Flow
Calibrated XPSWMM Flows
Precipitation
17/07/2012 19:12
17/07/2012 20:24
17/07/2012 21:36
17/07/2012 22:48
18/07/2012 0:00
18/07/2012 1:12
18/07/2012 2:24
18/07/2012 3:36
Date and Time



FLOW GAUGE 3 - EVENT 2 - Mayerthorpe Rainfall Gauge : XPSWMM OUTPUT VS. FLOW MONITORING
Flow (cms)
Precipitation (mm)
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
450
XPSWMM Output Flow
Flow Monitoring Gauge 1
Calibrated XPSWMM Model Flows
Precipitation
23/07/2012 2:24
23/07/2012 4:48
23/07/2012 7:12
23/07/2012 9:36
23/07/2012 12:00
23/07/2012 14:24
23/07/2012 16:48
23/07/2012 19:12
23/07/2012 21:36
24/07/2012 0:00
24/07/2012 2:24
Date and Time


FLOW GAUGE 3 - EVENT 3 - Mayerthorpe Rainfall Gauge : XPSWMM OUTPUT VS. FLOW MONITORING
Flow (cms)
0.6
0.5
0.4
0.3
0.2
0.1
0
Precipitation (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
XPSWMM Output Flow
Flow Monitoring Gauge 3
Calibrated XPSWMM Model Flows
Precipitation
21/07/2013 20:24
21/07/2013 21:36
21/07/2013 22:48
22/07/2013 0:00
22/07/2013 1:12
22/07/2013 2:24
22/07/2013 3:36
22/07/2013 4:48
22/07/2013 6:00
22/07/2013 7:12
22/07/2013 8:24
Date and Time

Feb 11, 2014

Event #	Date/Time	Duration	Rain (Mayerthorpe)			Runoff Volume					Peak Flow				
							Un-calibrated (m3)		Calibrated (m3)			Un-calibrated (m3)		Calibrated (m3)	
			Total Rain Depth (mm)	Total Rain Volume (m^3)	Max. Intensity (mm/hr)	Observed (m^3)	Volume (m^3)	Difference to Observed	Volume (m^3)	Difference to Observed	Observed (m^3/s)	Peak Flow Rate (m^3/s)	Difference to Observed	Peak Flow Rate (m^3/s)	Difference to Observed
1	17/07/2012 9:00:00 PM to 18/07/2012 2:50:00 AM	6 hr 50 min	27	1155	25.5	1908	4892	156%	3689	93%	0.74	0.85	15%	0.72	-1%
2	23/07/2012 5:00:00 AM to 24/07/2012 1:50:00 AM	20 hr 50 min	70	2927	25.2	10852	17121	58%	10882	0%	0.87	1.09	25%	0.95	9%
3	21/07/2013 10:00:00 PM to 22/07/2013 6:55:00 AM	8 hr 55 min	20	827	17.7	734	2790	280%	2285	211%	0.19	0.51	169%	0.45	135%