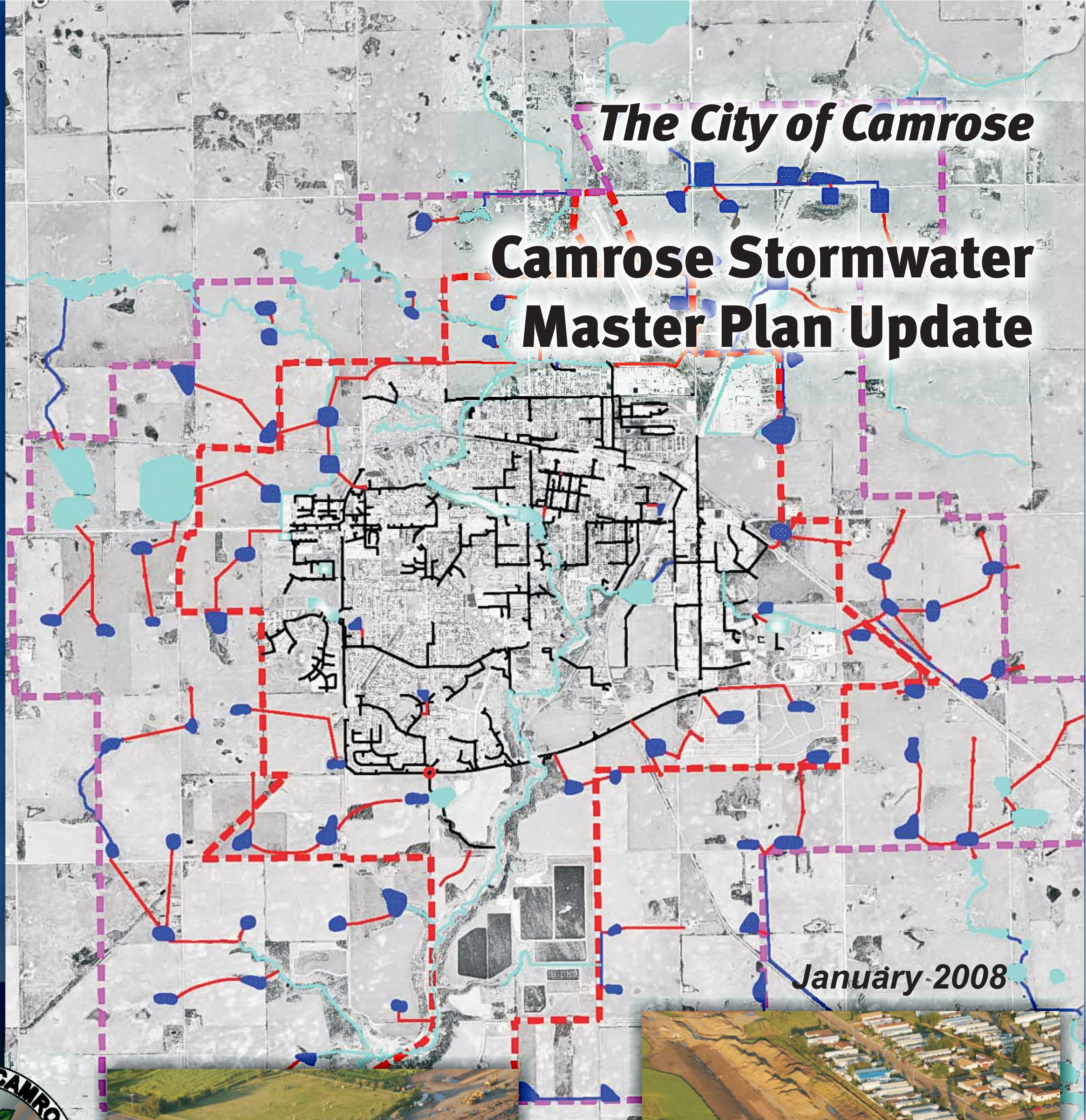
REPORT

The City of Camrose

Camrose Stormwater Master Plan Update



January 2008

Associated Engineering

Associated Engineering
GLOBAL PERSPECTIVE.
LOCAL FOCUS.

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January 16, 2008

File: 053804 - 5.0

Mr. Jeremy Enarson, E.I.T.
Assistant Municipal Engineer
City ofCamrose
5204 - 50th Avenue
Camrose, AB T4V 0S8

Re: CITY OF CAMROSE
CAMROSE STORMWATER MANAGEMENT MASTER PLAN

Dear Sir:

Enclosed please find twenty (20) copies of our above mentioned report.

The report contains an assessment of the existing stormwater drainage system capacity and a conceptual plan of storm drainage and stormwater management to accommodate future growth in the City of Camrose. It is a companion document to the sanitary Sewer Master Plan. We are confident that it will serve the City's needs for some time to come.

We thank you for the opportunity to assist you in this project. Please do not hesitate to contact the undersigned should you have any questions.

Yours truly,

Larry E. Bodnaruk P. Eng.
Project Manager

LEB/ja

Enclosures

REPORT

Executive Summary

1 PROJECT SCOPE

The City of Camrose requested Associated Engineering to update its Stormwater Master Plan which was developed in 2000. General objectives were to include development that have occurred since 2000, and changes to provincial and Federal legislation with regard to stormwater discharge. Stormwater management is now required for all new developments, with greater emphasis on water quality control and preservation of fisheries habitat. The master plan will also provide a framework for development over the next 50 years and more.

The present study builds on the previous Master Drainage Plan and provides updated and more detailed information to guide future development. This included the following:

- review recent and proposed developments within the City and update the computer models, where required,
- assess the existing system capacity using the latest planning information and design criteria,
- review system deficiencies and areas of spare capacity,
- develop an upgrade plan and assessment of capital priorities,
- review design standards and requirements for new and redevelopment areas,
- provide guidelines for future development areas.

The project involved the following tasks:

- update models to include new areas that have been developed in Camrose as well as new facilities that are in the planning stage,
- provide more detail for each basin,
- prepare a separate section for each area (neighborhood or sub-basin) that is indexed and easy to find, with an index map for the entire City to help locate the sub-area. Each area will include:
  - sub-basin or neighborhood maps,
  - the connection point and how the area is to be serviced,
  - details of constraints, design flows, existing and required capacities, specific upgrade requirements and phasing, development guidelines and limits, and release rates.
- define stormwater management control parameters for each development area.
- define stormwater management guidelines for potential redevelopment in the downtown commercial area and adjacent residential areas.
- develop a servicing plan for industrial areas east of Exhibition Drive and north of Highway 13.
- provide more details for other areas that were not specifically identified in the 2000 Master Plan.

- re-assess the condition of the coulee through the University site and identify any protection or upgrades that should be implemented.

2 DESIGN CRITERIA

Much of the City of Camrose storm sewer system was designed to a lower standard (1:2 year storm) than exists today (1:5 year storm for the pipe system and 1:100 year storm for the streets and overland flow paths).

It is practically impossible to upgrade existing drainage systems to meet current standards, short of replacing the storm sewers and re-grading the streets. Instead, stormwater management objectives in existing development areas should be to prevent damage to private property, especially buildings, in a major storm event, with priority to those areas where physical damage to private property has actually been reported.

The following changes are recommended to the City's servicing standards for storm drainage systems in future development areas:

- Increase the runoff factor for commercial areas from 0.65 for neighbourhood commercial and 0.80 for downtown commercial to 0.9 for all commercial land uses.

- Increase the runoff factor for industrial land uses from 0.70 to 0.80 in the 1:100 year storm (1:5 year is unchanged at 0.60).

- Increase the maximum flood storage depth from 1.2 m for wet ponds and 1.5 m for dry ponds, to a maximum of 2.0 m for all stormwater management ponds, to reduce the cost of stormwater management facilities.

- Provide 1.0 m of freeboard above the 1:100 year flood level to allow for more severe storms and unforeseen conditions.

- Provide an emergency overflow below the freeboard (property) line to protect private property from flooding adjacent to these ponds.

- Specify a maximum release rate of 5.0 l/s/ha for the design of stormwater management ponds and a maximum drawdown time of 3 days in residential areas, 4 days in industrial areas, and 5 days in commercial areas.

3 EXISTING SYSTEM CAPACITY

Portions of the pipe system are surcharged in the 1:5 year storm, and surcharge levels reach ground surface in places, especially along Marler and Mount Pleasant Drives, and locally in areas north and east of the downtown area.

Storm sewer performance is somewhat better in the newer areas that were constructed within the past 15 years and were designed for free-flow capacity in the 1:5 year storm.

The major drainage system performs reasonably well and there are relatively few complaints of property damage resulting from surface runoff. Large flows do occur on the street during major storm events but these are difficult (costly) to rectify and are mostly an inconvenience to the residents.

There is some flood potential at six trapped lows in the City. These are shown on Figure ES-1 and are located as follows (numbered to match Figure ES-1):

- #5 42 Avenue and 62 Street
- #7 Erickson Drive north of 36 Avenue
- #8 Parkview Drive at Camrose Drive
- #9 55 Avenue at 51 Street
- #12 48 Street between 50 and 51 Avenue
- #13 50 Avenue near 43 Street

Upgrades that the City has completed in the past five years have significantly reduced surcharge levels, improved drainage conditions, and reduced the risk of flooding in several areas.

Erosion is continuing in the ravine through the Augustana College, although there is some indication that natural armouring is occurring through selective erosion of till materials through which the ravine cuts. The newly constructed Augustana land bridge may help to reduce the erosion upstream of its location slightly, by providing a fixed point in the vertical profile.

Some erosion is occurring in the main drainage channel through the Mohler industrial area downstream of 41 Street and at the inlet to the CNR Mohler pond upstream of the CNR.

4 PROPOSED UPGRADING PLAN

It is not cost-effective to upgrade the existing storm drainage system to today's standard; instead a program of selective upgrading, with a total cost of about $2.4 million, is recommended to minimize flooding of private property. Figure ES-2 shows the general locations of the proposed works and Appendix A provides details. Table ES-1, which is reproduced in the following page, provides a summary of the proposed upgrades and their cost estimates at a conceptual level of accuracy.

The channel through the Mohler Industrial area, from 41 Street to the CNR Mohler pond, should be reshaped and protected against further erosion. The alternative of a storm trunk in conjunction with a major drainage route should be considered in the design stage.

The City should consider upgrading storm sewers in existing developed areas to current design criteria should they need to be replaced for structural or other reasons.

5 FUTURE DEVELOPMENT NEEDS

The City is expected to grow outward in concentric rings from the existing development area, generally following the logical direction of drainage development from downstream to upstream, and outward from Camrose Creek, which will facilitate the orderly development of services with a minimum of leap-frogging and over-sizing.

Stormwater management will be required in all new developments to control peak runoff rates and improve water quality.

A maximum outflow rate of 5 L/s/ha is proposed for pond design in Camrose, which provides a reasonable balance between the theoretical pre-development flow (3.5 L/s/ha) and drawdown criteria (5-7 L/s/ha). Preliminary estimates of storage volume required to control flows to this level are as follows:

Residential areas	550 m^3/ha
Industrial areas	800 m^3/ha
Commercial areas	930 m^3/ha

Large areas on the east side of the City (east of the airport and east of the Mohler Industrial area) drain through existing drainage systems that will need to be extended to serve these areas. A new outfall will also be required on northwest side of the City to drain the areas west and south of the Cornerstone development.

The proposed stormwater management concept plan in Figure ES-3 provides for more than 50 years of growth in the City of Camrose. Details are provided in Appendix B, subject to review during the development planning and subdivision design process.

A more detailed assessment of the storm sewer system in the downtown area should be undertaken if redevelopment is considered in the future, with the storm sewers upgraded to provide greater capacity as is common for high volume commercial areas.

In a redeveloping site, in existing serviced areas (in-fill or intensification), it is suggested that on-site stormwater management be provided on parking lots and rooftops for all parcels larger than 0.5 hectares, releasing at a rate of 35 L/s/ha which corresponds roughly to the 1:2 year storm runoff rate that was used in the original design of the storm sewer system. The City should look for opportunities for on-lot stormwater management on lots smaller than 0.5 ha. A storm service connection should be provided for the stormwater management facility, except for lots smaller than 0.5 ha, which could be allowed to discharge on the surface.

Future stormwater management facilities near the airport should be designed as dry ponds or have minimal water areas with naturalized shorelines, to discourage the presence of birds and waterfowl that can be a threat to aircraft.

The coulee through the Augustana College should be monitored for erosion and corrective action taken as required.

The drainage channel through the CRE site should be modified to bypass the upstream flows, and provide separate storage for the lower campground areas.

New developments draining to the 39 Street trunk in the northeast of the Mohler Industrial area, should provide stormwater detention facilities and the area north of the CPR should be drained to the north with the widening of 39 Street to four lanes, to reduce surcharge levels in the 39 Street trunk

Table ES.1
Camrose Storm Sewer Master Plan
Capital Priorities Plan
(See Figure ES-2 for locations)

ITEM #	PROPOSED UPGRADE	PURPOSE	SCOPE OF WORK*	APPROXIMATE COST*	Cost Rating**	Benefit Rating**	Benefit/ Cost Rating***	Relative Priority (1=highest, 8=lowest)
9	Swale from 55 Avenue to Ring Road ROW	Prevent flooding at sag at 55 Avenue and 51 Street	50 m swale and easement	$ 22,000	1	2	2.0	1
17	CRE pond improvements	Prevent overloading of CRE pond; provide capacity for campsite development	Re-align channel and construct 1,600 m^3 dry pond	$ 54,000	1	2	2.0	1
15	Rehabilitate and protect Mohler channel	Reduce erosion of channel; protect sanitary line at inlet to pond	300 m of channel restoration plus gabion drop structure at CNR pond inlet	$ 420,000	2	3	1.5	3
5	Dry pond in park at 67 Street and 42 Avenue	Prevent flooding at sag due to surcharged storm sewer	1500 m^3 dry pond plus 120 m of 900 mm storm sewer	$ 490,000	2	2	1.0	4
8	Intercept Camrose Drive storm sewer	Reduce flooding at Erickson Drive intersection	2 manholes and 750 m storm sewer	$ 61,000	1	1	1.0	4
12	Downtown storm sewer inter-connections	Reduce surcharge levels and potential for flooding in the Downtown area	110 m of 450 and 900 mm storm sewer	$ 380,000	2	2	1.0	4
13	Dry pond in park at 49 Avenue and CNR (Bethany)	Prevent flooding in street sags on 50 Avenue near 43 Street	2600 m^3 flood storage plus 140 m of 600 mm storm sewer	$ 550,000	3	2	0.7	7
7	Dry pond in park at Erickson Drive and 36 Avenue	Prevent flooding at sag due to surcharged storm sewer	1000 m^3 dry pond plus 140 m of 600 mm storm sewer	$ 400,000	2	1	0.5	8
	Total Cost			$ 2,377,000				
	Within 5 years			$ 2,377,000				
	5-10 years			$ -				
	Beyond 10 years			$ -				

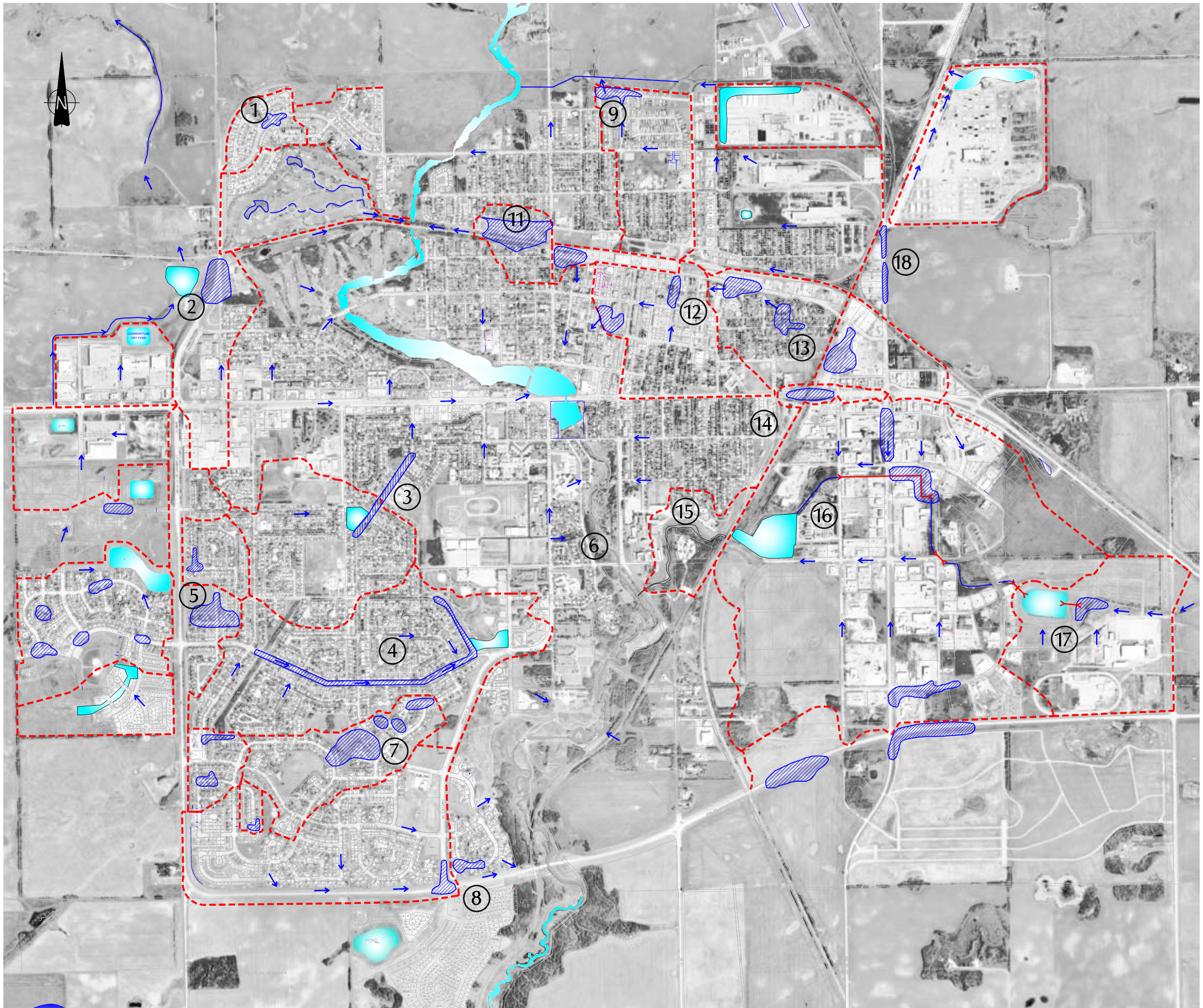
* 2008 budget level estimates only (subject to confirmation in final design) including construction, contingency (40%), engineering (15%), and GST (5%)

**Cost and benefit ratings:

Rating	Cost	Benefit
1	<$100,000	Reported or simulated street flooding
2	$100,000-$500,000	Simulated property damage
3	>$500,000	Reported property damage

*** = Benefit Rating / Cost Rating

Note: excludes developer-funded system expansion costs



THE CITY OF CAMROSE

MAJOR DRAINAGE SYSTEM

LEGEND:

- CATCHMENT BOUNDARY
- FLOW DIRECTION
- CULVERT
- TRAPPED LOW (NOT NECESSARILY FLOODED)
- SWM POND
- 4 LOCATION NUMBERS IN REPORT TEXT

SCALE : 1 : 20 000

JANUARY, 2008

FIGURE ES-1

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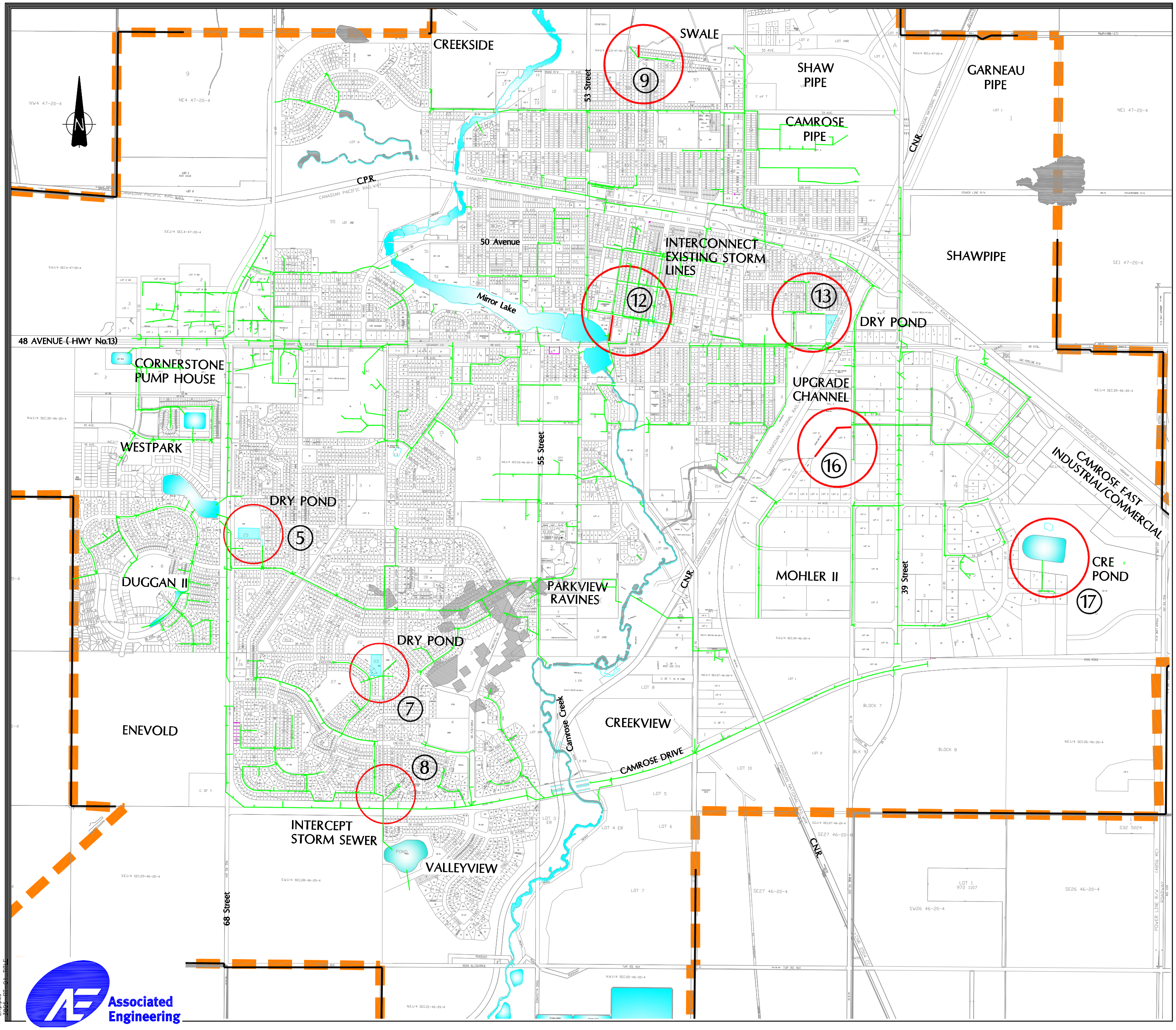


THE CITY OF CAMROSE

STORM WATER MASTER PLAN
PROPOSED UPGRADING PLAN

LEGEND:

- CITY BOUNDARY
- EXISTING STORM SEWER
- PROPOSED STORM SEWER
- MANHOLE
- STORM WATER POND
- (4) PROPOSED UPGRADE LOCATION

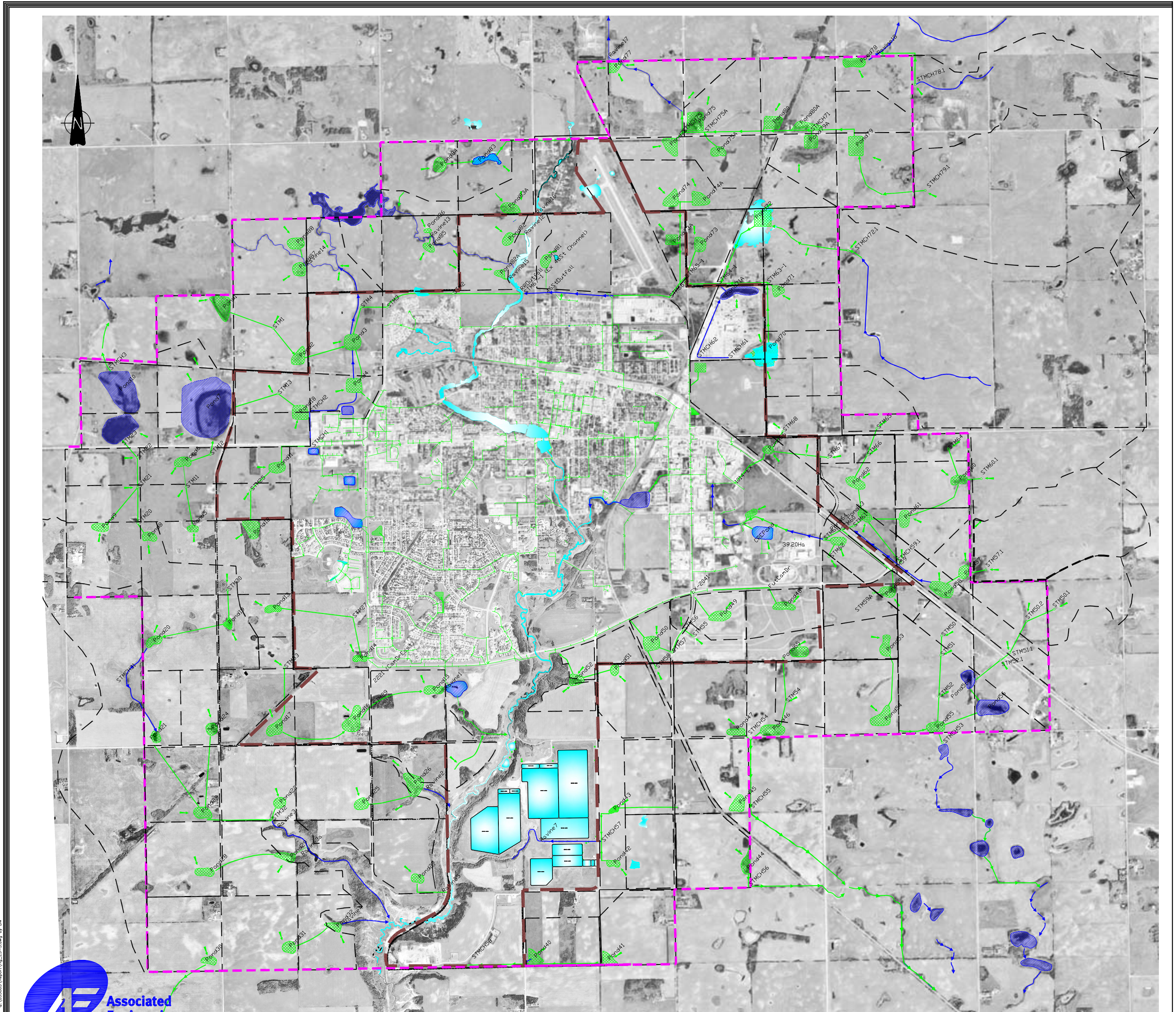
NOTE: 2005 PIPE NETWORK

0 500 1000

SCALE: 1 : 20,000

JANUARY, 2008

FIGURE ES-2



Associated Engineering

THE CITY OF CAMROSE

STORM SEWER DRAINAGE CONCEPT PLAN

LEGEND:

- CAMROSE CREEK FLOOD PLAIN
- EXISTING WETLAND
- EXISTING STORM SEWER
- PROPOSED STORM TRUNK
- STORM INLET NODE
- STORM PUMP STATION
- STORMWATER MANAGEMENT FACILITY
- EXISTING DRAINAGE CHANNEL
- PROPOSED DRAINAGE CHANNEL
- SUB-CATCHMENT BOUNDARY
- CITY BOUNDARY
- PLAN AREA BOUNDARY

SCALE : 1 : 40 000

JANUARY, 2008

FIGURE ES-3

Table of Contents

1 Introduction

The City of Camrose requested Associated Engineering to update its Stormwater Master Plan.

In 2000, Associated Engineering completed the Master Drainage Plan for the City of Camrose. The master plan was a strategic planning document that provided an overall concept plan and general guidelines for upgrading and developing the storm and sanitary drainage systems.

Since the completion of the master plan in 2000, there has been considerable development in the City and a number of changes to the drainage system. The design and construction of recent developments have also identified drainage options and constraints that need to be considered. There have also been changes to provincial and Federal legislation with regard to stormwater discharge. Stormwater management is now required for all new developments, with greater emphasis on water quality control and preservation of fisheries habitat.

The City now requires an updated document that provides more current direction.

Figure 1.1 provides an overview of the City of Camrose and the existing storm drainage system. It shows the areas that are currently developed or under development, areas remaining to be developed within the City boundary, and future development areas outside the City boundary that are included in the plan area. Camrose has experienced considerable growth in the past number of years. As a result the study area for this Master Plan update has been expanded so that the City will be able to plan for and service future developments.

1.1 OBJECTIVES

The present study builds on the previous Master Drainage Plan and provides more updated and more detailed information to guide future development. This includes the following:

- review recent and proposed developments within the City and update the computer models, where required,
- assess the existing system capacity using the latest planning information and design criteria,
- review system deficiencies and areas of spare capacity,
- develop an upgrade plan and assessment of capital priorities,
- review design standards and requirements for new and redevelopment areas,
- provide guidelines for future development areas.

1.2 PROJECT SCOPE

This project involved the following tasks:

- update models to include new areas that have been developed in Camrose as well as new facilities that are in the planning stage,
- provide more detail for each basin,
- prepare a separate section for each area (neighborhood or sub-basin) that is indexed and easy to find, with an index map for the entire City to help locate the sub-area. Each area will include:
  - sub-basin or neighborhood maps,
  - the connection point and how the area is to be serviced,
  - details of constraints, design flows, existing and required capacities, specific upgrade requirements and phasing, development guidelines and limits, and release rates.

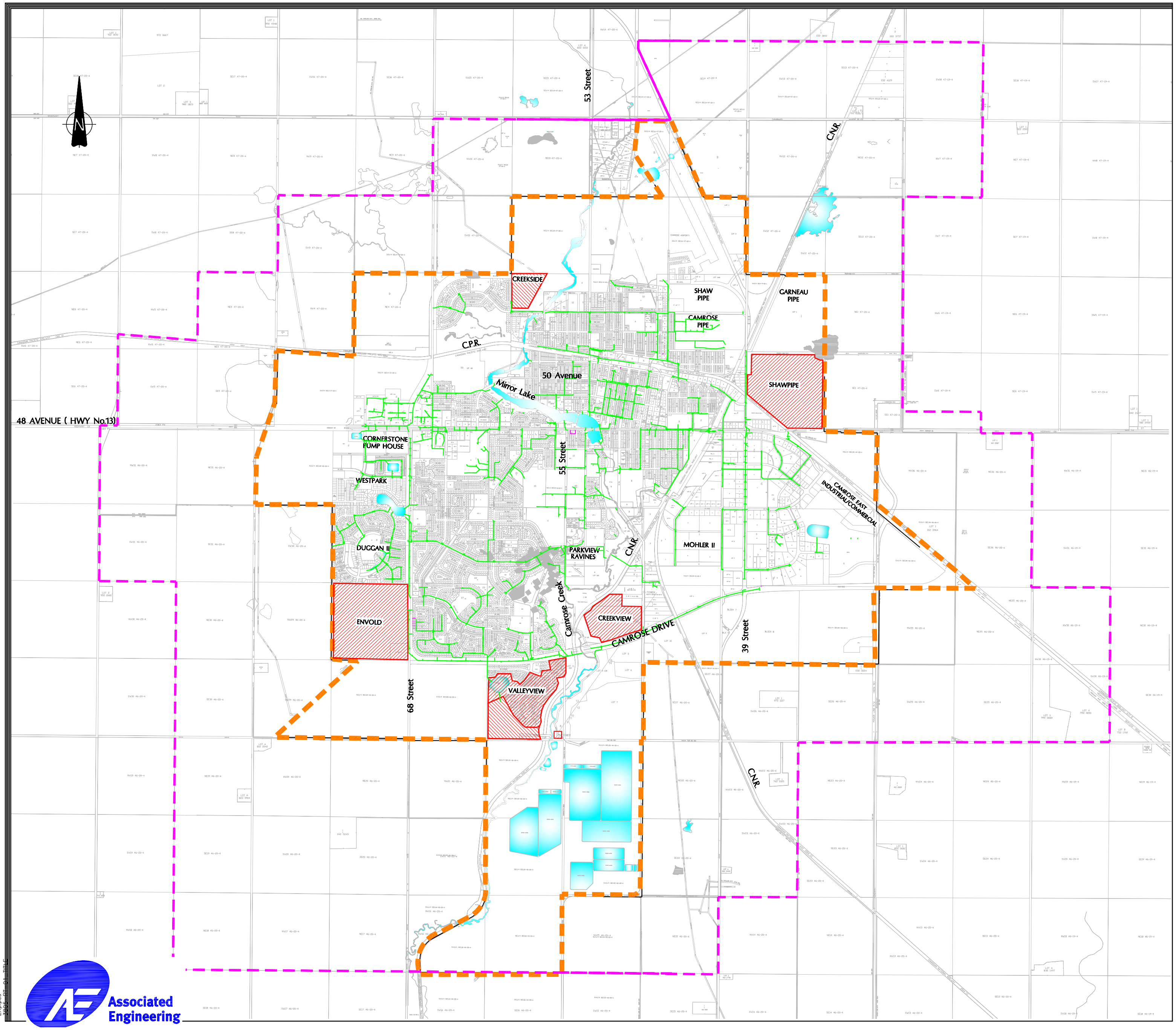
Special requirements of the Stormwater Master Plan Update are to:

- define stormwater management control parameters for each development area,
- define stormwater management guidelines for potential redevelopment in the downtown commercial area and adjacent residential areas,
- develop a servicing plan for industrial areas east of Exhibition Drive and north of Highway 13,
- provide more details for other areas that were not specifically identified in the 2000 Master Plan,
- re-assess the condition of the coulee through the University site and identify any protection or upgrades that should be implemented.

1.3 BACKGROUND DATA

The following data and reports were used in this study:

- GIS information (pipes diameters, inverts, ground elevations)
- Record plans or design drawings for recent developments
- Updated cadastral plans, contours and airphotos
- DEM elevation data from AltaLis for areas outside of the City contours
- 1999- Southwest Camrose Flood Study, Associated Engineering
- 2000- Storm and Sanitary Master Plan, Associated Engineering
- 2002- Mohler Olstead Industrial Area Drainage Upgrade Plan, Associated Engineering
- 2002- Enevold Subdivision Storm and Sanitary Pre-Design Report, Bek MK
- 2002- Valleyview Subdivision Storm and Sanitary Pre-Design Report, Bek MK
- 2005- Camrose Resort and Casino Stormwater Management Report, Earth Tech
- 2006- Camrose Sports Development Center Stormwater Design, Stantec
- 2006- Creekview Area Structure Plan, Stantec



THE CITY OF CAMROSE

EXISTING STORM SEWER COLLECTION SYSTEM

LEGEND:

- CITY BOUNDARY
- INTERIM DEVELOPMENT (< 5 Years)
- STORM SEWER
- PLAN AREA BOUNDARY

NOTE: 2005 PIPE NETWORK

0 500 1000

SCALE: 1 : 40,000

JANUARY, 2008

FIGURE 1.1

2 Design Criteria

Design criteria were adopted from current City standards and Alberta Environment stormwater management guidelines. The following is a summary.

2.1 DESIGN STORM

In most of the existing developed areas of the City, which were developed before the late 1980's, the existing storm sewer system was designed to have capacity for the 1:2 year storm.

In more recent years the design standard in the City of Camrose has required that the minor system be designed to have capacity for the 1:5 year storm and that the major drainage system be designed to accommodate the 1:100 year storm. New drainage systems will be developed to meet these criteria.

It is practically impossible to upgrade existing drainage systems that were developed to a lesser standard, to meet current standards, short of replacing the storm sewers and re-grading the streets. Therefore the assessment will aim to meet the following criteria:

- Prevent sewers from surcharging to grade in a minor (1:5 year storm event),
- Limit the potential for flooding of private property in a major (1:100 year) storm event.

Table 2.1 provides a summary of the design storm events used in this study for the assessment of the existing drainage system.

Table 2.1
Design Storms for the Assessment of the Existing Storm Drainage System

Component	Return Period	Duration	Distribution	Design Objective
Existing storm sewers (minor system)	1:2 years	4 hours	City of Edmonton "Chicago" type storm	- no surcharge
	1:5 years	1 hour	City of Camrose design storm	- no flooding on street
Existing street sags (major system)	1:100 years	4 hours	City of Edmonton "Chicago" type storm	- no flooding of buildings - maximum depth 0.5 m

Future storm sewers are sized for the 1:5 year storm as specified in the City of Camrose Development Standards.

2.2 RUNOFF FACTORS

The following runoff factors were used for sizing storm sewers using the Rational Method and stormwater management facilities using the Modified Rational Method, based on the City of Camrose Development Standards and local experience:

Table 2.2
Runoff Factors*

Land Use	1:5 Year Storm	1:100 Year Storm
Single-family Residential	0.4	0.6
Multi-family Residential	0.7	0.8
Industrial	0.6	**0.8**
Commercial	**0.9**	0.9

Values shown in bold in Table 2.2 are slightly higher than the minimum values specified in the City's Development Standards. For all Industrial land uses, the recommended runoff factor is 0.60 in the 1:5 year storm and 0.80 in the 1:100 year storm (City Standards require a minimum of 0.60 and 0.70 for Light Industrial and do not specify values for other industrial uses). A runoff factor of 0.90 is recommended for all commercial land uses (the Standards require a minimum value of 0.65 for neighbourhood commercial and 0.85 for downtown commercial for the 1:5 year storm and do not indicate a value for highway commercial).

2.3 HYDRAULIC MODEL PARAMETERS

The storm sewer system was modelled using the XP-SWMM computer model. XP-SWMM is a fully dynamic computer model designed for simulating flows and water levels in sewer systems. It contains a RUNOFF model to compute the runoff rate from lots and street services, and the HYDRAULICS model to compute the resulting flows and water levels. It is capable of simulating real storm events as well as design flows, and surcharging and backwater conditions as well as stormwater pond operation and reverse flows in complicated pipe systems. It uses a large number of parameters of which the key ones are described below:

- Runoff time step length: 5 minutes

- Runoff factor (Imperviousness) residential 40%
  industrial 60%
  commercial 90%

- XP Runoff Block Parameters:

  - Horton Infiltration Parameters
    - Initial Value (fo) 15 mm/hr
    - Final Value (fc) 4.0 m/hour
    - Decay Rate (k) 0.00115 hour-1
    - Average Overland Gradient 0.5%

  - Manning's Roughness Coefficient ("n") for overland flow
    - Impervious 0.014
    - Pervious 0.250

  - Interception storage
    - impervious areas 2.0 mm
    - pervious areas 5.0 mm
    - percent of area with zero detention 10%

2.4 STORM SEWERS

- Manning's roughness coefficient ("n"):
  - Open ditches 0.040
  - Concrete pipe 0.013
  - Corrugated metal pipe 0.025

- Minimum Cover 1.85 m above obvert (storm sewers)

2.5 STORMWATER MANAGEMENT FACILITIES

In general, stormwater management will be required in all new development areas to ensure that development does not lead to downstream flooding, to control erosion, and to protect the water quality in the receiving waters.

The previous Master Plan provided an analysis of pre-development flows based on Alberta Environment's floodplain study for the City of Camrose. It concluded that pre-development flows in the Camrose Creek basin were about 3.5 L/s/ha or less.

The previous study also included an analysis of storage volumes and drawdown times in stormwater management facilities. City of Camrose Development Standards requires that flood storage be emptied within 72 hours (3 days) after the end of the storm. The previous analysis demonstrated that that design outflow rates of 5 L/s/ha for would be required in residential areas, 6 L/s/ha in industrial areas, and 7 L/s/ha in commercial areas, to achieve this objective.

Currently, a maximum outflow rate of 5 L/s/ha is proposed for pond design in Camrose, irrespective of land use, which provides a reasonable balance between the theoretical pre-development flow (3.5 L/s/ha) and drawdown criteria (5-7 L/s/ha).

Table 2.3 shows the corresponding storage volume required for different land uses in the 1:100 year 24 hour storm based on a maximum release rate of 5 L/s/ha:

Table 2.3
Preliminary Storage Volumes and Drawdown Times for Stormwater Management Facilities
(For 1:100 Year Storm and Maximum Pond Outflow of 5 L/s/ha)

Land Use	Runoff Factor	Design Storage for the 1:100 Year Storm (m^3/ha)	Drawdown Time (hours)
Residential	0.6	550	61
Industrial	0.8	800	89
Commercial	0.9	930	103

These storage volumes were estimated using the Modified Rational Method, which computes a mass balance of runoff and outflow to estimate the storage volume. The Modified Rational Method uses the 1:100 year storm Intensity-Duration-Frequency Curve from the City of Edmonton, and the runoff factors (expressed as a proportion of runoff to rainfall) in the previous section of this report, to compute the storage volumes required in a range of storm having a duration of 5 minutes to 24 hours. The design storage volume corresponds to that storm which generates the highest storage volume for the given outflow rate of 5 L/s/ha.

The calculation assumes the following:

- That outflows vary in a linear fashion with time as the pond fills and drains (this is a reasonable approximation for most common gravity outlets, and will tend to overestimate storage volume for a pond with a constant, pumped outlet).

- That the maximum storage volume occurs at the end of the storm event (this assumption neglects temporal rainfall and catchment routing effects and tends to be slightly conservative).

In previous studies these assumptions have been found to produce similar results to computer model simulations and are therefore recommended for the planning and conceptual design of stormwater management facilities. Table 2.3 shows that the storage volumes required for different types of land uses will range from 550 m^3 per hectare of residential area to 930 m^3/ha in commercial areas. **The size of each pond should be confirmed prior to the design stage when details of the pond design and the development concept are finalized.**

The table also shows that the stormwater storage volumes would be emptied within 3 days after a major storm event in a residential area and approximately 4 days in a commercial area. Note that the City's Development Standards currently specify a maximum drawdown time (the time required to return to Normal Water Level after the design storm event) of 72 hours which would be exceeded in Commercial and industrial areas**. Therefore, the City's Development Standards for stormwater management ponds should be modified to specify a maximum release rate of 5.0 L/s/ha in the 1:100 year storm and a maximum drawdown time of 3 days in residential areas, 4 days in industrial areas, and 5 days in commercial areas**.

The following criteria were used for preliminary sizing of stormwater management facilities in future development areas. They are derived from City of Camrose Development Standards except as noted in bold below, and are typical of values used in other communities.

Wet (retention) ponds and wetlands:

- Design storage volume — 1:100 year storm
- Pond area — Minimum 2.0 ha at Normal Water Level
- Pond side slope — 7H:1V
- Permanent pool depth — Minimum 2.0 m
- Storage depth — Maximum 2.0 m above Normal Water Level **(Current City of Camrose standard specifies 1.2 m. A greater depth of 2.0 m is recommended to reduce pond size and land requirements)**
- Freeboard — **Recommend 1.0 m (vertical) to property line Emergency overflow above the 1:100 year water level and below the freeboard (property) line**

Dry (detention) ponds:

- Design storage volume — 1:100 year storm
- Pond side slope — 7H:1V
- Storage depth — Maximum 2.0 m **(Current City of Camrose standard specifies 1.5 m. A greater depth of 2.0 m is recommended to reduce pond size and land requirements)**
- Freeboard — **Recommend 1.0 m (vertical) to property line Emergency overflow above the 1:100 year water level and below the freeboard (property) line**

2.6 WATER QUALITY

Alberta Environment's stormwater management guidelines require 85% removal of suspended sediments larger than 75 microns (fine sand and larger particles). Experience has shown that this target can be achieved with wet (detention) facilities and stormwater wetlands, and may be achievable with dry (detention) facilities. However, suspended silt has a larger impact on aquatic habitat than sand, and, therefore, stormwater management practices should aim at reducing the silt load, at least for small and medium sized storm events.

Generally, wet ponds or wetlands provide a higher level of treatment than dry ponds, especially in the removal of nutrients, from urban runoff and are preferable to dry ponds from a water quality treatment point of view.

Generally, these criteria apply only to new developments. However, the standards and guidelines are subject to change over time and, where possible, water quality treatment facilities may be required in the future for existing development areas. As in the case of hydraulic design standards, Alberta Environment does not expect these water quality guidelines to be met in situations where constructing wet ponds and wetlands might not be possible due to space limitations.

Existing wetlands provide significant benefits in improving water quality and providing wildlife habitat and natural areas, and should therefore be preserved wherever possible. If they cannot be preserved, Alberta Environment will require replacement or compensation.

3 Existing Storm Drainage Systems

3.1 STORM SEWER (MINOR) DRAINAGE SYSTEM

In the 2000 Master Plan, the existing storm drainage system was modeled for the 1:2 year and the 1:5 year storms to determine its capacity and to identify any constraints. Generally the previous analysis showed that most of the existing storm sewers have sufficient capacity to handle the 1:2 year storm, which was the design standard for much of the storm drainage system. Many of the storm sewers were surcharged in the 1:5 year storm. In some places, surcharge reached ground surface, which could contribute to surface flows and the risk of flooding in the major drainage system.

To the layman, water collecting on the street is often termed “flooding”, whether it causes physical damage or not. In the context of this report, flooding is deemed to be water on the street that is likely to cause property damage, especially damage to buildings, or exceeds a rate or velocity that poses a serious safety hazard to people. This is a somewhat qualitative criterion, as it varies with local conditions, lot grading and curb elevations. Priority is given to those locations where physical damage to private property has actually occurred and then to those locations where the model results indicate it is likely to occur.

The previous study identified a number of issues and constraints. Subsequently the City has a addressed a number of these concerns by upgrading the storm drainage system in a number of areas:

- Twinning of the main trunk line in the Mohler Industrial area between 39 Street and 41 Street,
- Construction of the CNR Mohler Pond to control flows from the industrial area, prevent flooding upstream of the CNR, and reduce the rate of erosion in the ravine downstream of the CNR,
- Construction of the 46 Street Storm trunk and outfall channel to Camrose Creek, to improve drainage in the Rosebud area and along 46 Street and adjacent areas.

In addition there has been considerable development in the Mohler and Cornerstone areas, which have added flows to the downstream system at a controlled rate. In the current assessment the storm sewer model was updated to include these upgrades and new developments. The updated model was used to simulate the 1:5 year storm.

Figures 3.1 and 3.2 show the principal results of the 1:5 year storm simulation with the current pipe system:

- Figure 3.1 shows the peak flow loading in each pipe, being the ratio of peak discharge to the pipefull capacity (Q_p/Q_{cap}). A value of 1.0 means that the pipe is operating at its theoretical pipefull capacity, and a higher value indicate that the pipe is carrying more flow than it was designed to carry. Generally, the potential impacts increase with higher peak flow loadings.

- Figure 3.2 shows the surcharge level in each manhole, being the level of the water surface below ground level.

Appendix C provides longitudinal profiles for the main trunks showing the hydraulic grade line profile (water level) in the 1:5 year storm.

The model results show that portions of the pipe system are surcharged in the 1:5 year storm, and that surcharge levels reach ground surface in places. Key areas are along Marler and Mount Pleasant, and locally in areas north and east of the downtown area. Storm sewer performance is somewhat better in the newer areas that were designed for free-flow capacity in the 1:5 year storm.

Currently the City of Camrose requires storm sewers to be designed for the 1:5 year storm event and the major drainage system to be designed for the 1:100 year storm. Previously, storm sewers in Camrose and elsewhere were designed for the 1:2 year to 1:5 year storm event and little consideration was given to the major drainage system. Consequently, in a major storm that exceeds the pipe capacity, runoff gathers in low places on the street where it could potentially flood private property. Generally, upgrading an existing system to provide the capacity required by current design standards would be costly and expensive and is typically done where flooding is actually experienced.

The storm sewer model was used to simulate the system performance in the major, 1:100 year 4 hour duration, storm event. Figure 3.3 shows the simulated surcharge levels. Red dots on this map show locations where the storm sewer system is surcharged to ground surface and could overflow to the street, causing ponding in low areas. The dots are scaled in proportion to the overflow volume, and therefore the larger dots show areas of greatest concern. The red dots are labelled to show the approximate volume of ponding (greater than 150 m^3). Note that model results for a major storm event are only approximate as the actual volume and locations of ponding depend on the inlet capacity and details of the major drainage system that are not explicitly modelled (except in the Century Meadows area where a more detailed model was developed for the design of this neighbourhood).

Generally the surcharged manholes correspond to locations where the City staff has noted water on the streets in a major storm event. The most affected areas include:

- The Marler and Mount Pleasant area,
- The north side of the City along 55 Avenue, east of the creek,
- The east end of the downtown area.

The impact of these surface flows depends on the performance of the major drainage system as will be discussed below.

These results will be reviewed in greater detail in the system assessment later in this section.

3.2 SURFACE (MAJOR) DRAINAGE SYSTEM

The major drainage system consists of the streets, channels, and overland flow paths that carry runoff to the storm sewer inlets, and carry the extra runoff that exceeds the pipe system capacity in a major storm event.

Figure 3.4 shows the major overland flow system in the existing developed areas of Camrose. The map shows the general direction of surface drainage, the locations of trapped lows and stormwater management facilities, and the outline of the drainage areas contributing to those trapped lows and stormwater ponds. Trapped lows are topographically low areas where water may collect during a major storm. These trapped lows could be at risk of flooding in a major storm event if the pipe capacity is restricted or is insufficient to drain these areas. The actual extent of flooding depends on a number of factors, including the capacity of the storm sewer pipe system, the area draining to the site, and the depth of the trapped low below its spill point.

There are also a number of shallow street sags where the maximum potential depth of ponding is relatively minor; these are generally of no great concern and are therefore not shown on this map.

The major drainage map shows that:

- Most of Camrose has a continuous major drainage system, with relatively few trapped lows, due to its proximity to Camrose Creek.
- The trapped lows that do exist tend to be located in the upper reaches of the drainage system, where the topography is flatter and where they drain relatively limited areas. This reduces their potential for flooding.
- The continuous street grades lead to long runs on the street. Combined with the relatively limited pipe capacity (typically a 1:2 year design capacity), this leads to large flows on the street surface such as occurred in the June 5, 2007 storm (see Photo 3.1).
- There are relatively long runs on the street to the first catchbasin or inlet to the storm sewers, in some places as long as 400 m, which also contribute to large street flows

The City has recently constructed two dry ponds in Marler and Kinsmen Park to relieve surface flooding problems in those areas. Photo 3.2 shows the dry pond in Kinsmen Park during the June 2007 storm when it was filled with overflow from the street surface.

In general the major drainage system performs reasonably well and there are relatively few flooding (as previously defined) complaints resulting from surface runoff. Large flows do occur on the street during major storm events but these are difficult (costly) to rectify and are mostly an inconvenience to the residents except where they may flood private property.

Potential problem areas are at the following locations (numbered to correspond to Figure 3.4):

5. 67 Street at 42 Avenue – trapped low that could flood private property when the storm sewer surcharges.

7. Between Mount Pleasant Drive and Erickson Drive, near 58 Street - several trapped lows that could flood onto private property.

8. Parkview Drive at Camrose Drive – localized street flooding occurs at the intersection and will potentially shut down the intersection during a major storm event.

9. 56 Avenue at 51 Street – trapped low at intersection could spill through private property.

12. 48 Street between 50 and 51 Avenue – street flooding reported in 2008.

13. Northeast of downtown area – three trapped lows exist near 51 Avenue.

These are discussed in greater detail below.

3.3 STORM DRAINAGE SYSTEM ASSESSMENT

The previous study contained a detailed assessment of system capacity and identified a number of deficiencies that should be addressed. In general, the results of the previous study still apply. These will be reviewed below based on the revised modeling of the storm sewer system and the major drainage system constraints and issues.

The discussion focuses on specific deficiencies or areas of concern, and proposed remedial measures. These are shown conceptually in Figure 3.5. The discussion also refers to the major drainage system plan in Figure 3.4 and simulated ponding conditions in the 1:100 year storm in Figure 3.3. Appendix A provides details of the proposed upgrade plan.

3.4 VICTORIA PARK

The Victoria Park drainage basin is located in the northwest corner of the City of Camrose (see Figure 3.2 for location). It consists of two separate pipe networks; in the west, pipes collect runoff along 66 Street and 64 Street and discharge to a pond in the golf course, and in the east, runoff is carried along 54 Avenue to the outfall at Camrose Creek.

Existing System Capacity: Modeling indicates this system would be surcharged in the 1:5 year storm but this is generally not a concern due to good street drainage and proximity to the creek, which allows excess runoff to drain via the roadway. Roadway drainage (the major system) runs to the corner of 66 Street and 53 Avenue which has no surface outlet other than through private property. Flooding to a depth of 0.4 m is estimated at this location. (Item 1 in Figure 3.4)

Upgrades for Existing Conditions: Upgrading of the 66 Street storm line would be required if flooding of the 66 Street/53 Avenue sag is to be prevented. However as the depth of flooding is not severe, this upgrading is given low priority.

The City has reported that the Victoria Park storm sewer system could back up due to backwater from the downstream channel through the golf course. **This channel should be cleaned out and maintained as required to prevent backup into the storm sewer system.**

Upgrades for Future Conditions: Outlying areas to the west and north are too low to be drained to the existing storm sewers in Victoria Park and will drain to a separate system when they are developed.

3.5 GRANDVIEW/CORNERSTONE

The Grandview storm basin consists of two pipe systems: Grandview East and Grandview West. These systems drain areas located on the west side of Camrose on the north and south sides of Highway 13. There are two outfalls, one for each storm line, which both discharge into the upstream end of Mirror Lake.

Since the previous study was completed, the Cornerstone Commercial development has occurred. It includes commercial developments on the north and south sides of Highway 13, west of 68 Street. In addition, West Park, which is a 42.7 ha residential subdivision, located south of Cornerstone is underway. Both of these new developments drain north and tie into the West Grandview system at 68 Street and 50 Avenue.

West Park has a stormwater management facility that acts as a surge pond. This pond drains north to the Cornerstone pond located on the south side of Highway 13. From here the pond outflow is pumped off-peak to a 900 mm culvert and continues by gravity across Highway 13 and north to the connection with Grandview West. There is also a drainage channel which carries the major overland flow from this pond and the area to the south, toward the northeast.

There is also a dry pond north of the Cornerstone commercial development that will control the flows from the commercial area on the north side of 48 Avenue. This pond drains to 68 Street and through Grandview West to Camrose Creek.

Development of the Cascades subdivision, with its own stormwater pond, is being planned for the area north of Cornerstone.

Existing System Capacity: The storm trunk along 50 Avenue is undersized for the 1:5 year storm and could surcharge to grade at 68 Street. However, with a continuous major drainage system, the potential for flooding of private property is limited. The Cornerstone dry pond acts as a surge pond and allows the trunk sewers to flow backward in a major storm to control surcharging in the Grandview trunk.

Upgrading for Existing Conditions: The Grandview East storm sewer is undersized by today's standard, as it will surcharge in a 1:5 year storm. Some street flooding was reported on 66 Street near the golf course. It appears that there is sufficient street grade to effectively drain the area such that ponding on the street is limited. Therefore no upgrading is recommended at this time.

Upgrading for Future Conditions: The Cascades stormwater management pond should be designed as a surge facility to control surcharge levels on 68 Street, and the overflow path to the north should be maintained. Grading around the pond should be designed to permit surface runoff from 66/68 Street to the pond in a major storm event (Item 2 in Figure 3.4.) Before additional areas are developed to the west and south, a new outfall pipe will be required to Camrose Creek. Specific details are provided in Section 4.

3.6 MOUNT PLEASANT

The Mount Pleasant Storm Basin is located along Mount Pleasant Drive from 43 Avenue north to Highway 13. It contains one dry pond and has one outfall which discharges to Camrose Creek.

Existing System Capacity: The storm sewer system surcharges to grade on Mount Pleasant Drive and 45 Avenue. The dry pond was constructed in 1991 to control surcharge levels and reduce flows on the street surface.

Modelling indicates that substantial volumes of runoff collect on Mount Pleasant Drive (about 5,000 m^3 in the 1:100 year storm), as has been reported by the City (Item 3 in Figure 3.4.)

The major drainage system previously spilled over private property from 47 Avenue to 47A Avenue east of Mount Pleasant Drive. The City has subsequently constructed a swale between the two properties as recommended in the previous Master Plan. Manhole lids were sealed in 1999 to reduce inflows into the sanitary sewer system in this basin.

Upgrading for Existing Conditions: The Southwest Camrose flood study in 1998 and previous studies in 1991 concluded that it is not economical to upgrade the storm sewers to provide a higher level of service in the basin.

Upgrading for Future Conditions: As the basin is fully developed no further upgrading is required. **Should the storm sewers need replacement in the future, due to structural conditions or other underground work, they should be upgraded to provide greater capacity**.

3.7 MARLER BASIN

The Marler basin is located in Southwest Camrose and includes the sub-basins of Duggan Park, 68 Street North, 68 Street South, and Marler Drive. The 68 Street storm sewers drain to the existing Duggan Park stormwater pond which drains to the Marler Drive storm trunk. There is one outfall into Camrose Creek west of the ski hill.

The southern half of the Duggan Park quarter section, about 34.5 ha, is currently being developed. The 2000 Master Plan recommended that a stormwater management facility be constructed to service this development so as to avoid overloading the Duggan Park Pond. A series of ponds, or parkway channels, have been designed to store and control flows from this residential development; it is understood that these ponds have been designed to store and control flows in the 1:100 year event. These ponds discharge to the existing Duggan Park pond.

The Parkview Ravines development of approximately 1.5 ha is proposed for the east side of the Marler Basin. This development will tie into the existing 1350 mm trunk running down 55th Street. This is a small development connecting only a few pipe lengths upstream of the outfall; therefore, it is expected to have a negligible impact on this basin.

Existing System Capacity: The Marler Drive trunk is surcharged to grade throughout much of its length in the 1:5 year storm, resulting in large flows on the street (see Photo 3.1 and Item 4 in Figure 3.4). The street was filled to curb-top in the June 2007 storms. The excess flows in a major storm event are carried overland to Parkview Drive.

Flooding has occurred during major storm events in the street sag at 42nd Avenue/67th Street and in Kinsmen Park at the intersection of 43

Avenue, Marler Drive and Parkview Drive. The southern portion of Kinsmen Park was re-graded in 1999 to reduce flooding on the street at this location (see Photo 3.2).

Upgrades for Existing Conditions: Upgrading the storm sewer on Marler Drive to present standards is not practical or cost effective as the damages due to street flooding are relatively minor. **A stormwater detention site is proposed to reduce the risk of flooding at the 67 Street and 42 Avenue sag (Item 5 in Figure 3.5).** Ponding of about 1,300 m^3 occurred in the 1:100 year storm, in the model, reaching a depth of about 0.5 m, which would flood private property. It is not certain whether property damage has actually occurred at this site.

The benefits of this improvement are mostly limited to the immediate vicinity of the dry pond. A slight reduction in surcharge and ponding would occur in the Marler Drive trunk, but because this pond is located at the upstream end of the trunk, it would have limited effect further downstream. No other suitable sites are available for construction of a surge pond further downstream.

Ponding and flowing water in Marler Drive contribute to inflow/infiltration into sanitary sewers through vent holes in sanitary manhole lids. The City annually inspects all the manholes on Marler and Mount Pleasant Drives and reinstalls corks in these vent holes. **The City should upgrade the sanitary manhole lids to an NF-80 sealed unit when either of these roads are upgraded. Storm sewer upgrading should be considered at that time as a means to reduce water ponding and flowing on the street**.

Upgrades for Future Conditions: No additional areas are proposed to drain through this system beyond the southern portion of the Duggan quarter-section, which will be controlled with stormwater management facilities. Should the storm sewers need replacement in the future, due to structural conditions or underground work, they should be upgraded to provide greater capacity.

3.8 FAIRGROUNDS

The Fairgrounds storm basin is located within Kinsmen Park and extends east to Camrose Creek, between 42 Avenue and 46 Avenue. This system discharges to Camrose Creek.

Existing System Capacity: Modelling showed that this system would be surcharged in the 1:5 year storm. There are no significant sags in this area nor were there reports of significant flooding.

Upgrading for Existing Conditions: Although there is some surcharging to grade during the 1:5 year storm and 1:100 year storms, it does not appear to cause any major problems.

The City has reported flooding of one lot in the vicinity of 52 Street and 44 A Avenue which could be related to surcharging of this storm sewer system and major overland flow along 44 A Avenue (Item 6 in Figure 3.4). A catchbasin has been added to provide relief. **Surface drainage conditions should be monitored to confirm the effectiveness of this measure.**

Upgrading for Future Conditions: A new sportsplex is proposed west of 55 Street and north of 44 Avenue. As part of this development, a new stormwater detention facility will be constructed to the west of the sportsplex and will control flows from the new development. The proposed pond will have a storage volume of 3,700 m^3 and will be designed as a wetland to maximize treatment. In addition, the existing 375 mm storm sewer along 44 Avenue will have to be relocated.

3.9 CENTURY MEADOWS/VALLEYVIEW

The Century Meadows storm basin is located in southwest Camrose, east of 68 Street and north of Camrose Drive. It discharges to a stormwater pond in the Valleyview subdivision, south of Camrose Drive, and then via a coulee to Camrose Creek. The stormwater pond was constructed in 1999 to control flows to the coulee and to reduce erosion of the coulee. This pond was subsequently converted into a wet pond in order to service the Valleyview subdivision. More recently, the City has constructed a pipe and outfall from the Valleyview Pond to Camrose Creek.

Existing System Capacity: Flooding in the trapped sag on Erickson Drive north of 36 Avenue (Item 7 in Figure 3.4) has been previously reported, and the storm sewers are surcharged in the model. Model results indicate some potential for street flooding (about 250 m^3 in each of three street sags at this location) reaching a depth of about 0.3 m in the street, which suggested that the previous reports were related to street flooding and not flooding of property.

The new drainage system in south Century Meadows, constructed in 2000 and 2001, was designed by Associated Engineering to have capacity for the 1:5 year storm, and the major drainage system has been designed to accommodate the 1:100 year storm. As shown in Figures 3.2 and 3.3, this system functions as intended.

The minor system in Valleyview has been designed to modern standards to have capacity for the 1:5 year storm, and the major drainage system has been designed to accommodate the 1:100 year storm. Therefore, this system was not modeled.

Upgrades for Existing Conditions: **A dry pond (Item 7 in Figure 3.5) is proposed in the park east of Erickson Drive.** It would act as a surge facility to reduce the surcharge in the trunk sewer and the ponding in the street sag in order to prevent flooding of private property around the sag. As the computed flood volumes are relatively small, this project should be given low priority, unless the reported flooding can be related to actual damage of private property.

Upgrades for Future Conditions: The Valleyview pond will be expanded to serve the quarter section to the west. Future development areas further west will have their own stormwater management facilities draining through this system.

3.10 CAMROSE DRIVE WEST/ENEVOLD

The Camrose Drive West storm basin is located in the southwest corner of Camrose. The Camrose Drive storm trunk, ranging from 300 to 900 mm in diameter, runs south on 68 Street and continues east on Camrose Drive to Camrose Creek. Branch lines provide service to residential areas along Parkview Drive and Parkridge Drive. It crosses, but does not connect to the Century Meadows/Valleyview storm trunk described above. This system has one outfall, which is located south of the Camrose Drive Bridge and discharges directly into Camrose Creek.

Existing System Capacity: The model has shown some surcharging of the storm line during the 1:5 year storm but no flooding problems have been reported except at the intersection of Camrose Drive and Parkview Drive (Item 8 in Figure 3.4). Camrose Drive was modelled as a twinned roadway as is planned for the future.

The Enevold residential subdivision, which is proposed for the quarter section directly west of Century Meadows, is currently in the design phase. This 65 ha development will have its own stormwater pond discharging at pre-development rates of flow to the Camrose Drive trunk.

Upgrading for Existing Conditions: Flooding to a depth of approximately 1 m has occurred in the sag located in the northeast corner of the intersection of Parkview Drive and Camrose Drive, which could force the intersection to be closed in a major storm event. Model results indicate ponding of about 2,500 m^3 in the 1:100 year storm. **The most cost effective measure is to intercept the Camrose Drive storm sewer into the Century Meadows trunk and the Valleyview stormwater pond (Item 8 in Figure 3.5).** This upgrade will reduce the surcharging of the Camrose Drive trunk and the volume and duration of ponding at Parkview Drive. It will add a small amount of runoff to the Century Meadows/Valleyview pond, but since the roadway area is much smaller than the pond's catchment area, the impact on pond water levels will be slight and can be easily accommodated in the future expansion of this pond to the west.

The alternative is to construct a swale to the east, between the noise berm and the north curb of Camrose Drive to carry overflow eastward on the surface, or to raise the elevation of Parkview Drive which would be costly and difficult to accomplish.

3.11 NORTH END

The North End storm basin is located north of the CPR and includes the Rosebud residential area north of 52 Avenue, a mobile home district, pipe plants to the east, and the airport. A large off-site area also drains through this system from the County of Camrose to the east.

The previous master plan identified a number of capacity issues in the main trunk along 54 Avenue. Major upgrades have been constructed since the 2000 Master Plan, involving a storm sewer along 46 Street to intercept a large portion of the storm flows, and a new outfall channel along the future Ring Road alignment, north of 55 Avenue, to Camrose Creek. This outfall channel is the primary outlet for the northeast side of the City including the 46 Street storm sewer, the airport, the Ring Road, the offsite flows, and future development from the east.

The 46 Street storm sewer ranges in diameter from 1,050 mm to 1,500 mm and extends from 52 Avenue northward to the new outfall channel. Short sections of pipe were also installed on 52B, 53, and 54 Avenues to inter-connect with the existing systems. Storm sewers were also extended eastward along 52B Avenue to 43 Street to improve drainage in the Rosebud neighbourhood.

Existing System Capacity: The updated model shows a major reduction in surcharge levels due to the recent upgrades. However, there is still significant overflow in the 1:100 year storm (Figure 3.3). Runoff spills overland on the street surface to a trapped sag at the corner of 55 Avenue and 52 Street.

This sag has no outlet. The depth is not great (estimated to be 0.3 m in the 1:100 year storm), and there have not been reports of property damage in the vicinity.

Model results show ponding of about 4,000 m^3 in a low area on the south of the railway, to a depth of about 0.5 to 1.0 m. The storm sewer to the north, connecting to the new 46 Street trunk, is surcharged to move than twice its capacity in the 1:5 year storm.

Upgrades for Existing Conditions: **If the City were to relieve the trapped sag at 55 Avenue and 52 Street, a swale within an easement would be required between two lots to the Ring Road right-of-way (Item 9 in Figure 3.5).** There is no practical way to reduce ponding on the south side of the railway.

Upgrading for Future Conditions: Drainage east of the airport is poor-to-non-existing and will need to be upgraded as the area is developed. This can be accomplished through extension of the Ring Road/46 Street outfall channel, as an open channel or pipe system as will be discussed in Section 4.

3.12 CP RAIL

The CP Rail storm basin principally drains the railway and a small area to the north from 49 Street to 57 Street. It outfalls to a ditch at 57 Street which then drains into Camrose Creek.

Existing System Capacity: The line from the north along 52 Avenue surcharges to grade in the 1:5 year storm: however, there have been no reports of flooding in this area. There are no significant sags along 52 Avenue and the major drainage system drains away to the north.

Contour maps show a trapped low on the north of the railway, and therefore the property grades should be surveyed to confirm the potential depth of ponding.

3.13 WEST CENTRAL

The West Central Storm Basin is located on the east side of Camrose Creek, from Mirror Lake north to the CPR. This storm system has one outfall which discharges directly into Mirror Lake at 56 Street.

Existing System Capacity: The storm sewer surcharges to grade near the sag at the CPR in 1:5 year storm. Model results indicate ponding of about 1,000 m^3 in the 1:100 year storm, on the south side of the CPR near 54th Street.

Upgrading for Existing Conditions In the previous Master Plan, re-grading of the CPR ditch was proposed to prevent flooding in a major storm event on the south side of the CPR. Subsequently, City personnel have inspected the area and confirmed that there is a culvert through the CPR draining the surface runoff to the north, thus reducing the risk of flooding. Therefore, the ditch regrading is no longer required.

3.14 DOWNTOWN

The Downtown basin lies between 53 Street and 48 Street, and between 48 Avenue (Highway 13) and the CPR. It has a complex network of sewers and manholes, some of which are parallel and interconnected, resulting from the history of development in the area.

Existing System Capacity: The model results show that the storm drainage system is functioning reasonably well but that that some portions of the parallel system in the City center are not operating at their potential capacity.

City staff reported that water "lapped at the door" of the Masonic Temple, on 48 Street between 50 Avenue and 51 Avenue, in the June 2007 storm (Item 12 in Figure 3.4). Model results show that the storm sewer on 48 Street is surcharged to twice its capacity in the 1:5 year storm, resulting in surface ponding of about 1,000 m^3 in the 1:100 year storm.

Upgrading for Existing Conditions: **Drainage of the downtown area can be improved by interconnecting the parallel lines to make full use of their capacity (Item 12 in Figure 3.5).** The City has interconnected at two locations as recommended in the previous Master Plan, which has helped to reduce surface ponding. The modelling shows that further improvement is possible by connecting to another storm sewer on 47 Avenue as shown in Appendix A. This will help to reduce pipe surcharging and street flooding in a major storm event.

Upgrading for Future Conditions: **Should the City need to replace or resurface roads in the downtown in the future, consideration should be given to increasing the storm sewer capacity as is common for high-value commercial areas. A more detailed assessment of the storm sewer system should be carried out in the development of a downtown re-development plan, should such an initiative be anticipated. The City should explore opportunities for on-lot stormwater management, in roof-top and parking lot areas, in any redevelopment in the downtown area, to reduce the runoff from the lots in a major storm event**.

3.15 COLLEGE/BETHANY

The College and Bethany storm sewers drain the area between Camrose Creek and the CNR, and between 45 Avenue and the CPR. The two systems are inter-connected at 44 Street and 46 Street. They also drain the underpass of Highway 13 under the CNR.

Existing System Capacity: According to the model results, the storm sewers surcharge to grade in the 1:5 year storm in the vicinity of 50 Avenue and 43 Street (Item 13 in Figure 3.4), where there is a trapped low. Ponding water could reach a depth of 0.5 m in the 1:100 year storm. In the previous (2000) Master Plan, city staff had reported flooding of 50 Avenue between 42 and 43 Streets, similar to the model results.

Model results also indicate that the storm sewer would surcharge to grade at the highway underpass in the 1:100 year storm (Item 14 in Figure 3.4), which could result in the underpass being impassable for short periods of time. As there have been no reports of flooding, even in the June 2007 storms, the risk appears low and could probably be tolerated. There is a flow restrictor in the tributary line from the north, which helps to control surcharge levels in the underpass but contributes to surcharging in the 50 Avenue area.

Storm sewers are also surcharged to grade in the vicinity of 47 Street and 46-48 Avenue. However, there have been no reports of flooding in the vicinity, which indicates that the major drainage system is carrying away the excess runoff.

Upgrading for Existing Conditions: **A stormwater dry pond is proposed in the lot south of 49 Avenue next to the CNR (Item 13 in Figure 3.5)**. It would be linked to the 44 Street storm sewer and would act as a surge facility to control surcharge levels and allow the 50 Avenue sag to drain more effectively. As the lot appears to be used as a sports field, agreement of the Battle River School District would be required to complete this work. An alternative site for this dry pond is on the Charlie Killam School grounds, immediately west of the Sifton School, which has a larger open field area and is immediately adjacent to the existing storm sewer. **A detailed review of street and lot grades should be completed in the vicinity of the 50 Avenue sag to assess the risk of property damage.**

3.16 MOHLER OLSTEAD INDUSTRIAL AREA

This storm sewer system drains a large industrial area east of the CNR, through a ravine which bisects the Augustana College, to Camrose Creek at 50 Street. An open channel forms the main stem of the minor and major drainage systems through this area. It also conveys runoff from a large undeveloped area to the east of Highway 13 on the east side of the City.

The 2000 Master Plan identified a number of capacity issues in the Mohler Industrial area and a problem of erosion in the ravine resulting from increased runoff from the industrial area.

As a result, Associated Engineering completed the Mohler Olstead Industrial Area Drainage Upgrade Plan in 2002, which examined the basin needs in greater detail. The report recommended the construction of the CNR Mohler Pond immediately east of the CNR to provide stormwater management for most of the Mohler Industrial area, to control flows released to the coulee, and to prevent flooding upstream (east) of the railway. This pond has subsequently been completed.

Photo 3.3 provides a recent view of the coulee near the footbridge at the College and shows clear evidence that erosion has been occurring. Some natural armouring is occurring as the bed is eroded, which may help to stabilize the creek. Some corrective action (placement of bank riprap) has been undertaken near the footbridge (Photo 3.4). Note that since the photos were taken, the University of Alberta has replaced the footbridge with a berm, and has piped the creek under the berm.

Beaver dams are common in the creek upstream of this location and help to stabilize the creek (Photo 3.5).

In conjunction with the CNR Mohler pond, the main trunk sewer south of 47 Avenue (between 39 Street and 41 Street) was twinned to provide additional capacity and to reduce the risk of flooding in the industrial area further upstream. The CNR Mohler pond will allow these and future developments to drain through the basin at a controlled rate while minimizing their impact on the downstream system.

At the same time, several developments have occurred:

- The Casino development and highway commercial strip along Highway 13 were developed with on-site stormwater management so that runoff from the site would be limited to 35 L/s/ha.

- Shaw Pipe Plant expansion, a 56.5 ha heavy industrial development located east of the CNR, has been completed with its own stormwater management facility, which will be pumped to the 39 Street storm trunk. Preliminary analysis indicates a storage volume of 66,000 m^3 will be required, to be pumped out at a rate of 210 L/s to an existing 750 mm diameter storm sewer approximately 120 m north of the CPR crossing.

- Mohler II, a 53.5 ha light industrial development, north of Camrose Drive and west of 41 Street, has been designed with a new 1200 mm diameter storm sewer draining along 44 Avenue from 41 Street to the new CNR Mohler pond to service this area.

It is clear that industrial development in the Mohler basin has substantially increased the volume of runoff to the coulee and that erosion of the creek channel is occurring (Item 15 in Figure 3.4). The CNR Mohler pond will control peak flows and help to minimize these impacts. Natural armouring is also occurring and may help to control the amount of erosion. The land bridge and pipe will help to prevent erosion from occurring upstream of their location, by providing a fixed point in the channel profile.

Stormwater management will be required for future developments within the basin, as in other areas of Camrose, to minimize any future impacts, but as development continues it will introduce more runoff volume to the coulee. The creek channel will adjust to the increased runoff by becoming wider and deeper with a flatter slope, as evidenced by the channel erosion that has been occurring to date. The rate and full extent of these adjustments are difficult to quantify precisely, and therefore **it is recommended that the City continue to monitor the creek and to take corrective action (bed and bank armouring) as required**. If bed and bank erosion becomes too severe the City may need to install a storm sewer down the coulee bottom to carry the creek flows to Camrose Creek.

Some erosion of the main channel is occurring from 41 Street, westward to the pond (Item 16 in Figures 3.4 and 3.5). The inlet channel to the pond has been damaged by recent high flows. **This channel and pond inlet should be re-built and armoured to protect it against further erosion.** The alternative is to install a storm sewer to replace this channel, but would involve additional cost and would require the major drainage flow path to be preserved.

Following is further assessment of the drainage system capacity within the Mohler/Olstead industrial area:

Existing System Capacity

Model results in Figure 3.1 show that portions of the storm sewer system are operating above their design capacity in the 1:5 year storm:

- along 41 Street and 39 Street to the north of 47 Avenue,
- along 37 Street to the south of Highway 13.

Scattered ponding or street flooding occurs at isolated street sags throughout the Mohler Olstead Industrial area in the 1:100 year storm (Figure 3.3). The depth of water could exceed 0.5 m at and cause flooding of private property and obstruction to traffic at the following locations:

- along 39 Street from the CNR to 47 Avenue (City personnel reported street flooding south of 48 Avenue in June 2007),
- along 51 Avenue west of 41 Street,
- on 42 Avenue at 38 Street in the south side of the industrial area.

Upgrading for Existing Development: The previous stormwater master plan recommended a surge pond to be constructed in the area of 41 Street and 51 Avenue to relieve surcharging of the 41 Street storm trunk, which is no longer possible as this site has subsequently been developed. **It is recommended that the City consider an overflow pipe under the CNR to the proposed dry pond on the west side of the CPR**.

The Shaw Pipe expansion area has been provided with a storage facility, discharging at a controlled rate, so as not to contribute to peak flows in the 39 Street storm sewer system.

Upgrading for Future Development: Modelling shows that the storm sewer along 39 Street, south of the CNR, will be overloaded when the roadway is expanded to its ultimate 4-lane configuration and the adjacent areas are developed.

In the pre-design study for 39 Street, Stantec has proposed a storm sewer system along 39 Street to the north of the CNR. **This storm sewer system should be extended to the south of the CNR to drain the area between the CNR and CPR**.

The following are also recommended:

- **That new development draining to the 39 Avenue storm sewer be provided with stormwater detention facilities discharging at a controlled rate of 5 L/s/ha in the 1:100 year storm event,**

- **That the City require on-lot stormwater management discharging at 35 L/s/ha in the 1:100 year storm, as a condition of re-development of any lots larger than 0.5 ha in the Mohler Olstead Industrial area (as well as other developed areas of the City), and continue to look for opportunities for on-lot stormwater management on**

smaller parcels, to control the flows in the existing trunk sewers.

Model results also indicate that some flooding would occur along 43 Street in the southeast of the Mohler area (this area is being re-designed with the Mohler II development).

3.17 CRE POND

The CRE pond drains the CRE site and a rural area of approximately 500 hectares to the east of Highway 13. Originally this pond was designed to provide capacity for the partially developed CRE site and the upstream drainage area. Due to recent upgrades on the CRE site, the amount of stormwater entering the CRE pond has increased, resulting in a decrease in the amount of available storage in the CRE pond. Furthermore, modelling has shown that the existing pond has sufficient capacity for the CRE site itself (35 ha) but that its outlet cannot accommodate the runoff from area to the east, either in its present undeveloped state or when the area is developed.

Therefore the following are proposed (Item 17 in Figure 3.5):

- **that the upstream flows be routed around the pond site, directly to the existing outlet channel through the Mohler industrial area, to avoid overloading the pond,**
- **that the pond outlet be modified to reduce its outflow rate to 175 L/s (based on the proposed service area of 35 ha and a release rate of 5 L/s/ha),**
- **that stormwater management be provided in future development areas to control peak flows to pre-development as will be discussed in the next section of this report.**

Details are provided in Appendix A.

3.18 ON-LOT STORMWATER MANAGEMENT

As noted above, the existing storm sewer system throughout the majority of the older areas of the City typically has capacity for a 1:2 year to a 1:5 year design storm, and there are no designed major drainages systems in these areas**. Therefore, the City should consider requiring on-lot stormwater management for larger parcels larger than 0.5 ha, and should look for opportunities on smaller lots, should those parcels be re-developed through intensification or infill. Their runoff rates should be controlled to 35 L/s/ha which corresponds, roughly, to the 1:2 year peak flow rate and the storm sewer system capacity.**

Ideally, a storm service connection should be provided for the on-lot facilities. If the nearest storm sewer is too far away, on-lot facilities on lots smaller than 0.5 ha could be allowed to drain to the surface.

On-lot stormwater management can be provided on flat roofs, in parking lots, and in landscaped depressions on larger lots.

3.19 SIMULATION OF THE PROPOSED UPGRADE PLAN

The proposed upgrades were modelled to assess their performance. Figure 3.6 shows simulated surcharge levels and ponding/overflow volumes in the 1:100 year design storm for ultimate development conditions, with the proposed upgrades. Comparison with existing conditions in Figure 3.3 shows significant reduction in ponding volumes, which will reduce flood risk at the proposed upgrade sites. There remain other areas where significant ponding and major drainage system flows will continue to occur, but where no remedial action is proposed unless there are reports of property damage.

3.20 CONCEPTUAL DESIGN AND COST ESTIMATE

Appendix A provides the conceptual design and cost estimates of the proposed storm drainage system upgrading, including:

- Preliminary pipe lengths and sizes,
- Pond volumes, sizes, and preliminary elevations.

Pipe sizes and capacities and stormwater management pond sizes are conceptual and subject to review during the final design.

Cost estimates are based on the following:

- Costs are for 2008 at a conceptual level of detail.
- They include 15% engineering, 40% contingency and 5% G.S.T.
- Costs for open cut include stripping, trenching, supply/install pipe and manholes every 120 m, and surface restoration.

Table 3.1 provides a summary. Line items in Table 3.1 are numbered to match Figure 3.5. The Table includes an assessment of the relative costs and benefits of the proposed upgrades and, based on these rankings, an assessment of their relative priority to aid in their scheduling.


Photo 3.1: Major drainage system flowing to top of curb on Marler Drive in the June 5, 2007 storm.


Photo 3.2: Major drainage system overflow from Mount Pleasant Drive to Kinsmen Park dry pond in June 5, 2007 storm.

Photo 3.3: Natural armouring through selective erosion of till materials in the ravine near Augustana College.

Photo 3.4: Bank riprap placed near the footbridge in Augustana College.

Photo 3.5: Beaver dams in the creek upstream of the footbridge in Augustana College.

Table 3.1
Camrose Storm Sewer Master Plan
Capital Priorities Plan
(See Figure 3.5 for locations)

ITEM #	PROPOSED UPGRADE	PURPOSE	SCOPE OF WORK*	APPROXIMATE COST*	Cost Rating**	Benefit Rating**	Benefit/ Cost Rating***	Relative Priority (1=highest, 8=lowest)
9	Swale from 55 Avenue to Ring Road ROW	Prevent flooding at sag at 55 Avenue and 51 Street	50 m swale and easement	$ 22,000	1	2	2.0	1
17	CRE pond improvements	Prevent overloading of CRE pond; provide capacity for campsite development	Re-align channel and construct 1,600 m^3 dry pond	$ 54,000	1	2	2.0	1
15	Rehabilitate and protect Mohler channel	Reduce erosion of channel; protect sanitary line at inlet to pond	300 m of channel restoration plus gabion drop structure at CNR pond inlet	$ 420,000	2	3	1.5	3
5	Dry pond in park at 67 Street and 42 Avenue	Prevent flooding at sag due to surcharged storm sewer	1500 m^3 dry pond plus 120 m of 900 mm storm sewer	$ 490,000	2	2	1.0	4
8	Intercept Camrose Drive storm sewer	Reduce flooding at Erickson Drive intersection	2 manholes and 750 m storm sewer	$ 61,000	1	1	1.0	4
12	Downtown storm sewer inter-connections	Reduce surcharge levels and potential for flooding in the Downtown area	110 m of 450 and 900 mm storm sewer	$ 380,000	2	2	1.0	4
13	Dry pond in park at 49 Avenue and CNR (Bethany)	Prevent flooding in street sags on 50 Avenue near 43 Street	2600 m^3 flood storage plus 140 m of 600 mm storm sewer	$ 550,000	3	2	0.7	7
7	Dry pond in park at Erickson Drive and 36 Avenue	Prevent flooding at sag due to surcharged storm sewer	1000 m^3 dry pond plus 140 m of 600 mm storm sewer	$ 400,000	2	1	0.5	8
	Total Cost			$ 2,377,000				
	Within 5 years			$ 2,377,000				
	5-10 years			$ -				
	Beyond 10 years			$ -				

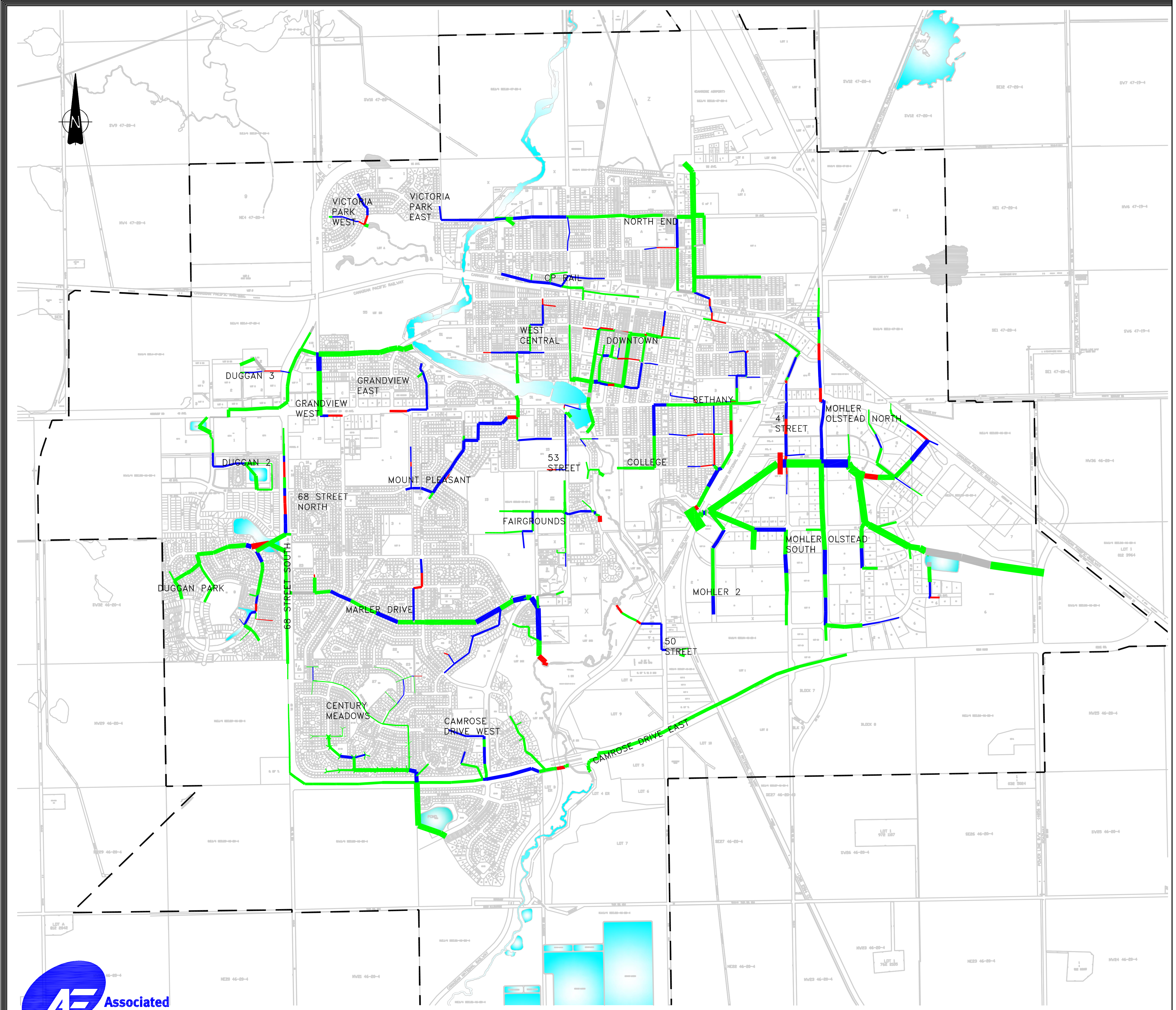
* 2008 budget level estimates only (subject to confirmation in final design) including construction, contingency (40%), engineering (15%), and GST (5%)

**Cost and benefit ratings:

Rating	Cost	Benefit
1	<$100,000	Reported or simulated street flooding
2	$100,000-$500,000	Simulated property damage
3	>$500,000	Reported property damage

*** = Benefit Rating / Cost Rating

Note: excludes developer-funded system expansion costs



THE CITY OF *CAMROSE*

SIMULATED FLOW LOADING
FOR THE 1:5 YEAR STORM
WITH EXISTING CONDITIONS

LEGEND:

Qp / Qcap > 2.0

Qp / Qcap = 1.0 - 2.0

Qp / Qcap < 1.0

NEGATIVE FLOW

NOTE:

PIPES ARE SCALED IN PROPORTION TO THEIR DIAMETER

0 500 1000

SCALE: 1 : 20,000

JANUARY, 2008

Associated Engineering

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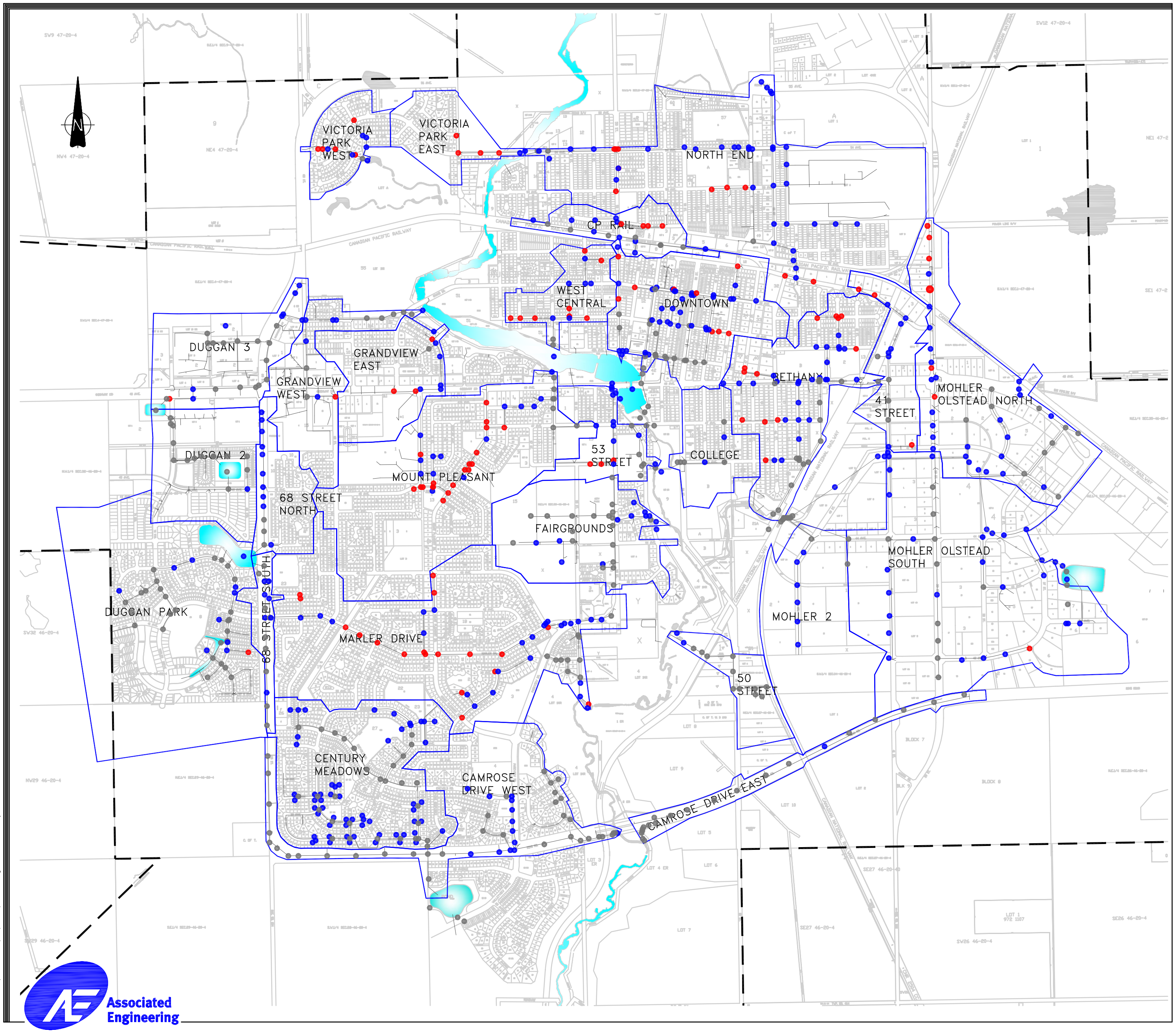
FIGURE 3.1



THE CITY OF CAMROSE

SIMULATED SURCHARGE LEVELS FOR THE 1:5 YEAR STORM WITH EXISTING CONDITIONS

LEGEND:

DEPTH BELOW GROUND SURFACE

- 0.0 METERS
- 0.0 to 2.0 METERS
- >2.0 METERS

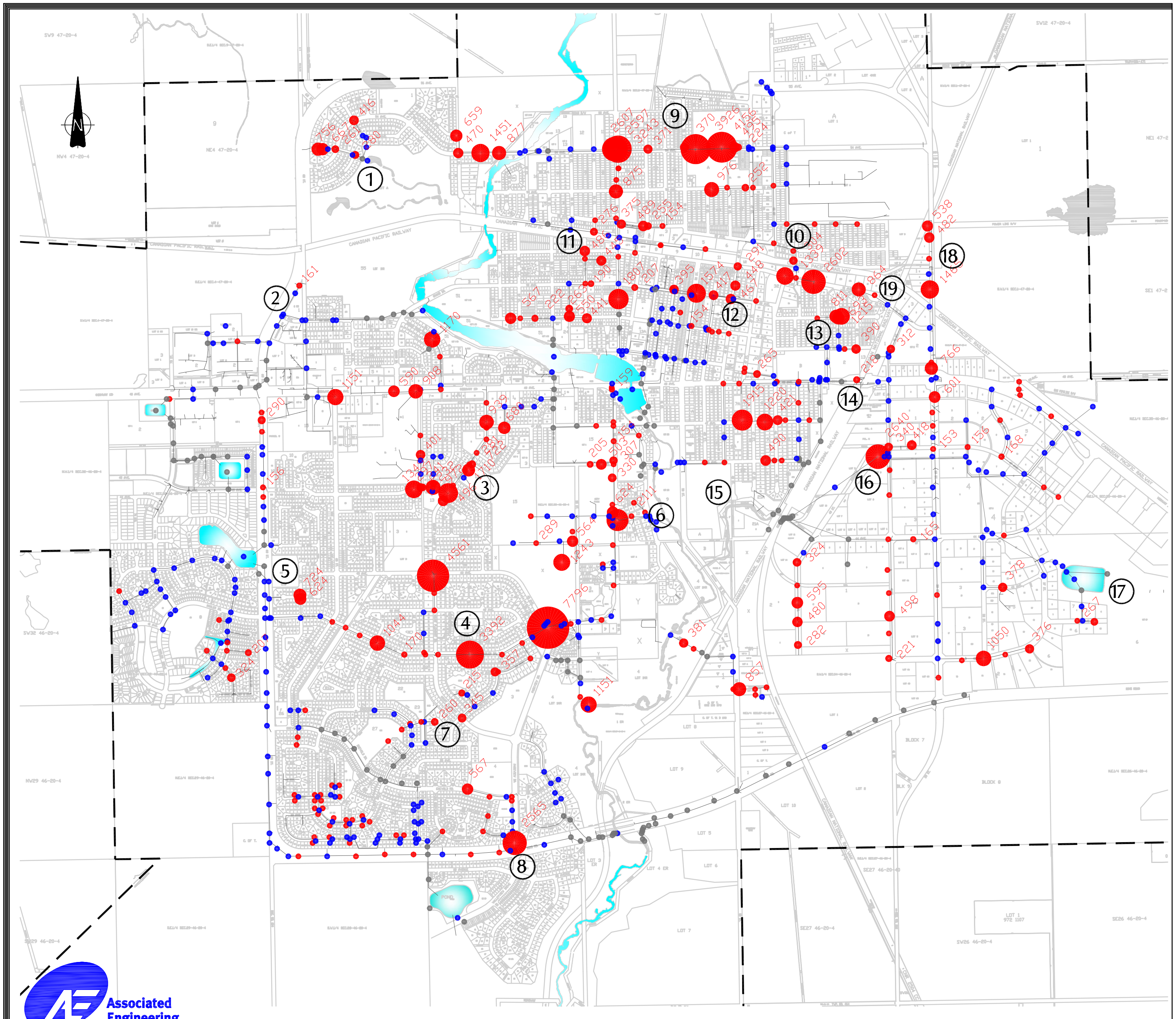
0 500 1000

SCALE: 1 : 20,000

JANUARY, 2008

FIGURE 3.2

File: Q:\053805\Report\3804_fg_3.2.DWG by BW



THE CITY OF CAMROSE

SIMULATED SURCHARGE LEVELS FOR THE 1:100 YEAR STORM WITH EXISTING CONDITIONS

LEGEND:

DEPTH BELOW GROUND SURFACE

- 0.0 METERS
- 0.0 to 2.0 METERS
- >2.0 METERS

NOTE:

- FLOODED NODES ARE SCALED IN PROPORTION TO PONDING VOLUME.
- PONDING VOLUMES ARE INDICATED IN RED TEXT.

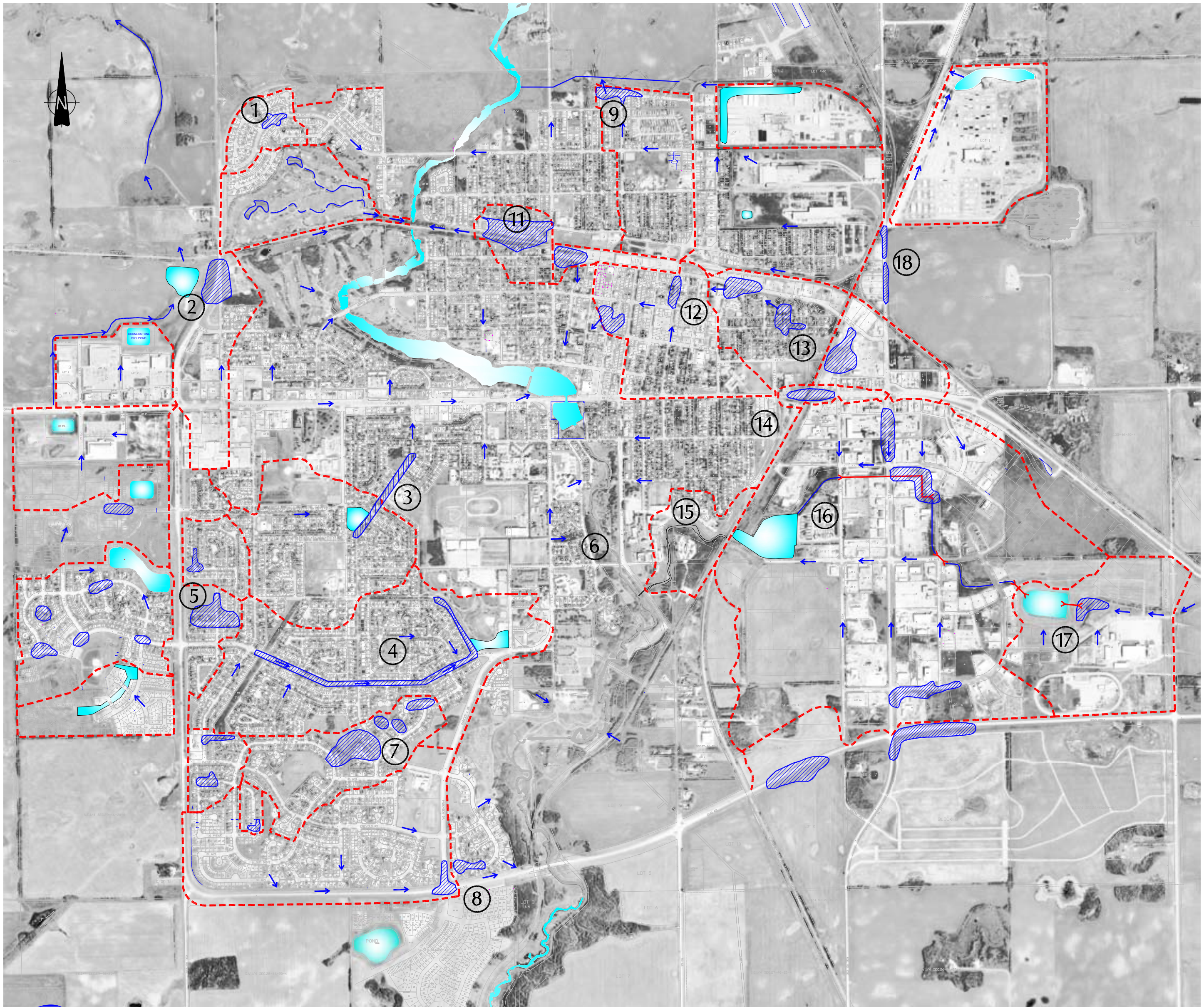
0 500 1000

SCALE: 1 : 20,000

JANUARY, 2008

FIGURE 3.3

File: Q:\053805\Report\3804_fg_3.3.dwg by BW



THE CITY OF CAMROSE

MAJOR DRAINAGE SYSTEM

LEGEND:

CATCHMENT BOUNDARY

FLOW DIRECTION

CULVERT

TRAPPED LOW
(NOT NECESSARILY FLOODED)

SWM POND

LOCATION NUMBERS IN REPORT TEXT

SCALE : 1 : 20 000

JANUARY, 2008

Associated Engineering

FIGURE 3.4

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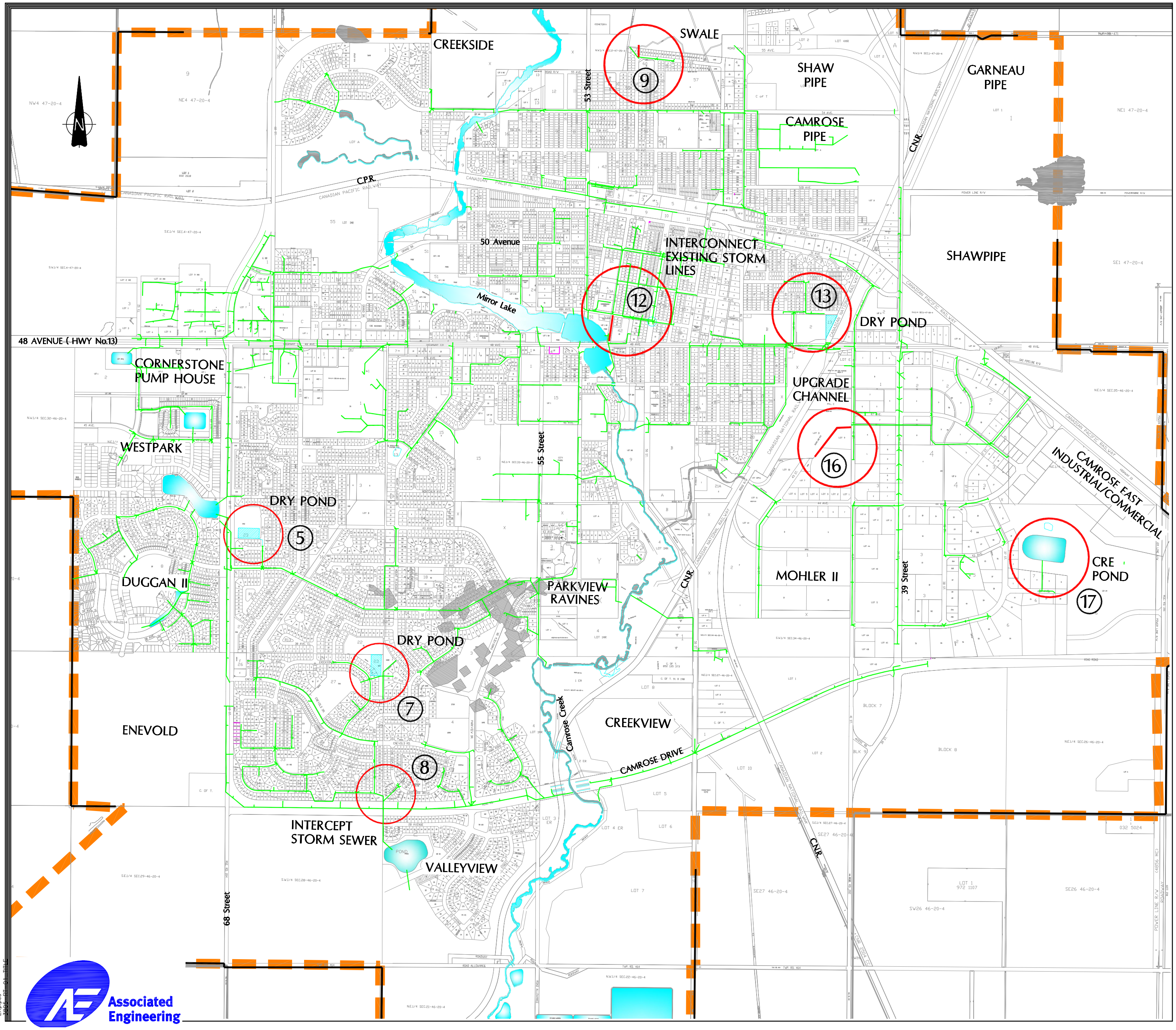


THE CITY OF CAMROSE

STORM WATER MASTER PLAN PROPOSED UPGRADING PLAN

LEGEND:

- CITY BOUNDARY
- EXISTING STORM SEWER
- PROPOSED STORM SEWER
- MANHOLE
- STORM WATER POND
- 4 PROPOSED UPGRADE LOCATION

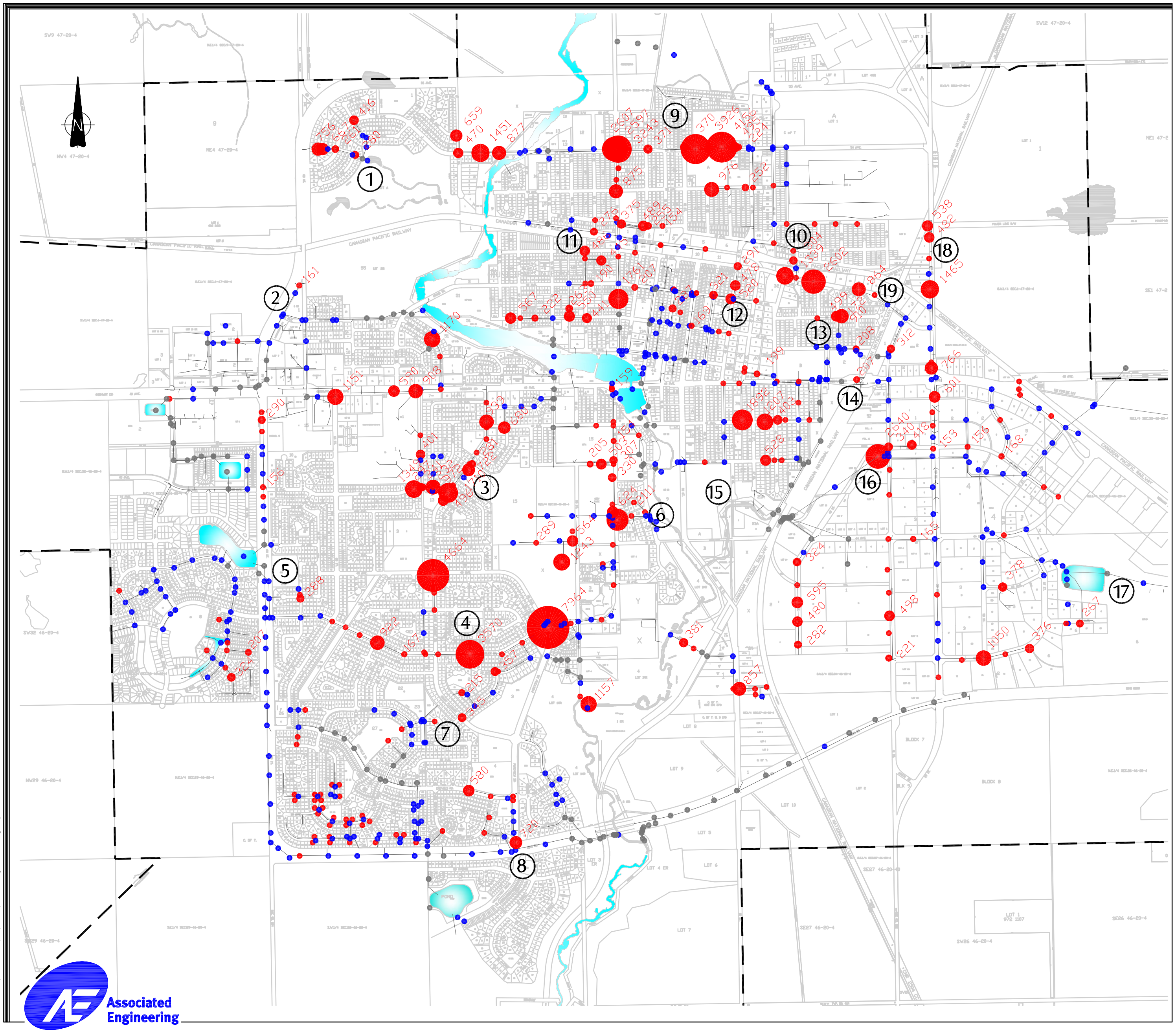
NOTE: 2005 PIPE NETWORK

0 500 1000

SCALE: 1 : 20,000

JANUARY, 2008

FIGURE 3.5



THE CITY OF CAMROSE

SIMULATED SURCHARGE LEVELS FOR THE 1:100 YEAR STORM WITH PROPOSED UPGRADE PLAN

LEGEND:

DEPTH BELOW GROUND SURFACE

- 0.0 METERS (red)
- 0.0 to 2.0 METERS (blue)
- >2.0 METERS (grey)

NOTE:

- FLOODED NODES ARE SCALED IN PROPORTION TO PONDING VOLUME.
- PONDING VOLUMES ARE INDICATED IN RED TEXT.

0 500 1000

SCALE: 1 : 20,000

JANUARY, 2008

FIGURE 3.6

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4 Future Development Needs

4.1 LAND USE

This study area includes all of the land within the City boundary plus approximately 60 quarter sections outside the current City boundary. The Sanitary Master Plan, developed in parallel with the present document, outlines the land use and development plans for this area.

Figure 4.1 shows the assumed land use in the plan area, including the following:

- Continued residential development in northwest and southwest sectors,
- Light industrial land uses in the southeast, similar to those in the Mohler Industrial area,
- Heavy industrial land uses (storage and manufacturing plants) in the northeast, such as the pipe plants that have been constructed in this area,
- Highway commercial developments along Highways 13 and 26 on the east and west sides of the City.

Figure 4.2 shows the anticipated development staging in the plan area. Generally, development is anticipated to grow outward in concentric rings from the existing development area, which will facilitate the orderly development of services with a minimum of leap-frogging and over-sizing. The drainage plan provides for development extending beyond 50 years.

4.2 REGIONAL DRAINAGE CHARACTERISTICS

Figure 4.3 shows the regional drainage for the area tributary to the City of Camrose.

Generally, Camrose is divided in half by Camrose Creek with the east and west sides of the City draining towards the creek. The City itself is drained by a network of storm sewer systems to Camrose Creek that are shown generally in Figure 4.3. Outlying, undeveloped, areas also drain to this storm sewer system, particularly on the east side of the City. As these areas are developed, provision will need to be made for the increased runoff.

On the east side of the creek:

- The area on the southeast drains away to the south to the Battle River, downstream of the City. About 550 ha of the plan area drains to the south, through the County of Camrose, through a series of natural sloughs and wetlands and a seasonal, intermittent drainage system (Catchment 2 in Figure 4.3). Development in this catchment will need to mitigate the potential impact of increasing runoff and may require improvements to the downstream drainage courses where they are intermittent and poorly defined.

- Catchment 3, on the east side of the City, is an area of about 500 ha which drains to the existing Mohler Industrial area. About one-half of this area lies within the project plan area and the reminder will continue to drain in its undeveloped condition. The Mohler area drains through a system of open channels and storm trunks to Camrose creek. The CNR Mohler pond has recently been constructed to regulate flows through the CNR and in the coulee through the Augustana College grounds further downstream. Therefore, runoff from the upstream development will need to be controlled so as not to overload the downstream system.

- Catchment 4, further north, is an area of about 900 ha that drains westward through an intermittent, poorly defined drainage system to the airport area and westward to Camrose Creek. West of the airport this drainage course is being replaced with a constructed channel along the future Ring Road alignment, which also serves as the outlet from the newly constructed 46 Street storm trunk. The area east of the airport is flat and poorly drained and will require extension of the drainage channel to serve future development (about 4 quarter-sections or 250 ha) within the plan area boundary.

- Catchment 5, lying to the northeast of the airport, drains northward towards several large wetlands and then via a constructed channel, through the County of Camrose, to Camrose Creek. It includes about 500 ha of the development plan area. This area is relatively flat and poorly drained. These low gradients and the need to control runoff to pre-development rates will constrain the drainage options in this catchment. The drainage concept plan will need to preserve the existing wetlands and may be able to use them to store runoff from the development area.

On the west side of Camrose Creek:

- Catchment 6 includes a small portion (100 ha) of the plan area that drains overland, directly to Camrose Creek. This area is relatively well drained, but flow rates to Camrose Creek need to be controlled to prevent increasing creek flows. Development will also need to avoid the floodplain of Camrose Creek.

- Catchment 7 extends westward to Highway 21and drains a large area (about 30 km^2 or 3000 ha) to Camrose Creek. About 850 ha of this catchment lie within the project area. This catchment has the most severe drainage challenges. It contains a large number of natural wetlands including the two large wetlands on the west City boundary, north of Highway 13. The southern portion of this catchment drains to the Grandview storm sewers, which are loaded to capacity. The northern portion drains through a shallow drainage course to Camrose Creek; here, the shallow channel and flat grades will pose challenges for stormwater drainage.

- Catchment 8, on the southwest side of the City, drains southeast to two natural coulees and Camrose Creek. Most of this catchment (about 1000 ha) lies within the project plan area. Drainage to the coulees will need to be controlled to prevent serious erosion such as has been experienced in the Century Meadows outfall, further north.

Smaller, undeveloped, fringe areas within the City boundary drain to the existing storm sewer system. Provision will be made for these areas in the drainage concept plan described in subsequent sections of this report.

4.3 STORMWATER MANAGEMENT REQUIREMENTS

As noted above, the capacities of the existing storm sewers and natural drainage systems pose significant constraints to the development of future drainage systems. In general, control of runoff rates will be required to prevent overloading these drainage systems. In addition, Alberta Environment's stormwater management guidelines require control of water quality in urban stormwater. At the moment, the minimum requirement is to remove at least 85% of the suspended sediments larger than 75 micron (.075 mm) in size (fine sand and larger), but these requirements are likely to increase over time. Suspended silts, which are finer than 75 micron, are particularly damaging to aquatic habitat, and more attention is likely to be paid to the removal of these silts, as well as suspended and dissolved nutrients.

According to Alberta Environment's stormwater management guidelines, wet ponds and stormwater wetlands typically remove 80-90% of the suspended solids and 40-60% of the suspended and dissolved nutrients in urban stormwater. Dry ponds, which do not contain a permanent pool of water, tend to have lower removal rates. Therefore, best management practice implies that wet facilities be used wherever possible. Existing wetlands and water bodies should be preserved wherever possible. If this is not possible, Alberta Environment will require replacement or compensation.

As indicated in Section 2, a maximum outflow rate of 5 L/s/ha is proposed for pond design in Camrose. Table 2.3 provides the resulting storage volumes and drawdown times for different land use classes.

As indicated in Table 2.3, the storage volumes will range from 550 m^3 per hectare of residential area to 930 m^3/ha in commercial areas. Stormwater storage volumes will be emptied within 3 days after a major storm event in a residential area and 5 days in a commercial area.

The storage volumes in Table 2.3 are recommended for the conceptual pond sizing in future development areas. The size of each pond should be confirmed at the design stage when details of the pond design and the development concept are finalized.

4.4 PROPOSED STORMWATER MANANGEMENT PLAN

Figure 4.4 provides an overall view of the stormwater management concept plan for the future development area. Its development was guided by the following principles:

- Respect the existing system capacities and constraints as summarized in Section 3.
- Respect the stormwater management objectives described above to prevent flooding and erosion of downstream systems and to protect the quality of water in the receiving streams.
- Follow the existing topography and drainage systems wherever possible, so as to provide cost-effective drainage solutions and to minimize the cost of new facilities.
- Provide orderly drainage development from downstream to upstream so as to minimize leap-frogging and oversizing of drainage facilities.
- Coordinate the stormwater management plan with the sanitary servicing plan and catchment areas described in the Sanitary Master Plan report, to facilitate orderly and cost-effective development.
- Respect land ownership boundaries to minimize the need for coordinating plans of multiple developers and landowners while minimizing the proliferation of small stormwater management facilities (this implies that developments and drainage facilities will be developed on a ¼ section scale).
- Preserve existing wetlands wherever possible.

The following section provides further information and describes the specific issues and their solutions for each of the four sectors of the City, as well as guidelines for their implementation.

Appendix A provides more detailed plans showing the stormwater management concepts for the four sectors of the City (NE, NW, SE, SW), along with the sanitary sewer concept plans for these sectors. Smaller versions of these plans are provided in Figures 4.5 to 4.8. The Appendix also provides details of the stormwater pond sizing, storage volumes, outflow rates, and preliminary pipe sizes. These are all subject to review in the design stage based on the design standards that apply at the time and based on details of the servicing of those areas.

The stormwater management concept plan sets out the primary parameters that will guide future development. It is not meant to be prescriptive, and it is subject to further review in subsequent stages of the development process. Hopefully, it will lead to innovative solutions during subdivision planning and design. It is a living document that will need to be adapted over time as stormwater management requirements evolve.

4.5 NORTHWEST

As shown in Figure 4.1, it is assumed that future areas along Highway 13, on the northwest side of the City, will be developed as highway commercial property, similar to the commercial strip along the existing Highway 13 (48 Avenue) corridor. Multi-family development will separate the highway commercial development from predominantly single-family residential development to the north and south, outside the first half mile from the highway.

Drainage of this area faces some unique and difficult challenges that differ from the south to the north side of the CPR. The drainage concept for this sector is shown in the Figure 4.5 and is described below.

4.5.1 South of CPR

The area on the south side of the CPR drains to existing storm sewers on 68 Street and to the Grandview storm trunk that are currently loaded to capacity.

For some time, a new storm trunk has been planned to carry the runoff from this area, through the golf course, to Camrose Creek, but has not been constructed due to its cost. In the interim, the Cornerstone and West Park developments have been connected to the 68 Street and Grandview storm sewers through a system of stormwater management facilities, which includes the following:

- The Cornerstone south stormwater management facilities have been fitted with a pump that discharges off-peak, after the storm event, when capacity is available.
- The Cornerstone north development has a dry pond that can act as a surge facility when the downstream trunks are developed.
- An open ditch west of Cornerstone carries the major overland flow from the south side of the Highway, and provides an emergency overflow route should the pond on the south side of the highway be overloaded.

- This overflow path continues through a culvert under the CPR to the drainage course to the north (it appears to have been the natural drainage outlet from the area before the Grandview area was developed).
- Currently, the Cascades (Cypress Creek) development is under way, in the north part of the ¼ section between Cornerstone and the CPR. It will have a stormwater management pond draining to the 68 Street storm sewers. This pond will also act as a surge facility that will allow the storm sewers to flow backward and thereby reduce the sewer surcharge on 68 Street and Grandview. The major overland flow path will continue to the north, through the CPR culvert.

In the longer term, it is proposed that the pond outfall be diverted to the north, to the future system north of the CPR and to the future Ring Road Trunk. This diversion will provide an outlet for the remainder of the drainage basin to the south and west of Cornerstone and will replace the trunk sewer through the golf course that had previously been proposed. Future developments within the basin area will have their own stormwater management facilities to control their outflows to the proposed trunk.

A number of alternatives have been considered for this storm outfall including an alignment through the golf course and one along Camrose Drive. The golf course alignment is shorter and somewhat shallower; however, it would require substantial disturbance to the golf course and may need to be done with trenchless methods, which would substantially increase the cost. A storm trunk along the Ring Road would be somewhat deeper, due to higher topography, but would serve the Ring Road as well as the development area. Since the road and the development are likely to occur in about the same time frame, there are some cost savings in a shared scheme. The proposed alignment connects with the future pond to the north, and then follows the Ring Road, to minimize the deep portion of pipe and to maximize the area served.

A large wetland north of Highway 13 occupies almost the entire quarter section, S.E. ¼ 5-47-20-4. At present there is no visible outlet from the wetland. It appears that the wetland receives runoff from a limited catchment area and the water levels are kept in check by evaporation from the water surface.

It is proposed that this wetland be preserved and incorporated into future development. It will provide stormwater management for the local area as well as "polishing" of water quality for the tributary area to the south of the Highway. The remaining area in the quarter section, not occupied by the wetland, and a small area to the north, will drain directly to the wetland. The one and a half quarter sections south of the wetland will have their own stormwater management facilities that will drain at a controlled rate to the wetland. The wetland will be provided with an outlet to the east to join the rest of the drainage system described above.

A second wetland further west along Highway 13, in the SW ¼ 5-47-20-4, drains to the north. About 3 quarter sections south of Highway 13, plus the future highway commercial frontage on the north will drain to this wetland. Areas on the south side of the highway will have their own stormwater management facilities that will drain at a controlled rate to the wetland. The wetland will provide storage for the immediate quarter section and "polishing" of water quality for the area to the south of the highway.

4.5.2 North of CPR

The area north of the CPR drains to a low-lying, flat and poorly-drained area west of Victoria Park (68 Street) and then northward in a constructed drainage channel to the natural drainage course that drains all of Catchment 7 in Figure 4.3. This drainage course drains to a large wetland, located northwest of Victoria Park, and then via a shallow, natural drainage course to Camrose Creek.

The area west of Victoria Park is too low to be drained northward in its existing course when it is developed. Therefore a trunk sewer is proposed to follow the Ring Road when the roadway is developed. It will provide drainage of the Ring Road and the development to the west as well as the drainage basin south of the CPR. The three quarter sections west of Victoria Park will each have a stormwater management facility that will drain to this system.

The area north of the Ring Road will continue to drain at a controlled rate to the existing wetland and the natural drainage course to Camrose Creek. Some storage will be provided in the wetland, and additional smaller stormwater management facilities will be required upstream and downstream to control runoff to the channel. Some regrading of the channel may be required for about 500 m downstream of this wetland, subject to field survey and more detailed assessment, so as to contain the outflows from the wetland and prevent flooding of the adjacent land.

4.6 NORTHEAST

The 13 quarter sections in the northeast corner of the City, east of the airport, are anticipated to be developed into heavy industrial uses such as the pipe plants and storage areas that currently exist in parts of this catchment (there is some possibility of country residential development in the portion that is currently in the County).

Figure 4.6 shows the drainage concept for this sector. There is a drainage divide on the north side on the City, east of the airport. Approximately seven quarter sections located in the far northeast corner of the study area drain to a natural drainage course to the north, through the County of Camrose. Several wetlands in this drainage system will be preserved to provide storage to control the runoff as the area is developed.

The remaining area to the south of the divide drains to the Ring Road drainage channel, currently under construction on the north side of the City. This channel will need to be extended upstream past the airport, as an open channel or pipe system, to provide an adequate outlet from the area to the east. There are significant right-of-way restrictions between the airport and the Shaw Pipe Plant which may require a pipe instead of a channel. Stormwater management facilities will be provided to control the runoff to pre-development rates.

It is recommended that all future stormwater management facilities within the vicinity of the airport be constructed as dry ponds or have minimal water areas with naturalized shorelines due to their proximity to the airport. This will discourage the presence of birds and waterfowl that can be a threat to aircraft.

Other measures to discourage large waterfowl in the vicinity of the airport could include:

- Draining wet areas.
- Minimizing open-water areas.
- Providing steep shorelines (5:1 to 4:1), naturalized with shrubs and tall grass to discourage nesting and feeding activities (especially geese).

The City is currently developing a wetland policy that will look at these issues in more detail.

The City is also in the process of determining whether the large wetland in the middle of the pipe plants will remain or be drained. This wetland is very near to the airport runway centreline. Alberta Environment will require wetland compensation/replacement, under the Water Act, if a wetland is drained. If this wetland is retained, the quarter section on the east side of the wetland drain to the wetland to help maintain its water balance. An outlet channel to the north will be required.

The Garneau and Shaw Pipe developments have their own stormwater management facilities. Garneau drains to the 46 Street channel, and the Shaw Pipe facility will have a stormwater pond that will be pumped out off-peak at a controlled rate of 210 l/s to a 750 mm storm sewer on 39th Street, approximately 120 m north of the CPR crossing.

4.7 SOUTHEAST

The majority of the southeast area is anticipated to develop as light industrial except for highway commercial in the 300 m strip on either side of the highway. This area is divided, topographically, into two basins with the divide roughly following Camrose Drive and Highway 13 East. The drainage concept for these areas is shown in Figure 4.7 and is described below.

4.7.1 North of Camrose Drive

The area north of Camrose drive and Highway 13 drains through the Mohler basin. A large off-site area east of the City also drains through the Mohler basin. Runoff from this area and the Mohler industrial area itself is carried by an open channel and trunk network to the regional stormwater management pond at the CNR. The pond discharges to a coulee through Augustana College which discharges to Camrose Creek.

The CNR Mohler pond was recently constructed to provide stormwater management for the existing development in the Mohler Industrial area. As future areas are developed to the east of Highway 13, they will require stormwater management facilities to control their runoff to pre-development rates and to minimize their potential impacts further downstream.

Controlling flows at the CNR will help to slow down the rate of erosion, but more corrective action (bank and bed armouring) may be required in the future as the volumes of runoff increase with further development. The land bridge which the University constructed to replace the aging footbridge at Augustana College will have minor impact as it was designed to pass the peak flows. **It is recommended that the coulee be monitored and that additional bed and bank armouring be undertaken if it proves necessary**.

As the coulee is within Augustana property (owned by the University of Alberta), negotiations would be required with the University.

4.7.2 South of Camrose Drive

Most of the area south of Camrose Drive drains to the southeast through a natural, intermittent, drainage course through agricultural land (Figure 4.3). This drainage course will have to be improved to accommodate the increased volume of runoff that will occur when the area develops so as to avoid impacting the agricultural lands. A drainage easement will likely have to be negotiated with current landowners.

Approximately two quarter-sections will drain at a controlled rate to the Camrose Drive trunk sewer and about two quarters will drain at a controlled rate to Camrose Creek.

The lands in and around the lagoons and landfill currently drain overland and via a ditch system to Camrose Creek. These drainage patterns will be preserved in the future.

4.8 SOUTHWEST

Residential development will continue in the southwest sector of the City. All future areas will be developed with stormwater management facilities that will discharge at a controlled rate to three coulees that drain to Camrose Creek, as shown in Figure 4.8.

The Enevold quarter section west of Century Meadows and 23.3 ha further west are proposed to drain at a controlled rate to the West Camrose Drive storm trunk, as indicated previously in Section 3.3.7.

The three quarter sections west of Valleyview will drain through the Valleyview system to Camrose Creek, to follow the natural direction of drainage in this region. Each quarter section will have its own stormwater management pond, discharging at pre-development peak rates, to the downstream system. The quarter section west of Valleyview will be served by an expansion of the Valleyview pond. All of these facilities will drain through a storm sewer that the City recently constructed to Camrose Creek. In this way, the drainage system will be extended westward in stages to follow the likely sequence of development in this basin.

As the City extends southward of Valleyview, the future developments adjacent to Camrose Creek will have stormwater management facilities that will discharge at a controlled rate to two stream courses. Drainage systems will be extended westward (upstream) as development progresses in this direction, eventually extending around the west side of the City. As the upstream areas are developed they will be provided with stormwater management facilities discharging at a rate of 5 L/s/ha. This concept will minimize the over-sizing and sharing of costs between developments and will follow the likely sequence of development, outward from the existing development area, and from east to west away from Camrose Creek. As these areas are developed, and the runoff volumes are increased, the natural drainage courses in the coulees may need to be replaced with piped systems, similar to the Century Meadows/Valleyview outfall, to prevent erosion of the coulees.

One quarter-section on the southeast of this sector, directly across from the lagoons, is wedged between Camrose Creek and the south coulee. It will have a stormwater management pond discharging to Camrose Creek, or to the coulee to the south. The precise alignment and construction method will require detailed study at the design stage due to steep slopes. Another quarter-section on the extreme southwest will have a stormwater management pond that will drain to the south along the road right-of-way towards the Battle River, as this is the natural drainage outlet from this area.

4.9 PRELIMINARY SIZES AND CAPACITIES

Appendix B provides details of the stormwater management concept plan for the ultimate future development of the plan area, including:

- Preliminary pipe length, slope, and invert elevations,
- Peak flow rates for the future development scenario,
- Pond volume, sizes, and preliminary elevations.

Appendix C, provided separately on CD, contains GIS data base files with the details of the ultimate development scenario including:

- Length,
- Slope,
- Inverts,
- Ultimate peak flow,
- Ultimate pipe diameters,
- Estimated cost for each of the ultimate pipes and stormwater management facilities.

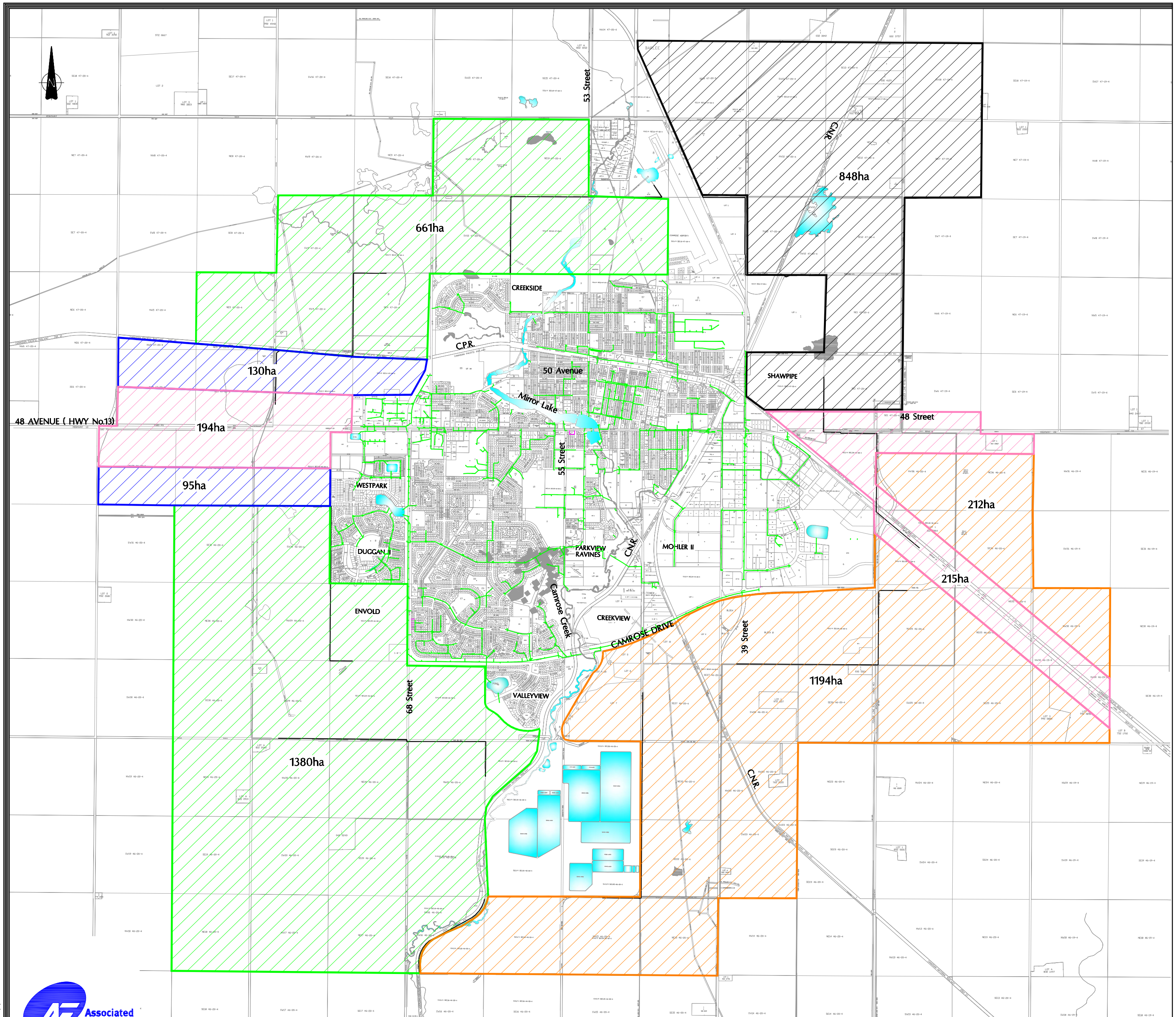
These data base files will allow the City personnel to easily access all the details of the Master Plan report. The information they contain is at a conceptual level of detail and is subject to review during the detailed design process.

Cost estimates assume the following:

- The costs included for future projects are conceptual only.
- Costs are for 2008.
- Costs include 15% engineering, 40% contingency and 5% G.S.T.
- Costs for open cut include stripping, trenching, supply/install pipe and manholes every 120 m.

THE CITY OF CAMROSE

ASSUMED LAND USE IN FUTURE DEVELOPMENT AREAS



LEGEND:

- HEAVY INDUSTRIAL
- LIGHT INDUSTRIAL
- PRIMARILY SINGLE FAMILY RESIDENTIAL
- MULTI-FAMILY RESIDENTIAL
- HIGHWAY COMMERCIAL
- EXISTING STORM SEWER

0 500 1000

SCALE: 1 : 40,000

JANUARY, 2008

Associated Engineering

FIGURE 4.1

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Date: Jan 17, 2008
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Xrefs: 3804-RP01_BASE_2005_nad27
EXpipes

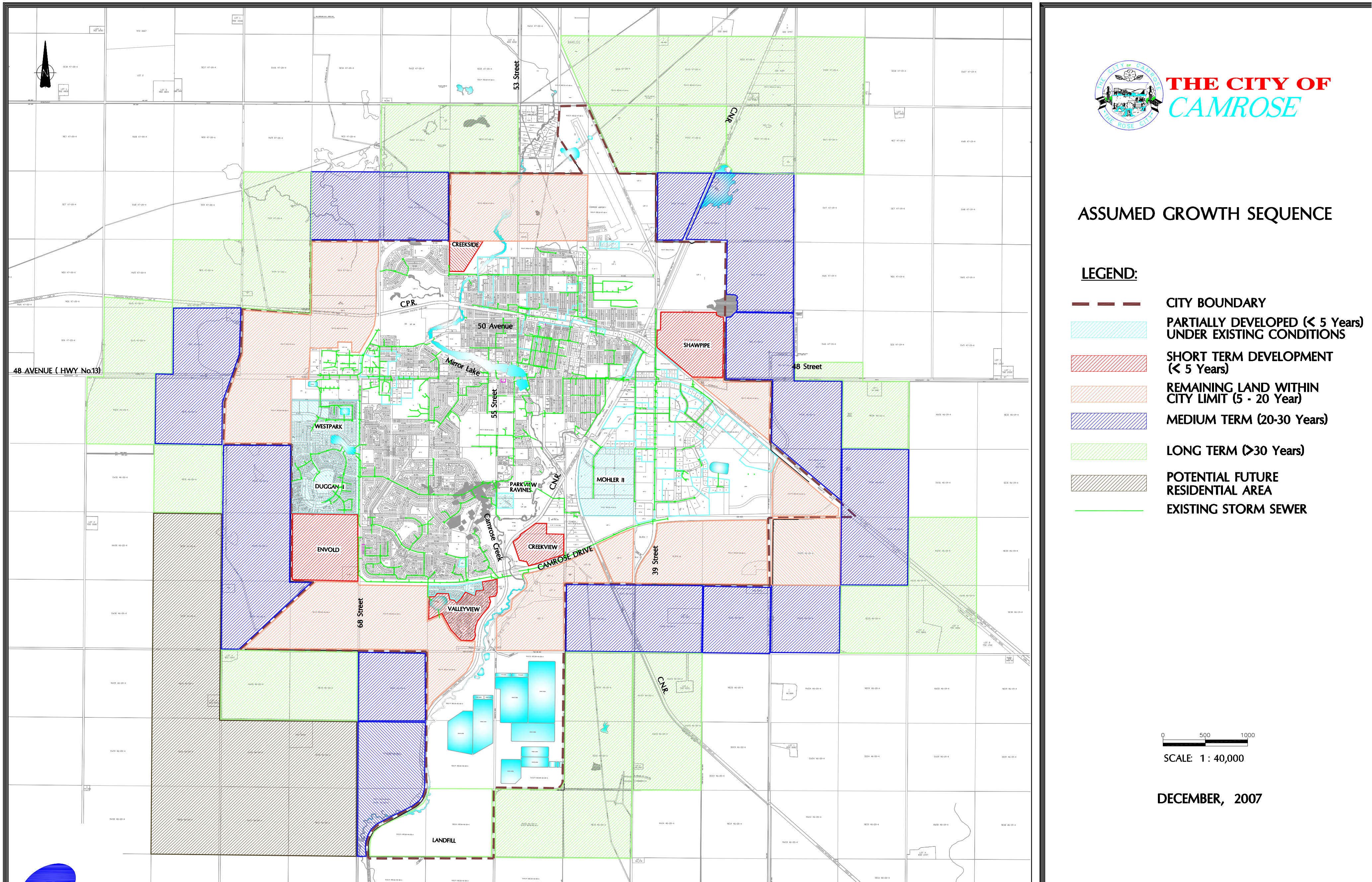

FIGURE 4.2

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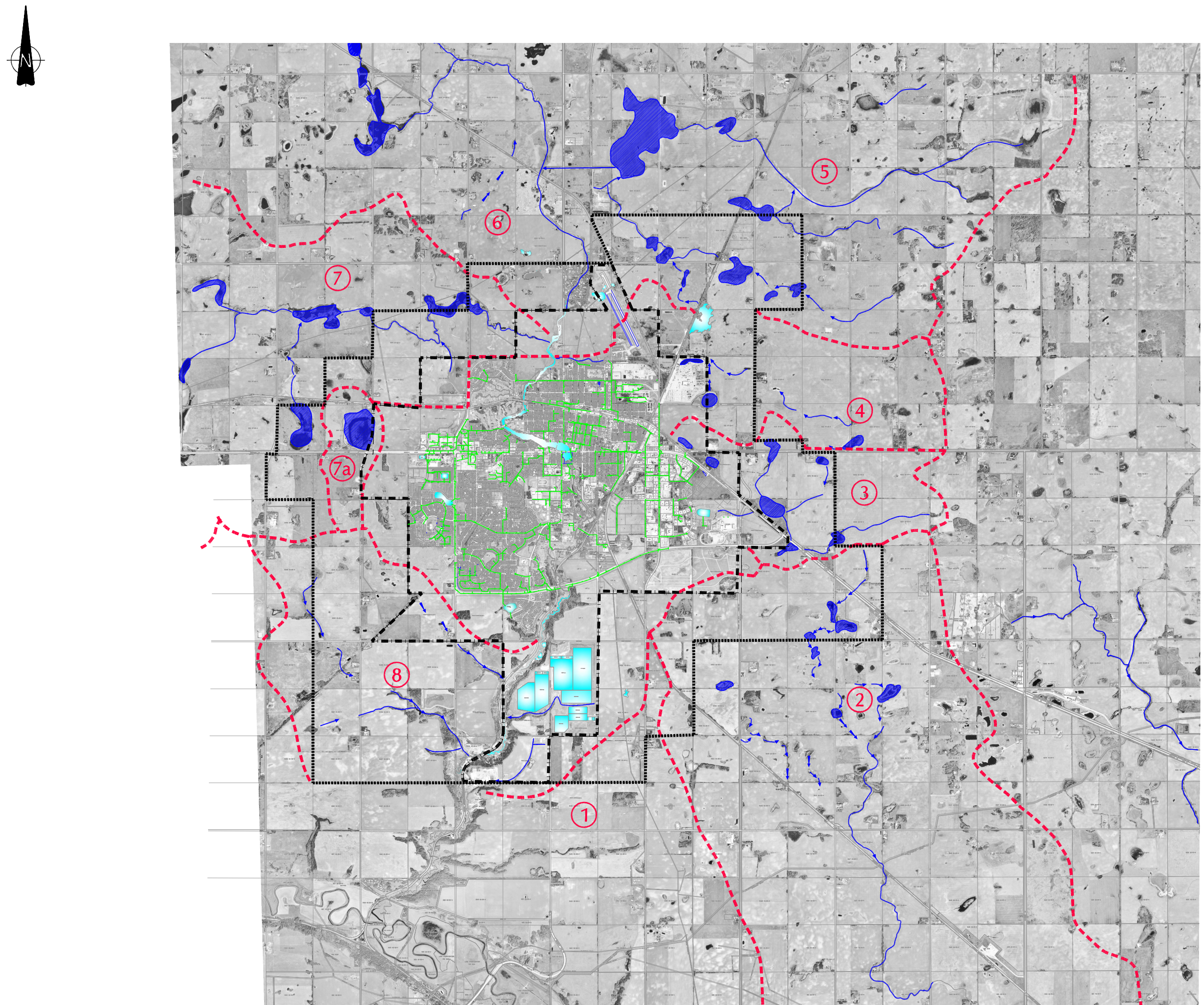


THE CITY OF CAMROSE

REGIONAL DRAINAGE

LEGEND:

- PRESENT CITY BOUNDARY
- PLANNING AREA BOUNDARY
- DRAINAGE COURSE
- SEASONAL OR INTERMITTENT DRAINAGE
- WETLAND OR WATER BODY
- CATCHMENT BOUNDARY
- 4 CATCHMENT NUMBER
- EXISTING STORM SEWER

NOTE:
1. AIRPHOTO PROVIDED BY CAMROSE COUNTY

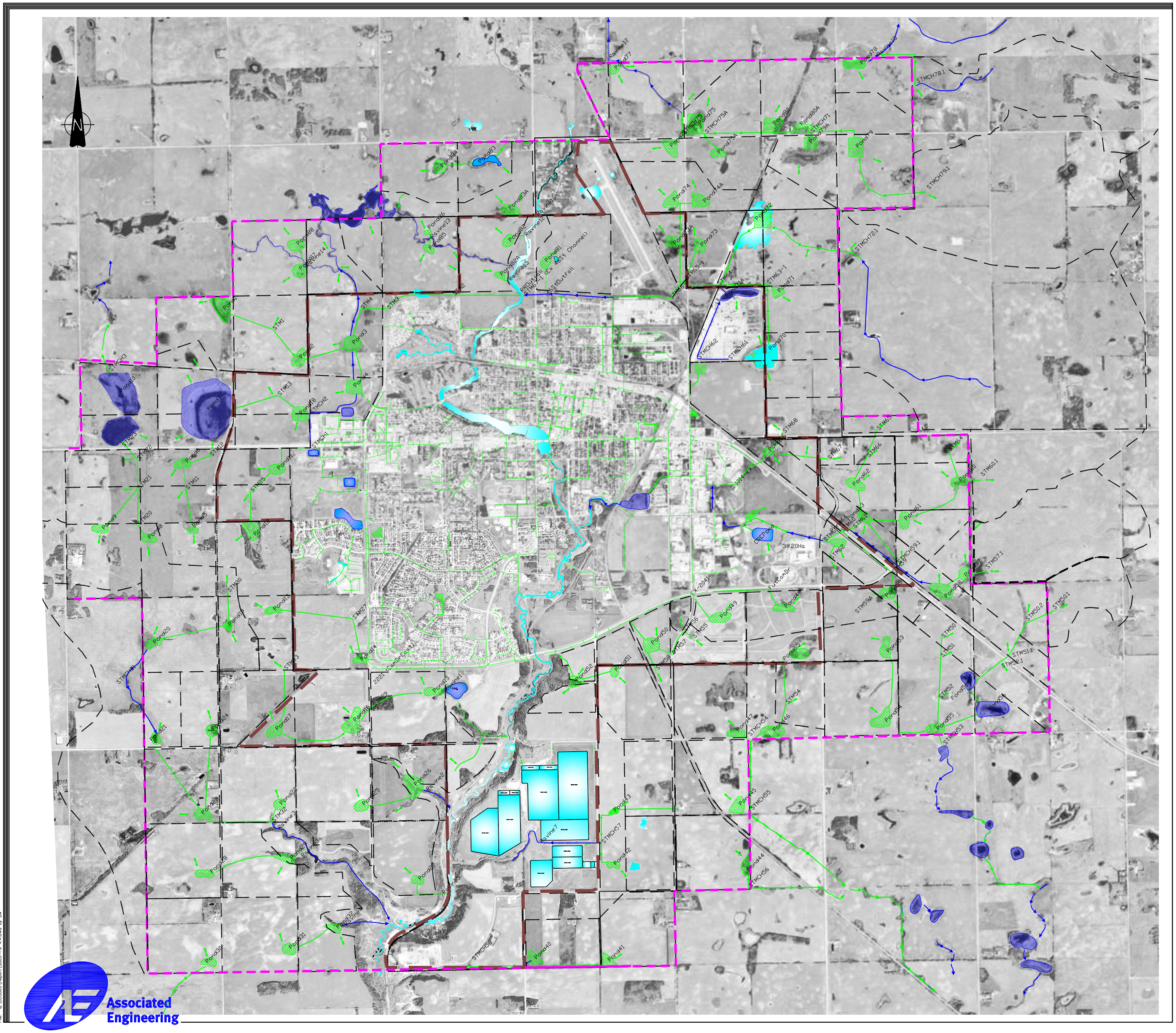
SCALE = 1 : 75 000

JANUARY, 2008

FIGURE 4.3

Associated Engineering

Q:\053805\Report\fig_4.3.dwg–Jan. 21, 2008 10:53am



Associated Engineering

THE CITY OF CAMROSE

STORM SEWER DRAINAGE CONCEPT PLAN

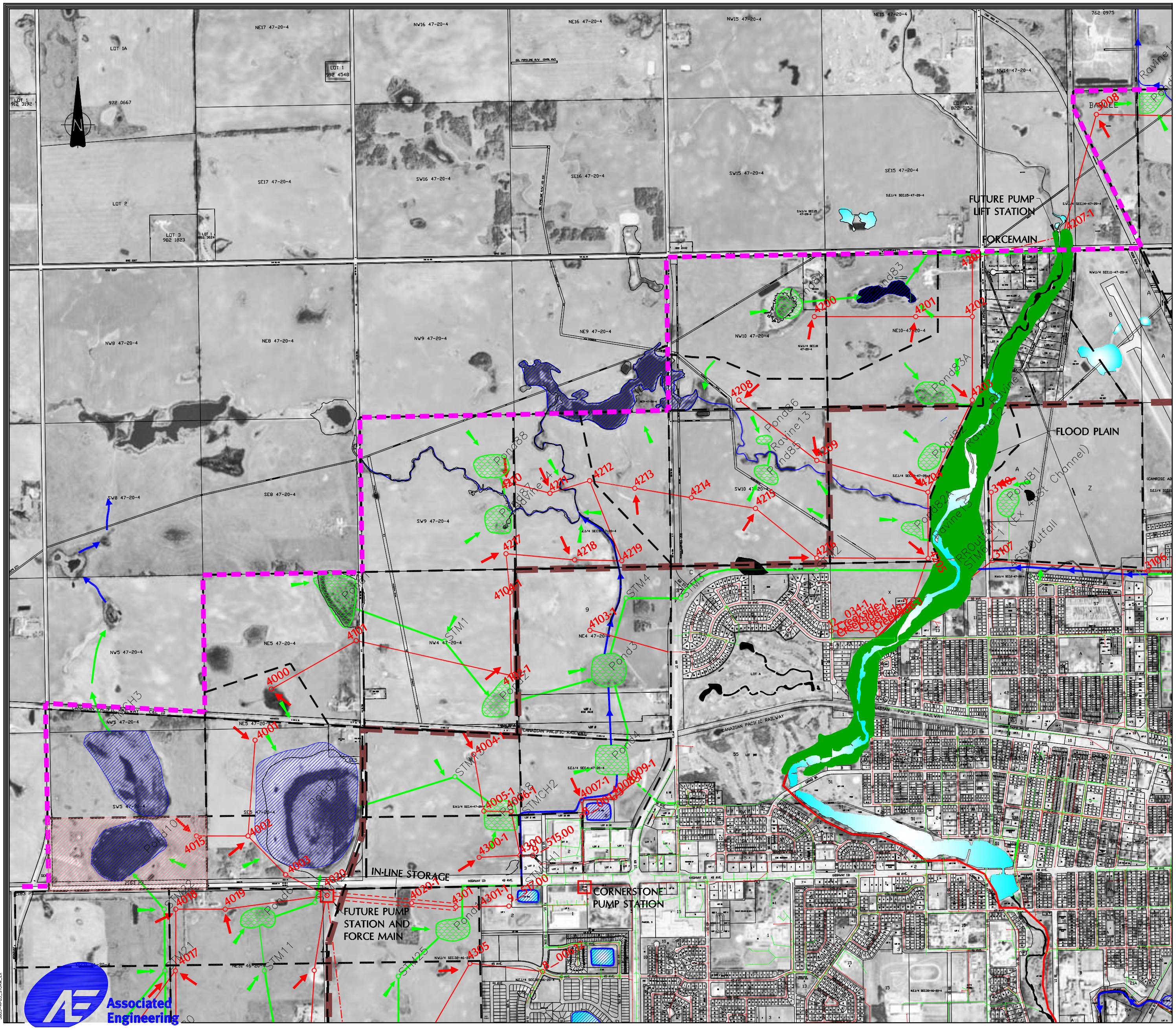
LEGEND:

- CAMROSE CREEK FLOOD PLAIN
- EXISTING WETLAND
- EXISTING STORM SEWER
- PROPOSED STORM TRUNK
- STORM INLET NODE
- STORM PUMP STATION
- STORMWATER MANAGEMENT FACILITY
- EXISTING DRAINAGE CHANNEL
- PROPOSED DRAINAGE CHANNEL
- SUB-CATCHMENT BOUNDARY
- CITY BOUNDARY
- PLAN AREA BOUNDARY

SCALE : 1 : 40 000

JANUARY, 2008

FIGURE 4.4



THE CITY OF CAMROSE

DRAINAGE CONCEPT PLAN
NORTHWEST CAMROSE

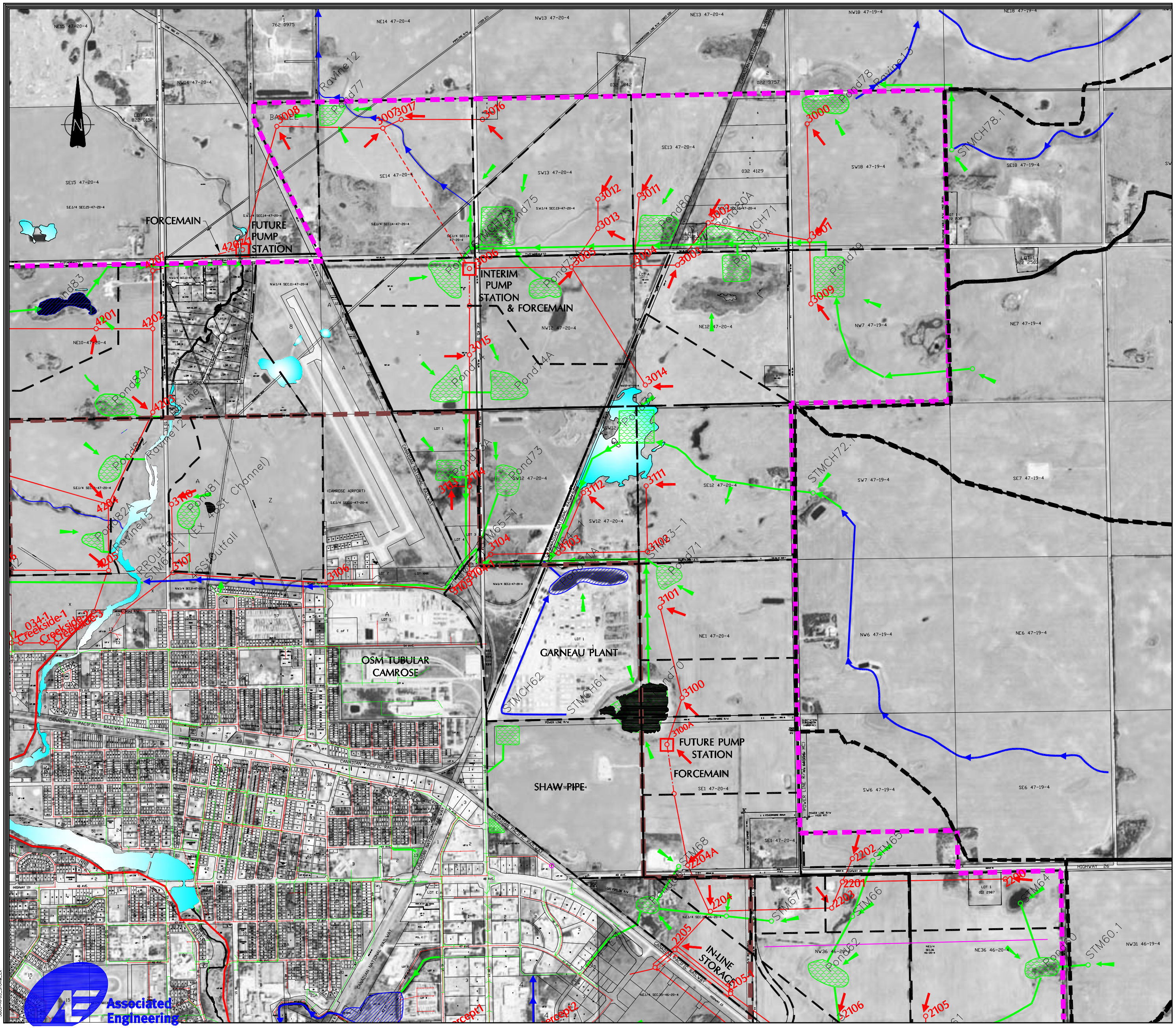
LEGEND:

- EXISTING SANITARY TRUNK
- PROPOSED SANITARY TRUNK
- OPTIONAL (ULTIMATE) SANITARY TRUNK
- SANITARY FORCEMAIN
- PIPE BRIDGE
- IN-LINE STORAGE PIPE
- SANITARY INLET NODE
- SANITARY PUMP STATION
- 4214 STORM NODE NUMBERS
- CAMROSE CREEK FLOOD PLAIN
- EXISTING WETLAND
- EXISTING STORM SEWER
- STORM TRUNK
- OPTIONAL STORM TRUNK
- STORM INLET NODE
- STORM PUMP STATION
- STORMWATER MANAGEMENT FACILITY
- EXISTING DRAINAGE CHANNEL
- PROPOSED DRAINAGE CHANNEL
- SUB-CATCHMENT BOUNDARY
- CITY BOUNDARY
- PLAN AREA BOUNDARY

SCALE : 1 : 20 000

JANUARY, 2008

FIGURE 4.5



THE CITY OF CAMROSE

DRAINAGE CONCEPT PLAN
NORTHEAST CAMROSE

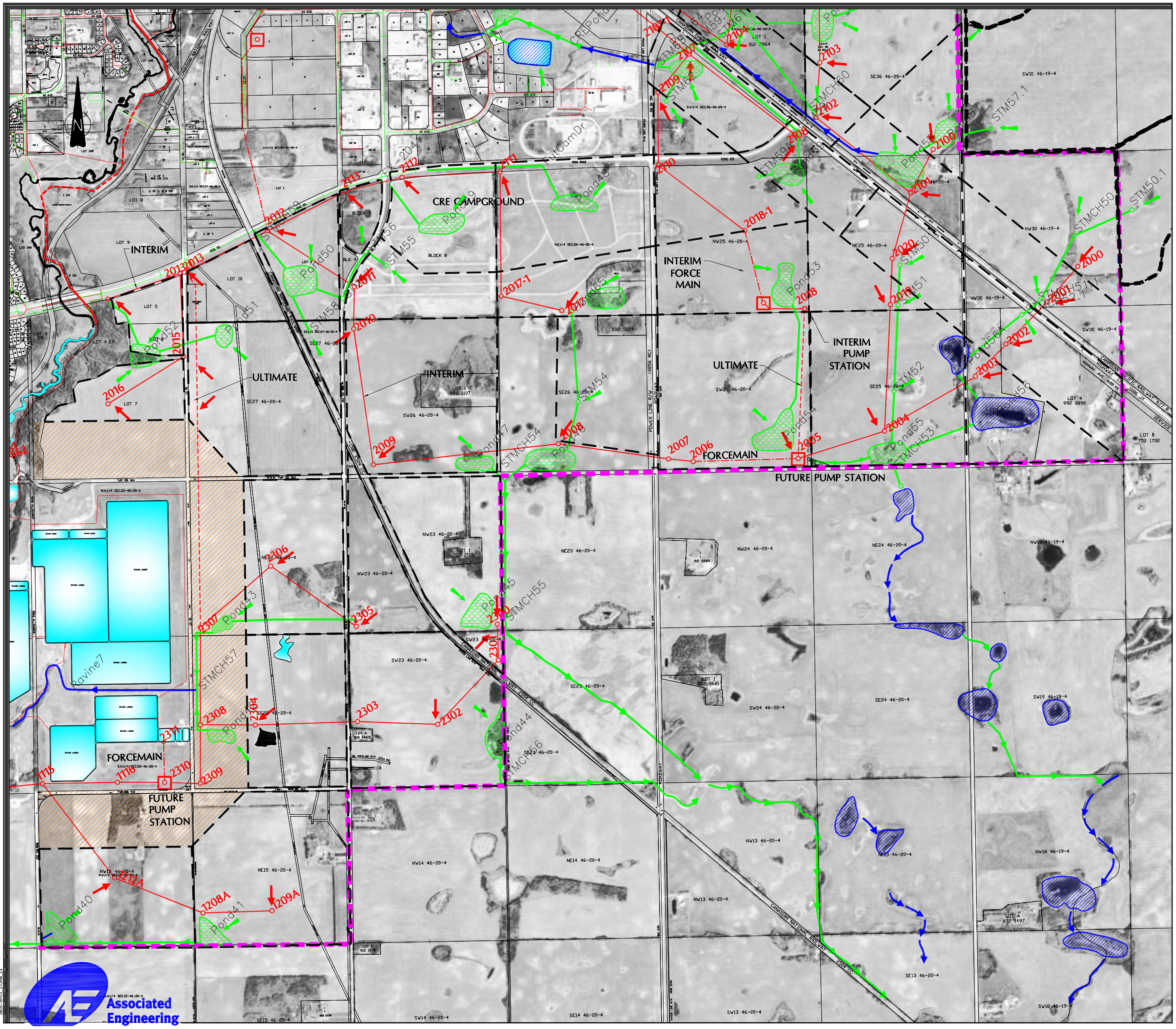
LEGEND:

- EXISTING SANITARY TRUNK
- PROPOSED SANITARY TRUNK
- OPTIONAL (ULTIMATE) SANITARY TRUNK
- SANITARY FORCEMAIN
- PIPE BRIDGE
- IN-LINE STORAGE PIPE
- SANITARY INLET NODE
- SANITARY PUMP STATION
- 4214 STORM NODE NUMBERS
- CAMROSE CREEK FLOOD PLAIN
- EXISTING WETLAND
- EXISTING STORM SEWER
- STORM TRUNK
- OPTIONAL STORM TRUNK
- STORM INLET NODE
- STORM PUMP STATION
- STORMWATER MANAGEMENT FACILITY
- EXISTING DRAINAGE CHANNEL
- PROPOSED DRAINAGE CHANNEL
- SUB-CATCHMENT BOUNDARY
- CITY BOUNDARY
- PLAN AREA BOUNDARY

SCALE : 1 : 20 000

JANUARY, 2008

FIGURE 4.6



THE CITY OF CAMROSE

DRAINAGE CONCEPT PLAN
SOUTHEAST CAMROSE

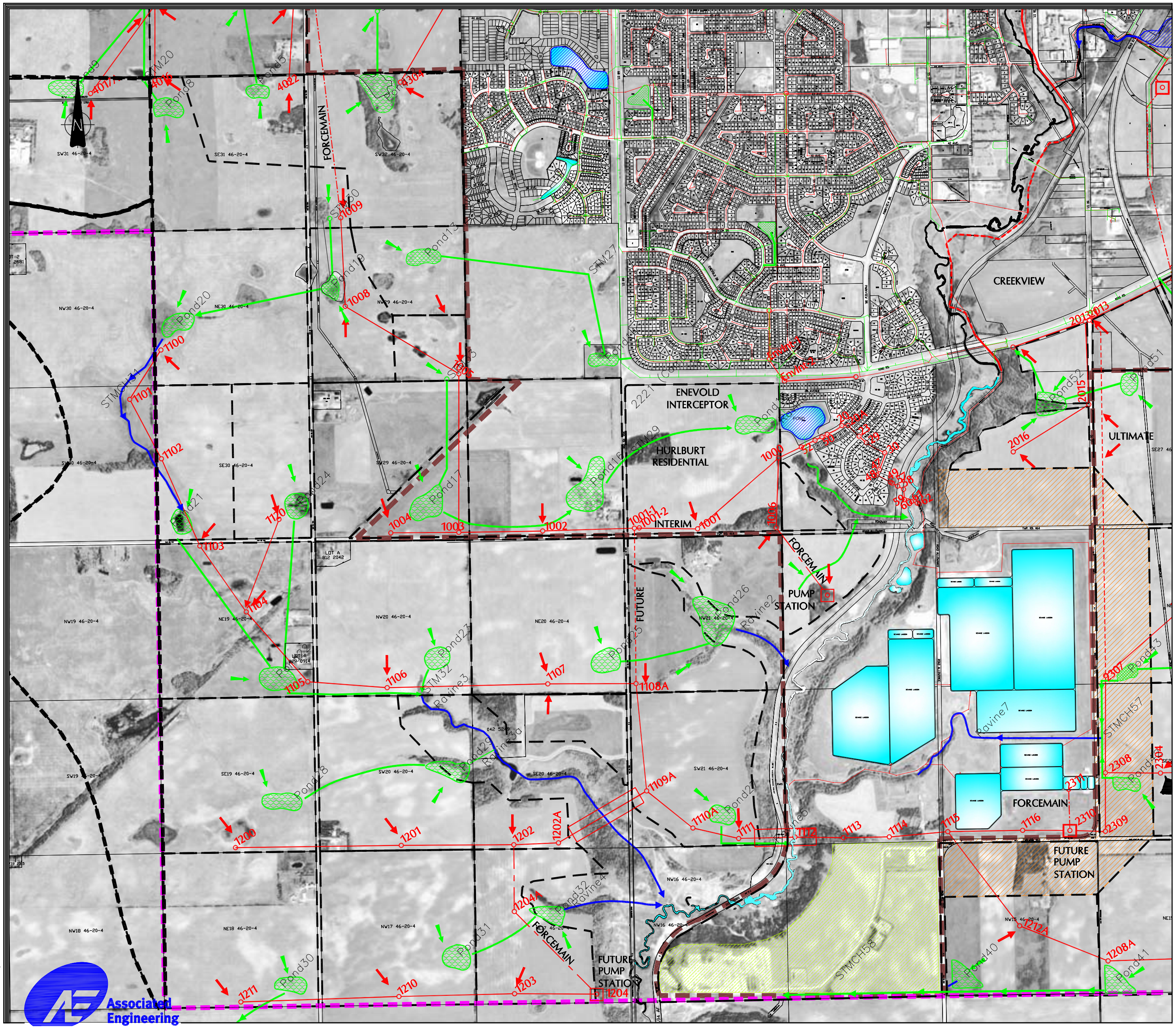
LEGEND:

- EXISTING SANITARY TRUNK
- PROPOSED SANITARY TRUNK
- OPTIONAL (ULTIMATE) SANITARY TRUNK
- SANITARY FORCEMAIN
- PIPE BRIDGE
- IN-LINE STORAGE PIPE
- SANITARY INLET NODE
- SANITARY PUMP STATION
- 4214 STORM NODE NUMBERS
- CAMROSE CREEK FLOOD PLAIN
- EXISTING WETLAND
- EXISTING STORM SEWER
- STORM TRUNK
- OPTIONAL STORM TRUNK
- STORM INLET NODE
- STORM PUMP STATION
- STORMWATER MANAGEMENT FACILITY
- EXISTING DRAINAGE CHANNEL
- PROPOSED DRAINAGE CHANNEL
- SUB-CATCHMENT BOUNDARY
- CITY BOUNDARY
- PLAN AREA BOUNDARY

SCALE : 1 : 20 000

JANUARY, 2008

FIGURE 4.7



THE CITY OF CAMROSE

DRAINAGE CONCEPT PLAN
SOUTHWEST CAMROSE

LEGEND:

- EXISTING SANITARY TRUNK
- PROPOSED SANITARY TRUNK
- OPTIONAL (ULTIMATE) SANITARY TRUNK
- SANITARY FORCEMAIN
- PIPE BRIDGE
- IN-LINE STORAGE PIPE
- SANITARY INLET NODE
- SANITARY PUMP STATION
- 4214 STORM NODE NUMBERS
- CAMROSE CREEK FLOOD PLAIN
- EXISTING WETLAND
- EXISTING STORM SEWER
- STORM TRUNK
- OPTIONAL STORM TRUNK
- STORM INLET NODE
- STORM PUMP STATION
- STORMWATER MANAGEMENT FACILITY
- EXISTING DRAINAGE CHANNEL
- PROPOSED DRAINAGE CHANNEL
- SUB-CATCHMENT BOUNDARY
- CITY BOUNDARY
- PLAN AREA BOUNDARY

SCALE : 1 : 20 000

JANUARY, 2008

FIGURE 4.8

5 Conclusions

5.1 DESIGN STANDARDS

- Much of the City of Camrose storm sewer system was designed to a lower standard (1:2 year storm) than exists today (1:5 year storm for the minor system, 1:100 year storm for the major system).

- It is practically impossible to upgrade existing drainage systems to meet current standards, short of replacing the storm sewers and re-grading the streets.

5.2 EXISTING SYSTEM CAPACITY

- Portions of the pipe system are surcharged in the 1:5 year storm (and larger storms), and surcharge levels reach ground surface in places, especially along Marler and Mount Pleasant Drives, and locally in areas north and east of the downtown area.

- Storm sewer performance is somewhat better in the newer areas that were constructed within the past 15 years and were designed for free-flow capacity in the 1:5 year storm.

- The major drainage system performs reasonably well and there are relatively few complaints of property damage resulting from surface runoff. Large flows do occur on the street during major storm events but these are difficult (costly) to rectify and are mostly an inconvenience to the residents.

- There is some flood potential at six (6) trapped lows in the City. These are shown on Figure 3.4 and are located as follows (numbered to match Figure 3.4):

  - #5 42 Avenue and 62 Street
  - #7 Erickson Drive north of 36 Avenue
  - #8 Parkview Drive at Camrose Drive
  - #9 55 Avenue at 51 Street
  - #12 48 Street between 50 and 51 Avenue
  - #13 50 Avenue near 43 Street

- It is not cost-effective to upgrade the existing storm drainage system to today's standard; instead a program of selective upgrading is recommended to minimize flooding of private property.

- Upgrades that the City has completed in the past five years have significantly reduced surcharge levels, improved drainage conditions, and reduced the risk of flooding in several areas.

- Erosion is continuing in the ravine through the Augustana College, although there is some indication that natural armouring is occurring through selective erosion of till materials through which the ravine cuts. The newly constructed Augustana land bridge may reduce the erosion upstream of its location slightly, by providing a fixed point in the vertical profile.

- Some erosion is occurring in the main drainage channel through the Mohler industrial area downstream of 41 Street and at the inlet to the CNR Mohler pond upstream of the CNR.

5.3 FUTURE DEVELOPMENT NEEDS

- The City is expected to grow outward in concentric rings from the existing development area, generally following the logical direction of drainage development from downstream to upstream, outward from Camrose Creek, which will facilitate the orderly development of services with a minimum of leap-frogging and over-sizing.

- Stormwater management will be required in all new developments to control peak runoff rates and water quality.

- Large areas on the east side of the City (east of the airport and east of the Mohler Industrial area) drain through existing drainage systems that will need to be extended upstream to serve these areas.

- A new outfall will be required along the north Ring Road on the northwest side of the City to drain the areas west and south of the Cornerstone development.

- The stormwater management concept plan in Figure 4.4 provides for more than 50 years of growth in the City of Camrose. Details are provided in Appendix B.

6 Recommendations

6.1 DESIGN STANDARDS

The following changes are recommended to the City's servicing standards:

- Increase the runoff factor for commercial areas from 0.65 for neighbourhood commercial and 0.80 for downtown commercial to 0.9 for all commercial land uses.

- Increase the runoff factor for industrial areas from 0.70 to 0.80 in the 1:100 year storm (1:5 year is unchanged at 0.6).

- Increase the maximum flood storage depth from 1.2 m for wet ponds and 1.5 m for dry ponds to a maximum of 2.0 m for all stormwater ponds reduce the cost of stormwater management facilities.

- Provide 1.0 m of freeboard above the 1:100 year flood level to allow for more severe storms and unforeseen conditions.

- Provide an emergency overflow below the freeboard (property) line to protect private property from flooding adjacent to these ponds.

- Adopt the following criteria for evaluating existing drainage system designed to a lower standard:

  - Minimize surcharging to grade in a minor (1:5 year storm event),
  - Limit the potential for flooding of private property in a major (1:100 year) storm event.

- Specify a maximum release rate of 5.0 l/s/ha in the 1:100 year 24 hour storm for the design of stormwater management ponds, and a maximum drawdown time of 3 days in residential areas, 4 days in industrial areas and 5 days in commercial areas.

6.2 EXISTING SYSTEM

- It is recommended that the channel through the Mohler Industrial area, from 41 Street to the CNR Mohler pond, be reshaped and protected against further erosion. The alternative of a storm trunk in conjunction with a major drainage route should be considered in the design stage.

- Selective upgrades should be considered at eight locations shown in Figure 3.5, and summarized in Table 3.1, to improve drainage and reduce the risk of flooding or erosion at a total cost of about $2.4 million.

- A more detailed assessment of the storm sewer system in the downtown area should be undertaken if redevelopment is considered in the future, with the storm sewers upgraded to provide greater capacity as is common for high value commercial areas.

- Consider upgrading storm sewers should they need to be replaced for structure or other reasons.

6.3 FUTURE DEVELOPMENT

- Provide stormwater management facilities in all future development areas to control flows and runoff water quality.

- Adopt the stormwater management plan in Figure 4.4 as the basis for future drainage design and development, subject to review during the development planning and subdivision design process.

- In a redeveloping site, in existing serviced areas (in-fill or intensification), it is suggested that on-site stormwater management be provided on parking lots and rooftops for all parcels larger than 0.5 hectares, releasing at a rate of 35 L/s/ha which corresponds roughly to the 1:2 year storm runoff rate that was used in the original design of the storm sewer system, and that the City should look for opportunities for on-lot stormwater management on smaller lots. A storm service connection should be provided for the on lot stormwater management facility except for lots smaller than 0.5 ha which could be allowed to discharge on the surface.

- Adopt a maximum outflow rate of 5 L/s/ha for pond design in Camrose, which provides a reasonable balance between the theoretical pre-development flow (3.5 L/s/ha) and drawdown criteria (5-7 L/s/ha). Preliminary estimates of storage volume required to control flows to this level are as follows:

Residential areas	550 m^3/ha
Industrial areas	800 m^3/ha
Commercial areas	930 m^3/ha

- Preserve existing wetlands, water bodies, and overland drainage courses.

- Future stormwater management facilities near the airport should be designed as dry ponds or have minimal water areas with naturalized shorelines, to discourage the presence of birds and waterfowl that can be a threat to aircraft.

- Address water quality improvements in all drainage design.

- Monitor the coulee through the Augustana College for erosion and take corrective action as required.

- Modify the CRE pond to bypass the upstream flows, and provide separate storage for the lower campground areas.

- Provide stormwater detention facilities for new development draining to the 39 Avenue storm sewer in the northeast of the Mohler Industrial area, and drain the area north of the CPR to the north when 39 Street is widened to four lanes, to reduce surcharge levels in the 39 Street trunk.

Closure

This report was prepared for the City of Camrose to provide a Stormwater Master Plan drainage concept for the City of Camrose.

The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering Alberta Ltd.

PROFESSIONAL ENGINEER — LARRY E. BODNARUK — ALBERTA

Jan. 14, 2008

Larry Bodnaruk, P. Eng.
Project Manager

PROFESSIONAL ENGINEER — ALICIA M. DMYTRUK — ALBERTA

Jan 14/08.

Alicia Dmytruk, M.Eng., P.Eng.
Project Engineer

PERMIT TO PRACTICE
ASSOCIATED ENGINEERING ALBERTA LTD.
Signature ____________
Date Jan. 14, 2008
PERMIT NUMBER: P 3979
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

PERMIT STAMP

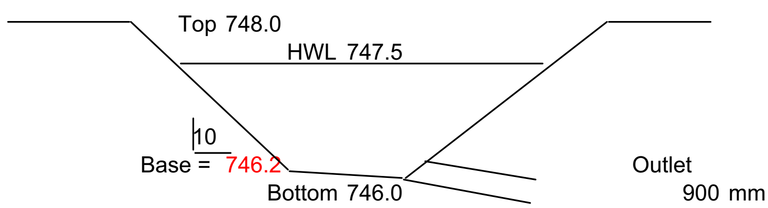
A Appendix A – Drainage Upgrade Concept Plans

TABLE A-1

City of Camrose
Proposed Upgrade Plan

Location: **67 Street Dry Pond (Upgrade #5)**
Design by: LEB **Date:** 12-Jan-08
Checked by: **Date:**

Conceptual cross-section



Design Parameters

Item	Elevation m	Depth (m)	Area ha	Total Volume m3	Storage Volume m3
Top	748.0	0.00	0.29	2700	2700
High water level	747.5	0.50	0.19	1500	1500
Base	746.2	1.83	0.03	0	0
Bottom	746.0	2.00	0.00	0	0
Storage capacity					1500
Average existing ground	748.0		0.29	2700	

Cost Estimate

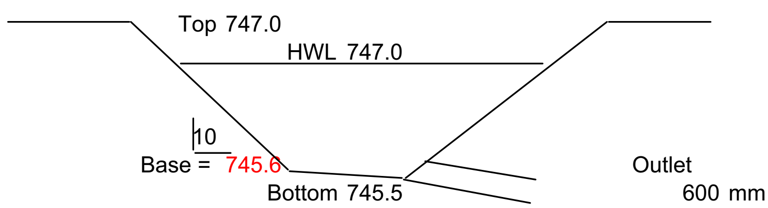
Item	Quantity	Units	Unit cost	Extension
Clearing and grubbing		ha	$10,000	$0
Stripping	0.3	ha	$10,000	$2,870
Excavation and disposal	2700	m3	$15	$40,500
Topsoil	0.3	ha	$10,000	$2,870
Landscaping	0.3	ha	$50,000	$12,912
Restore pavement	300.0	m2	$100	$30,000
Restore curb/gutter	5.0	m	$150	$750
Restore grassed areas	200.0	m2	$10	$2,000
Restore gravelled areas		m2	$25	$0
900 mm storm sewer	120.0	m	$1,100	$132,000
Manholes	3	ea	$10,000	$30,000
Total construction cost				$253,903
Land cost		ha	$1,000,000	$0
Sub-total				$253,903
Contingencies			40%	$101,561
Design services			10%	$25,390
Construction services			5%	$12,695
Project total				$393,550
GST			5%	$19,677
Total cost in 2007				$413,227
Cost escalation 2007-2008			18%	$74,381
Total cost in 2007				$487,608
			(say)	$490,000
Cost per m3 storage				$327

TABLE A-2

City of Camrose
Proposed Upgrade Plan

Location: **Erickson Dry Pond (Upgrade #7)**
Design by: LEB **Date:** 12-Jan-08
Checked by: **Date:**

Conceptual cross-section



Design Parameters

Item	Elevation m	Depth (m)	Area ha	Total Volume m3	Storage Volume m3
Top	747.0	0.00	0.13	1000	1000
High water level	747.0	0.00	0.13	1000	1000
Base	745.6	1.43	0.01	0	0
Bottom	745.5	1.50	0.00	0	0
Storage capacity					1000
Average existing ground	747.5		0.21	1848	

Cost Estimate

Item	Quantity	Units	Unit cost	Extension
Clearing and grubbing		ha	$10,000	$0
Stripping	0.1	ha	$10,000	$1,288
Excavation and disposal	1848	m3	$15	$27,727
Topsoil	0.1	ha	$10,000	$1,288
Landscaping	0.1	ha	$50,000	$6,169
Restore pavement	200.0	m2	$100	$20,000
Restore curb/gutter	5.0	m	$150	$750
Restore grassed areas	500.0	m2	$10	$5,000
Restore gravelled areas		m2	$25	$0
600 mm storm sewer	140.0	m	$900	$126,000
Manholes	2	ea	$10,000	$20,000
Total construction cost				$208,221
Land cost		ha	$1,000,000	$0
Sub-total				$208,221
Contingencies			40%	$83,289
Design services			10%	$20,822
Construction services			5%	$10,411
Project total				$322,743
GST			5%	$16,137
Total cost in 2007				$338,880
Cost escalation 2007-2008			18%	$60,998
Total cost in 2008				$399,879
			(say)	$400,000
Cost per m3 storage				$400

TABLE A-3

City of Camrose
Proposed Upgrade Plan

Location: **Camrose Drive Intercept (Upgrade #8)**
Option 1

Design by:	LEB	**Date:**	12-Jan-08
Checked by:		**Date:**	

Cost Estimate

Item	Quantity	Units	Unit cost	Extension
Clearing and grubbing		ha	$10,000	$0
Stripping		ha	$10,000	$0
Excavation and disposal		m3	$25	$0
Topsoil		ha	$10,000	$0
Landscaping		ha	$50,000	$0
Restore pavement	30.0	m2	$100	$3,000
Restore curb/gutter		m	$150	$0
Restore grassed areas		m2	$10	$0
Restore gravelled areas		m2	$25	$0
750 mm storm sewer	10.0	m	$900	$9,000
Manholes	2	ea	$10,000	$20,000
Total construction cost				$32,000
Land cost		ha	$1,000,000	$0
Sub-total				$32,000
Contingencies			40%	$12,800
Design services			10%	$3,200
Construction services			5%	$1,600
Project total				$49,600
GST			5%	$2,480
Total cost in 2007				$52,080
Cost escalation 2007-2008			18%	$9,374
Total cost in 2008				$61,454
			(say)	$61,000

TABLE A-4

City of Camrose
Proposed Upgrade Plan

Location: **Parkview Swale (Upgrade #8)**
Option 2

Design by:	LEB	**Date:**	12-Jan-08
Checked by:		**Date:**	

Cost Estimate

Item	Quantity	Units	Unit cost	Extension
Clearing and grubbing		ha	$10,000	$0
Stripping	0.2	ha	$10,000	$2,000
Excavation and disposal	200	m3	$25	$5,000
Topsoil	0.2	ha	$10,000	$2,000
Landscaping		ha	$50,000	$0
Restore pavement		m2	$100	$0
Restore curb/gutter	5.0	m	$150	$750
Restore grassed areas		m2	$10	$0
Restore gravelled areas		m2	$25	$0
600 mm storm sewer		m	$900	$0
Manholes		ea	$10,000	$0
Total construction cost				$9,750
Land cost		ha	$1,000,000	$0
Sub-total				$9,750
Contingencies			40%	$3,900
Design services			10%	$975
Construction services			5%	$488
Project total				$15,113
GST			5%	$756
Total cost in 2007				$15,868
Cost escalation 2007-2008			18%	$2,856
Total cost in 2008				$18,724
			(say)	$19,000

TABLE A-5

City of Camrose
Proposed Upgrade Plan

Location:	**55 Avenue Swale (Upgrade #9)**		
Design by:	LEB	**Date:**	12-Jan-08
Checked by:		**Date:**	

Cost Estimate

Item	Quantity	Units	Unit cost	Extension
Clearing and grubbing		ha	$10,000	$0
Stripping	0.01	ha	$10,000	$100
Excavation and disposal	50	m3	$25	$1,250
Topsoil	0.01	ha	$10,000	$100
Landscaping		ha	$50,000	$0
Restore pavement		m2	$100	$0
Restore curb/gutter	5.0	m	$150	$750
Restore grassed areas		m2	$10	$0
Restore gravelled areas		m2	$25	$0
600 mm storm sewer		m	$900	$0
Manholes		ea	$10,000	$0
Total construction cost				$2,200
Land cost	0.01	ha	$1,000,000	$10,000
Sub-total				$12,200
Contingencies			40%	$4,880
Design services			10%	$220
Construction services			5%	$110
Project total				$17,410
GST			5%	$871
Total cost in 2007				$18,281
Cost escalation 2007-2008			18%	$3,290
Total cost in 2008				$21,571
			(say)	$22,000

TABLE A-6

City of Camrose
Proposed Upgrade Plan

Location: **Downtown Storm Sewer (Upgrade #12)**

Design by:	LEB	**Date:**	12-Jan-08
Checked by:		**Date:**	

Cost Estimate

Item	Quantity	Units	Unit cost	Extension
Clearing and grubbing		ha	$10,000	$0
Stripping		ha	$10,000	$0
Excavation and disposal		m3	$25	$0
Topsoil		ha	$10,000	$0
Landscaping		ha	$50,000	$0
Restore pavement	330.0	m2	$100	$33,000
Restore curb/gutter	110.0	m	$150	$16,500
Restore grassed areas		m2	$10	$0
Restore gravelled areas		m2	$25	$0
900 mm storm sewer	100.0	m	$1,100	$110,000
Manholes	4	ea	$10,000	$40,000
Total construction cost				$199,500
Land cost		ha	$1,000,000	$0
Sub-total				$199,500
Contingencies			40%	$79,800
Design services			10%	$19,950
Construction services			5%	$9,975
Project total				$309,225
GST			5%	$15,461
Total cost in 2007				$324,686
Cost escalation 2007-2008			18%	$58,444
Total cost in 2008				$383,130
			(say)	$380,000

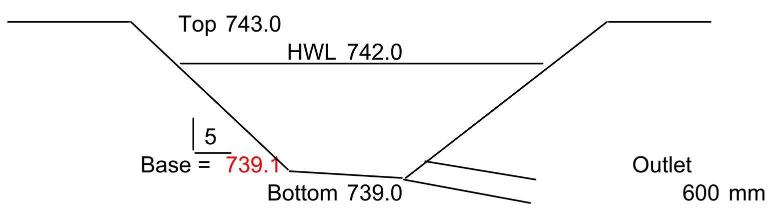
TABLE A-7

City of Camrose
Proposed Upgrade Plan

Location: **Bethany Dry Pond (Upgrade #13)**

Design by:	LEB	**Date:**	12-Jan-08
Checked by:		**Date:**	

Conceptual cross-section



Design Parameters

Item	Elevation m	Depth (m)	Area ha	Total Volume m3	Storage Volume m3
Top	743.0	0.00	0.26	4700	4700
High water level	742.0	1.00	0.16	2600	2600
Base	739.1	3.88	0.01	0	0
Bottom	739.0	4.00	0.00	0	0
Storage capacity					2600
Average existing ground	743.0		0.26	4700	

Cost Estimate

Item	Quantity	Units	Unit cost	Extension
Clearing and grubbing		ha	$10,000	$0
Stripping	0.3	ha	$10,000	$2,550
Excavation and disposal	4700	m3	$25	$117,500
Topsoil	0.3	ha	$10,000	$2,550
Landscaping	0.2	ha	$50,000	$12,070
Restore pavement	25.0	m2	$100	$2,500
Restore curb/gutter	5.0	m	$150	$750
Restore grassed areas	500.0	m2	$10	$5,000
Restore gravelled areas		m2	$25	$0
600 mm storm sewer	140.0	m	$900	$126,000
Manholes	2	ea	$10,000	$20,000
Total construction cost				$288,920
Land cost		ha	$1,000,000	$0
Sub-total				$288,920
Contingencies			40%	$115,568
Design services			10%	$28,892
Construction services			5%	$14,446
Project total				$447,826
GST			5%	$22,391
Total cost in 2007				$470,217
Cost escalation 2007-2008			18%	$84,639
Total cost in 2008				$554,856
			(say)	$550,000
Cost per m3 storage				$212

TABLE A-8

City of Camrose
Proposed Upgrade Plan

Location:	**Mohler Channel Upgrade (#15)**		
Design by:	LEB	**Date:**	12-Jan-08
Checked by:		**Date:**	

Cost Estimate

Item	Quantity	Units	Unit cost	Extension
Clearing and grubbing		ha	$10,000	$0
Stripping	1.00	ha	$10,000	$10,000
Excavation and disposal	2000	m3	$25	$50,000
Topsoil/seed	1.00	ha	$10,000	$10,000
Landscaping		ha	$50,000	$0
Restore pavement		m2	$100	$0
Restore curb/gutter	10.0	m	$150	$1,500
Restore grassed areas		ha	$10	$0
Restore gravelled areas		m2	$25	$0
Erosion protection mat	3000.0	m2	$15	$45,000
Gabion mat and substrate	500.0	m2	$200	$100,000
Manholes		ea	$10,000	$0
Total construction cost				$216,500
Land cost		ha	$1,000,000	$0
Sub-total				$216,500
Contingencies			40%	$86,600
Design services			10%	$21,650
Construction services			5%	$10,825
Project total				$335,575
GST			5%	$16,779
Total cost in 2007				$352,354
Cost escalation 2007-2008			18%	$63,424
Total cost in 2008				$415,777
			(say)	$420,000

CRE POND CONCEPTUAL DESIGN

The CRE site is being planned for re-development. Figure A-1 provides a plan view of the site and the contributing basin, and the stormwater management plan that is proposed for the area.

Currently the CRE site covers approximately 57 ha which includes the following:

•	CRE main building, parking lot, and exhibition grounds	28.3 ha
•	Camping	23.2 ha
•	Pond and immediate vicinity	5.4 ha
	TOTAL	**56.9 ha**

Runoff is carried to the pond by storm sewers from 42A Avenue and the exhibition grounds. An open channel also collects runoff from the main building and parking lot as well as approximately 500 ha of un-developed area to the east of Highway 13. This channel drains to the pond through a 1200 mm diameter culvert at the east end of the pond. A 2 m long weir and 600 mm diameter outlet culvert control the outflows from the pond to a maximum of about 0.8 m^3/s.

Table A-9 provides the storage volume calculation for the CRE site, assuming a maximum release rate of 5 L/s/ha. It shows that approximately 30,000 m^3 of flood storage would be required to serve the CRE site.

Table A-10 summarizes the hydraulic characteristics of the CRE pond. It has a flood storage volume capacity of approximately 32,500 m^3 (with 0.5 m freeboard), which is sufficient to serve the CRE site.

The 2000 Master Plan had proposed to drain an additional 63 ha to the pond; this would have required the pond to be enlarged to provide 100,000 m^3 of storage for the ultimate development, as had been proposed previously by ISL. However, the pond's outlet does not have sufficient capacity for the pre-development flow from the tributary basin east of Highway 13 or the controlled flow that will occur from that area when it is developed (about 2.5 m^3/s). This means that the pond would be overloaded by runoff from the upstream portion of the basin in a major storm or snowmelt flood. The 2000 Master Plan had proposed that the pond outlet could be modified by lowering the weir so as to increase the storage capacity, and replacing the outlet pipe with a 1500 mm pipe in order to accommodate the inflows from the basin further east.

Figure A-9 shows a revised concept plan for the CRE site that avoids altering the CRE pond. The revised plan includes the following:

- Runoff from the exhibition grounds and the main building and parking lot will be directed to the pond through existing and proposed storm sewers and roadside ditches along the main access road.

- The drainage channel which carries the runoff from the basin east of the CRE will be routed through the campground, to the existing culvert and drainage channel at 37 Street, and thus bypass the pond.

- The pond would provide the 30,000 m^3 of storage required for the CRE building and parking lot, the exhibition grounds, and the proposed campground area between the exhibition grounds and the pond as outlined in Table A-9.

- Storage for the campground north of the pond (1,500 m^3) would be provided in a low landscaped area adjacent to the drainage channel.

- An orifice would be added to the outlet of the pond to control its outflows to 175 L/s based on a service area of about 35 ha.

Separate stormwater management facilities will serve future development east of the CRE site.

Table A-11 provides the cost estimate for the channel re-construction. It does not include the cost of the new dry pond or modifications to the existing pond, which presumably would be the responsibility of the developer.

TABLE A-9
Storage Volume Calculation for CRE Site

For storm durations 1 to 24 hours

Location: CRE Re-development
Project # Date: 06/21/07 Computed by: LEB

IDF Curve	Edmonton (COE,1997)	
	Area (ha)	**Cv**
CRE/parking	5	0.9
Exhibition Grounds	23	0.8
Camping	5	0.4
Pond	5.4	0.9
Parks		0.3
Total area =	38.4 ha	
Cv =	0.78	
Return period	100 years	
Peak outflow rate	5 l/s/ha	

Pipe Design:	
Return Period	5 years
Tc	10 minutes
Q	145.8 l/s/ha

Storage Parameters		
Peak inflow	10.64	m3/s
Peak outflow	192	l/s
Storage volume	29460	m3
Critical storm event	24	hours
Time to drain	85	hours
	4	days

Rainfall parameters for storage		
Return period	100	years
IDF Curve	Edmonton (COE,1997)	
IDF Curve Number	5	
a	43.22826031	(t in hours)
b	-0.661	
c	0.025333333	hours

Rainfall parameters for pipe design		
Return period	5	years
IDF Curve	Edmonton (COE,1997)	
IDF Curve Number	2	
a	23.03938186	(t in hours)
b	-0.654	
c	0.0257	hours

Storage volume for Edmonton (COE,1997) 1:100 year storm Cv = 0.78

Duration (minutes) minutes	Duration (hours)	Rainfall (mm)	Runoff (m3/ha)	Storage per ha for various peak flow rates (l/s) 0.5	1.2	2.5	5	10	Design value 5	Duration hours
10	0.166666667	21.45	166	166	166	165	165	163	165	0.166667
15	0.25	25	196	196	196	195	194	192	194	0.25
30	0.5	33	256	256	255	254	252	247	252	0.5
45	0.75	38	297	297	296	294	291	284	291	0.75
60	1	43	330	329	327	325	321	312	321	1
	2	54	420	418	416	411	402	384	402	2
	3	62	484	481	477	470	457	430	457	3
	4	69	534	530	525	516	498	462	498	4
	6	79	613	608	600	586	559	505	559	6
	12	100	777	766	751	723	669	561	669	12
	18	115	892	875	853	811	730	568	730	18
	24	127	983	962	931	875	767	551	767	24

		0.5	1.2	2.5	5	10	Design value 5
Maximum storage req'd (m3/ha)		962	931	875	767	568	767
	mm	96.2	93.1	87.5	76.7	56.8	76.7
Critical storm duration (hours)		24	24	24	24	18	24
Critical event		24	24	24	24	18	24
Time to drain	hours	1068.5	431.2	194.5	85.2	31.5	85.2
	days	44.5	18.0	8.1	3.6	1.3	3.6

Table A-10
CRE Pond - Storage Characteristics

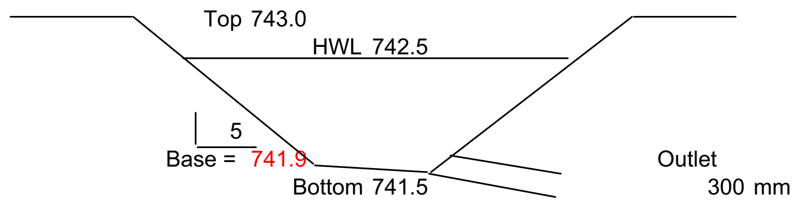
	Elevation (m)	Area (ha)	Total Volume (m3)	Live Storage (m3)	Discharge (m3/s)
Bottom of Pond	739.6		0	0	0
Normal Water level	741.27	2.5	37620	0	0
High Water Level	742.5	2.8	70140	32520	0.8
Top of Berm	743.0	3.0	84520	46900	0.95

TABLE A-11

City of Camrose
Proposed Upgrade Plan

Location: CRE campsite pond and channel (#17)
Design by: LEB **Date:** 12-Jan-08
Checked by: **Date:**

Conceptual cross-section (Campground Pond)

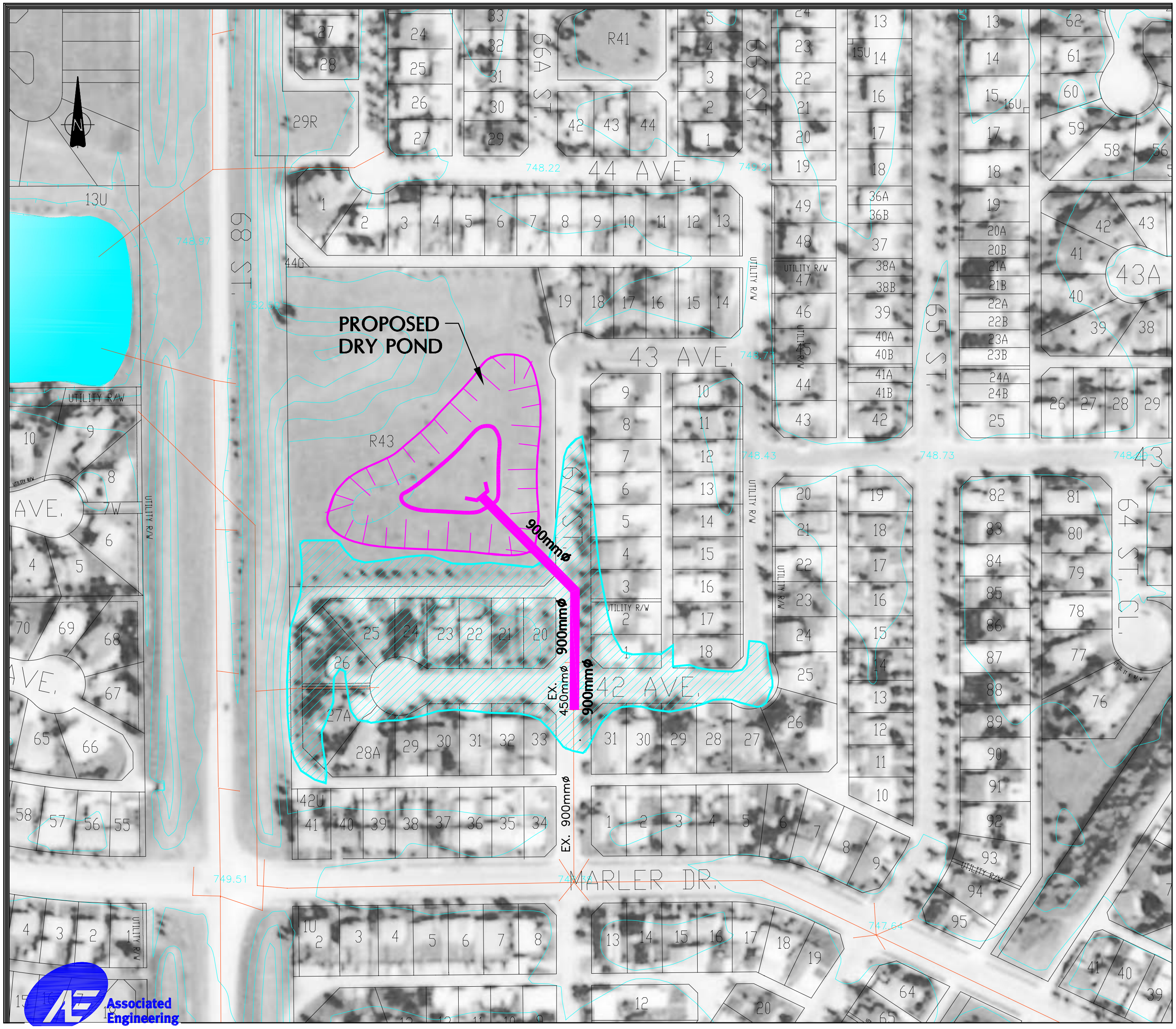


Campground Pond - Design Parameters

Item	Elevation m	Depth (m)	Area ha	Total Volume m3	Storage Volume m3
Top	743.0	0.00	0.30	3000	3000
High water level	742.5	0.50	0.25	1600	1600
Base	741.9	1.06	0.20	400	400
Bottom	741.5	1.50	0.00	0	0
Storage capacity					1600
Average existing ground	742.0		0.20	498	

Cost Estimate (Channel re-construction only)

Item	Quantity	Units	Unit cost	Extension
Clearing and grubbing		ha	$10,000	$0
Stripping	0.3	ha	$10,000	$3,000
Topsoil/seeding	1.0	ha	$10,000	$10,000
Restore pavement		m2	$100	$0
Restore curb/gutter		m	$150	$0
Restore grassed areas		m2	$10	$0
Restore gravelled areas		m2	$25	$0
Channel excavation	1000.0	m3	$15	$15,000
Total construction cost				$28,000
Land cost		ha	$1,000,000	$0
Sub-total				$28,000
Contingencies			40%	$11,200
Design services			10%	$2,800
Construction services			5%	$1,400
Project total				$43,400
GST			5%	$2,170
Total cost in 2007				$45,570
Cost escalation 2007-2008			18%	$8,203
Total cost in 2008				$53,773
			(say)	$54,000
Cost per m3 storage				$34



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THE CITY OF CAMROSE

CONCEPTUAL DESIGN

PROPOSED 67 STREET DRY POND

(UPGRADE No. 5)

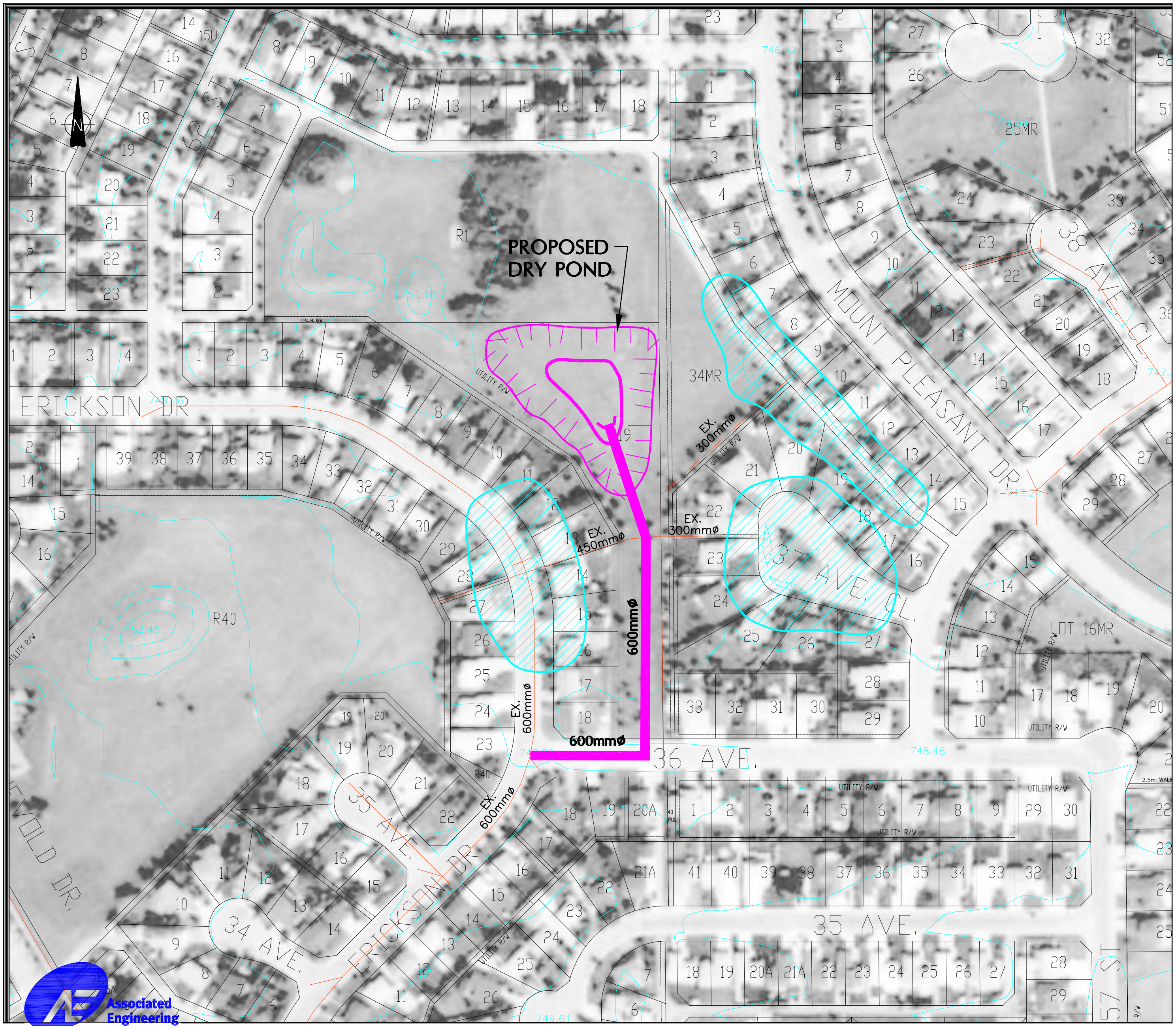
LEGEND:

- EXISTING STORM SEWER
- EXISTING GROUND ELEVATION CONTOURS
- PROTENTIAL FLOOD RISK AREA (APPROXIMATE)
- PROPOSED DRY POND
- PROPOSED STORM SEWER

SCALE : 1 : 2 000

JANUARY, 2008

FIGURE A-1



THE CITY OF CAMROSE

CONCEPTUAL DESIGN

PROPOSED ERICKSON DRY POND

(UPGRADE No. 7)

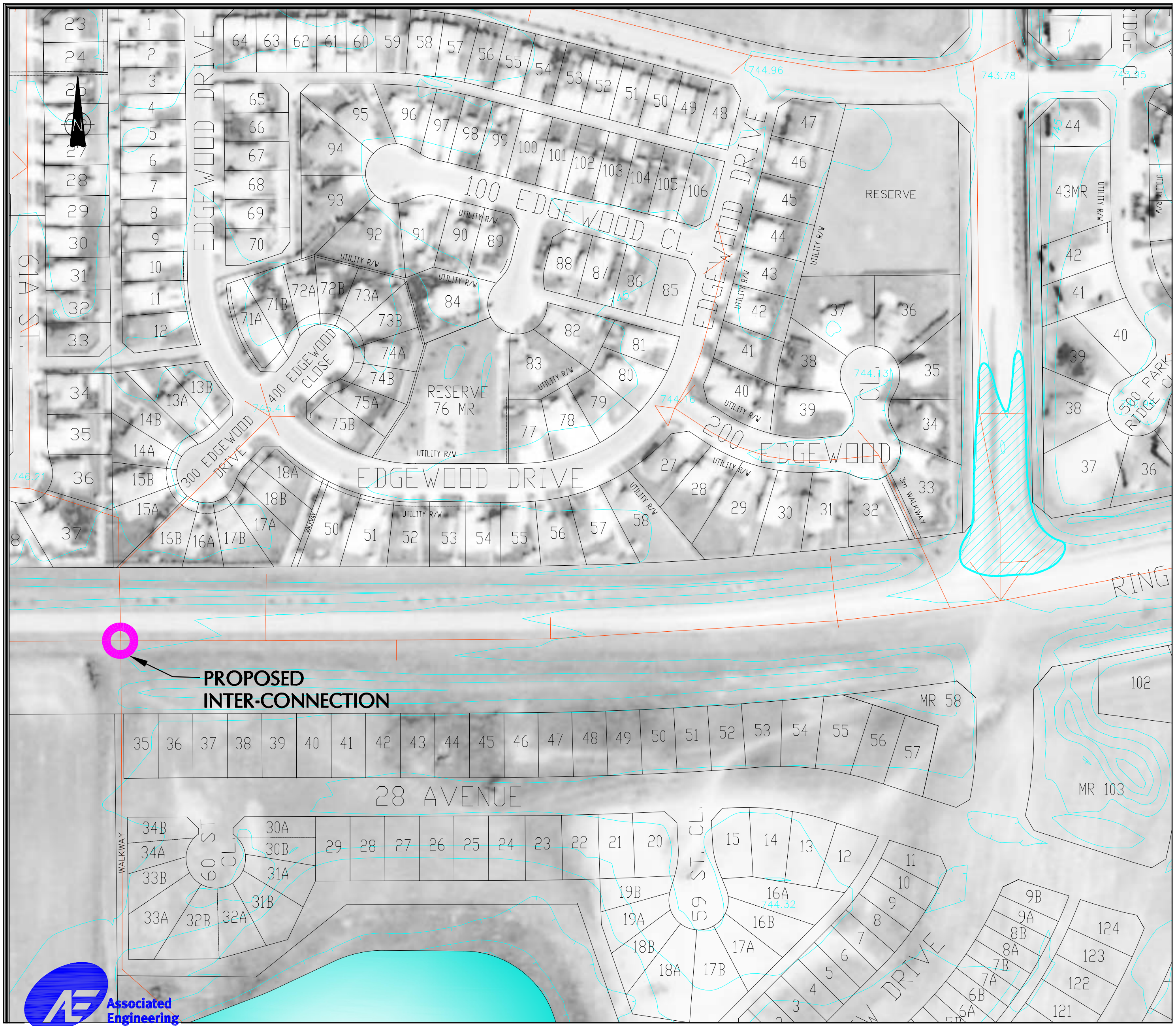
LEGEND:

- EXISTING STORM SEWER
- EXISTING GROUND ELEVATION CONTOURS
- PROTENTIAL FLOOD RISK AREA (APPROXIMATE)
- PROPOSED DRY POND
- PROPOSED STORM SEWER

SCALE : 1 : 2 000

JANUARY, 2008

FIGURE A-2



THE CITY OF CAMROSE

CONCEPTUAL DESIGN

PROPOSED CAMROSE DRIVE STORM SEWER INTER-CONNECTION

(UPGRADE No. 8 - OPTION 1)

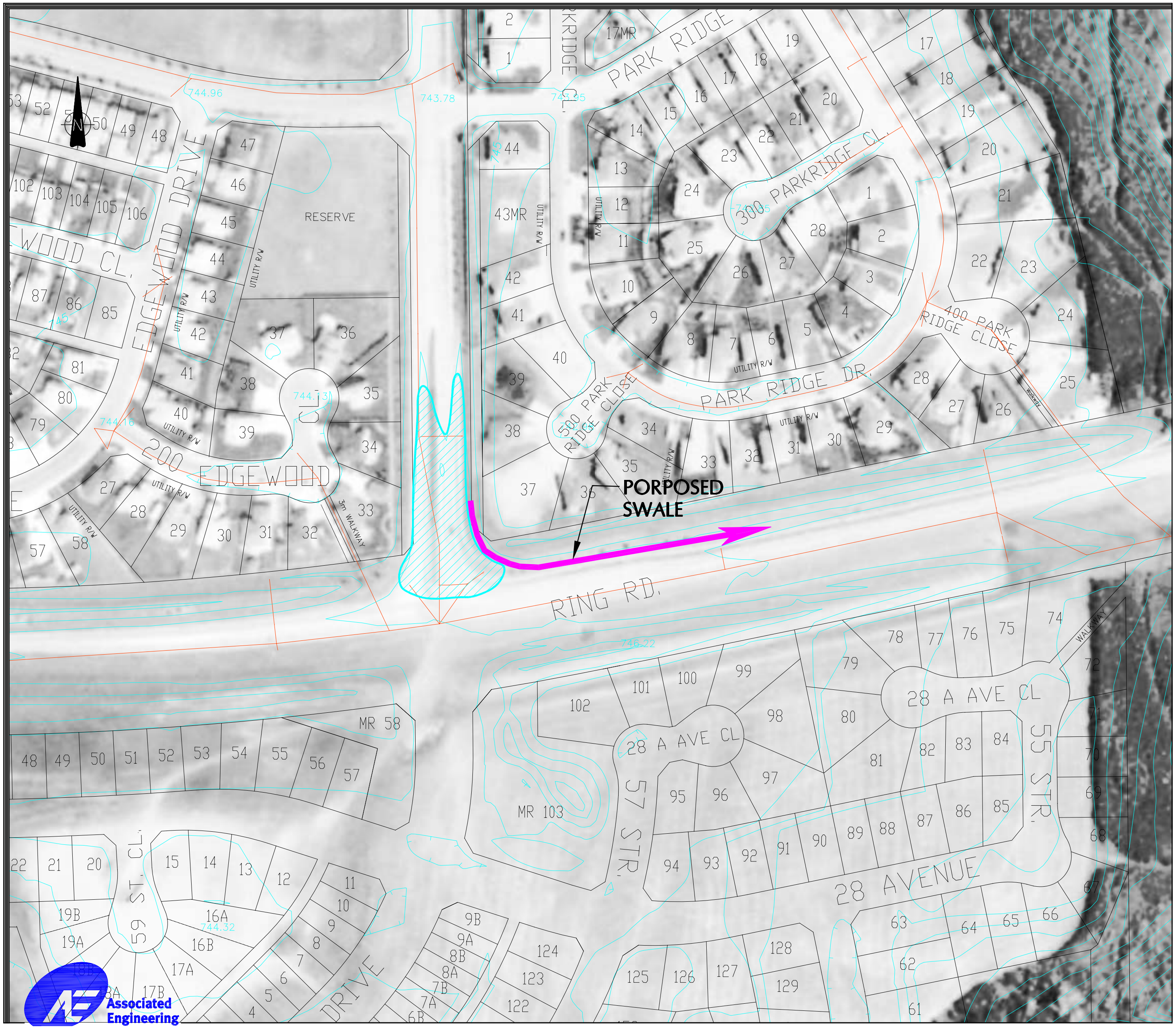
LEGEND:

- EXISTING STORM SEWER
- EXISTING GROUND ELEVATION CONTOURS
- PROTENTIAL FLOOD RISK AREA (APPROXIMATE)

SCALE : 1 : 2 000

JANUARY, 2008

FIGURE A-3



THE CITY OF CAMROSE

CONCEPTUAL DESIGN

PROPOSED PARKVIEW DRIVE SWALE

(UPGRADE No. 8 - OPTION 2)

LEGEND:

- EXISTING STORM SEWER
- EXISTING GROUND ELEVATION CONTOURS
- PROTENTIAL FLOOD RISK AREA (APPROXIMATE)
- PROPOSED SWALE

SCALE : 1 : 2 000

JANUARY, 2008

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FIGURE A-4

THE CITY OF CAMROSE

CONCEPTUAL DESIGN

PROPOSED SWALE FROM 55 AVE. TO RING ROAD R.O.W.

(UPGRADE No. 9)

LEGEND:

- EXISTING STORM SEWER
- EXISTING GROUND ELEVATION CONTOURS
- PROTENTIAL FLOOD RISK AREA (APPROXIMATE)
- PROPOSED SWALE

SCALE : 1 : 2 000

JANUARY, 2008

FIGURE A-5

THE CITY OF CAMROSE

CONCEPTUAL DESIGN

PROPOSED DOWNTOWN STORM SEWER INTER-CONNECTIONS

(UPGRADE No. 12)

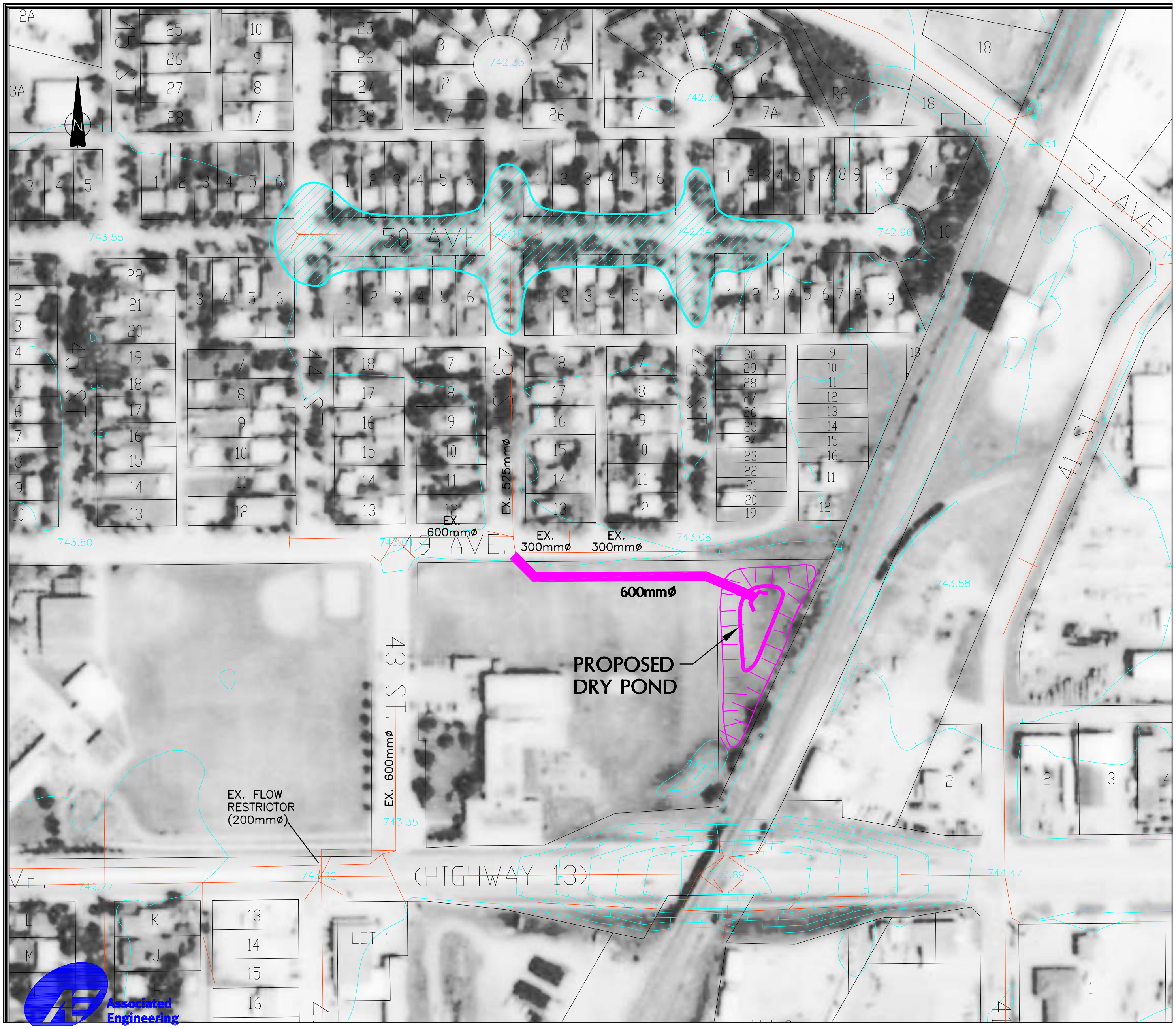
LEGEND:

- EXISTING STORM SEWER
- EXISTING GROUND ELEVATION CONTOURS
- PROTENTIAL FLOOD RISK AREA (APPROXIMATE)
- PROPOSED STORM SEWER

SCALE : 1 : 3 000

JANUARY, 2008

FIGURE A-6



THE CITY OF CAMROSE

CONCEPTUAL DESIGN

PROPOSED BETNARY DRY POND

(UPGRADE No. 13)

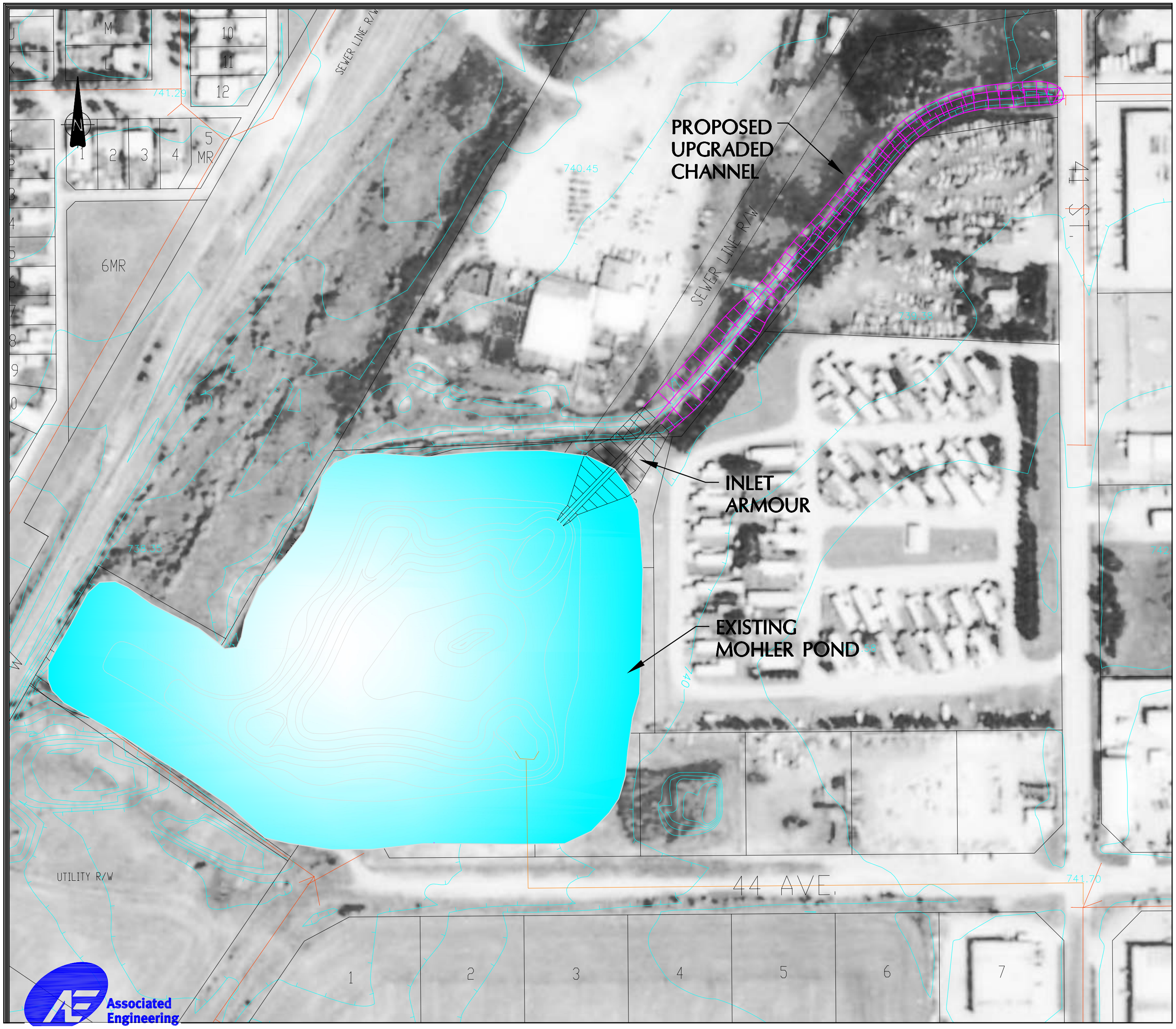
LEGEND:

- EXISTING STORM SEWER
- EXISTING GROUND ELEVATION CONTOURS
- PROTENTIAL FLOOD RISK AREA (APPROXIMATE)
- PROPOSED DRY POND
- PROPOSED STORM SEWER

SCALE : 1 : 2 000

JANUARY, 2008

FIGURE A-7



THE CITY OF CAMROSE

CONCEPTUAL DESIGN

PROPOSED MOHLER CHANNEL UPGRADING

(UPGRADE No. 15)

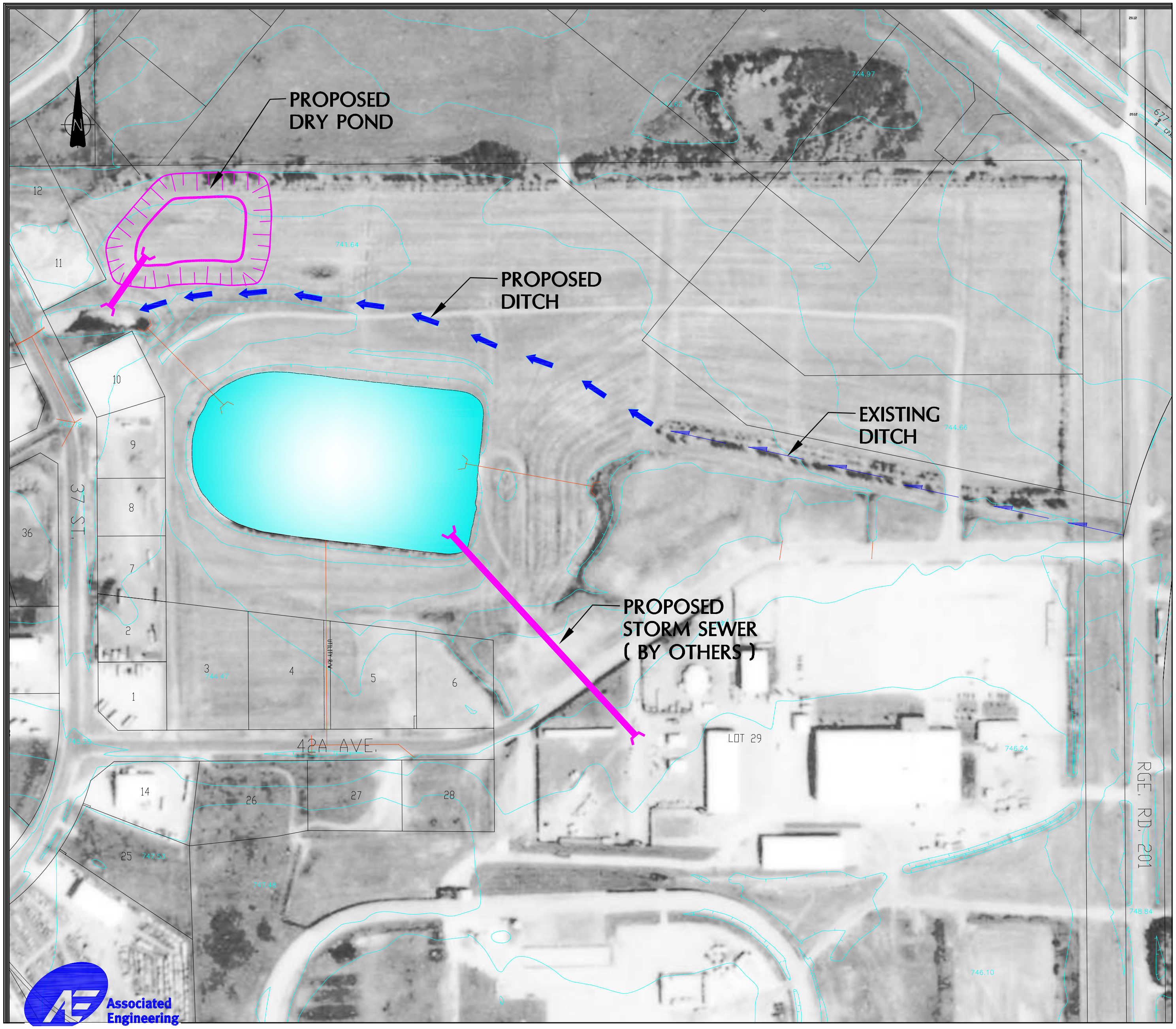
LEGEND:

- EXISTING STORM SEWER
- EXISTING GROUND ELEVATION CONTOURS
- EXISTING STORMWATER MANAGEMENT POND
- PROPOSED STORM SEWER

SCALE : 1 : 2 000

JANUARY, 2008

FIGURE A-8



THE CITY OF CAMROSE

CONCEPTUAL DESIGN

PROPOSED CRE CAMPSITE DEVELOPMENT STORMWATER MANAGEMENT CONCEPT

(UPGRADE No. 17)

LEGEND:

- EXISTING STORM SEWER
- EXISTING GROUND ELEVATION CONTOURS
- PROPOSED DRY POND
- PROPOSED STORM SEWER
- EXISTING DITCH
- PROPOSED DITCH

SCALE : 1 : 3 000

JANUARY, 2008

FIGURE A-9

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B Appendix B - Future Storm Servicing Concept Plan

Land Use	Required Storage		Allowable Outflow	
Residential	550	m3/ha	5	L/s/ha
Industrial	800	m3/ha	5	L/s/ha
Commercial	930	m3/ha	5	L/s/ha

CAMROSE STORMWATER MASTER PLAN UPDATE, JANUARY 2008
FUTURE STORMWATER MANAGEMENT FACILITIES
(SUBJECT TO CONFIRMATION IN DETAILED DESIGN)

POND ID	Cummulative Area	Required Storage	NWL	HWL	Property Line	Top Area	Cummulative Outflow
	(ha)	(m3)				(ha)	(L/s)
CRECamp	18.2	1600	741.5	742.5	743.0	0.3	91
Pond1	51.4	28300	747.0	749.0	750.0	2.9	257
Pond10	143.7	119200	747.5	749.5	750.5	10.2	1231
Pond11	60.7	44500	747.5	749.5	750.5	4.2	589
Pond12	57.0	31300	750.0	752.0	753.0	3.1	285
Pond13	23.3	12800	753.5	755.5	756.5	2.0	117
Pond14	64.5	35500	749.0	751.0	752.0	3.5	439
Pond15	62.0	34100	741.0	743.0	744.0	3.3	1019
Pond16	64.5	35500	745.0	747.0	748.0	3.5	709
Pond17	77.4	42500	748.0	750.0	751.0	4.0	387
Pond18	67.5	49100	743.8	745.0	746.0	5.4	1208
Pond19	34.8	19200	754.0	756.0	757.0	2.1	174
Pond2	66.3	36500	742.5	744.5	745.5	3.5	589
Pond20	64.5	35500	750.5	751.5	752.5	4.4	497
Pond21	32.3	17700	748.0	750.5	751.5	2.0	658
Pond22	64.5	35500	744.0	746.0	747.0	3.5	1142
Pond23	64.5	35500	742.0	744.0	745.0	3.5	323
Pond24	32.3	17700	749.0	751.0	752.0	2.0	161
Pond25	64.5	35500	740.0	742.0	743.0	3.5	323
Pond26	47.1	25900	737.0	739.0	740.0	2.7	558
Pond27	42.7	23500	735.5	737.5	738.5	2.5	213
Pond28	64.5	35500	741.0	743.0	744.0	3.5	323
Pond29	51.9	28500	738.0	740.0	741.0	2.9	582
Pond3	71.4	39300	739.0	741.0	742.0	3.8	2876
Pond30	64.5	35500	736.5	738.5	739.5	3.5	323
Pond31	64.5	35500	737.0	739.0	740.0	3.5	323
Pond32	41.3	22700	732.0	734.0	735.0	2.4	529
Pond4	26.9	14800	742.0	744.0	745.0	2.0	1930
Pond40	41.4	38500	736.8	739.8	740.8	3.3	515
Pond41	61.5	57200	737.5	739.5	740.5	5.2	308
Pond42	40.9	38000	739.0	741.0	742.0	3.7	205
Pond43	60.6	56400	738.8	740.8	741.8	5.1	303
Pond44	60.1	55900	740.5	742.5	743.5	5.1	301
Pond45	42.7	39700	744.0	746.0	747.0	3.8	213
Pond46	66.9	62200	743.0	745.0	746.0	5.6	465
Pond47	61.4	57100	744.0	746.0	747.0	5.2	307
Pond48	43.9	40800	744.0	745.5	746.5	4.3	220
Pond49	28.7	26700	742.8	745.0	746.0	2.7	143
Pond5	26.4	14500	749.0	751.0	752.0	2.0	132
Pond50	53.8	50100	741.5	743.5	744.5	4.6	269
Pond51	67.1	62400	739.5	741.5	742.5	5.6	335
Pond52	28.3	26300	737.0	739.0	740.0	2.7	477
Pond53	32.9	30600	743.5	745.5	746.5	3.1	165
Pond54	64.5	60000	742.0	744.0	745.0	5.4	487
Pond55	98.5	89200	739.0	742.3	743.3	6.5	1903
Pond56	26.2	24300	740.6	744.0	745.0	2.3	924
Pond56A	103.6	87800	742.0	744.0	745.0	7.7	793
Pond57	18.6	14900	748.0	750.0	751.0	2.0	863
Pond58	21.2	19700	747.0	749.0	750.0	2.2	969
Pond59	46.0	39200	744.5	746.5	747.5	3.8	230
Pond6	65.7	48800	749.0	751.0	752.0	4.5	461
Pond60	63.6	53900	748.0	750.0	751.0	4.9	853
Pond61	29.4	23500	744.5	746.5	747.5	2.5	1000
Pond62	62.0	53000	743.5	745.5	746.5	4.9	310
Pond63	35.6	33100	742.0	744.0	745.0	3.3	1488

Land Use	Required Storage		Allowable Outflow	
Residential	550	m3/ha	5	L/s/ha
Industrial	800	m3/ha	5	L/s/ha
Commercial	930	m3/ha	5	L/s/ha

CAMROSE STORMWATER MASTER PLAN UPDATE, JANUARY 2008
FUTURE STORMWATER MANAGEMENT FACILITIES
(SUBJECT TO CONFIRMATION IN DETAILED DESIGN)

POND ID	Cummulative Area	Required Storage	NWL	HWL	Property Line	Top Area	Cummulative Outflow
	(ha)	(m3)				(ha)	(L/s)
Pond64	31.9	28500	742.0	744.0	745.0	2.9	160
Pond65	26.0	24200	746.3	748.3	749.3	2.5	130
Pond66	80.2	70400	741.0	743.0	744.0	6.3	401
Pond7	81.9	56100	746.0	748.0	749.0	5.1	870
Pond70	56.1	44900	739.5	741.5	742.5	4.2	281
Pond71	40.7	32500	737.5	739.0	740.0	3.5	203
Pond71A	52.6	42100	736.5	738.5	739.5	4.0	263
Pond72	115.3	92300	736.8	738.0	739.0	9.7	4364
Pond73	39.5	31600	735.3	736.5	737.5	3.6	198
Pond73A	21.4	17100	735.5	736.5	737.5	2.4	107
Pond74	30.9	24700	735.8	737.3	738.3	2.8	270
Pond74A	23.0	18400	736.0	737.5	738.5	2.2	115
Pond75	49.5	39600	734.5	736.5	737.5	3.8	247
Pond75A	44.0	35200	734.0	736.0	737.0	3.4	220
Pond76	18.0	14400	735.0	737.0	738.0	2.0	90
Pond77	79.2	63300	733.0	735.0	736.0	5.7	396
Pond78	36.3	29000	736.5	738.5	739.5	2.9	181
Pond79	64.5	51600	737.0	739.0	740.0	4.8	1972
Pond79A	39.4	31600	735.5	737.5	738.5	3.1	197
Pond8	38.1	20900	752.0	754.0	755.0	2.3	190
Pond80	30.3	24300	735.5	737.5	738.5	2.6	152
Pond80A	36.0	28800	735.5	737.5	738.5	2.9	180
Pond81	62.0	34100	731.0	733.0	734.0	3.3	310
Pond82	28.7	15800	726.0	728.0	729.0	2.0	143
Pond82A	19.5	10700	729.0	731.0	732.0	2.0	97
Pond83	31.9	17500	736.0	738.0	739.0	2.0	402
Pond83A	32.6	17900	732.0	734.0	735.0	2.0	163
Pond84	48.5	26700	736.0	738.0	739.0	2.7	243
Pond85	51.9	28500	736.5	738.5	739.5	2.9	259
Pond86	29.8	16400	736.5	738.5	739.5	2.0	149
Pond87	40.1	22000	741.0	743.0	744.0	2.4	200
Pond88	24.5	13400	741.0	743.0	744.0	2.0	122
Pond9	64.5	35500	755.5	757.5	758.5	3.5	323

Land Use	Required Storage		Allowable Outflow	
Residential	550	m3/ha	5	L/s/ha
Industrial	800	m3/ha	5	L/s/ha
Commercial	930	m3/ha	5	L/s/ha

CAMROSE STORMWATER MASTER PLAN UPDATE, JANUARY 2008

FUTURE STORM SERVICING CONCEPT

(SUBJECT TO CONFIRMATION IN DETAILED DESIGN)

U/S Node	D/S Node	Land Use	Catchment Area	Cummulative Area	Catch. Length	Outflow	Design Q	Length	Slope	Diameter	Channel Depth	U/S Invert	U/S Rim	U/S X- Coor.	U/S Y- Coor.	D/S Invert	D/S Rim	D/S X- Coor.	D/S Y- Coor.
			(ha)	(ha)	(m)	(L/s)	(L/s)	(m)	(%)	(mm)	(m)								
CRECamp	MohlerDitch	Campgrnd	18.2	18.2	511.9	91	91	113.6	0.44		1	741.5	743.0	80791	5875649	741.0	742.2	80730	5875549
Pond1	STM1	Res.	51.4	51.4	860.7	257	257	500.8	0.48	600		747.0	750.0	75142	5877864	744.6	748.8	75679	5877649
Pond10	STMCH3	Comm.	74.0	246.2	1032.1	370	1231	477.6	0.2		1.8	747.5	750.5	74030	5876977	746.5	750.5	73919	5877204
Pond11	STMCH1	Comm.	29.1	117.7	647.2	145	589	488.4	0.72	750		747.5	750.5	75725	5876146	744.0	745.5	76098	5876377
Pond12	STM25	Res.	57.0	57.0	905.9	285	285	333.0	0.28	675		749.3	753.0	75471	5875437	748.4	752.5	75439	5875906
Pond13	STM27	Res.	23.3	23.3	579.6	117	117	773.4	0.31	450		753.1	756.5	75683	5874629	750.7	753.5	76538	5874538
Pond14	2221 (CamDrEast)	Res.	64.5	87.8	963.7	323	439	246.6	0.53	675		748.3	752.0	76621	5874085	747.0	750.8	76757	5873839
Pond15	Ravine1	Res.	62.0	203.9	944.9	310	1019	10.0	0.50	900		740.1	744.0	77399	5873749	740.1	743.0	77524	5873763
Pond16	STM29	Res.	64.5	141.9	963.7	323	709	234.3	0.38	900		744.1	748.0	76545	5873436	743.2	746.5	76757	5873599
Pond17	Pond16	Res.	64.5	77.4	963.7	323	387	724.3	0.31	750		747.3	751.0	75707	5873342	745.0	748.0	76545	5873436
Pond18	STMCH2	Comm.	31.6	241.5	674.9	158	1208	25.0	0.48	1050		743.8	746.0	75964	5876737	743.6	746.8	76081	5876745
Pond19	Pond20	Res.	28.4	34.8	638.9	142	174	675.2	0.44	525		753.5	757.0	75197	5874468	750.5	752.5	74392	5874273
Pond2	Pond3	Res.	0.0	117.8	0.0	0	589	449.1	0.78	750		742.5	745.5	75965	5877341	739.0	742.0	76532	5877495
Pond20	STMCH31	Res.	64.5	99.3	963.7	323	497	503.0	0.09		1.5	749.0	752.5	74392	5874273	748.5	753.3	73998	5873839
Pond21	Pond22	Res.	32.3	131.6	681.5	161	658	835.7	0.37	900		747.1	751.5	74357	5873224	744.0	747.0	74910	5872438
Pond22	STM32	Res.	64.5	228.3	963.7	323	1142	655.9	0.63	900		743.1	747.0	74910	5872438	739.0	743.0	75671	5872357
Pond23	STM32	Res.	64.5	64.5	963.7	323	323	138.8	1.05	525		741.5	745.0	75752	5872541	740.0	743.0	75671	5872357
Pond24	Pond22	Res.	32.3	32.3	681.5	161	161	776.4	0.59	450		748.6	752.0	75018	5873338	744.0	747.0	75671	5872438
Pond25	Pond26	Res.	64.5	64.5	963.7	323	323	472.6	0.45	600		739.4	743.0	76641	5872533	737.0	740.0	77196	5872746
Pond26	Ravine2	Res.	47.1	111.6	823.2	235	558	10.0	0.70	675		736.3	740.0	77196	5872746	736.3	739.0	77327	5872690
Pond27	Ravine5	Res.	42.7	42.7	783.7	213	213	460.3	0.75	525		735.0	738.5	77243	5871730	731.5	734.0	77499	5871579
Pond28	Pond29	Res.	64.5	64.5	963.7	323	323	673.3	0.35	675		740.3	744.0	75003	5871804	738.0	741.0	75864	5871954
Pond29	Ravine3a	Res.	51.9	116.4	864.5	260	582	10.0	0.50	750		737.3	741.0	75864	5871954	737.2	740.0	75982	5871978
Pond3	STM4	Res.	71.4	575.3	1014.0	357	2876	298.4	0.35	1500		739.0	742.0	76532	5877495	738.0	743.0	76624	5877873
Pond30	STMCH34	Res.	64.5	64.5	963.7	323	323	10.0	0.50	600		735.9	739.5	75001	5870842	735.9	738.5	74956	5870794
Pond31	Pond32	Res.	64.5	64.5	963.7	323	323	408.4	1.10	525		736.5	740.0	75853	5870989	732.0	735.0	76362	5871206
Pond32	Ravine4	Res.	41.3	105.8	770.7	206	529	10.0	0.40	750		731.3	735.0	76362	5871206	731.2	734.0	76449	5871242
Pond4	Pond3	Res.	26.9	386.1	622.2	134	1930	301.9	0.60	1200		740.8	745.0	76548	5877033	739.0	742.0	76532	5877495
Pond40	STMCH58	Ind.	41.4	102.9	771.8	207	515	621.8	0.29		1.5	736.8	740.8	78491	5870880	734.9	737.5	77821	5870867
Pond41	Pond40	Ind.	61.5	61.5	941.4	308	308	638.7	0.10		1.5	737.4	740.5	79281	5870854	736.8	740.8	78491	5870880
Pond42	STMCH57	Ind.	40.9	40.9	767.4	205	205	224.5	0.40		1.5	737.5	742.0	79344	5871891	736.6	741.0	79216	5872126
Pond43	STMCH57	Ind.	60.6	60.6	934.2	303	303	320.7	0.20		1.5	737.3	741.8	79342	5872465	736.6	741.0	79216	5872126
Pond44	STMCH56	Ind.	60.1	60.1	930.3	301	301	120.0	0.25		1.5	740.5	743.5	80778	5871829	740.2	743.3	80798	5871653
Pond45	STMCH55	Ind.	42.7	42.7	783.8	213	213	75.0	0.50		1.5	744.0	747.0	80691	5872533	743.6	745.8	80816	5872484
Pond46	STMCH54	Ind.	30.7	92.9	664.9	154	465	136.7	0.17	900		743.0	746.0	81055	5873329	742.8	747.0	80791	5873281
Pond47	STMCH54	Ind.	61.4	61.4	940.3	307	307	40.0	0.15	750		743.3	747.0	80662	5873329	743.2	747.0	80791	5873281
Pond48	FutCamDr	Ind.	43.9	43.9	795.3	220	220	185.9	0.22	600		742.9	746.5	81180	5874659	742.5	747.0	81009	5874855
Pond49	EX-2041	Ind.	28.7	28.7	642.8	143	143	316.7	0.34	525		742.5	746.0	80487	5874547	741.4	745.5	80173	5874794
Pond5	STM11	Res.	26.4	26.4	616.2	132	132	413.3	0.15	525		749.0	752.0	74812	5875527	748.4	752.0	74742	5875934
Pond50	EX-2040	Ind.	19.8	53.8	533.6	99	269	311.9	0.19		1.5	741.5	744.5	79747	5874265	740.9	746.0	79542	5874461
Pond51	Pond52	Ind.	67.1	67.1	982.6	335	335	301.5	0.63	600		738.9	742.5	79355	5873975	737.0	740.0	78934	5873868
Pond52	Ravine6	Ind.	28.3	95.4	638.4	142	477	50.0	0.50	750		736.3	740.0	78934	5873868	736.0	737.0	78720	5873863
Pond53	Pond54	Ind.	32.9	32.9	688.3	165	165	554.5	0.16	600		742.9	746.5	82278	5874176	742.0	745.0	82260	5873430
Pond54	Pond55	Ind.	64.5	97.4	963.7	323	487	431.8	0.41		1.5	742.0	745.0	82260	5873430	740.3	743.3	82816	5873365
Pond55	STMCH53	Ind.	0.0	380.6	0.0	0	1903	25.0	0.16	1500		740.3	743.3	82816	5873365	740.2	742.8	82837	5873278
Pond56	Pond55	Ind.	26.2	184.8	614.0	131	924	450.0	0.39	1050		742.0	745.0	83372	5873558	740.3	743.3	82816	5873365
Pond56A	Pond56	Comm.	34.7	158.6	707.2	174	793	168.3	0.15	1050		742.0	745.0	83216	5873818	741.8	745.0	83372	5873558
Pond57	Pond58	Ind.	18.6	172.6	517.7	93	863	207.2	0.48	900		748.0	751.0	83114	5874997	747.0	750.0	82876	5874840
Pond58	STM61	Comm.	21.2	193.8	552.1	106	969	1048.7	0.20		1.5	745.5	750.0	82876	5874840	743.4	745.0	81920	5875517
Pond59	STM59	Comm.	18.5	46.0	515.4	92	230	180.1	0.22	600		743.9	747.5	82298	5874803	743.5	747.5	82339	5875032
Pond6	STM12	Comm.	33.3	92.1	692.0	166	461	220.5	0.61	675		748.3	752.0	74740	5876223	747.0	750.5	75005	5876290

Land Use	Required Storage		Allowable Outflow	
Residential	550	m3/ha	5	L/s/ha
Industrial	800	m3/ha	5	L/s/ha
Commercial	930	m3/ha	5	L/s/ha

CAMROSE STORMWATER MASTER PLAN UPDATE, JANUARY 2008

FUTURE STORM SERVICING CONCEPT

(SUBJECT TO CONFIRMATION IN DETAILED DESIGN)

U/S Node	D/S Node	Land Use	Catchment Area	Cummulative Area	Catch. Length	Outflow	Design Q	Length	Slope	Diameter	Channel Depth	U/S Invert	U/S Rim	U/S X- Coor.	U/S Y- Coor.	D/S Invert	D/S Rim	D/S X- Coor.	D/S Y- Coor.
			(ha)	(ha)	(m)	(L/s)	(L/s)	(m)	(%)	(mm)	(m)								
Pond60	Pond61	Ind.	40.1	170.6	760.2	201	853	693.7	0.37	900		747.1	751.0	83057	5876018	744.5	747.5	82470	5875601
Pond61	Pond63	Ind.	29.4	200.0	650.8	147	1000	291.6	0.55	900		743.6	747.5	82470	5875601	742.0	745.0	82041	5875632
Pond62	Pond63	Ind.	35.9	62.0	719.2	180	310	201.0	0.41	675		742.8	746.5	81927	5875992	742.0	745.0	82041	5875632
Pond63	STM61	Comm.	27.5	297.6	628.8	137	1488	116.9	0.23	1200		742.0	745.0	82041	5875632	741.7	745.0	81920	5875517
Pond64	STM63	Comm.	23.1	31.9	576.6	115	160	48.6	0.30	525		742.0	745.0	81671	5875473	741.9	745.5	81603	5875375
Pond65	STM54	Ind.	26.0	26.0	612.4	130	130	469.4	0.17	525		745.7	749.3	81163	5874094	744.9	749.0	81196	5873626
Pond66	1014-EX	Comm.	36.1	80.2	721.4	181	401	472.5	0.16	900		740.1	744.0	81008	5876345	739.3	743.0	80645	5875982
Pond7	STM13	Comm.	81.9	174.0	1086.0	410	870	539.8	0.39	900		746.0	749.0	74969	5876785	743.9	748.3	75733	5876944
Pond70	STM63-1	Ind.	56.1	56.1	898.8	281	281	651.5	0.22	675		738.8	742.5	81014	5877431	737.4	739.8	80994	5878140
Pond71	STM63-1	Ind.	40.7	40.7	765.2	203	203	74.6	0.10	675		737.5	740.0	81107	5878056	737.4	739.8	80994	5878140
Pond71A	STM64-1	Ind.	52.6	52.6	870.6	263	263	120.1	0.35		1.2	736.5	739.5	80541	5878000	736.1	739.0	80461	5878129
Pond72	STM64-1	Ind.	115.3	872.7	1288.6	577	4364	532.8	0.28		1.8	736.8	739.0	80864	5878829	735.3	739.0	80461	5878129
Pond73	STM65-1	Ind.	39.5	39.5	754.5	198	198	277.2	0.18	675		735.3	737.5	80276	5878548	734.8	738.0	80110	5878191
Pond73A	STM65-1	Ind.	21.4	21.4	555.0	107	107	442.5	0.17	600		735.5	737.5	79983	5878566	734.8	738.0	80110	5878191
Pond74	STM65-1	Ind.	30.9	53.9	666.7	154	270	859.0	0.12		1.2	735.8	738.3	79979	5879034	734.8	738.0	80110	5878191
Pond74A	Pond74	Ind.	23.0	23.0	575.9	115	115	148.7	0.17	525		736.0	738.5	80307	5879018	735.8	738.3	79979	5879034
Pond75	STMCH75	Ind.	49.5	49.5	844.0	247	247	99.0	0.22	675		734.5	737.5	80252	5879857	734.3	736.5	80081	5879754
Pond75A	STMCH75A	Ind.	44.0	44.0	796.4	220	220	207.2	0.25	600		734.0	737.0	80458	5879547	733.5	736.5	80316	5879758
Pond76	STMCH75	Ind.	18.0	18.0	508.4	90	90	94.8	0.50	375		735.0	738.0	79948	5879616	734.5	736.5	80081	5879754
Pond77	Ravine17	Ind.	79.2	79.2	1067.8	396	396	70.6	0.71		1.5	733.0	736.0	79353	5880453	732.5	736.0	79370	5880734
Pond78	Ravine18	Ind.	36.3	36.3	722.6	181	181	150	0.67		1.2	736.5	739.5	81994	5880508	735.5	738.5	82175	5880594
Pond79	STMCH71	Ind.	64.5	394.3	963.7	323	1972	640.7	0.25		2	737.0	740.0	81949	5879609	735.4	738.5	81464	5879772
Pond79A	STMCH71	Ind.	39.4	39.4	753.6	197	197	55.0	0.19		1.5	735.5	738.5	81447	5879659	735.4	738.5	81000	5879871
Pond8	STM20	Res.	38.1	38.1	740.2	190	190	126.1	0.31	525		751.5	755.0	74335	5875402	751.1	754.5	74225	5875550
Pond80	STMCH71	Ind.	30.3	30.3	661.0	152	152	35.0	0.29		1.5	735.5	738.5	81056	5879857	735.4	738.5	81000	5879871
Pond80A	STMCH71	Ind.	36.0	36.0	719.9	180	180	35.0	0.29		1.5	735.5	738.5	81348	5879848	735.4	738.5	81000	5879871
Pond81	46StOutfall	Res.	62.0	62.0	944.5	310	310	267.75	0.60	600		731.0	734.0	78603	5878381	729.4	733.0	78615	5878030
Pond82	Ravine12	Res.	28.7	28.7	642.3	143	143	50.0	0.35	525		725.5	729.0	78215	5878599	725.3	728.0	78387	5878659
Pond82A	Ravine15	Res.	19.5	19.5	529.4	97	97	50.0	0.35	450		729.0	732.0	78122	5878232	728.8	730.0	78216	5878178
Pond83	Ravine 11	Res.	31.9	80.4	677.4	159	402	900.0	0.31	750		734.0	739.0	77889	5879443	731.2	732.0	78883	5879687
Pond83A	Ravine16	Res.	32.6	32.6	685.2	163	163	150.0	1.17	450		731.6	735.0	78212	5878945	729.8	730.0	78511	5878879
Pond84	Pond83	Res.	48.5	48.5	835.7	243	243	297.4	0.17	750		735.3	739.0	77481	5879398	734.8	739.0	77889	5879443
Pond85	Ravine13	Res.	51.9	51.9	864.2	259	259	74.5	0.47	600		735.9	739.5	77355	5878513	735.5	738.0	77374	5878636
Pond86	Ravine13	Res.	29.8	29.8	655.0	149	149	43.3	0.5	450		736.1	739.5	77343	5878733	735.8	738.0	77374	5878636
Pond87	Ravine14	Res.	40.1	40.1	759.4	200	200	24.9	0.35	525		740.5	744.0	75961	5878293	740.4	743.0	76033	5878326
Pond88	Ravine14	Res.	24.5	24.5	593.4	122	122	102.5	0.35	450		740.6	744.0	75933	5878563	740.2	743.0	75995	5878406
Pond9	STM21	Res.	64.5	64.5	963.7	323	323	518.4	0.98	525		755.0	758.5	73842	5875503	749.9	753.8	74224	5875935
STM1	Pond2	Res.	66.3	117.8	977.3	332	3787	364.8	0.29	1650		743.5	748.8	75679	5877649	742.5	745.5	75965	5877341
STM11	Pond6	Res.	32.5	58.9	684.0	162	1862	235.8	0.24	1350		747.6	752.0	74742	5875934	747.0	752.0	74740	5876223
STM12	Pond7	Comm.	0.0	92.1	0.0	0	461	146.7	0.67	675		747.0	750.5	75005	5876290	746.0	749.0	74969	5876785
STM13	Pond18	Res.	35.9	209.9	718.6	179	2780	215.1	0.25	1500		743.3	748.3	75733	5876944	742.8	746.0	75964	5876737
STM2	RROutfall	Comm.	6.0	587.3	293.9	30	4396	740.5	0.71	1500		733.8	739.5	77615	5878020	728.5	730.0	78355	5878017
STM20	STM21	Res.	0.0	38.1	0.0	0	190	385.6	0.31	525		751.1	754.5	74225	5875550	749.9	753.8	74224	5875935
STM21	STM22	Res.	37.9	140.4	738.5	189	2533	319.8	0.21	1500		748.9	753.8	74224	5875935	748.3	753.5	74221	5876255
STM22	Pond10	Comm.	31.8	172.2	676.7	159	5073	215.4	1.05	1500		748.3	753.5	74221	5876255	746.0	750.5	74030	5876977
STM25	Pond11	Res.	31.6	88.6	674.9	158	1965	290.1	0.21	1350		747.7	752.5	75439	5875906	747.1	750.5	75725	5876146
STM27	Pond14	Res.	0.0	23.3	0.0	0	117	424.1	0.39	450		750.7	753.5	76538	5874538	749.0	752.0	76621	5874085
STM29	Pond15	Res.	0.0	141.9	0.0	0	709	573.2	0.38	900		743.2	746.5	76757	5873599	741.0	744.0	77399	5873749
STM3	STM2	Comm.	6.0	581.3	293.9	30	3636	761.7	0.42	1500		737.0	743.5	76906	5877873	733.8	739.5	77615	5878020
STM30	Pond19	Res.	6.5	6.5	305.7	32	550	296.9	0.28	900		754.7	757.5	75191	5874829	753.9	757.0	75197	5874468
STM32	Ravine3	Res.	0.0	292.8	0.0	0	1464	10.0	0.50	1050		738.8	743.0	75671	5872357	738.8	742.0	75730	5872277
STM33	Pond17	Res.	12.9	12.9	430.2	64	890	561.1	0.50	900		750.8	755.8	75801	5873994	748.0	751.0	75707	5873342

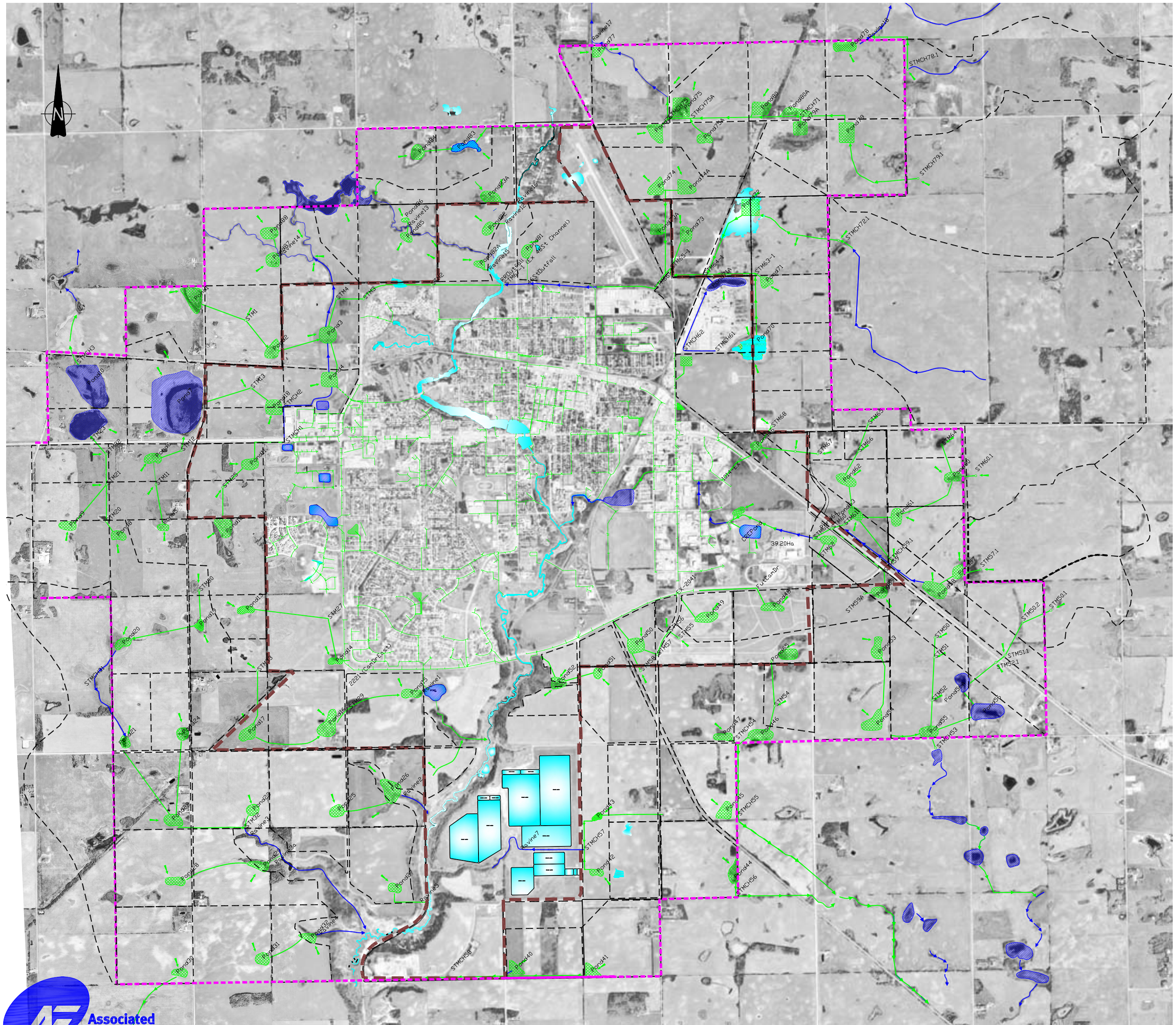
Land Use	Required Storage		Allowable Outflow	
Residential	550	m3/ha	5	L/s/ha
Industrial	800	m3/ha	5	L/s/ha
Commercial	930	m3/ha	5	L/s/ha

CAMROSE STORMWATER MASTER PLAN UPDATE, JANUARY 2008

FUTURE STORM SERVICING CONCEPT

(SUBJECT TO CONFIRMATION IN DETAILED DESIGN)

U/S Node	D/S Node	Land Use	Catchment Area	Cummulative Area	Catch. Length	Outflow	Design Q	Length	Slope	Diameter	Channel Depth	U/S Invert	U/S Rim	U/S X- Coor.	U/S Y- Coor.	D/S Invert	D/S Rim	D/S X- Coor.	D/S Y- Coor.
			(ha)	(ha)	(m)	(L/s)	(L/s)	(m)	(%)	(mm)	(m)								
STM4	STM3	Comm.	0.0	575.3	0.0	0	2876	282.5	0.35	1500		738.0	743.0	76624	5877873	737.0	743.5	76906	5877873
STM50	STM51	Comm.	18.7	18.7	519.1	94	1490	208.7	0.38	1200		744.2	747.5	82870	5874338	743.4	746.5	82861	5874129
STM50.1	STM50.2	Rural	55.0	55.0	889.9	275	275	327.2	0.84	600		747.5	752.5	84079	5874624	744.7	751.5	83767	5874469
STM50.2	STM51.1	Ind.	38.3	93.3	742.4	191	2995	372.0	0.50	1350		744.7	751.5	83767	5874469	742.9	747.8	83580	5874159
STM51	STM52	Ind.	16.8	35.5	491.4	84	2680	447.8	0.44	1350		743.2	746.5	82861	5874129	741.2	744.3	82840	5873682
STM51.1	STM52.1	Comm.	30.6	123.8	663.5	153	5435	91.8	0.15	2700	culvert	742.9	747.8	83580	5874159	742.7	747.8	83514	5874094
STM52	Pond55	Ind.	63.0	98.5	952.5	315	7150	268.5	0.35	2100		740.5	744.3	82840	5873682	739.6	743.3	82816	5873365
STM52.1	Pond56A	Comm.	0.0	123.8	0.0	0	5435	414.1	0.18	2100		742.7	747.8	83514	5874094	742.0	745.0	83216	5873818
STM54	Pond46	Ind.	36.2	62.2	721.7	181	2701	261.3	0.36	1500		743.9	749.0	81196	5873626	743.0	746.0	81055	5873329
STM55	STM56	Ind.	21.7	21.7	558.4	108	1540	123.0	0.21	1350		741.8	745.3	80195	5874335	741.6	745.0	80094	5874405
STM56	STM57	Ind.	6.6	28.2	307.6	33	2280	274.8	0.22	1500		741.4	745.0	80094	5874405	740.8	745.0	79971	5874162
STM57	Pond50	Ind.	0.0	28.2	0.0	0	2280	146.5	0.22	1500		740.8	745.0	79971	5874162	740.5	744.5	79747	5874265
STM57.1	Pond57	Rural	154.0	154.0	1489.2	770	770	184.6	0.3	900		747.1	750.0	83344	5875047	746.5	751.0	83114	5874997
STM58	Pond50	Ind.	5.9	5.9	290.2	29	660	200.6	0.30	900		742.1	745.0	79798	5873992	741.5	744.5	79747	5874265
STM59	STM60	Comm.	0.0	46.0	0.0	0	230	707.3	0.22	600		743.5	747.5	82339	5875032	741.9	745.0	81791	5875479
STM59A	Pond59	Ind.	27.5	27.5	629.6	138	1950	72.2	0.40	1200		744.8	748.3	82135	5874798	744.5	747.5	82298	5874803
STM60	STM63	Comm.	0.0	537.4	0.0	0	2687	215.6	0.20	1650		741.2	745.0	81791	5875479	740.8	745.5	81603	5875375
STM60.1	Pond60	Rural	107.0	107.0	1241.3	535	535	152.2	0.40	750		747.9	752.5	83295	5876028	747.3	751.0	83057	5876018
STM61	STM60	Comm.	0.0	491.4	0.0	0	2457	134.1	0.20	1500		741.7	745.0	81920	5875517	741.4	745.0	81791	5875479
STM62	Pond64	Ind.	8.8	8.8	356.8	44	990	192.4	0.70	900		744.3	749.0	81656	5875190	742.9	745.5	81671	5875473
STM63	MohlerDitch	Comm.	0.0	569.3	0.0	0	2847	932.7	0.16		2	740.8	745.5	81603	5875375	739.3	742.2	80730	5875549
STM63-1	STM64-1	Ind.	0.0	96.8	0.0	0	484	532.8	0.15	900		737.2	739.8	80994	5878140	736.4	739.0	80461	5878129
STM64	Pond60	Comm.	23.5	23.5	581.5	117	1870	301.1	0.24	1350		748.2	752.0	82942	5876350	747.5	751.0	83057	5876018
STM64-1	STM65-1	Ind.	0.0	1022.1	0.0	0	5111	419.9	0.13		2	735.3	739.0	80461	5878129	734.8	738.0	80110	5878191
STM65	STM66	Comm.	14.3	14.3	453.9	72	1140	308.7	0.12	1350		744.0	747.0	82174	5876571	743.6	747.5	82068	5876281
STM65-1	STM66-1	Ind.	0.0	1136.9	0.0	0	5685	269.7	0.13		2	734.8	738.0	80110	5878191	734.4	738.0	79944	5877981
STM66	Pond62	Comm.	11.8	26.1	411.9	59	2080	269.7	0.12	1650		743.3	747.5	82068	5876281	743.0	746.5	81927	5875992
STM66-1	STM67-1 (Ex 46St Channel)	Ind.	0.0	1136.9	0.0	0	5685	604.7	0.13		2	734.4	738.0	79944	5877981	733.7	736.3	78381	5878023
STM67	Pond66	Comm.	11.8	11.8	411.9	59	940	589.0	0.50	900		743.9	747.0	81647	5876256	741.0	744.0	81008	5876345
STM68	Pond66	Ind.	32.3	32.3	681.5	161	2290	210.8	0.17	1500		741.1	746.3	81164	5876541	740.7	744.0	81008	5876345
STMCH1	STMCH2	Comm.	0.0	117.7	0.0	0	589	361.3	0.10		1.5	744.0	745.5	76098	5876377	743.6	746.8	76081	5876745
STMCH2	Pond4	Comm.	0.0	359.2	0.0	0	1796	627.0	0.13		2	743.6	746.8	76081	5876745	742.8	745.0	76548	5877033
STMCH31	Pond21	Res.	0.0	99.3	0.0	0	497	641.9	0.09		1.5	748.5	753.3	73998	5873839	748.0	751.5	74357	5873224
STMCH54	STMCH55	Ind.	0.0	154.3	0.0	0	772	800.4	0.17		1.5	742.8	747.0	80791	5873281	741.4	745.8	80816	5872484
STMCH57	Ravine7	Ind.	0.0	101.5	0.0	0	508	665.7	0.20		1.5	736.6	741.0	79216	5872126	735.3	739.5	78550	5872128
STMCH59.1	Pond63	Comm.	8.2	8.2	342.6	41	1030	545.6	0.51	900		744.8	748.8	82431	5875133	742.0	745.0	82041	5875632
STMCH61	STMCH62	Ind.	0.0	0.0	0.0	0	0	333.5	0.42		1.2	740.8	743.8	80579	5877331	739.4	743.0	80246	5877340
STMCH62	Pond71A	Ind.	0.0	0.0	0.0	0	0	677.2	0.42		1.2	739.4	743.0	80246	5877340	736.5	739.5	80541	5878000
STMCH71	STMCH75A	Ind.	0.0	500.1	0.0	0	2500	1072.6	0.18		2	735.4	738.5	81464	5879772	733.5	736.5	80316	5879758
STMCH72.1	Pond72	Rural	757.4	757.4	3302.5	3787	3787	894.4	0.36		2	740.0	742.0	81863	5878483	736.8	739.0	80864	5878829
STMCH75	Ravine17	Ind.	15.3	626.8	469.5	77	3134	1280.3	0.16		2	733.1	736.5	80081	5879754	731.0	736.0	79370	5880734
STMCH75A	STMCH75	Ind.	0.0	544.1	0.0	0	2721	235.2	0.16		2	733.5	736.5	80316	5879758	733.1	736.5	80081	5879754
STMCH78.1	Ravine 18	Rural	221.4	221.4	1785.4	1107	1107	726.8	0.30		1.8	738.8	740.8	82585	5880269	736.6	738.5	82175	5880594
STMCH79.1	Pond79	Rural	329.8	329.8	2179.2	1649	1649	990.9	0.30		2	740.0	742.0	82693	5879129	737.0	740.0	81949	5879609



Associated Engineering

THE CITY OF CAMROSE

STORM SEWER DRAINAGE CONCEPT PLAN

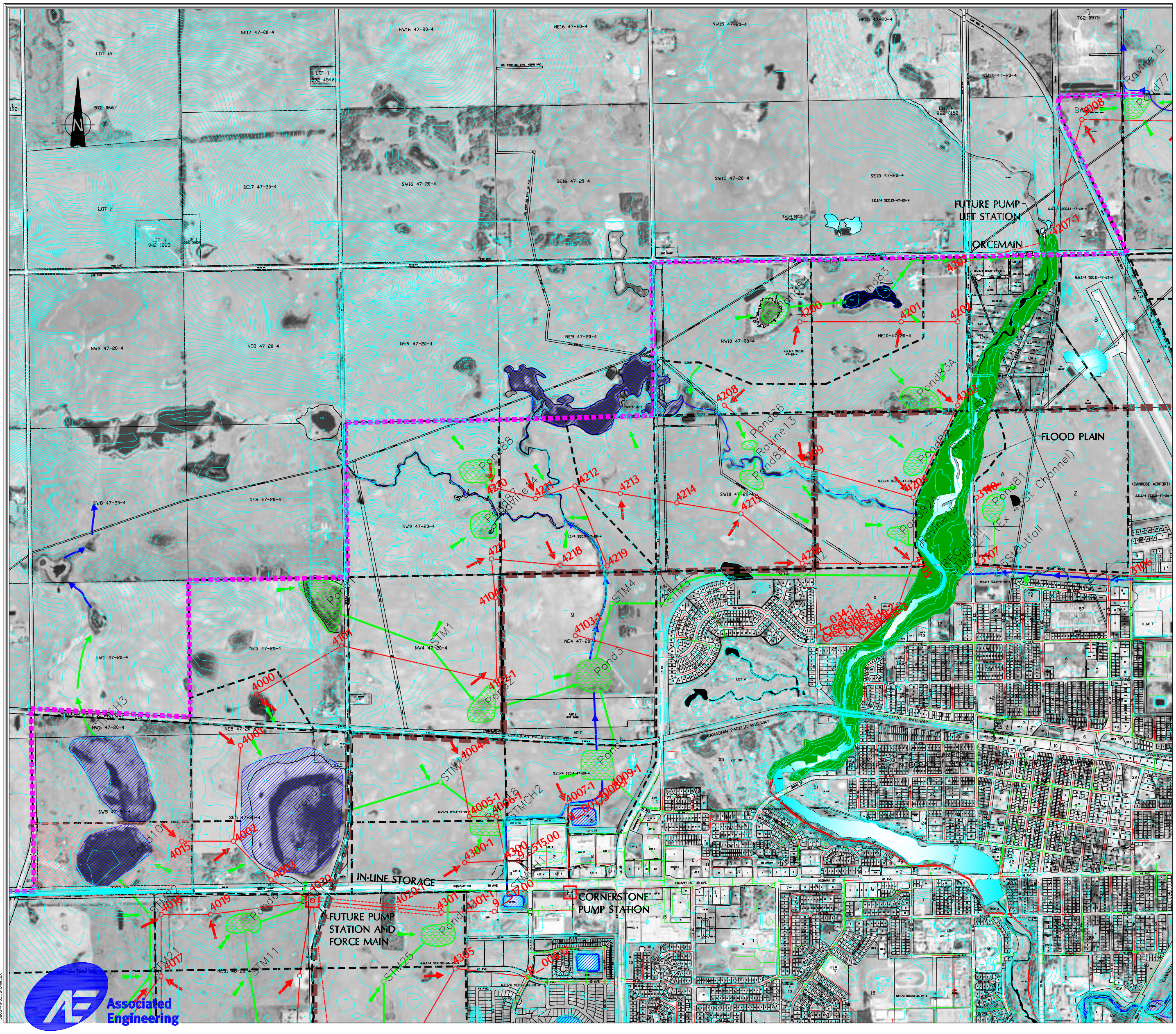
LEGEND:

- CAMROSE CREEK FLOOD PLAIN
- EXISTING WETLAND
- EXISTING STORM SEWER
- PROPOSED STORM TRUNK
- STORM INLET NODE
- STORM PUMP STATION
- STORMWATER MANAGEMENT FACILITY
- EXISTING DRAINAGE CHANNEL
- PROPOSED DRAINAGE CHANNEL
- SUB-CATCHMENT BOUNDARY
- CITY BOUNDARY
- PLAN AREA BOUNDARY

SCALE : 1 : 20 000

JANUARY, 2008

FIGURE B.1



THE CITY OF CAMROSE

DRAINAGE CONCEPT PLAN
NORTHWEST CAMROSE

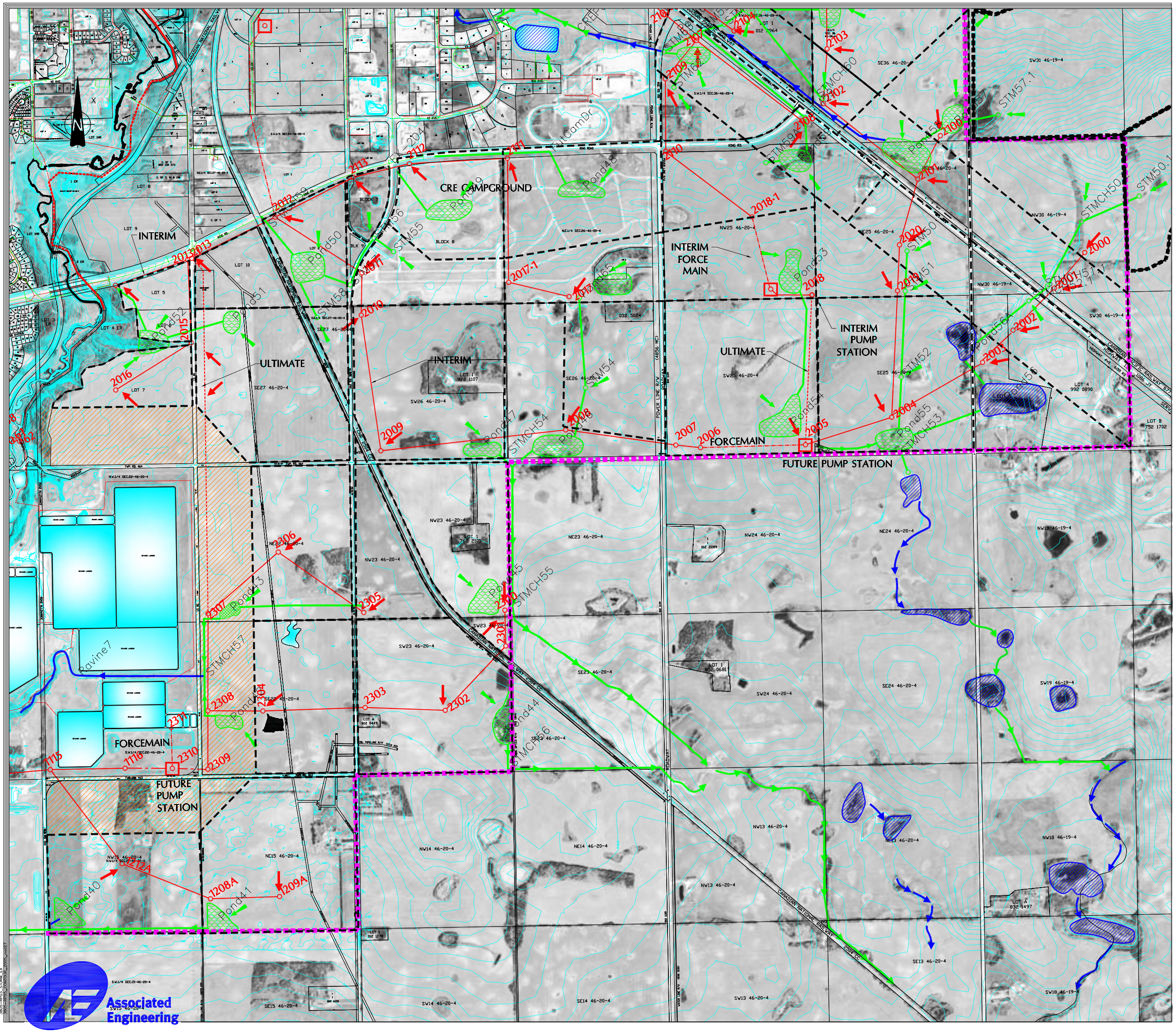
LEGEND:

- EXISTING SANITARY TRUNK
- PROPOSED SANITARY TRUNK
- OPTIONAL (ULTIMATE) SANITARY TRUNK
- SANITARY FORCEMAIN
- PIPE BRIDGE
- IN-LINE STORAGE PIPE
- SANITARY INLET NODE
- SANITARY PUMP STATION
- 4214 STORM NODE NUMBERS
- CAMROSE CREEK FLOOD PLAIN
- EXISTING WETLAND
- EXISTING STORM SEWER
- STORM TRUNK
- OPTIONAL STORM TRUNK
- STORM INLET NODE
- STORM PUMP STATION
- STORMWATER MANAGEMENT FACILITY
- EXISTING DRAINAGE CHANNEL
- PROPOSED DRAINAGE CHANNEL
- SUB-CATCHMENT BOUNDARY
- CITY BOUNDARY
- PLAN AREA BOUNDARY

SCALE : 1 : 10 000

JANUARY, 2008

FIGURE B-NW



THE CITY OF CAMROSE

DRAINAGE CONCEPT PLAN
SOUTHEAST CAMROSE

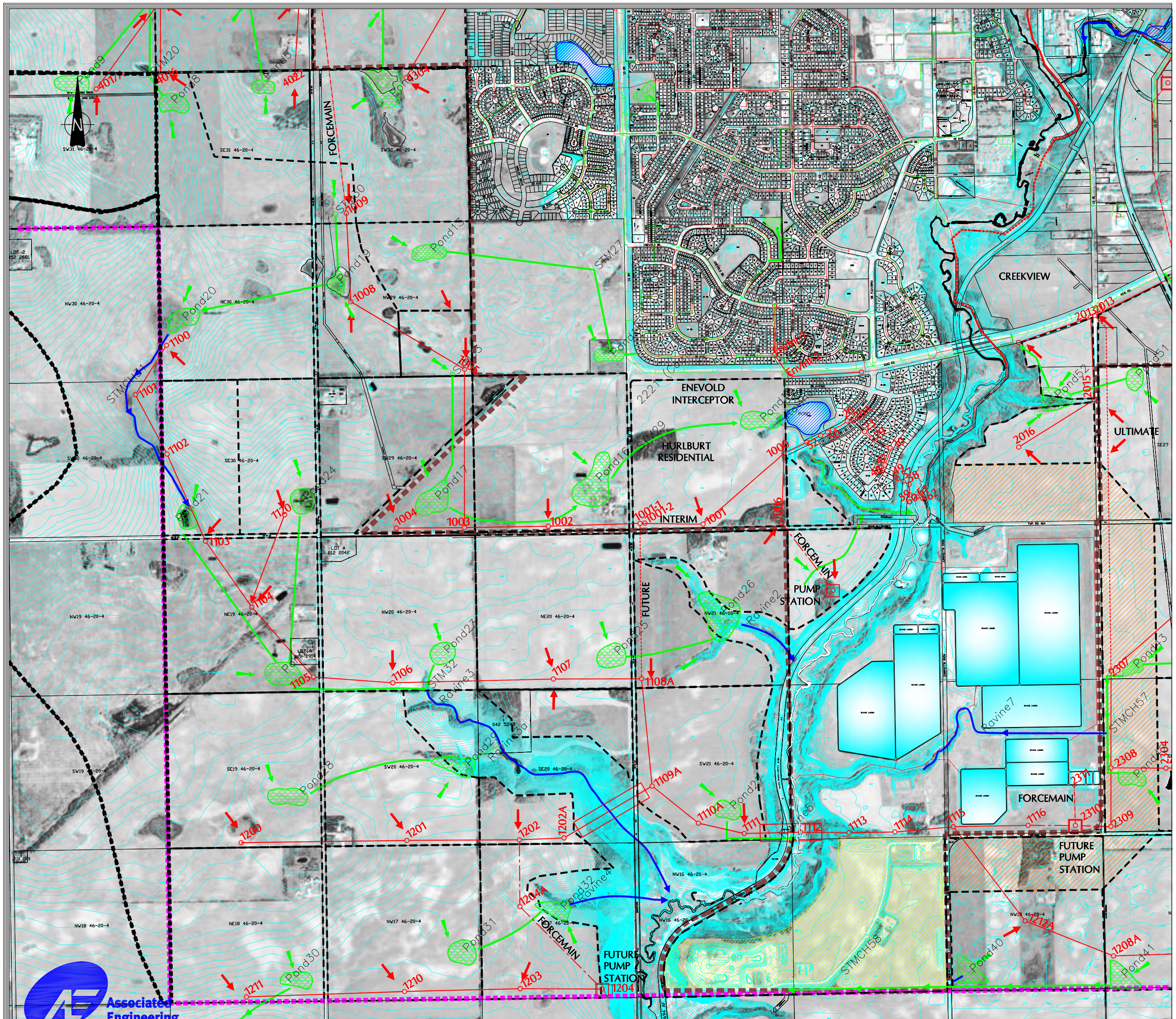
LEGEND:

- EXISTING SANITARY TRUNK
- PROPOSED SANITARY TRUNK
- OPTIONAL (ULTIMATE) SANITARY TRUNK
- SANITARY FORCEMAIN
- PIPE BRIDGE
- IN-LINE STORAGE PIPE
- SANITARY INLET NODE
- SANITARY PUMP STATION
- 4214 STORM NODE NUMBERS
- CAMROSE CREEK FLOOD PLAIN
- EXISTING WETLAND
- EXISTING STORM SEWER
- STORM TRUNK
- OPTIONAL STORM TRUNK
- STORM INLET NODE
- STORM PUMP STATION
- STORMWATER MANAGEMENT FACILITY
- EXISTING DRAINAGE CHANNEL
- PROPOSED DRAINAGE CHANNEL
- SUB-CATCHMENT BOUNDARY
- CITY BOUNDARY
- PLAN AREA BOUNDARY

SCALE : 1 : 10 000

JANUARY, 2008

FIGURE B-SE



THE CITY OF CAMROSE

DRAINAGE CONCEPT PLAN
SOUTHWEST CAMROSE

LEGEND:

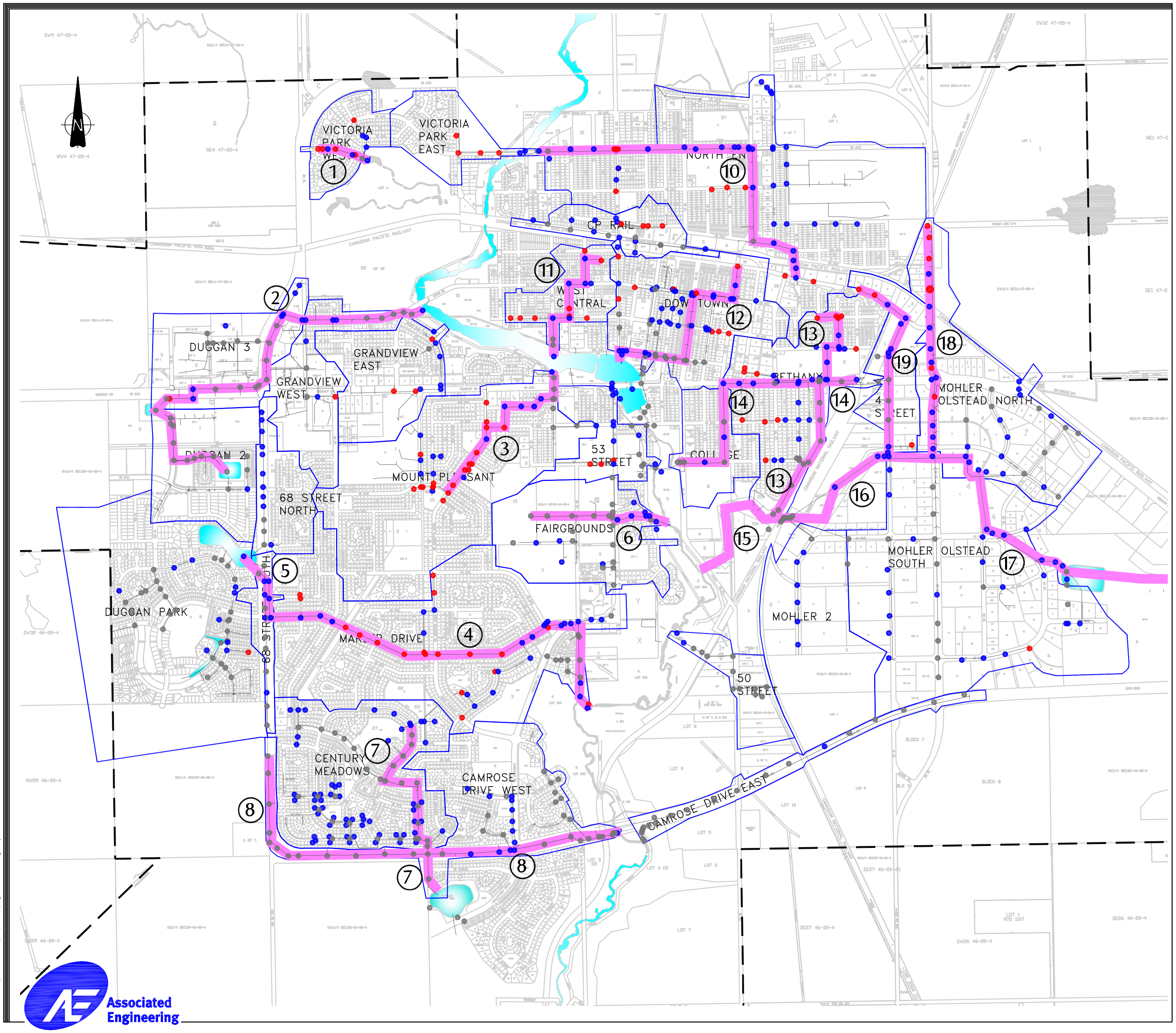
- EXISTING SANITARY TRUNK
- PROPOSED SANITARY TRUNK
- OPTIONAL (ULTIMATE) SANITARY TRUNK
- SANITARY FORCEMAIN
- PIPE BRIDGE
- IN-LINE STORAGE PIPE
- SANITARY INLET NODE
- SANITARY PUMP STATION
- 4214 STORM NODE NUMBERS
- CAMROSE CREEK FLOOD PLAIN
- EXISTING WETLAND
- EXISTING STORM SEWER
- STORM TRUNK
- OPTIONAL STORM TRUNK
- STORM INLET NODE
- STORM PUMP STATION
- STORMWATER MANAGEMENT FACILITY
- EXISTING DRAINAGE CHANNEL
- PROPOSED DRAINAGE CHANNEL
- SUB-CATCHMENT BOUNDARY
- CITY BOUNDARY
- PLAN AREA BOUNDARY

SCALE : 1 : 10 000

JANUARY, 2008

FIGURE B-SW

C Appendix C - Trunk Sewer Profiles



THE CITY OF *CAMROSE*

PROFILE LOCATION PLAN
WITH 1:5 YEAR STORM SURCHARGE LEVELS
FOR EXISTING CONDITIONS

LEGEND:

(8) PROFILE NUMBER

PROFILE LOCATION

DEPTH BELOW GROUND SURFACE
1:5 YEAR STORM

0.0 METERS

0.0 to 2.0 METERS

>2.0 METERS

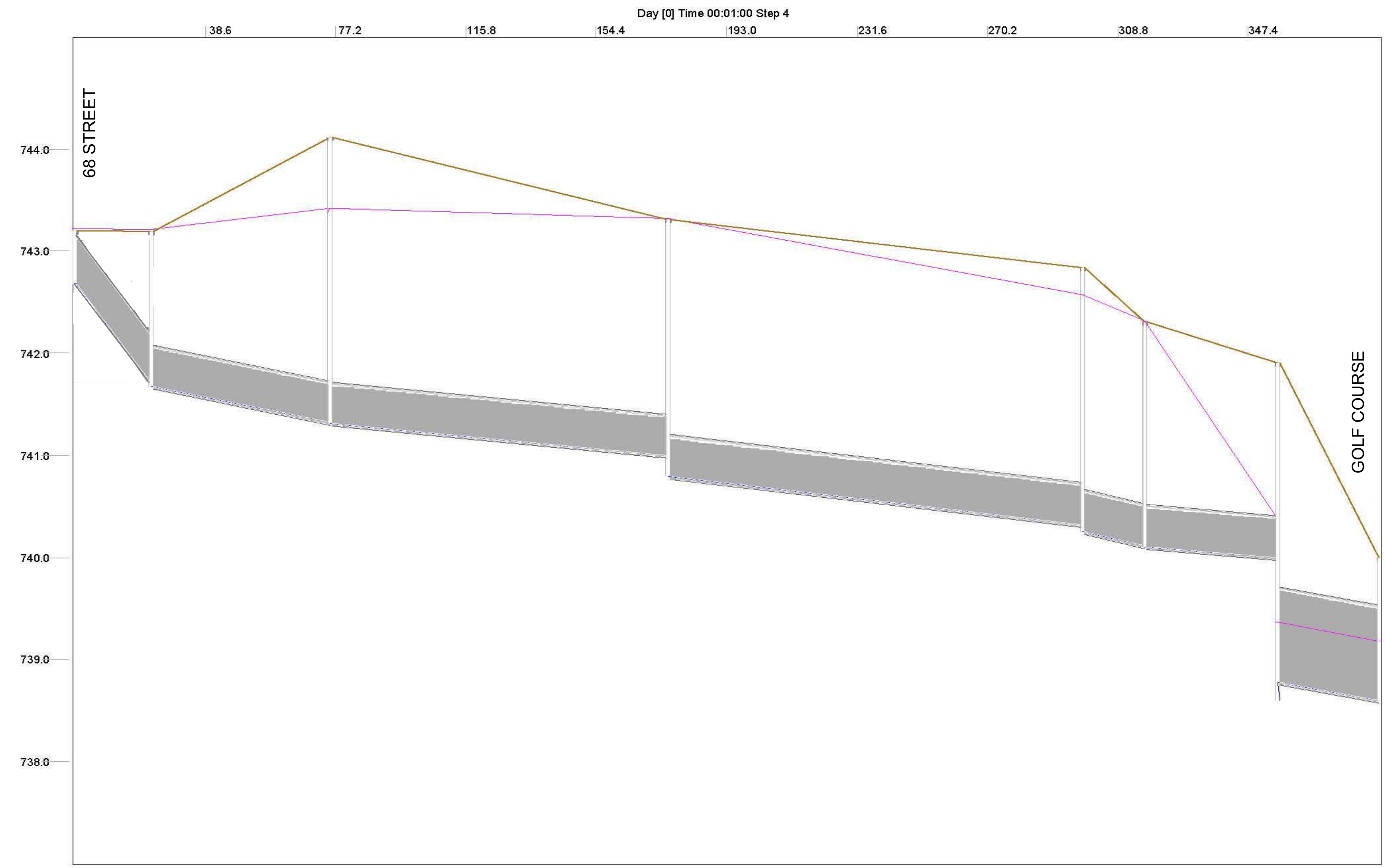
0 500 1000

SCALE: 1 : 20,000

JANUARY, 2008

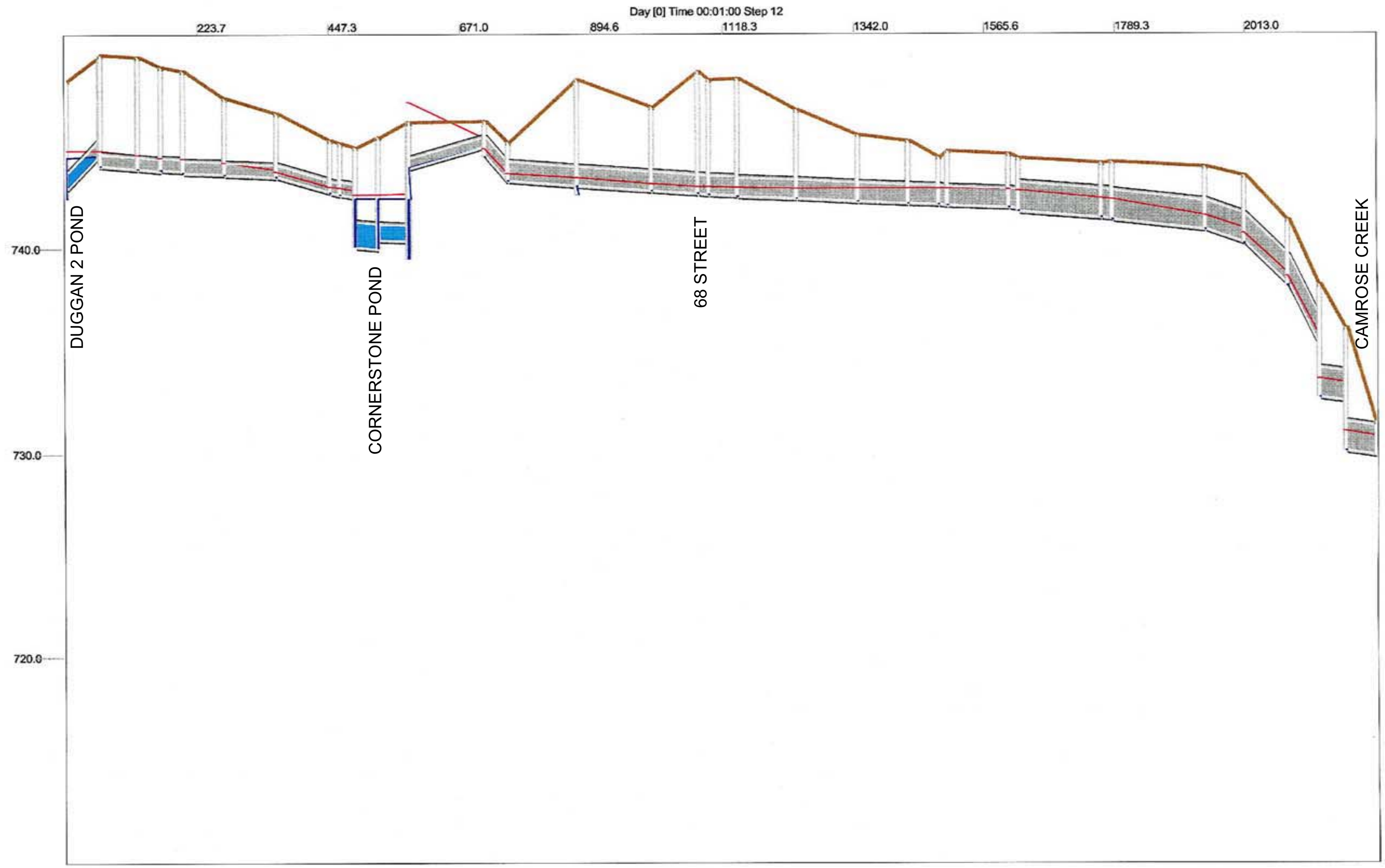
FIGURE C-1

File: Q:\053805\Report\fig_C-1.dwg by BW

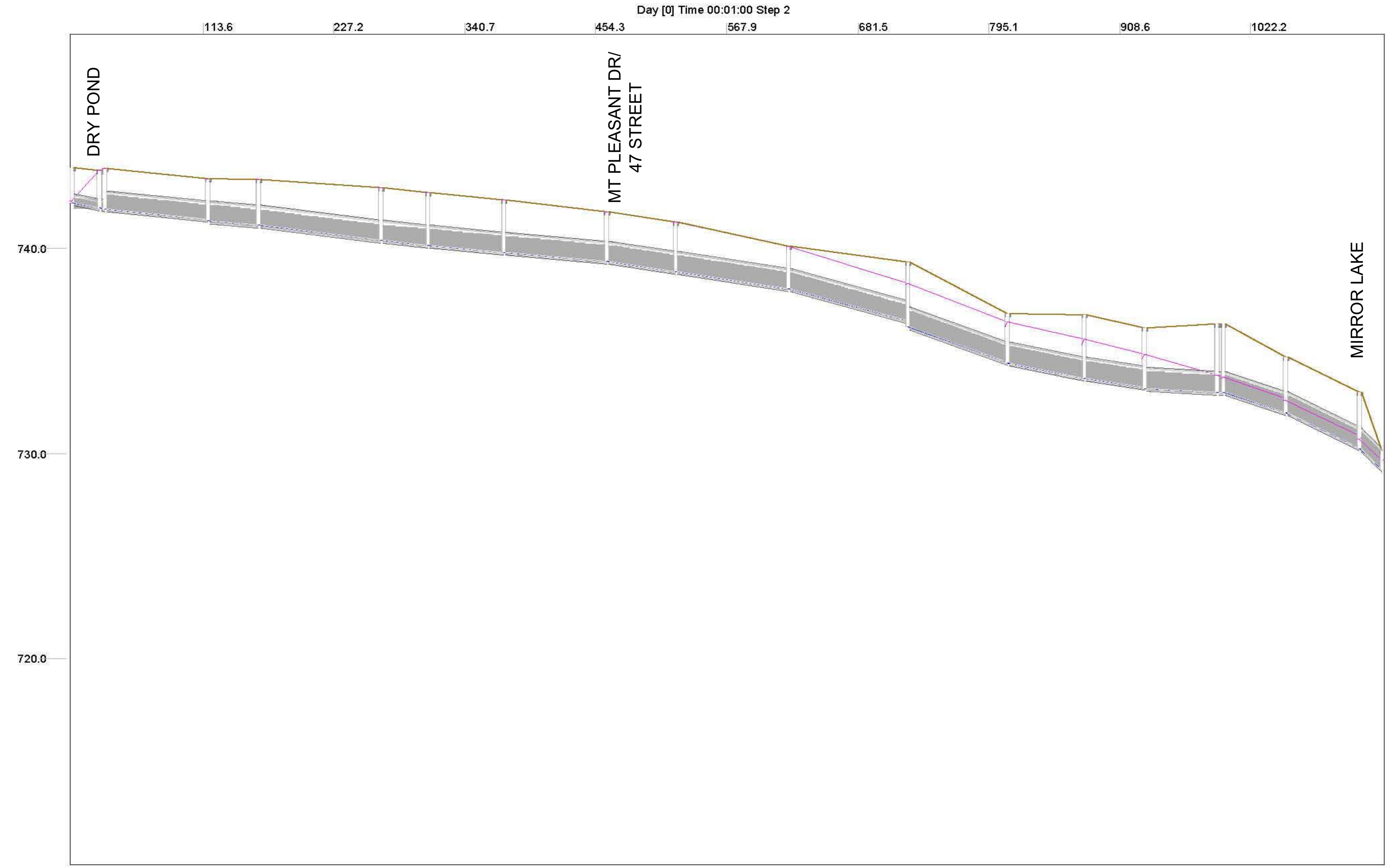


PROFILE #1
VICTORIA PARK WEST TRUNK
1:5 YEAR STORM - EXISTING CONDITIONS

profile1 (2)

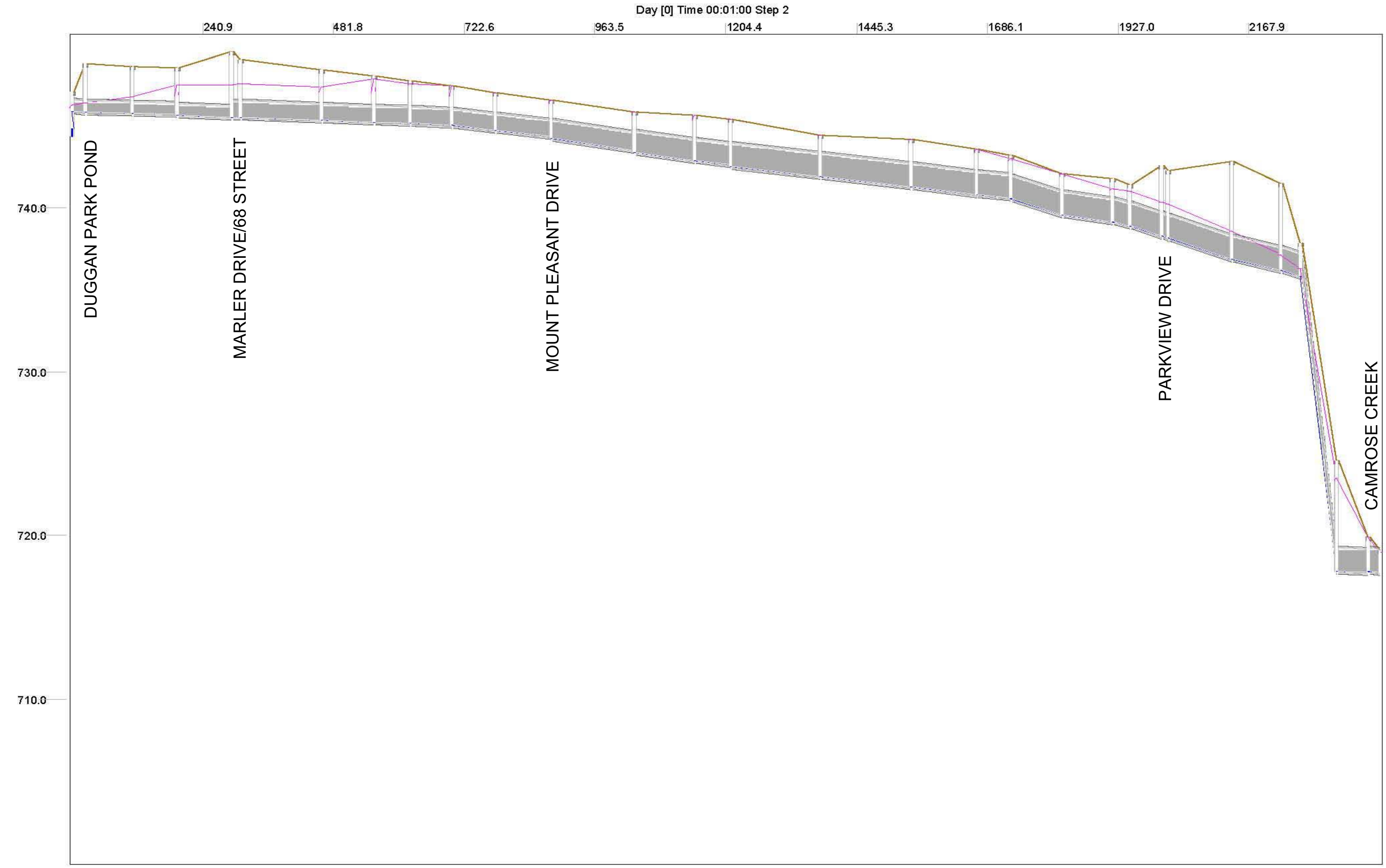


PROFILE #2
DUGGAN 2/CORNERSTONE/GRANDVIEW TRUNK
1:5 YEAR STORM - EXISTING CONDITIONS



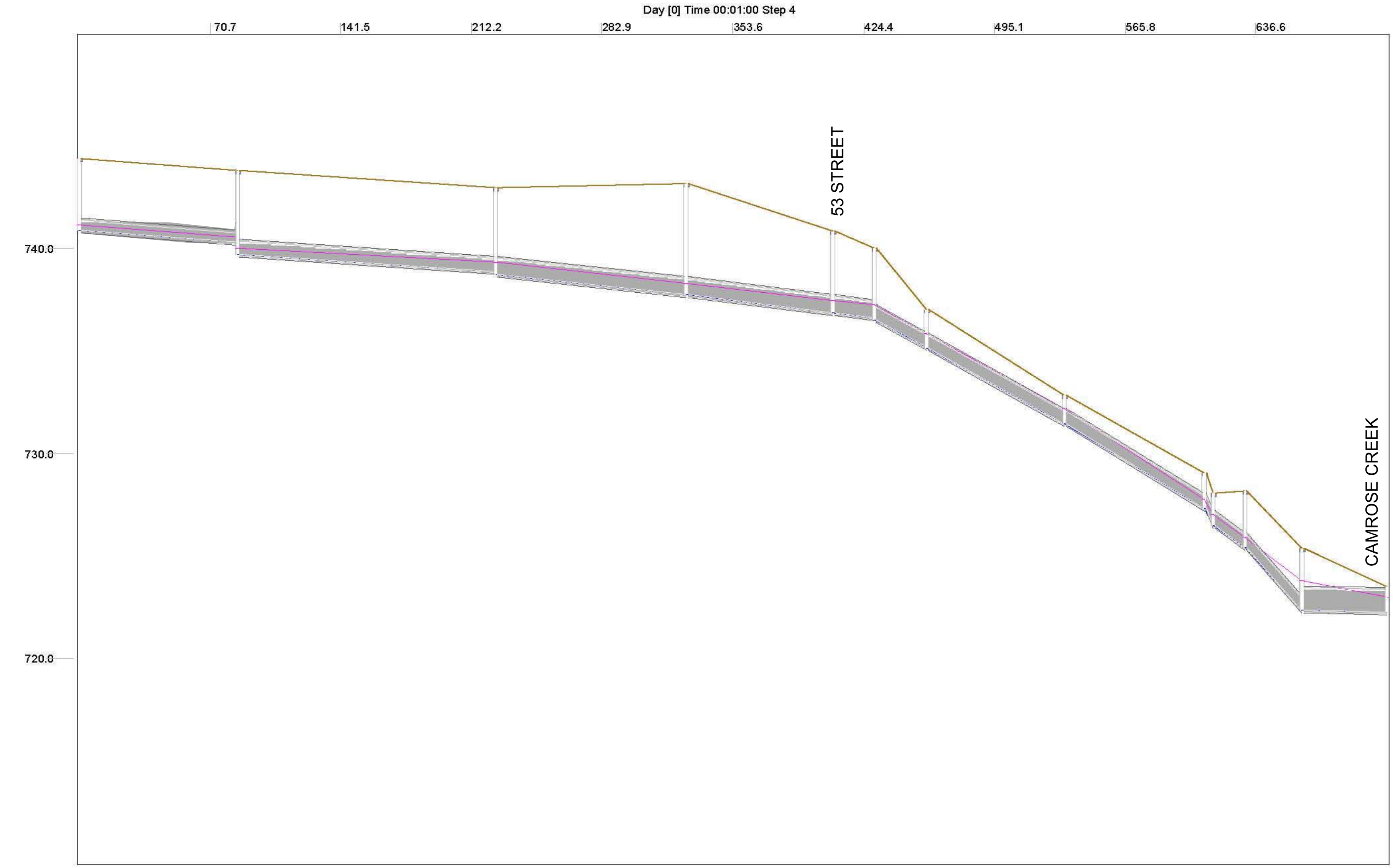
PROFILE #3
MOUNT PLEASANT TRUNK
1:5 YEAR STORM - EXISTING CONDITIONS

profile3 (2)



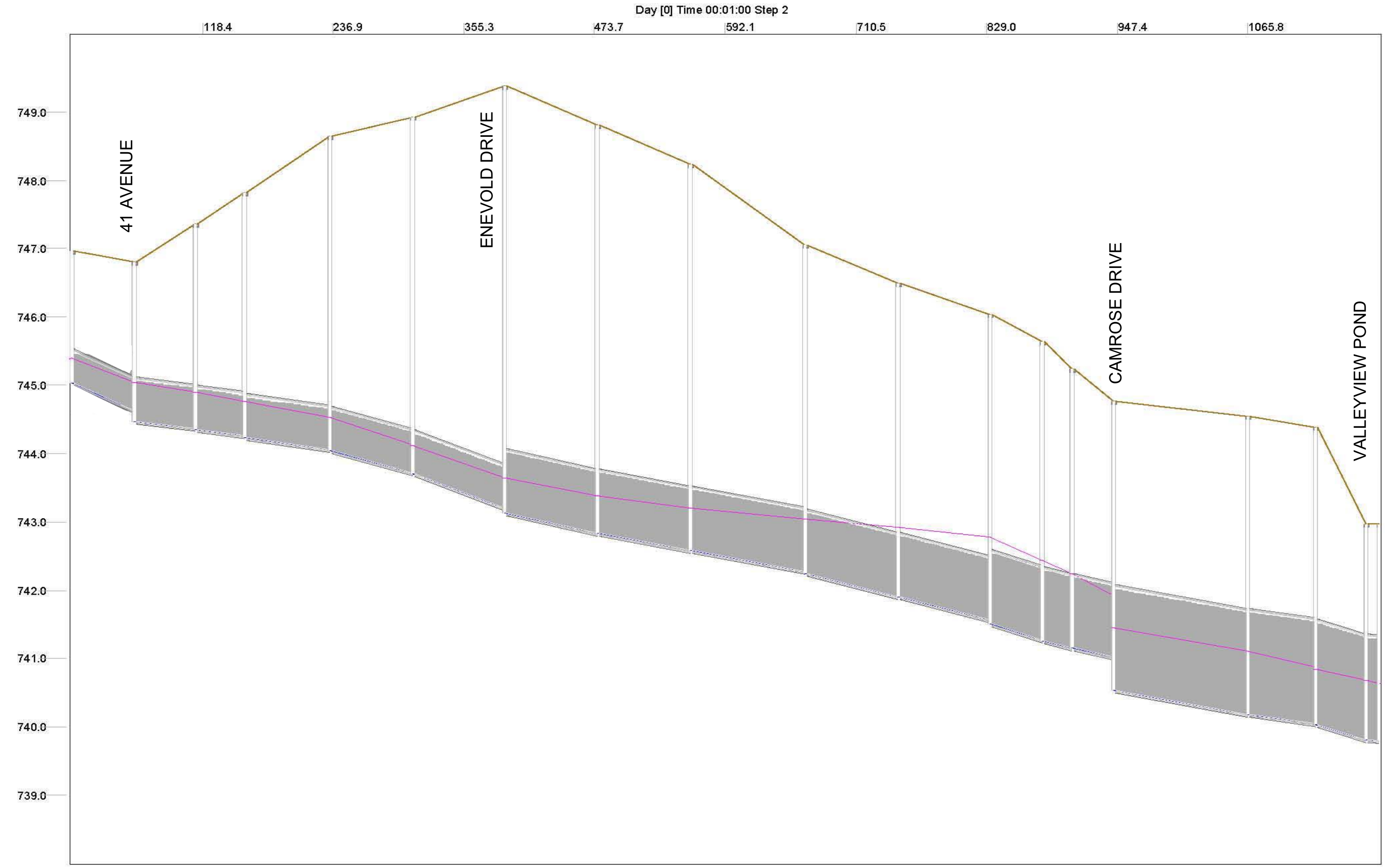
PROFILE #4/5
MARLER DRIVE TRUNK
1:5 YEAR STORM - EXISTING CONDITIONS

profile4-5 (2)



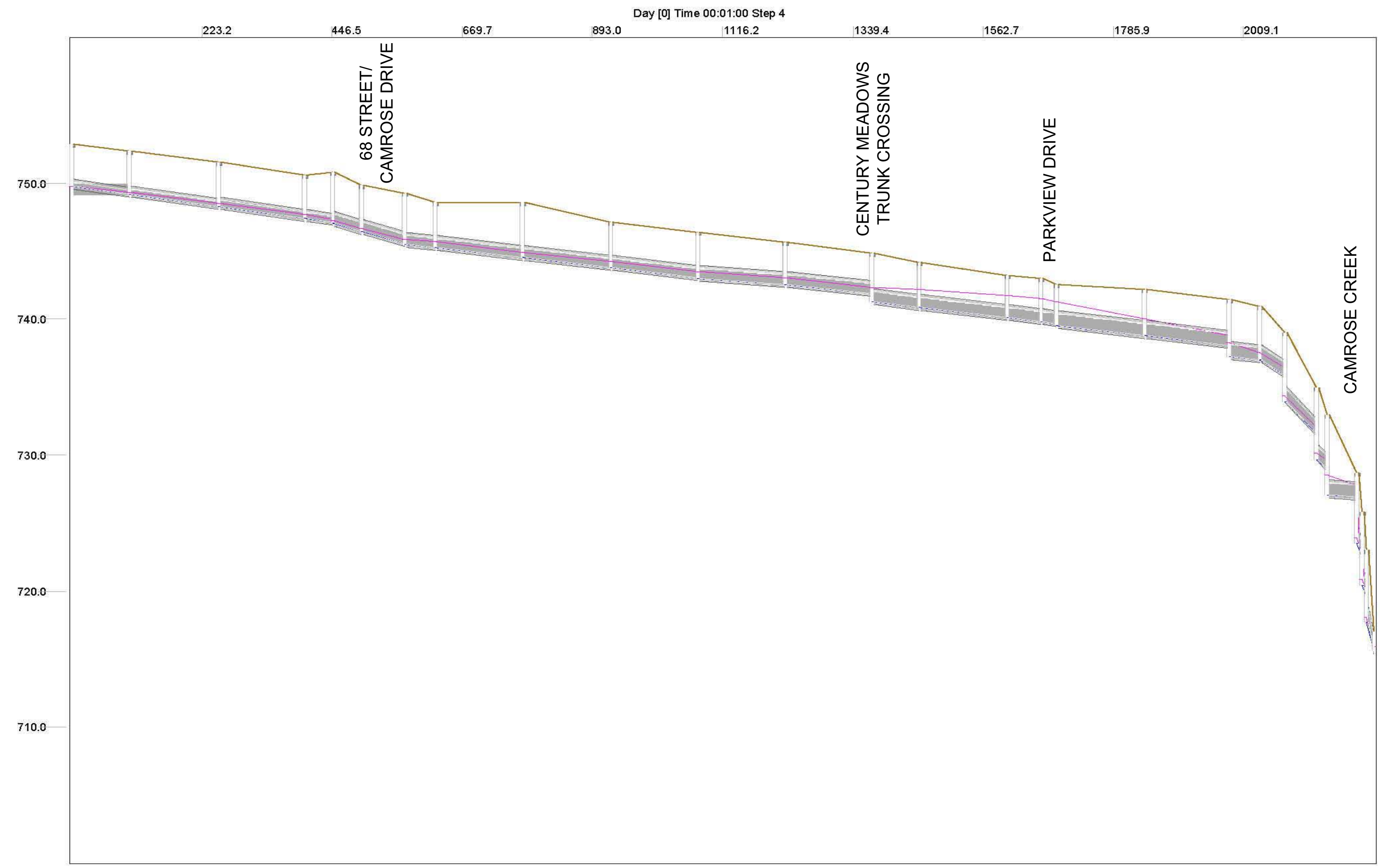
PROFILE #6
FAIRGROUNDS TRUNK
1:5 YEAR STORM - EXISTING CONDITIONS

profile6 (2)

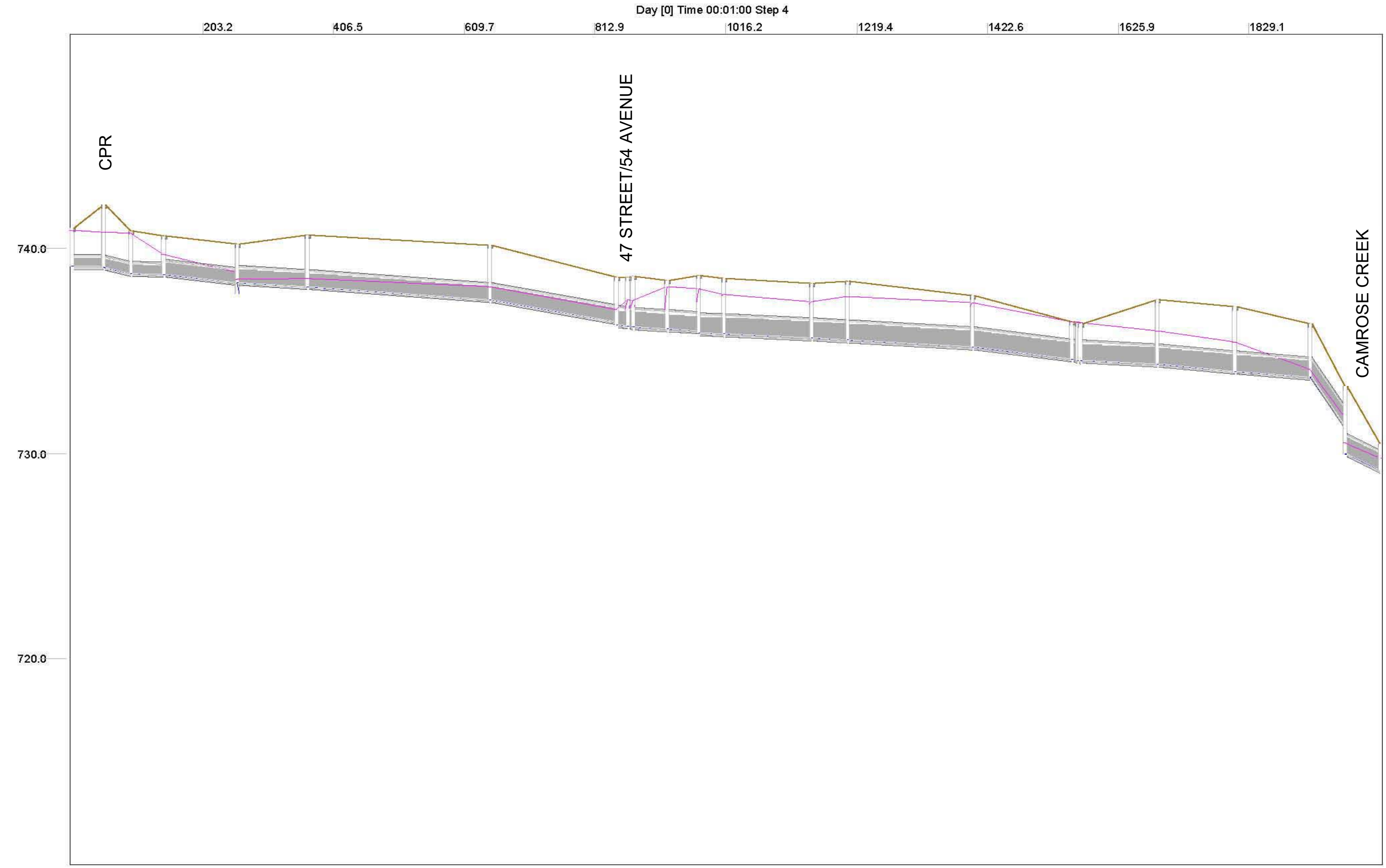


PROFILE #7
CENTURY MEADOWS TRUNK
1:5 YEAR STORM - EXISTING CONDITIONS

profile7 (2)

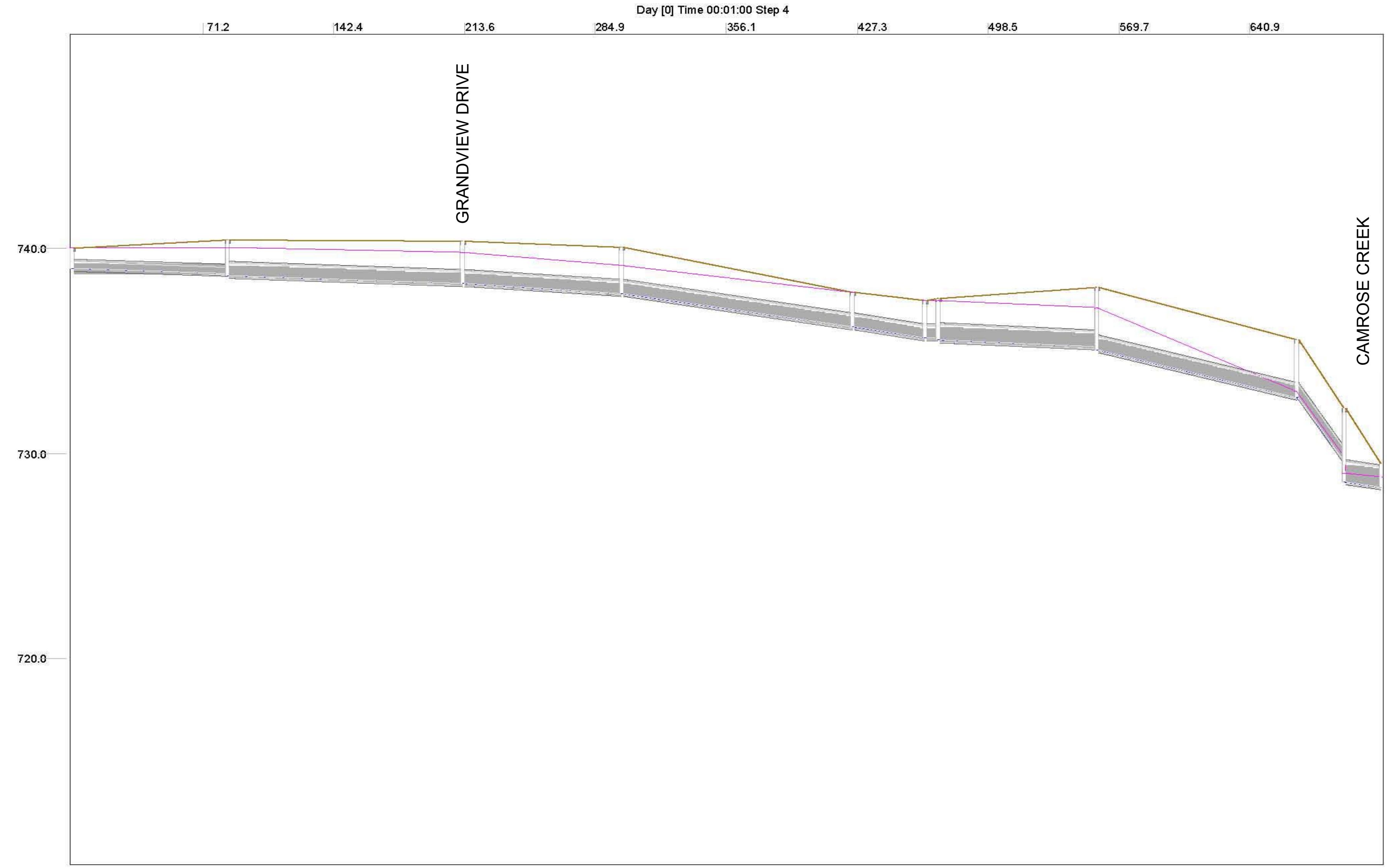


PROFILE #8
CAMROSE DRIVE WEST TRUNK
1:5 YEAR STORM - EXISTING CONDITIONS



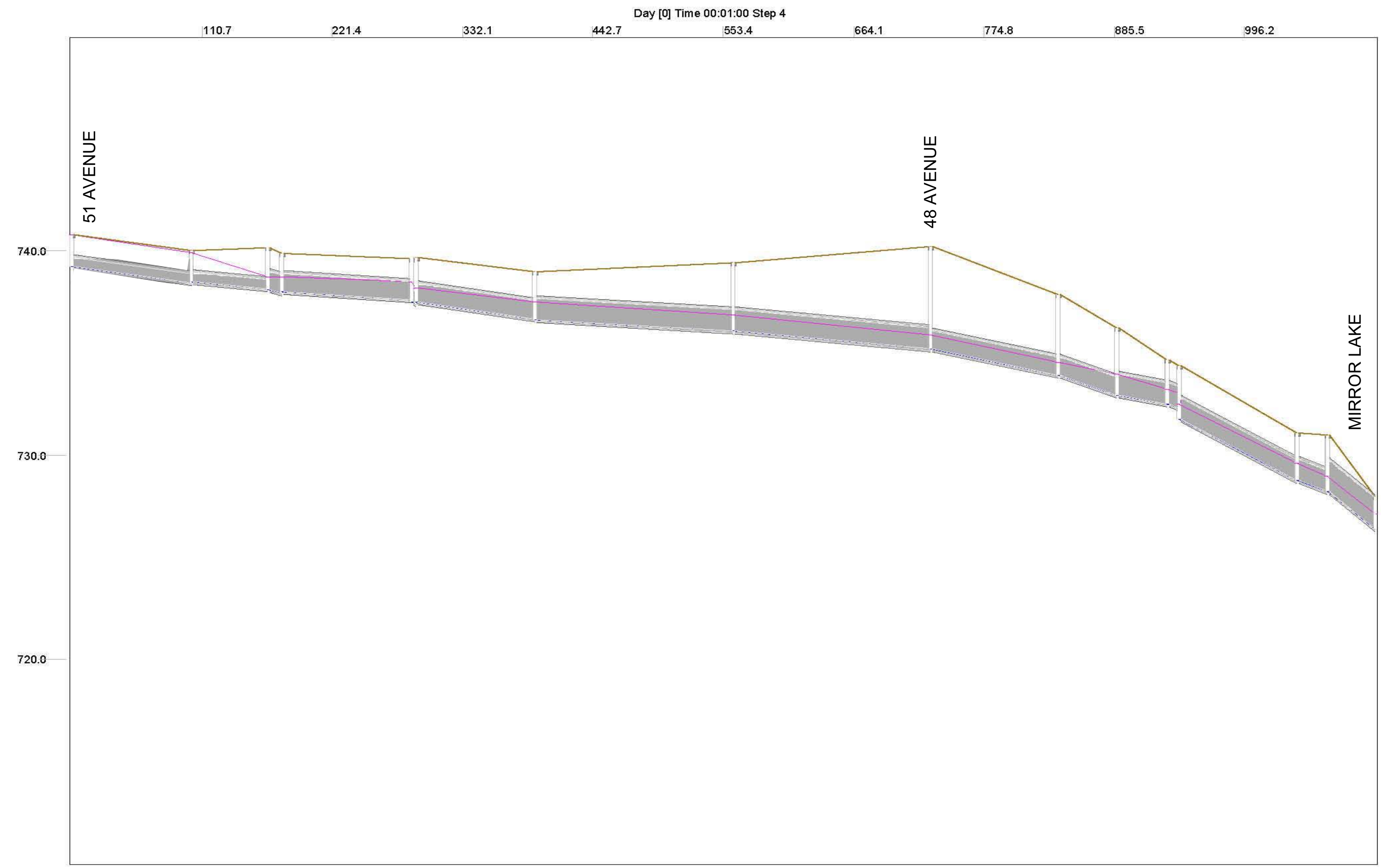
PROFILE #10
NORTH END TRUNK
1:5 YEAR STORM - EXISTING CONDITIONS

profile10 (2)



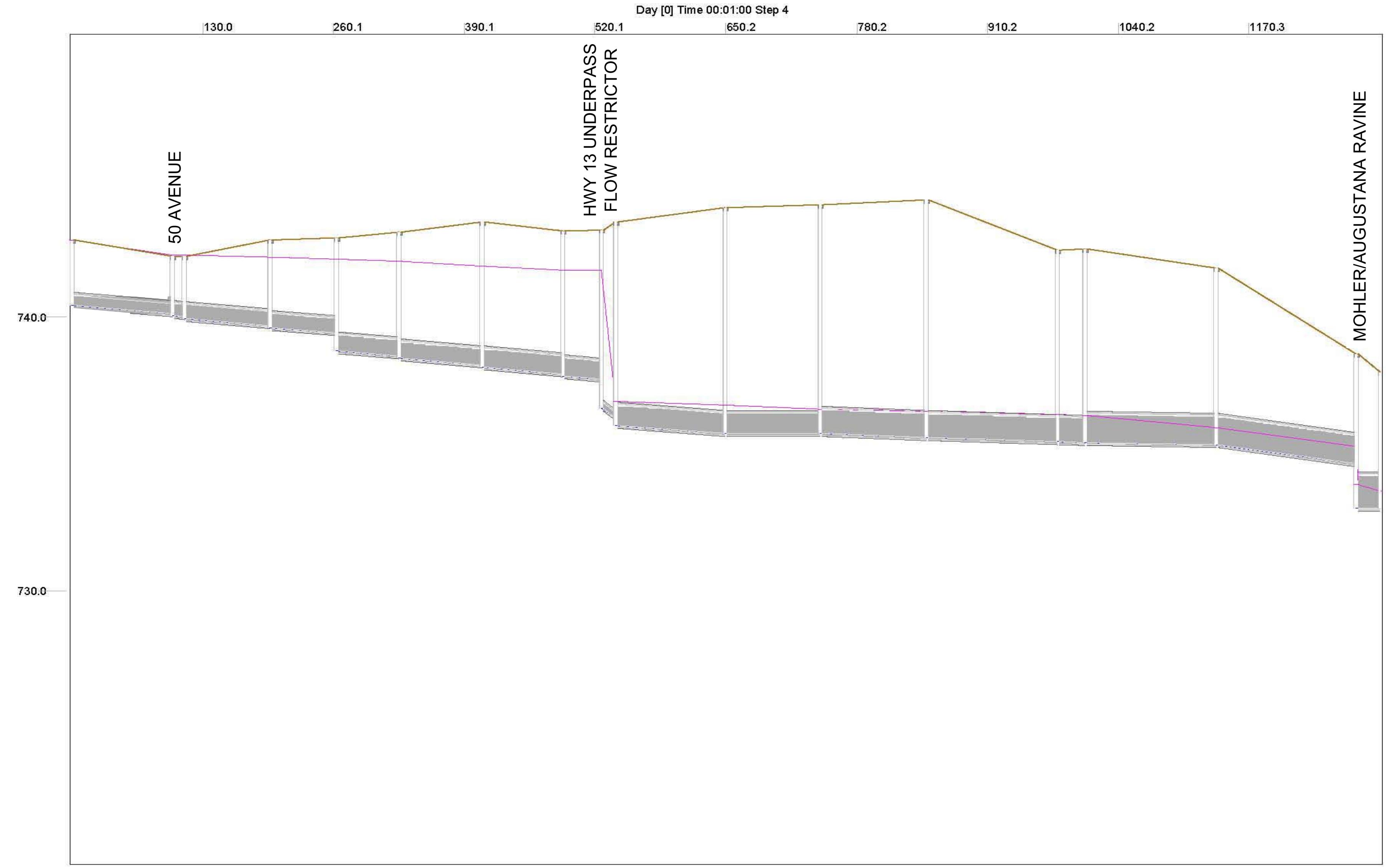
PROFILE #11
WEST CENTRAL TRUNK
1:5 YEAR STORM - EXISTING CONDITIONS

profile11 (2)

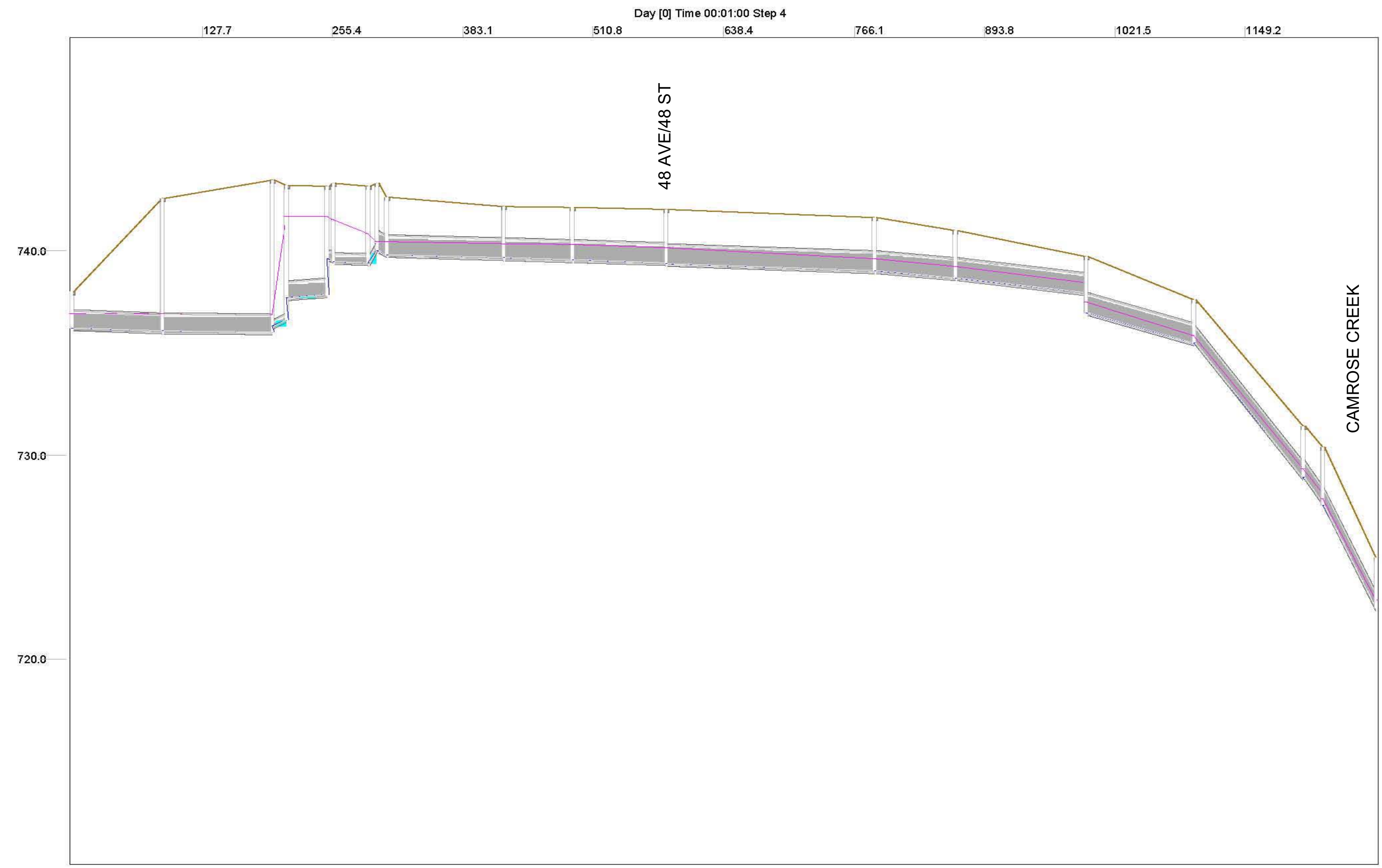


PROFILE #12
DOWNTOWN TRUNK
1:5 YEAR STORM - EXISTING CONDITIONS

profile12 (2)

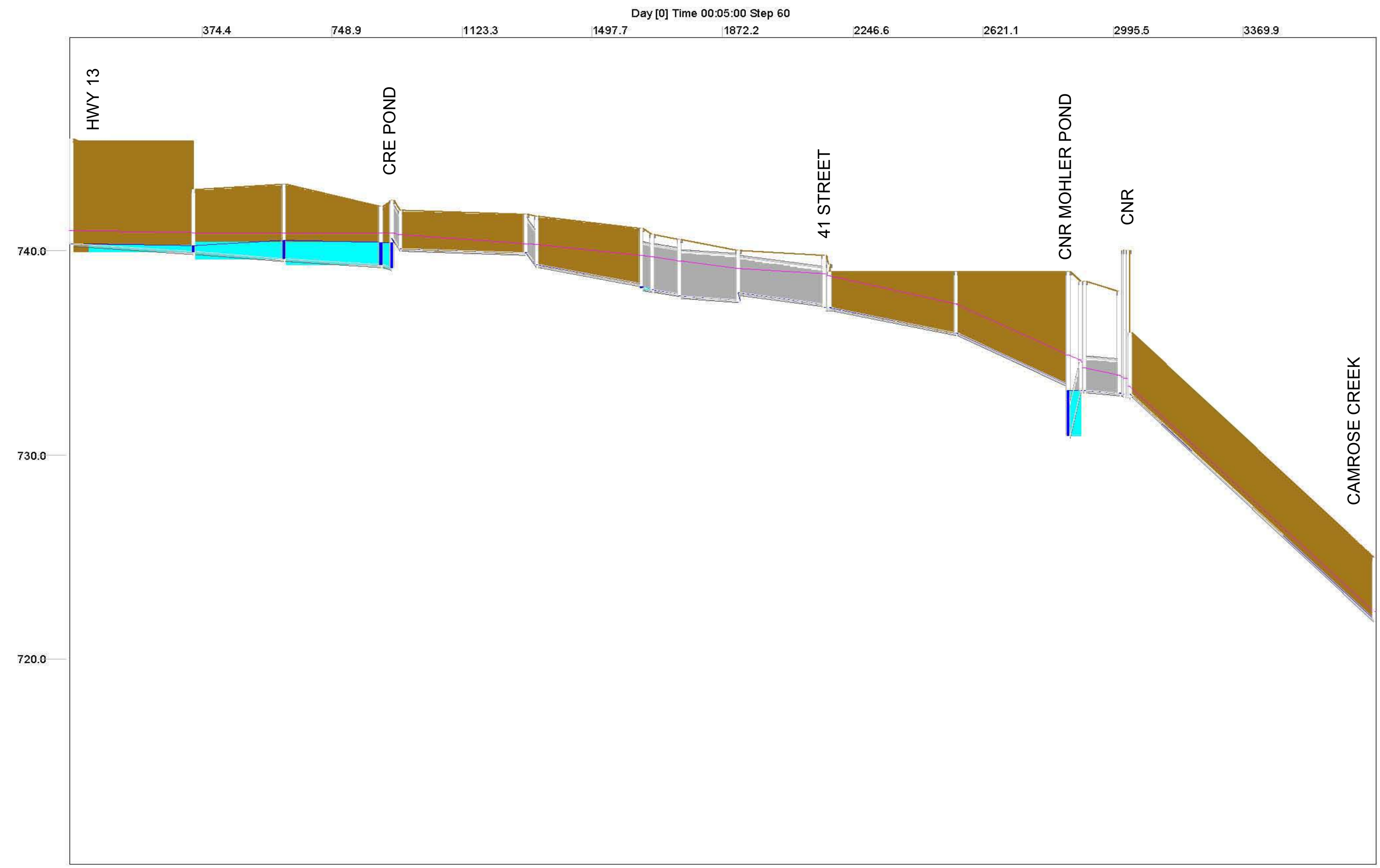


PROFILE #13
BETHANY TRUNK
1:5 YEAR STORM - EXISTING CONDITIONS

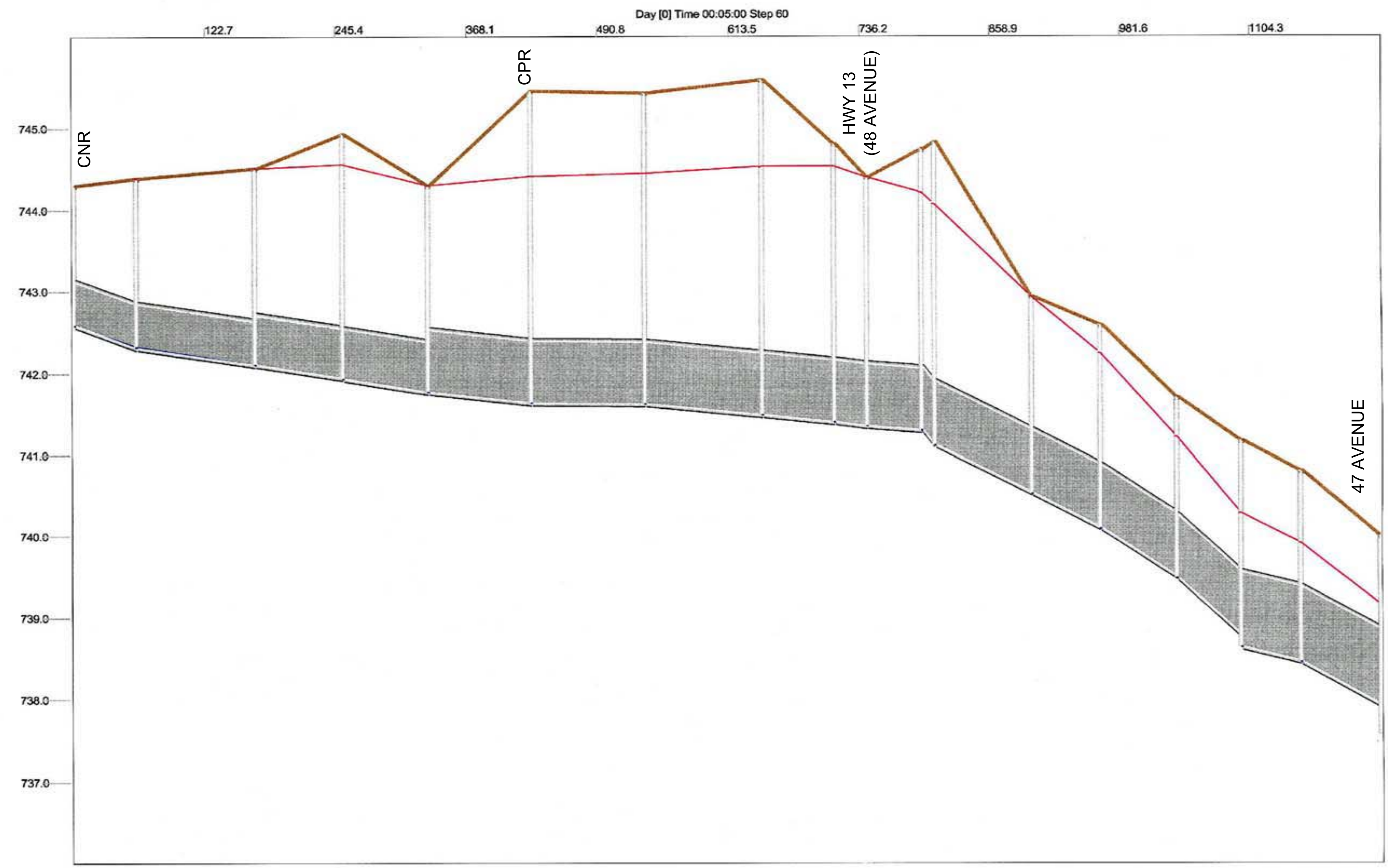


PROFILE #14
BETHANY/COLLEGE
1:5 YEAR STORM - EXISTING CONDITIONS

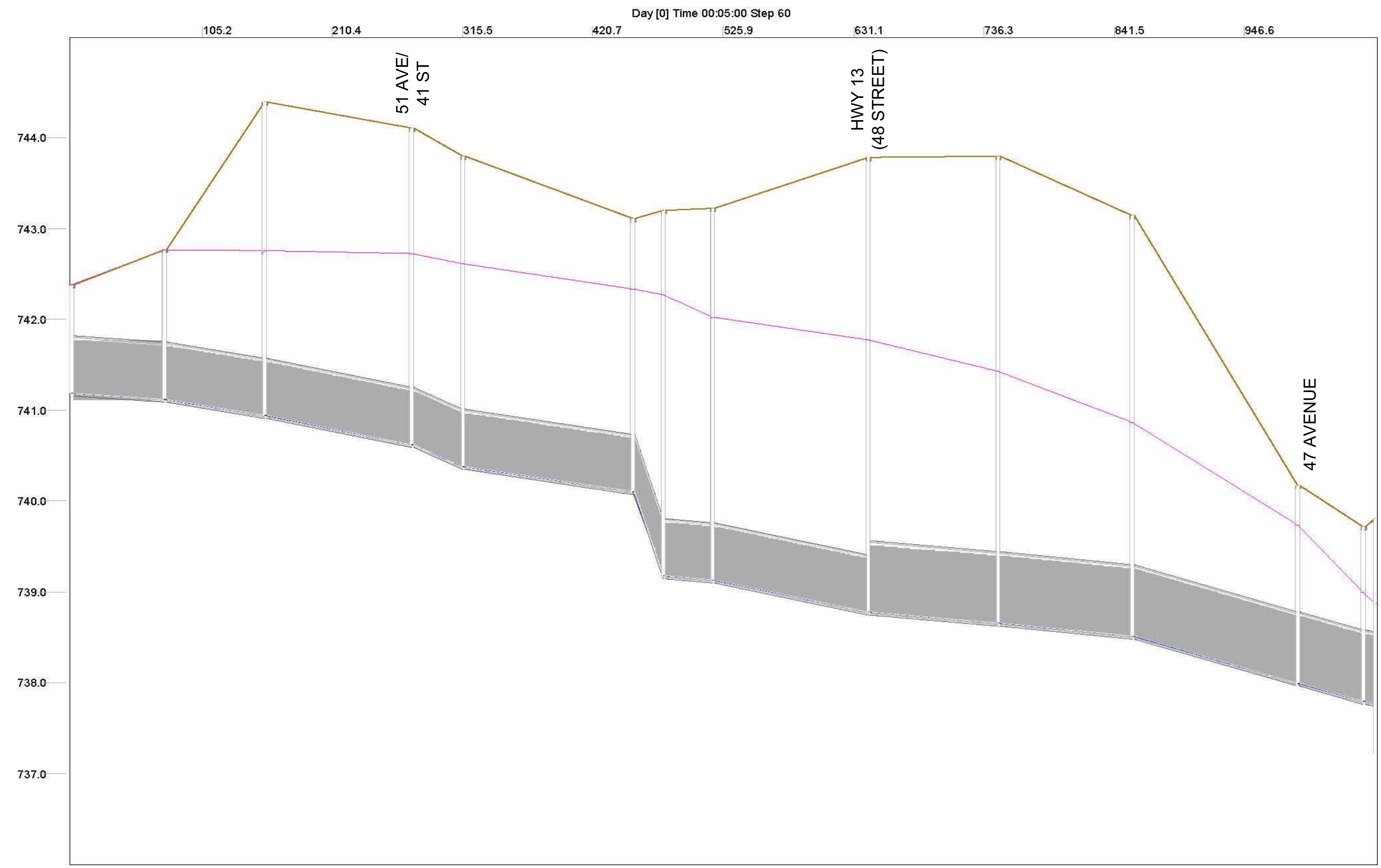
profile14 (2)



PROFILE #16/17
MOHLER OLSTEAD TRUNK AND CHANNEL
1:5 YEAR STORM - EXISTING CONDITIONS



PROFILE #18
MOHLER OLSTEAD NORTH 39 STREET TRUNK
1:5 YEAR STORM - EXISTING CONDITIONS



PROFILE #19
MOHLER OLSTEAD NORTH 41 STREET TRUNK
1:5 YEAR STORM - EXISTING CONDITIONS

profile19