STORMWATER MASTER SERVICING STUDY

TOWN OF STRATHMORE

FINAL REPORT

SEPTEMBER 2024

ISL Engineering and Land Services Ltd. is an award-winning full-service consulting firm dedicated to working with all levels of government and the private sector to deliver planning and design solutions for transportation, water, and land projects.

At ISL, your identity is part of our identity. Diversity, Equity, and Inclusion (DEI) speaks to our core values and provides space for our teams to bring their authentic selves to work. ISL believes DEI creates the best outcomes for our clients while sustaining a happy and thriving work environment that allows for career development opportunities for all staff. ISL is committed to a focused effort on continuous improvement and development of a respectful and safe workplace.

4015 7 Street SE, Calgary AB T2G 2Y9, T: 403.254.0544 F: 403.254.9186

September 11, 2024

Our Reference: 28436

Town of Strathmore
1 Parklane Drive
P.O. Box 2280
Strathmore, AB T1P 1J2

Attention: Catherine Boddington, Development and Project Technologist

Dear C. Boddington:

Reference: Town of Strathmore Stormwater Master Servicing Study – Final Report

---

Enclosed is the Final Report for the Strathmore Stormwater Master Servicing Study. We trust that it meets your expectations.

The Town of Strathmore (the Town) requisitioned ISL Engineering and Land Services Ltd. (ISL) to provide engineering services for a Stormwater Master Servicing Study (SWMSS). This study was prompted by the desire to incorporate infrastructure updates and upgrades into the SWMSS since its completion in 2018.

The intent of the study is to ensure sound stormwater system planning and to provide a road map to Town Council for assessing the capability of the infrastructure to accommodate new development in the short-term and long-term.

We sincerely appreciate the opportunity to undertake this project on behalf of the Town of Strathmore. Should you have any questions or concerns, please do not hesitate to contact the undersigned at 403.254.0544.

Sincerely,
ISL Engineering and Land Services Ltd.

Sarah Barbosa

Sarah Barbosa, P.Eng., ENV SP
Lead, Municipal Infrastructure Planning

Corporate Authorization

This document entitled "Stormwater Master Servicing Study" has been prepared by ISL Engineering and Land Services Ltd. (ISL) for the use of the Town of Strathmore. The information and data provided herein represent ISL's professional judgment at the time of preparation. ISL denies any liability whatsoever to any other parties who may obtain this report and use it, or any of its contents, without prior written consent from ISL.

September 11 2024

Sarah Barbosa, P.Eng., ENV SP
Lead, Municipal Infrastructure Planning

Permit to Practice
ISL Engineering and Land Services Ltd.

RM Signature:

RM APEGA ID: 66731

Date: 2024 September 12

Permit Number P4741
The Association of Professional Engineers and Geoscientists of Alberta

Executive Summary

Introduction

The Town of Strathmore (the Town) hired ISL Engineering and Land Services Ltd. (ISL) to update the Stormwater Master Servicing Study (SWMSS) for the existing and future stormwater system. The SWMSS aims to provide a comprehensive assessment of the current and projected stormwater infrastructure needs, identify areas of concern, and recommend solutions and upgrades. The SWMSS also incorporates the Cooperative Stormwater Management Initiative (CSMI) agreement between the Western Irrigation District (WID), the City of Calgary, Rocky View County, and the Town of Strathmore. The SWMSS uses a robust hydrodynamic InfoWorks ICM 1D-2D model to simulate the stormwater system under various scenarios and design criteria.

Study Overview

Within the Town, the stormwater consists of both major and minor drainage systems. The minor system includes any underground infrastructure, including the pipe network and any of its associated structures. The Town's current stormwater system consists of approximately 4 km of culverts, 1,242 manholes, 10 km of channels, 55 km of main line storm infrastructure, 55 outlets, and 16 stormwater ponds. The design criteria used to assess the Town's stormwater system was derived from the City of Calgary Stormwater Management and Design Manual, Alberta Environment and Park's standards and guidelines, and engineering best practices utilized by ISL on similar projects across Alberta.

The model used for assessing the Town's stormwater system was InfoWorks ICM developed by Innovyze, which was selected for its advanced capabilities associated with 2D modelling. The stormwater model was constructed by utilizing available data combined with confirmations from survey, limited record drawings, and certain assumptions, with both a 1D and 2D model constructed.

The existing stormwater system was assessed under 1:5 year 1-hour Chicago rainfall event and 1:100 year 24-hour Chicago rainfall event conditions, for the minor and major systems, respectively. To assess the Town's existing overland drainage system, 2D modelling results were extracted at the maxima for both water depth relative to the LiDAR surface (represented through the mesh elements) and surface flow velocity.

Future drainage basins were established and summarized, with catchments delineated based on current topography. Pond sizing was provided for a range of runoff coefficients, depending on how development in the future drainage basins progresses. LID options were also provided to potentially be integrated into the stormwater design. This would reduce the overall runoff produced by the developed site. Environmental impacts were considered and could be minimized by implementing appropriate erosion and sediment control.

Conclusions and Recommendations

The main conclusions and recommendations of the study are summarized below.

- The existing stormwater system was found to have minimal surcharging and flooding issues under the 1:5 year 1-hour and 1:100 year 24-hour design events, except for some localized areas that were identified and recommended for upgrades. The proposed upgrades include pipe upsizing, culvert replacement, and catch basin improvement.
- The future stormwater system was designed to accommodate the projected growth and development of the Town, as well as the regional stormwater plan agreement with the CSMI. The future system concept includes new SWMFs, new pipes and outfalls, and recommendations for low impact development practices. The future system was sized under the same design events as the existing system and was found to meet the performance criteria and regulatory requirements.
- The climate change resiliency of the stormwater system was evaluated by using the IDF_CC Tool to generate the worst-case climate change scenario for the year 2100. The results showed that the existing and future stormwater system would experience increased runoff and flooding under the climate change scenario, as expected. The study recommended that the Town consider the climate change impacts and resiliency to system design.
- The wetland conservation and protection of the Town was addressed by identifying the natural wetlands within the study area and recommending setbacks and retention measures for them. The study also suggested that the Town adopt a wetland policy and a wetland inventory to ensure the long-term preservation and enhancement of the wetland functions and values.
- The infrastructure maintenance strategy of the Town was developed by performing a desktop condition assessment of the stormwater pipes based on their age and material. The study also proposed a methodology for conducting sewer inspections, condition assessment, rehabilitation recommendations, and staging implementation plan. The study advised that the Town prioritize the sewer repairs and replacements based on the condition ratings and the available budget.

Table of Contents

1.0 Introduction 1
1.1 Authorization 1
1.2 Background 1
1.3 Purpose of Study 1

2.0 Study Area 2
2.1 Location 2
2.2 Land Use 2
2.3 Growth Horizons 3
2.4 Top Five Historic Precipitation Events 4

3.0 Existing Stormwater System 11
3.1 Stormwater Conveyance System 11
3.2 Existing Drainage Patterns 12
3.3 Stormwater Management Facilities 12
3.4 Wetland Conservation and Protection 13

4.0 Hydraulic Model Development 14
4.1 Model Set-Up 14
4.2 Subcatchment Delineation 19

5.0 Design Criteria 20
5.1 Pre-Development Runoff Rate Analysis 20
5.2 Design Rainfall Event 20
5.3 Assessment Criteria 21
5.4 Design Guidelines for Future Stormwater Management Facilities 23

6.0 Existing System Assessment and Upgrades 24
6.1 1:5 Year Event Result Summary 24
6.2 1:100 Year Event Result Summary 25
6.3 Recommendations for Observed Areas of Exceedance 25
6.4 Condition Assessment 28
6.5 Infrastructure Maintenance Strategy 29
6.6 Climate Change Resiliency 31
6.7 Cost Estimates 33

7.0 Future System Assessment and Upgrades 34
7.1 Future Drainage Patterns 34
7.2 Future System Concept 35
7.3 Low Impact Developments 40
7.4 Erosion and Sediment Control 44
7.5 Cost Estimates 45
7.6 Phasing Plan 47

8.0 Conclusion and Recommendations 48

9.0 References 49

APPENDICES

Appendix A 1:25 Year and 1:50 Year Return Period Simulations

Appendix B Longitudinal Profiles

Appendix C Detailed Cost Estimates

TABLES

Table 2.1: Existing Land Use District Classifications....3

Table 2.2: Top Five Rainfall Events in the Last Fifteen Years....4

Table 2.3: Top 5 Rainfall Event Breakdown - #1....5

Table 2.4: Top 5 Rainfall Event Breakdown - #2....5

Table 2.5: Top 5 Rainfall Event Breakdown - #3....5

Table 2.6: Top 5 Rainfall Event Breakdown - #4....6

Table 2.7: Top 5 Rainfall Event Breakdown - #5....6

Table 3.1: Stormwater Sewer Size Statistics....12

Table 3.2: Primary Stormwater Management Facilities....13

Table 4.1: Mesh Zone Parameters per Land Use Type....18

Table 4.2: Roughness Zone Parameters per Land Use Type....18

Table 4.3: Infiltration Zone Parameters per Land Use Type....19

Table 5.1: City of Calgary's Adjusted MSC IDF Curve – Intensity Summary (mm/hr)....20

Table 5.2: City of Calgary's Adjusted MSC IDF Parameters....20

Table 6.1: Summary of Areas of Exceedance....following page 25

Table 6.2: Summary of Proposed Upgrades....26

Table 6.3: Proposed Culvert Upgrades and Recommendations....27

Table 6.4: Installation Year and Material Scores....28

Table 6.5: Final Score Rating Scale....28

Table 6.6: Pipe Condition Rating Summary....28

Table 6.7: Pipe Condition Definitions....29

Table 6.8: Rainfall Depth Increases Due to Climate Change....32

Table 6.9: Existing Upgrades Cost Estimate Summary....33

Table 7.1: Summary of Future Development Drainage Patterns....35

Table 7.2: Minimum Design Slopes for Sewers....35

Table 7.3: Proposed Pond Design Parameters....36

Table 7.4: Orifice Sizing .... following page 38
Table 7.5: Pipe Sizing .... following page 38
Table 7.6: Pond Sizing .... following page 38
Table 7.7: Source Control Practice Table 42
Table 7.8: Applicability Matrix 43
Table 7.9: Expected Performance 44
Table 7.10: Pond Concept Cost Estimates Summary 46
Table 7.11: Proposed Gravity Main Cost Estimates Summary 46

EXHIBITS — On Page

Exhibit 2.1: Highest Rainfall Intensity Radar Imagery for Rainfall Event #1 7
Exhibit 2.2: Highest Rainfall Intensity Radar Imagery for Rainfall Event #3 7
Exhibit 2.3: Highest Rainfall Intensity Radar Imagery for Rainfall Event #4 8
Exhibit 2.4: Highest Rainfall Intensity Radar Imagery for Rainfall Event #5 8
Exhibit 2.5: Hourly Precipitation Breakdown for Rainfall Event #1 9
Exhibit 2.6: Hourly Precipitation Breakdown for Rainfall Event #3 9
Exhibit 2.7: Hourly Precipitation Breakdown for Rainfall Event #4 10
Exhibit 2.8: Hourly Precipitation Breakdown for Rainfall Event #5 10
Exhibit 4.1: Catch Basin Inlet Capacities 16
Exhibit 5.1: Utilized Design Rainfall Event Hydrographs 21
Exhibit 5.2: Permissible Depths for Submerged Objects 23
Exhibit 6.2: Calgary Chicago Distribution Climate Change Design Storms 32
Exhibit 7.1: Proposed Concept Discharge Locations (MPE, 2020) 37

FIGURES — Following Page

Figure 2.1: Study Area 2
Figure 2.2: Topography 2
Figure 2.3: Watershed Boundaries 2
Figure 2.4: Existing Land Use 2
Figure 2.5: Future Land Use 2
Figure 2.6: Population Horizons 3
Figure 3.1: Stormwater System Overview 11

Figure 3.2: Pipe Diameter 11
Figure 3.3: Pipe Material 11
Figure 3.4: Installation Year 11
Figure 3.5: Wetlands 13
Figure 4.1: Survey Locations Overview 14
Figure 4.2: Survey Locations Overview, Additional Survey Location 14
Figure 4.3: Existing 1D Subcatchments 19
Figure 6.1: 5 Year Pipe Results Q-Qman and Max HGL 24
Figure 6.2: 5 Year Pipe Results Spare Capacity 24
Figure 6.3: 5 Year Pipe Results Q-Qman and Max HGL Areas of Exceedance 24
Figure 6.4: 5 Year Pipe Results Spare Capacity Areas of Exceedance 24
Figure 6.5: 100 Year Pipe Results Q-Qman and Max HGL 25
Figure 6.6: 100 Year Pipe Results Spare Capacity 25
Figure 6.7: 100 Year Max Depth Areas of Concern 25
Figure 6.8: 100 Year Max Velocity Areas of Concern 25
Figure 6.9: Proposed Upgrades 26
Figure 6.10: Proposed Upgrades IDS 26
Figure 6.11: Condition Assessment 28
Figure 6.12: 5 Year Pipe Results Q-Qman and Max HGL Climate Change 32
Figure 6.13: 5 Year Pipe Results Spare Capacity Climate Change 32
Figure 6.14: 100 Year Max Depth Climate Change 32
Figure 6.15: 100 Year Max Velocity Climate Change 32
Figure 7.1: Discharge Boundaries 34
Figure 7.2: Future Subcatchments 36
Figure 7.3: Proposed Ponds 37

1.0 Introduction

1.1 Authorization

The Town of Strathmore (the Town) retained ISL Engineering and Land Services Ltd. (ISL) to complete a Stormwater Master Servicing Study (SWMSS). This SWMSS includes an assessment of the Town's current stormwater conveyance infrastructure capacity and the Town's future stormwater infrastructure needs. A robust hydrodynamic InfoWorks ICM 1D-2D model was constructed to enable the comprehensive assessment of the stormwater system. The project was initiated to ensure sound stormwater planning. The intent is to provide a road map to Town Council for assessing the capability of the infrastructure to accommodate new development in the short-term and long-term.

1.2 Background

The Town is looking to update their SWMSS to incorporate infrastructure updates. The previous SWMSS was completed in 2018 in response to development pressure and to include the newly annexed lands. The study provided an understanding of how the Town's stormwater system operated, and the impact development would have on existing infrastructure. It has also been used as a framework for future planning and provided an overview of the proposed system to meet the Town's projected stormwater objectives. The report outlined the order-of-magnitude cost estimates for various infrastructure upgrade recommendations.

The study was designed to include negotiations of the Cooperative Stormwater Management Initiative (CSMI) between the Western Irrigation District (WID), the City of Calgary, Rocky View County, and the Town of Strathmore. The Town also has WID agreements both internally to the Town and via the Eagle Lake Drainage easement. Since the acceptance of the 2018 SWMSS, the Town and the CSMI have finalized a cooperative regional stormwater plan agreement, which is incorporated within the updated SWMSS.

The SWMSS will help the Town understand the implications of servicing new developments and the servicing approach and constraints. By applying a comprehensive design, consistent approaches to issues, and sound engineering principles, while all the time protecting the natural and human environment, this study will guide effective infrastructure implementation. The study will also examine the capacity of the existing infrastructure system to determine the extent of upgrades required to maintain quality service to residents.

1.3 Purpose of Study

The objectives of developing the SWMSS include:

- Assessing existing drainage conditions and determining design criteria for the stormwater drainage system, including runoff rates and volumes.
- Providing an inventory of and analyzing existing natural drainage conveyance.
- Determining if any upgrades are required to the existing system to properly meet the needs of the Town and to allow future growth to occur.
- Developing stormwater infrastructure plans, including stormwater management facility (SWMF) sizing, to manage increased and redirected runoff from future development. Locations and timing may depend on:
  - Availability of sufficient servicing needs
  - Undeveloped land locations
  - District planning
- Producing a drainage basin specific stormwater management plan that uses best management practices to minimize the effect to the natural hydrological and hydrogeological regimes, and to ensure the planned stormwater management system meets regulatory authority requirements.
- Providing cost estimates for infrastructure upgrades, which will also provide inputs to an off-site levy bylaw.
- Commenting on possible staging options of upgrades for the most effective infrastructure implementation.

2.0 Study Area

2.1 Location

The Town of Strathmore is situated in southern Alberta, approximately 50 km east of the City of Calgary. The Town is bounded by Township Road 244 to the north, George Freeman Trail to the east, Wildflower Road to the west, and Township Road 240 to the south. The Trans-Canada Highway (TCH) transects the town and provides a linkage to the City of Calgary.

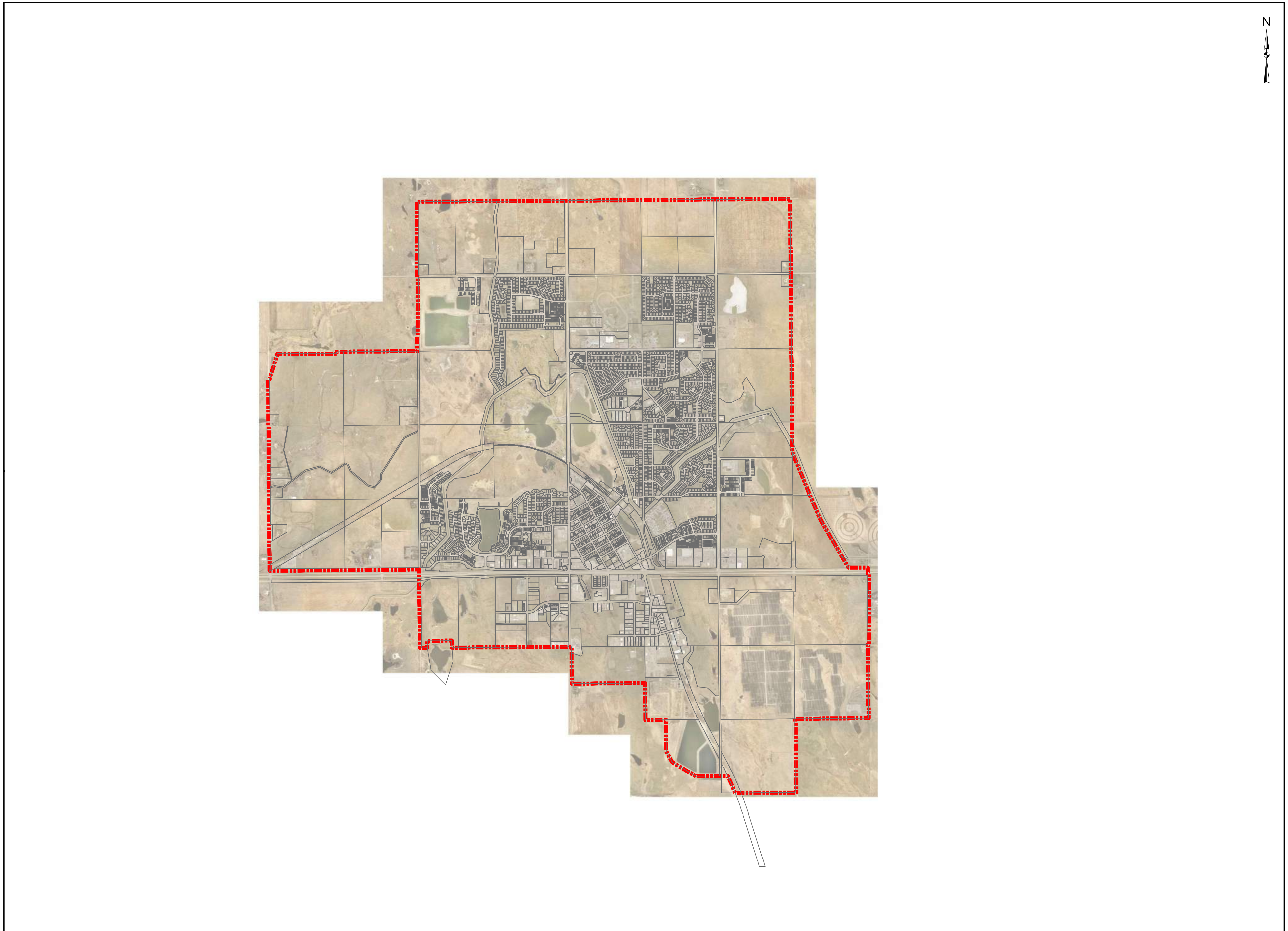
The overall study area includes all stormwater infrastructure including overland drainage components to conduct modelling of the existing system, as well as any annexed land for future growth horizon considerations. The study area encompasses a total area of over 2,800 ha. **Figure 2.1** highlights the study area.

The town covers an elevation band between 942.79 m in the southeast near the Eagle Lake Ditch and 989.83 m in the southwest near the intersection of Wildflower Road and Westridge Road. There is a ridge that bisects the town diagonally from southwest to northeast, causing most of the town to drain to the southeast and a portion to drain to the northwest. A topographical map of Strathmore is shown in **Figure 2.2**.

Strathmore is in the South Saskatchewan River watershed, part of the Nelson-Churchill (Hudson Bay) continental drainage basin. Within the South Saskatchewan River watershed, Strathmore is in Regions 05BM and 05CE. 05BM represents a reach of the Bow River and 05CE represents a reach of the Red Deer River. A map of the watershed boundaries is in **Figure 2.3**.

2.2 Land Use

The type of land use in the town influences imperviousness values, surface roughness coefficients, and mesh element areas. Obtaining appropriate classification was therefore vital to ensure that an accurate representation of the Town's conveyance systems could be achieved. The town was divided as primarily residential, commercial, institutional, industrial, or open space areas, as per **Table 2.1.** The solar farm in the southeast portion of the Town was classified as its own land use type with its own parameters. Existing land use types are shown in **Figure 2.4,** with future land use designations shown in **Figure 2.5.**



Legend

Cadastral

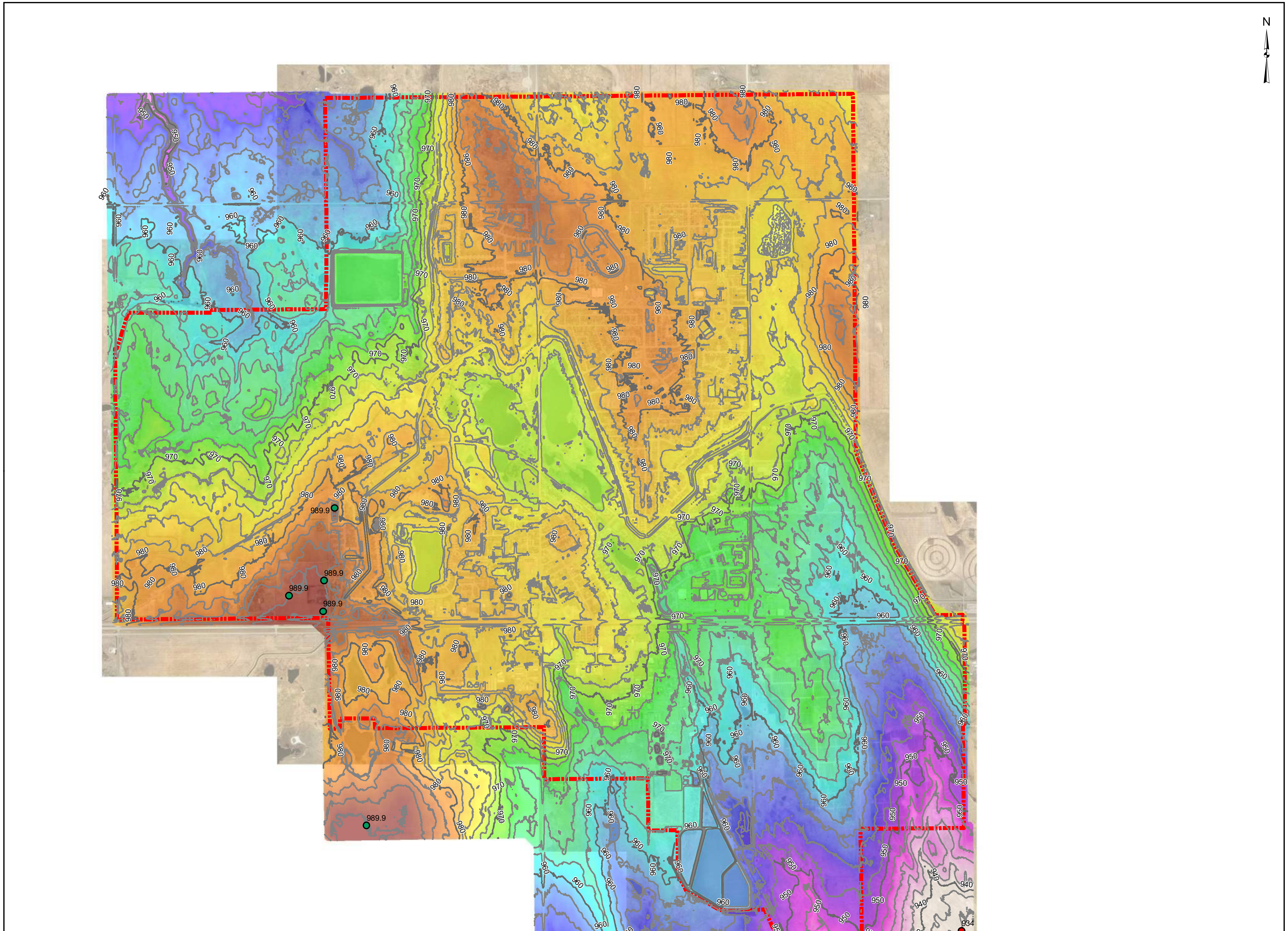
Town Boundary

1:40,000 WGS 1984 Web Mercator Auxiliary Sphere

FIGURE 2.1
STUDY AREA
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore



Legend

Major Contour - 10m Interval

Minor Contour - 2m Interval

Cadastral

Town Boundary

Elevation (m)

High : 989.9

Low : 934.31

Highest Elevation

Lowest Elevation

0 175 350 700 1,050 1,400 Meters

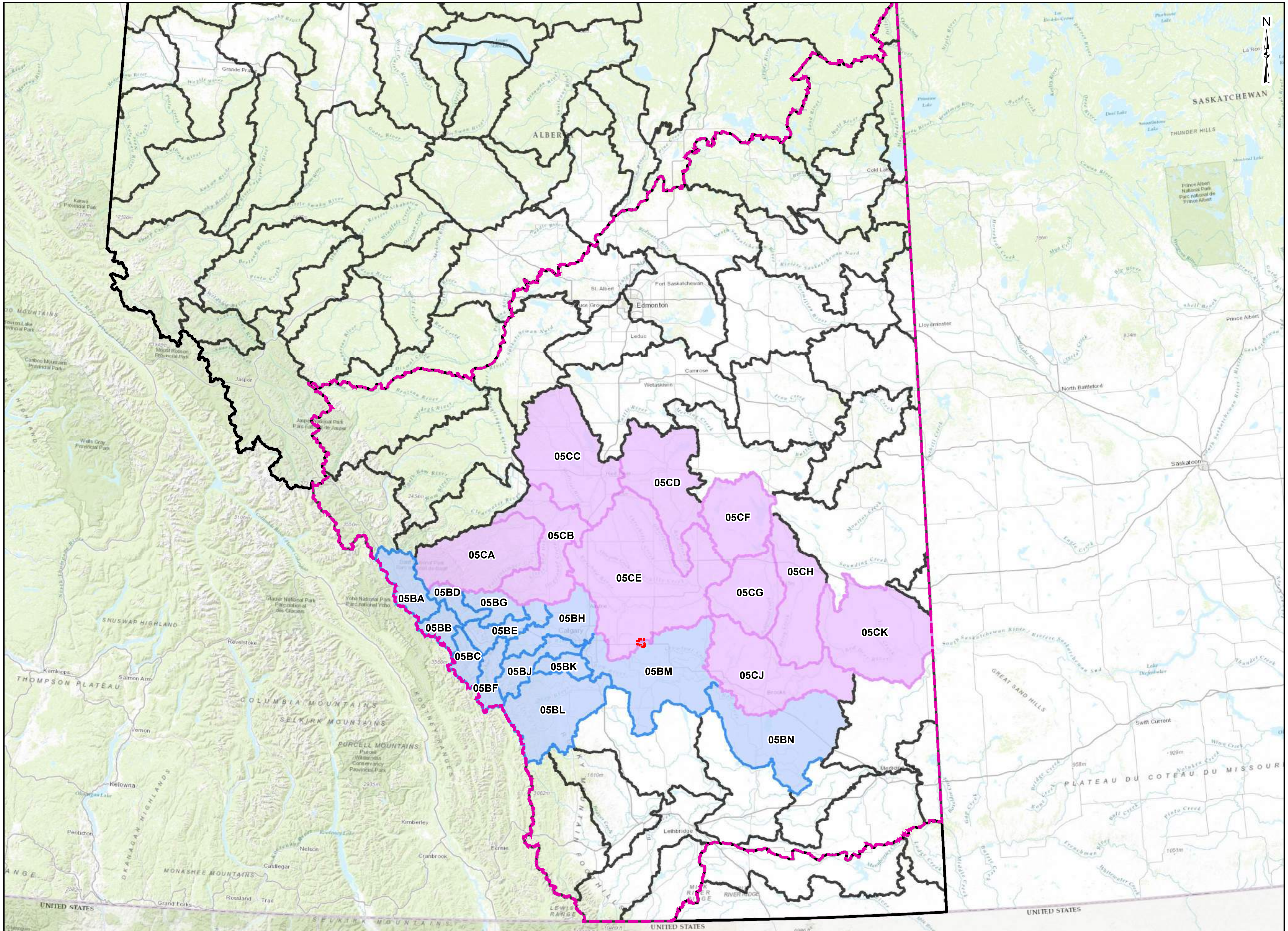
1:28,296 CANA83 3TM114

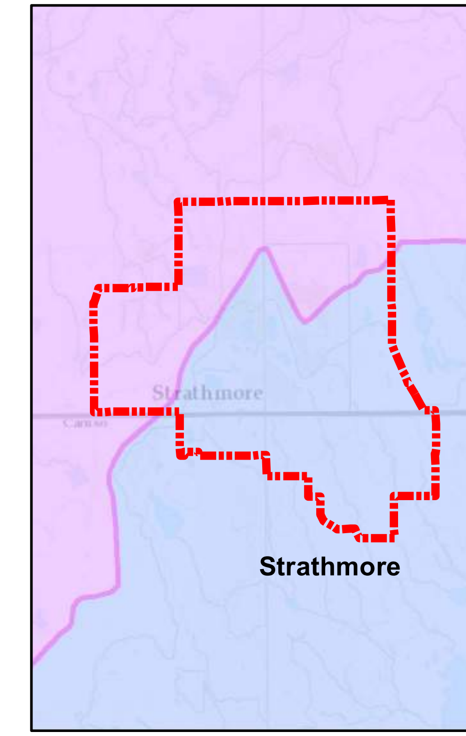
FIGURE 2.2
TOPOGRAPHY
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Integrated Expertise. Locally Delivered.





Legend

- Cadastral
- Town Boundary

Continental Drainage Basins

- Nelson-Churchill (Hudson Bay)
- Mackenzie (Arctic Ocean)
- Mississippi (Gulf of Mexico)

Watersheds

- Bow River
- Red Deer River
- Remaining Watershed Regions

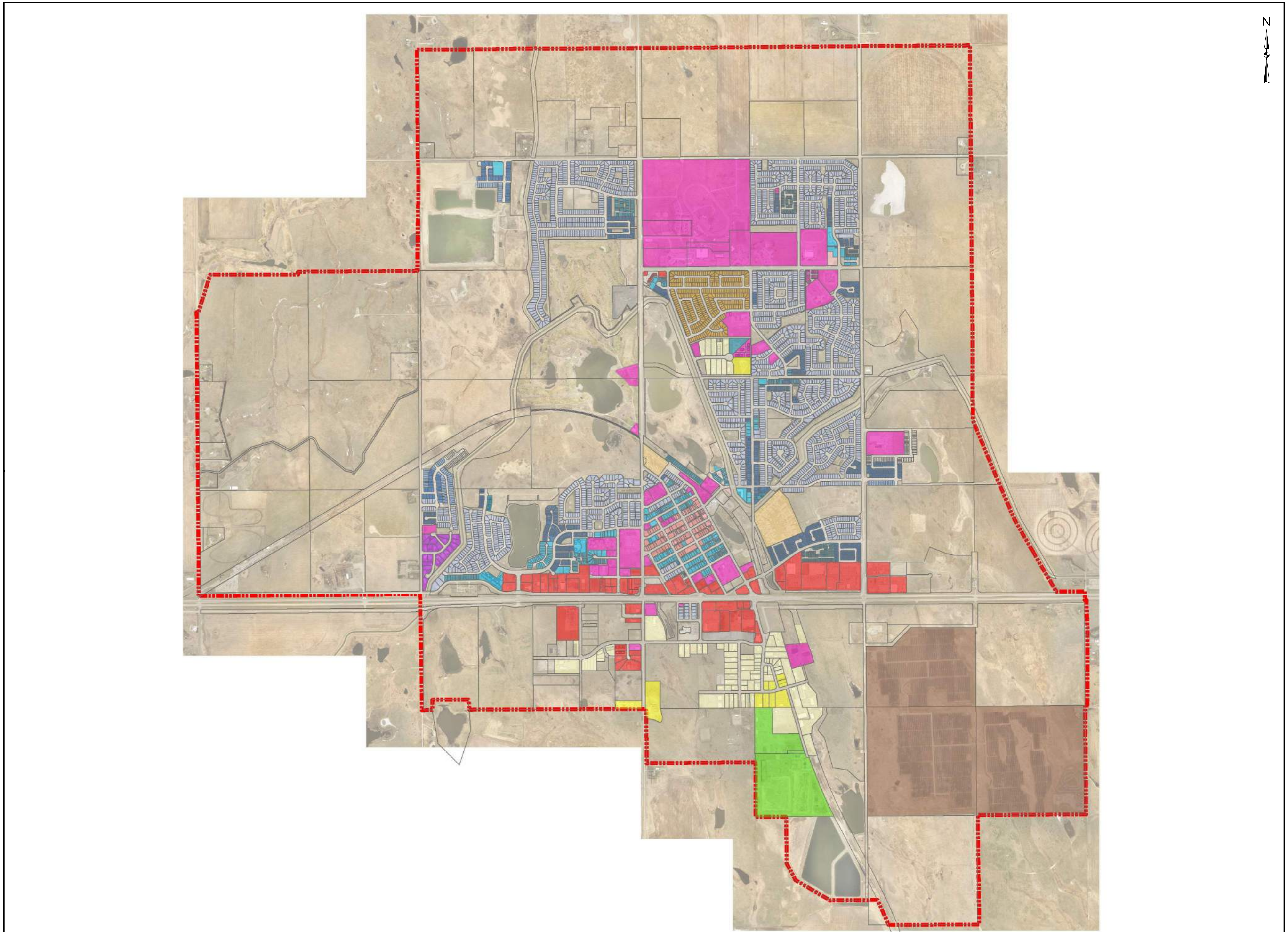
0 38,750 77,500 155,000 Meters

1:3,000,000 CANA83 3TM114

FIGURE 2.3
WATERSHEDS
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore



Legend

Cadastral

Town Boundary

Land Use District

- AG - Agriculture General
- C1 - Neighbourhood Commercial
- CB - Central Business
- CHWY - Highway Commercial
- CR1 - Country Residential
- M1 - Light Industrial
- M2 - General Industrial
- MHP - Manufactured Home Park
- MHS - Manufactured Home Subdivision
- P1 - Public Service
- R1 - Single Detached Residential
- R1N - Single Detached Residential (Narrow Lot)
- R1S - Single Detached Residential (Small Lot)
- R2 - Low Density Residential
- R2X - Medium Density Attached Housing
- R3 - High Density Residential
- R3M - Medium Density Modest Residential
- UR - Urban Reserve
- Solar Farm

Developed parcels only.

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 2.4
EXISTING LAND USE DISTRICTS
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Integrated Expertise. Locally Delivered.

Date: 5/23/2024 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure 2.4_Existing Land Use.mxd

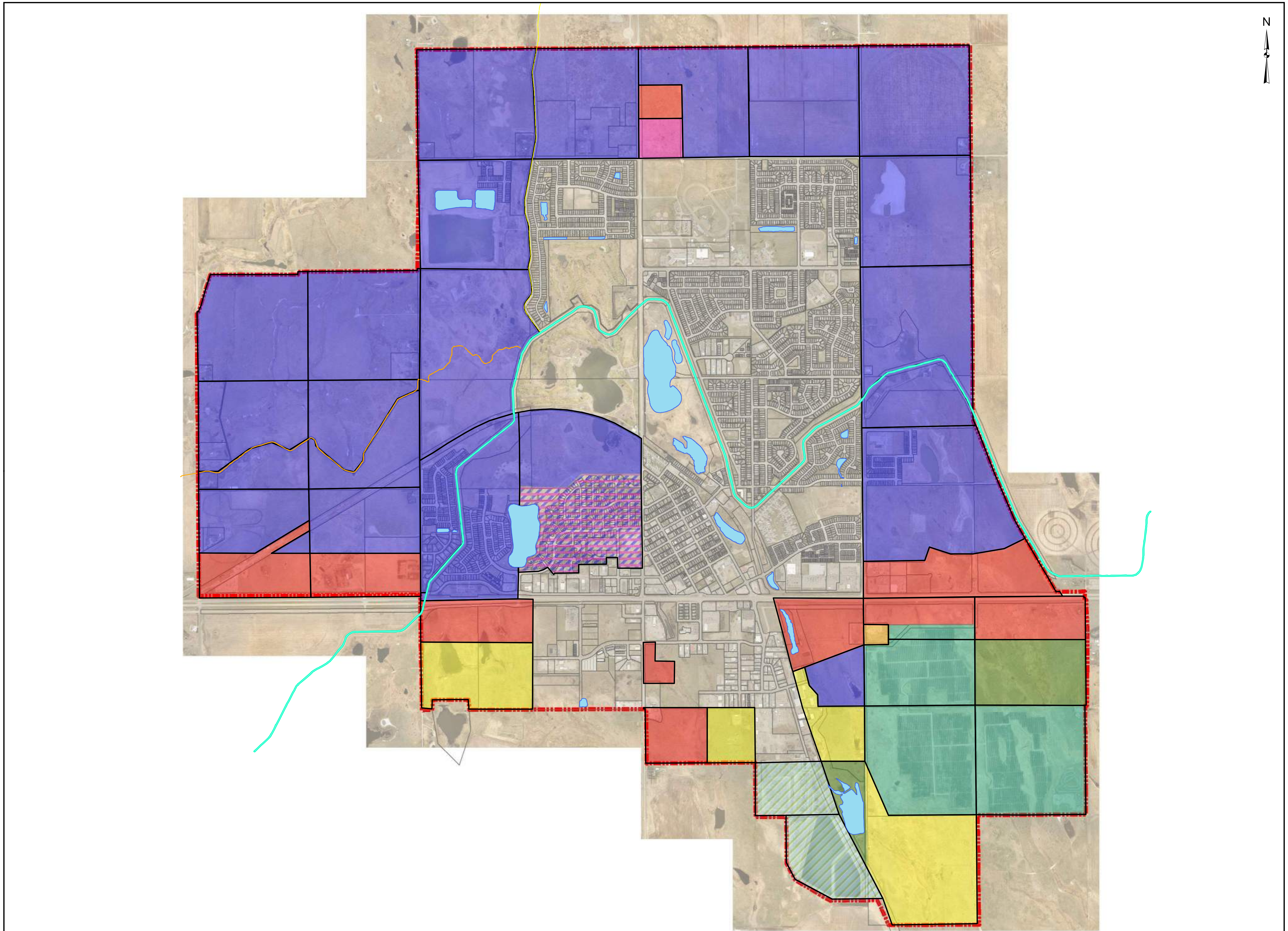


FIGURE 2.5
FUTURE LAND USE
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

Table 2.1: Existing Land Use District Classifications

Classification	Existing Land Use District
Commercial	Neighbourhood Commercial
	Central Business
	Highway Commercial
Industrial	Light Industrial
	General Industrial
Institutional	Public Service
Open Space	Agriculture General
	Urban Reserve
Residential	Country Residential
	Manufactured Home Park
	Manufactured Home Subdivision
	Single Detached Residential (Narrow Lot)
	Single Detached Residential (Small Lot)
	Low Density Residential
	Medium Density Attached Housing
	High Density Residential
	Medium Density Modest Residential
Solar Farm	Solar Farm

2.3 Growth Horizons

Strathmore's stormwater system was assessed under three scenarios, with growth horizons shown in **Figure 2.6:**

- Existing conditions (population of 14,339 based on the most recent census data) noting that this represents the serviced population
- Interim growth of pertinent area structure plans (ASPs)
- Full build-out of the Town (population of 71,379)

Interim growth includes the build-out of the following ASPs, which are also shown in **Figure 2.6**:

- Wildflower Ranch
- Lakewood Meadows
- The Ranch
- Legacy Farms
- Canal Gardens
- Canal Crossing
- Edgefield (Residential and Commercial)

The interim growth horizon presented in this document consists of the growth to the five ASP areas noted above, as well as densification throughout the existing system.

All other ASP areas and undeveloped areas without ASPs were included as part of the full build-out of the Town. Land use classification was assigned depending on the land use stipulated in the 2014 Municipal Development Plan (MDP).

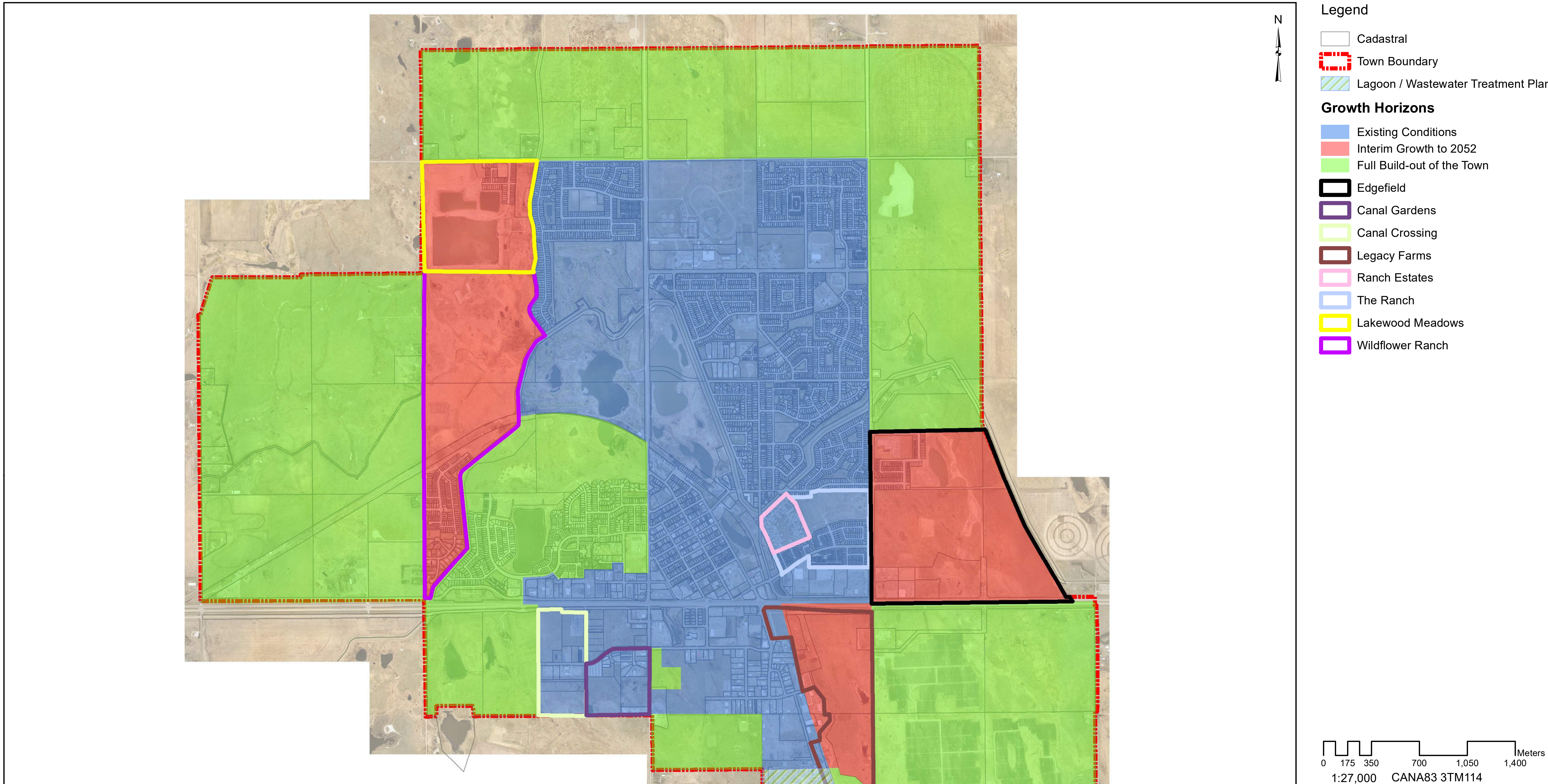


FIGURE 2.6
POPULATION HORIZONS
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Date: 8/14/2024 Document: Z:\Shared\GIS\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure 2.6_Population Horizons.mxd

Integrated Expertise. Locally Delivered.

2.4 Top Five Historic Precipitation Events

2.4.1 Data Collection

The methodology for identifying and analyzing the top five precipitation events from the last fifteen years for Strathmore entailed a multi-step approach encompassing data collection, analysis, and visualization. Initially, historical total precipitation data for Strathmore was gathered online from Canada Weather Stats, with historical weather data obtained from Environment and Climate Change Canada. This dataset, spanning the past fifteen years, provided comprehensive records of precipitation levels, enabling the identification of the top five precipitation events based on total rainfall accumulation.

Subsequently, hourly breakdowns of each identified precipitation event were obtained from the Strathmore Automated Data Gathering and Monitoring (ADGM) station results, accessed through Environment and Climate Change Canada. These hourly measurements offered detailed insights into precipitation patterns and intensity over time during each event, facilitating a thorough analysis.

Radar imagery corresponding to the highest intensity period of each precipitation event was then retrieved from the Canadian Historical Weather Radar database, also provided by Environment and Climate Change Canada. This radar data allowed for the visualization and analysis of the spatial distribution and intensity of precipitation during the peak period of each event, offering valuable insights into its characteristics.

Graphical representations of each precipitation event were created using the hourly data and radar imagery. Hourly precipitation data was plotted over time to visualize the temporal distribution of rainfall intensity, while radar imagery aided in determining the range of rainfall intensity during the peak period of each event. Through the integration of these datasets, a comprehensive understanding of the intensity, duration, and spatial extent of each precipitation event was achieved.

By adhering to this methodology, the top five precipitation events from the last fifteen years were effectively identified and analyzed, providing valuable insights into the nature and impacts of extreme precipitation events in the Strathmore region. The results of this analysis are summarized below, with each precipitation events' hourly breakdown and range of rainfall intensity, radar imagery of the most intense precipitation period, and hourly breakdown graph presented.

2.4.2 Results

The top five precipitation events from the last fifteen years in Strathmore are summarized in **Table 2.1** below. In **Tables 2.3 to 2.7**, each event is then broken down to the hour of when there was precipitation, along with the range of rainfall intensity identified from the radar imagery in **Section 2.4.3**.

The time for the radar data is in UTC (universal time coordinated) and was converted from LST (local standard time) of Strathmore, or MST (mountain standard time).

Table 2.2: Top Five Rainfall Events in the Last Fifteen Years

Rainfall ID	Date	Total Precipitation
		mm
#1	July 12, 2015	61.1
#2	May 24, 2013	49.9
#3	June 14, 2022	48.4
#4	July 15, 2016	46.5
#5	August 3, 2016	42.2

Table 2.3: Top 5 Rainfall Event Breakdown - #1

Date	Total Precipitation	Hourly Breakdown		Range of Rainfall Intensity
		Time	Precipitation Amount	
	mm	MST	mm	mm/hr
July 12, 2015	61.1	8:00 AM	38.7	12 - 75
		9:00 AM	17.1	
		10:00 AM	3.3	
		11:00 AM	2.0	

Table 2.4: Top 5 Rainfall Event Breakdown - #2

Date	Total Precipitation	Hourly Breakdown	Range of Rainfall Intensity
	mm		mm/hr
May 24, 2013	49.9	No data available	No radar data available

Note: *Event #2 does not have any detailed information from other than the total precipitation fallen that day. Therefore, there is no hourly breakdown, radar imagery, or graph.*

Table 2.5: Top 5 Rainfall Event Breakdown - #3

Date	Total Precipitation	Hourly Breakdown		Range of Rainfall Intensity
		Time	Precipitation Amount	
	mm	MST	mm	mm/hr
June 14, 2022	48.4	0:00 AM	1.0	4 - 24
		1:00 AM	0.4	
		2:00 AM	2.1	
		3:00 AM	5.0	
		4:00 AM	3.1	
		5:00 AM	1.1	
		6:00 AM	2.1	
		7:00 AM	4.6	
		8:00 AM	2.1	
		9:00 AM	4.7	
		10:00 AM	1.1	
		11:00 AM	2.4	
		12:00 PM	0.6	
		1:00 PM	0.0	
		2:00 PM	2.0	
		3:00 PM	0.0	
		4:00 PM	0.0	
		5:00 PM	0.0	
		6:00 PM	0.0	
		7:00 PM	0.9	
		8:00 PM	0.6	
		9:00 PM	5.1	
		10:00 PM	8.5	
		11:00 PM	1.0	

Table 2.6: Top 5 Rainfall Event Breakdown - #4

Date	Total Precipitation	Hourly Breakdown		Range of Rainfall Intensity
		Time	Precipitation Amount	
	mm	MST	mm	mm/hr
July 15, 2016	46.5	1:00 PM	0.9	8 - 50
		2:00 PM	21.4	
		3:00 PM	2.4	
		4:00 PM	0.0	
		5:00 PM	0.0	
		6:00 PM	1.4	
		7:00 PM	4.3	
		8:00 PM	3.7	
		9:00 PM	5.9	
		10:00 PM	6.5	

Table 2.7: Top 5 Rainfall Event Breakdown - #5

Date	Total Precipitation	Hourly Breakdown		Range of Rainfall Intensity
		Time	Precipitation Amount	
	mm	MST	mm	mm/hr
August 3, 2016	42.2	0:00 AM	2.8	4 - 18
		1:00 AM	3.7	
		2:00 AM	2.4	
		3:00 AM	0.0	
		4:00 AM	0.9	
		5:00 AM	2.2	
		6:00 AM	5.5	
		7:00 AM	4.1	
		8:00 AM	2.5	
		9:00 AM	4.2	
		10:00 AM	5.5	
		11:00 AM	3.0	
		12:00 PM	1.2	
		1:00 PM	1.0	
		2:00 PM	1.2	
		3:00 PM	0.4	
		4:00 PM	0.0	
		5:00 PM	1.0	
		6:00 PM	0.6	

2.4.3 Radar Imagery

The radar imagery of the highest intensity period for each event is presented below in **Exhibits 2.1** to **2.4,** with the colour coded intensity on the right-hand side. This was done automatically by the Canadian Historical Weather Radar database.

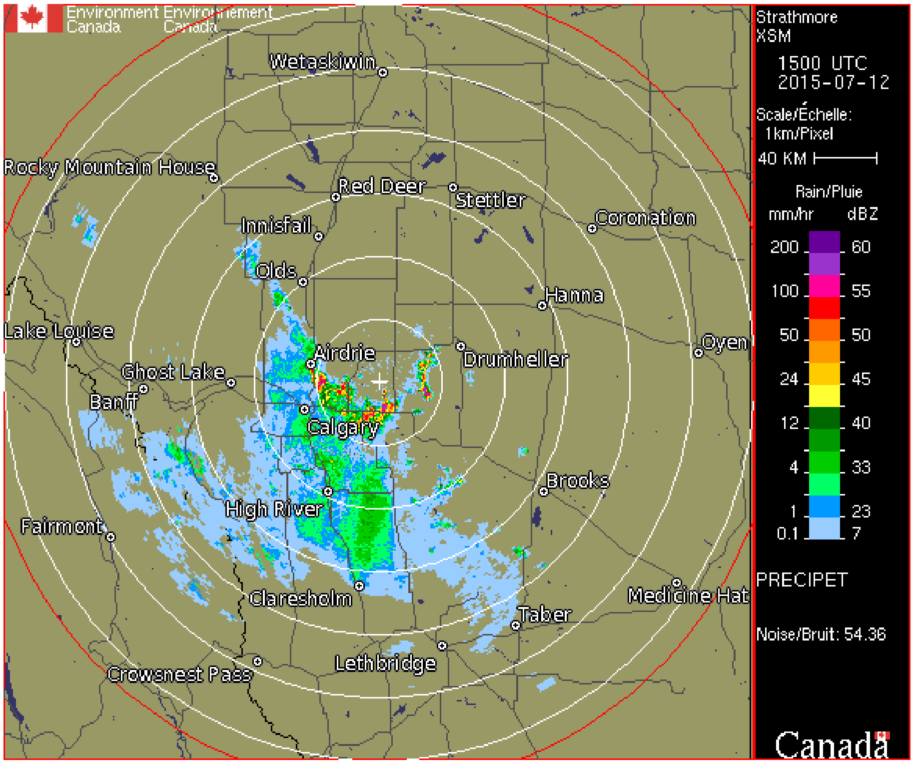


Exhibit 2.1: Highest Rainfall Intensity Radar Imagery for Rainfall Event #1

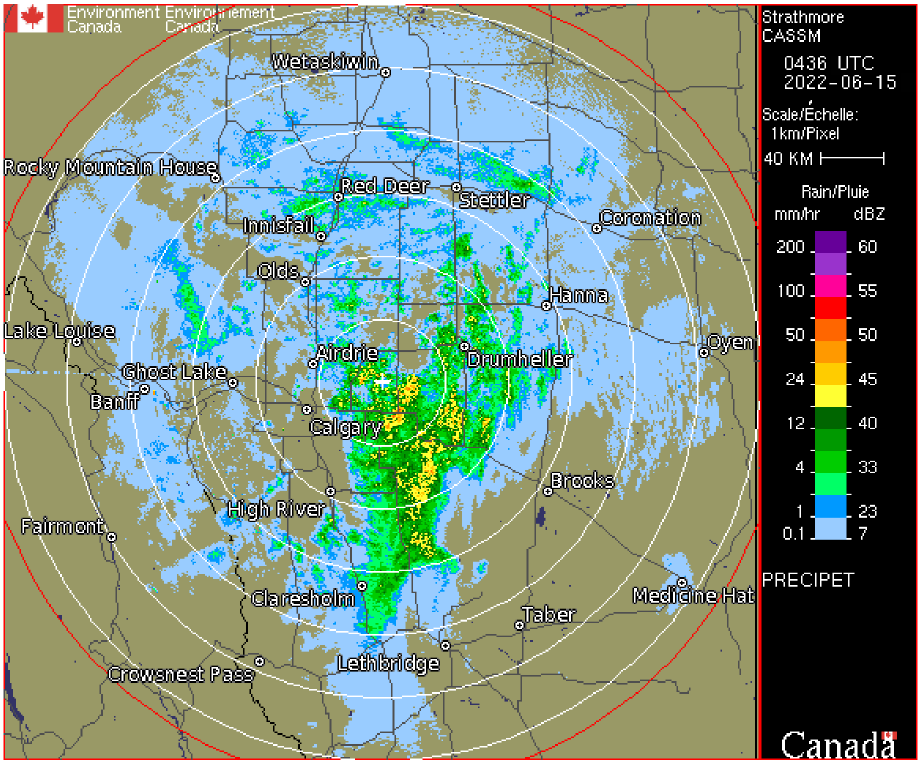


Exhibit 2.2: Highest Rainfall Intensity Radar Imagery for Rainfall Event #3

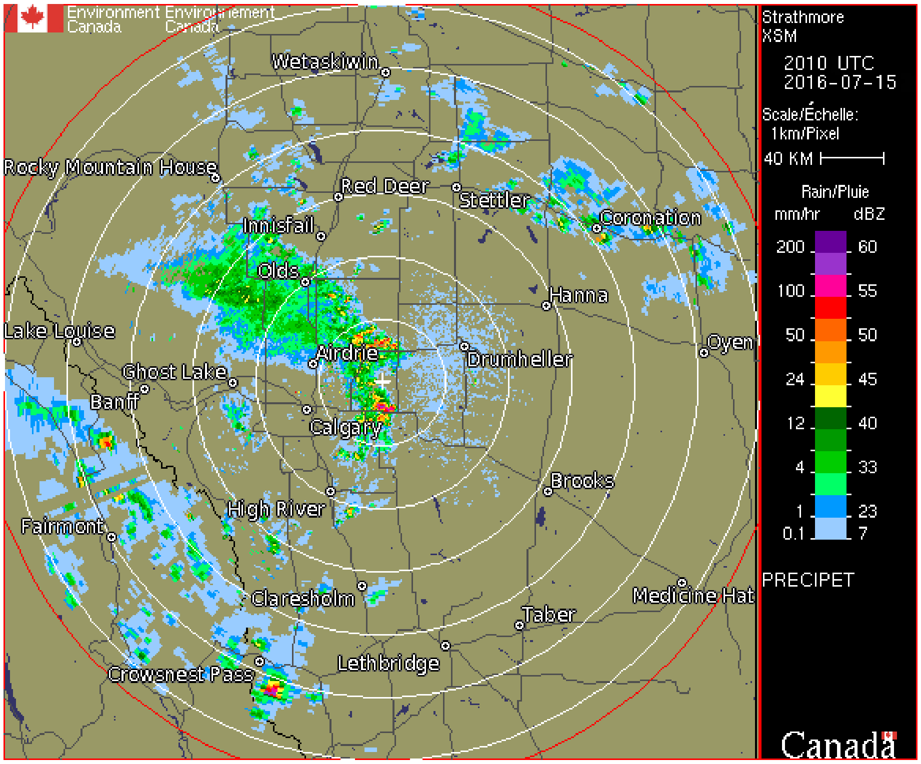


Exhibit 2.3: Highest Rainfall Intensity Radar Imagery for Rainfall Event #4

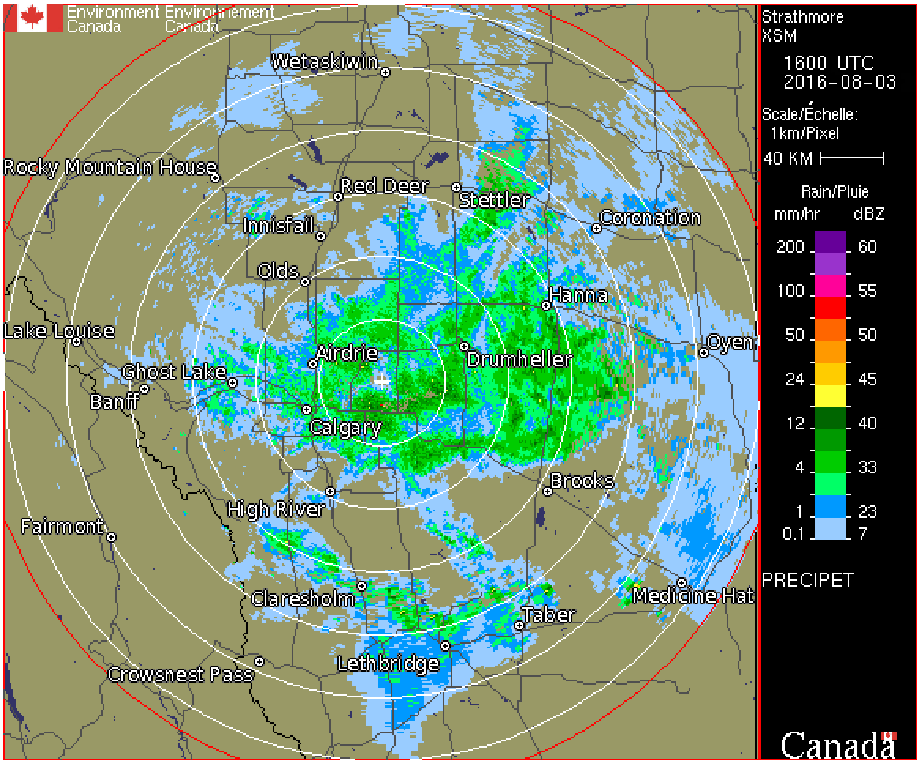


Exhibit 2.4: Highest Rainfall Intensity Radar Imagery for Rainfall Event #5

2.4.4 Hourly Precipitation Breakdown

Exhibits 2.5 to 2.8 below visualize the hourly breakdown of precipitation in each event. These figures show the peak rainfall intensities for the total duration of each event. Events 1 and 4 occurred over much smaller periods of time, while Events 2 and 5 happened over most of the day.

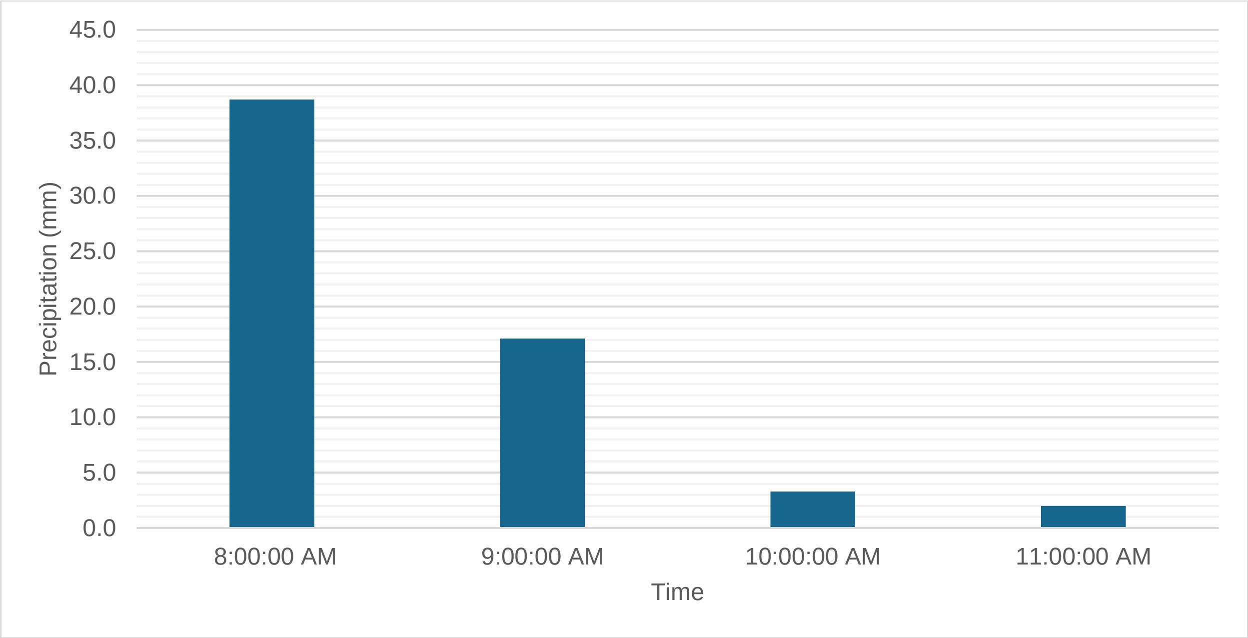


Exhibit 2.5: Hourly Precipitation Breakdown for Rainfall Event #1

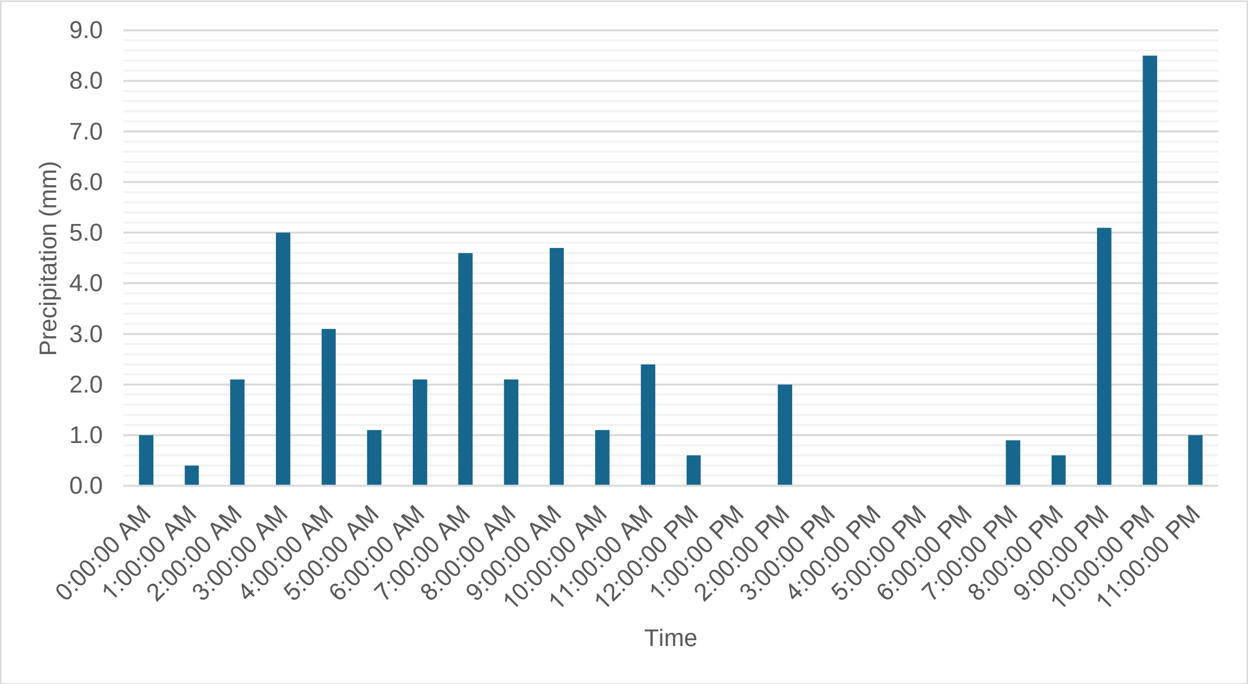


Exhibit 2.6: Hourly Precipitation Breakdown for Rainfall Event #3

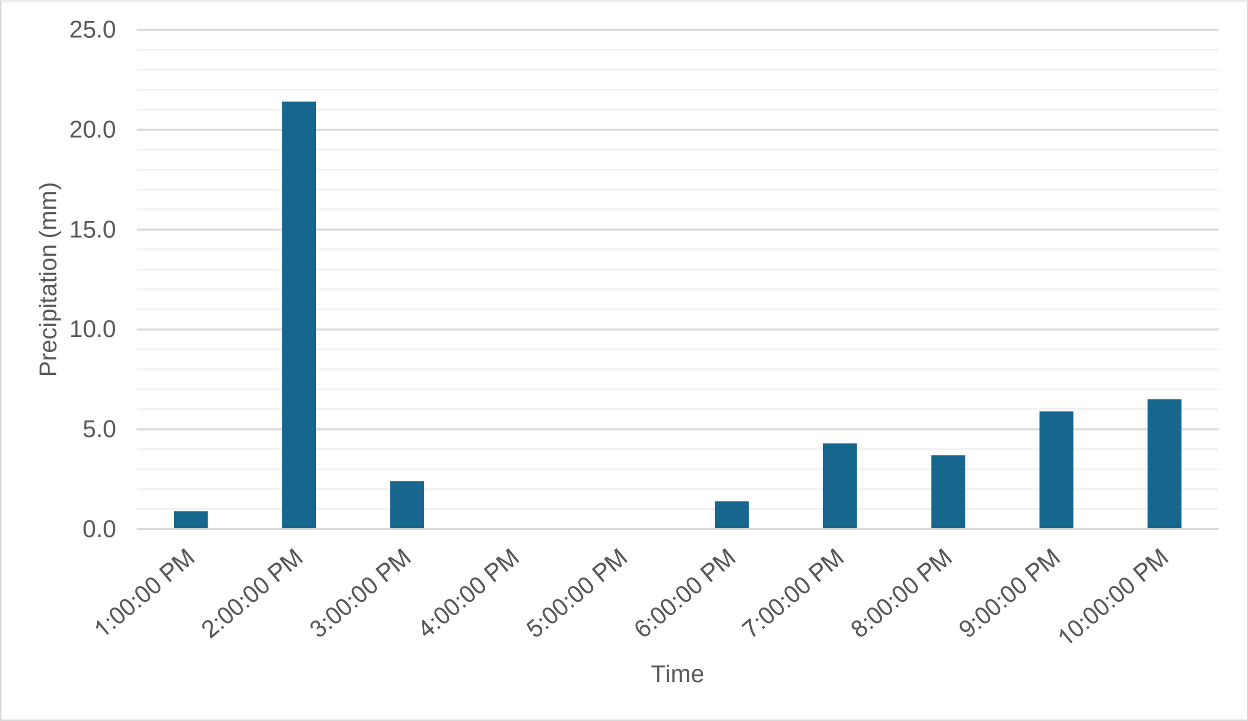


Exhibit 2.7: Hourly Precipitation Breakdown for Rainfall Event #4

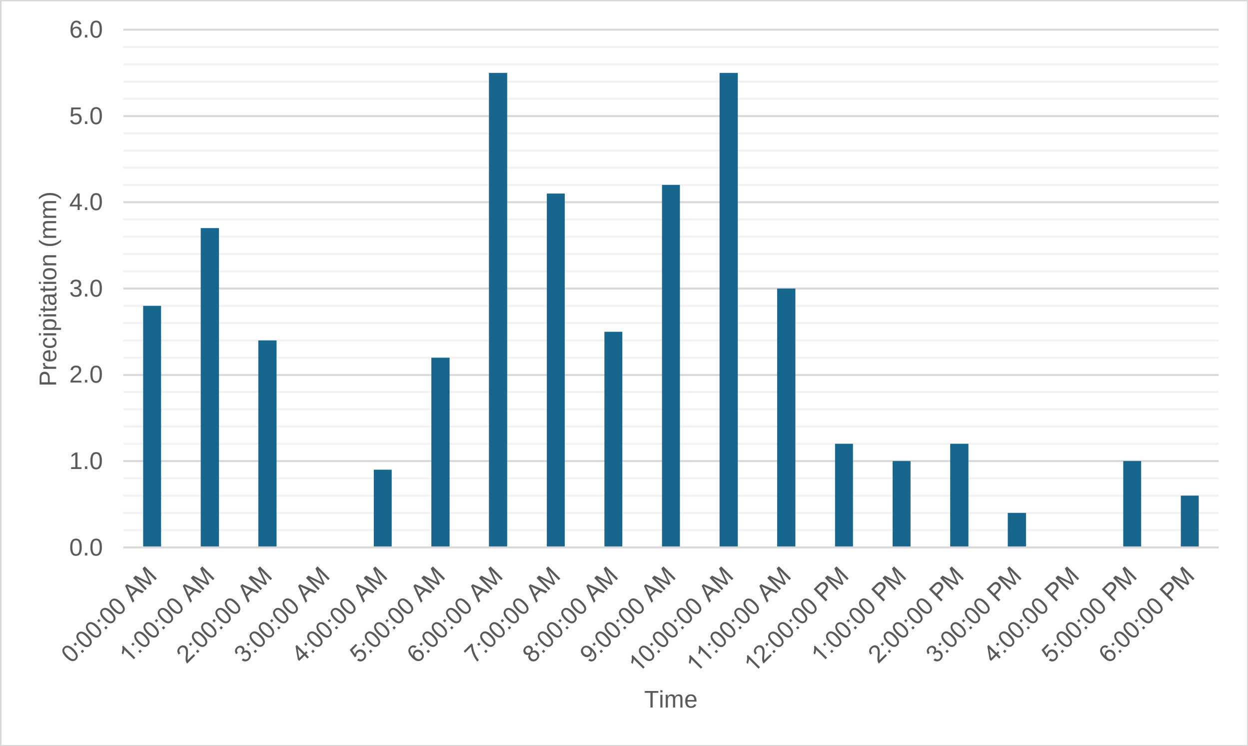


Exhibit 2.8: Hourly Precipitation Breakdown for Rainfall Event #5

3.0 Existing Stormwater System

3.1 Stormwater Conveyance System

Within Strathmore, the stormwater consists of both major and minor drainage systems. The major system consists of any overland drainage and conveys stormwater runoff that is more than the minor system. The minor system includes any underground infrastructure, including the pipe network and any of its associated structures. An overview of the Town's stormwater system is shown in **Figure 3.1.**

The major system consists of the following types of drainage components:

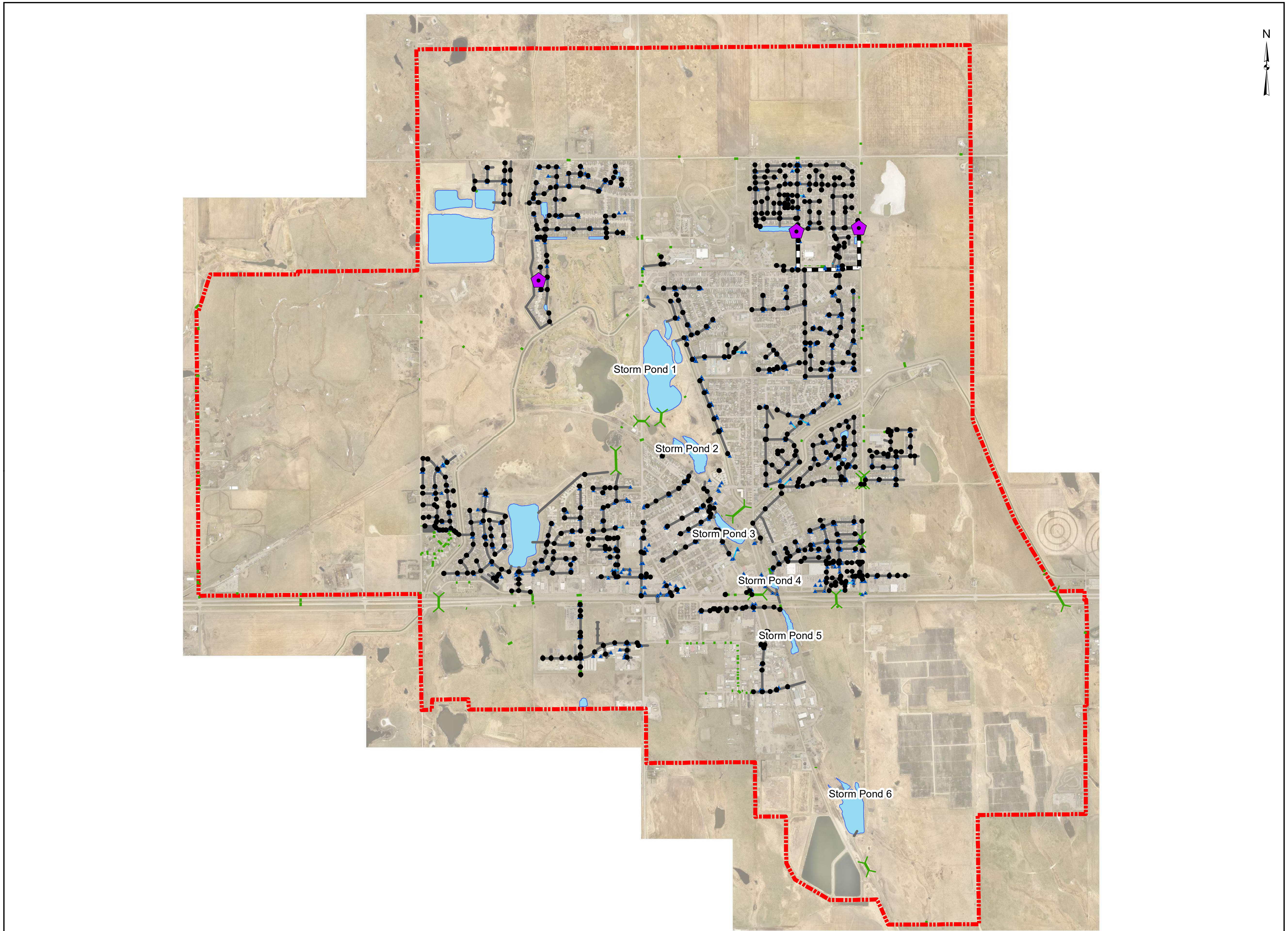
- Surface (overland) drainage
- Roads
- Ditches
- Swales
- Escape routes
- Storage facilities
- Wet/dry ponds
- Traplows

The minor system consists of the following types of drainage infrastructure:

- System operating under gravity conditions
- Catch basins, inlets and leads
- Manholes and junctions
- Outfalls

Drainage components such as culverts and gutters are part of both systems as these features facilitate an exchange of stormwater runoff between the overland (major) and piped (minor) systems. In addition, some drainage in undeveloped or open areas is achieved by uncontrolled overland drainage.

The Town's piped stormwater system detailed with regards to size is illustrated in **Figure 3.2** and summarized below in **Table 3.1**. **Figure 3.3** and **Figure 3.4** illustrate the system with regards to material and installation period respectively.



Legend

- Storm Catch Basins
- Storm Manholes
- Lift Station
- Storm Gravity Main
- Pressure Main
- Culvert
- Catch Basin Lead
- Storm Ponds
- Town Boundary

0 175 350 700 1,050 1,400 Meters

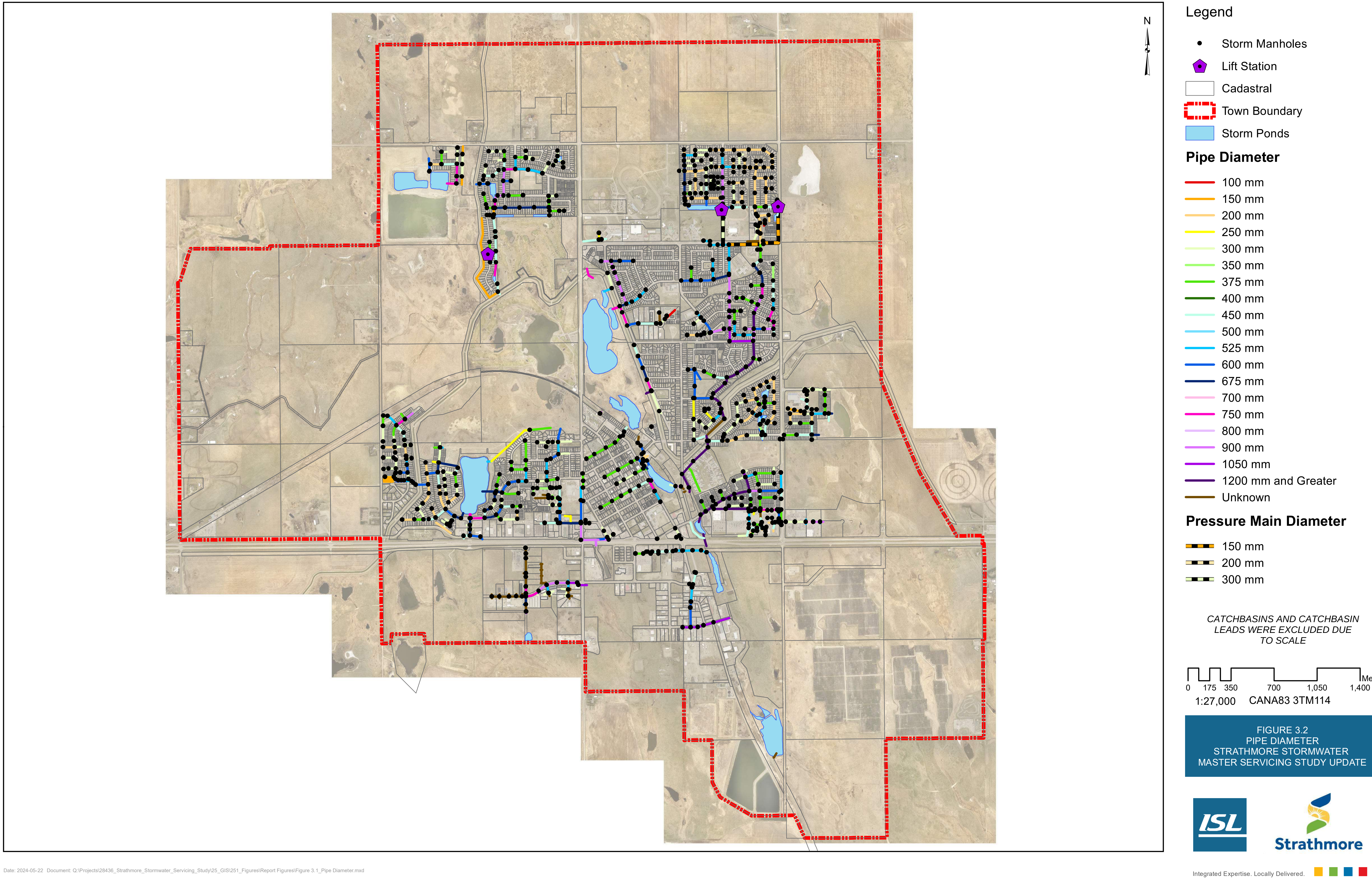
1:27,000 CANA83 3TM114

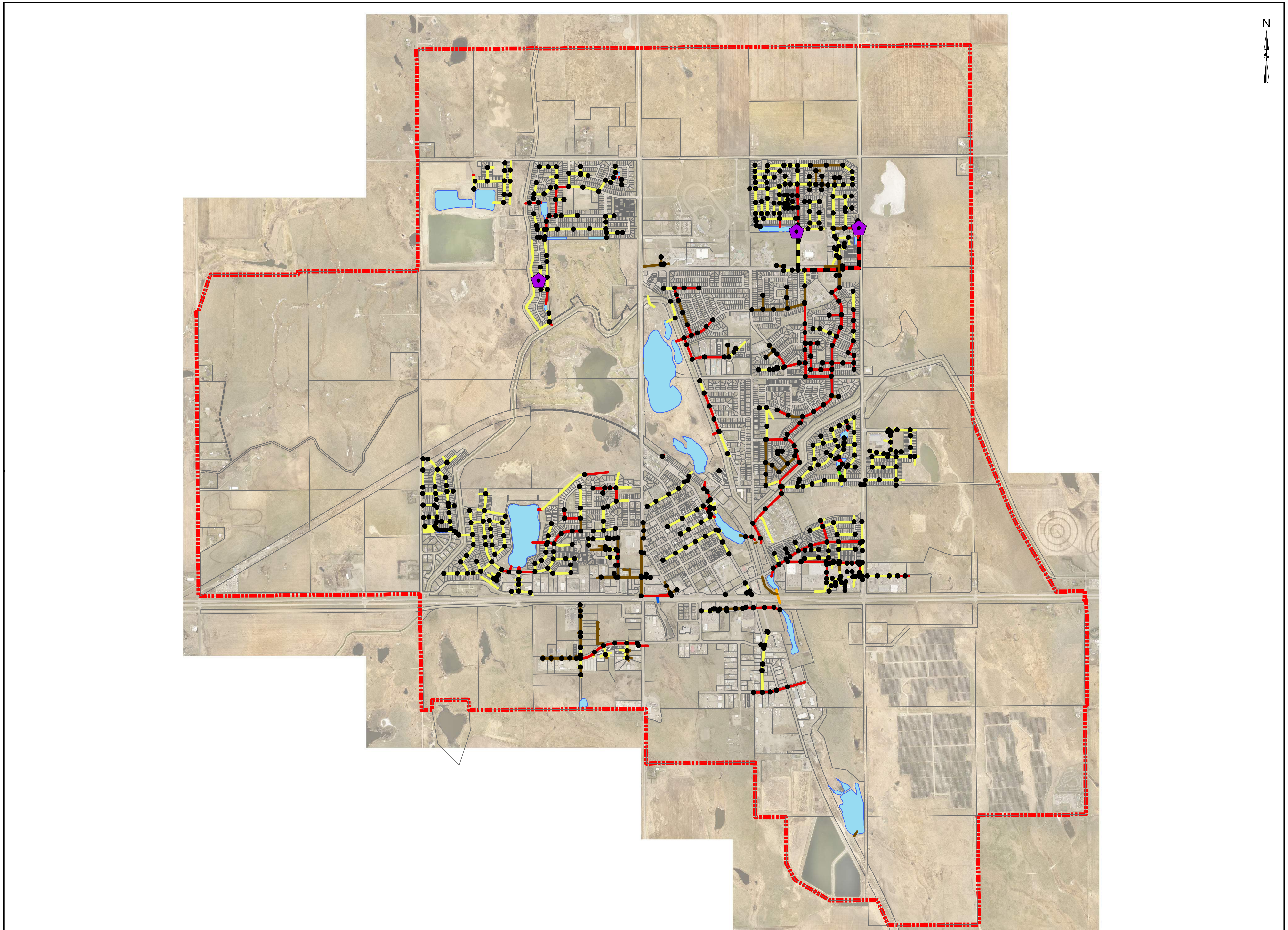
FIGURE 3,1
STORMWATER SYSTEM OVERVIEW
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

Strathmore

Date: 2024-05-22 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure 3.1_Survey Locations Overview_Post Survey.mxd

Integrated Expertise. Locally Delivered.


N
Legend
Storm Manholes
Lift Station
Cadastral
Town Boundary
Storm Ponds
Pipe Diameter
100 mm
150 mm
200 mm
250 mm
300 mm
350 mm
375 mm
400 mm
450 mm
500 mm
525 mm
600 mm
675 mm
700 mm
750 mm
800 mm
900 mm
1050 mm
1200 mm and Greater
Unknown
Pressure Main Diameter
150 mm
200 mm
300 mm
CATCHBASINS AND CATCHBASIN LEADS WERE EXCLUDED DUE TO SCALE
0 175 350 700 1,050 1,400 Meters
1:27,000 CANA83 3TM114
FIGURE 3.2
PIPE DIAMETER
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE
Integrated Expertise. Locally Delivered.



Legend

- Storm Manholes
- Lift Station
- Cadastral
- Town Boundary
- Storm Ponds

Pipe Material

- Corrugated Metal
- Concrete
- Corrugated Steel
- Polyvinyl Chloride
- Spiral Welded Steel
- Unknown

Pressure Main Material

- Concrete
- High Density Polyethylene
- Polyvinyl Chloride
- Unknown

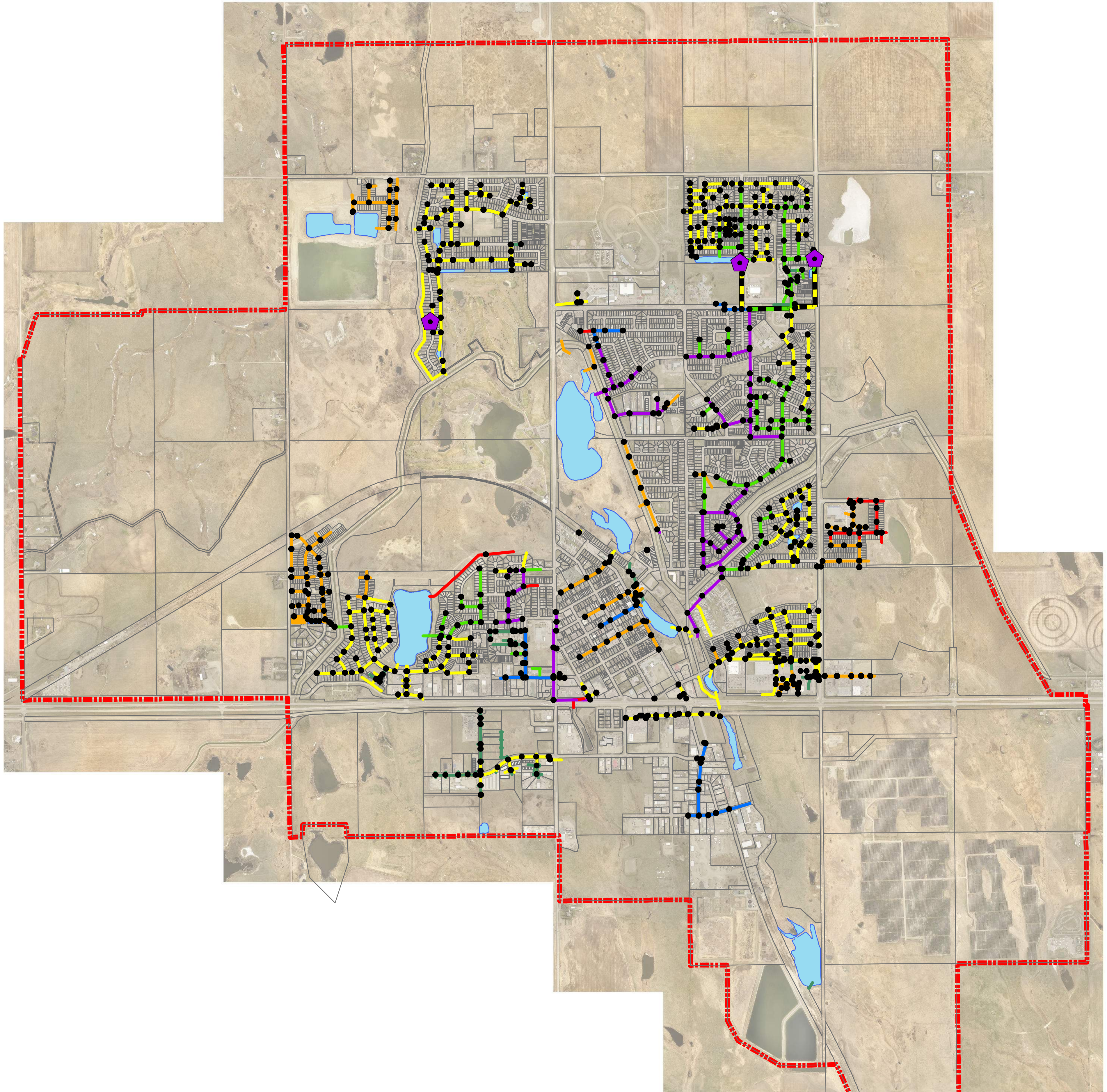
CATCHBASINS AND CATCHBASIN LEADS WERE EXCLUDED DUE TO SCALE

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 3.3
PIPE MATERIAL
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL Strathmore



Legend

- Storm Manholes
- Lift Station
- Cadastral
- Town Boundary
- Storm Ponds

Pipe Decade Installed

- 1970s
- 1980s
- 1990s
- 2000s
- 2010s
- 2020s
- Unknown

Pressure Main Decade Installed

- 1990s
- 2000s

CATCHBASINS AND CATCHBASIN LEADS WERE EXCLUDED DUE TO SCALE

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 3.4
INSTALLATION DECADE
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Integrated Expertise. Locally Delivered.

Table 3.1: Stormwater Sewer Size Statistics

Diameter	Total Length	Percent of Total
mm	m	%
100	180	0.32%
150	1,631	2.89%
200	6,971	12.36%
250	1,070	1.90%
254	101	0.18%
300	9,587	17.00%
350	558	0.99%
375	6,756	11.98%
400	5	0.01%
450	6,442	11.42%
500	71	0.13%
525	4,430	7.86%
.600	4,391	7.79%
675	2,760	4.89%
700	60	0.11%
750	2,172	3.85%
800	44	0.08%
900	3,257	5.78%
1050	1,002	1.78%
1200	1,113	1.97%
1350	887	1.57%
1500	428	0.76%
1650	116	0.21%
1800	60	0.11%
Unknown	2,298	4.08%
Total	**56,392**	**100.00%**

3.2 Existing Drainage Patterns

As previously noted, Strathmore lies in the South Saskatchewan River watershed, which is part of the Nelson-Churchill (Hudson Bay) continental drainage basin. Within the South Saskatchewan River watershed, Strathmore is located in Regions 05BM and 05CE.

A significant portion of the Town's drainage system discharges to the Western Irrigation District (WID) irrigation system. Drainage sources for the WID include Eagle Lake Ditch, WID 'A' Main Canal, and WID 'A' North Canal. Drainage that doesn't end up as irrigation is conveyed further southeast into Eagle Lake, located approximately 2.5 km south of the Town. The Town is bisected diagonally from southwest to northeast by a ridge which causes most stormwater to drain to the southeast and a portion to drain to the northwest.

3.3 Stormwater Management Facilities

Stormwater management facilities in Strathmore consist of both wet ponds and dry ponds. Drainage from most developed areas in Strathmore is primarily conveyed southwest towards Eagle Lake Ditch, ultimately to Eagle Lake, through a series of wet ponds, listed below in **Table 3.2**.

Table 3.2: Primary Stormwater Management Facilities

Pond ID	Construction Type	Location	Catchment Area
			ha
Storm Pond 1	Natural	Gray's Park	111.8
Storm Pond 2	Natural	East of Lakeside Views and West of Thomas Drive	392.1
Storm Pond 3	Manmade	Kinsmen Park	424.5
Storm Pond 4	Manmade	East of Ranch Market Shopping Plaza	677.5
Storm Pond 5	Natural	Southeast of Highway 1/Spruce Park Drive Intersection	697.0
Storm Pond 6	Natural	East of Wastewater Lagoons	960.7

Note: *Catchment areas are taken from the Master Servicing Study – Annexation 2006 Report.*

Pond 6 discharges to the Eagle Lake Ditch via a hydraulic control system consisting of a 250 mm diameter pipe, a 900 mm diameter gate at an invert of 954.31 m, a 0.8 m weir with a crest elevation of 955.375 m, and a 1.40 m overflow weir with a crest elevation of 955.70 m (Allnorth, 2018). It previously had a separate outflow to the Eagle Lake Drainage, however the Town has noted that this hydraulic control structure was decommissioned in 2023 to ensure the pond only discharges to the Eagle Lake Ditch.

3.4 Wetland Conservation and Protection

Generally, ISL recommends retention of reasonably permanent, large, and/or complex wetlands due to the potential landscape hydrologic impact. Typically, these basins have limited anthropogenic disturbance resulting in native plant communities, high potential for rare species, and stable wildlife habitat for waterfowl, shorebirds, amphibians, and invertebrate species. Additionally, these basins typically hold more water than other wetlands and may be significant to catchment hydrology. To infill them during development would not only displace this water, but also likely impact the overland flow dynamics, which could lead to flooding and/or spring melt and stormwater management issues.

It should also be noted that less permanent wetlands also provide important wetland functions such as stormwater retention, sediment and nutrient retention, as well as wildlife habitat. The impact of their disturbance is however anticipated to be less since there is a greater chance that they have been historically disturbed by cultivation. ISL recommends that during development, conservation of these wetlands be considered. **Figure 3.5** shows the location of Strathmore's natural wetlands.

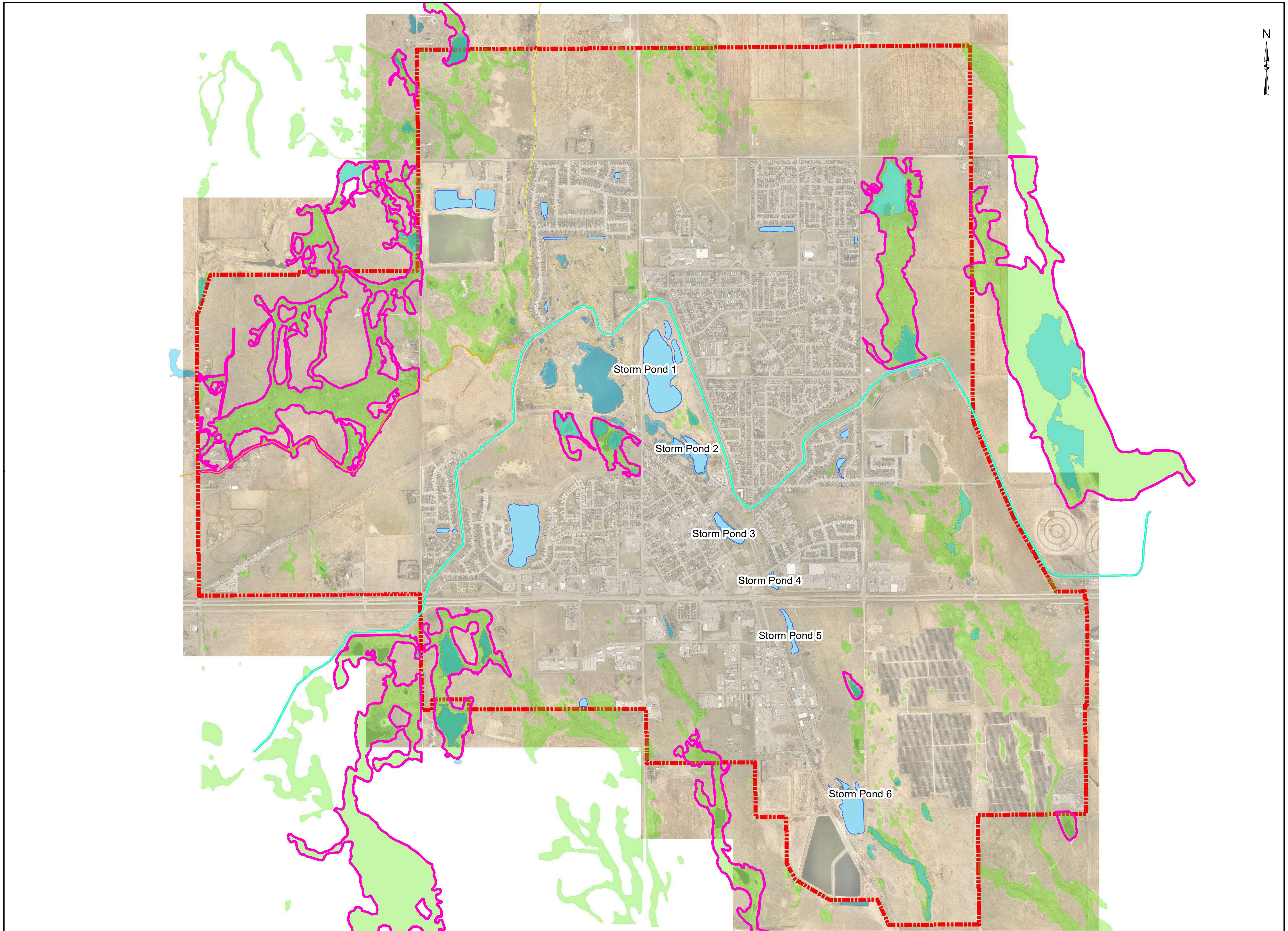
3.4.1 Setbacks

Wetland setbacks are important to consider for development planning. Setbacks provide a buffer of vegetation and help to filter water and other inputs, provide habitat for wildlife, and help protect the wetland from disturbance.

The Alberta government recommends 20 m for glacial till or 50 m for coarse textured sands and gravels adjacent to Class III (Stewart and Kantrud, 1971) and above wetlands as well as lakes, rivers, streams, seeps, and springs (AESRD, 2012b). Class II wetlands (Stewart and Kantrud, 1971) have a recommended 10 m setback (AESRD, 2013).

3.4.2 Recommended Areas to Retain

ISL primarily recommends retention of crown-claimed wetlands. Additionally, ISL recommends that other intact wetlands and their connections, be retained into the future and have a 50 m setback applied. A 20 m setback is recommended for other intact waterbodies that have low disturbance and/or high potential for habitat.



Legend

- W.I.D. Infrastructure
- W.I.D. Main Canal
- W.I.D. North Canal
- Potentially Crown Claimable Wetland
- Storm Ponds
- Other Water Bodies
- Other Natural Wetlands
- Town Boundary

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 3.5
WETLANDS
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Date: 5/24/2024 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure 3.5_Wetlands_v2.mxd

Integrated Expertise. Locally Delivered.

4.0 Hydraulic Model Development

4.1 Model Set-Up

The model used for assessing the Town's stormwater system was InfoWorks ICM developed by Innovyze, which was selected for its advanced capabilities associated with 2-dimensional (2D) modelling. Some of the advantages of InfoWorks ICM that were an asset are summarized below:

- Effective in urban applications, InfoWorks ICM is the preferred modelling software used by numerous municipalities across the country.
- Ease with applying differential cell sizing.
- "Rain on Mesh" option is available, meaning that overland flow path assumptions are not necessarily required upfront.
- Triangular mesh elements mean that the surface can be modelled with extreme accuracy.
- Ability for terrain sensitive meshing, ensuring that changes in topography are reflected in the mesh.
- Mesh generation effectively accounts for building footprints.
- Model is very stable, therefore reducing the potential for corruptions. As well, the model saves automatically, so any fatal errors that may occur do not result in a loss of work.
- Many result formats are available, including 3-dimensional (3D) videos that can be used for presentations to stakeholders.
- There is complete integration with ArcGIS.

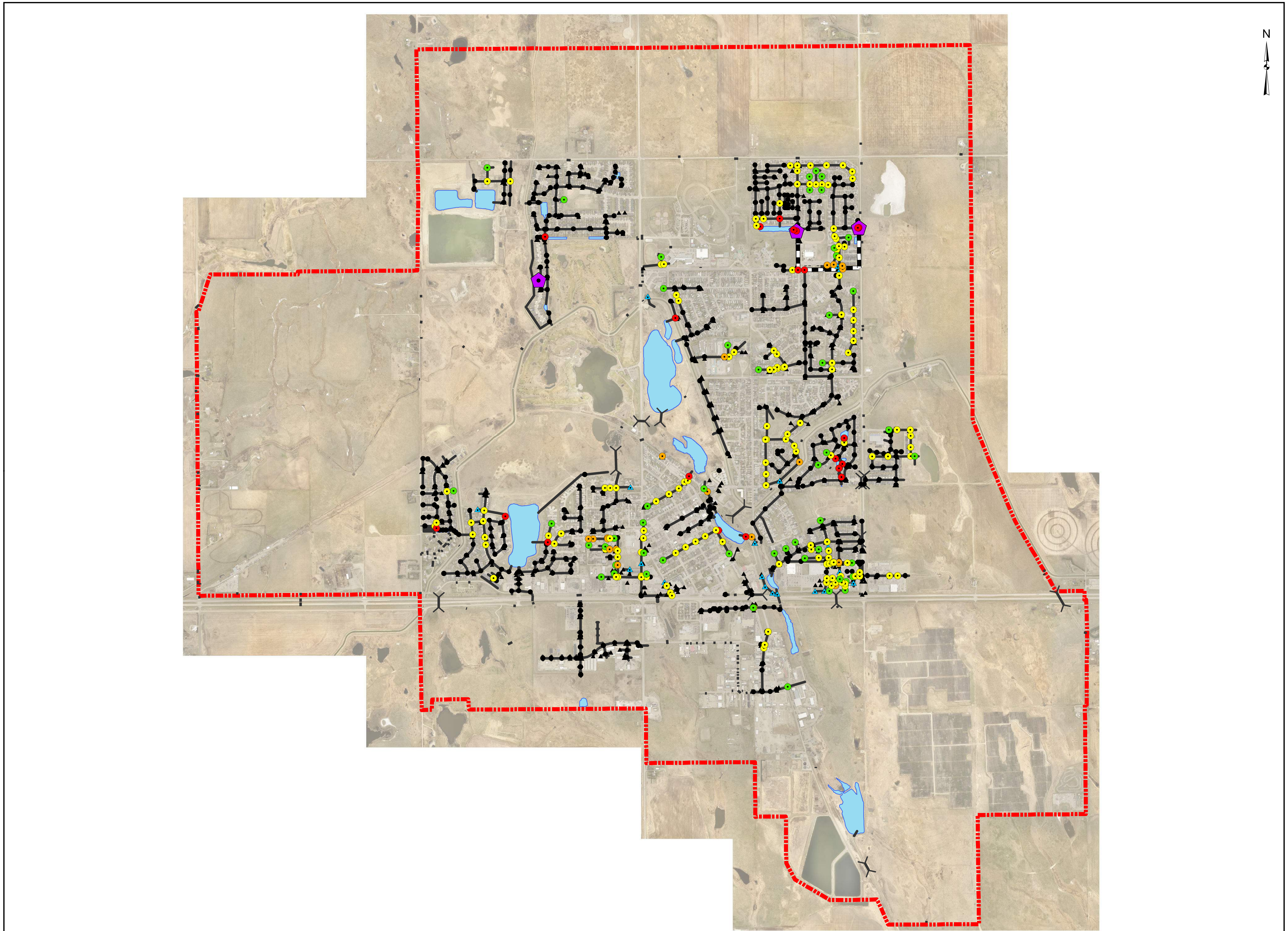
The stormwater model was constructed by utilizing available data combined with confirmations from survey, limited record drawings, and certain assumptions. The processes that were undertaken to develop the 1-dimensional (1D) and 2D portions of the model are described below.

4.1.1 Survey Exercise

Limited information was available at the start of this project related to the Town's minor stormwater system. ISL reviewed existing record drawings and identified areas recommended for supplemental survey. Surveying was undertaken by ISL in 2023 as part of this project to fill in some of the data gaps. The 2023 survey consisted of determining the rim elevation of manholes, then measuring the depth to the bottom of the manhole and for any pipe inverts. Several pipe diameters were also measured during the survey program.

Areas flagged for survey were further broken down into five priorities, with priority one being the highest survey priority and priority five the lowest. These locations are shown in **Figure 4.1.** It is recommended that any flagged locations not surveyed be done so in the future.

When reviewing longitudinal profiles of the Town's minor system, additional areas were flagged as being potentially erroneous. It is recommended that these areas are also surveyed in the future to confirm invert elevations. These locations along with locations surveyed by ISL are shown in **Figure 4.2.**



Legend

- Storm Catch Basins
- Storm Manholes
- Lift Station
- Storm Gravity Main
- Pressure Main
- Culvert
- Catch Basin Lead
- Storm Ponds
- Town Boundary

Manhole Survey Priority

- Priority 1 (23)
- Priority 2 (17)
- Priority 3 (144)
- Priority 4 (50)

Catch Basin Survey Priority

- Priority 5 (23)

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

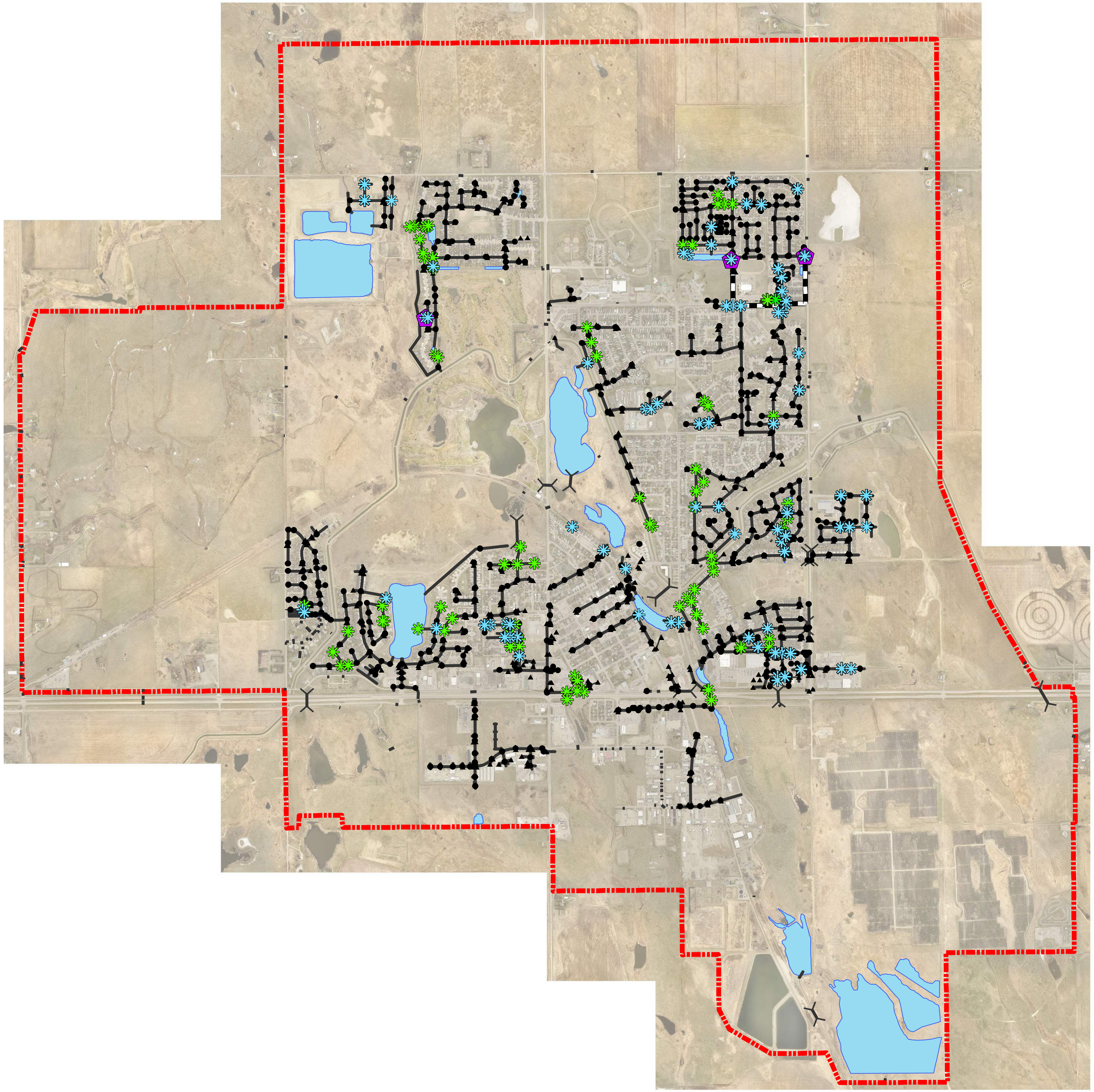
FIGURE 4.1
SURVEY LOCATIONS OVERVIEW
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Date: 5/24/2024 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure 4.1_Survey Locations Overview_Post Survey_MW.mxd

Integrated Expertise. Locally Delivered.



N

Legend

- Storm Catch Basins
- Storm Manholes
- Surveyed Locations
- Additional Recommended Survey Locations
- Lift Station
- Storm Gravity Main
- Pressure Main
- Culvert
- Catch Basin Lead
- Storm Ponds
- Town Boundary

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 4.2
ADDITIONAL RECOMMENDED SURVEY LOCATIONS
STRATHMORE STORMWATER MASTER SERVICING STUDY UPDATE

ISL

Strathmore

4.1.2 Minor (1D) System Development

To develop the 1D portion of the model, information pertaining to the Town's minor stormwater infrastructure was required. There was a significant amount of missing data at the start of this project related to the minor stormwater system, thus several sources and assumptions were required to fill in the data gaps.

Information gained through the survey exercise was added to the Town's GIS and used for model development. Remaining missing diameters were assigned values through assumptions from neighbouring infrastructure. Unknown pipe materials were assumed to have a Manning's roughness of 0.013, thus assumes a concrete pipe. Unknown culvert diameters were assumed to be 600 mm in size while unknown culvert materials were assumed to have a Manning's roughness of 0.024, as is consistent with corrugated metal pipe (CMP).

Information pertaining to catch basin leads was not available in geographic information system (GIS) for some of the Town, thus required to be manually added into the model. Catch basin leads with missing information were assumed to be 150 mm in size and have a roughness of 0.013 if information on the pipe's material was not available.

Missing upstream and downstream pipe invert elevations were populated by one of the following methods, which was site specific depending on adjacent pipe information and surface elevations. Any locations surveyed by the Town in the future can be easily updated in the model to remove any of the associated assumptions:

1. Where possible, inverts were interpolated between adjacent upstream and downstream invert elevations, given the length of the pipe.
2. If upstream or downstream inverts were unavailable, and grading worked properly (i.e., did not put the upstream invert below the downstream invert) a minimum depth of cover of 1.2 m based on the City of Calgary's Stormwater Management and Design Manual was assumed.
3. As a last resort, the minimum slope criteria as per the City of Calgary's guidelines was used.

All catch basins and culverts were designated as 2D nodes, to facilitate the exchange between the 1D and 2D systems (referred to as coupling). Rating curves were assigned to each catch basin and catch basin manhole based on the inlet type based on the City of Calgary's Stormwater Management and Design Manual. Where an inlet type was not present in the GIS data, the rating curve for the dominant inlet type in the surrounding area was used. Rating curves for manholes was assumed to be negligible. Catch basin inlet capacity curves are summarized below in **Exhibit 4.1.** In addition to those shown below, separate inlet capacities calculated using the orifice equation were assumed to represent a super catch basin located within the town and all culvert inlets.

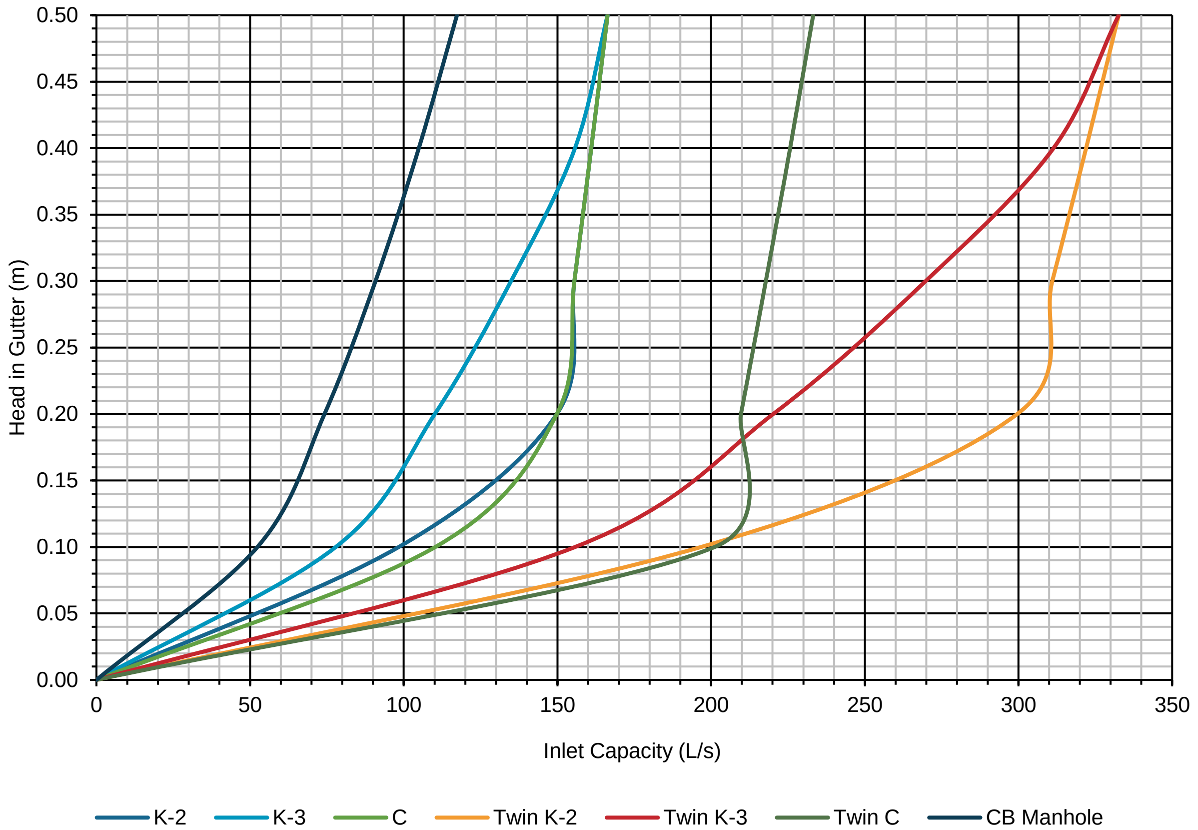


Exhibit 4.1: Catch Basin Inlet Capacities

Following the identification and resolution of all data gaps, an extensive quality assurance/quality control (QA/QC) process was undertaken to ensure proper connectivity between all links and nodes in the model.

4.1.3 Major (2D) System Development

The major system consists of all overland drainage components listed in Section 3.0. In Strathmore, the following parameters have been considered to develop a mesh, which ultimately represents the overland drainage system:

- 2D Zone
- Mesh Zones
- Roughness Zones
- Infiltration Zones
- Building Footprints

The 2D Zone represents the boundary in which the 2D analysis will occur in. The 2D Zone was digitized to be a simplified version of the Town boundary. A mesh will be created within a 2D Zone. The mesh represents the surface using triangulation. Each triangle is referred to as a mesh element, each with their own unique elevation, which is calculated using surface data, ultimately making each mesh element flat. Together with other mesh elements, a surface is created. The number of mesh elements has a direct impact on simulation run times. Various parameters can be considered when developing a mesh. For the model that has been developed as part of the SWMSS, these parameters include the Mesh, Roughness, and Infiltration Zones

The Mesh Zone specifies different mesh element densities for various zones, to either increase or decrease the resolution of a zone depending on its importance. For example, in order to capture pertinent features such as the crowns of roads or curb and gutters, roadways are generally defined by denser, smaller elements. Alternatively, greenfields that do not impact existing developments could be considered for larger mesh elements.

The Roughness Zone allows various Manning's n roughness values for different parts of the mesh. A roughness value is assigned to each mesh element depending on which Roughness Zone that mesh element is a part of. The Roughness Zone allows for a more accurate representation of different surfaces within the model.

The Infiltration Zone allows for various infiltration parameters across the mesh, depending on the different surfaces that are apparent within the mesh. Each Infiltration Zone is designated an Infiltration Surface, where an Infiltration Type can be specified. Four Infiltration Types are available along with their related parameters, including:

- Fixed
  - Fixed Runoff Coefficient
- Horton
  - Horton Initial
  - Horton Limiting
  - Horton Decay
  - Horton Recovery
- Constant Infiltration
  - Fixed Runoff Coefficient
  - Infiltration Loss Coefficient
- Green-Ampt
  - Green-Ampt Suction
  - Green-Ampt Conductivity
  - Green-Ampt Deficit

In this model, impervious surfaces are represented through a fixed runoff coefficient, while pervious surfaces are represented by the Horton Infiltration Type.

Default mesh, roughness, and infiltration parameters were defined in the 2D Zone to represent impervious areas such as roadways and buildings. These default parameters are stipulated below in **Tables 4.1, 4.2,** and **4.3**. Additionally, the options to 'Apply rainfall etc. directly to mesh' and 'Terrain-sensitive meshing' were selected. The 'Apply rainfall etc. directly to mesh' option ensures that rainfall is falling directly onto the surface, which provides a more accurate representation of overland flows. The 'Terrain-sensitive meshing' option better represents the surface topography among the mesh elements.

The Mesh, Roughness, and Infiltration Zones were generated through geospatial land use information, to specify different criteria depending on land use. It is noted that the physical boundaries of each Mesh, Roughness, and Infiltration Zone polygon are identical, however the parameters vary depending on the type of polygon (i.e., whether it is a Mesh, Roughness, or Infiltration Zone). Maintaining the same extent for each polygon type ensured there would be no errors regarding overlaps between the different polygon layers. These polygons, differentiated based on land use type, are illustrated in **Figure 2.4**.

The parameters applied per land use are specified in **Tables 4.1, 4.2,** and **4.3** below for the Mesh, Roughness, and Infiltration Zones, respectively. The Mesh Zone parameters are based on ISL's past experience using InfoWorks ICM, optimizing both model simulation time and level of detail. The Roughness Zone parameters are based on engineering best practices, and are consistent with past projects completed by ISL. The Infiltration Zone parameters are based on a combination of the runoff coefficients stipulated in the Stormwater Management and Design Manual (City of Calgary, 2011), a review of pavement to grass ratios of various parcels throughout the Town and engineering best practices.

Table 4.1: Mesh Zone Parameters per Land Use Type

Land Use	Maximum Triangle Area	Minimum Element Area
	m^2	m^2
Commercial	50	25
Industrial	100	25
Institutional	50	25
Open Space	100	50
Residential – High Density	50	25
Residential – Low Density	50	25
Residential – Medium Density	50	25
Residential – Mobile	50	25
Solar Farm	100	50

Table 4.2: Roughness Zone Parameters per Land Use Type

Land Use	Roughness Coefficient
Commercial	0.0181
Industrial	0.0167
Institutional	0.0195
Open Space	0.03
Residential – High Density	0.0258
Residential – Low Density	0.0258
Residential – Medium Density	0.0258
Residential – Mobile	0.0258
Solar Farm	0.025

Table 4.3: Infiltration Zone Parameters per Land Use Type

Land Use	Infiltration Type	Fixed Runoff Coefficient	Horton Initial	Horton Limiting	Horton Decay	Horton Recovery
			mm/hr	mm/hr	1/hour	1/hour
Commercial	Fixed	0.85	-	-	-	-
Industrial	Fixed	0.9	-	-	-	-
Institutional	Fixed	0.6	-	-	-	-
Open Space	Horton	-	75	7.5	4.14	0.001
Residential – High Density	Fixed	0.7	-	-	-	-
Residential – Low Density	Fixed	0.5	-	-	-	-
Residential – Medium Density	Fixed	0.6	-	-	-	-
Residential – Mobile	Fixed	0.4	-	-	-	-
Solar Farm	Fixed	0.25	-	-	-	-

Incorporating buildings into the 2D model was a major consideration. Ultimately, as the models utilize a rain on mesh ideology, the most conservative and effective approach was found to be raising the buildings on the light detection and ranging (LiDAR) surface such that runoff could not penetrate the buildings and allow rainfall to land on top of the building and fall off naturally. Building footprints were digitized based on the available aerial imagery. The building footprint polygons were clipped from the Mesh, Roughness, and Infiltration Zones such that there was a buffer between the edge of the building footprint polygon and the edge of each of the zones.

Mesh generation was an iterative process, to produce a smooth mesh with limited unnecessary mesh elements caused by small gaps between polygons or excessive vertices. With the mesh elements loaded to the network, these small clusters of mesh elements could be easily identified, as they appeared darker than other areas of the mesh. These issues were mitigated by closing the gaps between polygons, or by removing any unnecessary vertices. The result of this iterative process was a smooth mesh without excess mesh elements.

4.2 Subcatchment Delineation

4.2.1 Existing Subcatchments

Existing subcatchments were also delineated as part of this project. As the existing model is fully integrated between 1D-2D, the subcatchments were largely not necessary for the modelling process. Subcatchments were delineated nonetheless to be appended to the final version of the model for future use in 1D modelling applications. The subcatchments were delineated using a powerful ArcGIS tool, which found the highest elevations around an inflow node and digitized boundaries based on these elevations. The subcatchments were then checked for quality assurance/quality control (QA/QC), and refined adjusted, if required, for additional accuracy. Runoff parameters such as subcatchment area, average slope, and width were assigned to the shapefile polygons, in addition to unique IDs. The existing 1D subcatchments are shown in **Figure 4.3.**

4.2.2 Future Subcatchments

Generally speaking, future subcatchments were delineated based on a per quarter section basis with the assumption that current topography will be maintained. As such, these subcatchments should be revisited at the development stage to ensure that the proposed grading of each development site is accounted for. Some quarter sections were further divided, or grouped where necessary, based on significant changes in grade. One major consideration for the delineation of these subcatchments was the division of drainage to Eagle Lake Ditch or to Serviceberry Creek. Runoff parameters such as subcatchment area, average slope, width, and composite runoff coefficients were assigned to each subcatchment, in addition to unique IDs.

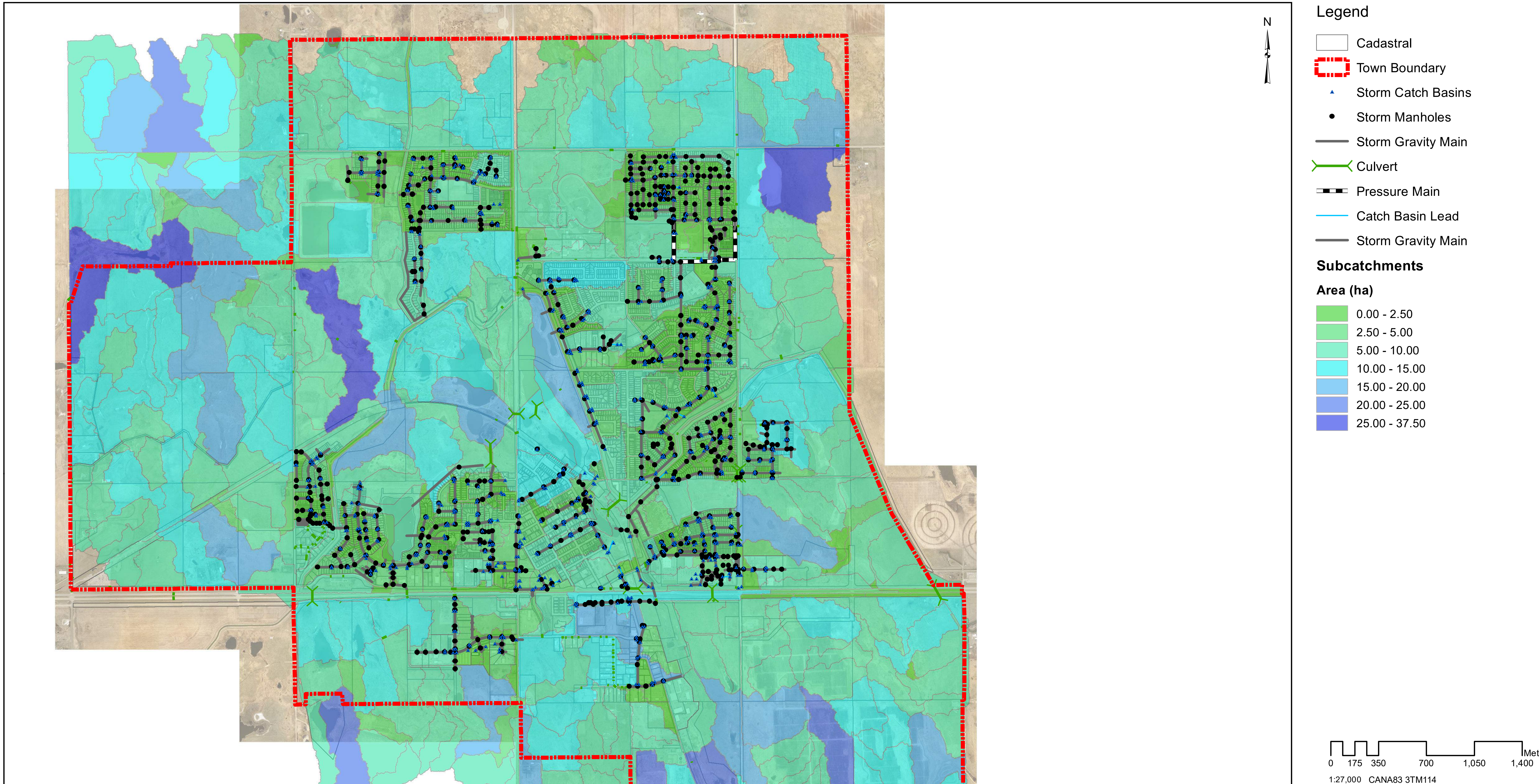


FIGURE 4.3
SUBCATCHMENTS
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Date: 5/24/2024 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure7.4_Subcatchments1.mxd

Integrated Expertise. Locally Delivered.

5.0 Design Criteria

The design criteria used to assess the stormwater system was based primarily on the City of Calgary's Stormwater Management and Design Manual, and engineering best practices utilized by ISL based on our experience with similar projects across Alberta, such as the City of Calgary, Town of High River, Town of Hinton, Rocky View County, and Mountain View County. The design criteria selected were then used for input into the InfoWorks ICM model to design and assess the stormwater drainage system.

5.1 Pre-Development Runoff Rate Analysis

Stormwater runoff is collected via major overland drainage pathways (typically along roadways) and in storm sewers and conveyed to SWMFs where runoff is stored and released at pre-development release rates. Allowable SWMF release rates are:

- 0.8 L/s/ha for lands the Town has annexed as stipulated by the Co-operative Stormwater Management Initiative
- 1.09 L/s/ha for areas that will discharge to Eagle Lake Ditch not subject to the 0.8 L/s/ha criteria

To limit discharge to the Eagle Lake Ditch to keep it under the established maximum of 1,700 L/s (Allnorth, 2019), the Eagle Lake Ditch release rate was reduced to 0.6 L/s/ha. This is to account for the allowable release rate of 1,228 L/s already coming from existing Ponds 1-6 (UMA/AECOM, 2006).

5.2 Design Rainfall Event

The design storms applied in this study are based on the City of Calgary's adjusted Meteorological Service of Canada (MSC) intensity-duration-frequency (IDF) curves that are stipulated in the Stormwater Management and Design Manual document (City of Calgary, 2011). The adjusted MSC IDF curves are intended for computer modelling applications, as they are more closely fine-tuned to the best-fit curves. **Tables 5.1** and **5.2** summarize the IDF intensities and parameters, respectfully.

Table 5.1: City of Calgary's Adjusted MSC IDF Curve – Intensity Summary (mm/hr)

Time	Return Frequency					
Minutes	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
5	58.80	87.60	106.80	132.00	150.00	168.00
60	13.70	19.40	23.20	28.00	31.60	35.10
720	2.59	3.50	4.09	4.85	5.41	5.97
1440	1.55	2.13	2.52	3.00	3.37	3.73

Table 5.2: City of Calgary's Adjusted MSC IDF Parameters

Parameter	Return Frequency					
	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
a	243.0	353.5	429.1	522.6	594.9	663.1
b	2.710	2.290	2.160	1.960	1.940	1.870
c	0.695	0.703	0.707	0.709	0.711	0.712

In assessing the storm drainage system in the area, a design rainfall event is required to generate runoff that will subsequently enter the network. The minor system is assessed to handle the runoff from storms up to the 1:5 year storm event while the major system must handle the excess flow during events that are greater than the 1:5 year storm event. Further to this, storm sewers shall be sized to convey the 1:5 year design peak flow and the major drainage system shall be designed to handle at least the 1:100 year storm event. These return periods are consistent with many other municipalities, therefore were used in assessing the stormwater system. The storms are set in 5-minute time steps, with the peak intensity set to a 5-minute duration for the selected storm return period.

The 1:5 year storm event is a 1-hour Chicago rainfall distribution. This storm tests the stormwater drainage system's capability of accommodating short duration, high intensity storm events – it is typically a critical event to review the minor (piped) drainage system. The 1:100 year storm is a 24-hour Chicago rainfall distribution. These rainfall distributions are based on the City of Calgary's IDF curves. Hyetographs of the 1:5 year 1-hour and 1:100 year 24-hour Chicago rainfall distributions based on Calgary's IDF parameters are illustrated below in **Exhibit 5.1.** Also shown on this figure are the 1:25 year and 1:50 year 1-hour Chicago rainfall distributions, to provide comparison to the assessment events.

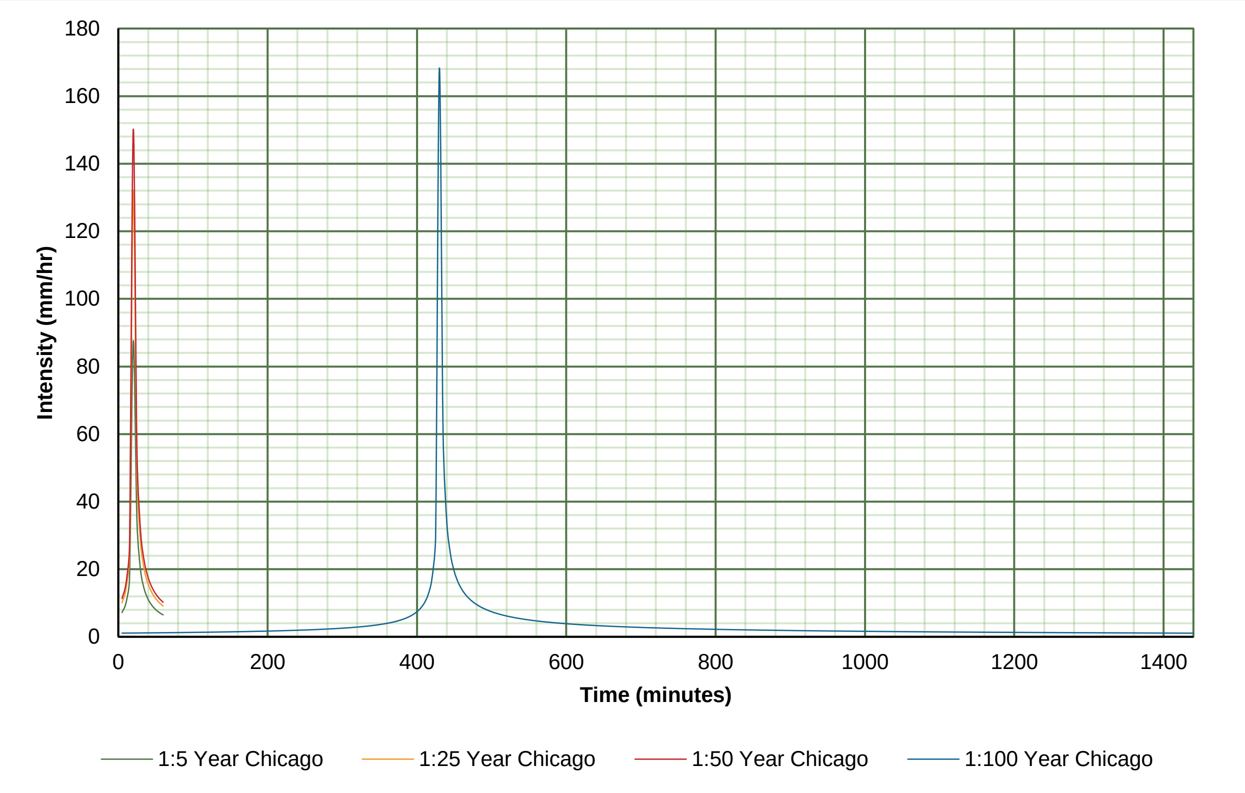


Exhibit 5.1: Utilized Design Rainfall Event Hydrographs

5.3 Assessment Criteria

The existing stormwater collection system was analyzed under the following two assessment scenarios as noted above to determine system conditions:

- 1:5 Year 1-Hour Chicago rainfall event
- 1:100 Year 24-Hour Chicago rainfall event

The performance of the stormwater collection system under the existing conditions is ultimately determined based on the following criteria.

Maximum HGL Elevation Relative to the Ground

Maximum HGL elevation relative to the ground is the amount of freeboard between the maximum water elevation and ground elevation at each manhole at the moment when maximum flow passes through.

Hence, the maximum HGL elevation relative to the ground with a value of:

- Greater than 0.00 m is denoted as a red dot – indicating a surcharge/back-up to surface
- Between 0.00 m and -1.2 m is denoted as an orange dot – maximum HGL peaks within 1.2 m below the ground
- Between -1.2 m and -2.5 m is denoted as a yellow dot – maximum HGL peaks between 1.2 m and 2.5 m below the ground
- Less than -2.5 m is denoted as a green dot – maximum HGL peaks 2.5 m below the ground

Peak Discharge Relative to Sewer Capacity

Peak discharge relative to sewer capacity indicates the ratio of peak flow to sewer capacity; as a corollary to this, the data can be interpreted to indicate the amount of spare capacity during peak flows. This is calculated by employing a ratio of modelled flow in a sewer and its corresponding capacity. Sewers with ratios greater than one are considered to have no spare capacity thus indicating a section of sewer that might require upgrading, particularly where the length of the section is long enough to cause surcharge conditions immediately in the upstream reach.

Hence, the peak discharge relative to sewer capacity (Q/Qman) with a ratio of:

- Greater than 1.00 is denoted as a red line – over capacity, or in another words the capacity is diminishing as the maximum flow theoretically occurs at roughly 93% of the sewer's diameter. This means that in principle, sewers with a Q/Qman ratio equal to or less than 1.05 have their flow still contained within the sewer
- Between 0.86 and 1.00 is denoted as an orange line – less than 14% of spare capacity available
- Less than 0.86 is denoted as a green line – spare capacity available

Additional Criteria

In addition to these two scenarios, the spare capacity of each sewer was determined. This indicates the amount of additional flow each sewer can handle before it becomes completely used. The amount of spare capacity ranges from less than 0 L/s to over 100 L/s, with the least capacity illustrated in red and the most capacity illustrated in green. In determining spare capacity, it becomes evident which sewers are available to handle any additional flows from future development, and which sewers should remain untouched.

2D Assessments

To present and evaluate 2D assessment model results, model files were reviewed, and results data was extracted for both depth and velocity at the maxima, for the 1:5 year and 1:100 year events, respectively. The complete model file contains velocity and depth properties at any time step within the simulation in the event they are required, including for the 1:25 year and 1:50 year return period events.

To increase public safety, The Province of Alberta and the City of Calgary have stipulated permissible depths for submerged objects in relation to water velocity to ensure that a 20 kg child would be able to withstand the force of moving water, thus preventing possible tragedies. **Exhibit 5.2** indicates these requirements.

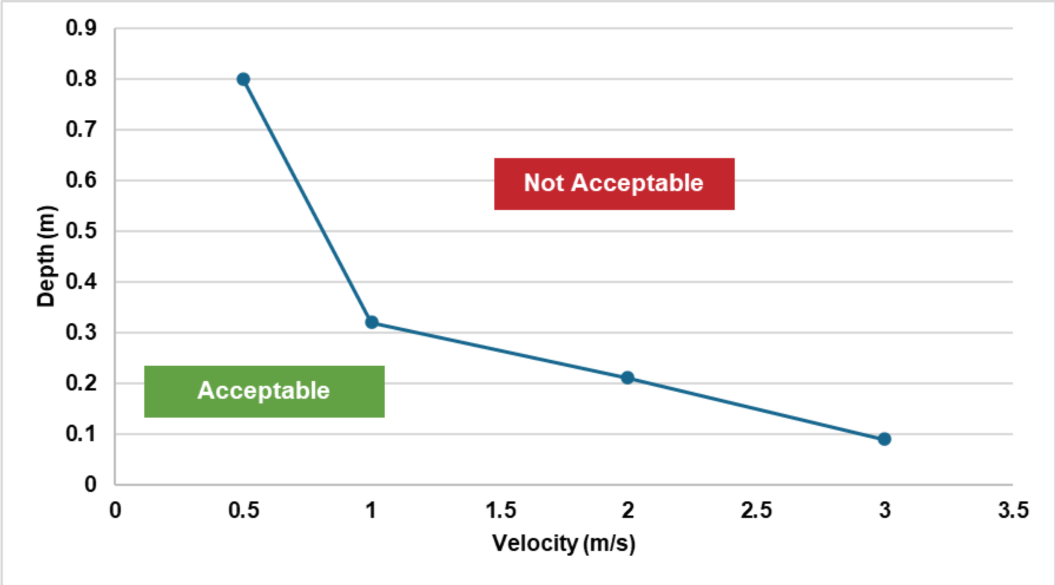


Exhibit 5.2: Permissible Depths for Submerged Objects

5.4 Design Guidelines for Future Stormwater Management Facilities

In determining future development requirements, the same criteria detailed in **Table 4.5** was utilized to calculate runoff. In addition to this, there are several hydraulic design criteria necessary to conceptualize a future stormwater management system for the study area. The following criteria were utilized to develop the model under proposed conditions. Unless otherwise noted, these criteria are based on the Design Summary Guide for Wet Ponds in Table 6-2 of the City of Calgary's Stormwater Management and Design Manual.

- Maximum allowable area release rates of:
- 0.8 L/s/ha for lands the Town has annexed as stipulated by the Co-operative Stormwater Management Initiative
- 1.09 L/s/ha for areas that will discharge to Eagle Lake Ditch in the 2018 SWMSS not subject to the 0.8 L/s/ha criteria
- A maximum allowable rate of 0.67 L/s/ha is stipulated for areas that will discharge to Unnamed Watercourse (B) and Eagle Lake Drainage in the 2018 SWMSS. However, as all southerly discharge is now proposed to be directed to Eagle Lake Ditch, so this requirement is no longer required.
- Minimum removal of 85% of particles 50 microns and larger on an annual basis as per Alberta Environment standards.
- New SWMFs were sized using a 1:100 year design storm with a maximum depth of 1.5 m from the normal water level (NWL) to the high water level (HWL).
- New pipes were sized to accommodate the maximum discharge rate from each proposed SWMF.
- Permanent pool depth of 2.0 m at a minimum.
- Maximum interior side slopes of 5:1 to 7:1 (H:V) within permanent pool, 5:1 between NWL and HWL, and 4:1 to 5:1 above HWL. It is noted that for the purposes of this SWMSS, a 5:1 side slope was maintained throughout.
- Minimum effective length to width ratio of 3:1 to 5:1.
- Minimum freeboard of 0.3 m.
- Quality control provided – typically by an oil/grit separator, normally upstream of the SWMF.

6.0 Existing System Assessment and Upgrades

The existing system was assessed using the design criteria stipulated in **Section 5.0**. The 1:5 year 1-hour Chicago distribution design event was simulated to assess the minor piped system and the 1:100 year 24-hour Chicago distribution design event was simulated to assess the major overland system. Simulation results for the design events are summarized in **Sections 6.1** and **6.2**, respectively. The 1:25 year and 1:50 year 1-hour Chicago distribution design events were simulated for comparison purposes only, with results provided in **Appendix A**.

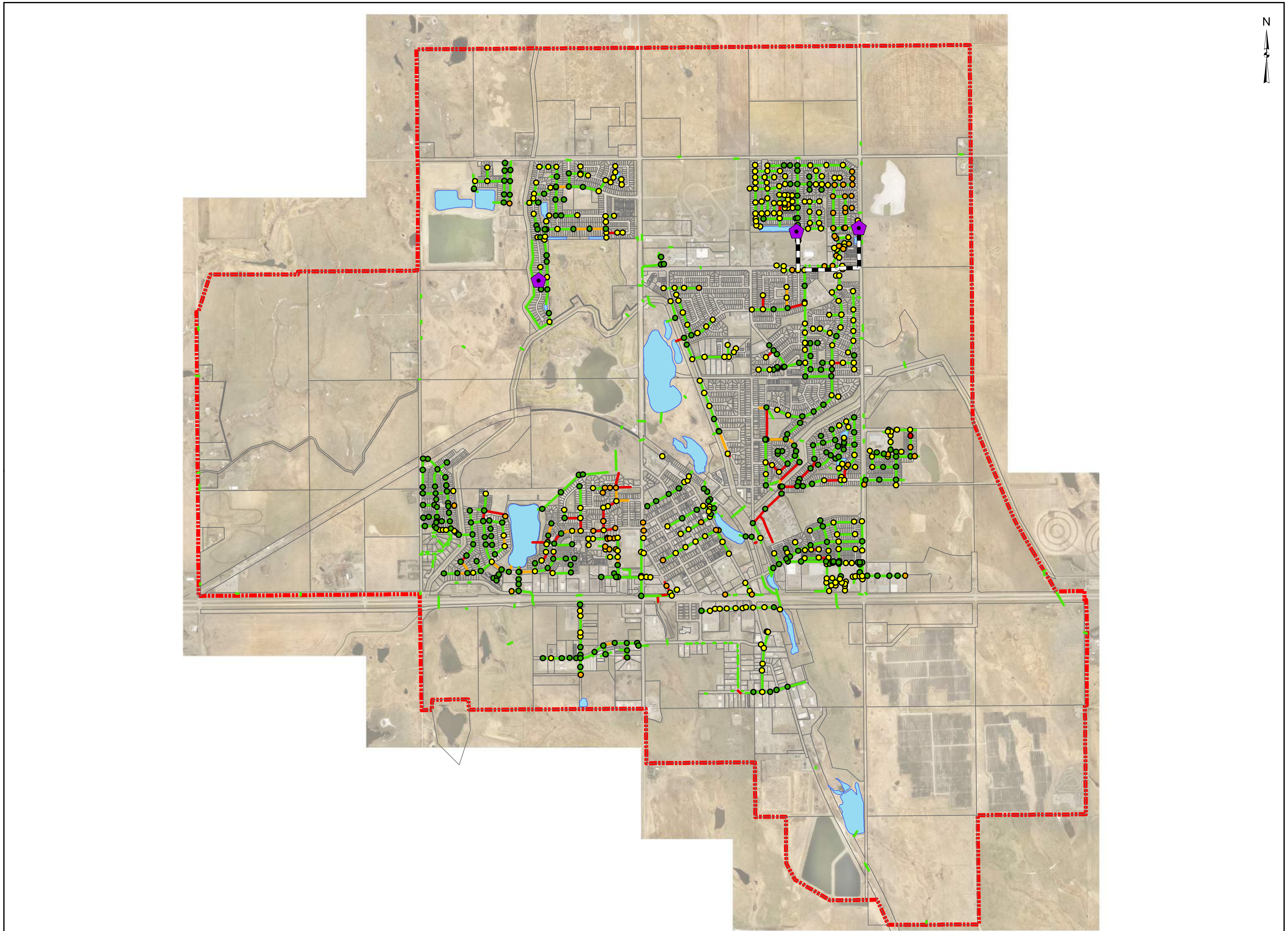
6.1 1:5 Year Event Result Summary

6.1.1 1D Model Results

The results for the peak discharge relative to sewer capacity and the maximum HGL elevation relative to ground are shown in **Figure 6.1.** The spare capacity results are illustrated in **Figure 6.2**. Model results indicate that surcharging to surface is minimal and limited to a single node on Edgefield Street. Upon further review, this is caused by a discrepancy between the manhole/pipe inverts at this location and existing LiDAR data. As this is a newer area, grading is likely to have occurred during development, which is not reflected in the existing LiDAR data set. It is recommended that LiDAR is recollected regularly (based on the speed of development in the Town) to reflect changes in grade. New LiDAR data could be used in the future to update the 2D surface elevations and better represent newer areas in the Town. Model results also indicate areas where pipe capacity is being exceeded, which are shown **in Figures 6.3** and **6.4**. Longitudinal profiles are also provided for these areas in **Appendix B.** For areas where capacity is a concern, it is recommended to check for service connections where the simulated HGL is within 2.5 m below the surface.

It is evident from the spare capacity results that there are a number of sewers that possess spare capacity. These results align well with the peak discharge relative to sewer capacity results. Though there are stretches of sewers with some spare capacity, there are also stretches of sewer either upstream or downstream of many of those sewers that are lacking capacity. Tying additional potential sewers into many of these sections would likely still require some existing sewers to be upsized. It is additionally noted that in areas with spare sewer capacity, if there are noted issues with ponding, catch basin upgrades could be contemplated. In addition to the locations identified in **Figures 6.3** and **6.4,** there are numerous catch basin leads throughout the study area lacking spare capacity, though these do not pose a significant concern to the stormwater network as a whole.

There are several pipes shown in **Figure 6.1** as lacking capacity but were not flagged. This is due to their flat slopes resulting in no capacity in a very localized section; the HGL is still within the pipe and therefore not a concern. There are also a number of pipes with a negative slope that were left due to either inadequate information to make assumptions that would resolve the negative slope or the pipe's grade was deemed minor enough to not significantly impact the system's overall results. There is also a jump in pipe elevation from the downstream invert of the pipe on Wellington Cove to the upstream invert of the pipe along Westchester Road, and from the downstream invert of the pipe along Hillview Road to the upstream invert of the pipe in the easement conveying south. These were left in the model as it is unclear if any existing values may be erroneous or if these jumps actually exist. There also does not appear to be any significant impacts on the overall system. However, it is recommended any such sections be surveyed to confirm pipe inverts prior to any upgrades that may be impacted directly by the pipe.



Legend

Lift Station

Storm Pressure Main

Cadastral

Town Boundary

Storm Ponds

Maximum HGL Relative to Ground

Less than 2.5m

-2.5m to -1.2m

-1.2m to 0.0m

Greater than 0.0m

Peak Flow Relative to Capacity

Less than 86%

86% to 100%

Greater than 100%

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

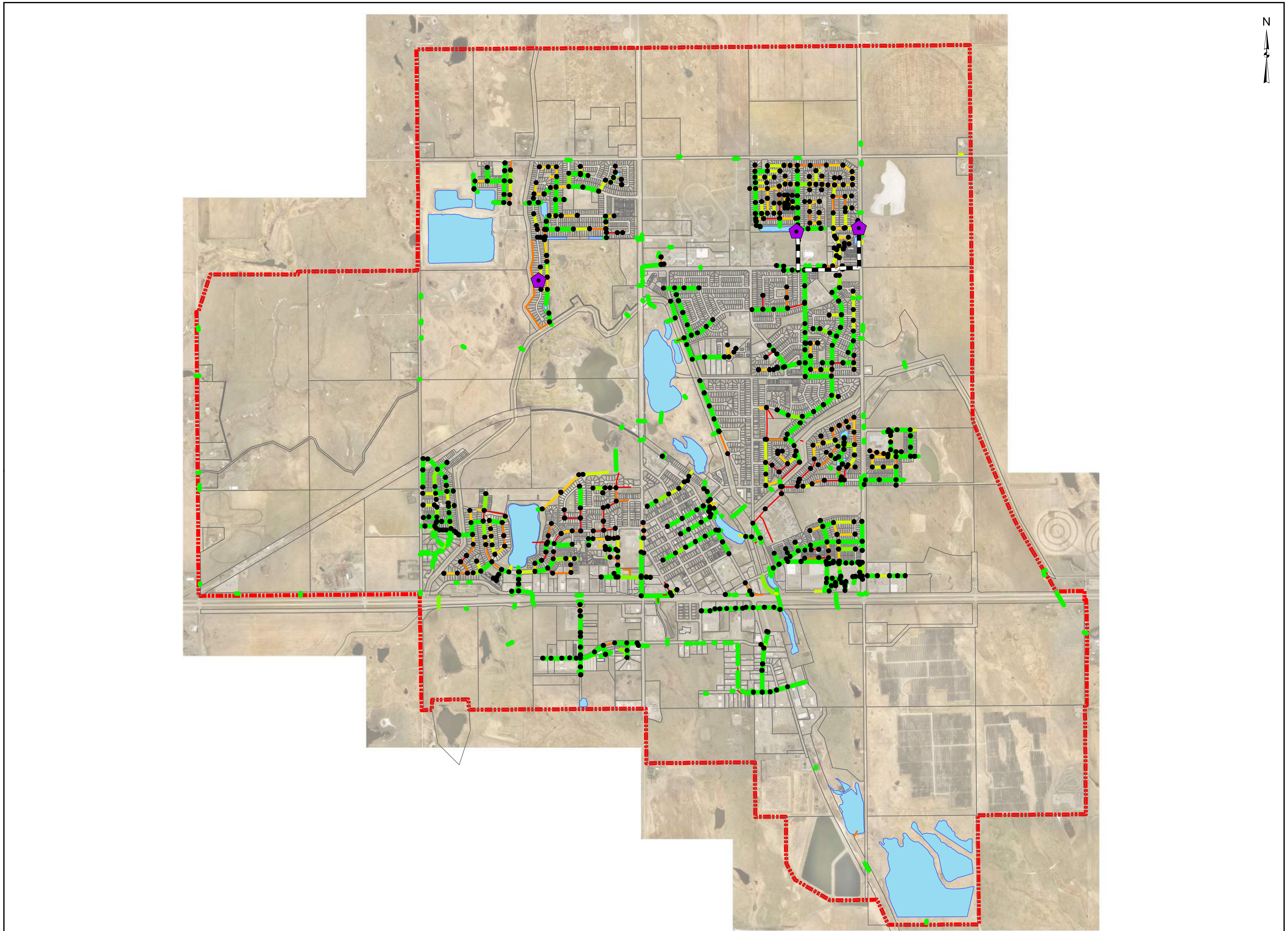
FIGURE 6.1
EXISTING SYSTEM ASSESSMENT - 1D
5 YR 1 HR DESIGN STORM
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Integrated Expertise. Locally Delivered.

Date: 4/11/2024 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure 6.1_5 Year_Pipe Results_Q-Qman and Max HGL_2.5 Scale.mxd



Legend

- Storm Manholes
- Lift Station
- Storm Pressure Main
- Cadastral
- Town Boundary
- Storm Ponds

Spare Capacity

- Less than 0L/s
- 0 - 25L/s
- 25 - 50L/s
- 50 - 75L/s
- 75 - 100L/s
- Greater than 100L/s

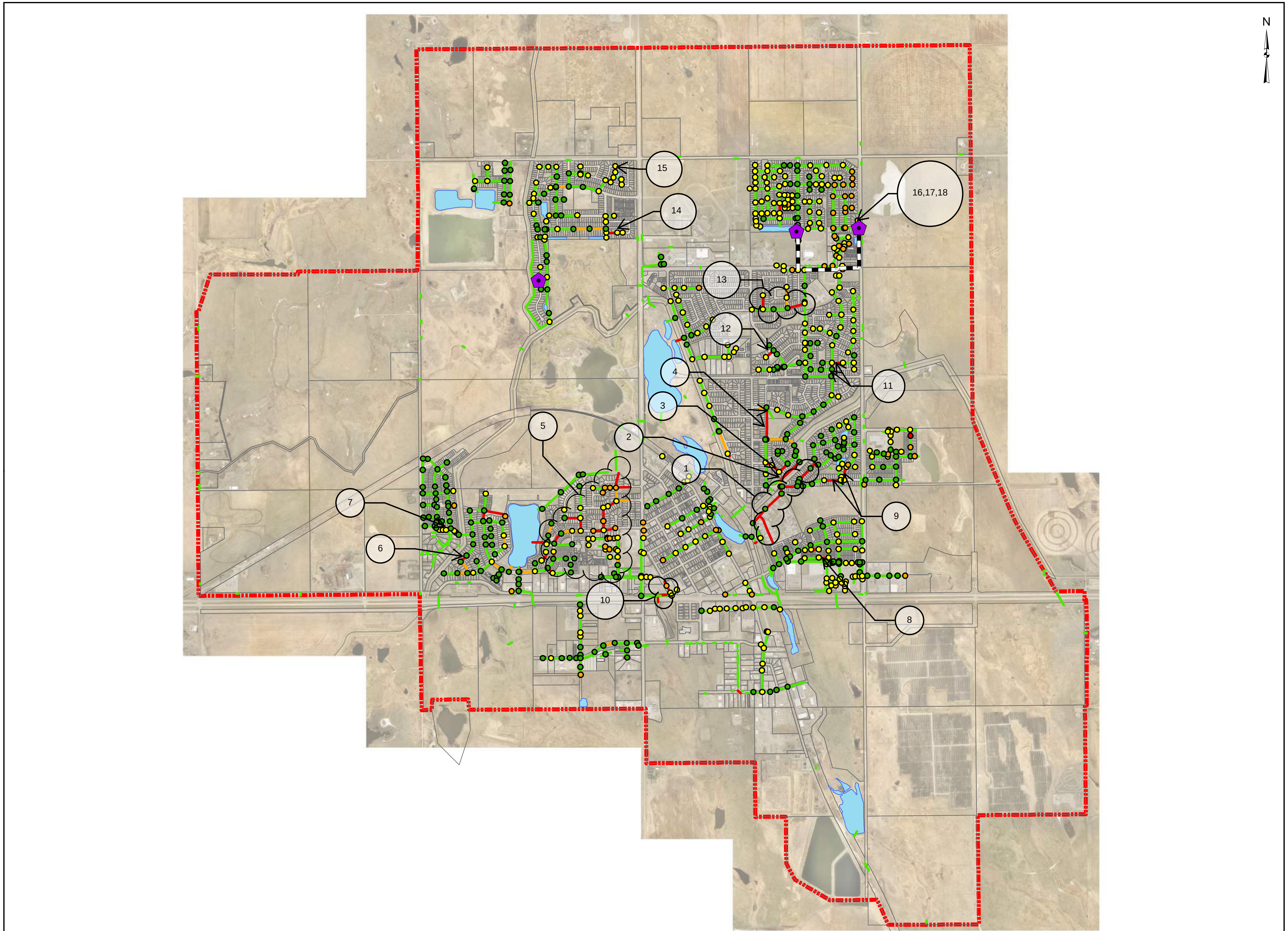
0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 6.2
SPARE CAPACITY - 1D
5 YR 1 HR DESIGN STORM
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore



Legend

- Lift Station
- Storm Pressure Main
- Cadastral
- Town Boundary
- Storm Ponds

Maximum HGL Relative to Ground

- Less than 2.5m
- -2.5m to -1.2m
- -1.2m to 0.0m
- Greater than 0.0m

Peak Flow Relative to Capacity

- Less than 86%
- 86% to 100%
- Greater than 100%

LABELS REPRESENT AREAS OF EXCEEDANCE ID's

0 175 350 700 1,050 1,400 Meters

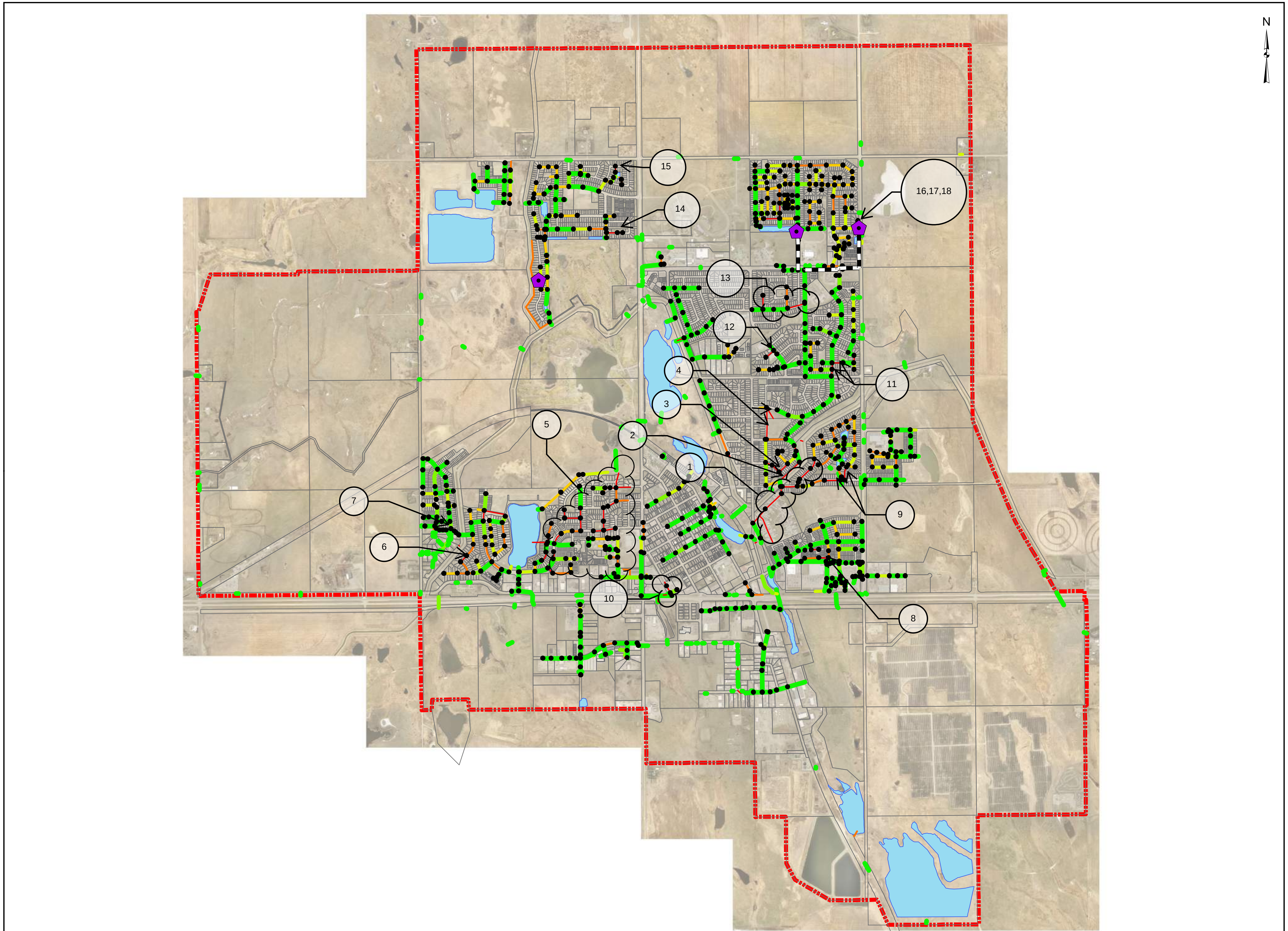
1:27,000 CANA83 3TM114

FIGURE 6.3
EXISTING SYSTEM ASSESSMENT - 1D
5 YR 1 HR DESIGN STORM
AREAS OF EXCEEDANCE
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL Strathmore

Integrated Expertise. Locally Delivered.

Date: 5/23/2024 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure 6.3_5 Year_Pipe Results_Q-Qman and Max HGL_2.5 Scale_Areas of Exceedance.mxd



Legend

- Storm Manholes
- Lift Station
- Storm Pressure Main
- Cadastral
- Town Boundary
- Storm Ponds

Spare Capacity

- Less than 0L/s
- 0 - 25L/s
- 25 - 50L/s
- 50 - 75L/s
- 75 - 100L/s
- Greater than 100L/s

LABELS REPRESENT AREAS OF EXCEEDANCE ID's

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 6.4
SPARE CAPACITY - 1D
5 YR 1 HR DESIGN STORM
AREAS OF EXCEEDANCE
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Integrated Expertise. Locally Delivered.

6.2 1:100 Year Event Result Summary

6.2.1 1D Model Results

The results for the peak discharge relative to sewer capacity and the maximum HGL elevation relative to ground are shown in **Figure 6.5**. The spare capacity results are illustrated in **Figure 6.6**. The minor system results under the 1:100 year 24-hour Chicago rainfall distribution generally align with those under the 1:5 year 1-hour Chicago rainfall distribution, though conditions generally worsen under the 1:100 year event. Areas where worsening conditions are more significant under the 1:00 year 24-hour event include Hillview, Strathmore Lakes, and Cambridge Glen. Typically, in a 1D model, it would be anticipated that the 1:100 year 24-hour Chicago storm would completely overwhelm the minor system. That is not necessarily observed when reviewing these results, however. In a 2D model, low points on the surface are better represented on the mesh, thus providing storage points throughout the study area. This model also considered inlet capacities at each catch basin and culvert, thus limiting the amount of flow that can enter the minor system. It is likely that the catch basins are reaching their full capture potential under the 1:5 year scenario, meaning that the majority of additional runoff attributed to the 1:100 year scenario is remaining on the surface (evaluated further in **Section 6.2.2**).

6.2.2 2D Model Results

To assess Strathmore's existing overland drainage system, model results were extracted at the maxima for both water depth relative to the LiDAR surface and surface flow velocity. It is noted that the maxima represents the peak depth/velocity value of each mesh element at a specific point in time. That said, the time stamps for each mesh element do not necessarily overlap, and each occurrence is independent of the next. The water depth and surface flow velocity results are illustrated in **Figure 6.7** and **Figure 6.8,** respectively.

On August 5th, the Town of Strathmore experienced a significant rainfall event, with approximately 50 mm of rainfall over a period of 90 minutes. As the return period of this event generally aligns with the level of service event used for overland drainage assessment, one recorded flood location was used as a high-level validation check of the developed model. Generally, there is agreement between the flooding observed and the model.

The results shown on **Figure 6.7** and **Figure 6.8** indicate that there are a number of locations throughout Strathmore that would experience surface flooding to some extent under the 1:100 year rainfall event. Peak depth and velocity results are colour-coded and categorized based on the Stormwater Management Guidelines (Alberta, 1999), as described in Section 5.3. This helps to illustrate which areas exceed the provincial requirements.

6.3 Recommendations for Observed Areas of Exceedance

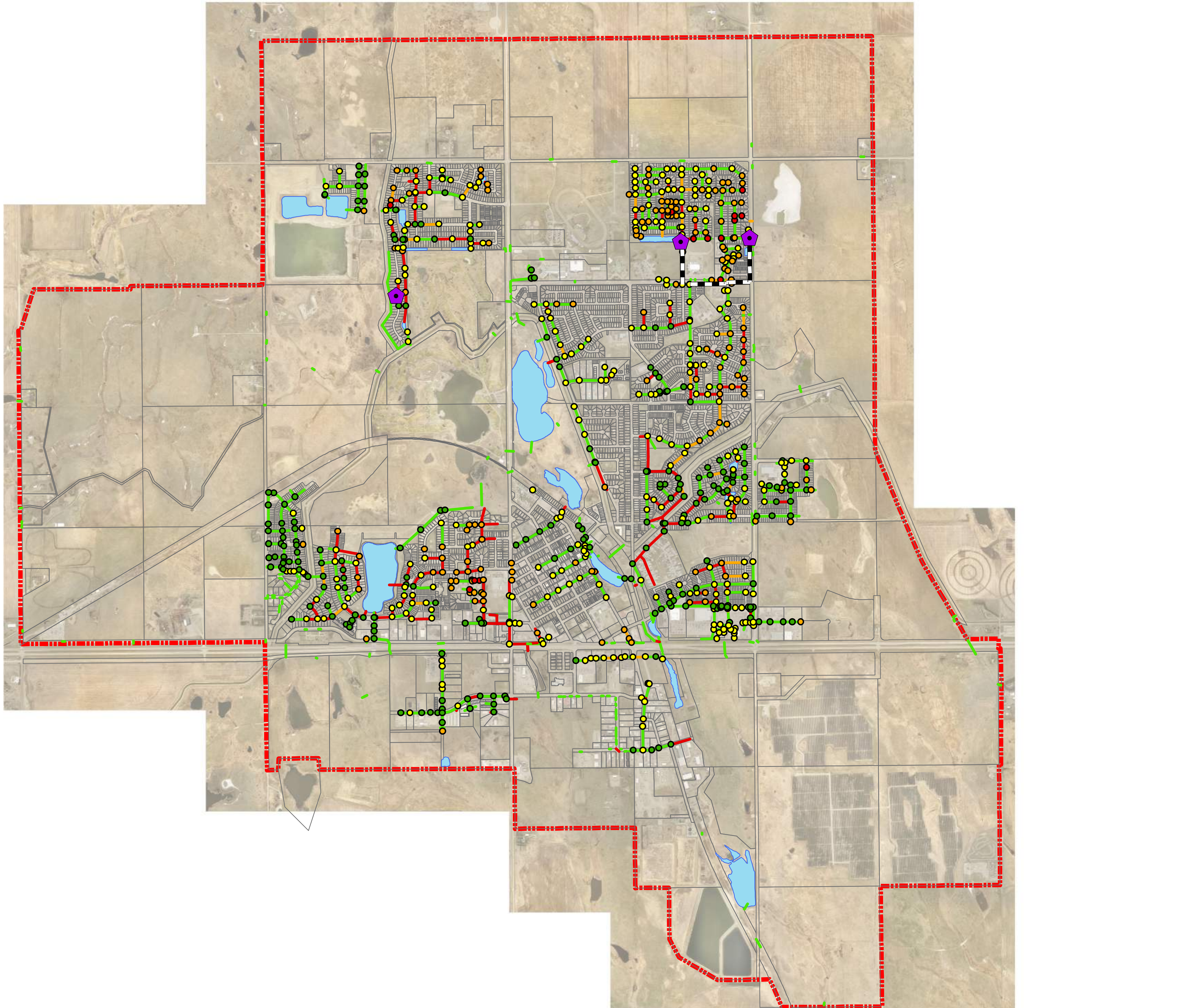
Based on the findings of the 1:5 year 1-hour and 1:100 year 24-hour Chicago storm event scenarios, a summary of the areas of exceedance was determine and is included below in **Table 6.1**. In this table, areas of note, their location (both geographically and in reference to their longitudinal profile), diameter, length, and results are summarized. Each area of note is also assessed as to whether upgrades are required, or if there are additional investigations that are recommended.

Table 6.1: Summary of Areas of Exceedance

Areas of Note ID	Figure #	Location	Diameter[1]	Length[1]	Maximum Q/Qman[2]	Maximum HGL[1]	Comments	Additional Survey Recommended	Upgrades Recommended
			mm	m		m			
1	LP.1 – LP.2	Along Aspen Creek Way, Park Lane Drive, and Doubletree Way, that discharge to a concrete swale in the trailer park	300 to 1350	1202	1.02 to 1.3	-5.8 to -2.4	Assumptions made for inverts of sewers discharging into trailer park. Check for service connections. Upgrades not recommended unless issues present themselves.	Yes	No
2	LP.3	The sewer in between Aspen Creek Way and Parkwood Crescent	Unknown; 1350	329	1.03	-5.8 to -4.7	Pipe diameter assumed in model.	Yes	No
3	LP.4	The sewers along Parkwood Crescent	300	462	1.2 to 1.3	-3.7 to -2.1	Flag and monitor closely. Check for service connections..	Yes	No
4	LP.5	The sewers along Parkview Estates and Parkwood Crescent adjacent to Parkwood Park	600	428	1.5 to 6.1	-4.6 to -2.8	Reduced capacity due to flat grade of upstream pipe. Assumptions made for some inverts.	Yes	No
5a – 5l	LP.6 – LP.16	Multiple sewers in the residential area east of Strathmore Lake and the pipes discharging into the east and south ends of Strathmore Lake	300 to 750; unknown	3236	1.02 to 2.2	-4.7 to -0.4	Upgrades recommended for 5a, 5b, 5c, 5d, 5j, 5h, and 5i. Check for service connections. Minor surcharging with backwater from lake and catch basin over capacity, monitoring recommended.	Yes	Yes (UPG-1, UPG-2, UPG-3, UPG-4, UPG-5)
6	LP.17	Sewer along Strathmore Lakes Bend	200 to 300	262	1.4	-3.6 to -2.7	Flag and monitor	Yes	No
7	LP.18	Sewer discharging into small storm pond north of Wildflower Crescent	450 to 675	79	1.09	-4.4 to -2.0	Some assumed inverts. Existing bottleneck but not generally a concern. Check for service connections.	Yes	No
8	LP.19	Sewer along Ranch Ridge	300 to 375	225	1.134	-2.1 to -1.9	Some assumed inverts - flag and monitor. Check for service connections. Catchbasin capacity, minor surcharging.	Yes	No
9a – 9b	LP.20 – LP.21	Sewer along Parklane Drive and sewer along Aspen Circle discharging into storm pond	200 to 450	565	1.1 to 2.3	-3.0 to -0.8	Recommend upgrading 9b. Check for service connections.	No	Yes (UPG-6)
10	LP.22	Sewers adjacent to Ridge Road west of Strathmore Station and sewers crossing Highway 1	300 to 900	274	1.05 to 2.7	-2.4 to -0.3	Some assumed inverts. Upgrades recommended. Check for service connections.	Yes	Yes (UPG-7)
11	LP.23	Sewers draining from field west then south along Cambridge Glen Drive	600 to 1200	401	1.1 to 1.1	-3.2 to -2.1	Some assumed inverts. Flag and monitor. Check for service connections.	Yes	No
12	LP.24	Sewer along Maple Ridge Estates	300 to 600	223	1.1	-3.8 to -1.4	Some assumed inverts. Flag and monitor. Check for service connections. Monitor catchbasin capacity	Yes	No

[1] Ranges include of all values in LP selection.
[2] Ranges include only exceedance values in LP selection.

Areas of Note ID	Figure #	Location	Diameter[1]	Length[1]	Maximum Q/Qman[2]	Maximum HGL[1]	Comments	Additional Survey Recommended	Upgrades Recommended
			mm	m		m			
13	LP.25	Sewer along Maple Grove Crescent and down Brentwood Drive East	375 to 900	567	1.1	-3.8 to -1.2	Flag and monitor. Check for service connections.	No	No
14	LP.26	Sewer south of Hillview Road discharging into storm pond	150 to 450	118	N/A	-4.2 to -1.8	Check for upgrades depending on the Town's risk tolerance. Check for service connections.	Yes	No
15	LP.27	Sewers along Hillvale Crescent	300 to 675	267	1.2 to 1.4	-2.9 to -1.2	Check for upgrades depending on the Town's risk tolerance. Check for service connections.	No	No
16	LP.28	Sewers discharging into Highland Circle storm pond	300	56	1.5 to 1.7	-1.6 to -1.2	Check for upgrades depending on the Town's risk tolerance. Check for service connections. CB capacity	No	No
17	LP.29	Sewer discharging into forcemain heading east along 100 Strathaven Way	200	97	1.1 to 2.3	-0.9 to -0.5	Backwater from lift station. Recommend looking into pumping capacity. Check for service connections.	No	No
18	LP.30	Stub discharging into forcemain from the south	150	4	1.1	-1.2	Assumed upstream invert. Check for service connections.	Yes	No
19	LP.31	Concreate main alongside forcemain discharging to storm pond	450	69	1.1	-1.2	Some backwater but otherwise not a concern. Flag and monitor. Check for service connections.	No	No
20	LP.32	Sewer discharging into Kinsmen Lake from 3 Avenue	375	103	1.56	-1.47	Some backwater but otherwise not a concern. Flag and monitor. Check for service connections	No	No



Legend

- Lift Station
- Storm Pressure Main
- Cadastral
- Town Boundary
- Storm Ponds

Maximum HGL Relative to Ground

- Less than 2.5m
- -2.5m to -1.2m
- -1.2m to 0.0m
- Greater than 0.0m

Peak Flow Relative to Capacity

- Less than 86%
- 86% to 100%
- Greater than 100%

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 6.5
EXISTING SYSTEM ASSESSMENT - 1D
100 YR 24 HR DESIGN STORM
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL Strathmore

Integrated Expertise. Locally Delivered.

Date: 5/23/2024 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure 6.5_100 Year_Pipe Results_Q-Qman and Max HGL_2.5 Scale.mxd

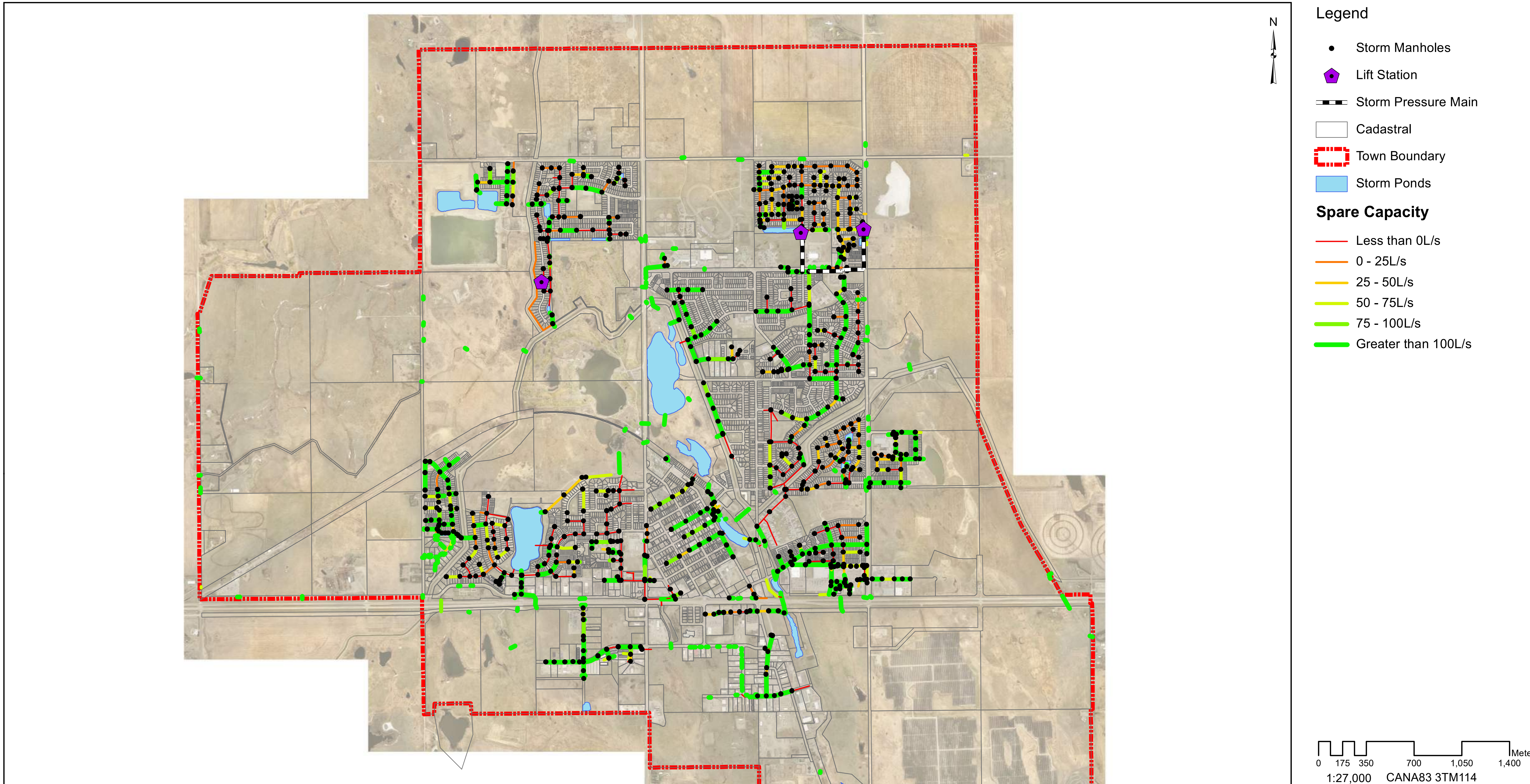


FIGURE 6.6
SPARE CAPACITY - 1D
100 YR 24 HR DESIGN STORM
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Date: 2024-05-23 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure 6.6_100 Year_Pipe Results_Spare Capacity.mxd

Integrated Expertise. Locally Delivered.

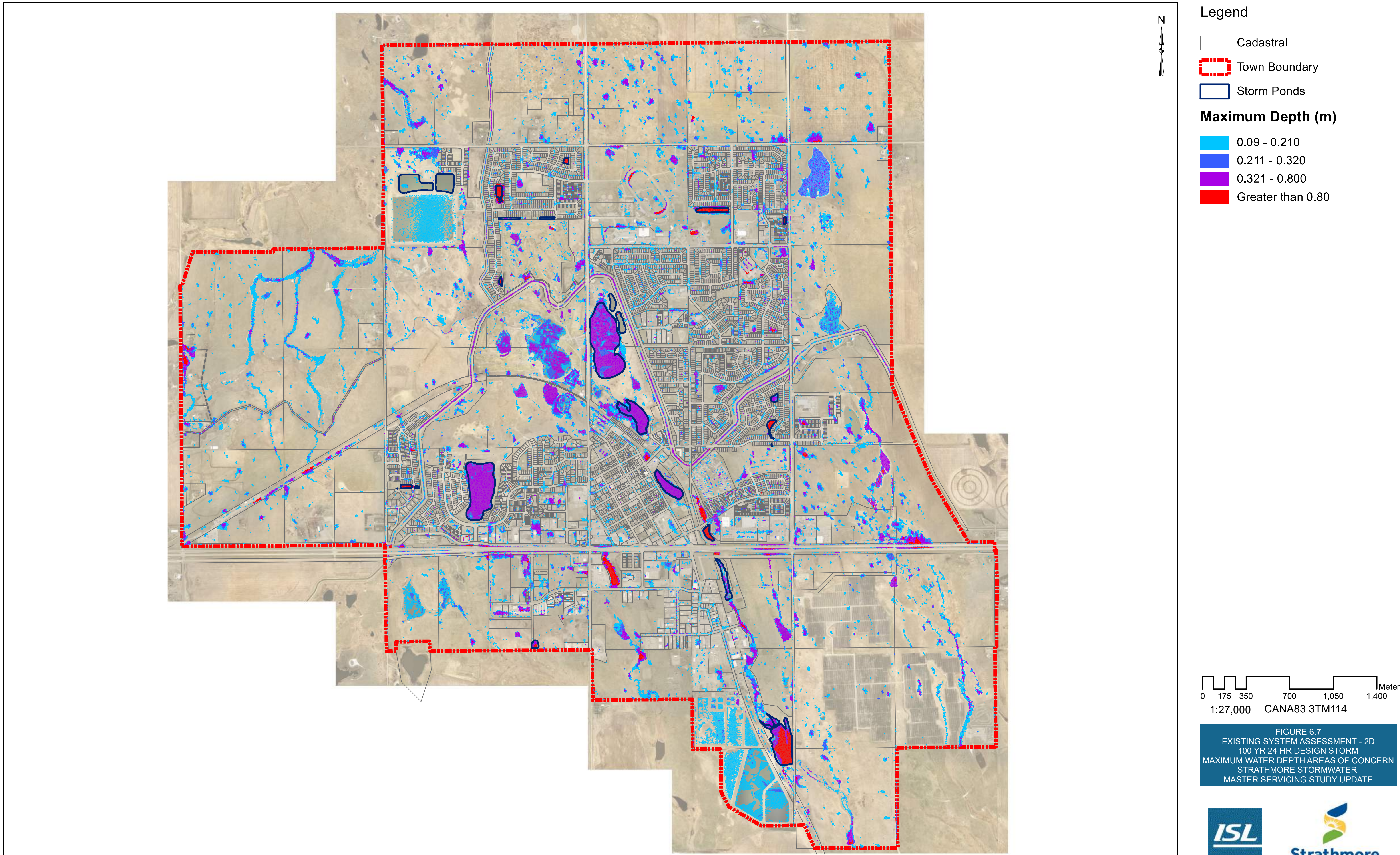


FIGURE 6.7
EXISTING SYSTEM ASSESSMENT - 2D
100 YR 24 HR DESIGN STORM
MAXIMUM WATER DEPTH AREAS OF CONCERN
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL Strathmore

Date: 5/23/2024 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure 6.7_100 Year_Max Depth_Areas of Concern.mxd

Integrated Expertise. Locally Delivered.

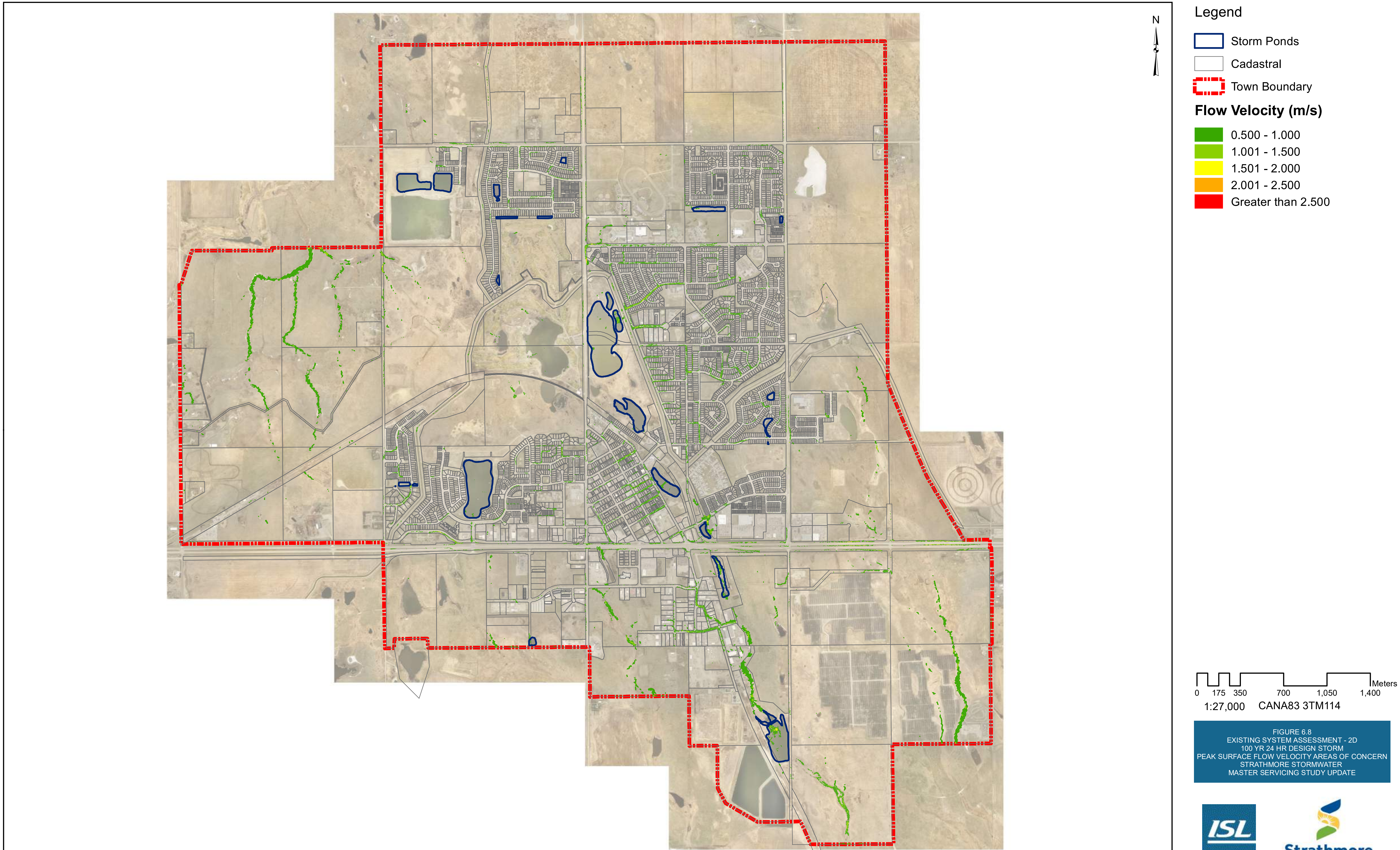


FIGURE 6.8
EXISTING SYSTEM ASSESSMENT - 2D
100 YR 24 HR DESIGN STORM
PEAK SURFACE FLOW VELOCITY AREAS OF CONCERN
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL
Strathmore

Proposed upgrades identified in **Table 6.2** are shown in **Figure 6.9 and Figure 6.10** and summarized below in **Table 6.2**. Longitudinal profiles for modelled upgrades are shown in **Appendix B.**

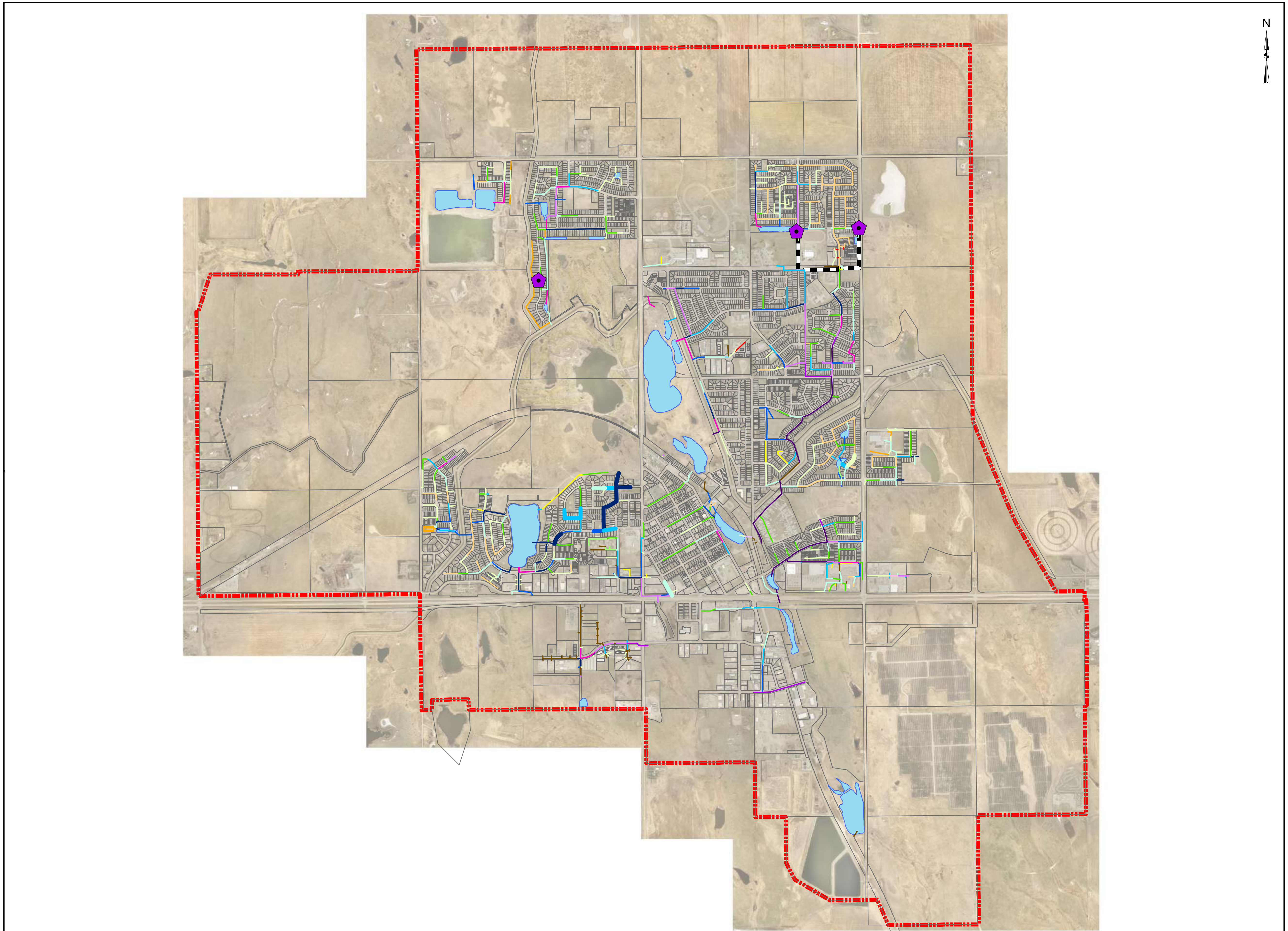
Priorities included in **Table 6.2** are ranked based on the following criteria, noting that only two categories are triggered in this SWMSS:

- Priority 0: the upgrades recommended at these locations are ongoing as of this SWMSS.
- Priority 1: these locations exceed the depth-velocity guidelines prescribed by Alberta Environment.
- Priority 2: these locations exhibit higher depth-velocity relationships, however, do not exceed the criteria stipulated by Alberta Environment.
- Priority 3: this location exhibits a higher depth-velocity relationship, however, does not exceed the criteria stipulated by Alberta Environment and is also located on private property.
- Priority 4: these locations do not exhibit higher depth-velocity relationships.
- Priority N/A: this location exceeds the depth-velocity criteria, however as the criteria is exceeded within an existing wetland, it is not flagged for upgrades. It is recommended that this location is only monitored, and upgrades proceed only if conditions within this wetland change or become an issue.

Table 6.2: Summary of Proposed Upgrades

LPs	Upgrade ID	Location	Length (m)	Proposed Pipe Diameters	Priority
5a,b,c	1	Along Westmount Drive from Wales Green to Windsor Place	165.5	525 mm 600 mm	4
5a,b,c	2	Along Westwood Street, Willow Drive, and Wheeler Street from Westmount Drive to 35 m south of Wheeler Place	372.1	600 mm 675 mm	2
5d, j	3	Along alley north of Westview Place and along north end of green space from Westview Street to Wheatland Trail	273.6	300 mm 450 mm 525 mm	2
5h, i	4	Pipes along Strathmore Lakes Crescent and Strathmore Lakes Way south of Willow Drive	250.3	300 mm 450 mm	4
5h	5	Along bend of Westmount Drive between Westlake Circle	93.1	675 mm	4
9b	6	Along Aspen Circle to storm pond north of Park Lane Drive	149.8	300 mm 450 mm 525 mm	4
10	7	Along Ridge Road in between Highway 1 and 5 Avenue	116.3	450 mm	4

It is noted that many of the descriptions include confirming the current pipe size prior to performing any upgrades. This condition is stipulated due to the number of assumptions that were needed in terms of pipe sizing when constructing the existing system model. Thus, in some events where assumptions were needed, the more conservative, smaller, pipe size was taken. This means that there is the potential that some of these pipes are already at the recommended pipe size, however, were modelled as the smaller size. Confirming the size of these locations is therefore critical, to avoid completing unnecessary upgrades. This is recommended at the pre-design stage of an upgrade project.



Legend

- Lift Station
- Pressure Main
- Cadastral
- Town Boundary
- Storm Ponds

Existing Pipe Diameter

- 100 mm
- 150 mm
- 200 mm
- 250 mm
- 300 mm
- 350 mm
- 375 mm
- 400 mm
- 450 mm
- 500 mm
- 525 mm
- 600 mm
- 675 mm
- 700 mm
- 750 mm
- 800 mm
- 900 mm
- 1050 mm
- 1200 mm and Greater
- Unknown

Proposed Pipe Diameter

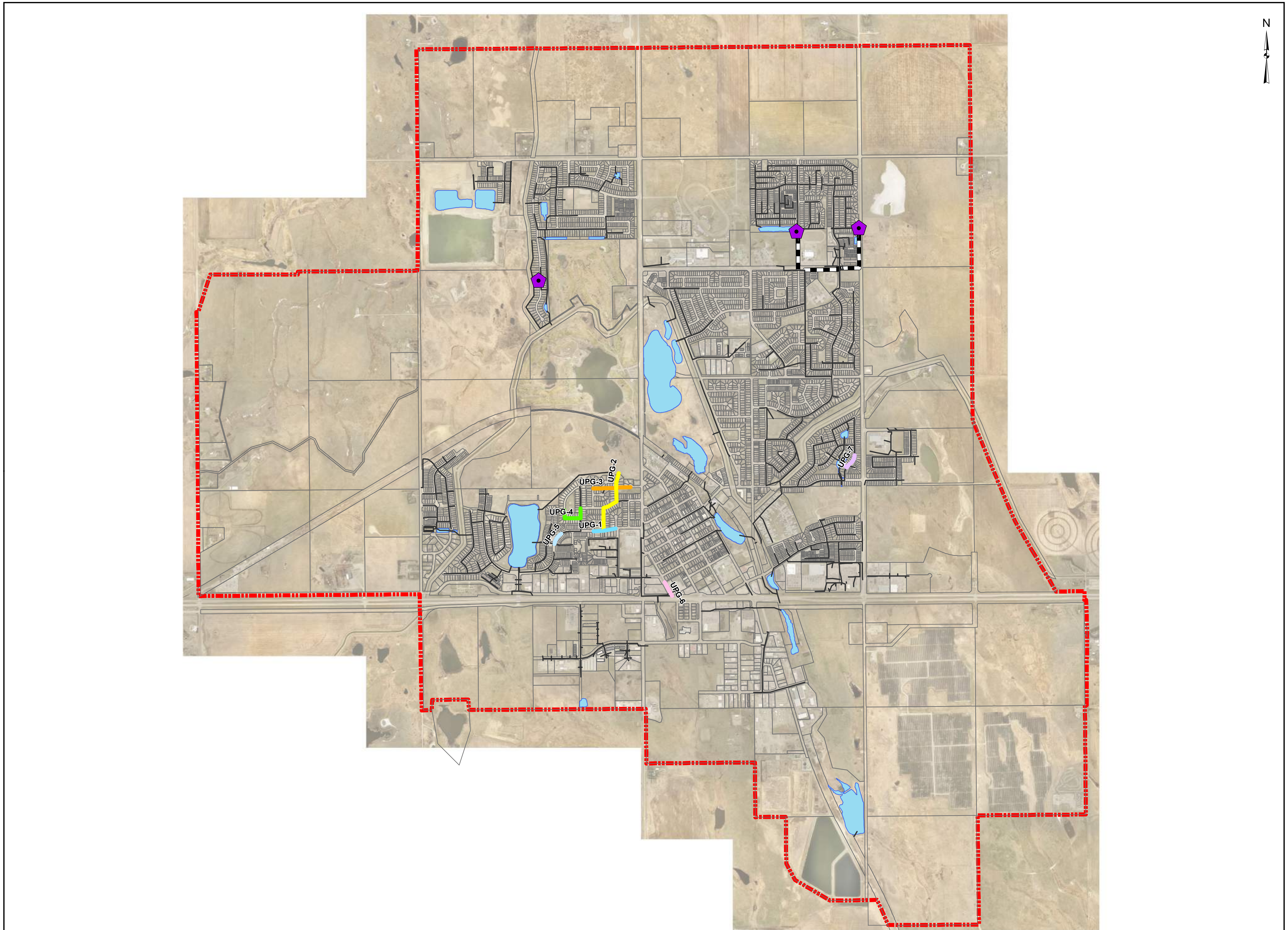
- 300 mm
- 450 mm
- 525 mm
- 600 mm
- 675 mm

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 6.9
PROPOSED UPGRADES
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL
Strathmore



Legend

- Lift Station
- Cadastral
- Town Boundary
- Storm Ponds
- Existing Gravity Main
- Pressure Main

Upgrade ID

- UPG-1
- UPG-2
- UPG-3
- UPG-4
- UPG-5
- UPG-6
- UPG-7

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 6.10
PROPOSED UPGRADES - IDS
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Integrated Expertise. Locally Delivered.

In addition to the areas flagged above, it is recommended that the Town look into upsizing culverts in the following areas described in **Table 6.3.**

Table 6.3: Proposed Culvert Upgrades and Recommendations

Location	Existing Culvert Size	Existing Material	Installation Year	Proposed Upgrade	Estimated Upgrade Unit Cost
	mm				$/m
At the intersection of Brent Boulevard and Wheatland Trail, to address regular culvert maintenance and ponding recorded by the Town.	Unknown	Unknown	Unknown	Survey culvert to confirm parameters	Further review required prior to recommending upgrades
Across Archie Klaiber Trail in between the existing storm pond and ditch.	1800	Corrugated Steel	Unknown	Upgrade to 2100 mm concrete pipe	$5,000– $6,000
Near the existing storm pond by the Kal Tire across Orchard Park Road.	Unknown	Unknown	1999	Survey culvert to confirm parameters	Further review required prior to recommending upgrades
Across Highway 1 just east of the existing residential property.	Unknown	Unknown	Unknown	Survey culvert to confirm parameters	Further review required prior to recommending upgrades

Note: *Sizing for the culvert across Archie Klaiber Trail should be confirmed during preliminary and detailed design.*

6.4 Condition Assessment

ISL performed a desktop condition assessment of the Town's stormwater system that took into consideration a pipe's age and material to estimate the remaining service life, with a higher emphasis placed on the decade installed. Pipes with unknown installation years were assigned an inconclusive (INC) rating, and pipes with unknown materials were assumed to be the least favourable material (spiral welded steel). **Table 6.4** shows the distribution of scores assigned to each installation date and material, and **Table 6.5** shows the distribution of scores assigned to each rating. The final score was determined by multiplying both the age and material scores, with the scores for installation decade first tripled in order to factor it more heavily into the results.

Table 6.4: Installation Year and Material Scores

Scores			
Decade Installed		Material	
Unknown	-	Unknown	-
1970	6	Corrugated Metal	3
1980	5	Concrete	2
1990	4	Corrugated Steel	3
2000	3	PVC	1
2010	2	Spiral Welded Steel	4
2020	0.5		

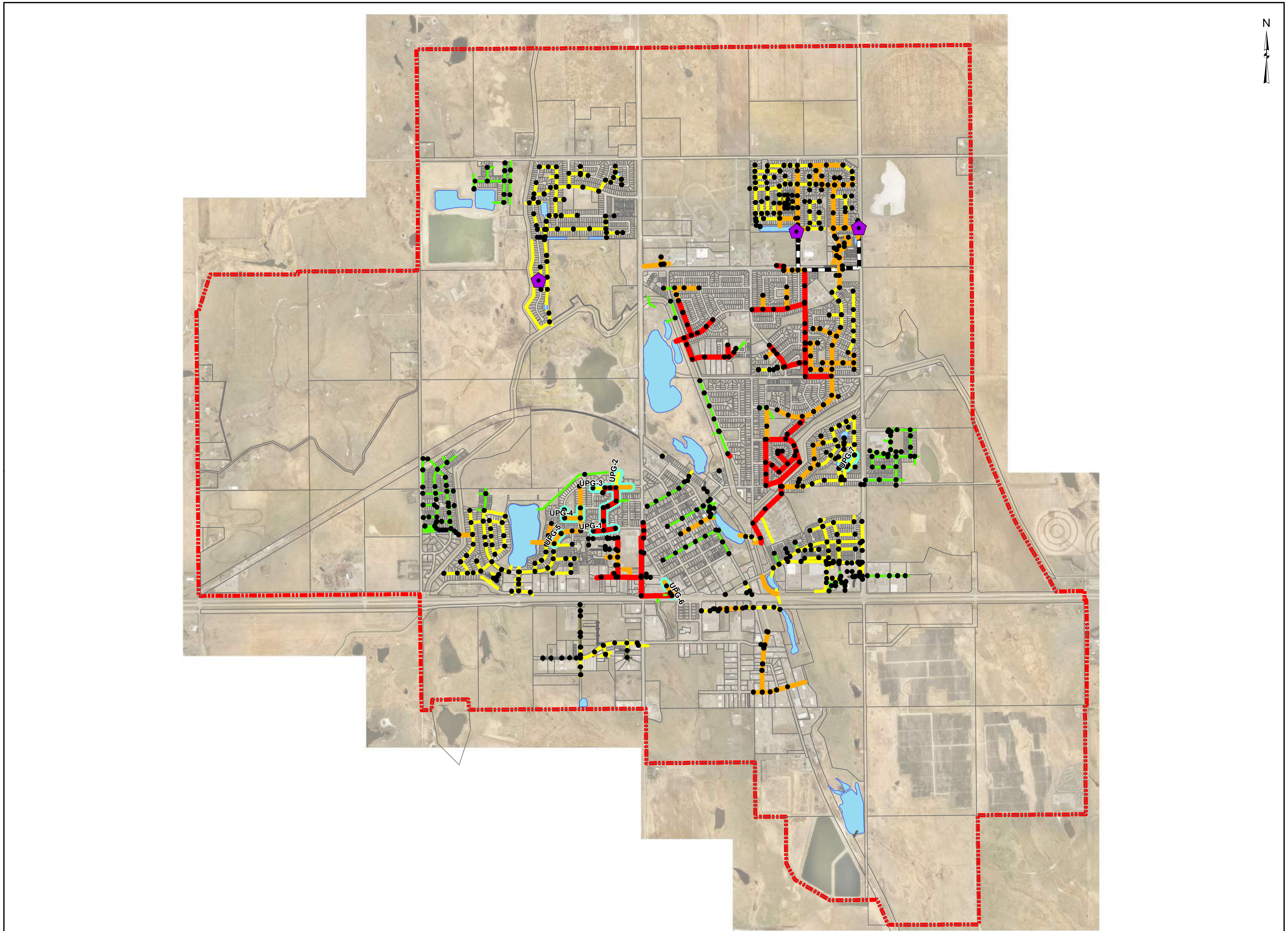
Table 6.5: Final Score Rating Scale

Score	Rating
0-7	Excellent
8-12	Good
13-17	Fair
18+	Poor

The resulting ratings for various combinations of a pipe's material and the decade it was installed are presented in **Table 6.6** and represent a pipe's rating in relation to the rest of the system. Definitions of these ratings are summarized in **Table 6.7**, and the condition assessment is visualized in **Figure 6.11.**

Table 6.6: Pipe Condition Rating Summary

	Unknown	Spiral Welded Steel	Corrugated Metal	Corrugated Steel	Concrete	PVC
Unknown	INC	INC	INC	INC	INC	INC
1970	Poor	Poor	Poor	Poor	Poor	Poor
1980	Poor	Poor	Poor	Poor	Fair	Fair
1990	Fair	Fair	Fair	Fair	Fair	Fair
2000	Fair	Fair	Good	Good	Good	Good
2010	Good	Good	Good	Good	Good	Good
2020	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent



Legend

- Storm Manholes
- Lift Station
- Pressure Main
- Proposed Upgrade
- Cadastral
- Town Boundary
- Storm Ponds

Condition Rating

- Excellent
- Good
- Fair
- Poor
- INC

Condition ratings are based on rankings relative to the rest of the storm network and are not intended to represent an absolute condition.

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 6.11
CONDITION ASSESSMENT
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Table 6.7: Pipe Condition Definitions

Rating	Condition	Description
1	Excellent	No further action recommended.
2	Good	CCTV (closed-circuit television) is recommended to determine if maintenance is needed.
3	Fair	CCTV recommended to confirm condition. Repairs are likely needed in the next ten (10) to twenty (20) years.
4	Poor	CCTV recommended to confirm condition. Repairs are likely needed in the next five (5) to ten (10) years.

6.5 Infrastructure Maintenance Strategy

The broad purpose of an Infrastructure Maintenance Strategy is to highlight sewers that are reaching their end-of-life stage and will need replacement or rehabilitation in the foreseeable future. Many areas of the have aging infrastructure, which may not be as effective as it was when first installed. In terms of stormwater sewers, this could be attributed to root intrusion, cracks/holes in the pipes and manholes, or sedimentation.

The development of an Infrastructure Maintenance Strategy would involve the following steps, described further below:

- Compile Existing Information
- Sewer Inspections
- Condition Assessment
- Rehabilitation Recommendations
- Staging Implementation Plan

6.5.1 Compile Existing Information

The Town is already in possession of a significant portion of the data that is required to successfully conduct and implement an Infrastructure Maintenance Strategy (the Strategy). This step involves compiling all this information into a single location so that all parties conducting the Strategy can do so with ease. Information that would be relevant to the development of the Strategy includes:

- Stormwater system data in a geographic information system (GIS) format
  - Gravity sewers
  - Manholes
  - Catch basins
  - Catch basin leads
  - Culverts
  - Lift stations
  - Forcemains
  - Special structures (e.g. orifices, weirs and storage tanks)
- Information pertaining to the installation year and material of the stormwater system data (ideally in a GIS format)
- Operations and maintenance data
  - Pumping system record drawings
  - Pumping system pump curves

- Lift station record drawings
    - Supervisory control and data acquisition (SCADA) data
    - Operational cost information
    - Record drawings of completed upgrades that may not be reflected in the digital data
    - Reported flooding records
- Previous condition assessment reports
    - CCTV records
    - Flow monitoring information

A summary of the collected data would then be recorded to determine any data gaps that would be needed to perform the condition assessment successfully. These data gaps would be addressed through field investigation and sewer inspections, discussed below.

6.5.2 Sewer Inspections

For the Strategy, the most critical information would be the physical condition of the existing sewers, determined through CCTV records. Sections of sewer that do not have or have outdated CCTV records should be inspected. A cleaning process should be integrated into the inspection, and camera units should be equipped with cutting arms to address encrustation and ensure the camera is able to pass. Observations during the CCTV inspections that have substantial negative effects on public safety or the environment should be identified to the Town immediately.

Depending on the scope and budget of the Strategy (i.e., if it is being performed on a Town-wide basis, for older areas, or only in a specific neighbourhood), a method of prioritization may be needed. For example, older sewers would be ranked higher than recent sewer installations, thus missing data gaps would take precedence on these sewers. More critical sewers, such as trunk sewers, could take precedence in some cases as well.

6.5.3 Condition Assessment

Though a desktop condition assessment has been undertaken in this SWMSS, the Strategy would require a more in-depth condition assessment performed primarily based on the CCTV recordings. Sewer conditions for lengths of sewers that have CCTV recordings would be classified as a field in the sewer digital data, as one of the following, with a specific scoring criteria:

- Very good
- Good
- Good/fair
- Fair/poor
- Poor
- No data available

The assessment of the condition of sewers would include, but is not limited to the following factors:

- Structural condition of the sewer
- Sewer grades (i.e., if the grade does not have a positive, continuous slope)
- Sewer sedimentation
- Root intrusion
- Sewer cracks
- Sewer chips
- Old sewer materials (such as wood, brick, asbestos cement)
- Neighbourhood debris causing blockages

- Chemical corrosion
- Exposed rebar
- Aggregate exposure

The condition assessment scores would then be used as input for the development of recommendations for rehabilitation, as discussed below.

6.5.4 Rehabilitation Recommendations

Each section of sewer that has CCTV data would then be provided with a recommendation in terms of rehabilitation. Six ranks of rehabilitation are typically used, to help prioritize a staging plan based on annual Town budgets. These are summarized below:

- **Rank 1** – Do Nothing: the section of sewer is in good condition and does not require further action for the foreseeable future.
- **Rank 2** – Monitor the Sewer: the section of sewer is in decent condition, however, should be continually monitored to observe if conditions change, or if deterioration is noted.
- **Rank 3** – Clean the Sewer: the CCTV inspections recorded indication of significant sedimentation or debris, causing blockages in the sewer. These blockages may be generally straightforward to remove through pigging or flushing the section of sewer.
- **Rank 4** – Minor Sewer Repair: in some events, small local repairs and maintenance may be sufficient to improve the quality of the sewer. This may include sealing any smaller cracks in the sewer or removing root intrusions.
- **Rank 5** – Sewer Lining: lining the sewer may be applicable if the grade and structural integrity of the section of sewer is intact, however there are many cracks or chips. Sewer lining would maximize the remaining useful life of the sewer while avoiding expensive upfront costs associated with complete sewer replacements.
- **Rank 6** – Replace the Sewer: these are sewers that are in very poor condition and reaching their end-of-life. Sewers approaching 50-60 years + in age would be key candidates for sewer replacement.

6.5.5 Staging Implementation Plan

Sewer sections would then be amalgamated into larger regions, and aggregated condition scores compiled. It is suggested that the regions are divided in terms of constructability, to allow all sewers within full regions to be remediated simultaneously. These aggregated condition scores will be critical to determine a staging plan for the implementation of the Strategy.

The staging of the rehabilitation measures is dependent on the budget the Town is comfortable allocating to sewer repairs. That said, the more critical regions could be replaced in a year where the only other actionable items involve CCTV inspections or sewer cleaning, while the next year can focus on local repairs and sewer lining. It is recommended that regions with larger aggregated scores are addressed first, as these will be the more critical areas.

Additionally, rehabilitation of existing sewers can be staged in alignment with local roadway improvements to see additional cost savings. The rehabilitation may also be well suited in conjunction with the upgrades recommended for the existing system, or future infrastructure required to service new areas.

6.6 Climate Change Resiliency

Climate change is expected to increase rainfall intensity in the future, which will negatively impact the existing risk of flooding within existing stormwater drainage systems. To assess the impacts of climate change, ISL used the Computerized Tool for the Development of Intensity-Duration-Frequency Curves under Climate Change – Version 7.0 tool, also known as IDF_CC Tool 7.0. This is a publicly available and web-based tool that has historical rainfall information for 898 Environment and Climate Change rainfall stations. Using this tool, ISL exported the worst-case climate change scenario for review.

ISL selected the Calgary International rain gauge, ID: 3031094, due to its proximity to Strathmore. A Gumbel distribution and SSP5.85 model was selected to estimate IDF curves for the year 2100 (RCP8.5). RCP8.5 refers to Representative Concentration Pathway resulting in radiative forcing of 8.5 W/m^2 by 2100, and where radiative forcing continues to rise beyond this year. This scenario provides the most severe climate change impacts compared to other RCP scenarios.

The 1:5 year 1-hour and 1:100 year 24-hour Chicago distribution design storms were developed for the RCP 8.5 climate change scenario. Climate change design storms are summarized below in **Exhibit 6.2** for the Chicago distribution.

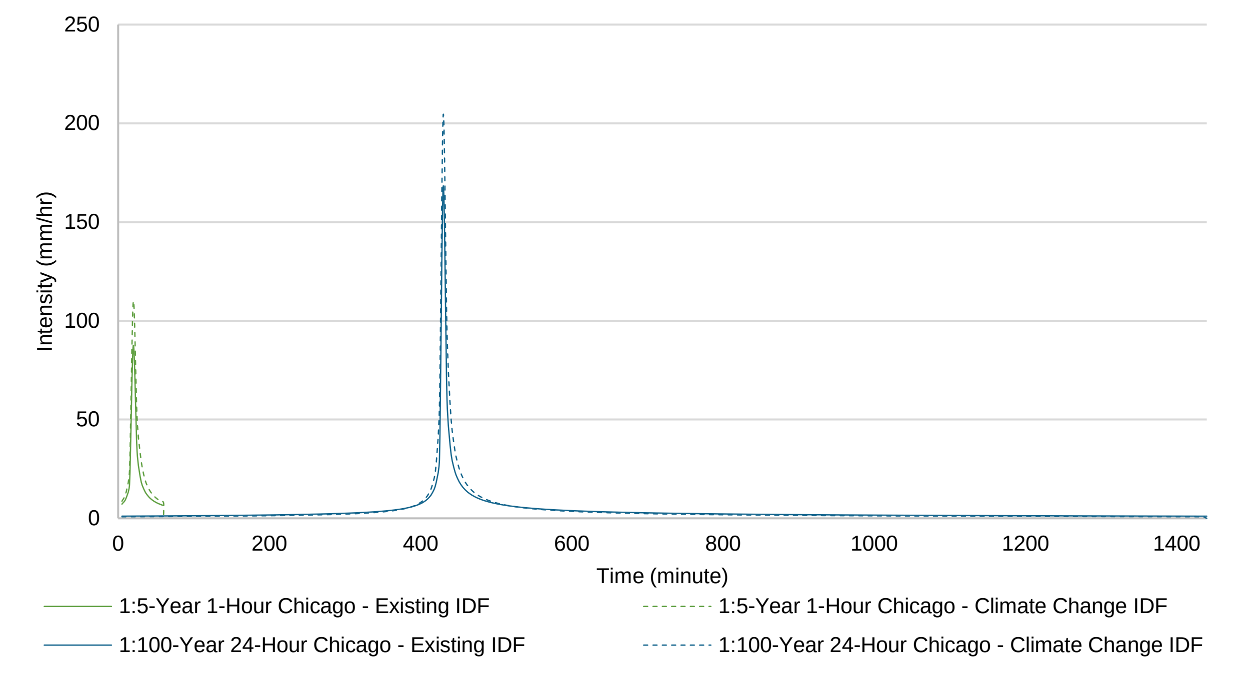


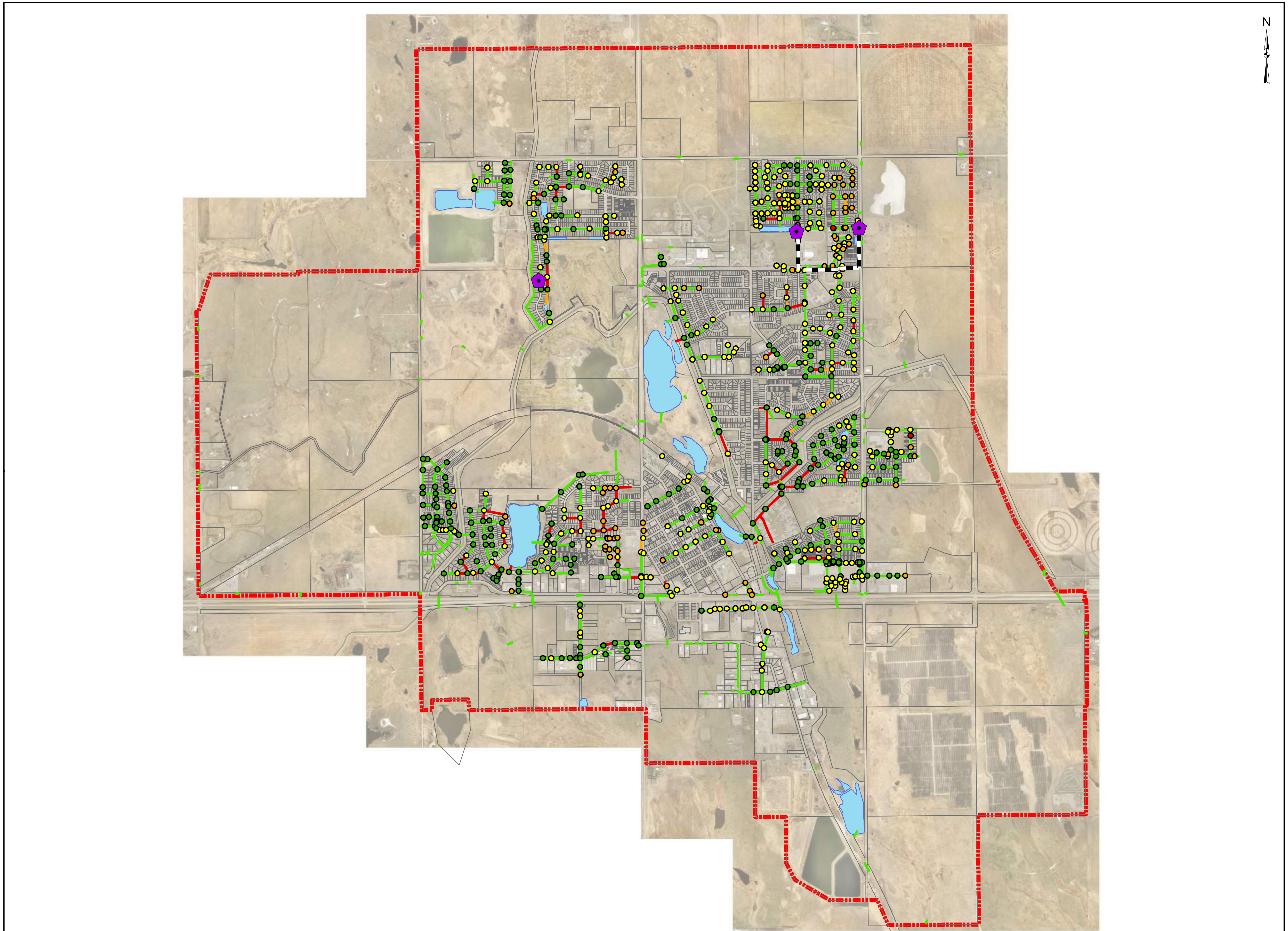
Exhibit 6.2: Calgary Chicago Distribution Climate Change Design Storms

A summary of the increase in peak rainfall intensity for the 1:5-year and 1:100-year return periods between the existing and climate change scenarios is provided in **Table 6.8**.

Table 6.8: Rainfall Depth Increases Due to Climate Change

Return Period	Existing IDF Peak Rainfall Intensity	RCP 8.5 IDF Peak Rainfall Intensity	Percent Increase
	mm/hr	mm/hr	%
1:5 Year	87.5	109.7	25.4
1:100 Year	168.1	204.3	21.5

The results for the peak discharge relative to sewer capacity and the maximum HGL elevation relative to ground under the 1:5 year 1-hour Chicago distribution rainfall event accounting for climate change are shown in **Figure 6.12**. The spare capacity results are illustrated in **Figure 6.13**. Likewise, the results for the peak water depth and surface flow velocity under the 1:100 year 24-hour Chicago distribution rainfall event accounting for climate change are shown in **Figures 6.14 and 6.15,** respectively.



Legend

- Lift Station
- Storm Pressure Main
- Cadastral
- Town Boundary
- Storm Ponds

Maximum HGL Relative to Ground

- Less than 2.5m
- -2.5m to -1.2m
- -1.2m to 0.0m
- Greater than 0.0m

Peak Flow Relative to Capacity

- Less than 86%
- 86% to 100%
- Greater than 100%

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

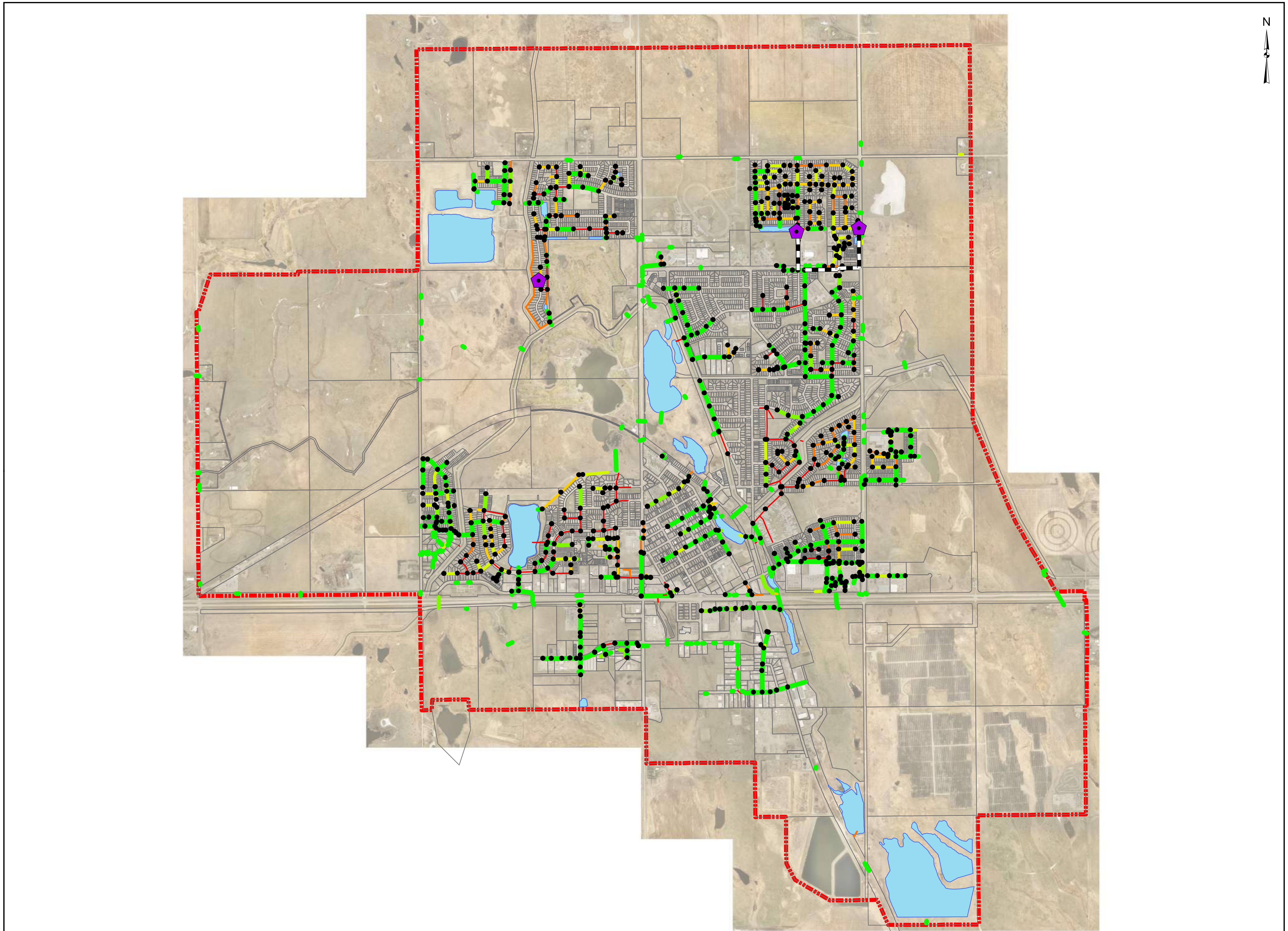
FIGURE 6.12
EXISTING SYSTEM ASSESSMENT - 1D
5 YR 1 HR DESIGN STORM
WITH CLIMATE CHANGE
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Integrated Expertise. Locally Delivered.

Date: 2024-05-23 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure 6.13_5 Year_Pipe Results_Q-Qman and Max HGL_Climate Change.mxd



Legend

- Storm Manholes
- Lift Station
- Storm Pressure Main
- Cadastral
- Town Boundary
- Storm Ponds

Spare Capacity

- Less than 0L/s
- 0 - 25L/s
- 25 - 50L/s
- 50 - 75L/s
- 75 - 100L/s
- Greater than 100L/s

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

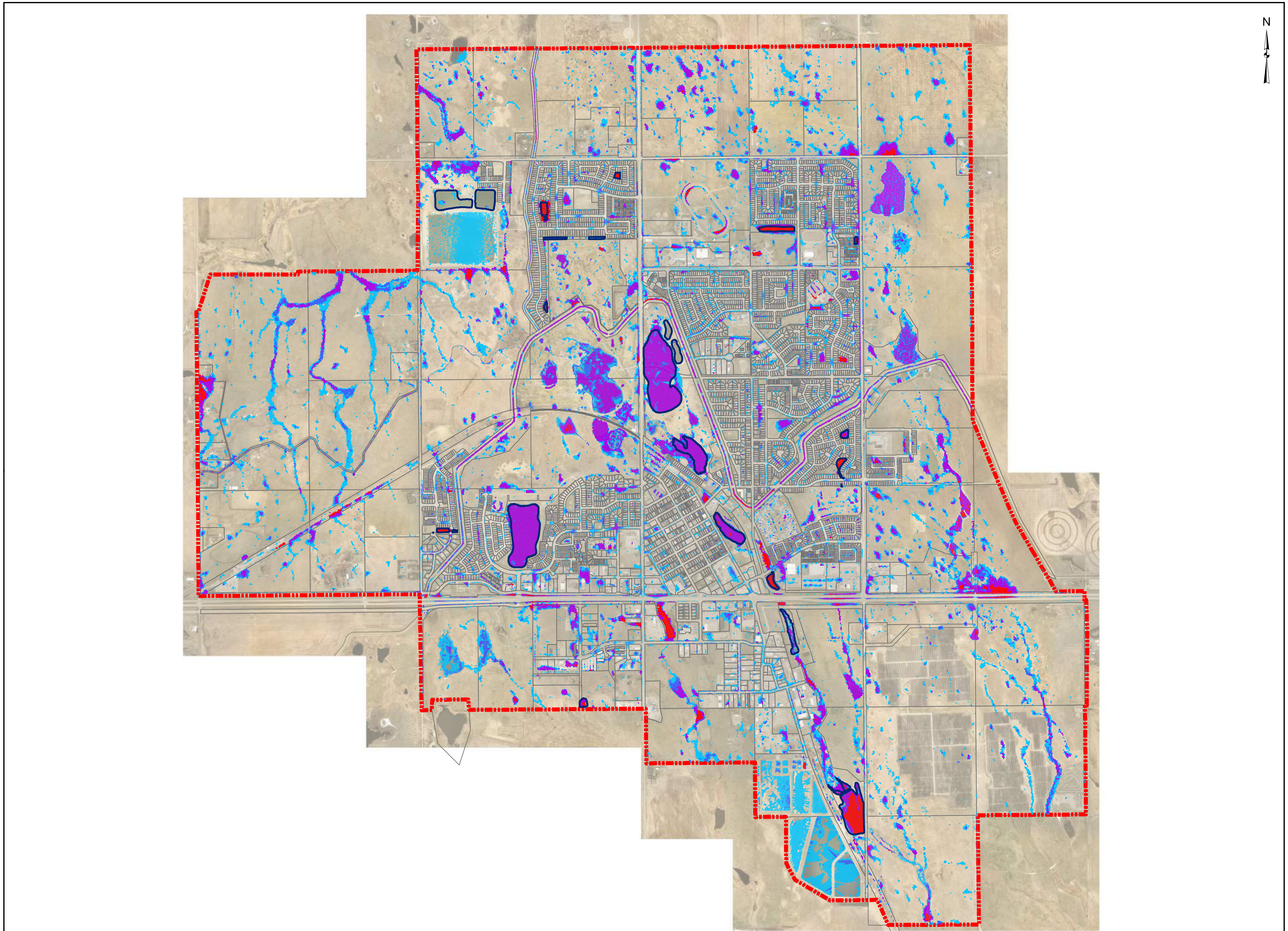
FIGURE 6.13
SPARE CAPACITY - 1D
5 YR 1 HR DESIGN STORM
WITH CLIMATE CHANGE
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Date: 2024-05-23 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure 6.14_5 Year_Pipe Results_Spare Capacity_Climate Change.mxd

Integrated Expertise. Locally Delivered.



Legend

Cadastral

Town Boundary

Storm Ponds

Maximum Depth (m)

0.09 - 0.210

0.211 - 0.320

0.321 - 0.800

Greater than 0.80

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 6.14
EXISTING SYSTEM ASSESSMENT - 2D
100 YR 24 HR DESIGN STORM
WITH CLIMATE CHANGE
MAXIMUM WATER DEPTH
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

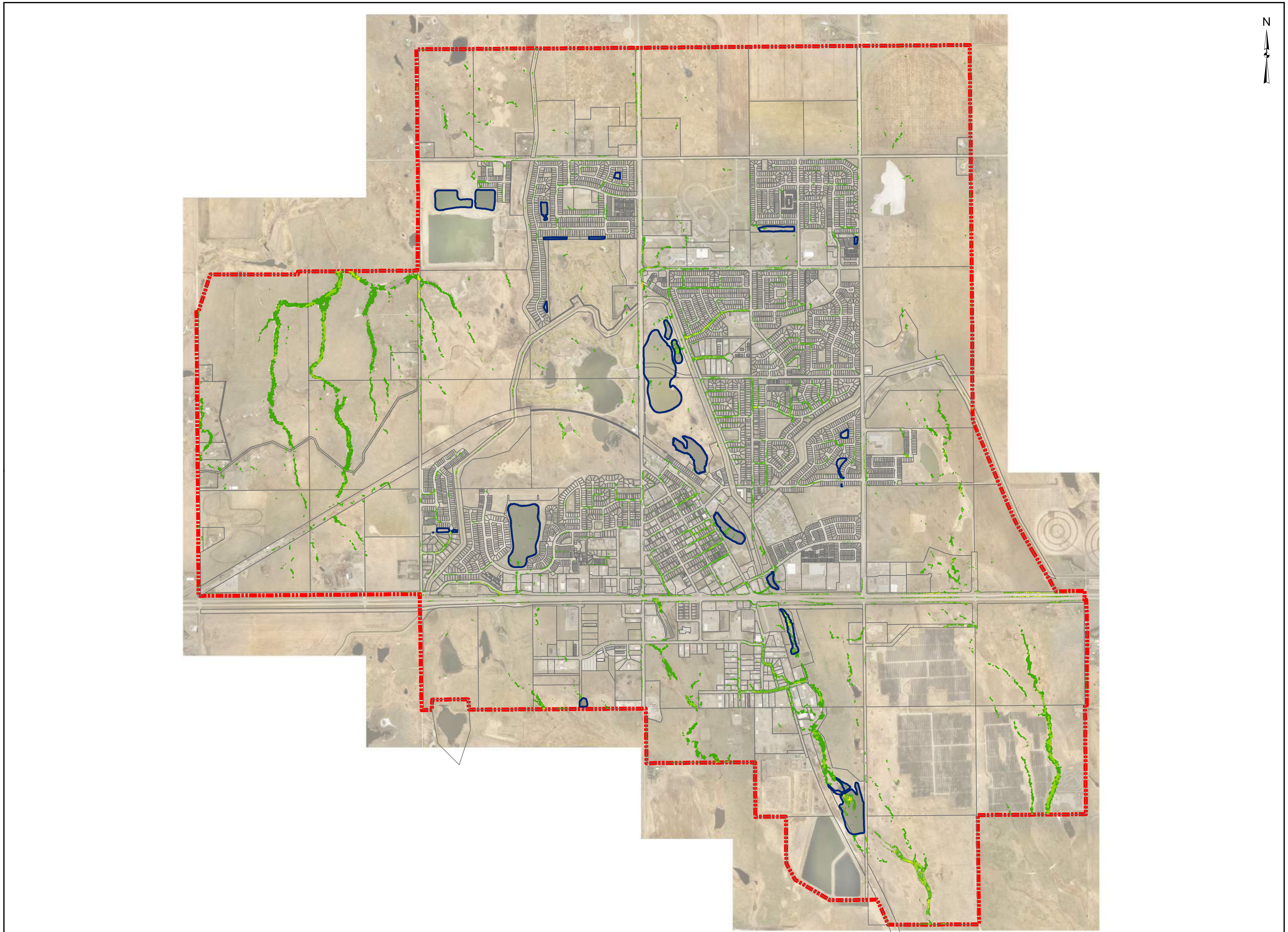


FIGURE 6.15
EXISTING SYSTEM ASSESSMENT - 2D
100 YR 24 HR DESIGN STORM
WITH CLIMATE CHANGE
PEAK SURFACE FLOW VELOCITY
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

The increase in stormwater runoff attributed to more intense rainfall events from climate change does not overwhelm the Town's stormwater network entirely when compared to the existing IDF curves. In the newer neighbourhoods where minimal flooding was observed under the existing IDF curve scenarios, similar results were generally show in the climate change scenarios (i.e., minimal flooding, in some nodes/conduits the level of surcharging increased by one colour code grouping). This suggests that the newer infrastructure was sized adequately. More significant surcharging and flooding was observed in the Hillview and Strathcona areas (i.e. increases of more than two colour code groupings), however, suggesting localized capacity constraints. Though this is provided as a sensitivity analysis for comparative purposes, if the Town wishes to pursue a more conservative and resilient approach that considers climate change, additional pipe upgrades may be required in these areas.

Where sewers were previously indicated as being surcharged to the point of surface flooding under the existing IDF curve scenarios, increases in surface flooding in the vicinity of these locations was evident. This further supports the locations identified for upgrading.

6.7 Cost Estimates

For the existing upgrades identified, the cost estimates summary for each upgrade are presented in **Table 6.9** below. The detailed cost estimate is provided in **Appendix C**.

When developing the cost estimate the following assumptions were made:

- Mobilization and demobilization costs are not included.
- Costs are representative of 2024 dollars.
- The final total cost has been rounded to the nearest $5,000.

Table 6.9: Existing Upgrades Cost Estimate Summary

ID	Description	Total Cost
1	Upgrade the existing pipes on Westmount Drive between Wales Green and Windsor Place to 600 mm on the West side and 525 mm on the east side.	$545,000
2	Upgrade the existing pipes on Westwood Street, Wheeler Street, and Willow Drive between Westwood Street and Wheeler Street to 675 mm.	$1,695,000
3	Upgrade the existing pipes along the back lane on the west side of Wheeler Street to Westview Street to 525 mm and 450 mm. Also upgrade the existing pipes on the West side of Wheeler Street along the green space to Wheatland Green to 675 mm.	$710,000
4	Upgrade the existing pipes along the South side of Strathmore Lakes Crescent and Strathmore Lakes Way to 525 mm.	$800,000
5	Upgrade the existing pipes on Westmount Drive between Westlake Circle and Strathmore Lakes Bay to 675 mm.	$325,000
6	Upgrade the existing pipes on Ridge Road in front of the Strathmore Station Restaurant and Pub area to 450 mm.	$345,000
7	Upgrade the existing pipes on Aspen Circle from Aspen Mews and northward to 300 mm and 450 mm. Also upgrade the pipes going along the houses to the storm pond behind the houses on Aspen Circle and Aspen Point to 525 mm.	$370,000
	Total	**$4,790,000**

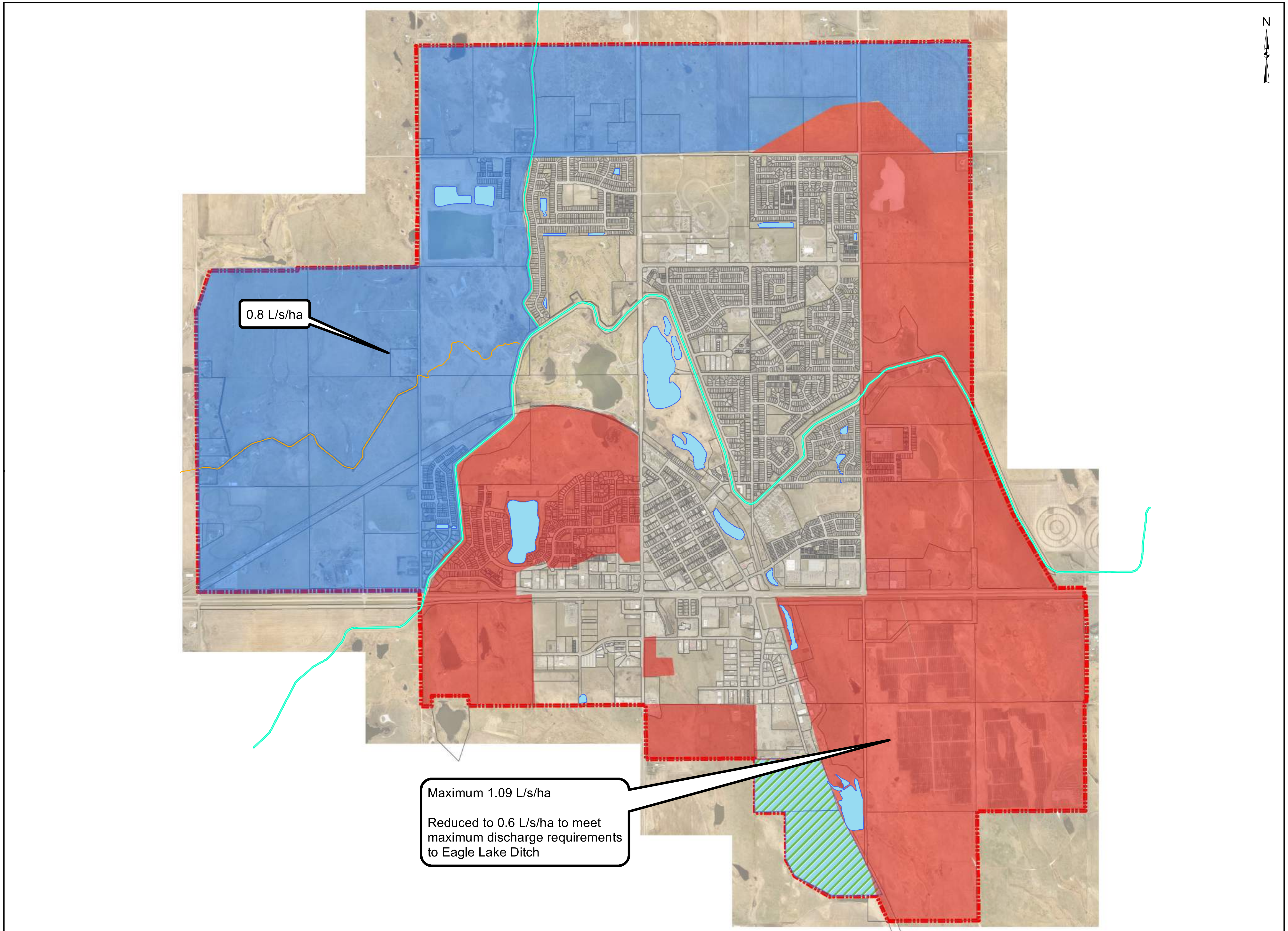
7.0 Future System Assessment and Upgrades

In terms of planning for the Town's future stormwater system, only quarter sections where growth is currently planned for are included. Further discussion pertaining to the quarter sections that are planned for future development is provided below.

7.1 Future Drainage Patterns

Major and minor stormwater drainage systems are required to collect and control runoff in proposed development areas. Runoff due to development in these areas must be controlled to ensure public safety and minimize property damage and environmental impacts. This is best accomplished by collecting storm runoff by major storm sewers and conveying it to a SWMF where the release rate can be controlled. Based on Alberta Environment and Protected Areas (AEPA) regulations, it is specified that post-development flows released should not exceed pre-development flows and the pre-development runoff rate criteria established in **Section 5.1**.

Future catchments based on drainage to either the CSMI Serviceberry Creek alignment or Eagle Lake Ditch were established and are shown in **Figure 7.1**. These catchments were delineated based on the current topography. These catchments should be revisited at the development stage to ensure that the proposed grading of each development site is accounted for. Noted in **Section 4.2.2**, drainage patterns are generally divided on a per quarter section basis and further split or grouped based on major changes in topography and natural drainage patterns. Generally, future development area drainage patterns are summarized in **Table 7.1**. These catchments were delineated based on the current topography. As mentioned, these catchments should be revisited at the development stage to ensure that the proposed grading of each development site is accounted for. Noted above, drainage patterns are generally divided on a per quarter section basis and further split or grouped based on major changes in topography.



Legend

- Cadastral
- Town Boundary
- W.I.D. 'A' Canal
- W.I.D. Canal
- Existing Storm Pond
- Lagoon / Wastewater Treatment Plant

Discharge Boundary

- CSMI - 0.8 L/s/ha
- Eagle Lake Ditch Drainage - 1.09 L/s/ha

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 7.1
DISCHARGE BOUNDARIES
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL Strathmore

Date: 5/24/2024 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Figure 7.1_Discharge Boundaries.mxd

Integrated Expertise. Locally Delivered.

Table 7.1: Summary of Future Development Drainage Patterns

Pond ID	Watershed	Drainage Direction	Area
			ha
Proposed Pond 1	Red Deer River	Northwest	70.18
Proposed Pond 2	Red Deer River	Northwest	35.97
Proposed Pond 3	Red Deer River	Northwest	26.62
Proposed Pond 4	Red Deer River	Northwest	56.44
Proposed Pond 5	Red Deer River	Northwest	49.11
Proposed Pond 6	Red Deer River	Northwest	53.15
Proposed Pond 7	Bow River / Red Deer River	Southeast	96.34
Proposed Pond 8	Red Deer River	Northwest	106.10
Proposed Pond 9	Red Deer River	Northwest	152.27
Proposed Pond 10	Bow River	Southeast	65.70
Proposed Pond 11	Red Deer River	Northwest	65.86
Proposed Pond 12	Bow River / Red Deer River	Northwest	86.24
Proposed Pond 13	Bow River / Red Deer River	Northwest	74.26
Proposed Pond 14	Bow River	Southeast	99.01
Proposed Pond 15	Bow River	Southeast	100.28
Proposed Pond 16	Bow River	Southeast	69.31
Proposed Pond 17	Bow River	Southeast	32.78
Proposed Pond 18	Bow River	Southeast	191.24
Proposed Pond 19 (Storm Pond #7)	Bow River	Southeast	131.22

7.2 Future System Concept

The specified sewer sizes are the smallest possible determined based on the required minimum design slope to provide a self-cleansing full sewer velocity, under the derived peak flows, based on the parameters summarized in **Table 7.2**. All proposed stormwater sewers were assumed to have relatively straight alignments.

Table 7.2: Minimum Design Slopes for Sewers

Nominal Sewer Size	Material	Minimum Design Slope		Full Sewer Capacity	Full Sewer Velocity
mm		%	m/m	L/s	m/s
200	PVC	0.60%	0.006	30.02	0.96
250	PVC	0.40%	0.004	44.45	0.91
300	PVC	0.32%	0.0032	64.65	0.91
375	PVC	0.24%	0.0024	101.51	0.92
450	PVC	0.18%	0.0018	142.95	0.90
525	PVC	0.16%	0.0016	203.30	0.94
600	PVC	0.12%	0.0012	251.37	0.89
675	CONC	0.15%	0.0015	325.56	0.91
750	CONC	0.13%	0.0013	401.40	0.91
1350	CONC	0.10%	0.001	1687.83	1.18

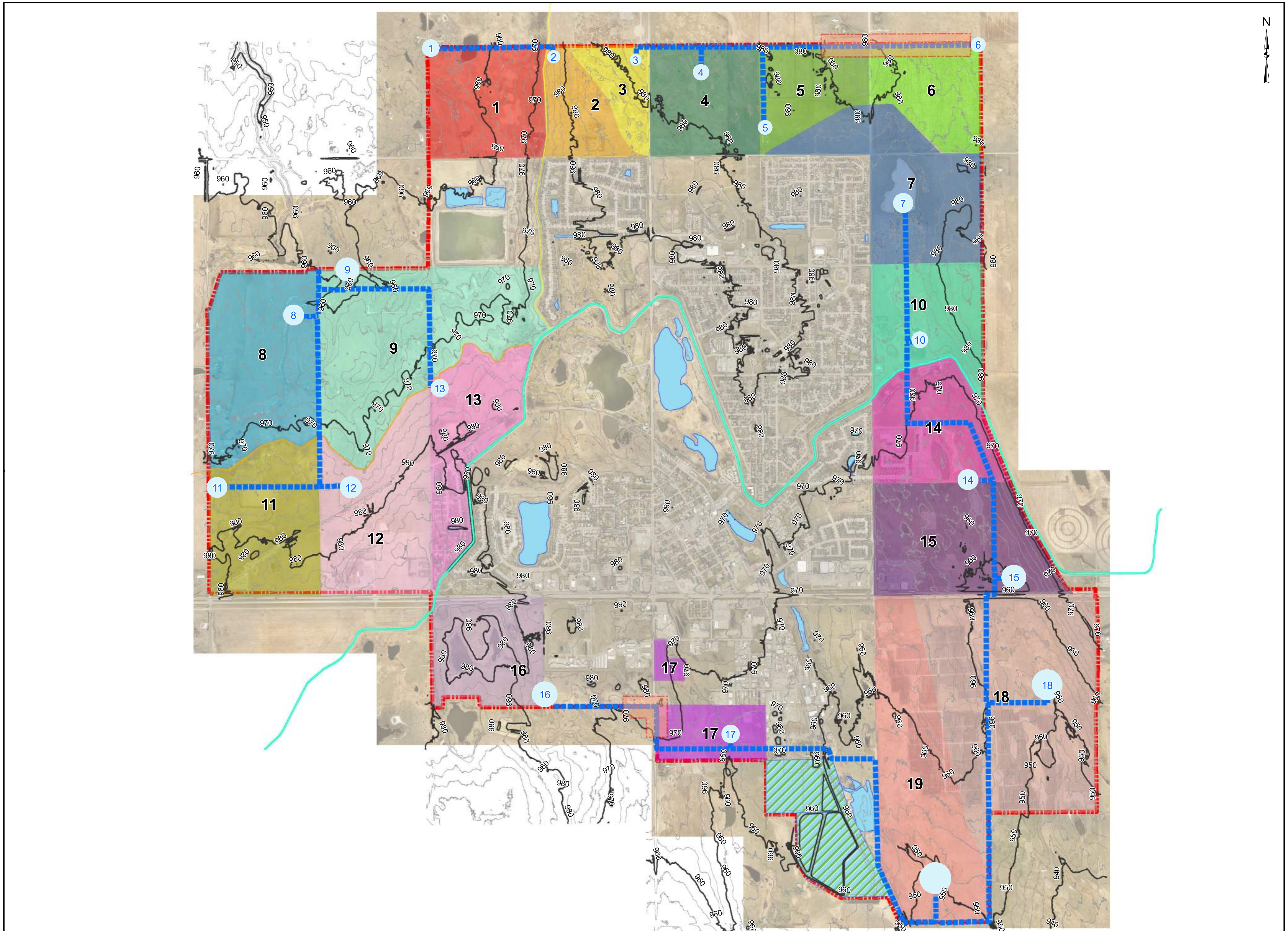
If flatter slopes are preferred or required at the detailed design stages, this can be reviewed, though it could have negative repercussions. If this was acceptable, the determined sewer sizes would potentially need to be increased to meet the specified design flows. Alternatively, steeper slopes could potentially be achieved depending on topography and how the developments are ultimately graded. This could result in a potentially smaller pipe diameter, which again, should be reviewed during detailed design.

Design parameters used to size the proposed ponds are shown in **Table 7.3** while catchments are shown in **Figure 7.2**. It is noted that the average annual runoff volumes recommended by the CSMI report are 20 mm and 40 mm for the Eagle Lake Ditch and Serviceberry Creek drainage courses, respectively. The release rates in **Table 7.3** should be followed to adhere to the Town's CSMI Agreement for discharge to Serviceberry Creek, and to not exceed a maximum discharge of 1,700 L/s to the Eagle Lake Ditch.

Table 7.3: Proposed Pond Design Parameters

Pond ID	Discharge Location	Catchment Area	Release Rate	Max. Release Flow
		ha	L/s/ha	L/s
Proposed Pond 7	Eagle Lake Ditch	96.3	0.6[1]	57.9
Proposed Pond 10	Eagle Lake Ditch	65.7		39.5
Proposed Pond 14	Eagle Lake Ditch	99.0		59.5
Proposed Pond 15	Eagle Lake Ditch	100.3		60.2
Proposed Pond 16	Eagle Lake Ditch	64.4		38.7
Proposed Pond 17	Eagle Lake Ditch	37.7		22.7
Proposed Pond 18	Eagle Lake Ditch	191.2		114.9
Proposed Pond 19 (Storm Pond #7)	Eagle Lake Ditch	131.2		78.8
Proposed Pond 1	Serviceberry Creek via Bazant Drain	70.2	0.8	56.1
Proposed Pond 2	Serviceberry Creek via Bazant Drain	36.0		28.8
Proposed Pond 3	Serviceberry Creek via new ditch system east of Highway 817	26.6		21.3
Proposed Pond 4	Serviceberry Creek via new ditch system east of Highway 817	56.4		45.2
Proposed Pond 5	Serviceberry Creek via new ditch system east of Highway 817	49.1		39.3
Proposed Pond 6	Serviceberry Creek via new ditch system east of Highway 817	53.2		42.5
Proposed Pond 8	Serviceberry Creek via Bazant Drain	106.1		84.9
Proposed Pond 9	Serviceberry Creek via Bazant Drain	152.3		121.8
Proposed Pond 11	Serviceberry Creek via Bazant Drain	65.9		52.7
Proposed Pond 12	Serviceberry Creek via Bazant Drain	86.2		69.0
Proposed Pond 13	Serviceberry Creek via Bazant Drain	74.3		59.4

[1] *Reduced from 1.09 L/s/ha to meet the overall allowable discharge to the Eagle Lake Ditch.*



Legend

- Major Contour - 10m Interval
- Minor Contour - 2m Interval
- Proposed Gravity Main
- W.I.D. Infrastructure
- W.I.D. Main Canal
- W.I.D. North Canal
- Proposed Storm Pond - Scaled
- Potential Pressure Main Location
- Town Boundary
- Existing Storm Pond
- Lagoon / Wastewater Treatment Plant

Subcatchment ID

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE 7.2
FUTURE SUBCATCHMENTS
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Integrated Expertise. Locally Delivered.

Exhibit 7.1 illustrates the ultimate discharge locations to Eagle Lake and Serviceberry Creek via either the Eagle Lake Ditch, the Bazant Drain, or a new ditch tying to a tributary of Serviceberry Creek. The base figure was obtained from the CSMI Modelling and Stage Development Final Report (MPE, 2020), and markups relevant to this study are shown in red.

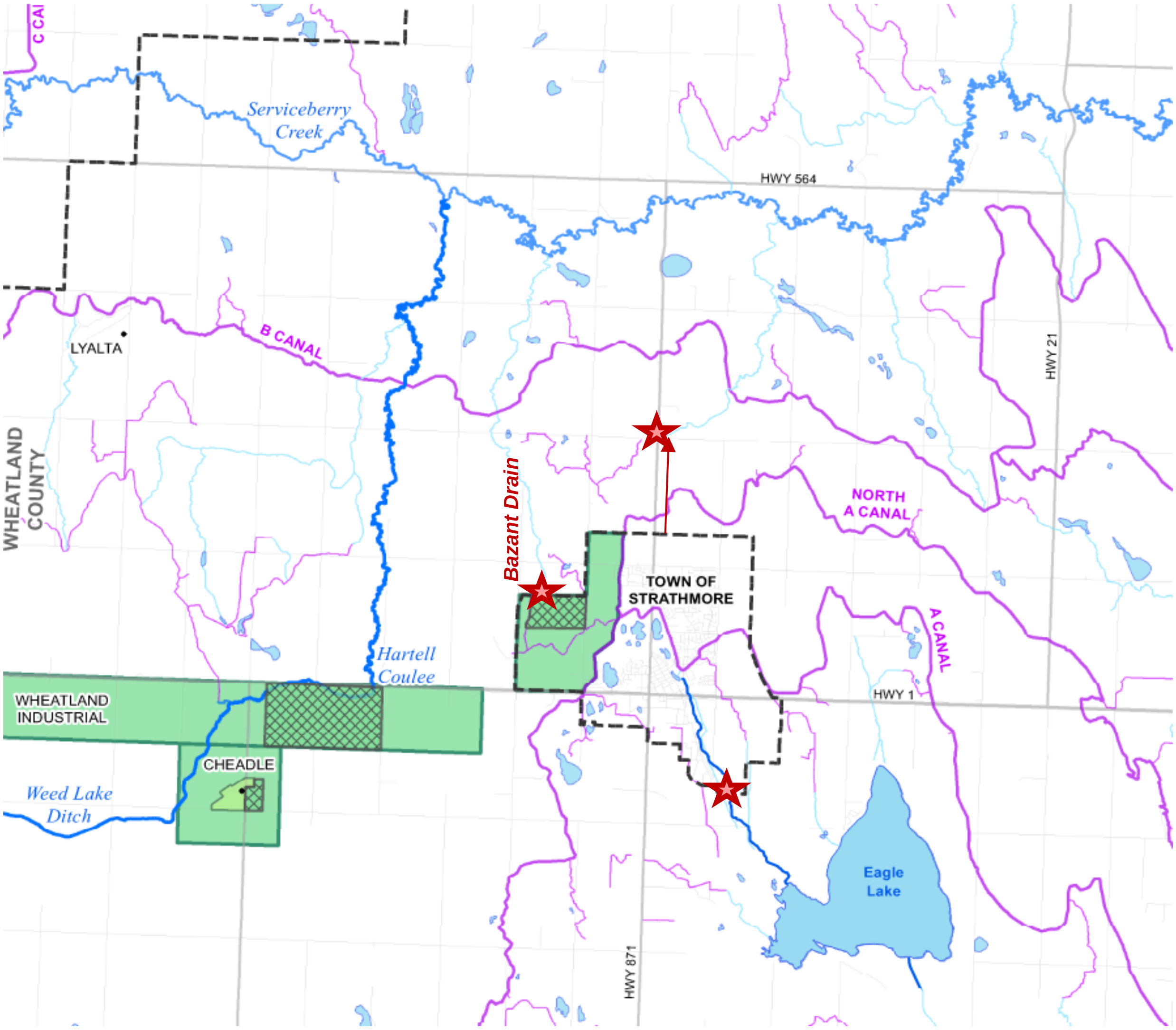
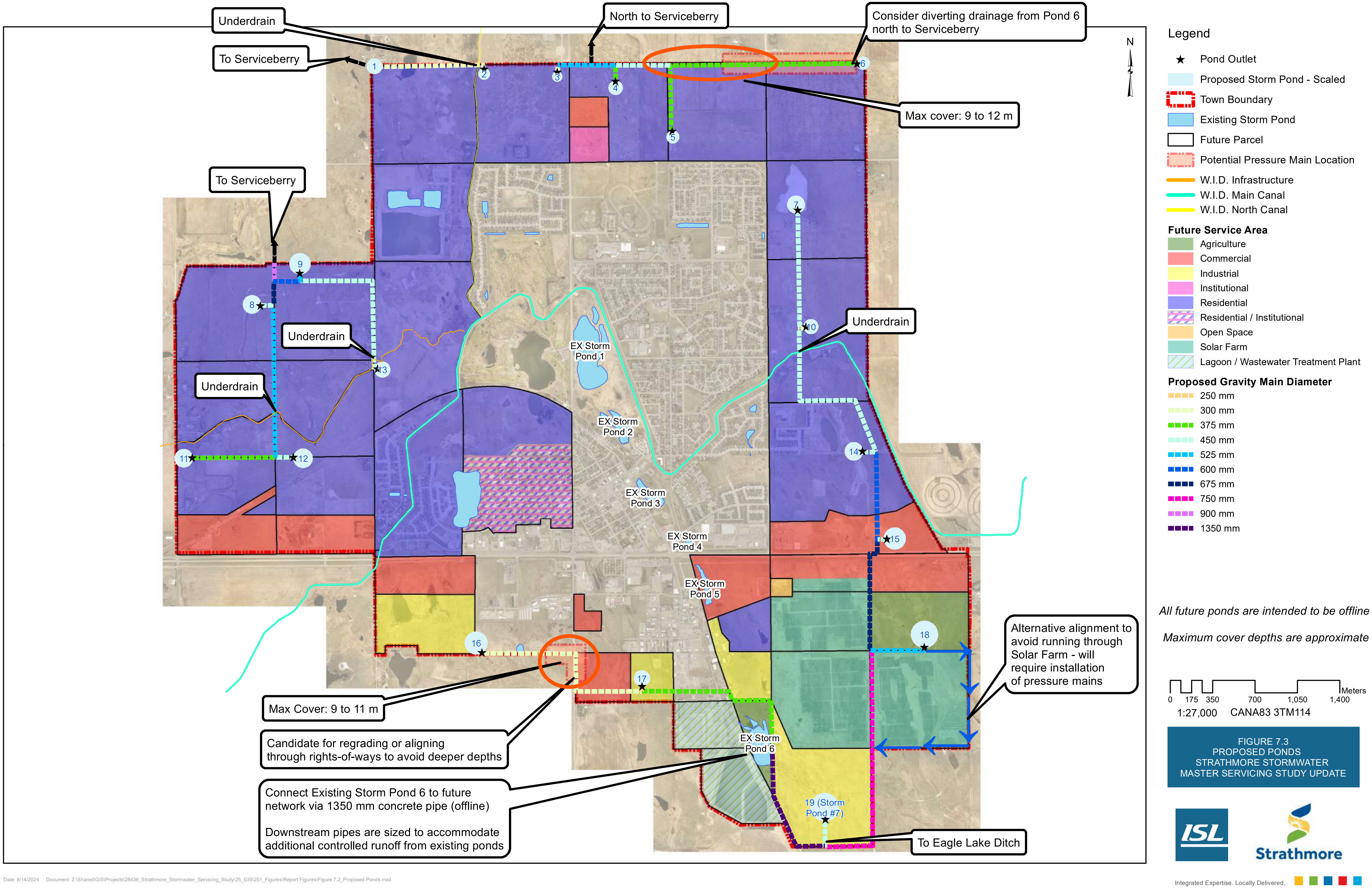


Exhibit 7.1: Proposed Concept Discharge Locations (MPE, 2020)

Based on this design criteria, and that described in Section 5.4, trunk storm sewers and SWMFs were sized for new development areas within Strathmore. The conceptual design of the future SWMFs and conveyance can be seen in **Figure 7 3.** Local storm sewers feeding each SWMFs would be built by the respective developers in each area at the time of development, thus were excluded for this purpose.

In order to avoid deeper sections and installation of a pressure main, it is recommended that regrading or aligning through rights-of-way be considered in the area downstream of Proposed Pond 16 as indicated on **Figure 7.3**. The current future alignment south of Proposed Pond 18 currently has the pipe running through the solar farm. This alignment can be diverted to go around the solar farm but will require the installation of pressure mains. This is also indicated in **Figure 7.3.**



Underdrain
To Serviceberry
North to Serviceberry
Consider diverting drainage from Pond 6 north to Serviceberry
Max cover: 9 to 12 m
To Serviceberry
Underdrain
Underdrain
Underdrain
EX Storm Pond 1
EX Storm Pond 2
EX Storm Pond 3
EX Storm Pond 4
EX Storm Pond 5
EX Storm Pond 6
19 (Storm Pond #7)
Max Cover: 9 to 11 m
Candidate for regrading or aligning through rights-of-ways to avoid deeper depths
Connect Existing Storm Pond 6 to future network via 1350 mm concrete pipe (offline)
Downstream pipes are sized to accommodate additional controlled runoff from existing ponds
To Eagle Lake Ditch
Alternative alignment to avoid running through Solar Farm - will require installation of pressure mains
N
Legend
Pond Outlet
Proposed Storm Pond - Scaled
Town Boundary
Existing Storm Pond
Future Parcel
Potential Pressure Main Location
W.I.D. Infrastructure
W.I.D. Main Canal
W.I.D. North Canal
Future Service Area
Agriculture
Commercial
Industrial
Institutional
Residential
Residential / Institutional
Open Space
Solar Farm
Lagoon / Wastewater Treatment Plant
Proposed Gravity Main Diameter
250 mm
300 mm
375 mm
450 mm
525 mm
600 mm
675 mm
750 mm
900 mm
1350 mm
All future ponds are intended to be offline
Maximum cover depths are approximate
0 175 350 700 1,050 1,400 Meters
1:27,000 CANA83 3TM114
FIGURE 7.3
PROPOSED PONDS
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE
ISL
Strathmore
Integrated Expertise. Locally Delivered.

Strathmore could consider implementing low impact development (LID) techniques in the new development areas to assist with reducing stormwater runoff and increasing the quality of stormwater being distributed into the downstream receiving bodies of water. Some of these techniques include rain gardens, green roofs and pervious pavement. A summary of many of the best management practices (BMP) options available is provided in **Section 7.3**.

When sizing the SWMFs, the allowable discharge flow rates were applied to the orifice equation to determine the required orifice size. The orifices were then rounded down to the nearest nominal diameter (50 mm increments) to ensure the SWMFs would be able to accommodate the total volume without allowing additional discharge over the stipulated flow rates. Orifice sizing is detailed in **Table 7.4**, pipe sizing is in **Table 7.5**, and SWMF sizing is summarized in **Table 7.6.**

2D modelling was not performed for the future system. As the exact grading and configuration of the future areas cannot be known until development begins to occur, determining ultimate grading and detailed land use types (to provide input into Mesh, Roughness, and Infiltration Zone parameters) would be a complete estimation. Therefore, 2D modelling at this point is premature as it could not accurately depict or foresee areas with enhanced surface flows. Additionally, it is assumed that developers are required to maintain pre-development flow rates, thus there would in theory be no net impact caused by the added developments. It is recommended that the 2D model be updated and assessed on a regular basis to include developments that have just come online.

7.2.1 Future Storm SWMF 19 (Storm Pond 7)

The footprint of Storm Pond 7 was determined to be 4.34 ha; a significant reduction from previous concepts which had the footprint comprising almost an entire quarter section. This is due to the addition of the solar farm (i.e., reduction in runoff) and implementing smaller upstream ponds instead of one larger pond. Storm Pond 7 is designed to be offline of Existing Pond 6 but shares the same discharge pipe to the Eagle Lake Ditch.

It is noted that the outflow from Existing Pond 6 under the 1:100 year 24-hour Chicago distribution is 1,239 L/s, representing a combined outflow from the conduit, orifice, weir and overflow weir. As this is within 1% of the allowable release rate from the pond based on the 2006 Master Servicing Study (UMA/AECOM, 2006), this alleviates the need to offload Existing Pond 6 to Storm Pond 7 as noted in the previous Stormwater Master Servicing Study (Allnorth, 2018). There is a significant discrepancy in flows between the previous modelling approach and findings from this study. This is not unexpected, given 1D models tend to overestimate flow contributions due to less accurate flow routing, times of concentration, depression storage, and infiltration parameters. Assumptions pertaining to node flooding can also impact when and where flows re-enter the minor system or how they are conveyed downstream. Though the 1D-2D modelling approach adopted in this study is more accurate, it is recommended that flows from Pond 6 be monitored during the rainy season to observe trends. It is also noted that any improvements made in the existing system (i.e., improvement of catch basin capture, regrading areas, or mitigating minor system surcharging) could result in increased flows downstream. This has the potential to increase outflows from Existing Pond 6, and should be closely monitored as recommended above.

As an alternative, a global Storm Pond 7 combining the other proposed SWMFs in the Eagle Lake Ditch catchment could be considered if the overall volume and discharge requirements are met. This would consist of an amalgamation of Storm Pond 7 and Proposed Ponds 14-18.

Table 7.4: Orifice Sizing

Pond ID	Total Catchment Area	Percent Impervious	Release Rate	Orifice Area	Orifice Diameter	Nominal Orifice Diameter	Nominal Diameter Orifice Area	Release Rate Criteria
	ha		L/s	m^2	m	mm	m^2	
Proposed Pond 1	70.2	32%	56.1	0.0172	0.148	100	0.0079	Serviceberry
Proposed Pond 2	36.0	32%	28.8	0.0088	0.106	100	0.0079	Serviceberry
Proposed Pond 3	26.6	32%	21.3	0.0065	0.091	50	0.0020	Serviceberry
Proposed Pond 4	56.4	36%	45.2	0.0139	0.133	100	0.0079	Serviceberry
Proposed Pond 5	49.1	32%	39.3	0.0121	0.124	100	0.0079	Serviceberry
Proposed Pond 6	53.2	32%	42.5	0.0131	0.129	100	0.0079	Serviceberry
Proposed Pond 7	96.3	32%	57.9	0.0178	0.150	150	0.0177	Eagle Lake Ditch
Proposed Pond 8	106.1	32%	84.9	0.0261	0.182	150	0.0177	Serviceberry
Proposed Pond 9	152.3	32%	121.8	0.0374	0.218	200	0.0314	Serviceberry
Proposed Pond 10	65.7	32%	39.5	0.0121	0.124	100	0.0079	Eagle Lake Ditch
Proposed Pond 11	65.9	55%	52.7	0.0162	0.144	100	0.0079	Serviceberry
Proposed Pond 12	86.2	48%	69.0	0.0212	0.164	150	0.0177	Serviceberry
Proposed Pond 13	74.3	32%	59.4	0.0183	0.152	150	0.0177	Serviceberry
Proposed Pond 14	99.0	32%	59.5	0.0183	0.153	150	0.0177	Eagle Lake Ditch
Proposed Pond 15	100.3	55%	60.2	0.0185	0.153	150	0.0177	Eagle Lake Ditch
Proposed Pond 16	64.4	93%	38.7	0.0119	0.123	100	0.0079	Eagle Lake Ditch
Proposed Pond 17	37.7	89%	22.7	0.0070	0.094	50	0.0020	Eagle Lake Ditch
Proposed Pond 18	191.2	46%	114.9	0.0353	0.212	200	0.0314	Eagle Lake Ditch
Proposed Pond 19 (Storm Pond #7)	131.2	72%	78.8	0.0242	0.176	150	0.0177	Eagle Lake Ditch

Table 7.5: Pipe Sizing

Pipe ID	Flow Rate	Design Flow[1]	Required Diameter	Nominal Diameter	Material	Minimum Slope	Nominal Pipe Capacity	Spare Capacity[2]
	L/s	L/s	mm	mm			L/s	L/s
Proposed Pond 1	56.14	65.28	374	375	PVC	0.0024	101.5	45.4
Proposed Pond 2	28.78	33.46	291	300	PVC	0.0032	64.6	35.9
Proposed Pond 3	21.29	24.76	260	300	PVC	0.0032	64.6	43.4
Proposed Pond 4	45.15	52.51	345	375	PVC	0.0024	101.5	56.4
Proposed Pond 5	39.29	45.68	328	375	PVC	0.0024	101.5	62.2
Proposed Pond 6	42.52	49.45	337	375	PVC	0.0024	101.5	59.0
Proposed Pond 7	57.86	67.28	379	450	PVC	0.0018	143.0	85.1
Proposed Pond 8	84.88	98.70	437	450	PVC	0.0018	143.0	58.1
Proposed Pond 9	121.82	141.65	501	525	PVC	0.0016	203.3	81.5
Proposed Pond 10	39.46	45.89	328	300	PVC	0.0032	64.6	25.2
Proposed Pond 11	52.69	61.27	366	375	PVC	0.0024	101.5	48.8
Proposed Pond 12	68.99	80.22	405	450	PVC	0.0018	143.0	74.0
Proposed Pond 13	59.41	69.08	383	450	PVC	0.0018	143.0	83.5
Proposed Pond 14	59.47	69.15	383	450	PVC	0.0018	143.0	83.5
Proposed Pond 15	60.23	70.03	384	450	PVC	0.0018	143.0	82.7
Proposed Pond 16	38.66	44.95	326	300	PVC	0.0032	64.6	26.0
Proposed Pond 17	22.65	26.34	266	250	PVC	0.004	44.4	21.8
Proposed Pond 18	114.86	133.56	490	525	PVC	0.0016	203.3	88.4
Proposed Pond 19 (Storm Pond #7)	78.81	91.64	425	450	PVC	0.0018	143.0	64.1
Proposed Ponds 16+17 Pipe	61.31	71.29	387	450	PVC	0.0018	143.0	81.6
Proposed Ponds 7+10 Pipe	97.32	113.17	460	525	PVC	0.0016	203.3	106.0
Proposed Ponds 7+10+14 Pipe	156.79	182.31	550	600	PVC	0.0012	251.4	94.6
Proposed Ponds 7+10+14+15 Pipe	217.02	252.34	662	675	CON	0.0015	325.6	108.5
Proposed Ponds 7+10+14+15+18 Pipe	331.87	385.90	776	900	CON	0.001	572.5	240.6
Proposed Ponds 5+6 Pipe	81.81	95.13	431	450	PVC	0.0018	143.0	61.1
Proposed Ponds 5+6+4 Pipe	126.96	147.63	509	525	PVC	0.0016	203.3	76.3
Proposed Ponds 5+6+4+3 Pipe	148.26	172.39	539	600	PVC	0.0012	251.4	103.1
Proposed Ponds 11+12 Pipe	121.68	141.49	500	525	PVC	0.0016	203.3	81.6
Proposed Ponds 11+12+8 Pipe	206.56	240.19	610	675	CON	0.0015	384.8	178.2
Proposed Ponds 9+13 Pipe	181.23	210.73	581	600	PVC	0.0012	251.4	70.1
Proposed Ponds 11+12+8+9+13 Pipe	387.79	450.92	823	900	CON	0.001	572.5	184.7
Existing Pond 6 (Includes Existing Ponds 1-6)	1228.00	1427.91	1268	1350	CON	0.001	1687.8	459.8
Existing Ponds + Pond 16+17 Pipe	1289.31	1499.20	1291	1350	CON	0.001	1687.8	398.5

[1] Assumes pipe is 86% full.
[2] Assuming pipe is at 100% capacity.

Table 7.6: Pond Sizing

Pond ID	Total Catchment Area	Pond Bottom Elevation	Pond Top Elevation	Pond Bottom Area	Pond NWL Area	Pond HWL Area	Pond Top of Freeboard Area	Permanent Pond Volume	Active Pond Volume	Pond Freeboard Volume	Total Pond Volume	Percent of Catchment Area
	ha	m	m	m²	m²	m²	m²	m³	m³	m³	m³	
Proposed Pond 1	70.2	949.8	954.6	6,100	9,100	12,800	13,400	15,200	21,900	4,000	41,100	1.91%
Proposed Pond 2	36.0	964.1	968.9	2,400	4,400	7,100	7,600	6,800	11,700	2,200	20,700	2.11%
Proposed Pond 3	26.6	972.1	976.9	1,500	3,100	5,400	5,800	4,600	8,500	1,700	14,800	2.18%
Proposed Pond 4	56.4	969.6	974.4	4,800	7,500	10,900	11,500	12,300	19,000	3,400	34,700	2.04%
Proposed Pond 5	49.1	970.8	975.6	3,400	5,800	8,800	9,300	9,100	14,800	2,700	26,600	1.89%
Proposed Pond 6	53.2	969.5	974.3	3,800	6,200	9,300	9,800	10,000	16,100	2,900	29,000	1.84%
Proposed Pond 7	96.3	969.1	973.9	9,200	12,900	17,200	17,900	22,100	30,700	5,300	58,100	1.86%
Proposed Pond 8	106.1	958.4	963.2	9,800	13,600	18,100	18,800	23,400	31,800	5,600	60,800	1.77%
Proposed Pond 9	152.3	952.9	957.7	14,200	18,700	23,900	24,700	32,900	44,200	7,300	84,400	1.62%
Proposed Pond 10	65.7	967.8	972.6	5,300	8,200	11,700	12,300	13,400	20,300	3,600	37,300	1.87%
Proposed Pond 11	65.9	969.4	974.2	9,700	13,500	18,000	18,700	23,200	32,000	5,500	60,700	2.84%
Proposed Pond 12	86.2	969.3	974.1	11,200	15,200	19,900	20,700	26,400	35,300	6,100	67,800	2.40%
Proposed Pond 13	74.3	969.2	974.0	6,500	9,700	13,500	14,100	16,100	23,200	4,200	43,500	1.90%
Proposed Pond 14	99.0	956.5	961.3	9,800	13,600	18,000	18,700	23,400	31,600	5,500	60,500	1.89%
Proposed Pond 15	100.3	954.9	959.7	15,900	20,700	26,100	26,900	36,500	48,900	8,000	93,400	2.68%
Proposed Pond 16	64.4	969.5	974.3	16,700	21,600	27,100	28,000	38,200	49,500	8,300	96,000	4.35%
Proposed Pond 17	37.7	955.2	960.0	8,400	12,000	16,200	16,900	20,300	28,700	5,000	54,000	4.48%
Proposed Pond 18	191.2	944.8	949.6	28,600	34,900	41,900	43,000	63,500	80,200	12,800	156,500	2.25%
Proposed Pond 19 (Storm Pond #7)	131.2	942.9	947.7	29,000	35,300	42,300	43,400	64,300	77,800	12,900	155,000	3.31%

7.2.2 Interim Developments

The following subsections summarize key developments that are ongoing or imminent within the Town of Strathmore. Each subsection provides a description of the details provided in the ASP, if available, and a summary of the key findings of the stormwater assessments presented in this SWMSS.

Wildflower Ranch

As per the Wildflower Ranch ASP, the development will consist of a series of ponds that flow to the north and west until reaching an outfall (B&A Planning Group, 2010). Flows must meet the maximum flow rate to meet or exceed the stipulations set out in the Alberta Environment guidelines for water quality (B&A Planning Group, 2010). Land use will consist of primarily low-density residential areas and will include a large natural wetland area in the northwest of the community (B&A Planning Group, 2010).

This area is currently under development. The Wildflower Ranch ASP area is within the CSMI discharge boundary, which outlets to Serviceberry Creek. The maximum discharge rate in this area is 0.8 L/s/ha. The W.I.D. 'A' Canal transects this ASP and requires an underdrain to convey controlled runoff from south to north. There are two ponds proposed in this catchment, SWMFs 13 and 9. SWMF 13 captures runoff south of the W.I.D. 'A' Canal while SWMF 9 captures runoff from the north side of the Canal, along with some contributions from surrounding areas.

The ASP has a wetland complex in the northwest corner as noted above, ultimately collecting runoff from several smaller tributary ponds. Discharge from the wetland is conveyed to the west towards SWMF 9. As this area is under development, the development could proceed as planned in the ASP, with an ultimate reduction in SWMF 9 as this would be staged through the smaller SWMFs throughout Wildflower Ranch.

Lakewood Meadows

Lakewood Meadows will primarily consist of residential land use and open space (La Terra et al., 2021). The ASP stipulates that the storm pond will always maintain a maximum depth of 15 ft, unless weather conditions such as drought do not make this feasible (La Terra et al., 2021). The ASP also states that the stormwater facility in Lakewood Meadows could have capacity to accommodate stormwater from surrounding communities (La Terra et al., 2021). However, the servicing concept proposed in this SWMM allows development to occur independently of Lakewood Meadows.

This area is currently under development and is within the CSMI discharge boundary. Runoff must be controlled to a rate of 0.8 L/s/ha to meet the agreement with the CSMI, with an ultimate discharge to Serviceberry Creek. There is currently a manmade lake that previously served as the Town's water reservoir prior to the East Calgary Regional Waterline. Additional SWMFs exist north of this lake as well, with ultimate discharge to the north. For this reason, no additional facilities are proposed, and staging can proceed as planned as it remains independent of future catchments.

The Ranch

The Ranch is a multi-phase, partially developed residential area. There is currently no ASP for this development, given it was started prior the requirement for an ASP but understood that Phase 5 has started development (Strathmore, 2021). 2D assessment results in this area suggest some pockets of surface depths in the 0.3 m to 0.8 m range, generally in low points as expected. This is likely due to a lack of minor system infrastructure and current grading of the area, which is likely to change as development progresses in future phases of development. Proper site grading in minor system infrastructure tying to the sewer on Ranch Gate would mitigate flooding when developed. The sewer system downstream of the tie-in point on Ranch Gate has sufficient spare capacity under the 1:5 year existing condition scenario results. However, flooding at the downstream end along Archie Klaiber Trail is evident due to the culvert deficiencies summarized in **Table 6.3**. Additional catch basins could also be implemented to further mitigate ponding along Archie Klaiber Trail.

Legacy Farms

Legacy Farms is located west of the solar farm. Land use consists primarily of a mix of industrial, commercial, agriculture, and urban reserve areas (MVH Urban Planning & Design, 2022). Overland flow will primarily drain from north to south, and storm ponds will accommodate runoff from the development with stormwater conveyed by pipes. Legacy Farms' outfall ultimately discharges to Existing Storm Pond 6 (MVH Urban Planning & Design, 2022), and Existing Storm Pond 5 is currently in the northwest corner of the development. Runoff is controlled via these existing storm ponds.

This area is currently under development and is within the Eagle Lake Ditch discharge boundary. Runoff must be controlled to an ultimate rate of 1.09 L/s/ha. As Existing Storm Ponds 5 and 6 are operational, no additional facilities are proposed.

Canal Gardens/Crossing

Canal Gardens and Canal Crossing are subdivisions located in the southwest of Strathmore, south of Highway 1. These areas are currently under development and ultimately contribute to Existing Storm Pond 6. These areas are in the Eagle Lake Ditch discharge boundary, with runoff ultimately controlled to a rate of 1.09 L/s/ha.

Edgefield (Residential and Commercial Developments)

Land use for Edgefield consists of primarily low-density residential and commercial areas (Town of Strathmore, 2015). Stormwater will be conveyed via gravity mains to several storm ponds throughout the development (Town of Strathmore, 2015).

This area is currently under development and contributes to the Eagle Lake Ditch. There are two main catchments and ponds proposed for this area; SWMFs 14 and 15. Though the ASP suggests a series of storm ponds, the alignments and general footprints in this SWMSS are meant to align with the ASP concept and can be staged as development progresses. While the ASP has runoff discharging to Existing Storm Pond 6, this will be realigned directly to Eagle Lake Ditch and will be controlled to keep the discharge of the ditch within the maximum rate of 1,700 L/s. A discharge pipe, ultimately to the Eagle Lake Ditch, is proposed. That said, overland drainage to the Eagle Lake Ditch if an overall equivalent capacity is maintained could be an alternative.

7.3 Low Impact Developments

In order to reduce the overall runoff produced by the developed site, several LID options may be integrated into the stormwater design. LID generally functions to improve stormwater conditions by providing a combination of peak flow attenuation, water quality improvement, and volume reduction through the promotion of infiltration and evapotranspiration.

Integrating LID into the stormwater design of individual sites within the overall development will improve the volumes and quality of water flowing to the proposed SWMFs, resulting in a reduced required SWMF size as discussed above. In addition to this, LID implementation can provide reductions in the total loadings to the receiving waters. As such, LID would support the development in adhering to the recommendation to reduce total suspended solids (TSS), carbonaceous biochemical oxygen demand (CBOD), nitrogen, and phosphorus in accordance with the City of Calgary Total Loading Management Plan (TLMP). It is noted that the implementation of LID measures aligns closer to scenarios where there are mandated volume targets. The following information should be leveraged if volume targets are introduced in Strathmore.

7.3.1 Available Source Control Measures

Source control measures are physical measures that are located at the beginning of a drainage system, generally on private properties which may include:

- Residential properties
- Community centers
- Municipal buildings
- Places of worship
- Schools
- Parks

It is recommended that the Town employ a selection of the technologies in conjunction with the SWMFs to achieve an optimal stormwater runoff water quality and volume reduction. Source control options to be considered are summarized in **Table 7.7**.

Table 7.7: Source Control Practice Table

Source Control Practice	Description	Driving Forces
Stormwater Re-use/ Rainwater Harvesting	Stormwater could be captured in SWMFs or underground storage tanks and used for non-potable uses such as irrigation. This would need to be assessed at the time of development as to whether suitable guidelines for stormwater re-use exist at that stage.	• Potentially significant use of stormwater runoff • Stormwater pollutants retained by storage ponds • Highly applicable to both residential and commercial areas
Bioswales /Vegetated Swales	Stormwater is diverted into surface drainage swales that are vegetated. The net effect is similar to a combination of a grassed swale and an infiltration trench. Significant vegetation is planted to provide additional quality treatment. Subdrains are often installed in soils with infiltration rates below 12.5 mm/hr.	• Provides high amount of volume/rate control • Provides high amount of stormwater pollutant control by retaining pollutants in the swales • Highly applicable to both residential, light commercial, and industrial areas
Absorbent Landscapes	Stormwater runoff is reduced by promoting infiltration into the soil as runoff flows overland. This is often accomplished by designing for significant greenspace. Increased depth of topsoil and reduced soil compaction are also provided for the landscaped areas. This promoted infiltration can allow the soil to work like a sponge to absorb stormwater. Given this technology operates through the promotion of infiltration, soil with a high infiltration rate (low fines content) is recommended. Local geology may limit the effectiveness of this option if a low-permeable soil underlays the added topsoil. A geotechnical report is recommended if this source control is to be implemented.	• Provides high amount of volume/rate control • Highly applicable for low-intensity commercial areas • Somewhat applicable for residential areas • Minimal maintenance required
Green Roofs	Stormwater runoff is reduced by using vegetated roofs. Stormwater is absorbed into soil and is then either evaporated naturally or collected by a subdrain system.	• Works well for roofs of larger buildings (normally commercial and industrial) • Provides high amount of volume/rate control, particularly for small events • Can be used as on-lot stormwater control for commercial/industrial areas
Bioretention Areas	Bioretention areas consist of of depressed, landscaped areas utilized to improve water quality, attenuate peak flows to the stormwater minor system, and to reduce overall stormwater volume through promotion of evapotranspiration. Stormwater is absorbed into soil and is then either evaporated naturally or collected by a subdrain system. Plantings are chosen specifically to optimize the uptake of stormwater nutrient loadings (nitrogen, phosphorus) in the geographic location of interest. Municipalities should be mindful that some maintenance of these systems is required when sediment buildup occurs and following the winter frost.	• Works well for most land uses (can be incorporated into parks, roadway medians, parking lots, sidewalk planting strips, etc.) • Can be used as on-lot stormwater control for commercial, residential, and industrial areas. • Provides high amount of volume/rate control, particularly for small events • Provides high amount of stormwater pollutant control by retaining pollutants

7.3.2 Feasibility of LID

Loam to silt loam (SCS Class C) soil types are generally not ideal from a soil infiltration aspect and require the provision of a subdrain for all LIDs. This suggests a physical constraint which could limit the use of LID source and conveyance controls depending on area-specific soils. It does not in any way indicate that areas with soils with lower relative infiltration rates be excluded from infiltration practices. The infiltration rate of soils will have an obvious effect on the drawdown-time of the facility between events and therefore should be sized accordingly based on design guidance from sources such as the City of Calgary Source Control Practices Handbook (2007) and TRCA/CVC LID Planning and Design Guide (2010). The ultimate infiltration rate of the local soils should not be interpreted as a prohibition but as a caution that controls relying primarily on infiltration may not be as effective as they could be on soils with higher relative rate of infiltration. LID stormwater management practices in soils with lower infiltration rates are designed through the provision of a subdrain, such that they utilize multiple mechanisms (beyond simply infiltration). This might include, but is not limited to filtration, retention, evaporation and/or transpiration.

The primary function of LID practices in soils with low infiltration rates is not infiltration. Through in-situ testing of the site-specific native soils, the application of appropriate safety factors, the LID designs will function in a manner such that the facility only infiltrates what the local soils can reasonably accommodate within the recommended emptying times. The mechanisms of filtration, retention, and evaporation and/or transpiration can be used to improve water quality and reducing runoff volumes. Provided that the proposed LID techniques incorporate the appropriate runoff storage volumes, empty within inter-event periods and are otherwise appropriately sited, designed, monitored and maintained (similar to all other SWMFs), there should be no impediment to the application of LID technologies in the Town. This is supported by The City of Calgary Source Control Practices Handbook (2007) which presents a summary overview of the potential applicability of LID controls measures within an urban context and in relation to Calgary soils and climate (**Table 7.8**).

Table 7.8: Applicability Matrix

LID Practice	Suitability for Calgary Climate and Soils[1]	Land Use Type			
		Industrial	Commercial and Multi Family	Residential	Parks and Open Space
Stormwater Re-use/ Rainwater harvesting	High	✓✓	✓✓	✓✓	✓✓
Grass Swale/Bioswales	High	✓✓	✓	✓✓	✓✓
Bioretention	High	✓	✓✓	✓✓	✓✓
Green Roofs	High	✓✓	✓✓	*X*	*X*
Absorptive Landscapes	High	✓✓	✓✓	✓	✓✓

✓ = somewhat applicable, ✓✓ = highly applicable, *X = not applicable*
[1] Subdrain system may be required

***Note:** Adapted from Table I-2 & I-3, City of Calgary Source Control Practices Handbook (2007)*

7.3.3 LID Performance

In general, water quality improvements begin with filtration of particulates as runoff flows over the surface of the LID and through vegetation, mulch, soil layers and or aggregate layers (City of Edmonton, 2011). For vegetated practices, soil microbes provide decomposition for pollutants such as hydrocarbons and nutrients. Soils also allow metals and chemicals to sorb to soil particles and compounds within the soil, preventing their release to receiving streams. **Table 7.9** summarizes the environmental performance of LID practices.

Table 7.9: Expected Performance

LID Practice (with Subdrain)	Environmental Performance		
	Pollutant Removal	Peak Flow Reduction (Small Events)	Volume Reduction (Estimated)
Stormwater Re-use/ Rainwater Harvesting	N/A	Medium	Medium (40%)[1]
Grass swale/Bioswales	High	Medium	Medium (45-55%)[1]
Bioretention	High	Medium	Medium (45%)[1]
Green Roofs	Medium	Medium	Medium (45-55%)[1]
Absorptive Landscapes	High	Medium	High (varies)
Perforated Pipe Systems	Medium	High	High (89%)[1]

Note: *Adapted from Table I-3 - City of Calgary Source Control Practices Handbook (2007) and amended by TRCA/CVC 2011.*

7.4 Erosion and Sediment Control

A priority of this study is to minimize environmental impacts and support the health of the watersheds in the face of increasing developments. During construction, the removal of topsoil and vegetation will expose subsoils that are more susceptible to erosion since they are not as compacted. Developments which result in an increase of runoff may also contribute to erosion if not properly managed.

Erosive agents, such as wind and water, have the ability of detaching, entraining, and transporting soil particles, thus causing erosion. This process is dependent on the cohesion and texture of the soils, as well as the erosive energy of the agent, such as gravitational and fluid forces. Deposition/sedimentation will occur when the fluid forces of the erosive agent are less than the force of gravity of the soil particles. As the soil particles can no longer be entrained in the air or water, they begin to settle and form depositions. Generally, this is caused by a reduction in flow velocity or turbulence.

If temporary construction and permanent development erosion and sediment control (ESC) practices are not implemented, it can lead to the transport of sediment and other contaminants thus polluting downstream waterbodies. This can result in the following negative impacts:

- Transportation of hydrocarbons, metals, and nutrients with the eroded soils to a water source
- Destruction aquatic habitats
- Sediment deposition in infrastructure and waterbodies
- Reduced quality of water supply
- Limitations to the effectiveness of flood control measures
- Affect recreational areas

The most effective and economical method of controlling erosion is at the source. This includes the implementation of methods such as controlling stormwater runoff (generally accomplished by stipulating maximum allowable area release rates) or by stabilizing exposed soils. Potential options to mitigate negative impacts of erosion are outlined below. Note that the information found in this section has been taken from the Guidelines for Erosion and Sediment Control (City of Calgary, 2011).

All developments are required to submit a detailed ESC report detailing the downstream erosion impacts caused by the proposed stormwater discharge and detail how these impacts are being mitigated.

7.4.1 Vegetative Check Dams

Vegetative check dams act as low-lying barriers within a drainage ditch or channel to decrease the flow velocity and improve water quality. These control measures are generally used for a combination of erosion and sediment control. The dams sit perpendicular to the direction of flow and only allow a certain amount of water to pass through at a time while also retaining sediment. There are limitations involved with vegetative check dams including a maximum feasible slope for implementation of approximately 8% and a minimum slope of 1% to 2%. However, this erosion mitigation measure serves this purpose and achieves the improved water quality objective.

7.4.2 Erosion Control Blankets

Erosion control blankets are the most appropriate erosion mitigation measure when runoff quantity and velocities are the driving force behind the erosion risk. They offer a typical erosion reduction of 95% to 99%. Two of these types of erosion control measures include:

- Straw Blankets:
  - Ideal for short-term erosion control
- Turf Reinforcement Mats:
  - Synthetic material
  - Recommended for additional shear resistance
  - Promotes longevity of a channel
  - Ideal for more long-term erosion control

A substantial length of erosion control blankets would be required due to the long length of steep sloping channels. This steepness may also create issues with feasibility of installation and considerations for the environmental implications must also be made. The soil characteristics of these existing channels may affect the overall performance of erosion control measures and should also be accounted for during construction.

7.5 Cost Estimates

For the pond concepts identified, the cost estimate summary for each pond is presented in **Table 7.10** below. The cost estimates of the gravity mains for these pond concepts are presented in **Table 7.11** below as well. The detailed cost estimates for both are available in **Appendix C**.

When developing this cost estimates, the following assumptions were made:

- Mobilization and demobilization costs are not included.
- Costs are representative of 2024 dollars.
- The final total cost has been rounded to the nearest $5,000.

Table 7.10: Pond Concept Cost Estimates Summary

Pond ID	Total Cost (Rounded)
Proposed Pond 1	$1,465,000
Proposed Pond 2	$905,000
Proposed Pond 3	$745,000
Proposed Pond 4	$1,290,000
Proposed Pond 5	$1,070,000
Proposed Pond 6	$1,135,000
Proposed Pond 7	$1,935,000
Proposed Pond 8	$2,010,000
Proposed Pond 9	$2,655,000
Proposed Pond 10	$1,365,000
Proposed Pond 11	$2,010,000
Proposed Pond 12	$2,205,000
Proposed Pond 13	$1,535,000
Proposed Pond 14	$2,000,000
Proposed Pond 15	$2,900,000
Proposed Pond 16	$2,975,000
Proposed Pond 17	$1,825,000
Proposed Pond 18	$4,630,000
Proposed Pond 19 (Storm Pond #7)	$4,590,000
Total	**$34,655,000**

Table 7.11: Proposed Gravity Main Cost Estimates Summary

Item	Total Cost (Rounded)
250 mm PVC Gravity Main	$70,000
300 mm PVC Gravity Main	$1,750,000
375 mm PVC Gravity Main	$3,620,000
450 mm PVC Gravity Main	$4,555,000
525 mm PVC Gravity Main	$2,390,000
600 mm PVC Gravity Main	$1,145,000
675 mm PVC Gravity Main	$1,585,000
750 mm PVC Gravity Main	$3,560,000
900 mm Concrete Gravity Main	$445,000
1350 mm Concrete Gravity Main	$4,760,000
Total	**$23,880,000**

7.6 Phasing Plan

The proposed network identified in the future network are mainly development-driven by the build-out of the ASP areas. The timeline of the improvements will primarily correlate with the progress of the build-out based on size and type of development, staging of development, and location of development. When new developments are planned, it is that the stormwater concepts are revisited to ensure that the proposed grading of each development site is accounted for.

SWMFs and downstream sewer infrastructure to the discharge locations should be in place prior to the new developments coming online. This will ensure that the additional flows as a result of increased impervious surfaces are accommodated. The stormwater infrastructure required for a specific proposed development site is dictated based on which stormwater catchment the proposed development site is within.

8.0 Conclusion and Recommendations

The Town retained ISL to complete a SWMSS, including an assessment of the Town's current stormwater conveyance infrastructure capacity and the Town's future stormwater infrastructure needs. A robust hydrodynamic InfoWorks ICM 1D-2D model was constructed to enable the comprehensive assessment of the stormwater system. The project was initiated to ensure sound stormwater planning.

The SWMSS will help the Town understand the implications of servicing new developments and the servicing approach and constraints. By applying a comprehensive design, consistent approaches to issues, and sound engineering principles, while all the time protecting the natural and human environment, this study will guide effective infrastructure implementation. The study will also examine the capacity of the existing infrastructure system to determine the extent of upgrades required to maintain quality service to residents.

The objectives of developing the SWMSS include:

- Assessing existing drainage conditions and determining design criteria for the stormwater drainage system, including runoff rates and volumes.
- Providing an inventory of and analyzing existing natural drainage conveyance.
- Determining if any upgrades are required to the existing system to properly meet the needs of the Town and to allow future growth to occur.
- Developing stormwater infrastructure plans, including stormwater management facility (SWMF) sizing, to manage increased and redirected runoff from future development
- Producing a drainage basin specific stormwater management plan that uses best management practices to minimize the effect to the natural hydrological and hydrogeological regimes, and to ensure the planned stormwater management system meets regulatory authority requirements.
- Providing cost estimates for infrastructure upgrades, which will also provide inputs to an off-site levy bylaw.
- Commenting on possible staging options of upgrades for the most effective infrastructure implementation.

The main conclusions and recommendations of the study are summarized below.

- The existing stormwater system was found to have minimal surcharging and flooding issues under the 1:5 year 1-hour and 1:100 year 24-hour design events, except for some localized areas that were identified and recommended for upgrades. The proposed upgrades include pipe upsizing, culvert replacement, and catch basin improvement.
- The future stormwater system was designed to accommodate the projected growth and development of the Town, as well as the regional stormwater plan agreement with the CSMI. The future system concept includes new SWMFs, new pipes and outfalls, and recommendations for low impact development practices. The future system was sized under the same design events as the existing system and was found to meet the performance criteria and regulatory requirements.
- The climate change resiliency of the stormwater system was evaluated by using the IDF_CC Tool to generate the worst-case climate change scenario for the year 2100. The results showed that the existing and future stormwater system would experience increased runoff and flooding under the climate change scenario, as expected. The study recommended that the Town consider the climate change impacts and resiliency to system design.
- The wetland conservation and protection of the Town was addressed by identifying the natural wetlands within the study area and recommending setbacks and retention measures for them. The study also suggested that the Town adopt a wetland policy and a wetland inventory to ensure the long-term preservation and enhancement of the wetland functions and values.

The infrastructure maintenance strategy of the Town was developed by performing a desktop condition assessment of the stormwater pipes based on their age and material. The study also proposed a methodology for conducting sewer inspections, condition assessment, rehabilitation recommendations, and staging implementation plan. The study advised that the Town prioritize the sewer repairs and replacements based on the condition ratings and the available budget.

9.0 References

Alberta Environment. 1999. *Stormwater Management Guidelines for the Province of Alberta.* Alberta.

Alberta Environment. 2012. *Standards and Guidelines for Municipal Waterworks, Wastewater, and Storm Drainage Systems*. Alberta.

Alberta Environment and Sustainable Resource Development. 2013. *Engineering Consultant Guidelines for Highway, Bridge, and Water Projects. Volume 2 – Construction Contract Administration 2013.* Alberta.

Allnorth. July 2018. *Stormwater Master Servicing Study.* Alberta.

B&A Planning Group. October 2010. *Wildflower Ranch Area Structure Plan*. Alberta.

City of Calgary. September 2011. *Stormwater Management and Design Manual*. Alberta.

City of Calgary. October 2011. *Guidelines for Erosion and Sediment Control*. Alberta.

City of Calgary. April 2015. *Total Loading Management Plan – An Integrated Watershed Management Approach*. Alberta.

City of Calgary. 2007. *Source Control Practices Handbook.* Alberta.

City of Edmonton. 2011. *Low Impact Development Best Management Practices Design Guide (Edition 1.0).* Alberta.

Town of Strathmore. *Edgefield Area Structure Plan*. October 2015. Alberta.

Town of Strathmore, *The Ranch.* (2021). Website: https://strathmore.ca/en/residents/the-ranch.aspx

Environment and Climate Change Canada. (n.d.). ADGM Hourly Data Report. Website: https://climate.weather.gc.ca/climate_data/hourly_data_e.html?hlyRange=2004-06-18%7C2024-05-21&dlyRange=2004-06-01%7C2024-05-21&mlyRange=2004-06-01%7C2007-10-01&StationID=42725&Prov=AB&urlExtension=_e.html&searchType=stnName&optLimit=yearRange&StartYear=1840&EndYear=2024&selRowPerPage=25&Line=1&searchMethod=contains&Month=5&Day=21&txtStationName=strathmore&timeframe=1&Year=2024

Environment and Climate Change Canada. (n.d.). *Radar*. Government of Canada. Website: https://climate.weather.gc.ca/radar/index_e.html

La Terra Development Group, Patricia Maloney & Associates, and Skyscaoe Management Inc. February 2021. *Lakewood Meadows Area Structure Plan.* Alberta.

MVH Urban Planning & Design. January 2022. *Legacy Farm Area Structure Plan*. Alberta.

Stewart and Kantrud. 1971*. Classification of Natural Ponds and Lakes in the Glaciated Prairie Region*. Alberta.

TRCA/CVC. 2010. *Low Impact Development and Stormwater Planning and Design Guide.* Ontario.

WeatherStats. *Precipitation - Strathmore Weather*. (n.d.). Website: https://strathmore.weatherstats.ca/metrics/precipitation.html

Western University. *Computerized Tool for the Development of Intensity-Duration-Frequency Curves under Climate Change – Version 7.0, IDF_CC Tool 7.0*. Website: idf-cc-uwo.ca

UMA Engineering Ltd. May 2007. *Master Servicing Study – Annexation 2006*. Alberta.

APPENDIX A
1:25 Year and 1:50 Year Return Period Simulations

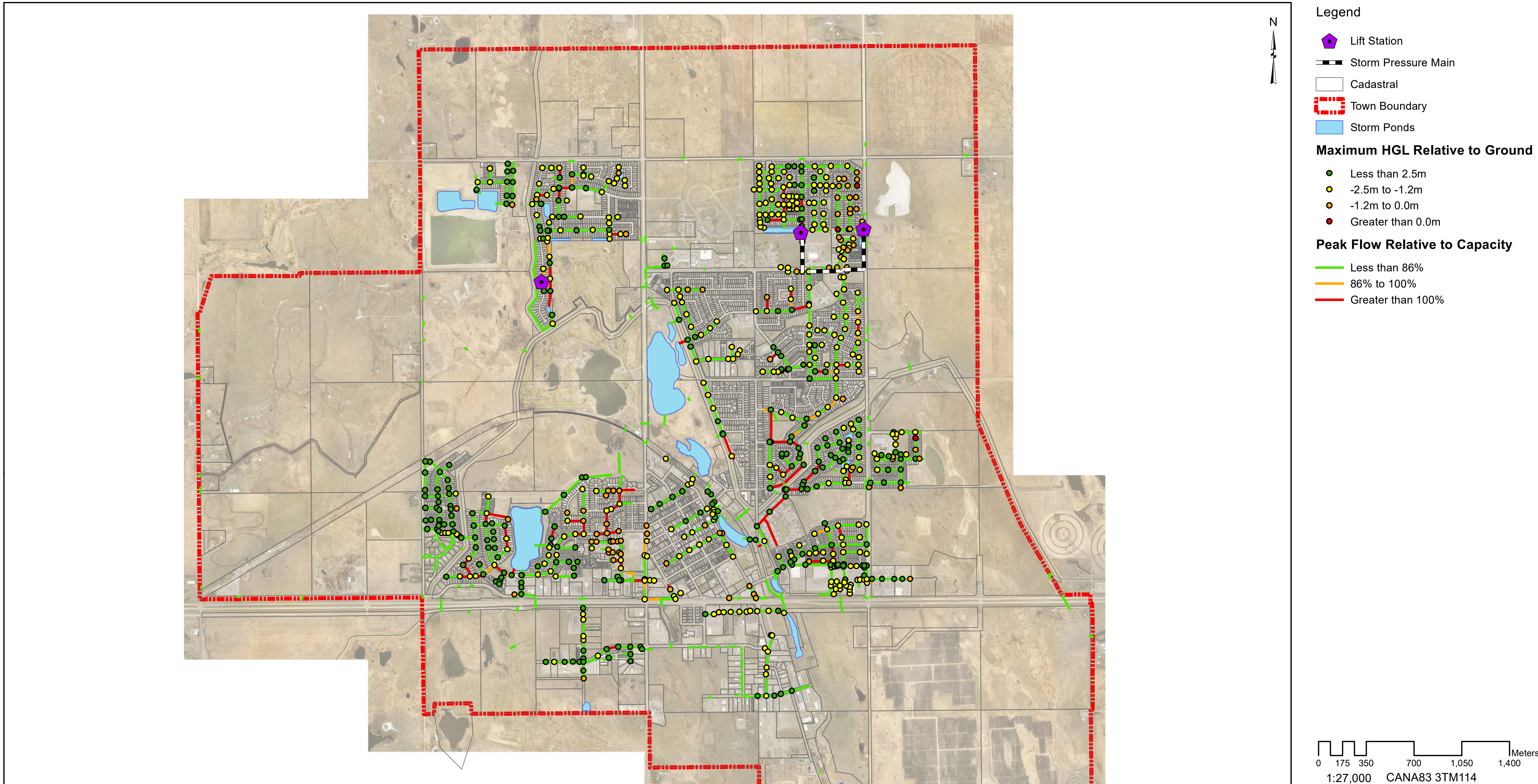
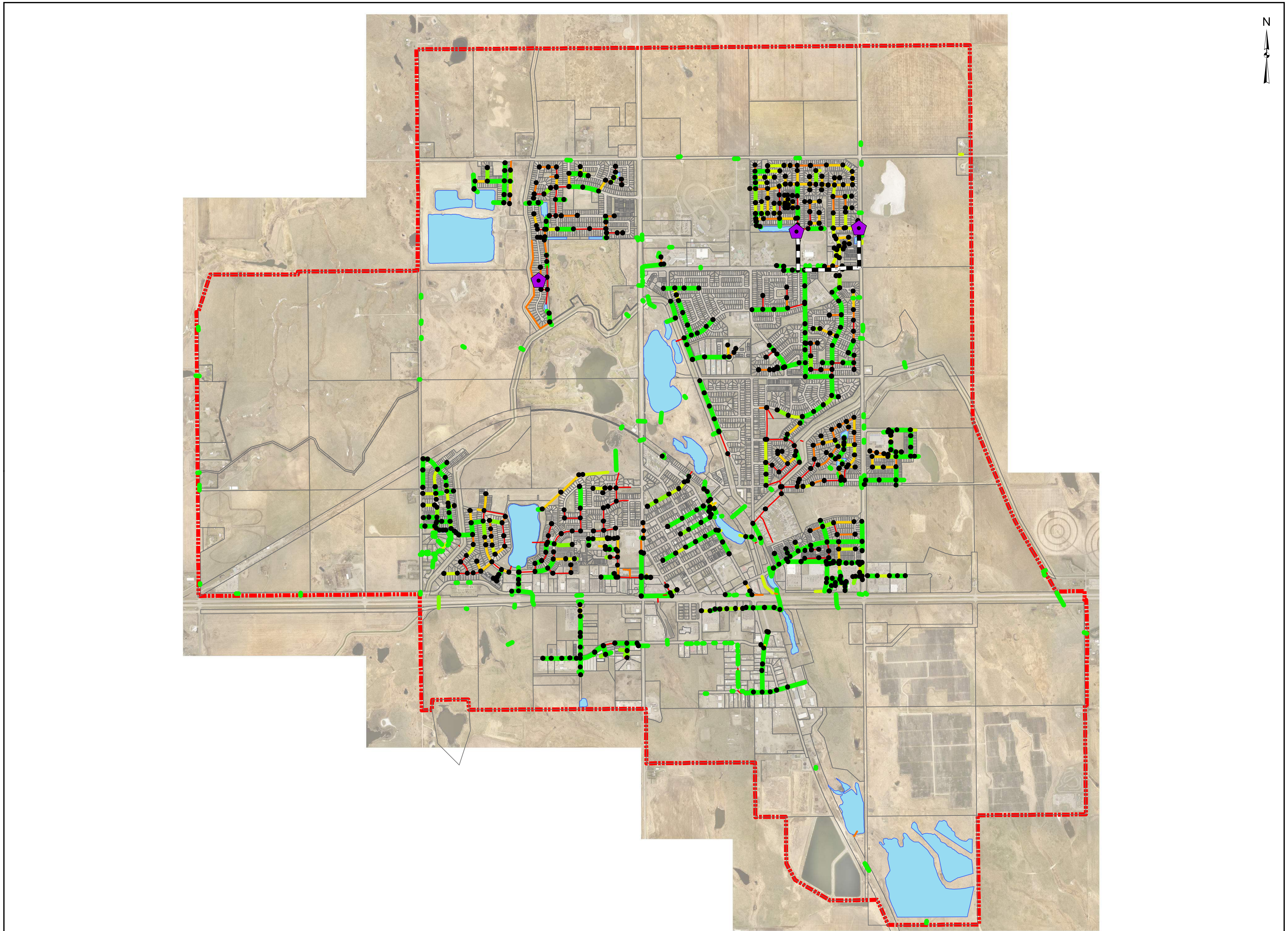


FIGURE A.1
EXISTING SYSTEM ASSESSMENT - 1D
25 YR 1 HR DESIGN STORM
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL Strathmore

Date: 2024-05-23 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Appendix X - 25 and 50 Year Return Period Simulations\Figure X.1_25 Year_Pipe Results_Q-Qman and Max HGL.mxd

Integrated Expertise. Locally Delivered.



Legend

- Storm Manholes
- Lift Station
- Storm Pressure Main
- Cadastral
- Town Boundary
- Storm Ponds

Spare Capacity

- Less than 0L/s
- 0 - 25L/s
- 25 - 50L/s
- 50 - 75L/s
- 75 - 100L/s
- Greater than 100L/s

0 175 350 700 1,050 1,400 Meters

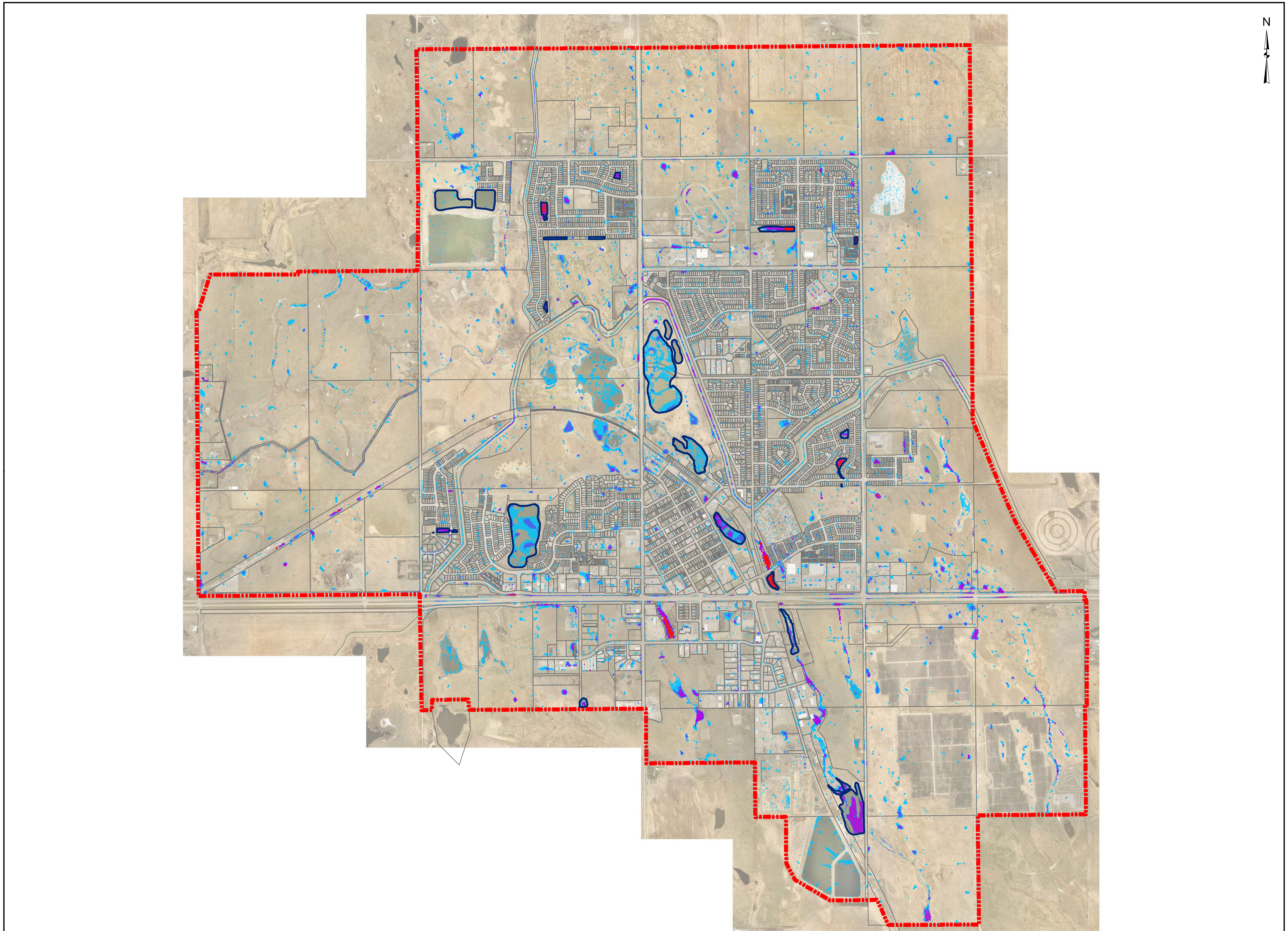
1:27,000 CANA83 3TM114

FIGURE A.2
SPARE CAPACITY - 1D
25 YR 1 HR DESIGN STORM
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL Strathmore

Integrated Expertise. Locally Delivered.

Date: 2024-05-23 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Appendix X - 25 and 50 Year Return Period Simulations\Figure X.2_25 Year_Pipe Results_Spare Capacity.mxd



Legend

Cadastral

Town Boundary

Storm Ponds

Maximum Depth (m)

0.09 - 0.210

0.211 - 0.320

0.321 - 0.800

Greater than 0.80

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

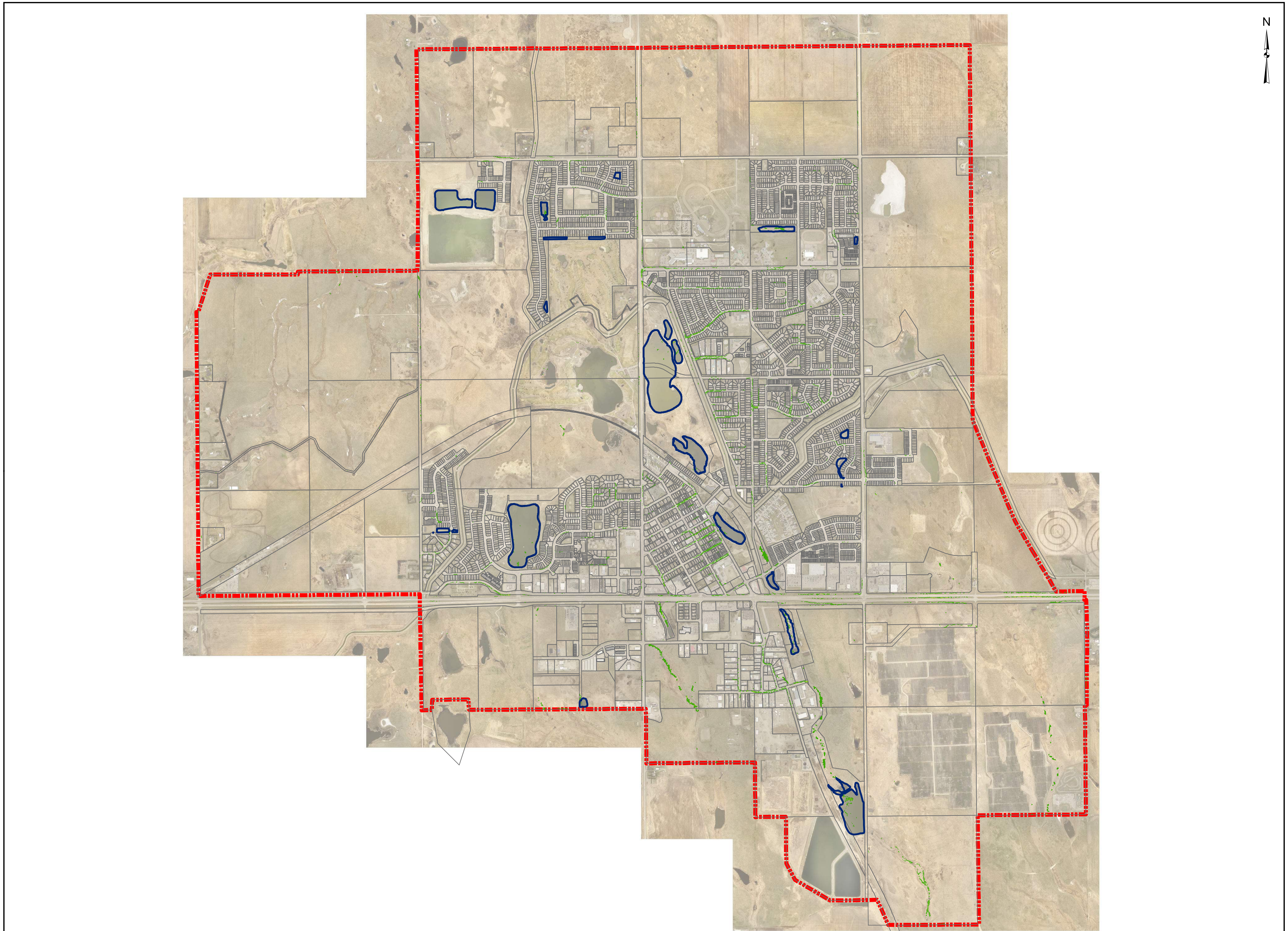
FIGURE A.3
EXISTING SYSTEM ASSESSMENT - 2D
25 YR 1 HR DESIGN STORM
MAXIMUM WATER DEPTH
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Date: 2024-05-23 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Appendix X - 25 and 50 Year Return Period Simulations\Figure X.3_25 Year_Max Depth.mxd

Integrated Expertise. Locally Delivered.



Legend

- Storm Ponds
- Cadastral
- Town Boundary

Flow Velocity (m/s)

- 0.500 - 1.000
- 1.001 - 1.500
- 1.501 - 2.000
- 2.001 - 2.500
- Greater than 2.500

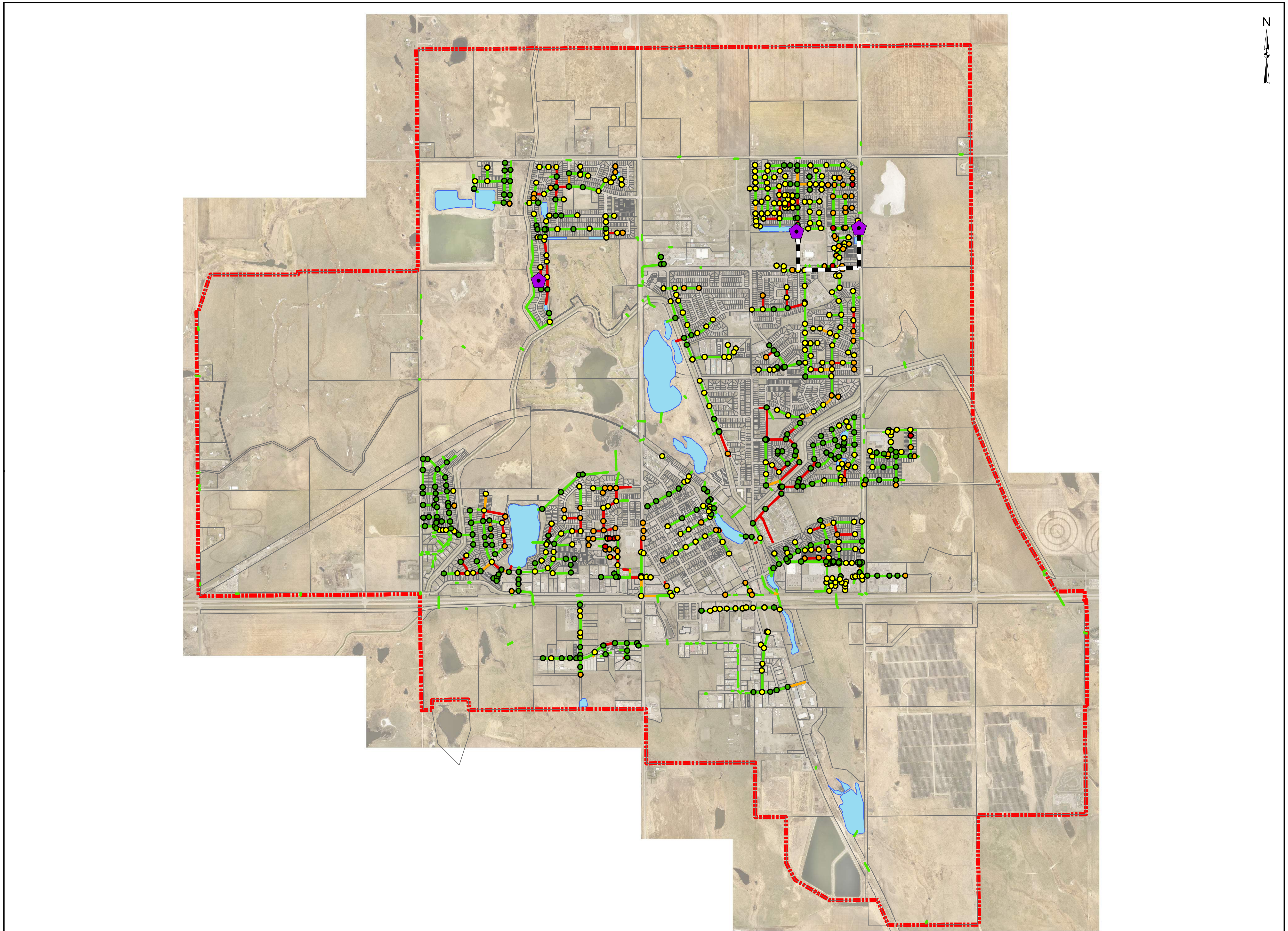
0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE A.4
EXISTING SYSTEM ASSESSMENT - 2D
25 YR 1 HR DESIGN STORM
PEAK SURFACE FLOW VELOCITY
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore



Legend

- Lift Station
- Storm Pressure Main
- Cadastral
- Town Boundary
- Storm Ponds

Maximum HGL Relative to Ground

- Less than 2.5m
- -2.5m to -1.2m
- -1.2m to 0.0m
- Greater than 0.0m

Peak Flow Relative to Capacity

- Less than 86%
- 86% to 100%
- Greater than 100%

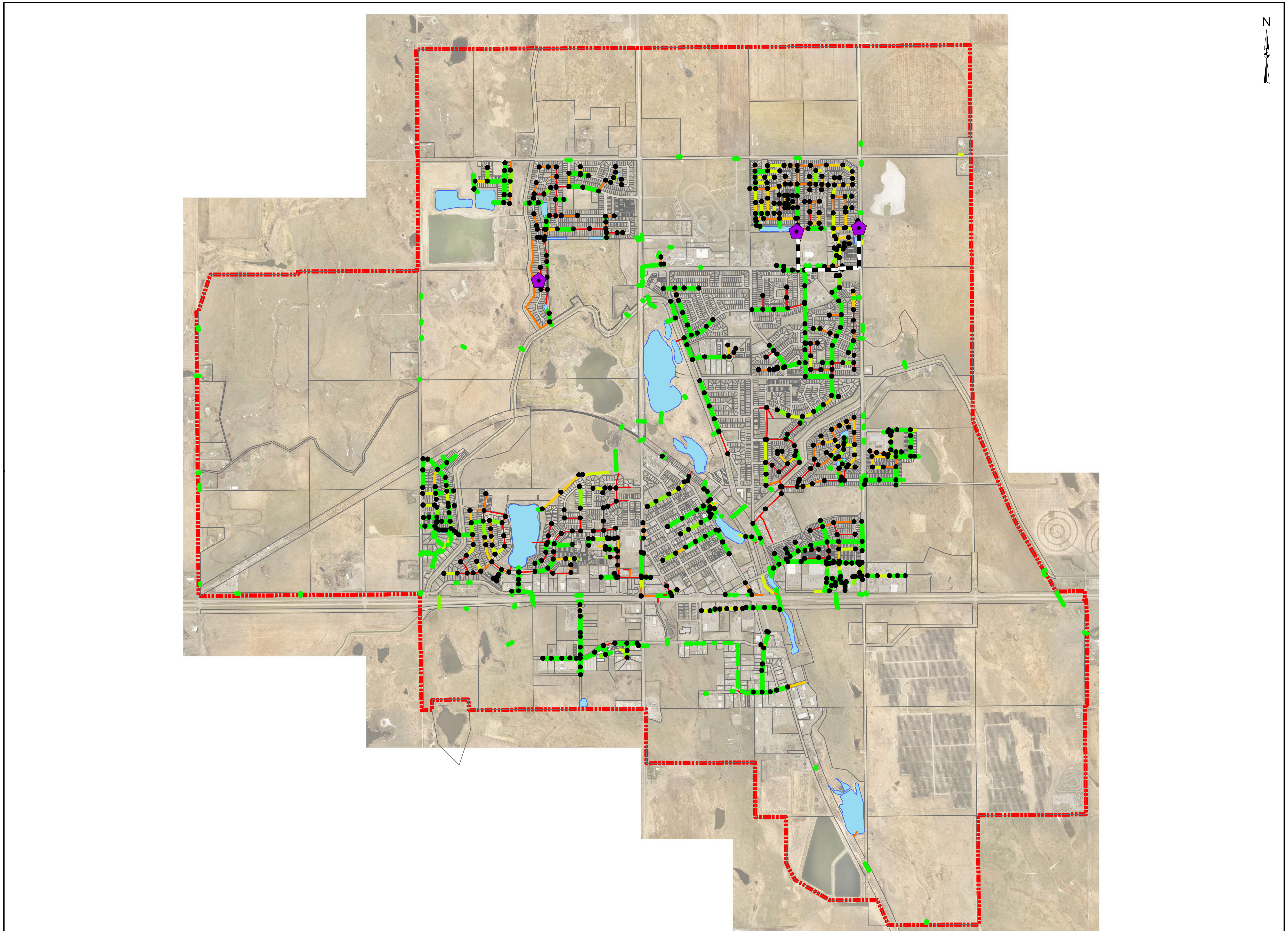
0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE A.5
EXISTING SYSTEM ASSESSMENT - 1D
50 YR 1 HR DESIGN STORM
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore



Legend

- Storm Manholes
- Lift Station
- Storm Pressure Main
- Cadastral
- Town Boundary
- Storm Ponds

Spare Capacity

- Less than 0L/s
- 0 - 25L/s
- 25 - 50L/s
- 50 - 75L/s
- 75 - 100L/s
- Greater than 100L/s

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

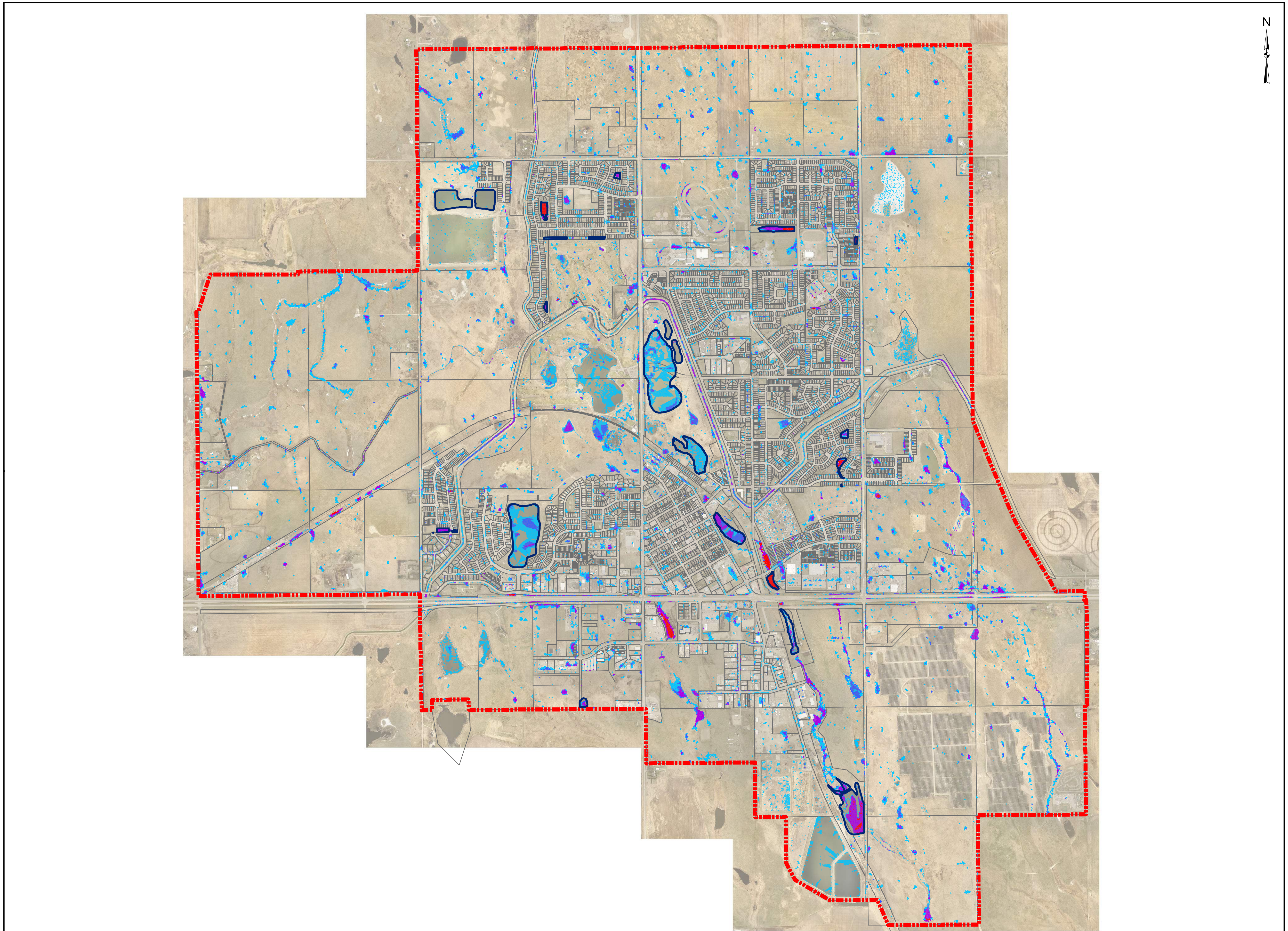
FIGURE A.6
SPARE CAPACITY - 1D
50 YR 1 HR DESIGN STORM
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Integrated Expertise. Locally Delivered.

Date: 2024-05-23 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Appendix X - 25 and 50 Year Return Period Simulations\Figure X.6_50 Year_Pipe Results_Spare Capacity.mxd



Legend

Cadastral

Town Boundary

Storm Ponds

Maximum Depth (m)

0.09 - 0.210

0.211 - 0.320

0.321 - 0.800

Greater than 0.80

0 175 350 700 1,050 1,400 Meters

1:27,000 CANA83 3TM114

FIGURE A.7
EXISTING SYSTEM ASSESSMENT - 2D
50 YR 1 HR DESIGN STORM
MAXIMUM WATER DEPTH
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Integrated Expertise. Locally Delivered.

Date: 2024-05-23 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Appendix X - 25 and 50 Year Return Period Simulations\Figure X.7_50 Year_Max Depth.mxd

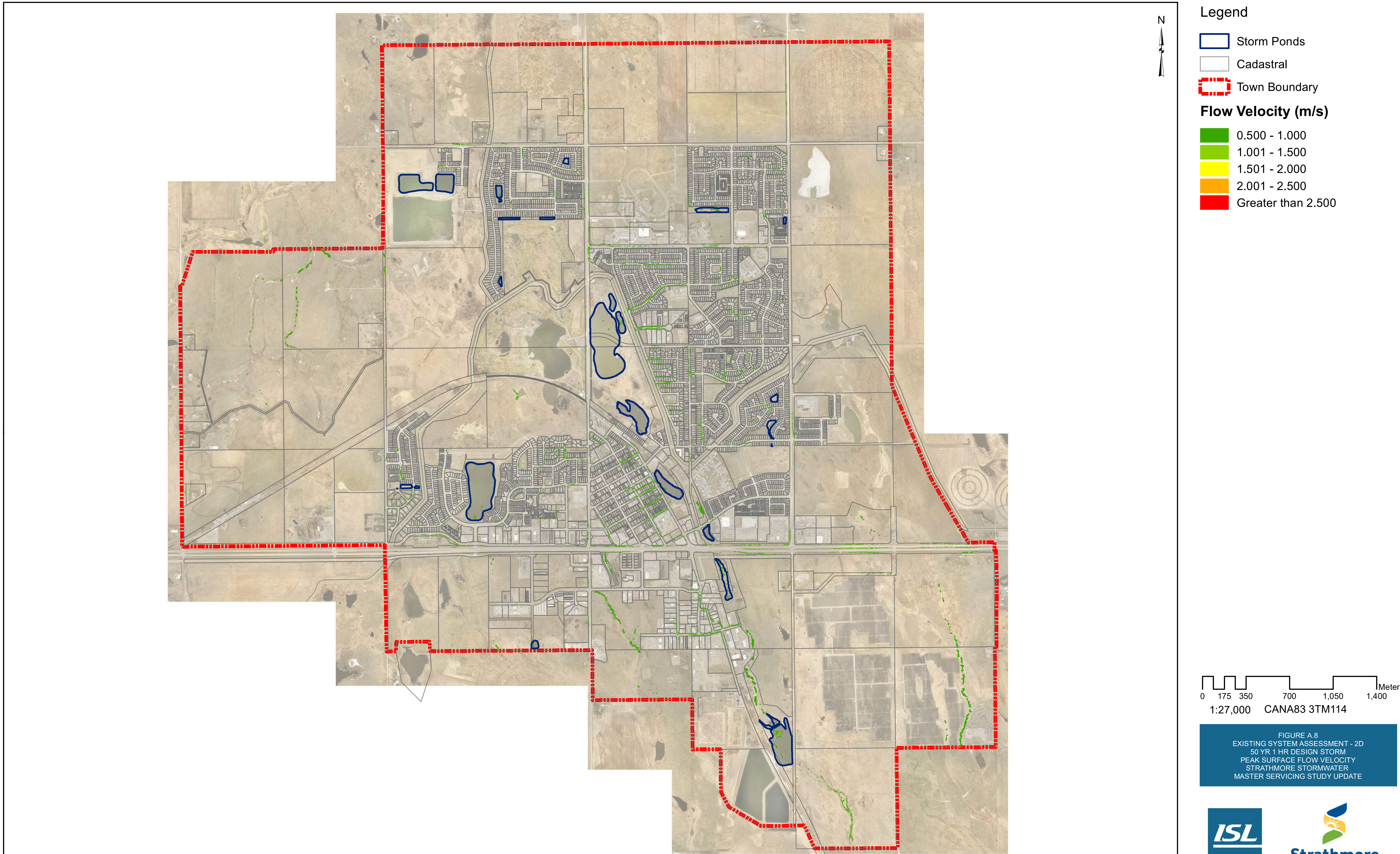


FIGURE A.8
EXISTING SYSTEM ASSESSMENT - 2D
50 YR 1 HR DESIGN STORM
PEAK SURFACE FLOW VELOCITY
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL Strathmore

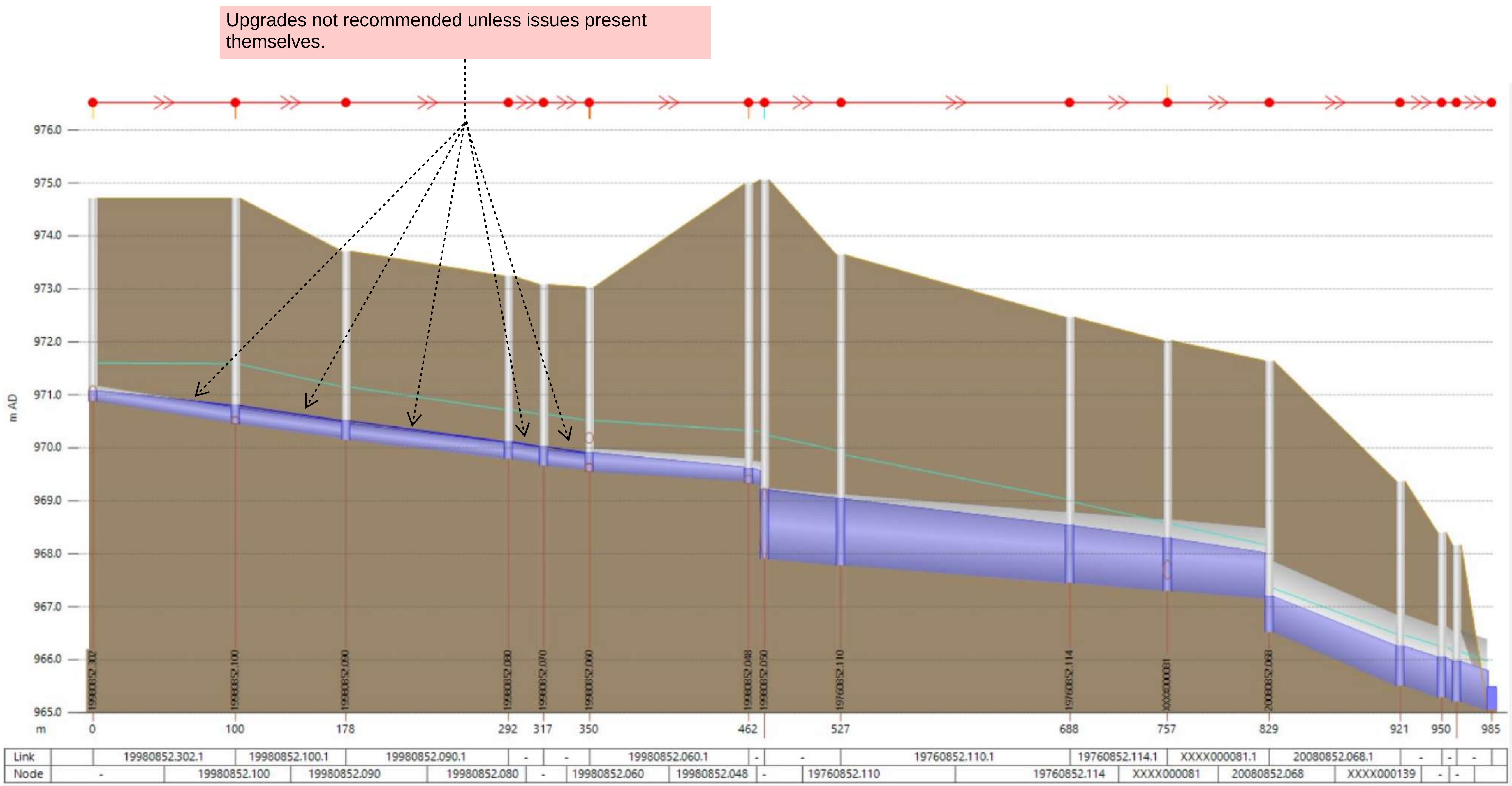
Date: 2024-05-23 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Report Figures\Appendix X - 25 and 50 Year Return Period Simulations\Figure X.8_50 Year_Max Velocity.mxd

Integrated Expertise. Locally Delivered.

APPENDIX B
Longitudinal Profiles

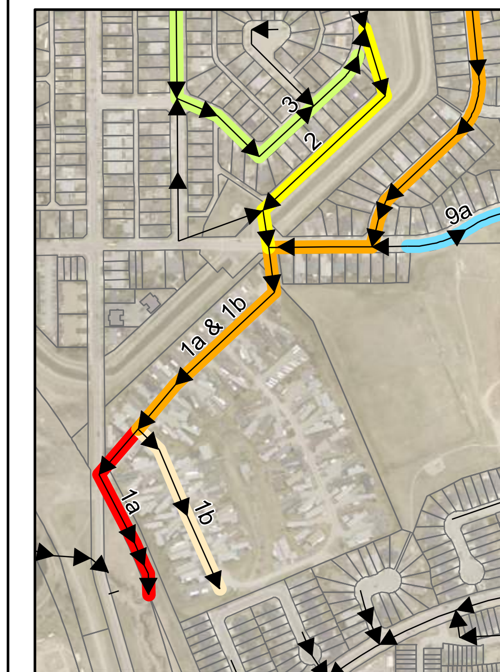
Longitudinal Profiles – Areas of Exceedance

Report Appendix



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



0 75 150 300 450 Meters

1:9,000 CANA83 3TM114

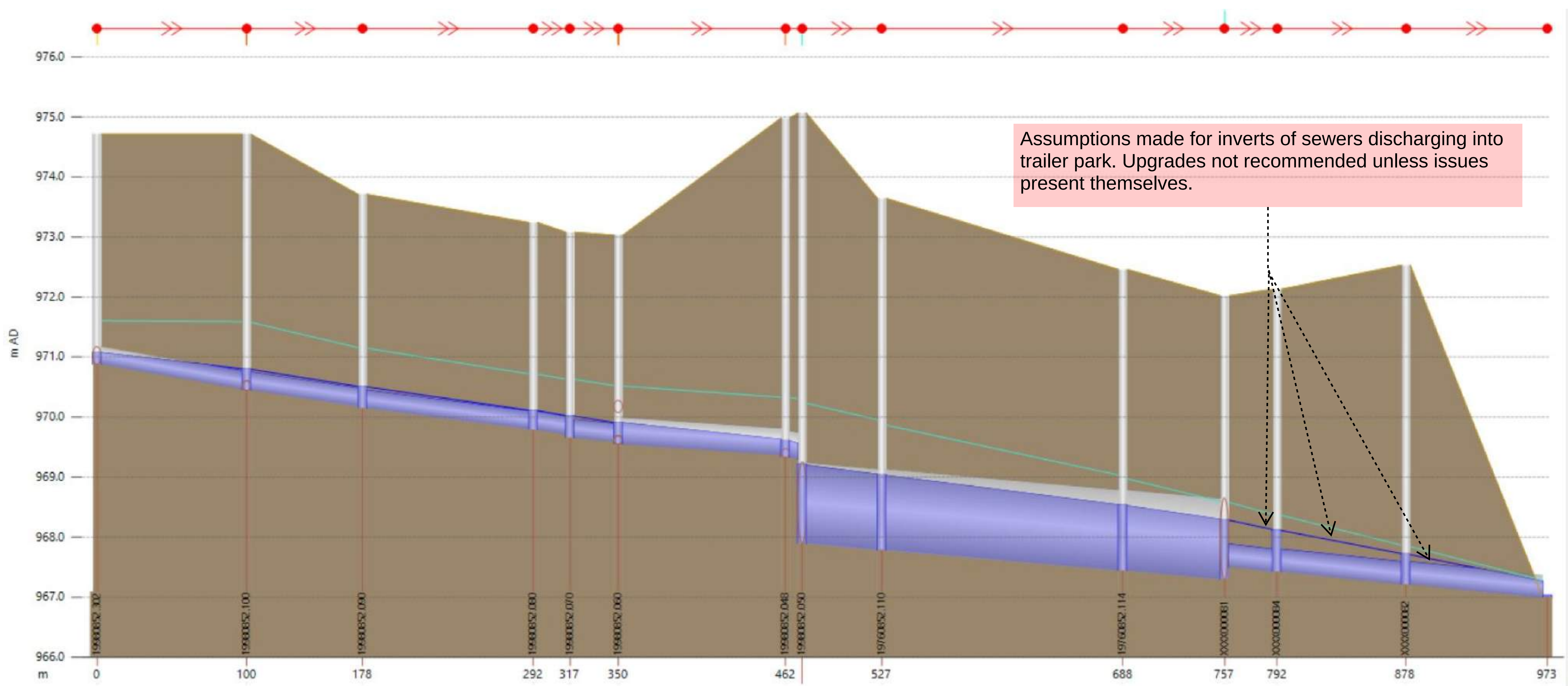
FIGURE LP.1
LONGITUDINAL PROFILE 1A
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Integrated Expertise. Locally Delivered.

Date: 2/26/2024 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Preliminary Figures\LPs\28436_LP 1a_v2.mxd

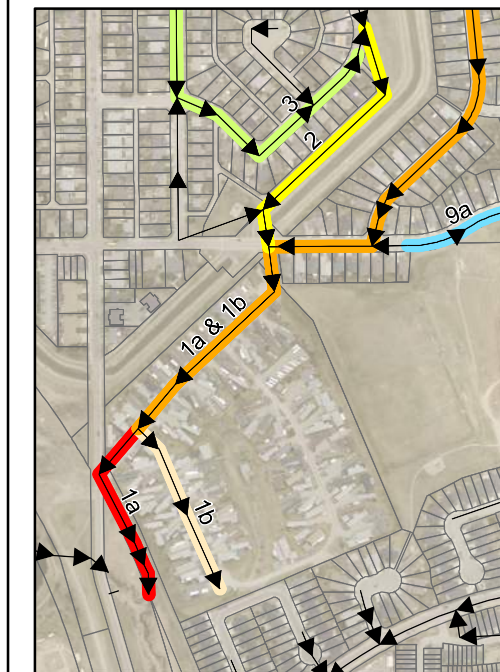


Link		19980852.302.1	19980852.100.1	19980852.090.1	-	-	19980852.060.1	-	-	19760852.110.1	19760852.114.1	-	XXXX000084.1	XXXX000082.1	
Node	-	19980852.100	19980852.090	19980852.080	-	19980852.060	19980852.048	-	19760852.110	19760852.114	-	XXXX000084	XXXX000082	-	

Legend

5 Year 1 Hour Storm Event

100 Year 24 Hour Storm Event



0 75 150 300 450 Meters

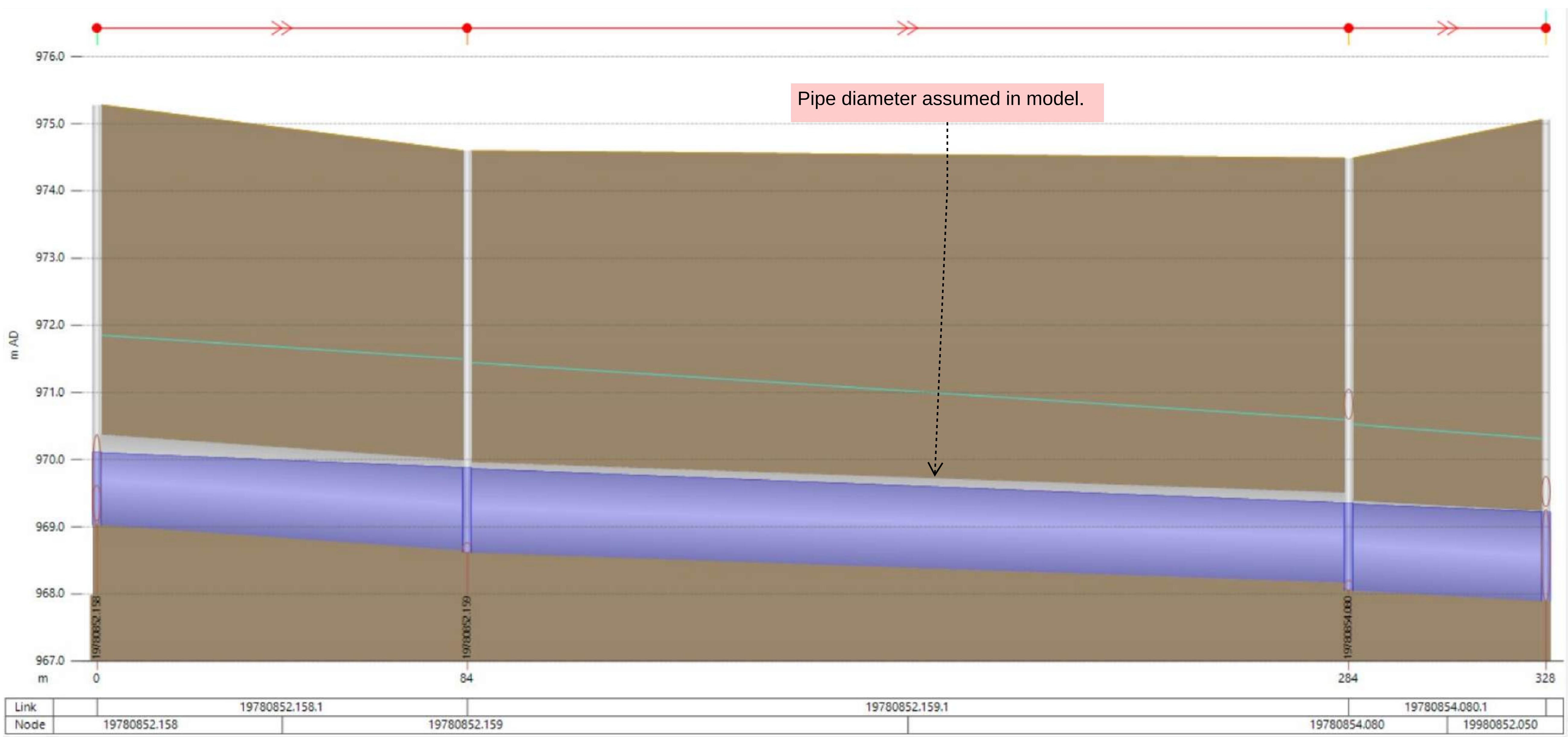
1:9,000 CANA83 3TM114

FIGURE LP.2
LONGITUDINAL PROFILE 1B
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

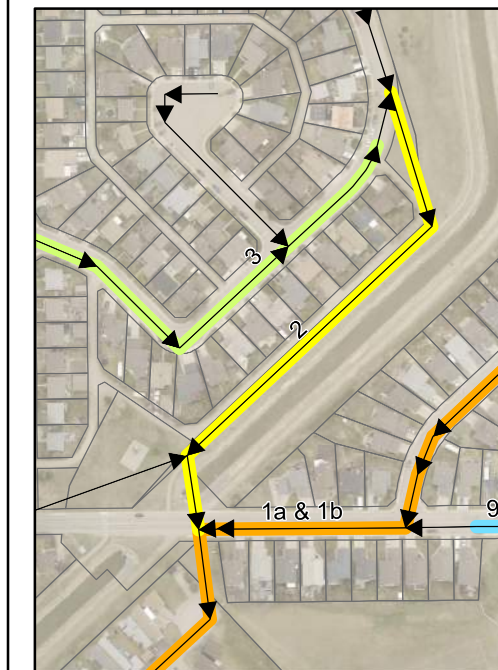
Integrated Expertise. Locally Delivered.



Legend

5 Year 1 Hour Storm Event

100 Year 24 Hour Storm Event



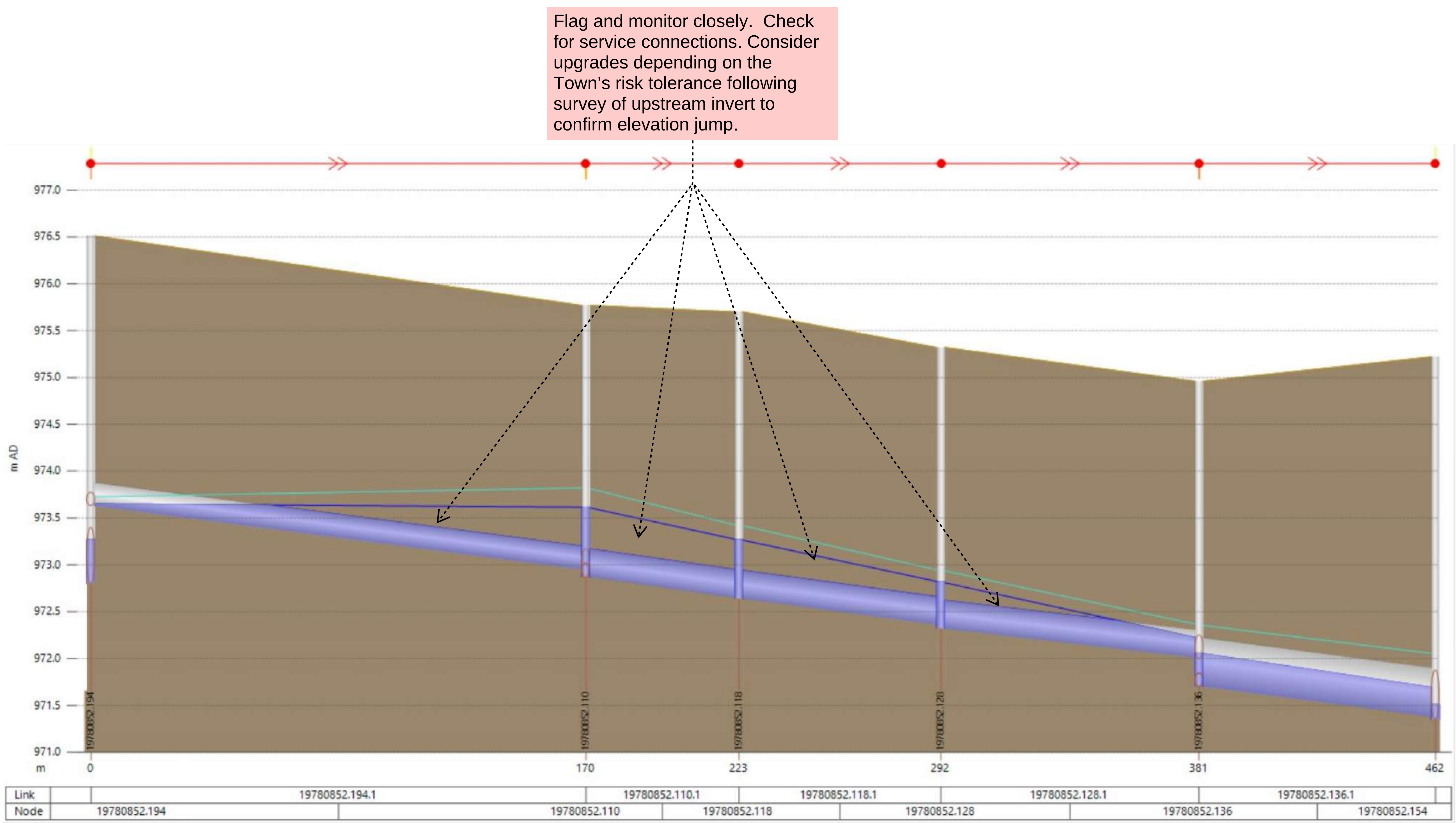
0 37.5 75 150 225 Meters

1:4,500 CANA83 3TM114

FIGURE LP.3
LONGITUDINAL PROFILE 2
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

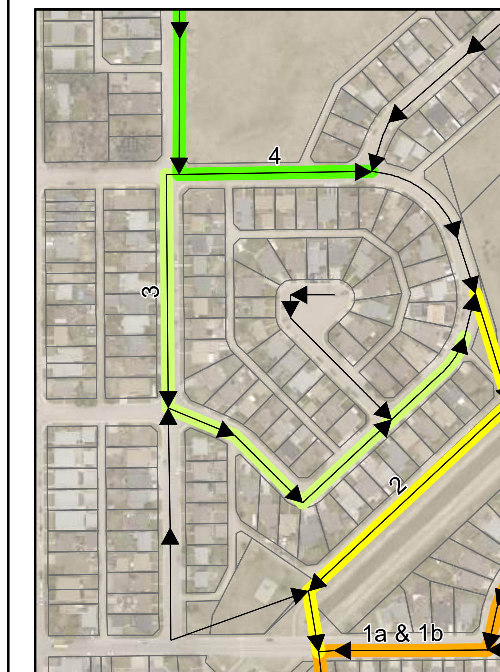
ISL

Strathmore



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



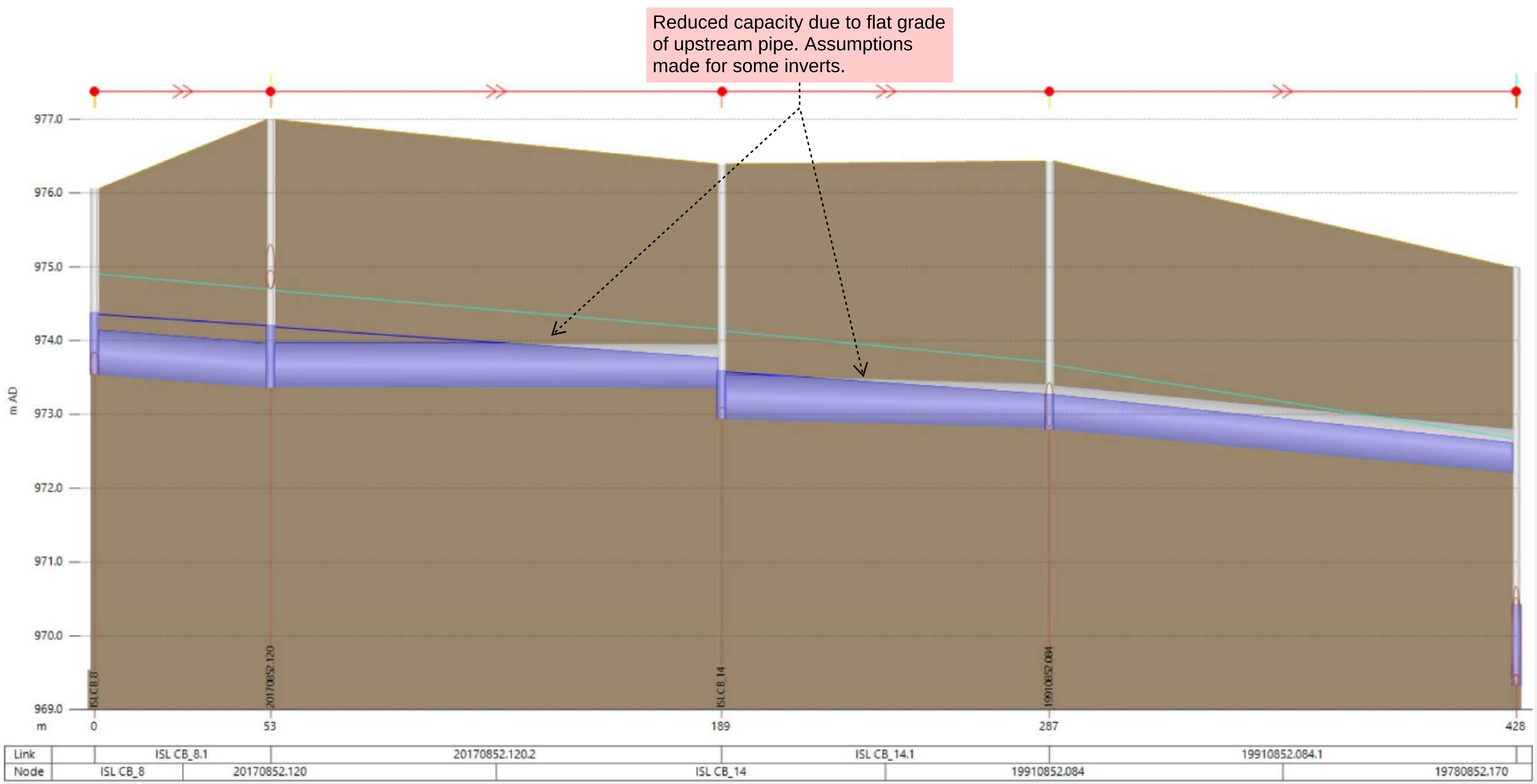
0 45 90 180 270 Meters

1:5,500 CANA83 3TM114

FIGURE LP.4
LONGITUDINAL PROFILE 3
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

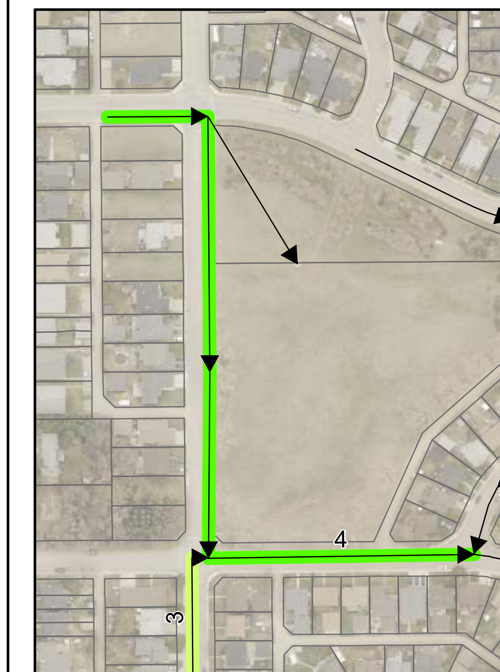
Strathmore



Legend

5 Year 1 Hour Storm Event

100 Year 24 Hour Storm Event



0 30 60 120 180 Meters

1:4,000 CANA83 3TM114

FIGURE LP.5
LONGITUDINAL PROFILE 4
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

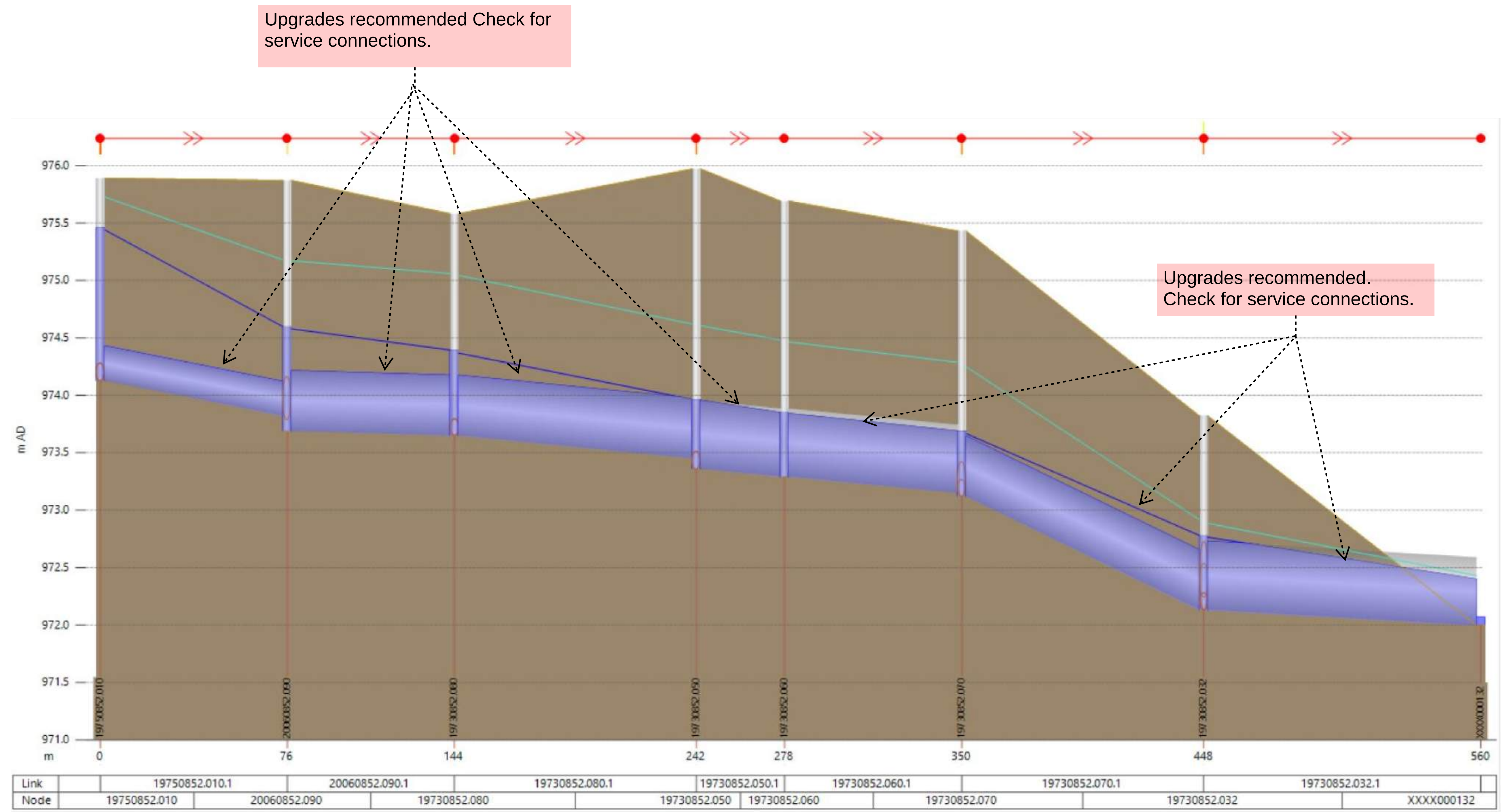
ISL

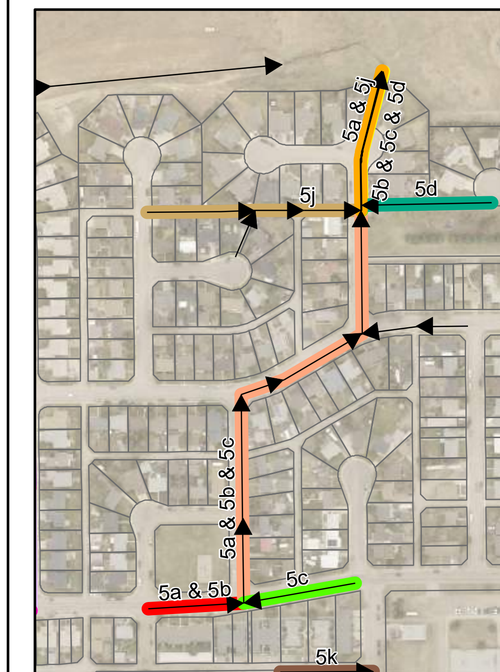
Strathmore

Integrated Expertise. Locally Delivered.

Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



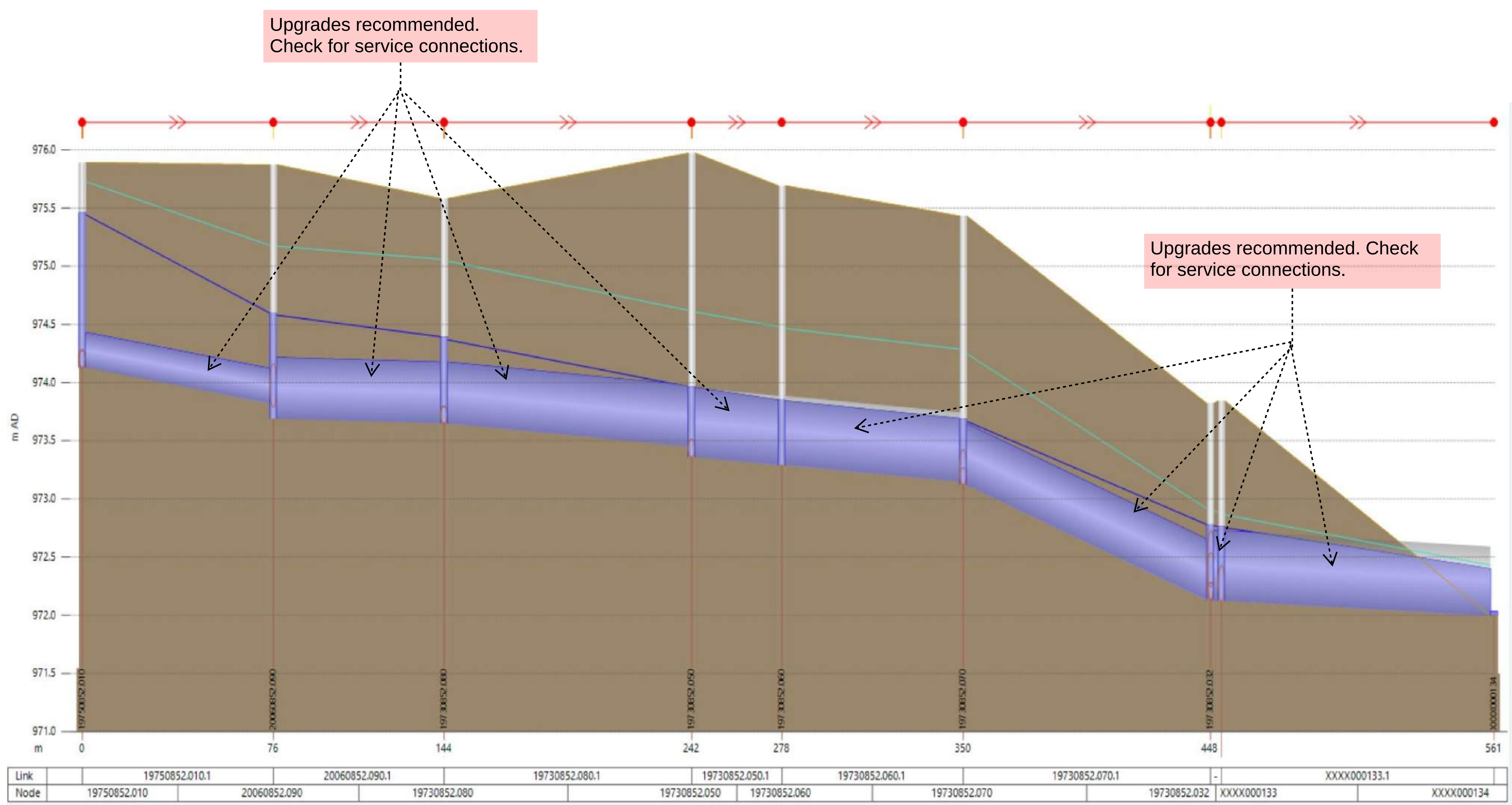


0 50 100 200 300 Meters

1:6,000 CANA83 3TM114

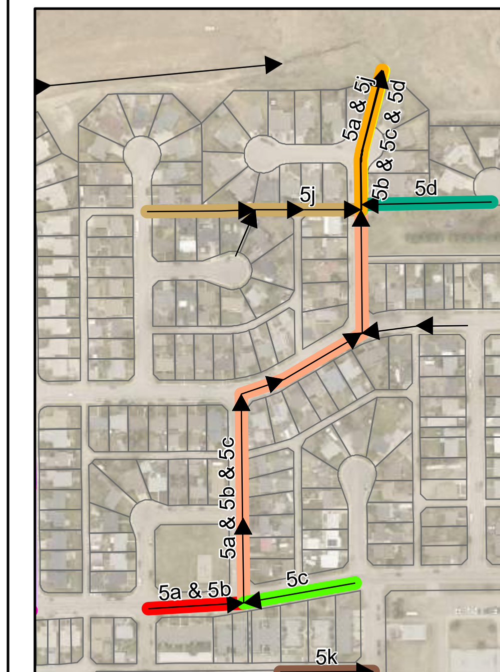
FIGURE LP.6
LONGITUDINAL PROFILE 5A
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL
Strathmore



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



0 50 100 200 300 Meters

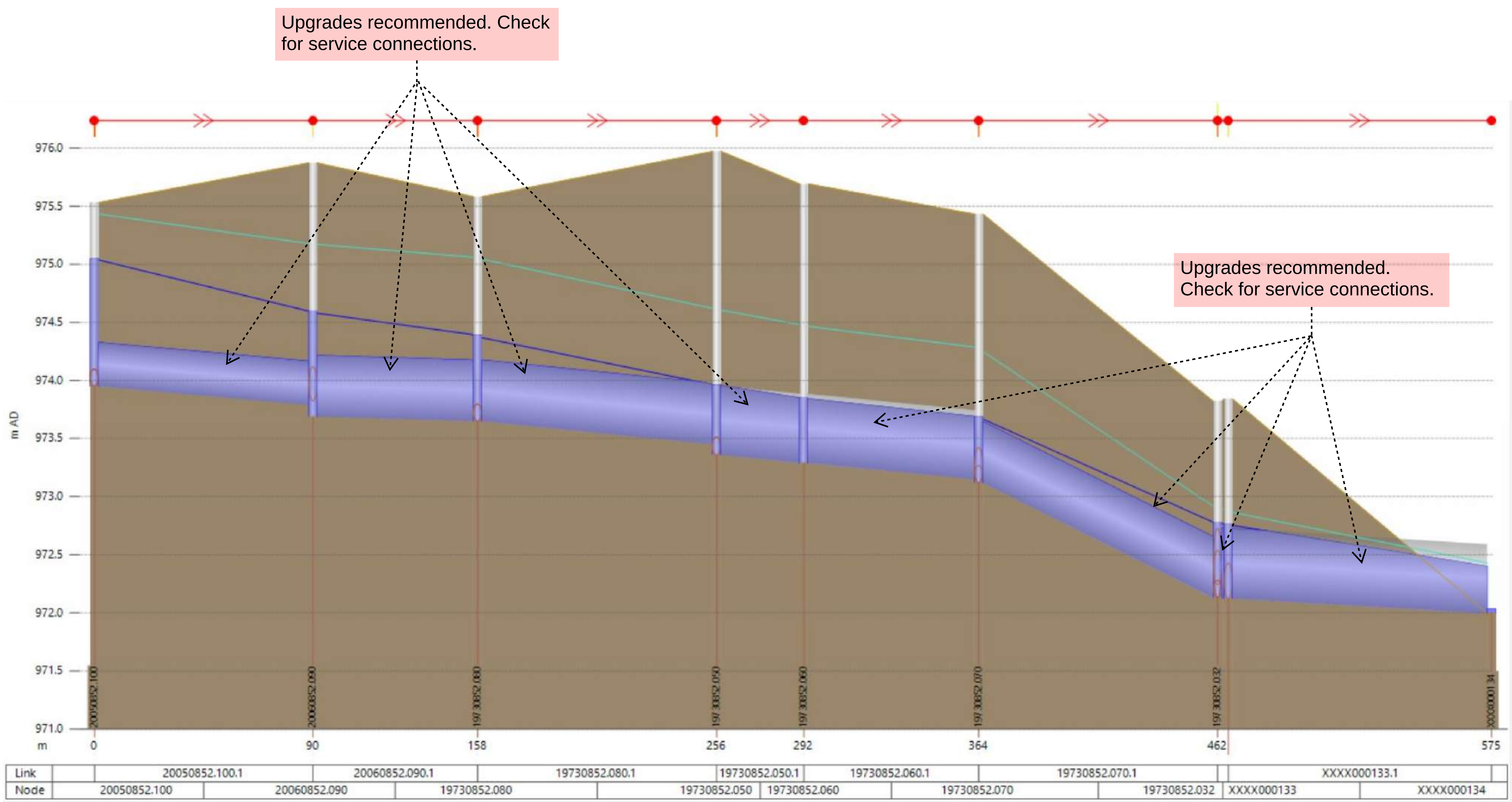
1:6,000 CANA83 3TM114

FIGURE LP.7
LONGITUDINAL PROFILE 5B
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

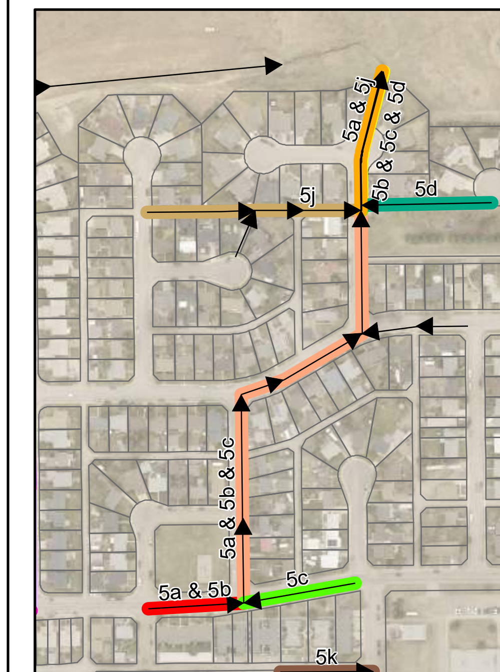
Strathmore

Integrated Expertise. Locally Delivered.



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



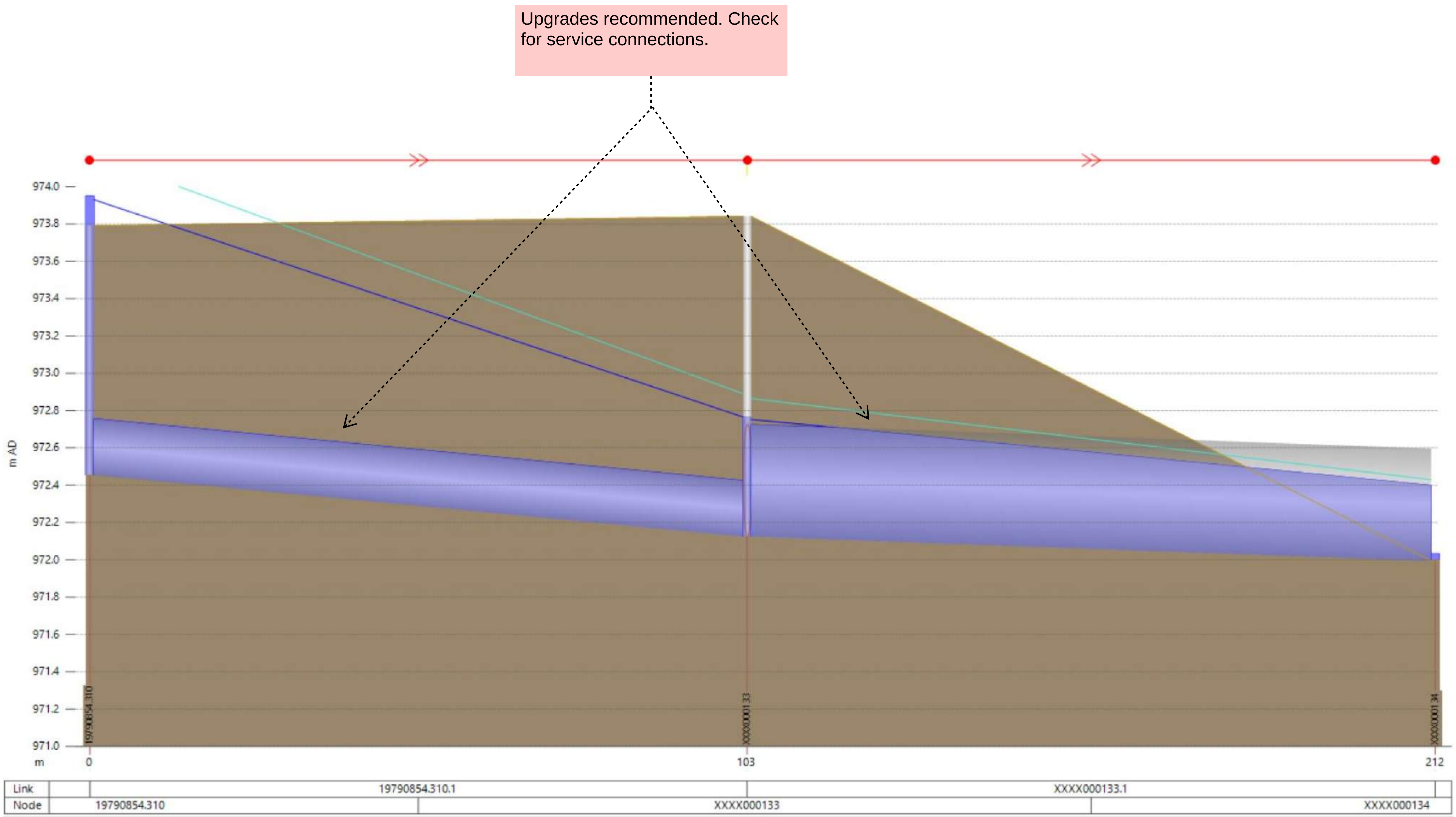
0 50 100 200 300 Meters

1:6,000 CANA83 3TM114

FIGURE LP.8
LONGITUDINAL PROFILE 5C
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

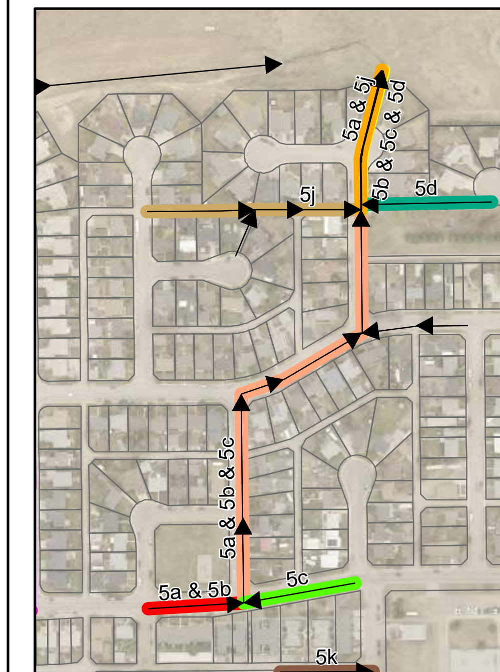
ISL Strathmore

Integrated Expertise. Locally Delivered.



Legend

5 Year 1 Hour Storm Event
100 Year 24 Hour Storm Event



0 50 100 200 300 Meters

1:6,000 CANA83 3TM114

FIGURE LP.9
LONGITUDINAL PROFILE 5D
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

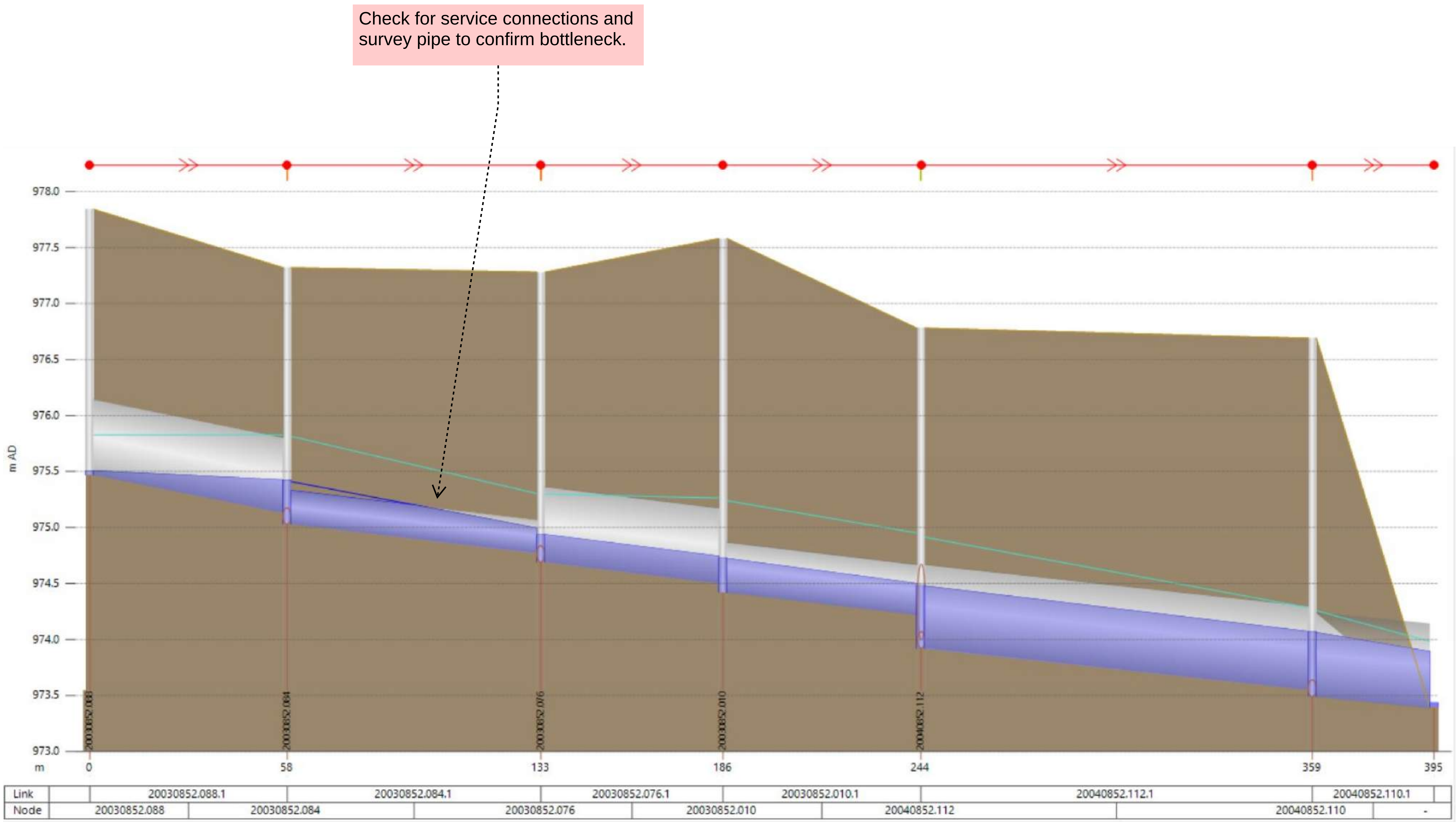
Strathmore

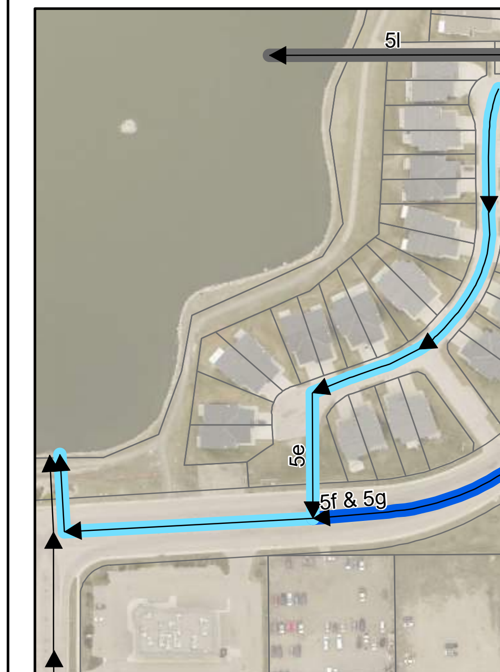
Integrated Expertise. Locally Delivered.

Legend

5 Year 1 Hour Storm Event

100 Year 24 Hour Storm Event





0 25 50 100 150 Meters

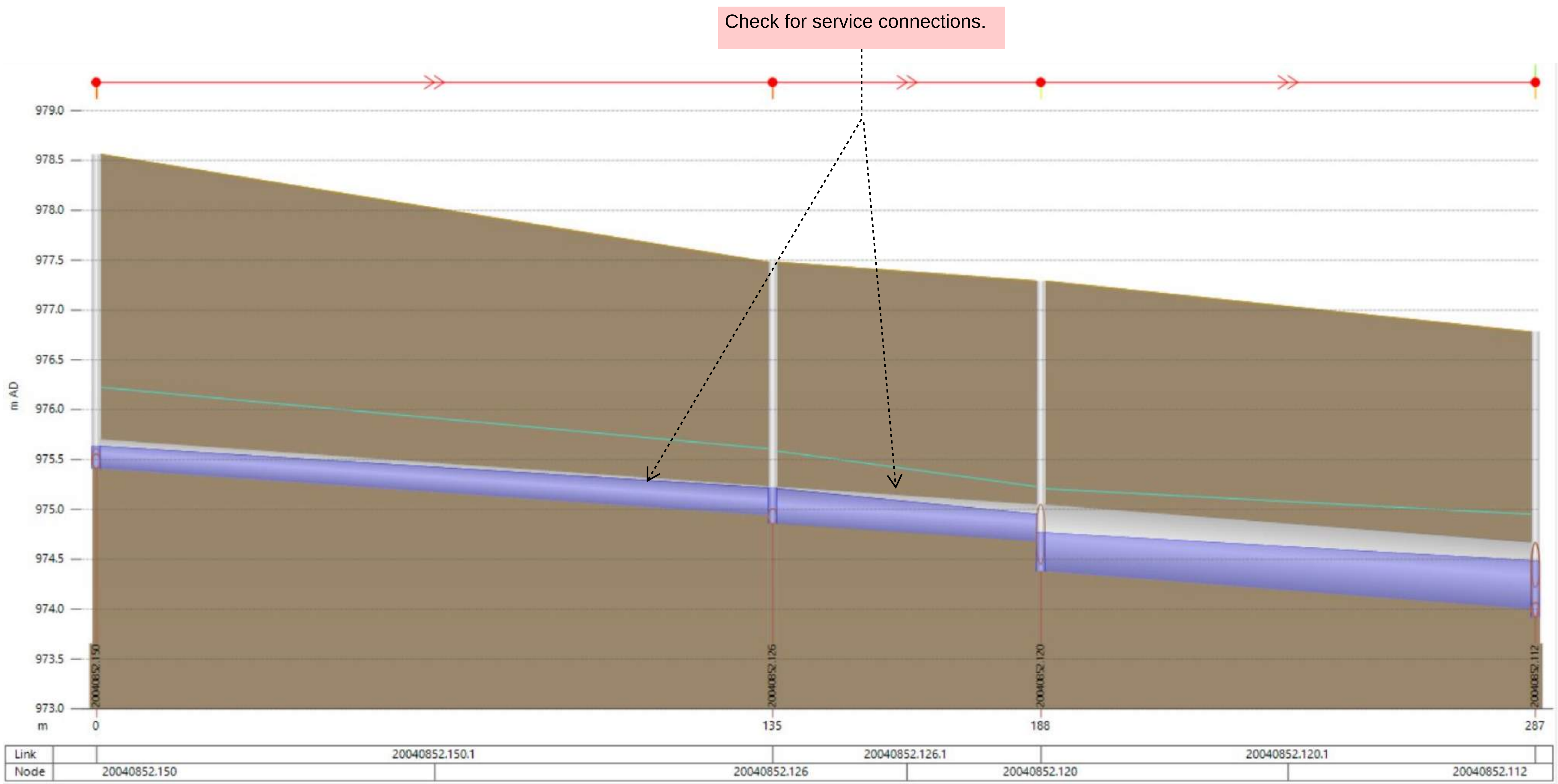
1:3,500 CANA83 3TM114

FIGURE LP.10
LONGITUDINAL PROFILE 5E
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

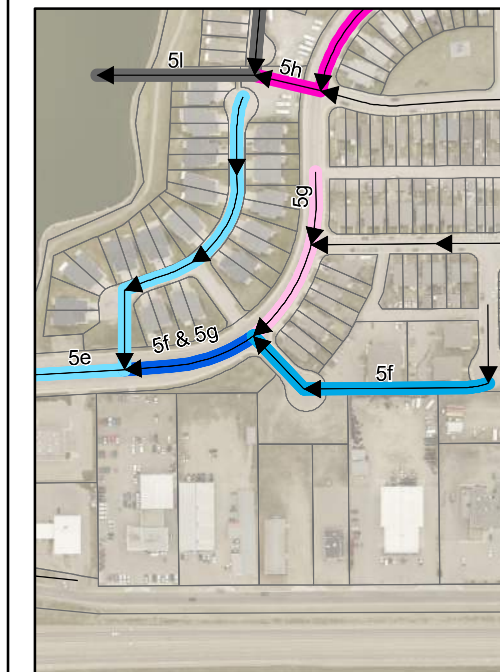
Strathmore

Integrated Expertise. Locally Delivered.



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



0 45 90 180 270 Meters

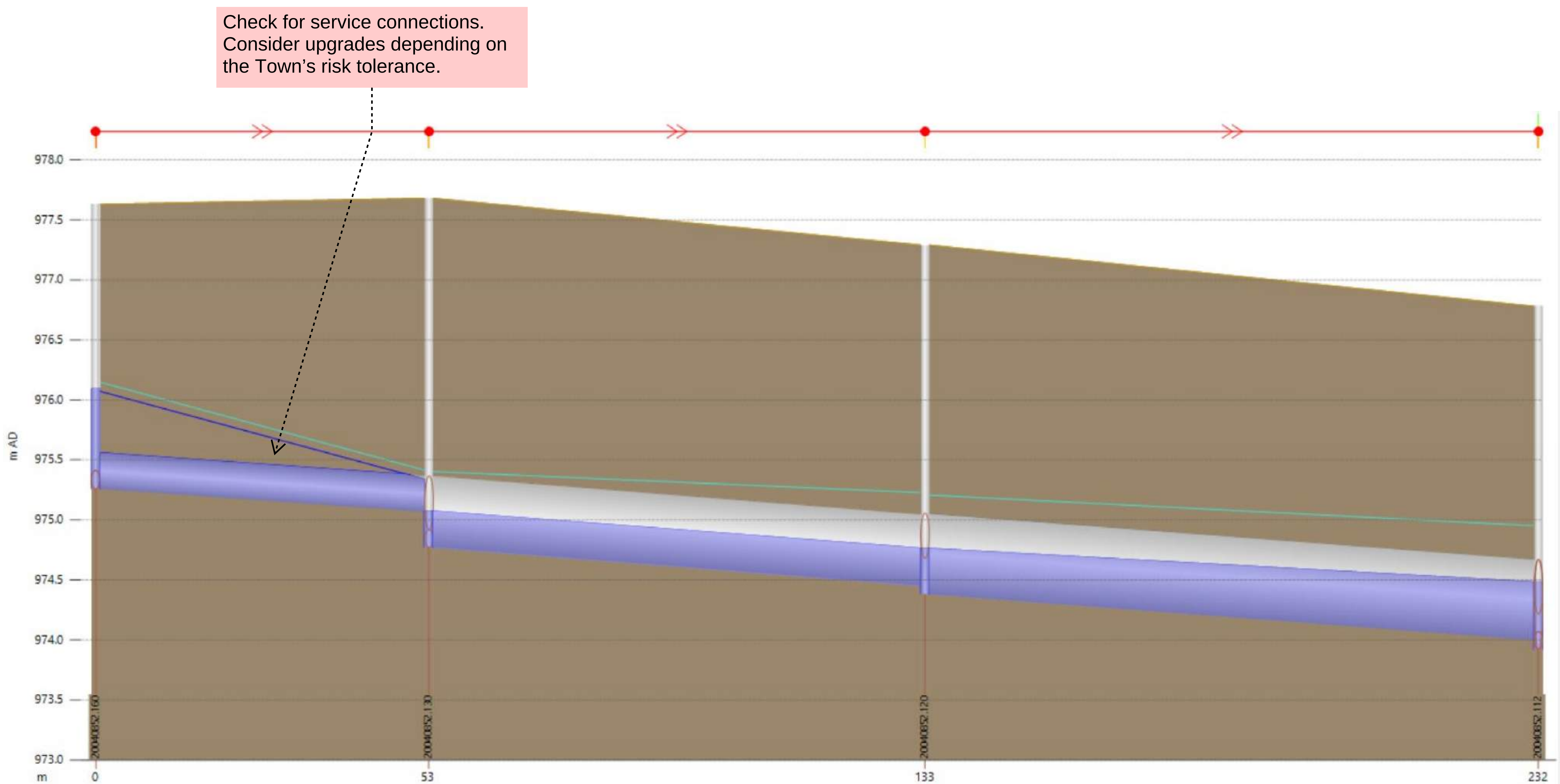
1:5,500 CANA83 3TM114

FIGURE LP.11
LONGITUDINAL PROFILE 5F
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

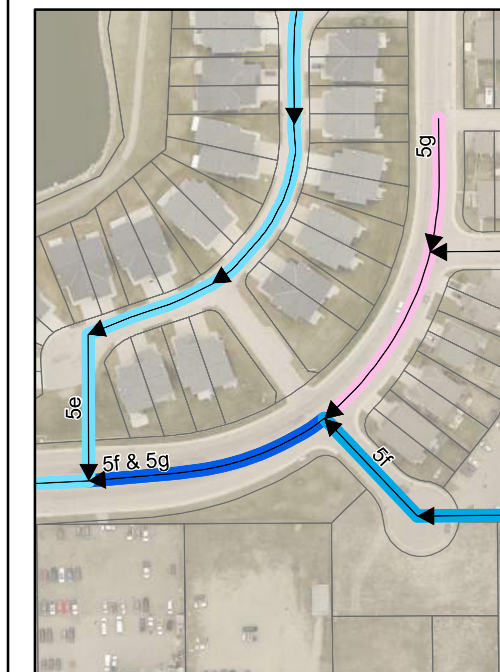
Integrated Expertise. Locally Delivered.



Link	20040852.160.1	20040852.130.1	20040852.120.1
Node	20040852.160 / 20040852.130	20040852.120	20040852.112

Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



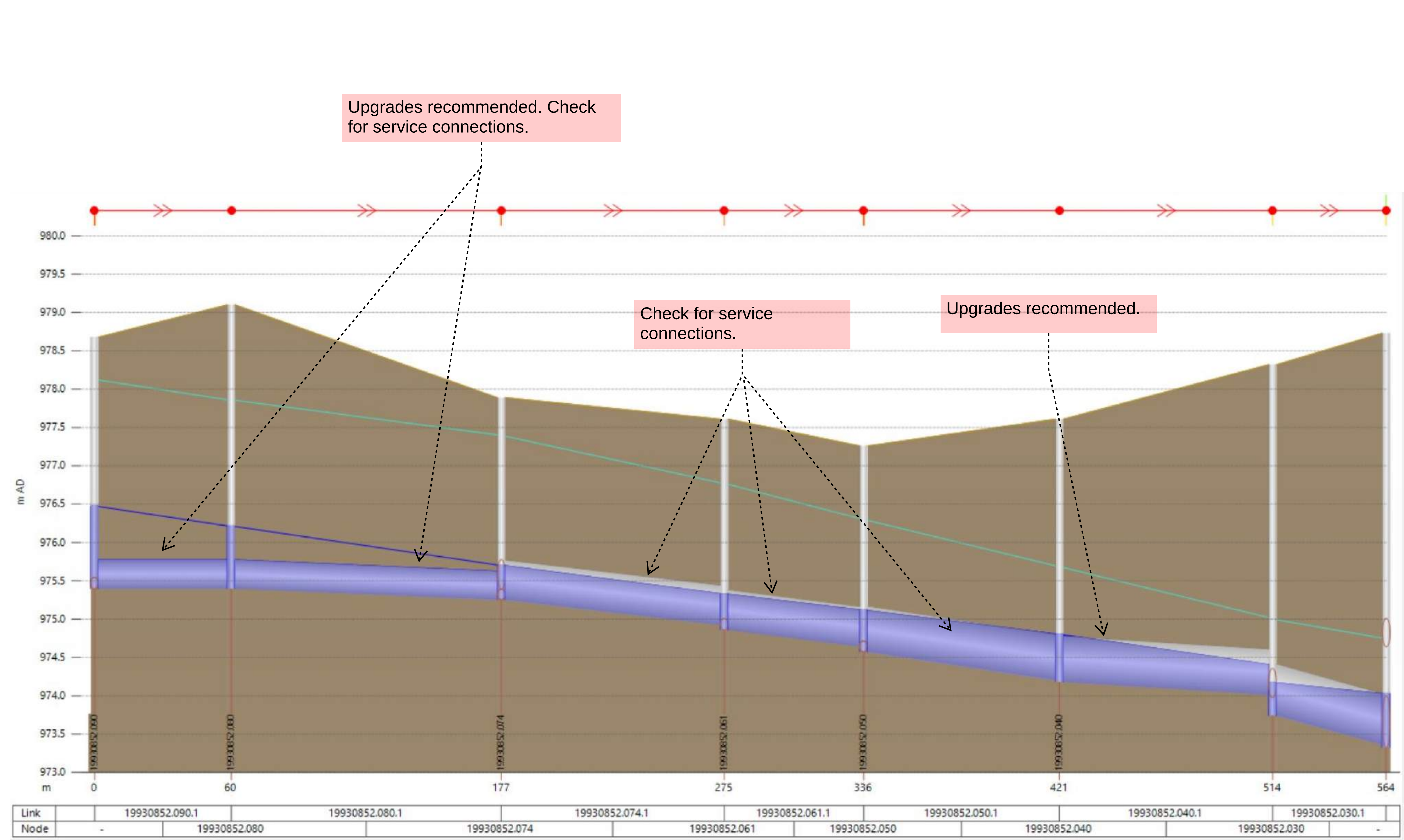
0 25 50 100 150 Meters

1:3,000 CANA83 3TM114

FIGURE LP.12
LONGITUDINAL PROFILE 5G
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

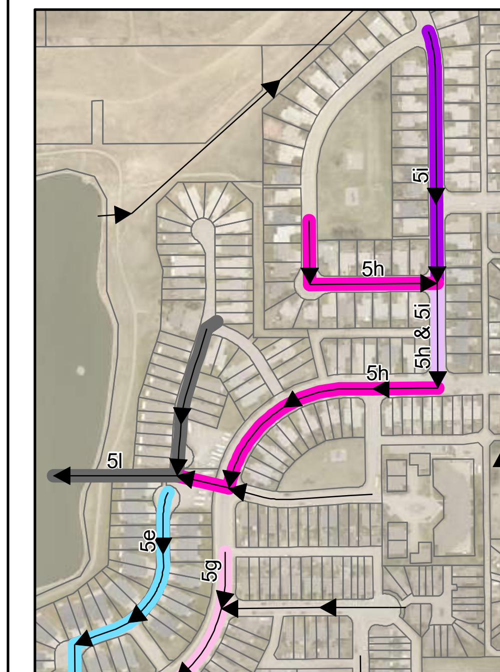
ISL Strathmore

Integrated Expertise. Locally Delivered.



Legend

5 Year 1 Hour Storm Event
100 Year 24 Hour Storm Event



0 60 120 240 360 Meters

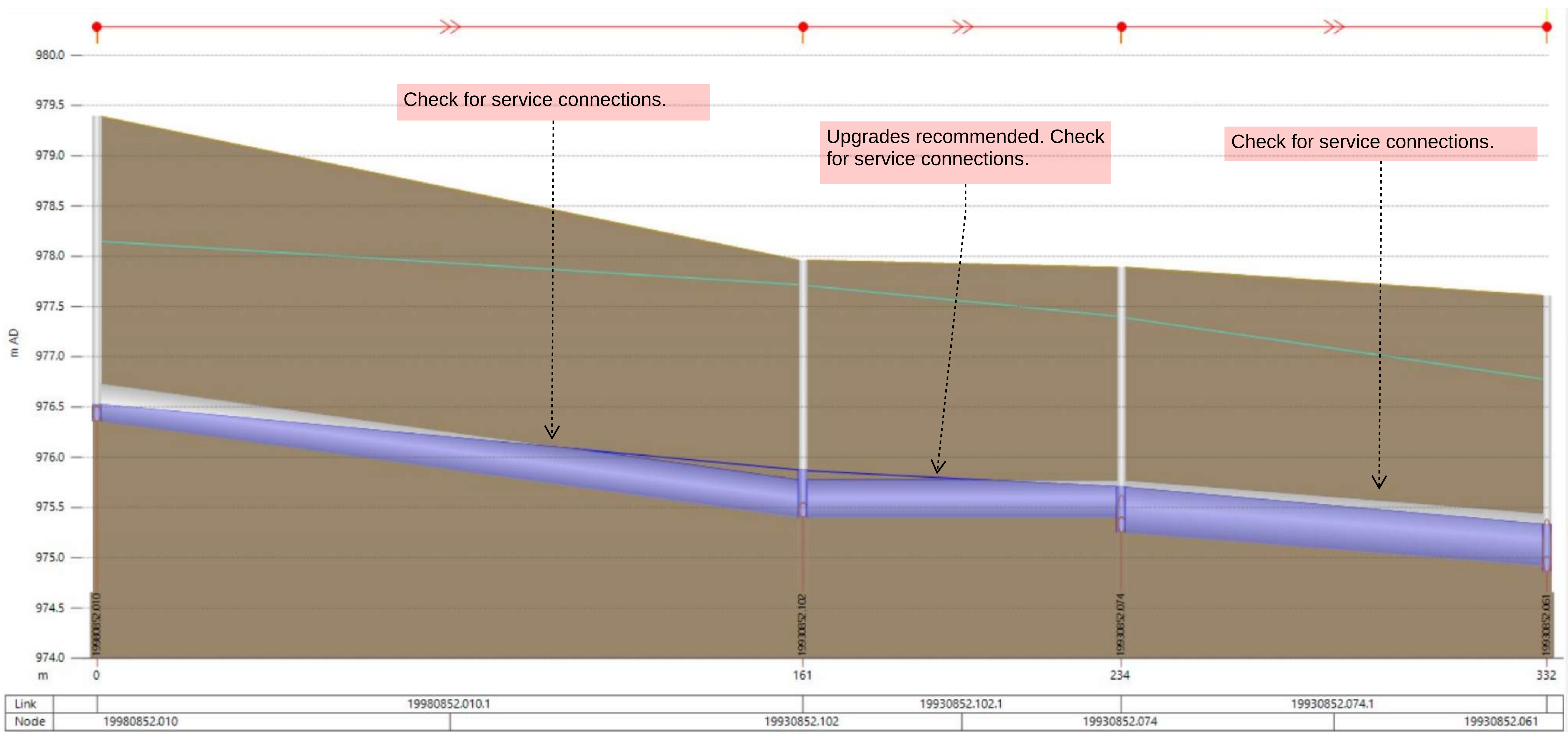
1:7,000 CANA83 3TM114

FIGURE LP.13
LONGITUDINAL PROFILE 5H
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

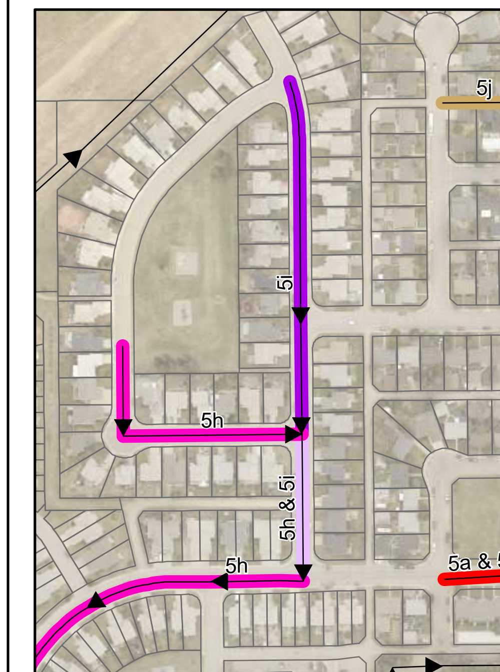
Strathmore

Integrated Expertise. Locally Delivered.



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



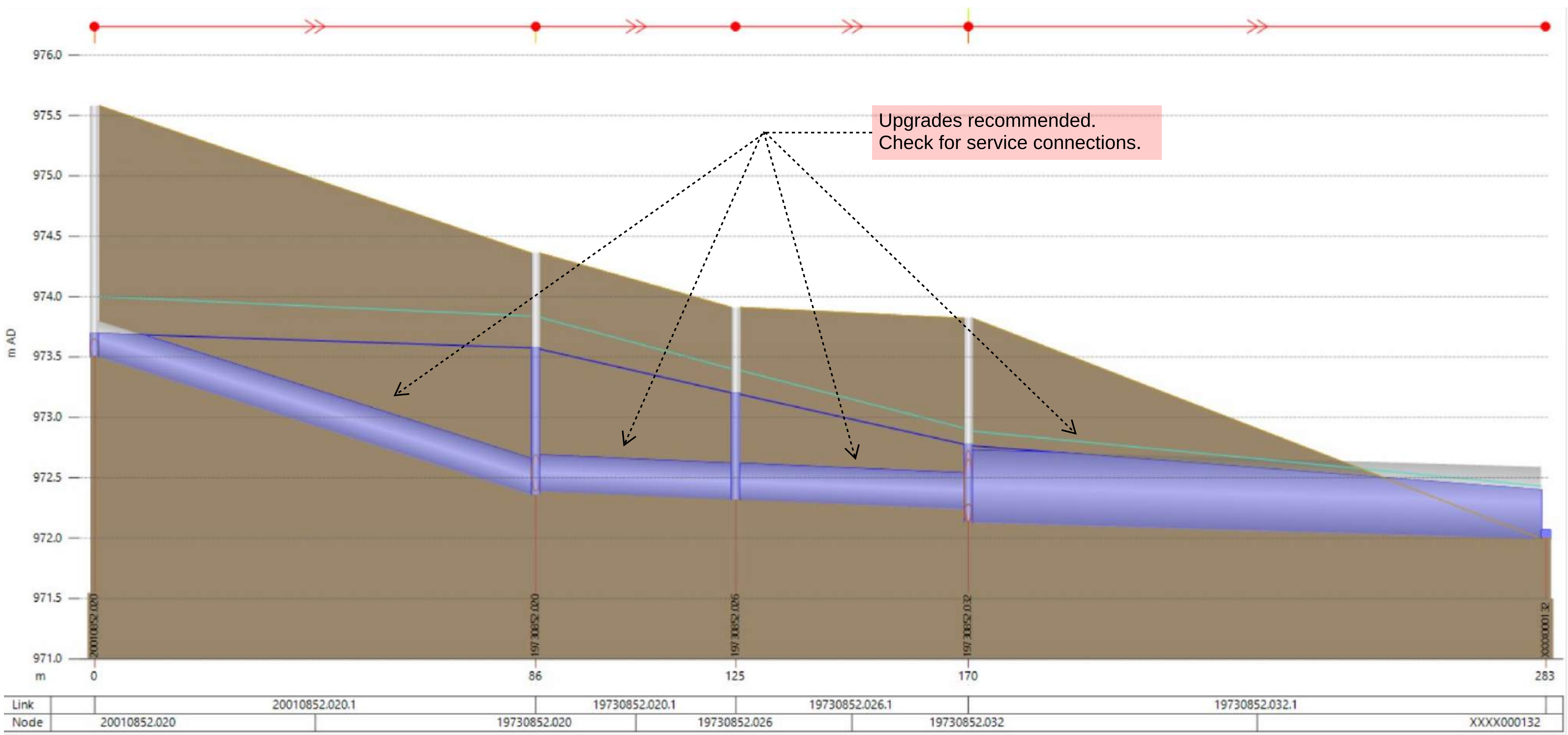
0 40 80 160 240 Meters

1:5,000 CANA83 3TM114

FIGURE LP.14
LONGITUDINAL PROFILE 5I
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL Strathmore

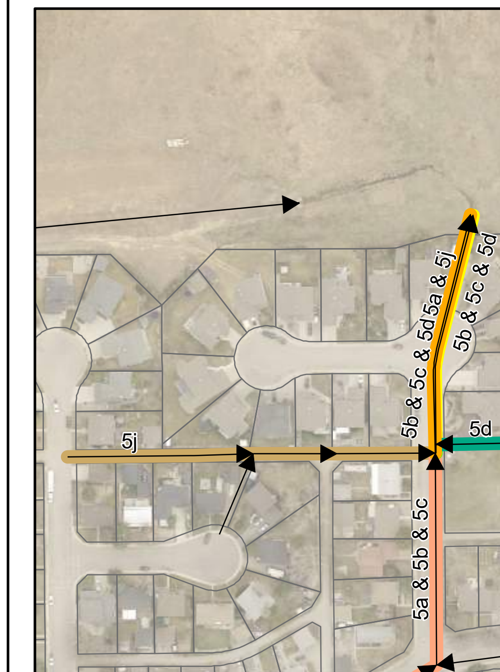
Integrated Expertise. Locally Delivered.



Legend

5 Year 1 Hour Storm Event

100 Year 24 Hour Storm Event



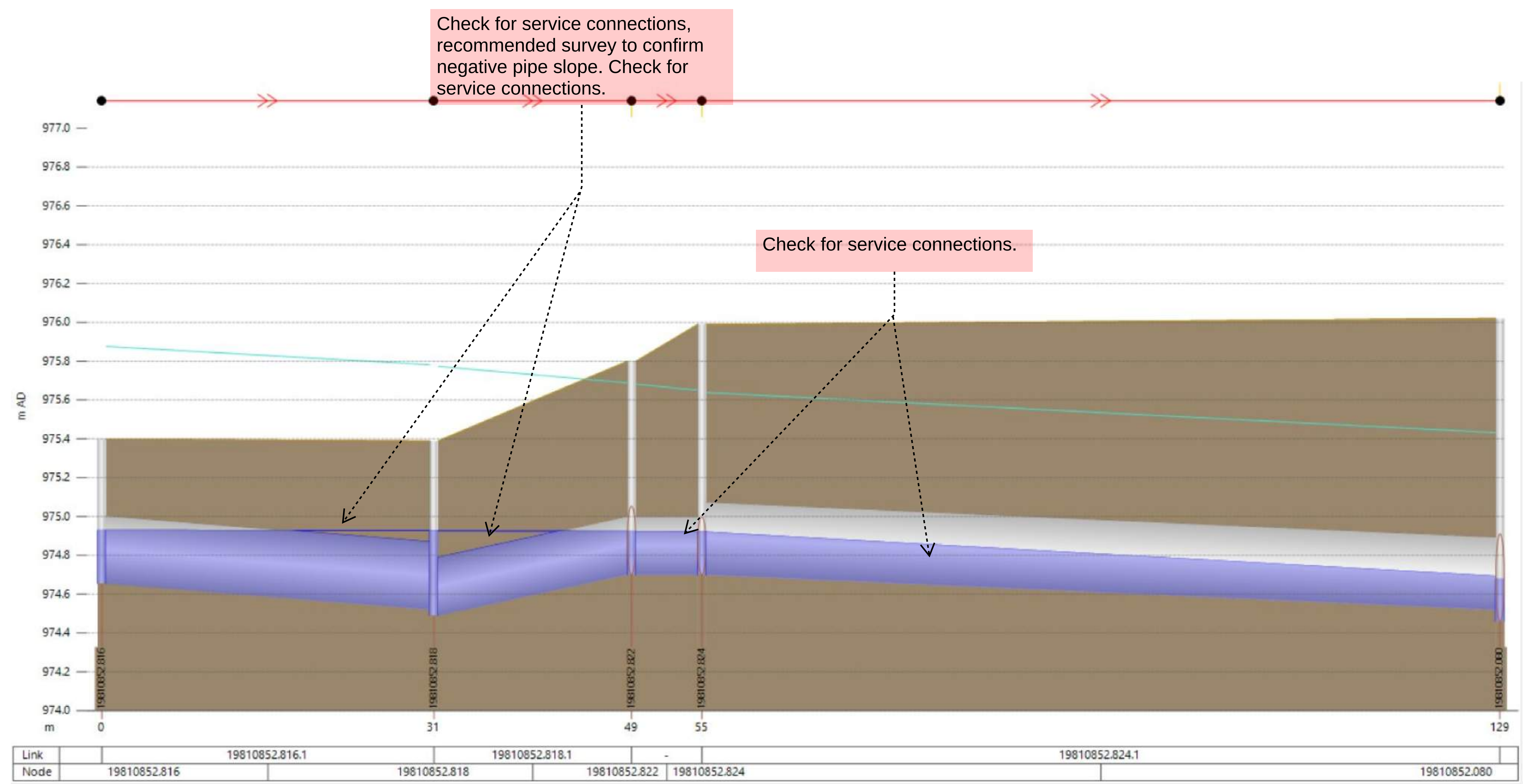
0 25 50 100 150 Meters

1:3,500 CANA83 3TM114

FIGURE LP.15
LONGITUDINAL PROFILE 5J
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

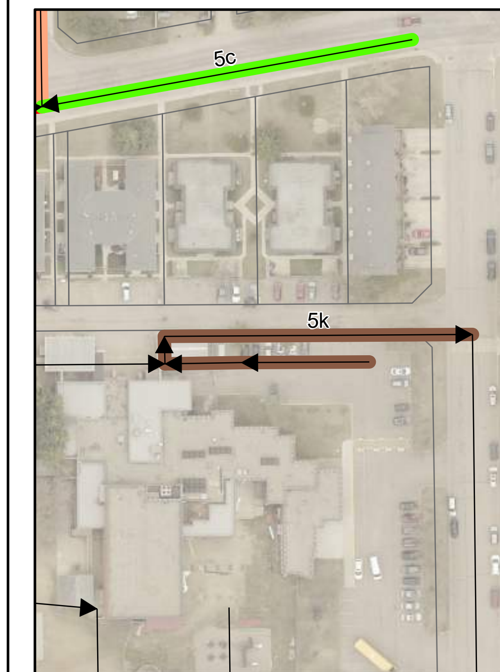
ISL Strathmore

Integrated Expertise. Locally Delivered.



Legend

5 Year 1 Hour Storm Event
100 Year 24 Hour Storm Event



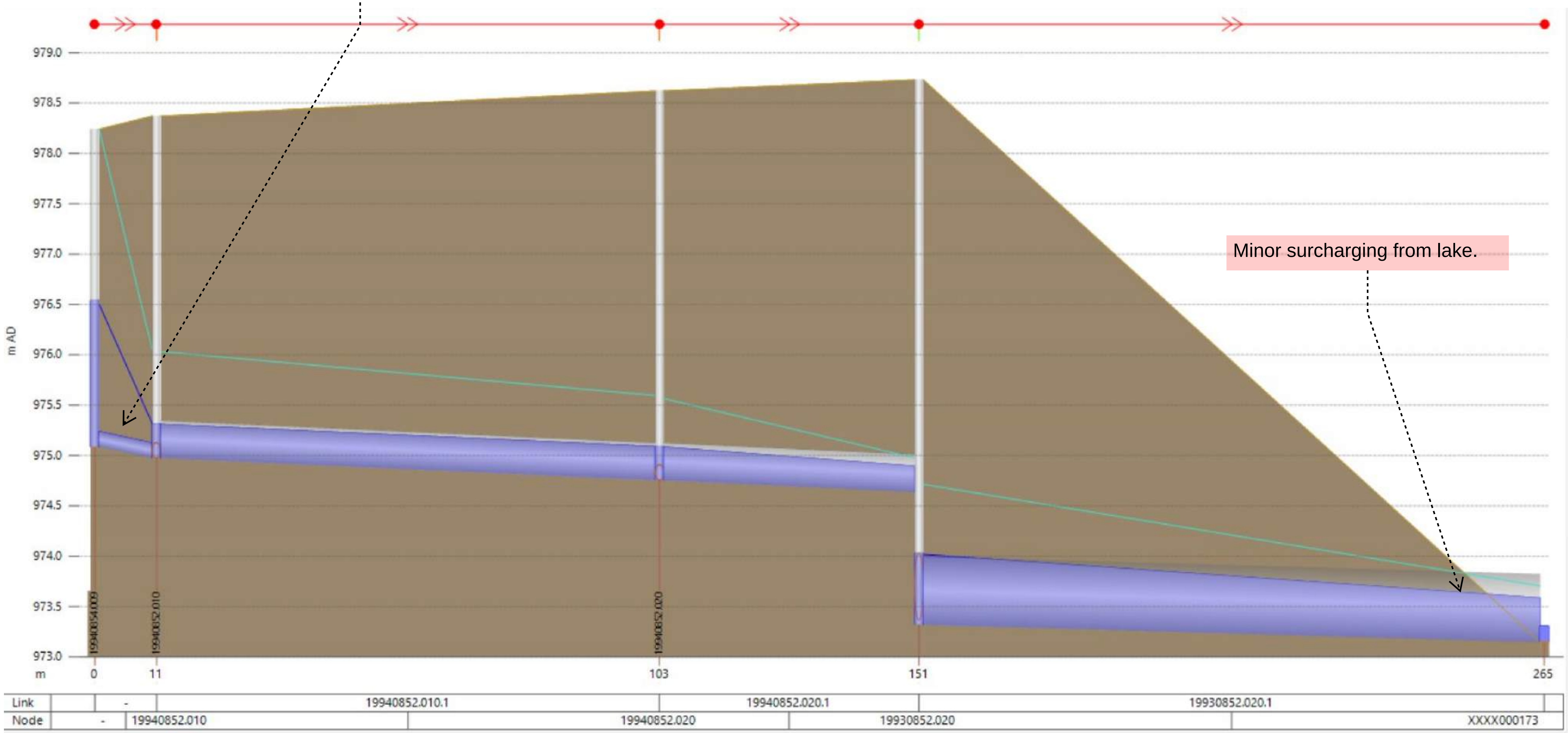
0 15 30 60 90 Meters

1:1,800 CANA83 3TM114

FIGURE LP.16
LONGITUDINAL PROFILE 5K
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

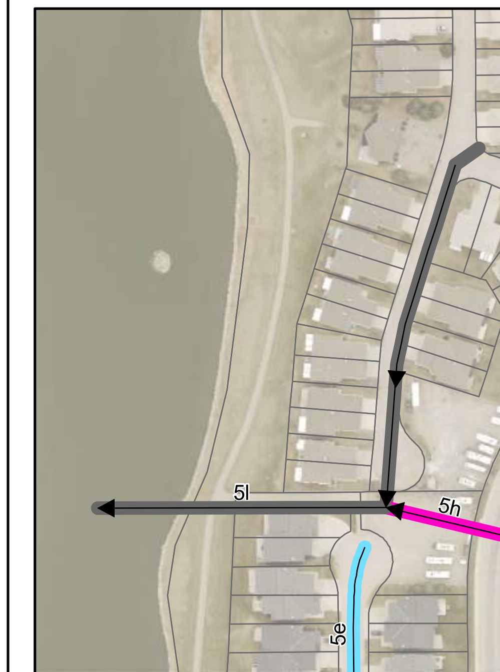
ISL Strathmore

Integrated Expertise. Locally Delivered.



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



0 25 50 100 150 Meters

1:3,000 CANA83 3TM114

FIGURE LP.17
LONGITUDINAL PROFILE 5L
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

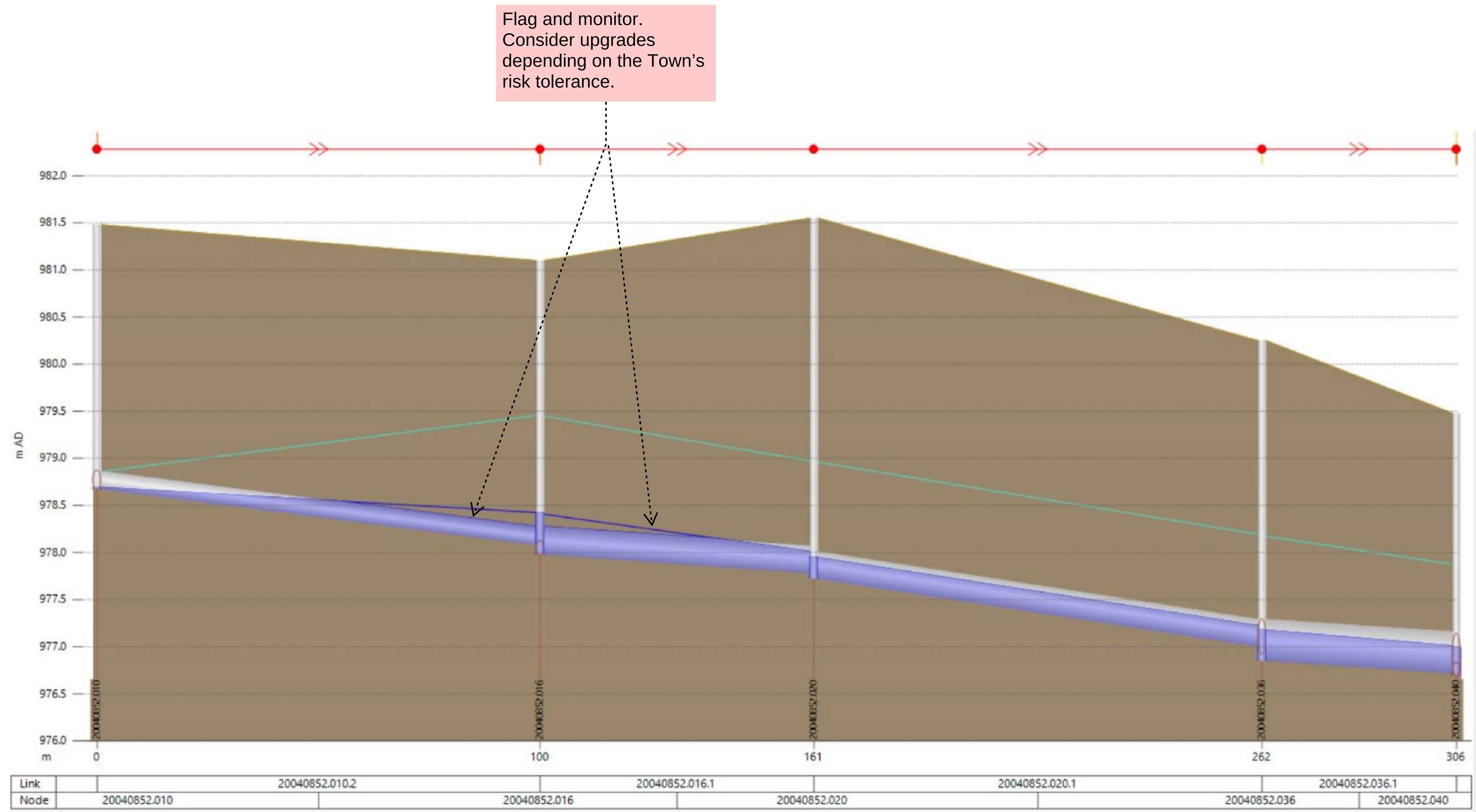
Strathmore

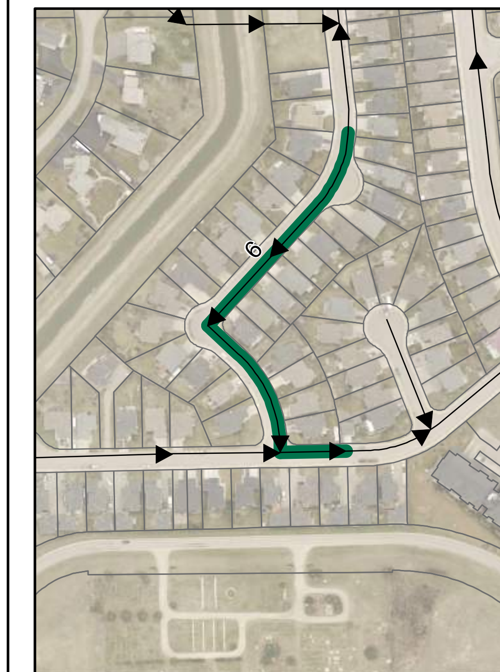
Integrated Expertise. Locally Delivered.

Legend

5 Year 1 Hour Storm Event

100 Year 24 Hour Storm Event





0 40 80 160 240 Meters

1:5,000 CANA83 3TM114

FIGURE LP.18
LONGITUDINAL PROFILE 6
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

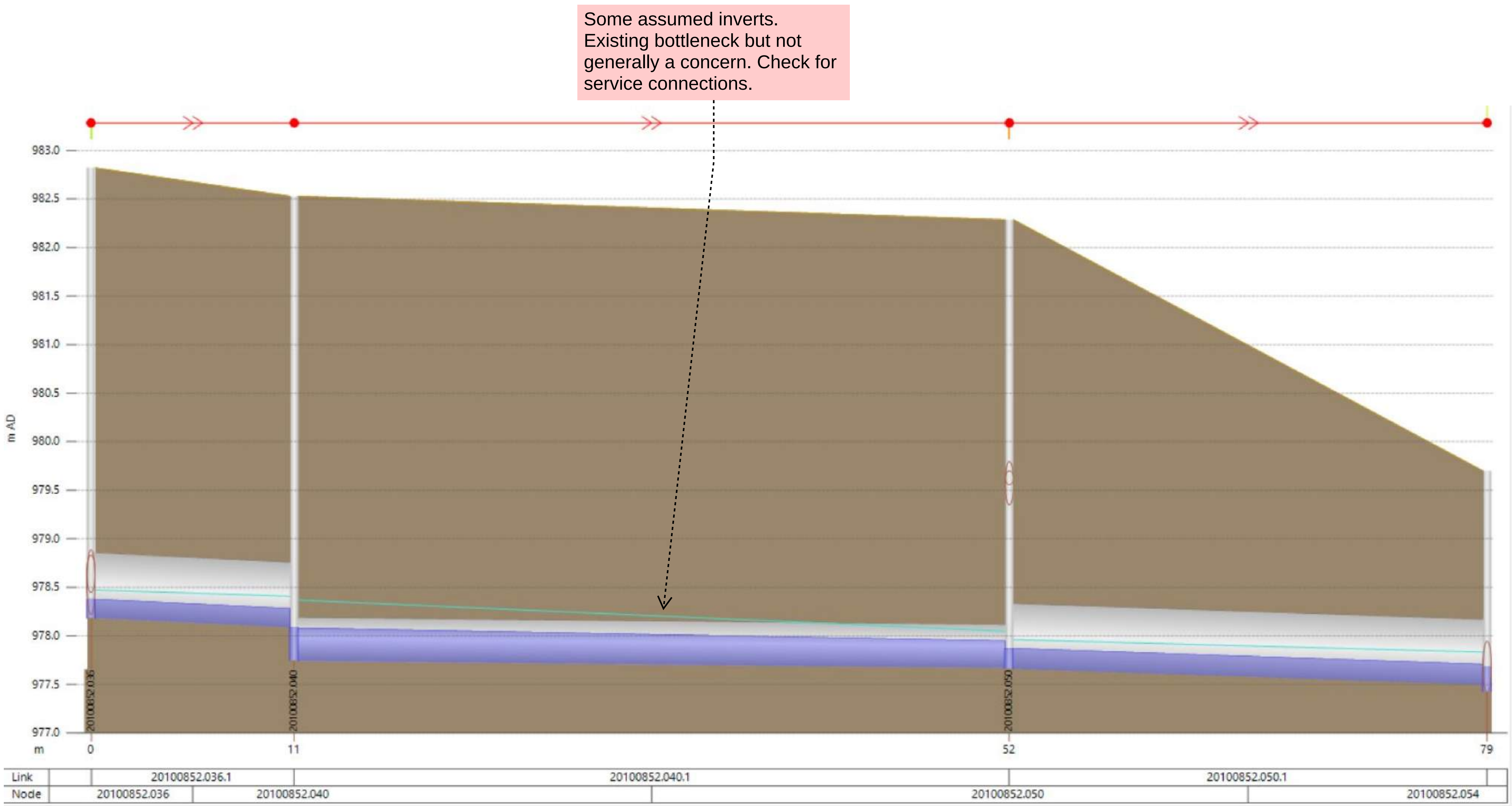
Strathmore

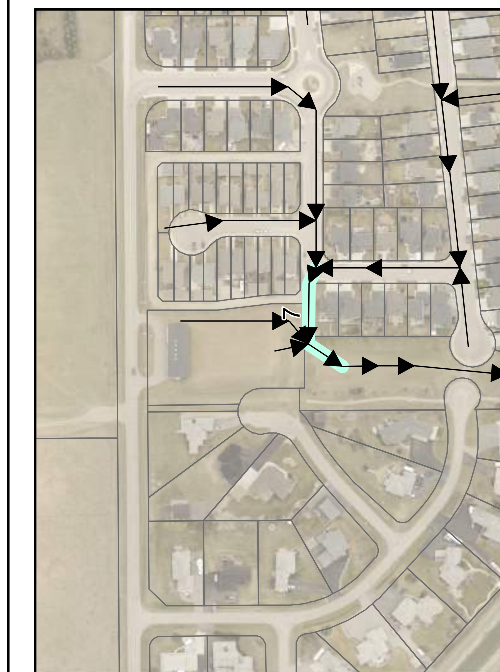
Integrated Expertise. Locally Delivered.

Legend

5 Year 1 Hour Storm Event

100 Year 24 Hour Storm Event





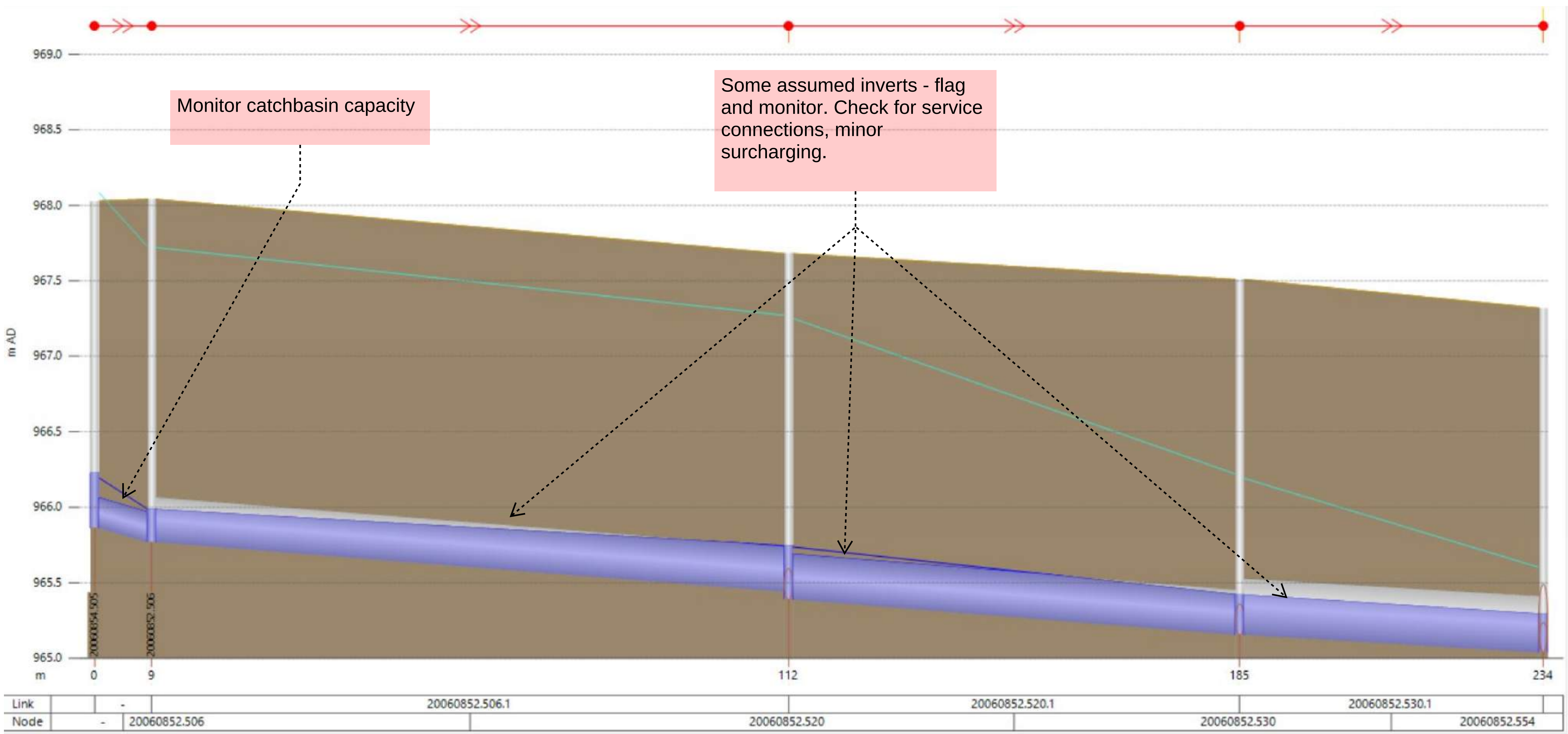
0 40 80 160 240 Meters

1:5,000 CANA83 3TM114

FIGURE LP.19
LONGITUDINAL PROFILE 7
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

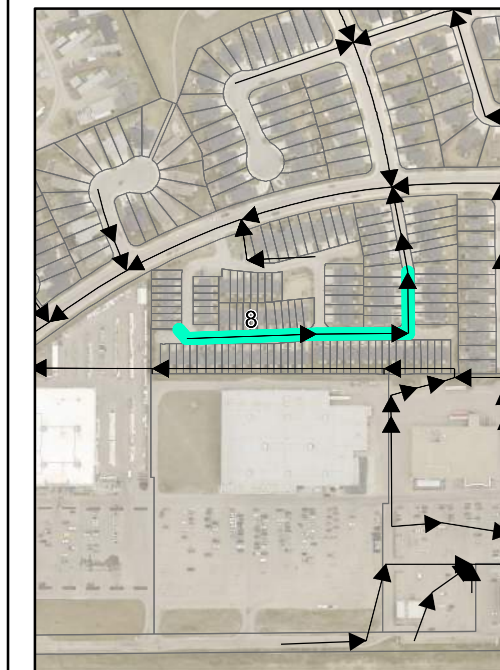
ISL

Strathmore



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



0 50 100 200 300 Meters

1:6,000 CANA83 3TM114

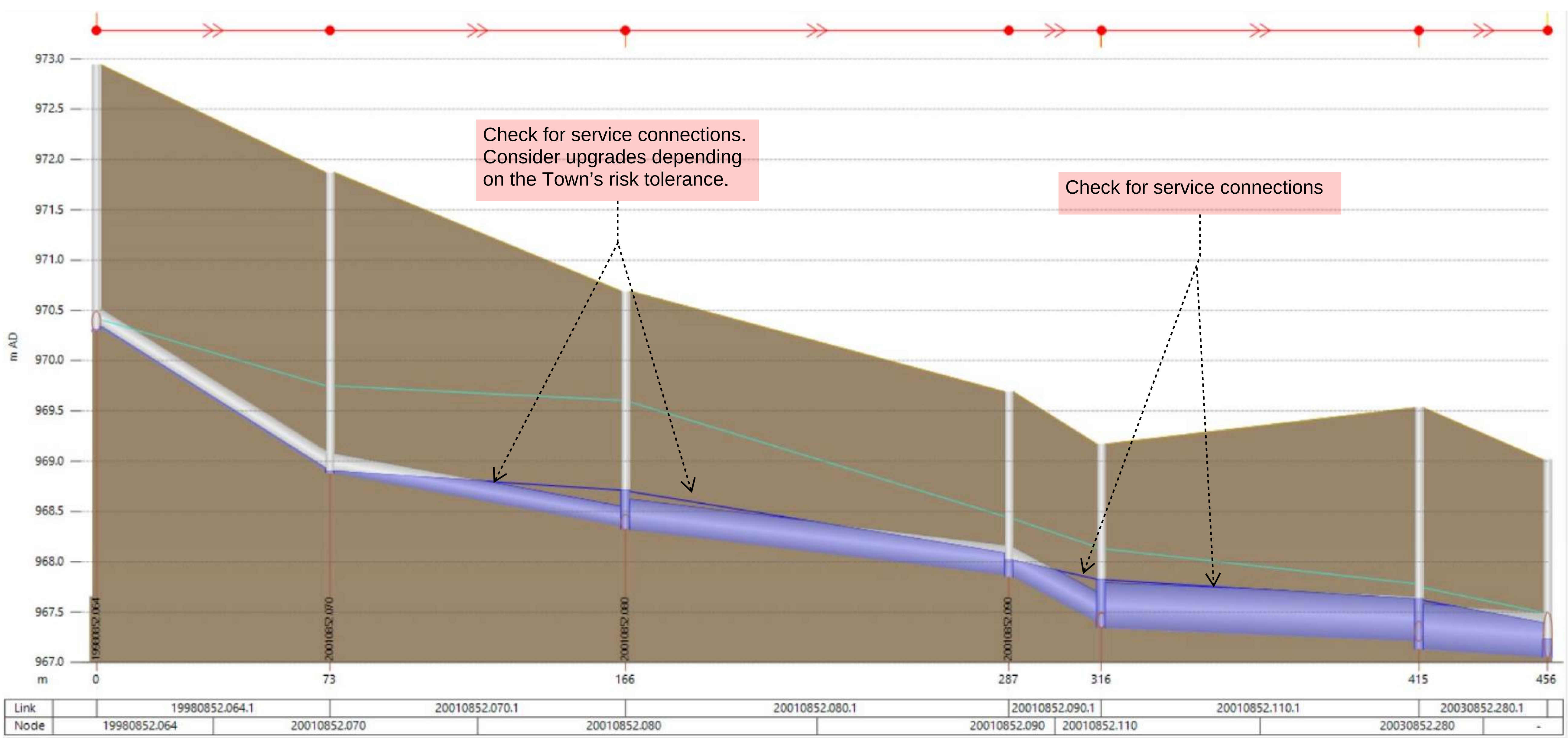
FIGURE LP.20
LONGITUDINAL PROFILE 8
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

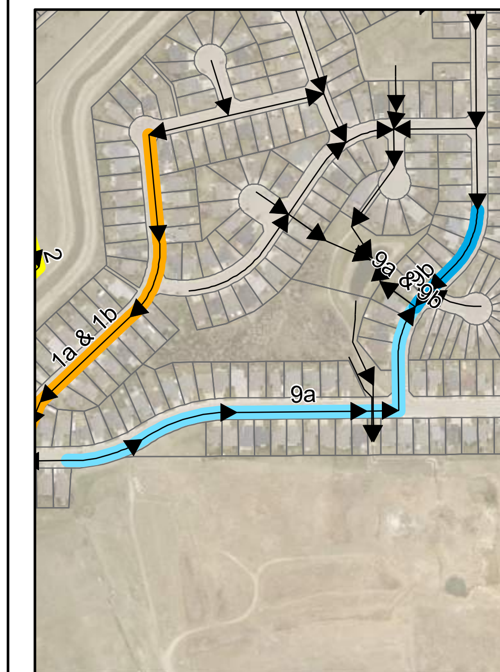
Integrated Expertise. Locally Delivered.

Date: 2/26/2024 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Preliminary Figures\LPs\28436_LP 8.mxd



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



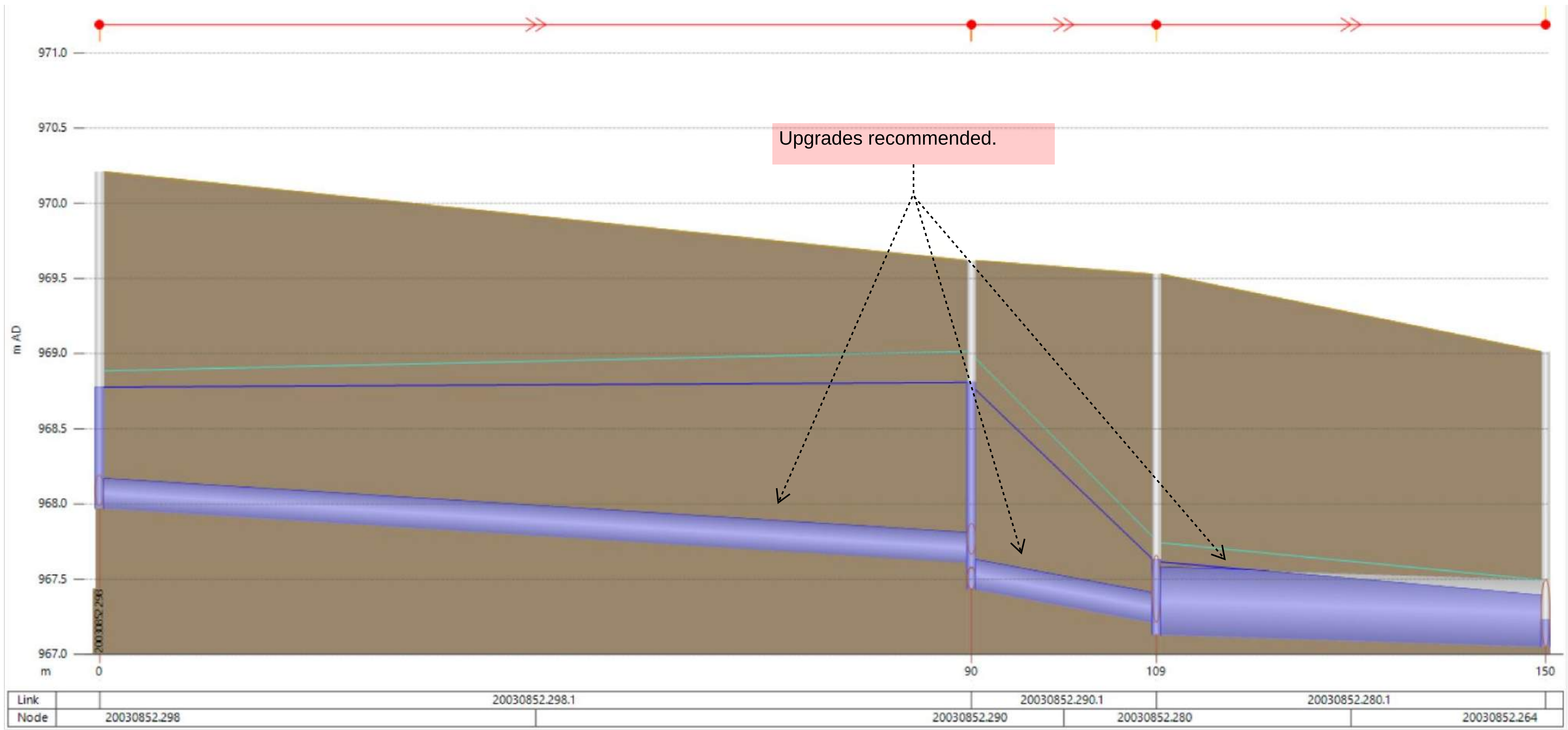
0 60 120 240 360 Meters

1:7,000 CANA83 3TM114

FIGURE LP.21
LONGITUDINAL PROFILE 9A
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL
Strathmore

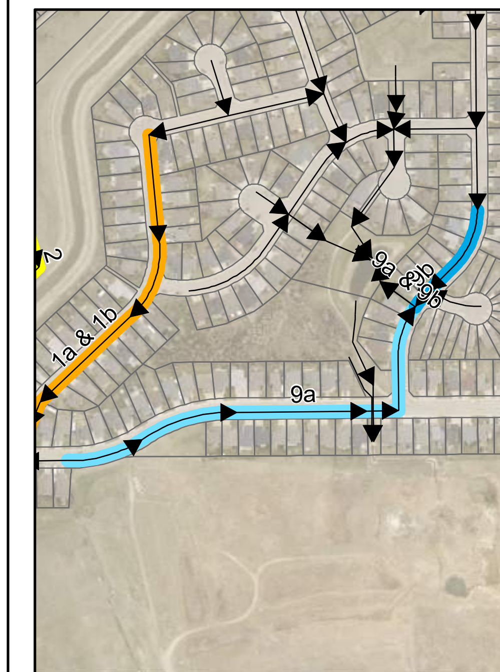
Integrated Expertise. Locally Delivered.



Legend

5 Year 1 Hour Storm Event

100 Year 24 Hour Storm Event



0 60 120 240 360 Meters

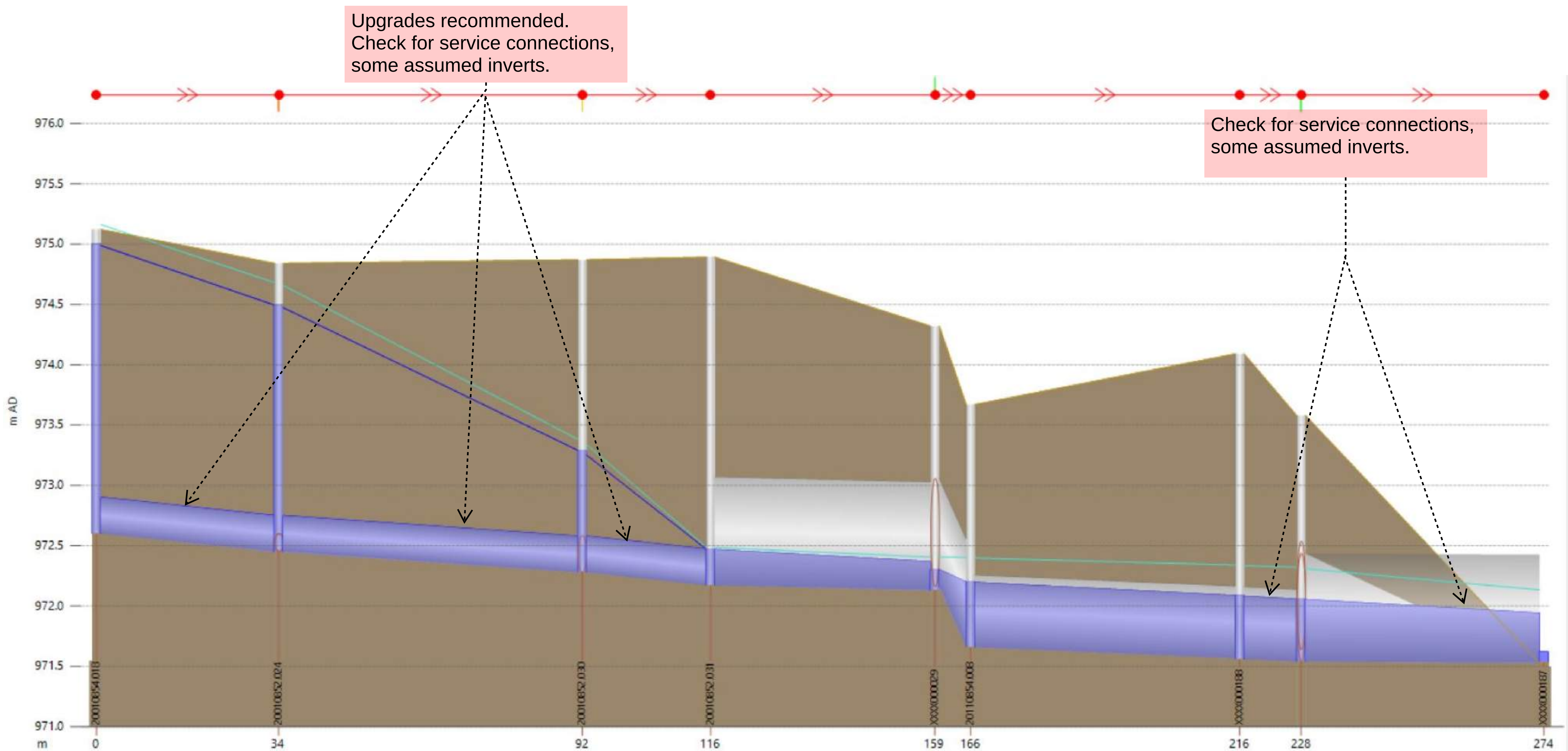
1:7,000 CANA83 3TM114

FIGURE LP.22
LONGITUDINAL PROFILE 9B
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Integrated Expertise. Locally Delivered.

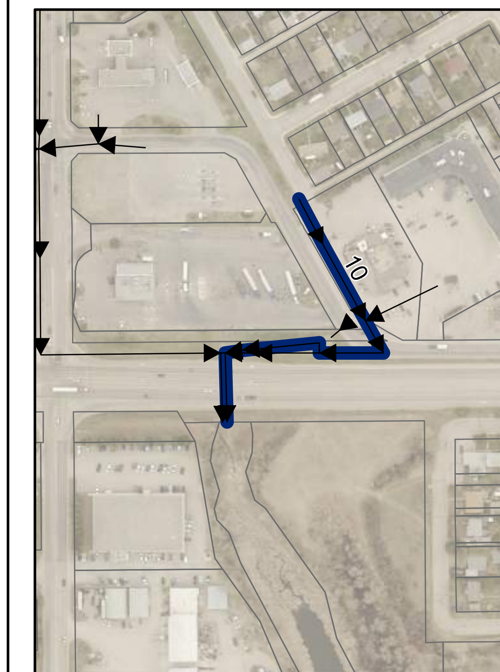


Link		20010854.018.1	20010852.024.1	20010852.030.1	20010852.031.1	-	20110854.008.1	-	20220854.004.1	
Node	20010854.018	20010852.024	20010852.030	20010852.031	XXXX000029	20110854.008	XXXX000188	20220854.004	XXXX000187	

Legend

5 Year 1 Hour Storm Event

100 Year 24 Hour Storm Event



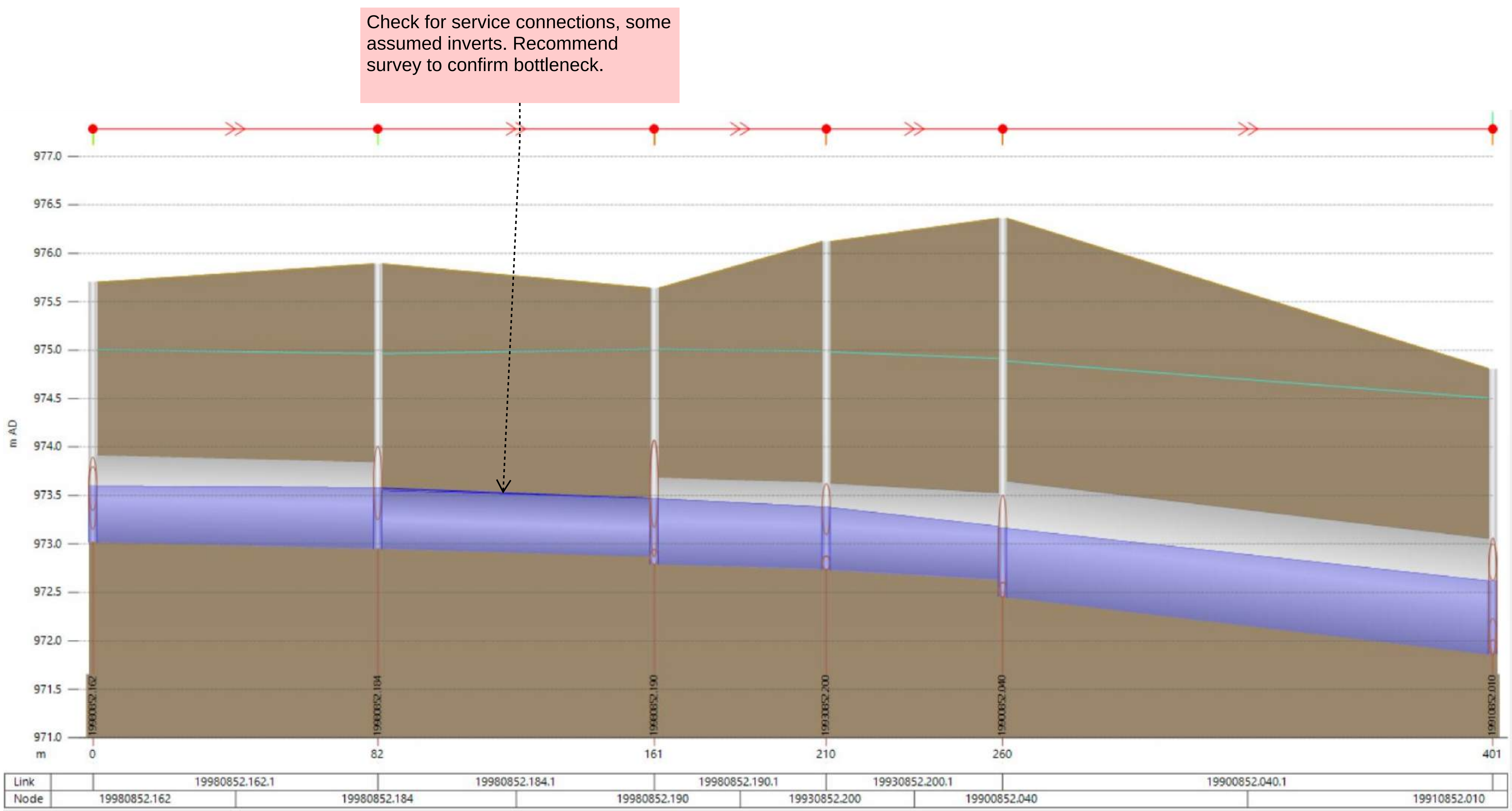
0 40 80 160 240 Meters

1:5,000 CANA83 3TM114

FIGURE LP.23
LONGITUDINAL PROFILE 10
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

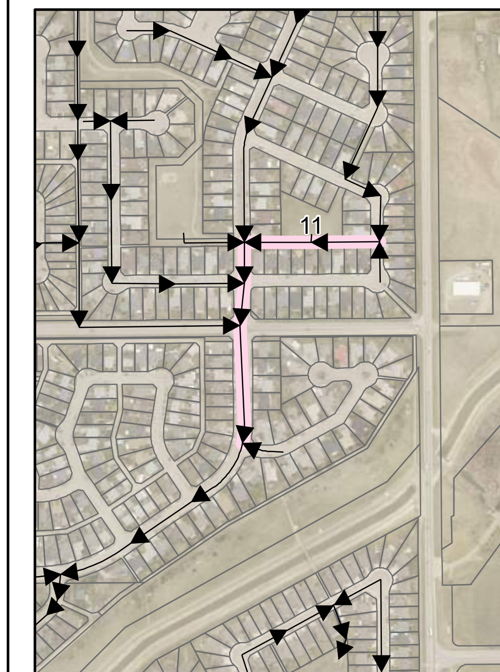
ISL Strathmore

Integrated Expertise. Locally Delivered.



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



0 75 150 300 450 Meters

1:9,000 CANA83 3TM114

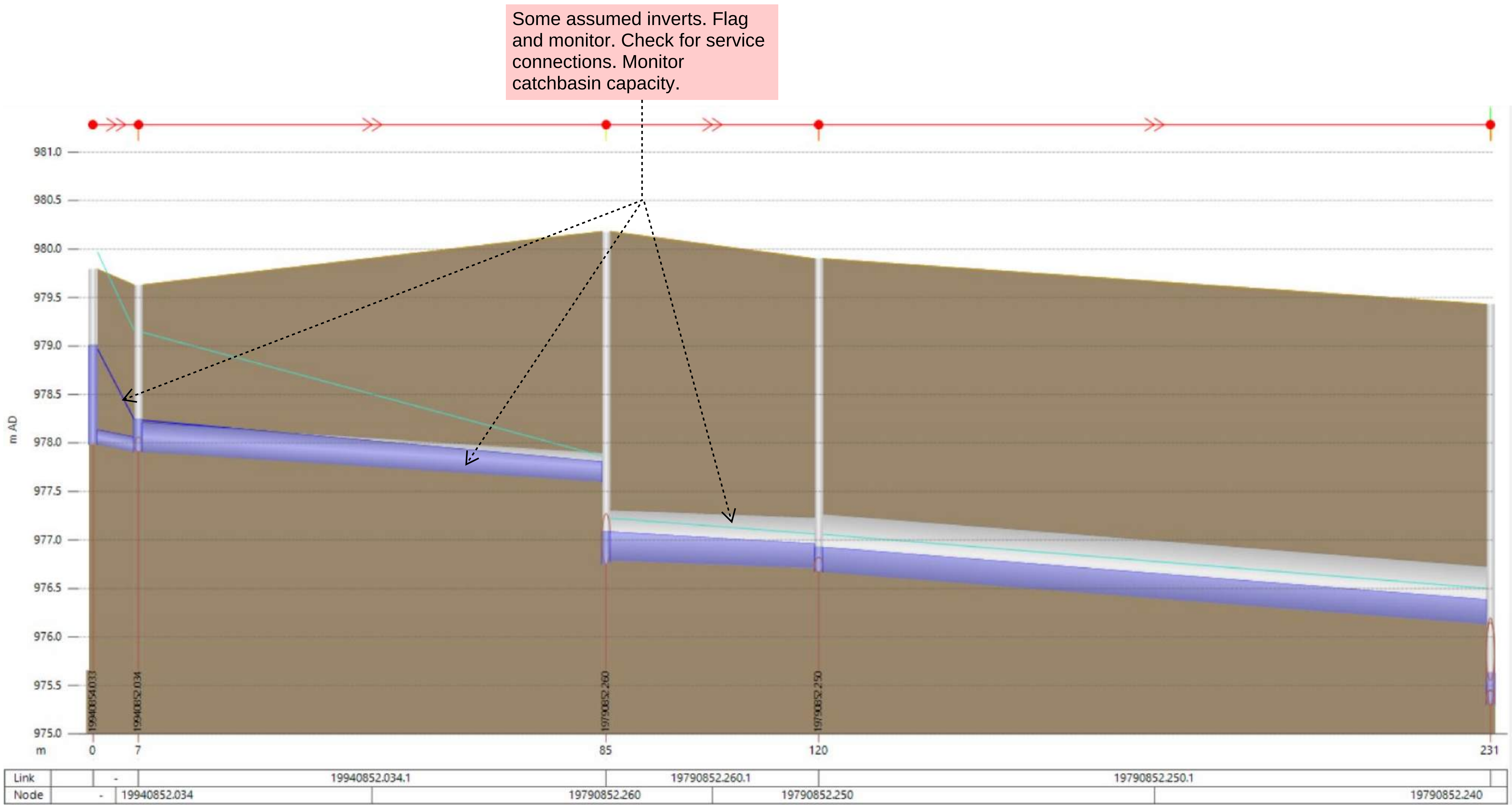
FIGURE LP.24
LONGITUDINAL PROFILE 11
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

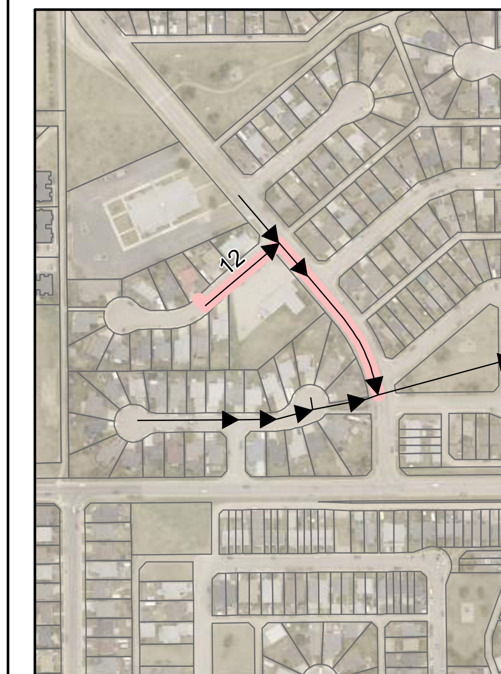
ISL Strathmore

Integrated Expertise. Locally Delivered.

Legend

5 Year 1 Hour Storm Event
100 Year 24 Hour Storm Event



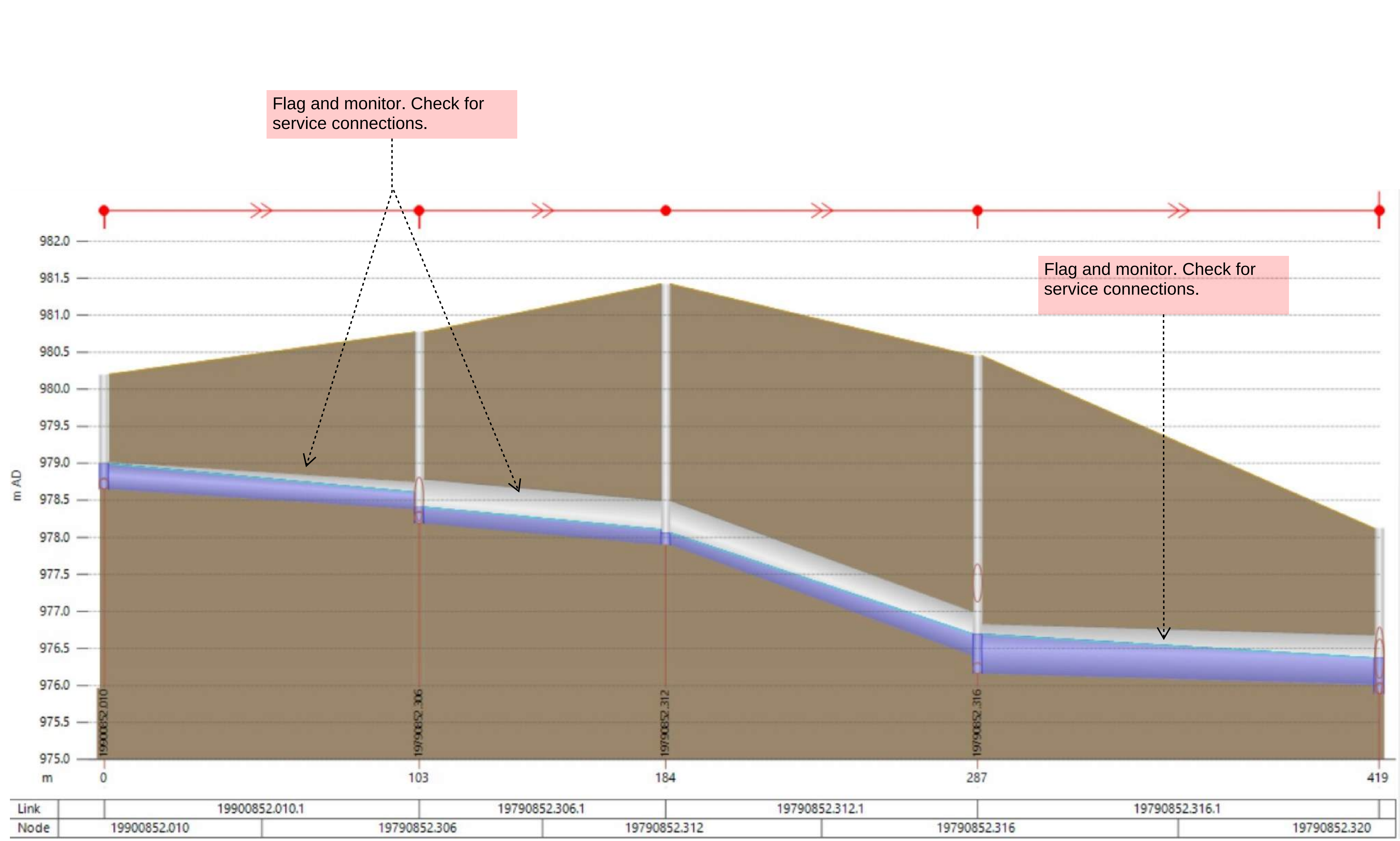


0 50 100 200 300 Meters

1:6,000 CANA83 3TM114

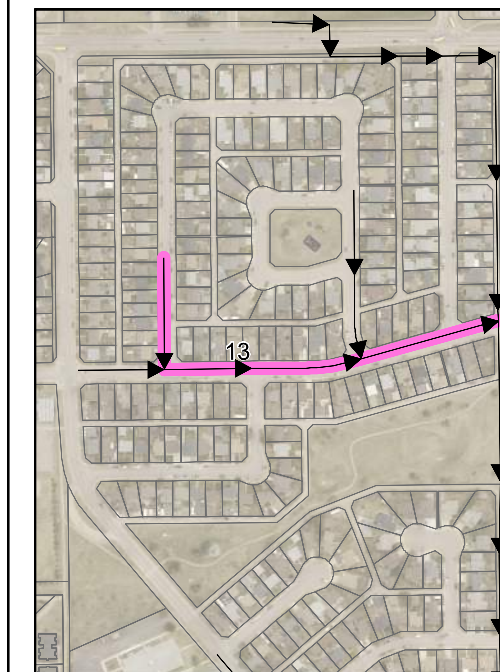
FIGURE LP.25
LONGITUDINAL PROFILE 12
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

Integrated Expertise. Locally Delivered.



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event

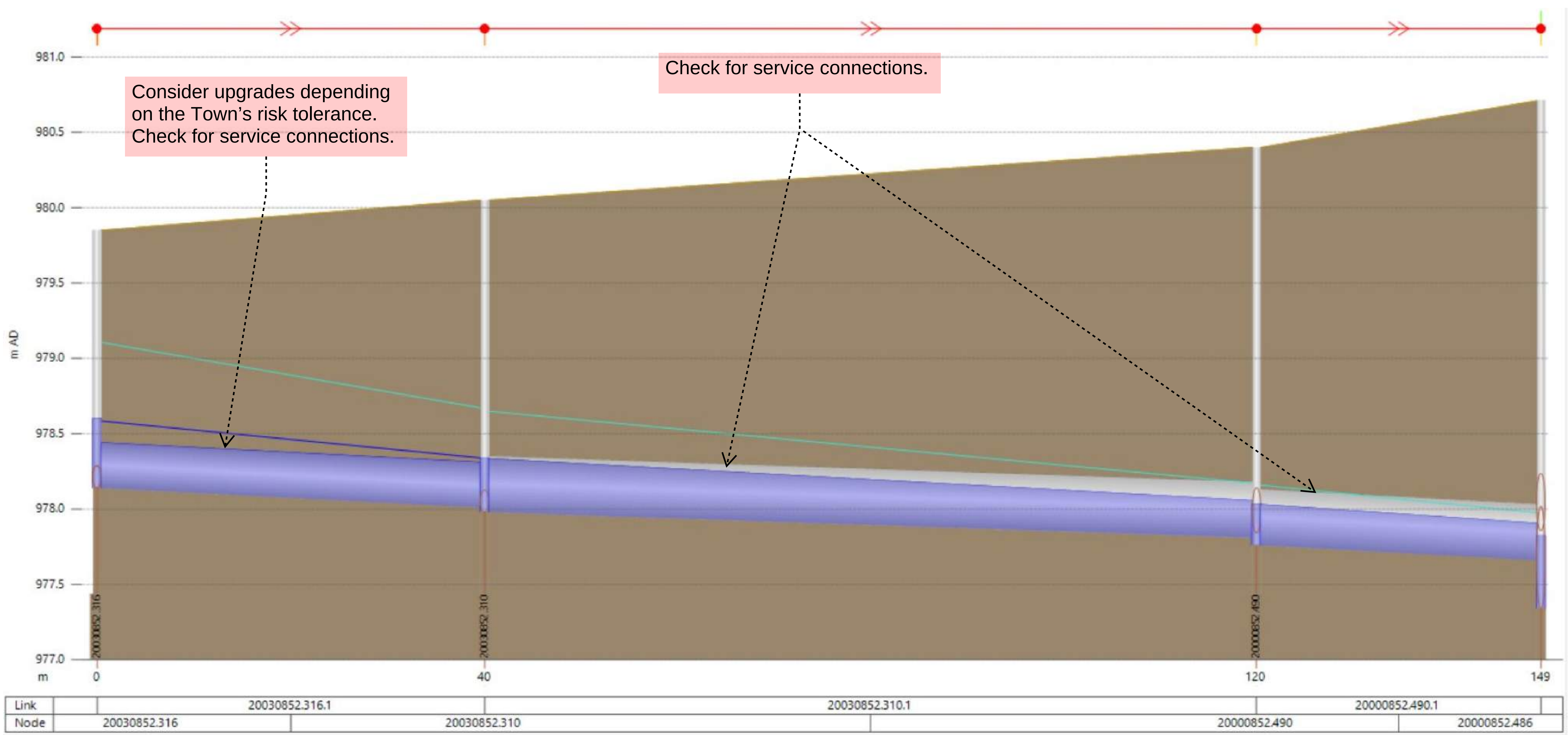


0 60 120 240 360 Meters

1:7,000 CANA83 3TM114

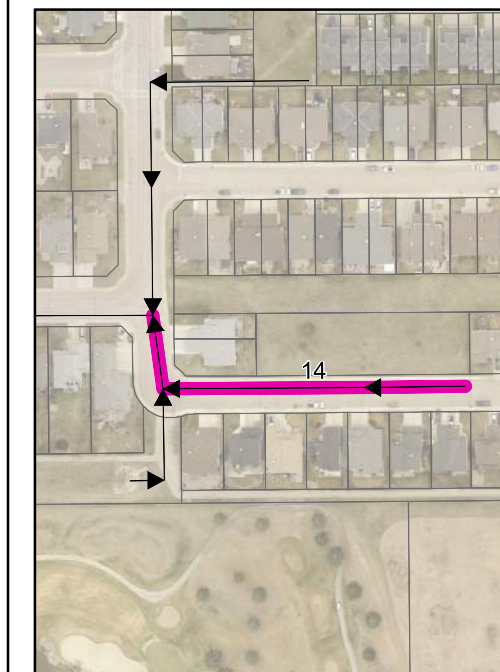
FIGURE LP.26
LONGITUDINAL PROFILE 13
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL
Strathmore



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



0 25 50 100 150 Meters

1:3,000 CANA83 3TM114

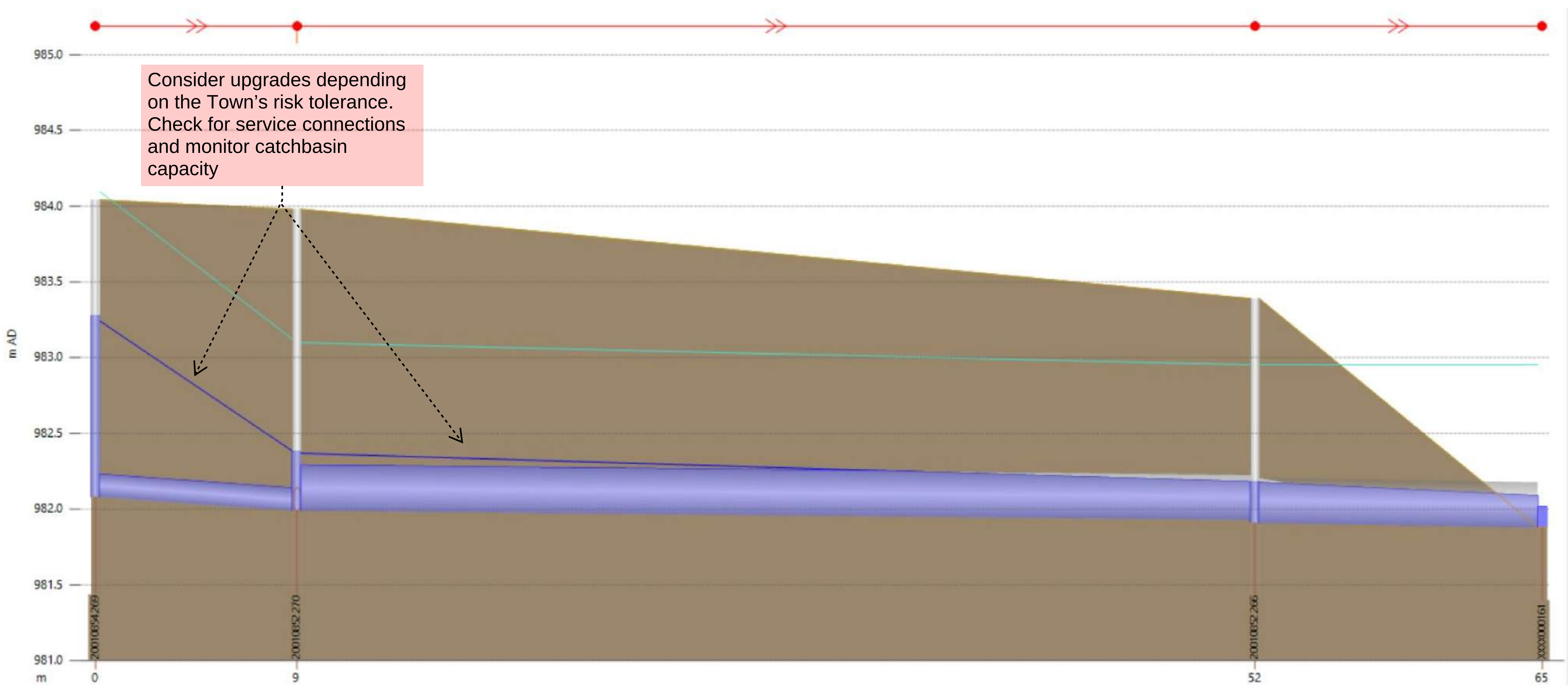
FIGURE LP.27
LONGITUDINAL PROFILE 14
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL Strathmore

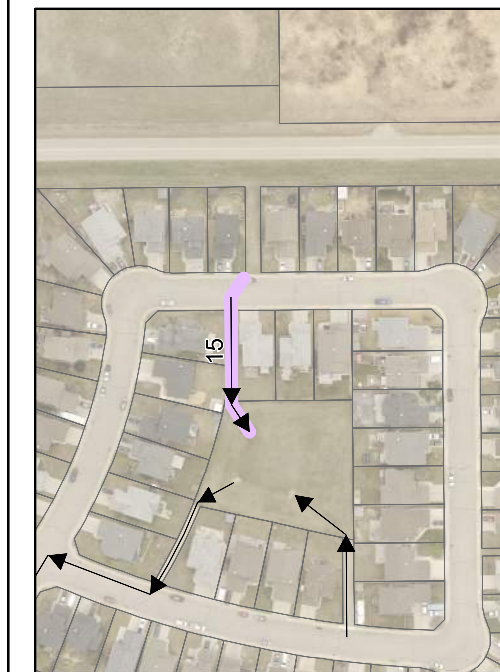
Integrated Expertise. Locally Delivered.

Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



Link		20010854.269.1		20010852.270.1		20010852.266.1	
Node	20010854.269	20010852.270			20010852.266		XXXX000161



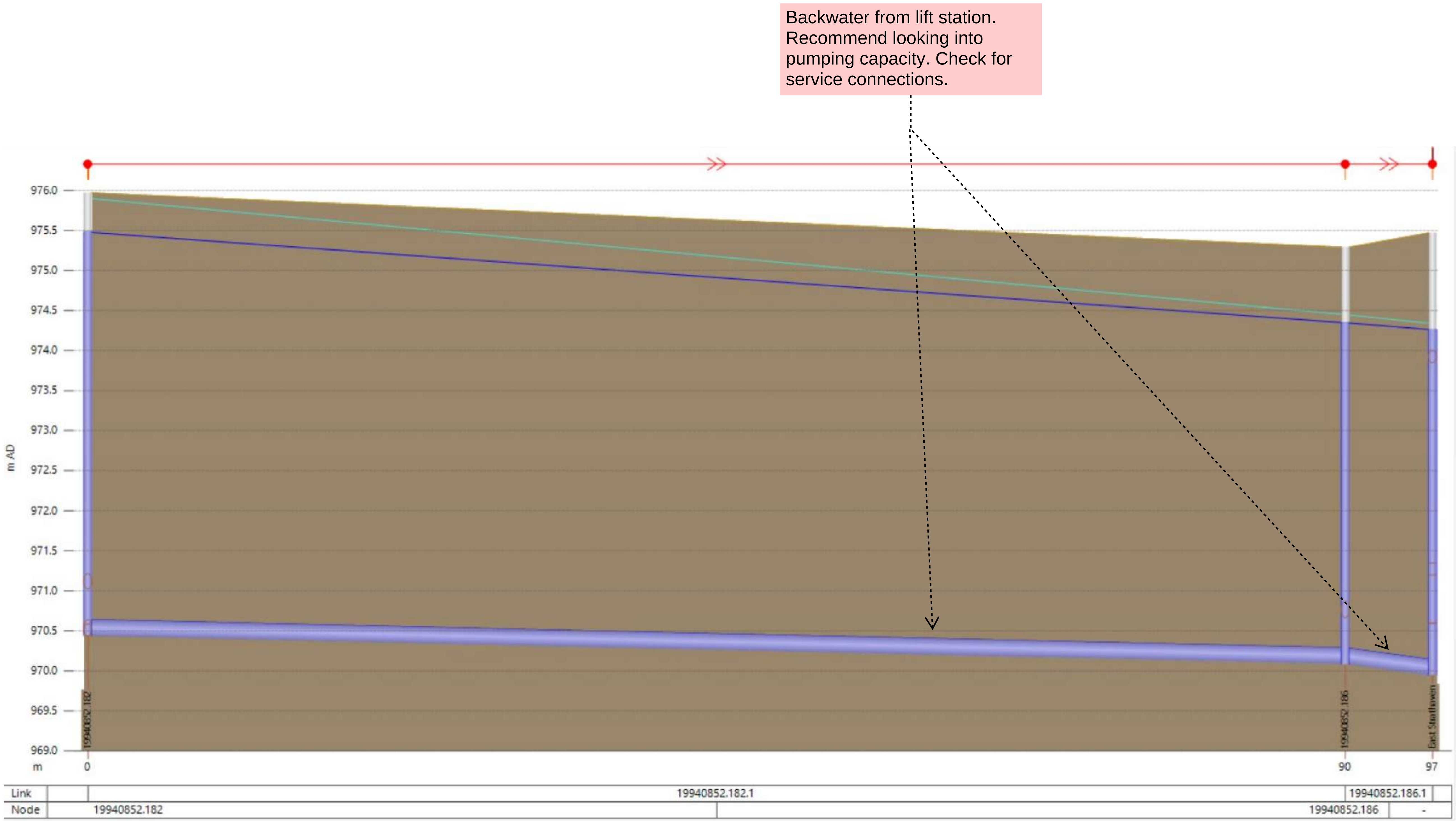
0 25 50 100 150 Meters

1:3,000 CANA83 3TM114

FIGURE LP.28
LONGITUDINAL PROFILE 15
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

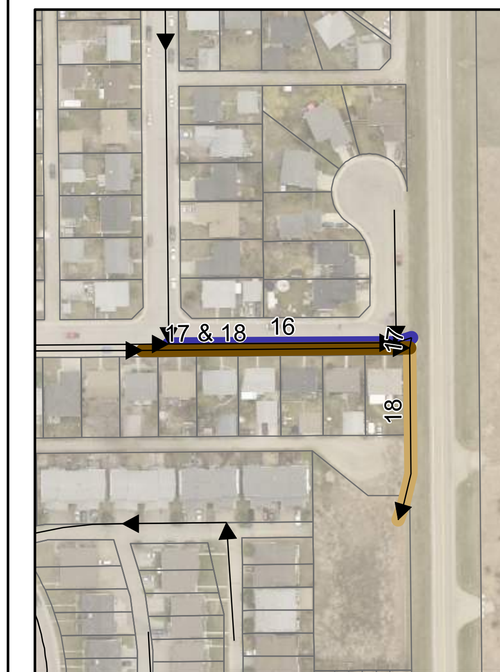
ISL

Strathmore



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



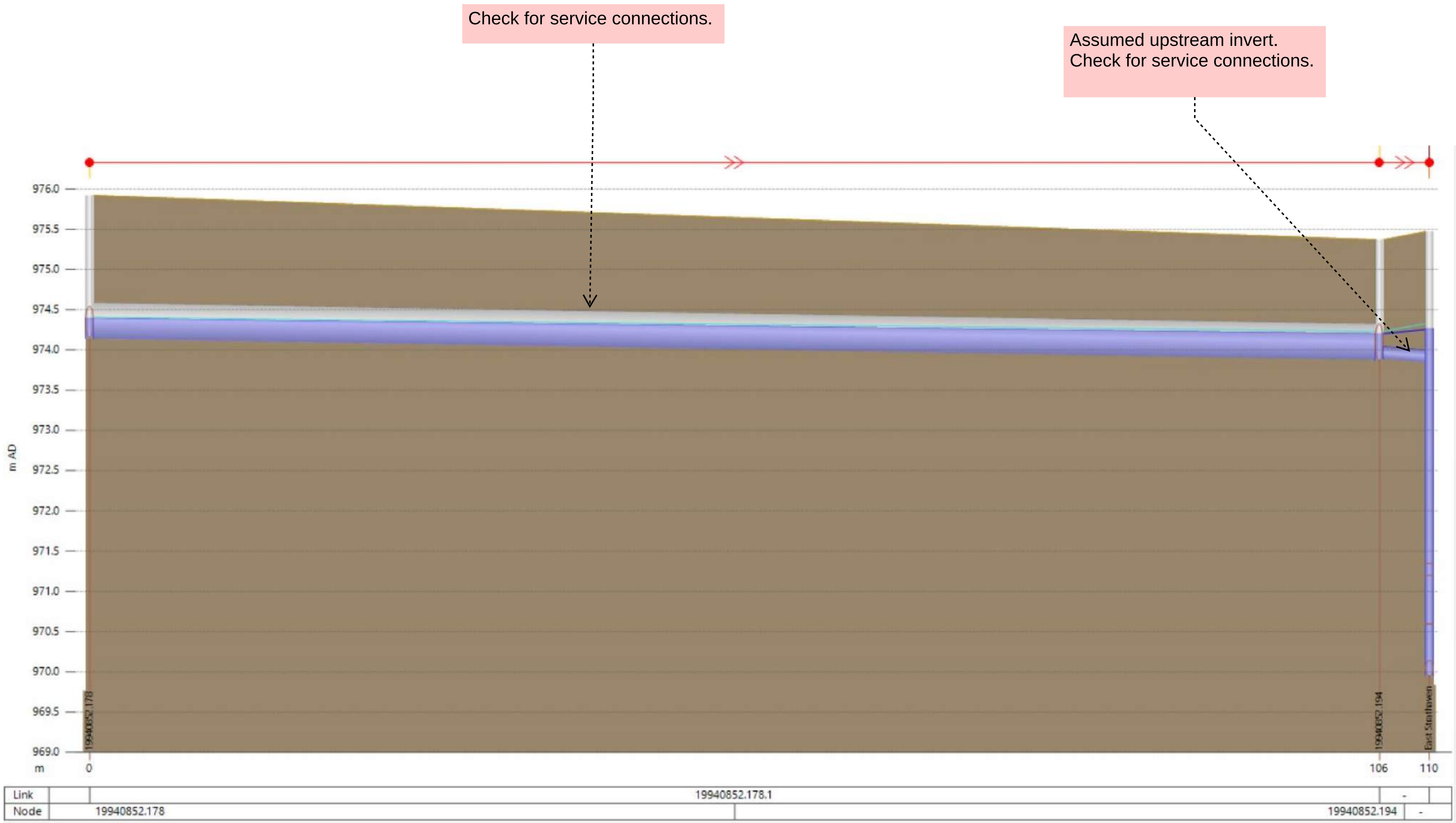
0 25 50 100 150 Meters

1:3,000 CANA83 3TM114

FIGURE LP.29
LONGITUDINAL PROFILE 16
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

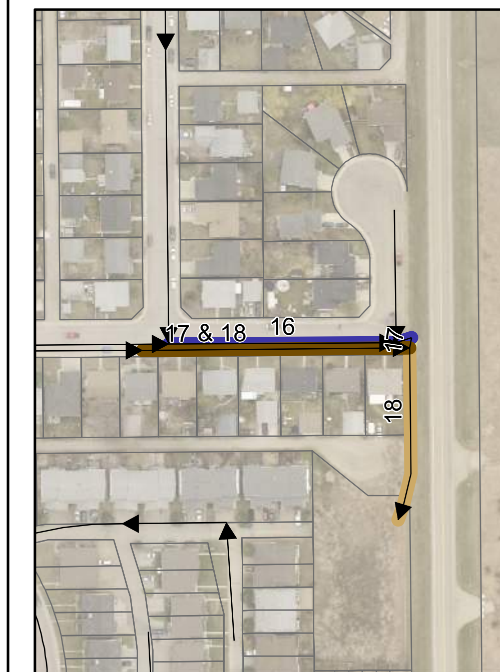
ISL

Strathmore



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



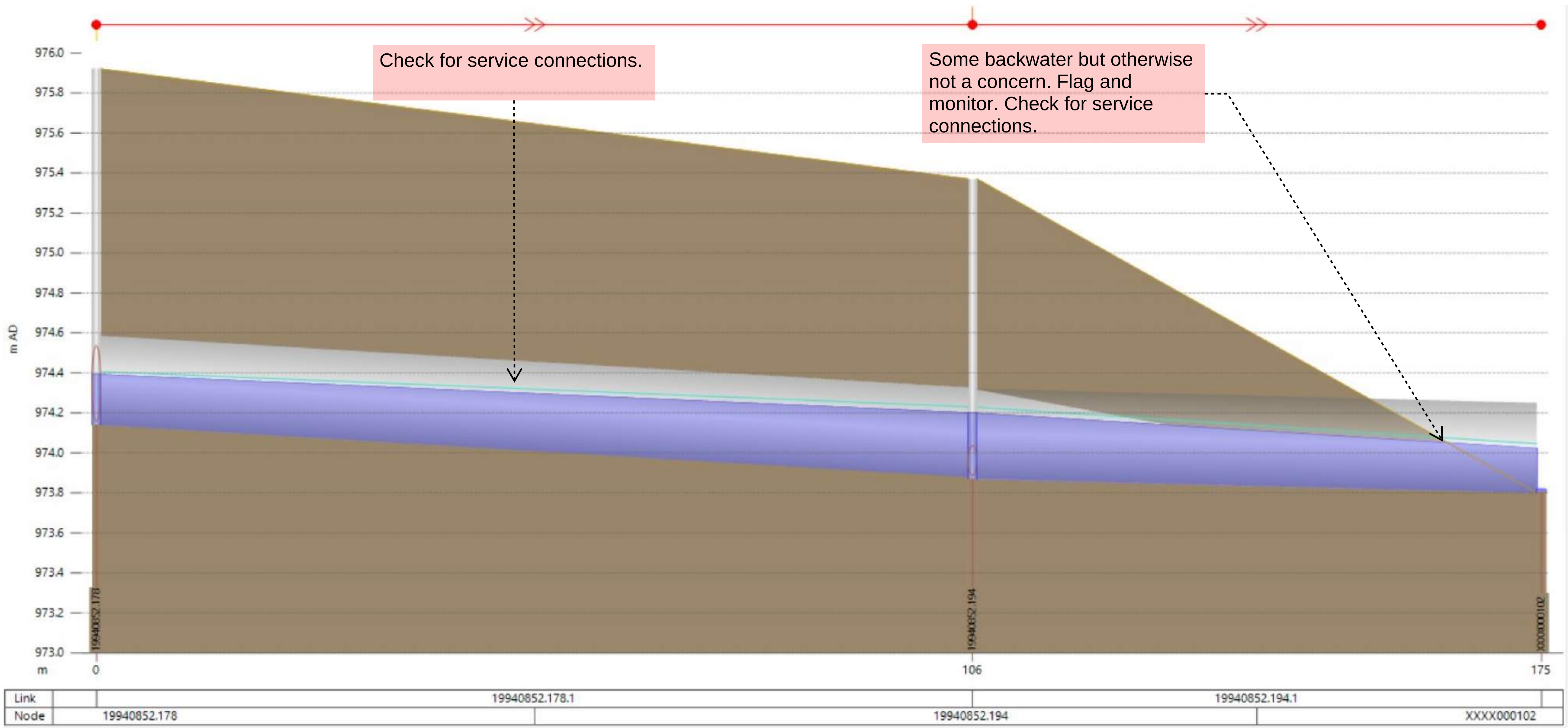
0 25 50 100 150 Meters

1:3,000 CANA83 3TM114

FIGURE LP.30
LONGITUDINAL PROFILE 17
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

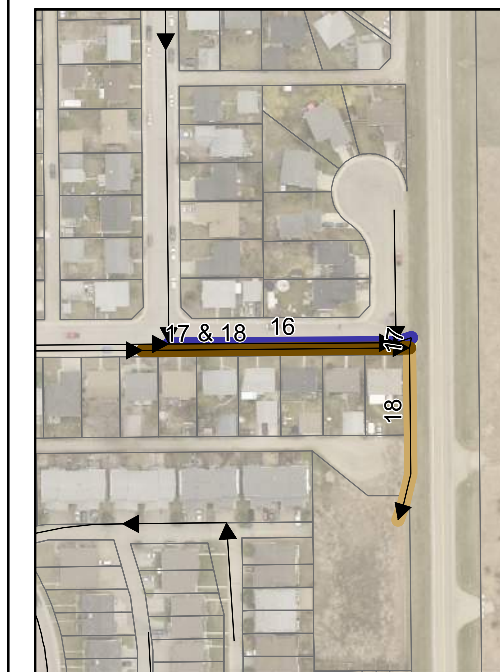
ISL

Strathmore



Legend

- 5 Year 1 Hour Storm Event
- 100 Year 24 Hour Storm Event



0 25 50 100 150 Meters

1:3,000 CANA83 3TM114

FIGURE LP.31
LONGITUDINAL PROFILE 18
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

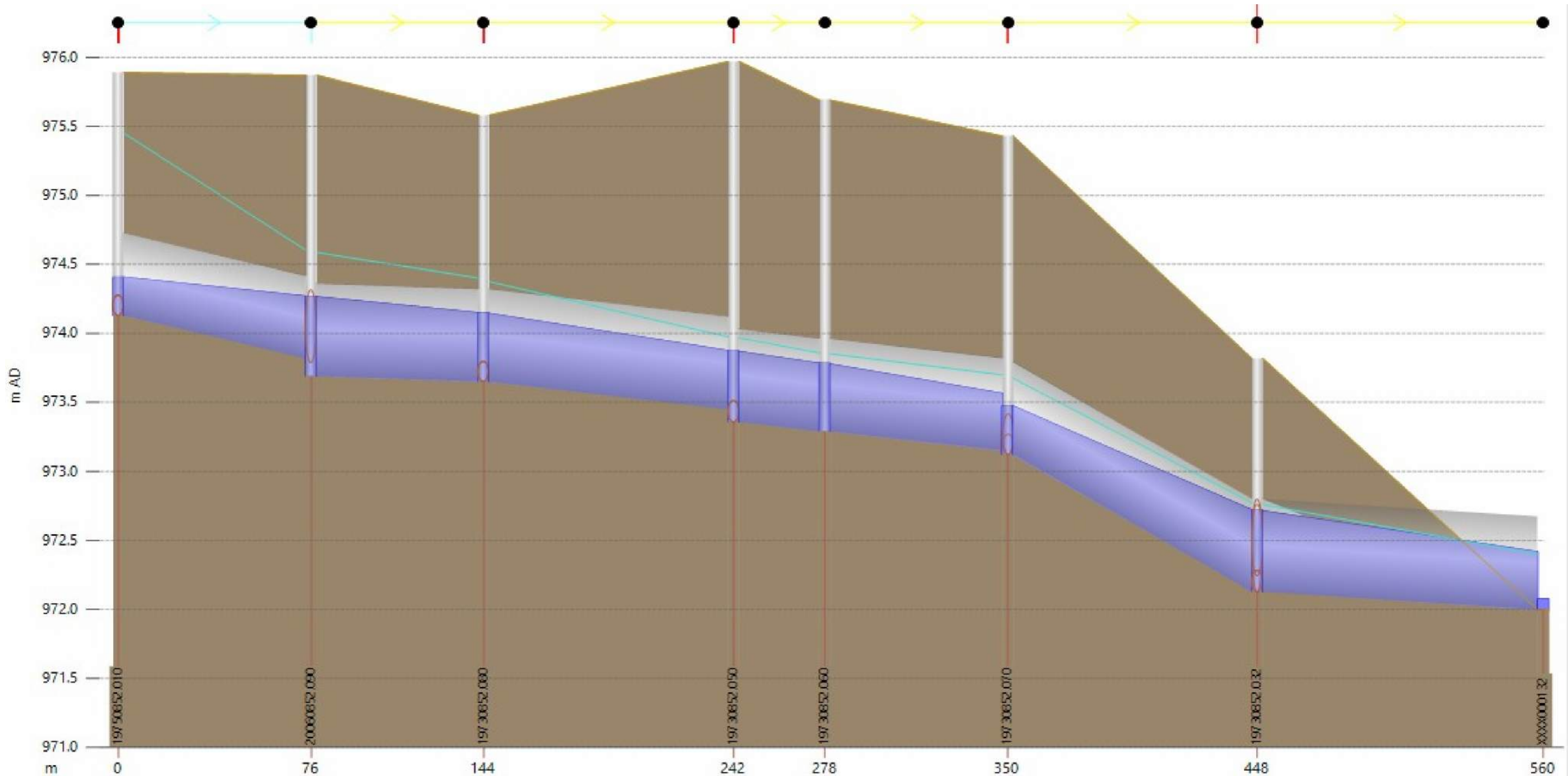
Integrated Expertise. Locally Delivered.

Longitudinal Profiles – Proposed Upgrades

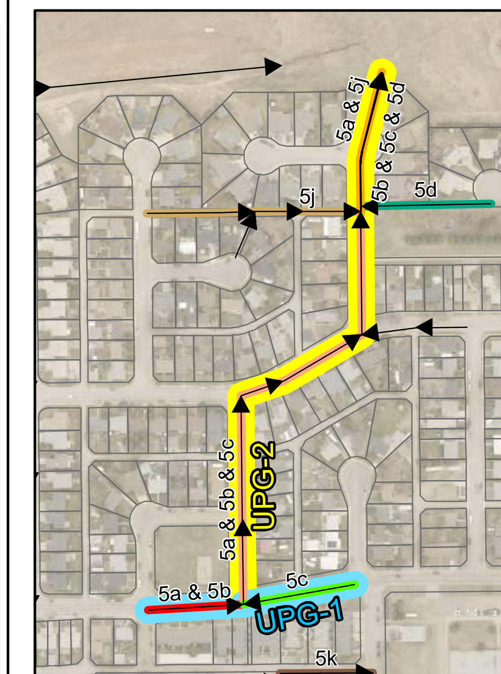
Report Appendix

Legend

5 Year 1 Hour Storm Event - Proposed Upgrade
5 Year 1 Hour Storm Event - Existing Conditions
UPG-1
UPG-2



Link		19750852.010.1	20060852.090.1	19730852.080.1	-	19730852.060.1	19730852.070.1	19730852.032.1
Node	-	20060852.090	19730852.080	19730852.050	19730852.060	19730852.070	19730852.032	XXXX000132

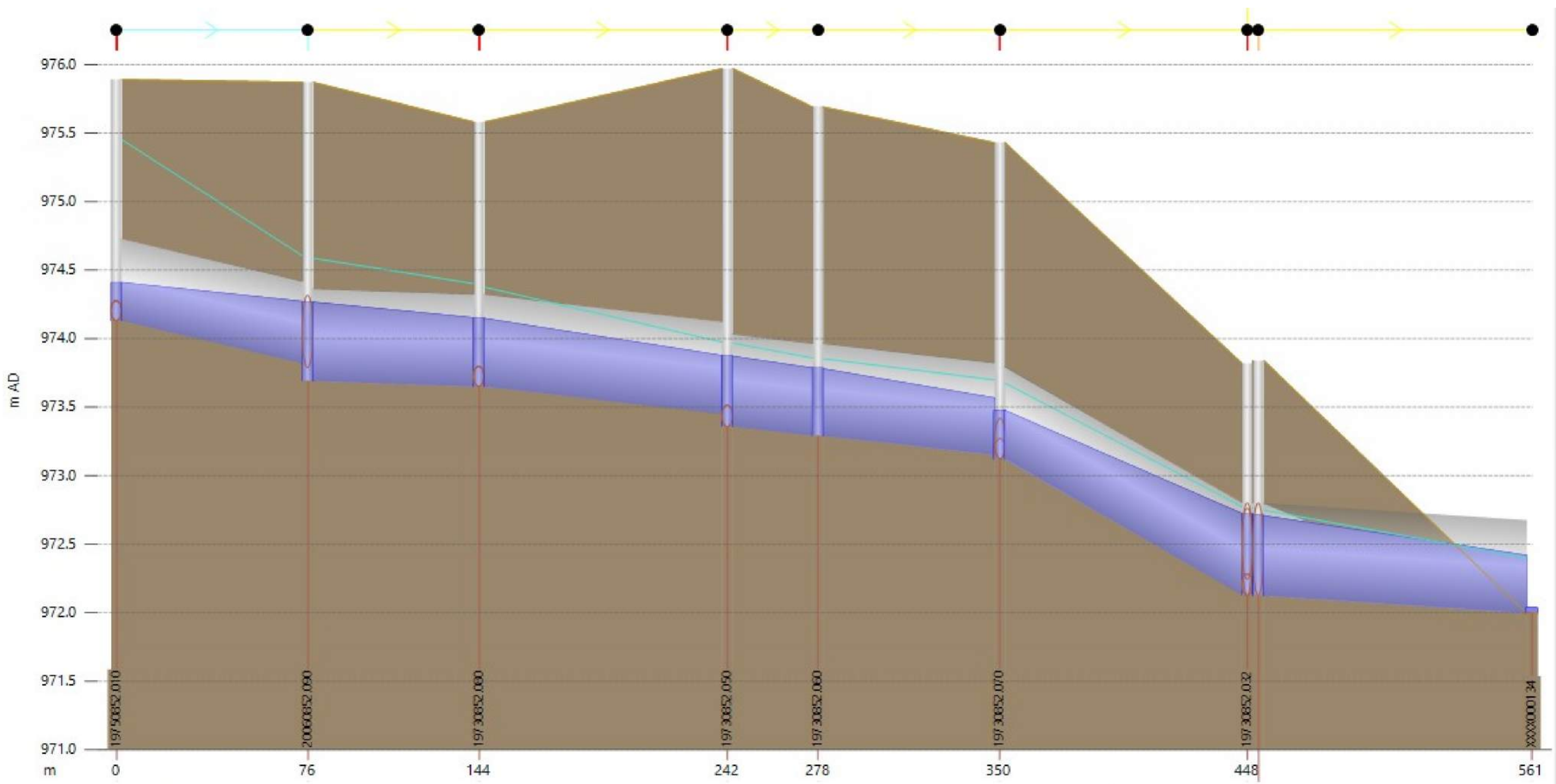


0 50 100 200 300 Meters

1:6,000 CANA83 3TM114

FIGURE LP.32
PROPOSED UPGRADES - PRELIMINARY
LONGITUDINAL PROFILE 5A
UPG-1 & UPG-2
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

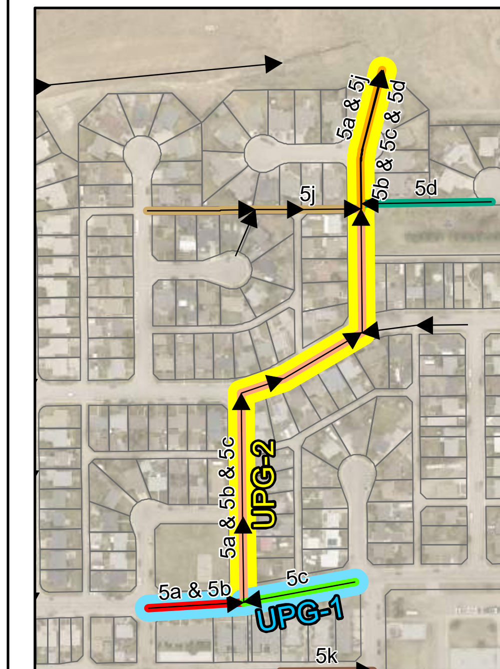
ISL Strathmore



Link		19750852.010.1	20060852.090.1	19730852.080.1	-	19730852.060.1	19730852.070.1		XXXX000133.1	
Node	-	20060852.090	19730852.080	19730852.050	19730852.060	19730852.070	19730852.032	XXXX000133	XXXX000134	

Legend

- 5 Year 1 Hour Storm Event - Proposed Upgrade
- 5 Year 1 Hour Storm Event - Existing Conditions
- UPG-1
- UPG-2



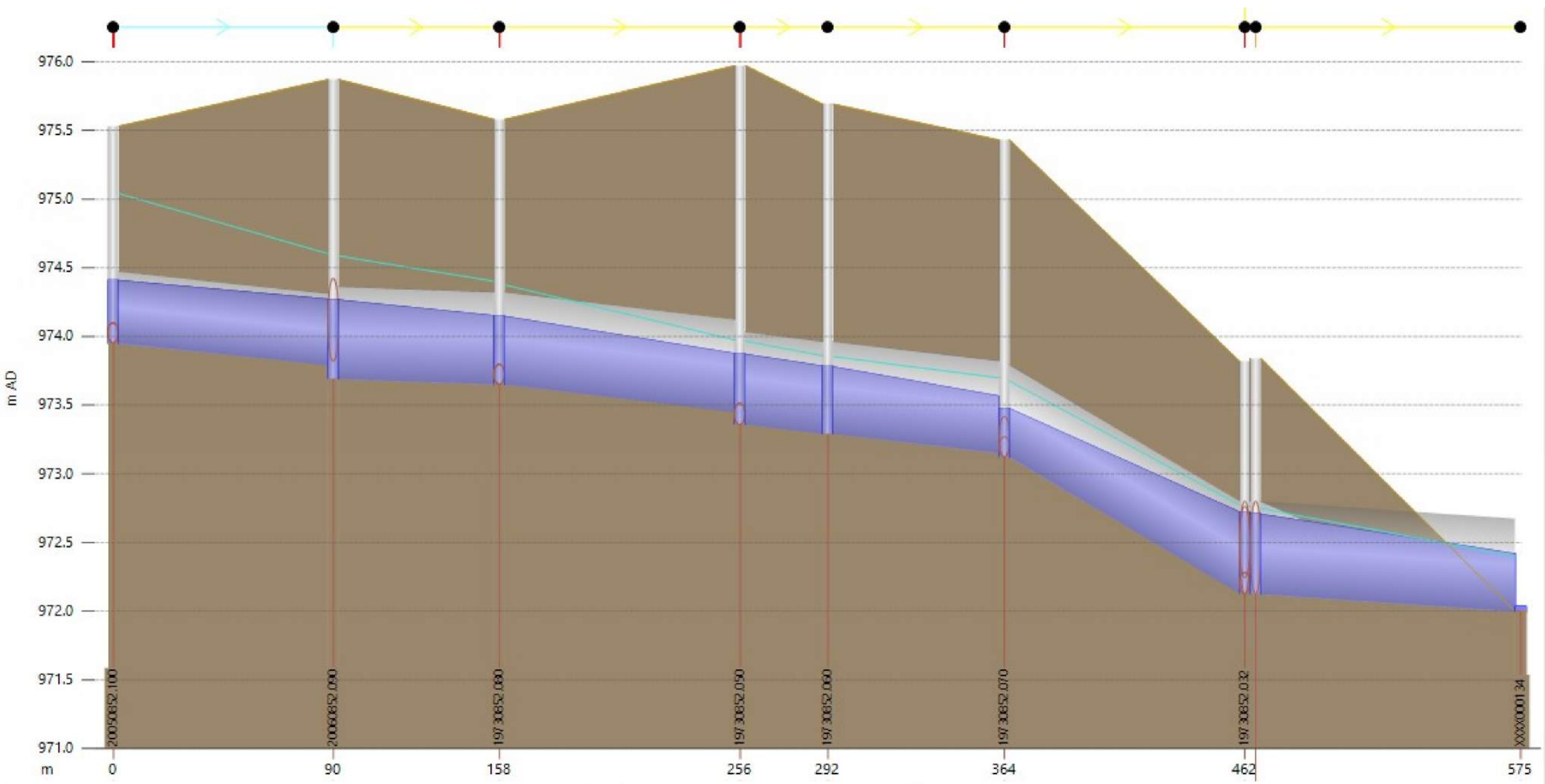
0 50 100 200 300 Meters

1:6,000 CANA83 3TM114

FIGURE LP.33
PROPOSED UPGRADES - PRELIMINARY
LONGITUDINAL PROFILE 5B
UPG-1 & UPG-2
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

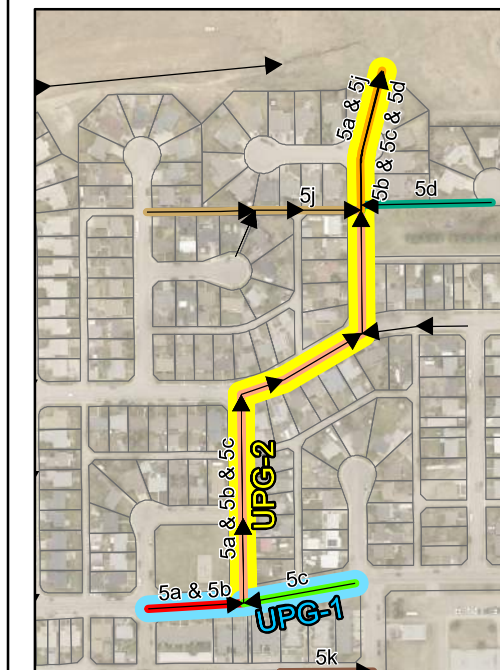
Strathmore



Link		20050852.100.1	20060852.090.1	19730852.080.1	-	19730852.060.1	19730852.070.1		XXXX000133.1	
Node	20050852.100	20060852.090	19730852.080	19730852.050	19730852.060	19730852.070	19730852.032	XXXX000133	XXXX000134	

Legend

- 5 Year 1 Hour Storm Event - Proposed Upgrade
- 5 Year 1 Hour Storm Event - Existing Conditions
- UPG-1
- UPG-2



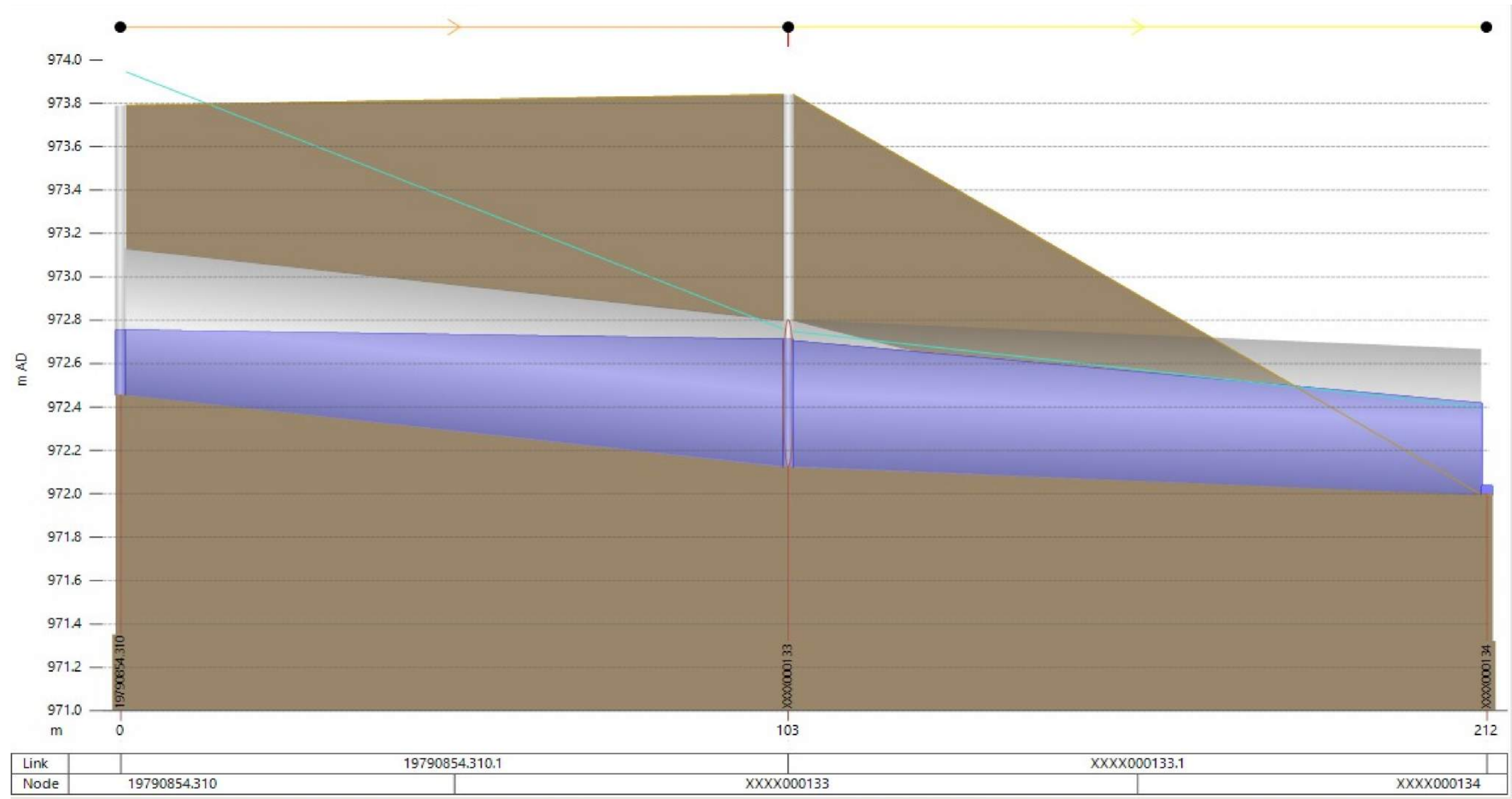
0 50 100 200 300 Meters

1:6,000 CANA83 3TM114

FIGURE LP.34
PROPOSED UPGRADES - PRELIMINARY
LONGITUDINAL PROFILE 5C
UPG-1 & UPG-2
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

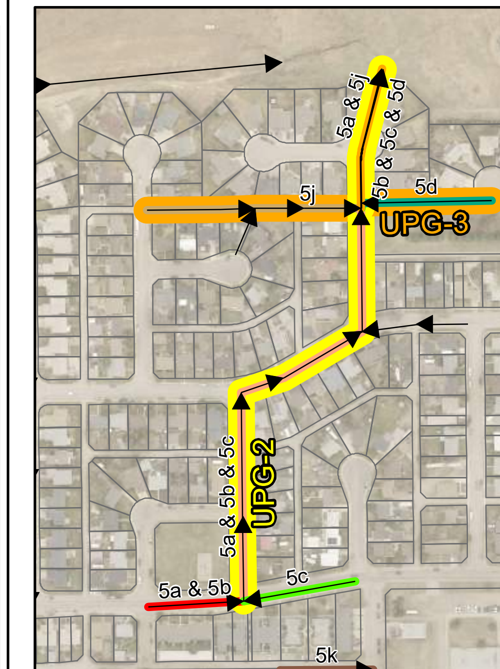
ISL Strathmore

Integrated Expertise. Locally Delivered.



Legend

- 5 Year 1 Hour Storm Event - Proposed
- 5 Year 1 Hour Storm Event - Existing
- UPG-2
- UPG-3



0 50 100 200 300 Meters

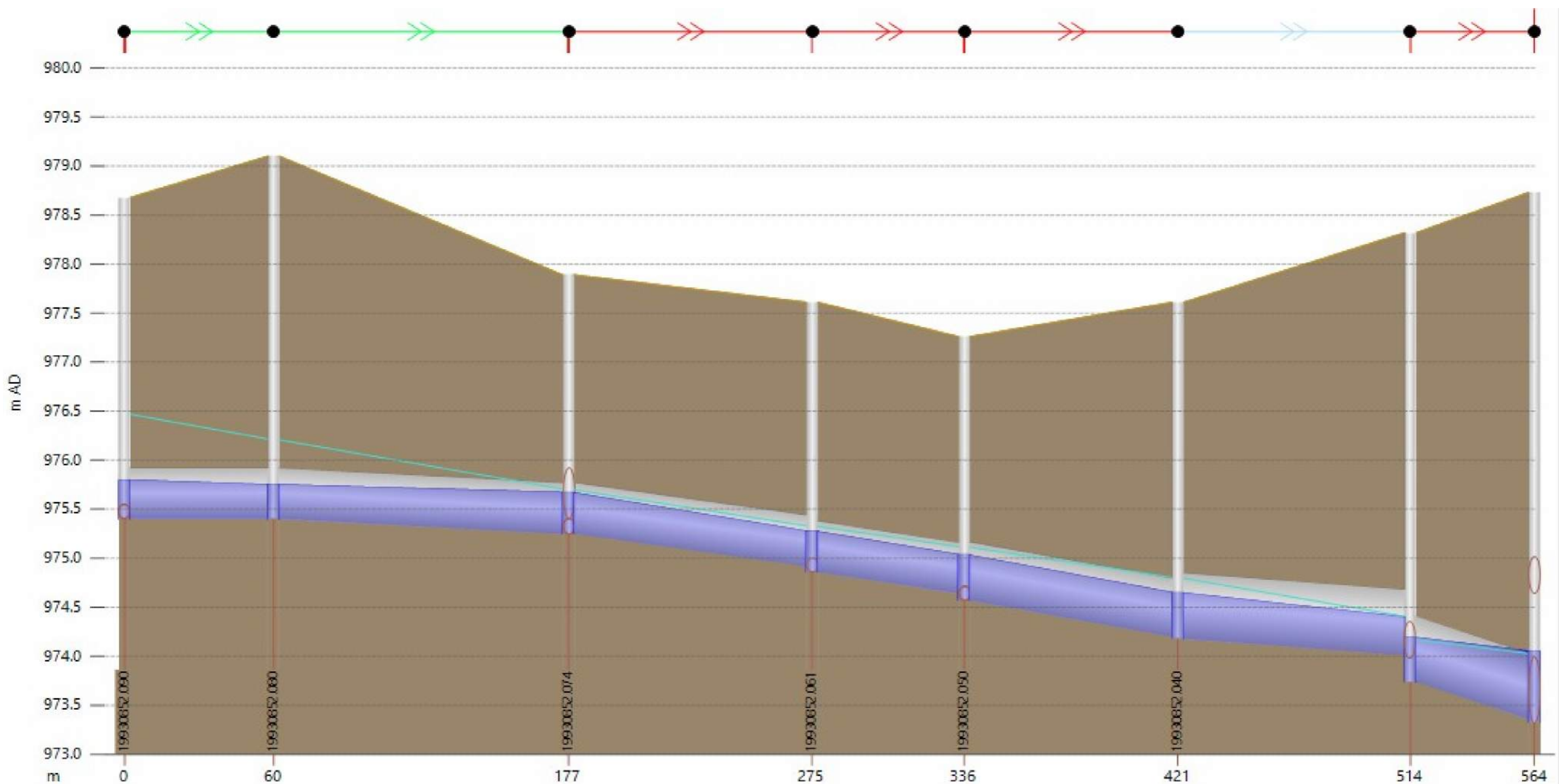
1:6,000 CANA83 3TM114

FIGURE LP.35
PROPOSED UPGRADES - PRELIMINARY
LONGITUDINAL PROFILE 5D
UPG-2 & UPG-3
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

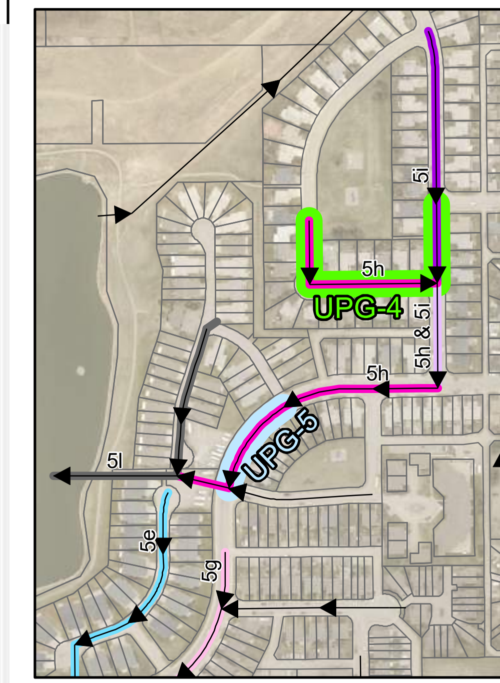
ISL Strathmore

Legend

- 5 Year 1 Hour Storm Event - Proposed Upgrade
- 5 Year 1 Hour Storm Event - Existing Conditions
- UPG-4
- UPG-5
- No Upgrade Proposed



Link	19930852.090.1	19930852.080.1	19930852.074.1	19930852.061.1	19930852.050.1	19930852.040.1	19930852.030.1
Node	-	19930852.080	19930852.074	19930852.061	19930852.050	19930852.040	19930852.030	-

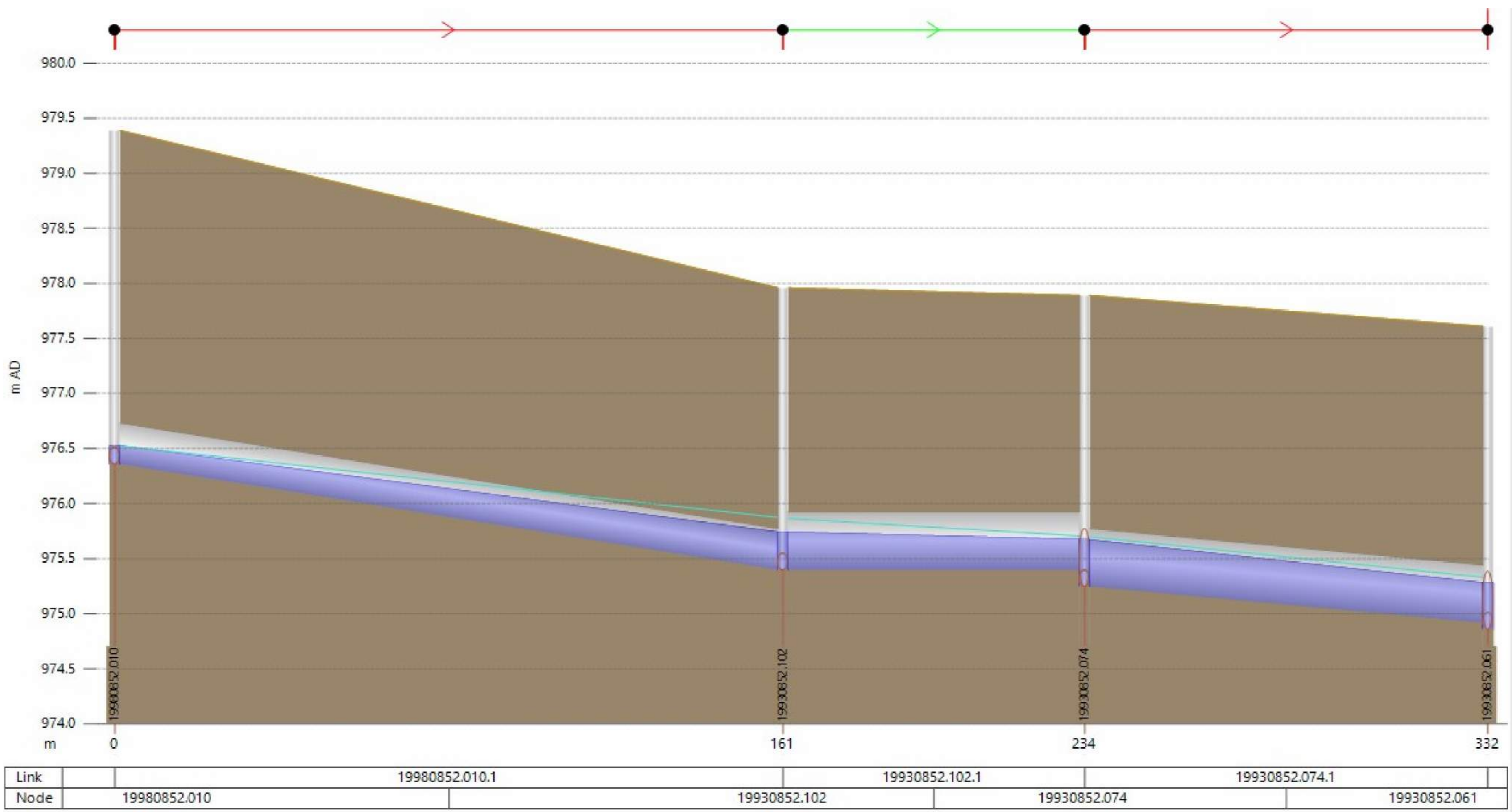


0 60 120 240 360 Meters

1:7,000 CANA83 3TM114

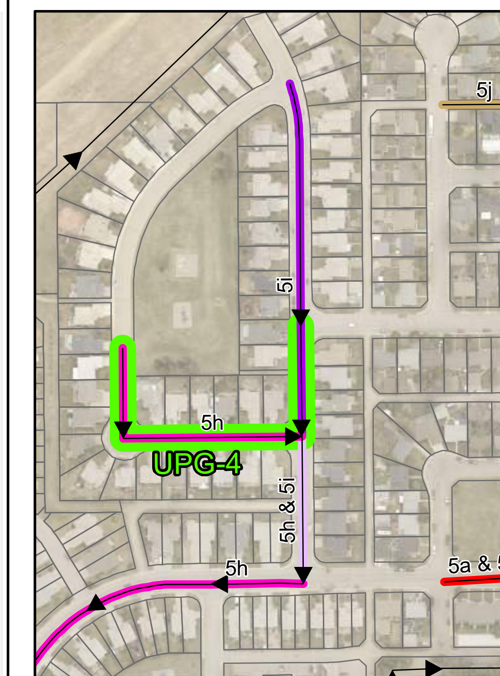
FIGURE LP.36
PROPOSED UPGRADES - PRELIMINARY
LONGITUDINAL PROFILE 5H
UPG-4 & UPG-5
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL Strathmore



Legend

- 5 Year 1 Hour Storm Event - Proposed Upgrade
- 5 Year 1 Hour Storm Event - Existing Conditions
- UPG-4
- No Upgrade Proposed



0 40 80 160 240 Meters

1:5,000 CANA83 3TM114

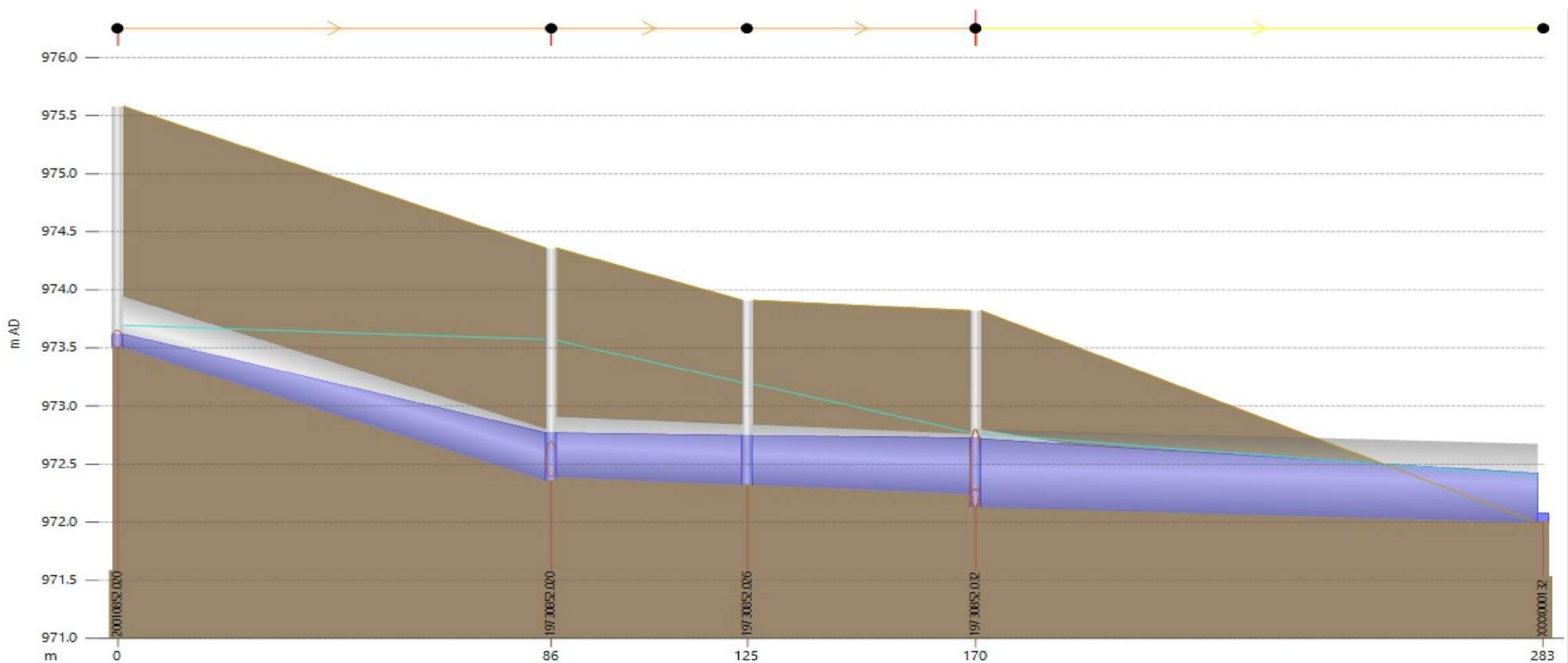
FIGURE LP.37
PROPOSED UPGRADES - PRELIMINARY
LONGITUDINAL PROFILE 5I
UPG-4
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Date: 2/27/2024 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Preliminary Figures\LPs\28436_LP 5i Upgrade.mxd

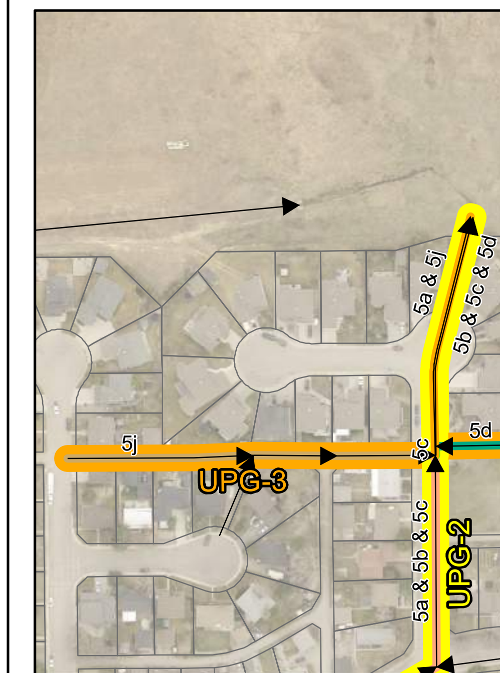
Integrated Expertise. Locally Delivered.



Link	20010852.020.1	19730852.020.1	19730852.026.1	19730852.032.1	
Node	20010852.020	19730852.020	19730852.026	19730852.032	XXXX000132

Legend

- 5 Year 1 Hour Storm Event - Proposed
- 5 Year 1 Hour Storm Event - Existing
- UPG-2
- UPG-3



0 30 60 120 180 Meters

1:3,500 CANA83 3TM114

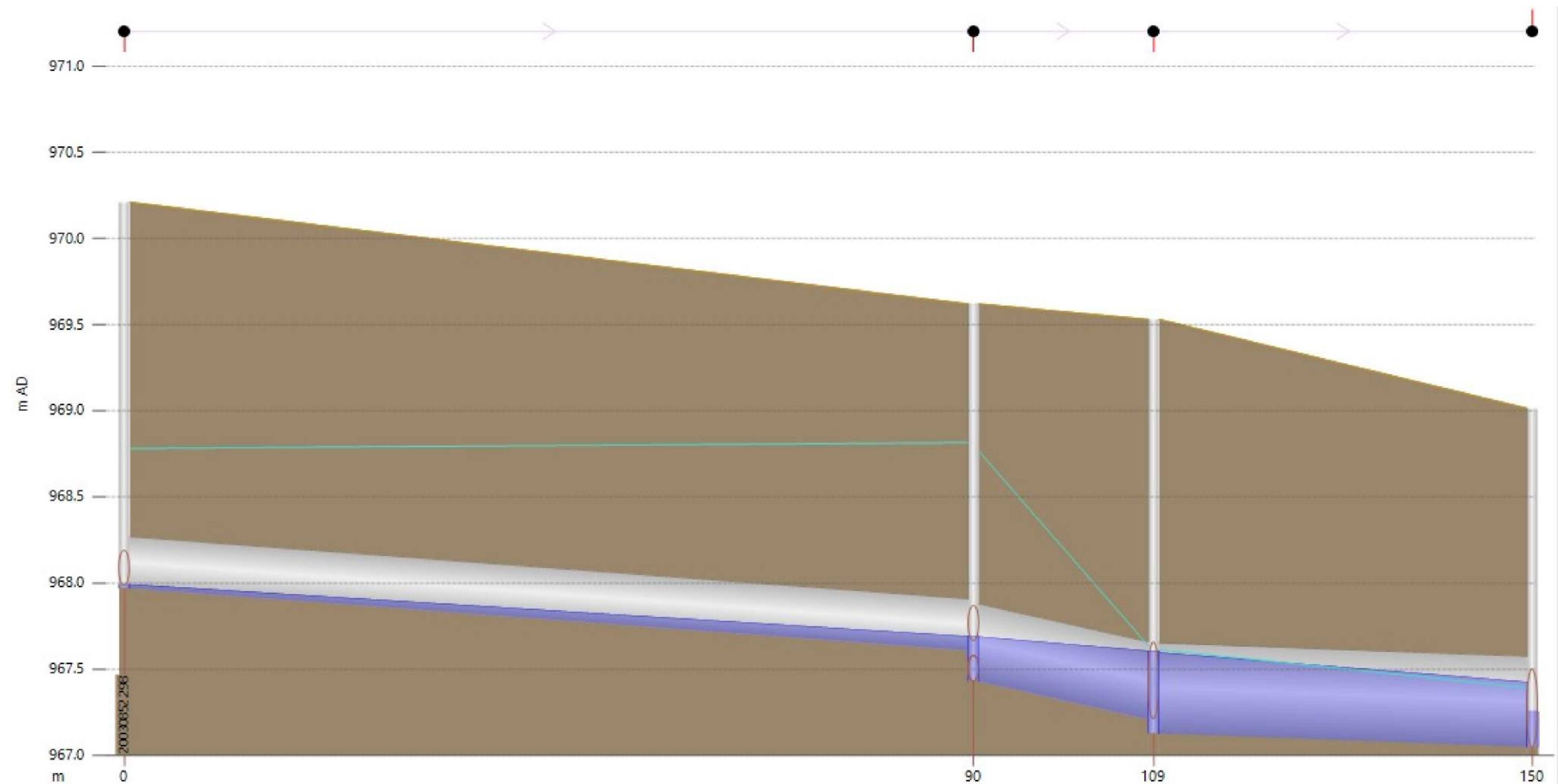
FIGURE LP.38
PROPOSED UPGRADES - PRELIMINARY
LONGITUDINAL PROFILE 5J
UPG-2 AND UPG-3
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL

Strathmore

Integrated Expertise. Locally Delivered.

Date: 2/27/2024 Document: Q:\Projects\28436_Strathmore_Stormwater_Servicing_Study\25_GIS\251_Figures\Preliminary Figures\LPs\28436_LP 5j Upgrade.mxd



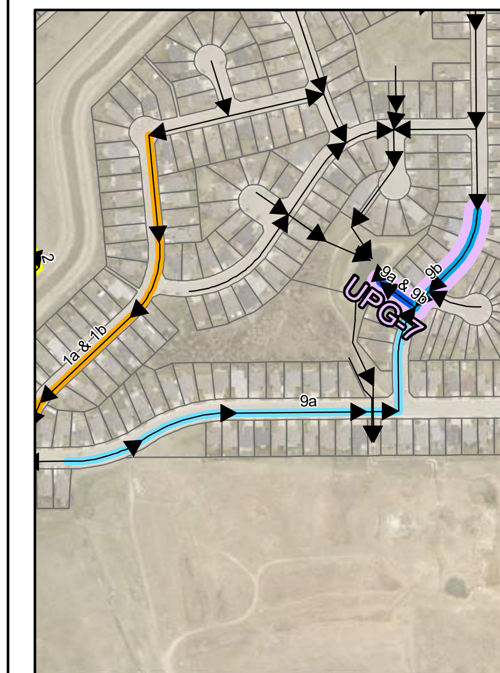
Link		20030852.298.1	20030852.290.1	20030852.280.1
Node	20030852.298	20030852.290	20030852.280	20030852.264

Legend

5 Year 1 Hour Storm Event - Proposed Upgrade

5 Year 1 Hour Storm Event - Existing Conditions

UPG-7



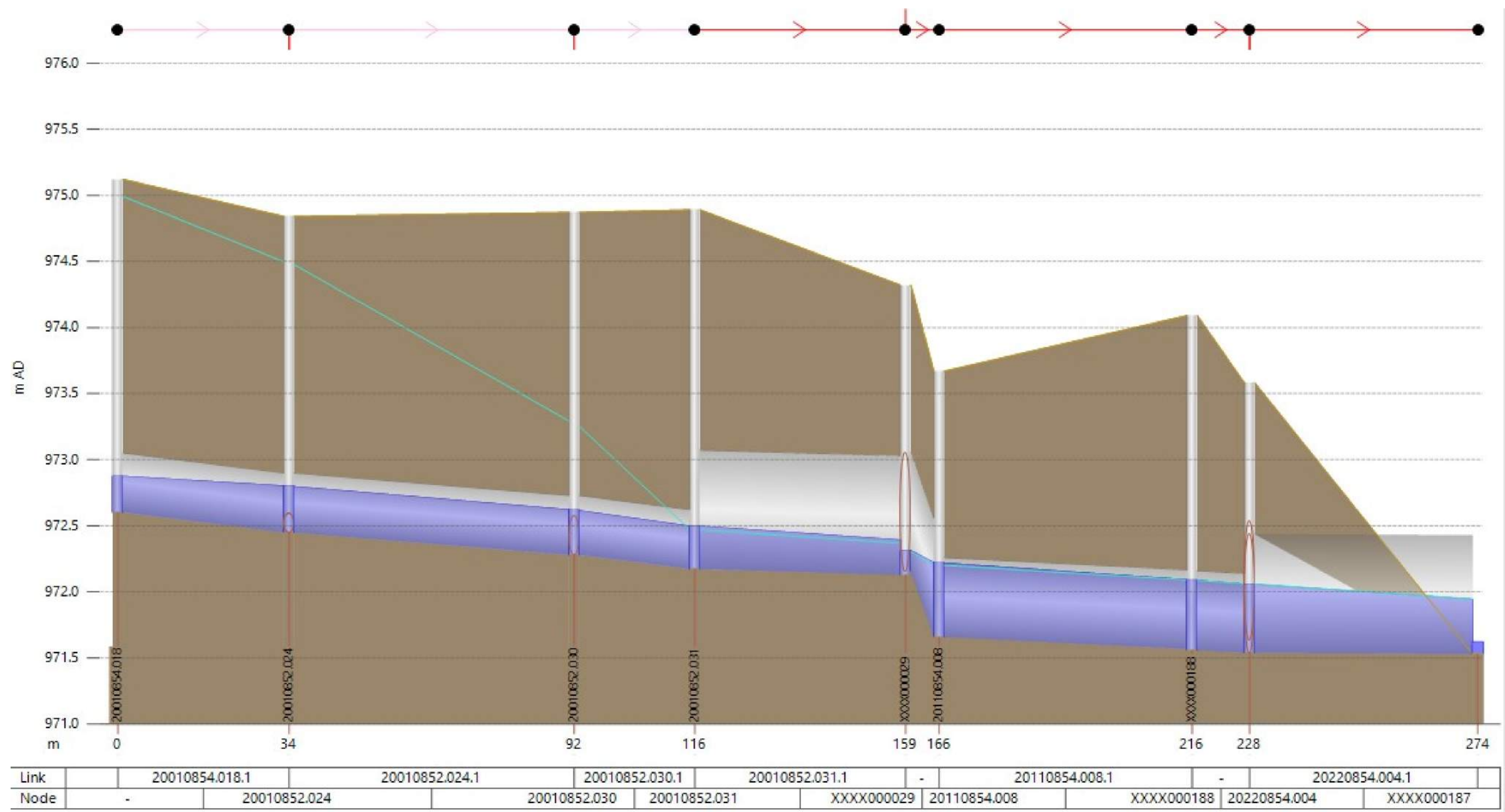
0 60 120 240 360 Meters

1:7,000 CANA83 3TM114

FIGURE LP.39
PROPOSED UPGRADES - PRELIMINARY
LONGITUDINAL PROFILE 9B
UPG-7
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

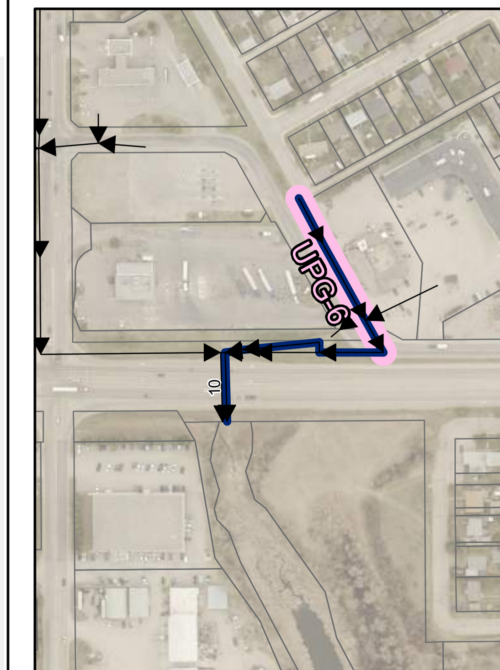
ISL Strathmore

Integrated Expertise. Locally Delivered.



Legend

- 5 Year 1 Hour Storm Event - Proposed Upgrade
- 5 Year 1 Hour Storm Event - Existing Conditions
- UPG-6
- No Upgrade Proposed



0 40 80 160 240 Meters

1:5,000 CANA83 3TM114

FIGURE LP.40
PROPOSED UPGRADES - PRELIMINARY
LONGITUDINAL PROFILE 10
UPG-6
STRATHMORE STORMWATER
MASTER SERVICING STUDY UPDATE

ISL Strathmore

Integrated Expertise. Locally Delivered.

ISL

APPENDIX
Detailed Cost Estimates

C

Table C.1: Detailed Existing Upgrades Cost Estimate

ID	Description	Items	Quantity	Units	Material	Unit Cost	Sub-Total	Contingency	Engineering	Total Cost
								30%	15%	
1	Upgrade the existing pipes on Westmount Drive between Wales Green and Windsor Place to 600 mm on the West side and 525 mm on the East side.	Existing Pipe Removal	166	m	PVC	$ 240	$ 40,000	$ 12,000	$ 7,800	$ 60,000
		Pavement Rehabilitation	166	m	PVC	$ 1,200	$ 199,000	$ 59,700	$ 38,805	$ 298,000
		600 mm Gravity Sewer	76	m	PVC	$ 800	$ 61,000	$ 18,300	$ 11,895	$ 91,000
		525 mm Gravity Sewer	90	m	PVC	$ 700	$ 63,000	$ 18,900	$ 12,285	$ 94,000
						Sub-Total:	**$ 363,000**	**$ 108,900**	**$ 70,785**	**$ 545,000**
2	Upgrade the existing pipes on Westwood Street, Wheeler Street, and Willow Drive between Westwood Street and Wheeler Street to 675 mm.	Existing Pipe Removal	485	m	PVC	$ 240	$ 116,000	$ 34,800	$ 22,620	$ 173,000
		Pavement Rehabilitation	485	m	PVC	$ 1,200	$ 582,000	$ 174,600	$ 113,490	$ 870,000
		675 mm Gravity Sewer	485	m	PVC	$ 900	$ 437,000	$ 131,100	$ 85,215	$ 653,000
						Sub-Total:	**$ 1,135,000**	**$ 340,500**	**$ 221,325**	**$ 1,695,000**
3	Upgrade the existing pipes along the back lane on the West side of Wheeler Street to Westview Street to 525 mm and 450 mm. Also upgrade the existing pipes on the West side of Wheeler Street along the green space to Wheatland Green to 675 mm.	Existing Pipe Removal	273	m	PVC	$ 240	$ 66,000	$ 19,800	$ 12,870	$ 99,000
		Pavement Rehabilitation	170	m	PVC	$ 1,200	$ 204,000	$ 61,200	$ 39,780	$ 305,000
		675 mm Gravity Sewer	103	m	PVC	$ 900	$ 93,000	$ 27,900	$ 18,135	$ 139,000
		525 mm Gravity Sewer	84	m	PVC	$ 700	$ 59,000	$ 17,700	$ 11,505	$ 88,000
		450 mm Gravity Sewer	86	m	PVC	$ 615	$ 53,000	$ 15,900	$ 10,335	$ 79,000
						Sub-Total:	**$ 475,000**	**$ 142,500**	**$ 92,625**	**$ 710,000**
4	Upgrade the existing pipes along the South side of Strathmore Lakes Crescent and Strathmore Lakes Way to 525 mm.	Existing Pipe Removal	250	m	PVC	$ 240	$ 60,000	$ 18,000	$ 11,700	$ 90,000
		Pavement Rehabilitation	250	m	PVC	$ 1,200	$ 300,000	$ 90,000	$ 58,500	$ 449,000
		525 mm Gravity Sewer	250	m	PVC	$ 700	$ 175,000	$ 52,500	$ 34,125	$ 262,000
						Sub-Total:	**$ 535,000**	**$ 160,500**	**$ 104,325**	**$ 800,000**
5	Upgrade the existing pipes on Westmount Drive between Westlake Circle and Strathmore Lakes Bay to 675 mm.	Existing Pipe Removal	93	m	PVC	$ 240	$ 22,000	$ 6,600	$ 4,290	$ 33,000
		Pavement Rehabilitation	93	m	PVC	$ 1,200	$ 112,000	$ 33,600	$ 21,840	$ 167,000
		675 mm Gravity Sewer	93	m	PVC	$ 900	$ 84,000	$ 25,200	$ 16,380	$ 126,000
						Sub-Total:	**$ 218,000**	**$ 65,400**	**$ 42,510**	**$ 325,000**
6	Upgrade the existing pipes on Ridge Road in front of the Strathmore Station Restaurant and Pub area to 450 mm.	Existing Pipe Removal	116	m	PVC	$ 240	$ 28,000	$ 8,400	$ 5,460	$ 42,000
		Pavement Rehabilitation	116	m	PVC	$ 1,200	$ 139,000	$ 41,700	$ 27,105	$ 208,000
		450 mm Gravity Sewer	116	m	PVC	$ 615	$ 71,000	$ 21,300	$ 13,845	$ 106,000
						Sub-Total:	**$ 238,000**	**$ 71,400**	**$ 35,700**	**$ 345,000**
7	Upgrade the existing pipes on Aspen Circle from Aspen Mews and northward to 300 mm and 450 mm. Also upgrade the pipes going along the houses to the storm pond behind the houses on Aspen Circle and Aspen Point to 525 mm.	Existing Pipe Removal	150	m	PVC	$ 240	$ 36,000	$ 10,800	$ 7,020	$ 54,000
		Pavement Rehabilitation	110	m	PVC	$ 1,200	$ 132,000	$ 39,600	$ 25,740	$ 197,000
		525 mm Gravity Sewer	40	m	PVC	$ 700	$ 28,000	$ 8,400	$ 5,460	$ 42,000
		450 mm Gravity Sewer	20	m	PVC	$ 615	$ 12,000	$ 3,600	$ 2,340	$ 18,000
		300 mm Gravity Sewer	90	m	PVC	$ 445	$ 40,000	$ 12,000	$ 7,800	$ 60,000
						Sub-Total:	**$ 248,000**	**$ 74,400**	**$ 48,360**	**$ 370,000**
						Total	**$ 3,212,000**	**$ 963,600**	**$ 615,630**	**$ 4,790,000**

Table C.2: Detailed Proposed Ponds Cost Estimate

Pond ID	Stripping Cost	Excavation Cost	Landscaping Cost	Outlet Control Structure Cost	Sub-Total	Contingency	Engineering Fees	Total Cost
						30%	15%	
Proposed Pond 1	$80,000	$668,000	$18,300	$215,000	$981,000	$294,000	$191,000	**$1,465,000**
Proposed Pond 2	$46,000	$333,000	$13,000	$215,000	$607,000	$182,000	$118,000	**$905,000**
Proposed Pond 3	$35,000	$236,000	$10,800	$215,000	$497,000	$149,000	$97,000	**$745,000**
Proposed Pond 4	$69,000	$563,000	$16,800	$215,000	$864,000	$259,000	$168,000	**$1,290,000**
Proposed Pond 5	$56,000	$430,000	$14,800	$215,000	$716,000	$215,000	$140,000	**$1,070,000**
Proposed Pond 6	$59,000	$470,000	$15,000	$215,000	$759,000	$228,000	$148,000	**$1,135,000**
Proposed Pond 7	$107,000	$950,000	$21,800	$215,000	$1,294,000	$388,000	$252,000	**$1,935,000**
Proposed Pond 8	$113,000	$994,000	$22,500	$215,000	$1,345,000	$404,000	$262,000	**$2,010,000**
Proposed Pond 9	$148,000	$1,388,000	$26,300	$215,000	$1,777,000	$533,000	$347,000	**$2,655,000**
Proposed Pond 10	$74,000	$607,000	$17,500	$215,000	$914,000	$274,000	$178,000	**$1,365,000**
Proposed Pond 11	$112,000	$994,000	$22,500	$215,000	$1,344,000	$403,000	$262,000	**$2,010,000**
Proposed Pond 12	$124,000	$1,111,000	$23,800	$215,000	$1,474,000	$442,000	$287,000	**$2,205,000**
Proposed Pond 13	$85,000	$707,000	$19,000	$215,000	$1,026,000	$308,000	$200,000	**$1,535,000**
Proposed Pond 14	$112,000	$990,000	$22,300	$215,000	$1,339,000	$402,000	$261,000	**$2,000,000**
Proposed Pond 15	$161,000	$1,537,000	$27,500	$215,000	$1,941,000	$582,000	$378,000	**$2,900,000**
Proposed Pond 16	$168,000	$1,579,000	$28,300	$215,000	$1,990,000	$597,000	$388,000	**$2,975,000**
Proposed Pond 17	$101,000	$882,000	$21,300	$215,000	$1,219,000	$366,000	$238,000	**$1,825,000**
Proposed Pond 18	$258,000	$2,587,000	$36,000	$215,000	$3,096,000	$929,000	$604,000	**$4,630,000**
Proposed Pond 19 (Storm Pond #7)	$260,000	$2,558,000	$36,000	$215,000	$3,069,000	$921,000	$599,000	**$4,590,000**
Total (Rounded):	**$1,910,000**	**$17,025,000**	**$380,000**	**$3,870,000**	**$23,185,000**	**$6,955,000**	**$4,520,000**	**$34,655,000**

Unit prices:

Excavation	*$18.00*	*/m³*
Stripping	*$6.00*	*/m²*
Landscaping	*$2.50*	*/m²*
Outlet Control Structure	*$215,000.00*	*/unit*
Fill Cost	*$30.00*	*/m³*

Table C.3: Detailed Proposed Gravity Mains Cost Estimate

Item	Quantity	Units	Unit Cost	Sub-Total	Contingency (30%)	Engineering (15%)	Total Cost
250 mm PVC Gravity Main	116	m	$400	$46,000	$14,000	$9,000	**$70,000**
300 mm PVC Gravity Main	2628	m	$445	$1,169,000	$351,000	$228,000	**$1,750,000**
375 mm PVC Gravity Main	4400	m	$550	$2,420,000	$726,000	$472,000	**$3,620,000**
450 mm PVC Gravity Main	4955	m	$615	$3,047,000	$914,000	$594,000	**$4,555,000**
525 mm PVC Gravity Main	2285	m	$700	$1,600,000	$480,000	$312,000	**$2,390,000**
600 mm PVC Gravity Main	957	m	$800	$766,000	$230,000	$149,000	**$1,145,000**
675 mm PVC Gravity Main	1177	m	$900	$1,059,000	$318,000	$207,000	**$1,585,000**
750 mm PVC Gravity Main	1984	m	$1,200	$2,381,000	$714,000	$464,000	**$3,560,000**
900 mm Concrete Gravity Main	149	m	$2,000	$298,000	$89,000	$58,000	**$445,000**
1350 mm Concrete Gravity Main	1098	m	$2,900	$3,184,000	$955,000	$621,000	**$4,760,000**
			Total (Rounded):	**$15,970,000**	**$4,790,000**	**$3,115,000**	**$23,880,000**