REPORT / RECOMMENDATION

To: MAYOR AND CITY COUNCIL

Agenda Item #: VIII. C.

From: Ross Bintner, P.E., Environmental Engineer

Action ☐
Discussion ☒
Information ☐

Date: June 17, 2014

Subject: Flood Protection and Clean Water Improvement Study Update

Action Requested:

No specific action requested. Provide input or direction on project recommendations.

Information / Background:

This report summarizes the findings of Part 1 and Part 2 of the 2014 Flood Protection and Clean Water Improvement Study, Improvement Number STS-406. This study provides preliminary engineering and stormwater planning for six project areas to help solve flooding and water pollution issues designated in the City of Edina 2011 Comprehensive Water Resources Management Plan (CWRMP). This assembly of projects includes those CWRMP priority items intended for study in the ENG-13-011 flood protection and clean water improvement project, and those that synchronize well with existing Capital Improvement Program (CIP) project priorities in the ENG-13-004 neighborhood reconstruction program.

Systems Understanding

In addition to the specific project recommendations summarized in the section below, this study expands the understanding of water resource systems in the City of Edina and emphasizes the connection of land use management, surface water resources, and the sanitary and stormwater utilities. The following is a summary to provide context to the report.

Updated science to inform flood risk assessment:

- The intensity of 1% and 2% annual probability storms has increase in the last decades. The 1% and 2% events were previously defined as a 6.0 inch and 5.4 inch 24 hour storm. The updated National Weather Service "Atlas 14" document now defines the 1% and 2% probability event as a 7.5 inch and 6.4 inch 24 hour storm, a 20-25% increase.
- The Minnehaha Creek Watershed District (MCWD) has also been studying this issue with a soon to be released Stormwater Adaptation Study.
- Future infrastructure projects will be larger, and cost more due to this effective change in standard.
- For more detail review Part 1, Section 2.1

Storm water utility flood protection and clean water service levels:

- Significant portions on the City of Edina stormwater system do not meet the 10% probability (10 year) level of service and 1% probability (100 year) level of protection defined in Comprehensive Water Resources Master Plan (CWRMP) policy.

- While system improvements made during neighborhood reconstruction continues annually, the Atlas 14 updated understanding of risk, meaning even some newly rebuilt systems fail to meet the desired level of service and level of protection.
- Some areas of the City have entrenched flood and drainage issues. These issues may have a technically feasible solution, but are politically or economically imprudent to solve with an infrastructure project approach.
- The overlap between solving flood issues and providing new clean water treatment is very narrow: low impact development (LID) techniques and Living Streets can provide new clean water treatment, but only play a small role in reducing flood risk.

Sanitary sewer system infiltration and inflow:

- The connection between extended wet periods, the resulting high groundwater table and infiltration into sanitary pipes has been well established. Effective foundation drains and working sump pumps are the best protection for both private property and the public sanitary system.
- This study reiterates the need for effective engineering oversight and standards during the development review process to raise redeveloping buildings out of regional and local flood zones to reduce the potential for structure damage and stormwater inflow into the sanitary system.
- Current zoning standards relating to building floor elevation change and requiring a basement are sometimes in conflict with desired floor elevations to meet flood risk standards.

Impacts of residential redevelopment:

- Increased impervious surface cover causes increased runoff volume.
- That increased runoff volume has minimal impact on flood elevations in large events, but can have a major effect on runoff depth and nuisance drainage in small storm events.
- While the Atlas 14 rainfall for the 10% probability, 10-year event is essentially unchanged, the increase in directly connected impervious surface due to redevelopment will result in 20% increase in runoff depth.
- For more detail, review Part 1, Section 4.3.1.

<u>Project Recommendations</u>

Below is a summary of management options for both short term (ST) (ex: capital projects, programmatic efforts) and long term (LT) (ex: manage redevelopment to bring buildings out of floodplain.)

Project area 1 General: Part 1, Section 3 – Highway 62, East of Highway 100.

- ST: Modify Swimming Pool Pond outlet in coordination with 2015 aquatic center parking lot rehabilitation.

Project area 1A: Part 1, Section 3.1 - West 64th between Ashcroft and St. Johns.

- ST: Communicate flood risk and offer technical and financial assistance to private property owners to flood proof structures.
- LT: Coordinate with MnDOT to upsize pipe crossing HWY 62 at time of major maintenance or expansion.

Project area 1B: Part 1, Section 3.2 – Barrie Road

- ST: Minimal potential for structure damage, no action recommended.
- LT: Partner with the watershed district to create a development standard overlay to require additional flood storage and consider providing financial assistance with oversizing at time of redevelopment.
- LT: Monitor area for sanitary inflow potential due to overtopping of flood flows into parking garage structures.

Project area 1C: Part 1, Section 3.2 – York Avenue Pond

- ST: Communicate flood risk and offer technical and financial assistance to private property owners to flood proof structures.

- LT: Partner with the watershed district to create a development standard overlay to require additional flood storage and consider providing financial assistance with stormwater system oversizing at time of redevelopment.

Project area 3: Part 1, Section 4 – Chowen and 60th

- ST: Televise sanitary sewer during wet weather for potential cross connections.
- ST: Verify flood risk at Ewing emergency outflow (EOF), communicate flood risk, and get community feedback on potential solutions during 2016 Strachauer Park A neighborhood reconstruction program meetings.
- LT: Alternative 1, No action, and redevelopment approach to raise homes out of flood zone.
- LT: Alternative 2, Include pipe option D in 2018 Chowen Park A and B, and 60th Street West neighborhood project.

Project area 4: Part 2, Section 3 – Cahill Road and Dewey Road

- ST: Verify sanitary inflow potential.
- ST: Communicate flood risk and offer technical and financial assistance to private property owners to flood proof structures.

Project area 5: Part 2, Section 4 – Sally Lane and Paiute Pass

- ST: Include pipe option A in 2014 Valley View Road project.
- LT: Upsize pipe option A in 2014, or construct options B or C overflows at time of as-yet-unscheduled neighborhood street reconstruction.

Project area 7: Part 1, Section 5 – Low area between France and Scott Terrace

- ST: Communicate flood risk and offer technical and financial assistance to private property owners to flood proof structures.
- LT: No action, and redevelopment approach to raise home out of flood zone.

A variety of project recommendations to be incorporated into upcoming projects.

STS-406 Project Area	Neighborhood	CWRMP Priority #	Project Implementation	Estimated Cost
1	Southdale B, Concord A, B Strachauer Park B	E-1, E-10, E-14, C-21, C-31	2015 Swimming Pool Pond Outlet 2015 Building Flood Proofing	$200,000 $15,000
3	Chowen Park, Strachauer Park	E-4, C-27	LT Alt 1: LT Alt 2: 2018 Chowen Park B	$0 $828,743
4	Cahill	E-6	2015 Building Flood Proofing	$50,000
5	Indian Trails	E-7, E-8	2014 Valley View Road	$275,000
7	Morningside B	C-23	2015 Building Flood Proofing	$7,500
8	Morningside A, White Oaks A, B, C	E-16	This project area is currently being monitored for water elevations and infiltration rate and will be the focus of Part 3 scheduled for completion before December 31, 2014. A portion of this project could be completed as part of the 2016 White Oaks C, Morningside A neighborhood reconstruction project.	TBD

Attachments:

STS-406 Improvement Project Part 1, Study Area 1, 3, 7 Report
STS-406 Improvement Project Part 2, Study Area 4, 5 Report

STS-406 Improvement Project

Part 1: Project Areas 1, 3, and 7

Prepared for
City of Edina

February 17, 2014

STS-406 Improvement Project

Part 1: Project Areas 1, 3, and 7

Prepared for
City of Edina

February 17, 2014

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STS-406 Improvement Project
Part 1: Project Areas 1, 3, and 7

February 17, 2014

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1.0 Project Background

The City of Edina *Comprehensive Water Resource Management Plan* (December 2011) was developed to address current and future stormwater issues, especially those related to future development and redevelopment. The plan addresses stormwater runoff management and flood control, water quality management, and wetlands protection through establishment of stormwater planning policies and recommendations. This plan serves as a master plan for the City's water resources management and storm drainage system improvements.

One of the goals of the *Comprehensive Water Resource Management Plan* (CWRMP) is to provide stormwater runoff management and flood control. The CWRMP establishes design criteria for the City's preferred level of service for stormwater management and level of protection from flooding provided to residents of the city. These design criteria serve as a target for the City as redevelopment occurs and infrastructure improvements are considered. Another goal of the CWRMP is to provide water quality management for the water bodies throughout the city. Water quality management policies and design standards have also been established to protect the water quality of the waterbodies within the city.

The CWRMP identifies several areas throughout the city where the desired 100-year level of flood protection may not currently be provided, based on results of the hydrologic and hydraulic modeling analyses conducted as part of the CWRMP development. Since identification of these areas, the City has been evaluating flood improvement options on a case-by-case basis, in conjunction with nearby street reconstruction or other improvement projects. The STS-406 Improvement Project includes a detailed evaluation of several areas with high flood potential that correspond to anticipated street reconstruction projects within the upcoming 5 years. This report summarizes our flood protection analyses and conclusions for the following project areas within the STS-406 Improvement Project:

(1) **Project Area 1**
   a. Ashcroft Lane
   b. Barrie Road and York Avenue

(2) **Project Area 3**
   a. West 60th Street and Chowen Avenue

(3) **Project Area 7**
   a. France Avenue and Scott Terrace

Locations of Project Areas 1, 3, and 7 are shown in Figure 1-1.

All elevations included in this report reflect Mean Sea Level (MSL) elevations in feet using the NGVD 29 vertical datum.

2.0 Project Approach

2.1 Flood Protection

Detailed hydrologic and hydraulic modeling of the flood areas within Project Areas 1, 3, and 7 was conducted using the XP-SWMM models that were originally developed in 2003 as part of the CWRMP. Updates made to the models as part of this project are described below and within the subsequent sections of this report.

2.1.1 Changes to Published Precipitation Depths

In 2013, NOAA's National Weather Service (NWS) published new precipitation frequency estimates ("Atlas 14") for the state of Minnesota and other Midwestern states. The Atlas 14 precipitation frequency estimates, which are the estimated rainfall depths for various rainfall durations and exceedance probabilities, replace the precipitation estimates published in *Technical Paper No. 40 Rainfall Frequency Atlas of the United States* ("TP 40"). The Atlas 14 rainfall frequency estimates indicate a significant increase in the depth of the 50-year and 100-year frequency rainfall events (i.e., rainfall events with exceedance probabilities of 2% and 1%, respectively) across Minnesota and neighboring states, as compared with TP 40 estimates. For the Minneapolis/St. Paul area, the increases in 24-hour duration precipitation depths over TP 40 are as high 25% (Figure 2-1). These precipitation depth increases are of concern, as they can have serious implications for how stormwater systems are designed and managed.

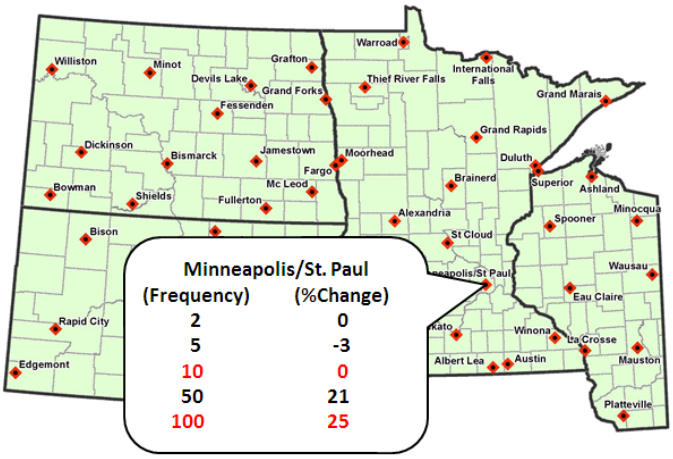


Figure 2-1 Atlas 14 percent of change in precipitation depth for the 24-hour duration storm, as compared to TP 40

The hydrologic and hydraulic modeling conducted for and summarized in the CWRMP used a 24-hour rainfall depth of 6.0 inches based on TP 40, and the SCS Type II nested distribution. For this project, the rainfall depths used in the models were updated based on Atlas 14 precipitation estimates for Edina (Table 2-1). A nested rainfall distribution was developed using precipitation frequency estimates for Edina (Coordinates: 44.8716, -93.3762). The depth-duration data were downloaded from NOAA's Precipitation Frequency Data Server (PFDS) at http://dipper.nws.noaa.gov/hdsc/pfds/. Nested distributions for selected

recurrence intervals events were created by using the Frequency Storm utility found in the meteorological modeling component of HEC-HMS to produce 24-hour hyetographs with 5-minute intervals.

Flood frequency data is often also described in terms of a percentage of risk, or annual exceedance probability. For example, the 100-year frequency flood inundation area represents an area that has a 1 percent chance of flooding (1-percent-annual chance flood) for any given year. Structures located within the 1-percent-annual chance flood inundation area have a 26 percent chance of flooding during the life of a standard 30-year mortgage.

Table 2-1 24-hour duration rainfall depths using NOAA Atlas 14 for Edina, MN for a range of storm recurrence intervals

Storm Recurrence Interval	24-hour Rainfall Depth (inches)	Annual Exceedance Probability[1]
1-year	2.5	100%
2-year	2.9	50%
10-year	4.3	10%
25-year	5.4	4%
50-year	6.4	2%
100-year	7.5	1%

[1] Annual Exceedance Probability refers to the percent chance of occurrence in any given year

2.1.2 Updated Elevation Data

For each of the study areas, City staff conducted a topographic field survey of the flood inundation areas within the targeted subwatersheds. The topographic survey data was combined with 2011 LiDAR elevation data from the Minnesota Department of Natural Resources to refine the elevation/storage relationships used in the modeling analyses. The City's survey also included low entry elevations for structures (including houses and detached garages) adjacent to the flood inundation areas within the targeted subwatersheds. The low entry elevations were used to define the flood improvement target elevations.

2.2 Water Quality Improvement

While improving flood risk was the primary focus for Project Areas 1, 3 and 7, improvement options that provide multiple water resource benefits were identified and considered. In addition to quantifying flood improvement benefits, the improvement options were evaluated for volume reduction and pollutant removal using the Minnesota Pollution Control Agency (MPCA) Minimal Impact Design Standards calculator (November 2012 version).

3.0 Project Area 1: North Cornelia Subwatersheds

Project Area 1 is generally located near France Avenue, west of Xerxes Avenue and east of Trunk Highway (T.H.) 100, and both north and south of T.H. 62. There are two separate study areas that fall within Project Area 1—(1) Ashcroft Lane and (2) Barrie Road and York Avenue. Both areas are tributary to the Mn/DOT T.H. 62 drainage system and ultimately discharge into North Lake Cornelia. The T.H. 62 infrastructure is currently the controlling factor in the management of storm water from both study areas within Project Area 1. The primary objective of this evaluation was to identify opportunities within the upstream drainage area(s) to reduce flooding in the identified subwatersheds (NC_26, NC_39, NC_40, NC_86, NC_88, and NC_97) and provide runoff volume reduction and/or water quality treatment.

3.1 Ashcroft Lane Area (Subwatersheds NC_26 and NC_40)

3.1.1 Problem Description

A low area exists directly north of North Lake Cornelia, encompassing portions of T.H. 62 and West 64th Street between Ashcroft Lane and St. Johns Avenue (Subwatersheds NC_26 and NC_40). Flow from the low area is conveyed to North Lake Cornelia (NC_62) through a series of pipes ranging from an 18-inch to a 21-inch reinforced concrete pipe (RCP), with a 12-inch corrugated metal pipe (CMP) inlet in the backyard area north of West 64th Street, two catch basins on West 64th Street and several inlets along T.H. 62, including an inlet in the grassed median of T.H. 62. During large storm events, this area is inundated with stormwater runoff, receiving flows from the subwatersheds directly tributary to the system, as well as flow not captured by the storm sewer system at the intersection of Ashcroft Lane and West 64th Street and excess T.H. 62 flows not collected upstream. Because of the topography and the slope of the highway and adjacent West 64th Street at this location, runoff from these roadways not collected by the existing storm sewer system will flow overland toward the low area on T.H. 62 and West 64th Street during intense rainstorm events. As discussed in more detail in the CWRMP, the modern standard of practice is usually that storm sewer systems be designed for the "10-year" storm event, which means that there is roughly a 10 percent probability *in any year* that the system will be overtaxed. Therefore, during large storm events, it is not uncommon for water to be conveyed along streets and intersection flooding is common, especially in low-lying areas.

3.1.2 Existing Conditions Flood Risk

Table 3-1 summarizes the predicted water surface elevations under existing conditions for the subwatersheds within the Ashcroft Lane study area for the 1-, 2-, 10-, 25-, 50-, and 100-year frequency, 24-hour duration events. The 100-year frequency, 24-hour flood elevation for the T.H. 62 and West 64th Street area is 868.2. The inundation area corresponding to the 868.2 flood elevation is shown in Figure 3-1.

Comparison of the 100-year flood elevation with adjacent low entry elevations surveyed by the City indicates that three residential dwellings will be impacted by the 100-year, 24-hour storm event. The surveyed low entry elevations for these three dwellings (6325 and 6329 Ashcroft Lane, and 6332 St. Johns

Avenue) are 866.1, 865.9, and 868.2, respectively. The two dwellings on Ashcroft Lane (6325 and 6329 Ashcroft Lane) will be impacted by the 10-year frequency, 24-hour event.

Table 3-1 Maximum water surface elevations (feet, MSL) under existing conditions in Subwatershed NC_40 and the number of dwellings (shown in parentheses) that are inundated at the corresponding elevation

24-hour Storm Recurrence Interval	Water Surface Elevation in NC_40[1]
1-year	864.3 (0)
2-year	865.3 (0)
10-year	866.9 (2)
25-year	867.6 (2)
50-year	867.9 (2)
100-year	868.2 (3)

[1] *Elevations based on Atlas 14 precipitation depths*

Flood risk analysis maps, often generically referred to as "flood risk maps," were also generated for the Ashcroft Lane area. Figure 3-2 and Figure 3-3 show the results of two flood risk maps developed for the Ashcroft Lane area. Figure 3-2 ("Annual Flood Risk"), depicts the approximate chance of flooding (as a percentage) for any given year. Figure 3-3 depicts the approximate chance of flooding (also as a percentage) over the life of a typical 30-year home mortgage. The purpose of these flood risk maps is to help property owners and the community better understand their potential flood hazard and risk within the inundation areas shown on these maps. These types of flood risk assessments can help guide community mitigation efforts by highlighting areas where risk reduction actions may produce the highest return on investment.

3.1.3 Improvement Options

Three flood improvement options were evaluated to reduce flood risk in the low area along West 64th Avenue between Ashcroft Lane and St. Johns Avenue, immediately north of T.H. 62. The three options include:

Option A: Installation of 42-inch corrugated polyethylene pipe (CPEP) from NC_40 eastward to connect with the existing storm sewer system between NC_2 and NC_62.

Option B: Installation of an additional 36-inch CPEP beneath T.H. 62 from NC_40 southward to North Lake Cornelia (direction drill pipe beneath T.H. 62)

Option C: Installation of a large-capacity culvert beneath T.H. 62 from NC_40 southward to North Lake Cornelia (4-foot by 12-foot box culvert)

Option A (Figure 3-4)—proposes the installation of a 42–inch CPEP from the low area along West 64th Street and the adjacent low backyard area eastward connecting with the existing 42-inch storm sewer system that conveys water between Garrison Pond (NC_2) and North Lake Cornelia (NC_62). This

option would limit construction to City right-of-way and private parcels that are currently at risk of experiencing flooding in a 100-year event.

Option B (Figure 3-5)—proposes the installation of a 36-inch CPEP from the low area along West 64th Street and the adjacent low backyard area southward to North Lake Cornelia. The new 36-inch pipe would be directionally drilled beneath T.H. 62 to avoid closure of the highly-traveled roadway.

Option C (Figure 3-6)—is similar to Option B, but with the installation of a higher-capacity system (4-foot by 12-foot box culvert) beneath T.H. 62. Option C is intended to provide a level of protection for the 100-year, 24-hour storm event for all dwellings and structures in this area. The system installation would require an open cut installation through T.H. 62, likely to be completed in conjunction with future highway improvements.

Flood Benefits

Table 3-2 summarizes the water surface elevations at the low area on West 64th Street resulting from the three improvement options for the 1-, 2-, 10-, 25-, 50-, and 100-year frequency events. The number of dwellings impacted for each scenario is also included in Table 3-2. Options A and B provide similar benefits, with respect to both the reduction in the maximum water surface elevation and the number of dwellings protected. Implementing either Option A or B would result in the two dwellings on Ashcroft Lane no longer being inundated during the more frequent 10-year, 24-hour storm (both dwellings would have at least one-half foot of protection or freeboard). Options A and B reduce the chance of flooding each year, but do not protect the lowest two dwellings on Ashcroft Lane from larger storm events. Modeling results indicate these structures will still be impacted during a 25-year frequency event or greater (or a 4% chance of being inundated in any given year).

As shown in Table 3-2, Option C provides a 100-year level of protection for all dwellings in this study area. However, an open cut of T.H. 62 will be required to install the 4-foot by 12-foot box culvert, which will require a temporary closure of the highway. None of the three improvement options evaluated have an impact on the 100-year frequency flood elevation of North Lake Cornelia.

Table 3-2 Maximum water surface elevations (feet, MSL) at NC_40 under proposed conditions and the number of dwellings (shown in parentheses) that are inundated at that corresponding elevation

24-hour Storm Recurrence Interval	Existing Conditions[1]	Option A[1] (42" pipe to existing storm sewer)	Option B[1] (36" pipe to NC_62)	Option C[1] (4' by 12' box culvert to NC_62)
1-year	864.3 (0)	861.9 (0)	861.9 (0)	861.8 (0)
2-year	865.3 (0)	862.4 (0)	862.4 (0)	862.3 (0)
10-year	866.9 (2)	865.5 (0)	865.3 (0)	863.7 (0)
25-year	867.6 (2)	866.4 (2)	866.4 (2)	864.5 (0)
50-year	867.9 (2)	867.0 (2)	867.0 (2)	865.0 (0)
100-year	868.2 (3)	867.7 (2)	867.7 (2)	865.4 (0)

[1] *Elevations based on Atlas 14 precipitation depths*

Table 3-3 summarizes the 100-year peak discharge rates through the proposed storm sewer pipes for Options A, B, and C.

Table 3-3 100-year peak flow rates through the proposed pipes for Ashcroft Lane improvement Options A, B, and C

24-hour Storm Recurrence Interval	Option A (42" pipe to existing storm sewer)	Option B (36" pipe to NC_62)	Option C (4' by 12' box culvert to NC_62)
100-year	61 cfs	58 cfs	156 cfs

3.1.4 Engineer's Opinions of Probable Costs

Planning level engineer's opinions of probable costs were prepared for Options A, B, and C. The opinions of probable cost, summarized in Table 3-4, are based on our experience on similar construction projects and the level of information available to determine costs for the proposed projects. Given that the costs are based on planning-level designs, a contingency of 30% was applied to the estimated construction costs. See Appendix A for detailed summaries of the costs for Options A, B, and C.

Many of the flood improvement options identified in this study have high costs. To help evaluate the costs, we have also included an estimated cost for the City to obtain the properties that do not receive a 100-year level of protection under existing conditions. The buy-out costs summarized in Table 3-4 are based on the estimated market values of impacted properties as established by the Hennepin County assessor as of January 2, 2012. The City may also wish to consider retrofitting flood-prone residential structures as an alternative option. Retrofitting options and costs vary considerably by individual situation. The Federal Emergency Management Agency (FEMA) has developed retrofitting guidance documents including *Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures (FEMA P-259 / January 2012)* and *Homeowner's Guide to Retrofitting – Six Ways to Protect Your Home From*

Flooding (FEMA P-312 / December 2009) that can provide additional reference information as the City considers flood improvement options.

Table 3-4 Estimated costs for Ashcroft Lane (Project Area 1) improvement Options A, B, C and buy-out option

Improvement Option	Estimated Cost[2]
Option A: 42" CPEP to existing storm sewer	$380,000
Option B: 36" RCP to NC_62	$410,000
Option C: 4' by 12' box culvert to NC_62	$710,000
Buy-out Option[1]	$770,000

[1] Buy-out costs based on combined estimated market value for three impacted dwellings under existing conditions for the 100-year frequency event, as reported on Hennepin County property information search website.

[2] Costs rounded up to the nearest $10,000.

3.2 Barrie Road and York Avenue Area (Subwatersheds NC_86, NC_88, NC_97, NC_99)

3.2.1 Problem Description

Figure 3-7 shows the Project Area 1 study area within the Barrie Road and York Avenue areas. These areas are described in further detail below. Discharge from both of these study areas currently is conveyed to Lake Cornelia. Lake Cornelia is listed on the MPCA impaired waters list for excess nutrients (phosphorus). A Use Attainability Analysis (UAA) was conducted by the Nine Mile Creek Watershed District (NMCWD) in 2009-2010 to evaluate the problem of excess phosphorus in Lake Cornelia and identify sources. Stormwater runoff was determined to be the primary source of phosphorus to the lake, and opportunities to reduce phosphorus contributions to the lake should be considered as redevelopment and infrastructure improvements occur within the Lake Cornelia watershed.

Barrie Road (Subwatersheds NC_86, NC_97 and NC_99)

A depression area exists at the intersection of Barrie Road and Heritage Drive and extends south of the intersection along Barrie Road to West 65th Street. Stormwater from Subwatersheds NC_86 and NC_97 is collected by storm sewer that flows northward, connecting with the T.H. 62 system near the intersection of Heritage Drive and Barrie Road. Stormwater runoff from Subwatershed NC_99 is conveyed eastward to the pond at West 64th Street and York Avenue; however, surface flow-by (runoff not captured by the storm sewer system) from NC_99 flows northward along Barrie Road to the low area. During large storm events, this large depression area is inundated, causing street and parking lot flooding. The subwatershed divides shown on Figure 3-7 were previously delineated using the City's 2-foot topography data from 2001. However, newer and more accurate topographic data (MNDNR 2011 LiDAR elevation data) were used for modeling storage and delineating inundation areas for this project; therefore, the inundation

areas shown in Figure 3-7 that appear to overflow from one subwatershed to the next are not actually surface overflows, but rather represent areas where slight changes to subwatershed divides (such that the inundation area along Barrie Road remains within Subwatersheds NC_86 and NC_97) may be warranted in the future.

Pond at West 64th Street & York Avenue (Subwatershed NC_88)

A stormwater detention basin (York Pond) is located just south of West 64th Street between York Avenue and Xerxes Avenue. The York Pond, which receives direct runoff from Subwatershed NC_88 and runoff from Subwatershed NC_99 via storm sewer, is land-locked. In the past, two separate pumped outlets have controlled water levels in the pond. The first outlet has two pumps, each with an approximate pumping rate of 500 gpm (1.1 cfs), that discharges west through a forcemain connecting to the gravity system along Barrie Road. The second outlet to the east is also controlled by two 500 gpm pumps, discharging south along Xerxes Avenue, eventually connecting into the West 66th Street system. The XP-SWMM modeling completed for the CWRMP assumed that the first pumps on each system turned on when the water elevation reaches 863, with the second pumps turning on at elevation 864. All pumps turned off when the water level recedes to 862. At the time of this study, City staff indicated that the pumping system to the west is not currently operational.

3.2.2 Model Updates

The XP-SWMM model for the Barrie Road and York Avenue study area was updated to reflect new rainfall depths as defined by Atlas 14. Because of the increase in rainfall depths, several additional surface overflows were added to the model in the areas of interest to accommodate the additional flows. The original XP-SWMM model for the Barrie Road and York Avenue area included two pumps at the York Pond. Because the west pumping system is not currently operational, the model was revised to reflect the reduced pumping capacity. The stage-storage relationship of the subwatersheds within the Barrie Road and West 64th and York Avenue study areas were updated based on the 2011 LiDAR elevation dataset from the MDNR.

3.2.3 Existing Conditions Flood Risk

Table 3-5 summarizes the predicted water surface elevations under existing conditions for the subwatersheds within the Barrie Road and York Avenue study area for the 1-, 2-, 10-, 25-, 50-, and 100-year frequency events. The inundation areas corresponding to the 100-year, 24-hour flood elevations along Barrie Road and in the York Avenue Pond area (NC_88) are shown in Figure 3-7.

Table 3-5 Maximum water surface elevations (feet, MSL) under existing conditions at Barrie Road (NC_86) and York Pond (NC_88) and the impact to structures at that corresponding elevation

24-hour Storm Recurrence Interval	Water Surface Elevation[1] at Barrie Road (NC_86)[2]	Water Surface Elevation[1] at York Pond (NC_88)[3]
1-year	874.3 (0/0)	866.2 (0)
2-year	876.7 (0/0)	867.4 (0)
10-year	879.3 (0/0)	870.5 (1)
25-year	879.7 (0/0)	871.9 (5)
50-year	880.0 (0/0)	872.8 (6)
100-year	880.4 (0/11)	873.6 (8)

[1] Elevations based on Atlas 14 precipitation depths
[2] Number of impacted dwelling/garage structures shown in parentheses (garages may be multi-stall)
[3] Number of parcels where any structure (dwelling and/or garage) is impacted shown in parentheses (dwellings may be multi-unit and garages may be multi-stall)

Barrie Road

Along Barrie Road, there are eleven garage structures that will be potentially impacted by the 100-year 24-hour storm event. These garage structures are along the entire stretch of the east side of Barrie Road (Figure 3-7). The flood elevation for the 100-year, 24-storm is approximately the same as the low entry elevation of three of the garage structures and slightly above the low entry elevation of the remaining eight garage structures; therefore, where inundation occurs, the flooding depth is minimal (about 0.1-0.2 feet).

York Avenue Pond

The 100-year frequency, 24-hour flood elevation for the York Pond is 873.6, which is higher than the 100-year flood elevation identified in the CWRMP (870.9). The increase in flood level is a result of the increased precipitation depth and runoff volume based on Atlas 14, as well as the reduced pumping capacity. The inundation area corresponding to the 873.6 flood elevation is shown in Figure 3-7. Comparison of the flood elevations for York Pond (NC_88) with adjacent low entry elevations surveyed by the City indicates that eight parcels will have impacted structures from the 100-year flood elevation. This includes multi-unit buildings at 6415 York Avenue and 6455 York Avenue, and 2-unit buildings (side-by-side homes) at 6338, 6344, 6400, 6408, 6416, and 6420 Xerxes Avenue.

The lowest structure, adjacent to York Pond (6415 York Avenue in NC_88), has a low entry elevation of 869.1. The next two lowest structures (both located at 6455 York Avenue) have low entry elevations of 871.1 feet and 871.2 feet. As shown in Table 3-5, the parcel with the lowest structure will be potentially impacted by the 10-year 24-hour storm event. The parcel with the next lowest two structures is potentially impacted by a 25-year 24-hour storm event.

Flood risk analysis maps, often generically referred to as "flood risk maps" were also generated for the Barrie Road and York Pond area. Figure 3-8 ("Annual Flood Risk"), depicts the approximate chance of flooding (as a percentage) for any given year. Figure 3-9 depicts the approximate chance of flooding (also as a percentage) over the life of a typical 30-year home mortgage. The purpose of these flood risk maps is to help property owners and the community better understand their potential flood hazard and risk in the inundation areas shown on these maps. These types of flood risk assessments can help guide community mitigation efforts by highlighting areas where risk reduction actions may produce the highest return on investment.

3.2.4 Improvement Options

Several flood improvement options were evaluated to reduce flood risk in the low area along Barrie Road and the York Pond area. The following three options were effective in reducing flood risks in this study area and were therefore more closely evaluated (including preparation of a cost estimate):

Option A: Installation of a 36-inch CPEP from the Barrie Road low point westward to the Swimming Pool Pond (NC_3)

Option B: Installation of a 48-inch CPEP from the Barrie Road low point westward to the Swimming Pool Pond (NC_3) and increase pump capacity

Option C: Installation of a 36-inch CPEP from the Barrie Road low point westward to the Swimming Pool Pond (NC_3) and install underground storage in NC_88 subwatershed

Option A (Figure 3-10)—proposes the installation of a new 36-inch pipe CPEP that runs south along Barrie Road, then westerly along West 65th Street, discharging into the Swimming Pool Pond (NC_3). This option includes the removal of the existing storm sewer that conveys runoff from Subwatershed NC_99 to York Pond. Option A reduces the flood risk on Barrie Road and significantly reduces the volume of water contributing to flooding in the York Avenue Pond (NC_88).

Option B (Figure 3-11)—is similar to Option A, but includes the installation of a larger (48-inch) CPEP to the west and increased pumping capacity from the York Pond (NC_88). The current non-operational 1000 gpm pump system to the west would be replaced with a 3500 gpm pump system, with the flow directed westward through a forcemain to the new proposed 48-inch Barrie Road pipe system.

Option C (Figure 3-12)—includes Option A (installation of the 36-inch CPEP from Barrie Road to Swimming Pool Pond) and installation of underground storage/infiltration chambers within the NC_88 subwatershed to reduce the volume of runoff reaching the York Pond. The Hennepin County Soil Survey indicates that soils in this area are Hydrologic Soil Group "A" indicating that the soils are well drained having high infiltration potential. This option is intended to provide a 100-year level of protection for all parcels in this area, with exception of the parcel nearest to the York Pond (building with 14 condominiums at 6415 York Avenue) with a low entry elevation of 869.1.

Option C assumes installation of approximately 2 acre-feet of storage volume in the underground infiltration chambers. Due to the topography within Subwatershed NC_88 and existing utility locations, available space for the installation of an underground system is limited. However, it appears feasible if multiple chambers are installed in the portion of the right-of-way throughout the NC_88 subwatershed not conflicting with sanitary sewer and water main and beneath the access road and parking lot of 6455 York Avenue. Based on the assumptions that water in the underground storage system infiltrates at a rate of 0.8 inches per hour (Minnesota Stormwater Manual) and the chamber/rock storage system has a volume depth of 5 feet, an infiltration footprint of approximately 0.7 acres would be required to achieve the 2 acre-feet of desired storage volume.

Several other improvement options were evaluated using the XP-SWMM hydrologic and hydraulic model, but were not effective in reducing flood risk in the Barrie Road and York Pond areas. The improvement options that were evaluated included re-grading of Strachauer Park north of T.H. 62 to provide flood storage and detention, and significantly upsizing the T.H. 62 storm sewer system and pipes that connect the T.H. 62 system to Barrie Road.

Flood Benefits

Table 3-6 summarizes the reductions in water surface elevations along Barrie Road for Options A, B, and C. The additional outflow capacity provided in Option A is sufficient to lower the 100-year maximum water surface elevation along Barrie Road below the low entries of the lowest lying garage structures (the predicted water surface elevation is 0.2 feet lower than the lowest entry elevation). However, the road would still be inundated (approximately 2 feet of flood depth at the lowest point) during a 100-year, 24-hour storm event.

Table 3-6 Maximum water surface elevations (feet, MSL) under proposed conditions at Barrie Road and the number of garage structures (shown in parentheses) that are inundated at that corresponding elevation

24-hour Storm Recurrence Interval	Existing Conditions[1]	Option A[1] (Reroute Barrie Rd. with 36" pipe)	Option B[1] (Reroute Barrie Rd. with 48" pipe and pump pond)	Option C[1] (Reroute Barrie Rd. with 36" pipe and use underground storage)
1-year	874.3 (0)	874.3 (0)	874.4 (0)	874.3 (0)
2-year	876.7 (0)	874.7 (0)	874.9 (0)	874.7 (0)
10-year	879.3 (0)	878.6 (0)	876.7 (0)	878.6 (0)
25-year	879.7 (0)	879.3 (0)	878.6 (0)	879.3 (0)
50-year	880.0 (0)	879.7 (0)	879.1 (0)	879.7 (0)
100-year	880.4 (11)	880.0 (0)	879.5 (0)	880.0 (0)

[1] *Elevations based on Atlas 14 precipitation depths*

Table 3-7 summarizes the reductions in water surface elevations in NC_88 (York Pond) as a result of Options A, B, and C. In addition to reducing the flood risk along Barrie Road, Option A reduces the number of parcels with impacted structures adjacent to York Pond from eight to five for the 100-year event, 24-hour event. The additional Barrie Road capacity and the diversion of runoff from Subwatershed NC_99 results in a significant reduction in runoff volume to York Pond, reducing the flood elevations in the NC_88 area for all storm events (Table 3-7). However, two parcels are still provided less than a 50-year level of protection under Option A.

Option B, along with the proposed 48-inch CPEP system between Barrie Road and Swimming Pool Pond, provides a 100-year level of protection to all parcels, with exception of 6415 York Avenue, the lowest-lying dwelling. Similarly, Option C, which includes underground storage and the proposed 36-inch CPEP system between Barrie Road and Swimming Pool Pond, provides a 100-year level of protection to all parcels, with exception of 6415 York Avenue, the lowest lying dwelling.

Table 3-7 Maximum water surface elevations (feet, MSL) under proposed conditions in York Pond (NC_88) and the number of parcels (shown in parentheses) with impacted structures at that corresponding elevation

24-hour Storm Recurrence Interval	Existing Conditions[1]	Option A[1] (Reroute Barrie Rd. with 36" pipe)	Option B[1] (Reroute Barrie Rd. with 48" pipe and pump pond)	Option C[1] (Reroute Barrie Rd. with 36" pipe and use underground storage)
1-year	866.2 (0)	864.4 (0)	863.1 (0)	862.0 (0)
2-year	867.4 (0)	865.2 (0)	863.7 (0)	862.0 (0)
10-year	870.5 (1)	868.6 (0)	866.5 (0)	864.7 (0)
25-year	871.9 (5)	870.3 (1)	868.7 (0)	867.7 (0)
50-year	872.8 (6)	871.3 (2)	870.0 (1)	869.6 (1)
100-year	873.6 (8)	872.1 (5)	871.1 (1)	871.0 (1)

[1] *Elevations based on Atlas 14 precipitation depths*

While the goal of Options A, B, and C is to provide additional flow capacity to reduce flooding in the Barrie Road and York Avenue areas, it is also important to ensure that the downstream storage areas receiving the additional water are not impacted such that they cause new flooding concerns. Table 3-8 summarizes the maximum water surface elevations for the 100-year 24-hour storm event in the storage areas directly downstream of the proposed improvements as a result of Options A, B, and C. Options A, B, and C all result in approximately 0.1 foot increase to the flood elevation of North Lake Cornelia. Option B results in approximately 0.1 foot increase to the flood elevation in Swimming Pool Pond and Point of France Pond, while Options A and C cause no increases to Swimming Pool Pond and Point of France Pond.

Table 3-8 Maximum water surface elevations (feet, MSL) under proposed conditions for the 100-year 24-hour storm event in North Cornelia, Swim Pool Pond, and Point of France Pond

Water Body	Existing Conditions[1]	Option A[1] (Reroute Barrie Rd. with 36" pipe)	Option B[1] (Reroute Barrie Rd. with 48" pipe and pump pond)	Option C[1] (Reroute Barrie Rd. with 36" pipe and use underground storage)
North Lake Cornelia	865.0	865.1	865.1	865.1
Swimming Pool Pond	865.7	865.7	865.8	865.7
Point of France Pond	866.6	866.6	866.7	866.6

[1] *Elevations based on Atlas 14 precipitation depths*

Water Quality Benefits

Although flood risk reduction is the primary objective of this analysis, water quality benefits of the identified Options A, B, and C should also be considered, especially considering that downstream Lake Cornelia is on the MPCA impaired waters list for excess nutrients (phosphorus). All of the identified options include rerouting Subwatershed NC_99 to the Swimming Pool Pond, instead of conveying runoff from this subwatershed to the York Pond. While this system modification will result in more runoff being discharged to Lake Cornelia on an average annual basis, the stormwater will receive treatment as it flows through the Swimming Pool Pond to Lake Cornelia. The CWRMP indicates that the Swimming Pool Pond (NC_3) achieves 25-40% annual total phosphorus removal under existing drainage and land use conditions. If the proposed Barrie Road storm sewer is installed, additional opportunities for pretreatment or infiltration prior to discharge to NC_3 should be considered.

Option C, rerouting the Barrie Road system and installing an underground storage and infiltration system, has the greatest water quality benefit of all options considered. Currently, runoff that reaches York Pond either infiltrates, evaporates, or is pumped downstream to Lake Cornelia. Without detailed pumping records, it is difficult to determine the annual runoff volume that is lost through infiltration or evaporation versus pumped downstream. However, with installation of the proposed underground storage system, essentially all of the annual runoff would be captured in the underground storage system or pond and infiltrated.

3.2.5 Engineer's Opinion of Probable Costs

Planning level engineer's opinions of probable costs were prepared for Options A, B, and C. The opinions of probable cost, summarized in Table 3-9, are based on our experience on similar construction projects and the level of information available to determine costs for the proposed projects. Given that the costs are based on planning-level designs, a contingency of 30% was applied to the estimated construction costs. See Appendix B for detailed summaries of the costs for Options A, B, and C.

Many of the flood improvement options identified in this study have high costs. To help evaluate the costs, we have also included an estimated cost for the City to obtain the properties that do not receive a

100-year level of protection under existing conditions. The costs to obtain the properties are summarized in Table 3-9 and are based on the estimated market values of parcels with impacted structures as established by the Hennepin County assessor as of January 2, 2012. The City may also wish to consider retrofitting flood-prone residential structures as an alternative option. Retrofitting options and costs vary considerably by individual situation. The Federal Emergency Management Agency (FEMA) has developed retrofitting guidance documents including *Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures (FEMA P-259 / January 2012)* and *Homeowner's Guide to Retrofitting – Six Ways to Protect Your Home From Flooding (FEMA P-312 / December 2009)* that can provide additional reference information as the City considers flood improvement options.

Table 3-9 Estimated costs for Barrie Road and York Avenue (Project Area 1) improvement Options A, B, C and buy-out option

Improvement Option	Estimated Cost[2]
Option A: 36″ CPEP from Barrie Road to Swimming Pool Pond	$1,820,000
Option B: 48″ CPEP from Barrie Road to Swimming Pool Pond and increased pump capacity	$2,590,000
Option C: 36″ CPEP from Barrie Road to Swimming Pool Pond and underground storage/infiltration	$3,770,000
Buy-out Option[1]	$5,350,000

[1] Buy-out costs based on combined estimated market value for impacted dwellings (multi-unit buildings) under existing conditions for the 100-year frequency event, as reported on Hennepin County property information search website. This cost assumes buy-outs of all units in the multi-unit buildings; purchase of only select impacted units may be an option, but would require additional survey and review of the layout of the multi-unit buildings.

[2] Costs rounded up to the nearest $10,000.

4.0 Project Area 3: Lake Pamela Subwatersheds LP_24 and LP_27

4.1 Problem Description

Figure 4-1 shows the Project Area 3 study area. Hydrologic and hydraulic modeling of this area indicates that a flooding problem occurs at the West 60th Street and Chowen Avenue intersection, as well as in the backyard areas on the east side of the 5800 block of Chowen Avenue. The backyard depression area (Subwatershed LP_24) currently is not connected to the City storm sewer system and becomes inundated during large rainfall events, potentially impacting several adjacent structures. Stormwater from the backyard area will flow to Chowen Avenue via surface overflow at an elevation of 883.3 feet based on the City's topographic survey. During the City's field survey, several drain inlets were observed in the backyard area. Further investigation by City staff indicated that these drains were not connected to the City's storm sewer or sanitary sewer systems, and appear to be French drain-type system(s). For purposes of this modeling analysis, it was assumed that these drains are not functional.

Project Area 3 is drained by a storm sewer system that discharges into Lake Pamela (LP_26). The system was originally designed and constructed in the mid-1950s and thus was not sized in a manner consistent with the City's current design criteria. The lack of sufficient capacity in the existing system results in flows backing up and pooling in the low area at the intersection of West 60th Street and Chowen Avenue during large storm events, potentially impacting several adjacent structures.

The Project Area 3 neighborhood is one of the residential areas within Edina where significant residential redevelopment is anticipated. As houses are remodeled or torn down and rebuilt, the impervious footprint tends to increase from original construction conditions. This increase in impervious surface and/or directly-connected impervious surface can result in increased stormwater runoff rate and volume.

The streets within the portion of the Project Area 3 study area east of France Avenue will be reconstructed in upcoming years (2014 – 2018). The upcoming street reconstruction may present unique opportunities for stormwater infrastructure improvements to reduce flood risk within Project Area 3 and improve the water quality being discharged to downstream Lake Pamela and Minnehaha Creek.

4.2 Model Updates

The XP-SWMM hydrologic and hydraulic model for Project Area 3 was updated to reflect new rainfall depths as defined by NOAA Atlas 14. Because of the increase in rainfall depths, several additional overflows were added to the model within the Project Area 3 study area. The City provided topographic survey of the backyard depression area and low area along Chowen Avenue. This information was used in conjunction with the MNDNR's 2011 LiDAR elevation dataset to update the stage-storage relationships in the model for subwatersheds within the Project Area 3 study area. The storm sewer information in the model was also updated based on a survey conducted by the City.

4.3 Existing Conditions Flood Risk

Table 4-1 summarizes the predicted water surface elevations under existing conditions for the subwatersheds within Project Area 3 for the 1-, 2-, 10-, 25-, 50-, and 100-year frequency, 24-hour duration events. The 100-year frequency, 24-hour flood elevation for Project Area 3 (LP_24 and LP_27) is 883.9. The inundation area corresponding to the 883.9 flood elevation is shown in Figure 4-1. Flood frequency data is often also described in terms of a percentage of risk. For example, the 100-year frequency flood inundation area represents an area that has a 1% chance of flooding (1-percent-annual chance flood) for any given year. Structures located within the 1-percent-annual chance flood inundation area have a 26 percent chance of flooding during the life of a standard 30-year mortgage.

The City provided survey of the low entry elevations for properties adjacent to the LP_24 and LP_27 low areas. Comparison of these elevations with the 100-year flood elevation indicates that seven dwellings will be impacted by the 100-year flood elevation in the backyard depression area (LP_24) and sixteen dwellings will be impacted at West 60th and Chowen Avenue (LP_27). As shown in Table 4-1, six dwellings in the backyard depression area and seven structures along Chowen Avenue will be impacted by the 10-year frequency event. Modeling results indicate that three dwellings within Subwatershed LP 24 and one dwelling within Subwatershed LP_27 (5932 Chowen Avenue) are impacted as often as the 1-year frequency event (in other words, a 100-percent-annual chance). Although modeling results indicate potential impacts in the LP_24 subwatershed as often as the 1-year event, the French drain-type system(s) in place may be functioning sufficiently to reduce the frequency of flooding.

Table 4-1 Maximum water surface elevations (feet, MSL) under existing conditions at the Chowen Avenue backyard depression area (LP_24) and West 60th street and Chowen Avenue intersection (LP_27) and the number of dwellings/ garages (shown in parentheses) that are inundated at that corresponding elevation

24-hour Storm Recurrence Interval	Water Surface Elevation at Chowen Ave LP_24	Water Surface Elevation at LP_27
1-year	882.7 (3/2)	880.8 (1/0)
2-year	882.9 (3/2)	881.4 (2/1)
10-year	883.3 (6/2)	882.7 (7/2)
25-year	883.5 (6/2)	883.3 (9/2)
50-year	883.6 (7/2)	883.6 (12/3)
100-year	883.9 (7/2)	883.9 (16/3)

Flood risk analysis maps, often generically referred to as "flood risk maps," were also generated for the Project Area 3 study area. Figure 4-2 ("Annual Flood Risk"), depicts the approximate chance of flooding (as a percentage) for any given year. Figure 4-3 depicts the approximate chance of flooding (also as a

percentage) over the life of a typical 30-year home mortgage. The purpose of these flood risk maps is to help property owners and the community better understand their potential flood hazard and risk in the inundation areas shown on these maps. These types of flood risk assessments can help guide community mitigation efforts by highlighting areas where risk reduction actions may produce the highest return on investment.

4.3.1 Residential Redevelopment

Residential redevelopment within Project Area 3 is resulting in properties with an increased percentage of impervious area or directly-connected impervious area, which can increase the stormwater runoff rate and volume. A review of recent residential directly-connected imperviousness increases was conducted using GIS to approximate a "typical" impervious percentage for redeveloped residential properties. A modeling analysis was then conducted for this project area to help identify the potential impacts from the increased imperviousness in this and other Edina neighborhoods.

The impervious areas of several recent residential redevelopment lots throughout Edina were delineated using GIS. The approximated directly-connected imperviousness (DCI) of these lots ranged from 30% to 45%. For the modeling analysis, a directly-connected imperviousness of 40% was used for low-density residential areas, which is a significant increase from the 20% directly-connected imperviousness assumption used in the original XP-SWMM models developed for the City. Three redevelopment "scenarios" were modeled for Project Area 3: (1) 1/3 of residential properties redeveloped, (2) 2/3 of residential properties redeveloped, and (3) all residential properties redeveloped. The modeling results, summarized in Table 4-2, indicate that the increase in imperviousness has minimal impact on flood volume in subwatershed LP_27 for the 100-year, 24-hour rainfall event. The corresponding increase in peak flood elevation is also minimal (approximately 0.1 feet under the 100% redevelopment scenario).

Table 4-2 Comparison of flood volumes in Subwatershed LP_27 for the 100-year, 24-hour rainfall event under varying residential redevelopment scenarios

Scenario	Subwatershed LP_27 Total Flood Volume[1] (acre-feet)	% Increase in Total Flood Volume[1]
No Redevelopment	8.50	-
Scenario 1: 1/3 redevelopment[2]	8.68	2%
Scenario 2: 2/3 redevelopment[2]	8.85	4%
Scenario 3: all lots redeveloped[2]	9.02	6%

[1] Total flood volume represents the volume of runoff stored in Subwatershed LP_27 at the time corresponding with the peak water surface elevation.

[2] Increases in flood depth range from 0.03 to 0.1 feet for the 1/3 redevelopment to the 100% redevelopment scenarios.

Upon review of the modeling results for the redevelopment scenarios, the following question may arise "Why does the increased imperviousness not have a greater impact on 100-year flood elevations in the LP_27 subwatershed?" The answer is that the existing storm sewer system has insufficient capacity to drain the LP_27 and adjacent subwatersheds, resulting in significant ponding at West 60th Street and Chowen Avenue. A moderate increase in runoff volume is therefore distributed over a large area. The intensity of the 100-year event is another reason that the impacts of increased imperviousness are not greater. During the peak intensity of large storm events, the rainfall intensity (inches/hour) often greatly exceeds the infiltration capacity of the underlying soils. During these times, the amount of rainfall infiltrated in a given time period can be small compared to the amount of runoff generated.

Table 4-3 summarizes the impacts of increased imperviousness on runoff depths generated from rainfall events ranging from 1-year to 100-year frequencies. The runoff depths are from a representative residential subwatershed within Project Area 3 (LP_20), comprised entirely of B soils (predominant soil type in Edina). As shown in Table 4-3, the percent increase in runoff resulting from increased imperviousness is greater for more frequent, less intense rainfall events. The increase in runoff depth decreases as the rainfall event becomes more intense.

Table 4-3 Comparison of runoff depths from a residential Subwatershed (LP_20) with B soils under varying directly-connected imperviousness (DCI) scenarios and precipitation frequencies

Recurrence Interval	24-hour Rainfall Depth (inches)	Subwatershed LP_20				
		Runoff Depth[1] with 20% DCI (inches/acre) *Existing Conditions*	Runoff Depth[1] with 27% DCI (inches/acre) *1/3 Redeveloped*	Runoff Depth[1] with 33% DCI (inches/acre) *2/3 Redeveloped*	Runoff Depth[1] with 40% DCI (inches/acre) *100% Redeveloped*	Increase in Runoff Depth between Existing Conditions and 100% Redeveloped (%)
1-year	2.5	0.84	0.96	1.09	1.22	46%
2-year	2.9	1.13	1.26	1.40	1.53	36%
10-year	4.3	2.30	2.46	2.61	2.76	20%
25-year	5.4	3.28	3.45	3.61	3.78	15%
50-year	6.4	4.17	4.35	4.52	4.69	13%
100-year	7.5	5.17	5.36	5.54	5.72	11%

[1] *Runoff depths reflect site runoff only (i.e., subwatershed runoff that has not been conveyed downstream).*

4.4 Improvement Options

The following flood improvement options were evaluated to reduce flood risk in the low areas within Project Area 3:

Option A: **Infiltration Swales**

Incorporate stormwater infiltration swales within City right-of-way. Install a new pipe to drain LP_24 backyard depression area.

Option B: **Infiltration Swales with Storage Pipes**

Incorporate stormwater infiltration swales and 36-inch perforated underground storage/infiltration pipes (CPEP) within City right-of-way. Install a new pipe to drain LP_24 backyard depression area.

Option C: **New Pipe on West 60th Street**

Install a new pipe to drain LP_24 backyard depression area; install a new pipe to drain LP_27 low area, connecting to the existing system near the intersection of France Avenue and Halifax; upsize the existing storm sewer from France Avenue and Halifax to Pamela Park stormwater pond (LP_26)

Option D: **Upsize Existing Storm Sewer**

Install new pipe to drain LP_24 backyard depression area; Upsize the existing storm sewer from West 60th Street and Chowen Avenue to Lake Pamela (LP_26)

Options A and B: Right-of-Way Stormwater Storage/Infiltration

The lack of sufficient capacity in the existing system results in flows "backing up" and pooling in the low area at the intersection of West 60th Street and Chowen Avenue during large storm events. One method to reduce the runoff that reaches this intersection is to provide additional flood storage and infiltration throughout the drainage area. Options A and B reflect two Living Streets stormwater storage and infiltration concepts that were developed for Project Area 3. Option A includes infiltration swales installed within the City right-of-way. The shallow (6- to 1-inches deep) swales or depressed gardens, shown conceptually in Figure 4-4 as turfed swales, would collect and infiltrate runoff from the roadway and adjacent driveways. For modeling and cost estimating purposes, it was assumed that infiltration swales would be installed in approximately 70% of the parcels within the street reconstruction area (see Figure 4-5). A collector pipe would also be installed between the infiltration swales and street to convey overflows and draintile flows, where appropriate, to the existing storm sewer system.

Option B includes the right-of-way infiltration swales of Option A, in addition to installation of 36-inch perforated pipes (CPEP) between the infiltration swales and street to provide additional flood storage and infiltration.

Both Options A and B include installation of a new 24-inch CPEP from the LP_24 backyard depression to the existing system at the West 60th Street and Chowen Avenue intersection.

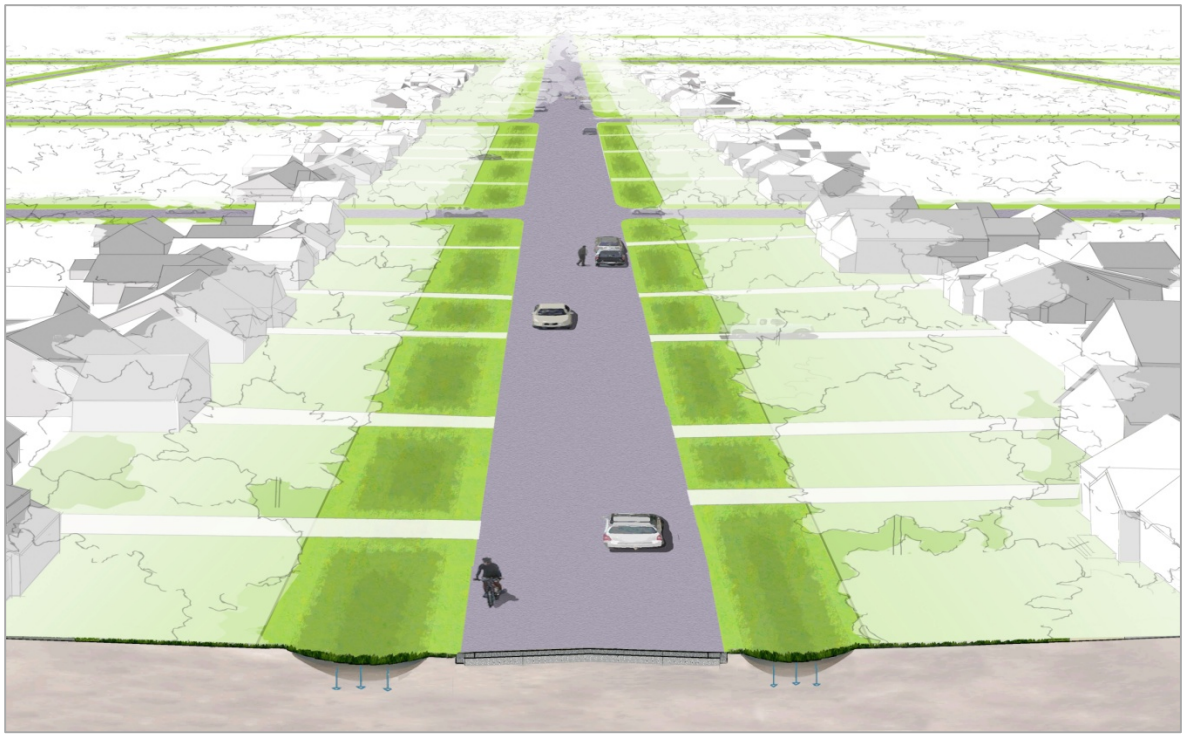


Figure 4-4 Conceptual drawing of Option A, right-of-way infiltration swales for Project Area 3 street reconstruction areas

Options C and D: Additional Storm Sewer Capacity

Improvement Options C and D both provide additional storm sewer capacity to reduce the flood risk in Subwatersheds LP_27 and LP_24, but differ in the proposed storm sewer configuration. Option C (Figure 4-6) includes installation of a new 48-inch pipe westward along West 60th Street from the existing system at West 60th Street and Chowen Avenue intersection (Subwatershed LP_27) to France Avenue, then southward to the existing system near the intersection of France Avenue and Halifax Avenue. Option C also includes upgrading the existing storm sewer pipes to 60-inch CPEP (or equivalent capacity) from France and Halifax to Lake Pamela (Subwatershed LP_26). One advantage of this storm sewer configuration is that it does not require replacement of pipes between properties on France Avenue and Ewing Avenue. However, review of elevation data indicates that a deep cut would be necessary for installation along West 60th Street and France Avenue.

Option D (Figure 4-7) includes upsizing of the existing storm sewer system from West 60th Street and Chowen Avenue to Lake Pamela (Subwatershed LP_26). Table 4-4 describes the proposed pipe size increases.

Table 4-4 Proposed pipe size increases for Option D in Project Area 3 (West 60th Street and Chowen Avenue)

Pipe Segment	Existing Size (Diameter)	Proposed Size (Diameter)
Pipe on Chowen Avenue from West 60th to West 61st Street	24-inch	54-inch
Pipe on West 61st Street from Chowen to Ewing Avenues	24-inch	54-inch
Pipe from intersection of Ewing Avenue and West 61st Street west to France Avenue	24-inch	60-inch
Pipe on France Avenue from approximately 150 feet north of the intersection of France Avenue and Halifax Avenue to the Lake Pamela outfall	42-inch	60-inch

4.4.1 Flood Benefits

Table 4-5 summarizes the reductions in water surface elevations in the LP_24 backyard depression area for Options A, B, C, and D for the 1-, 2-, 10-, 25-, 50-, and 100-year frequency, 24-hour rainfall events. Note that all options shown in Table 4-5 include installation of a new pipe to drain the backyard area. Modeling results indicate that connection of the backyard depression area without increasing the downstream pipe capacity will not provide 100-year level of protection to the adjacent properties.

Table 4-5 Maximum water surface elevations (feet, MSL) under proposed conditions in LP_24 and the number of dwellings / detached garages (shown in parentheses) that are inundated at that corresponding elevation

24-hour Storm Recurrence Interval	Existing Conditions[1]	Option A[1]: Infiltration Swales	Option B[1]: Infiltration Swales with Storage Pipes	Option C[1]: New Pipe on West 60th Street	Option D[1]: Upsize Existing Storm Sewer
1-year	882.7 (3/2)	881.3 (0/0)	877.3 (0/0)	877.3 (0/0)	877.3 (0/0)
2-year	882.9 (3/2)	881.3 (0/0)	881.2 (0/0)	877.5 (0/0)	877.5 (0/0)
10-year	883.3 (6/2)	882.7 (3/2)	882.4 (3/2)	878.1 (0/0)	878.1 (0/0)
25-year	883.5 (6/2)	883.3 (6/2)	883.1 (5/2)	878.7 (0/0)	878.7 (0/0)
50-year	883.6 (7/2)	883.5 (7/2)	883.4 (6/2)	881.1 (0/0)	881.5 (0/0)
100-year	883.9 (7/2)	883.9 (7/2)	883.8 (7/2)	881.8 (0/0)	882.0 (0/1)

[1] *Elevations based on Atlas 14 precipitation depths*

Table 4-6 summarizes the reductions in water surface elevations in the low area at West 60th Street and Chowen Avenue (LP_27) for Options A, B, C, and D for the 1-, 2-, 10-, 25-, 50-, and 100-year frequency, 24-hour rainfall events. Options A and B offer some flood risk reduction in the more frequent storms (1-year and 2-year events), but do not result in significant improvements in the less frequency storms. Options C and D provide a 50-year level of protection for all adjacent structures and a 100-year level protection for all structures with exception of one dwelling at 5932 Chowen Avenue.

Table 4-6 Maximum water surface elevations (feet, MSL) under proposed conditions in LP_27 and the number of dwellings / detached garages (shown in parentheses) that are inundated at that corresponding elevation

24-hour Storm Recurrence Interval	Existing Conditions[1]	Option A[1]: Infiltration Swales	Option B[1]: Infiltration Swales with Storage Pipes	Option C[1]: New Pipe on West 60th Street	Option D[1]: Upsize Existing Storm Sewer
1-year	880.8 (1/0)	880.3 (1/0)	877.1 (0/0)	873.6 (0/0)	871.0 (0/0)
2-year	881.4 (2/1)	881.3 (2/1)	879.5 (0/0)	874.0 (0/0)	871.3 (0/0)
10-year	882.7 (7/2)	882.7 (7/2)	882.4 (5/2)	875.0 (0/0)	872.8 (0/0)
25-year	883.3 (9/2)	883.2 (9/2)	883.1 (9/2)	876.4 (0/0)	876.1 (0/0)
50-year	883.6 (12/3)	883.5 (12/2)	883.4 (11/2)	879.4 (0/0)	880.0 (0/0)
100-year	883.9 (16/3)	883.9 (13/3)	883.8 (13/3)	880.7 (1/0)	880.9 (1/0)

[1] *Elevations based on Atlas 14 precipitation depths*

Table 4-7 summarizes the 100-year peak discharge rates through the proposed storm sewer pipes for Options A, B, C, and D.

The storm sewer manhole located on France Avenue approximately 120 feet south of Halifax Avenue, where flows from the France Avenue system are conveyed westward to Lake Pamela, surcharges under existing and proposed conditions. Based on the topographic information, the surcharged runoff pools on France Avenue and then flows overland to Lake Pamela between 6117 Halifax Avenue and 6108 France Avenue. Options C and D result in increased overland flows between France Avenue and Lake Pamela for the 10-year rainfall event and greater. The City should consider surveying the overland flow conveyance channel between these two properties to verify flow capacity, assess potential impacts to the dwellings, and determine if any grading modifications should be considered to reduce flood risk.

Table 4-7 100-year peak flow rates through the proposed pipes for Project Area 3 improvement Options A, B, C, and D

24-hour Storm Recurrence Interval	Existing Conditions[1]	Option A[1]: Infiltration Swales	Option B[1]: Infiltration Swales with Storage Pipes	Option C[2]: New Pipe on West 60th Street	Option D[1]: Upsize Existing Storm Sewer
100-year	27	27	27	120	158

[1] Flow rates reflect flow through pipe on Chowen Avenue between West 60th Street and West 61st Street.
[2] Flow rates reflect flow through proposed pipe on West 60th Street between France Avenue and Chowen Avenue and do not include flow to the existing pipe on Chowen Avenue between West 60th and 61st Streets.

4.4.2 Water Quality Benefits

Although flood risk reduction is the primary objective of this analysis, water quality benefits of the identified Options A, B, C, and D should also be considered. Currently, runoff from Project Area 3 is discharged downstream to Lake Pamela without any water quality treatment or pretreatment. While incorporating living streets concepts into the upcoming street reconstruction project (Options A and B) has less impactful flood risk reduction benefits than providing additional storm sewer capacity (Options C and D), the water quality benefits of Options A and B are substantially greater.

With implementation of Option A (infiltration swales in the right-of-way), the average annual runoff volume, total phosphorus, and total suspended solids generated from the portion of the study area tributary to the infiltrations swales will be reduced by approximately 70%. This equates to an approximate 30% reduction in total phosphorus and total suspended solids from the entire Project Area 3 drainage area tributary to Lake Pamela. With Option B, the average annual reduction in total phosphorus and total suspended solids loading from Project Area 3 to Lake Pamela is reduced by 40%, based on the MPCA MIDS calculator.

Options A or B would also help mitigate water quality impacts to downstream Lake Pamela and Minnehaha Creek from impervious increases resulting from residential redevelopment.

For Options C and D, installation of underground treatment structures within the tributary drainage area would be recommended as part of pipe upgrades, to provide pretreatment of the water prior to discharge to Lake Pamela. The opinions of probable cost for Options C and D include installation of a 96-inch diameter sump manhole with a SAFL baffle.

4.5 Engineer's Opinion of Probable Costs

Planning level engineer's opinions of probable costs were prepared for Options A, B, C, and D. The opinions of probable cost, summarized in Table 4-8, are based on our experience with similar construction projects and the level of information available to determine costs for the proposed projects. Given that the costs are based on planning-level designs, a contingency of 30% was applied to the estimated construction costs. See Appendix C for detailed summaries of the costs for Options A, B, C, and D.

Many of the flood improvement options identified in this study have high costs. To help evaluate the costs, we have also included an estimated cost for the City to obtain the properties that do not receive a 100-year level of protection under existing conditions. The costs to obtain the properties are summarized in Table 4-8 and are based on the estimated market values of impacted dwellings as established by the Hennepin County assessor as of January 2, 2012. The City may also wish to consider retrofitting flood-prone residential structures as an alternative option. Retrofitting options and costs vary considerably by individual situation. The Federal Emergency Management Agency (FEMA) has developed retrofitting guidance documents including *Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures (FEMA P-259 / January 2012)* and *Homeowner's Guide to Retrofitting – Six Ways to Protect Your Home From Flooding (FEMA P-312 / December 2009)* that can provide additional reference information as the City considers flood improvement options.

Table 4-8 Estimated costs for West 60th Street and Chowen Avenue (Project Area 3) improvement Options A, B, C, D and buy-out option

Improvement Option	Estimated Cost[2]
Option A: New storm sewer connection to backyard area; Infiltration swales in right-of-way	$1,160,000
Option B: New storm sewer connection to backyard area; Infiltration swales with storage pipe in right-of-way	$1,660,000
Option C: New storm sewer connection to backyard area; New pipe on West 60th Street	$830,000
Option D: New storm sewer connection to backyard area; Upsize existing storm sewer	$1,230,000
Buy-out Option[1]	$6,210,000

[1] Buy-out costs based on combined estimated market value for impacted dwellings under existing conditions for the 100-year frequency event, as reported on Hennepin County property information search website.

[2] Costs rounded up to the nearest $10,000.

5.0 Project Area 7 Morningside Subwatershed MS_17

5.1 Problem Description

The backyard depression area in Subwatershed MS_17 between France Avenue and Scott Terrace is land-locked and currently is not served by City storm sewer. During large storm events, the backyard depression area becomes inundated and impacts two adjacent structures (4308 and 4312 France Avenue).

5.2 Model Updates

The XP-SWMM model for Project Area 7 was updated to reflect new rainfall depths as defined by Atlas 14. Because of the increase in rainfall depths, additional surface overflows were added to the model to account for the increased flows. The stage-storage curve for the specific subwatershed of interest (MS_17) was updated based on a detailed topographic survey of the backyard depression area and the 2011 LiDAR elevation dataset (Minnesota Department of Natural Resources, MNDNR).

5.3 Existing Conditions Flood Risks

Table 5-1 summarizes the predicted water surface elevations in Subwatershed MS_17 for the 1-, 2-, 10-, 25-, 50-, and 100-year frequency, 24-hour duration events (under existing conditions). The 100-year frequency, 24-hour flood elevation is 902.6 in the backyard area. Comparison of the 100-year flood elevation with adjacent low entry elevations surveyed by City staff indicates that two dwellings will be impacted by the 100-year, 24-hour storm event. The inundation area corresponding to the 100-year frequency flood elevation is shown in Figure 5-1.

Table 5-1 Maximum water surface elevations (feet, MSL) in Subwatershed MS_17 and the number of dwellings (shown in parentheses) that are inundated at the corresponding elevation

24-hour Storm Recurrence Interval	Existing Conditions[1]	New pipe connecting MS_17 to existing Scott Terrace storm sewer[1]
1-year	900.4 (1/1)	894.2 (0/0)[2]
2-year	900.7 (1/1)	894.4 (0/0)[2]
10-year	901.5 (2/1)	895.7 (0/0)[2]
25-year	902 (2/2)	898.4 (0/0)[2]
50-year	902.4 (2/2)	898.5 (0/0)
100-year	902.6 (2/2)	898.6 (0/0)

[1] Elevations based on Atlas 14 precipitation amounts

[2] The assumed invert of the proposed pipe is 893.3 and the ground elevation is 898.4; therefore, all water is contained within the proposed storm sewer under this storm event.

5.4 Improvement Options

Several improvement options were considered to reduce the flood risk in the land-locked backyard depression area, including installation of a gravity overflow swale toward France Avenue, installation of underground storage in the backyard area, and installation of a storm sewer to connect the backyard area to the existing storm sewer approximately 500 feet north on Scott Terrace. Installation of a gravity overflow swale toward France Avenue was not feasible due to site topography. Installation of underground storage was also deemed not feasible, due to the limited land area available within the backyard depression area for installation of stormwater storage.

Installation of a 21-inch CPEP storm sewer to connect MS_17 with the existing storm sewer system on Scott Terrace was determined to be feasible and effective in reducing flood risk for adjacent properties (see Figure 5-2). Table 5-1 summarizes the reductions in water surface elevations in the MS_17 backyard depression area for the 1-, 2-, 10-, 25-, 50-, and 100-year frequency, 24-hour rainfall events. The proposed system provides a 100-year level of protection for all of the adjacent properties. However, connecting the MS_17 backyard area to the existing Scott Terrace storm sewer results in increased 100-year flood elevations in several downstream subwatersheds, including MS_52 and MS_50, which is in conflict with the City's policy that prohibits exacerbating existing downstream flooding problems.

5.5 Engineer's Opinion of Probable Costs

A planning level engineer's opinion of probable cost was prepared for installation of a pipe connecting MS_17 to the existing Scott Terrace storm sewer system. The opinion of probable cost summarized in Table 5-2 is based on our experience with similar construction projects and the level of information available to determine costs for the proposed projects. Given that the cost is based on a planning-level design, a contingency of 30% was applied to the estimated construction costs. See Appendix D for a detailed summary of the cost estimate.

Table 5-2 also includes an estimated cost for the City to obtain the properties that do not receive a 100-year level of protection under existing conditions. The costs to obtain the properties are summarized in Table 5-2 based on the estimated market values of impacted dwellings as established by the Hennepin County assessor as of January 2, 2012. The City may also wish to consider retrofitting flood-prone residential structures as an alternative option. Retrofitting options and costs vary considerably by individual situation. The Federal Emergency Management Agency (FEMA) has developed retrofitting guidance documents including *Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures (FEMA P-259 / January 2012)* and *Homeowner's Guide to Retrofitting – Six Ways to Protect Your Home From Flooding (FEMA P-312 / December 2009)* that can provide additional reference information as the City considers flood improvement options.

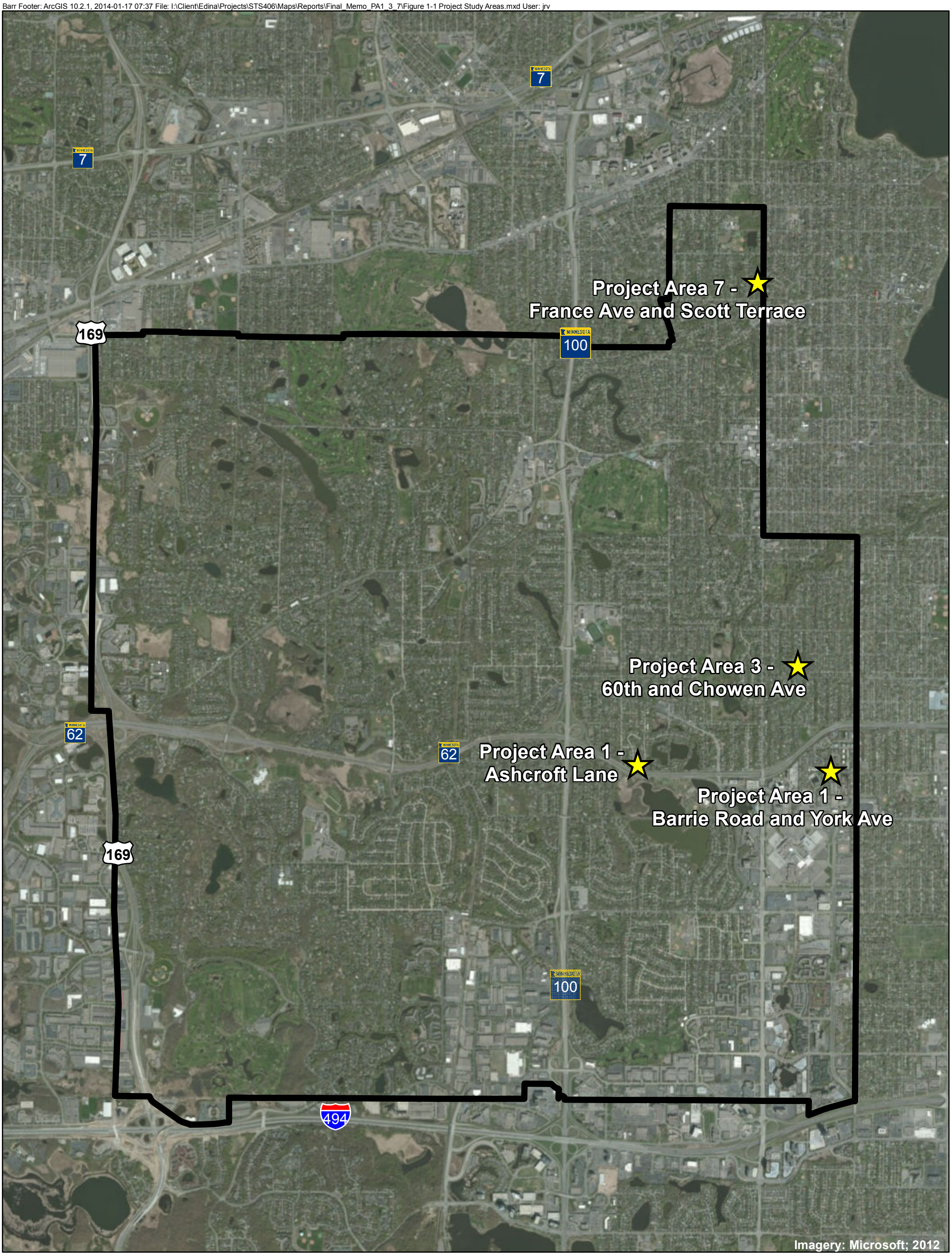
Table 5-2 Estimated costs for Scott Terrace and France Avenue (Project Area 7) improvement option and buy-out option

Improvement Option	Estimated Cost[2]
New pipe connection from MS_17 to existing Scott Terrace storm sewer system	$190,000
Buy-out Option[1]	$950,000

[1] Buy-out costs based on combined estimated market value for two impacted dwellings under existing conditions for the 100-year frequency event, as reported on Hennepin County property information search website.

[2] Costs rounded up to the nearest $10,000.

Figures



Project Areas

City of Edina Boundary

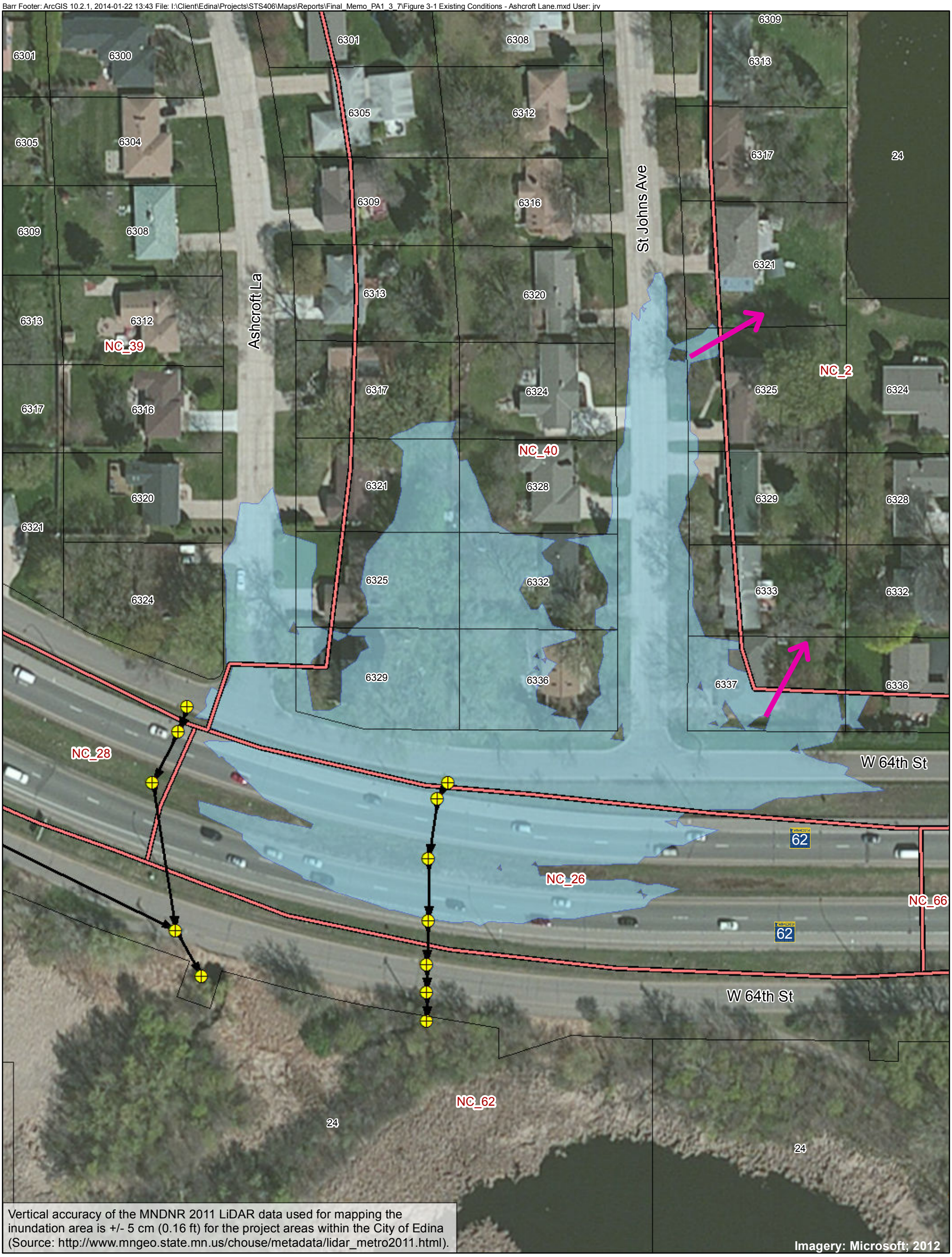
N

Feet
0 2,500 5,000

BARR

Figure 1-1

PROJECT STUDY AREAS



Existing Manhole/Catch Basin

Surface Overflow

Existing Storm Sewer

100 Year 24-Hour Event Inundation Area*

Subwatersheds

Parcels

N

Feet

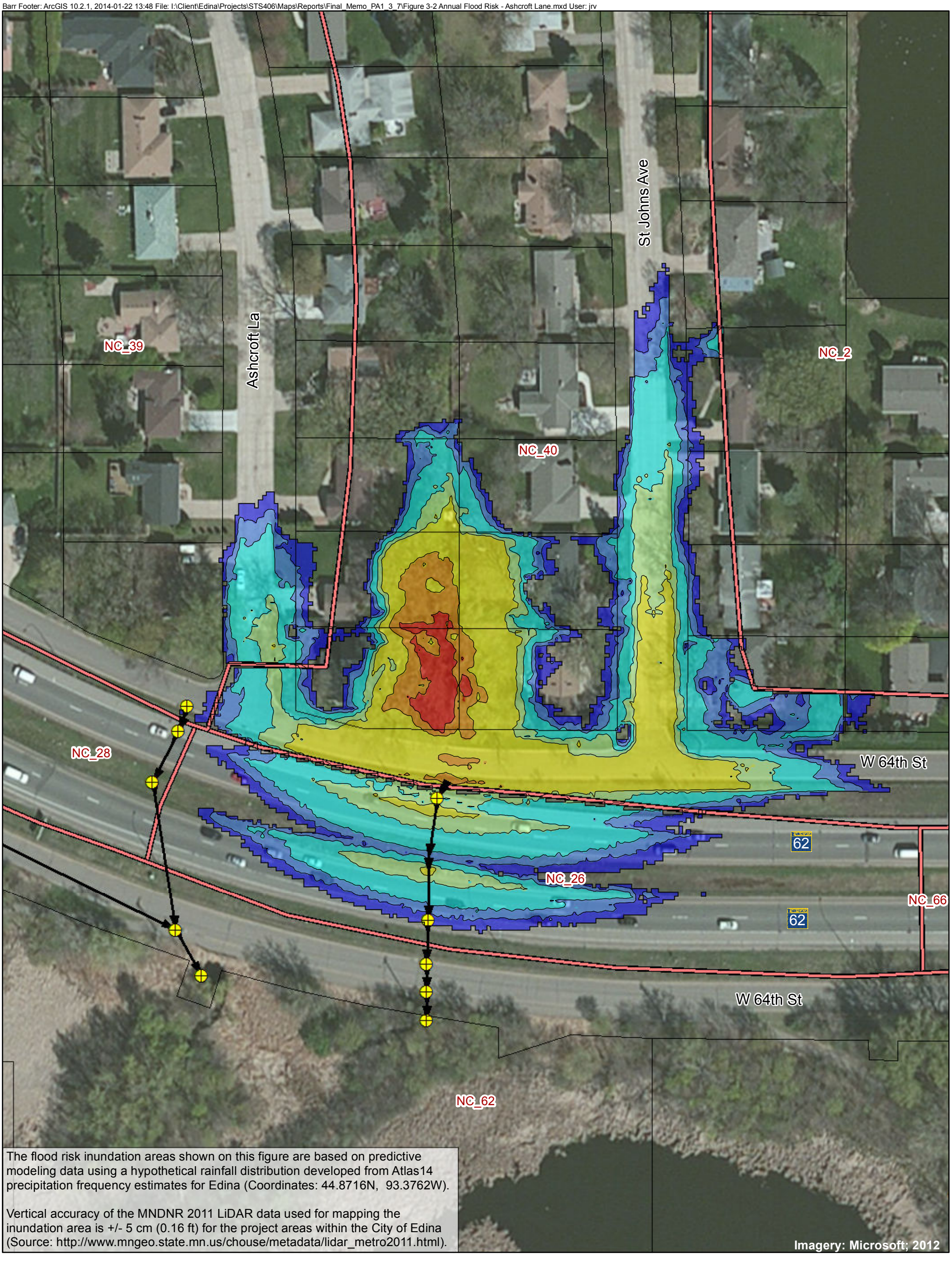
0 75 150

BARR

Figure 3-1

EXISTING CONDITIONS
100 YEAR INUNDATION
Project Area 1 - Ashcroft Lane

*Vertical Datum: NGVD 29, Feet



The flood risk inundation areas shown on this figure are based on predictive modeling data using a hypothetical rainfall distribution developed from Atlas14 precipitation frequency estimates for Edina (Coordinates: 44.8716N, 93.3762W).

Vertical accuracy of the MNDNR 2011 LiDAR data used for mapping the inundation area is +/- 5 cm (0.16 ft) for the project areas within the City of Edina (Source: http://www.mngeo.state.mn.us/chouse/metadata/lidar_metro2011.html).

Existing Manhole /Catch Basin

Existing Storm Sewer

Subwatersheds

Parcels

Annual Flood Risk*

- >80%
- 50% - 80%
- 20% - 50%
- 10% - 20%
- 4% - 10%
- 2% - 4%
- 1% - 2%

N

Feet

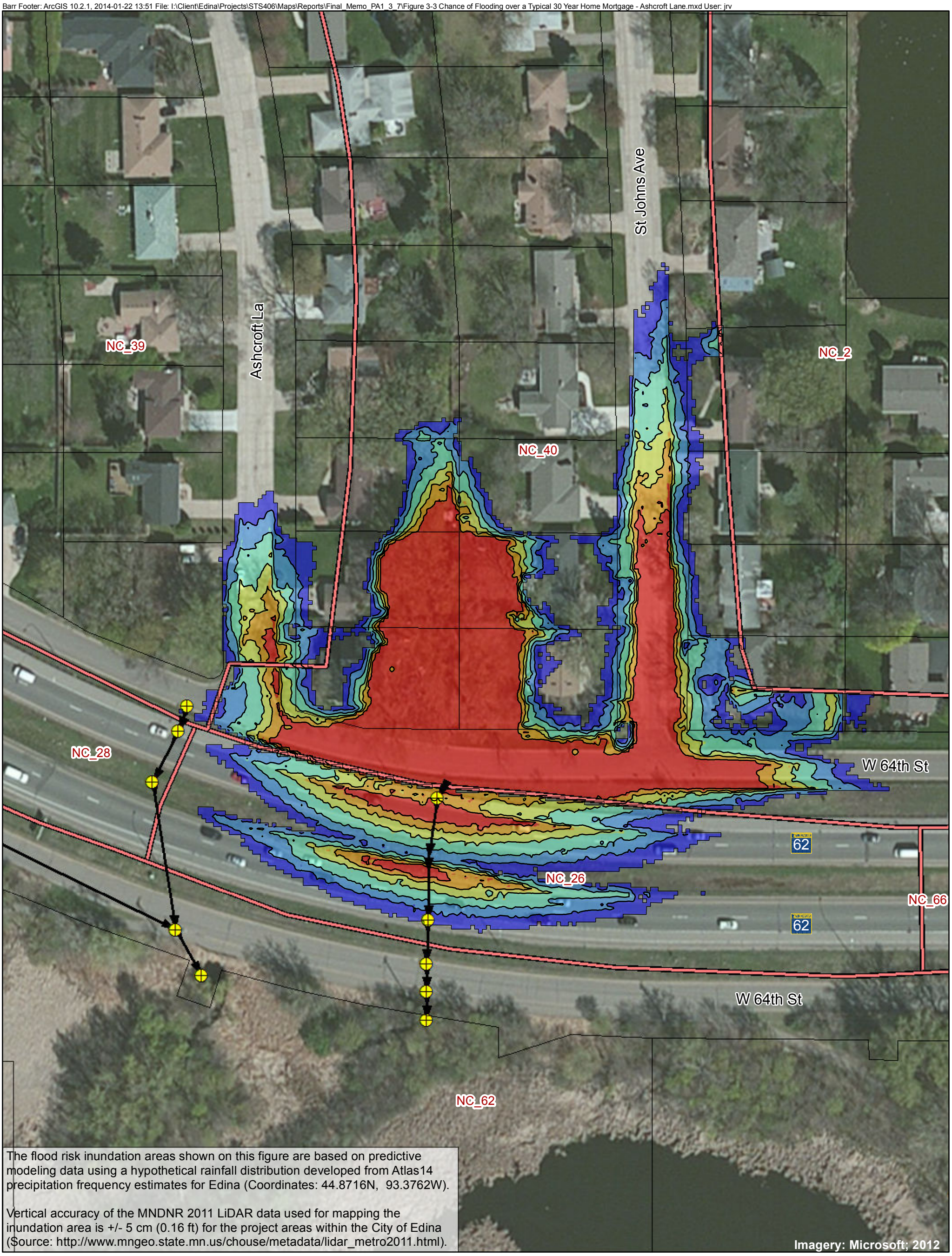
0 75 150

BARR

Figure 3-2

ANNUAL FLOOD RISK
Project Area 1 - Ashcroft Lane
City of Edina

*Vertical Datum: NGVD 29, Feet



Existing Manhole /Catch Basin

Existing Storm Sewer

Subwatersheds

Parcels

30 Year Flood Probability*

- >99%
- 95% - 99%
- 90% - 95%
- 75% - 90%
- 50% - 75%
- 26% - 50%

N

Feet

0 75 150

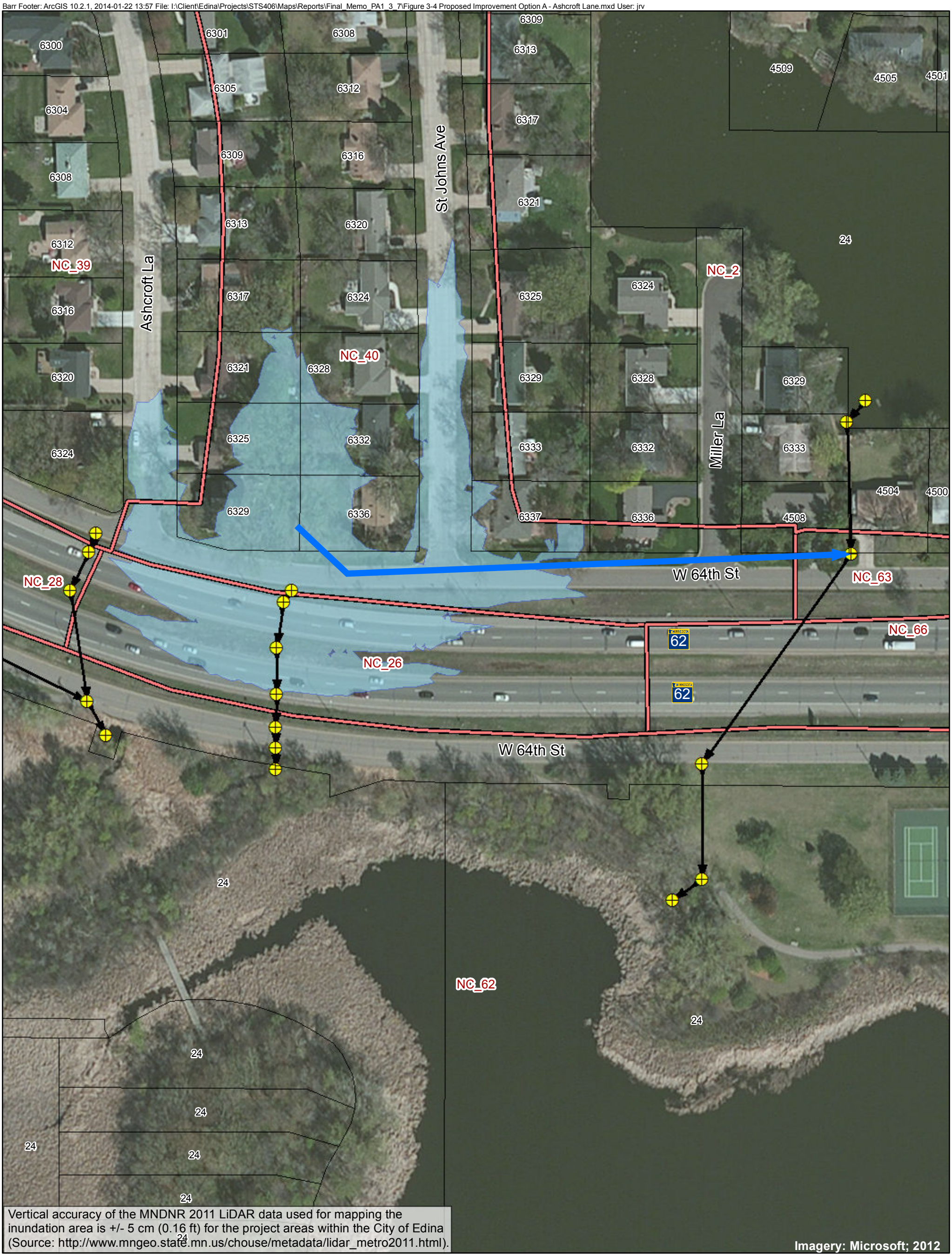
BARR

Figure 3-3

CHANCE OF FLOODING OVER A TYPICAL 30 YEAR HOME MORTGAGE
Project Area 1 - Ashcroft Lane
City of Edina

*Vertical Datum: NGVD 29, Feet

Barr Footer: ArcGIS 10.2.1, 2014-01-22 13:57 File: I:\Client\Edina\Projects\STS406\Maps\Reports\Final_Memo_PA1_3_7\Figure 3-4 Proposed Improvement Option A - Ashcroft Lane.mxd User: jrv



Existing Manhole/Catch Basin

Existing Storm Sewer

Option A: 100 Year 24-Hour Event Inundation Area*

Option A: Proposed Storm Sewer (42" Pipe)

Subwatersheds

Parcels

N

Feet

0 100 200

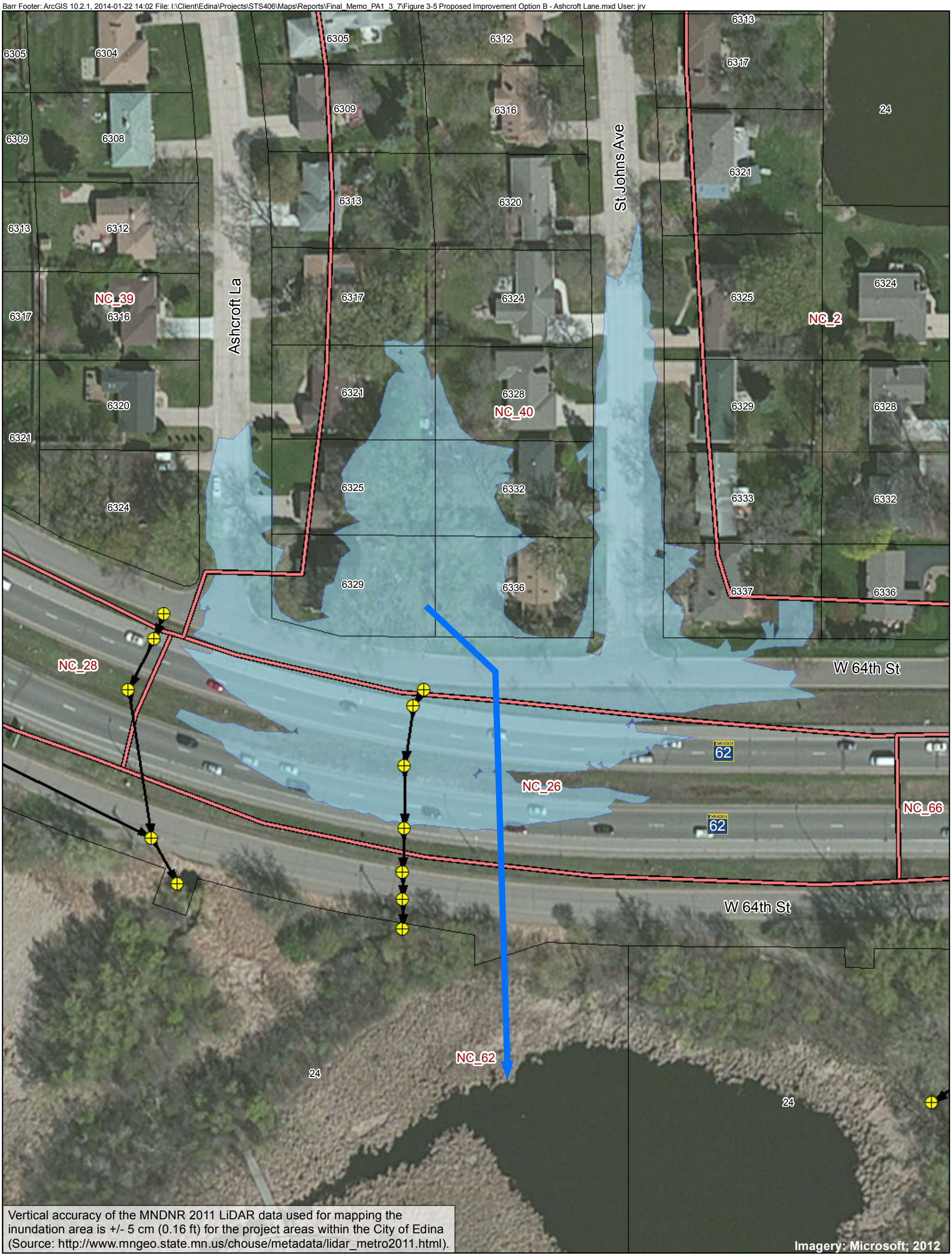
BARR

Figure 3-4

PROPOSED IMPROVEMENT OPTION A
Project Area 1 - Ashcroft Lane
City of Edina

*Vertical Datum: NGVD 29, Feet

Barr Footer: ArcGIS 10.2.1, 2014-01-22 14:02 File: I:\Client\Edina\Projects\STS406\Maps\Reports\Final_Memo_PA1_3_7\Figure 3-5 Proposed Improvement Option B - Ashcroft Lane.mxd User: jrv



Existing Manhole/Catch Basin

Existing Storm Sewer

Option B: Proposed Storm Sewer (36" Pipe)

Option B: 100 Year 24-Hour Event Inundation Area*

Subwatersheds

Parcels

N

Feet

0 75 150

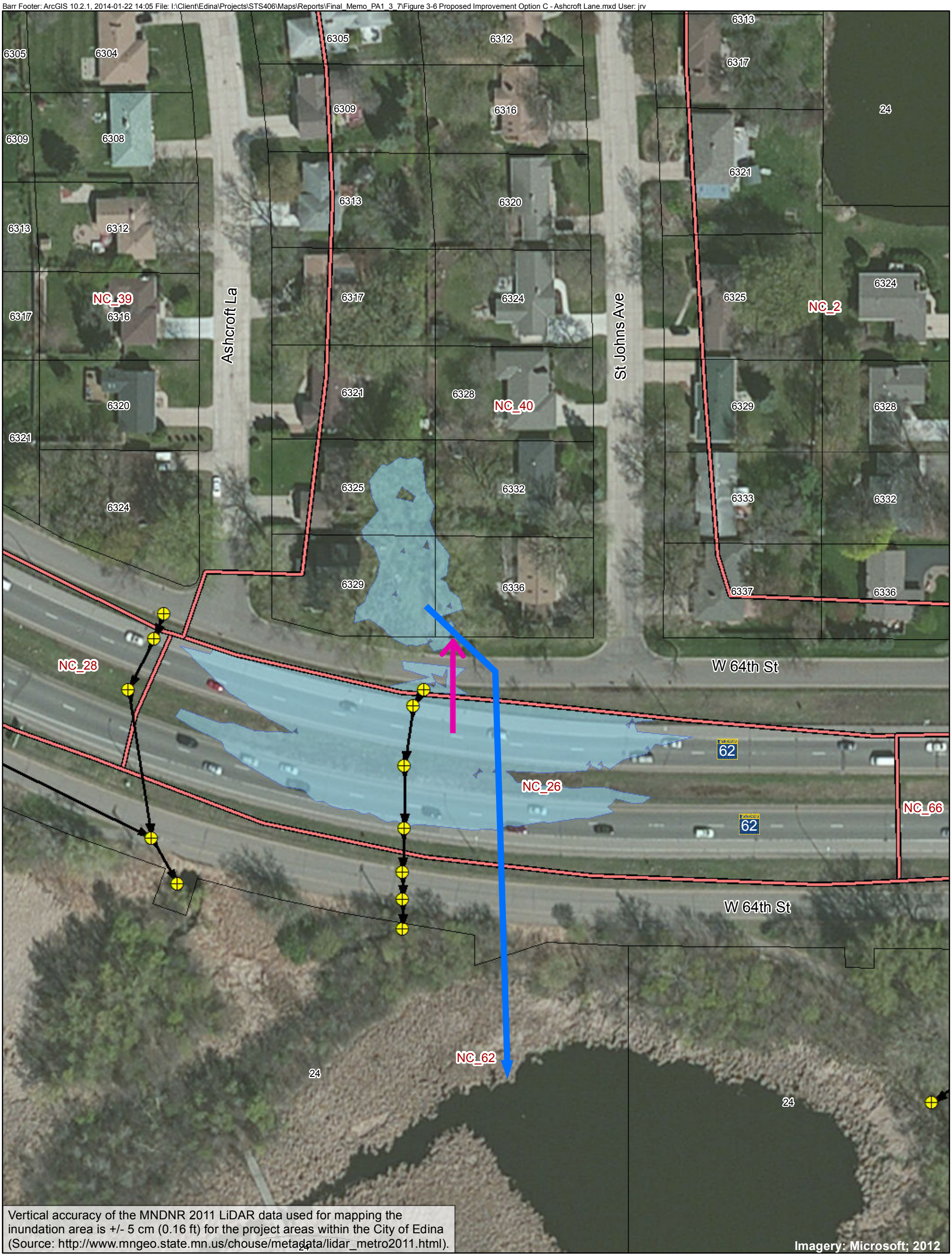
BARR

Figure 3-5

PROPOSED IMPROVEMENT
OPTION B
Project Area 1 - Ashcroft Lane
City of Edina

*Vertical Datum: NGVD 29, Feet

Barr Footer: ArcGIS 10.2.1, 2014-01-22 14:05 File: I:\Client\Edina\Projects\STS406\Maps\Reports\Final_Memo_PA1_3_7\Figure 3-6 Proposed Improvement Option C - Ashcroft Lane.mxd User: jrv



Vertical accuracy of the MNDNR 2011 LiDAR data used for mapping the inundation area is +/- 5 cm (0.16 ft) for the project areas within the City of Edina (Source: http://www.mngeo.state.mn.us/chouse/metadata/lidar_metro2011.html).

Existing Manhole/Catch Basin

Surface Overflow

Existing Storm Sewer

Option C- Proposed Storm Sewer (4' x 12' box culvert)

Option C: 100 Year 24-Hour Event Inundation Area*

Subwatersheds

Parcels

*Vertical Datum: NGVD 29, Feet

N

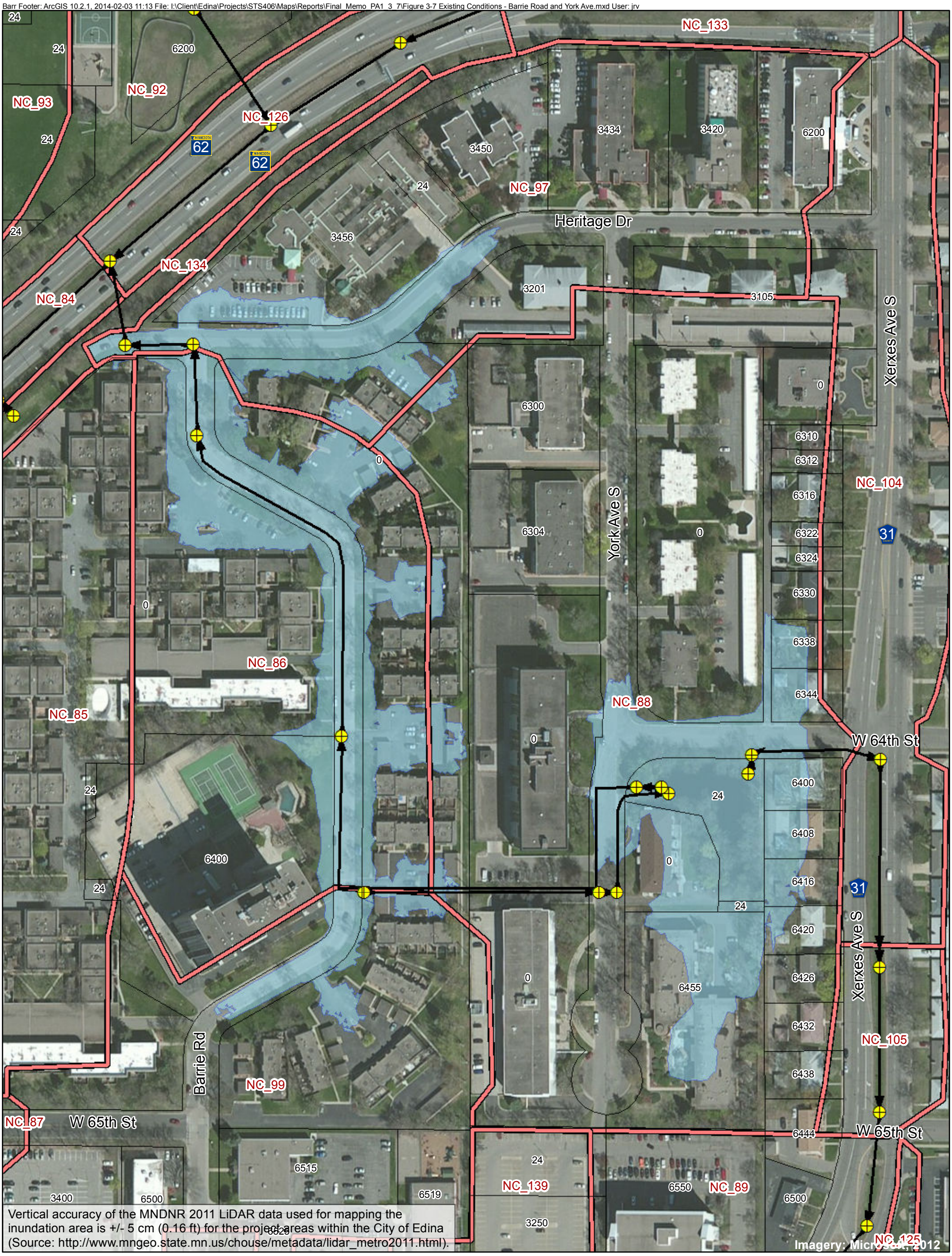
Feet

0 75 150

BARR

Figure 3-6

PROPOSED IMPROVEMENT OPTION C
Project Area 1 - Ashcroft Lane
City of Edina



Existing Manhole/Catch Basin

Existing Storm Sewer

100 Year 24-Hour Event Inundation Area*

Subwatersheds

Parcels

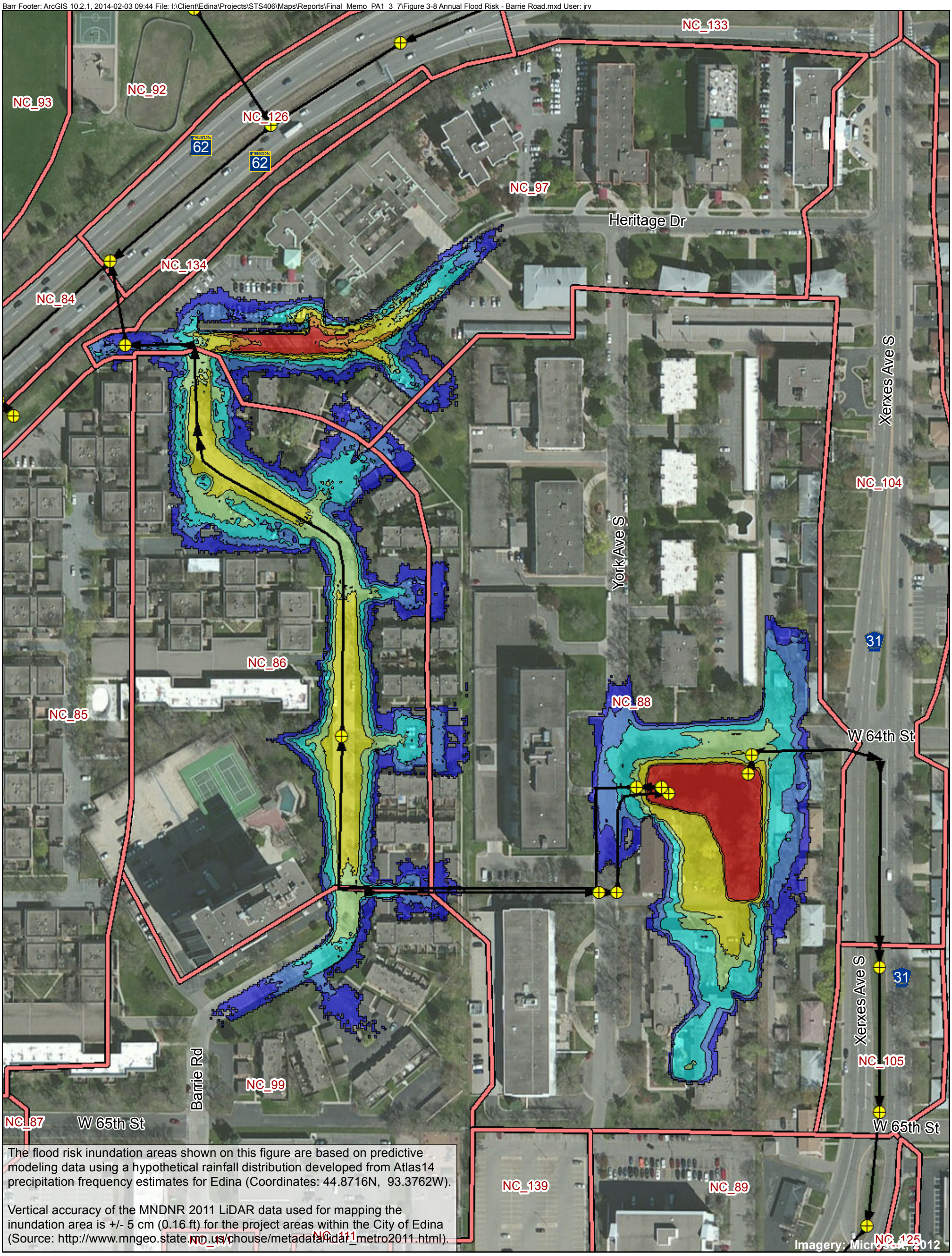
Feet
0 150 300

BARR

Figure 3-7

EXISTING CONDITIONS
100 YEAR INUNDATION
Project Area 1 -
Barrie Road and York Ave

*Vertical Datum: NGVD 29, Feet



The flood risk inundation areas shown on this figure are based on predictive modeling data using a hypothetical rainfall distribution developed from Atlas14 precipitation frequency estimates for Edina (Coordinates: 44.8716N, 93.3762W).

Vertical accuracy of the MNDNR 2011 LiDAR data used for mapping the inundation area is +/- 5 cm (0.16 ft) for the project areas within the City of Edina (Source: http://www.mngeo.state.mn.us/chouse/metadata/lidar_metro2011.html).

Existing Manhole /Catch Basin

Existing Storm Sewer

Subwatersheds

Annual Flood Risk*

- >80%
- 50% - 80%
- 20% - 50%
- 10% - 20%
- 4% - 10%
- 2% - 4%
- 1% - 2%

N

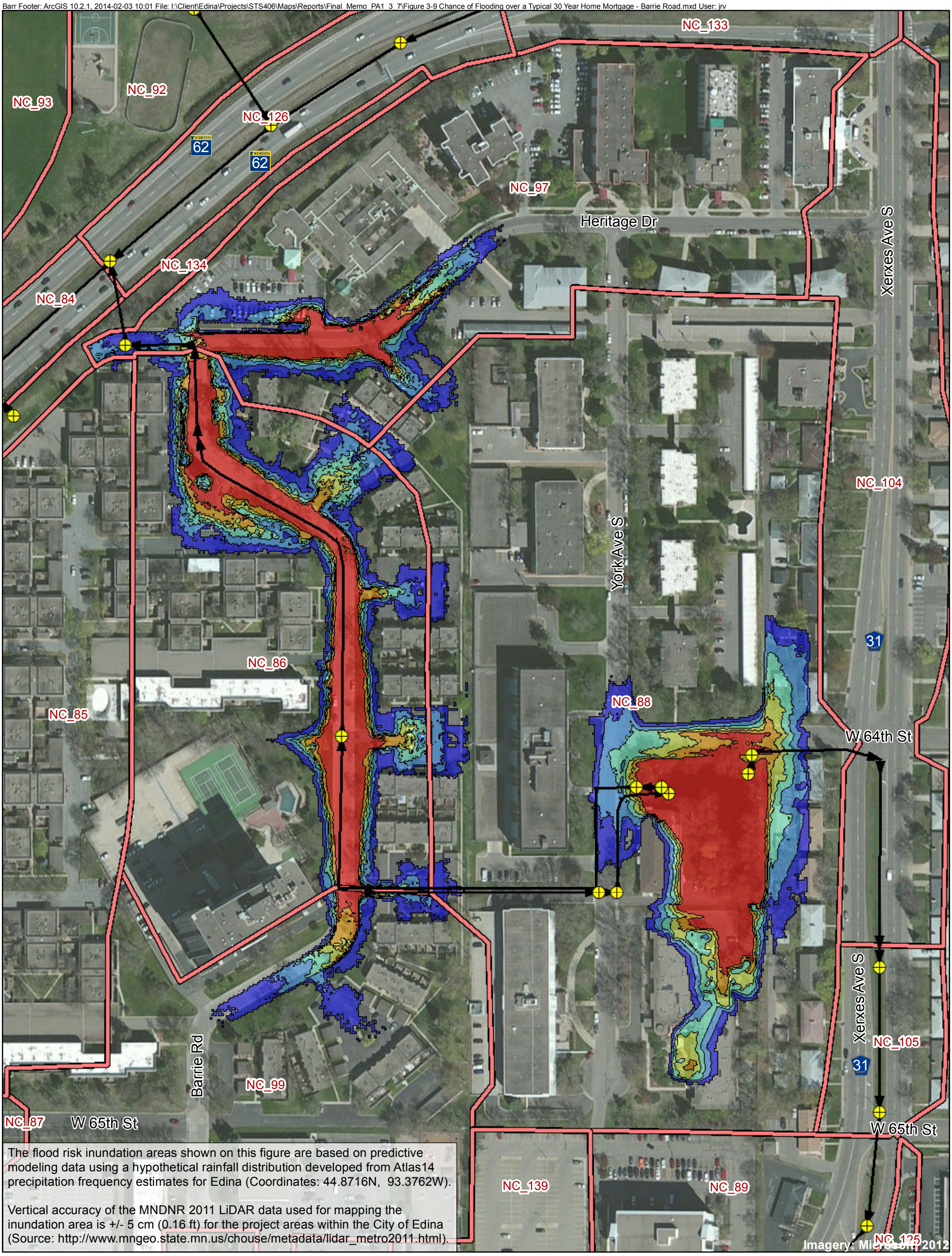
Feet
0 150 300

BARR

Figure 3-8

ANNUAL FLOOD RISK
Project Area 1 -
Barrie Road and York Ave
City of Edina

*Vertical Datum: NGVD 29, Feet



The flood risk inundation areas shown on this figure are based on predictive modeling data using a hypothetical rainfall distribution developed from Atlas14 precipitation frequency estimates for Edina (Coordinates: 44.8716N, 93.3762W).

Vertical accuracy of the MNDNR 2011 LiDAR data used for mapping the inundation area is +/- 5 cm (0.16 ft) for the project areas within the City of Edina (Source: http://www.mngeo.state.mn.us/chouse/metadata/lidar_metro2011.html).

Existing Manhole /Catch Basin

Existing Storm Sewer

Subwatersheds

30 Year Flood Risk*

- >99%
- 95% - 99%
- 90% - 95%
- 75% - 90%
- 50% - 75%
- 26% - 50%

N

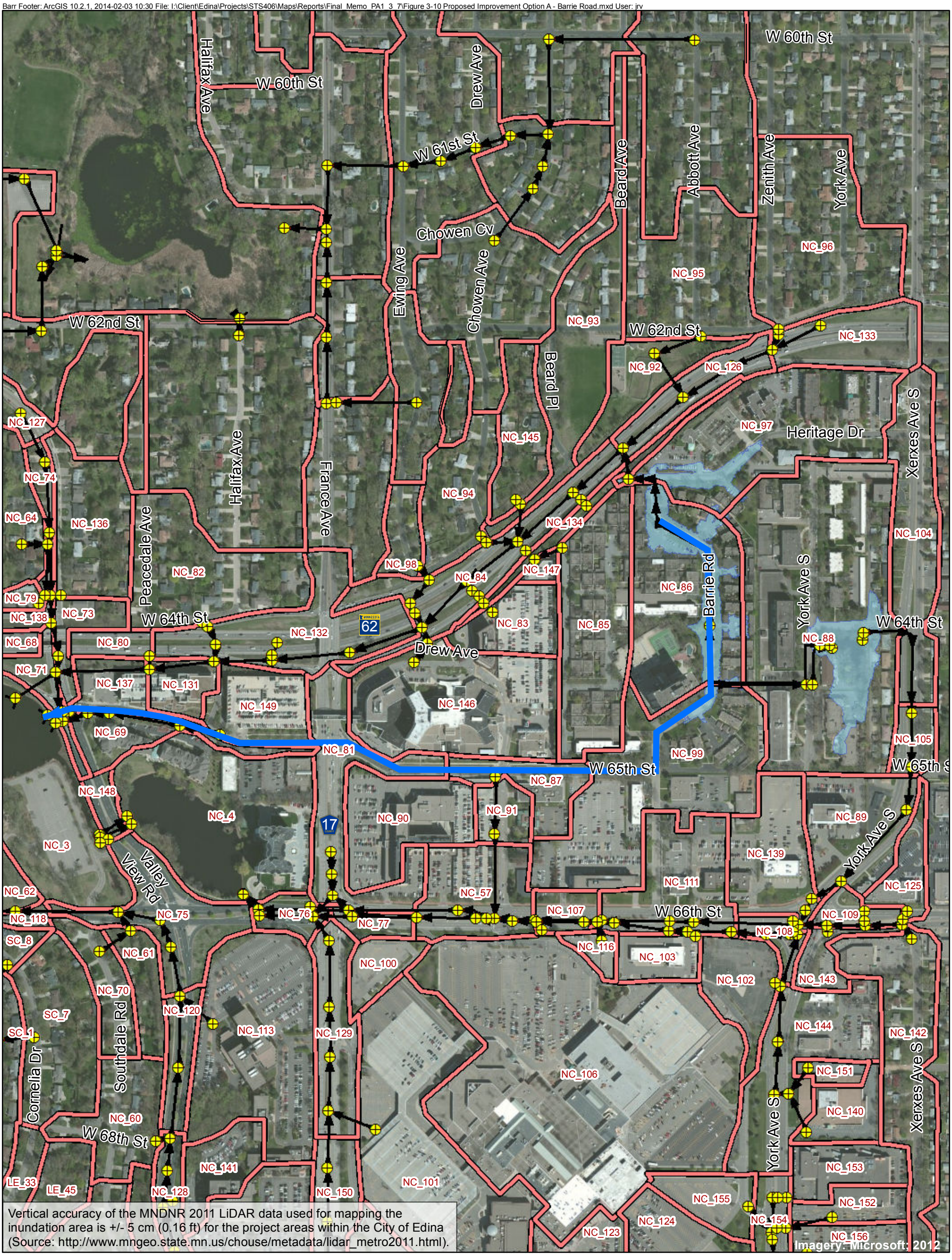
Feet
0 150 300

BARR

Figure 3-9

CHANCE OF FLOODING OVER A TYPICAL 30 YEAR HOME MORTGAGE
Project Area 1 - Barrie Road and York Ave
City of Edina

*Vertical Datum: NGVD 29, Feet



Vertical accuracy of the MNDNR 2011 LiDAR data used for mapping the inundation area is +/- 5 cm (0.16 ft) for the project areas within the City of Edina (Source: http://www.mngeo.state.mn.us/chouse/metadata/lidar_metro2011.html).

- Existing Manhole/Catch Basin
- Existing Storm Sewer
- Option A- Proposed Storm Sewer (36" pipe)
- Option A: 100 Year 24-Hour Event Inundation Area (Atlas 14)*
- Subwatersheds

N

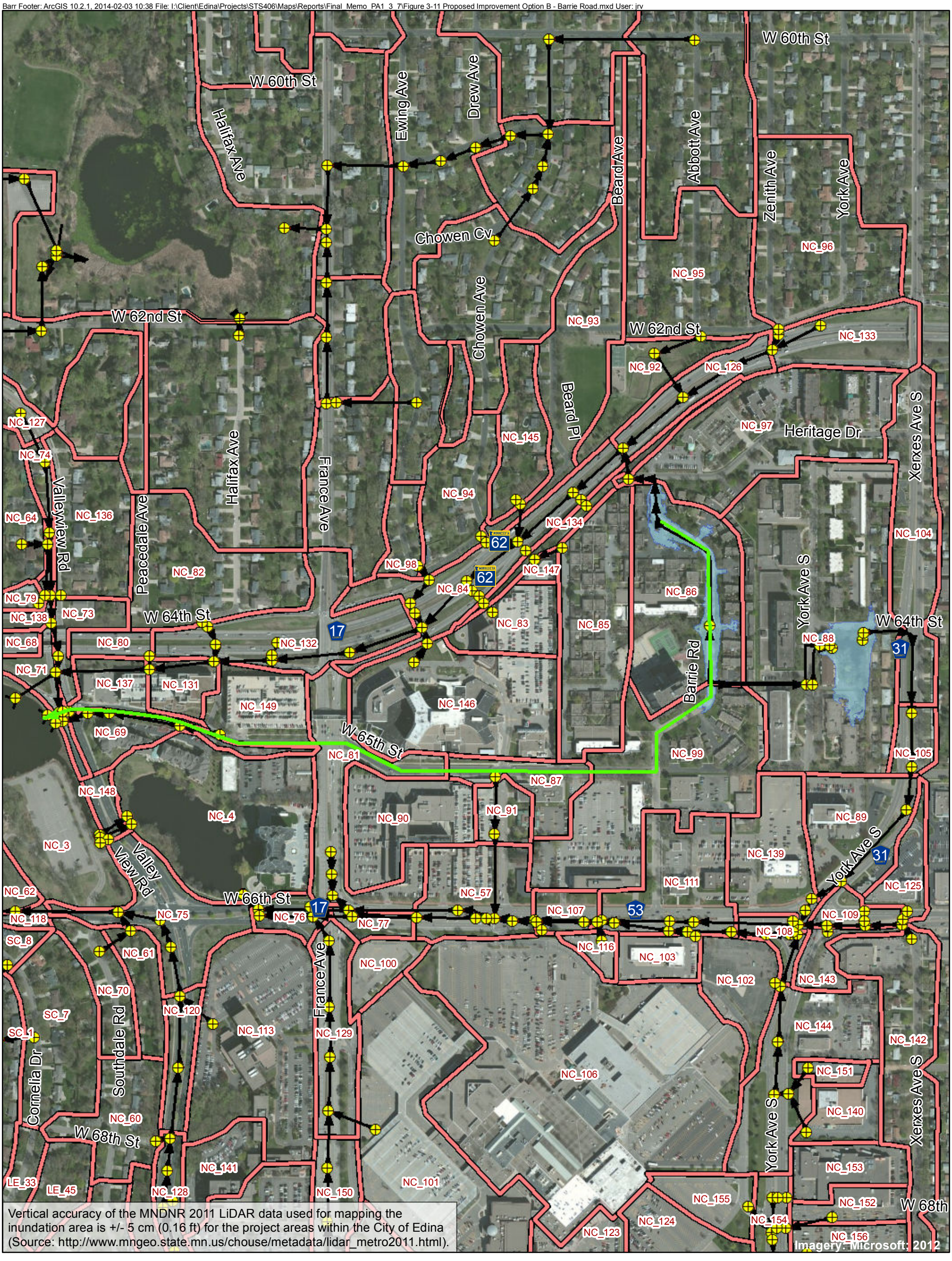
Feet
0 400 800

BARR

Figure 3-10

PROPOSED IMPROVEMENT
OPTION A
Project Area 1 -
Barrie Road and York Ave
City of Edina

*Vertical Datum: NGVD 29, Feet



Vertical accuracy of the MNDNR 2011 LiDAR data used for mapping the inundation area is +/- 5 cm (0.16 ft) for the project areas within the City of Edina (Source: http://www.mngeo.state.mn.us/chouse/metadata/lidar_metro2011.html).

- Existing Manhole/Catch Basin
- Existing Storm Sewer
- Option B- Proposed Storm Sewer (48" pipe) and Additional Pump Capacity (In Subwatershed NC_88)
- Option B: 100 Year 24-Hour Event Inundation Area*
- Subwatersheds

N

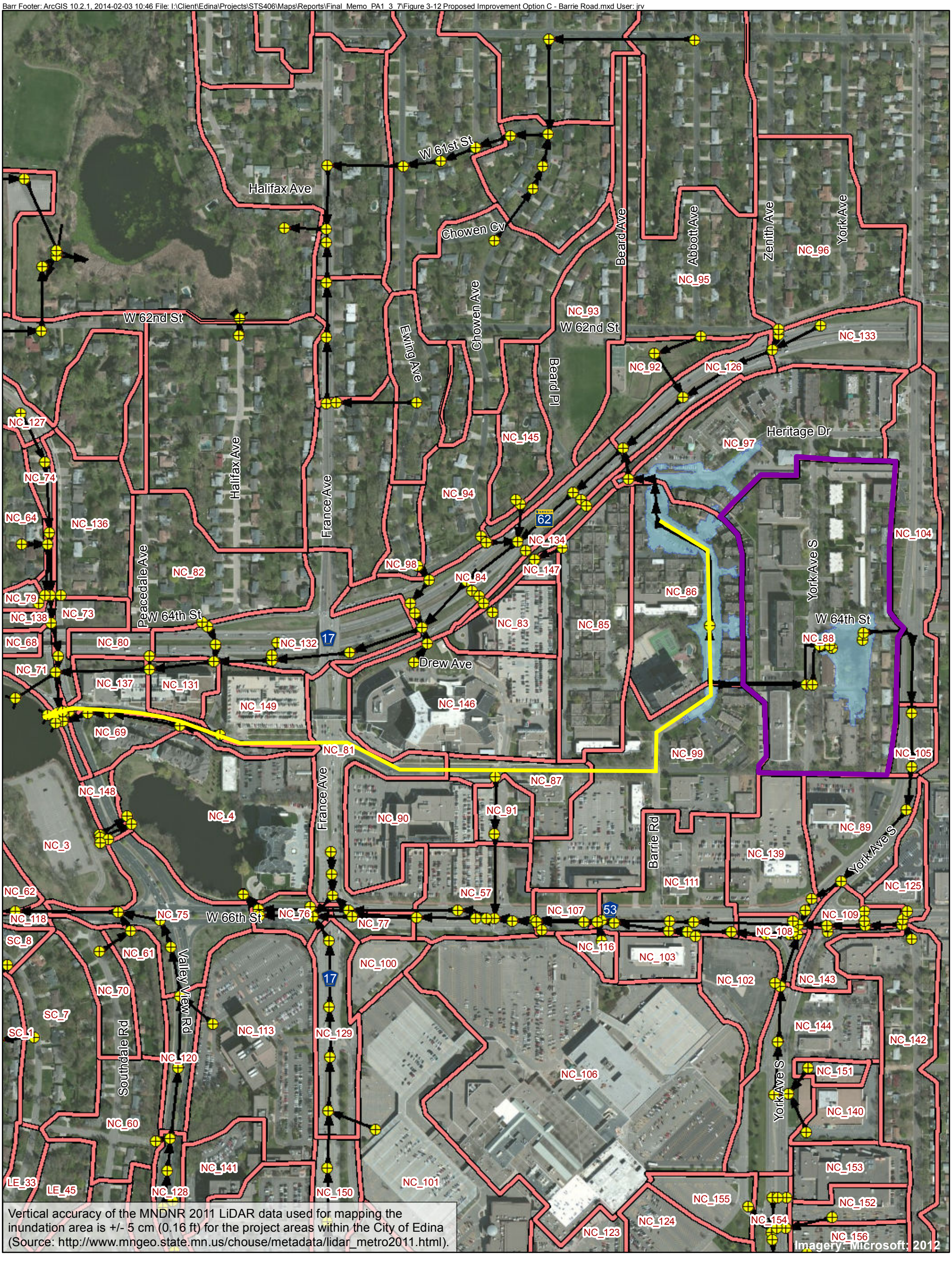
Feet
0 400 800

BARR

Figure 3-11

PROPOSED IMPROVEMENT
OPTION B
Project Area 1 -
Barrie Road and York Ave
City of Edina

*Vertical Datum: NGVD 29, Feet



Vertical accuracy of the MNDNR 2011 LiDAR data used for mapping the inundation area is +/- 5 cm (0.16 ft) for the project areas within the City of Edina (Source: http://www.mngeo.state.mn.us/chouse/metadata/lidar_metro2011.html).

Existing Manhole/Catch Basin

Existing Storm Sewer

Option C- Proposed Storm Sewer (36" pipe) and Underground Storage (In Subwatershed NC_88)

Option C: 100 Year 24-Hour Event Inundation Area*

Subwatersheds

Proposed Underground Storage Distributed Through Subwatershed NC_88

N

Feet

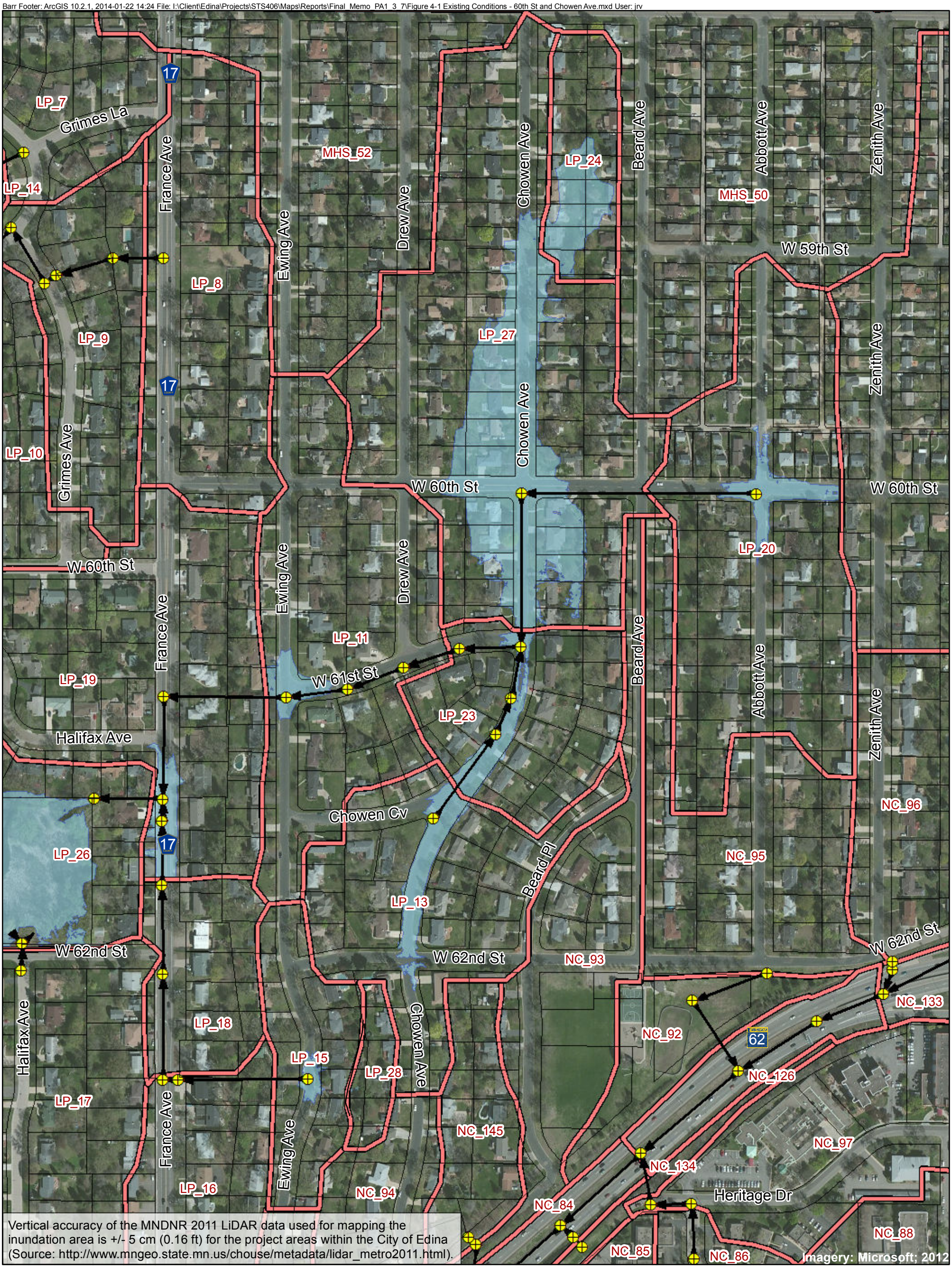
0 400 800

*Vertical Datum: NGVD 29, Feet

BARR

Figure 3-12

PROPOSED IMPROVEMENT
OPTION C
Project Area 1 -
Barrie Road and York Ave
City of Edina



Existing Manhole/Catch Basin

Existing Storm Sewer

100 Year 24-Hour Event Inundation Area*

Subwatersheds

Parcels

N

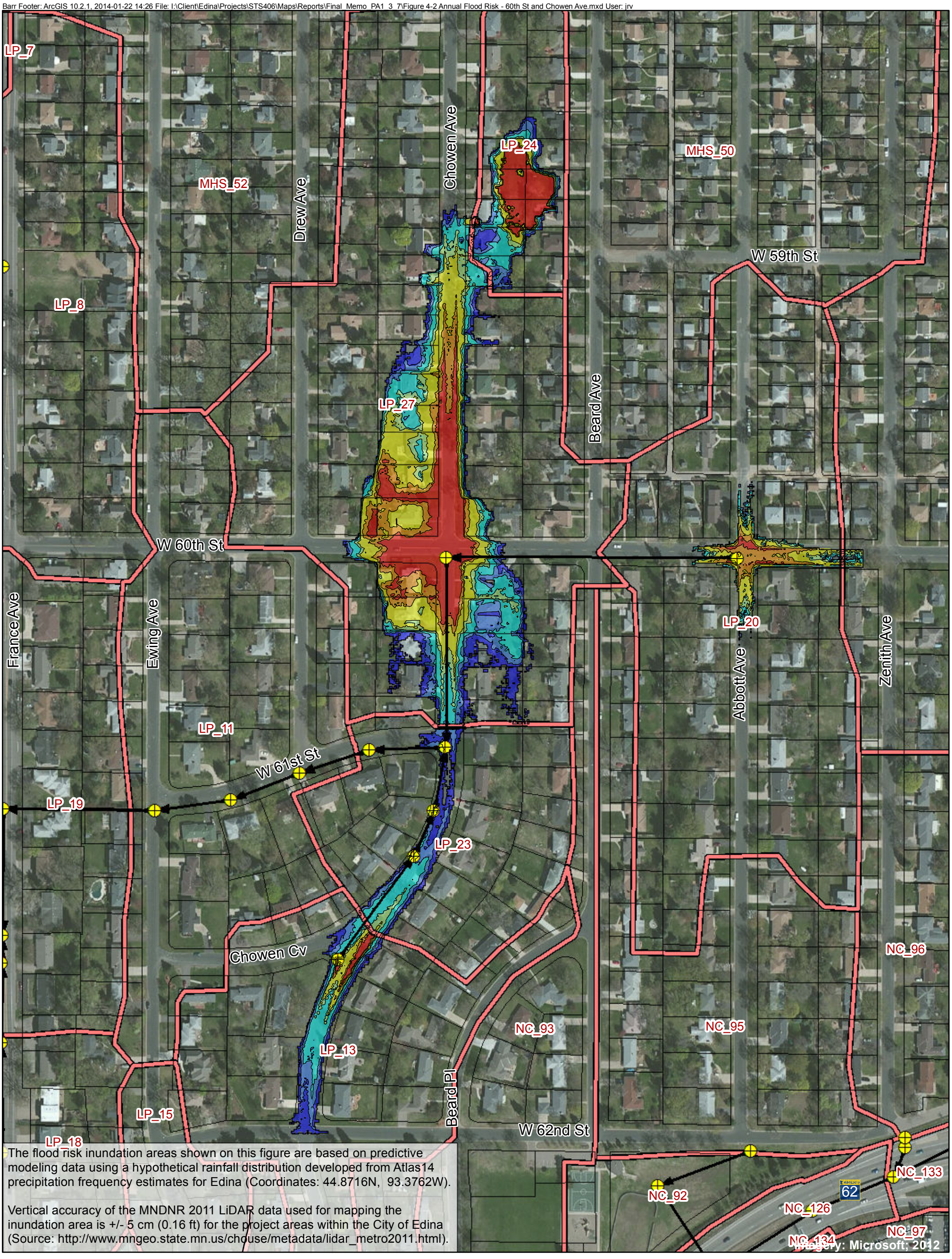
Feet
0 250 500

BARR

Figure 4-1

EXISTING CONDITIONS
100 YEAR INUNDATION
Project Area 3 -
60th St and Chowen Ave

*Vertical Datum: NGVD 29, Feet



The flood risk inundation areas shown on this figure are based on predictive modeling data using a hypothetical rainfall distribution developed from Atlas14 precipitation frequency estimates for Edina (Coordinates: 44.8716N, 93.3762W).

Vertical accuracy of the MNDNR 2011 LiDAR data used for mapping the inundation area is +/- 5 cm (0.16 ft) for the project areas within the City of Edina (Source: http://www.mngeo.state.mn.us/chouse/metadata/lidar_metro2011.html).

Existing Manhole /Catch Basin

Existing Storm Sewer

Subwatersheds

Parcels

Annual Flood Risk*

- >80%
- 50% - 80%
- 20% - 50%
- 10% - 20%
- 4% - 10%
- 2% - 4%
- 1% - 2%

N

Feet

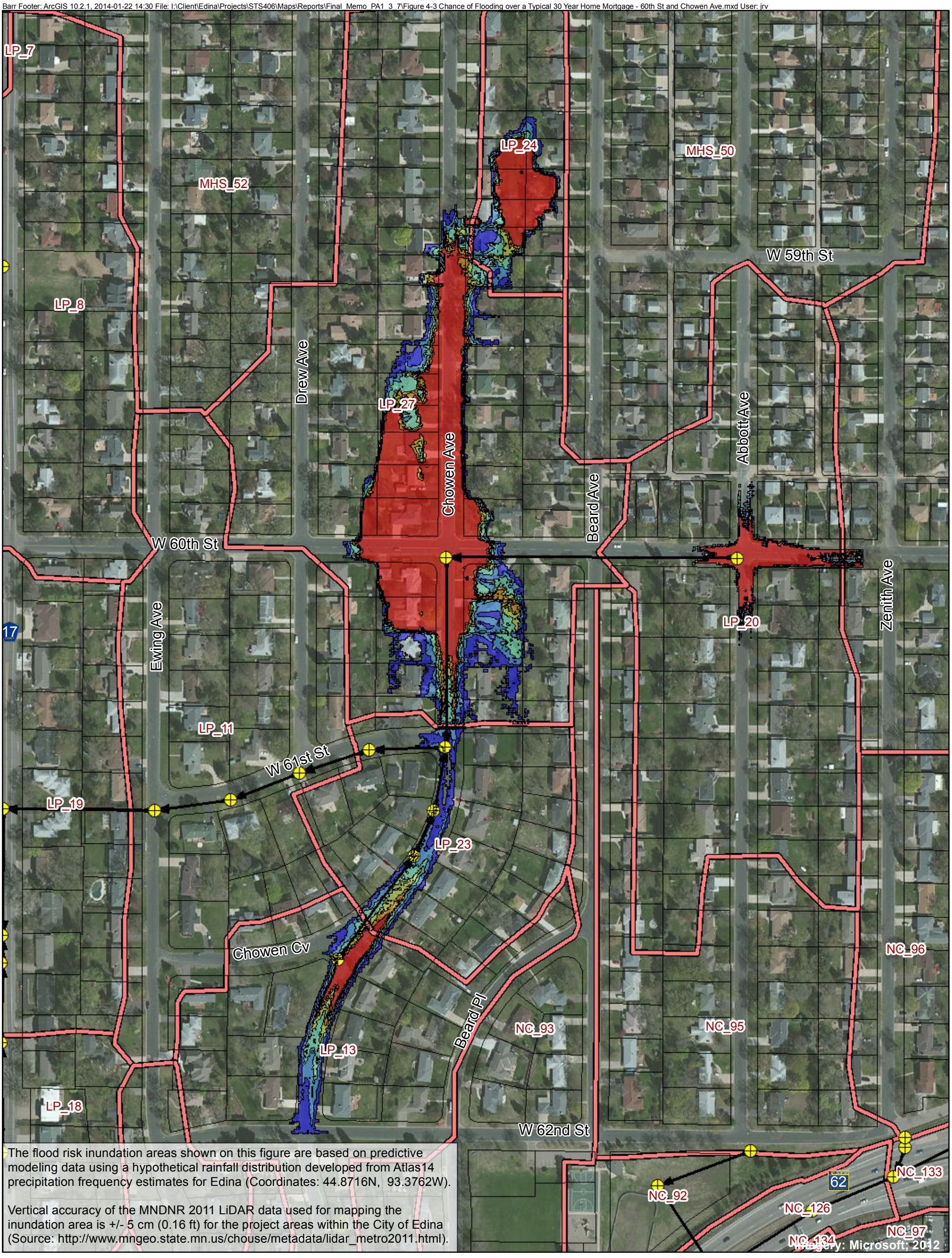
0 200 400

BARR

Figure 4-2

ANNUAL FLOOD RISK
Project Area 3 - 60th St and Chowen Ave
City of Edina

*Vertical Datum: NGVD 29, Feet



The flood risk inundation areas shown on this figure are based on predictive modeling data using a hypothetical rainfall distribution developed from Atlas14 precipitation frequency estimates for Edina (Coordinates: 44.8716N, 93.3762W).

Vertical accuracy of the MNDNR 2011 LiDAR data used for mapping the inundation area is +/- 5 cm (0.16 ft) for the project areas within the City of Edina (Source: http://www.mngeo.state.mn.us/chouse/metadata/lidar_metro2011.html).

Existing Manhole /Catch Basin

Existing Storm Sewer

Subwatersheds

Parcels

30 Year Flood Risk*

- >99%
- 95% - 99%
- 90% - 95%
- 75% - 90%
- 50% - 75%
- 26% - 50%

N

Feet

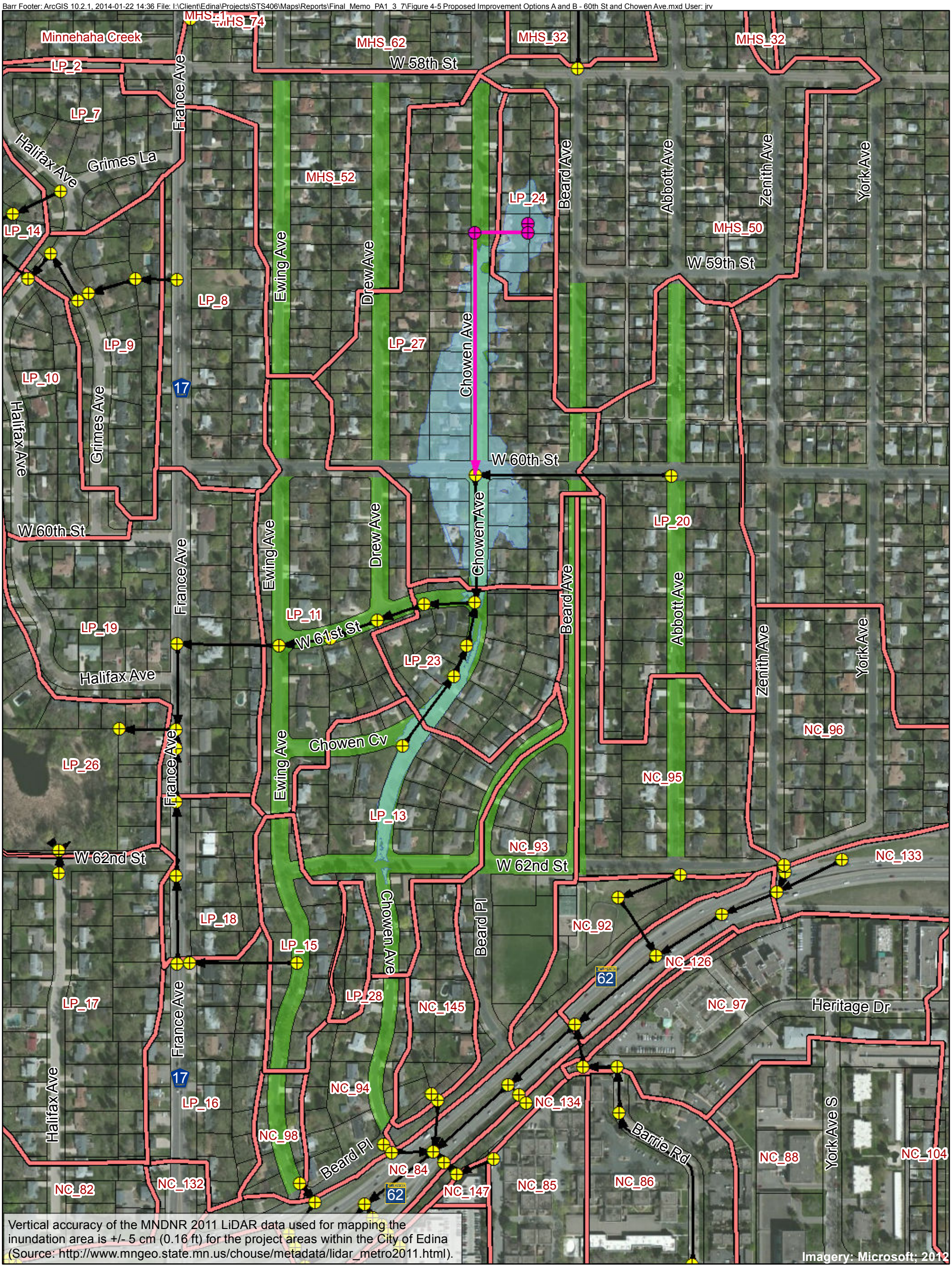
0 200 400

BARR

Figure 4-3

CHANCE OF FLOODING OVER A TYPICAL 30 YEAR HOME MORTGAGE
Project Area 3 - 60th Street and Chowen Ave
City of Edina

*Vertical Datum: NGVD 29, Feet



Vertical accuracy of the MNDNR 2011 LiDAR data used for mapping the inundation area is +/- 5 cm (0.16 ft) for the project areas within the City of Edina (Source: http://www.mngeo.state.mn.us/chouse/metadata/lidar_metro2011.html).

- Proposed Manhole/Catch Basin
- Existing Manhole/Catch Basin
- Proposed New Pipe
- Existing Storm Sewer
- Streets with Infiltration Swales
- Options A and B: 100 year 24-hour Event Inundation Area*
- Subwatersheds
- Parcels

N

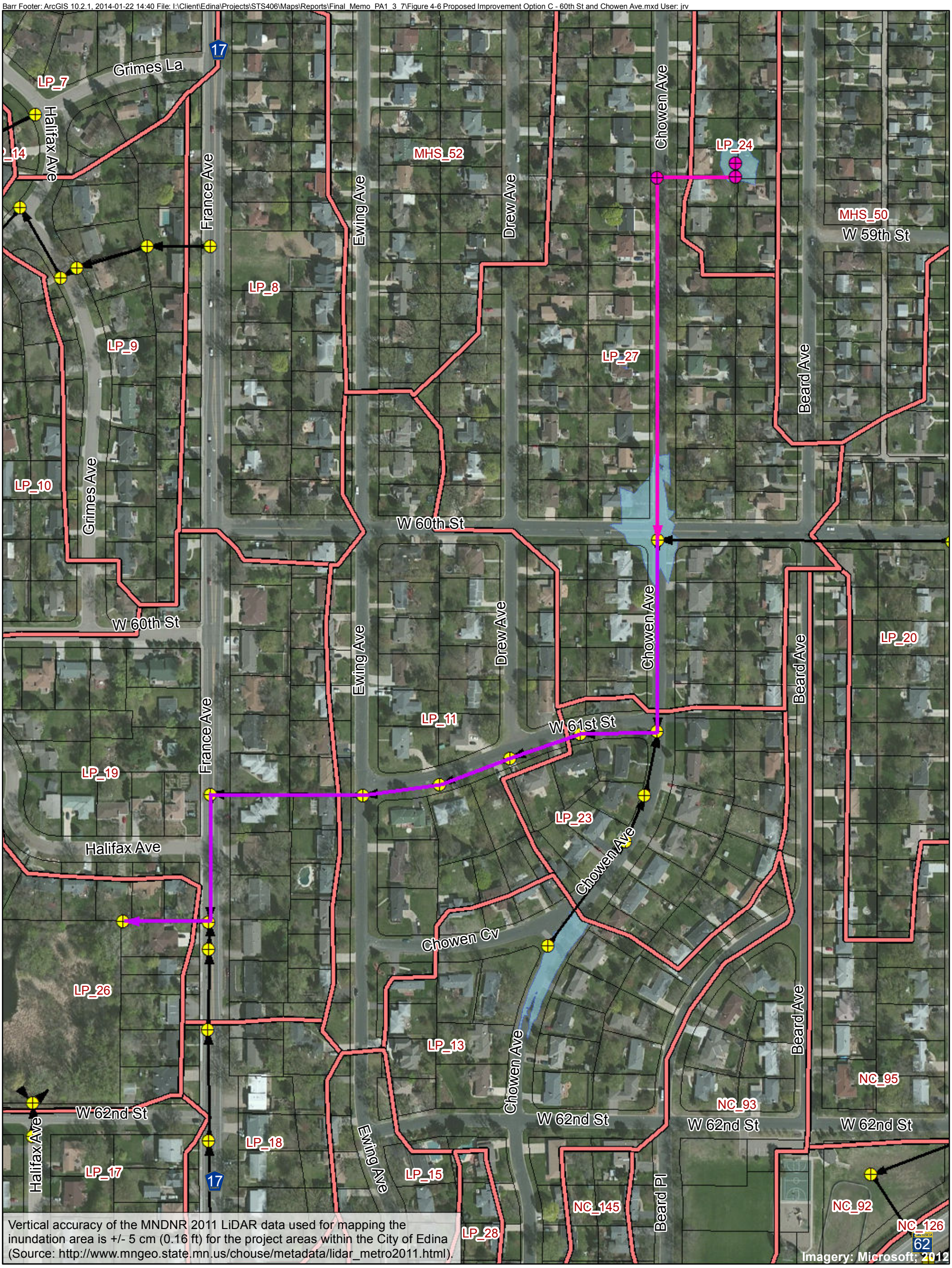
Feet
0 300 600

BARR

Figure 4-5

PROPOSED IMPROVEMENT OPTIONS A AND B
Project Area 3 -
60th St and Chowen Ave
City of Edina

*Vertical Datum: NGVD 29, Feet



Vertical accuracy of the MNDNR 2011 LiDAR data used for mapping the inundation area is +/- 5 cm (0.16 ft) for the project areas within the City of Edina (Source: http://www.mngeo.state.mn.us/chouse/metadata/lidar_metro2011.html).

- Proposed Manhole/Catch Basin
- Existing Manhole/Catch Basin
- Proposed New Pipe
- Proposed Pipe Upgrade
- Existing Storm Sewer
- Option C: 100 Year 24-Hour Event Inundation Area*
- Subwatersheds
- Parcels

N

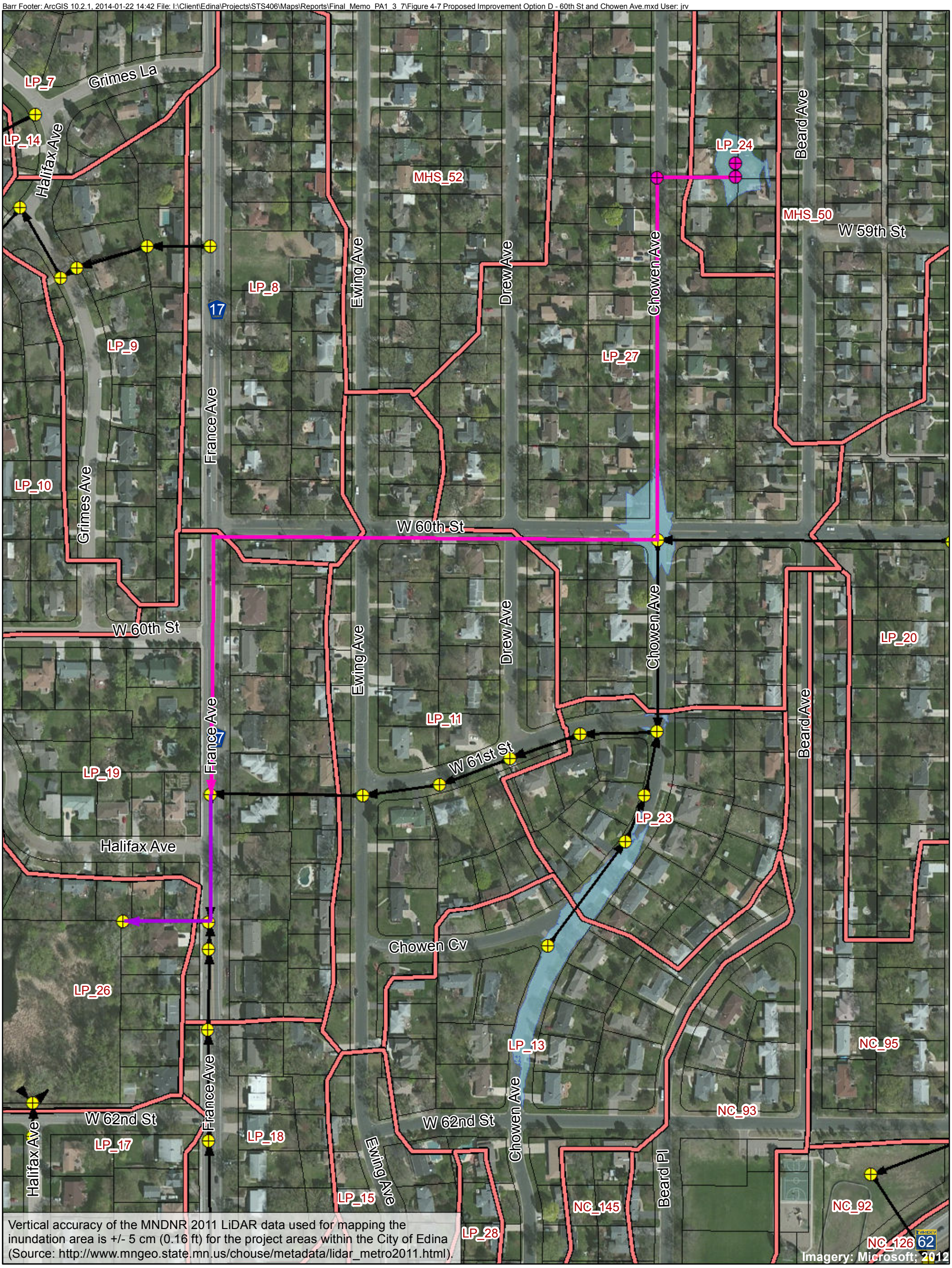
Feet
0 200 400

BARR

Figure 4-6

PROPOSED IMPROVEMENT
OPTION C
Project Area 3 -
60th St and Chowen Ave
City of Edina

*Vertical Datum: NGVD 29, Feet



Proposed Manhole/Catch Basin

Parcels

Existing Manhole/Catch Basin

Proposed New Pipe

Proposed Pipe Upgrade

Existing Storm Sewer

Option D: 100 Year 24-Hour Event Inundation Area*

Subwatersheds

N

Feet

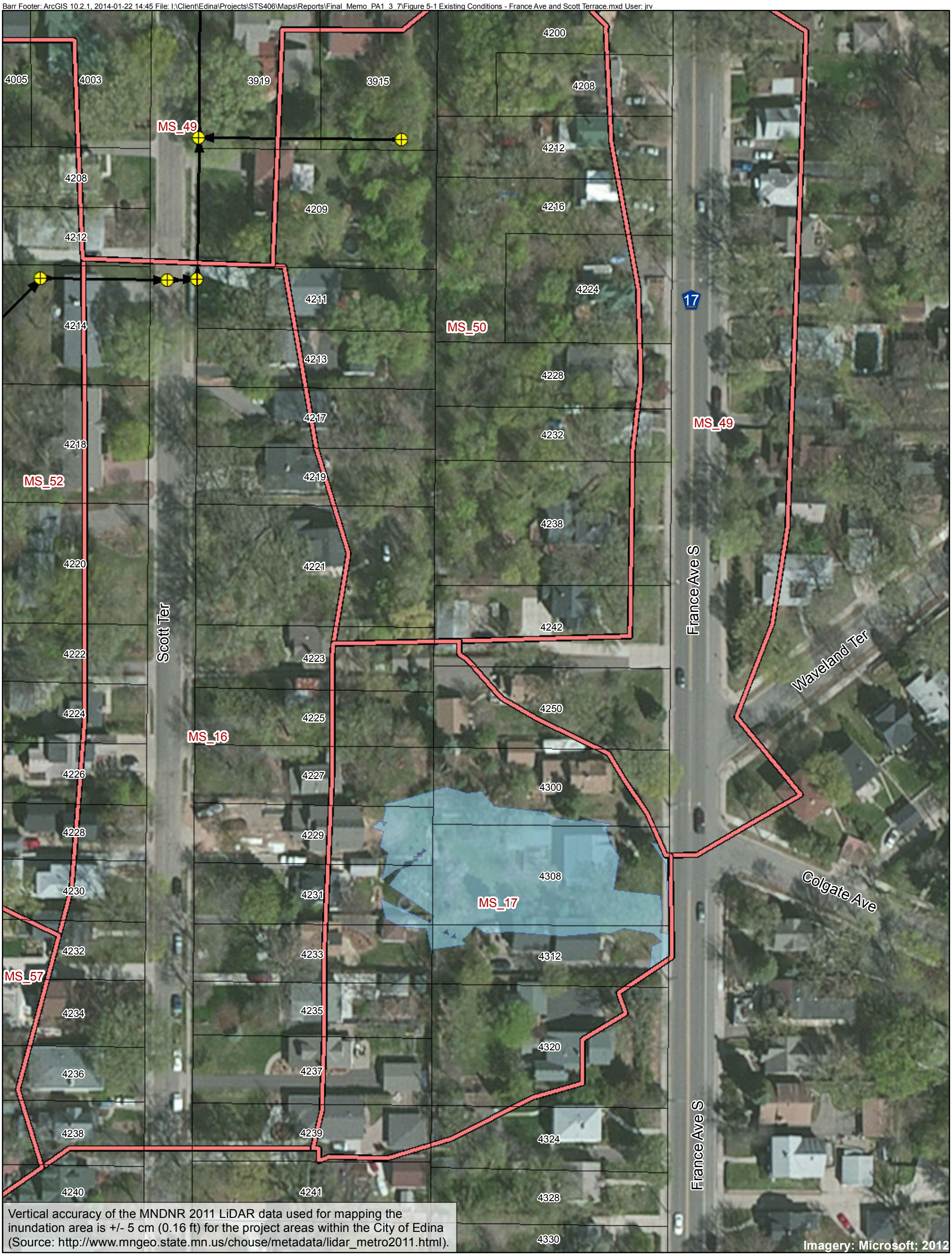
0 200 400

BARR

Figure 4-7

PROPOSED IMPROVEMENT
OPTION D
Project Area 3 -
60th St and Chowen Ave
City of Edina

*Vertical Datum: NGVD 29, Feet



Existing Manhole/Catch Basin

Existing Storm Sewer

100 Year 24-Hour Event Inundation Area*

Subwatersheds

Parcels

N

Feet

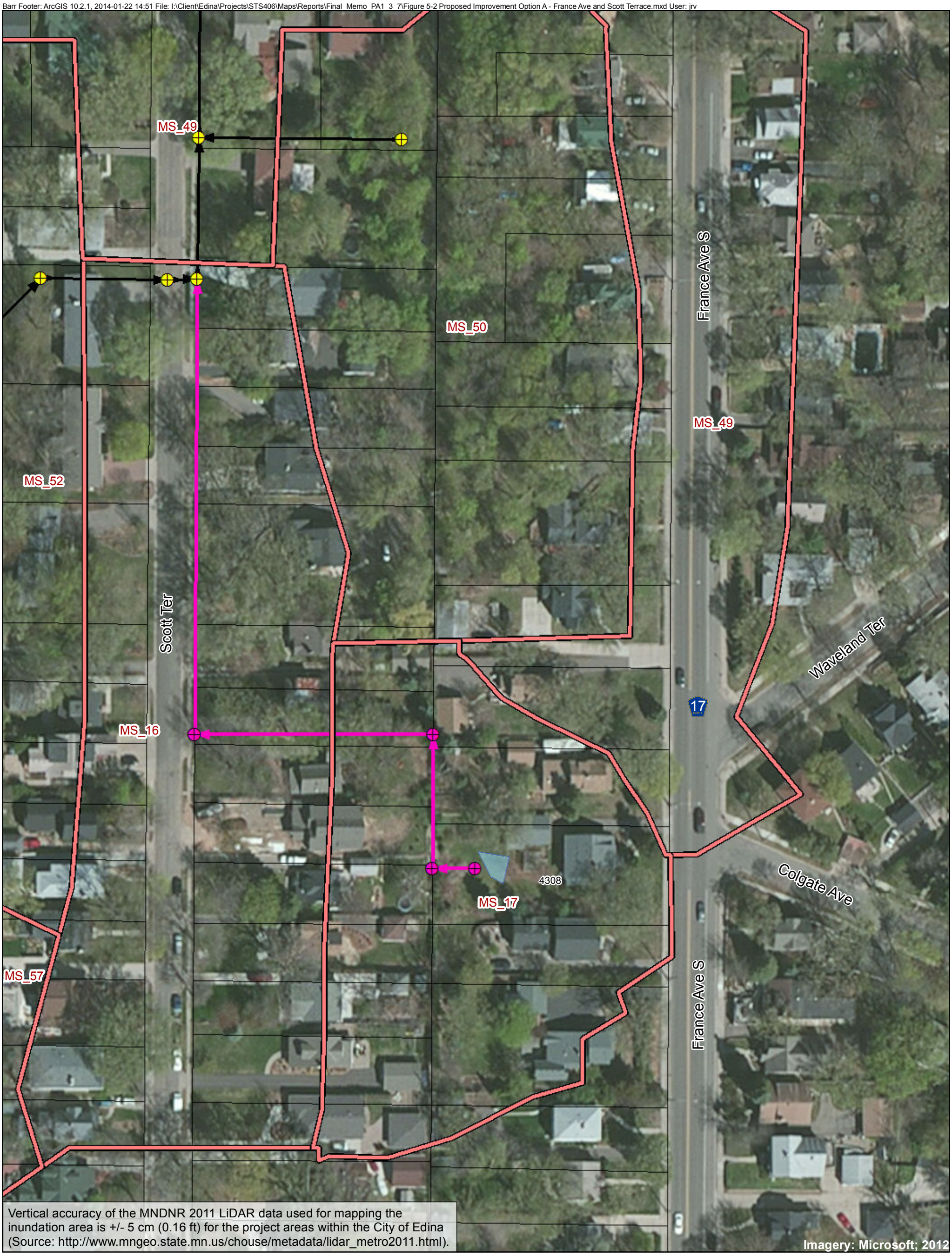
0 75 150

BARR

Figure 5-1

EXISTING CONDITIONS
100 YEAR INUNDATION
Project Area 7 -
France Ave and Scott Terrace

*Vertical Datum: NGVD 29, Feet



Proposed Manhole/Catchbasin
Parcels
Existing Manhole/Catch Basin
Proposed Storm Sewer
Existing Storm Sewer
Option A: 100 Year 24-Hour Event Inundation Area*
Subwatersheds

N

Feet
0 75 150

BARR

Figure 5-2

PROPOSED IMPROVEMENT
OPTION A
Project Area 7 -
France Ave and Scott Terrace
City of Edina

*Vertical Datum: NGVD 29, Feet

Appendices

Appendix A

Cost Estimates
Project Area 1, Ashcroft Lane

ENGINEER'S OPINION OF PROBABLE COST: AREA 1, OPTION "A"
W. 64th ST. Northside, Ashcroft to Millers Ln. 42" Pipe
January 21, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 31,000.00	$ 31,000.00
TRAFFIC CONTROL	LS	1	$ 2,700.00	$ 2,700.00
EROSION CONTROL	LS	1	$ 4,360.00	$ 4,360.00
REMOVALS				
SAW CUT BITUMINOUS PAVEMENT	LN FT	112	$ 3.50	$ 392.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	1600	$ 2.00	$ 3,200.00
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	600	$ 5.00	$ 3,000.00
REMOVE SANITARY SEWER PIPE	LN FT	1260	$ 10.00	$ 12,600.00
REMOVE SANITARY SEWER MANHOLE	EACH	6	$ 500.00	$ 3,000.00
BY-PASS PUMPING SANITARY SEWER	LS	1	$ 4,500.00	$ 4,500.00
UTILITY CONFLICKS	LS	1	$ 5,000.00	$ 5,000.00
STORM AND SANITARY SEWER				
18" PVC SDR-35 SANITARY SEWER	LN FT	655	$ 28.00	$ 18,340.00
42" CPEP STORM SEWER	LN FT	556	$ 68.00	$ 37,808.00
42" RCP-ARCH CL 2	LN FT	44	$ 192.00	$ 8,448.00
42" RCP-ARCH F.E.S. W/BN TRASH RACK	EACH	1	$ 4,017.00	$ 4,017.00
48" DIA. RC STANDARD SANITARY MANHOLE	LN FT	60	$ 325.00	$ 19,500.00
84" DIA. RC MANHOLE	LN FT	20	$ 897.00	$ 17,940.00
STREET PAVEMENT				
SELECT GRANULAR SUB BASE	CU YD	533	$ 12.00	$ 6,396.00
8" AGGREGATE BASE CLASS 5	CU YD	357	$ 34.00	$ 12,138.00
TOP SOIL BORROW	CU YD	31	$ 20.00	$ 620.00
REPLACE B618 CONC. CURB & GUTTER	LN FT	600	$ 13.50	$ 8,100.00
2" BITUMINOUS BASE COURSE	SQ YD	1600	$ 7.50	$ 12,000.00
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	1600	$ 8.50	$ 13,600.00
ADJUST EXISTING SANITARY MANHOLE	EACH	8	$ 330.00	$ 2,640.00
SEEDING TURF GRASSES	AC	0.06	$ 12,500.00	$ 750.00
SITE RESTORATION	LS	1	$ 7,000.00	$ 7,000.00
SUB TOTAL				**$ 239,049.00**
OTHER				
CONTINGENCY			30%	$ 71,714.70
ENGINEERING AND DESIGN			15%	$ 46,614.56
CONSTRUCTION ADMINISTRATION AND OBSERVATION			7%	$ 21,753.46
AREA 1, OPTION A TOTAL COST				**$ 379,131.71**

ENGINEER'S OPINION OF PROBABLE COST: AREA 1, OPTION "B"
36" STORM SEWER JACKED UNDER HWY 62
January 21, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 34,000.00	$ 34,000.00
TRAFFIC CONTROL	LS	1	$ 2,700.00	$ 2,700.00
EROSION CONTROL	LS	1	$ 2,790.00	$ 2,790.00
REMOVALS				
CLEAR AND GRUB	LS	1	$ 5,000.00	$ 5,000.00
SAW CUT BITUMINOUS PAVEMENT	LN FT	56	$ 3.50	$ 196.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	160	$ 2.00	$ 320.00
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	120	$ 5.00	$ 600.00
STORM AND SANITARY SEWER				
36" RCP CL 2	LN FT	110	$ 110.00	$ 12,100.00
36" RCP-JACKING PIPE	LN FT	220	$ 150.00	$ 33,000.00
JACKING/BORING 36" RCP UNDER HWY 62	LN FT	220	$ 600.00	$ 132,000.00
36" RCP F.E.S. W/BN TRASH RACK	LN FT	2	$ 3,549.00	$ 7,098.00
84" DIA. RC MANHOLE	LN FT	12	$ 897.00	$ 10,764.00
CLASS 3 RIP RAP AND FILTER	TON	30	$ 48.00	$ 1,440.00
UTILITY CONFLICKS	LS	1	$ 3,000.00	$ 3,000.00
STREET PAVEMENT				
SELECT GRANULAR SUB BASE	CU YD	53	$ 12.00	$ 636.00
8" AGGREGATE BASE CLASS 5	CU YD	36	$ 34.00	$ 1,224.00
TOP SOIL BORROW	CU YD	10	$ 20.00	$ 200.00
REPLACE B618 CONC. CURB & GUTTER	LN FT	120	$ 13.50	$ 1,620.00
2" BITUMINOUS BASE COURSE	SQ YD	160	$ 7.50	$ 1,200.00
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	160	$ 8.50	$ 1,360.00
ADJUST EXISTING SANITARY MANHOLE	EACH	2	$ 330.00	$ 660.00
SEEDING TURF GRASSES	LS	1	$ 500.00	$ 500.00
SEEDING NATIVE GRASSES	LS	1	$ 1,000.00	$ 1,000.00
SITE RESTORATION	LS	1	$ 5,000.00	$ 5,000.00
SUB TOTAL				**$ 258,408.00**
OTHER				
CONTINGENCY			30%	$ 77,522.40
ENGINEERING AND DESIGN			15%	$ 50,389.56
CONSTRUCTION ADMINISTRATION AND OBSERVATION			7%	$ 23,515.13
AREA 1, OPTION B TOTAL COST				**$ 409,835.09**

ENGINEER'S OPINION OF PROBABLE COST: AREA 1, OPTION "C"
4' X 12' BOX CULVERT STORM SEWER OPEN CUT ACROSS HWY 62
January 21, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 58,000.00	$ 58,000.00
TRAFFIC CONTROL	LS	1	$ 15,000.00	$ 15,000.00
EROSION CONTROL	LS	1	$ 8,900.00	$ 8,900.00
REMOVALS				
CLEAR AND GRUB	LS	1	$ 5,000.00	$ 5,000.00
SAW CUT BITUMINOUS PAVEMENT	LN FT	56	$ 3.50	$ 196.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	300	$ 2.00	$ 600.00
REMOVE CONC. CURB & GUTTER (B618)	LN FT	300	$ 5.00	$ 1,500.00
HWY 62 PAVEMENT				
SAW CUT BITUMINOUS PAVEMENT	LN FT	192	$ 3.50	$ 672.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	420	$ 2.00	$ 840.00
REMOVE CONC. CURB & GUTTER (D418)	LN FT	150	$ 5.00	$ 750.00
STORM AND SANITARY SEWER				
36" RCP CL 2	LN FT	44	$ 110.00	$ 4,840.00
4' x 12' BOX CULVERT	LN FT	330	$ 758.00	$ 250,140.00
4' x 12' BOX CULVERT END SECTION	LN FT	1	$ 6,208.00	$ 6,208.00
6' x 12' BOX CULVERT FLOOD INLET	EACH	2	$ 15,000.00	$ 30,000.00
48" DIA. RC STANDARD SANITARY MANHOLE	LN FT	20	$ 325.00	$ 6,500.00
CLASS 3 RIP RAP AND FILTER	TON	70	$ 48.00	$ 3,360.00
48" DIA. CATCH BASIN	EACH	2	$ 3,500.00	$ 7,000.00
MEDIAN DRAIN	EACH	2	$ 2,700.00	$ 5,400.00
ADJUST EXISTING SANITARY MANHOLE	EACH	2	$ 330.00	$ 660.00
UTILITY CONFLICKS	LS	1	$ 5,000.00	$ 5,000.00
STREET PAVEMENT				
SELECT GRANULAR SUB BASE	CU YD	53	$ 12.00	$ 636.00
8" AGGREGATE BASE CLASS 5	CU YD	78	$ 34.00	$ 2,652.00
TOP SOIL BORROW	CU YD	36	$ 20.00	$ 720.00
REPLACE B618 CONC. CURB & GUTTER	LN FT	150	$ 13.50	$ 2,025.00
2" BITUMINOUS BASE COURSE	SQ YD	300	$ 7.50	$ 2,250.00
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	300	$ 8.50	$ 2,550.00
HWY 62 PAVEMENT				
SELECT GRANULAR SUB BASE	CU YD	93	$ 12.00	$ 1,116.00
12" AGGREGATE BASE CLASS 5	CU YD	93	$ 34.00	$ 3,162.00
TOP SOIL BORROW	CU YD	22	$ 20.00	$ 440.00
REPLACE D418 CONC. CURB & GUTTER	LN FT	150	$ 13.50	$ 2,025.00
4" BITUMINOUS BASE COURSE	SQ YD	420	$ 15.00	$ 6,300.00
4" BITUMINOUS WEARING COURSE W/TACK	SQ YD	420	$ 17.00	$ 7,140.00
SEEDING TURF GRASSES	LS	1	$ 750.00	$ 750.00
SEEDING NATIVE GRASSES	LS	1	$ 1,000.00	$ 1,000.00
SITE RESTORATION	LS	1	$ 5,000.00	$ 5,000.00
SUB TOTAL				**$ 448,332.00**
OTHER				
CONTINGENCY			30%	$ 134,499.60
ENGINEERING AND DESIGN			15%	$ 87,424.74
CONSTRUCTION ADMINISTRATION AND OBSERVATION			7%	$ 40,798.21
AREA 1, OPTION D TOTAL COST				**$ 711,054.55**

Appendix B

Cost Estimates
Project Area 1, Barrie Road and York Avenue

ENGINEER'S OPINION OF PROBABLE COST: AREA 1 OPTION "A"
Barrie Road
36" CPEP (connecting to existing system)
January 21, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 149,000.00	$ 149,000.00
TRAFFIC CONTROL	LS	1	$ 2,700.00	$ 2,700.00
SEEDING TURF GRASSES	AC	0.07	$ 12,500.00	$ 875.00
SITE RESTORATION	LS	1	$ 7,000.00	$ 7,000.00
TEMPORARY AND PERMANENT EROSION CONTROL				
SILT FENCE	LN FT	8330	$ 3.50	$ 29,155.00
INLET PROTECTION	EACH	24	$ 350.00	$ 8,400.00
CAT. 4 EROSION CONTROL BLANKET	SQ YD	339	$ 1.85	$ 626.78
REMOVALS				
SAW CUT BITUMINOUS PAVEMENT	LN FT	8400	$ 3.50	$ 29,400.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	16197	$ 2.00	$ 32,394.44
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	8330	$ 5.00	$ 41,650.00
REMOVE 18" RCP	LN FT	150	$ 8.00	$ 1,200.00
REMOVE 21" RCP	LN FT	635	$ 10.00	$ 6,350.00
STORM AND SANITARY SEWER				
36" CPEP - 5' - 12' DEPTH	LN FT	1200	$ 41.78	$ 50,138.40
36" CPEP - 12' - 16' DEPTH	LN FT	800	$ 56.16	$ 44,928.00
36" CPEP - 16' - 24' DEPTH	LN FT	1380	$ 67.46	$ 93,090.66
48" CPEP - 6' - 12' DEPTH	LN FT	150	$ 73.01	$ 10,951.50
60" CPEP - 7' - 12' DEPTH	LN FT	635	$ 122.73	$ 77,933.55
36" FES WITH TRASH RACK	EACH	1	$ 3,549.00	$ 3,549.00
CLASS 3 RIPRAP WITH FILTER	TON	30	$ 48.00	$ 1,440.00
CONNECT TO EXISTING STORM SEWER	EACH	16	$ 500.00	$ 8,000.00
48" DIA. RC CATCH BASIN, COMPLETE	LN FT	167	$ 300.00	$ 50,100.00
STREET PAVEMENT				
8" AGGREGATE BASE CLASS 5	CU YD	3617	$ 34.00	$ 122,990.91
TOP SOIL BORROW	CU YD	56	$ 20.00	$ 1,129.33
REPLACE B618 CONC. CURB & GUTTER	LN FT	8330	$ 13.50	$ 112,455.00
2" BITUMINOUS BASE COURSE	SQ YD	16197	$ 7.50	$ 121,479.17
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	16197	$ 8.50	$ 137,676.39
SUBTOTAL				**$ 1,144,613.13**
OTHER				
CONTINGENCY		30%		$ 343,384.00
ENGINEERING AND DESIGN		15%		$ 223,200.00
CONSTRUCTION ADMINISTRATION AND OBSERVATION		7%		$ 104,160.00
AREA 1, BARRIE RD, OPTION A TOTAL COST				**$ 1,815,357.00**

ENGINEER'S OPINION OF PROBABLE COST: AREA 1 OPTION "B"
Barrie Road
48" CPEP (connecting to existing system)
January 21, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 165,000.00	$ 165,000.00
TRAFFIC CONTROL	LS	1	$ 2,700.00	$ 2,700.00
SEEDING TURF GRASSES	AC	0.07	$ 12,500.00	$ 875.00
SITE RESTORATION	LS	1	$ 7,000.00	$ 7,000.00
TEMPORARY AND PERMANENT EROSION CONTROL				
SILT FENCE	LN FT	8330	$ 3.50	$ 29,155.00
INLET PROTECTION	EACH	24	$ 350.00	$ 8,400.00
CAT. 4 EROSION CONTROL BLANKET	SQ YD	339	$ 1.85	$ 626.78
REMOVALS				
SAW CUT BITUMINOUS PAVEMENT	LN FT	8400	$ 3.50	$ 29,400.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	16197	$ 2.00	$ 32,394.44
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	8330	$ 5.00	$ 41,650.00
REMOVE 18" RCP	LN FT	150	$ 8.00	$ 1,200.00
REMOVE 21" RCP	LN FT	635	$ 10.00	$ 6,350.00
STORM AND SANITARY SEWER				
48" CPEP - 6' - 12' DEPTH	LN FT	1200	$ 73.01	$ 87,617.40
48" CPEP - 12' - 16' DEPTH	LN FT	800	$ 85.85	$ 68,681.60
48" CPEP - 16' - 24' DEPTH	LN FT	1380	$ 97.15	$ 134,065.62
60" CPEP - 7' - 12' DEPTH	LN FT	785	$ 122.73	$ 96,343.05
36" FES WITH TRASH RACK	EACH	1	$ 3,549.00	$ 3,549.00
CLASS 3 RIPRAP WITH FILTER	TON	30	$ 48.00	$ 1,440.00
CONNECT TO EXISTING STORM SEWER	EACH	16	$ 500.00	$ 8,000.00
48" DIA. RC CATCH BASIN, COMPLETE	LN FT	167	$ 300.00	$ 50,100.00
STREET PAVEMENT				
8" AGGREGATE BASE CLASS 5	CU YD	3617	$ 34.00	$ 122,990.91
TOP SOIL BORROW	CU YD	56	$ 20.00	$ 1,129.33
REPLACE B618 CONC. CURB & GUTTER	LN FT	8330	$ 13.50	$ 112,455.00
2" BITUMINOUS BASE COURSE	SQ YD	16197	$ 7.50	$ 121,479.17
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	16197	$ 8.50	$ 137,676.39
SUBTOTAL				**$ 1,270,278.69**
OTHER				
CONTINGENCY		30%		$ 381,084.00
ENGINEERING AND DESIGN		15%		$ 247,704.00
CONSTRUCTION ADMINISTRATION AND OBSERVATION		7%		$ 115,595.00
AREA 1, BARRIE RD, OPTION B TOTAL COST				**$ 2,014,662.00**

ENGINEER'S OPINION OF PROBABLE COST: AREA 1 OPTION "B"
Barrie Road
Additional 3500 gpm pump capacity
January 21, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 47,000.00	$ 47,000.00
TRAFFIC CONTROL	LS	1	$ 5,000.00	$ 5,000.00
EROSION CONTROL	LS	1	$ 5,000.00	$ 5,000.00
REMOVALS*				
SAW CUT BITUMINOUS PAVEMENT	LN FT	900	$ 3.50	$ 3,150.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	2000	$ 2.00	$ 4,000.00
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	900	$ 5.00	$ 4,500.00
REMOVE EXISTING PUMP AND MANHOLE	LS	1	$ 4,000.00	$ 4,000.00
UTILITY CONFLICTS	LS	1	$ 10,000.00	$ 10,000.00
STORM SEWER				
18" DR17 HDPE PIPE	LN FT	965	$ 110.00	$ 106,150.00
25 HP PUMP, 3500 GPM 18' TDH	EACH	1	$ 40,000.00	$ 40,000.00
CONTROLS	LS	1	$ 30,000.00	$ 30,000.00
LIFT STATION PIPING, VALVES, APPURTENANCES	LS	1	$ 25,000.00	$ 25,000.00
96" DIA. RC MANHOLE	LN FT	10	$ 1,156.00	$ 11,560.00
STREET PAVEMENT				
8" AGGREGATE BASE CLASS 5	CU YD	450	$ 34.00	$ 15,300.00
REPLACE B618 CONC. CURB & GUTTER	LN FT	900	$ 13.50	$ 12,150.00
2" BITUMINOUS BASE COURSE	SQ YD	2000	$ 7.50	$ 15,000.00
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	2000	$ 8.50	$ 17,000.00
SITE RESTORATION	LS	1	$ 5,000.00	$ 5,000.00
SUB TOTAL				**$ 359,810.00**
OTHER				
CONTINGENCY			30%	$ 107,943.00
ENGINEERING AND DESIGN			15%	$ 70,163.00
CONSTRUCTION ADMINISTRATION AND OBSERVATION			7%	$ 32,743.00
AREA 1, BARRIE ROAD OPTION B TOTAL COST				**$ 570,659.00**

*This cost estimate includes removing and replacing all roadway materials.

ENGINEER'S OPINION OF PROBABLE COST: AREA 1 OPTION "C"
Barrie Road
Stormtech Underground Storage
January 21, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 160,000.00	$ 160,000.00
TRAFFIC CONTROL	LS	1	$ 2,700.00	$ 2,700.00
SEEDING TURF GRASSES	AC	0.4	$ 12,500.00	$ 5,531.52
SITE RESTORATION	LS	1	$ 7,000.00	$ 7,000.00
TEMPORARY AND PERMANENT EROSION CONTROL				
SILT FENCE	LN FT	1869	$ 3.50	$ 6,541.50
INLET PROTECTION	EACH	2	$ 350.00	$ 700.00
CAT. 4 EROSION CONTROL BLANKET	SQ YD	2142	$ 1.85	$ 3,962.34
REMOVALS				
SAW CUT BITUMINOUS PAVEMENT	LN FT	4602	$ 3.50	$ 16,107.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	3584	$ 2.00	$ 7,167.50
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	3315	$ 5.00	$ 16,575.00
STRIP AND REMOVE SOD	AC	0.4	$ 3.00	$ 1.33
REMOVE TREE	EACH	5	$ 400.00	$ 2,000.00
REMOVE AND REPLACE SIGN	EACH	3	$ 450.00	$ 1,350.00
REMOVE AND REPLACE STREET LIGHT	EACH	3	$ 500.00	$ 1,500.00
STORM AND SANITARY SEWER				
STORMTECH CHAMBERS	CF	88863	$ 9.00	$ 799,767.00
CONNECT TO EXISTING STORM SEWER	EACH	14	$ 500.00	$ 7,000.00
REMOVE 24" RCP	LN FT	425	$ 15.00	$ 6,375.00
REMOVE 10" FORCE MAIN	LN FT	425	$ 9.00	$ 3,825.00
BULKHEAD EXISTING STORM SEWER	EACH	2	$ 500.00	$ 1,000.00
NEW FORCEMAIN	LIN FT	425	$ 110.00	$ 46,750.00
STREET PAVEMENT				
8" AGGREGATE BASE CLASS 5	CU YD	800	$ 34.00	$ 27,212.61
TOP SOIL BORROW	CU YD	357	$ 20.00	$ 7,139.35
REPLACE B618 CONC. CURB & GUTTER	LN FT	3315	$ 13.50	$ 44,752.50
2" BITUMINOUS BASE COURSE	SQ YD	3584	$ 7.50	$ 26,878.13
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	3584	$ 8.50	$ 30,461.88
SUBTOTAL				**$ 1,232,297.65**
OTHER				
CONTINGENCY		30%		$ 369,689.00
ENGINEERING AND DESIGN		15%		$ 240,298.00
CONSTRUCTION ADMINISTRATION AND OBSERVATION		7%		$ 112,139.00
AREA 1, BARRIE RD, OPTION C TOTAL COST				**$ 1,954,424.00**

Appendix C

Cost Estimates
Project Area 3, West 60th Street and Chowen Avenue

ENGINEER'S OPINION OF PROBABLE COST: AREA 3, OPTION "A"

Living Streets Alternate, 8" Swales with 12" pipe

January 21, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 95,000.00	$ 95,000.00
TRAFFIC CONTROL	LS	1	$ 10,000.00	$ 10,000.00
EROSION CONTROL	LS	1	$ 15,000.00	$ 15,000.00
REMOVALS*				
SAW CUT BITUMINOUS PAVEMENT	LN FT	867	$ 3.50	$ 3,034.50
REMOVE BITUMINOUS PAVEMENT	SQ YD	1927	$ 2.00	$ 3,854.00
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	867	$ 5.00	$ 4,335.00
EARTHWORK AND RESTORATION				
EXCAVATION	CU YD	1750	$ 15.00	$ 26,250.00
AMMENDED SOIL	CU YD	1750	$ 35.00	$ 61,250.00
UTILITY CONFLICTS	LS	1	$ 10,000.00	$ 10,000.00
SOD	SQ YD	9750	$ 4.00	$ 39,000.00
STORM SEWER				
CONNECT TO EXISTING STORM SEWER	EACH	8	$ 500.00	$ 4,000.00
12" CPEP STORM SEWER, 7' to 12' deep	LN FT	8000	$ 15.61	$ 124,880.00
24" CPEP STORM SEWER, 7' to 12' deep	LN FT	1033	$ 30.00	$ 30,990.00
30" CATCH BASIN	EACH	117	$ 2,000.00	$ 234,000.00
48" DIA. RC CATCH BASIN, COMPLETE	LN FT	24	$ 300.00	$ 7,200.00
48" DIA. RC MANHOLE	LN FT	20	$ 300.00	$ 6,000.00
STREET PAVEMENT				
8" AGGREGATE BASE CLASS 5	CU YD	430	$ 34.00	$ 14,620.00
REPLACE B618 CONC. CURB & GUTTER	LN FT	867	$ 13.50	$ 11,704.50
2" BITUMINOUS BASE COURSE	SQ YD	1927	$ 7.50	$ 14,452.50
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	1927	$ 8.50	$ 16,379.50
SUBTOTAL				**$ 731,950.00**
OTHER				
CONTINGENCY		30%		$ 219,585.00
ENGINEERING AND DESIGN		15%		$ 142,730.00
CONSTRUCTION ADMINISTRATION AND OBSERVATION		7%		$ 66,607.00
AREA 3, OPTION A TOTAL COST				**$ 1,160,872.00**

*Estimate includes pavement removal and replacement for Chowen Ave north of 60th St

ENGINEER'S OPINION OF PROBABLE COST: AREA 3, OPTION "B"

Living Streets Alternate, 8" Swales with 36" pipe storage

January 21, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 136,000.00	$ 136,000.00
TRAFFIC CONTROL	LS	1	$ 10,000.00	$ 10,000.00
EROSION CONTROL	LS	1	$ 15,000.00	$ 15,000.00
REMOVALS*				
SAW CUT BITUMINOUS PAVEMENT	LN FT	867	$ 3.50	$ 3,034.50
REMOVE BITUMINOUS PAVEMENT	SQ YD	1927	$ 2.00	$ 3,854.00
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	867	$ 5.00	$ 4,335.00
EARTHWORK AND RESTORATION				
EXCAVATION	CU YD	1750	$ 15.00	$ 26,250.00
AMMENDED SOIL	CU YD	1750	$ 35.00	$ 61,250.00
UTILITY CONFLICTS	LS	1	$ 10,000.00	$ 10,000.00
SOD	SQ YD	9750	$ 4.00	$ 39,000.00
STORM SEWER				
CONNECT TO EXISTING STORM SEWER	EACH	8	$ 500.00	$ 4,000.00
36" CPEP STORM SEWER, 7' to 12' deep	LN FT	8000	$ 51.84	$ 414,720.00
24" CPEP STORM SEWER, 7' to 12' deep	LN FT	1033	$ 30.00	$ 30,990.00
24" Inline Drain - StormTech	EACH	117	$ 1,750.00	$ 204,750.00
48" DIA. RC CATCH BASIN, COMPLETE	LN FT	24	$ 300.00	$ 7,200.00
84" DIA. RC MANHOLE	LN FT	20	$ 897.00	$ 17,940.00
STREET PAVEMENT				
8" AGGREGATE BASE CLASS 5	CU YD	430	$ 34.00	$ 14,620.00
REPLACE B618 CONC. CURB & GUTTER	LN FT	867	$ 13.50	$ 11,704.50
2" BITUMINOUS BASE COURSE	SQ YD	1927	$ 7.50	$ 14,452.50
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	1927	$ 8.50	$ 16,379.50
SUBTOTAL				**$ 1,045,480.00**
OTHER				
CONTINGENCY		30%		$ 313,644.00
ENGINEERING AND DESIGN		15%		$ 203,869.00
CONSTRUCTION ADMINISTRATION AND OBSERVATION		7%		$ 95,139.00
AREA 3, OPTION B TOTAL COST				**$ 1,658,132.00**

*Estimate includes pavement removal and replacement for Chowen Ave north of 60th St

ENGINEER'S OPINION OF PROBABLE COST: AREA 3, OPTION "C"
60th Street to France into Lake Pamela
January 21, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 68,000.00	$ 68,000.00
TRAFFIC CONTROL	LS	1	$ 10,000.00	$ 10,000.00
EROSION CONTROL	LS	1	$ 15,000.00	$ 15,000.00
REMOVALS*				
SAW CUT BITUMINOUS PAVEMENT	LN FT	1152	$ 3.50	$ 4,032.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	2560	$ 2.00	$ 5,120.00
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	1152	$ 5.00	$ 5,760.00
REMOVE CONC. WALK	SQ YD	160	$ 2.75	$ 440.00
REMOVE 18" RCP	LN FT	310	$ 9.00	$ 2,790.00
REMOVE 42" RCP	LN FT	478	$ 20.00	$ 9,560.00
REMOVE MANHOLE STRUCTURES	EACH	5	$ 500.00	$ 2,500.00
UTILITY CONFLICTS	LS	1	$ 10,000.00	$ 10,000.00
STORM SEWER				
CONNECT TO EXISTING STORM SEWER	EACH	4	$ 500.00	$ 2,000.00
36" CPEP STORM SEWER, 7' to 12' deep	LN FT	1033	$ 51.84	$ 53,550.72
48" CPEP STORM SEWER, 7' to 12' deep	LN FT	771	$ 73.00	$ 56,283.00
48" CPEP STORM SEWER, 12' to 16' deep	LN FT	328	$ 85.85	$ 28,158.80
48" CPEP STORM SEWER, 16' to 24' deep	LN FT	913	$ 97.15	$ 88,697.95
Headwall at 60" CPEP	LS	1	$ 10,000.00	$ 10,000.00
60" DIA. RC MANHOLE	LN FT	20	$ 650.00	$ 13,000.00
84" DIA. RC MANHOLE	LN FT	37	$ 897.00	$ 33,189.00
96" DIA. RC MANHOLE	LN FT	42	$ 1,156.00	$ 48,552.00
108" DIA. RC MANHOLE	LN FT	16	$ 1,828.00	$ 29,248.00
48" DIA. RC CATCH BASIN, COMPLETE	LN FT	128	$ 300.00	$ 38,400.00
96" SAFL BAFFLE	EACH	1	$ 10,000.00	$ 10,000.00
STREET PAVEMENT				
8" AGGREGATE BASE CLASS 5	CU YD	570	$ 34.00	$ 19,380.00
REPLACE B618 CONC. CURB & GUTTER	LN FT	1152	$ 13.50	$ 15,552.00
2" BITUMINOUS BASE COURSE	SQ YD	2560	$ 7.50	$ 19,200.00
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	2560	$ 8.50	$ 21,760.00
TOP SOIL BORROW	CU YD	120	$ 20.00	$ 2,400.00
SEEDING TURF GRASSES	AC	0.07	$ 12,500.00	$ 875.00
SITE RESTORATION	LS	1	$ 7,000.00	$ 7,000.00
SUBTOTAL				**$ 522,536.00**
OTHER				
CONTINGENCY		30%		$ 156,761.00
ENGINEERING AND DESIGN		15%		$ 101,895.00
CONSTRUCTION ADMINISTRATION AND OBSERVATION		7%		$ 47,551.00
AREA 3, OPTION C TOTAL COST				**$ 828,743.00**

*Estimate includes pavement removal and replacement for France Ave and Chowen Ave north of 60th St

ENGINEER'S OPINION OF PROBABLE COST: AREA 3, OPTION "D"

Chowen Avenue to 61st Street, France into Lake Pamela

January 21, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 101,000.00	$ 101,000.00
TRAFFIC CONTROL	LS	1	$ 10,000.00	$ 10,000.00
EROSION CONTROL	LS	1	$ 15,000.00	$ 15,000.00
REMOVALS*				
SAW CUT BITUMINOUS PAVEMENT	LN FT	1152	$ 3.50	$ 4,032.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	1536	$ 2.00	$ 3,072.00
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	1152	$ 5.00	$ 5,760.00
REMOVE 6" CONC. WALK	SQ YD	160	$ 2.75	$ 440.00
REMOVE 24" RCP	LN FT	1440	$ 10.00	$ 14,400.00
REMOVE 42" RCP	LN FT	470	$ 20.00	$ 9,400.00
REMOVE MANHOLE STRUCTURES	EACH	9	$ 500.00	$ 4,500.00
UTILITY CONFLICTS	LS	1	$ 10,000.00	$ 10,000.00
STORM SEWER				
CONNECT TO EXISTING STORM SEWER	EACH	12	$ 500.00	$ 6,000.00
36" CPEP STORM SEWER, 7' to 12' deep	LN FT	1033	$ 51.84	$ 53,550.72
60" CPEP STORM SEWER, 7' to 12' deep	LN FT	1739	$ 123.00	$ 213,897.00
60" CPEP STORM SEWER, 12' to 16' deep	LN FT	173	$ 134.00	$ 23,182.00
Headwall at 60" CPEP	LS	1	$ 10,000.00	$ 10,000.00
84" DIA. RC MANHOLE	LN FT	14	$ 897.00	$ 12,558.00
96" DIA. RC MANHOLE	LN FT	17	$ 1,156.00	$ 19,652.00
108" DIA. RC MANHOLE	LN FT	83	$ 1,828.00	$ 151,724.00
48" DIA. RC CATCH BASIN, COMPLETE	LN FT	96	$ 300.00	$ 28,800.00
96" SAFL BAFFLE	EACH	1	$ 10,000.00	$ 10,000.00
STREET PAVEMENT				
8" AGGREGATE BASE CLASS 5	CU YD	340	$ 34.00	$ 11,560.00
REPLACE B618 CONC. CURB & GUTTER	LN FT	1152	$ 13.50	$ 15,552.00
2" BITUMINOUS BASE COURSE	SQ YD	1536	$ 7.50	$ 11,520.00
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	1536	$ 8.50	$ 13,056.00
6" CONCRETE WALK	SQ YD	160	$ 45.00	$ 7,200.00
TOP SOIL BORROW	CU YD	120	$ 20.00	$ 2,400.00
SEEDING TURF GRASSES	AC	0.07	$ 12,500.00	$ 875.00
SITE RESTORATION	LS	1	$ 7,000.00	$ 7,000.00
SUBTOTAL				**$ 776,130.72**
OTHER				
CONTINGENCY		30%		$ 232,839.00
ENGINEERING AND DESIGN		15%		$ 151,345.00
CONSTRUCTION ADMINISTRATION AND OBSERVATION		7%		$ 70,628.00
AREA 3, OPTION D TOTAL COST				**$ 1,230,942.72**

*Estimate includes pavement removal and replacement for France Ave and Chowen Ave north of 60th St

Appendix D

Cost Estimates
Project Area 7, France Avenue and Scott Terrace

ENGINEER'S OPINION OF PROBABLE COST: AREA 7, OPTION "A"

21" RCP*

January 21, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 16,000.00	$ 16,000.00
TRAFFIC CONTROL	LS	1	$ 5,000.00	$ 5,000.00
EROSION CONTROL	LS	1	$ 5,000.00	$ 5,000.00
UTILITY CONFLICTS	LS	1	$ 5,000.00	$ 5,000.00
STORM SEWER				
CONNECT TO EXISTING STORM SEWER	EACH	1	$ 500.00	$ 500.00
21" CPEP STORM SEWER, 7' to 12' deep	LN FT	800	$ 73.00	$ 58,400.00
60" DIA. RC MANHOLE	LN FT	24	$ 650.00	$ 15,600.00
48" DIA. RC CATCH BASIN, COMPLETE	LN FT	5	$ 300.00	$ 1,500.00
60" SAFL BAFFLE	EACH	1	$ 6,000.00	$ 6,000.00
RESTORATION				
TOP SOIL BORROW	CU YD	75	$ 20.00	$ 1,500.00
SEEDING TURF GRASSES	AC	0.05	$ 12,500.00	$ 625.00
SITE RESTORATION	LS	1	$ 7,000.00	$ 7,000.00
SUBTOTAL				**$ 122,125.00**
OTHER				
CONTINGENCY		30%		$ 36,638.00
ENGINEERING AND DESIGN		15%		$ 23,814.00
CONSTRUCTION ADMINISTRATION AND OBSERVATION		7%		$ 11,113.00
AREA 7, OPTION A TOTAL COST				**$ 193,690.00**

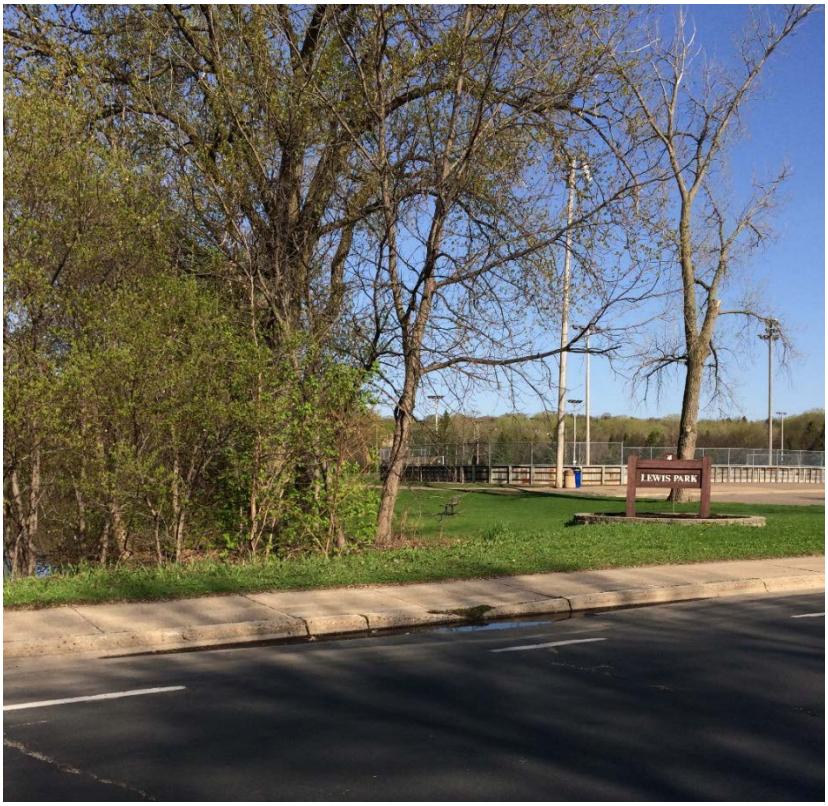
*Pavement removal and replacement is not included in this cost estimate.

STS-406 Improvement Project

Part 2: Project Areas 4 and 5

Prepared for
City of Edina

May 28, 2014



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STS-406 Improvement Project
Part 2: Project Areas 4 and 5

May 28, 2014

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1.0 Project Background

The City of Edina *Comprehensive Water Resource Management Plan* (December 2011) was developed to address current and future stormwater issues, especially those related to future development and redevelopment. The plan addresses stormwater runoff management and flood control, water quality management, and wetlands protection through establishment of stormwater planning policies and recommendations. This plan serves as a master plan for the City's water resources management and storm drainage system improvements.

One of the goals of the *Comprehensive Water Resource Management Plan* (CWRMP) is to provide stormwater runoff management and flood control. The CWRMP establishes design criteria for the City's preferred level of service for stormwater management and level of protection from flooding provided to residents of the city. These design criteria serve as a target for the City as redevelopment occurs and infrastructure improvements are considered. Another goal of the CWRMP is to provide water quality management for the water bodies throughout the city. Water quality management policies and design standards have also been established to protect the water quality of the waterbodies within the city.

The CWRMP identifies several areas throughout the city where the desired 100-year level of flood protection may not currently be provided, based on results of the hydrologic and hydraulic modeling analyses conducted as part of the CWRMP development. Since identification of these areas, the City has been evaluating flood improvement options on a case-by-case basis, in conjunction with nearby street reconstruction or other improvement projects. The STS-406 Improvement Project includes a detailed evaluation of several areas with high flood potential that correspond to anticipated street reconstruction projects within the upcoming 5 years. This report summarizes our flood protection analyses and conclusions for the following project areas within the STS-406 Improvement Project:

(1) **Project Area 4 – Cahill Road and Dewey Hill Road**

(2) **Project Area 5 – Sally Lane and Paiute Pass**

Locations of Project Areas 4 and 5 are shown in Figure 1-1.

All elevations included in this report reflect Mean Sea Level (MSL) elevations in feet using the NGVD 29 vertical datum.

2.0 Project Approach

2.1 Flood Protection

Detailed hydrologic and hydraulic modeling of the flood areas within Project Areas 4 and 5 was conducted using the XP-SWMM models that were originally developed in 2003 as part of the CWRMP. Updates made to the models as part of this project are described below and within the subsequent sections of this report.

2.1.1 Changes to Published Precipitation Depths

In 2013, NOAA's National Weather Service (NWS) published new precipitation frequency estimates ("Atlas 14") for the state of Minnesota and other Midwestern states. The Atlas 14 precipitation frequency estimates, which are the estimated rainfall depths for various rainfall durations and exceedance probabilities, replace the precipitation estimates published in *Technical Paper No. 40 Rainfall Frequency Atlas of the United States* ("TP 40"). The Atlas 14 rainfall frequency estimates indicate a significant increase in the depth of the 50-year and 100-year frequency rainfall events (i.e., rainfall events with exceedance probabilities of 2% and 1%, respectively) across Minnesota and neighboring states, as compared with TP 40 estimates. For the Minneapolis/St. Paul area, the increases in 24-hour duration precipitation depths over TP 40 are as high 25% (Figure 2-1). These precipitation depth increases are of concern, as they can have serious implications for how stormwater systems are designed and managed.

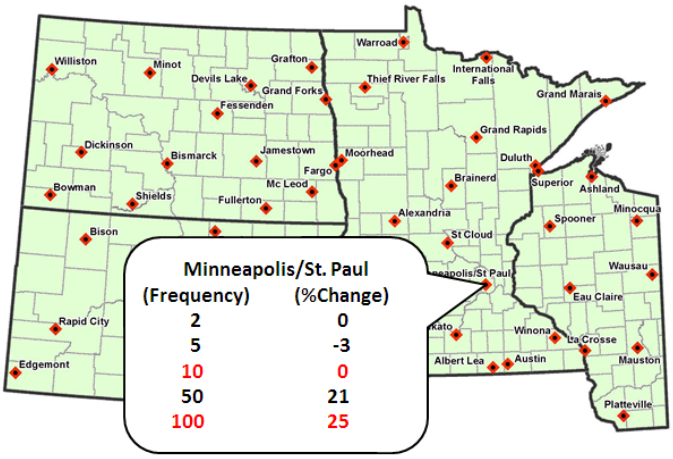


Figure 2-1 Atlas 14 percent of change in precipitation depth for the 24-hour duration storm, as compared to TP 40

The hydrologic and hydraulic modeling conducted for and summarized in the CWRMP used a 24-hour rainfall depth of 6.0 inches based on TP 40, and the SCS Type II nested distribution. For this project, the rainfall depths used in the models were updated based on Atlas 14 precipitation estimates for Edina (Table 2-1). A nested rainfall distribution was developed using precipitation frequency estimates for Edina (Coordinates: 44.8716, -93.3762). The depth-duration data were downloaded from NOAA's Precipitation Frequency Data Server (PFDS) at http://dipper.nws.noaa.gov/hdsc/pfds/. Nested distributions for selected

recurrence intervals events were created by using the Frequency Storm utility found in the meteorological modeling component of HEC-HMS to produce 24-hour hyetographs with 5-minute intervals.

Flood frequency data is often also described in terms of a percentage of risk, or annual exceedance probability. For example, the 100-year frequency flood inundation area represents an area that has a 1 percent chance of flooding (1-percent-annual chance flood) for any given year. Structures located within the 1-percent-annual chance flood inundation area have a 26 percent chance of flooding during the life of a standard 30-year mortgage.

Table 2-1 24-hour duration rainfall depths using NOAA Atlas 14 for Edina, MN for a range of storm recurrence intervals

Storm Recurrence Interval	24-hour Rainfall Depth (inches)	Annual Exceedance Probability[1]
1-year	2.5	100%
2-year	2.9	50%
10-year	4.3	10%
25-year	5.4	4%
50-year	6.4	2%
100-year	7.5	1%

[1] *Annual Exceedance Probability refers to the percent chance of occurrence in any given year*

2.1.2 Updated Elevation Data

For each of the study areas, City staff conducted a topographic field survey of the flood inundation areas within the targeted subwatersheds. The topographic survey data was combined with 2011 LiDAR elevation data from the Minnesota Department of Natural Resources (MNDNR) to refine the elevation/storage relationships used in the modeling analyses. The City's survey also included low entry elevations for structures adjacent to the flood inundation areas within the targeted subwatersheds. The low entry elevations were used to define the flood improvement target elevations.

3.0 Project Area 4—Cahill Road and Dewey Hill Road (Southwest Ponds Catchment)

Project Area 4 is located near Cahill Road and Dewey Hill Road (Figure 1-1) and is located within the Southwest Ponds major drainage area. The Southwest Ponds watershed encompasses approximately 411 acres. The land use within the watershed is mainly low- and medium-density residential, in addition to the commercial and industrial area on the eastern portion of the watershed along Cahill Road and Lewis Park (located west of Cahill Road and north of Dewey Hill Road). The watershed is characterized by a series of ponding basins, that ultimately outlet to the South Fork of Nine Mile Creek via a storm sewer system that travels southward from the intersection of West 78th Street and Delaney Boulevard and discharges into a detention pond north of Interstate 494. Discharge from this detention pond flows beneath Interstate 494 and enters the South Fork of Nine Mile Creek.

3.1 Problem Description

The primary objective of this evaluation was to identify opportunities to reduce the potential for flooding in the low area on Cahill Road just north of Dewey Hill Road and in the parking lot of 5400 Dewey Hill Road, a FilmTec Corporation property (FilmTec). The ponds and ball fields within Lewis Park, located north of Dewey Hill Road and west of Cahill Road, serve as regional flood storage for the Southwest Ponds major drainage area. When water levels in the Lewis Park pond (SWP_35) and adjacent ball fields get high enough, flood waters extend eastward onto Cahill Road and into the FilmTec parking lot, inundating the parking lot and causing flooding problems in the loading dock area and lobby. Figure 3-1 is an image of FilmTec, showing the loading docks at the west end of the parking lot and Figure 3-2 is an image of the lobby at the east end of the parking lot. Anecdotal information from FilmTec staff indicates that in the past 9 years that FilmTec Corporation has occupied this property, the lobby has flooded about once every three or four years.

Figure 3-3 shows the subwatersheds and existing storm sewer within the study area. Stormwater runoff from Cahill Road (subwatershed SWP_46) currently drains to the pond just north of Dewey Hill Road in Lewis Park (SWP_35) via a 42-inch storm sewer system. A separate 24-inch storm sewer system conveys runoff from the parking lot and low area of the FilmTec parking lot (subwatershed SWP_46X) to the Lewis Park pond (SWP_35). The Lewis Park pond discharges southward under Dewey Hill Road and through a subsequent series of ponds and wetlands. The normal water level of the Lewis Park Pond (SWP_35) is currently controlled at 828 feet by the outlet structure of the pond on the south side of Dewey Hill Road (SWP_5).

Figure 3-1 The loading dock area of FilmTec Corporation's (5400 Dewey Hill Road) parking lot where flooding can occur frequently

Figure 3-2 The lobby area of FilmTec Corporation (5400 Dewey Hill Road) where flooding has occurred

3.2 Model Updates

The XP-SWMM hydrologic and hydraulic model for Project Area 4 was updated to reflect updated rainfall depths as defined by NOAA Atlas 14. Because of the increase in rainfall depths, several additional overflows were added to the model within and around the Project Area 4 study area. The City provided topographic survey at the intersection of Cahill Road and Dewey Hill Road, as well as within the parking lot of FilmTec Corporation to define critical elevations. This information was used in conjunction with the MNDNR's 2011 LiDAR elevation dataset to update the stage-storage relationships in the model for subwatersheds within and around the Project Area 4 study area. The storm sewer information in the model, particularly regarding pipes from FilmTec's parking lot, was also updated based on additional information provided by the City.

3.3 Existing Conditions Flooding

Figure 3-3 shows the predicted inundation areas throughout the Project Area 4 study area for the 100-year, 24-hour rainfall event. As shown in the figure, nearly all of Lewis Park becomes inundated, along with nearby Cahill and Dewey Hill Roads and the FilmTec parking lot. The predicted 100-year, 24-hour water surface elevation within the Lewis Park storage area and the surrounding hydraulically connected areas, including the FilmTec property, is 834.3 feet. This peak water surface elevation exceeds the surveyed low-entry elevation of 832.8 feet at FilmTec. This is the elevation at which stormwater reaches: (a) the loading docks at FilmTec (Figure 3-1), potentially causing inflow and infiltration (I/I) into the City sanitary sewer system via the floor drains of the loading dock area, and (b) FilmTec's lobby area located at the southeast corner of the building (Figure 3-2).

Review of the modeling results indicate potential flooding in subwatershed SWP_60 as a result of the updated precipitation depths and resulting increased flood elevations in the SWP_40 pond and adjacent SWP_60 low area. The 100-year, 24-hour maximum water surface elevation in both SWP_40 and SWP_60 is 837.8 feet, which appears to potentially impact townhome structures along Oak Glen Road west of Cahill Road.

3.4 Improvement Options

Multiple improvement options were evaluated for their ability to provide a 100-year level of protection to the FilmTec property. As mentioned above, the ponds and ball fields within and near Lewis Park serve as regional flood storage for the Southwest Ponds drainage area. Figure 3-4 shows the relationship between elevation and flood storage volume in the Lewis Park storage area (subwatersheds SWP_34, SWP_35, SWP_46, SWP_46X, SWP_21, SWP_48, SWP_17, SWP_5, and SWP_14). Under existing conditions, approximately 81 acre-feet of flood storage is provided in the Lewis Park storage area between the 100-year flood elevation of 834.3 feet and the control elevation of 828 feet. Reducing the 100-year flood elevation of the Lewis Park storage area to an elevation below the low-entry elevation at FilmTec (832.8 feet) would result in a loss of approximately 36 acre-feet of flood storage, requiring that volume of water to be managed some other way (Figure 3-4).

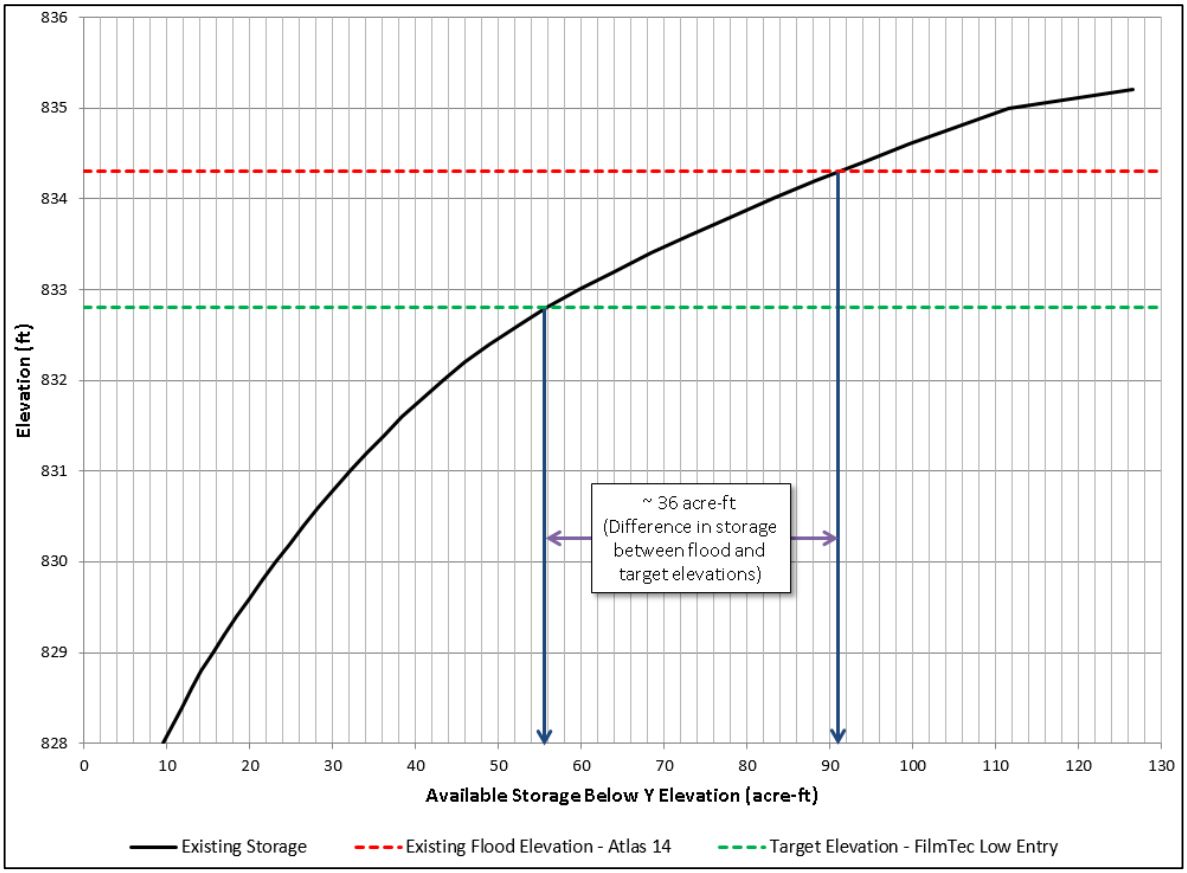


Figure 3-4 The relationship between elevation and flood storage volume in the Lewis Park storage area (subwatersheds SWP_34, SWP_35, SWP_46, SWP_46X, SWP_21, SWP_48, SWP_17, SWP_5, and SWP_14)

The improvement options evaluated were selected to help mitigate or replace the potential loss of flood storage and included providing additional storage within Lewis Park below the target elevation of 832.8 feet, providing additional storage upstream of the Lewis Park storage area, and increasing discharge from the Lewis Park storage area (moving water downstream more quickly). These improvement options are discussed in further detail below.

3.4.1 Option A: Providing Additional Flood Storage in Lewis Park Storage Area

Option A involves providing additional flood storage below the target flood elevation of 832.8 feet (FilmTec low entry elevation) by significantly lowering the ground surface of Lewis Park. While this option is the only evaluated option that effectively reduces the 100-year flood elevation below the target elevation, the lowered ground surface may result in wet conditions in the park and parking lot due to proximity to groundwater. Improvement Option A includes several components, which are described below and shown in Figure 3-5.

- Provide approximately 60 acre-feet of additional storage below 832.8 feet at Lewis Park to compensate both for lost storage above elevation 832.8 feet and resulting changes in system

hydraulics. This area is currently made up of three soccer fields, parking lots and general park area. The additional storage would require lowering the elevation of these features (all features would retain existing functionality, after construction). For modeling purposes, the ground elevation within the park (shown in Figure 3-5) was lowered to 827.4 feet.

- Provide additional flow capacity from the parking lot of FilmTec (SWP_46X) to the Lewis Park pond (SWP_35). The main purpose of the increased pipe capacity is to convey the initial peak flow from Cahill Road and other impervious areas of SWP_46X out of FilmTec's parking lot before the water level in SWP_35 rises due to inflows from the subwatersheds to the north and west. The modeling analysis assumed an additional 36-inch diameter RCP, with upstream and downstream invert elevations of 828.2 feet and 827.0 feet, respectively, and a peak 100-year flow of 21 cfs,
- Lower the outlet of the pond immediately south of Dewey Hill Road (SWP_5) from 828 feet to 827 feet, effectively lowering the normal water level of this pond and the ponds in Lewis Park by 1 foot.
- Replace the outlet pipe from SWP_2 to SWP_1 with an equal diameter (24-inch) RCP, with the control elevation at or below 827.0 feet. The existing CMP outlet pipe is in disrepair and in need of maintenance or replacement.

Improvement Option A results in a 100-year water surface elevation of 832.6 feet in the FilmTec parking lot (SWP_46X), which is 0.2 feet lower than the FilmTec low entry elevation, thus providing a 100-year level of protection. Additionally, this improvement option does not have adverse impacts to nearby or downstream flood elevations. However, lowering the ground elevation of the park will require significant excavation, which is likely cost prohibitive. Lowering the soccer fields and other park amenities (tennis courts and parking lot) may also result in frequent wet conditions and difficult constructability and/or longevity due to close proximity to groundwater.

3.4.2 Option B: Providing Additional Upstream Storage

Due to the fully-developed nature of the area upstream of Lewis Park, the availability of land for upstream storage was limited. Increasing the flood storage in the currently wooded area in SWP_47 was evaluated. The resulting decrease in 100-year flood elevation in the Lewis Park storage area was minimal and did not alleviate the flooding at FilmTec. Therefore, this improvement option was not pursued further.

3.4.3 Option C: Increasing Flow from Lewis Park Storage Area

One way to decrease the required flood storage is to increase the discharge to downstream subwatersheds. Increased flow capacity from the Lewis Park storage area was evaluated (assuming the flow capacity from SWP_5 was increased from about 20 cfs to over 200 cfs), which resulted in decreased 100-year flood elevations in the Lewis Park storage area. However, the decrease was not sufficient to alleviate the flooding at FilmTec and resulted in increased flood elevations in downstream waterbodies. Given these reasons, this improvement option was not pursued further.

3.4.4 Option D: Localized Flood Proofing

Given the high costs of Option A and the potential detriments to the soccer fields and other park amenities resulting from lowering the park, we recommend that the City and/or FilmTec consider retrofitting the flood-prone structure and parking lot as an alternative option to reduce the frequency of flooding. Retrofitting efforts could include relocating the entryway and lobby at FilmTec to minimize the flooding potential. Retrofitting efforts could also include grading modifications in the parking lot to help keep flood waters from reaching the loading dock and lobby areas during the more frequent, less severe events.

The loading dock area at FilmTec has several floor drains that are currently served by the City's sanitary sewer service. When flood waters reach the loading dock area, water enters the sanitary sewer through these drains, adding to the City's I/I problem. Modifications to the FilmTec sanitary drains in the loading dock area should be considered to minimize or prevent flow to the sanitary system during times of stormwater inundation. Modifications may include installation of a manual or automated valve system (float valve/float control) or installation of a low-flow/high-flow diversion structure with pipes connecting the drains to the stormwater system, or some combination thereof. The feasibility of this type of retrofit to reduce I/I at FilmTec is dependent on several factors, including local plumbing code restrictions and the connectedness of the loading dock drains to the main sanitary line serving FilmTec.

Retrofitting options and costs will vary considerably depending on the specific design modifications.

3.4.5 Engineer's Opinion of Probable Cost

A planning level engineer's opinion of probable cost was prepared for Option A- Providing Additional Flood Storage in the Lewis Park storage area. The opinion of probable cost, summarized in Table 3-1 was based on our experience on similar construction projects and the level of information available to determine cost for the proposed project. Given that the cost is based on planning-level design, a contingency of 30% was applied to the estimated construction cost. A significant portion of the estimated cost is related to excavation and disposal, which can vary significantly depending on site soil conditions. The assumed unit cost of $15 per cubic yard for excavation and disposal was used as a conservative estimate assuming clean soil. See Appendix A for a detailed summary of the cost associated with Option A.

Table 3-1 Estimated cost for Cahill and Dewey (Project Area 4) improvement Option A

Improvement Option	Estimated Cost[1]
Option A- Providing Additional Flood Storage in Lewis Park Storage Area	$3,980,000
[1]Costs rounded up to the nearest $10,000.	

3.4.6 Water Quality Considerations

Although flood risk reduction is the primary objective of this analysis, the water quality benefits or detriments from the evaluated improvement option were also considered. Currently, runoff from Project

Area 4 receives treatment through sedimentation, as the stormwater flows through the series of ponds and wetlands downstream of the park. P8 modeling conducted as part of the CWRMP indicates that the Lewis Park Pond (SWP_35) achieves 52% and 88% removal of total phosphorus (TP) and total suspended sediment (TSS), respectively, during an average water year (based on 1994-1995 water year). One component of Option A is to lower the normal water levels of the ponds in SWP_5 and SWP_35 by 1 foot. Lowering the normal water levels will reduce the amount of dead storage (storage below the normal water level) available in these ponds, which can reduce sedimentation. The P8 model was revised to reflect the proposed change in normal water levels. Results indicate that the decreased effectiveness of these ponds due to the proposed change in normal water level was minimal (predicted removal efficiencies were reduced to 51% and 87% for TP and TSS, respectively).

4.0 Project Area 5—Sally Lane and Paiute Pass

Project Area 5 encompasses the area that drains to the intersection of Sally Lane and Paiute Pass which includes Nine Mile South Branch Catchments NMSB_70, _83, and _84 (Figure 1-1). The stormwater model for this area indicates potential flooding at this intersection as well as in a backyard depression area located at 7005 and 7009 Sally Lane. The City provided a detailed topographic survey of this intersection and backyard depression area, allowing available storage to be quantified more accurately, low entry elevations to be determined for the structures adjacent to the low areas, and overflow elevations between the street and nearby low areas to be identified.

4.1 Problem Description

Hydrologic and hydraulic modeling of Project Area 5 suggests that flooding will occur in the low area surrounding the intersection of Sally Lane and Paiute Pass (NMSB_83 and _84) and the backyard depression area behind 7009 and 7013 Sally Lane (NMSB_70) during a 100-year, 24-hour rainfall event. The low area at the intersection of Sally Lane and Paiute Pass is currently drained by two storm sewer pipes that flow westward, discharging to the drainageway behind the homes on the west side of Sally Lane (Braemar Branch of Nine Mile Creek). The backyard depression area is currently drained by a storm sewer pipe that ties into the existing system at Sally Lane and Paiute Pass. The flooding in these areas appears to be primarily a result of localized storm sewer capacity limitations.

4.1.1 Sally Lane and Paiute Pass Intersection (NMSB_83, NMSB_84)

The storm sewer system at the Sally Lane and Paiute Pass intersection collects stormwater from a total drainage area of approximately 27 acres. The existing system discharges into the Braemar Branch via two 24-inch pipes. During the 100-year, 24-hour rainfall event, the Paiute Pass/Sally Lane intersection is inundated with stormwater and ponding occurs. Based on the topographic survey information, ponding will occur in this intersection and onto nearby properties. Two overland flow paths have been identified where water will flow westward to the Braemar Branch. The north overland flow path conveys water between properties 6836 and 7000 Sally Lane. The south overland flow path conveys water between 7000 and 7004 Sally Lane. The upstream invert for the north overland flow path is 862.0 feet and the upstream invert for the south overland flow path is 861.3 feet. The surveyed low entry elevations in this area are 861.6 feet, 861.5 feet, and 862.0 feet at 7000, 7004, and 6845 Sally Lane, respectively.

4.1.2 7009 and 7013 Sally Lane Backyard Depression Area (NMSB_70)

A backyard depression area exists behind the homes along Sally Lane and Paiute Pass. A 12-inch piped outlet exists from this area, draining northward and connecting to the system along Paiute Pass. During large rainfall events such as the 100-year, 24-hour rainfall event, the piped outlet does not provide sufficient capacity, and ponding will occur. Two overland flow paths exist which convey flow westward to Sally Lane. The north overland flow path conveys water between properties 7009 and 7013 Sally Lane. The south overland flow path conveys water between 7013 and 7017 Sally Lane. The upstream invert for the north overland flow path is 863.0 feet and the upstream invert for the south overland flow path is 862.9

feet. Based on the topographic survey information, the low entry elevations in this area are 862.9 feet and 863.1 feet at 7009 and 7005 Sally Lane, respectively.

4.2 Model Updates

The XP-SWMM hydrologic and hydraulic model for Project Area 5 was updated to reflect new rainfall depths as defined by NOAA Atlas 14. Because of the increase in rainfall depths, additional surface overflows were added to the model within the Project Area 5 study area, as needed. The City provided topographic survey at the intersection of Sally Lane and Paiute Pass, as well as the Sally Lane backyard depression area. This information was used in conjunction with the MNDNR's 2011 LiDAR elevation dataset to update the stage-storage relationships in the model for subwatersheds within the Project Area 5 study area. The storm sewer information in the model was also updated based on a survey conducted by the City.

4.3 Existing Conditions Flooding

Table 4-1 summarizes the predicted 100-year, 24-hour water surface elevations under existing conditions for the subwatersheds within the Project Area 5 study. The 100-year flood elevation for the intersection of Sally Lane and Paiute Pass is 862.0 (subwatersheds NMSB_83 and NMSB_84), which exceeds the low entry elevation of three structures (6845, 7000, and 7004 Sally Lane). The 100-year flood elevation for the backyard depression area (subwatershed NMSB_70) is 863.2 feet, which exceeds the surveyed low entry elevation of two structures (7005 and 7009 sally Lane). The inundation areas corresponding to these two flood elevations are shown in Figure 4-1.

Table 4-1 Maximum water surface elevations (feet, MSL) under existing conditions and the number of dwellings (shown in parentheses) that are inundated at the corresponding elevation

Flooding Area	Water Surface Elevation[1], 100-year, 24-hour Rainfall Recurrence Interval	Lowest Low Entry Elevation
Intersection of Sally Lane and Paiute Pass (NMSB_83 and _84)	862.0 (3)	861.5[2]
7009 and 7013 Sally Lane Backyard Depression Area (NMSB_70)	863.2 (2)	862.9[3]

[1] Elevations based on Atlas 14 precipitation depths
[2] 7004 Sally Lane
[3] 7009 Sally Lane

4.4 Improvement Options

Three flood improvement options were evaluated to reduce flood risk in the low area at Sally Lane and Paiute Pass and the backyard depression area. These three options are being considered separately for the purpose of identifying component costs, but the final alternative will be a combination of either Option A with Option B or Option A with Option C. The three options include:

Option A: Installation of a 24-inch diameter corrugated polyethylene storm sewer pipe to drain the backyard area behind homes on the south side of Paiute Pass and the east side of Sally Lane. The proposed 930 lineal feet of pipe would discharge to the Braemar Branch just downstream of the Valley View Road crossing.

Option B: Increasing the capacity of the existing north outfall pipe from Sally Lane to the Braemar Branch by replacing the existing 24-inch diameter CMP with a 36-inch diameter corrugated polyethylene pipe. In addition, increasing the capacity of the existing south outfall pipe from Sally Lane to the Braemar Branch by replacing the existing 24-inch diameter CMP with a 48-inch diameter corrugated polyethylene pipe.

Option C: Constructing two gravity overflow channels to convey overland flow from Sally Lane to the Braemar Branch. One proposed overflow channel is to be located between 6836 Sally Lane and 7000 Sally Lane. The second overflow channel is to be located between 7000 Sally Lane and 7004 Sally Lane. The overflow channels will be controlled positive overflow paths which will ensure the homes are protected from flood waters and not altered in the future by private property owners.

4.4.1 Option A: Install Additional Pipe from Backyard Depression Area

As described in Figure 4-2 and Figure 4-3, Option A encompasses installation of 930 lineal feet of 24-inch diameter corrugated polyethylene storm sewer pipe from the backyard area south and east of Paiute Pass and Sally Lane. The existing pipe which directs runoff to the north will continue to service the backyard area. The proposed pipe exits the existing catch basin in the backyard area and runs south before it turns 90 degrees to the west and passes between 7009 Sally Lane and 7013 Sally Lane. The pipe then runs to the south under Sally Lane, crosses Valley View Road, and discharges into the Braemar Branch downstream of the culvert crossing with Valley View Road. An easement and careful coordination with the affected property owners will be required for the properties crossed by this new pipe.

Throughout this analysis, careful consideration was given to preventing adverse downstream impacts as a result of proposed flood improvements. The proposed pipe from the backyard area discharges to the Braemar Branch downstream of Valley View Road, which is a modification to current drainage patterns. To ensure that installation of the new pipe would not cause flood concerns downstream of Valley View Road, the proposed pipe was added to the Nine Mile Creek Watershed District's XP-SWMM model and run for the 100-year, 24-hour rainfall event. Model results indicate a negligible change in maximum surface water elevation downstream of Valley View Road.

The City may wish to consider further optimization of Option A (upsizing the proposed pipe and extending it northward along Sally Lane- described in more detail in Section 4.4.4) to collect runoff from the low intersection of Sally Lane and Paiute Pass. While not evaluated in detail as part of this analysis, this option may have the potential to reduce or eliminate the need for additional pipe capacity as outlined in Option B. Further analysis as part of final design would be required to evaluate detailed design considerations and assess cost implications and potential downstream impacts of more significant drainage pattern modifications.

4.4.2 Option B: Increase Capacity of Sally Lane Storm Sewer

As described in Figure 4-2, Option B includes increasing the capacity of the north outfall pipe from Sally Lane to the Braemar Branch by replacing the 24-inch pipe with a 36-inch diameter corrugated polyethylene pipe. The capacity of the south outfall pipe from Sally Lane to the Braemar Branch will also be increased by replacing the 24-inch pipe with a 48-inch diameter corrugated polyethylene pipe. The pipes will follow their existing alignment between 6836 and 7000 Sally Lane. The available installation space will be tight in this area and will require careful coordination with the contractor and the homeowners. The current easement may need to be widened due to the increased size of these pipes. Careful coordination and communication with the property owners affected by this option will be necessary.

4.4.3 Option C: Construct Surface Overflow Channels from Sally Lane

As described in Figure 4-3, Option C includes construction of two gravity surface overflow channels from Sally Lane to the Braemar Branch. The northern channel having an upstream invert of 860.1 feet will pass between 6836 Sally Lane and 7000 Sally Lane. The southern channel will pass between 7000 Sally Lane and 7004 Sally Lane and will have an upstream invert of 860.3 feet. Both of the channels are being proposed with vertical retaining walls and riprap bottoms due to the high design flows and velocities associated with the 100 year, 24-hour rainfall event and the narrow space available between the homes.

The easement located between 6836 Sally Lane and 7000 Sally Lane may need to be widened for the north overflow channel. The south overflow will require the creation of an easement between 7000 and 7004 Sally Lane. Careful coordination and communication with the property owners affected by this option will be necessary.

4.4.4 Flood Benefits

Table 4-2 summarizes the water surface elevations in the two low areas near the intersection of Sally Lane and Paiute Pass for the 100-year, 24-hour rainfall event. The number of dwellings impacted for each scenario is also included in Table 4-2. Option A lowers the 100-year maximum water surface elevation below the low entry elevations at 7005 and 7009 Sally Lane. Inundation will still occur in the backyard area during the 100-year, 24-hour rainfall event; however, it should not directly impact any structures.

Options B and C provide similar benefits, with respect to both the reduction in the maximum water surface elevation and the number of dwellings protected. Implementing either Option B or C would result in lowering the maximum water surface elevation below the low entry elevations of the three impacted dwellings (6845, 7000, and 7004 Sally Lane). There will still be isolated flooding on the street during the 100-year, 24-hour rainfall event; however, it should not directly impact any structures.

None of the three improvement options evaluated have an impact on the 100-year flood elevation in the Braemar Branch.

As described in Section 4.4.1, a potential alternative to combining Options A and B would be to upsize and extend the Option A pipe northward along Sally Lane to collect additional flow from the low area at Sally Lane and Paiute Pass and reduce or eliminate the need for additional pipe capacity as outlined in Option B. This option would require installation of a larger and longer pipe that would convey flow from the intersection of Sally Lane and Paiute Pass south to the downstream side of Valley View Road. An increased depth of excavation along Sally Lane would be required to allow for tie-in of the low area of the Sally Lane and Paiute Pass intersection. Depth of cover near the low area, a less than desirable pipe slope along Sally Lane (less than 0.5%), and potential adverse downstream impacts due to redirection of significantly higher flows may also pose design concerns and/or challenges.

Table 4-2 100-year, 24-hour maximum water surface elevations (feet, MSL) under proposed conditions and the number of dwellings (shown in parentheses) that are inundated at that corresponding elevation

Flooding Area	Existing Conditions[1]	Option A[1] (2-ft Dia. Pipe to Braemar Branch)	Option B[1] (Increased Outflow Pipes)	Option C[1] (Constructed Overflows)
Intersection of Sally Lane and Paiute Pass (NMSB_83 and _84)	862.0 (3)	NA	861.3 (0)	861.4 (0)
7009 and 7013 Sally Lane Backyard Depression Area (NMSB_70)	863.2 (2)	862.2 (0)	NA	NA

[1] *Elevations based on Atlas 14 precipitation depths*

Table 4-3 summarizes the 100-year, 24-hour peak discharge rates through the proposed storm sewer pipes and overflows for Options A, B, and C.

Table 4-3 100-year, 24-hour peak flow rates through the proposed pipes for Sally Lane improvement Options A, B, and C

24-hour Storm Recurrence Interval	Option A (2-ft Pipe to Braemar Branch)	Option B (North Outflow Pipe)	Option B (South Outflow Pipe)	Option C (North Overflow)	Option C (South Overflow)
100-year	20 cfs	51 cfs	103 cfs	76 cfs	84 cfs

4.4.5 Engineer's Opinions of Probable Costs

Planning level engineer's opinions of probable costs were prepared for Options A, B, and C. The opinions of probable cost, summarized in Table 4-4, are based on our experience on similar construction projects and the level of information available to determine costs for the proposed projects. Given that the costs are based on planning-level designs, a contingency of 30% was applied to the estimated construction costs. The cost associated with the purchase of easements or the widening of existing easements has not been included in this estimate. See Appendix B for detailed summaries of the costs for Options A, B, and C.

Table 4-4 Estimated costs for Sally Lane and Paiute Pass (Project Area 5) improvement Options A, B, and C

Improvement Option	Estimated Cost[1]
Option A: 24" RCP draining Sally Lane backyard depression area to existing storm sewer	$210,000
Option B: increasing the pipe sizes for the north and south outfalls from Sally Lane to the Braemar Branch of Nine Mile Creek	$150,000
Option C: construction of two overflow channels from Sally Lane to the Braemar Branch of Nine Mile Creek	$160,000
Combined Option A +B	$360,000
Combined Option A + C	$370,000

[1] *Costs rounded up to the nearest $10,000.*

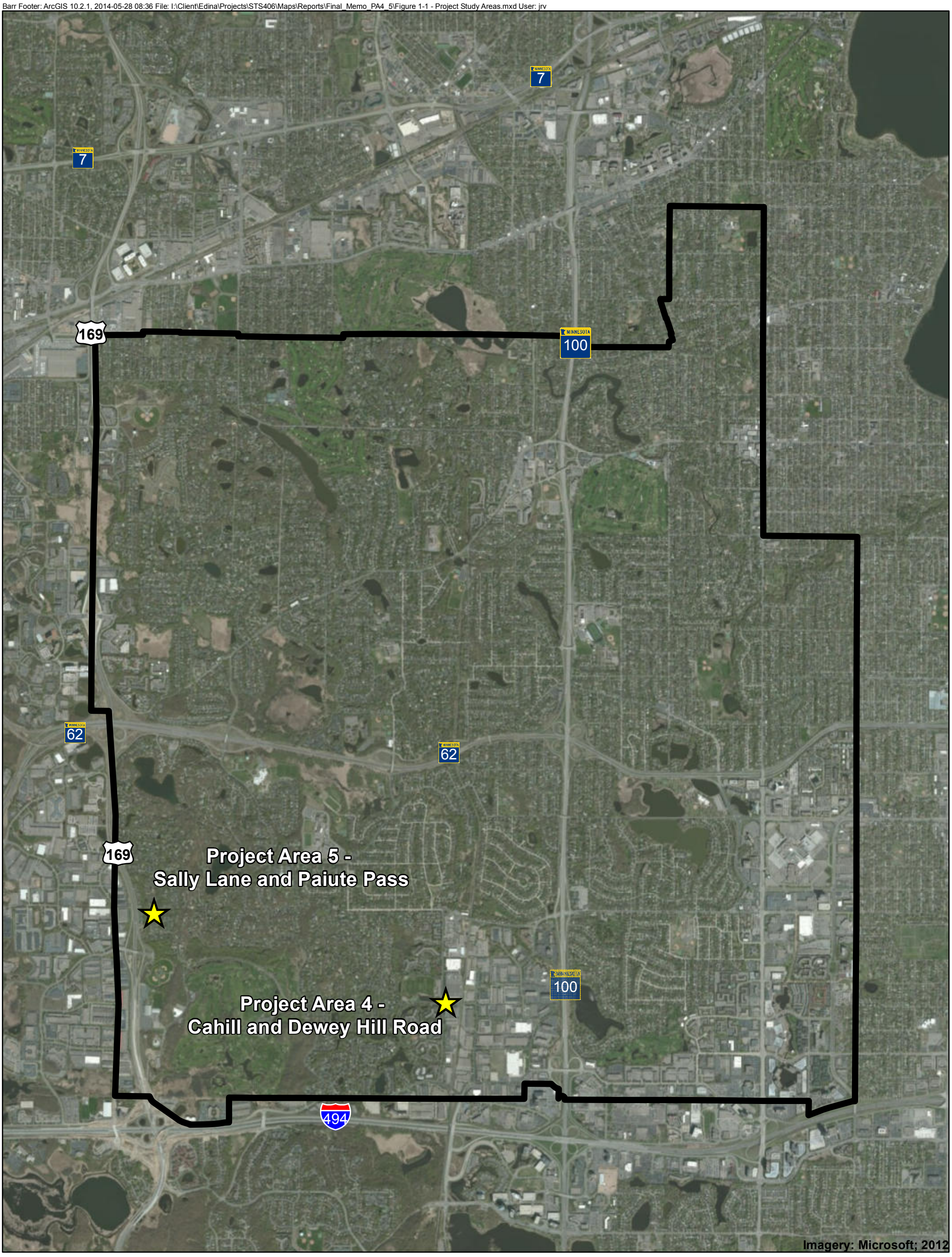
4.4.6 Water Quality Benefits

Although flood risk reduction was the primary objective of this analysis, opportunities to implement water quality improvements within the study area were also considered. Due to the limited availability of undeveloped or publicly-owned land within the direct study area, construction of water quality BMPs is difficult. However, we recommend that the City consider installation of rainwater gardens in the City right-of-way or installation of sump manholes with SAFL Baffles (or other underground hydrodynamic treatment structures) to provide opportunity for settling of sediment prior to discharge of stormwater to the Braemar Branch.

Although somewhat beyond the study area, a wooded area at the north end of the Braemar Branch was identified as a potential site for stormwater management. The low area (approximately 2.4 acres), which is located west of 6800 through 6812 Sally Lane and south of Sioux Trail in subwatershed NMSB_77, receives stormwater from portions of Edina and Eden Prairie. Review of the National Wetland Inventory indicates that the low area may not be classified as a wetland. The City may want to consider this site for future stormwater management efforts given the high proportion of previously untreated flows to this location.

Figures

Barr Footer: ArcGIS 10.2.1, 2014-05-28 08:36 File: I:\Client\Edina\Projects\STS406\Maps\Reports\Final_Memo_PA4_5\Figure 1-1 - Project Study Areas.mxd User: jrv



Project Areas

City of Edina Boundary

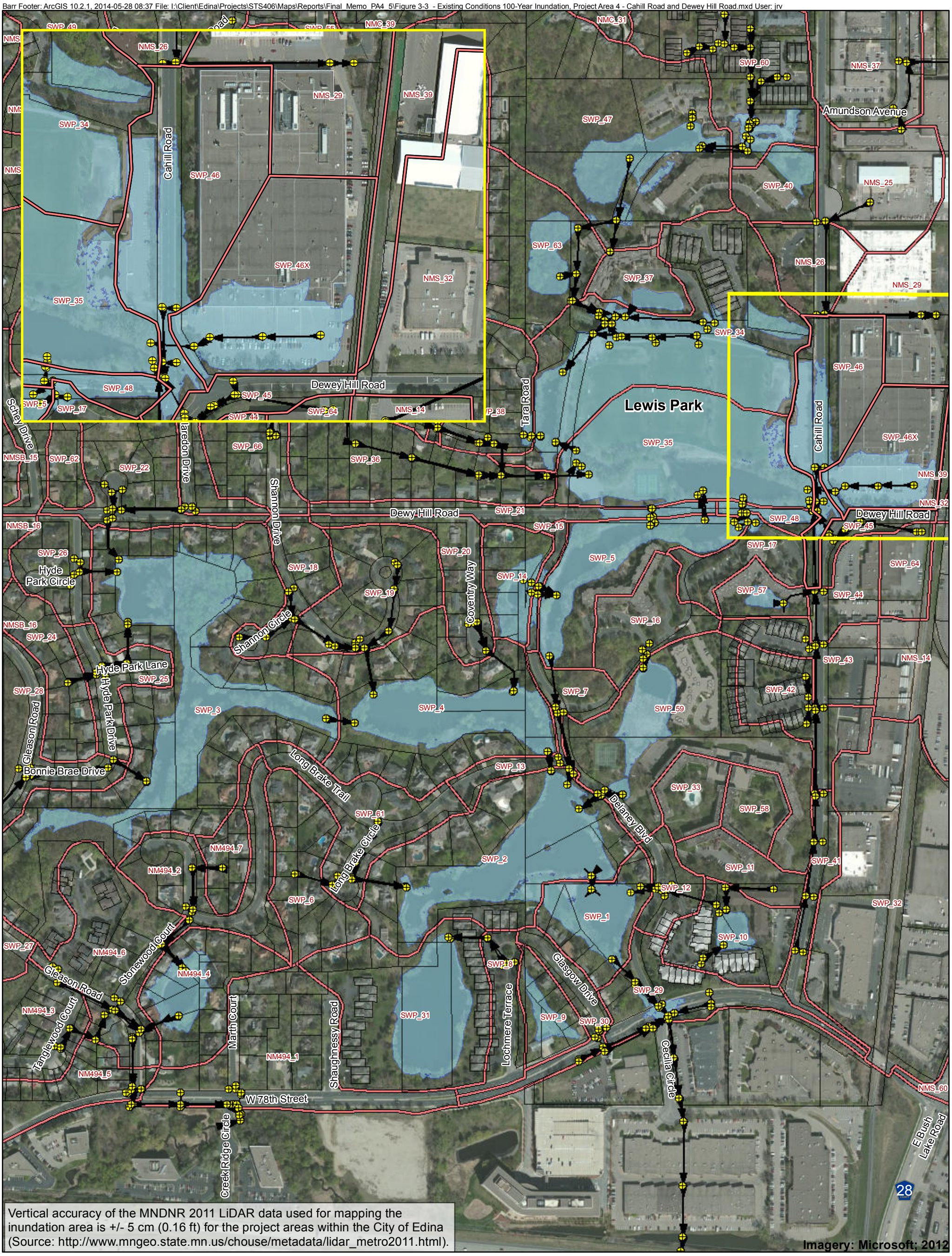
N

Feet
0 2,500 5,000

BARR

Figure 1-1

PROJECT STUDY AREAS



Vertical accuracy of the MNDNR 2011 LiDAR data used for mapping the inundation area is +/- 5 cm (0.16 ft) for the project areas within the City of Edina (Source: http://www.mngeo.state.mn.us/chouse/metadata/lidar_metro2011.html).

Imagery: Microsoft; 2012

- Existing Manhole/Catch Basin
- Existing Storm Sewer
- 100-Year 24-Hour Event Inundation Area*
- Subwatersheds
- Parcels

N

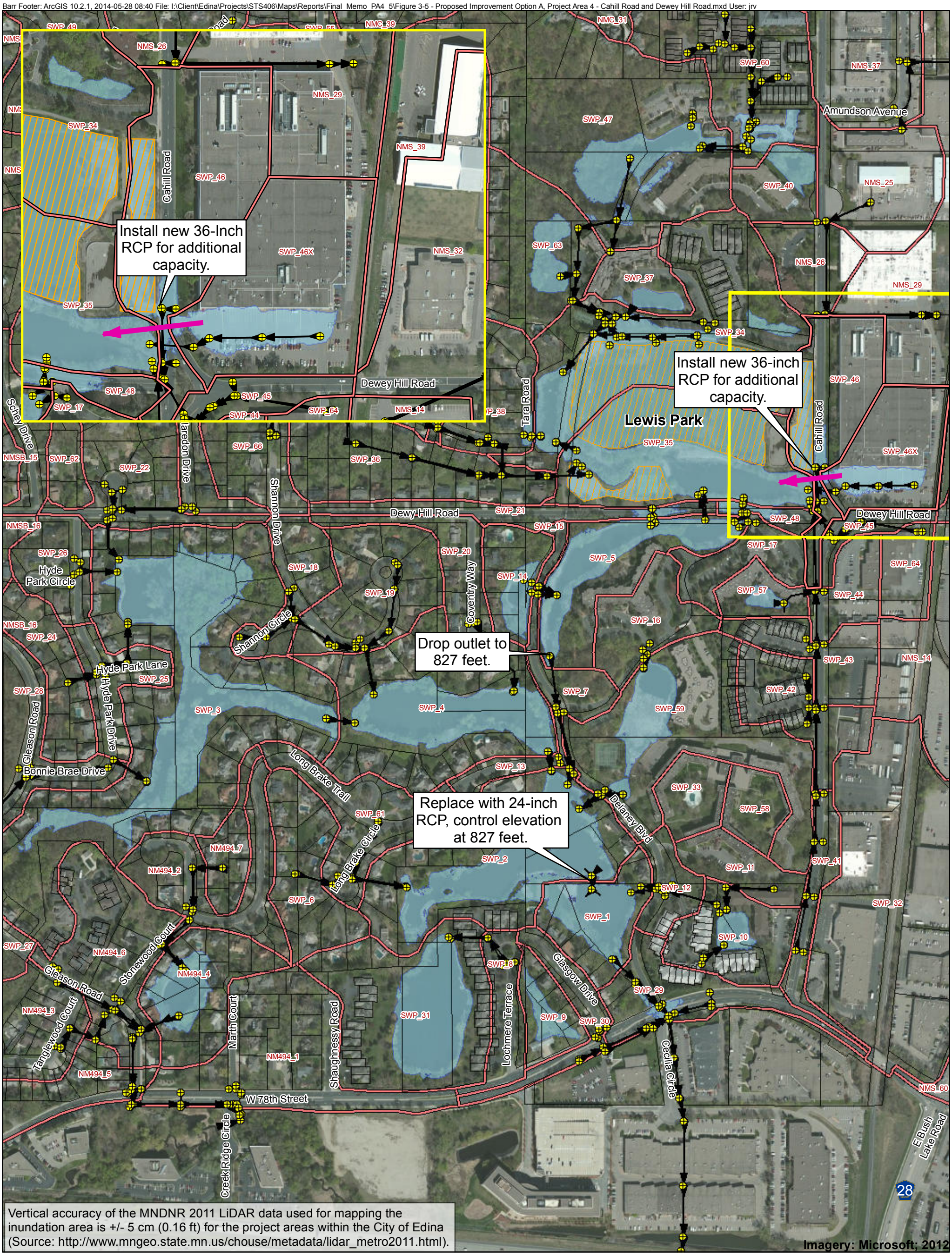
Feet
0 400 800

BARR

Figure 3-3

EXISTING CONDITIONS
100-YEAR INUNDATION
Project Area 4 -
Cahill Road and Dewey Hill Road

*Vertical Datum: NGVD 29, Feet



Existing Manhole/Catch Basin

Surface Overflow

Existing Storm Sewer

Option A: 100-Year 24-Hour Event Inundation Area*

Option A: Soil Removal

Subwatersheds

Parcels

*Vertical Datum: NGVD 29, Feet

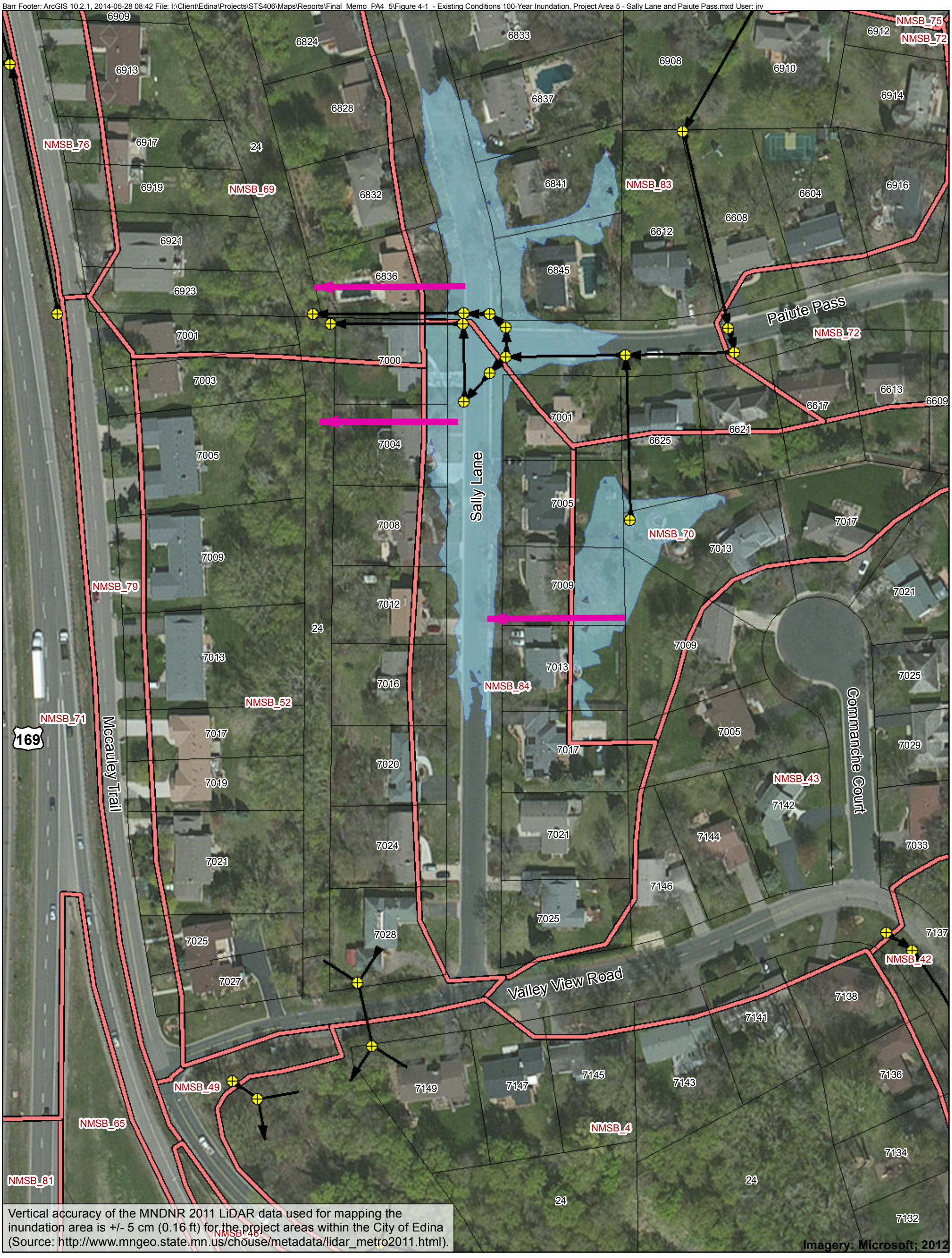
N

Feet
0 400 800

BARR

Figure 3-5

PROPOSED IMPROVEMENT OPTION A
Project Area 4 -
Cahill Road and Dewey Hill Road



Existing Manhole/Catch Basin

Surface Overflow

Existing Storm Sewer

100-Year 24-Hour Event Inundation Area*

Subwatersheds

Parcels

N

Feet

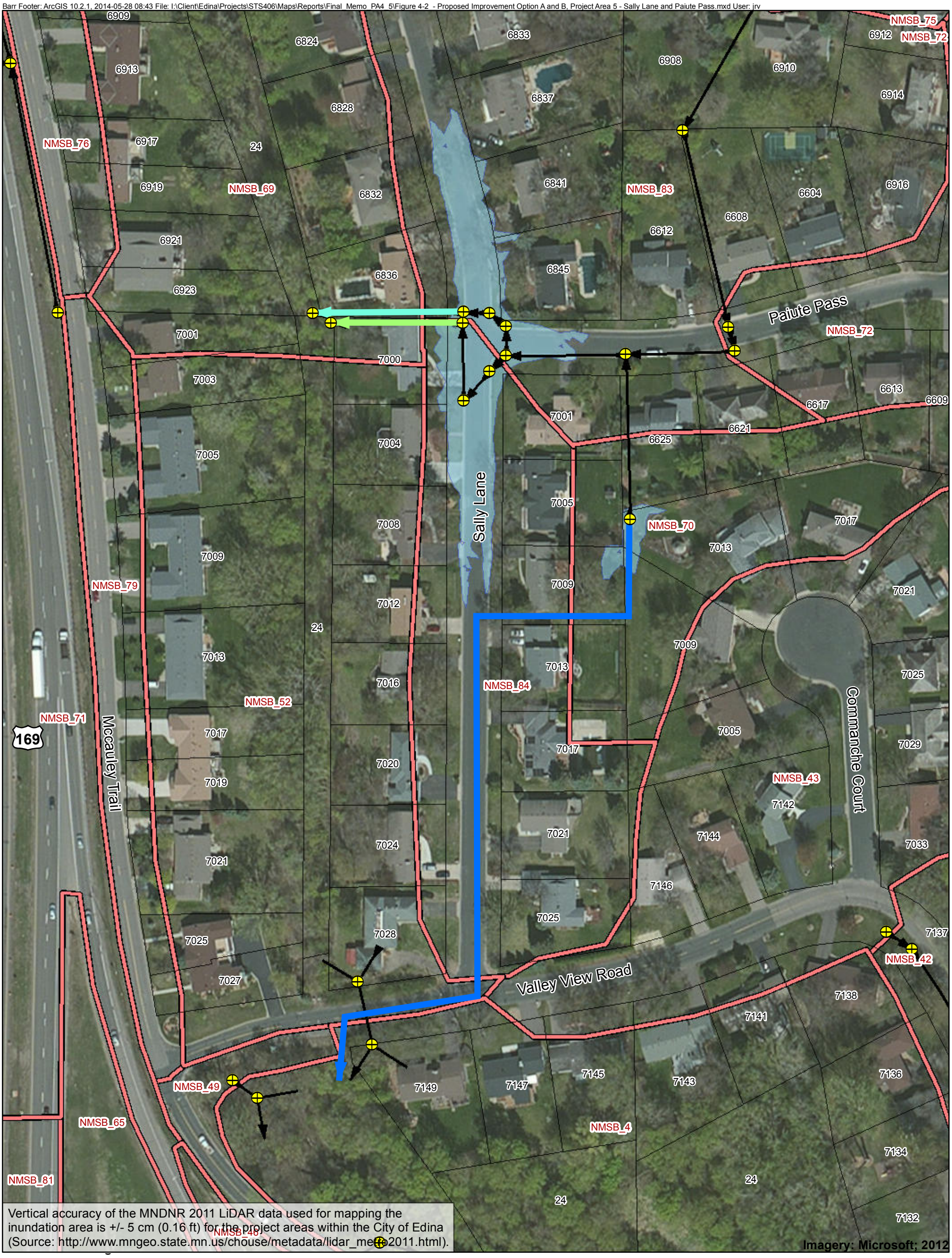
0 100 200

BARR

Figure 4-1

EXISTING CONDITIONS
100-YEAR INUNDATION
Project Area 5 -
Sally Lane and Paiute Pass

*Vertical Datum: NGVD 29, Feet



Existing Storm Sewer

Option A and B:
100-Year 24-Hour Event
Inundation Area*

Option A: Proposed Storm Sewer (2' pipe)

Option B: North Pipe (3' Pipe)

Option B: South Pipe (4' Pipe)

Subwatersheds

Parcels

*Vertical Datum: NGVD 29, Feet

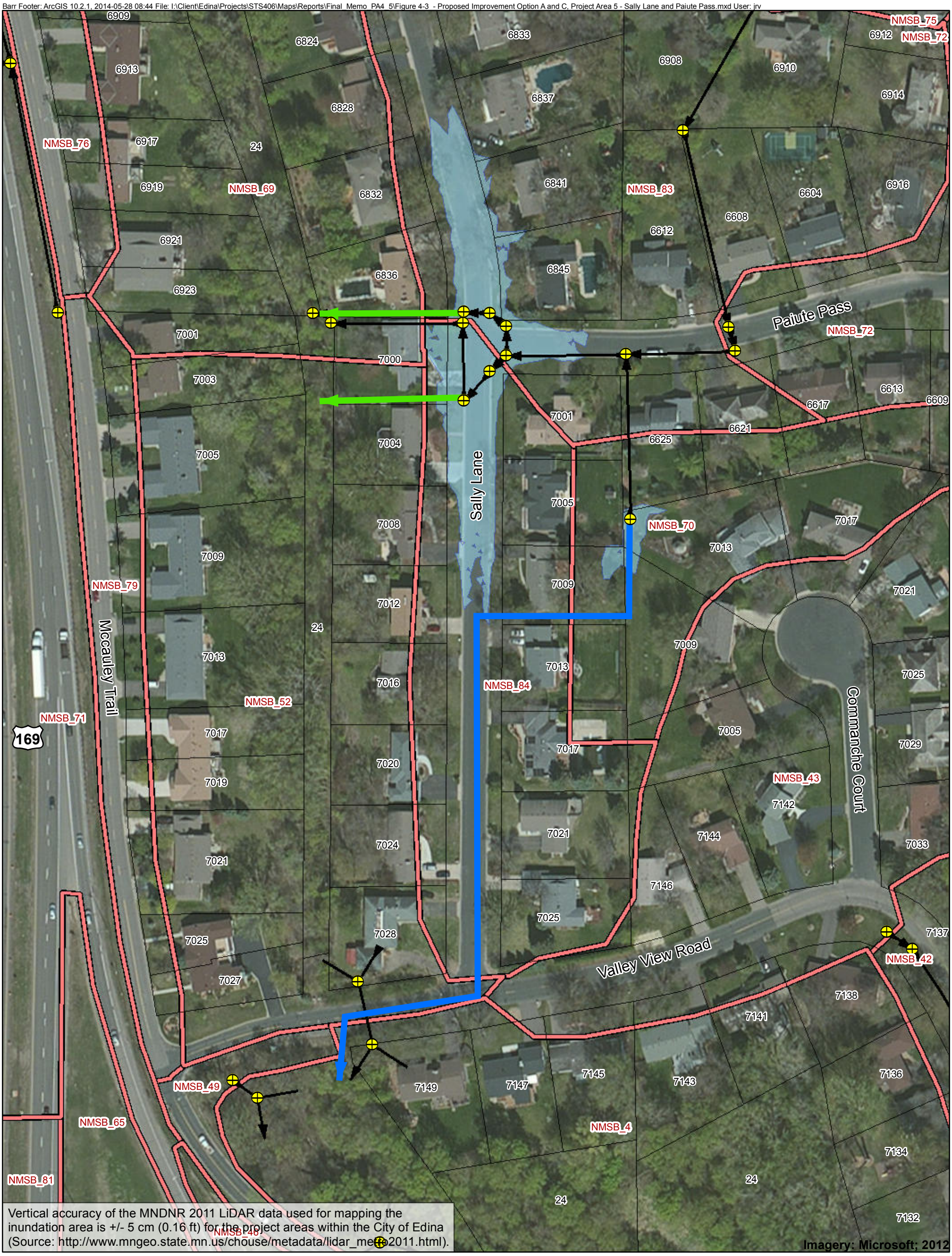
N

Feet
0 100 200

BARR

Figure 4-2

PROPOSED IMPROVEMENT
OPTIONS A AND B
Project Area 5 -
Sally Lane and Paiute Pass



Existing Manhole/Catch Basin

Existing Storm Sewer

Option A and C:
100-Year 24-Hour Event
Inundation Area*

Option A: Proposed Storm Sewer (2' pipe)

Option C: Overflow Channels

Subwatersheds

Parcels

*Vertical Datum: NGVD 29, Feet

N

Feet
0 100 200

BARR

Figure 4-3

PROPOSED IMPROVEMENT
OPTIONS A AND C
Project Area 5 -
Sally Lane and Paiute Pass

Appendices

Appendix A

Cost Estimate
Project Area 4—Cahill Road and Dewey Hill Road

ENGINEER'S OPINION OF PROBABLE COST: AREA 4, OPTION "A"
Cahill and Dewey
May 15, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 33,000.00	$ 33,000.00
TRAFFIC CONTROL	LS	1	$ 5,000.00	$ 5,000.00
EROSION CONTROL	LS	1	$ 7,000.00	$ 7,000.00
REMOVALS AND EARTHWORK				
SAW CUT BITUMINOUS PAVEMENT	LN FT	300	$ 3.50	$ 1,050.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	7515	$ 2.00	$ 15,030.00
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	1680	$ 5.00	$ 8,400.00
REMOVE TENNIS COURTS	SQ YD	1850	$ 2.00	$ 3,700.00
REMOVE TENNIS COURT FENCE	LS	1	$ 500.00	$ 500.00
EARTHWORK CUT AND DISPOSAL	CY	113000	$ 15.00	$ 1,695,000.00
FINAL GRADING	ACRE	14	$ 7,000.00	$ 98,000.00
STORM SEWER				
36" CPEP STORM SEWER, 4 to 12' DEPTH	LN FT	200	$ 52.00	$ 10,400.00
60" DIA RC CATCH BASIN	EACH	1	$ 3,500.00	$ 3,500.00
36" END SECTION	EACH	1	$ 400.00	$ 400.00
MODIFY OUTLET GRATE	EACH	1	$ 3,000.00	$ 3,000.00
STREET PAVEMENT				
8" AGGREGATE BASE CLASS 5	CU YD	2090	$ 34.00	$ 71,060.00
TOP SOIL BORROW	CU YD	11300	$ 20.00	$ 226,000.00
REPLACE B618 CONC. CURB & GUTTER	LN FT	1680	$ 13.50	$ 22,680.00
2" BITUMINOUS BASE COURSE	SQ YD	9365	$ 7.50	$ 70,237.50
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	9365	$ 8.50	$ 79,602.50
TENNIS COURT PAVEMENT	SQ YD	1850	$ 15.00	$ 27,750.00
TENNIS COURT FENCE	LN FT	520	$ 90.00	$ 46,800.00
SEEDING TURF GRASSES	AC	14	$ 5,000.00	$ 70,000.00
SITE RESTORATION	LS	1	$ 10,000.00	$ 10,000.00
SUB TOTAL				**$2,508,110.00**
OTHER				
CONTINGENCY			30%	$ 752,433.00
ENGINEERING AND DESIGN			15%	$ 489,081.45
CONSTRUCTION ADMINISTRATION AND OBSERVATION			7%	$ 228,238.01
AREA 4, OPTION A TOTAL COST				**$3,977,862.46**

Appendix B

Cost Estimates
Project Area 5—Sally Lane and Paiute Pass

ENGINEER'S OPINION OF PROBABLE COST: AREA 5 OPTION "A"
Sally Lane and Paiute Pass, Outflow Pipe

May 15, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 17,000.00	$ 17,000.00
TRAFFIC CONTROL	LS	1	$ 5,000.00	$ 5,000.00
SEEDING TURF GRASSES	AC	0.13	$ 12,500.00	$ 1,625.00
SITE RESTORATION	LS	1	$ 5,000.00	$ 5,000.00
TEMPORARY AND PERMANENT EROSION CONTROL				
SILT FENCE	LN FT	500	$ 3.50	$ 1,750.00
INLET PROTECTION	EACH	10	$ 350.00	$ 3,500.00
CAT. 4 EROSION CONTROL BLANKET	SQ YD	600	$ 1.85	$ 1,110.00
REMOVALS				
SAW CUT BITUMINOUS PAVEMENT	LN FT	600	$ 3.50	$ 2,100.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	935	$ 2.00	$ 1,870.00
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	410	$ 5.00	$ 2,050.00
STORM AND SANITARY SEWER				
24" CPEP - 4 TO 12' DEPTH	LN FT	930	$ 30.00	$ 27,900.00
24" FES	EACH	1	$ 500.00	$ 500.00
CONNECT TO EXISTING STORM SEWER	EACH	1	$ 500.00	$ 500.00
48" DIA. RC CATCH BASIN, COMPLETE	LN FT	30	$ 300.00	$ 9,000.00
60" DIA. RC CATCH BASIN, COMPLETE	LN FT	30	$ 650.00	$ 19,500.00
STREET PAVEMENT/RESTORATION				
8" AGGREGATE BASE CLASS 5	CU YD	210	$ 34.00	$ 7,140.00
REPLACE B618 CONC. CURB & GUTTER	LN FT	410	$ 13.50	$ 5,535.00
2" BITUMINOUS BASE COURSE	SQ YD	935	$ 7.50	$ 7,012.50
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	935	$ 8.50	$ 7,947.50
TOP SOIL BORROW	CU YD	100	$ 20.00	$ 2,000.00
SUBTOTAL				**$ 128,040.00**
OTHER				
CONTINGENCY		30%		$ 38,412.00
ENGINEERING AND DESIGN		15%		$ 24,968.00
CONSTRUCTION ADMINISTRATION AND OBSERVATION		7%		$ 11,652.00
AREA 5, SALLY LANE, OPTION A TOTAL COST				**$ 203,072.00**

ENGINEER'S OPINION OF PROBABLE COST: AREA 5 OPTION "B"
Sally Lane and Paiute Pass - Increased Pipe Size at Overflow

May 15, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 13,000.00	$ 13,000.00
TRAFFIC CONTROL	LS	1	$ 2,000.00	$ 2,000.00
SEEDING TURF GRASSES	AC	0.1	$ 12,500.00	$ 1,250.00
SITE RESTORATION	LS	1	$ 4,000.00	$ 4,000.00
TEMPORARY AND PERMANENT EROSION CONTROL				
SILT FENCE	LN FT	450	$ 3.50	$ 1,575.00
INLET PROTECTION	EACH	7	$ 350.00	$ 2,450.00
CAT. 4 EROSION CONTROL BLANKET	SQ YD	470	$ 1.85	$ 869.50
REMOVALS				
SAW CUT BITUMINOUS PAVEMENT	LN FT	40	$ 10.00	$ 400.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	40	$ 5.00	$ 200.00
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	40	$ 5.00	$ 200.00
REMOVE 24" RCP	LN FT	390	$ 10.00	$ 3,900.00
STORM AND SANITARY SEWER				
36" CPEP - 4 TO 12' DEPTH	LN FT	210	$ 52.00	$ 10,920.00
36" FES	EACH	1	$ 500.00	$ 500.00
48" CPEP - 6 TO 12' DEPTH	LN FT	190	$ 73.00	$ 13,870.00
48" FES	EACH	1	$ 800.00	$ 800.00
CONNECT TO EXISTING STORM SEWER	EACH	2	$ 500.00	$ 1,000.00
60" DIA. RC CATCH BASIN, COMPLETE	LN FT	36	$ 650.00	$ 23,400.00
CLASS 5 RIPRAP WITH FILTER	TON	60	$ 75.00	$ 4,500.00
STREET PAVEMENT				
8" AGGREGATE BASE CLASS 5	CU YD	80	$ 34.00	$ 2,720.00
REPLACE B618 CONC. CURB & GUTTER	LN FT	40	$ 13.50	$ 540.00
2" BITUMINOUS BASE COURSE	SQ YD	40	$ 7.50	$ 300.00
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	40	$ 8.50	$ 340.00
TOP SOIL BORROW	CU YD	80	$ 20.00	$ 1,600.00
SUBTOTAL				**$ 90,334.50**
OTHER				
CONTINGENCY		30%		$ 27,100.00
ENGINEERING AND DESIGN		15%		$ 17,615.00
CONSTRUCTION ADMINISTRATION AND OBSERVATION		7%		$ 8,220.00
AREA 5, SALLY LANE, OPTION B TOTAL COST				**$ 143,270.00**

ENGINEER'S OPINION OF PROBABLE COST: AREA 5 OPTION "C"
Sally Lane and Paiute Pass - Channel with Walls at Overflow

May 15, 2014

ITEM DESCRIPTION	UNIT	AMOUNT	UNIT COST	TOTAL COST
MOBILIZATION/DEMOBILIZATION	LS	1	$ 12,500.00	$ 12,500.00
TRAFFIC CONTROL	LS	1	$ 2,000.00	$ 2,000.00
SEEDING TURF GRASSES	AC	0.1	$ 12,500.00	$ 1,250.00
SITE RESTORATION	LS	1	$ 4,000.00	$ 4,000.00
TEMPORARY AND PERMANENT EROSION CONTROL				
SILT FENCE	LN FT	450	$ 3.50	$ 1,575.00
INLET PROTECTION	EACH	7	$ 350.00	$ 2,450.00
CAT. 4 EROSION CONTROL BLANKET	SQ YD	120	$ 1.85	$ 222.00
REMOVALS				
SAW CUT BITUMINOUS PAVEMENT	LN FT	40	$ 10.00	$ 400.00
REMOVE BITUMINOUS PAVEMENT	SQ YD	40	$ 5.00	$ 200.00
REMOVE CONC. CURB & GUTTER (B-618)	LN FT	40	$ 5.00	$ 200.00
REMOVE 24" RCP	LN FT	390	$ 10.00	$ 3,900.00
STORM SEWER AND WALLS				
CONCRETE SLAB	CY	23.5	$ 390.00	$ 9,165.00
CONCRETE VERTICAL WALLS	CY	17.8	$ 490.00	$ 8,722.00
DECORATIVE CONCRETE	SF	720	$ 12.00	$ 8,640.00
RAILING	LF	190	$ 150.00	$ 28,500.00
CLASS 5 RIPRAP WITH FILTER	TON	100	$ 75.00	$ 7,500.00
STREET PAVEMENT				
8" AGGREGATE BASE CLASS 5	CU YD	80	$ 34.00	$ 2,720.00
REPLACE B618 CONC. CURB & GUTTER	LN FT	40	$ 13.50	$ 540.00
2" BITUMINOUS BASE COURSE	SQ YD	40	$ 7.50	$ 300.00
2" BITUMINOUS WEARING COURSE W/TACK	SQ YD	40	$ 8.50	$ 340.00
TOP SOIL BORROW	CU YD	20	$ 20.00	$ 400.00
SUBTOTAL				**$ 95,524.00**
OTHER				
CONTINGENCY		30%		$ 28,657.00
ENGINEERING AND DESIGN		15%		$ 18,627.00
CONSTRUCTION ADMINISTRATION AND OBSERVATION		7%		$ 8,693.00
AREA 5, SALLY LANE, OPTION C TOTAL COST				**$ 151,501.00**