# REPORT / RECOMMENDATION

**To:** MAYOR AND COUNCIL

**Agenda Item #:** VIII. F.

**From:** Chad Millner PE, - Interim City Engineer

**Action** ☒
**Discussion** ☐
**Information** ☐

**Date:** December 17, 2013

**Subject:** Accept Report and Authorize Professional Services – Trunk Sanitary Sewer Lining.

**Action Requested:**
Accept report and authorize City Manager to sign professional services proposal with Bolton and Menk, Inc. for trunk sanitary rehabilitation design and construction services.

**Information / Background:**
The City of Edina sanitary sewer system was designed to transmit daily and peak flows without surcharge and with minimal risk of human exposure. The sanitary conveyance system is aging; the majority built between 1950 and 1970, with portions built prior to 1940. Efficiently and effectively maintaining this critical infrastructure system requires study and prioritization. The attached report is the latest effort to understand system function and prioritize interventions to maintain it. This is the first study to investigate the system of "trunk" sanitary sewers, those large and deep lines that constantly carry millions of gallons of wastewater each day.

The attached Trunk Sanitary Sewer Infiltration Study Report spells out risk factors to clear water infiltration and inflow (I/I). The report recommends trunk lining and manhole rehabilitation projects that address the oldest and most degraded and leaking pipes in the system, further investigation where risk factors point to high I/I potential, and continued periodic review for lines in good condition. The development of this report coincided with, and was informed by, the first televising of these trunk pipes. The televising was made possible by the purchase of a new, larger sewer camera and cable reel purchased as part of CIP item UT-11-008 in early 2013 and contracted sewer televising conducted this fall.

The first trunk sewer lining project envisioned in CIP item UT-08-014 was split into two implementation years, 2013 and 2014, totaling $1.14 million over the two years. The attached proposal would develop plans and specifications for two project areas, combined into a single project as described below. Funding planned for 2013 would be extended into 2014, thus modifying the approved CIP. This prospective project is eligible for approximately $195,200 in grant funding secured though the Metropolitan Council and authorized by the City Council on February 19, 2013.

The attached proposal would prepare plans and specifications for trunk lining and manhole rehabilitation for project areas 1 and 2 (Table 2) as described in the report. This area extends from Xerxes Avenue and Minnehaha Creek, upstream, under France Avenue to Woodland Circle and Woodland Lane (Figure 16 and 17). The project challenges would include a temporary bypass, tight access along backyards in the Minnehaha Creek corridor, significant disruption of service to around 16-20 households with service

connections directly off the trunk line or near access manholes, and minor disruption of service to a handful of nearby lateral lines and to local traffic. Communication and coordination with affected residents is included in the proposal.

The proposed schedule would include design in January and February, bid advertisement and bid opening in March, to return to the City Council for consideration of bid award on April 1. If the City Council approves the project on April 1, the work would begin in early April and be complete by June 30.

Project funding summary:

| **ITEM** | **COST / ESTIMATE** | **CITY COUNCIL DATE /SCHEDULE** |
|---|---|---|
| Trunk Sanitary Sewer Infiltration Study | $47,336 (actual) | 6/18/2013 |
| Project area 1 and 2 Design | $52,464 (estimate) | 12/17/2013 |
| Project area 1 and 2 project management | $100,000 (estimate) | 4/1/2014 |
| Project area 1 and 2 construction | $1,000,000 (estimate) | 4/1/2014 |
| **TOTAL** | **$1,199,800 (estimate)** | |

Funding Sources summary:

| **ITEM** | **AMOUNT** | **CITY COUNCIL DATE** |
|---|---|---|
| CIP UT-08-014 2013 | $540,000 | 2012 |
| CIP UT-08-014 2014 | $600,000 | 2012 |
| Met Council I/I abatement grant | $195,200 | 2/19/2013 |
| **TOTAL** | **$1,335,200** | |

Additional reimbursement through the Met Council I/I abatement grant total approximately $362,700.

**Attachments:**
Proposal for Engineering Services – Bolton and Menk
Trunk Sanitary Sewer Infiltration Study Report – Bolton and Menk

BOLTON & MENK, INC.
Consulting Engineers & Surveyors
12224 Nicollet Avenue • Burnsville, MN 55337
Phone (952) 890-0509 • Fax (952) 890-8065
www.bolton-menk.com

December 5, 2013

Mr. Ross Bintner, P.E., Environmental Engineer
City of Edina – Engineering Department
7450 Metro Boulevard
Edina, MN 55439

RE: SUPPLEMENTAL LETTER AGREEMENT
2014 Trunk Sewer Rehabilitation Improvements
City of Edina, Minnesota

Dear Mr. Bintner,

Bolton & Menk, Inc. is pleased to present this proposal to you for professional engineering services in support of its 2014 Trunk Sewer Rehabilitation Improvements. As a part of this proposal, we describe our understanding of the project, detail our proposed scope of work, and provide our fees for service. This proposal is being offered as a Supplemental Agreement to our June 18, 2013 Master Agreement for Professional Engineering Services with the City of Edina.

## PROJECT UNDERSTANDING

The City of Edina recently completed an evaluation of its trunk sanitary sewer system in order to identify sewer segments susceptible to infiltration problems and to prioritize trunk sewer lines for future rehabilitation and renewal. The study concluded that the 24" vitrified clay pipe (VCP) along Minnehaha Creek has a high potential for infiltration. This conclusion was confirmed via subsequent televising of the sewer pipe, which revealed active infiltration into the pipe.

Earlier this year, the City secured grant monies from the Metropolitan Council in support of rehabilitation projects along its trunk sewers which would reduce infiltration into its sanitary sewer system. At this time, the City is interested in proceeding with a grant-eligible cured in place pipe (CIPP) lining project along the Minnehaha Creek trunk sewer. The segment of trunk sewer encompassed by this project stretches from the intersection of Woodland Lane and Woodland Circle, downstream along Minnehaha Creek to the intersection of Xerxes Avenue and West 54th Street. The length of this sewer is approximately 4700 feet.

The City of Edina has requested this proposal from Bolton & Menk to complete final design, bidding, and construction observation and administration services in support of this project.

## SCOPE OF WORK

Bolton & Menk proposes to complete the following services:

### Final Design and Bidding

1. Project base mapping, utilizing existing City of Edina GIS map layers.
2. Field confirmation of existing ground cover conditions and sewer manhole locations, conditions and accessibility.

3. Meet with selected adjacent property owners to discuss and negotiate temporary access to the trunk sewer system for construction purposes (up to 6 meetings).
4. Prepare technical construction plans and specifications for CIPP lining improvements and manhole improvements along the trunk sewer.
5. Identify temporary sewer bypassing needs and establish parameters for inclusion in bidding documents.
6. Conduct a neighborhood open house to discuss the proposed project and expectations during construction.
7. Complete and submit required construction permit applications (fees to be paid by City).
8. Prepare project cost estimates.
9. Prepare bidding documents.
10. Advertise project according to standard City practices.
11. Address contractor questions during the bidding period and distribute any necessary addenda.
12. Conduct bid opening, evaluate bids, and make recommendation for project award.
13. City progress meetings (up to 2 meetings).

### Construction Services

1. Facilitate execution of construction contract between City and contractor.
2. Conduct preconstruction meeting.
3. Review construction material submittals and shop drawings.
4. Conduct preconstruction neighborhood open house.
5. Provide construction observation and administration services including, but not limited to, conducting weekly construction meetings, serve as a liaison between the City, its residents and the contractor, review of the work for general conformance with construction documents, review of material test results, maintenance of construction documentation, preparation of pay estimates and any necessary change orders.
6. Completion of record drawings.

We understand the City's desire to utilize its own staff to provide construction services to the extent practical during construction. Therefore we are prepared to adjust our levels of construction services in accordance with the City's requests and requirements.

## PROPOSED FEES

Estimated fees for the final design and bidding services as described above are summarized as follows:

| | |
|---|---|
| Base Mapping and Field Verifications | $ 6,566 |
| Discuss Site Access with Affected Residents | $ 2,232 |
| Technical Construction Plans & Specifications | $30,484 |
| Design Phase Open House | $ 1,440 |
| Permit Applications | $ 1,272 |
| Project Cost Estimates | $ 2,948 |
| Bidding Documents | $ 2,224 |
| Bidding Assistance | $ 3,024 |
| City Progress Meetings | $ 2,274 |
| **TOTAL** | **$52,464** |

The costs for these individual work tasks are estimates. Bolton & Menk proposes to complete the final design and bidding services for a not-to-exceed fixed fee of $52,464.

Because the consultant does not have direct control over the construction contractor's operations or schedule, our construction observation and administration services are provided on an hourly basis. Personnel rates for anticipated staffing are as follows:

| | |
|---|---|
| Principal Engineer: | $160 per hour |
| Project Manager: | $119 per hour |
| Construction Observer: | $114 per hour |
| Engineering Technician: | $94 per hour |

If you find this proposal satisfactory, your signature of this proposal will constitute acceptance of the terms outlined and your authority for us to proceed. Please call if you wish to discuss this proposal. We look forward to providing these professional engineering services to you on this project and appreciate your consideration of Bolton & Menk, Inc.

Sincerely,

**BOLTON & MENK, INC.**

Marcus A Thomas

Marcus A. Thomas, P.E.
Principal Engineer

_____ _____
Signed Date

_____
Printed Name

# Trunk Sanitary Sewer Infiltration Study Report

## City of Edina, Minnesota

**December 2013**

**Project No. T16.106814**

BOLTON & MENK, INC.
Consulting Engineers & Surveyors

**CERTIFICATION**

Preliminary Engineering Report

for

**Trunk Sanitary Sewer Infiltration Study Report**

City of Edina
Edina, Minnesota
T16.106814

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

By: Marcus A Thomas

Marcus A. Thomas
License No. 26499

Date: 12/5/2013

## TABLE OF CONTENTS


I. STUDY BACKGROUND ..... 1

II. STUDY PURPOSE ..... 2

III. AVAILABLE STUDY BACKGROUND MATERIAL AND DATA ..... 2

IV. ANALYSIS OF AVAILABLE DATA ..... 4

V. PIPE REHABILITATION METHODS ..... 7

VI. RECOMMENDED PROJECT LIMITS ..... 9


## APPENDIX


FIGURE 1 ..... SANITARY SERVICE AREA SUMMARY

FIGURE 2 ..... ENVIRONMENTAL FEATURES & IMPAIRED WATERS

FIGURE 3 ..... DEVELOPMENT & SEWER CONSTRUCTION HISTORY

FIGURE 4 ..... YEARS OF DEVELOPMENT AND REDEVELOPMENT PROJECTS

FIGURE 5 ..... TRUNK SEWER PIPE DEVEOPMENT AGE

FIGURE 6 ..... OVERALL INFILTRATION SUMMARY

FIGURE 7 ..... OVERALL INFILTRATION PER ACRE SERVICE AREA

FIGURE 8 ..... GROUNDWATER DEPTH ABOVE INVERT

FIGURE 9 ..... DRY WEATHER PIPE CAPACITY

FIGURE 10 ..... PIPE MATERIAL

FIGURE 11 ..... SERVICE CONNECTIONS ALONG TRUNK LINES

FIGURE 12 ..... PIPE SIZE

FIGURE 13 ..... TRUNK SEWER INFILTRATION ABATEMENT PRIORITY

FIGURE 14 ..... 5-YEAR ROAD IMPROVEMENT PLAN

FIGURE 15 ..... EXAMPLE OF PROJECT SYNERGIES

FIGURES 16 TO 32 ..... REHAB PROJECTS

# I. STUDY BACKGROUND

This trunk sanitary sewer infiltration study report was ordered in support of the City of Edina's overarching goals of reducing infiltration and inflow into its sanitary sewer system, and renewal of its aging sanitary conveyance system. The City's Wastewater and Comprehensive Sewer Plan defines the "service" the City provides as "effective and efficient removal of sanitary sewage for all areas of the City of Edina, while also eliminating inflow and infiltration, protecting the health, safety and welfare of our citizens, and supporting the needs of a dynamic and sustainable community."

Identification and reduction of infiltration and inflow (I/I) has been a regional priority of Metropolitan Council Environmental Services (MCES). Infiltration, which typically contributes a continuous flow of "clean water" into the system through cracked pipes and manholes, increases the City's flows into MCES facilities and directly increases costs to the City for the ongoing treatment of these excess flows. Inflow typically comes through illicit storm water connections into the sanitary sewer system (e.g., roof drains, sump pump drains, etc.) or surface openings such as openings in manhole lids, and deteriorating rings and castings. These flows are less continuous but typically cause greater flow "spikes" during storm events and can exceed pipe capacity and cause system backups and consequential damages. A current response by MCES is to assess a surcharge to those municipalities exhibiting these types of spikes in their systems.

*Recent Evaluations and Mitigation Efforts*

The City of Edina recognizes both the regional and local implications of I/I and continues to take action toward eliminating these problems within the City. Past steps taken by the City include various studies and field evaluations. Large area I/I studies were completed in 1983 (Donohue) and 1997 (TKDA) which quantified volumes of I/I entering the City's sanitary sewer system, provided estimated costs for system rehabilitation, and identified neighborhoods with sump pump connections to the sanitary sewer. Pipe televising and field inspections of sewer manholes have been completed in advance of neighborhood reconstruction projects to identify necessary sewer infrastructure improvements; the result being replacement and rehabilitation projects implemented throughout the City's system. Local sewer system analyses have been completed in conjunction with redevelopment projects to determine capacity needs. In 2005/2006, Barr Engineering collected sewer flow meter readings and completed system wide modeling to estimate general volumes of infiltration being carried by the trunk sewer system. Most recently, the City has been televising the trunk sewer system, much of which has never been visually inspected to this degree in the past.

*Special Trunk Sewer Considerations*

Sanitary trunk sewers, which are the focus of this study report, are the primary pipes within the City of Edina's sanitary sewer system. In addition to their larger diameter, these trunk lines can generally be identified by their deeper depths and by their alignments along creeks and other low terrain. The trunk lines are a critical component of the City's sanitary sewer system, as they ultimately collect and rout all sewer flows out of the City and into MCES facilities. It is imperative that the trunk sewers are maintained in a structurally sound condition and are free of excessive "clear water" flows via groundwater infiltration. Therefore, the rehabilitation priority recommendations given in this report are in support of both necessary system renewal and infiltration reduction. The trunk sewer system that is the subject of this study is illustrated in Figure 1.

The City of Edina's trunk lines are relatively aged, and based on previous assessments as described above, groundwater and storm water infiltration flows into the trunk lines are evident. Specific attributes of the trunk sewer system that raise concerns of I/I problems include pipe alignments along creek beds, high groundwater, and flood-prone zones; exposure of deteriorating manholes; antiquated manhole covers (including those with vent hole openings); and overall age, material type and diameter of the trunk sewer pipes. These attributes, which are given further consideration in this report, can be correlated to various levels of potential infiltration within the trunk sewer system. Finally, it should be noted that while a focus on the City's trunk sewer system is certainly warranted, it is also important to recognize the I/I potential of the broader lateral (or neighborhood) sanitary sewers throughout the City, and that the City of Edina should continue its proactive practice of lateral system evaluation and maintenance.

## II. STUDY PURPOSE

This trunk sewer infiltration study supports the City of Edina's objectives of reducing infiltration into its sanitary sewer system, initiating an overall trunk sewer system renewal process and the establishment of a service-reliable, next-generation trunk sewer system. This report includes recommendations for prioritizing trunk sewer system segments for rehabilitation, along with a preliminary identification of individual project areas. A discussion of various rehabilitation methods is included, with a focus on cured in place pipe (CIPP) lining as a viable trenchless alternative for many of the trunk sewer segments. Estimated project costs are also provided for capital improvement planning.

## III. AVAILABLE STUDY BACKGROUND MATERIAL AND DATA

Several sources of information were assembled for this study to define the sanitary system and its proximity to other physical system components. Important relationships between quantitative and qualitative information were also developed as a method to measure specific system characteristics and their effect on potential infiltration.

*GIS Information*

The City of Edina has a comprehensive inventory of its existing sanitary system maintained in a geographical information management system (GIS). This includes geometric information for manholes, gravity pipe, force mains, lift stations, service connections, valves, and fittings. Other GIS data provided by the City includes groundwater depth information and development age. The available data is further summarized below.

- Sanitary system wide data**:** The attributed data contained in the City's sanitary system GIS is extensive. Manhole information includes elevation data when available; information on the physical condition and the date of inspection; structure type and material; and a unique identity number. Pipe information, including gravity and pressure main, includes diameter, material, length, slope (where available), and additional inspection records. Other system information incorporated in the GIS includes services, lift stations, supervisory control and data acquisition (SCADA) sensors, pipe fittings, valves, pipe casings, and clean out structures.
- Ground water elevation model: A Metropolitan Area Groundwater Flow Model was developed by Met Council and Barr Engineering, et al, for the Twin Cities area called Metro Model 2, which further enhanced a model developed by the MPCA in 2000. One product of Metro Model 2 is the approximate water elevation of the aquifer based on water budget data, historic climate data, stream elevations, and well information. The data is stored as a digital

elevation model (DEM); each cell in the DEM raster represents a water table elevation. The approximate resolution of the data is +/- 20 feet vertically. Therefore the data was considered preliminary and approximate and used as a relative comparison to structure elevations.

- Citywide development age: Utilizing historic development information, the City assembled a map showing the principal periods of significant residential construction from 1940 (and before) to 1970 (and after) in 10 year increments. The map was digitized by Bolton & Menk in GIS to be used for geospatial analysis, as seen in Figure 3. The City also provided parcel information including the actual age of development and redevelopment. This data is shown in Figure 4. While the parcel information was useful in determining when construction activity took place on the parcel, it does not always correlate to the age of the sanitary system. Therefore, Figure 3 was used to develop approximate pipe age.
- Flow meter locations: In 2005, several temporary flow meters were installed throughout the system to collect wet and dry weather flows at key discharge points. The locations of the flow meters were used to develop the contributing sanitary service area including gravity main, force main, lateral lines, and services. These areas are illustrated in Figure 1. The flow meters, in conjunction with approximate infiltration summary data developed by Barr Engineering, were then used to develop relationships between service area, length of pipe, age of development, and other system parameters and approximate infiltration.
- Other statewide and regional data: Additional GIS data was collected in the area from state, county, and local sources including light detection and ranging (LiDAR) mapping, surface water information, and parcels. While most of the data was utilized for display, some was used to develop important proximity relationships.

*City Wide Sanitary Sewer Model*

The City of Edina and Barr Engineering established a hydraulic model of the sanitary sewer system using XPSWMM in 2005/2006 to develop dry and wet weather system capacities and to identify areas in the City where I/I was likely originating. In 2008, an effort to update and calibrate the hydraulic model was performed utilizing Met Council flow monitoring locations at the City's trunk outfalls plus several flow meters along the trunk lines at key locations throughout the City. Figure 1 identifies the metering locations and corresponding service areas. The flow monitoring was performed during drier, winter months to establish a better base flow condition and during the spring months to capture system flows during a high likelihood of rainfall. The difference between the modeled base flow and calibrated peak wet weather flow hydrographs correlated the expected infiltration. The results of this analysis were summarized for each of the meter locations.

*2008 Sanitary Sewer Comprehensive Plan*

Chapter 8 of the City's Comprehensive Plan, addresses Water Resources Management, including a comprehensive plan for wastewater and sanitary sewer. Since the City is fully developed, the Comprehensive Plan addresses system capacity and required improvements for major areas of redevelopment, increases in residential and commercial development densities, and anticipated future land use changes. Based on two development scenarios, increases in the trunk sewer and resulting increase in flow to MCES interceptors were summarized. The Comprehensive Plan indicates that two thirds if the City's sewage flows into MCES meter M-129 and into interceptor 1-RF-491. This interceptor is critical to the planning of Edina's future growth since the majority of planned future flow increases will be directed to this interceptor. As a result, the City has mapped the potential trunk sewer upgrades in their Comprehensive Plan which is utilized to help the City prioritize sewer improvements based on future capacity needs and level of current infiltration. See Figure S-4 in the 2008 Comprehensive Plan.

*Field Observations*

On August 8th, 2013, Bolton & Menk staff completed a field analysis of the trunk sewer lines analyzed in this project. The goals of the field observations were to analyze the trunk system on the ground, locate critical manholes, determine access points for rehabilitation equipment, identify areas where open-cut replacement options were viable, and formulate a set of notes to help establish future project locations.

*Sewer Televising*

The City of Edina Public Works Department has televised several thousand feet of sewer to collect critical information regarding the condition of pipes and manholes that indicate sources of infiltration. The City has also contracted for the televising of other critical pipe segments. Televising of pipe segments reveals crushed and cracked pipe, separated joints, root intrusion, leaky services, pipe material where previously unknown, signs of infiltration in manholes, and a wealth of other information that is otherwise impossible to collect.

*Local Knowledge from City Staff*

The City's cumulative knowledge of the trunk system provided specific information that may otherwise not be evident in the GIS and televising. This includes areas with known issues, lift station conditions, areas of future bypass or relief lines, areas with regular sewer backup issues, specific pipe rehab and concrete encasing projects, and other anecdotal and qualitative information useful in determining the condition of the existing system.

## IV. ANALYSIS OF AVAILABLE DATA

The available study materials and background information was organized and populated in a GIS database to develop geospatial relationships that identify trunk sewer infiltration potential and prioritize rehabilitation. A system was developed to assign a rating to each level of data acquired so that the cumulative "score" could be easily compiled.

*Quantitate Infiltration Data*

Infiltration data provided by Barr Engineering and the location of the flow meters in the system were used to establish sanitary service areas, which are displayed in Figure 1 with additional system information summarized further. Flow data collected at the meters during dry and wet weather periods and the resulting estimates of infiltration based on hydraulic model calibration was used as a predictor of the degree of infiltration within the service area. It is difficult, however, to directly correlate infiltration on the trunk line to this data because of the unknown infiltration potential in the extensive upstream lateral system. For instance, while the meter-shed associated with temporary meter 4 has the second highest calculated infiltration, it also has nearly 37 miles of trunk sewer and 2500 service connections.

Figure 6 shows the overall results of the infiltration analysis for each meter-shed associated with the 2005 temporary meter locations. Another representation of the data is to normalize the data over the area to better predict the severity of infiltration. Figure 7 shows the result of the normalization. When comparing Figures 6 and 7, it is observed that the distribution of infiltration across the city changes when the data is normalized over area. Other techniques were considered, including normalizing the data based on number of service connections along the trunk line or length of lateral or trunk line pipe. However, it is still difficult to target the source of infiltration without additional flow data and modeling in the lateral systems.

*Compiled Qualitative Data*

Information regarding known sources of infiltration, historic sewer backups, and previously determined pipe upgrade recommendations was compiled to help further prioritize future rehabilitation projects. While this information was not used to enhance or inhibit a pipe segment's need for rehabilitation, it was used to check the results of this physical system analysis to verify its accuracy.

*Creation of the Prioritization Database*

As described above, several sources of system information were provided to compile a database that was manipulated to describe the primary sources of infiltration in the system. In all cases, the study trunk sewer pipe was utilized to create a set of raster, or grid data that describes each of the prioritization criteria. Using this method, rasters are reclassified to rank the importance of layer in terms of infiltration potential, and a summation of the relative infiltration risks is utilized to calculate the cumulative ranking. The final layers used to prioritize rehabilitation projects are described below. The referenced figures include a color gradation from green to yellow to red defining low to medium to high (respectively) infiltration potential. This study is focused on the trunk lines' contribution to infiltration only. The upstream lateral system is also a critical component to overall infiltration. The limitations of each analysis layer are also discussed below.

- Age of development: Pipe age was correlated to the development age information provided by the City (Figure 3). The result of this intersection is shown in Figure 5. The age categories used were based on the historic development information maintained by the City. In this case, it is assumed that older pipe has a higher likelihood of infiltration.
- Groundwater depth: Sanitary manhole structure invert (pipe elevation) data was compared to the Metro Model 2 groundwater elevation model to determine the height of groundwater above the invert. Manholes along the trunk sewer line were selected and used to intersect with groundwater elevations. Subtracting the groundwater depth from the invert generates a depth of groundwater above the invert. In some cases, the manhole invert has two or more feet of separation from the water table. In others, the depth above the invert was as much as 21 feet. The higher the groundwater depth above the invert, the higher the correlation to infiltration. Figure 8 shows the resulting raster generated from the manhole intersection along the trunk sewer line.
- Dry weather pipe capacity: Dry weather pipe capacities were provided by Barr Engineering from the 2008 hydraulic model to determine the current level of service of the trunk sewer pipe. While dry weather capacity is not correlated to infiltration, it does provide information on what trunk lines need to be replaced and upsized. In an open cut rehabilitation, it is crucial that the City understands the current capacity and installs a pipe that meets future growth patterns. Figure 9 shows the City's service level as of 2008. Lower capacity pipes are given a higher priority of rehabilitation. We understand that the City is currently in process of updating the 2008 hydraulic system model with current land use and service flows. This new information, when available, can be reviewed in conjunction with the modeling results of this study to determine if any the recommendations in this report need updating.
- Pipe material: The City's sewer system GIS contains information regarding pipe material. The pipes in Edina consist of vitrified clay pipe (VCP), reinforced concrete pipe (RCP), cast iron pipe (CIP), and pipe that has already undergone a cured-in-place pipe (CIPP) rehabilitation. Pipe age, and often condition, can be correlated to pipe material. VCP is the oldest material in town and has the highest probability of leaking joints or other significant structural issues. While RCP is strong, it can be susceptible to deterioration by long term exposure to hydrogen sulfide gases generated by wastewater. This is evident in some recent

sewer television videos that illustrate spalling (loss of cement) along the crown of some concrete pipes. This type of deterioration, particularly in the vicinity of individual pipe joints, can often lead to infiltration. CIP and CIPP are less susceptible to infiltration. Figure 10 shows the locations of pipe material in the City along the trunk lines. This data describes infiltration susceptibility along the trunk line only. A CIP or CIPP trunk line may include lateral systems that are all VCP, indicating that the trunk line is not the only culprit susceptible to infiltration.

- Service connection frequency: Figure 11 shows the number of service connections per 1,000 feet of trunk line. Service connections are a critical point for infiltration. Therefore, a higher number of service connections can lead to a higher infiltration potential. However, service connections along lateral lines must also be considered in the overall infiltration potential. A trunk line with no service connections can still have a large infiltration contribution from a heavily serviced lateral system.
- Pipe Size: Figure 12 is a summary of the pipe sizes along the trunk lines. In general, pipes with large diameter have a higher surface area susceptible to infiltration issues. Therefore, larger pipes should be targeted over smaller ones where high rates of infiltration are known.

*Comprehensive Plan Information*

The 2008 Comprehensive Plan discusses the impacts of recent significant redevelopment to the sanitary sewer system, including higher density residential and commercial development. The Comprehensive Plan indicates that the majority of this development will impact the area draining to MCES interceptor 1-RF-491, with smaller portions draining to 1-RF-490 and 3-NB-499. With the hydraulic model developed by Barr, the system was analyzed for two development scenarios under a range of population growth projections. Figure S-4 in the Comprehensive Plan shows the areas of the City that may require upgrades as development continues. As growth plans in these areas become more refined, these trunk upgrade areas should be considered for pipe replacement projects, if necessary, to account for increases in service flows.

The Comprehensive Plan also addresses future infrastructure improvements based on known I/I related issues. The City's CIP also includes a five-year plan for sanitary system improvement projects. The projects identified in the Comprehensive Plan include manhole rehabilitation, pipe rehabilitation of low lying sewers near Minnehaha Creek, drainage improvements near 70$^{th}$ and France, and disconnection of systems contributing runoff to the sanitary system.

*Prioritization of Trunk Sewer Rehabilitation*

The items listed above are the essential quantitative and qualitative components of the GIS database used to prioritize pipe rehabilitation projects. The process for determining the prioritization factors is discussed below.

1. Populate the GIS: For this analysis, all of the GIS layers used were based on the trunk sewer segments largely delineated by the location of flow metering data. The geometry type includes lines, broken at each manhole. Therefore, as seen in the figures described above, all data used for the analysis was first converted to line geometry.
2. Convert to Raster: Each line shapefile was converted to a raster with a cell size of 60'. It was essential to ensure that each analysis layer had the same cell size as well as identical alignments. If all of the layers do not overlap exactly, the results of the spatial analysis will be skewed at the non-overlapping cells.

3. Reclassify Cells Based on Determined Prioritization Factors: Prioritization factors were assigned to each unique field in the GIS based on the potential contribution to infiltration. For instance, older, clay pipe has a higher susceptibility to infiltration that a newly lined CIPP pipe. Therefore, the clay pipe should have a higher priority for rehabilitation. The prioritization factors range from 0 to 5 and are summarized for each layer in Table 1 below.

4. Calculate Cumulative Prioritization Ranking: Once the rasters have been reclassified, simple raster math was performed in ArcGIS to sum the individual factors and generate a cumulative rehabilitation score. The higher the score, the higher the priority for rehabilitation. The final trunk sewer infiltration abatement priority is displayed in Figure 13.

**Table 1: Summary of trunk sewer infiltration abatement prioritization factors.**

| Prioritization Factor | Pipe Age | Groundwater Depth Above Pipe Invert | Dry Weather Capacity | Pipe Material | Service Connection Frequency (per 1000') | Pipe Size |
|---|---|---|---|---|---|---|
| 0 | | < -2.0 | | CIPP | | |
| 1 | >1970 | -2.0 - 3.0 | 0-10% | CIP | 0-3 | 15" - 16" |
| 2 | | 3.0 - 5.0 | 11-50% | | 3-10 | 18" |
| 3 | 1960-1969 | 5.0 - 7.0 | 51-70% | RCP | 10-18 | 20" - 21" |
| 4 | 1950-1959 | 7.0 - 10.0 | 71-100% | | 18-31 | 24" |
| 5 | 1940-1949 | >10.0 | >100% | VCP | 31-74 | 33" |

## V. PIPE REHABILITATION METHODS

As a sanitary sewer pipeline nears its end of useful life, there are a variety of methods that can be considered for its rehabilitation or replacement. In general, the pipe can be replaced via traditional open trench methods, or there exists a few different trenchless methods that can also be employed.

*Open Trench Replacement*

Open trench pipe replacement basically involves the excavation and removal of the existing pipe and the laying of a new pipe in its place. This approach is typically most feasible for relatively shallow sewers where necessary surface restoration is minimal or when coordinated with overlying road reconstruction projects. It is many times the most feasible way to upsize a pipe's diameter to increase flow capacity. Existing service connections are typically reinstated with traditional wye fittings and couplers connected to the service lines.

*Cured In Place Pipe (CIPP)*

Cured in place pipe (CIPP) has become a very popular trenchless method of rehabilitating and effectively replacing existing pipes. The process involves inverting a resin-filled felt tube into the existing (host) pipe that, when cured, results in a new pipe that fits tightly against the inside of the existing pipe. When properly designed, the new liner pipe does not rely on the host pipe for any structural or flow carrying capacity. While the interior of the CIPP liner may have a slightly smaller diameter than the original host pipe, the increased smoothness of the liner plus the reduction of infiltration flows typically result in a new pipe with similar flow capacity as the original pipe.

The CIPP process can usually be completed via access manholes, with little to no digging required. Service connections are also typically reinstated, trenchlessly, through the use of robotic cutting machines navigated within the new pipe. The flexibility of the pre-cured liner also makes it adaptable to offset pipe joints, sweeps, and low-degree angle bends along the pipe alignment. Individual runs can typically extend between 750' to 1,000'. Given its typical cost effective nature up to around 48" diameter pipes, it is widely used by cities and MCES, alike.

Special consideration should be given to groundwater conditions when implementing a CIPP liner solution. For design purposes, high groundwater increases external pressures on the pipe, which can influence the liner's design thickness. During construction, it may be necessary to lower the groundwater to below the pipe zone if there is potential for significant infiltration flows to interfere with the liner's curing process.

*Slip Lining/ Fold-and-Form Liner*

Slip lining is the process of inserting a new "rigid" pipe into an existing pipe. Unlike the CIPP process that constructs and cures a new pipe inside of the old, the slip lining process involves sliding a smaller diameter pipe (usually HDPE or PVC) inside of the existing host pipe. For larger diameter pipes (>48" dia.), fiberglass pipe such as Hobas is sometimes used. The annular space between the inside and outside pipes is typically filled with grout to complete the process. Fold and form liners are round HDPE pipes that are pre-folded in half lengthwise to make a U-shape, then pulled through the host pipe and heated to reestablish their original round shape. In both cases, slip liners and fold and form liners do not rely on the continued integrity of the host pipe, but often time result in greater pipe diameter reductions than CIPP lining. While the lining processes typically require little to no excavation (sometimes only at the launching or receiving ends), reinstating service connections to these liners typically requires a dig at each location. Compared to CIPP lining, slip lining sanitary sewers typically becomes more cost effective for larger diameter pipes (>60").

*Pipe Bursting*

Pipe bursting is a trenchless process which involves the literal "bursting" of the existing pipe via the use of a larger diameter expanding head which breaks apart the existing pipe, then pulling a new pipe through the resulting opening. The result is the placement of a new pipe (typically HDPE, PVC, or DIP) along the old pipe's alignment. In addition to the trenchless replacement of similar size pipes, as CIPP and slip lining provides, pipe bursting also allows for the upsizing of pipes where additional capacity is required. A disadvantage of pipe bursting is that individual service connections need to be dug up to be reconnected. Pipe bursting is also generally more expensive than CIPP and slip lining.

*General Trunk Sewer Rehabilitation Recommendations*

In consideration of the typical characteristics of the City of Edina's trunk sewer system, it is recommended that CIPP lining be considered as the initial approach to rehabilitating the City's system. Factors that support this general recommendation include the need for a trenchless solution, as much of the pipe has very limited access potential, such as along Minnehaha Creek. As a trenchless solution, CIPP also conforms well to Edina's trunk sewer pipe sizes of 33" and less, and there are many lines with service connections which could be reinstated trenchlessly with the CIPP system. CIPP also continues to be a cost-competitive method amongst the variety of trenchless rehabilitation methods. Prioritization recommendations and project limit recommendations (discussed later in this report) are based, to some extent, on project costs. The costs of CIPP rehabilitation are a basis of these recommendations. In addition to the mainline lining of a CIPP project, individual projects should be reviewed for necessary manhole and service

line repairs. For example, manholes within a project area that are found to be deteriorated and susceptible to infiltration may also be lined using various epoxy or cement based coating technologies. Mainline pipe televising sometimes reveals service line problems near the connection point. Short segments of service pipe can also be lined from the mainline in some circumstances.

Under certain circumstances, it may be desirable to replace a trunk sewer segment via open trench replacement; particularly in concert with future road projects where the ground surface is already being disturbed. Figure 14 illustrates the trunk sewer system with an overlay of the City's 5-year road improvement plans. An example of potential project synergies exists along Minnehaha Boulevard, between West 52nd and 54th Streets – this area is further detailed in Figure 15. Consideration could be given to reconstructing this trunk sewer line directly underneath the street, in conjunction with a street reconstruction project.

In general, alternative alignments and other factors (such as future capacity and pipe size needs) that could influence pipe improvement project decisions should be considered in conjunction with any future sewer rehabilitation projects. Full evaluation of those factors is beyond the scope of this particular study.

*Pre-Televising Inspections*

General knowledge of an existing pipe's characteristics and condition is oftentimes all that is needed to make preliminary recommendations as to what type of trenchless rehabilitation method may be feasible. It is important that pre-televising inspections be done, however, to confirm the suitability of the selected method. Sections of collapsed pipe or service connections that extensively protrude into the pipe, for example, may require "spot dig" repairs in order for a CIPP liner to be installed. If the City can acquire this televising information early on, this information can help inform the design phase of a project. In any case, it is standard protocol for lining contractors to pre-televise, themselves, to confirm existing conditions.

*Flow Bypassing During Construction*

All pipeline replacement and rehabilitation methods can, to a certain extent, interfere with normal sewer flows through the pipes. During open trench replacement projects, these flows are typically diverted during the daytime construction hours using pumps to route flows from manhole to manhole around the construction zone. Properties with direct connections within the construction zone are given advance notice to reduce or eliminate sewer discharges during the working hours. It is typically a minor inconvenience lasting for a couple of days with normal sewer use being granted during the evenings and overnight.

Trenchless methods can potentially extend the disruption of sewer service to properties for longer, more continuous lengths of time. In some cases, bypass pumps may need to run 24 hours per day for several days, depending on the rehabilitation processes used and the unique circumstances of the project area. For any specific project, these factors can usually be identified ahead of time and coordinated with affected property owners. Effective communication during the design and construction phases of these projects can help ensure project success.

## VI. RECOMMENDED PROJECT LIMITS

Based on the prioritization maps and estimated project costs, rehabilitation project limits were delineated. Rehabilitation lengths were divided into 2,000 to 2,500 foot segments based on an estimated total project cost of $500,000. It is assumed that all rehabilitation projects will be CIPP. However, it may be more cost effective for the City to consider alternative methods where

applicable. Project delineations are illustrated in Figures #16 through #32.

*Project Cost Estimates*

A review of CIPP cost estimates and recent project bid abstracts was performed to calculate an average project cost per foot of pipe. Several components to the rehabilitation process were considered, including average cost of CIPP lining for pipes ranging from 15" to 33"; service connections; temporary bypassing and services; and pre- and post-construction televising. CIPP rehabilitation projects within the range of Edina's trunk sewer diameters cost an average of $200 to $250 per foot. Therefore, based on the City's annual budget of $500,000, the average project length is 2,000 to 2,500 feet. If the City wishes to extend the budget to $1M per year, two project segments could be rehabilitated.

*Access Considerations*

Manhole access is very important in determining project segments because CIPP lining begins and ends at a manhole. Based on field investigations performed in August, 2013, manhole access was reviewed for the entire trunk system. Individual project delineations based on project costs, manhole access and other field observations are summarized in Figures 16 to 32.

*Final Project Prioritization*

The prioritization recommendations for future trunk sewer rehabilitation investments are summarized in Figure 13. This priority map represents a weighted summation of the various sewer pipe attributes described previously in this report and illustrates the relative potential for infiltration throughout the trunk sewer system.

The Minnehaha Creek line stands out as the highest priority trunk sewer for future rehabilitation. Recent televising of this line also confirms our analysis and recommendations, as it revealed active infiltration at multiple locations along this VCP sewer. It is recommended that the City considers including the rehabilitation of this line in its upcoming capital improvement planning schedule. This would include project segments #1 through #5.

The prioritization map illustrates a second priority segment, just east of T.H. 100, extending through the Lake Edina/ South Cornelia neighborhoods. Projects #8 and #9 encompass most of this line. This is primarily an RCP line. It is recommended that this line be televised to verify its infiltration potential. If active infiltration is discovered, similar to the Minnehaha line, it is further recommended that this line be considered as a part of the City's upcoming capital improvement plan. If televising does not reveal immediate and significant concerns, it is recommended that this line be monitored on a more frequent basis, either through televising or flow metering, in response to the infiltration potential this line exhibits. It is important to reiterate the redevelopment growth and resulting flow increases that the Comprehensive Sanitary Sewer plan anticipates in this area. Future increases in flow may also dictate pipe size increases in conjunction with future rehabilitation projects.

Initial televising is also recommended for the trunk sewer immediately downstream of meter #6, which travels through The Heights neighborhood. Projects #12 through #14 encompass this line. A similar response of CIP planning or more frequent monitoring, depending on the initial televising results, is also recommended. Because this is a VCP sewer pipe, it could possibly deteriorate more rapidly than its RCP counterparts, and therefore presents further reason to monitor this line more frequently if it is not currently exhibiting immediate and significant concerns.

The City of Edina currently televises its entire sanitary sewer system on a rotation schedule of approximately thirteen years. It is recommended that the remainder of the trunk sewer lines evaluated as a part this study be managed within the City's normal schedule and maintained and rehabilitated in response to any concerns that are revealed.

Table 2, below, summarizes the priority recommendations. The recommendations are generally as follows:

Include in CIP: These sewers have been confirmed via televising that pipe deterioration and resulting infiltration is present and that they are nearing the end of their service life.

Verify Priority: These sewer rank higher in priority for potential infiltration problems and should be televised for confirmation.

Regular Televising: These sewers rank lower in priority for potential infiltration problems but should continue to be a part of the City's regular sewer televising schedule.

Potential open cut segments are also summarized and correlated to the City's 5-Year Road Improvement Plan.

**Table 2: Summary of Rehabilitation Projects.**

| Project # | Rehab Length (ft) | Recommendation | Potential Open Cut? | Potential Coordination w/ Upcoming Street Project? | Street Imp. Year |
|---|---|---|---|---|---|
| 1 | 2115 | Include in CIP | No | No | |
| 2 | 2598 | Include in CIP | No | No | |
| 3 | 2373 | Include in CIP | No | No | |
| 4 | 1727 | Include in CIP | Yes | Yes | 2015 |
| 5 | 2142 | Include in CIP | No | No | |
| 6 | 3430 | Regular Televising | Yes | No | |
| 7 | 2800 | Regular Televising | Yes | No | |
| 8 | 2180 | Verify Priority | Yes | Yes | 2013 |
| 9 | 2250 | Verify Priority | Yes | Yes | 2013 |
| 10 | 2405 | Regular Televising | Yes | Yes | 2013 |
| 11 | 1865 | Regular Televising | Yes | No | |
| 12 | 2260 | Verify Priority | No | No | |
| 13 | 2400 | Verify Priority | Yes | No | |
| 14 | 2560 | Verify Priority | Yes | No | |
| 15 | 2500 | Regular Televising | Yes | No | |
| 16 | 2540 | Regular Televising | No | No | |
| 17 | 1640 | Regular Televising | Yes | No | |
| 18 | 2570 | Regular Televising | Yes | No | |
| 19 | 2200 | Regular Televising | Yes | No | |
| 20 | 2480 | Regular Televising | Yes | No | |
| 21 | 2330 | Regular Televising | Yes | Yes | 2015 |
| 22 | 3040 | Regular Televising | No | No | |

# APPENDIX

FIGURE 1 ..... SANITARY SERVICE AREA SUMMARY
FIGURE 2 ..... ENVIRONMENTAL FEATURES & IMPAIRED WATERS
FIGURE 3 ..... DEVELOPMENT & SEWER CONSTRUCTION HISTORY
FIGURE 4 ..... YEARS OF DEVELOPMENT AND REDEVELOPMENT PROJECTS
FIGURE 5 ..... TRUNK SEWER PIPE DEVEOPMENT AGE
FIGURE 6 ..... OVERALL INFILTRATION SUMMARY
FIGURE 7 ..... OVERALL INFILTRATION PER ACRE SERVICE AREA
FIGURE 8 ..... GROUNDWATER DEPTH ABOVE INVERT
FIGURE 9 ..... DRY WEATHER PIPE CAPACITY
FIGURE 10 ..... PIPE MATERIAL
FIGURE 11 ..... SERVICE CONNECTIONS ALONG TRUNK LINES
FIGURE 12 ..... PIPE SIZE
FIGURE 13 ..... TRUNK SEWER INFILTRATION ABATEMENT PRIORITY
FIGURE 14 ..... 5-YEAR ROAD IMPROVEMENT PLAN
FIGURE 15 ..... EXAMPLE OF PROJECT SYNERGIES
FIGURES 16 TO 32 ..... REHAB PROJECTS