



PPH Investigation and Sanitary Sewer Study

Prepared for: City of Glendale, WI

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Prepared by: Clark Dietz, Inc.
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Executive Summary

Introduction

The City of Glendale is located in Milwaukee County just north of the City of Milwaukee along the Milwaukee River. The City is a combination of a medium density residential community, an industrial community and a commercial center providing goods and services to several adjacent suburbs in northern Milwaukee County. Glendale is a completely built out community and is in an urban portion of a metropolitan area.

Glendale was incorporated in 1950 and has a current population of around 14,000 residents. The City owns and operates about 328,000 linear feet of 8" to 21" sanitary sewer and about 1,500 sanitary manholes. Glendale's sanitary sewer collection system has 48 connections into MMSD's MIS sewer. Glendale discharges flow to neighboring communities at 15 locations and does not receive any discharge flow from neighboring communities. This comprehensive sewer study evaluates the City's existing system and creates rankings based on inflow and infiltration related issues present in the collection system. While Glendale has previously participated in MMSD's private property inflow and infiltration reduction program through lining of private sewer laterals, no comprehensive study to identify priorities and focal points for such work has been undertaken. This comprehensive sewer study aims to identify priorities and focal points and concludes with an action program of long-range goals for inflow and infiltration reduction and implementation procedures.

Purpose

The purpose of the project is to provide the City of Glendale information to implement a plan recommending construction and rehabilitation measures to reduce the amount of inflow and infiltration to their sanitary sewer collection system.

Evaluations

Field data and previous metering information available throughout the City was used to identify dry weather flows, wet weather flows, and separate inflow from infiltration in the system. The existing system information was used to create a hydraulic assessment computer model to correlate private property inputs with measured and observed flows throughout the City. The systemwide hydraulic calibration will identify sewershed level private property inflow and infiltration inputs in the system and create a ranking system for the sewersheds. The modeling software used is XP-SWMM. The City of Glendale previously did not have any model of their system to start with, so a new model was created from scratch as part of this study.

Next Steps

An implementation plan recommendation is included in greater detail in Chapter 5. In summary, next steps following this comprehensive study should be as follows:

- City Council to select and approve an implementation plan outlined in this study
- Update Capacity, Management, Operations, and Management (CMOM) Plan during next revision to be consistent with any new policies put in place.
- Continue participating in MMSD PPII programs
- Educate residents by including PPII information on the City's website and the City's quarterly print newsletter.

Definitions

Clear Water – Inflow and Infiltration water that enters the sanitary sewer. This is to distinguish it from normal sanitary sewage water in the sewer system.

CMOM Capacity, Management, Operations and Maintenance – A program to efficiently operate and maintain collection system assets to minimize performance failures and overflows.

Closed Caption Televising (CCTV) - sewer inspection inserting a video camera into the sewer system. It is used to locate sewer defects, leaks, deformations, and identify the presence of I/I from sanitary sewer laterals.

Infiltration ^[1] – water other than wastewater that enters a sewerage system (including sewer service connections) from the ground through such sources as defective pipes, pipe joints, connections, or manholes. Infiltration does not include, and is distinguished from, inflow.

Inflow ^[1] – water other than wastewater that enters a sewerage system (including sewer service connections) from sources such as roof leaders, cellar drains, yard drains, area drains, foundation drains, sump pumps, drains from springs and swampy areas, manhole covers, cross connections between storm sewers and sanitary sewers, catch basins, cooling towers, storm waters, surface runoff, street wash waters, or drainage. Inflow does not include, and is distinguished from, infiltration.

I/I – Abbreviation for Inflow and Infiltration

Interceptor Sewer ^[1] – a sewer whose primary purpose is to transport wastewaters from collector sewers to a treatment facility.

Laterals – A pipe from the building to the sewer main in the street or right-of-way to convey wastewater from the buildings to the City's sanitary sewer system.

Manholes – Access points to the sanitary sewer or storm sewer systems.

MIS – An interceptor Sewer system owned and operated by the Milwaukee Metropolitan Sewerage District.

MMSD – Milwaukee Metropolitan Sewerage District.

PPII – Abbreviation for private property inflow and infiltration.

Sanitary Flow – Domestic, commercial, and industrial wastewater flow with no inflow or infiltration.

Sanitary Sewer System ^[1] – all structures, conduits and pipes, by which sewage is collected, treated, and disposed of, except plumbing inside and in connection with buildings served, and service pipes, from building to street main.

Sanitary Sewer – A sewer intended to convey wastewater from homes and businesses.

Sanitary Sewer Overflow (SSO) ^[1] – a release of wastewater from a sewage collection system or an interceptor sewer directly into a water of the state or to the land surface.

WDNR – The Wisconsin Department of Natural Resources

[1] Definition from *Wisconsin DNR Chapter NR 110*

CHAPTER 1 - INTRODUCTION

1.1 OVERVIEW

The City of Glendale is located in Milwaukee County just north of the City of Milwaukee along the Milwaukee River. The City is a combination of a medium density residential community, an industrial community and a commercial center providing goods and services to several adjacent suburbs in northern Milwaukee County. Glendale is a completely built out community and is in an urban portion of a metropolitan area. The City neighbors the Village of Whitefish Bay, Village of Fox Point, Village of River Hills and the City of Milwaukee. Glendale was incorporated in 1950 and has a current population of around 14,000 residents.



Wastewater from the City of Glendale discharges to the Milwaukee Metropolitan Sewer District (MMSD) via 48 Metropolitan Interceptor Sewers (MIS) connections along the MMSD's North Shore MIS. MMSD is responsible for treating wastewater from its service area. The wastewater gets treated at Jones Island Water Reclamation Facility.

This comprehensive sewer study evaluates the City's existing system for inflow and infiltration potential and creates rankings based on I/I related issues present in the collection system.

While Glendale has previously participated in MMSD's private property inflow and infiltration (PPII) reduction program through lining of private sewer laterals, no comprehensive study to identify priorities and focal points for such work has been undertaken. This comprehensive sewer study aims to identify priorities and focal points and concludes with an action program of long-range goals for inflow and infiltration reduction and implementation procedures.

The reduction of inflow and infiltration is prudent for the City to remain under MMSD's allowable discharge volume as well as preventing potential future basement backups to their residents during major storm events. With aging infrastructure, it is important to implement a plan to address issues before they become major problems and large expenses to the tax payers.

1.2 OBJECTIVES

Inflow and infiltration (I/I) are terms used to describe the ways that groundwater and stormwater enter into dedicated sanitary sewer systems. These clear water sources entering a sanitary sewer system reduces the capacity and capability of sewer systems to transport wastewater and can tax treatment facility's ability to treat

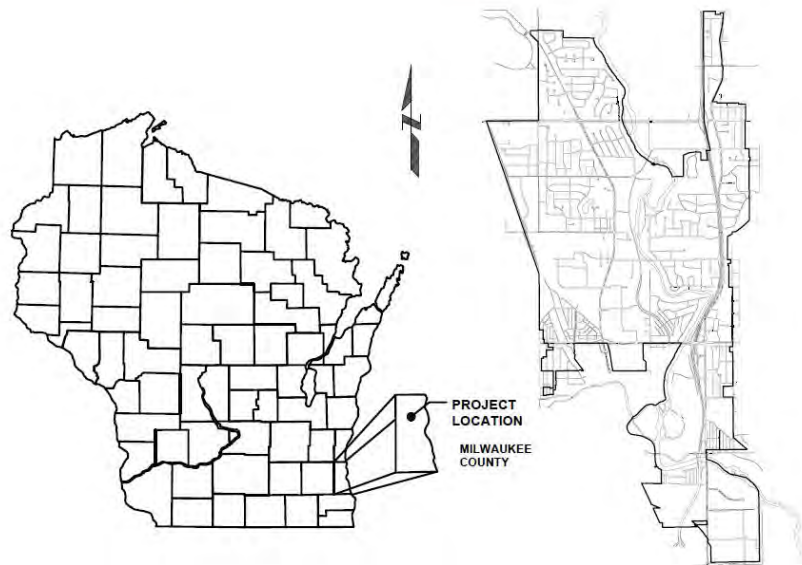


Figure 1.1 Location Map

wastewaters. The elimination of inflow and infiltration by sewer rehabilitation and an on-going operation and maintenance program to identify these areas is vital to protect the City's investment in their sewer system and the service it provides to their residents.

Inflow is stormwater that enters sanitary sewer systems at points of direct connection to the systems. Some examples of inflow points are roof drain downspout connections, foundation drain sump pump connections, and storm drain cross connections that are connected into the sanitary sewer system, rather than the storm sewer system. These sources are typically improperly or illegally connected to sanitary sewer systems, via either direct connections or discharge into drains that are directly connected to the sewer system. Improper connections let water from sources other than sanitary fixtures and drains to enter the sanitary sewer system, also known as clear water. The clear water should be directed to the stormwater sewer system or allowed to soak into the ground without entering the sanitary sewer system.



Figure 1.2 Example of Infiltration

Infiltration is groundwater that enters the sanitary sewer system through defects in sanitary sewer pipes. The defects in sanitary sewer sewers include cracks, open joints, root intrusion points, and faulty connections into the public sanitary sewer. These infiltration points give a pathway where clear water may enter the sanitary sewer system. Service laterals can be particularly insidious as these are often poorly constructed and rarely, if ever, inspected until a failure occurs. They are often near trees and shrubs whose roots can penetrate and degrade the lateral. It is not uncommon for service laterals to contribute 50% or more of the total I&I.

The objective of the study is to identify major sources of inflow and infiltration in the sanitary sewer system and develop a program to address repairing the sources. It is

also important to look at the sanitary sewer system for areas that may be hydraulically sensitive to increased flows. This study also aims to create a ranking of the City's sewersheds by highest I/I potential to create a point of focus for future repairs.

1.3 SANITARY COLLECTION SYSTEM

The City owns and operates about 328,000 linear feet of 8" to 21" sanitary sewer and about 1,500 sanitary manholes. Glendale's sanitary sewer collection system has 48 connections into MMSD's MIS sewer. Glendale discharges flow to neighboring communities at 15 locations and does not receive any discharge flow from neighboring communities. Glendale has separate sanitary and storm sewers; there are no combined sewers owned by the City. The City also does not own or operate any lift stations.

A majority of Glendale's sewer system was built in the 1950's when it was incorporated. This puts the age of most of their system around 70 years old, well past the intended design life of the sewer. While the City does not have a complete inventory on pipe material, most of the sewer pipes are believed to be vitrified clay pipe (vcp). This goes for sanitary sewer main as well as most private sanitary sewer laterals. As clay pipe ages, it becomes very susceptible to infiltration from the joints or cracks and becomes structurally deficient. The City had identified this as a concern in 2004. The City has increased their inspection and rehabilitation budgets to address the structural deficiencies in the sewers and the infiltration. Glendale has spent over \$7 million since

2004 on rehabilitation. The City budgeted \$600,000 for expenditures in 2019. To date Glendale has rehabilitated over 45% of the sanitary sewer system via cured in place lining and 37% of the manholes.

Glendale has an aggressive inspection program of their sanitary sewer system. The City inspects all their manholes at a minimum of once every 5 years. Almost 100% of the sewer system was televised in 2014, 2015, and 2016. They continue to televise all sanitary sewers adjacent to any roadway construction projects to address any issues before new pavement is placed. Rehabilitation work is planned to address issues found from these inspections. Some of the outstanding rehabilitation work left to be complete has been outlined in the Collection System Recommendations Report (Superior Engineering, 2020).

Figure 1.3 shows the complete sanitary sewer system owned and operated by Glendale as well as the MIS sewer which their system discharges into. The 48 connections to the MIS are also shown.

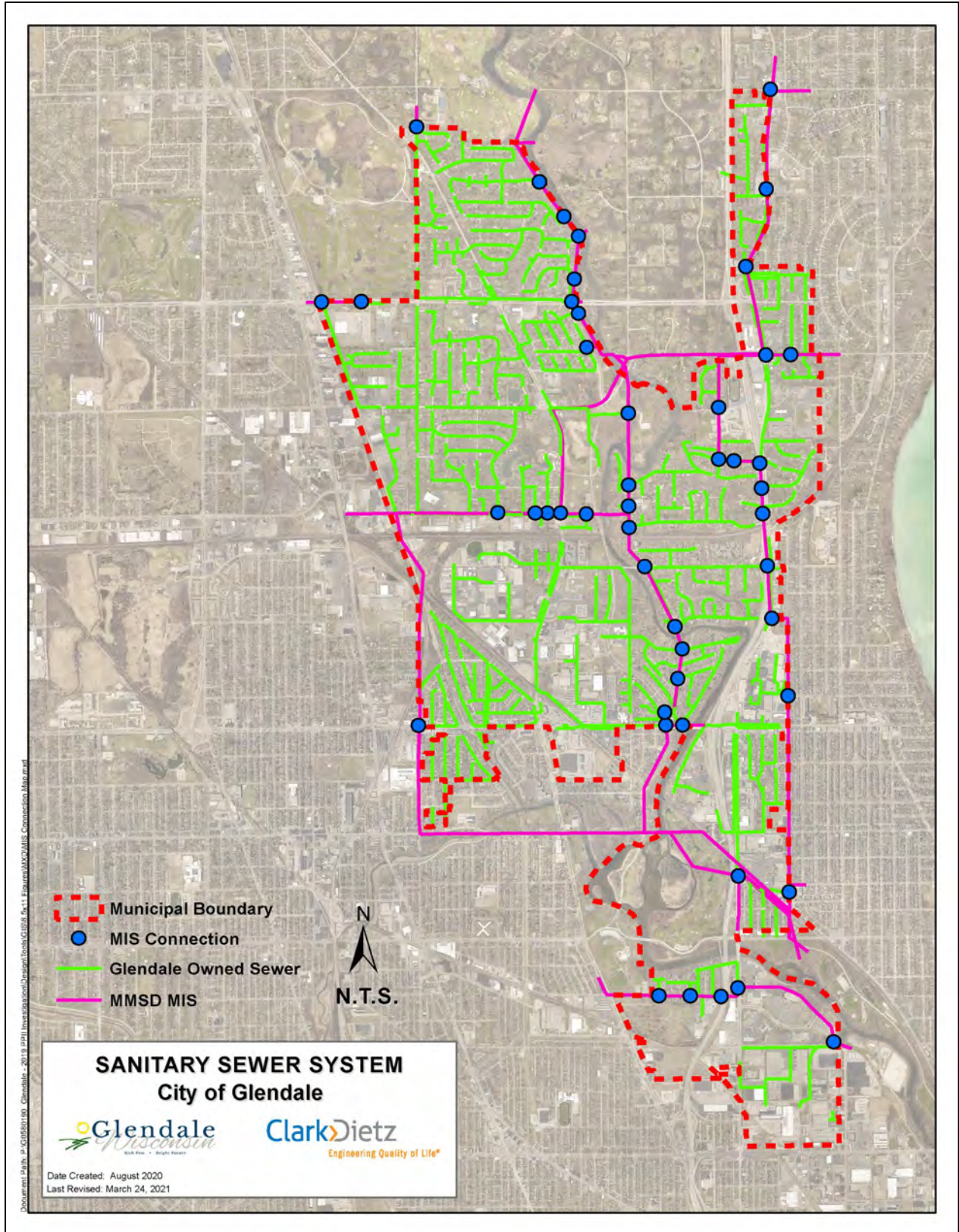


Figure 1.3 Glendale's Sanitary Sewer System

CHAPTER 2 - PREVIOUS SANITARY SEWER SYSTEMS STUDIES

2.1 SANITARY SEWER SYSTEM

2.1.1 MMSD'S 2020 FACILITIES PLAN

The MMSD 2020 Facilities plan establishes the basis for the use of the watershed approach to facilities planning, the importance of public involvement and watershed education, and outlines the planning objective and plan organization. It also describes the relationship between the MMSD 2020 Facilities Plan (2020 FP) and the Southeastern Wisconsin Regional Planning Commission (SEWRPC) Regional Water Quality Management Plan Update (RWQMUPU). The MMSD is responsible for the construction, operation, and maintenance of interceptor sewers and wastewater treatment facilities within its sewer service area and has permissive authority for flood management and watercourse improvements. The MMSD has the authority to impose rules and regulations, which may be promulgated by MMSD so long as they are necessary and proper to promote the best operation of the system, prevent damage to the sewerage system, prevent surcharging in all or part of the sewerage system, prevent interference with the process of sewage treatment or disposal, or to comply with federal or state pretreatment requirements (Wis. Stats. 200.45).

A Flow Allocation Summary, Table 5D-54 in the plan summarizes the proposed peak allowable wet weather flow rates into the MMSD conveyance system from the City's sewersheds. The maximum total peak flow the City is permitted to discharge to MMSD's MIS system is 27.3MGD.

2.1.2 CITY OF GLENDALE CMOM 2019 ANNUAL REPORT

A Capacity, Management, Operations and Maintenance (CMOM) Plan was prepared to comply with the stipulation entered between the state of Wisconsin (more specifically, the Wisconsin Department of Natural Resources (DNR) and the satellite municipalities (Stipulation - State of Wisconsin v. Milwaukee Metropolitan Sewerage District, et. al. Case No. 2005-CS-000013) as well as the stipulation entered between the State of Wisconsin and the District (Stipulation - State of Wisconsin v. Milwaukee Metropolitan Sewerage District. Case No. 02-CS-2701). The City has met all of the stipulation requirements.

Per the Stipulation, the City developed a CMOM Plan in 2010 and was updated in 2014 and 2019 in the report, "City of Glendale CMOM Plan" (Superior Engineering, LLC 2020) to provide a roadmap to maintain their assets and assist the District reduce sanitary sewer overflows (SSOs). The Elements of the CMOM plan are management, operations & maintenance, capacity, overflow response, and communications and audit.

2.1.3 GLENDALE COLLECTION SYSTEM RECOMMENDATIONS, SEPTEMBER 2020

The City of Glendale Collection System Recommendations report (Superior Engineering, 2020) expands on their collection system capacity, operation, and maintenance (CMOM) plan. The recommendation plan outlines pro-active operation and maintenance (O&M) and rehabilitation plan and recommends developing a long-term plan for inspection and sewer rehabilitation. The plan outlines long term recommendations as well as identifies specific areas of the collection system that needs to be addressed.

CHAPTER 3 - INFLOW AND INFILTRATION INVESTIGATION

3.1 GENERAL CONSIDERATIONS

3.1.1 AGE

A majority of Glendale's sewer system was built in the 1950's when it was incorporated. This puts the age of most of their system around 70 years old, well past the intended design life of the sewer. Most sewer design life is 20-50 years old. While the City does not have a complete inventory on pipe material, most of the sewer pipes are believed to be vitrified clay pipe (vcp). This goes for sanitary sewer main as well as most private sanitary sewer laterals. As clay pipe ages, it becomes very susceptible to infiltration from the joints or cracks and becomes structurally deficient. The City has identified this as a concern in 2004. The City has increased their inspection and rehabilitation budgets to address the structural deficiencies in the sewers and the infiltration. Unless addressed, the sewer system will continue to have increased infiltration as it ages. It is important the City continue its inspection and rehabilitation efforts to keep up with their aging sanitary system.

3.1.2 SOIL

Soil type can have a significant impact on infiltration. Soils with high infiltration rates, such as clay, have more water flowing through the soil and therefore a higher likelihood of infiltration into the sewer. The National Resource Conservation Service completed a soil survey for the majority of areas in the United States. This soil survey is shown in Figure 3.1.

Unfortunately, roughly half of Glendale has no digital data available. Most soils observed throughout the City are silt loams to clay type soils. For the purpose of this study, it was assumed that the City has a uniform soil type and sewersheds were not treated differently based off soil type.

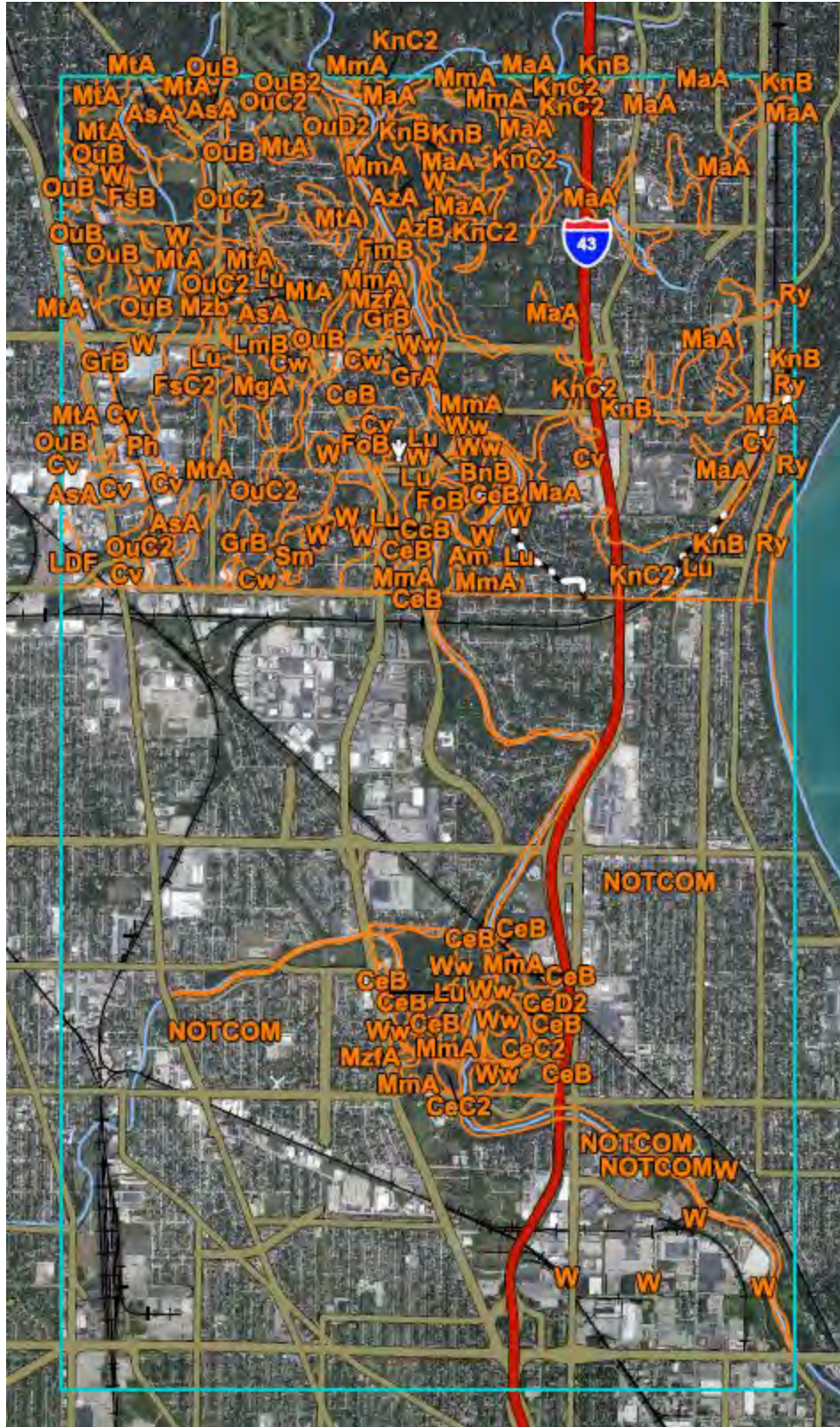


Figure 3.1 NRCS National Cooperative Soil Survey

3.1.3 SSOs

Sanitary sewer systems are meant to collect and transport all the sewage that flows into them to a wastewater treatment facility. It is possible that unintentional discharges of sewage from sanitary sewers may occur in the sewer system. These discharges are called SSOs. The untreated sewage from these overflows can threaten public health, cause serious water quality problems, and cause significant property damage when overflows are into buildings.

Problems that typically cause continuing SSOs include inflow and infiltration (I/I), undersized systems, pipe failures, and deteriorating sewer system. SSOs contain raw sewage. They can carry bacteria, viruses, parasitic organisms, intestinal worms, and inhaled molds and fungi.

**No Sanitary Sewer
Overflows (SSOs)
Since 1998**

SSOs can also cause property damage. When basements flood, the damaged area must be thoroughly cleaned and disinfected to reduce the risk of disease, and rugs, curtains, flooring, wallboard panels, and upholstered furniture usually must be replaced. Cleanup can be expensive for homeowners and municipalities. SSOs that enter oceans, bays, estuaries, rivers, lakes, streams, or brackish waters can negatively impact water quality. Glendale has historically not had issues with SSOs. There has not been a recorded sanitary sewer overflow in the City since 1998. Although they are currently not an issue, it is important to understand the significance of SSOs and to manage the sanitary sewer system to continue to not experience SSOs as rain events become larger and as the system ages.

3.2 MMSD FLOW ALLOCATION ANALYSIS

MMSD facility plans outline sanitary sewer flow allocation to each of Glendale’s sewersheds. These allocations are based from population and potential for development. Table 5D-54 in the plan summarizes the proposed peak allowable wet weather flow rates into the MMSD conveyance system from the City’s sewersheds. The maximum total peak flow the City is permitted to discharge to MMSD’s MIS system is 27.3MGD.

The new MMSD 2050 facility plan continues monitoring the sanitary sewer flow allocations. Table 3.1 displays the percent of sanitary sewer flow remaining from the 2050 MMSD Sewer Flow Allocations.

The sewershed areas colored in red have 0 percent of flow remaining. The orange areas have less than 10% flow remaining, the green areas have more than 10% and less than 30% flow remaining, and the blue areas have between 30 and 70% flow remaining.

The areas with the most potential for development do have high flow remaining as expected. The areas colored in red with no flow remaining are almost 100% residential, or do not have any development potential such as GL5054, which is all park land.

Table 3.1 MMSD 2050 Sewershed Capacity

SIMULATED SEWERSHED FLOWS IN THE CITY OF GLENDALE BY SEWERSHED		
	2050 % Flow Remaining	CDI SewerShed
Sewershed	(%)	Areas (acres)
GL4024	0.0%	6.98
GL4032	0.0%	13.85
GL5028	0.0%	42
GL5030	0.0%	29.29
GL5054	0.0%	220
GL5002	0.0%	167.14
GL4031	0.0%	10.58
GL5013	0.0%	16.73
GL5009	0.0%	68.11
GL5033	1.4%	300.39
GL5008	1.7%	125.15
GL4052	2.1%	70.33
GL5051	2.5%	142.23
GL5023	4.9%	330.66
GL5004	5.4%	293.57
GL5011	6.5%	82.36
GL4055	7.1%	72.03
GL4025	12.1%	397.58
GL4053	16.9%	89.21
GL5007	17.8%	337.4
GL5016	27.5%	235.89
GL5014	31.3%	167.61
GL5018	37.2%	211.57
GL5050	46.7%	51.46
GL5001*	48.0%	146.36
GL5012*	70.2%	195.88

The MMSD facility plans also break down sewershed flows to display average base flows as well as Peak I/I flow amounts. This information is useful when trying to compare inflow and infiltration potential by sewersheds. It also allows Municipalities to compare their wet weather flows to nearby communities to see comparatively how well they are managing their system. Figure 3.2 shows the comparison of Glendale’s wet weather peak flow to that of its neighboring communities. Glendale’s sewer system performs very well in comparison, with a wet weather flow per acre significantly lower than that of its neighbors. Whitefish Bay is almost twice the peak flow while Fox Point is more than twice the peak flow. The only community performing better in comparing wet weather peak flow per acre than Glendale is River Hills. This is expected as River hills is significantly less densely populated than Glendale and therefore has less sewer pipe in their system per acre of land than Glendale. This creates less opportunity for inflow and infiltration. Figure 3.3 shows Glendale’s base sewer flow compared to their peak I/I flow as a percentage. While Glendale is performing relatively well when compared to neighboring communities, there is still a lot of room for improvement as peak I/I is roughly a 90% increase of flow from base flow.

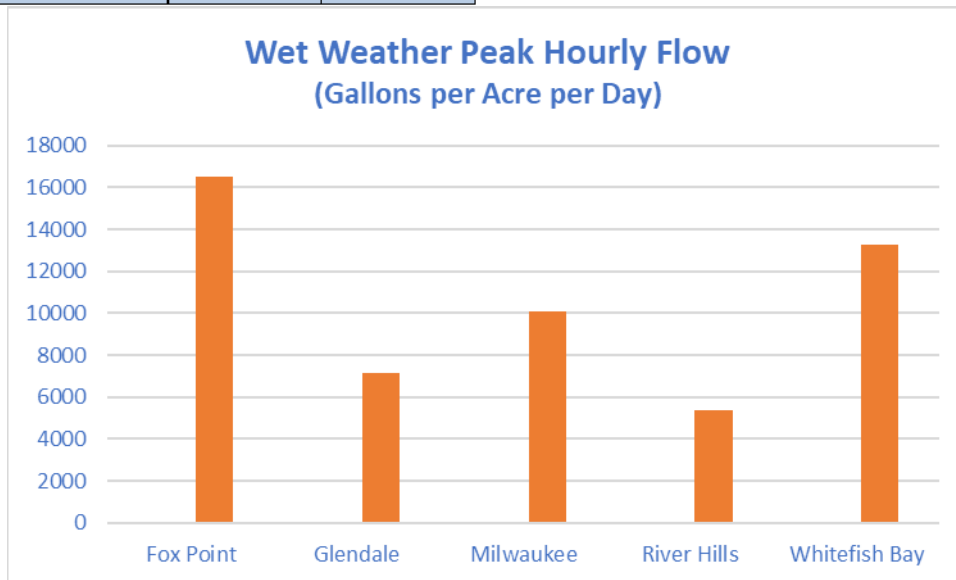


Figure 3.2 Comparison of Peak Wet Weather Flows (gallons per acre per day)

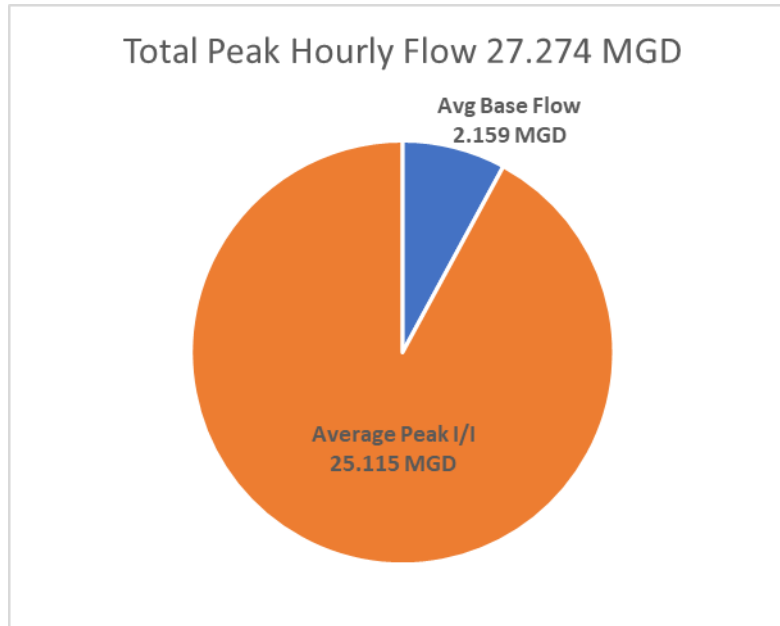


Figure 3.3 Glendale WI, 5-Year Peak Hourly Flow

The United States Environmental Protection Agency (EPA) defines infiltration excessive if a systems average dry weather flow is more than 120 gallons per capita per day. Another EPA method suggests system wide infiltration rates above 1500 gallons per day per inch mile of pipe are excessive. Glendale has a rough infiltration rate of 265 gallons per capita per day or 6650 gallons per day per inch mile of pipe. The EPA's inflow benchmark is 275 gallons per capita per day. Glendale's inflow is estimated to be 1760 gallons per capita per day which is well above the EPA excessive benchmarks. While Glendale's inflow and infiltration are low comparing to neighboring communities, they are still classified as excessive flows per EPA standards.

3.3 COMPUTER MODELS

3.3.1 GEOGRAPHIC INFORMATION SYSTEM (GIS)

The City of Glendale has created a geographic information system (GIS) in 2018 of all the City owned utilities. It provides asset data and is a great tool to use for collection system maintenance. It allows the system information to be updated in real time and corrects mistakes as they are found in the field. The system is invaluable when it comes to planning efforts and provides long term flexibility for the City to operate the collection systems cost effectively. Glendale's GIS is still relatively young and is constantly being updated as more information becomes available. The current sanitary GIS system tracks:

- | <u>Manholes</u> | <u>Pipes</u> |
|---|--|
| <ul style="list-style-type: none"> • Manhole ID • Rim Elevation • Sewershed • Depth • Rehab Work | <ul style="list-style-type: none"> • Pipe ID • Invert Elevations • Upstream and Downstream Manholes • Diameter • Material • Install Year • Sewershed • CCTV Year • Lining Year • Last Flush Date |

Maintaining and updating the GIS system is critical to future planning efforts for the collection system.

3.3.2 XPSWMM SEWER SYSTEM MODEL

The City of Glendale previously did not have a model of their sanitary sewer collection system. They did not have the ability to analyze the hydraulics of their system to see where potential problem areas exist. As part of this study, a sanitary sewer system model was created in XPSWMM modeling software.

XPSWMM is a holistic modeling package for stormwater and wastewater problems. It helps engineers and watershed managers to simulate hydrology, hydraulics, water quality and surface flooding. The hydraulic assessment computer model correlates private property inputs with measured and observed flows throughout the City. The system wide calibration will identify sewershed level private property inflow and infiltration inputs in the system and create a ranking system for the sewersheds.

To create the XPSWMM model for Glendale, updates to the GIS system needed to be complete. There was missing information that was required for the model. Figure 3.4 highlights the pipes needing updates in the GIS system for the model. This information was field investigated or imputed based on another source of data as part of this study. In summary, 363 manhole rims and 579 inverts had to be populated and updated in Glendale's GIS.

3.4 CLOSED CAPTION TELEVISION (CCTV)

Closed Caption Television (CCTV) is a sewer inspection method completed by inserting a video camera into the sewer system. It is used to locate sewer defects, leaks, deformations, and identify the presence of I/I from sanitary sewer laterals. Glendale has an aggressive inspection program of their sanitary sewer system. The City inspects all their manholes at a minimum of once every 5 years. Almost 100% of the sewer system was televised in 2014, 2015, and 2016 and sewers in poor conditions have been identified. Due to the age of the previous CCTV inspection, The City is completing new CCTV inspections on all sanitary sewers adjacent to any roadway construction projects to address any issues before new pavement is placed. Rehabilitation work is planned to address issues found from these inspections. Some of the outstanding rehabilitation work left to be complete has been outlined in the Collection System Recommendations Report (Superior Engineering, 2020). The sanitary sewer system should continue to be inspected and televised to identify problem areas and potential sources of inflow and infiltration. Glendale's CCTV sewer map is shown in Figure 3.5.

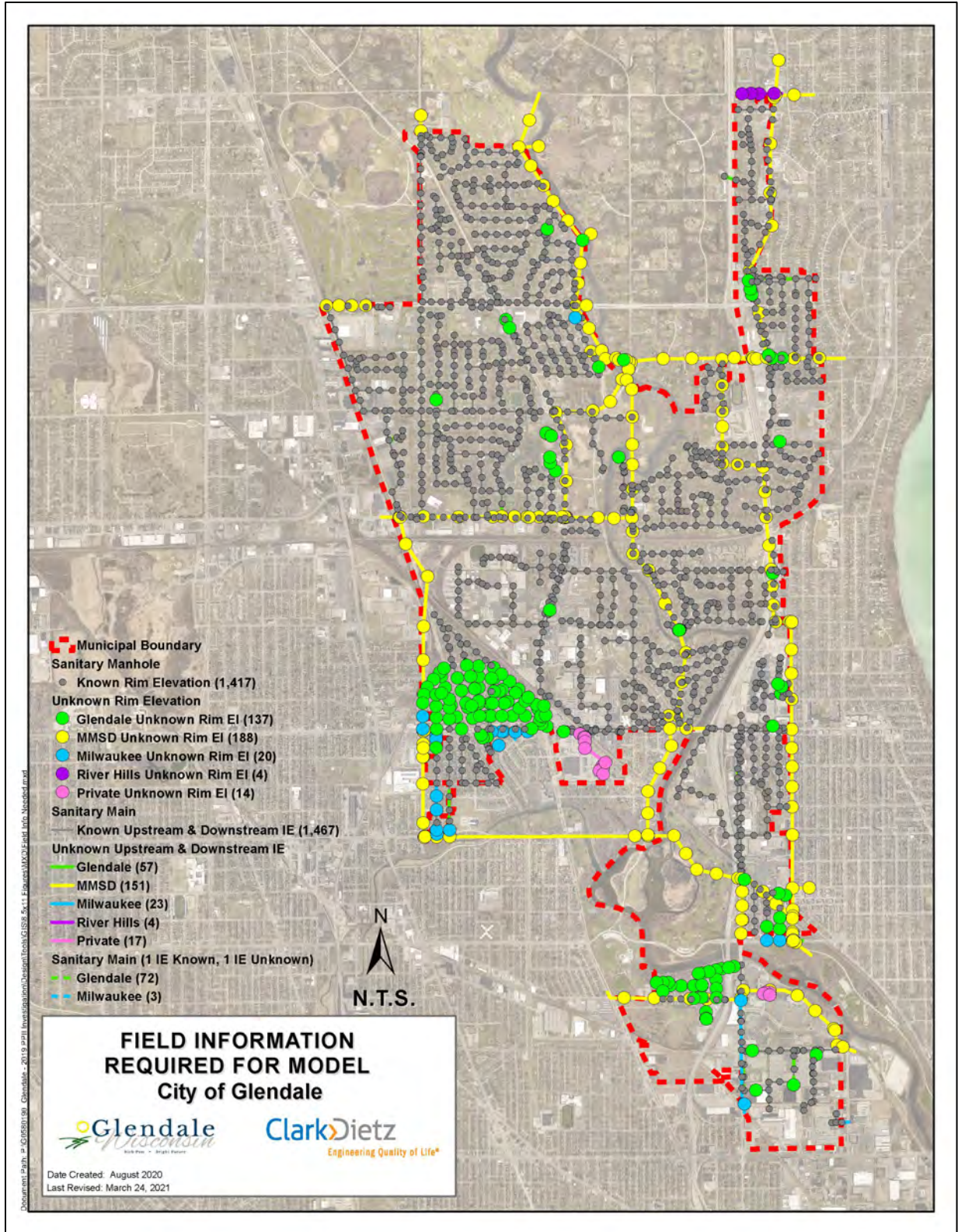


Figure 3.4 Field Information Required for Model

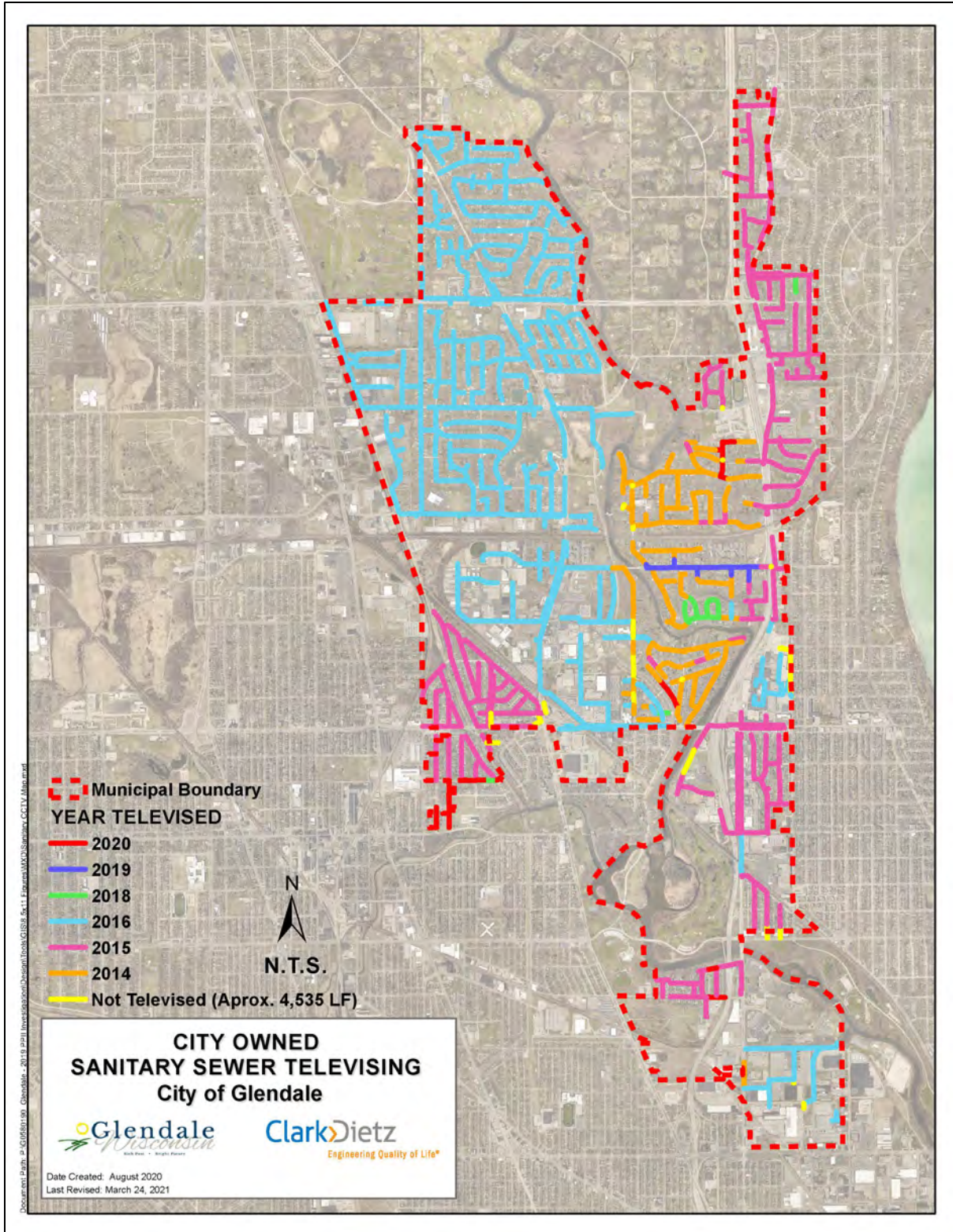


Figure 3.5 City Owned Sanitary Sewer Main Televising Map

3.5 PREVIOUS LINING EFFORTS

3.5.1 PUBLIC MAIN

Glendale has rehabilitated over 45% of the sanitary sewer via cured-in-place lining and 37% of the manholes. The cured-in-place lining is typically the most cost-effective method for rehabilitating aging sewers and is a commonly used method in the Milwaukee area. The cured-in-place lining rehabilitates the sewer pipe and eliminates infiltration potential as well as any structural deficiencies. The lining extends the design life of the sewer pipe. The liner does slightly reduce the inside diameter of the pipe, but the reduction is considered to be minimal and the benefits far outweigh the reduced capacity. Figure 3.6 shows the lining efforts completed in the sewer system.

The City is able to provide a higher level of service and reduce the risk of basement backups as a result of these improvements. However, there is approximately 215,000 ft of unlined sewer that are starting to show signs of age and infiltration. Lining should continue to be utilized by the City to maintain the high level of service they are providing.

3.5.2 PRIVATE LATERALS

The DNR requires that inflow and infiltration (I/I) from private property is addressed (NR 210.23). Clear water is prohibited from entering the sanitary sewer system. This can occur via direct connections on private property including downspouts, sump pumps illegally connected to the sanitary sewer, and defective sewer laterals.

Clear water entering the sanitary sewer system from private sources can often times account for 40 to 80% of the clear water entering the sanitary sewer system. It should be a focus of any I/I reduction program. This is often because the lateral maintenance on private property is the responsibility of the property owner. Maintenance is often ignored until there is a total failure or sewer backup.

The City has used MMSD private property infiltration and inflow (PPII) funding since 2012 to address problem areas mostly in the Crestwood area. This program was done on an annual basis and this study aims to provide some direction for future years of the program.

The City discontinued the requirement of home inspections during the sale of the house based on Wisconsin regulations. However, the City should implement a program to continue the investigating of illegal sump pump connections and other illegal connections. The City should verify that all downspouts were disconnected during previous inspections. Properties that were part of the MMSD PPII program are shown in Figure 3.7.

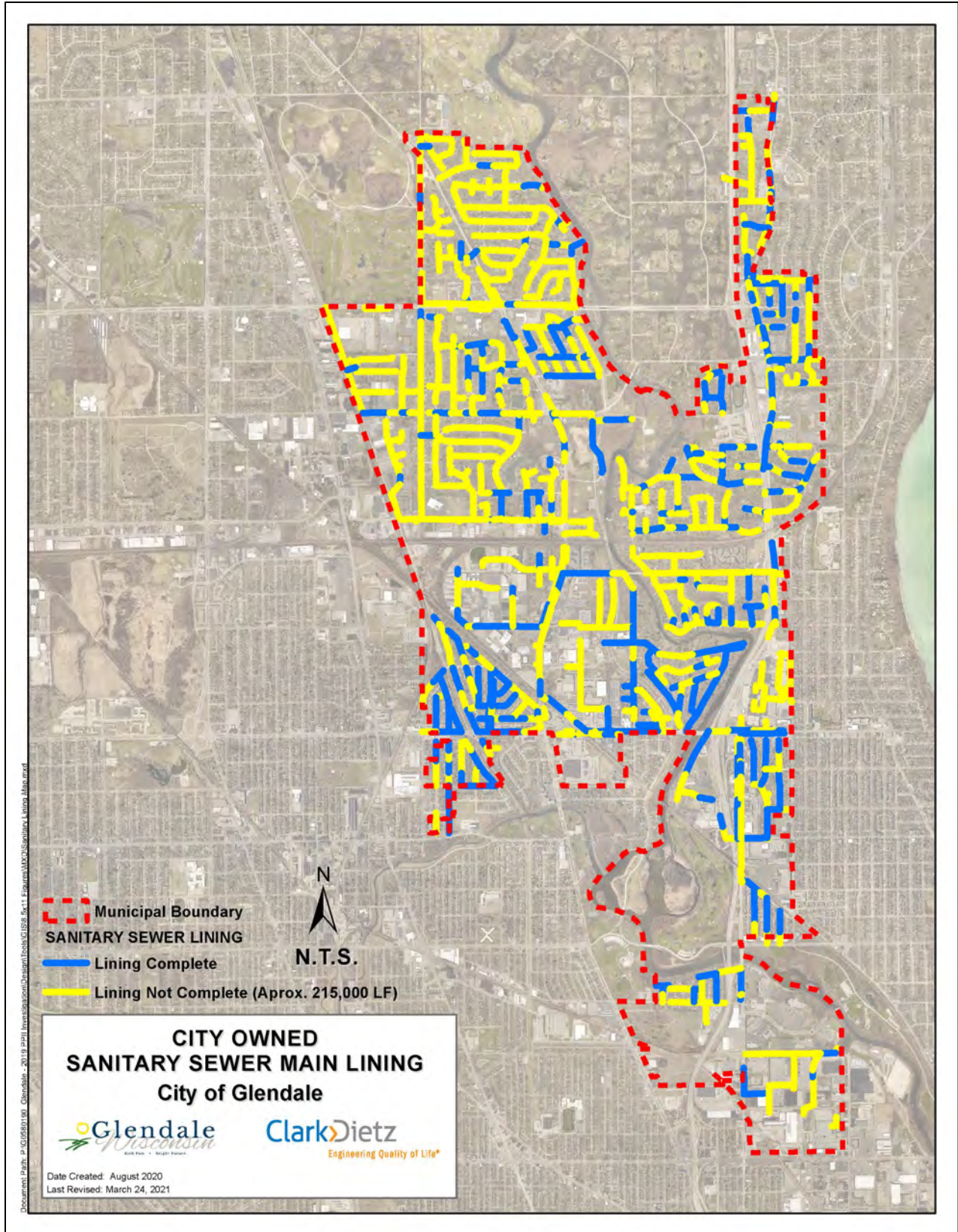


Figure 3.6 City Owned Sanitary Sewer Main Lining Map

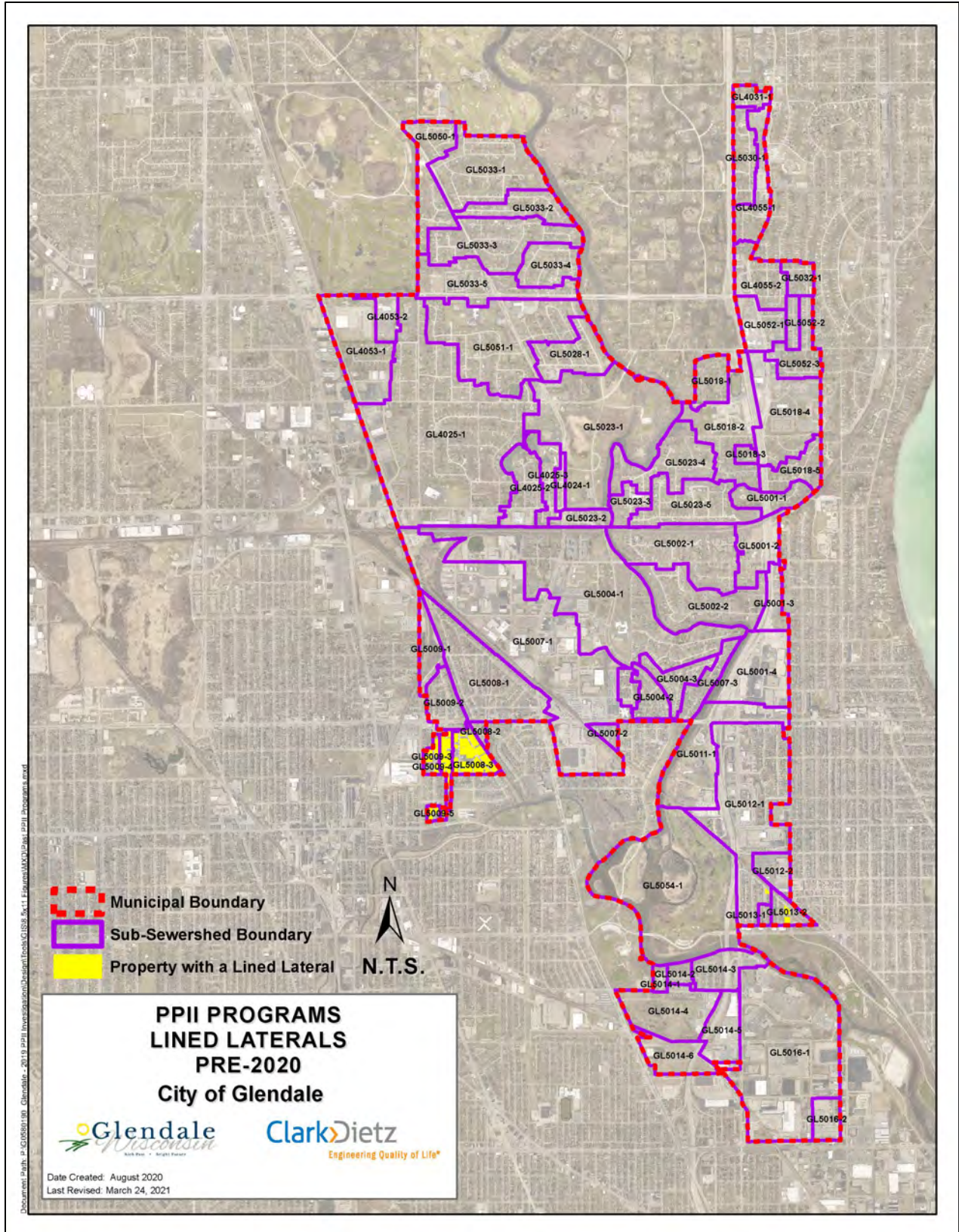


Figure 3.7 Glendale P2II Programs, Lined Laterals

3.6 FIELD TESTING PILOT PROGRAM

In 2020, Glendale implemented a pilot program to complete field investigation of their sanitary sewer system. The field work included dye water flooding of storm sewers at four roadway and storm sewer segments in the City as identified by the wet weather peak flows identified for each sewershed. Glendale performed smoke testing along approximately 22 sewer segments throughout the City. The locations of the testing performed are found in Figure 3.8 - 3.10.

Smoke testing focused on identifying illegally intended and unintended direct connections to the sewer collection system where the dye water flooding focused on identifying the precise location of inflow and infiltration coming from the City owned storm sewer.

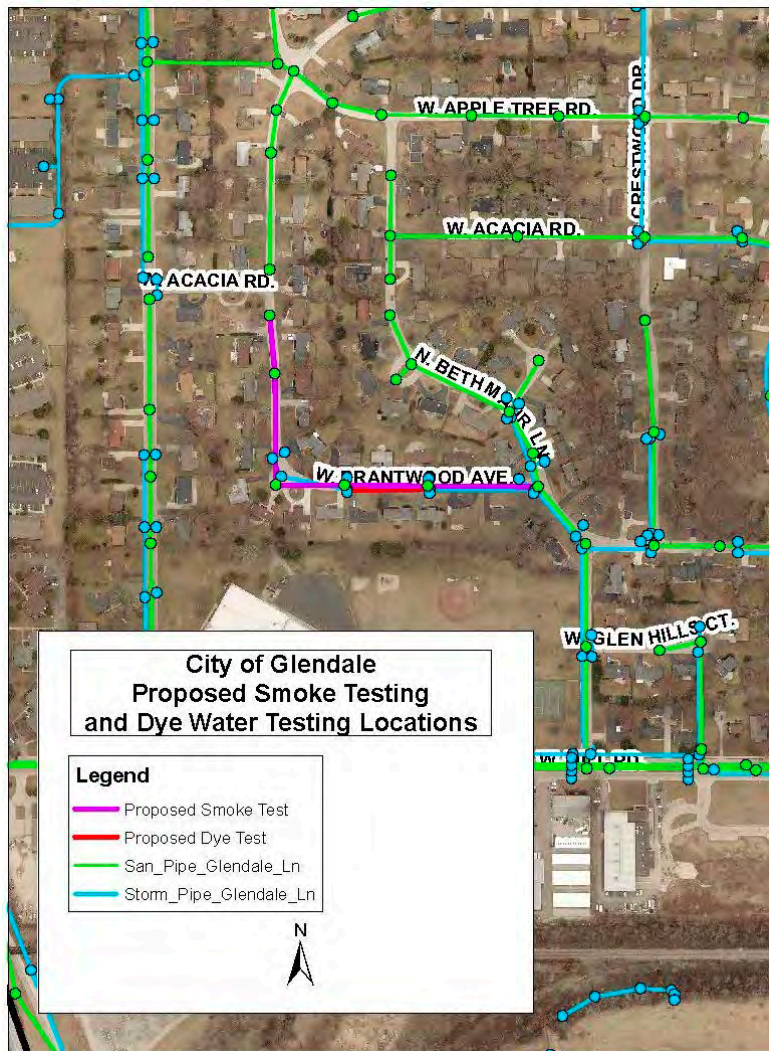


Figure 3.8 Smoke and Dye Testing Location Map 1

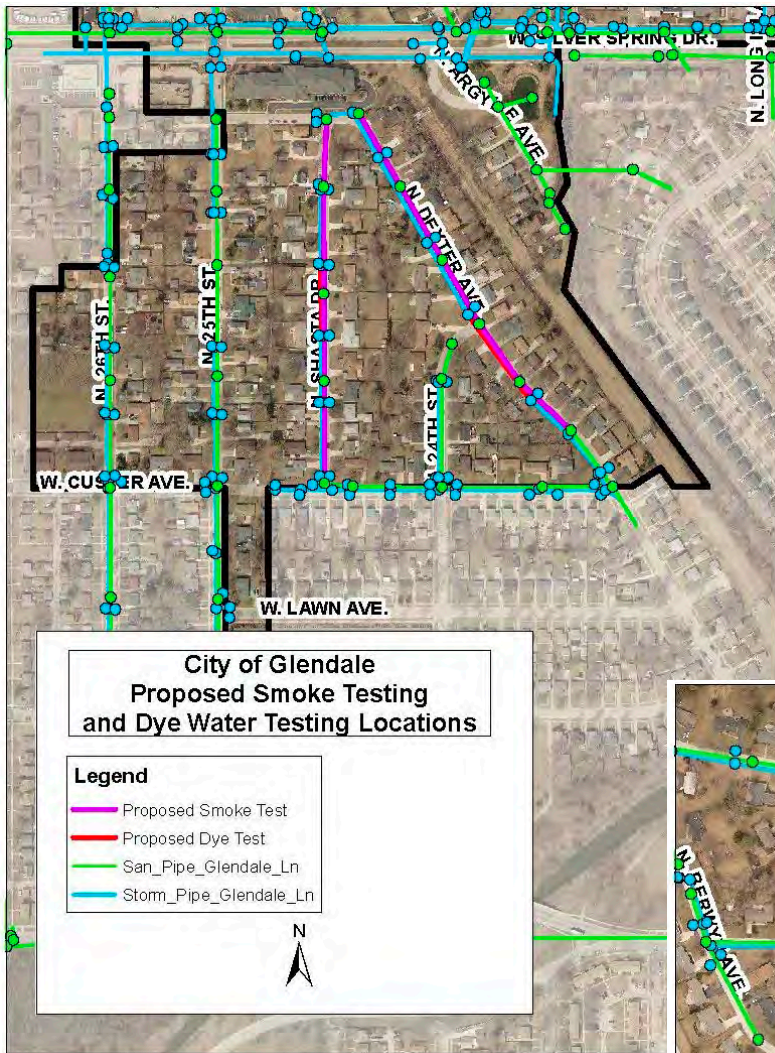


Figure 3.9 Smoke and Dye Testing Location Map 2



Figure 3.10 Smoke and Dye Testing Location Map 3

3.6.1 SMOKE TESTING

The City of Glendale conducted smoke testing of the sanitary sewer system. Smoke testing involves blowing a special non-toxic smoke into the sanitary sewer system. The smoke is manufactured for this purpose, leaves no residuals or stains, and has no effect on plant or animal life. The task of the testing was to locate breaks and defects in the sewer system. The smoke also reveals sources of where storm and other surface water enter the sanitary sewer system.

The Smoke testing is an effective test due to how quickly it can be completed and the ability to perform the test over large areas at a low cost. It does well at identifying point sources of inflow but will frequently miss infiltration sources.

Glendale performed smoke testing along approximately 22 sewer segments throughout the City in three different sewersheds. Some of the major results that the test identified were cross infiltration from the storm sewer and sanitary sewer along Applewood Ln. This was indicated by two smoking storm inlets. A cracked lateral at 5465 N. Dexter Ave was also discovered which is causing infiltration into the system. It also revealed that 6529 W Brentwood Ave. has a connected sump pump causing inflow into the sanitary collection system.

While smoke testing is quick to perform over large areas, it requires a lot of resident and emergency response coordination. All the residents in the test areas were notified twice of the test being performed. Because the plumbing appliances in the homes or building are connected to the sanitary sewer system, it is possible that smoke may enter the building. Multiple notices were sent to try to prevent the fire department from being called by mistake. Even with the notices and the relatively small test area, the fire department was called and showed up twice during the day of testing. There were also some residents that came out and said their home was filled with smoke but were able to identify that it was the test smoke and not a fire. See Appendix E for the complete smoke test report.

3.6.2 DYE WATER TESTING

Glendale also performed a dye water flooding test as a pilot program performed at the same time as the smoke testing. Dye water testing is performed by flooding an area with non-toxic fluorescent dye while televising (CCTV) the sanitary sewer to identify the location and magnitude of a defect. In the tests, the flooding was contained to the storm sewer system. The testing objective is to identify storm water sources that are entering the sanitary sewer system. Since storm sewers are the collection point for runoff, the amount of potential infiltration at these locations are substantial.

The test revealed five private laterals that showed dye transference from the storm sewer indicating infiltration from the storm sewer into the sanitary sewer. The locations were 2415 W. Brantwood Ave, 2145 N. Applewood Ln, 2125 N. Applewood Ln, 2115 N. Applewood Ln, and 2140 N. Applewood Ln. The amount of flow being infiltrated from these 5 laterals was substantial. See Figure 3.11 showing an image captured during the test identifying exactly which lateral is causing infiltration. The full dye water test report can be found in Appendix D.



Figure 3.11 Private Property Lateral showing I/I from Dye Water Test

3.7 GLENDALE CURRENT ORDINANCE

The Glendale city ordinance shall be consistent with values and goals of the MMSD PPII program. The current ordinance reads:

15.1.32 DISCHARGE OF CLEAR WATERS.

(a) Discharge. No person shall cause, allow or permit any roof drain, surface drain, subsoil drain, drain from any mechanical device, gutter, ditch, pipe, conduit, sump pump or any other object or thing used for the purposes of collecting, conducting, transporting, diverting, draining or discharging clear water from any part of any private premises owned or occupied by said person to discharge into a sanitary sewer, public street, alley, sidewalk or public lands dedicated to public uses other than storm water collection, or adjacent private property.

(b) Nuisance. The discharge into a sanitary sewer, public street, alley, sidewalk, public lands dedicated to public use, or adjacent private property, from any roof drain, surface drain, drain from any mechanical device, gutter, ditch, pipe, conduit, sump pump or any other object or thing used for the purposes of collecting, conducting, transporting, diverting, draining or discharging clear water from any part of any private premises is hereby declared to be a public nuisance and a hazard to the health, safety and well-being of the residents of the City and to the protection of the property.

(c) Groundwater. Where deemed necessary by the Building Inspector, every house shall have a sump pump installed for the purpose of discharging clear waters from foundation drains and ground infiltration and where the building is not serviced by a storm sewer shall either discharge into an underground conduit leading to a drainage ditch, gutter, dry well or shall discharge onto the ground surface in such other manner as will not constitute a nuisance as defined herein.

(d) Storm Water. All roof drains, surface drains, drains from any mechanical device, gutters, pipe, conduits or any other objects or things used for the purpose of collecting, conducting, transporting, diverting, draining or discharging storm waters shall be discharged either to a storm sewer, a dry well, an underground conduit leading to a drainage ditch or onto the ground surface in such other manner as will not constitute a nuisance as defined herein.

(e) Storm Sewer Lateral. Where municipal storm sewers are provided and it is deemed necessary by the property owner and/or the City to discharge clear waters from a parcel of land, a storm sewer lateral shall be installed and connected to the storm sewer main at the expense of the owner.

(f) Conducting Tests. If the Building Inspector or his designated agent suspects an illegal clear water discharge as defined by this Chapter or by any other applicable provision of the Wisconsin Administrative Code as it may, from time to time, be amended, he may, upon reasonable notice and at reasonable times, enter the private premises where such illegal clear water discharge is suspected and conduct appropriate tests to determine whether such suspected illegal clear water discharge actually exists.

(g) Penalty. Any violation of this section may be prosecuted or enforced as provided in Section 1.1.7 of the Glendale Code.

CHAPTER 4 - COLLECTION SYSTEM ANALYSIS AND EVALUATION

4.1 SUB SEWERSHEDS

MMSD identifies 26 sewersheds throughout Glendale. Many of these sewersheds cover large areas that are covered by different collector sewers. For the purpose of this study, MMSD's 26 sewersheds were further broken down into 66 sub-sewersheds. The sewersheds were broken down by MIS connection manhole or neighboring communities discharge manhole. The sub-sewershed approach allows for isolating collector sewers and a more detailed analysis during modeling. The MMSD sewersheds and new sub-sewersheds can be seen in Figure 4.1. There is also a full table breakdown found in Appendix B. While doing the analysis, the total sub-sewershed area varied slightly from the published MMSD sewershed areas. The study and analysis used the calculated sub-sewershed areas instead of the MMSD facility plan areas.

4.2 SANITARY SEWER SYSTEM MODEL

A model of the Glendale sanitary sewer system was developed in XP-SWMM to simulate the system response to wet weather flows. The XP-SWMM model heavily focused on hydraulic conditions of the sanitary sewer system to identify which sub-sewersheds were susceptible to sanitary sewer overflows with small increases of inflow and infiltration. The model also identified the sub-sewersheds with highest inflow and infiltration potential. Lined sewers and laterals were assumed to experience zero infiltration in the modeling process. This assumption was tested during the smoke and dyewater tests where we tested a lined sewer to ensure the results of lining performed as designed. While the results were expected, it was imperative to field test or to confirm in the field, as this assumption greatly impacts the results of our sewershed rankings based on inflow and infiltration potential.

The model created will help Glendale with future sanitary sewer projects and planning. The model helps establish a baseline for inflow and infiltration work that is expected to occur in the coming years. The sanitary sewer hydrologic model uses the XP-SWMM RUNOFF method, intended for direct runoff, to simulate I/I in the sanitary sewers. The model increases the direct runoff (simulated I/I) in the sub-sewersheds to determine hydraulic sensitivity. The model is generically calibrated to a 5-year rain event using the MMSD projected flows but has the ability to be fine tuned in the future as more rainfall and storm event data becomes available.

The model assumes that any sewer with flows entering Glendale from a neighboring community or MIS line is flowing half full or at 50% capacity for base flows. The I/I simulation is then completed to add additional flows to these sewers. This is to simulate the MMSD MIS carrying base sewer flows from upstream neighboring communities through Glendale.

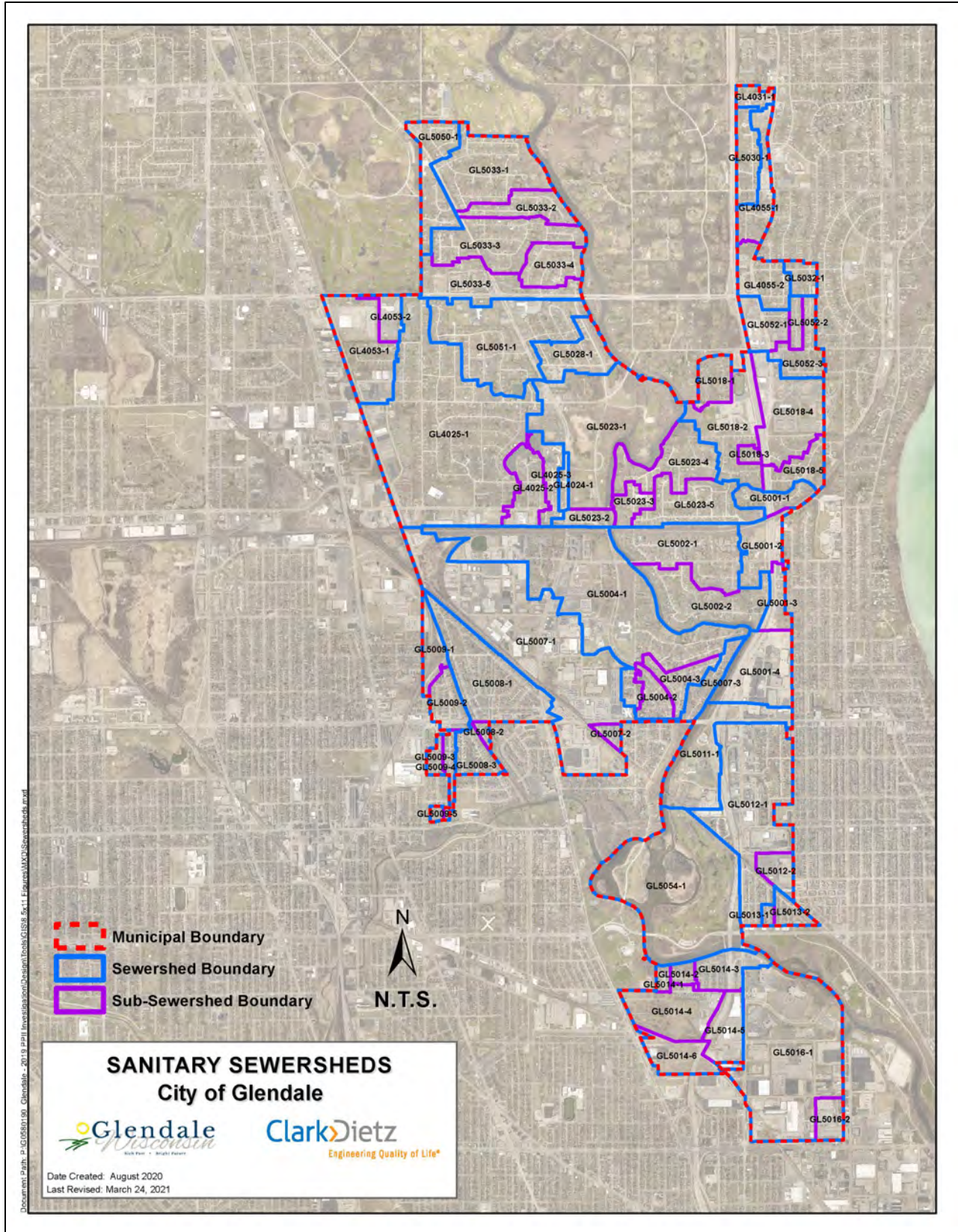


Figure 4.1 Glendale Sanitary Sewersheds

4.3 SEWERSHED RANKINGS

The ranking of sewersheds is a valuable tool to evaluate inflow and infiltration reduction and prioritize where proposed work plans are implemented. Sewersheds can be ranked in a range of ways. By changing the raw flow data into a measured unit rate, comparisons may be made between sewersheds (and sub-sewerheds) as well as comparisons relating factors such as general age of the sanitary sewer system. For this study, the rankings include unit inflow or infiltration rate of mgd/inch-mile of pipe (million gallons a day per inch mile of pipe).

Figure 4.2 shows the sub-sewershed rankings for public sanitary sewer inflow and infiltration. Figure 4.3 shows the sub-sewershed rankings for private property inflow and infiltration (PPII). Figure 4.4 shows the combined rankings using solid colors for public main and a line hatch for private property sources. Figure 4.5 shows the comparison of public sanitary main inflow and infiltration risk against the City's previous efforts for cured in place lining. The complete table showing the exact rankings can be found in Appendix B.

The Glendale sub-sewershed rankings are subjective to only the other sub-sewerheds located within Glendale. Action ASAP or high risk sewersheds may not propose significant risk to basement backups or even large amounts of inflow and infiltration when compared to neighboring communities. This evaluation only compares the sub-sewerheds located within the City limits. The bottom third of inflow potential is classified as low risk, middle third is medium risk, while the top third is classified as high risk. The highest potential of inflow and infiltration outliers are classified as Action ASAP and should be Glendale's priority for future rehabilitation projects. It is important to remember that rankings may change as the system ages or land use shifts.

4.4 SYSTEM HYDRAULICS

The XP-SWMM model created for this study was used to evaluate the hydraulic conditions of the sanitary sewer system. The model identifies the sub-sewerheds that are most susceptible to sanitary sewer overflow risk with small increases of inflow and infiltration. The model increases the size of rainfall events while measuring the freeboard elevation at the manholes. The sub-sewerheds were tracked by which would experience an overflow first. Sewersheds that did not experience any overflows during the increasing rain event were classified as low risk. Figure 4.6 shows a snapshot of the model simulation as well as identifying the sub-sewershed at most risk for a potential sanitary sewer overflow. Figure 4.7 shows the complete system ranked by their hydraulic stability.

The hydraulic stability shall be considered alongside the sewershed inflow and infiltration potential rankings. While there has not been a recorded sanitary sewer overflow in Glendale since 1998, increases to inflow and infiltration in some unstable sub-sewerheds could create higher risks. Sub-sewershed GL5033-5 in particular should be monitored in the future as it is ranked third for hydraulic stability and ranked 21st for public inflow and infiltration potential. Since it is in the top 33% of sewersheds it is ranked high risk even though estimated inflow and infiltration is comparatively low to other high-risk basins located in Glendale.

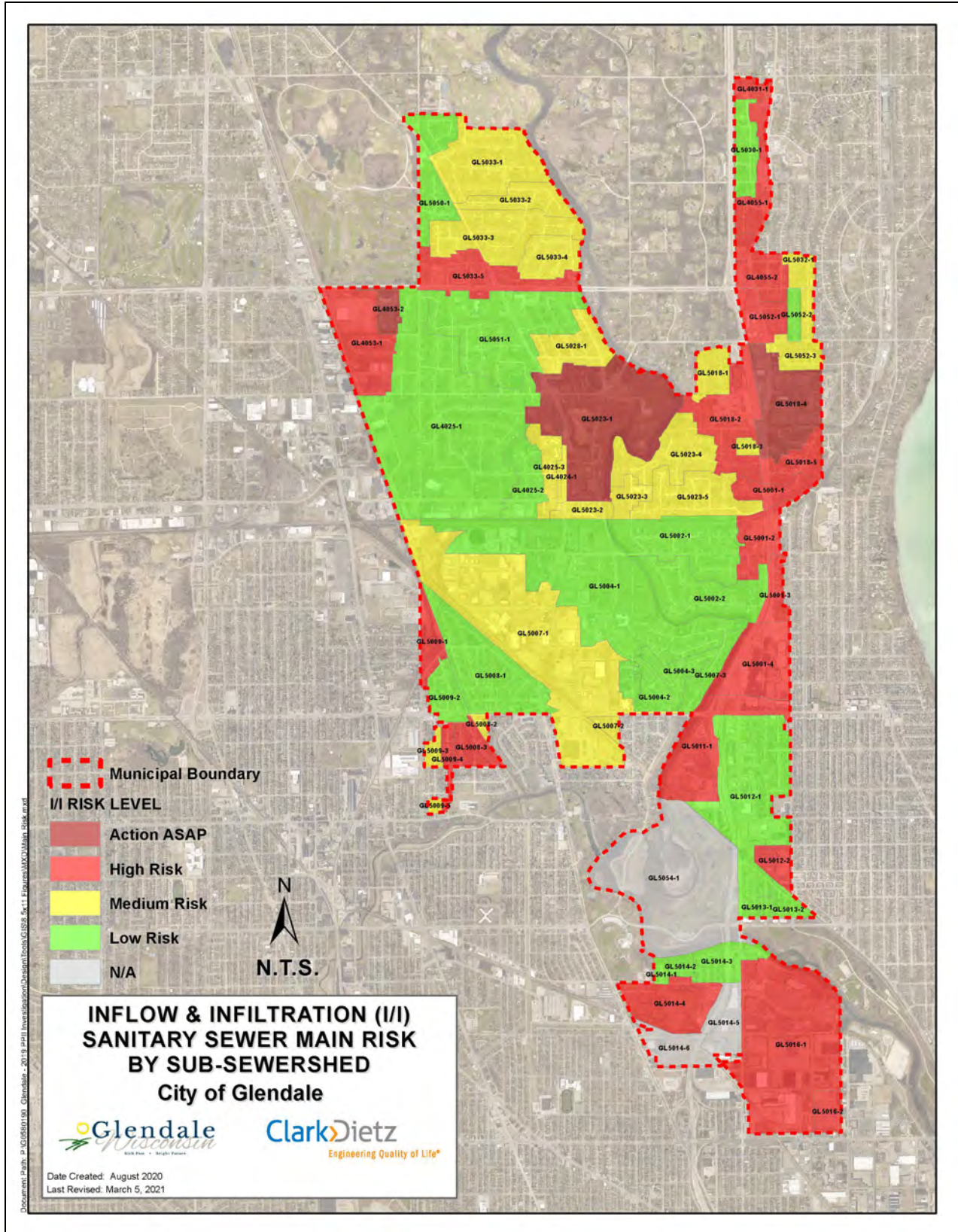


Figure 4.2 Inflow & Infiltration (I/I) Sanitary Sewer Main Risk by Sewershed

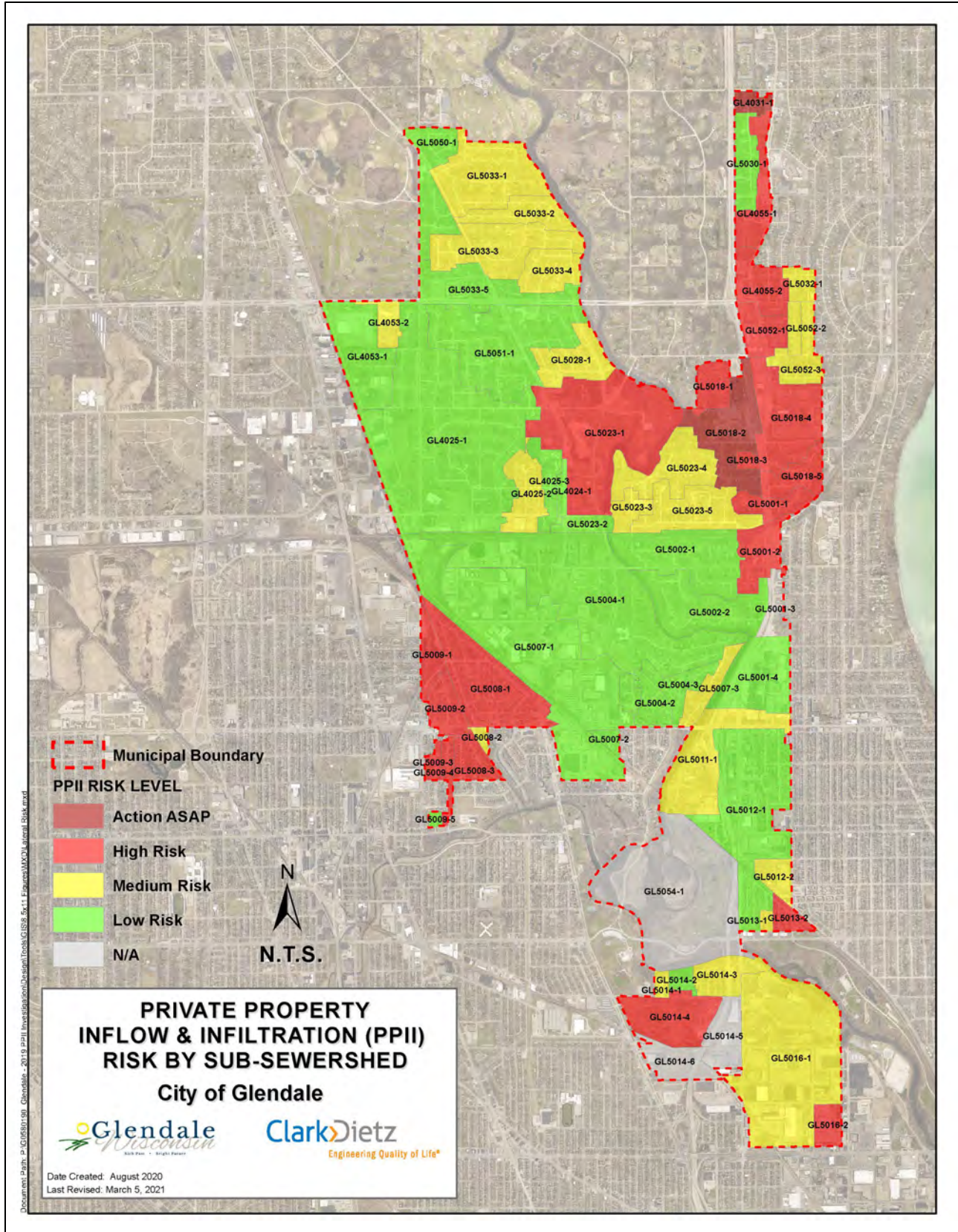


Figure 4.3 Private Property Inflow & Infiltration (PPII) Risk by Sewershed

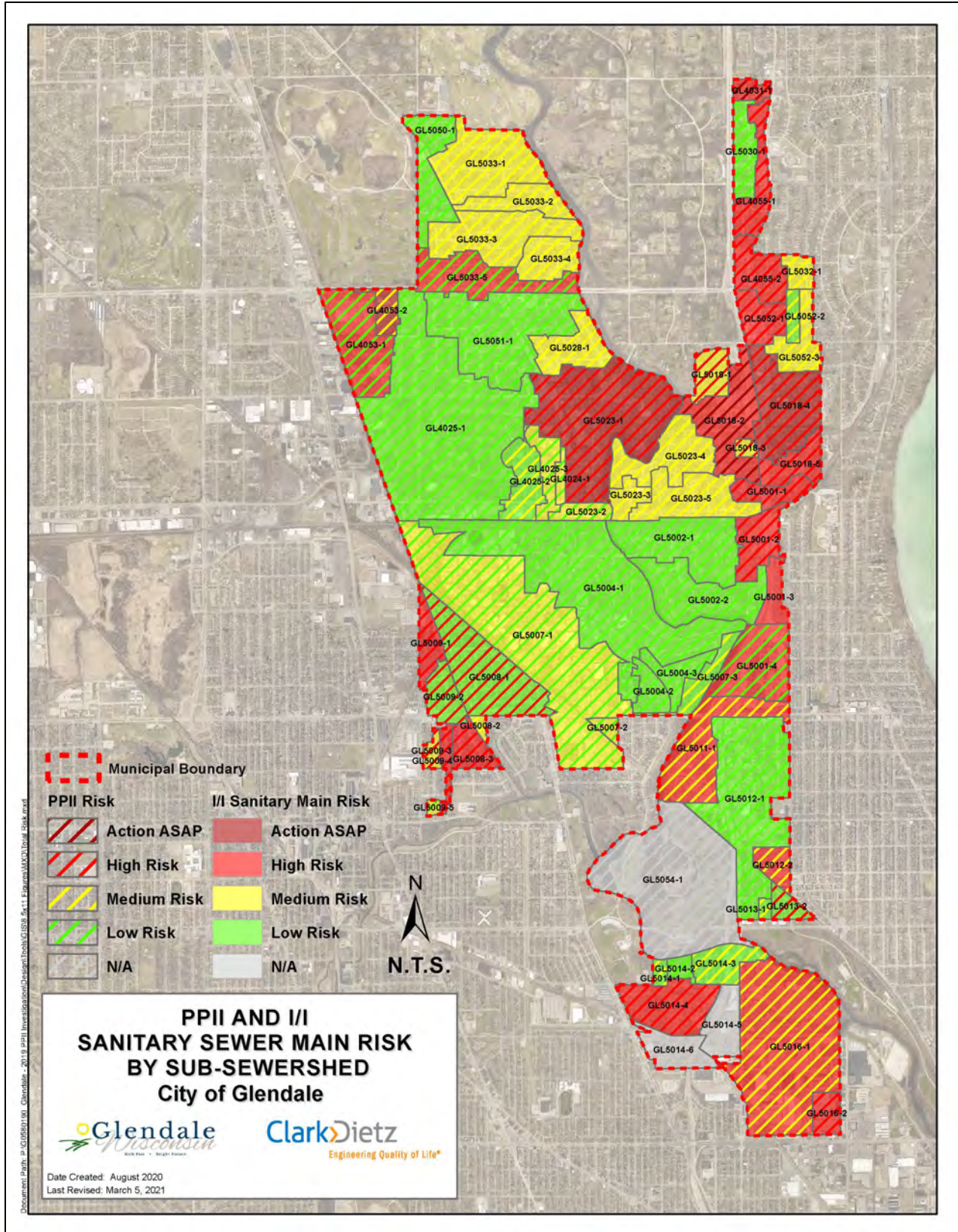


Figure 4.4 PPII and I/I Sanitary Sewer Main Risk by Sewershed

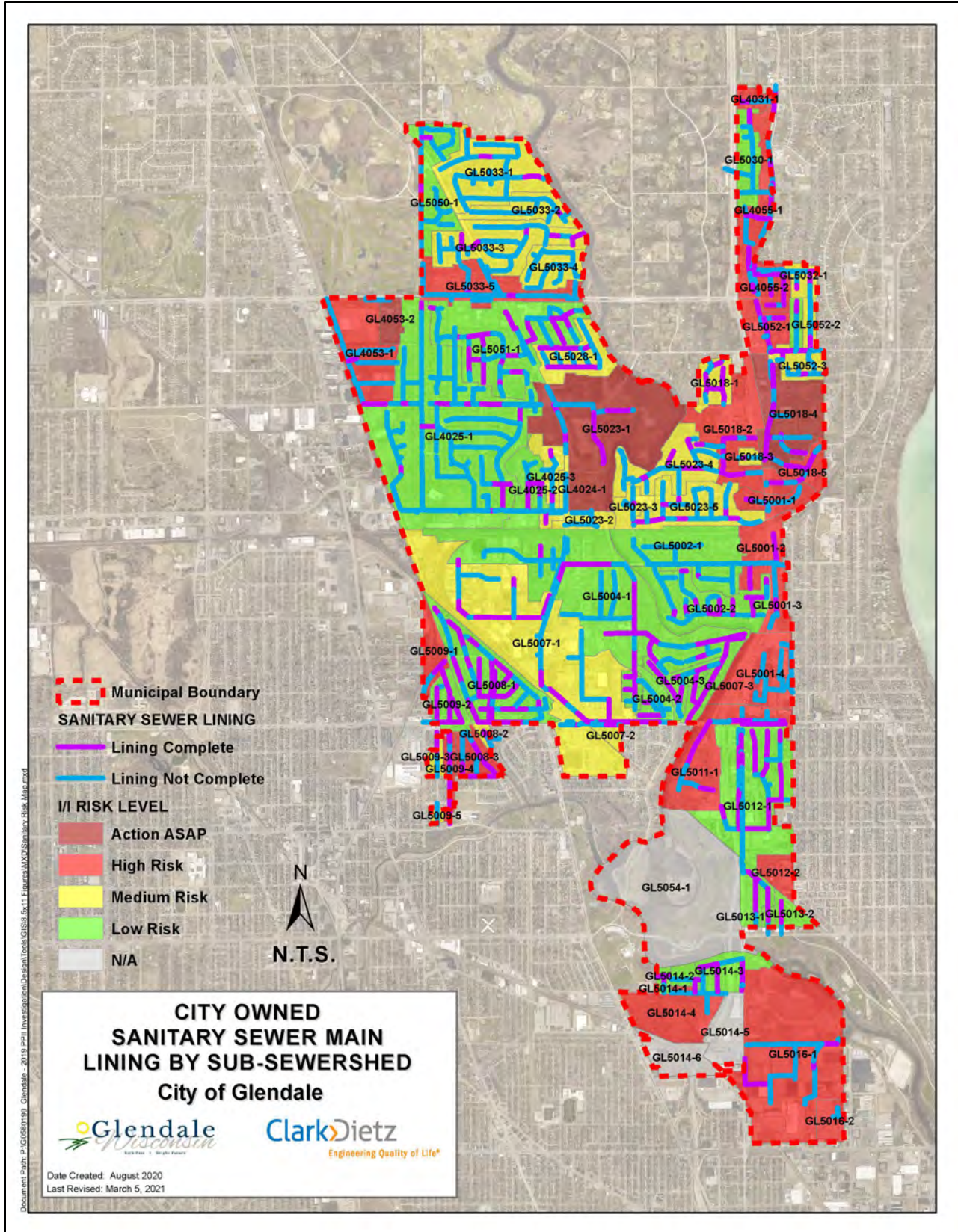


Figure 4.5 City Owned Sanitary Sewer Main Lining by Sewershed I/I Risk

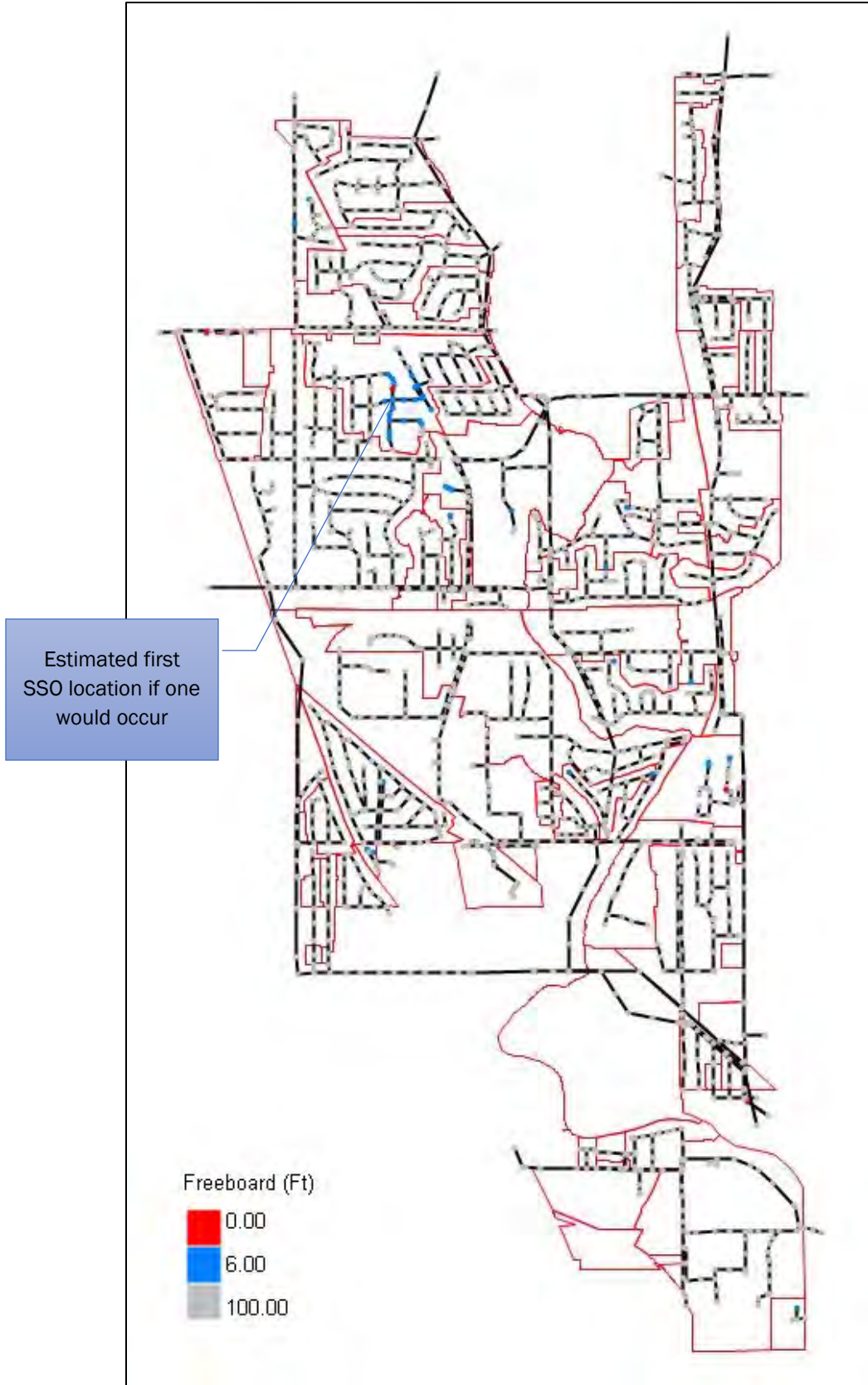


Figure 4.6 XPSWMM Model Hydraulic Sensitivity Simulation

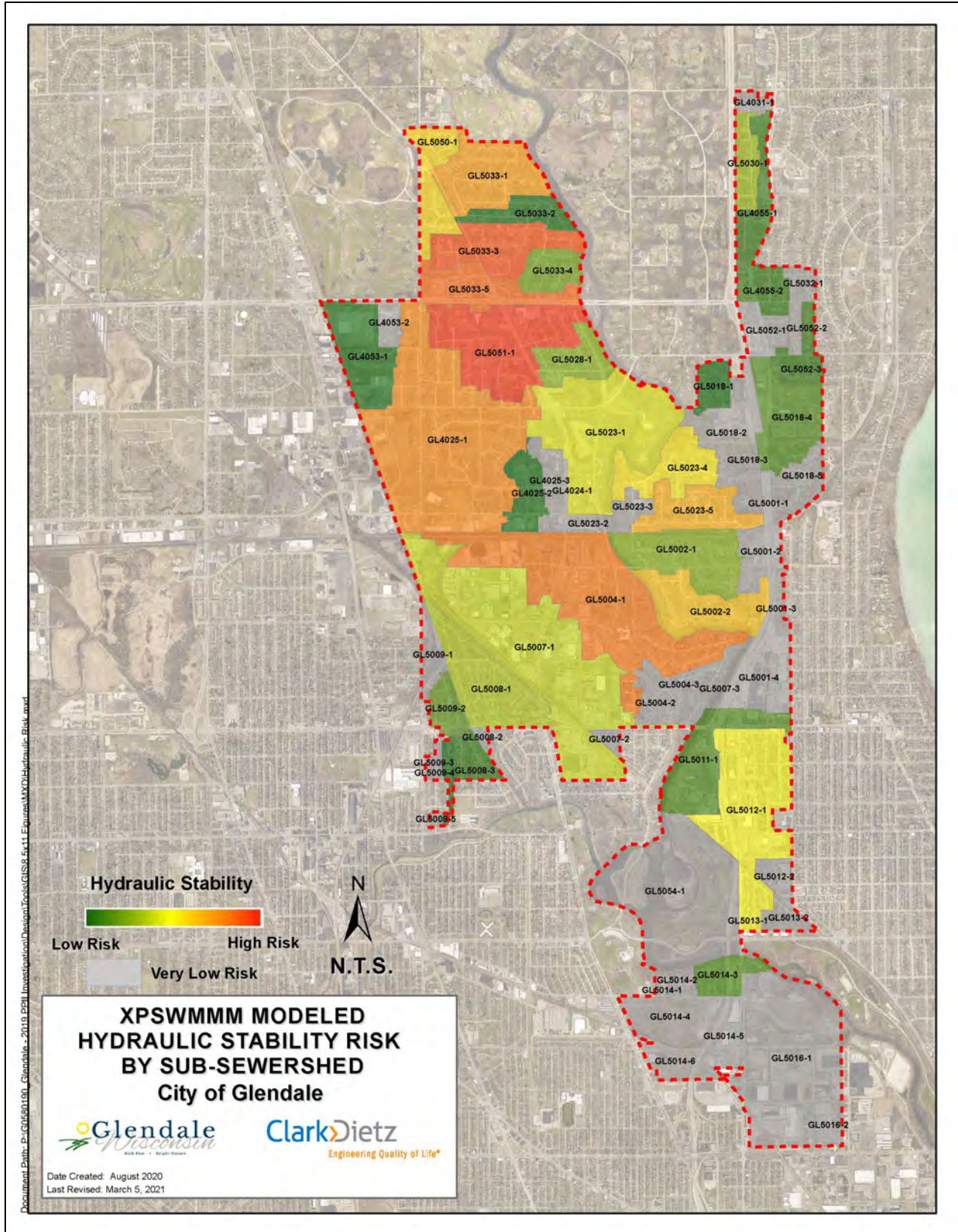


Figure 4.7 XPSWMM Modeled Hydraulic Stability Risk by Sewershed

CHAPTER 5 - IMPLEMENTATION PLAN RECOMMENDATIONS

Inflow and infiltration problems are difficult to resolve because of the enormity of the infrastructure in place. The implementation plan outlined in this chapter aims to make solving inflow and infiltration problems more manageable while considering complex city budgets and other funding programs.

5.1 PUBLIC SANITARY SEWER SYSTEM LINING

It is recommended that the City of Glendale continue lining their sanitary sewer system. The cured in place lining will help reduce infiltration into the system with the added benefit of solving structural deficiencies to the aging sewer system. Evaluating construction project bid tabs for similar projects, it was estimated that it costs \$34,000 per inch-mile of pipe to line the sewer main in 2020 dollars. The analysis uses a 3% inflation increase and an additional 15% for engineering services. The bid tabs for the projects used for comparison can be found in Appendix C.

Three proposed options are outlined which provide different levels of inflow and infiltration reduction. Each of the three plans has a 10 year, 12 year, and 15 year annual capital improvement plan budget allowing for some flexibility in the City budget. The estimated annual cost per year for each of the outline plans are indicated in Table 5.1. The proposed plans range from \$126,000 to \$280,000 per year budgeted.

- Proposed Option 1 aims to provide inflow and infiltration reduction from public sources from sewersheds estimating to be contributing more than .05 MGD per in-mile of pipe of I/I. There are 17 sewersheds that fall under this criteria of reduction with a total length of 61 in-miles of unlined pipe needing rehabilitation. Once the plan is complete, the estimated inflow and infiltration reduction is 1.27 MGD.
- Proposed Option 2 aims to provide inflow and infiltration reduction from public sources from sewersheds estimating to be contributing more than .06 MGD per in-mile of pipe of I/I. There are 12 sewersheds that fall under this criteria of reduction with a total length of 51 in-miles of unlined pipe needing rehabilitation. Once the plan is complete, the estimated inflow and infiltration reduction is 1.00 MGD.
- Proposed Option 3 aims to provide inflow and infiltration reduction from public sources from sewersheds estimating to be contributing more than .07 MGD per in-mile of pipe of I/I. There are 8 sewersheds that fall under this criteria of reduction with a total length of 38 in-miles of unlined pipe needing rehabilitation. Once the plan is complete, the estimated inflow and infiltration reduction is 0.75 MGD.

Table 5.1 Per Year Spending Implementation Plan Options

	Proposed Option 1 Line sewersheds with more than .05 MGD per in-mile of I/I (Line 61 in-mile)	Proposed Option 2 Line sewersheds with more than .06 MGD per in-mile of I/I (Line 51 in-mile)	Proposed Option 3 Line sewersheds with more than .07 MGD per in-mile of I/I (Line 38 in-mile)
Cost Option 1 - 10 Years	\$280,000.00	\$233,000.00	\$174,000.00
Cost Option 2 - 12 Years	\$241,000.00	\$200,000.00	\$150,000.00
Cost Option 3 - 15 Years	\$202,000.00	\$168,000.00	\$126,000.00

The sewersheds priority list for the proposed three plans is shown in Table 5.2. All the listed sewersheds (blue, orange, and gray) would be rehabilitated under proposed option 1, sewersheds highlighted in blue and orange would be rehabilitated under proposed option 2, and only sewersheds highlighted in blue would be rehabilitated under proposed option 3.

Table 5.2 Ranking of Sewersheds with more than .05 MGD I/I

Sub Sewershed Name	Inch-Mile of Main Pipe UNLINED	Total Inflow due to UNLINED Public Main (MGD)	Proposed Option
GL5023-1	4.17	0.171	1, 2, & 3
GL4053-2	0.96	0.096	1, 2, & 3
GL5018-4	4.44	0.095	1, 2, & 3
GL5001-4	8.17	0.090	1, 2, & 3
GL4055-1	4.61	0.082	1, 2, & 3
GL5016-1	12.16	0.073	1, 2, & 3
GL5009-1	1.41	0.073	1, 2, & 3
GL5001-2	1.66	0.071	1, 2, & 3
GL5018-2	2.75	0.064	1 & 2
GL4055-2	5.64	0.063	1 & 2
GL5014-4	2.33	0.061	1 & 2
GL5001-3	1.97	0.061	1 & 2
GL4031-1	1.03	0.057	1
GL5011-1	5.44	0.056	1
GL5009-4	0.83	0.055	1
GL5008-3	2.21	0.054	1
GL5012-2	0.77	0.051	1

The following graphs and tables provide a comparison at the different cost options over a 10 year (blue), 12 year (orange), or 15 year (gray) budget plan. Figures 5.1 to 5.3 outline the total estimated amount of sewer main to be lined with a cured in place lining method.

Tables 5.3 to 5.5 and Figures 5.4 to 5.6 aim to estimate the amount of inflow and infiltration reduction expected under the proposed plan per year. The plan assumes rehabilitation starting in the highest inflow sewershed and rehabilitation 100% of the sewers before moving on to the next sewershed.

It is important to keep in mind that not all sewer pipes are good candidates for cured in place lining. Sags in the sewers along with multiple other defects such as offset joints would better be rehabilitated by full replacement rather than a cured in place liner. These sewer segments would need to be evaluated on a case-by-case basis as the estimated cost for replacement can vary greatly due to sewer depth and size. Plans and estimated costs to rehabilitate these case-by-case sewers would be presented to the City as they are discovered.

The engineering’s recommendation would be to approve a budget for proposed option 2 with a 10-year budget plan of \$233,000 a year. With most of the sewers past their design life, it is important to be aggressive in the rehabilitation plan to continue to provide a good level of service to the residents and maintain no sanitary sewer overflows. The 10-year budget options speeds up rehabilitation time frame and allows for another assessment of the plan sooner than the other options. Proposed option 2 provides a good balance between aggressive rehabilitation while being affordable.



Figure 5.1 Proposed Option 1 Estimated Sewer Main Lined



Figure 5.2 Proposed Option 2 Estimated Sewer Main Lined



Figure 5.3 Proposed Option 3 Estimated Sewer Main Lined

Table 5.3 Proposed Option 1 - Repair 0.05 MGD per inch-mile of pipe Sewersheds

Estimated I/I Reduction (MGD)			
	10 Year Option	12 Year Option	15 Year Option
Year 1	0.98	0.88	0.79
Year 2	0.62	0.54	0.46
Year 3	0.57	0.51	0.42
Year 4	0.48	0.45	0.40
Year 5	0.45	0.39	0.35
Year 6	0.42	0.37	0.31
Year 7	0.37	0.35	0.31
Year 8	0.35	0.31	0.30
Year 9	0.31	0.29	0.26
Year 10	0.27	0.27	0.24
Year 11		0.25	0.23
Year 12		0.20	0.22
Year 13			0.20
Year 14			0.19
Year 15			0.12



Figure 5.4 Proposed Option 1 Estimated I/I Reduction

Table 5.4 Proposed Option 2 - Repair 0.06 MGD per inch-mile of pipe Sewersheds

Estimated I/I Reduction (MGD)			
	10 Year Option	12 Year Option	15 Year Option
Year 1	0.86	0.79	0.71
Year 2	0.52	0.46	0.38
Year 3	0.49	0.42	0.36
Year 4	0.44	0.40	0.34
Year 5	0.38	0.35	0.32
Year 6	0.36	0.31	0.29
Year 7	0.35	0.30	0.25
Year 8	0.30	0.29	0.25
Year 9	0.29	0.26	0.24
Year 10	0.25	0.24	0.23
Year 11		0.23	0.21
Year 12		0.19	0.19
Year 13			0.18
Year 14			0.17
Year 15			0.12



Figure 5.5 Proposed Option 2 Estimated I/I Reduction

Table 5.5 Proposed Option 3 - Repair 0.07 MGD per inch-mile of pipe Sewersheds

Estimated I/I Reduction (MGD)			
	10 Year Option	12 Year Option	15 Year Option
Year 1	0.73	0.63	0.53
Year 2	0.40	0.38	0.37
Year 3	0.37	0.32	0.28
Year 4	0.35	0.30	0.26
Year 5	0.32	0.30	0.25
Year 6	0.29	0.26	0.24
Year 7	0.26	0.24	0.22
Year 8	0.25	0.22	0.21
Year 9	0.25	0.21	0.18
Year 10	0.22	0.21	0.17
Year 11		0.20	0.17
Year 12		0.16	0.16
Year 13			0.16
Year 14			0.15
Year 15			0.10



Figure 5.6 Proposed Option 3 Estimated I/I Reduction

5.2 PRIVATE PROPERTY LATERAL LINING

Private property lateral lining should be investigated in sewersheds that have been identified has high potential for private inflow and infiltration. The highest 14 sewersheds are listed in Table 5.6.

The investigation should be a continuation of the smoke testing and dye water flooding pilot program that was started in 2020. The pilot program did a great job identifying exactly which lateral causes large amounts of infiltration due to a cross infiltration with a nearby storm sewer. Lining these identified laterals would be the highest cost to benefit ratio for I/I reduction. The pilot program should begin in the sewersheds identified as high inflow and infiltration potential.

Table 5.6 Ranking of High Risk PPII Potential by Sewershed

Sub Sewershed Name	Total Estimated Number of Private Laterals	Total Inflow due to UNLINED Private Lateral (MGD)
GL5018-2	58	0.077
GL4031-1	23	0.073
GL5001-2	28	0.068
GL5018-5	35	0.061
GL5023-1	26	0.061
GL5018-1	38	0.053
GL5052-1	30	0.048
GL5009-2	87	0.048
GL5018-4	39	0.047
GL5014-4	31	0.046
GL4055-1	45	0.045
GL5009-1	15	0.044
GL5009-4	42	0.042
GL4055-2	63	0.040

Smoke testing will quickly identify sewer segments that are prone to infiltration. The smoke testing will also have the value of discovering point sources of inflow. These sources can be recorded, and homeowners can be approached with a plan on how to address sources found. Once areas of infiltration sources are identified, the dye water flooding will reveal which laterals are causing the large source of the problem. It does not seem cost effective to dye water flood the entire basins, therefore it is recommended to start with smoke testing and selectively choose dye water flooding based on the results. Figure 5.7 shows an example from the 2020 pilot test. The figure identifies one lateral out of the five to be higher risk of infiltration due to dye water transfer from the nearby storm sewer. While the other four laterals may still be causing infiltration, it is assumed the amount would be significantly less than the lateral that is discovered during the dye water flooding. With limited budget to line private property laterals, it is recommended to only target specific laterals identified during testing. Targeting all laterals within a specified area would not be as cost effective when comparing amount of I/I reduced per dollar spent.

The 2020 pilot test identified the following properties having large sources of infiltration.

- 2415 W. Brantwood Ave. (dye transfer)
- 2145 N. Applewood Ln. (dye transfer)

- 2125 N. Applewood Ln. (dye transfer)
- 2115 N. Applewood Ln. (dye transfer)
- 2140 N. Applewood Ln. (dye transfer)
- 5465 N. Dexter Ave. (smoke seen)

These properties should be included on the list created of homeowners to be approached to participate in private property inflow and infiltration programs.



Figure 5.7 Summary Example of Private Laterals with Dye Present during Field Investigation

MMSD is preparing to roll out their new PPII 2.0 program which will provide the City of Glendale with an opportunity for funding for private property inflow and infiltration reduction. The City should be prepared to take advantage of the funding and be ready to create work plans once the funding applications become available. The recommendation is to continue the smoke test and dye water flooding pilot program to identify laterals causing major sources of I/I. Only homeowners that are identified as major sources should be approached and invited to participate in the MMSD PPII 2.0 program. This will create the highest cost to benefit ratio for the limited MMSD funds that are available.

5.3 IN-HOME INSPECTIONS AND SUMP PUMP DISCONNECTION PROGRAM

The City discontinued the requirement of home inspections during the sale of the house based on Wisconsin regulations. The City should consider a pilot program to be able to continue in-home inspections and sump pump disconnections. Known connections of sump pumps to the sewers exist and one was found during the sewer smoke field testing. The City should verify that all downspouts and other illegal connections discovered from past inspections were properly disconnected. The pilot program should aim to identify and remedy these connections in a fair and equitable manner. The disconnection of these illegal connections would remove direct sources of inflow to the sanitary sewer collection system.

5.4 PUBLIC EDUCATION AND OUTREACH

The purpose of public education and outreach is to inform residents about private sources of inflow and infiltration that they may be unknowingly contributing from illegal sump pump connections, connected foundation drains, or connected downspouts. Getting the education out is a great way for sources of inflow to become identified and recorded with the city. The public needs to understand how PPII could contribute to City flooding and that their participation in such a program would increase the level of protection that the City is able to provide in the most cost-effective manner.

Glendale will add specific PPII related information on its existing website from this study. Additional information will be included in the City's quarterly print newsletter to further extend outreach to the public while providing contacts should they have questions.

CHAPTER 6 - BIBLIOGRAPHY

Glendale (2020) *Code of Ordinances*

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













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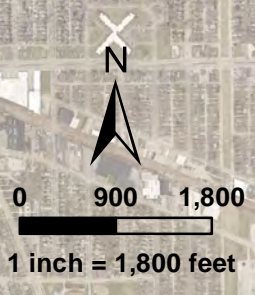
Appendix A



Report Full Size Figures

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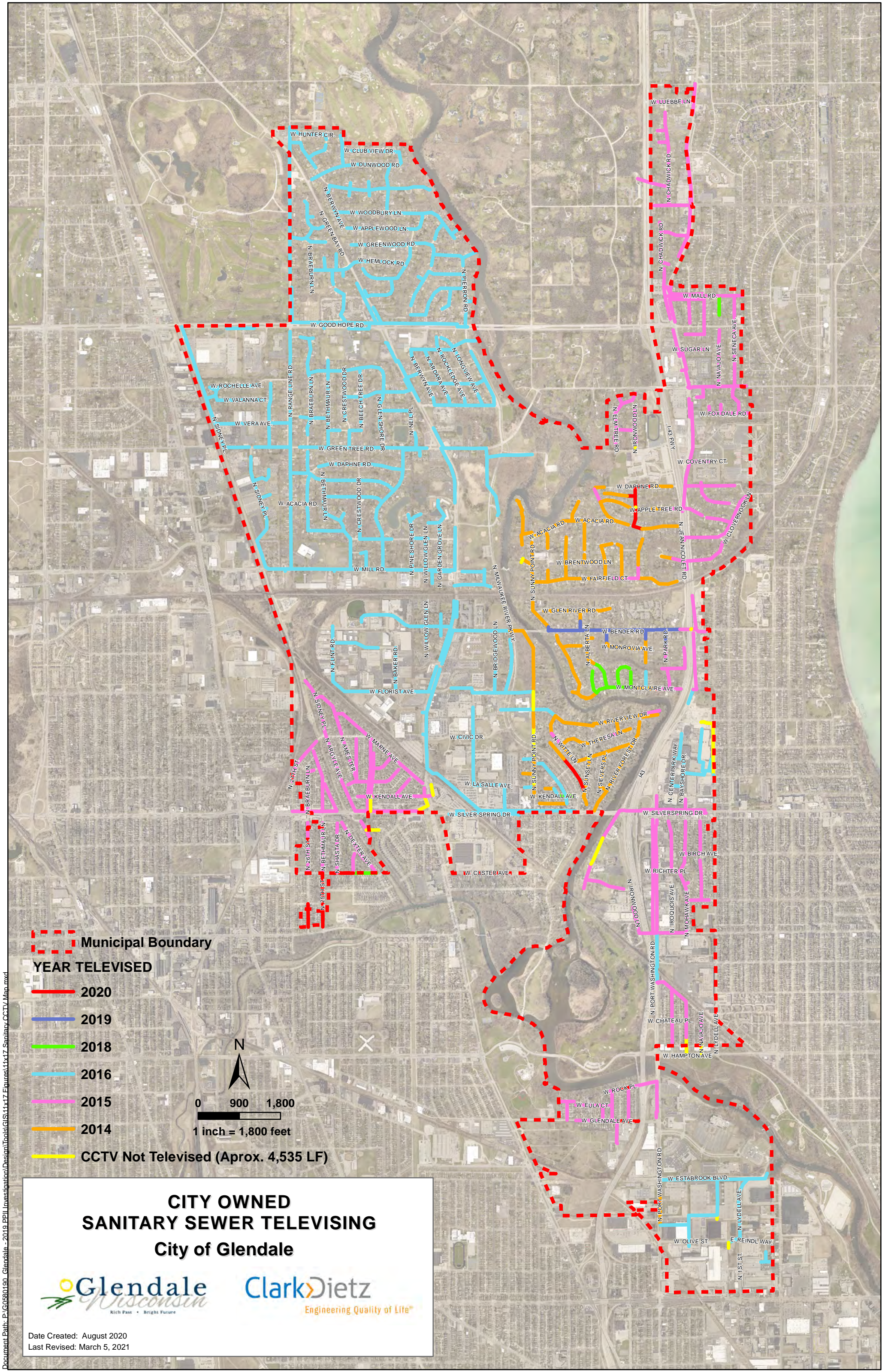
-  **Municipal Boundary**
- Sanitary Manhole**
 -  **Known Rim Elevation (1,417)**
 - Unknown Rim Elevation**
 -  **Glendale Unknown Rim EI (137)**
 -  **MMSD Unknown Rim EI (188)**
 -  **Milwaukee Unknown Rim EI (20)**
 -  **River Hills Unknown Rim EI (4)**
 -  **Private Unknown Rim EI (14)**
- Sanitary Main**
 -  **Known Upstream & Downstream IE (1,467)**
 - Unknown Upstream & Downstream IE**
 -  **Glendale (57)**
 -  **MMSD (151)**
 -  **Milwaukee (23)**
 -  **River Hills (4)**
 -  **Private (17)**
 - Sanitary Main (1 IE Known, 1 IE Unknown)**
 -  **Glendale (72)**
 -  **Milwaukee (3)**



**FIELD INFORMATION
REQUIRED FOR MODEL
City of Glendale**

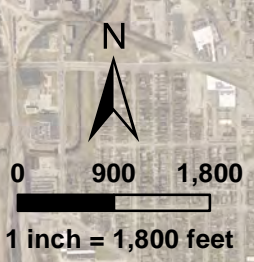


Date Created: August 2020
Last Revised: March 24, 2021



Municipal Boundary

- YEAR TELEVISIED**
- 2020
 - 2019
 - 2018
 - 2016
 - 2015
 - 2014
 - CCTV Not Televised (Aprox. 4,535 LF)



**CITY OWNED
SANITARY SEWER TELEVISING
City of Glendale**



Date Created: August 2020
Last Revised: March 5, 2021

Document Path: P:\GIS\0580180_Glendale - 2019 PPIL Investigation\Design\Tools\GIS\11x17 Figures\11x17 Sanitary CCTV Map.mxd

Document Path: P:\GIS\0580180_Glendale - 2019 PPIL Investigation\Design\Tools\GIS\11x17 Figures\11x17 Sanitary Lining Map.mxd

Municipal Boundary

SANITARY SEWER LINING

Lining Complete

Lining Not Complete (Aprox. 215,000 LF)

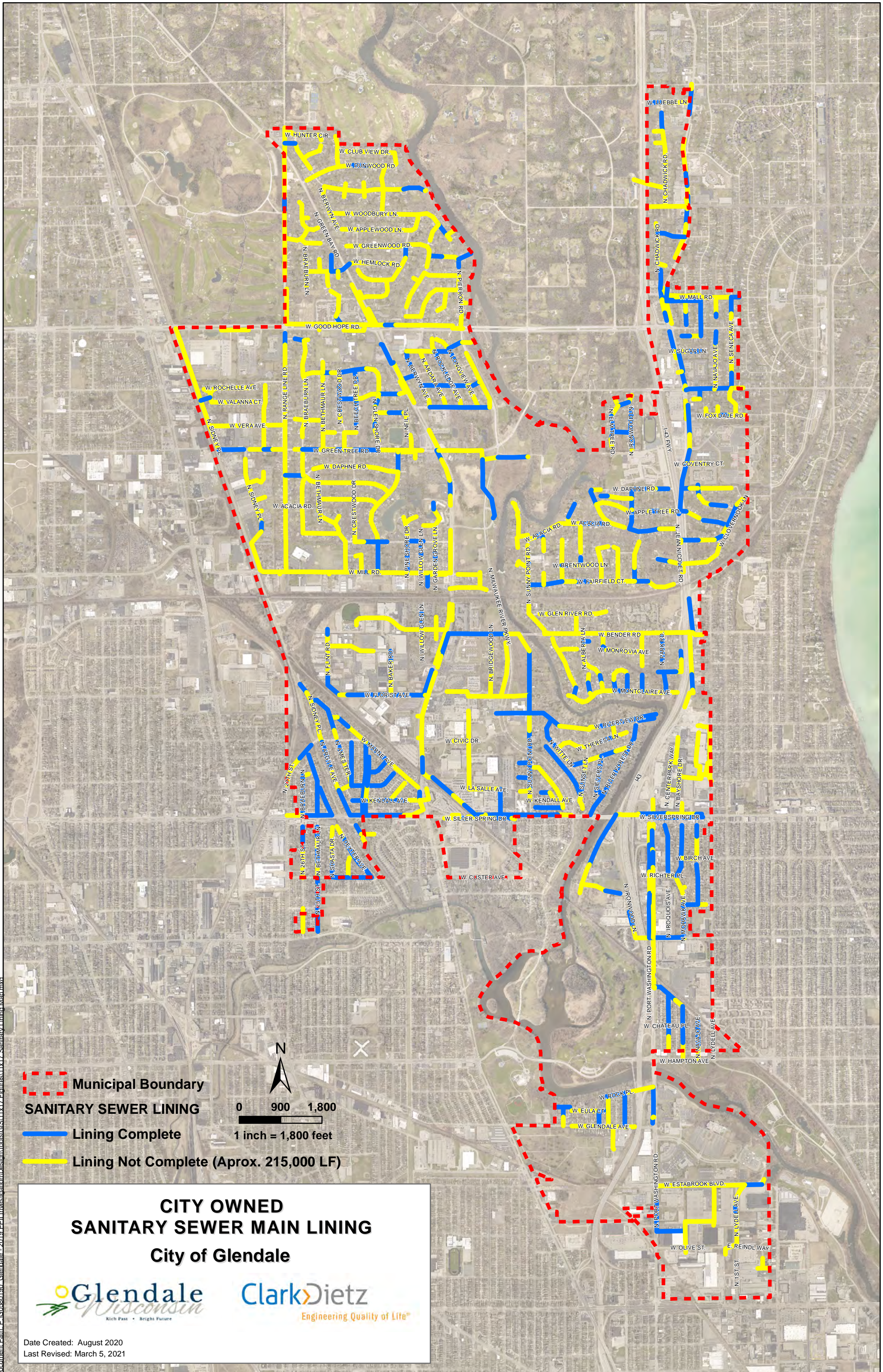
0 900 1,800
1 inch = 1,800 feet



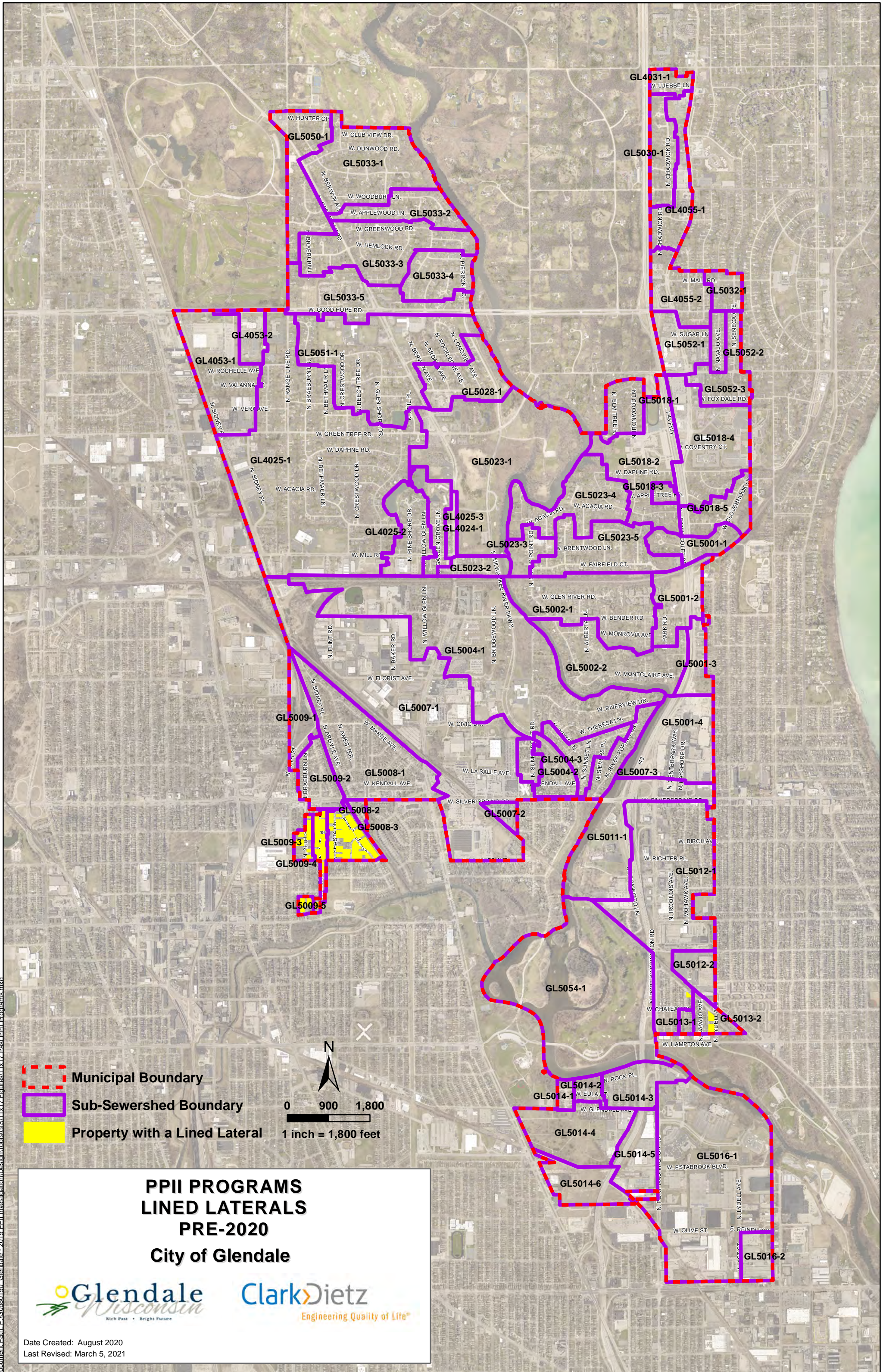
**CITY OWNED
SANITARY SEWER MAIN LINING
City of Glendale**


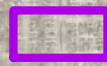



Date Created: August 2020
Last Revised: March 5, 2021



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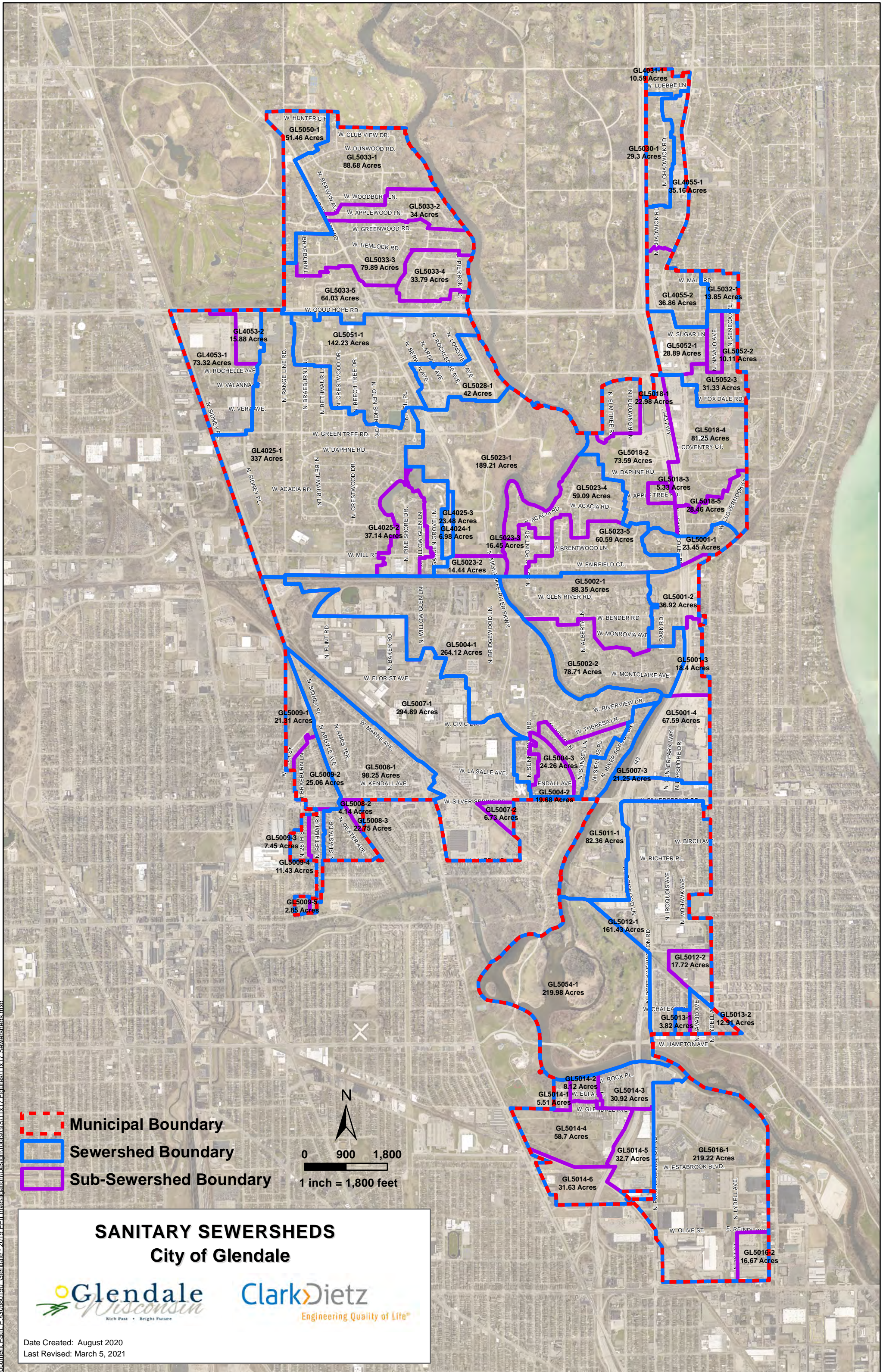
-  Municipal Boundary
 -  Sub-Sewershed Boundary
 -  Property with a Lined Lateral
- 0 900 1,800
1 inch = 1,800 feet


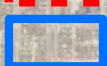

**PPII PROGRAMS
LINED LATERALS
PRE-2020
City of Glendale**

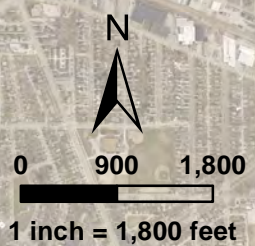


Date Created: August 2020
Last Revised: March 5, 2021

Document Path: P:\GIS\0580180_Glendale - 2019 PPIL Investigation\Design\Tools\GIS\11x17\Figures\11x17 Sewersheds.mxd



-  Municipal Boundary
-  Sewershed Boundary
-  Sub-Sewershed Boundary

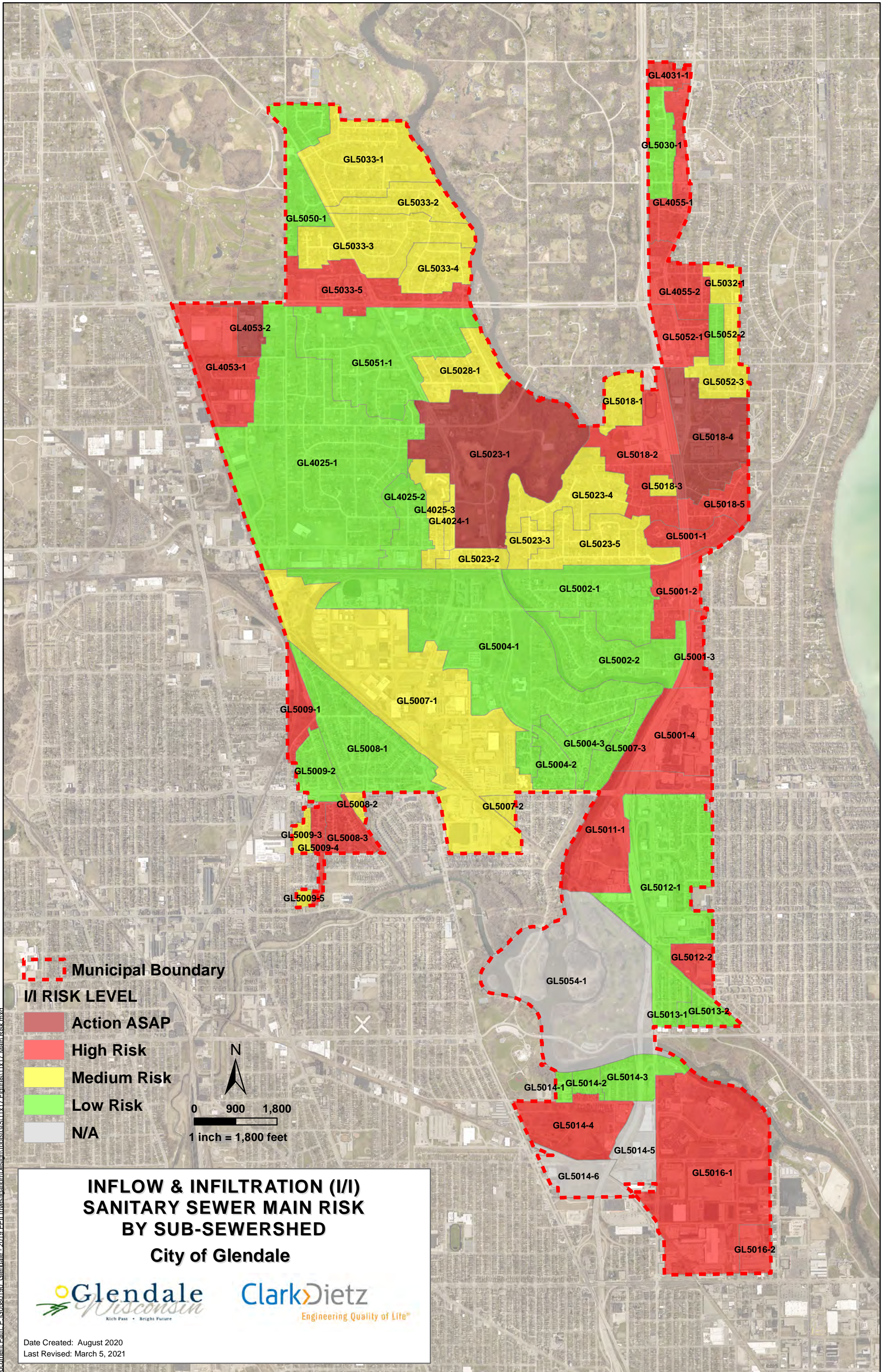


SANITARY SEWERSHEDS

City of Glendale

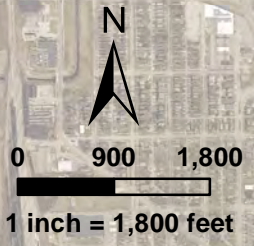


Date Created: August 2020
Last Revised: March 5, 2021



Municipal Boundary

- I/I RISK LEVEL**
- Action ASAP
 - High Risk
 - Medium Risk
 - Low Risk
 - N/A

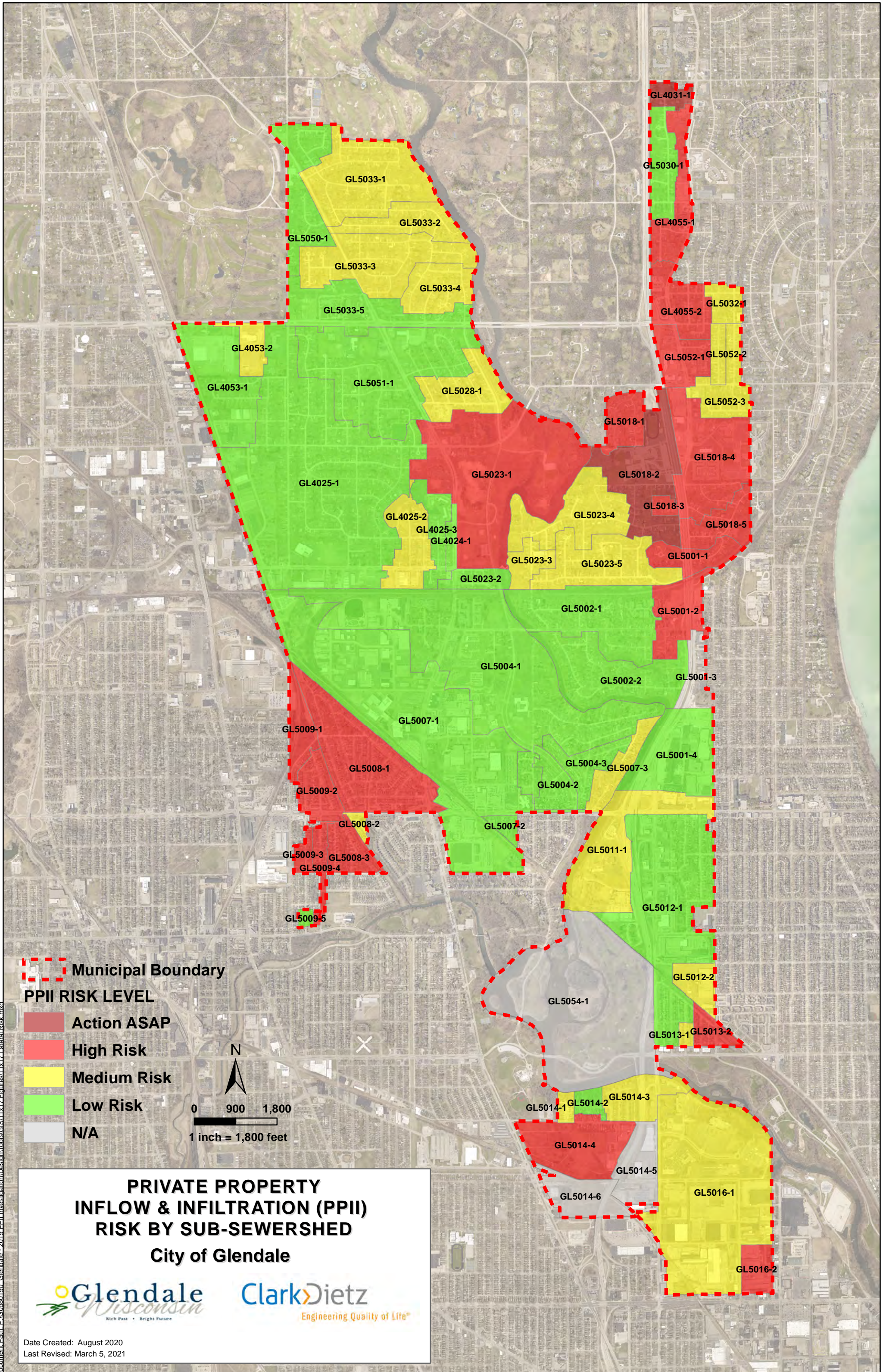


**INFLOW & INFILTRATION (I/I)
SANITARY SEWER MAIN RISK
BY SUB-SEWERSHED
City of Glendale**



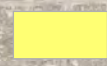
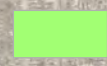
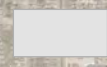


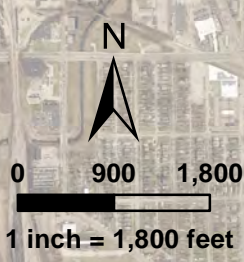
Date Created: August 2020
Last Revised: March 5, 2021

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 Municipal Boundary

- PPII RISK LEVEL**
-  Action ASAP
 -  High Risk
 -  Medium Risk
 -  Low Risk
 -  N/A

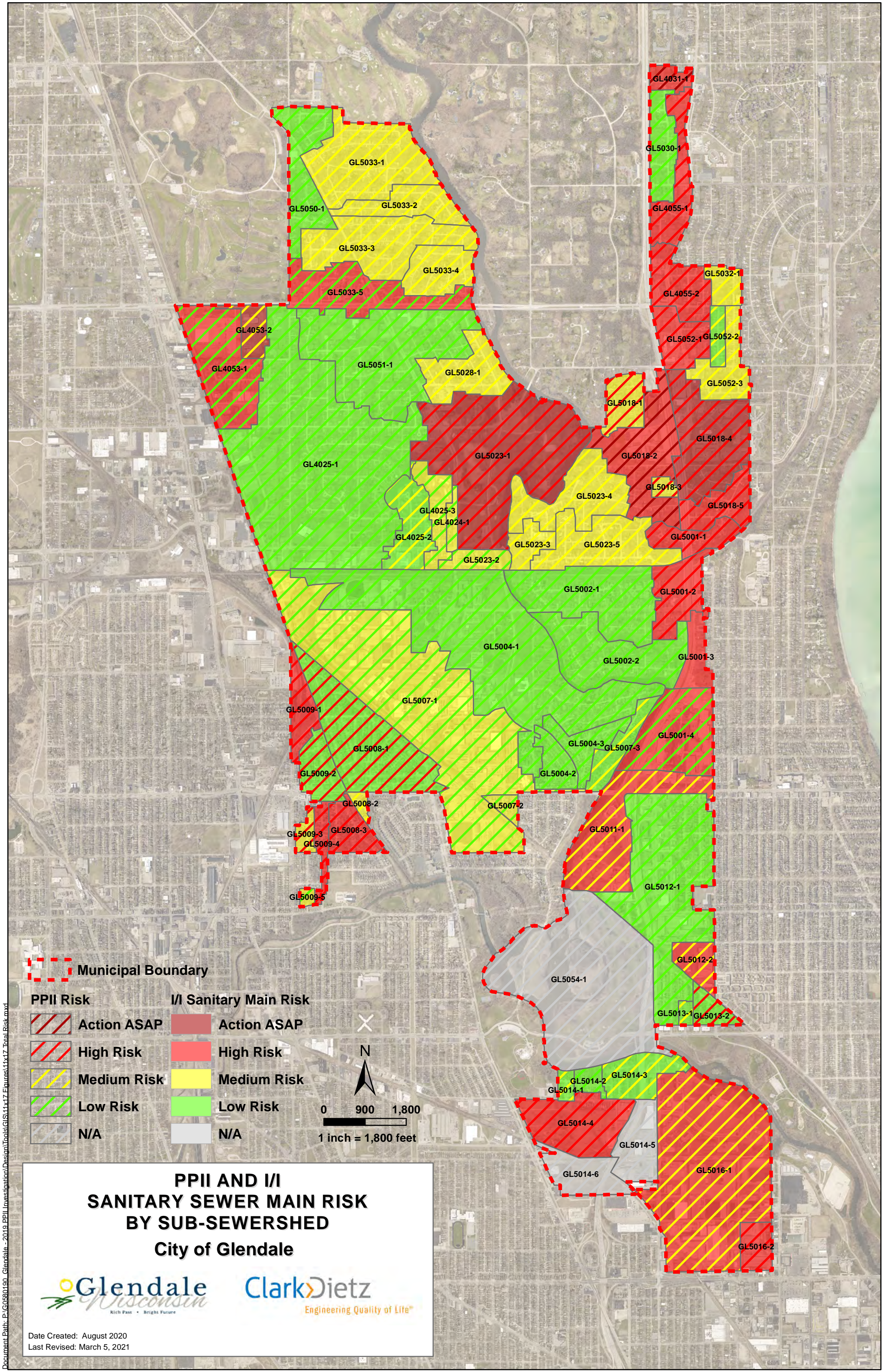


**PRIVATE PROPERTY
INFLOW & INFILTRATION (PPII)
RISK BY SUB-SEWSHED
City of Glendale**



Date Created: August 2020
Last Revised: March 5, 2021

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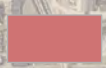
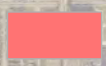
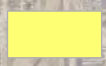
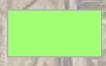


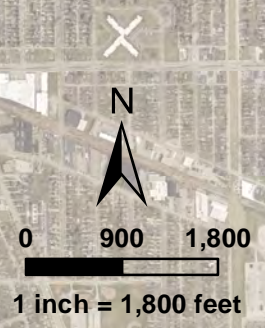
 Municipal Boundary

PPII Risk

-  Action ASAP
-  High Risk
-  Medium Risk
-  Low Risk
-  N/A

I/I Sanitary Main Risk

-  Action ASAP
-  High Risk
-  Medium Risk
-  Low Risk
-  N/A





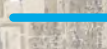


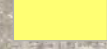
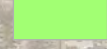
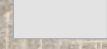
**PPII AND I/I
SANITARY SEWER MAIN RISK
BY SUB-SEWERSHED
City of Glendale**

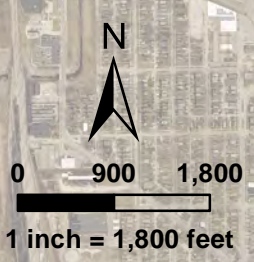


Date Created: August 2020
Last Revised: March 5, 2021

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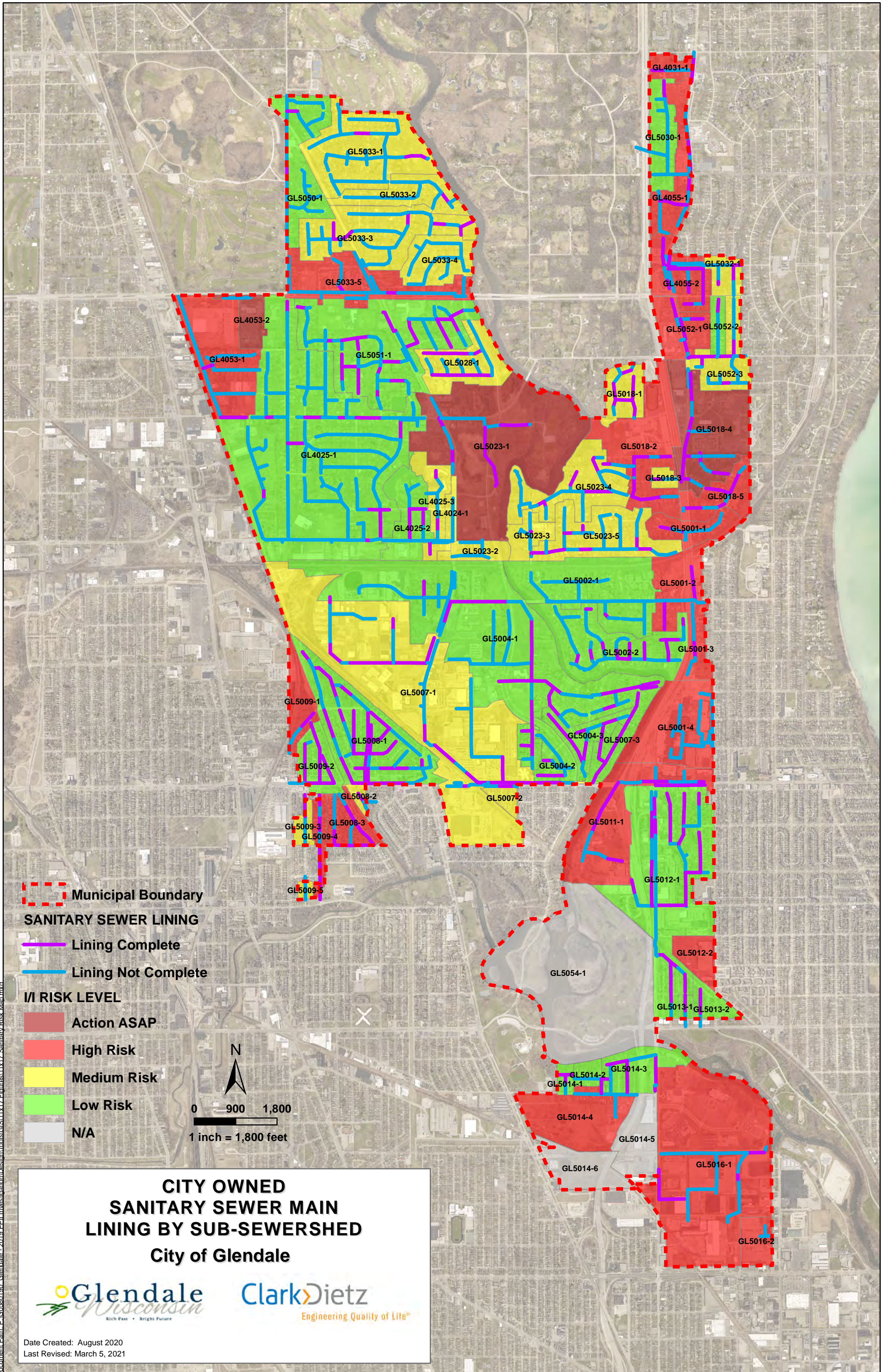
-  Municipal Boundary
- SANITARY SEWER LINING**
-  Lining Complete
-  Lining Not Complete
- I/I RISK LEVEL**
-  Action ASAP
-  High Risk
-  Medium Risk
-  Low Risk
-  N/A

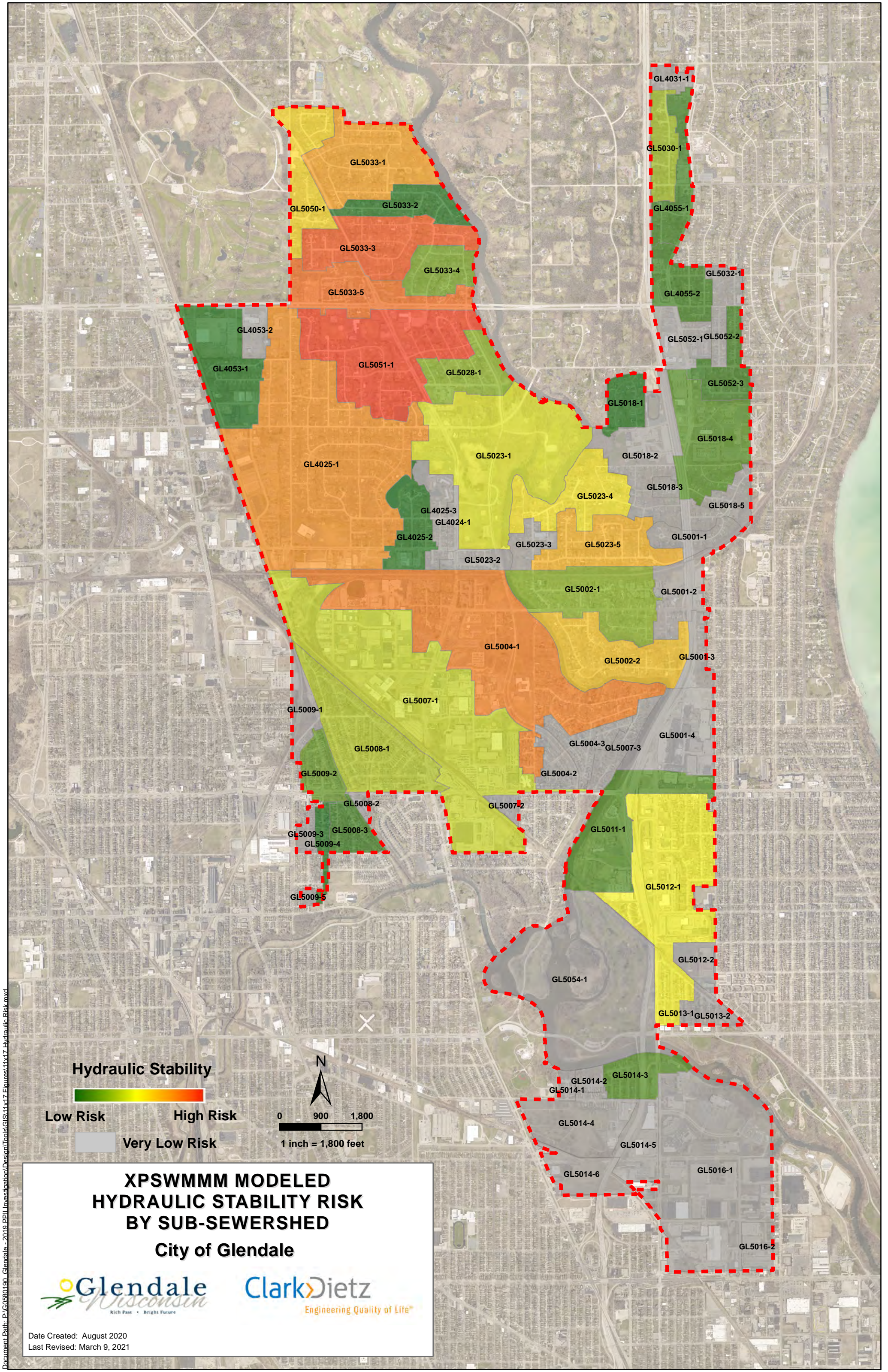


**CITY OWNED
SANITARY SEWER MAIN
LINING BY SUB-SEWERSHED
City of Glendale**

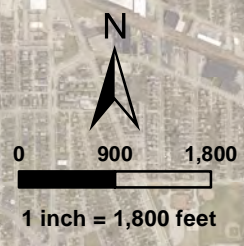
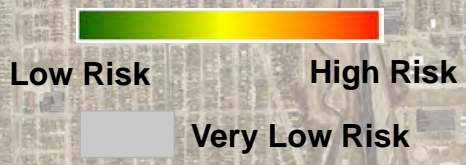


Date Created: August 2020
Last Revised: March 5, 2021





Hydraulic Stability



**XPSWMM MODELED
HYDRAULIC STABILITY RISK
BY SUB-SEWERSHED
City of Glendale**



Date Created: August 2020
Last Revised: March 9, 2021

Document Path: P:\G0580180_Glendale - 2019 PPIL Investigation\Design\Tools\GIS\11x17 Figures\11x17 Hydraulic Risk.mxd

Appendix B



Sewershed Data Tables

Sub-Sewershed Inflow and Infiltration Data

Sub Sewershed Name	ALL MAIN	ONLY UNLINED PIPE	ONLY LINED PIPE	NUMBER OF PARCELS	ASSUMED ESTIMATE											
	Inch-Mile of Main Pipe	Inch-Mile of Main Pipe UNLINED	Inch-Mile of Main Pipe LINED	Total Estimated Number of Private Laterals	Estimated Number of Laterals LINED	Estimated Number of Laterals UNLINED	MMSD Modeled Inflow (MGD)	Inch-Mile of Private Lateral Pipe UNLINED	Total Inch-Mile UNLINED Pipe (Main + Lateral)	Total Inflow Per Inch-Mile of Main and Lateral Pipe	Total Inflow due to UNLINED Private Lateral (MGD)	Total Inflow due to UNLINED Public Main (MGD)	Inflow Private Lateral Risk Ranking	Inflow Public Main Risk Ranking	Hydraulic Sensitivity (Low is Bad)	
GL4024-1	1.83	1.83	0.00	14	0	14	0.081	0.795	2.62	0.0309	0.009	0.022	Low Risk	Medium Risk		
GL4025-1	66.35	58.09	8.26	492	0	492	1.604	27.955	86.05	0.0186	0.006	0.013	Low Risk	Low Risk	5	
GL4025-2	5.52	3.47	2.05	60	0	60	0.177	3.409	6.87	0.0257	0.013	0.013	Medium Risk	Low Risk	27	
GL4025-3	3.84	2.84	1.00	31	0	31	0.112	1.761	4.60	0.0243	0.009	0.015	Low Risk	Medium Risk		
GL4031-1	2.32	1.03	1.29	23	0	23	0.304	1.307	2.34	0.1300	0.073	0.057	Action ASAP	High Risk		
GL4053-1	13.58	12.21	1.37	62	0	62	0.591	3.523	15.73	0.0376	0.008	0.029	Low Risk	High Risk	27	
GL4053-2	0.96	0.96	0.00	3	0	3	0.128	0.170	1.13	0.1130	0.017	0.096	Medium Risk	Action ASAP		
GL4055-1	6.79	4.61	2.18	45	0	45	0.912	2.557	7.17	0.1272	0.045	0.082	High Risk	High Risk	23	
GL4055-2	10.51	5.64	4.87	63	0	63	0.956	3.580	9.22	0.1037	0.040	0.063	High Risk	High Risk	23	
GL5001-1	2.66	2.21	0.45	29	0	29	0.288	1.648	3.85	0.0747	0.032	0.043	High Risk	High Risk		
GL5001-2	3.73	1.66	2.07	28	0	28	0.453	1.591	3.25	0.1393	0.068	0.071	High Risk	High Risk		
GL5001-3	2.48	1.97	0.50	13	0	13	0.226	0.739	2.71	0.0833	0.023	0.061	High Risk	High Risk		
GL5001-4	8.17	8.17	0.00	9	0	9	0.829	0.511	8.68	0.0955	0.006	0.090	Low Risk	High Risk		
GL5002-1	10.55	10.39	0.16	140	0	140	0.250	7.955	18.34	0.0136	0.006	0.008	Low Risk	Low Risk	16	
GL5002-2	13.79	9.31	4.47	175	0	175	0.223	9.943	19.26	0.0116	0.006	0.006	Low Risk	Low Risk	8	
GL5004-1	49.17	27.51	21.66	262	0	262	0.696	14.886	42.40	0.0164	0.006	0.011	Low Risk	Low Risk	4	
GL5004-2	3.73	2.53	1.20	59	0	59	0.052	3.352	5.89	0.0088	0.005	0.004	Low Risk	Low Risk		
GL5004-3	6.24	2.05	4.18	101	0	101	0.064	5.739	7.79	0.0082	0.006	0.002	Low Risk	Low Risk		
GL5007-1	40.21	22.22	17.99	81	0	81	0.922	4.602	26.82	0.0344	0.006	0.028	Low Risk	Medium Risk	13	
GL5007-2	1.32	0.72	0.60	4	0	4	0.021	0.227	0.95	0.0222	0.005	0.017	Low Risk	Medium Risk		
GL5007-3	4.75	0.00	4.75	64	0	64	0.066	3.636	3.64	0.0183	0.018	0.000	Medium Risk	Low Risk		
GL5008-1	29.88	10.48	19.40	359	0	359	1.259	20.398	30.88	0.0408	0.027	0.014	High Risk	Low Risk	14	
GL5008-2	1.36	0.90	0.46	10	0	10	0.053	0.568	1.47	0.0361	0.014	0.022	Medium Risk	Medium Risk		
GL5008-3	5.65	2.21	3.43	77	55	22	0.291	1.250	3.46	0.0842	0.030	0.054	High Risk	High Risk	23	
GL5009-1	2.08	1.41	0.67	15	0	15	0.263	0.852	2.26	0.1164	0.044	0.073	High Risk	High Risk		
GL5009-2	6.01	0.72	5.29	87	0	87	0.309	4.943	5.66	0.0546	0.048	0.007	High Risk	Low Risk	19	
GL5009-3	1.67	0.95	0.72	28	13	15	0.092	0.852	1.80	0.0510	0.024	0.027	High Risk	Medium Risk		
GL5009-4	3.44	0.83	2.61	42	31	11	0.141	0.625	1.45	0.0971	0.042	0.055	High Risk	High Risk	27	
GL5009-5	0.77	0.77	0.00	15	8	7	0.035	0.398	1.17	0.0301	0.010	0.020	Low Risk	Medium Risk		
GL5011-1	12.45	5.44	7.01	20	0	20	0.449	1.136	6.58	0.0683	0.012	0.056	Medium Risk	High Risk	20	
GL5012-1	28.75	13.10	15.64	302	1	301	0.533	17.102	30.21	0.0176	0.010	0.008	Low Risk	Low Risk	11	
GL5012-2	0.77	0.77	0.00	3	0	3	0.058	0.170	0.94	0.0622	0.011	0.051	Medium Risk	High Risk		
GL5013-1	1.05	0.52	0.52	21	0	21	0.031	1.193	1.72	0.0179	0.012	0.005	Medium Risk	Low Risk		
GL5013-2	1.23	0.43	0.80	44	8	36	0.104	2.045	2.48	0.0420	0.035	0.007	High Risk	Low Risk		
GL5014-1	1.08	0.30	0.78	27	0	27	0.041	1.534	1.83	0.0224	0.019	0.004	Medium Risk	Low Risk		
GL5014-2	2.18	1.70	0.48	31	0	31	0.060	1.761	3.47	0.0175	0.009	0.009	Low Risk	Low Risk		
GL5014-3	5.47	2.41	3.06	78	0	78	0.230	4.432	6.84	0.0336	0.022	0.012	Medium Risk	Low Risk	20	
GL5014-4	2.33	2.33	0.00	31	0	31	0.437	1.761	4.10	0.1067	0.046	0.061	High Risk	High Risk		
GL5016-1	15.84	12.16	3.68	65	0	65	1.505	3.693	15.85	0.0949	0.022	0.073	Medium Risk	High Risk		
GL5016-2	0.81	0.81	0.00	11	0	11	0.114	0.625	1.43	0.0798	0.035	0.045	High Risk	High Risk		
GL5018-1	4.24	1.14	3.10	38	0	38	0.267	2.159	3.30	0.0808	0.053	0.028	High Risk	Medium Risk	27	
GL5018-2	5.06	2.75	2.31	58	0	58	0.856	3.295	6.04	0.1416	0.077	0.064	Action ASAP	High Risk		
GL5018-3	0.82	0.46	0.36	13	0	13	0.062	0.739	1.20	0.0517	0.032	0.020	High Risk	Medium Risk		
GL5018-4	9.46	4.44	5.03	39	0	39	0.945	2.216	6.65	0.1420	0.047	0.095	High Risk	Action ASAP	20	
GL5018-5	3.70	1.29	2.42	35	0	35	0.331	1.989	3.27	0.1011	0.061	0.040	High Risk	High Risk		
GL5023-1	8.36	4.17	4.19	26	0	26	1.307	1.477	5.64	0.2316	0.061	0.171	High Risk	Action ASAP	12	
GL5023-2	2.45	2.45	0.00	27	0	27	0.100	1.534	3.99	0.0249	0.010	0.015	Low Risk	Medium Risk		
GL5023-3	1.72	1.68	0.04	22	0	22	0.113	1.250	2.93	0.0387	0.016	0.022	Medium Risk	Medium Risk		
GL5023-4	10.27	7.80	2.47	99	0	99	0.408	5.625	13.43	0.0304	0.013	0.018	Medium Risk	Medium Risk	10	
GL5023-5	11.97	8.84	3.12	120	0	120	0.418	6.818	15.66	0.0267	0.012	0.015	Medium Risk	Medium Risk	7	
GL5028-1	8.19	4.43	3.76	65	0	65	0.401	3.693	8.12	0.0494	0.022	0.027	Medium Risk	Medium Risk	16	
GL5030-1	5.93	5.32	0.60	45	0	45	1.102	2.557	7.88	0.0129	0.004	0.009	Low Risk	Low Risk	15	
GL5032-1	3.36	2.26	1.10	29	0	29	0.103	1.648	3.91	0.0263	0.011	0.015	Medium Risk	Medium Risk		
GL5033-1	15.34	13.94	1.40	141	0	141	0.859	8.011	21.95	0.0391	0.014	0.025	Medium Risk	Medium Risk	6	
GL5033-2	6.20	5.76	0.44	70	0	70	0.329	3.977	9.74	0.0338	0.014	0.020	Medium Risk	Medium Risk	27	
GL5033-3	15.36	12.33	3.03	143	0	143	0.774	8.125	20.45	0.0379	0.015	0.023	Medium Risk	Medium Risk	2	
GL5033-4	6.80	6.80	0.00	68	0	68	0.327	3.864	10.66	0.0307	0.011	0.020	Medium Risk	Medium Risk	18	
GL5033-5	12.36	11.68	0.67	53	0	53	0.620	3.011	14.69	0.0422	0.009	0.034	Low Risk	High Risk	3	
GL5050-1	11.56	10.75	0.80	87	0	87	0.258	4.943	15.70	0.0164	0.005	0.011	Low Risk	Low Risk	9	
GL5051-1	26.12	14.67	11.45	225	0	225	0.546	12.784	27.45	0.0199	0.009	0.011	Low Risk	Low Risk	1	
GL5052-1	3.42	1.10	2.31	30	0	30	0.224	1.705	2.81	0.0797	0.048	0.031	High Risk	High Risk		
GL5052-2	1.92	1.53	0.39	37	0	37	0.078	2.102	3.63	0.0216	0.013	0.009	Medium Risk	Low Risk		
GL5052-3	6.99	4.47	2.52	73	0	73	0.243	4.148	8.61	0.0282	0.014	0.015	Medium Risk	Medium Risk	23	

Ranking of Total Public Main I/I Risk

Sub Sewershed Name	Inch-Mile of Main Pipe UNLINED	MMSD Modeled Inflow (MGD)	Total Inflow due to UNLINED Public Main (MGD)	Inflow Public Main Risk Ranking	Hydraulic Sensitivity (Low is Bad)
GL5023-1	4.17	1.307	0.171	Action ASAP	12
GL4053-2	0.96	0.128	0.096	Action ASAP	
GL5018-4	4.44	0.945	0.095	Action ASAP	20
GL5001-4	8.17	0.829	0.090	High Risk	
GL4055-1	4.61	0.912	0.082	High Risk	23
GL5016-1	12.16	1.505	0.073	High Risk	
GL5009-1	1.41	0.263	0.073	High Risk	
GL5001-2	1.66	0.453	0.071	High Risk	
GL5018-2	2.75	0.856	0.064	High Risk	
GL4055-2	5.64	0.956	0.063	High Risk	23
GL5014-4	2.33	0.437	0.061	High Risk	
GL5001-3	1.97	0.226	0.061	High Risk	
GL4031-1	1.03	0.304	0.057	High Risk	
GL5011-1	5.44	0.449	0.056	High Risk	20
GL5009-4	0.83	0.141	0.055	High Risk	27
GL5008-3	2.21	0.291	0.054	High Risk	23
GL5012-2	0.77	0.058	0.051	High Risk	
GL5016-2	0.81	0.114	0.045	High Risk	
GL5001-1	2.21	0.288	0.043	High Risk	
GL5018-5	1.29	0.331	0.040	High Risk	
GL5033-5	11.68	0.620	0.034	High Risk	3
GL5052-1	1.10	0.224	0.031	High Risk	
GL4053-1	12.21	0.591	0.029	High Risk	27
GL5007-1	22.22	0.922	0.028	Medium Risk	13
GL5018-1	1.14	0.267	0.028	Medium Risk	27
GL5028-1	4.43	0.401	0.027	Medium Risk	16
GL5009-3	0.95	0.092	0.027	Medium Risk	
GL5033-1	13.94	0.859	0.025	Medium Risk	6
GL5033-3	12.33	0.774	0.023	Medium Risk	2
GL5023-3	1.68	0.113	0.022	Medium Risk	
GL5008-2	0.90	0.053	0.022	Medium Risk	
GL4024-1	1.83	0.081	0.022	Medium Risk	
GL5033-2	5.76	0.329	0.020	Medium Risk	27
GL5018-3	0.46	0.062	0.020	Medium Risk	
GL5009-5	0.77	0.035	0.020	Medium Risk	
GL5033-4	6.80	0.327	0.020	Medium Risk	18
GL5023-4	7.80	0.408	0.018	Medium Risk	10
GL5007-2	0.72	0.021	0.017	Medium Risk	
GL5023-2	2.45	0.100	0.015	Medium Risk	
GL5032-1	2.26	0.103	0.015	Medium Risk	
GL5023-5	8.84	0.418	0.015	Medium Risk	7
GL4025-3	2.84	0.112	0.015	Medium Risk	
GL5052-3	4.47	0.243	0.015	Medium Risk	23
GL5008-1	10.48	1.259	0.014	Low Risk	14
GL4025-2	3.47	0.177	0.013	Low Risk	27
GL4025-1	58.09	1.604	0.013	Low Risk	5
GL5014-3	2.41	0.230	0.012	Low Risk	20
GL5050-1	10.75	0.258	0.011	Low Risk	9
GL5004-1	27.51	0.696	0.011	Low Risk	4
GL5051-1	14.67	0.546	0.011	Low Risk	1
GL5052-2	1.53	0.078	0.009	Low Risk	
GL5030-1	5.32	0.102	0.009	Low Risk	15
GL5014-2	1.70	0.060	0.009	Low Risk	
GL5002-1	10.39	0.250	0.008	Low Risk	16
GL5012-1	13.10	0.533	0.008	Low Risk	11
GL5013-2	0.43	0.104	0.007	Low Risk	
GL5009-2	0.72	0.309	0.007	Low Risk	19
GL5002-2	9.31	0.223	0.006	Low Risk	8
GL5013-1	0.52	0.031	0.005	Low Risk	
GL5004-2	2.53	0.052	0.004	Low Risk	
GL5014-1	0.30	0.041	0.004	Low Risk	
GL5004-3	2.05	0.064	0.002	Low Risk	
GL5007-3	0.00	0.066	0.000	Low Risk	

Ranking of Total Private Lateral I/I Risk

Sub Sewershed Name	Estimated Number of Laterals LINED	Estimated Number of Laterals UNLINED	Total Inflow due to UNLINED Private Lateral (MGD)	Inflow Private Lateral Risk Ranking	Hydraulic Sensitivity (Low is Bad)
GL5018-2	0	58	0.077	Action ASAP	
GL4031-1	0	23	0.073	Action ASAP	
GL5001-2	0	28	0.068	High Risk	
GL5018-5	0	35	0.061	High Risk	
GL5023-1	0	26	0.061	High Risk	12
GL5018-1	0	38	0.053	High Risk	27
GL5052-1	0	30	0.048	High Risk	
GL5009-2	0	87	0.048	High Risk	19
GL5018-4	0	39	0.047	High Risk	20
GL5014-4	0	31	0.046	High Risk	
GL4055-1	0	45	0.045	High Risk	23
GL5009-1	0	15	0.044	High Risk	
GL5009-4	31	11	0.042	High Risk	27
GL4055-2	0	63	0.040	High Risk	23
GL5016-2	0	11	0.035	High Risk	
GL5013-2	8	36	0.035	High Risk	
GL5001-1	0	29	0.032	High Risk	
GL5018-3	0	13	0.032	High Risk	
GL5008-3	55	22	0.030	High Risk	23
GL5008-1	0	359	0.027	High Risk	14
GL5009-3	13	15	0.024	High Risk	
GL5001-3	0	13	0.023	High Risk	
GL5028-1	0	65	0.022	Medium Risk	16
GL5016-1	0	65	0.022	Medium Risk	
GL5014-3	0	78	0.022	Medium Risk	20
GL5014-1	0	27	0.019	Medium Risk	
GL5007-3	0	64	0.018	Medium Risk	
GL4053-2	0	3	0.017	Medium Risk	
GL5023-3	0	22	0.016	Medium Risk	
GL5033-3	0	143	0.015	Medium Risk	2
GL5033-1	0	141	0.014	Medium Risk	6
GL5008-2	0	10	0.014	Medium Risk	
GL5033-2	0	70	0.014	Medium Risk	27
GL5052-3	0	73	0.014	Medium Risk	23
GL5023-4	0	99	0.013	Medium Risk	10
GL4025-2	0	60	0.013	Medium Risk	27
GL5052-2	0	37	0.013	Medium Risk	
GL5013-1	0	21	0.012	Medium Risk	
GL5011-1	0	20	0.012	Medium Risk	20
GL5023-5	0	120	0.012	Medium Risk	7
GL5012-2	0	3	0.011	Medium Risk	
GL5033-4	0	68	0.011	Medium Risk	18
GL5032-1	0	29	0.011	Medium Risk	
GL5009-5	8	7	0.010	Low Risk	
GL5012-1	1	301	0.010	Low Risk	11
GL5023-2	0	27	0.010	Low Risk	
GL4024-1	0	14	0.009	Low Risk	
GL4025-3	0	31	0.009	Low Risk	
GL5051-1	0	225	0.009	Low Risk	1
GL5014-2	0	31	0.009	Low Risk	
GL5033-5	0	53	0.009	Low Risk	3
GL4053-1	0	62	0.008	Low Risk	27
GL4025-1	0	492	0.006	Low Risk	5
GL5004-3	0	101	0.006	Low Risk	
GL5002-2	0	175	0.006	Low Risk	8
GL5002-1	0	140	0.006	Low Risk	16
GL5007-1	0	81	0.006	Low Risk	13
GL5004-1	0	262	0.006	Low Risk	4
GL5001-4	0	9	0.006	Low Risk	
GL5007-2	0	4	0.005	Low Risk	
GL5050-1	0	87	0.005	Low Risk	9
GL5004-2	0	59	0.005	Low Risk	
GL5030-1	0	45	0.004	Low Risk	15

XPSWMM Model Input Variables

CD Sub-Sewershed	Number of Glendale Manholes (Each)	Acres	Avg DWF per Manhole (CFS)	Peak Total I/I per Manhole (CFS)
GL4024-1	5	1.40	0.0034	0.025
GL4025-1	159	2.12	0.0025	0.016
GL4025-2	16	2.32	0.0027	0.017
GL4025-3	13	1.81	0.0021	0.013
GL4031-1	5	2.12	0.0019	0.094
GL4053-1	28	2.62	0.0055	0.033
GL4053-2	4	3.97	0.0083	0.050
GL4055-1	22	1.60	0.0010	0.064
GL4055-2	33	1.12	0.0007	0.045
GL5001-1	9	2.61	0.0027	0.049
GL5001-2	11	3.36	0.0035	0.064
GL5001-3	8	2.30	0.0024	0.044
GL5001-4	30	2.25	0.0023	0.043
GL5002-1	32	2.76	0.0039	0.012
GL5002-2	50	1.57	0.0022	0.007
GL5004-1	99	2.67	0.0041	0.011
GL5004-2	14	1.41	0.0022	0.006
GL5004-3	22	1.10	0.0017	0.004
GL5007-1	74	3.98	0.0079	0.019
GL5007-2	5	1.35	0.0027	0.007
GL5007-3	11	1.93	0.0039	0.009
GL5008-1	71	1.38	0.0019	0.027
GL5008-2	7	0.59	0.0008	0.012
GL5008-3	17	1.34	0.0018	0.027
GL5009-1	6	3.55	0.0074	0.068
GL5009-2	14	1.79	0.0037	0.034
GL5009-3	4	1.86	0.0039	0.036
GL5009-4	8	1.43	0.0030	0.027
GL5009-5	1	2.85	0.0060	0.054
GL5011-1	28	2.94	0.0087	0.025

XPSWMM Model Input Variables

CD Sub-Sewershed	Number of Glendale Manholes (Each)	Acres	Avg DWF per Manhole (CFS)	Peak Total I/I per Manhole (CFS)
GL5012-1	73	2.21	0.0052	0.011
GL5012-2	3	5.91	0.0140	0.030
GL5013-1	2	1.91	0.0143	0.024
GL5013-2	3	4.30	0.0322	0.054
GL5014-1	5	1.10	0.0020	0.013
GL5014-2	4	2.03	0.0037	0.023
GL5014-3	19	1.63	0.0030	0.019
GL5014-4	10	5.87	0.0107	0.068
GL5014-5	0	0.00	0.0000	0.000
GL5014-6	0	0.00	0.0000	0.000
GL5016-1	34	6.45	0.0151	0.068
GL5016-2	4	4.17	0.0097	0.044
GL5018-1	13	1.76	0.0009	0.032
GL5018-2	18	4.09	0.0022	0.074
GL5018-3	3	1.78	0.0009	0.032
GL5018-4	27	3.01	0.0016	0.054
GL5018-5	11	2.59	0.0014	0.047
GL5023-1	26	7.28	0.0088	0.078
GL5023-2	8	1.80	0.0022	0.019
GL5023-3	9	1.82	0.0022	0.019
GL5023-4	40	1.48	0.0018	0.016
GL5023-5	34	1.78	0.0022	0.019
GL5028-1	23	1.83	0.0030	0.027
GL5030-1	17	1.72	0.0013	0.009
GL5032-1	7	1.98	0.0022	0.023
GL5033-1	44	2.02	0.0042	0.030
GL5033-2	18	1.89	0.0039	0.028
GL5033-3	47	1.70	0.0035	0.025
GL5033-4	20	1.69	0.0035	0.025
GL5033-5	39	1.64	0.0034	0.025
GL5050-1	40	1.29	0.0009	0.010
GL5051-1	77	1.85	0.0025	0.011
GL5052-1	15	1.93	0.0030	0.023
GL5052-2	6	1.69	0.0027	0.020
GL5052-3	21	1.49	0.0024	0.018
GL5054-1	0	0.00	0.0000	0.000

Appendix C



Cost Estimate Tables

Public Sewer Main Lining Bid Tabs

Project 1

Village of Whitefish Bay 2019 PPII Project

Size (inches)	LF	Company 1	Company 2	Company 3	Company 4	Company 5	Average Unit Price (LF)	Total	Cost per in-mile	Added Misc. Costs	Adjusted Cost per in-mile	
		Unit Price	Unit Price	Unit Price	Unit Price	Unit Price						
8	10620	\$22.15	\$20.50	\$24.75	\$28.00	\$39.00	\$26.88	\$285,465.60	\$17,740.80	\$6,327.00	\$24,067.80	
10	332	\$31.80	\$26.50	\$30.00	\$33.20	\$41.00	\$32.50	\$10,790.00	\$17,160.00	\$6,327.00	\$23,487.00	
12	3010	\$25.90	\$32.00	\$27.75	\$30.70	\$43.00	\$31.87	\$95,928.70	\$14,022.80	\$6,327.00	\$20,349.80	
15	4290	\$34.15	\$47.00	\$42.00	\$45.70	\$47.00	\$43.17	\$185,199.30	\$15,195.84	\$6,327.00	\$21,522.84	
Misc. Costs	Lateral Grouting	25	\$290.00	\$655.00	\$692.00	\$1,824.60	\$1,600.00	\$1,012.32	\$25,308.00		Average	\$22,356.86
								Sum of Misc. Costs	\$25,308.00			

Project 2

Madison - CIPP REHAB OF SANITARY AND STORM SEWER MAINS - 2019

<https://www.cityofmadison.com/business/pw/contracts/docAndSpecs.cfm?ContractNumber=9426>

Size (inches)	LF	Company 1	Company 2	Company 3	Average Unit Price (LF)	Total	Cost per in-mile	Added Misc. Costs	Adjusted Cost per in-mile			
		Unit Price	Unit Price	Unit Price								
6	788	\$31.50	\$42.75	\$28.50	\$34.25	\$26,989.00	\$30,140.00	\$19,292.65	\$49,432.65			
8	19526	\$23.00	\$23.50	\$29.60	\$25.37	\$495,309.53	\$16,742.00	\$19,292.65	\$36,034.65			
10	2929	\$27.60	\$35.00	\$37.30	\$33.30	\$97,535.70	\$17,582.40	\$19,292.65	\$36,875.05			
12	4430	\$32.25	\$40.00	\$42.90	\$38.38	\$170,038.17	\$16,888.67	\$19,292.65	\$36,181.31			
15	1930	\$43.10	\$68.00	\$58.30	\$56.47	\$108,980.67	\$19,876.27	\$19,292.65	\$39,168.91			
Misc. Costs	Traffic Control - Lump Sum	1	\$5,000.00	\$34,550.00	\$22,800.80		\$20,783.60	\$20,783.60		Average	\$39,538.51	
	Mobilization - Lump Sum	1	\$13,000.00	\$55,779.00	\$55,107.90		\$41,295.63	\$41,295.63				
	Reinstate and Reconnect	320	\$75.00	\$95.75	\$151.60		\$107.45	\$34,384.00				
								Sum of Misc. Costs	\$96,463.23			

Project 3

Madison - UV CIPP REHAB OF SANITARY SEWERS - 2019

<https://www.cityofmadison.com/business/pw/contracts/docAndSpecs.cfm?ContractNumber=8532>

Size (inches)	LF	Company 1	Company 2	Company 3	Average Unit Price (LF)	Total	Cost per in-mile	Added Misc. Costs	Adjusted Cost per in-mile			
		Unit Price	Unit Price	Unit Price								
8	1716	\$34.00	\$60.00	\$53.30	\$49.10	\$84,255.60	\$32,406.00	\$13,204.62	\$45,610.62			
12	291	\$50.00	\$64.00	\$77.80	\$63.93	\$18,604.60	\$28,130.67	\$13,204.62	\$41,335.29			
15	1070	\$56.00	\$78.00	\$87.30	\$73.77	\$78,930.33	\$25,965.87	\$13,204.62	\$39,170.49			
18	2141	\$89.00	\$80.00	\$107.50	\$92.17	\$197,328.83	\$27,035.56	\$13,204.62	\$40,240.18			
24	1642	\$109.00	\$130.00	\$167.30	\$135.43	\$222,381.53	\$29,795.33	\$13,204.62	\$42,999.95			
Misc. Costs	Traffic Control - Lump Sum	1	\$22,720.00	\$10,000.00	\$5,408.30		\$12,709.43	\$12,709.43		Average	\$41,871.30	
	Mobilization - Lump Sum	1	\$21,541.00	\$26,000.00	\$33,443.00		\$26,994.67	\$26,994.67				
	Reinstate and Reconnect	93	\$230.00	\$400.00	\$219.00		\$283.00	\$26,319.00				
								Sum of Misc. Costs	\$66,023.10			

Project 4

Madison - CIPP REHAB OF SANITARY AND STORM SEWERS - 2019

<https://www.cityofmadison.com/business/pw/contracts/docAndSpecs.cfm?ContractNumber=8461>

Size (inches)	LF	Company 1	Company 2	Company 3	Average Unit Price (LF)	Total	Cost per in-mile	Added Misc. Costs	Adjusted Cost per in-mile			
		Unit Price	Unit Price	Unit Price								
6	1151	\$32.50	\$35.75	\$30.75	\$33.00	\$37,983.00	\$29,040.00	\$14,175.67	\$43,215.67			
8	32029	\$21.30	\$20.25	\$21.25	\$20.93	\$670,473.73	\$13,816.00	\$14,175.67	\$27,991.67			
10	2569	\$24.55	\$23.50	\$26.25	\$24.77	\$63,625.57	\$13,076.80	\$14,175.67	\$27,252.47			
12	5823	\$29.25	\$32.00	\$35.00	\$32.08	\$186,821.25	\$14,116.67	\$14,175.67	\$28,292.33			
15	1189	\$50.00	\$46.50	\$56.50	\$51.00	\$60,639.00	\$17,952.00	\$14,175.67	\$32,127.67			
Misc. Costs	Traffic Control - Lump Sum	1	\$4,000.00	\$40,000.00	\$6,900.00		\$16,966.67	\$16,966.67		Average	\$31,775.96	
	Mobilization - Lump Sum	1	\$15,200.00	\$39,805.00	\$41,000.00		\$32,001.67	\$32,001.67				
	Reinstate and Reconnect	313	\$75.00	\$75.00	\$60.00		\$70.00	\$21,910.00				
								Sum of Misc. Costs	\$70,878.33			

Summary

Average cost per in-mile

Project 1	\$22,356.86
Project 2	\$39,538.51
Project 3	\$41,871.30
Project 4	\$31,775.96
Total Average	\$33,885.66

Assumed 2020 cost in report \$34,000.00 per inch-mile of pipe

Private Lateral Lining Bid Tabs

Project 1

Village of Whitefish Bay, WI - 2017 Private Lateral Rehabilitation

TABULATION OF BIDS RECEIVED 5/9/17

Description	Unit	Quantity	Company 1	Company 2	Company 3	Average Unit Price	Average Total
			Unit Price	Unit Price	Unit Price		
Mobilization	LS	1	\$12,500.00	\$45,000.00	\$10,000.00	\$22,500.00	\$22,500.00
Sanitary Sewer Lateral Cured-in-Place Lining, 6" Diameter	LF	10,000	\$69.80	\$90.00	\$85.00	\$81.60	\$816,000.00
Sanitary Sewer CCTV Lateral Inspection & Cleaning	LF	12,500	\$4.75	\$11.00	\$4.00	\$6.58	\$82,291.67
Interim Conveyance	EA	10	\$1,500.00	\$2,250.00	\$500.00	\$1,416.67	\$14,166.67
Lateral Grouting	EA	10	\$500.00	\$650.00	\$500.00	\$550.00	\$5,500.00
Lateral Repairs	EA	10	\$5,200.00	\$6,000.00	\$5,000.00	\$5,400.00	\$54,000.00
Install Temporary Access Cleanout (vac-a-tee), to be sealed and capped after post lining inspection	EA	200	\$1,250.00	\$995.00	\$5,000.00	\$2,415.00	\$483,000.00
Post-Inspection Report – includes mandatory meeting and presentation of inspection findings	LS	1	\$8,000.00	\$5,000.00	\$5,000.00	\$6,000.00	\$6,000.00
						Average Project Total	\$1,483,458.33
						Number of Laterals Lined	200
						Average Cost per Lateral	\$7,417.29

Project 2

Village of Whitefish Bay, WI - 2019 Private Lateral Rehab

TABULATION OF BIDS RECEIVED 6/13/19

Description	Unit	Quantity	Company 1	Company 2	Average Unit Price	Average Total	
			Unit Price	Unit Price			
Pre-Cleaning CCTV Lateral Inspection	EA	50	\$1,700.00	\$250.00	\$975.00	\$48,750.00	
Cured-In-Place Mainline Sewer & Lateral Seal	EA	26	\$8,200.00	\$3,500.00	\$5,850.00	\$152,100.00	
Sanitary Sewer Lateral Cured-In-Place Lining Extended from Lateral Seal	LF	1550	\$10.00	\$55.00	\$32.50	\$50,375.00	
Sanitary Sewer Lateral Cured-In-Place Lining without Seal	LF	940	\$35.00	\$217.00	\$126.00	\$118,440.00	
Excavated Lateral Spot Repair, 5 feet	EA	1	\$10,000.00	\$6,500.00	\$8,250.00	\$8,250.00	
Lateral Grouting Per Joint	EA	3	\$800.00	\$300.00	\$550.00	\$1,650.00	
						Average Project Total	\$379,565.00
						Number of Laterals Lined	50
						Average Cost per Lateral	\$7,591.30

Summary	Average cost per Lateral Lined
Project 1	\$7,417.29
Project 2	\$7,591.30
Total Average	\$7,504.30
Assumed 2020 cost in report	\$7,500.00

Appendix D



Dye Water Flooding Report

Upstream MH

290

Downstream MH

291

Date	Time	Location (Street)			Job Number
11/23/2020	2:53 PM	N SHASTA DR			20521W-08
Use of Sewer	Pipe Size	Material	Jt. Spacing	Shape	Survey Direction
Sanitary	8	Vitrified Clay Pipe	3	Circular	Downstream
Pre-Cleaning	Weather	Surface	US MH Depth	DS MH Depth	Flow Direction
Jetting	Dry	Asphalt	11	12	S
Media No.	Surveyed Length	Total Length	Surveyor	Certificate No.	Truck No.
DVD 01	320	320	RAFAL W	U-109-8006	226

Comments

Ftg.	Code	Description	Position	Cont.	Comment
0.0	AMH	Access Point - Manhole			Starting Manhole: 290
0.0	MWL	Water Level			
25.1	TF	Tap, Factory Made	10		T LINER (CIPP)
46.4	TF	Tap, Factory Made	2		T LINER (CIPP)
49.2	TFC	Tap, Factory Made: Capped	10		
90.1	TF	Tap, Factory Made	10		T LINER (CIPP)
123.0	TFC	Tap, Factory Made: Capped	10		
126.0	TF	Tap, Factory Made	3		
202.3	TF	Tap, Factory Made	10		T LINER (CIPP)
205.1	TF	Tap, Factory Made	3		T LINER (CIPP)
284.3	TF	Tap, Factory Made	10		T LINER (CIPP)
287.2	TF	Tap, Factory Made	2		
320.0	AMH	Access Point - Manhole			MH 291

Upstream MH

290

Downstream MH

291

Date

11/23/2020

Time

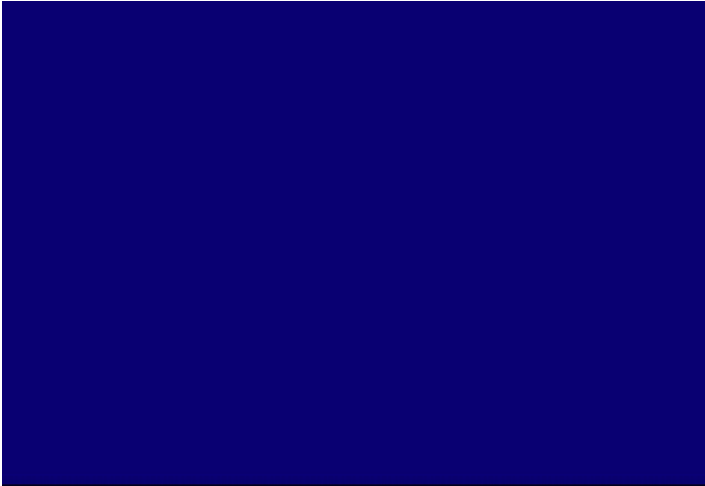
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Location (Street)

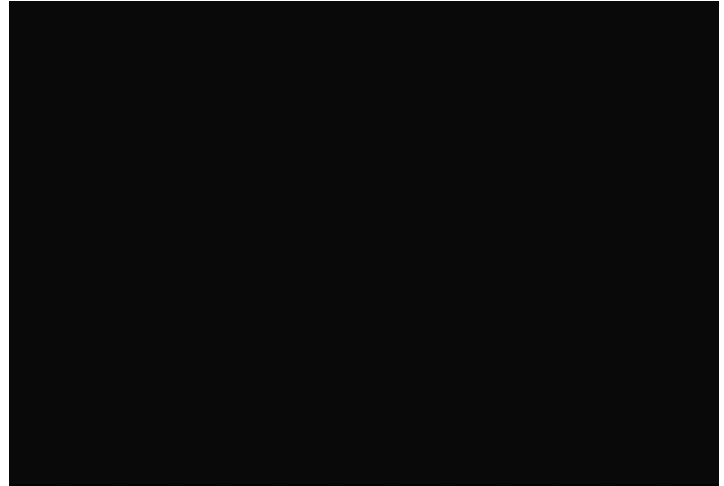
N SHASTA DR

Job Number

20521W-08



AMH - Access Point - Manhole @ 0.0 ft.
Starting Manhole: 290



MWL - Water Level @ 0.0 ft.



TF - Tap, Factory Made @ 25.1 ft. T
LINER (CIPP)



TF - Tap, Factory Made @ 46.4 ft. T
LINER (CIPP)

Upstream MH

290

Downstream MH

291

Date	Time	Location (Street)	Job Number
11/23/2020	2:53 PM	N SHASTA DR	20521W-08



TFC - Tap, Factory Made: Capped @ 49.2 ft.



TF - Tap, Factory Made @ 90.1 ft. T LINER (CIPP)



TFC - Tap, Factory Made: Capped @ 123.0 ft.



TF - Tap, Factory Made @ 126.0 ft.

Upstream MH

290

Downstream MH

291

Date	Time	Location (Street)	Job Number
11/23/2020	2:53 PM	N SHASTA DR	20521W-08



TF - Tap, Factory Made @ 202.3 ft. T
 LINER (CIPP)



TF - Tap, Factory Made @ 205.1 ft. T
 LINER (CIPP)



TF - Tap, Factory Made @ 284.3 ft. T
 LINER (CIPP)



TF - Tap, Factory Made @ 287.2 ft.

Upstream MH

290

Downstream MH

291

Date

11/23/2020

Time

2:53 PM

Location (Street)

N SHASTA DR

Job Number

20521W-08



AMH - Access Point - Manhole @ 320.0 ft.
MH 291

Upstream MH

291

Downstream MH

292

Date 11/23/2020	Time 3:49 PM	Location (Street) N SHASTA DR			Job Number 20521W-08
Use of Sewer Sanitary	Pipe Size 8	Material Vitrified Clay Pipe	Jt. Spacing 3	Shape Circular	Survey Direction Downstream
Pre-Cleaning Jetting	Weather Dry	Surface Asphalt	US MH Depth 12	DS MH Depth 12	Flow Direction S
Media No. DVD 01	Surveyed Length 263.1	Total Length 263.1	Surveyor RAFAL W	Certificate No. U-109-8006	Truck No. 226

Comments

Ftg.	Code	Description	Position	Cont.	Comment
0.0	AMH	Access Point - Manhole			Starting Manhole: 291
0.0	MWL	Water Level			
14.5	DSGV	Deposits Settled: Gravel	5 to 7	S01	
49.4	TF	Tap, Factory Made	10		T LINER (CIPP)
52.4	TFC	Tap, Factory Made: Capped	2		
131.7	TFA	Tap, Factory Made: Active	10		
134.9	TF	Tap, Factory Made	2		
220.5	TF	Tap, Factory Made	10		
223.5	TF	Tap, Factory Made	3		T LINER (CIPP)
263.1	DSGV	Deposits Settled: Gravel	5 to 7	F01	
263.1	AMH	Access Point - Manhole			MH 292

Upstream MH

291

Downstream MH

292

Date

11/23/2020

Time

3:49 PM

Location (Street)

N SHASTA DR

Job Number

20521W-08



AMH - Access Point - Manhole @ 0.0 ft.
Starting Manhole: 291

MWL - Water Level @ 0.0 ft.



DSGV - Deposits Settled: Gravel @ 14.5 ft.



TF - Tap, Factory Made @ 49.4 ft. T
LINER (CIPP)

Upstream MH

291

Downstream MH

292

Date	Time	Location (Street)	Job Number
11/23/2020	3:49 PM	N SHASTA DR	20521W-08



TFC - Tap, Factory Made: Capped @ 52.4 ft.



TFA - Tap, Factory Made: Active @ 131.7 ft.



TF - Tap, Factory Made @ 134.9 ft.



TF - Tap, Factory Made @ 220.5 ft.

Upstream MH

291

Downstream MH

292

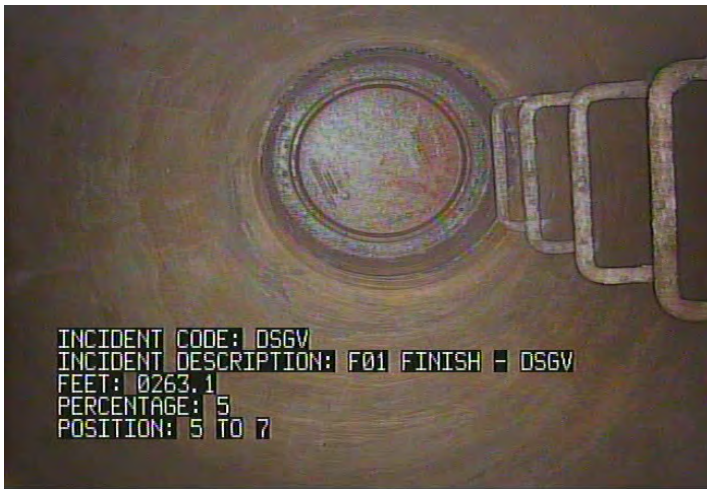
Date	Time	Location (Street)	Job Number
11/23/2020	3:49 PM	N SHASTA DR	20521W-08



TF - Tap, Factory Made @ 223.5 ft. T LINER (CIPP)



DSGV - Deposits Settled: Gravel @ 263.1 ft.



AMH - Access Point - Manhole @ 263.1 ft. MH 292

Upstream MH

301

Downstream MH

300

Date	Time	Location (Street)			Job Number
11/23/2020	2:41 PM	N DEXTER AVE			20521W-08
Use of Sewer	Pipe Size	Material	Jt. Spacing	Shape	Survey Direction
Sanitary	8	Other	12	Circular	Downstream
Pre-Cleaning	Weather	Surface	US MH Depth	DS MH Depth	Flow Direction
Jetting	Dry	Asphalt	10	11	S
Media No.	Surveyed Length	Total Length	Surveyor	Certificate No.	Truck No.
DVD 01	211.1	211.1	RAFAL W	U-109-8006	226

Comments

PIPE IS LINED (CIPP)



Upstream MH

301

Downstream MH

300

Date

11/23/2020

Time

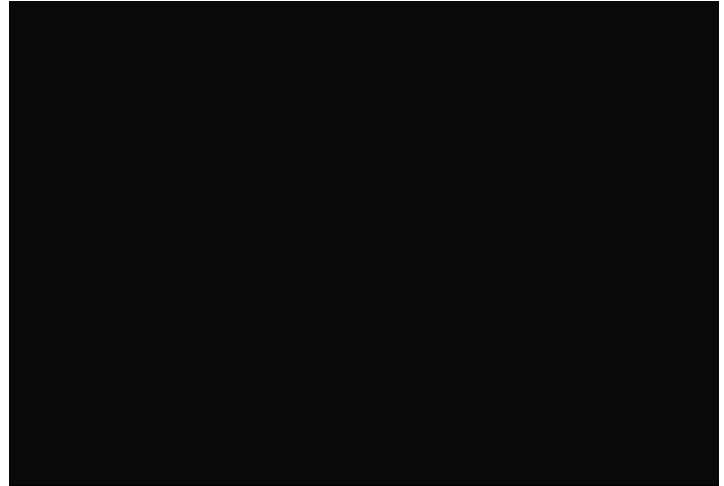
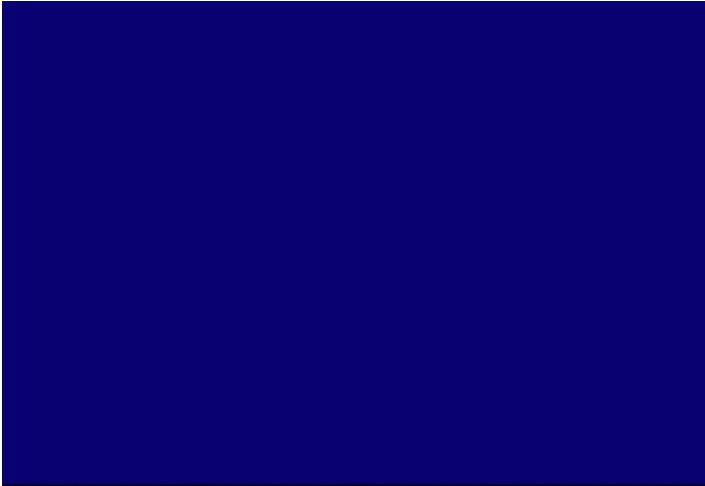
2:41 PM

Location (Street)

N DEXTER AVE

Job Number

20521W-08



AMH - Access Point - Manhole @ 0.0 ft.
Starting Manhole: 301

MWL - Water Level @ 0.0 ft.



TF - Tap, Factory Made @ 58.9 ft. T
LINER (CIPP)



TFA - Tap, Factory Made: Active @ 60.1 ft.

Upstream MH

301

Downstream MH

300

Date

11/23/2020

Time

2:41 PM

Location (Street)

N DEXTER AVE

Job Number

20521W-08



TF - Tap, Factory Made @ 141.9 ft. T LINER (CIPP)



TF - Tap, Factory Made @ 184.6 ft. T LINER (CIPP)



AMH - Access Point - Manhole @ 211.1 ft. MH 300

Upstream MH

302

Downstream MH

301

Date 11/23/2020	Time 2:20 PM	Location (Street) N DEXTER AVE		Job Number 20521W-08	
Use of Sewer Sanitary	Pipe Size 8	Material Other	Jt. Spacing 12	Shape Circular	Survey Direction Downstream
Pre-Cleaning Jetting	Weather Dry	Surface Asphalt	US MH Depth 10	DS MH Depth 10	Flow Direction S
Media No. DVD 01	Surveyed Length 211.9	Total Length 211.9	Surveyor RAFAL W	Certificate No. U-109-8006	Truck No. 226

Comments

PIPE IS LINED (CIPP)



Upstream MH

302

Downstream MH

301

Date

11/23/2020

Time

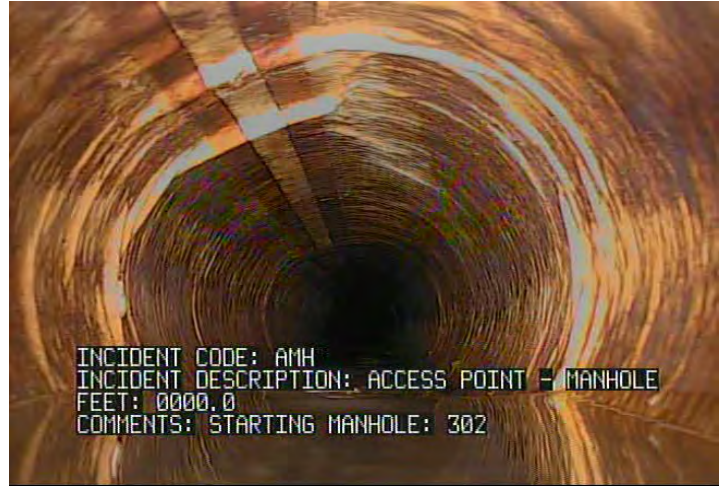
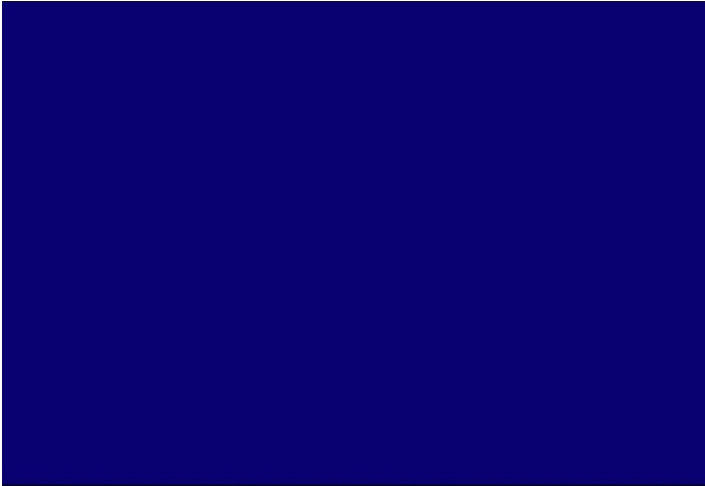
2:20 PM

Location (Street)

N DEXTER AVE

Job Number

20521W-08



AMH - Access Point - Manhole @ 0.0 ft.
 Starting Manhole: 302

MWL - Water Level @ 0.0 ft.



TF - Tap, Factory Made @ 73.3 ft.



TF - Tap, Factory Made @ 91.8 ft. T
 LINER (CIPP)

Upstream MH

302

Downstream MH

301

Date	Time	Location (Street)	Job Number
11/23/2020	2:20 PM	N DEXTER AVE	20521W-08



TF - Tap, Factory Made @ 143.6 ft. T LINER (CIPP)



TF - Tap, Factory Made @ 186.1 ft. T LINER (CIPP)



AMH - Access Point - Manhole @ 211.9 ft. MH 301

Upstream MH

303

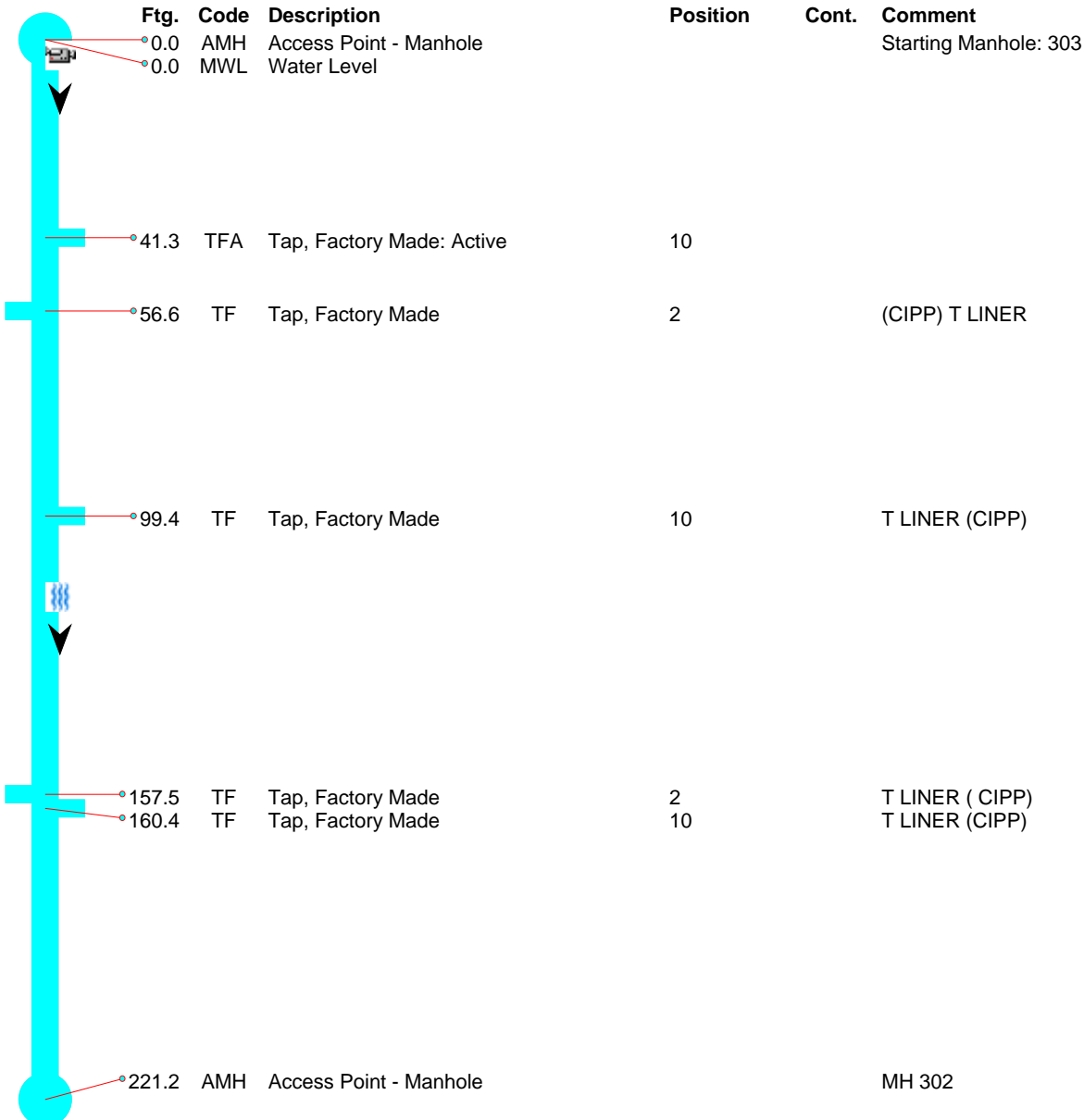
Downstream MH

302

Date 11/23/2020	Time 12:25 PM	Location (Street) N DEXTER AVE			Job Number 20521W-08
Use of Sewer Sanitary	Pipe Size 8	Material Other	Jt. Spacing 12	Shape Circular	Survey Direction Downstream
Pre-Cleaning Jetting	Weather Dry	Surface Asphalt	US MH Depth 10	DS MH Depth 10	Flow Direction S
Media No. DVD 01	Surveyed Length 221.2	Total Length 221.2	Surveyor RAFAL W	Certificate No. U-109-8006	Truck No. 226

Comments

PIPE IS LINED (CIPP)



Upstream MH

303

Downstream MH

302

Date

11/23/2020

Time

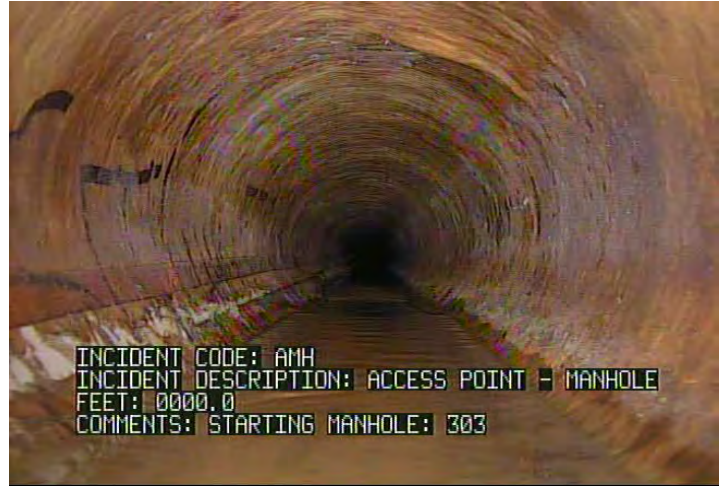
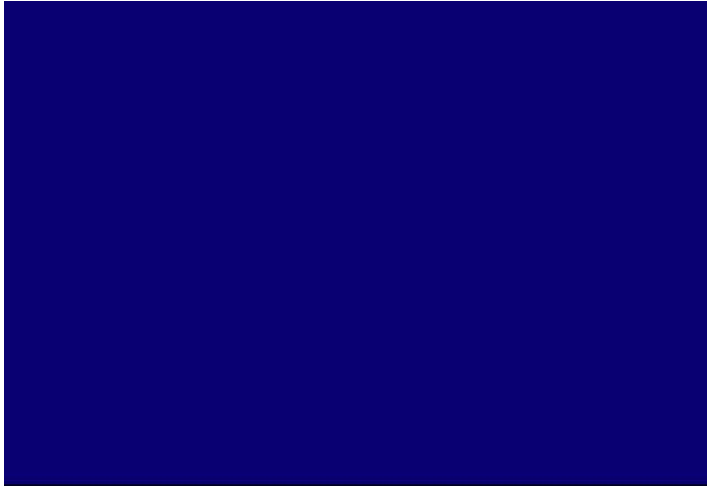
12:25 PM

Location (Street)

N DEXTER AVE

Job Number

20521W-08



AMH - Access Point - Manhole @ 0.0 ft.
 Starting Manhole: 303

MWL - Water Level @ 0.0 ft.



TFA - Tap, Factory Made: Active @ 41.3 ft.



TF - Tap, Factory Made @ 56.6 ft. (CIPP)
 T LINER

Upstream MH

303

Downstream MH

302

Date	Time	Location (Street)	Job Number
11/23/2020	12:25 PM	N DEXTER AVE	20521W-08



TF - Tap, Factory Made @ 99.4 ft. T LINER (CIPP)



TF - Tap, Factory Made @ 157.5 ft. T LINER (CIPP)



TF - Tap, Factory Made @ 160.4 ft. T LINER (CIPP)



AMH - Access Point - Manhole @ 221.2 ft. MH 302

Upstream MH

831

Downstream MH

830

Date 11/23/2020	Time 11:28 AM	Location (Street) W BRANTWOOD AVE			Job Number 20521W-08
Use of Sewer Sanitary	Pipe Size 8	Material Concrete Pipe (non-reinforced)	Jt. Spacing 12	Shape Circular	Survey Direction Downstream
Pre-Cleaning Jetting	Weather Dry	Surface Asphalt	US MH Depth 11	DS MH Depth 11	Flow Direction E
Media No. DVD 01	Surveyed Length 332.6	Total Length 332.6	Surveyor RAFAL W	Certificate No. U-109-8006	Truck No. 226

Comments

Ftg.	Code	Description	Position	Cont.	Comment
0.0	AMH	Access Point - Manhole			Starting Manhole: 831
0.0	MWL	Water Level			
15.9	TF	Tap, Factory Made	3		
101.4	TF	Tap, Factory Made	9		
113.6	TFA	Tap, Factory Made: Active	3		DYE PRESENT
223.7	TF	Tap, Factory Made	10		
240.2	TFA	Tap, Factory Made: Active	3		
332.6	AMH	Access Point - Manhole			MH 830

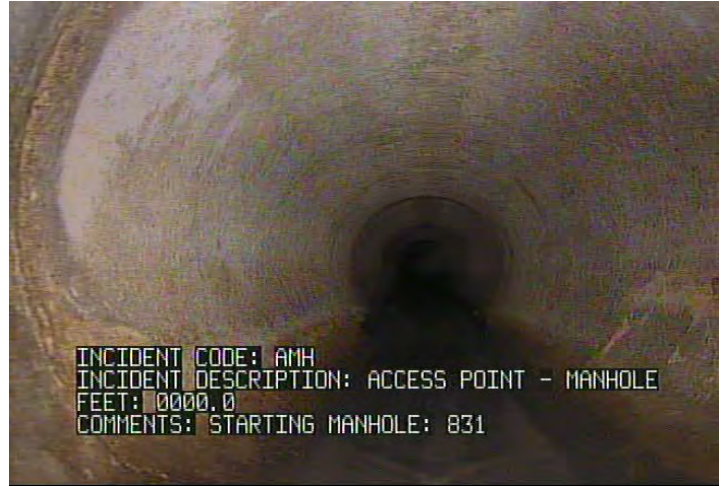
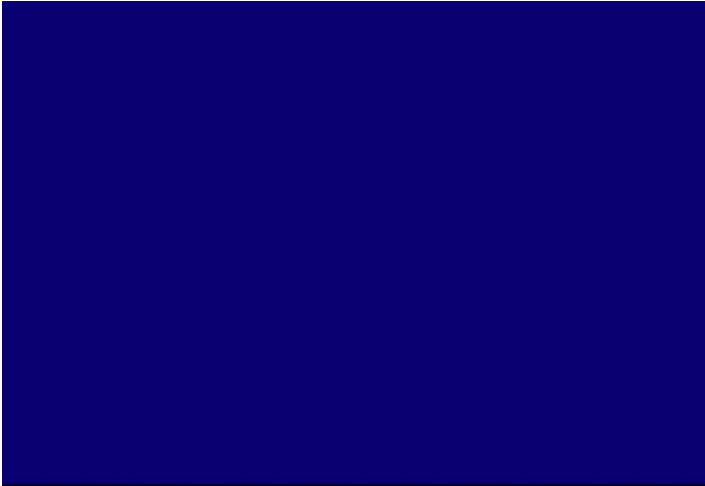
Upstream MH

831

Downstream MH

830

Date	Time	Location (Street)	Job Number
11/23/2020	11:28 AM	W BRANTWOOD AVE	20521W-08



AMH - Access Point - Manhole @ 0.0 ft.
 Starting Manhole: 831

MWL - Water Level @ 0.0 ft.



TF - Tap, Factory Made @ 15.9 ft.



TF - Tap, Factory Made @ 101.4 ft.

Upstream MH

831

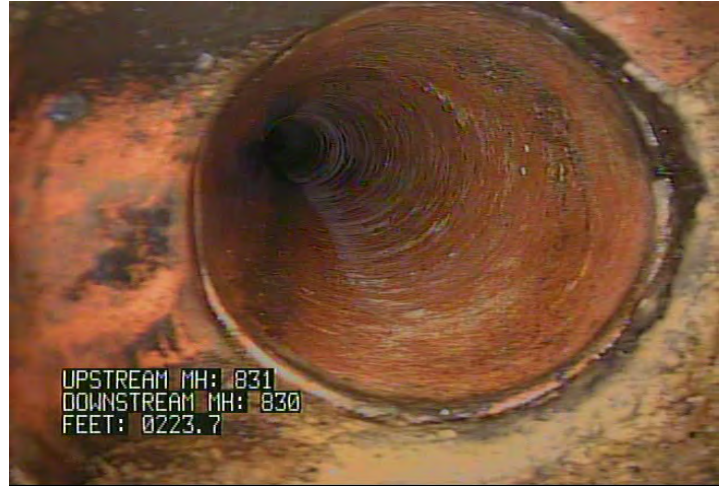
Downstream MH

830

Date	Time	Location (Street)	Job Number
11/23/2020	11:28 AM	W BRANTWOOD AVE	20521W-08



TFA - Tap, Factory Made: Active @ 113.6 ft. DYE PRESENT



TF - Tap, Factory Made @ 223.7 ft.



TFA - Tap, Factory Made: Active @ 240.2 ft.



AMH - Access Point - Manhole @ 332.6 ft. MH 830

Upstream MH

1414

Downstream MH

1413

Date 11/23/2020	Time 10:37 AM	Location (Street) N APPLEWOOD LN			Job Number 20521W-08
Use of Sewer Sanitary	Pipe Size 8	Material Reinforced Plastic Pipe (Truss Pipe)	Jt. Spacing 12	Shape Circular	Survey Direction Downstream
Pre-Cleaning Jetting	Weather Dry	Surface Asphalt	US MH Depth 10	DS MH Depth 10	Flow Direction E
Media No. DVD 01	Surveyed Length 294.6	Total Length 294.6	Surveyor RAFAL W	Certificate No. U-109-8006	Truck No. 226

Comments

Ftg.	Code	Description	Position	Cont.	Comment
0.0	AMH	Access Point - Manhole			Starting Manhole: 1414
0.0	MWL	Water Level			
77.9	TFA	Tap, Factory Made: Active	3		DYE PRESENT
83.2	TFA	Tap, Factory Made: Active	9		DYE PRESENT
179.8	TFA	Tap, Factory Made: Active	3		DYE PRESENT
189.9	TFA	Tap, Factory Made: Active	9		
294.6	TFA	Tap, Factory Made: Active	3		LATERAL INSIDE THE MH (DYE PRESENT)
294.6	AMH	Access Point - Manhole			MH 1413

Upstream MH

1414

Downstream MH

1413

Date

11/23/2020

Time

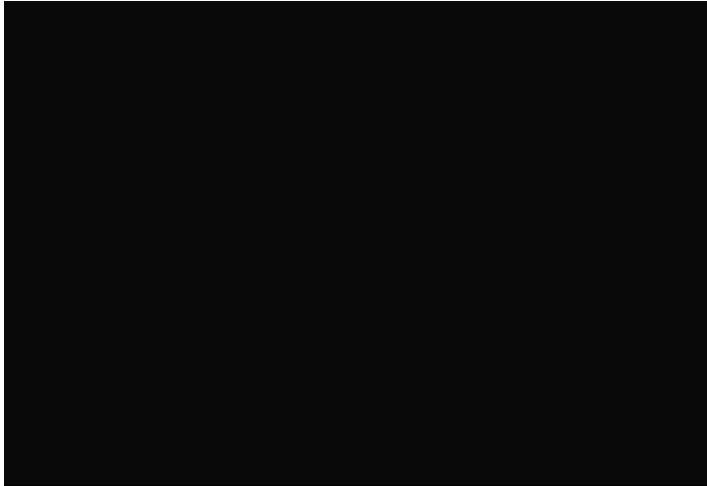
10:37 AM

Location (Street)

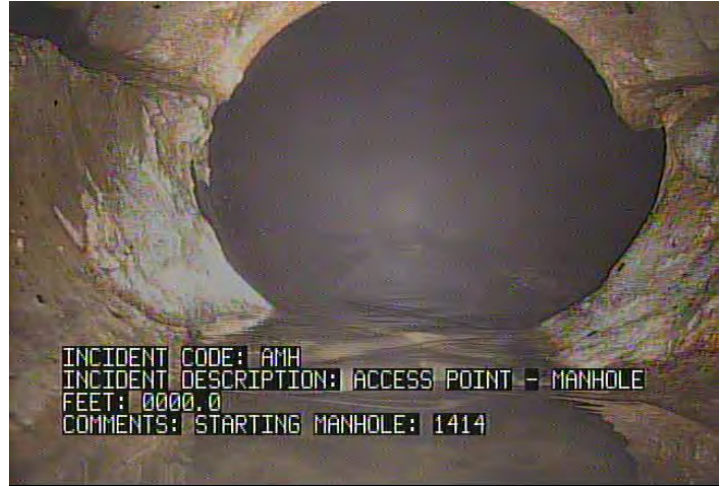
N APPLEWOOD LN

Job Number

20521W-08



AMH - Access Point - Manhole @ 0.0 ft.
Starting Manhole: 1414



MWL - Water Level @ 0.0 ft.



TFA - Tap, Factory Made: Active @ 77.9 ft.
DYE PRESENT



TFA - Tap, Factory Made: Active @ 83.2 ft.
DYE PRESENT

Upstream MH

1414

Downstream MH

1413

Date	Time	Location (Street)	Job Number
11/23/2020	10:37 AM	N APPLEWOOD LN	20521W-08



TFA - Tap, Factory Made: Active @ 179.8 ft. DYE PRESENT



TFA - Tap, Factory Made: Active @ 189.9 ft.



TFA - Tap, Factory Made: Active @ 294.6 ft. LATERAL INSIDE THE MH (DYE PRESENT)



AMH - Access Point - Manhole @ 294.6 ft. MH 1413

Upstream MH

1415

Downstream MH

1414

Date 11/23/2020	Time 9:20 AM	Location (Street) N APPLEWOOD LN			Job Number 20521W-08
Use of Sewer Sanitary	Pipe Size 8	Material Concrete Pipe (non-reinforced)	Jt. Spacing 6	Shape Circular	Survey Direction Downstream
Pre-Cleaning Jetting	Weather Dry	Surface Asphalt	US MH Depth 9	DS MH Depth 10	Flow Direction E
Media No. DVD 01	Surveyed Length 317.8	Total Length 317.9	Surveyor RAFAL W	Certificate No. U-109-8006	Truck No. 226

Comments

NO DYE PRESENT

Ftg.	Code	Description	Position	Cont.	Comment
0.0	AMH	Access Point - Manhole			Starting Manhole: 1415
0.0	MWL	Water Level			
35.6	TF	Tap, Factory Made	10		
88.5	TFA	Tap, Factory Made: Active	3		
142.1	TF	Tap, Factory Made	10		
187.2	TF	Tap, Factory Made	3		
252.9	TFA	Tap, Factory Made: Active	10		
290.0	TF	Tap, Factory Made	2		
317.8	AMH	Access Point - Manhole			MH 1414

Upstream MH

1415

Downstream MH

1414

Date

11/23/2020

Time

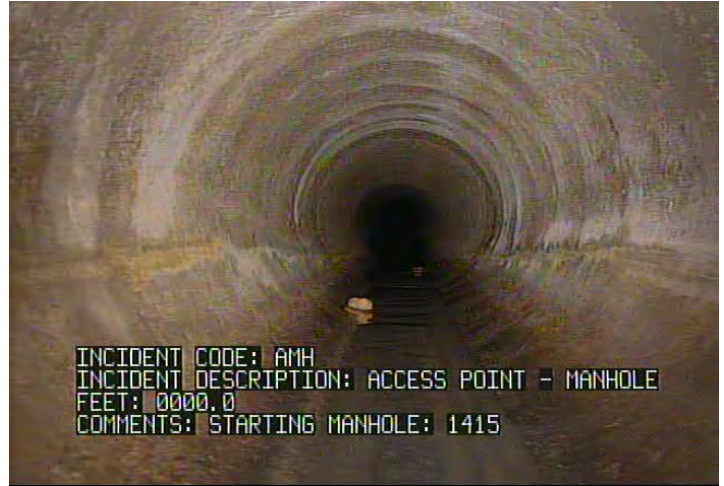
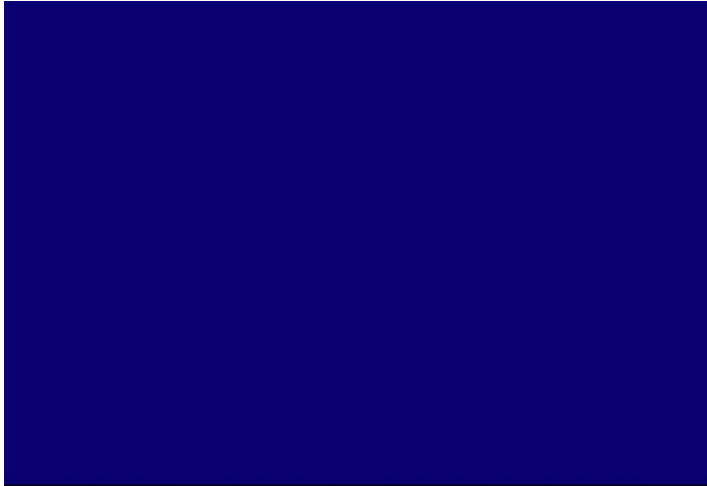
9:20 AM

Location (Street)

N APPLEWOOD LN

Job Number

20521W-08



INCIDENT CODE: AMH
 INCIDENT DESCRIPTION: ACCESS POINT - MANHOLE
 FEET: 0000.0
 COMMENTS: STARTING MANHOLE: 1415

AMH - Access Point - Manhole @ 0.0 ft.
 Starting Manhole: 1415

MWL - Water Level @ 0.0 ft.



UPSTREAM MH: 1415
 DOWNSTREAM MH: 1414
 FEET: 0035.6

TF - Tap, Factory Made @ 35.6 ft.



UPSTREAM MH: 1415
 DOWNSTREAM MH: 1414
 FEET: 0088.5

TFA - Tap, Factory Made: Active @ 88.5 ft.

Upstream MH

1415

Downstream MH

1414

Date	Time	Location (Street)	Job Number
11/23/2020	9:20 AM	N APPLEWOOD LN	20521W-08



TF - Tap, Factory Made @ 142.1 ft.



TF - Tap, Factory Made @ 187.2 ft.



TFA - Tap, Factory Made: Active @ 252.9 ft.



TF - Tap, Factory Made @ 290.0 ft.

Upstream MH

1415

Downstream MH

1414

Date

11/23/2020

Time

9:20 AM

Location (Street)

N APPLEWOOD LN

Job Number

20521W-08



AMH - Access Point - Manhole @ 317.8 ft.
MH 1414

Appendix E



Smoke Testing Report

20521W-08 City of Glendale

Table of Contents

W. Brentwood ave, BMH#833, DSMH#830, USMH#835, Nov 23rd 2020	3
N dexter Ave., BMH#302, DSMH#300, USMH#305, Nov 23rd 2020	10
N. Applewood In., BMH#1414, DSMH#1410, USMH#1417, Nov 23rd 2020	14
N Shasta dr., BMH#291, DSMH#293, USMH#289, Nov 23rd 2020	25



Header

Surveyed By: Jason r	Owner: Clark dietz inc	Customer: Clark dietz inc	PO Number:20521w-08
Date: Nov 23rd 2020	Time: 9:25 am	Street: W. Brentwood ave	City: Glendale
Blower MH#: 833	Upstream MH#: 835	Downstream MH#: 830	
Drainage Area:		Segment Length: 1289 ft	
Smoke Quality: SQG - Good		Weather Code: 1 - Dry	
Comments: Manholes. 835,834,833,832,831,830			

Observations

Observations #1

Smoke Quality: SQG - Good	Defect Type: MFC - Manhole Frame/Cover
Defect Location: AMH - Manhole	
Defect Address: 834	Inflow Potential: IX - None Likely
Distance from Upstream Manhole:	Surface Cover: ST - Street
Surface Material Paved: true	Geolocation: 43.13694356666666 E -87.94437718333332 N
Comments:	

Observations #2

Smoke Quality: SQG - Good	Defect Type: MFC - Manhole Frame/Cover
Defect Location: AMH - Manhole	
Defect Address: 835	Inflow Potential: IX - None Likely
Distance from Upstream Manhole:	Surface Cover: ST - Street
Surface Material Paved: true	Geolocation: 43.13742283333333 E -87.94440986666665 N
Comments:	

Observations #3

Smoke Quality:	SQG - Good	Defect Type:	MFC - Manhole Frame/Cover
Defect Location:			AMH - Manhole
Defect Address:	832	Inflow Potential:	IX - None Likely
Distance from Upstream Manhole:		Surface Cover:	ST - Street
Surface Material Paved:	true	Geolocation:	43.136180117129136 E -87.94379957863363 N
Comments:			

Observations #4

Smoke Quality:	SQF - Fair	Defect Type:	MFC - Manhole Frame/Cover
Defect Location:			AMH - Manhole
Defect Address:	831	Inflow Potential:	IN - None
Distance from Upstream Manhole:		Surface Cover:	ST - Street
Surface Material Paved:	true	Geolocation:	43.13600301666667 E -87.94269451666665 N
Comments:			

Observations #5

Smoke Quality:	SQG - Good	Defect Type:	PIB - Plumbing In Building
Defect Location:			PSL - Private Service Lateral
Defect Address:	2401 house	Inflow Potential:	IN - None
Distance from Upstream Manhole:		Surface Cover:	WB - Within Building
Surface Material Paved:		Geolocation:	43.13583148833333 E -87.94186262 N
Comments: Knichien Sink			

Observations #6

Smoke Quality:	SQG - Good	Defect Type:	MFC - Manhole Frame/Cover
Defect Location:			AMH - Manhole
Defect Address:	830	Inflow Potential:	IX - None Likely
Distance from Upstream Manhole:		Surface Cover:	ST - Street
Surface Material Paved:	true	Geolocation:	43.1359717 E -87.9414623 N
Comments:			

Observations #7

Smoke Quality:	SQG - Good	Defect Type:	DBS - Basement Drain/Sump
Defect Location:			PSL - Private Service Lateral
Defect Address:	6529 house	Inflow Potential:	IS - Severe
Distance from Upstream Manhole:		Surface Cover:	WB - Within Building
Surface Material Paved:		Geolocation:	
Comments: In side house basement			

Observations #9

Smoke Quality:	SQG - Good	Defect Type:	PIB - Plumbing In Building
Defect Location:			ACOH - Cleanout House
Defect Address:	2500 W Brentwood Ave	Inflow Potential:	IN - None
Distance from Upstream Manhole:		Surface Cover:	WB - Within Building
Surface Material Paved:		Geolocation:	
Comments: kitchen sink no trap in place			



Header

Nov 23rd 2020 8:42 am

Observations / 1

Nov 23rd 2020 8:45 am





Observations / 2

Nov 23rd 2020 8:48 am



Observations / 3

Nov 23rd 2020 8:52 am



Observations / 4

Nov 23rd 2020 8:55 am



Observations / 5

Nov 23rd 2020 8:59 am





Observations / 6

Nov 23rd 2020 9:00 am



Observations / 7

Nov 23rd 2020 9:08 am



Observations / 9

Dec 18th 2020 1:29 pm





Header

Surveyed By: Jason r	Owner: Clark dietz.inc	Customer: Clark dietz inc.	PO Number: 20521w08
Date: Nov 23rd 2020	Time: 10:57 am	Street: N dexter Ave.	City: Glendale
Blower MH#: 302	Upstream MH#: 305	Downstream MH#: 300	
Drainage Area:		Segment Length: 1143 ft	
Smoke Quality: SQG - Good		Weather Code: 1 - Dry	
Comments:	Manholes 305,304,303,302,301,300		

Observations

Observations #1

Smoke Quality: SQG - Good	Defect Type: MFC - Manhole Frame/Cover
Defect Location: AMH - Manhole	
Defect Address: 300	Inflow Potential: IX - None Likely
Distance from Upstream Manhole:	Surface Cover: ST - Street
Surface Material Paved: true	Geolocation: 43.11588151666666 E -87.93992070000002 N
Comments:	

Observations #2

Smoke Quality: SQG - Good	Defect Type: LKM - Multiple Leaks
Defect Location: PSL - Private Service Lateral	
Defect Address: 5465 dexter	Inflow Potential: IM - Moderate
Distance from Upstream Manhole:	Surface Cover: YD - Yard
Surface Material Paved:	Geolocation: 43.1164557 E -87.94090775000001 N
Comments:	Front Yard

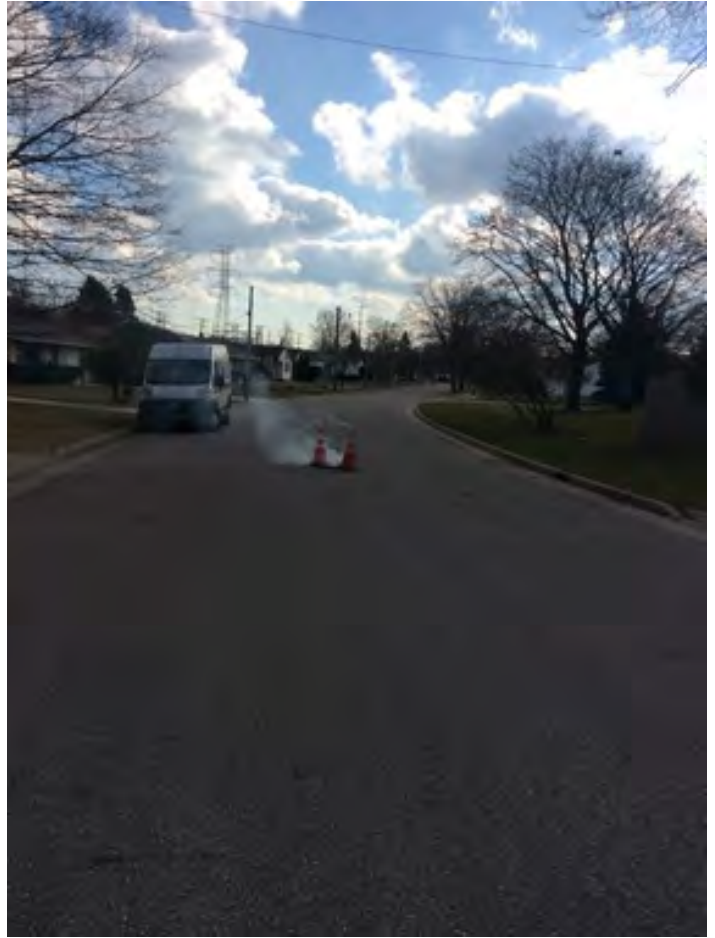


Header

Nov 23rd 2020 10:06 am

Observations / 1

Nov 23rd 2020 10:16 am





Observations / 1

Nov 23rd 2020 10:16 am



Observations / 2

Nov 23rd 2020 10:21 am





Observations / 2

Nov 23rd 2020 10:21 am





Header

Surveyed By: Jason r	Owner: Clark diets, inc.	Customer: Clark diets, inc	PO Number:20521w-08
Date: Nov 23rd 2020	Time: 8:06 am	Street:N. Applewood In.	City: Glendale
Blower MH#: 1414	Upstream MH#: 1417	Downstream MH#:	1410
Drainage Area:		Segment Length:	1821 ft
Smoke Quality: SQG - Good		Weather Code:	1 - Dry
Comments:	Manholes. 1417,1416,1415,1414,1413,1412,1411,1410		

Observations

Observations #1

Smoke Quality: SQF - Fair	Defect Type: MFC - Manhole Frame/Cover
Defect Location: AMH - Manhole	
Defect Address: 1415	Inflow Potential: IL - Light
Distance from Upstream Manhole:	Surface Cover: ST - Street
Surface Material Paved: true	Geolocation: 43.15405258333333 E -87.93823846666668 N
Comments:	

Observations #2

Smoke Quality: SQF - Fair	Defect Type: MFC - Manhole Frame/Cover
Defect Location: AMH - Manhole	
Defect Address: 1417	Inflow Potential: IX - None Likely
Distance from Upstream Manhole:	Surface Cover: ST - Street
Surface Material Paved: true	Geolocation: 43.154123221666666 E -87.94059893500001 N
Comments:	

Observations #3

Smoke Quality:	SQF - Fair	Defect Type:	MFC - Manhole Frame/Cover
Defect Location:			AMH - Manhole
Defect Address:	Stormsewer	Inflow Potential:	IS - Severe
Distance from Upstream Manhole:		Surface Cover:	ST - Street
Surface Material Paved:	true	Geolocation:	43.15399486666665 E -87.93720036666667 N
Comments:	Storm in front of 2200		

Observations #4

Smoke Quality:	SQG - Good	Defect Type:	MFC - Manhole Frame/Cover
Defect Location:			AMH - Manhole
Defect Address:	1413	Inflow Potential:	IL - Light
Distance from Upstream Manhole:		Surface Cover:	ST - Street
Surface Material Paved:	true	Geolocation:	43.15398793333334 E -87.93598203333335 N
Comments:			

Observations #5

Smoke Quality:	SQF - Fair	Defect Type:	MFC - Manhole Frame/Cover
Defect Location:			AMH - Manhole
Defect Address:	1412	Inflow Potential:	IX - None Likely
Distance from Upstream Manhole:		Surface Cover:	ST - Street
Surface Material Paved:	true	Geolocation:	43.15397275000001 E -87.93492771666666 N
Comments:			

Observations #6

Smoke Quality:	SQF - Fair	Defect Type:	MFC - Manhole Frame/Cover
Defect Location:			AMH - Manhole
Defect Address:	1411	Inflow Potential:	IL - Light
Distance from Upstream Manhole:		Surface Cover:	ST - Street
Surface Material Paved:	true	Geolocation:	43.154065599999996 E -87.93461106666668 N
Comments:			

Observations #7

Smoke Quality:	SQG - Good	Defect Type:	MFC - Manhole Frame/Cover
Defect Location:			AMH - Manhole
Defect Address:	1410	Inflow Potential:	IL - Light
Distance from Upstream Manhole:		Surface Cover:	ST - Street
Surface Material Paved:	true	Geolocation:	43.154640986666664 E -87.93438021666668 N
Comments:			

Observations #8

Smoke Quality:	SQG - Good	Defect Type:	MFC - Manhole Frame/Cover
Defect Location:			AMH - Manhole
Defect Address:	Storm	Inflow Potential:	IS - Severe
Distance from Upstream Manhole:		Surface Cover:	ST - Street
Surface Material Paved:	true	Geolocation:	43.15395531666666 E -87.93617151666668 N
Comments: House 2115 driveway			



Observations #10

Smoke Quality:	SQG - Good	Defect Type:	MFC - Manhole Frame/Cover
Defect Location:			AMH - Manhole
Defect Address:	Storm	Inflow Potential:	IS - Severe
Distance from Upstream Manhole:		Surface Cover:	ST - Street
Surface Material Paved:	true	Geolocation:	43.15401091666666 E -87.93616865 N
Comments:	Storm in front of house 2110		

Observations #12

Smoke Quality:	SQG - Good	Defect Type:	MFC - Manhole Frame/Cover
Defect Location:			AMH - Manhole
Defect Address:	Storm sewer	Inflow Potential:	IS - Severe
Distance from Upstream Manhole:		Surface Cover:	ST - Street
Surface Material Paved:	true	Geolocation:	43.15397345 E -87.93617716666667 N
Comments:	House 2115 storm		

Observations #13

Smoke Quality:	SQG - Good	Defect Type:	DBS - Basement Drain/Sump
Defect Location:			PSL - Private Service Lateral
Defect Address:	2210	Inflow Potential:	IX - None Likely
Distance from Upstream Manhole:		Surface Cover:	WB - Within Building
Surface Material Paved:		Geolocation:	43.15426622606954 E -87.93759281710318 N
Comments:	Smoke in drian		



Header

Nov 23rd 2020 7:15 am

Observations / 1

Nov 23rd 2020 7:19 am





Observations / 2

Nov 23rd 2020 7:23 am



Observations / 3

Nov 23rd 2020 7:29 am





Observations / 4

Nov 23rd 2020 7:31 am



Observations / 5

Nov 23rd 2020 7:33 am





Observations / 6

Nov 23rd 2020 7:35 am



Observations / 7

Nov 23rd 2020 7:36 am





Observations / 8

Nov 23rd 2020 7:39 am



Observations / 10

Nov 23rd 2020 7:41 am





Observations / 12

Nov 23rd 2020 7:43 am



Observations / 13

Nov 23rd 2020 7:46 am





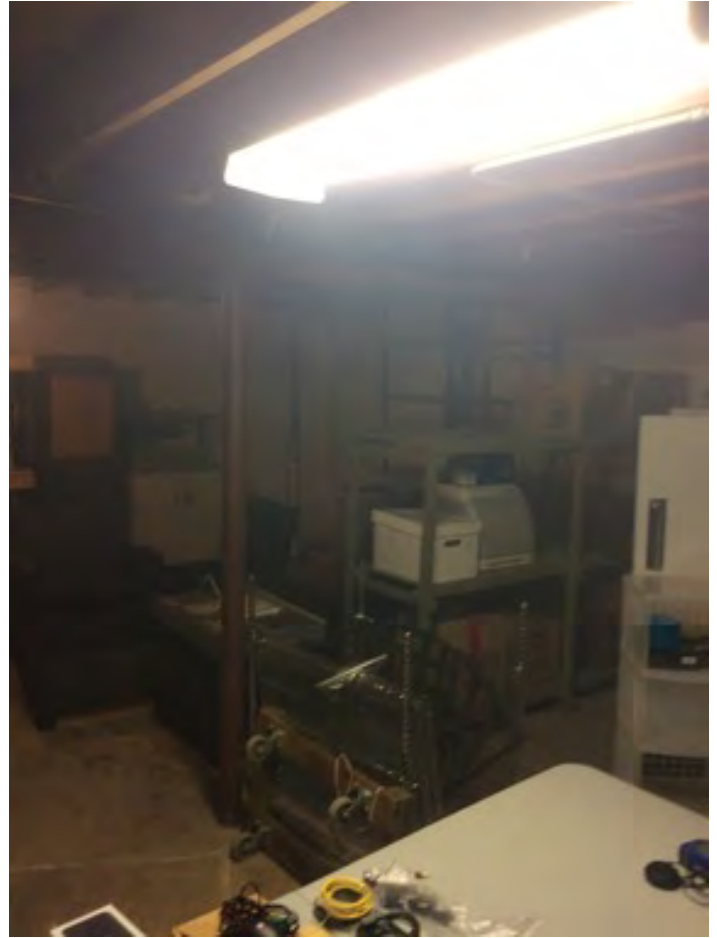
Observations / 13

Nov 23rd 2020 7:50 am



Observations / 13

Nov 23rd 2020 7:52 am



Header

Surveyed By: Jason r	Owner: Clark dietz inc	Customer: Clark dietz inc	PO Number:20521w-08
Date: Nov 23rd 2020	Time: 11:44 am	Street: N Shasta dr.	City: Glendale
Blower MH#: 291	Upstream MH#: 289	Downstream MH#: 293	
Drainage Area:		Segment Length: 1084 ft	
Smoke Quality: SQG - Good		Weather Code: 1 - Dry	
Comments: Manholes 289,290,291,292,293			

Observations

Observations #1

Smoke Quality: SQG - Good	Defect Type: MFC - Manhole Frame/Cover
Defect Location: AMH - Manhole	
Defect Address: 290	Inflow Potential: IX - None Likely
Distance from Upstream Manhole:	Surface Cover: ST - Street
Surface Material Paved: true	Geolocation: 43.11790501666666 E -87.94263463333333 N
Comments:	

Observations #2

Smoke Quality: SQG - Good	Defect Type: MFC - Manhole Frame/Cover
Defect Location: AMH - Manhole	
Defect Address: 293	Inflow Potential: IN - None
Distance from Upstream Manhole:	Surface Cover: ST - Street
Surface Material Paved: true	Geolocation: 43.11548586333333 E -87.94270015 N
Comments:	



Header

Nov 23rd 2020 10:46 am

Observations / 1

Nov 23rd 2020 10:48 am





Observations / 2

Nov 23rd 2020 10:57 am



Clark Dietz, Inc.
759 N. Milwaukee Street
Suite 624
Milwaukee, WI 53202

p 414.727.4990
clarkdietz.com

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