APPENDIX 6A: Conveyance Alternative Analyses

Purpose

This appendix provides additional details for 2050 Facilities Plan (2050 FP) Chapter 6 that are specific to Milwaukee Metropolitan Sewerage District's (MMSD's) Conveyance and Storage Asset System. This appendix is not a stand-alone document; it should always be used in conjunction with the 2050 FP, which outlines a coordinated facilities management plan for all of MMSD's asset systems.

6 Alternative Analyses

6.1 Purpose

This chapter analyzes alternatives to mitigate the potential risks to the Conveyance and Storage Asset System that were identified in Chapter 5 and identifies the recommended projects. The analyses are presented in two sections: those for projects that address regulatory guidelines and permit requirements during the 2020 to 2040 regulatory planning period and those for projects that address MMSD's 2035 Vision and 2050 Foundational Goals (FG), which address non-permit requirements and include projects that address Commission policy and rules established by MMSD, projects that help to improve regional water quality and reduce energy usage, and projects that are designed to save MMSD money in the long term:

- **Regulatory Guidelines and Permit Requirements**. Includes all capacity and physical mortality risks identified in Chapter 5 plus level of service and economic efficiency risks that could potentially impact the ability to meet regulatory guidelines and permit requirements. These analyses are identified as CS R1 (Conveyance System Risk 1), CS R2, etc.
- **2050 Foundational Goals:** Includes the remaining level of service and economic efficiency risks to meeting 2050 Foundational Goals. These analyses are identified as CS FG1 (Conveyance System Foundational Goal Risk 1), CS FG2, etc.

Some of the analyses are inter-related – for instance, where a project identified to address physical mortality risks would be made obsolete by a recommended capacity project that would abandon the infrastructure. These inter-relationships are identified in each analysis.

For each potential risk identified in Chapter 5, Table 6A-1 shows when the risk is predicted to occur and gives the name of the analysis in this chapter that identifies potential strategies to mitigate the risk.

TABLE 6A-1: ALTERNATIVE ANALYSES FOR POTENTIAL CONVEYANCE RISKS IDENTIFIED IN CHAPTER 5 [1]

Potential Risk Identified in Ch 5	Specific Description of Potential Risk	How Potential Risk was Identified	Estimated Timing of Potential Risk	Type of Potential Risk	Ch 6 Analysis
Capacity risks	A critical elevation is exceeded by 8.4 ft. at MH17604 in the South Howell Avenue MIS	Hydraulic model run of the 5-year level of protection (LOP) flow	Existing (Conveyance Baseline Conditions)	Risk to meeting regulatory guidelines / permit requirements	CS R1, South Howell Ave Pipe Capacity
	A critical elevation is exceeded by 3.7 ft. at MH08307 in the South 81st – 84th Street MIS		Existing (Conveyance Baseline Conditions)	Risk to meeting regulatory guidelines / permit requirements	CS R2, South 81-84 St Pipe Capacity
	A critical elevation is exceeded by 5.2 ft. at MH 12221 in the North Sherman Boulevard MIS [2]		Existing (Conveyance Baseline Conditions)	Risk to meeting regulatory guidelines / permit requirements	CS R3, North Sherman Blvd Pipe Capacity
	A critical elevation is exceeded by 1.3 ft. at MH12104 in the West Hampton Avenue MIS [2]		Existing (Conveyance Baseline Conditions)	Risk to meeting regulatory guidelines / permit requirements	CS R4, West Hampton Ave Pipe Capacity
	A critical elevation is exceeded by 0.6 ft. at MH00901 in the North Commerce Street MIS [2]		Existing (Conveyance Baseline Conditions)	Risk to meeting regulatory guidelines / permit requirements	CS R5, N Commerce St Pipe Capacity
	A critical elevation is exceeded by 2.1 ft. at MH40802 in the West Ryan Road MIS		2035 (Conveyance Future Conditions)	Risk to meeting regulatory guidelines / permit requirements	CS R6, Ryan Rd Pipe Capacity
	A critical elevation is exceeded by 10.5 ft. at MH19713 in in the North 91st Street MIS [2]		2035 (Conveyance Future Conditions)	Risk to meeting regulatory guidelines / permit requirements	CS R7, N 91st Pipe Capacity
	A critical elevation is exceeded by 0.8 ft. at IS502 at West Greeves Street in the North 27th Street MIS		2035 (Conveyance Future Conditions)	Risk to meeting regulatory guidelines / permit requirements	CS R8, 27th St Pipe Capacity
	Non-compliant enforcement metershed assessment used more current data than hydraulic model. At least 14 percent of the enforcement metersheds are identified as non-compliant, indicating there may be even more capacity risks than those identified under the hydraulic capacity assessment.	Assessment of Enforcement Metersheds	Existing (as of 2019)	Risk to meeting regulatory guidelines / permit requirements	Noted in CS R1 through CS R9
Physical mortality risks	If pipes are not maintained, ongoing pipe degradation could cause I/I to increase by 14 percent from Conveyance Baseline I/I flows	Ad Hoc Request 211 analysis	2040 (end of 2020–2040 regulatory planning period)	Risk to meeting regulatory guidelines / permit requirements	CS R9, Combat I/I Impact
Physical mortality risks	If aging pipes and facilities are not rehabbed or replaced, there may be localized failures	AssetView condition data	Varies	Risk to meeting regulatory guidelines / permit requirements	CS 10, Physical Mortality Evaluation
Level of service risks	Risk of frequent SSOs at BS0603 due to configuration of overflow weir and bypass orifice	Historical data and modeling data	Existing (Conveyance Baseline Conditions)	Risk to meeting regulatory guidelines / permit requirements	CS 11, Risk of SSOs Occurring at BS0603

TABLE 6A-1: ALTERNATIVE ANALYSES FOR POTENTIAL CONVEYANCE RISKS IDENTIFIED IN CHAPTER 5 [1]

Potential Risk Identified in Ch 5	Specific Description of Potential Risk	How Potential Risk was Identified	Estimated Timing of Potential Risk	Type of Potential Risk	Ch 6 Analysis
Level of service risks	Risk of pipe damage and safety concerns due to the presence of H_2S in metropolitan interceptor sewer (MIS) in various parts of the Conveyance system	MMSD staff identified as a high priority area of concern	Existing (Conveyance Baseline Conditions)	Risk to meeting Foundational Goal	CS FG1, Programmatic Approach to H2S in Collection System CS FG3, H_2S, Odors, and Venting Also see Appendix 5A-13, H_2S, Odor, and Venting Technical Memorandum
Level of service risks	Risk of surcharges in the MIS due to outfalls that lack free discharge and outfalls that allow receiving waters to back up into Conveyance system	MMSD staff identified as a high priority area of concern	Existing (Conveyance Baseline Conditions)	Risk to meeting Foundational Goal	CS FG2, Outfall Alternatives Also see Appendix 5A-15, Outfall Alternatives Technical Memorandum
Level of service risks	Risk of sediment accumulating due to low flows during dry weather, which may lead to odor and hydrogen sulfide (H_2S) issues in sewers as well as additional maintenance/cleaning. Low flows create other risks as well, such as increased volatile fatty acids and higher strength wastes to WRFs that may challenge treatment strategies.	Conveyance Risk Register risk no. C060 MMSD staff identified as a high priority area of concern	Existing (Conveyance Baseline Conditions)	Risk to meeting Foundational Goal	CS FG4, Sewer Self Cleansing/Low Flow Also see Appendix 5A-16, Sewer Self-Cleansing Technical Memorandum
Level of service risks	The methodology used during the 2020 FP for developing future flows creates challenges for municipal development once flow allocations for the planning horizon are met. Additionally, increased flows from new development lower the level of protection against SSOs and CSOs. Future flows must be determined so that conveyance projects can be planned to accommodate the flows.	Conveyance Risk Register risk no. C066	Existing (Conveyance Baseline Conditions)	Risk to meeting regulatory guidelines / permit requirements	Appendix 4A-2 identifies community flow allocations incorporated to the analysis Conveyance Capacity Analyses CS R1 to CS R8 address specific concerns using projected flows that incorporate flow allocations
Level of service risks	Risk of too much clear water in the system and increase to conveyance, storage, and treatment costs as well as basement backups, SSOs, and negative public perception due to failure to achieve goals for infiltration and inflow (I/I) reduction	Conveyance Risk Register risk no. C085	2040 (end of 2020 – 2040 regulatory planning period)	Risk to meeting regulatory guidelines / permit requirements	CS R 9, Combat I/I Impact
Level of service risks	Risk of inability to safely and efficiently maintain the collection system due to access constraints	MMSD staff identified as a high priority area of concern	Existing (Conveyance Baseline Conditions)	Risk to meeting Foundational Goal	CS FG5, Conveyance Access Issues Also see Appendix 5A-14, Conveyance Access Alternatives Technical Memorandum
Level of service risks	Community risk/cost due to water in basements	Conveyance Risk Register risk no. C159	Varies, see specific analyses	Risk to meeting regulatory guidelines / permit requirements	Conveyance Capacity Analyses CS R1 to CS R8 address specific concerns using projected flows that incorporate flow allocations at a 5-year LOP
Level of service risks	Risks due to the potential presence of polychlorinated biphenyls (PCBs) in the Conveyance system	MMSD staff identified as a high priority area of concern	Existing (Conveyance Baseline Conditions)	Risk to meeting regulatory guidelines / permit requirements	N/A Potential PCB issues will be addressed by MMSD outside of the 2050 FP

TABLE 6A-1: ALTERNATIVE ANALYSES FOR POTENTIAL CONVEYANCE RISKS IDENTIFIED IN CHAPTER 5 [1]

Potential Risk Identified in Ch 5	Specific Description of Potential Risk	How Potential Risk was Identified	Estimated Timing of Potential Risk	Type of Potential Risk	Ch 6 Analysis
Level of service risks	The risk of the ISS PS being inoperable due to physical mortality or JIWRF power failure	MMSD staff identified as a high priority area of concern	Existing (Conveyance Baseline Conditions)	Risk to meeting regulatory guidelines / permit requirements	WRF R7, Physical Mortality Evaluation and WRF R9, Loss of Electrical Power at JIWRF Substations in Appendix 6B

1) Subsequent to the assessment of potential risks conducted for Chapter 5, MMSD identified several additional Conveyance projects to be completed. Because alternative analyses for these projects were not conducted for the 2050 FP, they are not listed in this table. However, they are included in the recommended projects list in Section 6.5 to document that they are proposed MMSD projects.

2) Modeling indicates that multiple critical elevations are exceeded along the subject MIS. Only the worst case within the evaluated section is listed in this table.

6.2 METHODOLOGY

The methodology used to analyze the alternatives varies by analysis and is documented in the Approach section under each analysis.

Because the 2050 FP was developed during a period when a large number of MMSD projects and programs were already underway, the 2050 FP project team also reviewed MMSD's 2020 to 2025 long-range finance plan to determine if any of the existing projects would address the identified risks.

6.3 ANALYSIS OF RISKS TO MEETING REGULATORY/PERMIT REQUIREMENTS

This section evaluates potential alternatives to address the identified risks to meeting MMSD's Wisconsin Pollutant Discharge Elimination System (WPDES) permit requirements and NR 110 guidelines during the regulatory planning period of 2020 to 2040.

Conveyance Pipeline Capacity Analysis Methodology

This section discusses the methodology that was employed to identify pipeline capacity deficiencies in the following analyses:

- CS R1, South Howell Ave Pipe Capacity
- CS R2, South 81-84 St Pipe Capacity
- CS R3, N Sherman Blvd Pipe Capacity
- CS R4, Hampton Ave Pipe Capacity
- CS R5, N Commerce St Pipe Capacity
- CS R6, Ryan Rd Pipe Capacity
- CS R7, N 91st St Pipe Capacity
- CS R8, 27th St Pipe Capacity

Background information such as pipeline age, original construction material and method, depth, potential environmental constraints, and general characteristics within the project vicinity is summarized for each of the eight projects in Section 6.3.

As stated in Chapter 5, MMSD is committed to providing at least a 5-year level of protection (LOP) throughout the conveyance system. The 5-year LOP is defined as both the probability of impacting a critical elevation (CE) and/or an occurrence of a separate sewer overflow (SSO) during the 5-year peak flow. Modeled pipeline capacity deficiencies were identified for the 5-year recurrence interval wet-weather event for Conveyance Baseline (2010) and Conveyance Future (2040) Conditions at various locations within MMSD's metropolitan interceptor system (MIS) system. The analysis focused on conceptual capacity enhancement alternatives (i.e., sewer construction projects) for eight locations within the MIS system.

The project name, MIS subsystem and leg, and applicable capacity risk are listed in Table 6A-2.

TABLE 6A-2: CONVEYANCE CAPACITY PROJECTS

Project No.	Project Name/Location	Subsystem, Leg	Capacity Risk	Risk Criterion	Specific Description of Potential Risk
1	South Howell Avenue MIS	1, N	Conveyance Baseline (2010), 5-year Event	5-yr LOP exceeded under Conveyance Baseline Conditions	Model predicted that the critical elevation at MH17604 was exceeded by 8.4 ft.
2	South 81st Street – South 84th Street MIS	3, K1	Conveyance Baseline (2010), 5-year Event	5-yr LOP exceeded under Conveyance Baseline Conditions	Model predicted that the critical elevation at MH08307 was exceeded by 3.7 ft.
3	North Sherman Boulevard MIS	5, C	Conveyance Baseline (2010), 5-year Event	5-yr LOP exceeded under Conveyance Baseline Conditions	Model predicted that the critical elevation at MH12221 was exceeded by 5.2 ft. [1]
4	West Hampton Avenue MIS	5, C	Conveyance Baseline (2010), 5-year Event	5-yr LOP exceeded under Conveyance Baseline Conditions	Model predicted that the critical elevation at MH12104 was exceeded by 1.3 ft. [1]
5	North Commerce Street MIS	7, SB	Conveyance Baseline (2010), 5-year Event	5-yr LOP exceeded under Conveyance Baseline Conditions	Model predicted that the critical elevation at MH00901 was exceeded by 0.6 ft. [1]
6	Ryan Road – South Pennsylvania Ave. MIS	2, Q	Conveyance Future (2035), 5-year Event	5-yr LOP exceeded under Conveyance Future Conditions	Model predicted that the critical elevation at MH40802 was exceeded by 2.1 ft.
7	North 91st Street MIS	3, H	Conveyance Future (2035), 5-year Event	5-yr LOP exceeded under Conveyance Future Conditions	Model predicted that the critical elevation at MH 19713 was exceeded by 10.5 ft. [1]
8	North 27th Street MIS	7, W	Conveyance Future (2035), 5-year Event	5-yr LOP exceeded under Conveyance Future Conditions	Model predicted that the critical elevation at IS502 was exceeded by 0.8 ft.

1) Modeling indicates that multiple critical elevations are exceeded along the subject MIS. Only the worst case within the evaluated section is listed in this table.

In addition to the locations listed in Table 6A-2, the initial modeling results identified several more MIS sections with capacity restrictions for the 5-year recurrence interval event under Conveyance Baseline or Conveyance Future Conditions. These MIS sections were evaluated and were determined to often be the result of modeling anomalies (e.g., model input having the entire sewershed flow "loaded" into a single local connection point instead of distributed at several connection points, erroneous pipe size, or system configuration). These areas were eliminated from consideration and not evaluated under the 2050 FP. Some locations were within an area that a current (2019) detailed planning study or preliminary engineering project (e.g., North Shore MIS, Contract No. C04010P01) is addressing the problem. These additional projects are discussed in Section 6.5.

A planning-level hydraulic design was performed to establish pipe sizes and approximate pipe slopes. Planning-level conceptual costs were developed for each alternative, and other potential conveyance-related improvements were identified for several projects (e.g., modification of nearby flow control structures or operations). MMSD intends to consider all viable opportunities to cost effectively achieve a higher than 5-year LOP during design of the recommended projects. While these potential improvements were not evaluated under this project, MMSD intends to consider them for implementation during design in conjunction with or independent of the specific pipeline construction project.

Prior to implementation of any conveyance project, the sewersheds in the separate sewer service area (SSSA) should be evaluated to determine if excessive infiltration and inflow (I/I) exists in any metersheds within the tributary area as defined by MMSD Chapter 3 rules for allowable flows. If excessive I/I is present, I/I reduction should be evaluated as an alternative or as a component of any alternative proposed for a conveyance project.

Additionally, detailed modeling should be performed to determine actual flows in the system based on any new meters installed in the system and recently-calibrated meter data. Flow monitoring data for the past few years should also be reviewed to determine if the modeled results are representative of actual flows. For projects identified due to future development, flow allocation requests in the tributary areas should be tracked in the coming months and years to determine the rate of development in the areas. If the tributary areas are realizing the projected future growth, conveyance capacity projects should be started.

Other flow reduction strategies such as the impact of green infrastructure (GI) and storm sewer inlet restrictor devices (within the combined sewer service area [CSSA]) were not evaluated as part of the conveyance pipeline capacity analysis methodology but should also be considered as potential measures to reduce the design flow required for specific conveyance projects during preliminary engineering.

All of the MIS evaluated in the capacity analyses are located in the 2050 FP planning area and no new assets are anticipated to be installed in undeveloped or environmentally sensitive corridors based on any of the alternatives reviewed. No review of topography, soil investigation, or floodplain review was completed as part of the alternative analyses. Topography descriptions, soil investigations, and designations of any portion of proposed sewers in a floodplain or wetland will be included in the preliminary engineering of recommended projects when implemented.

Design Flows and Hydraulic Modeling

For the planning-level designs, pipe sizes for the conceptual alternatives are based on flows estimated from year 2050 population projections and land use with climate change conditions (Buildout Conditions) provided by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) and the 5-year recurrence interval wet-weather event. The 5-year recurrence event used in the hydraulic simulation for Buildout Conditions for each project location is listed in Table 6A-3.

TABLE 6A-3: 5-YEAR DESIGN EVENT (BUILDOUT CONDITIONS)

Project No.	Project Name/Location	Simulated 5-year Event
CS R1	South Howell Avenue MIS	August 1953
CS R2	South 84th Street – South 81st Street MIS	May 2000
CS R3	North Sherman Boulevard MIS	July 1977
CS R4	West Hampton Avenue MIS	July 1977
CS R5	North Commerce Street MIS	May 1990
CS R6	Ryan Road – South Pennsylvania Avenue MIS	July 1977
CS R7	North 91st Street MIS	June 2008
CS R8	North 27th Street MIS	June 1999

A detailed discussion of the hydraulic modeling programs parameters, procedures, assumptions, and results is included in Appendix 4A-3 of Chapter 4.

Hydraulic Modeling Limitations

The information, conclusions, and recommendations presented in this section should be considered preliminary based on limitations inherent in a facilities planning level of evaluation. Specific limitations related to the hydraulic modeling include the following:

- The MMSD flow monitoring network may not provide accurate flow data in all MIS segments. The density of the flow monitoring network is sufficient for planning purposes, but more focused monitoring is needed to verify flows in specific MIS segments to support detailed sewer planning and design.
- The hydraulic models used in the 2050 FP were not calibrated for the project using recent flow meter data.
- The accuracy of the flow data used to calibrate the hydraulic models prior to the 2050 FP may be limited by the use of level-only meters. The use of level-only meters and rating curves to derive values for flow is reasonably accurate where wastewater flows are near normal depth in the pipe. However, the accuracy diminishes at locations subject to backwater or surcharging, which is the case for many areas of the MIS. Surcharging of the MIS is acceptable depending upon the location and other factors. However, surcharging does affect level-only measurements. Although the majority of meters in the MIS system currently utilize the more accurate area-velocity flow measurement technique, the flow data used to calibrate the models were measured by level-only meters.
- The population and development projections provided by SEWRPC for 2050 (Buildout) conditions may overpredict actual population growth and development in some locations. Consequently, projected flows may not be realized until late in the planning period, if at all. In all cases, it is not known if or when the projected future flows will actually occur.

Although the hydraulic modeling identified a capacity risk for Conveyance Baseline Conditions for five of the eight projects, indicating a current risk in those locations, the limitations noted above need to be considered for all projects. The hydraulic restrictions identified for the various MIS sections that are based on Future (2040) and Buildout (2050) Conditions should be viewed as indicative of areas of the MIS system that are potentially vulnerable to hydraulic problems if the projected growth occurs.

Recommendations for the specific projects presented were developed for the purpose of estimating the conceptual costs of potential conveyance enhancements. However, the actual need for a conveyance enhancement should be verified by focused flow monitoring and a physical condition assessment of the MIS pipelines in the areas of concern before proceeding with any improvements. If flow monitoring confirms that flows are increasing, the projected growth should be verified by tracking flow requests from the municipalities. This additional growth may cause flows to approach levels that will result in hydraulic restrictions and the possibility of basement backups, combined sewer overflows (CSOs) or SSOs. Detailed hydraulic modeling and preliminary engineering should be performed to identify the most appropriate conveyance system enhancements.

The project evaluations identified several discrepancies in the hydraulic model that should be reviewed as part of future model updates. For several sewersheds, the wastewater flow “loading” location was concentrated in a single node (i.e., manhole) whereas the actual tributary area is connected to the subject MIS in multiple locations. The concentrated flow input could overload the MIS in the model and result in a reported capacity problem that does not actually exist.

Additionally, model input for the pipe size is not correct for at least one MIS included in the alternatives analyses and for one MIS segment initially identified but excluded from the analyses, which could affect the modeling results. Review of model input as noted in the project summaries should be addressed when the models are recalibrated and updated.

Development of Alternatives

For the various MIS sections with identified conveyance restrictions, a relief or replacement sewer was designed to provide sufficient capacity and lower the hydraulic grade line (HGL) below nearby affected CEs for the design (Buildout) flow rate. CEs are defined as the maximum HGL that can occur in the MIS without causing basement backups or overflows in local municipalities. CEs vary based on site conditions. For example, CEs at manholes might be the invert elevation of the municipal sewer connection, the crown elevation of the MIS, or the invert elevations of local sewers upstream in the vicinity of the connection.

A minimum of two alternatives were analyzed for each project site: a relief sewer and a replacement sewer. The relief alternative provides a second, typically smaller sewer, so that the total conveyance capacity of both the relief sewer and the existing sewer is sufficient to convey the peak design flow (Buildout, 5-year event). For Project CS R8, both alternatives are relief sewers because the existing sewer was structurally rehabilitated in 2004, indicating that replacement is likely to be unnecessary. The sewer replacement alternative replaces the existing MIS with a larger sewer to convey the design flow tributary to the subject MIS segment.

A limited review of the MIS capacity immediately downstream from the deficient section was performed to assess whether the improvement could be implemented without causing downstream problems. Detailed hydraulic modeling of the proposed improvements was not included in the evaluations.

Additionally, I/I reduction was considered for two project areas because the difference between the existing pipe capacity and the design flow is relatively small (1 to 4 cubic feet per second [cfs]) or where I/I reduction would likely benefit a local sewer system that experiences chronic basement backups. Typical I/I reduction strategies include potential private property clear water source reduction (foundation drain disconnection, lateral rehabilitation, etc.), municipal storm sewer rehabilitation (to reduce exfiltration), and/or sanitary sewer rehabilitation in the local municipal sewers tributary to the MIS segments that require capacity enhancement. To address the risk identified in Chapter 5 that there may be even more capacity risks than those identified under the hydraulic capacity assessment due to non-compliant metersheds, MMSD should work with all governing units in the MMSD sewer service area through its Wet Weather Peak Flow Management Program (WWPFMP) to ensure that they monitor non-compliant metersheds and develop plans to bring them into compliance with MMSD rules.

I/I reduction would benefit the local municipality's sewer system and could potentially eliminate the need for an improvement project in MMSD's MIS system. I/I reduction was evaluated for Project CS R3 and Project CS R4 and was found to be the alternative with the highest value ratio for both projects.

Cost Estimates and Alternatives Analysis

Construction costs for relief and replacement sewers are based on unit prices for pipelines obtained from the AssetView database provided by MMSD in 2018. These prices are used by MMSD for planning and long-range cost forecasting. The unit prices include costs for excavation, pipe installation, backfill as applicable, and surface restoration. At the conceptual planning level, no distinction was made between open-cut pipe installations and microtunneling. The AssetView unit prices correlate reasonably well with the 2050 FP project teams' assessment of 2019 data for microtunneling based on a nationwide review of applicable construction costs. Accordingly, the 2018 AssetView data was not escalated for inflation to 2019.

The planning-level costs for I/I reduction methods are based on the cost curve developed under MMSD Ad Hoc Request 211, Figure 1. [1] This method estimates the unit cost of I/I reduction expressed in dollars per gallon per day (gpd) of 5-year peak hour I/I removed as a function of the pre-rehabilitation 5-year peak hour I/I in gpd. The costs were developed for a wide range of I/I removal techniques for numerous rehabilitation projects and I/I studies in the Milwaukee area. Costs from the previous rehabilitation projects and I/I studies were adjusted for an assumed year 2020 Engineering News-Record (ENR) Construction Cost Index of 15,000.

Mobilization and demobilization costs were estimated at $500K for projects ranging from $0 to $5 million, $750K for projects ranging from $5 to $10 million, $1M for projects ranging from $10 to $25 million, $2M for projects ranging from $25 to $100 million, and $3 to 5M for projects ranging from $100 to $300 million. Estimated costs for shafts on sewers installed by tunneling were developed by the 2050 FP project team and include excavation, dewatering, backfill, and surface improvements. Estimated operation and maintenance (O&M) costs are based on actual costs and information provided by Veolia Water Milwaukee, LLC (Veolia).

To develop a capital cost, the estimated construction costs were escalated by 20 percent for undesigned details to address potential items that are unknown during the conceptual/planning stage but may become necessary during preliminary or final design; by another 20 percent to address general construction contingencies; and by another 20 percent for engineering, bidding, engineering services during construction, and MMSD administrative costs. The present worth of annual O&M costs assuming a 20-year planning period was added to the capital cost to determine the total present worth. O&M costs for relief sewers were doubled in the estimates to reflect the additional length of pipeline that would result from construction of a relief sewer in comparison to the length of replacing the existing MIS. Salvage values were not included in the cost analysis.

Analysis-specific performance factors were developed and used to rate the alternatives against each other and then a total weighted score was calculated for each alternative. Each alternative was scored against the following performance factors: Permit/Legal Requirements, Energy, Environmental Improvements (non-regulatory, resource recovery), Fiscal Responsibility, Management and Operational Effectiveness, Safety, and Customer Service/Community Economic Development and Organizational Reputation. For each alternative, the total weighted score was divided by the alternative's present worth to determine its value ratio (the value that the alternative provides per million spent). The highest value ratio was used to determine the recommended planning-level alternative. A detailed discussion of the overall 2050 FP alternatives scoring methodology is provided in Chapter 6.

Alternatives and recommendations have been developed based primarily on the hydraulic modeling study performed as described herein. Prior to implementation of any of the projects, it is recommended that flow monitoring and hydraulic analysis with updated and calibrated model(s) be performed to verify that the estimated flows occur and confirm that the capacity enhancements are definitely needed for the MIS segment(s). Additionally, preliminary engineering should be performed to assess the physical condition of the sewers; verify sewer alignments; explore alternate sewer routes; and identify real estate needs, environmental constraints, and potentially significant existing utility conflicts.

CS R1 – South Howell Ave Pipe Capacity

Purpose

The purpose of this analysis is to identify potential risk mitigation strategies for a pipeline capacity deficiency identified as part of the capacity assessment in Chapter 5 (refer to Chapter 5 for a discussion of the assessments done on the existing facilities). Modeled pipeline capacity deficiencies were identified for the 5-year wastewater recurrence interval event for Conveyance Baseline and Conveyance Future Conditions at various locations within the MIS system.

This alternative analysis includes an evaluation of the 27-inch diameter MIS located within Subsystem 1, Leg N along South Howell Avenue in the City of Milwaukee.

Approach

Refer to the previous Conveyance Pipeline Capacity Analysis Methodology subsection of Section 6.3 for details on the methodology used for this analysis.

A capacity deficiency for the 5-year wastewater recurrence interval event for Conveyance Baseline Conditions was identified in a 1,421-foot-long section of 27-inch diameter pipeline that flows north along South Howell Avenue from MMSD manhole (MH) 17604 to diversion chamber (DC) 0102 just south of West Layton Avenue. The deficient section is part of an MIS that extends 7,651 feet from about 500 feet south of West Citation Way and General Mitchel International Airport (GMIA) north to DC0102 at West Layton Avenue. The MIS is generally located along the east side of southbound South Howell Avenue.

Flow tributary to the South Howell Avenue MIS is from a northeastern portion of Franklin, a southeastern portion of Greenfield, a southeastern portion of Milwaukee, including GMIA, and a northeastern portion of Oak Creek. The tributary area does not have excessive I/I and the peak flows are within the allowable rates by MMSD.

The problem area consists of two pipe sections: A 255-foot-long section of the 27-inch diameter MIS immediately south of West Layton Avenue is a monolithic concrete pipeline installed in 1963 (56 years old), and the next upstream 1,166-foot-long section is vitrified clay pipe installed in 1941 (78 years old). The MIS ranges from approximately 23 to 25 feet below the ground surface.

Modeling indicates the full-pipe capacity of the 27-inch diameter MIS is exceeded by approximately 17 cfs during the 5-year wastewater event under Conveyance Baseline Conditions, causing water levels to exceed an adjacent CE at MH 17604 by approximately 8.4 feet. Additionally, the previous 2020 Facilities Plan evaluation for this same MIS resulted in a simulated bypass at a sanitary sewer overflow (WPDES 220) along South Howell Avenue near GMIA, which emphasizes the importance of maintaining adequate capacity in this MIS. [2] The modeled profiles with CEs for the Conveyance Baseline, Future, and Buildout Conditions are provided in Appendix 6A-1.

The sewers downstream from the 27-inch diameter MIS are only partially full when the flow level at MH 17604 exceeds the CE and the ground elevations. The 48-inch diameter connecting pipeline from DC0102 to MH 31101 (on the 144-inch diameter MIS in Layton Avenue) is only 35 percent full, and the 144-inch diameter MIS (MH 31101 to MH 30901) is only 68 percent full. This indicates the capacity restriction in the 27-inch diameter MIS could be relieved without causing additional downstream problems.

Even though the 144-inch diameter MIS surcharges later in the event, the sewer is relatively deep (approximately 70 to 90 feet) and still provides a free outlet for flow from the South Howell Avenue MIS. The CE of the 144-inch diameter MIS in Layton Avenue is approximately 45 feet above the crown of the pipe, and the peak flow level does not exceed the CE during a 5-year wastewater event. The design capacities of the 48-inch diameter connecting pipe at DC0102 and the 144-inch diameter MIS are 117 cfs and 417 cfs, respectfully.

There have been no hydrogen sulfide/odor issues reported or manhole access constraints identified along the noted section of MIS.

The land use along South Howell Avenue is commercial and industrial. South Howell Avenue borders the west side of GMIA for about 0.8 miles and the 27-inch diameter MIS passes through the southern part of the airport grounds for about 0.6 miles.

Potential environmental constraints associated with construction along this route include possible impacted soil associated with historical or current land uses or activity and potential temporary impacts to traffic in both South Howell Avenue and West Layton Avenue.

The South Howell Avenue MIS was identified as having a capacity deficiency as part of the previous 2020 Facilities Plan based on the modeling data, assumptions, and design criteria used for that study. [2] No projects have been completed or are under design in this reach of the MIS system since the publication of the 2020 Facilities Plan.

Alternatives Description

To mitigate the risk, two alternatives consisting of a relief sewer and a replacement sewer were identified. Descriptions of each alternative are presented below.

The pipe sizing for the conceptual alternatives are based on flows developed from 2050 population projections and land use with climate change conditions (Buildout Conditions) and the 5-year wastewater recurrence interval event. The existing pipe capacity is based on the average pipe slope for the subject MIS. The Buildout Conditions 5-year wastewater design flow in the 27-inch diameter MIS is 42 cfs. The full pipe capacity of the pipeline is 17 cfs (0.286 percent pipe slope), resulting in a deficit of 25 cfs.

Alternative pipe sizes are based on use of standard precast concrete pipe sizes, a Manning's Equation roughness coefficient (n) of 0.013, and full-pipe capacity. For both alternatives, a smaller pipe installed at a moderately steeper slope could also potentially provide adequate flow capacity. The elevation difference for a steeper sewer may be acceptable depending on the design HGL, elevations of any CEs along the route, and the details of the connections to the existing system. Relief sewers were evaluated to determine if they could be raised to reduce depth and meet CE requirements. Relief sewers maintained existing pipe elevations unless they could be raised 5 feet or more and have 2 feet of freeboard from the crown of the relief sewer to the CE since detailed modeling was not completed for each alternative.

Alternative 1 – Relief Sewer

Alternative 1 consists of constructing a 1,421-foot-long relief sewer along South Howell Avenue adjacent to the existing sewer alignment at approximately the same pipe slope to provide additional capacity equal to or greater than the 25 cfs deficiency. Due to the CE at MH 17604, the relief sewer would not be able to be raised to reduce depth. The relief sewer would extend from MH 17604 to DC0102. Modifications at DC0102 could be performed to route all flows from Howell Avenue to the 144-inch MIS flowing east along Layton Avenue to eliminate the unused connection to the existing 24-inch MIS flowing west along Layton Avenue. A 36-inch diameter pipe at 0.286 percent slope provides a full-pipe capacity of 35 cfs, which exceeds the required flow.

Because the relief sewer would be approximately 22 to 25 feet deep and to minimize disruption of South Howell Avenue, it is assumed that this alternative would be installed using tunneling construction methods. However, excavations would be required at the connections to the existing system and for manholes and any intermediate shafts. Three shaft structures are estimated for construction of this sewer.

The planning-level present worth cost for Alternative 1 (36-inch diameter pipe) is estimated to be $4.8 million, including construction, contingencies, engineering and administration, and operation and maintenance costs. A schematic of Alternative 1 is presented in Appendix 6A-2.

Alternative 2 – Replacement Sewer

Alternative 2 consists of constructing a 1,421-foot-long replacement sewer generally along the same alignment at the same pipe slope to provide capacity equal to or greater than the Buildout Conditions 5-year wastewater design flow of 42 cfs. The replacement sewer would extend from MH 17604 to DC0102. Modifications at DC0102 could be performed to route all flows from Howell Avenue to the 144-inch MIS flowing east along Layton Avenue to eliminate the unused connection to the existing 24-inch MIS flowing west along Layton Ave. A 42-inch diameter pipe at 0.286 percent slope provides a full-pipe capacity of 53 cfs, which exceeds the design flow.

Because the relief sewer would be approximately 22 to 25 feet deep and to minimize disruption of South Howell Avenue, it is assumed that this alternative would be installed using tunneling construction methods. However, excavations would be required at the connections to the existing system and for manholes and any intermediate shafts. Three shaft structures are estimated for construction of this sewer.

The planning-level present worth cost for Alternative 2 (42-inch diameter pipe) is estimated to be $5.1 million, including construction, contingencies, operation and management, and engineering and administrative costs. A schematic of Alternative 2 is presented in Appendix 6A-3.

Evaluation

Planning-level cost estimates have been developed for each alternative, which are presented in Table 6A-4. Details for cost estimates are presented in Appendix 6A-4. Analysis-specific performance factors are developed in Table 6A-5. These performance factors were used to rate the alternatives against each other and then a total weighted score was calculated for each alternative. For each alternative, the total weighted score was divided by the alternative's present worth to determine its value ratio (the value that the alternative provides per million spent), which is presented in Table 6A-6.

TABLE 6A-4: CS R1, SOUTH HOWELL AVE PIPE CAPACITY

PRESENT WORTH PLANNING-LEVEL COST COMPARISON

Planning-Level Costs	Alternative 1	Alternative 2
Capital Cost	$4,700,000	$5,080,000
Annual O&M	$2,000	$14,000
Present Value of Annual O&M Costs	$29,000	$26,000
Total Present Value	**$4,729,000**	**$5,094,000**

TABLE 6A-5: CS R1, SOUTH HOWELL AVE PIPE CAPACITY ANALYSIS-SPECIFIC PERFORMANCE FACTORS

Triple Bottom Line Measure	Level of Service Category	Performance Factor
Environmental	**Permit Requirements**	Measure of a given alternative's likelihood to meet permit requirements. *KPIs for permit requirements related to conveyance alternatives are: 0 SSOs and 6 CSOs (regulatory) and 0 CSOs (MMSD goal).*
	Energy	A measure of a given alternative's relative impact to baseline energy usage (with reduction in energy demand receiving highest score). *The difference between gravity conveyance alternatives is assumed to be negligible. I/I alternatives are assumed to have minimal impact.*
	Environmental Improvements	Measure of the advantages of a given alternative in terms of improvements to the environment. *Specific consideration could include impact on meeting specific KPIs and PIs such as the 85 percent regulatory requirement and the 100 percent goal of capture of flow into the MMSD system.*
Economic	**Fiscal Responsibility**	General measure of how well a given alternative reduces identified risk(s) in a cost-effective manner. *The most cost-effective alternative receives the highest score with a reduction of 1 point per 20 percent increase in cost.*
	Management Effectiveness	Measure of a given alternative's ability to help management achieve the permit and contract goals. Factors to consider include complexity to implement/operate new technologies or alternatives that simplify operations from baseline. *Conveyance projects will assume the highest score for new sewer pipe. Relief sewers will be rated by priority categories A=1, B=2, C=3, and D=4 scoring.*
Social	**Safety**	Measure of a given alternative's ability to minimize safety risks to employees, contractors, and the general public. *For conveyance, relief and replacement sewers, along with I/I assume design considerations would be accounted for to minimize safety risks.*
	Customer Service, Communication and Employee Development	Measure of the advantages of a given alternative to reduce potential complaints and notices of violation, improve communication effectiveness, and/or provide employee development opportunities. *For Conveyance, this is primarily wet weather capacity related to preventing/minimizing overflows and basement backups due to MIS capacity deficiencies.*

TABLE 6A-6: CS R1, ALTERNATIVES SCORING MATRIX

Alternative Scoring Matrix South Howell Avenue MIS Conveyance Capacity Project CS R1	Alternative 20-yr Present Worth ($ million)	Permit / Legal Requirements	Energy	Environmental Improvements (non-regulatory, resource recovery)	Fiscal Resp.	Management and Operational Effectiveness	Safety	Customer Service, Community Economic Development and Organizational Reputation	Total Weighted Score	Value Ratio (Total Weighted Score / Present Worth
Weights		26	17	15	17	6	13	6	100	
Alternative 1 - 1,421 LF, 36-inch diam. Relief Sewer	$4.73	5	5	5	5	4	5	5	494	104.5
Alternative 2 - 1,421 LF, 42-inch diam. Replacement Sewer	$5.09	5	5	5	4	5	5	5	483	94.8

Recommendations

According to the scoring matrix, Alternative 1 provides a higher value ratio, which indicates that it provides the most value per million dollars spent. Therefore, Alternative 1 is recommended. The recommended relief sewer route is shown in Appendix 6A-2.

The proposed alternative improvements should be evaluated further during preliminary design of a future project, including detailed hydraulic modeling of other sewers and facilities that affect this MIS.

Although the modeling identified a capacity risk for Conveyance Baseline Conditions, the design flows are based on future projections for population and land use. Accordingly, flow monitoring should be prioritized along this MIS to help determine when the modeled capacity deficiency approaches the actual performance of the MIS and to help determine if preliminary engineering of a project should be initiated. Additionally, an internal inspection of the MIS along South Howell Avenue should be performed to assess the structural condition of the pipeline during the preliminary engineering process.

The potential for implementing I/I reduction measures by the appropriate municipality should be evaluated to determine if tributary metersheds are in compliance with the requirements of MMD Rules, Chapter 3. Any I/I reduction would likely benefit the local municipality's sewers in addition to reducing the capacity needs of the affected MIS segment. Currently, there are no sewersheds identified tributary to the South Howell Avenue MIS segments that are non-compliant. However, MMSD is still in the process of collecting data for some metersheds with tributary sewersheds that could affect this MIS segment. As projects are evaluated for capacity needs, all tributary sewersheds should be brought into compliance to the extent practicable before additional capacity is added.

CS R2 – South 81-84 St Pipe Capacity

Purpose

The purpose of this analysis is to identify potential risk mitigation strategies for a pipeline capacity deficiency identified as part of the capacity assessment in Chapter 5 (refer to Chapter 5 for a discussion of the assessments done on the existing facilities). Modeled pipeline capacity deficiencies were identified for the 5-year wastewater recurrence interval event for Conveyance Baseline and Conveyance Future Conditions at various locations within the MIS system.

This alternatives analysis includes an evaluation of the 18-inch diameter MIS located within Subsystem 3, Leg K1 along South 84th Street, West Rogers Street and South 81st Street in the City of Milwaukee.

Approach

Refer to the previous Conveyance Pipeline Capacity Analysis Methodology subsection of Section 6.3 for details on the methodology used for this analysis.

A capacity deficiency for the 5-year wastewater recurrence interval event for Conveyance Baseline Conditions was identified in a 2,857-foot-long section of 18-inch diameter MIS that flows generally south beginning on South 84th Street near the intersection of West National Avenue and West Burnham Street.

At MMSD MH 08310 flow can either go south through the 18-inch diameter MIS or be diverted to the north by gravity to a 27-inch diameter MIS. The 18-inch diameter MIS runs south along South 84th Street to West Rogers Street where it turns and runs east to South 81st Street. The 18-inch diameter sewer then runs south along South 81st Street to West Grant Street at MMSD MH 08302. From MMSD MH 08302 flow either continues south through an 18-inch diameter MIS or is diverted east through a 24-inch MIS to MH 08313 then through a 36-inch diameter MIS connecting pipe to a 96-inch diameter MIS that flows east in West Grant Street at MH 50103. [2]

The 18-inch diameter MIS is generally located along the east side of South 84th Street in the parking lane, along the north side of West Rogers Street in the parking lane, and along the west side of South 81st Street under the terrace and/or sidewalk.

Flows tributary to the South 81st Street – 84th Street MIS are from a central portion of West Allis. The tributary area does not have excessive I/I according to the WWPFMP. The high flows in this MIS may be attributed to the simplified flow loading into this branch of the hydraulic model.

The 18-inch diameter MIS is a lined vitrified clay pipe (terra cotta) and was constructed in 1926 (93 years old). The depth to the pipe invert ranges from approximately 18 to 28 feet below the ground surface.

Modeling indicates the capacity of the 18-inch MIS is exceeded by approximately 14 cfs during the 5-year wastewater event under Conveyance Baseline Conditions, causing the HGL to exceed a CE by approximately 3.7 feet at MH 08307 at the intersection of West Rogers Street and South 81st Street. Additionally, the modeled HGL is within approximately two feet of the ground surface elevation at MH 08037. The modeled profiles with CEs for the Conveyance Baseline, Future, and Buildout Conditions are provided in Appendix 6A-5.

The downstream 96-inch diameter MIS in West Grant Street is surcharged during the 5-year wastewater recurrence interval event. However, the HGL is 84-feet below the next downstream CE in MH 50003 at West 69th Street. This indicates the capacity restriction in the 18-inch diameter MIS could be relieved without causing additional downstream problems.

There have been no hydrogen sulfide/odor issues reported or manhole access constraints identified along the subject MIS.

The land use along South 84th Street, West Rogers Street, and South 81st Street is largely single-family residential. South 84th Street borders a portion of Honey Creek Park for approximately one block.

Potential environmental constraints associated with construction along this route include possible impacted soil associated with historical land uses or activity, most likely along South 84th Street, temporary impacts to traffic, access to private driveways, and general temporary disruption in the area.

The South 81st Street to 84th Street MIS was identified as having a capacity deficiency as part of the previous 2020 Facilities Plan based on the modeling data, assumptions, and design criteria used for that study. [2] No projects have been completed or are under design in this reach of the MIS system since the publication of the 2020 Facilities Plan.

Alternatives Description

To mitigate the risk, two alternatives consisting of a relief sewer and a replacement sewer were identified. Descriptions of each alternative are presented below.

The pipe sizes for conceptual alternatives are based on flows estimated from 2050 population projections and land use with climate change conditions (Buildout Conditions) and the 5-year wastewater recurrence interval event. The existing pipe capacities are based on the average pipe slope for the subject MIS. The 5-year wastewater design flow under Buildout Conditions in the 2,857-foot-long 18-inch MIS is estimated to be approximately 25 cfs. The 18-inch full pipe capacity is approximately 5 cfs (0.195 percent slope), resulting in a 20 cfs deficiency.

Alternative pipe sizes are based on the use of standard precast concrete pipe sizes, a Manning's Equation roughness coefficient (n) of 0.013, and full-pipe capacity. For both alternatives, a smaller pipe installed at a moderately steeper slope could also provide adequate flow capacity. The minimal elevation difference for the steeper pipeline may be acceptable depending on the design HGL, elevations of any CEs along the route, and the details of the connections to the existing system. Relief sewers were evaluated to determine if they could be raised to reduce depth and meet CE requirements. Relief sewers maintained existing pipe elevations unless they could be raised five feet or more and have two feet of freeboard from the crown of the relief sewer to the CE since detailed modeling was not completed for each alternative.

Alternative 1 – Relief Sewer

Alternative 1 consists of constructing a 2,857-foot-long 30-inch diameter relief sewer along the existing alignment at approximately the same pipe slope and depth to provide additional capacity equal to or greater than the 20 cfs deficiency. Due to the CE at MH 8307, the relief sewer would not be able to be raised to reduce depth. The relief sewer would extend from MH 08310 to MH 08313. A 30-inch diameter pipe at 0.27 percent slope provides a full-pipe capacity of approximately 21 cfs, which exceeds the required relief flow. Modifications at MH 08313 would be required to accept the additional 30-inch relief sewer.

Because the maximum depth of the sewer would be approximately 28 feet and to minimize disruption of the residential neighborhood, it is assumed that this alternative would be installed using tunneling construction methods. However, excavations would be required at the connections to the existing system and for manholes and any intermediate shafts. Five shaft structures are estimated for construction of this sewer.

The planning-level present worth cost for Alternative 1 (30-inch diameter pipe) is estimated to be $8.2 million, including construction, contingencies, engineering and administrative costs, and operation and maintenance costs. A schematic of Alternative 1 is presented in Appendix 6A-6.

Alternative 2 – Replacement Sewer

Alternative 2 consists of constructing a 2,857-foot-long 36-inch diameter replacement sewer generally along the same alignment at the same pipe slope to provide capacity equal to or greater than the 5-year wastewater design flow under Buildout Conditions of 25 cfs. The replacement sewer would extend from MH 08310 to MH 08313. A 36-inch diameter pipe at 0.195 percent slope provides a full-pipe capacity of approximately 29 cfs, which exceeds the full flow required. Modifications at MH 08313 would be required to accept the additional 36-inch replacement sewer.

Because the maximum depth of the sewer would be approximately 28 feet and to minimize disruption of the residential neighborhood, it is assumed that this alternative would be installed using tunneling construction methods. However, excavations would be required at the connections to the existing system and for any intermediate shafts and/or manholes. Five shaft structures are estimated for construction of this sewer.

The planning-level present worth cost for Alternative 2 (36-inch diameter pipe) is estimated to be $9.0 million, including construction, contingencies, engineering and administrative costs, and operation and maintenance costs. A schematic of Alternative 2 is presented in Appendix 6A-7.

Evaluation

Planning-level cost estimates have been developed for each alternative, presented in Table 6A-7. Details for cost estimates are presented in Appendix 6A-8. Analysis-specific performance factors are developed in Table 6A-8. These performance factors were used to rate the alternatives against each other and then a total weighted score was calculated for each alternative. For each alternative, the total weighted score was divided by the alternative's present worth to determine its value ratio (the value that the alternative provides per million spent), which is presented in Table 6A-9.

TABLE 6A-7: CS R2, SOUTH 81-84 ST PIPE CAPACITY PRESENT WORTH PLANNING-LEVEL COST COMPARISON

Planning-Level Costs	Alternative 1	Alternative 2
Capital Cost	$8,090,000	$8,980,000
Annual O&M	$4,300	$2,100
Present Value of Annual O&M Costs	$60,000	$30,000
Total Present Value	**$8,150,000**	**$9,010,000**

TABLE 6A-8: CS R2, SOUTH 81-84 ST PIPE CAPACITY ANALYSIS-SPECIFIC PERFORMANCE FACTORS

Triple Bottom Line Measure	Level of Service Category	Performance Factor
Environmental	**Permit Requirements**	Measure of a given alternative's likelihood to meet permit requirements. *KPIs for permit requirements related to conveyance alternatives are: 0 SSOs and 6 CSOs (regulatory) and 0 CSOs (MMSD goal).*
	Energy	A measure of a given alternative's relative impact to baseline energy usage (with reduction in energy demand receiving highest score). *The difference between gravity conveyance alternatives is assumed to be negligible. I/I alternatives are assumed to have minimal impact.*
	Environmental Improvements	Measure of the advantages of a given alternative in terms of improvements to the environment. *Specific consideration could include impact on meeting specific KPIs and PIs such as the 85 percent regulatory requirement and the 100 percent goal of capture of flow into the MMSD system.*
Economic	**Fiscal Responsibility**	General measure of how well a given alternative reduces identified risk(s) in a cost-effective manner. *The most cost-effective alternative receives the highest score with reduction of 1 point per 20 percent increase in cost.*
	Management Effectiveness	Measure of a given alternative's ability to help management achieve the permit and contract goals. Factors to consider include complexity to implement/operate new technologies or alternatives that simplify operations from baseline. *Conveyance projects will assume the highest score for new sewer pipe. Relief sewers will be rated by priority categories A=1, B=2, C=3, and D=4 scoring.*
Social	**Safety**	Measure of a given alternative's ability to minimize safety risks to employees, contractors, and the general public. *For conveyance, relief and replacement sewers, along with I/I assume design considerations would be accounted for to minimize safety risks.*
	Customer Service, Communication and Employee Development	Measure of the advantages of a given alternative to reduce potential complaints and notices of violation, improve communication effectiveness, and/or provide employee development opportunities. *For Conveyance, this is primarily wet weather capacity related to preventing/minimizing overflows and basement backups due to MIS capacity deficiencies.*

TABLE 6A-9: CS R2, ALTERNATIVES SCORING MATRIX

Alternative Scoring Matrix South 84th St.- South 81st St. MIS Conveyance Capacity Project CS R2	Alternative 20-year Present Worth ($ million)	Permit / Legal Requirements	Energy	Environmental Improvements (non-regulatory, resource recovery)	Fiscal Resp.	Management and Operational Effectiveness	Safety	Customer Service, Community Economic Development and Organizational Reputation	Total Weighted Score	Value Ratio (Total Weighted Score / Present Worth
Weights		26	17	15	17	6	13	6	100	
Alternative 1 - 2,857 LF, 30-inch diameter Relief Sewer	$8.15	5	5	5	5	4	5	5	494	60.6
Alternative 2 - 2,857 LF, 36-inch diameter Replacement Sewer	$9.01	5	5	5	4	5	5	5	483	53.6

Recommendations

Detailed hydraulic modeling should be performed to verify this project prior to starting design. The hydraulic model input should be reviewed and adjusted if necessary. It may be more appropriate to introduce (i.e., load) approximately 60 percent of the tributary sewershed WE3013 at MH 08307. The remaining sewershed flow should be loaded to the upstream PD3304. Under this scenario, a portion of the flow will likely be diverted north through the 27-inch diameter South 84th Street MIS when the depth exceeds the bypass elevation. This could lower the flow in the subject 18-inch diameter MIS and potentially reduce the size of the relief or replacement sewer.

Although the modeling identified a capacity risk for Conveyance Baseline Conditions, the design flows are based on future projections for population and land use. Accordingly, flow monitoring should be prioritized along this MIS to help determine when the modeled capacity deficiency approaches the actual performance of the MIS and to help determine if preliminary engineering of a project should be initiated. Additionally, an internal inspection of the MIS along South 84th Street and South 81st Street should be performed to assess the structural condition of the pipeline during the preliminary engineering process.

The potential for implementing I/I reduction measures by the appropriate municipality should be evaluated to determine if tributary metersheds are in compliance with the requirements of MMD Rules, Chapter 3. Any I/I reduction would likely benefit the local municipality’s sewers in addition to reducing the capacity needs of the affected MIS segment. Currently, there are no sewersheds identified tributary to the South 81st Street – South 84th Street MIS segments that are non-compliant. However, MMSD is still in the process of collecting data for some metersheds with tributary sewersheds that could affect this MIS segment. As projects are evaluated for capacity needs, all tributary sewersheds should be brought into compliance to the extent practicable before additional capacity is added.

According to the scoring matrix, Alternative 1 provides a higher value ratio, which indicates that it provides the most value per million dollars spent. Therefore, Alternative 1 is recommended. The recommended relief sewer route is shown in Appendix 6A-6.

CS R3 – N Sherman Blvd Pipe Capacity

Purpose

The purpose of this analysis is to identify potential risk mitigation strategies for a pipeline capacity deficiency identified as part of the Conveyance and Storage System Risk Mitigation Alternatives assessment developed in Chapter 5 (refer to Chapter 5 for a discussion of the assessments done on the existing facilities). Modeled pipeline capacity deficiencies were identified for the 5-year wastewater recurrence interval event for Conveyance Baseline and Conveyance Future Conditions at various locations within the MIS system.

This alternatives analysis includes an evaluation of the 12-inch diameter MIS and 21-inch diameter MIS located within Subsystem 5, Leg C along North Sherman Boulevard in the City of Milwaukee.

Approach

Refer to the previous Conveyance Pipeline Capacity Analysis Methodology subsection of Section 6.3 for details on the methodology used for this analysis.

A capacity deficiency for the 5-year wastewater recurrence event for Conveyance Baseline Conditions was identified in a 1,381-foot-long section of 21-inch diameter MIS that flows north beginning at the intersection of West Glendale Avenue and North Sherman Boulevard. The 21-inch diameter MIS is connected to a 48-inch diameter MIS along the south side of West Hampton Avenue. Additionally, there is a parallel 1,414-foot-long 12-inch diameter MIS in North Sherman Boulevard that also begins at West Glendale Avenue. The 12-inch diameter MIS is connected to a 36-inch diameter MIS along the north side of West Hampton Avenue. A passive diversion (PD) 5508 at West Hampton Avenue and North Sherman Boulevard interconnects the 12-inch diameter MIS and the 24-inch diameter MIS with both the 36-inch diameter MIS and the 48-inch diameter MIS. The 12-inch diameter MIS was identified as having a capacity deficiency for the 5-year wastewater recurrence interval event for Conveyance Future Conditions.

The 12-inch diameter MIS and the 21-inch dimeter MIS are interconnected at West Glendale Avenue via a 15-inch diameter pipeline. Because one pipeline should be able to relieve the other depending on the distribution of flow and relative capacity, the design flows and capacity deficiencies for both the 12-inch diameter MIS and the 21-inch diameter MIS are combined for the purposes of this evaluation. Additionally, there is a relatively complicated system of interconnections between the two North Sherman Boulevard MIS pipelines and the two West Hampton Avenue MIS pipelines, including backflow gates in manholes on the 12-inch diameter MIS and the 21-inch diameter MIS near West Hampton Avenue.

The 21-inch diameter MIS is a vitrified clay (terra cotta) pipe installed in 1947 (72 years old) and the depth to the pipe invert ranges from 20 to 29 feet below the ground surface. The 12-inch diameter MIS is a lined vitrified clay pipe installed in 1925 (94 years old) and the depth to the pipe invert ranges from 20 to 27 feet below the ground surface. The construction methods are unknown. Flows tributary to North Sherman Boulevard are from a portion of north-central Milwaukee.

Modeling indicates the full pipe capacity of the 21-inch diameter MIS is exceeded by approximately 2 cfs during the 5-year wastewater recurrence event for Conveyance Baseline Conditions, causing the HGL to exceed a CE by approximately 5.2 feet at MH 12221. The capacity of the 12-inch diameter MIS is exceeded by approximately 1 cfs during the 5-year wastewater event for Conveyance Future Conditions, causing the HGL to exceed a CE by approximately 3.9 feet at MH 12228. Both manholes are at the upstream end of each MIS near the intersection of North Sherman Boulevard and West Glendale Avenue. The modeled profiles with CEs for the Conveyance Baseline, Future, and Buildout Conditions are provided in Appendix 6A-9.

There have been no hydrogen sulfide/odor issues reported, and there are no documented manhole access constraints identified along the subject MIS.

The land use along the MIS route is a mix of single-family residential and multi-family residential.

Potential environmental constraints associated with construction along this route include possible impacted soil associated with historical or current land uses or activity and potential temporary impacts to traffic and the residences within the neighborhood.

The North Sherman Boulevard MIS sewers were not identified as having a capacity deficiency as part of the previous 2020 Facilities Plan based on the modeling data, assumptions, and design criteria used for that study. No projects have been completed or are under design in this reach of the MIS system since the publication of the 2020 Facilities Plan.

Alternatives Description

To mitigate the risk, three alternatives consisting of a relief sewer, a replacement sewer, and I/I reduction efforts were identified. Descriptions of each alternative are presented below.

The pipe sizes for the conceptual alternatives are based on flows estimated from 2050 population projections and land use with climate change conditions (Buildout Conditions) and the 5-year wastewater recurrence interval event. The existing pipe capacities are based on the average pipe slope for the subject MIS. The 5-year wastewater design flow for Buildout Conditions in the 21-inch diameter MIS is estimated to be approximately 13 cfs. The full pipe capacity of the pipeline is approximately 10 cfs (0.377 percent pipe slope), resulting in a deficit of 3 cfs under Buildout Conditions. The 5-year wastewater design flow for Buildout Conditions in the 12-inch diameter MIS is approximately 3 cfs. The full pipe capacity of the pipeline is approximately 2 cfs (0.332 percent pipe slope), resulting in a deficiency of 1 cfs. The combined design flow is 16 cfs and the combined deficiency is 4 cfs.

Alternative pipe sizes are based on use of standard precast concrete pipe sizes, a Manning's Equation roughness coefficient (n) of 0.013, and full-pipe capacity. For Alternatives 1 and 2, a smaller pipe installed at a moderately steeper slope could also potentially provide adequate flow capacity. The elevation difference for a steeper sewer may be acceptable depending on the design HGL, elevations of any CEs along the route, and the details of the connections to the existing system. Relief sewers were evaluated to determine if they could be raised to reduce depth and meet CE requirements. Relief sewers maintained existing pipe elevations unless they could be raised 5 feet or more and have 2 feet of freeboard from the crown of the relief sewer to the CE since detailed modeling was not completed for each alternative.

Because the capacity deficiency is relatively small (4 cfs), the potential for removing I/I in lieu of constructing a relief or replacement MIS was considered. I/I reduction would benefit the local sewers in addition to the MIS system. For the sewershed tributary to these MIS segments (No. MI5024), the normalized I/I rate for the 5-year wastewater event under Buildout Conditions is 47,567 gallons per acre per day (gpad), which places it in the top 4 percent of I/I-prone sewersheds in the service area (i.e., an

I/I rate greater than 30,000 gpad). Based on Section 3.2 of MMSD Rules, the allowable peak flow rate for a sewershed of this size (223 acres) is 22,000 gpad. If sewershed MI5024 could be rehabilitated to reduce the peak flow rate by 38 percent, the capacity deficiency would be eliminated.

Alternative 1 – Relief Sewer

Alternative 1 consists of constructing a 1,381-foot-long 18-inch diameter relief sewer along North Sherman Boulevard generally adjacent to the existing sewer alignment at approximately the same pipe slope and depth to provide additional capacity equal to or greater than the combined 4 cfs deficiency for the 5-year wastewater event design flow under Buildout Conditions. Due to the CE at MH 12221, the relief sewer would not be able to be raised to reduce depth.

The relief sewer would extend from the upstream limit of the MIS at West Glendale Avenue to West Hampton Avenue. It is assumed that the relief sewer would discharge to the 48-inch MIS in West Hampton Avenue. The 48-inch diameter MIS has adequate capacity for the additional flow from the North Sherman Avenue MIS system and is located on the south side of West Hampton Avenue. This would simplify construction compared to connecting to the 36-inch diameter MIS located on the north side of West Hampton Avenue. An 18-inch diameter pipe at 0.332 percent slope provides a full-pipe capacity of approximately 6 cfs, which exceeds the flow required.

Because the relief sewer would be as much as 29 feet deep below the ground surface, it is assumed that this alternative would be installed using tunneling construction methods. However, excavations would be required at the connections to the existing system and for any intermediate access shafts and/or manholes. Three shaft structures are estimated for construction of this sewer.

The planning-level present worth cost for Alternative 1 (18-inch diameter pipe) is estimated to be $3.4 million, including construction, contingencies, engineering and administration, and operation and maintenance costs. A schematic of Alternative 1 is presented in Appendix 6A-10.

Alternative 2 – Replacement Sewer

Alternative 2 consists of constructing a 1,381-foot-long 27-inch diameter replacement sewer along North Sherman Boulevard generally adjacent to the existing sewer alignment at approximately the same pipe slope and depth to provide additional capacity equal to or greater than the combined 5-year wastewater event design flow of 16 cfs under Buildout Conditions. The limits of the replacement sewer would be the same as for the relief sewer. A 27-inch diameter pipe at 0.332 percent slope provides a full-pipe capacity of approximately 18 cfs, which exceeds the design flow.

Because the replacement sewer would be as much as 29 feet below the ground surface, it is assumed that this alternative would be installed using tunneling construction methods. However, excavations would be required at the connections to the existing system and for any intermediate access shafts and/or manholes. Three shaft structures are estimated for construction of this sewer.

The planning-level present-worth cost for Alternative 2 (27-inch diameter pipe) is estimated to be $4.0 million, including construction, contingencies, engineering and administration, and operation and maintenance costs. A schematic of Alternative 2 is presented in Appendix 6A-11.

Alternative 3 – I/I Removal

Alternative 3 does not include specific rehabilitation methods for specific areas of the sewershed. A variety of methods can be utilized to reduce I/I in municipal sanitary sewers and manholes, private sewer service laterals, and other private plumbing components (e.g., foundation drains). Additionally, improvements can be made to reduce exfiltration from storm sewers that can enter the sanitary sewer system.

If the 223 acre sewershed MI5024 could be rehabilitated to reduce the peak flow rate by 38 percent to approximately 30,000 gpad (i.e., an I/I rate equivalent to a Buildout Conditions 3-year flow), the capacity deficiency would be eliminated. While a 38 percent reduction represents a significant I/I reduction, it only represents I/I reduction down to a 5-year peak flow of 30,000 gpad. A reduction to 22,000 gpad for the 5-year peak flow would achieve compliance for this sewershed.

The planning-level costs for I/I reduction methods are based on the cost curve developed under MMSD Ad Hoc Request 211, Figure 1. [1] This method estimates the unit cost of I/I reduction expressed in dollars per gpd of 5-year peak hour I/I removed as a function of the pre-rehabilitation 5-year peak hour I/I in gpad. The costs were developed for a wide range of I/I removal techniques for numerous rehabilitation projects and I/I studies in the Milwaukee area. Costs used in the study were adjusted for an assumed year 2020 ENR Construction Cost Index of 15,000.

The peak hourly 5-year flow for MI5024 is approximately 16.4 cfs for Buildout Conditions. The target peak flow after I/I reduction is 10.2 cfs (6.2 cfs = 4.01 million gallons per day [MGD] reduction). Based on a pre-rehabilitation I/I flow of 47,600 gpad, the unit cost of I/I removal is $1.42/gpd.

The planning-level present worth cost for Alternative 3 (I/I reduction) is estimated to be $6.9 million, including construction, contingencies, engineering and administration, and operation and maintenance costs. The costs for this alternative would be shared between MMSD, the City of Milwaukee, and the residents. The City of Milwaukee would be responsible for rehabilitation of their own assets. For reduction of I/I from private property, a cost-share with residents could be initiated. For cost comparison to the relief and replacement alternatives, it is assumed that MMSD would be responsible for 50 percent of the cost for I/I reduction, resulting in a cost to MMSD of $3.4 million. A schematic of Alternative 3 is presented in Appendix 6A-12.

Evaluation

Planning-level cost estimates have been developed for each alternative, presented in Table 6A-10. Details for cost estimates are presented in Appendix 6A-13. Analysis-specific performance factors are developed in Table 6A-11. These performance factors were used to rate the alternatives against each other and then a total weighted score was calculated for each alternative. For each alternative, the total weighted score was divided by the alternative's present worth to determine its value ratio (the value that the alternative provides per million spent), which is presented in Table 6A-12.

TABLE 6A-10: CS R3, N SHERMAN BLVD PIPE CAPACITY PRESENT WORTH PLANNING-LEVEL COST COMPARISON

Planning-Level Costs	Alternative 1	Alternative 2	Alternative 3[1]
Capital Cost	$3,360,000	$4,010,000	$3,415,000
Annual O&M	$3,100	$1,000	$1,050
Present Value of Annual O&M Costs	$45,000	$14,000	$15,000
Total Present Value	**$3,405,000**	**$4,024,000**	**$3,430,000**

1) Total costs for Alternative 3 are $6.9 million. It is assumed that MMSD would be responsible for 50 percent of the cost for I/I reduction and the remaining cost would be shared between the City of Milwaukee and the residents.

TABLE 6A-11: CS R3, N SHERMAN BLVD PIPE CAPACITY ANALYSIS-SPECIFIC PERFORMANCE FACTORS

Triple Bottom Line Measure	Level of Service Category	Performance Factor
Environmental	**Permit Requirements**	Measure of a given alternative's likelihood to meet permit requirements. *KPIs for permit requirements related to conveyance alternatives are: 0 SSOs and 6 CSOs (regulatory) and 0 CSOs (MMSD goal).*
	Energy	A measure of a given alternative's relative impact to baseline energy usage (with reduction in energy demand receiving highest score). *The difference between gravity conveyance alternatives is assumed to be negligible. I/I alternatives are assumed to have minimal impact.*
	Environmental Improvements	Measure of the advantages of a given alternative in terms of improvements to the environment. *Specific consideration could include impact on meeting specific KPIs and PIs such as the 85 percent regulatory requirement and the 100 percent goal of capture of flow into the MMSD system.*
Economic	**Fiscal Responsibility**	General measure of how well a given alternative reduces identified risk(s) in a cost-effective manner. *The most cost-effective alternative receives the highest score with reduction of 1 point per 20 percent increase in cost.*
	Management Effectiveness	Measure of a given alternative's ability to help management achieve the permit and contract goals. Factors to consider include complexity to implement/operate new technologies or alternatives that simplify operations from baseline. *Conveyance projects will assume the highest score for new sewer pipe. Relief sewers will be rated by priority categories A=1, B=2, C=3, and D=4 scoring.*
Social	**Safety**	Measure of a given alternative's ability to minimize safety risks to employees, contractors, and the general public. *For conveyance, relief and replacement sewers, along with I/I assume design considerations would be accounted for to minimize safety risks.*
	Customer Service, Communication and Employee Development	Measure of the advantages of a given alternative to reduce potential complaints and notices of violation, improve communication effectiveness, and/or provide employee development opportunities. *For Conveyance, this is primarily wet weather capacity related to preventing/minimizing overflows and basement backups due to MIS capacity deficiencies.*

TABLE 6A-12: CS R3, ALTERNATIVES SCORING MATRIX

Alternative Scoring Matrix North Sherman Boulevard MIS Conveyance Capacity Project CS R3	Alternative 20-yr Present Worth ($ million)	Permit / Legal Requirements	Energy	Environmental Improvements (non-regulatory, resource recovery)	Fiscal Resp.	Management and Operational Effectiveness	Safety	Customer Service, Community Economic Development and Organizational Reputation	Total Weighted Score	Value Ratio (Total Weighted Score / Present Worth
Weights		26	17	15	17	6	13	6	100	
Alternative 1 – 1,421 LF, 36-inch diam. Relief Sewer	$3.41	5	5	5	5	4	4	5	481	141.3
Alternative 2 – 1,421 LF, 42-inch diam. Replacement Sewer	$4.02	5	5	5	4	4	4	5	464	115.3
Alternative 3 – 6.2 cfs I/I Removal	$3.43	5	5	5	5	5	5	5	500	145.8

Recommendations

According to the scoring matrix, Alternative 3 provides a higher value ratio, which indicates that it provides the most value per million dollars spent. Therefore, Alternative 3 is recommended. The recommended alternative is shown in Appendix 6A-12.

Based on a review of model input, the flow loading locations for the two MIS pipelines in North Sherman Boulevard should be confirmed and the model revised accordingly. The entire sewershed (MI5024) is loaded into the 12-inch diameter MIS in MH 12228. The actual tributary area for this location and MIS is approximately 40 percent of the sewershed. The remainder of the flow should be loaded at MH 12228. However, this refinement may not eliminate the modeled capacity deficiency. The proposed improvements should be evaluated further during preliminary design of a future project, including detailed hydraulic modeling of other sewers and facilities that affect this MIS.

While the modeling identified a capacity risk for Conveyance Baseline Conditions, the design flows are based on future projections for population and land use. Accordingly, flow monitoring should be prioritized along this MIS to help determine when the modeled capacity deficiency approaches the actual performance of the MIS and to help determine if preliminary engineering of a project should be initiated. Additionally, an internal inspection of the MIS pipelines along North Sherman Boulevard should be performed to assess the structural condition of the two systems during the preliminary engineering process.

CS R4 – Hampton Ave Pipe Capacity

Purpose

The purpose of this analysis is to identify potential risk mitigation strategies for a pipeline capacity deficiency identified as part of the capacity assessment in Chapter 5 (refer to Chapter 5 for a discussion of the assessments done on the existing facilities). Modeled pipeline capacity deficiencies were identified for the 5-year wastewater recurrence interval event for Conveyance Baseline and Conveyance Future conditions at various locations within the MIS system.

This alternatives analysis includes an evaluation of a 60-inch diameter MIS in West Hampton Avenue located within Subsystem 5, Leg C in the City of Milwaukee.

Approach

Refer to the previous Conveyance Pipeline Capacity Analysis Methodology subsection of Section 6.3 for details on the methodology used for this analysis.

A capacity deficiency for the 5-year wastewater recurrence interval event for Conveyance Baseline Conditions was identified for a section of the 60-inch diameter MIS that runs east along West Hampton Avenue. The 4,903-foot-long deficient section extends from North 32nd Street to North Green Bay Road.

The 60-inch diameter MIS is a monolithic concrete pipeline constructed in 1923 (96-years old). The depth to the pipe invert for the 60-inch diameter MIS ranges from 12 to 32 feet below the ground surface, and it was installed using both open-cut and tunnel construction methods. According to the MMSD database, the pipeline was rehabilitated in 2002. The rehabilitation method is unknown.

MMSD has reported that there have been chronic basement backups in the sewersheds tributary to this MIS. A contributing factor may be the result of excessive I/I from the tributary area to this MIS. Additionally, five CEs are close to or just below the elevation of the crown of the West Hampton Avenue MIS, indicating that the MIS capacity is limited to full-pipe capacity and any surcharging would impact the local sewer system. Three of the five CEs in the deficient section are adjacent to each other between North Green Bay Road and North 20th Street (MHs 12001, 11907, 11906), MH 12004 is located at North 25th Street, and MH 12104 is located at North 32nd Street. Modeling indicates the full-pipe capacity of the 60-inch diameter MIS is exceeded by approximately 17 cfs during the 5-year wastewater event under Conveyance Baseline Conditions, causing water levels to exceed the five CEs noted. In the worst-case occurrence, the HGL exceeds a CE by approximately 1.3 feet at MH 12104.

The CE in MH 12001 located approximately 1,572 feet west of North Green Bay Road is 0.05 feet below the crown of the 60-inch diameter MIS. The CEs in MH 11906 and MH 11907 are at the crown of the MIS. While the CEs in MH 12004 and MH 12104 are 0.72 feet and 0.06 feet, respectfully, above the crown of the MIS, the HGL for the Buildout Conditions 5-year wastewater design flow exceeds the CEs. The modeled profiles with CEs for the Conveyance Baseline, Future, and Buildout Conditions are provided in Appendix 6A-14.

In addition to the relative elevation of the CEs, the MIS is shallow in this area. The depth of cover over the pipe is approximately 7 to 9 feet in some places along the 1,572-foot-long section of the MIS that includes the three adjacent manholes and CEs noted above. This limits the depth for the connections of the incoming local sewers and results in basement floor elevations that are likely close to the elevation of the pipeline and the HGL when the MIS is full or surcharged during wet weather events. Considering the sensitivity of these CEs, the elevations as represented in the hydraulic model should be confirmed with record drawings or data from the local municipalities.

The land use along West Hampton Avenue in this area is a mix of single-family residential, multi-family residential, and retail/commercial properties. There are several churches, one major intersection with North Teutonia Avenue, and one railroad crossing. West Hampton Avenue was reconstructed within the last five years based on aerial photography. The land use on the west side of North Green Bay Road south of West Hampton Avenue is predominantly single-family residential. Lincoln Park is on the east side of North Green Bay Road.

There have been no hydrogen sulfide/odor issues reported, and there are no documented access constraints along the subject MIS sections.

Potential environmental constraints associated with construction along this route include possible impacted soil associated with historical or current land uses or activity and potential temporary impacts to traffic and access to Lincoln Park during construction.

The West Hampton Road MIS was not identified as having a capacity deficiency as part of the previous 2020 Facilities Plan based on the modeling data, assumptions, and design criteria used for that study. No projects have been completed or are under design in this reach of the MIS system since the publication of the 2020 Facilities Plan.

Alternatives Description

To mitigate the risk, three alternatives consisting of a relief sewer, a replacement sewer, and I/I reduction efforts were identified. Descriptions of each alternative are presented below.

The pipe sizes for the conceptual alternatives are based on flows estimated from 2050 population projections and land use with climate change conditions (Buildout Conditions) and the 5-year wastewater recurrence interval event. The existing pipe capacities are based on the average pipe slope for the subject MIS. The 5-year wastewater design flow for Buildout Conditions in the 60-inch diameter MIS along West Hampton Avenue is estimated to be approximately 56 cfs. The full-pipe capacity of the MIS is approximately 39 cfs (0.022 percent pipe slope), resulting in a deficit of 17 cfs. The full-pipe capacity of the 66-inch diameter MIS in North Green Bay Road is approximately 60 cfs (0.032 percent pipe slope), which exceeds the design flow.

Alternative pipe sizes are based on use of standard precast concrete pipe sizes, a Manning's Equation roughness coefficient (n) of 0.013, and full-pipe capacity. For the relief sewer and replacement sewer alternatives, a smaller pipe installed at a moderately steeper slope could also potentially provide adequate flow capacity. The elevation difference for a steeper sewer may be acceptable depending on the design HGL, elevations of any CEs along the route, and the details of the connections to the existing system. Relief sewers were evaluated to determine if they could be raised to reduce depth and meet CE requirements. Relief sewers maintained existing pipe elevations unless they could be raised 5 feet or more and have 2 feet of freeboard from the crown of the relief sewer to the CE since detailed modeling was not completed for each alternative.

Due to the prevalence of reported basement backups and several relatively high I/I sewersheds tributary to this MIS, the potential for removing I/I in lieu of constructing a relief or replacement MIS was also considered. I/I reduction could benefit the local sewers in addition to the MIS system.

Alternative 1 – Relief Sewer

Alternative 1 consists of constructing a 3,439-foot-long 36-inch diameter relief sewer generally adjacent to the existing sewer along West Hampton Avenue from MH 80027 at North Green Bay Road to MH 12004 at North 25th Street. The relief sewer would be sized to convey a portion of the design flow in the existing 60-inch diameter MIS and lower the HGL below the CEs noted above. Due to the CEs at MH 12001 and MH 11907, the relief sewer would not be able to be raised to reduce depth. A 36-inch diameter pipe at 0.050 percent slope has a capacity of approximately 15 cfs, which would reduce the flow in the existing 60-inch diameter MIS to approximately 41 cfs. The slope is based on setting the downstream crown of the relief sewer at the HGL in the 66-inch diameter MIS at the transition from 60-inch diameter to 66-inch diameter pipes at MH 80027 and matching the crown of the 60-inch diameter MIS at MH 12004. At this flow rate, the normal depth of flow in the 60-inch diameter MIS is approximately 4.7 feet. This would lower the HGL below the CEs at the noted manholes. Three shaft structures and three open cut structures are estimated for construction of this sewer.

Because the relief sewer would be up to 32 feet below the ground surface, it is assumed that part of the alternative would be installed using tunneling construction methods and the shallower sections around 15 feet deep would be open cut. However, excavations would also be required at the connections to the existing system and for any intermediate access shafts and manholes. Three shafts are estimated for construction of the tunnel sewer and three manholes for the open cut section.

The planning-level present-worth cost for Alternative 1 (36-inch diameter pipe) is estimated to be $10.1 million, including construction, contingencies, engineering and administration, and operation and maintenance costs. A schematic of Alternative 1 is presented in Appendix 6A-15.

Alternative 2 – Replacement Sewer

Alternative 2 consists of constructing a 3,439-foot-long 66-inch dimeter replacement sewer generally adjacent to the existing sewer along West Hampton Avenue from MH 80027 at North Green Bay Road to MH 12004 at North 25th Street. The new sewer would match existing invert elevations at the noted manholes. The replacement sewer would be sized to convey the design flow and lower the HGL below the CEs noted above. A 66-inch diameter pipe at 0.036 percent slope has a capacity of approximately 64 cfs, which exceeds the estimated design flow. At the design flow, the normal depth in the 66-inch diameter replacement sewer is approximately 4.4 feet. This would lower the HGL below the CEs at the noted manholes.

Because the replacement sewer would be up to 32 feet below the ground surface, it is assumed that part of the alternative would be installed using tunneling construction methods and the shallower sections around 15 feet deep would be open cut. However, excavations would also be required at the connections to the existing system and for any intermediate access shafts and manholes. Three shaft structures, and three open cut structures are estimated for construction of this sewer.

The planning-level present-worth cost for Alternative 2 (66-inch diameter pipe) is estimated to be $15.8 million, including construction, contingencies, engineering and administration, and operation and maintenance costs. A schematic of Alternative 2 is presented in Appendix 6A-16.

Alternative 3 – I/I Reduction

Alternative 3 does not include specific rehabilitation methods for specific areas of the sewershed. A variety of methods can be utilized to reduce I/I in municipal sanitary sewers and manholes, private sewer service laterals, and other private plumbing components (e.g., foundation drains). Additionally, improvements can be made to reduce exfiltration from storm sewers that can enter the sanitary sewer system.

This alternative evaluates the rehabilitation of the two sewersheds with the highest I/I of the four sewersheds directly tributary to the West Hampton Road MIS (No. MI5054 and No. MI5025) and the sewershed tributary to the West Hampton Road MIS at North Sherman Boulevard (No. MI5024).

- Sewershed MI5054 (321 acres) has a normalized I/I rate for the 5-year wastewater event under Buildout Conditions of approximately 27,200 gpad.
- Sewershed MI5025 (276 acres) has a normalized I/I rate for the 5-year wastewater event under Buildout Conditions of approximately 17,840 gpad.
- Sewershed No MI5024 (223 acres) is tributary to the West Hampton Road MIS at North Sherman Boulevard. The normalized I/I rate for the 5-year wastewater event under Buildout Conditions is 47,567 gpad, which places it in the top 4 percent of I/I-prone sewersheds in the service area (i.e., an I/I rate greater than 30,000 gpad).

The three sewersheds together make up 820 acres of the 3,100 acres that send sanitary sewer flow to the 60-inch diameter MIS in West Hampton Avenue. The allowable flow rate for an 820-acre area, based on Chapter 3, Section 2 of MMSD Rules, is 19,000 gpad. If the three sewersheds could be rehabilitated to reduce the peak I/I flow rate to the allowable rate, the peak inflow rate would be reduced by 13 cfs. This leaves a capacity deficiency of approximately 4 cfs in the 60-inch diameter MIS in West Hampton Avenue. To address the remaining deficiency, modifications to the operations of the existing diversion chambers could be made.

The planning-level costs for I/I reduction is based on the cost curve developed under MMSD Ad Hoc Request 211, Figure 1. [1] This method estimates the unit cost of I/I reduction expressed in dollars per gpd of 5-year peak hour I/I removed as a function of the pre-rehabilitation 5-year peak hour I/I in gpad. The costs were developed for a wide range of I/I removal techniques for numerous rehabilitation projects and I/I studies in the Milwaukee area. Costs were adjusted for an assumed year 2020 ENR Construction Cost Index of 15,000.

The peak 5-year sewershed flow for MI5054 is approximately 13.5 cfs. The target peak flow after I/I reduction is 10.4 cfs. This flowrate is based on the allowable peak flow rate per Chapter 3, MMSD Rules for sewersheds from 250 to 499 acres (21,000 gpad x 321 acres). This corresponds to an I/I reduction of 3.1 cfs (2.0 MGD). Based on a pre-rehabilitation I/I flow of 27,200 gpad, the unit cost of removal is $2.10/gpd.

The peak 5-year sewershed flow for MI5025 is 7.6 cfs. The target peak flow after I/I reduction is 6.4 cfs (1.2 cfs = 0.78 MGD reduction). Based on a pre-rehabilitation I/I flow of 17,838 gpad, the unit cost of removal is $2.82/gpd. This sewershed is compliant with Chapter 3, MMSD Rules. However, reduction of the I/I present in the sewershed should be considered to the extent noted.

The peak 5-year sewershed flow for MI5024 is approximately 16.4 cfs. The target peak flow after I/I reduction is 7.6 cfs. This flowrate is based on the allowable peak flow rate per Chapter 3, MMSD Rules for sewersheds less than 250 acres (22,000 gpad x 223 acres). This corresponds to an I/I reduction of 8.8 cfs (5.7 MGD). Based on a pre-rehabilitation I/I flow of 47,600 gpad, the unit cost of I/I removal is $1.42/gpd.

Modifications to Diversion Chambers

Because the estimated 13 cfs of I/I removal alone does not eliminate the entire capacity deficiency of 17 cfs in the 60-inch diameter MIS along Hampton Avenue, modifications to the operation of the existing DCs that affect this MIS could be made to bring the HGL down in the 60-inch MIS. It may be possible to reduce the flow in the West Hampton Avenue MIS by modifying the control strategy in DC0504 and DC0503. DC0504 is located upstream from the deficient section of 60-inch diameter MIS at North 31st Street and West Hampton Avenue adjacent to Lincoln Creek. DC0503 is located downstream from the deficient section on a 72-inch diameter MIS at West River Woods Parkway (extended) adjacent to the Milwaukee River. Note that the conceptual alternatives do not assume changes in flow as a result of possible changes to DC0503 or DC0504.

Any changes to the operation of DC0503 or DC0504 could impact performance of the associated near surface collector system (NSC) and increase flow diverted to the inline storage system (ISS). Any potential changes to the diversion chambers must be evaluated in greater detail during preliminary design of a future project.

The planning-level present-worth cost for Alternative 3 (I/I Reduction) is estimated to be $17.4 million, including construction, contingencies, engineering and administration, and operation and maintenance costs. The costs for this alternative would be shared between MMSD, the City of Milwaukee, and the residents. The City of Milwaukee would be responsible for rehabilitation of their own assets. For reduction of I/I from private property, a cost-share with residents could be initiated.

For the cost comparison to the relief and replacement alternatives, it is assumed that MMSD would be responsible for 50 percent of the cost for I/I reduction, resulting in a cost to MMSD of $8.7 million. Furthermore, if Alternative 3 for Project CS R3 North Sherman Boulevard Pipe Capacity is implemented, then the cost of this project is reduced by $6.8 million for the total project cost, and $3.4 million reduced for the MMSD share of the project cost. A schematic of Alternative 3 is presented in Appendix 6A-17.

Evaluation

Planning-level cost estimates have been developed for each alternative, which are presented in Table 6A-13. Details for cost estimates are presented in Appendix 6A-18. Analysis-specific performance factors are developed in Table 6A-14. These performance factors are used to score the alternatives against each other, presented in Table 6A-15.

TABLE 6A-13: CS R4, HAMPTON AVE PIPE CAPACITY PRESENT WORTH PLANNING-LEVEL COST COMPARISON

Planning-Level Costs	Alternative 1	Alternative 2	Alternative 3 [1, 2, 3]
Capital Cost	$9,960,000	$15,780,000	$8,695,000
Annual O&M	$5,200	$2,600	$1,300
Present Value of Annual O&M Costs	$75,000	$37,000	$19,000
Total Present Value	**$10,035,000**	**$15,817,000**	**$8,714,000**

1) Total costs for Alternative 3 are $17.4 million. It is assumed that MMSD would be responsible for 50 percent of the cost for I/I reduction and the remaining cost would be shared between the City of Milwaukee and the residents.

2) If Alternative 3 for Project CS R3 N Sherman Boulevard Pipe Capacity is implemented, the total cost for this project would be reduced to $10.6 million, and MMSD's portion of the project cost would be reduced to $5.3 million.

3) I/I reduction alone under Alternative 3 does not eliminate all of the capacity deficiency. Four cfs will still need to be eliminated, which could be addressed through modifications to the operation of diversion chambers. The cost of these modifications (if any) will need to be determined during preliminary engineering.

TABLE 6A-14: CS R4, HAMPTON AVE PIPE CAPACITY ANALYSIS SPECIFIC PERFORMANCE FACTORS

Triple Bottom Line Measure	Level of Service Category	Performance Factor
Environmental	**Permit Requirements**	Measure of a given alternative's likelihood to meet permit requirements. *KPIs for permit requirements related to conveyance alternatives are: 0 SSOs and 6 CSOs (regulatory) and 0 CSOs (MMSD goal).*
	Energy	A measure of a given alternative's relative impact to baseline energy usage (with reduction in energy demand receiving highest score). *The difference between gravity conveyance alternatives is assumed to be negligible. I/I alternatives are assumed to have minimal impact.*
	Environmental Improvements	Measure of the advantages of a given alternative in terms of improvements to the environment. *Specific consideration could include impact on meeting specific KPIs and PIs such as the 85 percent regulatory requirement and the 100 percent goal of capture of flow into the MMSD system.*
Economic	**Fiscal Responsibility**	General measure of how well a given alternative reduces identified risk(s) in a cost-effective manner. *The most cost-effective alternative receives the highest score with a reduction of 1 point per 20 percent increase in cost.*
	Management Effectiveness	Measure of a given alternative's ability to help management achieve the permit and contract goals. Factors to consider include complexity to implement/operate new technologies or alternatives that simplify operations from baseline. *Conveyance projects will assume the highest score for new sewer pipe. Relief sewers will be rated by priority categories A=1, B=2, C=3, and D=4 scoring.*
Social	**Safety**	Measure of a given alternative's ability to minimize safety risks to employees, contractors, and the general public. *For conveyance, relief and replacement sewers, along with I/I assume design considerations would be accounted for to minimize safety risks.*
	Customer Service, Communication and Employee Development	Measure of the advantages of a given alternative to reduce potential complaints and notices of violation, improve communication effectiveness, and/or provide employee development opportunities. *For Conveyance, this is primarily wet weather capacity related to preventing/minimizing overflows and basement backups due to MIS capacity deficiencies.*

TABLE 6A-15: CS R4, ALTERNATIVES SCORING MATRIX

Alternative Scoring Matrix West Hampton Road MIS Conveyance Capacity Project CS R4	Alternative 20-yr Present Worth ($ million)	Permit / Legal Requirements	Energy	Environmental Improvements (non-regulatory, resource recovery)	Fiscal Resp.	Management and Operational Effectiveness	Safety	Customer Service, Community Economic Development and Organizational Reputation	Total Weighted Score	Value Ratio (Total Weighted Score / Present Worth
Weights		26	17	15	17	6	13	6	100	
Alternative 1 – 3,439 LF, 36-inch diam. Relief Sewer	$10.04	5	5	5	5	4	4	4	475	47.3
Alternative 2 – 3,439 LF, 66-inch diam. Replacement Sewer	$15.82	5	5	5	2	4	4	4	424	26.8
Alternative 3 – I/I Reduction	$8.71	5	5	5	5	5	5	5	500	57.4

Recommendations

According to the scoring matrix, Alternative 3 provides a higher value ratio, which indicates that it provides the most value per million dollars spent. Therefore, Alternative 3 is recommended. The recommended alternative is shown in Appendix 6A-17. Alternative 3 includes the concept of modifying the operation of DC0503 and DC0504 to eliminate the remaining 4 cfs capacity deficiency in the MIS that would still exist after I/I reduction efforts are implemented. It is assumed that these changes are operational in nature and would not include significant capital costs, if any. Furthermore, if Alternative 3 for Project CS R3 North Sherman Boulevard Pipe Capacity is implemented, then the cost of this project is reduced by $6.8 million for the total project cost and reduced by $3.4 million for the MMSD share of the project cost increasing the calculated value ratio accordingly.

The proposed improvements should be evaluated further during preliminary design of a future project, including detailed hydraulic modeling of other sewers and facilities that affect this MIS. Also, because diversion control modifications at DC0503 and DC0504 could impact operation of the NSC system and increase the amount of flow diverted to the ISS, any potential modifications to the diversion chambers should be evaluated.

Although the modeling identified a risk for Conveyance Baseline Conditions, the design flows are based on future projections for population and land use. Accordingly, flow monitoring should be prioritized along this MIS to help determine when the modeled capacity deficiency approaches the actual performance of the MIS and to help determine if preliminary engineering of a project should be initiated. Additionally, an internal inspection of the MIS along West Hampton Avenue should be performed to assess the structural condition of the pipeline during the preliminary engineering process.

Hydraulic model input should be reviewed and corrected if necessary. The model reportedly reflects a 60-inch diameter pipeline in the first three pipe sections of the MIS in North Green Bay Road south of West Hampton Avenue, whereas the actual pipe size is 66-inch diameter. However, it is not anticipated that this correction alone would eliminate the capacity deficiency. Additionally, the CE values noted above should be confirmed.

CS R5 – N Commerce St Pipe Capacity

Purpose

The purpose of this analysis is to identify potential risk mitigation strategies for a pipeline capacity deficiency identified as part of the capacity assessment in Chapter 5 (refer to Chapter 5 for a discussion of the assessments done on the existing facilities). Modeled pipeline capacity deficiencies were identified for the 5-year wastewater recurrence interval event for Conveyance Baseline and Conveyance Future Conditions at various locations within the MIS system.

This alternatives analysis includes an evaluation of the 30-inch and 36-inch diameter MIS located within Subsystem 7, Leg SB along North Commerce Street in the City of Milwaukee.

Approach

Refer to the previous Conveyance Pipeline Capacity Analysis Methodology subsection of Section 6.3 for details on the methodology used for this analysis.

A capacity deficiency for the 5-year wastewater recurrence event for Conveyance Baseline Conditions was identified in a 3,051-foot-long section of MIS that flows generally southwesterly along North Commerce Street from North Weil Street to just northeast of East Pleasant Street. Based strictly on model results, the deficient sections consist of several intermittent 30-inch and 36-inch diameter MIS pipelines totaling 1,544 feet within the overall length noted. The smaller 30-inch diameter MIS is downstream from the 36-inch diameter MIS. For the purposes of this alternative evaluation, the entire 3,051-foot-long section is considered part of the potential project limits.

The Commerce Street MIS begins approximately 900 feet east of North Humboldt Avenue at the end of North Riverboat Road. Flows tributary to the North Commerce Street MIS are from combined sewers in the eastern part of Milwaukee.

Both the 30-inch diameter MIS and the 36-inch diameter MIS are monolithic concrete pipelines. The 30-inch diameter MIS was constructed by tunneling methods in 1918 (101 years old) and the pipe invert is approximately 17 to 23 feet below the ground surface. The 36-inch diameter MIS was constructed in 1924 (95 years old) and is approximately 14 to 16 feet below the ground surface. The construction method is unknown.

Modeling indicates the full-pipe capacity of several sections of the 30-inch MIS and the 36-inch MIS are exceeded by approximately 2 cfs during the 5-year wastewater event under Conveyance Baseline Conditions, causing the pipeline to surcharge. There are eight combined sewer (CS) connections along the 30-inch and 36-inch MIS and five additional CS connections in a 42-inch diameter MIS immediately downstream from the subject MIS section that discharge into this system. For the Baseline flow, the HGL exceeds four CEs[1] along the 30-inch diameter MIS and 36-inch diameter MIS (MHs 00707, 00708, 00802, and 00901). The CEs for the first three manholes noted are at elevation 4.0 as footnoted. However, the CE in MH 00901 is at elevation 5.37. The CE in MH 00901 is exceeded by approximately 0.6 feet.

[1] *The CEs at manholes within the Lake Michigan estuary area are typically defined as 4 feet, unless otherwise noted. The estuary area includes portions of three tributaries to Lake Michigan, which are the lower 3.1 miles of the Milwaukee River downstream of the former North Avenue Dam, the lower 3.0 miles of the Menomonee River downstream of 35th Street, and the lower 2.5 miles of the Kinnickinnic River downstream of Chase Avenue. The estuary area also includes the inner and outer harbors as well as the nearshore of Lake Michigan.*

Additionally, the HGL in the downstream 72-inch diameter NSC significantly affects the HGL in the North Commerce Street MIS during wet-weather events. Furthermore, when the gates to the ISS are closed, the HGL in the NSC is influenced by the water level of the Milwaukee River. The modeled profiles with CEs for the Conveyance Baseline, Future, and Buildout Conditions are provided in Appendix 6A-19.

There have been no hydrogen sulfide/odor issues reported or manhole access constraints identified along the subject MIS.

The land use along the MIS route is a mix of multi-family residential and commercial. The area along North Commerce Street has undergone significant redevelopment, changing from a heavily industrialized area to a modern urban neighborhood. Potential environmental constraints associated with construction along this route include possible impacted soil associated with historical land uses or activity and potential temporary impacts to traffic and the residences in the neighborhood.

The North Commerce Street MIS sewers were not identified as having a capacity deficiency as part of the previous 2020 Facilities Plan based on the modeling data, assumptions, and design criteria used for that study. No projects have been completed or are under design in this reach of the MIS system since the publication of the 2020 Facilities Plan.

Alternatives Description

To mitigate the risk, two alternatives consisting of a relief sewer and a replacement sewer were identified. Descriptions of each alternative are presented below.

The pipe sizes for the conceptual alternatives are based on flows estimated from 2050 population projections and land use with climate change conditions (Buildout Conditions) and the 5-year wastewater recurrence interval event. The existing pipe capacity is based on the average pipe slope for the subject MIS. The 5-year wastewater design flow for Buildout Conditions in the 30-inch and 36-inch MIS is estimated to be approximately 18 cfs. The full pipe capacity of the 30-inch diameter MIS is approximately 16 cfs (0.151 percent pipe slope), resulting in a deficit of 2 cfs. Conveyance Future and Buildout Conditions modeling profiles with CEs are provided in Appendix 6A-19.

For the design flow, the HGL exceeds four CEs along the 30-inch diameter MIS and 36-inch diameter MIS (MHs 00707, 00708, 00802, and 00901). These CEs are at elevation 4.0 as footnoted previously. However, the CE in MH 00901 is at elevation 5.37. Because the HGL in the North Commerce Street MIS is affected by downstream sewers, capacity improvements alone are not enough to mitigate the risk. The relief sewer alternative assumes physical or operational modifications would be required to downstream facilities (e.g., intercepting structure [IS] 209 and/or 72-inch diameter NSC) to lower the HGL to an acceptable level. Because any such modifications could affect performance of downstream sewers and/or operation of the ISS, an evaluation of any potential changes must be performed during preliminary design of a future project.

Alternative pipe sizes are based on use of standard precast concrete pipe sizes, a Manning's Equation roughness coefficient (n) of 0.013, and full-pipe capacity. For both alternatives, a smaller pipe installed at a moderately steeper slope could also potentially provide adequate flow capacity. The elevation difference for a steeper sewer may be acceptable depending on the design HGL, elevations of any CEs along the route, and the details of the connections to the existing system. Relief sewers were evaluated to determine if they could be raised to reduce depth and meet CE requirements. Relief sewers maintained existing pipe elevations unless they could be raised 5 feet or more and have 2 feet of freeboard from the crown of the relief sewer to the CE since detailed modeling was not completed for each alternative.

Alternative 1 – Relief Sewer

Alternative 1 consists of constructing a 3,451-foot-long 15-inch diameter relief sewer along the approximate route of the North Commerce Street MIS and modification to downstream facilities. The relief sewer would be constructed generally along the existing sewer alignment at approximately the same pipe slope and depth to provide additional capacity equal to or greater than the 2 cfs deficiency for the 5-year wastewater flow under Conveyance Buildout Conditions. Due to the CE at MH 00802, the relief sewer would not be able to be raised to reduce depth. The relief sewer would extend from MH 00702 at the intersection of North Commerce Street and just north of East Pleasant Street to MH 00901 at the intersection of North Commerce Street and North Humboldt Avenue. A 15-inch diameter pipe at 0.151 percent slope provides a full-pipe capacity of 2.5 cfs, which exceeds the flow required.

Because the relief sewer would be up to 23 feet below the ground surface, it is assumed that this alternative would be installed using tunneling construction methods. However, excavations would be required at the connections to the existing system and for any intermediate access shafts and/or manholes. Five shaft structures are estimated for construction of this sewer.

The planning-level present-worth cost for Alternative 1 (15-inch diameter pipe) is estimated to be $6.5 million, including construction, contingencies, engineering and administration, and operation and maintenance costs. A schematic of Alternative 1 is presented in Appendix 6A-20.

Alternative 2 – Replacement Sewer

Alternative 2 consists of constructing a 3,451-foot-long 36-inch diameter replacement sewer generally along the same alignment of the existing 30-inch diameter MIS and 36-inch diameter MIS in North Commerce Street between the same limits as Alternative 1. The replacement sewer would be constructed at the approximate slope of the HGL of the 36-inch diameter MIS downstream of MH 00702 for the design flow. The resulting HGL for the design flow in the replacement section would be lower than the CEs in the four manholes noted above.

Alternative 2 does not assume any physical or operational modifications to downstream facilities. The replacement sewer would match invert elevations at MH 00702 and extend to MH 00901 at slope to provide capacity equal to or greater than the 2050, 5-year wastewater flow of 18 cfs. A 36-inch diameter pipe at 0.073 percent slope provides a full-pipe capacity of 18 cfs which equals the design flow. The replacement sewer would eliminate the section of 30-inch diameter MIS, and the pipe invert would be approximately 2 feet lower than the existing invert elevation at MH 00901.

Because the relief sewer would be up to 23 feet deep below the ground surface, it is assumed that this alternative would be installed using tunneling construction methods. However, excavations would be required at the connections to the existing system and for any intermediate access shafts and/or manholes. Eight shaft structures are estimated for construction of this sewer.

The planning-level present-worth cost for Alternative 2 (36-inch diameter pipe) is estimated to be $10.9 million, including construction, contingencies, engineering and administration, and operation and maintenance costs. A schematic of Alternative 2 is presented in Appendix 6A-21.

Evaluation

Planning-level cost estimates have been developed for each alternative, presented in Table 6A-16. Details for cost estimates are presented in Appendix 6A-22. Analysis specific performance factors are developed in Table 6A-17. These performance factors were used to rate the alternatives against each other and then a total weighted score was calculated for each alternative. For each alternative, the total weighted score was divided by the alternative's present worth to determine its value ratio (the value that the alternative provides per million spent), which is presented in Table 6A-18.

TABLE 6A-16: CS R5, N COMMERCE ST. PIPE CAPACITY PRESENT WORTH PLANNING-LEVEL COST COMPARISON

Planning-Level Costs	Alternative 1	Alternative 2
Capital Cost	$6,380,000	$10,830,000
Annual O&M	$5,200	$2,600
Present Value of Annual O&M Costs	$75,000	$37,000
Total Present Value	**$6,455,000**	**$10,867,000**

TABLE 6A-17: CS R5, N COMMERCE ST. PIPE CAPACITY ANALYSIS-SPECIFIC PERFORMANCE FACTORS

Triple Bottom Line Measure	Level of Service Category	Performance Factor
Environmental	**Permit Requirements**	Measure of a given alternative's likelihood to meet permit requirements. *KPIs for Permit Requirements related to conveyance alternatives are: 0 SSOs and 6 CSOs (regulatory) and 0 CSOs (MMSD goal).*
	Energy	A measure of a given alternative's relative impact to baseline energy usage (with reduction in energy demand receiving highest score). *The difference between gravity conveyance alternatives is assumed to be negligible. I/I alternatives are assumed to have minimal impact.*
	Environmental Improvements	Measure of the advantages of a given alternative in terms of improvements to the environment. *Specific consideration could include impact on meeting specific KPIs and PIs such as the 85 percent regulatory requirement and the 100 percent goal of capture of flow into the MMSD system.*
Economic	**Fiscal Responsibility**	General measure of how well a given alternative reduces identified risk(s) in a cost-effective manner. *The most cost-effective alternative receives the highest score with reduction of 1 point per 20 percent increase in cost.*
	Management Effectiveness	Measure of a given alternative's ability to help management achieve the permit and contract goals. Factors to consider include complexity to implement/operate new technologies or alternatives that simplify operations from baseline. *Conveyance projects will assume the highest score for new sewer pipe. Relief sewers will be rated by priority categories A=1, B=2, C=3, and D=4 scoring.*
Social	**Safety**	Measure of a given alternative's ability to minimize safety risks to employees, contractors, and the general public. *For conveyance, relief and replacement sewers, along with I/I assume design considerations would be accounted for to minimize safety risks.*
	Customer Service, Communication and Employee Development	Measure of the advantages of a given alternative to reduce potential complaints and notices of violation, improve communication effectiveness, and/or provide employee development opportunities. *For Conveyance, this is primarily wet weather capacity related to preventing/minimizing overflows and basement backups due to MIS capacity deficiencies.*

TABLE 6A-18: CS R5, ALTERNATIVES SCORING MATRIX

Alternative Scoring Matrix North Commerce Street MIS Conveyance Capacity Project CS R5	Alternative 20-year Present Worth ($ million)	Permit / Legal Requirements	Energy	Environmental Improvements (non-regulatory, resource recovery)	Fiscal Resp.	Management and Operational Effectiveness	Safety	Customer Service, Community Economic Development and Organizational Reputation	Total Weighted Score	Value Ratio (Total Weighted Score / Present Worth
Weights		26	17	15	17	6	13	6	100	
Alternative 1 – 3,451 LF, 15-inch diam. Relief Sewer	$6.46	5	5	5	5	4	5	5	494	76.5
Alternative 2 – 3,451 LF, 36-inch diam. Replacement Sewer	$10.87	5	5	5	2	5	5	5	449	41.3

Recommendations

According to the scoring matrix, Alternative 1 provides a higher value ratio, which indicates that it provides the most value per million dollars spent. Therefore, Alternative 1 is recommended. The recommended relief sewer route is shown in Appendix 6A-20.

The proposed improvements should be evaluated further during preliminary design of a future project, including detailed hydraulic modeling of other sewers and facilities that affect this MIS including an assessment of potential changes to the flow control strategy in intercepting and diversion structures on the west side of the NS08 NSC system. Additionally, it should be verified that a relief sewer or replacement sewer would actually reduce the HGL, as conditions downstream in the MIS or NSC may be influencing the elevation in this section of the MIS. A detailed hydraulic evaluation is recommended to fully understand the cause of the surcharge on this MIS. Because this MIS is within the CSSA, the flow reduction that could be achieved through the installation of GI or storm sewer inlet restrictors in the tributary area to this MIS should be considered.

While the modeling identified a capacity risk for Conveyance Baseline Conditions, the design flows are based on future projections for population and land use. Accordingly, flow monitoring should be prioritized along this MIS to help determine when the modeled capacity deficiency approaches the actual performance of the MIS and to help determine if preliminary engineering of a project should be initiated. Additionally, an internal inspection of the MIS along North Commerce Street should be performed to assess the structural condition of the pipeline during the preliminary engineering process.

CS R6 – Ryan Rd Pipe Capacity

Purpose

The purpose of this analysis is to identify potential risk mitigation strategies for a pipeline capacity deficiency identified as part of the capacity assessment in Chapter 5 (refer to Chapter 5 for a discussion of the assessments done on the existing facilities). Modeled pipeline capacity deficiencies were identified for the 5-year wastewater recurrence interval event for Conveyance Baseline and Conveyance Future Conditions at various locations within the MIS system.

This alternatives analysis includes an evaluation of the 84-inch diameter MIS located within Subsystem 2, Leg Q along East and West Ryan Road and South Pennsylvania Avenue in the City of Oak Creek.

Approach

Refer to the previous Conveyance Pipeline Capacity Analysis Methodology subsection of Section 6.3 for details on the methodology used for this analysis.

A capacity deficiency for the 5-year wastewater recurrence interval event for Conveyance Future Conditions was identified in a 14,704-foot-long section of the 84-inch diameter MIS in South Pennsylvania Avenue and West Ryan Road. The deficient section along West Ryan Road begins approximately one-half mile west of South Howell Avenue. From this point, the MIS flows east for 10,583 feet along Ryan Road and then flows north in South Pennsylvania Avenue for approximately 4,121 feet where it connects to the 150-inch diameter MIS in East Puetz Road. Modeling indicates the full-pipe capacity of the 84-inch diameter MIS is exceeded during the 5-year wastewater event under Conveyance Future Conditions, causing water levels to exceed an adjacent CE at MH 40802 by approximately 2.1 feet. Note that the subject sections of this MIS have adequate capacity for Conveyance Baseline Conditions.

Flows tributary to the Ryan Road MIS are from Franklin, Muskego, Greendale, Hales Corners, a southern portion of Oak Creek, a southwestern portion of West Allis, a southern portion of Milwaukee, a western portion of Greenfield, a southeastern portion of New Berlin, a northern portion of Caledonia, and an eastern portion of Raymond. The Ryan Road MIS serves over 30 percent of the MMSD sanitary sewer service area.

The 84-inch diameter MIS is a monolithic concrete pipeline installed by tunneling between 1963 and 1967 (52 to 56 years old). The depth to the pipe invert ranges from approximately 60 to 130 feet deep below the ground surface.

The flow in the 150-inch diameter MIS in East Puetz Road downstream from the subject 84-inch diameter MIS exceeds its design capacity in some segments. However, the 150-inch diameter MIS is relatively deep, and the CE in MH 30202 at the intersection of South Pennsylvania Avenue and East Puetz Road is approximately 55 feet above the crown of the MIS. There are no additional CEs in the 150-inch diameter MIS. This indicates the capacity restriction in the 84-inch MIS could be relieved without causing additional downstream problems in the 150-inch diameter MIS. Conveyance Baseline, Future, and Buildout Conditions modeling profiles with CEs are provided in Appendix 6A-23.

There have been no hydrogen sulfide/odor issues reported or manhole access constraints identified along the subject 84-inch diameter MIS.

The land use on East and West Ryan Road and South Pennsylvania Avenue is a mix of relatively low-density residential, commercial, industrial, and agricultural with some open undeveloped green space.

Potential environmental constraints associated with construction along this route include possible impacted soil associated with historical or current land uses or activity, potential temporary impacts to traffic on both Ryan Road and South Pennsylvania Avenue, and potential endangered species or sensitive habitat issues related to the semi-rural and undeveloped nature of part of the route.

The East and West Ryan Road and South Pennsylvania MIS were identified as having capacity deficiencies as part of the 2020 Facilities Plan based on the modeling data, assumptions, and design criteria used for that study. [2] No projects have been completed or are under design in this reach of the MIS system since the publication of the 2020 Facilities Plan.

Alternatives Description

To mitigate the risk, two alternatives consisting of a relief sewer and a replacement sewer were identified. Descriptions and conceptual schematics of each alternative are presented below.

The pipe sizes for the conceptual alternatives are based on design flows estimated from 2050 population projections and land use with climate change conditions (Buildout Conditions) and the 5-year wastewater recurrence interval event. The existing pipe capacities are based on the average pipe slope for the subject MIS. The 5-year wastewater design flows under Buildout Conditions in the 84-inch diameter MIS are estimated to be approximately 268 cfs along Ryan Road and 278 cfs along South Pennsylvania Avenue. The full pipe capacities of the MIS along Ryan Road and South Pennsylvania Avenue are approximately 228 cfs and 229 cfs (0.127 percent, 0.128 percent pipe slope), resulting in capacity deficits of 39 cfs and 49 cfs, respectfully.

Alternative pipe sizes are based on use of standard precast concrete pipe sizes, a Manning's Equation roughness coefficient (n) of 0.013, and full-pipe capacity. For both alternatives, a smaller pipe installed at a moderately steeper slope could also potentially provide adequate flow capacity. The elevation difference for a steeper sewer may be acceptable depending on the design HGL, elevations of any CEs along the route, and the details of the connections to the existing system. Relief sewers were evaluated to determine if they could be raised to reduce depth and meet CE requirements. Relief sewers maintained existing pipe elevations unless they could be raised 5 feet or more and have 2 feet of freeboard from the crown of the relief sewer to the CE since detailed modeling was not completed for each alternative.

For the 5-year wastewater recurrence interval event under Buildout Conditions, increasing the size of the 84-inch diameter Ryan Road MIS and the South Pennsylvania Ave MIS alone are not enough to lower the HGL below the elevation of CEs at MH 40802 located at South 60th Street and West Ryan Road and in manholes upstream from this point (MH 40901, MH 40903, ME 41001) to meet the respective CEs. Because the 150-inch diameter Puetz Road MIS is the influent sewer to the South Shore Water Reclamation Facility (SSWRF), the hydraulic performance of the facility significantly influences the HGL of both the 150-inch diameter MIS in Puetz Road and the MIS in Ryan Road and Pennsylvania Avenue.

To adequately lower the HGL in the MIS, the SSWRF influent flow control structure would need to be adjusted to allow more flow to be conveyed to the facility, and the SSWRF would likely need capacity improvements or an overall expansion to treat the additional flow. Without further modeling, it is not possible to determine the necessary modifications to the flow control structure or the extent of a potential expansion of the SSWRF. Note that though the Conveyance analysis set Buildout Conditions at 2050, review of the SSWRF future demand in Chapter 4 determined that the SSWRF service area is not projected to reach Buildout Conditions flows and wasteloads by the year 2050. Therefore, no additional costs related to modifications to SSWRF are included in the 2050 FP. Additional discussion of this issue is noted in Appendix 6B, in analysis WRF R3, SSWRF Primary Clarification, Secondary Treatment Capacity Analysis.

Accordingly, this evaluation assumes that modifications at SSWRF are undertaken in the future to increase capacity and reduce the HGL in the 150-inch diameter Puetz Road MIS. In addition to the modifications at SSWRF, construction of a relief sewer or replacement sewer for the deficient section of the 84-inch MIS and upstream/west to MH 40802 at West Ryan Road and South 60th Street would be needed to prevent the HGL from exceeding the CE at MH 40802 and the additional upstream CEs noted above for the 5-year wastewater recurrence interval event under Buildout Conditions.

Alternative 1 – Relief Sewer

Alternative 1 consists of constructing an approximately 34,600-foot-long 48-inch diameter relief sewer adjacent to the existing sewer alignment along Ryan Road to provide additional capacity equal to or greater than the 39 cfs deficiency and along South Pennsylvania Avenue to provide additional capacity equal to or greater than the 49 cfs deficiency for the 5-year wastewater flow under Buildout Conditions. The relief sewer would extend from MH 40802 at 60th Street to MH 40101 along Ryan Road, then north on South Pennsylvania Avenue from MH 40101 to MH 30206 near the intersection with East Puetz Road and the 150-inch diameter MIS.

A 48-inch diameter pipe at 0.15 percent slope provides a full-pipe capacity of 55 cfs, which exceeds the flow required for both the Ryan Road section and the South Pennsylvania Avenue section of the relief sewer. The slope of the relief sewer is based on matching the downstream crown of the pipe with the HGL in the 150-inch diameter Puetz Road MIS, assuming modifications at SSWRF lower the HGL to approximately elevation 25, and setting the upstream crown of the pipe 2 feet below the CE in MH 40802 (elevation 78.43) at West Ryan Road and South 60th Street. Due to the CE in MH 40802, the relief sewer could only be raised 10 feet above the existing MIS.

Because the sewer would be approximately 40 to 110 feet deep, it is assumed that this alternative would be installed using tunneling construction methods. However, excavations would be required at the connections to the existing system and for any intermediate access shafts and/or manholes. Forty shaft structures with an average depth of 65 feet were used to estimate cost for the construction of the tunnel sewer.

The planning-level present-worth cost for Alternative 1 (48-inch diameter pipe) is estimated to be $143.0 million, including construction, contingencies, engineering and administration, and operation and maintenance costs. A schematic of Alternative 1 is presented in Appendix 6A-24.

Alternative 2 – Replacement Sewer

Alternative 2 consists of constructing an approximately 34,600-foot-long 96-inch diameter replacement sewer generally along the same alignment at the same pipe slope to provide capacity equal to or greater than the 5-year wastewater design flows under Buildout Conditions of 267 cfs and 278 cfs for the Ryan Road section and the South Pennsylvania Avenue section of the MIS, respectfully. The limits of the replacement sewer would be the same as the relief sewer described above. A 96-inch diameter pipe at 0.127 percent slope provides a full-pipe capacity of 325 cfs, which exceeds the design flow.

Because the sewer would be approximately 40 to 130 feet deep, it is assumed that this alternative would be installed using tunneling construction methods. However, excavations would be required at the connections to the existing system and for any intermediate shafts and/or manholes. Forty shaft structures with an average depth of 75 feet were used to estimate cost for the construction of the tunnel sewer.

The planning-level present-worth cost for Alternative 2 (96-inch diameter pipe) is estimated to be $250.2 million, including construction, contingencies, engineering and administrative costs, and operation and maintenance costs. A schematic of Alternative 2 is presented in Appendix 6A-25.

Evaluation

Planning-level cost estimates have been developed for each alternative, presented in Table 6A-19. Details for cost estimates are presented in Appendix 6A-26. Analysis-specific performance factors are developed in Table 6A-20. These performance factors were used to rate the alternatives against each other and then a total weighted score was calculated for each alternative. For each alternative, the total weighted score was divided by the alternative's present worth to determine its value ratio (the value that the alternative provides per million spent), which is presented in Table 6A-21.

Other Considerations: Also note an example scenario where the SSWRF capacity is increased to 630 MGD (evaluated for Conveyance Future Conditions using flows generated by the August 1986 wet weather event). This could lower the HGL by 13 feet at MH 30202 at East Puetz Road and South Pennsylvania Avenue. With this level of capacity expansion at SSWRF, the 84-inch Ryan Road - Pennsylvania Avenue MIS relief or replacement sewer may be reduced in size. Note that the cost estimates for Alternative 1 and Alternative 2 do not include the costs for any modifications at SSWRF.

Future growth in Franklin and Muskego that connects to the Ryan Creek Interceptor may still pose a capacity issue and CE issue at MH 40802 where it connects to the MIS in Ryan Road.

TABLE 6A-19: CS R6, RYAN RD PIPE CAPACITY PRESENT WORTH PLANNING-LEVEL COST COMPARISON

Planning-Level Costs	Alternative 1	Alternative 2
Capital Cost	$141,670,000	$249,510,000
Annual O&M	$51,900	$26,000
Present Value of Annual O&M Costs	$750,000	$370,000
Total Present Value	**$142,420,000**	**$249,880,000**

TABLE 6A-20: CS R6, RYAN RD PIPE CAPACITY ANALYSIS-SPECIFIC PERFORMANCE FACTORS

Triple Bottom Line Measure	Level of Service Category	Performance Factor
Environmental	**Permit Requirements**	Measure of a given alternative's likelihood to meet permit requirements. *KPIs for Permit Requirements related to conveyance alternatives are: 0 SSOs and 6 CSOs (regulatory) and 0 CSOs (MMSD goal).*
	Energy	A measure of a given alternative's relative impact to baseline energy usage (with reduction in energy demand receiving highest score). *The difference between gravity conveyance alternatives is assumed to be negligible. I/I alternatives are assumed to have minimal impact.*
	Environmental Improvements	Measure of the advantages of a given alternative in terms of improvements to the environment. *Specific consideration could include impact on meeting specific KPIs and PIs such as the 85 percent regulatory requirement and the 100 percent goal of capture of flow into the MMSD system.*
Economic	**Fiscal Responsibility**	General measure of how well a given alternative reduces identified risk(s) in a cost-effective manner. *The most cost-effective alternative receives the highest score with reduction of 1 point per 20 percent increase in cost.*
	Management Effectiveness	Measure of a given alternative's ability to help management achieve the permit and contract goals. Factors to consider include complexity to implement/operate new technologies or alternatives that simplify operations from baseline. *Conveyance projects will assume the highest score for new sewer pipe. Relief sewers will be rated by priority categories A=1, B=2, C=3, and D=4 scoring.*
Social	**Safety**	Measure of a given alternative's ability to minimize safety risks to employees, contractors, and the general public. *For conveyance, relief and replacement sewers, along with I/I assume design considerations would be accounted for to minimize safety risks.*
	Customer Service, Communication and Employee Development	Measure of the advantages of a given alternative to reduce potential complaints and notices of violation, improve communication effectiveness, and/or provide employee development opportunities. *For Conveyance, this is primarily wet weather capacity related to preventing/minimizing overflows and basement backups due to MIS capacity deficiencies.*

TABLE 6A-21: CS R6, ALTERNATIVES SCORING MATRIX

Alternative Scoring Matrix West Ryan Rd-South Pennsylvania Avenue MIS Conveyance Capacity Project CS R6	Alternative 20-year Present Worth ($ million)	Permit / Legal Requirements	Energy	Environmental Improvements (non-regulatory, resource recovery)	Fiscal Resp.	Management and Operational Effectiveness	Safety	Customer Service, Community Economic Development and Organizational Reputation	Total Weighted Score	Value Ratio (Total Weighted Score / Present Worth
Weights		26	17	15	17	6	13	6	100	
Alternative 1 – 34,600 LF, 48-inch diam. Relief Sewer	$142.42	5	5	5	5	4	5	5	494	3.5
Alternative 2 – 34,600 LF, 96-inch diam. Replacement Sewer	$249.88	5	5	5	1	5	5	5	432	1.7

Recommendations

According to the scoring matrix, Alternative 1 provides a higher value ratio, which indicates that it provides the most value per million dollars spent. Therefore, Alternative 1 is recommended. The recommended relief sewer route is shown in Appendix 6A-24.

This project should be implemented only after modeling indicates the critical elevation is exceeded by 2.1 feet at MH40802 in the West Ryan Road MIS. The proposed improvements should be evaluated further during preliminary design of a future project, including detailed hydraulic modeling of other sewers and facilities that affect this MIS and an assessment of potential changes to SSWRF. Preliminary engineering may need to evaluate the facility needs from both Conveyance Future and Buildout population and land use values.

The design flows are based on future projections for population and land use. Accordingly, flow monitoring should be prioritized along this MIS to help determine when the modeled capacity deficiency approaches the actual performance of the MIS and to help determine if preliminary engineering of a project should be initiated. Additionally, an internal inspection of the MIS along Ryan Road and South Pennsylvania Avenue should be performed to assess the structural condition of the pipelines during the preliminary engineering process.

The potential for implementing I/I reduction measures by the appropriate municipality should be evaluated to determine if tributary metersheds are in compliance with the requirements of MMD Rules, Chapter 3. Any I/I reduction would likely benefit the local municipality's sewers in addition to reducing the capacity needs of the affected MIS segment. Currently, there are no sewersheds identified tributary to the West Ryan Road – South Pennsylvania Avenue MIS segments that are non-compliant. However, MMSD is still in the process of collecting data for some metersheds with tributary sewersheds that could affect this MIS segment. As projects are evaluated for capacity needs, all tributary sewersheds should be brought into compliance to the extent practicable before additional capacity is added

Due to the cost of the alternatives, an evaluation of the CEs and impacted properties should be considered. Other alternatives, such as the use of a tunnel boring machine, could be considered instead to reduce the number of shafts compared to microtunneling construction. A local pump station with force main to remove properties that are impacted by the CE should also be evaluated as a cost-effective solution to the downstream capacity improvements.

CS R7 – N 91st St Pipe Capacity

Purpose

The purpose of this analysis is to identify potential risk mitigation strategies for a pipeline capacity deficiency identified as part of the capacity assessment in Chapter 5 (refer to Chapter 5 for a discussion of the assessments done on the existing facilities). Modeled pipeline capacity deficiencies were identified for the 5-year wastewater recurrence interval event for Conveyance Baseline and Conveyance Future Conditions at various locations within the MIS system.

This alternatives analysis includes an evaluation of the 57-inch special section (SS) MIS to 72-inch SS MIS located within Subsystem 3, Leg H generally along North 107th Street, West Brown Deer Road, and North 91st Street in the City of Milwaukee.

Approach

Refer to the previous Conveyance Pipeline Capacity Analysis Methodology subsection of Section 6.3 for details on the methodology used for this analysis.

A capacity deficiency for the 5-year wastewater recurrence event for Conveyance Future Conditions was identified in a 24,107-foot-long section of MIS that flows generally south beginning at the intersection of North 107th Street and West County Line Road. The deficient section consists of a 57-inch SS MIS that starts at West County Line Road and runs south along North 107th Street and then southeast along the Little Menomonee River then south along North 91st Street to just south of West Good Hope Road where it becomes a 72-inch SS. The 72-inch SS MIS continues south to North 85th Street where it turns west into the Little Menomonee River Parkway.

Approximately 672 feet west of North 91st Street, the 72-inch SS passes through Diversion Chamber DC0308. High flows are diverted to the Northwest Side Remote Storage (NWSRS) facility via a pair of 8-foot-wide passive weirs. The 72-inch SS continues south for approximately 3 miles to West Hampton Avenue where it joins a second 72-inch diameter MIS from the west and continues south for approximately 1.7 miles to West Keefe Avenue and the Menomonee River Parkway where the pipe size increases to 96-inch diameter.

Flows tributary to the North 91st Street MIS are from Germantown, the northeast portion of Menomonee Falls, the southwest portion of Mequon, and the northwest portion of Milwaukee.

Both the 57-inch SS and 72-inch SS MIS are monolithic concrete pipelines and were installed by tunneling. The 57-inch SS MIS is approximately 20,818-feet-long and was constructed between 1958 and 1962 (57 to 61 years old) and the depth to the pipe invert ranges from 26 to 65 feet below the ground surface. The 72-inch SS MIS is approximately 3,289-feet-long and was constructed in 1958 (61 years old) and the depth to the pipe invert ranges from 43 to 65 feet below the ground surface.

Modeling indicates the full-pipe capacity of the 57-inch SS MIS is exceeded during the 5-year wastewater event under Conveyance Future Conditions, causing the HGL to exceed six CEs and the ground surface elevation at six manholes. In the worst-case occurrence, the HGL exceeds a CE by approximately 10.6 feet at MH19713. The full pipe capacity of the 72-inch SS is also exceeded between West Good Hope Road and DC0308, but the resulting HGL does not exceed the one CE along the 72-inch SS MIS. Note that the subject sections of this MIS have adequate capacity for Conveyance Baseline Conditions. The modeled profiles with CEs for the Conveyance Baseline, Future, and Buildout Conditions are provided in Appendix 6A-27.

The HGL in the 57-inch SS MIS and the 72-inch SS is partially controlled by the diversion weir elevation in DC0308. The crest of the adjustable-height weir is nominally 8 feet above the crown of the 72-inch SS. The weir elevation can be lowered by removing stop logs. However, even with the stop logs removed, the concrete bench at the weir would still be 6 feet above the crown of the 72-inch SS.

Hydrogen sulfide and odor issues have been reported in MH 19715 and MH 19716 on North 107th Street, which is likely due to turbulence associated with a 23-foot drop in MH 19197 at the intersection of North 107th Street and West County Line Road. Reported manhole access issues include buried structures along West Brown Deer Road (MH 19703 and MH 19704).

The land use along the MIS route is a mix of residential, commercial, and industrial, and undeveloped parkland. North 91st Street borders the east side of the Little Menomonee River Parkway for about 2.2 miles and the 57-inch SS MIS passes through the parkway for about 0.6 miles.

Potential environmental constraints associated with construction along this route include possible impacted soil associated with historical or current land uses or activity and potential temporary impacts to traffic. A large petroleum storage and distribution facility is located on the west side of North 107th Street from West County Line Road to West Brown Deer Road. This facility may potentially increase the likelihood of contaminated soil or groundwater along the route.

The North 91st Street MIS was identified as having a capacity deficiency as part of the previous 2020 Facilities Plan based on the modeling data, assumptions, and design criteria used for that study. [2] No projects have been completed or are under design in this reach of the MIS system since the publication of the 2020 Facilities Plan.

Alternatives Description

To mitigate the risk, two alternatives consisting of a relief sewer and a replacement sewer were identified. Descriptions and schematics of each alternative are presented below.

The pipe sizes for the conceptual alternatives are based on flows estimated from 2050 population projections and land use with climate change conditions (Buildout Conditions) and the 5-year wastewater recurrence interval event. Existing pipe capacities are based on the average pipe slope for the subject MIS. The modeled profiles with CEs for the Conveyance Baseline, Future, and Buildout Conditions are provided in Appendix 6A-27.

The 5-year wastewater design flow under Buildout Conditions in the 57-inch SS MIS is estimated to be approximately 67 cfs. The full pipe capacity of the pipeline is approximately 47 cfs (0.106 percent pipe slope), resulting in a deficit of 20 cfs. The 5-year wastewater design flow under Buildout Conditions in the 72-inch SS MIS is approximately 85 cfs. The full pipe capacity of the pipeline is approximately 60 cfs (0.045 percent pipe slope), resulting in a deficit of 25 cfs.

Because the HGL does not exceed the one CE or the ground surface along the 72-inch SS MIS, the alternatives do not include modification of this MIS. The alternative improvements consist of relief or replacement of the 57-inch SS MIS and modifying the weir elevation in DC0308.

For both alternatives, the weir height in DC0308 would need to be lowered approximately 6 feet to the crown of the 72-inch SS MIS to prevent the HGL from exceeding the lowest CE at MH 19713 or the ground surface at MH 19715. This would require partial removal of the 8.5-foot-thick concrete bench between the 72-inch SS MIS and the diversion channel leading to the NWSRS. Additional stop logs would need to be installed to allow adjustment of the weir based on operational requirements.

The weir height and the resulting amount of flow diverted at DC0308 affects the operation of the NWSRS. Notably, lowering the weir height would start passive diversion to the NWSRS earlier, which could lead to earlier closing of the active diversion gate at DC0304 and result in a reduction of relief capacity for the 96-inch diameter Menomonee River Parkway MIS. Additionally, modeling indicates the 10-year wastewater flow under Buildout Conditions exceeds capacity of the 72-inch diameter MIS downstream of DC0308, indicating that this MIS is potentially sensitive to increases in flow resulting from increasing upstream capacity. Accordingly, changes to the DC0308 weir or structure and the operation of the NWSRS, along with the performance of downstream MIS sections, must be evaluated in greater detail during preliminary design of a future project.

Alternative pipe sizes are based on use of standard precast concrete pipe sizes, a Manning's Equation roughness coefficient (n) of 0.013, and full-pipe capacity. For both alternatives, a smaller pipe installed at a moderately steeper slope could also potentially provide adequate flow capacity. The elevation difference for a steeper sewer may be acceptable depending on the design HGL, elevations of any CEs along the route, and the details of the connections to the existing system. Relief sewers were evaluated to determine if they could be raised to reduce depth and meet CE requirements. Relief sewers maintained existing pipe elevations unless they could be raised 5 feet or more and have 2 feet of freeboard from the crown of the relief sewer to the CE since detailed modeling was not completed for each alternative.

Note: A third alternative was developed for the 2020 Facilities Plan, which included modifications to DC0308, a 10-inch local relief sewer, and a local pump station at the intersection of North 107th Street and West County Line Road. The relief sewer would capture the flow from the four local connections between West County Line Road and West Glenbrook Court along North 107th Street and convey them north to a pump station that would pump the flow into the 57-inch SS MIS. The approximate depth of the local relief sewer is 30 to 40 feet below the ground surface. Although this alternative was not evaluated for the 2050 FP, it should be considered for evaluation if future capacity issues are identified in this MIS.

Alternative 1 – Relief Sewer

Alternative 1 consists of constructing an approximately 21,600-foot-long 42-inch diameter relief sewer along the general route of the 57-inch SS MIS from MH 19716 at West County Line Road to MH 19407 just south of West Good Hope Road and lowering the weir height in DC0308. The relief sewer would be constructed along the existing sewer alignment, except the proposed route would follow West Brown Deer Road to North 91st Street to avoid construction along the Little Menomonee River. The relief sewer would be installed approximately 5 feet above the existing MIS at the same pipe slope to provide additional capacity equal to or greater than the 20 cfs deficiency for the 5-year wastewater flow under Buildout Conditions. A 42-inch diameter pipe at 0.106 percent slope provides a full-pipe capacity of 33 cfs, which exceeds the flow required.

Because the relief sewer would be approximately 20 to 60 feet below ground surface, it is assumed that this alternative would be installed using tunneling construction methods. However, excavations would be required at the connections to the existing system and for any intermediate access shafts and/or manholes. Twenty-eight shaft structures with an average depth of 30 feet were used to estimate cost for the construction of the microtunnel sewer.

The planning-level present-worth cost for Alternative 1 (42-inch diameter pipe) is estimated to be $68.6 million, including construction, contingencies, engineering and administration, and operation and maintenance costs. A schematic of Alternative 1 is presented in Appendix 6A-28.

Alternative 2 – Replacement Sewer

Alternative 2 consists of constructing an approximately 21,600-foot-long 60-inch diameter replacement sewer generally along the same alignment of the 57-inch SS from MH 19716 at West County Line Road to MH 19407 just south of West Good Hope Road and lowering the weir height in DC0308. The replacement sewer would be constructed along the existing sewer alignment, except the proposed route would follow West Brown Deer Road to North 91st Street to avoid construction along the Little Menomonee River. The replacement sewer would be installed at approximately the same pipe slope and depth to provide capacity equal to or greater than the 5-year wastewater flow under Buildout Conditions of 67 cfs. A 60-inch diameter pipe at 0.106 percent slope provides a full-pipe capacity of 85 cfs, which exceeds the design flow.

Because the replacement sewer would be approximately 26 to 65 feet below ground surface, it is assumed that this alternative would be installed using tunneling construction methods. However, excavations would be required at the connections to the existing system and for any intermediate access shafts and/or manholes. Twenty-eight shafts with an average depth of 35 feet were used to estimate cost for the construction of the microtunnel sewer.

The planning-level present-worth cost for Alternative 2 (60-inch diameter pipe) is estimated to be $89.8 million, including construction, contingencies, and engineering and administrative costs. A schematic of Alternative 2 is presented in Appendix 6A-29.

Evaluation

Planning-level cost estimates have been developed for each alternative, which are presented in Table 6A-22. Details for cost estimates are presented in Appendix 6A-30. Analysis-specific performance factors are developed in Table 6A-23. These performance factors were used to rate the alternatives against each other and then a total weighted score was calculated for each alternative. For each alternative, the total weighted score was divided by the alternative's present worth to determine its value ratio (the value that the alternative provides per million spent), which is presented in Table 6A-24.

TABLE 6A-22: CS R7, N 91ST ST PIPE CAPACITY PRESENT WORTH PLANNING-LEVEL COST COMPARISON

Planning-Level Costs	Alternative 1	Alternative 2
Capital Cost	$67,720,000	$89,400,000
Annual O&M	$32,400	$16,200
Present Value of Annual O&M Costs	$470,000	$230,000
Total Present Value	**$68,190,000**	**$89,630,000**

TABLE 6A-23: CS R7, N 91ST ST PIPE CAPACITY ANALYSIS-SPECIFIC PERFORMANCE FACTORS

Triple Bottom Line Measure	Level of Service Category	Performance Factor
Environmental	**Permit Requirements**	Measure of a given alternative's likelihood to meet permit requirements. *KPIs for Permit Requirements related to conveyance alternatives are: 0 SSOs and 6 CSOs (regulatory) and 0 CSOs (MMSD goal).*
	Energy	A measure of a given alternative's relative impact to baseline energy usage (with reduction in energy demand receiving highest score). *The difference between gravity conveyance alternatives is assumed to be negligible. I/I alternatives are assumed to have minimal impact.*
	Environmental Improvements	Measure of the advantages of a given alternative in terms of improvements to the environment. *Specific consideration could include impact on meeting specific KPIs and PIs such as the 85 percent regulatory requirement and the 100 percent goal of capture of flow into the MMSD system.*
Economic	**Fiscal Responsibility**	General measure of how well a given alternative reduces identified risk(s) in a cost-effective manner. *The most cost-effective alternative receives the highest score with reduction of 1 point per 20 percent increase in cost.*
	Management Effectiveness	Measure of a given alternative's ability to help management achieve the permit and contract goals. Factors to consider include complexity to implement/operate new technologies or alternatives that simplify operations from baseline. *Conveyance projects will assume the highest score for new sewer pipe. Relief sewers will be rated by priority categories A=1, B=2, C=3, and D=4 scoring.*
Social	**Safety**	Measure of a given alternative's ability to minimize safety risks to employees, contractors, and the general public. *For conveyance, relief and replacement sewers, along with I/I assume design considerations would be accounted for to minimize safety risks.*
	Customer Service, Communication and Employee Development	Measure of the advantages of a given alternative to reduce potential complaints and notices of violation, improve communication effectiveness, and/or provide employee development opportunities. *For Conveyance, this is primarily wet weather capacity related to preventing/minimizing overflows and basement backups due to MIS capacity deficiencies.*

TABLE 6A-24: CS R7, ALTERNATIVES SCORING MATRIX

Alternative Scoring Matrix North 91st Street MIS Conveyance Capacity Project CS R7	Alternative 20-year Present Worth ($ million)	Permit / Legal Requirements	Energy	Environmental Improvements (non-regulatory, resource recovery)	Fiscal Resp.	Management and Operational Effectiveness	Safety	Customer Service, Community Economic Development and Organizational Reputation	Total Weighted Score	Value Ratio (Total Weighted Score / Present Worth
Weights		26	17	15	17	6	13	6	100	
Alternative 1 – 21,600 LF, 42-inch diam. Relief Sewer	$68.19	5	5	5	5	4	5	5	494	7.2
Alternative 2 – 21,600 LF, 60-inch diam. Replacement Sewer	$89.63	5	5	5	3	5	5	5	466	5.2

Recommendations

According to the scoring matrix, Alternative 1 provides a higher value ratio, which indicates that it provides the most value per million dollars spent. Therefore, Alternative 1 is recommended. The recommended relief sewer route is shown in Appendix 6A-28.

This project should be implemented only after modeling indicates the critical elevation is exceeded by 10.5 feet at MH19713 in the North 91st Street MIS. The proposed improvements should be evaluated further during preliminary design of a future project, including detailed hydraulic modeling of other sewers and facilities that affect this MIS, an assessment of changes to the DC0308 weir or structure, the performance of downstream MIS sections, and operation of the NWSRS.

The design flows are based on future projections for population and land use. Accordingly, flow monitoring should be prioritized along this MIS to help determine when the modeled capacity deficiency approaches the actual performance of the MIS and to help determine if preliminary engineering of a project should be initiated. Additionally, an internal inspection of the MIS along North 91st Street and adjacent areas should be performed to assess the structural condition of the pipeline during the preliminary engineering process.

The potential for implementing I/I reduction measures by the appropriate municipality should be evaluated to determine if tributary metersheds are in compliance with the requirements of MMD Rules, Chapter 3. Any I/I reduction would likely benefit the local municipality's sewers in addition to reducing the capacity needs of the affected MIS segment. Currently, there are no sewersheds identified tributary to the North 91st Street MIS segments that are non-compliant. However, MMSD is still in the process of collecting data for some metersheds with tributary sewersheds that could affect this MIS segment. As projects are evaluated for capacity needs, all tributary sewersheds should be brought into compliance to the extent practicable before additional capacity is added

CS R8 – 27th St Pipe Capacity

Purpose

The purpose of this analysis is to identify potential risk mitigation strategies for a pipeline capacity deficiency identified as part of the capacity assessment in Chapter 5 (refer to Chapter 5 for a discussion of the assessments done on the existing facilities). Modeled pipeline capacity deficiencies were identified for the 5-year wastewater recurrence interval event for Conveyance Baseline and Conveyance Future Conditions at various locations within the MIS system.

This alternatives analysis includes an evaluation of a section of the 42-inch diameter MIS within Subsystem 7, Leg W generally located under the 27th Street Viaduct between West Canal Street and West Greeves Street in the City of Milwaukee.

Approach

Refer to the previous Conveyance Pipeline Capacity Analysis Methodology subsection of Section 6.3 for details on the methodology used for this analysis.

A capacity deficiency for the 5-year wastewater recurrence event for Conveyance Future Conditions was identified in one section of the approximately 1,379-foot-long 30-inch to 42-inch diameter MIS that starts at intercepting structure (IS) 380 near North 25th Street and West Greeves Street and runs west along West Greeves Street to the North 27th Street Viaduct. The MIS continues south where it connects to an 84-inch diameter MIS at DC 0705 just north of West Canal Street. The deficient 542-foot-long 42-inch diameter MIS section begins at MH 04010 under east side of the North 27th Street Viaduct and flows south between two industrial buildings to MH 60118 just upstream from DC0705.

Flows tributary to the North 27th Street MIS are from a combined sewer and a storm inlet along West Greeves Street connected to IS502 and a 96-inch diameter combined sewer connected to IS380 at North 25th Street that serve a portion of west-central Milwaukee. Additionally, the service laterals for the two industrial buildings are connected directly to the 42-inch diameter MIS under the viaduct.

The 42-inch diameter MIS is a monolithic concrete pipeline installed by open-cut construction in 1919 (100 years old) and the depth to the pipe invert is approximately 12 to 13 feet below the ground surface. The two industrial buildings and the substructure for the North 27th Street Viaduct were constructed after the MIS. The design drawings for Pier No. 15 of the viaduct (Wisconsin Department of Transportation Bridge No. B-40-513) [3] indicate the pile cap was modified to allow it to be constructed immediately adjacent to the MIS. The 42-inch MIS was rehabilitated by installation of a cured-in-place liner in 2004. [4]

Modeling indicates the full-pipe capacity of the 42-inch diameter MIS is exceeded during the 5-year wastewater event under Conveyance Future Conditions, causing the HGL to exceed a CE[2] by approximately 0.8 feet at IS502

[2] *The CEs at manholes within the Lake Michigan estuary area are typically defined as 4 feet, unless otherwise noted. The estuary area includes portions of three tributaries to Lake Michigan, which are the lower 3.1 miles of the Milwaukee River downstream of the former North Avenue Dam, the lower 3.0 miles of the Menomonee River downstream of 35th Street, and the lower 2.5 miles of the Kinnickinnic River downstream of Chase Avenue. The estuary area also includes the inner and outer harbors as well as the nearshore of Lake Michigan.*

(MH 04010) at West Greeves Street under the North 27th Street Viaduct. Conveyance modeling profiles with CEs for Baseline, Future, and Buildout Conditions are provided in Appendix 6A-31.

The land use along the existing MIS is industrial, including railroad right-of-way and a railroad undercrossing by the MIS. The industrial properties and the MIS are located adjacent to the north/west bank of the Menomonee River.

There have been no hydrogen sulfide or odor issues reported and while there have been no manhole access constraints identified along the 42-inch diameter MIS, it appears the adjacent industries have built various facilities over the existing alignment of the MIS based on aerial and ground level photos.

Potential environmental constraints associated with construction along this route include possible impacted soil and groundwater associated with historical or current land uses or activity and potential temporary impacts to operations at the adjacent industries or along the railroad. Because significant portions of the Menomonee River Valley contain uncontrolled historical fill placed to create buildable land, a wide variety of soil and other materials requiring special handling and disposal are likely to be encountered in excavations.

The North 27th Street MIS sewer was not identified as having a capacity deficiency as part of the 2020 Facilities Plan based on the modeling data, assumptions, and design criteria used for that study. No projects have been completed or are under design in this reach of the MIS system since the publication of the 2020 Facilities Plan.

Alternatives Description

To mitigate the risk, two alternatives consisting of relief sewers along two different alignments were identified. Because the 42-inch diameter MIS was rehabilitated in 2004 by installation of a cured-in-place structural liner, complete replacement of the MIS is not likely to be warranted.

The pipe sizes for the conceptual alternatives are based on flows estimated from 2050 population projections and land use with climate change conditions (Buildout Conditions) and the 5-year wastewater recurrence interval event. The existing pipe capacity is based on the average pipe slope for the subject MIS. The 5-year wastewater design flow under Buildout Conditions in the 42-inch diameter MIS is estimated to be approximately 76 cfs. The full-pipe capacity of the existing pipeline is approximately 13 cfs (0.0107 percent pipe slope), resulting in a deficit of 63 cfs.

The two alternative relief sewers are sized to provide additional capacity equal to or greater than the 63 cfs deficiency for the 5-year wastewater flow under Buildout Conditions.

Alternative pipe sizes are based on use of standard precast concrete pipe sizes, a Manning's Equation roughness coefficient (n) of 0.013, and full-pipe capacity. For both alternatives, a smaller pipe installed at a moderately steeper slope could also potentially provide adequate flow capacity. The elevation difference for a steeper sewer may be acceptable depending on the design HGL, elevations of any CEs along the route, and the details of the connections to the existing system. Relief sewers were evaluated to determine if they could be raised to reduce depth and meet CE requirements. Relief sewers maintained existing pipe elevations unless they could be raised 5 feet or more and have 2 feet of freeboard from the crown of the relief sewer to the CE since detailed modeling was not completed for each alternative.

Additionally, future planning efforts should evaluate the flow control strategy in IS380 and IS502. It may be possible to limit the amount of flow entering the 42-inch diameter MIS during wet weather and prevent or reduce the capacity deficiency.

Alternative 1 – Relief Sewer (West Greeves Street Alignment)

Alternative 1 consists of an approximately 980-foot-long 54-inch diameter relief sewer extended from MH 04010 to the west along West Greeves Street connecting to the existing 84-inch diameter MIS at MH 60105 upstream from the existing 42-inch diameter MIS connection at DC0705 adjacent to the Menomonee River.

The proposed 54-inch diameter pipe invert in MH 04010 would be at approximately the elevation -2.0 feet, and the proposed invert at or adjacent to the 84-inch diameter MIS at MH 60105 would be approximately at elevation -3.0 feet. A 54-inch diameter pipe at 0.102 percent slope provides a full-pipe capacity of 63 cfs, which equals the flow required.

Segments of the 84-inch diameter MIS downstream segments from MH 60105 have adequate capacity, and there are no CEs identified along the 84-inch diameter MIS downstream from this area. This indicates that Alternative 1 should be acceptable without the additional flow causing downstream problems.

Because the relief sewer would be less than 15 feet below the ground surface and there is a likelihood of encountering utilities and/or other unknown subsurface conditions that would be problematic for trenchless construction, it is assumed that this alternative would be installed using open-cut construction methods. Three structures are estimated to be needed for the construction of the relief sewer.

The planning-level present-worth cost for Alternative 1 (54-inch diameter relief sewer) is estimated to be $4.1 million, including construction, contingencies, engineering and administration, and operation and maintenance costs. A schematic of Alternative 1 is presented in Appendix 6A-32.

Alternative 2 – Relief Sewer (27th Street Viaduct Alignment)

Alternative 2 consists of an approximately 650-foot-long 42-inch diameter relief sewer that would generally follow the existing alignment of the 42-inch diameter MIS for approximately 650 feet under the North 27th Street Viaduct. Alternative 2 would be difficult to construct due to the lack of space between the two existing industrial buildings and associated facilities and the substructure of the viaduct. Changes to the industrial properties, including acquisition and removal of existing facilities, would likely be required to provide a route for this alternative. Because the existing MIS is located on the east side of the viaduct piers, the alternative alignment would be located on the west side. Right-of-way acquisition and demolition was estimated at $1 million.

The proposed 42-inch diameter pipe invert would be at elevation -3.0 feet in MH 04010 and the invert would be at elevation -5.5 feet at or adjacent to DC0705. A 42-inch diameter pipe at 0.386 percent slope provides a full-pipe capacity of 63 cfs, which equals the flow required.

The 42-inch diameter MIS downstream from DC0705 east of the Menomonee River should be able to accommodate the additional flow from Alternative 2. The HGL for the current peak flow is approximately 3 ft below the CEs in this section of the 42-inch diameter MIS.

Because the relief sewer would be less than 15 feet below ground surface and there is a likelihood of encountering utilities and/or other unknown subsurface conditions that would be problematic for trenchless construction, it is assumed that this alternative would be installed using open-cut construction methods. Three structures are estimated to be needed for the construction of the relief sewer.

The planning-level present-worth cost for Alternative 2 (42-inch diameter pipe) is estimated to be $3.8 million, including construction, contingencies, engineering and administrative, assumed right-of way acquisition, and operation and maintenance costs. A schematic of Alternative 2 is presented in Appendix 6A-33.

Evaluation

Planning-level cost estimates have been developed for each alternative, which are presented in Table 6A-25. Details for cost estimates are presented in Appendix 6A-34. Analysis-specific performance factors are developed in Table 6A-26. These performance factors were used to rate the alternatives against each other and then a total weighted score was calculated for each alternative. For each alternative, the total weighted score was divided by the alternative's present worth to determine its value ratio (the value that the alternative provides per million spent), which is presented in Table 6A-27.

TABLE 6A-25: CS R8, 27TH ST PIPE CAPACITY PRESENT WORTH PLANNING-LEVEL COST COMPARISON

Planning-Level Costs	Alternative 1	Alternative 2
Capital Cost	$4,100,000	$3,800,000
Annual O&M	$1,500	$1,500
Present Value of Annual O&M Costs	$20,000	$20,000
Total Present Value	**$4,120,000**	**$3,820,000**

TABLE 6A-26: CS R8, 27TH ST PIPE CAPACITY ANALYSIS-SPECIFIC PERFORMANCE FACTORS

Triple Bottom Line Measure	Level of Service Category	Performance Factor
Environmental	**Permit Requirements**	Measure of a given alternative's likelihood to meet permit requirements. *KPIs for Permit Requirements related to conveyance alternatives are: 0 SSOs and 6 CSOs (regulatory) and 0 CSOs (MMSD goal).*
	Energy	A measure of a given alternative's relative impact to baseline energy usage (with reduction in energy demand receiving highest score). *The difference between gravity conveyance alternatives is assumed to be negligible. I/I alternatives are assumed to have minimal impact.*
	Environmental Improvements	Measure of the advantages of a given alternative in terms of improvements to the environment. *Specific consideration could include impact on meeting specific KPIs and PIs such as the 85 percent regulatory requirement and the 100 percent goal of capture of flow into the MMSD system.*
Economic	**Fiscal Responsibility**	General measure of how well a given alternative reduces identified risk(s) in a cost-effective manner. *The most cost-effective alternative receives the highest score with reduction of 1 point per 20 percent increase in cost.*
	Management Effectiveness	Measure of a given alternative's ability to help management achieve the permit and contract goals. Factors to consider include complexity to implement/operate new technologies or alternatives that simplify operations from baseline. *Conveyance projects will assume the highest score for new sewer pipe. Relief sewers will be rated by priority categories A=1, B=2, C=3, and D=4 scoring.*
Social	**Safety**	Measure of a given alternative's ability to minimize safety risks to employees, contractors, and the general public. *For conveyance, relief and replacement sewers, along with I/I assume design considerations would be accounted for to minimize safety risks.*
	Customer Service, Communication and Employee Development	Measure of the advantages of a given alternative to reduce potential complaints and notices of violation, improve communication effectiveness, and/or provide employee development opportunities. *For Conveyance, this is primarily wet weather capacity related to preventing/minimizing overflows and basement backups due to MIS capacity deficiencies.*

TABLE 6A-27: CS R8, ALTERNATIVES SCORING MATRIX

Alternative Scoring Matrix North 27th Street MIS Conveyance Capacity Project CS R8	Alternative 20-year Present Worth ($ million)	Permit / Legal Requirements	Energy	Environmental Improvements (non-regulatory, resource recovery)	Fiscal Resp.	Management and Operational Effectiveness	Safety	Customer Service, Community Economic Development and Organizational Reputation	Total Weighted Score	Value Ratio (Total Weighted Score / Present Worth
Weights		26	17	15	17	6	13	6	100	
Alternative 1 – 980 LF, 54-inch diam. Relief Sewer	$4.12	5	5	5	4	4	5	5	477	115.8
Alternative 2 – 650 LF, 42-inch diam. Relief Sewer	$3.82	5	5	5	5	4	5	5	494	129.3

Recommendations

According to the scoring matrix, Alternative 2 provides a higher value ratio, which indicates that it provides the most value per million dollars spent. Therefore, Alternative 2 is recommended. Note that Alternative 2 has an estimated right-of-way easement and demolition cost of $1 million, which will need to be evaluated to determine total capital cost. The recommended relief sewer route is shown in Appendix 6A-33.

This project should be implemented only after modeling indicates the critical elevation is exceeded by 0.8 feet at IS502 at West Greeves Street in the North 27th St. MIS. The proposed improvements should be evaluated further during preliminary design of a future project, including detailed hydraulic modeling of other sewers and facilities that affect this MIS and an assessment of potential changes to the flow control strategy in IS380 and IS502. Additionally, the flow reduction that could be achieved through the installation of GI or storm sewer inlet restrictors in the tributary area to this MIS should be considered.

The design flows are based on future projections for population and land use. Accordingly, flow monitoring should be prioritized along this MIS to help determine when the modeled capacity deficiency approaches the actual performance of the MIS and to help determine if preliminary engineering of a project should be initiated. Additionally, an internal inspection of the MIS along North 27th Street and adjacent areas should be performed to assess the structural condition of the pipeline during the preliminary engineering process.

CS R9 – Combat I/I Impact

Purpose

The purpose of this analysis is to identify ways that MMSD and its stakeholders can combat I/I in MMSD's conveyance system. This analysis covers the following risks identified in Chapter 5, Assessment of Existing Facilities:

- The risk that I/I could increase by 14 percent from Conveyance Baseline I/I flows by the end of the planning period (2040) if pipe degradation is allowed to continue with no pipe replacement or rehabilitation.
- The risk that there may be even more capacity risks than those identified under the hydraulic capacity assessment because that assessment was not calibrated with the most current data.

As noted in Chapter 5, modeling for the 2050 FP assumes the only increase in I/I during the planning period is due to new growth, which is consistent with NR 110 facilities planning requirements. However, from a practical standpoint, MMSD recognizes that there is a risk that I/I will increase as pipes continue to age, which is a capacity risk that needs to be addressed. Therefore, MMSD has developed a private property I/I (PPI/I) reduction program, which is focused on developing and implementing remedies for I/I. MMSD also has gathered updated meter flow and identified enforcement metersheds[3] under the WWPFMP to better quantify where I/I concerns are located within the MMSD service area. MMSD recognizes that the funding budgeted for the PPI/I reduction program and the WWPFMP may not be sufficient to prevent the increase of I/I over time due to degradation. Additional I/I will impact MMSD's ability to meet its goal of zero overflows and zero basement backups and strategies are required to prevent this increase in SSOs and basement backups.

The intent of this analysis is to estimate the additional funding needed for the following existing programs (the amount over and above the funding included in the 2020 to 2025 long-range finance plan):

- M10003, PPI/I Phase 2 – existing PPI/I reduction program as of December 2019
- M10004, PPI/I Implementation Phase 2 (Labor) – management of existing PPI/I reduction program as of December 2019, including MMSD labor and consultant contracts
- M10005, Post 2050 FP PPI/I Approach – planned PPI/I program – MMSD is transitioning from M10003 to this project number upon the completion of the 2050 FP
- M10006, PPI/I Research and Development – program to research best practices in I/I reduction in support of the efforts to be continued under projects M10004 and M10005 and to support municipalities efforts combat I/I

For the purposes of this analysis, the additional budget needed to manage the WWPFMP is assumed to be over and above what is budgeted for M10004 in 2020 to 2025 long-range finance plan, with the acknowledgement that MMSD may decide to manage the WWPFMP differently in the budget. The additional budget to implement PPI/I reduction is assumed to be over and above the budget for Project M10005 that is already included in the 2020 to 2025 long-range finance plan.

Note: This discussion only covers the costs to <u>*maintain*</u> current I/I levels over the planning period based on the assumption of a 14 percent increase in I/I systemwide during the planning period. The additional costs necessary

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[3] A metershed measures flow from one or more sewersheds. Refer to the Conveyance capacity failure mode assessment in Chapter 5 for a description of the enforcement metershed program, which is enforced under Chapter 3 of the MMSD Rules.

to reduce I/I in order to achieve zero SSOs is discussed in the Systemwide Analysis FG2, Zero Overflows Alternative Analysis, in Appendix 6E, Systemwide Alternative Analyses.

Approach

MMSD commissioned Brown and Caldwell (B&C) under a separate project to complete Ad Hoc Modeling Request 211, Evaluation of I/I Influences, in part, which was a sensitivity analysis of the estimated cost to maintain current I/I levels instead of allowing I/I to increase over time due to degradation; this study focused on the sewersheds with the most I/I. This report is provided in Appendix 6A-35, CS R9 Ad Hoc 211. That project also included the development of a business case evaluation (CBC033), which identifies potential strategies for mitigating projected I/I increases. [5] At the time of publication of the 2050 FP, CBC033 was still in draft form. This analysis summarizes the findings from these B&C projects.

In the Ad Hoc 211 Study, B&C evaluated how the risk of SSO occurrence varies based on the level of I/I into the conveyance system. [1] The analysis considered the influence of I/I on municipal systems, specifically as they relate to basement backups. The impact of I/I on the MMSD regional conveyance system was not specifically evaluated.

The Ad Hoc 211 Study assumed a systemwide degradation rate of 14 percent over the 20-year regulatory planning period to estimate the amount of work needed to maintain a constant level of I/I over the planning period. This rate is consistent with the assumptions used in the 2020 FP. The study points out, however, that the actual rate of degradation is unknown. The study used an assumed 2020 ENR Construction Cost Index of 15,000. The study then modeled the extent of rehabilitation and replacement needed under Conveyance Future Conditions to maintain Baseline I/I rates.

Two of the strategies identified in business case evaluation CBC033 were specifically related to mitigating the projected 14 percent increase in I/I to keep levels at the current Baseline condition:

1. (*Strategy 2*) Improve the enforcement capability of the WWPFMP targets to offset I/I growth. These targets would focus on the sewersheds with the highest I/I. Only administrative costs would be incurred by MMSD under this strategy.
2. (*Strategy 4*) Focus municipal I/I reduction work as well as private property infiltration and inflow (PPI/I) on the sewersheds with the highest I/I that were identified in the Ad Hoc 211 Study. Programmatic costs for this strategy assume that the PPI/I program grows in kind with the WWPFMP program.

The second risk was originally identified using the more current enforcement metershed data from the WWPFMP. Upon further review of the data, the 2050 FP project team determined rather than addressing it as separate risk, the data could instead be used to help MMSD prioritize its initial I/I reduction efforts. This would also address the concern that there are even more capacity risks than those identified under the hydraulic capacity assessment. Therefore, the second prong of this approach was to estimate the cost to bring just the 21 non-compliant enforcement metersheds identified in Chapter into compliance, which represents a subset of the total cost to address all of the sewersheds with the most I/I. The following process was used to calculate the cost.

The second prong of the approach to combat I/I was to identify the cost to bring just the 21 non-compliant enforcement metersheds identified in Chapter 5 into compliance (instead of all of the metersheds with the most I/I). The following process was used to calculate this cost:

- The Ad Hoc 211 Study identified a unit cost per gallon per day to remove I/I from the system.

- Modeling compared the Conveyance Baseline Conditions' 5-year recurrence flow to maximum allowable flow according to MMSD Rules.
- The difference is the I/I reduction needed to bring the specific sewershed under the enforcement metershed into compliance. That amount of I/I reduction was multiplied by the unit cost identified in the Ad Hoc 211 Study to determine the total cost per specific sewershed under the enforcement metershed into compliance.

The third prong of the approach to combat I/I was to compare the total estimated costs against the budgeted amount for projects M10004 and M10005 in the 2020 to 2025 long-range finance plan in order to determine the additional recommended budget for the 2020 to 2025 time period and for years 2026 to 2040 in the planning period.

Findings

The 2050 FP modeling effort found that a 14 percent increase in I/I would result in a 375 percent increase in SSO volume, which would increase the frequency of ISS-related SSOs from once in 7 years to once in 3 years.

While specific SSO sites within the conveyance system would increase in volume and frequency as a result of sewer degradation and increased I/I from tributary areas, specific sites were not evaluated individually for this analysis.

Business case evaluation CBC033 describes the two potential strategies to mitigate the potential 14 percent increase in I/I over the 20-year regulatory planning period as follows:

(CBC033 Strategy 2) Improve the enforcement capability of the WWPFMP to mitigate the 14 percent increase in I/I. CBC033 describes this strategy as follows:

> *Strategy 2 would focus the WWPFMP on the sewersheds associated with the non-compliant metersheds and would require additional MMSD administration costs associated with expanding the program. In this strategy, the enhanced program would mitigate the projected 14% increase in systemwide I/I by targeting higher I/I areas that have the potential for better I/I removal cost efficiencies.*
>
> *Ad Hoc 211 (Case 2 – Maintain) estimated the total cost of addressing future I/I at $1,500 million (private, municipal, and MMSD combined). While this cost is significant, much of this cost is already spent by municipalities during routine maintenance of the system but does not address any PPI/I. Maintenance would need to be focused on the sewersheds associated with the non-compliant metersheds and reducing I/I in sufficient amount to counteract a 14% increase in peak flow. Assuming that the annual metering program does not change (primarily in terms of number of sites), the additional costs to MMSD would be limited to increased MMSD analysis staff time that would be spent focusing on additional metersheds. Currently 21 metersheds are non-compliant and administrative activities include letters, meetings, engineering, support, etc. As indicated by MMSD staff, administrative costs for the WWPFMP were estimated to be approximately $325,000 annually. Using ratios, administrative costs would increase to $2.83 million to expand the focus from the current 21 non-compliant metersheds to all of the metersheds associated with sewersheds with the most I/I. Costs are programmatic costs and do not result in construction. Under this scenario, there is no increase to funding of MMSD's PPI/I Program, and all I/I reduction costs would be incurred by the municipalities. [5]*

(CBC033 Strategy 4) Reduce I/I through increased PPI/I Program funding to mitigate the 14% increase in I/I. CBC033 describes this strategy as follows:

> *Systemwide I/I could be reduced by establishing MMSD policy and programs to encourage reduction of I/I from private property, evaluate the results, and modify the current programs to be more effective. The key difference between Strategy 4, compared to Strategy 2, is the increase in MMSD's PPI/I Program funding available to the municipalities in addition to focusing PPI/I work on the sewersheds with the most I/I identified in the Ad Hoc 211 TM. As in Strategy 2, the increase in funding and I/I mitigation efforts would mitigate the projected 14% increase in I/I to keep levels at the current baseline condition. From the 2050 FP, the baseline 2010 condition has approximately 1 tunnel-related SSO every 7 years. It should be noted that an important PPI/I policy change would be necessary to accomplish this strategy. Specifically, MMSD would need to require municipalities to spend available PPI/I funding in non-compliant sewersheds first, before utilizing these funds elsewhere in the municipality. This is not currently required and therefore not the practice of municipalities that have non-compliant sewersheds under current Chapter 3 limits.*
>
> *Costs were calculated using the following method assuming that the PPI/I Program Funding grows in kind with the WWPFMP program:*
>
> 1. *Determine the number of sanitary sewersheds (SS) currently in the WWPFMP and which municipalities they are in*
> 2. *Sum up the PPI/I dollars allocated under the current program to those current WWPFMP municipalities*
> 3. *Determine the additional sewersheds needed under WWPFMP scenario and what municipalities will be new to WWPFMP*
> 4. *For those municipalities that are already in WWPFMP and will have more sewersheds in the program, estimate their new PPI/I Program allocation by scaling their current PPI/I allocation by the ratio of the new sewershed area being added to the WWPFMP*
> 5. *Calculate the average PPI/I dollars per Asset Value per WWPFMP acre area for the municipalities already in the program.*
> 6. *For those municipalities that are new to WWPFMP, multiply the ratio calculated in Step 5 by the asset value of the municipality as well as the area of the sewersheds included in the WWPFMP for the additional PPI/I funds needed.*
> 7. *Add the additional PPI/I funds calculated in Step 6 to the original PPI/I fund for that municipality.*
> 8. *Summed up PPI/I Fund components from Steps 4 and 7 to get a total new PPI/I Program value across all municipalities for this flow reduction scenario.*
>
> *Using this procedure, it was calculated that a total annual cost of $9.71 million should be spent by MMSD on the targeted sewersheds for the PPI/I program in conjunction with the WWPFMP program cost of $2.83, million for a total annual cost of $12.5 million. The annual*

cost for municipalities, private, and MMSD to mitigate the projected 14% increase in I/I was calculated by the Ad Hoc 211 analysis (Case 2 – Maintain) to be $75 million[4] or a total of $1.5 billion over 20 years. As noted in Strategy 2, much of this spending is already being done on the public sewer systems by the municipalities.

Maintenance would need to be focused on the sewersheds with the most I/I and reducing I/I as necessary to counteract the projected 14 percent increase in peak flow. Assuming that the number of sites does not change for the annual metering program, the additional costs to MMSD would be limited to increased MMSD analysis staff time that would be spent focusing on additional sewersheds and PPI/I projects.

Additional considerations provided by B&C:

B&C reviewed the presentation of CBC033 information in the context of the 2050 FP and presented the following additional considerations regarding the $1.5 billion cost when implementing CBC033 Strategy 4:

Of the $1.5 billion, $0.5 billion is the cost to address I/I in existing sewersheds with the highest I/I rates. The remaining $1.0 billion is the cost to address the assumed 14 percent increase in I/I due to pipe degradation over the 20-year planning period.

Summary of CBC033 Findings

Table 6A-28 summarizes the findings of CBC033 using present worth cost assumptions for the 2050 FP, the details of which are provided in Appendix 6A-36, CS R9 Combat I/I Details.

[4] *Based on this information, the cost to the municipalities and private homeowners is $62.5 million annually for rehabilitation and replacement and I/I reduction work on municipal and private sewers. A range of $60 to $65 million annually is assumed for the 2050 FP.*

TABLE 6A-28: CS R9, ESTIMATED TOTAL COST TO MITIGATE I/I IN SEWERSHEDS WITH MOST I/I

Item	Annual Costs[1]	Total Net Present Value, (20-year, 3.375% discount rate)
WWPFMP program costs	$2,830,000	$40,700,000
MMSD PPI/I program implementation costs to address sewersheds with the most I/I	$9,710,000	$139,600,000
MMSD TOTAL	**$12,540,000**	**$180,300,000**
Municipality and private property owner implementation costs to address sewersheds with the most I/I	$62,460,000[2]	$897,800,000
GRAND TOTAL	**$75,000,000**	**$1,078,100,000**[3]

1) Costs per business case evaluation CBC033 completed as part of Ad Hoc Modeling Request 211, Evaluation of I/I Influences.
2) The annual cost to municipal and private property owners for rehabilitation and replacement and I/I reduction work on municipal and private sewers to maintain baseline I/I is assumed for the 2050 FP to be a range, $60 to $65 million. Note that most of these costs are not new costs to the municipalities; they are expenses that are assumed to be incurred to reduce excess I/I and maintain I/I levels as required by MMSD Rules as part of its existing conveyance system maintenance programs.
3) Ad Hoc Modeling Request 211 calculated a total of $1.5 billion, which has a net present value of $1.08 billion per 2050 FP net present value assumptions.

Because the MMSD implementation costs to address all of the sewersheds with the most I/I are quite high ($9.71 million per year), this analysis also calculated the implementation costs to rehabilitate just the 21 non-compliant enforcement metersheds identified in Chapter 5. Table 6A-29 summarizes the conceptual cost estimates by governing unit to rehabilitate the non-compliant metersheds using the cost per gallon per day developed in Ad Hoc 211. The details of the development of these conceptual costs are provided in Appendix 6A-36, CS R9 Combat I/I Details. Because some metersheds are still under evaluation, there could be additional governing units that are not currently identified and additional costs to bring those metersheds into compliance. A conceptual cost estimate of $156.5 million for I/I reduction was calculated to bring just the 21 non-compliant metersheds into compliance. For planning purposes, this cost was divided into 20 equal annual values of $7.8 million.

The total budget for projects M10004 and M10005 in the 2020 to 2025 long-range finance plan was reviewed against the findings above to determine the recommended additional budget needed to fund the costs calculated in this analysis. The findings are presented below:

- Project No. M10004, PPI/I Implementation Phase 2 (Labor):
  - Analysis indicated a total program need of $2.83M per year for the WWPFMP. For the years 2020 to 2025, MMSD has budgeted an average of just over $600,000 per year.
  - MMSD has determined it wants to take a phased approach by increasing the total annual budget to $1.5M per year for the years 2021 to 2025. To achieve this, the total budget for the years 2021 to 2025 would need to be increased by $3.90M, representing an average annual increase of $680,000.
  - For years 2026 to 2040, it is a assumed the annual budget would be increased to the total

recommended budget of $2.83M per year, for a total budget for the 15-year time period of $42.45M.

- Project No. M10005, Post 2050 FP PPI/I Approach:
  - Analysis indicated a total program need of $9.71M per year for implementation of PPI/I. For the years 2020 to 2025, MMSD has budgeted an average of just over $2.73M per year.
  - Taking a phased approach, the total annual budget would be increased to $7.82M per year for the years 2021 to 2025 to address identified non-compliant metersheds. To achieve this, the total budget for the years 2021 to 2025 would need to be increased by $8.43M, representing an average annual increase of $2.81M.
  - For years 2026 to 2040, it is a assumed the annual budget would be increased to the total recommended budget of $9.71M per year, for a total budget for the 15-year time period of $145.65M. The 2020 to 2025 long-range finance plan already includes future costs of 13.62M under Project M10005, so the total additional budget needed for years 2026 to 2040 would be $132.03M.

TABLE 6A-29: COST TO REHABILITATE NON-COMPLIANT METERSHEDS[1]

Governing Unit	Non-Compliant Metershed Enforcement Meter ID	Sewersheds associated with Non-Compliant Metershed	Cost of I/I Reduction
Milwaukee	MS0116	MI1100	$4,970,000
	MS0118	MI1123	$1,650,000
	MS0305	MI3096	$8,560,000
	MS0305	MI3124	$490,000
	MS0315[2]	MI3095	$8,000,000
	MS0338	MI3065	$1,000,000
	MS0339	MI3041	$9,830,000
	MS0411	MI4067	$3,270,000
	MS0417[2]	MI4159	$80,000
	MS0418	MI4046	$3,450,000
	MS0420	MI4139	$2,920,000
	MS0448	MI4042	$3,770,000
	MS0448	MI4043	$1,190,000
	MS0448	MI4044	$970,000
	MS0448	MI4160	$30,000
	MS0513	MI5049	$2,120,000
	MS0528	MI5058	$9,690,000
	MS0536	MI5045	$2,230,000
	MS0536	MI5048	$13,720,000
	MS0536	MI5157	$1,920,000
	MS0538	MI5053	$2,370,000
		TOTAL:	**$82,230,000**
West Allis	MS0118	WE1018	$4,850,000
	MS0118	WE1032	$5,530,000
	MS0309[2]	WE3013	$6,400,000
	MS0130	WE1020	$3,690,000
	MS0131	WE1021	$5,140,000
	MS0305	WE3015	$2,800,000
	MS0305	WE3016	$3,410,000
	MS0305	WE3017	$1,510,000
	MS0415	WE4023	$6,090,000
		TOTAL:	**$39,420,000**

TABLE 6A-29: COST TO REHABILITATE NON-COMPLIANT METERSHEDS[1]

Governing Unit	Non-Compliant Metershed Enforcement Meter ID	Sewersheds associated with Non-Compliant Metershed	Cost of I/I Reduction
Wauwatosa	MS0411	WA4001	$4,580,000
	MS0411	WA4002	$6,000,000
	MS0411	WA4035	$2,910,000
	MS0417[2]	WA4010	$5,100,000
	MS0417[2]	WA4016	$1,170,000
		TOTAL:	**$19,760,000**
Cudahy	DC066E	CU6009	$650,000
	DC066E	CU6010	$1,790,000
	DC066E	CU6012	$730,000
	DC066E	CU6013	$1,070,000
	DC066E	CU6014	$440,000
	DC066E	CU6015	$20,000
	DC066E	CU6019	$100,000
		TOTAL:	**$4,800,000**
Fox Point	MS0417[2]	FP4003	$2,620,000
	MS0417[2]	FP4004	$1,170,000
		TOTAL:	**$3,790,000**
Shorewood	MS0522	SH5001	$2,970,000
	MS0523	SH5009	$400,000
		TOTAL:	**$3,370,000**
West Milwaukee	MS0131	WM1002	$1,170,000
	MS0606	WM6011	$580,000
		TOTAL:	**$1,750,000**
Whitefish Bay	MS0523	WB5003	$1,350,000
		TOTAL:	**$1,350,000**
		GRAND TOTAL:	**$156,470,000**

1) This table presents the sewersheds associated with the 21 non-compliant metersheds. Since it is organized by governing unit, meter IDs are repeated for each individual sewershed, with some metersheds monitoring sewersheds from multiple governing units.

2) These meters are identified as either “inconclusive” or “not analyzed” but are upstream of non-compliant metersheds so they have been added to the list. MS0309 is upstream of MS0118. MS0315 is upstream of MS0305. MS0417 is upstream of MS0448.

Source: MMSD WWPFMP

Recommendations

Strategy 2 of CBC033 only includes MMSD management costs to improve the enforcement capability of the WWPFMP, not the estimated implementation costs to mitigate I/I. Because the 2050 FP assumes that current I/I levels need to be maintained over the course of the 2020 to 2040 regulatory planning period, the recommended approach as presented in Strategy 4 (which includes the Strategy 2 recommendations) to mitigate I/I increases over time due to sewer system degradation should be implemented. The estimated costs represent total costs for program management and implementation to address sewersheds with the most I/I. To maintain the Conveyance Baseline Condition levels of I/I, the recommendation is to implement Strategy 4 in a phased approach by addressing sewersheds with the most I/I first. To implement Strategy 4, it is recommended that the following additional funding be added to the 2020 to 2025 long-range finance plan for projects M10004 and M10005:

- Project No. M10004, PPI/I Implementation Phase 2 (Labor) – additional WWPFMP[5] costs:
  - First phase: for years 2021 to 2025, increase the average budget by $680,000 per year to achieve a total annual budget of $1.5M per year. This represents a total budget increase of $3.90M for the years 2021 to 2025.
  - Second phase: for years 2026 to 2040, increase the annual budget to $2.83M per year, representing a total budget for the 15-year time period of $42.45M.
- Project No. M10005, Post 2050 FP PPI/I Approach – additional implementation costs:
  - First phase: to address identified non-compliant metersheds, increase the average annual budget for years 2021 to 2025 by $2.81M per year to achieve a total annual budget of $7.82M per year. This represents a total budget increase of $8.43M for the years 2021 to 2025.
  - Second phase: for years 2026 to 2040, increase the annual budget to the total recommended budget of $9.71M per year, representing a total budget for the 15-year time period of $145.65M. Because the 2020 to 2025 long-range finance plan already includes future costs of $13.62M under Project M10005, the total additional budget for years 2026 to 2040 would be $132.03M.

Under the WWPFMP (program costs included in CBC033 Strategy 4 recommendation), an in-depth flow monitoring analysis will be needed for each non-compliant metershed to determine the causes for the excessive I/I. Once the causes are determined, non-compliant metershed rehabilitation projects such as GI, downspout disconnection, lateral replacement, and local sewer linings would need to be implemented by the municipalities to reduce the excess I/I. Post-project flow monitoring will be required to confirm compliance and to use as data points to evaluate other metersheds. The WWPFMP should develop procedures to document and track I/I causes, cost, projects, best practices, and lessons learned. Metersheds will need to be periodically re-evaluated as part of the WWPFMP to confirm that they maintain compliance.

The strategies described above provide a framework for proceeding; however, the following considerations need to be noted:

- The planning-level costs presented include the potentially significant costs for which the municipalities would be responsible. As the Ad Hoc 211 Study noted, while this cost is significant, much of this cost is already spent by municipalities during routine maintenance of the system but does not address any PPI/I.

[5] *Additional WWPFMP costs may be managed by MMSD under other programs in addition to project M10004, but funds are shown under this project for simplicity.*

- This recommendation will require a policy change to the current MMSD PPI/I program. Specifically, MMSD would need to require municipalities to spend available PPI/I funding in non-compliant sewersheds first, before utilizing these funds elsewhere in the municipality. This is not currently required and therefore not the practice of municipalities that have non-compliant sewersheds under current Chapter 3 limits.
- As noted in the approach, the amount of work needed to maintain a constant level of I/I over the planning period is estimated based on preventing an assumed degradation rate of 7 percent per decade. However, the actual rate of degradation is unknown. MMSD is currently calibrating the Conveyance and Storage Asset System model as part of Project C98056 to more accurately determine the amount of I/I in the system.

CS R10 – Physical Mortality Evaluation

Purpose

This evaluation develops the planning level costs to address the physical mortality risks that were identified in the AssetView Analysis in Chapter 5.[6]

Allowances for unplanned capital repair projects to address physical mortality issues are already included in Project C90001, Allowance for Future Conveyance Rehab Projects in MMSD's 2020 to 2025 long-range finance plan. The information used in this evaluation is not detailed enough to recommend if additional budget should be added to the 2020 to 2025 long-range finance plan over and above the budget in Project C90001. A detailed, field investigation evaluation is needed to verify the planning level costs determined in this analysis. Therefore, the costs for that detailed investigative evaluation are also developed in this analysis.

Approach

All elements of the conveyance system will eventually need to be rehabilitated or replaced. The first phase of the evaluation places the elements into one of four priority categories based on the expected time horizon for their replacement or rehabilitation.

The priority categories are as follows:

- A (high priority): now through 2024
- B (medium priority): 2025 through 2029
- C (low priority): 2030 through 2039
- D (long term): 2040 and later

Conveyance system elements fall into one of two groups: pipes (sewers) and facilities (pump stations, diversion/intercepting structures, meter stations, dropshafts and appurtenances, and valve vaults). The data types and quality are very different for the two groups and are therefore analyzed separately. Capital costs to repair and replace the assets identified in the high priority category were calculated for pipes and facilities.

To estimate the cost for conducting the detailed investigative evaluation, the number of segments in AssetView that have reached the end of their useful life was identified as well as the number of pump stations that have equipment and buildings identified for replacement during the 2020–2024 time period.

Evaluation

Group 1: Conveyance Pipes

The "Conveyance Pipe Forecast" workbook was provided by MMSD, which contains condition information such as install year, rehabilitation year, anticipated replacement year, replacement cost, and rehabilitation cost. The costs used in the recommendation for this analysis uses rehabilitation costs for pipes, since rehabilitation is a less expensive option at larger pipe sizes and it can significantly reduce the likelihood of failure for most pipes due to physical mortality without the need to replace entire pipe segments.

[6] *The physical mortality risks due to I/I that were identified in the Ad Hoc 211 Study in Chapter 5 are addressed in CS R9, Combat I/I Impact.*

As explained in more detail in Appendix 5A, the methodology for establishing the projected replacement year is based on the following levels:

- Level 1 is age based, assigning a life of 100 years from original construction year or 50 years from rehabilitation year. In some cases, the resulting replacement year is less than 100 years from original construction, where sewers were rehabilitated before they were 50 years old.
- Level 2 assigns the replacement year based on reports of CCTV (closed-circuit television) inspections between 2008 and 2018. Replacement years reflect projections of remaining life ranging from 5 to 90 years. The logic applied in determining remaining life is unknown but is based on the PACP (Pipeline Assessment Certification Program) quick rating, determined by the unedited defect codes entered in the field by the CCTV technicians. A few segments list an inspection year but no replacement year, presumably because the inspection identified no defects. Of the 3,422 segments with Level 2 evaluations, the average projected remaining life is 71 years.
- Level 3 refines the projected replacement year based on an engineering review of the CCTV records. Experience has shown that the codes entered by the CCTV technicians sometimes over- or under-project the severity of the defect. The Level 3 reviews conducted since 2009 produced revised estimates of remaining life and resulting replacement years for 169 segments. The average projected remaining life for the 169 segments with Level 3 evaluations is about 23 years.

The governing replacement year for each segment is the replacement year associated with the highest available confidence level for the sewer segment. Of the 3,891 segments included in the database, 467 use Level 1 for the governing year, 3,253 use Level 2, and 169 use Level 3.

The Governing Year column was used to place each segment into one of the four priority categories listed above. This initial screening resulted in the following:

TABLE 6A-30: CONVEYANCE PIPES PER CATEGORY, INITIAL SCREENING

Category	Segments	LF
A	97	36,366
B	99	40,017
C	152	67,623
D	3,543	1,387,242
Total	**3,891**	**1,531,247**

Subsystem maps are provided in Appendix 6A-37, CS R10 Conveyance Physical Mortality Maps showing the pipe segments by the priority category. Eighty-six potential projects are identified on the subsystem maps that have been identified for rehabilitation or replacement in the planning period.

A complete list of pipe segments and estimated year of rehabilitation or replacement with cost is provided in Appendix 6A-38, CS R10 Conveyance Pipe and Pump Station Workbooks.

Conveyance Pipe Recommendations

When pipe segments are determined to be in Category A, they should be evaluated by a NASSCO (National Association of Sewer Service Companies) certified evaluator to determine the PACP rating. This additional review will determine if a capital project is needed to rehabilitate or replace pipe segments. If the pipe segments are determined to be in a better condition than initially reviewed, the mortality age should be updated in the Conveyance Pipe Forecast workbook. This workbook should be updated annually to determine what pipe segments should go through the certified evaluation.

Group 2: Facilities

Facility cost were developed by evaluating pump stations only. These costs were developed based on a 20-year life cycle cost for pump replacement and electrical and control systems equipment replacement, rather than rehabilitation. The costs do not include any building, structure, or piping replacement costs. This approach overestimates the costs to address pumps and electrical and control system assets that may only need repair but underestimates potential other facility costs not included, with the assumption that actual costs will be refined during preliminary engineering. The Milwaukee and Kinnickinnic River flushing pump stations were excluded from the cost because, since they are pump stations that take flow from the lake to flush local rivers, they are not typical conveyance system pump stations and are infrequently used.

Further Evaluation

The analysis of the AssetView data determined that there are 77 segments requiring replacement and 19 pump stations with equipment assets requiring replacement during the 2020–2024 time period. Based on these findings, a projected capital cost of $0.54M is estimated to conduct a detailed evaluation to confirm the 77 pipe segments require repair and $0.56M is estimated to conduct a detailed evaluation to confirm the repair and replacement needs at the pump stations.

Recommendations Table 6A-31 summarizes the cost assessment of the evaluation. Cost development information is included in Appendix 6A-38, CS R10 Conveyance Pipe and Pump Station Workbook. As stated in the Purpose section, MMSD already has an allowance, C90001, which includes $10M for unplanned repair and replacement. The information presented below appears to indicate additional budget should be added to the 2020 to 2025 long-range finance plan. However, these costs should be verified in a detailed investigative evaluation before additional budget is added to future long-range finance plans. Note that net present value is not calculated for physical mortality costs because there are no operations and maintenance costs, only capital costs.

TABLE 6A-31: CS R10 CONVEYANCE PHYSICAL MORTALITY COST ASSESSMENT

Time Period	Conveyance Physical Mortality Capital Costs ($ millions)	
	Conveyance Pipes[1]	Facilities[2]
2020 – 2024 Time Period	$10.8	$4.1
2025 – 2029 Time Period	$14.0	$1.0
2030 – 2039 Time Period	$22.2	$6.3
Total Costs (2020 – 2039)	$47.0	$11.4
Grand Total	**$58.4**	

1) Physical mortality costs for pipes represent rehabilitation costs.
2) Physical morality costs for facilities represent pump and electrical and control systems equipment replacement costs only. The costs do not include any building, structure, or piping replacement costs.

Source: Appendix 6A-36

Two detailed investigative evaluation projects are recommended to verify the validity of the costs identified in Table 6A-31 and if additional budget is needed in future long-range finance plans: $0.54M to conduct a detailed evaluation to confirm the 77 pipe segments require repair or replacement and $0.56M to conduct a detailed evaluation to confirm identified pump station physical mortality needs.

CS R11 – Risk of SSOs Occurring at BS0603

Purpose

This analysis covers the following identified risks:

TABLE 6A-32: RISKS ADDRESSED

Risk ID	Description
C147	Risk of SSOs Occurring at BS0603

The intent of this analysis is to evaluate alternatives to reduce the amount of SSOs occurring at bypass structure (BS)0603. BS0603 contains an overflow weir and a bypass orifice that both influence the amount of flow in the MIS and the amount of SSO during wet weather. Three SSOs have occurred at BS0603 over a 15-year time frame (2001 to 2016), which is about one every 5 years. These SSOs are WPDES permit violations and can lead to negative environmental impacts to the area affected by the overflow, potential health hazards, as well as complaints and negative public perception of MMSD.

Approach

The SSO at BS0603, located in West Lincoln Avenue just west of South 43rd Street, has activated three times in 15 years (2001 to 2016), or approximately one event every five years. The 2050 FP modeling results indicate that this overflow has an approximate 5- to 6-year recurrence interval (13 events in 75 years) under Conveyance Baseline population and land use conditions and an approximate 5-year recurrence interval (15 events in 75 years) under Conveyance Future population and land use conditions.

The South 43rd Street Relief Sewer located downstream from this SSO should prevent overflows from occurring at BS0603. However, the structural configuration of the overflow may be contributing to the frequent overflows. Using Conveyance Future population and land use conditions, the Comprehensive System Model (CSM) was run without and with the modifications described in the selected alternatives to determine the volume of overflow at BS0603 under four different peak flow events.

The events modeled were August 1986, June 2008, July 2010, and June 1997. These events were chosen because they represent peak-flow recurrence events. The events range from an estimated 75-year recurrence interval peak flow event (August 1986) to an estimated 19-year recurrence interval peak flow event (June 1997). Under the Conveyance Future Simulation 1 Baseline Conditions, the August 1986 event results in the largest SSO volume at BS0603 and the highest water levels in the sewer network in the study area. The June 2008, July 2010, and June 1997 events result in the second, third, and fourth largest overflow volumes and highest water levels, respectively.

Based on modeling without any structural modifications at BS0603, the August 1986, June 2008, July 2010, and June 1997 events produced overflow volumes of 2.07 MG, 1.49 MG, 0.94 MG, and 0.70 MG, respectively.

Alternatives Description

A brief summary of each alternative is included below.

Alternative 1 – Remove 24-inch orifice

The BS0603 SSO structure contains a 24-inch diameter orifice that limits the capacity of the 36-inch MIS. Removing the orifice, which is no longer necessary since the installation of the South 43rd Street Relief Sewer, would allow more capacity in the MIS to be utilized before an overflow would occur. Based on modeling, it is assumed that removing the 24-inch orifice would reduce the amount and frequency of overflow that occurs at BS0603 and would not cause water levels to exceed CEs in the area.

Alternative 2 – Raise the weir 6 inches

The BS0603 SSO structure has a low weir elevation (65.1 feet) that allows an overflow to occur at only 20.5 inches of depth in the pipeline (57 percent) before the full capacity of the 36-inch MIS is utilized. Increasing the weir elevation to 65.6 feet would allow more capacity in the MIS to be utilized before an overflow would occur. An elevation of 65.6 feet was chosen as an iterative value for modeling and represents an elevation about half way between the current weir elevation and the elevation of full pipe capacity.

Alternative 3 – Raise weir 1 foot and remove orifice

This alternative is similar to Alternative 2, but increases the weir elevation to 66.1 feet (an increase of 1 foot) and remove the orifice. This would allow more capacity in the MIS to be utilized before an overflow would occur. An elevation of 66.1 feet is close to the elevation of full pipe capacity. Removing the orifice and raising the weir 1 foot is expected to prevent surcharging and the exceedance of CEs upstream of the overflow.

Evaluation

Alternative 1 – Remove 24-inch orifice

Based on modeling with the orifice removed, this alternative can eliminate SSO volume at BS0603 to a negligible amount for the June 1997 event, and it is assumed that the overflow at BS0603 will not occur in events smaller than the June 1997 event. The June 1997 event is a 19-year recurrence interval peak flow event. Therefore, it is estimated this alternative would lower the LOF to occur at least once every 6 to 25 years.

Alternative 2 – Raise the weir 6 inches

Based on modeling with the weir raised 6 inches, this alternative does not decrease the likelihood of an SSO by any significant amount.

Alternative 3 – Raise weir 1 foot and remove orifice

Based on the modeling with the weir raised 1 foot and the orifice removed, this alternative can eliminate SSO volume at BS0603 for the August 1986 event. Since this alternative eliminated the SSO at BS0603 for the August 1986 event, it is assumed that the overflow at BS0603 will not occur in events smaller than the August 1986 event. The August event is a 75-year recurrence interval peak flow event. Therefore, it is estimated this alternative would reduce the likelihood of an SSO occurring to at least once every 51 to 100 years. This alternative does not increase the flow levels to exceed the CEs in the August 1986 event. The resulting maximum flow levels for this event range from 1.3 to 18.2 feet below the CEs.

Planning-level cost estimates have been developed for each alternative, which are presented in Table 6A-33. Analysis-specific performance factors are developed in Table 6A-34. These performance factors were used to rate the alternatives against each other and then a total weighted score was calculated for each alternative. For each alternative, the total weighted score was divided by the alternative's present worth to determine its value ratio (the value that the alternative provides per million spent), which is presented in Table 6A-35.

TABLE 6A-33: CS R11, EXCESSIVE SSOS AT BS0603 PRESENT WORTH PLANNING-LEVEL COST COMPARISON

Planning-Level Costs	Alternative 1 – Remove 24-inch orifice	Alternative 2 – Raise the weir 6 inches	Alternative 3 - Raise weir 1 foot and remove orifice
Total Net Present Value 20-year, 3.375% discount rate	$13,800	$1,600	$19,900

TABLE 6A-34: CS R11, SSOS AT BS0603 ANALYSIS-SPECIFIC PERFORMANCE FACTORS

Triple Bottom Line Measure	Level of Service Category	Performance Factor
Environmental	**Permit Requirements**	Measure of a given strategy's likelihood to meet permit requirements. KPIs for Permit Requirements related to the conveyance system are: 0 SSOs and 6 CSOs (regulatory); and 0 CSOs (MMSD goal). *For this analysis, the MMSD WPDES permit prohibits unscheduled bypassing of wastewater at an overflow from the collection system (SSO).*
	Energy	A measure of a given strategy's relative impact to baseline energy usage (with reduction in energy demand receiving highest score). *The difference between strategies for this analysis is assumed to be negligible.*
	Environmental Improvements	Measure of the advantages of a given strategy in terms of improvements to the environment. Specific consideration could include impact on meeting specific KPIs and PIs such as the 85% regulatory requirement and the 100% goal of capture of flow into the MMSD system. *For this analysis, SSOs can pose environmental and health concerns at and around the discharge site.*
Economic	**Fiscal Responsibility**	General measure of how well a given strategy reduces identified risk(s) in a cost-effective manner. *For this analysis, the most cost-effective strategy receives the highest score with a reduction of 1 point per 20 percent increase in cost for other strategies. Additionally, there is a potential for MMSD to be fined by WDNR for SSOs.*
	Management Effectiveness	Measure of a given strategy's ability to help management achieve the permit and contract goals. Factors to consider include complexity to implement/operate new technologies or strategies that simplify operations from baseline. *SSOs result in permit violations that need to be addressed by MMSD staff.*
Social	**Safety**	Measure of a given strategy's ability to minimize safety risks to employees, contractors, and the general public. *The difference between strategies for this analysis is assumed to be negligible.*
	Customer Service, Communication and Employee Development	Measure of the advantages of a given strategy to reduce potential complaints and notices of violation, improve communication effectiveness, and/or provide employee development opportunities. *For this analysis, SSOs can lead to complaints and negative public perception of MMSD.*

TABLE 6A-35: CS R11, ALTERNATIVES SCORING MATRIX

Alternative Scoring Matrix SSOs at BS0603 Conveyance Capacity Project CS R11	Alternative 20-yr Present Worth ($ million)	Permit / Legal Requirements	Energy	Environmental Improvements (non-regulatory, resource recovery)	Fiscal Resp.	Management and Operational Effectiveness	Safety	Customer Service, Community Economic Development and Organizational Reputation	Total Weighted Score	Value Ratio (Total Weighted Score / Present Worth
Weights		26	17	15	17	6	13	6	100	
Alternative 1: Remove 24-inch orifice	$0.0140	4	0	4	4	4	0	4	280	20,000
Alternative 2: Raise weir 6 inches	$0.0016	1	0	1	1	1	0	1	55	34,375
Alternative 3: Raise weir 1 foot and remove orifice	$0.0200	5	0	5	5	5	0	5	350	17,500

Recommendations

Hydraulic modeling results indicate that the Alternative 3 will significantly reduce the risk of SSOs from occurring at BS0603 as compared to the SSO risk reduction indicated for Alternative 1 and Alternative 2. Implementation of Alternative 3 would also reduce the chance of violating the WPDES permit and MMSD potentially incurring fines. Alternative 3 also has the highest total weighted score. Even though Alternative 3 does not have the highest value ratio, the cost differential is quite small. For the reasons noted above, and based on engineering judgment, Alternative 3 is recommended.

Note: In November 2019, a project was completed based on the recommendation. Therefore, no additional project is recommended, and this risk is considered addressed.

6.4 Analysis of Risks to Meeting 2050 Foundational Goals

This section evaluates potential alternatives to address the identified risks to meeting MMSD's 2050 Foundational Goals, which address non-permit requirements and include projects that address Commission policy and rules established by MMSD, projects that help to improve regional water quality and reduce energy usage, and projects that are designed to save MMSD money in the long term. Specifically, all of the Conveyance risks that are analyzed in this section are potential risks to meeting the following 2050 Foundational Goals:

- G1: Change the District from an organization that impacts the environment to an organization that benefits the environment.
- G2: Incorporate new technologies and operational improvements to minimize the District's financial burden on ratepayers.

CS FG1 – Programmatic Approach to H_2S in Conveyance System

Purpose

This analysis covers the following identified risk:

TABLE 6A-36: RISKS ADDRESSED

Risk ID	Description
C126	High levels of hydrogen sulfide (H_2S) in various MIS locations

The intent of this analysis is to take a programmatic approach to identifying ways to reduce the amount of hydrogen sulfide (H_2S) present in the MMSD sewer system to assist in meeting environmental, safety, and system performance goals. It reviews and outlines potential new strategies to address these risks.

Elevated levels (greater than 5 parts per million [ppm]) of H_2S are present in the MIS system at various locations. H_2S in sewer segments can lead to odor complaints and pose health risks to the public and maintenance staff. Additionally, corrosion of sewer pipelines, structures, and other equipment can occur from the presence of H_2S in the system (after it has been converted to sulfuric acid) leading to potential failure of the pipeline and related appurtenances.

Approach

Elevated levels of H_2S have been detected at approximately 50 sites within the MMSD conveyance system. MMSD currently monitors and stores H_2S data from these locations; however, no formalized methodology or criteria have been developed to make decisions for projects to address the H_2S at these sites. The goal of this analysis is to identify a programmatic alternative to address this risk.

Strategy Description

A brief summary of the identified strategies is included below.

Strategy 1 – Create a Data Collection Program

A new H_2S data collection and pipe condition assessment program would be developed and implemented. The program would focus on developing a formalized procedure for a data collection methodology. Although MMSD currently collects the data, there is no formalized methodology for doing so. Additionally, there is not a methodology or criteria developed to make decisions for projects or solutions based on the collected data. The procedure would include when, how, and where to collect data. Based on the data collected, the program would rank locations in the MIS by risk of failure and develop projects to address these risks. A consultant would be contracted to help with the program startup.

Strategy 2 – Create an Acceptable Wastewater Discharge Standards Program

A new H_2S wastewater discharge standards program would be developed. The program would develop standards for acceptable wastewater loads (or concentrations) from municipal dischargers and industrial dischargers and would create a regulatory program for MMSD to implement. This program would reduce potential sources of H_2S. This program would not necessarily prevent all instances of H_2S from occurring in the conveyance system due to the various causes of H_2S. A consultant would be contracted to help with the program startup.

Evaluation

Planning-level cost estimates have been developed for each strategy, which are presented in Table 6A-37. The 2050 FP project team developed costs for the conceptual programmatic strategies, which consist of estimated consultant, MMSD staff, and monitoring technician labor costs, as well as costs for advanced inspection techniques, field equipment maintenance, and mileage. Analysis-specific performance factors are developed in Table 6A-38. These performance factors were used to rate the alternatives against each other and then a total weighted score was calculated for each alternative. For each alternative, the total weighted score was divided by the alternative's present worth to determine its value ratio (the value that the alternative provides per million spent), which is presented in Table 6A-39.

TABLE 6A-37: CS FG1, PROGRAMMATIC APPROACH TO H2S PRESENT WORTH PLANNING-LEVEL COST COMPARISON

Planning-Level Costs	Strategy 1 – Create a Data Collection Program	Strategy 2 – Create an Acceptable Wastewater Discharge Standards Program
Total Net Present Value (20-year, 3.375% discount rate)	$10,260,000	$12,470,000

TABLE 6A-38: CS FG1, PROGRAMMATIC APPROACH TO H2S ANALYSIS-SPECIFIC PERFORMANCE FACTORS

Triple Bottom Line Measure	Level of Service Category	Performance Factor
Environmental	**Permit Requirements**	Measure of a given strategy's likelihood to meet permit requirements. KPIs for Permit Requirements related to the conveyance system are: 0 SSOs and 6 CSOs (regulatory); and 0 CSOs (MMSD goal). *For this analysis, H_2S in the sewer can lead to structural failure of pipelines that can lead to an SSO.*
	Energy	A measure of a given strategy's relative impact to baseline energy usage (with reduction in energy demand receiving highest score). *The difference between strategies for this analysis is assumed to be negligible.*
	Environmental Improvements	Measure of the advantages of a given strategy in terms of improvements to the environment. Specific consideration could include impact on meeting specific KPIs and PIs such as the 85% regulatory requirement and the 100% goal of capture of flow into the MMSD system. *For this analysis, H_2S in the sewer can lead to structural failure of pipelines that can lead to an SSO.*
Economic	**Fiscal Responsibility**	General measure of how well a given strategy reduces identified risk(s) in a cost-effective manner. *The most cost-effective strategy receiving highest score with reduction of 1 point per 20 percent increase in cost.*
	Management Effectiveness	Measure of a given strategy's ability to help management achieve the permit and contract goals. Factors to consider include complexity to implement/operate new technologies or strategies that simplify operations from baseline. *Sites with H_2S can prevent maintenance work from being performed, increasing risk of pipe failure and cost of asset rehabilitation/replacement.*
Social	**Safety**	Measure of a given strategy's ability to minimize safety risks to employees, contractors, and the general public. *For this analysis, high concentrations of H_2S can lead to health concerns for maintenance workers; basement backups can occur from structural failure if maintenance activities are unable to be completed leading to public health concerns.*
	Customer Service, Communication and Employee Development	Measure of the advantages of a given strategy to reduce potential complaints and notices of violation, improve communication effectiveness, and/or provide employee development opportunities. *For this analysis, H_2S can lead to odor complaints and negative perception of MMSD from the public.*

TABLE 6A-39: CS FG1, ALTERNATIVE SCORING MATRIX

Alternative Scoring Matrix Programmatic Approach to H_2S Conveyance Project CS FG1	Alternative 20-year Present Worth ($ million)	Permit / Legal Requirements	Energy	Environmental Improvements (non-regulatory, resource recovery)	Fiscal Resp.	Management and Operational Effectiveness	Safety	Customer Service, Community Economic Development and Organizational Reputation	Total Weighted Score	Value Ratio (Total Weighted Score / Present Worth
Weights		26	17	15	17	6	13	6	100	
Alternative 1 – Create a Data Collection Program	$10.26	5	5	5	5	5	5	5	500	48.7
Alternative 2 – Create an Acceptable Wastewater Discharge Standards Program	$12.47	5	4	4	4	4	4	5	432	34.6

Recommendations

The cost of Alternative 1 is 21.5 percent less than Alternative 2. Additionally, Alternative 1 was rated slightly higher in several other categories because it would provide data and an initial foundation for determining where H_2S issues exist in the conveyance system. This would allow MMSD to react sooner to conditions that affect the structural performance of the system, safety, and public health compared to Alternative 2. According to the scoring matrix, Alternative 1 provides a higher value ratio, which indicates that it provides the most value per million dollars spent. Therefore, Alternative 1 is recommended.

Note: Subsequent to development of this analysis, MMSD initiated Contract C02009P01 - H_2S and Odor Mitigation Planning Study. It is assumed that this effort will address the need for a programmatic approach to H_2S mitigation and describe such a program in more detail than what is outlined here. Therefore, the cost for the execution of Contract No. C02009P01 is listed in Table 6A-41 in Section 6.6 as the recommended project to meet 2050 Foundational Goals to address the corresponding Chapter 5 risks. The total approved cost for C02009P01 is noted. It is recommended that the information presented in this analysis be used as appropriate during the study that is executed under Contract No. C02009C01.

CS FG2 – Outfall Alternatives

MMSD identified this risk as a high priority area of concern for the Conveyance system during the development of the 2050 FP. The goal of this analysis is not to identify recommended projects; rather it is to develop general recommendations for ways to manage this risk. The detailed results of this analysis are provided in the Outfall Alternatives technical memorandum (TM), which is provided as Appendix 5A-15 to Chapter 5. This section provides a brief summary of the findings that are outlined in that TM.

Purpose

The purpose of this analysis is to identify generic alternatives for addressing combined sewer and separate sewer outfalls that either lack free discharge or have the potential to allow waters of the state to back up into the conveyance system. These outfall issues cause surcharge in the MIS, which can restrict flow from municipal conveyance systems and lead to basement backups.

Alternatives Description

The Outfall Alternatives TM identifies seven potential alternatives: three for outfalls lacking free discharge and four for outfalls that allow receiving waters to backup into the Conveyance system.

Recommendations

The Outfall Alternatives TM presents the pros and cons of the identified alternatives. The 2050 FP project team recommends that each specific outfall be evaluated to determine if a problem exists and which alternative would be the most appropriate solution at each outfall. The 2050 FP project team also recommends that MIS overflow structures and outfall locations and systems be further studied to determine the potential occurrences of backups in the system. Outfalls that are experiencing more frequent problems should be considered for additional evaluation and future projects. Projects and upgrades that reduce or eliminate the amount of MIS system wastewater overflows should continue to be investigated.

CS FG3 – H_2S, Odors, and Venting

MMSD identified this risk as a high priority area of concern for the Conveyance system during the development of the 2050 FP. The goal of this analysis is not to identify recommended projects; rather it is to develop general recommendations for ways to manage this risk. The detailed results of this analysis are provided in the H_2S, Odor, and Venting TM, which is provided as Appendix 5A-13 to Chapter 5. This section provides a brief summary of the findings that are outlined in that TM.

Purpose

The purpose of this analysis is to review and make recommendations on three types of sewer conditions that exist in the MMSD MIS system:

1. High H_2S levels in the sanitary and combined conveyance systems
2. Excessive fugitive odors emitted from the sanitary and combined conveyance systems
3. Inadequate ventilation of the sanitary and combined conveyance systems

A description of each sewer condition and its associated problems is provided in the TM. Alternative solutions are outlined for each sewer condition with the goal of reducing the presence of H_2S and odor in the collection systems. Solutions to improve controlled venting of the system are also included.

Alternatives Description

The H_2S, Odor, and Venting TM discusses the following potential solutions to help mitigate the production, accumulation, and release of H_2S gas and odors:

- Sewer cleaning to remove settled organics deposits and fats, oils, and grease (FOG)
- H_2S discharge regulation
- Structural modifications to reduce/eliminate turbulence
- Oxygen injections to increase dissolved oxygen and reduce sulfide generation
- Chemical additions
- Carbon filters
- Bio-filters
- Bio-trickling filters
- Chemical scrubbers
- Alternative media scrubbers
- Air jumpers at siphons
- Vent stacks
- Controlled release of odorous gases

Additionally, the TM notes that in some areas with H_2S or odor problems, construction of a "dual" or parallel sewer could be considered. The dual sewer would be designed primarily to convey low or normal flows at optimum velocity to help prevent formation of H_2S or odors compared to the existing larger sewer. The larger sewer would still be available for flows that exceed the capacity of the smaller system. Implementation of this concept would require careful planning and only be feasible where topography and other physical constraints would allow the necessary installation details. Additionally, route selection and alignment of second sewer system would likely be challenging and costly in some areas.

Recommendations

Based on the review of the causes, problems, and potential solutions for H_2S gas, odor, and inadequate venting in a sewerage conveyance system, the H_2S, Odor, and Venting TM makes the following conclusions and recommendations:

1. Understanding the characteristics of the conveyance system can help determine causes and help predict future issues. It is recommended that problem sewers be monitored for H_2S concentrations, sewer pressure, odor complaints, and wastewater characteristics.
2. H_2S formation is commonly caused by decomposition of solids and debris that accumulates in sewer pipes. It is recommended that the design and modification of conveyance systems result in a cleansing velocity of at least 2.5 feet per second (fps) at average daily flow to prevent solids from accumulating on the bottom of pipes.
3. Identification of H_2S problem areas is important to determine where treatment or system improvements should be implemented. Use of MMSD's existing data system that identifies these areas should continue as necessary to track odor complaints (date, location, resolution of complaint). CS FG1, Programmatic Approach to H_2S expands the wastewater data collection program(s) and helps identify projects to address H_2S issues at these problem locations.
4. For future H_2S monitoring or data collection efforts, a gaseous H_2S concentration of 5 ppm should be used as a threshold to determine when H_2S treatment to prevent corrosion from occurring in the sewer.
5. The TM provides a tabulation of known problem areas that have excessive levels of H_2S or are suspected of having H_2S issues. These areas should be further investigated, and treatment alternatives should be selected to help lower the H_2S levels.
6. H_2S problems can be caused by a variety of circumstances. An H_2S assessment tool provided with the TM provides a methodology to evaluate locations and reasons why H_2S is forming in the collection system and provides potential solutions for each reason.
7. Multiple technologies are available to prevent the development of or mitigate H_2S gas or odors. A detailed study of alternatives should be completed at each problem location to determine feasibility, capital costs, and operation and maintenance costs. If necessary, a combination of alternatives can be implemented at specific locations for more efficient treatment.
8. A method of preventing the formation and presence of H_2S in sewers is the continuation of programs that regulate industrial discharges. Further studies could be done to identify locations and problem areas where industrial discharges may be contributing to H_2S formation.
9. During MMSD plan reviews of municipal sewer projects, special consideration should be given to the amount of industrial discharge the municipality receives. Pre-treatment of the industrial wastewater may be necessary before it is discharged into the municipal sewer system, and eventually, the MIS.

10. MMSD's 39-inch "special section" sewers appear to allow more solids to settle compared to round pipes, thereby increasing the likelihood of H_2S formation. This increase in settlement should be considered if a special section is considered for the design of a new sewer, if rehabilitation of a special section sewer is planned, or when maintenance activities are scheduled.
11. Measuring the concentration of H_2S in the conveyance system is necessary before a chemical treatment is selected. Wastewater characteristics should be measured prior to treatment to determine baseline values, followed by pilot studies to determine proper doses and the effectiveness of various chemicals treatments.
12. Installing vent stacks at specific locations within the conveyance system can be an effective way control the release of odorous gases. Vent stacks can be configured to release odorous gas at locations away from or at elevations above the public thereby reducing or eliminating complaints.
13. Monitoring H_2S levels downstream of problem areas after implementation to determine effectiveness of treatment.

Note: Subsequent to development of this analysis, MMSD initiated Contract C02009P01 - H_2S and Odor Mitigation Planning Study. It is assumed that the information presented in this analysis could be incorporated into that project.

CS FG4 – Sewer Self Cleaning/Low Flow

MMSD identified this risk as a high priority area of concern for the Conveyance system during the development of the 2050 FP. The goal of this analysis is not to identify recommended projects; rather it is to develop general recommendations for ways to manage this risk. The detailed results of this analysis are provided in the Sewer Self-Cleansing TM, which is provided as Appendix 5A-16 to Chapter 5. This section provides a brief summary of the findings that are outlined in that TM.

Purpose

The purpose of this analysis is to consider whether MMSD should revise its design velocity requirements for new and existing MIS segments (not local municipal sewers) to address the issues related to the accumulation of sewer solids and low velocities experienced in MMSD's MIS system.

The wastewater characteristics and predominant sewer sizes of the MMSD system are the reasons why velocity requirements should be greater than the required 2.0 fps to scour or remove settled solids within the sewer segments.

The analysis also discusses causes of and possible solutions to continuous settlement of solids in the existing MIS system. The accumulation of solids in a sewer reduces its conveyance capacity and can potentially cause anaerobic conditions, resulting in methane gas, hydrogen sulfide gas, odors, and corrosion of the sewer infrastructure. If these conditions cannot be prevented, more frequent cleaning and maintenance is needed.

Finally, the analysis also includes a review of the state of the industry regarding potential solutions to the problem of inadequate sewer self-cleansing velocity and excess accumulation of solids, including operation and maintenance innovations, strategies, and techniques that other organizations have implemented to address these issues.

Alternatives Description

The Sewer Self-Cleansing TM (Appendix 5A-16 to Chapter 5) provides several potential corrective actions for addressing inadequate self-cleansing velocities in sewers that are caused by the following:

<u>Physical Attributes</u>

- Sewer constructed at less than minimum slope
- Sags or settlement in sections of sewers
- Defective/offset joints or cracked pipe
- Obstructions in the sewer
- Non-laminar transitions at manholes with multiple inlets
- Intrusion of roots at defective joints and municipal connections

<u>Flow Characteristics</u>

- Actual flows less than design flows
- Reduced diurnal flow rates

- I/I reduction efforts lowering flows throughout collection system
- Industrial discharges of granular or heavy particles
- New building construction utilizing modern reduced flow plumbing fixtures

Maintenance Conditions

- Increased roughness of sewer walls
- Lack of physical access to manholes for routine cleaning and maintenance
- Accumulation of domestic, industrial, and commercial solids or FOG

Recommendations

The Sewer Self-Cleansing TM (Appendix 5A-16 to Chapter 5) makes the following conclusions and recommendations:

1. Design/improve sewers with adequate slopes to prevent solids accumulation. It is recommended that during sewer design or improvement, sewers be constructed to give daily scour velocities of not less than 2.0 fps. When this criterion cannot be met, additional operations, maintenance, and monitoring steps should be considered.
2. Consider low diurnal flows, specific wastewater characteristics, and grit loads when designing or improving sewers. In areas where scour velocities may need to be increased, the use of flushing gates, stored rainwater or sewage, or rerouted flows from other sewer collection systems can be used.
3. Establish collection system design criteria for the MIS system to be used for sewer design and improvements. As stated previously, different collection systems may require different scouring velocities, depending on wastewater, pipe, and flow characteristics. An independent analysis could be commissioned to establish design criteria for MMSD's collection system. Modeling should be performed with the established design criteria to determine the overall effectiveness of the criteria.
4. Continue to implement and enforce local limits and local capacity, management, operations, and maintenance (CMOM) requirements.
5. Perform more frequent inspection to identify sewers with deteriorating infrastructure and conduct more frequent cleaning to address excess solids settlement and accumulation of FOG. Document sewers that require sewer rehabilitation and more frequent cleaning to focus efforts appropriately. Sewers with diameters greater than 48 inches and require maintenance should be cleaned by contractors with the expertise and specialized equipment necessary for working in large sewers.
6. Implement a project that uses the large-diameter sewer cleaning methodologies as described in the TM to evaluate the effectiveness of these systems.
7. Maintain the conveyance system model to determine deficient velocities within the collection system. MMSD should keep the existing conveyance model up to date with collection system modifications, improvements, and upgrades.

CS FG5 – Access Issues

MMSD identified this risk as a high priority area of concern for the Conveyance system during the development of the 2050 FP. For this evaluation, MMSD identified three areas in the MIS system as being very difficult to access. The locations were selected based on staff knowledge and may not include all sewer segments with access issues in the conveyance system. The three areas evaluated are listed below under Alternatives Description. These areas contain numerous segments of the MIS system that have consistent accessibility issues.

The evaluation of each area discussed in this TM is intended to provide a preliminary investigation of access issues, potential solutions, general recommendations, and conceptual costs for risk mitigation measures at each location. A more detailed analysis would be necessary to refine the alternatives, costs, and recommendations discussed in the TM. The alternatives and recommendations provided for each location can be used as an example for other locations within the system identified as having similar access issues. Additionally, the conceptual costs for the risk mitigation measures were not developed using the 2050 FP procedures and are not used to compare alternatives.

The goal of this analysis is not to identify recommended projects in the context of the 2050 FP; rather it is to develop general recommendations for ways to manage the identified risk. The detailed results of this analysis are provided in the Conveyance Access Alternatives TM, which is provided as Appendix 5A-14 to Chapter 5. This section provides a brief summary of the findings that are outlined in that TM.

Purpose

The purpose of this analysis is to evaluate three areas of the MIS system that Veolia and MMSD have identified as having difficult-to-access sewer segments and to provide alternatives to improve access. The alternatives focus on providing access to manholes when large equipment is required for sewer cleaning and emergencies. Alternatives that are reviewed in this analysis help identify conceptual measures to alleviate accessibility issues in specific sewer segments. Any sewer realignment alternatives identified in this study should be considered at the time the existing MIS would need to either be replaced due to mortality or improved due to capacity. Additional locations that are difficult to access may be identified as further inspections of the system are conducted.

Alternatives Description

The Conveyance Access Alternatives TM (Appendix 5A-14 to Chapter 5) provides potential alternatives for providing equipment/vehicle access to structures and providing access to buried/not found structures for the following specific sewer segments:

- Oak Creek North Branch Interceptor (Segment Leg Q)
- Caesar's Park off Warren Avenue (Segment Leg XB, NS07 CSO 099)
- Milwaukee River West Main (Segment Leg A2)

Recommendations

The Conveyance Access Alternatives TM (Appendix 5A-14 to Chapter 5) makes the following conclusions and recommendations:

1. Follow the recommendations provided in the individual investigations in TM. It is recommended that further investigation of Leg XB (Caesar's Park off Warren Ave) and Leg A2 (Milwaukee River West Main) be conducted to determine if relocation of MIS segments in these areas would be practical and cost effective.
2. The MIS system should be accessible in emergencies. Structures that are only accessible in winter months may be acceptable for inspections, but not for emergency sewer work. As rehabilitation or replacement projects for sewers with access issues become necessary, accessibility problems along these segments should be addressed during project planning and design.
3. The presence of H_2S and PCBs hinder maintenance and inspection of sewers. It is recommended that locations with H_2S and PCB issues be further evaluated and measures taken to alleviate the H_2S and PCB issues to allow inspection and maintenance work to occur at these locations.
4. All MIS segments and other conveyance facilities should be investigated and analyzed for accessibility. Based on this analysis, additional locations with access issues should be added to the Risk Register to be addressed by MMSD in the future. The locations should also be added to leg maps that will be used during project planning to incorporate potential access improvements into larger scale projects that are in these areas.
5. Both Veolia and MMSD have collected data regarding access issues, located in Attachment A to the TM. Veolia and MMSD records should be compiled into a single accurate and useable database.
6. The area surrounding the structures significantly affects accessibility at each location. A GIS database should be created to include all the structures in the MMSD conveyance system. The practice of taking pictures of each manhole by MMSD should be continued to help describe specific locations and the area surrounding each access point. The database should be updated periodically with new pictures and when new segments of the sewer system are (re)constructed. This GIS tool would make it easier and more efficient to locate structures throughout the system and to assess any new or changed conditions.
7. Drawings should be prepared showing the best route(s) to structures that are difficult to locate. These drawings can be incorporated into the emergency action plans recommended to be prepared for the various locations with access issues. This would save time when attempting to access these areas during an emergency.

6.5 Additional Projects

The 2050 FP was developed during a period when a large number of MMSD initiatives were already underway and MMSD had already initiated several Conveyance projects that align with the goals of the 2050 FP. Although alternative analyses for these projects are not included in the 2050 FP, they are listed here to document that they are MMSD projects that are included in Chapter 7, Recommended Plan to meet Regulatory Guidelines and Permit Requirements, or Chapter 8, Recommended Plan to meet Foundational Goals.

Projects to meet Regulatory Guidelines and Permit Requirements

Mill Road Relief Sewer – Project No. C04010

The purpose of this project is to reduce SSOs and provide conveyance relief to the 72-inch diameter MIS from West Green Tree Road and North River Road at bypass structure BS0404 to West Mill Road and North Sydney Place at Diversion Chamber DC0409. In both 2014 and 2015, overflows occurred at BS0404 while the ISS was available for inflows from this area. The overflows are an indication that enough development has occurred to cause a need for conveyance enhancement or relief of the 72-inch diameter MIS downstream of BS0404.

The scope of this project also includes a hydraulic evaluation to determine a solution that will address the 72-inch diameter MIS as well as other known conveyance issues on the northeast side of MMSD's service area. Planning-level cost estimates for this project were based on the construction of conveyance relief improvements consisting of 8,300 linear feet of 108-inch diameter sewer and 12 manholes with depths between 20 and 50 feet.

The planning-level cost for the Mill Road Relief Sewer Project is estimated to be $51 million, including construction, contingencies, and engineering and administrative costs based on the preliminary MMSD 2020 to 2025 long-range finance plan. Construction is scheduled to occur between May 2023 and January 2026.

Brown Deer Road Sewer – Project No. C04013

The purpose of this project is to reduce the risk of basement backups in the Village of Bayside by replacing a deep and undersized MIS that experiences frequent surcharging. The scope of the project includes the design and construction of approximately 600 feet of new 24-inch diameter sanitary sewer, abandonment of approximately 600 feet of existing 15-inch diameter PVC MIS, reconnecting sewer laterals serving three houses along the south side of East Brown Deer Road, two new cast-in-place manholes, and one new monitoring manhole for installation of monitoring station (MS)0440.

All properties served by the Brown Deer Road sewer are in the Village of Bayside. Upon completion of this project, ownership of the sewer will be transferred to the Village of Bayside. It is anticipated that this project will decrease maintenance costs for MMSD once the sewer is transferred to the Village of Bayside.

The planning-level cost for the Brown Deer Road Sewer Project is estimated to be $2.3 million, including construction, contingencies, and engineering and administrative costs based on the preliminary MMSD 2020 to 2025 long-range finance plan. Construction is scheduled to occur between October 2021 and January 2026.

River Road MIS - Project No. C05053

The purpose of this project is to improve the hydraulic capacity of MMSD's North Shore MIS by constructing a relief sewer for the Milwaukee River MIS north of Green Tree Road. The existing Milwaukee River MIS surcharges and reaches CEs during large rain events, which has led to overflows at the Range Line Road Pump Station. The relief sewer will divert wet weather flows from West Dean Road to West Green Tree Road via North River Road.

The project includes design and construction of 11,780 feet of 42-inch and 48-inch sewers installed by microtunneling.

The planning-level cost for the River Road MIS Project is estimated to be $57.8 million, including construction, contingencies, and engineering and administrative costs based on the projected cost estimate from MMSD's Technical Services Division. The project is scheduled to start in October 2026, with completion expected in 2030.

Projects to meet Foundational Goals

Edgewood Avenue MIS Extension – Project No. C05051

The purpose of this project is to improve the hydraulic conditions at the connection between the local sewer and MMSD facilities. This improvement will reduce the likelihood of basement backups in the Village of Shorewood and the City of Milwaukee. Reducing water levels in the area will result in a greater level of service to the municipalities.

The project is planned to include the construction of approximately 2,300 feet of 72-inch diameter near surface collector sewer and two new diversion structures in East Edgewood Avenue.

The planning-level cost for the Edgewood Avenue MIS Extension Project is estimated to be $11.5 million, including construction, contingencies, and engineering and administrative costs based on the preliminary MMSD 2020 to 2025 long-range finance plan. Construction is scheduled to occur between November 2020 and July 2022.

North Shore (NS)12 Collector System Improvements – Project No. I06001

The purpose of this project is to reduce the risk of CSOs and wastewater discharges to the ground surface related to the NS12 collector system. The improvements were recommended as part of the root cause analysis of frequent unintended overflows at CSO145.

This project will help prevent future unintended CSOs and surface flooding as a result of blown manhole covers. This project is planned to include the construction of two new structures, 2,440 feet of 84-inch diameter pipe, and level and flow monitoring equipment.

The planning-level cost for the NS12 Collector System Improvements Project is estimated to be $18.2 million, including construction, contingencies, and engineering and administrative costs based on the preliminary MMSD 2020 to 2025 long-range finance plan. Construction is scheduled to occur between October 2021 and January 2026.

Oak Creek Southwest MIS Extension - Project No. C02013

This project should be implemented only after coordination with Village of Raymond and Town of Caledonia's facility planning efforts indicates a need (coordination may also include the Cities of Oak Creek and Franklin). The proposed MIS extension is intended to primarily convey wastewater from an approximately 7.5 square mile area of existing and potential future development in the Town of Raymond and the Village of Caledonia in Racine County. Approximately another 2.5 square miles of the sewer service area for the MIS extension would be within Milwaukee County in an area located east and west of South 27th Street, north of the county line, and south of West Ryan Road.

The MIS extension would connect to an existing 24-inch diameter MIS at MMSD MH40517 near the intersection of West Oakwood Road and South 27th Street and extend approximately 5,200 feet south to a point just south of the Root River near the I-94 west frontage road. The proposed MIS would terminate just north of the Racine County-Milwaukee County border, and the Town of Raymond and the Village of Caledonia would connect local sewers to the MIS at this point.

The depth of the proposed 24-inch diameter MIS would range from approximately 91 feet at MH 40517 to 18 feet at the upstream end south of West County Line Road. The MIS would be constructed beneath the Root River with a minimum depth of cover below the river bottom of approximately 5 feet based on the conceptual pipe profile. Assuming one manhole every 500 feet, there would be 10 to 11 manholes along the alignment.

The full-pipe capacity of the proposed 24-inch diameter MIS extension would be approximately 13 cfs (0.33 percent pipe slope), which is approximately the same as the existing 24-inch diameter MIS. The existing 24-inch diameter MIS connects to an 84-inch diameter MIS at West Ryan Road one mile north of West Oakwood Road.

Based on the overall depth of the proposed pipeline and the need to construct an approximately 200-foot-long crossing beneath the Root River, it is assumed that the majority of the pipeline would be installed by microtunneling. However, 500 to 1,000 feet of the pipeline could also be installed by open-cut construction where the depth of cover is less than 20 feet adjacent to the river.

The planning-level 20-year present-worth cost for the Oak Creek Southwest MIS Extension is estimated to be $21.3 million, including construction, contingencies, engineering and administrative costs and operation and maintenance costs. This estimate is based on using the cost estimating procedures developed for the conveyance capacity project analyses (see projects CS R1 to CS R8 in Section 6.3).

6.6 RECOMMENDED CONVEYANCE PROJECTS

This section presents a summary of the recommended Conveyance projects.

- Table 6A-40 summarizes the recommended Conveyance projects to meet regulatory guidelines and permit requirements.
- Table 6A-41 summarizes the recommended Conveyance projects to meet 2050 Foundational Goals.

TABLE 6A-40: SUMMARY OF RECOMMENDED CONVEYANCE PROJECTS TO MEET REGULATORY GUIDELINES/PERMIT REQUIREMENTS

Ch 6 Analysis	Specific Description of Potential Risk	How Potential Risk was Identified	Name of Recommended Project	More Research/ Effort Recommended Prior to Project? (Y/N)[1]	Recommended Timeframe of Project	Capital Costs ($ millions)	Annual O&M Costs ($ thousands)	Present Worth Cost ($ millions)
CS R1, South Howell Ave Pipe Capacity	A critical elevation is exceeded by 8.4 ft. at MH17604 in the South Howell Avenue MIS	Model run of 5-year LOP flow	Alternative 1 – relief sewer	Y – flow monitoring and updated modeling	2020–2024	$4.7	$2.0	$4.7
CS R2, South 81-84 St Pipe Capacity	A critical elevation is exceeded by 3.7 ft. at MH08307 in the South 81st – 84th Street MIS	Model run of 5-year LOP flow	Alternative 1 – relief sewer	Y – flow monitoring and updated modeling	2020–2024	$8.1	$4.3	$8.2
CS R3, North Sherman Blvd Pipe Capacity	A critical elevation is exceeded by 5.2 ft. at MH 12221 in the North Sherman Blvd. MIS [2]	Model run of 5-year LOP flow	Alternative 3 – I/I reduction	Y – flow monitoring and updated modeling	2020–2024	$3.4	$3.1	$3.4[3]
CS R4, West Hampton Ave Pipe Capacity	A critical elevation is exceeded by 1.3 ft. at MH12104 in the West Hampton Avenue MIS [2]	Model run of 5-year LOP flow	Alternative 3 – I/I reduction	Y – flow monitoring and updated modeling	2020–2024	$8.7	$1.3	$8.7[3]
CS R5, N Commerce St Pipe Capacity	A critical elevation is exceeded by 0.6 ft. at MH00901 in the North Commerce Street MIS [2]	Model run of 5-year LOP flow	Alternative 1 – relief sewer	Y – flow monitoring and updated modeling	2020–2024	$6.4	$5.2	$6.5
CS R6, Ryan Rd Pipe Capacity	A critical elevation is exceeded by 2.1 ft. at MH40802 in the West Ryan Road MIS	Model run of 5-year LOP flow	Alternative 1 – relief sewer	Y – monitor development/growth and flow increases, updated modeling	Dependent on growth and flow	$141.7	$52	$142
CS R7, N 91st Pipe Capacity	A critical elevation is exceeded by 10.5 ft. at MH19713 in in the North 91st Street MIS [2]	Model run of 5-year LOP flow	Alternative 1 – relief sewer	Y – monitor development/growth and flow increases, updated modeling	Dependent on growth and flow	$67.7	$32.4	$68.2
CS R8, 27th St Pipe Capacity	A critical elevation is exceeded by 0.8 ft. at IS502 at West Greeves Street in the North 27th St. MIS	Model run of 5-year LOP flow	Alternative 2 – 42-inch relief sewer	Y – monitor development/growth and flow increases, updated modeling	Dependent on growth and flow	$3.8	$1.5	$3.8
CS R9, Combat I/I Impact	If pipes are not maintained, ongoing pipe degradation could cause I/I to increase by 14 percent from Conveyance Baseline I/I flows	Ad Hoc Request 211 analysis Enforcement Metershed Assessment	WWPFMP - Program Funding under Project No. M10004	Y - policy change to PPI/I program, update model, in-depth flow monitoring analysis	2020–2025	$3.9[4]	$0	$3.9[4]
					2026–2040	$42.5[4]	$0	$42.5[4]
			I/I Mitigation Implementation – Program Funding under Project No. M10005		2020–2025	$8.4[4]	$0	$8.4[4]
					2026–2040	$132.0[4]	$0	$132.0[4]
CS 10, Physical Mortality Evaluation	If aging pipes and facilities are not rehabbed or replaced, there may be system failures	AssetView condition data	Conveyance pipes - evaluate repair/replacement needs for Category A pipes	N –evaluation is the project	2020–2024	$0.5[5]	$0	$0.5[5]
			Facilities – evaluate repair/replacement needs in pump stations (only pumping and electrical/control equipment considered)	N –evaluation is the project	2020–2024	$0.6[5]	$0	$0.6[5]

TABLE 6A-40: SUMMARY OF RECOMMENDED CONVEYANCE PROJECTS TO MEET REGULATORY GUIDELINES/PERMIT REQUIREMENTS

Ch 6 Analysis	Specific Description of Potential Risk	How Potential Risk was Identified	Name of Recommended Project	More Research/ Effort Recommended Prior to Project? (Y/N)[1]	Recommended Timeframe of Project	Capital Costs ($ millions)	Annual O&M Costs ($ thousands)	Present Worth Cost ($ millions)
CS 11, Risk of SSOs Occurring at BS0603	Frequent SSOs have occurred at BSO603	Historical data and modeling data	None Project completed in November 2019 per recommendation: Alternative 3 – raise weir 1 foot and remove orifice	N	NA	NA	N/A	NA
N/A[6]	Conveyance Risk Register No. C002, C003, C007, C034	MMSD staff	Mill Road Relief Sewer, Project No. C04010 (relief sewer)	N	2020–2024	$51.0	$6.0	$51.1
N/A[6]	Conveyance Risk Register No. C071, C072, 110	MMSD staff	Brown Deer Road Sewer, Project No. C04013 (replacement sewer)	N	2020–2024	$2.3	$0.5	$2.3
N/A[6]	Conveyance Risk Register No. C085	MMSD staff	River Road MIS, Project No. C05053 (replacement sewer)	N	2020 – 2024	$57.8	$9.0	$57.9

1) Where applicable, additional research opportunities are identified in Chapter 9.
2) Modeling indicates that multiple critical elevations are exceeded along the subject MIS. Only the worst case within the evaluated section is listed in this table.
3) The cost to the MMSD listed is based on an assumed 50/50 cost share between MMSD and the applicable municipality.
4) Capital costs represent total additional costs to projects in the 2020 to 2025 long-range finance plan. Additional costs to municipalities and private property estimated to be $60-65M annually for rehabilitation and replacement and I/I reduction work on municipal and private sewers. Note that most of these costs are not new costs to the municipalities; they are expenses that are assumed to be incurred to reduce excess I/I and maintain I/I levels as required by MMSD Rules as part of its existing conveyance system maintenance programs.
5) Evaluations will assess the physical mortality needs to determine if costs already allocated to Project No. C90001, Allowance for Future Conveyance Rehab Projects are adequate.
6) Subsequent to the assessment of potential risks conducted for Chapter 5, MMSD identified several additional Conveyance projects to be completed. Although alternative analyses for these projects were not conducted for the 2050 FP, they are listed in this table to document that they are proposed MMSD projects.

TABLE 6A-41: SUMMARY OF RECOMMENDED CONVEYANCE PROJECTS TO MEET 2050 FOUNDATIONAL GOALS

Ch 6 Analysis	Specific Risk Description	How Potential Risk was Identified	Name of Recommended Project	More Research Recommended Prior to Project? (Y/N)[1]	Recommended Timeframe of Project	Capital Costs ($ millions)	Annual O&M Costs ($ thousands)	Present Worth Cost ($ millions)
CS FG1, Programmatic Approach to H_2S	H2S in sewer system can cause odor complaints, pose health risks, and cause corrosion	MMSD staff identified as a high priority area of concern. Documented in H_2S, Odors, and Venting TM	Implementation of contract C02009P01, H2S and Odor Mitigation Planning Study	Y – to be covered in planning study	2020–2024	$0[2]	N/A	$0[2]
CS FG2, Outfall Alternatives	Combined sewer and separate sewer outfalls that lack free discharge or have the potential to allow waters to back into the conveyance system can cause surcharges in the MIS	MMSD staff identified as a high priority area of concern. Documented in Outfall Alternatives TM.	N/A (purpose of analysis was to identify ways to manage issue, not to identify specific projects)	Y – evaluate identified outfalls to determine if problem exists and which alternative would be most appropriate, study MIS overflow structures and outfall locations[3]	N/A	$0[3]	N/A	$0[3]
CS FG3, H_2S, Odors, and Venting	H2S in sewer system can cause odor complaints, pose health risks, and cause corrosion	MMSD staff identified as a high priority area of concern. Documented in H_2S, Odors, and Venting TM	N/A (purpose of analysis was to identify ways to manage issue, not to identify specific projects, though information could be used in Contract No. C02009P01, H2S and Odor Mitigation Planning Study)	Y – to be covered in planning study	2020–2024	N/A	N/A	N/A
CS FG4, Sewer Self Cleaning / Low Flow	Low flows can lead to accumulation of sewer solids, potentially causing methane gas, H_2S gas, odors, and corrosion of sewers	MMSD staff identified as a high priority area of concern. Documented in Sewer Self Cleansing/Low Flow TM	N/A (purpose of analysis was to identify ways to manage issue, not to identify specific projects)	N/A	N/A	N/A	N/A	N/A
CS FG5, Access Issues		MMSD staff identified as a high priority area of concern. Documented in Conveyance Access Issues TM	N/A (primary purpose of analysis was to identify ways to manage issue, not to identify specific projects)	N/A	N/A	N/A	N/A	N/A
N/A[4]	Conveyance Risk Register No. C096	MMSD staff	Edgewood Avenue MIS Extension, Project No. C05051 (relief NSC sewer)	N	2020–2024	$11.5	$2.0	$11.5
N/A[4]	Conveyance Risk Register No. C107	MMSD staff	NS 12 Collector System Improvements, Project No. I06001 (relief NSC sewer)	N	2020–2024	$18.2	$2.0	$18.2

Ch 6 Analysis	Specific Risk Description	How Potential Risk was Identified	Name of Recommended Project	More Research Recommended Prior to Project? (Y/N)[1]	Recommended Timeframe of Project	Capital Costs ($ millions)	Annual O&M Costs ($ thousands)	Present Worth Cost ($ millions)
N/A[4]	Conveyance Risk Register No. C066	MMSD staff	Oak Creek Southwest MIS Extension, Project No. C02013 (sewer extension)	Y - coordination with Village of Raymond and Town of Caledonia facility planning	2025–2029	$21.3	$4.0	$21.4

1) Where applicable, additional research opportunities are identified in Chapter 9.
2) Total Approved Project Costs from MMSD Commission Document is $1.2M. Planning/engineering services contract amount as awarded in July 2019 is $0.38 million.
3) Outfall locations are presented in the Conveyance Subsystem Dashboards, in Appendices 5A-1 through 5A-7, and Leg Maps in Appendix 5A1-7. See Appendix 5A-15, Outfall Alternatives TM, for more details.
4) Subsequent to the assessment of potential risks conducted for Chapter 5, MMSD identified several additional Conveyance projects to be completed. Although alternative analyses for these projects were not conducted for the 2050 FP, they are listed in this table to document that they are proposed MMSD projects.

6.7 APPENDICES

- Appendix 6A-1, CS R1 Peak HGL Conveyance Model Profiles
- Appendix 6A-2, CS R1 Alternative 1 Schematic Map
- Appendix 6A-3, CS R1Alternative 2 Schematic Map
- Appendix 6A-4, CS R1Conveyance Project Conceptual Costs
- Appendix 6A-5, CS R2 Peak HGL Conveyance Model Profiles
- Appendix 6A-6, CS R2 Alternative 1 Schematic Map
- Appendix 6A-7, CS R2 Alternative 2 Schematic Map
- Appendix 6A-8, CS R2 Conveyance Project Conceptual Costs
- Appendix 6A-9, CS R3 Peak HGL Conveyance Model Profiles
- Appendix 6A-10, CS R3 Alternative 1 Schematic Map
- Appendix 6A-11, CS R3 Alternative 2 Schematic Map
- Appendix 6A-12, CS R3 Alternative 3 Schematic Map
- Appendix 6A-13, CS R3 Conveyance Project Conceptual Costs
- Appendix 6A-14, CS R4 Peak HGL Conveyance Model Profiles
- Appendix 6A-15, CS R4 Alternative 1 Schematic Map
- Appendix 6A-16, CS R4 Alternative 2 Schematic Map
- Appendix 6A-17, CS R4 Alternative 3 Schematic Map
- Appendix 6A-18, CS R4 Conveyance Project Conceptual Costs
- Appendix 6A-19, CS R5 Peak HGL Conveyance Model Profiles
- Appendix 6A-20, CS R5 Alternative 1 Schematic Map
- Appendix 6A-21, CS R5 Alternative 2 Schematic Map
- Appendix 6A-22, CS R5 Conveyance Project Conceptual Costs
- Appendix 6A-23, CS R6 Peak HGL Conveyance Model Profiles
- Appendix 6A-24, CS R6 Alternative 1 Schematic Map
- Appendix 6A-25, CS R6 Alternative 2 Schematic Map
- Appendix 6A-26, CS R6 Conveyance Project Conceptual Costs
- Appendix 6A-27, CS R7 Peak HGL Conveyance Model Profiles
- Appendix 6A-28, CS R7 Alternative 1 Schematic Map
- Appendix 6A-29, CS R7 Alternative 2 Schematic Map

- Appendix 6A-30, CS R7 Conveyance Project Conceptual Costs
- Appendix 6A-31, CS R8 Peak HGL Conveyance Model Profiles
- Appendix 6A-32, CS R8 Alternative 1 Schematic Map
- Appendix 6A-33, CS R8 Alternative 2 Schematic Map
- Appendix 6A-34, CS R8 Conveyance Project Conceptual Costs
- Appendix 6A-35, CS R9 Ad Hoc 211
- Appendix 6A-36, CS R9 Combat I/I Details
- Appendix 6A-37, CS R10 Conveyance Physical Mortality Maps
- Appendix 6A-38, CS R10 Conveyance Pipe and Pump Station Workbooks

6.8 REFERENCES

[1] Brown and Caldwell, "Ad Hoc Modeling Request 211: Evaluation of I/I Influences," Brown and Caldwell, Milwaukee, WI, 2018.

[2] 2020 Facilities Plan Team, "2020 Facilities Plan Report," Milwaukee Metropolitan Sewerage District, Milwaukee, WI, March 2007.

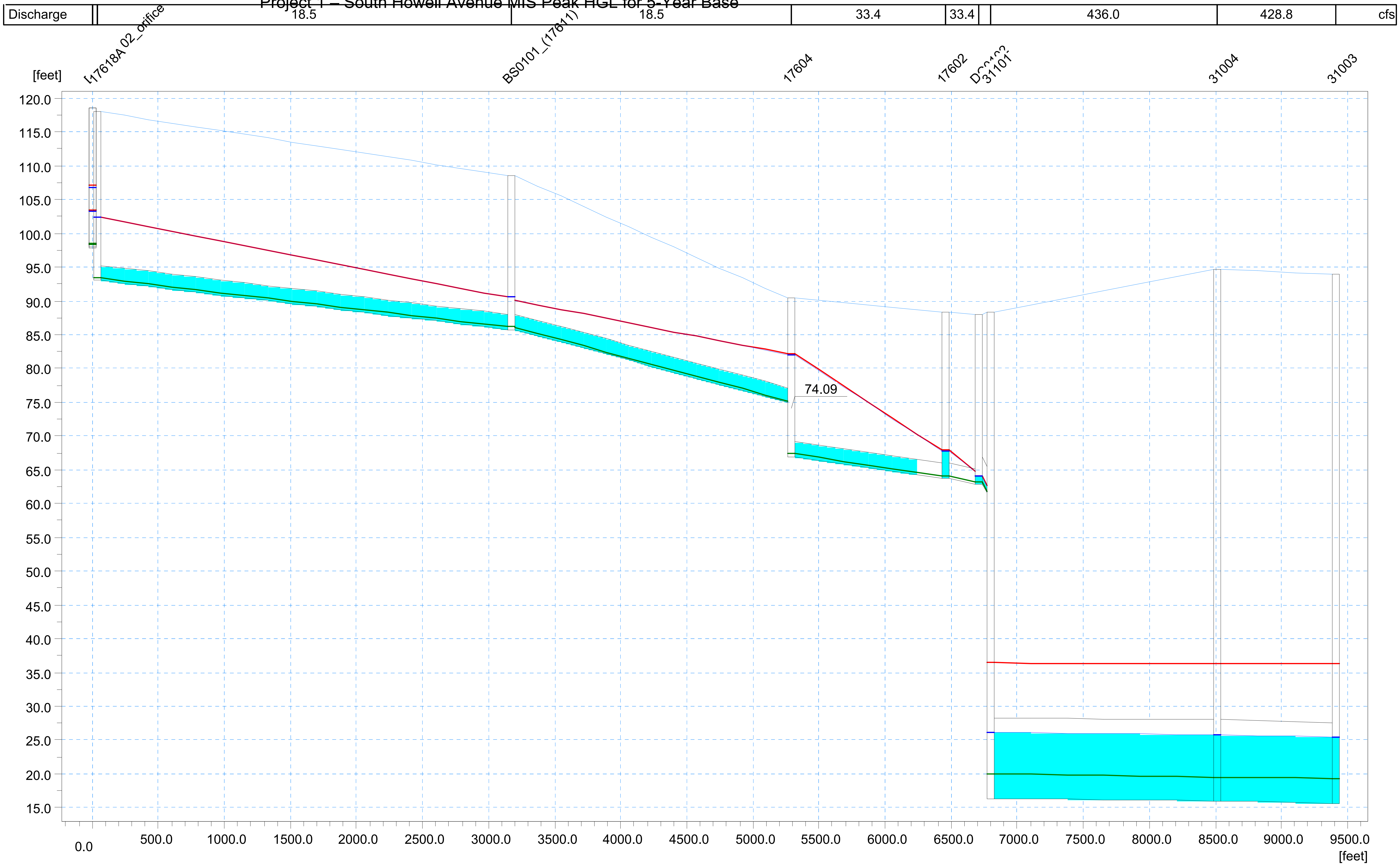
[3] Wisconsin Department of Transportation, Construction Plans, Bridge B-40-513, November 1978.

[4] Milwaukee Metropolitan Sewerage District, Record Drawings, Contract No. C07006C01 - Menomonee Special-West, Milwaukee, WI: MMSD, June 2007.

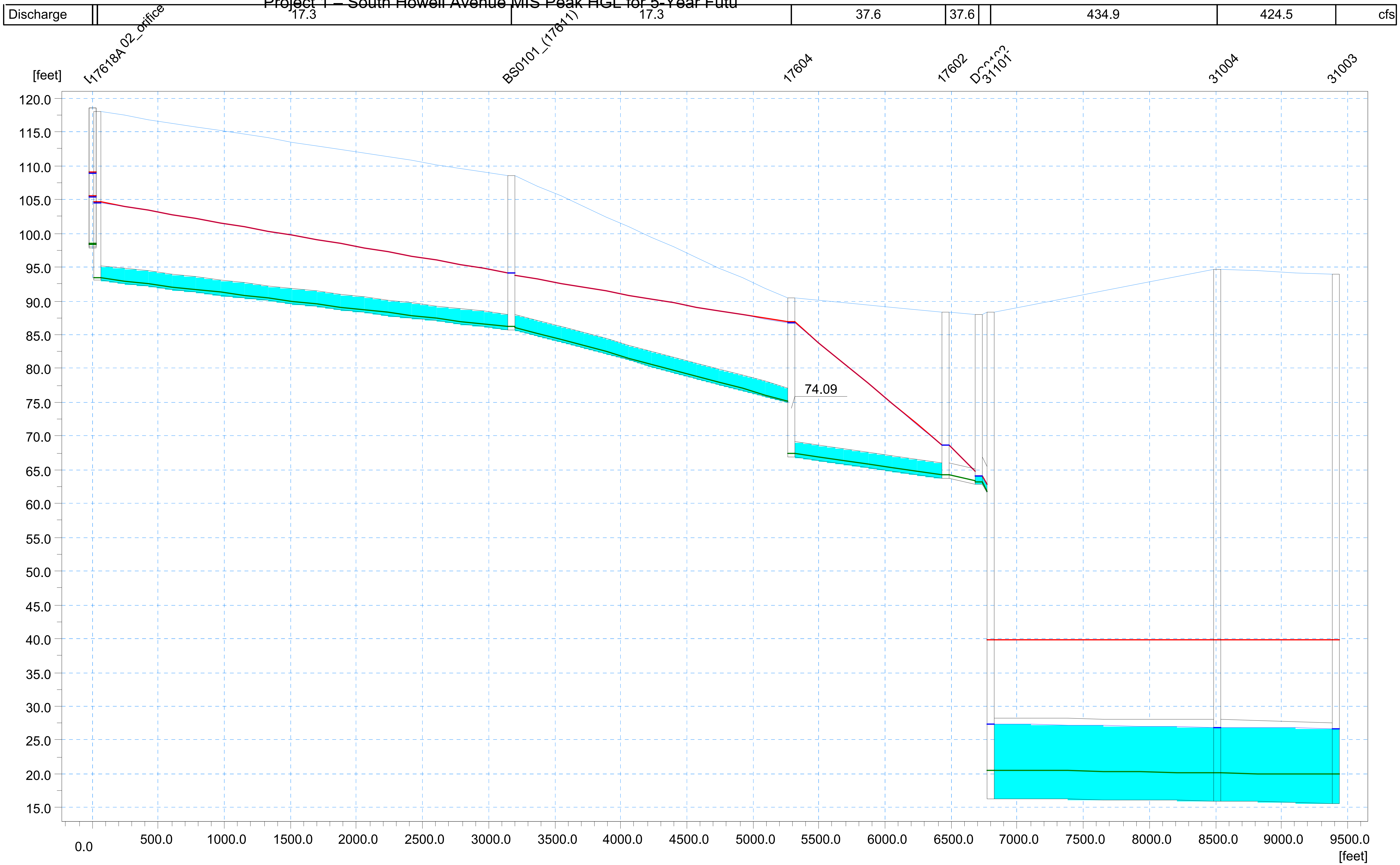
[5] Brown & Caldwell, Business Case Summary 033 - Infiltration & Inflow MIS and Regional Impacts (draft), December 21, 2018.

APPENDIX 6A-1: CS R1 South Howell Ave Capacity Profiles -

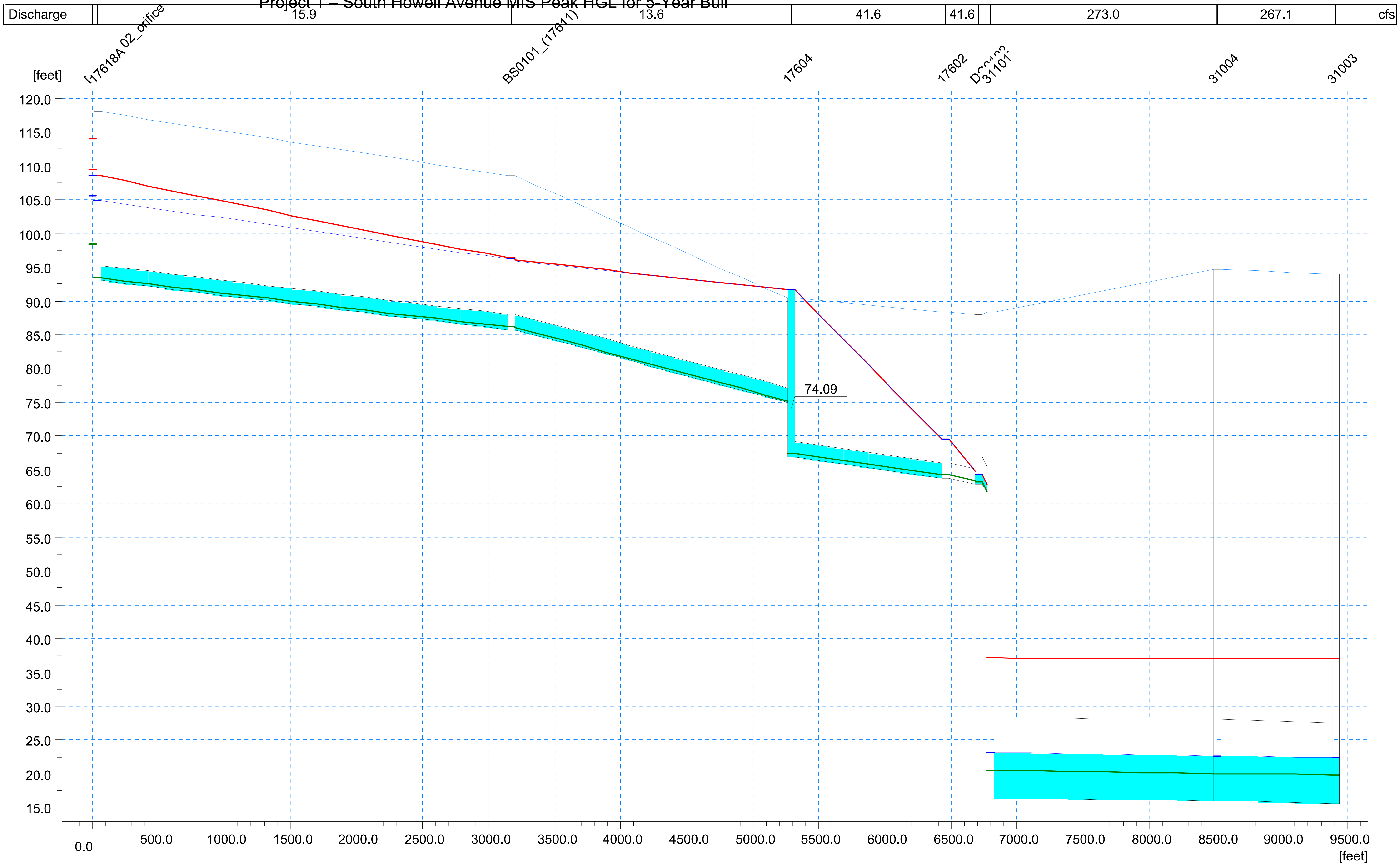
Project 1 – South Howell Avenue MIS Peak HGL for 5-Year Baseline Conditions - 18-7-1977 03:03:14 1977JulBase.PRF



Project 1 – South Howell Avenue MIS Peak HGL for 5-Year Future Conditions - 18-7-1977 03:03:16 1977JULBase.PRF



Project 1 – South Howell Avenue MIS Peak HGL for 5-Year Buildout Conditions - 1-8-1953 01:04:41 1953AUGBase.PRF



APPENDIX 6A-2: CS R1 South Howell Ave Alt 1 Map -

LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

0 100 200
Feet

PROJECT 1

SOUTH HOWELL AVENUE MIS

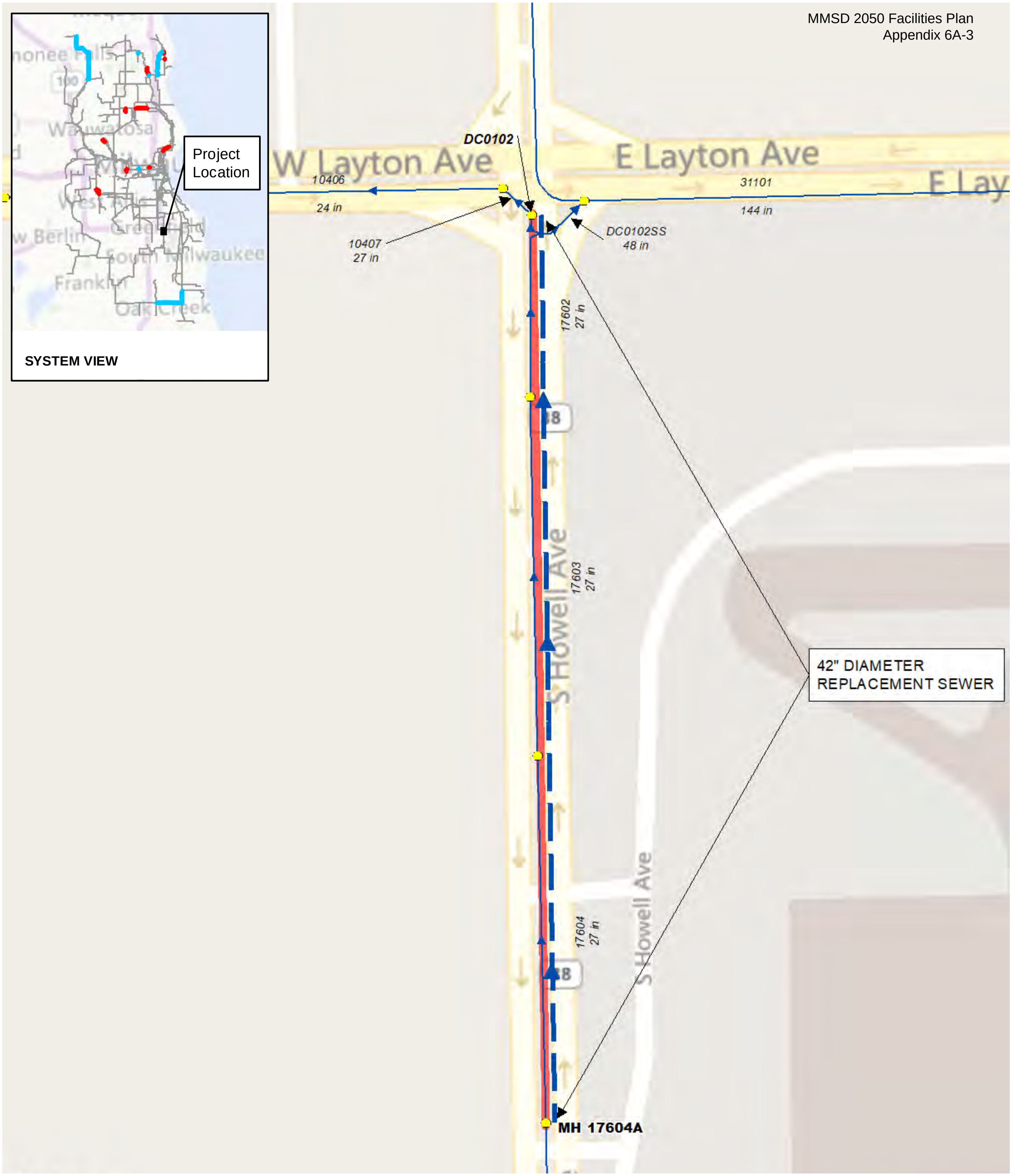
ALTERNATIVE 1

RELIEF SEWER

2050 Facilities Plan

DRAFT - 9/26/2019

APPENDIX 6A-3: CS R1 South Howell Ave Alt 2 Map -



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

0 100 200
Feet

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

PROJECT 1

SOUTH HOWELL AVENUE MIS
ALTERNATIVE 2
REPLACEMENT SEWER

2050 Facilities Plan
DRAFT - 9/26/2019

APPENDIX 6A-4: CS R1 South Howell Ave Capacity Costs -

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 1 - South Howell Avenue MIS - Alternative 1
36-inch Diameter Relief Sewer

General Description:
Construct 1,421 LF of 36-inch diameter sewer to relieve the existing 27-inch diameter MIS in S. Howell Ave. Installation assumed to be by tunneling, up to 25 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 500,000	$ 500,000	$ 600,000
Item 2 - 36" Microtunnel	LF	1,421	$ 1,444	$ 2,870,000	$ 3,440,000
Item 3 - 25ft Depth Shaft Structure	EACH	3	$ 130,000	$ 550,000	$ 660,000
Total Construction Cost				**$ 3,920,000**	
Total Capital Cost					**$ 4,700,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	2,842	0.75	$ 2,000
(double length for relief sewer because there will be two pipes to maintain)				
Life Cycle Analysis				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 29,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH

Capital Costs	$ 4,700,000
Present Worth of O&M Costs	$ 29,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 4,729,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 1 - South Howell Avenue MIS - Alternative 1

36-inch Diameter Relief Sewer

General Description:
Construct 1,421 LF of 36-inch diameter sewer to relieve the existing 27-inch diameter MIS in S. Howell Ave. Installation assumed to be by tunneling, up to 25 ft. deep.

ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - Mob/Demob		LS	1	$ 500,000	$ 500,000	-	-	-	$ 500,000	20%	$ 600,000
Item 2 - 36" Microtunnel		LF	1,421	$ 1,444	$ 2,051,924	20%	20%	$ 2,870,000	$ 2,870,000	20%	$ 3,440,000
Item 3 - 25ft Depth Shaft Structure		EACH	3	$ 130,000	$ 390,000	20%	20%	$ 550,000	$ 550,000	20%	$ 660,000
										Total Capital Cost	**$ 4,700,000**

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Microtunnel cost from ASSETVIEW
3) Mob/Demob cost is estimated at $500k for projects ranging from $0-$5 million.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 1 - South Howell Avenue MIS - Alternative 2
42-inch Diameter Replacement Sewer

General Description:
Construct 1,421 LF of 42-inch diameter sewer to replace the existing 27-inch diameter MIS in S. Howell Ave. Installation assumed to be by tunneling, up to 25 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$500,000	$ 500,000	$ 600,000
Item 2 - 42" Microtunnel	LF	1,421	$1,599	$ 3,180,000	$ 3,820,000
Item 3 - 25ft Depth Shaft Structure	EACH	3	$130,000	$ 550,000	$ 660,000
Total Construction Cost				**$ 4,230,000**	
Total Capital Cost					**$ 5,080,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	1,421	0.75	$ 1,000
<u>Life Cycle Analysis</u>				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 14,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH	
Capital Costs	$ 5,080,000
Present Worth of O&M Costs	$ 14,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 5,094,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS
Project No. 1 - South Howell Avenue MIS - Alternative 2
42-inch Diameter Replacement Sewer

General Description:
Construct 1,421 LF of 42-inch diameter sewer to replace the existing 27-inch diameter MIS in S. Howell Ave. Installation assumed to be by tunneling, up to 25 ft. deep.

ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - Mob/Demob		LS	1	$ 500,000	$ 500,000	-	-	-	$ 500,000	20%	$ 600,000
Item 2 - 42" Microtunnel		LF	1421	$ 1,599	$ 2,272,179	20%	20%	$ 3,180,000	$ 3,180,000	20%	$ 3,820,000
Item 3 - 25ft Depth Shaft Structure		EACH	3	$ 130,000	$ 390,000	20%	20%	$ 550,000	$ 550,000	20%	$ 660,000
										Total Capital Cost	**$ 5,080,000**

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Microtunnel cost from ASSETVIEW
3) Mob/Demob cost is estimated at $500k for projects ranging from $0-$5 million.

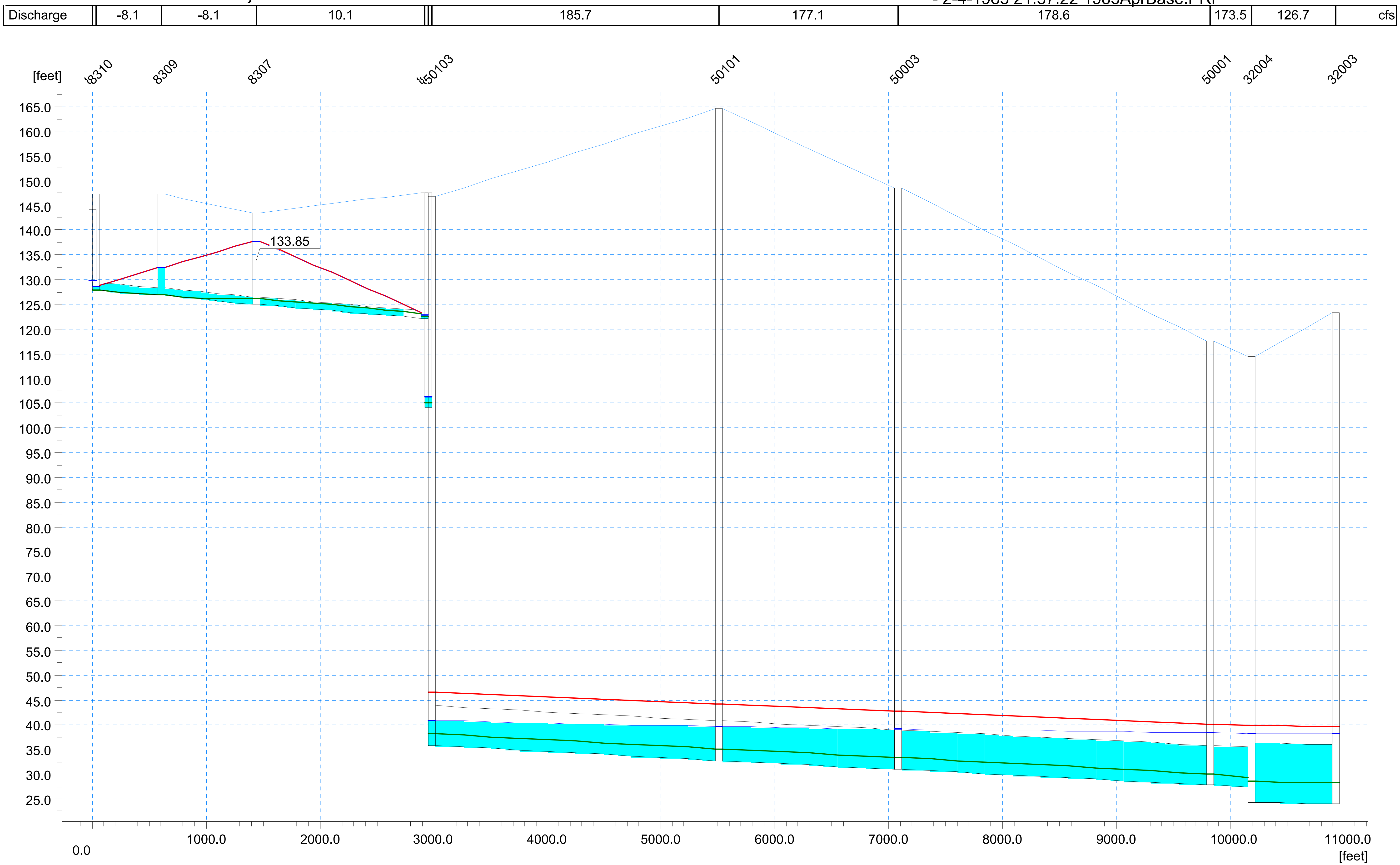
Milwaukee Metropolitan Sewerage District
2050 FACILITIES PLAN
BUSINESS CASE EVALUATIONS
Assumptions

General			Source	Comments
Milwaukee ENR **December 2019**	14,700		Historic_ENRvalues 1974-2019-05_MCA_KMZREV.xlsx	Milwaukee ENR is the average between Chicago and Minneapolis Construction Cost Index values published monthly by ENR. Milwaukee ENR December 2019 is a projected value from May 2019 based on average historical monthly increase in value from 2007 (2020 Facilities Plan published June 2007) to May 2019.
Annual increase in costs	0%		Discussions with MMSD	
Discount Rate	3.375%		Email from Andrew Dutcher, WDNR to Troy Deibert, HNTB on 6/5/19	**Facility planning is using the value established by the WDNR.**
Life Cycle - number years	20			
Capital Costs				
Un-designed Details Allowance - Varies, see below			**Allowance varies at engineer's discretion based on definitions provided for each %**	
all major components have documented installed unit costs	10%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
costs missing for some components, but other costs are for installed facilities and well documented (connections to existing systems, etc.)	20%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Alternative development is still conceptual	30%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Contingency Allowance - Set %				
Planning Level Contingency	20%		2050 FP Team - WRF discussion on 1/30/17	
Contractor Overhead & Profit - Varies, see below				
Equipment costs are from manufacturers	25%		2050 FP Team - WRF discussion on 1/30/17	
Costs are from previous project, unit costs already include OH&P	0%		2050 FP Team - cost estimate discussion on 5/20/19	
Design, Bidding, & MMSD Oversight				
Total Percent, Conveyance	20%		Total Percent used for Planning, Preliminary Engineering, Design, Construction (exc. Contractor Cost) and Post Construction in the BCE	**For FP Use only. This is incorporated into AMP BCE template already.** Varies for each asset system
Total Percent, WRFs	40%			
Total Percent, Watercourse	20%			
Total Percent, GI	15%			

Power assumptions			SOURCE	Comments
Gas	2018 Current Rates			
turbine fuel, LFG	$2.500	/Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
turbine fuel, NG	$5.000	/Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
Electrical				
Electrical Rates, JI/SS	Varies		Kziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	Detailed assumptions need to be included in backup on a case by case basis
Labor assumptions				
Veolia Labor	$50	per hour	Included in BCE assumptions	
Contractor Labor	$70	per hour	To be included in capital costs	

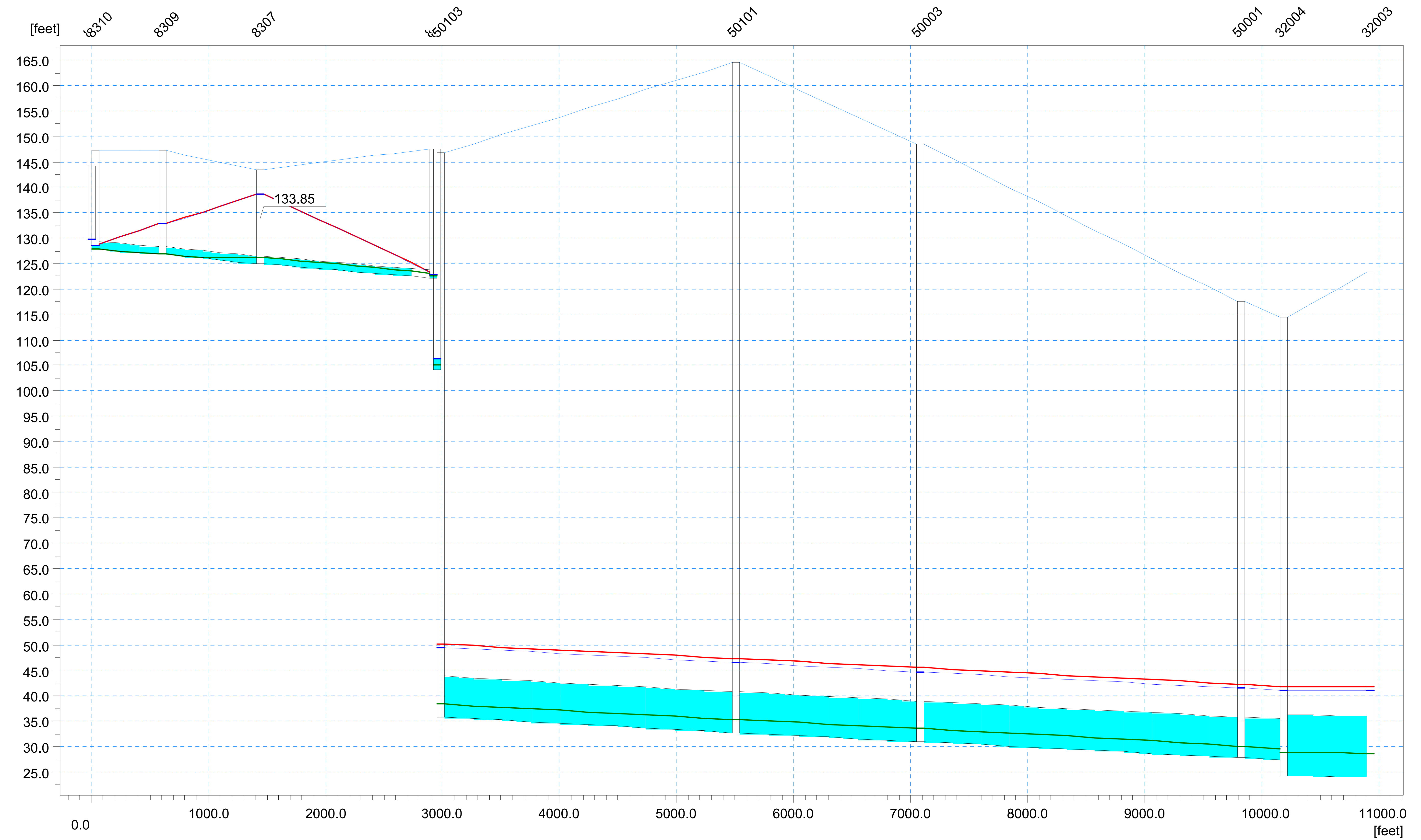
APPENDIX 6A-5: CS R2 South 81-84 St Capacity Profiles -

Project 2 – South 84th Street – South 81st Street MIS Peak HGL for 5-Year Baseline Conditions - 2-4-1983 21:37:22 1983AprBase.PRF



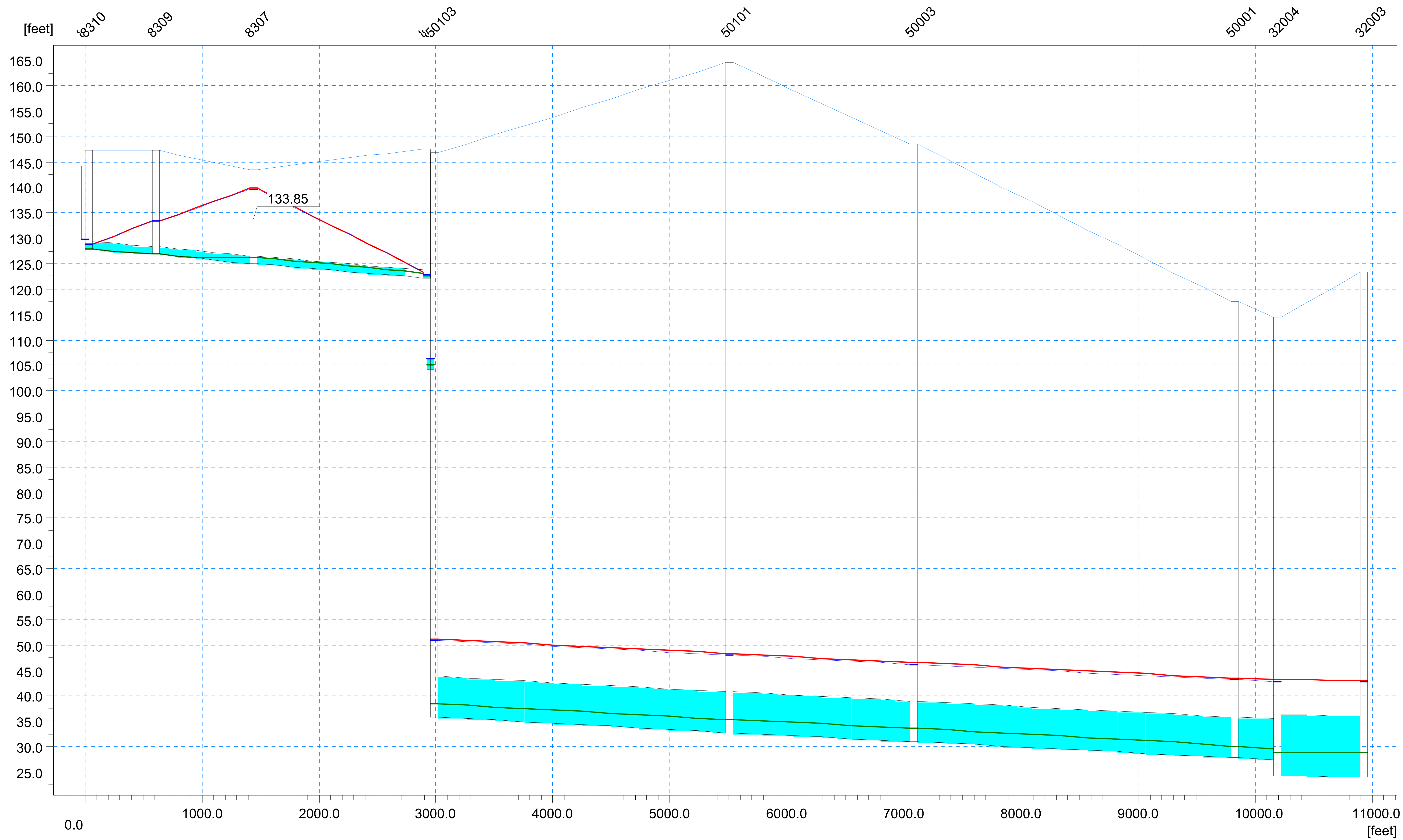
Project 2 – South 84th Street – South 81st Street MIS Peak HGL for 5-Year Future Conditions - 18-5-2000 18:56:09 2000MAYBase.PRF

Discharge	-8.5	-8.5	10.4	297.9	299.7	301.7	301.5	191.1	cfs



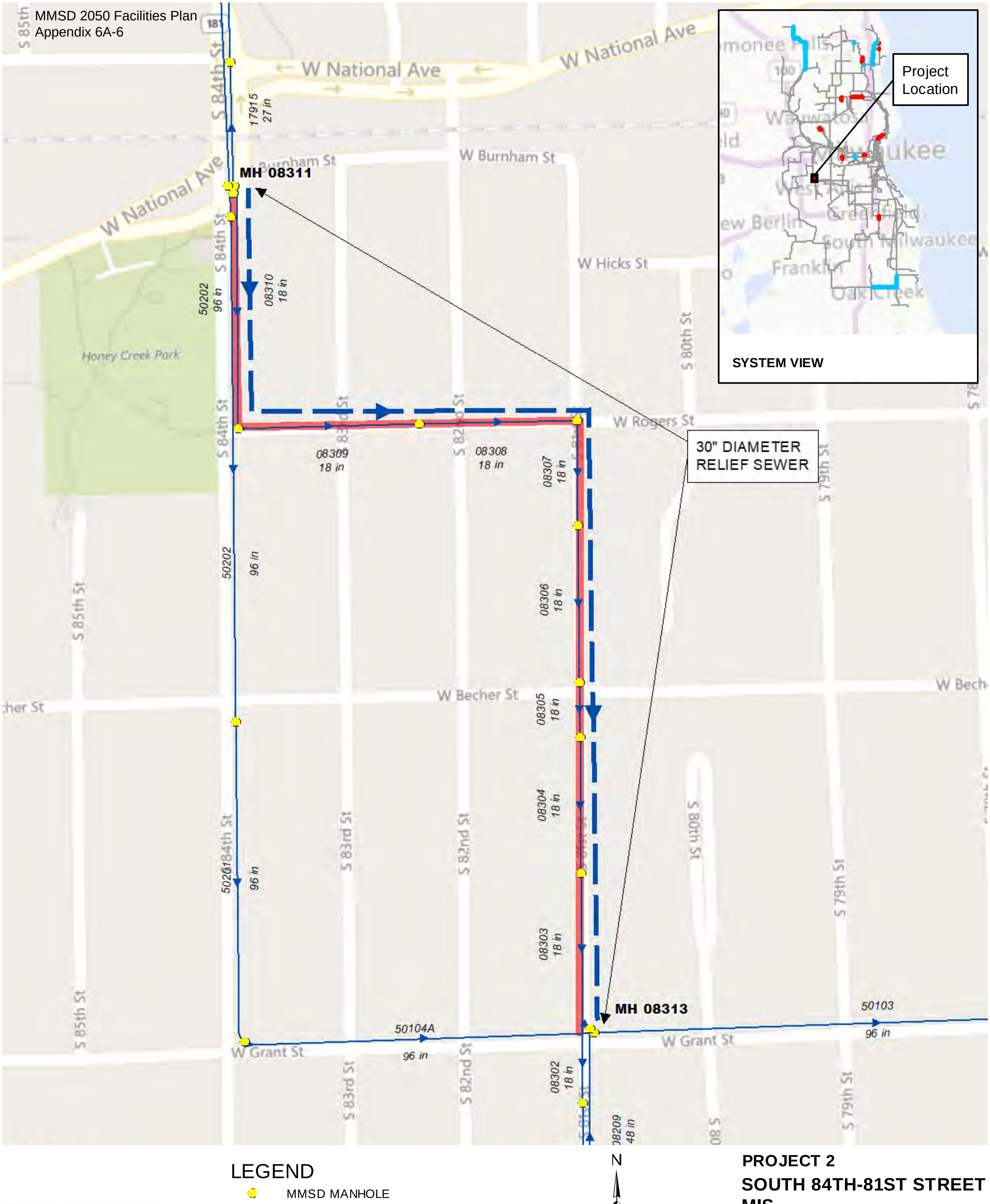
Project 2 – South 84th Street – South 81st Street MIS Peak HGL for 5-Year Buildout Conditions - 18-5-2000 18:51:02 2000MAYBase.PRF

Discharge	-9.0	-9.0	10.7	302.4	302.9	303.7	300.8	168.7		cfs



APPENDIX 6A-6: CS R2 South 81-84 St Alt 1 Map -

MMSD 2050 Facilities Plan
Appendix 6A-6



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

MMSD PARTNERS FOR A CLEANER ENVIRONMENT

PROJECT 2

SOUTH 84TH-81ST STREET MIS

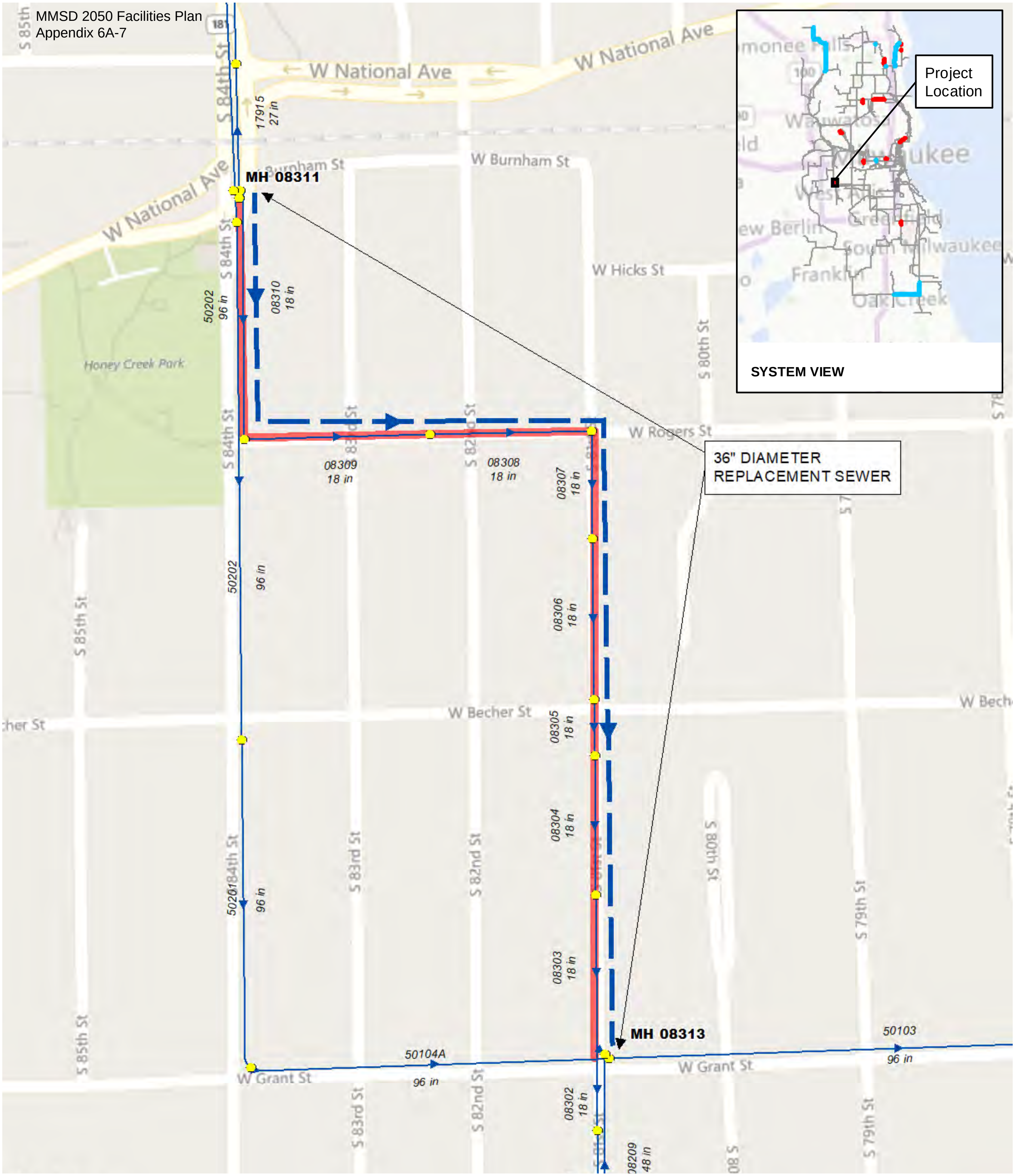
ALTERNATIVE 1

RELIEF SEWER

2050 Facilities Plan

DRAFT - 9/26/2019

APPENDIX 6A-7: CS R2 South 81-84 St Alt 2 Map -



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

0 100 200
Feet

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

PROJECT 2

SOUTH 84TH-81ST STREET MIS

ALTERNATIVE 2

REPLACEMENT SEWER

2050 Facilities Plan

DRAFT - 9/26/2019

APPENDIX 6A-8: CS R2 South 81-84 St Capacity Costs -

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

MMSD PARTNERS FOR A CLEANER ENVIRONMENT

COST TABLE SUMMARY
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 2 - S. 84th St. to S. 81st St. MIS - Alternative 1
30-inch Diameter Relief Sewer

General Description:
Contstruct 2,857 LF of 30-inch diameter sewer to relieve the existing 18-inch diameter MIS in S. 84th to S. 81st Sts. Installation assumed to be by tunneling, up to 28 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 750,000	$ 900,000
Item 2 - 30" Microtunnel	LF	2,857	$ 1,224	$ 5,880,000
Item 3 - 30 ft. Depth Shaft Structure (Avg. of 25' & 35' costs)	EACH	5	$ 155,000	$ 1,310,000
Total Capital Cost				**$ 8,090,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	5,714	0.75	$ 4,300
(double length for relief sewer because there will be two pipes to maintain)				$ -
				$ -
Life Cycle Analysis				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 60,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH

Capital Costs	$ 8,090,000
Present Worth of O&M Costs	$ 60,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 8,150,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS
Project No. 2 - S. 84th St. to S. 81st St. MIS - Alternative 1
30-inch Diameter Relief Sewer

General Description:
Contstruct 2,857 LF of 30-inch diameter sewer to relieve the existing 18-inch diameter MIS in S. 84th to S. 81st Sts. Installation assumed to be by tunneling, up to 28 ft. deep.

ITEM	Life Years	Units	Quantity	Unit Cost ($)	Capital Costs SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - Mob/Demob		LS	1	$ 750,000	$ 750,000	-	-	$ 750,000	$ 750,000	20%	$ 900,000
Item 2 - 30" Microtunnel		LF	2,857	$ 1,224	$ 3,496,968	20%	20%	$ 4,900,000	$ 4,900,000	20%	$ 5,880,000
Item 3 - 30 ft. Depth Shaft Structure (Avg. of 25' & 35' costs)		EACH	5	$ 155,000	$ 775,000	20%	20%	$ 1,090,000	$ 1,090,000	20%	$ 1,310,000
										Total Capital Cost	**$ 8,090,000**

Notes:
1) Definitions:
   LS - lump sum
   LF - linear foot
2) Microtunnel Cost from ASSETVIEW
3) Mob/Demob cost is estimated at $750k for projects ranging from $5-$10 million.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 2 - S. 84th St. to S. 81st St. MIS - Alternative 2
36-inch Diameter Replacement Sewer

General Description:
Contstruct 2,857 LF of 36-inch diameter sewer to replace the existing 18-inch diameter MIS in S. 84th to S. 81st Sts. Installation assumed to be by tunneling, up to 28 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 750,000	$ 900,000
Item 2 - 36" Microtunnel	LF	2,857	$ 1,411	$ 6,770,000
Item 3 - 30 ft. Depth Shaft Structure (Avg. of 25' & 35' costs)	EACH	5	$ 155,000	$ 1,310,000
Total Capital Cost				**$ 8,980,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	2,857	0.75	$ 2,100
				$ -
				$ -
Life Cycle Analysis				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 30,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH

Capital Costs	$ 8,980,000
Present Worth of O&M Costs	$ 30,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 9,010,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 2 - S. 84th St. to S. 81st St. MIS - Alternative 2
36-inch Diameter Replacement Sewer

General Description:
Contstruct 2,857 LF of 36-inch diameter sewer to replace the existing 18-inch diameter MIS in S. 84th to S. 81st Sts. Installation assumed to be by tunneling, up to 28 ft. deep.

ITEM	Life Years	Units	Quantity	Unit Cost ($)	Capital Costs SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - Mob/Demob		LS	1	$ 750,000	$ 750,000	-	-	$ 750,000	$ 750,000	20%	$ 900,000
Item 2 - 36" Microtunnel		LF	2,857	$ 1,411	$ 4,031,227	20%	20%	$ 5,640,000	$ 5,640,000	20%	$ 6,770,000
Item 3 - 30 ft. Depth Shaft Structure (Avg. of 25' & 35' costs)		EACH	5	$ 155,000	$ 775,000	20%	20%	$ 1,090,000	$ 1,090,000	20%	$ 1,310,000
										Total Capital Cost	**$ 8,980,000**

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Microtunnel Cost from ASSETVIEW
3) Mob/Demob cost is estimated at $750k for projects ranging from $5-$10 million.

Milwaukee Metropolitan Sewerage District
2050 FACILITIES PLAN
BUSINESS CASE EVALUATIONS
Assumptions

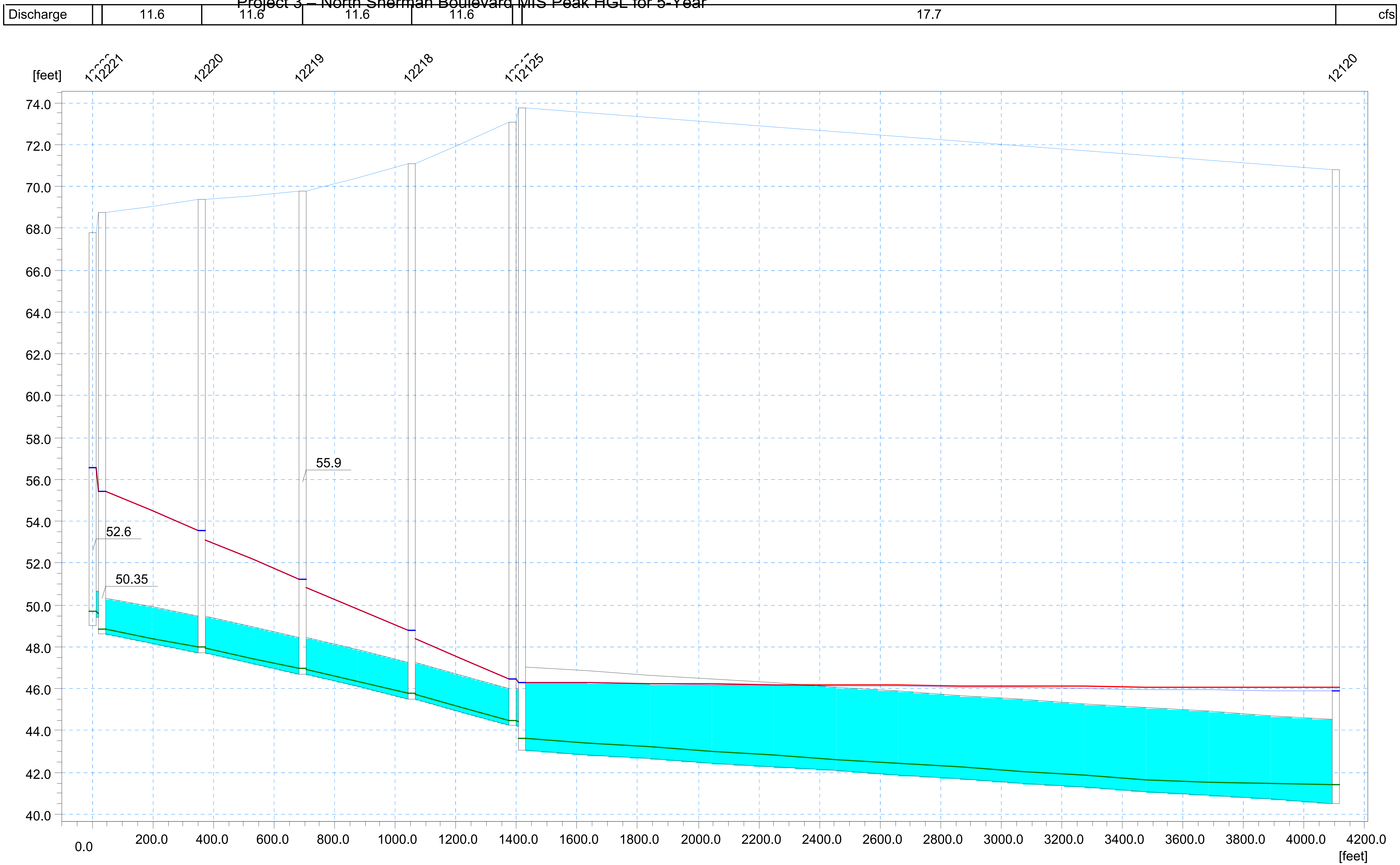
General			Source	Comments
Milwaukee ENR **December 2019**	14,700		Historic_ENRvalues 1974-2019-05_MCA_KMZREV.xlsx	Milwaukee ENR is the average between Chicago and Minneapolis Construction Cost Index values published monthly by ENR. Milwaukee ENR December 2019 is a projected value from May 2019 based on average historical monthly increase in value from 2007 (2020 Facilities Plan published June 2007) to May 2019.
Annual increase in costs	0%		Discussions with MMSD	
Discount Rate	3.375%		Email from Andrew Dutcher, WDNR to Troy Deibert, HNTB on 6/5/19	**Facility planning is using the value established by the WDNR.**
Life Cycle - number years	20			
Capital Costs				
Un-designed Details Allowance - Varies, see below			**Allowance varies at engineer's discretion based on definitions provided for each %**	
all major components have documented installed unit costs	10%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
costs missing for some components, but other costs are for installed facilities and well documented (connections to existing systems, etc.)	20%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Alternative development is still conceptual	30%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Contingency Allowance - Set %				
Planning Level Contingency	20%		2050 FP Team - WRF discussion on 1/30/17	
Contractor Overhead & Profit - Varies, see below				
Equipment costs are from manufacturers	25%		2050 FP Team - WRF discussion on 1/30/17	
Costs are from previous project, unit costs already include OH&P	0%		2050 FP Team - cost estimate discussion on 5/20/19	
Design, Bidding, & MMSD Oversight				
Total Percent, Conveyance	20%		Total Percent used for Planning, Preliminary Engineering, Design, Construction (exc. Contractor Cost) and Post Construction in the BCE	**For FP Use only. This is incorporated into AMP BCE template already.** Varies for each asset system
Total Percent, WRFs	40%			
Total Percent, Watercourse	20%			
Total Percent, GI	15%			

Power assumptions			SOURCE	Comments
Gas	2018 Current Rates			
turbine fuel, LFG	$2.500	/Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
turbine fuel, NG	$5.000	/Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
Electrical				
Electrical Rates, JI/SS	Varies		Kziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	Detailed assumptions need to be included in backup on a case by case basis
Labor assumptions				
Veolia Labor	$50	per hour	Included in BCE assumptions	
Contractor Labor	$70	per hour	To be included in capital costs	

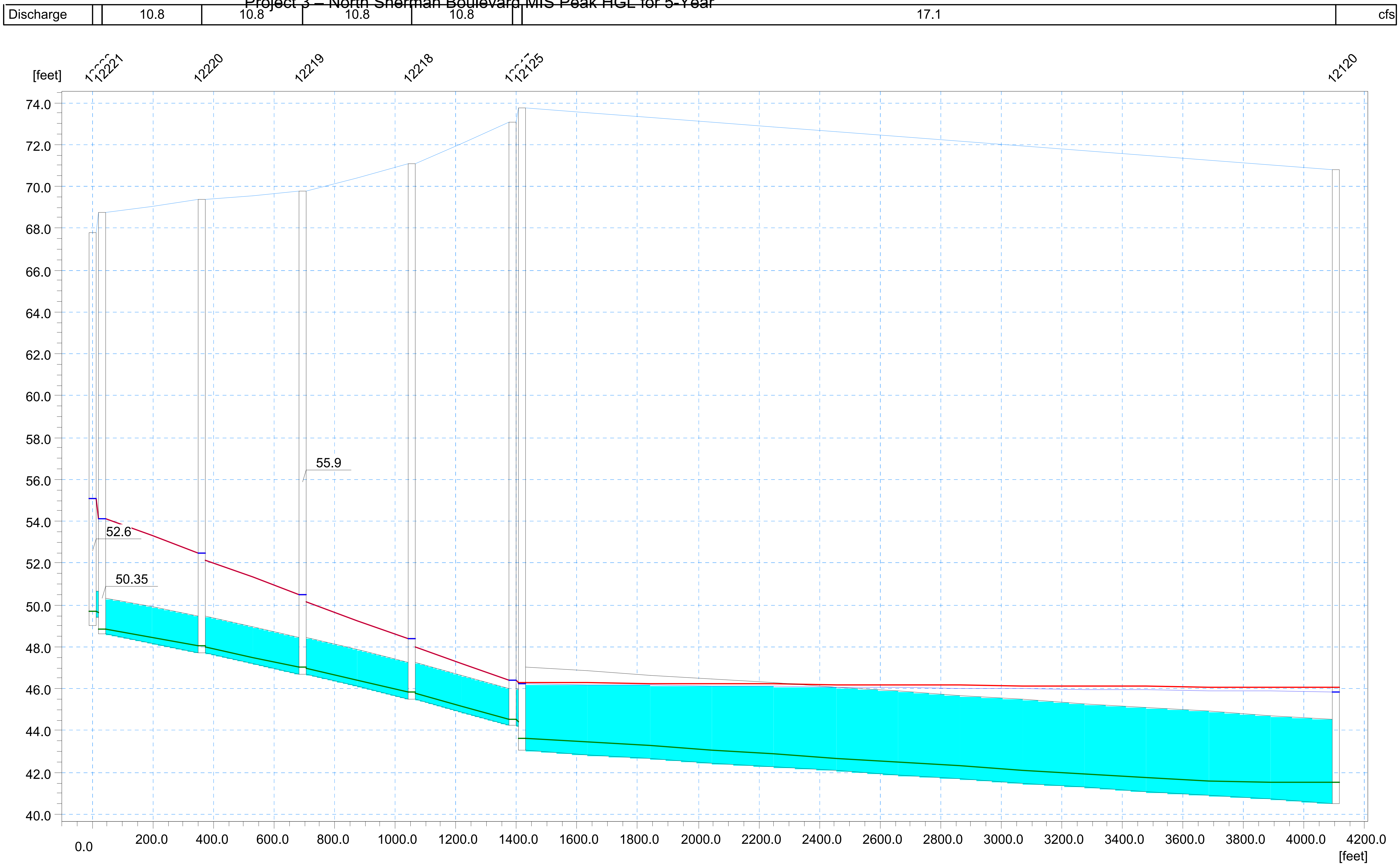
APPENDIX 6A-9: CS R3 N Sherman Blvd Capacity Profiles -

Project 3 – North Sherman Boulevard MIS Peak HGL for 5-Year

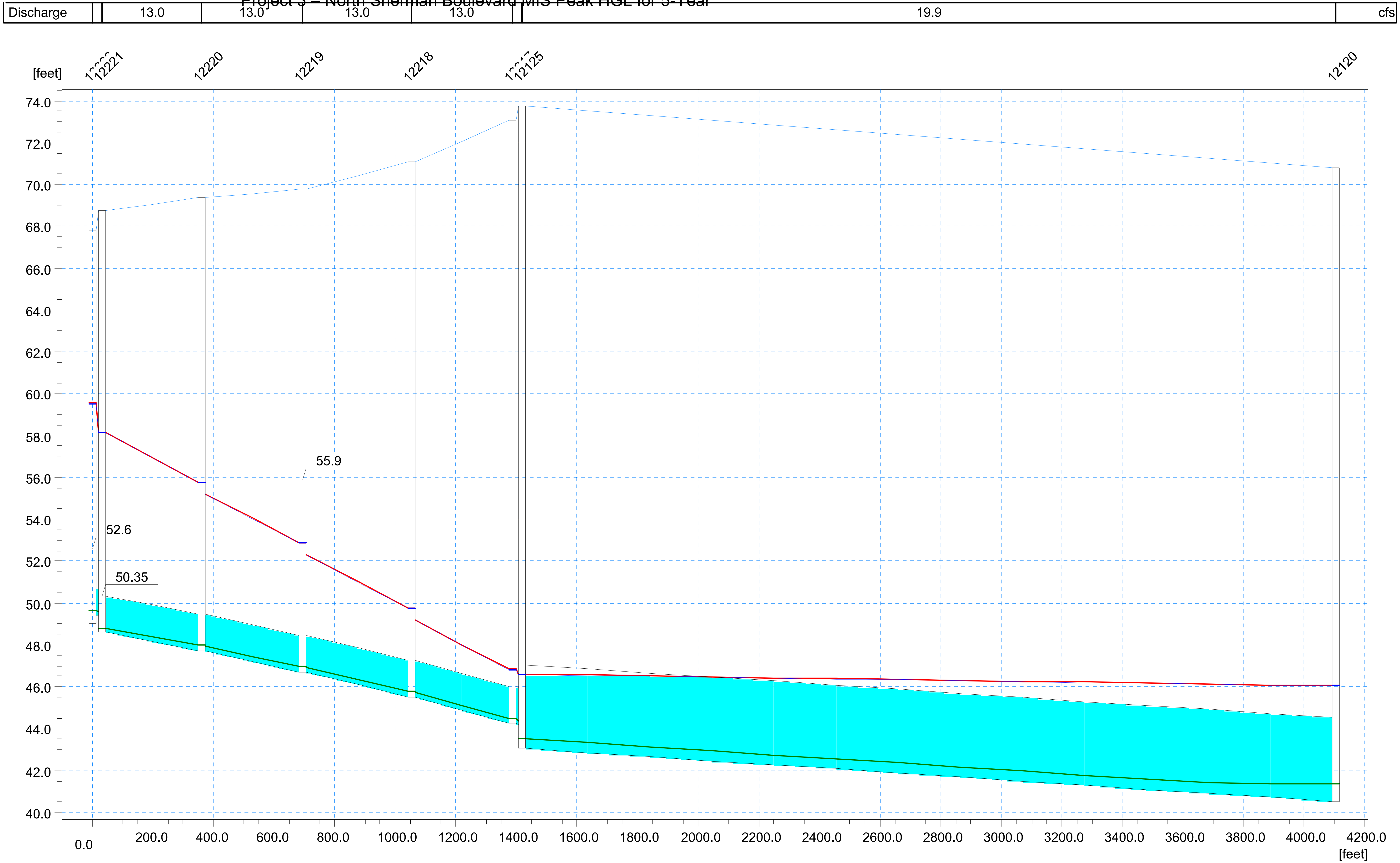
Baseline Conditions - 23-4-1999 05:05:04 1999APRBase.PRF



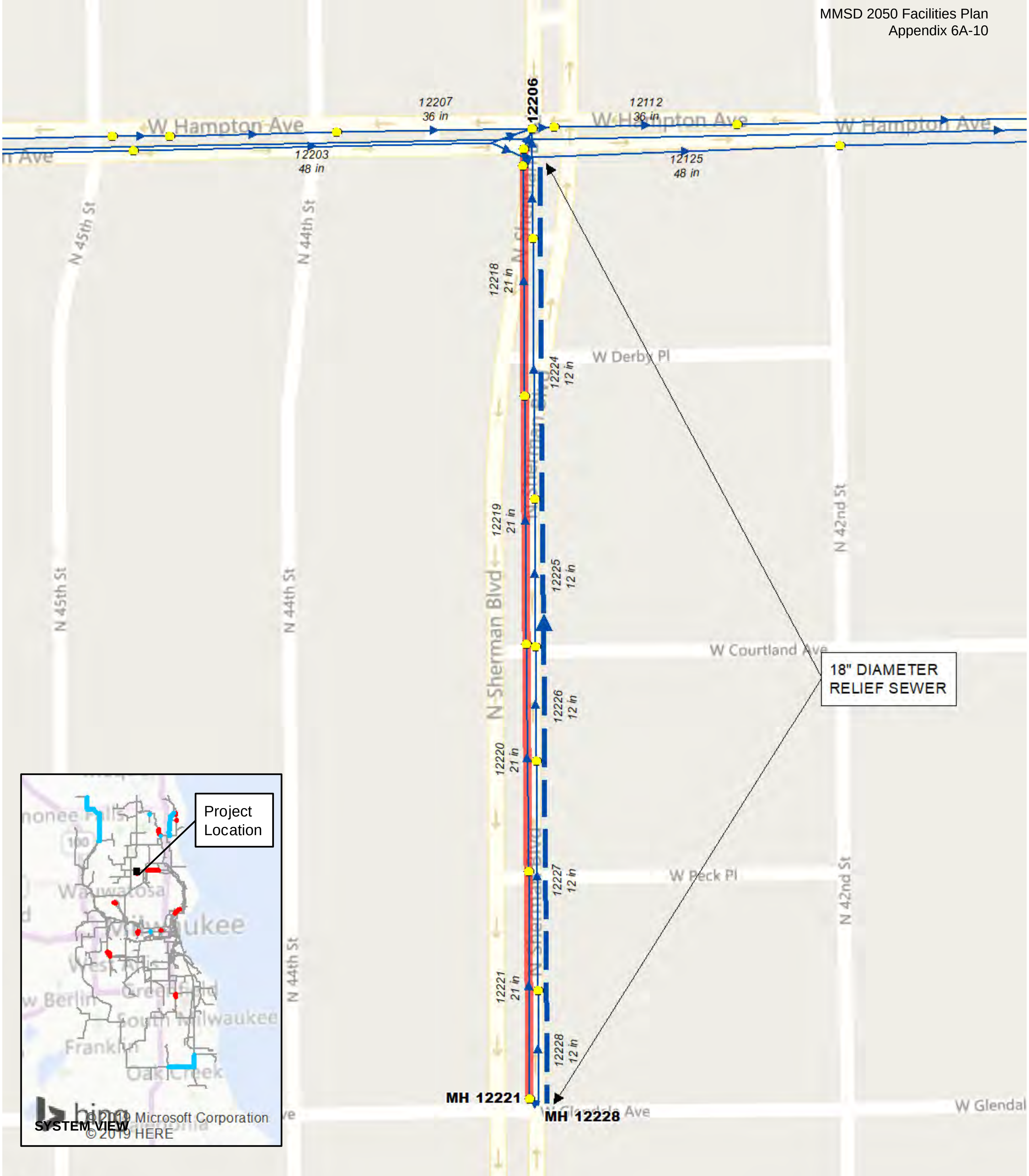
Project 3 – North Sherman Boulevard MIS Peak HGL for 5-Year Future Conditions - 19-4-1993 21:14:20 1993APRBase.PRF



Project 3 – North Sherman Boulevard MIS Peak HGL for 5-Year Buildout Conditions - 18-7-1977 06:21:04 1977JULBase.PRF



APPENDIX 6A-10: CS R3 N Sherman Blvd Alt 1 Map -



MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

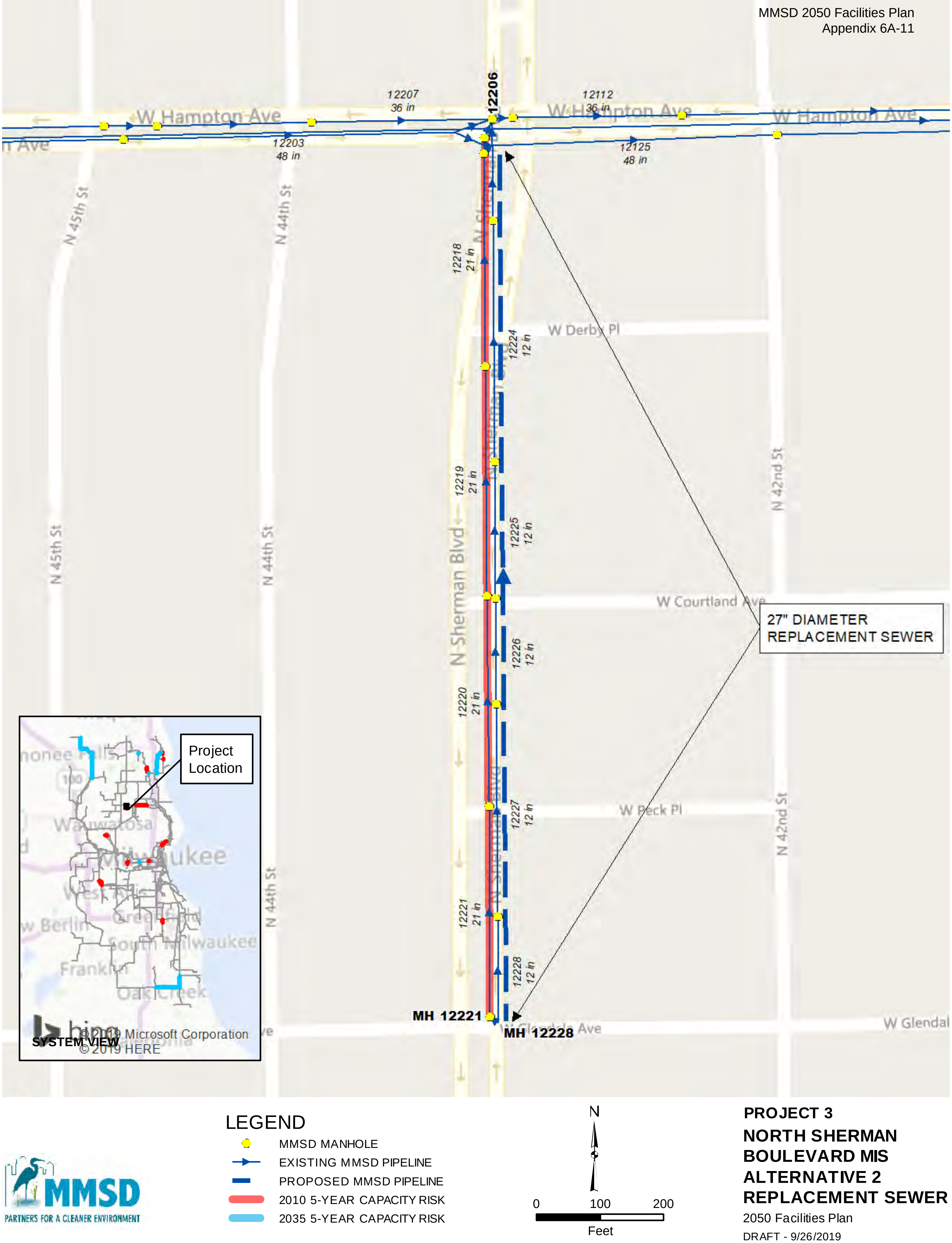
PROJECT 3

NORTH SHERMAN BOULEVARD MIS ALTERNATIVE 1 RELIEF SEWER

2050 Facilities Plan

DRAFT - 9/26/2019

APPENDIX 6A-11: CS R3 N Sherman Blvd Alt 2 Map -



PARTNERS FOR A CLEANER ENVIRONMENT

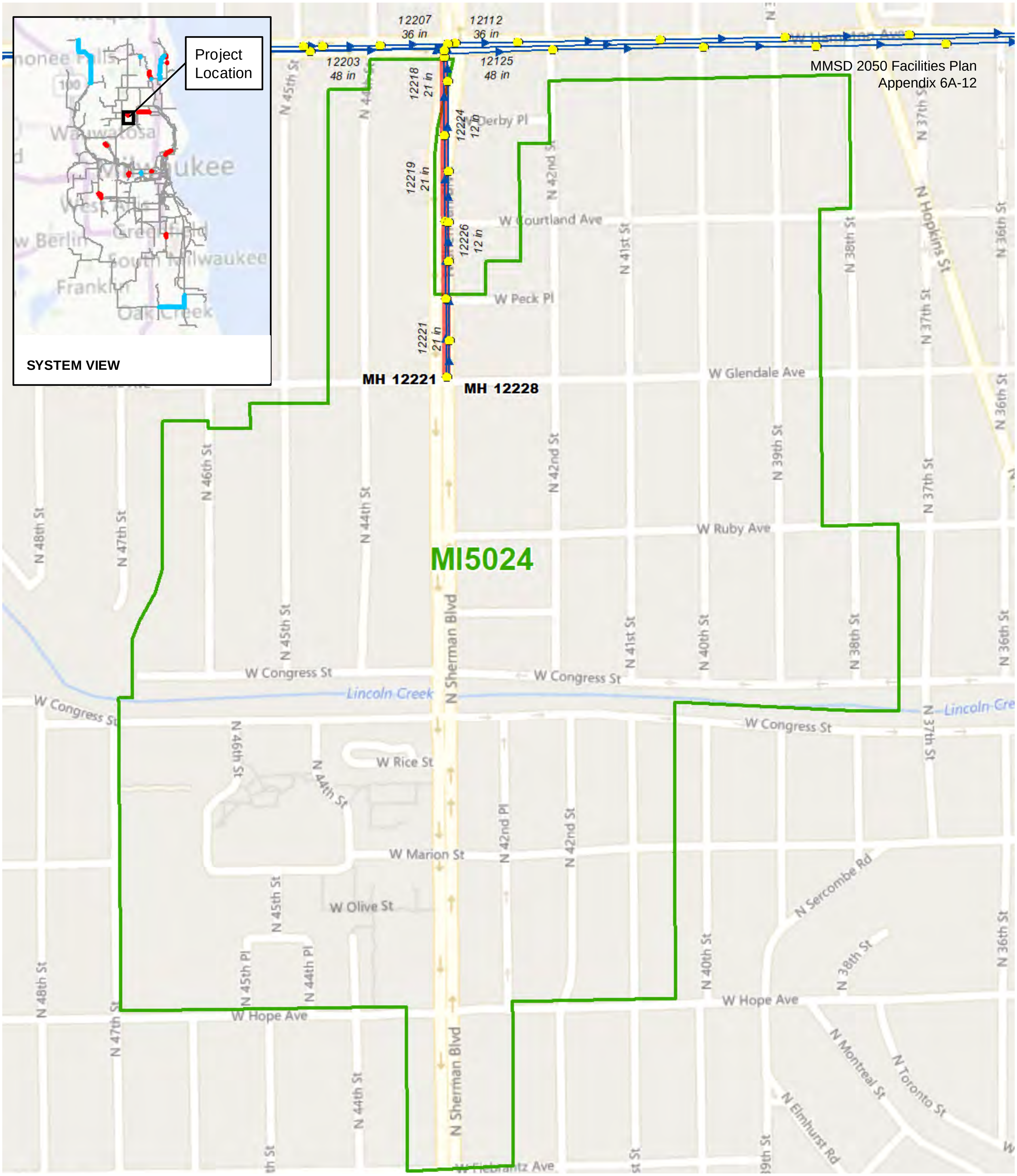
PROJECT 3

NORTH SHERMAN BOULEVARD MIS ALTERNATIVE 2 REPLACEMENT SEWER

2050 Facilities Plan

DRAFT - 9/26/2019

APPENDIX 6A-12: CS R3 N Sherman Blvd Alt 3 Map -



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

0 250 500
Feet

PROJECT 3

NORTH SHERMAN BOULEVARD MIS ALTERNATIVE 3 I/I REDUCTION

2050 Facilities Plan

DRAFT - 9/26/2019

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

APPENDIX 6A-13: CS R3 N Sherman Blvd Capacity Costs -

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 3 - North Sherman Blvd. - Alternative 1
18-inch Diameter Relief Sewer

General Description:
Construct 1,381 LF of 18-inch diameter sewer to relieve the existing 21-inch diameter & 12-inch diameter MIS in North Sherman Blvd. Installation assumed to be by tunneling, up to 29 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 500,000	$ 500,000	$ 600,000
Item 2 - 18" Microtunnel	LF	1,381	$ 851	$ 1,650,000	$ 1,980,000
Item 3 - 30 ft. Depth Shaft Structure (Avg. of 25' & 35' costs)	EACH	3	$ 155,000	$ 650,000	$ 780,000
Total Construction Cost				**$ 2,800,000**	
Total Capital Cost					**$ 3,360,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	4,143	0.75	$ 3,100
(triple length for relief sewer because there will be three pipes to maintain)				
Life Cycle Analysis				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 45,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH	
Capital Costs	$ 3,360,000
Present Worth of O&M Costs	$ 45,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 3,405,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS
Project No. 3 - North Sherman Blvd. - Alternative 1
18-inch Diameter Relief Sewer

General Description:
Construct 1,381 LF of 18-inch diameter sewer to relieve the existing 21-inch diameter & 12-inch diameter MIS in North Sherman Blvd. Installation assumed to be by tunneling, up to 29 ft. deep.

ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
					Capital Costs						
Item 1 - Mob/Demob		LS	1	$ 500,000	$ 500,000	-	-	-	$ 500,000	20%	$ 600,000
Item 2 - 18" Microtunnel		LF	1,381	$ 851	$ 1,175,231	20%	20%	$ 1,650,000	$ 1,650,000	20%	$ 1,980,000
Item 3 - 30 ft. Depth Shaft Structure (Avg. of 25' & 35' costs)		EACH	3	$ 155,000	$ 465,000	20%	20%	$ 650,000	$ 650,000	20%	$ 780,000
										Total Capital Cost	**$ 3,360,000**

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Microtunnel cost from ASSETVIEW
3) Mob/Demob cost is estimated at $500k for projects ranging from $0-$5 million.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS
Project No. 3 - North Sherman Blvd. - Alternative 2
27-inch Diameter Replacement Sewer

General Description:
Construct 1,381 LF of 27-inch diameter sewer to replace the existing 21-inch diameter & 12-inch diameter MIS in North Sherman Blvd. Installation assumed to be by tunneling, up to 29 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 500,000	$ 500,000	$ 600,000
Item 2 - 27" Microtunnel	LF	1,381	$ 1,131	$ 2,190,000	$ 2,630,000
Item 3 - 30 ft. Depth Shaft Structure (Avg. of 25' & 35' costs)	EACH	3	$ 155,000	$ 650,000	$ 780,000
Total Construction Cost				**$ 3,340,000**	
Total Capital Cost					**$ 4,010,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	1,381	0.75	$ 1,000
				$ -
				$ -
Life Cycle Analysis				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 14,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH

Capital Costs	$ 4,010,000
Present Worth of O&M Costs	$ 14,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 4,024,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS
Project No. 3 - North Sherman Blvd. - Alternative 2
27-inch Diameter Replacement Sewer

General Description:
Construct 1,381 LF of 27-inch diameter sewer to replace the existing 21-inch diameter & 12-inch diameter MIS in North Sherman Blvd. Installation assumed to be by tunneling, up to 29 ft. deep.

Capital Costs											
ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - Mob/Demob		LS	1	$ 500,000	$ 500,000	-	-	-	$ 500,000	20%	$ 600,000
Item 2 - 27" Microtunnel		LF	1,381	$ 1,131	$ 1,561,911	20%	20%	$ 2,190,000	$ 2,190,000	20%	$ 2,630,000
Item 3 - 30 ft. Depth Shaft Structure (Avg. of 25' & 35' costs)		EACH	3	$ 155,000	$ 465,000	20%	20%	$ 650,000	$ 650,000	20%	$ 780,000
										Total Capital Cost	**$ 4,010,000**

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Microtunnel cost from ASSETVIEW
3) Mob/Demob cost is estimated at $500k for projects ranging from $0-$5 million.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 3 - North Sherman Blvd. MIS - Alternative No. 3
I/I Removal
REVISED 11-20-19

General Description:
Remove up to 6.2 cfs of I/I to reduce peak flow rate from Sewershed MI5024 to levels where existing MIS performs adequately. An I/I removal program would be in-lieu of relief or replacment sewer. CAPITAL COSTS EDITED FOLLOWING FIRST REIVEW TO REFLECT A 50% COST SPLIT BETWEEN MUNICIPALITY AND MMSD.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM		Units	Quantity	Unit Cost ($)/GPD		Capital Cost ($)
Item 1 - I/I Reduction in Sewershed MI5024		MGD	4.01	$1.42	$	6,830,000
50% Total Capital Cost					**$**	**3,415,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)		Annual Cost ($)
Operation and Maintenance Labor *(existing project length of MIS will be assumed for I/I alternatives)*	LF	2,762	0.75	$	1,050
Life Cycle Analysis					
Present Worth Factor (including annual increase)	14.375				
50% Present Worth of Operation and Maintenance Costs				**$**	**15,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)		Value ($)
Present Worth of Equipment Replacement Costs (Note 2)				**$**	**-**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)		Value ($)
Present Worth of Equipment Replacement Costs (Note 2)				**$**	**-**

50% TOTAL PRESENT WORTH

Capital Costs	$	3,415,000
Present Worth of O&M Costs	$	15,000
Present Worth of Equipment Replacement	$	-
Present Worth of Salvage Value	$	-
Total Present Worth	**$**	**3,430,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.
2) Assumed O&M cost is for routine annual sewer cleaning of rehabbed public sewers for entire sewershed.
3) I/I removal costs from MMSD Ad-Hoc Modeling Request 211 with costs based on assumed year 2020 ENRCCI 15,000.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS
Project No. 3 - North Sherman Blvd. MIS - Alternative No. 3
I/I Removal
REVISED 11-20-19

General Description:
Remove up to 6.2 cfs of I/I to reduce peak flow rate from Sewershed MI5024 to levels where existing MIS performs adequately. An I/I removal program would be in-lieu of relief or replacment sewer. CAPITAL COSTS EDITED FOLLOWING FIRST REIVEW TO REFLECT A 50% COST SPLIT BETWEEN MUNICIPALITY AND MMSD.

				Capital Costs							
ITEM	Life Years	Units	Quantity	Unit Cost ($)/GPD	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - I/I Reduction in Sewershed MI5024		MGD	4.01	$1.42	$ 5,688,520	-	-	-	$ 5,688,520	20%	$ 6,830,000
										Total Capital Cost	$ 6,830,000

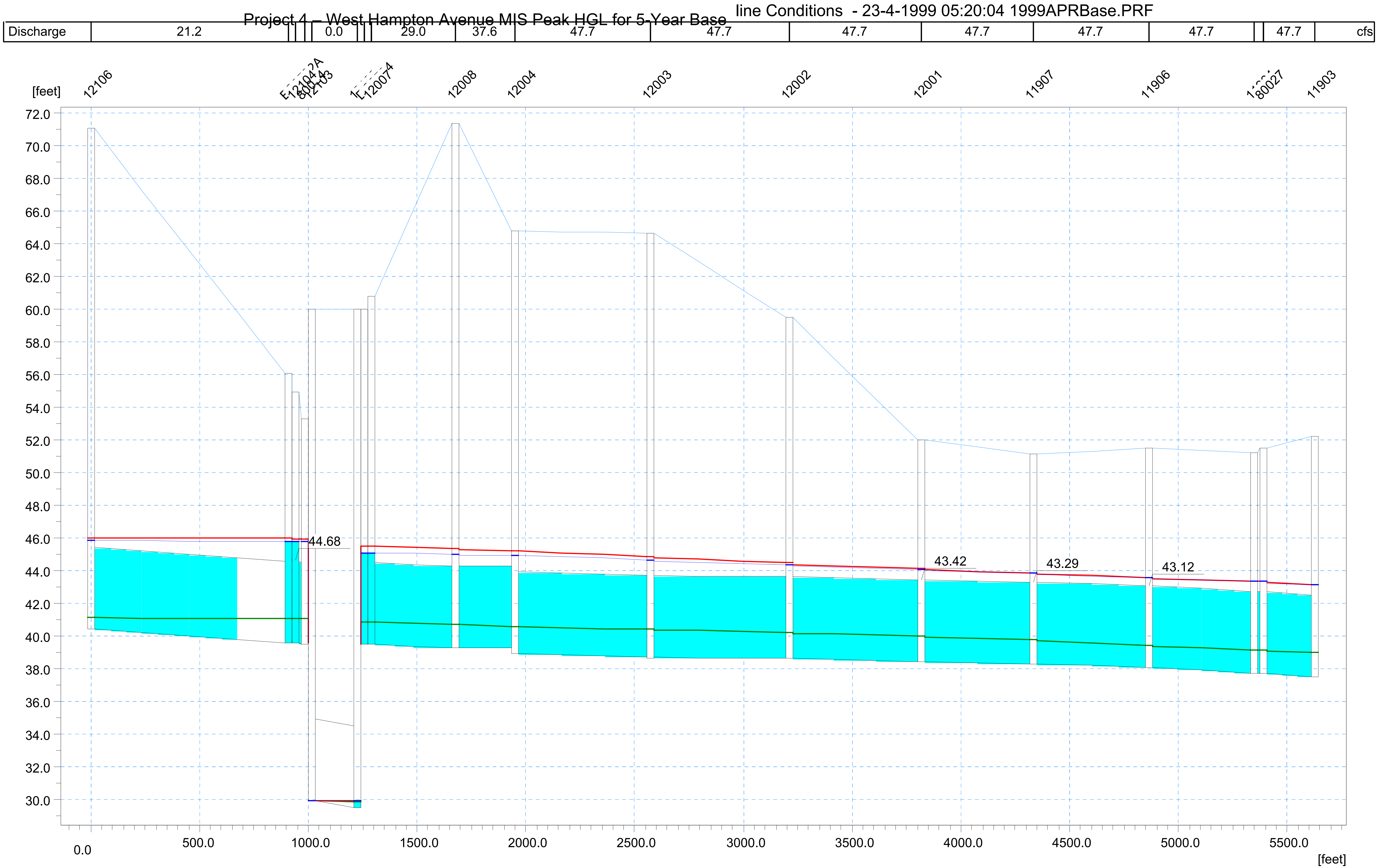
Notes:
1) Definitions:
MGD - million gallons per day
2) Source costs are from actual projects, so contractor O&P should be captured in the $/gpd of I/I removed values
3) I/I removal costs from MMSD Ad-Hoc Modeling Request 211 with costs based on assumed year 2020 ENRCCI 15,000.

Milwaukee Metropolitan Sewerage District
2050 FACILITIES PLAN
BUSINESS CASE EVALUATIONS
Assumptions

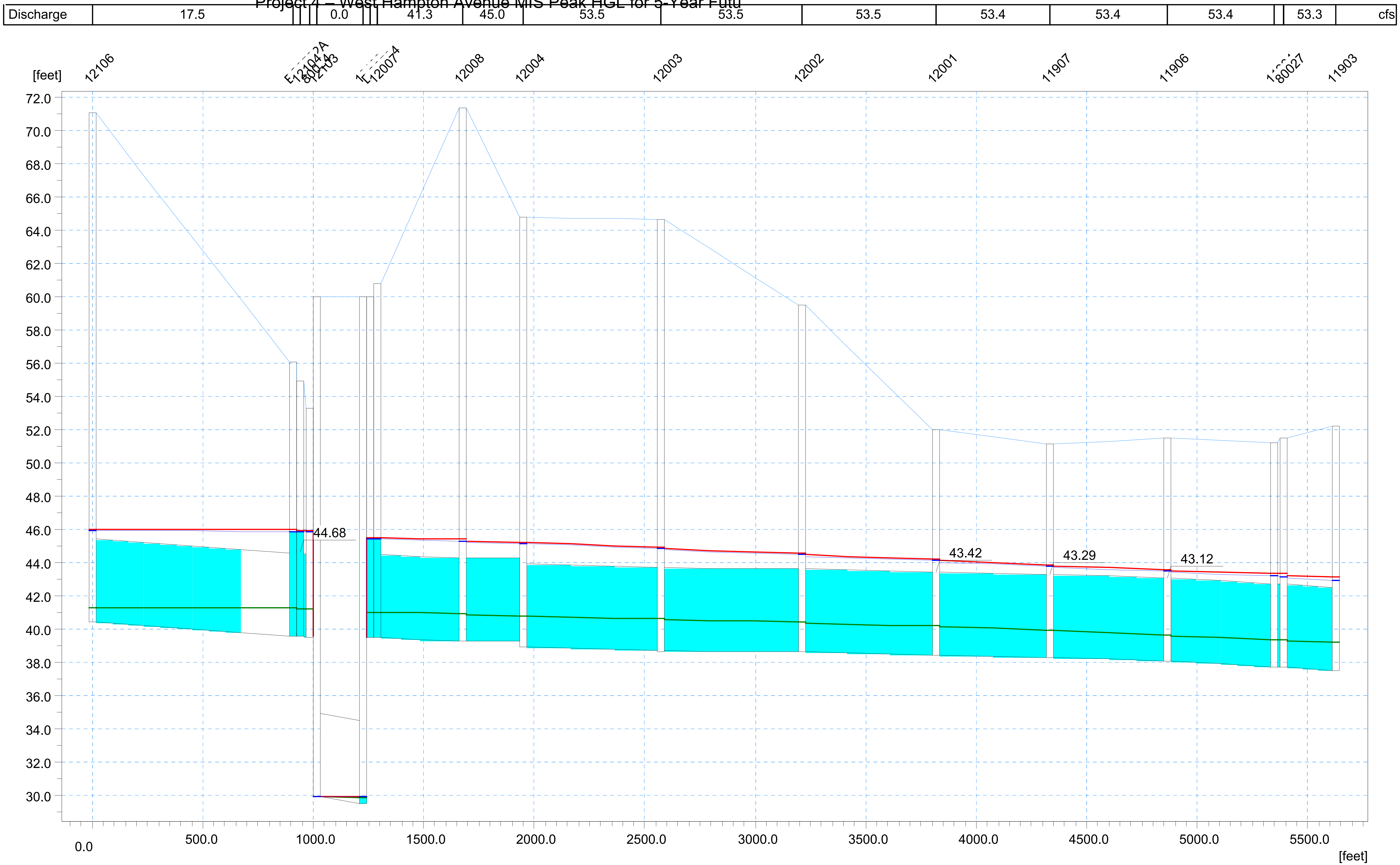
General		Source	Comments
Milwaukee ENR **December 2019**	14,700	Historic_ENRvalues 1974-2019-05_MCA_KMZREV.xlsx	Milwaukee ENR is the average between Chicago and Minneapolis Construction Cost Index values published monthly by ENR. Milwaukee ENR December 2019 is a projected value from May 2019 based on average historical monthly increase in value from 2007 (2020 Facilities Plan published June 2007) to May 2019.
Annual increase in costs	0%	Discussions with MMSD	
Discount Rate	3.375%	Email from Andrew Dutcher, WDNR to Troy Deibert, HNTB on 6/5/19	**Facility planning is using the value established by the WDNR.**
Life Cycle - number years	20		
Capital Costs			
Un-designed Details Allowance - Varies, see below		**Allowance varies at engineer's discretion based on definitions provided for each %**	
all major components have documented installed unit costs	10%	K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
costs missing for some components, but other costs are for installed facilities and well documented (connections to existing systems, etc.)	20%	K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Alternative development is still conceptual	30%	K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Contingency Allowance - Set %			
Planning Level Contingency	20%	2050 FP Team - WRF discussion on 1/30/17	
Contractor Overhead & Profit - Varies, see below			
Equipment costs are from manufacturers	25%	2050 FP Team - WRF discussion on 1/30/17	
Costs are from previous project, unit costs already include OH&P	0%	2050 FP Team - cost estimate discussion on 5/20/19	
Design, Bidding, & MMSD Oversight			
Total Percent, Conveyance	20%	Total Percent used for Planning, Preliminary Engineering, Design, Construction (exc. Contractor Cost) and Post Construction in the BCE	**For FP Use only. This is incorporated into AMP BCE template already.** Varies for each asset system
Total Percent, WRFs	40%		
Total Percent, Watercourse	20%		
Total Percent, GI	15%		

Power assumptions		SOURCE	Comments
Gas	2018 Current Rates		
turbine fuel, LFG	$2.500 /Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
turbine fuel, NG	$5.000 /Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
Electrical			
Electrical Rates, JI/SS	Varies	Kziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	Detailed assumptions need to be included in backup on a case by case basis
Labor assumptions			
Veolia Labor	$50 per hour	Included in BCE assumptions	
Contractor Labor	$70 per hour	To be included in capital costs	

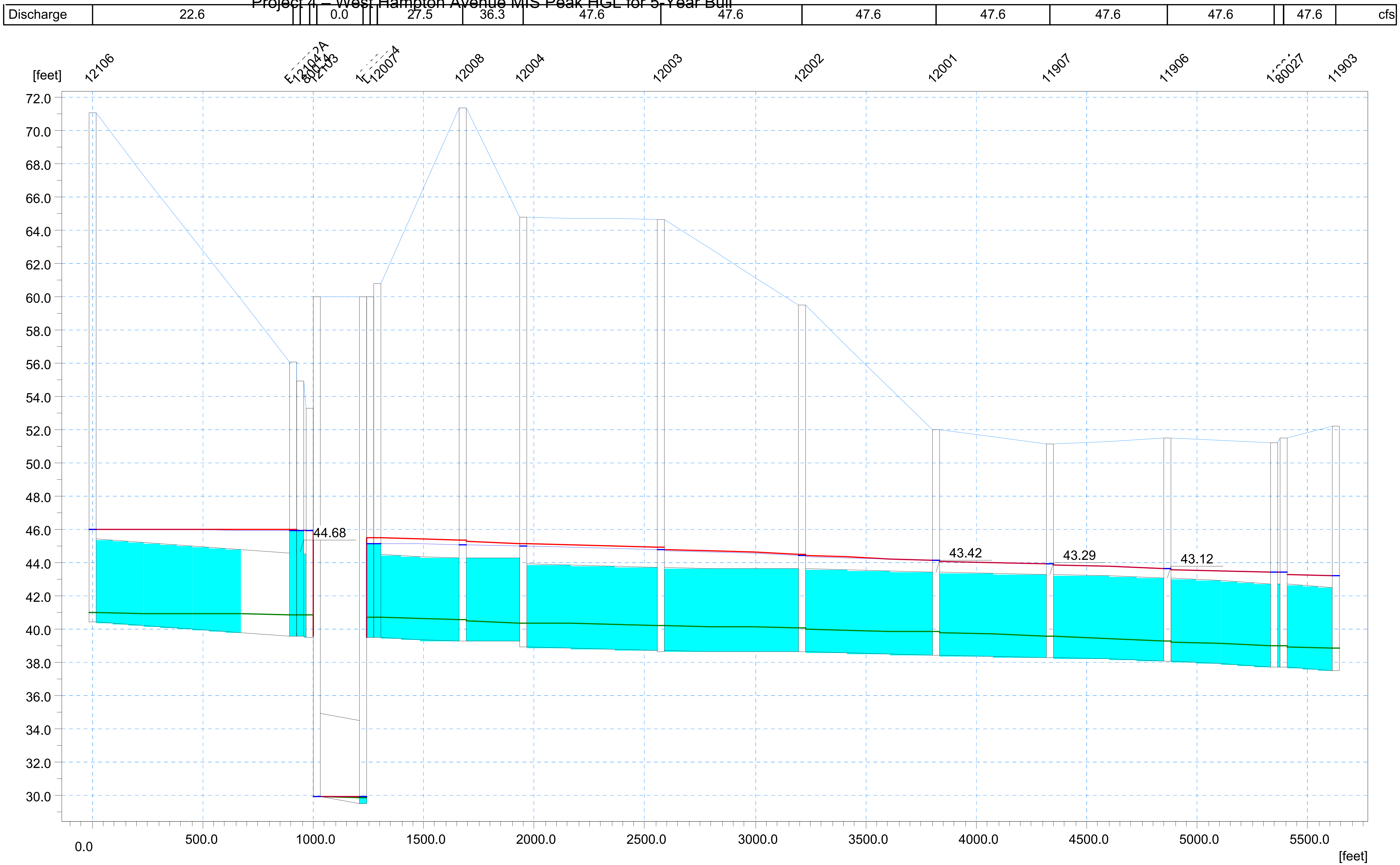
APPENDIX 6A-14: CS R4 Hampton Ave Capacity Profiles -

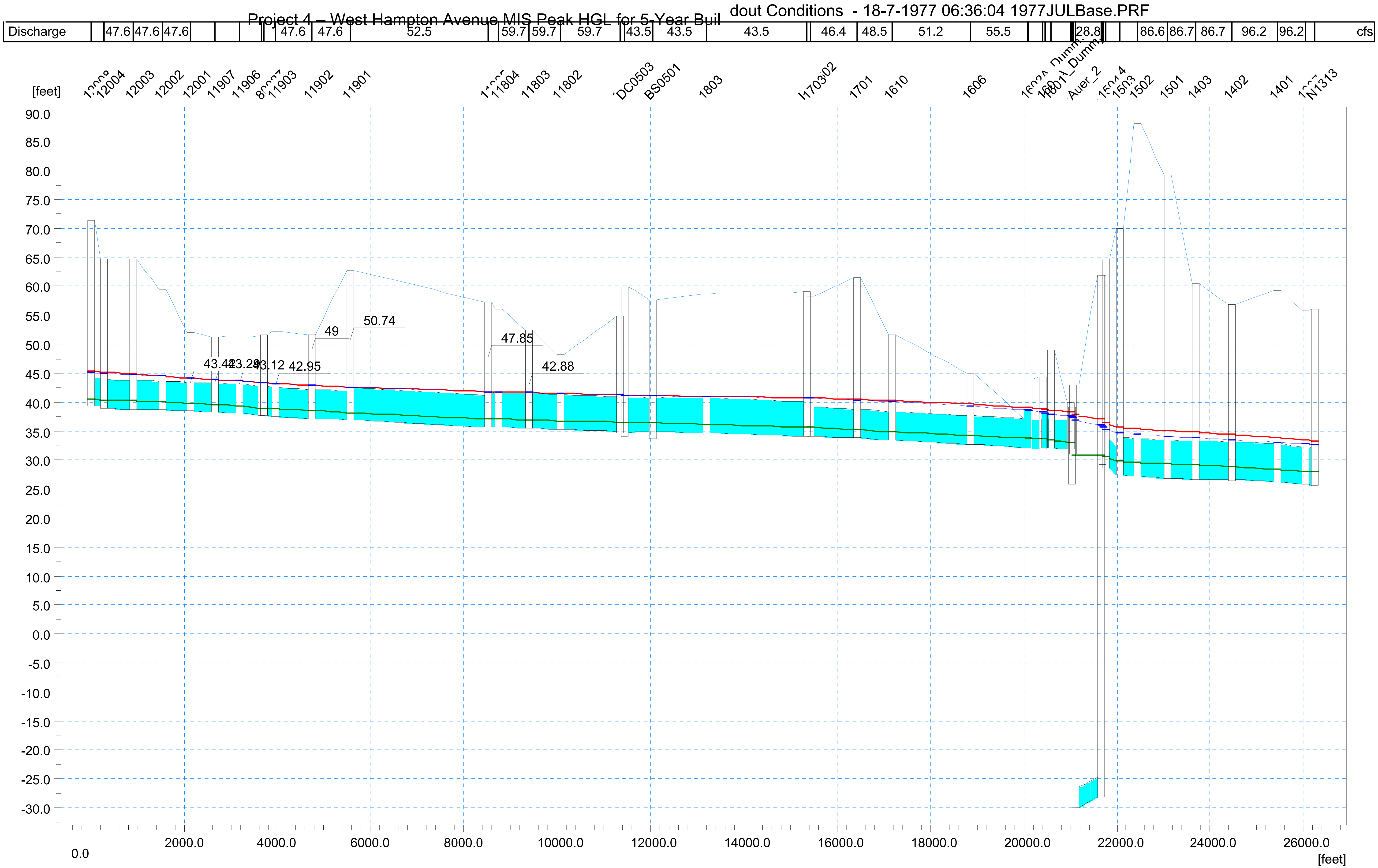

Project 4 – West Hampton Avenue MIS Peak HGL for 5-Year Baseline Conditions - 23-4-1999 05:20:04 1999APRBase.PRF
Discharge
21.2
0.0
29.0
37.6
47.7
47.7
47.7
47.7
47.7
47.7
47.7
cfs
[feet]
12106
12008
12004
12003
12002
12001
11907
11906
80027
11903
44.68
43.42
43.29
43.12
72.0
70.0
68.0
66.0
64.0
62.0
60.0
58.0
56.0
54.0
52.0
50.0
48.0
46.0
44.0
42.0
40.0
38.0
36.0
34.0
32.0
30.0
0.0
500.0
1000.0
1500.0
2000.0
2500.0
3000.0
3500.0
4000.0
4500.0
5000.0
5500.0
[feet]

Project 4 – West Hampton Avenue MIS Peak HGL for 5-Year Future Conditions - 20-4-1993 02:14:20 1993APRBase.PRF

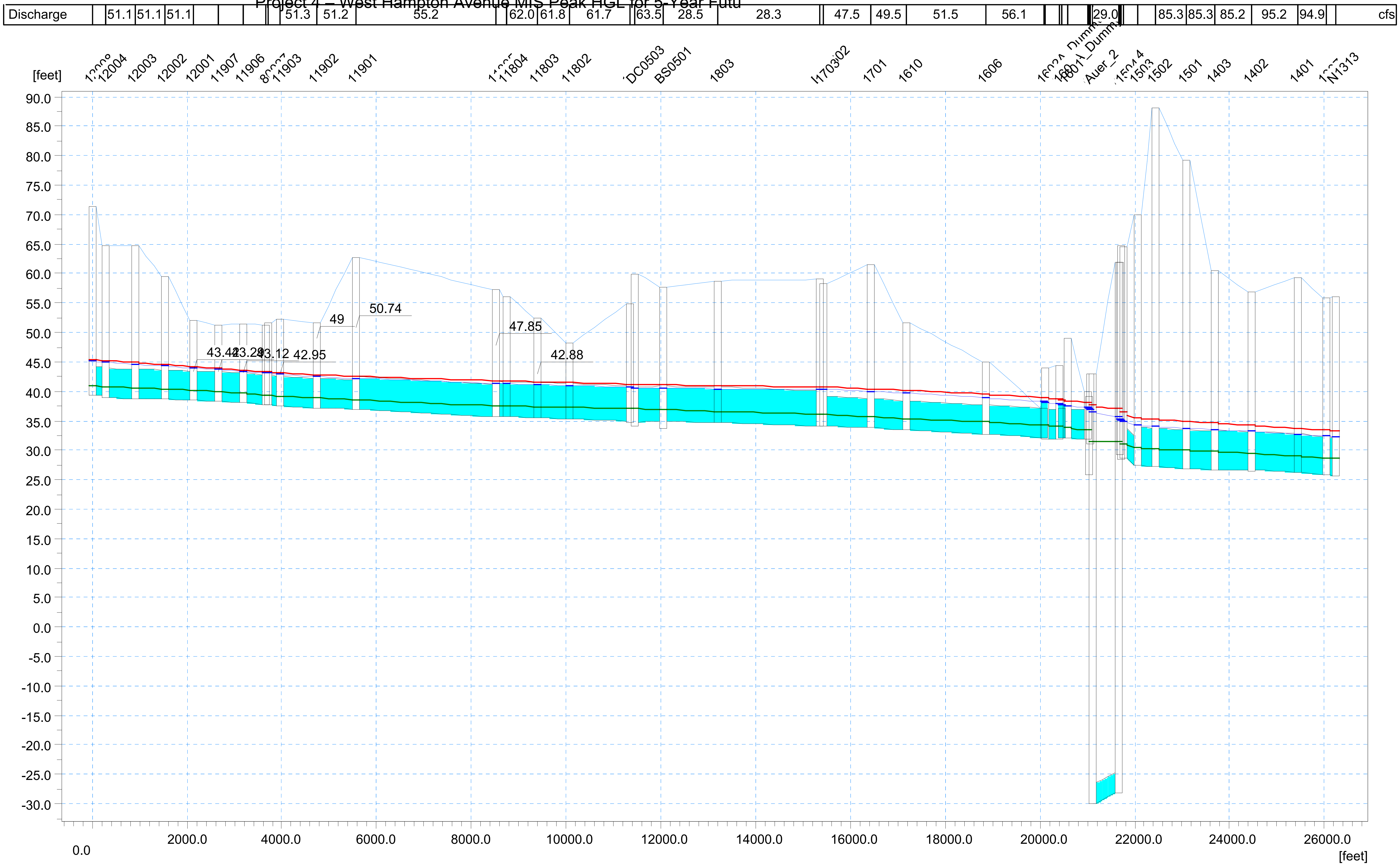


Project 4 – West Hampton Avenue MIS Peak HGL for 5-Year Buildout Conditions - 18-7-1977 06:41:04 1977JULBase.PRF

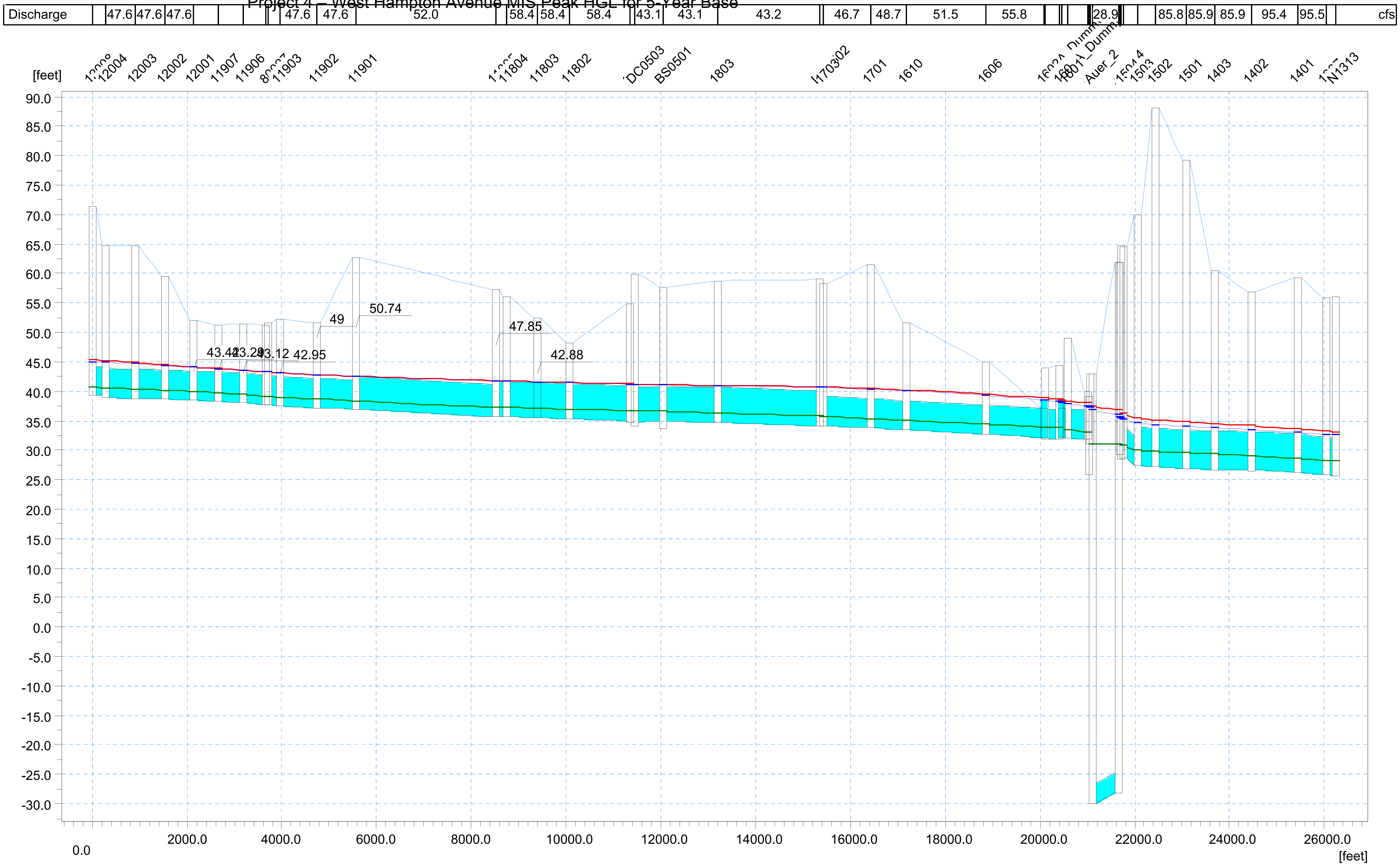



Project 4 – West Hampton Avenue MIS Peak HGL for 5-Year Buildout Conditions - 18-7-1977 06:36:04 1977JULBase.PRF
Discharge
cfs
[feet]
49
50.74
47.85
42.88
43.12
42.95
[feet]

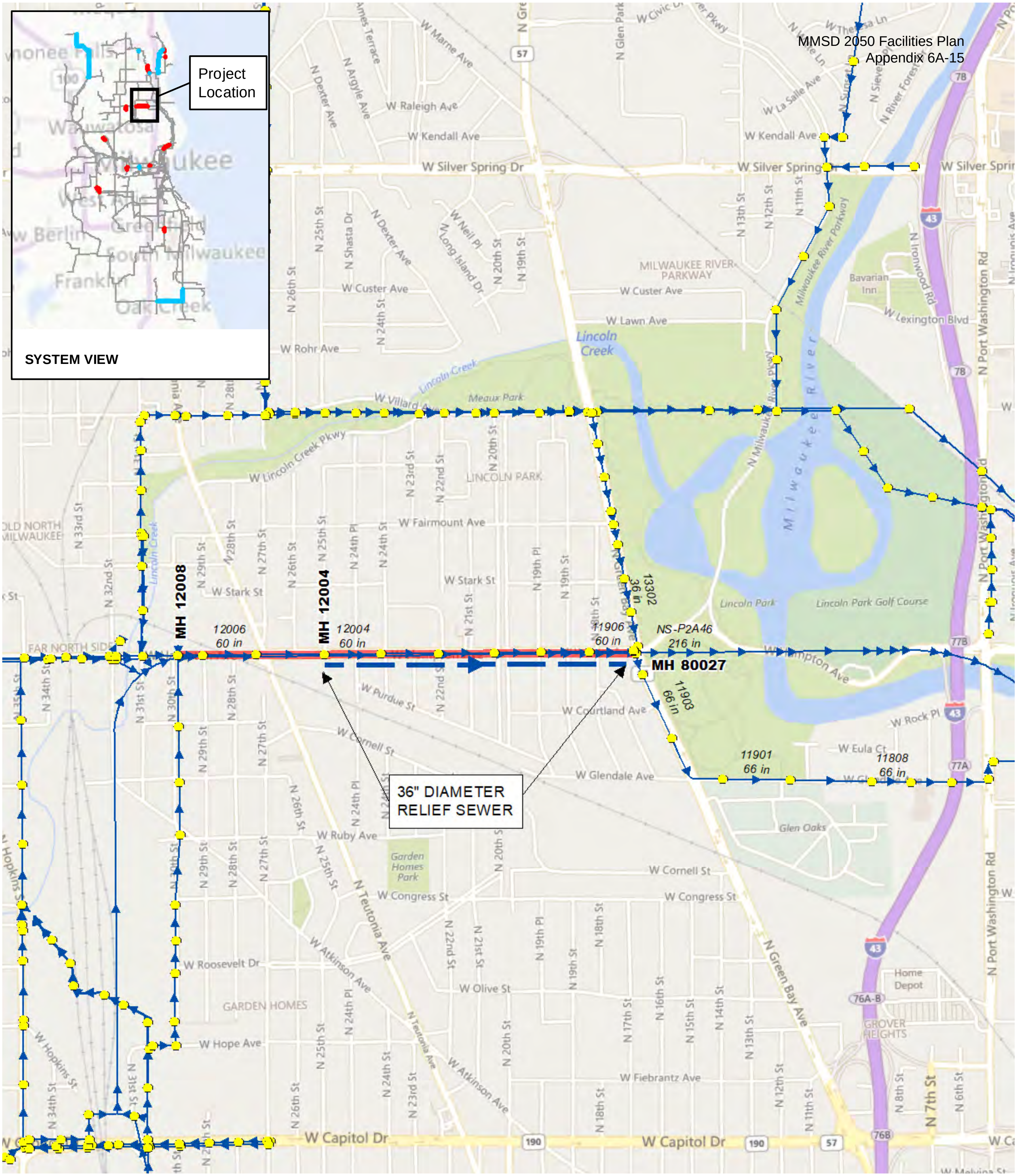
Project 4 – West Hampton Avenue MIS Peak HGL for 5-Year Future Conditions - 20-4-1993 02:24:20 1993APRBase.PRF



Project 4 – West Hampton Avenue MIS Peak HGL for 5-Year Baseline Conditions - 23-4-1999 05:00:04 1999APRBase.PRF



APPENDIX 6A-15: CS R4 Hampton Ave Alt 1 Map -



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

0 500 1,000
Feet

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

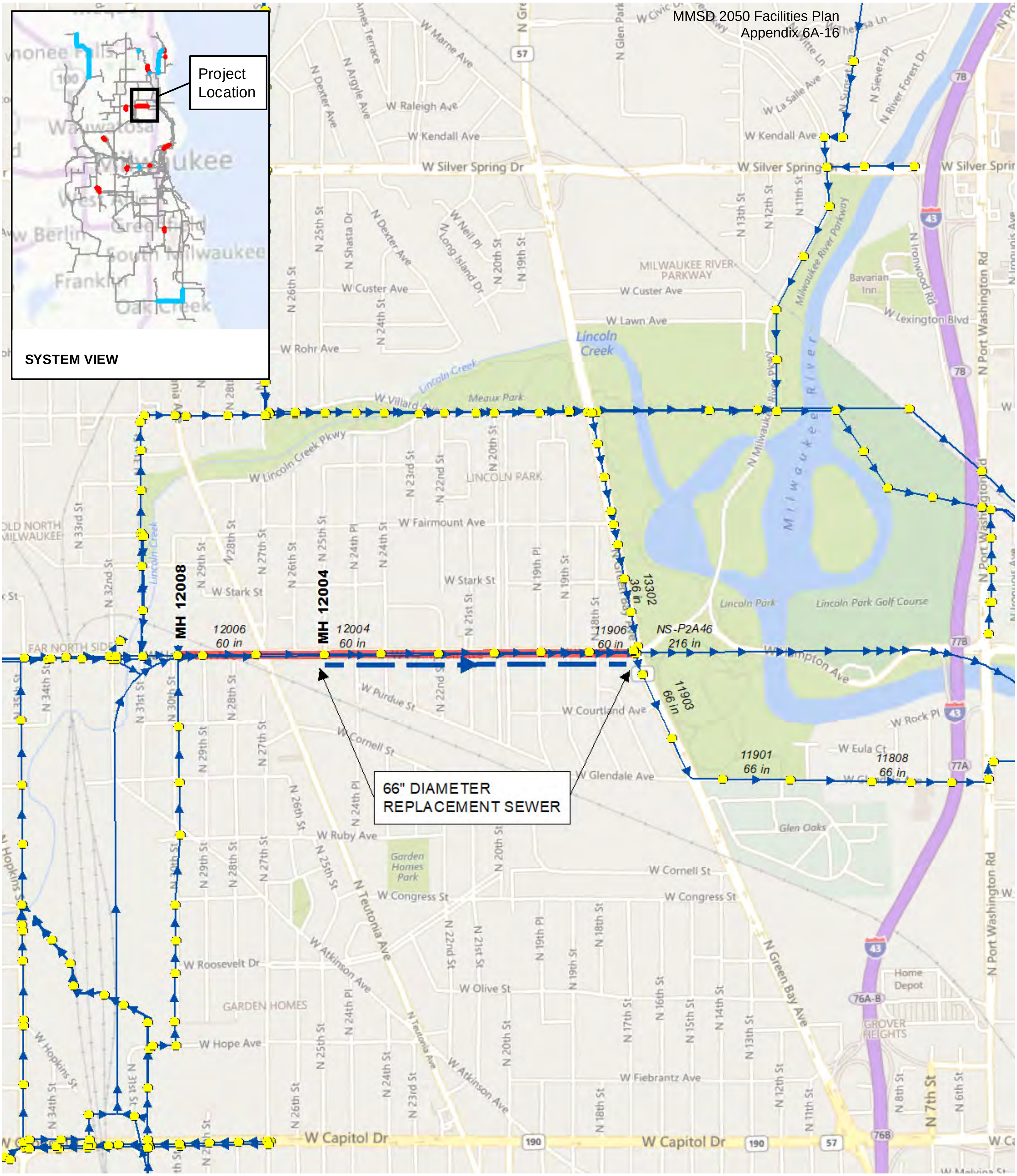
PROJECT 4

WEST HAMPTON AVENUE - NORTH GREEN BAY ROAD MIS ALTERNATIVE 1 RELIEF SEWER

2050 Facilities Plan

DRAFT - 9/26/2019

APPENDIX 6A-16: CS R4 Hampton Ave Alt 2 Map -



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

0 500 1,000
Feet

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

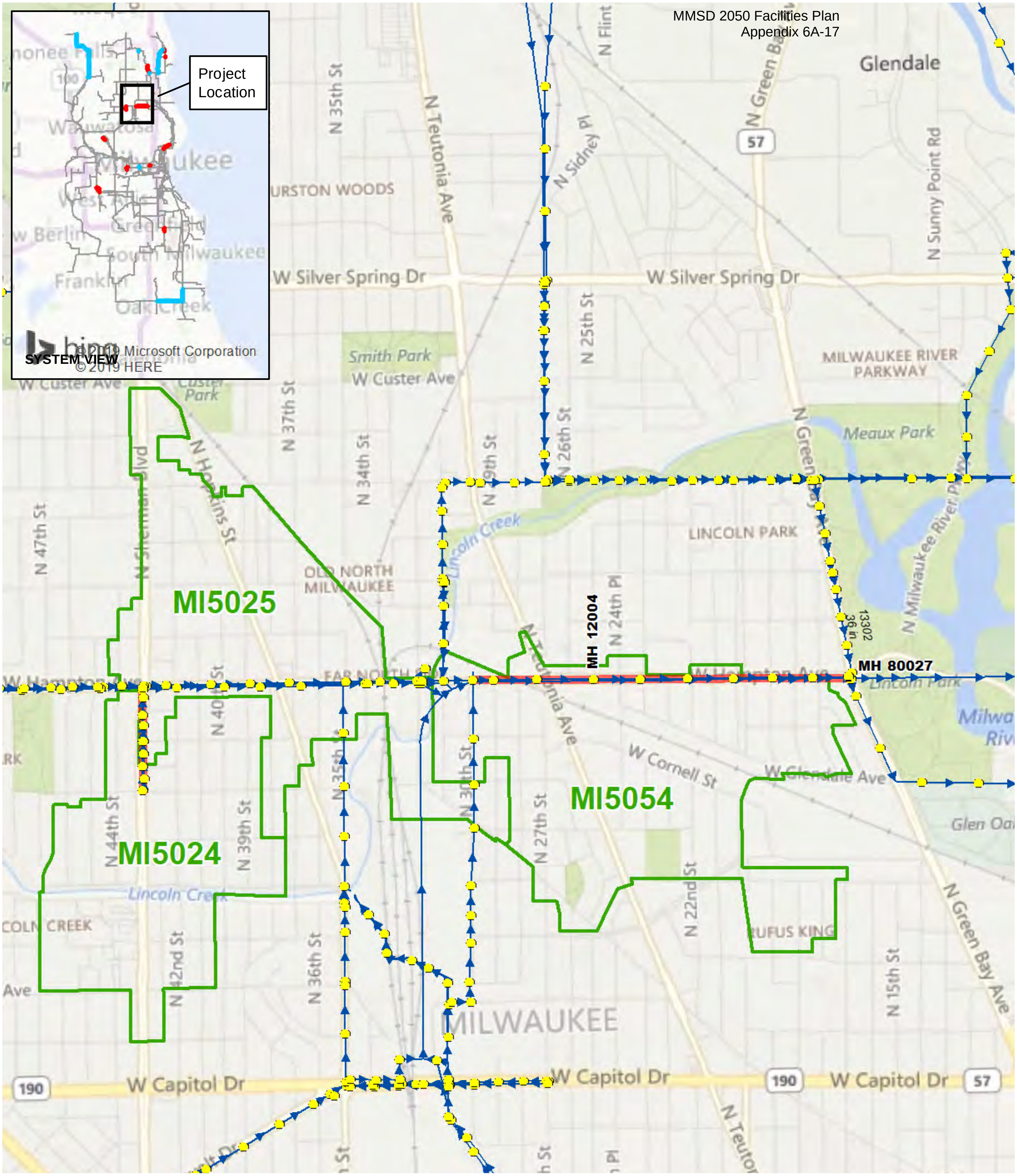
PROJECT 4

WEST HAMPTON AVENUE - NORTH GREEN BAY ROAD MIS ALTERNATIVE 2 REPLACEMENT SEWER

2050 Facilities Plan

DRAFT - 9/26/2019

APPENDIX 6A-17: CS R4 Hampton Ave Alt 3 Map -



LEGEND
- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

0 500 1,000
Feet

PARTNERS FOR A CLEANER ENVIRONMENT

PROJECT 4

WEST HAMPTON AVENUE - NORTH GREEN BAY ROAD MIS ALTERNATIVE 3

I/I REDUCTION

2050 Facilities Plan

DRAFT - 11/21/2019

APPENDIX 6A-18: CS R4 Hampton Ave Capacity Costs -

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 4 - West Hampton Avenue MIS - Alternative 1
36-inch Diameter Relief Sewer

General Description:
Construct 3,439 LF of 36-inch diameter sewer to relieve the existing 60-inch MIS. Installation assumed to be by both open-cut up to 20 ft. deep and by tunneling, up to 32 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 750,000	$ 750,000	$ 900,000
Item 2 - 36" Open-Cut and Microtunnel	LF	3,439	$ 1,411	$ 6,790,000	$ 8,150,000
Item 3 - 30 ft. Depth Shaft Structure (Avg. of 25' & 35' costs)	EACH	3	$ 155,000	$ 650,000	$ 780,000
Item 4 - 72" Diameter Structure (15-20 ft Depth, Open Cut)	EACH	3	$ 25,000	$ 110,000	$ 130,000
Total Construction Cost				**$ 8,300,000**	
Total Capital Cost					**$ 9,960,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	6,878	0.75	$ 5,200
(double length for relief sewer because there will be two pipes to maintain)				$ -
				$ -
<u>**Life Cycle Analysis**</u>				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 75,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH

Capital Costs	$ 9,960,000
Present Worth of O&M Costs	$ 75,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 10,035,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 4 - West Hampton Avenue MIS - Alternative 1
36-inch Diameter Relief Sewer

General Description:
Construct 3,439 LF of 36-inch diameter sewer to relieve the existing 60-inch MIS. Installation assumed to be by both open-cut up to 20 ft. deep and by tunneling, up to 32 ft. deep.

				Capital Costs							
ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - Mob/Demob		LS	1	$ 750,000	$ 750,000	-	-	-	$ 750,000	20%	$ 900,000
Item 2 - 36" Open-Cut and Microtunnel		LF	3,439	$ 1,411	$ 4,852,429	20%	20%	$ 6,790,000	$ 6,790,000	20%	$ 8,150,000
Item 3 - 30 ft. Depth Shaft Structure (Avg. of 25' & 35' costs)		EACH	3	$ 155,000	$ 465,000	20%	20%	$ 650,000	$ 650,000	20%	$ 780,000
Item 4 - 72" Diameter Structure (15-20 ft Depth, Open Cut)		EACH	3	$ 25,000	$ 75,000	20%	20%	$ 110,000	$ 110,000	20%	$ 130,000
										Total Capital Cost	**$ 9,960,000**

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Microtunnel cost from ASSETVIEW
3) Mob/Demob cost is estimated at $750k for projects ranging from $5-$10 million.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS
Project No. 4 - West Hampton Avenue MIS - Alternative 2
66-inch Diameter Replacement Sewer

General Description:
Contstruct 3,439 LF of 66-inch diameter sewer to replace the existing 60-inch MIS. Installation assumed to be by both open-cut up to 20 ft. deep and by tunneling, up to 32 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 1,000,000	$ 1,000,000	$ 1,200,000
Item 2 - 66" Open-Cut and Microtunnel	LF	3,439	$ 2,354	$ 11,330,000	$ 13,600,000
Item 3 - 30 ft. Depth Shaft Structure (Avg. of 25' & 35' costs)	EACH	3	$ 155,000	$ 650,000	$ 780,000
Item 4 - 120" Diameter Structure (15-20 ft Depth, Open Cut)	EACH	3	$ 40,000	$ 170,000	$ 200,000
Total Construction Cost				**$ 13,150,000**	
Total Capital Cost					**$ 15,780,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	3,439	0.75	$ 2,600
				$ -
				$ -
<u>**Life Cycle Analysis**</u>				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 37,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH

Capital Costs	$ 15,780,000
Present Worth of O&M Costs	$ 37,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 15,817,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 4 - West Hampton Avenue MIS - Alternative 2
66-inch Diameter Replacement Sewer

General Description:
Contstruct 3,439 LF of 66-inch diameter sewer to replace the existing 60-inch MIS. Installation assumed to be by both open-cut up to 20 ft. deep and by tunneling, up to 32 ft. deep.

ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - Mob/Demob		LS	1	$ 1,000,000	$ 1,000,000	-	-	-	$ 1,000,000	20%	$ 1,200,000
Item 2 - 66" Open-Cut and Microtunnel		LF	3,439	$ 2,354	$ 8,095,406	20%	20%	$ 11,330,000	$ 11,330,000	20%	$ 13,600,000
Item 3 - 30 ft. Depth Shaft Structure (Avg. of 25' & 35' costs)		EACH	3	$ 155,000	$ 465,000	20%	20%	$ 650,000	$ 650,000	20%	$ 780,000
Item 4 - 120" Diameter Structure (15-20 ft Depth, Open Cut)		EACH	3	$ 40,000	$ 120,000	20%	20%	$ 170,000	$ 170,000	20%	$ 200,000
										Total Capital Cost	**$ 15,780,000**

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Microtunnel cost from ASSETVIEW
3) Mob/Demob cost is estimated at $1M for projects ranging from $10-$25 million.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

MMSD PARTNERS FOR A CLEANER ENVIRONMENT

COST TABLE SUMMARY
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 4 - West Hampton Avenue MIS - Alternative No. 3
I/I Reduction
REVISED 11/20/19

General Description:
Remove up to 13 cfs of I/I to reduce peak flow rate from Sewersheds MI5054, MI5025, MI5024. CAPITAL COSTS EDITED FOLLOWING FIRST REIVEW TO REFLECT A 50% COST SPLIT BETWEEN MUNICIPALITY AND MMSD.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)/GPD	Construction Cost ($)	Capital Cost ($)
Item 1 - I/I Reduction in Sewershed MI5054	MGD	2.00	$ 2.10	$ 4,200,000	$ 5,040,000
Item 2 - I/I Reduction in Sewershed MI5025	MGD	0.78	$ 2.82	$ 2,199,600	$ 2,640,000
Item 3 - I/I Reduction in Sewershed MI5024	MGD	5.70	$ 1.42	$ 8,094,000	$ 9,710,000
Total Construction Cost				**14,493,600**	
50% Total Capital Cost					**$ 8,695,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	3,439	$ 0.75	$ 1,300
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 19,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

50% TOTAL PRESENT WORTH

Capital Costs	$ 8,695,000
Present Worth of O&M Costs	$ 19,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 8,714,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.
2) I/I removal costs from MMSD *Ad-Hoc Modeling Request 211* with costs based on assumed year 2020 ENRCCI 15,000. Not adjusted down to 12/2019 ENRCCI=14,700
3) O&M cost is assumed for routine annual sewer cleaning of rehabbed public sewers for each sewershed.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 4 - West Hampton Avenue MIS - Alternative No. 3
I/I Reduction

REVISED 11/20/19

General Description:
Remove up to 13 cfs of I/I to reduce peak flow rate from Sewersheds MI5054, MI5025, MI5024. CAPITAL COSTS EDITED FOLLOWING FIRST REIVEW TO REFLECT A 50% COST SPLIT BETWEEN MUNICIPALITY AND MMSD.

Capital Costs

ITEM	Life Years	Units	Quantity	Unit Cost ($)/GPD	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - I/I Reduction in Sewershed MI5054		MGD	2.00	$ 2.10	$ 4,200,000	-	-	-	$ 4,200,000	20%	$ 5,040,000
Item 2 - I/I Reduction in Sewershed MI5025		MGD	0.78	$ 2.82	$ 2,199,600	-	-	-	$ 2,199,600	20%	$ 2,640,000
Item 3 - I/I Reduction in Sewershed MI5024		MGD	5.70	$ 1.42	$ 8,094,000	-	-	-	$ 8,094,000	20%	$ 9,710,000
										Total Capital Cost	**$ 17,390,000**

Notes:
1) Definitions:
MGD - million gallons per day

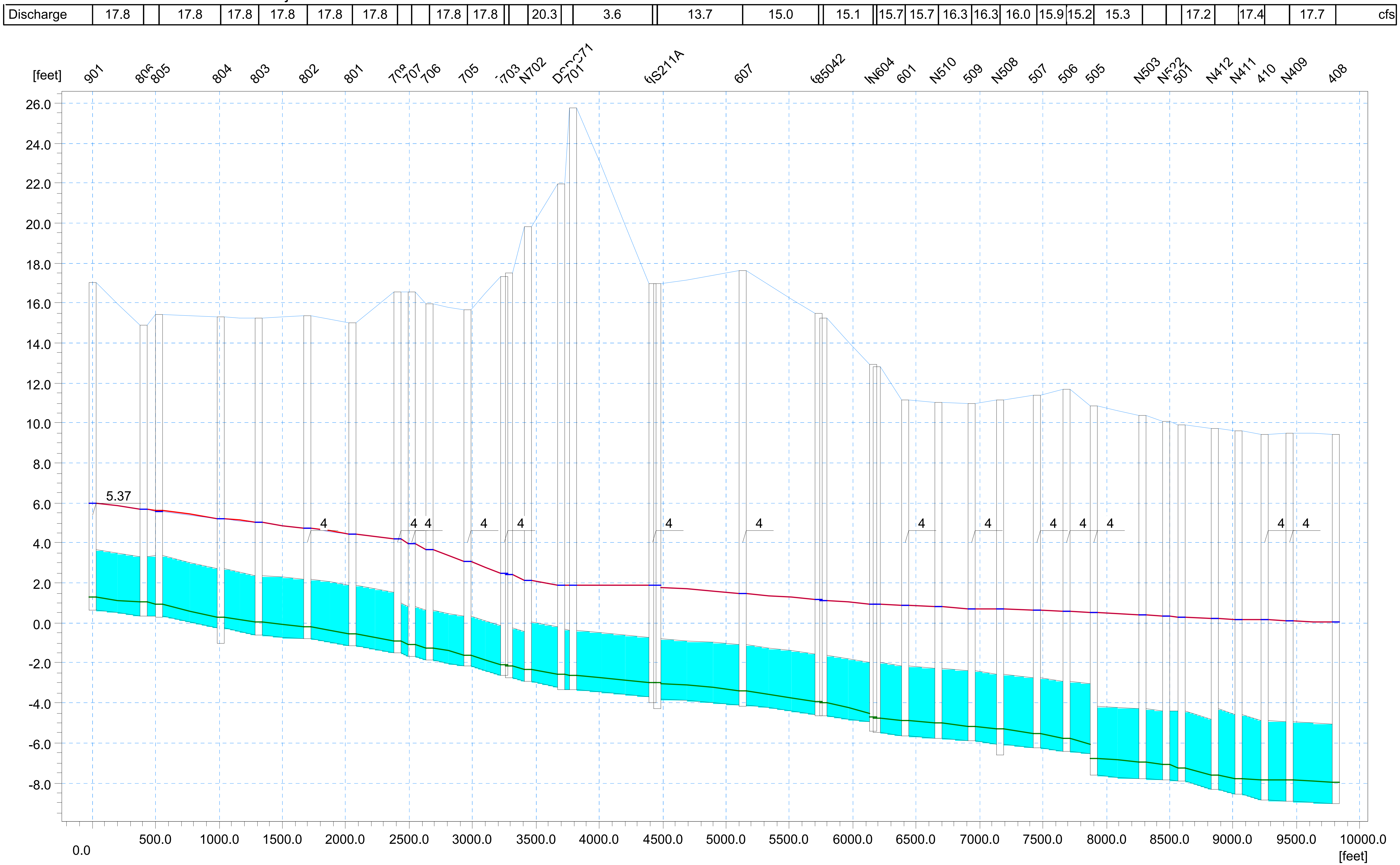
Milwaukee Metropolitan Sewerage District
2050 FACILITIES PLAN
BUSINESS CASE EVALUATIONS
Assumptions

General			Source	Comments
Milwaukee ENR **December 2019**	14,700		Historic_ENRvalues 1974-2019-05_MCA_KMZREV.xlsx	Milwaukee ENR is the average between Chicago and Minneapolis Construction Cost Index values published monthly by ENR. Milwaukee ENR December 2019 is a projected value from May 2019 based on average historical monthly increase in value from 2007 (2020 Facilities Plan published June 2007) to May 2019.
Annual increase in costs	0%		Discussions with MMSD	
Discount Rate	3.375%		Email from Andrew Dutcher, WDNR to Troy Deibert, HNTB on 6/5/19	**Facility planning is using the value established by the WDNR.**
Life Cycle - number years	20			
Capital Costs				
Un-designed Details Allowance - Varies, see below			**Allowance varies at engineer's discretion based on definitions provided for each %**	
all major components have documented installed unit costs	10%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
costs missing for some components, but other costs are for installed facilities and well documented (connections to existing systems, etc.)	20%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Alternative development is still conceptual	30%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Contingency Allowance - Set %				
Planning Level Contingency	20%		2050 FP Team - WRF discussion on 1/30/17	
Contractor Overhead & Profit - Varies, see below				
Equipment costs are from manufacturers	25%		2050 FP Team - WRF discussion on 1/30/17	
Costs are from previous project, unit costs already include OH&P	0%		2050 FP Team - cost estimate discussion on 5/20/19	
Design, Bidding, & MMSD Oversight				
Total Percent, Conveyance	20%		Total Percent used for Planning, Preliminary Engineering, Design, Construction (exc. Contractor Cost) and Post Construction in the BCE	**For FP Use only. This is incorporated into AMP BCE template already.** Varies for each asset system
Total Percent, WRFs	40%			
Total Percent, Watercourse	20%			
Total Percent, GI	15%			

Power assumptions			SOURCE	Comments
Gas	2018 Current Rates			
turbine fuel, LFG	$2.500	/Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
turbine fuel, NG	$5.000	/Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
Electrical				
Electrical Rates, JI/SS	Varies		Kziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	Detailed assumptions need to be included in backup on a case by case basis
Labor assumptions				
Veolia Labor	$50	per hour	Included in BCE assumptions	
Contractor Labor	$70	per hour	To be included in capital costs	

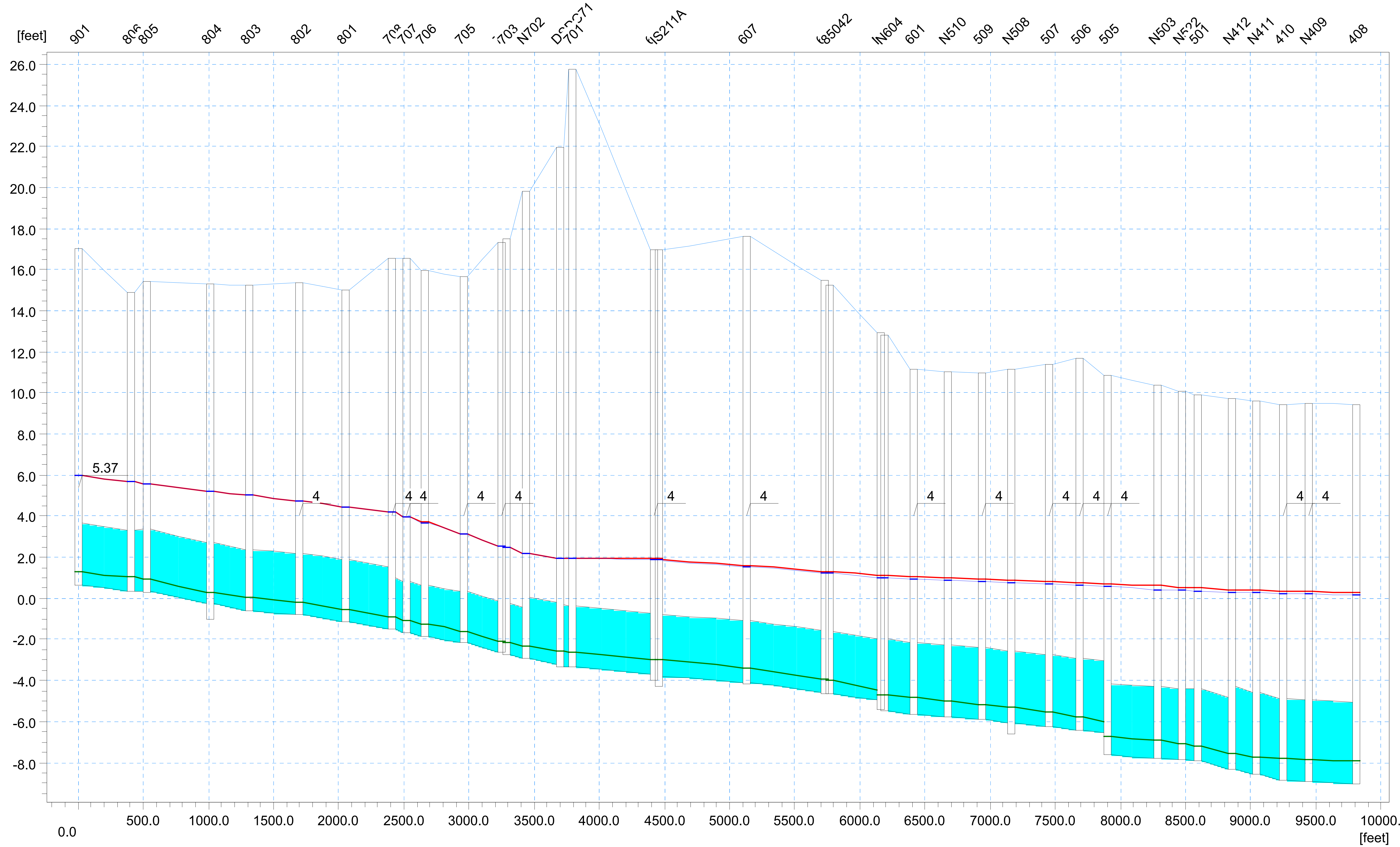
APPENDIX 6A-19: CS R5 N Commerce St Capacity Profiles -

Project 5 – North Commerce Street MIS Peak HGL for 5-Year Baseline Conditions - 3-6-1954 07:00:08 1954JUNBase.PRF



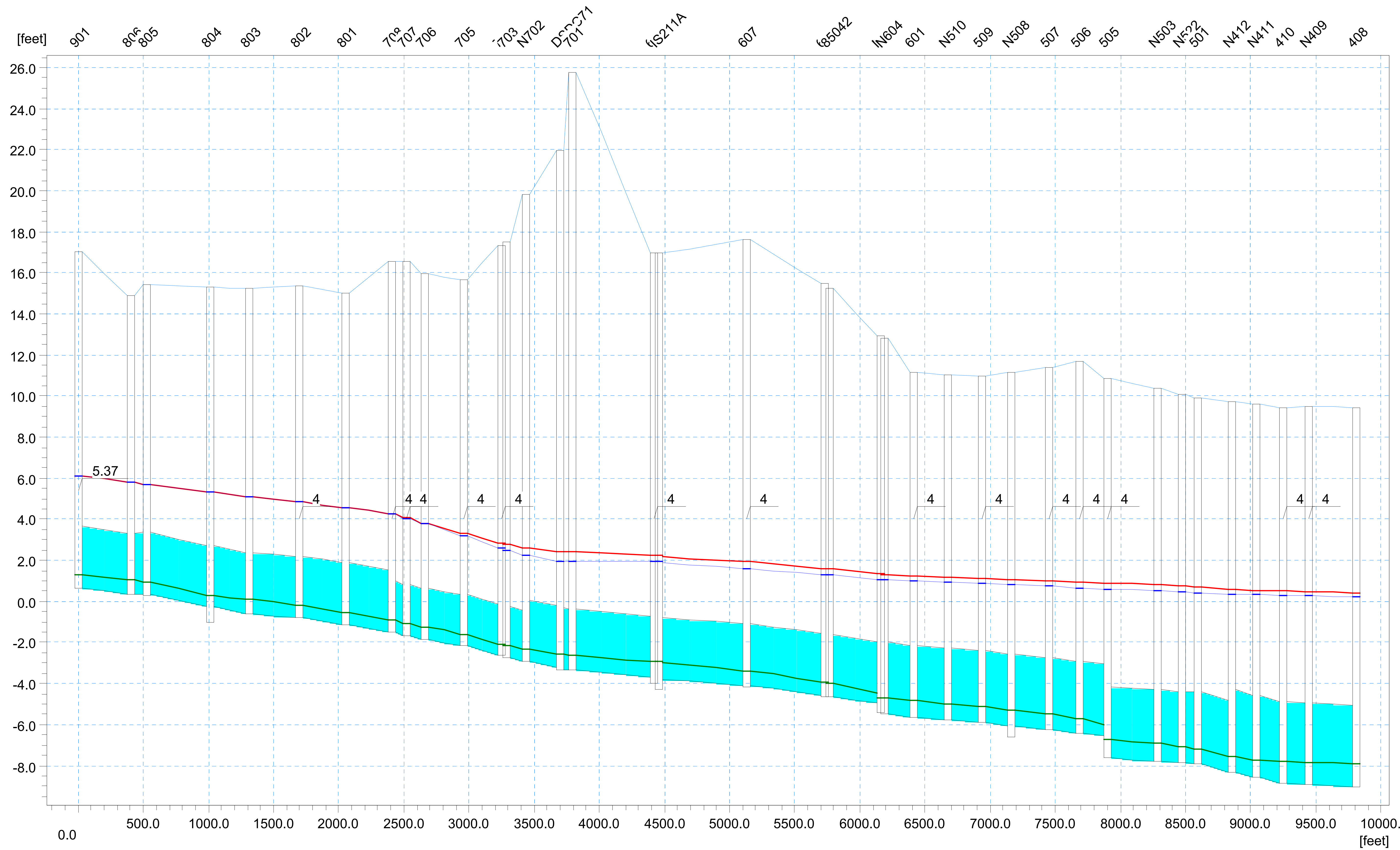
Project 5 – North Commerce Street MIS Peak HGL for 5-Year Future Conditions - 10-5-1990 02:02:43 1990MAYBase.PRF

Discharge	17.7		17.7	17.7	17.7	17.7	17.7			17.7	17.7		20.3		3.0		13.2	14.7		14.7	15.3	15.4	15.9	15.9	15.7	15.8	15.3	15.5			17.1		17.8		17.9	cfs

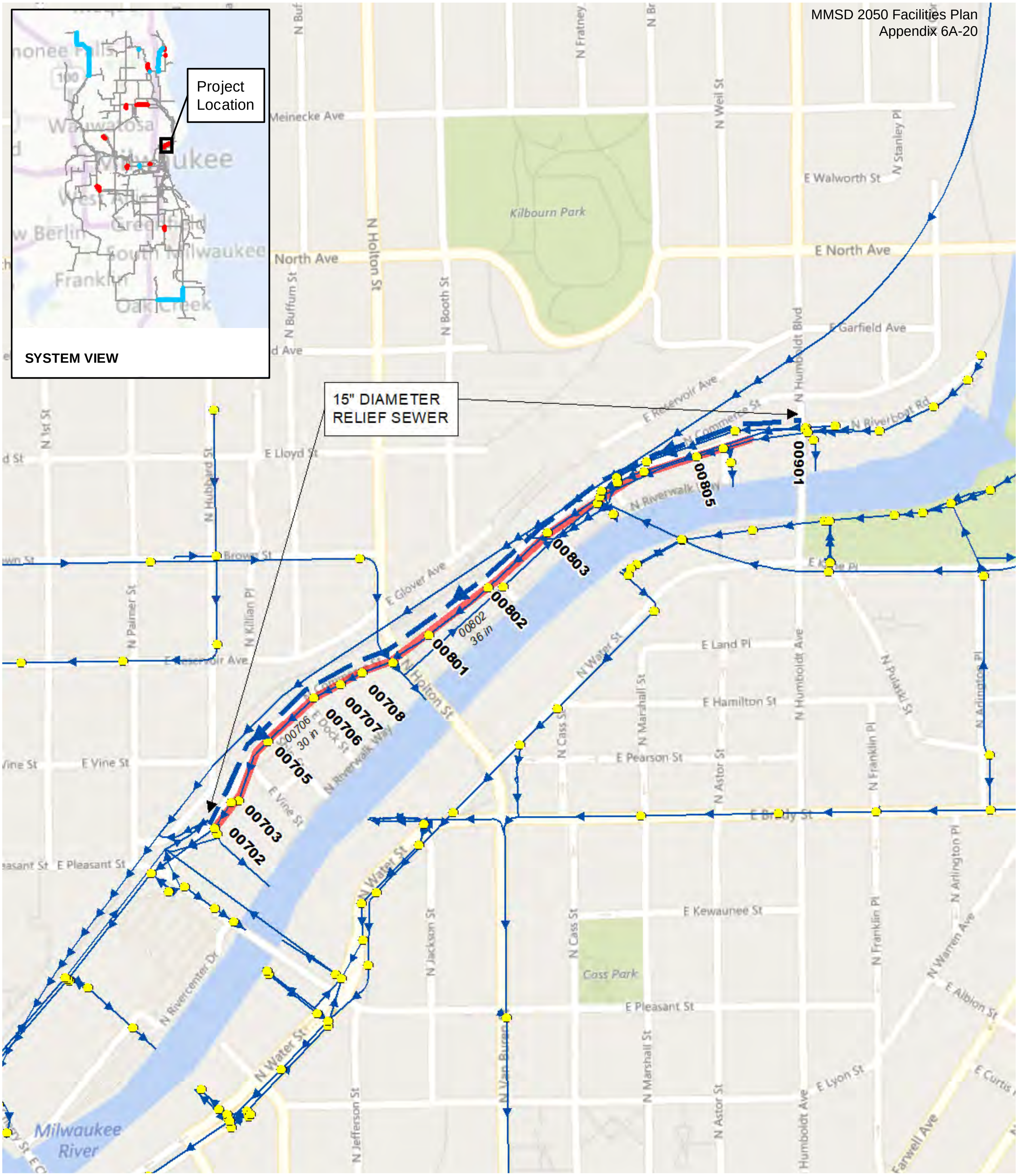


Project 5 – North Commerce Street MIS Peak HGL for 5-Year Buildout Conditions - 10-5-1990 02:16:09 1990MAYBase.PRF

Discharge	17.9		17.9	17.9	17.9	17.9	17.9			17.9	17.9		20.7		2.6	12.9	14.6		14.6	15.2	15.2	15.7	15.7	15.6	15.7	15.3	15.4			16.9		17.7		18.1	cfs



APPENDIX 6A-20: CS R5 N Commerce St Alt 1 Map -



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

0 250 500
Feet

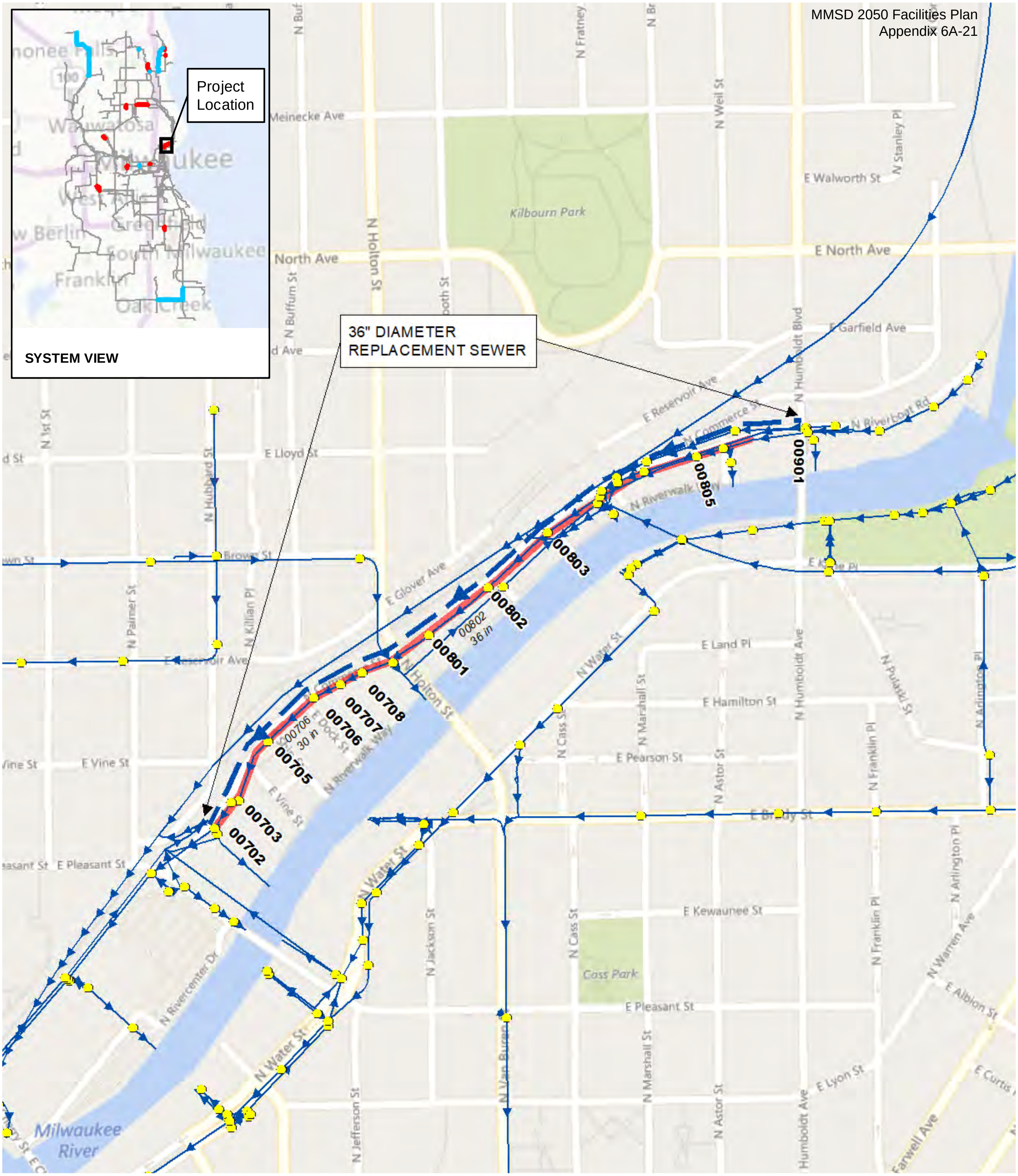
MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

PROJECT 5
COMMERCE STREET MIS
ALTERNATIVE 1
RELIEF SEWER

2050 Facilities Plan

DRAFT - 9/26/2019

APPENDIX 6A-21: CS R5 N Commerce St Alt 2 Map -



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

0 250 500

Feet

MMSD PARTNERS FOR A CLEANER ENVIRONMENT

PROJECT 5

COMMERCE STREET MIS ALTERNATIVE 2 REPLACEMENT SEWER

2050 Facilities Plan

DRAFT - 9/26/2019

APPENDIX 6A-22: CS R5 N Commerce St Capacity Costs -

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 5 - North Commerce St. MIS - Alternative No. 1
15-inch Diameter Relief Sewer

General Description:
Construct 3,451 LF of 15-inch diameter sewer along N. Commerce St. to relieve the existing 30"-36" diameter MIS. Installation assumed to be by open-cut construction, up to 23 ft. deep.

ENR Index = 14700 (projected to December 2019)
Annual Increase in Costs = 0.0%
Discount Rate 3.375%
Number of Years 20

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 750,000	$ 750,000	$ 900,000
Item 2 - 15" Microtunnel	LF	3,451	$ 758	$ 3,660,000	$ 4,390,000
Item 3 - 25 ft. Depth Shaft Structure	EACH	5	$ 130,000	$ 910,000	$ 1,090,000
Total Construction Cost				**$ 5,320,000**	
Total Capital Cost					**$ 6,380,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	6,902	0.75	$ 5,200
(double length for relief sewer because there will be two pipes to maintain)				$ -
				$ -
<u>**Life Cycle Analysis**</u>				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 75,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH

Capital Costs	$ 6,380,000
Present Worth of O&M Costs	$ 75,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 6,455,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 5 - North Commerce St. MIS - Alternative No. 1
15-inch Diameter Relief Sewer

General Description:
Construct 3,451 LF of 15-inch diameter sewer along N. Commerce St. to relieve the existing 30"-36" diameter MIS. Installation assumed to be by open-cut construction, up to 23 ft. deep.

				Capital Costs							
ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - Mob/Demob		LS	1	$ 750,000	$ 750,000	-	-	-	$ 750,000	20%	$ 900,000
Item 2 - 15" Microtunnel		LF	3,451	$ 758	$ 2,615,858	20%	20%	$ 3,660,000	$ 3,660,000	20%	$ 4,390,000
Item 3 - 25 ft. Depth Shaft Structure		EACH	5	$ 130,000	$ 650,000	20%	20%	$ 910,000	$ 910,000	20%	$ 1,090,000
										Total Capital Cost	**$ 6,380,000**

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Microtunnel cost from ASSETVIEW
3) Mob/Demob cost is estimated at $750k for projects ranging from $5-$10 million.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

MMSD PARTNERS FOR A CLEANER ENVIRONMENT

COST TABLE SUMMARY
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 5 - North Commerce St. MIS - Alternative No. 2
36-inch Diameter Replacement Sewer

General Description:
Construct 3,451 LF of 36-inch diameter sewer along N. Commerce St. to replace the existing 30"-36" diameter MIS. Installation assumed to be tunnel construction, up to 23 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 750,000	$ 750,000	$ 900,000
Item 2 - 36" Microtunnel	LF	3,451	$ 1,411	$ 6,820,000	$ 8,180,000
Item 3 - 25 ft. Depth Shaft Structure	EACH	8	$ 130,000	$ 1,460,000	$ 1,750,000
Total Construction Cost				**$ 9,030,000**	
Total Capital Cost					**$ 10,830,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	3,451	0.75	$ 2,600
				$ -
				$ -
Life Cycle Analysis				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 37,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH

Capital Costs	$ 10,830,000
Present Worth of O&M Costs	$ 37,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 10,867,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS
Project No. 5 - North Commerce St. MIS - Alternative No. 2
36-inch Diameter Replacement Sewer

General Description:
Construct 3,451 LF of 36-inch diameter sewer along N. Commerce St. to replace the existing 30"-36" diameter MIS. Installation assumed to be tunnel construction, up to 23 ft. deep.

ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
					Capital Costs						
Item 1 - Mob/Demob		LS	1	$ 750,000	$ 750,000	-	-	-	$ 750,000	20%	$ 900,000
Item 2 - 36" Microtunnel		LF	3,451	$ 1,411	$ 4,869,361	20%	20%	$ 6,820,000	$ 6,820,000	20%	$ 8,180,000
Item 3 - 25 ft. Depth Shaft Structure		EACH	8	$ 130,000	$ 1,040,000	20%	20%	$ 1,460,000	$ 1,460,000	20%	$ 1,750,000
Assume 8 shafts minimum for CS connections											
										Total Capital Cost	**$ 10,830,000**

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Microtunnel cost from ASSETVIEW
3) Mob/Demob cost is estimated at $750k for projects ranging from $5-$10 million construction cost.

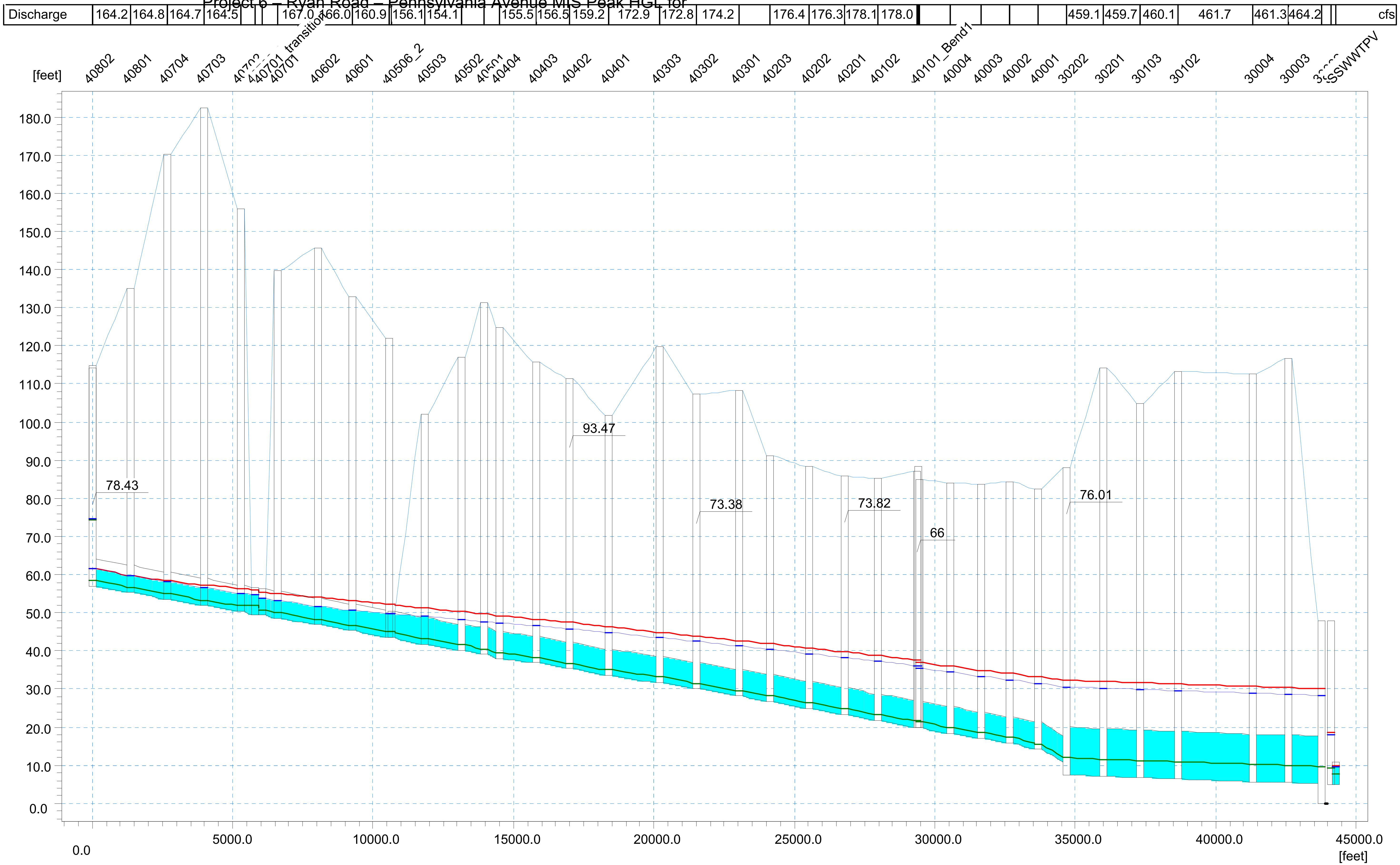
Milwaukee Metropolitan Sewerage District
2050 FACILITIES PLAN
BUSINESS CASE EVALUATIONS
Assumptions

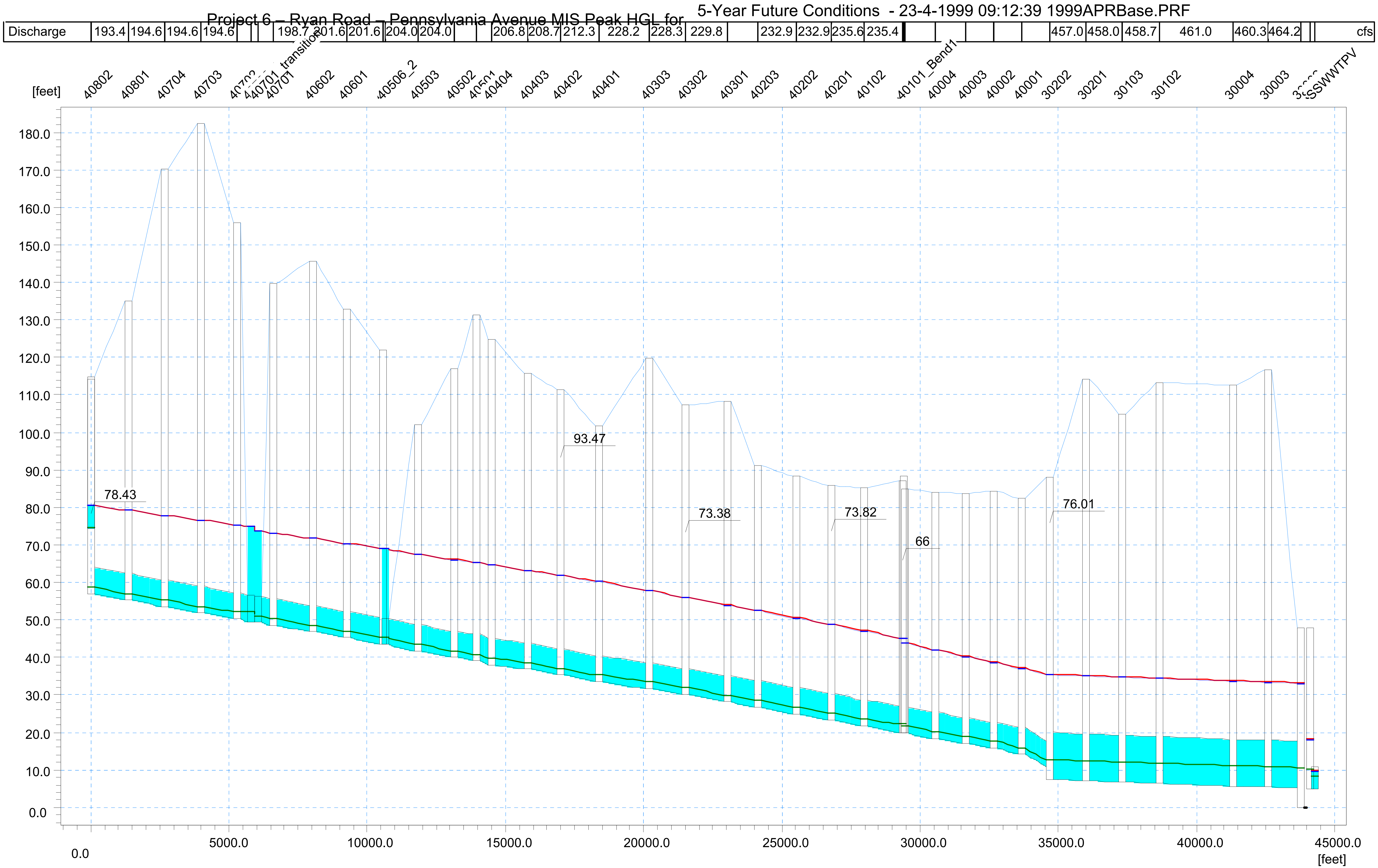
		Source	Comments
General			
Milwaukee ENR **December 2019**	14,700	Historic_ENRvalues 1974-2019-05_MCA_KMZREV.xlsx	Milwaukee ENR is the average between Chicago and Minneapolis Construction Cost Index values published monthly by ENR. Milwaukee ENR December 2019 is a projected value from May 2019 based on average historical monthly increase in value from 2007 (2020 Facilities Plan published June 2007) to May 2019.
Annual increase in costs	0%	Discussions with MMSD	
Discount Rate	3.375%	Email from Andrew Dutcher, WDNR to Troy Deibert, HNTB on 6/5/19	**Facility planning is using the value established by the WDNR.**
Life Cycle - number years	20		
Capital Costs			
Un-designed Details Allowance - Varies, see below		**Allowance varies at engineer's discretion based on definitions provided for each %**	
all major components have documented installed unit costs	10%	K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
costs missing for some components, but other costs are for installed facilities and well documented (connections to existing systems, etc.)	20%	K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Alternative development is still conceptual	30%	K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Contingency Allowance - Set %			
Planning Level Contingency	20%	2050 FP Team - WRF discussion on 1/30/17	
Contractor Overhead & Profit - Varies, see below			
Equipment costs are from manufacturers	25%	2050 FP Team - WRF discussion on 1/30/17	
Costs are from previous project, unit costs already include OH&P	0%	2050 FP Team - cost estimate discussion on 5/20/19	
Design, Bidding, & MMSD Oversight			
Total Percent, Conveyance	20%	Total Percent used for Planning, Preliminary Engineering, Design, Construction (exc. Contractor Cost) and Post Construction in the BCE	**For FP Use only. This is incorporated into AMP BCE template already.** Varies for each asset system
Total Percent, WRFs	40%		
Total Percent, Watercourse	20%		
Total Percent, GI	15%		

		SOURCE	Comments
Power assumptions			
Gas	2018 Current Rates		
turbine fuel, LFG	$2.500 /Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
turbine fuel, NG	$5.000 /Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
Electrical			
Electrical Rates, JI/SS	Varies	Kziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	Detailed assumptions need to be included in backup on a case by case basis
Labor assumptions			
Veolia Labor	$50 per hour	Included in BCE assumptions	
Contractor Labor	$70 per hour	To be included in capital costs	

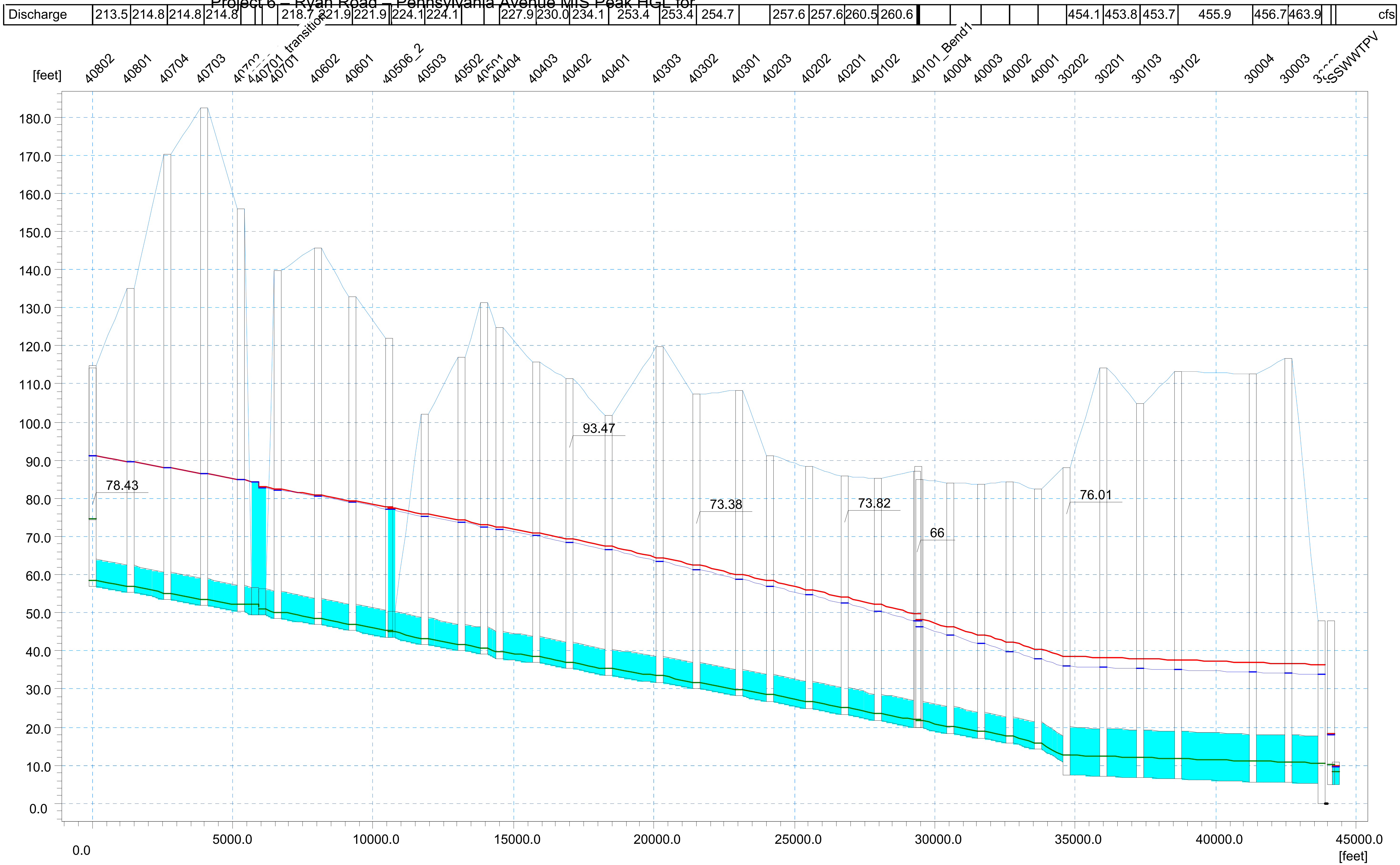
APPENDIX 6A-23: CS R6 Ryan Rd Capacity Profiles -

Project 6 – Ryan Road – Pennsylvania Avenue MIS Peak HGL for 5-Year Baseline Conditions - 24-4-1976 18:00:19 1976APRBase.PRF

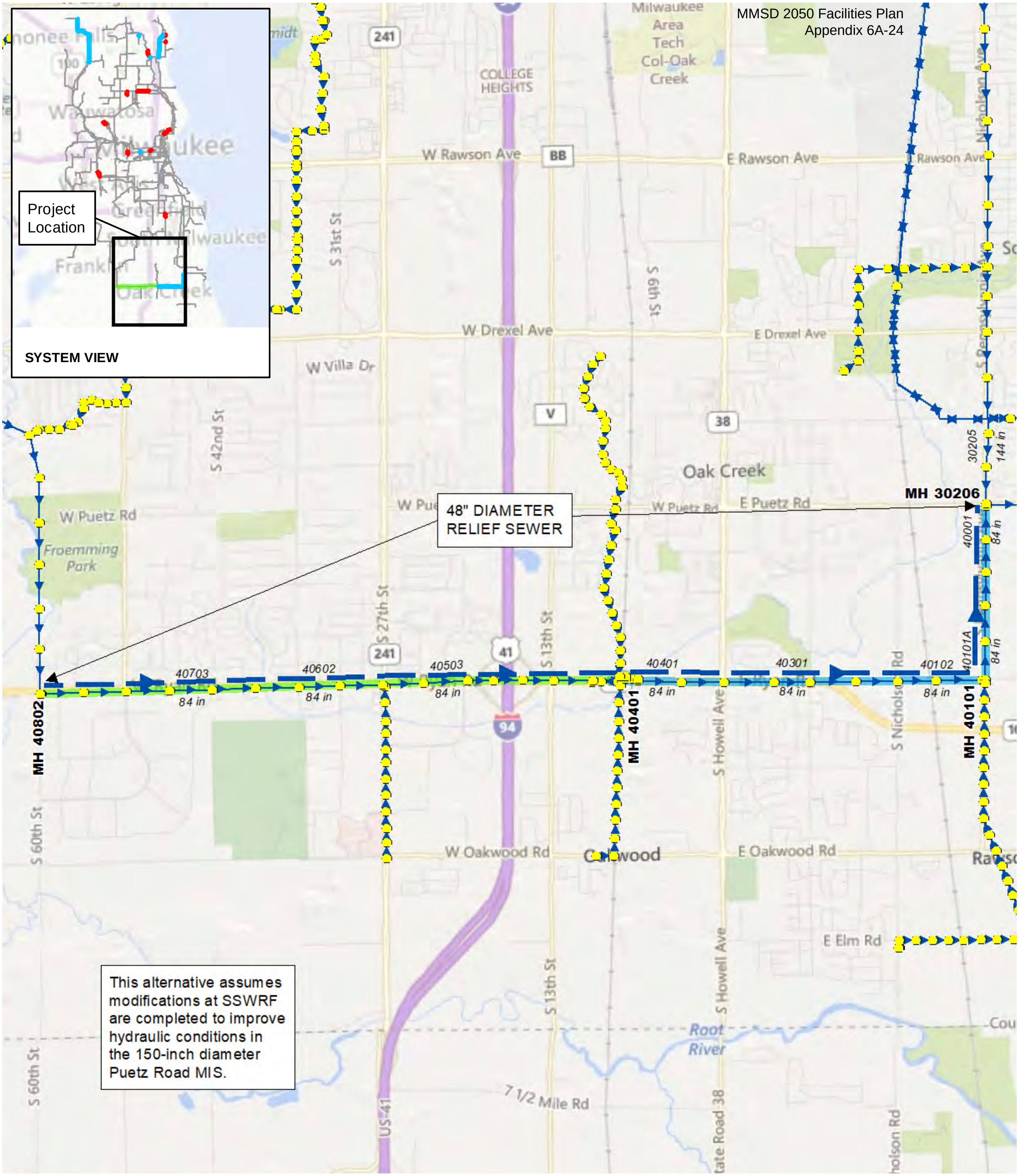



Project 6 – Ryan Road – Pennsylvania Avenue MIS Peak HGL for 5-Year Future Conditions - 23-4-1999 09:12:39 1999APRBase.PRF
Discharge
193.4 194.6 194.6 194.6 198.7 201.6 201.6 204.0 204.0 206.8 208.7 212.3 228.2 228.3 229.8 232.9 232.9 235.6 235.4 457.0 458.0 458.7 461.0 460.3 464.2
cfs
[feet]
40802 40801 40704 40703 40701_transition 40701 40602 40601 40506_2 40503 40502 40404 40403 40402 40401 40303 40302 40301 40203 40202 40201 40102 40101_Bend1 40004 40003 40002 40001 30202 30201 30103 30102 30004 30003 SSWWTPV
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
78.43
93.47
73.38
73.82
66
76.01
0.0
5000.0
10000.0
15000.0
20000.0
25000.0
30000.0
35000.0
40000.0
45000.0
[feet]

Project 6 – Ryan Road – Pennsylvania Avenue MIS Peak HGL for 5-Year Buildout Condition - 18-7-1977 09:46:04 1977JULBase.PRF



APPENDIX 6A-24: CS R6 Ryan Rd Alt 1 Map -



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK
- 2050 5-YEAR CAPACITY RISK

N

0 2,000 4,000
Feet

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

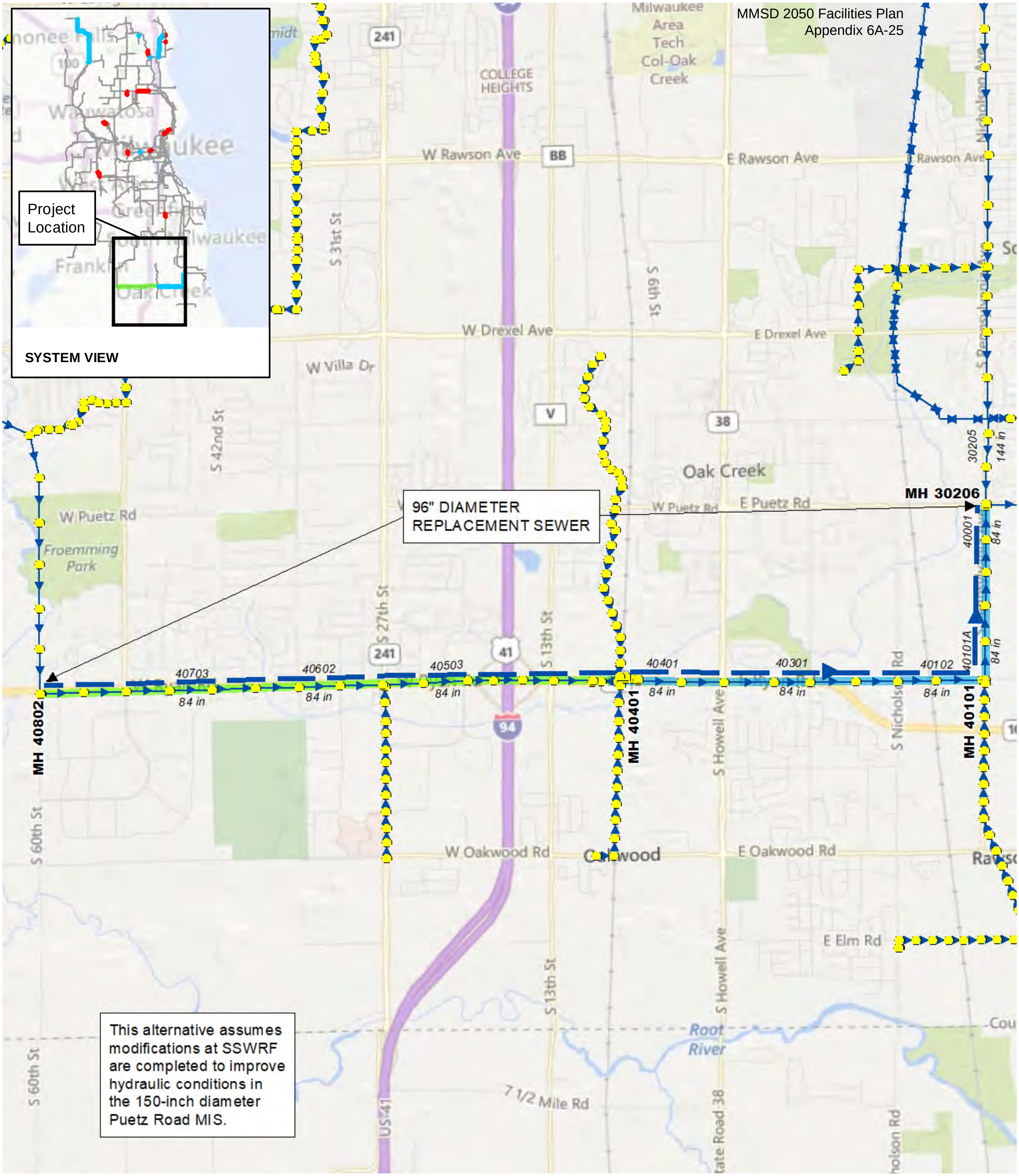
PROJECT 6

RYAN ROAD - PENNSYLVANIA AVENUE MIS ALTERNATIVE 1 RELIEF SEWER

2050 Facilities Plan

DRAFT - 9/26/2019

APPENDIX 6A-25: CS R6 Ryan Rd Alt 2 Map -



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK
- 2050 5-YEAR CAPACITY RISK

N

0 2,000 4,000
Feet

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

PROJECT 6

RYAN ROAD - PENNSYLVANIA AVENUE MIS ALTERNATIVE 2 REPLACEMENT SEWER

2050 Facilities Plan

DRAFT - 9/26/2019

APPENDIX 6A-26: CS R6 Ryan Rd Capacity Costs -

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 6 - Ryan Road-Pennsylvania Avenue MIS - Alternative 1
48-inch Diameter Relief Sewer

General Description:
Construct 34,600 LF of 48-inch diameter sewer to relieve the existing 84-inch diameter MIS in Ryan Rd and S. Pennsylvania Ave. Installation assumed to be by tunneling, up to 110 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 3,500,000	$ 3,500,000	$ 4,200,000
Item 2 - 48" Microtunnel	LF	34,600	$ 1,787	$ 86,560,000	$ 103,870,000
Item 3 - 65 ft. Depth Shaft Structure (Approx. Avg.)	EACH	40	$ 500,000	$ 28,000,000	$ 33,600,000
Total Construction Cost				**$ 118,060,000**	
Total Capital Cost					**$ 141,670,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	69,200	0.75	$ 51,900
(double length for relief sewer because there will be two pipes to maintain)				$ -
				$ -
Life Cycle Analysis				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 750,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH	
Capital Costs	$ 141,670,000
Present Worth of O&M Costs	$ 750,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 142,420,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 6 - Ryan Road-Pennsylvania Avenue MIS - Alternative 1
48-inch Diameter Relief Sewer

General Description:
Construct 34,600 LF of 48-inch diameter sewer to relieve the existing 84-inch diameter MIS in Ryan Rd and S. Pennsylvania Ave. Installation assumed to be by tunneling, up to 110 ft. deep.

ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - Mob/Demob		LS	1	$ 3,500,000	$ 3,500,000	-	-	-	$ 3,500,000	20%	$ 4,200,000
Item 2 - 48" Microtunnel		LF	34,600	$ 1,787	$ 61,830,200	20%	20%	$ 86,560,000	$ 86,560,000	20%	$ 103,870,000
Item 3 - 65 ft. Depth Shaft Structure (Approx. Avg.)		EACH	40	$ 500,000	$ 20,000,000	20%	20%	$ 28,000,000	$ 28,000,000	20%	$ 33,600,000
										Total Capital Cost	**$ 141,670,000**

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Microtunnel cost from ASSETVIEW
3) Mob/Demob cost is estimated at $3-5M for projects ranging from $100-$300 million.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 6 - Ryan Road-Pennsylvania Avenue MIS - Alternative 2
96-inch Diameter Relief Sewer

General Description:
Construct 34,600 LF of 96-inch diameter sewer to replace the existing 84-inch diameter MIS in W. Ryan Rd and S. Pennsylvania Ave. Installation assumed to be by tunneling, up to 130 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 4,000,000	$ 4,000,000	$ 4,800,000
Item 2 - 96" Microtunnel	LF	34,600	$ 3,308	$ 160,240,000	$ 192,290,000
Item 3 - 75 ft. Depth Shaft Structure (Approx. Avg.)	EACH	40	$ 780,000	$ 43,680,000	$ 52,420,000
Total Construction Cost				**$ 207,920,000**	
Total Capital Cost					**$ 249,510,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	34,600	0.75	$ 26,000
(double length for relief sewer because there will be two pipes to maintain)				$ -
				$ -
<u>**Life Cycle Analysis**</u>				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 370,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH	
Capital Costs	$ 249,510,000
Present Worth of O&M Costs	$ 370,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 249,880,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

CAPITAL COST DETAILS
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS
Project No. 6 - Ryan Road-Pennsylvania Avenue MIS - Alternative 2
96-inch Diameter Relief Sewer

General Description:
Construct 34,600 LF of 96-inch diameter sewer to replace the existing 84-inch diameter MIS in W. Ryan Rd and S. Pennsylvania Ave. Installation assumed to be by tunneling, up to 130 ft. deep.

ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
					Capital Costs						
Item 1 - Mob/Demob		LS	1	$ 4,000,000	$ 4,000,000	-	-	-	$ 4,000,000	20%	$ 4,800,000
Item 2 - 96" Microtunnel		LF	34,600	$ 3,308	$ 114,456,800	20%	20%	$ 160,240,000	$ 160,240,000	20%	$ 192,290,000
Item 3 - 75 ft. Depth Shaft Structure (Approx. Avg.)		EACH	40	$ 780,000	$ 31,200,000	20%	20%	$ 43,680,000	$ 43,680,000	20%	$ 52,420,000
										Total Capital Cost	**$ 249,510,000**

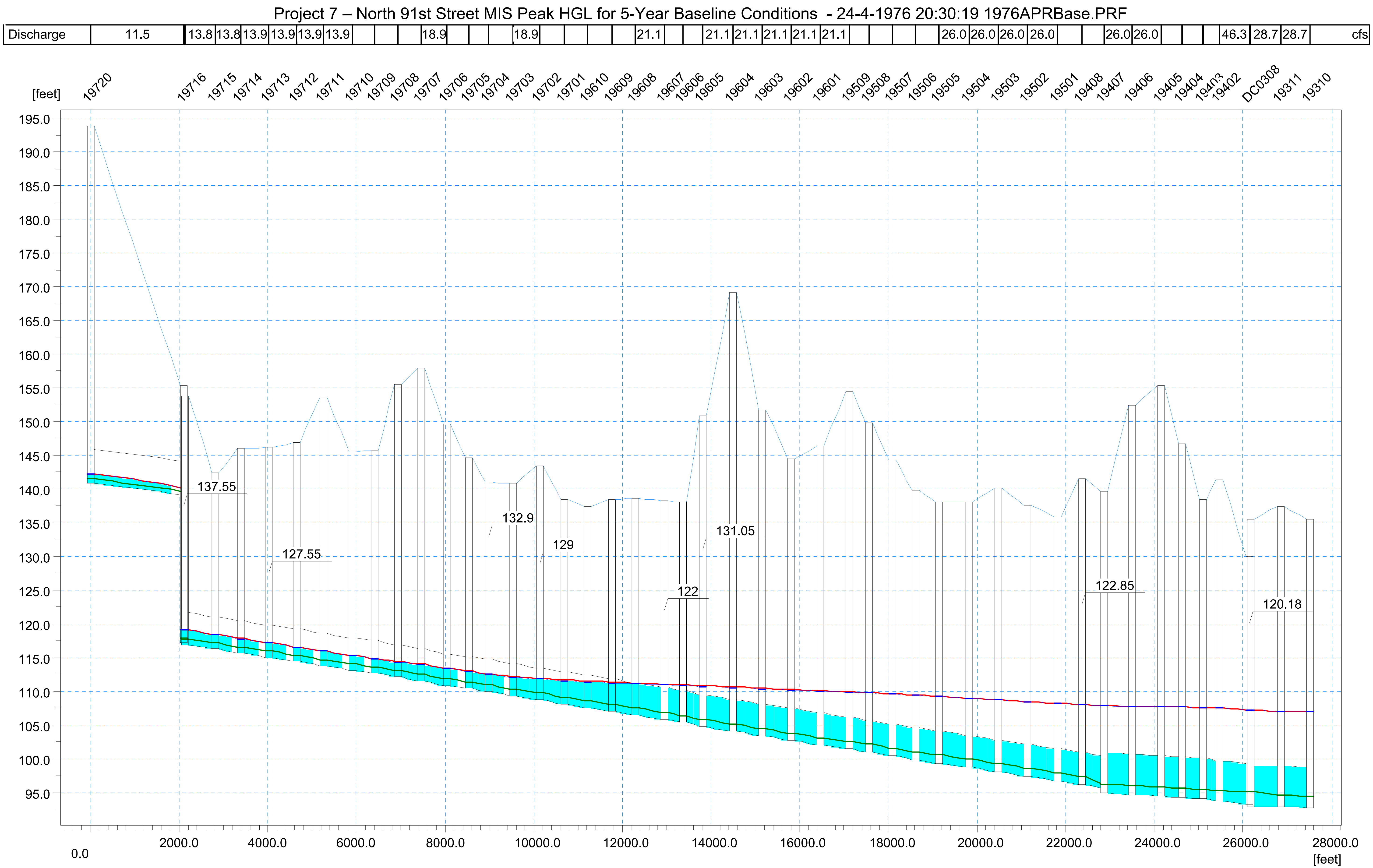
Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Microtunnel cost from ASSETVIEW
3) Mob/Demob cost is estimated at $3-5M for projects ranging from $100-$300 million.

Milwaukee Metropolitan Sewerage District
2050 FACILITIES PLAN
BUSINESS CASE EVALUATIONS
Assumptions

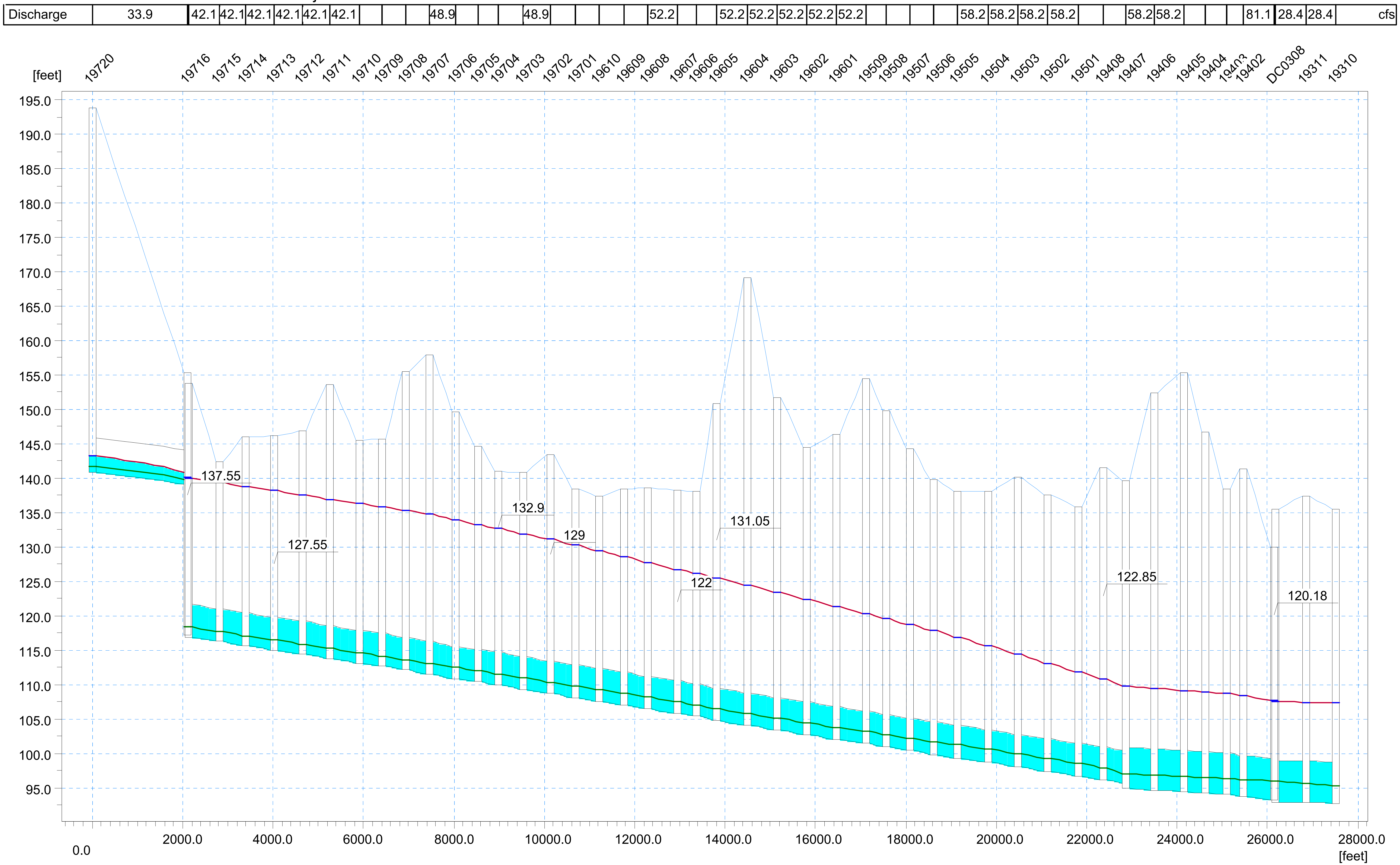
General			Source	Comments
Milwaukee ENR **December 2019**	14,700		Historic_ENRvalues 1974-2019-05_MCA_KMZREV.xlsx	Milwaukee ENR is the average between Chicago and Minneapolis Construction Cost Index values published monthly by ENR. Milwaukee ENR December 2019 is a projected value from May 2019 based on average historical monthly increase in value from 2007 (2020 Facilities Plan published June 2007) to May 2019.
Annual increase in costs	0%		Discussions with MMSD	
Discount Rate	3.375%		Email from Andrew Dutcher, WDNR to Troy Deibert, HNTB on 6/5/19	**Facility planning is using the value established by the WDNR.**
Life Cycle - number years	20			
Capital Costs				
Un-designed Details Allowance - Varies, see below			**Allowance varies at engineer's discretion based on definitions provided for each %**	
all major components have documented installed unit costs	10%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
costs missing for some components, but other costs are for installed facilities and well documented (connections to existing systems, etc.)	20%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Alternative development is still conceptual	30%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Contingency Allowance - Set %				
Planning Level Contingency	20%		2050 FP Team - WRF discussion on 1/30/17	
Contractor Overhead & Profit - Varies, see below				
Equipment costs are from manufacturers	25%		2050 FP Team - WRF discussion on 1/30/17	
Costs are from previous project, unit costs already include OH&P	0%		2050 FP Team - cost estimate discussion on 5/20/19	
Design, Bidding, & MMSD Oversight				
Total Percent, Conveyance	20%		Total Percent used for Planning, Preliminary Engineering, Design, Construction (exc. Contractor Cost) and Post Construction in the BCE	**For FP Use only. This is incorporated into AMP BCE template already.** Varies for each asset system
Total Percent, WRFs	40%			
Total Percent, Watercourse	20%			
Total Percent, GI	15%			

Power assumptions			SOURCE	Comments
Gas	2018 Current Rates			
turbine fuel, LFG	$2.500	/Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
turbine fuel, NG	$5.000	/Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
Electrical				
Electrical Rates, JI/SS	Varies		Kziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	Detailed assumptions need to be included in backup on a case by case basis
Labor assumptions				
Veolia Labor	$50	per hour	Included in BCE assumptions	
Contractor Labor	$70	per hour	To be included in capital costs	

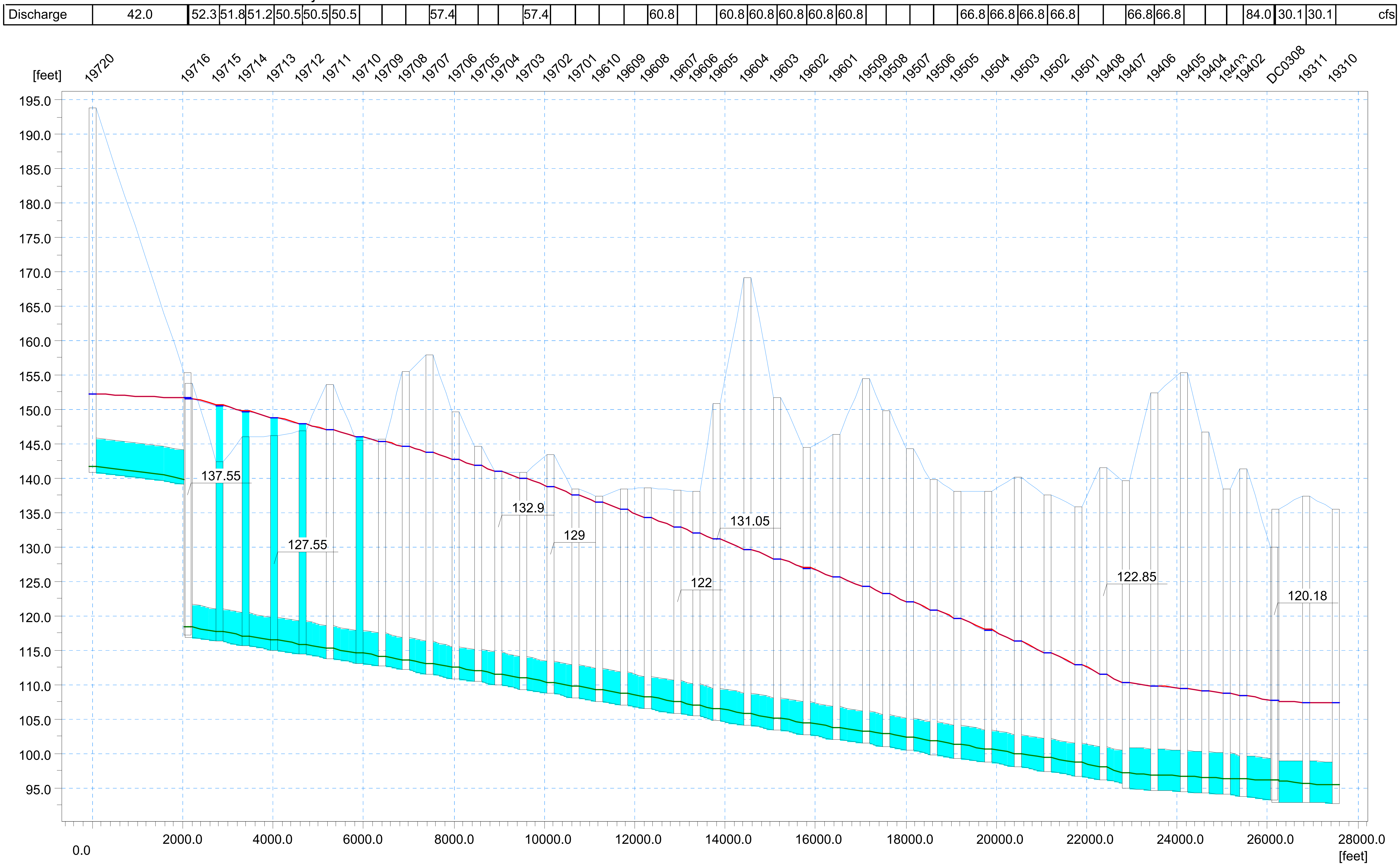
APPENDIX 6A-27: CS R7 N 91st St Capacity Profiles


Project 7 – North 91st Street MIS Peak HGL for 5-Year Baseline Conditions - 24-4-1976 20:30:19 1976APRBase.PRF
Discharge
cfs
[feet]
137.55
127.55
132.9
129
122
131.05
122.85
120.18

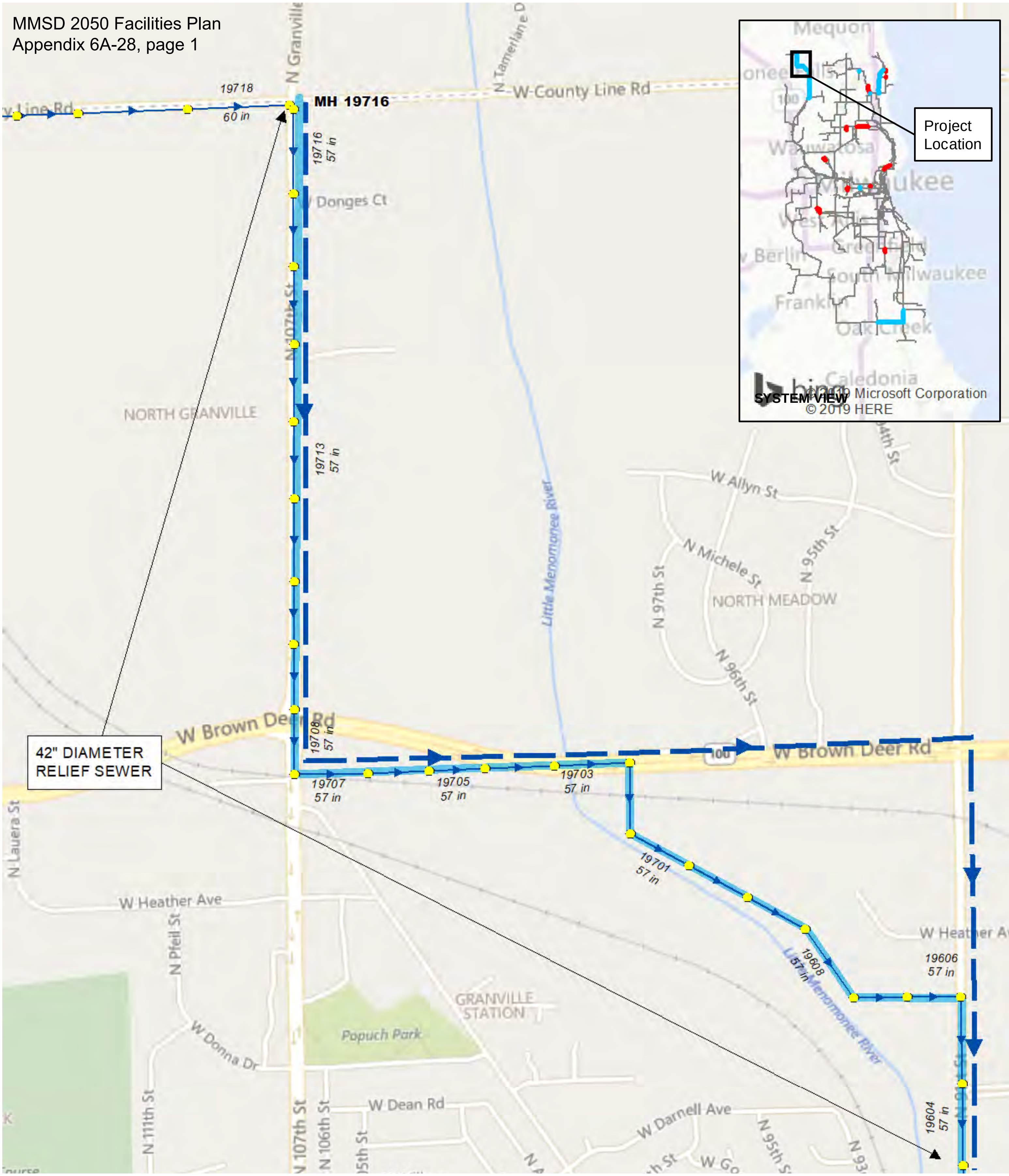
Project 7 – North 91st Street MIS Peak HGL for 5-Year Future Conditions - 13-6-1999 13:01:15 1999JUNBase.PRF



Project 7 – North 91st Street MIS Peak HGL for 5-Year Buildout Conditions - 9-6-2008 00:02:04 2008JUNBase.PRF



APPENDIX 6A-28: CS R7 N 91st St Alt 1 Map



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

0 500 1,000
Feet

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

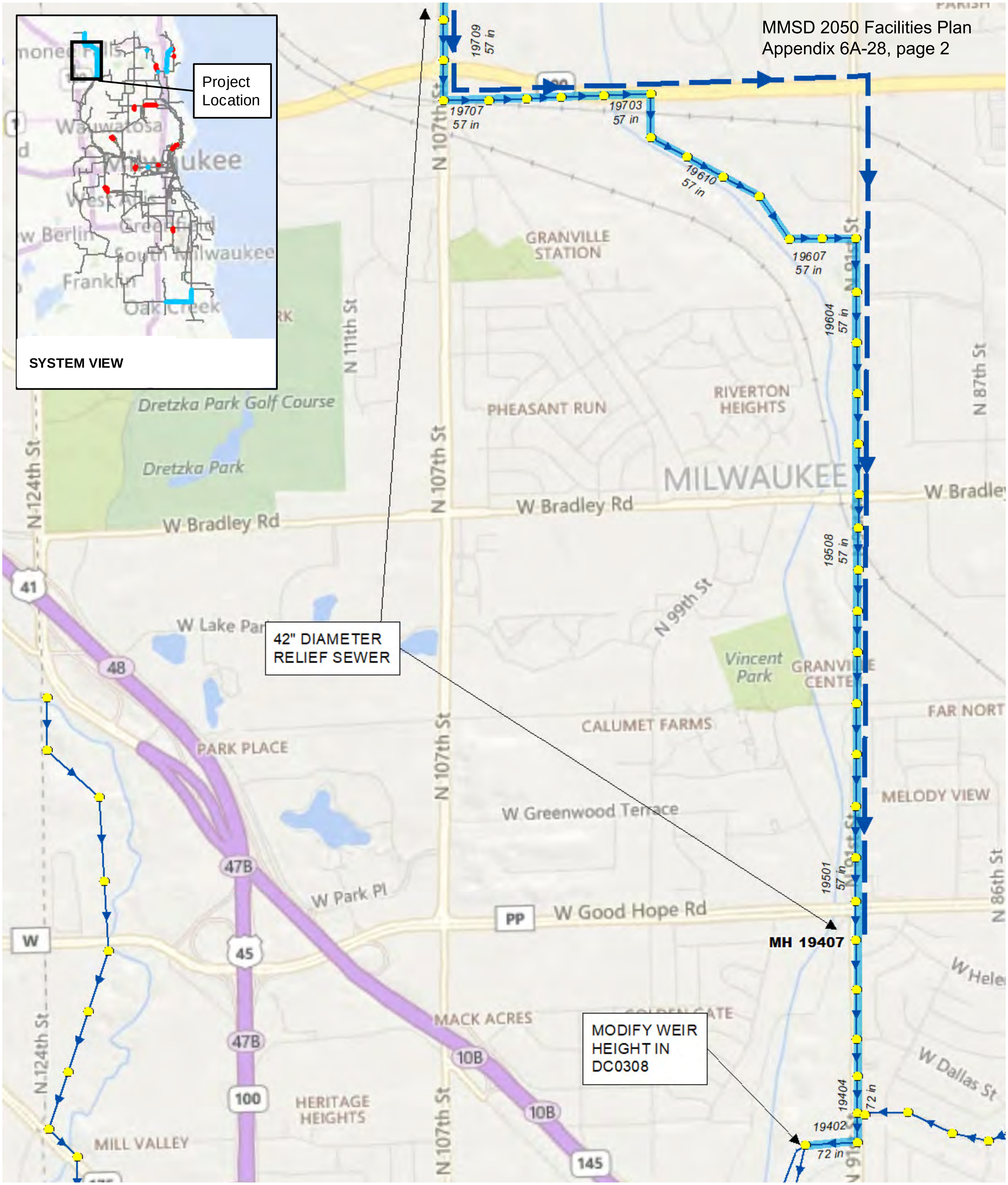
PROJECT 7

NORTH 91ST STREET MIS
ALTERNATIVE 1
RELIEF SEWER
SHEET 1 OF 2

2050 Facilities Plan

DRAFT - 9/26/2019

MMSD 2050 Facilities Plan
Appendix 6A-28, page 2



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

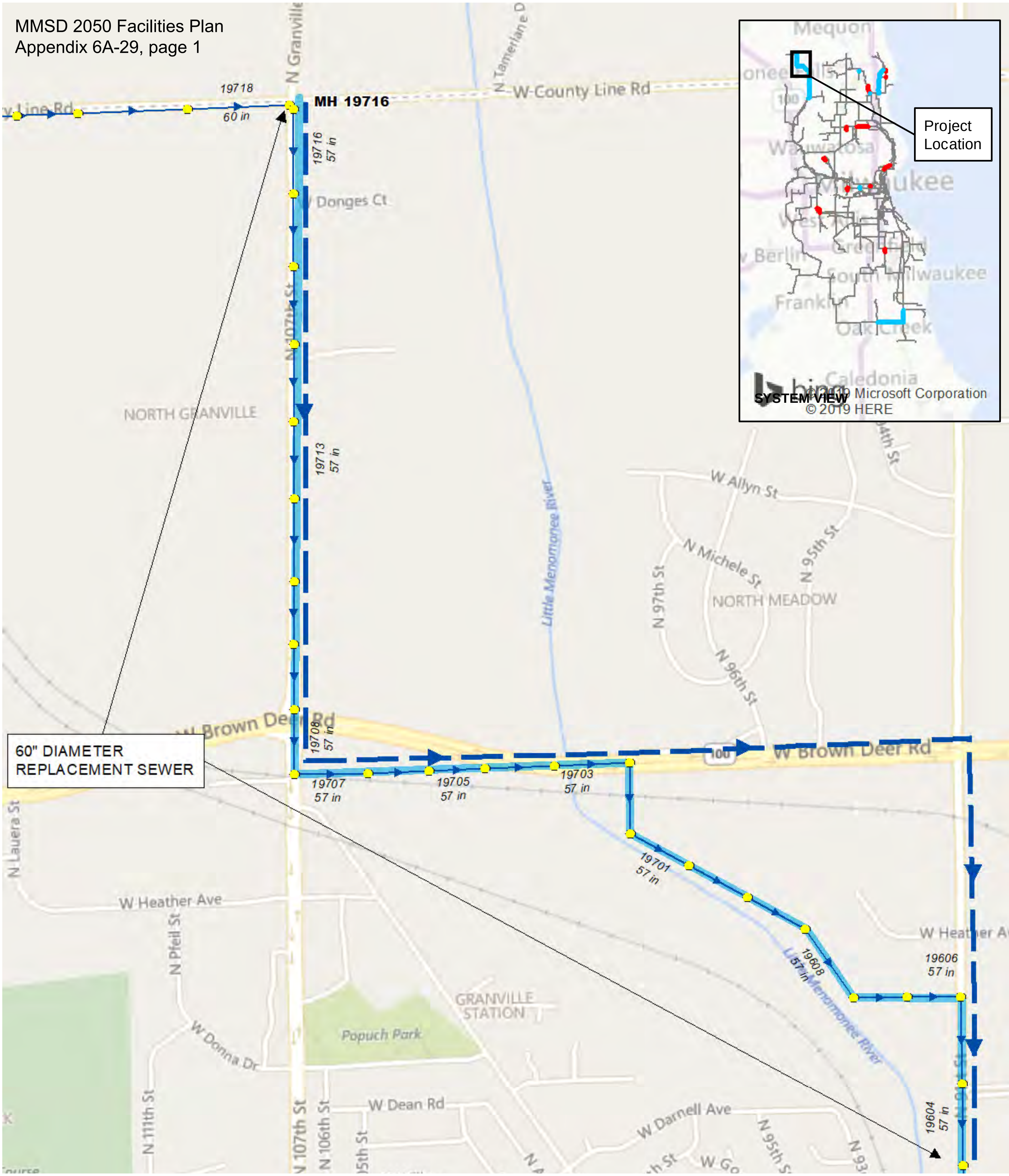
0 750 1,500
Feet

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

PROJECT 7
NORTH 91ST STREET MIS
ALTERNATIVE 1
RELIEF SEWER
SHEET 2 OF 2
2050 Facilities Plan
DRAFT - 9/26/2019

APPENDIX 6A-29: CS R7 N 91st St Alt 2 Map

MMSD 2050 Facilities Plan
Appendix 6A-29, page 1



MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

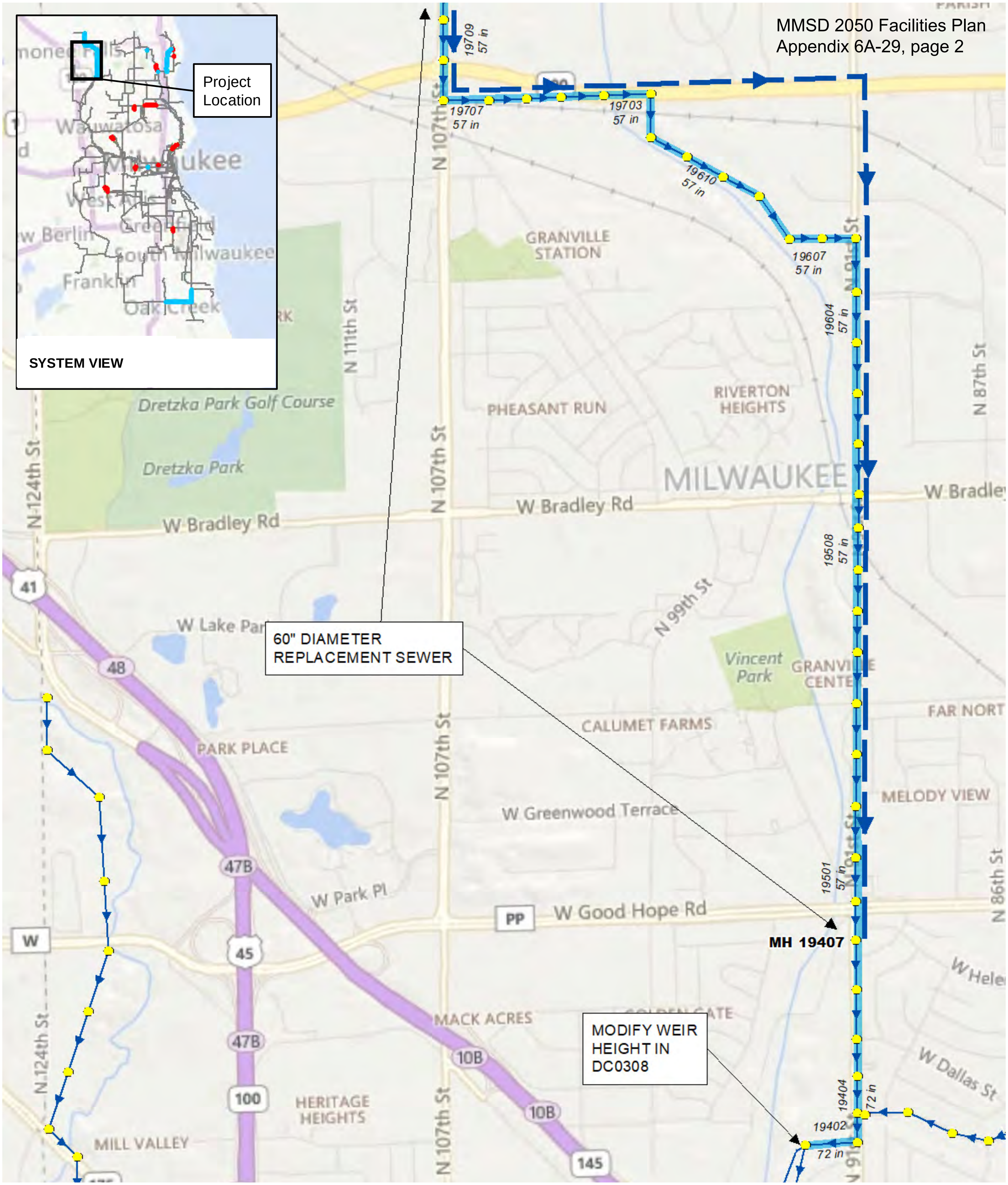
0 500 1,000
Feet

PROJECT 7

NORTH 91ST STREET MIS ALTERNATIVE 2 REPLACEMENT SEWER SHEET 1 OF 2

2050 Facilities Plan

DRAFT - 9/26/2019



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

0 750 1,500
Feet

PROJECT 7

NORTH 91ST STREET MIS
ALTERNATIVE 2
REPLACEMENT SEWER
SHEET 2 OF 2

2050 Facilities Plan

DRAFT - 9/26/2019

PARTNERS FOR A CLEANER ENVIRONMENT

APPENDIX 6A-30: CS R7 N 91st St Capacity Costs

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 7 - North 91st Street MIS - Alternative 1
42-inch Diameter Relief Sewer

General Description:
Construct 21,600 LF of 42-inch diameter sewer to relieve the existing 57-inch Special Section MIS. Installation assumed to be by tunneling, up to 65 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 2,000,000	$ 2,000,000	$ 2,400,000
Item 2 - 42" Microtunnel	LF	21,600	$ 1,599	$ 48,350,000	$ 58,020,000
Item 3 - 30 ft. Depth Shaft Structure (Approx. Avg.)	EACH	28	$ 155,000	$ 6,080,000	$ 7,300,000
Total Construction Cost				**$ 56,430,000**	
Total Capital Cost					**$ 67,720,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	43,200	0.75	$ 32,400
(double length for relief sewer because there will be two pipes to maintain)				$ -
				$ -
Life Cycle Analysis				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 470,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH

Capital Costs	$ 67,720,000
Present Worth of O&M Costs	$ 470,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 68,190,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS
Project No. 7 - North 91st Street MIS - Alternative 1
42-inch Diameter Relief Sewer

General Description:
Construct 21,600 LF of 42-inch diameter sewer to relieve the existing 57-inch Special Section MIS. Installation assumed to be by tunneling, up to 65 ft. deep.

ITEM	Life Years	Units	Quantity	Capital Costs Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - Mob/Demob		LS	1	$ 2,000,000	$ 2,000,000	-	-	-	$ 2,000,000	20%	$ 2,400,000
Item 2 - 42" Microtunnel		LF	21,600	$ 1,599	$ 34,538,400	20%	20%	$ 48,350,000	$ 48,350,000	20%	$ 58,020,000
Item 3 - 30 ft. Depth Shaft Structure (Approx. Avg.)		EACH	28	$ 155,000	$ 4,340,000	20%	20%	$ 6,080,000	$ 6,080,000	20%	$ 7,300,000
Item 4 - Modifications at DC0308		LS	1	$ 50,000	$ 50,000	20%	20%	$ 70,000	$ 70,000	20%	$ 80,000
										Total Capital Cost	**$ 67,800,000**

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Microtunnel cost from ASSETVIEW
3) Mob/Demob cost is estimated at $2M for projects ranging from $25-$100 million.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 7 - North 91st Street MIS - Alternative 2
60-inch Diameter Replacement Sewer

General Description:
Construct 21,600 LF of 60-inch diameter sewer to replace the existing 57-inch Special Section MIS. Installation assumed to be by tunneling, up to 65 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 2,000,000	$ 2,000,000	$ 2,400,000
Item 2 - 60" Microtunnel	LF	21,600	$ 2,164	$ 65,440,000	$ 78,530,000
Item 3 - 35 ft. Depth Shaft Structure (Approx. Avg.)	EACH	28	$ 180,000	$ 7,060,000	$ 8,470,000
Total Construction Cost				**$ 74,500,000**	
Total Capital Cost					**$ 89,400,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	21,600	0.75	$ 16,200
(double length for relief sewer because there will be two pipes to maintain)				$ -
				$ -
<u>**Life Cycle Analysis**</u>				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 230,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH

Capital Costs	$ 89,400,000
Present Worth of O&M Costs	$ 230,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 89,630,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS
Project No. 7 - North 91st Street MIS - Alternative 2
60-inch Diameter Replacement Sewer

General Description:
Construct 21,600 LF of 60-inch diameter sewer to replace the existing 57-inch Special Section MIS. Installation assumed to be by tunneling, up to 65 ft. deep.

ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - Mob/Demob		LS	1	$ 2,000,000	$ 2,000,000	-	-	-	$ 2,000,000	20%	$ 2,400,000
Item 2 - 60" Microtunnel		LF	21,600	$ 2,164	$ 46,742,400	20%	20%	$ 65,440,000	$ 65,440,000	20%	$ 78,530,000
Item 3 - 35 ft. Depth Shaft Structure (Approx. Avg.)		EACH	28	$ 180,000	$ 5,040,000	20%	20%	$ 7,060,000	$ 7,060,000	20%	$ 8,470,000
Item 4 - Modifications at DC0308		LS	1	$ 50,000	$ 50,000	20%	20%	$ 70,000	$ 70,000	20%	$ 80,000
										Total Capital Cost	$ 89,480,000

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Microtunnel cost from ASSETVIEW
3) Mob/Demob cost is estimated at $2M for projects ranging from $25-$100 million.

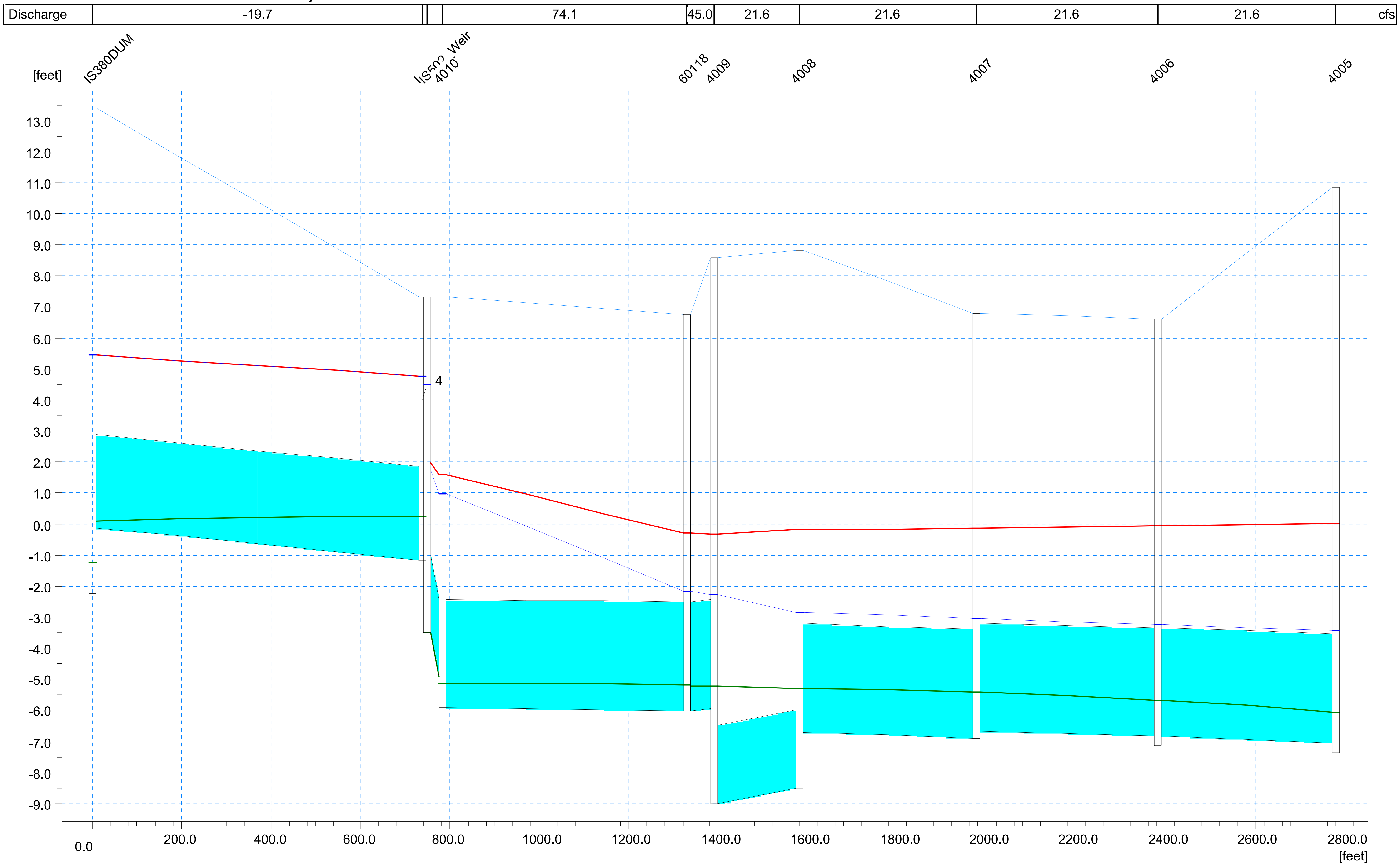
Milwaukee Metropolitan Sewerage District
2050 FACILITIES PLAN
BUSINESS CASE EVALUATIONS
Assumptions

General		Source	Comments
Milwaukee ENR **December 2019**	14,700	Historic_ENRvalues 1974-2019-05_MCA_KMZREV.xlsx	Milwaukee ENR is the average between Chicago and Minneapolis Construction Cost Index values published monthly by ENR. Milwaukee ENR December 2019 is a projected value from May 2019 based on average historical monthly increase in value from 2007 (2020 Facilities Plan published June 2007) to May 2019.
Annual increase in costs	0%	Discussions with MMSD	
Discount Rate	3.375%	Email from Andrew Dutcher, WDNR to Troy Deibert, HNTB on 6/5/19	**Facility planning is using the value established by the WDNR.**
Life Cycle - number years	20		
Capital Costs			
Un-designed Details Allowance - Varies, see below		**Allowance varies at engineer's discretion based on definitions provided for each %**	
all major components have documented installed unit costs	10%	K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
costs missing for some components, but other costs are for installed facilities and well documented (connections to existing systems, etc.)	20%	K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Alternative development is still conceptual	30%	K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Contingency Allowance - Set %			
Planning Level Contingency	20%	2050 FP Team - WRF discussion on 1/30/17	
Contractor Overhead & Profit - Varies, see below			
Equipment costs are from manufacturers	25%	2050 FP Team - WRF discussion on 1/30/17	
Costs are from previous project, unit costs already include OH&P	0%	2050 FP Team - cost estimate discussion on 5/20/19	
Design, Bidding, & MMSD Oversight			
Total Percent, Conveyance	20%	Total Percent used for Planning, Preliminary Engineering, Design, Construction (exc. Contractor Cost) and Post Construction in the BCE	**For FP Use only. This is incorporated into AMP BCE template already.** Varies for each asset system
Total Percent, WRFs	40%		
Total Percent, Watercourse	20%		
Total Percent, GI	15%		

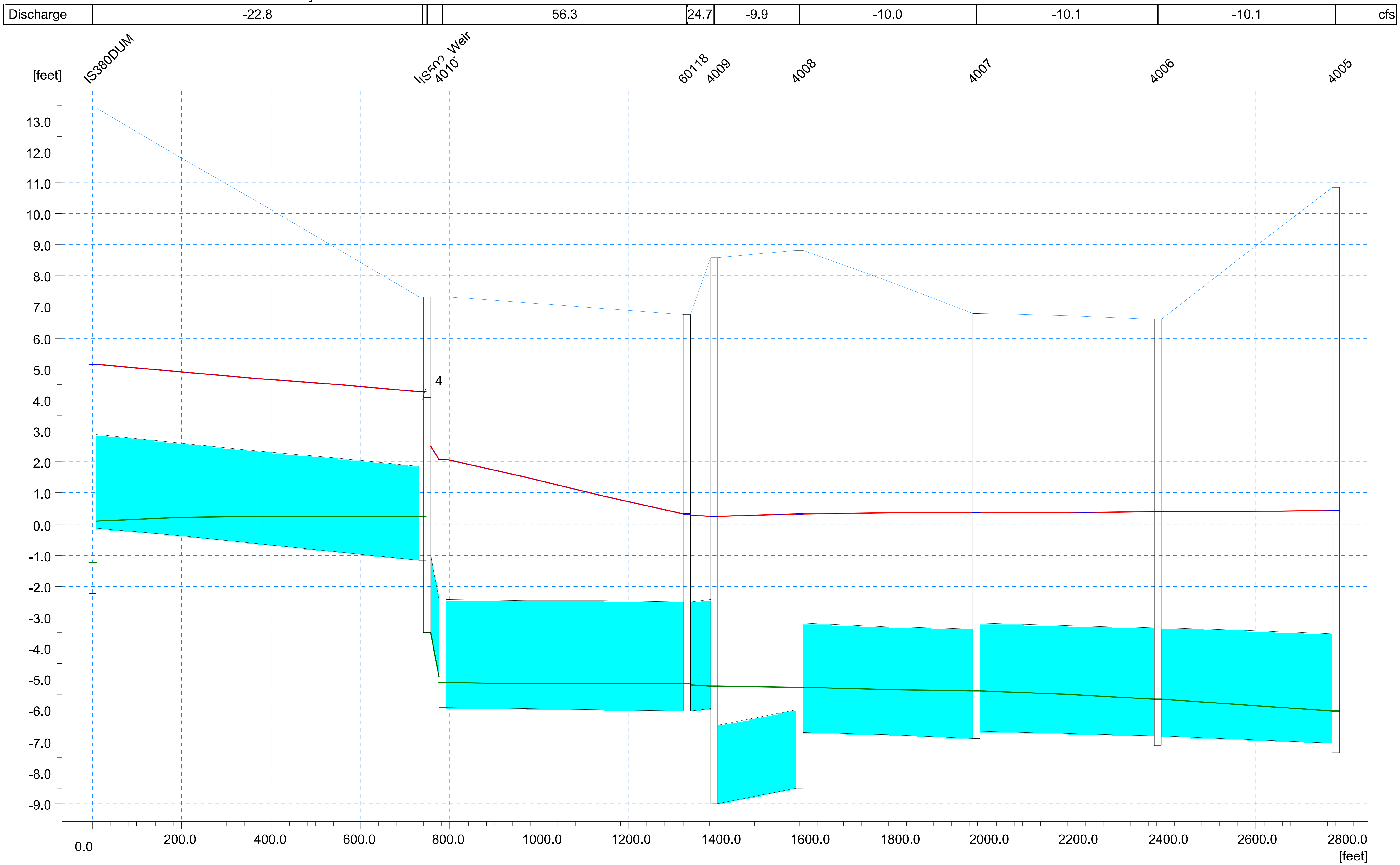
Power assumptions		SOURCE	Comments
Gas	2018 Current Rates		
turbine fuel, LFG	$2.500 /Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
turbine fuel, NG	$5.000 /Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
Electrical			
Electrical Rates, JI/SS	Varies	Kziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	Detailed assumptions need to be included in backup on a case by case basis
Labor assumptions			
Veolia Labor	$50 per hour	Included in BCE assumptions	
Contractor Labor	$70 per hour	To be included in capital costs	

APPENDIX 6A-31: CS R8 S 27th St Capacity Profiles

Project 8 – South 27th Street MIS Peak HGL for 5-Year Baseline Conditions - 19-7-1950 07:58:26 1950JulBase.PRF

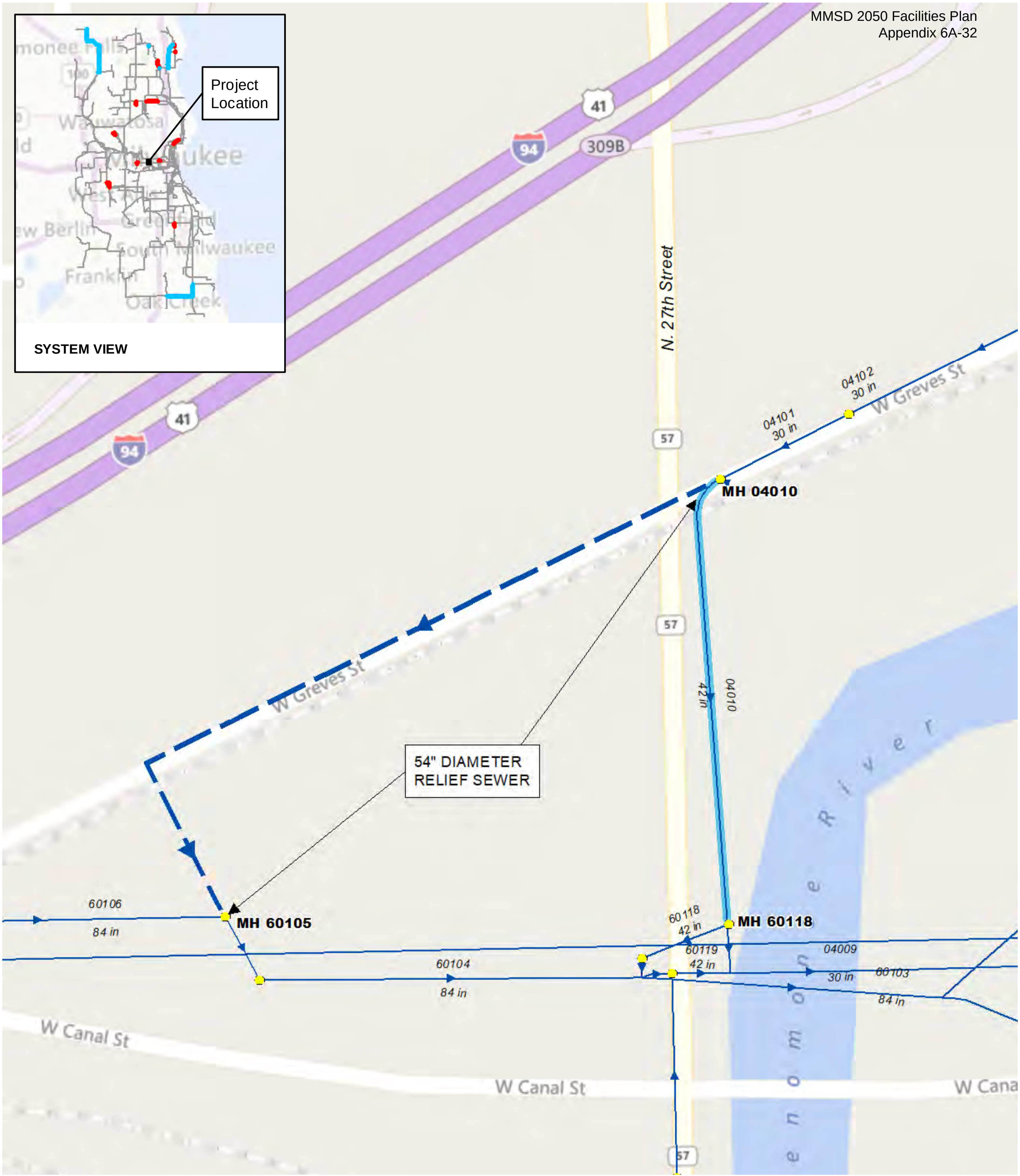


Project 8 – South 27th Street MIS Peak HGL for 5-Year Future Conditions - 10-5-1990 01:17:43 1990MAYBase.PRF



Project 8 – South 27th Street MIS Peak HGL for 5-Year Buildout Conditions - 13-6-1999 03:56:35 1999JUNBase.PRF

APPENDIX 6A-32: CS R8 S 27th St Alt 1 Map



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

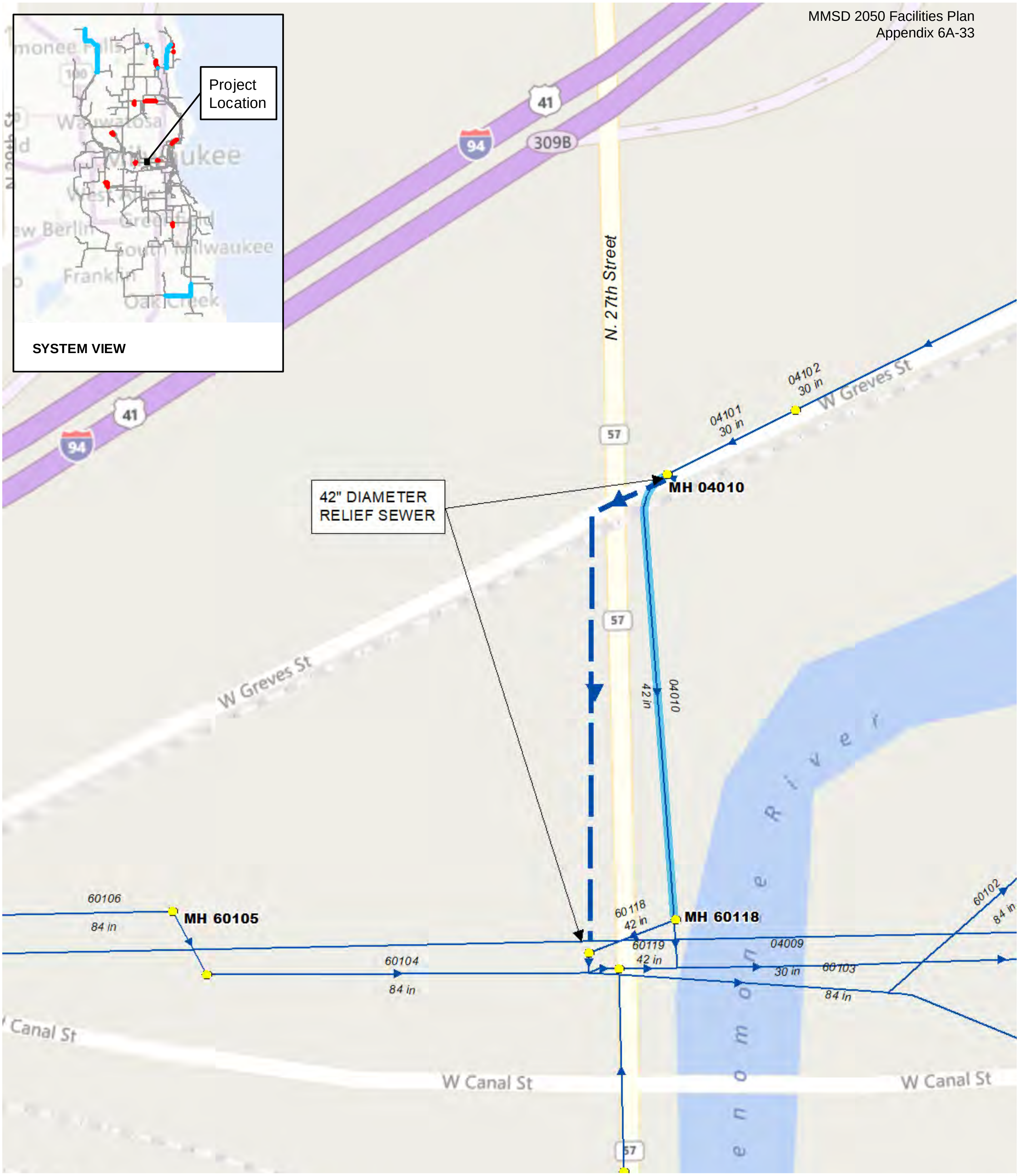
N

0 100 200
Feet

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

PROJECT 8
NORTH 27TH STREET MIS
ALTERNATIVE 1
RELIEF SEWER
(WEST GREEVES STREET)
2050 Facilities Plan
DRAFT - 9/26/2019

APPENDIX 6A-33: CS R8 S 27th St Alt 2 Map



LEGEND

- MMSD MANHOLE
- EXISTING MMSD PIPELINE
- PROPOSED MMSD PIPELINE
- 2010 5-YEAR CAPACITY RISK
- 2035 5-YEAR CAPACITY RISK

N

0 100 200
Feet

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

PROJECT 8
NORTH 27TH STREET MIS
ALTERNATIVE 2
RELIEF SEWER
(NORTH 27TH STREET)

2050 Facilities Plan

DRAFT - 9/26/2019

APPENDIX 6A-34: CS R8 S 27th St Capacity Costs

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 8 - North 27st Street MIS - Alternative 1
54-inch Diameter Relief Sewer (along West Greeves Street)

General Description:
Construct 980 LF of 54-inch diameter sewer along W. Greeves St. to relieve the existing 42-inch diameter MIS in S. 27th St. Installation assumed to be by open-cut construction, up to 15 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 500,000	$ 500,000	$ 600,000
Item 2 - 54" Open-Cut	LF	980	$ 1,975	$ 2,710,000	$ 3,250,000
Item 3 - 144" Diameter Structure (15-20 ft Depth, Open Cut)	EACH	3	$ 50,000	$ 210,000	$ 250,000
Total Construction Cost				**$ 3,420,000**	
Total Capital Cost					**$ 4,100,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	1,960	0.75	$ 1,500
(double length for relief sewer because there will be two pipes to maintain)				$ -
				$ -
<u>**Life Cycle Analysis**</u>				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 20,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH

Capital Costs	$ 4,100,000
Present Worth of O&M Costs	$ 20,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 4,120,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 8 - North 27st Street MIS - Alternative 1
54-inch Diameter Relief Sewer (along West Greeves Street)

General Description:
Construct 980 LF of 54-inch diameter sewer along W. Greeves St. to relieve the existing 42-inch diameter MIS in S. 27th St. Installation assumed to be by open-cut construction, up to 15 ft. deep.

ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Item 1 - Mob/Demob		LS	1	$ 500,000	$ 500,000	-	-	-	$ 500,000	20%	$ 600,000
Item 2 - 54" Open-Cut		LF	980	$ 1,975	$ 1,935,500	20%	20%	$ 2,710,000	$ 2,710,000	20%	$ 3,250,000
Item 3 - 144" Diameter Structure (15-20 ft Depth, Open Cut)		EACH	3	$ 50,000	$ 150,000	20%	20%	$ 210,000	$ 210,000	20%	$ 250,000
										Total Capital Cost	**$ 4,100,000**

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Open-Cut cost pipe cost from ASSETVIEW
3) Mob/Demob cost is estimated at $500k for projects ranging from $0-$5 million.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 8 - North 27st Street MIS - Alternative 2
42-inch Diameter Relief Sewer (along 27th Street)

General Description:
Construct 650 LF of 42-inch diameter sewer along 27th Street to relieve the existing 42-inch diameter MIS in S. 27th St. Installation assumed to be by open-cut construction, up to 15 ft. deep.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	

Capital Costs

ITEM	Units	Quantity	Unit Cost ($)	Construction Cost ($)	Capital Cost ($)
Item 1 - Mob/Demob	LS	1	$ 500,000	$ 500,000	$ 600,000
Item 2 - 42" Open-Cut	LF	650	$ 1,599	$ 1,460,000	$ 1,750,000
Item 3 - 144" Diam. Structure (15-20 ft Depth, Open Cut)	EACH	3	$ 50,000	$ 210,000	$ 250,000
Item 4 - ROW/Easement Acquisition	LS	1	$ 1,000,000	$ 1,000,000	$ 1,200,000
Total Construction Cost				**$ 2,170,000**	
Total Capital Cost					**$ 3,800,000**

Operation and Maintenance Costs

ITEM	Units	Quantity	Unit Cost ($)	Annual Cost ($)
Operation and Maintenance Labor	LF	1,960	0.75	$ 1,500
(double length for relief sewer because there will be two pipes to maintain)				$ -
				$ -
__Life Cycle Analysis__				
Present Worth Factor (including annual increase)	14.375			
Present Worth of Operation and Maintenance Costs				**$ 20,000**

Equipment Replacement Costs

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

Salvage Value

ITEM	Units	Quantity	Unit Value ($)	Value ($)
Present Worth of Equipment Replacement Costs				**$ -**

TOTAL PRESENT WORTH	
Capital Costs	$ 3,800,000
Present Worth of O&M Costs	$ 20,000
Present Worth of Equipment Replacement	$ -
Present Worth of Salvage Value	$ -
Total Present Worth	**$ 3,820,000**

Notes:
1) See Capital Cost Details for additional capital cost breakdown.

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS

OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS

Project No. 8 - North 27st Street MIS - Alternative 2
42-inch Diameter Relief Sewer (along 27th Street)

General Description:
Construct 650 LF of 42-inch diameter sewer along 27th Street to relieve the existing 42-inch diameter MIS in S. 27th St. Installation assumed to be by open-cut construction, up to 15 ft. deep.

ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
					Capital Costs						
Item 1 - Mob/Demob		LS	1	$ 500,000	$ 500,000	-	-	-	$ 500,000	20%	$ 600,000
Item 2 - 42" Open-Cut		LF	650	$ 1,599	$ 1,039,350	20%	20%	$ 1,460,000	$ 1,460,000	20%	$ 1,750,000
Item 3 - 144" Diam. Structure (15-20 ft Depth, Open Cut)		EACH	3	$ 50,000	$ 150,000	20%	20%	$ 210,000	$ 210,000	20%	$ 250,000
Item 4 - ROW/Easement Acquisition		LS	1	$ 1,000,000	$ 1,000,000	-	-	-	$ 1,000,000	20%	$ 1,200,000
										Total Capital Cost	$ 3,800,000

Notes:
1) Definitions:
LS - lump sum
LF - linear foot
2) Open-Cut pipe cost from ASSETVIEW
3) Mob/Demob cost is estimated at $500k for projects ranging from $0-$5 million.

Milwaukee Metropolitan Sewerage District
2050 FACILITIES PLAN
BUSINESS CASE EVALUATIONS
Assumptions

General			Source	Comments
Milwaukee ENR **December 2019**	14,700		Historic_ENRvalues 1974-2019-05_MCA_KMZREV.xlsx	Milwaukee ENR is the average between Chicago and Minneapolis Construction Cost Index values published monthly by ENR. Milwaukee ENR December 2019 is a projected value from May 2019 based on average historical monthly increase in value from 2007 (2020 Facilities Plan published June 2007) to May 2019.
Annual increase in costs	0%		Discussions with MMSD	
Discount Rate	3.375%		Email from Andrew Dutcher, WDNR to Troy Deibert, HNTB on 6/5/19	**Facility planning is using the value established by the WDNR.**
Life Cycle - number years	20			
Capital Costs				
Un-designed Details Allowance - Varies, see below			**Allowance varies at engineer's discretion based on definitions provided for each %**	
all major components have documented installed unit costs	10%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
costs missing for some components, but other costs are for installed facilities and well documented (connections to existing systems, etc.)	20%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Alternative development is still conceptual	30%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Contingency Allowance - Set %				
Planning Level Contingency	20%		2050 FP Team - WRF discussion on 1/30/17	
Contractor Overhead & Profit - Varies, see below				
Equipment costs are from manufacturers	25%		2050 FP Team - WRF discussion on 1/30/17	
Costs are from previous project, unit costs already include OH&P	0%		2050 FP Team - cost estimate discussion on 5/20/19	
Design, Bidding, & MMSD Oversight				
Total Percent, Conveyance	20%		Total Percent used for Planning, Preliminary Engineering, Design, Construction (exc. Contractor Cost) and Post Construction in the BCE	**For FP Use only. This is incorporated into AMP BCE template already.** Varies for each asset system
Total Percent, WRFs	40%			
Total Percent, Watercourse	20%			
Total Percent, GI	15%			

Power assumptions			SOURCE	Comments
Gas	2018 Current Rates			
turbine fuel, LFG	$2.500	/Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
turbine fuel, NG	$5.000	/Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
Electrical				
Electrical Rates, JI/SS	Varies		Kziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	Detailed assumptions need to be included in backup on a case by case basis
Labor assumptions				
Veolia Labor	$50	per hour	Included in BCE assumptions	
Contractor Labor	$70	per hour	To be included in capital costs	

APPENDIX 6A-35: CS R9 Ad Hoc 211 -

Contract Number: M03016P05.P7700

Memorandum

To: - *Cari Roper, MMSD*
Greg Hottinger, MMSD
Jerome Flogel, MMSD

From: - *David Perry, Brown and Caldwell*
Laura Gerold, Brown and Caldwell

QA/QC: - *Julie McMullin, Brown and Caldwell*

Date: - *December 17, 2018*

Subject: - *Ad Hoc Modeling Request 211: Evaluation of I/I Influences*

Objectives

Infiltration and inflow (I/I) into the sanitary sewer system can cause peak flows that exceed the conveyance capacity of the pipes, resulting in surcharged sewers and, in some events, backups of sewage into basements. The source of I/I can be leakage into any part of the collection system, from the private laterals, to the public sewer mains and manholes owned by the municipalities, and the conveyance facilities owned by the Milwaukee Metropolitan Sewerage District (MMSD).

This ad hoc modeling study is focused on the influence of I/I on the municipal sewer systems. It does not look at the consequences of I/I on the MMSD system. This investigation is a planning-level evaluation of the risk of basement backups (BBUs) relative to the I/I rates. It is not meant to be a detailed hydraulic evaluation of specific parts of the system. Instead, it seeks to estimate the overall risk of BBUs, and to understand how the risk of BBUs can be reduced by rehabilitation of the sewer system with the goal of reducing the I/I rates. The findings of this study will be used as input to the 2050 Facilities Plan (2050FP) that is being prepared by others.

Ad Hoc 211 had two tasks. Task 1 studied the relationships between BBUs and I/I. In this task the cost of BBU damage was estimated, first for the existing I/I rates, and then for a series of cases with assumed levels of reduced I/I. Task 1 produced a set of curves showing how spending money on I/I reduction could reduce the cost of BBU damage.

Task 2 was a set of specific future flow cases that were designed to support the business case evaluations, Conveyance Business Case (CBC) CBC033 and CBC034, that are part of the 2050FP. The cases assumed a rate of I/I change due to degradation of the sewer system over time. The cost to repair the system to prevent I/I change was accounted for along with additional work needed to improve the system so the risk of sanitary sewer overflows (SSOs) does not increase in the future. Four cases were studied in Task 2, including one case that estimated the cost of extensive I/I improvements to prevent SSOs in the future.

These tasks are described in detail throughout this technical memorandum (TM).

Task 1: Influences of I/I on Basement Backup Costs

For Task 1, the Ad Hoc Modeling team compared the cost of rehabilitation to achieve progressively lower levels of I/I to the reduction in BBU damage cost. For this comparison, the team used a performance-based I/I cost estimation approach. This method has been used on multiple other projects for MMSD, as well as for other utilities across the United States. The approach is based on a Water Environment Research Foundation (WERF) protocol that was developed to standardize the reporting of I/I reduction projects (WERF 2003). Using the protocol, projects from across the United States were plotted on a single graph to show the cost per gallon of flow removed versus the leakiness of the system before rehabilitation. This method was the basis of a performance-based unit cost curve that was used for the 2020 Facilities Plan (2020 FP) (MMSD 2007b).

Wastewater flow in a sewer is composed of base sanitary flow (BSF), produced by the users, and the I/I produced by wet weather conditions and groundwater entering the sewers. In this analysis the I/I component is reduced and BSF is left unchanged. The I/I reduction was assumed to be implemented in a series of steps of progressively lower I/I rates.

The cost of I/I reduction is implemented on the sewershed scale and summed up to obtain the total cost to achieve I/I reduction in the entire MMSD service area. The method does not specify the type or location of the rehabilitation. It could be on private property, or in the municipal sewers, or in the MMSD facilities. The cost is defined only by the sewershed I/I rate before rehabilitation and the amount of peak flow that is to be removed.

The analysis used a series of steps to reduce I/I to progressively lower I/I thresholds. All sewersheds with I/I rates above the threshold for each step were reduced to the threshold value. Then the cost to achieve each step was estimated using the performance-based method.

An additional component of cost is the ongoing rehabilitation and repairs (R&R) needed to keep the overall I/I rate from increasing as the system ages. The cost of R&R can be a significant component of the cost. An assumed rate of degradation was used to estimate how much work must be completed to maintain a constant level of I/I over a long period. MMSD and the team agreed to assume I/I increases at a rate of 7 percent per decade. This assumption is consistent with the assumptions in the 2020FP, although the actual rate of degradation is unknown. The consultant team for the North Shore MIS project (Contract No. C04010P01) reviewed the 2018 metershed recalibration to see if those results shed any light on degradation, but the conclusion was that the amount of I/I degradation was unknown because while some metersheds had increases in I/I, others had decreases. In addition, the metering technology changed dramatically from the original model calibration, so it was unknown if changes in I/I were legitimate or just because different types of meters were used. The consultant team also performed a search for past research on typical increases in I/I as a sanitary sewer system degrades but did not find a definitive answer. Consequently, the 7 percent increase per decade is included to demonstrate a method for accounting for R&R cost and as a reminder that there is cost for R&R that should not be neglected. The assumption has neither been confirmed nor shown to be wrong by any other studies.

The results of the evaluation produced two curves: cost to reduce I/I and cost of BBUs. These two curves were used to obtain the total cost for a range of I/I reduction levels.

Unit Cost Curve

The unit cost curve for reducing I/I is equal to the construction cost divided by the gallons removed from the 5-year peak flow. A unit cost curve was developed for the 2020FP to be used for planning. The curve was based on data collected in the Milwaukee area and many other projects nationwide. Each project used the WERF protocol to report the unit cost of rehabilitation that achieved a reduction in I/I. There is a wide range in results. In general, the unit cost is relatively low in basins with high I/I rates. However, in basins with low I/I, the unit cost of reduction is relatively expensive. For the sake of planning, the projects with exceptionally low costs were not considered suitable to help inform planning-level estimates. The planning-level unit cost curve was fit as an exponential trendline to most of the other points.

As part of the Ad Hoc 211 analysis, the Ad Hoc and Onsite Modeling Part 2 consultant team reviewed and updated this unit cost curve as shown in Figure 1. Additional projects were added to the data set, including projects in the Private Property Infiltration and Inflow (PPI/I) study. The general shape of the curve (as defined by the exponent in the equation) has been constant. The coefficient in the equation was updated to a future cost index value (*Engineering News-Record* [ENR] Construction Cost Index) of 15,000 for 2020.

Local data points added to the curve because of additional I/I reduction evaluations that the team has completed for the PPII Reduction Program are as follows:

- Milwaukee Concordia Meter Basin 1401-7
- Milwaukee Cooper Park Meter Basin 1386-2 (including sump pump foundation drain - disconnections) -
- Milwaukee Cooper Park Meter Basin 1386-4
- Shorewood Meter Basin SH0257
- Wauwatosa Meter Basin FM6
- Wauwatosa Meter Basin MS0411

- Wauwatosa N 65th Street and Eagle Street pilot project
- West Milwaukee, N 52nd Street
- Franklin Meter Basin 3325 (36th St)
- West Allis 1 Meter Basin WE7023

These projects represent a mix of I/I reduction techniques including lateral lining, foundation drain disconnections, lateral replacement, storm sewer rehabilitation, and sanitary sewer and manhole rehabilitation.

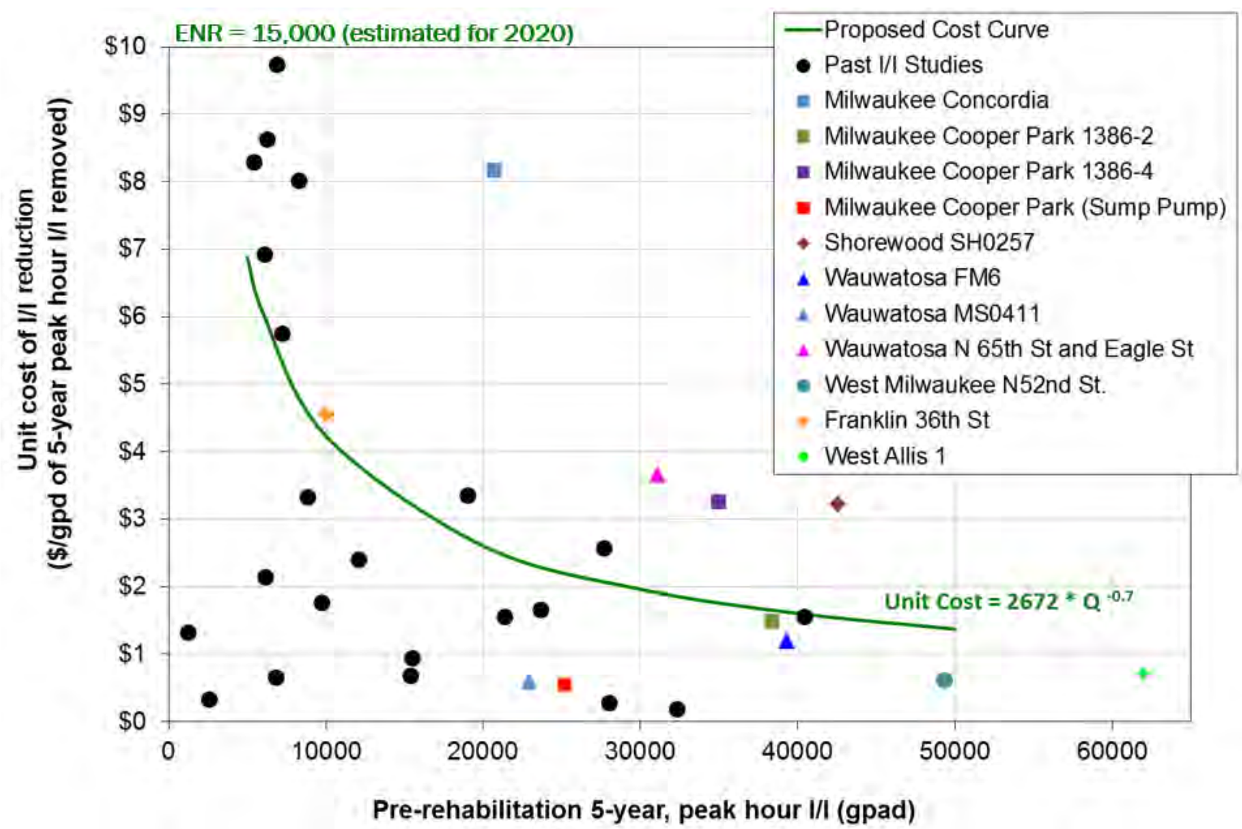


Figure 1. Performance-Based I/I Rehabilitation Unit Cost Curve Update

The following assumptions were made:

- The ENR Construction Cost Index value (15,000) was estimated for 2020.
- The planning curve was fit to the data to follow the upper trend of the data points (not including the projects with exceptionally low unit cost values).

- Many different types of I/I reduction or removal technologies were included on the graph.
- The WERF protocol was used to develop the curve (WERF 2003).
- Data from the WERF study are included from across the United States and were updated with additional MMSD projects.

Inflow and Infiltration Costs

Metered areas in the MMSD service area are further broken down by municipality as well as where flows enter MMSD facilities. These areas are referred to as sewersheds. Sewershed I/I rates before rehabilitation are shown in Figure 2. These I/I rates are normalized by the sewershed area to give the peak hourly flow per unit area. The units are gallons per acre per day (gpad). All sewersheds in the MMSD service area are ordered in the figure by I/I rate from highest to lowest. This format is used to identify those sewersheds that are above each I/I threshold step. I/I was reduced in six steps ranging from 30,000 gpad to 5,000 gpad.

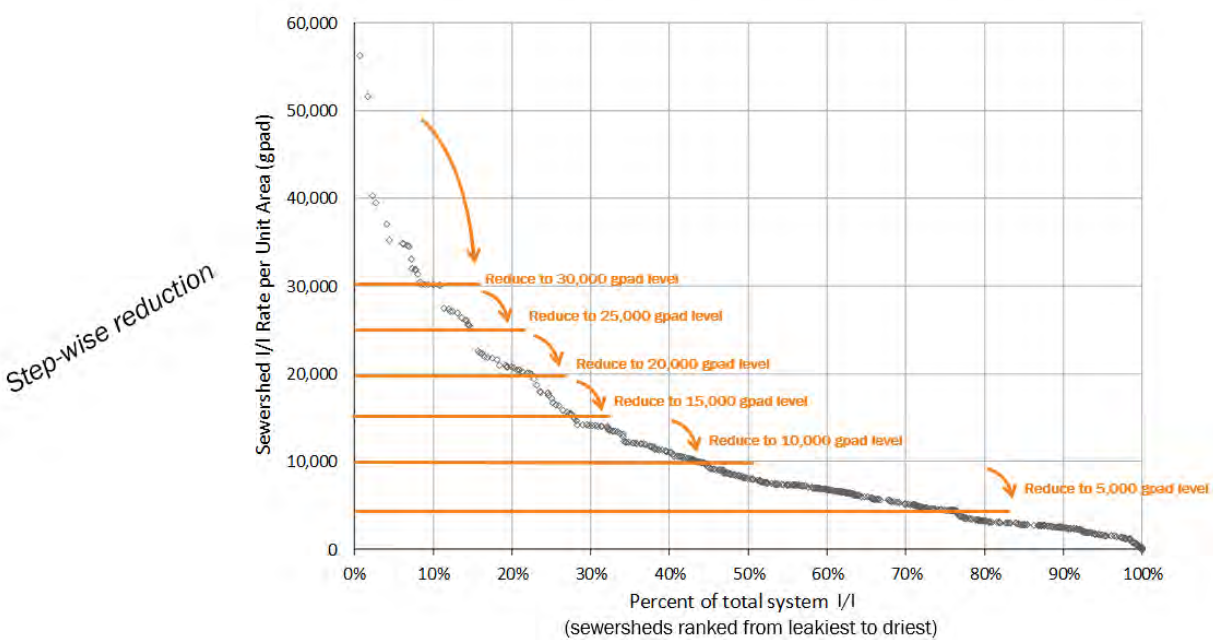


Figure 2. Sewershed I/I Rates and I/I Reduction Steps

For each step, the flows in the sewersheds above that step were reduced to the threshold value for that step. Costs were then applied to the amount of I/I removed using the unit cost values from the curve in Figure 1 above.

In addition to the work performed to reduce the I/I in the leaky sewersheds, R&R work is needed in all sewersheds to mitigate system degradation that would allow I/I rates to increase over time. The

R&R cost is the overall amount spent by all municipalities, MMSD, and private property owners for R&R on their own facilities.

R&R costs were calculated for all sewersheds using the following process as visualized in Figure 3:

1. Start with the 2010 sewershed flows (2020FP calibration).
2. Assume that I/I increases at a rate of 7 percent per decade in all sewersheds.
3. Every 10 years, spend to restore I/I rates to original values (using the unit cost curve).
4. Sum the R&R cost over 20 years (two cycles of repair).

Figure 3. Two Cycles of R&R to Keep I/I from Increasing Over 20-year Planning Period

It is important to account for R&R costs, even if the value in this study is a placeholder until better information is available. It highlights the need to keep the condition of all sewersheds in mind, not just those that have been identified for I/I reduction.

The reasonableness of the assumption is discussed later in this TM from the point of view of whether it gives an estimate of the regular repair cost that is consistent with the replacement value of the collection system and similar to the actual spending rates by the municipalities.

The Ad Hoc and Onsite Modeling Part 2 consultant team attempted to obtain insight and experience into I/I change over time by reviewing the recently recalibrated sewersheds in the MMSD North Shore Metropolitan Interceptor Sewer (MIS) area. This area was calibrated to data in the 1998–2004 period for the 2020FP (MMSD 2007a). The sewersheds were recalibrated in 2017 for the North Shore MIS study (Brown and Caldwell 2018b). Some metersheds had higher flow rates in the recent recalibration and others had lower rates; there was no general trend. Furthermore, the changes are more likely to be due to changes in flow monitoring technology (from level-only meters to area-velocity meters) rather than evidence of degradation or improvement. Because of the uncertainty associated with the change in flow meter technology, the North Shore study did not provide any insights to inform a better value for the rate of I/I degradation. Therefore, the 7 percent assumption was retained for this analysis.

Results

Figure 4 and Table 1 show the cost of reduction to achieve the progressively lower levels of I/I. This curve is based on the six levels of I/I reduction from 30,000 to 5,000 gpad. The graph plots the cost relative to the percent reduction in system-wide flows. (The system-wide total value is the sum of the sewershed peak flows; it is not a hydraulically routed downstream flow as observed at the water reclamation facilities [WRFs]).

The cost of R&R is also shown on the graph (assuming a 7 percent per decade degradation rate). The sum of the two curves is the total cost of work to reduce and control I/I.

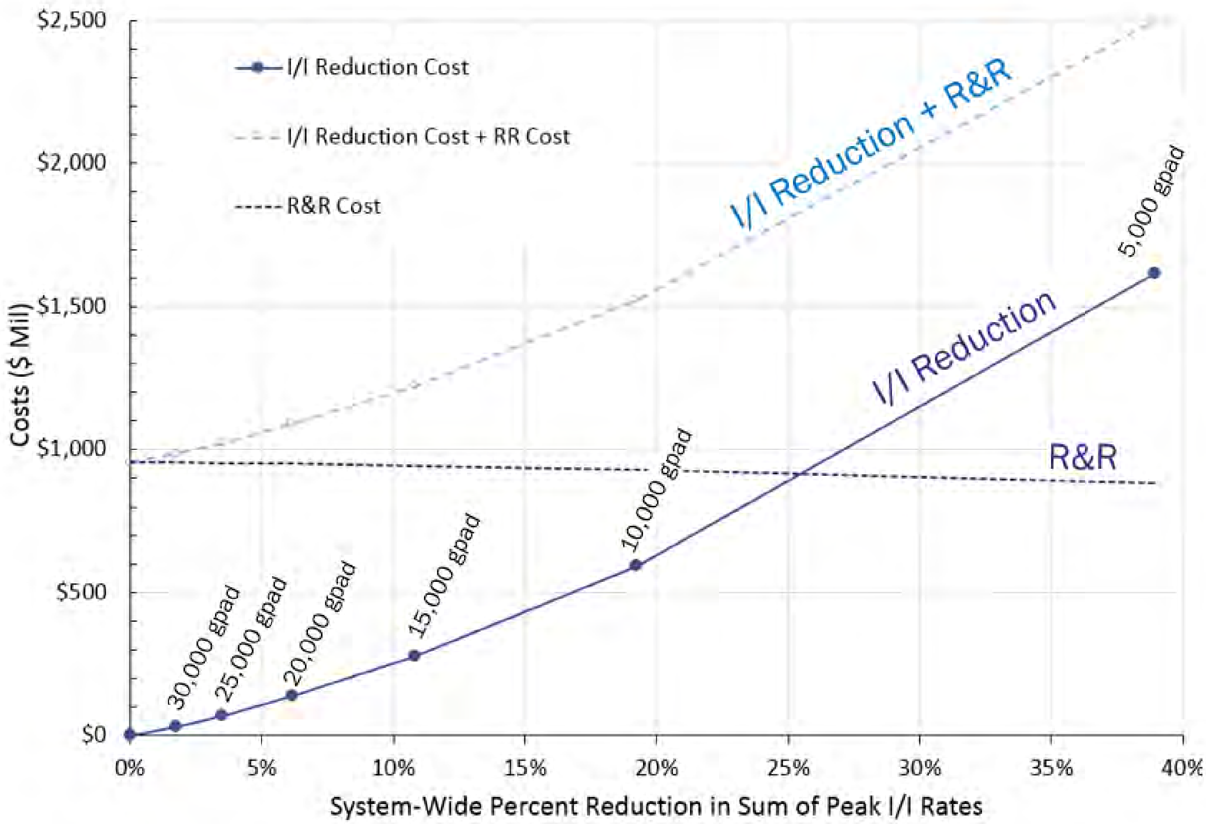


Figure 4. Inflow/Infiltration (I/I) Reduction Cost Graph -

Table 1: I/I Reduction Steps and Cost of Rehabilitation				
Step	**I/I Reduction Threshold (gpad)**	**Sum I/I Rates, Percent Reduction**	**I/I Reduction Cost ($Mil)**	**Reduction+R&R ($Mil) ENR 15,000**
-	-	0	0	960
1	30,000	2	30	990
2	25,000	3	70	1,020
3	20,000	6	140	1,090
4	15,000	11	280	1,220
5	10,000	19	590	1,520
6	5,000	29	1,030	2,500

ENR = 15,000 (assumed value for 2020).

Using the assumption that system degradation causes I/I rates to increase by 7 percent per decade, regular repair costs to mitigate degradation are approximately $1 billion over a 20-year period, or approximately $50 million per year.

One reason this is such a large cost is because it requires work on all sewersheds. It is also important to remember that the cost is the total amount spent by all parties (MMSD, municipalities, and private property owners) to repair their respective parts of the collection system. The reasonableness of this value was discussed in the June 11, 2018, meeting at MMSD (Brown and Caldwell 2018a). There are two arguments for why this value may be realistic. One argument is based on the total replacement value of the system, and the other is a review of the actual expenditures by some municipalities on their public sewers.

To the Ad Hoc and Onsite Modeling Part 2 consultant team's knowledge, the replacement value of all collection system elements (owned by MMSD, municipalities, and private property) is not documented so a rough estimate of the total replacement value was developed for this study. There are approximately 300 miles of MMSD-owned sewers, 3,400 miles of municipal public sewers, and 3,000 miles of public laterals. The replacement value of the MMSD facilities is estimated to be $2 billion, municipal sewers is $4 billion, and private laterals is $2 billion; this is a total replacement cost value of $8 billion. If these assets average a 100-year life, the annual replacement cost would be approximately $80 million (assuming a uniform rate of replacement during the 100-year life).

The 7 percent per decade assumption implies an annual cost of $50 million for R&R. This is a reasonable number (of the right order of magnitude) compared to the annual replacement cost, considering that I/I control is one of several reasons for R&R of the collection systems.

The R&R costs were also compared to the actual rate of spending by the City of Milwaukee, shown in Figure 5. Based on a review of Milwaukee's published budget values, the annual sewer lining and replacement expenditures have averaged $30 million for the last decade for work on both the sanitary and the stormwater systems (see the City of Milwaukee budget website, www.city.milwaukee.gov/Budget). The costs reported are capital costs for construction and do not include Milwaukee staff salary costs. It is assumed that one third of the capital costs (that is, $10 million per year) is for work on the sanitary sewers that helps mitigate I/I (the rest of the budget is spent on the stormwater pipes and for work that is not related to I/I).

The replacement value for Milwaukee is $1 billion for 1,000 miles of public sanitary sewer or about one eighth of the replacement value of the MMSD service area. If Milwaukee spends $10 million per year to repair a system with a $1 billion replacement value, then Milwaukee is spending in proportion to a 100-year replacement cycle.

Considering the spending rates in Milwaukee, it seems reasonable to say the R&R cost for all the collection system elements within the MMSD service area in this study should be in the range of $80 million per year. This analysis, using the 7 percent per decade degradation rate, estimated an annual R&R cost of $50 million. This is in the acceptable range of accuracy for planning.

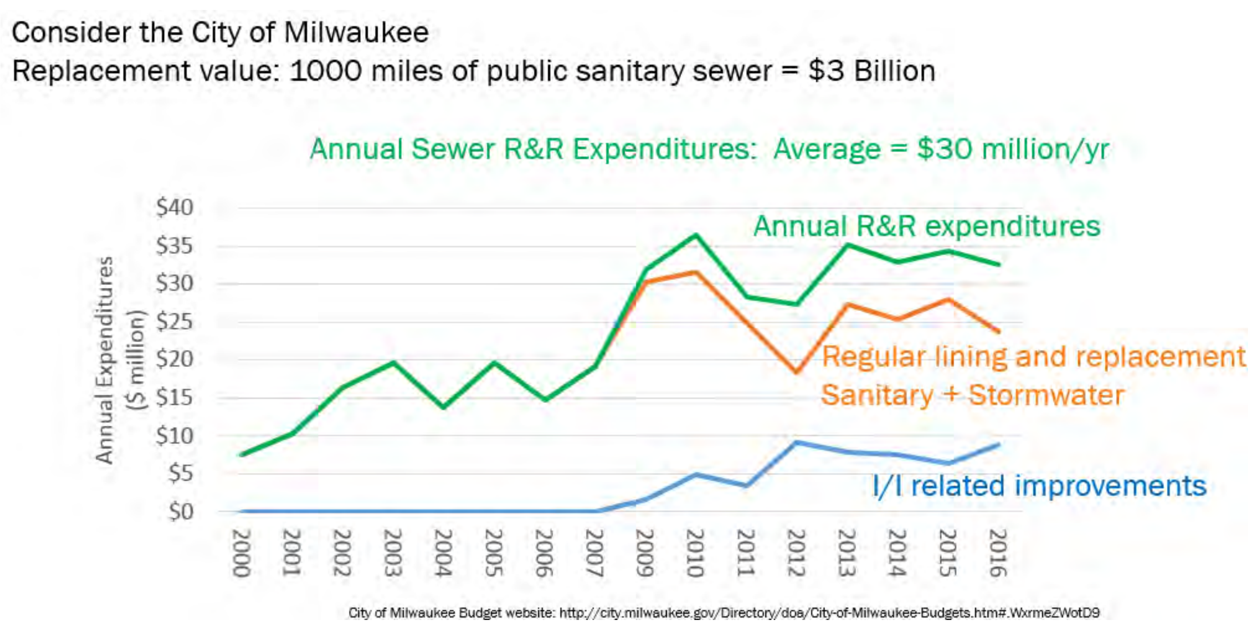


Figure 5. City of Milwaukee Sewer R&R Annual Expenditures

Reduce I/I to Reduce BBU Damage Costs

As part of the MMSD PPI/I project, BC recently completed a BBU risk analysis to estimate the risk of BBUs at a planning level across the municipalities serviced by MMSD (Brown and Caldwell 2018c). In this analysis, two types of calculations were used to estimate a planning-level cost on BBUs: a conceptual method and a capacity method.

The conceptual method calculated the hydraulic response of an idealized sewer system to estimate the degree of basement flooding for a range of storm sizes. The resulting values were used to compute the cost of basement damage over a 20-year period.

The capacity method accounted for the capacity of the sewer system by comparing it with peak flows in the system. (In this analysis, the total peak flow, which is equal to dry weather flow and I/I, was compared to the pipe capacity.) As the ratio of peak flow to pipe capacity increases, the risk of flooding increases. This method is implemented pipe by pipe to estimate the costs in a more accurate way than the conceptual method. Appendix A of this TM provides additional details on the capacity method process. The steps in the method are not described in detail in this TM. Appendix A presents a concise summary of the method. More information is in the TM written on the BBU risk analysis (Brown and Caldwell 2018c).

To use the capacity method, geographic information system (GIS) data are needed for the entire municipal sanitary sewer system including pipe diameters, slopes, connectivity, tributary area, and number of parcels. This information was available for all but nine municipalities (Brown Deer, Cudahy, Franklin, Germantown, Glendale, Hales Corners, New Berlin, St. Francis, and Wauwatosa), as shown in Figure 6. Therefore, the capacity method was used for most municipalities and the conceptual method was used for the nine municipalities with no available GIS data.

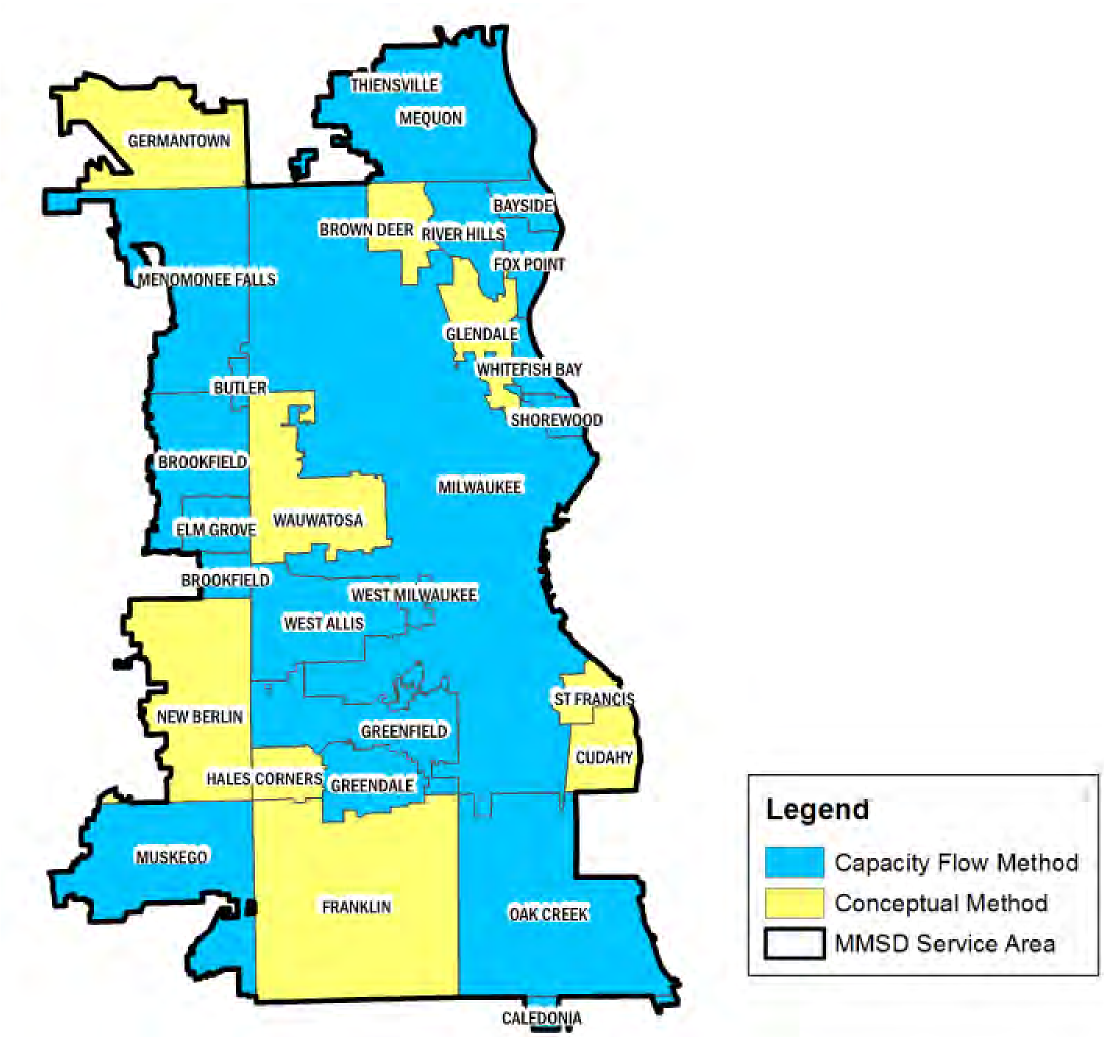


Figure 6. Capacity Flow and Conceptual Method Application Across the MMSD Service Area

For this study, the I/I rates were progressively reduced in steps. The steps corresponded to the steps used in the I/I evaluation discussed above in the Infiltration and Inflow Costs section. BBU costs for a 20-year period were graphed with system-wide percent reduction in peak I/I rate in Figure 7. The BBU damage cost is approximately $360 million in the baseline case assuming no change in the I/I rates. BBU costs decrease as I/I flow is reduced. In the sixth step, the I/I is reduced 39 percent and BBU costs are $60 million. Given the planning-level nature of the analysis, these cost values should be taken as general trends rather than specific values.

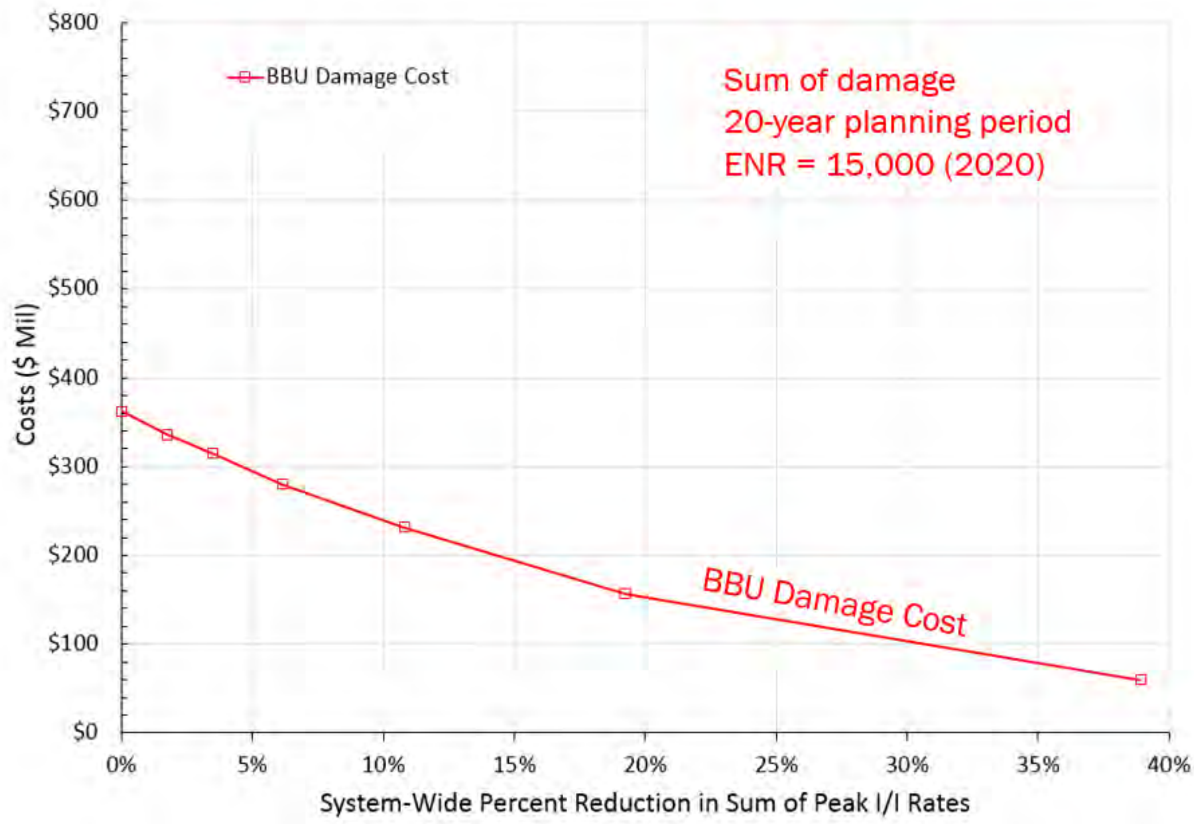


Figure 7. Basement Backup Damage Costs and I/I Reduction

Figure 8 shows the BBU damage costs and I/I reduction cost. The sum of the BBU cost and I/I reduction cost is the total cost. For the first two steps of I/I reduction, the BBU savings are roughly equal to the cost of I/I reduction. But at higher levels of I/I reduction, spending on I/I reduction is increasingly greater than the savings from the BBU reduction. However, reduction of BBUs is only one of many cost benefits from I/I reduction. I/I reduction also reduces the need for additional conveyance and treatment, thereby reducing the spending needed for capital improvements in the municipal conveyance systems and in the MMSD system (both conveyance systems and at the water reclamation facilities). Other benefits besides cost include SSO reduction in regional and municipal conveyance systems, which are not permitted by the Wisconsin Department of Natural Resources (WDNR) and improved public perception.

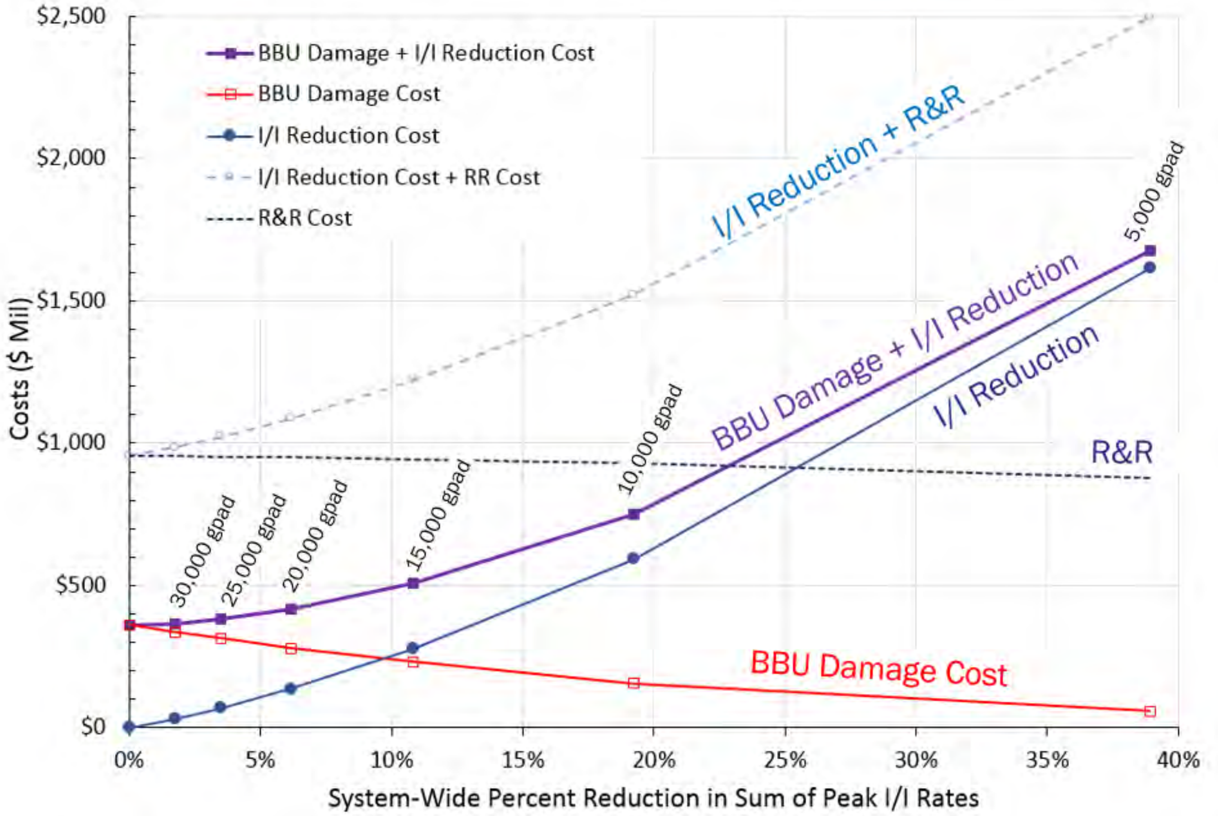


Figure 8. Basement Backup Costs and I/I Reduction Costs with Decreasing I/I Flow

Table 2 summarizes the BBU damage costs shown in the figures above. This table also lists the stepwise savings in BBU damage cost from one I/I reduction step to the next. The stepwise BBU damage costs can be compared to the stepwise I/I reduction cost in the form of a stepwise cost-effectiveness ratio. In the first two steps, the ratio values are in the range of 1.3 to 1.5. This means that the savings are not as large as the spending, but they are roughly equal. In subsequent steps, the ratio becomes increasingly larger. In step 6, the ratio is greater than 10. This means spending $10 on I/I reduction will save $1 in BBU damage cost. The cost of I/I reduction, up to 5 percent system-wide, may be partially offset by the savings in BBU damage. Higher levels of I/I reduction are not justified by BBU savings alone.

Table 2: BBU Damage Cost and I/I Reduction cost							
Step	**I/I Threshold (gpad)**	**Percent Total Flow Reduction**	**BBU Damage Cost ($Mil)**	**Stepwise BBU Savings ($Mil)**	**I/I Reduction Cost ($Mil)**	**Stepwise I/I Reduction Cost ($Mil)**	**Stepwise Cost Effectiveness Ratio**
Baseline	-	0	360		0		
1	30,000	2	340	20	30	30	1.5
2	25,000	3	310	30	70	40	1.3
3	20,000	6	280	30	140	70	2.3
4	15,000	11	230	50	280	140	2.8
5	10,000	19	160	70	590	310	4.4
6	5,000	39	60	100	1,620	1,030	10.3

ENR = 15,000 (2020).
BBU damage: sum of costs during a 20-year planning period.

Upsize Pipe to Reduce BBU Damage Costs

Strategy 5 of CBC034 is to "Increase Sewer Capacity" and the consultant team needed a method for evaluating how BBU damage can be reduced by increasing conveyance capacity in the pipe network if I/I rates remain unchanged. The ideal method for evaluating this would be to use the CSM to model the sewer interactions of the entire MMSD service area, identify sewers with insufficient capacity, and calculate the appropriate diameters for upsizing these sewers with insufficient capacity, work that will be completed under the Engineering Services for Conveyance System Evaluation and Modeling Software Improvements contract (Contract No. C98056P01). The schedule of completing Ad Hoc 211 and CBC034, however, dictated that a more simplistic method was needed as a placeholder for comparing Strategy 5 to the other strategies in CBC034. In this simplistic evaluation, the diameters of pipe segments are upsized based on simple estimates of pipe capacity as calculated using Manning's equation. This is not a formal engineering evaluation of the hydraulics of the system and the analysis is performed pipe by pipe in a spreadsheet without regard for how it would function as a system.

This analysis considers only pipes in municipal sewer systems. It does not consider costs for improvements downstream in the MMSD system or at the WRFs. Since the MMSD system already has at least a 5-year level of service there should not be any upsizing costs outside of the municipal systems up to the 5-year event. For larger events, the MMSD system would also need to be evaluated, but that is beyond the scope of this work. Therefore, the cost values shown are the municipal part of the total cost for the 10, 20, and 50-year events.

The analysis is developed in steps for the 1-, 2-, 5-, 10-, 20-, and 50-year events. In each step, the pipes are upsized to mitigate the risk of BBU for a storm up to the magnitude of each step. Then the remaining damage is estimated for larger storms above the magnitude of each step. For example, upsizing for the 5-year event reduces the risk of BBU in a 5-year event, but in larger events the upsized system helps to reduce, but does not eliminate, the risk of BBUs.

The method estimates the pipe sizes required to convey the flow with a ratio of peak hourly flow to pipe capacity equal to 0.5. This is the same flow ratio used to estimate the BBU costs in the Task 1 analysis. The calculated pipe size is generally an irregular diameter, so the sizes are rounded up to the next standard pipe size.

Figure 9 shows the cost of upsizing to achieve each level of protection step. Between 1- and 2-year recurrence interval (RI) events, the cost of upsizing markedly increases, and later continues to increase at a slower rate, likely because the costs for upsizing MMSD facilities are not included.

The remaining BBU damage cost for each step of upsizing is also shown in Figure 9. These are the 20-year costs of BBU damage. The sum of the upsizing and BBU damage costs is the gray curve in the figure. The minimum cost is for the case with pipes upsized for events in the 1- to 2-year RI range. The minimum cost for upsizing and BBU damage is approximately $300 million. The BBU damage cost curve drops rapidly with upsizing to achieve the 1- to 2-year RI level. Costs above a 5-year recurrence event become increasingly more inaccurate, because costs for upsizing MMSD facilities are not included.

Upsizing pipes is not a standalone solution to BBUs. Furthermore, this analysis does not account for the downstream impacts of upsizing pipes, thus conveying the problems of excessive I/I downstream. Downstream facilities are designed for about a 5-year RI event. Therefore, upsizing municipal sewers to address problems in the 1- to 2-year RI size should not aggravate the downstream facilities. This is a very simplistic analysis of hydraulic capacity. Ideally, the municipal sewers should already have at least a 5-year conveyance capacity. However, if some pipes have reduced capacity, upsizing may be a part of a larger solution that may also include some I/I reduction. Additionally, if I/I is not addressed, then upsizing pipes would only reduce BBUs temporarily as the LOS could not be sustained over time.

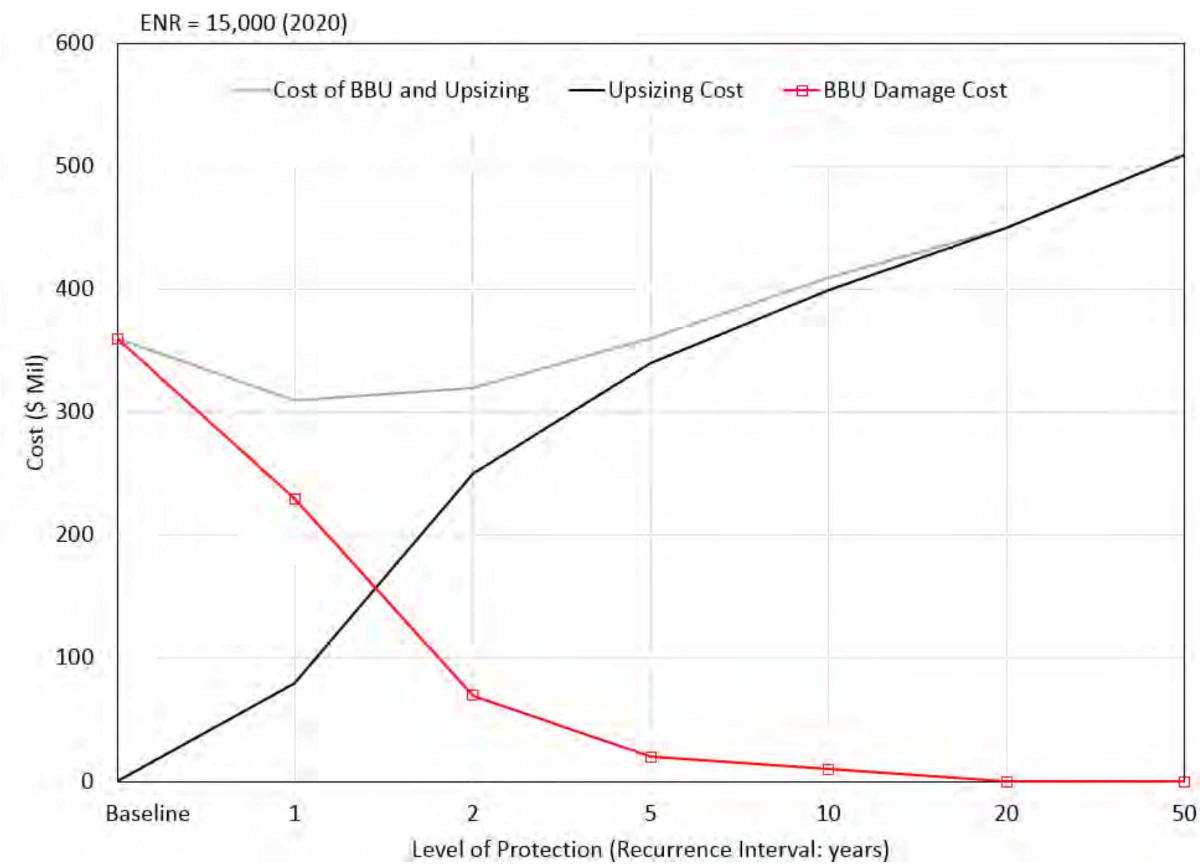


Figure 9. Cost of Upsizing Municipal Sewers and Cost of BBU Damage

Task 2: I/I Influences on Basement Backups and SSOs

Task 2 was a set of specific future flow cases that were designed to support business case evaluations CBC033 and CBC034 that are part of the 2050FP. The CBC conditions stipulated that this analysis use 2035 population and land use conditions. The cases assumed a rate of I/I change because of degradation of the sewer system over time. The cost to repair the system to prevent I/I change was accounted for along with additional work needed to improve the system so the risk of BBUs and SSOs does not increase in the future. Four scenario cases were proposed to evaluate the influence of I/I on BBUs and SSOs. These scenario cases were used to establish the cost and risk associated with a set of I/I management choices.

Analysis

The methods used to estimate the cost of I/I reduction and the cost of BBU risk used the same methods as described in Task 1. The main difference between Tasks 1 and 2 is that Task 2 also evaluated the SSO risk.

This evaluation used the Simplified System Model (SSM) to run long-term simulations to estimate the frequency and volume of sanitary sewer flow into the Inline Storage System (ISS) as metrics to evaluate the potential SSO risk of the system. One simulation with the Comprehensive System Model (CSM) was run to identify the extent of I/I reduction necessary to eliminate simulated SSOs during the largest SSO event in the period of record. Flows for this event were simulated in the SSM, providing a benchmark of the zero SSO goal and the corresponding volume of separate sewage diverted to the ISS.

As summarized in Table 3, the following cases were considered:

- **Case 0: baseline**. Population and land use for 2010 with baseline I/I rates and existing BBU risk.
- **Case 1: degraded**. Population and land use for 2035 with future degraded conditions in - which I/I rates for all sewersheds increased by 14 percent greater than baseline. -
- **Case 2: SSO control with R&R**. Population and land use for 2035 and baseline I/I rates controlled by R&R in all sewersheds. This assumes a 14 percent increase in I/I followed by R&R in some sewersheds to restore I/I rates to the baseline condition. In sewersheds with the highest I/I rates, I/I is reduced substantially until the SSO risk is restored to a frequency equal to the 2010 baseline condition.
- **Case 3: SSO control with I/I reduction**. Population and land use for 2035 and I/I rates 14 percent greater in most sewersheds. I/I reduction work in sewersheds with the highest I/I rates to restore the SSO risk to a frequency equal to the 2010 baseline condition.
- **Case 4: zero SSO**. Population and land use for 2035 and I/I rates 14 percent greater in some sewersheds. I/I reduction work in sewersheds with the highest I/I rates until there is no remaining SSO risk in the simulation results.

Steps in the evaluation process were as follows:

1. - Define the level of I/I reduction by using sewershed-specific values to achieve an overall - system outcome. -
2. - For the largest SSO event, run the CSM to identify the level of I/I reduction needed to end the risk of simulated SSOs.
3. - Transform the flows to conform to the assumed I/I conditions (accounting for increases in the degraded sewersheds and decreases in rehabilitated sewersheds).
4. - Generate the input hydrographs for the SSM using a utility program (called FFS-to-SSM.exe).
5. - Estimate the flow to the ISS from the SSM simulations, iterating the simulations until the flow to the ISS is reduced to the point where the goal is achieved.

6. - Calculate the cost of BBU damage by adjusting sewershed peak flow rates according to the assumed levels; use the BBU cost methods to estimate BBU damage cost for the 20-year planning period.

7. - Calculate the cost of I/I reduction by using the performance-based I/I reduction unit cost curve. Implement with the "stepwise" method to achieve progressively lower I/I rates until the SSO objective is achieved.

8. - Integrate the I/I reduction and BBU damage costs into a total cost value.

Table 3: Description of Cases						
Number	**Name**	**Description**	**I/I Degradation**	**Initial R&R for I/I Control**	**I/I Reduction for SSO Control**	**SSO Outcome**
0	Baseline	2010 population and land use, existing I/I rate	None	None	None	Baseline
1	Degraded	Do nothing, allow degradation of all sewersheds	14% increase	None	None	Increase
2	SSO control with R&R	Regular repair in all sewersheds, rehabilitate a few sewersheds to get SSO to baseline	14% increase	14% restored	Rehabilitate a few sewersheds	Equal to baseline
3	SSO control with I/I reduction	Most sewersheds degrade, rehabilitate many of the sewersheds with the highest I/I to get SSO equal to baseline	14% increase	None	Rehabilitate many of the sewersheds with the highest I/I	Equal to baseline
4	Zero SSO	Most sewersheds degrade, extensive rehabilitation of sewersheds with the highest I/I until zero simulated SSOs	14% increase	None	Extensive rehabilitation of sewersheds with the highest I/I	Zero

Case 2 includes an initial investment in R&R to mitigate the 14 percent degradation in those sewersheds that would not require more substantial I/I reduction work needed to achieve the desired SSO outcome. Ongoing R&R would still be required after the planning period to avoid further degradation in the future. For the other cases in Task 2, this accounting does not include ongoing R&R to avoid further degradation in time. That is why Table 3 lists R&R only for Case 2 to achieve an initial level of I/I control.

Figure 10 is a diagram of the concepts of Task 2, where the risk of SSOs is considered along with the cost of I/I reduction and BBU damage. The SSM was used to simulate 75 years of sanitary sewer flow to understand the risk of SSOs. The SSM is a water balance model to simulate the overall movement of water in the MMSD system. The SSM model accounts for flow to the WRFs, the ISS, combined sewer overflows (CSOs), and tunnel-related SSOs. In the SSM water balance, tunnel-related SSOs are a very small fraction of the total volume. Because of this, there is a greater amount of relative uncertainty in the simulated SSO values than in other simulation results, such as WRF volume.

One way to estimate the risk of SSOs is to study the simulated volume of sanitary sewer flow that enters the ISS and the Northwest Side Remote Storage (NWSRS) facility. When flow in the MIS exceeds the capacities of the WRFs, the sanitary flow is relieved by entering the ISS. When the ISS reaches full capacity, there is a risk of an SSO event. The volume of sanitary flow entering the ISS is a larger fraction of the SSM water balance than the volume of SSOs; as a result, the flow entering the ISS is a simulation result that has a higher degree of relative accuracy than the simulation results for SSO alone. In this study, changes in SSO risk are assumed to be proportional to changes in the volume of sanitary flow entering the ISS.

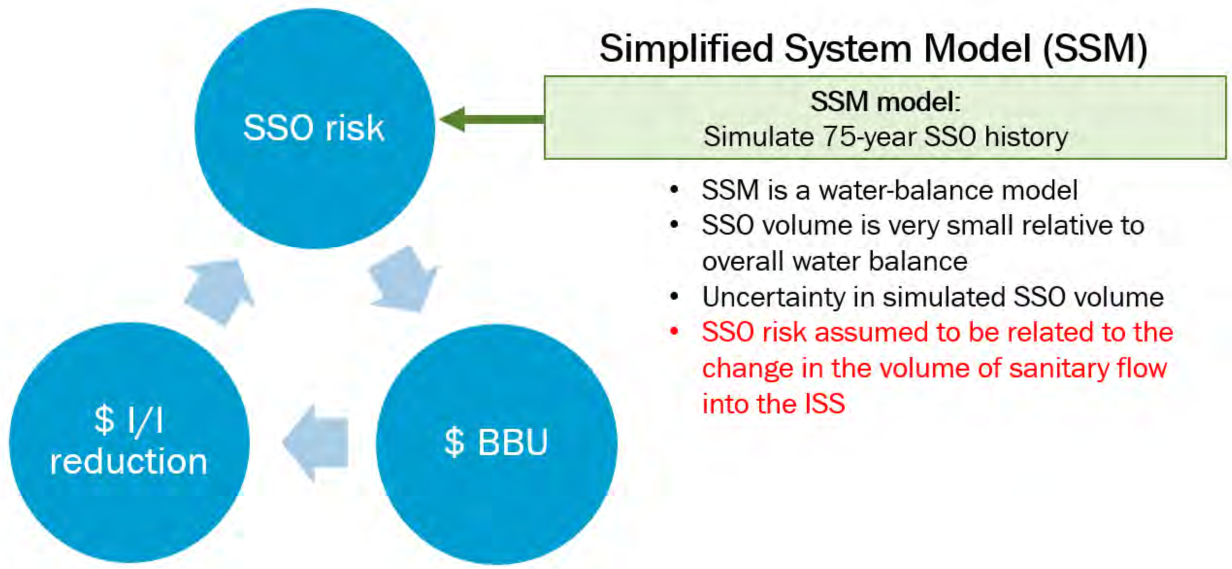


Figure 10. Simplified System Model Description

For Task 2 specifically, the SSM was used for all four cases. The CSM was used to simulate an extreme event (the March 1960 event) to help determine the parameters that would be needed to have zero SSOs for Case 4. This is demonstrated in Figure 11.

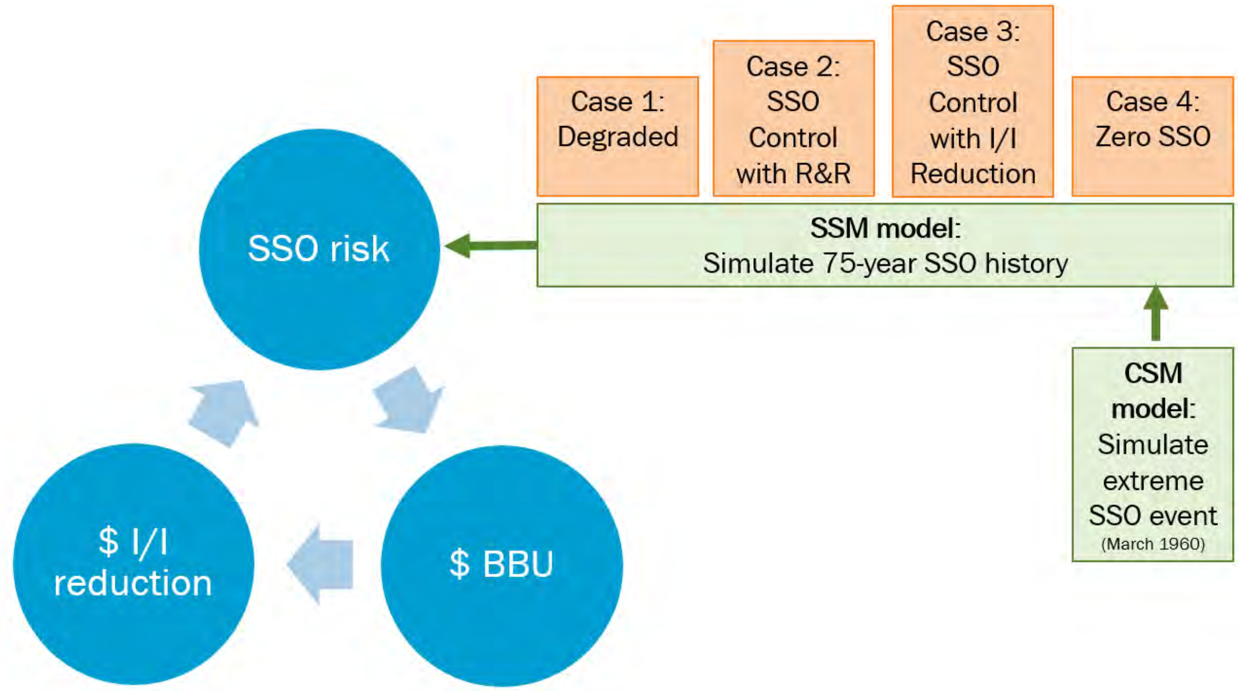


Figure 11. Simplified System Model Description for Task 2

This analysis included the following assumptions:

- The SSO risk is not an exact number for how many overflows occurred in the system but a representative number based on sanitary sewer flow into the ISS.
- The SSM used 75 years' worth of data for the model simulation and was used for all four cases.
- The CSM used an extreme event from 1960 to define a condition that achieves zero SSOs.

Table 4 summarizes the modeling results and compares the various cases. It is important to note that the I/I reduction and R&R costs represented in this table are the costs shared by private property owners, municipalities, and MMSD. Funding is already being spent on all three components but, at this time, it is not always targeted on the sewersheds with the highest I/I.

For Case 1, where the system is allowed to degrade with no R&R, the risk of an SSO is more than three times greater than the baseline. Cases 2 and 3 have approximately the same risk as the baseline case. Case 4, with no SSOs, would require I/I reduction work in 67 percent of the sewersheds and achieve a 45 percent reduction in the system-wide I/I rate.

Table 4: Modeling Results and Costs for the CBC Cases							
Case	Description	Percent of Sewersheds with Initial R&R	Percent of Sewersheds with I/I Reduction	Percent Flow Change from 2010	SSO Volume, Percent of Baseline Case	I/I Reduction and R&R Cost ($ Mil)	BBU Cost ($ Mil)
0	Baseline	0	0	0	100	0	360
1	Degraded	0	0	21	375	0	500
2	SSO control with R&R	67	33	-7	96	1,500	200
3	SSO control with I/I reduction	0	59	-8	90	1,500	200
4	Zero SSO	0	67	-45	0	2,000	60

Conclusion

The results of this evaluation of BBU damage, I/I reduction, and SSO risk are used in the business case evaluation of CBC033 and CBC034; the significance of the results are discussed in those evaluations. The results will be documented as an appendix to the 2050FP. The objective of this Ad Hoc 211 TM is to discuss the wider implications of these results, so any conclusions are limited to the primary results of this investigation.

To reduce BBU damage, flow can be reduced by rehabilitation to remove I/I or by increasing the conveyance capacity (upsizing pipes). Planning-level methods were developed to estimate the cost of BBU damage and the cost of I/I reduction. These methods are intended to give planning-level cost values to show the trends and relationships between BBU damage, I/I reduction, and upsizing. The actual numerical values have a large margin of uncertainty.

The main results from the Task 1 evaluation are as follows:

- The first two steps of I/I reduction assume that sewersheds with the highest I/I rates are reduced to 25,000 gpad. In these steps, the cost of I/I reduction is approximately equal to the savings in BBU damage cost. This level of I/I reduction is generally in the same range as compliance with the MMSD performance standard.
- Ongoing R&R is a substantial cost (based on the 7 percent per decade assumed rate of I/I degradation). This assumption may be reasonable in that it is approximately equal to a 100-year replacement cycle. The main point of using an assumed rate of I/I degradation is to show how R&R can be accounted for.

- Upsizing municipal sewers can reduce the BBU damage cost quickly, for the 1- to 2-year RI event. However, this approach would require an evaluation of how upsizing the municipal sewers would affect the results in the downstream sewer system, which was outside of the scope of Ad Hoc 211.

The main results from the Task 2 evaluation are as follows:

- The risk of SSOs may increase substantially (three to four times) if ongoing R&R is not - successful in controlling I/I rates at the current level (this is Case 1). -
- Cases 2 and 3 achieve the same outcome (that is, the SSO risk is the same as the baseline - case) and costs for I/I reduction and BBUs are approximately the same amount. -
- Case 4 with zero SSOs would require extensive I/I reduction so that the sum of the I/I rates is reduced 45 percent.

References

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Appendix A: Basement Backup Cost for Existing Conditions

The basement backup damage cost method was developed for the PPI/I project (Brown and Caldwell 2018c). The analysis produces an estimate of the damage cost based on the ratio of peak wet weather flow relative to the nominal pipe capacity. It is called the "capacity-flow" method, or more briefly as the "capacity" method to contrast it with the other method called the "conceptual" method.

This appendix summarizes the key results of the analysis for existing system conditions. The outcome is a cost value for the cumulative damage that may be sustained in a 20-year planning period. Cost values were scaled to a future ENR index value of 15,000.

Figure A-1 shows the estimated BBU damage cost in a single event. Values are plotted for event sizes ranging from 1- to 50-year RIs. For example, in a 5-year event, the damage cost is estimated to be $33 million; this is a one-time cost in a single event.

Over the 20-year period, 20 events of various sizes are assumed. This method assumes 10 events of the 1-year RI, 6 events of a 2-year RI, 2 events of a 5-year RI, one 10-year RI event, and one larger RI event. (For cost estimating, the one larger RI event is accounted for by using a 0.6 factor on the cost of a 25-year event and a 0.4 factor on the cost of a 50-year event.)

Figure A-2 shows the BBU costs for events in each RI size class. These values are the single event costs. The total cost of the 20-year planning period is approximately $365 million. The 2-year RI event accounts for the most damage due to the number of events in that size. The largest events contribute relatively little to the total cost.

The method is intended to be a planning-level cost-estimating tool. It is not based on a thorough engineering analysis of hydraulic conditions in the sewer. The goal is to have a systematic way to estimate the rough cost of damage. The method has also been used to estimate the reduction in BBU damage due to I/I reduction work or if pipe sizes are increased.

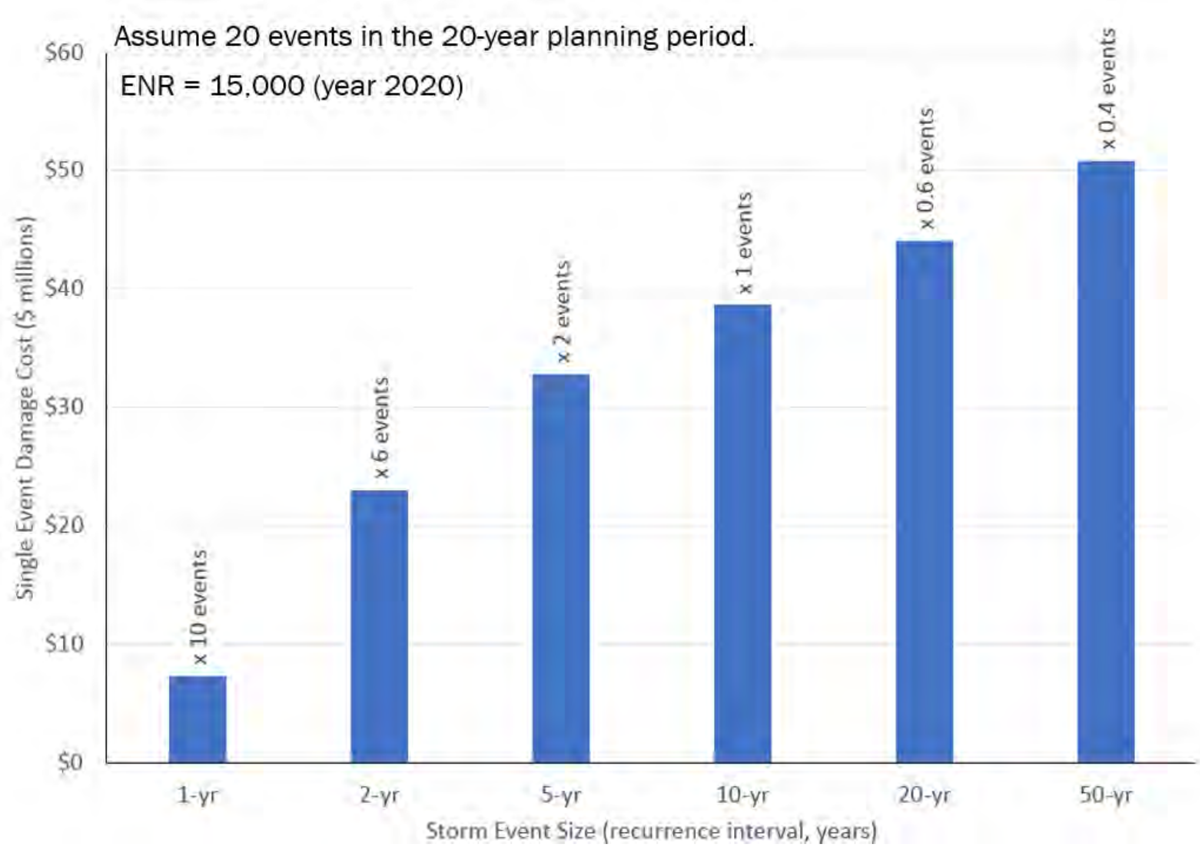

Figure A-1. Single-Event BBU Damage Cost

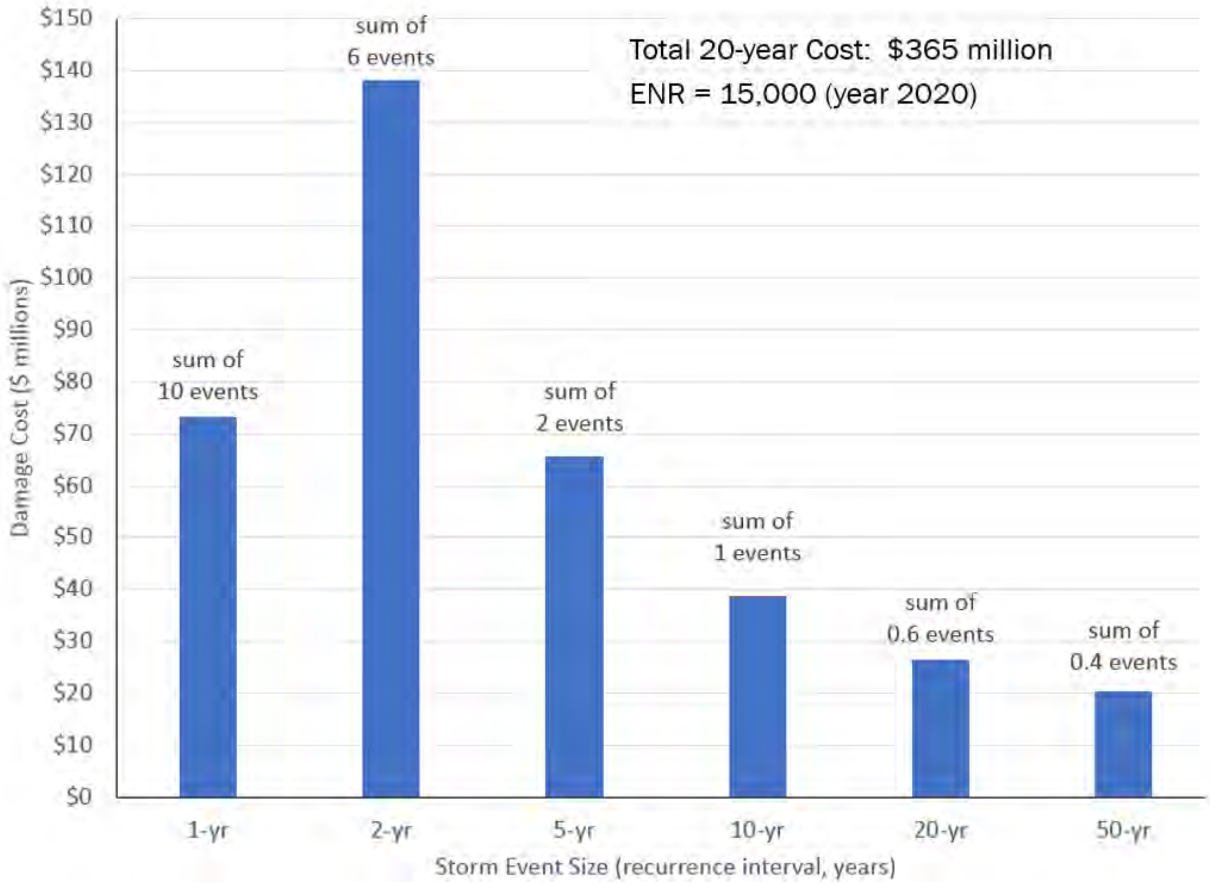

Figure A-2. BBU Damage Cost over a 20-year Period, Distributed by Event Size

APPENDIX 6A-36: CS R9 Combat I-I Details -

CS R9, Combat I/I Impact
Proposed additonal capital costs to add to 2020-2025 long-range finance plans

Created by KMZ 2/5/2020
Checked by
Updated By

Existing Capital Programs:

Project ID	Project Name	Previous Actuals	2020 Project Act/Est	2021 Forecast	2022 Forecast	2023 Forecast	2024 Forecast	2025 Forecast	2026 Forecast	2027 Forecast	2028 Forecast	2029 Forecast	2030 Forecast	Future Forecast	Total Project Act/Est
M10003	PPI/I Phase 2	$6,053,191	$10,029,076	$3,491,243	$2,849,855	$16,495,249	$0	$0	$0	$0	$0	$0	$0	$0	$38,918,614
M10004	PPI/I Implementation Phase 2 (Labor)	$1,285,623	$1,049,032	$877,522	$805,769	$623,746	$187,947	$106,180	$23,270	$0	$0	$0	$0	$0	$4,959,089
M10005	Post 2050 FP PP/II Approach	$0	$0	$4	$1,351,230	$5,004,850	$5,022,054	$4,998,963	$4,896,955	$0	$0	$0	$0	$8,725,944	$30,000,000
M10006	PPII Research and Development	$0	$0	$368,656	$333,129	$485,743	$595,057	$559,467	$500,294	$0	$0	$0	$0	$694,601	$3,536,946

For the purposes of this 2050 FP:

- it is assumed M10004, PPI/I Implementation Phase 2 (Labor) is associated with the CS R9, Combat I/I WWPFMP Program
- it is assumed M10005, Post 2050 FP PP/II Approach, is associated with the CS R9, Combat I/I MMSD Implementation Costs
- it is assumed M10003, PPI/I Phase 2, includes already committed costs for the PPI/I program that are not recommended to change
- it is assumed M10006, PPII Research and Development is related to CS R9, Combat I/I but is for separate research and development program that should continue without changes

Recommended WWPFMP Funding Costs

Project recommended to meet Baseline Conditions:

MMSD has identified $1.3M as an interim annual costs needed to ramp up the program (full cost identified in CS R9 as $2.83M per year, see Future/Buildout Conditions)
For purposes of this analysis, this is assumed to be a new project called CS R9 Combat I/I (WWPFMP Program) that makes up the difference between what is currently included in
Project M10004, PPI/I Implementation Phase 2 (Labor), 2021-2025 costs in the 2020-2025 long-term financial plan.
The year 2021 is the start date since this 2050 FP will not be approved until the end of 2020. Only the total capital cost is presented in the recommended plan, with the implementation to be determined by MMSD.

		2021	2022	2023	2024	2025	Total
CS R9	Combat I/I (WWPFMP Funding)	$422,478	$494,231	$676,254	$1,112,053	$1,193,820	$3,898,836

Project recommended to meet Future/Buildout Conditions:

CS R9 recommends a full WWPFMP Program Cost of $2.83M
For purposes of this analysis, this is assumed to be CS R9 Combat I/I (WWPFMP Program) but at $2.83M over the remaining 15 years of the planning period (2026-2040)
Only the total capital cost is presented in the recommended plan, with the implementation to be determined by MMSD.

			Future	Total
CS R9	Combat I/I (WWPFMP Funding)	Future/Buildout Conditions:	$42,450,000	$42,450,000

Recommended MMSD Implementation Costs

Project recommended to meet Baseline Conditions:

CS R9 identified the cost to address non-compliant enforcement metersheds at $7.82M (full cost identified in CS R9 as $9.71M per year, see Future/Buildout Conditions)
For purposes of this analysis, this is assumed to be a new project called CS R9 Combat I/I (MMSD Implementation) that makes up the difference between what is currently included in
Project M10005, Post 2050 FP PP/II Approach, 2021-2025 costs in the 2020-2025 long-term financial plan.
The year 2023 is the start date since this is presented as the first year of full project costs for M10005. Only the total capital cost is presented in the recommended plan, with the implementation to be determined by MMSD.

		2021	2022	2023	2024	2025	Total
CS R9	Combat I/I (MMSD Implementation)			$2,815,150	$2,797,946	$2,821,037	$8,434,134

Project recommended to meet Future/Buildout Conditions:

CS R9 recommends full MMSD Implementation cost of $9.71M
For purposes of this analysis, this is assumed to be CS R9 Combat I/I (MMSD Implementation) but at $9.71M over the remaining 15 years of the planning period (2026-2040)
minus the future (2026 and future in list above) costs already identified for M10005, Post 2050 PP/II Approach
Only the total capital cost is presented in the recommended plan, with the implementation to be determined by MMSD.

			Future	Total
CS R9	Combat I/I (MMSD Implementation)	Future/Buildout Conditions:	$132,027,100	$132,027,100

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

COST TABLE SUMMARY
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS
CS R9, Combat I/I Impact

General Description:
Cost to maintain I/I to baseline, counteract the projected 14 percent increase in peak flow over the planning period from 2020-2040, along with bring identified non-compliant enforcement metersheds into compliance.

ENR Index =	14700	(projected to December 2019)
Annual Increase in Costs =	0.0%	
Discount Rate	3.375%	
Number of Years	20	
Present Worth Factor (including annual increase)	14.375	

Operation and Maintenance Costs

ITEM	Annual Cost ($)		Present Worth ($)
MITITGATE INCREASES IN I/I			
WWPFMP Program Costs	2,830,000	$	40,700,000
MMSD Implementation Costs	9,710,000	$	139,600,000
MMSD Total Mitigate Increases to I/I Costs	**12,540,000**	**$**	**180,300,000**
Municipality and Private Property Implementation Costs	62,460,000	$	897,800,000
Total Costs from CBC033 - Strategy 4	**75,000,000**	**$**	**1,078,100,000**
ENFORCEMENT METERSHED COMPLIANCE			
Non-Compliant Metersheds - MMSD cost to bring into compliance	7,823,500.000	$	112,500,000
TOTAL COSTS			
MMSD Total Costs	20,363,500		292,800,000
Municipality and Private Property Total Costs	62,460,000		897,800,000
GRAND TOTAL	**82,823,500**		**1,190,600,000**

Notes:
1) Annual costs are from CBC033 with present worth costs updated based on 2050 FP assumptions
2) WWPFMP = Wet Weather Peak Flow Management Program

Milwaukee Metropolitan Sewerage District
2050 FACILITIES PLAN
BUSINESS CASE EVALUATIONS
Assumptions

General			Source	Comments
Milwaukee ENR **December 2019**	14,700		Historic_ENRvalues 1974-2019-05_MCA_KMZREV.xlsx	Milwaukee ENR is the average between Chicago and Minneapolis Construction Cost Index values published monthly by ENR. Milwaukee ENR December 2019 is a projected value from May 2019 based on average historical monthly increase in value from 2007 (2020 Facilities Plan published June 2007) to May 2019.
Annual increase in costs	0%		Discussion with MMSD	
Discount Rate	3.375%		Email from Andrew Dutcher, WDNR to Troy Deibert, HNTB on 6/5/19	**Facility planning is using the value established by the WDNR.**
Life Cycle - number years	20			
Capital Costs				
Un-designed Details Allowance - Varies, see below			**Allowance varies at engineer's discretion based on definitions provided for each %**	
all major components have documented installed unit costs	10%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
costs missing for some components, but other costs are for installed facilities and well documented (connections to existing systems, etc.)	20%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Alternative development is still conceptual	30%		K. Ziino email to B. Krill on 6/8/17, confirmed on 6/19/17	
Contingency Allowance - Set %				
Planning Level Contingency	20%		2050 FP Team - WRF discussion on 1/30/17	
Contractor Overhead & Profit - Varies, see below				
Equipment costs are from manufacturers	25%		2050 FP Team - WRF discussion on 1/30/17	
Costs are from previous project, unit costs already include OH&P	0%		2050 FP Team - cost estimate discussion on 5/20/19	
Design, Bidding, & MMSD Oversight				
Total Percent, Conveyance	20%		Total Percent used for Planning, Preliminary Engineering, Design, Construction (exc. Contractor Cost) and Post Construction in the BCE	**For FP Use only. This is incorporated into AMP BCE template already.** Varies for each asset system
Total Percent, WRFs	40%			
Total Percent, Watercourse	20%			
Total Percent, GI	15%			

Power assumptions			SOURCE	Comments
Gas	2018 Current Rates			
turbine fuel, LFG	$2.500	/Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
turbine fuel, NG	$5.000	/Dtherm	K. Ziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	
Electrical				
Electrical Rates, JI/SS	Varies		Kziino email sent 4/20/17 called "2050 - WRF TBC Energy Cost Assumptions" for assumptions	Detailed assumptions need to be included in backup on a case by case basis
Labor assumptions				
Veolia Labor	$50	per hour	Included in BCE assumptions	
Contractor Labor	$70	per hour	To be included in capital costs	

Non-Compliant Metersheds - MMSD cost to bring into compliance

Enforcement Meter ID	Meter Location	Total Metershed Sewered Area (acres) [1, 2]	Sewershed Meter	Sewershed Sewered Area (acres) [1]	% of Total Metershed Area [2]	Muni	Governing Unit	Total % of Metershed Area [2]	Upstream Meter (included in total metershed area)[3]	5-Year Recurrence Q (gpad)	Maximum Allowable Q (gpad)	I/I Reduction Required for Compliance (gpad)	I/I Reduction (gpd)	Unit Cost of I/I Reduction ($/gpd of 5-Yr. Peak I/I Removed) [3]	Cost of I/I Reduction
MS0116	2685 S 43rd Street	118	MI1100	118	100%	MI	Milwaukee	100%	-	54,800	22,000	32,800	3,860,000	$1.29	$4,970,000
MS0118	6050 W Arthur Avenue (w/o S 60th Street in alley)	350	MI1123	48	14%	MI	Milwaukee	14%	MS0309 (PD)	40,700	19,000	21,700	1,040,000	$1.59	$1,650,000
			WE1018	141	40%	WE	West Allis	91%		40,700	19,000	21,700	3,060,000	$1.59	$4,850,000
			WE1032	161	46%	WE	West Allis			40,700	19,000	21,700	3,490,000	$1.59	$5,530,000
MS0309[4]	2106 S 81st Street	186	WE3013	186	100%	WE	West Allis	100%	-	40,700	19,000	21,700	4,040,000	$1.59	$6,400,000
MS0130	5025 W Lincoln Avenue	150	WE1020	150	100%	WE	West Allis	100%	-	36,300	22,000	14,300	2,150,000	$1.72	$3,690,000
MS0131	4905 W Burnham Street	281	WE1021	229	82%	WE	West Allis	82%	-	33,300	21,000	12,300	2,820,000	$1.82	$5,140,000
			WM1002	52	18%	WM	West Milwaukee	18%		33,300	21,000	12,300	640,000	$1.82	$1,170,000
MS0305	S 81st Street (just n/o W Hayes Avenue)	1561	MI3096	540	35%	MI	Milwaukee	69%	MS0315	22,000	15,500	6,500	3,510,000	$2.44	$8,560,000
		1561	MI3124	30	2%	MI	Milwaukee			22,000	15,500	6,500	200,000	$2.44	$490,000
		1561	WE3015	177	11%	WE	West Allis	31%		22,000	15,500	6,500	1,150,000	$2.44	$2,800,000
		1561	WE3016	215	14%	WE	West Allis			22,000	15,500	6,500	1,400,000	$2.44	$3,410,000
		1561	WE3017	95	6%	WE	West Allis			22,000	15,500	6,500	620,000	$2.44	$1,510,000
MS0315[4]	8002 W Oklahoma Avenue	504	MI3095	504	100%	MI	Milwaukee	100%	-	22,000	15,500	6,500	3,280,000	$2.44	$8,000,000
MS0338	2675 N Menomonee River Parkway	191	MI3065	191	100%	MI	Milwaukee	100%	-	24,300	22,000	2,300	440,000	$2.27	$1,000,000
MS0339	9911 W Concordia Avenue	401	MI3041	401	100%	MI	Milwaukee	100%	-	34,900	21,000	13,900	5,570,000	$1.77	$9,830,000
MS0411	6000 W Martin Drive	798	MI4067	156	19%	MI	Milwaukee	19%	5-year	29,600	19,000	10,600	1,650,000	$1.98	$3,270,000
		798	WA4001	218	27%	WA	Wauwatosa	81%		29,600	19,000	10,600	2,310,000	$1.98	$4,580,000
		798	WA4002	286	36%	WA	Wauwatosa			29,600	19,000	10,600	3,030,000	$1.98	$6,000,000
		798	WA4035	139	17%	WA	Wauwatosa			29,600	19,000	10,600	1,470,000	$1.98	$2,910,000
MS0415	6005 W Mitchell Street	262	WE4023	262	100%	WE	West Allis	100%	-	33,900	21,000	12,900	3,380,000	$1.80	$6,090,000
MS0418	3366 N 51st Boulevard	265	MI4046	265	100%	MI	Milwaukee	100%	-	27,200	21,000	6,200	1,640,000	$2.10	$3,450,000
MS0420	5026 W Congress Street	104	MI4139	104	100%	MI	Milwaukee	100%	-	39,300	22,000	17,300	1,800,000	$1.62	$2,920,000
MS0448	W Roosevelt Drive at N 58th Street	1589	MI4042	487	31%	MI	Milwaukee	49%	MS0417	18,300	15,500	2,800	1,360,000	$2.77	$3,770,000
		1589	MI4043	153	10%	MI	Milwaukee			18,300	15,500	2,800	430,000	$2.77	$1,190,000
		1589	MI4044	126	8%	MI	Milwaukee			18,300	15,500	2,800	350,000	$2.77	$970,000
		1589	MI4160	5	0%	MI	Milwaukee			18,300	15,500	2,800	10,000	$2.77	$30,000
MS0417[4]	3104 N Menomonee River Parkway (eastern parkway, n/o Burleigh)	819	MI4159	12	1%	MI	Milwaukee	1%	-	18,300	15,500	2,800	30,000	$2.77	$80,000
		819	WA4010	658	80%	WA	Wauwatosa	99%		18,300	15,500	2,800	1,840,000	$2.77	$5,100,000
		819	WA4016	149	18%	WA	Wauwatosa			18,300	15,500	2,800	420,000	$2.77	$1,170,000
		533	FP4003	369	69%	FP	Fox Point	100%		21,900	19,000	2,900	1,070,000	$2.45	$2,620,000
		533	FP4004	164	31%	FP	Fox Point			21,900	19,000	2,900	480,000	$2.45	$1,170,000
MS0513	3615 W Roosevelt Drive	137	MI5049	137	100%	MI	Milwaukee	100%	-	29,900	22,000	7,900	1,080,000	$1.97	$2,120,000
MS0522	4200 N Estabrook Parkway	93	SH5001	93	100%	SH	Shorewood	100%	-	43,000	22,000	21,000	1,950,000	$1.53	$2,970,000
MS0523	550 E Courtland Place	103	SH5009	24	23%	SH	Shorewood	23%	-	30,800	22,000	8,800	210,000	$1.93	$400,000
		103	WB5003	79	77%	WB	Whitefish Bay	77%		30,800	22,000	8,800	700,000	$1.93	$1,350,000
MS0528	2750 W Silver Spring Drive	269	MI5058	269	100%	MI	Milwaukee	100%	-	45,600	21,000	24,600	6,620,000	$1.46	$9,690,000
MS0536	3612 W Roosevelt Drive	747	MI5045	112	15%	MI	Milwaukee	100%		32,800	22,000	10,800	1,210,000	$1.84	$2,230,000
			MI5157	96	13%	MI	Milwaukee			32,800	22,000	10,800	1,040,000	$1.84	$1,920,000
			MI5048	539	72%	MI	Milwaukee			32,800	19,000	13,800	7,440,000	$1.84	$13,720,000
MS0538	5185 N 28th Street	169	MI5053	169	100%	MI	Milwaukee	100%	-	29,000	22,000	7,000	1,180,000	$2.01	$2,370,000
DC066E	4300 S Barland Avenue	616	CU6009	84	14%	CU	Cudahy	100%	-	22,200	19,000	3,200	270,000	$2.42	$650,000
		616	CU6010	231	37%	CU	Cudahy			22,200	19,000	3,200	740,000	$2.42	$1,790,000
		616	CU6012	95	15%	CU	Cudahy			22,200	19,000	3,200	300,000	$2.42	$730,000
		616	CU6013	139	23%	CU	Cudahy			22,200	19,000	3,200	440,000	$2.42	$1,070,000
		616	CU6014	55	9%	CU	Cudahy			22,200	19,000	3,200	180,000	$2.42	$440,000
		616	CU6015	2	0%	CU	Cudahy			22,200	19,000	3,200	10,000	$2.42	$20,000
		616	CU6019	11	2%	CU	Cudahy			22,200	19,000	3,200	40,000	$2.42	$100,000
MS0606	4950 W National Avenue	86	WM6011	86	100%	WM	West Milwaukee	100%	-	25,000	22,000	3,000	260,000	$2.23	$580,000

Governing Unit	Enforcement Meter ID	Non-Compliant Sewershed	Cost of I/I Reduction
Milwaukee	MS0116	MI1100	$4,970,000
	MS0118	MI1123	$1,650,000
	MS0305	MI3096	$8,560,000
	MS0305	MI3124	$490,000
	MS0315	MI3095	$8,000,000
	MS0338	MI3065	$1,000,000
	MS0339	MI3041	$9,830,000
	MS0411	MI4067	$3,270,000
	MS0417	MI4159	$80,000
	MS0418	MI4046	$3,450,000
	MS0420	MI4139	$2,920,000
	MS0448	MI4042	$3,770,000
	MS0448	MI4043	$1,190,000
	MS0448	MI4044	$970,000
	MS0448	MI4160	$30,000
	MS0513	MI5049	$2,120,000
	MS0528	MI5058	$9,690,000
	MS0536	MI5045	$2,230,000
	MS0536	MI5048	$13,720,000
	MS0536	MI5157	$1,920,000
	MS0538	MI5053	$2,370,000
		TOTAL:	**$82,230,000**
West Allis	MS0118	WE1018	$4,850,000
	MS0118	WE1032	$5,530,000
	MS0130	WE1020	$3,690,000
	MS0131	WE1021	$5,140,000
	MS0305	WE3015	$2,800,000
	MS0305	WE3016	$3,410,000
	MS0305	WE3017	$1,510,000
	MS0309	WE3013	$6,400,000
	MS0415	WE4023	$6,090,000
	TOTAL:		**$39,420,000**
Wauwatosa	MS0411	WA4001	$4,580,000
	MS0411	WA4002	$6,000,000
	MS0411	WA4035	$2,910,000
	MS0417	WA4010	$5,100,000
	MS0417	WA4016	$1,170,000
		TOTAL:	**$19,760,000**
Cudahy	DC066E	CU6009	$650,000
	DC066E	CU6010	$1,790,000
	DC066E	CU6012	$730,000
	DC066E	CU6013	$1,070,000
	DC066E	CU6014	$440,000
	DC066E	CU6015	$20,000
	DC066E	CU6019	$100,000
		TOTAL:	**$4,800,000**
Fox Point	MS0417	FP4003	$2,620,000
	MS0417	FP4004	$1,170,000
		TOTAL:	**$3,790,000**
Shorewood	MS0522	SH5001	$2,970,000
	MS0523	SH5009	$400,000
		TOTAL:	**$3,370,000**
West Milwaukee	MS0131	WM1002	$1,170,000
	MS0606	WM6011	$580,000
		TOTAL:	**$1,750,000**
Whitefish Bay	MS0523	WB5003	$1,350,000
		TOTAL:	**$1,350,000**
		GRAND TOTAL	**$156,470,000**

Notes

[1] *All areas shown in this table are sewered areas. Unsewered areas are not accounted for in this table but are part of the areas shown on the map; therefore, the values shown in the table may seem smaller than the mapped areas. The areas are subject to change based on changes to the sanitary sewer systems within your or adjacent*

[2] *If an upstream meter is listed in the last column of this table, the sewersheds from the upstream meters are incorporated in the total metershed sewered areas and the total percentages. Italicized municipality percentages come from these upstream metersheds.*

[3] *Unit costs from Ad Hoc Modeling Request 211: Evaluation of I/I Influencers (Brown &Caldwell, Dec. 2018).*

4 These meters are not identified as non-compliant but are upstream of non-compliant metersheds so added to the list. MS0309, identified as "inconclusive" is upstream of MS0118. MS0315, identified as "not analyzed" is upstream of MS0305. MS0417, identified as "not analyzed" is upstream of MS0448.

Metershed	Tributary Sewersheds	Tributary Upstream Metersheds	Area (ac)	5-Year Recurrence Q (gpad)	Maximum Allowable (gpad)	Weather Station	Notes
MS0116	MI1100	---	122	54,800	22,000	WS1203	
MS0118	MI1123 WE1018 WE1032	MS0309 (PD)	359	40,700	19,000	WS1216	
MS0130	WE1020	---	159	36,300	22,000	WS1204	was MS0609
MS0131	WE1021 WM1002	---	309	33,300	21,000	WS1204	was MS0604
MS0305	MI3096 MI3124 WE3015 WE3016 WE3017	MS0315	1,165	22,000	15,500	WS1216	
MS0338	MI3065	---	204	24,300	22,000	WS1204	
MS0339	MI3041	---	402	34,900	21,000	WS1207	
MS0411	MI4067 WA4001 WA4002 WA4035	---	835	29,600	19,000	WS1206	draft evaluation = 18,800 gpad
MS0415	WE4023	---	291	33,900	21,000	WS1204	
MS0418	MI4046	---	267	27,200	21,000	WS1206	
MS0420	MI4139	---	111	39,300	22,000	WS1206	
MS0448	MI4042 MI4043 MI4044 MI4160	MS0417	1,028	18,300	15,500	WS1206	
MS0454	BA4010 FP4003 FP4004	---	632	21,900	19,000	WS1224	replaced MS0439
MS0513	MI5049	---	139	29,900	22,000	WS1206	
MS0522	SH5001	---	100	43,000	22,000	WS1225	
MS0523	SH5009 WB5003	---	106	30,800	22,000	WS1225	
MS0528	MI5058	---	271	45,600	21,000	WS1202	
MS036	MI5045 MI5048 MI5157	---	747	32,800	10,800		- Added as 21st non-compliant metershed - Maximum Allowable for MI5157 is 13,800
MS0538	MI5053	---	196	29,000	22,000	WS1202	replaced MS0510
DC066E	CU6009 CU6010 CU6012 CU6013 CU6014 CU6015 CU6019	---	981	22,200	19,000	WS1222	
MS0606	WM6011 MI6072A	---	87	25,000	22,000	WS1221	

Note: MS0536added after initial table created, weather station information was not provided

FORECASTED MODELING SCHEDULE FOR ENFORCEMENT METERS

Note: Highlighted meters were found to not have enough good data for recalibration but already had a status in place. These would be "NOT ANALYZED" but they carry their previous determination until a new one can be made.

ENFORCEMENT METER	ENFORCEMENT STATUS	CURRENT STATUS DETERMINATION DATE	NEXT EVALUATION FORECASTED DATE	BA	BD	BR	BU	CA	CU	EG	FP	FR	GD	GE	GF	GL	HC	ME	MF	MI	MU	NB	OC	RH	SF	SH	TH	WA	WB	WE	WM
				24	28	18	2	2	25	10	14	11	5	6	49	40	2	28	14	##	1	7	11	28	40	16	8	32	16	54	35
MS0104	COMPLIANT	6/3/2010	8/28/2018												1					1										1	
MS0105	COMPLIANT	10/29/2015	10/28/2020												1					1										1	
MS0110	NOT ANALYZED	N/A	2/20/2020						1																						
MS0113	COMPLIANT	5/5/2011	3/14/2018												1					1											
MS0116	NON-COMPLIANT	1/8/2014	1/13/2019																	1											
MS0118	NON-COMPLIANT	11/12/2011	11/13/2018																	1										1	
MS0123	NOT ANALYZED	N/A	7/13/2019																	1											
MS0124	COMPLIANT	11/30/2011	3/8/2018									1			1					1			1								
MS0125	COMPLIANT	11/29/2011	6/26/2018									1			1					1			1								
MS0126	COMPLIANT	1/10/2014	3/14/2018																	1											
MS0127	COMPLIANT	10/21/2015	10/20/2020												1					1										1	
MS0128	NOT ANALYZED	N/A	1/23/2019																				1								
MS0129	NOT ANALYZED	N/A	1/12/2020																	1										1	1
MS0130	NON-COMPLIANT	6/1/2009	11/13/2018																	1										1	1
MS0131	NON-COMPLIANT	4/1/2010	1/1/2021																	1										1	1
MS0206	NOT ANALYZED	N/A	1/2/2019									1											1								
MS0207	NOT ANALYZED	N/A	1/2/2019									1	1		1																
MS0208	NOT ANALYZED	N/A	10/8/2018									1	1		1																
MS0209	NOT ANALYZED	N/A	1/29/2019												1		1					1									
MS0212	NOT ANALYZED	N/A	6/13/2019												1					1										1	
MS0213	NOT ANALYZED	N/A	11/13/2018																			1								1	
MS0215	NOT ANALYZED	N/A	8/28/2017																				1								
MS0216	NOT ANALYZED	N/A	7/29/2018																				1								
MS0217	NOT ANALYZED	N/A	6/14/2018									1																			
MS0218	INCONCLUSIVE	10/31/2016	10/31/2021									1																			
MS0219	NOT ANALYZED	N/A	11/21/2018									1																			
MS0220	INCONCLUSIVE	11/2/2016	11/16/2018									1																			
MS0221	COMPLIANT	10/7/2011	11/16/2017										1																		
MS0222	NOT ANALYZED	N/A	11/16/2017										1																		
MS0223	NOT ANALYZED	N/A	2/15/2018										1																		
MS0231	NOT ANALYZED	N/A	10/19/2017												1																
MS0233	COMPLIANT	1/29/2014	11/13/2018												1					1											
MS0234	NOT ANALYZED	N/A	11/13/2018												1							1									
MS0236	COMPLIANT	12/2/2016	12/2/2021					1															1								
MS0238	COMPLIANT	7/21/2011	10/7/2018																				1								
MS0239	COMPLIANT	8/22/2011	2/7/2019																				1								
MS0241	COMPLIANT	8/22/2011	11/16/2017									1																			
MS0242	NOT ANALYZED	N/A	12/10/2017																		1	1									
MS0244	COMPLIANT	12/2/2016	12/2/2021												1															1	
MS0245	NOT ANALYZED	N/A	3/7/2019					1															1								
MS0246	NOT ANALYZED	N/A	1/13/2019												1		1					1									
MP0248	COMPLIANT	11/20/2015	11/19/2020																				1								
MP0250	INCONCLUSIVE	10/21/2016	12/31/2017									1																			

FORECASTED MODELING SCHEDULE FOR ENFORCEMENT METERS

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ENFORCEMENT METER	ENFORCEMENT STATUS	CURRENT STATUS DETERMINATION DATE	NEXT EVALUATION FORECASTED DATE	BA	BD	BR	BU	CA	CU	EG	FP	FR	GD	GE	GF	GL	HC	ME	MF	MI	MU	NB	OC	RH	SF	SH	TH	WA	WB	WE	WM
				12	14	9	1	0	12	5	7	0	0	3	17	20	0	14	7	##	0	1	0	14	20	8	4	16	8	22	16
MP0252	COMPLIANT	12/21/2015	12/20/2020												1							1									
MS0305	NON-COMPLIANT	1/7/2013	12/6/2018																	1										1	
MS0306	COMPLIANT	12/12/2011	1/29/2019			1				1																					
MS0307	COMPLIANT	10/10/2011	3/6/2019																1												
MS0309	INCONCLUSIVE	12/5/2013	2/7/2019																	1										1	
MS0310	COMPLIANT	11/3/2015	11/2/2020											1				1	1	1											
MS0311	NOT ANALYZED	N/A	10/8/2018			1													1												
MS0312	COMPLIANT	12/1/2011	3/19/2020			1													1												
MS0313	COMPLIANT	12/1/2011	9/12/2018				1																								
MS0315	NOT ANALYZED	N/A	6/18/2018																	1										1	
MS0317	NOT ANALYZED	N/A	12/6/2018																											1	
MS0318	NOT ANALYZED	N/A	8/21/2017																											1	
MS0322	NOT ANALYZED	N/A	7/16/2018																									1		1	
MS0328	NOT ANALYZED	N/A	4/4/2018																									1			
MS0329	NOT ANALYZED	N/A	11/27/2018			1				1																		1			
MS0330	COMPLIANT	5/1/2011	10/15/2019			1				1																		1			
MS0337	COMPLIANT	10/18/2011	7/16/2018			1																								1	
MS0338	NON-COMPLIANT	10/18/2010	9/12/2018																	1											
MS0339	NON-COMPLIANT	10/18/2010	7/13/2019																	1											
MS0340	NOT ANALYZED	N/A	1/2/2019																	1								1			
MS0346	NOT ANALYZED	N/A	9/12/2018																	1											
MS0347	NOT ANALYZED	N/A	2/15/2018																	1											
MS0348	NOT ANALYZED	N/A	6/18/2018																	1											
MS0351	NOT ANALYZED	N/A	3/24/2019											1				1	1	1											
MP0355	COMPLIANT	12/1/2011	5/3/2020																	1											
MS0356	NOT ANALYZED	N/A	7/3/2018																	1										1	
MS0358	NOT ANALYZED	N/A	8/20/2018																									1		1	
MS0359	NOT ANALYZED	N/A	8/20/2018																									1			
MS0360	NOT ANALYZED	N/A	7/29/2018			1				1																		1			
MS0361	COMPLIANT	11/29/2011	4/29/2018			1				1																					
MS0362	COMPLIANT	12/5/2011	5/8/2018			1																						1			
MS0363	NOT ANALYZED	N/A	11/16/2017																1	1											
MS0364	COMPLIANT	5/25/2011	2/7/2019																	1											
MS0365	NOT ANALYZED	N/A	10/15/2019																	1										1	
MS0366	NOT ANALYZED	N/A	12/5/2019											1				1	1	1											
MP0367	NOT ANALYZED	N/A	12/9/2018																	1											
MS0369	NOT ANALYZED	N/A	4/4/2018																									1			
MS0399	COMPLIANT	11/30/2011	6/3/2018																	1											
MS0406	INCONCLUSIVE	3/22/2017	3/22/2022	1							1																				
MS0407	COMPLIANT	6/9/2010	3/19/2020																	1											
MS0409	COMPLIANT	6/7/2010	7/16/2018	1														1													
MS0410	NOT ANALYZED	N/A	5/10/2018																	1								1			
MS0411	NON-COMPLIANT	9/29/2011	8/13/2019																	1								1			

FORECASTED MODELING SCHEDULE FOR ENFORCEMENT METERS

Note: Highlighted meters were found to not have enough good data for recalibration but already had a status in place. These would be "NOT ANALYZED" but they carry their previous determination until a new one can be made.

				5	7	0	0	0	6	0	3	0	0	0	8	10	0	5	0	55	0	0	0	7	10	4	2	2	4	6	8
ENFORCEMENT METER	ENFORCEMENT STATUS	CURRENT STATUS DETERMINATION DATE	NEXT EVALUATION FORECASTED DATE	BA	BD	BR	BU	CA	CU	EG	FP	FR	GD	GE	GF	GL	HC	ME	MF	MI	MU	NB	OC	RH	SF	SH	TH	WA	WB	WE	WM
MS0412	NOT ANALYZED	N/A	7/22/2019																	1											
MS0413	NOT ANALYZED	N/A	1/23/2019		1															1											
MS0415	NON-COMPLIANT	11/2/2011	11/16/2017																											1	
MS0416	NOT ANALYZED	N/A	3/28/2018																	1										1	
MS0417	NOT ANALYZED	N/A	8/6/2018																	1								1			
MS0418	NON-COMPLIANT	10/18/2010	11/16/2017																	1											
MS0419	NOT ANALYZED	N/A	11/21/2018																	1											
MS0420	NON-COMPLIANT	6/1/2010	6/24/2019																	1											
MS0430	NOT ANALYZED	N/A	6/13/2019													1				1											
MS0433	NOT ANALYZED	N/A	1/29/2019		1															1											
MS0436	COMPLIANT	11/13/2015	11/12/2020															1									1				
MS0437	COMPLIANT	3/22/2017	3/22/2022													1															
MS0438	COMPLIANT	3/22/2017	3/22/2022								1					1															
MS0440	COMPLIANT	3/22/2017	3/22/2022	1																											
MS0441	COMPLIANT	3/22/2017	3/22/2022	1																				1							
MP0447	COMPLIANT	3/22/2017	3/22/2022	1														1													
MS0448	NON-COMPLIANT	11/3/2011	6/13/2019																	1								1			
MS0450	NOT ANALYZED	N/A	7/16/2018		1															1											
MS0454	NON-COMPLIANT	3/22/2017	3/22/2022	1							1																				
MS0455	INCONCLUSIVE	3/22/2017	3/22/2022	1																				1							
MS0456	INCONCLUSIVE	3/22/2017	3/22/2022								1					1								1							
MS0457	NOT ANALYZED	N/A	6/24/2019		1																										
MS0458	NOT ANALYZED	N/A	7/3/2019		1															1											
MS0459	NOT ANALYZED	N/A	6/24/2019															1									1				
MS0507	INCONCLUSIVE	12/17/2013	11/13/2018																										1		
MS0513	NON-COMPLIANT	10/18/2010	3/19/2018																	1											
MS0516	COMPLIANT	12/14/2011	2/20/2020																	1											
MS0522	NON-COMPLIANT	10/18/2010	8/15/2017																							1					
MS0523	NON-COMPLIANT	10/18/2010	2/7/2019																							1			1		
MS0525	INCONCLUSIVE	3/22/2017	3/22/2022																										1		
MS0526	COMPLIANT	3/22/2017	3/22/2022													1				1											
MS0528	NON-COMPLIANT	3/22/2017	3/22/2022																	1											
MS0530	COMPLIANT	3/22/2017	3/22/2022													1															
MS0531	COMPLIANT	3/22/2017	3/22/2022													1								1							
MS0532	COMPLIANT	3/22/2017	3/22/2022		1											1		1		1				1							
MS0534	NOT ANALYZED	N/A	5/27/2019																	1											
MS0536[1]	NOT ANALYZED	N/A	8/26/2019																	1											
MS0538	NON-COMPLIANT	3/22/2017	3/22/2022																	1											
MS0539	NOT ANALYZED	N/A	8/22/2019													1				1				1							
MS0541	NOT ANALYZED	N/A	2/20/2020																	1											
MP0542	COMPLIANT	11/25/2015	11/24/2020		1											1		1		1				1							
MS0543	COMPLIANT	3/22/2017	3/22/2022																										1		

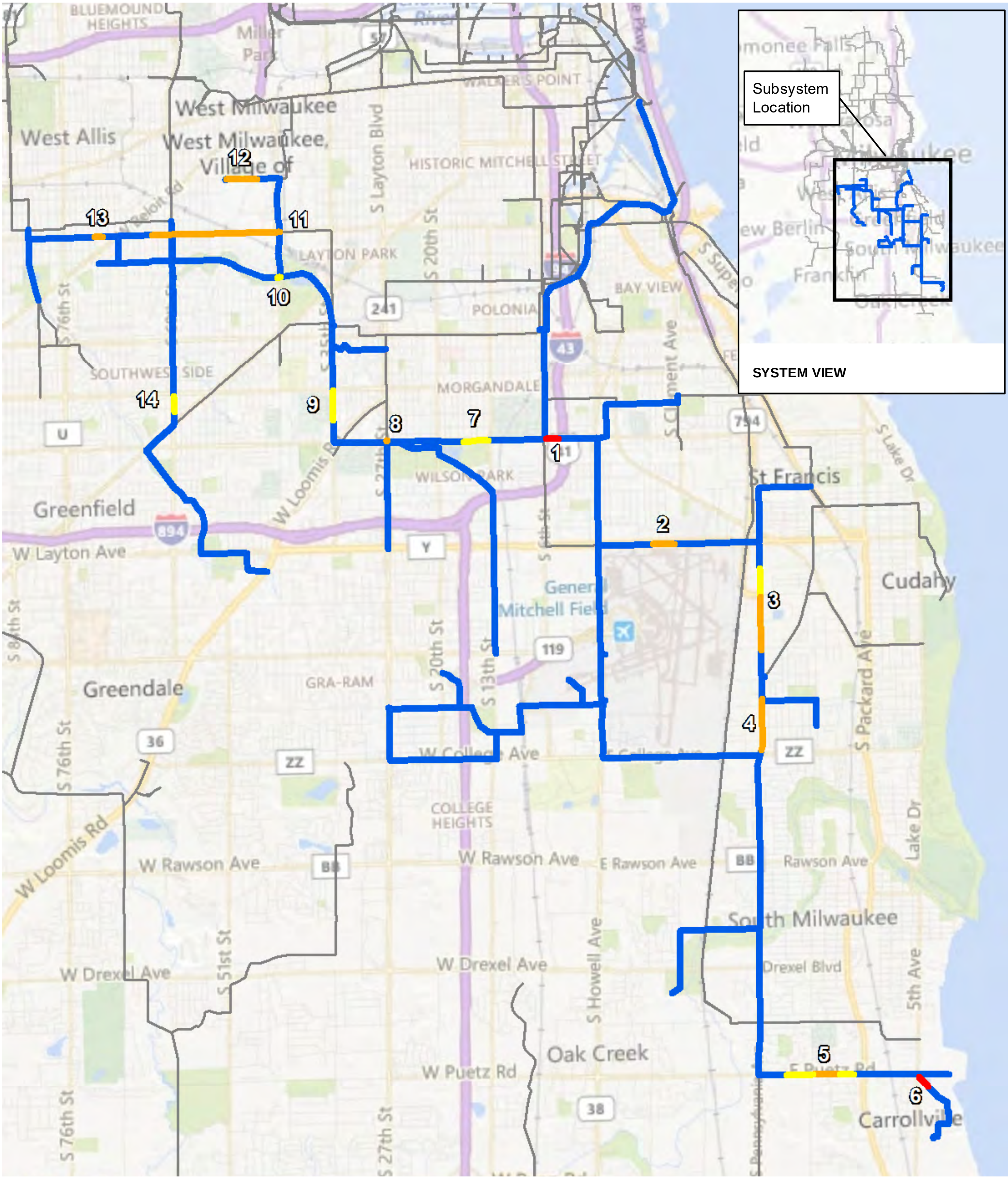
FORECASTED MODELING SCHEDULE FOR ENFORCEMENT METERS

Note: Highlighted meters were found to not have enough good data for recalibration but already had a status in place. These would be "NOT ANALYZED" but they carry their previous determination until a new one can be made.

ENFORCEMENT METER	ENFORCEMENT STATUS	CURRENT STATUS DETERMINATION DATE	NEXT EVALUATION FORECASTED DATE	BA	BD	BR	BU	CA	CU	EG	FP	FR	GD	GE	GF	GL	HC	ME	MF	MI	MU	NB	OC	RH	SF	SH	TH	WA	WB	WE	WM
				0	0	0	0	0	3	0	0	0	0	0	4	0	0	0	0	16	0	0	0	0	5	1	0	0	0	2	4
MP0546	NOT ANALYZED	N/A	9/10/2020																							1					
DC066E	NON-COMPLIANT	10/26/2015	10/25/2020						1																						
DC066W	COMPLIANT	10/27/2015	10/26/2020						1											1					1						
MS0602	INCONCLUSIVE	10/1/2009	12/6/2018												1					1											
MS0606	NON-COMPLIANT	12/13/2016	12/13/2021																	1										1	1
MS0610	NOT ANALYZED	N/A	12/6/2018																	1											
MS0611	NOT ANALYZED	N/A	7/29/2018																	1					1						
MS0614	INCONCLUSIVE	10/27/2015	10/26/2020						1											1					1						
MS0618	NOT ANALYZED	N/A	5/27/2019												1					1											
MS0619	NOT ANALYZED	N/A	9/3/2019												1					1											
MS0620	COMPLIANT	12/1/2010	2/15/2018												1					1											
MS0621	COMPLIANT	11/15/2011	11/16/2017																	1											1
MS0623	NOT ANALYZED	N/A	9/3/2019																	1					1						
MP0624	COMPLIANT	12/29/2016	12/29/2021																	1										1	1
MS0703	COMPLIANT	11/8/2015	11/7/2020																	1											
MS0704	NOT ANALYZED	N/A	2/15/2018																	1					1						
MS0708	NOT ANALYZED	N/A	4/14/2019																	1											
MS0709	NOT ANALYZED	N/A	4/29/2018																	1											1

Note: After this spreadsheet was provided, MS0536 was also identified as non-compliant

APPENDIX 6A-37: CS R9 Physical Mortality Alt 1 Map -



N

0 1 2

Miles

LEGEND

- Existing MMSD MIS
- Priority Category A – Year 2020-2024
- Priority Category B – Year 2025-2029
- Priority Category C – Year 2030-2039

MMSD

PARTNERS FOR A CLEANER ENVIRONMENT

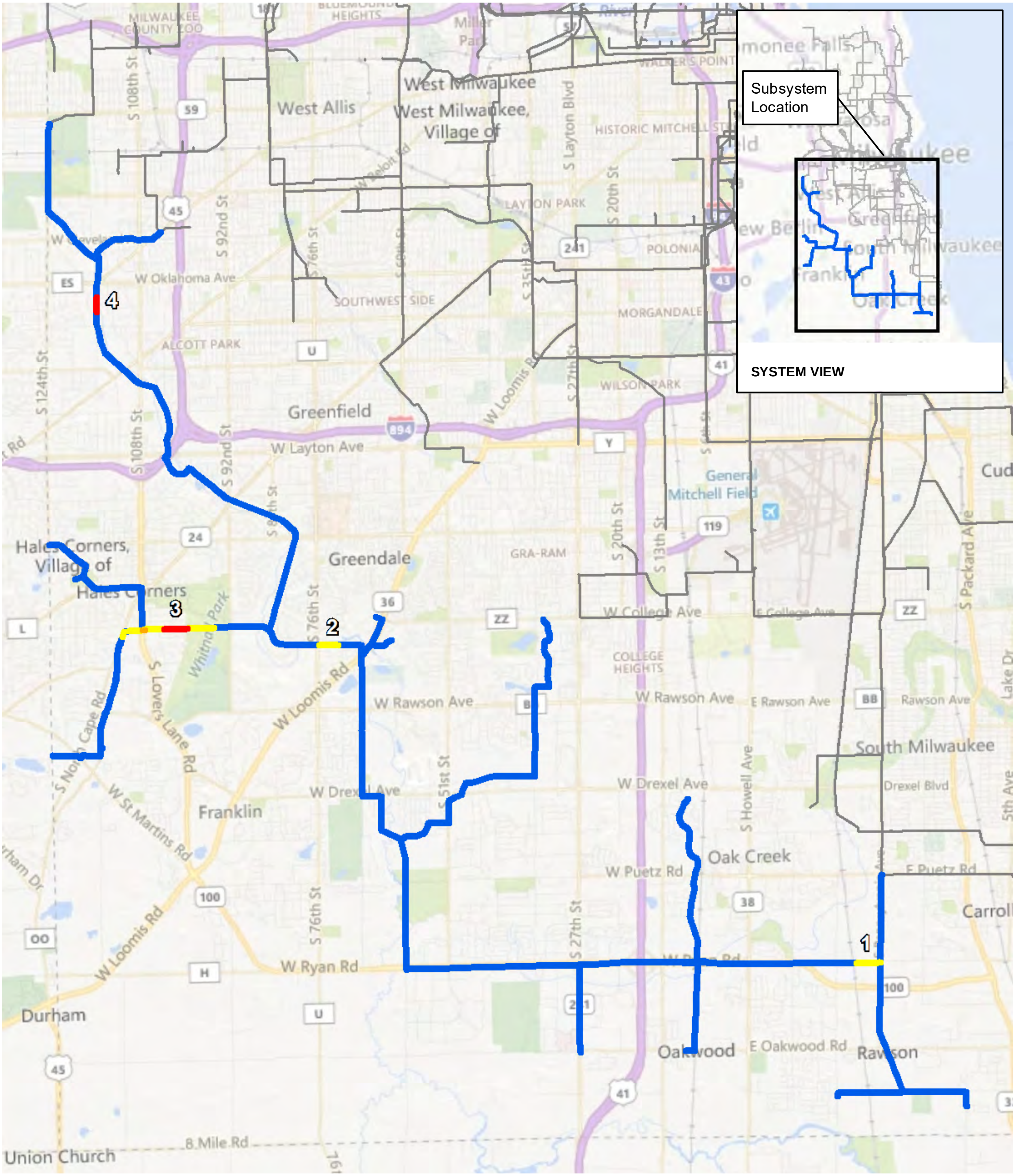
MMSD 2050 Facilities Plan
Appendix 6A-37

CONVEYANCE PIPE PHYSICAL MORTALITY

SUBSYSTEM 1

2050 Facilities Plan

DRAFT - 10/11/2019



LEGEND

- Existing MMSD MIS
- Priority Category A – Year 2020-2024
- Priority Category B – Year 2025-2029
- Priority Category C – Year 2030-2039

N

0 1 2
Miles

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

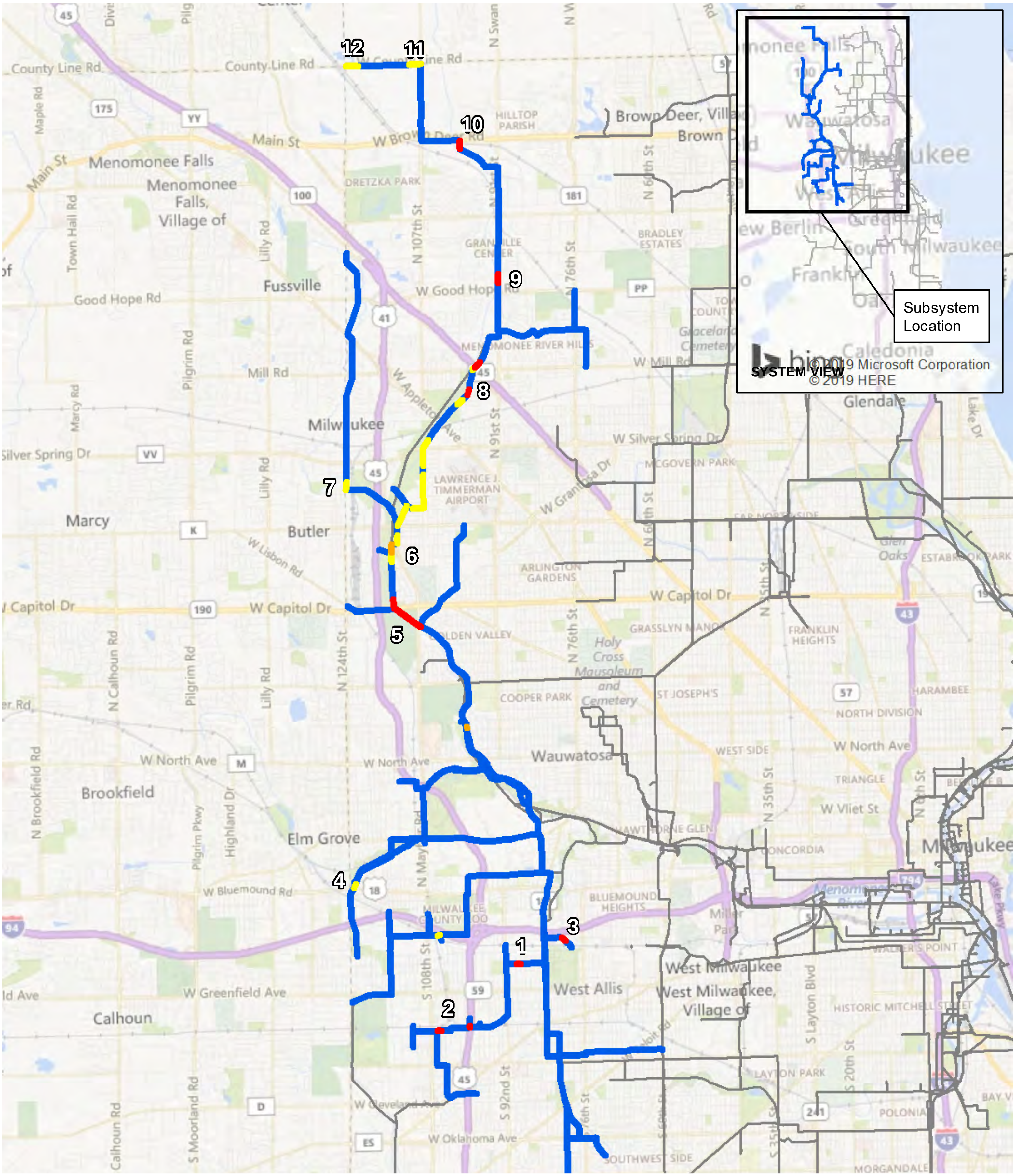
MMSD 2050 Facilities Plan
Appendix 6A-37

CONVEYANCE PIPE PHYSICAL MORTALITY

SUBSYSTEM 2

2050 Facilities Plan

DRAFT - 10/11/2019



LEGEND

- Existing MMSD MIS
- Priority Category A – Year 2020-2024
- Priority Category B – Year 2025-2029
- Priority Category C – Year 2030-2039

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

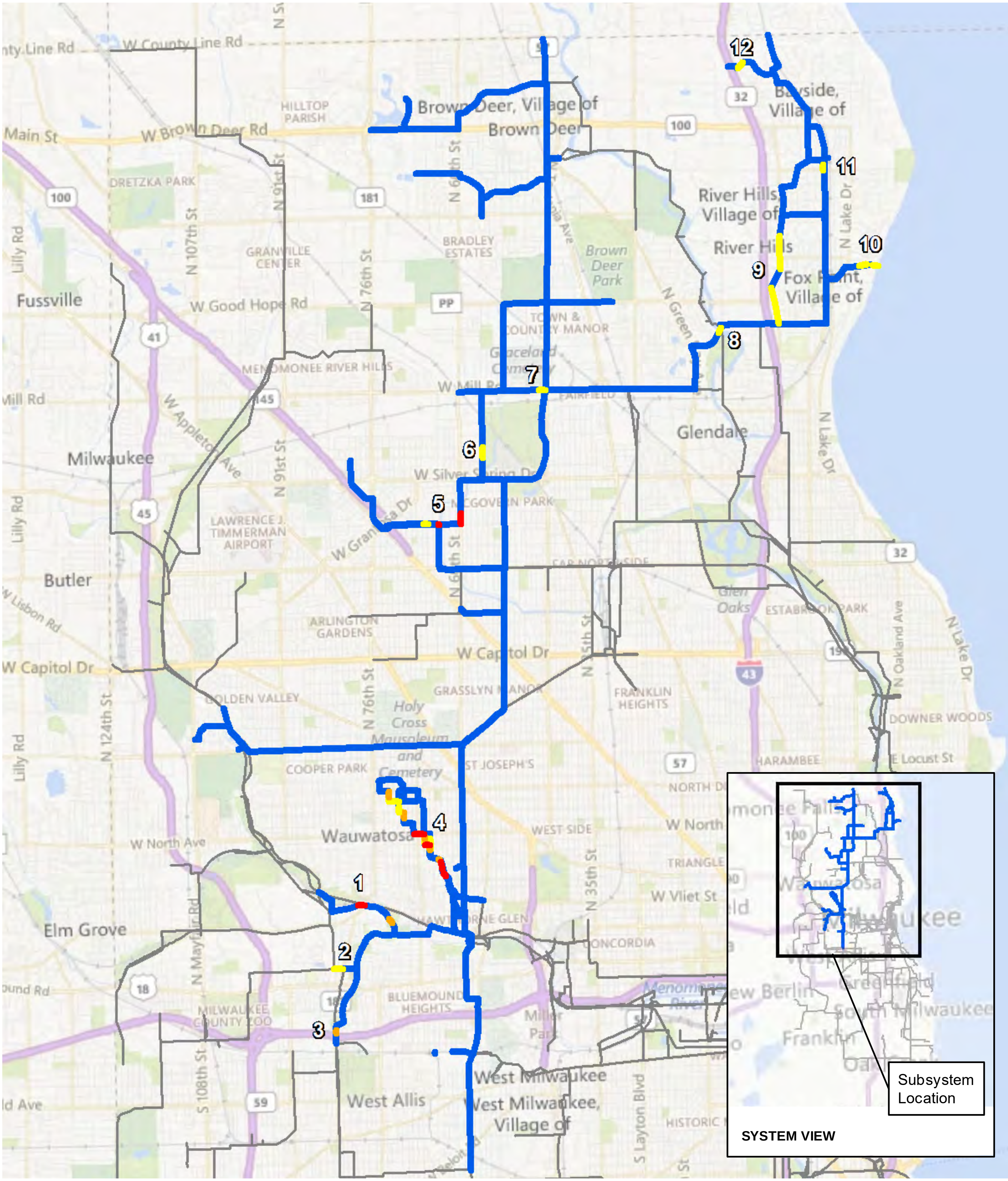
MMSD 2050 Facilities Plan
Appendix 6A-37

CONVEYANCE PIPE PHYSICAL MORTALITY

SUBSYSTEM 3

2050 Facilities Plan

DRAFT - 10/11/2019



LEGEND

- Existing MMSD MIS
- Priority Category A – Year 2020-2024
- Priority Category B – Year 2025-2029
- Priority Category C – Year 2030-2039

N

0 1 2
Miles

MMSD 2050 Facilities Plan
Appendix 6A-37

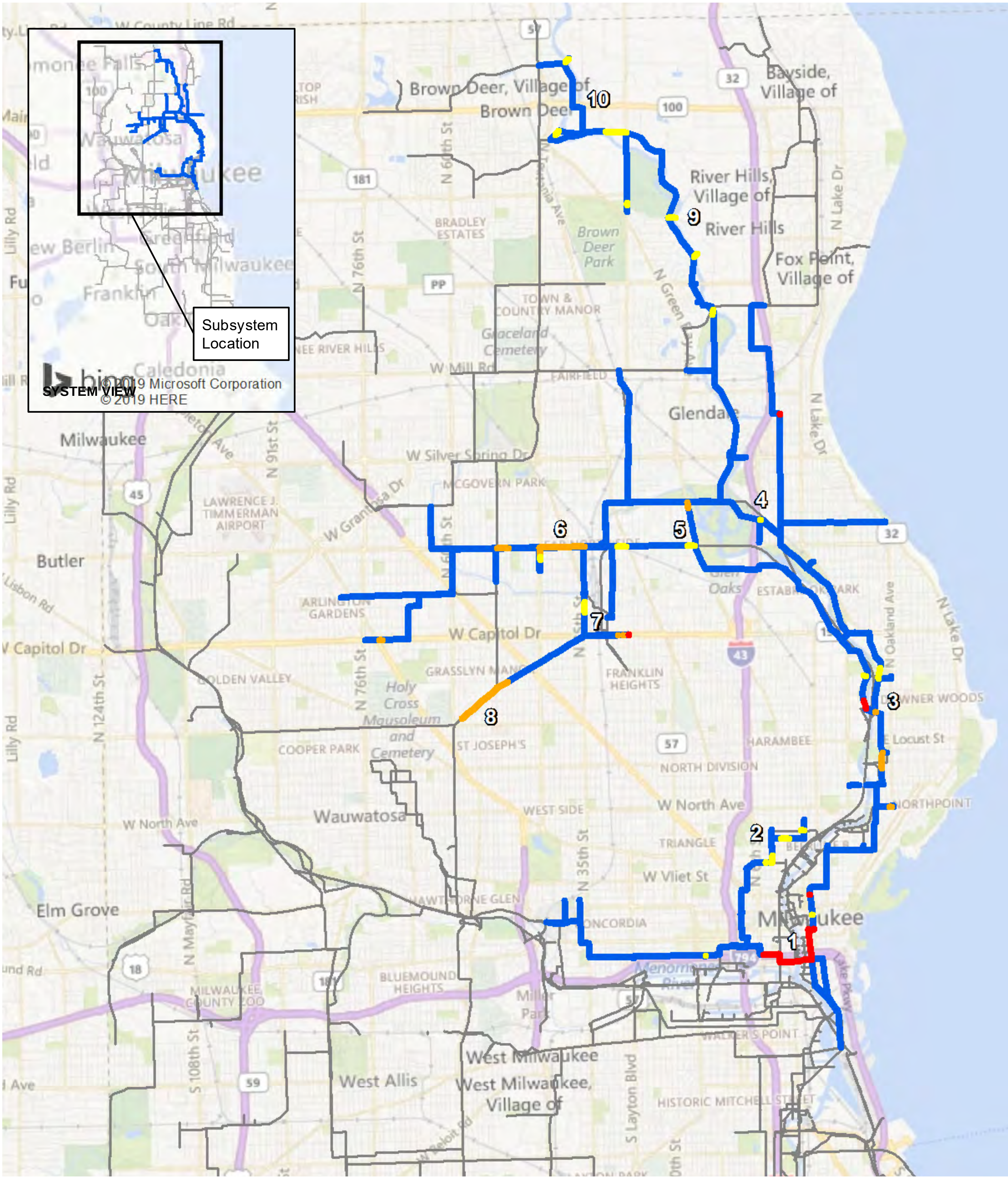
CONVEYANCE PIPE PHYSICAL MORTALITY

SUBSYSTEM 4

2050 Facilities Plan

DRAFT - 10/11/2019

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT



LEGEND

- Existing MMSD MIS
- Priority Category A – Year 2020-2024
- Priority Category B – Year 2025-2029
- Priority Category C – Year 2030-2039

N

0 1 2
Miles

MMSD PARTNERS FOR A CLEANER ENVIRONMENT

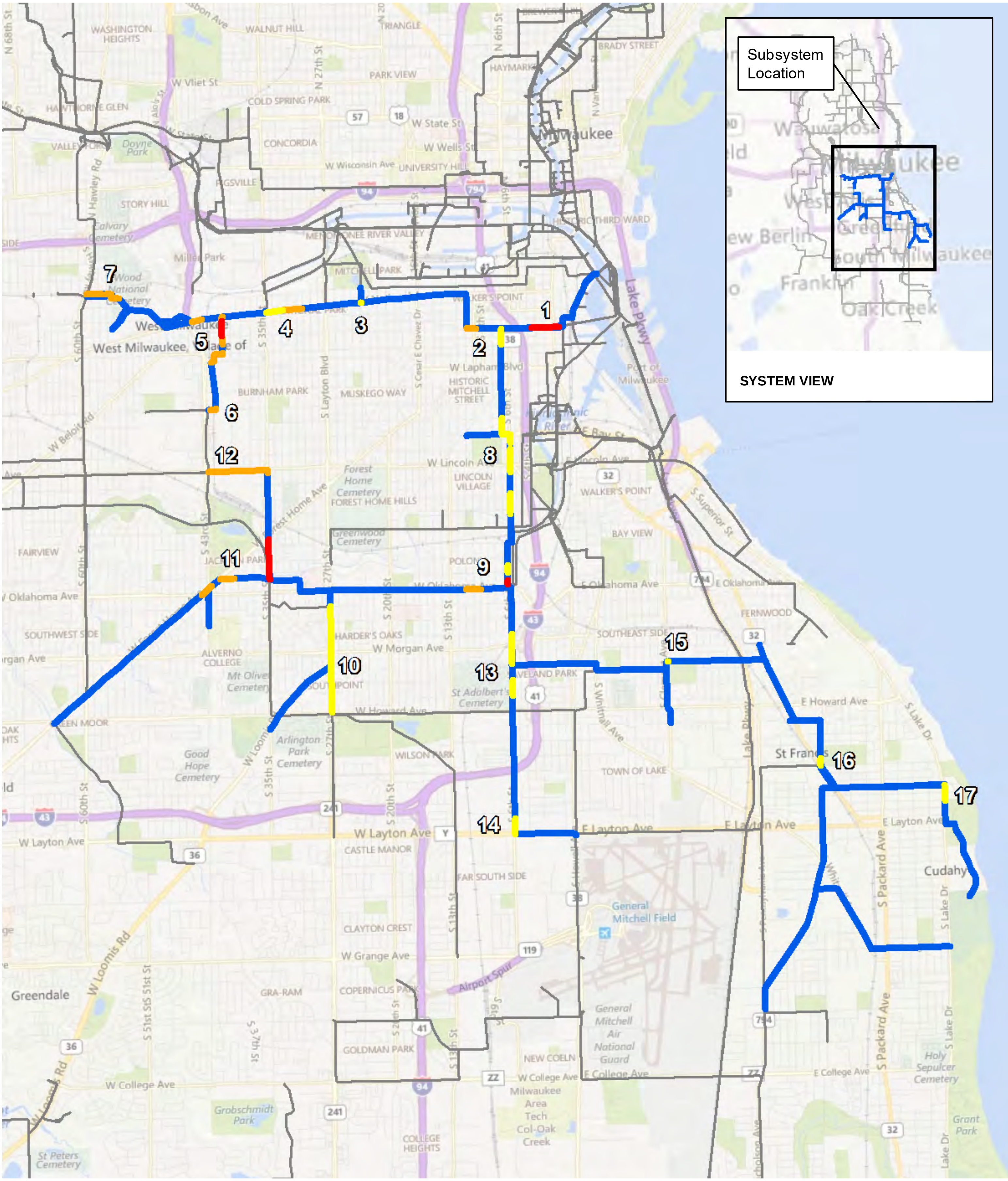
MMSD 2050 Facilities Plan
Appendix 6A-37

CONVEYANCE PIPE PHYSICAL MORTALITY

SUBSYSTEM 5

2050 Facilities Plan

DRAFT - 10/11/2019



MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

LEGEND

- Existing MMSD MIS
- Priority Category A – Year 2020-2024
- Priority Category B – Year 2025-2029
- Priority Category C – Year 2030-2039

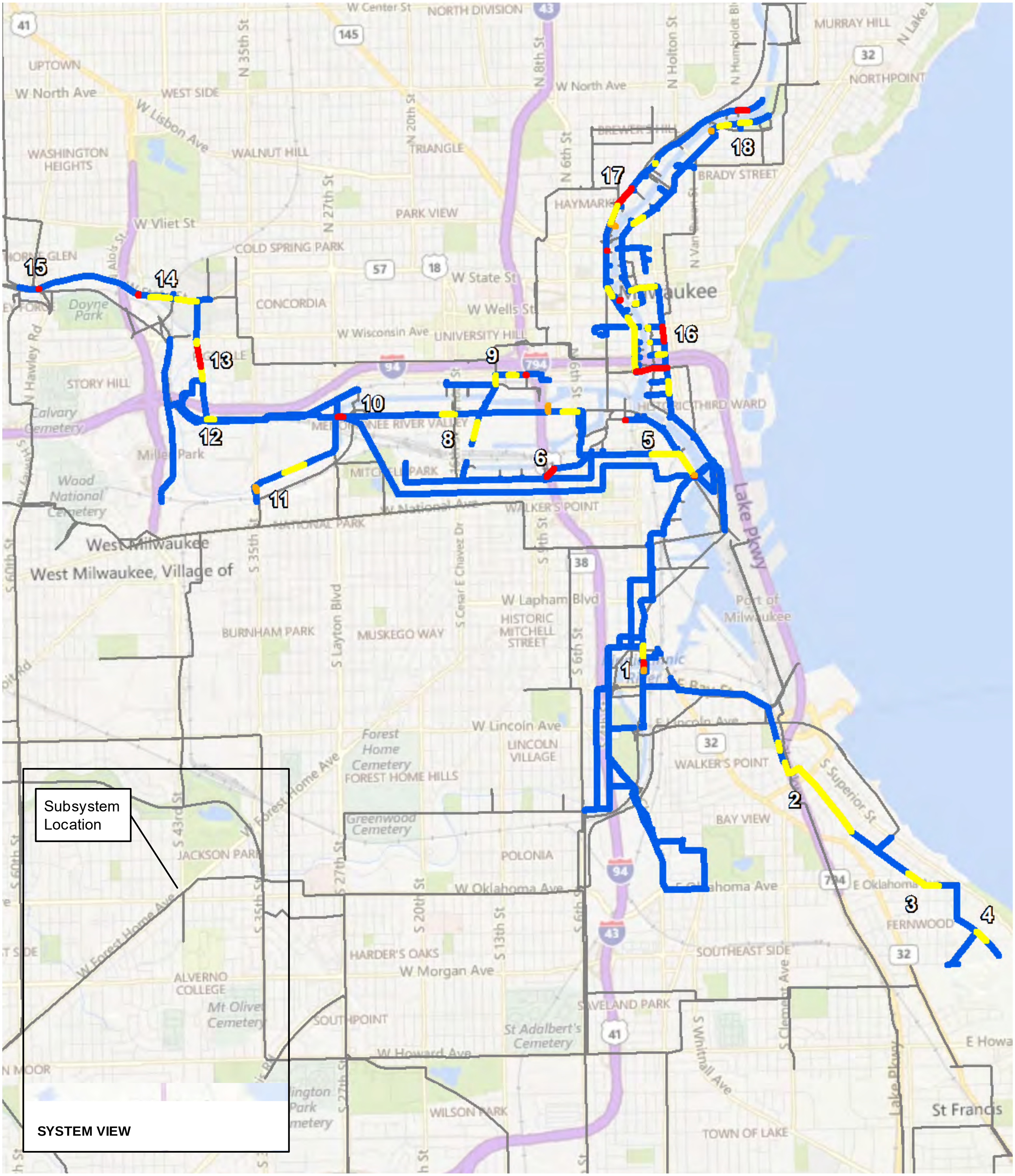
N

0 1 2
Miles

MMSD 2050 Facilities Plan
Appendix 6A-37

CONVEYANCE PIPE PHYSICAL MORTALITY
SUBSYSTEM 6

2050 Facilities Plan
DRAFT - 10/11/2019



LEGEND

- Existing MMSD MIS
- Priority Category A – Year 2020-2024
- Priority Category B – Year 2025-2029
- Priority Category C – Year 2030-2039

MMSD 2050 Facilities Plan
Appendix 6A-37

CONVEYANCE PIPE PHYSICAL MORTALITY

SUBSYSTEM 7

2050 Facilities Plan

DRAFT - 10/11/2019

MMSD PARTNERS FOR A CLEANER ENVIRONMENT

APPENDIX 6A-38: CS R10 Conveyance Pipe and Pump Station Workbooks -

MMSD Asset ID	Convert to Pipe_NR	Construction Year	Rehab Year	Sewer Type	Height	Width	Asbuilt Length	Pipe Material	Leg	Subsystem	GIS Subtype	L1age Rehab Replace	Life	L2age Rehab Replace	L2 Insp year	Life2	L3 Rehab Replace	L3 Inspection Year	Assessment Review Date	Life3	Governing Replace Rehab Year	Total Rehab Cost	Total Replace Cost	Condition Score
133295	10106	1928		GRAVITY	39	30	28	SS MONOLITHIC CONCRETE	M	1	MIS	2028	100			0				0	2028	$6,126	$42,786	B
133711	30007	1970		GRAVITY	48	48	671	RCP	R1	1	MIS	2070	100	2052	2012	40	2022	2012	2012	10	2022	$182,717	$1,198,208	A
133578	30102	1962		GRAVITY	150	150	694	MONOLITHIC CONCRETE	R1	1	MIS	2062	100	2009	2009	0	2039	2009		30	2039	$695,010	$3,506,341	C
133580	30103	1962		GRAVITY	150	150	1343	MONOLITHIC CONCRETE	R1	1	MIS	2062	100	2009	2009	0	2029	2009	2010	20	2029	$1,345,522	$6,788,187	B
133581	30201	1962		GRAVITY	150	150	1309	MONOLITHIC CONCRETE	R1	1	MIS	2062	100	2009	2009	0	2039	2009		30	2039	$1,311,885	$6,618,489	C
133617	30604	1968		GRAVITY	144	144	1177	MONOLITHIC CONCRETE	R1	1	MIS	2068	100	2009	2009	0	2029	2009		20	2029	$1,123,684	$5,718,299	B
133618	30701	1968		GRAVITY	144	144	1422	MONOLITHIC CONCRETE	R1	1	MIS	2068	100	2009	2009	0	2029	2009	2010	20	2029	$1,357,954	$6,910,472	B
133621	30801	1964		GRAVITY	144	144	1192	MONOLITHIC CONCRETE	R1	1	MIS	2064	100	2009	2009	0	2029	2009	2010	20	2029	$1,138,064	$5,791,477	B
133622	30802	1964		GRAVITY	144	144	1466	MONOLITHIC CONCRETE	R1	1	MIS	2064	100	2009	2009	0	2029	2009	2010	20	2029	$1,399,862	$7,123,737	B
133623	30803	1964		GRAVITY	144	144	1407	MONOLITHIC CONCRETE	R1	1	MIS	2064	100	2019	2009	10	2039	2009	2010	30	2039	$1,343,918	$6,839,044	C
133629	31003	1965		GRAVITY	144	144	1088	MONOLITHIC CONCRETE	R1	1	MIS	2065	100	2102	2012	90	2029	2009	2010	20	2029	$1,039,296	$5,288,855	B
133646	31402	1967		GRAVITY	144	144	1283	MONOLITHIC CONCRETE	R1	1	MIS	2067	100	2009	2009	0	2039	2009	2010	30	2039	$1,224,726	$6,232,486	C
133655	31701	1968		GRAVITY	144	144	1489	MONOLITHIC CONCRETE	R1	1	MIS	2068	100	2009	2009	0	2039	2009	2011	30	2039	$1,421,833	$7,235,544	C
133676	31803	1969		GRAVITY	144	144	150	MONOLITHIC CONCRETE	R1	1	MIS	2069	100	2099	2009	90	2039	2009	2010	30	2039	$143,226	$728,861	C
133644	31302A	1967		GRAVITY	144	144	634	MONOLITHIC CONCRETE	R1	1	MIS	2067	100	2021	2011	10		2011		0	2021	$605,560	$3,081,622	A
133982	08038	1985		GRAVITY	60	60	765	RCP, CLASS III	R2	1	MIS	2085	100	2103	2013	90	2039	2009	2013	30	2039	$268,095	$1,656,145	C
133937	08107	1926		GRAVITY	36	36	406	MONOLITHIC CONCRETE	R2	1	MIS	2026	100	2105	2015	90	2029	2009	2013	20	2029	$79,910	$573,232	B
134030	06705	1925	2015	GRAVITY	36	36	637	MONOLITHIC CONCRETE	R4	1	MIS	2065	50	2059	2014	45	2029	2009	2011	20	2029	$125,348	$899,186	B
134031	06706	1925	2015	GRAVITY	36	36	490	MONOLITHIC CONCRETE	R4	1	MIS	2065	50	2059	2014	45	2029	2009	2011	20	2029	$96,451	$691,889	B
134032	06707	1925	2015	GRAVITY	36	36	263	MONOLITHIC CONCRETE	R4	1	MIS	2065	50	2059	2014	45	2029	2009	2011	20	2029	$51,793	$371,537	B
134034	06709	1925	2015	GRAVITY	36	36	113	MONOLITHIC CONCRETE	R4	1	MIS	2065	50	2035	2015	20				0	2035	$22,319	$160,105	C
134044	07901	1926		GRAVITY	36	36	66	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$12,984	$93,142	B
134045	07902	1926		GRAVITY	36	36	550	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$108,162	$775,900	B
134046	07903	1926		GRAVITY	36	36	512	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$100,785	$722,978	B
134047	07904	1926		GRAVITY	36	36	524	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$103,037	$739,137	B
134048	07905	1926		GRAVITY	36	36	535	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$105,280	$755,225	B
134049	07906	1926		GRAVITY	36	36	509	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$100,177	$718,618	B
134050	07907	1926		GRAVITY	36	36	531	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$104,411	$748,987	B
134051	07908	1926		GRAVITY	36	36	4	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$820	$5,885	B
134052	08001	1926		GRAVITY	36	36	534	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$104,961	$752,939	B
134053	08002	1926		GRAVITY	36	36	508	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$99,874	$716,444	B
134054	08003	1926		GRAVITY	36	36	500	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$98,322	$705,310	B
134055	08004	1926		GRAVITY	36	36	575	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$113,086	$811,223	B
134056	08005	1926		GRAVITY	36	36	495	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$97,403	$698,719	B
134057	08006	1926		GRAVITY	36	36	180	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$35,437	$254,207	B
134058	08007	1926		GRAVITY	36	36	494	MONOLITHIC CONCRETE	R4	1	MIS	2026	100			0				0	2026	$97,128	$696,743	B
134120	40101	1965		GRAVITY	84	84	98	MONOLITHIC CONCRETE	Q	2	MIS	2065	100	2099	2009	90	2039	2009		30	2039	$50,185	$286,435	C
134142	40102	1965		GRAVITY	84	84	1400	MONOLITHIC CONCRETE	Q	2	MIS	2065	100	2103	2013	90	2039	2009		30	2039	$717,290	$4,093,983	C
134242	41501	1971		GRAVITY	84	84	1201	MONOLITHIC CONCRETE	Q	2	MIS	2071	100	2103	2013	90	2039	2009		30	2039	$615,208	$3,511,342	C
134264	41701	1971		GRAVITY	84	84	1634	MONOLITHIC CONCRETE	Q	2	MIS	2071	100	2099	2009	90	2039	2009		30	2039	$837,262	$4,778,731	C
134265	41702	1971		GRAVITY	84	84	1380	MONOLITHIC CONCRETE	Q	2	MIS	2071	100	2023	2013	10	2019	2009		10	2019	$707,036	$4,035,455	A
134266	41703	1971		GRAVITY	84	84	1166	MONOLITHIC CONCRETE	Q	2	MIS	2071	100	2063	2013	50	2039	2009	2010	30	2039	$597,487	$3,410,199	C
134678	42406	1983		GRAVITY	54	54	912	RCP	Q	2	MIS	2083	100	2071	2011	60	2021	2011	2011	10	2021	$283,669	$1,800,887	A
134736	44002	1984	2011	GRAVITY	36	36	40	DUCTILE IRON	Q	2	MIS	2061	50	2028	2008	20				0	2028	$7,928	$56,873	B
134737	44003	1984	2011	GRAVITY	36	36	140	DUCTILE IRON	Q	2	MIS	2061	50	2028	2008	20				0	2028	$27,621	$198,138	B
134739	44005	1984	2011	GRAVITY	36	36	420	DUCTILE IRON	Q	2	MIS	2061	50	2034	2014	20				0	2034	$82,593	$592,481	C
134740	44006	1984	2011	GRAVITY	36	36	371	DUCTILE IRON	Q	2	MIS	2061	50	2034	2014	20				0	2034	$72,991	$523,598	C
134742	44008	1984	2011	GRAVITY	36	36	325	DUCTILE IRON	Q	2	MIS	2061	50	2034	2014	20				0	2034	$63,947	$458,724	C
134864	18401	1949		GRAVITY	72.01	54	598	SS MONOLITHIC CONCRETE	H	3	MIS	2049	100	2054	2014	40	2020	2010	2011	10	2020	$257,311	$1,520,892	A
134865	18402	1949		GRAVITY	72.01	54	1079	SS MONOLITHIC CONCRETE	H	3	MIS	2049	100	2054	2014	40	2029	2009	2011	20	2029	$464,442	$2,745,190	B
134866	18403	1949		GRAVITY	72.01	54	500	SS MONOLITHIC CONCRETE	H	3	MIS	2049	100	2051	2011	40	2021	2011	2011	10	2021	$215,252	$1,272,298	A

MMSD Asset ID	Convert to Pipe_NR	Construction Year	Rehab Year	Sewer Type	Height	Width	Asbuilt Length	Pipe Material	Leg	Subsystem	GIS Subtype	L1age Rehab Replace	Life	L2age Rehab Replace	L2 Insp year	Life2	L3 Rehab Replace	L3 Inspection Year	Assessment Review Date	Life3	Governing Replace Rehab Year	Total Rehab Cost	Total Replace Cost	Condition Score
134875	18404	1949		GRAVITY	72.01	54	87	SS MONOLITHIC CONCRETE	H	3	MIS	2049	100	2051	2011	40	2031	2011	2011	20	2031	$37,320	$220,588	C
134876	18405	1950		GRAVITY	72.01	54	599	SS MONOLITHIC CONCRETE	H	3	MIS	2050	100	2055	2015	40	2030	2010	2011	20	2030	$257,625	$1,522,749	C
134881	19002	1955		GRAVITY	72.01	54	605	SS MONOLITHIC CONCRETE	H	3	MIS	2055	100	2053	2013	40	2039	2009	2010	30	2039	$260,508	$1,539,791	C
134882	19003	1955		GRAVITY	72.01	54	604	SS MONOLITHIC CONCRETE	H	3	MIS	2055	100	2053	2013	40	2029	2009	2011	20	2029	$260,095	$1,537,349	B
134884	19005	1955		GRAVITY	72.01	54	547	SS MONOLITHIC CONCRETE	H	3	MIS	2055	100	2055	2015	40	2039	2009	2011	30	2039	$235,526	$1,392,131	C
135036	19101	1956		GRAVITY	72.01	54	673	SS MONOLITHIC CONCRETE	H	3	MIS	2056	100	2056	2016	40	2019	2009		10	2019	$289,660	$1,712,100	A
135037	19102	1956		GRAVITY	72.01	54	622	SS MONOLITHIC CONCRETE	H	3	MIS	2056	100	2056	2016	40	2019	2009		10	2019	$267,747	$1,582,576	A
135039	19104	1956		GRAVITY	72.01	54	789	SS MONOLITHIC CONCRETE	H	3	MIS	2056	100	2055	2015	40	2019	2009		10	2019	$339,563	$2,007,065	A
135040	19105	1956		GRAVITY	72.01	54	706	SS MONOLITHIC CONCRETE	H	3	MIS	2056	100	2055	2015	40	2019	2009		10	2019	$304,029	$1,797,034	A
135041	19106	1956		GRAVITY	72.01	54	711	SS MONOLITHIC CONCRETE	H	3	MIS	2056	100	2055	2015	40	2019	2009		10	2019	$305,957	$1,808,429	A
135042	19107	1956		GRAVITY	72.01	54	317	SS MONOLITHIC CONCRETE	H	3	MIS	2056	100	2055	2015	40	2019	2009		10	2019	$136,292	$805,583	A
135043	19201	1956		GRAVITY	72.01	54	599	SS MONOLITHIC CONCRETE	H	3	MIS	2056	100	2055	2015	40	2019	2009		10	2019	$257,715	$1,523,283	A
135045	19203	1956	1987	GRAVITY	72.01	54	548	SS MONOLITHIC CONCRETE	H	3	MIS	2037	50	2035	2015	20	2018	2009		9	2018	$235,698	$1,393,148	A
135046	19204	1956	1987	GRAVITY	72.01	54	549	SS MONOLITHIC CONCRETE	H	3	MIS	2037	50	2016	2016	0	2018	2009		9	2018	$236,370	$1,397,116	A
135062	19206	1957		GRAVITY	72.01	54	664	SS MONOLITHIC CONCRETE	H	3	MIS	2057	100	2056	2016	40	2021	2011	2011	10	2021	$285,843	$1,689,538	A
135068	19302	1957		GRAVITY	72.01	54	468	SS MONOLITHIC CONCRETE	H	3	MIS	2057	100	2051	2011	40	2031	2011	2013	20	2031	$201,309	$1,189,883	C
135070	19304	1957		GRAVITY	72.01	54	448	SS MONOLITHIC CONCRETE	H	3	MIS	2057	100	2107	2017	90	2021	2011	2012	10	2021	$192,685	$1,138,907	A
135074	19308	1958		GRAVITY	72.01	54	256	SS MONOLITHIC CONCRETE	H	3	MIS	2058	100	2019	2009	10	2039	2009	2011	30	2039	$110,183	$651,258	C
135075	19309	1958		GRAVITY	72.01	54	525	SS MONOLITHIC CONCRETE	H	3	MIS	2058	100	2009	2009	0	2019	2009	2010	10	2019	$226,007	$1,335,864	A
135122	19502	1958		GRAVITY	57	42	663	SS MONOLITHIC CONCRETE	H	3	MIS	2058	100	2102	2012	90	2019	2009		10	2019	$219,400	$1,373,216	A
135143	19702	1960		GRAVITY	57	42	567	SS MONOLITHIC CONCRETE	H	3	MIS	2060	100	2051	2011	40	2021	2011	2011	10	2021	$187,657	$1,174,538	A
135174	19718	1988		GRAVITY	60	60	814	RCP, CLASS IV	H	3	MIS	2088	100	2036	2016	20	2039	2009	2013	30	2039	$285,063	$1,760,964	C
135180	19724	1988		GRAVITY	48	48	866	MONOLITHIC CONCRETE	H	3	MIS	2088	100	2052	2012	40	2032	2012	2013	20	2032	$235,921	$1,547,108	C
134942	20201	1968		GRAVITY	72.01	54	597	SS MONOLITHIC CONCRETE	H	3	MIS	2068	100	2046	2016	30	2039	2009	2009	30	2039	$256,863	$1,518,246	C
135281	09502	1929		GRAVITY	39	30	201	SS MONOLITHIC CONCRETE	I	3	MIS	2029	100	2029	2009	20	2039	2009	2010	30	2039	$43,258	$302,138	C
135398	09017	1925		GRAVITY	24	24	365	VITRIFIED CLAY	J1	3	MIS	2025	100	2024	2014	10		2014		0	2024	$44,920	$378,625	A
135427	16606	1940		GRAVITY	39	30	335	SS MONOLITHIC CONCRETE	J2	3	MIS	2040	100	2057	2017	40	2022	2012	2012	10	2022	$72,245	$504,601	A
135450	16906	1939		GRAVITY	39	30	324	SS MONOLITHIC CONCRETE	J2	3	MIS	2039	100	2052	2012	40	2018	2012	2012	6	2018	$69,739	$487,099	A
135494	16909	1939		GRAVITY	10	10	145	VITRIFIED CLAY	J2	3	MIS	2039	100	2027	2017	10	2018	2011	2012	7	2018	$5,762	$87,261	A
135923	08511	1930		GRAVITY	15	15	141	VITRIFIED CLAY	K2	3	MIS	2030	100	2027	2017	10				0	2027	$9,756	$106,832	B
135809	16108	1937		GRAVITY	39	30	334	SS MONOLITHIC CONCRETE	K2	3	MIS	2037	100	2052	2012	40	2032	2012	2012	20	2032	$71,928	$502,389	C
136358	16302	1934		FORCE MAIN	6	6	481	CAST IRON	B1	4	MIS	2034	100			0				0	2034	$7,992	$231,010	C
136369	16303	1934		GRAVITY	10	10	27	TERRA COTTA	B1	4	MIS	2034	100	2103	2013	90	2039	2009		30	2039	$1,091	$16,521	C
136371	16305	1934		GRAVITY	10	10	344	TERRA COTTA	B1	4	MIS	2034	100	2103	2013	90	2039	2009		30	2039	$13,701	$207,510	C
136591	15514	1957		GRAVITY	15	15	348	VITRIFIED CLAY	B2	4	MIS	2057	100	2054	2014	40	2039	2009		30	2039	$24,102	$263,926	C
136613	18901	1957		GRAVITY	39	30	475	SS MONOLITHIC CONCRETE	B2	4	MIS	2057	100	2105	2015	90	2039	2009		30	2039	$102,284	$714,409	C
136440	34102	1983		GRAVITY	72	72	1135	RCP	B2	4	MIS	2083	100	2013	2013	0	2039	2009		30	2039	$488,447	$2,887,077	C
136441	34201	1983		GRAVITY	72	72	1086	RCP	B2	4	MIS	2083	100	2085	2015	70	2039	2009		30	2039	$467,184	$2,761,394	C
136443	34203	1983		GRAVITY	72	72	826	RCP	B2	4	MIS	2083	100	2093	2013	80	2039	2009		30	2039	$355,564	$2,101,639	C
136444	34301	1983		GRAVITY	72	72	1227	RCP	B2	4	MIS	2083	100	2105	2015	90	2039	2009		30	2039	$527,833	$3,119,874	C
136406	34004M	1982		GRAVITY	29	45	325	RCP HE	B2	4	MIS	2082	100	2009	2009	0	2039	2009	2018	30	2039	$82,374	$550,404	C
136407	34004N	1982		GRAVITY	29	45	325	RCP HE	B2	4	MIS	2082	100	2009	2009	0	2039	2009	2018	30	2039	$82,325	$550,083	C
136408	34004S	1982		GRAVITY	29	45	325	RCP HE	B2	4	MIS	2082	100	2009	2009	0	2039	2009	2018	30	2039	$82,366	$550,353	C
136656	17205	1939		GRAVITY	39	30	665	SS MONOLITHIC CONCRETE	D2	4	MIS	2039	100	2035	2015	20		2009		0	2035	$143,335	$1,001,136	C
136716	17311	1949		GRAVITY	24	24	412	VITRIFIED CLAY	D2	4	MIS	2049	100	2034	2014	20		2014		0	2034	$50,671	$427,097	C
136828	14009	1949		GRAVITY	24	24	29	TERRA COTTA	D3	4	MIS	2049	100	2104	2014	90	2021	2011	2011	10	2021	$3,536	$29,807	A
136831	14012	1949		GRAVITY	24	24	330	MONOLITHIC CONCRETE	D3	4	MIS	2049	100	2107	2017	90	2039	2009	2010	30	2039	$40,621	$342,385	C
136820	16203	1937		GRAVITY	39	30	650	SS MONOLITHIC CONCRETE	D3	4	MIS	2037	100	2101	2011	90	2018	2011	2011	7	2018	$140,002	$977,854	A
137029	07101	1924		GRAVITY	24	24	321	TERRA COTTA	F1	4	MIS	2024	100	2067	2017	50	2029	2009		20	2029	$39,514	$333,058	B
137036	07108	1924		GRAVITY	24	24	414	TERRA COTTA	F1	4	MIS	2024	100	2054	2014	40	2020	2010	2011	10	2020	$50,908	$429,089	A
136992	09113	1929		GRAVITY	39	30	552	SS MONOLITHIC CONCRETE	F1	4	MIS	2029	100	2052	2012	40	2032	2012	2012	20	2032	$118,842	$830,066	C

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136980	09007A	1925		GRAVITY	24	24	343	VITRIFIED CLAY	F1	4	MIS	2025	100			0				0	2025	$42,198	$355,676	B
137080	08416	1943		GRAVITY	27	27	278	VITRIFIED CLAY	F2	4	MIS	2043	100	2034	2014	20		2014		0	2034	$39,274	$314,295	C
137081	08417	1943		GRAVITY	27	27	402	VITRIFIED CLAY	F2	4	MIS	2043	100	2037	2017	20				0	2037	$56,753	$454,170	C
137084	08424	1928		GRAVITY	18	18	257	TERRA COTTA	F2	4	MIS	2028	100	2057	2017	40	2019	2009	2010	10	2019	$22,400	$219,013	A
137087	08427	1928		GRAVITY	18	18	471	TERRA COTTA	F2	4	MIS	2028	100	2017	2017	0	2020	2010	2010	10	2020	$41,035	$401,223	A
137089	08429	1928		GRAVITY	18	18	133	TERRA COTTA	F2	4	MIS	2028	100	2027	2017	10		2013		0	2027	$11,564	$113,065	B
137094	08434	1928		GRAVITY	18	18	339	TERRA COTTA	F2	4	MIS	2028	100	2027	2017	10		2013		0	2027	$29,494	$288,380	B
137095	08435	1928		GRAVITY	18	18	301	TERRA COTTA	F2	4	MIS	2028	100	2023	2013	10		2013		0	2023	$26,195	$256,123	A
137099	08503	1943		GRAVITY	27	27	320	VITRIFIED CLAY	F2	4	MIS	2043	100	2063	2013	50	2022	2012	2012	10	2022	$45,152	$361,334	A
137101	08505	1928		GRAVITY	18	18	329	TERRA COTTA	F2	4	MIS	2028	100	2033	2013	20		2013		0	2033	$28,677	$280,394	C
137102	08506	1928		GRAVITY	18	18	303	TERRA COTTA	F2	4	MIS	2028	100	2027	2017	10		2013		0	2027	$26,343	$257,570	B
137104	08508	1928		GRAVITY	15	15	319	TERRA COTTA	F2	4	MIS	2028	100	2063	2013	50	2020	2010	2010	10	2020	$22,085	$241,841	A
137112	18106	1948		GRAVITY	24	24	326	VITRIFIED CLAY	F2	4	MIS	2048	100	2027	2017	10		2013		0	2027	$40,181	$338,682	B
137113	18107	1948		GRAVITY	24	24	296	VITRIFIED CLAY	F2	4	MIS	2048	100	2037	2017	20		2012		0	2037	$36,452	$307,245	C
137114	18108	1951		GRAVITY	21	21	356	VITRIFIED CLAY	F2	4	MIS	2051	100	2037	2017	20				0	2037	$37,378	$336,107	C
137116	18110	1951		GRAVITY	18	18	288	VITRIFIED CLAY	F2	4	MIS	2051	100	2037	2017	20		2013		0	2037	$25,076	$245,183	C
137117	18111	1951		GRAVITY	18	18	307	VITRIFIED CLAY	F2	4	MIS	2051	100	2037	2017	20				0	2037	$26,717	$261,231	C
137118	18112	1951		GRAVITY	18	18	294	VITRIFIED CLAY	F2	4	MIS	2051	100	2037	2017	20				0	2037	$25,590	$250,206	C
137119	18113	1951		GRAVITY	18	18	338	VITRIFIED CLAY	F2	4	MIS	2051	100	2027	2017	10				0	2027	$29,419	$287,647	B
137639	13308	1926		GRAVITY	36	36	349	RCP	A1	5	MIS	2026	100			0				0	2026	$68,661	$492,537	B
137460	13705	1932		GRAVITY	39	30	34	SS MONOLITHIC CONCRETE	A1	5	MIS	2032	100			0				0	2032	$7,261	$50,717	C
137493	14406	1932		GRAVITY	39	30	330	SS MONOLITHIC CONCRETE	A1	5	MIS	2032	100			0				0	2032	$71,012	$495,993	C
137515	14411	1931		GRAVITY	8	8	276	DUCTILE IRON	A1	5	MIS	2031	100			0				0	2031	$7,792	$149,728	C
137735	14509	1932		GRAVITY	8	8	267	DUCTILE IRON	A2	5	MIS	2032	100			0				0	2032	$7,544	$144,963	C
137738	14610	1933		GRAVITY	8	8	347	DUCTILE IRON	A2	5	MIS	2033	100			0				0	2033	$9,784	$188,022	C
137706	14801	1932		GRAVITY	39	30	1242	SS MONOLITHIC CONCRETE	A2	5	MIS	2032	100	2105	2015	90	2032	2012	2012	20	2032	$267,668	$1,869,549	C
137761	14911	1932		GRAVITY	10	10	135	VITRIFIED CLAY	A2	5	MIS	2032	100	2102	2012	90	2039	2009		30	2039	$5,400	$81,784	C
137791	15046	1933		GRAVITY	12	12	359	TERRA COTTA	A2	5	MIS	2033	100			0				0	2033	$18,519	$238,985	C
137739	14610A	1933		GRAVITY	8	8	148	VITRIFIED CLAY	A2	5	MIS	2033	100			0				0	2033	$4,166	$80,052	C
137744	14859B	1960		GRAVITY	18	18	324	DUCTILE IRON	A2	5	MIS	2060	100	2052	2012	40	2032	2012	2012	20	2032	$28,211	$275,831	C
137813	01509	1931		GRAVITY	54	54	663	MONOLITHIC CONCRETE	B1	5	MIS	2031	100	2063	2013	50	2039	2009	2010	30	2039	$206,174	$1,308,906	C
137999	BS0513D	1941		GRAVITY	30	30	16	MONOLITHIC CONCRETE	B1	5	MIS	2041	100	2104	2014	90	2021	2011	2011	10	2021	$2,585	$19,819	A
138044	01521	1925		GRAVITY	60	60	12	MONOLITHIC CONCRETE	C	5	MIS	2025	100			0				0	2025	$4,288	$26,491	B
138045	01524	1918		GRAVITY	60	60	6	MONOLITHIC CONCRETE	C	5	MIS	2018	100			0				0	2018	$2,116	$13,073	A
138049	01601	1918		GRAVITY	60	60	404	MONOLITHIC CONCRETE	C	5	MIS	2018	100			0				0	2018	$141,682	$875,233	A
138271	01616		2008	GRAVITY	15	15	171	VITRIFIED CLAY	C	5	MIS		-2008	2036	2016	20				0	2036	$11,850	$129,760	C
138108	11906	1923	2002	GRAVITY	60	60	479	MONOLITHIC CONCRETE	C	5	MIS	2052	50	2036	2016	20		2011		0	2036	$167,871	$1,037,017	C
138115	12006	1923	2002	GRAVITY	60	60	580	MONOLITHIC CONCRETE	C	5	MIS	2052	50	2036	2016	20				0	2036	$203,076	$1,254,489	C
138156	12108	1925		GRAVITY	36	36	752	MONOLITHIC CONCRETE	C	5	MIS	2025	100			0				0	2025	$147,990	$1,061,605	B
138157	12109	1925		GRAVITY	36	36	524	MONOLITHIC CONCRETE	C	5	MIS	2025	100			0				0	2025	$103,142	$739,885	B
138158	12110	1925		GRAVITY	36	36	526	MONOLITHIC CONCRETE	C	5	MIS	2025	100			0				0	2025	$103,399	$741,734	B
138159	12111	1925		GRAVITY	36	36	602	MONOLITHIC CONCRETE	C	5	MIS	2025	100			0				0	2025	$118,498	$850,046	B
138160	12112	1925		GRAVITY	36	36	265	MONOLITHIC CONCRETE	C	5	MIS	2025	100			0				0	2025	$52,198	$374,444	B
138166	12206	1925		GRAVITY	36	36	32	MONOLITHIC CONCRETE	C	5	MIS	2025	100			0				0	2025	$6,244	$44,793	B
138206	12222	1925		GRAVITY	12	12	42	MONOLITHIC CONCRETE	C	5	MIS	2025	100			0				0	2025	$2,172	$28,023	B
138207	12223	1925		GRAVITY	12	12	117	RCP	C	5	MIS	2025	100	2016	2016	0	2026	2016	2018	10	2026	$6,049	$78,066	B
138208	12224	1925		GRAVITY	12	12	378	TERRA COTTA	C	5	MIS	2025	100			0				0	2025	$19,498	$251,619	B
138209	12225	1925		GRAVITY	12	12	214	TERRA COTTA	C	5	MIS	2025	100	2036	2016	20				0	2036	$11,046	$142,547	C
138177	12317	1925		GRAVITY	36	36	323	MONOLITHIC CONCRETE	C	5	MIS	2025	100			0				0	2025	$63,548	$455,859	B
138178	12318	1925		GRAVITY	36	36	330	RCP	C	5	MIS	2025	100			0				0	2025	$64,911	$465,639	B
138179	12319	1925		GRAVITY	36	36	39	RCP	C	5	MIS	2025	100			0				0	2025	$7,682	$55,109	B

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138292	12406	1924	2002	GRAVITY	42	42	649	MONOLITHIC CONCRETE	C	5	MIS	2052	50	2034	2014	20				0	2034	$152,084	$1,037,612	C
138341	12606	1927		GRAVITY	42	42	716	MONOLITHIC CONCRETE	C	5	MIS	2027	100			0				0	2027	$167,886	$1,145,419	B
138342	12607	1927		GRAVITY	42	42	574	MONOLITHIC CONCRETE	C	5	MIS	2027	100			0				0	2027	$134,399	$916,950	B
138344	12704	1927		GRAVITY	42	42	575	MONOLITHIC CONCRETE	C	5	MIS	2027	100			0				0	2027	$134,849	$920,019	B
138345	12705	1927		GRAVITY	42	42	579	MONOLITHIC CONCRETE	C	5	MIS	2027	100			0				0	2027	$135,641	$925,423	B
138346	12706	1927		GRAVITY	42	42	572	MONOLITHIC CONCRETE	C	5	MIS	2027	100			0				0	2027	$134,050	$914,567	B
138347	12707	1927		GRAVITY	42	42	524	MONOLITHIC CONCRETE	C	5	MIS	2027	100			0				0	2027	$122,862	$838,240	B
138050	01601AL	1918		GRAVITY	60	60	131	MONOLITHIC CONCRETE	C	5	MIS	2018	100			0				0	2018	$45,803	$282,943	A
138379	PD5505	1928		GRAVITY	12	12	31	TERRA COTTA	C	5	MIS	2028	100			0				0	2028	$1,596	$20,602	B
138380	PD5506	1928		GRAVITY	8	8	34	TERRA COTTA	C	5	MIS	2028	100			0				0	2028	$967	$18,589	B
138381	PD5507	1924		GRAVITY	8	8	47	RCP	C	5	MIS	2024	100			0				0	2024	$1,325	$25,457	A
138499	14336	1952		GRAVITY	18	18	229	VITRIFIED CLAY	D1	5	MIS	2052	100	2034	2014	20	2029	2009	2010	20	2029	$19,920	$194,767	B
138552	00307	1920		INVERTED SIPHON	72	72	989	MONOLITHIC CONCRETE	ST	5	MIS	2020	100			0				0	2020	$425,801	$2,516,793	A
138689	05108	1921	2008	GRAVITY	30	30	51	UNKNOWN	ST	5	MIS	2058	50	2031	2011	20				0	2031	$8,107	$62,162	C
138554	05201	1920		INVERTED SIPHON	72	72	495	MONOLITHIC CONCRETE	ST	5	MIS	2020	100			0				0	2020	$213,096	$1,259,554	A
138555	05202	1920		INVERTED SIPHON	72	72	868	MONOLITHIC CONCRETE	ST	5	MIS	2020	100			0				0	2020	$373,445	$2,207,329	A
138594	05404	1920	2002	GRAVITY	36	36	515	MONOLITHIC CONCRETE	ST	5	MIS	2052	50	2030	2010	20				0	2030	$101,237	$726,224	C
138625	05408	1939		GRAVITY	15	15	58	TERRA COTTA	ST	5	MIS		-1939	2035	2015	20		2011		0	2035	$3,985	$43,640	C
138601	05502	1920	2002	GRAVITY	36	36	504	MONOLITHIC CONCRETE	ST	5	MIS	2052	50	2035	2015	20				0	2035	$99,085	$710,785	C
138553	00308T	1918		INVERTED SIPHON	54.01	90	1033	MONOLITHIC CONCRETE	ST	5	MIS	2018	100			0				0	2018	$572,613	$3,219,045	A
138611	IS199	1920	2008	GRAVITY	15	15	201	TERRA COTTA	ST	5	MIS	2058	50	2031	2011	20				0	2031	$13,889	$152,096	C
138730	01101	1924		GRAVITY	72	72	410	MONOLITHIC CONCRETE	XT	5	MIS	2024	100			0				0	2024	$176,422	$1,042,782	A
138783	01310	1925		INVERTED SIPHON	15	15	151	TERRA COTTA	XT	5	MIS	2025	100			0				0	2025	$10,468	$114,629	B
138770	01402	1925		GRAVITY	78	78	987	MONOLITHIC CONCRETE	XT	5	MIS	2025	100	2026	2016	10		2010		0	2026	$464,850	$2,697,550	B
138726	00305AT	1918		PRESSURE	54	54	84	DUCTILE IRON Mono RC	XT	5	MIS	2018	100			0				0	2018	$26,065	$165,475	A
138727	00305T	1916		PRESSURE	51	51	1802	DUCTILE IRON Mono RC	XT	5	MIS	2016	100			0				0	2016	$525,804	$3,390,086	A
138817	IS145	1924		GRAVITY	12	12	20	TERRA COTTA	XT	5	MIS	2024	100	2014	2014	0	2018	2012	2012	6	2018	$1,046	$13,499	A
138823	IS147	1924	2008	GRAVITY	15	15	35	UNKNOWN	XT	5	MIS	2058	50	2032	2012	20				0	2032	$2,446	$26,788	C
138916	07705	1924		GRAVITY	36	36	9	MONOLITHIC CONCRETE	L1	6	MIS	2024	100			0				0	2024	$1,694	$12,151	A
138917	07706	1924		GRAVITY	36	36	126	MONOLITHIC CONCRETE	L1	6	MIS	2024	100			0				0	2024	$24,875	$178,437	A
138918	07707	1924		GRAVITY	36	36	131	MONOLITHIC CONCRETE	L1	6	MIS	2024	100			0				0	2024	$25,778	$184,915	A
138919	07708	1924		GRAVITY	36	36	447	MONOLITHIC CONCRETE	L1	6	MIS	2024	100			0				0	2024	$87,848	$630,175	A
138920	07709	1924		GRAVITY	36	36	358	MONOLITHIC CONCRETE	L1	6	MIS	2024	100			0				0	2024	$70,524	$505,901	A
138921	07710	1924		GRAVITY	36	36	331	MONOLITHIC CONCRETE	L1	6	MIS	2024	100			0				0	2024	$65,145	$467,318	A
138922	07711	1924		GRAVITY	36	36	313	MONOLITHIC CONCRETE	L1	6	MIS	2024	100			0				0	2024	$61,655	$442,283	A
138932	07803	1926		GRAVITY	36	36	584	MONOLITHIC CONCRETE	L1	6	MIS	2026	100			0				0	2026	$114,967	$824,715	B
138933	07804	1926		GRAVITY	36	36	535	MONOLITHIC CONCRETE	L1	6	MIS	2026	100			0				0	2026	$105,215	$754,759	B
138934	07805	1926		GRAVITY	36	36	533	MONOLITHIC CONCRETE	L1	6	MIS	2026	100			0				0	2026	$104,904	$752,530	B
138935	07806	1926		GRAVITY	36	36	69	MONOLITHIC CONCRETE	L1	6	MIS	2026	100			0				0	2026	$13,590	$97,488	B
138936	07809	1926		GRAVITY	36	36	465	MONOLITHIC CONCRETE	L1	6	MIS	2026	100			0				0	2026	$91,383	$655,535	B
138855	09704	1928		GRAVITY	39	30	595	SS MONOLITHIC CONCRETE	L1	6	MIS	2028	100			0				0	2028	$128,112	$894,810	B
138857	09706	1928		GRAVITY	39	30	192	SS MONOLITHIC CONCRETE	L1	6	MIS	2028	100			0				0	2028	$41,398	$289,150	B
138858	09707	1928		GRAVITY	39	30	380	SS MONOLITHIC CONCRETE	L1	6	MIS	2028	100			0				0	2028	$81,930	$572,250	B
138937	07901A	1926		GRAVITY	36	36	467	MONOLITHIC CONCRETE	L1	6	MIS	2026	100			0				0	2026	$91,932	$659,472	B
139034	11501	1934		GRAVITY	18	18	696	TERRA COTTA	OP	6	MIS	2034	100	2034	2014	20				0	2034	$60,609	$592,602	C
139067	06004	1922	2001	GRAVITY	48	48	438	MONOLITHIC CONCRETE	T	6	MIS	2051	50	2059	2014	45	2029	2009		20	2029	$119,414	$783,087	B
139086	06202	1922	2001	GRAVITY	48	48	8	MONOLITHIC CONCRETE	T	6	MIS	2051	50	2034	2009	25				0	2034	$2,292	$15,027	C
139091	06207	1923	2001	GRAVITY	42	42	832	MONOLITHIC CONCRETE	T	6	MIS	2051	50	2029	2009	20				0	2029	$194,903	$1,329,746	B
139092	06211	1923	2001	GRAVITY	42	42	702	MONOLITHIC CONCRETE	T	6	MIS	2051	50	2034	2009	25				0	2034	$164,535	$1,122,556	C
139165	06310	1925		GRAVITY	36	36	193	MONOLITHIC CONCRETE	T	6	MIS	2025	100			0				0	2025	$37,928	$272,073	B
139185	06505	1925		GRAVITY	18	18	296	TERRA COTTA	T	6	MIS	2025	100			0				0	2025	$25,807	$252,326	B

MMSD Asset ID	Convert to Pipe_NR	Construction Year	Rehab Year	Sewer Type	Height	Width	Asbuilt Length	Pipe Material	Leg	Subsystem	GIS Subtype	L1age Rehab Replace	Life	L2age Rehab Replace	L2 Insp year	Life2	L3 Rehab Replace	L3 Inspection Year	Assessment Review Date	Life3	Governing Replace Rehab Year	Total Rehab Cost	Total Replace Cost	Condition Score
139187	06519	1925		GRAVITY	18	18	160	TERRA COTTA	T	6	MIS	2025	100			0				0	2025	$13,964	$136,536	B
139188	06520	1925		GRAVITY	18	18	266	TERRA COTTA	T	6	MIS	2025	100			0				0	2025	$23,201	$226,845	B
139190	06521	1925		GRAVITY	18	18	234	TERRA COTTA	T	6	MIS	2025	100			0				0	2025	$20,384	$199,305	B
139191	06522	1925		GRAVITY	18	18	244	TERRA COTTA	T	6	MIS	2025	100			0				0	2025	$21,242	$207,690	B
139192	06523	1925		GRAVITY	18	18	237	TERRA COTTA	T	6	MIS	2025	100			0				0	2025	$20,615	$201,561	B
139193	06524	1925		GRAVITY	18	18	19	TERRA COTTA	T	6	MIS	2025	100			0				0	2025	$1,646	$16,090	B
139166	06601	1925		GRAVITY	36	36	630	MONOLITHIC CONCRETE	T	6	MIS	2025	100	2046	2016	30	2019	2009		10	2019	$124,017	$889,632	A
139167	06602	1925		GRAVITY	36	36	373	MONOLITHIC CONCRETE	T	6	MIS	2025	100	2054	2014	40	2029	2009		20	2029	$73,355	$526,209	B
139169	06604	1925		GRAVITY	36	36	458	MONOLITHIC CONCRETE	T	6	MIS	2025	100			0				0	2025	$90,069	$646,108	B
139170	06605	1925		GRAVITY	36	36	197	MONOLITHIC CONCRETE	T	6	MIS	2025	100			0				0	2025	$38,809	$278,395	B
139171	06606	1925		GRAVITY	36	36	167	MONOLITHIC CONCRETE	T	6	MIS	2025	100			0				0	2025	$32,885	$235,903	B
139179	06702	1925		GRAVITY	36	36	293	MONOLITHIC CONCRETE	T	6	MIS	2025	100			0				0	2025	$57,707	$413,959	B
139121	06307A	1925		GRAVITY	36	36	420	MONOLITHIC CONCRETE	T	6	MIS	2025	100			0				0	2025	$82,627	$592,721	B
139217	05601	1923	2004	GRAVITY	60	60	684	MONOLITHIC CONCRETE	U1	6	MIS	2054	50	2038	2013	25	2030	2010	2011	20	2030	$239,503	$1,479,514	C
139223	05705	1922	2004	GRAVITY	60	60	679	MONOLITHIC CONCRETE	U1	6	MIS	2054	50	2030	2010	20				0	2030	$237,968	$1,470,035	C
139224	05706	1923	2004	GRAVITY	42	42	364	MONOLITHIC CONCRETE	U1	6	MIS	2054	50	2031	2011	20				0	2031	$85,368	$582,430	C
139225	05801	1923	2004	GRAVITY	60	60	350	MONOLITHIC CONCRETE	U1	6	MIS	2054	50	2032	2012	20				0	2032	$122,493	$756,693	C
139227	05803	1923	2004	GRAVITY	60	60	997	MONOLITHIC CONCRETE	U1	6	MIS	2054	50	2033	2013	20				0	2033	$349,474	$2,158,854	C
139229	05805	1923	2004	GRAVITY	60	60	895	MONOLITHIC CONCRETE	U1	6	MIS	2054	50	2031	2011	20				0	2031	$313,712	$1,937,941	C
139249	05906	1923		GRAVITY	60	60	335	MONOLITHIC CONCRETE	U1	6	MIS	2023	100	2053	2013	40	2030	2010	2011	20	2030	$117,213	$724,077	C
139266	02311B	1924		INVERTED SIPHON	48	48	252	CAST IRON	U1	6	MIS	2024	100			0				0	2024	$68,728	$450,697	A
139267	02311C	1924		INVERTED SIPHON	48	48	969	CAST IRON	U1	6	MIS	2024	100			0				0	2024	$264,033	$1,731,458	A
139251	05908L	1923		GRAVITY	60	60	188	MONOLITHIC CONCRETE	U1	6	MIS	2023	100			0				0	2023	$65,756	$406,201	A
139291	05913	1924		GRAVITY	42	42	646	MONOLITHIC CONCRETE	U2	6	MIS	2024	100	2053	2013	40	2029	2009		20	2029	$151,489	$1,033,551	B
139319	10101	1928		GRAVITY	39	30	545	SS MONOLITHIC CONCRETE	U2	6	MIS	2028	100	2053	2013	40	2018	2008	2011	10	2018	$117,526	$820,871	A
139320	10102	1928		GRAVITY	39	30	554	SS MONOLITHIC CONCRETE	U2	6	MIS	2028	100	2053	2013	40	2018	2010	2011	8	2018	$119,312	$833,347	A
139382	10202	1926		GRAVITY	36	36	667	MONOLITHIC CONCRETE	U2	6	MIS	2026	100	2053	2013	40	2039	2009		30	2039	$131,201	$941,170	C
139391	10305	1926		GRAVITY	36	36	696	MONOLITHIC CONCRETE	U2	6	MIS	2026	100	2055	2015	40	2032	2012	2012	20	2032	$136,940	$982,336	C
139460	10903	1926		GRAVITY	36	36	308	MONOLITHIC CONCRETE	U2	6	MIS	2026	100	2055	2015	40	2038	2008	2013	30	2038	$60,611	$434,789	C
139369	15704	1924		GRAVITY	42	42	716	MONOLITHIC CONCRETE	U2	6	MIS	2024	100	2053	2013	40	2039	2009		30	2039	$167,792	$1,144,780	C
139370	15705	1924		GRAVITY	42	42	567	MONOLITHIC CONCRETE	U2	6	MIS	2024	100	2053	2013	40	2039	2009		30	2039	$132,852	$906,397	C
139421	15904	1924		GRAVITY	36	36	17	MONOLITHIC CONCRETE	U2	6	MIS	2024	100	2103	2013	90	2039	2009		30	2039	$3,329	$23,878	C
139525	00310	1918	2003	GRAVITY	48	48	176	MONOLITHIC CONCRETE	SB	7	MIS	2053	50	2031	2011	20				0	2031	$47,902	$314,128	C
139526	00311	1918	2003	GRAVITY	48	48	269	MONOLITHIC CONCRETE	SB	7	MIS	2053	50	2031	2011	20				0	2031	$73,401	$481,342	C
139528	00313	1918	2003	GRAVITY	48	48	193	MONOLITHIC CONCRETE	SB	7	MIS	2053	50	2031	2011	20				0	2031	$52,673	$345,416	C
139529	00326	1918	2003	GRAVITY	48	48	37	MONOLITHIC CONCRETE	SB	7	MIS	2053	50	2035	2015	20				0	2035	$10,049	$65,899	C
139531	00407	1918	2003	GRAVITY	48	48	233	MONOLITHIC CONCRETE	SB	7	MIS	2053	50	2030	2010	20				0	2030	$63,619	$417,194	C
139532	00408	1918	2003	GRAVITY	48	48	129	MONOLITHIC CONCRETE	SB	7	MIS	2053	50	2030	2010	20				0	2030	$35,172	$230,647	C
139533	00409	1918	2003	GRAVITY	48	48	372	MONOLITHIC CONCRETE	SB	7	MIS	2053	50	2030	2010	20				0	2030	$101,387	$664,869	C
139534	00410	1918	2003	GRAVITY	48	48	196	MONOLITHIC CONCRETE	SB	7	MIS	2053	50	2035	2010	25				0	2035	$53,368	$349,972	C
139535	00411	1918	2003	GRAVITY	48	48	211	MONOLITHIC CONCRETE	SB	7	MIS	2053	50	2030	2010	20				0	2030	$57,422	$376,561	C
139544	00505	1918	2003	GRAVITY	42	42	322	MONOLITHIC CONCRETE	SB	7	MIS	2053	50	2030	2010	20				0	2030	$75,399	$514,417	C
139629	00516	1918		GRAVITY	12	12	38	TERRA COTTA	SB	7	MIS	2018	100			0				0	2018	$1,965	$25,361	A
139597	00519	1918		GRAVITY	12	12	34	TERRA COTTA	SB	7	MIS	2018	100	2022	2012	10	2018	2012	2012	6	2018	$1,771	$22,851	A
139556	00607	1918	2003	GRAVITY	36	36	599	MONOLITHIC CONCRETE	SB	7	MIS	2053	50	2030	2010	20				0	2030	$117,774	$844,853	C
139576	00704	1918	2003	GRAVITY	30	30	36	MONOLITHIC CONCRETE	SB	7	MIS	2053	50	2035	2010	25				0	2035	$5,759	$44,155	C
139588	00902	1924		GRAVITY	24	24	116	TERRA COTTA	SB	7	MIS	2024	100			0				0	2024	$14,296	$120,495	A
139601	85042	1927		GRAVITY	36	36	188	MONOLITHIC CONCRETE	SB	7	CSO	2027	100			0				0	2027	$37,032	$265,652	B
139522	00306B	1918		INVERTED SIPHON	36	36	1007	MONOLITHIC CONCRETE	SB	7	MIS	2018	100			0				0	2018	$198,107	$1,421,119	A
139559	00608B	1918		GRAVITY	36	36	703	MONOLITHIC CONCRETE	SB	7	MIS	2018	100			0				0	2018	$138,219	$991,509	A
139563	00701A	1918		GRAVITY	36	36	12	MONOLITHIC CONCRETE	SB	7	MIS	2018	100			0				0	2018	$2,339	$16,780	A

MMSD Asset ID	Convert to Pipe_NR	Construction Year	Rehab Year	Sewer Type	Height	Width	Asbuilt Length	Pipe Material	Leg	Subsystem	GIS Subtype	L1age Rehab Replace	Life	L2age Rehab Replace	L2 Insp year	Life2	L3 Rehab Replace	L3 Inspection Year	Assessment Review Date	Life3	Governing Replace Rehab Year	Total Rehab Cost	Total Replace Cost	Condition Score
139591	IS207A	1924		GRAVITY	24	24	211	TERRA COTTA	SB	7	MIS	2024	100			0				0	2024	$25,933	$218,581	A
139630	IS215	1918		GRAVITY	12	12	2	UNKNOWN	SB	7	MIS	2018	100			0				0	2018	$106	$1,365	A
139733	02501	1919	2007	GRAVITY	48	48	384	MONOLITHIC CONCRETE	V	7	MIS	2057	50	2036	2011	25				0	2036	$104,763	$687,008	C
139740	02505	1919		INVERTED SIPHON	30	30	270	DUCTILE IRON	V	7	MIS	2019	100			0				0	2019	$43,123	$330,652	A
139765	03005	1919	2001	GRAVITY	42	42	276	MONOLITHIC CONCRETE	V	7	MIS	2051	50	2030	2010	20				0	2030	$64,697	$441,399	C
139768	03007	1919	2001	GRAVITY	42	42	343	MONOLITHIC CONCRETE	V	7	MIS	2051	50	2030	2010	20				0	2030	$80,402	$548,552	C
139769	03008	1919	2001	GRAVITY	42	42	476	MONOLITHIC CONCRETE	V	7	MIS	2051	50	2030	2010	20				0	2030	$111,511	$760,794	C
139770	03009	1919	2001	GRAVITY	42	42	809	MONOLITHIC CONCRETE	V	7	MIS	2051	50	2030	2010	20				0	2030	$189,612	$1,293,645	C
139771	03010	1919	2001	GRAVITY	42	42	855	MONOLITHIC CONCRETE	V	7	MIS	2051	50	2030	2010	20				0	2030	$200,438	$1,367,510	C
139772	03101	1919	2001	GRAVITY	42	42	402	MONOLITHIC CONCRETE	V	7	MIS	2051	50	2030	2010	20				0	2030	$94,312	$643,457	C
139773	03102	1919	2001	GRAVITY	42	42	553	MONOLITHIC CONCRETE	V	7	MIS	2051	50	2030	2010	20				0	2030	$129,524	$883,694	C
139782	03204	1925	2001	GRAVITY	36	36	674	MONOLITHIC CONCRETE	V	7	MIS	2051	50	2035	2010	25				0	2035	$132,612	$951,289	C
139783	03205	1925	2001	GRAVITY	36	36	462	MONOLITHIC CONCRETE	V	7	MIS	2051	50	2030	2010	20				0	2030	$90,811	$651,428	C
139791	10506	1926	2001	GRAVITY	24	24	433	TERRA COTTA	V	7	MIS	2051	50	2035	2010	25				0	2035	$53,284	$449,123	C
139822	85046	1926		GRAVITY	48	48	54	MONOLITHIC CONCRETE	V	7	CSO	2026	100			0				0	2026	$14,654	$96,097	B
139932	00117	1918	2001	GRAVITY	54	54	358	MONOLITHIC CONCRETE	W	7	MIS	2051	50	2030	2010	20				0	2030	$111,329	$706,780	C
139933	00118	1918	2001	GRAVITY	54	54	455	MONOLITHIC CONCRETE	W	7	MIS	2051	50	2030	2010	20				0	2030	$141,499	$898,310	C
139934	00119	1918	2001	GRAVITY	54	54	37	MONOLITHIC CONCRETE	W	7	MIS	2051	50	2032	2012	20				0	2032	$11,612	$73,720	C
139935	00120	1918	2001	GRAVITY	54	54	425	MONOLITHIC CONCRETE	W	7	MIS	2051	50	2033	2013	20				0	2033	$132,332	$840,116	C
139936	00129	1923		GRAVITY	54	54	15	MONOLITHIC CONCRETE	W	7	MIS	2023	100			0				0	2023	$4,708	$29,887	A
139937	03301	1918	2001	GRAVITY	54	54	448	MONOLITHIC CONCRETE	W	7	MIS	2051	50	2035	2010	25				0	2035	$139,249	$884,028	C
140159	03412	2000		GRAVITY	36	36	368	RCP, CLASS V	W	7	MIS	2100	100	2106	2016	90	2018	2010	2011	8	2018	$72,428	$519,562	A
139979	03807	1919	2001	GRAVITY	42	42	427	MONOLITHIC CONCRETE	W	7	MIS	2051	50	2035	2010	25				0	2035	$100,110	$683,012	C
140237	03816	1927	2009	GRAVITY	18	18	121	TERRA COTTA	W	7	MIS	2059	50	2035	2010	25				0	2035	$10,560	$103,249	C
140238	03817	1927	2009	GRAVITY	18	18	220	TERRA COTTA	W	7	MIS	2059	50	2035	2010	25				0	2035	$19,115	$186,901	C
140239	03818	1927	2009	GRAVITY	18	18	90	TERRA COTTA	W	7	MIS	2059	50	2030	2010	20				0	2030	$7,850	$76,756	C
140210	03904	1920	2009	GRAVITY	24	24	263	TERRA COTTA	W	7	MIS	2059	50	2030	2010	20				0	2030	$32,319	$272,406	C
139988	04009	1919		INVERTED SIPHON	30	30	192	MONOLITHIC CONCRETE	W	7	MIS	2019	100			0				0	2019	$30,616	$234,753	A
140255	04201	1926	2009	GRAVITY	27	27	412	TERRA COTTA	W	7	MIS	2059	50	2030	2010	20				0	2030	$58,214	$465,862	C
140256	04202	1926	2009	GRAVITY	27	27	300	TERRA COTTA	W	7	MIS	2059	50	2030	2010	20				0	2030	$42,451	$339,714	C
140262	04206	1926		INVERTED SIPHON	10	10	154	DUCTILE IRON	W	7	MIS	2026	100			0				0	2026	$6,131	$92,852	B
140016	04404	?		GRAVITY	60	60	403	BRICK	W	7	MIS		0	2053	2013	40	2030	2010	2011	20	2030	$141,255	$872,593	C
140017	04501		2000	GRAVITY	60	60	772	BRICK	W	7	MIS		-2000	2033	2013	20	2020	2010	2011	10	2020	$270,474	$1,670,841	A
140022	04505		2000	GRAVITY	60	60	658	BRICK	W	7	MIS		-2000	2033	2013	20	2030	2010	2011	20	2030	$230,428	$1,423,458	C
140078	06813	1923	2000	GRAVITY	24	24	381	DUCTILE IRON	W	7	MIS	2050	50	2032	2012	20				0	2032	$46,884	$395,173	C
140027	60113	2004		GRAVITY	84	84	240	RCP, CLASS V	W	7	MIS	2104	100	2053	2013	40	2030	2010	2011	20	2030	$123,026	$702,181	C
140082	65047	1926		GRAVITY	48	48	176	MONOLITHIC CONCRETE	W	7	CSO	2026	100			0				0	2026	$48,065	$315,200	B
140083	85047	1926		GRAVITY	48	48	38	MONOLITHIC CONCRETE	W	7	CSO	2026	100			0				0	2026	$10,417	$68,311	B
139948	03707-2	1920	2001	GRAVITY	48	48	501	MONOLITHIC CONCRETE	W	7	MIS	2051	50	2031	2011	20				0	2031	$136,512	$895,212	C
140240	03818A	1927	2009	GRAVITY	18	18	128	TERRA COTTA	W	7	MIS	2059	50	2035	2010	25				0	2035	$11,141	$108,928	C
140204	03901A	1920	2009	GRAVITY	30	30	305	MONOLITHIC CONCRETE	W	7	MIS	2059	50	2030	2010	20				0	2030	$48,701	$373,424	C
140018	04501A		2000	GRAVITY	60	60	121	BRICK	W	7	MIS		-2000	2033	2013	20				0	2033	$42,474	$262,382	C
140079	06813A	1923	2000	GRAVITY	24	24	258	DUCTILE IRON	W	7	MIS	2050	50	2037	2012	25				0	2037	$31,770	$267,779	C
140053	06904A	1923		GRAVITY	48	48	21	MONOLITHIC CONCRETE	W	7	MIS	2023	100			0				0	2023	$5,676	$37,220	A
140054	06904B	1923		GRAVITY	60	60	20	15h x 72w MONOLITHIC CONCRETE	W	7	MIS	2023	100			0				0	2023	$6,965	$43,027	A
140087	85040A	1926		GRAVITY	38.99	60	6	Box MONOLITHIC CONCRETE	W	7	MIS	2026	100			0				0	2026	$2,043	$12,618	B
140114	BS0507D	1923		GRAVITY	48	48	57	MONOLITHIC CONCRETE	W	7	MIS	2023	100			0				0	2023	$15,531	$101,850	A
140228	IS386	1920		GRAVITY	15	15	22	TERRA COTTA	W	7	MIS	2020	100	2021	2011	10		2011		0	2021	$1,497	$16,390	A
140138	IS404	1921		GRAVITY	15	15	21	TERRA COTTA	W	7	MIS	2021	100			0				0	2021	$1,455	$15,935	A
140561	00317	1916	2008	GRAVITY	12	12	251	TERRA COTTA	XB	7	MIS	2058	50	2035	2015	20				0	2035	$12,935	$166,923	C
140432	00405	1916	2003	GRAVITY	36	36	550	MONOLITHIC CONCRETE	XB	7	MIS	2053	50	2030	2010	20				0	2030	$108,198	$776,154	C

MMSD Asset ID	Convert to Pipe_NR	Construction Year	Rehab Year	Sewer Type	Height	Width	Asbuilt Length	Pipe Material	Leg	Subsystem	GIS Subtype	L1age Rehab Replace	Life	L2age Rehab Replace	L2 Insp year	Life2	L3 Rehab Replace	L3 Inspection Year	Assessment Review Date	Life3	Governing Replace Rehab Year	Total Rehab Cost	Total Replace Cost	Condition Score
140433	00406	1916	2003	GRAVITY	36	36	268	MONOLITHIC CONCRETE	XB	7	MIS	2053	50	2030	2010	20				0	2030	$52,635	$377,577	C
140488	00433	1985	2003	GRAVITY	15	15	35	TERRA COTTA	XB	7	MIS	2053	50	2031	2011	20				0	2031	$2,405	$26,340	C
140489	00434	1916	2003	GRAVITY	10	10	53	TERRA COTTA	XB	7	MIS	2053	50	2035	2015	20		2011		0	2035	$2,108	$31,919	C
140552	00439	1916	2006	GRAVITY	10	10	29	TERRA COTTA	XB	7	MIS	2056	50	2037	2012	25				0	2037	$1,172	$17,753	C
140445	00613	1916	2003	GRAVITY	36	36	393	MONOLITHIC CONCRETE	XB	7	MIS	2053	50	2038	2013	25				0	2038	$77,242	$554,095	C
140469	00813	1916	2003	GRAVITY	30	30	335	MONOLITHIC CONCRETE	XB	7	MIS	2053	50	2037	2012	25				0	2037	$53,483	$410,087	C
140471	00906	1916	2003	GRAVITY	24	24	325	TERRA COTTA	XB	7	MIS	2053	50	2032	2012	20				0	2032	$39,945	$336,690	C
140496	85043	1927		GRAVITY	36	36	32	MONOLITHIC CONCRETE	XB	7	CSO	2027	100			0				0	2027	$6,370	$45,696	B
140417	00301B	1918	2005	GRAVITY	49	68	405	MONOLITHIC CONCRETE	XB	7	MIS	2055	50	2016	2011	5	2031	2011	2018	20	2031	$163,579	$979,981	C
140429	00402B	1916	2008	GRAVITY	36	36	515	MONOLITHIC CONCRETE	XB	7	MIS	2058	50	2020	2010	10				0	2020	$101,355	$727,071	A
140553	IS241/DS126	1992	2006	GRAVITY	15	15	4	RCP	XB	7	MIS	2056	50	2037	2012	25				0	2037	$277	$3,034	C
140558	IS242	1916	2008	GRAVITY	12	12	19	VITRIFIED CLAY	XB	7	MIS	2058	50	2032	2012	20				0	2032	$964	$12,441	C

Conveyance Facilities (Pump Stations) Worksheet

Pump Station ID	Location	No. of Pumps	Capacity	Year Activated/ Upgraded	Rehab Year	Unit Pump Cost	Total Cost	Material Pump Costs	Notes	Escalation Costs (3%/yr)	Year	Installation Costs 50%	Electrical and Controls 30%	Total Installation Costs	20% Undesigned Detail + 30% Construction Contingency	Construction Cost	20% Engineering, Administration, & ESDC	Total Capital Cost	Timeframe	Total Cost per Timeframe
BS0502	n/o W Hampton Ave. & e/o N 32nd St	4	25,500 gpm	1999/--	2019	$970,000	$3,880,000	$370,000	7	$44,400	4	$207,200	$124,320	$745,920	$372,960	$1,118,880	$223,776	$1,342,656	2020-24	$4,125,000
BS0503	W Roosevelt Dr, w/o N 35th St	2	10,000 gpm	1961/2004	2024	$380,000	$760,000	$145,000	6	$17,400	4	$81,200	$48,720	$292,320	$146,160	$438,480	$87,696	$526,176		
BS0505	W Villard Ave & N 27th St	2	2,000 gpm	1954/2004	2024	$140,000	$280,000	$60,000	6	$0	0	$30,000	$18,000	$108,000	$54,000	$162,000	$32,400	$194,400		
BS0506	N Range Line Rd, s/o W Dean Rd	2	500 gpm	1963/2004	2024	$40,000	$80,000	$15,000	2	$1,800	4	$8,400	$5,040	$30,240	$15,120	$45,360	$9,072	$54,432		
BS0601	S 35th St, n/o W Manitoba St	1	10,000 gpm	1955/2004	2024	$525,000	$525,000	$200,000	3	$24,000	4	$112,000	$67,200	$403,200	$201,600	$604,800	$120,960	$725,760		
BS0601	S 35th St, n/o W Manitoba St	1	5,000 gpm	1955/2004	2024	$316,000	$316,000	$135,000	1	$0	0	$67,500	$40,500	$243,000	$121,500	$364,500	$72,900	$437,400		
PS0101	5300 S Howell Ave.	3	1,150 gpm	2002/--	2022	$70,000	$210,000	$26,000	4	$3,900	5	$14,950	$8,970	$53,820	$26,910	$80,730	$16,146	$96,876		
PS0402	9421 N Lake Dr	2	500 gpm	1965/2004	2024	$40,000	$80,000	$15,000	2	$1,800	4	$8,400	$5,040	$30,240	$15,120	$45,360	$9,072	$54,432		
PS0704	301 N 42nd St	4	11,000 gpm	2002/--	2022	$420,000	$1,680,000	$160,000	6	$19,200	4	$89,600	$53,760	$322,560	$161,280	$483,840	$96,768	$580,608		
PS0704	301 N 42nd St	2	1,250 gpm	2002/--	2022	$80,000	$160,000	$30,000	4	$4,500	5	$17,250	$10,350	$62,100	$31,050	$93,150	$18,630	$111,780		
BS0303	W Oklahoma Ave, w/o S 74th St	2	5,000 gpm	1960/2006	2026	$316,000	$632,000	$135,000	1	$0	0	$67,500	$40,500	$243,000	$121,500	$364,500	$72,900	$437,400	2025-29	$960,000
PS0501	5020 N Port Washington Rd	2	7,000 gpm	1932/2009	2029	$375,000	$750,000	$160,000	6	$0	0	$80,000	$48,000	$288,000	$144,000	$432,000	$86,400	$518,400		
PS0301	S 124th St, s/o W Greenfield Ave	4	5,000 gpm	1984 & 1999/2013	2033	$316,000	$1,264,000	$135,000	1	$0	0	$67,500	$40,500	$243,000	$121,500	$364,500	$72,900	$437,400	2030-39	$6,266,000
PS0302	V Underwood Creek Pkwy & W Potter Rd (ext'd	5	8750 gpm	1983/2013	2033	$425,000	$2,125,000	$175,000	7	$5,250	1	$90,125	$54,075	$324,450	$162,225	$486,675	$97,335	$584,010		
PS0401	7509 N Beach Dr	2	550 gpm	1934/2013	2033	$40,000	$80,000	$15,000	2	$1,800	4	$8,400	$5,040	$30,240	$15,120	$45,360	$9,072	$54,432		
BS0401	W Wisconsin Ave, w/o N Honey Creek Pkwy	2	10,000 gpm	1962/2004/2013	2033	$525,000	$1,050,000	$200,000	3	$24,000	4	$112,000	$67,200	$403,200	$201,600	$604,800	$120,960	$725,760		
BS0405	N 59th St (ext'd), s/o W State St	6	30,200 gpm	2011/--	2031	$1,180,000	$7,080,000	$450,000	7	$54,000	4	$252,000	$151,200	$907,200	$453,600	$1,360,800	$272,160	$1,632,960		
PS0502	6985 N River Rd	4	3,350 gpm	1984/2013	2033	$160,000	$640,000	$60,000	5	$9,000	5	$34,500	$20,700	$124,200	$62,100	$186,300	$37,260	$223,560		
PS0801	700 E Jones St	3	48,000 gpm	1986/2013	2033	$1,900,000	$5,700,000	$700,000	7	$105,000	5	$402,500	$241,500	$1,449,000	$724,500	$2,173,500	$434,700	$2,608,200		

Notes
1. Grand Junction, IN - Westfield, IN - Recent as-bid costs- 2018
2. Muncie, IN WWPS-(small pumps) manufacturer costs from 2016
3. Muncie, IN WWPS-(large pumps) manufacturer costs from 2016
4. Harbour water (1.5 MGD) - construction costs from 2014
5. Harbour water (5.0 MGD) - construction costs from 2014
6. Extrapolated costs, used Grand Junction (#1) as basis.
7. Extrapolated costs, used Muncie, IN large (#3) as basis.
8. The inactive Milwaukee River and Kinnickinnic River Flushing Stations are excluded from this evaluation.

	Location	MIS Leg	Station Type (Purpose)	No. of pumps	Capacity	Available Data	Muncipality	Contract Numbers	Year Activated/Upgraded	Unit Pump cost	Total Cost
BS0303	W Oklahoma Ave, w/o S 74th St	R3	Lift Station (SSO)	2	5,000 gpm	Level, Volume, Gate Position	Milwaukee	M167/C98039C01	1960/2006	$ 316,000	$ 632,000
BS0401	W Wisconsin Ave, w/o N Honey Creek Pkwy	F1	Lift Station (SSO)	2	10,000 gpm	Level, Volume	Wauwatosa	M17B/C98039C01/C98041C01	1962/2004/2013	$ 525,000	$ 1,050,000
BS0405	N 59th St (ext'd), s/o W State St	G	Lift Station (SSO)	6	30,200 gpm	Level, Volume, Gate Position	Milwaukee	C04006C01	2011/--	$ 1,180,000	$ 7,080,000
BS0502	n/o W Hampton Ave. & e/o N 32nd St	C	Lift Station (SSO)	4	25,500 gpm	Level, Flow, Volume	Milwaukee	C042GX020	1999/--	$ 970,000	$ 3,880,000
BS0503	W Roosevelt Dr, w/o N 35th St	C	Lift Station (SSO)	2	10,000 gpm	Level, Volume	Milwaukee	702/C98039C01	1961/2004	$ 380,000	$ 760,000
BS0505	W Villard Ave & N 27th St	A1	Lift Station (SSO)	2	2,000 gpm	Level, Volume	Milwaukee	585 (P20G11)/C05036C01	1954/2004	$ 140,000	$ 280,000
BS0506	N Range Line Rd, s/o W Dean Rd	A2	Lift Station (SSO)	2	500 gpm	Level, Volume	River Hills	M196/C98039C01	1963/2004	$ 40,000	$ 80,000
BS0601	S 35th St, n/o W Manitoba St	L1	Lift Station (SSO)	1	10,000 gpm	Level, Flow, Volume	Milwaukee	581 (P20G21)/C98039C01	1955/2004	$ 525,000	$ 525,000
			Lift Station (SSO)	1	5,000 gpm	Level, Flow, Volume	Milwaukee	581 (P20G21)/C98039C01	1955/2004	$ 316,000	$ 316,000
PS0101	5300 S Howell Ave.	R1	Pump Stat. (Wet Weather Diversion)	3	1,150 gpm	Level, Flow	Milwaukee	C01004C01	2002/--	$ 70,000	$ 210,000
PS0301	S 124th St, s/o W Greenfield Ave	Q	Pump Stat. (Wet Weather Diversion)	4	5,000 gpm	Level, Flow	West Allis	I70621 & P20631/C98041C01	1984 & 1999/2013	$ 316,000	$ 1,264,000
PS0302	W Underwood Creek Pkwy & W Potter Rd (ext't)	K2	Pump Stat. (Wet Weather Diversion)	5	8750 gpm	Level, Volume, Gate Position	Wauwatosa	I60G21/C98041C01	1983/2013	$ 425,000	$ 2,125,000
PS0401	7509 N Beach Dr	B1	Pump Station (Continual)	2	550 gpm	Level, Flow, Volume	Fox Point	M71/C98039C01	1934/2013	$ 40,000	$ 80,000
PS0402	9421 N Lake Dr	B2	Pump Station (Continual)	2	500 gpm	Level, Flow, Volume	Bayside	M202/C98039C01	1965/2004	$ 40,000	$ 80,000
PS0501	5020 N Port Washington Rd	B1	Pump Station (Continual)	2	7,000 gpm	Level, Flow	Glendale	M50 & 50A/C05035C01	1932/2009	$ 375,000	$ 750,000
PS0502	6985 N River Rd	B2	Lift Station (Wet Weather Diversion)	4	3,350 gpm	Level, Volume, Gate Position	River Hills	M251/C98041C01	1984/2013	$ 160,000	$ 640,000
PS0704	301 N 42nd St	n/a	Lift Station (Storm Water)	4	11,000 gpm	Level	Milwaukee	W023GX010	2002/--	$ 420,000	$ 1,680,000
			Lift Station (Storm Water)	2	1,250 gpm	Level	Milwaukee	W023GX010	2002/--	$ 80,000	$ 160,000
PS0801	700 E Jones St	n/a	Lift Station (Drain ISS)	3	48,000 gpm	Level, Flow, Volume	Milwaukee	I37E12/J01009C03	1986/2013	$ 1,900,000	$ 5,700,000
PS1101*	1701 N Lincoln Memorial Dr	n/a	Flushing Station (Flush River)	1	198,000 gpm	Flow, Pressure	Milwaukee	M002GX010	1888/1996	$ 7,900,000	$ 7,900,000
PS1102**	2644 S Chase Ave	n/a	Flushing Station (Flush River)	1	183,000 gpm	Flow, Pressure	Milwaukee	None	1910/1973	$ 7,100,000	$ 7,100,000

MILWAUKEE METROPOLITAN SEWAGE DISTRICT
2050 FACILITIES PLAN
Conveyance Project Alternatives Analysis

CAPITAL COST DETAILS
OPINION OF BUDGETARY PROBABLE CONSTRUCTION COSTS
CS R10, Conveyance Assets Physical Mortality Evaluation
Estimated Cost of Recommended Evaluation

General Description:
Detailed evaluation to establish specific repair and/or replacement costs for conveyance and storage asset system pipes and facilities for MMSD future planning

				Capital Costs								
ITEM	Life Years	Units	Quantity	Unit Cost ($)	SUBTOTAL 1 ($)	Undesigned Details	Contingency	SUBTOTAL 2 ($)	Constr. Overhead & Profit	CONSTR. COST ($)	Design, Bidding, Const. Oversight	CAPITAL COST ($)
Conveyance - Pipe Evaluation (Notes 1-5)												
Evaluation - PM	NA	hrs	200	$ 250	$ 50,000	20%	20%	$ 70,000	0%	$ 70,000	0%	$ 70,000
Evaluation - Engineer	NA	hrs	1000	$ 150	$ 150,000	20%	20%	$ 210,000	0%	$ 210,000	0%	$ 210,000
Technical Expert	NA	hrs	240	$ 300	$ 72,000	20%	20%	$ 100,000	0%	$ 100,000	0%	$ 100,000
Project Engineer	NA	hrs	620	$ 175	$ 108,500	20%	20%	$ 150,000	0%	$ 150,000	0%	$ 150,000
Expenses												$ 10,000
											Total Capital Cost	**$ 540,000**
Conveyance - Facilities Evaluation (Notes 1,5,6-8)												
Evaluation - PM	NA	hrs	200	$ 250	$ 50,000	20%	20%	$ 70,000	0%	$ 70,000	0%	$ 70,000
Evaluation - Engineer	NA	hrs	1100	$ 150	$ 165,000	20%	20%	$ 230,000	0%	$ 230,000	0%	$ 230,000
Technical Expert	NA	hrs	230	$ 300	$ 69,000	20%	20%	$ 100,000	0%	$ 100,000	0%	$ 100,000
Project Engineer	NA	hrs	600	$ 175	$ 105,000	20%	20%	$ 150,000	0%	$ 150,000	0%	$ 150,000
Expenses												$ 10,000
											Total Capital Cost	**$ 560,000**

Notes:
1) Definitions:
Hrs - hours of time
2) 77 pipe segments identified as Category A, assume each gets a report
3) PM time - meetings, oversight of evaluation and development of alternatives, review of reports, QC
4) 77 segments with physical mortality concerns - assume one report for each segment, $6000 per report
5) Only cost for evaluation includeds, no capital costs of potential recommendations
6) 19 Pump Stations identified, assume each gets a report
7) PM time - meetings, oversight of evaluation and development of alternatives, review of reports, QC
8) 19 pump stations - assume one report for each pump station, $25,000 per report.