6 Alternative Analyses

6.1 PURPOSE

The development and evaluation of alternatives is a key element in the facilities planning process. The purpose of this chapter is to describe the steps used to define, develop, and evaluate the alternatives that were evaluated to mitigate the potential risks identified in Chapter 5. This chapter also presents a summary of the recommended projects. Note that these recommendations are presented by asset system. The recommended plan to meet regulatory guidelines and permit requirements is presented in Chapter 7 and the recommended plan to address 2050 Foundational Goals is presented in Chapter 8. The implementation plan for the recommended plans is presented in Chapter 9. Refer to Figure 6-1 for a flow diagram of the chapter content for Chapters 6, 7, 8, and 9.

As with Chapters 4 and 5, this chapter provides a summary of the asset-system specific data that is provided in the appendices. The alternative analysis details are presented in the following appendices:

- Appendix 6A – Conveyance Alternative Analyses
- Appendix 6B – Water Reclamation Facilities (WRFs) and Biosolids Alternative Analyses
- Appendix 6C – Watercourse and Flood Management (WCFM) Alternative Analyses
- Appendix 6D – Green Infrastructure (GI) Alternative Analyses
- Appendix 6E – Systemwide Alternative Analyses

The general process used to develop the alternative analyses is presented in Section 6.2. Alternative analyses fall into one of two categories:

- **Alternative Analyses of Risks to Meeting Regulatory Guidelines and Permit Requirements:** These analyses consider alternatives to address risks to meeting regulatory guidelines and permit requirements during the 2020 to 2040 regulatory planning period. This includes all potential capacity and physical mortality risks identified in Chapter 5, plus the level of service and economic efficiency risks in the risk registers that could impact regulatory guidelines and permit requirements. These alternative analyses are identified as R1, R2, etc.
- **Alternative Analyses of Risks to Meeting 2050 Foundational Goals:** Analyzes projects that address risks to meeting 2050 Foundational Goals (FGs). These 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. These alternative analyses are identified as FG1, FG2, etc.

Tables 6-1 through 6-5 list the alternative analyses that were conducted for each asset system. Each table presents the type of risk that was identified in Chapter 5, the specific description of the potential risk, including the specific parameter that triggered the identification of the risk, how the risk was identified, the estimated timing, the type of potential risk (regulatory or FG as listed in the bullets above), and the alternative analysis that evaluates the risk. The projected timing of the risk is “existing” if the risk is already present in the system.

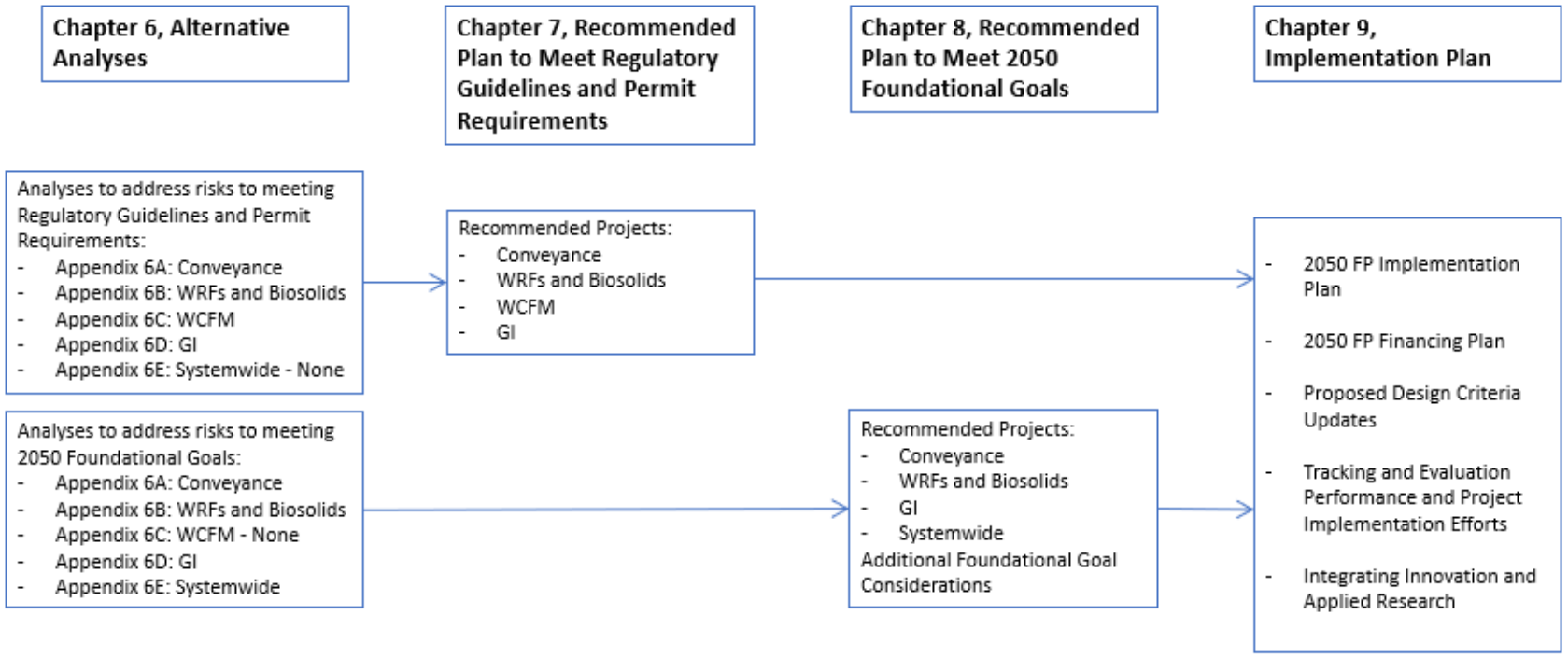

FIGURE 6-1: ORGANIZATIONAL FLOW CHART FROM CHAPTER 6 THROUGH CHAPTER 9

TABLE 6-1: CONVEYANCE ALTERNATIVE ANALYSES FOR POTENTIAL 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[3] 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
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

TABLE 6-1: CONVEYANCE ALTERNATIVE ANALYSES FOR POTENTIAL 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 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[3]. 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 municipality 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
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.
3) SSO – separate sewer overflow; CSO – combined sewer overflow.

TABLE 6-2: WRFS AND BIOSOLIDS ALTERNATIVE ANALYSES FOR POTENTIAL RISKS IDENTIFIED IN CHAPTER 5

Potential Risk Identified in Ch 5	Specific Description of Potential Risk[1]	How Potential Risk was Identified	Estimated Timing of Potential Risk[2]	Type of Potential Risk	Ch 6 Analysis
Capacity risks at JIWRF	Capacity risks at major process MP02, 04, 05, and 06, listed as percent of design capacity MP02 – Average WLR at 102% MP04 – BOD load at 106% (max month) to 128% (avg) MP05 – SLR at 133% (avg) to 148% (max month) MP06 – max day RAS flow at 138%, WAS flow at 107%	WRF Capacity Assessment	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R2, JIWRF Primary Clarification, Secondary Treatment Capacity
	Capacity risks at MP08 – max month processing at 135% of design capacity	WRF Capacity Assessment	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R7, Physical Mortality Evaluation WRF FG2, Alternative Biosolids Processing and Disposal Systems
	Capacity risks at MP10– max month processing at 110% of design capacity	WRF Capacity Assessment	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R8, Milorganite® Process System Physical Mortality Evaluation
	Capacity risks at MP11–max month processing at 108% of design capacity	WRF Capacity Assessment	2025–2029	Risk to meeting regulatory guidelines / permit requirements	WRF R8, Milorganite Process System Physical Mortality Evaluation
	Capacity risks at MP13 – 96% of days storage design capacity at max month production (want more than 100%)	WRF Capacity Assessment	2030–2039	Risk to meeting regulatory guidelines / permit requirements	WRF R7, Physical Mortality Evaluation
	Risk of not enough JIWRF wet weather capacity to maintain interim goal of maintaining baseline CSO frequency (need up to 150 MGD blending capacity)	WRF Capacity Assessment	2040[3]	Risk to meeting Foundational Goal G1: Change MMSD from an organization that impacts the environment to an organization that benefits the environment	WRF FG8, JIWRF Wet Weather Capacity
	Risk of necessity to implement emergency operations and the corresponding cost impacts due to the insufficient capacity of the D&D sludge cake bypass belt to process all dewatered biosolids in the event that the south side system goes offline	WRF Risk Register risk no. R039	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R8, Milorganite Process System Physical Mortality Evaluation
	Risk of conveyance system overflows by not maximizing ISS pump out blending at JIWRF	WRF Risk Register risk no. R240	2020–2024	Risk to meeting Foundational Goal G1: Change MMSD from an organization that impacts the environment to an organization that benefits the environment	WRF FG8, JIWRF Wet Weather Capacity

TABLE 6-2: WRFS AND BIOSOLIDS ALTERNATIVE ANALYSES FOR POTENTIAL RISKS IDENTIFIED IN CHAPTER 5

Potential Risk Identified in Ch 5	Specific Description of Potential Risk[1]	How Potential Risk was Identified	Estimated Timing of Potential Risk[2]	Type of Potential Risk	Ch 6 Analysis
Capacity risks at SSWRF	Capacity risks at MP02, MP04, MP05, listed as percent of design capacity MP02 – Avg WLR at 106% MP04 – BOD load at 110% (max month) to 129% (average), oxygen demand at 116% (avg) to 124% (max month) MP05 – Avg SOR at 109%, SLR at 103%(avg), 110% (max)	WRF Capacity Assessment	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R3, SSWRF Primary Clarification, Secondary Treatment Capacity
	Capacity risks at MP06 – Avg RAS flow at 123% of design capacity	WRF Capacity Assessment	2030–2039	Risk to meeting regulatory guidelines / permit requirements	WRF R3, SSWRF Primary Clarification, Secondary Treatment Capacity
	Capacity risks at MP09 – Avg TSS loading at 107% of design capacity	WRF Capacity Assessment	2030–2039	Risk to meeting regulatory guidelines / permit requirements	WRF R7, Physical Mortality Evaluation
	Risk of insufficient solids processing and disposal capacity at SSWRF during a JIWRF D&D extended or short-term shutdown	WRF Risk Register risk no. R190	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R5, D&D Shutdown Solids Handling Capacity
Physical mortality risks at JIWRF and SSWRF	Various physical mortality risks due to asset age	AssetView condition data	Varies	Risk to meeting regulatory guidelines / permit requirements	WRF R7, Physical Mortality Evaluation
Physical mortality risks at JIWRF	Risk of loss of JIWRF electrical power due to the condition of substation equipment (Dewey and Harbor)	WRF Risk Register risk no. R005	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R9, Loss of Electrical Power at JIWRF Substations
	Risk of loss of power due to age and reliability of electric substations, MCCs and other power distribution systems	WRF Risk Register risk no. R125	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R9, Loss of Electrical Power at JIWRF Substations
	Risk of various system failures due to age of multiple D&D systems	WRF Risk Register, multiple risks	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R8, Milorganite Process System Physical Mortality Evaluation
	Risk of Milorganite phosphorus-to-nitrogen ratio not meeting state regulations	WRF Risk Register risk no. R172	2020–2024	Risk to meeting Foundational Goal G2: Incorporate new technologies and operational improvements to minimize MMSD's financial burden on ratepayers	WRF FG1, Milorganite Quantity/Quality
	Risk of wet weather capacity restrictions and permit violations due to D&D facility drying capacity/reliability issues	WRF Risk Register risk no. R173	2020–2024	Risk to meeting Foundational Goals: G1: Change MMSD from an organization that impacts the environment to an organization that benefits the environment G2: Incorporate new technologies and operational improvements to minimize MMSD's financial burden on ratepayers.	WRF FG2, Alternative Biosolids Processing Disposal Systems
	Risk of excessive power consumption and potential air permit non-compliance due to the condition, performance and power use of D&D wet ESPs	WRF Risk Register risk no. R057	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R10, Condition and Performance of Dryer Emission Controls
Physical mortality risks at SSWRF	Risk of failure of the plate and frame dewatering system due to the aged PLC system and the fact that parts are no longer supported by the vendor	WRF Risk Register risk no. R111	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R5, D&D Shutdown Solids Handling Capacity

TABLE 6-2: WRFS AND BIOSOLIDS ALTERNATIVE ANALYSES FOR POTENTIAL RISKS IDENTIFIED IN CHAPTER 5

Potential Risk Identified in Ch 5	Specific Description of Potential Risk[1]	How Potential Risk was Identified	Estimated Timing of Potential Risk[2]	Type of Potential Risk	Ch 6 Analysis
	Risk of failure of the plate and frame dewatering system due to the challenges to maintaining the feed pumps	WRF Risk Register risk R112	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R5, D&D Shutdown Solids Handling Capacity
Level of service risks at JIWRF and SSWRF	Risk that the disinfection systems in MP07 at JIWRF and SSWRF are not adequate to meet future WPDES permit requirements	October 23, 2019 WDNR legislation regarding change in pathogen indicator in wastewater from fecal coliform to *E. coli*	2024–2029[4]	Risk to meeting regulatory guidelines / permit requirements	WRF R4, Meeting Future *E. coli* Limits at JIWRF and SSWRF (MP07)
	Risk that effluent pumps will not be able to operate to full capacity due to projected rising lake levels due to climate change	Wisconsin's Changing Climate: Impacts and Adaption, first report of WICCI[5]	By 2040	Risk to meeting regulatory guidelines / permit requirements	WRF R1, Effluent Pump Capacity with Rising Lake Levels
Level of service risks at JIWRF	Risk of negative publicity, community impacts and not meeting 2017 NR 110 requirements due to JIWRF treatment process odors	WRF Risk Register risk no. R120	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R11, JIWRF Odor Monitoring and Control
	Risk of air permit non-compliance due to trend of increasing stack testing emissions	WRF Risk Register risk no. R228	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R10, Condition and Performance of Dryer Emission
	Safety risks in dryer systems due to the utilization of waste heat and the high oxygen levels in the dryer systems	WRF Risk Register risk no. R177	2020–2024	Risk to meeting Foundational Goals: G1: Change MMSD from an organization that impacts the environment to an organization that benefits the environment G2: Incorporate new technologies and operational improvements to minimize MMSD's financial burden on ratepayers	WRF FG2, Alternative Biosolids Processing Disposal Systems
	Risk that JIWRF will not be able to meet WLA effluent limits due to higher waste mass loadings anticipated during wet weather events	Review of 2019 WPDES permit as part of WRF Capacity Assessment	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R6, JIWRF TMDL Management

TABLE 6-2: WRFS AND BIOSOLIDS ALTERNATIVE ANALYSES FOR POTENTIAL RISKS IDENTIFIED IN CHAPTER 5

Potential Risk Identified in Ch 5	Specific Description of Potential Risk[1]	How Potential Risk was Identified	Estimated Timing of Potential Risk[2]	Type of Potential Risk	Ch 6 Analysis
Level of service risks at SSWRF	Risk of conveyance system overflows at BS0405 and DC0103 by not utilizing the potential to blend at SSWRF	WRF Risk Register risk no. R090	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF FG9, SSWRF Wet Weather Capacity
	Risk of incorrect reporting, treatment management, and future planning due to Incorrect results from the SSWRF influent sampling system	WRF Risk Register risk no. R211	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R3, SSWRF Primary Clarification, Secondary Treatment Capacity
	Risk of limited black start capability utilization because existing battery has capacity for only one start and backup power capacity is not available in a power outage	WRF Risk Register risk no. R197	2020–2024	Risk to meeting Foundational Goals: G1: Change MMSD from an organization that impacts the environment to an organization that benefits the environment G2: Incorporate new technologies and operational improvements to minimize MMSD's financial burden on ratepayers G5: Provide adaptive leadership to climate change	WRF FG7, Backup Power for Black Start System at SSWRF
	Risk of not meeting KPIs for 100% of annual energy from renewable sources and 80% of annual energy from MMSD-generated renewable sources by not utilizing the most energy efficient systems and available renewable energy.	2015 – 2017 actual performance trends against KPIs Energy Plan 2035 Vision	By 2035	Risk to meeting Foundational Goals: G1: Change MMSD from an organization that impacts the environment to an organization that benefits the environment G2: Incorporate new technologies and operational improvements to minimize MMSD's financial burden on ratepayers G5: Provide adaptive leadership to climate change	WRF FG4, Increase SSWRF Renewable Energy Use WRF FG5, JIWRF and SSWRF Interplant Energy Connection WRF FG6, Reduction of SSWRF Energy Use
Economic efficiency risk at JIWRF	Risk of not being able to contract with a Milorganite packaging / bagging vendor due to the limited number of vendors (only one)	WRF Risk Register risk no. R261	2020–2024	Risk to meeting Foundational Goal G2: Incorporate new technologies and operational improvements to minimize MMSD's financial burden on ratepayers	WRF FG3, JIWRF Milorganite Bagging
Economic efficiency risks at SSWRF	Engine generators have high maintenance and high downtime, which is costly and not consistent with MMSD energy goals	WRF Risk Register risk no. R113	2020–2024	Risk to meeting regulatory guidelines / permit requirements	WRF R7, Physical Mortality Evaluation

1) Values listed are design parameters that were exceed in capacity assessment in Chapter 5. See referenced analysis for details, including definitions of parameters listed.
2) Estimate timing of potential risks for capacity risks is based on the interpolation of the mass balances developed for WRF Baseline, WRF Future and Buildout Conditions, set using most immediate timing out of all risks identified.
3) Estimated timing for JIWRF Wet Weather capacity risk based on Conveyance Future Conditions flow projections; see chapters 4 and 5 for more details.
4) Estimated timing for risk that the disinfection systems in MP07 at JIWRF and SSWRF are not adequate to meet future WPDES permit requirements is based on the anticipated timing of the next permit.
5) WICCI – Wisconsin's Initiative on Climate Change Impacts; first report published in 2011.

TABLE 6-3: WATERCOURSE AND FLOOD MANAGEMENT ALTERNATIVE ANALYSES TO ADDRESS RISKS IDENTIFIED IN CHAPTER 5

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
Physical mortality risks	Risk of flooding due to the failure of concrete-lined channels	WCFM Risk Register risk nos. W014, W015, W109, W110 WCFM Program inspection reports	Existing (Baseline Conditions)	Risk to meeting regulatory guidelines / permit requirements	WCFM R1, Identified WCFM Projects
Level of service risks	Risk of unforeseen emergency situations due to a lack of a Watercourse Asset Management Program (multiple watersheds)	WCFM Risk Register risk no. W016	Existing (Baseline Conditions)	Risk to meeting regulatory guidelines / permit requirements	WCFM R1, Identified WCFM Projects
	Risk of flooded structures due to structures remaining within the 1--percent annual probability event	WCFM Program internal documentation	Existing (Baseline Conditions)	Risk to meeting regulatory guidelines / permit requirements	WCFM R2, SEWRPC Flooding Evaluation
	Risk of downstream MMSD assets (stream restoration projects, conveyance system, WRFs) being adversely impacted by non-MMSD entities not following Chapter 13 Stormwater Rule (multiple watersheds)	WCFM Risk Register risk no. W055	Existing (Baseline Conditions)	Risk to meeting regulatory guidelines / permit requirements	WCFM R3, Community Engagement

TABLE 6-4: GREEN INFRASTRUCTURE ALTERNATIVE ANALYSES TO ADDRESS RISKS IDENTIFIED IN CHAPTER 5

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
Physical mortality risks	Risk of failing GI assets due to physical mortality	MMSD GI SharePoint database	By 2035	Risk to meeting Foundational Goal G3: Integrate green infrastructure into all facets of development and redevelopment	GI FG3, Foundational Goal Financial Analysis GI FG4, Tracking and Goals Analysis GI FG6, Operations and Maintenance Analysis
Level of service risks	Risk of not providing the desired level of service due to an insufficient number of GI assets being built by 2035 (i.e., not meeting the 200 MG permit goal or the 740 MG 2035 Vision goal, with only approximately 40 MG of GI installed as of the end of 2019)	WPDES permits through regulatory period (200 MG goal) 2035 Vision (740 MG goal and zero overflows goal) GI Risk Register	By 2035	Risk to meeting regulatory guidelines / permit requirements Risk to meeting Foundational Goal G3: Integrate green infrastructure into all facets of development and redevelopment	GI R1, Regulatory Financial Analysis GI FG1, Education Analysis GI FG2, Effectiveness Analysis GI FG3, Foundational Goal Financial Analysis GI FG4, Tracking and Goals Analysis GI FG5, Regulations Analysis GI FG6, Operations and Maintenance Analysis
Economic efficiency risks	GI costs more than traditional stormwater practices	GI Risk Register	By 2035	Risk to meeting Foundational Goal G3: Integrate green infrastructure into all facets of development and redevelopment	GI FG3, Foundational Goal Financial Analysis

TABLE 6-5: SYSTEMWIDE ANALYSES TO ADDRESS RISKS IDENTIFIED IN CHAPTER 5

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 [1]	Ch 6 Analysis
JIWRF and SSWRF capacity risks	Risk to of increased rates to rate payers if capacity risks are not mitigated in the most effective manner. In order to optimize WRF capacity in the most cost-effective manner, it is important to identify the most effective ways to reutilize various treatment and transportation options at JIWRF, SSWRF, and the Conveyance System Risk of negatively impacting community relationships if changes in customer expectations related to JIWRF odors, noise and nuisance, and recreational opportunities around JIWRF are not addressed Structural risks identified at JIWRF that are due to the construction on wood piles	Systemwide assessment	Varies	Risk to meeting Foundational Goals G1, G2, and G5	SW FG1, JIWRF and SSWRF Reutilization
Level of service risks	Risk of not meeting PI target of 0 SSO events per year	Actual historical performance trends MMSD staff identified as a top priority related to its 2035 Vision	Existing[2]	Risk to meeting Foundational Goal G1, G2 and G5	SW FG2, Zero Overflows
	Risk of not meeting PI target of 0 CSO events per year	Actual historical performance trends MMSD staff identified as a top priority related to its 2035 Vision	By 2035 (2035 Vision)	Risk to meeting Foundational Goal G1, G2 and G5	SW FG2, Zero Overflows
	Risk of not meeting KPI target of 100% of annual energy from renewable sources	Actual historical performance trends with focus on 2017 baseline energy use MMSD staff identified as a top priority related to its 2035 Vision	By 2035 (2035 Vision)	Risk to meeting Foundational Goal G1, G2 and G5	SW FG3, Energy Plan Additional Alternatives SW FG4, Energy 2035 Vision
	Risk of not meeting KPI target of 80% of annual energy from MMSD-generated renewable sources	Actual historical performance trends with focus on 2017 baseline energy use MMSD staff identified as a top priority related to its 2035 Vision	By 2035 (2035 Vision)	Risk to meeting Foundational Goal G1, G2 and G5	SW FG3, Energy Plan Additional Alternatives SW FG4, Energy 2035 Vision

1) 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, G3: Integrate green infrastructure into all facets of development and redevelopment, G4: Support urban biodiversity activities within the region, and G5: Provide adaptive leadership to climate change and the other drivers.
2) Timing is 'existing' since 2019 WDPES permit does not allow SSOs.

6.2 ALTERNATIVE DEVELOPMENT PROCESS

Alternative Analysis Assumptions

In general, the criteria used in the capacity, physical mortality, level of service, and economic efficiency assessments to identify specific risks in Chapter 5 as presented in Tables 6-1 through 6-5 were used to develop the alternative analyses. In cases where updates to the risks identified in Chapter 5 were warranted based on the more detailed evaluation in this chapter, the specific changes to assumptions are noted in individual analyses. Specific assumptions used to develop the alternative analyses regarding demand conditions, environmental assessments and flooding impacts are presented below.

Demand Conditions

Because a number of alternative analyses are based on capacity risks identified through assessment of facilities against demand projections, the following demand conditions, as defined in Chapter 4, are presented again for reference:

- **Baseline Conditions:** most recent available data set used as a reference point to compare Future Conditions and Buildout Conditions projections. For Conveyance and Storage, WCFM, and GI Asset Systems, the 2010 population and land use data from SEWRPC were used. The WRFs and Biosolids Asset System used WRF influent measured data from September 1, 2013 to August 31, 2016.
- **Future Conditions:** established as the year 2035 to align with the 2035 Vision and Strategic Objectives document developed by MMSD. The 2050 Facilities Plan (2050 FP) assumes that conditions in 2040 will be substantially equivalent to conditions in 2035 because growth projections in the region historically have been more optimistic than actual growth. Additionally, the assumption that 2040 conditions will be equal to 2035 conditions adds some justifiable conservatism to the projections.
- **Buildout Conditions:** estimated future demand conditions when the MMSD planning area is built out. Based on population and land use data from SEWRPC and assigned the year 2050 by MMSD for all asset system except the WRFs and Biosolids Asset System. Evaluations determined that Jones Island Water Reclamation Facility (JIWRF) Future Conditions are equivalent to Buildout Conditions. South Shore Water Reclamation Facility (SSWRF) Buildout Conditions are not anticipated to be met by 2050 based on recent data trends.

Environmental Assessments

None of the risks identified in Chapter 5 is anticipated to result in a proposed alternative that would require significant new land use or have other environmental impacts, such as increased air emissions, so no environmental assessment of alternatives was performed. Environmental impacts will be considered during the preliminary engineering phase of each project selected for implementation and the need for an environmental assessment will be reviewed again at that time.

Flooding Impacts

None of the risks identified in Chapter 5 is anticipated to result in a proposed alternative that would require significant structures to be built within a floodplain so no flooding analysis of alternatives was

performed. Flooding impacts will be considered during the preliminary engineering phase of each project selected for implementation and the need for flooding analysis will be reviewed again at that time.

Process Overview

As a critical part of the 2050 FP process, the 2050 FP project team developed alternatives and evaluated them using the project's evaluation criteria. Each alternative was developed to address the potential risks identified in Chapter 5.

Once developed and analyzed, the recommended alternatives were presented to the MMSD Commission and to public and stakeholder groups for input and review. The recommended plan to meet regulatory guidelines and permit requirements (Chapter 7) and recommended plan to meet 2050 Foundational Goals (Chapter 8) were developed based on a thorough evaluation of these alternatives.

Because the 2050 FP was developed during a period when a large number of MMSD projects and programs were already underway, as part of the alternative analysis process, the 2050 FP project team reviewed MMSD's current long-range finance plan (2020 to 2025 long-range finance plan) to determine if any of the existing projects would address the potential risks.

Attributes for Alternatives

In order to be considered, each alternative was required to have the following attributes:

1. MMSD must be able to meet permit, O&M contract and other requirements if the alternative is implemented.
2. The alternative must be technologically feasible. Alternatives that are not technologically feasible were not considered. For example, alternatives using technologies that are not fully developed or deemed not feasible to reach the objectives were not considered.
3. It must be possible to implement the alternative within the time periods analyzed in the 2050 FP (the 2020 to 2040 timeframe to address regulatory guidelines and permit requirements, and the 2020 to 2050 timeframe to meet 2050 Foundational Goals).
4. An alternative must have an outcome defined to reduce the identified risks.

Alternative Analysis Scoring Methodology

As part of each alternative analysis, the alternatives were scored against each other using a triple bottom line approach that considers a broad framework of social, environmental, and financial impacts (not just cost) per Wis. Admin. Code NR 110.09(1). The scoring process identified the alternative that has the highest value ratio, indicating that it provides the most value per million dollars spent. This section describes the methodology that was used to score the alternatives.

Paired Comparison Analysis

Prior to the alternative analysis scoring process, senior MMSD executives conducted a paired comparison analysis to determine the relative importance of each level of service category identified in Chapter 3. The paired comparison analysis helps to define priorities when there are conflicting demands on an organization's resources and helps to avoid situations where all options are considered equally 'important.'

Note that by default all level of service categories are considered important or they would not have been selected; however, some of level of service categories are more important than others when compared to each other. Therefore, weighting factors were assigned, as discussed in the methodology below, to determine the relative weight of each level of service category.

The paired comparison analysis was conducted as follows:

1. First, each level of service category was compared individually against the other six categories to determine its relative importance. For example, the importance of meeting permit requirements was compared to energy usage.
2. Then the difference in importance between each two-category comparison was scored from 0 (slight difference in importance) to 3 (major difference, one is much more important than the other).
3. A minimum score of 3 was added to each level of service category to establish a baseline of importance and to establish a total comparison score.
4. The points for each level of service category were summed and normalized to 100 to assign a weighting factor. The resulting weighting factors are presented in Table 6-6. The backup calculations are presented in Appendix 6F.

TABLE 6-6: LEVEL OF SERVICE CATEGORY WEIGHTING FACTORS

Triple Bottom Line Measure	Level of Service Category	Weighting Factor
Environmental	Permit Requirements	26
	Energy	17
	Environmental Improvements	15
Economic	Fiscal Responsibility	17
	Management Effectiveness	6
Social	Safety	13
	Customer Service, Communication and Employee Development	6

Alternative Analysis Scoring Process

After the initial paired comparison analysis was completed, the 2050 FP project team scored the alternatives. For each alternative analysis, the alternatives were scored against each other. To complete the scoring, a net present worth was calculated for each alternative using the following assumptions:

- Capital costs escalated using the Engineering News-Record Construction Cost Index (ENR-CCI), which was projected to be 14,700 in December 2019 for Milwaukee.[1]
- Capital costs include construction costs, which include allowances for undesigned details, contingency and contractor overhead and profit, plus markups to account for design, bidding, MMSD oversight, and project closeout. Specific assumptions are provided in cost estimate appendices.
- Annual We Energies electrical rates in effect as of December 23, 2014. [1] [2]
- Annual natural gas rate of $5/Dtherm and landfill gas rate of $2.50/Dtherm.[3]
- Other annual operating and maintenance (O&M) costs as specified in individual analyses.
- No annual increase in costs.
- Discount rate set at 3.375 percent, as directed by WDNR. [2]
- Equipment replacement costs for major equipment replaced during 20-year life cycle.
- Salvage value for major structural facilities (pipes, buildings, structures).
- Present worth assumes a 20-year life cycle and is the sum of capital costs, present worth of annual O&M costs, equipment replacement costs and salvage value, and is accurate within a range of +50 to -30 percent of the values presented.

Each alternative was scored against the seven level of service categories identified in Chapter 3, which are grouped into the triple bottom line impacts. The scoring process for each alternative analysis involved the following steps:

1. The 2050 FP project team identified the analysis-specific performance factors for each level of service category that were to be considered when scoring the alternatives. Performance factors that were considered included the key performance indicators (KPIs) and performance indicators (PIs) identified in Chapter 3 as well as other relevant factors.
2. Next, the 2050 FP project team rated each level of service category for each alternative considered. This rating was based on how closely each alternative conformed to the level of service category's defined performance factors. Alternatives were rated from 1 (poor) to 5 (very good). If the level of service category was not applicable (meaning that there was no relevant performance factor for that category), a rating of 0 was assigned for all alternatives.
3. Ratings were multiplied by the weighting factor to obtain weighted scores for each alternative/ level of service category combination.

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[1] The ENR- CCI represents the cost of a common base of construction labor and materials (including concrete, steel, and lumber). The ENR-CCI for Milwaukee (Milwaukee ENR) is calculated as 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.

[2] For more complicated analyses (for instance, the WRF FG2, Alternative Biosolids Processing and Disposal System presented in Appendix 6B), spreadsheet energy rate calculators for JIWRF and SSWRF provided by MMSD were used to determine blended electrical rates based on projected generated and purchased electricity. There is a new WE Energies rate structure effective January 1st, 2020, projected to increase electric revenue by an average of 1.3 percent from those effective as of December 23, 2014. [13] However, it is not anticipated the recommendations would change if the 2020 rates were used instead.

[3] Natural gas rates fluctuate and landfill gas rates are set as a percentage of natural gas rates. Assumptions presented for planning purposes are those set in the spreadsheet energy rate calculators provided by MMSD.

4. Total weighted scores were calculated for each alternative and then divided by the alternative's present worth to determine the value ratio, which is the alternative that provides the most value per million dollars spent.
5. Recommendations were made by considering the total present worth costs, the weighted scores, and the value ratio as guidance. Through an iterative process, MMSD input and consensus was obtained prior to finalizing scores and selecting a recommended alternative. While the value ratio was typically used to make a recommendation, there are some situations where recommendations were made on the total weighted score. When this situation occurred or when value ratios were close, the top recommendation is presented along with the other alternatives that should receive additional consideration as part of preliminary engineering.

The following example tables shows the result of the scoring process for Conveyance Capacity Project CS R1, South Howell Ave Pipe Capacity, presented in Appendix 6A, Conveyance Alternative Analyses, which addresses the risk of a pipeline capacity deficiency. Table 6-7 shows the analysis-specific performance factors that were selected for scoring alternatives and Table 6-8 shows the scoring matrix for this analysis.

TABLE 6-7: EXAMPLE ANALYSIS-SPECIFIC PERFORMANCE FACTORS FOR CONVEYANCE CAPACITY PROJECT CS R1

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 conveyance alternatives are: 0 SSOs and 6 CSOs (regulatory) and 0 CSOs (MMSD goal).*
	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 gravity conveyance alternatives 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. *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 strategy 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 strategy's ability to help management achieve the permit and O&M contract goals. Factors to consider include complexity to implement/operate new technologies or strategies 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 strategy'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 strategy 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 6-8: EXAMPLE ALTERNATIVES SCORING MATRIX FOR CONVEYANCE CAPACITY PROJECT CS R1

Alternative Scoring Matrix South Howell Ave Pipe Capacity 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

In the above example, Alternative 1 provides a higher value ratio, which indicates that it provides the most value per million dollars spent. Therefore, Alternative 1 is recommended.

Exceptions

There were a few evaluations that did not follow the standard alternative analysis format as follows:

- Physical Mortality Evaluations - The physical mortality evaluations for the Conveyance and Storage Asset System and WRFs and Biosolids Asset System did not develop alternatives to make recommendations. Instead, these evaluations developed recommended projects from the assets identified in Chapter 5 by grouping similar projects and adding additional project costs (administration, design, etc.) to the installation costs included in AssetView. The details of these projects are presented in the appropriate asset system appendices.
- Conveyance – Several Conveyance analyses conducted programmatic evaluations and identified recommended management strategies instead of specific projects. A summary of the recommendations from these evaluations is included in this chapter.
- WRFs and Biosolids – Several WRFs and Biosolids analyses developed only one alternative to verify specific projects. A summary of the recommendations from these evaluations is included in this chapter.
- WCFM – The WCFM Program had already identified projects to address the risks identified in Chapter 5. Therefore, these projects and their associated costs are summarized in this chapter and no alternative analyses were performed.
- GI – Because several of the potential GI risks are inter-related, they will require multi-pronged alternatives consisting of multiple parallel and related projects. Therefore, these risks have been grouped into one of six analyses. Because of the programmatic nature of the risks and the recommended projects, only one alternative was considered for each analysis, which is recommended.
- Systemwide – the Energy Plan additional alternatives analysis did not compare alternatives against each other. Instead, the analysis considered each alternative separately for opportunities to cost-effectively reduce energy demands or use more renewable energy.

6.3 SUMMARY OF RECOMMENDED PROJECTS

This section presents the recommended projects (if any) from each alternative analysis presented in Appendices 6A to 6E. Each alternative analysis presents the recommended project, including whether more research is recommended prior to the start of the project, the recommended timeframe of the project, and the present worth cost of the project. The capital and O&M costs for these recommended projects are presented in more detail in Chapters 7 and 8.

Recommended Projects to Meet Regulatory Guidelines and Permit Requirements

Tables 6-9 through 6-11 summarize the recommended projects for each asset system to meet regulatory guidelines and permit requirements. The present worth cost presented for each project reflects the incremental increase in costs to MMSD over and above what is in their 2020 to 2025 long-range finance plan and annual budget. For example, in those cases where MMSD already has a system in place, the incremental increase is presented instead of the total project cost. Footnotes are provided to identify the projects where these costs have been adjusted from the present worth costs presented in the alternative analysis.

TABLE 6-9: 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	$1.1	$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]	$0.0	$3.9[4]
					2026–2040	$42.5[4]	$0.0	$42.5[4]
			I/I Mitigation Implementation – Program Funding under Project No. M10005		2020–2025	$8.4[4]	$0.0	$8.4[4]
					2026–2040	$132.0[4]	$0.0	$132.0[4]

TABLE 6-9: 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 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	$0.5[5]
			Facilities – evaluate repair/replacement needs for pump stations (only pumping and electrical/control equipment considered)	N –evaluation is the project	2020–2024	$0.6[5]	$0.0	$0.6[5]
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– 024	$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 M10004 and M10005 in the 2020 to 2025 long-range finance plan. Additional costs to municipalities and private property estimated to be in the range of $60M-$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 as part of their 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 6-10: SUMMARY OF RECOMMENDED WRFS AND BIOSOLIDS PROJECTS TO MEET REGULATORY GUIDELINES AND PERMIT REQUIREMENTS

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)
WRF R1, Effluent Pump Capacity with Rising Lake Levels	Risk that effluent pumps would not be able to operate to full capacity due to projected rising lake levels due to climate change	Wisconsin's Changing Climate: Impacts and Adaption, first report of WICCI[2]	Effluent pump capacity evaluation	N – project is the evaluation	2020–2024	$0.1	$0.0	$0.1
WRF R2, JIWRF Primary Clarification, Secondary Treatment Capacity Analysis	Analysis determined risks identified in Chapter 5 were not applicable	WRF Capacity Assessment	Alternative 2, which maintains nitrification, is considered WRF Baseline Conditions, is recommended so no costs	N/A	N/A	N/A	N/A	N/A
WRF R3, SSWRF Primary Clarification, Secondary Treatment Capacity Analysis	Capacity risks identified at SSWRF (MP02, 04, 05,06), listed as percent of design capacity: MP02 – Avg WLR at 106% MP04 – BOD load at 110% (max month) to 129% (average), oxygen demand at 116% (avg) to 124% (max month) MP05 – Avg SOR at 109%, SLR at 103%(avg), 110% (max) MP06 – Avg RAS flow at 123% WRF Risk Register risk no. R221	WRF Capacity Assessment WRF Risk Register	Phase 1 – Implement Alternative 4A, phase 1 – CEPT and nitrification WRF Baseline Condition needs: aeration diffuser upgrades, selector baffle walls, step feed modifications, and RAS chlorination upgrades as part of Project No. S02015	N – for Phase 1 Y – consider impacts from Phase 2 to biosolids and Milorganite production, especially due to increased iron addition. Impacts to biosolids, and possibly renewable energy impacts, should be considered as part of Advanced Biosolids Facility Project	2020–2024	$0.0[3]	$1.8[3]	$26.2[3]
			Phase 2 - Alternative 4A, phase 2 – CEPT and nitrification WRF Baseline Condition needs: blower system expansion and anaerobic digester upgrades to be implemented if/when BOD loading to secondary treatment reaches 90 percent of design		Dependent on growth and flow	$34.0[4]	$1,095.0[4]	$56.3[4]
WRF R4, Meeting Future *E. coli* Limits at JIWRF and SSWRF Analysis	Risk that the disinfection systems at JIWRF and SSWRF are not adequate to meet future WPDES permit requirements	October 23, 2019 WDNR legislation regarding change in pathogen indicator in wastewater from fecal coliform to E. coli	Alternative 1 – free chlorine disinfection	Y – conduct full-scale testing and prove performance. If future permit limits cannot be met in testing, initiate a capital project - consider UV treatment in preliminary engineering, refer to emerging contaminants as discussed in Chapter 8.	2025–2029	$0.0	$730.0[5]	$10.5[5]

TABLE 6-10: SUMMARY OF RECOMMENDED WRFS AND BIOSOLIDS PROJECTS TO MEET REGULATORY GUIDELINES AND PERMIT REQUIREMENTS

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)
WRF R5, D&D Shutdown Solids Handling Capacity	Risk of failure of the plate and frame dewatering system due to the aged PLC system and the fact that parts are no longer supported by the vendor Risk of failure of the plate and frame dewatering system due to the challenges to maintaining the feed pumps Risk of insufficient solids processing and disposal capacity at SSWRF during a JIWRF D&D extended or short-term shutdown	WRF Risk Register risk no. R111 WRF Risk Register risk R112 WRF Risk Register risk no. R190	Alternative 1 – process and Dispose of Biosolids at SSWRF with GBT Thickening and Plate and Frame Press Dewatering	Y – further refine this recommendation during development of Biosolids Advanced Facility Plan based on future biosolids projections and recommended biosolids alternative chosen in advanced planning effort	2020–2024	$9.4[6]	$270.0	$13.3[6]
WRF R6, JIWRF TMDL Management	Risk that JIWRF will not be able to meet WLA effluent limits due to higher waste mass loadings anticipated during wet weather events	WRF Capacity Assessment	Effluent filtration for blending	Y – operational management procedures to limit permit violations	Dependent on findings of implementation of procedures	$45.7	$430.0	$51.8
WRF R7, Physical Mortality Evaluation	Capacity risks at JIWRF (MP08, MP13) and SSWRF (MP09), listed as percent of design capacity JIWRF MP08 – max month processing at 135% JIWRF MP13 – 96% of days storage design capacity at max month production (want more than 100%) SSWRF MP09 – Avg TSS loading at 107% Various physical mortality risks due to asset age Engine generators have high maintenance and high downtime, which is costly and not consistent with MMSD energy goals	WRF Capacity Assessment AssetView condition data WRF Risk Register risk no. R113	JIWRF Detailed Evaluation	N - Project is the evaluation regarding repair/replacement need	2020–2024	$0.8	$0.0	$0.8
			JIWRF Detailed Evaluation	N - Project is the evaluation regarding repair/replacement need	2020–2024	$0.7	$0	$0.7

TABLE 6-10: SUMMARY OF RECOMMENDED WRFS AND BIOSOLIDS PROJECTS TO MEET REGULATORY GUIDELINES AND PERMIT REQUIREMENTS

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)
WRF R8, Milorganite Process System Physical Mortality Evaluation	Capacity risks at JIWRF (MP10, MP11), listed as percent of design capacity JIWRF MP10– max month processing at 110% JIWRF MP11– max month processing at 108% Risk of necessity to implement emergency operations and the corresponding cost impacts due to the insufficient capacity of the D&D sludge cake bypass belt to process all dewatered biosolids in the event that the south side system goes offline Risk of various system failures (N = 96) due to age of multiple D&D systems	WRF Capacity Assessment WRF Risk Register risk no. R039 WRF Risk Register, multiple risks	None – evaluate needs under JIWRF evaluation recommended in WRF R7	NA	NA	$0.0	$0.0	$0.0
WRF R9, Loss of Electrical Power at JIWRF Substations	Risk of loss of JIWRF electrical power due to the condition of substation equipment (Dewey and Harbor) Risk of loss of power due to age and reliability of electric substations, MCCs and other power distribution systems	WRF Risk Register risk no. R005 WRF Risk Register risk no. R005	Alternative 3 – replace critical MMSD Dewey Substation components	N	2020–2024	$2.1	$0.0	$2.1
WRF R10, Condition and Performance of Dryer Emissions Controls	Risk of air permit non-compliance due to trend of increasing stack testing emissions Risk of excessive power consumption and potential air permit non-compliance due to the condition, performance and power use of D&D wet ESPs	WRF Risk Register risk no. R228 WRF Risk Register risk no. R057	No new project – under Project No. J04064, if condition assessment determines need, consider Alternative 3 – rehabilitation of the existing cyclones and replacement of the rectifier transformers for the existing WESPs	N	Depends on condition assessment	$0.0	$0.0	$0.0
WRF R11, JIWRF Odor Monitoring and Control	Risk of negative publicity, community impacts and not meeting 2017 NR 110 requirements due to JIWRF treatment process odors	WRF Risk Register risk no. R120	No new project – Project No. J06078 identified to assess effectiveness of recently-implemented odor logging, reporting and response protocols and systems	N	2020–2024	$0.0	$0.0	$0.0

1) Where applicable, additional research opportunities are identified in Chapter 9.
2) WICCI – Wisconsin's Initiatives on Climate Change Impacts.
3) MMSD project S02015 is budgeted for $26.9 million, which covers $23.8 million of the total $57.8 million estimate provided in Table 6B-26. The annual O&M costs represent additional costs estimated after the project is implemented, and the present worth reflects just those annual O&M costs.
4) Capital costs reflect the remaining costs out of the $57.8M total estimated in Table 6B-26, and the annual O&M costs reflect the additional incremental increase in annual O&M costs for the additional facilities.
5) Of the $1.1M of annual O&M costs presented in Table 6B-35 for Alternative 1, $0.73M is projected to be an increase in WRF Baseline annual O&M costs due to the additional chemicals, representing an incremental present worth cost of $10.5M.
6) MMSD already has two projects, S04010 and S04012 identified to address some of the risks. The capital represents the additional recommended capital costs to address the full risk - $9.4M, which has an associated present worth of $13.3M.

TABLE 6-11: SUMMARY OF RECOMMENDED WATERCOURSE AND FLOOD MANAGEMENT PROJECTS TO MEET REGULATORY GUIDELINES AND PERMIT REQUIREMENTS

Ch 6 Analysis	Specific Description of Potential Risk	How Potential Risk was Identified	Name of Recommended Project	More Research Recommended Prior to Project? (Y/N)[1]	Recommended Timeframe of Project	Present Worth Cost ($ millions)
WCFM R1, Identified WCFM Projects	Risk of flooding due to the failure of concrete-lined channels	WCFM Risk Register risk nos. W014, W015, W109, W110 WCFM Program inspection reports	Multiple watershed projects	N	2020–2024	$142.8
	Risk of unforeseen emergency situations due to a lack of a Watercourse Asset Management Program (multiple watersheds)	WCFM Risk Register risk no. W016			2025–2029	$81.3
					2030–2039	$386.1[2]
WCFM R2, SEWRPC Flooding Evaluation	Risk of flooded structures due to structures remaining within the 1-percent annual probability event	WCFM Program internal documentation	None at this time – monitor for increases in design rainfall intensities and flow rates	N/A	N/A	N/A
WCFM R3, Community Engagement and Inter-Governmental Relations	Risk of downstream MMSD assets (stream restoration projects, conveyance system, WRFs) being adversely impacted by non-MMSD entities not following Chapter 13 Stormwater Rule (multiple watersheds)	WCFM Risk Register risk no. W055	Implementation of community engagement efforts to encourage entities to implement MMSD Chapter 13 Rules	N/A	N/A	N/A

1) Where applicable, additional research opportunities are identified in Chapter 9.
2) Costs for 2040–2049 presented in Appendix 6C are not included since they are outside the 2020–2040 regulatory period.

TABLE 6-12: SUMMARY OF RECOMMENDED GREEN INFRASTRUCTURE PROJECTS TO MEET REGULATORY GUIDELINES AND PERMIT REQUIREMENTS

Ch 6 Analysis	Specific Description of Potential Risk	How Potential Risk was Identified	Name of Recommended Project	More Research Recommended Prior to Project? (Y/N)[1]	Recommended Timeframe of Project	Annual MMSD GI Capital Program Funding	Present Worth Cost ($ millions)
GI R1, Financial Analysis	Risk of not meeting WPDES assumed permit goal of 200 MG of GI by 2040	GI Risk Register risk nos. G003, G014, and G024	Continued and increased funding for GI program	Y - Success of first CBGI project should be evaluated	By 2035	Average of $29.7M between 2020 and 2035[2]	$362.6M[2]

1) Where applicable, additional research opportunities are identified in Chapter 9.
2) The average annual cost and present worth cost include $20M already included in the 2020 to 2025 long-range finance plan and the proposed additional $30M to be added to the 2020 to 2025 long-range finance 6-year time period. The remaining present worth for future costs after 2025 is equal to $312.6M.

Recommended Projects to Meet 2050 Foundational Goals

Tables 6-13 through 6-16 summarize the recommended projects to meet 2050 Foundational Goals. The present worth cost presented for each project reflects the incremental increase in costs to MMSD over and above what is in their 2020 to 2025 long-range finance plan and annual budget. For example, in those cases where MMSD already has a system in place, the incremental increase is presented instead of the total project cost. Footnotes are provided to identify those projects where these costs have been adjusted from the present worth costs presented in the alternative analysis.

TABLE 6-13: 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 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	$0.0[2]	N/A	$0.0[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	$0.0[3]	N/A	$0.0[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
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

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 Costs ($ thousands)	Present Worth Cost ($ millions)

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.

TABLE 6-14: SUMMARY OF RECOMMENDED WRFS AND BIOSOLIDS 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 Costs ($ thousands)	Present Worth Cost ($ millions)
WRF FG 1, Milorganite Quantity and Quality	Risk of Milorganite phosphorus-to-nitrogen ratio not meeting state regulations	WRF Risk Register No. R172	Due to high costs, no alternatives are recommended at this time	Y – monitor the impact of the nutrient ratio in Milorganite on sales. Monitor changes in labeling requirements.	N/A	$0.0	$0.0	$0.0
WRF FG2, Alternative Biosolids Processing Disposal Systems	Risk of wet weather capacity restrictions and permit violations due to D&D facility drying capacity/reliability issues Safety risks in dryer systems due to the utilization of waste heat and the high oxygen levels in the dryer systems	WRF Risk Register risk no. 173 WRF Risk Register risk no. 177	Alternative 1: Produce Milorganite with new drying systems at JIWRF D&D Facility	Y – a sensitivity analysis as part of the Biosolids Advanced Facility Planning project, include biosolids processing assumptions, energy costs and biosolids revenue, and future capacity of JIWRF MP08, MP13, SSWRF MP09	2020–2024	$214.6	($8,200.0)[2]	$94.6[2]
WRF FG3, JIWRF Milorganite Bagging	Risk of not being able to contract with a Milorganite packaging / bagging vendor due to the limited number of vendors (only one)	WRF Risk Register No. R261	None – purpose was to provide guidance for preliminary engineering of J04074, Milorganite Packaging Facility	Y – additional alternatives are identified for additional research as part of preliminary engineering. See Appendix 6B.	Committed project to be completed prior to bagging contract renewal in 2024	$0.0	$0.0	$0.0
WRF FG4, Increase SSWRF Renewable Energy Use	Risk of not meeting KPIs for 100% of annual energy from renewable sources and 80% of annual energy from MMSD-generated renewable sources by not utilizing the most energy efficient systems and available renewable energy	2015 – 2017 actual performance trends against KPIs Energy Plan 2035 Vision	Alternative 2 – 3.2 MW Solar with battery storage	See WRF FG5 below for additional analysis that was conducted to confirm need	2020–2024	$19.5	($880.0)[3]	$4.7[3]
WRF FG5, JIWRF and SSWRF Interplant Energy Connection	Risk of not meeting KPIs for 100% of annual energy from renewable sources and 80% of annual energy from MMSD-generated renewable sources by not utilizing the most energy efficient systems and available renewable energy	2015 – 2017 actual performance trends against KPIs Energy Plan 2035 Vision	This additional analysis confirmed that Alternative 2 from WRF FG4 – 3.2 MW Solar with battery storage is still recommended	N/A	N/A	$0.0	$0.0	$0.0

TABLE 6-14: SUMMARY OF RECOMMENDED WRFS AND BIOSOLIDS 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 Costs ($ thousands)	Present Worth Cost ($ millions)
WRF FG6, Reduction of SSWRF Energy Use	Risk of not meeting KPIs for 100% of annual energy from renewable sources and 80% of annual energy from MMSD-generated renewable sources by not utilizing the most energy efficient systems and available renewable energy	2015 – 2017 actual performance trends against KPIs Energy Plan 2035 Vision	None (MMSD already has a project to implement lighting upgrades at SSWRF as noted under Alternative 5.)	N/A	N/A	$0.0	$0.0	$0.0
WRF FG7, Backup Power for Black Start System at SSWRF	Risk of limited black start capability utilization because existing battery has capacity for only one start and backup power capacity is not available in a power outage	WRF Risk Register risk no. R197	Alternative 1: Backup power for black start system	N	2020–2024	$0.0[4]	$0.0[4]	$0.0[4]
WRF FG8, JIWRF Wet Weather Capacity	Risk that baseline CSO frequency will increase due to increased flows if JIWRF wet weather capacity is not increased (need up to 150 MGD blending capacity) Risk of conveyance system overflows by not maximizing ISS pump out blending at JIWRF	WRF Capacity Assessment WRF Risk Register risk no. R240	Alternative 1 – increase blending to the maximum system capacity available	Y – recommendations should be incorporated when implementing changes for WRF R4	Dependent on findings from operational management procedures implemented under WRF R6	$0.1 for just bypass channel and disinfection upgrades $48.5 for all	$30.0 for just bypass channel and disinfection upgrades $1,120.0 for all	$0.9 for just bypass channel and disinfection upgrades $64.6 for all
WRF FG9, SSWRF Wet Weather Capacity	Capacity risks at SSWRF (MP01) Risk of conveyance system overflows at BS0405 and DC0103 by not utilizing the potential to blend at SSWRF	WRF Capacity Assessment WRF Risk Register risk no. R090	No additional project. Project No. S03003 is moving forward with Alternative 1 – implement blending process when needed to convey > 300 MGD of wet weather flows	Y – see details in WRF FG9 analysis	Dependent on growth and flow	$0.0[5]	$30.0[5]	$0.4[5]

1) Where applicable, additional research opportunities are identified in Chapter 9.
2) Annual O&M cost represents an incremental cost savings compared to annual O&M costs for WRF Baseline Conditions drying system. The present worth represents the cost after the incremental annual cost savings and salvage value are applied.
3) Annual O&M cost represents an incremental cost savings compared to annual O&M and energy costs under WRF Baseline Conditions. The present worth represents the cost after the incremental annual cost savings and salvage value are applied.
4) Cost for recommended project from WRF FG7, Backup Power for Black Start at SSWRF is $0.3 million. This cost is already included in the recommended project for WRF FG4 so this cost is not presented in the table.
5) No capital cost is presented since MMSD already is moving forward with project S03003. Annual costs, and present worth, represent the additional annual O&M estimated after the project is operational.

TABLE 6-15: SUMMARY OF RECOMMENDED GREEN INFRASTRUCTURE 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)	Recommended Timeframe of Project	Annual MMSD Labor Costs (Current/New Staff)[1] ($ thousands)	Annual MMSD Contractor Costs[1] ($ thousands)	Annual MMSD GI Program Funding[1] ($ millions)	Present Worth Cost[1] ($ millions)
GI FG1, Education Analysis	Risk that key stakeholders are not being educated about the benefits of GI	GI Risk Register risk nos. G005, G018, G020, G025, and G026	Several recommended GI education projects. See GI FG1 analysis.	N	By 2035	$3.6 for training costs; existing and new labor costs covered under other alternatives	$322.5	None (included under other alternatives)	$4.4
GI FG2, Effectiveness Analysis	Risks associated with ineffective GI caused by inadequate planning, design, and installation	GI Risk Register risk nos. G006, G007, G008, G013	Several recommended GI effectiveness projects. See GI FG2 analysis.	N	By 2035	$0.0 (existing and new labor costs covered under other alternatives)	$308.0	None (included under other alternatives)	$2.7
GI FG3, Financial Analysis	Risks that are associated with ensuring the efficient and effective use of the financial resources applied to MMSD's GI Programs	GI Risk Register risk nos. G003, G014, G015, G017, G021, G022, and G027	Several recommended GI financial projects. See GI FG3 analysis.	N	By 2035	$600.0 (existing and new labor costs)	$0.0	$15.7	$234.0
GI FG4, Tracking and Goals Analysis	Risk that is associated with inadequate inventorying and tracking of the location, scope, and condition of GI	GI Risk Register risk no. G004	Several recommended GI tracking and goals projects. See GI FG4 analysis.	N	By 2035	$100.0	$0.0	$0.0	$1.4
GI FG5, Regulations Analysis	Risks that are associated with regulations at the local, regional, and state level that inhibit the planning, design, installation, and maintenance of GI	GI Risk Register risk nos. G001, G012, G019, G023, and G024	Several recommended GI regulations projects. See GI FG5 analysis.	N	By 2035	$0.0 (labor costs included elsewhere)	$100.0	$0.0	$0.5
GI FG6, Operations and Maintenance Analysis	Risks that are associated with GI assets not performing as designed and potentially requiring premature replacement without adequate, consistent, and effective maintenance	GI Risk Register risk nos. G002 and G010	Several recommended GI operations and maintenance projects. See GI FG6 analysis.	N	By 2035	$175.0	$0.0	$3.0	$45.5

1) These numbers include costs for the related existing projects that are assumed to be continued in addition to the costs to implement the new recommended strategies. These costs are further presented in Chapters 8 and 9.

TABLE 6-16: SUMMARY OF RECOMMENDED SYSTEMWIDE 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 (Millions)	Present Worth Cost (Millions)
SW FG1, JIWRF and SSWRF Reutilization	Risk to of increased rates to rate payers if capacity risks are not mitigated in the most effective manner. In order to optimize WRF capacity in the most cost-effective manner, it is important to identify the most effective ways to reutilize various treatment and transportation options at JIWRF, SSWRF, and the Conveyance System Risk of negatively impacting community relationships if changes in customer expectations related to JIWRF odors, noise and nuisance, and recreational opportunities around JIWRF are not addressed Structural risks identified at JIWRF that are due to the construction on wood piles	JIWRF and SSWRF capacity risks identified in Systemwide Assessment MMSD staff identified as a top priority related to its 2035 Vision	Assessment of Conveyance system – diversion of flow from JIWRF service area to SSWRF service area	N – recommendation includes research	2020–2024	$0.1	$0.0	$0.1
SW FG2, Zero Overflows	Risk of not meeting PI target of 0 SSO events per year Risk of not meeting PI target of 0 CSO events per year	Actual historical performance trends MMSD staff identified as a top priority related to its 2035 Vision	Phase 1: See recommended projects in Appendices 6A, 6B, 6D: - CS R1 through R8, Capacity - CS R9, Combat I/I Impact from Pipe Degradation - WRF FG8, JIWRF Wet Weather Capacity - WRF FG9, SSWRF Wet Weather Capacity - GI projects to get to 740 MG	N	2020–2025	$0.0	$0.0	$0.0
			Phase 2: assessment of system through modeling	N - recommendation includes research	2026–2050	$10.0	$0.0	$10.0
			Phase 3: JIWRF HRT, Conveyance Related Overflow projects, select CSO HRT	Y - Phase 2 assessment	2030–2039	$982.4	$0.0	$982.4
			Phase 4: SSWRF HRT	Y - Phase 2 assessment	After 2050	$355.8	$0.0	$355.8

TABLE 6-16: SUMMARY OF RECOMMENDED SYSTEMWIDE 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 (Millions)	Present Worth Cost (Millions)
SW FG3, Energy Plan Additional Alternatives	Risk of not meeting KPI target of 100% of annual energy from renewable sources Risk of not meeting KPI target of 80% of annual energy from MMSD-generated renewable sources	Actual historical performance trends using information from Energy Plan MMSD staff identified as a top priority related to its 2035 Vision	No additional projects over and above those already committed to in the Energy Plan	N/A	N/A	$0.0	$0.0	$0.0
SW FG4, Energy 2035 Vision	Risk of not meeting KPI target of 100% of annual energy from renewable sources Risk of not meeting KPI target of 80% of annual energy from MMSD-generated renewable sources	Actual historical performance trends with focus on 2017 baseline energy use MMSD staff identified as a top priority related to its 2035 Vision	Update Energy Plan completed in 2015 Include projected impact from recommended projects in Appendix 6B: - WRF FG2, Alternative Biosolids Processing and Disposal Systems - WRF FG4, Increase SSWRF Renewable Energy Use	N- recommendation is research	2020–2024	$1.6	$0.0	$1.6

1) Where applicable, additional research opportunities are identified in Chapter 9.

6.4 APPENDICES

- Appendix 6A – Conveyance Alternative Analyses
- Appendix 6B – Water Reclamation Facilities (WRFs) and Biosolids Alternative Analyses
- Appendix 6C – Watercourse and Flood Management (WCFM) Alternative Analyses
- Appendix 6D – Green Infrastructure (GI) Alternative Analyses
- Appendix 6E – Systemwide Alternative Analyses
- Appendix 6F – Paired Comparison Analysis Process

6.5 REFERENCES

[1] Wisconsin Electric Power Company, "Volume 19 - Electric Rates, Revision 10 Sheet 65, Amendment No. 759, Rate Schedule Cp 1," Wisconsin Electric Power Company, Milwaukee, WI, 2014.

[2] A. Dutcher, "Email to Troy Deibert, HNTB, subject: "discount rate"," Wisconsin Department of Natural Resources, Madison, WI, 2019.

[3] G. Boulton, "PSC approves a 1.3% increase in electric revenue for We Energies," Milwaukee Journal Sentinel, Milwaukee, WI, 2019.

[4] Milwaukee Metropolitan Sewerage District, *The Milwaukee Metropolitan Sewerage District's 2035 Vision and Strategic Objectives,* Milwaukee, WI: MMSD, 2011.