

9. ALTERNATIVE RANKING & EVALUATION

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ALTERNATIVE RANKING & EVALUATION

Background

All identified near-term and long-term alternatives were ranked and evaluated with the evaluation criteria developed previously. Alternatives were assigned a relative score of 1 to 10 for each criterion by the project team according to criteria defined in Table 9-1. Then, the score for each criterion was multiplied by the level of importance for that criterion. For example, if the life cycle cost criterion (with a level of importance of 26) received a score of 10, the weighted score for that criterion is $26 \times 10 = 260$. Total scores for each alternative were then calculated by adding the weighted score for each criterion for that alternative. Planning alternatives with higher total scores represent more favorable alternatives than those with lower scores. Details of the master planning alternative ranking and evaluation are provided in Appendix I, TM9 – Planning Alternative Ranking and Evaluation.

Table 9-1 Planning Alternative Evaluation Criteria Definitions

Evaluation Criteria	Definition
Life Cycle Cost	Life cycle cost is the total discounted dollar cost of owning, operating, and maintaining the planning alternatives. A ranking score of “10” for this criterion represents the lowest life cycle cost.
Public Acceptance	Public acceptance is the support level of the public to a planning alternative. A ranking score of “10” for this criterion represents the highest level of public acceptance.
Watershed Balance	Watershed balance is the potential of a planning alternative to mitigate imbalanced inter-basin water transfer. A ranking score of “10” for this criterion represents the highest potential to mitigate imbalanced inter-basin water transfer.
Flexibility Expandability Compatibility	This criterion is used to gauge alternatives for their potential to be readily modified or expanded to meet future needs, and their compatibility with the existing system. A ranking score of “10” for this criterion represents the highest level of flexibility, expandability and compatibility.
Effluent Reuse	This criterion is used to evaluate all planning alternatives for their potential to provide treated effluent utilization. A ranking score of “10” for this criterion represents the highest potential for effluent reuse.
Regulatory Constraints	This criterion is used to evaluate the potential regulatory constraints that may affect the implementation of the planning alternative. A ranking score of “10” for this criterion represents the lowest level of regulatory constraints.
Proven Effectiveness	This criterion is used to evaluate planning alternatives for their proven reliability in providing the required level of conveyance and treatment. A ranking score of “10” for this criterion represents the highest level of effectiveness.
Carbon Footprint	This criterion is used to evaluate planning alternatives for their impacts on the environment in terms of the amount of the greenhouse gases produced. A ranking score of “10” for this criterion represents the lowest carbon footprint.
Ease of Operation	This criterion is used to rank the efforts involved in the facility operation. A ranking score of “10” for this criterion represents the relatively easiest operation.

Evaluation Criteria	Definition
Staffing Implications	This criterion is used to rank all planning alternatives for the staffing requirements in terms of staffing level and required skills. A ranking score of "10" for this criterion represents staffing level and skill requirements most similar to or less than the current requirements.

Near-Term Alternative Evaluation

In this section, all four variations of the Alternative MP-1 are compared to the two variations of the Alternative MP-2 to determine the planning alternative to be implemented between 2010 and 2030. Life cycle costs were calculated for these planning alternatives based on the costs of construction, operation and maintenance costs, replacement/rehabilitation costs, and salvage values. Operation costs include the costs for pumping wastewater to the treatment plants and pumping effluent from the plants to the various discharge locations, and the operational costs for high quality effluent facilities. The results were presented in Tables 9-2 and 9-3 and were used for subsequent planning alternative evaluation and ranking.

Table 9-2 Alternative MP-1 Life Cycle Cost Analysis

Item	MP-1A	MP-1B	MP-1C	MP-1D
Initial Capital Costs	\$50,881,000	\$68,581,000	\$75,068,000	\$75,068,000
Life Cycle O/M Costs	\$18,881,000	\$30,843,000	\$32,901,000	\$33,029,000
Life Cycle Costs for Facility Improvement & Replacement	\$2,758,000	\$7,313,000	\$7,698,000	\$7,698,000
Salvage Value	(\$3,298,000)	(\$3,702,000)	(\$4,115,000)	(\$4,115,000)
50-Year Total Present Value	\$69,222,000	\$103,034,000	\$111,552,000	\$111,680,000

Table 9-3 Alternative MP-2 Life Cycle Cost Analysis

Item	MP-2A	MP-2B
Initial Capital Costs	\$67,905,000	\$72,305,000
Life Cycle O/M Costs	\$32,407,000	\$34,036,000
Life Cycle Costs for Facility Improvement & Replacement	\$14,028,000	\$14,414,000
Salvage Value	(\$2,261,000)	(\$2,516,000)
50-Year Total Present Value	\$112,079,000	\$118,239,000

The implementation dates and rankings for planning alternatives MP-1 and MP-2 are summarized in Tables 9-4 and 9-5.

Table 9-4 Near-Term Master Planning Alternative Evaluation

Project Variable	Sugar River Watershed Service Alternatives					
	1A	1B	1C	1D	2A	2B
Treatment Plant Location	Nine Springs	Nine Springs	Nine Springs	Nine Springs	Sugar River	Sugar River
High Quality Effluent Treatment Design DAF (mgd)	0.0	4.3	4.3	4.3	4.3	4.3
Effluent Discharge Location	Badger Mill Creek	Badger Mill Creek	Sugar River	Headwaters of Sugar River	Sugar River	Headwaters of Sugar River
NSVI Improvements - Year Required						
PS 11 Firm Pumping Capacity	2015	2015	2015	2015	2045	2045
PS 11 Major Condition Upgrade	2015	2015	2015	2015	2015	2015
PS 11 Force Main Capacity	2025	2025	2025	2025	2051	2051
PS 12 Firm Pumping Capacity	2015	2015	2015	2015	2025	2025
PS 12 Major Condition Upgrade	2015	2015	2015	2015	2015	2015
PS 12 Force Main Capacity	>2060	>2060	>2060	>2060	>2060	>2060
PS 17 Firm Capacity	2015	2015	2015	2015	2020	2020
PS 17 Force Main Capacity	2015	2015	2015	2015	2020	2020
NSVI from PS 11 to PS 12	2020	2020	2020	2020	>2060	>2060
NSVI above PS 12	2020	2020	2020	2020	>2060	>2060
Effluent Return Facilities Required						
To Sugar River South of Verona	No	No	Yes	No	No	No
To Sugar River Headwaters	No	No	No	Yes	No	Yes
To Badger Mill Creek	No	Yes	Yes	Yes	No	No
To Badfish Creek	No	No	No	No	No	No

Table 9-5 Near-Term Master Planning Alternative Evaluation

Project Variable	Sugar River Watershed Service Alternatives					
	1A	1B	1C	1D	2A	2B
Treatment Plant Location	Nine Springs	Nine Springs	Nine Springs	Nine Springs	Sugar River	Sugar River
Evaluation Criteria						
Life Cycle Cost (in millions)	69.2	103.0	111.6	111.7	112.1	118.2
Relative Life Cycle Cost	1.0	1.5	1.6	1.6	1.6	1.7
Ranking Score	10.0	6.7	6.2	6.2	6.2	5.9
Level of Importance	26					
Weighted Score	260	175	161	161	160	152
Public Acceptance						

Project Variable	Sugar River Watershed Service Alternatives					
	1A	1B	1C	1D	2A	2B
Ranking Score	8	9	6	5	4	3
Level of Importance	13					
Weighted Score	104	117	78	65	52	39
Watershed Balance						
Ranking Score	5	8	9	10	9	10
Level of Importance	11					
Weighted Score	55	88	99	110	99	110
Flexibility/Expandability/Compatibility						
Ranking Score	5	6	8	8	8	8
Level of Importance	9					
Weighted Score	45	54	72	72	72	72
Effluent Reuse						
Ranking Score	6	7	8	8	7	8
Level of Importance	9					
Weighted Score	54	63	72	72	63	72
Regulatory Constraints						
Ranking Score	9	7	4	3	4	3
Level of Importance	9					
Weighted Score	81	63	36	27	36	27
Proven Effectiveness						
Ranking Score	8	6	4	4	4	4
Level of Importance	8					
Weighted Score	64	48	32	32	32	32
Carbon Footprint						
Ranking Score	8	6	5	5	10	9
Level of Importance	5					
Weighted Score	40	30	25	25	50	45
Ease of Operation						
Ranking Score	10	7	6	6	3	2
Level of Importance	5					
Weighted Score	50	35	30	30	15	10
Staffing Implications						
Ranking Score	10	9	8	8	5	5
Level of Importance	5					
Weighted Score	50	45	40	40	25	25
Total	803	718	645	634	604	584

Long-Term Planning Alternative Evaluation (4 MGD Capacity)

Planning alternative MP-3A includes the 4 mgd additional treatment facilities at the NSWTP to produce high quality effluent as well as the pumping facilities to return the high quality effluent to the PS 13 site northeast of the Dane County Regional Airport. Planning alternative MP-4A includes the 4 mgd stand-alone high quality effluent treatment plant at the PS 13 service area northeast of the Dane County Regional Airport.

Life cycle costs were calculated for these two planning alternative based on the costs of construction, operating and maintenance costs, replacement/rehabilitation costs, and salvage values. The results are presented in Tables 9-6 and are used for subsequent planning alternative evaluation and ranking.

Table 9-6 Alternative MP-3A/MP-4A Life Cycle Cost Analysis

Item	Alternative MP-3A	Alternative MP-4A
Initial Capital Costs	\$27,100,000	\$40,000,000
Life Cycle O/M Costs	\$20,024,000	\$26,167,000
Life Cycle Costs for Facility Improvement & Replacement	\$4,631,000	\$10,292,000
Salvage Value	(\$1,103,000)	(\$912,000)
50-Year Total Present Value	\$50,652,000	\$75,547,000

The rankings for planning alternatives MP-3A and MP-4A are summarized in Tables 9-7 and 9-8.

Table 9-7 Long-Term Master Planning Alternative Summary (4 MGD Plant)

Project Variable	High Quality Effluent Treatment Plant Alternatives	
	MP-3A	MP-4A
Treatment Plant Location	Nine Springs	Northeast of the Dane County Regional Airport
Treatment Plant Design ADF (mgd)	4.0	4.0
Effluent Discharge Location	Yahara River Watershed	Yahara River Watershed
Effluent Return Pump Capacity (mgd)	4.0	0
Effluent Return Force Main Capacity (mgd)	10.0	0

Table 9-8 Long-Term Master Planning Alternative Evaluation (4 MGD Plant)

Project Variable	High Quality Effluent Treatment Plant Alternatives	
	MP-3A	MP-4A
Treatment Plant Location	Nine Springs	Northeast of the Dane County Regional Airport
Evaluation Criteria		
Life Cycle Cost (in millions)	50.7	75.5
Relative Life Cycle Cost	1.0	1.5
Level of Importance	26	
Weighted Score	260	175
Public Acceptance		
Ranking Score	6	4
Level of Importance	13	
Weighted Score	78	52
Watershed Balance		
Ranking Score	8	8
Level of Importance	11	
Weighted Score	88	88
Flexibility/Expandability/Compatibility		
Ranking Score	7	5
Level of Importance	9	
Weighted Score	63	45
Effluent Reuse		
Ranking Score	8	6
Level of Importance	9	
Weighted Score	72	54
Regulatory Constraints		
Ranking Score	3	3
Level of Importance	9	
Weighted Score	27	27
Proven Effectiveness		
Ranking Score	4	4
Level of Importance	8	
Weighted Score	32	32
Carbon Footprint		
Ranking Score	5	6
Level of Importance	5	
Weighted Score	25	30
Ease of Operation		
Ranking Score	5	2
Level of Importance	5	
Weighted Score	25	10
Staffing Implications		
Ranking Score	5	3
Level of Importance	5	
Weighted Score	25	15
Total	695	528

Long-Term Planning Alternative Evaluation (10 MGD Capacity)

Planning alternative MP-3B includes the 10 mgd additional treatment facilities at the NSWTP to produce high quality effluent as well as the pumping facilities to return the high quality effluent to the PS 13 site northeast of the Dane County Regional Airport. Planning alternative MP-4B includes the 10 mgd stand-alone high quality effluent treatment plant at the PS 13 service area northeast of the Dane County Regional Airport.

Life cycle costs were calculated for these two planning alternative based on the costs of construction, operating and maintenance costs, replacement/rehabilitation costs, and salvage values. The results are presented in Tables 9-9 and are used for subsequent planning alternative evaluation and ranking.

Table 9-9 Alternative MP-3B/MP-4B Life Cycle Cost Analysis

Item	Alternative MP-3B	Alternative MP-4B
Initial Capital Costs	\$45,500,000	\$80,000,000
Life Cycle O/M Costs	\$47,949,000	\$56,670,000
Life Cycle Costs for Facility Improvement & Replacement	\$8,362,000	\$20,584,000
Salvage Value	(\$1,730,000)	(\$1,825,000)
50-Year Total Present Value	\$100,081,000	\$155,429,000

The rankings for planning alternatives MP-3B and MP-4B are summarized in Tables 9-10 and 9-11.

Table 9-10 Long-Term Master Planning Alternative Summary (10 MGD Plant)

Project Variable	High Quality Effluent Treatment Plant Alternatives	
	MP-3B	MP-4B
Treatment Plant Location	Nine Springs	Northeast of the Dane County Regional Airport
Treatment Plant Design ADF (mgd)	10.0	10.0
Effluent Discharge Location	Yahara River Watershed	Yahara River Watershed
Effluent Return Pump Capacity (mgd)	10.0	0
Effluent Return Force Main Capacity (mgd)	10.0	0

Table 9-11 Long-Term Master Planning Alternative Evaluation (10 MGD Plant)

Project Variable	High Quality Effluent Treatment Plant Alternatives	
	MP-3B	MP-4B
Treatment Plant Location	Nine Springs	Northeast of the Dane County Regional Airport
Evaluation Criteria		
Life Cycle Cost	100.1	155.4
Relative Life Cycle Cost	1.0	1.6
Level of Importance	26	
Weighted Score	260	167
Public Acceptance		
Ranking Score	6	4
Level of Importance	13	
Weighted Score	78	52
Watershed Balance		
Ranking Score	8	8
Level of Importance	11	
Weighted Score	88	88
Flexibility/Expandability/Compatibility		
Ranking Score	7	5
Level of Importance	9	
Weighted Score	63	45
Effluent Reuse		
Ranking Score	8	6
Level of Importance	9	
Weighted Score	72	54
Regulatory Constraints		
Ranking Score	3	3
Level of Importance	9	
Weighted Score	27	27
Proven Effectiveness		
Ranking Score	4	4
Level of Importance	8	
Weighted Score	32	32
Carbon Footprint		
Ranking Score	5	6
Level of Importance	5	
Weighted Score	25	30
Ease of Operation		
Ranking Score	5	2
Level of Importance	5	
Weighted Score	25	10
Staffing Implications		
Ranking Score	5	3
Level of Importance	5	
Weighted Score	25	15

Project Variable	High Quality Effluent Treatment Plant Alternatives	
	MP-3B	MP-4B
Total	695	520

Planning Alternative Implementation Recommendation

Near-Term Planning Alternative Implementation

Based on the evaluation of the six near-term planning alternatives for MMSD’s operation in the Sugar River watershed, alternative MP-1A has the highest total score. Its high score is due largely to its lowest life cycle cost, fewer regulatory constraints, long track record of proven effectiveness, ease of operation and minimal staffing implications. Overall alternative MP-1A achieves the highest cost efficiency in providing wastewater conveyance and treatment service in MMSD’s westside service area. However, alternative MP-1A will not be able to alleviate the issue of imbalanced inter-basin water transfer. By pumping additional 4.3 mgd of treated effluent to the Sugar River watershed, the Sugar River base flow reduction would be avoided. However the additional total life cycle costs would be \$34 million, assuming the current discharge limits to Badger Mill Creek and Badfish Creek stay unchanged, but higher quality effluent discharge limits would be required for discharges in the Sugar River watershed. If higher quality effluent was ever required for both Badfish Creek and Badger Mill Creek discharges due to more stringent regulatory requirements, the cost to avoid this base flow reduction may be insignificant.

Alternative MP-1B includes construction of high quality effluent treatment facilities at the NSWTP and pumping of both regular and high quality treated effluent to the Badger Mill Creek outfall through the existing force main. This alternative has the second highest total score and also can achieve high efficiency in providing MMSD’s current service in the area. Unlike MP-1A, in 2060 this alternative returns a total of 7.9 mgd of treated effluent to the Sugar River via Badger Mill Creek, and can effectively alleviate the imbalanced inter-basin water transfer issue. Since the increased flow is high quality effluent, it will not significantly increase the current TP or TN loads to the Badger Mill Creek, and therefore it may have less regulatory constraints for implementation.

Alternatives MP-1C, MP-1D and MP-2A represent centralized and decentralized approaches to solve the watershed balance issue. These three alternatives discharge the same amount of treated effluent to Badger Mill Creek and the Sugar River, and therefore will achieve similar benefits of watershed balance. Alternatives MP-1C and MP-2A would have identical discharge locations. Alternative MP-1D would use a Sugar River headwaters discharge location. Alternatives MP-1C and MP-1D would provide more potential for effluent reuse than alternative MP-2A. Alternatives MP-1C, MP-1D and MP-2A have similar life cycle costs; however, Alternative MP-1C is favored over MP -1D and MP-2A due to its higher rankings in public acceptance, effluent reuse potential, ease of operation, and staffing implications.

Alternative MP-2B represents a decentralized approach to solve the watershed balance issue. This alternative discharges the same amount of treated effluent to Badger Mill Creek and the Sugar River as alternatives MP-1C, MP-1D and MP-2A, but the Sugar River discharge is split between a headwaters location and a location downstream of the confluence with Badger Mill Creek. It will achieve slightly better benefits of watershed balance compared to alternatives MP-1C, MP-1D and MP-2A and slightly higher potential for effluent reuse than alternative MP-2A. The total life cycle cost increases by \$6 million to achieve this better result.

According to the evaluation results, Alternative MP-1A appears to be the most effective alternative for providing service in the Sugar River watershed. If more stringent discharge limits are implemented, a high quality effluent treatment process will also be added at the NSWTP, which will make this alternative less favorable over the other alternatives. Currently there is no impact on the base flow in Badger Mill Creek or the Sugar River due to the return of effluent to Badger Mill Creek. As more development occurs in the Sugar River basin, base flow will be reduced in the Sugar River. If the reduction in base flow in the Sugar River were to become an issue that required mitigation, alternative MP-1B should then be considered for implementation to alleviate the base flow reduction while still maintaining relatively high cost efficiency. Alternatives MP-1C and MP-1D address base flow augmentation in the Sugar River and reduce the flow in Badger Mill Creek to its more normal levels. If the higher flows in Badger Mill Creek became an issue, alternative MP-1C or MP-1D could then be considered for implementation. Since the conceptual life cycle costs for alternatives MP-1B, MP-1C, MP-1D, MP-2A, and MP-2B are relatively close, more detailed facility planning is recommended to determine the more accurate costs for these alternatives before the final decisions are made.

Reduction of inflow/infiltration (I/I) to the existing conveyance system is an important element for the areas that experience high groundwater during wet weather conditions. Effective I/I reduction could delay the need for major capital improvement projects required to expand the capacities of the conveyance system and treatment facilities. Therefore programs to reduce I/I are recommended for all planning alternatives.

Long-Term Planning Alternative (4 MGD Capacity) Implementation Recommendation

Based on the evaluation of the two long-term planning alternatives for a high quality effluent treatment plant with 4 mgd capacity, Alternative MP-3A has higher ranking than MP-4A for almost all ranking criteria except for carbon footprint. Alternative MP-3A has significantly lower life cycle cost than MP-4A due to its lower operational cost achieved through economy of scale. Alternative MP-3A also has higher public

acceptance since most of the new facilities will be constructed at the current NSWTP property. Alternative MP-3A also has higher flexibility for effluent reuse options. Therefore MP-3A is recommended for implementation of a high quality effluent treatment plant with 4 mgd capacity.

Long-Term Planning Alternative (10 MGD Capacity) Implementation Recommendation

Based on the evaluation of the two long-term planning alternatives for a high quality effluent treatment plant with 10 mgd capacity, Alternative MP-3B has higher ranking than MP-4B for almost all ranking criteria except for carbon footprint. Alternative MP-3B has significantly lower life cycle cost than MP-4B due to its lower operational cost achieved through economy of scale. Alternative MP-3B also has higher public acceptance since most of the new facilities will be constructed at the current NSWTP property. Alternative MP-3B also has higher flexibility for effluent reuse options. Therefore MP-3B is recommended for implementation of a high quality effluent treatment plant with 10 mgd capacity.