

Pump Station 7 Improvements



Pump Station 7

Project Purpose:

The purpose of this project is to ensure that Pump Station 7 continues to operate in an efficient and effective manner following construction of Pump Station 18.

Project Proposers/Champions: Todd Gebert

Department: Engineering/Operations & Maintenance

Project Involvement:

Management of the project will be provided by the Engineering Department. Staff from the Engineering Department and the O&M Department will be assigned to areas of need as the project schedule and scope become better defined. Strand Associates was retained in January of 2018 to provide design services for the improvements.

Project History and Status:

In its 2009 *Collection System Study*, the Capital Area Regional Planning Commission (CARPC) projected peak hourly flow rates at Pump Station 7 of 60 million gallons per day (mgd) and 72 mgd for the years 2030 and 2060, respectively. The existing firm capacity at Pump Station 7 is only 39 mgd, thus a major capacity upgrade was required to convey these future flowrates.

Pump Station 7, located at 6300 Metropolitan Lane, had been the largest District pumping facility by volume of wastewater pumped prior to the construction of Pump Station 18. Prior to Pump Station 18 becoming operational Pump Station 7 pumped roughly 40% of the District's wastewater to the Nine Springs Wastewater Treatment Plant, delivering flow from the entire east side of the City of Madison as well as the villages of DeForest, Waunakee, Cottage Grove and McFarland. The facility is in excess of 60 years old and was last rehabilitated in 1992. Elements of the 1992 rehabilitation included an increase in flow capacity, installation of surge control facilities, and the replacement of pumps, electrical gear, and other equipment.

Pump Station 18 was placed into operation in April of 2015 and works in tandem with Pump Station 7 by intercepting part of the flow that presently flows to Pump Station 7. The District plans to provide repairs, replacement, and upgrades to Pump Station 7 to ensure that it continues to function properly and work well in parallel with Pump Station 18.

Pump Station 18 has generally performed as expected since being placed into operation. From April of 2015 until November of 2015 it conveyed 70% of the flow that was previously pumped only by Pump Station 7. Some problems have been experienced in diverting so much flow away from Pump Station 7, however. Prior to Pump Station 18, the A pump at Pump Station 7 did not cycle very often and was able to provide a consistent and steady flow to the treatment plant. With the drop in flow to Pump Station 7 in April of 2015, the A pump began to cycle much more frequently and the flowrate to the treatment plant became more sporadic. This had the effect of making it difficult to balance the flows in the west aeration tanks.

In an effort to correct this, in November and December of 2015 the flow split between the two stations was essentially reversed, such that Pump Station 7 now pumps roughly 2/3 of the flow and Pump Station 18 the remaining 1/3 of the flow from the combined service area. This has helped to reduce the cycling of the A pump at Pump Station 7 and a more stable input of flow to the west aeration tanks.

It is also believed that total suspended solids may be depositing at a greater rate in the Pump Station 7 force mains than prior to the start-up of Pump Station 18. This is due to the lower flowrate (and velocities) being pumped from Pump Station 7. While the large pump at Pump Station 7 is operated on a routine basis to help scour the force mains, data from the District's User Charge program indicates a decrease in solids from this service area since April of 2015.

Options:

a. Description:

Pump Station 7 must continue to operate efficiently and effectively after Pump Station 18 becomes operational. As such, anticipated improvements to Pump Station 7 must be considered in evaluating the various options for meeting capacity needs in the Eastside Collection System.

Recommendations for improvements to Pump Station 7 were identified in AECOM's Final Design

Report for Pump Station 18 (March 2013). The following is a list of improvements to Pump Station 7 based on AECOM's design report and evaluation by District staff:

- Replacement of existing controllers and control system
- Replacement of electrical switchgear, including outdoor transformers and utility equipment
- Replacement of Pump A
- Installation of odor control system
- Replacement and/or modifications to HVAC system
- Separation of control room space from garage area and screen room
- Installation of variable speed drive to optimize pumping operations
- Replacement of manual valves with electrically actuated valves

b. Alternatives

Alternative 1 – Pump Station 7 Improvements

Improvements at Pump Station 7 will be implemented after Pump Station 18 is brought online to address deficiencies related to existing equipment condition and age. Examples of these improvements include replacement of aging pump controllers and the control system. Replacement parts for these items are becoming obsolete and difficult to obtain. Other potential improvements include: replacement of electric switchgear, HVAC modifications, isolation of the dry well and wet well spaces, installation of an odor control system, installation of a variable speed pump drive and replacement of manual valves with electrically actuated valves (including installing an electrically actuated valve on each force main to allow for operation of a single force main during dry weather).

Alternative 2 – Do nothing

As part of this alternative improvements will not be undertaken at Pump Station 7. Pumps, electrical and control equipment will continue to be refurbished or replaced as their component parts fail. This option may eventually lead to sanitary sewer overflows in the collection system due to its inability to meet capacity requirements and due to increased failures of critical electrical and control equipment. Since this option does not provide the District's required level of service it was not advanced for further economic analysis.

c. Key Risks and Issues

Alternative 1

A more detailed evaluation of asset condition and potential alternatives is required to determine all of the key risks and issues associated with this alternative. Despite the addition of Pump Station 18, Pump Station 7 must continue to be an operational pumping station; however, the critical nature of the pumping station is significantly reduced.

The following areas are of the greatest concern at Pump Station 7:

- The controllers and message displays on the pumping units and station control center installed during the rehabilitation in 1992 are over twenty years old and are becoming obsolete. Individual pumps each have their own controllers and the telemetry system's controller provides backup to the station control center. The District does have some of the obsolete controllers in stock.
- The HVAC system no longer functions as originally designed. This is an issue that should be considered along with structural changes that would separate the control room from the rest of the station. Migration of hydrogen sulfide gasses into the dry well and control room areas adds to deterioration of existing equipment, especially electrical gear and control systems.
- The diversion of flow from Pump Station 7 has increased the cycling of the pumps and may be causing solids deposition in the force mains due to the reduced pumping velocities. Installing a variable frequency drive on one of the smaller pumps will allow more efficient coverage of flows and reduce pump cycling. Installation of electrically actuated valves on the force mains will allow one force main to operate during normal dry weather and increase the flow velocity such that solids are less likely to settle.

It should also be noted that Pump Station 7 is adjacent to the Monona Riverfront redevelopment project. The area proposed for redevelopment is bounded by Bridge Road, West Broadway and the Yahara River. The types and location of specific land uses within the redeveloped area could influence the need, timing and scope of some of the improvements at Pump Station 7 (i.e. odor control).

Alternative 2

This alternative poses a very high degree of risk. Much of the mechanical and electrical equipment at the station has reached the end of their useful lives. Failure to modify the HVAC system and separate the dry well and wet well spaces will allow corrosion to further deteriorate the equipment. Continuing to operate this station without major repairs and/or replacement will result in escalating maintenance costs going forward and catastrophic failure of key equipment at some point. The ultimate consequences of this option will be a high risk of sewer backups into businesses and homes in the City of Monona and an increased chance for overflows from the collection system into the Yahara River.

d. Economic Analysis

Please see the attached 40-year life cycle cost estimate. A summary of present worth costs is provided in the following table:

	Capital Cost	Replacement Cost	O&M Cost	Salvage Value	Total Present Worth
Alternative 1	\$3,860,000	\$600,000	\$79,000	\$81,000	\$4,501,000
Alternative 2	Not evaluated				

Recommended Option

Staff recommends Alternative 1 as the preferred option. Pump Station 7 will remain a vital component of the District’s collection system, even with the recent addition of Pump Station 18. The replacement of aging equipment and the addition of measures to better control the corrosive atmosphere at Pump Station 7 are essential to ensure that the station continues to operate in a reliable and efficient manner.

Alternative 2 presents significant risk as it will eventually lead to equipment failures and possible basement backups in adjacent homes and/or sanitary sewer overflows to the Yahara River. Staff does not consider this to be a viable alternative.

Project Schedule:

A preliminary schedule for Pump Station 7 improvements is outlined below:

	Pump Station 7 Improvements	
	Start	Completion
Planning	6/2013	12/2017
Design	1/2018	10/2018
Bid Date	11/2018	11/2018
Construction	8/2019	9/2020

Financial Summary (2019 dollars):

Total Project Cost	
District Staff	\$336,000
Consultant	\$503,000
Contractor	\$3,352,000
Total	\$4,191,000

Fiscal Year Allocation (2019 dollars):

	2017	2018	2019	2020
District Staff	\$16,000	\$114,000	\$105,000	\$101,000
Consultant	\$0	\$265,000	\$137,000	\$101,000
Construction	\$0	\$0	\$1,676,000	\$1,676,000
Total	\$16,000	\$379,000	\$1,918,000	\$1,878,000

Fiscal Year Allocation (actual dollars):

	2017	2018	2019	2020
District Staff	\$16,000	\$114,000	\$105,000	\$104,000
Consultant	\$0	\$265,000	\$137,000	\$104,000
Construction	\$0	\$0	\$1,676,000	\$1,726,000
Total	\$16,000	\$379,000	\$1,918,000	\$1,934,000

**40-YEAR PRESENT WORTH COST ANALYSIS
FOR PUMP STATION 7 IMPROVEMENTS**

Present-Worth Analysis Year 2019
 Analysis Period (yrs) 40
 End of Analysis Year 2059

Project Description	Year	Capital Cost		Replacement Costs		O&M Costs	Salvage Value		Total 2019 Present Worth
		Cost in Year Constructed	2019 Present Worth	Replacement Year	2019 Present Worth	2019 Present Worth	Year 2059	2019 Present Worth	
<u>Alternative 1 - Pump 7 Improvements</u>									
Controllers & Control System	2019	425,000	425,000	-	0	0	0	0	425,000
Replace Electric Switchgear	2019	660,000	660,000	-	0	0	0	0	660,000
HVAC Replacement	2019	375,000	375,000	2039	200,000	0	0	0	575,000
Isolate Electrical Equipment	2019	470,000	470,000	-	0	0	282,000	68,000	402,000
Odor Control System	2019	755,000	755,000	2039	400,000	120,000	0	0	1,275,000
Pump VFD	2019	280,000	280,000	-	0	0	0	0	280,000
Electrically actuated valves	2019	660,000	660,000	-	0	0	0	0	660,000
Sustainability Initiatives	2019	235,000	235,000	-	0	0	47,000	11,000	224,000
New Pump A	2019	175,000	175,000	-	0	0	0	0	175,000
TOTALS		3,860,000	3,860,000		600,000	120,000		79,000	4,501,000
<u>Alternative 2 - Do Nothing</u>	Not evaluated as a viable alternative								

Assumptions and Notes:

- (1). Base interest rate = 3.63%
- (2). Construction cost escalation rate = 3.00%
- (3). HVAC/Odor Control Service Life (yrs) = 20
- (4). Pump/Drive & Controls Service Life (yrs) = 40
- (5). Building Service Life (yrs) = 100
- (6). Electric Equipment Life (yrs) = 40
- (7). Screening Equipment Life (yrs) = 40
- (8). Sustainability Initiatives Life (yrs) = 50
- (9). See attached annual O&M costs.

**CAPITAL COSTS
FOR PUMP STATION 7 IMPROVEMENTS**

Capital Costs for Pump Station 7 Improvements				
Description	Quantity	Units	2019 Unit Cost	2019 Total Cost
Controllers & Control System	1	L.S.	\$225,000	\$225,000
Replace Electric Switchgear	1	L.S.	\$350,000	\$350,000
HVAC Replacement	1	L.S.	\$200,000	\$200,000
Isolate Electrical Equipment	1	L.S.	\$250,000	\$250,000
Odor Control System	1	L.S.	\$400,000	\$400,000
Pump VFD	1	L.S.	\$150,000	\$150,000
Electrically actuated valves	1	L.S.	\$350,000	\$350,000
Sustainability Initiatives	1	L.S.	\$125,000	\$125,000
New Pump A	1	EACH	\$175,000	\$175,000
		Subtotal		\$2,225,000
		I&C/Mech/Elec	20%	\$445,000
		Project Subtotal		\$2,670,000
		Contingencies	26%	\$683,520
		Construction Total		\$3,353,520
		Engineering	25%	\$838,380
			2019 Project Cost	\$4,190,000
			2019 Project Cost	\$4,190,000

ANNUAL OPERATION AND MAINTENANCE COSTS FOR PUMP STATION 7 IMPROVEMENTS

Interest rate = 3.625%																	
Labor inflation rate/construction cost escalation = 3.625%																	
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	
	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
PW Factor	1.0000	0.9650	0.9313	0.8987	0.8672	0.8369	0.8076	0.7794	0.7521	0.7258	0.7004	0.6759	0.6523	0.6294	0.6074	0.5862	
Description	Footnotes	=															
PS 7 - Control Upgrades - Annual Costs	(1)	\$0															
PS 7 - Control Upgrades - 2019 PW Costs		\$0															
PS 7 - Electric Switchgear - Annual Costs	(1)	\$0															
PS 7 - Electric Switchgear - 2019 PW Costs		\$0															
PS 7 - HVAC - Replacement Costs	(1)	\$200,000															
PS 7 - HVAC - 2019 PW Costs		\$200,000															
PS 7 - Odor Control - Annual Costs	(2)	\$20,000				\$23,898				\$28,555						\$34,119	
PS 7 - Odor Control - 2019 PW Costs		\$20,000				\$20,000				\$20,000						\$20,000	
PS 7 - Odor Control - Replacement Costs		\$400,000															
PS 7 - Odor Control - 2019 PW Costs		\$400,000															
PS 7 - Pump VFD - Annual Costs	(1)	\$0															
PS 7 - Pump VFD - 2019 PW Costs		\$0															
PS 7 - Firm Capacity Improvements - Annual Costs	(1)	\$0															
PS 7 - Firm Capacity Improvements - 2019 PW Costs		\$0															
PS 7 - Replace Valves - Annual Costs	(1)	\$0															
PS 7 - Replace Valves - 2019 PW Costs		\$0															

Notes:

- (1). Equipment O&M costs are incidental to existing PS 7 O&M costs.
- (2). Assume carbon system with replacement every five years.

ANNUAL OPERATION AND MAINTENANCE COSTS FOR PUMP STATION 7 IMPROVEMENTS

Interest rate = 3.625%		2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	
Labor inflation rate/construction cost escalation = 3.625%		Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	
PW Factor		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Description		Footnotes	0.5657	0.5459	0.5268	0.5084	0.4906	0.4734	0.4569	0.4409	0.4255	0.4106	0.3962	0.3823	0.3690	0.3561	0.3436	0.3316
PS 7 - Control Upgrades - Annual Costs		(1)																
PS 7 - Control Upgrades - 2019 PW Costs																		
PS 7 - Electric Switchgear - Annual Costs		(1)																
PS 7 - Electric Switchgear - 2019 PW Costs																		
PS 7 - HVAC - Replacement Costs		(1)				\$407,681												
PS 7 - HVAC - 2019 PW Costs						\$200,000												
PS 7 - Odor Control - Annual Costs		(2)									\$48,713						\$58,206	
PS 7 - Odor Control - 2019 PW Costs											\$20,000						\$20,000	
PS 7 - Odor Control - Replacement Costs						\$815,363												
PS 7 - Odor Control - 2019 PW Costs						\$400,000												
PS 7 - Pump VFD - Annual Costs		(1)																
PS 7 - Pump VFD - 2019 PW Costs																		
PS 7 - Firm Capacity Improvements - Annual Costs		(1)																
PS 7 - Firm Capacity Improvements - 2019 PW Costs																		
PS 7 - Replace Valves - Annual Costs		(1)																
PS 7 - Replace Valves - 2019 PW Costs																		

Notes:

- (1). Equipment O&M costs are incidental to existing PS 7 O&M costs.
- (2). Assume carbon system with replacement every five years.

ANNUAL OPERATION AND MAINTENANCE COSTS FOR PUMP STATION 7 IMPROVEMENTS

Interest rate = 3.625%		2051	2052	2053	2054	2055	2056	2057	2058	2059	TOTALS
Labor inflation rate/construction cost escalation = 3.625%		Year	Year	Year	Year	Year	Year	Year	Year	Year	
PW Factor		32	33	34	35	36	37	38	39	40	
Description	Footnotes	0.3200	0.3088	0.2980	0.2876	0.2775	0.2678	0.2584	0.2494	0.2407	
PS 7 - Control Upgrades - Annual Costs	(1)										
PS 7 - Control Upgrades - 2019 PW Costs											\$0
PS 7 - Electric Switchgear - Annual Costs	(1)										
PS 7 - Electric Switchgear - 2019 PW Costs											\$0
PS 7 - HVAC - Replacement Costs	(1)										
PS 7 - HVAC - 2019 PW Costs											\$200,000
PS 7 - Odor Control - Annual Costs	(2)				\$69,549						
PS 7 - Odor Control - 2019 PW Costs					\$20,000						\$120,000
PS 7 - Odor Control - Replacement Costs											
PS 7 - Odor Control - 2019 PW Costs											\$400,000
PS 7 - Pump VFD - Annual Costs	(1)										
PS 7 - Pump VFD - 2019 PW Costs											\$0
PS 7 - Firm Capacity Improvements - Annual Costs	(1)										
PS 7 - Firm Capacity Improvements - 2019 PW Costs											\$0
PS 7 - Replace Valves - Annual Costs	(1)										
PS 7 - Replace Valves - 2019 PW Costs											\$0

Notes:

- (1). Equipment O&M costs are incidental to existing PS 7 O&M costs.
- (2). Assume carbon system with replacement every five years.