Albuquerque Bernalillo County Water Utility Authority

Southside Water Reclamation Plant Renewal and Asset Management Plan (RAMP) Update

2015 Report

December 2015

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Appendix – Risk Assessment

Executive Summary

PURPOSE

The original Southside Water Reclamation Plant (SWRP) Renewal and Asset Management Plan (RAMP) Report was completed in 2010 (2010 RAMP Report). That report documented the many challenges facing the SWRP due to failing infrastructure and equipment as well as capacity bottlenecks. The plan presented in the 2010 RAMP Report identified numerous capital improvements required to give the SWRP a firm design capacity of 76 mgd.

The purpose of this updated RAMP Report is (1) to document the improvements that have been completed and are currently underway since the 2010 RAMP Report was issued and (2) to provide an updated plan to complete the required improvements.

PLANT DESCRIPTION

The SWRP was originally constructed in the early 1960's. Since that time it has undergone several expansions and process changes. The plant has a nominal capacity of 76 mgd, based on a maximum month average daily flow rate (MMF). The maximum month average daily plant flow rate for 2015 was 53.4 mgd. The average annual flow rate was 50.9 mgd. These values are based on the effluent flow sent to the Rio Grande plus the effluent diverted to the Reuse Facility.

The plant uses the Modified Ludzak-Ettinger (MLE) Process for treating the sewage to remove biochemical oxygen demand (BOD) as well as ammonia and nitrate. The headworks has recently been replaced with a new Preliminary Treatment Facility (PTF) that includes screening and two stages of grit removal (course and fine). Primary clarifiers are downstream of the PTF and upstream of the MLE Process Basins. Final clarifiers settle out the biosolids ahead of the Ultraviolet Disinfection Facility.

The solids collected in the Primary and Final Clarifiers are sent to the Anaerobic Digesters for treatment. The secondary solids are first thickened at the Dissolved Air Floatation (DAF) Facility. The digested solids are treated by a set of centrifuges at the Solids Dewatering Facility. The dry cake is hauled off site to the Water Authority's Solids Amendment Facility (SAF).

SWRP CAPITAL IMPROVMENTS: 2010 - 2015

The Water Authority's Governing Board has made a commitment to expend $250-million towards renewal of the SWRP. This commitment was made based on the findings documented in the 2010 RAMP Report.

Table ES-1 summarizes expenditures on improvements at the SWRP during the past five years. Overall, the Water Authority has spent approximately $106-million towards renewal of the SWRP. This includes approximately $91-million in physical improvements (e.g., construction costs) and approximately $15-million for engineering services. Section 2 of this report provides a more detailed breakdown of the different projects and their associated costs.

Table ES-1

Recent Capital Improvement Expenditures at the Southside Water Reclamation Plant

Description	Approximate Expenditure ($-million)
Construction Expenditures:	
Preliminary Treatment Facility	34.2
Primary Clarifiers	0.4
Process Basins	5.3
Blowers	2.6
Secondary/Final Clarifiers	8.4
UV Disinfection	8.7
DAF Facility	0.5
Digesters	3.5
Solids Dewatering Facility	3.7
Cogeneration Facilities	0.2
Plant Electrical Distribution System	5.2
Plant Control System	0.4
Non-Potable Water System[1]	16.9
Miscellaneous Improvements	1.4
Subtotal =	91.4
Engineering Expenditures	15.0
Total Expenditures =	**106.4**

Notes:

1. Non-potable filtration facility sized to serve off-site as well as SWRP site requirements.

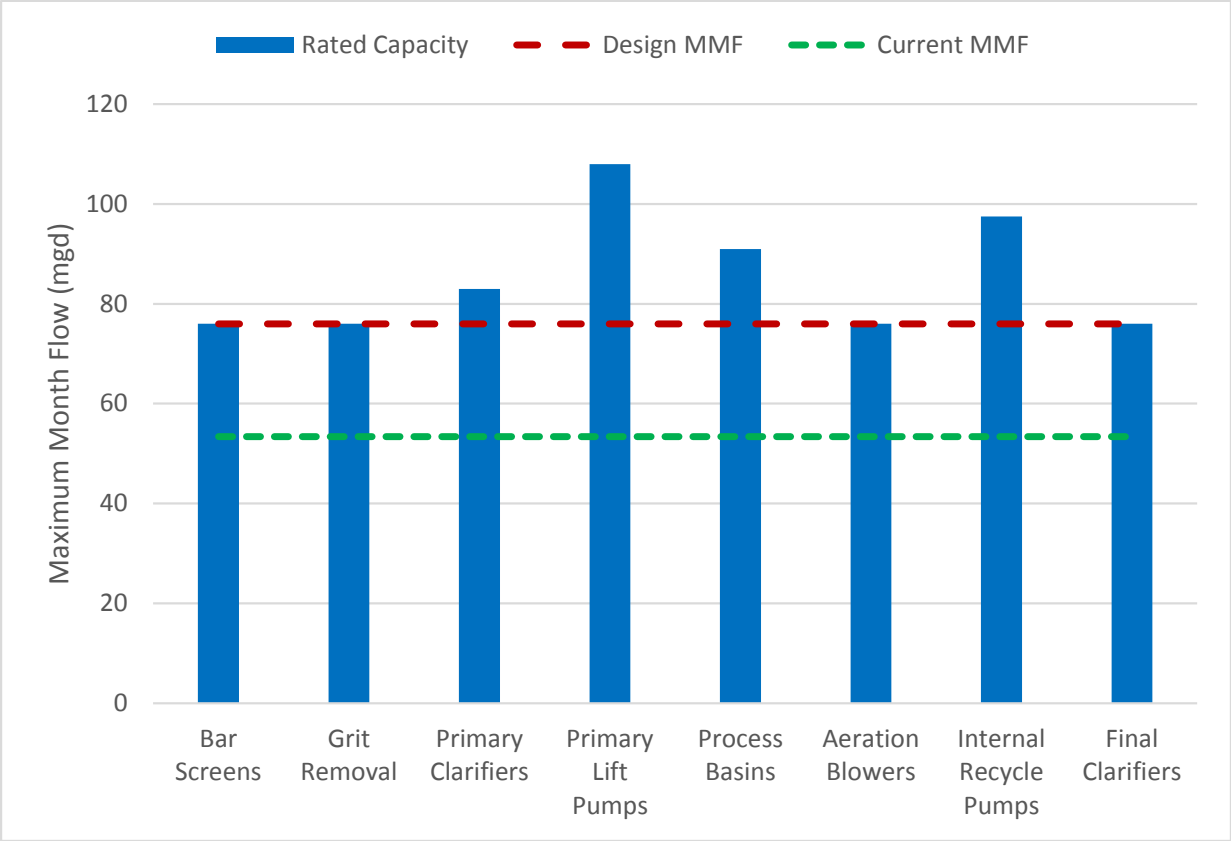
PLANT CAPACITY ASSESSMENT

As mentioned above, the SWRP has a nominal capacity of 76 mgd maximum month average daily flow rate (MMF). The intent of the RAMP is to make the necessary improvements to the plant to provide this capacity. This capacity is to be “firm” capacity with adequate standby capacity to enhance the reliability of the plant. The assessment of the capacity of the individual unit processes is based on industry standard design criteria and actual plant performance data. This information is provided in the different sections of the report.

Figure ES-1 summarizes the capacity assessment for the liquid stream treatment processes at the SWRP. With the start-up of the new Preliminary Treatment Facility (PTF) in August of 2015, all of the liquid stream processes have adequate capacity for treating the 76 mgd MMF.

The original RAMP Report identified the Aeration Blowers as being potentially process limiting. Capital improvements made since then have eliminated this potential limitation. The replacement of the aeration basin diffusers and the sealing of leaks in the air piping have reduced air requirements.

A new potential capacity limitation has been identified for the Modified Ludzak-Ettinger Process. Water conservation in the Water Authority's service area has resulted in more concentrated organic levels in the influent. This can be measured as biochemical oxygen demand (BOD). Continued increased organic strength could potentially increase the solids loading rate on the final/secondary clarifiers, which could potentially increase suspended solids in the plant effluent. However, as discussed in Section 4 of this report, improved organics removal during primary clarification through chemically enhanced primary treatment (CEPT) can be implemented to address this impact, if it becomes necessary.

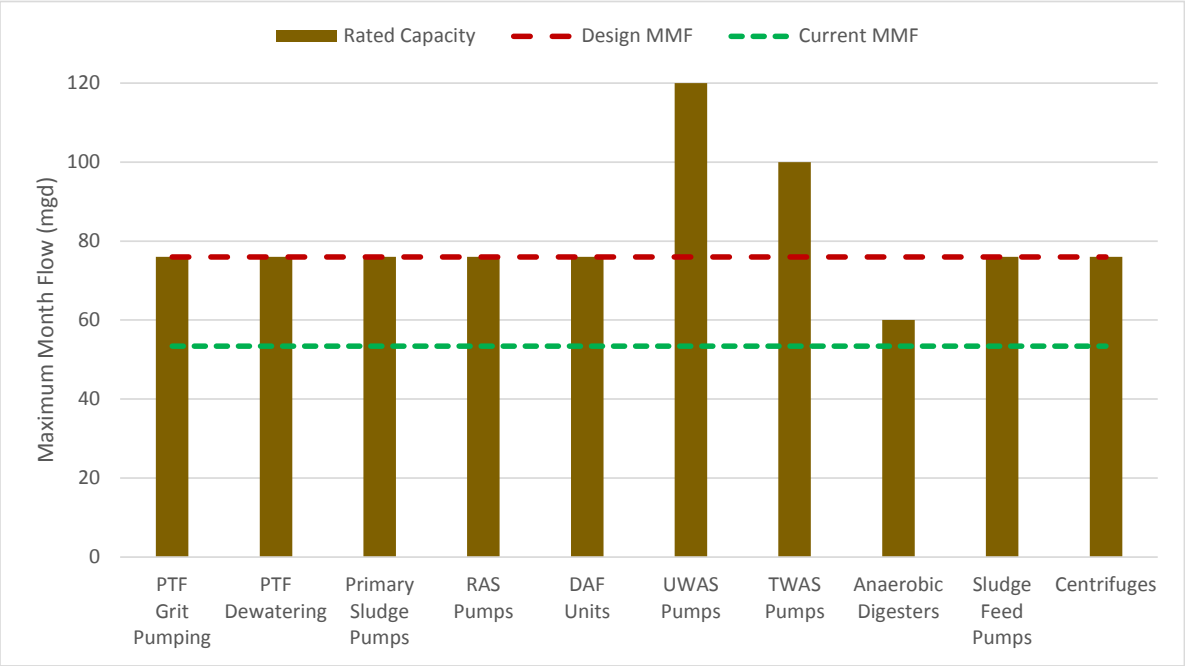


Liquid Stream Treatment Capacity

Figure ES-1

Figure ES-2 summarizes the capacity assessment for the solids stream treatment processes at the SWRP. The new PTF has been designed for a peak flow of 120 mgd to accommodate the diurnal flow variation associated with the 76 mgd MMF. The current plan to increase the capacity of the anaerobic digesters is to convert the existing four secondary digesters to primary digesters. This will be initiated once a new 2.0-million gallon (mil gal) liquid digested storage tank is constructed as part of the rehabilitation of the Solids Dewatering Facility (SDF).

The centrifuges at the SDF are currently being operated 24 hours per day (hr/day), rather than the previous 8 hr/day mode of operation. Operating continuously, one centrifuge is almost able to process the digested sludge currently produced at the SWRP's current flow rate (i.e., 53.4 mgd MMF). Once the SDF rehabilitation project is completed, there will be three Alfa Laval G2-120 centrifuges: two duty, one standby. This, together with other improvements including a 50 percent increase in dry cake storage capacity, should provide the SDF with a firm capacity of at least 76 mgd.



Solids Stream Treatment Capacity

Figure ES-2

UPDATED RENEWAL PLAN

Table ES-2 summarizes the different SWRP facility improvements and the associated fiscal year budgets. The fiscal years start on July 1st and end on June 30th. For instance, Fiscal Year (FY) 2016 started on July 1, 2015 and ends on June 30, 2016. The Water Authority is currently committing additional funding for completing the SWRP renewal program recognizing the priority to make improvements at the SWRP. As the decade proceeds and the different renewal projects are implemented, the level of spending will taper off but will still be significant. As previously described, the Water Authority has so far spent approximately $106-million on renewing the SWRP. As shown in Table ES-2, during the next decade, an additional $218-million is anticipated to be spent on improvements at the SWRP.

Section 14 of this report provides a more detailed description of the planned capital improvements spending planned for the SWRP.

Table ES-2

Planned Renewal Spending at the Southside Water Reclamation Plant

Facility and Project Description	Annual Fiscal Year Budget Projections ($-million)										Total Decade Budget ($-million)
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
Preliminary Treatment Facility	3.08	-	-	-	-	-	-	-	-	-	**3.08**
Dewatering Facility Replacement	7.66	16.00	-	-	-	-	-	-	-	-	**23.66**
Blower Capacity Improvements	0.82	-	-	-	-	-	-	-	-	-	**0.82**
Existing Digester Rehabilitation and Improvements (Phase 1)	3.80	2.02	11.07	-	-	-	-	-	-	-	**16.89**
Primary Clarifier Improvements (Phase 1)	1.99	1.50	1.40	2.10	-	-	-	-	3.66	1.00	**11.65**
Aeration Basin Rehabilitation	0.07	0.10	-	-	-	-	-	-	-	-	**0.17**
Secondary Sludge Thickening Improvements	0.25	-	5.20	2.00	-	-	-	-	-	-	**7.45**
Cogeneration Improvements	0.00	-	-	0.59	6.00	10.00	0.75	-	-	-	**17.34**
SWRP Renewal Contingency	1.13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**10.13**
ABB Service Contract	0.00	0.14	0.16	0.16	0.16	0.17	0.17	0.17	0.17	0.17	**1.46**
Plant-Wide Electrical, Instrumentation and Control Improvements	2.59	1.50	2.20	1.98	2.48	9.75	15.00	0.50	-	-	**35.99**
RAS and Sludge Withdrawal Pumps Improvements	0.22	-	0.75	-	-	-	-	-	-	-	**0.97**
Plant-Wide Non Potable Water Improvements	-	-	-	-	-	-	-	0.09	1.50	-	**1.59**
Warehouse Facility Renewal	-	-	-	-	-	-	0.10	1.15	0.29	-	**1.53**
Maintenance Facility Renewal	0.75	-	-	-	-	-	0.10	1.15	0.29	-	**2.28**
Plant Landscaping	-	-	-	-	-	-	-	1.00	0.86	0.94	**2.80**
O&M Facility Renewal	-	-	-	-	-	-	0.10	1.15	0.29	-	**1.53**
Storm Water Drainage Improvements	0.06	0.25	-	-	-	-	-	-	-	-	**0.31**
Sludge Drying Beds Demolition	0.15	-	-	-	-	-	-	-	-	-	**0.15**
Storm Water and Spill Retention Basins	0.91	-	-	-	-	-	-	-	-	-	**0.91**
Primary Clarifier Improvements (Phase 2)	-	-	-	-	-	0.63	4.00	3.80	5.95	8.55	**22.93**
RAMP Report Update	0.36	-	-	-	-	-	-	-	-	-	**0.36**
Program Management Assistance	0.21	-	-	-	-	-	-	-	-	-	**0.21**
High Efficiency Blower Upgrades	0.65	-	-	1.50	4.40	2.43	-	-	-	-	**8.98**
Digester Capacity Improvements	5.71	-	1.00	5.45	5.74	-	2.76	4.00	-	-	**24.66**
Digester Cleaning Program	0.60	0.20	0.20	0.20	-	-	-	-	-	-	**1.20**
Chemical Storage and Feed Systems Upgrade	1.21	2.11	-	-	-	-	-	-	-	-	**3.32**
Pre-Screens for UV Disinfection Facility	0.84	1.60	-	-	-	-	-	-	-	-	**2.44**
As-Built Drawings	0.10	0.10	0.03	0.03	0.03	0.03	0.03	-	-	-	**0.33**
FOG Receiving Station	0.10	-	-	-	-	-	-	-	-	-	**0.10**
Aeration Basin Improvements	-	-	-	4.00	2.20	-	-	-	-	-	**6.20**
Existing Digester Rehabilitation and Improvements (Phase 2)	-	-	-	2.73	2.00	2.00	-	-	-	-	**6.73**
Total	**33.3**	**26.5**	**23.0**	**21.7**	**24.0**	**26.0**	**24.0**	**14.0**	**14.0**	**11.7**	**218.2**

Section 1
Introduction

Section 1
Introduction

1.1 PURPOSE

In 2010, the original Renewal and Asset Management Plan (RAMP) Report was completed. It documented capacity and condition assessments done on the Water Authority's Southside Water Reclamation Plant (SWRP). A general conclusion at that time was that the SWRP was facing many challenges due to failing infrastructure and equipment, capacity bottlenecks, process upsets and frequent power failures/fluctuations. The original RAMP report also documented a risk analysis to assist in developing a prioritized schedule of capital improvements for the SWRP.

The purpose of this updated RAMP Report is to document the improvements that have been completed and are currently underway to address the identified deficiencies at the SWRP. It also provides an updated plan for completing the improvements.

1.2 PLANT DESCRIPTION

The SWRP was originally constructed in the early 1960's. Since that time it has undergone several expansions and process changes. The plant currently has a nominal capacity of 76 mgd, based on a maximum month average daily flow rate (MMF). The maximum month average daily plant flow rate for 2015 was 53.4 mgd. The average annual flow rate was 50.9 mgd. These values are based on the effluent flow sent to the Rio Grande plus the effluent diverted to the Reuse Facility.

The plant uses the Modified Ludzak-Ettinger (MLE) Process for treating the sewage to remove biochemical oxygen demand (BOD) as well as ammonia and nitrate. The headworks has recently been replaced with a new Preliminary Treatment Facility (PTF) that includes screening and two stages of grit removal (course and fine). Primary clarifiers are downstream of the PTF and upstream of the MLE Process Basins. Final clarifiers settle out the biosolids ahead of the Ultraviolet Disinfection Facility.

The solids collected in the Primary and Final Clarifiers are sent to the Anaerobic Digesters for treatment. The secondary solids are first thickened at the Dissolved Air Floatation (DAF) Facility. The digested solids are treated by a set of centrifuges at the Solids Dewatering Facility. The dry cake is hauled off site to the Water Authority's Solids Amendment Facility (SAF).

1.3 PLANT CAPACITY ASSESSMENT

As mentioned above, the SWRP has a nominal capacity of 76 mgd (MMF). The intent of the RAMP is to make the necessary improvements to the plant to provide this capacity. This capacity is to be "firm" capacity with adequate standby capacity to enhance the reliability of the plant. The assessment of the capacity of the individual unit processes is based on industry standard design criteria and actual plant performance data. This information is provided in the different sections of the report.

Influent flows into the SWRP have not increased substantially over the last 20-years due to conservation and water reuse efforts. Based on our estimates of future growth, the 76 mgd capacity will be sufficient for another 20 to 30-years.

1.4 PLANT RISK ASSESSMENT

Asset management principles are being used to assist in prioritizing the different capital improvement projects. The risk posed by the potential failure of the different plant facilities/elements at the SWRP have been assessed and ranked. Those facilities that pose higher levels of risk are being addressed sooner than lesser risk facilities. Risk is estimated by the following formula:

Risk = (Probability of Failure) x (Consequence of Failure) x (Redundancy Factor)

The probability of failure for the different plant facilities was based on a set of condition assessments and included such factors as the age of the equipment included in the facilities. The consequence of failure was based on the experience and judgement of subject matter experts.

The Appendix contains additional information on the risk assessment procedures and spreadsheet tables of the risk ranking for different plant elements.

1.4.1 Summary of Plant Facilities Risk Scores

Table 1-1 provides a prioritized list of plant facilities with the highest risk scores. This list is largely based on the findings documented in the original RAMP Report. **Section 2** of this report provides a detailed discussion of the improvements implemented during the past five years (i.e., since completion of the original RAMP Report).

Table 1-1

SWRP Facility Risk Ranking

Plant Facility/Activity	Risk Score
Preliminary Treatment Facility	74.2
Anaerobic Digesters	68.8
Aeration Basin Blowers	67.4
Plant Wide Electrical Improvements	67.0
Solids Dewatering Facility	66.5
Secondary Sludge Thickening (DAF) Facility	65.6
Primary Clarifiers	64.0
Anaerobic Digester Cleaning Program	62.6

Section 2

Plant Improvements: 2010 - 2015

Section 2
Plant Improvements: 2010 - 2015

This section of the report provides descriptions of plant improvements (renewal projects) that have been completed and underway since completion of the original RAMP Report. This section is generally organized by treatment process area.

Subsequent sections of the report provide detailed descriptions of the different process areas, their identified deficiencies per the original RAMP Report, the description of improvements completed since the original RAMP Report, and a description of the remaining renewal needs.

2.1 SUMMARY OF IMPROVEMENTS: 2010 - 2015

Table 2-1 lists the different capital improvement projects implemented at the SWRP during the past five years or so. The table is organized by treatment process area starting with the Preliminary Treatment Facility (PTF). The total construction cost is listed along with the general contractor associated with the project. As indicated, over $90-million has been spent making improvements to the plant during this period. Not included in the summation of costs are the maintenance projects completed by Water Authority staff members. This includes such items as major overhauls to the cogeneration equipment, replacing valves and actuators, and other minor capital improvement projects.

Table 2-2 lists the different engineering projects (e.g., studies and designs) completed towards the renewal of the SWRP during the past five years or so. Most of these projects are related to the construction projects listed in Table 2-1. The consultant and engineering fees associated with the different projects are listed. The total for the different projects adds up to approximately $15-million.

As will be presented in Section 14 and as previously presented in the Executive Summary, the Water Authority is projected to spend an additional $224-million on renewal projects at the SWRP during the next decade. This amount is in terms of project costs (i.e., engineering plus construction costs.)

2.2 SPECIFIC PROCESS AREA IMPROVEMENTS: 2010 - 2015

2.2.1 Preliminary Treatment Facility

A completely new Preliminary Treatment Facility (PTF) has been designed, constructed, and started-up at the Southside Water Reclamation Plant (SWRP). The total project cost was approximately $37.6-million, including approximately $34.1-million for construction and $3.5-million for engineering services. The facility was started-up in August of 2015.

The old PTF did not perform well, especially in terms of grit removal. This resulted in excessive wear on downstream treatment process equipment, including pumps, mixers, and centrifuges. The high grit concentration also led to routine clogging of sludge withdrawal piping at some of the primary clarifiers as well as accumulation in the digesters.

Table 2-1

Summary of Construction Projects and Costs for Renewal Projects at the Southside Water Reclamation Plant: 2010 – 2015

Description		Total Construction Cost ($)	Contractor
Preliminary Treatment Facility, including LS 11A			
New PTF		34,100,000	PCL
Retrofit Impellers for LS 11A Pumps 1, 2, & 3		54,628	Sulzer
East Grit Chamber Cleaning		6,972	Ace
West Grit Chamber Cleaning		25,684	Ace
	Subtotal =	**34,187,284**	
Primary Clarifiers			
Primary Clarifier No. 4 Sludge Hopper Repair		18,934	TLC
Primary Clarifier Nos. 3 & 4 Launder Cover Platform Rehab		58,559	RMCI
Primary Pump House No. 2 AC Unit Replacement		62,509	B&D Industries
SWRP Splitter Box Repairs		127,501	RMCI
Primary Pump House No. 2 Scum Valve		16,889	Bradbury Stamm
Primary Clarifier No. 6 Gate Replacement		8,000	Bradbury Stamm
Primary Pump House No. 3 Line Unplugging		73,355	ABI
Primary Pumping House No. 3 Roof Repairs		1,825	National
	Subtotal =	**367,573**	
Process Basins			
South Basins 5 & 6 Diffuser Renewal		492,028	Bradbury Stamm
South Aeration Basins 1 & 2 Diffuser Renewal		178,043	TLC
South Process Basin No. 4 Drain Valve Rehab		75,350	TLC
South Process Basin No. 3 Influent Leak Repair		49,610	TLC
North Process Basin Nos. 5 & 6 Diffuser Renewal		794,989	TLC
North Process Basin Nos. 3 & 4 Diffuser Renewal		880,866	TLC
Soda Ash System Renewal		79,436	TLC
South Process Basin No. 3 Membrane Replacements		57,017	RMCI
Soda Ash Silo Cleaning		10,631	RMCI
SWRP Handrail Repair		39,313	RMCI
South Aeration Basins 7 & 8 Rehab		1,151,733	ABI
North Aeration Basins 1 & 2		317,441	ABI
Biological Nutrient Removal Monitoring System		785,617	ABI
North Process Basin No. 4 Cleaning		59,323	Ace
South Process Basin No. 1 Cleaning		40,867	Ace
South Process Basin No. 2 Cleaning		47,078	Ace
South Process Basin No. 3 Cleaning		73,008	Ace
South Process Basin No. 4 Cleaning		82,791	Ace
South Process Basin No. 7 Cleaning		29,898	Ace
South Process Basin No. 8 Cleaning		32,902	Ace
	Subtotal =	**5,277,938**	
Blowers			
South Blowers 5 and 6 Replacement		966,585	RMCI
Blower Air Piping Leaks		317,720	RMCI
South Blower Bldg. Air Filtration System Renewal		218,086	RMCI
South Blower Bldg. Bridge Crane Replacement		241,934	RMCI
North Blower Bldg. Air Filtration System Renewal		88,230	RMCI
South Blower Bldg. Piping and Base Improvements		785,617	ABI
South Blower Bldg. Roof Repairs		2,100	DKG
North Blower Bldg. Roof Repairs		14,641	DKG
	Subtotal =	**2,634,914**	

Table 2-1 (continued)

Summary of Construction Projects and Costs for Renewal Projects at the Southside Water Reclamation Plant: 2010 – 2015

Description		Total Construction Cost ($)	Contractor
Secondary/Final Clarifiers			
Envirodyne (Clarifier Equipment Package)		4,056,330	Envirodyne
Install two owner furnished clarifier mechanisms		575,519	Bradbury Stamm
Install ten owner furnished clarifier mechanisms		2,937,697	Bradbury Stamm
SWRP North Final Clarifier Repairs		72,114	RMCI
Sluice Gate and Motorized Actuator Renewal		148,658	RMCI
South Final Clarifier 2 Valve Stem Rehab		32,087	AUI
Handrail base repairs in South Final Clarifiers		202,738	RMCI
Clarifier Gate Rehab		350,837	ABI
	Subtotal =	**8,375,980**	
Ultra-Violet Disinfection Facility			
UV Disinfection Facility		8,662,668	RMCI
Underground Utility Survey for UV Pre-Screen Project		7,150	Cobb Fendley
	Subtotal =	**8,669,818**	
DAF Facility			
DAF Polymer Tank Cleaning		34,692	RMCI
DAF Polymer Tank Cleaning		10,335	ABI
Steam Cleaning System Replacement		54,975	ABI
DAF Building Roof Rehab		372,333	ABI
	Subtotal =	**472,333**	
Digesters			
Digester Hatch & PRV Replacement & Linear Mixer Install		1,339,639	RMCI
Epoxy Grouting		9,058	RMCI
SWRP Digester Center Mixer Repair		27,728	RMCI
Digester 13 Center Mixer Collar Repair		18,561	RMCI
Sludge Blending Tank Mixer Repair		36,196	ABI
Digester 2 Hatch Repair		14,187	ABI
Digester 13 Draft Tube Rehab		8,436	ABI
Digester Crack Repairs		90,682	AUI
Repair to Digester 4 Corbels		59,000	Bradbury Stamm
Repair to Digester 12 Floating Cover and Corbels		261,562	Bradbury Stamm
Magnetic Flow Meter Installation		21,313	Bradbury Stamm
Heat Exchanger Replacement (Digesters 11, 13, & 14)		325,869	Archer Western
Digester No. 1 Cleaning		88,330	Ace
Digester No. 2 Cleaning		77,308	Ace
Digester No. 3 Cleaning		63,124	Ace
Digester No. 4 Cleaning		77,162	Ace
Digester No. 5 Cleaning		100,203	Ace
Digester No. 6 Cleaning		73,453	Ace
Digester No. 7 Cleaning		76,849	Ace
Digester No. 8 Cleaning		71,049	Ace
Digester No. 9 Cleaning		71,669	Ace
Digester No. 10 Cleaning		79,248	Ace
Digester No. 11 Cleaning		105,499	Ace
Digester No. 12 Cleaning		156,808	Ace
Digester No. 13 Cleaning		50,592	Ace
Digester No. 14 Cleaning		50,524	Ace
Digester No. 2 Cleaning		34,408	Ace
Digester No. 13 Cleaning		50,592	Ace
Digester No. 14 Cleaning		50,524	Ace
	Subtotal =	**3,489,580**	

Table 2-1 (continued)

Summary of Construction Projects and Costs for Renewal Projects at the Southside Water Reclamation Plant: 2010 – 2015

Description		Total Construction Cost ($)	Contractor
Solids Dewatering Facility			
Heating Mods at SWRP Solids Dewatering Facility		276,151	TLC
SWRP Solids Dewatering Facility Steam Cleaner Replacement		21,902	RMCI
Solids Dewatering Building Spill Tray Repair		38,781	RMCI
Spare Rotating Assembly for R2 Centrifuges		497,700	Alfa Laval
Replacement Conveyor Belt Assembly		76,196	Serpentix
Replacement Conveyor Belt Assembly		95,649	Serpentix
Repairs on Cake Bins 2 and 3		23,820	ABI
Underground Utility Survey for SDF Renewal Project		8,437	Cobb Fendley
Underground Utility Survey for SDF Renewal Project		7,939	Cobb Fendley
Underground Utility Survey for SDF Renewal Project		4,390	Cobb Fendley
Centrate Line Inspection		993	Aardvark
Drain Line Cleaning		786	Aardvark
Solids Dewatering Building Roof Renewal		64,148	National
Cake Bin Screen Installation and Cleaning		23,587	ABI
Installation of Owner Furnished Centrifuge		310,233	Archer Western
Cake Conveyor Belt Replacement		106,063	Archer Western
Supply Three Alfa Laval G2-120 Centrifuges		2,108,138	Bradbury Stamm
	Subtotal =	**3,664,913**	
Cogeneration Facilities			
North Cogen Roof Leak Repairs		2,399	DKG
South Cogen Roof Replacement		87,413	National
South Cogen High Pressure Gas Line from North Cogen		49,849	ABI
South Cogen Non-Potable Water Piping Rehab		90,750	ABI
Engine No. 2 30,000-hour Major Overall		N/A	In-house
Engine No. 4 30,000-hour Major Overall		N/A	In-house
Engine No. 4 Upgraded Engine Controls and Ignition System		N/A	In-house
Engineer No. 3 Major Overhaul		N/A	In-house
Engine No. 3 Upgraded Engine Controls and Ignition System		N/A	In-house
Generator No. 3 Overhaul, New Bearings, Rotating Rectifier		N/A	In-house
Engine No. 1 30,000-hour Major Overhaul		N/A	In-house
Engine No. 2 15,000-hour Top End Overhaul		N/A	In-house
Engine No. 4 15,000-hour Top End Overhaul		N/A	In-house
Engine No. 3 15,000-hour Top End Overhaul		N/A	In-house
Engine No. 1 15,000-hour Top End Overhaul		N/A	In-house
Generator No. 4 Overhaul		N/A	In-house
Engine No. 4 30,000-hour Major Overall		N/A	In-house
Engine No. 2 30,000-hour Major Overall		N/A	In-house
	Subtotal =	**230,411**	
Plant Electrical Distribution System			
New FIS		2,833,992	Bradbury Stamm
FIS Ground Fault Repairs		88,192.81	ABI
Switchboard 22 Rehab		56,462	B&D Industries
12 GSS Switchgear Rehab		85,636	B&D Industries
GC Switch Station Rehab		27,165	B&D Industries
5th Avenue Switch Station Rehab		133,446	B&D Industries
Primary Switch Station Rehab		165,063	B&D Industries
G Switch Station Rehab		253,532	B&D Industries
Generator Tie In		83,085	B&D Industries
North Blowers and Pad Mounted Switch Rehab		272,305	B&D Industries
Switchboard 22 and 14 Improvements		115,865	Eaton
Portable Generator Connections		55,011	
Standby Portable Generators Acquisition		1,007,267	
	Subtotal =	**5,177,022**	

Table 2-1 (continued)

Summary of Construction Projects and Costs for Renewal Projects at the Southside Water Reclamation Plant: 2010 – 2015

Description		Total Construction Cost ($)	Contractor
Plant Instrumentation and Control System			
ABB Harmony Hardware Upgrades		65,588	
ABB Symphony Plus SCADA System Software Upgrade		353,311	
	Subtotal =	**418,899**	
Non-Potable Water System			
New Reuse Treatment Facility		16,617,256	Archer Western
SWRP Ammonia Feed Emergency Eye Wash Relocation		20,559	TLC
SWRP Reuse Facility Cleanup Project		142,441	RMCI
Ammonium Sulfate Feed System		48,543	RMCI
Temporary Ammonium Sulfate System Heat Tracing		11,717	ABI
Water Valve and Hydrant Rehab		136,950	ABI
Water Line Leak Repair Between North Cogen & DAF Facility		15,871	ABI
	Subtotal =	**16,993,338**	
Misc. SWRP Renewal			
SWRP JB 1 Leak Repair (Initial Repair)		2,955	TLC
SWRP JB 1 Leak Repair (Final Repair)		269,002	ABI
SWRP Roadway Dust Control		8,284	RMCI
Convert SO_2 and Cl_2 Facilities to Storage Facilities		198,462	ABI
SWRP IT Trailer Construction		867,616	ABI
Security Gate Installation		19,048	ABI
SWRP Gas Line Location		3,683	ABI
Site Security Cameras		43,321	McDade
O&M Building Roof Repairs		19,933	Everguard
	Subtotal =	**1,432,304**	
	TOTAL =	**91,385,163**	

Notes:
1. Does not include costs associated with maintenance and rehabilitation performed by Water Authority staff.

Table 2-2

Summary of Engineering Projects and Costs for Renewal Projects at the Southside Water Reclamation Plant: 2010 – 2015

Description		Engineering Cost ($)	Consultant
Preliminary Treatment Facility, including LS 11A			
Design and ESDC of the New PTF		3,433,251	CDM Smith
Evaluate LS11A Improvement Requirements		52,522	Brown & Caldwell
	Subtotal =	**3,485,773**	
Primary Clarifiers			
Design Analysis of Primary Clarifier Improvements		266,092	CDM Smith
Primary Clarifiers 1 - 4 Rehab Evaluation		48,036	CDM Smith
Primary Clarifier No. 4 Rehab Design		232,516	Carollo
Pinch Valve Ahead of Primary Clarifiers 1 -4 Replacement Design		52,687	Molzen Corbin
Primary Pump House 3 By-Pass Structure Renewal		43,706	Molzen Corbin
Review of Primary Pump House 3 By-Pass Structure Renewal		1,400	AECOM
Primary Clarifier No. 4 Sludge Box Repair Design		3,700	AECOM
Primary Clarifier No. 4 Scum Tray Access Design		4,986	AECOM
	Subtotal =	**653,123**	
Process Basins			
Handrail Supports at Concrete Structures Evaluation		16,160	AECOM
Aeration Basin Piping Improvements Design		124,334	Water Works
Soda Ash System Improvements Design (Phase 1)		22,431	Water Works
Soda Ash System Improvements Design (Phase 2)		49,662	CDM Smith
South Process Basin 7 Leak Repair Design		1,359	AECOM
Drain Valve Rehab in South Basin 4 Design		2,461	AECOM
South Basins 3 and 4 Platform Support Repair Design		1,562	AECOM
North Process Basin 5 Concrete Repair Design		3,325	AECOM
Biological Nutrient Removal Monitoring System Study		33,705	Carollo
Biological Nutrient Removal Monitoring System Design		145,067	Carollo
BioWin Process Modeling		81,846	Carollo
	Subtotal =	**481,914**	
Blowers			
Blower and Inlet Air Filter Renewal Study		330,421	AECOM
South Blowers 1, 2 & 7 Base and Piping Improvements Design		126,902	AECOM
Blower Evaluation (Work Performed by MWH as a subconsultant)		60,887	Water Works/MWH
High Efficiency Blower Study		77,073	Carollo
	Subtotal =	**595,283**	
Secondary/Final Clarifiers			
Preparation of Technical Spec for Final Clarifier Mechanism Replacement		8,844	CDM Smith
Field Surveys for Secondary Clarifier Replacement Project		27,326	WH Pacific
Final Clarifier Gate Rehab Design		52,688	Molzen Corbin
Final Clarifier Access Platform & Electrical Improvements Design		79,822	AECOM
	Subtotal =	**168,680**	
Ultra-Violet Disinfection Facility			
Design Services, Construction Engineering Services, & Startup Assistance		753,884	CH2M-Hill
Pre-UV Bar Screen Evaluation Study		46,224	AECOM
Pre-UV Bar Screen Design		136,128	Brown & Caldwell
	Subtotal =	**936,236**	
DAF Facility			
Secondary Sludge Thickening Technology Pre-Design Study		118,598	Brown & Caldwell
Secondary Sludge Thickening Technology Pilot Studies		43,746	CDM Smith
DAF Facility Roof Rehab Design		19,370	AECOM
	Subtotal =	**181,714**	
Digesters			
Digester Roof Replacement/Philadelphia Mixer Feasibility Study		132,676	AECOM
Secondary Digester Nos. 4, 6, 10 & 12 Interior Evaluation		26,885	AECOM
Digester Hatch and Safety Valve Replacement Design		1,722	AECOM
Digester Rehab Design		332,450	AECOM
Digester 13 Linear Mixer Design		113,420	AECOM
Fats, Oils, and Grease (FOG) Receiving Station Study		71,042	Carollo
Digester Gas Holder and Sphere Condition Assessments		80,490	Carollo
	Subtotal =	**758,686**	

Table 2-2 (continued)

Summary of Engineering Projects and Costs for Renewal Projects at the Southside Water Reclamation Plant: 2010 – 2015

Description		Engineering Cost ($)	Consultant
Solids Dewatering Facility			
Engineering for PTF/SDF Complex		1,171,927	CDM Smith
Value Engineering Study for PTF/SDF Complex		98,676	Carollo
Other Agency Site Visits (N. Calf.)		7,085	Carollo
Other Agency Site Visits (Phx)		6,689	Carollo
SDR Roof Replacement Design		42,747	Carollo
SDR Renewal Project (Proj. No.: 478111)		3,274,376	Carollo
Biosolids Drying Evaluation		33,112	Brown & Caldwell
Second G2 Centrifuge Installation Design and Structural Analysis		74,721	Molzen Corbin
SDF Building Heating System Renewal Design		64,535	AECOM
Centrifuge Feed Pump Replacement Technical Specification		11,096	CDM Smith
	Subtotal =	**4,784,964**	
Cogeneration Facilities			
South Cogen Building Fire Damage Engineering Support		10,466	AECOM
South Cogen High Pressure Gas Line Design		19,600	Molzen Corbin
South Cogen Water Line Rehab Design		24,300	Molzen Corbin
North Cogen Sensor Design		6,409	Molzen Corbin
	Subtotal =	**60,775**	
Plant Electrical Distribution System			
Feeder Isolation Switch (FIS) Ground Fault Investigation		5,576	Molzen Corbin
SWRP Electrical System Evaluation		150,121	AECOM
PNM Vacuum Breaker Interlock and Status Design		4,876	Molzen Corbin
SWRP Electrical System Priority Renewal Planning		59,885	Carollo
Primary Pump House 3 UPS Modification Design		5,335	Molzen Corbin
SWRP Power Panels Replacement Design		68,899	Carollo
SWRP MCC and Switchgear Replacement Design		236,638	Carollo
SWRP Electrical Critical Deficiency Assessment		14,859	B&D Industries
Preventative Maintenance Program Design		16,917	B&D Industries
	Subtotal =	**563,106**	
Plant Instrumentation and Control System			
Standardized Piping & Instrumentation Drawing Format Development		30,757	Brown & Caldwell
SWRP Instrumentation and Control System Evaluation		37,880	Brown & Caldwell
Transition Plan to PLC-Based Plant Control System Development		235,812	Brown & Caldwell
	Subtotal =	**304,450**	
Non-Potable Water System			
SWRP Reuse Filtration Facility Design		1,710,102	Molzen Corbin
Chlorine Residual Testing Program		24,973	Water Works
Interim Ammonium Sulfate Storage and Feed Facility Design		205,120	Water Works
	Subtotal =	**1,940,195**	
Misc. SWRP Renewal			
Rezoning of SWRP Site for Bernalillo County Special Use Permit		99,022	CDM Smith
Effluent Supplemental Dissolved Oxygen Facility Design Analysis		61,121	Carollo
Old Septage As-Built Drawings		19,009	Molzen Corbin
RAMP Report Update Assistance		89,966	CDM Smith
	Subtotal =	**269,117**	
	TOTAL =	**15,001,663**	

Notes:
1. Does not include project management and administration performed by Water Authority staff.

The initial operation of the new PTF has demonstrated much improved grit removal performance. Also, the tighter spacing on the bar screens has improved the performance of removing rags and other debris from the plant influent. The new PTF consists of the following elements:

- Lift Station 11a that is used to pump raw sewage delivered to the plant by the Valley Interceptor (a.k.a., Interceptor 142A) and the South Valley Interceptor. These interceptors currently deliver approximately 20 to 25 percent of the sewage to the SWRP.
- First Stage Grit Removal that is used for removing larger grit
- Mechanical Screens that are used to remove rags and other debris
- Second Stage Grit Removal that is used to remove smaller grit
- Washer/Compactors for dewatering screenings
- Grit Slurry Clarifiers/Classifiers for dewatering the grit
- Roll-Off Bins for temporary storage of dewatered grit, rags and other debris

2.2.2 Primary Clarifiers and Pumping Houses

Since the 2010 RAMP, the following improvements have been made or will soon be made to the process.

Pump House No. 1

- Replaced scum pump with new rotary lobe style pump (January 2013)
- Installed new electric actuator on Sludge Valve #1 (January 2014)
- Replaced Grinders #1 and #2 (May 2014)
- Replaced Sludge Pump #2 with new rotary lobe style pump (July 2014)
- Installed new rotary lobe style scum pump (July 2014)
- Installed new air conditioning unit in electrical room (2014)

Pump House No. 2:

- Replaced Sludge Pump #3 with new rotary lobe style pump (February 2013)
- Replaced Sludge Pump #4 with new rotary lobe style pump (September 2013)
- Replaced Grinders #3 and #4 (June 2014)
- Repaired and cleaned Sludge line (January 2015)
- Repaired and reinstalled Sludge Pump #3 rotary lobe style pump (April 2015)
- Installed new air conditioning unit in electrical room (2014)

Pump House No. 3:

- Replaced Check valves on sludge piping with new Check valves (2011)
- Replaced Sludge Pump #6 with new rotary lobe style pump (September 2012)
- Installed new standby Sludge Pump #10 (February 2013)

- Replaced Sludge Pump #7 with new rotary lobe style pump (April 2013 – later removed and reused elsewhere)
- Replaced Grinders #6 and #7 (May 2014)
- Installed new rotary lobe style pump Sludge Pump #7 (July 2014)
- Installed new rotary lobe style pump Sludge Pump #8 (July 2014)
- Installed new rotary lobe style pump Sludge Pump #9 (August 2014)
- Replaced Stand by grinder (August 2014)
- Repaired and reinstalled Sludge Pump #7 rotary lobe style pump (February 2015)
- Replaced Grinder #7 with new (August 2015)
- Installed new air conditioning unit in electrical room (2014)
- Replaced Isolation valves on sludge piping with new plug style valves (2013)

Primary Clarifiers (PCs) 5-8:

- Installed new 2-inch stainless steel flushing water line, and removed grit from PC-8 hopper (February 2015)
- Installed new flushing lines (2014)
- Design in progress to rebuild the Primary Clarifiers 5-8 effluent bypass structure and associated equipment.

Primary Clarifiers (PCs) 1-4:

- Design in progress to rehabilitate PC-4. The design includes installing a new spiral blade clarifier mechanism, effluent launders, launder covers and foam control system.
- Design in progress to replace the primary clarifier flow control valve. The design includes removal of the existing valve and vault, and replacement with new plug valve, vault and associated equipment.

2.2.3 Modified Ludzak-Ettinger (MLE) Process

The MLE process includes the Process Basins, Aeration Basin Blowers, Internal Recycle Pumps, Final Clarifiers, and Return Activated Sludge (RAS) Pumps. Together these elements provide secondary treatment of the sewage including the removal of biochemical oxygen demand (BOD), ammonia and nitrate. The Final Clarifiers and RAS Pumps also allow for the controlled removal of biosolids from the flow and the production of clear effluent ahead of the Ultraviolet Disinfection Facility.

2.2.3.1 Process Basin Improvements

The SWRP has 14 process basins where the sewage undergoes sequential anoxic and aerobic conditions to promote the growth of microorganisms to allow the removal of BOD, ammonia, and nitrate from the sewage (a.k.a., mixed liquor). Each basin has thousands of diffusers, including the swing zones. The anoxic zones of each basin use vertical mixers to keep the sewage mixed. Each basin has an internal recycle pump to return aerated mixed liquor to the anoxic zones.

Aeration Diffuser Replacement

Since the original RAMP Report, the focus of the process basin improvements has been on renewing all of the aeration diffusers. The plant had sets of ceramic and membrane diffusers that were beyond their expected useful life. These have been replaced with new membrane diffusers. In some of the basins, Teflon-coated diffusers have been installed to determine if these will provide longer useful lives over the standard EPDM diffusers. The original thin-wall diffuser piping has also been replaced with new, schedule 40 PVC piping. All the basins have been cleaned to removal several inches of accumulated grit.

Changing out the aeration diffusers has had a dramatic effect on the efficiency of oxygen transfer into the mixed liquor. The plant is able to maintain oxygen levels resulting in very good BOD and ammonia removal performance. Moreover, the number of on-line aeration blowers required has dropped from 7 to 8 down to 4 to 5.

On-line Monitoring of Biological Nutrient Removal

A very important project is currently underway to test the reliability of on-line instrumentation for MLE process control. Ammonia, nitrate, oxygen and ORP probes have been installed to monitor effluent ammonia and nitrate, solids concentrations in the bioreactors and ORP readings in the anoxic zones.

2.2.3.2 Aeration Basin Blowers

The original RAMP Report indicated that the SWRP's 12 multi-stage centrifugal blowers were deficient in capacity for meeting the 76 mgd nominal plant capacity, even if they were all functional. At the time, two of the blowers had failed and were missing from their positions.

During the past five years, the missing blowers have been replaced and all the other blowers have been repaired to good working order. The aforementioned renewal of the aeration basin diffusers, together with the sealing of numerous air piping leaks, has allowed a better assessment of aeration blower capacity requirements. As will be discussed in the report section on the MLE Process, the 76 mgd flow rate can be treated with 11 blowers.

The Water Authority is still interested in eventually replacing some or all of the multi-stage blowers with higher efficiency units. However, this improvement will be to reduce electrical energy use rather than the need to increase aeration blower capacity. The Water Authority completed a feasibility study on replacing the blowers in the North Blower Building with high efficiency units.

2.2.3.3 Secondary/Final Clarifiers

The Water Authority replaced the original sludge collection mechanisms in the 12 Secondary/Final Clarifiers. The new mechanisms use spiral blades and are fabricated from stainless steel. The interior launders were also removed to facilitate algae cleaning.

2.2.3.4 Return Activated Sludge Pumps

There are four RAS Pumps that are used to pump settled solids from the Secondary/Final Clarifiers back to the Process Basins. The Water Authority had RAS Pump No. 2 rebuilt and it purchased a standby pump. This improves the reliability of the plant by allowing immediate installation of the standby pump when one of the in-place units is removed for renewal. This allows the plant to maintain proper recycle rates.

2.2.4 Ultra-Violet Disinfection Facility

In April 2011, the Water Authority started-up the new Ultra-Violet (UV) Disinfection Facility at the SWRP. This allowed the elimination of the hazardous chemicals: chlorine and sulfur dioxide from the site. The UV disinfection system performs well to inactivate microorganisms in the plant effluent.

The Water Authority is currently designing a set of pre-screens to remove algae and other debris from the secondary clarified sewage ahead of the UV Disinfection Facility. This will reduce operator maintenance towards keeping the UV bulbs clean.

2.2.5 Secondary Sludge Thickening

The SWRP currently uses dissolved air flotation (DAF) to thicken the secondary sludge wasted from the MLE process. The existing DAF Facility has undergone improvements since the original RAMP report was published and further improvements are underway, including an evaluation of using an alternative sludge thickening technology to DAF.

A set of pilot studies were conducted during 2015 to examine different sludge thickening technologies, including centrifuges, screw presses, drum presses, and improved DAF. Additional evaluation of the alternative technologies is currently being conducted before making a final decision.

Among the planned improvements to the existing DAF Facility are renewal of the electrical and HVAC systems. Structural modifications to the DAF Building are planned to better isolate electrical equipment from the process areas.

2.2.6 Anaerobic Digestion

Considerable work has been done during the past five years and are currently underway to improve the condition of the 14 anaerobic digesters at the SWRP. All of the digesters have undergone cleaning to remove sand and other sediment. The existing draft tube mixers have been repaired and the heat exchangers have been replaced so that more effective mixing and heating of the sludge is provided. Hatches and safety pressure/vacuum valves are being replaced and cracks in the walls and roofs of the digesters have been sealed.

The Water Authority will be evaluating the use of a linear mixer as an alternative to the existing draft tube mixers. If the new type of mixer provides similar or better performance, then the Water Authority will likely replace all the draft tube mixers with linear mixers. Pumped mixing is another alternative approach being considered.

2.2.7 Solids Dewatering

Since the original RAMP Report, a design analysis has been completed to evaluated renewal options for the existing Solids Dewatering Facility (SDF) at the SWRP. The results of this analysis indicated that the existing facility has sufficient capacity for the foreseeable future and that rehabbing this facility was more cost effective than constructing a new facility.

The design of the SDF renewal is currently underway and should be completed in the first half of calendar year 2016. Once complete, construction will begin including the addition of 2.0 million gallons (mil gal) of additional liquid digested sludge storage capacity and a 50 percent increase in dry cake storage capacity. These later improvements will improve the ability of the SWRP to be able to waste primary and secondary solids, improving the performance and reliability of the MLE process.

As indicated in the previously presented Table 2-1, improvements to the SDF building and equipment have already been implemented.

2.2.8 Cogeneration Facilities

The Water Authority operates two cogeneration facilities with a total of four engine-generators. The condition assessment completed for the original RAMP Report indicated that these facilities were in overall good condition. Most of the capital improvements to the cogeneration systems during the past five years have been completed by Water Authority staff. This includes major overhauls to the engines and generators. Other recent improvements at the Cogeneration Facilities includes natural gas and water piping renewal as well as renewal of the roofs of the two buildings.

2.2.9 Plant Electrical Distribution Systems

The electrical power distribution system at the SWRP is complex and has been constructed in phases during the past five decades. The original RAMP Report identified the electrical systems at the SWRP, including the distribution system, as being in need for renewal. Many of the switches and panels were at or approaching the end of their useful lives. Also, due to their age, this electrical equipment did not meet current electrical codes. Since that time, the Water Authority has had more detailed evaluations of completed to assist in prioritizing the required capital improvements

As previously presented in Table 2-1, over $5-million has been expended on these capital improvements. This includes renewal of several switches have been completed. A new Field/Feeder Isolation Switch (FIS) Facility has been constructed. In addition, large standby generators have been purchased and installed to improve the reliability of power for key plant facilities (e.g., pumping stations).

As will be presented in Section 14 and as previously presented in the Executive Summary, the Water Authority is projected to spend an additional $36-million on renewal of the electrical system, including those for individual process areas, at the SWRP during the next decade. This

does not include the additional $17-million scheduled to be spend on improvements to the Cogeneration Facilities.

2.2.10 Plant Instrumentation and Control Systems

The Water Authority has evaluated the existing distributed control system (DCS) at the SWRP and has decided to migrate to a programmable logic controller (PLC) based system. The Water Authority plans to make the change over the next several years, having just upgraded the hardware and software associated with the existing DCS.

2.2.11 Non-Potable Water System

In September of 2012, the Water Authority started up a new effluent filtration and disinfection system that provides non-potable water from the SWRP as well as for off-site uses (e.g., irrigation of parks). The Water Authority has also completed a program of renewing broken isolation valves and hydrants in the SWRP non-potable water distribution system. In addition, a backup connection to the Water Authority's potable water system has been renewed. Together, these projects have provided the SWRP with a reliable non-potable water system.

One new improvement to the non-potable system that has been designed and is currently under construction is the Ammonium Sulfate Storage and Feed Facility. This facility will replace a temporary system and provide for a more consistent total chlorine (i.e., mono-chloramine) disinfection residual in the non-potable water.

2.2.12 Other Improvements

Other notable recent improvements at the SWRP include improvements to site security through the installation of cameras and a new gate. Additional parts and equipment covered storage space has been provided through the conversion of the Chlorine Building and Sulfur Dioxide Buildings.

Section 3

Preliminary Treatment Facility

Section 3
Preliminary Treatment Facility

3.1 INTRODUCTION AND PROCESS OVERVIEW

The construction of the new Preliminary Treatment Facility (PTF) was completed in October of 2015. The previous facility was among the highest risk facilities at the Southside Water Reclamation Plant (SWRP). It did not perform well at removing grit or rags, was high maintenance, and many of its systems and equipment components were at the end of their useful lives. The new PTF is a new "greenfield" facility completely replacing the old facility, rather than a rehab project.

3.2 PTF PROCESS IMPROVEMENTS (2010 – 2015)

As mentioned above, a new PTF has been constructed and started up. It consists of the following elements:

- Lift Station 11A that is used to pump raw sewage delivered to the plant by the Valley Interceptor (a.k.a., Interceptor 142A) and the South Valley Interceptor. These interceptors currently deliver approximately 20 to 25 percent of the sewage to the SWRP.
- First Stage Grit Removal that is used for removing larger grit
- Mechanical Screens that are used to remove rags and other debris
- Second Stage Grit Removal that is used to remove smaller grit
- Washer/Compactors for dewatering screenings
- Grit Slurry Clarifiers/Classifiers for dewatering the grit
- Roll-Off Bins for temporary storage of dewatered grit, rags and other debris

3.3 CAPACITY ANALYSIS

Table 3-1 provides the design criteria and capacity data for the equipment in the new PTF. Preliminary treatment processes, also known as "headworks," are primarily sized for peak flow conditions. The reason for this is the basic headworks processes, screening and grit removal facilities, are physical processes that are affected primarily by hydraulic loading and the passing of peak flows is the most critical design criteria for the equipment. Also, peak screenings and grit loads take place at the higher flows when sewer system flushing occurs. The new PTF is sized for a peak instantaneous flow of 120 mgd, rather than the maximum month average flow of 76 mgd.

3.3.1 Lift Station 11A

Lift Station 11A is fitted with three identical submersible pumps. Each pump has a design flow capacity of approximately 9,000 gallons per minute (gpm) or 13 million gallons per day (mgd) at maximum speed. Each pump has a variable frequency drive to allow flow capacity turndown to accommodate the variable influent flows during the day. With the two duty pumps in-service, Lift Station 11A has a firm capacity of approximately 18,000 gpm or 26 mgd.

Table 3-1
Preliminary Treatment Facility Design Criteria Summary

Design Flows (mgd)	
Average Annual (AAF)	72
Maximum Month (MMF)	76
Peak Day (PDF)	90
Peak Hour (PHF)	110
Peak Instantaneous (PIF)	120
Lift Station 11A	
Type	Submersible non-clog
Number of Pumps	3 (2 duty, 1 standby)
Flow Capacity, each	13 mgd
Flow Capacity, firm	26 mgd
First Stage Grit Removal	
Type	Aerated with duckbill coarse bubble diffusers
Targeted Grit Size	Greater than 1 mm at PHF
Number of Basins	1 with by-pass channel
Volume	22,000 gallons
Detention Time	16 seconds at PHF; 26 seconds at AAF
Number of Blowers	2 (1 duty, 1 standby)
Blower Capacity, Each	100 cfm
Grit Removal System	Horizontal and inclined shafted augers
Bar Screens and Screenings Processing	
Screen Type	Mechanical Bar with multi-rake
Number of Screens	5 (4 duty, 1 standby) with by-pass channel
Bar Spacing	¼ -inch
Channel Dimensions	4.5 feet wide by 9 feet deep
Screenings Quantity	30 ft^3/hr average; 120 ft^3/hr peak
Screenings Conveyance	Sluice
Screenings Processing Type	Washer/Compactors
Number of Washer/Compactors	2 (1 duty, 1 standby) with bypass
Washer/Compactor Capacity, Each	210 ft^3/hr, 140 ft^3/hr when washing
Second Stage Grit Removal	
Type	Conical Tray Vortex
Number	4
Size	12 ft diameter
Number of Trays per Unit	12
Targeted Grit Size	100 micron
Grit Removal Pump Type	Recessed impeller
Number of Pumps	4
Pump Capacity, Each	300 gpm
Grit Dewatering Systems	Clarifier/Classifiers
Number of Dewatering Systems	4
Dewatering System Capacity, Each	400 gpm, 2000 lbs/hr. 20 ft^3/hr

The current maximum flow received at this lift station is approximately 15 mgd. The portions of the Albuquerque metropolitan areas served by the interceptors feeding LS 11A is largely built out and it is anticipated that this lift station will have ample capacity to handle all future flows.

3.3.2 First Stage Grit Removal System

The First Stage Grit System uses an aerated grit removal system to assist in separating organic matter from inorganic grit (e.g., sand). The First Stage Grit System targets larger grit (i.e., greater than 1 millimeter, mm). The facility includes a set of augers to collect and convey the settled grit to a roll-off dumpster. Once full, the roll-offs are transported to a municipal landfill for ultimate disposal of the grit. The facility includes a by-pass channel to allow maintenance on the auger system.

3.3.3 Bar Screens and Screenings Processing Systems

The new PTF includes a set of multi-rake type mechanical bar screens. The bars are spaced to provide ¼-inch openings versus the 3/8-inch bar spacing of the screens at the old PTF. The multi-rake screens are enclosed and ventilated to the odor control system. A water sluice is used to convey the screenings to a set of washer-compactors, which wash, dewater and compress the screenings. The dewatered screenings are conveyed to a set of roll-offs for temporary storage and eventual transport to a municipal landfill. A by-pass pipe has been added to the system in the case the washer-compactors are temporarily out of service.

3.3.4 Second Stage Grit Removal System

The new PTF uses a set of Eutek Head Cells® to remove the finer grit from the influent. This system targets grit down to about 100 micron in size. A set of recessed impeller grit pumps are used to withdraw the settled grit and convey it to a set of clarifier-classifiers, which dewater the grit and convey it to the roll-offs.

3.3.5 Odor Control System

The new PTF used a set of Bohn Biofilters to capture and neutralize odorous compounds. The Bohn Biofilters should provide more reliable performance and safer maintenance requirements than the previous chemical scrubber odor control system.

3.4 PTF PROCESS ASSET RISK ASSESSMENT

Table 3-2 provides a ranking of the PTF assets. As indicated, in general, the risk associated with a brand new facility is low. However, two issues were identified during startup and initial operation of the PTF. This includes the rapid failure of the pumps at Lift Station 11A and the clogging of the washer/compactors. The Water Authority is taking steps to resolve these issues and reduce the associated risk. The necessary modifications/improvements will be made as quickly as possible.

3.4.1 Lift Station 11A Pump Failures

All four of the pumps installed at Lift Station 11A failed after only about 1 month of service. An initial evaluation of the pumps indicated that the failure was due to a combination of rags collecting on the pump shafts and grit wearing out the mechanical seals. This resulted in water entering and shorting out the submersible motors.

The Water Authority is working with the pump vendor to retrofit each of the four pumps with a different style of impeller that is better suited for handling rags. Once the upgrades to the pumps are completed, these pumps will be re-installed at Lift Station 11A.

The Water Authority has also directed one of its on-call engineering consultants to evaluate the design of Lift Station 11A and make recommendations for any necessary improvements. This consultant is also evaluating the alternatives for installing bar screens ahead of Lift Station 11A.

3.4.2 Washer/Compactor Failures

The two washer/compactors used for dewatering screenings captured on the PTF bar screens clogged during initial operation. The issue has largely been resolved through modified operation of the screens when higher than normal grit loads appear in the plant influent. However, to additional protection from clogging, a by-pass chute has been installed that allows the screenings to go directly to the roll-off bins by-passing the washer compactors.

3.5 RECOMMENDED IMPROVEMENTS

Except for the modifications described above, no additional improvements for the new PTF have been identified.

Section 4

Primary Clarifiers

Section 4
Primary Clarifiers

4.1 INTRODUCTION AND PROCESS OVERVIEW

The purpose of this section is to (1) provide an overview and summarize the major improvements made to the Primary Clarification Process areas since the original RAMP was finalized in 2010; (2) reevaluate the capacity of this process; (3) describe the current condition of the process elements and the required improvements; and (4) present a plan for making required improvements.

The SWRP primary clarification process consists of four 120-foot conventional primary clarifiers (PCs) and four 150-foot "Clari-Thickeners" (clarifiers with center wells for sludge thickening). The process also includes primary effluent, sludge and scum pumping systems.

4.2 PRIMARY CLARIFIER IMPROVEMENTS (2010-2015)

Since the 2010 RAMP, the following improvements have been made or will soon be made to the process.

Pump House No. 1

- Replaced scum pump with new rotary lobe style pump (January 2013)
- Installed new electric actuator on Sludge Valve #1 (January 2014)
- Replaced Grinders #1 and #2 (May 2014)
- Replaced Sludge Pump #2 with new rotary lobe style pump (July 2014)
- Installed new rotary lobe style scum pump (July 2014)
- Installed new air conditioning unit in electrical room (2014)

Pump House No. 2:

- Replaced Sludge Pump #3 with new rotary lobe style pump (February 2013)
- Replaced Sludge Pump #4 with new rotary lobe style pump (September 2013)
- Replaced two Scum valve vaults (2013)
- Replaced Grinders #3 and #4 (June 2014)
- Repaired and cleaned Sludge line (January 2015)
- Repaired and reinstalled Sludge Pump #3 rotary lobe style pump (April 2015)
- Installed new air conditioning unit in electrical room (2014)

Pump House No. 3:

- Replaced Check valves on sludge piping with new Check valves (2011)
- Replaced Sludge Pump #6 with new rotary lobe style pump (September 2012)
- Installed new standby Sludge Pump #10 (February 2013)

- Replaced Sludge Pump #7 with new rotary lobe style pump (April 2013 – later removed and reused elsewhere)
- Replaced Grinders #6 and #7 (May 2014)
- Installed new rotary lobe style pump Sludge Pump #7 (July 2014)
- Installed new rotary lobe style pump Sludge Pump #8 (July 2014)
- Installed new rotary lobe style pump Sludge Pump #9 (August 2014)
- Replaced Stand by grinder (August 2014)
- Repaired and reinstalled Sludge Pump #7 rotary lobe style pump (February 2015)
- Replaced Grinder #7 with new (August 2015)
- Installed new air conditioning unit in electrical room (2014)
- Replaced Isolation valves on sludge piping with new plug style valves (2013)

Primary Clarifiers (PCs) 5-8:

- Installed new 2-inch stainless steel flushing water line, and removed grit from PC-8 hopper (February 2015)
- Installed new flushing lines (2014)
- Replaced PC-6 gate (2013)
- Design in progress to rebuild the Primary Clarifiers 5-8 effluent bypass structure and associated equipment.

Primary Clarifiers (PCs) 1-4:

- Evaluated rehab of launder cover platforms at PC-3 and PC-4 (2014)
- Repaired PC-4 sludge hopper leak (2014)
- Designed PC-4 concrete sludge box repair (2014)
- Designed PC-4 scum tray access (2014)
- Design in progress to rehabilitate PC-4. The design includes installing a new spiral blade clarifier mechanism, effluent launders, launder covers and foam control system.
- Design in progress to replace the primary clarifier flow control valve. The design includes removal of the existing valve and vault, and replacement with new plug valve, vault and associated equipment.

4.3 PRIMARY CLARIFIER PROCESS CAPACITY

This subsection provides an update to the RAMP capacity analysis for the Primary Clarification Process. The capacity is based on an analysis of the last five years of influent and operational data.

Per the original RAMP Report, peak flow capacity of the primary clarification process as a function of surface area was 118 mgd. This was based on the peak surface overflow rate (SOR) of 1200 gpd/ft^2 recommended in the New Mexico Environment Department (NMED) document, "Recommended Standards for Wastewater Facilities."

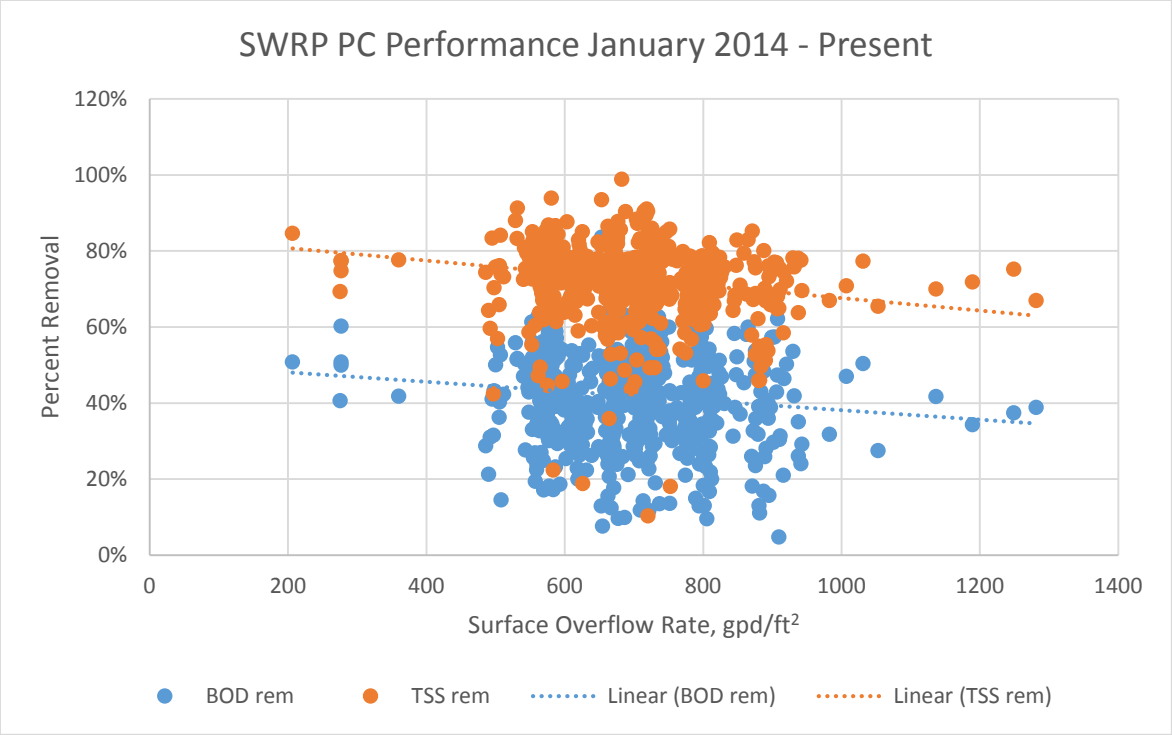
To determine the maximum month flow-rated capacity, peak hour design flow (118 mgd) is divided by maximum month flow factor (1.41) to obtain 83.3 mgd. This translates to a maximum month SOR of 850 gpd/ft^2 which is greater than the NMED-recommended SOR of 700 gpd/ft^2.

SWRP staff believes process performance has improved since September 19, 2005, when all the old primary clarifiers were taken off-line. However the data indicates that there has been only a slight increase in BOD and TSS removal since then, with BOD removal increasing from 42% to 45% and TSS removal increasing from 72% to 76%.

CDM Smith while developing the Primary Clarifier Renovation Project Preliminary Design Report in 2011, discussed whether the relatively conservative NMED Guidelines SOR recommendations were appropriate to use to evaluate options for new primary clarification process construction. Industry standard average flow SOR used for modern designs are 800 to 1200 gpd/ft^2.

Figure 4-1 illustrates SWRP primary clarifier performance data from January 2014 to the present. The data indicates BOD and TSS removal efficiency decreases as SOR increases. This may not be an appropriate conclusion given the scarcity of data points at higher SOR.

Until construction of all new primary clarifier facilities is being considered at the SWRP, this data indicates the continued use of the NMED peak flow criteria resulting in a maximum month SOR of 850 gpd/ft^2 is appropriate, resulting in a maximum month flow capacity for the primary clarification process of 83.3 mgd. Therefore, no additional primary clarifiers are required to achieve the design maximum month flow of 76 mgd.



SWRP Primary Clarifier Performance

Figure 4-1

4.4 PRIMARY CLARIFICATION PROCESS RISK ASSESSMENT

This section provides an update to the asset risk assessment for the Primary Clarification Process. A ranking of the primary clarification process assets is provided in the appendix.

4.4.1 Primary Clarifier Mechanisms and Tanks

The sludge scraper mechanisms for Primary Clarifiers 1-4 and 5-8 have the highest and next highest risk rankings, respectively. This is due to their age and criticality in the primary clarification process.

Primary Clarifiers 1-4 mechanisms are over 50 years old and a majority of the equipment requires replacement. Design is currently underway to replace the mechanism and associated equipment in Primary Clarifier No. 4. In subsequent rehabilitation projects the Water Authority plans to replace the mechanisms in Primary Clarifiers 1-3.

The overall condition of the concrete in Primary Clarifiers 1-4 appears to be fairly good. During design investigation for Primary Clarifiers 1-3 new mechanism, cracked concrete will be identified and included for repair.

Primary Clarifiers 5-8 mechanisms are approximately 30 years old, have experienced severe duty over the life of the equipment, and therefore are requiring replacement. An inspection of

PC-5 showed the tank to be in relatively good condition below the operating water surface. As already noted in the original RAMP Report, the walls of the effluent launders have corroded and require repair.

4.4.2 Primary Clarifiers – Draining

Completely draining the primary clarifiers is a burdensome task for SWRP staff. Due to the drain line placement at Primary Clarifiers 5-8, the tanks can only be emptied to the top of the sloped bottom. To drain the remaining portion of the tank, a portable pump must be lowered into the clarifier.

4.4.3 Sludge Pumps, Pipes and Valves

A majority of the sludge and scum pumps have been replaced in the last 5 years. Old progressive cavity sludge pumps were replaced with rotary lobe style pumps. The new pumps do not experience severe damage during run dry conditions; however, SWRP staff have noted premature failure of the seals. With the new Preliminary Treatment Facility (PTF) grit removal system now operational, SWRP staff have noted less clogging in sludge lines. This is evident at Primary Clarifiers 5-8 where grit from the sludge thickeners have been cleaned out. Regarding the issue of the restrictive sludge pipe alignment of Primary Clarifier 7, continued evaluation of the improved sludge pumping characteristics will be required to determine whether or not this piping issue still needs to be addressed.

4.4.4 Odor Control

Odor control is important but not only for health and esthetic reasons. In confined spaces where microbial action takes place and releases odorous H_2S gas, corrosion can severely damage surfaces and structures.

Odor control systems will be replaced during Primary Clarifiers 1-4 rehabilitation. The dual launders will be replaced with single launders, reducing the amount of air required for treatment by more than 50%. This will allow for significant downsizing of the blowers and bio filters.

At Primary Clarifiers 5-8, corrosion is evident in the effluent launder walls. The air flow rates and/or blower reliability have been insufficient to protect the concrete substrate because the odor control systems have reached their expected life. SWRP staff noted frequent failures of Primary Clarifiers 5-8 blowers. Holes have developed in the odor control ductwork at Primary Clarifiers 5-8 resulting in concrete degradation where condensate from the ductwork is dripping onto the concrete walls.

4.4.5 Spray and Wash water Systems

The existing spray systems have exceeded their expected life and are no longer used due to failure. Staff use fire hoses to direct excess scum into the hoppers when necessary.
The 2-inch wash water lines for scum piping in Primary Pump Hoses 1 and 2 are undersized and need to be increased to 4-inch or 6-inch to provided better cleanout.

4.4.6 HVAC

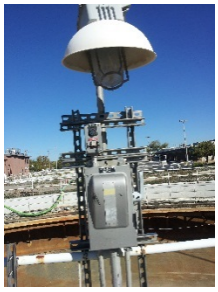
Air conditioning units have been installed in all of the Primary Pump House electrical rooms. However due to age and condition of equipment, new exhaust and supply fans are needed for all pump houses. SWRP staff also noted that supply fans may be turned off in the winter to prevent cold air from entering the building and freezing small diameter water piping.

4.4.7 Electrical, Instrumentation and Control Systems for the Primary Clarification Process

4.4.7.1 Primary Clarifiers 1-4

In November 2014 field investigations were performed by engineering consultant CDM Smith, documented in a Preliminary Design Report (March 2015), and confirmed with SWRP staff. Primary mechanisms and drives are in poor condition. Currently PC-4 drive has failed. Of the remaining operational mechanisms, PC-1 and PC-2 drives and equipment appear to be in the worst condition.

Associated field-located combination starters, disconnects, torque and limit switches, stanchion mounted light fixtures, junction boxes and conduit and wire are in poor condition and have reached the end of their useful life. Refer to images below of existing primary clarifier drive motors and local switch boxes taken during the Nov. 2014 field investigation.

PRIMARY CLARIFIER #1	PRIMARY CLARIFIER #2	PRIMARY CLARIFIER #3	PRIMARY CLARIFIER #4
			

Motor Control Center (MCC) No. 3, located in Pump House (PH)-1, and MCC No. 6, located in PH-2, were assessed for condition and suitability to provide power to the proposed replaced equipment. Both MCC's were determined to be in good working condition and have spare capacity for additional or future equipment.

The existing electrical duct banks between the primary clarifiers and the pump houses were inaccessible during the inspection. The condition of these duct banks must be assessed during preliminary design of any projects to address electrical improvements for PC's 1-4.
Odor Control Blowers for Primary Clarifiers 1-4 were not directly accessible during the field investigation; however, further discussions with Plant Staff recommend replacement of the blower motors, VFD's/starters, associated disconnects, control panels, junction boxes and conduit and wire.

Field instrumentation was found to be in poor condition and should be replaced along with associated conduit and wiring. The Existing Instrumentation Control Panels (ICP) were found to be outdated. It is recommended that these types of control systems be removed and replaced in favor of the current plant preference of remote control and monitoring via Remote Terminal Unit (RTU) and a centralized SCADA system.

4.4.7.2 Primary Clarifiers 5-8

SWRP staff were interviewed to develop an electrical equipment assessment for this study. The following determinations were made:

- Primary Clarifier 5-8 equipment including field-located combination starters, disconnects, torque and limit switches, stanchion mounted light fixtures, junction boxes and conduit and wire are from 5 to 20 years newer than the equivalent Primary Clarifier 1-4 equipment. However their condition is deemed poor by SWRP staff and should be replaced.
- Motor Control Center (MCC) No. 12 and MCC No. 13, located in PH-3 were assessed by SWRP staff for both condition and suitability to provide power to the proposed replaced equipment. Both MCC's were determined to be in good working condition and have spare capacity for additional or future equipment.
- The existing electrical duct banks between the primary clarifiers and the pump houses were not assessed and SWRP staff were not able to provide further input as to their condition. The condition of these duct banks must be assessed during preliminary design.
- SWRP staff recommend replacement of the blower motors, VFD's/starters, associated disconnects, control panels, junction boxes and conduit and wire.
- Based on the Primary Clarifier 1-4 field investigation and on feedback obtained from SWRP staff, field instrumentation is in similarly poor condition and should be replaced along with associated conduit and wiring. The existing Instrumentation Control Panels (ICP) are also dated. It is recommended that these types of control systems be removed and replaced in favor of the current plant preference of remote control and monitoring via RTU and a centralized SCADA system.

4.5 IMPROVEMENTS PLAN

This section provides an update to the near-, intermediate- and long-term improvements recommended for the Primary Clarification Process. These recommendations are revised to reflect the improvements made since the original RAMP as well as any new improvements that have become apparent as a result of the revised capacity analysis.

4.5.1 Near-Term Improvements

The most crucial need for primary clarification process improvements is replacement of the clarifier mechanisms and associated mechanical equipment in Primary Clarifiers 1-4. Design of a new spiral blade mechanism, effluent launders, spray systems and concrete repairs is currently underway for Primary Clarifier 4. Replacement of mechanisms in Primary Clarifier No. 1 through 3 should follow in the near term.

Another pressing need for improvement is replacement of the existing field instrumentation and controls at Primary Clarifiers 1-4. As noted previously the field instrumentation and associated conduit and wiring is in poor condition and should be replaced. Additionally the existing ICP are dated and it is recommended that these be replaced with remote control and monitoring via RTU and centralized SCADA system. These systems should be replaced when the mechanical equipment in Primary Clarifiers 1-4 is replaced.

Concurrent to replacement of equipment associated with Primary Clarifiers 1-4, the washwater lines for scum piping in Pump House 1 and 2 should be increased in size to provide better flushing of the lines minimizing the potential for plugging.

An odor control study is currently on-going to evaluate existing odor control systems throughout the entire plant, including those associated with the primary clarifiers. Recommendations for improvements and subsequent design projects should address the equipment and ductwork issues associated with all eight primary clarifiers.

4.5.2 Intermediate-Term Improvements

As noted in 4.4, the second-highest ranked risk are the mechanisms and drives in Primary Clarifiers 5-8. Associated in-tank equipment and instrumentation equipment should be replaced and upgraded. Upgrades to Primary Clarifiers 5-8 should also include repair of the corroded concrete effluent launders and modifications to the drain system and sludge suction lines as noted in 4.4. The need to upsize and improve alignment of sludge suction lines will be re-evaluated based on results of operating the new PTF.

Primary Pump Houses 1-3 inlet and exhaust fan replacements are identified as near- to intermediate-term improvements because operating and maintaining the equipment is difficult due to equipment age and obsolescence.

While not discussed in 4.4, influent structures gates and actuators should be replaced as the equipment nears its useful life and becomes more maintenance-intensive. SWRP staff noted that one of the gates at the inlet structure to Primary Clarifiers 1-4 is frozen in the open position which may indicate the equipment is beginning to experience severe corrosion.

4.5.3 Long-Term Improvements

As discussed in 4.3, no additional primary clarifier capacity is required to achieve the design maximum month flow rate of 76 MGD. Therefore no additional long-term improvements are required to address primary clarifier capacity.

The sludge pumps, grinders, and electrical feed equipment are in generally good condition with no current need for replacement. However as these components age--particularly the pumps and grinders which are a severe duty application--they should be included for replacement in long-term planning.

Per the Modified Ludzak-Ettinger (MLE) Process discussed in Section 5 of this report, increased influent concentrations have resulted in reduced maximum month flow capacity rating due to a limitation of final clarifier capacity. To address this limitation, one strategy is to implement chemically-enhanced primary treatment (CEPT) to increase BOD and TSS removal in the primary clarifiers. This reduces the load on the MLE process and allows it to treat 76 mgd at the higher influent concentrations.

CEPT is therefore another long-term improvement related to the primary clarifiers that should be considered. Implementation of CEPT would require the addition of chemical feed facilities and review of the sludge removal mechanism design to ensure it is capable of handling the increases quantities of primary sludge.

Section 5

Modified Ludzak-Ettinger Process

Section 5
Modified Ludzak-Ettinger Process

5.1 INTRODUCTION AND PROCESS OVERVIEW

The purpose of this section is to provide an updated evaluation of the secondary treatment facilities at the Southside Water Reclamation Plant (SWRP). The SWRP uses the Modified Ludzak-Ettinger (MLE) Process for removing biochemical oxygen demand (BOD), ammonia, and nitrate from the sewage.

The SWRP MLE process consists of primary effluent pumps, 14 MLE process bioreactors (basins) with mixers, aeration blowers fine bubble aeration diffusers, and internal recycle (IR) pumps; 12 secondary clarifiers with return activated sludge (RAS) pumps, waste activated sludge (WAS); and chemical feed facilities

There have been numerous improvements made to these facilities since the 2010 RAMP Report publication that are documented herein. The BioWin™ process simulation model for the SWRP has been recalibrated again to reflect current conditions so as to provide an update of unit process capacity evaluation.

5.2 MLE PROCESS IMPROVEMENTS (2010 – 2015)

Since the original RAMP Report, the following improvements have been made or will soon be made to the process:

South Aeration Basins 1 and 2: (May – September 2014)

- Replaced/repaired damaged groundwater pressure relief valves in the basin floors.
- Replaced diffusers (combination of ceramic and EPDM) with new EPDM membranes.

South Aeration Basin 3: (March – June 2014)

- Replaced diffusers (combination of ceramic and EPDM) with new EPDM membranes.

South Aeration Basin 4: (October 2013 – May 2014)

- Replaced drain valve (plug-style) in pipe gallery. (October 2013 – May 2014)
- Replaced ceramic diffusers with EPDM membranes.

South Aeration Basins 5 and 6: (2009 and 2013)

- Replaced ceramic diffusers with EPDM membranes.
- Replaced diffuser piping and appurtenances in 2009.

South Aeration Basins 7 and 8: (May 2013 – April 2014)

- Replaced all air diffuser laterals, manifolds, purging system and diffusers with new piping and diffusers. New membranes are Teflon-coated.
- Reconfigured the stainless steel air piping to get the air valves out of the mixed liquor. Replaced all air valves with stainless steel valves.
- Replaced all air valve actuators.
- Replaced two VFDs for internal recycle pumps.
- Replaced portion of 4-inch washwater line and added fire monitors to the flush hydrants.
- Replaced two influent sluice gate valves.

North Aeration Basins 1 and 2: (August 2014 – January 2015)

- Replaced all ceramic diffusers with EPDM membranes.

North Aeration Basins 3 and 4: (September 2015 – April 2016)

- Will replace all air diffuser piping and diffusers with new piping and diffusers. New membranes will be Teflon-coated.

North Aeration Basins 5 and 6: (February 2015 – August 2015)

- Replaced all air diffuser piping and diffusers with new piping and materials. New membranes are Teflon-coated.

South Blower Building (2013-2015)

- Replaced Blowers 4 and 5 with new blowers
- Installed new fabricated metal mounts to alleviate sinking conditions of concrete pads
- Installed new inlet air filtration systems

North Blower Building (2015)

- Installed new inlet air filtration systems

Secondary Clarifiers (2010-2011)

- Installed new spiral blade sludge collection mechanisms
- Removed interior launders to facilitate algae cleaning

Activated Sludge Pump Station (2015)

- Purchased standby RAS pump
- Rebuilt RAS Pump #2

A very important project is currently underway to test the reliability of on-line instrumentation for MLE process control. Ammonia, nitrate, solids and ORP probes are being installed to monitor effluent ammonia and nitrate, solids concentrations in the bioreactors and ORP readings in the anoxic zones. The reliability of on-line instruments has greatly increased in recent years and many activated sludge plants are being operated directly off readings from on-line instruments.

5.3 MLE PROCESS CAPACITY

Because of both population growth and continually increasing influent concentrations due to water conservation and use of water saving fixtures in new construction, it is important to update influent flows, flow peaking factors, influent concentrations and mass loading peaking factors on a regular basis. Updated flows and loads are then used to update the capacity evaluation.

5.3.1 Flow and Loading

Table 1-3 provides a summary of recent data for the period of January 1, 2010 to present and the results of the data analysis. The average values for the data was calculated after removing outliers below the 5th percentile and higher than the 95th percentile.

Table 1-3

Influent Data

Parameter	Avg. Since Jan 2010	Avg. Since Jan 2013	Max. Month	Max. Mo Factpr
Raw Wastewater				
COD, mg/L	625	693	902	1.3
cBOD, mg/L	249	291	342	1.18
BOD (calculated[1]), mg/L	274	320		
TSS, mg/L	451	466	677	1.45
VSS, mg/L	341	341		
Ammonia, mg/L	33	35	41	1.17
TN (calculated[2]), mg/L	46	49		
Primary Effluent				
Flow, MGD	52	51		
COD, mg/L	366	360		
BOD (calculated[1]), mg/L	182	187		
TSS, mg/L	137	123		

[1]Assumed BOD:cBOD ration of 1.1 [2]Assumed TKN:ammonia ratio of 1.4

For the blower capacity analysis it is necessary to determine a peak day organic loading factor. This was done by using the 98th percentile primary effluent cBOD data. The 98th percentile value for the five year period was 250 mg/L and the average was 170 mg/L resulting in a peak day organic load factor of 1.5.

Raw wastewater data indicates an increase in influent concentrations since 2008, a 25 percent increase in raw wastewater COD and an 88 percent increase in raw wastewater TSS. This increasing concentration trend can also be observed when comparing the last two years of data with the last five years of data as indicated in Table 2-1. This has the potential to change the results of a plant capacity evaluation, assuming current influent concentrations are assigned to the target design flow of 76 mgd. If the concentration of the SWRP influent continues to increase, the 76 mgd design flow may need to be reevaluated, at least when considering the capacities of the biological processes at the plant.

5.3.2 MLE Process Capacity

The capacity of the MLE Process and its components is based on the BioWin™ process simulator analysis that has been recalibrated using the last five years of influent and operational data. The purpose of this section is to provide an update of the MLE Process capacity analysis using the BioWin simulator, recalibrated to the most influent and operational data.

Table 5-2 provides a summary of plant operational data used to recalibrate the BioWin simulator and the results of the calibration. Because of the increasing raw wastewater concentration data from January 2013 to present was used rather than the entire 5 year data set.

It is important to note that the SWRP ceased measuring influent total nitrogen 5-6 years ago so a ratio of 1.4 with ammonia based on older data was used for this important parameter. Also, the raw and primary effluent BOD testing performed by the SWRP is using the nitrification inhibitor and being reported as cBOD. It has been well established that measuring cBOD in untreated wastewater results in an underestimation of actual BOD load and a factor of 1.1 was used to estimate actual BOD. It is recommended that the SWRP reinstate measurement of total nitrogen in the raw influent and/or primary effluent and cease use of the nitrification inhibitor.

5.3.2.1 Process Bioreactor Basin Capacity

Good calibration of the simulator was achieved for steady state conditions for the last 2.5 years of data with one exception. As found in the 2010 calibration, the raw wastewater influent TSS had to be lowered significantly to match the solids production data. Normally, wastewater sampling data would be trusted more than primary sludge data but in this case the primary sludge data is confirmed by the blended sludge data after adding in the WAS. This is of minor relevance to the MLE process evaluation because the primary sludge is sent directly to the anaerobic digesters but it does draw attention to a potential problem with the raw wastewater sampling point as it relates to TSS measurements.

The calibrated simulator was then used to determine whether the critical permit limits can be met at 76 mgd. The most critical permit limits for the SWRP are the daily maximum ammonia limit of 1.5 mg/L and the 30 day average TIN limit of 10 mg/L. It was confirmed that the TIN limit of 10 mg/L can easily be met at 76 mgd with a value of 6.1 mg/L indicated by the simulator. This is a significant change from the original RAMP because the limit used for that analysis was the more restrictive 6.7 mg/L that was in the NPDES permit at that time. Therefore the recommendation for supplemental carbon required to meet restrictive nitrogen limits made in the original RAMP is no longer valid.

At a minimum temperature of 15 degrees C, the minimum SRT required to meet the 1.5 mg/L ammonia limit is 8 days. This results in a MLSS of 4,000 mg/L and a solids loading rate to the secondary clarifiers of 25 lbs/day/ft^2 assuming one clarifier is out of service. This is a higher MLSS that the 3,300 mg/L the original MLE process design criteria. The steady state model indicates an acceptable effluent TSS of 6 mg/L. However, additional analysis of secondary clarifier capacity is warranted.

Table 5-2

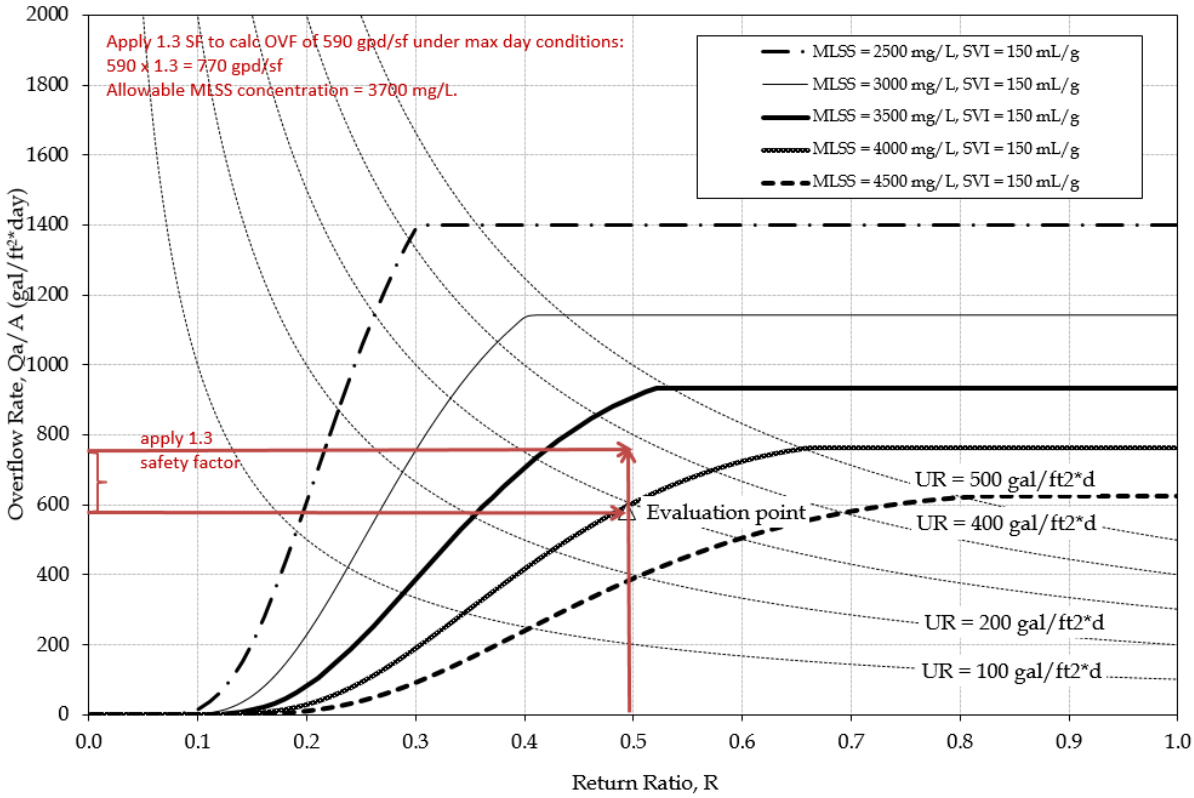
SWRP BioWin Simulator Calibration Results

Raw Wastewater	Data, mg/L	Simulator Results, mg/L
COD	690	690
BOD	320	320
TSS	470	330
Ammonia	35	35
TKN	No data	49
Primary Effluent	**Data, mg/L**	**Simulator Results, mg/L**
COD	360	410
BOD	190	220
TSS	120	120
Ammonia	No data	35
TKN	No data	43
Bioreactors	**Data**	**Simulator Results**
MLSS	4000 mg/L	3850 mg/L
SRT	9 days	9 days
Internal recycle	No data	330% of influent
Final Effluent	**Data, mg/L**	**Simulator Results, mg/L**
COD	39	33
BOD	2.5	2.5
TSS	7	6
Ammonia	0.2	0.2
Nitrate	7.4	7.4
Solids	**Data**	**Simulator Results**
Primary Sludge	87,000 lbs/d	88.000 lbs/d
Waste Activated Sludge	54,000 lbs/d	53,000 lbs/d
Digester VS Reduction	50%	55%
Dewatered Solids	84,000 lbs/d	79,000 lbs/d

5.3.2.2 Secondary Clarifier Capacity

To evaluate secondary clarifier capacity, it is necessary to take into account peak flows and less than optimal final clarifier performance. For this reason, a spreadsheet analysis tool was used that takes into account the peak flow to the clarifiers and incorporates a 1.3 safety factor to account for the many potential problems that can affect secondary clarifier performance.

Figure 5-1 shows the results of the spreadsheet analysis**.** For the peak day overflow rate, a peak day factor of 1.2 was assumed based on the peak day flow of 60 mgd and average day flow of 50 mgd since January 2013. After application of the 1.3 safety factor it can be seen that the allowable MLSS at 76 mgd is slightly over 3,700 mg/L, lower than the 4,000 mg/L indicated by the simulator at 76 mgd. Therefore, the secondary clarifier capacity may be exceeded at a flow of 76 mgd. This is not an unexpected finding with the SWRP influent concentrations being 30 percent higher than the original design concentrations. At the more concentrated loads, the maximum month design capacity may be reduced from 76 mgd to 72 mgd. Additional study of this issue is warranted.



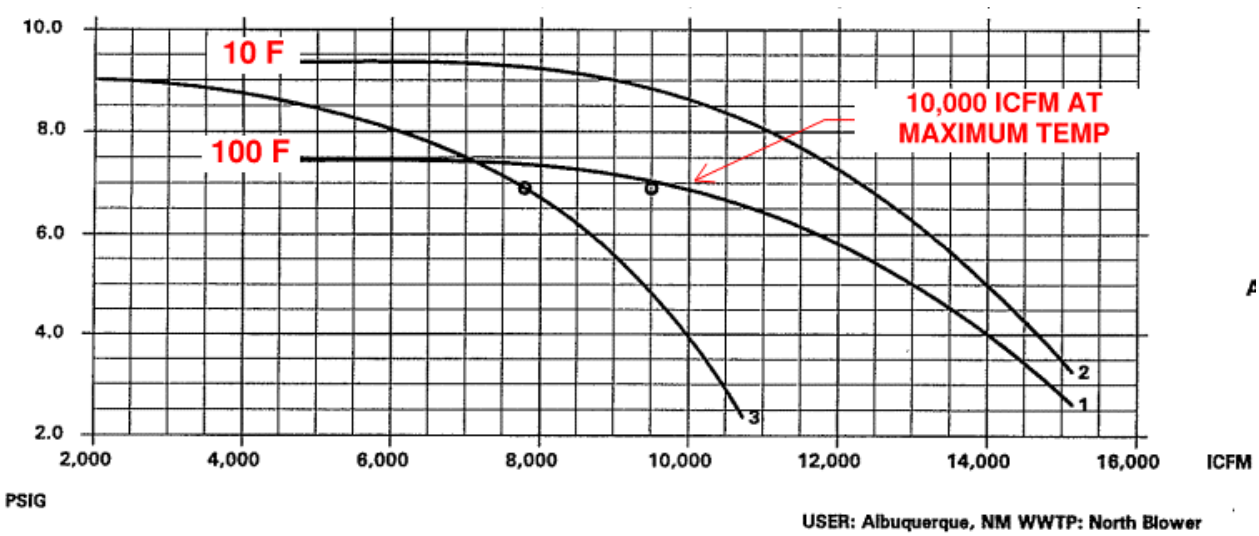
SWRP Secondary Clarifier Capacity Analysis

Figure 5-1

The performance of clarifiers depends on several interrelated processes and factors including: hydrodynamics, settling, turbulence, flocculation, sludge characteristics, atmospheric conditions, tank geometry, internal features and loading conditions. To address this limitation, one strategy is to implement chemically-enhanced primary treatment (CEPT) to increase BOD and TSS removal in the primary clarifiers. This reduces the load on the MLE process and allows it to treat 76 mgd at the higher influent concentrations. Another approach that can be used to increase the capacity of clarifiers is the application of polymers or a coagulant.

5.3.2.3 Aeration Basin Blower Capacity

The original RAMP predicted insufficient blower capacity due to increased aeration requirements when supplemental carbon was being added to meet the most stringent TIN requirement. That TIN requirement no longer exists and supplemental carbon is not required. Other reasons for the prediction of inadequate blower capacity are (a) assumption of excessively high peak day air factors and (b) failure to properly interpret the existing blower curves correctly. All 12 SWRP blowers are the same model and the curve for this blower is shown in Figure 2-2**.** The ICFM blower output is 10,000 at the maximum air temperature of 100 F and 11,400 ICFM at the average air temperature of 57 F.



SWRP Blower Curves
Figure 2-2

The BioWin simulator indicates at current flows an average air requirement of 41,000 ICFM. This is the equivalent of 3.6 blowers at average air temperature and this matches well with reports from the plant that normally only 4 blowers are required. The blowers are most challenged at the higher temperatures when aeration demand is greatest and blower output is the lowest. The simulator was run at the maximum MLSS temperature of 29 C and at a flow of 76 mgd the aeration requirement is 71,500 ICFM. The data indicates a 98th percentile BOD load of 1.5 times the average, so the peak air requirement is 107,000 ICFM. This is the equivalent of 10.7 blowers and the SWRP is equipped with 12 blowers. Therefore the SWRP has adequate blower capacity at maximum BOD load, maximum air temperature of 100 F and even at 76 mgd and the current higher influent concentrations when the MLE process capacity is 72 mgd as discussed previously.

5.4 MLE PROCESS CONDITION ASSESSMENT

This section provides an update to the asset risk assessment for the MLE Process. While the construction of the MLE Process was completed in 1996 and is therefore approaching 20 years old, many improvements to the process has been made in recent years, resulting in the need to revise the asset risk tables in the original RAMP Report.

5.4.1 MLE Process

Tables 5-2 and 5-3 provides ranking for the MLE Process assets. The major conclusions from the rankings are as follows:

- The number one ranked risk in Table 5-2 is the South instrumentation and controls (I&C) because of the importance of RAS and primary effluent pump controls and VFDs. All these systems are outdated, making it difficult to obtain parts. While the automatic switchgear that was found to be the cause for the failure of the primary effluent pumps

and the last major spill and the SWRP has been upgraded, the exterior cabinet for this important equipment is rusted and requires replacement.

- The second ranked risk in Table 5-2 is the South blowers. Blowers are the single most important piece of equipment in an activated sludge process and six out of eight of these blowers have been in operation for over twenty years. However, the reliability of this facility has greatly improved, with two new blowers being installed recently and all blowers being placed on new support to mitigate the concrete pad movement problems that were causing problems with misalignment of the blower piping and valves. The high ranking of this asset, despite these significant improvements, provides a general statement of the increased overall reliability of the MLE process components.

- The third ranked risk in Table 5-2 is the North blowers for much the same reason for the high ranking of the South blowers. While the blowers have been quite reliable, the importance and age of the equipment results in a high ranking.

- The number one and two ranked risk in Table 5-3 is the power systems for the South and North clarifiers. This is the result of a poor age ranking from the original RAMP and the status is apparently unchanged. Again, the high ranking of what logically does not seem to be a high risk item is a statement on the effectiveness of the many improvements made to the overall MLE process.

- The third ranked risk in Table 5-3 is the new mechanisms as a result of the consequence of failure of these mechanisms despite the mechanisms being new. This again reinforces the overall increased reliability of the process due to recent improvements made to these facilities.

5.4.2 Electrical, Instrumentation and Control Systems for MLE Process

The majority of the electrical distribution equipment including medium voltage switchgear, low voltage MCC's and transformers were installed as part of the 1996 plant construction. The equipment noted during the site visit in general was observed to be in poor physical condition. It should be noted that the average useful life of electrical equipment including cables is approximately 25-30 years. Therefore, many of the components (i.e.: circuit breakers, contactors, transformers, etc.) on this equipment may be worn beyond the manufacturer's recommended limits. Stickers indicating a regular testing and maintenance schedule were not observed on the equipment. It is not unreasonable to expect an increase in failures above normal levels of maintenance as this equipment is currently extending beyond its anticipated lifecycle. It is recommended that the electrical distribution equipment be replaced and that new distribution systems be designed. In instances where potential common mode failure points occur in the existing distribution systems, those areas should be evaluated to provide double ended MCC's that will allow flexibility in operation and maintenance.

The majority of the instrument and control systems observed during the site visit appeared to be the older style control panels with some updating of specific areas/systems. The older style control cabinets are now considered obsolete and should be considered for replacement.

5.5 IMPROVEMENTS PLAN

This section provides an update to the near-, intermediate- and long-term improvements recommended for the MLE Process. These recommendations are revised to reflect the improvements made since the original RAMP as well as any new improvements that have become apparent as a result of the revised capacity analysis. The effectiveness of the improvements made to these two process in the last 5 years is evidenced by the limited number of recommended improvements being identified.

5.5.1 Near-Term Improvements

The most pressing need for improvements for the MLE Process area is the VFD and control systems for the RAS and primary effluent pumps, particularly the older AB1336 VFDs that are now basically no longer supported by Allen Bradley. The maintenance staff reports that even the newer PowerFlex 700 VFDs are becoming difficult to get parts for. Also, the control systems in the room east of the VFD room are old and difficult to access with the building of office space being constructed to the North of the control cabinets. Given the importance of primary effluent and RAS pumping, these systems are the most in need of attention of all the MLE Process components.

While not identified in the equipment tables, the other short term “improvement” recommended in this report is to continue to upgrade the preventive maintenance (PM) and work order tracking systems in Maximo. Continued emphasis has been placed on completing PM’s and updating the information in Maximo so that the assets and PM work orders are scheduled and completed in a timely and efficient manner. There has been progress in these efforts over the last few years, but continued improvement is a high priority because a well-organized and implemented PM program is of the upmost importance. We are currently in the process of upgrading our Maximo work order software which includes data cleansing and development of SOP’s for improving efficiency.

Given all the improvements made by the Authority, no other short term improvements appear necessary.

5.5.2 Intermediate Term Improvements

The most important part of an activated sludge plant is the blower and aeration system not only because without it BOD and ammonia oxidation ceases and permit violations occur but also because aeration results in from 30-40% of the total energy costs in a water reclamation facility. Therefore, the intermediate term improvement recommended by this report is to continue to improve the blower efficiencies and aeration control systems at the SWRP. While the multi-stage centrifugal blowers have proven their long durability and reliability at the SWRP, increasingly efficient blowers are becoming available on the market place. As the Authority continues to look at replacement of the oldest blowers in the South Blower Building and eventually in the North Blower Building, consideration should be given to gaining experience with a high efficiency blower with one or more of these replacement projects.

While this was once identified as a high priority project, it is recommended here as an intermediate term project not only because two new multi-stage centrifugal blowers have been purchased for the South Blower Building but also because there has been mixed results with some of the newer high efficiency blower technologies, particularly the air-bearing high speed turbo blowers. It would benefit the Authority to continue to monitor these new blower technologies before committing to a major purchase.

Nuisance foam control is another intermediate term improvement recommended for the SWRP. It is not listed in the asset tables because there is currently nothing in place to deal with the issue. The SWRP has in the past been plagued with severe nuisance foaming outbreaks, resulting in process upsets and high effluent solids. These outbreaks have not occurred in recent years apparently due to better control of the sludge wasting program. The best way to prevent nuisance foam outbreaks is to operate the process to prevent them in the first place but sometimes this isn't good enough and an outbreak will occur. The SWRP aeration basins are constructed with intermediate baffle walls that prevent the foam from flowing forward in the basins where it can be trapped and removed in the effluent channel. The cost of modifying the walls and walkways to allow full width overflow of the walls is very high but should be placed on the CIP.

5.5.3 Long Term Improvements

The MLE process evaluation provided in this report has identified that the limiting factor in achieving the original design flow of 76 mgd is the 8 day SRT and resulting high MLSS for meeting the effluent ammonia limits and an excessive solids loading on the secondary clarifiers. Either more bioreactors or clarifiers or a combination of both will be required if it is intended for the plant to be continue to be rated at a 76 mgd maximum month flow at the current influent concentrations. This is listed as a long term improvement because it is possible that there will never be a need to achieve this design flow given the possibility that upstream water reclamation facilities may be built to foster more efficient effluent reuse.

Section 6

Ultra-Violet Disinfection Facility

Section 6
UV Disinfection Facility

6.1 INTRODUCTION AND PROCESS OVERVIEW

At the time the original RAMP Report was being prepared, the Water Authority was constructing the Ultra-Violet Light (UV) Disinfection Facility. The construction of this facility was completed in 2011. It has replaced the former the chlorination and de-chlorination processes at the Southside Water Reclamation Plant (SWRP). The total project cost was approximately $9.4-million, including $8.7-million for construction and $0.75-million for engineering.

Clarified effluent from the Secondary/Final Clarifiers flows into the UV Disinfection Facility. The flow passes through a course screen with approximate 2 inch square openings at the entrance to the facility to prevent large debris from passing through. The facility has three channels, each equipped with two banks of lamps. Each bank holds 232 lamps for a total of 1392 lamps. Each lamp produces UV light at a wavelength between 200 and 300 nanometers. This ultraviolet light disinfects water by instantly destroying the genetic material (DNA) within viruses, bacteria and chlorine-resistant protozoa, eliminating their ability to reproduce.

The disinfected water flows to Junction Box 11, where a Sample House is located. The Sample House contains a number of samplers and analyzers to provide information for process control purposes and permit compliance sampling. A stand-by diesel engine generator is at UV Disinfection Facility to provide emergency power for the facility in the event of a primary power outage at the SWRP.

6.2 UV FACILITY IMPROVEMENTS (2010 – 2015)

The UV Facility was brought on-line in April of 2011. There have been no facility improvements constructed since that time. However, initial operation of the facility has indicated that providing finer screening upstream of the facility would be beneficial. The existing coarse screen accumulates algae and other debris and has to be manually cleaned on a daily basis. To address this issue, the Water Authority has completed a preliminary design study and the detailed design of a screening facility is currently underway.

6.3 CAPACITY ANALYSIS

Table 6-1 summarizes the design criteria for the UV Disinfection Facility. The facility has a total peak hour treatment capacity of 120 mgd, which is consistent with the maximum month average day flow rate of 76 mgd (i.e., the design flow capacity of the SWRP).

6.4 UV DISINFECTION FACILTY RISK ASSESSMENT

In general, the risk associated with a new facility is low. The Water Authority is in the process of designing upstream screening, which will reduce the risk of potential damage to the UV bulbs as well as reduce the risk of algae and other materials building up on the bulbs and blocking the UV light.

Table 6-1

UV Disinfection Facility Design Criteria

Parameter	Design Value
Design Criteria at Peak Hour Flow Rate	
Flow Rate	120 mgd
UV Dose	30 mJ/cm^2
UV Transmittance (minimum)	65%
Total Suspended Solids	Less than 30 mg/L
Design Criteria at Peak Hour Flow Rate	
Flow Rate	76 mgd
UV Dose	40 mJ/cm^2
UV Transmittance (minimum)	65%
Total Suspended Solids	Less than 30 mg/L
Treatment Goals for Effluent E. Coli. Bacteria	
30-day Geometric Mean	Less than 47 cfu/100mL
Daily Maximum	Less than 88 cfu/100mL

The UV Facility is dependent on electrical power being available at all times. The facility has a dedicated standby generator in the case that primary power is lost. The Water Authority has made and will continue to make improvements to the SWRP electrical power systems to improve their reliability. These improvements are described in other sections of this report.

6.5 REQUIRED IMPROVEMENTS

As mentioned, the Water Authority is currently working with a consultant to design a set of mechanical bar screens to remove debris from the clarified water before it passes on to the UV Facility. The current estimated project cost for this work is roughly $3.7-million. The Water Authority is hoping to have this work substantially complete by the end of calendar year 2016.

Section 7

Secondary Sludge Thickening Facility

Section 7
Secondary Sludge Thickening

7.1 INTRODUCTION AND PROCESS OVERVIEW

The Southside Water Reclamation Plant (SWRP) uses dissolved air flotation (DAF) for thickening the waste activated sludge (WAS) and scum collected from the Secondary/Final Clarifiers. The first three DAF units were started operation in 1977. Four additional units were added in 1986.

The DAF Building consists of seven (7) rectangular DAFT concrete tanks, a lower pump gallery, MCC rooms, control room, air compressor room, polymer room, and outdoor polymer storage. The DAF system includes the UWAS pumping system, process tanks, saturation system, polymer system, thickened WAS (TWAS) pumping system, and bottom sludge pumping system.

7.2 DAF PROCESS IMPROVEMENTS (2010 – 2015)

This section describes the recent improvements to the Dissolved Air Flotation Thickening (DAFT) facility and investigative studies since the 2010 RAMP.

Two improvements projects have taken place since the 2010 RAMP Report was completed. In 2014, the Water Utility Authority (Water Authority) hired a consultant to evaluate the condition of the DAF facility roof and provide recommendations for repairs and rehabilitation. The consultant's recommendation was to replace the entire roof. The project included removal of the existing roofing system including the roofing gravel, perimeter base, counter, and vent stack flashings; installation of a new roof system comprised of built-up asphalt, insulation, sheet metal flashing and trim and wood curbing. The roof replacement project was completed in 2015. In 2014, the high pressure hot water washer was removed and replaced. This work was completed in the first quarter of 2015.

Recent studies include a field investigation for rehabilitation of the DAFT facility, evaluation of WAS thickening alternative technologies, and pilot testing of selected alternatives. Following the recommendations from the original RAMP Report, the Water Authority requested BC to investigate the DAF facility for rehabilitation and evaluate alternative WAS thickening technologies. Work begin in early 2014 with a field investigation which included testing of the DAF saturation tanks and a condition assessment of the mechanical, electrical, heating and ventilation and air conditioning (HVAC), and structural assets.

Five WAS thickening technologies were preliminarily evaluated based on non-economic criteria and life-cycle costs. Following, this preliminary evaluation, Water Authority began pilot testing of three recommended technologies including a Centrisys centrifuge, Huber screw thickener, and Parkson rotary drum thickener.

The pilot testing was completed in September 2015. The results from the pilot study and updated project costs will be incorporated in the WAS Thickening Evaluation report by BC. A final recommendation for design will also be documented in BC's report.

7.3 CAPACITY ANALYSIS

Provided in this section are the results of the updated DAF capacity analysis based on the flow and loading. The DAF capacity analysis focused on the overall DAF sizing and its major pumping systems. The DAF facility capacity evaluation includes the following systems:

- DAF Units
- UWAS Pumps
- TWAS Pumps

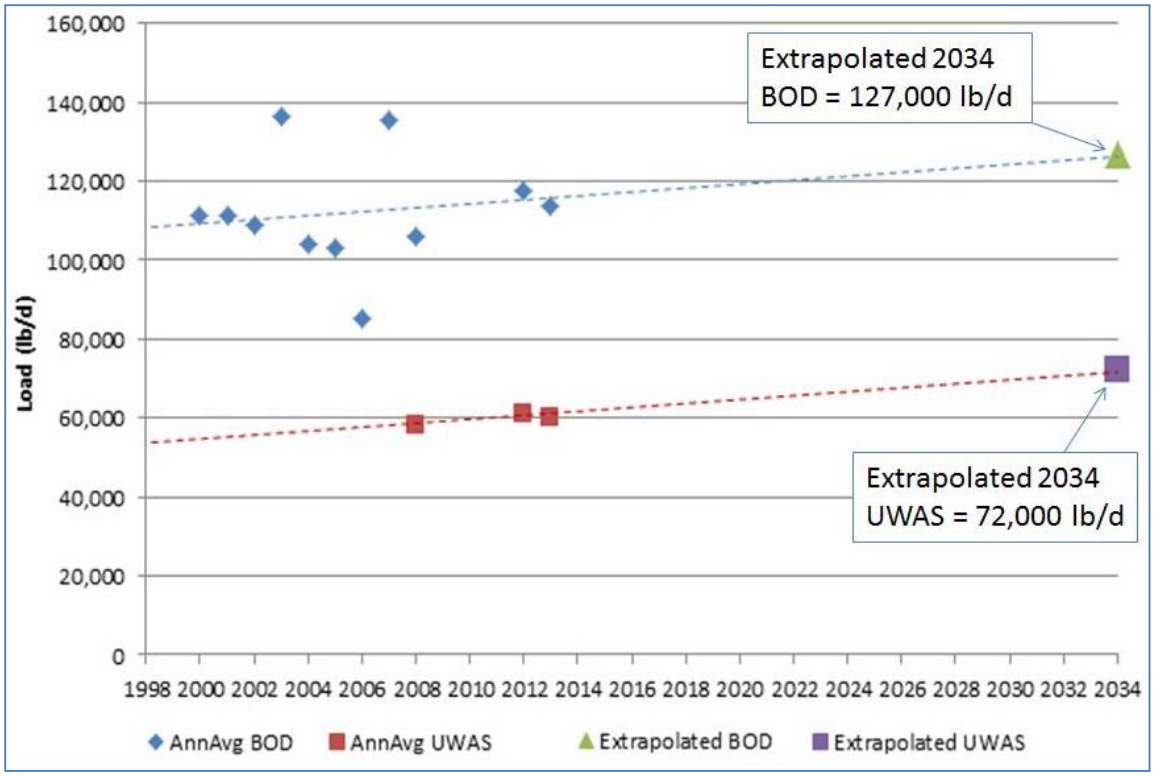
7.3.1 Capacity Design Basis

In the 2010 RAMP Report, the projected peak day unthickened waste activated sludge (UWAS) loading to the DAFs was determined to be 84,435 lb/d, based on the results of the calibrated whole-plant BioWin™ model prepared by BC. In 2013, a TM on the dry cake conveyance system was developed and included solids projections based on more recent BioWin modeling conducted by Carollo Engineers. The projected flows and loadings for the dry cake conveyance system are based on a plant data analysis that estimated a solids flow to dewatering of 757,400 gpd and a dry solids load of 149,700 lb/d. It is noted that these values are based on a linear extrapolation from the current plant flow to the design rated maximum month flow (MMF) of 76 mgd using the dewatering feed dry solids as the extrapolated criteria. The ratio of the projected digested sludge load to the current load is calculated as 1.48 (149,700 lb/d ÷ 100,917 lb/d). Assuming a similar ratio for the current WAS load of 59,693 lb/d as presented in the aforementioned BioWin modeling study, the estimated future WAS load is 88,550 lb/d.

7.3.2 Current Plant Data Evaluation

From plant reported data for the period 5/16/2012 through 5/16/2014, the maximum month average flow was 55.2 mgd, occurring during 2012. It is evident that plant flows have been generally decreasing. The reason for this general decrease is the water conservation program initiated by the City of Albuquerque in 1995, as pointed out in the Southside Water Reclamation Plant Capacity Analysis prepared by CDM in 1999.

Figure 7-1 shows that the 2034 extrapolated annual average UWAS load is approximately 72,000 lb/d. In contrast to the general decrease in influent flows, there has been a steady increase in influent loads and corresponding UWAS loads. The approximate assumed trend lines have been extended to 2034 which is considered to be a reasonable planning horizon for the upgraded thickening facility.



Annual Average Influent BOD Loads and UWAS Loads

Figure 7-1

Table 7-1 summarizes historical influent flow, BOD load and UWAS loads for 2008 and 2012 through 2014. Maximum day UWAS loads are as high as over 4-times the corresponding annual average load. It would be unreasonable to size expensive thickening facilities on daily peaks of such a magnitude. Sludge wastage from the activated sludge system is expected to be of a more uniform nature, in accordance with recommended practice for biological nutrient removal activated sludge plants. Abrupt changes in activated sludge wastage from the biological system are generally disruptive to the biology and deters from optimal performance, particularly for nitrification. Table 6-1 also shows 90-percentile daily UWAS loads. The 90-percentile values appear to be more consistent for the three years of plant data with values less than 50-percent over annual average values.

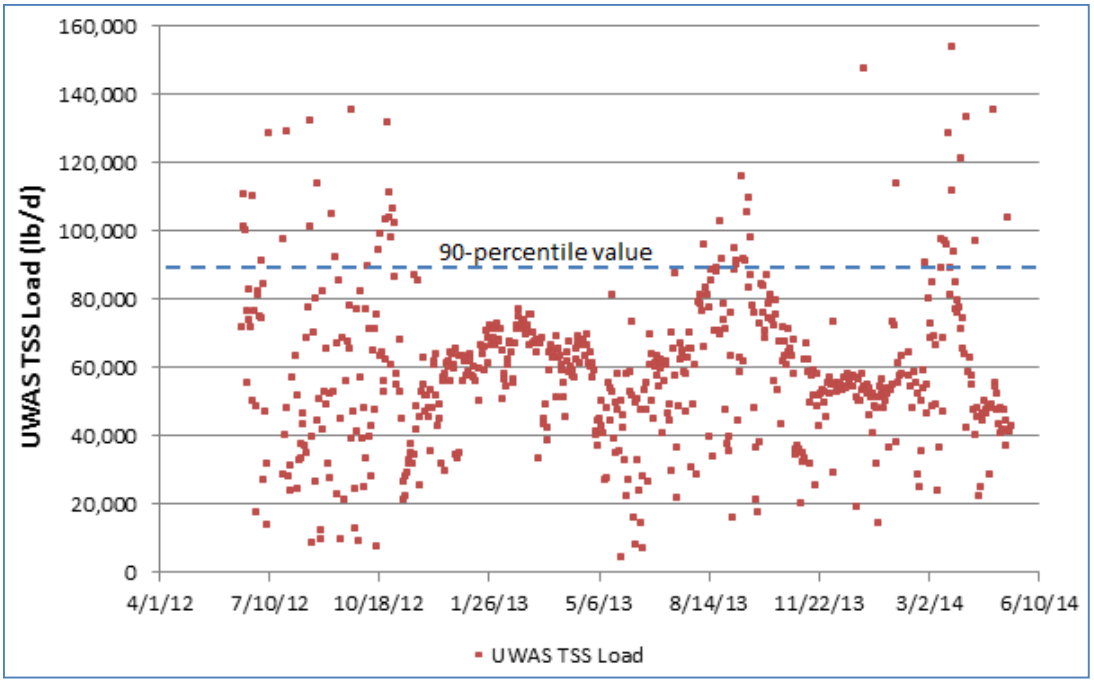
Table 7-1

Historical Influent BOD and UWAS Loads

Period	Annual Avg. Flow (mgd)	Annual Avg. Load (lb/d)	Annual Avg. Load (lb/d)	Max. Day UWAS Load (lb/d)	90th Percent. Day UWAS Load (lb/d)	Ratio Max. Day/ Annual Avg.	Ratio 90th Percent./ Annual Avg.
2008	54	105,800	58,300	147,800	81,400	2.54	1.40
2012-2013[1]	51	117,800	61,100	135,900	89,200	2.22	1.46
2013-2014[1]	47	113,800	60,100	244,700	88,300	4.08	1.47

Notes:
1. 365 days of data.

Figure 7-2 shows plant reported daily UWAS loads conveyed to the DAFT facility during the period 2012 through 2014.



Daily UWAS sludge loads

Figure 7-2

For design of the upgraded thickening facilities use of the 90-percentile of daily UWAS load values is proposed since this still allows for 90-percent of the historically recorded UWAS discharges. It also limits the size of the upgraded thickening facilities by recognizing the need to control the extraordinarily high peak UWAS discharges which have constituted only 10-percent of the historical UWAS discharges. Therefore, the design UWAS for the thickening facilities is assumed to be 1.47 times the design annual average value. Assuming a design year of 2034 for the facilities, the design maximum day UWAS load would be 72,000 x 1.47 = 105,800 lb/d.

The UWAS sludge design loads predicted in the manner described, using more recent reported plant data are higher than the extrapolated values predicted in both the 2010 RAMP Report and the 2013 dry cake conveyance technical memorandum. The principal reason for this is that sludge wastage from the activated sludge system was expected to be of a more uniform nature, as assumed in the process models used by the various consultants in accordance with recommended practice for biological nutrient removal activated sludge plants.

7.3.3 DAF Units

DAF unit capacity can be expressed as both a hydraulic and solids loading rate; however, DAFs are generally not limited by the hydraulic loading rate (in terms of gpm/ft^2). However, this does not refer to the hydraulic capacity of the DAF units and appurtenances. Based on the CDM Memo, the DAF units were expected to handle a hydraulic loading of 0.8 gpm/ft^2.

The recommended foam control improvements would increase the feed flows to the DAF units due to surface wasting of mixed liquor from the activated sludge system. This increase in flow depends on the hydraulic capacity of connecting pipe work and other hydraulic appurtenances that were not evaluated as part of the original RAMP Report. In terms of hydraulic loading, the DAFs are capable of handling loads much higher than the design value of 0.8 gpm/ft^2.

Hydraulic loadings above 5 gpm/ft^2 are not expected to be an issue with properly designed DAF systems. Therefore, a hydraulic capacity assessment of the DAF system and associated appurtenances is required to properly evaluate the impacts of surface wasting. Since the hydraulic loading rates would not be an issue with the DAFs, this evaluation focused on the solids loading rate aspects of the DAF system.

7.3.3.1 Assumptions

BC recommends a design solids loading rate of 0.5 to 1.5 lb/ft^2/hr for thickening of biological solids. This is slightly lower than the 2 lb/ft^2/hr loading rate provided in the 2009 Basic Design Criteria (provided by the SWRP) for the DAFs (also used in the CDM Memo). For the purpose of this assessment, 2 lb/ft^2/hr will be used as the capacity limitation of the DAF process units at peak day conditions. The solids loadings to the DAF units were determined from the data evaluation presented above.

7.3.3.2 Capacity

Table 7-2 shows the capacity of the DAF units. Although the peak day load is higher than the firm capacity, the resulting peak loading is 47 lb/ ft^2/d or 1.96 lb/ ft^2/hr with all seven units online. Based on these loadings, the existing DAF system is adequate to process the projected UWAS loadings for at least 20 years. Other DAF facilities thickening WAS routinely operate at solids loadings of over 120 lb/ft^2/d and over 5 gpm/ft^2. Therefore the projected maximum day loadings of 47 lb/ft^2/d and 0.43 gpm/ft^2 are well within the limitations for successful DAF operation. With one DAF tank out of service, the loadings would still be satisfactory.

Table 7-2

DAF Design Data

Number of DAF Units	Unit Area[1] (ft^2)	Unit Capacity[2] (lb/d)	Firm Capacity[3] (lb/d)	Peak Day Load (lb/d)	Capacity Deficiency (lb/d)	Add'l Units Req'd
7	322	15,456	92,736	105,800	13,064	0

Notes:
1. Based on 2009 Basic Design Data
2. Based on 2.0 lb/ft^2/hr peak loading limit
3. Based on one unit offline

7.3.4 UWAS Pumps

There are a total of nine (9) UWAS pumps, seven (7) duty and two (2) standby, that transfer WAS from the final clarifiers to the DAF process units.

7.3.4.1 Assumptions

Similar to the other processes, for this evaluation, one UWAS pump was assumed to be offline in order to determine the system's firm capacity. It should be noted that in the CDM Memo it was assumed that two units were offline for firm capacity; however, the memo did not state why this was assumed.

7.3.4.2 Capacity

Table 7-3 shows the peak day flow (PDF) and MMF capacity of the UWAS pumps. For calculation of the design MMF, the BioWin outputs from the RRAMP were used to determine a new design MMF based on BC's updated UWAS peak day load value of 105,800 lb/d. From the BioWin model, the projected UWAS MMF flow was 1.32 mgd and the associated peak day

load was 84,435 lb/d. The design MMF was calculated as a ratio of peak loads multiplied by 1.32 mgd (105,800 lb/d : 84,435 lb/d x 1.32 mgd). These results indicate that there is adequate capacity for these pumps.

Table 7-3

UWAS Pump Design Data

Number of Pumps	Unit Capacity (mgd)	Firm PDF Capacity (mgd)	Firm MMF Capacity (mgd)	Design MMF (mgd)	Capacity Dificiency (mgd)	Add'l Units Req'd
9	0.43	3.43	2.60	1.65	0	0

Notes:

1. Design capacity stated in the 2009 Basic Design Data
2 . Assumes one pump offline
3 . Based on ratio of RRAMP BioWin model output ratioed to updated peak day loading projection

7.3.5 TWAS Pumps

There are a total of four (4) TWAS pumps that pump the thickened sludge from the DAFT collection troughs to the blended sludge tank.

7.3.5.1 Assumptions

The CDM Memo assumed that the TWAS pumps operate 24-hours and this is same assumption that was made in this evaluation. The peak day flow predicted from BioWin™ and historical peaking factors was calculated as 0.20 mgd. It is assumed that the standby pump is primarily offline and is only used when the smaller TWAS pumps are out of service.

7.3.5.2 Capacity

Table 7-4 The PDF and MMF capacity of the TWAS pumps is presented below in. For calculation of the design MMF, the BioWin outputs from the 2010 RAMP Report were used to determine a new design MMF based on BC's updated UWAS peak day load value of 105,800 lb/d. From the BioWin model, the projected TWAS MMF flow was 0.2 mgd and the associated peak day load was 84,435 lb/d. The design MMF was calculated as a ratio of peak loads multiplied by 0.2 mgd (105,800 lb/d : 84,435 lb/d x 0.2 mgd). These results indicated that the TWAS pumps have adequate capacity for the peak flow. It is important to note that even with the standby pump off-line, the three TWAS pumps should provide adequate capacity to meet the peak flow.

Table 7-4

TWAS Pump Design Data

Number of Pumps	Unit Capacity[1] (mgd)	Firm PDF Capacity[2] (mgd)	Firm MMF Capacity (mgd)	Design MMF[3] (mgd)	Capacity Deficiency (mgd)	Add'l Units Req'd (mgd)
4	0.18	0.89	0.52	0.25	0	0

Notes:

1. Design capacity stated in the 2009 Basic Design Data
2. Assumes one TWAS pump is offline
3. Based on ratio of RRAMP BioWin model output ratioed to updated peak day loading projection

7.3.6 Summary

Based on the capacity evaluation of the DAF units the existing tanks can process the projected future solids loading. Also, the UWAS and TWAS pumps are sufficient to meet future demands and no additional pumps are required based on this evaluation. There is concern that the TWAS pumps are not pumping at their rated capacity and as such, we are recommending that additional TWAS pumps be considered during the preliminary design of the rehabilitation of this process area. If a new WAS thickening technology is installed, both the UWAS and TWAS pump will require replacement due to a change in design criteria and capacities.

7.4 ASSET CONDITION ASSESSMENT RESULTS

On May 22, 2014, BC conducted a field investigation of the DAF facility which included an evaluation and collection of information on the existing DAF system equipment, HVAC equipment, DAFT structures, piping, and electrical components. In addition, saturation tests were performed on the two (2) online DAF units. Details of the saturation test are presented below. A summary of the field investigation findings is provided in the following sections.

7.4.1 DAF Saturation Testing

As part of the field investigation, the degree of saturation achieved in the operating DAF tanks and air retention "R" tanks was measured. At that time, only two of the seven DAF units were operating: DAF Units Nos. 5 and 6. Each R-tank was tested in triplicate. At the beginning of each set of triplicate tests, the R-tank pressure and water temperature were noted within the test unit. The pressure of the saturated feed line at the DAF mixing box was also noted and determined to be within 1 psig of the pressures indicated by the pressure gages at the top of each R-tank.

From the results, it was evident that the two saturator systems, although equal in design, were quite different in terms of their respective efficiencies. R-tank 6 was only approximately 60-percent efficient. Therefore, only 60-percent of the theoretical amount of air is dissolved into the water and almost 40-percent of the energy expended in dissolving the air into the recycle stream for flotation is actually wasted energy.

In contrast, R-tank 5 was quite efficient. Despite being operated at 40 psig (almost 20 psig below R-tank 6), the efficiency of saturation is very good and probably could not be improved upon. The amount of air provided for flotation is similar, if not slightly higher, than for tank 6, although tank 6 operated at approximately 20 psig higher pressure.

Despite the limited number of DAF tanks that were on-line and available for testing, it is evident from the results from R-tank 5 that the original design of the saturation system is sound. Further investigation was recommended to determine why R-tank 6 did not perform well.

7.4.2 Electrical, Instrumentation, and Controls Evaluation

The majority of the equipment in both the process areas and within the electrical rooms shows signs of age and corrosion associated with exposure to contaminated air from the DAFT process area. It was also noted that various equipment installations were not in compliance with a variety of National Fire Protection Association (NFPA) codes.

NFPA 820 is the most commonly used standard to determine hazardous areas at a wastewater treatment facility and what the ventilation practices are to reduce the hazard levels and improve the working environment. Sludge thickening areas (DAF) can be considered Class I, Division 2 areas, if continuously ventilated with a minimum of 12 air changes per hour as described in NFPA 820, table 6.2(a), Row 8, line b, and Chapter 9 (Standard for Fire Protection in Wastewater Treatment and Collection Facilities). Therefore equipment installations must comply with NFPA 70, article 500 (National Electric Code) conditions for flammable and corrosive gases.

The majority of the electrical conduit is galvanized rigid steel or PVC-coated galvanized rigid steel routed to painted steel, stainless steel, or fiberglass reinforced plastic (FRP) junction boxes. Both the galvanized rigid steel and the painted steel junctions boxes and associated fittings are showing signs of corrosion and are not rated for a Class I, Division 2 area. The conduit penetrations into areas that should have different classifications from the DAFT area do not have conduit seal fittings that are required by NFPA 70, articles 225.27, 300.7, 501.10 (3) (B), and 501.15. Some of the motor control centers (MCCs) are approaching 30 years of age, which is the typical service life for this kind of equipment. All of the equipment local control stations, light switches, receptacles, lighting fixtures, thermostats, many of the position switches, and instrument housings are not rated for a Class I, Division 2 area and showing signs of corrosion. A number of the upper level main process area lights have had their protective/sealing covers removed. The light switches, light fixtures, receptacles, thermostats, and instrument housing installations are not compliant with NFPA 820, or NFPA 70, article 501.

The electrical room doors and window frames show signs of corrosion. The electrical room drop ceiling shows signs of corrosion from process gases and roof leaks and the ceiling tiles interfere with the operation of switchgear breaker lifting mechanisms. The electrical room doors entering the process area cannot be effectively sealed, and will allow flammable and corrosive gases access to the electrical equipment. The frames around the windows in the electrical room are also showing signs of corrosion. If the windows and seals are not continuously maintained to provide a complete seal between the electrical room and the process area, flammable and corrosive gases will have access to the electrical equipment. If the corrosive and flammable gases are allowed access to the electrical room (i.e., a permanent physical separation not provided), it must be considered a classified area. It is critical that these windows are sealed and the doorways are blocked off and relocated in order to segregate the electrical room from the process areas in order to avoid having to classify these areas. Introduction of corrosive and flammable gases to the electrical room not only corrodes the equipment, causing increased maintenance efforts, but also creates a possible ignition source.

7.4.3 Heating, Ventilation, and Air Conditioning Evaluation

The HVAC systems associated with the DAFT facility were modified in 1984 and in 1993. Discussions with operations and maintenance staff made it clear that the HVAC equipment has been used very seldom in recent years for ventilation with the exception of the air conditioning units dedicated to the MCC rooms. The odor control equipment has been abandoned and has not been in use for many years.

The existing equipment consists of seven makeup air heater units (MAUs), two air conditioning units (ACUs), two exhaust fans (associated with the odor control system), and several hot water unit/cabinet heaters at various locations. All of the units utilize hot water coils for heating during the winter months. The seven MAUs are all located in the basement and bring in outside air for supplying the areas through louvers. Exhaust duct located around the perimeter of the building collects exhaust air from the basement level and conveys it up to the foul air duct located on the roof using the odor control system's two foul air fans. There are also openings in the roof of the building used to exhaust air from the main floor.

All of the exhaust air from the facility is routed to the existing chemical scrubbers using FRP centrifugal fans. There are two chemical scrubbers; exhaust air from the 1977 Building is routed to one scrubber and exhaust air from the 1984 Building is routed to the other. The scrubbers and fans are located at grade on the east side of the facility. The Water Authority does not wish to keep the odor treatment system so it is assumed that the fans and scrubbers will be removed. The MCC rooms are equipped with packaged air conditioning units located on the roof of the building. Each ACU is equipped with a DX coil and an electric resistant heating coil for cooling and heating the room air. Unit and cabinet heaters are located throughout the facility to heat the space during the winter months.

During the field investigation, the HVAC equipment was evaluated based on physical condition, operational/working condition, performance and functionality. As stated above, it is understood that the ventilation systems, except the MCC ACUs, are not operated and have not been operated

since at least 2006. Plant staff indicated that it should be assumed that none of the equipment is operational and would all need to be replaced with new equipment. During the site visit, the ACU supplying the 1984 Building MCC room was operating and functioning to keep the area cool. Plant staff said both of these AC units were only 2-3 years old and do not need to be replaced. The 1977 Building MCC room AC unit will need some maintenance to get it operational but should not need replacement. The existing duct, louvers, registers and grilles within the building all appeared to be in relatively good condition and will be reused to the extent possible. It is recommended that the foul air duct located on the roof and associated with the existing odor control system be rehabilitated by re-wrapping most of the joints using FRP hand-layup methods and by recoating the exterior of the duct. Some of the duct supports appeared to be deteriorated and should also be replaced.

The evaluation also included an analysis of the facility in relation to the NFPA 820 requirements for a sludge thickening facility as described in the Electrical, Instrumentation, and Controls section. Preliminary evaluations of the existing ventilation systems indicate that the building does not comply with the current standard requirements. Even if the existing systems were operational, they would not provide a sufficient air change rate to allow for reduction in the extent of hazardous areas and the current classification of the building is considered Class I Division 1.

Additionally, the MCC rooms are not physically separated from the DAFT process area due to the connecting doorways and have potential exposure to the hazardous gasses produced from the thickening process. Thus, the electrical room is classified and should be equipped with Class I Division 2 rated equipment or the room should be physically separated from the process area to be unclassified.

7.4.4 Mechanical Evaluation

The mechanical evaluation included pumps, DAFT mechanisms, piping, and valves. Two DAFT units and associated pumping systems were online during the field investigation. General observations and facility staff input of the mechanical equipment are described below:

7.4.4.1 UWAS Pumps

The UWAS pumps transfer wasted RAS from the secondary clarifiers to the DAFT units. There are nine (9) UWAS pumps total including two standby pumps. The pumps are Flygt centrifugal immersible type pumps and were installed in 2009.

The primary issue with these pumps is that there are no pressure gauges or vents on the discharge lines which cause a safety issue for staff who need to bleed off the pumps when performing repairs or maintenance. Staff noted that these pumps have rarely failed and require little maintenance.

7.4.4.2 Grinders

There are two (2) inline grinders located on the two UWAS lines that split flow between the existing and new building areas. The grinders were installed during the 1984 facility upgrade project and are nearing the end of their useful life. The grinders appear to be relatively good condition, run well but have had some issues with the lower blades. New grinder designs address this typical wear condition.

7.4.4.3 DAF Mechanisms

There are a total of seven (7) EIMCO DAFT units installed at the DAFT facility. The DAFT mechanisms for DAFT Nos. 1-3 were recently replaced in 2006. The mechanisms for DAFT Nos. 4-7 are the original equipment installed during the 1984 DAFT facility expansion project. This equipment is in worse condition than DAFT Nos. 1-3 showing significant signs of corrosion but all were noted to have similar issues including:

- Difficulty to order parts such as sprockets, gears, and parts for the oilers
- Chains often fall off the guide railings
- Snails are found in the bearings
- Bearings, bushings and brackets are corroded or missing
- Top scrappers fall off
- Bottom scrapers are broken or not used

7.4.4.4 Inlet Diffusers

There are two inlet diffusers per DAF unit. The inlet diffusers that were visible during the inspection many showed signs of corrosion and appeared to be pulling away from the DAF tank walls.

7.4.4.5 Mixing Boxes

The mixing boxes are located at the head end of the tanks and provide a location for combining the UWAS, DAF recycle, and polymer solution prior to entering the DAF tank. A backpressure valve is located on the recycle (recirculation) pipe to control the recirculation system pressure. These valves can be finicky and require manual adjustment to balance the saturation system. Once set, the valve should rarely require adjustment. Facility staff noted issues and difficulty in moving the valves due to solids accumulation within the box and there are no means to flush them.

7.4.4.6 Recirculation Pumps

There are seven (7) recirculation pumps – one per DAF unit. The pumps are all horizontal centrifugal type pumps but have varying manufacturers – either Goulds or Peerless. The

recirculation pumps were noted as one of the major issues of operating and maintaining the DAF system. A number of the pumps are not operating at their rated capacity. It is unclear as to what is causing the capacity issues and how many pumps are impacted. It is possible that there could be cavitation or other operational problems with the pumps or associated flow meters.

7.4.4.7 Air Retention Tanks

There are seven (7) air retention tanks – one per DAF unit. According to facility staff, these tanks have never been inspected and they are all over 25 years old.

7.4.4.8 Air Compressors

There are two (2) reciprocating air compressors installed during the 1984 DAFT facility expansion project. Facility staff noted that these work well, rarely fail, but run almost continuously. Inspection of the air compressors found many oil leaks around the units and the surrounding environment was hot with wall paneling showing signs of excess heat. There is one additional screw type air compressor in the room that has failed and has been abandoned and is not planned for use.

7.4.4.9 Bottom Sludge Pumps

There are four (4) bottom sludge pumps – two are dedicated to DAFT Nos. 1-3 and two are dedicated to DAFT Nos. 4-7. None of these pumps have been in service in the past couple years. Facility staff noted that these have not worked for some time and a lot of money had been spent on them in the past, which is why they have since been abandoned. Additionally DAFT Nos. 1-3 have separate lower drain piping and valves which allows direct draining of the tanks in order to allow for maintenance. The bottom sludge pumps for DAFT Nos. 4-7 have a dual purpose for draining the tanks. This is the only means for draining these tanks efficiently.

7.4.4.10 Polymer Storage Tanks

Emulsified polymer is delivered to the DAFT facility and stored in two outdoor, underground 10,000 gallon FRP tanks. The main issue with these tanks is that a hard, crusty layer of polymer often forms on the top layer, creating issues for filling up and pumping from the tanks. The tanks are approximately 25 years old and could not be visually inspected during the site investigation. These tanks are serviced/cleaned every year at a substantial cost which only can be done by entering the tanks with the appropriate safety gear.

7.4.4.11 Polymer Batch Tanks

There are three (3) 1,100 gallon FRP polymer batch tanks. Two tanks are from the 1977 installation and the third was installed in the 1984 upgrade. All three tanks appear to be in fair condition with some discoloration in the interior, peeling paint on the exterior, and some noticeable corrosion on the tank mixers.

7.4.4.12 Polymer Transfer Pumps

There are currently two (2) polymer transfer pumps. Pump HS-3144, in service at the time of the site investigation, has recently been installed and appeared to be in good condition. The standby pump HS-3143 was installed in 1990 according to the name plate data, is in good condition, and will likely be replaced by facility staff when required.

7.4.4.13 Polymer Feed Pumps

There are a total of eight (8) polymer feed pumps. These pumps were all installed during the 1984 expansion) and are currently being replaced by facility staff with Netsche rotary lobe pumps. The pumps were not inspected since they are all being replaced in-house with new pumps.

7.4.4.14 TWAS Pumps

There are four (4) TWAS pumps currently installed. TWAS pumps Nos. 1-2 transfer TWAS from DAF Nos. 1-3 and TWAS pumps No. 3 and No. 4 pump TWAS from DAF Nos. 4-7. These pumps are currently being replaced in house with Netsche rotary lobe pumps and were not inspected. When asked about providing redundant pumps, facility staff did not feel that is necessary for the DAF operation as long as seven DAFs are available in the system. Facility staff did however note that they would like to have flow meters on the individual discharge lines as there is currently only one meter on the combined pipeline.

7.4.4.15 Sump Pumps

There are a total of seven (7) sump pumps and four (4) sump locations throughout the basement level. Facility staff noted that only one of the seven pumps works properly. The pumps were not inspected as part of the field investigation and it's unclear what issues are attributed to these pumps. One issue for the sump that receives some polymer spillage is that the polymer causes problems pumping because of the viscosity changes of the liquid.

7.4.4.16 Effluent Wash Water (EWW) System

The plant EWW system including piping, instruments, and controls was recently upgraded. This system was not evaluated as part of the site inspection. However, it was observed that the strainer unit in the basement was leaking heavily and had noticeable corrosion.

7.4.4.17 Piping and Valves

Piping was observed for leaking and corrosion. Interior of piping was not inspected. Generally, the piping is in good shape but requires cleaning and painting. There appeared to be a number of leaks with the polymer pumps and it is assumed these will be repaired as the polymer pumps are replaced by facility staff.

Many manual valves were noted by staff to have issues with operating properly. The majority of these valves are from the vintage of the original construction projects. The automated valves appear to be working well and no major issues were noted by facility staff. The motorized valves on the UWAS lines are currently being replaced.

7.4.5 Structural Evaluation

The DAF facility structure was originally constructed in 1977 and was expanded to the south in 1984. The 73-foot by 170-foot concrete building consists of two levels and houses seven (7) concrete DAF tanks, motor control center room, operations control room, polymer process room, compressor room, and various pieces of equipment.

The basement is constructed of a reinforced concrete slab-on-grade with perimeter concrete walls that extend the full height of the structure. The DAF tanks are located within the basement and consist of a thickened slab-on-grade and reinforced concrete walls. The tanks were constructed integrally with the main structure and are not independent of the building.

The main floor consists of concrete structural slabs supported by the basement walls and a system of beams and columns. Grating supported by metal framing is located along the north and south sides of the tanks. The elevation of the top of the tank walls is approximately 9-inches higher than the surrounding main floor elevation. Interior non-bearing CMU walls are located throughout to provide separation of the various rooms.

The roof is constructed of prestressed concrete double-tees supported by the perimeter concrete walls. Numerous skylights are located between the double-tee stems providing daylight into the facility. A bridge crane is supported by the roof and spans the entire length of the building. Though the original building was constructed over 35 years ago, the structure appeared to be in overall good condition based on the areas of the building that were visible during the site observation. The items noted below are primarily standard maintenance issues or cosmetic/architectural in nature.

7.4.5.1 Basement

In general, the structural condition of the basement appeared to be good. The slab-on-grade appeared to have a minimal amount of visible cracks, with the majority of them being hairline in nature which is typical for this type of construction and age of facility. In a number of locations on the west side of the 1984 structure, it appeared that previous equipment had been removed resulting in the top layer of concrete delaminated where the base plates were previously located. The 1984 portion of the building appeared to have an epoxy coating applied to the floor which was observed to be in fair condition.

The below-grade, reinforced concrete perimeter walls appeared to be in relatively good condition. As anticipated, cracks were visible, with the majority of them being hairline in width, with some cracks slightly larger. At a number of wall joints, the sealant appeared to have

deteriorated or separated due to some minimal movement of the structure. The wall paint on the 1984 portion was in poor condition throughout.

The reinforced concrete tank walls appeared to be in good condition based on observing the outside face only. A continuous horizontal crack was observed at each of the tanks. This crack was observed at approximately 4 feet above the floor on the west and the west half of the south walls of DAF No.1. At DAF No.2 and DAF No. 3, the crack was observed approximately 4 feet above the floor along the west wall and the west half of both the north and south walls. The horizontal crack was located approximately 1'-6" above the floor and at the west wall of DAF Nos. 4-7. Based on the consistent height of the cracks around much of the perimeter of the tanks, it is possible that this is a cold joint that occurred during construction. These cracks showed evidence of leakage, though no active leaks were visible at the time of the site observation. Personnel indicated that the leaking is minimal and primarily occurs during colder air temperatures.

The reinforced concrete ceiling slab, beams, and columns appeared to be in good condition. A small number or hairline cracks were observed in the ceiling concrete and beams.
One metal door and frame located in the north-west part of the building was extensively corroded at the bottom.

7.4.5.2 Main Floor

In general, the main floor level of the facility was observed to be in good condition structurally. The structural concrete floor appeared to have some minor hairline cracking around floor drains, typical of this type of construction. The floor coating in the control room was peeling extensively. At the floor joint between the 1977 construction and 1984 construction, the concrete floor has spalled at the joint cover plate and appeared to have been repaired previously. The floor grating and metal supports appeared to be in fair to good condition. Some rust was visible at some of the structural members and fasteners, but was in otherwise good condition. The guardrails appeared to be in good condition with the exception of some areas in which the toe plate was bent and not properly attached.

The interior surface of the tank walls could not be adequately viewed during the site observation. Four of the tanks were full of fluid and in operation while the remaining three tanks had a layer of scum coating the walls and floors. For a complete evaluation of the interior tank structure, each tank would be required to be shut down and cleaned for observation. For the minimal amount of tank structure that was visible, some cracking was observed at the top of the walls at the west troughs. Possible exposed aggregate was viewed at DAF No.1, but could not be confirmed due to lack of access. At DAF No.4, the weir plate was corroded such that fluid was no longer traveling over the top of the plate and was instead passing beneath the plate. Since only one other tank was in operation at the time of this visit, it was not possible to see if other weir plates have a similar integrity issue and are leaking.

The exterior reinforced concrete walls appeared to be in good condition. However, in a small number of locations the wall joint material has deteriorated or been damaged. One location was

also observed in which a small portion of concrete had spalled off. The interior non-bearing masonry walls were in generally good condition, with only minor cracking visible at a small percentage of the grout joints.

Based on information provided by personnel, the overhead door on the north side of the building did not work well and is often left in the open position to maintain air flow throughout the building. One metal door frame was found to be significantly corroded at the base but many of the doors showed signs of corrosion.

7.4.5.3 Roof

During the observation, only the structural components of the roof were observed. Flashing, sealants, and architectural components the roofing system was to be replaced in the near future due to leakage. The visible portion of the double-tee roof appeared to be in good condition. At a small number of locations, it was observed that the vertical joint between the double tees was damaged. The wall parapet was in fair to good condition. In some locations, the concrete had spalled off exposing the reinforcing. The large diameter ducts located on top of the roof were supported by metal framing. This framing appeared to have a coating of surface rust and did not have cap plates at the ends of many of the tube frames, but was generally in good condition. As indicated by personnel, the bridge crane that is supported by the double tees was in good working order.

7.5 FUTURE DAF PROCESS IMPROVEMENTS

The existing DAF Facility requires renewal but has adequate capacity for treating the solids associated with the SWRP's ultimate maximum monthly flow rate of 76 mgd. The Water Authority is considering alternative secondary sludge thickening technologies. Based on recent pilot studies, thicker sludge may be achievable with an alternative technology. Some of these technologies have limited full-scale experience and it would be prudent to obtain additional information on the different alternative technologies before making a decision to replace the existing DAF process. Visits to other plants using these technologies would be useful to obtain full-scale operational information.

The following paragraphs summarize the near-, intermediate, and potential long-term improvements.

7.5.1 Near-Term Improvements

The near-term improvements are to address the identified deficiencies with the existing DAF Facility at the SWRP to keep the existing DAF system in operation until an alternative technology replacement project is further considered.

7.5.1.1 Structural Improvements

To ensure the electrical upgrades do not fall victim to corrosion and comply with current requirements, structural changes such as separating the electrical rooms from the main process area and installing proper ventilation in the classified areas will need to be implemented at the same time the mechanical equipment modifications are being performed.

- Modify electrical rooms and air compressor room to separate the space from the classified process area. Provide new outdoor access doors, landings and stairs.
- Replace corroded doors and frames.
- Replace overhead door.
- Miscellaneous structural and architectural repairs including:
    - Repair cracks in walls, tanks, ceilings, and floors.
    - Repair and replace missing concrete.
    - Repair masonry cracks.
    - Reseal wall joints.
    - Recoat floors.
    - Repaint walls.

7.5.1.2 Electrical Improvements

- Replace MCCs associated with DAF Tank Nos. 1-3 and reuse this area to power the DAF replacement equipment
- Replace switchgear.
- Replace control stations that do not meet code.
- Replace all lighting and receptacles.
- Add new instruments as needed to serve the DAF replacement equipment.

7.5.1.3 HVAC Improvements

- Repair ACU for 1977 Building MCC room.
- Replace seven (7) MAUs.
- Replace two odor control exhaust fans.
- Demolish all odor control system elements outside of the exhaust fans and exhaust dispersion stack.
- Repair foul air ducting and replace duct supports on roof.

7.5.1.4 Mechanical Improvements

- Repair two DAF mechanisms and air saturation tanks in the near term for continued operation during the major mechanical dewatering equipment installation project construction.
- Replace air compressors if required for new thickening technology.
- Install new UWAS pumps to serve new mechanical dewatering equipment
- Install new TWAS pumps to serve new mechanical dewatering equipment.
- Install new polymer feed pumps to serve new mechanical dewatering equipment.
- Install new piping to serve new mechanical dewatering equipment and recoat any existing piping that is maintained as part of the new thickening facility.
- Replace inoperable manual valves on the UWAS and TWAS lines.
- Install new emulsion polymer storage tanks and dilution activation system. New mixing and aging tanks may also be required.

7.5.2 Intermediate-Term Improvements

The Water Authority should further evaluate alternative thickening technologies to the existing DAF system at the SWRP. This should include site visits to treatment plants using these technologies so at to obtain full-scale O&M data. Additional pilot tests may also be warranted.

7.5.3 Long-Term Improvements

If the evaluations of alterative thickening technologies indicates that replacing the existing DAF system is appropriate, then design and construct these improvements when capital improvement funding becomes available.

Section 8

Anaerobic Digesters

Section 8
Anaerobic Digesters

8.1 INTRODUCTION AND PROCESS OVERVIEW

The Southside Water Reclamation Plant (SWRP) treats primary and secondary solids using anaerobic digestion. A sludge blending tank mixes the primary and secondary sludge ahead of the primary digesters. The plant currently has ten primary digesters and four secondary digesters. The secondary digesters are used principally for storage of the digested sludge ahead of solids dewatering.

The current operation is to feed the primary digesters one at a time. This displaces volume in the primary digester, which overflows into the secondary digesters. The secondary digesters have floating roofs.

Bio-gas is collected from both the primary and secondary digesters and stored temporarily in two gas holder tanks with floating roofs. A set of compressors sends the gas to a high pressure gas storage sphere ahead of the two Cogeneration Facilities.

8.2 DIGESTER PROCESS IMPROVEMENTS (2010 – 2015)

During preparation of the 2010 RAMP Report, numerous deficiencies were identified with the anaerobic digestion system at the SWRP. During the subsequent five years, several projects have been done to address these deficiencies.

8.2.1 Digester Renewal Design Analysis Report (CIP Project 5593.06)

The consulting firm AECOM performed a set of inspections and evaluations of the anaerobic digesters at the SWRP. The purpose of the work was to provide more detailed analysis of the issue identified in the 2010 RAMP Report. A set of technical memoranda were produced on the following topics:

- Facility Deficiency Identification, Evaluation, and Recommendations including structural, process mechanical, HVAC, electrical, and instrumentation
- Conversion of Secondary Digesters to Primary Digesters
- Mixing System Alternatives
- Digester Draining Improvements

Several of the projects listed below are follow-on projects to the recommendations provided by this project.

8.2.2 Safety Valves & Other Appurtenance Renewal (CIP Proj. 5593.46 & 7893.97)

The Water Authority is currently replacing the safety pressure/vacuum relief valves mounted on the roofs of the primary digesters. As part of this project, corroded roof hatches, digester gas piping, and other roof-mounted appurtenances are also being renewed. Minor structural repairs are being made in part to seal cracks that allow biogas to escape.

8.2.3 Digester Mixer Renewal

Since completion of the 2010 RAMP Report, the Water Authority's Plant O&M Division has implemented an in-house digester mixer renewal program. This program involves sending worn mixers out for renewal. All the mixers are being fitted with improved seals, bearings, and new pressurized greasing units. This has resulted in all of the primary digesters having good mixing. Also, the improved design has resulted in more reliable mixers that require less on-going maintenance to keep running. This work is almost complete.

8.2.4 Linear Mixer Installation on Digester 13 (CIP Project 5593.49)

In lieu of renewing the existing center draft tube mixer for Primary Digester 13, a new linear mixer is being installed. This will allow this technology to be tested on a full-scale basis. Once on-line, the mixing performance will be compared with that of the other primary digesters in terms of bio-gas production and volatile solids reduction. The operation and maintenance (O&M) costs will also be evaluated. This project will allow the Water Authority to select a long-term mixing technology for the digesters.

8.2.5 Digester Cleaning (Purchase Order BP000008)

The Water Authority had the grit removed from the bottom of all 14 digesters during 2012 and 2014.

8.2.6 Digester Crack Repairs (CIP Project 7893.7805)

This project involved identification and sealing of several cracks in the walls and roofs of the digesters. An epoxy grout was used to seal the cracks to reduce bio-gas escape from the digesters.

8.2.7 Secondary Digester Structural Repairs (CIP Project 5593.11)

Interior inspection of the secondary digesters revealed broken corbels that are used to hold up the floating roof when the digester is drained. Design and construction of replacement corbels was completed.

8.2.8 Gas Holder Inspection (CIP Project 5594.19)

Project documents have been developed to solicit a contractor to allow for inspection of the two floating-roof gas holders and the high pressure gas sphere. These elements have not been inspected for approximately 20 years. Inspection may reveal that the interior protective coatings require renewal.

8.2.9 Digester Pipe Gallery 1 – 8 Flow Meter Renewal (CIP Project 7893.0801)

There are four (4) flow meters used at SWRP to monitor sludge flows at the Sludge Blending Pump Station, Primary Pump House 1 & 2 in Digesters #1-8 Pipe Gallery, and Pump P9 in Digesters #9-14 Pipe Gallery. Metering digester flows are critical to digester feed and sludge dewatering operations. In an effort to improve these operations, a new magnetic flow meter has been installed in Digester Pipe Gallery 1-8. This new meter now allows the monitoring of sludge flows during transfers between digesters as well as transfers to the dewatering process. The other remaining three (3) flow meters have been replaced recently by SWRP and are reported to be in great working order.

8.2.10 Digester Heat Exchanger Renewal (CIP Project 7891.3202)

This project removed and replaced the existing heat exchanger at the east end of the Digester Pipe Gallery for Digesters 11, 13, and 14 with new Alfa Laval spiral heat exchangers similar to those installed on Digesters 1, 2, 3, 5, 7, 8, and 9. Presently, all of the heat exchangers for the primary digesters have been renewed.

8.3 DIGESTER CAPACITY ANALYSIS

8.3.1 Sludge Flows

After passing through the Preliminary Treatment Facility, the screened and de-gritted wastewater enters the Primary Clarifiers. Primary solids that settle to the bottom of the primary clarifiers is pumped to the Sludge Blending Tank, which has a volume of 190,000 gallons. Thickened sludge from the Dissolved Air Flotation Facility is also sent to this tank. The blended sludge is then sent to the Primary Digesters. One digester is fed at a time from the Sludge Blending Tank.

Table 8-1 summarizes the primary and secondary sludge flows during 2015 to the Sludge Blending Tank ahead of the anaerobic digesters. The plant effluent flows are also shown for reference. During this time period, the plant had an average daily effluent flow rate of 50.3 mgd and maximum month effluent flow rate of 52.4 mgd. The average and maximum month blended sludge flows were 0.393 and 0.465 mgd, respectively.

Table 8-1

Summary of Plant and Sludge Flows for 2015[1]

Sludge Flow Condition	Plant Effluent Flow (mgd)	Primary Sludge Flow (mgd)	Secondary Sludge Flow (mgd)	Blended Sludge Flow (mgd)
Average Day	50.3	0.251	0.143	0.393
Maximum Month[2]	52.4	0.326	0.180	0.465
Maximum Half-Month[3]	52.9	0.332	0.186	0.480

Notes:

1. Includes data from 1/1/15 through 11/30/15.
2. The maximum month design flow is the largest volume of flow to occur during a continuous 30-day period, expressed as a daily average.
3. The maximum half-month flow is the largest volume of flow to occur during a continuous 15-day period, expressed as a daily average.

8.3.2 Digester Volume

Table 8-2 summarizes the capacity characteristics of the primary digesters. The ten primary digesters have a gross total capacity of 9.34 mil gal. With one of the largest digesters off-line, the primary digester capacity would be 8.27 mil gal. Assuming sediment fills the bottom cone volume prior to cleaning, the digester capacity with one of the largest units off-line would be approximately 7.25 mil gal. This may be considered the firm hydraulic capacity of the anaerobic digesters.

Table 8-3 summarizes the characteristics of the secondary digesters. The four secondary digesters have a gross total capacity of 3.61 mil gal. The secondary digesters are used principally for storing digested sludge ahead of solids dewatering. Biogas is collected from the secondary digesters; however, these units lack provisions for mixing and heating the temporarily stored sludge.

Table 8-2

Primary Anaerobic Digester Hydraulic Capacity Information

Digester No.	Start-up Year	Diameter (ft)	Straight Side Depth (ft)	Bottom Cone Depth (ft)	Straight Side Volume (mil gal)	Bottom Cone Volume (mil gal)	Total Unit Volume (mil gal)
1	1960	75	22.5	9.4	0.744	0.104	0.847
3	1960	75	22.5	9.4	0.744	0.104	0.847
5	1965	75	22.5	9.4	0.744	0.104	0.847
7	1965	75	22.5	9.4	0.744	0.104	0.847
9	1973	75	22.5	9.4	0.744	0.104	0.847
2	1960	75	25.5	9.4	0.843	0.104	0.947
8	1965	75	25.5	9.4	0.843	0.104	0.947
11	1984	85	22.5	10.6	0.921	0.150	1.071
13	1984	85	22.5	10.6	0.921	0.150	1.071
14	1984	85	22.5	10.6	0.921	0.150	1.071
Total					8.17	1.18	**9.34**

Table 8-3

Secondary Anaerobic Digester Hydraulic Capacity Information

Digester No.	Start-up Year	Diameter (ft)	Straight Side Depth (ft)	Bottom Cone Depth (ft)	Straight Side Volume (mil gal)	Bottom Cone Volume (mil gal)	Total Unit Volume (mil gal)
4	1960	75	22.5	9.4	0.744	0.104	0.847
6	1965	75	22.5	9.4	0.744	0.104	0.847
10	1973	75	22.5	9.4	0.744	0.104	0.847
12	1984	85	25.5	10.6	0.921	0.150	1.071
Total					3.15	0.46	**3.61**

8.3.3 Digester Operation

The digesters are operated to produce digested solids equivalent to the Class B pathogen requirements per USEPA Part 503. The SWRP uses the alternative of monitoring of indicator organisms to demonstrate compliance. This requires that the geometric mean fecal coliform density measured in samples of digested biosolids be less than 2 million most probable number (MPN) per gram (g) or total solids or less than 2 million colony forming units (cfu) per gram of total solids (dry weight basis). To produce Class B Biosolids, the primary digesters are operated to maintain a temperature of 95ºF (35ºC) for approximately 15 days.

For meeting the USEPA Part 503 requirements for reducing vector attraction, the SWRP uses the option of a minimum 38 percent reduction in volatile solids content. Under this option, the mass of volatile solids in the biosolids is reduced by at least 38 percent during anaerobic digestion.

Table 8-4 summarizes the fecal coliform density and percent reduction in volatile solids data for 2015. As indicated, the fecal coliform densities were well below the 2 million MPN/g limit. The average concentration based on the available data is 115,210 cfu/g. During a monitoring event, a total of seven samples are collected on seven weekdays during a two-week period. A monitoring period occurs once every 60 days (six times per year). Samples are collected from the conveyor at the Solids Dewatering Facility (SDF). As indicated, the average annual percent reduction was approximately 54 percent.

Table 8-4

2015 Digested Sludge Fecal Coliform Density and Volatile Solids Reduction Data

Period	Fecal Coliform Density[1] (MPN/gram)	Reduction in Volatile Solids[2] (%)
January - February	97,300	55.9
March - April	78,879	56.8
May - June	194,200	53.7
July - August	101,107	51.6
September - October	104,562	53.6
November - December		54.7
Annual Average	115,210	54.4

Notes:
1. Geometric mean concentration of the measured samples.
2. Average of daily measurements.

Table 8-5 summarizes the estimated hydraulic retention time (HRT) in the primary digesters under different sludge flow conditions. The analysis assumes a firm primary digester hydraulic capacity of 7.2 mil gal. Recall, this assumes one of the largest digesters being off-line and that the bottom cone sections of the on-line digesters are filled with sediment. The analysis indicates that under the different flow conditions, an HRT of at least 15 days is provided. This does not account for detention time in the secondary digesters at lower temperature and without mixing.

Table 8-5

Hydraulic Retention Time in Primary Digesters

Sludge Flow Condition	Blended Sludge Flow[1] (mgd)	Hydraulic Retention Time[2] (days)
Average Day	0.393	18.3
Maximum Month[3]	0.465	15.5
Maximum Half-Month[4]	0.480	15.0

Notes:

1. Includes data from 1/1/15 through 11/30/15.
2. Assumes a firm primary digester hydraulic capacity of approximately 7.2 mil gal.
3. The maximum month design flow is the largest volume of flow to occur during a continuous 30-day period, expressed as a daily average.
4. The maximum half-month flow is the largest volume of flow to occur during a continuous 15-day period, expressed as a daily average.

8.3.4 Digester Capacity Evaluation

Based on the information provide in the previous subsections, there appears to be adequate primary digester capacity for current plant flow conditions (Refer to Table 8.1 above). This conclusion agrees with the analyses performed in preparation of the 2010 RAMP Report, which indicated that the capacity of anaerobic digesters at the SWRP is approximately 60 mgd. This assumed the following: (1) all of the treatment occurs in the primary digesters, (2) one of the larger primary digesters is off-line, and (3) only 90 percent of the on-line primary digester capacity is available.

However, the desired capacity rating for the digesters and related systems is equivalent to the 76 mgd MMF. For predictions of future requirements, digester loading and HRT relationships apparent in the current data are assumed to hold for the future cases. In other words, a firm hydraulic primary digester capacity that provides approximately HRT of 15 days should likely be maintained at future, higher plant flow rates. Therefore, additional primary digester capacity will

be required as plant flow rates increase and to provide adequate digester capacity for the anticipated maximum month average daily flow rate of 76 mgd.

For a maximum month average daily flow of 76 mgd, the blended sludge flow is projected to be approximately 0.674 mgd (i.e., 76 mgd x 0.465 mgd / 52.4 mgd). To provide a minimum of 15 days of firm primary digester capacity, an on-line digester volume of approximately 10.1 mil gal would be required. This on-line volume would have to be available assuming one of the largest digesters is off-line and the bottom cone sections of the on-line units are filled with grit.

One approach for providing additional primary digester capacity is to convert the existing four secondary digesters to primary digesters. Converting all four of the current secondary digesters, would provide a total firm on-line capacity of approximately 10.4 mil gal. Note: Converting secondary digesters to primary digesters will be made possible, once the 2.0-mil gal digested sludge storage tank is constructed as part of the improvements to the Solids Dewatering Facility.

8.4 DIGESTER CONDITION ASSESSMENT

At the time the 2010 RAMP Report was being prepared, several deficiencies were identified with the anaerobic digestion system at the SWRP. As described in Subsection 8.2 above, some of these deficiencies have already been corrected and/or are currently being addressed. This subsection updates the description of the known deficiencies that still need to be addressed.

8.4.1 General Equipment

8.4.1.1 Sludge Withdrawal Pumps

There is no redundancy for the sludge pumps for secondary digesters #10 and #12 (Digesters 9-14). There are reported problems with both the pumps and related valves. Additionally, pumps from both digester complexes discharge into a single line to sludge dewatering (no redundancy). There is a single point of failure in each case.

8.4.1.2 Low Pressure Gas System

The low pressure gas system has the potential for leaks and needs to be inspected. Leaks and inadequate traps on drain lines pose safety issues. Additionally, inadequate moisture removal performance results in excess moisture to the cogeneration system.

8.4.1.3 HVAC

There is inadequate ventilation and heating in the Digester Complex. Successful process operation, worker safety and electrical code issues are all tied to adequate ventilation and heating systems. Loss of heat in winter can result in freezing of digester gas systems and result in uncontrolled gas release. Gas rooms should be isolated from other parts of the buildings for NFPA 820 compliance and electrical equipment ratings.

8.4.1.4 Instrumentation and Controls

Controls for the north digesters are antiquated and ineffective. Many of the instruments are obsolete. Control of digester temperatures is difficult due to poor instrumentation, ineffective control valves, and inadequate available heat. I/O for the North Digesters is remotely located in the main control building, making troubleshooting of circuits difficult.

Controls for the south digesters are antiquated and ineffective. Many of the instruments are obsolete. Control of digester temperatures is difficult due to poor instrumentation, ineffective control valves, and inadequate available heat. I/O for the South Digesters is remotely located in the DAFT building, making troubleshooting of circuits difficult.

Controls for the blended sludge pump station are in fair condition. Control for distribution of sludge to digesters is manually controlled and could be substantially improved through more automation. I/O for the blended sludge pump station is remotely located in the main control building, making troubleshooting of circuits difficult.

8.4.2 Electrical Equipment

8.4.2.1 General

Electrical systems within the digester gallery areas are only partially constructed with explosion-proof methods. An analysis of NFPA is needed to determine which areas of this facility require explosion-proof construction methods. Areas that are non-compliant present a risk of explosion and should be addressed.

In general, aging electrical equipment should be subjected to major overhaul or complete replacement to address safety and obsolescence. Only partial redundancy exists at peak conditions. A prolonged power would back-up the solids handling process until a repair or work around was implemented. Modern equipment would be more readily serviced without process disruptions.

PCU controllers are remote from the digester area with long control circuits having multiple interface points leading to unreliability and high maintenance levels.

8.4.2.2 North Digesters (Digesters 1 through 8)

North Digesters 1-8 are fed from a primary selective switch and unit-substation with provisions for a portable standby generator. Portions of the system are very old and near the end of their useful life. Some portions of this system may present personnel hazards due to their age and condition.

8.4.2.3 South Digesters (Digesters 9 through 14)

South Digesters 9-14 are fed from the DAF Building. There are substantial problems related to the age and condition of the equipment and the building.

8.4.2.4 Blended Sludge Pumping Station

The blended sludge pump station is powered from the north digesters electrical room. The equipment in this area is old, but in fair condition. Due to the age, this equipment is nearing the end of its useful life

8.5 IMPROVEMENTS PLAN

The Water Authority has implemented several projects to address the deficiencies identified in the 2010 RAMP Report. These are described above in Subsection 8.2. This section provides an update to the plan for near-, intermediate- and long-term improvements to the Anaerobic Digestion System at the SWRP. This plan is revised to reflect the improvements made since the original RAMP Report was completed as well as any new required improvements that have become apparent.

8.5.1 Near-Term Improvements

The plan for near-term improvements is to continue to address the different deficiencies with the existing digester complex.

8.5.1.1 Continue to Address Deficiencies in Existing Digesters

These largely focus on renewing the mechanical, electrical, and instrumentation systems. In addition, structural deficiencies such as cracks and spalling concrete have been and continue to be addressed.

8.5.1.2 Evaluate Alternative Mixing Technologies

The Water Authority is currently installing linear mixers in Primary Digester No. 13 to evaluate the potential operation and maintenance cost savings with this type of mixer. Also, the impacts on biogas production will be evaluated. Based on the findings of this evaluation, this type of mixer may be installed on all the primary digesters. Pumped mixing provides an alternative new mixing technology that has been evaluated will be considered as an alternative approach.

8.5.1.3 Additional Digested Liquid Sludge Storage Capacity

As part of the renewal of the Solids Dewatering Facility (SDF), the Water Authority is adding more than 2 million gallons (mil gal) of digested liquid sludge storage. Adding additional storage capacity will alleviate plant disruptions due to outages of the SDF (i.e., inability to waste

primary and secondary sludge from the clarifiers.) The other benefit of this additional storage capacity, is the opportunity to convert secondary digesters into primary digesters.

8.5.2 Intermediate-Term Improvements

The Water Authority needs to increase the treatment capacity of the primary digesters. This is to provide an additional capacity margin for treating current flows. However, it is also to provide sufficient primary digester capacity to allow digesters to be taken out of service for extended periods of time to allow structural and protective coating renewal of the digesters, while not disrupting the digestion process.

8.5.2.1 Additional Primary Digester Capacity

Once the additional digested liquid sludge storage capacity, as described above, is on-line, then two of the secondary digesters can be converted to primary digesters. This will add approximately 1.5 mil gal of firm primary digester capacity. It will also allow primary digesters to be taken out of service to allow renewal of the interior of the structures including the protective coatings, while maintaining adequate on-line digestion capacity.

8.5.2.2 Implementation of New Mixers

As described above, linear mixers are being considered as a replacement technology for the existing draft tube mixers used in the primary digesters. Pumped mixing is another alternative technology under consideration. Once a new mixing technology is selected, it will be implemented.

8.5.3 Long-Term Improvements

8.5.3.1 Additional Primary Digester Capacity

To provide adequate digestion capacity for treated the sludge from a 76 mgd capacity plant, a total firm primary digestion capacity of approximately 10.1 mil gal is required. One approach for providing this capacity would be to convert the remaining two secondary digesters to primary digesters. This would results in a total firm primary digester capacity of approximately 10.4 mil gal.

Alternatively, a new set of primary digesters could be constructed to provide adequate capacity for a 76 mgd treatment plant. Constructing new digester structures would allow optimized geometry (e.g., use of egg-shaped digesters). Alternative cover designs could also be used with new digesters.

8.5.3.2 Evaluate Alternative Anaerobic Digestion Technologies

New anaerobic digestion processes have been developed that provide benefits over the single stage Mesolithic digestion used at the SWRP. One option described in the original RAMP Report was temperature-phased anaerobic digestion (TPAD).

The TPAD process is two-phase system of thermophilic (55 degrees C) and mesophilic (35 degrees C) vessels, which can provide class B solids in a reduced process volume. The required volume for this type of system is generally considered to be about 25 percent less than a conventional mesophilic digestion system. Other benefits of TPAD include increased bio-gas production, reduced odors, and improved dewaterability of the digested solids.

8.5.3.3 Injection of Fat, Oil, and Grease

The Water Authority conducted a study for implementation of a receiving station for accepting fat, oil, and grease (FOG) at the SWRP. This material would be injected into the primary digesters along with the primary and secondary sludge and would increase the amount of biogas formed. The study revealed that the current technology for handling FOG is still being developed, so the Water Authority views this as a long-term project.

Section 9

Solids Dewatering Facility

9.1 INTRODUCTION AND PROCESS OVERVIEW

This chapter describes the results from the capacity evaluation and condition assessment for the major assets associated with the Solids Dewatering Facility (SDF). The 2010 RAMP Report identified the SDF has one of the higher risk facilities at the Southside Water Reclamation Plant (SWRP). In general, this facility was in poor condition and it was recommended that it be renewed as soon as practicable.

The SDF treats the digested sludge pumped from the Secondary Digesters. A set of sludge feed pumps then transfer the sludge to the centrifuges. There are a total of four sludge feed pumps and three centrifuges. Polymer is added in the pipeline prior to the centrifuges to enhance sludge dewaterability. The dewatered sludge from the centrifuges is discharged to a conveyor and then to a sludge auger for deposit into four dry cake storage bins. The centrate stream flows to a centrate storage tank and is then conveyed to Interceptor 142A upstream of the SWRP headworks.

The operation of the SDF can impact the operation of the main plant processes and potentially the quality of the effluent. The plant needs to waste primary and secondary sludge so that it does not accumulate to too high a level in the primary and secondary clarifiers. The over accumulation of sludge in the secondary clarifiers can jeopardize meeting the permitted solids concentration in the effluent. Therefore, it is important that the SDF operate in an uninterrupted manner as much as possible. This requires adequate storage capacity for the liquid digested sludge ahead of the centrifuges and dry cake storage capacity downstream of the centrifuges. The centrifuges and related equipment need to be maintained in a functional manner at all times.

9.2 SOLIDS DEWATERING FACILITY IMPROVEMENTS (2010 – 2015)

During preparation of the 2010 RAMP Report, numerous deficiencies were identified with the SDF. During the subsequent five years, projects have been done to address these deficiencies.

9.2.1 SDF Renewal Design Analysis Report (CIP Project CIP Project 4781.60)

The consulting firm Corollo Engineers performed a set of facility evaluations and prepared a set of technical memoranda and a design analysis report (DAR). The purpose of the work was to provide a more detailed analysis of the condition of the SDF and more thorough evaluation of renewal alternatives. This included evaluating the alternative of rehabbing the existing SDF and alternatives for constructing a new SDF. The conclusion was that it was more cost effective to rehab the existing SDF.

9.2.2 SDF Rehab Design (CIP Project 4781.60 – Phase 2)

Based on the findings documented in the design analysis report, Corollo Engineers is currently preparing construction documents for rehabbing the existing SDF. Major improvements to the SDF will include the following:

- A new 2.0 million gallon (mil gal) liquid digested sludge storage tank. This tank will provide approximately four days of sludge storage ahead of the SDF. This will be in addition to the storage currently provided in the Secondary Digesters.
- A new 7,000 gal wetwell for the centrifuge feed pumps. This tank will replace the existing undersized 3,000 gal wetwell tank.
- The installation of third new centrifuge (Alfa Laval G2-120). The third unit will join the other two new G2's that have been installed since the 2010 RAMP Report was completed (See project description below).
- A new Polymer System and Room. The existing dry polymer system will be supplemented with a new emulsion polymer system. The new system will be housed in a new room adjoining the SDF.
- The replacement of the single cake conveyor belt with a set of two shaft-less screw conveyors and a set of two cake pumps. The new conveyance system will provide for a more reliable, enclosed system with a fully redundant backup system.
- New set of dry cake storage bins that will increase the dry cake storage capacity by 50 percent.
- Modifications to the existing cake storage bin gates to allow quicker loading of cake haul truck trailers.

9.2.3 New Centrifuges (CIP Project CIP Projects, 5600.03 & 7891-36)

The Water Authority purchased three new Alfa Laval G2-120 centrifuges to replace the aged Pennwalt-Sharples DS706 units. Two of G'2s have been already installed. The third G2 will be installed as part of the SDF Renewal Project described above.

9.2.4 Roof Replacement (CIP Project CIP Project 5594.22 & 01025.00103)

These projects designed and replaced the roof on the SDF building with a new Thermoplastic Polyolefin roofing system.

9.2.5 HVAC Improvements (CIP Project 5593.17 & 7893.4904)

These projects designed and replaced the boiler and other elements of the building heating system.

9.2.6 Biosolids Drying Evaluation (CIP Project 5598.05)

This study evaluated the feasibility to dry the dewatered sludge cake produced by the centrifuges. The conclusion was that this process is currently not cost effective for the Water Authority and that there are higher priority projects to be completed.

9.2.7 Cake Conveyor Spill Containment (CIP Project 5599.11 & 7893.13402)

These projects designed and replaced the spill containment tray under the dry cake conveyor belt. Proper containment is necessary to prevent unsanitary conditions and dripping on electrical equipment.

9.2.8 Hotsy Replacement

This project replaced the Hotsy pressure washer used to clean out the process area around the centrifuges.

9.3 SDF PROCESS CAPACITY ASSESSMENT

At the time the 2010 RAMP Report wash completed, the SDF was operated during only part of the day. Since that time, the operation of the SDF has been changed to a full-time operation. The elimination of starting and stopping the centrifuges each day has resulted in a substantial reduction in maintenance costs. Full-time operation of the SDF will be maintained after the planned rehabilitation of the SDF.

9.3.1 Digested Sludge Flow and Loading

Table 8-1 summarizes the centrifuge sludge feed data for 2015. On average, the SDF centrifuges dewatered 435,000 gallons (gal) of digested sludge per day. The average total solids content of the feed sludge was 2.2 percent and the average total solids of the cake was 20.7 percent. On average, approximately 91,600 lbs (dry basis) of sludge was processed producing approximately 6,500 cubic feet (cf) of cake. This assumes a polymer dose of about 10 lbs per ton of dry solids and a 95 percent capture rate by the centrifuges. The average daily plant flow rate during this period was approximately 50.3 mgd.

Table 8-1

Centrifuge Feed Rate

Statistic	Daily Feed Volume Treated (mil gal)	Equivalent Daily Feed Rate (gpm)
Average	0.435	302
Median	0.369	256
90th Percentile	0.656	456
Maximum	0.744	517

9.3.2 Liquid Digested Sludge Storage

Currently, the SWRP stores liquid digested sludge in the four Secondary Digesters. Combined, the Secondary Digesters provide an operational storage volume of approximately 2.0 mil gal. This is less than the physical volume of the four digesters, because the full depth of the tanks are not used, but rather about 15 feet of the depth.

On average, 2.0 mil gal of operational storage provides up to approximately 4.5 days of storage capacity. However, in practice, the amount of storage capacity is variable due to the variable depth of the digesters with their floating roofs.

The SDF Renewal Project will add a new 2.0-mil gal tank for storing digested sludge. The layout of the site will allow for the future additional of a second 2.0-mil gal tank. Adding this new storage will allow the secondary digesters to be converted into primary digesters.

9.3.3 Centrifuge Capacity

Currently, the SDF has three centrifuges: two Alfa Laval G2-120's and a Pennwalt-Sharples DS706. The plant is able to operate each of these units at a flow of up to approximately 300 gpm and produce acceptable cake. One centrifuge is almost able to process the average daily digested sludge produced by the Anaerobic Digesters. The plant reports that a second centrifuge has to be run for a period of time each week to "catch up." Therefore, the SDF has more than sufficient capacity to process current sludge flows.

For the 76 mgd maximum month design flow for the SWRP, the projected digested sludge production is approximately 460 gpm. With each centrifuge operating at about 300 gpm, this would require a second centrifuge to operate approximately half the time (i.e. 90 hrs/week). Based on this, the SDF appears to have adequate centrifuge capacity for the projected ultimate capacity of the plant.

9.3.4 Sludge Cake Storage Bin Capacity

Currently, the SDF has four sludge cake storage bins used to temporarily store the cake and to load the truck trailers used to haul the cake to the Soil Amendment Facility (SAF). Each of the four bins has a capacity of approximately 3,000 cf resulting in a total bin capacity of approximately 12,000 cf. At the current average day cake production rate of 6,500 cf, this provides approximately 1.8 days of storage capacity. This is insufficient capacity to avoid truck trailer operation on the weekends.

Two additional cake bins will be added to the SDF as part of the SDF Renewal Project. This will increase the total storage capacity to approximately 18,000 cf. This will provide approximately 2.8 days of storage capacity at current production rates.

The layout of the new bins will allow for the future addition of two more bins, which will increase the storage capacity to about 24,000 cf. For the 76 mgd maximum month design flow for the SWRP, this will provide approximately 2.4 days of storage. This amount of dry cake storage together with the additional liquid digested sludge storage being added should allow uninterrupted operation of the SDF.

9.4 SDF CONDITION ASSESSMENT

The 2010 RAMP Report identified several deficiencies with the SDF. Several of these deficiencies have been addressed in the meantime. Also, the recent startup of the new Preliminary Treatment Facility (PTF) is reducing the amount of grit that enters the downstream treatment processes including the Digesters and SDF. This is reducing the rate of wear on the different elements of the SDF. Moreover, operating the SDF on a more continuous basis rather than stopping and starting the equipment daily has greatly reduced maintenance requirements of this facility.

9.4.1 Centrifuge Feed Pumps

Four new centrifuge feed pumps have been installed since the 2010 RAMP Report was completed. The new pumps are rotary lobe type, which are easier to repair than the previous progressive cavity units. The reduced grit in the digested sludge will reduce maintenance requirements on these pumps.

The SDF Renewal Project will install a new, larger wetwell tank for these pumps. The new 2.0-mil gal liquid digested sludge storage tank will be close enough to the SDF to allow the wetwell tank to be temporarily taken out of service for maintenance, while continuing to operate the centrifuges. Also, the SDF Renewal Project will install new feed piping from the Digester Complex including a redundant line.

9.4.2 Centrifuges

Since the 2010 RAMP Report was completed, the Water Authority has replaced two of the centrifuges with new Alfa Laval G2-120 units. These units included new control panels. A third new G2-120 and control panel will be installed as part of the SDF Renewal Project.

The recent startup of the new Preliminary Treatment Facility (PTF) is reducing the amount of grit that enters the downstream treatment processes including the Digesters and SDF. This will reduce the rate of wear on the centrifuges. The SWRP has a spare rotating assembly for the G2's to allow a centrifuge to be returned to service relatively quickly, while its rotating assembly is sent out for rehabilitation.

9.4.3 Dry Cake Conveyor

Since the 2010 RAMP Report was completed, the Water Authority has replaced the dry cake conveyor with a brand new unit. This belt is rehabbed on a routine basis to keep it in good working order. The reduced grit in the sludge with startup of the new PTF should reduce the rate of wear on this belt.

The SDF Renewal Project will replace the conveyor belt with two new shaft-less screw conveyors and a set of two cake pumps. Each conveyor and cake pump will have the capacity to handle the full production rate of cake from two of the centrifuges. This will eliminate the conveyance system as a single point of failure in the system. The new screw conveyors and cake pumps will be enclosed to reduce the occurrence of spills as well as reducing odors in the building.

9.4.4 Cake Storage Bin Gates

At the time the 2010 RAMP Report was being completed, the cake storage bin gates did not function properly and often froze in position. The hydraulic system did not function in cold weather and the bottom of the hoppers clogged.

The bin gates have been heat traced and insulated so that they no longer freeze in position. The bin gates will be enlarged and retrofitted with electric motor actuators as part of the aforementioned SDF Renewal Project.

9.4.5 Polymer System

The SDF Renewal Project will add a new emulsion polymer system to the SDF. The existing dry polymer system will be retained, but it is anticipated that this will serve solely as a backup system. Eventually, it is expected that the dry polymer system will be decommissioned. This will eliminate the issues with dry polymer spills, dust, and hazards associated with handling super-sacks of this material.

9.4.6 Centrate Tank and Pumping System

The centrate tank is located inside the building and does not have proper ventilation and odor control. This causes extreme odor problems within the building and increases the building's interior humidity which causes accelerated corrosion of the mechanical and electrical equipment as well as the structural elements of the system and is also a human health concern.

These deficiencies will be addressed as part of the aforementioned SDF Renewal Project.

9.4.7 HVAC System

At the time of the 2010 RAMP Report, the HVAC system was not functioning and thus the building lacked proper air exchange and humidity control. This caused a hazardous environment for both plant staff and accelerated deterioration of mechanical and electrical equipment as well as the structural elements within the building.

Components of the HVAC system have been repaired since the completion of the 2010 RAMP Report. The SDF Renewal Project will make further improvements to the HVAC system to bring the facility up to full code compliance.

9.4.8 Electrical Equipment

The 2010 RAMP Report indicated that the electrical equipment at the SDF was in better condition that at many of the other areas of the SWRP. It was noted that power outages resulted in time consuming cleaning of the centrifuges.

Numerous improvements have been made to the SWRP electrical systems in the past 5 years and others are currently underway. Among the improvements is a new Field Isolation Switch (FIS). Also, many corrective maintenance and preventative maintenance work orders have been completed. This has made the power more reliable at the SWRP. As part of the SDF Renewal Project, the MCC Room at the SDF will be expanded. Any deficient electrical equipment will be renewed as part of this project.

9.4.9 Instrumentation and Controls

The 2010 RAMP Report identified the following issues with the instrumentation and controls at the SDF:

- The sludge feed program is overly complicated and does not work well.
- Polymer batching and feed systems do not operate properly.
- Truck loading is controlled manually by operators visually estimating truck weight/fill. This makes it nearly impossible to optimize sludge transportation, because trucks are either way under or way over weight.
- Antiquated control panels are very difficult maintain.

These issues are being addressed as part of the SDF Renewal Program, including the retrofitting of the cake truck trailers with load cells to monitor their weight.

9.5 IMPROVEMENTS PLAN

The Water Authority together with Corollo Engineers completed a design analysis for the SDF in March of 2015. A principal conclusion of this study was that it was more cost effective to rehabilitate the existing SDF rather than design and construct a new facility. Part of the reason for this conclusion was the determination that the current SDF has sufficient capacity for the foreseeable future. A new SDF may be constructed in the future, if necessary.

Carollo Engineers is currently completing the design of the SDF Renewal Project, which will correct the current deficiencies of the SDF. It is anticipated that construction of the improvements will largely be completed by the end of 2017. As described above in Section 9.2, key elements of this project are as follows:

- A new 2.0 million gallon (mil gal) liquid digested sludge storage tank. This tank will provide approximately four days of sludge storage ahead of the SDF. This will be in addition to the storage currently provided in the Secondary Digesters.
- A new 7,000 gal wetwell for the centrifuge feed pumps. This tank will replace the existing undersized 3,000 gal wetwell tank.
- The installation of third new centrifuge (Alfa Laval G2-120). The third unit will join the other two new G2's that have been installed since the 2010 RAMP Report was completed (See project description below).
- A new Polymer System and Room. The existing dry polymer system will be supplemented with a new emulsion polymer system. The new system will be housed in a new room adjoining the SDF.
- The replacement of the single cake conveyor belt with a set of two shaft-less screw conveyors and a set of two cake pumps. The new conveyance system will provide for a more reliable, enclosed system with a fully redundant backup system.
- New set of dry cake storage bins that will increase the dry cake storage capacity by 50 percent.
- Modifications to the existing cake storage bin gates to allow quicker loading of cake haul truck trailers.
- HVAC improvements. Improvements to the system to improve ventilation and improve humidity control.

Section 10

Cogeneration Facilities

10.1 INTRODUCTION AND PROCESS OVERVIEW

This chapter describes the results from the capacity and condition assessments for the major assets associated with the cogeneration (cogen) facilities at the Southside Water Reclamation Plant (SWRP). In terms of risk, the cogen assets ranked as low priorities because most of the assets were found to be in good working condition. However, some safety and performance concerns have been identified at the two cogen facilities.

The SWRP operates two cogeneration facilities: the North and South Cogeneration Facilities. The North Cogeneration Building houses Generator Nos. 1 and 2; both of which are 2.2 megawatt units. The South Cogeneration Building houses Generator Nos. 3 and 4, which are both 1.1 megawatt units. All four generators can operate using biogas or natural gas. Generally, Generator Nos. 1 and 2 operate using natural gas purchased from New Mexico Gas Company and Generator Nos. 3 and 4 operate using biogas from the on-site Anaerobic Digesters.

Heat created by the engine generators is captured and used for heating the Primary Anaerobic Digesters and certain other buildings at the SWRP.

10.2 COGENERATION FACILITY IMPROVEMENTS (2010 – 2015)

The original capacity and condition assessment performed on the cogen facilities did not reveal major improvement project requirements. Most of the projects completed in the last five years have been maintenance type projects to keep the facilities in good working order.

10.2.1 In-House Projects

Below is a list of some of the rehabilitation projects completed at the Cogeneration Facilities during the past five years.

- Engine No. 2 - 30,000-hour Major Overall
- Engine No. 4 - 30,000-hour Major Overall
- Engine No. 4 Upgraded Engine Controls and Ignition System
- Engineer No. 3 Major Overhaul
- Engine No. 3 Upgraded Engine Controls and Ignition System
- Generator No. 3 Overhaul, New Bearings, Rotating Rectifier
- Engine No. 1 - 30,000-hour Major Overhaul
- Engine No. 2 - 15,000-hour Top End Overhaul
- Engine No. 4 - 15,000-hour Top End Overhaul
- Engine No. 3 - 15,000-hour Top End Overhaul
- Engine No. 1 - 15,000-hour Top End Overhaul
- Generator No. 4 Overhaul

- Engine No. 4 - 30,000-hour Major Overall
- Engine No. 2 - 30,000-hour Major Overall

Doing this and other renewal work with Water Authority staff members saves considerable revenue for the utility. It also allows good quality control to be maintained.

10.2.2 South Cogen Building Fire Damage Repair Project (CIP Project 7891.17)

This project consists of constructing repairs to the fire damaged roof of the South Cogeneration Building. The work includes replacement of miscellaneous lighting and mechanical equipment and installation of a new Fire Alarm Control System (FACS).

10.2.3 South Cogen Building Roof Rehab (CIP Project 1025.00803)

This project completed the roof renewal for the remainder of the building not replaced as part of CIP Project 7891.17.

10.2.4 North Cogen Building Roof Repairs (CIP Project 1025.00201)

This project made repairs to the stop leaks in the roof at the North Cogen Building

10.2.5 South Cogen Water Line Rehab Design (CIP Project 5599.09)

This project produced construction documents for leak repairs to water lines at the South Cogen Facility.

10.2.6 South Cogen High Pressure Gas Line Repair (CIP Project 7893.8703)

This project replaced leaking gas lines.

10.3 COGENERATION FACILITY CAPACITY

As mentioned above, there are two Cogeneration Facilities at the SWRP. The cogeneration equipment and support systems, like switchgear, are housed in a building.

10.3.1 South Cogeneration Facility Capacity

The South Cogeneration Facility is the older facility and has two 480V 1.1MW generators. The two 480V 1.1MW generators are connected via synchronizing circuit breakers to switchgear. In addition to station-power MCCs, the cogeneration switchgear provides alternate 480V power feeders for the south blower building, activated pump station, and DAF Facility. The main Feeder Isolation Switch (FIS) that connects the treatment plant to the electric utility can be remotely operated from this location.

10.3.2 North Cogeneration Facility Capacity

The North Cogeneration Facility has two 4160V 2.2MW generators. The two 4160V 2.2MW generators are connected via transformer and 12.47kV synchronizing circuit breakers to medium-voltage switchgear G12SS. The MCCs are connected to automatic-transfer switches to facilitate black-starting activities. A small portable generator can be connected as an emergency black-start power source. The main Feeder Isolation Switch (FIS) that connects the treatment plant to the electric utility can be remotely operated from this location.

10.4 COGEN FACILITY RISK ASSESSMENT

The cogeneration facilities were generally found to be in good condition. The equipment in the South is older than the North, and many are approaching their useful life. The overall risk scores for the Cogeneration Facility assets were relatively low and these assets are considered low priority for replacement. Because the overall risk scores are low, the proposed projects are generally not time-critical, with the exception of those related to the gas sphere, gas holder and South Cogeneration power systems.

10.4.1 Gas Sphere

The condition of the gas sphere and related piping is unknown. Without inspection and a condition assessment, there is a potential for uncontrolled digester gas leaks that could violate the SWRP's air permit and may create a safety issue. Odors would also be generated from a leak. The sphere has never been evaluated and its condition (including piping) is unknown. A condition assessment would provide the information necessary to gauge the necessity and extent of rehabilitation to provide for continued service. Additionally, there is no real redundancy and loss would require throttling of cogeneration operations during periods of low LSG availability.

10.4.2 HVAC

A cooling system is needed for the North Cogeneration Building engine area because the conditions are hot and uncomfortable for the SWRP staff. The air conditioning system in the MCC room is unreliable and could potentially cause the electrical equipment to fail. The South Cogeneration Building HVAC equipment is nearing it useful life and will need replacement. Also, additional exhaust fans would help improve the air circulation in the South Cogeneration Building.

10.4.3 Gas Holders

The condition of the gas holders and related piping is unknown. Operators report at least one gas holder cannot be used over the full range of travel due to wedging of the steel top. Without inspection and a condition assessment, there is a potential for uncontrolled digester gas leaks could violate the SWRP's air permit and may create a safety issue. Odors would also be generated from a leak. A condition assessment would provide the information necessary to gauge the necessity and extent of rehabilitation to provide for continued service.

10.4.4 Cogeneration Digester Gas Quality Improvements

Excessive moisture in compressed digester gas is affecting combustion, contributes to corrosion, and can increase siloxane deposits in the engines which substantially increases maintenance requirements.

10.4.5 Fuel Gas Metering Improvements

Gas flow meters are not correctly located and there are not enough of them to accurately measure compressed digester gas and natural gas (NG) usage.

10.4.6 North & South Cogeneration Building Sound Attenuation Improvements

The co-generators create a significant amount of noise (well above standards requiring hearing protection for worker exposure) within the generator rooms. While a hazard for those working within the building, the noise is so loud that it also travels beyond the building and beyond the fence line of the plant. It was reported that that the noise from the Cogeneration Building disturbs the neighbors off the plant site.

10.4.7 Electrical Equipment

Electrical systems within the digester gallery areas are only partially constructed with explosion-proof methods. An analysis of NFPA is needed to determine which areas of this facility require explosion-proof construction methods. Areas that are non-compliant present a risk of explosion and should be addressed.

10.4.7.1 North Cogeneration

The equipment is in good condition; however, the room is congested.

10.4.7.2 South Cogeneration

The electrical systems are old, but in fair condition. Due to age, the equipment is nearing the end of its useful life. The following specific problems were noted:

- Arrangement of the switchgear prohibits access to switchgear terminations.
- Manual synchronization of generators requires personnel to stand in front of 1200A switchgear. This creates an arc-flash risk.

10.4.8 Instrumentation and Controls

10.4.8.1 North Cogeneration

- The FIS dead-bus close (used to restore utility power when cogeneration is offline) does not work properly from this location. According to personnel, the automatic synchronization function of the FIS works properly, but manual synchronization does not.
- The units often fail to remain online when the FIS trips or is opened by the load-shed program. This complicated issue is discussed in more detail in Chapter 11.

10.4.8.2 South Cogeneration

- The FIS automatic synchronization does not work properly from this location. According to personnel, the dead-bus and manual synchronization functions of the FIS works properly.
- The units often fail to remain online when the FIS trips or is opened by the load-shed program. This complicated issue is discussed in more detail in Chapter 11.
- Automatic synchronization of generators is not possible.
- Failure of the controls UPS has resulted in difficulty keeping the FIS closed, causing substantial process disruption.

10.5 REQUIRED IMPROVEMENTS

The principal reason for the prioritization of the gas sphere and gas holder projects is that the condition of these systems is unknown and that there are safety, permit and odor concerns than cannot be quantified without additional study. The proposed South Cogeneration power equipment project will help address both a safety hazard and potential for loss of digester heating capacity

The remaining proposed projects are a mixture of relatively minor, inexpensive repair or replacement projects and more significant large-capital projects. The minor projects may be considered for either capital or operation and maintenance budgeting and may be reasonable add-ons to larger projects. The large-capital projects should be subjected to further study and assessment for alignment with WUA goals. Of particular note is the gas cleaning project which could both improve the efficiency and operations of the cogeneration equipment. Depending on the technology and configuration of equipment ultimately selected, this could also provide the Water Authority with a source of pipeline-quality natural gas that could be used for future building heating or vehicle fuel.

10.5.1 General Facilities and Equipment

The gas spheres and gas holders structures should be investigated and rehabilitated provided as may be indicated by the investigation. More specific information is provided below.

10.5.1.1 Gas Sphere

The proposed project involves the investigation of materials of construction, inspection of the gas sphere system, estimation of future requirements and preparation of a basis of design which will detail what repairs are required and what requires replacement.

Because of the need for adequate process heating capacity (normally from cogeneration), it is suggested that this work be undertaken when enough firm LSG- or NG-fired boiler capacity is available.

As part of the proposed project, we have assumed that the recommended inspection of this vessel will find them to be in need of structural rehabilitation and as such have included as a project blasting and recoating of the interior and exterior portions of the gas spheres. Piping associated with the gas systems that is buried, presumed to be steel, is also presumed to be in questionable condition, and as such, its replacement with HDPE pipe is included in the project list. Additional minor piping sections are also included in the projects such that exposed gas piping in poor condition will be replaced with 316L SST.

10.5.1.2 Gas Holders

The proposed project involves the investigation of materials of construction, inspection of the gas holder system, estimation of current and future requirements and then preparation of a basis of design which will detail what repairs are required and what requires replacement.
Because there are two vessels it is suggested that the inspection and construction be performed sequentially.

As part of the proposed project, we have assumed that the recommended inspection of these vessels will find them to be in need of structural rehabilitation and as such have included as a project blasting and coating of the interior and the exterior of the steel gas holders. Piping that is buried will be replaced with HDPE and exposed will be 316L SST. Also included in this estimate is concrete repair and recoating of the interior of the gas holders.

10.5.1.3 HVAC

HVAC-related projects may be done to improve cooling and air movement within the Cogeneration facilities.

10.5.1.4 Cogeneration Digester Gas Quality Improvements

This proposed project will initially evaluate the digester gas system and in basis of design, summarize the recommended design and construction which should take place to rehabilitate this system. Digester gas treatment systems to remove moisture and contaminants vary in complexity and cost. Depending on the technology and configuration of equipment ultimately selected, gas treatment systems can provide substantial improvements up to, and including,

making pipeline-quality gas suitable for use in NG-fired vehicles and equipment. The conceptual design adds (3) digester gas scrubbers/dryers to the existing system.

10.5.1.5 Fuel Gas Metering Improvements

This proposed project will initially evaluate the existing gas piping systems, estimate future requirements and in basis of design, summarize the recommended design and construction which should take place to rehabilitate this system. It has been assumed that the existing meter will be replaced and thermal mass flow meters provided for the LSG systems and turbine type flow meters provided for the NG systems.

10.5.1.6 North & South Cogeneration Building Sound Attenuation Improvements

The proposed project will evaluate the existing facilities, perform basis of design, detailed design and construction of new sound attention systems at both the North and South Cogeneration Buildings. Interior modifications will center around the application of attenuation panels. Exterior modifications can include, redirected stacks, stack shielding, berms and landscaping.

10.5.1.7 Replace South Cogeneration Equipment

The existing south cogeneration equipment are approximately 30 years old, lack the capacity the plant staff requests, and do not function efficiently. The proposed project will initially evaluate the existing generators and supporting systems, then a basis of design, design and construction of the recommended improvements will take place. The conceptual plan at this time is to remove the two (2) 1.1 MW generators and replace with two (2) 1.5 MW generators.

10.5.1.8 Power Improvements

Evaluation of cogeneration power performance will take place under the Plant-Wide Electrical Systems study. This proposed project will design and construct the rehabilitation measures consistent with the plant wide plan. Alternatives for load shedding and synchronization will be explored in addition to physical and electrical improvements.

Section 11

Electrical Distribution System

11.1 INTRODUCTION AND SYSTEMS OVERVIEW

This section describes the results from the asset risk assessment for the major assets associated with the electrical distribution system. In terms of risk, this system ranks high among the SWRP facilities due to system failures that are integral to all process systems and their performance. Reliability and redundancy of power to key facilities has been an ongoing problem. Outages sometimes last unacceptably long times which have resulted in effluent violations. The existing system is very complex, difficult to operate and is reported to have several safety issues for O&M staff.

Upgrades of individual process areas will be done within the area projects, guided by the results of a plant-wide power system study. Also, alternatives for providing reliable power to critical systems will be evaluated.

The SWRP electrical distribution system is fed from the Sewer Plant Substation which is one of two 12.47 kV utility sources, of which one source has an alternate power source from the Westmeco substation as redundancy from PNM's power system. There is another feed from the Sewer Plant Substation off the South Valley feeder system that powers the Water Quality Laboratory with an alternate feeder from the Plant power loop system as backup. A third utility service from PNM's Anderson Substation is no longer in use. This feeder was to be used for the Reuse facility but PNM refused to reuse the feeder due to contractual issues. Currently the feeder is not available to the Plant.

There are two 12,470 volt primary distribution loops and various branch and single feeders and sub-loops serving the Plant with 12.47 kV switches at each process area to allow power to be used from the available feeders. The arrangement of the underground feeders is quite complicated, and includes some radial-feed, primary-selective, and some loop-fed facilities.

Two cogeneration facilities with two generators each feed the underground distribution system. The cogeneration systems carry all the Plant loads with the utility tie acting as backup to the SWRP power system for emergencies and when Cogeneration is down for maintenance. Cogeneration makes use of site produced fuel which reduces the SWRP's utility energy requirements, and at times provide power back to the utility grid.

11.2 ELECTRICAL SYSTEM IMPROVEMENTS (2010 – 2015)

Since May of 2010, a number of electrical improvement projects have been identified and are either in design, construction, or have been completed. In March of 2012 Eaton completed an Arc Flash and Coordination study of the SWRP electrical system and identified underrated equipment from a Short Circuit analysis, uncoordinated settings in breakers from the Protective Device Coordination analysis, and provided recommendations for mitigating Arc Flash hazards. In July of 2014 AECOM provided a draft Electrical System Evaluation technical memorandum for the SWRP. Since these reports, the Water Authority has contracted with Carollo Engineers to design the replacement of underrated Power Panels, MCC, and Switchgear. Those designs are

anticipated to be complete in Fall 2016. All Arc Flash labeling for hazard mitigation has been completed by SWRP staff.

During 2015, scheduled preventative maintenance activities have been completed on critical equipment at the SWRP including the following: Switchboard 22, 12GSS Switchgear, GC Switch Station, 5th Avenue Switch Station, Primary Switch Station, GSS Switch Station, N. Blower Pad Mounted Switches, Switchboard 22, and Switchboard 14.

Portable power generators have been purchased and installed to provide standby power to Primary Pump House 1 & 2, and the Activated Sludge Pumping Building. Standby power to the new PTF and the South Blower Building is currently being procured.

The Water Authority is currently working with Carollo Engineering to perform an electrical system review of the SWRP and develop the SWRP Electrical System Master Plan. This task is to review the Eaton and AECOM reports as well as the record drawings of the electrical systems, produce a preliminary list of improvements, identify design packages for construction, review the existing lightning protection system and develop a phased master plan for the recommended improvements.

11.3 ELECTRICAL SYSTEM CAPACITY

While no issues have been identified with the load-carrying capabilities of the electrical distribution system, an analysis of the loading of system components is necessary to plan for future additions and modifications. Evaluation of the electrical system capacity is not included in this report. There are, however, several important topics which should be discussed for future considerations.

11.3.1 Fault Analysis

The first Plant wide Fault Analysis was conducted with the final report issued March 2012 by Eaton to be pro-active to meet the State Code requirements to identify and mark all electrical equipment with the caloric ratings so that the proper personal protective equipment can be identified and used to protect personnel working on the equipment.

A fault occurs when an electrical power component experiences a short circuit, either phase-to-phase or phase-to-ground. A fault can result in the release of a significant amount of energy, (measured in Calories) causing equipment damage, and/or personnel injury or death.

Each electrical equipment item is rated to withstand or interrupt a certain amperage during a fault event. If the rating of the equipment is lower than the available energy, catastrophic failure could be caused by a fault.

System Fault Analysis includes developing a computer model to calculate the amount of energy that would be released by a fault at all major electrical equipment. The calculations are then compared to equipment ratings, and any deficient equipment is identified for mitigation.

Due to the age and condition of some the electrical equipment at the treatment plant, some equipment is likely to be under-rated and at significant risk of catastrophic failure. As part of the study, recommendations were made regarding deficiencies noted in the model.

11.3.2 System Coordination

The Eaton study also performed a System Coordination Evaluation as developed in the Model that indicated where modifications were needed with relay trip settings and fuse coordination.

Electrical circuit breakers and fuses are provided with time-delay features to allow selective tripping to isolate a fault. A properly coordinated system results in localized tripping of failed circuits. This is possible because larger circuit breakers or fuses (higher up in the system) have longer time delays, allowing smaller units closer to the fault to isolate the problem. If not properly coordinated, a relatively minor fault can result in widespread outages. This can cause substantial process disruption and can cause troubleshooting to be more difficult.

Plant personnel has indicated that at least one coordination failure resulted in significant disruption: When a blower motor failed, the blower starter, MCC main, and MCC feeder fuse all failed to isolate the problem. Instead, a primary 12,470 volt fuse at the Generator Selective Switch (GSS) isolated the problem. If properly coordinated, the blower starter would have isolated the problem without causing an outage on other blowers on the MCC.

11.3.3 Arc Flash Hazard Analysis

An Arc-Flash produced by an electrical fault presents a significant personnel hazard. Proper personal protective equipment (PPE) must be used during certain maintenance activities such as switching or troubleshooting of live circuits. An Arc-Flash analysis estimates the potential hazard and makes PPE recommendations for certain activities based on the available energy (measured in Calories).

11.4 ELECTRICAL SYSTEM RISK ASSESSMENT

The electrical distribution system assets were estimated on a number of factors to determine overall risk based on the probability of failure, consequence of failure, and redundancy. The probability of failure for an asset is determined by its age, condition, and history. The total risk takes into account the probability of failure and consequence of failure rankings and that score is then modified based on redundancy.

11.4.1 System Management and Capacity

Much of the Primary power distribution system consists of manually-operated and interlocked switches that can be used to isolate portions of the system for maintenance or to isolate faulted cables. There is some automation related to load-shedding and cogeneration. Operation of these automated systems is based on two capacity limitations as described below. Although these are not physical assets, they play a major role in the overall reliability of the electrical distribution system, and how it is managed.

11.4.2 Utility Capacity

The typical Plant electrical loads run between 3,000 kW and 5,000 kW between the low and high diurnal flows respectively into the Plant at the average maximum of 55 MGD. The Cogeneration carries the majority of the Plant loads with some import or export depending upon buyback rates. The limitation to import is currently 5 MW at which time the control system isolates the Plant from PNM to avoid penalty.

11.4.3 Electrical System Controls

The electrical distribution system is monitored and controlled to prevent damage to the Cogeneration system if the UT breaker to PNM opens while importing power by shedding load in the Plant. Other controls provide emergency power to critical loads when the power system is compromised.

11.4.3.1 Energy Automation Features

The control system for the SWRP manages all the process areas including the Cogeneration system, the digestion system, and process operations of the Plant to maintain consistent processing to meet stringent discharge permit requirements.

When the Cogeneration system is not to full capacity due to maintenance activities, the control system is designed to limit the maximum import to less than the current contract limit of 5 MW. This control feature helps regulate the electric utility costs by shedding loads when the import exceeds 4.75 MW and, when conditions prevail, will open the UT breaker at 5 MW import to prevent penalties by PNM. While isolated from the utility, the cogeneration system provides power to the critical loads (primary treatment facility, influent pumps, and Lift Station 11, and others). The cogeneration facility reliability has improved such that when PNM isolates the feed into the Plant for upsets in their system the Cogeneration stays on line maintaining operations at the Plant. Many of the major plant outages were related to power failures typically associated with lightning strikes during weather events or utility issues that impact the Plant. Typical examples cited by personnel include:

- Power failures result in clogging of barscreens and overflow onto the street. Barscreens often fail to recover or break after the power outage due to inability to remove the accumulation of material.
- Grit systems become clogged during and after power outages.
- Power failures or load-shedding result in dewatering centrifuges stopping without being properly cleaned. This requires significant personnel activity to clean the centrifuge and return the unit to service.

11.4.3.1.1 Load Shed System

The load-shed system is managed by the SWRP control system to regulate the power demand when Cogeneration is operating at less than maximum capacity. The loads included in the load-

shedding program are Blowers, Activated Pump Station, DAF, Aeration Mixers, and Dewatering. The load shedding program responds to import power and sheds loads at 4.75 MW and trips the utility breaker (UT at FIS) at 5 MW.

Portions of the load-shed system may be disabled in the control system. The load-shed control program will need to be thoroughly reviewed by SWRP staff to verify that the correct process areas are being shed while critical processes are being sustained during an event. In certain situations when SWRP electrical demands are large and nonessential loads are not dropped fast enough, the cogeneration system may fail to remain on-line due to overload.

11.4.3.1.2 Cogeneration Systems Interconnection

The cogeneration generators consist of two north (2,200kW) and two south (1,100kW) engine/generator sets. The generator capacity is capable of carrying the whole SWRP using the Utility as the backup power source by maintaining a small import or export so as to minimize the impact of transition if the UT breaker opens. The connection to the Utility provides regulation for frequency and acts as the backup power source. While the existing total power production capacity is capable of sustaining the SWRP, there are times during planned maintenance of the generators when carrying the entire SWRP load will not be possible. During these times, if the SWRP were to disconnect from the utility, the load shedding program should engage. However, if the loads are still above what the system can handle, the cogeneration protection systems should take over and trip the generator breakers taking the power system off line.

11.4.3.2 Specific Electrical Equipment

11.4.3.2.1 Field Isolation Switchgear (FIS)

There are two redundant FIS facilities currently in operation at the SWRP. The recently installed switchgear now gives the SWRP the ability to perform routine maintenance on the older switchgear. The FIS facilities are located on the west side of the property and each contains the main utility circuit breaker (UT), which is protected by relays that monitor both the Plant and Utility power. The UT can be opened by the plant to protect against upsets in the power system from both PNM and/or the SWRP. The SWRP breaker controls allow the UT breaker to be reclosed from either of the cogeneration facilities on the east side of the property or reclosed locally. Manual and automatic reclosing controls are provided at both the North and South cogeneration facilities. The power system utilizes an auto-synchronization function to enable a parallel connection from the SWRP to the Utility. The implementation of new relay protection technology has improved the reliability and protection to the power system and works with the Auto-synchronization function to provide the necessary permissive signals that allow connection with the Utility.

11.4.3.2.2 Primary Power and Loop Feeder Interconnections

The ultimate goal of the distribution system is to deliver reliable power to the loads. There are several basic approaches to distribution system design. Each approach provides a higher degree of reliability while also increasing system cost.

Table 11-1 presents the reliability for different power system configurations. In each of the systems in the table, the most common source of failures is loss of utility power. In all but the Simple Radial configuration, frequency and/or duration of failures is reduced through the addition of a second electric utility power source. The least disruptive power systems provide for a second utility source and automatic transfer capabilities. The automatic transfer approach dramatically improves system availability.

Table 11-1

Reliability and Availability of Different Power Distribution Systems

Distribution Type	Failures Per Year	Forced Down-time (hr/yr)	Explanation
Simple Radial	1.9896	4.3033	This is a basic system with no redundancy features.
Primary Selective with 1 hour recovery (manual)	1.9896	2.9424	This is a system with two independent utility sources to the primary of the transformer.
Primary Selective with 5s recovery (auto)[1]	.3456	1.8835	This is the same as the above Primary Selective system, but with automatic transfer controls.
Secondary Selective with 1 hour recovery (manual)	1.9822	1.3735	This is a system with two independent utility sources the 480V switchgear level, using a tie breaker.
Secondary selective with 5s recovery (auto)	0.3175	0.2210	This is the same as the above Secondary Selective system, but with automatic transfer controls.

Notes:
1. Power Loss for less than 5 seconds at 480V is not considered a power loss.

The treatment plant distribution system one-line diagram is very-complex and includes a mix of equipment configured in Primary Selective, Secondary Selective, Primary Loop, and other

arrangements. A second utility supply is not available, but onsite cogeneration could mitigate the effects of utility supply loss if it was reliable. The following are some issues that were identified:

- There are parts of the system that have Primary Selective components, but lack the second power source or automatic transfer schemes needed to increase the reliability.
- All switching operations are manual, leading to significant time delays for recovery from failure.
- The system is overly complex, leading to confusion in finding and mitigating failures. The combination of loop-fed and primary selective features adds to the confusion without necessarily increasing reliability.
- The second utility source (Anderson) has been removed from service, increasing reliance on the single utility feeder.
- Some critical loads (Primary Treatment, Lift Station 11), are fed from a Primary Loop that is downstream of a Primary Selective system. There could be up to 15 devices and cables between these loads and the utility supply, increasing the probability of failures.
- For the blower systems, Primary Selective switches 89-7 and 89-24 tie both supply sources to a common bus, creating a single point of failure in what would otherwise be a Secondary Selective system.

11.4.3.2.3 Outdoor Standup Metal-Enclosed Switchgear

There are eight Outdoor Metal-Enclosed Switchgear standup switching stations. They range from several years to 23 years old. Each station feeds a major geographic area of the plant. The equipment has recently been serviced and tested, and some repairs were required. This equipment has some redundancy features built-in that allow for inspection or maintenance, but the procedure still requires some minor outages.

- **89-G –** The Generator Switching Station (GSS) is the main tie in point for the south cogeneration facility to feed power to the plant power grid. In addition, this station supplies power to the south plant loads such as the South Blowers, Activated Sludge Pump Station, and DAF.
- **89-12GSS –** The Generators 1 & 2 Switching Station (12GSS) is the main tie in point for the north cogeneration facility to feed power to the plant power grid.
- **89-5 –** The 5th Avenue Switching Station supplies power to northeast loads such as the Dewatering and Chlorine Buildings.
- **89-P –** The Primary Switching Station (PSS) provides power to northwest plant loads such as Primary Treatment, Lift Station 11, and Clarifiers 1-4. Several of these are critical plant loads and are fed from PSS via a Primary Selective Loop. Even though this is one of the most critical areas of the plant, it has one of the least reliable distribution arrangements due to the loop being sub-fed from the Primary Selective system.

- **89-29 –** This station provides power to the new Reuse facility which includes the filter building and the transfer pump station.
- **89-GC –** The Compression switching station which supplies power to the gas compression system.
- **FIS A –** The new interconnection point between the Plant and the Utility.
- **FIS –** The existing interconnection point between the Plant and the Utility.

11.4.3.2.4 Outdoor Pad-Mount Switches

There are sixteen (16) outdoor pad-mount switches that are used as interconnection points and loop intersections at each process area with the attendant power transformers. The switches range from 2 to 25 years old. In all cases, the switches are part of a Primary Selective or Primary Loop arrangement designed to provide some flexibility in recovering from underground cable faults or working with Outdoor Metal-Enclosed Switchgear outages. Switch 89-14 is a Primary Selective with sub-fed continuation of Feeder #3, and switch 89-10 provides an alternate connection to the North Cogeneration system.

The equipment has been recently serviced and tested and a maintenance program is being set up to provide maintenance service on the equipment on a scheduled basis. Several of these switches suffered failure from fault conditions of other equipment and one had a lightning arrestor fail. This equipment has no redundancy features allowing for inspection or maintenance without de-energizing the loads.

11.4.3.2.5 Underground Cable Systems

Some underground cables were replaced in a recent upgrade. Other cables are of varying age, and possibly reaching the end of their useful life. The arrangement of most of the distribution switches allows for isolation of most cables. Tee body cable connectors that exist in several of the manholes also allow sectionalizing for cable repairs and replacement.

One of the existing problems with the current cable system is that several electrical loops reside in the same duct bank and manhole system routed around the SWRP. This creates a challenge for maintaining the electrical cable system because in order to perform PM related activities, electrical isolation for safety is required. This results in multiple loop shutdowns while sustaining power to critical process areas.

11.4.3.2.6 Facility Electrical Equipment or Motor Control Centers (MCC)

Electrical control equipment or MCC's are located at each process area throughout the SWRP. For the most part, equipment dedicated to a particular process or building is discussed under the section for that process. It is important to note that there is one facility (UV) which has a permanent mounted emergency generator installed. Several new portable generators sized for some of the larger process areas are now available as emergency support power sources to maintain operations at critical load centers. In some cases, provisions for a portable generator exist. Personnel indicate that plant-wide power outages are typically resolved by either repairing

the electric utility supply, bringing cogeneration up from a black-start, or reconnecting back to the Utility.

11.4.3.2.7 Lightning Protection Systems

The SWRP has three (3) lightning masts connected to ground rods located around the aeration basins. Standup and pad-mounted switchgear also have lightning arrestors. The issues with the existing systems are that the existing lightning protection masts do not provide an adequate zone of protection for all of the structures at the SWRP. The lightning arrestors have failed in the past, and the surge protection equipment is out of date and not functional. The SWRP has a history of sustaining damage to electrical and electronic systems due to lightning or other electrical transient activity. A combination of lightning protection, lightning arrestors, and surge suppression are typically employed to protect against such failures, but the lightning protection system has not proven to work properly or adequately.

The Sodium Hypochlorite Building and the Re-use Facility are protected individually by having the lightning protection system attached directly to the structure. The protection components include the following: Air Terminals, Metal Parts, Ground Rods, and Copper Wire. These components create the needed zone of coverage for the entire structure for lightning protection in accordance with NFPA 780.

The following structures listed contain site specific high risk lightning consequences and a lightning protection system is recommended for each: Activated Sludge Pump Station, Primary Pump Station No. 1, No. 2, and No. 3, South Blower Building, North Blower Building, Lift Station 11A, South Cogen Building, North Cogen Building, PV System Interconnection, PTF Annex, PTF/Grit Building, 1st Stage Grit, Sludge Dewatering Facility, Sludge Hoppers, South Activated MCC Building, Gas Compressor Building, Gas Holder, Gas Sphere, Sludge Blending Tank, Digesters, Administration Building, O&M Complex, Water Quality Lab, Dissolved Air Flotation Building, MCC 2 Building, Yard Electrical Equipment, UV Facility, Filter Effluent Building, FIS Building, Clearwell Pump and Electrical Building.

The following structures do not contain sight specific high risk lightning consequences: Primary Clarifiers, Process Basins, Bio Filter, Final Clarifiers.

11.5 REQUIRED IMPROVEMENTS

11.5.1 Distribution System Short-Circuit, Coordination Load Flow, and Arc Flash Study

A complete study of the existing distribution system is an essential step in developing a full understanding of current issues and hazards at the SWRP. The previous Arc Flash and Coordination study was performed in 2012 and according to recommendations in the National Electric Code (NEC), these types of studies should be performed every 3 to 5 years due to changes resulting from rehabilitation and new construction. A complete arc flash analysis should include all system components operating at voltages above 240VAC to comply with NFPA 70E

study requirements. As new construction is being performed, the current code requirements are now included to require the particular facility to have the study performed and the proper labeling on all electrical equipment.

11.5.2 Evaluate Alternatives for Power Reliability for Critical Processes

EPA design guidelines require that at least two reliable sources power be provided to certain critical processes. A clear determination will be required of which process areas are “critical” or “vital” as defined by EPA as well as facilities that are critical based on the specifics of this plant.

At present, the existing Cogeneration Power System is considered to be the Primary power source with the Utility as the backup source. As a backup to the Utility power source, upgrades were constructed to establish a secondary and back-up source from a separate sub-station to further assure redundancy to the Utility back-up power system. However, as the SWRP is modified and expanded upon, the Primary power system Cogeneration also needs to be re-evaluated for expansion or upgrades to provide necessary capacity to remain the Primary source. Therefore an evaluation of alternative strategies for providing reliable power to critical facilities is recommended. Recommended alternatives include:

- Providing additional on-site generation of power to keep up with the power demands as the Plant expands and upgrades.
- Evaluate and incorporate modifications to the power loop systems such that each loop is in a separate duct bank and manhole system to allow shutdowns of one loop for maintenance without impacting the Plant or the other power loop.
- Break the loops up to allow for maintenance of sections without interference to adjacent process areas by using loop around back feeds to keep the power available.
- Expand the concept of multiple, large standby generators both portable and fixed with the appropriate connection stations and shore power systems to maintain the generators in a ready state and where required automatic transfer switches for specific facilities or co-located facilities as appropriate.
- Evaluate and incorporate alternate back feed schemes to all critical process areas in addition to the emergency generator systems so that options are available to address different failure modes and maintain full operations of the facility.
- Evaluate auto transfer modifications to the pad-mounted switches to speed up recovery when isolating and transferring from one loop to the other and to reduce the manpower needed to perform the switching requirements.

For each alternative, conceptual one-line diagrams, preliminary sizing of major equipment, preliminary plan layouts and Class 4 cost estimates will be developed. A memo summarizing the alternatives and pros and cons to support decision making will be prepared.

Section 12

Plant Control System

12.1 INTRODUCTION AND SYSTEMS OVERVIEW

The plant uses a distributed control system (DCS) currently supported by ABB Inc. This system is referred to as the Bailey, which was the original manufacturer of the system. The ABB/Bailey provides process monitoring, automation, and historical archiving for the treatment plant processes. This system consists of 16 Programmable Control Units (PCUs) distributed throughout the facility and interconnected through a redundant communication network.

At the time the 2010 RAMP Report was completed, the plant was starting the process of upgrading plant control system software and control room hardware. The system software and communication assets ranked as high priorities and the remaining assets ranked as moderate priorities replacement.

Several process areas include vendor-provided Programmable Logic Control (PLC) based controls (i.e. Solids Dewatering) that were installed and partially integrated into the DCS by the installing contractor during facility upgrades. The DCS provides the primary control and operator interface to the process through a fully redundant network of process controllers with individual controllers also being fully redundant. Controllers are placed throughout the facility at each major process area. The system redundancy has recently been expanded to include redundant communications power supplies to most of the network modules, similar to the controller power supplies.

Local to each process area, cabinets are located within the main electrical rooms providing hardwired access to process equipment and motor control centers. These hardwired signals are routed through Input/Output (I/O) cards within the cabinets, which are then accessed by the controllers to provide the functional process control. Data is routed up from the controllers through the network to local workstations and a single control room where operation staff can view the process through graphical screens.

The Authority has moved the control room to a space that was previously used as the facility's main control room, with all new ABB workstations and servers. The new workstations house the new process graphics which provide the operational access to process data and control screens. The servers include a new ABB provided historian server providing long-term data storage which will be accessed by the workstations to allow for longer duration process data trending.

12.2 SYSTEMS IMPROVEMENTS (2010 – 2015)

The 2010 RAMP Report stated that the DCS software systems had reached the end of their useful life and must be upgraded or replaced. Since that time, the Water Authority has implemented the latest version of the ABB/Bailey system software. Control room hardware has also been upgraded to the latest standard.

In working through the DCS upgrades and other SWRP facility improvements, the Water Authority has realized that there is a high level of continued maintenance costs and a need for highly skilled programming staff to maintain the ABB system. Given these issues, the Water Authority is now working on development of a 10-year transition plan to migrate the SWRP to a more commonly used PLC based process control system.

In April 2014, Brown and Caldwell (BC) was commissioned to provide a series of technical memoranda, which included a SWRP Control System Assessment, and also communicated a staff level perspective of the existing control system and areas of concern. The Water Authority also requested BC perform a cost-benefit analysis based on the selected alternative replacement options. This cost-benefit analysis included hardware and software cost comparisons, installation costs, maintenance and training cost comparisons, and staffing considerations. The study also included examining the benefits and drawbacks of both options, in addition to system reliability and scalability for potential future upgrades. The results of the studies confirm the Water Authority's desire to switch from the traditional DCS to a more modern PLC based system. In October 2015, BC was tasked with initializing the development of the transition plan.

12.3 INSTRUMENTATION AND CONROL SYSTEMS CAPACITY

With the recent upgrades both the hardware and software of the ABB/Bailey DCS, the system has the current and future needs of the facility.

12.4 INSTRUMENTATION AND CONROL SYSTEMS RISK ASSESSMENT

With the recent upgrades both the hardware and software of the ABB/Bailey DCS, the system has the current and future needs of the facility.

12.5 PLANNED IMPROVEMENTS

The Water Authority expects to have the complete 10-year DCS to PLC transition plan complete for the SWRP by the end of 2016. As the various SWRP process areas are rehabbed, the existing ABB control system components are anticipated to be converted, where possible, to the new PLC-based system in preparation for the future conversion.

In the short-term, rehab of existing control cabinets, uninterruptible power supplies, and other ancillary equipment will continue on a regular basis to sustain the current process control strategy. This direction should give the Water Authority the time it needs to complete the planning, continue with the planned rehab of process facilities, and process wastewater in compliance with all of the required regulations.

Section 13

Non-Potable Water System

Section 13
Plant Non-Potable Water System

13.1 INTRODUCTION AND SYSTEM OVERVIEW

The SWRP uses non-potable water for wash-down and other uses not requiring potable (i.e., drinking) water. The non-potable system is also the primary source of fire suppression water for the plant. Potable water is limited to drinking, handwashing, showering, and for emergency eyewashes/deluge showers.

At the time the 2010 RAMP Report was completed, the non-potable water system had several deficiencies, primarily involving broken isolation valves in the plant distribution system. Low pressure at certain locations was also a concern.

Since the 2010 RAMP Report, in September of 2012, a new filtration and disinfection facility was started-up at the SWRP. The source water is effluent from the UV Disinfection Facility. It filters and chlorinates the SWRP effluent to produce non-potable water. This water is also used to supply an off-site non-potable distribution system for irrigating parks and other large turf areas. The facility was designed to meet the requirements of the California Title 22 water recycling regulations.

The total project cost of the new filtration and disinfection system was approximately $35-million for construction and another $3.4-million for engineering. Approximately $16.6 million of these costs were associated with the construction of the on-site filtration plant. The remainder of the construction costs are associated with the off-site non-potable water transmission and distribution system.

13.2 NON-POTABLE WATER IMPROVEMENTS (2010 – 2015)

Since completion of the 2010 RAMP Report, the Water Authority has completed all the necessary improvements to provide a well performing, reliable non-potable water system at the SWRP.

13.2.1 SWRP Reuse Filtration Facility

Table 13-1 provides a summary of the design criteria for the new SWRP Reuse Filtration Facility. This system uses cloth media disc filters to produce low turbidity water. Sodium hypochlorite and ammonium sulfate are fed to the filtrate to provide a chloramine residual. Disinfection contact time is provided in a covered clear well. Two sets of high lift pumps are used: one set is used for creating pressurized water for on-site uses at the SWRP; the other set is used to pressurize the water for the off-site non-potable water system.

Table 13-1

Reuse Filtration System Design Capacity

Filtration System:	
Type	Non-woven nylon fiber
Number of filters	6 (5 duty; 1 standby)
Size (diameter)	7 feet
Capacity, Each	3,000 gpm
Total Firm Capacity	15,000 gpm (21.6 mgd)
Design Capacity	8.6 mgd (24 hour production rate)
Disinfection System:	
On-Site Hypochlorite System:	
Generation Capacity	160 lbs of chlorine per day
Storage Capacity	2,300 gal of 0.8% sodium hypochlorite (150 lbs of Cl_2)
Design Dose	2.1 mg/L
Ammonium Sulfate System:	
Delivered Concentration	40% solution
Storage Capacity	11,000 gal
Design Dose	0.5 mg/L as NH_3-N
On-Site High-Lift Pumping System:	
Type	Vertical Turbine
Number of Pumps	3 (2 duty; 1 standby)
Drive Type	Variable Frequency
Design Capacity, Each Pump	1,390 gpm (2.0 mgd)
Firm Capacity	2,780 gpm (4.0 mgd)
Target Discharge Pressure	90 psig

13.2.2 Distribution System Improvements

Since completion of the original RAMP Report, a project was implemented to fix all isolation valves and address all leaks in the on-site non-potable water distribution system. Twenty-seven problematic valves were initially identified. Others were added as the repair work was undertaken. Approximately $396,000 was expended completing this work.

13.2.3 Potable Water System Back-up Connection

To provide redundant capacity for the wash water and fire-fighting water supply provide by the new SWRP Reuse Facility, a connection to the Water Authority's potable water system was re-established. This involve renewing a connection to a 14-inch water main in 2nd Street in front of the SWRP. A 12 inch backflow preventer was renewed as part of this project.

13.3 NON-POTABLE SYSTEM CAPACITY

During 2015, the on-site use of non-potable water ranged from about 0.5 to 1.2 mgd, with an average daily usage of 0.67 mgd. With the recent improvements, there are no longer any flow or pressure capacity issues.

13.4 RISK ASSESSMENT

With the recent improvements, including the backup connection to the potable water system, risk due to failure of the non-potable system has been minimized.

13.5 REQUIRED IMPROVEMENTS

During the initial period of operation, it was difficult to maintain a steady chlorine residual in the non-potable water. A temporary ammonia feed system was installed to supplement the ammonia present in the SWRP effluent. This resolved the issue. The Water Authority has just authorized the construction of a permanent ammonium sulfate facility to replace the temporary system. The estimated project cost for the Ammonium Sulfate Facility is estimated to be approximately $1.3-million, including construction and engineering.

Section 14

SWRP Renewal Plan Update

14.1 INTRODUCTION AND RENWAL PLAN OVERVIEW

During the past five years, since completion of the original RAMP Report, numerous improvements have been made to the Southside Water Reclamation Plant (SWRP). These improvements are described in previous sections of this report. In this section, the plan of renewal improvements to be completed during the next five years and beyond are described.

Table 14-1 attached at the end of this section summarizes the different SWRP facility improvements and the associated fiscal year budgets. The fiscal years start on July 1st and end on June 30th. For instance, Fiscal Year (FY) 2016 started on July 1, 2015 and ends on June 30, 2016. The Water Authority is currently committing additional funding for completing the SWRP renewal program recognizing the priority to make improvements at the SWRP. As the decade proceeds and the different renewal projects are implemented, the level of spending will taper off but will still be significant. As previously described, the Water Authority has so far spent approximately $90-million on renewing the SWRP. As shown in Table 14-1, during the next decade, an additional $218-million is anticipated to be spent on improvements at the SWRP.

14.2 UPCOMING SWRP RENEWAL PROJECTS

Previous sections of this report described improvements that have been completed as well as remaining required renewal needs for the different SWRP process areas. The following subsections provide a description of the current planned approach for addressing these remaining needs.

14.2.1 Preliminary Treatment Facility including Lift Station 11A

14.2.1.1 Lift Station 11A

As described in Section 3, soon after starting up Lift Station 11A, the pumps failed. An evaluation of the damage to the pumps indicated that a combination of grit and rags resulted in very rapid seal wear. Ultimately, the seals failed allowing water to enter and short out the submersible motors.

The Water Authority is working with the pump manufacturer to retrofit the pumps with a different style of impeller that will be less affected by high levels of rags. The impellers and other wetted components will also be coated with a grit resistant coating. Once the retrofitted pumps are reinstalled, the Water Authority will assess if additional improvements to this facility are warranted.

In anticipation of additional required improvements at Lift Station 11A, the Water Authority is working with one of its consultants to evaluate alternatives for providing screens ahead of the pumps. The screens would be used to remove rags ahead of the pumps. Also, the screens would be sized to remove rocks and other heavy debris that could damage the pumps.

14.2.1.2 Washer-Compactor By-Pass Pipe

The new Preliminary Treatment Facility (PTF) uses two washer-compactors to dewater screenings collected on the bar screens. Normally, one washer-compactor can handle the screenings; while, the second unit serves as a standby. However, during initial operation of the facility, these units became clogged due to higher than anticipated loadings. This problem has largely been resolved through modifications to the operations of the screens. However, the Water Authority wanted to have a way to by-pass the washer-compactors incase the problem re-occurred. It has constructed a by-pass pipe that diverts the screenings directly to the roll-off bin where the screenings can drain by gravity before hauling them off-site for disposal.

14.2.2 Primary Clarifiers

14.2.2.1 Primary Clarifiers 1 through 4 Renewal

The Water Authority has authorized one of its design consultants to develop construction documents for replacing the mechanical scraper mechanisms in Primary Clarifiers 1 through 4. Structural improvements such as fixing spalls and re-grouting the clarifier bottoms will be included in the projects. Effluent launders and associated odor control systems will also be renewed. Once completed, this project should restore these four clarifiers to a like new state.

14.2.2.2 Influent Pinch Valve Replacement Ahead of Primary Clarifiers 1 through 4

The Water Authority is currently working with one if its consultants to replace an undersized pinch valve with a plug valve. The valve is used to control the flow to Primary Clarifiers 1 through 4. Once construction is completed, this will allow better flow distribution between the two banks of primary clarifiers. It will also facilitate taking individual clarifiers out of service for maintenance, while maintaining appropriate hydraulic loading rates on the on-line units.

14.2.2.3 Primary Pumping Station 3 By-Pass Structure Renewal

The existing By-Pass Structure adjacent to Primary Clarifier No. 8 is heavily corroded and the by-pass gate is frozen closed. This gate is used to divert primary clarified water from Primary Clarifiers 5 through 8 to Primary Pumping Houses 1 and 2. This is useful when maintenance work is required at Primary Pumping House 3, which is the normal pumping station for Clarifiers 5 through 8. An engineering consultant is currently designing the rehabilitation of the existing structure including the by-pass gate. Once the construction documents are available, the Water Authority will solicit offers from its On-Call Contractors to complete the construction of the improvements

14.2.3 Modified Ludzak-Ettinger Process Improvements

14.2.3.1 Air Piping Improvements at Process Basins

As described in Section 5 of this report, the Water Authority has almost completed the renewal of all the air diffusers in the 14 process basins at the SWRP. The last two basins are currently being renewed. This renewal program has significantly improved oxygen transfer and process performance. Also, fewer blowers are now required to meet the oxygen requirements.

However, the Water Authority wants to improve the reliability of the air control valves associated with the diffuser air piping. Currently, the control valves for most of the basins reside in the mixed liquor. This results in corrosion and makes it difficult to perform maintenance work on these valves. The Water Authority has already developed construction documents to allow the valves to be lifted up to the basin deck level. It has already made these improvements to South Process Basins 7 and 8. It plans to make these modifications the other process basins at the SWRP.

14.2.3.2 On-Line Biological Nutrient Removal Monitoring Systems

The Water Authority recently deployed on-line ammonia, nitrate, oxygen, and oxidation reduction potential (ORP) monitoring systems at several locations in the Process Basins. Initial findings indicate that these systems are providing useful information to the Plant Operators for controlling the processes. If these system prove to be reliable, then additional basins will be fitted with them.

14.2.3.3 High Efficiency Blowers

The Water Authority plans to become more energy self-sufficient at the SWRP. One approach is to reduce the plant's electrical energy demand by implementing higher efficiency blowers. The plant currently has 12 multi-stage centrifugal blowers fitted with 450-hp motors. A recent study performed for the Water Authority indicates that the four existing blowers in the North Blower Building could be replaced with a sufficient number of high-efficiency blowers to meet all of the air needs of the Process Basins. This would essentially allow the eight blowers in the South Blower Building to be used as standby units. The Water Authority will further evaluate the conversion to high efficiency blowers in the coming years.

14.2.3.4 Secondary/Final Clarifier Gates

The Water Authority has recently authorized the construction of new gates and stop logs for the 12 Secondary/Final Clarifiers. This project will allow individual clarifiers to be taken off-line for maintenance, while maintaining appropriate hydraulic loading rates for the on-line units. This will help avoid any hydraulic upsets that could result it solids carryover to the plant effluent.

14.2.4 Ultra-Violet Disinfection Facility

The Water Authority is currently working with one of its engineering consultants to design a screening system to capture debris ahead of ultra-violet (UV) disinfection. This system will likely have screen openings with an effective size in the range of 1 to 2 millimeters (mm).

14.2.5 Secondary Sludge Thickening

Waste activated sludge (WAS) is currently thickened at the Dissolved Air Floatation (DAF) Facility at the SWRP. A set of condition assessments of the DAF Facility have determined numerous improvements that need to be implemented. Many of these improvements include bringing electrical and ventilation systems up to current code requirements. The Water Authority has conducted a set of pilot studies to evaluate if implementing a new thickening technology would be beneficial. The Water Authority is working with one of its engineering consultants to evaluate the best alternative including the alternative of continuing to use the existing DAF process.

14.2.6 Anaerobic Digesters

14.2.6.1 Near-Term Improvements

The plan for near-term improvements is to continue to address the different deficiencies with the existing digester complex.

Continue to Address Deficiencies in Existing Digesters

These largely focus on renewing the mechanical, electrical, and instrumentation systems. In addition, structural deficiencies such as cracks and spalling concrete have been and continue to be addressed.

Evaluate Alternative Mixing Technologies

The Water Authority is currently installing linear mixers in Primary Digester No. 13 to evaluate the potential operation and maintenance cost savings with this type of mixer. Also, the impacts on biogas production will be evaluated. Based on the findings of this evaluation, this type of mixer may be installed on all the primary digesters. Pumped mixing provides an alternative new mixing technology that has been evaluated will be considered as an alternative approach.

Additional Digested Liquid Sludge Storage Capacity

As part of the renewal of the Solids Dewatering Facility (SDF), the Water Authority is adding more than 2 million gallons (mil gal) of digested liquid sludge storage. Adding additional storage capacity will alleviate plant disruptions due to outages of the SDF (i.e., inability to waste primary and secondary sludge from the clarifiers.) The other benefit of this additional storage capacity, is the opportunity to convert secondary digesters into primary digesters.

14.2.6.2 Intermediate-Term Improvements

The Water Authority needs to increase the treatment capacity of the primary digesters. This is to provide an additional capacity margin for treating current flows. However, it is also to provide sufficient primary digester capacity to allow digesters to be taken out of service for extended periods of time to allow structural and protective coating renewal of the digesters, while not disrupting the digestion process.

Additional Primary Digester Capacity

Once the additional digested liquid sludge storage capacity, as described above, is on-line, then two of the secondary digesters can be converted to primary digesters. This will add approximately 1.5 mil gal of firm primary digester capacity.

Interior Structure and Coating Renewal

Once additional primary digester capacity is available, the primary digesters will be taken out of service sequentially to allow renewal of the interior of the structures. This will also allow for the interior protective coatings to be renewed.

Implementation of New Mixers

As described above, linear mixers are being considered as a replacement technology for the existing draft tube mixers used in the primary digesters. Pumped mixing is another alternative technology under consideration. Once a new mixing technology is selected, it will be implemented.

14.2.6.3 Long-Term Improvements

Additional Primary Digester Capacity

To provide adequate digestion capacity for treated the sludge from a 76 mgd capacity plant, a total firm primary digestion capacity of approximately 10.1 mil gal is required. One approach for providing this capacity would be to convert the remaining two secondary digesters to primary digesters. This would results in a total firm primary digester capacity of approximately 10.4 mil gal.

Alternatively, a new set of primary digesters could be constructed to provide adequate capacity for a 76 mgd treatment plant. Constructing new digester structures would allow optimized geometry (e.g., use of egg-shaped digesters). Alternative cover designs could also be used with new digesters.

Evaluate Alternative Anaerobic Digestion Technologies

New anaerobic digestion processes have been developed that provide benefits over the single stage Mesolithic digestion used at the SWRP. One option described in the original RAMP Report was temperature-phased anaerobic digestion (TPAD).

The TPAD process is two-phase system of thermophilic (55 degrees C) and mesophilic (35 degrees C) vessels, which can provide class B solids in a reduced process volume. The required volume for this type of system is generally considered to be about 25 percent less than a conventional mesophilic digestion system. Other benefits of TPAD include increased bio-gas production, reduced odors, and improved dewaterability of the digested solids.

Injection of Fat, Oil, and Grease

The Water Authority conducted a study for implementation of a receiving station for accepting fat, oil, and grease (FOG) at the SWRP. This material would be injected into the primary digesters along with the primary and secondary sludge and would increase the amount of biogas formed. The study revealed that the current technology for handling FOG is still being developed, so the Water Authority views this as a long-term project.

14.2.7 Solids Dewatering Facility

The Water Authority together with Corollo Engineers completed a design analysis for the SDF in March of 2015. A principal conclusion of this study was that it was more cost effective to rehabilitate the existing SDF rather than design and construct a new facility. Part of the reason for this conclusion was the determination that the current SDF has sufficient capacity for the foreseeable future. A new SDF may be constructed in the future, if necessary.

The design of the SDF Renewal Project is scheduled to be complete by the spring of 2016. It is anticipated that construction of the improvements will largely be completed by the end of 2017. Key elements of this project are as follows:

- A new 2.0 million gallon (mil gal) liquid digested sludge storage tank. This tank will provide approximately four days of sludge storage ahead of the SDF. This will be in addition to the storage currently provided in the Secondary Digesters.
- A new 7,000 gal wetwell for the centrifuge feed pumps. This tank will replace the existing undersized 3,000 gal wetwell tank.
- The installation of third new centrifuge (Alfa Laval G2-120). The third unit will join the other two new G2's that have been installed since the 2010 RAMP Report was completed (See project description below).
- A new Polymer System and Room. The existing dry polymer system will be supplemented with a new emulsion polymer system. The new system will be housed in a new room adjoining the SDF.

- The replacement of the single cake conveyor belt with a set of two shaft-less screw conveyors and a set of two cake pumps. The new conveyance system will provide for a more reliable, enclosed system with a fully redundant backup system.
- New set of dry cake storage bins that will increase the dry cake storage capacity by 50 percent.
- Modifications to the existing cake storage bin gates to allow quicker loading of cake haul truck trailers.
- HVAC improvements. Improvements to the system to improve ventilation and improve humidity control.

14.2.8 Co-Generation Facility

The gas sphere and gas holder projects described below are priorities because the condition of these systems is unknown and there are safety, permit and odor concerns than cannot be quantified without additional study. The remaining proposed projects are a mixture of relatively minor, inexpensive repair or replacement projects and more significant large-capital projects. The minor projects may be considered for either capital or operation and maintenance budgeting and may be reasonable add-ons to larger projects. The large-capital projects should be subjected to further study and assessment for alignment with WUA goals. Of particular note is the gas cleaning project which could both improve the efficiency and operations of the cogeneration equipment. Depending on the technology and configuration of equipment ultimately selected, this could also provide the Water Authority with a source of pipeline-quality natural gas that could be used for future building heating or vehicle fuel.

14.2.8.1 Gas Sphere Condition Assessment

This project involves the inspection of the gas sphere system to determine renewal requirements. As part of the proposed project, we have assumed that the recommended inspection of this vessel will find them to be in need of structural rehabilitation and as such have included as a project blasting and recoating of the interior and exterior portions of the gas spheres. Piping associated with the gas systems that is buried, presumed to be steel, is also presumed to be in questionable condition, and as such, its replacement with HDPE pipe is included in the project list. Additional minor piping sections are also included in the projects such that exposed gas piping in poor condition will be replaced with 316L SST.

14.2.8.2 Gas Holders Condition Assessment

This project involves the investigation of materials of construction, inspection of the gas holder system, estimation of current and future requirements and then preparation of a basis of design which will detail what repairs are required and what requires replacement. Because there are two vessels it is suggested that the inspection and construction be performed sequentially.

As part of the proposed project, we have assumed that the recommended inspection of these vessels will find them to be in need of structural rehabilitation and as such have included as a project blasting and coating of the interior and the exterior of the steel gas holders. Piping that is buried will be replaced with HDPE and exposed will be 316L SST. Also included in this estimate is concrete repair and recoating of the interior of the gas holders.

14.2.8.3 HVAC System Upgrades

HVAC-related projects will be done to improve cooling and air movement within the Cogeneration facilities.

14.2.8.4 Cogeneration Digester Gas Quality Improvements

This proposed project will initially evaluate the digester gas system and in basis of design, summarize the recommended design and construction which should take place to rehabilitate this system. Digester gas treatment systems to remove moisture and contaminants vary in complexity and cost. Depending on the technology and configuration of equipment ultimately selected, gas treatment systems can provide substantial improvements up to, and including, making pipeline-quality gas suitable for use in NG-fired vehicles and equipment. The conceptual design adds (3) digester gas scrubbers/dryers to the existing system.

14.2.8.5 Fuel Gas Metering Improvements

This proposed project will initially evaluate the existing gas piping systems, estimate future requirements and in basis of design, summarize the recommended design and construction which should take place to rehabilitate this system. It has been assumed that the existing meter will be replaced and thermal mass flow meters provided for the LSG systems and turbine type flow meters provided for the NG systems.

14.2.8.6 North & South Cogeneration Building Sound Attenuation Improvements

The proposed project will evaluate the existing facilities, perform basis of design, detailed design and construction of new sound attention systems at both the North and South Cogeneration Buildings. Interior modifications will center around the application of attenuation panels. Exterior modifications can include, redirected stacks, stack shielding, berms and landscaping.

14.2.8.7 Replace South Cogeneration Equipment

The existing south cogeneration equipment are approximately 30 years old, lack the capacity the plant staff requests, and do not function efficiently. The proposed project will initially evaluate the existing generators and supporting systems, then a basis of design, design and construction of the recommended improvements will take place. The conceptual plan at this time is to remove the two (2) 1.1 MW generators and replace with two (2) 1.5 MW generators.

14.2.8.8 Power Improvements

Evaluation of cogeneration power performance will take place under the Plant-Wide Electrical Systems study. This proposed project will design and construct the rehabilitation measures consistent with the plant wide plan. Alternatives for load shedding and synchronization will be explored in addition to physical and electrical improvements.

14.2.9 Plant Electrical Distribution System

In addition to making upgrades to the electrical equipment and systems associated with specific process areas (e.g., Digesters), improvements are to be made to the SWRP's electrical distribution system. As described in Section 11 of this report, a number of improvements have already been implemented, including a new Field Isolation Switch (FIS) Facility.

14.2.9.1 Electrical System Master Plan

The Water Authority is working with one of its engineering consultants to prepare an electrical master plan for the SWRP. Over the last five decades, the SWRP has been enlarged and new processes added. The electrical master plan will take a comprehensive view of the existing plant facilities and consider likely future facilities and plan out the ultimate electrical distribution and control system. This will include consideration of the Water Authority's goal to have the SWRP as energy independent as possible.

14.2.9.2 Distribution System Short-Circuit, Coordination Load Flow, and Arc Flash Study

A complete study of the existing distribution system is an essential step in developing a full understanding of current issues and hazards at the SWRP. The previous Arc Flash and Coordination study was performed in 2012 and according to recommendations in the National Electric Code (NEC), these types of studies should be performed every 3 to 5 years due to changes resulting from rehabilitation and new construction. A complete arc flash analysis should include all system components operating at voltages above 240VAC to comply with NFPA 70E study requirements. As new construction is being performed, the current code requirements are now included to require the particular facility to have the study performed and the proper labeling on all electrical equipment.

14.2.9.2 Evaluate Alternatives for Power Reliability for Critical Processes

EPA design guidelines require that at least two reliable sources power be provided to certain critical processes. A clear determination will be required of which process areas are "critical" or "vital" as defined by EPA as well as facilities that are critical based on the specifics of this plant.

At present, the existing Cogeneration Power System is considered to be the Primary power source with the Utility as the backup source. As a backup to the Utility power source, upgrades were constructed to establish a secondary and back-up source from a separate sub-station to

further assure redundancy to the Utility back-up power system. However, as the SWRP is modified and expanded upon, the Primary power system Cogeneration also needs to be re-evaluated for expansion or upgrades to provide necessary capacity to remain the Primary source. Therefore an evaluation of alternative strategies for providing reliable power to critical facilities is recommended. Recommended alternatives include:

- Providing additional on-site generation of power to keep up with the power demands as the Plant expands and upgrades.
- Evaluate and incorporate modifications to the power loop systems such that each loop is in a separate duct bank and manhole system to allow shutdowns of one loop for maintenance without impacting the Plant or the other power loop.
- Break the loops up to allow for maintenance of sections without interference to adjacent process areas by using loop around back feeds to keep the power available.
- Expand the concept of multiple, large standby generators both portable and fixed with the appropriate connection stations and shore power systems to maintain the generators in a ready state and where required automatic transfer switches for specific facilities or co-located facilities as appropriate.
- Evaluate and incorporate alternate back feed schemes to all critical process areas in addition to the emergency generator systems so that options are available to address different failure modes and maintain full operations of the facility.
- Evaluate auto transfer modifications to the pad-mounted switches to speed up recovery when isolating and transferring from one loop to the other and to reduce the manpower needed to perform the switching requirements.

For each alternative, conceptual one-line diagrams, preliminary sizing of major equipment, preliminary plan layouts and Class 4 cost estimates will be developed. A memo summarizing the alternatives and pros and cons to support decision making will be prepared.

14.2.10 Plant Instrumentation and Control System

The Water Authority expects to have the complete 10-year DCS to PLC transition plan complete for the SWRP by the end of 2016. As the various SWRP process areas are rehabbed, the existing ABB control system components are anticipated to be converted, where possible, to the new PLC-based system in preparation for the future conversion.

In the short-term, rehab of existing control cabinets, uninterruptible power supplies, and other ancillary equipment will continue on a regular basis to sustain the current process control strategy. This direction should give the Water Authority the time it needs to complete the planning, continue with the planned rehab of process facilities, and process wastewater in compliance with all of the required regulations.

14.2.11 Plant Non-Potable Water System

The Water Authority is currently constructing a new Ammonium Sulfate Facility to replace a temporary system. The new facility is anticipated to be substantially complete by the summer of 2017.

14.2.12 Plant Site

The Water Authority has designed two storm/spill containment basins: one on the north side of the plant and a second on the south side of the plant. These basins will provide controlled containment of storm water that falls on the plant site. Also, they will provide containment of any future spills from the plant basins. Construction of both basins is scheduled to be completed by the summer of 2017.

14.2.13 Other Improvements

During the next decade, improvements will continue to be made to the Operations and Maintenance, warehouse, and maintenance buildings.

Table 14-1

Southside Water Reclamation Plant Planned Renewal Spending

Facility and Project Description	Annual Fiscal Year Budget Projections ($-million)										Total Decade Budget ($-million)
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
Preliminary Treatment Facility	3.08	-	-	-	-	-	-	-	-	-	**3.08**
Dewatering Facility Replacement	7.66	16.00	-	-	-	-	-	-	-	-	**23.66**
Blower Capacity Improvements	0.82	-	-	-	-	-	-	-	-	-	**0.82**
Existing Digester Rehabilitation and Improvements (Phase 1)	3.80	2.02	11.07	-	-	-	-	-	-	-	**16.89**
Primary Clarifier Improvements (Phase 1)	1.99	1.50	1.40	2.10	-	-	-	-	3.66	1.00	**11.65**
Aeration Basin Rehabilitation	0.07	0.10	-	-	-	-	-	-	-	-	**0.17**
Secondary Sludge Thickening Improvements	0.25	-	5.20	2.00	-	-	-	-	-	-	**7.45**
Cogeneration Improvements	0.00	-	-	0.59	6.00	10.00	0.75	-	-	-	**17.34**
SWRP Renewal Contingency	1.13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**10.13**
ABB Service Contract	0.00	0.14	0.16	0.16	0.16	0.17	0.17	0.17	0.17	0.17	**1.46**
Plant-Wide Electrical, Instrumentation and Control Improvements	2.59	1.50	2.20	1.98	2.48	9.75	15.00	0.50	-	-	**35.99**
RAS and Sludge Withdrawal Pumps Improvements	0.22	-	0.75	-	-	-	-	-	-	-	**0.97**
Plant-Wide Non Potable Water Improvements	-	-	-	-	-	-	-	0.09	1.50	-	**1.59**
Warehouse Facility Renewal	-	-	-	-	-	-	0.10	1.15	0.29	-	**1.53**
Maintenance Facility Renewal	0.75	-	-	-	-	-	0.10	1.15	0.29	-	**2.28**
Plant Landscaping	-	-	-	-	-	-	-	1.00	0.86	0.94	**2.80**
O&M Facility Renewal	-	-	-	-	-	-	0.10	1.15	0.29	-	**1.53**
Storm Water Drainage Improvements	0.06	0.25	-	-	-	-	-	-	-	-	**0.31**
Sludge Drying Beds Demolition	0.15	-	-	-	-	-	-	-	-	-	**0.15**
Storm Water and Spill Retention Basins	0.91	-	-	-	-	-	-	-	-	-	**0.91**
Primary Clarifier Improvements (Phase 2)	-	-	-	-	-	0.63	4.00	3.80	5.95	8.55	**22.93**
RAMP Report Update	0.36	-	-	-	-	-	-	-	-	-	**0.36**
Program Management Assistance	0.21	-	-	-	-	-	-	-	-	-	**0.21**
High Efficiency Blower Upgrades	0.65	-	-	1.50	4.40	2.43	-	-	-	-	**8.98**
Digester Capacity Improvements	5.71	-	1.00	5.45	5.74	-	2.76	4.00	-	-	**24.66**
Digester Cleaning Program	0.60	0.20	0.20	0.20	-	-	-	-	-	-	**1.20**
Chemical Storage and Feed Systems Upgrade	1.21	2.11	-	-	-	-	-	-	-	-	**3.32**
Pre-Screens for UV Disinfection Facility	0.84	1.60	-	-	-	-	-	-	-	-	**2.44**
As-Built Drawings	0.10	0.10	0.03	0.03	0.03	0.03	0.03	-	-	-	**0.33**
FOG Receiving Station	0.10	-	-	-	-	-	-	-	-	-	**0.10**
Aeration Basin Improvements	-	-	-	4.00	2.20	-	-	-	-	-	**6.20**
Existing Digester Rehabilitation and Improvements (Phase 2)	-	-	-	2.73	2.00	2.00	-	-	-	-	**6.73**
Total	**33.3**	**26.5**	**23.0**	**21.7**	**24.0**	**26.0**	**24.0**	**14.0**	**14.0**	**11.7**	**218.2**

Appendix

This appendix compiles the risk assessment tables developed for the different area of the Southside Water Reclamation Plant (SWRP).

RISK ASSESSMENT PROCEDURE

The goal of this asset risk assessment is to evaluate and prioritize plant needs based on risk.

Risk Score = (Consequence of Failure) x (Probability of Failure) x (Redundancy Factor)

Asset failure can be caused by multiple factors including mortality, inadequate capacity, limited performance, and efficiency of extraordinary costs. Assets or asset classes that have a high likelihood of failure and have a significant impact if they fail should have higher priority in the development of the capital improvement program for the SWRP.

The WUA is utilizing the WERF SIMPLE approach to asset management that includes the definition of business risk. Business risk exposure and the consequences of asset failure are ideally presented in actual dollar costs. However, the scope of the risk assessment for the SWRP RAMP project is limited to rating assets on relative consequence of failure based on 'triple bottom line' criteria for municipal services as applied to the SWRP. The business risk assessment for this phase of the RAMP is based on relative weighted risk scores for assets or asset groups that are a product of the probability of failure score and the consequence of failure score. The risk of asset failure is further modified or reduced if there is no reliable means of redundancy for the asset. The weighted risk scores are used to identify and prioritize asset risk and to develop potential capital improvement projects based on most critical assets and asset groups

The following subsections describe the components factored in the probability of failure, consequence of failure, and redundancy factor. Each component subsection has a description of how they are measured and weighted.

Probability of Failure

For the SWRP RAMP the likelihood of failure is estimated for major asset classes based on the following factors. Each of these factors is weighted, as indicated, based on estimated importance in affecting the probability of failure. Each factor impacting the probability of failure is rated for each asset class on a relative scale from 1 to 5 as discussed in the following sections.

Probability of Failure

Probability of Failure Factor	Weighted Importance
Age	30%
Condition	50%
History	20%

Age

As an asset approaches its expected useful life, the probability of failure generally increases due to wear or fatigue. Age may contribute to obsolescence if parts cannot be obtained or the equipment is not compatible with current technology. Remaining Useful Life (RUL) is the difference between the expected life and the age of an asset.

Asset Age Ratings

Rating	Current Age
1	Less than 20% of expected useful life
2	20% to 40% of expected useful life
3	40% to 60% of expected useful life
4	60% to 80% of expected useful life
5	> 80% of expected useful life

Condition

The condition of the asset is typically the most significant cause of asset failure. Deterioration - excessive wear and lack of maintenance may cause assets to fail prematurely and unexpectedly. Without a detailed physical assessment such as teardown and inspection, a relative evaluation can be made based on appearance, noise, vibration, performance, etc.

Asset Condition Ratings

Rating	Condition Ranking
1	Like new
2	Some visible wear and corrosion
3	Noticeable degradation of condition or performance
4	Significant and measurable deterioration, requires extraordinary maintenance
5	Has failed or imminent failure expected

History

If the asset has a history of failure, it is a strong indication that the probability of a future failure is high. The significance of the number of failures, meaning that the component or system does not perform the intended function, will vary with the type of asset and the cost to repair or

maintain. In more sophisticated analyses, this is addressed in a computation of the mean time between failures (MTBF). For this analysis, the following general guidelines are used for typical mechanical and electrical equipment in a wastewater plant.

Asset Frequency of Failure Ratings

Rating	Frequency of Failure
1	Never failed
2	Fails > every 5 years
3	Fails 1 to 5 years
4	Fails < 1 year
5	Fails < 1 month

Consequence of Failure

The consequence of asset failure for the SWRP is measured in terms of the 'triple bottom line' of municipal services to reflect the role of the SWRP in the community, and to provide a balanced approach to the risk assessment. The consequence of failure of assets is improved or offset by redundancy within asset groups and is discussed later in this section.

Multiple factors are used within each of the triple bottom line categories and each service level: social, environmental, and economic is considered equal for this evaluation. The factors and their weighted importance within each of the three service categories are listed in the following table.

Consequence of Failure

Consequence of Failure Factor	Weighted Importance (%)
Social	38.6
Disruption of Service	10.5
Health and Safety	13.2
Public Image	4.4
Board Policy	10.5
Environmental	32.5
Permit Compliance	16.3
Ecosystem	8.0
Aesthetics	8.2
Economic	28.9
Level of Service	17.0
Damage	6.8
High O&M Costs	5.1

Each factor is rated on a relative scale. More sophisticated methods are available to measure and weigh the consequences of failure including comparable costs, but these methods are outside the scope of this project. A reasonableness approach using best judgment and experience in

wastewater treatment facilities is used to provide a rating for each asset or asset group. The general rating scale for the impacts of asset failures is listed in the following table.

Consequence of Failure Ratings

Consequence of Failure Factor Rating	Potential Impact
0	No impact
1	Low or insignificant impact
3	Moderate, some measurable impact, disruption, or cost
5	High, substantial, dramatic, or multiple impacts

The following sections provide brief explanations of the consequence of failure factors and how they are applied to the rating.

Disruption of Service

Wastewater plant assets do not typically have a direct impact on customers or citizens, but there are conditions of failure than can impact customers. These may include, for example, influent pump failure that could cause a sewer line backup into residences or businesses, or loss of plant power that would prevent operation of some or all processes. Effluent reuse pump failure could impact reclaimed water customers, and digester failure may impact businesses or users relying on biosolids quality.

Health and Safety

Health and safety can be the most important factor to be included in the community or customer service category that considers plant staff are part of the community. Safety can apply to buildings and electrical equipment, as well as rotating equipment. For example, a building with inadequate lighting or railings would be judged to have failed since it does not meet its intended or required purpose in a safe manner. Dangerous conditions that currently exist without a specific failure incident should also be considered as an asset failure and may have a high impact.

Public Image

Public image within a wastewater plant is typically related to ongoing problems or failures or extended duration of other failure consequences. Ongoing odor issues may exist without asset failure if there are not adequate odor control facilities. Permit violations or ongoing safety problems can be publicized and may be caused by multiple or combinations of failures, and should be characterized as having public image impacts.

Board Policy

Board policy reflects community or social needs and expectations and is an important criteria is measuring the impact on the community. There are typically multiple policies that the plant needs to meet. Examples includes providing adequate treatment plant capacity, meeting all regulatory requirements, controlling costs, and minimizing treatment plant impacts such as odors and traffic on plant neighbors.

Inadequate capacity or capacity restrictions are considered a community impact if they restrict the capability of the community to achieve development or growth goals or otherwise limit service to the community. This can also be an impact without a specific failure incident. The asset failure is ongoing if the process or equipment does not have capacity to meet the desired needs of the community.

Permit Compliance

Failure of the asset or asset class would result in violation of the permits or other regulatory performance requirements associated with the SWRP. Typically this would include effluent or biosolids limits, but could include electrical code, OSHA, or similar requirements. Failure of some assets, such as disinfection or aeration, would directly affect permit violation and have a high impact, while others may have lesser or indirect impacts such as primary clarifier collector mechanism failure.

Ecosystem (Overflows and Spills)

While overflows and spills could be considered part of permit compliance, they represent a substantial impact on the environment that should be considered as a separate impact or factor. This may include chemical spills as well as wastewater spills and overflows.

Aesthetics (Odor, Noise)

Odor is an environmental nuisance but may become serious enough to be an environmental hazard. Failure of some systems can cause or exacerbate odors. Failure of an odor control system can be a high impact, but failure of influent screening equipment can be a moderate odor impact due to screenings build-up. Other aesthetic issues could be impacts from noise or visual appearance of the reclamation plant. Excessively loud or high frequency noise, or noise at night, may impact surrounding neighbors. Aesthetic issues have consequences that are typically identified by citizen complaints or through community involvement in design review or project approval.

Level of Service

Failure or loss of performance of a major asset or asset group can impact the performance of the treatment plant and may affect the performance or costs of other processes. This is a measure of the impact of failure of an asset, or the current inadequate performance of a process or asset

group. For example, if the grit removal system is not performing adequately, it will affect the downstream performance and costs related to accelerated equipment wear and manual removal.

High O&M Costs

Asset failures, whether a specific incident, or ongoing extraordinary maintenance or attention, may require plant staff to continuously respond to maintain service levels and plant performance. Assets that are not performing as intended may also require extraordinary operator attention to prevent process or other related plant failure. This extraordinary effort diverts plant staff from other regular and necessary duties and tends to create other and ongoing failures. Energy inefficiency is also a measure of high O&M costs.

Damage

Damage is the direct cost of an asset failure. It may be measured in costs of emergency response, repair, clean-up, damage to other facilities such as flooding, temporary equipment, fines, claims, and other related costs. For example, failure of power supply equipment such as breakers can have multiple costs impacts including expensive repairs, permit violation fines, injury to workers, and temporary emergency power.

Redundancy

Backup equipment reduces the probability of failure of a group of equipment or asset class. For example, multiple influent pumps or aeration blowers with one or more standby units reduces the likelihood that the entire asset group or class will fail and impact the wastewater plant performance. However, if the standby equipment is cannibalized or otherwise not operable, it does not provide redundancy.

The Redundancy Factor is a relative weighting of the reduction of the consequence of failure of assets within an asset group where redundancy is present. The consequence of failure score is reduced by the percentage shown in the following table to provide a new consequence score that considers the level of redundancy. If there is no reliable redundancy, the consequence of failure rating is not reduced.

Asset Redundancy Ratings

Redundancy Factor	Reduction of Consequence (%)	Level of Redundancy
1	80	Full redundancy at peak conditions, redundant equipment in good condition
2	50	Full redundancy at average conditions
3	25	Partial redundancy at peak conditions
4	10	Partial redundancy at average conditions
5	0	No reliable redundancy

Table A-1

Preliminary Treatment Facility Risk Assessment

Classification	Asset(s)	Expected Life	Weighting	Probability of Failure			Weighted Probability	Consequence of Failure	Redundancy Factor	Risk Score	Rank No.
				0.3	0.5	0.2					
			Age	Age	Condition	History					
Lift Station 11A	LS11A Pumps 1-3	20	1	1	5	5	3.8	5	1	3.8	2
First Stage Grit Removal	Trench and Inclined Screw Augers	20	1	1	1	1	1	2	5	2	6
	Aeration Blowers 1-2	20	1	1	1	1	1	2	1	0.4	20
	Roll Off Bin Conveyor	20	1	1	1	1	1	2	2	1	12
Screening Room	Mechanical Bar Screens 1-5	20	1	1	1	1	1	4	1	0.8	14
	Screenings Sluice	20	1	1	1	1	1	4	5	4	1
Second Stage Grit Removal	Conical Tray Vortex Separators 1-4	20	1	1	1	1	1	4	1	0.8	14
	Grit Pumps 1-4	20	1	1	1	1	1	4	1	0.8	14
Screenings and Grit Handling Room	Grit Classifiers 1-3	20	1	1	1	1	1	4	1	0.8	14
	Grit Screw Conveyors 1-2	20	1	1	1	1	1	4	1	0.8	14
	Washer Compactors 1-2	20	1	1	1	3	1.4	4	2	2.8	3
	Roll Off Bin Conveyors 1-2	20	1	1	1	1	1	2	1	0.4	20
EI&C	Power	20	1	1	1	1	1	5	2	2.5	5
	Instrumentation and Controls	15	1	1	1	1	1	3	4	2.7	4
Misc Mechanical	Gates	20	1	1	1	1	1	3	1	0.6	19
	Bridge Crane and Monorails	30	1	1	1	1	1	1	5	1	12
	Odor Control	20	1	1	1	1	1	2	1	0.4	20
	HVAC	20	1	1	1	1	1	2	3	1.5	8
Buildings/Structures	Lift Station 11A Wetwell	50	1	1	1	1	1	2	3	1.5	8
	First Stage Grit Removal Basins	50	1	1	1	1	1	2	3	1.5	8
	PTF Annex	50	1	1	1	1	1	2	3	1.5	8
	Conical Tray Vortex Separator Basins	50	1	1	1	1	1	2	1	0.4	20
	PTF Building	50	1	1	1	1	1	2	4	1.8	7

Table A-2

Primary Clarifiers Risk Assessment

Classification	Asset(s)	Expected Life	Weighting	Probability of Failure			Weighted Probability	Consequence of Failure	Redundancy Factor	Risk Score	Rank No.	Comments
				0.3	0.5	0.2						
			Age	Age	Condition	History						
PC 1-4 Structure	Tanks	75	55	4	4	4	4	2	4	7.2	7	Cracked areas need to be identified and repaired for all structures.
PC 1-4 Mechanical	Mechanisms	30	55	5	5	5	5	4	4	18	1	
Pump House 1 & 2 Structure	Building	50	55	5	2	2	2.9	1	2	1.45	21	
PC 1-4, PH 1&2 EI&C	Power	20	55	5	2	2	2.9	4	4	10.44	6	
	Instrumentation and Controls	15	55	5	5	5	5	3	4	13.5	3	
PC 1-4, PH 1&2 Pumping System	Sludge Pumps/Pipes/Valves	20	5	1	2	3	1.9	2	3	2.85	17	PH I new scum pump (tornado rotary lobe 1-24-13 new 7/10/2014); PH II new pump #3(rotary lobe tornado 2-7-2013), PH II, sludge pump #4 replaced (tornado rotary lobe); PH I, new auma actuator for sludge valve #1; PH 1 sludge pump #2 back in place 2014
	Grinders	20	2	1	2	2	1.7	1	2	0.85	23	PH I new grinders 1 & 2 (muffin monsters), PH II new grinder #3 6/14/2014. Need for new panels included in I&C.
PC 1-4, PH 1&2 Misc. Mechanical	Odor Control	15	15	5	4	4	4.3	2	3	6.45	9	
	HVAC	20	15	3	3	4	3.2	2	3	4.8	15	
PC 1-4 Other	Spraywater and Washwater Systems	20	25	5	4	4	4.3	2	3	6.45	11	
	Tank Draining	20	55	5	3	4	3.8	2	3	5.7	13	
	Cathodic Protection	20	30	5	4	4	4.3	1	2	2.15	20	
PC 5-8 Structure	Tanks	75	30	3	4	4	3.7	2	4	6.66	8	Above water line structure requires repair
PC 5-8 Mechanical	Mechanisms	30	30	5	4	3	4.1	4	4	14.76	2	
Pump House 3 Structure	Building	50	25	3	2	2	2.3	1	2	1.15	22	
PC 5-8, PH 3 EI&C	Power	20	25	5	2	2	2.9	4	4	10.44	5	
	Instrumentation and Controls	15	9	5	4	4	4.3	3	4	11.61	4	
PC 5-8, PH 3 Pumping System	Sludge Pumps/Pipes/Valves	20	5	1	2	3	1.9	2	3	2.85	16	installed pump #6 9/17/2012, installed standby pump #10 2/20/2013, installed new rotary lobe pump #7 4/20/2013, 7/15/14,2/2/2015; replaced lobes on pump #6 2/10/2014; sludge pump #8 new 2014; scum pump #9 new 2012
	Grinders	20	2	1	1	1	1	1	2	0.5	24	new grinders #6 and #7 5/30/2014; new standby grinder 7/9/2014, new #7 grinder 8/6/2015. Need for new panels included in I&C.
PC 5-8, PH 3 Misc Mechanisms	Odor Control	15	15	5	4	4	4.3	2	3	6.45	10	
	HVAC	20	10	3	3	3	3	1	3	2.25	18	
PC 5-8 Other	Spray and Washwater Systems	20	25	5	4	4	4.3	2	3	6.45	12	PC #8 cleaned out grit from hopper installed new 2" flushing water line (2/3/2015)
	Tank Draining	20	25	5	3	4	3.8	2	3	5.7	14	
	Cathodic Protection	20	25	5	4	4	4.3	1	2	2.15	19	

Table A-3

Modified Ludzak-Ettinger (MLE) Risk Assessment

Classification	Asset(s)	Expected Life	Weighting Age	Probability of Failure 0.3 Age	0.5 Condition	0.2 History	Weighted Probability	Consequence of Failure	Redundancy Factor	Risk Score	Rank No.	Notes
North Structures	Aeration Basins	75	20	2	2	1	1.8	1	2	0.9	28	
	Foam Control											
	Blower Bldg	50	20	2	2	1	1.8	1	2	0.9	28	
North EI&C	Power	20	20	5	3	3	3.6	4	2	7.2	6	
	Instrumentation and Controls	15	20	5	4	4	4.3	2	4	7.74	4	
North Aeration System	Blowers	25	20	4	3	3	3.3	5	2	8.25	3	New motor installed in blower #3 (2014)
	Diffusers	20	1	1	1	1	1	2	3	1.5	26	All new diffusers installed in 2014/2015
	Air Valves	20	20	5	4	5	4.5	2	3	6.75	8	
North Pumping System	Lift Pumps	25	20	4	1	1	1.9	3	2	2.85	23	
	RAS Pumps											RAS pumps ranked below in South Pumping Systems
	Recycle Pumps	20	20	5	3	3	3.6	2	4	6.48	11	
North Misc Mechanical	Mixers	20	20	5	2	1	2.7	2	3	4.05	18	
	Chemical Feed Systems	15	20	5	4	4	4.3	1	3	3.225	22	Ranking includes soda ash system with pending improvements
	HVAC	20	20	5	4	4	4.3	2	4	7.74	4	
	Valves & Gates	25	20	4	4	5	4.2	2	3	6.3	13	Multiple valve actuators replaced in 2014/2015
North Other	Spray Water & Washwater	20	20	5	4	5	4.5	2	3	6.75	8	
South Structures	Aeration Basins	75	25	2	3	2	2.5	2	2	2.5	25	
	Foam Control											
	Blower Bldg	50	45	5	4	5	4.5	2	3	6.75	8	
	Activated Pump Station	50	20	2	1	1	1.3	1	2	0.65	30	
South E&IC	South Blower Bldg Power	20	5	1	1	2	1.2	4	3	3.6	20	
	APS Power	20	20	5	2	3	3.1	3	3	6.975	7	
	Instrumentation and Controls	15	20	5	4	3	4.1	4	4	14.76	1	
South Aeration System	Blowers	20	25	5	4	4	4.3	5	2	10.75	2	New blowers #5 and #6 installed in 2014
	Diffusers	20	2	1	1	1	1	2	3	1.5	26	New diffusers installed in 2013/2014
	Air Valves	20	10	3	2	2	2.3	2	3	3.45	21	All valves raised and new in Basins 7 and 8 in 2014
South Pumping Systems	Lift Pumps	25	20	4	1	1	1.9	3	2	2.85	23	
	RAS Pumps	25	20	4	3	3	3.3	2	4	5.94	15	
	Recycle Pumps	25	20	4	3	3	3.3	2	4	5.94	15	VFDs replaced in Basin 7 and 8 (2014)
South Misc Mechanical	Mixers	20	20	5	2	1	2.7	2	3	4.05	18	New mixer installed in South Basin 8 in 2014
	Chemical Feed Systems											
	HVAC	20	20	5	4	4	4.3	2	3	6.45	12	
	Valves & Gates	25	20	3	4	5	3.9	2	3	5.85	17	
North Structures	Spray Water & Washwater	20	20	4	4	5	4.2	2	3	6.3	13	

Table A-3 (Continued)

Modified Ludzak-Ettinger (MLE) Risk Assessment

Classification	Asset(s)	Expected Life	Weighting	Probability of Failure			Weighted Probability	Consequence of Failure	Redundancy Factor	Risk Score	Rank No.	Notes
				0.3	0.5	0.2						
			Age	Age	Condition	History						
North FC 1-4 Structures	Tanks	75	20	2	2	1	1.8	1	3	1.35	27	
North FC 1-4 Mechanical	Mechanisms	30	5	2	1	1	1.3	5	3	4.875	3	New mechanisms installed in 2011
North FC 1-4 EI&C	Power	20	20	5	3	2	3.4	2	3	5.1	2	
	Instrumentation and Controls	15	5	2	1	1	1.3	1	3	0.975	28	New systems installed in 2011
North FC 1-4 Flow Splitters	Structure	75	20	4	2	1	2.4	2	4	4.32	12	
	Weir Boxes and Gates	25	20	5	2	1	2.7	2	4	4.86	6	
North FC 1-4 Misc Mechanical	Valves	40	20	3	2	1	2.1	2	2	2.1	22	
	Tank Draining	20	20	5	1	1	2.2	1	3	1.65	26	Tank 1 and 3 mud valves replaced in 2015
North FC 1-4 Other	Spray Water & Washwater Systems	20	5	2	2	2	2	2	3	3	17	New systems installed in 2010
	Algae Removal	20	5	2	2	2	2	2	4	3.6	13	New systems installed in 2010
	Cathodic Protection											Not required – new SS mechanism
South FC 1-4 Structure	Tanks	75	45	4	3	3	3.3	1	3	2.475	21	
South FC 1-4 Mechanical	Mechanisms	30	5	2	1	1	1.3	5	3	4.875	3	New mechanisms installed in 2010
South FC 1-4 EI&C	Power	20	45	5	5	3	4.6	2	3	6.9	1	
	Instrumentation and Controls	15	5	2	1	1	1.3	1	3	0.975	28	New systems installed in 2010
South FC 1-4 Flow Splitters	Structure	75	45	5	2	1	2.7	2	4	4.86	6	
	Weir Boxes and Gates	25	20	5	2	1	2.7	2	4	4.86	6	
South FC 1-4 Misc. Mechanical	Valves	40	6	1	2	3	1.9	2	2	1.9	23	
	Tank Draining	20	10	3	5	2	3.8	1	3	2.85	20	
South FC 1-4 Other	Spray Water & Washwater Systems	20	5	2	2	2	2	2	3	3	17	New systems installed in 2010
	Algae Removal	20	5	2	2	2	2	2	4	3.6	13	New systems installed in 2010
	Cathodic Protection											Not required – new SS mechanism
South FC 5-8 Structural	Tanks	75	32	3	2	2	2.3	1	3	1.725	24	
South FC 5-8 Mechanical	Mechanisms	30	5	2	1	1	1.3	5	3	4.875	3	New mechanisms installed in 2010
South FC 5-8 EI&C	Power	20	32	5	2	2	2.9	2	3	4.35	11	
	Instrumentation and Controls	15	5	2	1	1	1.3	1	3	0.975	28	New systems installed in 2010
South FC 5-8 Flow Splitters	Structure	75	32	5	2	1	2.7	2	4	4.86	6	
	Weir Boxes and Gates	25	32	5	2	1	2.7	2	4	4.86	6	
South FC 5-8 Misc Mechanical	Valves	40	7	2	1	3	1.7	2	2	1.7	25	
	Tank Draining	20	35	5	5	2	4.4	1	3	3.3	16	
South FC 5-8 Other	Spray Water & Washwater Systems	20	5	2	2	2	2	2	3	3	17	New systems installed in 2010
	Algae Removal	20	5	2	2	2	2	2	4	3.6	13	
	Cathodic Protection											Not required – new SS mechanism

Table A-4

Secondary Sludge Thickening Risk Assessment

				Probability of Failure				Consequence of Failure																	
								Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
Structure	DAF Tanks	75	30	3	2	3	2.5	0	1	0	2	0.342	1	1	1	0.325	3	3	3	0.867	1.534	3	2.9	12	TWAS Hoppers are considered in this ranking.
	DAF Building	50	30	4	3	4	3.5	0	3	0	0	0.396	1	0	1	0.245	1	3	3	0.527	1.168	2	2.0	15	
EI&C	Power	20	30	5	4	4	4.3	0	3	0	0	0.396	3	3	3	0.975	3	3	5	0.969	2.34	4	9.1	3	
	Instrumentation & Controls	15	14	5	4	4	4.3	0	3	0	0	0.396	3	3	3	0.975	1	3	5	0.629	2	4	7.7	5	
Mechanical	Collectors	20	12	3	3	3	3	0	1	0	1	0.237	1	0	1	0.245	3	1	3	0.731	1.213	3	2.7	13	
	Saturation System	20	12	3	4	4	3.7	0	3	0	1	0.501	1	0	3	0.409	3	3	3	0.867	1.777	4	5.9	7	Recirculation Pumps and Pressure Vessels are considered in this ranking.
Pumping Systems	TWAS Pumps	25	15	4	1	3	2.3	0	1	0	1	0.237	1	0	1	0.245	1	1	1	0.289	0.771	3	1.3	17	Ranking considers pumps replaced in 2008
	Bottom Sludge Pumps	25	14	3	5	4	4.2	0	1	0	2	0.342	1	0	1	0.245	3	3	3	0.867	1.454	5	6.1	6	
Polymer System	WAS (UWAS) and Scum Pumps	25	1	1	3	4	2.6	0	1	0	2	0.342	3	1	1	0.651	3	3	3	0.867	1.86	4	4.4	10	
	Polymer Storage Tanks	15	30	5	3	3	3.6	0	1	0	0	0.132	1	3	0	0.403	1	1	1	0.289	0.824	3	2.2	14	Ranking considers improvements made in 2009
	Polymer Batch Tanks	20	30	5	2	2	2.9	0	1	0	0	0.132	1	1	0	0.243	3	1	1	0.629	1.004	2	1.5	16	
	Transfer Pumps/Pipe	15	20	5	4	4	4.3	0	1	0	0	0.132	1	1	0	0.243	3	3	3	0.867	1.242	4	4.8	8	
	Feed Pumps/Pipe	15	20	5	4	4	4.3	0	1	0	0	0.132	1	1	0	0.243	3	3	3	0.867	1.242	4	4.8	8	
Misc. Mechanical	Odor Control	15	9	4	4	4	4	1	1	1	0	0.281	1	1	3	0.489	1	3	3	0.527	1.297	3	3.9	11	
	HVAC	20	16	4	5	5	4.7	0	3	0	0	0.396	3	3	3	0.975	1	3	3	0.527	1.898	5	8.9	4	
	Valves/Piping	20	23-30	5	4	5	4.5	0	3	0	0	0.396	3	1	3	0.815	3	3	3	0.867	2.078	5	9.4	2	Ranking includes all Sludge Systems.
Other	NPW Systems	20	?	4	5	5	4.7	1	3	0	0	0.501	3	1	1	0.651	3	3	5	0.969	2.121	5	10.0	1	

Table A-5
Anaerobic Digester Risk Assessment

								Consequence of Failure																
				Probability of Failure				Social					Environmental				Economic							
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*			
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.
AD 1-8 Structures & AD Sludge Blending	Digester Support Building	50	50	5	3	1	3.2	0	3	1	3	0.755	1	0	0	0.163	3	1	3	0.731	1.649	4	4.7	31
	Sludge Blending Tank	75	22	2	1	1	1.3	1	3	1	3	0.86	3	3	3	0.975	3	3	5	0.969	2.804	3	2.7	34
	Sludge Blending Building	50	22	3	2	1	2.1	0	3	1	3	0.755	1	0	0	0.163	1	1	3	0.391	1.309	2	1.4	36
AD 1-8 Digester Structures & AD Sludge Blending	Primary Digesters	75	45-50	4	4	3	3.8	5	5	3	5	1.842	5	3	1	1.137	5	3	5	1.309	4.288	5	16.3	3
	Primary Digester Covers/Gas/OF systems	40	45-50	5	4	5	4.5	3	5	3	5	1.632	3	3	3	0.975	5	5	5	1.445	4.052	5	18.2	1
AD 1-8 Digester Structures & AD Sludge Blending	Secondary Digesters	75	45-50	4	3	1	2.9	3	5	3	3	1.422	1	3	1	0.485	3	3	5	0.969	2.876	3	6.3	24
	Secondary Digester Covers/Gas/OF systems	40	45-50	5	4	5	4.5	3	5	3	5	1.632	3	3	3	0.975	3	3	5	0.969	3.576	5	16.1	8
AD 1-8 EI&C & AD Sludge Blending	Power	20	30-40	5	3	4	3.8	3	5	3	3	1.422	5	5	3	1.461	5	5	5	1.445	4.328	4	14.8	18
	Instrumentation & Controls	15	30-40	5	3	4	3.8	3	5	1	1	1.124	5	3	1	1.137	5	3	5	1.309	3.57	4	12.2	19
AD 1-8 Pumping System & AD Sludge Blending	Sludge Withdrawal Pumps	25	20	4	3	3	3.3	3	1	0	3	0.762	3	3	3	0.975	5	3	5	1.309	3.046	2	5.0	26
	Digester HEX Recirculation Pumps	25	8	2	2	3	2.2	1	1	0	3	0.552	3	0	0	0.489	5	1	3	1.071	2.112	5	4.6	32
	Sludge Grinders	25	4	1	2	3	1.9	1	3	0	3	0.816	1	1	0	0.243	3	3	3	0.867	1.926	2	1.8	35
	Blending Pumps	25	4	1	2	4	2.1	1	3	0	3	0.816	3	1	3	0.815	5	3	3	1.207	2.838	3	4.5	33
AD 1-8 Digester System & AD Sludge Blending	Sludge Heat Exchangers	30	50	5	3	2	3.4	3	1	0	5	0.972	3	1	0	0.569	5	1	3	1.071	2.612	5	8.9	21
	Valves	40	4	1	4	4	3.1	1	3	0	3	0.816	1	1	0	0.243	3	1	3	0.731	1.79	4	5.0	27
	Piping	40	25-35	5	3	3	3.6	1	3	0	3	0.816	1	1	0	0.243	3	3	5	0.969	2.028	4	6.6	23

Table A-5 (continued)

Anaerobic Digester Risk Assessment

								Consequence of Failure																
				Probability of Failure				Social					Environmental				Economic							
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*			
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.
AD 1-8 Misc. Mechanical	Mixers	20	28-50	5	5	5	5	3	3	1	5	1.28	3	0	1	0.571	5	3	5	1.309	3.16	5	15.8	12
	Low Pressure Gas System	30	45-50	5	4	3	4.1	1	5	1	5	1.334	5	1	3	1.141	5	3	5	1.309	3.784	5	15.5	14
	Heat Loop - Building Hot Water	30	23	4	5	5	4.7	3	1	0	5	0.972	5	1	1	0.977	5	5	5	1.445	3.394	5	16.0	10
AD 1-8 Misc. Mechanical	HVAC	20	18	5	5	4	4.8	1	5	0	5	1.29	3	0	3	0.735	5	3	3	1.207	3.232	5	15.5	15
	Valves	40	4	1	4	4	3.1	1	3	0	3	0.816	1	1	0	0.243	3	1	3	0.731	1.79	4	5.0	27
	Piping	40	23-50	4	3	3	3.3	1	3	0	3	0.816	1	1	0	0.243	3	3	5	0.969	2.028	4	6.0	25
AD 9-14 Structures	Digester Support Building	50	35	4	3	1	2.9	0	3	1	3	0.755	1	0	0	0.163	3	3	5	0.969	1.887	4	4.9	30
AD 9-14 Structures	Primary Digesters	75	19-35	4	4	3	3.8	5	5	3	5	1.842	5	3	1	1.137	5	3	5	1.309	4.288	5	16.3	3
	Primary Digester Covers/Gas/OF systems	40	25-35	5	4	5	4.5	3	5	3	5	1.632	3	3	3	0.975	5	5	5	1.445	4.052	5	18.2	1
AD 9-14 Structures	Secondary Digesters	75	25-35	5	4	5	4.5	3	5	3	1	1.212	1	3	1	0.485	3	3	5	0.969	2.666	3	9.0	20
	Secondary Digester Covers/Gas/OF systems	40	25-35	5	4	5	4.5	3	5	3	5	1.632	3	3	3	0.975	3	3	5	0.969	3.576	5	16.1	8
AD 9-14 EI&C	Power	20	25-35	5	5	4	4.8	3	5	3	1	1.212	5	5	3	1.461	5	1	3	1.071	3.744	4	16.2	7
	Instrumentation & Controls	15	25-35	5	5	4	4.8	3	5	1	1	1.124	5	3	1	1.137	5	3	5	1.309	3.57	4	15.4	17
AD 9-14 Pumping Systems	Sludge Withdrawal Pumps	25		5	5	5	5	3	1	0	5	0.972	3	3	3	0.975	5	3	5	1.309	3.256	5	16.3	5
	Digester HEX Recirculation Pumps	25		3	2	3	2.5	1	1	0	1	0.342	3	1	0	0.569	5	1	3	1.071	1.982	5	5.0	29
	Sludge Heat Exchangers	30	20-25	4	3	3	3.3	3	1	0	3	0.762	3	1	0	0.569	5	1	3	1.071	2.402	4	7.1	22
AD 9-14 Misc. Mechanical	Mixers	20	25-35	5	5	5	5	3	3	1	5	1.28	3	1	1	0.651	5	3	5	1.309	3.24	5	16.2	6
	Low Pressure Gas System	30	22	4	4	3	3.8	3	5	1	5	1.544	5	1	3	1.141	5	5	5	1.445	4.13	5	15.7	13
	Heat Loop - Building Hot Water	30	23	4	5	5	4.7	3	1	0	5	0.972	5	1	1	0.977	5	5	5	1.445	3.394	5	16.0	10
AD 9-14 Misc. Mechanical	HVAC	20	25	5	5	4	4.8	1	5	0	5	1.29	3	0	3	0.735	5	3	3	1.207	3.232	5	15.5	15
	Valves	40	4	1	4	4	3.1	1	3	0	3	0.816	1	1	0	0.243	3	1	3	0.731	1.79	4	5.0	27
	Piping	40	25-35	5	3	3	3.6	1	3	0	3	0.816	1	1	0	0.243	3	3	5	0.969	2.028	4	6.6	23

Table A-6

Solids Dewatering Facility Risk Assessment

				Probability of Failure				Consequence of Failure: Social					Consequence of Failure: Environmental				Consequence of Failure: Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
Structure	Building	50	23	3	4	4	3.7	0	3	0	0	0.396	1	1	3	0.489	3	3	3	0.867	1.752	3	4.9	12	
EI&C	Power	20	mixed	4	5	4	4.5	1	3	1	0	0.545	3	3	3	0.975	5	3	5	1.309	2.829	4	11.5	4	
	Instrumentation & Controls	15	mixed	4	5	4	4.5	1	3	1	0	0.545	3	3	3	0.975	3	3	5	0.969	2.489	4	10.1	5	
Mechanical	Centrifuges	20	12	3	4	4	3.7	3	3	1	5	1.28	3	3	3	0.975	5	3	5	1.309	3.564	5	13.2	1	
	Centrate Tank & Pumping System	25	mixed	3	4	4	3.7	3	3	1	3	1.07	3	3	3	0.975	5	5	5	1.445	3.49	5	12.9	2	
Sludge Pumping System	Sludge Feed Tank & Pumping System	25	mixed	4	3	4	3.5	1	1	1	3	0.596	3	1	1	0.651	3	5	5	1.105	2.352	5	8.2	9	See Digester section for additional information on Dig. 9-14 sludge pumping (Withdrawal Pumps)
Polymer System	Dry Polymer Feed System & Mixing Tanks	20	mixed	4	4	4	4	1	3	1	0	0.545	3	1	1	0.651	3	3	5	0.969	2.165	5	8.7	8	
	Polymer Feed Pumps & Piping	15	12	4	4	4	4	1	3	1	0	0.545	3	1	1	0.651	3	1	4	0.782	1.978	5	7.9	10	
Materials Handling	Conveyor	20	1	1	4	5	3.3	1	5	1	0	0.809	3	3	3	0.975	3	5	5	1.105	2.889	5	9.5	7	
	Hoppers	20	mixed	4	4	4	4	1	5	1	0	0.809	3	3	3	0.975	3	3	5	0.969	2.753	4	9.9	6	
Misc. Mechanical	HVAC	20	16	4	4	4	4	1	5	1	0	0.809	5	1	3	1.141	3	3	5	0.969	2.919	5	11.7	3	
	Odor Control	15	9	3	4	4	3.7	3	3	3	0	0.843	3	1	5	0.979	1	3	3	0.527	2.349	4	7.8	11	

Table A-7

Cogeneration and Hot Water System Risk Assessment

				Probability of Failure				Consequence of Failure																	
								Social					Environmental				Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
North Structures	Cogen Building	50	5	1	2	1	1.5	0	3	1	0	0.44	0	1	1	0.162	3	1	1	0.629	1.231	4	1.7	24	Sound attenuation to improve working conditions
North EI&C	Power	20	5	2	2	2	2	1	5	3	1	1.002	3	1	1	0.651	3	5	4	1.054	2.707	3	4.1	8	Air permit compliance risk (digester gas); redundancy partial at peak
	Instrumentation & Controls	15	5	3	2	4	2.7	0	1	0	1	0.237	3	1	1	0.651	3	5	4	1.054	1.942	3	3.9	10	Load-shed not effective in keeping engines running (economic damage); Air permit compliance risk; flow meters on gas systems
North Mechanical	Engines	40	5	1	2	2	1.7	0	3	0	1	0.501	3	1	1	0.651	3	5	3	1.003	2.155	3	2.7	16	Redundancy - partial at peak
North Hot Water System	Boiler	40	0	1	1	1	1	1	1	0	1	0.342	1	0	0	0.163	1	0	0	0.17	0.675	4	0.6	30	Potential new construction - new LSG (dual) - fired boiler for heat reliability and maintenance flexibility; connected to building HW loop.
	Heat Exchangers	30	5	2	2	3	2.2	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	5	3.4	12	Loss of heat to digester would result in potential permit issue on digested solids quality.
	Pumps	25	5	2	2	2	2	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	3	2.3	18	
	Pipe/ Valves	40	5	2	2	1	1.8	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	4	2.5	17	Potential new construction - connect to Building Hot Water System
North Misc Mechanical	Cooling Water System	30	5	2	2	2	2	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	3	2.3	18	Air permit compliance risk
	Cogen Bldg HVAC	20	5	2	3	4	2.9	1	3	1	1	0.65	3	0	0	0.489	3	1	3	0.731	1.87	5	5.4	4	Air permit compliance risk; risk of engine shutdown
South Structures	Cogen Bldg	50	23	3	2	1	2.1	0	3	1	0	0.44	0	1	1	0.162	3	1	1	0.629	1.231	4	2.3	21	Sound attenuation to improve working conditions
South Structures	Compressor Building	50	0	1	2	1	1.5	0	3	1	0	0.44	0	1	1	0.162	3	1	1	0.629	1.231	4	1.7	24	Ranking considers improvements in FY 2003 project
South EI&C	Power	20	23	5	2	2	2.9	0	5	3	1	0.897	3	1	1	0.651	3	5	4	1.054	2.602	3	5.7	3	Load-shed (economic damage); CB operation; difficult cable access; Air permit compliance risk
	Instrumentation & Controls	15	23	5	2	4	3.3	0	1	0	1	0.237	3	1	1	0.651	3	5	4	1.054	1.942	3	4.8	6	Load-shed not effective in keeping engines running (economic damage); Air permit compliance risk; flow meters on gas systems
South Mechanical	Engines	40	3	1	2	3	1.9	0	3	0	1	0.501	3	1	1	0.651	3	5	3	1.003	2.155	3	3.1	14	Ranking considers recent cogen rebuilds (#3 - 2007; #4 - 2008); partial redundancy at peak
South Gas System	Gas Compressor	20	0	1	1	1	1	1	1	0	1	0.342	3	1	1	0.651	3	1	3	0.731	1.724	2	0.9	28	Reconstruction pending (2009)
	Gas Dryers	20	0	1	1	1	1	1	1	0	1	0.342	3	1	1	0.651	3	1	3	0.731	1.724	2	0.9	28	Reconstruction pending (2009)
	Gas Cleaning	20	0	1	1	1	1	1	1	0	1	0.342	3	0	0	0.489	3	3	3	0.867	1.698	4	1.5	27	Potential future project - Improved gas quality reduces maintenance on engine
	Pipe/ Valves	40	23	3	3	3	3	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	2	2.3	18	

Table A-6 (continued)

Cogeneration and Hot Water System Risk Assessment

				Probability of Failure				Consequence of Failure: Social					Consequence of Failure: Environmental				Consequence of Failure: Economic								
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*				
	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.	Notes
	Gas Dryers	20	0	1	1	1	1	1	1	0	1	0.342	3	1	1	0.651	3	1	3	0.731	1.724	2	0.9	28	Reconstruction pending (2009)
	Gas Cleaning	20	0	1	1	1	1	1	1	0	1	0.342	3	0	0	0.489	3	3	3	0.867	1.698	4	1.5	27	Potential future project - Improved gas quality reduces maintenance on engine
Classification	Pipe/ Valves	40	23	3	3	3	3	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	2	2.3	18	
Gas Holders	Structure	40	23	3	2	1	2.1	1	5	1	1	0.914	3	1	3	0.815	3	1	5	0.833	2.562	3	4.0	9	Potential for uncontrolled digester gas leak (Air Permit); Unknown condition of sphere and related piping
	Equipment	30	23	4	2	1	2.4	1	5	1	1	0.914	3	1	3	0.815	3	1	5	0.833	2.562	3	4.6	7	
Gas Sphere	Structure	40	23	4	2	2	2.6	1	5	1	3	1.124	3	1	3	0.815	3	1	5	0.833	2.772	4	6.5	1	Potential for uncontrolled digester gas leak (Air Permit); Unknown condition of sphere and related piping
	Equipment	30	23	4	2	2	2.6	1	5	1	3	1.124	3	1	3	0.815	3	1	5	0.833	2.772	4	6.5	1	Unknown condition of sphere and related piping; potential for high pressure leak
South Hot Water System	Boiler	40	3	1	1	3	1.4	1	1	0	1	0.342	1	1	0	0.243	3	1	1	0.629	1.214	4	1.5	26	New boiler in 2006 - Natural gas only
	Heat Exchangers	30	23	4	2	2	2.6	1	1	0	3	0.552	3	0	0	0.489	3	1	3	0.731	1.772	3	3.5	11	
	Pumps	25	23	5	2	2	2.9	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	3	3.4	13	
	Pipe/ Valves	40	23	4	2	1	2.4	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	2	1.9	22	
South Misc Mechanical	Cooling Water System	30	23	4	2	2	2.6	1	1	0	1	0.342	3	0	0	0.489	3	1	3	0.731	1.562	3	3.0	15	Potential future construction - cooling water system would permit maximum use of LSG for electricity generation regardless of process need.
	HVAC	20	16	4	3	4	3.5	1	3	1	0	0.545	1	0	0	0.163	3	1	3	0.731	1.439	5	5.0	5	
	Compressor Bldg HVAC	20	0	1	1	1	1	1	3	1	0	0.545	3	0	0	0.489	3	1	3	0.731	1.765	5	1.8	23	Address in pending reconstruction project

Table A-7

Plant Wide Electrical Systems

				Probability of Failure				Consequence of Failure																
								Social					Environmental				Economic							
			Weighting	*0.3*	*0.5*	*0.2*	*1*	*0.105*	*0.132*	*0.044*	*0.105*	*0.386*	*0.163*	*0.08*	*0.082*	*0.325*	*0.17*	*0.068*	*0.051*	*0.289*	*1*			
Classification	Asset(s)	Expected Life	Age	Age	Condition	History	Weighted Probability	Service Disruption	Health/ Safety	Public Image	Board Policy	Social Impact	Permit Compliance	Eco-System	Aesthetics	Environ Impact	Level of Service	Damage	High O&M Costs	Economic Impact	Weighted Consequence	Redundancy Factor	Risk Score	Rank No.
Energy Automation Features	Load-Shed System	N/A	28	5	5	5	5	3	3	1		0.755	4	4	2	1.136	3	4	4	0.986	2.877	4	12.9	4
	Cogeneration Systems Interconnection	30	5-23	5	5	4.7	5	3	5	1		1.019	4	4	2	1.136	3	4	4	0.986	3.141	4	13.3	3
General Equipment	Feeder Isolation Switch (FIS)	30	24	5	5	4.7	5	4	5	1		1.124	4	4	2	1.136	5	4	4	1.326	3.586	4	15.2	2
	Primary Selective and Loop Feeder Arrangements	N/A	10	3	3	3.6	3	3	5	0		0.975	2	2	1	0.568	3	1	2	0.68	2.223	3	6.0	8
	Outdoor Metal-Enclosed Switchgear	30	24	2	2	2.6	2	5	5	0		1.185	2	2	1	0.568	5	2	2	1.088	2.841	3	5.5	9
	Outdoor Pad-Mount Switchgear	30	5-30	2	2	2.6	2	3	5	1		1.019	3	3	1	0.811	4	3	3	1.037	2.867	4	6.7	7
	Underground Cable Systems	30	5-30	2	2	2.3	2	3	3	0		0.711	1	1	1	0.325	3	1	2	0.68	1.716	1	0.8	10
	Facility Electrical Equipment	30	5-30	3	4	3.5	3	4	5	1		1.124	4	4	4	1.3	3	2	4	0.85	3.274	4	10.3	6
	Lightning Protection Systems	30	5-30	5	5	5	5	3	5	3		1.107	3	3	1	0.811	2	2	2	0.578	2.496	5	12.5	5
Critical Power Systems	Critical Power Systems	30	5-30	5	5	5	5	5	4	1		1.097	5	4	1	1.217	5	4	2	1.224	3.538	5	17.7	1