A BROADER VIEW

2016 ANNUAL REPORT

Madison Metropolitan Sewerage District

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Introduction

During 2016, Madison Metropolitan Sewerage District advanced its mission to protect public health and the environment through prudent financial management and budget initiatives tied closely to the district's strategic priorities. From research projects to resource recovery, our work throughout the year demonstrated our commitment to innovation and operational effectiveness.

Our district was established in 1930 to protect the lakes and streams of the upper Yahara watershed and we recognize our environmental responsibilities must be matched by a cost-conscious fiscal approach if we are to achieve sustainability.

Partnerships and progress defined the year with success on many levels. Highlights included:

- The opening of the Platinum-level LEED certified maintenance facility – one of only three buildings in the state of Wisconsin to be certified using rigorous LEED 2009 standards. Unique features include solar tube lighting and a heating and cooling system using treated effluent for temperature control. The building also serves as a source of inspiration and information for the community thanks to the opportunity for guided and self-guided tours.

- Completion of significant infrastructure rehabilitation projects. During 2016, two renovated pumping stations opened that were designed in conjunction with an innovative approach to community engagement known as the Envision process. The approach to the upgrades at Pumping Stations 11 and 12 factored in the surroundings of the facility as well as the interior functions. Both stations include white roofs (which reflect 90 percent of the sunlight), skylights and low or no mow native landscaping.

- During 2016, the district's groundbreaking adaptive management efforts also produced exceptional results. Yahara WINS began in 2012 with a pilot program focused on preventing excess nutrients from entering the watershed. During 2016, the project expanded its scope through an unprecedented agreement among local governments to support ongoing phosphorus reduction initiatives. Among its achievements, Yahara WINS aided 295 landowners/producers, implemented more than 313 conservation practices and reduced phosphorus by 18,392 pounds (new and carry-over).

- These successes were achieved even as the district continued careful focus on affordability. In 2016, the average annual residential sewer service charge of $294 remained 39 percent below the national average of $479. For the year, the district's operating revenues totaled $34.2 million, up 16 percent from $29.5 million in 2015. Total operating expenses increased by a smaller margin, to $26.9 million from $25.7 million in 2015. Reflecting these and other results, the district's change in net position improved to $130.1 million in 2016 from $124.7 million in 2015. The district again received an unqualified opinion or "clean bill of health" from its auditors for the year.

D. Michael Mucha, P.E., ENV-SP
Chief Engineer and Director

Organization

Madison Metropolitan Sewerage District (the district) is a body corporate with the powers of a municipal corporation for the purpose of carrying out the provisions of Sections 200.01 to 200.15 of the State of Wisconsin Statutes. These provisions allow for the creation of "metropolitan sewerage districts" governed by a commission to manage wastewater collection and treatment in metropolitan areas in Wisconsin. As part of the 2015 budget bill, 2015 Wisconsin Act 118, the legislature revised the makeup of such commissions in areas including Dane County.

COMMISSION

Commissioners and Executive Staff

The district is governed by a 9-member commission appointed for staggered 3-year terms. The mayor of Madison appoints five individuals as members of the commission. An executive council composed of the elected executive officers of each city and village that is wholly or partly within the boundaries of the district, except Madison, appoints three members of the commission by a majority vote of the members of the executive council. An executive council composed of the elected executive officers of each town that is wholly or partly within the boundaries of the district appoints one member of the commission by a majority vote of the members of the executive council.

Ken Clark (term ending June 30, 2019)
Sara Eskrich (term ending June 30, 2017)
Ezra Meyer (term ending June 30, 2019)
Thomas D. Hovel (term ending June 30, 2017)
Angela James (term ending June 30, 2017)
James Martin (term ending June 30, 2019)
Brad Murphy (term ending June 30, 2018)
Tom Wilson (term ending June 30, 2018)
Brian Potts (term ending June 30, 2018)

D. Michael Mucha serves as the chief engineer and director. Dave Gawenda, the treasurer of the City of Madison, serves as treasurer of the district. Paul Kent, Stafford Rosenbaum, LLP is attorney for the district.

Time and Place of Meetings

The commissioners of the district meet once or twice each month, at the Maintenance Facility Training Center at 1610 Moorland Road, Madison, WI 53713. Special meetings are held upon call of any member of the commission.

ANNEXATIONS TO THE DISTRICT

Table 1 – Annexations to the District

Annexation Name	Number	Municipality	Acres Added
Bishop's Bay – The Back Nine	2016-01	Town of Westport Utility District	468.52
Machian property – The Willows II	2016-02	City of Madison	10.55
Pleasant Hill DeForest	2016-03	Village of DeForest	37.30
Kettle Creek North	2016-04	City of Verona	66.55
Verona Technology Park (TID #8)	2016-05	City of Verona	111.60
		TOTAL	694.52

Chief Engineer and Director's Department

PERSONNEL

In the absence of labor contract, 2016 was the first year an employee handbook was in place for the entire organization. It also marked the first year of the commission approved Employee Leadership Council (ELC). This council is comprised of elected district employees and provides a pathway for employees to participate in responsible governance of the district. In 2016, the ELC selected a facilitator, began developing operating guidelines and went through extensive training on interest based problem-solving along with the executive team. The ELC also spent the last half of the year analyzing a district pay study and providing recommendations to the executive team on implementing the results. The ELC is a valuable resource to the employees and the organization.

Hires, Retires and Promotions of District Employees

New to the organization:
Sean Johnson – Relief Operator
Logan Miller – Relief Operator I
Lynn Kruchten – Program Resource Associate
Andrew Suesse – Regulatory and Compliance Engineer
Matt Leitzen – Procurement Agent
Jennifer Faust – Chemist I
Matt Seib – Process and Research Engineer
William Walker – Director of Planning and Strategy
Jennifer Hurlebaus – Project Engineer II
Chris Rentmeester – Network Technician

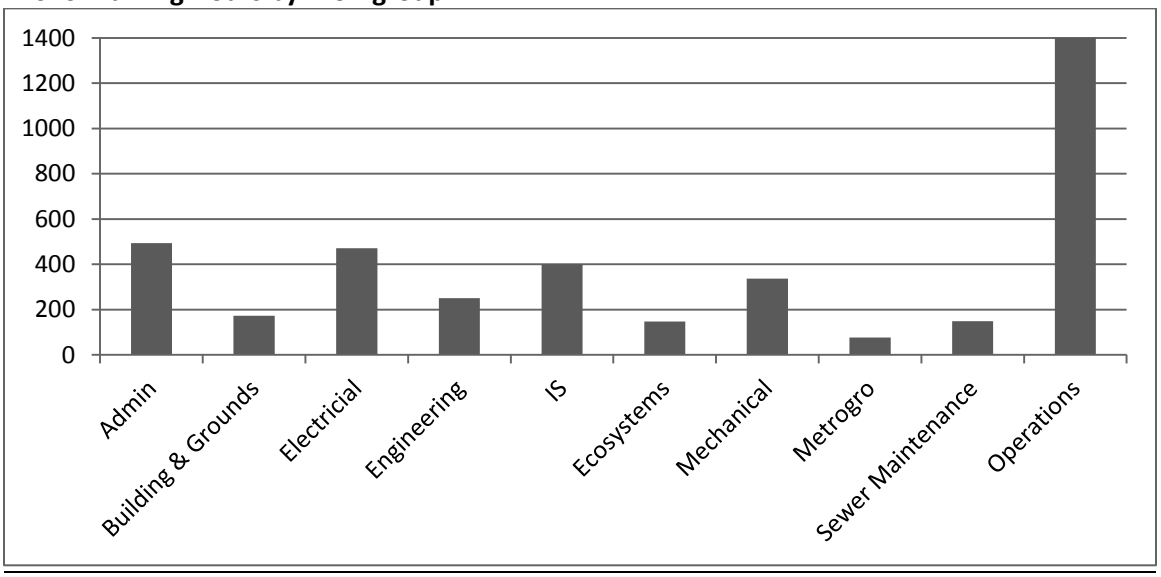
Retirements:
Steve Reusser - Operations Engineer
Michael Simon – Director of Planning and Assistant Chief Engineer & Director

Promotions:
John Alton – Senior Journeyman Mechanic
Tom Berg – Operator III
Ross Hollfelder – Biosolids Program Assistant
Steve Klein – Senior Journeyman Mechanic
Zenon Kochan – Senior Journeyman Mechanic II
Michael Kressin – Monitoring Services Worker II – Lead Worker
Jeff Kroning – Senior Journeyman Electrician II
Craig Palzkill – Process Control System Technician
Cory Pieper – Relief Operator II
Jake Schinderle – Operator II
Derek Steinhorst – Monitoring Services Worker I
Brian Suchomel – Journeyman Mechanic
Matt Zwolanek – Senior Building and Grounds

TRAINING ACTIVITIES

The district continues to value and support the growth and development of employee skills, knowledge and abilities through training activities. During 2016, district employees completed over 4,207 hours of training. As a whole district employees averaged over 44 hours of training per employee during the year.

Table 2 - 2016 Training Hours by Workgroup



SAFETY

In 2016, MMSD continued to see improvement in workplace safety which is reflected in our improved Occupational Safety and Health Administration incident and DART rates. The previous year's investments in implementing new safety programs which led to additional safety training has helped drive the district to one of its best years in regards to workplace injuries.

Table 3 – Incident and DART Rate Comparison

Year	Incident Rate	DART Rate
2011	5.50	5.50
2012	2.14	1.07
2013	4.18	4.18
2014	9.20	4.60
2015	5.70	2.30
2016	**3.4**	**1.1**

PUBLIC EDUCATION

District 2016 Tours and Public Education Summary

Tours are a popular free service that the district offers the community as a way to educate the public about the wastewater treatment process and sustainability concepts. Approximately 1,650 visitors toured the Nine Springs Wastewater Treatment Plant in 2016 in over 60 tours, which was an increase from 2015. Tours are made possible by many district staff members who help prepare for and lead tours, as well as dedicated external tour guides.

The diverse types of tour groups that came through the district in 2016 exemplify the breadth of interest in wastewater treatment and water issues in the community. The district provided tours for K-12 students, college classes, plumbing apprentices, government workers and officials, wastewater operators-in-training, homeschool groups, youth enrichment programs and more. A candidate for U.S. Senate toured the plant in 2016, highlighting the degree to which water quality issues have become a policy priority.

In addition to the standard tour of the treatment plant, the district also provides specialty tours from time to time for groups with specific interests and backgrounds. One such specialty tour was added in 2016 to showcase the new Maintenance Facility. The pollution prevention specialist, the lead engineer on the construction of the Maintenance Facility, and the resource team worked together to create a tour and signs that highlight the LEED features of the facility. This tour and signage contributed a point to the facility's LEED platinum score.

While tours have historically been the district's primary means of public education, the district started building the foundation for a more comprehensive public education program in 2016. Specifically, the district literally broke ground on the renovation of Shop One, which previously housed employees that moved to the new Maintenance Facility, into a permanent water education center. The district is starting to emphasize the one water concept as a central message of its public outreach, and Shop One is intended to help convey this concept to district visitors. Shop One has already become the starting point for district tours, and is planned to become a museum and educational space to enrich visitors' experience in the future.

Planning and Strategy Department

REORGANIZATION AND STAFFING

The Department of Planning and Strategy was formed in 2016 by moving functions from the Department of Engineering and Department of Operations and Maintenance.

The newly formed department has six full time employees (alphabetically by title):

- Asset Information Specialist
- Capital Planning Engineer
- Director (hired late 2016)
- Engineering Technician
- GIS Technician
- Sustainable Infrastructure Manager

RESPONSIBILITIES

The department's main responsibilities are as follows:

- Lead capital improvement planning (information management, interdepartmental coordination and decision support for all capital projects).
- Lead operational planning (information management, interdepartmental coordination and decision support for projects affecting the operating budget and staff workload).
- Develop sustainable infrastructure management program (business risk exposure framework, risk register, levels of service analysis and decision support).
- Provide GIS services (mapping, training, application development and support).
- Manage system connections (sewer extensions, other connection requests, connection charge rates and billing and connection tracking).
- Manage user charge billings (quarterly bills, analysis and coordination with monitoring services).
- Provide general decision support, strategic planning and long-term analysis to the district.

INITIATIVES

The department has three major initiatives that will carry forward from 2016 into 2017:

- Transition the district's GIS system (modernize and migrate databases, deploy modern GIS software, expand user capabilities, expand use of GIS applications and integrate geographic data more fully with other district systems).
- Develop an operational planning process (integrate district and department level strategic plans, support departments in identifying operational needs, develop business cases, develop project ranking tools and support development of operating budgets).
- Conduct sustainable infrastructure pilot plan projects (focus on sludge digestion process and heating ventilation and air conditioning systems, develop maintenance and capital investment strategies based on asset condition, risk and fiscal management considerations).

In 2016, the department was heavily involved in the effort to update connection charges policies. The work included a detailed land use study, in cooperation with the Capital Area Regional Planning Commission.

Operations and Maintenance Department

OPERATION OF WASTEWATER FACILITIES

Sources of Wastewater

The district receives and treats wastewater from the Cities of Fitchburg, Madison, Middleton, Monona and Verona; the Villages of Cottage Grove, Dane, DeForest, Maple Bluff, McFarland, Shorewood Hills and Waunakee; and from sanitary and utility districts and other areas in the Towns of Blooming Grove, Burke, Dunn, Madison, Middleton, Pleasant Springs, Verona, Vienna, Westport and Windsor. The district served 38 municipal customers in the first and second quarter of 2016. The City of Madison acquired customers in the Town of Blooming Grove in July 2016, thereby reducing the number of municipal customers served by the district to 37 in the third and fourth quarter of 2016. The district also accepts septic tank wastes and similar wastes from unsewered areas located primarily in rural Dane County. In 2016 694.52 acres of land was annexed by the district. The total area of the district at the end of 2016 was 183.61 square miles.

Interceptor Service

Interceptor sewer service is provided within the district through the district's main and intercepting sewers. The district operated and maintained 94.81 miles of gravity sewers and 31.74 miles of raw wastewater force main at the end of 2016. Wastewater collecting systems are owned and operated by the cities, villages and town sanitary and utility districts and are connected to the metropolitan interceptor system.

All wastewater generated in the district is treated at the Nine Springs Wastewater Treatment Plant located at 1610 Moorland Road, Madison, Wisconsin, located approximately 1 mile south of Lake Monona. The easterly part of the district is served by the East Interceptor, the Southeast Interceptor, the Northeast Interceptor and the Far East Interceptor. The westerly part of the district is served by the Lower Badger Mill Creek Interceptor, the West Interceptor, the Southwest Interceptor, the South Interceptor, and the Nine Springs Valley Interceptor.

The transmission of wastewater from the metropolitan area to the Nine Springs Wastewater Treatment Plant requires the operation of 132 pumping stations, not including 432 small grinder pump installations. The following two tables list the number of pumping stations operated and maintained by individual communities and the district.

Table 4 – Pumping stations operated and maintained by communities

Owner	Number of Pumping Stations	Number of Grinder Stations
City of Middleton	8	
City of Monona	7	
Village of Cottage Grove	4	
Village of Dane	1	
Village of DeForest	1	1
Village of McFarland	5	1
Village of Shorewood Hills	1	
Village of Waunakee	3	1
Town of Blooming Grove Waunona S. D. No. 2	1	
Town of Dunn Kegonsa Sanitary District	5	354
Town of Pleasant Springs Sanitary District No. 1	9	55
Town of Vienna Utility District No. 1	1	

Owner	Number of Pumping Stations	Number of Grinder Stations
Town of Vienna Utility District No. 2	1	5
Town of Westport Utility Districts	10	11
Town of Windsor Sanitary District No. 1	3	
Town of Windsor Morrisonville S. D. No. 1	1	
State of Wisconsin: University of Wisconsin Campus University of Wisconsin Arboretum	 6 1	 4
Dane County - Rodefeld Landfill	1	
Total	**69**	**432**

Table 5 – Pumping stations operated and maintained by the district

Owner	Number of Pumping Stations
Madison Metropolitan Sewerage District	18
City of Madison	29
City of Verona	2
Village of Maple Bluff	3
Town of Dunn Sanitary District No. 1	4
Town of Dunn Sanitary District No. 3	3
Town of Madison	3
Dane County Lake Farm Park	1
Total	**63**

Quantity of Wastewater

The district received 14,905,776,000 gallons of wastewater at the Nine Springs Wastewater Treatment Plant in 2016. This was a 6.63 percent increase from 2015. The average daily quantities of wastewater received from each municipality and through infiltration into the district's intercepting sewers in 2016 were as follows:

Table 6 – Average daily quantities of wastewater

Municipality	2016 (GPD)	% of Total
City of Fitchburg	1,925,000	4.73
City of Madison	26,736,000	65.65
City of Middleton	1,988,000	4.88
City of Monona	798,000	1.96
City of Verona	983,000	2.41
Village of Cottage Grove	665,000	1.63
Village of Dane	51,000	0.13
Village of DeForest	784,000	1.92
Village of Maple Bluff	179,000	0.44
Village of McFarland	667,000	1.64
Village of Shorewood Hills	129,000	0.32
Village of Waunakee	1,509,000	3.70

Municipality	2016 (GPD)	% of Total
Town of Blooming Grove	2,300	0.01
Town of Blooming Grove San. District No. 2	205,000	0.50
Town of Blooming Grove San. District No. 10	19,000	0.05
Town of Dunn San. District No. 1	166,000	0.41
Town of Dunn San. District No. 3	64,000	0.16
Town of Dunn San. District No. 4	14,000	0.03
Town of Dunn Kegonsa San. District	115,000	0.28
Town of Madison	639,000	1.57
Town of Middleton San. District No. 5	21,000	0.05
Town of Pleasant Springs San. District No. 1	62,000	0.15
Town of Verona	500	<0.01
Town of Verona Util. District No. 1	24,000	0.06
Town of Vienna – Wyst59 LLC	100	0.00
Town of Vienna Util. District No. 1	71,000	0.17
Town of Vienna Util. District No. 2	30,000	0.07
Town of Westport Util. District No. 1	149,000	0.37
Town of Westport Util. District No. 2	378,000	0.93
Town of Westport Util. District No. 3	11,000	0.03
Town of Westport Util. District No. 4	11,000	0.03
Town of Westport - Cherokee Golf & Tennis	6,900	0.02
Town of Windsor San. District No. 1	281,000	0.69
Town of Windsor San. District No. 3	200	<0.01
Town of Windsor - Hidden Springs San. District	3,600	0.01
Town of Windsor - Lake Windsor San. District	24,000	0.06
Town of Windsor - Morrisonville San. District	76,000	0.19
Town of Windsor - Oak Springs San. District	26,000	0.06
Total Wastewater	38,813,000	95.30

Wastewater Treatment

The district has a single treatment plant, the Nine Springs Wastewater Treatment Plant, located at 1610 Moorland Rd, approximately 1 mile south of Lake Monona. In 2016, the Nine Springs Wastewater Treatment Plant met all Wisconsin Department of Natural Resources (WDNR) discharge limitations. The National Association of Clean Water Agencies awarded the district a gold award for this high level of performance.

Preliminary treatment includes influent wastewater fine screening and grit removal. Fine screening is accomplished with three, rotating band screens with 5 mm openings and a vortex grit system is used for grit removal. Variable speed drives for the band screens are used to control the influent well level and to maintain a minimum level above the influent flow meters. Grit is removed continuously from three vortex grit chambers.

The dewatered grit and screenings are conveyed to dumpsters and hauled by a contractor to the landfill three to five times per week.

All material removed by the fine screens is conveyed to a screenings processing well. Pumps macerate the screenings and pump them to compactors which squeeze water out of the screenings before they are placed in a dumpster. Two to four times a day, the grit is removed from the well. The grit and accompanying rags are pumped to a separate settling basin, termed a "snail." The material settled in the snail is conveyed to the grit and screenings dumpster.

Following preliminary treatment, 19 primary settling tanks are used to remove floatable and settle-able material from the wastewater. The wastewater after primary settling is biologically treated in the activated sludge system. The activated sludge system consists of tanks with anaerobic, anoxic and aerobic zones configured for biological phosphorus removal, ammonia removal and decomposition of organic material. The material flowing out of the aeration tanks is a mixture of cleaned water and microorganisms. It flows to secondary clarifiers for separation. The secondary clarifiers are a combination of center feed/peripheral draw off and peripheral feed/peripheral draw off configurations and efficiently remove the suspended bacterial solids to meet advanced secondary standards. Most of the solids, which contain the microbial culture, are pumped back to the aeration tanks. A certain percentage of solids are pumped to the solids handling processes every day to maintain a desired bacterial growth rate; these removed solids are referred to as waste activated sludge (WAS). An eight to 10 day solids retention time is normally maintained in the process.

During 2016, the secondary portion of the Nine Springs Wastewater Treatment Plant was operated as four separate treatment units. Effluent from the individual plants was monitored to ensure adequate process control and to provide information on differing operating modes.

The treated water is disinfected by ultraviolet irradiation from April 15 through Oct. 15 and pumped to Badfish Creek and Badger Mill Creek. In 2016, approximately 39.06 million gallons per day (MGD) on average were pumped to Badfish Creek and 3.33 MGD were pumped to Badger Mill Creek.

The open-channel ultraviolet disinfection system has met the effluent fecal coliform concentration standard since starting in 1997. All lamp banks are cleaned with citric acid in the winter months when disinfection is not required. Lamp and ballast replacement is also accomplished during this period.

The primary sludge is removed from the 19 primary settling tanks on a rotating basis and is pumped to three gravity thickener tanks. The solids concentration from the gravity thickeners averaged 5.8 percent in 2016.

The waste-activated sludge was thickened on three gravity belt thickeners. Generally, two of the three units are in service with one unit as standby. The thickened solids concentration off the gravity belt thickeners averaged 5.85 percent in 2016.

The anaerobic digestion process was operated as a phased system throughout 2016. The sludge treatment flow train is normally run as follows:

- Gravity-thickened primary sludge is directly fed to acid phase digestion.
- Thickened waste activated sludge is heated with steam injection and fed to acid phase digestion.
- One acid phase digester is heated to approximately 95 degrees Fahrenheit with an approximately 1.2 day (29 hour) detention time.
- Acid phase sludge is fed to the east digesters 4-9 and the temperature is maintained at 95 to 98 degrees Fahrenheit. The detention time in the east digesters averaged approximately 25 days.

- Digested sludge from east digester 7 is normally pre-heated to approximately 120 degrees Fahrenheit through a Lackeby tube and shell heat exchanger and transferred to west digesters 1-3 for time/temperature Class A batching at 134 degrees Fahrenheit. The required batching time at that temperature is approximately 14 hours. In 2016 approximately 17 percent of the total biosolids mesophilically digested underwent additional time-temperature batch treatment to meet Class A criteria.

Digested sludge from both the east and west digesters was thickened on gravity belt thickeners for most of 2016. The thickened sludge was land applied as part of the Metrogro liquid land application program. Class A digested biosolids production started in November 2014; most of the production has remained in the liquid form and is thickened on GBTs and handled as Class B liquid biosolids. This has been due in part to awaiting final approval of the plan submitted to WDNR for production and distribution of Class A cake biosolids, since without approval to distribute production could not be removed from site and resulted in a stockpile. Approval of the submitted plan was received by WDNR Oct. 18, 2016. Because of this delay and the existing stockpile of biosolids, the centrifuge was only operated once (March 8) in 2016 to produce Class A cake biosolids.

The digested biosolids concentration averaged 2.87 percent for 2016 from the east digesters and 2.01 percent from the west digesters after the time/temperature batching operation. The digested biosolids were thickened to an average concentration of 5.55 percent in 2016, by the addition of polymer on a gravity belt thickener. An average of 25.2 tons/day of digested biosolids was thickened in 2016. The phased digestion process, despite the longer detention time in the digesters, continues to apparently result in degradation of thickening performance compared to years before phased digestion. Anaerobic digester foaming was not a major problem in 2016, an improvement from the situation preceding the 11th addition to Nine Springs.

Filtrates from the digested sludge gravity belt thickening, centrifuge dewatering, and the WAS thickening processes are combined and sent to the Ostara struvite (magnesium ammonium phosphate) harvesting process for nutrient recovery. The purpose of the struvite harvesting process is to remove phosphorus before anaerobic digestion where nuisance struvite is formed, and to reduce phosphorus in the biosolids which will be land applied.

The district utilizes biological phosphorus removal in its secondary process. In this process, anaerobic/aerobic cycling is used to alternately release/take up phosphorus in excess of metabolic requirements. In the anaerobic section, with the availability of organic material in the form of volatile fatty acids, the bacteria release phosphorus. This aspect of biological phosphorus removal is also used in the anaerobic WAS treatment tanks before the WAS gravity belt thickeners. A low flow stream of acid phase sludge is recycled to the treatment tanks and contains significant concentrations of volatile fatty acids, in excess of 5,000 mg/l. The volatile fatty acids in the acid phase sludge are utilized to affect release of phosphorus from the waste-activated sludge.

A significant amount of soluble phosphorus is also released in the acid phase digestion process. The filtrate from the WAS thickeners is thus rich in soluble phosphorus and is combined with the filtrate from the digested sludge thickener which has a high ammonia concentration. These streams are fed to the struvite harvesting reactors, which were purchased from Ostara. Magnesium chloride and sodium hydroxide are added to enhance struvite formation. The process forms spheroidal struvite pellets.

By contract, the product is sold to Ostara in one-ton bags. Ostara picks up the product and markets it as a slow release fertilizer for applications where high phosphorus content is required. Optimization efforts in close association with Ostara are ongoing, and significant production improvement was realized starting in July 2016. For 2016 a new total annual production record for Nine Springs was set, with 497.54 tons being shipped off-site

(about 1.36 ton per day), with 60 percent of that total occurring in the final six months of 2016. The capture of particulate phosphorus in the reactors improved in 2016 and was accompanied by a noticeable downward shift in average product size. Efforts tried by Ostara and district operational staff in 2016 included: changing chemical injection quills, focusing on cleaning up solids entering the reactor, adjustment of upflow and differential pressure variables, continuous seeding, trial of very small seed, and addition of polymer into the reactor itself. Research and optimization will be ongoing in 2017.

The digested liquid biosolids produced by the district are marketed under the name of "Metrogro." The GBT thickened biosolids are either pumped directly to truck loading facilities or to the Metrogro storage tanks. During the winter, all biosolids are stored in the Metrogro storage tanks. The tanks have a storage capacity of 19.5 million gallons. The biosolids are hauled and applied to cropland as a soil conditioner and fertilizer.

As a byproduct of the anaerobic digestion process, gas is produced that is approximately 60 percent methane. Digester gas production averaged around 740,000 cubic feet per day in 2016. Part of the digester gas was used to fuel boilers for plant heating and to fuel a 650 horsepower blower engine, which provides air to aeration tanks. The remainder of the gas is used to fuel two generator engines in sludge control building #2. Before use in the engines and boilers, the gas is treated by a gas treatment system which removes moisture, hydrogen sulfide and siloxanes from the gas. An average of 12,290 kilowatt-hour of electricity was generated each day in 2016. In addition, the blower engine saved the purchase of approximately 9,175 kilowatt-hours per day of electrical energy. The district supplements digester gas production with natural gas purchased from Madison Gas and Electric.

The district takes advantage of the heat recovered from the engines to heat anaerobic digesters and most plant buildings. Jacket water heat and engine exhaust heat are recovered from all three engines when available. Lube oil heat is recovered from the generator engines, but not from the blower engine. If plant heating demands cannot be satisfied with recovered heat, there are three sets of three boilers available for satisfying the heating load.

The electrical generation figure for 2016 is lower than typical because of issues with the oxidation catalysts on the generator engines. During the first quarter of the year the catalysts on both engines failed and damaged the catalyst housings. The WDNR had required the installation of the catalysts as Best Available Control Technology (BACT) for formaldehyde removal. Since the district's air emissions permit required the catalysts, the engines could not be operated without them. One of the catalyst housings was able to be used and a catalyst was installed so that engine could be run. The other engine needed to stay off line. The district submitted a request to WDNR that BACT be advanced maintenance for the engines rather than use of the catalysts. Near the end of the year the WDNR granted that request and a new discharge permit was issued. Following some exhaust piping modifications both engines were then able to be operated. During the time that one engine was not being used, some of the biogas not burned in the offline engine was used in boilers to produce hot water for heating. At times excess biogas necessitated the operation of the flare to burn off excess gas.

The section in this report entitled "Nine Springs Energy Use Profile" describes in detail the electrical and thermal demands at the treatment plant. Table 9, "Annual Energy Use Summary" shows a complete breakdown of the thermal and electrical savings from the use of digester gas.

The 2016 wastewater treatment data are reported in accordance with the district's Wisconsin Pollutant Discharge Elimination System Permit and a summary of this information is shown on the next page in Table 7. Monitoring data for effluent metals are reported in Table 8.

Table 7 – Yearly log of plant operations 2016

Month	Influent Flow (MGD)	BFC Effluent Flow (MGD)	BMC Effluent Flow (MGD)	BOD RAW BOD (MG/L)	TSS Effluent BOD (MG/L)	N RAW TSS (MG/L)	P Effluent TSS (MG/L)	Effluent RAW TKN (MG/L)	Min Hr Effluent NH3 (MG/L)	RAW TP (MG/L)	Effluent TP (MG/L)	FCOLI MPN/100 Mean (1)	Effluent D.O. (MG/L)
Feb – 16	38.65	37.37	3.00	266	7.5	231	5.7	44.8	0.18	6.1	0.31		5.49
Mar – 16	40.10	38.07	3.24	258	7.3	216	4.5	44.1	0.24	6.0	0.26		5.17
Apr – 16	41.33	39.81	3.42	254	6.3	235	5.5	44.4	0.25	6.0	0.29	60	7.29
May – 16	39.80	37.79	3.40	257	3.8	229	4.3	44.7	0.12	6.1	0.26	50	5.44
Jun – 16	39.37	38.18	3.50	258	3.6	236	3.9	43.2	0.43	6.1	0.29	86	5.60
Jul – 16	41.28	39.02	3.56	247	3.4	225	4.5	42.4	0.29	5.8	0.38	81	5.39
Aug – 16	42.68	41.07	3.60	237	4.0	219	5.9	40.9	0.07	5.6	0.46	85	5.70
Sep – 16	44.28	42.42	3.60	231	3.6	212	4.3	42.5	0.15	5.2	0.33	106	6.25
Oct – 16	41.72	40.28	3.60	251	5.0	235	4.8	44.3	0.16	5.5	0.31	87	5.25
Nov – 16	40.47	39.71	3.00	261	6.4	218	5.8	47.3	0.37	5.8	0.27		6.56
Dec – 16	39.14	37.68	3.00	259	6.7	228	6.1	45.0	0.16	5.6	0.27		6.89
Average	40.62	39.06	3.33	252	5.4	225	5.0	44.0	0.21	5.8	0.31	79	6.13

Table 8 – Influent and effluent metal concentrations 2016

		Cadmium (T)		Chromium (T)		Copper (T)		Lead (T)		Mercury (T)		Nickel (T)		Zinc (T)	
Date of Sample	Eff MGD	(PPB)		(PPB)		(PPB)		(PPB)		(PPT)		(PPB)		(PPB)	
		Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff
1/5/16	39.65	0.4	0.31	3.24	0.8b	78	8.33	4.11q	1.2b	102	3.51	3.39	1.85q	123	56.5
2/9/16	39.52	0.22q	0.09b	3.19	1.03q	73.1	7.5	3.56q	1.2b	72.3	1.03	2.29q	0.9b	120	51.4
3/1/16	38.71	0.18b	0.09b	2.61	0.8b	72.9	8.05	4.61	1.2b	117	1.16	3.28	0.9b	124	58.7
4/6/16	47.10	0.17q	0.11q	3.38	1.21q	63	5.32	5.13	1.2b	46.7	1.06	4.01	1.41q	168	59.2
5/10/16	44.96	0.17q	0.16b	4.6	2.12	77.5	7.54q	6.74	1.2b	136	1.14	4.3q	1.6b	145	50.7
6/1/16	45.46	0.16b	0.16b	5.75	2.7	98.5	5.4 q	7.46	1.2b	74.3	1.3	4.46q	1.6b	155	66.6
7/12/16	42.44	0.32b	0.16b	4.52	1.86q	87.2	5.17q	3.3q	1.2b	65.6	0.724	4.7q	2.39q	160	50.2
8/2/16	42.42	0.16 b	0.32b	2.87	1.03q	85	6.9 q	2.4	1.2b	50.4	1.95	3.92q	2q	150	48.4
9/6/16	44.79	0.16 b	0.16b	3.13	0.7q	94.5	5.77q	4.73	1.43q	48	1.26	3.12q	1.6b	138	30.7
10/4/16	43.63	0.16 b	0.16b	3.29	0.91q	84.4	3.56q	5.62	1.2b	65	1.06	4.54q	1.6b	129	28.7
11/1/16	42.64	0.16 q	0.16b	3.3	1.28q	73.8	4.93q	7.13	1.2b	42.8	1.26	3.16q	1.6b	132	28
12/6/16	41.51	0.21 q	0.16b	3.32	1.07q	88	4.66q	4.45	1.2b	47.07	1.73	2.96q	1.6	130	43.4

"b" validation code indicates that sample concentration is less than the method detection limit
"q" validation code indicates that sample concentration is less than the limit of quantitation and above the method detection limit

RESEARCH

Pilot-scale study to evaluate total nutrient removal with low dissolved oxygen

To address energy independence and constantly strive to provide better treatment, the district continued a research project that was initiated in 2013 with Dr. Daniel Noguera (civil and environmental engineering department, University of Wisconsin-Madison) to explore the possibility of removing both nitrogen and phosphorus at low dissolved oxygen (DO) concentrations. The removal of nitrogen at low DO is established, but the combined removal of both nitrogen and phosphorus at low DO concentrations is a relatively new concept, with full-scale attainment only at a few specialized types of facilities. The purpose of this study would ultimately be to see if this technology could be implemented at a conventional activated sludge type facility such as the Nine Springs Wastewater Treatment Plant.

Because of the relatively slow growth rate of the microorganisms involved and the novel nature of the research, the original study length and agreement were longer than typical. The funding of two graduate students for two years (2013-2015) to conduct this research was approved by the commission in 2013. In the summer of 2015, as the original two students were finishing their terms of study, it was determined that continued work in this area was desired. The pilot reactor work thus was extended through 2016, with commission approval. Results so far have shown potential to save approximately 30 percent on aeration energy costs for treatment while achieving the same or slightly better overall effluent quality.

The research performed in 2016 was aimed at reducing input oxygen levels to establish the practical boundaries of treatment. Overall results indicated that full-scale implementation in some form may be possible, but several equipment failures occurred throughout the year, clouding results. The commission approved an extension of this work for 2017, which is aimed at further establishing practical boundaries of treatment under annual transient conditions. Current results from this research are being utilized in the ongoing liquid process facilities plan efforts.

Bench-scale food waste co-digestion research

The district continued a research project evaluating the potential for diversion of food waste to co-digestion in order to produce additional biogas. This project was started in 2014 in partnership with Dr. Daniel Noguera (civil and environmental engineering department, University of Wisconsin-Madison) and a graduate research student. Funding for this project was partially covered from a SIRE-MEI grant (Sustainability Innovation in Research and Education - Major Extramural Initiatives) from the UW-Madison Office of Sustainability. The goal of this project was to investigate the feasibility of collecting source-separated organics, such as pre- and post-consumer food waste and using these materials in a co-digestion process at the Nine Springs Wastewater Treatment Plant. The project sought to gain knowledge from a literature review of similar co-digestion practices as well as bench-scale experimentation to simulate the impacts of co-digestion in the Nine Springs anaerobic digesters. Results from the research provided information on digester performance including gas production, volatile solids destruction, loading limits, dewatering requirements, and impacts of ammonia toxicity caused by different types of food waste. Results from this research are expected to be used as the district explores opportunities to achieve energy independence and evaluates a possible partnership with the City of Madison to co-digest organic waste.

Pilot-Scale Study to Evaluate Nitrite Shunt Activated Sludge Process for Total Nitrogen Removal

One aim of the current liquid process facilities plan effort is to identify possible alternatives to the current modified University of Cape Town (UCT) activated sludge process at Nine Springs that can reduce the total nitrogen content in the plant effluent. This is being done in anticipation of possible stricter permit limits for total nitrogen in the future and to advance the district's mission of environmental stewardship. One option identified

by the consultant involved in this effort is a relatively novel process known as “nitrite shunt.” This process has been shown to improve nitrogen removal while also achieving energy savings with minimal modifications to existing activated sludge infrastructure. However, this process has only been implemented at two facilities in the U.S. and the viability in cold regions such as Madison has not been demonstrated.

This project was started in November 2016, and seeks to evaluate the viability of adapting biomass from the full-scale UCT process at Nine Springs to the nitrite shunt process under cold weather conditions. The project involves the operation of a sequencing batch reactor that is fed primary effluent from the treatment plant. An additional aim of this project is to give district staff experience and insight with several advanced sensors required for many newer biological nutrient removal processes such as nitrite shunt. The project is being overseen by district staff with operational and analytical assistance being provided by Dr. Daniel Noguera (Civil and environmental engineering department, University of Wisconsin-Madison) and several graduate students. This project is expected to last until the end of 2017. Project findings are intended to help inform decisions with the liquid process facilities plan and subsequent design efforts.

Lab-Scale Partial Nitritation Study to Evaluate Side-Stream Ammonia Removal
To address challenges associated with side-stream nutrient loads, the district initiated a research project with Dr. Daniel Noguera (civil and environmental engineering department, University of Wisconsin-Madison) to explore the possibility of removing ammonia from struvite harvester effluent. Under current operations, biosolids produced during wastewater treatment are anaerobically digested and then dewatered using a gravity belt filter. The dewatered biosolids are land applied and the produced filtrate is sent to the Ostara process for struvite harvesting and then back to the main treatment process. The filtrate has ammonia in excess of what is required for struvite formation, resulting in a large nitrogen load being sent back to the main treatment process, which increased aeration energy demands.

This study was started in July 2016 and includes the operation of a lab-scale single-stage partial nitritation and anammox reactor similar to the DEMON process. The reactor is located at the University of Wisconsin – Madison and is fed struvite harvester effluent that is collected weekly. The goal of this study is to evaluate operational and control requirements for an ammonia/nitrogen removal technology for the struvite harvester effluent with the aim of minimizing energy requirements for side-stream flows. The study is expected to last until the end of 2017.

MAINTENANCE OF DISTRICT FACILITIES

The maintenance workgroups of the operations and maintenance department are responsible for the maintenance of the Nine Springs Wastewater Treatment Plant, the district pumping stations, the non-district pumping stations covered by maintenance agreements, and the district’s interceptor system. This work is performed by the mechanical maintenance section, the electrical maintenance section, the building and grounds section, and the monitoring services/sewer maintenance section.

In the first part of the year the maintenance crews moved into the newly constructed Maintenance Facility. This LEED Platinum building provides new shop work spaces as well as office work areas for the crewmembers. The inventory and purchasing functions are conveniently located in the center of the facility. Garage space is included at one end of the building. The building also has state of the art locker room facilities, a library and document storage area, a large training room, and a kitchen area. The building consolidates functions that had formerly been spread throughout the treatment plant.

Training of craftsmen continued to be an important function in 2016. Maintenance department personnel serve on the Joint Apprenticeship Training Committee (JATC), which oversees the activities of the apprenticeship programs for electricians and mechanics. Brian Suchomel completed his maintenance mechanic apprenticeship and received his journey worker certificate. Randy Conway continued in the industrial electrician apprenticeship program.

Additional training topics attended by maintenance department supervisors and craftsmen included:

- Fundamental Control Strategies for Heating Ventilation and Air Conditioning Systems
- Transition to Trainer
- Hazardous Location Wiring
- University of Wisconsin Training on Pumps and Motors
- Madison Supervisory Academy
- Arc Flash Hazard Awareness
- Sanitary Sewer Maintenance Technologies and Operations
- John Crane Seal School
- Maintenance Planning and Scheduling
- Pump Repair and Maintenance
- Listening for a Change
- Effective Preventive/Predictive Maintenance

In 2015, a technical writing company had been hired to assist the maintenance personnel in developing standard operating procedures (SOPs) for various tasks that need to be accomplished. The maintenance technicians continued developing SOPs on their own in 2016.

The district's reliability manager and the asset information specialist had developed a commissioning document to ensure that information on all new assets is collected and properly entered into the district's computerized maintenance management system known as Workforce Asset Management. This allows preventive maintenance work orders to be created, records warranty information, ensures that operations and maintenance manuals are present and provides for the creation of bills of materials for parts. The document continued to be used by the maintenance sections in 2016 to gather and enter data for the Maintenance Facility and Pumping Station 18 assets as well as the new assets being installed in Pumping Stations 11 and 12. Members of the maintenance sections continued working with the district's asset management group. 2016 activities involved condition assessment of assets.

Following are more detailed listings of the activities performed by each of the maintenance sections:

Building and Grounds Section

The section spent the majority of the year maintaining the district and non-district pumping stations, the Nine Springs Wastewater Treatment Plant buildings and grounds, odor control equipment, roads and small equipment. Routine work includes landscaping projects, cutting grass, plowing snow, cleaning plant buildings and galleries, maintaining lagoon and dike roads and painting and carpentry projects. This section also performs preventive maintenance work on the district's electrical manholes, process tanks, roofs and floors.

In 2016, building and grounds crew assisted the operations and engineering staff with projects including:

- Continued working jointly with the City of Madison on a non-intrusive wet well cleaning procedure. The procedure generally has eliminated entering a confined space, and the grease removed is taken directly to the landfill.

- Performed preventive maintenance on primary settling tanks 6, 7, 8, 19 and 20.
- Performed preventive maintenance on aeration tanks 1-9.
- Performed preventive maintenance on final clarifiers 13 through 16.
- Cleaned the dryers in the struvite harvesting building.
- Changed the media in one of the siloxane removal vessels and the hydrogen sulfide removal vessel.
- Cleaned accumulated struvite from the filtrate wells at the gravity belt thickener building and the waste activated sludge thickening building.
- Painted and landscaped at the wastewater treatment plant.
- Made plumbing repairs in district buildings.
- Exercised valves at the treatment plant and pumping stations.
- Repaired snow removal equipment and lawnmowers.
- Removed brush and trees along Badfish Creek.
- Inspected treatment plant and pumping station roofs.
- Assisted by the City of Madison, cleaned the wet wells of district owned Pumping Stations 1 and 14.
- Filled the odor control unit at Pumping Station 16 with media.

The building and grounds crew contracted for the following services:

- Media blasting and recoating of final clarifiers 13 and 15. Only clarifier 13 was completed in 2016.
- Electrostatic painting of fencing around primary tanks 9 – 16.
- Preparation and painting of the exterior of the vehicle loading building.
- Sealcoating of approximately 31,350 square feet of parking areas and roads at the plant.
- Removal and replacement of approximately 9,750 square feet of low volume roadway at the plant.
- Repairing of one of the grit/screenings dumpsters.
- Weed spraying of the plant perimeter fence.
- Repairing of the plant perimeter fence following damage from multiple downed trees.

Mechanical Maintenance Section

The goals of the mechanical maintenance section are to: 1) verify proper operation and effectively maintain the pumping stations of the district and its contract customers; 2) ensure that all collected wastewater is conveyed to the treatment plant; 3) effectively maintain and support operation of the treatment plant equipment and facilities while working with operations personnel to meet the district's goal of meeting or exceeding the district's effluent discharge permit; and 4) develop section staff members to their best professional and personal ability through the district's apprenticeship program, other training programs and wellness opportunities.

In addition to many planned and scheduled maintenance activities, major accomplishments completed in 2016 included:

- Responded to failure of oxidation catalysts on the exhaust of the generator engines.
- Rebuilt the inlet valves at Pumping Stations 7 and 14.
- Rebuilt the Metrogro storage tank isolation valves in the Metrogro pumping station.
- Rebuilt return activated sludge valves in Aeration Control Building 2.
- Tested a Boerger rotary lobe pump as a replacement for existing rotary lobe pumps.
- Installed a new air compressor in the west blower building.
- Created standard operation procedures for various jobs.
- Cleaned steam injectors.
- Contracted for the installation of new pressure relief vessels in the boiler building.

- Replaced the heating coils in two air handling units.
- Replaced all 11th addition rubber expansion joints on the hot water system with metal expansion joints.
- Consolidated all of the maintenance manuals in the new Maintenance Facility library.
- Throughout the year removed rags and other debris from collection system pumps.
- Made minor repairs to district vehicles.
- Rebuilt all of the vacuum breaker/pressure relief valves on the Badfish Creek force main.

Electrical Maintenance Section

The electrical maintenance section devoted a majority of the year to providing the knowledge and skills necessary to assure a high level of electrical reliability to district facilities and the facilities owned by others, yet maintained by the district. This was accomplished through a mix of preventive maintenance, staff training, planned improvements, construction projects and daily maintenance. Examples of preventive maintenance tasks developed by the section include: calibration, inspection, testing/cleaning of electrical and instrumentation equipment and thermographic testing of electrical devices. The section continued to lend its expertise to other departments to facilitate district projects and improve the treatment process. The continued use of the district's computerized maintenance management system has allowed the section to identify problems by tracking equipment data, scheduling maintenance and creating daily and preventive maintenance work orders.

In addition to normal maintenance tasks connected with the operation of the district's wastewater collection and treatment facilities, the following planned improvements or projects were completed or continued in 2016:

- Continued with the upgrading and documentation of electrical drawings for the district and non-district facilities.
- Provided electrical cross-training to the district's mechanics and operators.
- Continued with the in-house training of the apprentice electricians on electrical and instrumentation theory and hardware.
- Operated district portable generators to provide power to various pumping stations during planned and unplanned power outages.
- Continued to upgrade and modify existing electrical equipment at district facilities to accommodate the requirements of NFPA 70E (Arc Flash). The work at Town of Dunn Sanitary District #3 stations Bible Camp, Maple and Jordan and the Village of Maple Bluff Boathouse station was completed to lower the arc flash hazard from the Utility feed.
- Completed a controls upgrade at City of Madison Harper Pumping Station.
- Assisted with installation and programming of the odor control system upgrade at Pumping Station 16.
- Designed, constructed and installed a control panel for the effluent force main pressure relief system.
- Continued collection of data for the Pumping Stations 11, 12, 15, 18 and the Maintenance Facility electrical assets so that specifications, bills of materials and preventive maintenance work orders could be entered in the computerized maintenance management system.
- Created standard operating procedures for annual maintenance at several of the pumping stations owned by others but maintained by the district. Standard operating procedures were also created for buildings and equipment at the treatment plant.
- Assisted the engineering department with submittal review for Pumping Stations 11, 12, 15 and the Maintenance Facility and other upgrade projects.
- Assisted with the review and modification of the district's electrical safety program.
- Created condition assessment forms for electrical assets and used those forms to rate the condition of most electrical assets.
- The electrical maintenance section moved into the new Maintenance Facility.
- Lead the organization and development of the Maintenance Facility records room.

- Created journeyman electrician position and process control technician job descriptions.
- Developed an electrical department purpose statement.

Monitoring Services/Sewer Maintenance Section

A major portion of the work performed by this section is the collection of wastewater samples and flow information from the communities and sanitary districts that are served by the district. The analyses results measured by the district's laboratory on these samples and the flow data recorded by the crew are used to bill the district's municipal customers for treatment services. The crew also collects samples at companies who have discharge permits as issued by the district's industrial pretreatment program. In addition, the crew inspects portions of the district's collection system each year. Repair needs found by the crew are either made by the crew members or by contractors. In addition to the inspections performed by the crew, crewmembers work with contractors to televise and clean portions of the interceptor system. During 2016, the following activities were performed by the crew:

Annual Projects

- Conducted preventive maintenance work on all air release valves.
- Monitored and recorded all lateral connections.
- Purchased and used new laser and flow insert flow monitoring equipment.
- Inspected stop log and flap gate structures.
- Exercised valves in the collection system.
- Worked with a contractor to clean 11 siphons and three line sags (Burbank Place, Rimrock Interceptor and Wingra Drive).
- Assisted United States Infrastructure Corporation with the location of force mains.
- Viewed and coded interceptor televised videos.
- Monitored numerous construction projects involving utility crossings of district interceptors and force mains.
- Collaborated with other O&M sections to determine the cause of excursions from the standpipe near the end of the Badfish Creek force main.
- Investigated odor complaints.

2016 Special Projects

- Inspected the manholes and surrounding areas for the following interceptors:
    1. Far East Interceptor/Far East Interceptor-Far East Extension
    2. East Interceptor-Monona Interceptor
    3. Northeast Interceptor/Waunakee-Deforest Extension/Deforest Leg
    4. Northeast Interceptor/Waunakee-Deforest Extension/Waunakee Leg
    5. Northeast Interceptor/Waunakee-Deforest Extension/ Waunakee Union High School Leg
- Assisted mechanics on rebuild of check valves and air valves on Badger Mill Creek and Badfish Creek force mains.
- Replaced couplers on crosstown air valves with all new stainless steel couplers.
- Inspected where force main enters into gravity, for hydrogen sulfide damage.
- Replaced 24 castings and 25 covers as part of infiltration and inflow reduction.
- Inspected seven manholes that were covered under warranty following chemical sealing.
- Helped assist City of Madison personnel and district mechanics inspect the 16 inch sludge gallery piping in the plant.
- Worked with Red Horse at Pumping Station 16 when they epoxy coated the incoming channel due to corrosion and hydrogen sulfide degradation.

- Performed a flow assessment with laser units on the West Interceptor.
- Continued to work on standard operating procedures for the sewer maintenance/monitoring department.
- Inspected wet well at Pumping Station 1 and Pumping Station 14 for corrosion.
- Started coding the condition of manholes using manhole assessment and certification program.
- Used a new manhole inspection database created by Strand.
- Took manhole elevation readings on Randall Street and Regent Street for a future interceptor lining project.
- Assisted several municipalities with trying to reduce fats, oils and grease issues.

NINE SPRINGS ENERGY USE PROFILE

Table 9 shows an estimate of the total amount of electric and thermal energy used at the Nine Springs Wastewater Treatment Plant and the division between purchased and renewable (primarily self-produced) power. From 2012 to 2016, renewable energy used at the Nine Springs Wastewater Treatment Plant provided roughly 39 percent of the plant's energy needs and had an estimated total value approaching $6.5 million.

Notes:

- The district fuels three large gas driven engines from biogas produced in its anaerobic digestion process. Two of these engines drive electric generators while one powers an aeration system blower.
- Air permitting issues were resolved between the district and the Wisconsin Department of Natural Resources (WDNR) in 2012. Based upon permit requirements, the district increased exhaust stack heights and installed an oxidation catalyst on one of its gas engines. The catalyst was determined to be effective and thus in late 2014 the WDNR directed installation of catalyst equipment on the remaining two engines. This installation was completed in February 2015.
- Overhaul work on one of the engine generators in early 2014 removed an engine for service for a brief period and decreased the overall amount of generation from digester gas for the year.
- In March 2016, it was discovered that the catalyst elements on the two generators were failing due to an overheating condition resulting in damage to one catalyst housing. After discussion with the WDNR the district was able to restore one generator to operation but for most of 2016 the second generator was idle until determination of the long-term viability of catalysts was determined before committing to the high cost to repair the catalyst housing. This situation is reflected in a higher purchase of electricity from Madison Gas and Electric compared to past years.

Table 9 – Annual Energy Use Summary

Electric Energy	**2012**		**2013**		**2014**		**2015**		**2016**	
	kWh/ day	% of Total	kWh/ day	% of Total	kWh/ day	% of Total	kWh/ day	% of Total	kWh/ Day	% of Total
Commercial Service Purchased from MG&E	56,575	64.6%	57,556	65.6%	62,198	70.8%	58,544	66.6%	67,185	75.7%
Wind Power Purchased from MG&E	39	0.0%	26	0.0%	25	0.0%	40	0.0%	40	0.0%
Generated from Digester Gas	21,096	24.1%	20,550	23.4%	16,478	18.7%	19,968	22.7%	12,291	13.9%
Avoided Purchase Due to Blower Gas Engine	9,841	11.2%	9,556	10.9%	9,194	10.5%	9,406	10.7%	9,177	10.3%
Total Used & Avoided	**87,552**		**87,689**		**87,894**		**87,958**		**88,694**	
Average cost of purchased power ($/kWh)	$0.0857		$0.0880		$0.0843		$0.0921		$0.0834	
Estimated total monthly value of energy used	$228,308		$234,667		$225,282		$246,292		$225,670	
Estimated monthly value of renewable energy	$80,936	35.5%	$80,611	34.4%	$65,862	29.2%	$82,362	33.4%	$54,726	24.3%
Thermal Energy	**2012**		**2013**		**2014**		**2015**		**2016**	
	therms/ day	% of Total	therms/ day	% of Total	therms/ day	% of Total	therms/ day	% of Total	therms/ Day	% of Total
Generated from Natural Gas	306	15.0%	420	18.9%	665	28.8%	834	43.0%	831	36.5%
Generated from Digester Gas	18	0.9%	131	5.9%	292	12.6%	111	5.8%	333	14.6%
Recovered from Gas Engines	1,721	84.2%	1,674	75.3%	1,352	58.6%	992	51.2%	1,111	48.9%
Total hot water energy used	**2,045**		**2,224**		**2,309**		**1,938**		**2,275**	
Average cost of purchased gas ($/therm)	$ 0.5352		$ 0.5955		$ 0.6674		$ 0.4793		$ 0.4828	
Estimated total monthly value of gas used*	$44,502		$53,716		$62,507		$37,668		$35,454	
Estimated monthly value of renewable energy	$37,846	85.0%	$43,583	81.1%	$44,513	71.2%	$21,455	57.0%	$28,357	80.0%
Total Energy Use	**2012**		**2013**		**2014**		**2015**		**2016**	
	$ per month	% of Total	$ per month	% of Total	$ per month	% of Total	$ per month	% of Total	$ per month	% of Total
Total Estimated Value of Energy Used	$272,810		$288,384		$287,788		$283,960		$261,123	
Estimated Value of Renewable Energy Used	$118,844	43.6%	$124,221	43.1%	$110,375	38.4%	$103,817	36.6%	$83,084	31.8%

* Conversion of natural gas to heat is assumed to be 75% efficient and heat recovered from the gas engines is assumed to be 40%.
Note – due to rounding, numbers may not add exactly.

Engineering Department

ENGINEERING AND CONSTRUCTION

Nine Springs Valley Interceptor-Morse Pond Extension
The Nine Springs Valley Interceptor-Morse Pond Extension project will extend sanitary sewer service to undeveloped lands near the intersection of Highway PD and Highway M. The proposed interceptor will serve City of Verona lands south of Highway PD and City of Madison lands north of Highway PD. It is anticipated that the new twenty inch diameter sanitary sewer will be located along Raymond Road and will extend approximately 3,150 lineal feet from the district's Nine Springs Valley Interceptor -midtown extension to the southwest corner of Highway PD and Highway M.

Planning and design work for the interceptor are being completed in conjunction with Wisconsin Department of Transportation reconstruction of Highway M and are being performed by MSA Professional Services. The work has been delayed several times by Wisconsin Department of Transportation design changes associated with the road reconstruction, but work was nearing completion at the end of 2016. The design is expected to be finished in 2017, with construction of the new interceptor slated to occur in 2017 and 2018.

Maintenance Facility
Existing "non-process" buildings at the Nine Springs Treatment Plant were determined to no longer meet the needs of the operations and maintenance department. They lacked adequate space to properly perform required maintenance functions and did not include the necessary restroom, locker room, washing and ancillary facilities. Nearby buildings associated with maintenance were also identified as being over utilized, underutilized or near the end of their useful life.

In addition to maintenance areas, select Operations Building spaces needed evaluation to determine how they could best serve the long-term needs of the district. This included evaluating public entrance to the Operations Building, way-finding, determining future office space needs and assessing commission meeting space requirements.

To fully evaluate these needs, Bray Architects were retained to perform a comprehensive space needs study. The study identified and evaluated alternative methods to meet present and future district space requirements. The study also surveyed space needs of district departments, analyzed various alternatives and provided a recommended approach.

The space needs study was completed in early 2013 and was approved by the commission in July 2013. Recommendations included a new maintenance facility, renovations to Shop 1 and improvements to the first floor of the Operations Building. Design of the new facilities was completed in late 2014 and the project was bid Thursday, Jan. 22, 2015. The commissioners awarded the contract to C.D. Smith Construction Jan. 29, 2015, at their low bid price of $9,490,817. As of Dec. 31, 2016, work was approximately 99.8 percent complete.

Pumping Stations 11 and 12 Rehabilitation
The 2011 collection system facilities plan update identified Pumping Stations 11 and 12 as needing improvements to upgrade the overall reliability of the stations and to increase pumping capacity.

The rehabilitation of Pumping Stations 11 and 12 includes improvements to pumping equipment, electrical systems and to the exterior of the stations. The project also includes new heating, ventilation and air conditioning equipment and an addition to Pumping Station 11.

Detailed design began in 2013 and was completed in June 2014. Bids were opened Aug. 28, 2014, and Sept. 11, 2014, the contract was awarded to J.F. Ahern Company at their low bid price of $8,860,000. The project was expected to be complete by the end of 2016, but delays in pump delivery extended this into mid-2017. As of Dec. 31, 2016, work was approximately 96.3 percent complete.

Rimrock Interceptor Rehabilitation/Replacement

The Rimrock Interceptor was installed in 1959 and consists of approximately 3,800 feet of 12-inch concrete sewer. Portions of the interceptor lacked adequate capacity for future peak flows, suffered from inflow/infiltration and had concrete corrosion above the normal waterline. The interceptor also sagged in several locations, causing increased maintenance (i.e., cleaning) and an increased risk of overflows.

Planning and design of the project were completed by Town & Country Engineering and district staff in 2015. The project included lining approximately 1,600 feet of deteriorated 12-inch diameter concrete pipe and open cut replacement of approximately 2,000 feet of pipe. The project also included application of a protective coating to all manholes (both remaining and new).

The project was bid Thursday, Dec. 3, 2015. The commissioners awarded the contract to E&N Hughes Company Dec. 17, 2015, at their low bid price of $823,351.50. Construction activities began in early 2016 and were completed by the middle of the year. Work was formally accepted by the commissioners July 14, 2016. The final contract amount, including all change orders, was $834,359.23.

Pumping Station 15 Rehabilitation

The district's collection system facilities plan update (2011) identified Pumping Station 15 as requiring a firm capacity upgrade and replacement of major electrical and control equipment. The Pumping Station 15 rehabilitation project includes replacement of existing pumps and valves, enhancement of the power system, replacement of major electrical and control equipment; installation of new heating, ventilation and air conditioning systems, installation of a flow meter within an exterior valve vault and construction of a building superstructure that will allow new electrical equipment to be located above grade.

Planning and detailed design began in 2015 and was completed in early 2016. This work was performed by Baxter & Woodman and district staff. The project was bid Thursday, April 7, 2016. The commissioners awarded the contract to Miron Construction Company. April 14, 2016, at their low bid price of $3,085,728. Construction activities began in mid-2016 and were 35.8 percent complete by the end of 2016. Construction is expected to extend to the end of 2017.

Pumping Station 12 Force Main Relocation at Verona Road

The Pumping Station 12 force main relocation project will relocate the discharge end of the Pumping Station 12 force main and the associated downstream interceptor from the Verona Road/Highway PD right of way to the Cannonball bike path corridor. This is being done in advance of Wisconsin Department of Transportation improvements to Verona road and Highway PD, which will widen the roads and cause the force main and interceptor to be located beneath future traffic lanes.

In addition to this, the existing force main and interceptor, which were built in 1968, are showing signs of corrosion. They are also predicted to reach capacity by 2030. The relocated portion of pipe will be approximately

2,400 feet in length and will discharge to a new manhole structure on the north side of Highway PD. The project will abandon 1,400 feet of existing forty-two inch gravity interceptor sewer pipe and six manholes.

Planning and detailed design, which was performed by Strand Associates, began in 2015 and was completed in early 2016. The project was bid Tuesday, May 3, 2016. The commissioners awarded the contract to Speedway Sand & Gravel Incorporated, May 12, 2016, at their low bid price of $1,871,179.74. Construction activities began in the summer of 2016 and were 82.6 percent complete by the end of 2016. Construction is expected to be complete by the middle of 2017.

Liquid Processing Facilities Plan

The district's asset management program identified a number of treatment plant liquid processing needs that required further consideration. The liquid processing system includes the processes and equipment necessary for the plant's liquid stream, specifically screenings and grit removal, primary treatment, secondary treatment (including aeration and final clarification), ultraviolet disinfection, and effluent discharge. Before construction of any new major wastewater facility improvements, the Wisconsin Department of Natural Resources requires owners to prepare a facilities plan. The facilities plan would identify alternatives available to address the needs, evaluate the alternatives, select the best alternatives and prioritize the improvements.

Staff determined that with several potential liquid stream projects on the horizon, a single planning effort would be best to address the different needs and to provide coordination between them. The intent of this facilities planning effort is to evaluate the following needs in a coordinated and holistic manner:

- Regulatory Requirements and Plant Loadings
- Peak Flow Capacity/Management
- Aeration Systems
- Headworks Facility
- Ultraviolet Disinfection System
- Electrical Systems
- Other Miscellaneous Plant Improvements

Consultant selection for this effort was completed in early 2016, with the work being awarded to Strand Associates. Actual planning work began in the spring of 2016 and continued throughout the year. Work is expected to continue into mid-2017, and will likely result in the recommendation of new or rehabilitated facilities and several large capital improvement projects over the next decade.

West Interceptor MH02-003 to MH02-014A Rehabilitation

The original West Interceptor is one of the district's oldest facilities in the collection system. It was constructed in 1916 from Pumping Station 2 to the intersection of University Avenue and Farley Avenue. The section in Regent and Randall Streets, which extends from manhole MH02-003 to manhole MH02-014A, consists of approximately 4,575 feet of 24-inch cast iron pipe.

The West Interceptor was televised in 2011 to assess its condition. The primary defect in the cast iron sewer was tuberculation, or the buildup of deposits on the inside walls of the pipe due to chemical reactions between the wastewater and the cast iron pipe. The deposits generally form above the normal waterline and decrease the capacity of the sewer by reducing the effective diameter of the pipe and increasing the surface roughness. The tuberculation may also compromise the structural integrity of the pipe. Cleaning and cured-in-place lining of the sewer were recommended to rehabilitate the sewer and extend its useful life.

Planning and design for rehabilitating the interceptor began in 2015 and were completed in early 2016. In April 2016, the project was bid as a joint project with City of Madison. Due to bidding problems the project was not awarded and was delayed until 2017. At that time, the district project will be separated from the City of Madison work and will be bid as a district only project. The estimated construction cost of the project is approximately $1,300,000.

Lower Badger Mill Creek Interceptor-Phase IV

The Lower Badger Mill Creek watershed is located along the district's westerly boundary and includes lands in the Town of Middleton, Town of Verona, City of Madison and City of Verona. Starting in approximately 2004, the district began working with the City of Verona and City of Madison to design a regional interceptor to serve the entire basin. In 2006, the district and City of Verona built phase I of the Lower Badger Mill Creek (LBMC) Interceptor, which extended from Pumping Station 17 to Edwards Street. Phase II of the interceptor was installed in 2008, and extended service to the Epic Systems Corporation campus. Phase III of the LBMC Interceptor was constructed in 2013 to facilitate roadway and infrastructure improvements at Epic Systems.

Phase IV of the LBMC Interceptor will extend the interceptor to Highway PD and will accommodate further expansion of the Epic campus and/or future development near Highway PD. Phase IV of the LBMC Interceptor will include approximately 3,860 feet of 30-inch diameter sewer through open lands. Planning and design started in late 2016, with MSA Professional Services assisting with this work. Design is expected to be complete in mid-2017 with construction anticipated for late 2017. The estimated construction cost of the project is $1,100,000.

Shop One/One Water Center Site Improvements

As part of the LEED platinum Maintenance Facility project, Shop One was renovated to create a large, flexible, meeting space. The intent of the renovation was to use the space for large meetings, events, tours, etc. The renovation also provided options for a water education and outreach center that would promote one water concepts throughout the region.

To make this space more public and to welcome bicyclists, pedestrians, vehicles and buses to the facility, the district would like to improve the site around the building. The site improvements are envisioned to be inviting and geared-toward showcasing the one water concept. Conceptual ideas include water education areas, highlighting district recovered resources, and stormwater practices such as pervious paving, bioretention areas and native plantings. The intent would be that the site improvements highlight the district's commitment to water quality and protecting public health and the environment. Planning for the work began in late 2016. A consultant will be selected to assist with the work in 2017, with construction anticipated for 2018.

Capital City Bike Trail Relocation

The Capital City Recreational Trail, used by thousands of bikers, joggers, rollerbladers and walkers annually, passes through the eastern portion of the district campus. In this area, the trail crosses two entrances to the district vehicle loading building. The entrances are used by district personnel daily, including forty to fifty semi-tankers during the peak Metrogro hauling seasons. The crossings at the entrance/exit to the district vehicle loading building pose a safety concern for trail users, as district vehicles that enter/exit the facility conflict with trail usage. This is especially true for semi-tractor trailers, which are difficult to maneuver and may block the trail as they wait to enter onto South Towne Drive.

To alleviate these concerns, the district plans to relocate the trail. Improvements include better sight distances, better overall safety and a reduction of potential conflicts between trail users and district vehicles. Planning and

design work for the trail relocation began in 2016, with Ayres Associates assisting with the work. Construction is expected to occur in 2017, at a cost of approximately $100,000.

Ecosystem Services Department

RESEARCH

Chloride Initiatives

At high concentrations, chloride (a component of basic table salt NaCl) can pose a threat to freshwater ecosystems. Wastewater treatment at the district's Nine Springs Wastewater Treatment Plant does not remove chloride and the concentration of chloride that arrives at the Nine Springs Plant exceeds the water quality standard. During 2015, our consultant completed a study which determined that while possible, treatment would be cost-prohibitive, energy intensive and involve a multitude of other environmental impacts. Therefore, the district carries a variance with its Wisconsin Pollutant Discharge Elimination System permit which requires pollution prevention and source reduction initiatives.

Concurrently, a variety of initiatives were undertaken by the district (household softening study grant pilot programs), which determined that sufficient, viable, pollution prevention opportunities exist. Therefore, the district continues to strive to meet the chloride water quality standard through pollution prevention and source reduction initiatives. During 2015, district staff developed a chloride reduction strategy, which lays out how this will be accomplished over the next five years. This strategy includes: nontraditional investment, grant programs, behavior change initiatives, collaborations and industrial partnerships. If successful, district ratepayers will benefit by avoiding the cost associated with new and expensive treatment technology, while protecting and improving our valuable water resources.

One of these collaborations – Wisconsin Salt Wise Partnership (WISaltWise) – involves a variety of partners focused on optimizing road salt use. Road salt impacts water resources including drinking water, lakes and wetlands. It also contributes to high chloride concentrations in the wastewater during the winter months. WISaltWise includes focused messaging, a website, handouts and signs posted at local businesses. 2016's efforts will include additional collaborations, grant programs, industrial partnerships and behavior change initiatives.

District Golf Course Demonstration Project

Working in cooperation with the City of Fitchburg and the Nine Springs Golf Course, effluent is being used to irrigate a 5,200 square foot area on the seventh hole of the golf course, which includes the former green and portions of the adjacent fairway. This demonstration project began in 2004 as part of the district's on-going effort to evaluate opportunities to promote the beneficial reuse of effluent. Table 10 shows various application statistics for the past seven years.

Table 10 - Golf Course Irrigation Summary Information

General information	2010	2011	2012	2013	2014	2015	2016
Demonstration area (ft^2)	5,200	5,200	5,200	5,200	5,200	5,200	5,200
Irrigation period	11 Jun-12 Oct	09 May-08 Oct	17 May-09 Oct	12 Jul -27 Sept	6 Jun 9 Oct	1 Jul - 25 Sept	1 Jun-3 Sept
Days irrigated	46	68	106	56	28	18	26
Total volume (gallons)	40,110	68,640	94,430	48,832	24,416	15,696	22,672
Total gallons/acre	336,000	574,990	774,310	409,062	204,661	131,484	189,922
Total gallons/acre/day	7,305	8,456	7,305	7,305	7,305	7,305	7,305
Precipitation equivalent (in)	12.4	21.3	28.7	15.2	7.6	4.9	7.0

Commercial Fertilizer Additions (lbs/acre)	2010	2011	2012	2013	2014	2015	2016
Total Nitrogen	174	0	131	0	0	0	0
Total Phosphorus	0	0	0	0	0	0	0
Total Potassium	87	87	37	0	0	0	0
Effluent Additions (lbs/acre)	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Total Nitrogen	48	91	124	60	35	24	24
Total Phosphorus	1.0	1.8	2.0	1.1	0.7	0.5	0.6
Total Potassium	35	62	56	30	22	14	21

PHOSPHORUS WATERSHED ADAPTIVE MANAGEMENT PILOT PROJECT

Watershed-based, integrated solutions are the key to meeting increasingly stringent water quality standards in a cost-effective manner. The district is helping to pioneer this approach with the Yahara Watershed Improvement Network (Yahara WINS) project, a collaborative initiative to meet water quality criteria for phosphorus. This project leverages a codified compliance option in Wisconsin called watershed adaptive management, in which all sources of phosphorus in the watershed jointly implement strategies to reduce phosphorus loads at the lowest overall cost to the watershed. The Yahara WINS project is the first project in Wisconsin and the nation to use this approach as a permit compliance strategy. Since its inception in 2012 as a pilot project, the Yahara WINS project has become a national model of a successful watershed management program, with an unprecedented level of time and funding committed by a wide breadth of partners. The project is truly an embodiment of the one water movement.

Yahara WINS transitioned from a four year pilot project to a full-scale project in 2016. The full-scale Yahara WINS project addresses phosphorus reduction in a 540 square mile area, covering 23 municipal jurisdictions and three counties. Collectively, partners will make a $94 million investment to improve water quality with an ultimate target phosphorus reduction goal of 96,000 pounds per year at full build out. Significant efforts in 2016 included:

- A major press event highlighting the launch of the full-scale project.
- Execution of an intergovernmental agreement in which municipal partners including cities, villages, towns, wastewater treatment plants and others committed to working together in this 20 year effort, including providing financial support.
- Development of an adaptive management plan, which was submitted to Wisconsin Department of Natural Resources.
- Execution of a service agreement with Dane County, which included an innovative “pay for performance” concept.

The success of Yahara WINS reflects the district’s ability to effectively engage a diverse group of stakeholders around a shared vision of collaboration.

INDUSTRIAL PRETREATMENT PROGRAM

Certain substances, when added to sewage, can impact worker health and safety, the biology of the treatment plant, the quality of Metrogro biosolids, operation of sewers and pumping stations and water quality in the receiving streams. The district pretreatment program helps to ensure that toxic substances are kept out of the sanitary sewer system. The program enforces the sewer use ordinance, operates a permitting program and implements pollution prevention and source reduction initiatives.

The core of the permitting program is maintaining relationships with 21 industrial permittees with categorical wastewater processes or with dischargers affecting pollution prevention initiatives. Seven industrial permittees received reissued or revised permits in 2016. All industrial permittees received annual inspections and compliance monitoring of regulated wastewater discharges occurred in both semiannual periods. There were no instances of significant noncompliance by permittees or other users in 2016.

Permits are maintained with approximately 60 waste haulers and non-industrial wastewater sources as well; all waste haulers received annual permits in August and three non-typical permits were reissued in 2016. Staff continued to perform waste acceptance reviews and to respond to non-permitted industrial, hauled waste and other waste acceptance requests.

POLLUTION PREVENTION 2016

Pollution prevention has been a growing priority of the district to reduce pollutants that would be difficult or expensive to remove at the treatment plant, particularly chloride (mostly from salt), mercury, phosphorus and pharmaceutical waste. This approach involves widespread outreach, behavior change strategies, research and building and leveraging partnerships in the community.

In 2016, the district's primary pollution prevention focus areas were chloride reduction and mercury minimization. The district has permit limits and variances for both of these pollutants, so the need to minimize these pollutants to achieve regulatory compliance makes these pollutants a high priority of the district. The district took extensive actions to minimize chloride contributions to the sewer system from water softeners and road salt, detailed in the chloride reduction section of this report. On the mercury side, the district continued its long-running dental mercury minimization program and took steps to explore possible chemical influences on mercury levels in the collection system and in the effluent. In 2016, the district recorded the lowest annual median and average values for influent mercury since its current sampling program began, suggesting that historical and continued minimization efforts are making an impact.

In addition to chloride and mercury, the district is also applying the pollution prevention approach, and an overall one water message, for other pollutants of concern. Through presentations, meeting and tours throughout the year; the district communicated with audiences including health care organizations, customer communities and the general public about the issues of pharmaceutical waste and non-flushable materials and their proper disposal.

These types of initiatives will continue and grow in 2017, particularly with the addition of a new staff person devoted to pollution prevention and pretreatment. The district also plans to launch a pollution prevention newsletter to provide regular updates about its pollution prevention activities to customer communities in 2017.

ACCEPTANCE OF SEPTAGE AND ATYPICAL WASTES

Hauled wastes have been accepted at Nine Springs Wastewater Treatment Plant since 1986. In 2016, the district accepted wastewater from 26 permitted septage haulers. The haulers are charged a specific rate for each category of septage or type of hauled wastes that reflects the district's cost of treating the wastes. In 2016, hauled wastes treatment revenue totaled $513,000. Nearly 32-million gallons of wastewater were received via truck in 2016.

The following table lists the five domestic septage categories, the number of gallons of septage received during 2016 and the percent of increase or decrease in volume from 2015 to 2016.

Table 11 – Domestic Septage Received

Septic Tank	Holding Tank	Grease Trap	Settling Basin	Portable Toilet
11,162,000	17,475,000	498,000	208,000	467,000
12% increase	9% increase	5% decrease	14% decrease	3% increase

The hauled wastes receiving facility and the whey wells are the discharge points for other wastewater not characterized by the five domestic septage categories. In 2016, other wastewater types and volumes received included:

Table 12 – Other waste water received

Wastewater Received	Volume (gal)
Village of Belleville Biosolids (104 loads)	520,000
Village of Brooklyn Biosolids	65,000
Refuse Hideaway Landfill Leachate	149,000
Middleton Landfill Leachate	23,000
Slaughterhouse Wastewater	1,063,000
Other Gray Water	82,000
Grocery Store Food Waste	74,000
Remediation Projects Groundwater	63,000
WVDL Tissue Digester Residue	25,000
Total Other Wastewater Received	**2,064,000**

LAGOON SITE SUPERFUND PROJECT

Routine operations and maintenance activities continued in 2016. These activities included monthly visual inspections of capped areas and containment dikes, water management and vegetation control. United States EPA Region V will be conducting a five year review of the lagoon site in 2017. The five year review fulfills a statutory requirement on the part of Environmental Protection Agency and includes both a site visit and inspection, which will occur in the spring of 2017.

WATERSHED PROJECTS

Watershed Monitoring Program

The district conducts monitoring activities in both the Yahara and Sugar River Watersheds to help assess the overall condition of select streams. Monitoring initiatives include the collection of water chemistry samples and evaluation of the fish and macroinvertebrate communities to determine the biological health of select streams. In 2016, district staff collected water chemistry and macroinvertebrate samples and assisted a contractor (Underwater Habitat Investigations) in evaluating the fish communities. All water chemistry samples were analyzed at the district's laboratory. Macroinvertebrate samples were sent to the University of Wisconsin - Stevens Point for sorting and classification.

In general, water quality as measured by water chemistry was similar to the previous year. Fish communities were evaluated using an Index of Biotic Integrity. WDNR significantly modified the index metrics based on extensive statewide water temperature analysis, fish community data and modeling. Use of the cool-cold transitional index metrics indicated "excellent" environmental conditions within Badger Mill Creek and the Sugar River sites with scores being similar to scores reported over the previous two years. Favorable cool-cold index scores were also found in Badfish Creek but were somewhat more variable.

In a 2016 stream sampling effort, New Zealand mud snails were discovered in the Badger Mill Creek during routine macroinvertebrate sampling activities conducted by district staff. New Zealand mud snails are considered an invasive species and the discovery by the district led to increased surveillance efforts in Dane County streams by the Department of Natural Resources. This highlights the importance of stream monitoring programs, which are conducted on a voluntary basis by the district as part of its comprehensive environmental monitoring program.

The district also has joint funding agreements with the United States Geological Survey for two gauging stations in the Yahara Watershed and two gauging stations in the Sugar River Watershed. The stations in the Yahara watershed are used for traditional flow measurements. The stations in the Sugar River Watershed are used for flow, temperature, dissolved oxygen and conductivity measurements.

LABORATORY ACTIVITIES

During 2016, the district laboratory performed 67,247 analyses on 15,734 samples. These analyses included:

Table 13 - ANALYSES PERFORMED IN 2016

PARAMETERS	QUANTITY
Nutrients (TKN, TP, NH3-N, PO4-P, WEP)	20,856
Solids (Suspended and Total)	19,988
Biochemical Oxygen Demand	5,556
Anions (Cl, NO3-N, NO3+NO2, NO2-N, SO4)	5,539
Field Measurements (pH, TEMP, COND, DO)	4,835
Metals	6,271
Bacteria (FCOLI, TCOLI, ECOLI, Salmonella)	1,196
Volatile Fatty Acids (VFA)	1,197
Misc. Testing (Alkalinity, Density, Chlorophyll, CH4, CN, WET)	1,809

The district laboratory was also involved in the following activities:

- The laboratory analyzed 819 samples in support of the Yahara WINs adaptive management pilot study. 250 of these samples were collected by citizen volunteers.
- The City of Madison Engineering Department continued to bring the lab samples from their monitoring program. The city collects samples from various points throughout the collection system to use for billing purposes. The district analyzed 154 samples for TKN, TP, CBOD5, TSS and pH. This partnership will continue in 2017.
- As part of the pollutant minimization efforts, laboratory analyses for mercury and chloride were conducted on routine and special samples in order to attempt to identify sources of mercury and chloride reaching the plant.
- A mutually beneficial relationship between the UW-Madison and the district continued, with the laboratory providing analytical support for two graduate student research projects. A pilot scale study assessing nutrient removal under low dissolved oxygen conditions was underway in 2016, with the laboratory performing 1,215 analyses conducted on 459 samples taken from this pilot plant.
- 482 samples taken from the pilot scale food waste digester were analyzed in 2016, resulting in an additional 2,775 tests performed. This digester was maintained by a UW graduate student until the time she completed her research in May.

Other noteworthy activities in the laboratory during 2016 were the following:

- 100 percent of the results reported on the proficiency testing samples required for certification were acceptable.
- The laboratory continued with implementation of a new laboratory information management system. Parallel testing was performed with the old system and the new system, to ensure a live date of Jan. 1, 2017.

METROGRO

Metrogro operation

The district recycles biosolids to agricultural land through its Metrogro Program. Summary hauling and cost information for each of the past five years is given in the following table.

Table 14 – Metrogro past 5 years

Year	2011	2012	2013	2014	2015	2016
Gallons Recycled (MG)	38.4	38.2	36.9	38.8	34.3	36.9
Dry Tons Recycled	7,955	7,925	7,623	7,025	6,517	7462
Acres Applied	4,863	4,796	4,671	4,670	4,232	4,739
Program Cost ($000)	$1,605	$1,388	$1,480	$1,428	$1,286	$1,362
$/1000 Gallons	$41.77	$36.38	$40.12	$36.72	$37.54	$36.89
$/Capita	$4.72	$4.08	$4.35	$4.20	$3.78	$3.89
$/Dry Ton	$202	$175	$196	$203	$197	$183

The district continues to produce a high quality biosolids product. Metal concentrations in 2016 were below the concentrations used by Environmental Protection Agency to define an exceptional quality biosolid.
(Note: Wisconsin Department of Natural Resources uses the term “high quality" in NR 204).

Table 15 - Metrogro biosolids quality 2016 average values

Parameter	Concentration	EPA EQ Limit*	EPA Ceiling Limit	Units (Dry Weight)
Total Solids	4.84	NA	NA	%
TKN	8.48	NA	NA	%
NH3-N	4.11	NA	NA	%
Total-K	0.61	NA	NA	%
Total-P	3.68	NA	NA	%
Arsenic	4.3	41	75	mg/kg
Cadmium	1.30	39	85	mg/kg
Chromium	40.3	NA	NA	mg/kg
Copper	588	1,500	4,300	mg/kg
Lead	30	300	840	mg/kg
Mercury	0.70	17	57	mg/kg
Molybdenum	23.8	NA	75	mg/kg
Nickel	25	420	420	mg/kg
Selenium	7.2	100	100	mg/kg
Zinc	869	2,800	7,500	mg/kg
PCB	<0.0120	NA	NA	mg/kg

*EQ means "exceptional quality"
NA means not applicable
< data qualifier is used if one or more of the monthly values used to calculate the yearly average is reported as below the analytical limit of detection.

Environmental monitoring to support the Metrogro program continued in 2016. Approximately 630 water samples were collected from private wells, with samples being analyzed for a number of parameters, including nitrate nitrogen and coliform bacteria. Soil samples were also collected, with the soil test recommendations being used to determine Metrogro application rates.

The district administers a yield guarantee program to secure land during the spring hauling season. The payment structure for the yield guarantee program is based on the date at which application to a given field is completed. Weather conditions in 2016 extended the spring hauling season, resulting in slightly higher payments in the yield guarantee program when compared to 2015.

Each year the district contracts with a number of firms to provide semi tractor-trailers with drivers to pull the district's Metrogro trailers. Several of the firms also provide individuals to operate the district's Metrogro applicators. The district requested submittals from contractors to supply owner-operator semi tractors and equipment operators for 2015 with the option to extend the contract for three additional years. The district exercised the contract extension option for 2016.

METROMIX

MetroMix Program

The district goal is to diversity its overall biosolids management program by developing biosolid product(s) that can be used in markets not routinely served through the Metrogro program. Initial efforts involved combining dewatered biosolids with materials such as sand and sawdust to provide bulk and texture, with the resulting

product having a soil-like appearance. This product was given the trade name MetroMix and district efforts to develop alternative markets have generally been grouped under the MetroMix program.

Biosolids and biosolids products in non-agricultural markets must meet stringent regulatory requirements established by the Wisconsin Department of Natural Resources. Specifically, the product(s) must meet the Wisconsin Department of Natural Resources definition of “exceptional quality” sludge. The district took the final step in this process by obtaining a Class A determination with respect to pathogens for biosolids that would be used in the MetroMix program. This was a major achievement as there are only approximately 20 wastewater treatment plants in Wisconsin that have achieved a Class A biosolids designation.

Market development efforts in 2017 and beyond will be led by the district’s resource recovery manager and will be supported by multiple departments at the district.

Administrative Services Department

ACCOUNTING, PURCHASING AND BUSINESS SERVICES

The district's accounting and business services group provides accounting, budgeting and purchasing functions, and clerical support for all district departments. We support the commission process and core business applications such as Oracle Work and Asset Management, ACCPAC accounting software, and the OnBase Document Imaging System. Notable activities in 2016 included the following:

- The purchasing department moved from the operations and maintenance department to administrative services in 2016. We developed a new plan for that area and hired a procurement agent. The procurement agent is responsible for developing effective purchasing procedures and assuring that they are followed throughout the organization. This individual will serve as a resource and internal adviser to district staff regarding established policies and guidelines and be an advocate and leader for adopting best practices for purchasing within the organization.
- We experienced continued difficulty in implementing the Questica budget software. At the end of 2016 a review of the Questica implementation was underway in order to address the difficulties.
- The information technology strategic plan moved document management to a higher level of importance. A group will be formed in 2017 to address document management at the district.
- The district's Oracle Work and Asset Management (WAM) software is going through big changes. Oracle has introduced a major upgrade to the software, to version 2 (WAM V2), and will no longer support our current version in 2022. Preparing for the transition to WAM v2 and making the transition is expected to take several years. The district will begin planning for implementing WAM V2 in 2017.
- The program resource group, or resource team, implemented a major reformatting of the 2016 budget and capital improvement plan documents.
- The district received the Government Finance Officers Association (GFOA) Budget Presentation Award for our 2016 Budget, our fourth year receiving the award, and achieved a rating of outstanding on seven of the 14 mandatory criteria. The 2015 budget received an outstanding rating on four mandatory criteria.
- The district obtained a fiscal year 2016 audit by CliftonLarsonAllen, LLC that found no material weaknesses or significant deficiencies (a "clean" audit).

INFORMATION SYSTEMS ACTIVITY

The district's information systems workgroup provides infrastructure and software support, design services, data management, and technological consulting services for all departments at the district. Services and systems of note are listed below by department.

Administration

Services key to the function and productivity of the administration department include the budgeting database system, Questica Budget System, OnBase document and records management system, pump station billing database and applications, rate setting database and applications, Work and Asset Management (WAM) System and website support and administration.

Ecosystem Services

Our ecosystem services team is supported by information systems staff in the management of the Metrogro hauling and land application database, laboratory information management system and pretreatment database and applications.

Engineering
The construction administration database, construction plan holders application, annexations applications and the easements database programs support the work of our engineering department.

Operations & Maintenance
The following programs are important to the success of operations and maintenance: Data Access and Reporting Center process reporting system, process control data transfer and analysis, process control system reporting, lock-out/tag-out database and applications, and the manhole inspection database and applications.

Planning and Strategy
Significant programs supporting planning and strategy are the Geographical Information System database and applications, collection system applications, Oracle Work and Asset Management system (asset functions and applications) and the user charge billing system.

Districtwide
Throughout the district, these programs are key to our continued success: infrastructure management and administration, data/information storage and administration, server virtualization, desktop virtualization, virtual private network administration, network security, Microsoft Exchange administration (for Outlook email and calendars), email scanning and security, network administration and security, printers and scanning equipment, database management, business analysis, computer and device programming, smartphone management and configuration, project management, phone system administration, software upgrades, software testing, software customization and configuration, license management network disaster recovery plans.

Information systems staff were also involved in the following projects and activities in 2016**:**

- Managed and participated in the development of a strategic technology plan with our consultant, Elert & Associates. The plan provides a strategic direction for the next five years and includes a separate appendix of recommendations for our Geographic Information System. The plan was approved by the district's executive team in 2016 and will be presented to the district's commission in early 2017.
- Implemented new network infrastructure in the new Maintenance Facility Building. This work included: review of plans and recommendations for changes, network design, capacity planning and assistance with configuration of the audio-visual systems, installation of new network and desktop equipment and user training.
- Upgraded and migrated the Metrogro database application. This included enhancement of the applications, coordination of work with our consultant (Yahara Software) and migration of the system to a SQL server database for better performance and stability. Also included was the rewrite of the soil test data import application. This allowed automated import of data from the Rock River Laboratory, and significantly reduced the need for manual data entry.
- Upgrades to the process/operation network. Added a storage appliance to expand the process network's options for data archiving and to increase general network performance. Created additional virtual servers to more efficiently manage Hyper Historian database performance and increase overall network redundancy.
- Continued enhancement, expansion and development of the Data Access and Reporting Center (DARC) system. Reporting capabilities including: added customizations to integrate our laboratory information management system with DARC, upgraded the database so data loads and aggregation were notably faster and worked with operations staff to improve the efficiency and flexibility of manual data entry and system configuration.

- Hired and trained new Network Technician, Chris Rentmeester. He is now part of the team that supports both our administrative and plant network infrastructures. Chris came to us with several years of experience and he was able to hit the ground running. This was especially notable in his ability to immediately provide technical help desk support, and to assist with needed enhancements to the process network infrastructure.
- Provided technical support for the implementation, configuration and customization of the new laboratory information management system. Formal cut-over to this new system was made Jan. 2 2017.
- Provided implementation support, coordination of work with our consultant (Strand Associates), user training and customization services for the new manhole inspection application.
- Migrated district's smartphones from Verizon to AT&T to increase coverage and reliability of both voice and data services.
- Normal budgeted replacement of servers, desktop computers, laptops, tablets, smartphones, PCs, switches, wireless access points and network control appliances.

Financial Department

USER-CHARGE MONITORING AND BILLING

User-charge billing of the district's municipal customers is performed quarterly using data collected at the Nine Springs Wastewater Treatment Plant and within the collection system. The monitoring services/sewer maintenance crew supports quarterly billing by providing sampling and flow measurement at key points in the collection system. The monitoring crew and plant staff collected data and samples at 92 sampling points in 2016. The sampling points generated 4,429 samples throughout the year. The analysis of the user-charge field samples and Nine Springs influent samples by the district lab yielded 14,353 sample results for use in the user-charge billing process.

Sewerage service charges

Before the beginning of each calendar year, the district furnishes a written estimate of the cost of sewerage service for the ensuing year to each municipality in the district. This estimate is based on the previous year's wastewater contributions, any anticipated changes that may alter the municipality's prevailing volume and loadings trends and the service charge rates for the ensuing year.

The district's 2016 service charge rates, shown in the following table, were adopted October 30, 2014.

Table 16 – Service Charge Rate Summary Information

Parameter	Rate	Units
Volume	$685.47	per million gallons
Carbonaceous Biochemical Oxygen Demand (CBOD)	$0.16582	per pound
Suspended Solids	$0.23730	per pound
TKN-Nitrogen	$0.36385	per pound
Total Phosphorus	$3.54918	per pound
Actual Customers	$30.19	per year
Equivalent Meters	$31.57	per year

The 2016 rates included a 0.70 percent surcharge to recover the Wisconsin Department of Natural Resources NR101 effluent fees.

Wastewater volumes, Carbonaceous Biochemical Oxygen Demand (CBOD) loadings, suspended solids loadings, total Kjeldahl nitrogen (TKN) loadings and total phosphorus loadings are determined each quarter for each community. These determinations are based on a minimum of seven consecutive days of monitoring data for the current quarter and previous quarter's discharge data for each community.

Meter equivalencies are based on the capacities of the different sizes of water meters used throughout the district. A 5/8-inch water meter has a capacity of 20 gallons per minute and is defined as one equivalent meter. The capacities of larger water meters are divided by the 20 gallon per minute capacity of a 5/8-inch water meter to determine their meter equivalencies. An actual customer is defined as one water meter without regard to size. The numbers of equivalent meters and actual customers in each municipality are set by counting the number of each size of water meter in service in each municipality where water meters are used. In municipalities where water meters are not used, the number of each size water meter that would be required is estimated.

In 2016, the average annual residential service charge in the district was about $294. This amount includes $167 for services provided by the district and $127 for services provided by the municipality (e.g., the City of Madison). A survey of 167 of the nation's largest municipalities indicated that the typical residential service charges in the district in 2016 were 61 percent of the national average of $479.

Operating costs per million gallons of treated wastewater for the years 2012 through 2016 are shown in the table below. The cost per million gallons increased in 2016 to $2,139 per million gallons. This 0.8 percent increase compared to 2015 was due to an overall cost increase of 7.5 percent and a volume increase of 6.6 percent. In 2015 the cost per million gallons increased by 6.7 percent compared to 2014 due to the overall cost increase of 6.6 percent and a volume decrease of 0.8 percent.

Table 17 – Costs per Million Gallons of Wastewater Treated

District Function	2012	2013	2014	2015	2016
Administration	$237	$254	$270	$297	$357
Collection	141	146	138	150	142
Treatment	713	698	809	828	774
Debt Service	673	661	771	847	866
TOTAL	**$1,764**	**$1,759**	**$1,988**	**$2,122**	**$2,139**

In comparison with the 2015 costs, 2016 overall operating costs increased 7.5 percent. Administration costs increased 28.4 percent, collection costs decreased 0.9 percent, treatment costs decreased 0.3 percent, and debt service costs increased 9.0 percent. The increase in administration costs was driven by a Wisconsin Retirement System pension liability ($0.5 million), accrued sick leave costs for employees reaching 10 years of employment with the district and vacation time for six new hires ($0.2 million), and the movement of purchasing positions from the operations and maintenance department to the administrative services department ($0.2 million). The decrease in collection costs was due to reduced cost for replacement parts, salaries, contracted services and chemicals. The reduced collection costs for parts and salaries reflect reduced major maintenance work for pumping stations. The decrease in treatment costs was largely due to reduced salary costs charged to treatment because of the movement of purchasing staff to the administrative services department and reduced costs for repair services and chemicals. Debt service costs increased to support the district's capital improvement plan.

CLEAN WATER FUND LOANS

In 1989 the State of Wisconsin replaced the Wisconsin Fund Grant Program with the Clean Water Fund Loan Program. The Clean Water Fund is a state revolving loan fund that was capitalized initially with grants from the U.S. EPA and by bonds issued by the State of Wisconsin. The district has issued general obligation bonds and notes to the State of Wisconsin for 24 loans under this program. The total amount financed through these Clean Water Fund loans is $232.8 million.

The district had four Clean Water Fund loans in 2016 for which the final disbursement had not been received by the end of 2015. The status of those loans is as follows:

Process Control System Upgrade/Rehabilitation

The district issued General Obligation Sewerage System Promissory Notes, Series 2013C, Nov. 27, 2013, to the State of Wisconsin Clean Water Fund (CWF Project 4010-37). These bonds are for an aggregate amount not to exceed $4,746,580 and are to be repaid at an annualized interest rate of 2.625 percent. The first interest payment on the loan was made May 1, 2014. The first principal payment was made May 1, 2016. The final bond payment will be made May 1, 2033.

The district received the final loan disbursement in 2016, bringing the final total for the loan to $4,276,508.

Pumping Stations 11 & 12 Rehabilitation
The district issued General Obligation Sewerage System Promissory Notes, Series 2015A, Feb. 25, 2015, to the State of Wisconsin Clean Water Fund (CWF Project 4010-42). These bonds are for an aggregate amount not to exceed $10,663,025 and are to be repaid at an annualized interest rate of 2.26 percent. The first interest payment on the loan was made May 1, 2015. The first principal payment was made May 1, 2016. The final bond payment will be made May 1, 2034.

The district had received $9,445,896 for this project as of Dec. 31, 2016.

Maintenance Facility
The district issued General Obligation Sewerage System Promissory Notes, Series 2015B, May 27, 2015, to the State of Wisconsin Clean Water Fund (CWF Project 4010-41). These bonds are for an aggregate amount not to exceed $12,094,707 and are to be repaid at an annualized interest rate of 2.25 percent. The first interest payment on the loan was made November 1, 2015. The first principal payment was made May 1, 2016. The final bond payment will be made May 1, 2035.

The district had received $11,331,435 for this project as of Dec. 31, 2016.

Rimrock Interceptor Repair, Pumping Station 15 Rehabilitation, Pumping Station 12 Force Main Relocation
The district issued General Obligation Sewerage System Promissory Notes, Series 2016A, Nov. 9, 2016, to the State of Wisconsin Clean Water Fund (CWF Project 4010-46). These bonds are for an aggregate amount not to exceed $7,196,557and are to be repaid at an annualized interest rate of 1.96 percent. The first interest payment on the loan will be made May 1, 2017. The first principal payment was made May 1, 2018. The final bond payment will be made May 1, 2036.

The district had received $3,840,044 for this project as of Dec. 31, 2016.

FINANCES

A general district property tax was not placed on the tax rolls in 2016. The district collects operating and debt service costs through service charges. Levying a property tax would result in a less equitable cost recovery system since the services of the district are not directly related to property value and a substantial amount of property within the district is exempt from property taxes.

All financial transactions of the district were audited by CliftonLarsonAllen, LLP. The audit report for the year ending Dec. 31, 2015, is available at www.madsewer.org.

Madison Metropolitan Sewerage District

FINANCIAL SUMMARY
YEAR ENDED DECEMBER 31, 2015

FINANCIAL STATEMENT

This statement is for informational purposes only and is not intended to represent full financial disclosure. Complete financial statements and related footnotes are available on our website at www.madsewer.org or available upon request.

Table 18 – 2016 Financial Summary

	2016	2015
OPERATING REVENUES		
Charges for services:		
Transmission and treatment of sewage	$ 33,236,530	$ 28,487,402
Servicing pumping stations	287,010	402,495
Septage disposal	556,137	491,292
Pretreatment monitoring	25,122	21,719
Struvite Harvesting	142,664	124,131
Total operating revenues	34,247,463	29,527,039
OPERATING EXPENSES		
Administration	5,320,841	4,144,839
Treatment	11,540,575	11,574,414
Collection	2,407,292	2,503,672
Depreciation	7,608,072	7,525,846
Total operating expenses	26,876,780	25,748,771
Operating income	7,370,683	3,778,268
NONOPERATING REVENUES (EXPENSES)		
Investment income (losses)	136,848	55,510
Rent	70,858	69,634
Other	172,121	148,134
Construction Expenses	(338,980)	(569,827)
Disposal of property and equipment	(100,674)	(378,359)
Interest expense	(3,132,730)	(3,212,024)
Total non-operating revenues (expenses)	(3,192,557)	(3,886,932)
Income(loss) before capital contributions	4,178,126	(108,664)
CAPITAL CONTRIBUTIONS		
Interceptor connection charges	1,170,428	1,841,205
Total capital contributions	1,170,428	1,841,205
CHANGE IN NET POSITION	5,348,554	1,732,541
NET POSITION		
BEGINNING OF YEAR, AS PREVIOUSLY STATED	124,708,112	120,629,753
RESTATEMENT	-	2,345,818
BEGINNING OF YEAR, RESTATED	124,708,112	122,975,571
END OF YEAR	$ 130,056,666	$ 124,708,112

SUPPLEMENTAL DETAILED INFORMATION

The following information was prepared by the staff of Madison Metropolitan Sewerage District and is not a part of the independent auditor's financial report.

MADISON METROPOLITAN SEWERAGE DISTRICT
Madison, WI
GENERAL FUND
Year Ended Dec. 31, 2016
(with comparative amounts for 2015)

Repair and Replacement Expenditures	**2016**		**2015**
Engineering & Administration	144,597		146,271
Nine Springs Treatment Plant	897,225		922,544
Nine Springs Treatment Plant Vehicles	89,854		73,788
Collection System	16,819		16,700
Collection System Vehicles	8,183		4,466
Interceptors			
Pumping Station #1	7,200		2,984
Pumping Station #2	8,087		2,687
Pumping Station #3	-		1,134
Pumping Station #4	333		4,595
Pumping Station #5	722		1,771
Pumping Station #6	1,510		1,715
Pumping Station #7	2,862		13,399
Pumping Station #8	2,717		1,928
Pumping Station #9	92		1,135
Pumping Station #10	2,074		3,069
Pumping Station #11	-		7,043
Pumping Station #12	47		5,246
Pumping Station #13	8,868		3,480
Pumping Station #14	1,761		2,801
Pumping Station #15	2,034		1,211
Pumping Station #16	29,134		21,282
Pumping Station #17	9,470		4,458
Pumping Station #18	5,425		4,484
East Interceptor	21,521		16,784
Far East Interceptor	-		-
Nine Springs Valley Interceptor	1,142		-
Lower Badger Mill Creek Interceptor	-		-
Northeast Interceptor	3,960		6,343
South Interceptor	518		-
Southeast Interceptor	1,128		7,278
Southwest Interceptor	-		-
West Interceptor	5,033		2,870
City of Madison Pumping Stations	20,954		67,564
City of Verona Pumping Stations	1,124		3,735

GENERAL FUND (cont.)			
Village of Maple Bluff Pumping Stations	274		4,034
Town of Dunn SD#1 Pumping Stations	340		6,120
Town of Dunn SD#3 Pumping Stations	1,684		5,700
Town of Madison Pumping Stations	161		2,627
Dane County Parks	-		1,184
Total Repair & Replacement	$1,296,851		$1,372,430

Capital Outlay Expenditures	**2016**		**2015**
Concrete Sewer	-		-
Electrical Equipment	1,217		-
Heavy Mechanical Equipment	-		22,319
Light Mechanical Equipment	21,685		-
General Equipment	7,032		152,289
Office Equipment	89,711		-
Lab Equipment	5,850		41,169
Fixed Improvements	-		-
Vehicles	57,523		-
Total Capital Outlay	$183,018		$215,777

Appendix I: Glossary of Acronyms

CBOD	Carbonaceous Biochemical Oxygen Demand
CMMS	Computerized Maintenance Management System
CWF	Clean Water Fund (loan program for wastewater facilities)
DARC	Data Access and Reporting Center
DART	Days Away, Restricted or Transferred
DO	Dissolved Oxygen
ECOLI	Escherichia Coli
EPA	Environmental Protection Agency
FCOLI	Fecal Coliform
GBT	Gravity Belt Thickeners
GIS	Geographical Information System
GPM	Gallons per minute
HP	Horsepower
HVAC	Heating, Ventilation and Air Conditioning
kWh	kilowatt-hour(s)
LIMS	Laboratory Management System
MG&E	Madison Gas and Electric
MGD	Million Gallons per Day
MG/L	Milligrams per Liter
MPN/100	Most Probable Number per 100 milliliters
MW	Megawatt(s)
NH3-N	Ammoniacal Nitrogen
PCB	Polychlorinated Biphenyl
pH	Potential of Hydrogen
PPB	Parts per Billion
PPT	Parts per Trillion
SD	Sanitary District
SOP	Standard Operating Procedures
TCOLI	Taenia (aka taeniae) Coli
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
VFA	Volatile Fatty Acids
WAM	Workforce Asset Management (The district's CMMS Software)
WDNR	Wisconsin Department of Natural Resources
WEP	Water-extractable Phosphorus
WIN	Watershed Improvement Network

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