Permit Amendment Rationale

Date: October 26, 2023

Permit Writer: Ben Hucka

Facility Name: Waterloo, City of STP

Location: County: Blackhawk
Latitude: 42 degrees 28 minutes 18 seconds
Longitude: 92 degrees 18 minutes 18 seconds

Region/FO: DNR FO#1, Manchester

Design: **Easton Ave WWTP:** Discharge to Cedar River (A1, B(WW-1), HH) via river diffuser

Treatment: Activated Sludge
Date constructed: 1998
Flow: ADW: 12.7 MGD, AWW: 26.7 MGD, MWW: 36.0 MGD
Design BOD5: 30,000 LBS/day, TKN: 7,500 LBS/day, P.E. 179,641
Source: Construction Permit 98-361-S, issued August 21, 1998
and schedule G dated March 11, 1998

Satellite WWTP: Discharge to Cedar River (A1, B(WW-1), HH) via river diffuser
Treatment: Activated Sludge
Date constructed: 1995
Flow: ADW: 5.3 MGD, AWW: 8.1 MGD, MWW: 11.1 MG
Design: BOD5 58,000 LBS/day, TKN: 13,550 LBS/day, P.E. 347,305
Source: Construction Permit 95-317-S, issued July 7, 1995

Treatment Plant Description: The treatment plant consists of two equalization basins and two treatment facilities; the Easton Avenue Plant and Satellite Plant. The facility receives waste from two separate dedicated trunk lines. Industrial waste from the Northeast section of the city is sent to the Satellite Plant, while the rest of the City's waste is sent to the Easton Avenue Plant via the other line. Industrial wastewater arriving at the Satellite Plant can be treated at the Satellite plant or diverted to the Easton Avenue Plant. The Satellite Plant is currently not in operation and all wastewater is treated at the Easton Plant.
Wastewater treatment at the Easton Avenue Plant consists of bar screening, grit removal, two primary clarifiers, four single-pass aeration basins, four final clarifiers and ultraviolet disinfection. Effluent is then discharged via a river diffuser (outfall 801).

When in operation, the Satellite Plant receives pretreated industrial wastewater. Wastewater treatment consists of two two-stage aeration basins and four final clarifiers (outfall 008). When not in operation, wastewater from this truck line arrives at the Satellite pumping station and is routed directly to the Easton plant aeration basins, bypassing the headworks and primary clarification. The wastewater from the Tannery and Tyson's is pretreated prior to discharging to the Satellite trunk line at the anaerobic lagoon located near the Tyson facility.

Nutrient Reduction Feasibility Report: The NPDES permit issued June 1, 2021 required Waterloo to submit a Feasibility Study (Study) for reducing total nitrogen (TN) and total phosphorus (TP) by June 1, 2023, per requirements in Section 3 of Iowa's Nutrient Reduction Strategy (NRS). The facility submitted the final Study dated June 21, 2023.

The Study included monitoring data for TN and TP that showed that the facility is not capable of achieving the goals of the NRS and evaluated multiple treatment alternatives for achieving the goals. The treatment alternative capital cost ranged from $27 million to $67 million which would have significant impacts on user rates. The Study also outlines near term improvements to the wastewater treatment facility, not related to nutrient removal, totaling $1.33 million and extensive collection system improvements of the next 9 years totaling over $100 million. Building new facilities to comply with the NRS are not considered affordable at this time. Due to these factors, treatment plant improvements or replacement to address the goals of the NRS, while feasible, are not considered reasonable at this time. The tentative schedule is to start design on nutrient removal facilities in 2040.

Therefore, the department is amending the Waterloo permit to require the submittal of a new NRS feasibility study in five years. Please note that this approval is strictly related to achieving the goals of the NRS and does not represent any sort of facility plan approval or have any impact on any schedules that may be found in other permits or legal documents.

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June 29, 2023

Mr. Ben Hucka, Municipal Permit Coordinator
Iowa Department of Natural Resources
Water Quality Bureau
502 East 9th Street
Des Moines, IA 50319-0034

Re: Wastewater Treatment Plan (WWTP) Nutrient Reduction Study
City of Waterloo, Iowa (City)

Dear Mr. Hucka:

Enclosed is the Nutrient Reduction Study for the City which is due to be submitted to the Iowa Department of Natural Resources to comply with the City's National Pollutant Discharge Elimination System permit.

Please call me with any questions at 608-251-4843.

Sincerely,

STRAND ASSOCIATES, INC.®

Randall A. Wirtz, Ph.D., P.E.

Enclosure: Report

c: Brian Bowman, City of Waterloo
Randy Bennett, City of Waterloo

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Report for

City of Waterloo, Iowa

Nutrient Reduction Study

SEAL	I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa. FOR STRAND ASSOCIATES, INC.®
RANDALL A. WIRTZ 16137 LICENSED PROFESSIONAL ENGINEER IOWA	Randall A. Wirtz, Ph.D., P.E., ENV. SP. June 21, 2023 License Number 16137 My license renewal date is December 31, 2023 Report sections covered by this seal: All sections unless otherwise noted.

Prepared by:

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Madison, WI 53715
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June 2023

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NUTRIENT REDUCTION STUDY

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This Nutrient Reduction Study (Study) was prepared as required to meet the June 1, 2023, compliance schedule in the City of Waterloo's (City's) Iowa Department of Natural Resources (IDNR) National Pollutant Discharge Elimination System (NPDES) Permit No. 0790001. The purpose of this study is to evaluate the feasibility and reasonableness of reducing the amounts of total nitrogen (TN) and total phosphorus (TP) discharged into the Cedar River by the City's wastewater treatment plants (WWTPs).

EXISTING TREATMENT FACILITIES

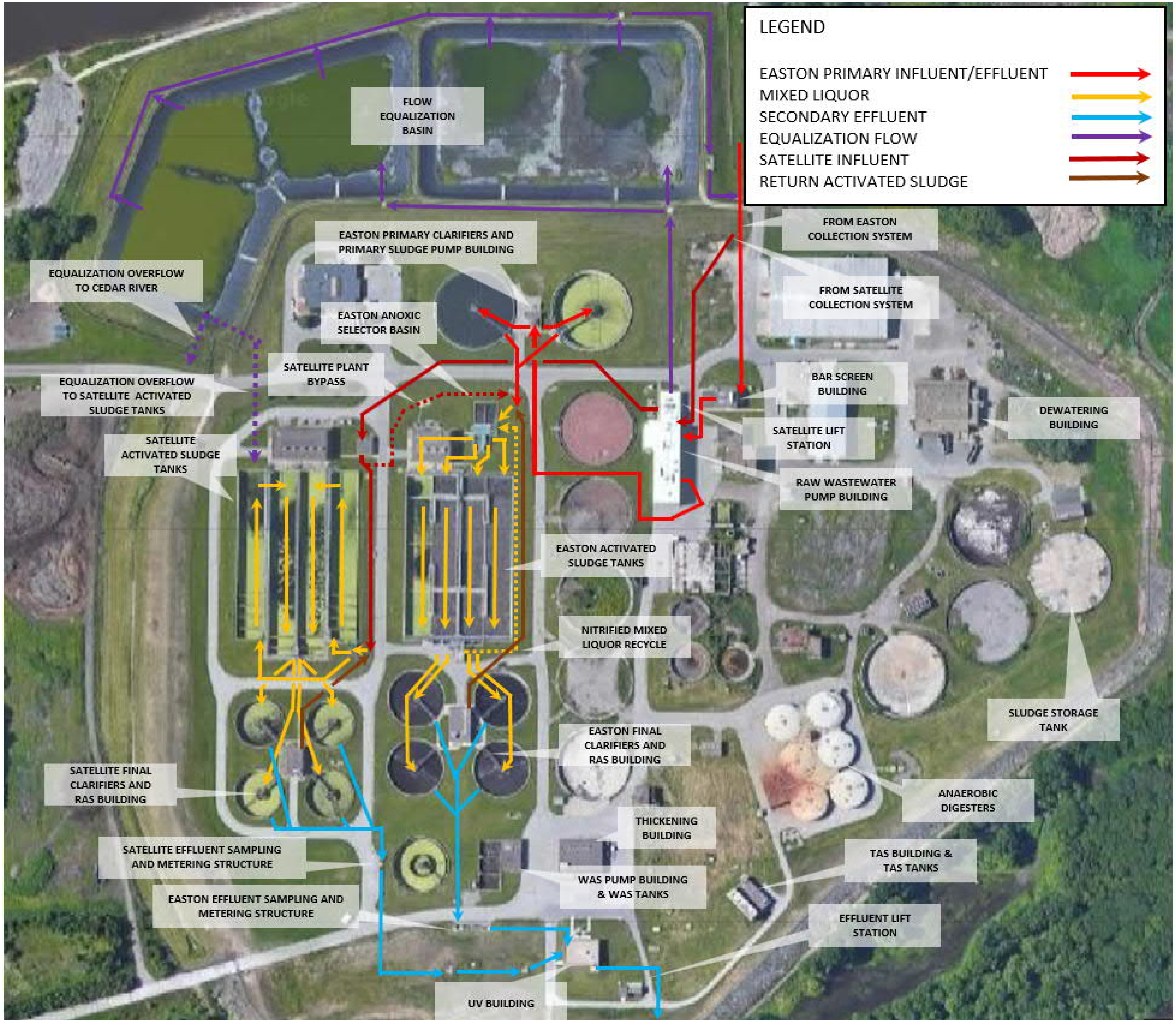
A. Background

The City operates three WWTPs: an anaerobic lagoon that treats wastewater from a food processing plant before discharge into the City sanitary sewer system, the Satellite WWTP that was designed to treat the industrial wastewater from the northeast portion of the City (including the lagoon effluent), and the Easton Avenue (Easton) WWTP that was designed to treat the wastewater from all other sources in the City. The Satellite and Easton WWTPs are located at the same site and share several facilities as described later in this section and they both discharge to the Cedar River. A flow diagram of the Satellite and Easton WWTPs is presented in Figure 1. The design flows and loadings are presented in Table 1. The City's NPDES Permit No. 0790001 is included in Appendix A.

	Easton Plant	Satellite Plant
Wastewater Flow		
Design Average Flow (DAF)	20.4 MGD	6.7 MGD
Design Average Wet Weather Flow (Maximum Month)	26.7 MGD	8.1 MGD
Design Maximum Wet Weather Flow (Maximum Day)	36.0 MGD	11.1 MGD
Design Peak Hourly Wet Weather Flow (PHF)	36.0 MGD	11.1 MGD
Wastewater Loading		
5-Day Biochemical Oxygen Demand (BOD_5)–Average Day	24,000 lb/day	38,800 lb/day
BOD_5–Maximum Month	30,000 lb/day	58,000 lb/day
BOD_5–Maximum Day	70,000 lb/day	80,400 lb/day
Total Kjeldahl Nitrogen (TKN)-Average Day	4,500 lb/day	7,025 lb/day
TKN-Maximum Month	7,500 lb/day	13,550 lb/day
TKN-Maximum Day	13,200 lb/day	19,300 lb/day
Total Suspended Solids (TSS)–Average Day	18,000 lb/day	38,300 lb/day
TSS–Maximum Month	25,000 lb/day	58,000 lb/day
TSS–Maximum Day	66,000 lb/day	80,400 lb/day

Notes:
MGD=million gallons per day
lb/day=pounds per day

Table 1 Design Flows and Loadings



WASTEWATER TREATMENT PLANT PROCESS FLOW DIAGRAM

NUTRIENT REDUCTION STUDY
CITY OF WATERLOO, IOWA

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FIGURE 1
4463.017

Wastewater service to the City was provided by the Easton WWTP alone until the Satellite WWTP was constructed in 1996. At that time, the Easton WWTP was a trickling filter WWTP with primary clarifiers, trickling filters, intermediate clarifiers, roughing filters, and final clarifiers. Following startup of the Satellite WWTP in 1998, a major upgrade to the Easton WWTP was undertaken, including the demolition or abandonment of much of the existing facility and the construction of new primary and final clarifiers along with the conversion to activated sludge biological treatment. While the Satellite WWTP was designed to treat the industrial wastewater from a portion of the City, it has been out of service for several years and is currently only used for storage during peak flow events. In March 2020, the City completed a project to convey equalization basin overflow to the Satellite WWTP activated sludge tanks for storage and blending with the Easton WWTP secondary effluent. While influent flow from the Satellite and Easton WWTP collection systems are measured separately, under current WWTP operation, the influent flow from the Satellite WWTP collection system is combined with the Easton WWTP influent flow upstream of the Easton WWTP anoxic selector basin and is treated using the Easton WWTP. Both the Satellite and Easton WWTPs are currently designed for TN removal using the Modified Ludzak-Ettinger (MLE) process.

B. Easton WWTP

Influent flow to the Easton WWTP passes through two 3/4-inch bar screens and enters an influent wet well where it is pumped with five raw wastewater pumps to the grit removal system. Flow is measured with magnetic flowmeters. The Bar Screen Building and the Raw Wastewater Pump Building were both constructed concurrently with the construction of the Satellite WWTP in 1996.

Following pumping, wastewater flows through two vortex grit removal basins located in the Raw Wastewater Pump Building. A sampler located downstream of the influent pumps and upstream of grit removal is used to collect Easton WWTP influent samples.

When flows to the Easton WWTP exceed the WWTP's hydraulic capacity, a portion of the flow can be diverted to two flow equalization basins located on the northern portion of the site using two downward opening weir gates in the grit chamber effluent channel. These basins were constructed in 1996 and have a total storage capacity of approximately 20 million gallons (MG). Wastewater stored in these basins can be returned to the Easton WWTP influent wet well when the WWTP has capacity to treat the flow. During extreme high-flow events, an overflow/bypass structure to the Cedar River can be used to discharge wastewater from the equalization basins.

After grit removal, flow is discharged by gravity to two circular primary clarifiers. Three primary sludge pumps located in the Primary Sludge Pump Building are used to pump sludge from the primary clarifiers to the blended sludge tanks or to the primary sludge transfer tanks at Structure 170. The primary sludge pumps were replaced in approximately 2017. Additional modifications to the primary sludge handling system were implemented in 2022, including an intermediate wet well and pumping system that can be used to thicken primary sludge while reducing pumping issues in the long primary sludge force main. Scum that is removed from the primary clarifiers is stored in a mixed scum tank and pumped to the thickened waste activated sludge (TWAS) tanks. The primary clarifiers and Primary Sludge Pump Building were constructed in 1998.

The activated sludge system uses the MLE process for biochemical oxygen demand (BOD), ammonia, and TN removal and includes an anoxic selector basin as well as four elongated rectangular aeration basins. The primary effluent flows into the anoxic selector basin and is mixed with the Satellite WWTP influent flow. The anoxic selector basin is mixed using coarse bubble air diffusers with a goal of maintaining anoxic conditions. This basin is also used to split the now combined flow between the four aeration basins. Each aeration basin consists of one anoxic zone with coarse bubble diffusers for mixing and three aerobic zones with fine bubble diffusers. Aeration is provided by three multistage centrifugal blowers. Flow from each of the basins is mixed in an outlet box which contains three mixed liquor (ML) recycle pumps to recycle nitrified ML to the front of the activated sludge system for alkalinity recovery and TN removal. The ML recycle pumps are constant-speed submersible pumps and do not allow operators to adjust the recycle flow based on flow and loading conditions, other than by turning more pumps on or off..

ML from the aeration tanks flow to four center-feed circular final clarifiers before joining the Satellite WWTP flow for disinfection in the Ultraviolet (UV) Building. Five return activated sludge (RAS) pumps located in the RAS Building return settled sludge to the primary effluent pipe upstream of the anoxic selector basin.

Secondary effluent passes through a Parshall flume for flow measurement and is sampled before disinfection. Disinfection is provided by two UV disinfection systems operated in series. The UV disinfection system and building were installed in 2013. Following disinfection, effluent flows to one of two outfalls. A river diffuser is used under normal river level conditions (Outfall 801). When the Cedar River level is high (river flow greater than 8,500 cubic feet per second [cfs]), four effluent pumps located in the effluent lift station are used to pump the effluent to a shoreline discharge (Outfall 011).

C. Satellite WWTP

As described earlier, the Satellite WWTP was designed to treat mostly industrial wastewater flows from a dedicated collection system from the northeast side of the City. The Satellite WWTP has been out of service since approximately 2012.

Flows from the Satellite WWTP collection system flow to the Satellite WWTP lift station at the Easton WWTP, which is on the north end of the Raw Wastewater Pump Building. Here the raw wastewater is sampled and pumped to the Magnesium Hydroxide Building using three submersible pumps. In the Magnesium Hydroxide Building, WWTP staff can add alkalinity to the raw wastewater by feeding magnesium hydroxide. Downstream of the Magnesium Hydroxide Building, wastewater discharges to the Easton WWTP primary effluent piping at the Satellite WWTP bypass structure. Under current WWTP operation, Satellite WWTP influent is diverted to the Easton WWTP through this bypass structure and no raw wastewater continues to the Satellite WWTP activated sludge system.

The Satellite WWTP activated sludge system uses the MLE process and includes two trains, each made up of two elongated rectangular tanks. An anoxic zone is provided in each train using coarse bubble diffuser mixing. Aeration is provided by fine bubble diffusers and five multistage centrifugal blowers. Two ML recycle pumps are used to return nitrified ML through the internal tank wall to the anoxic zone for denitrification and alkalinity recovery.

ML from the aeration tanks flows to four center-feed circular final clarifiers. Five RAS pumps located in the Satellite WWTP RAS Building return settled sludge to the raw wastewater piping upstream of the activated sludge tanks.

Secondary effluent passes through a Parshall Flume for flow measurement and is sampled before being combined with the Easton WWTP secondary effluent at the UV Building upstream of UV disinfection.

D. Sludge Processing

Waste activated sludge (WAS) is pulled from the Easton and Satellite RAS headers for wasting using automated control valves and flow meters. The WAS is pumped to WAS storage tanks until it is pumped to three gravity belt thickeners (GBTs) for thickening. Scum from the final clarifiers is also pumped to the WAS tanks. The WAS tanks are mixed using coarse-bubble aeration supplied from two positive displacement blowers.

TWAS is pumped from the GBTs to the three blended sludge storage tanks using three TWAS transfer pumps. In these tanks, the TWAS is mixed with the primary sludge from the Easton WWTP and primary scum to provide a consistent feed to the anaerobic digesters. Primary sludge is pumped to the Primary Sludge Transfer Tanks at the WAS Building or directly to the Blended Sludge Storage Tanks using three rotary lobe pumps. Sludge from the Primary Sludge Transfer Tanks is pumped to the Blended Sludge Storage tanks using two Primary Sludge Transfer Pumps. Before pumping, the primary sludge passes through two sludge grinders. Mixing is provided in the TWAS tanks with three submersible mixers.

Sludge is pumped from the blended sludge storage tanks to the anaerobic digesters using three progressing cavity pumps. The anaerobic digestion system uses a temperature-phased anaerobic digestion (TPAD) process with two thermophilic digesters and four mesophilic digesters. Two of the mesophilic digesters are equipped with floating covers for digester gas storage. The digesters are heated using a hot water boiler system. The TPAD system produces Class A biosolids.

Digested biosolids are pumped from the digesters to the biosolids storage tanks where it is stored until it is dewatered using two centrifuges and one belt filter press (BFP). Centrate from the dewatering process is discharged to a centrate equalization tank and pumped to the head of the plant. The dewatered biosolids are then land applied.

INFLUENT AND EFFLUENT DATA

A. Baseline Influent Data

The City currently measures influent flow from the Satellite collection system separate from the Easton WWTP influent flow. As discussed earlier, these flows are combined at the Easton WWTP anoxic selector basin under current WWTP operation. Flow to the equalization basin is measured by summing the discharge flow from the Easton raw wastewater pumps and subtracting the Easton influent flow. Flow that is returned from the equalization basin enters the Easton influent wet well and is included in the Easton influent flow. Easton influent samples currently include process return flows, including dewatering centrate, GBT filtrate, and tank drains. Estimates of these return flow loads and their impact of Easton influent loadings are presented later in this section.

Tables 2 through 4 present the 2017 through 2022 flow data by month for the Easton WWTP, Satellite WWTP, and combined influent. The average represents the average day flow for the entire month. “Min” and “Max” represent the lowest and highest day’s total daily (24-hour average) flow during that month, respectively. The Easton influent flow presented in Table 2 (and included in the combined flow in Table 4) includes the flow diverted to the equalization basin and subtracts the return flow from the equalization basin to approximate the actual total wastewater flow that is conveyed to the Easton WWTP site each day. A chart of the Satellite and the adjusted Easton influent flow from 2017 to 2022 is presented in Figure 2.

Table 2 Easton Influent Flow Summary

	2017			2018			2019			2020			2021			2022		
	Avg	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**
January	12.24	9.79	13.48	8.23	5.95	14.38	13.52	11.87	15.82	10.53	9.42	12.11	8.79	8.01	9.32	7.90	7.00	8.37
February	11.90	10.34	13.47	8.74	7.08	11.46	13.22	11.19	19.23	10.71	9.88	11.69	9.16	7.97	11.73	7.87	7.13	8.32
March	14.04	12.50	16.65	9.38	7.54	11.09	22.10	11.35	30.38	16.01	11.66	21.72	14.02	11.98	16.34	10.29	7.93	15.05
April	15.37	12.59	17.48	11.04	9.14	14.42	18.47	15.00	23.75	14.13	12.03	17.89	10.70	9.48	12.48	11.84	9.41	23.32
May	14.06	11.71	17.27	11.25	9.25	16.31	20.68	16.59	25.89	14.11	10.97	23.12	12.92	9.06	17.36	12.90	9.76	21.25
June	10.97	9.49	12.80	12.22	8.16	16.29	18.59	14.44	25.83	23.32	15.47	31.97	12.74	10.70	15.21	12.83	9.50	24.14
July	9.45	7.88	10.75	11.58	8.58	19.68	14.02	10.86	20.98	17.43	12.45	25.79	11.94	9.18	17.83	12.35	9.10	21.28
August	8.10	7.36	8.96	12.58	8.06	23.56	10.07	8.33	12.71	10.45	8.76	11.92	12.10	7.96	17.00	9.16	8.26	11.02
September	7.36	6.33	7.86	24.39	11.61	29.92	11.21	8.36	19.61	11.62	8.70	20.70	11.61	9.38	15.38	8.05	7.35	8.99
October	8.52	5.64	11.75	25.29	15.79	30.67	17.49	13.12	28.41	10.40	8.44	22.57	11.42	9.55	14.61	7.33	6.51	9.50
November	7.80	6.53	8.74	16.37	13.43	22.80	12.07	11.17	13.37	10.71	9.12	16.99	11.92	10.38	15.68	8.12	7.02	12.43
December	7.14	5.87	7.87	14.03	10.03	24.65	11.59	9.39	13.46	9.41	8.06	10.50	9.10	6.62	12.60	7.63	7.19	8.98
Annual Average	**10.58**	**-**	**-**	**13.76**	**-**	**-**	**15.25**	**-**	**-**	**13.24**	**-**	**-**	**11.37**	**-**	**-**	**9.69**	**-**	**-**
Minimum	**7.14**	**5.64**	**-**	**8.23**	**5.95**	**-**	**10.07**	**8.33**	**-**	**9.41**	**8.06**	**-**	**8.79**	**6.62**	**-**	**7.33**	**6.51**	**-**
Maximum	**15.37**	**-**	**17.48**	**25.29**	**-**	**30.67**	**22.10**	**-**	**30.38**	**23.32**	**-**	**31.97**	**14.02**	**-**	**17.83**	**12.90**	**-**	**24.14**

Notes:
Avg=average
Min=minimum
Max=maximum

Table 3 Satellite Influent Flow Summary

	2017			2018			2019			2020			2021			2022		
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
January	3.14	1.65	3.96	2.93	1.12	3.76	3.11	2.14	3.99	2.65	1.38	3.51	2.82	2.35	3.22	2.75	1.14	3.42
February	3.29	2.08	4.00	2.90	1.53	3.87	3.09	2.23	3.70	2.74	1.85	3.30	2.84	1.37	3.58	2.78	1.14	3.20
March	3.00	1.48	3.71	2.94	1.28	3.80	3.40	2.33	3.97	2.85	2.16	3.39	2.81	1.77	3.46	2.50	0.18	3.21
April	3.30	2.02	4.50	2.96	1.87	3.67	3.18	2.10	4.04	2.06	0.15	3.37	2.77	2.27	3.17	2.71	1.89	3.80
May	3.15	1.07	4.15	2.86	1.79	3.77	3.25	1.95	4.11	2.19	0.12	3.53	0.45	-	3.09	2.90	1.31	4.11
June	3.26	1.83	4.28	3.24	2.01	4.18	3.18	1.98	3.92	3.14	1.43	5.97	-	-	0.04	3.19	1.84	4.08
July	3.12	1.37	4.35	3.03	1.59	4.96	3.04	2.04	4.76	3.26	0.81	4.79	-	-	0.00	3.05	1.45	3.94
August	3.11	1.10	4.11	3.52	2.13	4.27	2.93	1.69	4.06	3.30	2.30	3.82	-	-	0.09	3.22	1.32	3.87
September	3.06	1.41	3.98	3.22	1.40	5.11	3.04	1.40	4.25	2.91	1.72	4.00	-	-	0.00	3.06	1.71	3.90
October	3.24	1.59	4.02	3.33	1.59	6.62	2.85	1.59	4.65	2.85	2.17	3.63	-	-	0.00	2.99	1.63	4.06
November	3.24	2.28	4.02	3.20	2.33	3.71	2.82	2.36	3.41	2.85	2.44	3.30	-	-	0.00	3.02	1.60	3.87
December	3.00	0.84	3.85	3.23	1.61	4.28	2.85	1.51	3.40	2.65	1.04	3.26	1.97	-	3.27	3.12	2.04	3.61
Annual Average	**3.16**	**-**	**-**	**3.11**	**-**	**-**	**3.06**	**-**	**-**	**2.79**	**-**	**-**	**2.28**	**-**	**-**	**2.94**	**-**	**-**
Minimum	**3.00**	**0.84**	**-**	**2.86**	**1.12**	**-**	**2.82**	**1.40**	**-**	**2.06**	**0.12**	**-**	**0.45**	**1.37**	**-**	**2.50**	**0.18**	**-**
Maximum	**3.30**	**-**	**4.50**	**3.52**	**-**	**6.62**	**3.40**	**-**	**4.76**	**3.30**	**-**	**5.97**	**2.84**	**-**	**3.58**	**3.22**	**-**	**4.11**

Table 4 Combined Influent Flow Summary

	2017			2018			2019			2020			2021			2022		
	Avg	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**
January	15.38	12.58	16.85	11.16	8.01	18.04	16.63	14.29	19.23	13.18	10.80	14.66	11.61	10.80	12.38	10.65	8.78	11.55
February	15.20	12.87	17.21	11.63	8.96	14.30	16.32	14.05	22.12	13.46	12.04	14.62	11.99	9.90	15.14	10.65	8.94	11.36
March	17.04	14.77	19.99	12.33	8.82	14.33	25.50	14.64	34.01	18.86	14.00	24.53	16.83	14.62	19.29	12.79	9.61	18.26
April	18.68	14.99	21.53	14.00	11.60	17.76	21.65	18.07	27.68	16.19	12.43	20.63	13.47	12.04	15.62	14.55	11.75	26.49
May	17.21	12.87	21.08	14.11	11.21	18.31	23.93	19.29	28.65	16.30	11.44	26.65	13.18	11.03	17.36	15.80	12.32	24.25
June	14.23	11.32	16.91	15.46	10.64	19.92	21.77	16.72	29.52	26.46	18.16	35.40	12.74	10.70	15.21	16.02	12.19	27.90
July	12.57	10.52	14.71	14.61	10.92	22.04	17.06	13.00	23.83	20.69	16.16	29.43	11.94	9.18	17.83	15.40	11.45	24.79
August	11.21	8.53	13.07	16.10	11.05	27.73	13.00	10.63	16.11	13.75	11.79	15.13	12.10	7.98	17.00	12.38	9.97	13.65
September	10.42	8.45	11.75	27.61	14.24	33.46	14.25	9.93	23.31	14.52	10.42	24.35	11.61	9.38	15.38	11.11	9.27	12.89
October	11.75	9.37	15.39	28.61	18.64	34.16	20.34	15.22	31.82	13.25	10.77	26.20	11.42	9.55	14.61	10.32	8.75	12.28
November	11.03	8.88	12.15	19.56	16.73	25.48	14.89	13.64	16.31	13.56	11.56	19.87	11.92	10.38	15.68	11.14	9.24	15.88
December	10.13	7.01	11.56	17.26	11.64	27.39	14.44	11.50	16.34	12.06	9.69	13.51	10.68	8.30	12.75	10.76	9.59	12.59
Annual Average	**13.74**	**-**	**-**	**16.87**	**-**	**-**	**18.32**	**-**	**-**	**16.02**	**-**	**-**	**12.46**	**-**	**-**	**12.63**	**-**	**-**
Minimum	**10.13**	**7.01**	**-**	**11.16**	**8.01**	**-**	**13.00**	**9.93**	**-**	**12.06**	**9.69**	**-**	**10.68**	**7.98**	**-**	**10.32**	**8.75**	**-**
Maximum	**18.68**	**-**	**21.53**	**28.61**	**-**	**34.16**	**25.50**	**-**	**34.01**	**26.46**	**-**	**35.40**	**16.83**	**-**	**19.29**	**16.02**	**-**	**27.90**

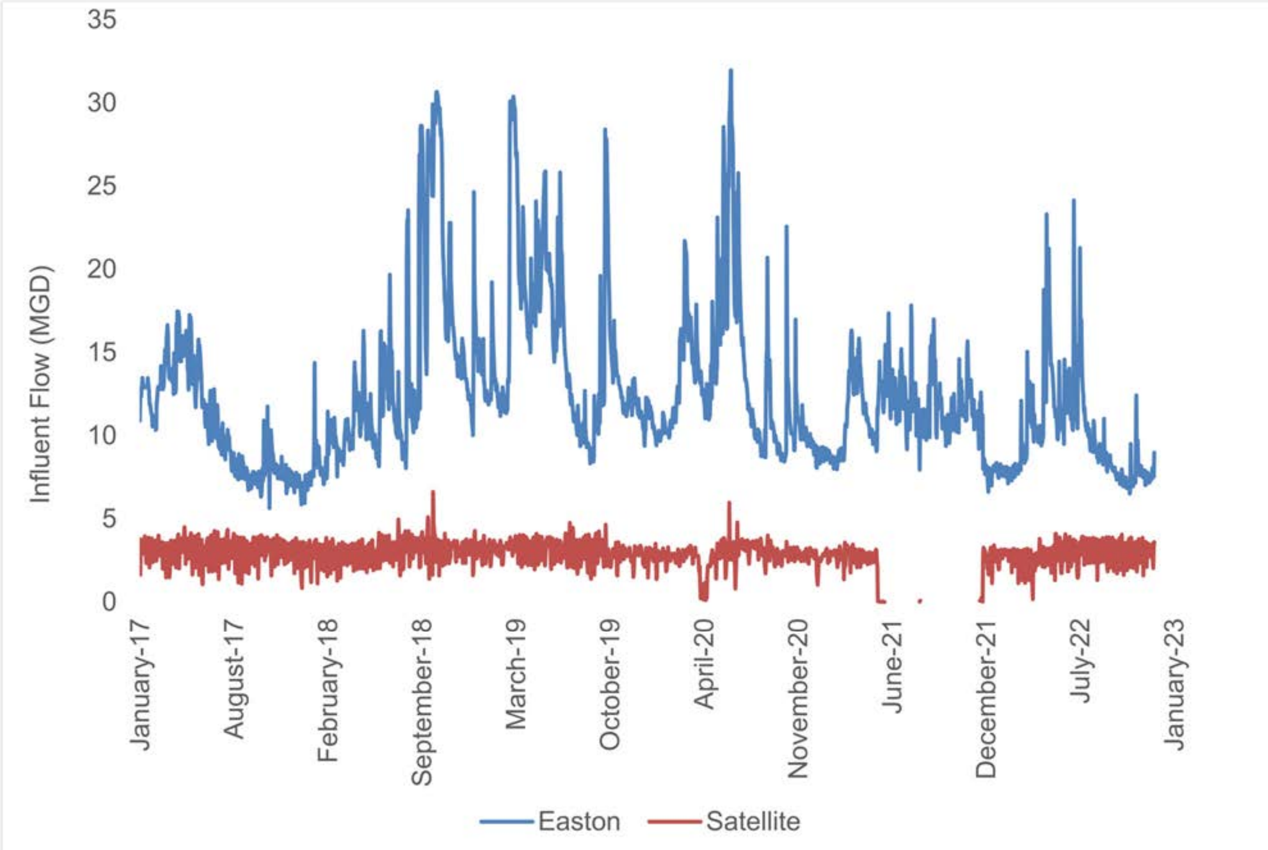

Figure 2 Influent Flow

While the Satellite WWTP influent flow data was relatively consistent in each of the 6 years analyzed, the average annual Easton WWTP influent flow was significantly higher in 2019 than in previous years, with an increase of more than 40 percent from 2017 to 2019. It appears that this increase in flow began in late September 2018. While increased winter flows from precipitation or snow melt are not unusual, the increase that occurred around this time does not appear to subside during dry weather conditions.

A portion of the increase in 2018 flow can be attributed to an extreme wet weather event in September 2018 that resulted in major flooding throughout northeastern and east central Iowa. According to National Oceanic and Atmospheric Administration data, the Cedar River at Waterloo crested at 18.96 feet on September 23, 2018, which is nearly 5 feet above flood stage.

The City does not currently measure influent flow upstream of influent pumps and, therefore, the maximum influent flow measurement is limited by the pump capacity. However, WWTP staff indicate that there have been no known instances of basement backups resulting from influent sewer surcharging in the past.

Minimum and maximum flows at one- and 30-day intervals from January 2017 to December 2022 are presented in Table 5.

	Easton Influent[1]	Satellite Influent	Combined Treated Influent
Influent Flow, MGD			
Average	12.6	3.0	15.0
Maximum Month (30-Day Maximum)	36.4	3.5	31.8
Minimum Month (30-Day Minimum)	7.0	1.4	9.9
Maximum Day	58.8	6.6	35.4[2]
Minimum Day	5.6	0.0	7.0

[1]Easton influent flow includes measured flows diverted to the equalization basin.
[2]Total influent into the Easton WWTP was 58.8 MGD, and 34.4 MGD was diverted to the overflow basin.

Table 5 Influent Flow Summary

As described earlier, when influent flows exceed the capacity of the Easton WWTP, a portion of the flow can be diverted to the equalization basins. This occurred on 111 days between January 2017 and December 2012, with an average diversion volume of 5.73 MG. Typically, this wastewater would be stored in the equalization basins until the Easton WWTP has adequate treatment capacity, at which time it would be returned to the Easton influent for treatment. In extreme wet weather conditions, the equalization basins may fill and overflow to a ditch that discharges to the Cedar River. As previously discussed, the City currently has a planned project to convey equalization basin overflow to the Satellite activated sludge tanks, effectively increasing storage volume in the near-term.

B. Influent BOD_5, TSS, and TKN Loadings

Tables 6 through 8 summarize the Easton WWTP, Satellite WWTP, and combined influent loadings of BOD_5, TSS, and TKN, respectively, from January 2017 to December 2022. The Easton WWTP influent loadings in these tables include the portion of the Easton WWTP influent flow that was diverted to the equalization basins. The combined influent flow excludes the excess flow diverted to the equalization basins.

	Easton Influent	Satellite Influent	Combined Influent
BOD Loading, lb/day			
Average	21,900	9,410	30,300
7-Day	50,600	17,800	47,800
30-Day Maximum	47,400	16,000	47,400

Table 6 Influent BOD Loading Summary

	Easton Influent	Satellite Influent	Combined Influent
TSS Loading, lb/day			
Average	23,300	10,900	33,000
7-Day	60,300	20,000	60,300
30-Day Maximum	53,900	17,700	53,900

Table 7 Influent TSS Loading Summary

	Easton Influent	Satellite Influent	Combined Influent
TKN Loading, lb/day			
Average	4,460	4,850	8,470
7-Day	11,000	7,300	16,000
30-Day Maximum	10,000	6,500	11,100

Table 8 Influent TKN Loading Summary

The City began collecting regular influent TN and TP samples in April 2016. Tables 9 and 10 summarize influent TN and TP loadings. The Easton influent loadings in these tables includes the portion of the Easton influent flow that was diverted to the equalization basins. The TN loadings are very similar to historical TKN loadings, indicating low nitrate/nitrite in the influent.

Table 9 Influent TN Loading Summary

Month	Easton Influent		Satellite		Combined	
	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)
January 2017	34	3,606	187	4,766	64	8,372
February 2017	35	3,521	172	4,661	65	8,182
March 2017	33	3,850	213	5,300	65	9,150
April 2017	31	3,922	206	4,943	58	8,865
May 2017	49	6,079	205	5,520	79	11,599
June 2017	49	4,306	202	5,540	86	9,846
July 2017	41	3,241	192	5,125	80	8,366
August 2017	59	4,058	195	5,268	97	9,326
September 2017	57	2,733	188	3,729	94	8,485
October 2017	47	3,360	165	4,387	78	7,747
November 2017	54	3,631	179	4,964	90	8,595
December 2017	57	3,536	209	4,723	97	8,259
January 2018	57	3,971	198	5,016	94	8,986
February 2018	77	5,687	210	5,177	109	10,864
March 2018	55	4,444	201	5,470	92	9,914
April 2018	50	4,684	208	5,241	83	9,924
May 2018	40	3,780	207	4,874	73	8,654
June 2018	30	3,118	178	4,838	59	7,956
July 2018	38	3,558	201	4,670	70	8,228
August 2018	33	3,581	172	4,594	60	8,175
September 2018	-	-	176	4,674	-	-
October 2018	15	2,624	168	3,988	33	8,265
November 2018	30	4,101	187	4,871	55	8,972
December 2018	33	4,273	195	5,100	60	9,373
January 2019	34	3,760	181	4,511	60	8,271
February 2019	41	4,583	211	5,212	72	9,795
March 2019	36	3,783	227	4,659	50	8,442
April 2019	34	5,527	179	5,279	57	10,806
May 2019	26	4,230	176	4,979	48	9,209
June 2019	29	3,372	198	4,095	41	7,467
July 2019	31	3,095	221	4,626	51	7,722
August 2019	41	3,542	186	3,877	70	7,419
September 2019	41	2,668	210	4,151	61	6,819
October 2019	24	3,345	201	4,566	49	7,911
November 2019	31	3,194	237	5,278	68	8,472
December 2019	51	4,864	208	4,713	80	9,578
January 2020	37	3,282	216	4,405	48	7,687
February 2020	35	3,202	231	5,180	74	8,382
March 2020	31	3,957	197	4,660	56	8,616
April 2020	27	3,182	250	2,891	45	6,073
May 2020	33	3,547	215	3,372	56	6,919
June 2020	20	3,618	166	4,021	36	7,639
July 2020	24	3,281	181	5,180	51	8,461
August 2020	37	2,471	156	4,126	57	6,597

Month	Easton Influent		Satellite		Combined	
	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)
September 2020	36	2,710	173	3,223	41	4,599
October 2020	47	3,764	181	4,271	77	8,035
November 2020	41	3,549	198	4,656	74	8,204
December 2020	40	2,562	204	3,735	76	7,828
January 2021	45	3,409	200	4,718	82	8,127
February 2021	49	3,718	200	4,977	86	8,695
March 2021	30	3,614	209	4,046	48	6,948
April 2021	55	4,821	207	4,719	87	9,540
May 2021	81	8,612	-	-	81	8,612
June 2021	74	4,657	-	-	44	4,657
July 2021	83	8,220	-	-	83	8,220
August 2021	92	7,555	-	-	73	7,555
September 2021	78	7,329	-	-	78	7,329
October 2021	100	9,485	-	-	100	9,485
November 2021	99	9,434	-	-	99	9,434
December 2021	71	6,047	235	5,747	101	9,495
January 2022	54	3,636	216	5,234	97	8,871
February 2022	52	3,401	237	5,796	102	9,198
March 2022	55	4,751	223	5,354	87	9,034
April 2022	41	2,544	247	3,969	62	6,514
May 2022	32	3,475	196	5,159	64	8,634
June 2022	35	3,488	166	4,471	63	7,959
July 2022	31	2,098	164	2,904	33	4,168
August 2022	42	2,525	175	4,081	50	6,388
September 2022	69	4,701	187	4,730	100	9,431
October 2022	49	2,423	184	4,506	75	6,929
November 2022	44	2,977	175	4,870	83	7,847
Average	**46**	**4,110**	**197**	**4,662**	**70**	**8,287**
Min Monthly	**15**	**2,098**	**156**	**2,891**	**33**	**4,168**
Max Monthly	**100**	**9,485**	**250**	**5,796**	**109**	**11,599**

Notes:
mg/L=milligrams per liter
Conc.=concentration

Table 10 Influent TP Loading Summary

Month	Easton Influent		Satellite		Combined	
	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)
January 2017	8	800	21	526	10	1,326
February 2017	10	1,015	22	581	13	1,596
March 2017	9	1,061	23	585	12	1,646
April 2017	6	747	21	510	8	1,258
May 2017	8	902	25	664	11	1,566
June 2017	11	980	23	635	14	1,615
July 2017	11	874	25	665	15	1,539
August 2017	15	1,007	25	690	18	1,698
September 2017	15	944	21	553	17	1,498
October 2017	14	982	21	557	16	1,539
November 2017	13	876	20	565	15	1,441
December 2017	16	1,026	22	479	17	1,505
January 2018	16	1,098	22	550	18	1,649
February 2018	12	908	22	533	14	1,441
March 2018	14	1,096	24	648	16	1,743
April 2018	11	1,056	22	562	13	1,618
May 2018	9	862	23	539	12	1,401
June 2018	7	775	22	595	10	1,371
July 2018	9	832	20	470	11	1,302
August 2018	10	1,145	18	489	12	1,633
September 2018	5	926	18	463	6	1,389
October 2018	3	553	17	408	5	1,200
November 2018	6	798	19	497	8	1,295
December 2018	7	880	19	486	9	1,366
January 2019	9	1,045	17	422	11	1,467
February 2019	9	1,009	19	477	11	1,485
March 2019	6	646	20	417	6	1,064
April 2019	5	858	19	570	8	1,428
May 2019	5	875	19	552	8	1,427
June 2019	6	754	21	445	7	1,199
July 2019	6	584	20	421	7	1,005
August 2019	9	727	22	436	11	1,162
September 2019	13	1,242	22	583	15	1,825
October 2019	6	851	23	509	9	1,360
November 2019	8	866	22	487	11	1,353
December 2019	9	851	25	575	12	1,427
January 2020	7	611	24	484	6	1,095
February 2020	13	1,214	23	528	15	1,742
March 2020	8	950	26	625	10	1,575
April 2020	6	669	18	364	8	1,033
May 2020	10	1,014	21	367	11	1,381
June 2020	4	749	25	611	7	1,360
July 2020	6	816	26	757	10	1,573
August 2020	9	790	34	883	14	1,674

Month	Easton Influent		Satellite		Combined	
	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)
September 2020	9	656	33	617	9	954
October 2020	16	1,220	41	969	21	2,189
November 2020	8	725	33	775	14	1,500
December 2020	13	860	34	628	17	1,749
January 2021	12	894	40	930	19	1,825
February 2021	12	936	36	914	18	1,850
March 2021	9	1,085	37	717	11	1,632
April 2021	13	1,151	37	838	18	1,989
May 2021	20	2,107	-	-	20	2,107
June 2021	16	985	-	-	9	985
July 2021	19	1,892	-	-	19	1,892
August 2021	18	1,469	-	-	14	1,469
September 2021	19	1,815	-	-	19	1,815
October 2021	18	1,729	-	-	18	1,729
November 2021	22	2,101	-	-	22	2,101
December 2021	20	1,573	37	917	23	2,123
January 2022	16	1,049	29	706	19	1,756
February 2022	12	806	31	765	17	1,571
March 2022	13	1,042	32	763	16	1,653
April 2022	10	850	26	561	13	1,411
May 2022	12	1,366	25	662	15	2,028
June 2022	7	707	22	601	10	1,307
July 2022	8	507	19	331	7	838
August 2022	11	683	19	454	11	1,137
September 2022	16	1,093	21	530	17	1,623
October 2022	14	694	23	553	14	1,247
November 2022	15	995	23	651	17	1,646
Average	**11**	**990**	**24**	**588**	**13**	**1,513**
Min Monthly	**3**	**507**	**17**	**331**	**5**	**838**
Max Monthly	**22**	**2,107**	**41**	**969**	**23**	**2,189**

In-plant waste loads including filtrate from sludge thickening and dewatering operations, biosolids storage tank decant, tank drains, and digester overflow are combined in the WWTP sewer system. The WWTP sewer flows through a Palmer-Bowlus flume just east of the septage receiving station for flow measurement. WWTP staff indicate that this flume is often surcharged and does not provide reliable flow measurements. Septage is combined with these in-plant return flows downstream of the flume. These flows combine with the Easton influent in a manhole upstream of the Bar Screen Building. Therefore, the flows and loads associated with these in-plant returns are included in the Easton influent flow measurement and samples.

City staff conducted special sampling in May and June 2017 that included grab samples of return flows from the GBTs and BFPs as presented in Table 11.

Parameter, mg/L	GBT Filtrate	BFP Filtrate
TP	10.3	73.8
PO_4-P	6.3	33.3
Ammonia	8.9	685
TKN	38.9	715
Nitrate	13.7	1.1
Nitrite	0.2	<0.1
TSS	308	1,123
VSS	252	756
Alkalinity	218	2,491

Notes:
VSS=volatile suspended solids
PO_4-P=phosphate

Table 11 Return Flow Sampling Summary–May and June 2017

Estimates of return flow loadings were made based on the 2014 to 2016 sludge flows, percent solids measurements, and estimates of wash water flows at approximately 120 gpm per GBT/BFP. This results in an estimated GBT filtrate and BFP filtrate flows of approximately 0.45 and 0.16 MGD, respectively. Estimated return loadings from these sources are presented in Table 12.

Parameter, lb/day	GBT Filtrate	BFP Filtrate	Filtrate Loading Percentage of Easton Influent
TP	39	98	15%
PO_4-P	24	44	-
Ammonia	33	914	-
TKN	146	954	25%
Nitrate	51	1.5	-
Nitrite	0.8	<0.1	-
TSS	1,160	1,500	10%
VSS	950	1,010	-
Alkalinity	820	3,320	-

Table 12 Return Flow Loading Estimates

C. Wastewater Treatment Performance

As described earlier, secondary effluents from the Satellite and Easton WWTPs are combined and disinfected before discharge to the Cedar River. The City has two permitted outfalls on the Cedar River: a diffuser located in the river that is used under normal conditions and a shoreline outfall that is used when the Cedar River level is high. The permitted effluent concentrations for all parameters except ammonia are identical for these two discharges. In the City's current NPDES permit, the shoreline outfall can be used during high river flows (above 8,500 cfs), resulting in higher ammonia limits both on a monthly average and daily maximum basis. Table 13 summarizes the City's average monthly effluent ammonia nitrogen (NH_3-N). Effluent NH_3-N during this period averaged 3.54 mg/L. The City was operating two to three of the Easton WWTP activated sludge trains for most of the 6-year period.

The City has a TN mass limits of 9,285.5 lb/day on a monthly average basis with a daily maximum limit of 15,199 lb/day. Effluent TN sample results are presented in Table 14. There were no exceedances of the City's maximum day or monthly average TN mass limits in the period evaluated.

While the City does not currently have a TP limit, they began monitoring effluent TP once per week in April 2016. Effluent TP data is presented in Table 15.

The MLE process currently used at the Easton WWTP was designed for TN removal and successfully removes approximately 48 percent of the influent TN based on the data presented in Tables 9 and 14. The data in Tables 10 and 15 suggest that the WWTP currently removes approximately 37 percent of the influent TP. Because the MLE process does not contain an anaerobic zone necessary for successful biological phosphorus removal (BPR), the demonstrated TP removal is likely attributable to biological uptake for cell growth and the removal of particulate TP.

Table 13 Effluent NH_3-N

	2017		2018		2019		2020		2021		2022	
	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)
January	35.90	4,368	7.83	688	1.09	37	1.03	6	1.13	37	5.07	384
February	23.33	2,686	27.68	2,573	3.60	373	1.30	37	3.00	257	14.27	1,119
March	3.71	441	12.94	1,265	6.06	1,477	1.32	110	1.68	144	1.06	13
April	4.27	601	9.55	1,099	13.25	2,312	1.02	8	1.38	71	1.05	8
May	2.76	402	4.09	420	2.07	339	<1.00	0	1.31	56	<1.00	0
June	1.08	12	1.04	12	1.03	28	1.29	125	2.93	228	<1.00	0
July	5.35	445	<1.00	0	<1.00	0	1.00	13	1.28	52	<1.00	0
August	4.99	423	1.05	10	1.59	69	1.48	91	1.15	32	<1.00	0
September	<1.00	0	<1.00	0	2.87	225	1.03	7	1.67	78	1.12	22
October	1.73	78	<1.00	0	<1.00	0	<1.00	0	<1.00	0	<1.00	0
November	<1.00	0	1.01	12	<1.00	0	<1.00	0	1.03	7	1.49	61
December	1.02	5	1.13	41	1.87	111	1.35	70	1.46	65	-	-
Annual Average	7.18	788	5.78	510	3.04	414	1.15	39	1.59	85	2.52	136

Table 14 Effluent TN

	2017		2018		2019		2020		2021		2022	
	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)
January	44	5,244	43	3,862	33	4,420	34	2,835	49	4,607	48	4,079
February	35	4,037	32	3,103	36	4,511	41	4,313	51	4,918	42	3,293
March	32	4,272	39	3,882	40	4,952	30	4,278	35	3,782	36	3,363
April	26	3,601	34	3,918	29	5,379	33	4,405	44	4,735	36	2,523
May	30	4,300	40	4,565	31	5,657	27	3,451	53	5,462	36	4,579
June	47	5,227	28	4,091	33	4,319	23	5,253	44	2,502	33	3,896
July	43	4,518	33	2,981	39	4,416	31	5,051	45	4,112	28	2,165
August	57	5,407	53	7,456	42	4,392	42	4,931	51	3,151	45	4,351
September	52	4,750	24	5,387	32	3,679	39	3,690	49	1,839	44	3,726
October	49	4,893	24	6,090	30	4,713	51	5,224	47	4,110	46	3,888
November	48	4,318	33	5,411	41	4,848	45	4,853	46	4,036	46	4,055
December	52	4,130	31	4,920	42	4,895	56	5,535	48	4,136	-	-
Annual Average	43	4,558	34	4,639	36	4,682	38	4,485	47	3,949	40	3,629

Table 15 Effluent TP

	2017		2018		2019		2020		2021		2022	
	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)	Conc. (mg/L)	Load (lb/day)
January	7	784	13	1,191	4	559	6	543	12	1,152	23	1,977
February	11	1,305	7	714	5	616	7	731	12	1,176	12	939
March	7	914	10	947	6	714	6	928	8	882	9	824
April	5	689	9	998	8	1,380	11	1,435	12	1,234	8	816
May	7	1,017	7	758	4	757	6	723	12	1,221	8	1,005
June	10	1,099	7	1,019	5	664	5	1,167	11	605	7	809
July	10	1,089	6	681	5	594	7	1,190	11	960	7	517
August	14	1,296	7	1,119	6	668	11	1,333	11	698	9	861
September	10	881	3	750	19	2,017	10	963	9	352	9	776
October	9	923	3	718	7	1,002	12	1,272	10	843	10	656
November	10	918	5	879	6	751	10	1,128	17	1,488	10	901
December	12	973	5	824	8	913	11	1,083	13	1,111	-	-
Annual Average	9	991	7	883	7	886	9	1,041	11	977	10	917

NUTRIENT REDUCTION GOALS

Using the influent TN and TP data collected between January 2017 and December 2022 and adjusting for the nutrient loads from return flows that were included in these samples, the average TN and TP for the combined WWTP influent are approximately 60.5 and 11.7 mg/L, respectively. Based on these influent concentrations, the IDNR's nutrient reduction goals are 20.2-mg/L TN (66 percent removal) and 2.9-mg/L TP (75 percent removal).

The City currently has mass limits for TN of 9,285.5 lb/day on a 30-day average basis and 15,199 lb/day on a daily maximum basis. There is no TP limit in the City's current NPDES permit. Based on the effluent target values calculated above, the combined average wet weather (AWW) design flow of 34.8 MGD, the anticipated TN and TP mass limits are approximately 5,850 pounds TN per day and 845 pounds TP per day.

EVALUATION OF OPERATIONAL CHANGES TO ENHANCE NUTRIENT REMOVAL

As presented earlier, the MLE process currently used at the WWTP results in effluent TN loads between 3,000 and 5,000 lb/day with concentrations of approximately 30 to 40 mg/L. Based on this performance, the City is currently able to achieve the annual TN effluent mass target of 5,850 lb/day but it appears that it would be unable to achieve this target should influent flows increase to the design flows.

Furthermore, the WWTP is not currently designed for phosphorus removal, which would require either anaerobic zones in the activated sludge system or significant chemical feed and storage facilities. Potential operational changes to improve BPR performance, such as eliminating the nitrified ML recycle to create an anaerobic zone, would result in loss of TN removal. Because of the high TKN loads to the WWTP, the elimination of the nitrified ML recycle and associated denitrification and alkalinity recovery is also anticipated to result in pH instability and the potential loss of nitrification.

The City conducted special sampling in May and June 2017 to further investigate nutrient removal at the WWTP. This sampling indicated that while the WWTP was successfully nitrifying (average effluent ammonia concentration of 1.5 mg/L), denitrification in the anoxic zone was incomplete with an average nitrate nitrogen (NO_3-N) concentration leaving the anoxic zone greater than 10 mg/L. The effluent TN during this period was approximately 36 mg/L, similar to the average presented earlier. The incomplete denitrification in the anoxic zone suggests that the anoxic zone is not large enough, there is too much dissolved oxygen in the anoxic zones, or there is insufficient influent BOD to completely denitrify. The anoxic retention time during this period was approximately 1.7 hours, which is within a typical range for anoxic zone sizing for the MLE process.

The City does not currently have the ability to control the ML recycle rate and, therefore, operational changes associated with variable recycle rates are not feasible without capital improvements. Modifying the RAS rate or solid retention rate (SRT) is not anticipated to significantly improve TN or TP removal without detrimentally affecting other process performance (nitrification, TSS removal, etc.). Increasing the anoxic zone size by reducing the size of the aerated zone will negatively impact nitrification, which is already challenging during the winter months at current flows and loads. The existing anoxic zone is not large enough to allocate a portion as an anaerobic zone for BPR without further reducing the ability to denitrify. While the City has tankage in the Satellite WWTP that is not currently in use, the facilities to convey influent from the Easton collection system to the Satellite activated sludge system are not in place. Operating the Satellite WWTP treating only the Satellite influent will exacerbate existing carbon deficiencies for nutrient removal (within the Easton WWTP) in addition to introducing other operational challenges.

Therefore, operational changes alone are not feasible to significantly reduce the TN and TP loads in the effluent without negative impacts on other treatment process performance. The modifications necessary for successful BNR, as noted above, will require significant capital improvements as discussed later in this report.

WASTELOAD AND FLOW FORECASTS

To evaluate processes and technologies to enhance existing nutrient reduction capabilities, wasteload and flow forecasts were completed for the City's WWTP service area. For the purposes of this study, it is anticipated that the overall area served by the City's WWTP will remain the same through the 20-year planning period.

A. Population Trends

According to the 2020 census, the City had 67,314 residents, 28,912 total households, and an average household size of 2.31 persons. Compared to the 2010 census City population of 68,406, this equates to a 10-year population decrease of approximately 0.15 percent. Population projections for the City obtained from the Black Hawk County Metropolitan Area Transportation Policy Board's *2045 Long Range Transportation Plan* are presented in Table 16 below.

Year	2020[a]	2025[b]	2035	2045
City of Waterloo Population	67,314	69,928	71,178	72,416

[a]2020 Census data

Table 16 Current and Projected Populations

These projections estimate a 25-year growth of approximately 8 percent, or an annual average growth rate of approximately 0.3 percent over the period. Based on these projections, a 2045 City population of 72,416 is used for projecting future residential wastewater flows and loadings in this Study.

B. Projected Wastewater Flows

Projecting future wastewater flows requires identification of residential, commercial, and industrial wastewater flow, base flows, peaking factors, and anticipated residential, commercial, and industrial growth in areas tributary to the Easton and Satellite WWTPs.

Table 17 shows the projected future design flows for the facility considering the expected growth. Current Easton dry weather flows used in these projections are based on the 2019 dry weather flow data. Future dry weather flow from the Easton collection system was determined by adding additional expected flow from growth at 100 gallons per capita per day (gpcd) to the dry weather base flow. The average and wet weather infiltration and inflow (I/I) values were then added to the base flow to determine the annual average, wet weather, and maximum day flows.

For the Easton WWTP, the total design I/I for annual average, maximum day flow, and wet weather flow was estimated using current peaking factors from the 2019 flow data. It is important to note that the maximum month wet weather flow at the Easton WWTP occurring in 2018 was 36.4 MGD. However, this value was found to be unusually high and not representative of typical wet weather values due to intense wet weather and flooding in the area. The 30-day rolling average between January 2017 and December 2022 are presented in Figure 3. The second highest value of 27.8 MGD occurred in 2019, and this value was used to estimate the wet weather flow peaking factor (PF).

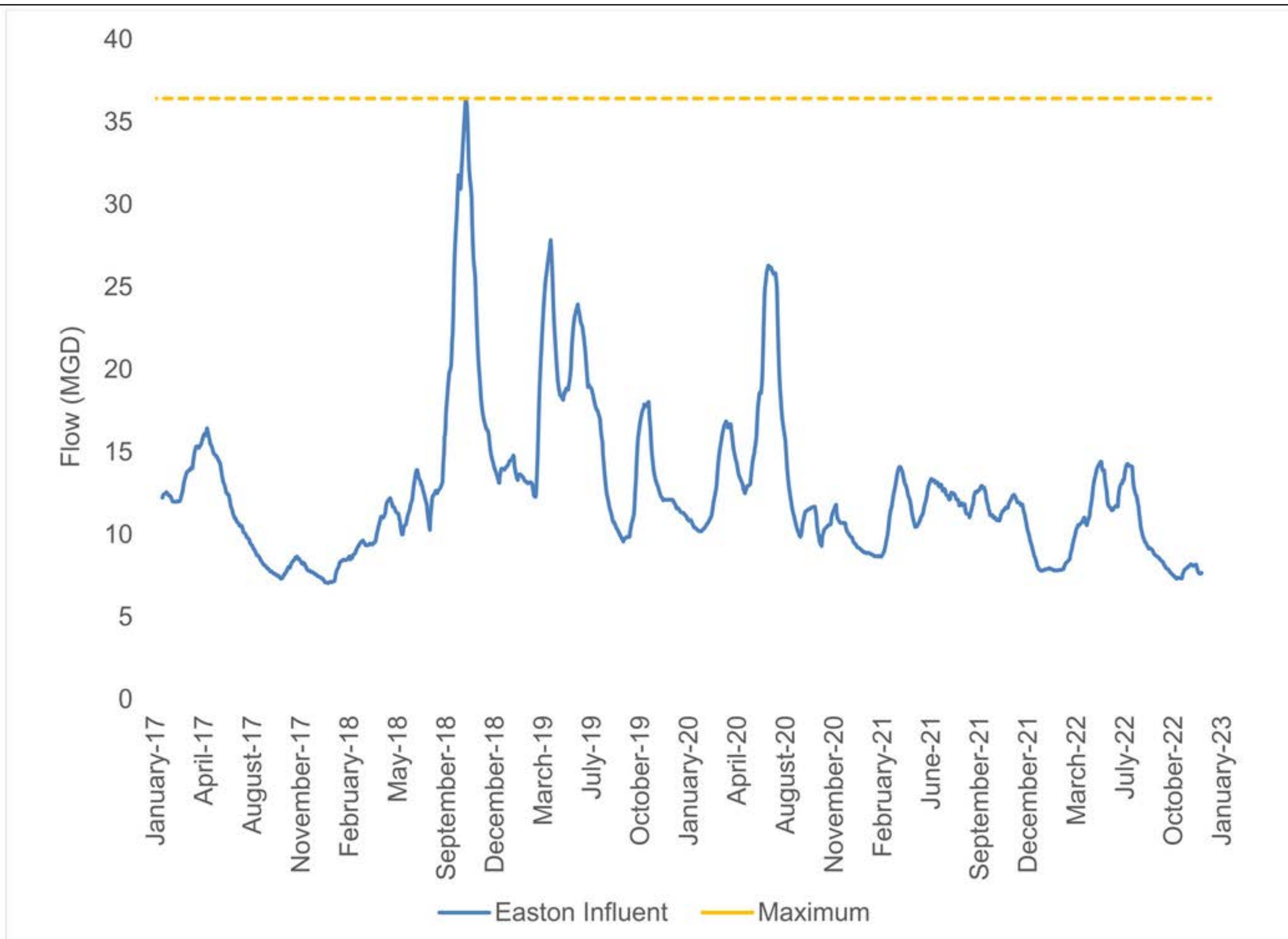

Figure 3 Easton Influent Flow

The design I/I flows for annual average and maximum day flows for the Satellite WWTP were estimated using current peaking factors from the 2017 flow data. The wet weather design I/I for the Satellite WWTP used the 2018 maximum month flow because it exceeded the 2017 value. Additional I/I from growth was estimated using wet weather peaking factors from the 2018 flow data and the projected additional dry weather flow from growth.

The City is currently implementing collection system improvements related to wet weather flows under a 2017 Consent Decree, including flow monitoring, sewer condition and capacity assessments, a footing drain removal program, a hydraulic model, and the development of a *Sanitary Sewer Master Plan*. It is anticipated that these improvements will impact future wet weather flows and, therefore, it is recommended an evaluation of peak flows to the WWTP using the City's hydraulic model is conducted following the completion of these collection system improvements. The need for future peak flow improvements at the WWTP should be reevaluated at that time.

Using this method, the projected design average flow for the Easton WWTP is 16.61 MGD, which is less than the current design average flow of 20.4 MGD. The projected design average flow of the Satellite WWTP is 3.49 MGD, which is less than the current design average flow of 6.7 MGD. The need for future peak flow improvements at the WWTP should be reevaluated at that time.

	Easton Flow (MGD)	**Satellite Flow (MGD)**	**Combined Flow (MGD)**
Current Dry Weather Flow	9.58[a]	2.87[b]	12.45
Projected Residential Growth[c]	0.51	-	0.51
Planned Industrial Growth[j]	-	-	-
Projected Dry Weather Flow	10.09	2.87	12.96
Design I/I[k]			
Annual Average	6.52[d]	0.29[g]	6.81
Wet Weather	19.22[e]	0.68[h]	19.90
Maximum Day	51.89 [f]	3.75[i]	55.64
Peak Hourly[l]	58.40	3.65	62.10
Projected Flows			
Annual Average	16.61	3.16	19.77
Average Wet Weather	29.31	3.55	32.86
Maximum Day	61.97	6.62	68.59
Peak Hourly	68.49	6.52	75.01

[a]2019 Easton influent flow used as baseline
[b]2017 Satellite influent flow used as baseline
[c]Additional residential flow of 5,102 persons at 100 gpcd.
[d]PF=1.65 x Dry Weather Flow (based on 2019 Easton flow data)
[e]PF=3.80 x Dry Weather Flow (based on 2019 Easton flow data)
[f]PF=6.14 x Dry Weather Flow (based on 2019 Easton flow data)
[g]PF=1.10 x Dry Weather Flow (based on 2019 Easton flow data)
[h]PF=1.24 x Dry Weather Flow (based on 2017 Satellite flow data)
[i]PF=2.31 x Dry Weather Flow (based on 2017 Satellite flow data)
[j]The City has not identified any specific planned industrial growth.
[k]Existing I/I + I/I from growth
[l]Based on analysis from the *2018 Nutrient Reduction Study*.

Table 17 Projected 2045 Flows

C. Projected Wasteloads

Future loads to the Easton WWTP were projected by using the populations presented earlier and per capita values of 0.22 pounds per capita day (pcd) for BOD_5, 0.22 pcd for TSS, 0.041 pcd for TKN, and 0.011 for TP, as well as the planned industrial growth. The current average BOD_5, TSS, and TKN loadings are based on the January 2017 to December 2022 average. Table 18 presents the estimated future loads for BOD_5, TSS, TKN, and TP.

	BOD_5 (lb/day)	TSS (lb/day)	TKN (lb/day)	TP (lb/day)
Current Average[a]	30,100	32,900	8,390	1,510
Projected Residential Growth	1,100[b]	1,100[c]	210[d]	60[e]
Planned Industrial Growth[f]	-	-	-	-
Projected Average	**31,200**	**34,000**	**8,600**	**1,570**

[a]2017 to 2022 data as baseline
[b]Additional load at 0.22 pcd
[c]Additional load at 0.22 pcd
[d]Additional load at 0.041 pcd
[e]Additional load at 0.011 pcd
[f]The City has not identified any specific planned industrial growth.

Table 18 Projected Future Loads–Combined Influent

Projected maximum monthly influent loadings are estimated by using a peaking factor of 1.5 for BOD_5, 1.6 for TSS, 1.3 for TKN, and 1.4 for TP. The peaking factors for BOD_5, TSS, and TKN were determined by dividing the highest 30-day average loading by the annual average loading from January 2017 to December 2022. The maximum monthly loadings are shown in Table 19.

	BOD_5 (lb/day)	TSS (lb/day)	TKN (lb/day)	TP (lb/day)
Projected Average Load	31,200	34,000	8,600	1,570
Peaking Factor	1.5	1.6	1.3	1.4
AWW Load	46,200	54,300	11,180	2,270

Table 19 Estimated Maximum Month Loads

Table 20 summarizes the projected year 2045 flows and loadings and compares to the full permitted design flows and loadings. Existing capacity greater than the 2045 flow and loadings projection is held as reserve capacity for unforeseen growth.

	2040 Projection	2045 Projection	Full Permitted Design
Annual Average Flow	18.9	19.8	27.1
Average Wet Weather Flow (Maximum Month)	34.8	32.9	34.8
Maximum Wet Weather Flow (Maximum Day)	72.6	68.6	79.1[a]
Peak Hourly Wet Weather Flow	76.8	75.0	79.1[a]
Annual Average BOD_5 (lb/day)	32,700	31,200	62,800
Maximum Month BOD_5 (lb/day)	42,500	46,200	88,000
Annual Average TSS (lb/day)	38,600	34,000	56,300
Maximum Month TSS (lb/day)	57,900	54,300	83,000
Annual Average TKN (lb/day)	9,990	8,600	11,525
Maximum Month TKN (lb/day)	12,000	11,180	21,050
Annual Average TP (lb/day)	1,590	1,570	2,490[b]
Maximum Month TP (lb/day)	1,900	2,770	2,980[c]

[a]Maximum day and peak hour flow of Easton headworks facility=68 MGD.
Maximum day and peak hour flow of Satellite=11.1 MGD.
[b]Additional TP load for 8.17 MGD reserve capacity at 100 gpcd and 0.011 pcd TP.
[c]Annual Average TP x 1.2 Peaking Factor

Table 20 Design Flows and Loads

EVALUATION OF TREATMENT TECHNOLOGIES TO MEET NUTRIENT REDUCTION GOALS

As previously discussed, operational changes alone will not be sufficient to achieve a significant increase in nutrient reduction and a major capital upgrade will be required to achieve the target reductions in TN and TP. Modifications to the existing activated sludge systems for TN and TP removal were evaluated in the *2018 Nutrient Reduction Study*, including those that treat the dewatering filtrate sidestreams separately from the main treatment process. System performance were evaluated using a BioWin model and the results of this modeling were presented for each alternative. A copy of the *2018 Nutrient Reduction Study* is included in Appendix B. This study included the following alternatives:

- Alternative Biological Nutrient Removal (BNR)1a–Anaerobic-anoxic-aerobic (A^2O) with BOD diversion from lagoon
- Alternative BNR1b–A^2O with VFA addition at WWTP
- Alternative BNR1c–A^2O with Struvite Harvesting; BOD diversion from lagoon
- Alternative BNR1d–A^2O with Struvite Harvesting; VFA addition at WWTP
- Alternative BNR1e–A^2O with Struvite Harvesting and primary sludge (PRS) fermentation; BOD diversion from lagoon
- Alternative BNR1f–A^2O with Struvite Harvesting and PRS fermentation; VFA addition at WWTP
- Alternative BNR2–MLE with Chemical Phosphorus Removal (CPR)
- Alternative BNR3–MLE with Sidestream Enhanced BPR

The evaluation of the 2045 flows and loadings showed that the projections are consistent with the 2040 flow and load projections shown in the *2018 Nutrient Reduction Study*. Therefore, this Study will rely on the results and findings of *the 2018 Nutrient Reduction Study*. For a detailed description of the alternatives and modeling summaries, refer to Appendix B. It is noted that other technologies could be considered, but the 2018 study is still representative of the state-of-the-art for BNR technologies because that report evaluated technologies that were very new and innovative at the time.

A. Monetary Comparison

Table 21 summarizes the 20-year present worth analysis for each of the BNR alternatives. Additional detail on the present worth analysis is provided in Appendix B. Note that costs are presented in second quarter 2023 values and were updated from the *2018 Nutrient Reduction Study* by assuming a construction cost index (CCI) of 13,176 compared to a first quarter of 2018 CCI of 10,909. Because of uncertainty in modeling results, the quantity of phosphorus removal chemical (PRC) or volatile fatty acid (VFA) that would be required to meet the TP target with *Alternative BNR3* if any, is unknown. Therefore, operational and maintenance (O&M) costs associated with *Alternative BNR3* are estimated as ranges, with the maximum values assuming chemical addition equal to those of Alternative BNR2. For the alternatives that include the diversion of BOD from the anaerobic lagoon to the WWTP, it is assumed that at a minimum, a screening facility would be required on the Satellite influent, and, therefore, the present worth cost of Satellite screening facility is included with these alternatives. Additionally, these alternatives include the lost revenue from the biogas that would have been generated at the lagoon if this BOD was not diverted, estimated in the range of $0 to $20 per million British Thermal Units (MMBTU), depending on the end-use of the lagoon biogas.

B. Nonmonetary Comparison

Nonmonetary considerations for each alternative were evaluated and are summarized in Table 22.

Table 21 BNR Present Worth Analysis Summary

	Alternative BNR1a A²O Process with BOD diversion from lagoon	Alternative BNR1b A²O Process with VFA addition at WWTP	Alternative BNR1c A²O Process with struvite harvesting; BOD diversion from lagoon	Alternative BNR1d A²O Process with struvite harvesting; VFA addition at WWTP	Alternative BNR1e A²O Process with struvite harvesting and PRS fermentation; BOD diversion from lagoon	Alternative BNR1f A²O Process with struvite harvesting and PRS fermentation; VFA addition at WWTP	Alternative BNR2 MLE Process with CPR	Alternative BNR3 MLE with Sidestream Enhanced BPR
Capital Costs								
Equipment/Structure Subtotal	$9,200,000	$6,500,000	$11,600,000	$6,900,000	$13,500,000	$7,800,000	$4,200,000	$2,800,000
Mechanical	$1,840,000	$1,320,000	$2,320,000	$1,390,000	$2,710,000	$1,560,000	$850,000	$990,000
Electrical	$2,300,000	$1,600,000	$2,900,000	$1,700,000	$3,400,000	$1,900,000	$1,100,000	$700,000
Heating, ventilation, and air conditioning (HVAC)	$920,000	$660,000	$1,160,000	$700,000	$1,350,000	$790,000	$420,000	$290,000
Sitework	$920,000	$660,000	$1,160,000	$700,000	$1,350,000	$790,000	$640,000	$420,000
Contractor General Conditions	$1,520,000	$1,090,000	$1,920,000	$1,150,000	$2,230,000	$1,290,000	$720,000	$530,000
Contingencies, Legal, and Engineering	$8,300,000	$6,000,000	$10,500,000	$6,300,000	$12,300,000	$7,100,000	$4,000,000	$2,900,000
Total Opinion of Capital Costs	**$25,000,000**	**$17,890,000**	**$31,580,000**	**$18,870,000**	**$36,840,000**	**$21,180,000**	**$11,870,000**	**$8,610,000**
Annual O&M Costs								
Labor	$12,000	$12,000	$24,000	$24,000	$48,000	$48,000	$72,000	$12,000 to $72,000
Power	$350,000	$350,000	$362,000	$362,000	$350,000	$350,000	$326,000	$326,000 to $362,000
Chemical	$72,000	$2,657,000	$169,000	$906,000	$169,000	$531,000	$797,000	$72,000 to $2657,000
Additional Sludge Disposal Cost	$266,000	$266,000	$48,000	$48,000	$48,000	$48,000	$205,000	$48,000 to $266,000
Maintenance and Supplies	$24,000	$24,000	$36,000	$36,000	$48,000	$48,000	$24,000	$24,000 to $48,000
Total	$725,000	$3,309,000	$640,000	$1,377,000	$664,000	$1,027,000	$1,425,000	$640,000 to $3,309,000
Present Worth of O&M	**$11,040,000**	**$50,390,000**	**$9,750,000**	**$20,970,000**	**$10,110,000**	**$15,630,000**	**$21,700,000**	**$9,750,000 to $50,390,000**
Summary of Present Worth Costs								
Capital Cost	$25,000,000	$17,890,000	$31,580,000	$18,870,000	$36,840,000	$21,180,000	$11,870,000	$8,610,000
Replacement	$530,000	$530,000	$530,000	$530,000	$530,000	$530,000	$530,000	$410,000
O&M Cost	$11,040,000	$50,390,000	$9,750,000	$20,970,000	$10,110,000	$15,630,000	$21,700,000	$9,750,000 to $50,390,000
Salvage Value	($1,140,000)	($1,740,000)	($1,280,000)	($1,330,000)	($1,390,000)	($1,110,000)	($1,070,000)	($680,000)
Satellite Influent Screening	$6,610,000	-	$6,610,000	-	$6,610,000	-	-	-
Lost Biogas Revenue at Lagoon	$0-$18,230,000	-	$0-$5,210,000	-	$0-$2,610,000	-	-	-
TOTAL PRESENT WORTH	**$42,040,000 to $60,270,000**	**$67,070,000**	**$47,190,000 to $52,400,000**	**$39,040,000**	**$55,700,000 to $55,310,000**	**$36,230,000**	**$33,030,000**	**$8,870,000 to $27,180,000**

Note: All costs in 2nd Quarter 2023 dollars.

Table 22 BNR Nonmonetary Considerations Summary

Alternative	Benefits	Limitations
BNR1a: *A^2O with BOD diversion from lagoon*	▪ TP and TN removal without chemical addition at WWTP.	▪ Significant reduction in lagoon biogas. ▪ Potential negative impact on WWTP processes and equipment from undesirable materials in diverted lagoon influent. ▪ Operation of BPR more challenging under varied influent conditions than CPR.
BNR1b: *A^2O with VFA addition at WWTP*	▪ TP and TN removal without metal salt addition at WWTP. ▪ Does not impact lagoon operation or lagoon biogas production.	▪ Additional chemical handling at WWTP; increase in truck traffic to site, new equipment to operate and maintain. ▪ Operation of BPR more challenging under varied influent conditions than CPR.
BNR1c: *A^2O with Struvite Harvesting; BOD diversion from lagoon*	▪ TP and TN removal without chemical addition at WWTP. ▪ Reduction of nuisance struvite formation through harvesting/sequestration. Potential for marketable struvite product.	▪ Reduction in lagoon biogas production. ▪ Potential negative impact on WWTP processes and equipment from undesirable materials in diverted lagoon influent. ▪ Operation of BPR more challenging under varied influent conditions than CPR. ▪ Increased complexity with additional process to operate and maintain.
BNR1d: *A^2O with Struvite Harvesting; VFA addition at WWTP*	▪ TP and TN removal without metal salt addition at WWTP. ▪ Does not impact lagoon operation or lagoon biogas production.	▪ Additional chemical handling at WWTP; increase in truck traffic to site, new equipment to operate and maintain. ▪ Operation of BPR more challenging under varied influent conditions than CPR. ▪ Increased complexity with additional process to operate and maintain.
BNR1e: *A^2O with Struvite Harvesting and PRS fermentation; BOD diversion from lagoon*	▪ TP and TN removal without chemical addition at WWTP. ▪ Reduction of nuisance struvite formation through harvesting/sequestration. Potential for marketable struvite product. ▪ VFA formation at WWTP stabilizes BPR performance under varied influent conditions.	▪ Reduction in lagoon biogas production. ▪ Potential negative impact on WWTP processes and equipment from undesirable materials in diverted lagoon influent. ▪ Operation of BPR more challenging under varied influent conditions than CPR. ▪ PRS Fermentation can be challenging to operate; odor concerns. ▪ Increased complexity with two additional processes to operate and maintain.
BNR1f: *A^2O with Struvite Harvesting and PRS fermentation; VFA addition at WWTP*	▪ TP and TN removal without metal salt addition at WWTP. ▪ Does not impact lagoon operation or lagoon biogas production.	▪ Additional chemical handling at WWTP; increase in truck traffic to site, new equipment to operate and maintain. ▪ Operation of BPR more challenging under varied influent conditions than CPR. ▪ PRS Fermentation can be challenging to operate; odor concerns. ▪ Increased complexity with additional processes to operate and maintain.
BNR2: *MLE with CPR*	▪ Modification to existing process, staff familiar with operation. ▪ CPR more reliable than BPR, especially with varied influent conditions.	▪ Additional chemical handling at WWTP; increase in truck traffic to site, new equipment to operate and maintain.
BNR3: *MLE with RAS Fermentation*	▪ Potential for TP and TN removal without chemical addition at WWTP. ▪ Can be tested in existing tankage while using MLE process in remaining tanks. ▪ Struvite harvesting and/or PRS fermentation could be added to improve TP removal if necessary.	▪ Developing process that has not been widely implemented to date. ▪ System performance cannot be predicted using current process modes.

C. Other Capital Improvements Required for Enhanced Nutrient Removal and WWTP Consolidation

In this section, other capital improvements that are recommended if enhanced nutrient removal or increased capacity were to be required are presented.

As previously described, the Satellite and Easton WWTPs are currently designed to operate as separate systems, each with their own influent pumps, activated sludge tanks, aeration systems, and final clarifiers. The City currently treats wastewater from both the Satellite and Easton collection systems using only the Easton WWTP activated sludge system because operating the two systems in parallel is inefficient and add significant operational complexity. It is also challenging to bring the Satellite WWTP online intermittently during periods of high flow/load, which would require ML to be manually transferred from the Easton tanks to the Satellite tanks, and for a second and significantly different activated sludge process to be initiated while biological treatment is under stress. For these reasons, it is recommended that the operations of the two facilities be combined into one common WWTP using infrastructure from both WWTPs. The proposed configuration would combine the Easton and Satellite flows before grit removal, and the existing activated sludge systems would be modified to operate as parallel sets of tanks using the same biological treatment process as indicated earlier. However, other capital improvements beyond those identified in the BNR alternatives would be required to consolidate the WWTP operation. This section describes these additional capital improvements that are required to implement the BNR alternatives.

1. Preliminary and Primary Treatment Improvements

The Satellite WWTPs influent does not currently undergo preliminary or primary treatment and is discharged either directly to the Satellite activated sludge system or to the Easton activated sludge system (current operation). Because the Satellite activated sludge system is approximately 5 feet higher in elevation than the Easton activated sludge system, gravity flow of a combined influent to the two systems is not possible without hydraulic modifications to the existing primary clarifiers and splitter structure. Improvements to the preliminary and primary treatment facilities to consolidate the WWTPs are as follows:

a. Replace Easton and Satellite WWTPs influent pumps.

b. Modify Satellite influent pump discharge piping to allow discharge upstream of grit removal, to the primary clarifier splitter box, and to the primary effluent splitter structure. Provide new flow measurement and sampling for Satellite influent.

c. Add larger opening with sluice gate between Easton and Satellite WWTPs influent wet wells to allow wet wells to operate as one.

d. Modify grit influent channel to reduce grit settling.

e. Replace grit collector mechanisms.

f. Replace grit pumps and associated piping.

g. Replace grit classifier with two grit washers.

h. Install additional primary influent pipe between grit removal effluent channel and primary clarifier splitter structure to increase hydraulic capacity to 64 MGD. Modify grit effluent piping and equalization basin downward opening weir control in degritter effluent channel.

i. Raise the walls and channels of the primary clarifiers and splitter structure approximately 5 feet to increase the water surface elevation in the primary clarifiers by approximately 5 feet.

j. Replace primary clarifier mechanisms and weirs.

k. Convert the existing Easton anoxic selector basin into primary effluent splitter structure to split flow between the Satellite and Easton activated sludge systems. Install new piping from splitter structure to Satellite activated sludge system.

2. Replacement of Aeration Blowers and Automation of Air Piping Cross-Connection

Air for the activated sludge system is currently provided by eight 800-horsepower (hp) multi-stage centrifugal blowers with nominal capacities of 10,500 standard cubic feet per minute (scfm) each. The City currently operates only one or two of these blowers under normal conditions. During periods of low flow and load, these blowers do not provide the desired turndown, resulting in high dissolved oxygen (DO) concentrations in the ML that is recycled to the anoxic zones. Newer blower technologies, such as high-speed turbo blowers and single-stage centrifugal blowers, are more energy efficient and would provide better turndown than the existing blowers.

It is recommended that four of the existing centrifugal blowers are replaced to improve energy efficiency and turndown while providing the oxygen for the simulated maximum month condition. For planning purposes, four 10,000 scfm high-speed turbo blowers are included in the recommended plan. It is also recommended the remaining four multistage centrifugal blowers are maintained to provide the additional air required for the full permitted design loading condition or should the anaerobic lagoon be offline for a period. In addition, new blower controls based on dissolved oxygen are recommended in all activated sludge basins. Automation is also included for the cross-connection between the existing Easton and Satellite aeration systems to allow the two aeration systems to operate as a combined system.

3. Final Clarifier Mechanism Replacement

The recommended BNR improvements and WWTP consolidation will allow the City to better use the existing final clarifiers, which is anticipated to improve clarifier performance. However, the Satellite final clarifiers have been out of service for several years and it is anticipated that some work will be required to bring them back into service. Based on this, the recommended near-term improvements include a budgetary cost to replace the existing clarifier mechanisms. Note that City staff are planning to advertise a project to replace one of the Easton final clarifier mechanisms in summer 2023, which was a near-term project identified in the *2018 Nutrient Reduction Study*.

4. Final Clarifier Cross-Connection and Flow Distribution Improvements

As discussed earlier, the Satellite and Easton activated sludge systems are completely separated, not allowing for final clarifiers to be used without using the associated activated sludge system. To improve clarifier capacity following WWTP consolidation, a cross-connection between the two systems upstream of the final clarifiers is recommended to provide the ability to transfer ML from the Satellite WWTP to the Easton WWTP. In addition, modifications to the existing final clarifier flow splitter boxes for both WWTPs are recommended to improve flow distribution and control. These splitter boxes, including the cross-connection piping and downward opening weir gate with ultrasonic flow measurement to control the transfer of ML from the Satellite WWTP to the Easton WWTP, would be extensions of the existing splitter boxes and ML recycle wet wells.

5. New Effluent Flow Metering Structure

Currently, secondary effluent from the Satellite and Easton WWTPs are measured separately using Parshall flumes at two different locations on-site. The existing Satellite secondary effluent flume is not adequately sized to measure the portion of the future combined WWTP flow that would be treated using the Satellite activated sludge tanks, requiring modifications to the existing means of effluent flow measurement. While the Easton secondary effluent flume is large enough to measure the portion of the future combined WWTP that would be treated using the Easton activated sludge system, it is not large enough to be used to measure the combined flows from the Easton and Satellite activated sludge systems. Therefore, the construction of a larger Parshall flume to measure the secondary effluent from both the Satellite and Easton activated sludge systems is proposed in the vicinity of the existing Easton effluent flume.

IMPLEMENTATION AND BUDGETARY CONSIDERATIONS

Because of the emergence of BNR technologies such as the sidestream enhanced biological phosphorus removal (EBPR) (*Alternative BNR3*) that are anticipated to result in significantly less chemical and energy use compared to CPR, a phased approach would allow further development and optimization of BNR at the WWTP at a lower operating cost than CPR. This approach would also provide flexibility to incorporate CPR in a future phase.

In addition, the City has several planned projects to improve facility performance which will require the commitment of significant funds as noted below:

1. WWTP Improvements Not Attributed to Nutrient Removal
   - Mid-Term (2023 to 2028): $1.33 million

2. Collection System Condition and Capacity Related Improvements:
   - 2023: $21.3 million
   - 2024 to 2026: $39.30 million
   - 2027 to 2029: $20.75 million
   - 2030 to 2032: $30.89 million

Because of the significant capital funds already planned toward improving facility performance, a phased approach is appropriate to reduce the financial burden on the City's rate payers in the near future.

A. Short-Term Improvements–Demonstrate and Optimize BNR

Based on the capital and present worth cost evaluation presented in Table 21, Alternative BNR3 is the least costly alternative for enhanced nutrient removal. This process has shown successful BNR for wastewaters that are carbon-limited for conventional BNR processes. The opinion of probable construction costs (OPCC) for the improvements necessary to implement nutrient removal at the WWTP are presented in Table 23.

Component	OPCC
Equipment/Structures	
Preliminary and Primary Treatment Improvements; Raise Primary Clarifiers	$5,070,000
BNR3–MLE with Sidestream Enhanced BPR	$2,800,000
Blower Replacement	$3,910,000
Final Clarifier Mechanism Replacement	$2,050,000
Final Clarifier Cross Connection and Flow Distribution Improvements	$1,210,000
Return Flow and Secondary Effluent Metering	$520,000
Replace Easton Bar Screens	$1,090,000
Piping and Mechanical	$5,890,000
Electrical	$3,660,000
Sitework	$1,050,000
HVAC	$540,000
Contractors' General Conditions	$2,780,000
Contingencies and Technical Services	$15,280,000
TOTAL OPINION OF CAPITAL COSTS	**$45,850,000**

Note: All costs are in second quarter 2023 dollars

Table 23 Recommended Near-Term Improvements for Nutrient Removal

B. Mid-Term Recommendations–Evaluate Struvite Recovery, Evaluate CPR If Necessary

Following BNR optimization, it is recommended that the City evaluate the necessity and potential benefits of adding a process to recover or sequester struvite from the anaerobic digester sludge of filtrate/centrate. While the City does not currently experience nuisance struvite formation within its anaerobic digesters, struvite concerns are apparent in the piping and tanks downstream of the digesters and dewatering. In addition, successful implementation of BPR would increase the phosphorus content of the biosolids and potentially lead to significantly more struvite in the digesters, dewatering operations, and centrate management systems.

Further evaluation of the combination of sidestream EBPR and struvite recovery is recommended following implementation of Alternative BNR3. It is anticipated that the construction of a struvite recovery or sequestration system would cost approximately $8 million assuming a sludge-based sequestration system and including technical services. CPR should also be evaluated at that time.

SEWER BUDGET IMPACT

The total OPCC for the near-term improvements is approximately $45.85 million (second Quarter 2023 dollar basis). Projecting this amount to an anticipated second Quarter 2026 bid date and applying a construction inflation rate of 4 percent annually, the anticipated total project costs are approximately $51.8 million.

The WWTP improvements are anticipated to be financed through Iowa's State Revolving Fund (SRF) loan program. The SRF program provides 0 percent interest financing for planning and design services for up to 3 years that can be rolled into the SRF construction loan. Construction loans are offered at 1.75 percent interest, typically for 20-year terms. In addition to the 1.75 percent interest loan, an administrative fee of 0.25 percent is added each year to the outstanding principal balance for administering the loan. Also, an additional 0.5 percent of the loan amount (up to $100,000) is included as a loan initiation fee.

Assuming a total loan amount of $51.8 million, plus the initiation fee of $100,000, the annual debt service payment is expected to be approximately $3.1 million. Table 24 presents a preliminary budget impact summary of the near-term improvements.

A preliminary analysis was conducted to estimate the impact of the near-term improvements on the WWTP budget. Although many components of the identified improvements are more energy efficient that current WWTP operation, particularly the replacement of the activated sludge blowers which can account for more than one-half of the energy of the WWTP, this analysis was conducted assuming there would be no change in annual O&M costs. While the improvements would likely result in overall O&M savings, the assumptions used in this analysis provide a conservative estimate of the impact on the sewer budget. A more detailed analysis of plant operation following the near-term improvements as well as a user charge study would be conducted as part of a facilities planning effort should the City decide to proceed with this major project.

	Near-Term Improvements
OPCC[1]	$51,810,000
Anticipated Annual Debt Service Payment[2]	$3,100,000

[1]Second Quarter 2026 Dollars
[2]20-year loan at 1.75 percent interest, 0.25 percent administration fee, and $100,000 loan initiation fee

Table 24 WWTP Budget Impact Summary for Near-Term Improvements

The City conducted a preliminary analysis of the impact on sewer rates for the projects described in this report as presented in this next section.

FINANCIAL INFORMATION

Substantial rate increases would be required to implement the projects outlined in the NRS in addition to the projects currently underway that are required by the Consent Decree. Projected rate increases to fund the additional required debt service are outlined in Table 25.

Fiscal Year	Additional Debt Service Required Annually	Rate Increase Required
FYE2024	$350,000	8%
FYE2025	$900,000	9%
FYE2026	$1,900,000	12%
FYE2027	$4,700,000	24%
FYE2028	$2,100,000	10%
FYE2029	$2,400,000	10%
Totals	$12,350,000	73%

FYE=Fiscal Year Ending

Table 25 Projected Rate Increases

These improvements would require rate increases totaling 73 percent over the 6 years of implementation. The City has a very diverse population. The sewer costs for the largest minority group would exceed 1.5 percent of median household income beginning in 2022 and could exceed it by as much as 29 percent by 2026.

The City has large industrial users that would be negatively impacted by these rate increases. If the largest user reduced its water/sewer use by 30 percent, the rate increases applied to all customers outlined above would need to increase by 79 percent to cover the annual debt service payments. That would cause the sewer cost for all population groups to exceed 1.5 percent of median household income by FYE 2026.

Fiscal Year	Additional Debt Service Required Annually	Rate Increase Required
FYE2024	$350,000	10%
FYE2025	$900,000	10%
FYE2026	$1,900,000	15%
FYE2027	$4,700,000	24%
FYE2028	$2,100,000	10%
FYE2029	$2,400,000	10%
Totals	$12,350,000	79%

Table 26 Projected Rate Increases with Reduced Industrial Use

SCHEDULE

Because of the significant capital funds already planned toward improving facility and collection system performance, implementation of the Nutrient Reduction Study in 2040 is appropriate to reduce the financial burden on the rate payers of the City. Table 9 presents a preliminary schedule for implementation of the recommended project at the WWTP.

Activity	Date
Begin Facilities Planning and Preliminary Design	2040
Begin Final Design	Second Quarter 2041
Complete Final Design	Second Quarter 2042
Advertise Project	Third Quarter 2042
Begin Construction	Fourth Quarter 2042
Complete Construction	Fourth Quarter 2045

Table 27 Preliminary Project Schedule

APPENDIX A
NPDES PERMIT

IOWA DEPARTMENT OF NATURAL RESOURCES

National Pollutant Discharge Elimination System (NPDES) Permit

OWNER NAME & ADDRESS

CITY OF WATERLOO
715 MULBERRY STREET
WATERLOO, IA 50703

FACILITY NAME & ADDRESS

WATERLOO CITY OF STP
3505 EASTON AVENUE
WATERLOO, IA 50702

Section 31, T89N, R12W
Black Hawk County

IOWA NPDES PERMIT NUMBER: 0790001
DATE OF ISSUANCE: 06/01/2021
DATE OF EXPIRATION: 05/31/2026

YOU ARE REQUIRED TO FILE FOR RENEWAL OF THIS PERMIT BY: 12/02/2025
EPA NUMBER: IA0042650

This permit is issued pursuant to the authority of section 402(b) of the Clean Water Act (33 U.S.C. 1342(b)), Iowa Code section 455B.174, and rule 567-64.3, Iowa Administrative Code. You are authorized to operate the disposal system and to discharge the pollutants specified in this permit in accordance with the effluent limitations, monitoring requirements and other terms set forth in this permit.

You may appeal any condition of this permit by filing a written notice of appeal and request for administrative hearing with the director of the department within 30 days of permit issuance.

Any existing, unexpired Iowa operation permit or Iowa NPDES permit previously issued by the department for the facility identified above is revoked by the issuance of this permit. This provision does not apply to any authorization to discharge under the terms and conditions of a general permit issued by the department or to any permit issued exclusively for the discharge of stormwater.

FOR THE DEPARTMENT OF NATURAL RESOURCES

By Ben Hucka Digitally signed by Ben Hucka Date: 2021.05.18 07:32:01 -05'00'

Ben Hucka
NPDES Section, Environmental Services Division

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

Outfall No.: 001 EASTON AVENUE ACTIVATED SLUDGE WASTEWATER TREATMENT FACILITY.

Receiving Stream: CEDAR RIVER

Route of Flow: CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Waters designated Class HH are those in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

Outfall No.: 004 BYPASS AT THE HACKETT ROAD LIFT STATION.

Receiving Stream: UNNAMED CREEK

Route of Flow: UNNAMED CREEK TO CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Outfall No.: 008 SATELLITE ACTIVATED SLUDGE WASTEWATER TREATMENT FACILITY.

Receiving Stream: CEDAR RIVER

Route of Flow: CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Waters designated Class HH are those in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

Outfall No.: 009 BYPASS AT SHORELINE OVERFLOW WHEN STREAM FLOW IS LESS THAN 8500 CFS (USGS GAGE 05464000)

Receiving Stream: CEDAR RIVER

Route of Flow: CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Waters designated Class HH are those in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

Outfall No.: 010 BYPASS AT EQUALIZATION BASIN OVERFLOW

Receiving Stream: CEDAR RIVER

Route of Flow: DRAINAGE DITCH TO CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Outfall No.: 011 TOTAL TREATMENT FACILITY SHORELINE DISCHARGE- STREAM FLOW IS GREATER THAN OR EQUAL TO 8500 CFS (USGS GAGE 05464000)

Receiving Stream: CEDAR RIVER

Route of Flow: CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Waters designated Class HH are those in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

Outfall No.: 012 BYPASS AT SERGEANT RD AND FLETCHER AVE

Receiving Stream: BLACK HAWK CREEK

Route of Flow: BLACK HAWK CREEK

Class A3 waters are children's recreational use waters in which recreational uses by children are common. Class A3 waters are water bodies having definite banks and bed with visible evidence of flow or occurrence of water. This type of use would primarily occur in urban or residential areas.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Waters designated Class HH are those in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

Outfall No.: 801 TOTAL TREATMENT FACILITY DIFFUSER DISCHARGE.

Receiving Stream: CEDAR RIVER

Route of Flow: CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Waters designated Class HH are those in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

Bypasses from any portion of a treatment facility or from a sanitary sewer collection system designed to carry only sewage are prohibited.

Facility Name: WATERLOO CITY OF STP
Permit Number: 0790001

Effluent Limitations:

You are prohibited from discharging pollutants except in compliance with the following effluent limitations:

001 EASTON AVENUE ACTIVATED SLUDGE WASTEWATER TREATMENT FACILITY.

Outfall: 001 Effective Dates: 06/01/2021 to 05/31/2026			
Parameter	**Season**	**Limit Type**	**Limits**
CBOD5			
	Yearly	7 Day Average	40 MG/L
	Yearly	30 Day Average	25 MG/L
TOTAL SUSPENDED SOLIDS			
	Yearly	7 Day Average	45 MG/L
	Yearly	30 Day Average	30 MG/L

008 SATELLITE ACTIVATED SLUDGE WASTEWATER TREATMENT FACILITY.

Outfall: 008 Effective Dates: 06/01/2021 to 05/31/2026			
Parameter	**Season**	**Limit Type**	**Limits**
CBOD5			
	Yearly	7 Day Average	40 MG/L
	Yearly	30 Day Average	25 MG/L
TOTAL SUSPENDED SOLIDS			
	Yearly	7 Day Average	45 MG/L
	Yearly	30 Day Average	30 MG/L

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

011 TOTAL TREATMENT FACILITY SHORELINE DISCHARGE- STREAM FLOW IS GREATER THAN OR EQUAL TO 8500 CFS (USGS GAGE 05464000)

Outfall: 011 Effective Dates: 06/01/2021 to 05/31/2026			
Parameter	**Season**	**Limit Type**	**Limits**
CBOD5			**85% Removal Required**
	Yearly	7 Day Average	11609 LBS/DAY
	Yearly	30 Day Average	7256 LBS/DAY
TOTAL SUSPENDED SOLIDS			**85% Removal Required**
	Yearly	7 Day Average	13060 LBS/DAY
	Yearly	30 Day Average	8707 LBS/DAY
NITROGEN, TOTAL (AS N)			
	Yearly	30 Day Average	9285.5 LBS/DAY
	Yearly	Daily Maximum	15199.0 LBS/DAY
PH			
	Yearly	Daily Maximum	9.0 STD UNITS
	Yearly	Daily Minimum	6.0 STD UNITS
E. COLI			
	MAR	Geometric Mean	126 #/100 ML
	APR	Geometric Mean	126 #/100 ML
	MAY	Geometric Mean	126 #/100 ML
	JUN	Geometric Mean	126 #/100 ML
	JUL	Geometric Mean	126 #/100 ML
	AUG	Geometric Mean	126 #/100 ML
	SEP	Geometric Mean	126 #/100 ML
	OCT	Geometric Mean	126 #/100 ML
	NOV	Geometric Mean	126 #/100 ML
ACUTE TOXICITY, CERIODAPHNIA			
	Yearly	Daily Maximum	1 NO TOXICITY
ACUTE TOXICITY, PIMEPHALES			
	Yearly	Daily Maximum	1 NO TOXICITY

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

Outfall: 011 Effective Dates: 06/01/2021 to 05/31/2026			
Parameter	**Season**	**Limit Type**	**Limits**
AMMONIA NITROGEN (N)			
	JAN	30 Day Average	69.4 MG/L 12696 LBS/DAY
	JAN	Daily Maximum	69.4 MG/L 12696 LBS/DAY
	FEB	30 Day Average	78.4 MG/L 13832 LBS/DAY
	FEB	Daily Maximum	78.4 MG/L 13832 LBS/DAY
	MAR	30 Day Average	68.0 MG/L 12392 LBS/DAY
	MAR	Daily Maximum	68.0 MG/L 12392 LBS/DAY
	APR	30 Day Average	53.9 MG/L 10546 LBS/DAY
	APR	Daily Maximum	53.9 MG/L 10546 LBS/DAY
	MAY	30 Day Average	60.5 MG/L 11394 LBS/DAY
	MAY	Daily Maximum	60.5 MG/L 11394 LBS/DAY
	JUN	30 Day Average	59.5 MG/L 10079 LBS/DAY
	JUN	Daily Maximum	59.5 MG/L 11114 LBS/DAY
	JUL	30 Day Average	64.1 MG/L 11575 LBS/DAY
	JUL	Daily Maximum	64.1 MG/L 12395 LBS/DAY
	AUG	30 Day Average	62.0 MG/L 10982 LBS/DAY
	AUG	Daily Maximum	62.0 MG/L 11823 LBS/DAY
	SEP	30 Day Average	55.2 MG/L 10890 LBS/DAY
	SEP	Daily Maximum	55.2 MG/L 10890 LBS/DAY
	OCT	30 Day Average	54.0 MG/L 10558 LBS/DAY
	OCT	Daily Maximum	54.0 MG/L 10558 LBS/DAY
	NOV	30 Day Average	52.5 MG/L 10145 LBS/DAY
	NOV	Daily Maximum	52.5 MG/L 10145 LBS/DAY
	DEC	30 Day Average	54.3 MG/L 10655 LBS/DAY
	DEC	Daily Maximum	54.3 MG/L 10655 LBS/DAY

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

801 TOTAL TREATMENT FACILITY DIFFUSER DISCHARGE.

Outfall: 801 Effective Dates: 06/01/2021 to 05/31/2026			
Parameter	**Season**	**Limit Type**	**Limits**
CBOD5			**85% Removal Required**
	Yearly	7 Day Average	11609 LBS/DAY
	Yearly	30 Day Average	7256 LBS/DAY
TOTAL SUSPENDED SOLIDS			**85% Removal Required**
	Yearly	7 Day Average	13060 LBS/DAY
	Yearly	30 Day Average	8707 LBS/DAY
NITROGEN, TOTAL (AS N)			
	Yearly	30 Day Average	9285.5 LBS/DAY
	Yearly	Daily Maximum	15199.0 LBS/DAY
PH			
	Yearly	Daily Maximum	9.0 STD UNITS
	Yearly	Daily Minimum	6.0 STD UNITS
E. COLI			
	MAR	Geometric Mean	126 #/100 ML
	APR	Geometric Mean	126 #/100 ML
	MAY	Geometric Mean	126 #/100 ML
	JUN	Geometric Mean	126 #/100 ML
	JUL	Geometric Mean	126 #/100 ML
	AUG	Geometric Mean	126 #/100 ML
	SEP	Geometric Mean	126 #/100 ML
	OCT	Geometric Mean	126 #/100 ML
	NOV	Geometric Mean	126 #/100 ML
ACUTE TOXICITY, CERIODAPHNIA			
	Yearly	Daily Maximum	1 NO TOXICITY
ACUTE TOXICITY, PIMEPHALES			
	Yearly	Daily Maximum	1 NO TOXICITY

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

Outfall: 801 Effective Dates: 06/01/2021 to 05/31/2026			
Parameter	**Season**	**Limit Type**	**Limits**
AMMONIA NITROGEN (N)			
	JAN	30 Day Average	55.9 MG/L 9364 LBS/DAY
	JAN	Daily Maximum	95.0 MG/L 16561 LBS/DAY
	FEB	30 Day Average	70.0 MG/L 11372 LBS/DAY
	FEB	Daily Maximum	116.5 MG/L 19558 LBS/DAY
	MAR	30 Day Average	30.7 MG/L 4998.7 LBS/DAY
	MAR	Daily Maximum	108.5 MG/L 21421 LBS/DAY
	APR	30 Day Average	21.5 MG/L 3519.0 LBS/DAY
	APR	Daily Maximum	79.8 MG/L 14363.0 LBS/DAY
	MAY	30 Day Average	18.0 MG/L 2962.7 LBS/DAY
	MAY	Daily Maximum	79.1 MG/L 14162.8 LBS/DAY
	JUN	30 Day Average	11.6 MG/L 1931.6 LBS/DAY
	JUN	Daily Maximum	78.1 MG/L 13877.8 LBS/DAY
	JUL	30 Day Average	14.2 MG/L 2283.2 LBS/DAY
	JUL	Daily Maximum	87.4 MG/L 25229 LBS/DAY
	AUG	30 Day Average	13.0 MG/L 2082.2 LBS/DAY
	AUG	Daily Maximum	74.1 MG/L 13652.6 LBS/DAY
	SEP	30 Day Average	13.4 MG/L 2221.8 LBS/DAY
	SEP	Daily Maximum	94.6 MG/L 16916 LBS/DAY
	OCT	30 Day Average	30.8 MG/L 5020.2 LBS/DAY
	OCT	Daily Maximum	93.5 MG/L 16990 LBS/DAY
	NOV	30 Day Average	38.7 MG/L 6282.3 LBS/DAY
	NOV	Daily Maximum	78.4 MG/L 13970.8 LBS/DAY
	DEC	30 Day Average	45.8 MG/L 8998 LBS/DAY
	DEC	Daily Maximum	72.7 MG/L 13467 LBS/DAY

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

Non-Standard Effluent Limits

Outfall #	Limits Effective During Blending Mode of Operation			
	Parameter	**Season**	**Limit Type**	**Limits**
011 and 801	**BIOCHEMICAL OXYGEN DEMAND (BOD5)**			
		Yearly	7 Day Average	45 MG/L 13060 LBS/DAY
		Yearly	30 Day Average	30 MG/L 8707 LBS/DAY

Monitoring and Reporting Requirements

(a) Samples and measurements taken shall be representative of the volume and nature of the monitored wastewater.

(b) Analytical and sampling methods specified in 40 CFR Part 136 or other methods approved in writing by the department shall be utilized. All effluent samples for which a limit applies must be analyzed using sufficiently sensitive methods (i.e. testing procedures) approved under 567 IAC Chapter 63 and 40 CFR Part 136 for the analysis of pollutants or pollutant parameters or as required under 40 CFR chapter I, subchapter N or O.

For the purposes of this paragraph, an approved method is sufficiently sensitive when:
(1) the method minimum level (ML) is at or below the level of the effluent limit established in the permit for the measured pollutant or pollutant parameter; or
(2) the method has the lowest ML of the approved analytical methods for the measured pollutant or pollutant parameter.

Samples collected for operational testing need not be analyzed by approved analytical methods; however, commonly accepted test methods should be used.

(c) You are required to report all data including calculated results needed to determine compliance with the limitations contained in this permit. The results of any monitoring not specified in this permit performed at the compliance monitoring point and analyzed according to 40 CFR Part 136 shall be included in the calculation and reporting of any data submitted in accordance with this permit. This includes daily maximums and minimums, 30-day averages and 7-day averages for all parameters that have concentration (mg/l) and mass (lbs/day) limits. In addition, flow data shall be reported in million gallons per day (MGD).

(d) Records of monitoring activities and results shall include for all samples: the date, exact place and time of the sampling; the dates the analyses were performed; who performed the analyses; the analytical techniques or methods used; and the results of such analyses.

(e) Results of all monitoring shall be recorded on forms provided by, or approved by, the department, and shall be submitted to the appropriate regional field office of the department by the fifteenth day following the close of the reporting period. Your reporting period is on a MONTHLY basis, ending on the last day of each reporting period.

(f) Operational performance monitoring for treatment unit process control shall be conducted to ensure that the facility is properly operated in accordance with its design. The results of any operational performance monitoring need not be reported to the department, but shall be maintained in accordance with rule 567 IAC 63.2 (455B). The results of any operational performance monitoring specified in this permit shall be submitted to the department in accordance with these reporting requirements.

(g) Chapter 63 of the rules provides you with further explanation of your monitoring requirements.

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

Outfall	Wastewater Parameter	Sample Frequency	Sample Type	Monitoring Location
The following monitoring requirements shall be in effect from 06/01/2021 to 05/31/2026				
001	BIOCHEMICAL OXYGEN DEMAND (BOD5)	7/WEEK OR DAILY	24 HOUR COMPOSITE	RAW WASTE
001	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	RAW WASTE
001	NITROGEN, TOTAL (AS N)	1 TIME PER WEEK	24 HOUR COMPOSITE	RAW WASTE
001	NITROGEN, TOTAL KJELDAHL (AS N)	1 TIME PER WEEK	24 HOUR COMPOSITE	RAW WASTE
001	PH	7/WEEK OR DAILY	GRAB	RAW WASTE
001	PHOSPHORUS, TOTAL (AS P)	1 TIME PER WEEK	24 HOUR COMPOSITE	RAW WASTE
001	TEMPERATURE	7/WEEK OR DAILY	GRAB	RAW WASTE
001	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	24 HOUR COMPOSITE	RAW WASTE
001	CBOD5	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT PRIOR TO DISINFECTION
001	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT PRIOR TO DISINFECTION
008	BIOCHEMICAL OXYGEN DEMAND (BOD5)	7/WEEK OR DAILY	24 HOUR COMPOSITE	RAW WASTE
008	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	RAW WASTE
008	NITROGEN, TOTAL (AS N)	1 TIME PER WEEK	24 HOUR COMPOSITE	RAW WASTE
008	NITROGEN, TOTAL KJELDAHL (AS N)	1 TIME PER WEEK	24 HOUR COMPOSITE	RAW WASTE
008	PH	7/WEEK OR DAILY	GRAB	RAW WASTE
008	PHOSPHORUS, TOTAL (AS P)	1 TIME PER WEEK	24 HOUR COMPOSITE	RAW WASTE
008	TEMPERATURE	7/WEEK OR DAILY	GRAB	RAW WASTE
008	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	24 HOUR COMPOSITE	RAW WASTE
008	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	BLENDED FLOW
008	CBOD5	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT PRIOR TO DISINFECTION
008	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT PRIOR TO DISINFECTION

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

Outfall	Wastewater Parameter	Sample Frequency	Sample Type	Monitoring Location
The following monitoring requirements shall be in effect from 06/01/2021 to 05/31/2026				
011	ACUTE TOXICITY, CERIODAPHNIA	1 EVERY 12 MONTHS	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
011	ACUTE TOXICITY, PIMEPHALES	1 EVERY 12 MONTHS	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
011	AMMONIA NITROGEN (N)	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
011	BIOCHEMICAL OXYGEN DEMAND (BOD5)	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
011	CBOD5	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
011	E. COLI	GEO. MEAN 1/3 MONTHS	GRAB	EFFLUENT AFTER DISINFECTION
011	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	EFFLUENT AFTER DISINFECTION
011	NITROGEN, TOTAL (AS N)	1 TIME PER WEEK	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
011	PH	7/WEEK OR DAILY	GRAB	EFFLUENT AFTER DISINFECTION
011	PHOSPHORUS, TOTAL (AS P)	1 TIME PER WEEK	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
011	TEMPERATURE	7/WEEK OR DAILY	GRAB	EFFLUENT AFTER DISINFECTION
011	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

Outfall	Wastewater Parameter	Sample Frequency	Sample Type	Monitoring Location
The following monitoring requirements shall be in effect from 06/01/2021 to 05/31/2026				
801	STREAM FLOW	7/WEEK OR DAILY	MEASUREMENT	CEDAR RIVER AT USGS STREAM GAGE 05464000
801	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	FLOW EQUALIZATION BASIN OVERFLOW TO SATELLITE PLANT
801	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	SPLIT FLOW EFFLUENT
801	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	FLOW EQUALIZATION BASIN RETURN
801	BIOCHEMICAL OXYGEN DEMAND (BOD5)	7/WEEK OR DAILY	CALCULATED	RAW WASTE
801	FLOW	7/WEEK OR DAILY	CALCULATED	TOTAL RAW WASTE FLOW
801	NITROGEN, TOTAL (AS N)	1 TIME PER WEEK	CALCULATED	RAW WASTE
801	NITROGEN, TOTAL KJELDAHL (AS N)	1 TIME PER WEEK	CALCULATED	RAW WASTE
801	PHOSPHORUS, TOTAL (AS P)	1 TIME PER WEEK	CALCULATED	RAW WASTE
801	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	CALCULATED	RAW WASTE
801	ACUTE TOXICITY, CERIODAPHNIA	1 EVERY 12 MONTHS	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	ACUTE TOXICITY, PIMEPHALES	1 EVERY 12 MONTHS	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	AMMONIA NITROGEN (N)	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	BATHYMETRIC REPORT	1 EVERY 12 MONTHS	MEASUREMENT	INSTREAM EFFLUENT DIFFUSER
801	BIOCHEMICAL OXYGEN DEMAND (BOD5)	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	CBOD5	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	DIFFUSER VALIDATION REPORT	1 EVERY 12 MONTHS	VISUAL	INSTREAM EFFLUENT DIFFUSER
801	E. COLI	GEO. MEAN 1/3 MONTHS	GRAB	EFFLUENT AFTER DISINFECTION
801	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	EFFLUENT AFTER DISINFECTION
801	NITROGEN, TOTAL (AS N)	1 TIME PER WEEK	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	PH	7/WEEK OR DAILY	GRAB	EFFLUENT AFTER DISINFECTION
801	PHOSPHORUS, TOTAL (AS P)	1 TIME PER WEEK	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	TEMPERATURE	7/WEEK OR DAILY	GRAB	EFFLUENT AFTER DISINFECTION
801	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	VISUAL OBSERVATION	1 EVERY MONTH	VISUAL	INSTREAM EFFLUENT DIFFUSER

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

Special Monitoring Requirements

Outfall #	Description
008	**FLOW**

Flow shall be reported if partially treated wastewater from the satellite plant is diverted to the disinfection chamber as outlined on the blending mode of operation page of this permit. If partially treated effluent is not being diverted to the disinfection unit, the facility shall report "not required" on the discharge monitoring report for that day.

011, 801 **BIOCHEMICAL OXYGEN DEMAND (BOD5)**

All BOD5 samples must be seeded at the laboratory prior to analysis when the disinfection equipment is in use.

E. COLI

The limit for E. coli of 126 org/100 ml specified on the limits pages of this permit for outfall(s) 801 and 011 is a monthly geometric mean. The disinfection season is established in the Iowa Administrative Code, Subparagraph 567 IAC 61.3(3)“a”(1), and is in effect from March 15 to November 15. Any disinfection system (chlorine, UV light, etc.) shall be operated to comply with the limit during the entire disinfection season whenever wastewater is being discharged from outfall(s) 801 and 011.

The facility must collect and analyze a minimum of five samples in one calendar month during each 3-month period from March 15 to November 15. The 3-month periods are March – May, June – August, and September – November. The collection of five samples in each 3-month period will result in a minimum of 15 samples being collected during a calendar year. For example, for the first 3-month period, the operator may choose April as the calendar month to collect the 5 individual E. coli samples to determine compliance with the limits. The operator may also choose the months of March or May as well, as long as each of the 5 samples is collected during a single calendar month. The same principle applies to the other two 3-month periods during the disinfection season. The following requirements apply to the individual samples collected in one calendar month:
Samples must be spaced over one calendar month.
No more than one sample can be collected on any one day.
There must be a minimum of two days between each sample.
No more than two samples may be collected in a period of seven consecutive days.

If the effluent has been disinfected using chlorine, ultraviolet light (UV), or any other process intended to disrupt the biological integrity of the E. coli, the samples shall be analyzed using the Most Probable Number method found in Standard Method 9223B (Colilert® or Colilert-18® made by IDEXX Laboratories, Inc.). If the effluent has not been disinfected the samples may be analyzed using either the MPN method above or EPA Method 1603: Escherichia coli (E. coli) in water by membrane filtration using modified membrane-thermotolerant E. coli agar (modified mTEC) or mColiBlue-24® made by the Hach Company.

The geometric mean must be calculated using all valid sample results collected during a month. The geometric mean formula is as follows:
Geometric Mean = (Sample one * Sample two * Sample three * Sample four *Sample five…Sample N)^(1/N), which is the Nth root of the result of the multiplication of all of the sample results where N = the number of samples. If a sample result is a less than value, the value reported by the lab without the less than sign should be used in the geometric mean calculation.

The geometric mean can be calculated in one of the following ways:
Use a scientific calculator that can calculate the powers of numbers.
Enter the samples in Microsoft Excel and use the function “GEOMEAN” to perform the calculation.
Use the geometric mean calculator on the Iowa DNR webpage at: http://www.iowadnr.gov/Environmental-Protection/Water-Quality/NPDES-Wastewater-Permitting/NPDES-Operator-Information/Bacteria-Sampling

Facility Name: WATERLOO CITY OF STP

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Outfall #	Description
011, 801	**NITROGEN, TOTAL (AS N)** Total nitrogen shall be determined by testing for Total Kjeldahl Nitrogen (TKN) and nitrate + nitrite nitrogen and reporting the sum of the TKN and nitrate + nitrite results (reported as N). Nitrate + nitrite can be analyzed together or separately.
801	**RAW WASTE FLOW** Raw flow shall be calculated as the sum of the 24-hour totals from the Easton Ave facility and the Satellite facility (recirculation flow shall not be included). **RAW WASTE: BOD5, TSS, TP, TN, TKN** Samples are required at each influent line to determine the mass loadings from each line. The total influent load to the treatment facility shall then be calculated and reported under outfall 801. **STREAM FLOW** A daily minimum value shall be reported.

Facility Name: WATERLOO CITY OF STP

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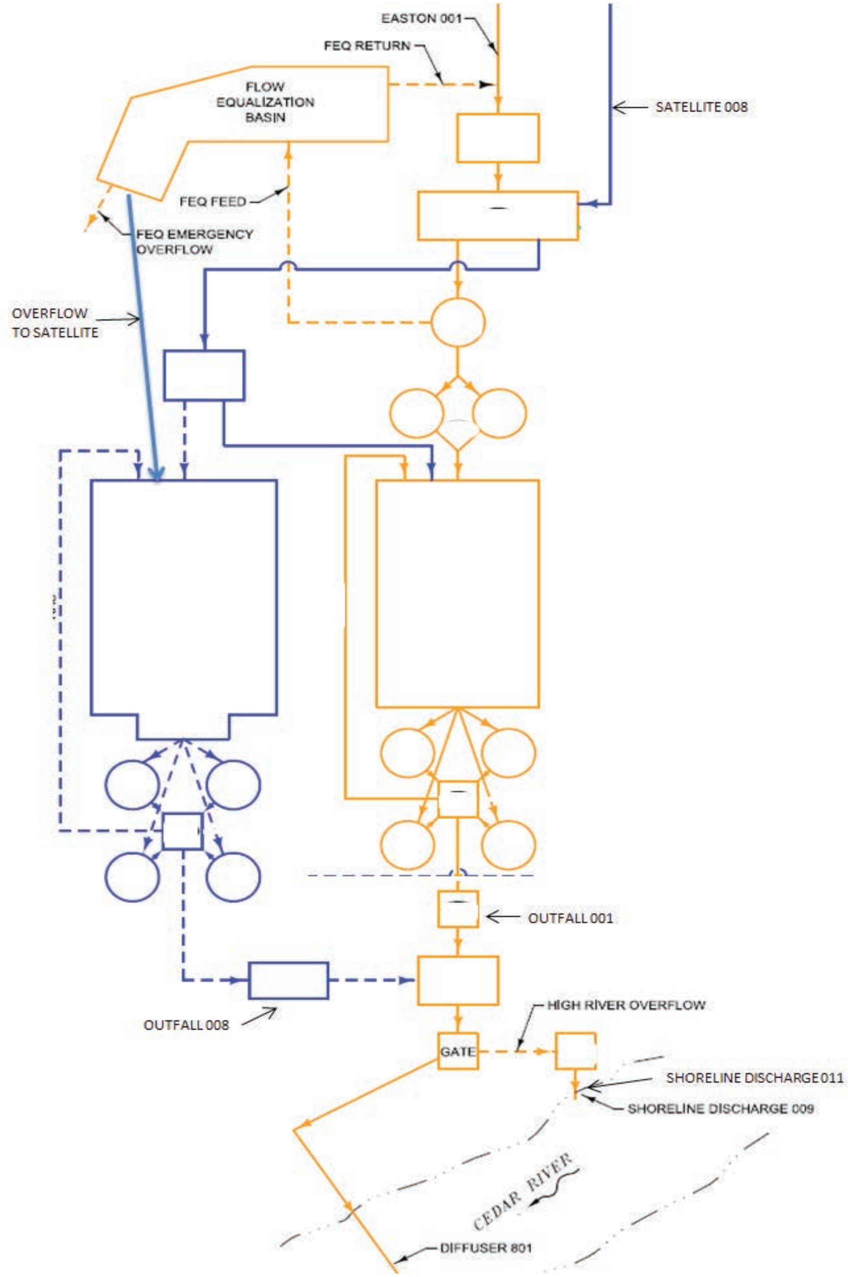
OUTFALL AND SAMPLING LOCATIONS



Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

Blending Mode of Operation

The City of Waterloo may operate their wastewater treatment plant in the following mode during peak influent flow conditions only.

Influent flows that exceed the hydraulic capacity of the Easton Avenue plant are diverted to two-flow equalization basins (FEQ) after passing through grit removal. Flows stored in the FEQ basins are returned to the Easton Wet Well once the Easton Avenue plant regains hydraulic capacity. In the event that the Easton Avenue plant has yet to regain hydraulic capacity, the flow from the FEQ will be diverted to the Satellite plant. The flows from the FEQ will be routed through the Satellite plant and returned to the headworks of the Easton Avenue plant via portable pumps. If the biological system at the Easton Avenue Plant could be jeopardized due to excessive flows, the partially treated wastewater from the Satellite plant will be diverted to the disinfection chamber and blended with the final effluent from the Easton plant. Once the Easton Avenue plant regains hydraulic capacity the facility is no longer authorized to blend the FEQ overflow via the Satellite plant.

Effluent limits and permit conditions remain in effect during this mode of operation.

Outfall Number: 011, 801

Ceriodaphnia and Pimephales Toxicity Effluent Testing

1. For facilities that have not been required to conduct toxicity testing by a previous NPDES permit, the initial annual toxicity test shall be conducted within three (3) months of permit issuance. For facilities that have been required to conduct toxicity testing by a previous NPDES permit, the initial annual toxicity test shall be conducted within twelve months (12) of the last toxicity test.

2. The test organisms that are to be used for acute toxicity testing shall be Ceriodaphnia dubia and Pimephales promelas. The acute toxicity testing procedures used to demonstrate compliance with permit limits shall be those listed in 40 CFR Part 136 and adopted by reference in rule 567 IAC 63.1(1). The method for measuring acute toxicity is specified in USEPA, October 2002, Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition. USEPA, Office of Water, Washington, D.C., EPA 821-R-02-012.

3. The diluted effluent sample must contain a minimum of 11.60 % effluent and no more than 88.40 % of culture water.

4. One valid positive toxicity result will require, at a minimum, quarterly testing for effluent toxicity until three successive tests are determined not to be positive.

5. Two successive valid positive toxicity results or three positive results out of five successive valid effluent toxicity tests will require a toxicity reduction evaluation to be completed to eliminate the toxicity.

6. A non-toxic test result shall be indicated as a "1" on the monthly operation report. A toxic test result shall be indicated as a "2" on the monthly operation report. DNR Form 542-1381 shall also be submitted to the DNR field office along with the monthly operation report.

Ceriodaphnia and Pimephales Toxicity Effluent Limits

The maximum limit of "1" for the parameters Acute Toxicity, Ceriodaphnia and Acute Toxicity, Pimephales means no positive toxicity results.

Definition: "Positive toxicity result" means a statistical difference of mortality rate between the control and the diluted effluent sample. For more information, see USEPA, October 2002, Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition, USEPA, Office of Water, Washington, D.C., EPA 821-R-02-012.

A toxicity test performed at the dilution percentage specified in item 3 of this page shall satisfy the monitoring requirements for both outfall 011 and 801 as required on pages 12 and 13 of this permit.

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

Design Capacity

Design:

Easton Avenue WPCF
The design capacity for the treatment works is specified in Construction Permit Number 98-361-S, issued August 21, 1998.
The treatment plant is designed to treat:
* An average dry weather (ADW) flow of 12.7 Million Gallons Per Day (MGD).
* An average wet weather (AWW) flow of 26.7 Million Gallons Per Day (MGD).
* A maximum wet weather (MWW) flow of 36.0 Million Gallons Per Day (MGD).
* A design 5-day biochemical oxygen demand (BOD5) load of 30,000 lbs/day.
* A design Total Kjeldahl Nitrogen (TKN) load of 7,500.00 lbs/day.

Satellite WPCF
The design capacity for the treatment works is specified in Construction Permit Number 95-317-S, issued July 7, 1995.
The treatment plant is designed to treat:
* An average dry weather (ADW) flow of 5.3 Million Gallons Per Day (MGD).
* An average wet weather (AWW) flow of 8.1 Million Gallons Per Day (MGD).
* A maximum wet weather (MWW) flow of 11.1 Million Gallons Per Day (MGD).
* A design 5-day biochemical oxygen demand (BOD5) load of 58,000 lbs/day.
* A design Total Kjeldahl Nitrogen (TKN) load of 13,550.00 lbs/day.

Operator Certification Type/Grade: WW/IV

Wastes in such volumes or quantities as to exceed the design capacity of the treatment works or reduce the effluent quality below that specified in the operation permit of the treatment works are considered to be a waste which interferes with the operation or performance of the treatment works and are prohibited by rule IAC 567-62.1(7).

SEWAGE SLUDGE HANDLING AND DISPOSAL REQUIREMENTS

"Sewage sludge" is solid, semisolid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge does not include the grit and screenings generated during preliminary treatment.

1. The permittee shall comply with all existing Federal and State laws and regulations that apply to the use and disposal of sewage sludge and with technical standards developed pursuant to Section 405(d) of the Clean Water Act when such standards are promulgated. If an applicable numerical limit or management practice for pollutants in sewage sludge is promulgated after issuance of this permit that is more stringent than a sludge pollutant limit or management practice specified in existing Federal or State laws or regulations, this permit shall be modified, or revoked and reissued, to conform to the regulations promulgated under Section 405(d) of the Clean Water Act. The permittee shall comply with the limitation no later than the compliance deadline specified in the applicable regulations.

2. The permittee shall provide written notice to the Department of Natural Resources prior to any planned changes in sludge disposal practices.

3. Land application of sewage sludge shall be conducted in accordance with criteria established in rule IAC 567 67.1 through 67.11 (455B).

Facility Name: WATERLOO CITY OF STP
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Diffuser Special Monitoring Requirements

Monthly Visual Monitoring:

At a frequency of at least once per month, the permittee shall visually observe the diffuser and record the observations in a log book. The permittee is required to visually observe and record the following items:

- Whether the diffuser and diffuser ports can be seen above or below the surface of the water;
- Whether the effluent dispersion pattern of the ports can be seen, and whether the patterns are uniform;
- Signs of non-uniform bubbling, uneven coloring or actual spraying of effluent above the water surface;
- Debris or materials that have collected on or may be obstructing the diffuser;
- General structural condition of the diffuser, diffuser ports, and protective materials;
- Condition of the shoreline outfall 011; and
- Actions taken, if applicable (i.e. corrective/ maintenance measures, adjustments of ports, removal of debris, etc.)

The log book entries shall be made available to the Department upon request. The permittee will indicate completion of the visual monitoring by entering a "1" in the "VISUAL" column on the day that the visual monitoring was completed on the Discharge Monitoring Report (DMR) spreadsheet.

Annual Diffuser Performance Analysis:

Minimum Requirements: Annually, by **June 1st**, the permittee is required to submit a Diffuser Performance Analysis report to the Department at both of the addresses shown below. The annual diffuser analysis should be performed at a stream flow as close as possible to stream critical low flow conditions.
The annual diffuser performance analysis should identify if all diffuser ports, that were active when the mixing percentage used in the current NPDES permit was established, are functioning properly. The annual diffuser performance analysis should also assess if rapid and uniform mixing is occurring within 100 feet downstream of the active diffuser ports, determined in a manner consistent with the methods that established the mixing percentage in this NPDES permit, with the stream flow as close as possible to critical low flow conditions.

If dye used in the Diffuser Performance Analysis shall meet the following requirements:

1) The Diffuser Performance Analysis shall use one of the following dyes:
   (a) Rhodamine WT dye
   (b) FWT red dye tablets
   (c) FLT Yellow/Green Liquid Concentrate dye
   (d) Green Sewer Tracing Dye
   (e) Fluorescent FLT Yellow/Green Powder
   (f) Bright Dye FWT Red Dye
   (g) FLT Yellow/Green dye tablets
   If a dye other than one listed above is used, you must obtain permission from the Department prior to use of the dye. Please contact Katie Greenstein at (515) 725-8400 or katie.greenstein@dnr.iowa.gov to request approval of dyes other than those listed above.
2) The dye shall be used according to the instructions provided by the manufacturer; and
3) The introduction of the dye into the receiving stream shall be limited to as short a time period as possible and the amount of dye used shall be as little as possible.

Video and/or pictures of the demonstration should be sent along with the diffuser analysis performance report to both addresses shown below.
The Diffuser Performance Analysis report shall describe any proposed location or discharge flow adjustments to the diffuser ports intended to comply with the designed operation of the diffuser. Any video and/or pictures of the demonstration should be included in the report. The permittee will indicate submittal of the Diffuser Performance Analysis report by entering a "1" in the "DIFFVAL" column on the Discharge Monitoring Report (DMR) spreadsheet on the day that the report is submitted. Select the No Discharge Indicator "NOT REQUIRED/MP" on the DMR spreadsheet during the months that the report is not required.

Additional Requirements: The Department will review the Diffuser Performance Analysis report. If the analysis does not show rapid and uniform mixing of the effluent within 100 feet downstream of the active diffuser ports, determined in a manner consistent with the methods that established the mixing percentage in this NPDES permit, you shall be notified of the requirement to submit a plan to correct diffuser deficiencies. The plan to correct the deficiencies shall be submitted to the Field Office address within 60 days of Department notification. A subsequent Diffuser Performance Analysis report shall be submitted to both addresses shown below no later than 60 days after implementing the plan to correct the diffuser deficiencies. If the subsequent Diffuser Performance Analysis report does not show rapid and uniform mixing of the effluent within 100 feet downstream of the active diffuser ports, determined in a manner consistent with the methods that established the mixing percentage in this NPDES permit, the permit shall be amended to include monitoring and limits necessary to be protective of the observed conditions**.**

The DNR Field Office 1 shall be notified by calling 563-927-2640 at least 48 hours prior to the use of dye.

Bathymetric Analysis:

Minimum Requirements: The permittee is required to perform a Bathymetric Analysis which shall be submitted annually, by **June 1st** to the Department at both of the addresses shown below. The bathymetric features shall be determined by measuring the receiving stream depth at a minimum of twenty (20) equidistant intervals across the entire width of the receiving stream at the location of the diffuser. The Bathymetric Analysis report shall characterize the bathymetric features and include clear documentation of the receiving stream cross section, diffuser location, and stream bottom substrate.

- Hydrologic Events: In addition, a Bathymetric Analysis must be performed if significant changes to the stream channel occur as a result of hydrologic events (such as flooding, stream channelization, reconstruction, etc.) A report of this analysis must be submitted to the Department at both of the addresses below within sixty (60) days of the event occurrence. If the Bathymetric Analysis shows that the changes to the receiving stream may alter the mixing achieved by the diffuser, a Diffuser Performance Analysis must also be performed to demonstrate the actual mixing achieved by the diffuser, determined in a manner consistent with the methods that established the mixing percentage in this NPDES permit. Modeling of the 100-foot diffuser mixing area may be used to perform the Diffuser Performance Analysis, with Department approval, if the receiving stream does not reach low flow conditions within four (4) months of the hydrologic event. The Diffuser Performance Analysis report must be submitted to the Department at both of the addresses below within ninety (90) days of the hydrologic event occurrence. A Diffuser Performance Analysis performed as a result of a hydrologic event will fulfill the annual report requirement for that year.

The permittee will indicate completion of the Bathymetric Analysis report by entering a "1" in the "BATHY" column on the Discharge Monitoring Report (DMR) spreadsheet on the day that the report is submitted. Select the No Discharge Indicator "NOT REQUIRED/MP" on the DMR spreadsheet during the months that the report is not required.

Addresses for Report Submittal:

Iowa Department of Natural Resources
Environmental Services Division
DNR Field Office 1
909 West Main St., Suite 4
Manchester, IA 52057

Iowa Department of Natural Resources
Ben Hucka
npdes.mail@dnr.iowa.gov

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

SIGNIFICANT INDUSTRIAL USER LIMITATIONS, MONITORING AND REPORTING REQUIREMENTS

1. You shall require all users of your facility to comply with Sections 204(b), 307, and 308 of the Clean Water Act.

   Section 204(b) requires that all users of the treatment works constructed with funds provided under Sections 201(g) or 601 of the Act to pay their proportionate share of the costs of operation, maintenance and replacement of the treatment works.

   Section 307 of the Act requires users to comply with pretreatment standards promulgated by EPA for pollutants that would cause interference with the treatment process or would pass through the treatment works.

   Section 308 of the Act requires users to allow access at reasonable times to state and EPA inspectors for the purpose of sampling the discharge, reviewing, and copying records.

2. You shall continue to implement the pretreatment program approved **March 14, 1984** and any amendments thereto.

3. An annual report in the form prescribed by the Department is to be submitted by March 1st of each year describing the pretreatment program activities for the preceding calendar year.

4. The City shall evaluate the adequacy of its local limits to meet the general prohibitions against interference and pass through listed in 40 CFR 403.5(a) and the specific prohibitions listed in 40 CFR 403.5(b). At a minimum this evaluation shall consist of the following:

   (a) Identify each pollutant with the potential to cause process inhibition, pass through the treatment plant in concentrations that will violate NPDES permit limits of water quality standards, endanger POTW worker health and safety or degrade sludge quality.

   (b) For each treatment plant, determine the maximum allowable headworks loading for each pollutant identified in item #4(a). that will prevent interference or a pass through.

   (c) After accounting for the contribution of each pollutant from uncontrolled (i.e.: domestic/commercial) sources to each treatment plant, determine the maximum allowable industrial loading for each pollutant identified in item #4(a).

   (d) Complete the evaluation and submit to the Department, by **June 1, 2022** a report containing the following information:
      1) A list of pollutants identified in item #4(a). For each pollutant, state the reason(s) for its inclusion (e.g. potential to cause interference, potential to cause pass through, etc.).
      2) The report shall contain all calculations used to determine the maximum allowable headworks loadings and shall identify the source(s) of all data used (e.g. literature value, site specific measurement, etc.).
      3) The contribution of each pollutant identified in item #4(d)1 to each treatment plant from uncontrolled sources and an explanation of how each contribution was determined.
      4) The allocation of the maximum allowable headworks loading for each pollutant to each treatment plant, and an explanation of how the allowable loadings will be allocated to significant industrial users regulated by the City's pretreatment program.

5. The City shall evaluate the approved pretreatment program for compliance with 40 CFR 403 and Iowa Administrative Code 567 – Chapter 62. Complete the evaluation and submit to the Department a report containing the findings of the evaluation, including a proposal for modifications to correct any deficiencies that are identified, by **June 1, 2022.**

Pretreatment reports shall be submitted to Ben Hucka at npdes.mail@dnr.iowa.gov.

Facility Name: WATERLOO CITY OF STP

Permit Number: 0790001

Nutrient Reduction Requirements

In support of the Iowa Nutrient Reduction Strategy you shall prepare and submit a report that evaluates the feasibility and reasonableness of reducing the amounts of nitrogen and phosphorus discharged into surface water. The report shall be submitted no later than **June 1, 2023** and shall address the following:

- A description of the existing treatment facility with particular emphasis on its capabilities for removing nitrogen and phosphorus. The description shall include monitoring data that define the current amounts of total nitrogen (TKN+nitrate+nitrite) and total phosphorus in both the raw wastewater and the final effluent.

- A description and evaluation of operational changes to the existing treatment facility that could be implemented to reduce the amounts of total nitrogen and total phosphorus discharged in the final effluent and the feasibility and reasonableness of each. Your evaluation must discuss the projected degree of total nitrogen and total phosphorus reduction achievable for each operational change. When evaluating feasibility, you must consider what, if any, effect operational changes would have on the removal of other pollutants (e.g. $CBOD_5$, TSS). When evaluating reasonableness, you shall include estimates of the additional cost, if any, to implement such changes and for a publicly-owned treatment works the impact on user rates.

- A description and evaluation of new or additional treatment technologies that would achieve significant reductions in the amounts of total nitrogen and total phosphorus discharged in the final effluent with a goal of achieving annual average concentrations of 10 mg/L total nitrogen and 1 mg/L total phosphorus for plants treating typical domestic strength sewage. For purposes of this evaluation typical domestic sewage is considered to contain approximately 25 – 35 mg/L total nitrogen and 4 - 8 mg/L total phosphorus. For plants treating wastewater with total nitrogen and/or total phosphorus concentrations greater than typical domestic strength sewage, the evaluation shall include the projected reductions in the total nitrogen and phosphorus effluent concentrations achievable with the application of feasible and reasonable treatment technology with a goal of achieving at least a 66 % reduction in nitrogen and 75% reduction in total phosphorus. For each treatment technology the report shall assess its feasibility, reasonableness, practicability, the availability of equipment, capital costs, annual operating costs, impact on user rates and any non-water quality environmental impacts (e.g. additional air pollution, increased sludge production, etc.).

- Based on the evaluations of operational changes and new or additional treatment technologies the report must select the preferred method(s) for reducing total nitrogen and total phosphorus in the final effluent, the rationale for the selected method(s) and an estimate of the effluent quality achievable.

- In addition to selecting operational changes and/or new or additional treatment technologies, the permittee may evaluate and propose to implement practices within the watershed that may achieve greater reductions in nitrogen or phosphorus than the preferred method(s) alone. Such evaluations are particularly encouraged when no feasible or reasonable operational changes or additional treatment technologies can be identified or when the schedule for installing the selected technology exceeds ten years.

- The report must include a schedule for making operational changes and/or installing new or additional treatment technologies to achieve the concentration and/or percentage removal goals listed above. Additional financial justification must be included in the report if no operational changes or treatment technologies are feasible or reasonable.

The schedule will be incorporated into the NPDES permit by amendment. Effluent discharge limits will be based on one full year of operating data after implementation of the operational changes or completion of plant modifications and a six-month optimization period.

The report shall be sent to the following address:
Ben Hucka
NPDES Section
npdes.mail@dnr.iowa.gov

STANDARD CONDITIONS

1. ADMINISTRATIVE RULES

Rules of this Department that govern the operation of your facility in connection with this permit are published in Part 567 of the Iowa Administrative Code (IAC) in Chapters 60-65, 67, and 121. Reference to the term "rule" in this permit means the designated provision of Part 567 of the IAC. Reference to the term "CFR" means the Code of Federal Regulations.

2. DEFINITIONS

(a) 7 day average means the sum of the total daily discharges by mass, volume, or concentration during a 7 consecutive day period, divided by the total number of days during the period that measurements were made. Four 7 consecutive day periods shall be used each month to calculate the 7-day average. The first 7-day period shall begin with the first day of the month.

(b) 30 day average means the sum of the total daily discharges by mass, volume, or concentration during a calendar month, divided by the total number of days during the month that measurements were made.

(c) Daily maximum means the total discharge by mass, volume, or concentration during a twenty-four hour period.

3. DUTY TO PROVIDE INFORMATION

You must furnish to the Director, within a reasonable time, any information the Director may request to determine compliance with this permit or determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, in accordance with 567 IAC 64.3(11)"*c*". You must also furnish to the Director, upon request, copies of any records required to be kept by this permit.

4. MONITORING AND RECORDS OF OPERATION

(a) Maintenance of records. You shall retain for a minimum of three years all paper and electronic records of monitoring activities and results including all original strip chart recordings for continuous monitoring instrumentation and calibration and maintenance records. ***{See 567 IAC 63.2(3)}***

(b) Any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than two years, or both. ***{See 40 CFR 122.41(j)(5)}***

5. SIGNATORY REQUIREMENTS

Applications, reports or other information submitted to the Department in connection with this permit must be signed and certified in accordance with 567 IAC 64.3(8).

6. OTHER INFORMATION

Where you become aware that you failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application, you must promptly submit such facts or information. Where you become aware that you failed to submit any relevant facts in the submission of in any report to the director, including records of operation, you shall promptly submit such facts or information.
{See 567 IAC 60.4(2)"a" and 567 IAC 63.7}

7. TRANSFER OF TITLE OR OWNER ADDRESS CHANGE

If title to your facility, or any part of it, is transferred the new owner shall be subject to this permit. You are required to notify the new owner of the requirements of this permit in writing prior to any transfer of title. The Director shall be notified in writing within 30 days of the transfer. No transfer of the authorization to discharge from the facility represented by the permit shall take place prior to notifying the department of the transfer of title. Whenever the address of the owner is changed, the department shall be notified in writing within 30 days of the address change. Electronic notification is not sufficient; all title transfers or address changes must be reported to the department by mail. ***{See 567 IAC 64.14}***

8. PROPER OPERATION AND MAINTENANCE

All facilities and control systems shall be operated as efficiently as possible and maintained in good working order. A sufficient number of staff, adequately trained and knowledgeable in the operation of your facility shall be retained at all times and adequate laboratory controls and appropriate quality assurance procedures shall be provided to maintain compliance with the conditions of this permit.
{See 40 CFR 122.41(e) and 567 IAC 64.7(7)"f"}

9. PERMIT MODIFICATION, SUSPENSION OR REVOCATION

(a) This permit may be modified, suspended, or revoked and reissued for cause including but not limited to those specified in 567 IAC 64.3(11).

(b) This permit may be modified due to conditions or information on which this permit is based, including any new standard the department may adopt that would change the required effluent limits. ***{See 567 IAC 64.3(11)}***

(c) If a toxic pollutant is present in your discharge and more stringent standards for toxic pollutants are established under Section 307(a) of the Clean Water Act, this permit will be modified in accordance with the new standards.
{See 40 CFR 122.62(a)(6) and 567 IAC 64.7(7)"g"}

The filing of a request for a permit modification, revocation or suspension, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

10. DUTY TO REAPPLY AND PERMIT CONTINUATION

If you wish to continue to discharge after the expiration date of this permit, you must file a complete application for reissuance at least 180 days prior to the expiration date of this permit. If a timely and sufficient application is submitted, this permit will remain in effect until the Department makes a final determination on the permit application. ***{See 567 IAC 64.8(1) and Iowa Code 17A.18}***

11. DUTY TO COMPLY

You must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Clean Water Act and is grounds for enforcement action; permit termination, revocation and reissuance, or modification; or denial of a permit renewal application. Issuance of this permit does not relieve you of the responsibility to comply with all local, state and federal laws, ordinances, regulations or other legal requirements applying to the operation of your facility. ***{See 40 CFR 122.41(a) and 567 IAC 64.7(4)"e"}***

12. DUTY TO MITIGATE
You shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment. ***{See 40 CFR 122.41(d) and 567 IAC 64.7(7)"i"}***

13. TWENTY-FOUR HOUR REPORTING
You shall report any noncompliance that may endanger human health or the environment, including, but not limited to, violations of maximum daily limits for any toxic pollutant (listed as toxic under 307(a)(1) of the Clean Water Act) or hazardous substance (as designated in 40 CFR Part 116 pursuant to 311 of the Clean Water Act). Information shall be provided orally within 24 hours from the time you become aware of the circumstances. A written submission that includes a description of noncompliance and its cause; the period of noncompliance including exact dates and times, whether the noncompliance has been corrected or the anticipated time it is expected to continue; and the steps taken or planned to reduce, eliminate, and prevent a reoccurrence of the noncompliance must be provided within 5 days of the occurrence. ***{See 567 IAC 63.12}***

14. OTHER NONCOMPLIANCE
You shall report all instances of noncompliance not reported under Condition #13 at the time monitoring reports are submitted. You shall give advance notice to the appropriate regional field office of the department of any planned activity which may result in noncompliance with permit requirements. ***{See 567 IAC 63.14}***

15. INSPECTION OF PREMISES, RECORDS, EQUIPMENT, METHODS AND DISCHARGES
You are required to permit authorized personnel to:
(a) Enter upon the premises where a regulated facility or activity is located or conducted or where records are kept under conditions of this permit;
(b) Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
(c) Inspect, at reasonable times, any facilities, equipment, practices or operations regulated or required under this permit; and
(d) Sample or monitor, at reasonable times, to assure compliance or as otherwise authorized by the Clean Water Act.

16. FAILURE TO SUBMIT FEES
This permit may be revoked, in whole or in part, if the appropriate permit fees are not submitted within thirty (30) days of the date of notification that such fees are due. ***{See 567 IAC 64.16(1)}***

17. NEED TO HALT OR REDUCE ACTIVITY
It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. ***{See 40 CFR 122.41(c) and 567 IAC 64.7(7)"j"}***

18. NOTICE OF CHANGED CONDITIONS
You are required to notify the director of any changes in existing conditions or information on which this permit is based. This includes, but is not limited to, the following:
(a) If your facility is a publicly owned treatment works (POTW) or otherwise may accept waste for treatment from an indirect discharger or industrial contributor (See 567 IAC 64.3(5) for further notice requirements).
(b) If your facility is a POTW and there is any substantial change in the volume or character of pollutants being introduced to the POTW by a source introducing pollutants into the POTW at the time of issuance of the permit. ***{See 40 CFR 122.42(b)}***
(c) As soon as you know or have reason to believe that any activity has occurred or will occur which would result in the discharge of any toxic pollutant which is not limited in this permit. ***{See 40 CFR 122.42(a)}***
(d) If you have begun or will begin to use or manufacture as an intermediate or final product or byproduct any toxic pollutant which was not reported in the permit application.

19. PLANNED CHANGES
The permittee shall give notice to the appropriate regional field office of the department 30 days prior to any planned physical alterations or additions to the permitted facility. Notice is required only when:
(a) Notice has not been given to any other section of the department. (Note: Facility expansions, production increases, or process modifications which may result in new or increased discharges of pollutants must be reported to the Director in advance. If such discharges will exceed effluent limitations, your report must include an application for a new permit. If any modification of, addition to, or construction of a disposal system is to be made, you must first obtain a written permit from this Department. In addition, no construction activity that will result in disturbance of one acre or more shall be initiated without first obtaining coverage under NPDES General Permit No. 2 for "Storm water discharge associated with construction activity.") ***{See 567 IAC 64.7(7)"a" and 64.2}***
(b) The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source as defined in 567 IAC 60.2;
(c) The alteration or addition results in a significant change in the permittee's sludge use or disposal practices; or
(d) The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants that are not subject to effluent limitations in the permit. ***{See 567 IAC 63.13 and 63.14}***

20. USE OF CERTIFIED LABORATORIES
Analyses of wastewater, groundwater or sewage sludge that are required to be submitted to the department as a result of this permit must be performed by a laboratory certified by the State of Iowa. Routine, on-site monitoring for pH, temperature, dissolved oxygen, total residual chlorine and other pollutants that must be analyzed immediately upon sample collection, settleable solids, physical measurements, and operational monitoring tests specified in 567 IAC 63.3(4) are excluded from this requirement.

21. BYPASSES

(a) Definition. "Bypass" means the diversion of waste streams from any portion of a treatment facility or collection system. A bypass does not include internal operational waste stream diversions that are part of the design of the treatment facility, maintenance diversions where redundancy is provided, diversions of wastewater from one point in a collection system to another point in a collection system, or wastewater backups into buildings that are caused in the building lateral or private sewer line.

(b) Prohibitions.

i. Bypasses from any portion of a treatment facility or from a sanitary sewer collection system designed to carry only sewage are prohibited.

ii. Bypass is prohibited and the department may not assess a civil penalty against a permittee for bypass if the permittee has complied with all of the following:

(1) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage; and

(2) There were no feasible alternatives to the bypass such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

(3) The permittee submitted notices as required by paragraph (d) of this section.

(c) The Director may approve an anticipated bypass after considering its adverse effects if the Director determines that it will meet the three conditions listed above and a request for bypass has been submitted to the Department in accordance with 567 IAC 63.6(2).

(d) Reporting bypasses. Bypasses shall be reported in accordance with 567 IAC 63.6.

22. UPSET PROVISION

(a) Definition. "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

(b) Effect of an upset. An upset constitutes an affirmative defense in an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph *"c"* of this condition are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

(c) Conditions necessary for demonstration of an upset. A permittee who wishes to establish the affirmative defense of upset shall demonstrate through properly signed operating logs or other relevant evidence that;

i. An upset occurred and that the permittee can identify the cause(s) of the upset;

ii. The permitted facility was at the time being properly operated;

iii. The permittee submitted notice of the upset to the Department in accordance with 567 IAC 63.6(3); and

iv. The permittee complied with any remedial measures required in accordance with 567 IAC 63.6(6)"*b*".

(d) Burden of Proof. In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

23. PROPERTY RIGHTS

This permit does not convey any property rights of any sort or any exclusive privilege. ***{See 567 IAC 64.4(3)"b"}***

24. EFFECT OF A PERMIT

Compliance with a permit during its term constitutes compliance, for purposes of enforcement, with Sections 301, 302, 306, 307, 318, 403 and 405(a)-(b) of the Clean Water Act, and equivalent limitations and standards set out in 567 IAC Chapters 61 and 62. ***{See 567 IAC 64.4(3)"a"}***

25. SEVERABILITY

The provisions of this permit are severable and if any provision or application of any provision to any circumstance is found to be invalid by this department or a court of law, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected by such finding.

APPENDIX B
2018 NUTRIENT REDUCTION STUDY

Nutrient Reduction Study

Report

City of

Waterloo, IA

March 2018

Report for
City of Waterloo, Iowa

Nutrient Reduction Study

LICENSED PROFESSIONAL ENGINEER RANDALL A. WIRTZ 16137 IOWA SEAL	I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa. FOR STRAND ASSOCIATES, INC.® Randall A. Wirtz
	Randall A. Wirtz, Ph.D., P.E. March 26, 2018 License Number 16137 My license renewal date is December 31, 2019 Report sections covered by this seal: All sections unless otherwise noted.

Prepared by:

STRAND ASSOCIATES, INC.®
910 West Wingra Drive
Madison, WI 53715
www.strand.com

March 2018

STRAND
ASSOCIATES®

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or Following

NUTRIENT REDUCTION STUDY

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This study was prepared as required to meet the April 1, 2018, compliance schedule in the City of Waterloo's (City's) Iowa Department of Natural Resources (IDNR) National Pollutant Discharge Elimination System (NPDES) Permit No. 0790001. The purpose of this report is to evaluate the feasibility and reasonableness of reducing the amounts of total nitrogen (TN) and total phosphorus (TP) discharged into the Cedar River by the City's wastewater treatment plants (WWTPs).

EXISTING TREATMENT FACILITIES

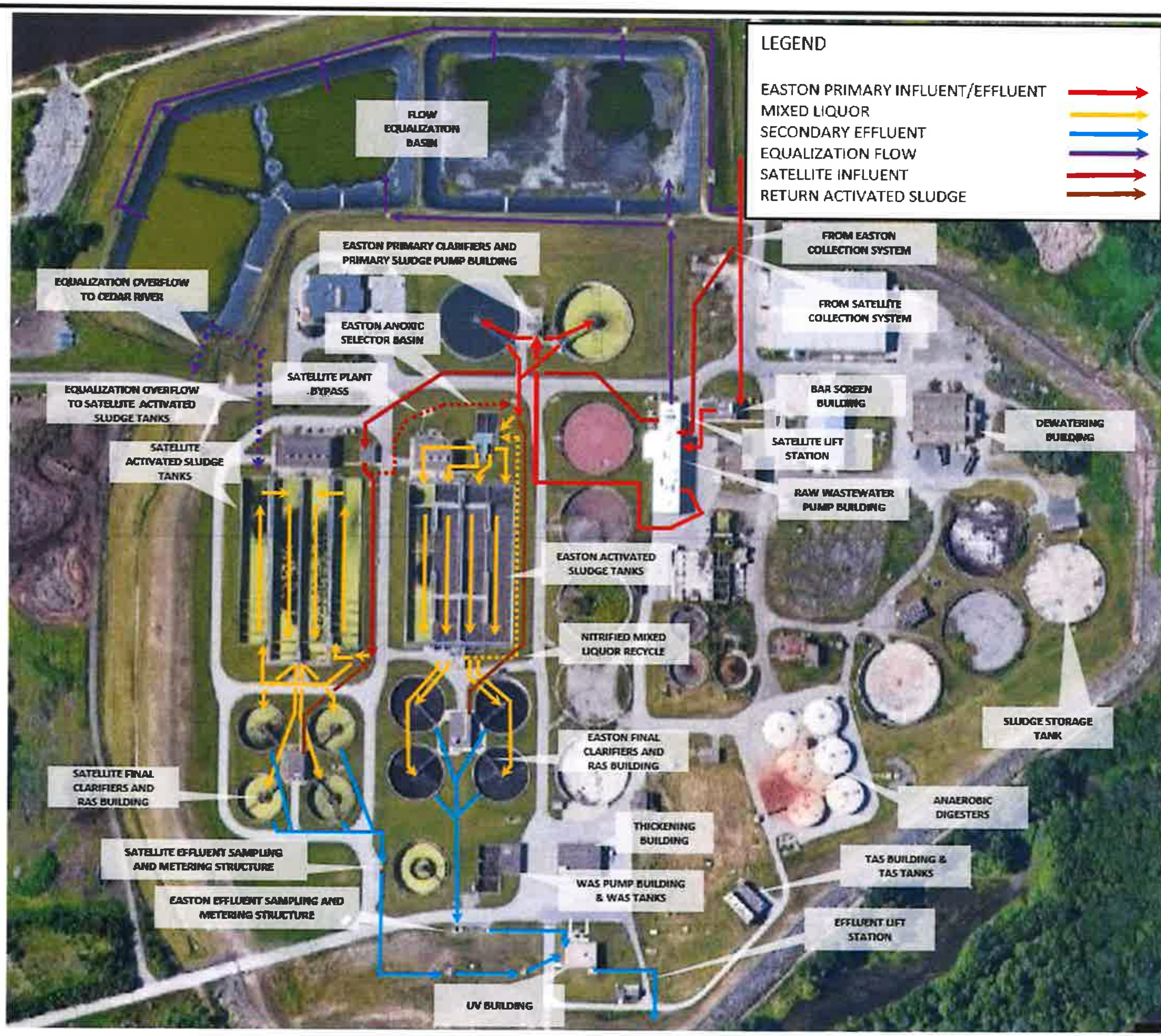
A. Background

The City of Waterloo (City) operates three wastewater treatment plants (WWTPs): an anaerobic lagoon that treats wastewater from a food processing plant prior to discharge into the City sanitary sewer system, the Satellite WWTP that was designed to treat the industrial wastewater from the northeast portion of the City (including the lagoon effluent), and the Easton Avenue (Easton) WWTP that was designed to treat the wastewater from all other sources in the City. The Satellite and Easton WWTPs are located at the same site and share several facilities as described later in this section and they both discharge to the Cedar River. A flow diagram of the Satellite and Easton WWTPs is presented in Figure 1. The design flows and loadings are presented in Table1. The City's National Pollutant Discharge Elimination System (NPDES) Permit No. 0790001 is included in Appendix A.

	Easton Plant	Satellite Plant
Wastewater Flow		
Design Average Flow (DAF)	20.4 mgd	6.7 mgd
Design Average Wet Weather Flow (Maximum Month)	26.7 mgd	8.1 mgd
Design Maximum Wet Weather Flow (Maximum Day)	36.0 mgd	11.1 mgd
Design Peak Hourly Wet Weather Flow (PHF)	36.0 mgd	11.1 mgd
Wastewater Loading		
5-day Biochemical Oxygen Demand (BOD_5)–Average Day	24,000 lbs/day	38,800 lbs/day
5-day Biochemical Oxygen Demand (BOD_5)–Maximum Month	30,000 lbs/day	58,000 lbs/day
5-day Biochemical Oxygen Demand (BOD_5)–Maximum Day	70,000 lbs/day	80,400 lbs/day
Total Kjeldahl Nitrogen (TKN)-Average Day	4,500 lbs/day	7,025 lbs/day
Total Kjeldahl Nitrogen (TKN)-Maximum Month	7,500 lbs/day	13,550 lbs/day
Total Kjeldahl Nitrogen (TKN)-Maximum Day	13,200 lbs/day	19,300 lbs/day
Total Suspended Solids (TSS)–Average Day	18,000 lbs/day	38,300 lbs/day
Total Suspended Solids (TSS)–Maximum Month	25,000 lbs/day	58,000 lbs/day
Total Suspended Solids (TSS)–Maximum Day	66,000 lbs/day	80,400 lbs/day

Note: mgd=million gallons per day

Table 1 Design Flows and Loadings



WASTEWATER TREATMENT PLANT PROCESS FLOW DIAGRAM

NUTRIENT REDUCTION STUDY
CITY OF WATERLOO, IOWA

STRAND ASSOCIATES®

FIGURE 1
4463.001

Wastewater service to the City was provided by the Easton WWTP alone until the Satellite WWTP was constructed in 1996. At that time, the Easton WWTP was a trickling filter WWTP with primary clarifiers, trickling filters, intermediate clarifiers, roughing filters, and final clarifiers. Following startup of the Satellite WWTP in 1998, a major upgrade to the Easton WWTP was undertaken, including the demolition or abandonment of much of the existing facility and the construction of new primary and final clarifiers along with the conversion to activated sludge biological treatment. While the Satellite WWTP was designed to treat the industrial wastewater from a portion of the City, it has been out of service for several years and is currently only used for storage during peak flow events. The City currently has a project planned to convey Equalization Basin overflow to the Satellite activated sludge tanks for storage and blending with Easton secondary effluent. This project is anticipated to be completed in 2018. While influent flow from the Satellite and Easton collection systems are measured separately, under current WWTP operation the influent flow from the Satellite collection system is combined with the Easton influent flow upstream of the Easton Anoxic Selector Basin and is treated using the Easton WWTP. Both the Satellite and Easton WWTPs are currently designed for TN removal.

B. Easton WWTP

Influent flow to the Easton WWTP passes through two 3/4-inch bar screens and enters an influent wet well where it is pumped with five raw wastewater pumps and flow is measured with magnetic flowmeters. The Bar Screen Building and the Raw Wastewater Pump Building were both constructed concurrently with the construction of the Satellite WWTP in 1996.

Following pumping, the wastewater flows through two vortex grit removal units located in the Raw Wastewater Pump Building. A sampler located downstream of the influent pumps and upstream of grit removal is used to collect Easton WWTP influent samples.

When flows to the Easton WWTP exceed the WWTP's hydraulic capacity, a portion of the flow can be diverted to two flow equalization basins located on the northern portion of the site using two downward opening weir gates in the grit chamber effluent channel. These basins were constructed in 1996 and have a total storage capacity of approximately 20 million gallons (MG). Wastewater stored in these basins can be returned to the Easton influent wet well when the WWTP has capacity to treat the flow. During extreme high flow events, an overflow/bypass structure to the Cedar River can be used to discharge wastewater from the equalization basins.

After grit removal, Easton WWTP influent flows through a magnetic flowmeter and to two circular primary clarifiers. Three primary sludge pumps located in the Primary Sludge Pump Building are used to pump sludge from the primary clarifiers to the thickened activated sludge (TAS) tanks. Scum that is removed from the primary clarifiers is stored in a mixed scum tank and pumped to the TAS tanks. The Primary Clarifiers and Primary Sludge Pump Building were constructed in 1998.

The activated sludge system uses the Modified Ludzack-Ettinger process for BOD, ammonia, and total nitrogen (TN) removal and includes four elongated rectangular tanks as well as a separate anoxic selector basin. Primary effluent is mixed with RAS and with mixed liquor (ML) recycle flow, and flows from the Satellite Bypass Structure in the Easton Anoxic Selector Basin. This basin is mixed using coarse bubble air diffusers with a goal of maintaining anoxic conditions. This basin is also used to split the flow between the four aeration basins. Each aeration basin consists of one anoxic zone with coarse bubble diffusers for mixing and three aerobic zones with fine bubble diffusers. Aeration is provided by three multistage centrifugal blowers. Flow from each of the basins is mixed in an outlet box which contains three ML recycle pumps to recycle nitrified ML to the front of the activated sludge system for alkalinity recovery and TN removal. The ML recycle pumps are constant-speed submersible pump and do not allow operators to adjust the recycle flow based on flow and loading conditions.

ML from the aeration tanks flows to four center-feed circular final clarifiers. Five RAS pumps located in the RAS Building return settled sludge to the primary effluent pipe upstream of the anoxic selector basin.

Secondary effluent passes through a Parshall Flume for flow measurement and is sampled prior to disinfection. Disinfection is provided by two ultraviolet (UV) disinfection systems operated in series. The ultraviolet disinfection system and building were installed in 2013. Following disinfection, effluent flows to one of two outfalls. A river diffuser is used under normal river level conditions (outfall 801). When the Cedar River level is high (river flow greater than 8,500 cfs), four effluent pumps located in the Effluent Lift Station are used to pump the effluent to a shoreline discharge (outfall 011).

C. Satellite WWTP

As described earlier, the Satellite WWTP was designed to treat mostly industrial wastewater flows from a dedicated collection system from the northeast side of the City and is not currently in use.

Flows from the Satellite collection system flow to the Satellite Lift Station at the Easton WWTP, which is on the north end of the Raw Wastewater Pump Building. Here the raw wastewater is sampled and pumped to the Magnesium Hydroxide Building using three submersible pumps. In the Magnesium Hydroxide Building, WWTP staff can add alkalinity to the raw wastewater by feeding magnesium hydroxide. Downstream of the Magnesium Hydroxide Building, the raw wastewater piping to the Satellite WWTP is connected to the Easton WWTP primary effluent piping at the Satellite Bypass Structure. Under current WWTP operation, Satellite WWTP influent is diverted to the Easton WWTP through this bypass structure and no raw wastewater continues to the Satellite activated sludge system.

The Satellite WWTP activated sludge system uses the Modified Ludzack-Ettinger process and includes two trains, each made up of two elongated rectangular tanks. An anoxic zone is provided in each train using coarse bubble diffuser mixing. Aeration is provided by fine bubble diffusers and five multistage centrifugal blowers. Two ML recycle pumps operating on variable frequency drives (VFDs) are used to return nitrified ML through the internal tank wall to the anoxic zone for denitrification and alkalinity recovery.

ML from the aeration tanks flows to four center-feed circular final clarifiers. Five RAS pumps located in the Satellite RAS Builidng return settled sludge to the raw wastewater piping upstream of the activated sludge tanks.

Secondary effluent passes through a Parshall Flume for flow measurement and is sampled prior to being combined with the Easton WWTP secondary effluent at the UV Building upstream of UV disinfection.

D. Sludge Processing

Waste Activated Sludge (WAS) is pulled from the Easton and Satellite RAS headers for wasting using automated control valves and flow meters. The WAS is pumped to three WAS tanks for storage until it is pumped to three gravity belt thickeners (GBTs). Scum from the final clarifiers are also pumped to the WAS tanks. The WAS tanks are mixed using coarse-bubble aeration and three positive displacement blowers.

TAS is pumped from the GBTs to the three TAS tanks using three TAS transfer pumps. In these tanks, the TAS is mixed with the primary sludge from the Easton WWTP and primary scum to provide a consistent feed to the anaerobic digesters. Primary sludge is pumped to the TAS tanks using three rotary lobe pumps. Prior to pumping, the primary sludge passes through two sludge grinders. Mixing is provided in the TAS tanks with four vertical shaft mixers.

Sludge is pumped from the TAS tanks to the anaerobic digesters using four progressing cavity pumps. The anaerobic digestion system uses a temperature-phased anaerobic digestion (TPAD) process with two thermophilic digesters and four mesophilic digesters. Two of the mesophilic digesters are equipped with floating covers for digester gas storage. The digesters are heated using a hot water boiler system. The TPAD system produces Class A biosolids.

Digested sludge is pumped from the digesters to the Sludge Storage Tanks where it is stored until it is dewatered using three belt filter presses. The dewatered sludge is then land applied.

INFLUENT AND EFFLUENT DATA

A. Baseline Influent Data

The WWTP currently measures influent flow from the Satellite collection system separate from the Easton WWTP influent flow. As discussed earlier, these flows are combined at the Easton WWTP Anoxic Selector Basin under current WWTP operation. Flow to the Equalization Basin is measured by summing the discharge flow from the Easton raw wastewater pumps and subtracting the Easton Influent Flow. Flow that is returned from the Equalization Basin enters the Easton influent wet well and is included in the Easton influent flow. Easton influent samples currently include process return flows. Estimates of these return flow loads and their impact of Easton influent loadings are presented later in this section.

Tables 2 through 4 present the 2014 through 2016 flow data by month for the Easton WWTP, Satellite WWTP, and combined influent. The average represents the average day flow for the entire month. "Min" and "Max" represent the lowest and highest day's total daily (24-hour average) flow during that month, respectively. The Easton influent flow presented in Table 2 (and included in the combined flow in Table 4) includes the flow diverted to the Equalization Basin and subtracts the return flow from the Equalization Basin to approximate the actual total wastewater flow that is conveyed to the Easton WWTP site each day. A chart of the Satellite and this adjusted Easton Influent Flow from

2014 to 2016 is presented in Figure 2. These reported flows are prior to ongoing wet weather improvements to the City's collection system and, therefore, do not reflect those ongoing efforts.

	Influent Flow (mgd)								
	2014			2015			2016		
	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
January	6.72	5.72	7.61	8.01	7.00	8.60	12.83	10.10	18.00
February	7.43	6.20	10.52	7.82	6.92	8.24	11.88	8.92	18.50
March	9.68	6.90	13.61	8.56	6.92	9.68	14.73	11.98	19.31
April	13.51	5.40	33.24	10.63	7.55	16.22	13.36	10.98	17.83
May	13.07	9.43	18.32	10.34	8.52	15.91	11.67	9.49	17.46
June	19.27	8.00	53.42	11.93	8.95	18.29	15.53	12.56	22.95
July	19.09	10.31	49.62	10.31	8.39	16.01	14.26	11.79	18.26
August	9.12	8.07	10.61	9.77	7.82	23.46	13.71	12.11	17.70
September	8.33	7.03	10.36	9.48	7.82	11.79	19.26	9.82	59.71
October	8.51	6.79	15.31	8.08	7.21	9.51	14.45	11.39	19.71
November	7.39	5.98	7.94	9.01	7.42	12.47	10.97	9.06	12.74
December	8.05	6.68	10.05	15.52	9.17	31.23	10.89	9.15	13.65
Annual Average	**10.85**	-	-	**9.96**	-	-	**13.63**	-	-
Minimum	**6.72**	**5.40**	-	**7.82**	**6.92**	**8.24**	**10.89**	**8.92**	-
Maximum	**19.27**	-	**53.42**	**15.52**	-	**31.23**	**19.26**	-	**59.71**

Table 2 Easton Influent Flow Summary

	Influent Flow (mgd)								
	2014			2015			2016		
	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
January	3.68	2.01	9.02	3.00	1.66	3.82	3.62	2.04	4.65
February	2.95	1.80	3.82	2.94	1.42	3.78	3.39	2.40	4.40
March	3.26	1.81	4.39	2.76	1.18	3.86	3.57	1.97	4.59
April	3.43	1.49	5.20	2.96	1.44	3.94	3.46	1.59	4.25
May	3.31	0.68	4.44	2.90	0.51	3.96	3.16	1.59	4.67
June	3.34	1.94	4.71	3.19	1.32	4.27	3.29	1.79	4.51
July	2.92	1.14	4.40	3.06	1.16	4.89	2.89	1.05	3.76
August	2.62	0.79	3.98	3.10	0.75	4.75	3.29	1.20	3.88
September	2.90	0.98	4.05	3.11	0.61	4.31	3.45	1.67	4.83
October	3.06	1.27	4.37	3.20	1.43	4.30	3.64	2.24	4.60
November	3.03	1.27	3.87	3.15	1.74	4.23	3.54	2.72	4.42
December	3.05	1.59	3.83	3.63	1.09	4.78	3.54	1.87	4.31
Annual Average	**3.13**	-	-	**3.08**	-	-	**3.40**	-	-
Minimum	**2.62**	**0.68**	-	**2.76**	**0.51**	-	**2.89**	**1.05**	-
Maximum	**3.68**	-	**9.02**	**3.63**	-	**4.89**	**3.64**	-	**4.83**

Table 3 Satellite Influent Flow Summary

	Influent Flow (mgd)								
	2014			2015			2016		
	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
January	10.40	8.06	15.57	11.02	9.05	12.33	16.45	13.05	21.94
February	10.38	8.15	13.79	10.76	8.57	11.89	15.28	11.51	22.61
March	12.94	8.93	17.73	11.32	9.10	13.39	18.31	14.62	23.90
April	16.94	6.89	35.52	13.59	9.19	19.75	16.82	13.79	21.73
May	16.38	10.52	22.37	13.24	10.53	19.18	14.83	11.23	20.57
June	22.61	10.46	56.84	15.12	10.25	21.01	18.82	14.55	27.46
July	22.01	12.16	53.59	13.37	9.55	19.88	17.16	13.02	21.15
August	11.74	9.42	13.61	12.87	8.57	27.55	17.00	13.84	21.58
September	11.24	8.57	13.61	12.58	8.43	15.17	22.71	11.86	64.18
October	11.57	8.06	19.55	11.28	8.66	13.22	18.08	13.98	23.68
November	10.42	8.38	11.81	12.16	9.17	15.65	14.51	11.98	16.59
December	11.10	8.54	12.95	19.15	12.66	35.31	14.43	12.69	16.69
Annual Average	**13.98**	-	-	**13.04**	-	-	**17.03**	-	-
Minimum	**10.38**	**6.89**	-	**10.76**	**8.43**	**11.89**	**14.43**	**11.23**	-
Maximum	**22.61**	-	**56.84**	**19.15**	-	**35.31**	**22.71**	-	**64.18**

Table 4 Combined Influent Flow Summary

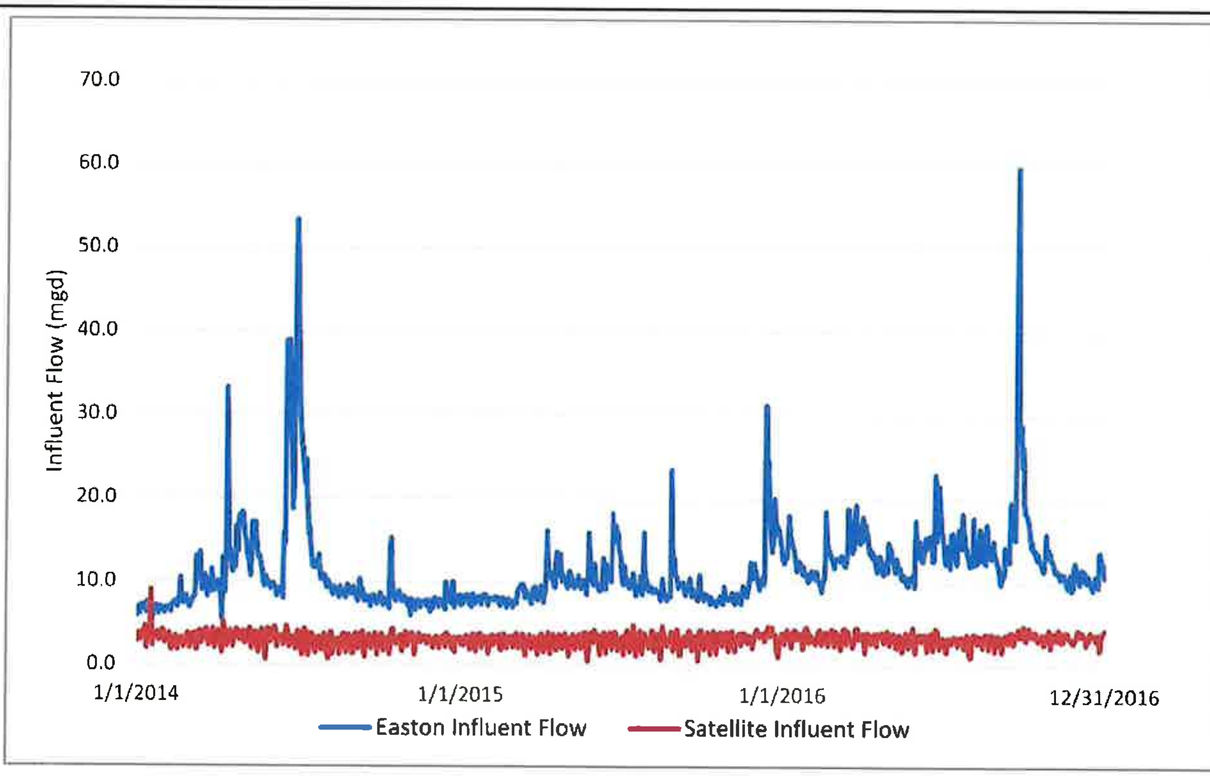


Figure 2 Influent Flow

While the Satellite Influent Flow data was relatively consistent in each of the three years analyzed, the Easton Influent Flow was significantly higher in 2016 than in previous years, with an increase of over 30 percent from 2014 and 2015 to 2016. It appears that this increase in flow began sometime in November or December 2015. While increased winter flows from precipitation or snow melt are not unusual, the increase that occurred around this time does not appear to subside during dry weather conditions. This is evident in the Easton influent minimum day flow in 2016 of 8.92 mgd, which is greater than 10 of the 24 monthly average values for 2014 and 2015.

A portion of the increase in 2016 flow can be attributed to an extreme wet weather event in September 2016 that resulted in major flooding throughout northeastern and east central Iowa. According to National Oceanic and Atmospheric Administration data, the Cedar River at Waterloo crested at 22.94 feet on September 26, 2016, which is nearly 10 feet above flood stage and the second highest crest on record. Power outages during this flooding event led to loss of flow measurement, resulting in estimates for reported flow values.

The City does not currently measure influent flow upstream of influent pumps and, therefore, the maximum influent flow measurement is limited by the pump capacity. However, WWTP staff indicate that there have been no known instances of basement backups resulting from influent sewer surcharging in the past. An evaluation of the pump flow totalizer data for the two highest flow days in 2014 to 2016 was conducted to estimate the peak hourly flow to the Easton WWTP. On September 24, 2016, during a major flooding event with a reported daily influent flow of 59.7 mgd, the maximum one-hour flow measured by the Easton influent totalizers was approximately 61.2 mgd. Similarly, on June 30, 2014, the reported daily influent flow was 53.4 mgd and the maximum one-hour flow measured by the Easton influent totalizers was 61.9 mgd. Data was not available for the maximum flow days in 2015 as a result of a software malfunction.

A similar analysis was conducted on the Satellite influent for several high flow days (influent flows above 4.4 mgd) which showed peak hour flow to daily average flow ratios of 1.2 to 1.3. Because the anaerobic lagoon provides some flow equalization and there is relatively little infiltration/inflow (I/I) observed in the Satellite collection system, the peaking factors for the Satellite influent are not anticipated to be nearly as high as those seen in the Easton influent. Based on this analysis, the current peak hour flow for the Satellite influent is estimated to be approximately 6 mgd (2016 maximum day flow of 4.8 mgd times 1.25).

Minimum and maximum flows at one- and 30-day intervals for the periods of January 2014 to November 2015 and December 2015 to December 2016 are presented in Table 5.

	Easton Influent	Satellite Influent	Combined Influent
Influent Flow			
January 2014 to November 2015			
Average	10.2	3.1	13.3
Maximum Month (30-day maximum)	28.1	3.7	31.3
Minimum Month (30-day minimum)	6.7	2.5	9.9
Maximum Day	53.4	9.0	56.8
Minimum Day	5.4	0.5	6.9
December 2015 to December 2016			
Average	13.8	3.4	17.2
Maximum Month (30-day maximum)	21.2*	3.8	25.0*
Minimum Month (30-day minimum)	10.5	2.8	14.0
Maximum Day	59.7	4.8	64.2
Minimum Day	8.9	1.1	11.2

*Includes estimated influent flow values resulting from power outage in September 2016 flooding event.

Table 5 Influent Flow Summary

As described earlier, when influent flows exceed the capacity of the Easton WWTP, a portion of the flow can be diverted to the Equalization Basins. This occurred on 153 days between 2014 and 2016, with an average diversion volume of 3.06 MG. Typically, this wastewater would be stored in the Equalization Basins until the Easton WWTP has adequate treatment capacity, at which time it would be returned to the Easton influent for treatment. In extreme wet weather conditions, the Equalization Basins may fill and overflow to a ditch that discharges to the Cedar River. As previously discussed, the City currently has a planned project to convey Equalization Basin overflow to the Satellite activated sludge tanks, effectively increasing storage volume in the near-term.

B. Influent BOD_5, TSS, and TKN Loadings

Tables 6 through 8 summarize the Easton WWTP, Satellite WWTP, and combined influent loadings of BOD_5, TSS, and TKN, respectively. Each influent loading is separated between the 23-month period from January 2014 through November 2015 and the 13-month period from December 2015 through December 2016. The Easton influent loadings in these tables include the portion of the Easton influent flow that was diverted to the Equalization Basins.

	Easton Influent	Satellite Influent	Combined Influent
BOD Loading, lb/day			
January 2014 to November 2015			
Average	18,746	7,877	26,634
7-day Maximum	27,989	14,253	37,681
30-day Maximum	25,213	11,161	34,175
December 2015 to December 2016			
Average	18,828	9,817	28,645
7-day Maximum	29,695	16,562	44,066
30-day Maximum	27,989	14,620	37,832

Table 6 Influent BOD Loading Summary

	Easton Influent	Satellite Influent	Combined Influent
TSS Loading, lb/day			
January 2014 to November 2015			
Average	18,867	8,846	27,713
7-day Maximum	43,235	22,897	51,784
30-day Maximum	28,037	12,878	37,123
December 2015 to December 2016			
Average	24,782	10,990	35,774
7-day Maximum	50,316	17,950	64,441
30-day Maximum	41,683	14,556	52,896

Table 7 Influent TSS Loading Summary

	Easton Influent	Satellite Influent	Combined Influent
TKN Loading, lb/day			
January 2014 to November 2015			
Average	3,984	4,506	8,489
Maximum	6,952	7,115	12,204
30-day Maximum	5,665	6,992	11,750
December 2015 to December 2016			
Average	3,863	5,478	9,341
Maximum*	5,535	6,688	11,210
30-day Maximum	5,239	6,231	10,932

*samples taken approximately once per week

Table 8 Influent TKN Summary

The City began collecting regular influent TN and TP samples in April 2016. Tables 9 and 10 summarize influent TN and TP loadings. The Easton influent loadings in these tables includes the portion of the Easton influent flow that was diverted to the Equalization Basins. The TN loadings are very similar to historical TKN loadings, indicating low nitrate/nitrite in the influent.

	Easton Influent		Satellite Influent		Combined Influent	
	Conc. (mg/L)	Load (lbs/day)	Conc. (mg/L)	Load (lbs/day)	Conc. (mg/L)	Load (lbs/day)
April 2016	38	4,125	172	5,074	67	9,199
May 2016	41	4,238	170	4,685	68	8,923
June 2016	35	4,164	202	5,620	66	9,784
July 2016	26	3,323	205	5,449	56	8,772
August 2016	34	3,575	203	5,988	70	9,563
September 2016	32	3,962	185	5,208	59	9,170
October 2016	34	3,980	192	5,644	64	9,624
November 2016	41	3,884	211	6,085	80	9,969
December 2016	40	3,723	199	5,990	80	9,713
Average	**36**	**3,886**	**193**	**5,527**	**68**	**9,413**
Minimum Month	**26**	**3,323**	**170**	**4,685**	**56**	**8,772**
Maximum Month	**41**	**4,238**	**211**	**6,085**	**80**	**9,969**

Note: mg/L=milligrams per Liter

Table 9 Influent TN Loading Summary

	Easton Influent		Satellite Influent		Combined Influent	
	Conc. (mg/L)	Load (lbs/day)	Conc. (mg/L)	Load (lbs/day)	Conc. (mg/L)	Load (lbs/day)
April 2016	10.2	1,087	19.6	575	12.2	1,662
May 2016	7.4	770	18.7	515	9.8	1,285
June 2016	7.3	843	19.6	548	9.6	1,391
July 2016	6.2	786	19.7	521	8.4	1,307
August 2016	6.8	724	21.6	638	10.0	1,362
September 2016	7.3	930	20.1	573	9.5	1,503
October 2016	7.7	906	21.2	620	10.3	1,526
November 2016	11.5	1,095	19.9	571	13.4	1,666
December 2016	10.0	958	20.1	603	12.8	1,561
Average	**8.3**	**900**	**20.0**	**574**	**10.7**	**1,474**
Minimum Month	**6.2**	**724**	**18.7**	**515**	**8.4**	**1,285**
Maximum Month	**11.5**	**1,095**	**21.6**	**638**	**13.4**	**1,666**

Table 10 Influent TP Loading Summary

In-plant waste loads including filtrate from sludge thickening and dewatering operations, sludge storage tank decant, tank drains, and digester overflow are combined in the WWTP sewer system. The WWTP sewer flows through a Palmer-Bowlus flume just east of the septage receiving station for flow measurement. WWTP staff indicate that this flume is often surcharged and does not provide reliable flow measurements. Septage is combined with these in-plant return flows downstream of the flume. These flows combine with the Easton influent in a manhole upstream of the Bar Screen Building. Therefore, the flows and loads associated with these in-plant returns are included in the Easton influent flow measurement and samples.

City staff conducted special sampling in May and June of 2017 that included grab samples of return flows from the GBT and belt filter press (BFP) as presented in Table 11.

Parameter, mg/L	GBT Filtrate	BFP Filtrate
TP	10.3	73.8
PO_4-P	6.3	33.3
Ammonia	8.9	685
TKN	38.9	715
Nitrate	13.7	1.1
Nitrite	0.2	<0.1
TSS	308	1,123
VSS	252	756
Alkalinity	218	2,491

Notes:VSS=volatile suspended solids, PO_4-P=phosphate

Table 11 Return Flow Sampling Summary–May and June 2017

Estimates of return flow loadings were made based on the 2014 to 2016 sludge flows, percent solids measurements, and estimates of wash water flows at approximately 120 gpm per GBT/BFP. This results in an estimated GBT filtrate and BFP filtrate flows of approximately 0.45 mgd and 0.16 mgd, respectively. Estimated return loadings from these sources are presented in Table 12.

Parameter, lbs/day	GBT Filtrate	BFP Filtrate	Filtrate Loading Percentage of Easton Influent
TP	39	98	15%
PO_4-P	24	44	-
Ammonia	33	914	-
TKN	146	954	25%
Nitrate	51	1.5	-
Nitrite	0.8	<0.1	-
TSS	1,160	1,500	10%
VSS	950	1,010	-
Alkalinity	820	3,320	-

Table 12 Return Flow Loading Estimates

C. Wastewater Treatment Performance

As described earlier, secondary effluent from the Satellite and Easton WWTPs are combined and disinfected prior to discharge to the Cedar River. The City has two permitted outfalls on the Cedar River: a diffuser located in the river that is used under normal conditions and a shoreline outfall that is used when the Cedar River level is high. The permitted effluent concentrations for all parameters except ammonia are identical for these two discharges. In the City's current NPDES permit, the shoreline outfall can be used during high river flows (above 8,500 cubic feet per second), resulting higher ammonia limits both on a monthly average and daily maximum basis. This shoreline discharge was used for 26 days in 2014, 14 days in 2015, and 44 days in 2016. Table 13 summarizes the City's average monthly effluent ammonia nitrogen (NH_3-N). Effluent CBOD during this period averaged 8 mg/L. The City was operating two to three of the Easton WWTP activated sludge trains for most of the three-year period.

	2014		2015		2016	
	Conc. (mg/L)	Load (lbs/day)	Conc. (mg/L)	Load (lbs/day)	Conc. (mg/L)	Load (lbs/day)
January	13.9	1,240	19.4	1,817	27.7	3,578
February	60.8	5,132	41.8	3,771	36.5	4,410
March	51.7	5,719	25.9	2,507	31.5	4,719
April	40.8	4,963	19.0	2,134	4.4	557
May	4.6	629	7.3	864	2.3	297
June	1.0	143	4.2	478	4.7	861
July	1.0	158	3.2	357	1.0	144
August	1.0	107	1.4	144	1.1	142
September	1.0	98	1.3	163	1.2	191
October	1.9	193	8.5	866	1.0	153
November	14.1	1,258	4.5	490	13.6	1,614
December	22.3	2,017	13.5	2,075	31.1	3,595
Annual Average	**17.8**	**1,805**	**12.5**	**1,306**	**13.0**	**1,688**

Table 13 Effluent NH_3-N

The City has a TN mass limits of 9,285.5 lbs/day on a monthly average basis with a daily maximum limit of 15,199 lbs/day. Effluent TN sample results are presented in Table 14 below. There were no exceedances of the City's maximum day or monthly average TN mass limits in the period evaluated.

	2014		2015		2016	
	Conc. (mg/L)	Load (lbs/day)	Conc. (mg/L)	Load (lbs/day)	Conc. (mg/L)	Load (lbs/day)
January	41.0	3,442	41.9	3,941	38.4	5,007
February	76.1	6,493	55.2	4,982	41.7	5,035
March	56.5	6,302	42.6	4,120	38.5	6,011
April	42.4	5,391	42.9	4,872	30.8	3,435
May	27.6	3,548	29.6	3,428	23.8	3,111
June	28.9	3,921	37.4	4,301	29.8	4,364
July	17.5	2,855	41.1	4,848	31.7	4,636
August	35.6	3,795	45.6	4,598	34.3	4,454
September	36.6	3,607	36.4	4,177	42.7	5,843
October	42.4	4,417	39.3	4,147	31.2	4,850
November	44.2	4,065	34.9	3,731	35.5	4,301
December	35.0	3,158	31.0	4,678	46.1	5,345
Annual Average	**40.3**	**4,250**	**39.8**	**4,319**	**35.4**	**4,699**

Table 14 Effluent TN

While the City does not currently have a TP limit, they began monitoring effluent TP once per week in April 2016. Effluent TP data is presented in Table 15.

	TP	
	Conc. (mg/L)	Load (lbs/day)
April 2016	7	826
May 2016	7	879
June 2016	7	970
July 2016	5	758
August 2016	6	832
September 2016	7	952
October 2016	7	1,028
November 2016	9	1,150
December 2016	8	974
Annual Average	**7**	**930**

Table 15 Effluent TP

The Modified Ludzak-Ettinger (MLE) process currently used at the Easton WWTP was designed for TN removal and successfully removes approximately 50 percent of the influent TN based on the data presented in Tables 9 and 14. The data in Tables 10 and 15 suggest that the WWTP currently removes approximately 37 percent of the influent TP. Because the MLE process does not contain an anaerobic zone necessary for successful biological phosphorus removal (BPR), the demonstrated TP removal is likely attributable to biological uptake for cell growth and the removal of particulate TP.

NUTRIENT REDUCTION GOALS

Using the influent TN and TP data collected between April and December 2016 and adjusting for the nutrient loads from return flows that were included in these samples, the average TN and TP for the combined WWTP influent are approximately 59.3 mg/L and 9.6 mg/L, respectively. Based on these influent concentrations the IDNR's nutrient reduction goals are 20.2 mg/L TN (66 percent removal) and 2.4 mg/L TP (75 percent removal).

The City currently has mass limits for TN of 9,285.5 lbs/day on a 30-day average basis and 15,199 lbs per day on a daily maximum basis. There is no TP limit in the City's current NPDES permit. Based on the effluent target values calculated above, the combined AWW design flow of 34.8 mgd, the anticipated TN and TP mass limits are approximately 5,863 lbs TN per day and 697 lbs TP per day.

EVALUATION OF OPERATIONAL CHANGES TO ENHANCE NUTRIENT REMOVAL

As presented earlier, the MLE process currently used at the WWTP results in effluent TN loads between 3,000 and 5,000 lbs/day with concentrations of approximately 30 to 40 mg/L. Based on this performance, the City is currently able to achieve the TN effluent mass target of 5,863 lbs/day but it appears that it would be unable to achieve this target should influent flows increase to the design flows.

Furthermore, the WWTP is not currently designed for phosphorus removal, which would require either anaerobic zones in the activated sludge system or significant chemical feed and storage facilities. Potential operational changes to improve BPR performance, such as eliminating the nitrified ML recycle to create an anaerobic zone, would result in loss of TN removal. Because of the high TKN loads to the WWTP, the elimination of the nitrified ML recycle and associated denitrification and alkalinity recovery is also anticipated to result in pH instability and the potential loss of nitrification.

The City conducted special sampling in May and June 2017 to further investigate nutrient removal at the WWTP. This sampling indicated that while the WWTP was successfully nitrifying (average effluent ammonia concentration of 1.5 mg/L), denitrification in the anoxic zone was incomplete with an average NO_3-N concentration leaving the anoxic zone greater than 10 mg/L. The effluent TN during this period was approximately 36 mg/L, similar to the annual average presented earlier. The incomplete denitrification in the anoxic zone suggests that either the anoxic zone is not large enough, there is too much dissolved oxygen in the anoxic zones, or there is insufficient influent BOD to completely denitrify. The anoxic retention time during this period was approximately 1.7 hours, which is a typical value for the MLE process.

The City does not currently have the ability to control the ML recycle rate and, therefore, operational changes associated with varied recycle rates are not feasible without capital improvements. Modifying the RAS rate or solid retention rate (SRT) is not anticipated to significantly improve TN or TP removal without detrimentally affecting other process performance (nitrification, TSS removal, etc.). Increasing the anoxic zone size by reducing the size of the aerated zone will negatively impact nitrification, which is already challenging during the winter months at current flows and loads. The existing anoxic zone is not large enough to allocate a portion as an anaerobic zone for BPR without further reducing the ability to denitrify. While the City has tankage in the Satellite WWTP that is not currently in use, the facilities to convey influent from the Easton collection system to the Satellite activated sludge system are not in place. Operating the Satellite WWTP treating only the Satellite influent will exacerbate existing carbon deficiencies for nutrient removal in addition to introducing other operational challenges.

No operational changes alone are feasible to significantly reduce the TN and TP loads in the effluent without negative impacts on other treatment process performance. The modifications necessary for successful BPR or chemical phosphorus removal (CPR), such as anaerobic zones, larger anoxic zones, chemical storage and feed facilities, better operational control, and infrastructure to operate the Satellite activated sludge tankage parallel with the Easton activated sludge tankage will require significant capital improvements as discussed later in this report.

WASTELOAD AND FLOW FORECASTS

To evaluate processes and technologies to enhance existing nutrient reduction capabilities, wasteload and flow forecasts were completed for the City's WWTP service area. For the purposes of this study, it is anticipated that the overall area served by the City's WWTP will remain the same through the 20-year planning period.

A. Population Trends

According to the 2010 census, the City had 68,406 residents, 28,607 total households, and an average household size of 2.35 persons. Compared to the 2000 census City population of 68,747, this equates to a 10-year population decrease of approximately 0.5 percent. Based on the 2011 to 2015 American Community Survey 5-Year Estimates, the estimated 2015 population of the City is

68,432, for an estimated 5-year population growth of approximately 0.04 percent from 2010. Population projections for the City obtained from the Black Hawk County Metropolitan Area Transportation Policy Board's 2040 Long Range Transportation Plan are presented in Table 16 below.

Year	2010[a]	2015[b]	2020	2030	2040
City of Waterloo Population	68,406	68,432	72,212	76,601	81,633

[a]2010 Census data
[b]2011 to 2015 American Community Survey 5-Year Estimates

Table 16 Current and Projected Populations

These projections estimate a 25-year growth of approximately 19 percent, or an annual growth of approximately 0.7 percent over the period. Based on these projections, a 2040 City population of 81,633 is used for projecting future residential wastewater flows and loadings in this study.

B. Projected Wastewater Flows

Projecting future wastewater flows requires identification of residential/commercial and industrial wastewater flow, base flows, peaking factors, and anticipated residential/commercial and industrial growth in areas tributary to the Easton and Satellite WWTPs.

Planned additional industrial discharges to the Satellite collection system, both upstream and downstream of the anaerobic lagoon, were provided by the City as presented in Table 17. Increased BOD_5 and TSS loadings discharged from the lagoon were estimated based on new planned discharges to the lagoon and existing removal efficiencies. No reduction in TKN or TP were assumed for new discharges from the lagoon.

	To Satellite Interceptor Downstream of Lagoon	To Anaerobic Lagoon	From Anaerobic Lagoon	Total Additional Planned Flow and Loading to Satellite/Easton WWTPs
Flow, mgd	0.116	0.184	0.184	0.30
BOD, mg/L	620	3,000	430	-
BOD, lbs/day	600	4,700	700	1,300
TSS, mg/L	750	2,900	1,100	-
TSS, lbs/day	700	4,500	1,700	2,400
TKN, mg/L	150	700	700	-
TKN, lbs/day	150	1,060	1,060	1,210
TP, mg/L	37	44	44	-
TP, lbs/day	36	68	68	100
pH, s.u.	6.1	6.5	6.5	-

Table 17 Planned Industrial Discharge Estimates

Table 18 shows the projected future design flows for the facility considering the expected growth. Current Easton dry weather flows used in these projections are based on the 2016 dry weather flow because this value is significantly greater than previous years. Future dry weather flow from the Easton collection system was determined by adding additional expected flow from growth at 100 gallons per capita per day (gcd) to the dry weather base flow.

The average and wet weather I/I values were then added to the base flow to determine the annual average, wet weather, maximum day, and peak hourly flows. The total design I/I for annual average, wet weather, maximum day, and peak hourly flows were estimated using current peaking factors from the 2016 flow data, with the exception of the Easton Wet Weather I/I, which used the 2014 maximum month flow because it exceeded the 2016 value. To account for the increase in base flow in 2016 and to avoid double counting I/I, the 2016 Dry Weather flow was subtracted from the 2014 Easton Wet Weather to estimate the current wet weather I/I. Additional I/I from growth was estimated using wet weather peaking factors from the 2016 flow data and the projected additional dry weather flow from growth.

The City is currently implementing collection system improvements related to wet weather flows under a 2017 Consent Decree, including flow monitoring, sewer condition and capacity assessments, a footing drain removal program, a hydraulic model, and the development of a Sanitary Sewer Master Plan. It is anticipated that these improvements will impact future wet weather flows and, therefore, it is recommended an evaluation of peak flows to the WWTP using the City's hydraulic model is conducted following the completion of these collection system improvements. The need for future peak flow improvements at the WWTP should be reevaluated at that time.

Using this method, the projected design average flow for the Easton WWTP is 15.32 mgd, which is less than the current design average flow of 20.4 mgd. The projected design average flow of the Satellite WWTP is 3.61 mgd, which is less than the current design average flow of 6.7 mgd. The need for future peak flow improvements at the WWTP should be reevaluated at that time.

	Easton Flow (mgd)	Satellite Flow (mgd)	Combined Flow (mgd)
Current Dry Weather Flow[a]	10.50	2.68	13.18
Projected Residential Growth[b]	1.32	-	1.32
Planned Industrial Growth	-	0.30	0.30
Projected Dry Weather Flow	11.82	2.98	14.80
Design I/I[k]			
Annual Average	3.5[c]	0.63[g]	4.13
Wet Weather	18.92[d]	1.11[h]	20.03
Maximum Day	55.4[e]	2.39[i]	57.8
Peak Hourly	58.4[f]	3.65[j]	62.1
Projected Flows			
Annual Average	15.32	3.61	18.93
Average Wet Weather	30.74	4.09	34.83
Maximum Day	67.22	5.37	72.59
Peak Hourly	70.18	6.63	76.81

[a]2016 Easton influent flow used as baseline
[b]Additional residential flow of 13,201 persons at 100 gcd.
[c]PF = 1.3 x Dry Weather Flow (based on 2016 Easton flow data)
[d]2014 Easton maximum month - 2016 Dry Weather Flow + I/I from growth @ PF=2.0
[e]PF = 5.7 x Dry Weather Flow (based on 2016 Easton flow data)
[f]PF = 5.8 x Dry Weather Flow (based on 2016 Easton flow data)
[g]PF = 1.2 x Dry Weather Flow (based on 2016 Satellite flow data)
[h]PF = 1.4 x Dry Weather Flow (based on 2016 Satellite flow data)
[i]PF = 1.7 x Dry Weather Flow (based on 2016 Satellite flow data)
[j]PF = 2.1 x Dry Weather Flow (based on 2016 Satellite flow data)
[k]Existing I/I + I/I from growth

Table 18 Projected 2040 Flows

C. Projected Wasteloads

Future loads to the Easton WWTP were projected by using the populations presented earlier and per capita values of 0.22 pcd for BOD_5, 0.22 pounds per capita per day (pcd) for TSS, 0.041 pcd for TKN, and 0.011 for TP, as well as the planned industrial growth. The current average BOD_5, TSS, and TKN loadings are based on the December 2015 to December 2016 average less the estimated return flow loadings. The current average TP loadings are based on the 2016 weekly TP sampling that began in April 2016 less the estimated return flow loadings. Table 19 presents the estimated future loads for BOD_5, TSS, TKN, and TP.

	BOD_5 (lbs/day)	TSS (lbs/day)	TKN (lbs/day)	TP (lbs/day)
Current Average[a]	28,500	33,300	8,240	1,340
Projected Residential Growth	2,900[b]	2,900[c]	540[d]	150[e]
Planned Industrial Growth	1,300	2,400	1,210	100
Projected Average	**32,700**	**38,600**	**9,990**	**1,590**

[a]2016 data as baseline (TP based on April 2016 to December 2016) less estimated return flow loadings.
[b]Additional load at 0.22 pcd
[c]Additional load at 0.22 pcd
[d]Additional load at 0.041 pcd
[e]Additional load at 0.011 pcd

Table 19 Projected Future Loads–Combined Influent

Projected maximum monthly influent loadings are estimated by using a peaking factor of 1.3 for BOD_5, 1.5 for TSS, 1.2 for TKN, and 1.1 for TP. The peaking factors for BOD_5, TSS, and TKN were determined by dividing the highest 30-day average loading by the annual average loading from December 2015 through December 2016. The peaking factor for TP was determined using the available influent TP data, which consisted of the nine-month period of April 2016 through December 2016, in which the 30-day maximum combined loading was 1,807 lb TP per day and the average loading was 1,474 lb TP per day. The maximum monthly loadings are shown in Table 20.

	BOD_5 (lbs/day)	TSS (lbs/day)	TKN (lbs/day)	Phosphorus (lbs/day)
Projected Average Load	32,700	38,600	9,990	1,590
Peaking Factor	1.3	1.5	1.2	1.2
Maximum Month Load	42,500	57,900	12,000	1,910

Table 20 Estimated Maximum Month Loads

Table 21 summarizes the projected year 2040 flows and loadings and compares to the full permitted flows and loadings. Existing capacity greater than the 2040 flow and loadings projection is held as reserve capacity for unforeseen growth.

	2040 Projection	Full Permitted Design
Annual Average Flow	18.9	27.1
Average Wet Weather Flow (Maximum Month)	34.8	34.8
Maximum Wet Weather Flow (Maximum Day)	72.6	79.1[a]
Peak Hourly Wet Weather Flow	76.8	79.1[a]
Annual Average BOD_5 (lbs/day)	32,700	62,800
Maximum Month BOD_5 (lbs/day)	42,500	88,000
Annual Average TSS (lbs/day)	38,600	56,300
Maximum Month TSS (lbs/day)	57,900	83,000
Annual Average TKN (lbs/day)	9,990	11,525
Maximum Month TKN (lbs/day)	12,000	21,050
Annual Average TP (lbs/day)	1,590	2,490[b]
Maximum Month TP (lbs/day)	1,900	2,980[c]

[a]Maximum day and peak hour flow of Easton headworks facility = 68 mgd. Maximum day and peak hour flow of Satellite = 11.1 mgd.
[b]Additional TP load for 8.17 mgd reserve capacity at 100 gcd and 0.011 pcd TP.
[c]Annual Average TP x 1.2 Peaking Factor

Table 21 Design Flows and Loads

EVALUATION OF TREATMENT TECHNOLOGIES TO MEET NUTRIENT REDUCTION GOALS

As previously discussed, operational changes alone will not be sufficient to achieve a significant increase in nutrient reduction and a major capital upgrade will be required to achieve the target reductions in TN and TP. In this section, modifications to the existing activated sludge systems for TN and TP removal are evaluated, including those that treat the dewatering filtrate sidestreams separately from the main treatment process. System performance was evaluated using a BioWin model and the results of this modeling are presented for each alternative.

A. Description of Alternatives

1. *Alternative BNR1–A²O process*

In this alternative, the existing activated sludge system would be modified to implement the A^2O process for biological phosphorus and nitrogen removal. These modifications include the conversion of the existing activated sludge system into eight trains using both the Satellite and Easton WWTPs, each consisting of anaerobic, anoxic, and aerobic zones, along with new nitrified ML recycles from the aerobic zones to the anoxic zones (See Figure 3). Nitrate from the oxidation of influent ammonia is returned to the anoxic zone through the recycled ML, where it can be used by heterotrophic organisms instead of oxygen. This results in denitrification and carbon oxidation without aeration as well as alkalinity recovery. ML is typically returned at a rate of 100 to 400 percent of the influent flow and RAS is returned to the anaerobic zone where it is mixed with the primary effluent. The anaerobic zone provides an environment to select for polyphosphate-accumulating organisms (PAOs), resulting in the uptake of phosphorus in the aerobic zones and phosphorus removal through sludge wasting. Assuming adequate carbon is

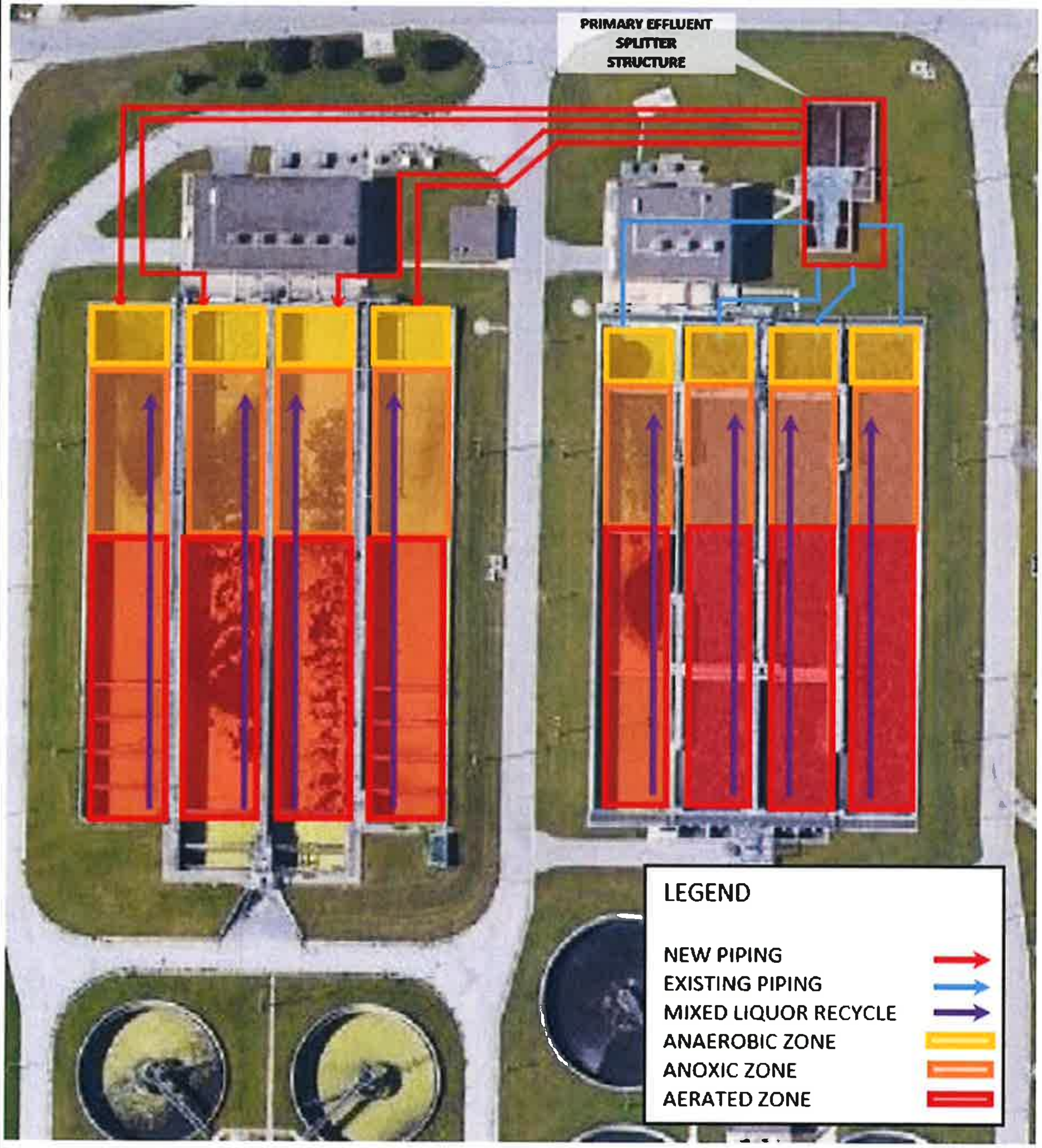


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FIGURE 3

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available, this process can normally attain effluent TP concentrations less than 1.0 mg/L and TN concentrations less than about 10 mg/L, depending on influent TP and TN concentrations.

The conversion of the existing activated sludge system to the A^2O process includes the following elements:

1. Modify the Satellite aeration tanks to operate as four separate trains flowing north to south.
2. Modify Easton and Satellite aeration tanks with anaerobic and anoxic zones by constructing new baffle walls and installing floating or submersible mixers.
3. Install new nitrate recycle pumps, piping, and controls to recycle nitrified ML from the end of the aerated zone to anoxic zone in each train.
4. Remove existing aeration diffusers and replace diffusers in new aerated zones.
5. Install backup CPR system, consisting of two 5,000-gallon chemical storage tanks, chemical feed pumps, chemical feed piping, and Chemical Building.

A calibrated BioWin model was developed for the Easton and Satellite activated sludge systems using special sampling data collected in 2017. This model was then used to predict the performance of the A^2O process using the existing activated sludge tankage modified to include anaerobic, anoxic, and aerated zones (See Figure 4). Model simulations were conducted at the 2040 projected average day and maximum month flows and loadings, as well as the full permitted combined design average day and maximum month flows and loadings as presented in Table 22.

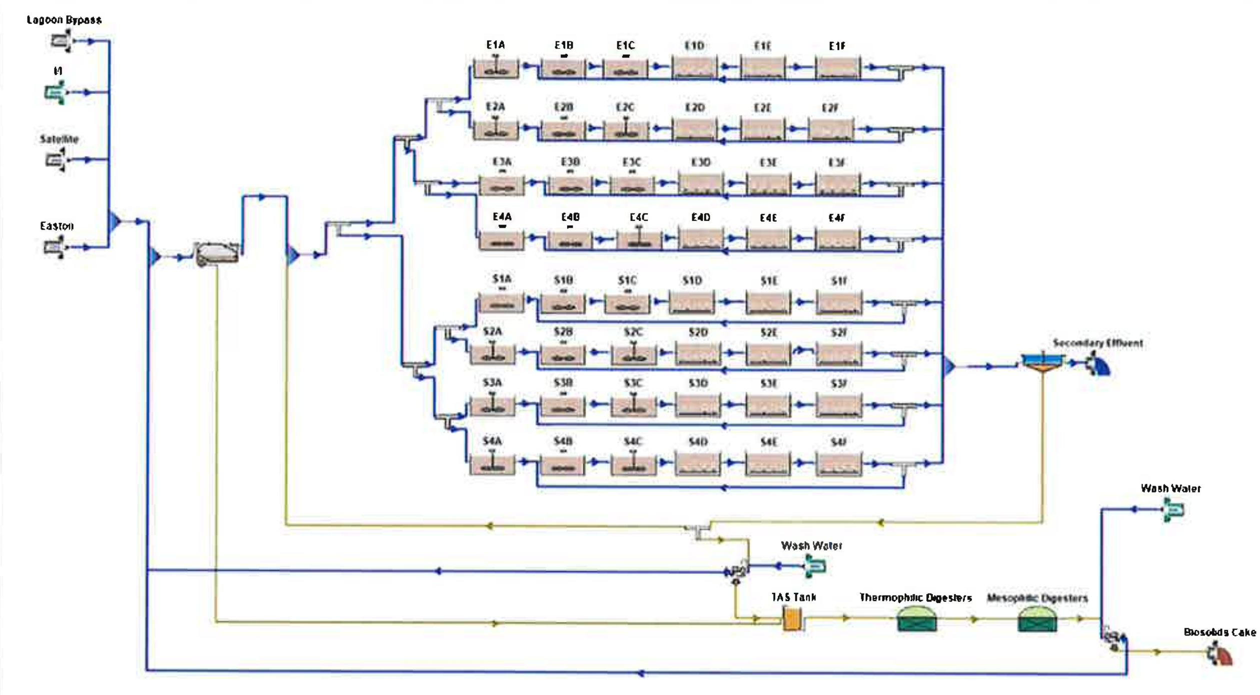

Figure 4 BioWin Model of A^2O Process

	2040 Projection		Full Permitted Design	
	Average Day	Maximum Month	Average Day	Maximum Month
Influent Parameters				
Flow, mgd	18.9	34.8	27.1	34.8
BOD_5 Load, lbs/day	32,700	42,500	62,800	88,000
TSS Load, lbs/day	38,600	57,900	56,300	83,000
TKN Load, lbs/day	9,990	12,000	11,525	21,050
TP Load, lbs/day	1,590	1,900	2,490	2,980
Model Effluent Results				
$cBOD_5$, mg/L	2.6	2.6	3.2	3.2
NH_3-N, mg/L	0.4	0.4	0.3	0.3
TN, mg/L (lbs/day)	25.6 (4,102)	20.3 (5,954)	15.5 (3,546)	30.1 (8,809)
TP, mg/L (lbs/day)	7.8 (1,250)	4.9 (1,424)	6.8 (1,559)	5.4 (1,581)
TSS, mg/L	7.9	8.3	9.8	8.6

Table 22 A^2O Process Modeling Summary

The BioWin simulations for all of the scenarios presented in Table 22 predict insufficient BPR to achieve the effluent TP target of less than 697 lbs TP/day. A key component of successful BPR is having adequate influent carbon in the form of volatile fatty acids (VFAs) or easily fermentable compounds to sustain the necessary PAO population. As presented in Table 23, the special sampling results suggest that the BOD:TP and soluble biochemical oxygen demand (sBOD):TP ratios to the activated sludge system are approximately 14:1 and 7:1, respectively. According to the *Water Environment Federation Manual of Practice No. 34: Nutrient Removal,* the minimum substrate to phosphorus requirements for BPR are 25:1 for carbonaceous biochemical oxygen demand ($cBOD_5$):TP and 15:1 for $sBOD_5$:TP, which supports the theory that the influent wastewater has inadequate carbon to provide adequate PAO activity in the process simulations.

	Easton Primary Effluent	Satellite Influent	**Combined**
BOD, lbs/day	11,350	9,410	**20,760**
sBOD, lbs/day	6,200	3,470	**9,670**
TP, lbs/day	850	630	**1,480**

Table 23 Special Sampling Data–May and June 2017

There are several approaches that are available for facilities that do not have adequate influent carbon for successful BPR, such as increasing influent carbon to the activated sludge system through primary sludge fermentation or removing phosphorus from the dewatering return flows. Additionally, the City is in the unique position of having a significant upstream carbon source being treated at the anaerobic lagoon that could be partially diverted to the WWTP to increase the influent BOD:TP ratio. Each of these approaches are described further below and additional process simulations are presented that evaluate their impact on overall nutrient removal at the WWTP.

a. Sidestream Phosphorus Removal

Sidestream phosphorus removal is typically based on harvesting or sequestering struvite (magnesium ammonium phosphate) to remove phosphorus from the sludge dewatering filtrate or from the digested sludge directly. This reduces the phosphorus load to the activated sludge system, effectively increasing the BOD:TP ratio. The City has noted some maintenance issues with struvite formation based on current WWTP operations, and implementation of a BPR process is anticipated to exacerbate struvite formation as more stored phosphorus is released in the anaerobic digesters. In addition to the reduced phosphorus loading to the activated sludge system, harvesting struvite can reduce maintenance from nuisance struvite formation, especially when harvested from the digested sludge directly. There are also opportunities to produce a marketable struvite product that can partially offset the costs of removal, depending on the technology used.

b. Primary Sludge Fermentation

One approach to increase VFAs to the activated sludge system is through primary sludge fermentation. This is typically accomplished in a covered, mixed tank in which thickened primary sludge is held to allow the biodegradable organic components to be fermented into VFAs. The retention time in the fermenter is closely controlled to maintain an adequate population of fermenting microorganisms while preventing methanogens from becoming prevalent. While primary sludge fermenters have been successfully implemented at many WWTPs to produce VFAs, the cost, operation, maintenance, and odors associated with fermentation must be considered. Additionally, the diversion of VFAs from the biosolids stream to the liquid stream for BPR will reduce the amount of biogas generated in the anaerobic digesters.

c. Anaerobic Lagoon Influent Diversion/Chemical Carbon Addition

The City's anaerobic lagoon received over 35,000 lbs BOD/day from 2014 to 2016 and discharged approximately 5,170 lbs BOD over the same period. The City has seen an increase in BOD loading to the lagoon in 2017, with recent months averaging over 40,000 lbs BOD/day, and also anticipates an increase in BOD loading to the lagoon with new industries. One option to increase the influent BOD:TP ratio at the WWTP is to divert a portion of the high-BOD lagoon influent to the WWTP. However, this would result in less biogas production at the lagoon and would likely necessitate the installation of influent screening on the Satellite influent, as described earlier in this section. It would also necessitate additional infrastructure at the WWTP to convert carbon compounds in the lagoon influent to VFAs for the PAOs. For planning purposes, it is assumed that a new storage tank and the necessary pumping equipment to store the Satellite influent and allow fermentation to occur would be constructed if lagoon influent diversion were to be implemented. Rather than divert BOD from the anaerobic lagoon influent, the City could also choose to purchase compounds that are high in biodegradable COD or VFAs and add these directly to the primary effluent to increase the BOD:TP (or VFA:TP) ratio. Alternatives with VFA addition at the WWTP include additional chemical storage and feed systems for this purpose.

Additional simulations of the A^2O process with struvite harvesting and primary sludge fermentation were conducted under the 2040 projected annual average conditions to evaluate the impact of each of these processes on nutrient removal. In each of these simulations, the influent VFA deficit predicted by the model was quantified by determining the VFA addition necessary to achieve the effluent TP target. The results of these simulations are presented in Table 24.

	Projected 2040 Conditions		
	Average Day	Average Day with Struvite Harvesting	Average Day with Struvite Harvesting and PRS Fermentation
Influent Parameters			
Flow, mgd	18.9	18.9	18.9
BOD_5 Load, lbs/day	32,700	32,700	32,700
TSS Load, lbs/day	38,600	38,600	38,600
TKN Load, lbs/day	9,990	9,990	9,990
TP Load, lbs/day	1,590	1,590	1,590
Model Results–Secondary Effluent			
$cBOD_5$, mg/L	3.6	3.4	3.5
NH_3-N, mg/L	0.7	0.4	0.4
TN, mg/L (lbs/day)	22.2 (3,556)	23.9 (3,841)	23.9 (3,841)
TP, mg/L (lbs/day)	4.3 (685)	4.2 (680)	4.3 (688)
TSS, mg/L	8.1	7.8	8.0
VFA Addition (lbs/day)	23,370	6,680	3,340

Table 24 A^2O Process Modeling Summary–with VFA Addition at 16°C, 2040 Conditions

The BioWin simulations predict that implementation of sidestream struvite harvesting and primary sludge fermentation would significantly reduce the amount of VFAs that would either have to be added at the WWTP or diverted from the anaerobic lagoon under the projected 2040 annual average conditions to achieve the effluent TP target of 697 lbs/day (Table 24). However, the model predicts that reaching the target would still require some VFA addition or lagoon influent diversion to increase the VFA:TP ratio. Under the full permitted design flows and loadings (Table 25), the model predicts effluent TP below the target values without VFA addition if struvite harvesting and primary sludge fermentation is implemented, because this loading condition has a more favorable BOD:TP ratio than the projected 2040 condition.

Based on this evaluation, the A^2O process is separated into the following alternatives:

- *BNR1a*–A^2O with BOD diversion from lagoon
- *BNR1b*–A^2O with VFA addition at WWTP
- *BNR1c*–A^2O with Struvite Harvesting; BOD diversion from lagoon
- *BNR1d*–A^2O with Struvite Harvesting; VFA addition at WWTP
- *BNR1e*–A^2O with Struvite Harvesting and PRS fermentation; BOD diversion from lagoon
- *BNR1f*–A^2O with Struvite Harvesting and PRS fermentation; VFA addition at WWTP

	Full Permitted Design Flows and Loadings		
	Average Day	Average Day with Struvite Harvesting	Average Day with Struvite Harvesting and PRS Fermentation
Influent Parameters			
Flow, mgd	27.1	27.1	27.1
BOD_5 Load, lbs/day	62,800	62,800	62,800
TSS Load, lbs/day	56,300	56,300	56,300
TKN Load, lbs/day	11,525	11,525	11,525
TP Load, lbs/day	2,490	2,490	2,490
Model Results–Secondary Effluent			
$cBOD_5$, mg/L	3.9	3.2	3.7
NH_3-N, mg/L	0.9	0.4	0.3
TN, mg/L (lbs/day)	14.1 (3,222)	14.6 (3,348)	13.9 (3,182)
TP, mg/L (lbs/day)	3.0 (685)	3.0 (678)	2.2 (510)
TSS, mg/L	9.6	8.0	12.4
VFA Addition (lbs/day)	18,360	0	0

Table 25 A^2O Process Modeling Summary–with VFA Addition at 16°C, Full Permitted Design Conditions

2. *Alternative BNR2–MLE with CPR*

In this alternative, the City would continue to implement the MLE process for biological nitrogen removal and would address phosphorus removal through chemical addition. The existing activated sludge system would be modified to improve performance and would result in eight trains instead of the current six by converting the Satellite activated sludge tanks into four parallel trains. New nitrified ML recycles from the aerobic zones to the anoxic zones would also be included (see Figure 5).

CPR involves the addition of a metal salt (commonly an iron or aluminum salt) to flocculate and precipitate soluble phosphorus in wastewater. The precipitated phosphorus is then removed during clarification and/or filtration. CPR is a relatively simple and predictable process, especially for effluent targets over 1.0 mg/L. Jar testing with multiple CPR chemicals is often performed to determine the most cost-effective chemical and to estimate the required chemical dosages.

There are several possible application points for CPR. The phosphorus removal chemical could be added to the primary influent, aeration tanks, or final clarifier influent. Application upstream of the primary clarifiers can provide additional primary removal of suspended solids and organic matter in addition to phosphorus removal, which would reduce loadings to the activated sludge system, reduce power costs, and result in additional digester gas production because of higher primary clarifier TSS and BOD removal rates. However, because of the complex nature of the raw wastewater, higher chemical dosages are typically required when added to the primary clarifier

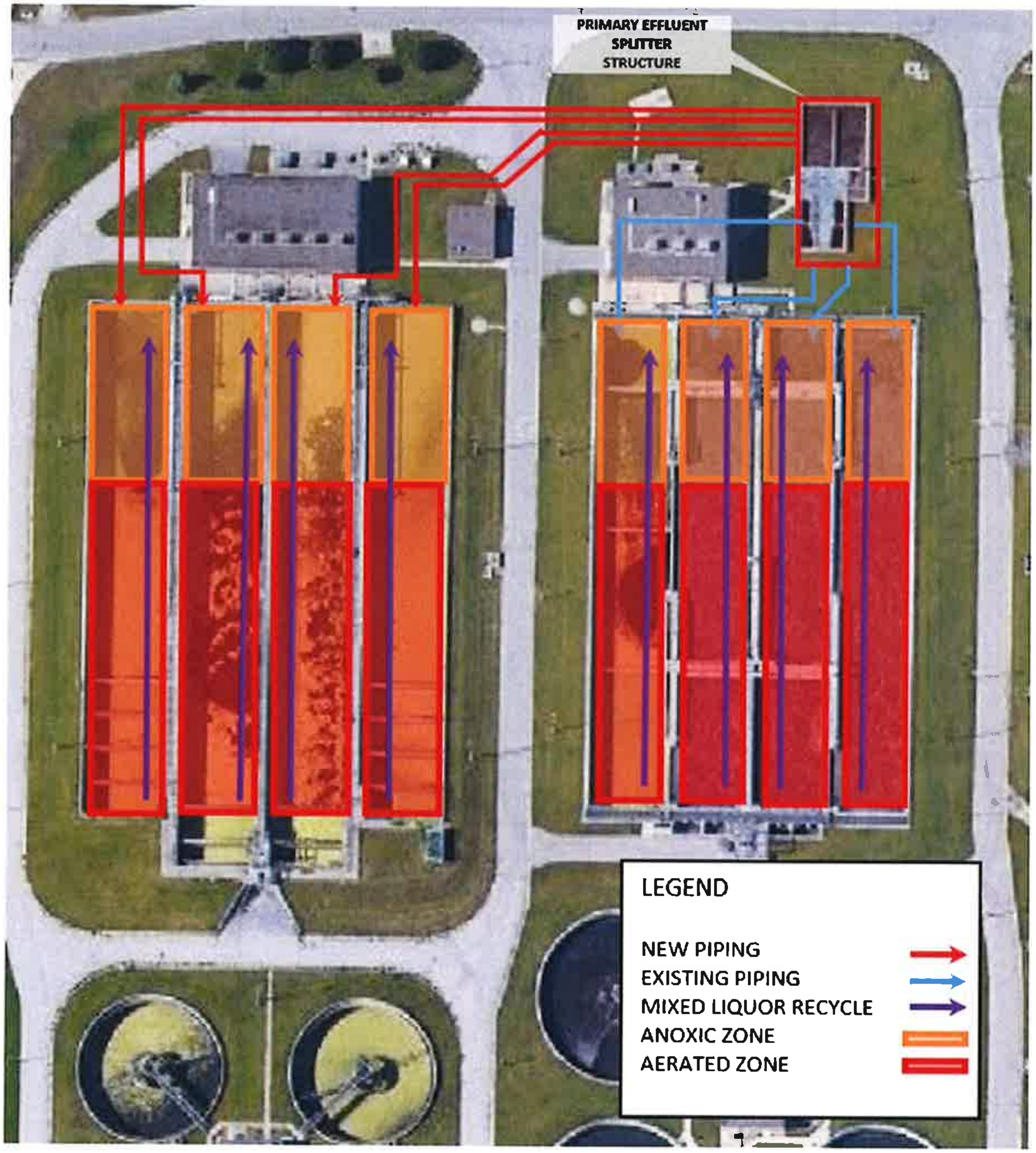

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FIGURE 5
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influent, and sludge production can increase by more than 20 percent in such systems. More than one application point is typically provided for optimization and flexibility.

Several chemicals are available for CPR, but aluminum sulfate (alum) and ferric chloride are two of the most commonly used. Alum is typically favored in soft water applications, while ferric chloride is used more in hard water applications. Both chemicals can affect sludge thickening and dewaterability and can also lower the pH of the wastewater. Sodium aluminate is also sometimes used for CPR and can be useful when pH or alkalinity is low because it is a basic chemical. Other chemicals that may be used include ferrous chloride, ferric or ferrous sulfate, polyaluminum chloride, and rare earth metals. For this report, it was assumed that ferric chloride would be used for CPR. Jar tests and/or full scale tests should be performed if the City elects to implement CPR to meet future effluent phosphorus limits.

A calibrated BioWin model was used to predict the performance of the MLE process using the existing activated sludge tankage with modified anoxic and aerated zones (See Figure 6). Model simulations were conducted at the 2040 projected average day and maximum month flows and loadings, as well as the full permitted combined design average day and maximum month flows and loadings as presented in Table 26.

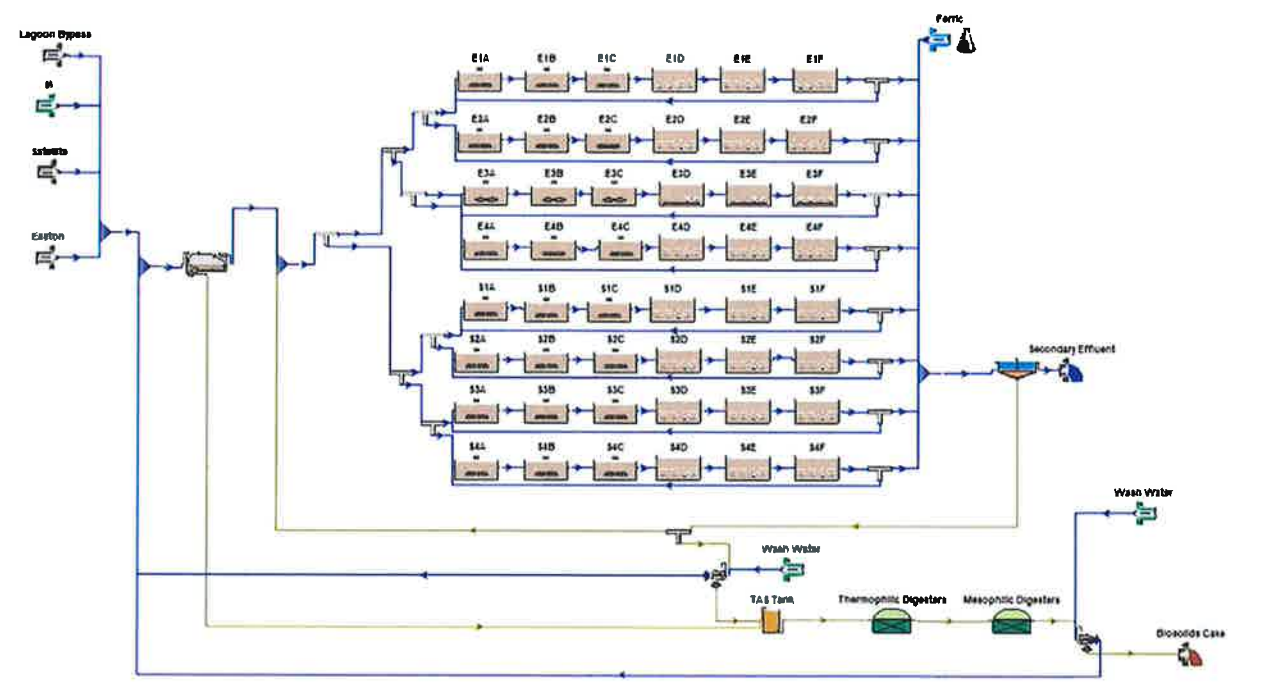

Figure 6 BioWin Model of MLE Process with CPR

	2040 Projection		Full Permitted Design Flows and Loadings		
	Average Day at 16°C	Maximum Month at 16°C	Average Day at 16°C	Maximum Month at 16°C	Maximum Month at 12°C
Influent Parameters					
Flow, mgd	18.9	34.8	27.1	34.8	34.8
BOD_5 Load, lbs/day	32,700	42,500	62,800	88,000	88,000
TSS Load, lbs/day	38,600	57,900	56,300	83,000	83,000
TKN Load, lbs/day	9,990	12,000	11,525	21,050	21,050
TP Load, lbs/day	1,590	1,900	2,490	2,980	2,980
Model Effluent Results					
$cBOD_5$, mg/L	1.9	2.4	2.8	3.3	3.9
NH_3-N, mg/L	0.2	0.4	0.1	0.7	0.5
TN, mg/L (lbs/day)	26.3 (4,216)	16.0 (4,687)	11.7 (2,676)	19.3 (5,655)	27.1 (7,943)
TP, mg/L (lbs/day)	4.1 (650)	2.4 (694)	2.9 (663)	2.3 (680)	2.3 (680)
TSS, mg/L	8.9	11.5	12.1	12.3	12.5
Ferric Chloride Dose, gpd	1,200	1,700	2,200	2,400	2,400

Table 26 MLE Process Modeling Summary with CPR

The BioWin simulations for the average day scenarios presented in Table 26 predict effluent TN loads below the target value of 5,863 lbs/day. Chemical doses necessary to achieve the effluent TP target of 697 lbs/day with single-point addition to the final clarifiers ranged from approximately 1,200 gpd at the projected annual average loading up to approximately 2,400 gpd at the full permitted design maximum month loading. Jar testing of various phosphorus-removal chemicals to estimate dose requirements is recommended prior to final design should this alternative be pursued further. A simulation conducted at the full permitted design maximum month condition and 12°C suggests that additional tankage is not needed to nitrify under this extreme condition. In this scenario, the ratio of anoxic to aerated volume was decreased as compared to the other simulations presented. Further refinement of zone sizes should be conducted should this alternative be pursued, potentially incorporating anoxic or aerated "swing" zones to account for varied loading conditions.

This alternative includes the following elements:

a. Modify the Satellite aeration tanks to operate as four separate trains flowing north to south.

b. Modify Easton and Satellite aeration tanks with anoxic zones by constructing new baffle walls and installing floating or submersible mixers.

c. Install new nitrate recycle pumps, piping, and controls to recycle nitrified ML from the end of the aerated zone to anoxic zone in each train.

d. Remove existing aeration diffusers and replace diffusers in new aerated zones.

e. Install CPR system, consisting of four 10,000-gallon chemical storage tanks, chemical feed pumps, chemical feed piping, and Chemical Building.

3. *Alternative BNR3–MLE with Sidestream Enhanced BPR*

Historically, BPR systems such as the A^2O process described earlier have relied on a group of PAOs known as *Accumulibacter* for phosphorus uptake and removal using combinations of anaerobic and aerated zones in the main liquid process train. A more recent development in phosphorus removal is sidestream enhanced BPR using RAS fermentation (Figure 7). In this process, a portion of the RAS (typically 10 to 25 percent) is diverted to a sidestream anaerobic tank with a detention time of 24 to 48 hours (or less with VFA addition) which can select for *Tetrasphaera* under deep anaerobic conditions [oxidation-reduction potential (ORP) less than -300 millivolts (mV)]. Research suggests that *Tetrasphaera* can ferment higher organic compounds and produce additional VFAs for *Accumulibacter* to work along-side them. Therefore, it may have an advantage for situations where BPR using the A^2O process is carbon-limited, such as the A^2O model is predicting in this case. This configuration has also been shown to safeguard against Glycol Accumulating Organisms (GAOs) that compete against PAOs under certain conditions. Other advantages to sidestream enhanced BPR include some additional protection from biomass washout and reduced detention times under peak flow conditions. However, while the mechanisms for this BPR process are currently a subject of significant research, the existing process models do not account for these two discrete PAO populations, and, therefore, process models cannot currently predict treatment performance of this configuration.

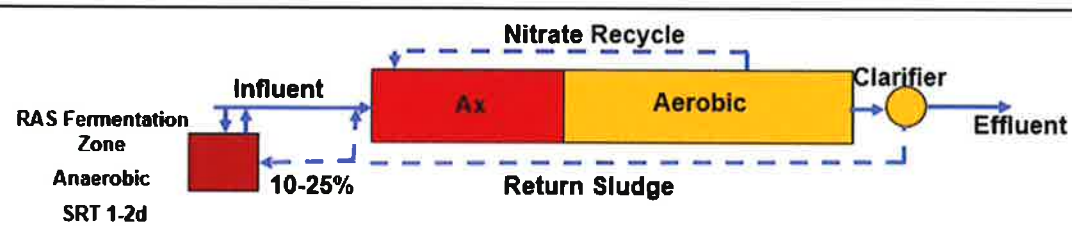

Figure 7 RAS Fermentation Process Diagram

Based on the industry's experience with RAS fermentation to-date, the design considerations described above (diversion of 10 to 25 percent of RAS to an anaerobic zone with SRT of 24 to 48 hours) have been suggested in the literature. For the City's design average flow of 27.1 mgd and a typical RAS rate equal to the average influent flow, the RAS fermentation zone would be approximately 5.4 MG to provide a 48 hour SRT for 10 percent of the RAS flow. This is approximately equal to one of the existing Satellite WWTP treatment trains, which each have a volume of approximately 5.8 MG. The remaining tanks would be configured with anoxic zones and aerated zones, similar to the MLE process described earlier. RAS flow would be diverted to the RAS fermentation zone from the RAS headers in the Easton and Satellite RAS Buildings and controlled with pumps and/or flow control valves. Effluent from the RAS Fermentation Zone would flow to the new Primary Effluent Splitter Structure where it would be combined with primary effluent and RAS. A preliminary schematic of this layout is presented in Figure 8.

This alternative includes the following elements:

a. Modify two of the Satellite aeration tanks to operate as two separate MLE trains flowing north to south.

b. Modify Easton and two Satellite aeration tanks with anoxic zones by constructing new baffle walls and installing floating or submersible mixers.

c. Install new nitrate recycle pumps, piping, and controls to recycle nitrified ML from the end of the aerated zone to the anoxic zone in each train.

d. Remove existing aeration diffusers and replace diffusers in new aerated zones.

e. Modify two of the Satellite aeration tanks into RAS Fermentation Zones with floating or submersible mixers. Install piping from the Easton and Satellite RAS buildings with pumps and/or flow control valves to feed RAS to the RAS Fermentation Zones.

f. Install CPR system, consisting of two 10,000-gallon chemical storage tank, chemical feed pumps, chemical feed piping, and Chemical Building. This will provide backup chemical addition in the event that this process does not operate efficiently.

While this process cannot be accurately modeled at this time, simulations were conducted to evaluate the ability of the activated sludge system to meet ammonia and TN targets using only the Easton tanks and two of the Satellite tanks without RAS fermentation. This scenario simulates the operation of these six trains in the MLE arrangement for TN removal without (or prior to) implementation of RAS fermentation. Several loading scenarios and conditions were evaluated as presented in Table 27. At the 2040 projected maximum month condition at 12°C, considered a stressed condition for nitrification, the simulation results predict effluent ammonia below 1.0 mg/L and TN below the target value. At the full permitted average day design loading conditions, effluent ammonia below 1.0 mg/L and TN below the target value was predicted for both 12°C and 16°C simulations. At the full permitted design maximum month condition, the simulated configuration did not completely nitrify at 12°C, with an effluent ammonia concentration of 4.5 mg/L. However, this value is significantly less than the lowest winter monthly average effluent ammonia limit in the current permit of 34.5 mg/L in December. Earlier simulations of the MLE process (presented in Table 26) suggest that the existing tankage could adequately nitrify under these conditions using all of the available tanks for the MLE process. Further evaluation should be conducted following development of process models to evaluate these loading conditions should lower effluent ammonia concentration be required in the future.

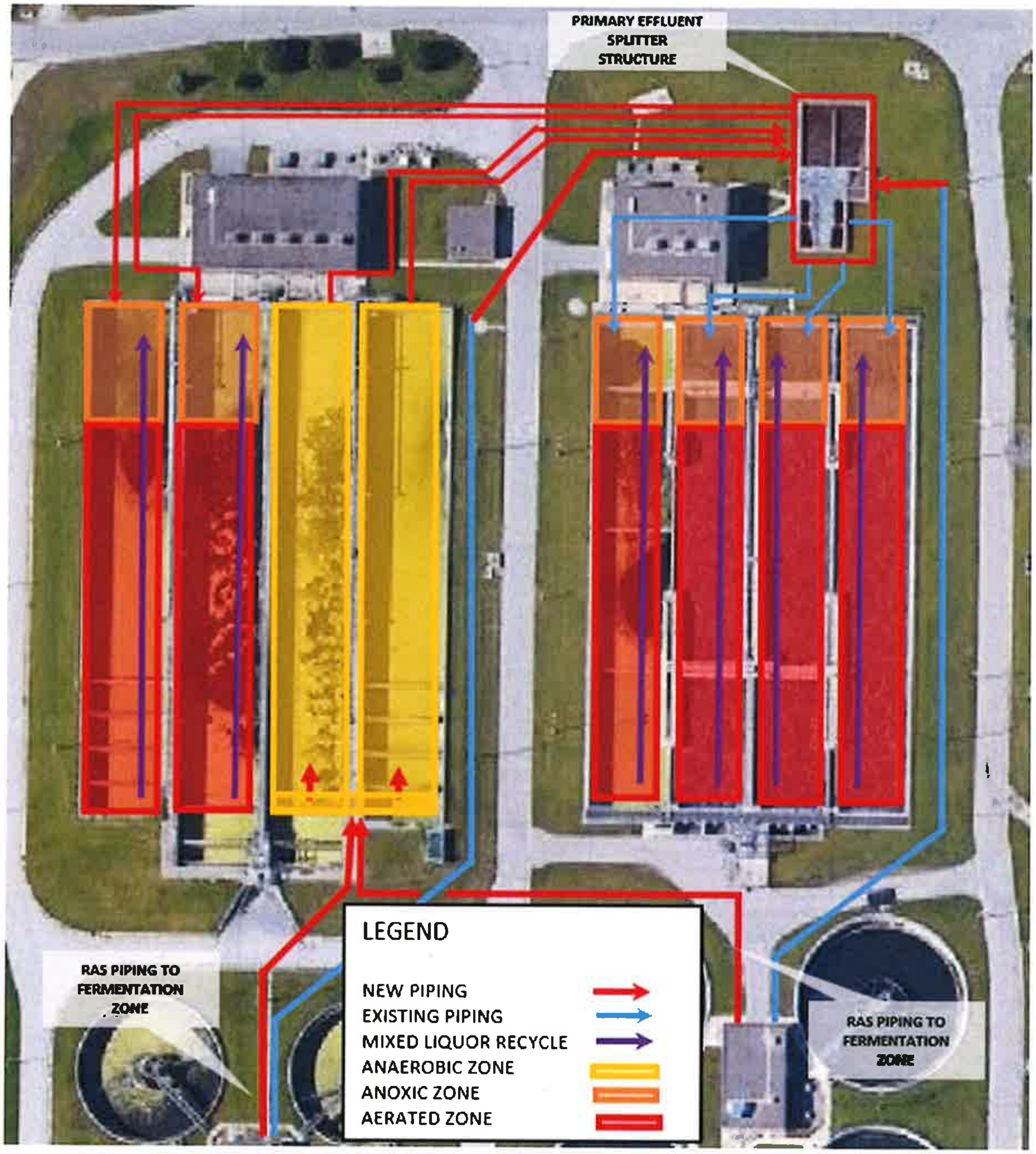

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FIGURE 8

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	2040 Projection	Full Permitted Design Loadings		
	Maximum Month at 12°C	Average Day At 12°C	Average Day At 16°C	Maximum Month at 12°C
Influent Parameters				
Flow, mgd	34.8	27.1	27.1	34.8
BOD_5 Load, lbs/day	42,500	62,800	62,800	88,000
TSS Load, lbs/day	57,900	56,300	56,300	83,000
TKN Load, lbs/day	12,000	11,525	11,525	21,050
TP Load, lbs/day	1,900	2,490	2,490	2,980
Model Effluent Results				
$cBOD_5$, mg/L	2.3	3.6	3.4	4.1
NH_3-N, mg/L	0.5	0.4	0.1	4.5
TN, mg/L (lbs/day)	19.1 (5,596)	12.6 (2,871)	12.5 (2,848)	27.0 (7,918)
TP, mg/L (lbs/day)	2.3 (669)	2.8 (650)	2.9 (654)	2.3 (678)
TSS, mg/L	10.0	12.9	12.6	13.1
Ferric Chloride Dose, gpd	1,700	2,200	2,200	2,400
Activated Sludge Volumetric Loading Rate assuming 35% removal in Primary Clarifiers (lb BOD_5/1,000 cf/day)	15.0	22.0	22.0	30.9

Table 27 MLE Process Modeling Summary with CPR–Two Satellite Trains Reserved for RAS Fermentation Zones

B. Monetary Comparison

Table 28 summarizes the 20-year present worth analysis for each of the BNR alternatives. Additional detail on the present worth analysis is provided in Appendix B. Because the phosphorus removal performance of *Alternative BNR3* cannot be predicted using process modeling at this time, the quantity of phosphorus removal chemical (PRC) or VFA that would be required to meet the TP target with this alternative, if any, is unknown. Therefore, operational and maintenance (O&M) costs associated with *Alternative BNR3* are estimated as ranges, with the maximum values assuming chemical addition equal to those of *Alternative BNR2*. For the alternatives that include the diversion of BOD from the anaerobic lagoon to the WWTP, it is assumed that at a minimum a screening facility would be required on the Satellite influent, and, therefore, the present worth cost of Satellite Screening facility is included with these alternatives. Additionally, these alternatives include the lost revenue from the biogas that would have been generated at the lagoon if this BOD was not diverted, estimated in the range of $0 to $20 per million British Thermal Units (MMBTU), depending on the end-use of the lagoon biogas.

C. Nonmonetary Considerations

Nonmonetary considerations for each alternative were evaluated and are summarized in Table 29.

Table 28 BNR Present Worth Analysis Summary

	Alternative BNR1a A^{2}O Process with BOD diversion from lagoon	Alternative BNR1b A^{2}O Process with VFA addition at WWTP	Alternative BNR1c A^{2}O Process with struvite harvesting; BOD diversion from lagoon	Alternative BNR1d A^{2}O Process with struvite harvesting; VFA addition at WWTP	Alternative BNR1e A^{2}O Process with struvite harvesting and PRS fermentation; BOD diversion from lagoon	Alternative BNR1f A^{2}O Process with struvite harvesting and PRS fermentation; VFA addition at WWTP	Alternative BNR2 MLE Process with CPR	Alternative BNR3 MLE with Sidestream Enhanced BPR
Capital Costs								
Equipment/Structure Subtotal	$7,600,000	$5,420,000	$9,600,000	$5,720,000	$11,200,000	$6,420,000	$3,490,000	$2,320,000
Mechanical	$1,520,000	$1,090,000	$1,920,000	$1,150,000	$2,240,000	$1,290,000	$700,000	$820,000
Electrical	$1,900,000	$1,360,000	$2,400,000	$1,430,000	$2,800,000	$1,610,000	$880,000	$580,000
Heating, ventilation, and air conditioning (HVAC)	$760,000	$550,000	$960,000	$580,000	$1,120,000	$650,000	$350,000	$240,000
Sitework	$760,000	$550,000	$960,000	$580,000	$1,120,000	$650,000	$530,000	$350,000
Contractor General Conditions	$1,260,000	$900,000	$1,590,000	$950,000	$1,850,000	$1,070,000	$600,000	$440,000
Contingencies, Legal, and Engineering	$6,900,000	$4,940,000	$8,720,000	$5,210,000	$10,170,000	$5,850,000	$3,280,000	$2,380,000
Total Opinion of Capital Costs	**$20,700,000**	**$14,810,000**	**$26,150,000**	**$15,620,000**	**$30,500,000**	**$17,540,000**	**$9,830,000**	**$7,130,000**
Annual O&M Costs								
Labor	$10,000	$10,000	$20,000	$20,000	$40,000	$40,000	$60,000	$7,000 to 60,000
Power	$290,000	$290,000	$300,000	$300,000	$290,000	$290,000	$270,000	$0 to $270,000
Chemical	$60,000	$2,200,000	$140,000	$750,000	$140,000	$440,000	$660,000	$0 to $660,000
Additional Sludge Disposal Cost	$220,000	$220,000	$40,000	$40,000	$40,000	$40,000	$170,000	$0 to $170,000
Maintenance and Supplies	$20,000	$20,000	$30,000	$30,000	$40,000	$40,000	$20,000	$20,000
Total	$600,000	$2,740,000	$530,000	$1,140,000	$550,000	$850,000	$1,180,000	$27,000 to $1,180,000
Present Worth of O&M	**$9,140,000**	**$41,720,000**	**$8,070,000**	**$17,360,000**	**$8,370,000**	**$12,940,000**	**$17,970,000**	**$460,000 to $17,970,000**
Summary of Present Worth Costs								
Capital Cost	$20,700,000	$14,810,000	$26,150,000	$15,620,000	$30,500,000	$17,540,000	$9,830,000	$7,130,000
Replacement	$440,000	$440,000	$440,000	$440,000	$440,000	$440,000	$440,000	$340,000
O&M Cost	$9,140,000	$41,720,000	$8,070,000	$17,360,000	$8,370,000	$12,940,000	$17,970,000	$460,000 to $17,970,000
Salvage Value	($940,000)	($1,440,000)	($1,060,000)	($1,100,000)	($1,150,000)	($920,000)	($890,000)	($560,000)
Satellite Influent Screening	$5,470,000	-	$5,470,000	-	$5,470,000	-	-	-
Lost Biogas Revenue at Lagoon	$0 to $15,090,000	-	$0 to $4,310,000	-	$0 to $2,160,000	-	-	-
TOTAL PRESENT WORTH	**$34,810,000 to $49,900,000**	**$55,530,000**	**$39,070,000 to $43,380,000**	**$32,320,000**	**$43,630,000 to $45,790,000**	**$30,000,000**	**$27,350,000**	**$7,370,000 to $24,880,000**

Notes: All costs in 1st Quarter 2018 dollars.

Table 29 Biological Nutrient Removal Nonmonetary Considerations Summary

Alternative	Benefits	Limitations
BNR1a: *A^2O with BOD diversion from lagoon*	▪ TP and TN removal without chemical addition at WWTF.	▪ Significant reduction in lagoon biogas. ▪ Potential negative impact on WWTF processes and equipment from undesirable materials in diverted lagoon influent. ▪ Operation of BPR more challenging under varied influent conditions than CPR.
BNR1b: *A^2O with VFA addition at WWTF*	▪ TP and TN removal without metal salt addition at WWTF. ▪ Does not impact lagoon operation or lagoon biogas production.	▪ Additional chemical handling at WWTF; increase in truck traffic to site, new equipment to operate and maintain. ▪ Operation of BPR more challenging under varied influent conditions than CPR.
BNR1c: *A^2O with Struvite Harvesting; BOD diversion from lagoon*	▪ TP and TN removal without chemical addition at WWTF. ▪ Reduction of nuisance struvite formation through harvesting/sequestration. Potential for marketable struvite product.	▪ Reduction in lagoon biogas production. ▪ Potential negative impact on WWTF processes and equipment from undesirable materials in diverted lagoon influent. ▪ Operation of BPR more challenging under varied influent conditions than CPR. ▪ Increased complexity with additional process to operate and maintain.
BNR1d: *A^2O with Struvite Harvesting; VFA addition at WWTF*	▪ TP and TN removal without metal salt addition at WWTF. ▪ Does not impact lagoon operation or lagoon biogas production.	▪ Additional chemical handling at WWTF; increase in truck traffic to site, new equipment to operate and maintain. ▪ Operation of BPR more challenging under varied influent conditions than CPR. ▪ Increased complexity with additional process to operate and maintain.
BNR1e: *A^2O with Struvite Harvesting and PRS fermentation; BOD diversion from lagoon*	▪ TP and TN removal without chemical addition at WWTF. ▪ Reduction of nuisance struvite formation through harvesting/sequestration. Potential for marketable struvite product. ▪ VFA formation at WWTF stabilizes BPR performance under varied influent conditions.	▪ Reduction in lagoon biogas production. ▪ Potential negative impact on WWTF processes and equipment from undesirable materials in diverted lagoon influent. ▪ Operation of BPR more challenging under varied influent conditions than CPR. ▪ PRS Fermentation can be challenging to operate; odor concerns. ▪ Increased complexity with two additional processes to operate and maintain.
BNR1f: *A^2O with Struvite Harvesting and PRS fermentation; VFA addition at WWTF*	▪ TP and TN removal without metal salt addition at WWTF. ▪ Does not impact lagoon operation or lagoon biogas production.	▪ Additional chemical handling at WWTF; increase in truck traffic to site, new equipment to operate and maintain. ▪ Operation of BPR more challenging under varied influent conditions than CPR. ▪ PRS Fermentation can be challenging to operate; odor concerns. ▪ Increased complexity with additional processes to operate and maintain.
BNR2: *MLE with CPR*	▪ Modification to existing process, staff familiar with operation. ▪ CPR more reliable than BPR, especially with varied influent conditions.	▪ Additional chemical handling at WWTF; increase in truck traffic to site, new equipment to operate and maintain.
BNR3: *MLE with RAS Fermentation*	▪ Potential for TP and TN removal without chemical addition at WWTF. ▪ Can be tested in existing tankage while using MLE process in remaining tanks. ▪ Struvite harvesting and/or PRS fermentation could be added to improve TP removal if necessary.	▪ Developing process that has not been widely implemented to date. ▪ System performance cannot be predicted using current process modes.

C. Other Capital Improvements Required for Enhanced Nutrient Removal and WWTP Consolidation

In this section, other capital improvements that are recommended if enhanced nutrient removal or increased capacity were to be required are presented. Improvements identified as recommendations for those purposes does imply that the City is consenting to implement these improvements at this time.

As described earlier, the Satellite and Easton WWTPs are currently designed to operate as separate systems, each with their own influent pumps, activated sludge tanks, aeration systems, and final clarifiers. The City currently treats wastewater from both the Satellite and Easton collection systems using only the Easton WWTP activated sludge system because operating the two systems in parallel is inefficient and add significant operational complexity. It is also challenging to bring the Satellite WWTP online intermittently during periods of high flow/load, which would require ML to be manually transferred from the Easton tanks to the Satellite tanks, and for a second and significantly different activated sludge process to be initiated while biological treatment is under stress. For these reasons, it is recommended that the operations of the two facilities be combined into one common WWTP using infrastructure from both WWTPs. The proposed configuration would combine the Easton and Satellite flows prior to grit removal, and the existing activated sludge systems would be modified to operate as parallel sets of tanks using the same biological treatment process as indicated earlier. However, other capital improvements beyond those identified in the BNR alternatives would be required to consolidate the WWTP operation. This section describes these additional capital improvements that are required to implement the BNR alternatives.

1. Preliminary and Primary Treatment Improvements

The Satellite influent does not currently undergo preliminary or primary treatment and is discharged either directly to the Satellite activated sludge system or to the Easton activated sludge system (current operation). Because the Satellite activated sludge system is approximately 5 feet higher in elevation than the Easton activated sludge system, gravity flow of a combined influent to the two systems is not possible without hydraulic modifications to the existing primary clarifiers and splitter structure. Improvements to the preliminary and primary treatment facilities to consolidate the WWTPs are as follows (see Figure 9):

a. Replace Easton and Satellite influent pumps.

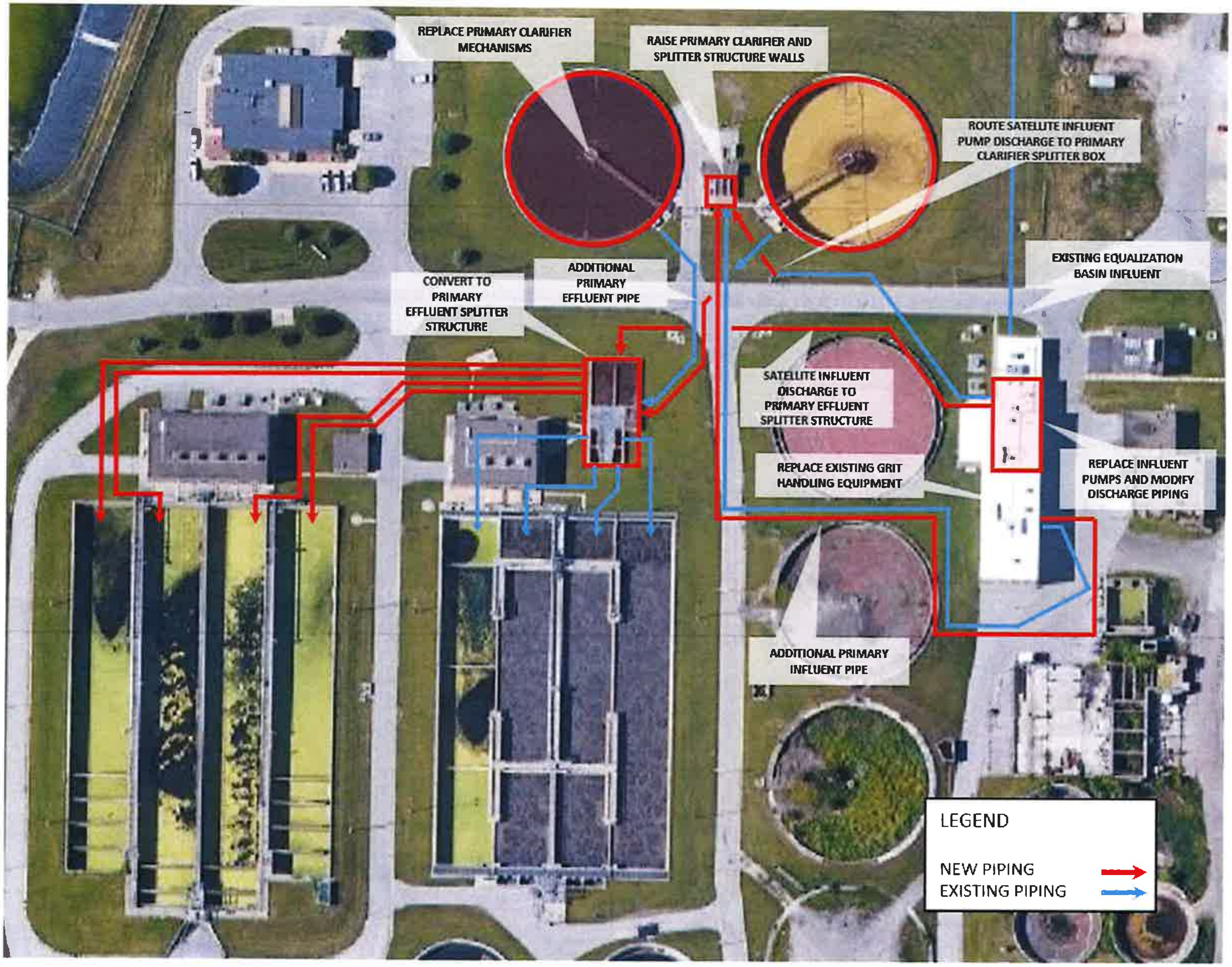
b. Modify Satellite influent pump discharge piping to allow discharge upstream of grit removal, to the Primary Clarifier Splitter Box, and to the primary effluent splitter structure. Provide new flow measurement and sampling for Satellite influent.

c. Add larger opening with sluice gate between Easton and Satellite influent wet wells to allow wetwells to operate as one.

d. Modify grit influent channel to reduce grit settling.

e. Replace grit collector mechanisms.

f. Replace grit pumps and associated piping.



PRELIMINARY AND PRIMARY TREATMENT IMPROVEMENTS

NUTRIENT REDUCTION STUDY
CITY OF WATERLOO, IOWA

STRAND ASSOCIATES

FIGURE 9
4463.001

g. Replace grit classifier with two grit washers.

h. Install additional primary influent pipe between grit removal effluent channel and primary clarifier splitter structure to increase hydraulic capacity to 64 mgd. Modify grit effluent piping and equalization basin downward opening weir control in degritter effluent channel.

i. Raise the walls and channels of the primary clarifiers and splitter structure approximately 5 feet to increase the water surface elevation in the primary clarifiers by approximately 5 feet.

j. Replace primary clarifier mechanisms and weirs.

k. Convert existing Easton Anoxic Selector Basin into primary effluent splitter structure to split flow between the Satellite and Easton activated sludge systems. Install new piping from splitter structure to Satellite activated sludge system.

2. Replacement of Aeration Blowers and Automation of Air Piping Cross-Connection

Air for the activated sludge system is currently provided by eight 800 horsepower (hp) multi-stage centrifugal blowers with nominal capacities of 10,500 standard cubic feet per minute (scfm) each. The City currently operates only one or two of these blowers under normal conditions. During periods of low flow and load these blowers do not provide the desired turndown, resulting in high dissolved oxygen concentrations in the ML that is recycled to the anoxic zones. Newer blower technologies, such as high speed turbo blowers and single-stage centrifugal blower, are more energy efficient and would provide better turndown than the existing blowers.

Based on the projected 2040 maximum month loading conditions, 1.1 lb O_2/lb BOD, and 4.6 lb O_2/lb TKN, an estimated oxygen transfer efficiency of 16 percent, and a diurnal peaking factor of 1.5, the air required for the activated sludge system is approximately 38,600 scfm. This conservative estimate does not account for the oxygen recovered from the recycled ML. Based on the process modeling presented earlier, a total airflow of approximately 14,600 scfm (22,000 scfm with a 1.5 diurnal peaking factor) is required to maintain a dissolved oxygen concentration of 2.0 mg/L in the aerated zones of the MLE process under the projected 2040 maximum month loading conditions. Under the full permitted combined design loading conditions (influent BOD of 88,000 lbs/day and TKN of 21,050 lbs/day), the air required for the activated sludge system based on the theoretical oxygen demand is approximately 73,000 scfm, which is similar to the total installed blower capacity. The influent BOD loading under this condition is similar to what the influent load to the WWTPs would be if the anaerobic lagoon were offline.

It is recommended that four of the existing centrifugal blowers are replaced to improve energy efficiency and turndown while providing the oxygen for the simulated maximum month condition. For planning purposes, four 10,000 scfm high speed turbo blowers are included in the recommended plan. It is also recommended the remaining four multistage centrifugal blowers are maintained to provide the additional air required for the full permitted design loading condition or should the anaerobic lagoon be offline for a period. In addition, new blower controls based on dissolved oxygen are recommended in all activated sludge basins. Automation is also included for the cross-connection between the existing Easton and Satellite aeration systems to allow the two aeration systems to operate as a combined system.

3. Final Clarifier Mechanism Replacement

The recommended BNR improvements and WWTP consolidation will allow the City to better use the existing final clarifiers, which is anticipated to improve clarifier performance. However, the Satellite final clarifiers have been out of service for several years and it is anticipated that some work will be required to bring them back into service. In addition, City staff indicates that one of the Easton final clarifier mechanisms has become out of plumb and will likely require repair or replacement in the near future. Based on this, the recommended near-term improvements include a budgetary cost to replace two clarifier mechanisms. This cost is also anticipated to cover the cost of repairs should several clarifier mechanisms require less extensive repairs rather than full mechanism replacement.

4. Final Clarifier Cross-Connection and Flow Distribution Improvements

As discussed earlier, the Satellite and Easton activated sludge systems are completely separated, not allowing for final clarifiers to be used without using the associated activated sludge system. To improve clarifier capacity following WWTP consolidation, a cross-connection between the two systems upstream of the final clarifiers is recommended to provide the ability to transfer ML from the Satellite WWTP to the Easton WWTP. In addition, modifications to the existing final clarifier flow splitter boxes for both WWTPs are recommended to improve flow distribution and control. These splitter boxes, including the cross-connection piping and downward opening weir gate with ultrasonic flow measurement to control the transfer of ML from the Satellite WWTP to the Easton WWTP, would be extensions of the existing splitter boxes and ML recycle wet wells.

5. New Effluent Flow Metering Structure

Currently, secondary effluent from the Satellite and Easton WWTPs are measured separately using Parshall flumes at two different locations on-site. The existing Satellite secondary effluent flume is not adequately sized to measure the portion of the future combined WWTP flow that would be treated using the Satellite activated sludge tanks, requiring modifications to the existing means of effluent flow measurement. While the Easton secondary effluent flume is large enough to measure the portion of the future combined WWTP that would be treated using the Easton activated sludge system, it is not large enough to be used to measure the combined flows from the Easton and Satellite activated sludge systems. Therefore, the construction of a larger Parshall flume to measure the secondary effluent from both the Satellite and Easton activated sludge systems is proposed in the vicinity of the existing Easton effluent flume.

6. BFP Filtrate Equalization

Currently, the filtrate from the digested sludge dewatering process is discharged to a return flow pipe that discharges directly to the Easton influent pipe. As presented earlier, the return flows from the dewatering process are high in ammonia, which results in slug loads to the WWTP during dewatering operation. Furthermore, if BPR is implemented at the WWTP, the phosphorus content of the filtrate will increase significantly as more phosphorus is released in the anaerobic digesters. To reduce the impact of these slug loadings on the WWTP, a new filtrate equalization tank is recommended to store filtrate (or centrate) from the dewatering process and slowly return it to the head of the WWTP. This tank consists of a 0.25 MG below-grade concrete structure, which would provide storage for more than one day of filtrate, as well as a submersible pumping station to allow a controlled discharge of this filtrate to the head of the WWTP. For planning purposes, it is assumed that this equalization tank would be located near the Dewatering Building and the drain piping that carries the filtrate from the building would be modified to discharge to the equalization tank.

7. Expansion of WAS Storage

The existing WAS storage volume of approximately 269,000 gallons provides less than a day of storage based on the current average WAS rate of over 360,000 gallons per day. This requires WWTP staff to reduce wasting rates over the weekend when the GBTs are not operating, significantly limiting operational control. It is recommended that additional WAS storage is provided, so that the total storage volume will exceed three days of storage at the anticipated wasting rate. The existing WAS storage tanks are located adjacent to an old final clarifier that has been out of service since the Easton WWTP was constructed. Converting this final clarifier tank to WAS storage would provide an additional 1.2 MG. This would bring the total WAS storage volume to approximately 1.5 MG, or over four days of storage at the current WAS rate. Conversion of this final clarifier to WAS storage includes the following elements:

a. Demolition of existing clarifier mechanism and effluent trough. Abandon existing ML and secondary effluent piping to and from clarifier.

b. Addition of new WAS piping from WAS Building to WAS storage tanks.

c. Addition of new diffusers, aeration blower, and associated air piping.

d. Replacement of Thickener Feed Pumps.

e. Modifications to WAS and Thickener Feed Pump piping in WAS Building to allow pumping of WAS to and from new WAS Storage Tanks.

IMPLEMENTATION AND BUDGETARY CONSIDERATIONS

Because of the emergence of BNR technologies such as the sidestream enhanced biological phosphorus removal (EBPR) (*Alternative BNR3*) that are anticipated to result in significantly less chemical and energy use compared to CPR, a phased approach would allow further development and optimization of BNR at the WWTP at a lower operating cost than CPR. This approach would also provide flexibility to incorporate CPR.

In addition, the City has several planned projects to improve facility performance which will require the commitment of significant funds as noted below:

- WWTP Improvements Not Attributed to Nutrient Removal
  - Near Term Improvements (2018 to 2023): $18.5 million
  - Mid Term (2023-2028): $30 million
- Collection System Condition and Capacity Related Improvements:
  - 2018 to 2020: $15.1 million
  - 2021 to 2023: $22.3 million
  - 2024 to 2026: $16.6 million (pending further review)
  - 2027 to 2029: $ 12.6 million (pending further review)
  - 2030 to 2032: $6.4 million (pending further review)

Because of the significant capital funds already planned toward improving facility performance, a phased approach is appropriate to reduce the financial burden on the City's rate payers in the near future.

A. Near-Term Improvements–Demonstrate and Optimize BNR

Based on the capital and present worth cost evaluation presented in Table 28, Alternative BNR3 is the least costly alternative for enhanced nutrient removal. This is an emerging process that has shown promise for successful BPR for wastewaters that are carbon-limited for conventional BPR processes, but the ability to meet the City's nutrient targets cannot be predicted with current process models. Because of this, providing several years to implement and optimize the process as industry experience grows will allow the City to determine the potential for the process to achieve its effluent nutrient targets without significant chemical addition. The opinion of probable construction costs for the improvements necessary to implement nutrient removal at the WWTP are presented in Table 30. As mentioned earlier, approximately $18.5 million in additional near-term capital improvements have been identified to address other needs at the WWTP, including improvements to biosolids handling facilities and beneficial use of digester gas.

Component	Opinion of Probable Capital Cost
Equipment/Structures	
Preliminary and Primary Treatment Improvements; Raise Primary Clarifiers	$4,200,000
BNR3–MLE with Sidestream Enhanced BPR	$2,320,000
Blower replacement	$3,240,000
Final Clarifier Mechanism Replacement	$430,000
Final Clarifier cross connection and flow distribution improvements	$1,000,000
Return flow and secondary effluent metering	$430,000
Expansion of WAS Storage, replacement of WAS storage pumps and aeration system	$920,000
BFP Filtrate Equalization	$500,000
Piping and Mechanical	$4,790,000
Electrical	$2,850,000
Sitework	$890,000
HVAC	$760,000
Contractors' General Conditions	$2,230,000
Contingencies and Technical Services	$12,280,000
TOTAL OPINION OF CAPITAL COSTS	**$36,840,000**

Note: All costs are in 1st quarter 2018 dollars

Table 30 Recommended Near-Term Improvements for Nutrient Removal

B. Mid-Term Recommendations–Evaluate Struvite Recovery, Evaluate CPR if necessary

Following BNR optimization, it is recommended that the City evaluate the necessity and potential benefits of adding a process to recover struvite from the anaerobic digester sludge of filtrate/centrate. While the City does not currently experience nuisance struvite formation in its anaerobic digesters, successful implementation of BPR would increase the phosphorus content of the biosolids and potentially lead to the formation of struvite in the digester heating system, mixers, digester tanks, or downstream processes, including BFP filtrate equalization and pumping.

As presented earlier, struvite recovery is anticipated to improve phosphorus removal and may allow the City to achieve its nutrient reduction targets if they are not achieved by BPR alone. Further evaluation of the combination of sidestream EBPR and struvite recovery is recommended following implementation of Alternative BNR3. It is anticipated that the construction of a struvite recovery system would cost approximately $6 million assuming a sludge-based sequestration system and including technical services. Additional CPR should also be evaluated at this time.

SEWER BUDGET IMPACT

The total opinion of capital costs for the near-term improvements is approximately $55.3 million (1st Quarter 2018 dollar basis). Projecting this amount to an anticipated 4th Quarter 2019 bid date, and applying a construction inflation rate of 3 percent annually, the anticipated total project costs are approximately $58.3 million.

The WWTP improvements are anticipated to be financed through Iowa's State Revolving Fund (SRF) loan program. The SRF program provides 0 percent interest financing for planning and design services for up to three years that can be rolled into the SRF construction loan. Construction loans are offered at 1.75 percent interest, typically for 20-year terms. In addition to the 1.75 percent interest loan, an administrative fee of 0.25 percent is added each year to the outstanding principal balance for administering the loan. Also, an additional 0.5 percent of the loan amount (up to $100,000) is included as a loan initiation fee.

Assuming a total loan amount of $58.3 million, plus the initiation fee of $100,000, the annual debt service payment is expected to be approximately $3.6 million. If the digester gas utilization improvements are not included in the near-term project, the annual debt service payment is expected to decrease to approximately $3.2 million (total loan amount of $51.3 million in 4th Quarter 2019 dollars).

A preliminary analysis was conducted to estimate the impact of the near-term improvements on the WWTP budget. Although many components of the identified improvements are more energy efficient that current WWTP operation, particularly the replacement of the activated sludge blowers which can account for over half of the energy of the WWTP, this analysis was conducted assuming there would be no change in annual O&M costs. While the improvements would likely result in overall O&M savings, the assumptions used in this analysis provide a conservative estimate of the impact on the sewer budget. Table 31 presents a preliminary budget impact summary of the near-term improvements with and without the capital improvements necessary for the production of pipeline quality gas. A more detailed analysis of plant operation following the near-term improvements as well as a user charge study is recommended to further evaluate the impact on sewer user rates.

Component	Near-Term Improvements With Pipeline Quality Gas Improvements	Near-Term Improvements Without Pipeline Quality Gas Improvements
Opinion of Probable Capital Cost[1]	$58,300,000	$51,300,000
Anticipated Annual Debt Service Payment[2]	$3,600,000	$3,200,000
Annual Revenue from Digester Gas[3]	($1,200,000)	$0
Net Debt Service Payment	**$2,400,000**	**$3,200,000**

[1]4th Quarter 2019 Bid
[2]20-year loan at 1.75 percent interest, 0.25 percent administration fee, and $100,000 loan initiation fee
[3]Net revenue for Alternative DG2 as presented in Wastewater Facilities Plan

Table 31 WWTP Budget Impact Summary for Near-Term Improvements

The City conducted a preliminary analysis of the impact on sewer rates for the projects described in this report as presented in the next section.

FINANCIAL INFORMATION

Substantial rate increases would be required to implement the projects outlined in the Nutrient Reduction Study, in addition to the projects currently underway that are required by the Consent Decree. Projected rate increases to fund the additional required debt service are outlined below:

Fiscal Year	Additional Debt Service Required Annually	Rate Increase Required
FYE2021	$1,200,000	13%
FYE2022	$1,200,000	10%
FYE2023	$1,150,000	9%
FYE2024	$1,100,000	8%
FYE2025	$1,100,000	7%
FYE2026	$600,000	4%
Totals	$6,350,000	57%

These improvements would require rate increases totaling 51 percent over the six years of implementation. The City has a very diverse population. The sewer costs for the largest minority group would exceed 1.5 percent of median household income beginning in 2022 and could exceed it by as much as 36 percent by 2026.

The City has large industrial users that would be negatively impacted by these rate increases. If the largest user reduced their water/sewer use by 30 percent, the rate increases applied to all customers outlined above would need to double to cover the annual debt service payments. That would cause the sewer cost for all population groups to exceed 1.5 percent of median household income for all years.

Fiscal Year	Additional Debt Service Required Annually	Rate Increase Required
FYE2021	$1,200,000	26%
FYE2022	$1,200,000	20%
FYE2023	$1,150,000	18%
FYE2024	$1,100,000	16%
FYE2025	$1,100,000	14%
FYE2026	$600,000	8%
Totals	$6,350,000	114%

APPENDIX A
NPDES PERMIT

IOWA DEPARTMENT OF NATURAL RESOURCES

National Pollutant Discharge Elimination System (NPDES) Permit

OWNER NAME & ADDRESS	**FACILITY NAME & ADDRESS**
CITY OF WATERLOO 715 MULBERRY STREET WATERLOO, IA 50703	WATERLOO CITY OF STP 3505 EASTON AVENUE WATERLOO, IA 50702 Section 31, T89N, R12W Black Hawk County

IOWA NPDES PERMIT NUMBER: 0790001
DATE OF ISSUANCE: 04/01/2016
DATE OF EXPIRATION: 03/31/2021

YOU ARE REQUIRED TO FILE FOR RENEWAL OF THIS PERMIT BY: 10/02/2020
EPA NUMBER: IA0042650

This permit is issued pursuant to the authority of section 402(b) of the Clean Water Act (33 U.S.C 1342(b)), Iowa Code section 455B.174, and rule 567-64.3, Iowa Administrative Code. You are authorized to operate the disposal system and to discharge the pollutants specified in this permit in accordance with the effluent limitations, monitoring requirements and other terms set forth in this permit.

You may appeal any condition of this permit by filing a written notice of appeal and request for administrative hearing with the director of this department within 30 days of your receipt of this permit.

Any existing unexpired Iowa operation permit or Iowa NPDES permit previously issued by the department for the facility identified above is revoked by the issuance of this permit. This provision does not apply to any authorization to discharge under the terms and conditions of a general permit issued by the department or to any permit issued exclusively for the discharge of stormwater.

FOR THE DEPARTMENT OF NATURAL RESOURCES

By

Brandy Beavers
NPDES Section
ENVIRONMENTAL SERVICES DIVISION

Outfall No.: 001 EASTON AVENUE ACTIVATED SLUDGE WASTEWATER TREATMENT FACILITY.
Receiving Stream: CEDAR RIVER

Route of Flow: CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Waters designated Class HH are those in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

Outfall No.: 004 BYPASS LOCATED AT THE HACKETT ROAD LIFT STATION.

Receiving Stream: UNNAMED CREEK

Route of Flow: UNNAMED CREEK TO CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Outfall No.: 008 SATELLITE ACTIVATED SLUDGE WASTEWATER TREATMENT FACILITY.

Receiving Stream: CEDAR RIVER

Route of Flow: CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Waters designated Class HH are those in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

Outfall No.: 009 BYPASS AT SHORELINE OVERFLOW WHEN STREAM FLOW IS LESS THAN 8500 CFS (USGS GAGE 05464000)

Receiving Stream: CEDAR RIVER

Route of Flow: CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Waters designated Class HH are those in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

Outfall No.: 010 BYPASS AT EQUALIZATION BASIN OVERFLOW

Receiving Stream: CEDAR RIVER

Route of Flow: DRAINAGE DITCH TO CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Outfall No.: 011 TOTAL TREATMENT FACILITY SHORELINE DISCHARGE- STREAM FLOW IS GREATER THAN OR EQUAL

TO 8500 CFS (USGS GAGE 05464000)

Receiving Stream: CEDAR RIVER

Route of Flow: CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Waters designated Class HH are those in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

Outfall No.: 801 TOTAL TREATMENT FACILITY DIFFUSER DISCHARGE.

Receiving Stream: CEDAR RIVER

Route of Flow: CEDAR RIVER

Class A1 waters are primary contact recreational use waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risks of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Waters designated Class B(WW1) are those in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrates species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

Waters designated Class HH are those in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

Bypasses from any portion of a treatment facility or from a sanitary sewer collection system designed to carry only sewage are prohibited.

Effluent Limitations:

You are prohibited from discharging pollutants except in compliance with the following effluent limitations:

001 EASTON AVENUE ACTIVATED SLUDGE WASTEWATER TREATMENT FACILITY.

Outfall: 001 Effective Dates: 04/01/2016 to 03/31/2021			
Parameter	**Season**	**Limit Type**	**Limits**
TOTAL SUSPENDED SOLIDS			
	Yearly	7 Day Average	45 MG/L
	Yearly	30 Day Average	30 MG/L

008 SATELLITE ACTIVATED SLUDGE WASTEWATER TREATMENT FACILITY.

Outfall: 008 Effective Dates: 04/01/2016 to 03/31/2021			
Parameter	**Season**	**Limit Type**	**Limits**
TOTAL SUSPENDED SOLIDS			

	Yearly	7 Day Average	45 MG/L
	Yearly	30 Day Average	30 MG/L

011 TOTAL TREATMENT FACILITY SHORELINE DISCHARGE- STREAM FLOW IS GREATER THAN OR EQUAL TO 8500 CFS (USGS GAGE 05464000)

Outfall: 011 Effective Dates: 04/01/2016 to 03/31/2021			
Parameter	**Season**	**Limit Type**	**Limits**
BIOCHEMICAL OXYGEN DEMAND (BOD5)			**85% Removal Required**
	Yearly	7 Day Average	45 MG/L 13060 LBS/DAY
	Yearly	30 Day Average	30 MG/L 8707 LBS/DAY
TOTAL SUSPENDED SOLIDS			**85% Removal Required**
	Yearly	7 Day Average	13060 LBS/DAY
	Yearly	30 Day Average	8707 LBS/DAY
NITROGEN, TOTAL (AS N)			
	Yearly	30 Day Average	9285.5 LBS/DAY
	Yearly	Daily Maximum	15199.0 LBS/DAY
PH			
	Yearly	Daily Maximum	9.0 STD UNITS
	Yearly	Minimum	6.0 STD UNITS
E. COLI			
	MAR	Geometric Mean	126 #/100 ML
	APR	Geometric Mean	126 #/100 ML
	MAY	Geometric Mean	126 #/100 ML
	JUN	Geometric Mean	126 #/100 ML
	JUL	Geometric Mean	126 #/100 ML
	AUG	Geometric Mean	126 #/100 ML
	SEP	Geometric Mean	126 #/100 ML
	OCT	Geometric Mean	126 #/100 ML
	NOV	Geometric Mean	126 #/100 ML
ACUTE TOXICITY, CERIODAPHNIA			
	Yearly	Daily Maximum	1 NO TOXICITY
ACUTE TOXICITY, PIMEPHALES			
	Yearly	Daily Maximum	1 NO TOXICITY

Outfall: 011 Effective Dates: 04/01/2016 to 03/31/2021			
Parameter	**Season**	**Limit Type**	**Limits**
AMMONIA NITROGEN (N)			

	JAN	30 Day Average	104.2 MG/L	17791 LBS/DAY
	JAN	Daily Maximum	104.2 MG/L	17791 LBS/DAY
	FEB	30 Day Average	120.6 MG/L	20091 LBS/DAY
	FEB	Daily Maximum	120.6 MG/L	20091 LBS/DAY
	MAR	30 Day Average	88.6 MG/L	15404 LBS/DAY
	MAR	Daily Maximum	88.6 MG/L	15404 LBS/DAY
	APR	30 Day Average	66.5 MG/L	12343 LBS/DAY
	APR	Daily Maximum	66.5 MG/L	12343 LBS/DAY
	MAY	30 Day Average	65.8 MG/L	12146 LBS/DAY
	MAY	Daily Maximum	65.8 MG/L	12146 LBS/DAY
	JUN	30 Day Average	64.8 MG/L	10079 LBS/DAY
	JUN	Daily Maximum	64.8 MG/L	11864 LBS/DAY
	JUL	30 Day Average	73.0 MG/L	12696 LBS/DAY
	JUL	Daily Maximum	73.0 MG/L	13673 LBS/DAY
	AUG	30 Day Average	62.2 MG/L	11578 LBS/DAY
	AUG	Daily Maximum	62.2 MG/L	11846 LBS/DAY
	SEP	30 Day Average	76.5 MG/L	11693 LBS/DAY
	SEP	Daily Maximum	78.2 MG/L	14193 LBS/DAY
	OCT	30 Day Average	77.1 MG/L	13895 LBS/DAY
	OCT	Daily Maximum	77.1 MG/L	13895 LBS/DAY
	NOV	30 Day Average	65.1 MG/L	11956 LBS/DAY
	NOV	Daily Maximum	65.1 MG/L	11956 LBS/DAY
	DEC	30 Day Average	77.5 MG/L	13992 LBS/DAY
	DEC	Daily Maximum	77.5 MG/L	13992 LBS/DAY

801 TOTAL TREATMENT FACILITY DIFFUSER DISCHARGE.

Outfall: 801 Effective Dates: 04/01/2016 to 03/31/2021

Parameter	Season	Limit Type	Limits
BIOCHEMICAL OXYGEN DEMAND (BOD5)			**85% Removal Required**
	Yearly	7 Day Average	45 MG/L 13060 LBS/DAY
	Yearly	30 Day Average	30 MG/L 8707 LBS/DAY
TOTAL SUSPENDED SOLIDS			**85% Removal Required**
	Yearly	7 Day Average	13060 LBS/DAY
	Yearly	30 Day Average	8707 LBS/DAY
NITROGEN, TOTAL (AS N)			
	Yearly	30 Day Average	9285.5 LBS/DAY
	Yearly	Daily Maximum	15199.0 LBS/DAY
PH			
	Yearly	Daily Maximum	9.0 STD UNITS
	Yearly	Minimum	6.0 STD UNITS
E. COLI			
	MAR	Geometric Mean	126 #/100 ML
	APR	Geometric Mean	126 #/100 ML
	MAY	Geometric Mean	126 #/100 ML
	JUN	Geometric Mean	126 #/100 ML
	JUL	Geometric Mean	126 #/100 ML
	AUG	Geometric Mean	126 #/100 ML
	SEP	Geometric Mean	126 #/100 ML
	OCT	Geometric Mean	126 #/100 ML
	NOV	Geometric Mean	126 #/100 ML
ACUTE TOXICITY, CERIODAPHNIA			
	Yearly	Daily Maximum	1 NO TOXICITY
ACUTE TOXICITY, PIMEPHALES			

	Yearly	Daily Maximum	1 NO TOXICITY

Outfall: 801 Effective Dates: 04/01/2016 to 03/31/2021			
Parameter	**Season**	**Limit Type**	**Limits**
AMMONIA NITROGEN (N)			
	JAN	30 Day Average	46.5 MG/L 7708 LBS/DAY
	JAN	Daily Maximum	97.8 MG/L 16824 LBS/DAY
	FEB	30 Day Average	52.9 MG/L 8750 LBS/DAY
	FEB	Daily Maximum	112.9 MG/L 18934 LBS/DAY
	MAR	30 Day Average	23.2 MG/L 3868 LBS/DAY
	MAR	Daily Maximum	83.3 MG/L 14602 LBS/DAY
	APR	30 Day Average	16.2 MG/L 2733 LBS/DAY
	APR	Daily Maximum	62.9 MG/L 11801 LBS/DAY
	MAY	30 Day Average	13.7 MG/L 2306 LBS/DAY
	MAY	Daily Maximum	62.2 MG/L 11348 LBS/DAY
	JUN	30 Day Average	8.8 MG/L 1516 LBS/DAY
	JUN	Daily Maximum	50.5 MG/L 6791 LBS/DAY
	JUL	30 Day Average	10.7 MG/L 1751 LBS/DAY
	JUL	Daily Maximum	40.3 MG/L 5369 LBS/DAY
	AUG	30 Day Average	9.7 MG/L 1597 LBS/DAY
	AUG	Daily Maximum	44.1 MG/L 5892 LBS/DAY
	SEP	30 Day Average	10.2 MG/L 1738 LBS/DAY
	SEP	Daily Maximum	46.3 MG/L 6182 LBS/DAY
	OCT	30 Day Average	23.3 MG/L 3885 LBS/DAY
	OCT	Daily Maximum	72.7 MG/L 13233 LBS/DAY
	NOV	30 Day Average	29.1 MG/L 4853 LBS/DAY
	NOV	Daily Maximum	61.5 MG/L 11415 LBS/DAY
	DEC	30 Day Average	34.5 MG/L 5738 LBS/DAY
	DEC	Daily Maximum	73.1 MG/L 13330 LBS/DAY

Monitoring and Reporting Requirements

(a) Samples and measurements taken shall be representative of the volume and nature of the monitored wastewater.

(b) Analytical and sampling methods specified in 40 CFR Part 136 or other methods approved in writing by the department shall be utilized. Samples collected for operational testing need not be analyzed by approved analytical methods; however, commonly accepted test methods should be used.

(c) You are required to report all data including calculated results needed to determine compliance with the limitations contained in this permit. The results of any monitoring not specified in this permit performed at the compliance monitoring point and analyzed according to 40 CFR Part 136 shall be included in the calculation and reporting of any data submitted in accordance with this permit. This includes daily maximums and minimums and 30-day and 7-day averages for all parameters that have concentration (mg/l) and mass (lbs/day) limits. In addition, flow data shall be reported in million gallons per day (MGD).

(d) Results of all monitoring shall be recorded on forms provided by, or approved by, the department, and shall be submitted to the appropriate regional field office of the department by the fifteenth day following the close of the reporting period. Your reporting period is on a ANNUAL basis, ending on the last day of each reporting period.

(e) Any records of monitoring activities and results shall include for all samples: the date, exact place and time of the sampling; the dates the analyses were performed; who performed the analyses; the analytical techniques or methods used; and the results of such analyses.

(f) Chapter 63 of the Iowa Administrative Code contains further explanation of these monitoring requirements.

Outfall	**Wastewater Parameter**	**Sample Frequency**	**Sample Type**	**Monitoring Location**
The following monitoring requirements shall be in effect from 04/01/2016 to 03/31/2021				
001	BIOCHEMICAL OXYGEN DEMAND (BOD5)	7/WEEK OR DAILY	24 HOUR COMPOSITE	RAW WASTE
001	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	RAW WASTE
001	NITROGEN, TOTAL (AS N)	1 TIME PER WEEK	24 HOUR COMPOSITE	RAW WASTE
001	NITROGEN, TOTAL KJELDAHL (AS N)	1 EVERY 2 WEEKS	24 HOUR COMPOSITE	RAW WASTE
001	PH	7/WEEK OR DAILY	GRAB	RAW WASTE
001	PHOSPHORUS, TOTAL (AS P)	1 TIME PER WEEK	24 HOUR COMPOSITE	RAW WASTE
001	TEMPERATURE	7/WEEK OR DAILY	GRAB	RAW WASTE
001	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	24 HOUR COMPOSITE	RAW WASTE
001	CBOD5	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT PRIOR TO DISINFECTION
001	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT PRIOR TO DISINFECTION
001	SETTLEABLE SOLIDS	7/WEEK OR DAILY	GRAB	EFFLUENT AFTER FINAL CLARIFIER
001	ALKALINITY, TOTAL (AS CACO3)	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 6 CONTENTS
001	PH	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 6 CONTENTS
001	TEMPERATURE	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 6 CONTENTS
001	VOLATILE ACIDS	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 6 CONTENTS
001	ALKALINITY, TOTAL (AS CACO3)	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 5 CONTENTS
001	PH	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 5 CONTENTS
001	TEMPERATURE	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 5 CONTENTS
001	VOLATILE ACIDS	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 5 CONTENTS
001	ALKALINITY, TOTAL (AS CACO3)	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 4 CONTENTS
001	PH	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 4 CONTENTS
001	TEMPERATURE	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 4 CONTENTS
001	VOLATILE ACIDS	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 4 CONTENTS
001	ALKALINITY, TOTAL (AS CACO3)	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 3

				CONTENTS
001	PH	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 3 CONTENTS
001	TEMPERATURE	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 3 CONTENTS
001	VOLATILE ACIDS	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 3 CONTENTS

Outfall	Wastewater Parameter	Sample Frequency	Sample Type	Monitoring Location
The following monitoring requirements shall be in effect from 04/01/2016 to 03/31/2021				
001	ALKALINITY, TOTAL (AS CACO3)	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 2 CONTENTS
001	PH	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 2 CONTENTS
001	TEMPERATURE	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 2 CONTENTS
001	VOLATILE ACIDS	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 2 CONTENTS
001	ALKALINITY, TOTAL (AS CACO3)	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 1 CONTENTS
001	PH	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 1 CONTENTS
001	TEMPERATURE	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 1 CONTENTS
001	VOLATILE ACIDS	2 TIMES PER WEEK	GRAB	ANAEROBIC DIGESTER 1 CONTENTS
001	30-MINUTE SETTLEABILITY	5 TIMES PER WEEK	GRAB	AERATION BASIN 4 CONTENTS
001	DISSOLVED OXYGEN	5 TIMES PER WEEK	GRAB	AERATION BASIN 4 CONTENTS
001	SOLIDS, MIXED LIQUOR SUSPENDED	5 TIMES PER WEEK	GRAB	AERATION BASIN 4 CONTENTS
001	TEMPERATURE	5 TIMES PER WEEK	GRAB	AERATION BASIN 4 CONTENTS
001	30-MINUTE SETTLEABILITY	5 TIMES PER WEEK	GRAB	AERATION BASIN 3 CONTENTS
001	DISSOLVED OXYGEN	5 TIMES PER WEEK	GRAB	AERATION BASIN 3 CONTENTS
001	SOLIDS, MIXED LIQUOR SUSPENDED	5 TIMES PER WEEK	GRAB	AERATION BASIN 3 CONTENTS
001	TEMPERATURE	5 TIMES PER WEEK	GRAB	AERATION BASIN 3 CONTENTS
001	30-MINUTE SETTLEABILITY	5 TIMES PER WEEK	GRAB	AERATION BASIN 2 CONTENTS
001	DISSOLVED OXYGEN	5 TIMES PER WEEK	GRAB	AERATION BASIN 2 CONTENTS
001	SOLIDS, MIXED LIQUOR SUSPENDED	5 TIMES PER WEEK	GRAB	AERATION BASIN 2 CONTENTS
001	TEMPERATURE	5 TIMES PER WEEK	GRAB	AERATION BASIN 2 CONTENTS
001	30-MINUTE SETTLEABILITY	5 TIMES PER WEEK	GRAB	AERATION BASIN 1 CONTENTS
001	DISSOLVED OXYGEN	5 TIMES PER WEEK	GRAB	AERATION BASIN 1 CONTENTS
001	SOLIDS, MIXED LIQUOR SUSPENDED	5 TIMES PER WEEK	GRAB	AERATION BASIN 1 CONTENTS
001	TEMPERATURE	5 TIMES PER WEEK	GRAB	AERATION BASIN 1 CONTENTS

Outfall	Wastewater Parameter	Sample Frequency	Sample Type	Monitoring Location
The following monitoring requirements shall be in effect from 04/01/2016 to 03/31/2021				
008	BIOCHEMICAL OXYGEN DEMAND (BOD5)	7/WEEK OR DAILY	24 HOUR COMPOSITE	RAW WASTE
008	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	RAW WASTE
008	NITROGEN, TOTAL (AS N)	1 TIME PER WEEK	24 HOUR COMPOSITE	RAW WASTE
008	NITROGEN, TOTAL KJELDAHL (AS N)	1 EVERY 2 WEEKS	24 HOUR COMPOSITE	RAW WASTE
008	PH	7/WEEK OR DAILY	GRAB	RAW WASTE
008	PHOSPHORUS, TOTAL (AS P)	1 TIME PER WEEK	24 HOUR COMPOSITE	RAW WASTE
008	TEMPERATURE	7/WEEK OR DAILY	GRAB	RAW WASTE

008	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	24 HOUR COMPOSITE	RAW WASTE
008	CBOD5	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT PRIOR TO DISINFECTION
008	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT PRIOR TO DISINFECTION
008	SETTLEABLE SOLIDS	7/WEEK OR DAILY	GRAB	EFFLUENT AFTER FINAL CLARIFIER
008	30-MINUTE SETTLEABILITY	5 TIMES PER WEEK	GRAB	AERATION BASIN 2 CONTENTS
008	DISSOLVED OXYGEN	5 TIMES PER WEEK	GRAB	AERATION BASIN 2 CONTENTS
008	SOLIDS, MIXED LIQUOR SUSPENDED	5 TIMES PER WEEK	GRAB	AERATION BASIN 2 CONTENTS
008	TEMPERATURE	5 TIMES PER WEEK	GRAB	AERATION BASIN 2 CONTENTS
008	30-MINUTE SETTLEABILITY	5 TIMES PER WEEK	GRAB	AERATION BASIN 1 CONTENTS
008	DISSOLVED OXYGEN	5 TIMES PER WEEK	GRAB	AERATION BASIN 1 CONTENTS
008	SOLIDS, MIXED LIQUOR SUSPENDED	5 TIMES PER WEEK	GRAB	AERATION BASIN 1 CONTENTS
008	TEMPERATURE	5 TIMES PER WEEK	GRAB	AERATION BASIN 1 CONTENTS

Outfall	Wastewater Parameter	Sample Frequency	Sample Type	Monitoring Location
The following monitoring requirements shall be in effect from 04/01/2016 to 03/31/2021				
011	ACUTE TOXICITY, CERIODAPHNIA	1 EVERY 12 MONTHS	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
011	ACUTE TOXICITY, PIMEPHALES	1 EVERY 12 MONTHS	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
011	AMMONIA NITROGEN (N)	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
011	BIOCHEMICAL OXYGEN DEMAND (BOD5)	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
011	E. COLI	1 TIME PER WEEK	GRAB	EFFLUENT AFTER DISINFECTION
011	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	EFFLUENT AFTER DISINFECTION
011	NITROGEN, TOTAL (AS N)	1 TIME PER WEEK	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
011	PH	7/WEEK OR DAILY	GRAB	EFFLUENT AFTER DISINFECTION
011	PHOSPHORUS, TOTAL (AS P)	1 TIME PER WEEK	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
011	TEMPERATURE	7/WEEK OR DAILY	GRAB	EFFLUENT AFTER DISINFECTION
011	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION

Outfall	Wastewater Parameter	Sample Frequency	Sample Type	Monitoring Location
The following monitoring requirements shall be in effect from 04/01/2016 to 03/31/2021				
801	STREAM FLOW	7/WEEK OR DAILY	MEASUREMENT	CEDAR RIVER AT USGS STREAM GAGE 05464000
801	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	FLOW EQUALIZATION BASIN RETURN
801	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	FLOW EQUALIZATION BASIN OVERFLOW TO SATELLITE PLANT
801	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	SPLIT FLOW EFFLUENT
801	BIOCHEMICAL OXYGEN DEMAND (BOD5)	7/WEEK OR DAILY	CALCULATED	RAW WASTE
801	FLOW	7/WEEK OR DAILY	CALCULATED	TOTAL RAW WASTE FLOW
801	NITROGEN, TOTAL (AS N)	1 TIME PER WEEK	CALCULATED	RAW WASTE
801	NITROGEN, TOTAL KJELDAHL (AS N)	1 EVERY 2 WEEKS	CALCULATED	RAW WASTE
801	PHOSPHORUS, TOTAL (AS P)	1 TIME PER WEEK	CALCULATED	RAW WASTE
801	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	CALCULATED	RAW WASTE
801	ACUTE TOXICITY, CERIODAPHNIA	1 EVERY 12 MONTHS	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	ACUTE TOXICITY, PIMEPHALES	1 EVERY 12 MONTHS	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION

801	AMMONIA NITROGEN (N)	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	BATHYMETRIC REPORT	ONCE PER PERMIT CYCLE	MEASUREMENT	INSTREAM EFFLUENT DIFFUSER
801	BIOCHEMICAL OXYGEN DEMAND (BOD5)	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	DIFFUSER VALIDATION REPORT	1 EVERY 12 MONTHS	VISUAL	INSTREAM EFFLUENT DIFFUSER
801	E. COLI	1 TIME PER WEEK	GRAB	EFFLUENT AFTER DISINFECTION
801	FLOW	7/WEEK OR DAILY	24 HOUR TOTAL	EFFLUENT AFTER DISINFECTION
801	NITROGEN, TOTAL (AS N)	1 TIME PER WEEK	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	PH	7/WEEK OR DAILY	GRAB	EFFLUENT AFTER DISINFECTION
801	PHOSPHORUS, TOTAL (AS P)	1 TIME PER WEEK	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	TEMPERATURE	7/WEEK OR DAILY	GRAB	EFFLUENT AFTER DISINFECTION
801	TOTAL SUSPENDED SOLIDS	7/WEEK OR DAILY	24 HOUR COMPOSITE	EFFLUENT AFTER DISINFECTION
801	VISUAL OBSERVATION	1 EVERY MONTH	VISUAL	INSTREAM EFFLUENT DIFFUSER

Special Condition

From **April 1, 2016 until March 31, 2017,** the facility may choose to collect the samples stated in the table below at a frequency of **3/week on non-consecutive days**. After March 31, 2017 all effluent sampling frequencies are required at the frequencies listed on pages 11-14 of this permit.

Outfall	Wastewater Parameter	Monitoring Location
001	BIOCHEMICAL OXYGEN DEMAND (BOD5)	RAW WASTE
001	TOTAL SUSPENDED SOLIDS	RAW WASTE
001	BIOCHEMICAL OXYGEN DEMAND (BOD5)	EFFLUENT PRIOR TO DISINFECTION
001	TOTAL SUSPENDED SOLIDS	EFFLUENT PRIOR TO DISINFECTION
001	SETTLEABLE SOLIDS	EFFLUENT AFTER FINAL CLARIFIER
008	BIOCHEMICAL OXYGEN DEMAND (BOD5)	RAW WASTE
008	TOTAL SUSPENDED SOLIDS	RAW WASTE
008	BIOCHEMICAL OXYGEN DEMAND (BOD5)	EFFLUENT PRIOR TO DISINFECTION
008	TOTAL SUSPENDED SOLIDS	EFFLUENT PRIOR TO DISINFECTION
008	SETTLEABLE SOLIDS	EFFLUENT AFTER FINAL CLARIFIER
011	AMMONIA NITROGEN (N)	EFFLUENT AFTER DISINFECTION
011	BIOCHEMICAL OXYGEN DEMAND (BOD5)	EFFLUENT AFTER DISINFECTION
011	TOTAL SUSPENDED SOLIDS	EFFLUENT AFTER DISINFECTION
801	BIOCHEMICAL OXYGEN DEMAND (BOD5)	RAW WASTE
801	TOTAL SUSPENDED SOLIDS	RAW WASTE
801	AMMONIA NITROGEN (N)	EFFLUENT AFTER DISINFECTION

801	BIOCHEMICAL OXYGEN DEMAND (BOD5)	EFFLUENT AFTER DISINFECTION
801	TOTAL SUSPENDED SOLIDS	EFFLUENT AFTER DISINFECTION

Special Monitoring Requirements

Outfall # Description

011, 801 **AMMONIA NITROGEN (N)**

Ammonia shall be sampled and analyzed using an EPA approved method specified in 40 CFR 136 or using the Timberline Method Ammonia-001 alternative test procedure.

BIOCHEMICAL OXYGEN DEMAND (BOD5)

All BOD5 samples must be seeded at the laboratory prior to analysis when the disinfection equipment is in use.

E. COLI

The limit for E. coli of 126 org/100 ml specified on the limits pages of this permit for outfall(s) 801, 009 and 011 is a monthly geometric mean. The disinfection season is established in the Iowa Administrative Code, Subparagraph 567 IAC 61.3(3)"a"(1), and is in effect from March 15 to November 15. Any disinfection system (chlorine, UV light, etc.) shall be operated to comply with the limit during the entire disinfection season whenever wastewater is being discharged from outfall(s) 801, 009 and 011.

The facility must collect and analyze a minimum of a weekly sample from March 15 to November 15. The collection of weekly samples will result in a minimum of 35 samples being collected during a calendar year.

The following requirements apply to the individual samples collected in one calendar month:
There must be a minimum of two days between each sample.
No more than two samples may be collected in a period of seven consecutive days.

If the effluent has been disinfected using chlorine, ultraviolet light (UV), or any other process intended to disrupt the biological integrity of the E. coli, the samples shall be analyzed using the Most Probable Number method found in Standard Method 9223B (Colilert® or Colilert-18® made by IDEXX Laboratories, Inc.). If the effluent has not been disinfected the samples may be analyzed using either the MPN method above or EPA Method 1603: Escherichia coli (E. coli) in water by membrane filtration using modified membrane-thermotolerant E. coli agar (modified mTEC) or mColiBlue-24® made by the Hach Company.

The geometric mean must be calculated using all valid sample results collected during a month. The geometric mean formula is as follows: Geometric Mean = (Sample one * Sample two * Sample three * Sample four *Sample five… Sample N)^(1/N), which is the Nth root of the result of the multiplication of all of the sample results where N = the number of samples. If a sample result is a less than value, the value reported by the lab without the less than sign should be used in the geometric mean calculation.

The geometric mean can be calculated in one of the following ways:
Use a scientific calculator that can calculate the powers of numbers.
Enter the samples in Microsoft Excel and use the function "GEOMEAN" to perform the calculation.
Use the geometric mean calculator on the Iowa DNR webpage at:
http://www.iowadnr.gov/InsideDNR/RegulatoryWater/NPDESWastewaterPermitting/NPDESOperatorInformation/BacteriaSampling.aspx.

TOTAL NITROGEN

Total nitrogen shall be determined by testing for Total Kjeldahl Nitrogen (TKN) and nitrate + nitrite nitrogen and reporting the sum of the TKN and nitrate + nitrite results (reported as N). Nitrate + nitrite can be analyzed together or separately.

801 **RAW WASTE FLOW**

Raw flow shall be calculated as the sum of the 24 hour totals from the Easton Ave facility and the Satellite facility.

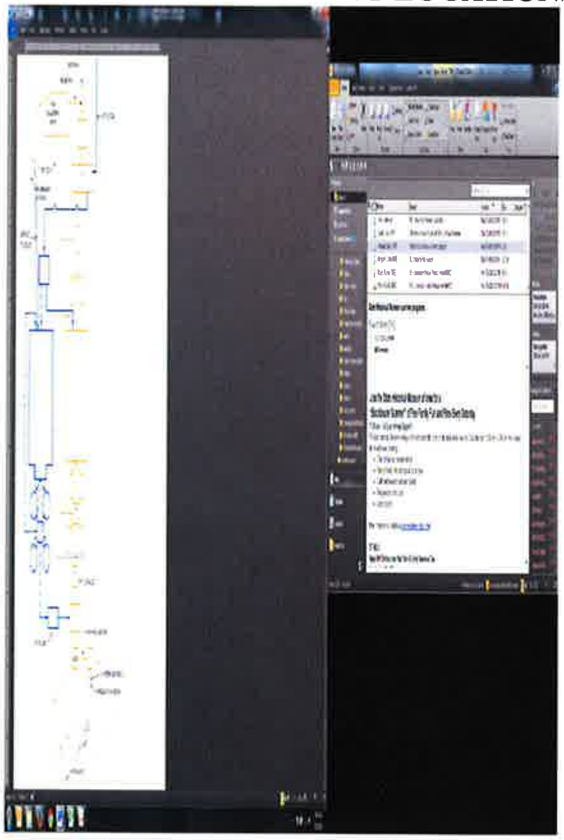
RAW WASTE: BOD5, TSS, TP, TN, TKN

Samples are required at each influent line to determine the mass loadings from each line. The total influent load to the treatment facility shall then be calculated and reported under outfall 801.

STREAM FLOW

A daily minimum value shall be reported.

OUTFALL AND SAMPLING LOCATIONS



Blending Mode of Operation

<u>This alternative mode of operation will be authorized on a temporary basis for the one permit cycle and is not subject to extension past March 31, 2021.</u>

The City of Waterloo may operate their wastewater treatment plant in the following mode during peak influent flow conditions only.

Influent flows that exceed the hydraulic capacity of the Easton Avenue plant are diverted to two-flow equalization basins (FEQ) after passing through grit removal. Flows stored in the FEQ basins are returned to the Easton Wet Well once the Easton Avenue plant regains hydraulic capacity. In the event that the Easton Avenue plant has yet to regain hydraulic capacity, the flow from the FEQ will be diverted to the Satellite plant. The flows from the FEQ will be routed through the Satellite plant and returned to the headworks of the Easton Avenue plant via portable pumps. If the biological system at the Easton Avenue Plant could be jeopardized due to excessive flows, the partially treated wastewater from the Satellite plant will be diverted to the disinfection chamber and blended with the final effluent from the Easton plant. Once the Easton Avenue plant regains hydraulic capacity the facility is no longer authorized to blend the FEQ overflow via the Satellite plant.

Effluent limits and permit conditions remain in effect during this mode of operation.

Outfall Number: 011, 801

Ceriodaphnia and Pimephales Toxicity Effluent Testing

1. For facilities that have not been required to conduct toxicity testing by a previous NPDES permit, the initial annual toxicity test shall be conducted within three (3) months of permit issuance. For facilities that have been required to conduct toxicity testing by a previous NPDES permit, the initial annual toxicity test shall be conducted within twelve months (12) of the last toxicity test.

2. The test organisms that are to be used for acute toxicity testing shall be Ceriodaphnia dubia and Pimephales promelas. The acute toxicity testing procedures used to demonstrate compliance with permit limits shall be those listed in 40 CFR Part 136 and adopted by reference in rule 567--63.1(1). The method for measuring acute toxicity is specified in USEPA, October 2002, Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition. U.S. Environmental Protection Agency, Office of Water, Washington, D.C., EPA 821-R-02-012.

3. The diluted effluent sample must contain a minimum of 12.40 % effluent and no more than 87.60 % of culture water.

4. One valid positive toxicity result will require, at a minimum, quarterly testing for effluent toxicity until three successive tests are determined not to be positive.

5. Two successive valid positive toxicity results or three positive results out of five successive valid effluent toxicity tests will require a toxicity reduction evaluation to be completed to eliminate the toxicity.

6. A non-toxic test result shall be indicated as a "1" on the monthly operation report. A toxic test result shall be indicated as a "2" on the monthly operation report. DNR Form 542-1381 shall also be submitted to the DNR field office along with the monthly operation report.

Ceriodaphnia and Pimephales Toxicity Effluent Limits

The maximum limit of "1" for the parameters Acute Toxicity, Ceriodaphnia and Acute Toxicity, Pimephales means no positive toxicity results.

Definition: "Positive toxicity result" means a statistical difference of mortality rate between the control and the diluted effluent sample. For more information see USEPA, October 2002, Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition, U.S. Environmental Protection Agency, Office of Water, Washington, D.C., EPA 821-R-02-012.

Design Capacity

Design:

Easton Avenue WPCF

The design capacity for the treatment works is specified in Construction Permit Number 98-361-S, issued August 21, 1998.
The treatment plant is designed to treat:
* An average dry weather (ADW) flow of 12.7 Million Gallons Per Day (MGD).
* An average wet weather (AWW) flow of 26.7 Million Gallons Per Day (MGD).
* A maximum wet weather (MWW) flow of 36.0 Million Gallons Per Day (MGD).
* A design 5-day biochemical oxygen demand (BOD5) load of 30,000 lbs/day.
* A design Total Kjeldahl Nitrogen (TKN) load of 7,500.00 lbs/day.

Satellite WPCF
The design capacity for the treatment works is specified in Construction Permit Number 95-317-S, issued July 7, 1995.
The treatment plant is designed to treat:
* An average dry weather (ADW) flow of 5.3 Million Gallons Per Day (MGD).
* An average wet weather (AWW) flow of 8.1 Million Gallons Per Day (MGD).
* A maximum wet weather (MWW) flow of 11.1 Million Gallons Per Day (MGD).
* A design 5-day biochemical oxygen demand (BOD5) load of 58,000 lbs/day.
* A design Total Kjeldahl Nitrogen (TKN) load of 13,550.00 lbs/day.

Operator Certification Type/Grade: WW/IV

Wastes in such volumes or quantities as to exceed the design capacity of the treatment works or reduce the effluent quality below that specified in the operation permit of the treatment works are considered to be a waste which interferes with the operation or performance of the treatment works and are prohibited by rule IAC 567-62.1(7).

SEWAGE SLUDGE HANDLING AND DISPOSAL REQUIREMENTS

"Sewage sludge" is solid, semisolid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge does not include the grit and screenings generated during preliminary treatment.

1. The permittee shall comply with all existing Federal and State laws and regulations that apply to the use and disposal of sewage sludge and with technical standards developed pursuant to Section 405(d) of the Clean Water Act when such standards are promulgated. If an applicable numerical limit or management practice for pollutants in sewage sludge is promulgated after issuance of this permit that is more stringent than a sludge pollutant limit or management practice specified in existing Federal or State laws or regulations, this permit shall be modified, or revoked and reissued, to conform to the regulations promulgated under Section 405(d) of the Clean Water Act. The permittee shall comply with the limitation no later than the compliance deadline specified in the applicable regulations.

2. The permittee shall provide written notice to the Department of Natural Resources prior to any planned changes in sludge disposal practices.

3. Land application of sewage sludge shall be conducted in accordance with criteria established in rule IAC 567--67.1 through 67.11 (455B).

Diffuser Special Monitoring Requirements

Monthly Visual Monitoring:

At a frequency of at least once per month, the permittee shall visually observe the diffuser and record the observations in a log book. The permittee is required to visually observe and record the following items:

- Whether the diffuser and diffuser ports can been seen above or below the surface of the water;
- Whether the effluent dispersion pattern of the ports can be seen, and whether the patterns are uniform;
- Signs of non-uniform bubbling, uneven coloring or actual spraying of effluent above the water surface;
- Debris or materials that have collected on or may be obstructing the diffuser;
- General structural condition of the diffuser, diffuser ports, and protective materials;
- Condition of the shoreline outfall 00X; and
- Actions taken, if applicable (i.e. corrective/ maintenance measures, adjustments of ports, removal of debris, etc.)

The log book entries shall be made available to the Department upon request. The permittee will indicate completion of the visual monitoring by entering a "1" in the Visual Observation column on the day that the visual monitoring was completed on the Discharge Monitoring Report (DMR) spreadsheet.

Annual Diffuser Performance Analysis:

Minimum Requirements: Annually, by April 1, the permittee is required to submit a Diffuser Performance Analysis report to the Department at both of the addresses shown below. The annual diffuser analysis should be performed at a stream flow as close as possible to stream critical low flow conditions. The annual diffuser performance analysis should identify if all diffuser ports, that were active when the mixing zone percentage used in the current NPDES permit was established, are functioning properly. The annual diffuser performance analysis should also assess if rapid mixing is occurring within 100 feet downstream of the active diffuser ports with the stream flow as close as possible to critical low flow conditions.

The dye used in the Diffuser Performance Analysis shall meet the following requirements:

1) The Diffuser Performance Analysis shall use one of the following dyes:
   (a) Rhodamine WT dye
   (b) FWT red dye tablets
   (c) FLT Yellow/Green Liquid Concentrate dye
   (d) Green Sewer Tracing Dye
   (e) Fluorescent FLT Yellow/Green Powder
   (f) Bright Dye FWT Red Dye
   (g) FLT Yellow/Green dye tablets

   If a dye other than one listed above is used, you must obtain permission from the Department prior to use of the dye. Please contact Connie Dou at (515) 725-8400 or connie.dou@dnr.iowa.gov to request approval of dyes other than those listed above.
2) The dye shall be used according to the instructions provided by the manufacturer; and
3) The introduction of the dye into the receiving stream shall be limited to as short a time period as possible and the amount of dye used shall be as little as possible.

Video and/or pictures of the demonstration should be sent along with the diffuser analysis performance report to both addresses shown below.

The Diffuser Performance Analysis report shall describe any proposed location or discharge flow adjustments to the diffuser ports intended to comply with the designed operation of the diffuser. Any video and/or pictures of the demonstration should be included in the report. The permittee will indicate submittal of the Diffuser Performance Analysis report by entering a "1" in the Diffuser Performance Analysis column on the Discharge Monitoring Report (DMR) spreadsheet on the day that the report is submitted. Select the No Discharge Indicator "NOT REQUIRED/MP" on the DMR spreadsheet during the months that the report is not required.

Additional Requirements: The Department will review the Diffuser Performance Analysis report. If the analysis does not show rapid and complete mixing of the effluent, you shall be notified of the requirement to submit a plan to correct diffuser deficiencies. The plan to correct the deficiencies shall be submitted to the Field Office address within 60 days of Department notification. If, after the submittal of a plan to correct deficiencies, the subsequent Diffuser Performance Analysis report does not show rapid and complete mixing of the effluent, the facility shall comply with the limits for Outfall *{insert bank discharge outfall number}*.

Bathymetric Analysis:

Minimum Requirements: By **April 1, 2020**, the permittee is required to perform a Bathymetric Analysis and submit a Bathymetric Analysis report to the Department at both of the addresses below. The bathymetric features shall be determined by measuring the receiving stream depth at a minimum of twenty (20) equidistant intervals across the entire width of the receiving stream at the location of the diffuser. The Bathymetric Analysis report shall characterize the bathymetric features and include clear documentation of the receiving stream cross section, diffuser location, and stream bottom substrate. The permittee will indicate submittal of the Bathymetric Analysis Report by entering a "1" in the Bathymetric Report column of the DMR spreadsheet on the day that the report was submitted. Select the No Discharge Indicator "NOT REQUIRED/MP" on the DMR spreadsheet during the months that the report is not required.

- Hydrologic Events: In addition, a Bathymetric Analysis must be performed if significant changes to the stream channel occur as a result of hydrologic events (such as flooding, stream channelization, reconstruction, etc.) A report of this analysis must be submitted to the Department at both of the addresses below within sixty (60) days of the event occurrence. If the Bathymetric Analysis shows that the changes to the receiving stream may alter the mixing achieved by the diffuser, a Diffuser Performance Analysis must also be performed to demonstrate the actual mixing achieved by the diffuser. Modeling of the mixing zone may be used to perform the Diffuser Performance Analysis, with Department approval, if the receiving stream does not reach low flow conditions within four (4) months of the hydrologic event. The Diffuser Performance Analysis report must be submitted to the Department at both of the addresses below within ninety (90) days of the hydrologic event occurrence. A Diffuser Performance Analysis performed as a result of a hydrologic event will fulfill the annual report requirement for that year.

Diffuser Mixing Zone Study Requirements

The effluent limits in this permit are based on the percent mixing capability of your diffuser. The current assumed percent mixing for your facility's diffuser is 73%. A mixing zone study shall be submitted with the permit renewal application to confirm the assumed percent mixing. If no such study is completed, effluent limits in the renewal permit will be based on default mixing.

The permittee is authorized to conduct a mixing zone study under the following conditions:

1) The mixing zone study shall use one of the following dyes:
   a) Rhodamine WT dye
   b) FWT red dye tablets
   c) FLT Yellow/Green Liquid Concentrate dye
   d) Green Sewer Tracing Dye
   e) Fluorescent FLT Yellow/Green Powder
   f) Bright Dye FWT Red Dye
   g) FLT Yellow/Green dye tablets

   If a dye other than one listed above is used, you must obtain permission from the Department prior to use of the dye. Please contact Connie Dou at (515) 281-3350 or connie.dou@dnr.iowa.gov for approval of dyes other than those listed above.
2) The dye shall be used according to the instructions provided by the manufacturer.
3) The introduction of the dye into the receiving stream shall be limited to as short a time period as possible and the amount of dye used shall be as little as possible.
4) The mixing zone study shall be conducted during low river flow conditions and it shall follow the DNR Mixing Zone Study Guidelines.
5) The mixing zone study report shall include clear documentation of the mixing characteristics and the percentages of the total river flows in the mixing zone.
6) The following restrictions to the maximum allowed mixing zone shall be recorded in the mixing zone study documentation:
   a) The distance to the juncture of two perennial streams.
   b) The distance to a public water supply intake.
   c) The distance to the upstream limits of an established recreational area, such as public beaches, and state, county and local parks.
   d) The distance to the middle of a crossover point in a stream where the main current flows from one bank across to the opposite bank.
7) The distance to another mixing zone. The mixing zone does not exceed a distance of 100 feet.

The DNR Field Office at least 48 hours prior to the use of dye.

Addresses for Report Submittal:

Iowa Department of Natural Resources	Iowa Department of Natural Resources
Environmental Services Division	502 E. 9th Street
DNR Field Office	Des Moines, IA 50319

SIGNIFICANT INDUSTRIAL USER LIMITATIONS, MONITORING AND REPORTING REQUIREMENTS

1. You shall require all users of your facility to comply with Sections 204(b), 307, and 308 of the Clean Water Act.

   Section 204(b) requires that all users of the treatment works constructed with funds provided under Sections 201(g) or 601 of the Act to pay their proportionate share of the costs of operation, maintenance and replacement of the treatment works.

Section 307 of the Act requires users to comply with pretreatment standards promulgated by EPA for pollutants that would cause interference with the treatment process or would pass through the treatment works.

Section 308 of the Act requires users to allow access at reasonable times to state and EPA inspectors for the purpose of sampling the discharge, reviewing, and copying records.

2. You shall continue to implement the pretreatment program approved March 14, 1984 and any amendments thereto.

3. An annual report in the form prescribed by the Department is to be submitted by March 1st of each year describing the pretreatment program activities for the preceding calendar year.

4. The City shall evaluate the adequacy of its local limits to meet the general prohibitions against interference and pass through listed in 40 CFR 403.5(a) and the specific prohibitions listed in 40 CFR 403.5(b). At a minimum this evaluation shall consist of the following:

(a) Identify each pollutant with the potential to cause process inhibition, pass through the treatment plant in concentrations that will violate NPDES permit limits of water quality standards, endanger POTW worker health and safety or degrade sludge quality.

(b) For each treatment plant, determine the maximum allowable headworks loading for each pollutant identified in item #4(a). that will prevent interference or a pass through.

(c) After accounting for the contribution of each pollutant from uncontrolled (i.e.: domestic/commercial) sources to each treatment plant, determine the maximum allowable industrial loading for each pollutant identified in item #4(a).

(d) Complete the evaluation and submit to the Department, by **April 1, 2017** a report containing the following information:

1) A list of pollutants identified in item #4(a). For each pollutant, state the reason(s) for its inclusion (e.g. potential to cause interference, potential to cause pass through, etc.).
2) The report shall contain all calculations used to determine the maximum allowable headworks loadings and shall identify the source(s) of all data used (e.g. literature value, site specific measurement, etc.).
3) The contribution of each pollutant identified in item #4(d)1 to each treatment plant from uncontrolled sources and an explanation of how each contribution was determined.
4) The allocation of the maximum allowable headworks loading for each pollutant to each treatment plant, and an explanation of how the

allowable loadings will be allocated to significant industrial users regulated by the City's pretreatment program.

5. The City shall evaluate the approved pretreatment program for compliance with 40 CFR 403 and Iowa Administrative Code 567 – Chapter 62, specifically with regards to the pretreatment streamlining rule published in the Federal Register on October 14, 2005. Complete the evaluation and submit to the Department a report containing the findings of the evaluation, including a proposal for modifications to correct any deficiencies that are identified, by **April 1, 2017.0**

2-4-14 ew/ ccsw

Nutrient Reduction Requirements

In support of the Iowa Nutrient Reduction Strategy you shall prepare and submit a report that evaluates the feasibility and reasonableness of reducing the amounts of nitrogen and phosphorus discharged into surface water. The report shall be submitted no later than **April 1, 2018** and shall address the following:

A description of the existing treatment facility with particular emphasis on its capabilities for removing nitrogen and phosphorus. The description shall include monitoring data that define the current amounts of total nitrogen (TKN+nitrate+nitrite) and total phosphorus in both the raw wastewater and the final effluent.

A description and evaluation of operational changes to the existing treatment facility that could be implemented to reduce the amounts of total nitrogen and total phosphorus discharged in the final effluent and the feasibility and reasonableness of each. Your evaluation must discuss the projected degree of total nitrogen and total phosphorus reduction achievable for each operational change. When evaluating feasibility you must consider what, if any, effect operational changes would have on the removal of other pollutants (e.g. $CBOD_5$, TSS). When evaluating reasonableness you shall include estimates of the additional cost, if any, to implement such changes and for a publicly-owned treatment works the impact on user rates.

A description and evaluation of new or additional treatment technologies that would achieve significant reductions in the amounts of total nitrogen and total phosphorus discharged in the final effluent with a goal of achieving annual average mass limits based on AWW design flow equivalent to concentrations of 10 mg/L total nitrogen and 1 mg/L total phosphorus for plants treating typical domestic strength sewage. For purposes of this evaluation typical domestic sewage is considered to contain approximately 25 – 35 mg/L total nitrogen and 4 - 8 mg/L total phosphorus. For plants treating wastewater with total nitrogen and/or total phosphorus concentrations greater than typical domestic strength sewage, the evaluation shall include the projected reductions in the total nitrogen and phosphorus effluent concentrations achievable with the application of feasible and reasonable treatment technology with a goal of achieving at least a 66 % reduction in nitrogen and 75% reduction in total phosphorus. For each treatment technology the report shall assess its feasibility, reasonableness, practicability, the availability of equipment, capital costs, annual operating costs, impact on user rates and any non-water quality environmental impacts (e.g. additional air pollution, increased sludge production, etc.).

Based on the evaluations of operational changes and new or additional treatment technologies the report must select the preferred method(s) for reducing total nitrogen and total phosphorus in the final effluent, the rationale for the selected method(s) and an estimate of the effluent quality achievable.

The report must include a schedule for making operational changes and/or installing new or additional treatment technologies to achieve the concentration and/or percentage removal goals listed above. Additional financial justification must be included in the report if no operational changes or treatment technologies are feasible or reasonable.

The schedule will be incorporated into the NPDES permit by amendment. Effluent discharge limits will be based on one full year of operating data after implementation of the operational changes or completion of plant modifications and a six month optimization period.

The report shall be sent to the following address:
Brandy Beavers
NPDES Section
Iowa Department of Natural Resources
502 East 9th Street
Des Moines, IA 50319

APPENDIX B
PRESENT WORTH ANALYSIS

City of Waterloo, Iowa
Wastewater Nutrient Reduction Study
Opinion of Present Worth Cost

Discount Rate 2.750%

Alternative BNR1a - A2O Process with BOD diversion from lagoon

ITEM	Initial Capital Cost	Future Capital Cost	Replacement Year	Replacement Cost (P.W.)	20-Year Salvage Value	Salvage Value (P.W.)
Satellite Aeration Tank Structural Modifications	$ 250,000	$ -	40	$ -	$ 130,000	$ 80,000
Baffle Walls - Anaerobic Zones	$ 230,000	$ -	40	$ -	$ 120,000	$ 70,000
Baffe Walls - Anoxic Zones	$ 230,000	$ -	40	$ -	$ 120,000	$ 70,000
Anaerobic/Anoxic Mixers	$ 480,000	$ -	20	$ -	$ -	$ -
Fine Bubble Diffusers	$ 600,000	$ 600,000	15	$ 400,000	$ 400,000	$ 230,000
Nitrate Recycle Pumps	$ 320,000	$ -	20	$ -	$ -	$ -
Lagoon Influent Structure Modifications	$ 100,000	$ -	40	$ -	$ 50,000	$ 30,000
Lagoon Influent Fermentation Tank and Appurtenances	$ 5,000,000		20		$ -	$ -
Chemical Storage Tank - CPR Backup	$ 80,000	$ -	20	$ -	$ -	$ -
Chemical Feed Systems	$ 60,000	$ 60,000	15	$ 40,000	$ 40,000	$ 20,000
Chemical Building	$ 250,000	$ -	40	$ -	$ 130,000	$ 80,000
Subtotal	$ 7,600,000	$ 660,000				
Piping and Mechanical (20%)	$ 1,520,000	$ -	40	$ -	$ 760,000	$ 440,000
HVAC (10%)	$ 760,000	$ -	20	$ -	$ -	$ -
Electrical (25%)	$ 1,900,000	$ -	20	$ -	$ -	$ -
Sitework (10%)	$ 760,000					
Subtotal	$ 12,540,000					
Contractor GCs (10%)	$ 1,260,000					
Total Construction Costs	$ 13,800,000					
Contingencies and Engineering Services (50%)	$ 6,900,000					
Total Capital Costs	$ 20,700,000			$ 440,000	$ 1,620,000	$ 940,000
Present Worth of Capital Costs	**$ 20,700,000**			$ 440,000		$ 940,000
Relative Labor ($40/hr)	$ 10,000					
Maintenance (~2% of equipment)	$ 20,000					
Power ($0.04/kWh)	$ 290,000					
Solids Disposal	$ 220,000					
Chemical Use	$ 60,000					
Total O&M Costs	$ 600,000					
Present Worth of O&M	**$ 9,140,000**					
Summary of Present Worth Costs						
Capital Cost	$ 20,700,000					
Replacement	$ 440,000					
O&M Cost	$ 9,140,000					
Salvage Value	$ (940,000)					
Total Present Worth	**$ 29,340,000**					
Alternative S3 - Satellite Bar Screen Building	**$ 5,470,000**					
Annual Lost Biogas Value	**$0-$990,000**					
Present Worth of Lost Biogas Revenue	**$0-$15,090,000**					
Alternative BNR1a + S3	**$ 34,810,000**					
With Biogas Value	**$34,810,000 - $49,900,000**					

City of Waterloo, Iowa
Wastewater Nutrient Reduction Study
Opinion of Present Worth Cost

Discount Rate 2.750%

Alternative BNR1b - A2O Process with VFA addition at WWTP

ITEM	Initial Capital Cost	Future Capital Cost	Replacement Year	Replacement Cost (P.W.)	20-Year Salvage Value	Salvage Value (P.W.)
Satellite Aeration Tank Structural Modifications	$ 250,000	$ -	40	$ -	$ 130,000	$ 80,000
Baffle Walls - Anaerobic Zones	$ 230,000	$ -	40	$ -	$ 120,000	$ 70,000
Baffe Walls - Anoxic Zones	$ 230,000	$ -	40	$ -	$ 120,000	$ 70,000
Anaerobic/Anoxic Mixers	$ 480,000	$ -	20	$ -	$ -	$ -
Fine Bubble Diffusers	$ 600,000	$ 600,000	15	$ 400,000	$ 400,000	$ 230,000
Nitrate Recycle Pumps	$ 320,000	$ -	20	$ -	$ -	$ -
Chemical Storage Tanks - CPR Backup and VFA	$ 750,000	$ -	20	$ -	$ -	$ -
Chemical Feed Systems	$ 60,000	$ 60,000	15	$ 40,000	$ 40,000	$ 20,000
Chemical Building	$ 2,500,000	$ -	40	$ -	$ 1,250,000	$ 730,000
Subtotal	$ 5,420,000	$ 660,000				
Piping and Mechanical (20%)	$ 1,090,000	$ -	40	$ -	$ 550,000	$ 320,000
HVAC (10%)	$ 550,000	$ -	20	$ -	$ -	$ -
Electrical (25%)	$ 1,360,000	$ -	20	$ -	$ -	$ -
Sitework (10%)	$ 550,000					
Subtotal	$ 8,970,000					
Contractor GCs (10%)	$ 900,000					
Total Construction Costs	$ 9,870,000					
Contingencies and Engineering Services (50%)	$ 4,940,000					
Total Capital Costs	$ 14,810,000			$ 440,000	$ 2,480,000	$ 1,440,000
Present Worth of Capital Costs	**$ 14,810,000**			$ 440,000		$ 1,440,000
Relative Labor ($40/hr)	$ 10,000					
Maintenance (~2% of equipment)	$ 20,000					
Power ($0.04/kWh)	$ 290,000					
Solids Disposal	$ 220,000					
Chemical Use	$ 2,200,000					
Total O&M Costs	$ 2,740,000					
Present Worth of O&M	**$ 41,720,000**					

Summary of Present Worth Costs

Capital Cost	$ 14,810,000
Replacement	$ 440,000
O&M Cost	$ 41,720,000
Salvage Value	$ (1,440,000)
Total Present Worth	**$ 55,530,000**

City of Waterloo, Iowa
Wastewater Nutrient Reduction Study
Opinion of Present Worth Cost

Discount Rate 2.750%

Alternative BNR1c - A2O Process with struvite harvesting; BOD diversion from lagoon

ITEM	**Initial Capital Cost**	**Future Capital Cost**	**Replacement Year**	**Replacement Cost (P.W.)**	**20-Year Salvage Value**	**Salvage Value (P.W.)**
Satellite Aeration Tank Structural Modifications	$ 250,000	$ -	40	$ -	$ 130,000	$ 80,000
Baffle Walls - Anaerobic Zones	$ 230,000	$ -	40	$ -	$ 120,000	$ 70,000
Baffe Walls - Anoxic Zones	$ 230,000	$ -	40	$ -	$ 120,000	$ 70,000
Anaerobic/Anoxic Mixers	$ 480,000	$ -	20	$ -	$ -	$ -
Fine Bubble Diffusers	$ 600,000	$ 600,000	15	$ 400,000	$ 400,000	$ 230,000
Nitrate Recycle Pumps	$ 320,000	$ -	20	$ -	$ -	$ -
Lagoon Influent Structure Modifications	$ 100,000	$ -	40	$ -	$ 50,000	$ 30,000
Lagoon Influent Fermentation Tank and Appurtenances	$ 5,000,000		20		$ -	$ -
Chemical Storage Tank - CPR backup	$ 80,000	$ -	20	$ -	$ -	$ -
Chemical Feed System	$ 60,000	$ 60,000	15	$ 40,000	$ 40,000	$ 20,000
Chemical Building	$ 250,000	$ -	40	$ -	$ 130,000	$ 80,000
Struvite Harvesting/Sequestration	$ 2,000,000	$ -	20	$ -	$ -	$ -
Subtotal	$ 9,600,000	$ 660,000				
Piping and Mechanical (20%)	$ 1,920,000	$ -	40	$ -	$ 960,000	$ 560,000
HVAC (10%)	$ 960,000	$ -	20	$ -	$ -	$ -
Electrical (25%)	$ 2,400,000	$ -	20	$ -	$ -	$ -
Sitework (10%)	$ 960,000					
Subtotal	$ 15,840,000					
Contractor GCs (10%)	$ 1,590,000					
Total Construction Costs	$ 17,430,000					
Contingencies and Engineering Services (50%)	$ 8,720,000					
Total Capital Costs	$ 26,150,000			$ 440,000	$ 1,820,000	$ 1,060,000
Present Worth of Capital Costs	**$ 26,150,000**			$ 440,000		$ 1,060,000

Relative Labor ($40/hr)	$ 20,000
Maintenance (~2% of equipment)	$ 30,000
Power ($0.04/kWh)	$ 300,000
Solids Disposal	$ 40,000
Chemical Use	$ 140,000
Total O&M Costs	$ 530,000
Present Worth of O&M	**$ 8,070,000**
Summary of Present Worth Costs	
Capital Cost	$ 26,150,000
Replacement	$ 440,000
O&M Cost	$ 8,070,000
Salvage Value	$ (1,060,000)
Total Present Worth	**$ 33,600,000**
Alternative S3 - Satellite Bar Screen Building	**$ 5,470,000**
Annual Lost Biogas Value	**$0-$283,000**
Present Worth of Lost Biogas Revenue	**$0-$4,310,000**
Alternative BNR1a + S3	**$ 39,070,000**
With Biogas Value	**$39,070,000-$43,380,000**

City of Waterloo, Iowa
Wastewater Nutrient Reduction Study
Opinion of Present Worth Cost

Discount Rate 2.750%

Alternative BNR1d - A2O Process with struvite harvesting; VFA addition at WWTP

ITEM	Initial Capital Cost	Future Capital Cost	Replacement Year	Replacement Cost (P.W.)	20-Year Salvage Value	Salvage Value (P.W.)
Satellite Aeration Tank Structural Modifications	$ 250,000	$ -	40	$ -	$ 130,000	$ 60,000
Baffle Walls - Anaerobic Zones	$ 230,000	$ -	40	$ -	$ 120,000	$ 70,000
Baffe Walls - Anoxic Zones	$ 230,000	$ -	40	$ -	$ 120,000	$ 70,000
Anaerobic/Anoxic Mixers	$ 480,000	$ -	20	$ -	$ -	$ -
Fine Bubble Diffusers	$ 600,000	$ 600,000	15	$ 400,000	$ 400,000	$ 230,000
Nitrate Recycle Pumps	$ 320,000	$ -	20	$ -	$ -	$ -
Chemical Storage Tanks - CPR backup and VFA	$ 300,000	$ -	20	$ -	$ -	$ -
Chemical Feed System	$ 60,000	$ 60,000	15	$ 40,000	$ 40,000	$ 20,000
Chemical Building	$ 1,250,000	$ -	40	$ -	$ 630,000	$ 370,000
Struvite Harvesting/Sequestration	$ 2,000,000	$ -	20	$ -	$ -	$ -
Subtotal	$ 5,720,000	$ 660,000				
Piping and Mechanical (20%)	$ 1,150,000	$ -	40	$ -	$ 580,000	$ 340,000
HVAC (10%)	$ 580,000	$ -	20	$ -	$ -	$ -
Electrical (25%)	$ 1,430,000	$ -	20	$ -	$ -	$ -
Sitework (10%)	$ 580,000					
Subtotal	$ 9,460,000					
Contractor GCs (10%)	$ 950,000					
Total Construction Costs	$ 10,410,000					
Contingencies and Engineering Services (50%)	$ 5,210,000					
Total Capital Costs	$ 15,620,000			$ 440,000	$ 1,890,000	$ 1,100,000
Present Worth of Capital Costs	**$ 15,620,000**			$ 440,000		$ 1,100,000
Relative Labor ($40/hr)	$ 20,000					
Maintenance (~2% of equipment)	$ 30,000					
Power ($0.04/kWh)	$ 300,000					
Solids Disposal	$ 40,000					
Chemical Use	$ 750,000					
Total O&M Costs	$ 1,140,000					
Present Worth of O&M	**$ 17,360,000**					
Summary of Present Worth Costs						
Capital Cost	$ 15,620,000					
Replacement	$ 440,000					
O&M Cost	$ 17,360,000					
Salvage Value	$ (1,100,000)					
Total Present Worth	**$ 32,320,000**					

City of Waterloo, Iowa
Wastewater Nutrient Reduction Study
Opinion of Present Worth Cost

Discount Rate 2.750%

Alternative BNR1e - A2O Process with struvite harvesting and PRS fermentation; BOD diversion from lagoon

ITEM	Initial Capital Cost	Future Capital Cost	Replacement Year	Replacement Cost (P.W.)	20-Year Salvage Value	Salvage Value (P.W.)
Satellite Aeration Tank Structural Modifications	$ 250,000	$ -	40	$ -	$ 130,000	$ 80,000
Baffle Walls - Anaerobic Zones	$ 230,000	$ -	40	$ -	$ 120,000	$ 70,000
Baffe Walls - Anoxic Zones	$ 230,000	$ -	40	$ -	$ 120,000	$ 70,000
Anaerobic/Anoxic Mixers	$ 480,000	$ -	20	$ -	$ -	$ -
Fine Bubble Diffusers	$ 600,000	$ 600,000	15	$ 400,000	$ 400,000	$ 230,000
Nitrate Recycle Pumps	$ 320,000	$ -	20	$ -	$ -	$ -
Lagoon Influent Structure Modifications	$ 100,000	$ -	40	$ -	$ 50,000	$ 30,000
Lagoon Influent Fermentation Tank and Appurtenances	$ 5,000,000		20		$ -	$ -
Chemical Storage Tank- CPR backup	$ 80,000	$ -	20	$ -	$ -	$ -
Chemical Feed System	$ 60,000	$ 60,000	15	$ 40,000	$ 40,000	$ 20,000
Chemical Building	$ 250,000	$ -	40	$ -	$ 130,000	$ 80,000
Primary Sludge Fermenter	$ 1,600,000		20	$ -	$ -	$ -
Struvite Harvesting/Sequestration	$ 2,000,000	$ -	20	$ -	$ -	$ -
Subtotal	$ 11,200,000	$ 660,000				
Piping and Mechanical (20%)	$ 2,240,000	$ -	40	$ -	$ 1,120,000	$ 650,000
HVAC (10%)	$ 1,120,000	$ -	20	$ -	$ -	$ -
Electrical (25%)	$ 2,800,000	$ -	20	$ -	$ -	$ -
Sitework (10%)	$ 1,120,000					
Subtotal	$ 18,480,000					
Contractor GCs (10%)	$ 1,850,000					
Total Construction Costs	$ 20,330,000					
Contingencies and Engineering Services (50%)	$ 10,170,000					
Total Capital Costs	$ 30,500,000			$ 440,000	$ 1,980,000	$ 1,150,000
Present Worth of Capital Costs	**$ 30,500,000**			$ 440,000		$ 1,150,000
Relative Labor ($40/hr)	$ 40,000					
Maintenance (~2% of equipment)	$ 40,000					
Power ($0.04/kWh)	$ 290,000					
Solids Disposal	$ 40,000					
Chemical Use	$ 140,000					
Total O&M Costs	$ 550,000					
Present Worth of O&M	**$ 8,370,000**					
Summary of Present Worth Costs						
Capital Cost	$ 30,500,000					
Replacement	$ 440,000					
O&M Cost	$ 8,370,000					
Salvage Value	$ (1,150,000)					
Total Present Worth	**$ 38,160,000**					
Alternative S3 - Satellite Bar Screen Building	**$ 5,470,000**					
Annual Lost Biogas Value	**$0-$142,000**					
Present Worth of Lost Biogas Revenue	**$0-$2,160,000**					
Alternative BNR1a + S3	**$ 43,630,000**					
With Biogas Value	**$43,630,000 - $45,790,000**					

City of Waterloo, Iowa
Wastewater Nutrient Reduction Study
Opinion of Present Worth Cost

Discount Rate 2.750%

Alternative BNR1f - A2O Process with struvite harvesting and PRS fermentation; VFA addition at WWTP

ITEM	Initial Capital Cost	Future Capital Cost	Replacement Year	Replacement Cost (P.W.)	20-Year Salvage Value	Salvage Value (P.W.)
Satellite Aeration Tank Structural Modifications	$ 250,000	$ -	40	$ -	$ 130,000	$ 80,000
Baffle Walls - Anaerobic Zones	$ 230,000	$ -	40	$ -	$ 120,000	$ 70,000
Baffe Walls - Anoxic Zones	$ 230,000	$ -	40	$ -	$ 120,000	$ 70,000
Anaerobic/Anoxic Mixers	$ 480,000	$ -	20	$ -	$ -	$ -
Fine Bubble Diffusers	$ 600,000	$ 600,000	15	$ 400,000	$ 400,000	$ 230,000
Nitrate Recycle Pumps	$ 320,000	$ -	20	$ -	$ -	$ -
Chemical Storage Tanks - CPR backup and VFA	$ 150,000	$ -	20	$ -	$ -	$ -
Chemical Feed System	$ 60,000	$ 60,000	15	$ 40,000	$ 40,000	$ 20,000
Chemical Building	$ 500,000	$ -	40	$ -	$ 250,000	$ 150,000
Primary Sludge Fermenter	$ 1,600,000		20	$ -	$ -	$ -
Struvite Harvesting/Sequestration	$ 2,000,000	$ -	20	$ -	$ -	$ -
Subtotal	$ 6,420,000	$ 660,000				
Piping and Mechanical (20%)	$ 1,290,000	$ -	40	$ -	$ 650,000	$ 380,000
HVAC (10%)	$ 650,000	$ -	20	$ -	$ -	$ -
Electrical (25%)	$ 1,610,000	$ -	20	$ -	$ -	$ -
Sitework (10%)	$ 650,000					
Subtotal	$ 10,620,000					
Contractor GCs (10%)	$ 1,070,000					
Total Construction Costs	$ 11,690,000					
Contingencies and Engineering Services (50%)	$ 5,850,000					
Total Capital Costs	$ 17,540,000			$ 440,000	$ 1,580,000	$ 920,000
Present Worth of Capital Costs	**$ 17,540,000**			$ 440,000		$ 920,000
Relative Labor ($40/hr)	$ 40,000					
Maintenance (~2% of equipment)	$ 40,000					
Power ($0.04/kWh)	$ 290,000					
Solids Disposal	$ 40,000					
Chemical Use	$ 440,000					
Total O&M Costs	$ 850,000					
Present Worth of O&M	**$ 12,940,000**					
Summary of Present Worth Costs						
Capital Cost	$ 17,540,000					
Replacement	$ 440,000					
O&M Cost	$ 12,940,000					
Salvage Value	$ (920,000)					
Total Present Worth	**$ 30,000,000**					