BLUE LAKE WASTEWATER TREATMENT PLANT IMPROVEMENTS FACILITY PLAN

METROPOLITAN COUNCIL

Blue Lake WWTP Improvements Facility Plan

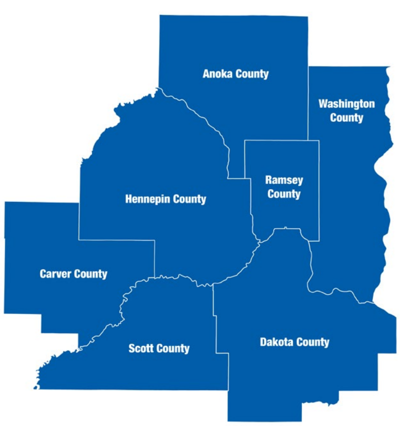
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Jason Peterson ________ Jason Peterson, P.E.; Registration Number 47067

The Council's mission is to foster efficient and economic growth for a prosperous metropolitan region

Metropolitan Council Members

Charlie Zelle	Chair	Raymond Zeran	District 9
Judy Johnson	District 1	Peter Lindstrom	District 10
Reva Chamblis	District 2	Susan Vento	District 11
Christopher Ferguson	District 3	Francisco J. Gonzalez	District 12
Deb Barber	District 4	Chai Lee	District 13
Molly Cummings	District 5	Kris Fredson	District 14
Lynnea Atlas-Ingebretson	District 6	Phillip Sterner	District 15
Robert Lilligren	District 7	Wendy Wulff	District 16
Abdirahman Muse	District 8		



The Metropolitan Council is the regional planning organization for the seven-county Twin Cities area. The Council operates the regional bus and rail system, collects and treats wastewater, coordinates regional water resources, plans and helps fund regional parks, and administers federal funds that provide housing opportunities for low- and moderate-income individuals and families. The 17-member Council board is appointed by and serves at the pleasure of the governor.

On request, this publication will be made available in alternative formats to people with disabilities. Call Metropolitan Council information at 651-602-1140 or TTY 651-291-0904.

Table of Contents

List of Appendices

List of Tables

List of Figures

Executive Summary

The Blue Lake Wastewater Treatment Plant (WWTP), which is owned and operated by the Metropolitan Council of Environmental Services (MCES), is located in Shakopee, MN. It serves a population of approximately 300,000 from 29 communities. Since its original construction, the plant has undergone construction of multiple expansion, rehabilitation, and improvements projects, and today it has a permitted average wet weather (AWW) flow capacity to treat 42 million gallons per day (mgd) of wastewater. Liquid treatment facilities include screening and grit removal, primary clarifiers, nitrifying activated sludge with biological phosphorus removal, final clarifiers, an effluent polishing pond and disinfection. Solid treatment facilities, which include sludge thickening, digestion, dewatering, and drying, produce fertilizer pellets that are suitable for land application without site restriction, or reuse in fertilizer manufacturing.

This Facility Plan has been developed in response to anticipated growth and development in the Blue Lake Service area, potential future regulatory requirements, and the need to rehabilitate aging equipment and infrastructure:

- The Blue Lake WWTP will reach its existing average daily wastewater flow capacity of 35 mgd before 2030 (see Table ES-1).
- The BioP process employed at the Blue Lake WWTP is insufficient for meeting proposed permit limits (see Table ES-2).
- Condition assessments indicate some facilities are nearing end of service life.

The estimated total budgetary cost for proposed Blue Lake WWTP Improvements is $408M.

The MPCA may impose permit requirements for perfluorooctane sulfonate (PFOS). For the purposes of this Facility Plan, it is too early to determine whether the MPCA will impose permit requirements or whether capital improvements will be necessary to address PFOS. MCES is committed to working with the MPCA within the regulatory framework to reduce PFOS discharged by MCES wastewater treatment plants.[1]

Table ES-1 Population and Flow Projections

PARAMETER	CURRENT	2020	2030	2040	2050
Population	312,201	327,726	379,476	431,226	482,976
Annual Average Flow, mgd	27.5	30	35	39	44
Annual Wet Weather Flow, mgd	33	36	42	47	53

[1] The existing permit is currently under review by the MPCA and is expected to be renewed before completion of recommended Blue Lake WWTP Improvements in this Facility Plan.

Table ES-2 Projected Blue Lake WWTP Phosphorus Discharge Criteria

EFFLUENT PERIOD	TYPE	UNIT	EXISTING PERMIT LIMITS	PROPOSED LIMITS
Jan-Dec	12 Month Moving Total	kg/yr	58,024	17,407[a]
June-Sept	Calendar Monthly Average	kg/d	NA	100.1[a]
Jan-Dec	12 Month Moving Average	mg/L	1	1

[a]For the permitted average wet weather (AWW) flow capacity of 42 mgd, proposed limits will require a discharge phosphorus concentration of no greater than 0.3 mg/L; this is the basis for recommended secondary treatment process improvements and tertiary filtration.

Table ES-3 provides a summary of the recommended capital improvements and associated cost estimates (2020 dollars), grouped into three phases of implementation. (See Section 6.1 for a complete list of improvements.)

Phase I Improvements are required within the next 10 years to meet customer level of service objectives. The following improvements represent 91% to Phase I total construction cost:

- Modification of the aeration tanks to increase secondary treatment process stability, efficiency and operability; replacement of air mixing in the existing aeration tanks; addition of 2 secondary clarifiers, a mixed liquor distribution structure and a second effluent channel/pipeline to increase capacity
- Expansion of the digestion complex by the addition of one digester
- Renewal of solids drying facilities within an expansion to Final Stabilization Facilities (FSF building).

Phase II Improvements can be deferred for 10 to 15 years while still maintaining customer level of service objectives. The following improvements represent 97% of Phase II total construction cost:

- New primary treatment complex, including the addition of 2 primary clarifiers and piping to expand primary treatment capacity; renewal of existing primary clarifiers, and replacement of grit removal equipment retrofitted in Phase I
- Addition of tertiary filtration to meet proposed permit requirements

Phase III Improvements are the remaining improvements identified for the 30-year planning period that can be deferred beyond 15 years while still maintaining customer level of service. The following improvements represent 92% of Phase III total construction cost:

- Addition of one aeration tank and one aeration blower to expand secondary treatment capacity
- Expansion of tertiary treatment
- Expansion of the effluent pump station and disinfection basin to increase capacity
- Digester complex renewal, including replacement of process equipment in the digester control building and replacement of the storage tank membrane cover
- Renewal of wastewater solids thickening and dewatering equipment

Note that implementation of industrial pretreatment at the Northern Star Company, a significant industrial user of the municipal wastewater system, may reduce organic and solids discharge to the Blue Lake WWTP such that some of the recommended improvements can be deferred.[2]

Figure ES-1 is a program implementation schedule that includes planning and implementation steps for project delivery. The estimated completion of construction and commissioning of Blue Lake WWTP Improvements is 2031 for Phase I; 2036 for Phase II, and 2041 for Phase III. MCES expects the Blue Lake WWTP can consistently and reliably achieve proposed permit limits in 2037, upon the completion of a process proving phase in Phase II.

[2] Northern Star has enrolled in MCES' Industrial Pretreatment Incentive Program (IPIP) whereby MCES provides low interest financing in exchange for industry owned and operated pretreatment facilities that will lower industrial loads to levels that are mutually beneficial.

Table ES-3 Recommended Blue Lake WWTP Improvements between 2020 and 2050: Total Construction Cost

PROCESS OR LOCATION	PHASE I: TOTAL COST	PHASE II: TOTAL COST	PHASE III: TOTAL COST
Preliminary Treatment Process – Screenings Building	$2,017,500	$282,000	$1,265,000
Primary Treatment Process	$2,495,500	$21,679,000	$22,500
Secondary Treatment Process[a]	$58,348,800	$0	$23,009,000
Tertiary Treatment	$0	$69,000,000	$15,000,000
Effluent Process	$1,519,050	$0	$3,660,000
Site Buildings	$1,890,000	$0	$0
Thickening and Dewatering	$0	$1,320,000	$5,924,000
Digestion Complex	$3,777,000	$1,093,000	$8,566,000
Final Stabilization Facility	$51,472,000	$0	$0
Chemical Handling Building	$0	$0	$1,615,000
Other Miscellaneous Improvements[b]	$3,510,000	$1,200,000	$1,905,000
Total Construction Cost (2020 dollars)	**$125,029,050**	**$94,574,000**	**$60,966,500**
Engineering and Admin (20%)	$25,005,810	$18,914,800	$12,193,300
Capital Cost (2020 dollars)	**$150,034,860**	**$113,488,800**	**$73,159,800**
Midpoint construction (years)	2	7	15
Escalated capital costs (3% per year)	**$159,171,983**	**$139,576,909**	**$113,980,585**

Notes:
a. Industrial Pretreatment Incentive Program (IPIP) may defer a $24,780,000 secondary clarifier expansion from Phase 1 to Phase III and a $12,980,000 aeration tank from Phase III to beyond Phase III. The net impact to Total Construction Cost would be -$24,780,000 for Phase I total construction cost and +$11,800,000 for Phase III total construction cost.
b. Other Miscellaneous Improvements include Liquid Waste Receiving expansion, PLC replacement in 5 years and again in 25 and repairs to the plant effluent structure.

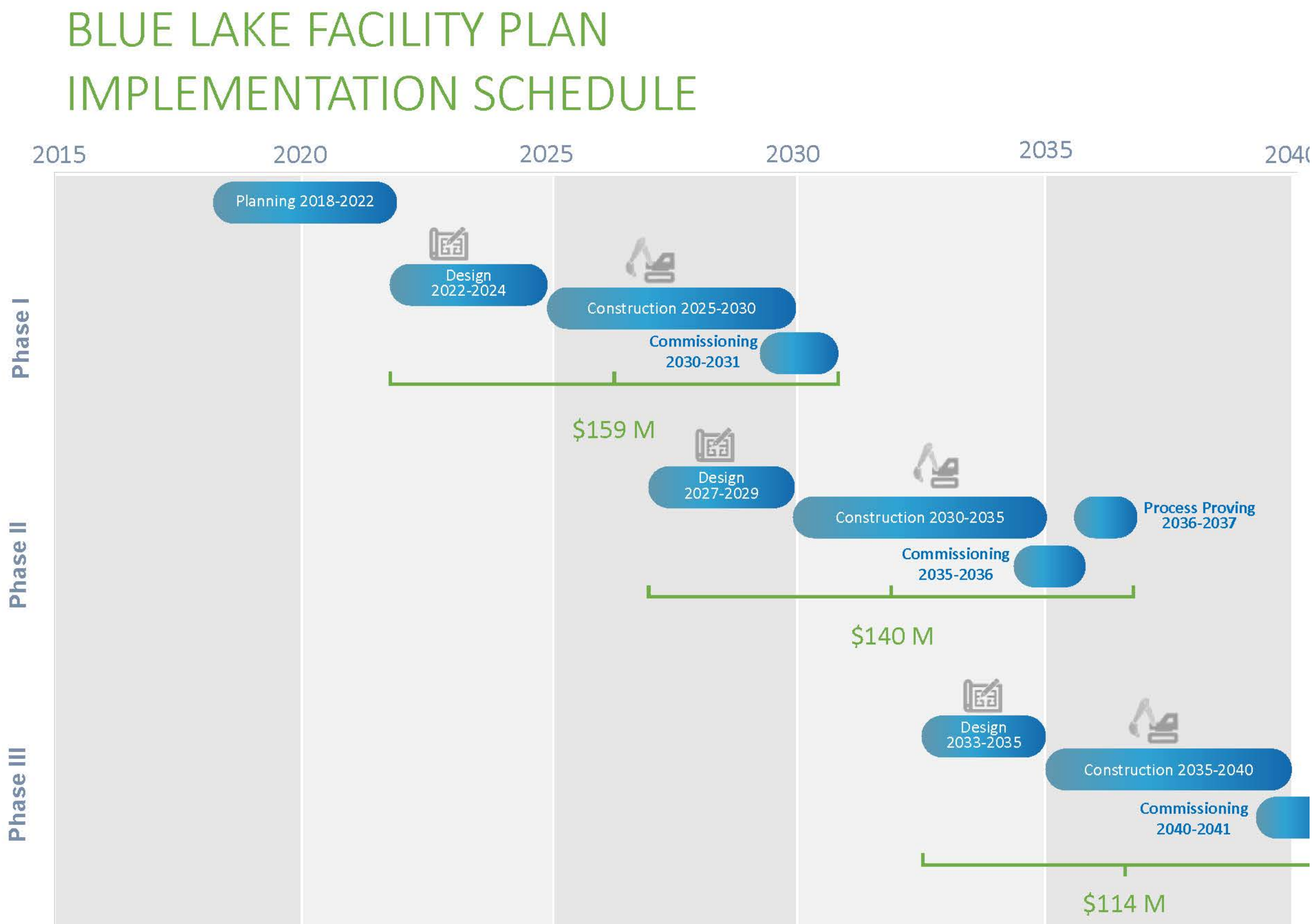


Figure ES-1 **Program schedule overview that includes planning and implementation steps for project delivery**

1 Introduction

1.1 *Objective*

This Facility Plan documents the planning activities conducted by Metropolitan Council Environmental Services (MCES) to evaluate and recommend facility improvements needed at the Blue Lake Wastewater Treatment Plant (WWTP) for the plant to reliably continue efficient and effective wastewater treatment service through the year 2050. The objective of this Facility Plan is to provide a basis for a) MCES management decisions concerning the implementation of this Facility Plan and b) review by the Minnesota Pollution Control Agency (MPCA) in qualifying the recommended facility improvements for funding through the Minnesota Public Facilities Authority (PFA).

This Facility Plan includes recommendations for phased implementation of Blue Lake WWTP Improvements based on projected wastewater flows and loads, condition assessment of existing assets, and anticipated future treatment requirements. Budgetary capital costs for the recommended improvements are also included in this Facility Plan.

1.2 *Background and Facilities Description*

The Metropolitan Council owns and operates the Blue Lake WWTP which provides service to approximately 300,000 people within the Twin Cities southwest metro area, including Minnetonka, Eden Prairie, Chanhassen, Chaska, Shakopee, communities surrounding Lake Minnetonka, and Loretto.[3] Note that a relatively small amount of wastewater flow from the northern-most portion of Hopkins (approximately 100 households in the Bell Grove addition) is served via Minnetonka by the Blue Lake WWTP.

The facility is located at 6957 County Road 101 E Shakopee, MN, 55379 and it currently treats an average of 27.5 million gallons municipal wastewater every day. Figure 1-1 is a map of the Blue Lake WWTP current and long-term service area.[4] Population within the existing service area is expected to increase 37% from 306,450 in 2020 to 420,650 in 2050.[5]

Sewered population within the existing Blue Lake WWTP service area is expected to increase 37% from 306,460 in 2020 to 420,650 in 2040; employment is expected to increase (21%) from 194,950 to 235,860 during this same time period.[4] The Blue Lake WWTP will reach its existing wastewater treatment capacity before 2030 due to growth within the service area.

Existing capacity of the Blue Lake WWTP is 35 million gallons per day (mgd) on an average daily flow basis; the planned long-term capacity is 50 mgd (post 2040). According to the MCES 2040 Water Resources Policy Plan, long-term capacity relief for the Blue Lake WWTP (post 2040) can be provided by a future Scott County WWTP.

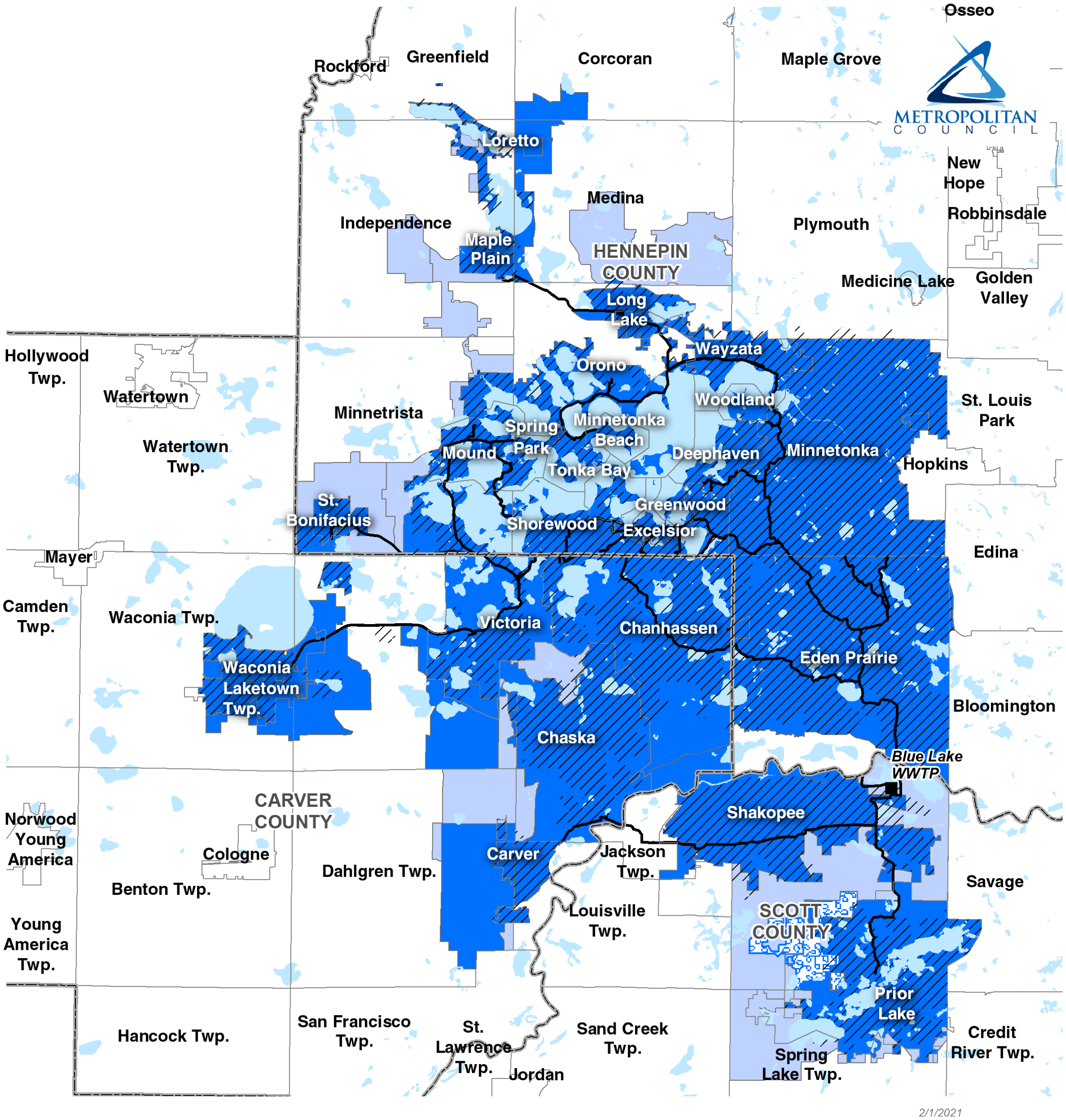
The WWTP utilizes a combination of biological, chemical, and physical treatment processes to remove pollutants from the raw wastewater. The liquids treatment process is rated for an average wet weather flow (AWWF) of 42 million gallons per day (mgd) and includes influent screening, grit removal, primary clarification, activated sludge operated for nitrification and

---

[3] Loretto will be served through the local collection system 2021. Additionally, northwest Medina and southwest Corcoran will be served through a future interceptor constructed post 2040.
[4] 2040 Water Resources Policy Plan, Metropolitan Council
[5] Residents + employees, as residential equivalents

phosphorus removal, secondary clarification, aerated polishing pond, chlorination and de-chlorination facilities, effluent pumping, and cascade aeration. The solids treatment process consists of sludge thickening, anaerobic digestion, sludge dewatering, sludge drying and biosolids storage. Blue Lake WWTP wastewater treatment facilities are shown on Figure 1-2.

Blue Lake is operated by Class A wastewater treatment plant operators as are all MCES wastewater treatment plants. Maintenance of MCES wastewater treatment plant assets are managed using Oracle® Work and Asset Management (WAM) asset management software.



Long Term Service Areas

	Current	Potential
Blue Lake		

Currently Served Areas

Blue Lake

Shakopee Mdewakanton Sioux Community

County Boundaries

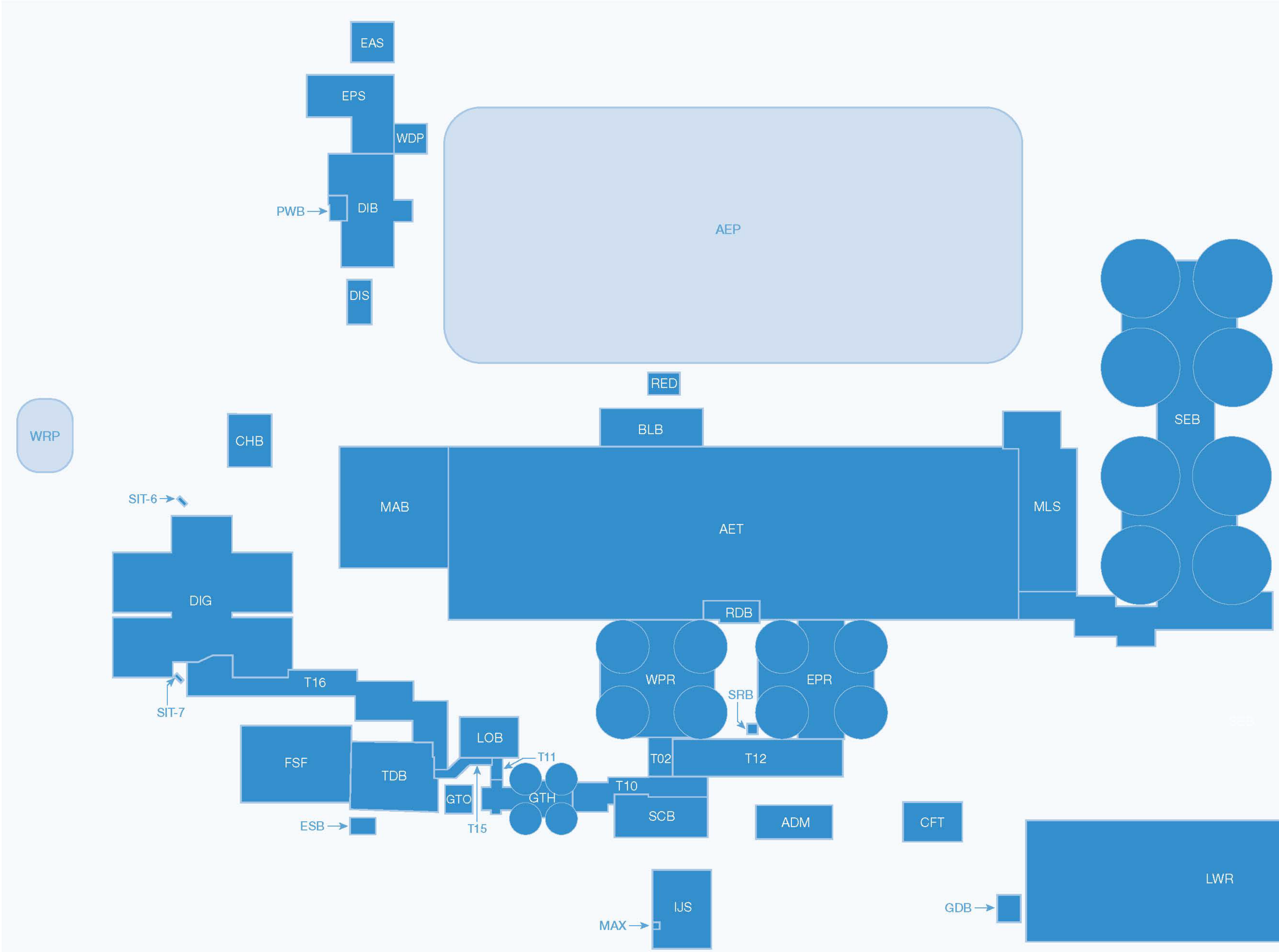
City and Township Boundaries

Lakes and Rivers

0 5 10

Miles

Figure 1-1 Blue Lake Wastewater Treatment Plant (WWTP) Service Area Map



Code	Description
ADM	Administration Building
AEP	Aeration Pond
AET	Aeration Basins
BLB	Blower Building
CFT	CFO Trailers
CHB	Chemical Building
DIG	Digester Complex
DIB	Disinfection Basins
DIS	Disinfection Building
EAS	Effluent Aeration Structure
EDP	East Pump Station
EPR	East Primary Clarifiers
ERP	East Retention Pond
EPS	Effluent Pump Station
ESB	Electrical Service Building
FSB	Final Stabilization Building
GDB	Guard Shack
GTH	Gravity Thickener
GTO	Gravity Thickener Odor Control Building
IJS	Influent Junction Structure
LOB	Sludge Loadout Building
LWR	Liquid Waste Receiving
MAB	Maintenance Building
MAX	Maintenance Box
MLS	Mixed Liquor Splitter Box
PWB	Plant Water Pump Building
RDB	RAS Distribution/WAS Pumping Station
RED	Red Shed
SCB	Screenings Building
SEB	Secondary Clarifiers & Building
SIT6	SIT-DW-DW6
SIT7	SIT-DW-DW7
SRB	Solid Stream Recycle Box
T02	Tunnel 2
T10	Tunnel 10
T11	Tunnel 11
T12	Tunnel 12
T15	Tunnel 15
T16	Tunnel 16
TDB	Thickening & Dewatering Building
WDP	West Drainage Pump Station
WPR	West Primary Clarifiers
WRP	West Retention Pond

Figure 1-2 Blue Lake Wastewater Treatment Plant (WWTP) Site Plan

1.2.1 Infiltration/Inflow (I/I)

MCES and the communities it serves are working collaboratively to reduce "clean" water from entering the municipal wastewater system. Clean water (groundwater and/or stormwater) that enters into wastewater sewer pipes consumes capacity of conveyance and wastewater treatment systems; it reduces the cost effectiveness of conveyance and treatment, and it limits the capacity available for growth. In the worst case, during unseasonably warm weather and/or high precipitation events, the added load of clean water on the wastewater system can cause sewage backups into homes and/or release sewage into waterways.

In the 1980s urban core communities and MCES worked intensively to separate storm sewers and municipal wastewater sewers. After its 1990 study found that approximately 20 percent of the average wastewater flow was attributable to infiltration and inflow, MCES initiated a grant program to re-adjudicate unused funds from a previous grant program for community I/I reduction investigations, studies, and projects see Figure 1-2). Since 2004, MCES and the communities it serves have spent over $275M[6] to reduce I/I and have avoided more than $1B in capacity improvements.

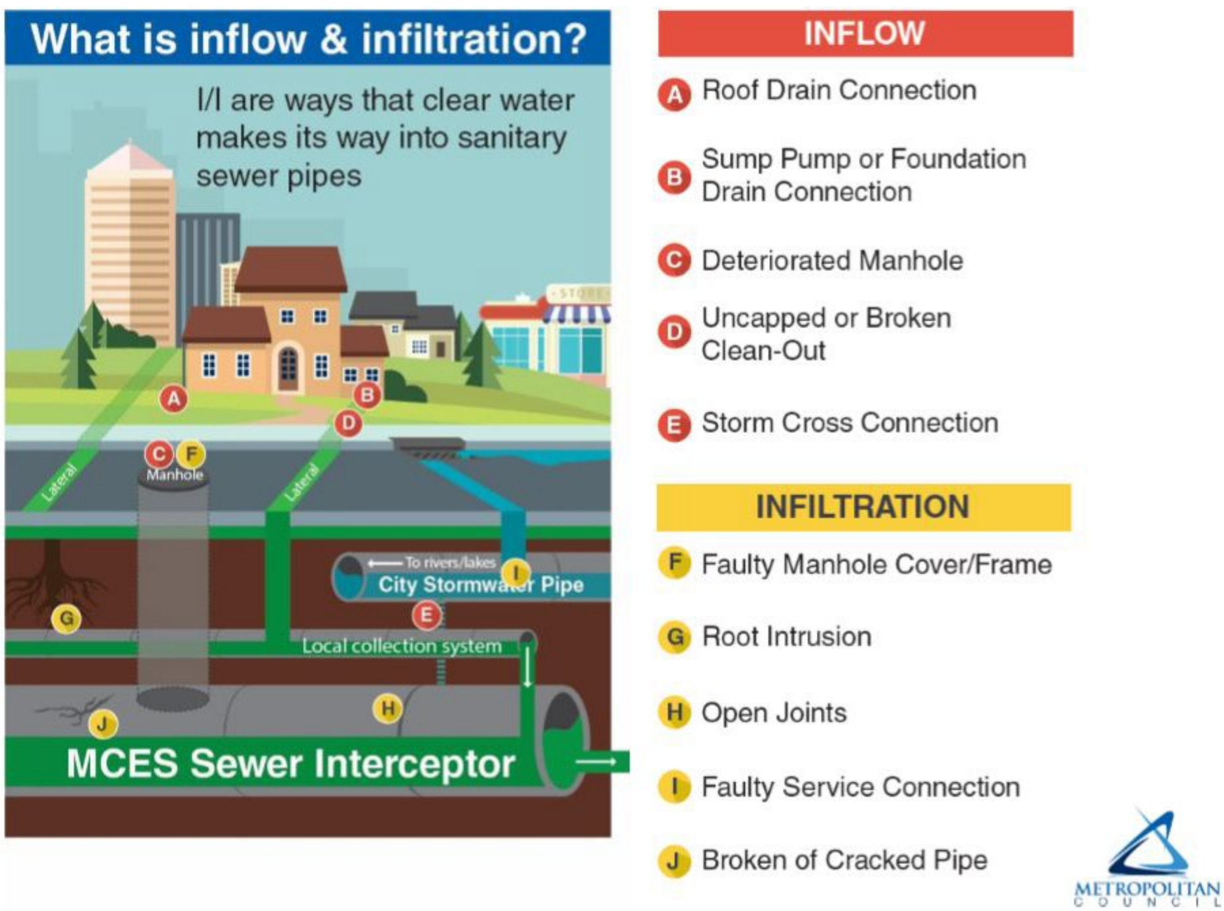


Figure 1-3 Sources of Infiltration/Inflow (I/I) from private property to the Sanitary Sewer

---

[6] MCES contribution to I/I reduction since 2004 is approximately $100M.

For the Blue Lake WWTP service area, the impact of the I/I Program can be seen by comparing two major storm events that occurred on October 4, 2005 and June 19, 2014, as summarized on Table 1-1. I/I mitigation efforts in the Blue Lake WWTP service area since 2004, have reduced I/I by at least 22%. This estimated I/I reduction is a minimum considering that the second 2014 storm was larger; the antecedent conditions prior to the 2014 storm included more precipitation volume, and growth occurred in the service area between 2005 and 2014.

Table 1-1 Estimated Impact of Mitigation Efforts in Reducing Infiltration/Inflow (I/I) in Wastewater Flow to the Blue Lake Wastewater Treatment Plant (WWTP)

PARAMETER	OCT. 4, 2005	JUN. 19, 2014	DIFFERENCE
Regional Precipitation (in)[a]	6.6	10.8	+62%
Annual Precipitation (in)[b]	32.2	37.7	+17%
Peak Daily Wastewater Flow, million gallons per day (mgd)	92.8	70.9	-22%
Peak Hourly Flow (mgd)[c]	--	--	--

[a]Average total rainfall over the region that occurred September 19-October 4, 2005 and June 1-June 19, 2014.
[b]Average total rainfall over the region that occurred in the 12 months preceding the event.
[c]Peak Hourly Flow during events exceeded the capacity of Blue Lake Plant meters.

MCES, with the cities and townships its serves, are committed to reducing I/I in the wastewater system. The MCES Ongoing I/I Mitigation Program establishes goals for each city and township discharging wastewater to the regional system and requires that communities with excessive flows eliminate the excessive I/I within a reasonable period of time. The program also provides informational and educational resources, technical assistance and advocates for state bond funds to be utilized for municipal I/I reduction projects.

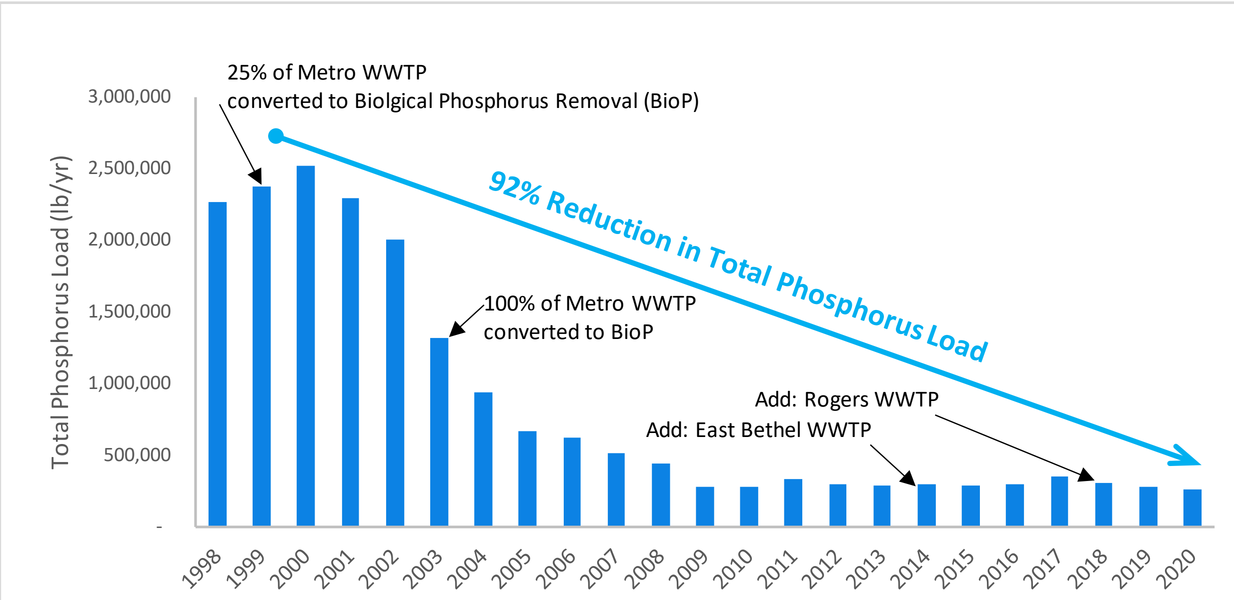
MCES continues to pursue dedicated and reliable funding sources to assist local communities in their I/I mitigation efforts.

1.2.2 Biological Phosphorus Removal

The State of Minnesota has had point source phosphorus effluent limits since the early 1970s (MPCA, 2019). In early 2000 MPCA began addressing phosphorus in National Pollution Discharge Elimination System (NPDES) permits.

Currently, all MCES wastewater treatment plants have chemical and/or biological phosphorus removal. As shown on Note: Hastings WWTP loading data missing Jan 2003, Mar 2003 - June 2004

Figure 1-4, MCES has achieved 92% percent removal of phosphorus discharged to Minnesota waterbodies from its wastewater treatment system.



Note: Hastings WWTP loading data missing Jan 2003, Mar 2003 - June 2004

Figure 1-4 MCES Wastewater Treatment Plant (WWTP) System-Wide Phosphorus Discharge Load

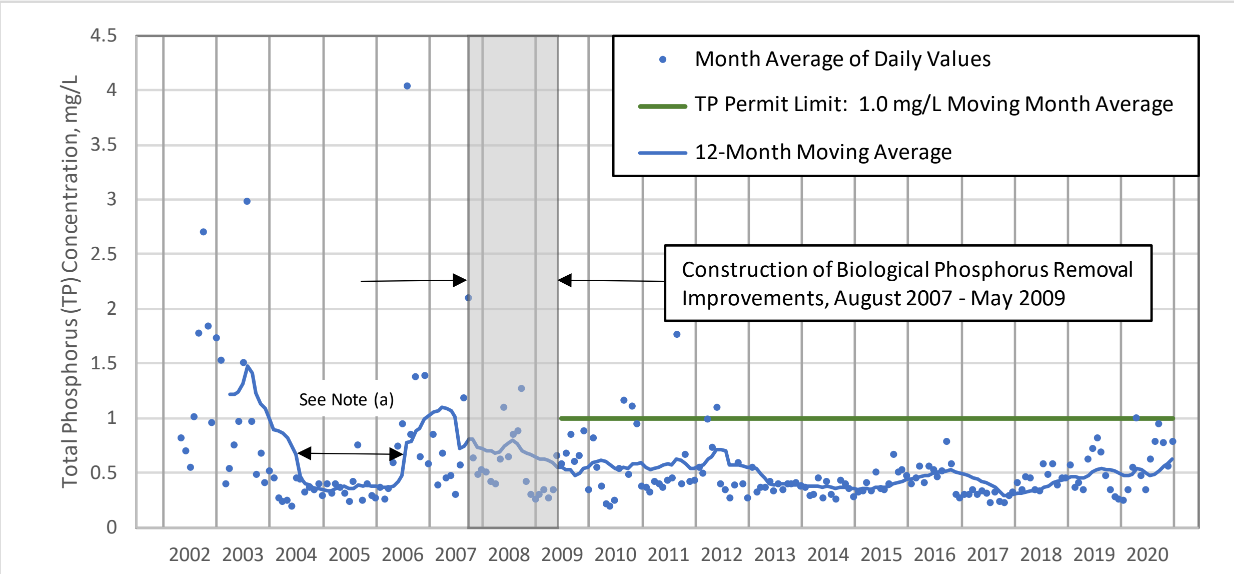
Biological phosphorus removal (Bio-P) was implemented at the Blue Lake WWTP in 2009 to meet a 1.0 mg/L permit limit for phosphorus in the plant's discharge to the Minnesota River.[7] The $7.5M project, which was constructed August 2007 through May 2009, included the following:

- addition of an anaerobic zone within each of all 8 aeration tanks to create the environment needed for Bio-P,
- replacement of air distribution piping and fine bubble air diffusers in all 8 aeration tanks,
- air distribution control improvements, and
- addition of ferric chloride chemical facilities to backup or supplement the Bio-P process

[7] 2009 National Pollution Discharge Elimination System (NPDES) permit number MN0029882 issued by the Minnesota Pollution Control Agency

The anaerobic zone was constructed by installing a course-bubble mixing section at the front end of each aeration tank and adding a baffle wall to separate the mixed section from downstream aeration.

Figure 1-4 is a graph of concentration data that shows the impact of Bio-P in successfully reducing phosphorus in the Blue Lake WWTP discharge.



Note: Blue Lake WWTP operations reduced airflow to portions of the aerations tank to demonstrate biological phosphorus removal.

Figure 1-5 Blue Lake Wastewater Treatment Plant WWTP Discharge Phosphorus Concentration Data (2002 – 2020)

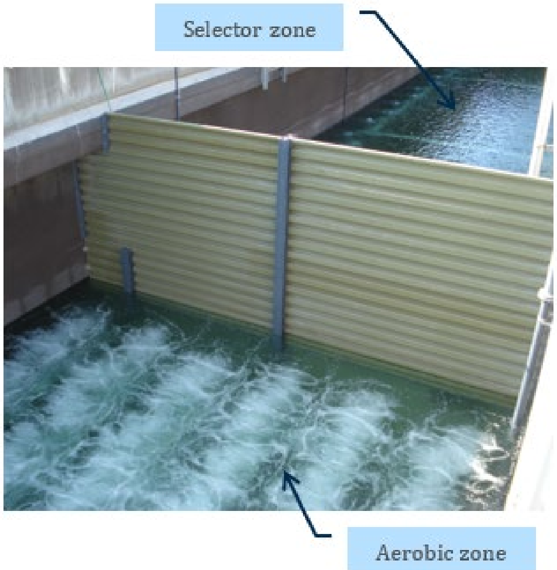


Figure 1-7 **Photograph (07/09/08): Aeration tank 3 pass 1 – new course bubble aeration system and new baffle**

Figure 1-6 **Photograph (11/14/08): New ferric chloride tank**

Construction Photos: Blue Lake WWTP Bio-P Improvements (MCES Project 80182)

1.2.3 Exceptional Quality (EQ) Class A Biosolids

Wastewater solids treatment facilities at the Blue Lake WWTP have successfully produced fertilizer pellets for over 20 years. Blue Lake's fertilizer pellets are marketable because they meet Class A, Exceptional Quality (EQ) biosolids.[8]

As shown on Figure 1-9, wastewater solids treatment at the Blue Lake WWTP includes:

- Digestion that destroys solids and reduces the amount of solid material transferred to downstream equipment and ultimately handled offsite.
- Centrifuge dewatering that removes water and reduces volume of material.
- Final stabilization that provides for drying, pelletizing and storage.

Figure 1-8 **Fertilizer pellets produced by Blue Lake Wastewater Treatment Plant.**

[8] 40CFR Part 503, Environmental Protection Agency

MCES currently manages operation and maintenance of the Blue Lake WWTP Final Stabilization Facility (FSF) and distributes Blue Lake fertilizer pellets to farmers and fertilizer companies through a contract with the New England Fertilizer Company (NEFCO).[9] MCES staff operate and maintain all onsite facilities.

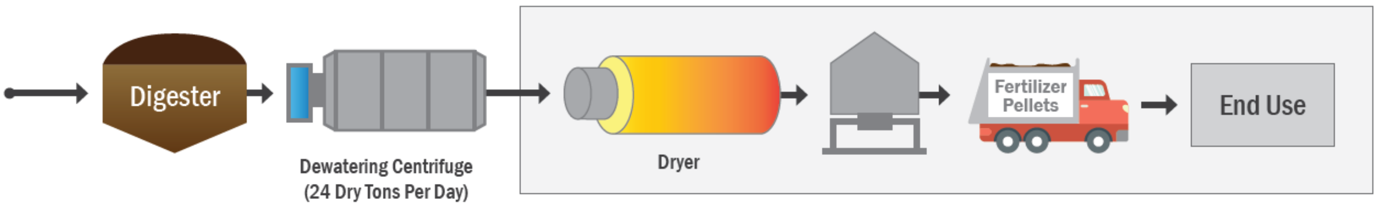


Figure 1-9 Blue Lake WWTP Wastewater Solids Treatment Process

1.2.4 Industrial Pretreatment Incentive Program (IPIP)

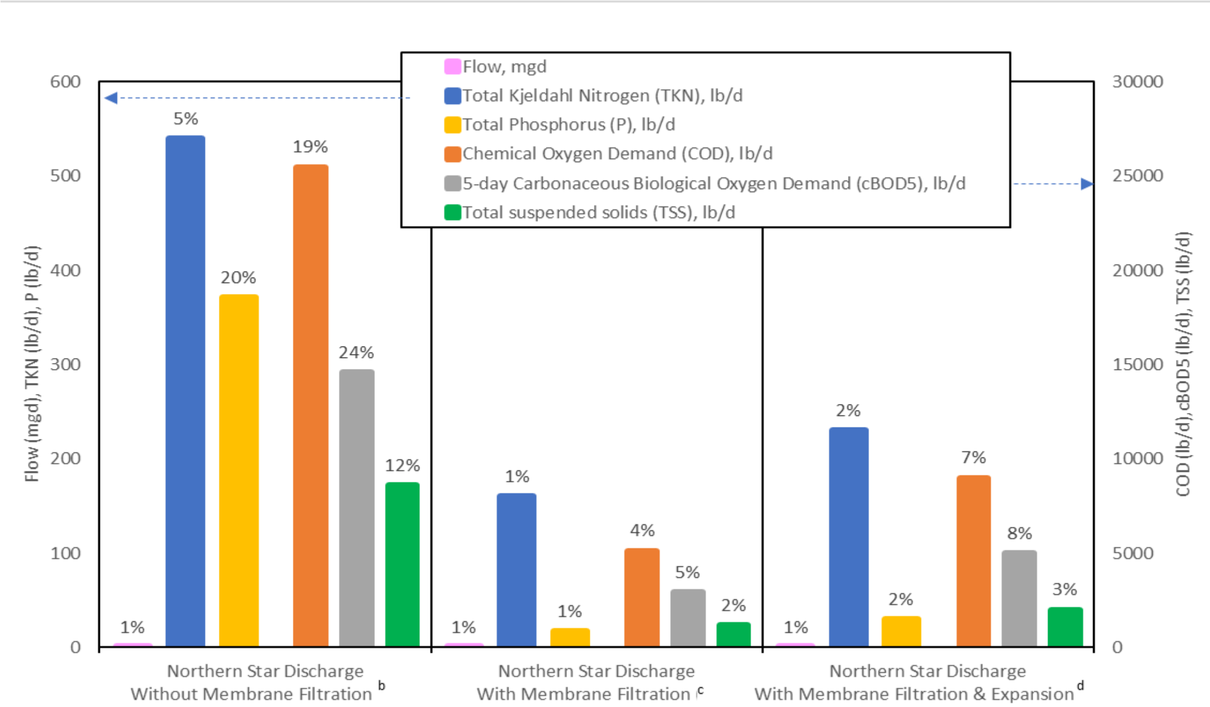
As part of its Industrial Pretreatment Incentive Program (IPIP), the Metropolitan Council provided a 10-year loan[10] to the Northern Star Company (Northern Star), a significant industrial waste discharger to the Blue Lake WWTP, to construct a new pretreatment system at its site located in Chaska, MN. Under IPIP, Northern Star can receive up to a 30% discount on annual loan payments based on performance of the constructed pretreatment system.

Figure 1-10 New industrial wastewater pretreatment membrane filtration unit at Northern Star Company, Chaska MN.

Northern Star owns and operates a potato processing plant in Chaska. The new pretreatment system, which is currently under construction, consists of a membrane filtration bank and appurtenant equipment. The new pretreatment system is expected to be in operation late 2021 or early 2022, and it will allow Northern Star to increase production at the Chaska site without significantly increasing the pollutant load in the discharge.

Figure 1-11 shows the expected reduction of pollutant loading to the Blue Lake WWTP, with and without an increase in production. The project may also reduce corrosion and odor in the interceptor system.

[9] The contract is $24.5M for a period of 10 years (2020-2030) and has provision for two, five-year extensions.
[10] General obligation bond in the amount of $11.3M



Notes:

a. Percentage values indicate the amount of the industrial wastewater discharge component in the Blue Lake total wastewater inflow (average of daily values, 2015 through 2019), as a percentage.

b. Characterization of Northern Star Discharge Without Membrane Filtration is based on data from 2015 and 2016.

c. Characterization of Northern Star Discharge with Membrane Filtration is based on estimated pretreatment performance received from Northern Star.

d. Characterization of Northern Star Discharge with Membrane Filtration & Expansion is based on estimated pretreatment performance received from Northern Star and Northern Star's planned increase in production.

Figure 1-11 Impact of New Membrane Filtration Pretreatment of Northern Star Company Industrial Wastewater Discharge to the Blue Lake WWTP

Successful implementation of IPIP projects benefits the MCES and the region it serves, as well as the industries that discharge industrial waste into the MCES wastewater treatment system:

- MCES can defer facility expansions and reduce operational costs related to treating high strength waste
- MCES customers benefit through a reduction in municipal wastewater charges and, if the industry expands as a result of IPIP, an increase in number of jobs
- Industrial users obtain low-cost public financing for pretreatment infrastructure and reduce the strength charges associated with industrial wastewater discharge into the MCES wastewater treatment plant

In order to qualify for an IPIP loan, financial analysis of the IPIP project must indicate a financial benefit for MCES. Proposed projects that treat high strength industrial wastewater and have a significant impact to secondary treatment at the WWTP are most likely to qualify for an IPIP loan.

2 Design Conditions

This section summarizes the facility planning period design, existing flows and loadings, projected influent flows and loadings, and projected biosolids loadings.

2.1 *Existing Flows and Loadings*

2.1.1 Influent Wastewater Flows and Loadings

The Blue Lake WWTP reported influent wastewater flows and loadings from January 2015 through December 2019 as presented in Table 2-1. Annual average and maximum month and day values are presented, along with the 5-year average.

Influent flows currently average approximately 27.5 mgd and have increased by roughly 0.9 mgd/year over the last 5 years. The maximum average wet weather flow (AWWF) of 34.4 mgd occurred during May 2019. The maximum day flow of 56.5 mgd occured on March 14, 2019 when precipitation events combined with high temperatures resulted in spring snow melt/runoff and higher I/I conditions. Current (2019) peak hour wet weather flow (PHWWF) of 80.1 mgd and peak instantaneous wet weather flow (PIWWF) of 102 mgd were determined using MPCA flow determination guidelines. Review of plant influent and effluent flow data records from 2005 through 2019 shows the highest peak hourly flow recorded was 95 to 100 mgd with one influent flow meter out of service due to construction in the upstream collection system. Review of historical flow patterns suggests 5 mgd of flow was being routed around the construction area/meter. This analysis increases the calculated PIWWF by 5 mgd to a total of 107 mgd. The PHWWF and PIWWF calculations are contained in Appendix 2-1.

Tables 2-2 through 2-7 summarizes the plant influent organic and nutrient loadings and wastewater temperatures. Influent $cBOD_5$, TSS and COD loadings have averaged roughly 60,000 lb/d, 70,000 lb/d and 130,000 lb/d respectively over the last 5 years. TKN and TP loadings average nearly 11,000 and 1,8000 lb/d, respectively. In general, maximum month loadings are 15 to 20 percent higher than average loadings with yearly maximum month peaking factors ranging from 1.1 to 1.3; typical of municipal wastewater treatment plants.

Appendix 2-2 present the reported flow and loadings on a daily and 30-day moving average with a general increasing loading trend over the last 5 year period.

Table 2-1 Blue Lake WWTP Reported Influent Flows

ITEM	2015	2016	2017	2018	2019	5-YEAR AVERAGE
Average, mgd	25.0	26.9	28.3	28.5	28.7	27.5
ADWF, mg	23.0	24.2	24.2	26.4	23.9	24.3
AWWF, mgd	28.0	31.3	34.0	32.1	34.4	32.0
Maximum day, mgd	34.9	41.3	47.4	37.6	56.5	43.5
AWWF: average	1.12	1.16	1.20	1.13	1.20	1.16
Maximum day: average	1.40	1.54	1.67	1.32	1.97	1.58
Peak hour wet weather flow. mgd	N/A	N/A	N/A	N/A	80.1	N/A
Peak instantaneous wet weather flow. mgd	N/A	N/A	N/A	N/A	107.0	N/A

Table 2-2 Blue Lake WWTP Reported Influent 5-day Carbonaceous Biochemical Oxygen Loadings

ITEM	2015	2016	2017	2018	2019	5-YEAR AVERAGE
Average, lb/d	50,279	51,657	61,016	64,193	65,406	58,510
Maximum month, lb/d	60,739	59,629	77,467	76,391	73,901	69,625
Maximum day, lb/d	76,074	89,304	98,696	102,352	115,911	96,467
Maximum month: average	1.21	1.15	1.27	1.19	1.13	1.19
Maximum day: average	1.51	1.73	1.62	1.59	1.77	1.65

Table 2-3 Blue Lake WWTP Reported Influent Chemical Oxygen Demand Loadings

ITEM	2015	2016	2017	2018	2019	5-YEAR AVERAGE
Average, lb/d	120,862	116,457	132,481	141,825	135,364	129,398
Maximum month, lb/d	133,399	133,524	180,243	168,863	154,332	154,072
Maximum day, lb/d	228,930	212,335	292,962	253,013	225,231	242,494
Maximum month: average	1.10	1.15	1.36	1.19	1.14	1.19
Maximum day: average	1.89	1.82	2.21	1.78	1.66	1.88

Table 2-4 Blue Lake WWTP Reported Influent Total Suspended Solids Loadings

ITEM	2015	2016	2017	2018	2019	5-YEAR AVERAGE
Average, lb/d	62,499	62,282	64,509	72,509	76,815	67,723
Maximum month, lb/d	75,638	73,206	74,259	82,827	96,720	80,530
Maximum day, lb/d	135,933	102,716	129,433	169,863	162,554	140,100
Maximum month: average	1.21	1.18	1.15	1.14	1.26	1.19
Maximum day: average	2.17	1.65	2.01	2.34	2.12	2.06

Table 2-5 Blue Lake WWTP Reported Total Phosphorus Loadings

ITEM	2015	2016	2017	2018	2019	5-YEAR AVERAGE
Average, lb/d	1,759	1,641	1,825	2,025	1,746	1,799
Maximum month, lb/d	2,002	1,849	2,349	2,328	2,017	2,109
Maximum day, lb/d	4,254	3,227	3,697	3,679	2,900	3,552
Maximum month: average	1.14	1.13	1.29	1.15	1.16	1.17
Maximum day: average	2.42	1.97	2.03	1.82	1.66	1.98

Table 2-6 Blue Lake WWTP Reported Influent Total Kjeldahl Nitrogen Loadings

ITEM	2015	2016	2017	2018	2019	5-YEAR AVERAGE
Average, lb/d	10,398	10,268	11,319	12,332	10,746	11,013
Maximum month, lb/d	11,312	11,249	14,083	13,789	11,762	12,439
Maximum day, lb/d	15,125	15,822	19,196	17,523	15,796	16,692
Maximum month: average	1.09	1.10	1.24	1.12	1.09	1.13
Maximum day: average	1.45	1.54	1.70	1.42	1.47	1.52

Table 2-7 Blue Lake WWTP Reported Influent Temperatures

CONDITION	2015	2016	2017	2018	2019	5-YEAR AVERAGE
Average	15.3	16.0	15.4	14.9	14.6	15.2
Maximum month	18.7	19.2	18.3	18.3	17.1	19.2
Minimum month	11.9	12.8	12.7	11.4	10.3	11.0

2.1.2 Industrial Contributions

The Blue Lake WWTP has 92 separate industrial contributors permitted to discharge into the collection system feeding the Blue Lake WWTP. Industrial wastewater enters the Blue Lake plant through the municipal sewer system or is hauled to the liquid waste receiving (LWR) at the plant. Hauled waste to the Blue Lake WWTP includes septage from subsurface sewage treatment systems, landfill leachate and other hauled industrial wastes.

Currently, most of the solids loading is contributed by a single industry. Northern Star Company, owned by Michael Foods, operates a potato processing factory in Chaska, MN. Northern Star was built in 2009 and is the largest contributor of organic loads to the Blue Lake WWTP. In 2016, approximately 73% and 82% of the overall COD and $cBOD_5$ loading contributed by industry came from Northern Star as shown in Figures 2-1 and 2-2.

Figure 2-1 Tanker truck emptying waste at liquid waste receiving dump station.

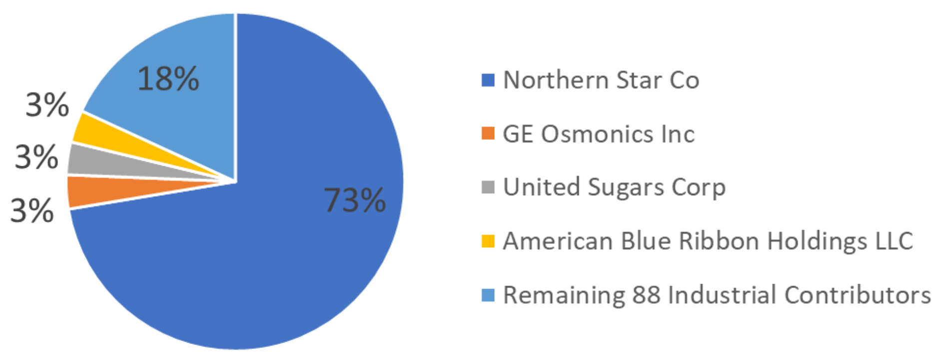


Figure 2-2 COD Loading by Top Industrial Contributors to Blue Lake WWTP (2016)

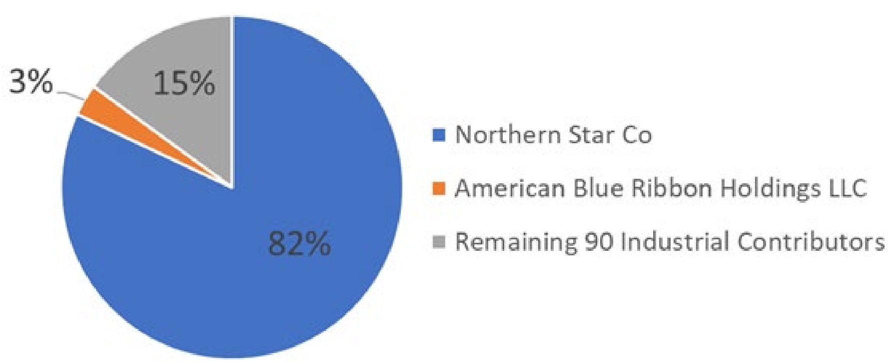


Figure 2-3 $cBOD_5$ Loading by Top Industrial Contributors to Blue Lake WWTP (2016)

Northern Star organic and phosphorus loadings to Blue Lake represents a significant contribution that impacts both liquids and solids stream capacity. However, Northern Star is constructing pre-treatment facilities that may permanently reduce loading to the Blue Lake WWTP, or temporarily reduce loading until production is increased (see Section 1.2.3).

For the purpose of this facility plan it is assumed the Northern Star pretreatment system is operational. Following implementation of pretreatment at Northern Star, re-characterization of the raw influent and loading reduction is recommended to maintain the accuracy of the current process model and confirm projected loadings.

Sensitivity analyses for major liquid sand solids stream processing facilities is included Sections 4, 5 and 6 in the event the pretreatment system does not become operational.

2.2 *Projected Influent Flows and Loads*

2.2.1 Population and Influent Flow Projections

Future flows and loadings will be based upon population projections for the Blue Lake service area. Three sources of populations projections were considered for developing future flows and loadings:

- Metropolitan Council 2040 Water Resource Policy Plan
- Metropolitan Council Thrive MSP 2040 report
- Historical population growth from 2000 to 2012 (1.4% compounded annually)

Figure 2-4 shows the historical population data and sewered population forecasts in the Blue Lake WWTP to 2050. The line indicating a growth rate of 1.4% is a future projection using historical population from 2000 to 2012.

Figure 2-4 also presents corresponding annual average influent flow projections through 2050 for the three projection methods along with influent flow projected to increase at historical rates observed over the last 20 years (1.1% compounded annually). The Thrive MSP2040 population and flow projections provide slightly higher projections throughout the planning period and are used as the basis for this analysis.

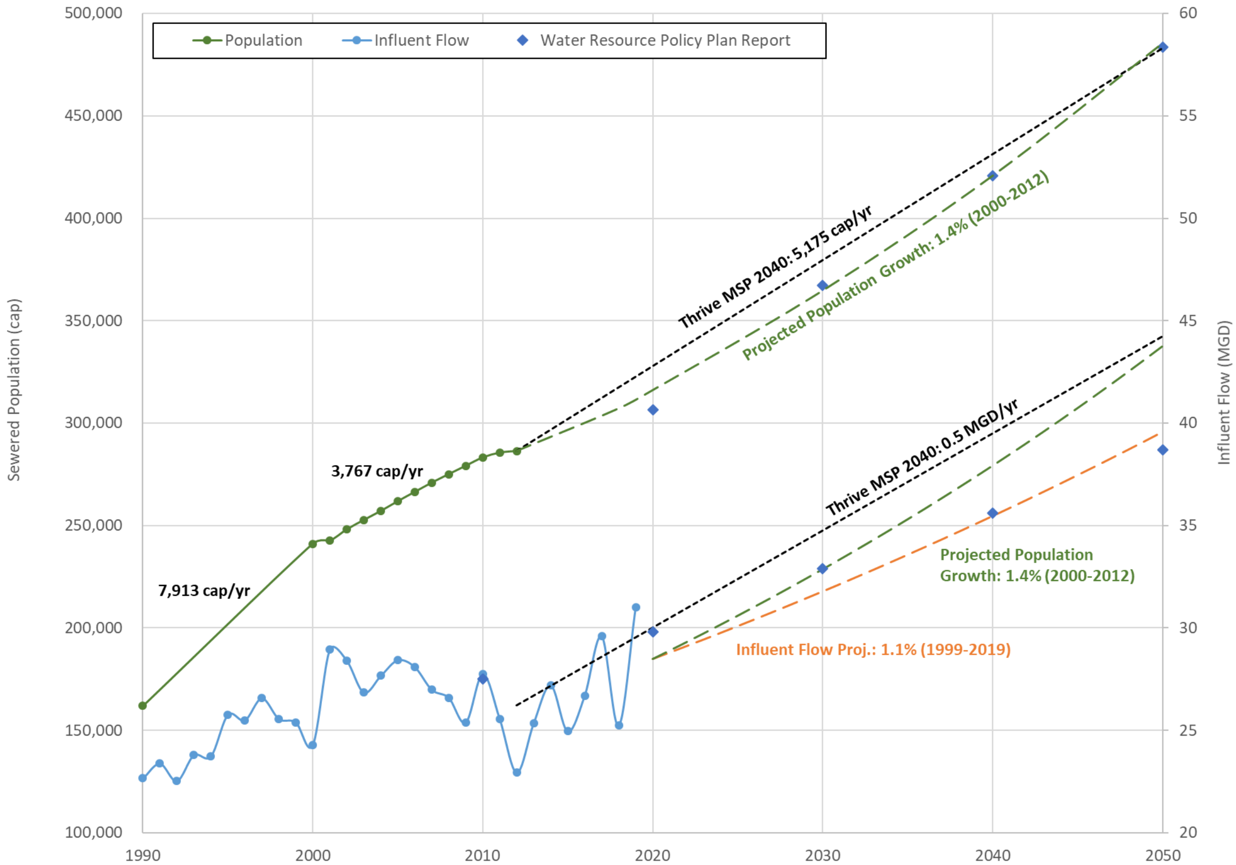


Figure 2-4 Comparison of Population and Influent Flow Projection Methods for Blue Lake WWTP Service Area

2.2.2 Future Growth Loading Rates

In addition to projecting future flows to the Blue Lake WWTP, it is also important to anticipate changes in influent loadings, especially with Northern Star implementing a pretreatment system. When the main contributors of wastewater are residential, the pollutant loading rates per capita typically remain constant. Per capita values for flow, cBOD5, TSS, TKN and TP are shown in Table 2-8. These values were calculated by dividing the annual average influent flow or loading by the estimated service population of the corresponding year.

Table 2-8 Blue Lake WWTP Average Annual Loading per Capita

YEAR	FLOW (GAL/CAP/D)	$CBOD_5$ (LB/CAP/D)	TSS (LB/CAP/D)	COD (LB/CAP/D)	TKN (LB/CAP/D)	TP (LB/CAP/D)
2015	87	0.18	0.22	0.42	0.036	0.0061
2016	94	0.18	0.22	0.41	0.036	0.0057
2017	99	0.21	0.23	0.46	0.040	0.0064
2018+	99	0.22	0.25	0.50	0.043	0.0071
2019	100	0.23	0.27	0.47	0.038	0.0061
Average 2015-2018[a]	**95**	**0.20**	**0.23**	**0.45**	**0.039**	**0.0063**
Projected Average[a,b]	**92**	**0.135**	**0.20**	**0.38**	**0.0374**	**0.0051**
Ten State Standards Domestic Design[c]	**100**	**0.17[c]**	**0.20**	**--**	**0.03**	**0.004**

Notes:
a. Per capita flows and loadings are based on 2012 estimated service population of 286,326.
b. Projected average is excluding the contribution from Northern Star Co. The loadings are added into the projections based on anticipated future loadings from Northern Star Co. but are kept separate than population projections.
c. Ten State Standards uses BOD_5 to estimate per capita.

The per capita flow rate is typical domestic sewered populations. The organic and nutrient loading rates per capita are higher than typical domestic sewage, specifically the $cBOD_5$, TSS, and TP. Given the significant loading reduction planned by Northern Star, a future projected average loading per capita was developed for calculating loadings beyond 2020 based upon the initial pretreatment reduction defined in Table 2-16. Northern Star growth after the pretreatment system is installed are accounted for separately.

2.2.3 Influent Flow and Loading Projections

With no known plans for additional industrial contributions to the sewerage system, future flows and loadings are based upon the following:

- Flows and loadings are projected to be directly proportional to the population growth of the surrounding communities.
- Projected annual average flows and loadings are based upon Thrive MSP 2040 population projections (5175 capita/year) and projected average unit flow and loading factors defined in Table 2-8.
- Northern Star (NS) loading reduction occurs in 2020 and NS planned growth/expansion all occurs by 2030. It is assumed a 1 pound reduction in Northern Star discharge equals a 1 pound reduction in Blue Lake WWTP influent loadings.
- Maximum month flows/loads are based upon highest maximum month peaking factor calculated over the last 5 years except TKN which is based upon the highest maximum month load.
- Future additional PHWWF and PIWWF flows are calculated by applying the MCES Thrive 2040 inflow/infiltration (I/I) design peaking factor of 2.0 for flows over 30 mgd to the projected annual average flow increase. This value is then added to the current (2020) PHWWF or PIWWF. See Appendix 2-1 for MPCA design flow determination worksheet.

Table 2-9 through 2-15 present the projected population forecasts and projected influent flows and loadings.

Table 2-9 Blue Lake Sewered System Projected Population Forecast

ITEM	CURRENT	2020	2030	2040	2050
Population	312,201	327,726	379,476	431,226	482,976

Table 2-10 Projected Influent Flows, mgd

CONDITION	CURRENT	2020	2030	2040	2050
Average	27.5	30	35	39	44
ADWF	24.7	27	31	36	40
AWWF	33.0	36	42	47	53
Maximum day	54.0	59	68	78	87
PHWWF	N/A	80	90	99	109
PIWWF	N/A	107	116	126	135

Table 2-11 Projected Influent 5-day carbonaceous biochemical oxygen demand loadings, lb/d

CONDITION	CURRENT	2020	2030	2040	2050
Average	59,000	49,000	60,000	67,000	74,000
Maximum month	74,000	62,000	76,000	85,000	94,000
Maximum day	104,000	87,000	106,000	118,000	131,000

Table 2-12 Projected Influent Chemical Oxygen Demand Loadings, lb/d

CONDITION	CURRENT	2020	2030	2040	2050
Average	129,000	116,000	139,000	158,000	178,000
Maximum month	168,000	150,000	181,000	206,000	231,000
Maximum day	286,000	256,000	307,000	350,000	393,000

Table 2-13 Projected Influent Total Suspended Solids, lb/d

CONDITION	CURRENT	2020	2030	2040	2050
Average	68,000	64,000	75,000	86,000	96,000
Maximum month	85,000	80,000	94,000	108,000	121,000
Maximum day	159,000	149,000	176,000	200,000	225,000

Table 2-14 Projected Influent Total Phosphorus Loadings, lb/d

CONDITION	CURRENT	2020	2030	2040	2050
Average	1,800	1,540	1,810	2,080	2,340
Maximum month	2,320	1,980	2,330	2,670	3,010
Maximum day	4,350	3,720	4,390	5,020	5,660

Table 2-15 Projected Influent Total Kjeldahl Nitrogen Loadings, lb/d

CONDITION	CURRENT	2020	2030	2040	2050
Average	11,000	11,200	13,200	15,200	17,100
Maximum month	13,800	14,100	16,600	19,000	21,400
Maximum day	18,700	19,000	22,400	25,700	29,000

2.3 *Future Solids Production*

The future solids projections are comprised of historical influent data, known changes (e.g. Northern Star pretreatment program), historical process performance data, and population projections to determine the rate of increase into the future. An existing BioWin process model was provided by Metropolitan Council as a method to develop future solids production projections. Details on how the BioWin Model was used for calculating current loadings is included in Appendix 2-3.

Influent solids loading projections were used in conjunction with anticipated industrial loadings and the BioWin Model to produce solids flow stream projections. These include initial projections in 2020 following the implementation of Northern Star's pretreatment system, 2030 population and Northern Star growth, and 2050 population growth. Northern Star's loadings were separated from the loading projections based on populations, however, other industrial loadings remained accounted for within the population projections. It would be anticipated to have industrial loading growth along with population growth; however, Northern Star was separated due to the scale and uniqueness of the waste stream. The projections incorporate low and high populations to create an envelope of potential future solids loading scenarios, see Table 2-16.

Table 2-16 Current and Future Average Solids Production Rates

STREAM	PARAMETER	CURRENT	2020	2030 - LOW	2030 - HIGH	2050 - LOW	2050 - HIGH
Primary Sludge: 1.5% solids	Flow, gpd	380,687	316,747	339,432	430,056	390,008	524,612
Primary Sludge: 1.5% solids	TS, lb/d	47,624	39,625	42,463	53,800	48,790	65,629
Primary Sludge: 1.5% solids	VS, lb/d	40,308	32,743	35,111	44,929	40,411	54,487
TPS: 4.8% Solids	Flow, gpd	111,386	92,611	99,213	125,734	114,009	153,330
TPS: 4.8% Solids	TS, lb/d	44,590	37,074	39,717	50,334	45,640	61,381
TPS: 4.8% Solids	VS, lb/d	37,821	30,704	32,914	42,125	37,882	51,064
WAS: 1.1% Solids	Flow, gpd	288,173	271,278	299,346	365,642	340,190	459,789
WAS: 1.1% Solids	TS, lb/d	26,437	24,887	27,462	33,544	31,209	42,181
WAS: 1.1% Solids	VS, lb/d	18,238	17,066	18,920	23,046	21,379	28,814
TWAS: 5.5% Solids	Flow, gpd	55,328	52,086	57,475	70,205	65,315	88,280
TWAS: 5.5% Solids	TS, lb/d	25,379	23,892	26,364	32,203	29,960	40,494
TWAS: 5.5% Solids	VS, lb/d	17,508	16,384	18,163	22,125	20,523	27,661
Digester Feed: 4.9% Solids	Flow, gpd	170,124	148,277	160,728	200,737	183,879	247,788
Digester Feed: 4.9% Solids	TS, lb/d	69,523	60,595	65,683	82,033	75,144	101,261
Digester Feed: 4.9% Solids	VS, lb/d	54,951	46,781	50,747	63,827	58,027	78,215
Digested Sludge: 2.7% Solids	Flow, gpd	192,726	158,989	172,250	214,072	197,130	265,597
Digested Sludge: 2.7% Solids	TS, lb/d	43,398	35,801	38,787	48,205	44,390	59,807
Digested Sludge: 2.7% Solids	VS, lb/d	25,827	21,987	23,851	29,999	27,273	36,761
Dewatered Cake	TS, lb/d	42,964	34,727	37,624	46,759	43,058	58,013

STREAM	PARAMETER	CURRENT	2020	2030 - LOW	2030 - HIGH	2050 - LOW	2050 - HIGH
Dewatered Cake	VS, lb/d	25,569	21,327	23,136	29,099	26,455	35,658

Notes:
Based on current average VSR of 53%.
Maximum month solids production values are 1.2 times average annual values based on mass balance at maximum month conditions. The dewatered cake projections directly relate to the dryer loading and generation of pellets and are displayed graphically in Figure 2-5.

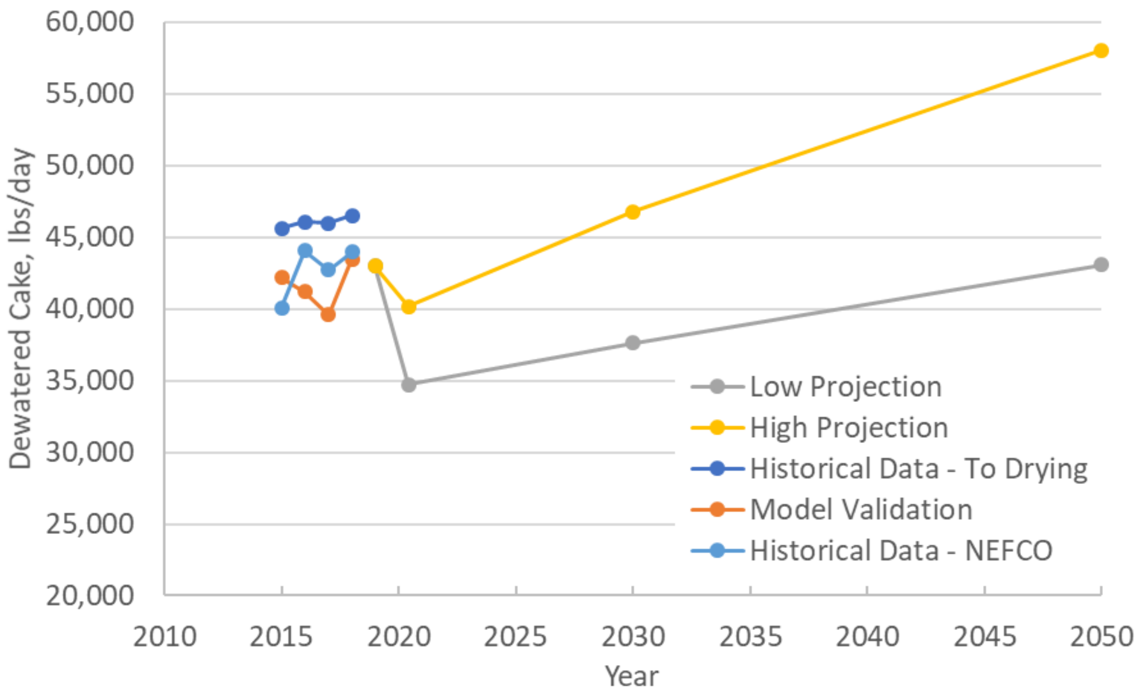


Figure 2-5 **Historical solids production and future solids projections based on population growth**

The solids projection envelope predicts an immediate drop in early 2020 due to the implementation of Northern Star's pretreatment process, but then it gradually increases as the plant begins increased production. As time progresses the envelope continues to widen showing the increasingly uncertainty of future projections. The main uncertainty with the solids projections shown is associated with the population projections and potential major industrial users.

This projection envelope can be used to plan future operations and capital improvements accordingly. The envelope provides a range of likely and more certain solids loading, these can be used to ensure Blue Lake WWTP facilities meet future needs while also not overbuilding based on one set of values.

2.3.1 Solids Projection Recommendations

There are numerous factors influencing the influent characteristics as well as the performance of the Blue Lake WWTP. The high and low limits of the projection envelope were developed based on population growth estimates or historic flows respectively, as well as assuming a significant decrease in loading by the largest industrial contributor. Although it is likely the actual change in the raw influent loadings will lay somewhere in the middle of the projection envelope, it is recommended that the Blue Lake WWTP plan for growth based on the high projections.

Planning plant growth based on the higher projection is the more conservative option, but it also may be the more realistic prediction as well. Both limits of the envelope are assuming Northern Star can remove over 80% of the total solids and phosphorus from the effluent they contribute, which could be optimistic. In addition, the high projection assumes the loading per capita remains constant, and bases the influent composition on the Thrive 2040 population growth plan. At a linear growth of 2% of the current community population, the Thrive 2040 population projections are aggressive, but it isn't unreasonable. The lower projection on the other hand assumes the loading per volume of water remains constant, and additional loading directly correlates to the increase in flow to the plant. While the flow projection may accurately predict future flows to the plant, the strength of the influent will continue to increase as water conservation measures continue to be implemented.

2.4 *IPIP Pretreatment Loading Projections Sensitivity Analysis*

The influent and solids flow and loadings projections presented in Sections 2.2 and 2.3 both assume Northern Star's pretreatment system is operational in 2020. The impact of Northern Star's pretreatment system operation was evaluated in terms of three components: influent wastewater characteristics which impact both liquids and solids stream facilities, influent loadings, and solids stream projections.

2.4.1 Influent Wastewater Characteristics

Figure 1-11 summarizes the impacts of operating the planned pretreatment system at Northern Star. In addition to the loading reduction identified, another key impact of the Northern Star's pretreatment system will be the change in Blue Lake influent wastewater characteristics critical for biological nutrient removal and solids generation. Figure 2-6 shows the projected impact of Northern Star's pretreatment on Blue Lake influent COD and phosphorus characteristics with and without the pretreatment system in 2050. Sections 2.3 and 2.3 address the significant impacts of the planned load reduction including:

- 50 to 60 percent reduction in influent total readily biodegradable COD (volatile fatty acids (VFA) plus readily biodegradable) which are critical enhanced biological phosphorus removal (EBPR) and impact BNR waste solids production.
- 20 percent reduction in influent TP with a 10 percent reduction in ortho-phosphate.

The sensitivity analysis accounts for less drastic reductions in influent COD and TP concentrations and characteristics if the Northern Star pretreatment system is not installed. Process modeling incorporates the influent wastewater characteristic changes shown in Figure 2-6 (2050 No Pretreatment) in the development of liquid stream alternatives and future biosolids production.

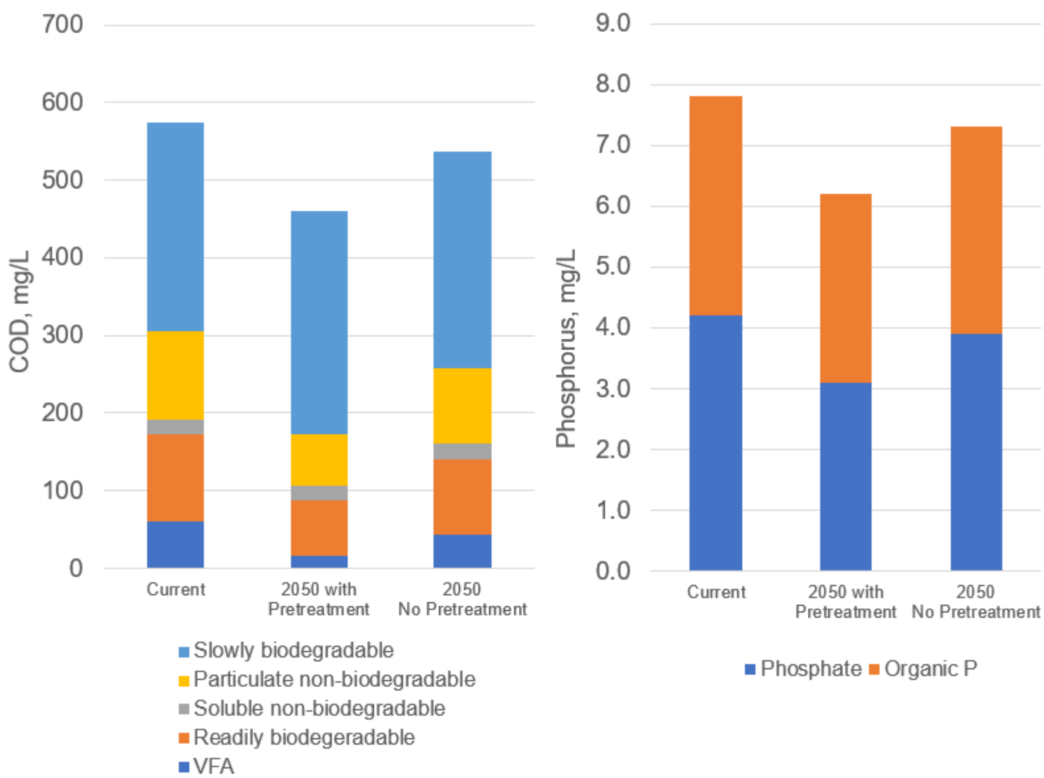


Figure 2-6 Impact of Northern Star pretreatment system on Blue Lake influent COD and phosphorus characteristics

2.4.2 Influent Loading Projections Sensitivity Analysis

Table 2-17 through Table 2-21 summarize the influent loading projections without Northern Star's planned pretreatment system pollutant loading reduction in 2020. Year 2020 loadings increase by the percentages shown in Figure 1-11 as a result of the higher loadings. The 2050 projected influent COD, $cBOD_5$, and TP loadings increase by 11 to 15 percent, influent TSS increases by roughly 7 percent, and influent TKN loadings increase by only 2 percent. Influent flow projections do not change from Table 2-10.

Table 2-17 Projected Influent 5-day Carbonaceous Biochemical Oxygen Demand Loadings without Northern Stars Planned IPIP Loading Reduction, lb/d

CONDITION	CURRENT	2020	2030	2040	2050
Average	59,000	61,000	71,000	78,000	85,000
Maximum month	74,000	77,000	91,000	100,000	108,000
Maximum day	104,000	107,000	127,000	139,000	151,000

Table 2-18 Projected Influent Chemical Oxygen Demand Loadings without Northern Stars Planned IPIP Loading Reduction, lb/d

CONDTION	CURRENT	2020	2030	2040	2050
Average	129,000	136,000	159,000	179,000	198,000
Maximum month	168,000	177,000	207,000	232,000	258,000
Maximum day	286,000	301,000	352,000	395,000	438,000

Table 2-19 Projected Influent Total Suspended Solids Demand Loadings without Northern Stars Planned IPIP Loading Reduction, lb/d

CONDITION	CURRENT	2020	2030	2040	2050
Average	68,000	71,000	82,000	93,000	103,000
Maximum month	85,000	90,000	104,000	117,000	130,000
Maximum day	159,000	167,000	193,000	218,000	242,000

Table 2-20 Projected Influent Total Phosphorus Demand Loadings without Northern Stars Planned IPIP Loading Reduction, lb/d, lb/d

CONDITION	CURRENT	2020	2030	2040	2050
Average	1,800	1,890	2,170	2,430	2,690
Maximum month	2,320	2,430	2,790	3,130	3,470
Maximum day	4,350	4,570	5,240	5,880	6,520

Table 2-21 Projected Influent Total Kjeldahl Nitrogen Demand Loadings without Northern Stars Planned IPIP Loading Reduction, lb/d, lb/d

CONDITION	CURRENT	2020	2030	2040	2050
Average	11,000	11,600	13,600	15,500	17,500
Maximum month	13,800	14,600	17,100	19,500	21,900
Maximum day	18,700	19,700	23,100	26,400	29,600

2.4.3 Solids Loading Projections Sensitivity Analysis

Table 2-22 summarizes the 2050 annual average solids loading projections without Northern Star's pretreatment system pollutant loading reductions in 2020. The flows and loadings are based upon the "high" or 2040 Thrive projections as these conditions were used in facility planning capital improvements planning. Compared to the 2050-high loadings presented in Table 2-17, the following correlation are observed without Northern Star pretreatment:

- 2050 annual average primary and thickened primary sludge loadings are roughly 3 to 4 percent higher
- 2050 annual average waste activated sludge (WAS) and thickened WAS (TWAS) loadings are roughly 15 percent higher than reported Table 2-5. The higher percent increase is the result of increased soluble COD loadings without pretreatment which ultimately increases WAS production in the secondary system.
- 2050 digester and centrifuge feed solids loadings increase by roughly 10 percent overall without pretreatment.

In addition, the 2050 maximum month solids loadings are 1.2 times annual average values as presented in Table 2-22.

Table 2-22 Blue Lake WWTP Solids Projections without Northern Stars Planned IPIP Loading Reduction

STREAM	PARAMETER	2050-AVERAGE (HIGH)
Primary Sludge: 1.5% solids	Flow, gpd	541,023
Primary Sludge: 1.5% solids	TS, lb/d	67,682
Primary Sludge: 1.5% solids	VS, lb/d	56,584
TPS: 4.8% Solids	Flow, gpd	158,383
TPS: 4.8% Solids	TS, lb/d	63,404
TPS: 4.8% Solids	VS, lb/d	53,118
WAS: 1.1% Solids	Flow, gpd	527,382
WAS: 1.1% Solids	TS, lb/d	48,382
WAS: 1.1% Solids	VS, lb/d	34,007

STREAM	PARAMETER	2050-AVERAGE (HIGH)
TWAS: 5.5% Solids	Flow, gpd	102,311
TWAS: 5.5% Solids	TS, lb/d	46,930
TWAS: 5.5% Solids	VS, lb/d	32,987
Digester Feed: 4.9% Solids	Flow, gpd	272,569
Digester Feed: 4.9% Solids	TS, lb/d	111,388
Digester Feed: 4.9% Solids	VS, lb/d	85,574
Digested Sludge: 2.7% Solids	Flow, gpd	300,067
Digested Sludge: 2.7% Solids	TS, lb/d	67,569
Digested Sludge: 2.7% Solids	VS, lb/d	40,165
Dewatered Cake	TS, lb/d	66,555
Dewatered Cake	VS, lb/d	39,562

3 Regulatory Review

3.1 *Current Requirements*

Table 3-1 lists the permits that regulate wastewater treatment and solids disposal by the Blue Lake WWTP, and associated permits, licenses and approvals needed for legal plant operations. MCES is currently in the permit renewal cycle with the applicable responsible governmental unit for expired permits. Expired permits remain in effect until they are re-issued. MCES is in compliance with permit renewal requirements.

Table 3-1 List of Permits, Licenses and Approval for the Blue Lake WWTP

PERMIT/ LICENSE/ APPROVAL	EFFECTIVE DATES	PERMIT NUMBER	RESPONSIBLE GOVERNMENTAL UNIT	NOTE
Air Quality Permit	06/18/99 - Indefinite	13900098-1	Minnesota Pollution Control Agency (MPCA)	Allows operation of 1250 kilowatt power generator for up to 500 hours per year
National Pollution Discharge Elimination System (NPDES) Permit	05/28/09 – 04/30/14	MN0029882	MPCA	Regulates wastewater treatment
Industrial Stormwater Permit	09/22/10 – 04/05/15	MNR05LT35	MPCA	Regulates stormwater discharge from the plant site. MCES has applied for site-specific coverage under NPDES/SDS.
Water Appropriation Permit	02/07/14 - indefinite	1992-6215	Minnesota Department of Natural Resources (DNR)	Regulates groundwater withdrawal
Biosolids State Disposal System (SDS) Permit	03/01/12 - 02/28/17	MN0064599	MPCA	Regulates wastewater solids handling and end use
Co-disposal of Wastewater Screenings and Grit Approval	03/06/09 - 03/09/11	M19-001 (DC Waste No.)	Dakota County	Provides for landfill disposal of wastewater solids collected from wastewater screenings and grit removal processes
Hazardous Waste Generator License	04/01/20 - 03/31/21	MND981798325	Scott County	Provides for storage of spent carbon from odor control facilities

Under the current NPDES permit, the Blue Lake WWTP can treat an average wet weather flow of up to 42 mgd of wastewater and continuously discharge treated water to the Minnesota River.

Plant facilities and equipment remove solids, organic compounds, ammonia and phosphorus from wastewater that enters the plant. Figure 3-1 is a topographic map showing the location of the Blue Lake WWTP relative to the plant's permitted discharge point in the Minnesota River at Surface Discharge station SD002. The Blue Lake WWTP has been in continuous compliance with permit limits for 15 years.

Wastewater solids collected at the Blue Lake WWTP are processed into pellets that meet Class A, Exceptional Quality (EQ) biosolids per Title 40 of the Codes of Federal Regulations (CFR) Part 503. As a Class A, EQ material, the pellets can be applied to land as a fertilizer without site restrictions. Management and storage of biosolids at the Blue Lake WWTP is regulated by the Biosolids State Disposal System (SDS) permit. A review of the data from the previous three years indicates the Blue Lake biosolids pellets have remained below the EQ limits for pollutants and have shown no regrowth of fecal coliform bacteria.

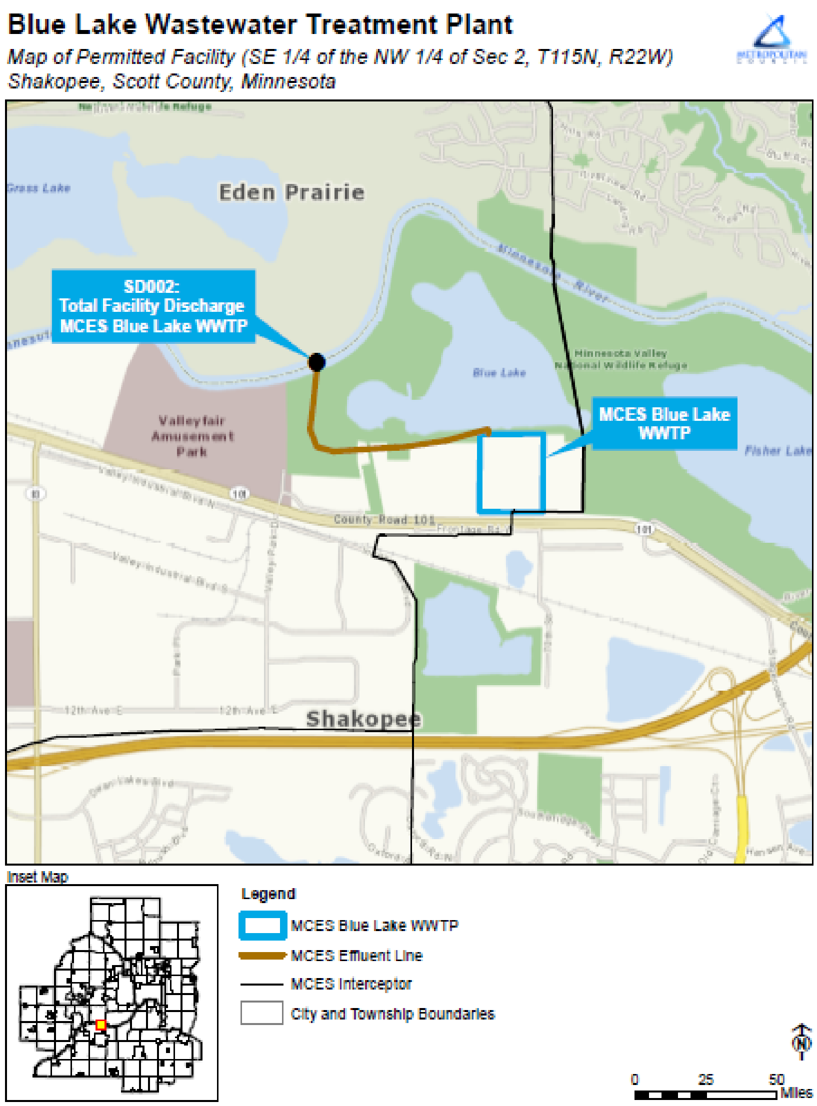


Figure 3-1 Location Map for the Blue Lake WWTP and Its Point Discharge (SDOO2)

3.2 *Potential for Regulatory Changes*

3.2.1 Phosphorus

The water body portion of the Minnesota River that the Blue Lake WWTP discharges to is currently listed on the MPCA 2018 Impaired Waters List with specific pollutant or stressor notes of “Nutrient/eutrophication biological indicators.” The MPCA has issued a River Eutrophication Standard (RES) for the Minnesota River that sets mass load (kg/day) limits for phosphorus from June to September. These limits are consistent with the Lake Pepin TMDL for phosphorus.

Based on communications with the MPCA, MCES anticipates that the MPCA will soon issue its review memorandum to establish a Total Maximum Daily Load (TMDL) for phosphorus loadings to the Minnesota River and to address phosphorus limits for NPDES wastewater treatment facilities. The TMDL, which is still in draft stage, is more protective from excess algae and results in reduced NPDES permit limits for phosphorus in the Blue Lake WWTP total discharge Table 3-2 compares existing and proposed NPDES permit limits.

Table 3-2 Blue Lake WWTP NPDES Permit Total Discharge Limits for Phosphorus

EFFECTIVE PERIOD	TYPE	UNIT	EXISTING LIMITS	PROPOSED LIMITS
Jan-Dec	12 Month Moving Total	kg/yr	58,024	17,407[a]
Jun-Sept	Calendar monthly Average	kg/d	N/A	100.1[a]
Jan-Dec	12 Month Moving Average	mg/L	1.0	1.0 mg/L

Notes:
a. Proposed mass load limits, based on the River Eutrophication Standard (RES) established for the Minnesota River, will require an effluent phosphorus concentration no greater than 0.3 mg/L at permitted average wet weather flow capacity of 42 mgd.

For the permitted average wet weather (AWWF) flow value of 42 mgd, the phosphorus concentration in the Blue Lake WWTP total discharge must be less than or equal to 0.3 mg/L to meet the Minnesota River RES standard.

Biological phosphorus removal was implemented at the Blue Lake WWTP in 2009 to meet existing total phosphorus discharge limits. Figure 3-2 is a chart of total phosphorus loading from the Blue Lake WWTP, which indicates that additional capital improvements will be needed to meet the proposed NPDES limits for phosphorus.

Evaluation of alternatives and the recommended capital improvements for addressing increased phosphorus removal requirements at the Blue Lake WWTP are included in this Facility Plan.

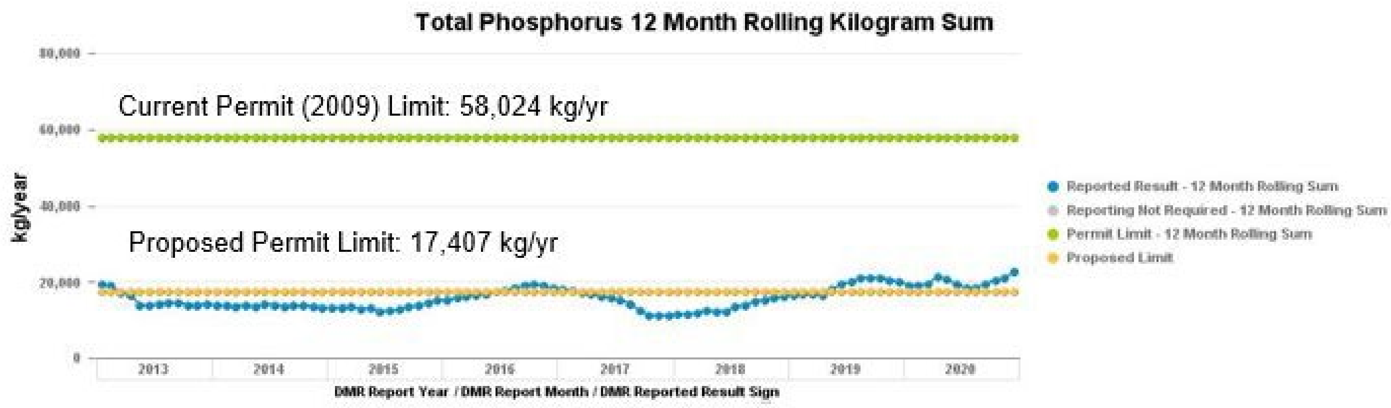


Figure 3-2 Blue Lake WWTP Discharge Total Phosphorus Load

3.2.2 Chloride

Due to observed increasing trends in chloride concentration in Minnesota rivers and streams, MCES reviewed all of its wastewater treatment plants for reasonable potential to exceed the 230 mg/L water quality standard (WQS) chronic limit for chloride. MCES used the MPCA's spreadsheet and available wastewater treatment plant data to calculate the reasonable potential to exceed the chloride water quality standard. Based on this review, MCES does not expect a Water Quality Based Effluent Limit (WQBEL) for chloride in the new Blue Lake WWTP NPDES permit.

Concerning the impact of the Blue Lake WWTP discharge on the chloride concentration in the Minnesota River, the following are key findings of this review:

- The Minnesota River has no observed chloride concentrations close to the state chloride WQS over the past 25 years.
- The Blue Lake WWTP does not have a reasonable potential to exceed the chloride water quality standard limits (pending formal determination by the MPCA).
- Chloride in Blue Lake WWTP process chemicals that are added to the wastewater for treatment (e.g., hypochlorite for disinfection) are estimated to comprise between 1.6% and 3.7% of the chloride in the Blue Lake WWTP discharge. The remainder enters the plant with the wastewater flow.

Because the Minnesota River is a large waterbody, high chloride concentrations in the Blue Lake WWTP discharge, up to 200% of measured values depending on river flow, will not result in the exceedance of the instream WQS.

MCES is also evaluating the impact of high chloride concentrations on the Whole Effluent Toxicity Testing (WET) required in the NPDES permit. MCES has found that hardness in the discharge protects microorganisms from the harmful effects of chloride. At this time, MCES believes they are not at an increased risk of failing the NPDES permit requirement for WET due to chloride.

3.2.3 Per- and Poly- fluoroakyl Substances (PFAS)

Per- and poly-fluoroakly substances (PFAS) --a group of numerous man-made chemical compounds—is a nationwide emerging contaminant of concern that has been linked to increased human health risks, including reduced immune system response, thyroid disease and cancer.

The MPCA is currently evaluating the need for PFAS water quality standards for Class 2 waters, and has recently established site-specific water quality criteria intended to increase protection from fish consumption, for PFAS compound, perfluorooctane sulfonate (PFOS):

- 0.37 nanograms PFOS per gram (ng/g) of fish tissue
- 0.05 nanograms PFOS per liter (ng/L) in surface water[11]

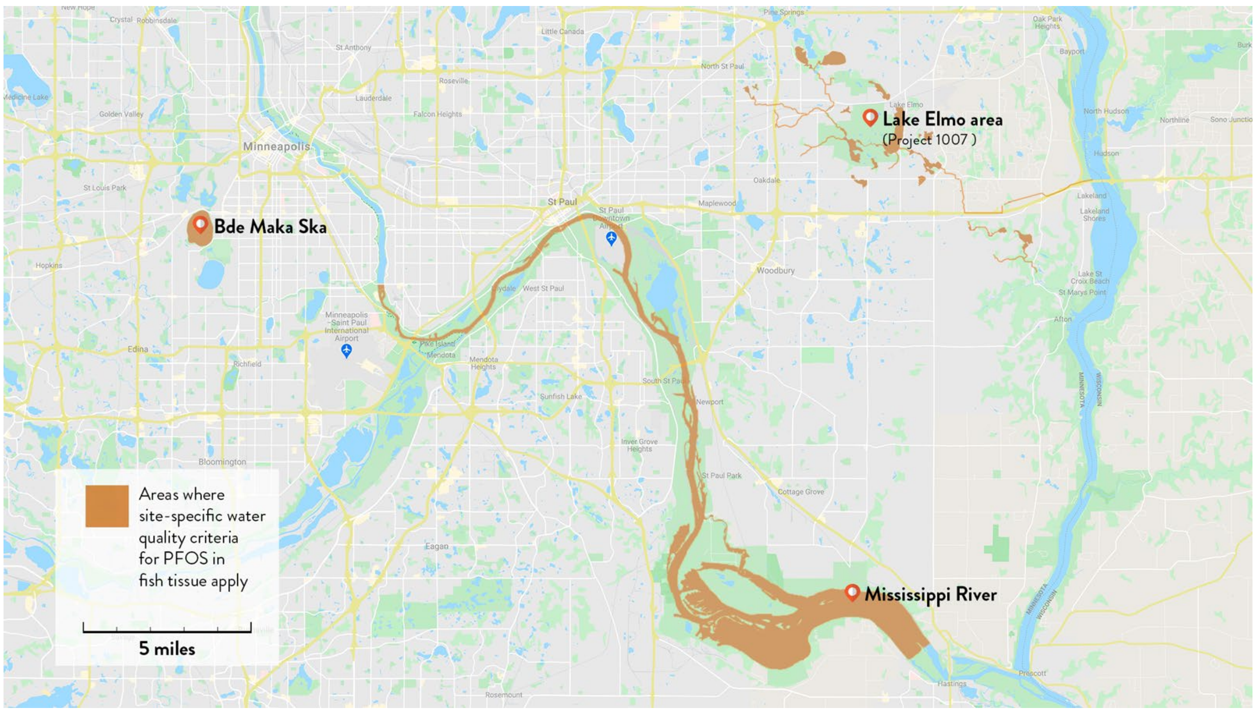


Figure 3-3 Waterbody sites for Perfluorooctane Substances (PFOS) Water Quality Criteria established by the Minnesota Pollution Control Agency (MPCA)

These water quality criteria apply to Lake Elmo and connected water bodies, Bde Maka Ska and Pool 2 of the Mississippi River, shown on Figure 3-3.

Because the Blue Lake WWTP discharges to Pool 2 of the Mississippi River, the Blue Lake NPDES permit (currently under review by the MPCA) may be impacted by the PFOS water quality criteria in the next permit reissuance. It is unknown to MCES how the PFOS water quality criteria will impact the Blue Lake WWTP permit requirements.

[11] This concentration is below the analytical detection limits, using analytical methods currently approved by the US Environmental Protection Agency (EPA).

The existing NPDES permit requires Blue Lake to monitor four (4) PFAS compounds quarterly in the discharge: Perfluorobutanoic acid (PFBA), Perfluorohexane sulfonate (PFHxS), Perfluorooctanoic acid (PFOA), and Perfluorooctane sulfonate (PFOS). Blue Lake effluent PFAS monitoring results since October 2012 are included in Appendix 3-1.

Due to the uncertainty in future regulatory requirements, there are no capital improvements for treatment of PFOS, or other PFAS chemical compounds, at the Blue Lake WWTP considered in this Facility Plan. Pending future evaluations, MCES expects that PFAS in wastewater treatment plant discharges may best be addressed through industrial wastewater source control.

Concerning PFAS in biosolids, the EPA and the MPCA are actively researching analytical methods and exposure pathways. Currently there is no EPA-approved method for measuring PFAS in biosolids. MCES is tracking future changes to MN Rules Chapter 7041 or 40 CFR 503 and intends to follow all regulations and best management practices as they evolve. Nationally, policy makers have been discussing the transport, fate and health impacts of microplastics, polyethylene and polyhydroxybutyrate microbeads, poly- and perfluo-alkyl substances (PFAS) and nutrients from land applied biosolids. To date, research has shown no measurable health impacts from these substances when applied to the land as a constituent in biosolids. Due to the uncertainty in future regulatory requirements for PFAS in biosolids, there are no changes to the management of wastewater solids at the Blue Lake WWTP considered in this Facility Plan.

4 Existing Facilities

An assessment of the treatment facilities was performed to evaluate the current condition and capacity of all buildings, equipment, and processes involved in the treatment processes at Blue Lake WWTP. The goal of the assessment is to inform staff where resources may be needed in the near term and what can be postponed for future projects. The solids treatment facilities include gravity thickeners, digesters, thickening & dewatering building, and the final stabilization facility. The liquids facilities include screens, grit system, primary clarifiers, aeration basins, secondary clarifiers, disinfection and effluent pumping. A summary of the existing facilities assessed can be found in Appendix 4-1.

The Condition Assessment found that some of the equipment in the plant was in poor condition and in need of immediate repair or replacement. A new project was started separate from the facility plan and is nearing the end of design. This project will advertise in the first quarter of 2021 and includes replacement of the Regenerative Thermal Oxidizer (RTO), pellet conveyance piping, Gravity Thickener AHUs, mixer feed conveyor, digester gas storage membrane, and associated instrumentation and valves. The cost of these upgrades is not included in the facility plan.

4.1 *Energy and Sustainability Reviews*

4.1.1 Energy Review

Consistent with the MPCA Minnesota Clean Water Revolving Fund Cost and Effectiveness Guidance Fact Sheet, MCES considered energy conservation, renewable energy and water conservation measures for this Facility Plan, as follows:

1. Energy Conservation
    a. Proposed fine bubble aeration diffusers in this Facility Plan will provide the highest level of aeration energy efficiency.
    b. The proposed project is limited to minor modifications to an existing wastewater treatment plant and is exempt from B3 SB 2030 Wastewater Treatment Plant Review[12].
2. Renewable Energy
    a. Digester gas utilization was evaluated as part of this Facility Plan. Continued use of digester gas in the dryer and the boiler is recommended (see Section 5.5.5).
    b. The new Regenerative Thermal Oxidizer (RTO), being provided under the current FSF Renewal Project, will increase RTO throughput. This will allow an estimated 28% increase in digester gas utilization in the dryer and reduced flaring (from 124 days to 24 days).
3. Water Conservation
    a. The Blue Lake WWTP reuses effluent water for non-potable uses, such as tank cleaning, within the plant. No additional opportunities to utilize effluent water were identified for this Facility Plan.

---

[12] Buildings, Benchmarks and Beyond (B3) Sustainable Building (SB) 2030 Wastewater Treatment Plant Review:

b. Potable use at the Blue Lake WWTP is limited to direct human contact uses and the city water meters (2) were replaced in 2010. No additional opportunities to reduce potable water use were identified for this Facility Plan.

4.1.2 Sustainability Review

The proposed project improves methane recovery from wastewater solids, which reduces fossil fuel derived energy, and returns more phosphorus to the environment in the form of fertilizer. Phosphorus is a non-renewable nutrient that promotes plant growth.

1. Methane Recovery - A previous construction project (2011) invested $28M at the Blue Lake WWTP to upgrade the plant and build infrastructure to recover methane from digester gas, which is 58% methane. The existing methane recovery approach is to use digester gas to fuel sludge dryers (with heat recovery) which offsets purchase of natural gas for drying.

   A separate project, initiated as a result of the planning activities conducted for this Facility Plan, will increase methane recovery by increasing the size of the dryer exhaust stack. This modification allows the dryer to continue to operate on digester gas, rather than transfer to natural gas service, during maintenance of a digester. The estimated greenhouse gas (GHG) emissions reduction is 2,330 tons per year as carbon dioxide (CO_2), based on 100-day reduction in wasted digester gas flaring.

2. Phosphorus Recovery – This Facility Plan recommends continuance of the existing biosolids treatment technology to produce Class A Exceptional Quality (EQ) biosolids at the Blue Lake WWTP. Alternative treatment technologies that do not produce EQ biosolids were considered unacceptable and screened from further consideration (see Section 5.4). This decision, along with increased phosphorus removal requirements, returns more phosphorus to the environment in a form that can be beneficially reused.

Wastewater treatment plant odors can impede good neighbor relations that are essential to sustainable wastewater treatment plant services. Based on review of the plant’s odor control systems (see Section 4.12.4), no odor control improvements are identified in this Facility Plan.

4.2 *Preliminary Treatment*

The preliminary treatment facilities include the liquid waste receiving, influent screening, and vortex grit removal. Two Parshall flumes are located directly downstream of the bar screens for influent flow metering, splitting and internal plant flow metering. A screened influent bypass is also located downstream of the bar screens.

4.2.1 Influent Junction Structure

The influent flow structure (IJS) is located upstream of the existing headworks building and is comprised of two main structures and connecting pipes as shown in Figure 4-1. The first structure is used to mix the flows from the Shakopee and Prior Lake interceptors and Minnesota River Siphon into one balanced influent flow. The final structure splits flow to the two influent channels leading to the east and west half of the screenings building.

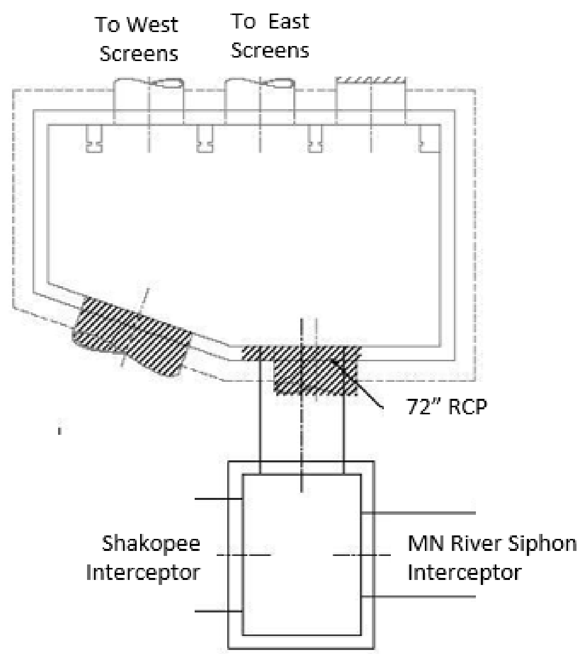


Figure 4-1 Influent Junction Structure

4.2.2 Liquid Waste Receiving

Receiving of trucked liquid waste was moved from the influent junction structure to the newly constructed liquid waste receiving (LWR) station in 2013. LWR currently has two discharge stations that direct waste through 12-inch laterals to the 72-inch North Interceptor line, which is located upstream of the IJS.

Liquid Waste Receiving Condition

Overall the LWR is in good condition but some areas will need attention.

Structural

The scale approach plate is coming loose and has surface corrosion. Curbs and painted metal have normal wear and tear. Concrete is in good condition.

Electrical

Electrical cabinets are in good condition but should be reviewed again in 10 years. Software for the kiosks was upgraded in 2019 and works well.

Process

Traffic capacity at LWR is frequently exceeded. During the day it is common for trucks waiting in line to backup past the plant entrance gate. Longer tanker trucks don't fit on the scale and must weigh in and out at their landfills. All data from the LWR computer system is entered manually into the Council's data system and there is no automated data upload.

Liquid Waste Receiving Capacity and Dumping Protocol

Several problems have been identified at the liquid waste receiving station. The liquids waste receiving station receives an average of 48 deliveries per day, 45% of which are within a 3-hour window (1:00 pm to 4:00 pm). During the peak unloading period, trucks line up along the plant entrance road. Increasing the dumping capacity by adding one more dump station could speed up operations. But there is only one-way entry into and out of the LWR gated area which adds queuing time for entry and exist. Trucks have no designated space for lining up, and when more than two trucks are waiting to enter the LWR, the bike path can be blocked.

When the scale is available, a truck signs in at the entry kiosk and then proceeds to the scale to obtain the "full" truck weight before dumping. The truck then pulls up to one of two dumping locations. Unloading times range from 10 to 20 minutes, depending on the size of the tanker. Trucks turn around and when the scale is available, they drive onto the scale, sign into the exit kiosk and obtain an empty weight. Exiting trucks pull up to the first turnaround and provide the guard shack with weights. The LWR layout is shown in Figure 4-2.

Figure 4-2 Liquid Waste Receiving Layout

Liquid Waste Receiving Expansion

Initial design concepts prepared during this facility plan need to be further developed during design to address dump station capacity and desired improvements in traffic flow and queue capacity.

4.2.3 Influent Screening

Influent screening consists of bar screens and a screenings conveyor.

Plant influent flow is conveyed from the influent structure to four, 8 ft wide channels, each with a climber style mechanically cleaned bar screen. The existing four bar screens are new having been recently updated in 2020. These screens are constructed of stainless steel. Under normal operations, two of the bar screens are in operation. The bar screens have 0.25-inch openings to capture rags and debris and protect downstream equipment. The 0.25-inch bar spacing minimizes the material that can pass through the screens. Most of the pass-through screening material is removed in primary clarifiers which is pumped to the gravity thickeners and further screened in the primary sludge screens. Previously the bar screens had 1-inch spacings which would occasionally pass through screenings which would result in operational problems for the grit pumps and gravity thickener sludge pumps.

Captured screenings are dropped onto a belt conveyor, washed and compacted, and conveyed to a dumpster for storage prior to disposal. The conveyor and screenings compactor was installed in 1992 and 2010 respectively and appear to be in good condition.

Influent Screening Capacity

MPCA requires that there must be an adequate number of units of a size such that, with the largest flow capacity unit out of service, the remaining will have a hydraulic capacity of at least 100% of the total peak instantaneous wet weather to that unit operation.

Projected peak instantaneous wet weather flows are:

- 2040 – 127 MGD
- 2050 – 135.4 MGD
- 2058 – 143.0 MGD

Each bar screen has a capacity of 74 mgd. However, each pair of bar screens is served by a single pipe with a capacity of 96 mgd. If any one screen is out of service, the current hydraulic capacity is 170 mgd reached by 74 mgd through the bar screen with an independent influent channel and 48 mgd each on the two bar screens sharing an influent pipe. That is adequate to meet projected wet weather flows through the planning horizon and no additional screening capacity is required.

4.2.4 Vortex Grit Removal

The vortex grit removal system consists of vortex grit tanks, grit pumps, and grit separators/washers. All grit tank facilities were installed in 1998.

Vortex Grit Tanks

There are two, 20-foot diameter, 12-feet deep circular vortex grit chambers. One grit chamber is dedicated to the east primary clarifier pod and the second to the west primary clarifier pod.

Each vortex grit chamber was designed to handle a peak hour flow of 40 mgd. With both units in service, the grit chambers can handle a peak hour flow of 80 mgd. The grit tanks can be bypassed if taken out of service for maintenance. Plant staff expressed concern of overloading the grit tanks if channels are not brought into service slowly, as discussed previously.

Grit Pumps

Each grit tank has two Wemco Model C grit pumps providing complete grit pumping redundancy. Grit pumps are in the tunnel galleries adjacent to the grit tanks. Grit is pumped continuously to traditional hydrocyclone grit washer/classifiers located in the Screenings Building. These pumps and associated piping show signs of wear and will need replacement during the planning period.

Grit Separators/Washer

In 2010 a new screenings washer was installed. At the same time the existing grit cyclones and classifiers were relocated for easier maintenance and a third train was added for resiliency. The plant reports that these are functiong well. The grit systems so far have had capacity to handle the increase removal but there has not been a peak event to study the effect on the system. At this time no improvements are needed to the system but a review of the piping and capacity is recommended if 5 years.

The grit slurry is pumped to Wemco Hydrogritters consisting of three cyclonic separators, each feeding to a screw type grit classifier (washer). The underflow from each cyclone is approximately 20 gallons per minute (gpm) and is discharged directly to the grit washer. The wasted grit appears to be relatively dry and is discharged directly to a dumpster for disposal in a landfill.

Vortex Grit Removal Capacity and Recommendations

MPCA guidelines do not address preliminary treatment units, disinfection, sludge handling, or collections systems. Grit tanks do not require redundancy, but for planning purposes, it was assumed that grit tanks will be designed to hydraulically handle peak instantaneous flows. Table 4-1 shows projected peak hour flows.

Table 4-1 Peak Hour Projected Flows

YEAR	2020	2030	2040	2050	2058 (PROJECTED PERMITTED FLOW)
Peak Hour Wet Weather Flow	80.1	89.7	100.1	108.5	116.1
Peak Instantaneous Wet Weather Flow	107.0	116.6	127.0	135.4	143.0

Each grit tank currently services one set of four primary clarifiers. Planned for is one additional separate grit unit process to be added to service the next set of primary clarifiers during the next primary treatment expansion. The new grit removal system will be dedicated to the new primary clarifier pod. Channels and basins for the new primary treatment system will be designed to meet peak instantaneous hydraulic requirements.

A layout of recommended grit system modifications can be found in Figure 4-3.

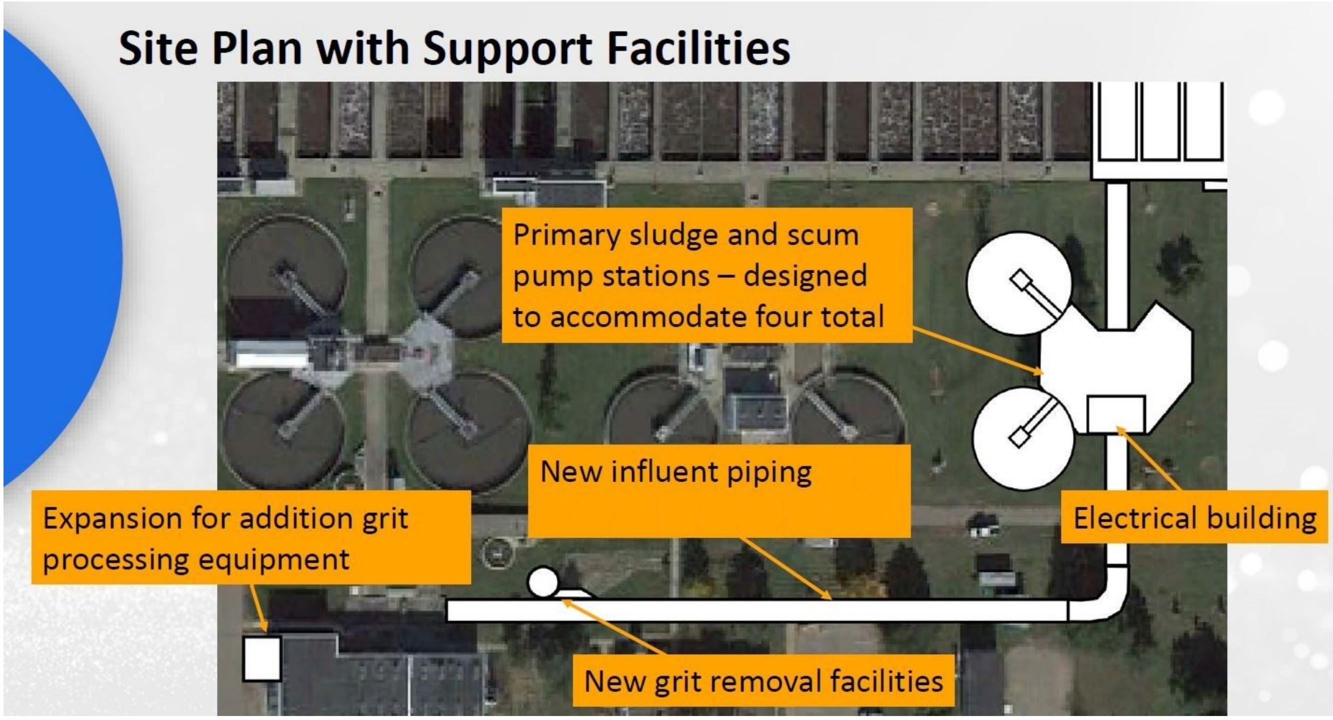


Figure 4-3 Recommended Grit System Modifications

4.2.5 Parshall Flumes

There are two Parshall flumes, one downstream of each bar screen channel. Each flume has a 48-inch throat width and a capacity of 47 mgd. The Parshall flumes are used for flow pacing the return acticvated sludge flows and also serve to split the incoming flows to the east and west primary clarifier pods. The flumes are currently not used for influent flow metering/reporting purposes. Each flume is dedicated to one pod of the primary clarifiers. These units have performed well. MCES is currently planning to construct enclosures around the Parshall flumes for maintenance purposes during cold weather. A third flume will be added with the third grit tank/primary clarifier pod is added.

4.2.6 Primary Influent Bypass

Downstream of the influent bar screens is a junction chamber which allows flow to be directed to either the east or west primary clarifier pods. Included in this junction chamber is a primary influent bypass. The 48-inch primary influent bypass conduit was designed to route flows in excess of 80 mgd to the aerated lagoon. Plant procedures do not allow for use of this bypass line and it is considered abandoned in place.

4.2.7 Recommended Preliminary Treatment Improvements Summary

Table 4-2 summarizes recommended improvements for the preliminary treatment facilities with projected construction costs. Construction costs for the new Parshall flumes vortex grit removal system and associated influent piping (roughly $3 million) are included in Section 4.2 under costs for constructing the two new primary clarifiers. The Sum Total for Phase I is $2,017,500, for Phase II is $282,000, and Phase III is $1,265,000.

Table 4-2 Recommended Preliminary Treatment Improvements

AREA	DISCIPLINE	IMPROVEMENT	PHASE I (<10 YEARS)	PHASE II (10-15 YEARS)	PHASE III (15-30 YEARS)	TYPE OF PROJECT
SCB	Arch	Replace doors & refinish frames	$5,000	$0	$0	P
SCB	Elec	Replace MCC-1E & 2E	$90,000	$0	$0	P
SCB	Elec	Replace T1E and T2E	$330,000	$0	$0	P
SCB	HVAC	Replace AHU-01,02, 03, ACC-03	$0	$282,000	$0	P
SCB	Process	Retrofit Grit Collection Units (x2)	$150,000	$0	$0	P
SCB	Process	Replace Grit System & Piping	$0	$0	$1,250,000	I
LWR	Str	Install Electromagnetic Shield Canopies	$15,000	$0	$0	I
LWR	Str	Repair and Repaint Metal Surfaces	$5,000	$0	$0	P
LWR	Str	Replace Scale Approach Plate	$2,500	$0	$0	P
LWR	Elec	Replace Kiosks (x2)	$0	$0	$10,000	P
LWR	Elec	Replace Electrical Panels	$0	$0	$5,000	P
LWR	Process	LWR Expansion	$1,420,000	$0	$0	E

- Area of Project: Screenings Building (SCB), Liquids Waste Receiving (LWR)
- Type of Project: Preservation (P), Improvements (I), Expansion (E)
- Construction costs presented in 2020 dollars and do not include engineering or administration

4.3 *Primary Treatment*

Primary treatment is provided by eight primary clarifiers. Each clarifier is 80 feet in diameter with a side water depth of 12 feet. The clarifiers are grouped into two sets of four clarifiers each, the East (EPR) and West (WPR), with a grit system and an electrical and controls building for each group.

4.3.1 Primary Clarifiers

The clarifiers are grouped into two pods of four clarifiers. The west primary clarifiers were installed in 1973 and the collection mechanisms were replaced in 2011. The east primary clarifiers were installed in 1992 and the collection mechanisms were painted in 2011. Plant staff have reported that the primary clarifiers have been very reliable. The plant takes one or two primary clarifiers down each year for cleaning. The cleaning is scheduled during dry weather.

Architecturally the buildings are in good shape except for a portion of the roof. The concrete for the tanks, walls, walkways and buildings are in good shape with no recommended repairs. There are five roof sections over the clarifier electrical and control buildings. The EPR was extended in 2011 and has a roof in good condition. All the WPR and half of the existing EPR were replaced in 2018 and are in good shape. The west half of the existing EPR structure has a leaking roof that is over 20 years old and needs to be replaced. Also, the doors to both electrical buildings have started corroding and need to be replaced. The frames are in good shape and need to be repainted.

The HVAC systems were replaced in 2011 and are in good condition and will be revaluated in 5-10 years. The controllers will need to be upgraded to work with new building automation software.

The transformers and EPR MCCs are over 30 years old and in need of replacement. The WPR MCCs were installed in 2011 and are starting to have surface corrosion. The corrosion needs to be cleaned off and the clean air supply to the MCCs needs to be verified to prevent future corrosion. Many miscellaneous components are old and corroding and in need of replacement. These components include bolts on disconnects, Unistrut, load banks, and lighting conduits.

The clarifier mechanisms are in fair shape. They are expected to have a life span of 40 years when protective coatings are applied at 20 years. The east mechanism was repainted in 2011 and will need to be replaced in 10 years. The west mechanism was installed in 2011 and will need to be painted in 10 years. The grit equipment is over 20 years old and nearing end of life. The equipment will be replaced in 5-10 years while the grit pumps are in good shape except for surface corrosion and will be repainted.

Each set of two primary clarifiers has three, 420 gpm constant speed Wemco Model C recessed impeller pumps for pumping primary sludge to the gravity thickeners. The west and east primary sludge pumps are original equipment. These pumps appear to be in good operating condition. The east primary sludge pumps had corrosion build-up on the pumps. Each primary clarifier sludge pump operates for 30 minutes every 2 hours. Thus, two sludge pumps are running simultaneously during typical operations.

4.3.2 Primary Scum Pumps

Primary scum is collected in four sump pits (one pit per two clarifiers) and pumped out weekly into trucks at primary clarifiers and hauled to the Metro Plant. Each clarifier has one, 200 gpm scum pump. These pumps were installed in 1992. Several scum pumps have recently been refurbished with new pump casings. These pumps are showing corrosion and reaching end of life. The pumps should be replaced in 5-10 years.

4.3.3 Primary Scum Grinders

Each primary clarifier has a dedicated twin-shaft style primary sludge grinder. These units were installed in 1992 and have operated well. They appear to be in good condition but are showing corrosion and reaching end of life. The grinders should be replaced in 5-10 years.

4.3.4 Primary Clarifier Capacity

Clarifier capacity is determined by surface overflow rates and weir loading rates. The current capacity of the primary clarifiers is shown in Table 4-3.

Table 4-3 Current Primary Clarifier Capacity Summary

CAPACITY	NO REDUNDANCY	REDUNDANCY (1 CLARIFIER OUT OF SERVICE)	FLOW PER CLARIFIER
Average Flow SOR (1,000 gpd/ft^2)	40 mgd	35 mgd	5 mgd
Peak Hourly Flow Max SOR (2,500 gpd/ft^2)	100 mgd	88 mgd	12.5 mgd
Average Flow WLR, (30,000 gpd/lf)	121 mgd	106 mgd	15 mgd

The capacity of the clarifiers needs to be equal to the influent loading plus the volume of internal plant recycle flows routed back to the primary clarifiers. The internal plant recycle flows currently average 3 to 4 mgd with future plans for up to 9 mgd if tertiary filtration is installed.

The current primary clarifiers do not have capacity to accommodate the projected growth shown in Section 2. In order to meet the projected growth one additional clarifier is needed by 2032 and a second by 2046 to meet peak hourly flow capacity needs with 9 mgd of internal plant recycles. The two additional primary clarifiers would be built as half of a third pod of four clarifiers. There will be an electrical and controls building and a designated vortex grit unit for the pod to match the two existing pods.

4.3.5 Recommended Primary Treatment Improvements

The recommended primary treatment improvements are presented in Table 4-4. As noted above, the two new primary clarifiers in Group II include costs for the new Parshall flume, vortex grit removal, and influent piping to the primary clarifiers. Table 4-4 also includes costs for raising the primary clarifier weirs, scum boxes, clarifier collector arms by 5-inches to address existing hydraulic constraints in order to achieve the treatment capacities noted in Table 4-3. The Sum Total for Phase I is $2,495,500, for Phase II is $21,679,000, and Phase III is $22,500.

Table 4-4 Primary Treatment Improvement Recommendations

AREA	DISCIPLINE	IMPROVEMENT	PHASE I (<10 YEARS)	PHASE II (10-15 YEARS)	PHASE III (15-30 YEARS)	TYPE OF PROJECT
EPR	Arch	Replace West Roof	$50,000	$0	$0	P
EPR	Elec	Replace MCCs	$225,000	$0	$0	P
EPR	Elec	Replace Transformers	$50,000	$0	$0	P
EPR	Elec	Replace Lighting Circuits	$90,000	$0	$0	P
EPR	HVAC	AHU Replacement	$0	$177,000	$0	P
EPR	Process	Replace Grit Equipment	$362,500	$0	$0	P
EPR	Process	Replace Clarifier Mechanism	$0	$3,022,000	$0	P

AREA	DISCIPLINE	IMPROVEMENT	PHASE I (<10 YEARS)	PHASE II (10-15 YEARS)	PHASE III (15-30 YEARS)	TYPE OF PROJECT
EPR	Arch	Replace Electrical Building Doors	$5,000	$0	$0	P
WPR	Elec	Clean MCCs 4A & B	$2,500	$0	$0	P
WPR	Elec	Replace LBs	$5,000	$0	$0	P
WPR	Process	Replace Grit Equipment	$362,500	$0	$0	P
WPR	Process	Resurface Clarifier Mechanism	$100,000	$0	$0	P
WPR	Process	Construct 2 new primary clarifiers	$0	$18,480,000	$0	E
WPR	Arch	Replace Electrical Building Doors	$5,000	$0	$0	P
EPR + WPR	Mech	Primary scum handling	$438,000	$0	$0	P
EPR + WPR	Mech	Primary sludge pump replacement	$0	$0	$22,500	P
EPR + WPR	Process	Raise clarifier weirs and scum boxes	$800,000	$0	$0	E

- Area of Project: East Primary Clarifiers (EPR), West Primary Clarifiers (WPR)
- Type of Project: Preservation (P), Expansion (E)
- Construction costs presented in 2020 dollars and do not include engineering or administration

4.4 *Secondary Treatment*

Secondary treatment is currently achieved using a nitrifying activated sludge system modified with coarse air selectors for biological phosphorus removal. The secondary system consists of aeration tanks, aeration blowers, final clarifiers, return activated sludge (RAS) pumps, waste activated sludge (WAS) pumps, scum pumping, aeration equipment, and an aerated pond.

4.4.1 Aeration Basin Condition

The aeration basins complex is in good condition. Some concrete cracking has occurred, and these cracks can be caulked when discovered. The electrical conduits to the analyzers fill with water and need to be rerouted to prevent damage to the wires and instruments. The fine bubble diffusers are fouling. They were installed in 2008 and should be replaced in the next 5-10 years. Also, the DO sensors continue to fail and should be replaced with new sensors as well as a compressed air line for automatic cleaning.

4.4.2 Aeration Basin Capacity

To determine aeration basin capacity, organic loading rates were reviewed and compared to state guidelines. Minnesota guidelines currently recommended aeration basin loadings are limited to 20-25 lbs BOD/1,000 cu ft. Historically the plant has all aeration basins in service and can schedule any cleaning during lower flow periods. Table 4-5 shows that the aeration basin capacity is sufficient to handle 2050 projected loadings.

Table 4-5 Aeration Basin Capacity Summary

AVERAGE ORGANIC LOADING (LB BOD/1,000 CU.FT.)	ALL BASINS IN SERVICE
2020	13.5
2030	16
2040	18
2050	20

4.4.3 Blower Building Condition

The blower building was built in 1973 and has undergone multiple upgrades. Most of the building is in good shape currently. Architecturally, the areas of concern are with the building envelope and rain entering the building. Rainwater enters the building through the roof, the west side wall, and south building walls. The roof membrane was installed in 2011 and appears to be in good condition. Upgrades to the curtain wall and site drainage to provide for drainage away from the building are needed as well as inspection of the window seals and other possible sources for the roof leak.

Electrically much of the building was replaced in 1990 and is reaching the end of life. These items include motor control centers and transformers. These should all be replaced in the next 5-10 years. For energy savings, the high-pressure sodium lights and T8 fluorescents should be replaced with LED fixtures.

Mechanically things are in good shape. A review of the HVAC system should be completed in 10 years and a P-trap should be added on the air handling units (AHUs). The blowers are 28 years old and in good condition.

4.4.4 Blower Building Capacity

There is currently sufficient capacity in the blower system. Two blowers are typically in service and this is appropriate for the summer and provides too much air in the winter, but one blower cannot handle the winter demand. As the flow increases one or two additional blowers of smaller size would help the air supply match the air demand without overaerating. The smaller blowers could be used with one big blower in winter or could be used for increased summer demand without the energy consumption of a third large blower.

4.4.5 Secondary Clarifiers

Aeration tank mixed liquor is conveyed to the secondary clarifier splitter box. The splitter box evenly distributes flows to eight, 125-foot circular secondary clarifiers. Each clarifier has a 16-foot sidewater depth. The clarifiers were constructed in 1992. The collector mechanism has a 12-foot diameter influent well and a 45-foot diameter flocculation well. The collector mechanism sludge removal system is a combined scraper and hydraulic sludge draw-off system. There is one central electrical building and a north and south pump gallery, each designated to a pod of four final clarifiers.

4.4.6 Secondary Clarifier Condition

The eight clarifiers are in good condition including the concrete and the mechanisms. All the mechanisms were installed new in 2010 and should be repainted in 10 years.

The Secondary Clarifier pump galleries both suffer from water intrusion from multiple sources. The ballast on the roof has been displaced and allowed the membrane to move. The caulking at the construction joints shows leakage and mold and should be replaced. Also, the wall penetrations leak and new link seals should be installed. Mechanically and electrically there are no concerns in the pump galleries currently. The HVAC system should be inspected in 10 years.

Twelve non-clog centrifugal variable speed pumps are used to pump RAS to the RAS distribution box near the aeration tanks. Each final clarifier has one dedicated 2400 gpm pump. Plant operations show these pumps have a practical capacity of 2,100 gpm (3 mgd) under current conditions. A standby RAS pump is provided for every two clarifiers. These pumps are currently in good condition and operating well.

The Secondary Clarifier Electrical Building is 30 years old and has many original electrical components that are nearing the end of life. The motor control centers, and the transformers should be replaced within 5-10 years. The electrical building roof is in good condition, but the foundation joints are leaking, and molding and the caulking should be replaced. Also, the fiberglass gel coat needs to be reapplied to many doors.

Mechanically the HVAC system is in good shape and should be inspected in 10 years. The building sump pumps are at capacity and should be increased in size.

4.4.7 Secondary Clarifier Capacity

The existing secondary clarifiers currently have hydraulic capacity to treat flows up to 80 to 90 mgd prior to either the secondary clarifier weirs or mixed liquor distribution box weirs becoming flooded. Section 5.1 identifies the hydraulic improvements needed to relive the existing hydraulic constraints and defines the additional secondary clarifiers needed for process capacity.

4.4.8 RAS Distribution

The RAS Distribution Building (RDB) was new in 2011 and has no issues currently reported. The WAS pumps are located in the tunnel beneath the RDB. There are four variable speed progressing cavity pumps used for WAS pumping. Each pump is rated for 1,400 gpm. These pumps were installed in 1992 and appear to be in good condition but will reach their end of life within the next 20 years.

4.4.9 Aerated Pond

Following secondary treatment, secondary effluent is directed to an aerated pond. This pond has a storage volume of 24.6 million gallons. The pond is equipped with coarse-bubble diffusers. The pond provides additional treatment for bypassed plant influent flows prior to disinfection and equalizes high secondary effluent solids events. There is no recommended action concerning the pond currently.

4.4.10 Recommended Secondary Treatment Improvements

Table 4-6 summarizes the secondary treatment recommended improvements associated with facility and equipment rehabilitation and level of service improvements. Section 5-1 presents facility improvements and associated construction costs for secondary treatment capacity improvements. The Sum Total for Phase I is $8,578,000, for Phase II is $0, and Phase III is $10,029,000.

Table 4-6 Secondary Treatment Improvement Recommendations

AREA	DISCIPLINE	IMPROVEMENT	PHASE I (<10 YRS)	PHASE II (10-15 YRS)	PHASE III (15-30 YRS)	TYPE OF PROJECT
AET	Elec	Replace analyzer conduit	$10,000	N/A	N/A	P
AET	Process	Replace fine bubble diffusers	$3,040,000	N/A	N/A	P
AET	Process	Replace dissolved oxygen sensors	$200,000	N/A	N/A	P
BLB	Arch	Investigate roof leaks	$5,000	N/A	N/A	P
BLB	Arch	Replace curtainwall system	$35,000	N/A	N/A	P
BLB	Arch	Investigate basement wall leaks	$5,000	N/A	N/A	P
BLB	Elec	Replace MCC-3H	$135,000	N/A	N/A	P
BLB	Elec	Replace MCC-3HA, 4HB, 1H, 2H	$270,000	N/A	N/A	P
BLB	Elec	Replace T1H & T2H	$290,000	N/A	N/A	P
BLB	Elec	Replace Lighting	$100,000	N/A	N/A	I
BLB	HVAC	Replace AHU-01, 02, 03 & ACC-02, 03	$145,000	N/A	N/A	P
BLB	Process	Install new Jockey Blowers (x2)	$3,590,000	N/A	N/A	I
BLB	Process	Blower Replacement (x4)	N/A	N/A	$9,489,000	P
SEB	Arch	Clean & re-seal stairwell panel/ foundation joint	$5,000	N/A	N/A	P
SEB	Arch	Investigate roof leaks	$10,000	N/A	N/A	P

AREA	DISCIPLINE	IMPROVEMENT	PHASE I (<10 YRS)	PHASE II (10-15 YRS)	PHASE III (15-30 YRS)	TYPE OF PROJECT
SEB	Arch	Electrical Building: Clean & re-seal panel/ foundation joint	$5,000	N/A	N/A	P
SEB	Elec	Electrical Building: Clean valve PV-162 disconnect	N/A	N/A	N/A	P
SEB	Elec	Electrical Building: Replace T1J & T2J	$113,000	N/A	N/A	P
SEB	HVAC	Electrical Building: Replace AHU-01, 03, 04 & ACC-01	$345,000	N/A	N/A	P
SEB	Process	Electrical Building: Replace sump pumps SE-J1 & J2	$10,000	N/A	N/A	P
SEB	Process	Pump Galleries: Remove scum pumps and piping	$20,000	N/A	N/A	P
SEB	Process	Resurface and repaint collector mechanisms	$200,000	N/A	N/A	P
RDB	HVAC	Replace AHU-01 & ACC-01	$45,000	N/A	N/A	P
RDB	Process	Replace WAS Pumps (x4)	N/A	N/A	$540,000	P

- Area of Project: Aeration Basins (AET), Blower Building (BLB) Secondary Clarifier (SEB), RAS Distribution Building (RDB)
- Type of Project: Preservation (P), Improvements (I)
- Construction costs presented in 2020 dollars and do not include engineering or administration
- See Section 5.1 for secondary treatment capacity and process efficiency related recommended improvements.

4.5 *Disinfection*

The effluent disinfection and dechlorination is provided using liquid sodium hypochlorite and liquid sodium bisulfite. The chlorination and dechlorination systems were both switched from gaseous to liquid systems in 2009.

4.5.1 Chlorination System Description

The disinfection system includes four 5,234-gallon sodium hypochlorite storage tanks, two large variable speed feed pumps with a capacity of 11,260 lbs/day, and 4 small variable speed feed pumps with a capacity of 750 lb/day. Two 54 mgd chlorine contact tanks are located adjacent to the disinfection building.

Sodium hypochlorite feed pumps convey chemical to each of four chemical induction units (two duty, two standby) located in the mixing chamber upstream of each chlorine contact tank. During normal operations, two small feed pumps serve as the duty pumps for each chlorine contact tank and one large feed pump serves as the standby pump. During high flow/high demand periods, the large pump is available to serve as the duty pump. The large pumps can also be used to deliver sodium hypochlorite to the return activated sludge for control of sludge bulking.

Sodium hypochlorite flow rate is variable based on influent flow and an operator selected target chlorine concentration at the point of addition. Chlorine residual is monitored by the programmable logic controllers (PLC) through the 5-minute and 30-minute chlorine analyzers. The PLC monitors the 5-minute chlorine residual value to ensure value is not higher than target concentration. The 30-minute chlorine residual value is used to adjust the sodium hypochlorite feed rate to maintain a residual prior to dechlorination of between 0.2 to 0.5 mg/L.

4.5.2 Dechlorination System Description

The dechlorination system includes two 5,234-gallon sodium bisulfite storage tanks and three variable speed feed pumps with a capacity of 2,280 lb/day.

The three variable speed feed pumps operate in a lead/lag/standby arrangement and deliver chemical to a single diffuser located at the entrance to the effluent channel upstream of the Parshall flume. Sodium bisulfite flow rate is based on the influent flow, the chlorine residual measured in the 30-minute chlorine residual analyzer, and an operator entered safety factor to ensure all residual chlorine is removed from the effluent prior to discharge.

4.5.3 Chlorine Contact Tank Description

There are two parallel chlorine contact tanks. Each tank has a volume of 56,545 gallons at a side water depth of 11.84 feet. The actual depth, and volume, varies with flow as the Parshall flume on the combined outlet from the tanks controls the liquid level in the tank. The tanks were constructed with a serpentine flow pattern. Two chemical induction units are provided in the mixing chamber ahead of each chlorine contact tank for mixing of sodium hypochlorite. The chlorine contact tank provides 15 minutes of detention time at a peak hour flow rate of 108 mgd with both contact tanks in service.

4.5.4 Condition of Chlorination System

The system has been maintained and is in generally good condition. Specific system items of note are as follows.

Disinfection Building

Sodium bisulfate sump pumps are starting to corrode, pumps and motors need to be cleaned. Mechanical systems are in good condition, recommend replacing in 5 to 10 years. Architecturally the roof system, precast walls, windows and doors were all replaced in 2011. Roof and precast walls are in good condition and no issues have been reported for the windows. The doors have ongoing issues. Faulty door panels need to be replaced and doors/frames need repainting using a compatible preparation and finish system. Electrical system is in good condition and no issues were reported.

Chlorine Contact Tanks

Tanks will require additional capacity to achieve target contact time during peak flow. Recommend expanding contact basins in 10-30 years.

4.5.5 Capacity of Chlorination Systems

Blue Lake's current NPDES permit disinfection requirements are presented in Table 4-7. These permit conditions are not anticipated to change in the future.

Table 4-7 NPDES Disinfection Requirements

EFFLUENT CHARACTERISTIC	VALUE
Maximum daily total residual chlorine limit	.038 mg/L
Fecal coliform monthly geometric mean	200 MPN/100 mL
Yearly disinfection period	April 1 to October 31

Ten State's Standard's, as presented in Table 4-8, were considered along with the NPDES permit requirements in analyzing the capacity of the chlorination system.

Table 4-8 Ten State's Standards Disinfection Requirements

TEN STATE'S STANDARDS REQUIREMENTS	VALUE
Maximum day chlorine usage, for nitrifying activated sludge systems	6 mg/L
Maximum day chlorine usage	Compare to historical usage
Standby equipment	Sufficient to replace largest unit during shutdowns

Chlorine dosages and usage for 2014 to 2019, as shown in Table 4-9, were used for the historical usage comparison.

Table 4-9 Historical Chlorination Dose and Usage

YEARS 2014-2019	AVERAGE	MAXIMUM DAY	MAXIMUM WEEK
Dose Rate, mg/L	1.1	4.8	2.6
Usage Rate, ppd	298	997	625

Current disinfection capacity can maintain 15 minutes of chlorine contact time at the peak hour of 108.5 mgd plus 4 mgd of recycle flow as shown in Table 4-10. Total firm capacities are based on continuing the use of 12.5% sodium hypochlorite feed solution. Total firm capacity assumes one large pump offline.

Table 4-10 Chlorination System Current Capacities

FACILITY	UNIT	NO. OF UNITS	UNIT CAPACITY	TOTAL CAPACITY	FIRM CAPACITY
Contact Tanks	mgd	2	54	108	108
Small Feed Pumps	lb/day	4	750	3,000	2,250
Large Feed Pumps	lb/day	2	11,260	22,520	11,260
Total Feed Capacity	lb/day	5	N/A	N/A	14,260
Storage Tanks	Gal	4	5,234	20,940	N/A

The existing equipment, apart from the chlorine contact tanks, are adequate to meet the planning horizon requirements. This assumes a 6.0 mg/L dose (5,630 lb/d) during the peak hour demand. This peak demand could be maintained for almost 4 days with the total storage tank volume.

The existing contact tanks have adequate volume through the year 2040. But an additional 42,000 gallons of volume will be required to meet projected 2050 peak hour flows.

4.5.6 Chlorination Alternative Analysis

A review of chlorination alternatives included the following:

Alternative 1: Expand existing chlorine contact tanks

Figure 4-4 shows the proposed expansion of the existing contact basins. These modifications would add two times the 42,000 gallons needed during the planning horizon and could potentially also be enough to meet capacity for plant buildout.

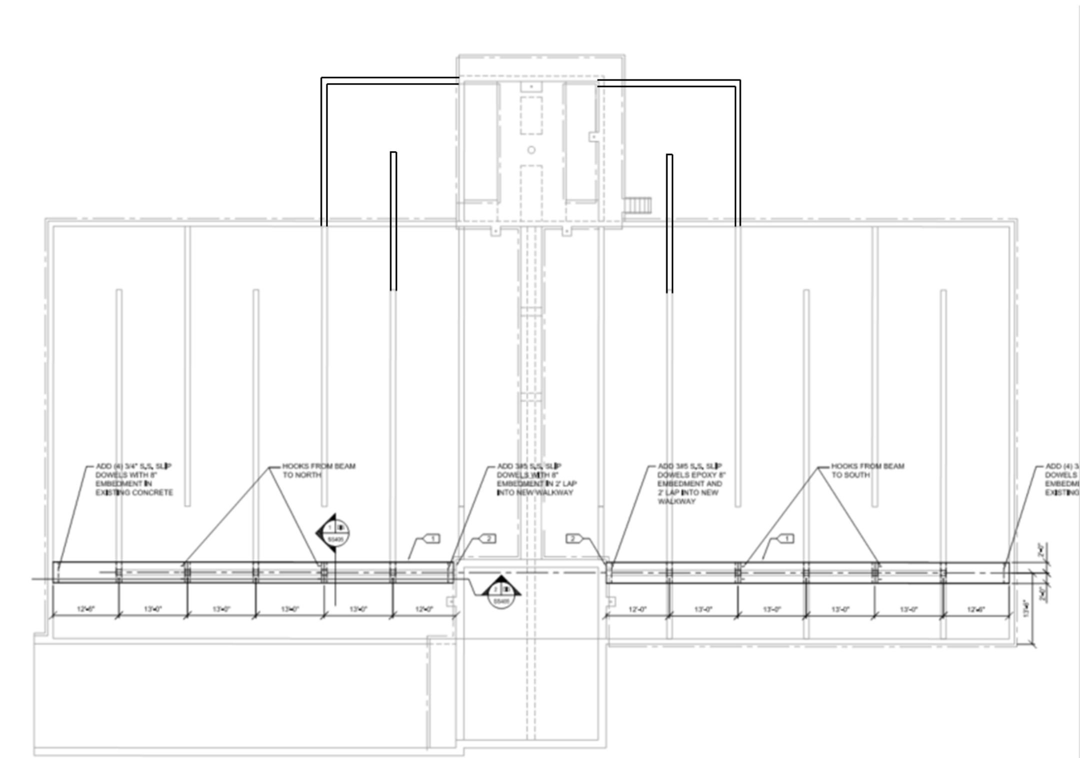


Figure 4-4 Chlorination Alt. 1 – Expand Contact Basins

Alternative 2: Request permit amendment for increased dosing at high flow rates

This alternative may be considered as an option, but for planning purposes, Alternative 1 was considered in determining future facility costs.

4.5.7 Capacity of Dechlorination Systems

Dechlorination at Blue Lake is accomplished using sodium bisulfate ($NaSO_4$). Design of the $NaSO_4$ system is based on using the theoretical dosage guidance of 1.465 mg/L of $NaSO_4$ per 1 mg/L of chlorine residual.

Sodium bisulfate historical dosages and usage for 2014 to 2019 are shown in Table 4-11.

Table 4-11 Historical Dechlorination Dose and Usage

YEARS 2014-2019	AVERAGE	MAXIMUM DAY	MAXIMUM WEEK
Dose Rate, mg/L	0.5	2.2	1.37
Usage Rate, ppd	128	379	320

The existing dechlorination equipment is adequate to meet the planning horizon requirements as shown in Table 4-12. This assumes continued use of 38% feed solution of sodium bisulfate at a 1.6 mg/L dose (1,550 lb/d) during the peak hour demand. There is adequate storage capacity for 22 days at the peak hour demand. No additional infrastructure will be required for the planning horizon.

Table 4-12 Dechlorination System Current Capacities

FACILITY	UNIT	NO. OF UNITS	UNIT CAPACITY	TOTAL CAPACITY	FIRM CAPACITY
Feed Pumps	lb/day	3	2,280	6,840	4,560
Storage Tanks	gal	2	5,234	10,470	N/A

4.6 *Effluent Pumping/Aeration/Outfall*

This section summarizes the plant effluent pumping, effluent aeration and outfall systems.

4.6.1 Effluent Pumping

Under normal operating conditions, disinfected effluent flows by gravity from the chlorine contact tank to the bottom of the effluent aeration structure and through the outfall to the Minnesota River.

Effluent pumping is only required at Blue Lake during two different river conditions in the Minnesota River:

- When the river level is too high to allow all flow to leave the plant by gravity.
- When the river flow is so low (<3,000 cfs) that there is insufficient dissolved oxygen in the river.

Under the first scenario, the effluent pumps are used to ensure flow through the plant. Effluent pumps are used under the second event to provide additional effluent aeration to increase dissolved oxygen (DO) in the river. Since the system began operation in 1991, the effluent pumps have never been used to provide DO during low flow conditions, even during droughts.

Effluent pumping station consists of three 108-inch diameter screw pumps. Each pump is rated at 40 mgd for a total capacity of 120 mgd as shown in Table 4-13. Original plant design did not include a standby pump for peak conditions. The effluent pumps are used on an intermittent basis. Plant staff exercises the pumping system regularly. The screw pumps are covered and were not observed during the inspection. During the previous years when the effluent pumps were used no significant operations problems were reported. Due to the lack of redundancy in the effluent pumps the plant has been very diligent in all preventative maintenance making sure all three screw pumps are exercised each spring in preparation for potential high flow events.

Table 4-13 Effluent Pumping System Existing Capacity

PUMPING SOURCE	NO. OF PUMPS	PUMP CAPACITY (MGD)	TOTAL CAPACITY (MGD)	FIRM CAPACITY (MGD)
Screw Pumps	3	40	120	80
Stormwater Pumps	4	7.5	30	22.5
Effluent Total	6	N/A	N/A	110 (with 1 screw pump out of service)

West Drainage Pump Station

Part of the effluent pumping capacity is provided by the stormwater pumps located in the west drainage pump station (as referenced in Table 4-12). There is a connection between the effluent pumping station and the west drainage pumping station (WDP) to allow effluent to be pumped by the stormwater pumps. The WDP structure was built in 1972 and is structurally in good condition. The seal water connections to the pumps has been problematic since the installation in 2010 and two of the pumps have seized.

Effluent Aeration

There is no specific permitted redundancy for the effluent aeration system, only that the permitted DO effluent levels must be maintained. Effluent aeration is a passive cascade type system. There are two parallel cascade aeration structures with a common sidewall. Each structure has two, 4-foot vertical cascades. Based on the US Army Corps of Engineers Technical Manual 4-692-2 (2001), vertical cascades will provide approximately 1 mg/L for every 2-ft of drop. The re-aeration capacity for the 8-ft cascade drop of the existing structure is assumed to provide 4 mg/L of DO.

The effluent pumps were conservatively estimated to provide 1 to 2 mg/L of DO and it was assumed that no additional DO was added from the re-aeration pond. Combining the cascade aeration from the screw pumps and from the aeration structures, the existing aeration system can meet the 7 mg/L DO requirement.

The current system is designed for a peak flow of 120 mgd and provides enough aeration to raise the effluent DO level to achieve the NPDES required level of 7 mg/L during summer months as shown in Table 4-14. There have been no historical DO violations (2016-current). The effluent aeration system appears to be in very good condition and there is enough aeration capacity through the planning horizon.

Table 4-14 NPDES DO Concentration Requirements

PERMIT REQUIREMENT	RIVER FLOW AT USGS JORDAN GAGING STATION	VALUE
Minimum Dissolved Oxygen, Dec to Mar	<20,000 cfs	7.0 mg/L
Minimum Dissolved Oxygen, Apr to Nov	<20,000 cfs	6.0 mg/L
Minimum Dissolved Oxygen, Dec to Mar	>20,000 cfs	Does Not Apply
Minimum Dissolved Oxygen, Apr to Nov	>20,000 cfs	Does Not Apply

Plant Outfall

The plant outfall was constructed in 1970 and consists of approximately 3,700 linear feet of 78-inch diameter reinforced concrete pipe and 1,300 linear feet of steel outfall pipe, which routes flow from the bottom of the effluent aeration structure to the Minnesota River. Design drawings indicate that the outfall pipe is moderately sloped (0.13 to 0.2 percent) for most of its length until it drops steeply at 30 percent for 27 feet and returns to 0.13 percent for a short distance until it connects to the river outfall structure. The manhole structures along the length of the pipeline are sealed to prevent overflow.

The outfall was originally sized for the following hydraulic conditions:

- Pass a peak hourly flow of 80 mgd by gravity at river stages less than 704.6 feet.
- Pass a peak hydraulic flow of 120 mgd by gravity at river stage less than 698 feet.
- At the 100-year flood stage elevation of 721.8 feet, up to 80 mgd can flow through the outfall. Flow in excess of 80 mgd will overflow the emergency overflow from the aeration structure. Under such conditions, the plant site will be surrounded by water on three sides.

During a field investigation, a casting at Manhole 4 was detached from the manhole structure and should be repaired. Limited outfall pipeline television inspection did show several locations of root intrusion which should also be removed.

The steel section of the outfall utilizes cathodic protection against corrosion. Recent investigations show the cathodic protection is in good condition.

MCES staff should inspect the manholes along the pipeline for pitting and surface voids in the concrete. Evidence of significant deterioration may warrant consideration of air vents/valves along the pipeline to relieve air pressurization.

Where the outfall ends at the river there is a concrete structure with rip rap boulders surrounding it. In the past 50 years the Minnesota River has changed course and there is erosion and scouring of the riverbank upstream and downstream of the outfall. It is recommended that rip rap is extended upstream and downstream from the outfall structure to create a smooth transition to the natural riverbank and slow future erosion.

4.6.2 Effluent Pumping Capacity

The peak instantaneous projected flow for the planning horizon is 150 mgd. The effluent system is currently designed so that effluent screw pumps and stormwater pumps at the west drainage pump station can be used concurrently to meet the effluent pumping demands. Currently, with one pump out of service, there is not adequate pumping capacity to meet the projected peak instantaneous requirement of 150 mgd. Using the re-aeration pond to attenuate peak instantaneous flows was examined but was deemed not practical.

Table 4-15 presents the impact of an additional screw pump to meet peak instantaneous flow of 150 mgd.

Table 4-15 Effluent Pumping System Proposed Capacity

PUMPING SOURCE	NO. OF PUMPS	PUMP CAPACITY (MGD)	TOTAL CAPACITY (MGD)	FIRM CAPACITY (MGD)
Screw Pumps	4	40	160	120
Stormwater Pumps	4	7.5	30	22.5
Effluent Total	7	N/A	N/A	150 (with 1 screw pump out of service)

4.6.3 Effluent Pumping Recommendations

Following are the recommendations:

1. One additional 40 mgd screw pump to be added during the planning horizon.
2. Continue using both screw and stormwater pumps to meet effluent pumping capacity.
3. Repair the stormwater pumps and upgrade the seal water system.
4. All effluent to be pumped when river elevations are at or above the 100-yr flood level.

Effluent pumping operation is anticipated as follows

- At river elevations < 697 feet: peak hydraulic flows can be achieved without effluent pumping
- At river elevations > 697 feet: operate effluent pumps as needed to avoid disruption of upstream facilities
- At 100-year river flood stage of 721.8 feet: 100% of the effluent flow to be pumped.

4.6.4 Recommended Effluent Improvements Summary

Table 4-16 summarizes of recommended improvements for the effluent facilities with projected construction costs. The Sum Total for Phase I is $1,519,000, for Phase II is $0, and Phase III is $3,660,000.

Table 4-16 Effluent Facilities Recommended Improvements

AREA	DISCIPLINE	IMPROVEMENT	PHASE I (<10 YRS)	PHASE II (10-15 YRS)	PHASE III (15-30 YRS)	TYPE OF PROJECT
DIS	Arch	Replace Doors & Refinish Frames	$5,000	N/A	N/A	P
DIS	HVAC	Replace AHU-01, 02, 03 & ACC-03	$140,000	N/A	N/A	P
DIS	Process	Disinfection Basin Expansion	N/A	N/A	$1,700,000	E
WDP	Process	Repair pumps and replace water system	$300,000	N/A	N/A	P
EPS	HVAC	Replace AHU-01 & ACC-01	$54,050	N/A	N/A	P
EPS	Elec	Replace MCC-1N, 2N	$250,000	N/A	N/A	P
EPS	Elec	Add standby power for screw pumps	$770,000	N/A	N/A	I
EPS	Process	Effluent Pump Station Expansion	N/A	N/A	$1,960,000	E

- Area of Project: Disinfection Building (DIS), West Drainage Pump Station (WDP), Effluent Pump Station (EPS)
- Type of Project: Preservation (P), Improvements (I), Expansion (E)
- Construction costs presented in 2020 dollars and do not include engineering or administration
- Costs listed include: Installation, Electrical and I&C, General Conditions (15%) and Contingency (50%)

4.7 *Gravity Thickeners*

Blue Lake WWTP has four gravity thickeners for thickening primary sludge, but typically only two units are online at a time. Every year the duty and offline thickeners are alternated so that two units are always available for annual maintenance. The thickeners have a diameter of 50 feet, a side water depth (SWD) of 11.75 feet, and a volume of 203,000 gallons each.

4.7.1 Gravity Thickener Condition

The gravity thickener units were originally constructed in 1987, and the mechanisms were replaced in 2011. Externally, the covers (i.e. geodomes) showed minor corrosion on some surfaces, but rivets at the seams have no issues, and the domes are in good overall condition. The concrete tanks are in very good condition externally, and internally they only show staining on the walls. Duct, supports and electrical equipment is in good condition in the thickener tanks. The aluminum walkways are in good condition, showing minimal corrosion. The two of the four mechanism drives showed moderate corrosion. The drive control panels are stainless steel and in good condition. The submerged mechanism components are in good condition, but the sections of metal above the water surface as well as scraper arm support rods show moderate corrosion. Also, the scum baffle and v-notched weirs in all four tanks show moderate corrosion.

Two of the thickener mechanism drives should be resurfaced and repainted in the next 5-10 years. It is likely that sections of the mechanism including the support rods may need to be replaced in the next five years. The scum baffle and v-notched weirs should also be periodically inspected, as they may need replacement in the next 5-10 years. The gravity thickeners rely on four thickened sludge pumps to send thickened primary sludge to the Thickening and Dewatering building. Each pair of thickener basins is piped and valved to feed two separate progressing cavity pumps for full redundancy. The thickened sludge pumps were installed in 1987 and draw sludge directly from the bottom of the gravity thickeners. The pumps alternate running, targeting a solids thickness between 4-6%. All pumps are in fair condition and will likely need to be replaced in the next 5-10 years.

Each pair of gravity thickeners also has a single centrifugal scum pump (2 total). The pumps were installed in 1987 and have not been used in many years due to plugging of the downstream scum pipes. It is unlikely that the pumps would be functional without a significant overhaul.

4.7.2 Gravity Thickener Capacity

Gravity thickeners are sized based on detention time, overflow rate and solids loading. The hydraulic retention time (HRT) is recommended to be between 3 and 12 hours. If the HRT is 24 hours or more, the sludge will likely turn septic and begin to digest. The overflow rate is typically designed between 600-800 gpd/ft^2, but the lower it is, the lower the TSS content of the supernatant (overflow). A typical solids loading rate ranges from 8 to 12 lb/day-ft^2 for primary sludge being thickened to 4-5%, but the loading of primary sludge can go as high as 29 lb/day-ft^2.

Primary sludge is fed continuously, at an average flow rate of 264 gpm and solids concentration of 1.5%. When primary sludge is fed to two gravity thickeners, the units provide a retention time of 25 hours, an overflow rate of 97 gpd/ft^2, and a solids loading rate of 12 lb/day-ft^2. Table 4-17 summarizes the existing hydraulic and solids loading conditions along with the recommended maximums.

Table 4-17 Gravity Thickener Capacity

DESIGN CRITERIA	UNITS	CURRENT	RECOMMENDATION
Loading Rate	lb BOD/day-ft2	12	< 29
Overflow Rate	gpd/ft2	97	< 800
Hydraulic Residence Time	hrs	26	3 < HRT < 12

The gravity thickeners far exceed the surface area as well as the volume requirements for thickening primary sludge. The loading rate and overflow rate are both well below the design criteria recommendations. The plant has expressed that the gravity thickeners work well and no modifications are recommended at this time.

4.7.3 Gravity Thickener Heating Units

The gravity thickeners are covered with geodesic stainless-steel domes in order to provide protection to operations and maintenance staff in the winter. The HVAC system providing heated air to the four thickeners relies on two air handling units, GTH-AHU03 and GTH-AHU04. These units were originally designed to provide either 6 or 12 air changes per hour (3,600 CFM or 7,200 CFM) in the gravity thickening tank currently in operation depending on occupancy as shown in Table 4-18. However, the units are not able to operate at the original design parameters and are currently operating at lower airflow levels. As a result, the thickening tanks are not able to maintain above-freezing air temperatures during the winter resulting in condensation and freezing of water vapor in the tanks. Heating load calculations estimate a heating load of 610,000 BTU/HR is required in order to maintain 55°F air temperature within a single active tank. It appears the existing units were adequately sized but are not able to operate at the design conditions. These units have also required ongoing maintenance and replacement of failed bearings. The Splitter Box Room is served by GTH-AHU02 which is a similar unit to GTH-AHU03 and GTH-AHU04 and has required similar ongoing maintenance and replacement of failed bearings and trouble with corrosion and air leakage. GTH-AHU02, GTH-AHU03 and GTH-AHU04 are currently planned for replacement with new gas-fired units appropriately sized for the required heating loads and air changes.

The building's electrical room is served by GTH-AHU01 which appears to be in good condition and has had minimal service issues. Its associated condensing unit (GTH-ACC01) was originally installed in 2011 and has experienced compressor failure due to corrosion. The tunnels are served by GTH-AHU05 which is in good condition and has had minimal service issues.

Table 4-18 Gravity Thickener Heating Unit Capacity

TANKS	AIR EXCHANGES/HR	FLOW RATE (CFM)	HEATING (MBH)
Duty	6	3,600	490
Duty	12	7,200	778
Duty + Standby	6	10,500	1,240
Duty + Standby	12	21,000	2,090

4.8 *Digestion*

Blue Lake WWTP has three digesters and one sludge holding tank (SHT). The digesters operate in series, where Digester Nos. 1 and 2 are fed thickened WAS and primary sludge directly, and Digester No. 3 is fed from Digester Nos. 1 and 2. Digested sludge is pumped to the sludge holding tank, which has a flexible membrane to allow for the storage of digester gas. The digesters all have rigid covers, and all four headspaces are connected, allowing for shared gas storage across all four units. The digester structures have a diameter of 90 feet, a side water depth (SWD) of 32.5 feet, and a volume of 1.6 million gallons each.

4.8.1 Digester Condition

The digester units and related equipment were originally constructed in 2011. Externally, the rigid covers and membrane appear to be in very good condition, and the sides of the sludge holding tank exhibit a small amount of superficial stains from corrosion of the membrane tension straps. Digester No. 3 was offline for a cleaning during the site visit, and it was possible to see the piping and settled grit on the floor. There was a significant amount of grit, but the piping, concrete supports and mixing nozzles all appeared to be in good condition. The interior walls of the basins showed flaking of the interior coating. All piping, valves, supports and ancillary equipment exterior to the digesters as well as below in the pump room are in very good condition. The pumps show no signs of corrosion and according to staff have no chronic maintenance issues. Each tank is taken out of service once every 4 or five years and it is recommended to recoat the interior of the covers when cleaning and inspection show coating failure.

As long as routine maintenance is performed on the pumps, valves, instruments and ancillary equipment, the digester equipment should last at least another 15 years, if not longer. The tanks should be periodically emptied and cleaned, and during this process, the interior coating of the tanks may need to be reapplied every 5-10 years. The concrete tanks and rigid covers are in good shape, and if well maintained, could possibly last 30-50 years and 20 years respectively.

4.8.2 Digester Capacity

Digesters are sized based on hydraulic loading as well as volatile solids loading. High rate mesophilic anaerobic digesters (MAD) typically provide a solids retention time (SRT) between 15 and 30 days. Generally speaking, the longer the SRT, the more volatile solids reduction. Plants using digestion to meet Class B pathogen reduction, require digesters to have a minimum SRT of 15 days. When the SRT is less than the growth rate of key members of the microbial community, biomass washout will occur leading to process failure. Methanogens are generally accepted as the slowest growing populations within MAD, and under mesophilic conditions are strongly impacted by reducing the SRT below 6 days.

In order to provide effective reduction of volatile solids, it is recommended the digesters provide an SRT of 15 days with one unit offline, or 20 days with all units online. Figure 4-5 below shows the historic digester loading along with the capacity of three digesters as well as four digesters with one unit offline.

Capacities in the figure as defined as follows:

- 2/1: Two digesters in service, one digester out of service
- 3/0: Three digesters in service, no digesters out of service
- 3/1: Three digesters in service, one digester out of service

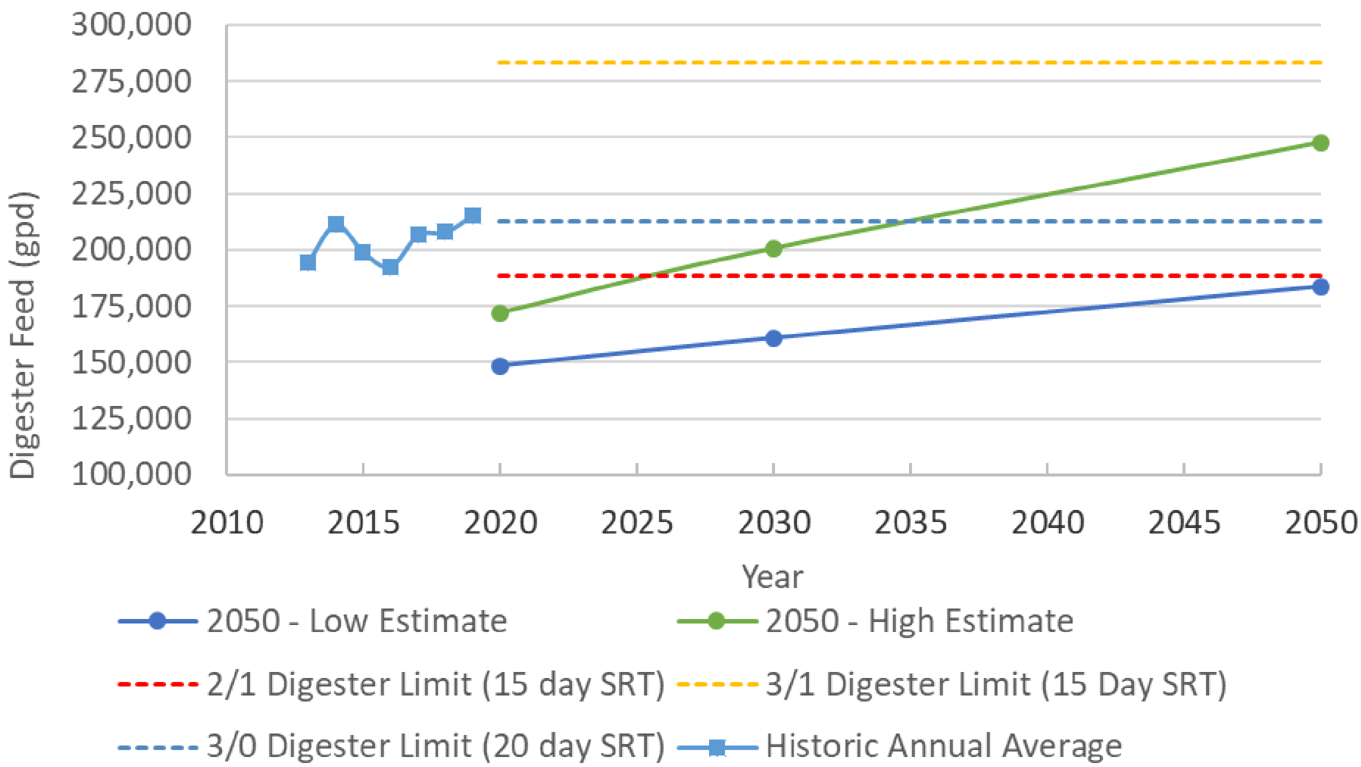


Figure 4-5 Historic Digester Loading and Digester Hydraulic Capacity

Recent hydraulic loading of the digesters is near or at the capacity when all three digesters are online. The recommended 15-day SRT would not be achieved with one unit offline, reducing the volatile solids reduction as well as digester gas generation. This also increases the loading on the centrifuge and dryer system.

It is anticipated that hydraulic loading to the digester will be reduced significantly when Northern Star reduces their loading to the plant. Following the more aggressive projections, the digesters would again reach capacity with one unit offline by 2025, and with all units online by 2035. The hydraulic capacity is a recommendation for optimal volatile solids reduction, but fortunately it isn't a requirement for operations to continue. Since the plant uses drying to achieve Class A biosolids, there is no regulated minimum SRT for the digesters. While they may not perform optimally below the recommended SRT of 15 days, the digesters will continue to function as long as they maintain a high enough SRT to avoid washout (> 6 days).

In addition to considering hydraulic loading, digesters should be sized to accommodate the volatile solids (VS) loading as well. It is generally accepted that digesters be designed to accommodate 0.12 lb VS/cu.ft./day to maintain effective volatile solids reduction. Figure 4-6 includes the historic volatile solids loading of the existing three digesters along with the projected loading to 2050.

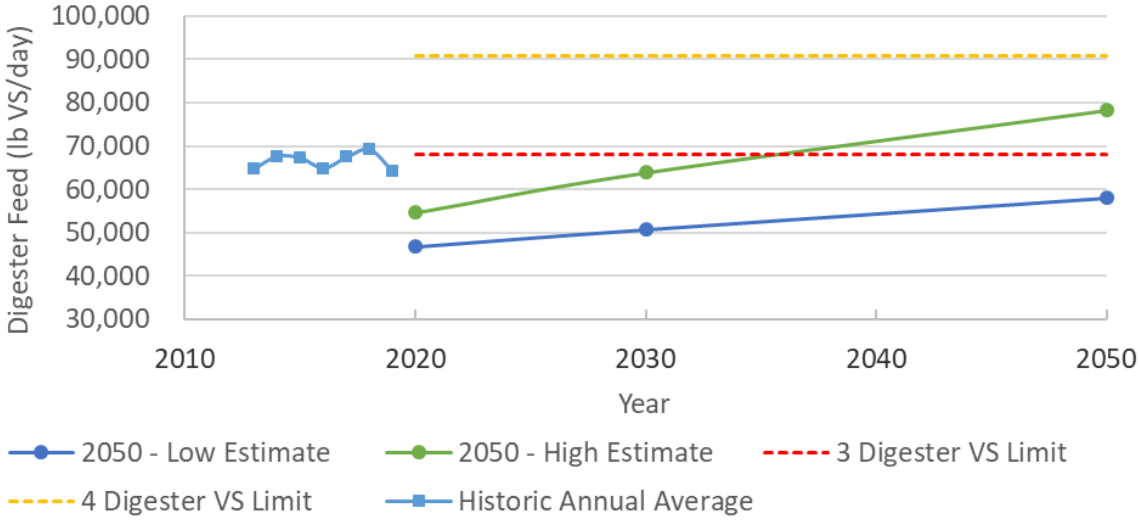


Figure 4-6 Historic and Projected Volatile Solids Loading

The volatile solids loading has hovered at the volatile solids loading limit since the digesters came online in 2012. It is anticipated that the volatile solids loading will drop significantly with the implementation of Northern Star's pretreatment process in early 2020, reducing the volatile solids loading at the Blue Lake WWTP digesters. The more aggressive volatile solids loading projection estimates that the current digesters won't exceed their volatile solids loading capacity until 2035.

4.8.3 New Storage Cover

The Blue Lake WWTP's sludge storage tank has a membrane gas holder cover installed on the tank. The gas holder is the Dystor gas holder system manufactured by Siemens. The system was installed in 2011. The system consists of two membranes, an outer cable restrained membrane and an inner membrane that floats on top of stored digester gas. Air is supplied between the two membranes to keep pressures within a useable range for the WWTP. The design criteria are presented in Table 4-19.

Table 4-19 Storage Tank Membrane Cover Design Criteria

DESIGN CATEGORY	DESIGN CRITERIA
Tank Diameter	90-ft
Tank Construction	Cast-in-place Concrete
Digester Gas Storage	165,000 cu ft
Digester Gas Pressure	7.5 to 12 in. water column

Blue Lake has not experienced any problems associated with the gas holder cover, however, the recommended life span for the membrane systems are 10 years. Therefore, MCES should plan to replace the membrane cover in a near term project and again in 12-15 years. Signs that the system may be failing would be system alarms, abnormal pressures or observing leaks in the cover.

4.8.4 Recommended Digestion Complex Improvements Summary

Table 4-20 summarizes the anaerobic digester/storage tank complex recommended improvements with projected construction costs. The magnesium hydroxide addition improvements are discussed in Section 5.3. The Sum Total for Phase I is $3,777,000, for Phase II is $1,093,000, and for Phase III is $8,566,000.

Table 4-20 Recommended Anaerobic Digestion Complex Improvements

AREA	DISCIPLINE	IMPROVEMENT	PHASE I (<10 YEARS)	PHASE II (10-15 YEARS)	PHASE III (15-30 YEARS)	TYPE OF PROJECT
DIG	Process	Storage Tank Membrane Cover	$0	$0	$1,668,000	E
DIG	Process	Digestion Expansion	$3,777,000	$0	$0	E
DIG	Process	Digester Gas Utilization Equipment	$0	$719,000	$0	P
DIG	Process	Digester Control Building Process Equipment	$0	$0	$5,447,000	P
DIG	HVAC	HVAC Improvements	$0	$0	$1,451,000	P
DIG	Process	Magnesium Hydroxide Addition	$0	$374,000	$0	I

- Area of Project: Digestion Complex (DIG)
- Type of Project: Preservation (P), Improvements (I), Expansion (E)
- Construction costs presented in 2020 dollars and do not include engineering or administration

4.8.5 Recommended Chemical Building Improvements Summary

Table 4-21 summarizes the Chemical Handling Building recommended improvements with projected construction costs. The Sum Total for Phase I is $0, for Phase II is $0, and for Phase III is $1,615,000.

Table 4-21 Recommended Chemical Handling Building Improvements

AREA	DISCIPLINE	IMPROVEMENT	PHASE I (<10 YEARS)	PHASE II (10-15 YEARS)	PHASE III (15-30 YEARS)	TYPE OF PROJECT
CHB	Process	Process Equipment	$0	$0	$1,199,000	P
CHB	HVAC	HVAC Improvements	$0	$0	$416,000	P

- Area of Project: Chemical Handling Building (CHB)
- Type of Project: Preservation (P)
- Construction costs presented in 2020 dollars and do not include engineering or administration

4.8.6 Primary Scum/FOG addition

MCES currently hauls scum from the Blue Lake WWTP to the Metro WWTP, where the scum is fed to the beginning of the WWTP process and is removed with other scum produced at Metro. Directing the primary scum produced at Blue Lake to the anaerobic digesters presents an opportunity to create additional digester gas that can be utilized as well as saving hauling costs associated with taking scum to the Metro WWTP. Table 4-22 below estimates the amount of scum produced at Blue Lake as well as the anticipated digester gas production from the scum.

Table 4-22 Digester Gas Production from Scum

DESIGN CATEGORY	DESIGN CRITERIA
Scum Volume	5,000 gpd
Scum Concentration (Estimate)	13% solids
Digester Gas Production	35,000 scfd

Blue Lake currently decants their primary clarifier scum pits daily and then every 1 to 2 weeks hauls the thickened scum to Metro. Decanting the scum is not a concern if the scum is directed to the digesters because the digesters can handle the additional water, which would be less than 5,000 gallons per day.

It is recommended that Blue Lake feed scum to the digesters on a consistent basis to ensure the digesters do not experience upset conditions. Blue Lake has four primary scum pits: two on the west primary clarifiers and two on the east primary clarifiers. It is recommended that Blue Lake feed scum from one set of clarifiers each day and then rotate and feed from the other set of clarifiers the next day and then continue to alternate between the two sets of clarifiers. On days the scum pits are not fed to the digesters, the scum pits should be decanted.

Blue Lake has a few different locations where scum could be fed to the digestion system: the Gravity Thickeners, the Thickening and Dewatering Building Digester Feed Wetwell, or directly into the digesters via a Sludge Recirculation line.

The Metro WWTP successfully pumps scum by flushing the piping with hot water. Based on the success at Metro, a hot water flushing system is recommended for any system that is installed to pump scum to the digesters. One potential solution for adding a hot water system, would be to add a tank in the Digester Control Building that could be filled with plant effluent water. The boilers and heating water loop in the Digester Control Building could be used to heat the plant effluent water which would then be used to backflush the scum pipelines.

It is recommended that Blue Lake proceed with a pilot system to deliver scum to the digesters. In lieu of hauling scum to Metro, Blue Lake could truck the scum from the primary scum pits to the Digester Control Building and then feed the scum into the Sludge Recirculation pipes in the Digester Control Building on the downstream side of the heat exchangers. The pilot system would allow MCES to confirm the additional digester gas production and Blue Lake could make observations about the potential of the pipes to plug due to the scum. Based on the results of the initial pilot, MCES could try piloting at other locations like the Digester Feed Wetwell located in the Thickening and Dewatering Building.

4.8.7 Digester Gas

Digester Gas Production

The Blue Lake WWTP utilizes three digesters and a sludge holding tank (SHT) for solids processing. The digesters and sludge holding tank are all identical in shape and size but provide different functions. Digester Nos. 1 & 2 are each directly fed a combined stream of thickened primary sludge (TPS) and thickened waste activated sludge (TWAS) and operate in parallel. Digester No. 3 is fed from both Digester Nos. 1 and 2 and provides a second stage of digestion before the solids are pumped to the sludge holding tank. Most of the volatile solids destruction and gas generation takes place in primary Digester Nos. 1 and 2. The sludge holding tank, provides the plant the capability to store solids when the dewatering or drying is temporarily not available.

The three digesters all have fixed dome covers while the sludge holding tank has a flexible double membrane. The outer membrane remains inflated in a fixed position, while the inner membrane moves freely as it stores or releases biogas. The headspace of all four tanks are tied together, maintaining a pressure equilibrium within the four process units. The majority of digester gas storage volume is provided by the flexible membrane of the sludge holding tank.

Digester Gas Metering

The digester gas produced at Blue Lake WWTP has three possible end uses: gas can be burned in the dryer, it can be used by Boiler 1 to heat process water, or it can be flared to the atmosphere. Each of these pathways is equipped with a flow meter which monitors the volume of gas utilized. Figure 4-7 shows the gas production and utilization from September 1, 2013 to April 1, 2019.

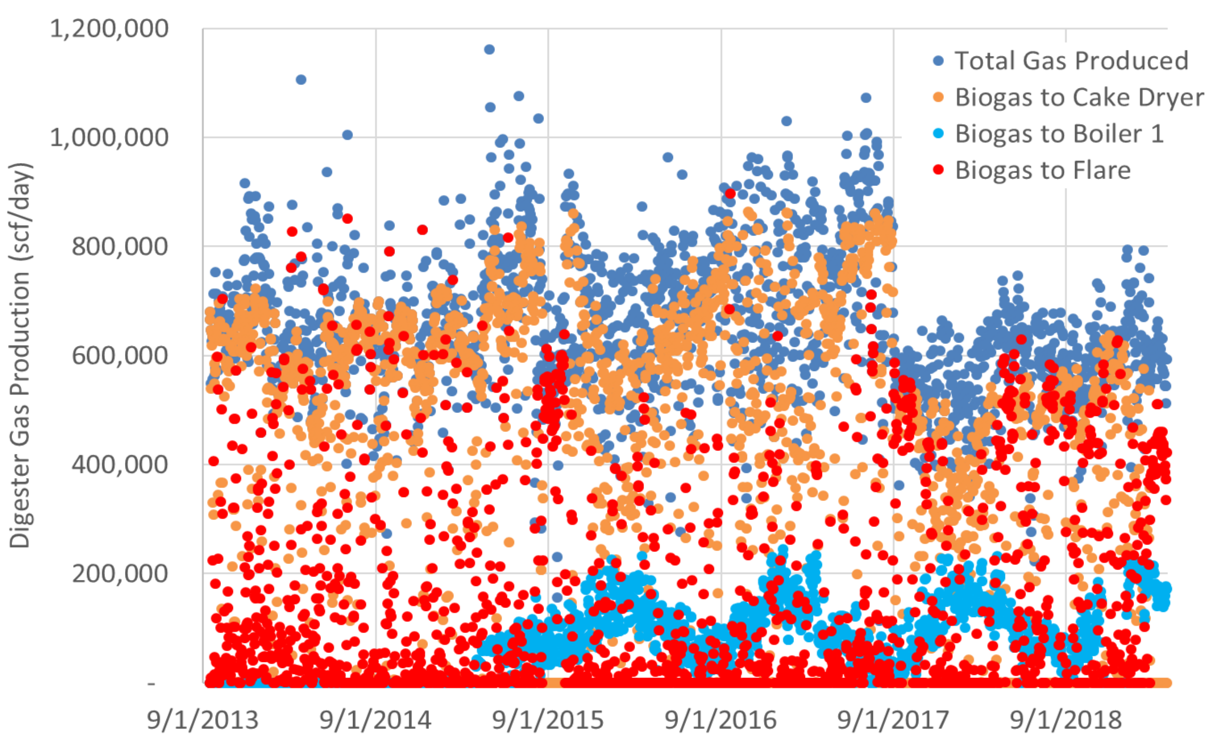


Figure 4-7 Digester Gas Production and Use (2013-2019)

The total gas produced is the calculated sum of gas sent to the dryer, boiler and flare. As the total gas produced isn't directly metered, the measurement of gas production is dependent on the accuracy of the three instruments monitoring the gas usage. In early September 2017, it was determined that the flow meter monitoring gas sent to the cake dryer was reading inaccurately and it was replaced. The drop in total gas production is directly related to the meter replacement and suggests that the cake dryer data collected prior to the meter replacement is not reliable. Figure 4-8 shows the annual digester gas production and volatile solids reduction from 2013-2019.

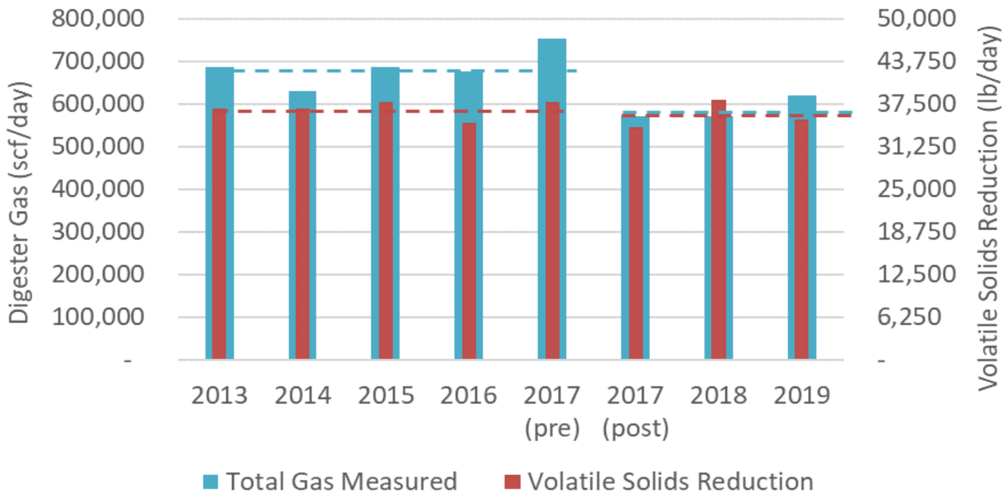


Figure 4-8 Annual Digester Gas Production and Volatile Solids Reduction (2013-2019)

In order to estimate the difference in flow metering between the old dryer gas meter and the newly calibrated meter, the combined digester gas measured was plotted against the annual average volatile solids reduction before and after the meter replacement. After the digester gas flow meter for the dryer was replaced in early September 017, the reported average annual production of digester gas dropped 101,000 scfd (15%), from 687,000 to 586,000 scfd. At the same time, the difference in volatile solids reduction between the two periods was only 1,000 lb/day, or 2.7%. Given that the relative volatile solids reduction remained relatively constant over the same 5-year period, for the topic of digester gas utilization, it has been assumed that the 101,000 scfd drop in digester gas production after the dryer gas flow meter was replaced was directly caused by inaccuracies in the previous meter recordings.

An overall trend of digester gas use is plotted in Figure 4-9 below. The reduction in digester gas sent to the dryer is believed to be both from the newly calibrated meter reading approximately 101,000 scfd lower, as well as a change in gas utilization resulting in an increase of gas sent to the boilers (54,000 scfd) and flare (74,000 scfd).

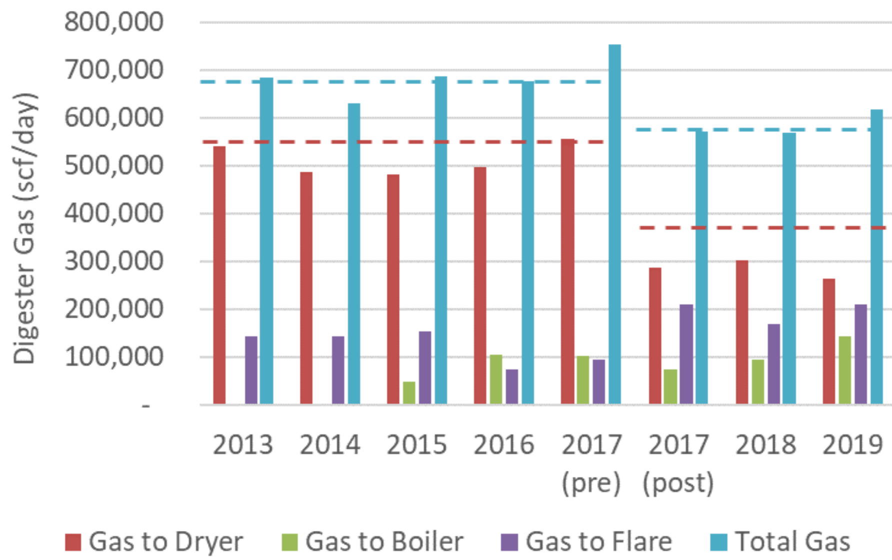


Figure 4-9 Digester Gas Meter Flows (2013-2019)

Digester Gas Utilization

As discussed in the previous sub-section, there are three separate destinations for digester gas: The dryers, the boilers, or the flare. Figure 4-7 represents the relative volume of digester gas used by the three processes. Prior to the meter replacement in 2017, most of the digester gas was used by the dryers. While the graph also includes the estimated 101,000 scfd inaccurately measured by the dryer gas meter, flow to the dryer is shown as using an average 74,000 scfd more than the flare each year. After the meter replacement, the dryer is still the main recipient of digester gas, but since 2017, it is more closely matched by the volume of gas flared. In order to determine the effectiveness of digester gas utilization at the Blue Lake WWTP, the historic production and usage was analyzed in detail (See Appendix 4-2).

Digester gas is flared when either an excess of gas is produced and it exceeds the demand of the dryer and boilers, or when the dryer is switched to run on natural gas. When reviewed on a day to day basic, the data shows that there are frequently extended periods of time where the dryer was exclusively fueled by natural gas, and a majority of digester gas generated was flared. Estimates of digester gas demand by the digesters based on the natural gas usage also suggests that the total digester gas volume produced nearly always exceeds the estimated digester gas demand of the dryer.

NEFCO is responsible for running the dryer, along with all other equipment in the final stabilization building. When asked why the dryer fuel source would be switched from digester gas to natural gas, three reasons were given: high regenerative thermal oxidizer (RTO) pressure differential, low RTO flame temperature, and low digester gas availability.

The first two issues are directly related to the capacity of the RTO. The RTO receives the dryer exhaust gas and raises the temperature high enough to break down undesirable contaminants. When the dryers run using digester gas, the exhaust has a higher volume than if it were running on natural gas due to the low methane content (58% vs. 94%). Digester gas requires nearly twice the volume to achieve the same heating potential as natural gas, which can result in RTO capacity issues.

The third reason for not using digester gas to operate the dryers was the volume of gas generated as too low. Analysis detailed in Appendix 4-2 suggests that on average, there was sufficient digester gas generated to meet the demand of the dryers each month at least from Sept 2017 to Feb 2019. Although it is possible for daily gas production to fall short of demands, given the storage capacity for digester gas in the solids holding tank, failing to meet the heating demands of the dryer should be exceedingly infrequent.

Given the unlikelihood that the volume of digester gas produced limits its use in the dryer, it stands that the RTO is undersized. A higher capacity RTO would allow for more frequent utilization of digester gas, reducing the fraction of gas flared.

Digester Gas Methane Content

The methane content of digester gas can vary significantly, depending on the bacteria population and the quality of their food source. Methane content is important for the thermal value of the gas, but it also is indicative of the digester health as well. In order to estimate the thermal value of the digester gas produced, the historic methane content was reviewed in detail (See Appendix 4-2).

Data recorded from 2013 to 2019 suggests that the methane content of digester gas dropped consistently from 58% in 2013 to 54% in 2019. The methane content of digester gas can range anywhere from 55-70%, but if the content starts to trend downward it typically means one of three things: Air intrusion, variation in the VA/A ratio and pH of the digester, or an increased hydraulic residence time (HRT).

After ruling out the three most likely reasons for a shift in methane content, the instruments monitoring methane content were tested and found to be inaccurate. The methane meters were reading approximately 3% lower than calibrated meters from the Empire WWTP, suggesting the methane content hasn't changed significantly over the last 6 years.

4.9 *Thickening & Dewatering*

The condition and capacity of both the thickening units and dewatering units were assessed considering anticipated changes in solids and hydraulic loading.

4.9.1 Gravity Belt Thickener Units

The Blue Lake WWTP utilizes two 2.0-meter GBT units for thickening WAS before it is mixed with TPS and pumped to the digester. The two thickening units run in duty/standby configuration, full redundancy in order to provide maintenance with the opportunity to inspect and repair the equipment as needed. The thickener units have both hydraulic as well as solids loading limitations.

4.9.2 Gravity Belt Thickener Condition

The gravity belt thickener units were originally installed in the year 2000 and have been operating for 20 years with minimal issues. The belt is the main wear component that maintenance has had to replace with some frequency (every few years), but since replacing the bearings on both units, the belts have lasted longer. The units require relatively little maintenance, with few moving or consumable parts. Given the minimal external corrosion, and the reliability observed by plant staff, it isn't unreasonable to assume if the gravity belt thickeners continue to be well maintained, they both could last another 10, even possibly 20 years.

4.9.3 Gravity Belt Thickener Capacity

Gravity belt thickeners are hydraulically limited based on the width of the belt. A general rule of thumb is that the thickener can handle 150 to 200 gpm per meter of belt width. 150 gpm is extremely conservative, and only considered a limit if the WAS has issues draining. Manufacturers claim that newer belt thickeners can have hydraulic capacities as high as 250 gpm per meter. Given a belt width of 2.0 meters, the hydraulic capacity for the Blue Lake thickeners ranges from 300 to 400 gpm for 1% WAS.

The solids loading capacity of a gravity belt thickener is determined by the manufacturer. When providing equipment, they commit to meeting design criteria which include the average daily loading as well as a one-day peak loading. The design conditions are based on the type of sludge, solids concentration, and required solids capture rate. When the units were purchased in 2000, Andritz committed to meeting the design criteria listed in Table 4-23.

Table 4-23 Gravity Belt Thickener Design Criteria

DESIGN CATEGORY	DESIGN CRITERIA
Type of Sludge	WAS
Hydraulic Capacity	300 - 400 gpm
Inlet Consistency	0.7 - 1.8%
Average Loading Rate	1,260 lb/hr
Peak Loading Capacity	2,340 lb/hr
Total Minimum Solids Concentration	5%
Minimum Solids Capture	93%

The average and peak loading rates are equivalent to daily loadings of 30,240 and 56,160 lb/day. The annual average WAS loading and flow, along with the max month loading factors for each year are included in Table 4-24.

Table 4-24 WAS Loading and Flow (2013-2019)

YEAR	PEAK LOADING (LB/DAY)	MAX MONTH (LB/DAY)	AVG. ANNUAL (LB/DAY)	MAX MONTH FACTOR	AA FLOW (GPM)	WAS % TS	1% ADJUSTED FLOW RATE (GPM)
2013	86,898	36,552	31,636	1.16	250	1.1	282
2014	87,851	44,507	35,081	1.27	250	1.2	301
2015	69,056	39,451	31,259	1.26	250	1.1	277
2016	78,234	32,144	28,858	1.11	250	1.0	248
2017	90,676	36,182	31,240	1.16	250	1.1	271
2018	74,327	34,574	29,824	1.16	225	1.1	251
2019	59,446	35,199	32,593	1.08	215	1.2	259

Table 4-24 includes a WAS feed rate adjusted to estimate the equivalent flow rate for a 1% WAS feed. As the WAS total solids is typically 1% or greater, the adjusted flow is almost always higher than the actual flowrate recorded. Even when considering the adjusted flow rate, it only exceeded the low end of the hydraulic capacity (300 gpm) in 2014, and on average remains 33% below the upper limit for the hydraulic capacity (400 gpm).

The solids loading design criteria provided an average capacity and a peak capacity. The average capacity indicates the target or optimal operating conditions, while the peak represents the maximum loading allowable in order to achieve the minimum solids concentration and solids capture targets. As the loading increases, the unit performance decreases. Exceedance of the hydraulic and loading capacities wouldn't result in any catastrophic failure, only performance inefficiencies. Figure 4-10 indicates the historic loading of the units, along with the high and low projected loadings with IPIP being implemented in 2020.

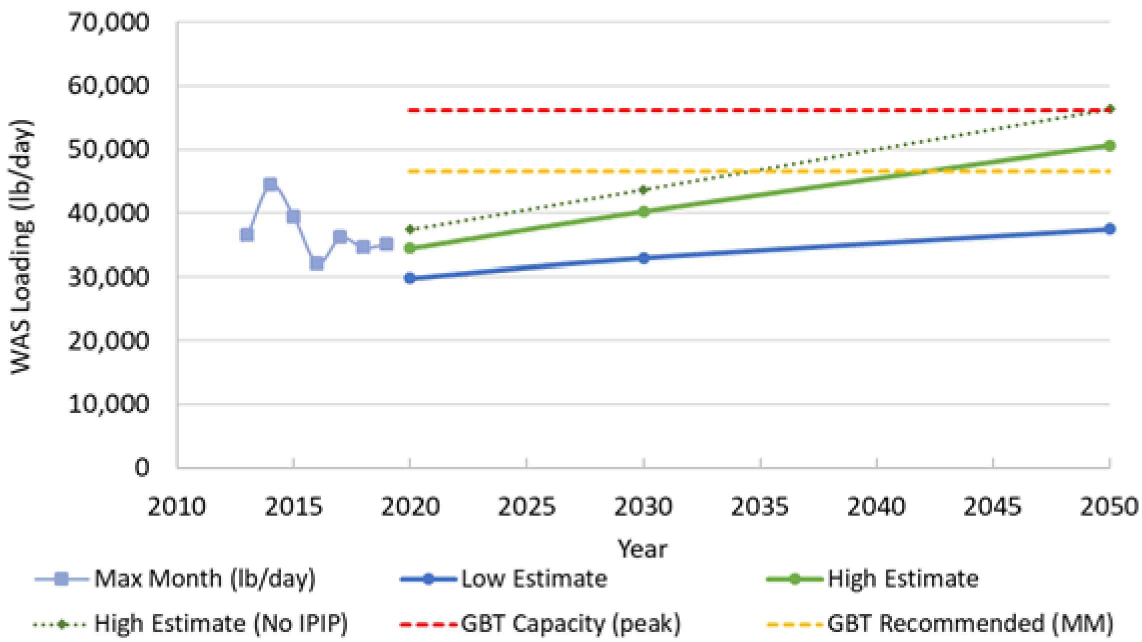


Figure 4-10 Gravity Belt Thickener Capacity vs. Projected Loading

The WAS loading is anticipated to decrease in the near future, and not expected to ever exceed the peak capacity. Also, the WAS loading is consistent, with an average max month factor of 1.1 over the last 6 years. Given the projections as well as the hydraulic and solids loading history, it is unlikely the gravity belt thickener capacity will be exceeded before the units require replacement in the next 10 to 20 years.

4.9.4 Centrifuge Dewatering Units

The Blue Lake WWTP utilizes two Sharples DS 706 centrifuge units for dewatering a mixture of thickened primary and waste active sludge. The resulting cake is transported on a belt conveyor into the final stabilization facility, where the moisture is removed, and the solids are pelletized by a dryer. As with the gravity belt thickeners, the two dewatering units run in duty/standby configuration. Full redundancy provides maintenance with the opportunity to inspect and repair the equipment as needed. The dewatering units have both hydraulic as well as solids loading limitations.

4.9.5 Centrifuge Condition

The centrifuge units were originally installed in the year 2000 and have been operating for 20 years with minimal issues. Overall, the units are in good condition, and visibly show little to no corrosion. Maintenance staff have recently implemented a monthly preventative maintenance routine in an effort to minimize the accumulation of struvite on the bowl and scroll. Both the bowl and scroll of the two units are in good condition as well. Abrasive grit wear and rag accumulation are main concerns for long term wear of the solid bowl and other centrifuge components. Given that the screens at the headworks will be replaced in the near future, and the primary sludge already has screening, the struvite is removed periodically, and the components most at risk aren't already exhibiting significant wear, it is likely the bowl and scroll will continue to last for many years. Based on the consistent performance of the units, the minimal downtime and the condition of the major components, it is estimated that if the centrifuge units both could continue to be well maintained (regular cleaning, lubrication and seal replacement), they will likely last an additional 10 to 15 years. It is more likely that other components within the dewatering system such as the cake conveyor, the polymer feed system and the progressive cavity feed pumps will wear down more quickly than the centrifuges.

4.9.6 Centrifuge Dewatering Capacity

The centrifuges have a rated capacity of 200 to 250 gpm for dewatering sludge with a feed concentration of 2-2.6%, or 2,600 to 3,250 lbs/h depending on the type and conditions of the sludge. The units are capable of dewatering up to 27%, but for the solids handling process at Blue Lake WWTP, the target is 19% solids. The centrifuge design criteria are shown in Table 4-25.

Table 4-25 Centrifuge Design Criteria

DESIGN CATEGORY	DESIGN CRITERIA
Type of Sludge	TPS + TWAS
Hydraulic Capacity	200 - 250 gpm
Inlet Consistency	2.0 - 2.6%
Average Loading Rate	2,600 lb/hr
Peak Loading Capacity	3,250 lb/hr
Maximum Cake Concentration	27%
Minimum Solids Capture	95%

The average and peak loading rates are equivalent to daily loadings of 62,000 and 78,000 lb/day. The annual average and maximum month loading and flow rate for each year are included in Table 4-26.

Table 4-26 Centrifuge Loading and Flow (2013-2019)

YEAR	AVG. ANNUAL LOADING (LB/DAY)	MAX MONTH LOADING (LB/DAY)	FEED % TS	AA FLOW (GPM)	MAX MONTH FLOW (GPM)
2013	39,527	46,158	2.4	137	141
2014	46,908	56,734	2.7	145	163
2015	45,847	59,925	2.7	144	168
2016	46,445	55,969	2.7	141	166
2017	41,476	54,058	2.6	140	166
2018	46,657	58,012	2.6	152	174
2019	43,781	53,819	2.3	164	168

The highest maximum month flow observed between 2013 and 2019 was 174 gpm, significantly lower than the hydraulic capacity rating of the centrifuge (200-250 gpm). Operations staff have noted that they keep the centrifuge feed below 200 gpm in order to keep from overloading the final stabilization facility with cake.

The solids loading design criteria provided an average and a peak capacity. The average capacity indicates the target or optimal operating conditions, while the peak represents the maximum loading allowed in order to achieve the specified performance. In order to maintain low total solids in the centrate, it is recommended that the maximum month solids loading rate not exceed the peak loading capacity of the centrifuge. Figure 4-13 indicates the historic maximum month loading of the units, along with the high and low projected loadings with IPIP being implemented in 2020.

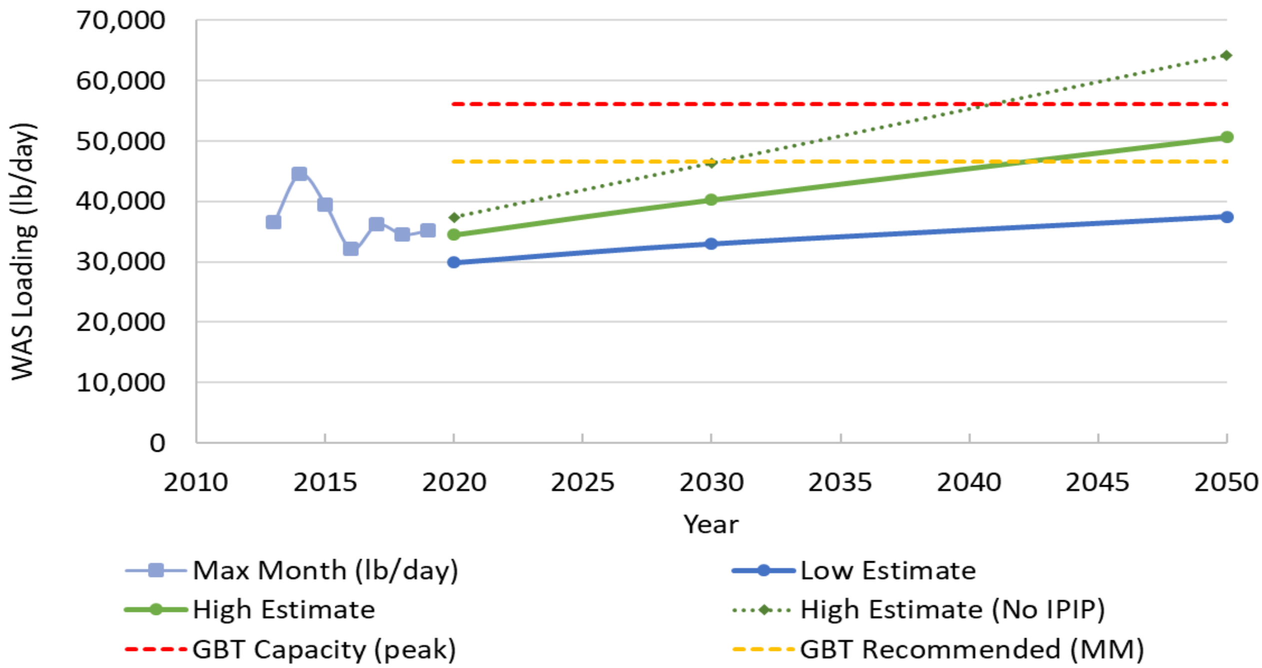


Figure 4-11 Centrifuge Dewatering Capacity vs. Projected Loading (Max Month)

A slight decrease in the centrifuge loading is anticipated in the near future, and even the high projection is not expected to exceed the peak capacity until 2050 at the earliest. Given the projections as well as the hydraulic and solids loading history, it is highly unlikely the centrifuge capacity will be exceeded before the units require replacement in the next 10 to 15 years.

4.9.7 Recommended Thickening and Dewatering Building Improvements Summary

Table 4-27 summarizes the Thickening and Dewatering Building recommended improvements with projected construction costs. The Sum Total for Phase I is $0, for Phase II is $0, and for Phase III is $4,464,000.

Table 4-27 Recommended Thickening and Dewatering Building Improvements

AREA	DISCIPLINE	IMPROVEMENT	PHASE I (<10 YEARS)	PHASE II (10-15 YEARS)	PHASE III (15-30 YEARS)	TYPE OF PROJECT
(TDB)	Process	Process Equipment	$0	$0	$4,464,000	P

- Area of Project: Thickening and Dewatering Building (TDB)
- Type of Project: Preservation (P)
- Construction costs presented in 2020 dollars and do not include engineering or administration

4.10 *Drying*

4.10.1 Final Stabilization Facility Equipment

The Final Stabilization Facility (FSF) uses a rotary drum thermal drying process to further treat biosolids from digestion and make a pelletized fertilizer product. The FSF consists of the solids treatment system, including rotary drum dryer, wet cake handling equipment, dried material handling equipment, product storage silos, process gas treatment system and stack, associated electrical, instrumentation, control and utility systems and a building to house the treatment system and staff facilities. The drying system has a nominal capacity of 4,440 dry pounds per hour (53.3 dry tons per day) at the original design feed cake concentration of 27% total solids and an evaporation capacity of 12,800 pounds per hour.

When the digestion facilities were brought online the FSF operator, New England Fertilizer Company (NEFCO), had difficulty making a pellet with drier cake and initially added water to the dryer feed, resulting in an equivalent cake feed concentration of 19 to 20% total solids. MCES eventually modified centrifuge operation to produce a wetter cake, such that NEFCO did not need to add water to the cake. Thermal dryers are principally evaporative devices, so that feed material with a higher moisture content will result in a reduced dry solids throughput. Figure 4-12 shows the thermal drying system solids capacity for different cake feed solids concentrations in comparison with solids projections.

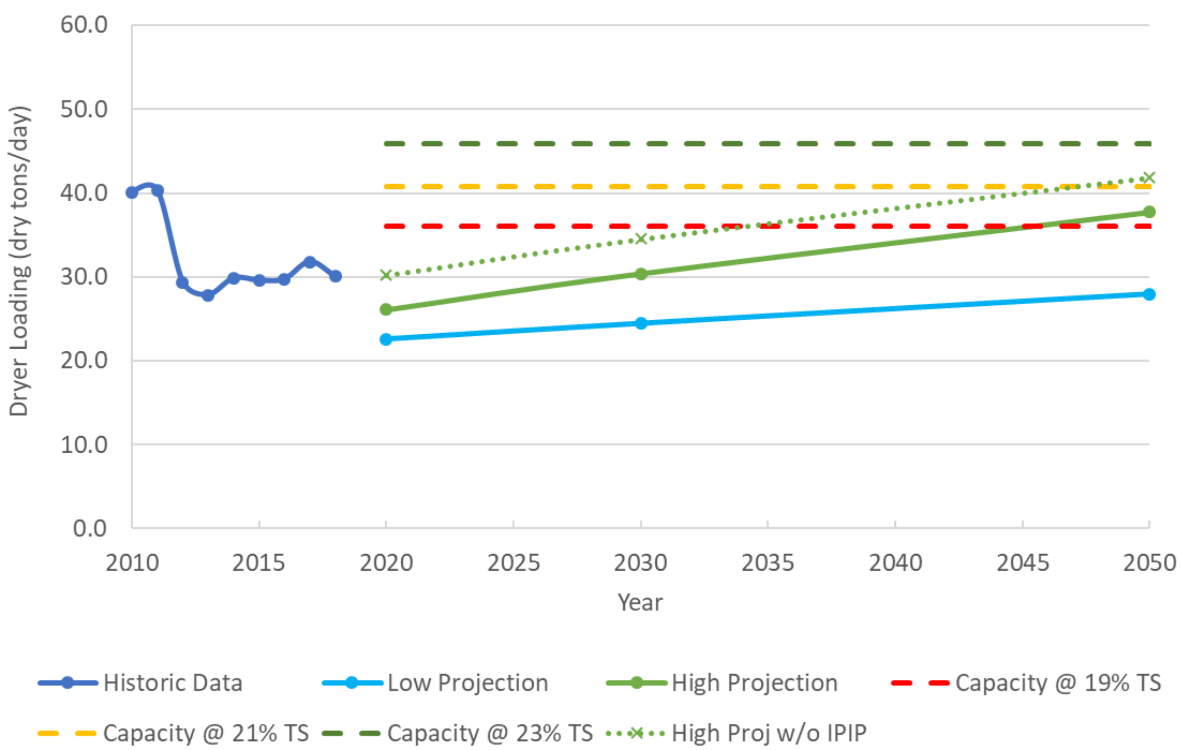


Figure 4-12 Dryer capacity and biosolids projections

The FSF was constructed in 2000, is owned by Council and has been operated by NEFCO since it was commissioned. The existing agreement between Council and NEFCO ends in 2030 and in 2019 a condition assessment of the FSF was completed to document the condition of the facility as the competitive bid for a new operations management contract was approaching. The

Condition assessment found groups of items that needed to be replaced immediately, replaced in 5-10 years and in good condition with greater than 10-year life span. The items identified to be at end of life are being replaced in 2021 and are outside the scope of this facility plan. The items that needed to be replaced immediately are being repaired outside the scope of this facility plan.

Equipment recommended for replacement from five to ten years consists of the following:

- Wet cake delivery conveyor
- Drum dryer discharge end R
- Dryer furnace
- Recycle bin
- Product silo screw conveyor
- Dust control pump
- Scrubber recirculation pump

In general, it is recommended that the location and configuration of this equipment be the same as the existing. More abrasion resistant surfaces, with successful experience at other dryer facilities, should be evaluated for areas of high erosion for the drum dryer discharge end, the recycle bin, and product silo screw conveyor. Stainless steel should be evaluated for areas experiencing corrosion on the furnace and furnace inlet plenum.

Table 4-28 shows a planning level opinion of probable construction cost for the recommended equipment replacement.

Table 4-28 Short Term Dryer Equipment Replacement Opinion of Probable Construction Cost

DESCRIPTION	COST
Wet cake delivery conveyor	$40,000
Drum dryer discharge end R	$230,000
Dryer furnace	$320,000
Recycle bin	$200,000
Product silo screw conveyor	$140,000
Dust control pump	$10,000
Scrubber recirculation pump	$15,000
Installation (20%)	$191,000
Electrical (10%)	$95,500
I&C (10%)	$95,500
Contingency (40%)	$382,000
Total Cost	**$1,719,000**

4.10.2 Long Term Dryer Needs (to 2050)

The thermal dryer system will be sized for the maximum month cake loading projected for 2050, which is shown in Table 4-29. If no industrial pretreatment program is implemented cake production is expected to reach 42 dry tons per day by 2050.

As reviewed in Section 4, a rotary drum dryer is the recommended dryer type. Two complete dryer systems are recommended for reliability and to allow ample time for dryer maintenance activities. The existing dried product silos are in good condition and can be used with the new dryer systems.

The existing dryer system will have been in operation for 30 years at end of the near-term planning period. Most of the equipment in the existing system is expected to have reached the end of its useful service life by 2030. Rather than replacing individual equipment items as they fail, it is recommended the existing system be completely replaced. A new dryer system will include safety and operational upgrades not available with the existing system.

Table 4-29 Design Parameters for the new Blue Lake WWTP Biosolids Dryer System

DESIGN CATEGORY	DESIGN CRITERIA
Number of dryers	2 (1 duty, 1 standby)
Dryer loading rate, dry ton/day	42
Dryer loading rate, wet ton/day	212
Dryer operation	24 hours/7 days per week
Cake feed, % solids	20%
Final product, % solids	95%
Evaporation rate, lb water/hr	14,000
Fuel	Digester gas and natural gas

A significant expansion of the existing dryer building will be needed to house two new dryer systems. The existing building will be expanded to the west to provide space that will contain one new dryer system. The existing building will be expanded to the south to provide additional space for electrical and HVAC equipment as well as provide more space in the existing dryer area for the second new dryer system. Depending on the dryer manufacturer selected, the roof elevation of the existing dryer building may need to be increased to accommodate the product handling equipment that is part of the new dryer system. A new belt conveyor will move cake from the dewatering centrifuges to the cake storage bins associated with each dryer system. A fourth dried product storage silo is proposed for extra storage area.

4.10.3 Recommended Final Stabilization Improvements Summary

Table 4-30 summarizes the Final Stabilization recommended improvements with projected construction costs. The Sum Total for Phase I is $51,472,000, for Phase II is $0, and Phase III is $0.

Table 4-30 **Recommended Final Stabilization Improvements**

AREA	DISCIPLINE	IMPROVEMENT	PHASE I (<10 YEARS)	PHASE II (10-15 YEARS)	PHASE III (15-30 YEARS)	TYPE OF PROJECT
FS	Process	Wet Cake Delivery Conveyor	$68,000	$0	$0	P
FS	Process	Drum Dryer Discharge End Rehab	$387,000	$0	$0	P
FS	Process	Dryer Furnace	$537,000	$0	$0	P
FS	Process	Recycle Bin	$336,000	$0	$0	P
FS	Process	Product Silo Screw Conveyor	$236,000	$0	$0	P
FS	Process	Dust Control Pump	$17,000	$0	$0	P
FS	Process	Scrubber Recirculation Pump	$26,000	$0	$0	P
FS	Process	Dryer Facility Expansion	$49,865,000	$0	$0	E

- Area of Project: Final Stabilization (FS)
- Type of Project: Preservation (P), Expansion (E)
- Construction costs presented in 2020 dollars and do not include engineering or administration

4.11 *Chemical Usage*

4.11.1 Bioxide

Metropolitan Council has incorporated the use of Bioxide® dosing within the Blue Lake WWTP collection system to mitigate odors and minimize corrosion. Bioxide® is a calcium nitrate solution that is dosed within the collection system as both a curative and preventative odor/corrosion preventer. In a curative application, the nitrates within the solution provide electrons for oxidation of H_2S to SO_4, reducing the presence of H_2S gas within the system. As a preventative measure the presence of nitrate maintains anoxic conditions, preventing anaerobic conditions and therefore minimizing the production of H_2S. A key aspect of successful Bioxide® application is adequate retention times, on the order of 2-3 hours as a minimum.

The application of Bioxide® for collection system odor and corrosion mitigation is a proven, successful technology but one potential downside is the consumption of readily biodegradable substrate (rbCOD/sBOD) within the collection system. Readily biodegradable substrate plays a critical role in stability of enhanced biological phosphorus removal (EBPR) at treatment plants. The use of Bioxide® within the Blue Lake WWTP collection system has been well documented, available data consists of:

- Dose/loading of calcium nitrate
- Plant influent nitrate/nitrite (NOx)
- Plant influent volatile fatty acids (VFAs)

Influent nitrate, nitrite, and VFAs have not been consistently measured but have been measured across various periods as a method to inform the impact of dosing rates. EBPR performance at Blue Lake WWTP has had periods of inconsistent performance. The main areas of concern related to Bioxide® dosing and EBPR impact are:

- **Influent Nitrate/Nitrite.** Significant concentrations of influent NOx could be detrimental to the anaerobic zones required for the selection of phosphorus accumulating organisms (PAOs). The zones at Blue Lake WWTP are setup to provide RAS denitrification prior to mixing with the primary effluent, if the primary effluent were also high in nitrate/nitrite this would reduce or eliminate the anaerobic portion of the basin.
- **Influent VFAs.** If the Bioxide® dosed to the collection system causes significant reduction in readily available carbon (rbCOD/sBOD) this would also reduce or eliminate the selective pressures for PAOs and successful EBPR.

A data review was performed to identify if there were any potential EBPR impacts of Bioxide® use within the collection system. Figured 4-15, 4-16, 4-17 and 4-18 summarize the available Bioxide® dosing, influent NOx, and VFA data available from 2014 versus the effluent total phosphorus concentration.

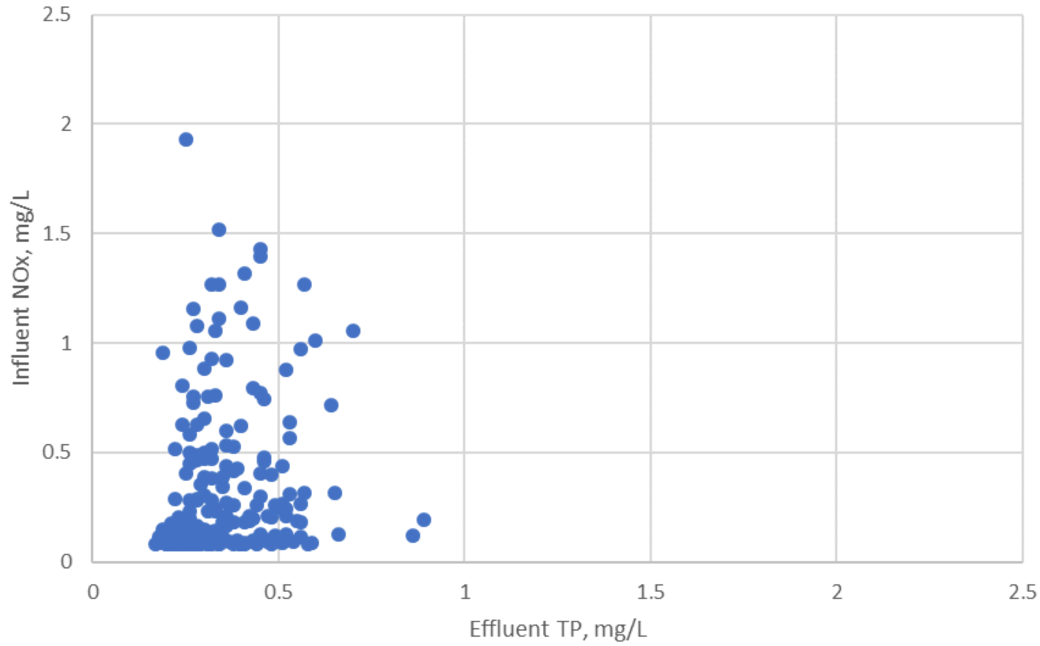


Figure 4-13 Blue Lake WWTP influent nitrate/nitrite (NOx) concentration vs. effluent total phosphorus. Data available from June 2017 through July 2019.

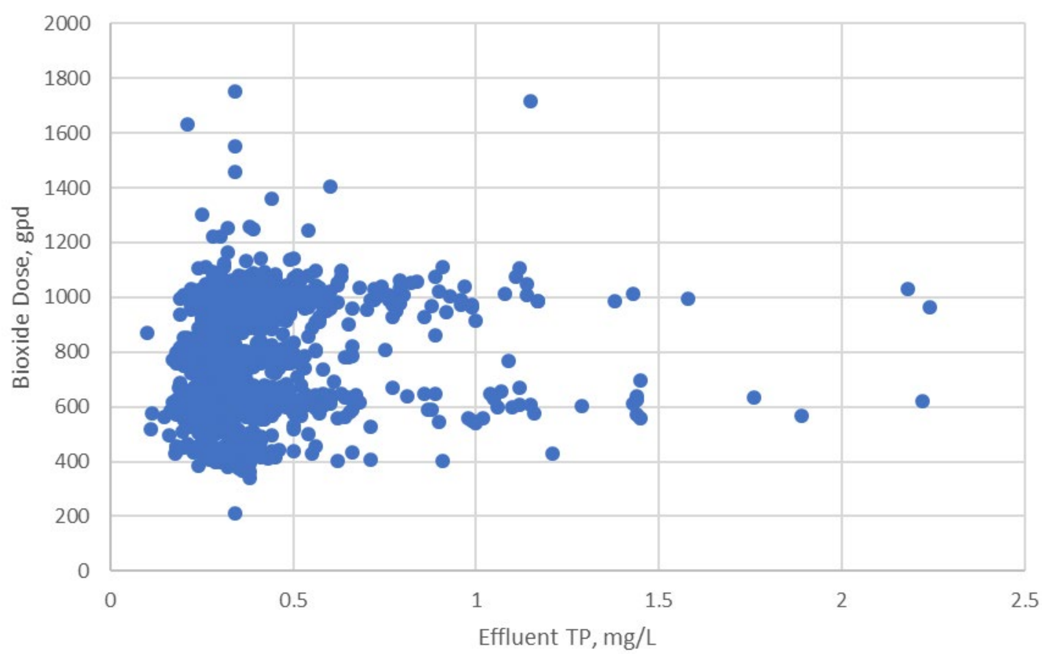


Figure 4-14 Blue Lake WWTP collection system Bioxide® dose rate vs. effluent total phosphorus. Data spans 2014 through September 2018.

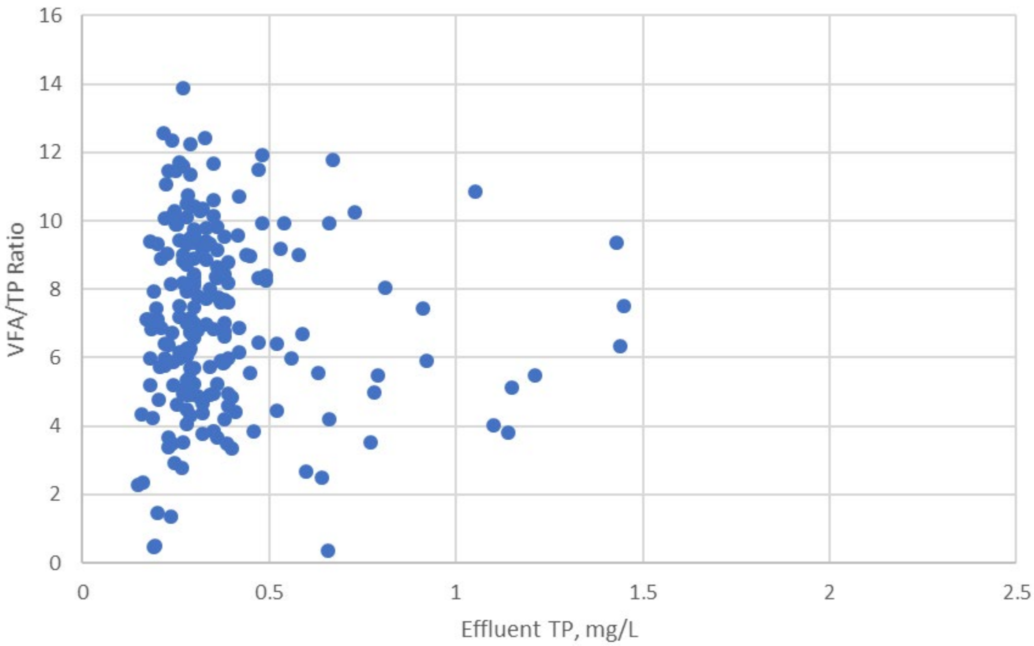


Figure 4-15 **Blue Lake WWTP influent VFA/TP ratio vs. effluent total phosphorus. Data available from January 2014 through February 2016**

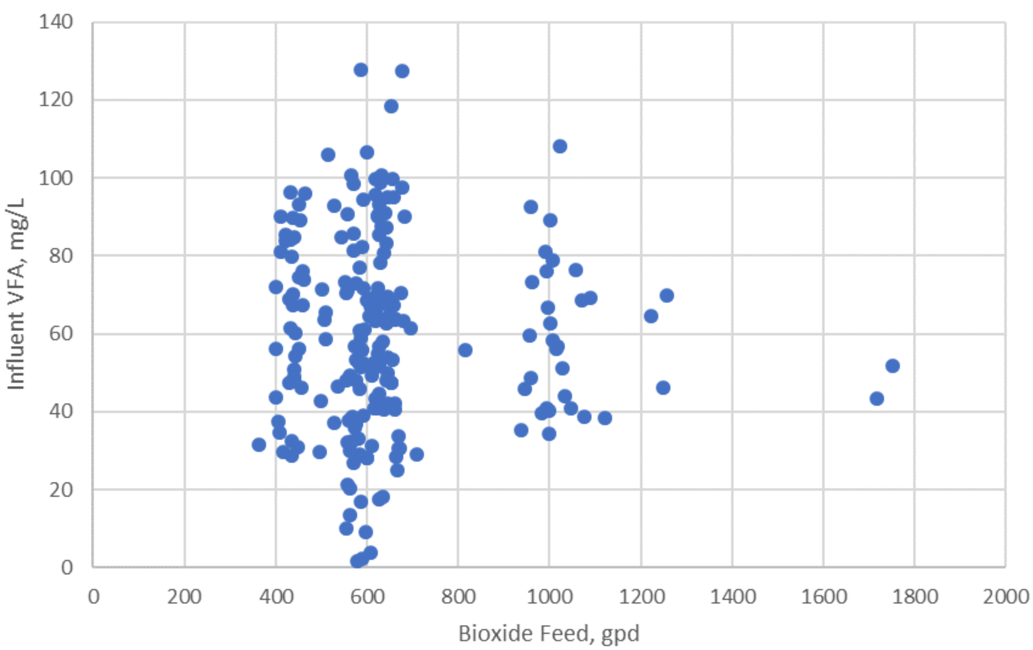


Figure 4-16 **Blue Lake WWTP influent VFA concentration vs. Bioxide® feed rate. Data available from January 2014 through February 2016.**

The available data does not suggest a trend related to Bioxide® dosing within the collection, neither a trend with decreased influent available carbon nor effluent phosphorus concentration. While there is no evidence of detrimental plant performance due to Bioxide® use it is recommended operations continue the current sampling protocol to reduce process performance risks associated with its use.

4.12 *Support Services*

4.12.1 Electrical & Instrumentation Assessment

Most of the equipment associated with the solids treatment process was constructed in 2011, and the electrical gear is in good shape overall. Most issues identified are minor, including light corrosion on conduit in several buildings. The project will include improvements identified in recent inspections.

PLC Replacement

Programmable logic controllers (PLCs) control and monitor the wastewater treatment processes. All nineteen Modicon PLCs at Blue Lake are no longer available from the manufacturer. By 2026, support for these PLCs will no longer be available from the manufacturer. There are also six Allen Bradley PLCs. Two are in an “active-mature” and three are in a “discontinued” status as listed by the manufacturer. All Modicon and Allen Bradley PLCs will be replaced by 2026.

It is difficult to predict future technology, but the traditional PLC life span is around 15 to 20 years. Another PLC replacement project should, at a minimum, be in the planning stage by 2045.

Lighting

The exterior lights have been upgraded to LED fixtures and are in good shape. All interior lights in the solids building are fluorescent fixtures. The interior lights are also in good shape, but they could be upgraded to LEDs to provide more energy efficiency.

Chemical Handling Building (CHB)

The ferric chlorine tank room shows several signs of moderate corrosion. The light fixture lens clamps are stainless steel and starting to corrode. The conduit steel clamps have moderate corrosion, and the conduit is in fair shape overall. The conduit strap and box hardware seem to be steel instead of stainless steel. They are all corroding and are estimated to last another 10 years. If the conduit straps corrode more significantly, they could start pulling away from the wall if pressure is applied.

Digester (DIG)

Engineering staff noted that the radar level instrument installed on Digester No. 3 cannot be isolated due to its method of installation. The instrument protrudes down past its gate valve and the valve cannot be closed to replace the instrument. Digester 3 would need to be taken out of service for the level instrument to be replaced.

Electrical equipment on the rooftop and in the basement is in good condition, but conduit at both locations is starting to corrode. Overall, the conduit is still in good shape.

MCC bucket has cardboard blocking access to live parts through the front cover. A new breaker will be purchased and installed under this project.

Thickening & Dewatering Building (TDB)

Interior Lighting: High bay lights in the thickening and dewatering equipment room have been retro fit with energy efficient LED screw in type fixtures.

Polymer Storage Room: Conduit in the polymer storage room has some corrosion but is in fair shape overall. The chemical scrubber section of the polymer room is under construction and has several issues. Conduit associated with the scrubber have LB fittings and boxes without covers, and temporary wire running through the room.

Thickening & Dewatering Room: Electrical hardware and conduit in the Centrifuge area has some minor corrosion.

Screening Area: Two lights in the screen area have discolored lenses.

Gravity Thickener Odor Control Building (GTO)

No improvements required

Gravity Thickener Building & Tanks (GTH)

Gravity Thickener Tank Exterior: Conduit, boxes and hardware on the outside of the tanks, next to the door is corroded.

Gravity Thickener Tank Interior: Conduit, boxes and hardware inside the tanks is corroded. Conduit next to the doors is flaking off and will be a problem when working on this equipment.

Gravity Thickener Building: The light fixture in the stairwell inside the building (above the landing between level 1 and the basement) isn't functional. There is plenty of light provided by the fixture on first floor landing, the broken fixture may not be needed. Fixture should be replaced or removed.

Basement: Conduit in the basement has mild corrosion, but overall is in fair shape.

Sludge Loadout Building (LOB)

Conduit in the Truck Bay has some minor corrosion, but overall it is in fair shape. There is an open LB fitting without a cover in the Truck Bay. Two wall mounted halogen lights are non-functional. The control panels on landing are starting to corrode. The electrical raceways in the electrical room area are open. It's recommended that the LB fitting and the electrical raceways be covered, and the wall mounted lights be repaired or replaced.

4.12.2 HVAC Assessment

The capacity and condition of the HVAC units associated with the solids processes at Blue Lake WWTP were assessed for this report. The Gravity Thickener Unit HVAC equipment was covered separately in section 4.1.2. A full summary table of the solids HVAC equipment can be found in Appendix 4-3.

Gravity Thickener Odor Control Building

GTO-AHU01 has required ongoing maintenance and replacement of failed bearings. GTO-FAN01 appears to be in good condition and has operated with minimal service issues.

In order to improve system reliability, it is recommended to replace GTO-AHU01 with a new gas-fired unit with appropriate coatings and filtration to prevent hydrogen sulfide corrosion.

Additionally, monitoring of space temperature in this building should be added to the central energy management system to indicate failure of HVAC equipment.

Chemical Handling Building

It was observed that internal components of CHB-AHU01 are showing signs of corrosion. It is believed that the source of corrosion has been identified and corrected. CHB-AHU02 appears to be in good condition and has had minimal service issues. CHB-ACC02 has experienced compressor failure due to corrosion.

CHB-AHU01 can continue to operate in its current condition. To ensure that the unit can stay in operation without an unplanned shutdown, corroded components of the unit will need to be replaced. CHB-ACC02 should be considered for replacement within 5-10 years at the end of its service life. When replaced, it should be provided with a phenolic Heresite® or equivalent corrosion resistant coating on its coils and components to protect against corrosion.

Digester Control Building

The current mechanical systems serving this building have been in operation for eight years and appear to be in good condition and have had minimal service issues. DIG-ACCU01 has experienced compressor failure due to corrosion.

DIG-ACCU01 should be considered for replacement within 5-10 years at the end of its service life. When replaced, it should be provided with a phenolic Heresite® or equivalent corrosion resistant coating on its coils and components to protect against corrosion.

Final Stabilization Facility

FSF-AHU301, FSF-AHU303 and FSF-ACC301 were originally installed approximately 18 years ago and have since been replaced within the last five years. These systems currently appear to be in good condition but were replaced in part because of compressor failure related to corrosion. The remaining equipment appears to be in fair condition but is approaching the end of its service life.

The HVAC equipment that has been in operation for 18 years will be at the end of its service life within 5-10 years and should be considered for replacement at that time. Replacement condensing units and rooftop units should be provided with a phenolic Heresite® or equivalent corrosion resistant coating on its coils and components to protect against corrosion.

Thickening and Dewatering Building

The mechanical systems serving this building appear to be in fair condition but are either at or nearing the end of their service life. TBD-MAU1 and TBD-MAU2 have required ongoing maintenance and because they are direct-fired makeup air units, it has led to a buildup of carbon monoxide in the building during the winter months.

TBD-MAU1 and TBD-MAU2 are at the end of their service life and should be considered for replacement at this time with new indirect-fired makeup air units. The remaining HVAC equipment (exhaust fans and rooftop unit) will be at the end of its service life within 5-10 years and should be considered for replacement at that time.

Sludge Loadout Building

The mechanical systems serving this building consist of exhaust fans and unit heaters. The exhaust fans have exceeded their service life. The heaters in the loadout bay were replaced in 2009 and appear to be in good condition.

Replacement of the exhaust fans should be considered as they have exceeded their service life.

4.12.3 ADA Accessibility Analysis

An accessibility consultant was hired by the Council to conduct an ADA accessibility review of all the wastewater treatment plants. A report was issued on October 10, 2019 with findings and recommendations for the Blue Lake WWTP. The recommendations include actions needed to address accessibility deviations and priorities and timelines for these actions. The recommendations and associated cost estimates can be found in Appendix 4-4. Accessibility improvements, excluding the administration building and others that have been completed by MCES maintenance staff, are included in this project.

4.12.4 Odor Control

MCES treats odors for the entire Blue Lake system, which includes a series of interceptors, pump stations, and a wastewater treatment plant. The interceptors and pump stations which bring flow to the plant is not included in this Facility Plan. Under a separate project MCES is analyzing air samples and air flows at different points in the interceptor. This data will be used to determine which locations need lining, ventilation and mechanical odor control equipment.

At the Blue Lake WWTP, there are covers on various tanks (gravity thickeners, digesters, sludge storage tank), as well as a number of odor control units to prevent odors from leaving the plant.

Screening Building. In 2020, new dry media adsorptive odor control units were added to the Screenings Building, a location that had not previously had any odor control. These units utilize an engineered media with carbon impregnated filters to capture odorous air leaving the building. The filter components will be replaced regularly by plant maintenance.

Gravity Thickeners. Odorous air from the gravity thickeners is conveyed to a radial flow odor unit, which utilizes activated carbon to treat all the air from the gravity thickener tanks. The vessel was recently inspected and repaired, and the carbon was replaced in 2020 with an anticipated 8-12 year life span. Included in the capital project were piping modifications which allow quicker carbon changes in the future.

Thickening and Dewatering Building. Odorous air from this building was previously conveyed to a chemical odor control scrubber, which was past the end of its life. In 2020, it was removed and replaced with a radial flow activated carbon unit similar to the Gravity Thickener unit. The carbon is better suited for the levels of H_2S and flows needed to treat all the air from the thickening and dewatering processes at the plant. The carbon has the same 8-12 year life span and the tank was installed to accommodate easy refills of carbon.

Digester Control Building Sump. Odorous air from the building sump is conveyed to a small activated carbon canister to treat odorous compounds. This unit was installed in 2012 and is in good working condition.

Regenerative Thermal Oxidizer (RTO) and Exhaust Stack. Odorous air from the dryer is conveyed to an RTO, which thermally destroys odorous compounds. An exhaust stack was built in 2008 to increase the elevation of the air outlet and included fins to direct the air upwards in varying wind conditions. The stack is in good shape and no changes are currently recommended.

The RTO was installed in 2000 but will be replaced in 2022 due to its condition, along with increasing the ability of the dryer to more fully utilize biogas, as mentioned in the existing facilities section.

4.13 *IPIP Pretreatment Impacts*

This section summarizes the proposed facility improvements impacts if the Northern Star 2020 load reduction in Section 1 is not achieved.

4.13.1 Liquid Stream

The liquid stream capacity analyses presented above are predicated by the projected design flows except secondary treatment system. No changes in the proposed preliminary, primary, disinfection, outfall or pumping systems are required if the planned Northern Star planned reduction does not occur. Secondary treatment facility requirements are impacted if higher influent loadings are observed than planned. Section 5.1.3 addresses the impacts to the secondary treatment recommended facilities and their phasing if the Northern Star 2020 load reduction does not occur.

4.13.2 Solids Stream

If the influent loading reductions do not occur as anticipated, solids loading will increase as presented in Section 2.4.3. No changes in the gravity thickeners, sludge screens, Thickening and Dewatering Building, and Final Stabilization improvements are required if the planned Northern Star planned reduction does not occur. The increase in projected solids loadings will have the following impacts to the proposed solids treatment processes.

Gravity Belt Thickeners

Figure 4-12 shows the GBT maximum month solids loading rates without IPIP pretreatment exceed the recommended GBT solids loading by 2035 and manufacturer rated capacity by 2050. Facility improvements are recommended from Phase III (15-30 years).

Anaerobic Digesters

As indicated previously, there are two conditions which relate to digester capacity: volatile solids loading and hydraulic loading. If reductions due to IPIP are not fully realized, loading of volatile loading becomes more critical, both for normal operations (i.e. 3 digesters) and during digester cleaning (i.e. 2 digesters). Figure 4-17 shows the digester volatile solids loading without IPIP Pretreatment. During all conditions, the VS loading rate will exceed the typical design value of 0.12 lb VS/cuft/day, although many digestion systems can routinely and effectively operate above this level. Primarily during digester cleanings, the projected VS loading rate will increase to high VS loading ranges in the coming years. Depending on the duration of cleaning, mitigations would be required to maintain good digester health during these times. Based on volatile loadings, a new digester should be considered in Phase I (0-10 years).

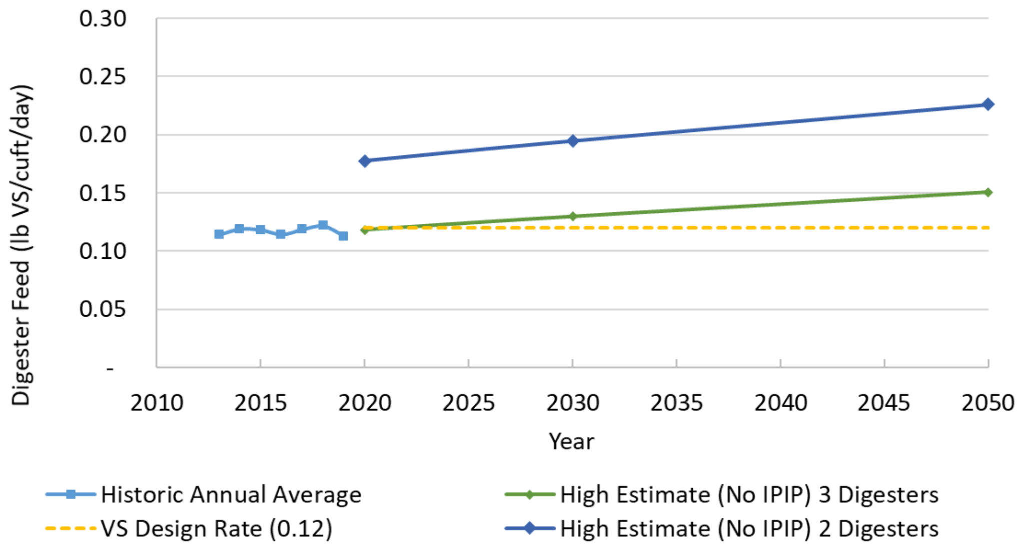


Figure 4-17 Digester volatile solids loading without IPIP Pretreatment

If reduction due to IPIP are not fully realized, hydraulic loading will affect the digesters both with normal operations (i.e. 3 digesters) and during digester cleaning (i.e. 2 digesters). Figure 4-18 shows the digester SRTs without IPIP pretreatment. Operations during digester cleaning is anticipated to become more challenging, as SRTs move from 14-15 days to lower values. Based on hydraulic constraints, the new digester should be considered in Phase I.

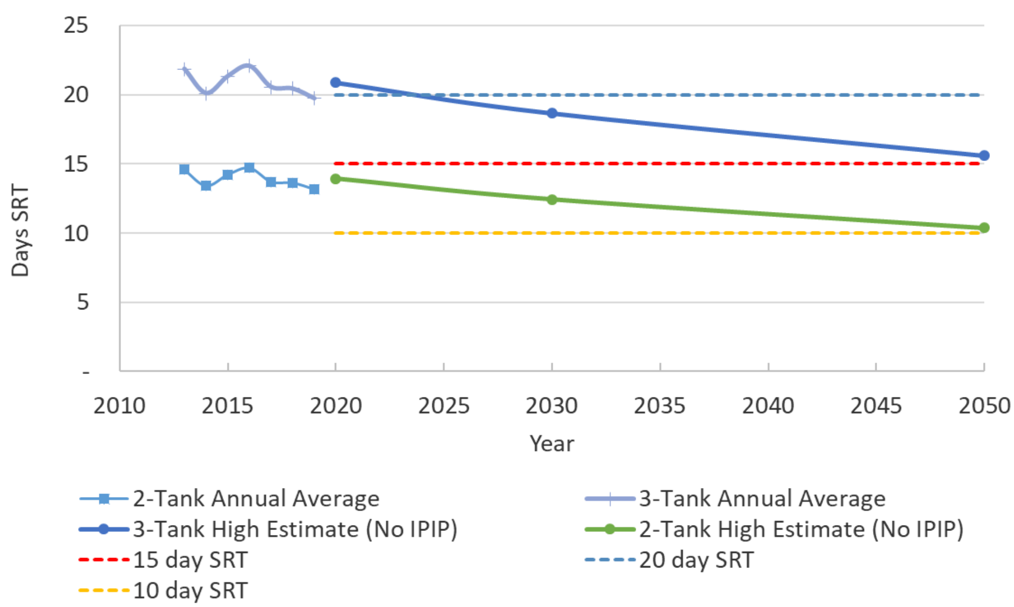


Figure 4-18 Digester solids retention time without IPIP Pretreatment

5 Process Evaluations

This section presents four alternatives evaluations for defining facility requirements during the planning period. These evaluations focused on biological nutrient removal, tertiary treatment for reduced phosphorus discharges, sidestream phosphorus management and biosolids stabilization.

5.1 *Biological Nutrient Removal Alternative Analysis*

The biological nutrient removal (BNR) alternative analysis focuses on facility requirements to meet current NPDES permit requirements with monthly TP discharges of 0.3 mg/L or less as presented in Section 3. The BNR alternative analysis assumes the plant continues enhanced biological phosphorus removal (EBPR) followed by effluent filtration. The tertiary treatment alternative analysis recommending effluent filtration to reduce monthly TP discharges below 0.3 mg/L is presented in Section 5.2. This section provides a summary of the BNR alternative analysis. Appendix 5-1 contains the detailed BNR alternative analysis.

5.1.1 Alternative Analysis

The BNR alternative analysis completed an in-depth alternative evaluation of six BNR technologies/flow schemes as summarized below:

- Alternative 0 – Current Operations (Baseline)
- Alternative 1 – Baseline with wet weather step feed
- Alternative 2 – Modified JHB with wet weather step feed
- Alternative 3 – Sidestream EBPR (S2EBPR) sidestream reactor (SSR) with wet weather step feed
- Alternative 4 – S2EBPR sidestream reactor with carbon (SSRC) with wet weather step feed
- Alternative 5 – Modified JHB with wet weather step feed and secondary effluent equalization

Alternative 0 represents the current operating flow scheme which serves a baseline for facility evaluations. Alternatives 1 through 5 all contain the following process enhancements to current operations:

- Step feeding 50 percent (66 percent for Alternative 5) of the secondary influent flow to Pass 2 during wet weather events to reduce secondary clarifiers solids loading rates (SLR) and protect the anaerobic selector,
- Addition of two baffles walls to each existing selector to increase the food: microorganism (F:M) in the initial selector zone to promote improved sludge quality (lower SVIs) and minimize back mixing in the selector zone, and
- Increasing the secondary clarifier flocculation well depth from 5 to 8 feet to minimize the solids density currents promoting a larger clarification zone, reduced clarifier sludge blankets, and reduced effluent suspended solids during critically loaded conditions.

Alternative 2 adds a dedicated RAS denitrification zone and extends the anaerobic selector to improve EBPR stability and reduce chemical (ferric chloride) consumption.

Alternatives 3 and 4 convert existing operations to S2EBPR without and with carbon addition to the sidestream reactor (converted AT0) respectively. Analysis of these alternatives showed the existing aeration tank selector zones were required to maintain monthly secondary effluent monthly TP discharges below 1.0 mg/L. It should be noted that S2EBPR process modeling is not well established to date and facility requirements should be confirmed with pilot- and full-scale demonstration testing. Alternative 5 combines Alternative 2 process modifications to promote stable EBPR with secondary effluent flow equalization to de-couple plant hydraulics and secondary clarifier process limitations to reduce the number of secondary clarifiers required.

Table 5-1 through Table 5-3 provide a summary of the key process data, comparative capital costs, annual operating costs in Year 2025 and net present value of each alternative. Alternative 5 has the lowest capital cost of roughly $48 million since additional aeration tank and secondary clarifiers are not required. Alternatives 1 and 2 capital cost are slightly higher at $52 to $55 million, respectively given two additional secondary clarifiers are needed in the planning period. The three remaining alternatives capital costs are 45 percent or more higher than Alternative 5. The existing investment in mainstream EBPR results in high capital costs for S2EBPR making these alternatives less attractive unless pilot- and demonstration testing shows an additional aeration basin is not required (Alternative 3).

Table 5-1 Existing Permit BNR Alternative Evaluation Key Process Design Data (2050): Aeration Tanks

ITEMS	UNITS	ALT. 0	ALT. 1	ALT. 2	ALT. 3	ALT. 4	ALT. 5
Additional 2.3 MG basins[a]	No.	1	0	0	1	1	0
Total volume	MG	21.96	19.66	19.66	19.96[b]	19.96[b]	19.66
Total SRT	days	13.8	13.8	17.1	18.3	18.3	17.1
Aerobic/ Anaerobic SRT	days	11.5/2.4	11.5/2.4	11.5/2.4	11.5/2.4[b]	11.5/2.4[b]	11.5/2.4
Maximum month MLSS	mg/L	3,800	4,300	4,400	4,200	4,800	4,400
MLSS at PHWWF	mg/L	3,800	3,200	3,350	3,250	3,750	2,900
Dissolved Oxygen	mg/L	1.8	1.8	1.8	1.8	1.8	1.8
Aeration Demand (avg)	scfm	38,850	38,850	37,640	37,940	39,770	37,740

Notes:

a. Facility requirements based upon projected flows and loadings in Section 2.2.3

b. Excludes 2.0 MG sidestream reactor

Table 5-2 Existing Permit BNR Alternative Evaluation Key Process Design Data (2050): Secondary Clarifiers

ITEMS	UNITS	ALT. 0	ALT. 1	ALT. 2	ALT. 3	ALT. 4	ALT. 5
Additional secondary 125-ft clarifiers[a]	No.	4	2	2	2	4	0
Clarifiers in service	No.	12	10	10	10	12	8
Diameter	feet	125	125	125	125	125	125
Return sludge flow	mgd/clarifier	5.0	5.0	5.0	5.0	6.0	6.0
Sludge volume index	mL/g	110	110	110	110	110	110
PHWWF SOR[b]	gal/ft^2-d	795	955	955	955	795	1190
PHWWF SLR[b]	lb/ft^2-d	38	36	38	37	40	41
Additional 125-ft clarifiers	No.	4	2	2	2	4	0
Filtration capacity required	mgd	65	65	60	70	70	65
Average ferric chloride	gal/d	640	630	355	635	590	380
Annual dewatered cake	lb TSS/d	61,120	60,700	60,300	61,620	62,010	60,330

Notes:
a. Facility requirements based upon projected flows and loadings in Section 2.2.3
b. Peak hour wet weather flow (PHWWF) surface overflow rate (SOR) and solids loading rate (SLR) include 9 mgd of plant internal recycle flows.

Table 5-3 Existing Permit BNR Alternative Evaluation Key Process Design Data (2050): Cost Summary

ITEMS	ALT. 0	ALT. 1	ALT. 2	ALT. 3	ALT. 4	ALT. 5
Total Capital Cost[a,b]	$81,816,000	$52,416,000	$54,912,000	$69,984,000	$85,572,000	$47,712,000
2025 Comparative annual O&M[a]	$230,000	$187,000	$49,000	$307,000	$346,000	$77,000
Net Present Value[a,c]	$89,000,000	$58,000,000	$56,000,000	$79,000,000	$96,000,000	$50,000,000

Notes:
a. Cost presented in 2020 dollars
b. Facility requirements based upon projected flows and loadings in Section 2.2.3.
c. Assumes 25 years of operation, 3% interest rate, 3% discount rate.

Alternative 2 provides the most reliable, robust and simple operations. Alternative 2 also provides the benefit of the least consumables (ferric chloride) for TP removal and lowest O&M requirements with plant familiarity similar to when feeding secondary influent through the second aeration tank influent gate, rather than the first tank inlet gate. Alternative 5 increases operational complexity by adding secondary effluent flow equalization, a Pass 1 swing zone, and Pass 2 wet weather step feed process constraint initiation requirements rather than hydraulic capacity constraints. Alternative 1 also represents very simple operations, however annual operating costs are higher than Alternatives 2 and 5 making it less attractive.

5.1.2 Recommendation

Alternative 2 – Modified JHB with Wet Weather Step Feed is recommended for continued BNR to meet the current NPDES permit. This recommendation reflects the most reliable, robust and simple operations with the least annual operating requirements. This alternative also provides the opportunity to implement Alternative 5 in the future which could decrease future expansion costs projected for Year 2040. Figure 5-1 presents Alternative 2's plant site layout. Existing facility capacity requires the two additional secondary clarifiers be added to meet Year 2040 projected process requirements.

In addition, the plant's 1980 primary and secondary treatment hydraulic capacity design was based upon a peak flow of 80 mgd. Implementation of Alternative 2 (or any other alternative) requires the following improvements be implemented immediately to alleviate hydraulic constraints:

- Construct a parallel secondary effluent channel/pipeline to the pond to prevent the secondary clarifier weirs from flooding,
- Construct a new mixed liquor distribution structure to maintain ML flow distribution control and prevent the aeration tank effluent weirs from flooding,
- Raise the primary clarifiers weirs by 5-inches along with automating one aeration tank Pass 2 inlet gate to prevent the primary clarifiers weirs from flooding.

Capital planning should include an additional $4 million for replacement of the existing selector air mixing system with submersible mechanical mixers or equal in the event the mixing system is replaced.

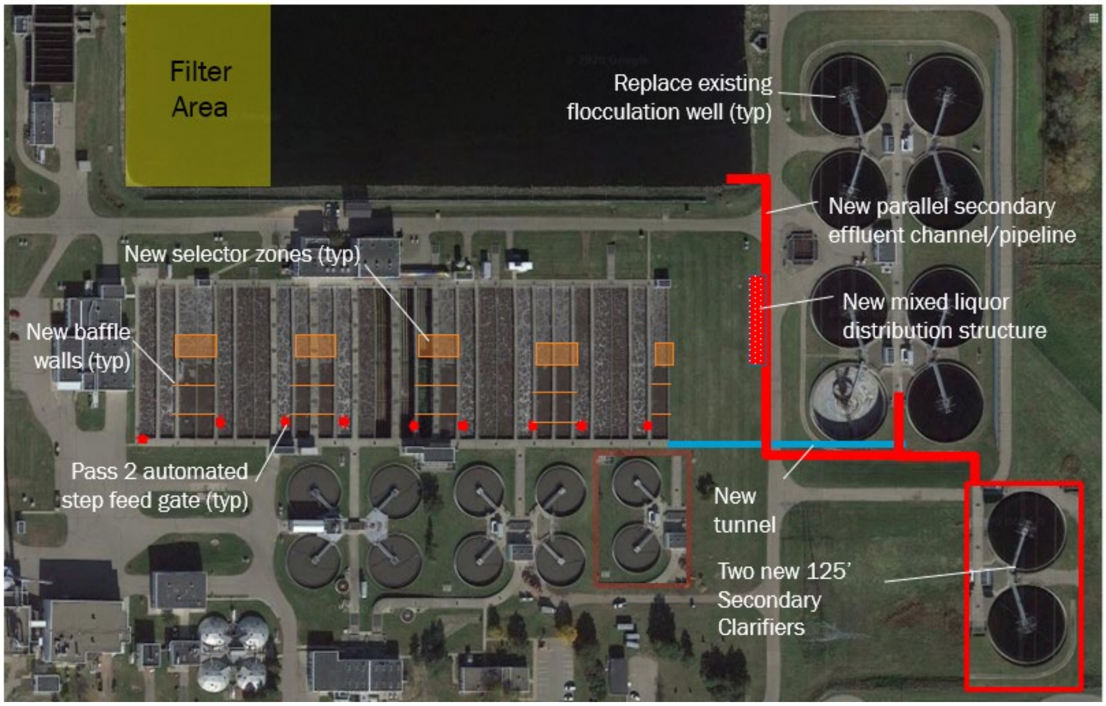


Figure 5-1 Alternative 2 – Modified JHB with Wet Weather Step Feed Site Layout (Year 2050)

5.1.3 IPIP Pretreatment Impacts

This section summarizes the facility impacts to Alternative 2 – Modified JHB with Wet Weather Step Feed if the Northern Star 2020 load reduction in Section 1 and 2 is not achieved. Based upon the increased influent loadings presented in Section 2-4, the 2050 maximum month MLSS increases slightly to 4400 mg/L with one additional 2.3 MG aeration basin. Assuming a design SVI of 110 mL/g and RAS pumping capacity of 6 mgd/clarifier, no additional secondary clarifiers are needed to maintain acceptable SLRs.

From a phasing perspective, the two new secondary clarifiers are required by 2032 with the additional aeration basin by 2045. The additional capital cost for the 10th aeration tank is $16 million (2020 dollars).

Continued analysis of future operations is recommended as a design SVI of 90 mL/g, aerobic SRT reduction from 11.5 to 10 days, or operating the current system in its bioaugmentation reaeration (BAR) configuration at a mainstream aerobic SRT of 9 days during periods of high loadings/MLSS would eliminate the need for the additional aeration tank during the planning period.

5.2 *Tertiary Treatment Enhanced Phosphorus Reduction*

This section presents a summary of the tertiary phosphorus reduction alternative analysis. Appendix 5-2 contains the detailed alternative screening and analysis.

5.2.1 Alternative Analysis

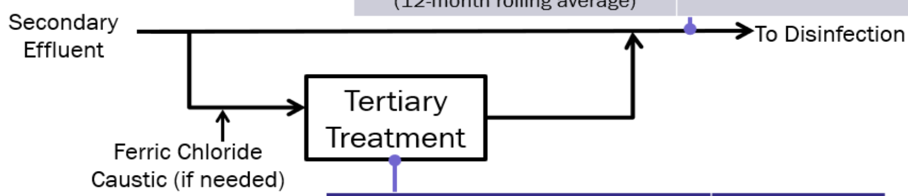
A review of tertiary treatment technologies was completed with the goal of selecting three alternatives for detailed analysis. Based upon goals of minimizing capital costs, annual operating costs, and consumables, and proven applications at similar sized facilities, the following technologies were selected for detailed evaluation:

- Alternative 1 – Conventional Filtration
- Alternative 2 – Cloth Media Filtration
- Alternative 3 – Single-stage continuous deep-bed backwash filtration

Alternative 2 system sizing is based upon Aqua-Aerobics MegaDisk™ filters and Alternative 3 is based upon Parkson Corporation DynaSand® filters. A description of each filtration technology is found in Appendix 5-2.

Tertiary filter sizing is based upon the process flow scheme presented in Figure 5-2 where secondary effluent is treated to further reduce phosphorus discharges via ferric chloride addition followed by filtration. The secondary effluent flow requiring treatment is based upon reducing the combined filtered effluent and remaining secondary effluent (if any) to the target effluent TP values shown in Figure 5-2.

Effluent TP Criteria	Target Effluent TP
17,407 kg/yr (12-month rolling)	≈ 13,900 kg/yr
100 kg/d (monthly)	≈ 80 kg/d
0.3 mg/L @ AWWF design flow (12-month rolling average)	≈ 0.24 mg/L @ AWWF



Tertiary Process	Max Month Effluent TP
Conventional and Cloth Media Filtration	0.24 mg/L
Continuous backwash deep bed filters	0.1 mg/L

Figure 5-2 Tertiary phosphorus reduction flow scheme.

Table 5-4 through Table 5-8 summarize the key process criteria, data and comparative capital costs, annual operating costs in Year 2025 and net present value of each alternative. Alternatives 1 and 2 require all flows less than 65 mgd be filtered to meet the effluent TP criteria whereas Alternative 3 requires flows less than 50 mgd be filtered. Alternative 3 required flow rates are lower than Alternatives 1 and 2 because its maximum month filtered effluent TP concentration of 0.1 mg/L is less than Alternatives 1 and 2 of 0.24 mg/L. Alternative 3's lower filtered effluent TP does require higher ferric chloride dosages than Alternatives 1 and 2 which also increases the solids generated from ferric addition. The number of filters required for each alternative are governed by the maximum filtration rate at average conditions. Each alternative's influent pumping station firm capacity is based upon the filters operating at 5 gpm/sf resulting in higher capacities than required for achieving the target effluent TP criteria. Peak filter influent flows range from 70 to 93 mgd which are in the range of the projected 2050 maximum week/day flows (70/99 mgd with internal plant recycles). Alternative 1 and 2 have potentially higher capacities of 125 mgd and 111 mgd at common filtration rates of 8 gpm/sf and 6 gpm/sf with low influent solids loadings.

Table 5-4 Tertiary Filtration Phosphorus Reduction Design Criteria (Year 2050)

ITEM	UNITS	ALT. 1	ALT. 2	ALT. 3
Annual average design flow	mgd	44	44	44
Maximum filtration rate – average flow[a]	gpm/sf	4	3.5	4.0
Maximum filtration rate – peak flow[a]	gpm/sf	5	5	5

Note:
a. Maximum filtration rates based upon 2 filters out of service at average conditions and 1 filter out of service at peak flow conditions.

Table 5-5 Tertiary Filtration Phosphorus Reduction Design Data (Year 2050): Filters

ITEM	UNITS	ALT. 1	ALT. 2	ALT. 3
Total number of filters	No.	10	6	16
Area per filter	ft^2	1200	2582	602
Media depth	inches	72	NA	84

Table 5-6 Tertiary Filtration Phosphorus Reduction Design Data (Year 2050): Filtration Rate

ITEM	UNITS	ALT. 1	ALT. 2	ALT. 3
Average filter feed flow	mgd	51	51	47
Peak feed flow for TP reduction goals	mgd	65	65	50
Average filtration rate – 2 filters out of service	gpm/sf	3.7	3.4	3.9
Peak feed flow - 1 filter out of service	gpm/sf	4.2	3.5	3.8
Design Peak at 5 gpm/sf-1 out of service	mgd	78	93	70
Capacity at x gpm/sf-1 out of service	mgd	125 (8 gpm/sf)	111 (6 gpm/sf)	--
Filter feed pump station capacity, firm	mgd	78	95	70
Backwash return pumping station capacity, firm	mgd	6	7	6

Table 5-7 Tertiary Filtration Phosphorus Reduction Design Data (Year 2050): Ferric Chloride

ITEM	UNITS	ALT. 1	ALT. 2	ALT. 3
Average usage (40% solution strength)	gpd	730	730	1260
Bulk Storage Tanks at 7500 gallons	No.	2	2	3
Additional solids generated - average	lb/d	3400	3400	5400

Table 5-8 Tertiary Filtration Phosphorus Reduction Cost Summary

ITEM	ALT. 1	ALT. 2	ALT. 3
Total Capital Cost[a]	**$83,000,000**	**$70,000,000**	**$71,000,000**
2025 Comparative Annual operating costs[a]	**$ 1,410,000**	**$ 1,460,000**	**$ 1,510,000**
Terminal Value[a]	($6,800,000)	($2,300,000)	($4,500,000)
Net Present Value[a,b]	**$120,000,000**	**$112,000,000**	**$113,000,000**

Note:
a. Cost presented in 2020 dollars
b. Assumes 25 years of operation, 3% interest rate, 3% discount rate

Table 5-8 shows Alternatives 2 and 3 have the same capital cost of $70 million while Alternative 1's capital cost of $83 Million is 18 percent higher. On a unit cost basis, Alternative 1 and 3 have similar unit capital costs of $1.06 to $1.01/gpd capacity at 5 gpm/sf while cloth media filtration is substantially less at $0.75/gpd capacity. When considering Alternative 1 and 2 peak filtration rates capacity of 8 and 6 gpm/sf respectively, unit capital costs decrease and are within 8 percent at $0.74 and $0.68/gpd capacity, respectively. Year 2025 annual operating costs of each alternative are within 7 percent and the NPVs range from $112 Million to $120 million and are considered equal since the values are within 7 percent.

5.2.2 Recommendation

Alternative 1 – Conventional Filters are recommended for tertiary TP reduction based upon its excellent performance and proven experience at similar sized facilities, ability to handle high solids loadings, less prone to plugging/biofouling/scaling, ability to treat flows of 78 mgd with potential to treat peak flows up to 125 mgd, potential to be used as a denitrification filter, and NPV within 7 percent of the other alternatives with lower annual operating costs.

5.2.3 IPIP Pretreatment Impacts

The recommended filtration system facility sizing is not impacted by the increased influent loadings (Appendix 5-2) if Northern Star's planned 2020 load reduction does not occur.

5.3 *Sidestream Phosphorus Management*

The Metropolitan Council has been and continues to take a proactive approach to phosphorus management at each of its facilities as described in Section 1.

Blue Lake currently adds ferric chloride to its anaerobic digesters for sidestream phosphorus control, struvite mitigation, and digester H_2S control. Recent operations have indicated the potential need to add more ferric chloride to the anaerobic digesters to further reduce the sidestream phosphorus loading, however, the pH within the digesters is preventing a significant increase from the current dosing rate. While there has not been a direct link of the sidestream phosphorus loading with EBPR stability and effluent TP, alternative phosphorus management approaches could provide other benefits. Struvite formation at the dewatering centrifuges and anaerobic digestion health (related to pH) are drivers to consider alternatives to ferric chloride dosing for struvite mitigation. This evaluation considers four phosphorus management strategies including:

- Alternative 1 – Ferric chloride ($FeCl_3$) addition to the anaerobic digesters and sidestream centrate. (Baseline).
- Alternative 2 – Baseline with magnesium hydroxide ($Mg(OH)_2$) addition to the anaerobic digesters.
- Alternative 3 – Anaerobic Digestion with Centrate Struvite Harvesting.
- Alternative 4 – Anaerobic Digestion with Phosphorus Sequestration.

Alternative 1 represents current baseline operations with ferric chloride addition. Alternative 2 adds $Mg(OH)_2$ to the anaerobic digesters to promote controlled struvite formation with continued ferric chloride addition for H_2S control. Capital investments for Alternative 2 are limited to chemical storage/metering equipment and requires plant staff to manage two chemicals, rather than one. Alternative 3 adds a struvite harvesting system such as Ostara's Pearl™ technology to recovery phosphate from the centrate flow and reduce phosphorus recycles back to the main liquid stream. Alternative 4 adds a phosphorus sequestration system such as CNP MagPrex™ (formerly known as AirPrex) post-anaerobic digesters to form struvite which is maintained in the biosolids and reduces phosphorus recycles. Alternatives which release and recover phosphorus upstream of the digesters were not considered in this evaluation as it would decrease the phosphorus content in the dried pellet product from roughly 4.3 percent to 3.2 percent.

This evaluation defines the system needs to reduce all recycle phosphorus loads to the same level. The decrease in recycle load will improve EBPR process stability, reduce predicted P discharges, and reduce struvite formation in the digesters as the reduced secondary influent phosphorus loads will decrease the amount of magnesium in the waste sludge, thereby reducing struvite formation.

Table 5-3 summarizes the capital and NPV of the annual O&M cost, which were then used to produce 20-year net present value costs. The status quo alternative assumes additional $FeCl_3$ feed to the centrate stream to match equivalent sidestream loading of all the alternatives. Table 5-9 provides a summary comparison of these costs for each alternative. A detailed description of these evaluations is presented in Appendix 5-3.

Table 5-9 Phosphorus Management alternative capital and O&M cost summaries

PARAMETER	ALT. 1	ALT. 2	ALT. 3	ALT. 4
Capital Costs[a]	$0	$222,000	$6,849,000	$5,183,000
Net Present Value (NPV) of Annual O&M[b]	$22,883,000	$19,852,000	$13,041,000[c]	$15,177,000
Total	$22,883,000	$20,074,000	$19,890,000	$20,360,000

PARAMETER	ALT. 1	ALT. 2	ALT. 3	ALT. 4
Payback Period to Current Status Quo[d]	N/A	<1 year	6 years	5.5 years

Notes:
a. Capital costs assume a 30% contingency and engineering fees.
b. Assumed payback NPV of 10 years with 3% discount and 3% escalation.
c. Struvite recovery was assumed at 30% with a value of $100 per ton.
d. Payback periods assumed to status quo with FeCl3 feed to both the digester and centrate stream to provide equivalent levels of treatment phosphorus loading in the return stream.

The least costly alternative from a capital cost standpoint is the status quo and alternative adding $Mg(OH)_2$. The addition of $Mg(OH)_2$ alternative requires minimal capital investment due to the existing caustic feed and storage equipment that is assumed for repurposing with the $Mg(OH)_2$.

Due to the relative uncertainty related to the dose ratios of all three proposed alternatives, it is recommended that Metropolitan Council further refine the assumptions of all or the most preferred alternative. These can be refined with pilot testing in the field and/or bench scale testing to reduce overall cost implications. The addition of $Mg(OH)_2$ is likely the most applicable to field pilot testing due to the presence of unused caustic feed and storage equipment. The struvite harvesting/sequestration alternatives can be refined with some field sampling (identify phosphorus concentrations without addition of $FeCl_3$) and bench scale testing to better identify site specific ratios.

Additionally, due to the relatively unknown causes of EBPR instability, special sampling during well and poorly performing periods is recommended. This special sampling could provide better insight into focus areas to improve EBPR performance and the relative impact of the existing sidestream phosphorus loading. If it is determined during this sampling that the recycle loading does have a significant impact on the mainstream process performance and ultimately effluent water quality, piloting of a revised operational approach is recommended.

5.4 *Biosolids Stabilization*

During planning multiple biosolids stabilization alternatives were identified. From these alternatives only ones that produce a non-liquid, Class A final product and are well-established were further developed. The two viable alternatives for the Blue Lake WWTP are thermal drying and hydrolysis.

5.4.1 Thermal Drying Alternative

The thermal drying process removes water from the biosolids using heat and air flow. Thermally dried biosolids with less than 10% moisture are a Class A product.

There are many types of thermal drying systems available for municipal biosolids drying. The most common are rotary drum, paddle or disc, belt and fluid bed dryers. Rotary drum and fluid bed dryers have a typical evaporation capacity of greater than 5,000 pounds of water per hour. Paddle and belt dryers typically evaporate less than 7,000 pounds of water per hour.

Operating data indicate the existing dryer regularly evaporates more than 8,000 pounds of water per hour. Thus, one paddle and belt dryer would not have the capacity to dry the current cake loading. A rotary drum or fluid bed dryer can meet the current and future dryer capacity requirements.

Fluid bed dryers have a vertical arrangement as shown in Figure 5-3. Cake is introduced into the drying chamber continuously. Fluidizing warm air mixes and dries the material in the chamber. Dried product is collected in a bin on the side of the chamber. The process produces a lot of dust, but the dust is recycled in the system under normal operating conditions. Fluid bed dryers are not commonly used in the U.S. but are more prevalent in Europe.

Figure 5-3 Fluid bed dryers

Rotary drum dryers have a horizontal drum arrangement with vertically arranged product cooling and sorting equipment as shown in Figure 5-4. Cake is continuously fed to a mixer where it is mixed with recycled pellets. The wet material is then conveyed to the dryer drum. The dried pellets are sorted, and oversized or undersized pellets are recycled to the mixer. Rotary drum dryers are the most commonly used drying technology in the U.S. for municipal biosolids.

Figure 5-4 Rotary drum dryer at Winston-Salem, NC

The quality of the dried product differs between the rotary drum and fluid bed dryers. The dried product from a rotary drum dryer is a pellet with a set range of diameters. Oversized or undersized pellets are recycled through the process. Fluid bed dryers produce less uniform pellets than rotary drum dryers. Product quality and uniformity are important to the users of the dried product from Blue Lake WWTP, and as such, rotary drum dryers are the recommended dryer technology for this facility.

5.4.2 Hydrolysis Alternative

Hydrolysis of waste activated sludge (WAS) can increase the solids loading to anaerobic digesters and boost digester gas production. In addition, WAS hydrolysis is known to improve dewaterability of the digested sludge to achieve cake that is 25 – 30% dry solids. The process uses heat and pressure or chemicals to break apart the cell walls of the microorganisms in the sludge. This increases the compounds within the sludge that can be consumed by the microorganisms in the anaerobic digesters. Hydrolysis increases the digestibility of the WAS in the anaerobic digesters, in turn increasing the capacity of the digesters, and boosts digester gas production.

Hydrolysis was initially considered for Blue Lake WWTP to boost digester gas production and improve dewatering performance. However, the dryer system as currently operated could not use dewatered cake at 25% dry solids. Water would be added to the cake to achieve about 20% dry solids for proper dried pellet production, negating the benefits of improved dewatering. The existing digester gas system fuels the biosolids dryer, but the dryer is not currently using all the gas produced. Additional digester gas is not needed with the current systems. It was determined that WAS hydrolysis would not benefit the biosolids processes at this time and the technology was not carried forward for further evaluation.

5.4.3 Recommended Stabilization Solution

Based on a lifecycle cost evaluation it is recommended that Blue Lake WWTP continue to use the rotary drum drying technology, which is the lowest cost alternative. A rotary drum dryer system can be sized to process all the biosolids produced at the facility in a single drum through 2050. The rotary drum drying system is familiar to maintenance personnel and produces the consistent, high quality pellet that MCES requires. The summary of costs is shown on Table 5-10.

Table 5-10 Stabilization Solution Alternative Cost Comparison

COST ITEM	ALT. 1 DIGESTION WITH DRYING	ALT. 2 HYDROLYSIS
Capital Costs[a]	$0	$15,104,000
Net Present Value (NPV) of Annual O&M[b]	$10,755,000	$22,772,000
Total	$10,755,000	$37,876,000

5.5 *Future Gas Utilization*

5.5.1 Future Digester Gas Production

Future digester gas production was predicted using the BioWin solids loading projections and making assumptions based on historic plant performance. While it is difficult to calculate the bioavailability of a waste stream, the reduction of volatile solids within a digester identifies the quantity of digested solids and can be used to predict future digester performance. A detailed analysis of the BioWin solids loading projections can be found in Appendix 5-4.

The volatile solids projections along with the digester performance provide an estimate of solids digested. Historically, the rate of gas generation has ranged from 15 to 18 scf per pound of volatile solids consumed. Typical digester performance is 15 scf/lb VS, and as the heavily bioavailable waste stream from Northern Star will be significantly reduced in 2020, using the rate of gas generation of a typical municipal wastewater digester is appropriate.

The organic loading by Northern Star is highly bioavailable, and their planned reduction in solids contributions through IPIP are project to significantly reduce digester gas production. The projected rate of digester gas production is shown in Figure 5-5, and includes the historic gas generation from 2013 to 2019.

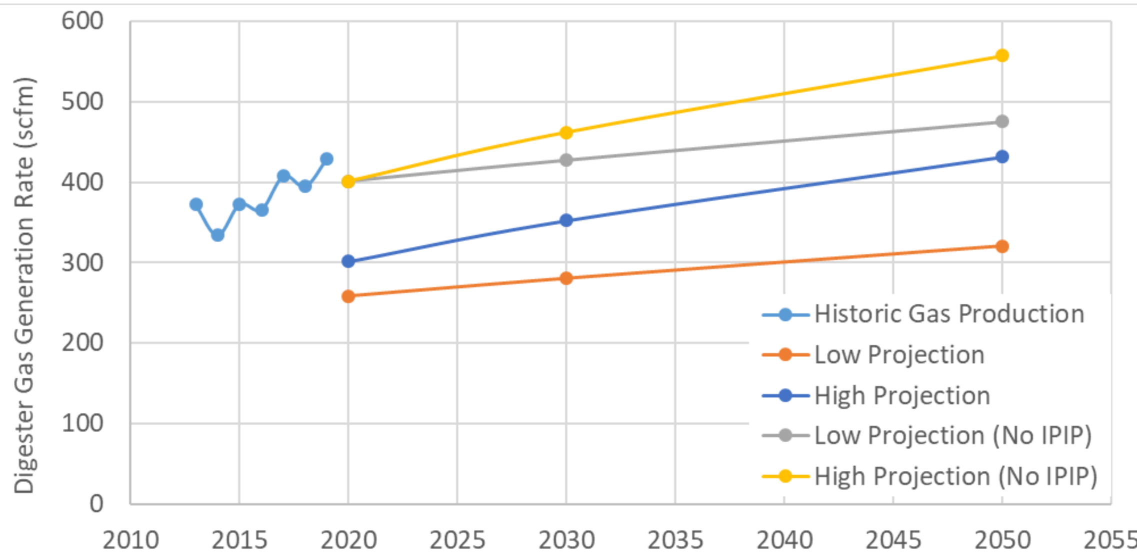


Figure 5-5 Digester Gas Production Projections

Digester gas utilization needs to consider the full range of gas production when evaluating the economics of gas utilization.

5.5.2 Modification of Current Use of Digester Gas

Using digester gas in the dryers would continue to be a beneficial use of the digester gas but the value of the gas is only as an offset to purchased natural gas. In recent years digester gas use in the dryers was limited by the condition of the RTO. This recent history also illustrates that without an alternative to drying as an end use for the gas, most of the digester gas must be wasted. To provide a 20-year planning horizon, the projected 2030 gas production is used as a mid-point for evaluating the gas utilization alternatives. Because of the anticipated reduction in loading, the projected gas production is lower than in recent years. The digesters have capacity for additional organic loading if high strength waste were added for co-digestion the additional digester gas would provide more offset or revenue.

Two alternative end uses for digester gas are combined heat and power (CHP) using engine generators and upgrading of the digester gas to renewable natural gas (RNG).

5.5.3 Combined Heat and Power (CHP)

CHP involves the generation of electricity and heat by combusting digester gas in engine generators. Electricity generated by the engine offsets Blue Lake WWTP's demand from the utility, and the heat generated can be recycled by heating the digester feed or meeting building heating needs. In order to implement CHP at Blue Lake, the existing digester gas treatment system would require siloxane removal to protect equipment, as well as a 1,500 kW engine generator.

Most savings provided by CHP comes from offsetting electrical demands (85%). Although the Blue Lake WWTP has sufficient electrical demand to utilize electricity generated by CHP, the value of offsetting purchased electricity varies depending on the time of day. Electricity is provided by Xcel Energy, which charges based on a two-tier rate structure. Xcel has noted that in the near future, the plant will be subjected to a three-tier rate structure, which could significantly impact the electrical costs offset by generating electricity at the plant. Cost benefit analysis was performed using both the two-tier and hypothetical three-tier rate structures and is explained in detail in Appendix 5-4.

The operation of a CHP system is fairly complicated and maintenance intensive. The engine generator requires frequent cleaning due to the combustion of digester gas, and the siloxane removal system has a high operating cost. In addition, timing the generator to operate during peak hours and switching electrical sources is complex, especially if digester gas is additionally utilized by the dryers during non-peak hours. The current rate structure doesn't make CHP look as attractive as using the digester gas directly in the dryers, and future changes to the rate structure only reduce the potential revenue and increase the complications. Given the additional complexity and reduced savings potential, CHP is not an attractive option for the Blue Lake WWTP.

5.5.4 Renewable Natural Gas (RNG)

An RNG system would condition all digester gas to RNG suitable for injection into the gas utility pipeline. In this alternative, the existing moisture removal system would continue to be used but both H_2S removal and siloxane removal would be also required. In addition, a second stage would be added to remove carbon dioxide (CO_2) to create nearly pure methane. Capital costs considered include the gas treatment system, piping gas to the injection point and interconnection charges at the pipeline.

The operation of the gas treatment system is straightforward, and the process equipment is proven and reliable. But working with the gas utility and marketing the gas to off-takers and managing the renewable energy incentives requires specialists and may mean more management time for MCES staff. Although the value of renewable identification numbers (RINs) is near historic lows, there continues to be growth in RNG. In the analysis for Blue Lake, RNG remains the economic choice purely based on potential revenue despite the low value of RINs. The future market for RNG may not be RINs and vehicle fuel. It appears that RNG will have demand for its inherent carbon offsets compared to fossil fuels and these renewable attributes will continue to have value in the future.

5.5.5 Recommended Solution

Appendix 5-4 includes tables breaking down the 20-year NPV for five separate gas utilization alternatives: No Utilization (100% Flare), Current Use (34% Flare), Alternative 1 (100% Dryer), Alternative 2 (CHP) and Alternative 3 (RNG). Currently, approximately 34% of the digester gas produced is flared, and the remainder is utilized by either the dryer or the boiler. If the capacity of the RTO is increased, it is anticipated that the dryer fuel source will no longer be limited, and it can utilize digester gas without limitation.

Two NPV analysis have been done, one given the current electrical rate structure and one using the future rate structure. Table 5-11 below summarizes the costs associated with each of the 5 options given the two rate structures.

Table 5-11 Alternative Cost Comparison

ALTERNATIVE	CAPITAL COST	ANNUAL O&M COST	PRESENT WORTH OF ANNUAL O&M	PRESENT WORTH
Flare All Gas	$0	$468,00	$6,690,000	$6,960,000
Current Use (34% Flare)	$744,000	$264,000	$2,950,000	$3,694,000
100% Digester Gas in Dryer	$744,000	$76,000	$1,140,000	$1,884,000
CHP Current Rate	$5,777,000	($267,000)	($3,980,000)	$1,886,000
CHP Future Rate	$5,777,000	($227,000)	($3,380,000)	$2,486,000
RNG	$9,629,000	($674,000)	($10,202,000)	($390,000)

The recommended solution is based on the high digester gas production projections with loss of industrial loading. Digester gas alternatives are sensitive to energy pricing. The cost analysis does not include any escalation of either natural gas or electricity prices. However, based on the current cost structure the CHP and dryer alternatives are essentially equivalent on a present worth basis. Since the dryer alternative requires a lower capital investment and no change in operations it is the more favorable alternative.

RNG is economically attractive but has significant uncertainties that may affect future economics and requires the largest capital investment.

The disadvantage to continuing with the dryers as the single end use is that gas is wasted when the dryer(s) are not available. However, alternative end uses can be re-evaluated and added in the future should there be a change in the economics or plant operations.

The recommended plan is the continued use of digester gas in the dryers.

6 Implementation Plan

6.1 *Introduction*

The recommended implementation plan consists of three phases:

Phase I Improvements required within the next 10 years to meet customer level of service objectives:

- Retrofit of the existing grit collection system and other miscellaneous improvements identified for liquid waste receiving (LWR)
- Primary treatment improvements for scum handling, including fats, oils and grease (FOG); replacement of grit removal pumps and piping; and elevation of the primary clarifier weirs and scum boxes to maintain treatment performance during peak flows
- Modification of existing aeration tanks to increase secondary treatment process stability, efficiency and operability; replacement of air mixing in the existing aeration tanks; addition of 2 secondary clarifiers, a mixed liquor distribution structure and a second effluent channel/pipeline to increase capacity
- Effluent process improvements, including rehabilitation of stormwater pumps and the addition of effluent pumping standby power
- Site Buildings architectural (Arch) renewal for, SCB, EPR, WPR, BLB and SEB
- Addition of 1 digester to increase digestion capacity
- Renewal of solids treatment facilities in the Final Stabilization Facility (FSF) building and associated building expansion
- Renewal of the plant process control system, including replacement of 25 supervisory programmable logic controllers
- Expansion of liquid waste receiving (LWR)

Phase II Improvements that can be deferred for 10 to 15 years while maintaining customer level of service objectives:

- New primary treatment complex, including expansion of the screenings building with an additional grit classifier, the addition of 2 primary clarifiers and piping to expand primary treatment capacity, and renewal of existing primary clarifiers
- Addition of tertiary filtration to meet proposed permit requirements
- Digester complex improvements for the renewal of digester gas utilization equipment and new chemical addition facilities
- Addition of one gravity belt thickener (GBT)
- Rehabilitation of the plant effluent structure

Phase III Remaining Improvements identified within the 30-year planning period that can be deferred beyond 15 years while maintaining customer level of service:

- Replacement of grit removal cyclones, classifiers and associated piping; replacement of liquid waste receiving (LWR) kiosks and electrical panels
- Replace primary sludge pumps
- Addition of one aeration tank and one aeration blower to expand secondary treatment capacity

- Demolish the aerated pond and install a zero-headloss channel to tertiary filtration
- Expansion of the effluent pump station and disinfection basin to increase capacity
- Digester complex renewal, including replacement of process equipment in the digester control building and replacement of the storage tank membrane cover
- Renewal of wastewater solids thickening and dewatering equipment, and the addition of one dewatering centrifuge
- Replacement of process equipment and facilities in the Chemical Handling Building
- Renewal of the plant process control system, including replacement of 25 supervisory programmable logic controllers

All phases include renewal of associated building electrical and mechanical systems, or new systems for new buildings/treatment facilities.

The estimated total budgetary cost for implementation of all three phases of the Blue Lake WWTP Improvements is $408M. Table 6-1 summarizes budgetary 2020 construction costs for the recommended implementation plan for each phase. Table 6-1 also identifies types of work – asset preservation, capacity expansion (growth), or quality improvement – as a percentage of construction cost. Table 6-2 summarizes budgetary costs for administration, engineering, and escalation to midpoint of construction for each phase. Detailed opinions of probable cost estimates are included in Appendix 6-1.

The implementation of industrial pretreatment at the Northern Star Company may reduce the organic and solids loading to the Blue Lake WWTP. The potential impact of this load reduction on the recommended implementation plan is the deferral of secondary treatment improvements, as summarized in Table 6-3. IPIP performance will be evaluated during design through completion of commissioning of the current project. For additional information on IPIP, refer to Sections 1.2.4, 2.4 and 4.13.

Table 6-1 Opinion of Probable Cost Summary: Total Construction Cost

PROCESS OR LOCATION WORK CATEGORY %	PHASE I ASSET PRES.	PHASE I CAP. EXP.	PHASE I QUAL. IMPROV.	PHASE I TOTAL COST	PHASE II ASSET PRES.	PHASE II CAP. EXP.	PHASE II QUAL. IMPROV.	PHASE II TOTAL COST	PHASE III ASSET PRES.	PHASE III CAP. EXP.	PHASE III QUAL. IMPROV.	PHASE III TOTAL COST
Preliminary Treatment Process – Screenings Building	30%	70%	0%	$597,500	100%	0%	0%	$282,000	0%	100%	0%	$1,265,000
Primary Treatment Process	32%	68%	0%	$2,495,500	15%	85%	0%	$21,679,000	100%	0%	0%	$22,500
Secondary Treatment Process[a]	49%	15%	36%	$58,348,800	0%	0%	0%	$0	44%	56%	0%	$23,009,000
Tertiary Treatment	0%	0%	0%	$0	0%	0%	100%	$69,000,000	0%	100%	0%	$15,000,000
Effluent Process	49%	51%	0%	$1,519,050	0%	0%	0%	$0	0%	100%	0%	$3,660,000
Site Buildings	100%	0%	0%	$1,890,000	0%	0%	0%	$0	0%	0%	0%	$0
Thickening and Dewatering	0%	0%	0%	$0	0%	100%	0%	$1,320,000	75%	25%	0%	$5,924,000
Digestion Complex	0%	100%	0%	$3,777,000	66%	34%	0%	$1,093,000	81%	19%	0%	$8,566,000
Final Stabilization Facility	100%	0%	0%	$51,472,000	0%	0%	0%	$0	0%	0%	0%	$0
Chemical Handling Building	0%	0%	0%	$0	0%	0%	0%	$0	100%	0%	0%	$1,615,000
Other Miscellaneous Improvements[b]	55%	0%	45%	$3,510,000	100%	0%	0%	$1,200,000	100%	0%	0%	$1,905,000
Total Construction Cost (2020 dollars)	**43%**	**54%**	**17%**	**$123,609,050**	**6%**	**21%**	**73%**	**$94,574,000**	**25%**	**75%**	**0%**	**$60,966,500**

Notes:

a. Industrial Pretreatment Incentive Program (IPIP) may defer a $24,780,000 secondary clarifier expansion from Phase 1 to Phase III and a $12,980,000 aeration tank from Phase III to beyond Phase III. The net impact to Total Construction Cost would be -$24,780,000 for Phase I total construction cost and +$11,800,000 for Phase III total construction cost.

b. Other Miscellaneous Improvements include Liquid Waste Receiving expansion (pending development of concept during design), PLC replacement in 5 years and again in 25 and repairs to the plant effluent structure.

Table 6-2 Opinion of Probable Cost Summary: Capital Costs

DESCRIPTION	FACILITY PLAN PHASE I	FACILITY PLAN PHASE II	FACILITY PLAN UPDATE PHASE III
Engineering and Admin (20%)	$25,005,810	$18,914,800	$12,193,300
Capital Cost (2020 dollars)	**$150,034,860**	**$113,488,800**	**$73,159,800**
Midpoint construction (years)	2	7	15
Escalated capital costs (3% per year)	**$159,171,983**	**$139,576,909**	**$113,980,585**

The implementation of industrial pretreatment at the Northern Star Company may reduce the organic and solids loading to the Blue Lake WWTP. The potential impact of this load reduction on the recommended implementation plan is the deferral of Secondary Treatment improvements, as summarized in Table 6-3. IPIP performance will be evaluated during design through completion of commissioning of the current project. For additional information on IPIP, refer to Sections 1.2.4, 2.4 and 4.13.

Table 6-3 Potential Impact from Northern Star's IPIP Loading Reduction

IMPROVEMENTS DEFERRED BY IPIP LOADING REDUCTION	CHANGE IN PHASE I CONSTRUCTION COST	CHANGE IN PHASE III CONSTRUCTION COST
Phase I: Secondary clarifier expansion deferred to Phase III	-$24,780,000	+$24,780,000
Phase III: Aeration expansion (1 tank & 1 aeration blower) deferred beyond planning period	--	-$12,980,000
Net Change in Construction Cost:	-$24,780,000	$11,800,000

6.2 *Implementation Plan*

A planning level implementation plan is shown on Figure 6-1. MCES may move certain scope items between phases, or otherwise refine the schedule of this plan as conditions evolve toward the end of the planning period. These changes will be based on engineering evaluations following Planning (2018-2022).

6.2.1 Phase I Implementation

Phase I construction is expected to occur between 2025 and 2030. Phase I improvements address near term needs to increase hydraulic capacity, renew the dryer in the Final Stabilization Facility (FSF), and renew other components identified for this construction period. Substantial completion of the parallel secondary effluent channel/pipeline and new mixed liquor distribution structure by 2030, along with other hydraulic improvements in Primary Treatment, achieve projected hydraulic capacity needs.

Secondary treatment process improvements are included in Phase I to optimize performance of the existing biological phosphorus removal process prior to the implementation of tertiary treatment in Phase II. Expansion of the secondary clarifiers is included in this phase to coincide with installation of the secondary effluent channel/pipeline for improved constructability; however, based on performance of new industrial pretreatment facilities at the Northern Star Company, expansion of the secondary clarifiers may be deferred to Phase III.

6.2.2 Phase II Implementation

Phase II construction is expected to occur between 2030 and 2035. The initiation of Phase II will be governed by MCES review of phosphorus permit requirements with the MPCA during the permit reissuance period. MCES anticipates that the reissued permit will provide the regulatory requirements for phosphorus and a compliance schedule for phosphorus reduction improvements. Tertiary filtration is the recommended technology for achieving proposed phosphorus limits at the Blue Lake WWTP, and it is a new technology for MCES, not currently implemented at any MCES WWTP. The implementation plan includes a process proving phase following construction of Phase II improvements so that MCES can address unforeseen issues and optimize phosphorus removal performance.

Phase II Improvements include a new primary treatment complex to meet 2050 projected growth in the service area and other renewal components identified for this construction period.

6.2.3 Phase III Implementation

Phase III construction is expected to occur between 2035 and 2040. It includes long term planned expansions for preliminary treatment, secondary treatment, disinfection and effluent pumping to meet 2050 projected growth in the Blue Lake WWTP Service area. This phase includes whole system renewals for the following wastewater treatment systems: primary clarifiers, sludge thickening and dewatering equipment, and Chemical Handling Building facilities. Phase III also includes replacement of the aerated ponds with low headloss channels.

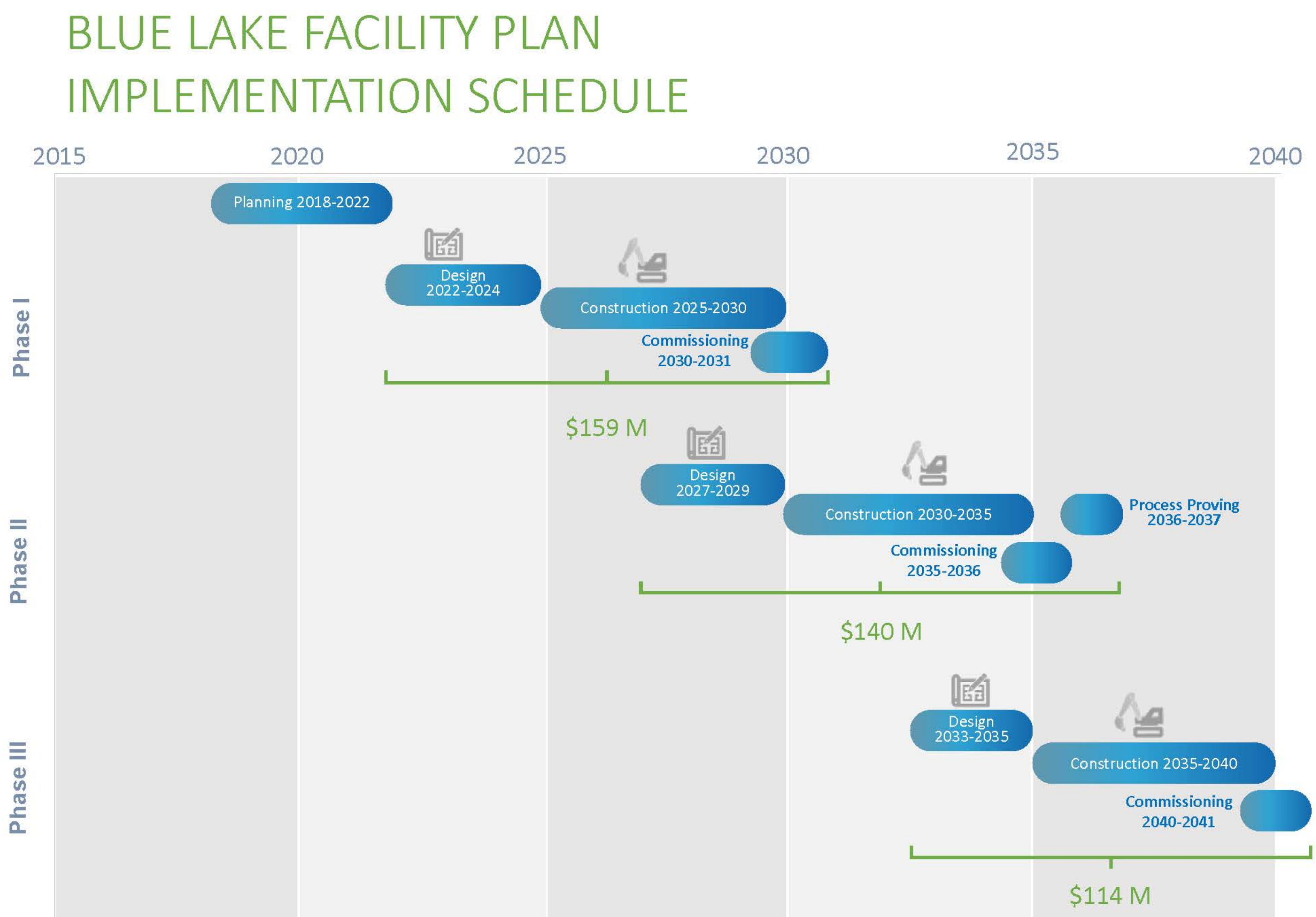


Figure 6-1 Program schedule overview that includes planning and implementation steps for project delivery

METROPOLITAN
COUNCIL

390 Robert Street North
Saint Paul, MN 55101-1805

651.602.1000
TTY 651.291.0904
public.info@metc.state.mn.us
metrocouncil.org

Follow us on:
twitter.com/metcouncilnews
facebook.com/MetropolitanCouncil
youtube.com/MetropolitanCouncil