BEMIDJI CITY COUNCIL

Special Work Session Agenda

Tuesday, January 22, 2018

City Hall
Conference Room
4:30 P.M.

1. CALL TO ORDER / ROLL CALL

2. WASTE WATER TREATMENT FACILITY – CAPACITY EVALUATION REPORT

3. ADJOURNMENT

NOTE: Please switch all cellphones and pagers to a non-audible function during Council and Committee meetings.

COUNCIL AGENDA ITEM

Meeting Date: January 22, 2018 Work Session

Action Requested: Waste Water Treatment Facility – Capacity Evaluation Report

Prepared By: Craig Gray, DPW/City Engineer

Reviewed By: Nate Mathews, City Manager

Background:

The City contracted with SEH Engineering to complete, with assistance and input from staff, a capacity analysis of the city's wastewater treatment facility (WWTF). The goal was to evaluate each of the Facility's twelve (12) treatment systems in regards to existing flow and for both proposed and anticipated future service areas. The study is now complete and Jessica Hedin from SEH will be at the work session to present a power point on the results of the study. A copy of her presentation slides are attached.

The twelve process systems that make up the WWTF which were analyzed as part of this study and final report are:

- Fine Screening Equipment
- Aerated Grit Chamber
- Raw Wastewater Pumping Station
- Primary Clarifiers
- Activated Sludge System
- Final Clarifiers
- Granular Media Filtration System
- Ultraviolet Disinfection System
- Chemical Phosphorus Removal System
- Dissolved Air Floatation Thickening
- Anaerobic Digestion System
- Biosolids Storage Capacity

Each of these systems were evaluated for existing flows coming into the plant and for the ability to handle future capacity.

Discussion

A. Capacity Analysis – REUs – Table 1

In order to allow SEH to evaluate the plant for future capacity I sent them maps of 22 areas within the city and JPB planning area that do not currently have sanitary sewer service and which at one time or another have been talked about for proposed or possible

service expansion. The maps of those 22 areas are included as Appendix A within the full report (a copy of the full report will be given to you on Tuesday evening) and Table 1 is a written summary of the maps.

Examples of areas shown on the maps include all neighborhoods surrounding Lake Bemidji, areas north and south of Division Street, expansion areas of the city's industrial park, existing city neighborhoods without sanitary sewer services and undeveloped parcels within the JPB planning area.

The design and capacity of the 12 wastewater plant systems are based on residential equivalent units (REUs) or total flow. An REU is a method of converting all types of development into an equivalent number of single family homes. We know that the average single family home uses about 146 gallons of water per day. By converting present and future development into REUs we can reasonably estimate the total additional flow and solids loading that a development is expected to generate and direct to the WWTF. All of the areas described above had REUs calculated for them. For example, the new Delta Dental facility is 20 REUs. That means that this development will generate approximately the same amount of wastewater as 20 single family homes.

Consequently, Table 1 of the report shows the calculated REUs for each of the map areas. The 22 areas were estimated to include **a total of 3,070 additional REUs**. For comparison purposes, the existing plant serves approximately 6,500 REUs. The nice thing about Table 1 is that the REUs are broken down by map/neighborhood area so it provides a good reference tool for staff when proposed service expansions or development is considered.

B. Systems Capacity/Clarifier Redundancy - Table 9

The 12 systems were all analyzed by SEH to see if they were sufficient for our existing flow and our proposed flows from the mapped service areas. Table 9 of the report is a summary showing the results of that analysis. The good news is that 10 of the 12 systems are suitable for both our current flow and any proposed expansion of our sewer system. That number rises to 11 of 12 when you consider that the aerated grit chamber is suitable for another 2,100 REUs which is a number that will likely take a long time to reach.

The biggest system issue right now, as the table shows, are the Final Clarifiers. We have two final clarifiers and the SEH report shows that these do not currently meet what is termed the "redundancy design requirement" (Rule Standard) of the MPCA. The MPCA Redundancy Rule requires that the plant as currently designed be able to meet or comply with system treatment and discharge standards with one clarifier out of service for maintenance. The plant currently can meet all the MPCA requirements with both clarifiers operational but we do not meet them with one of the clarifiers out of service. In order to meet this requirement a third final clarifier would have to be constructed. Estimated cost of a third final clarifier is $6.0 M.

Currently one of the final clarifiers is out of service for maintenance every year for about 6-8 weeks. It is during this maintenance period that we do not meet the design requirements established by the MPCA. During this 6-8 week time period the plant superintendent, Al Gorick, makes every effort to insure our effluent from the plant meets all of our discharge permit requirements. However, he noted, that as the flows increase to the plant this is becoming more and more difficult. This is confirmed by SEH in their report, where they state, ***"the risk of exceeding effluent limits increases as flow increases."***

C. Nitrogen & Permitting

If the fix was simply just a new third clarifier I'd be elated, but in addition to the design issues noted above and as shown in Table 9 we also have a very real possibility that the MPCA may establish an ammonia-nitrogen effluent limit for the city as part of one of our upcoming permit cycles.

The city operates our WWTF under a National Pollutant Discharge Elimination System (NPDES) permit that is issued by the MPCA. The permit is a five year permit. Our existing permit expires on November 30, 2019 and staff will be working on submitting a new permit application this year. Our existing permit requires that we monitor and test for ammonia nitrogen and report those results to the MPCA. Right now we are not required to treat for nitrogen. However this is what we are advised will inevitably occur during the city's upcoming permit cycles:

1. Current permit requires monitoring for nitrogen – expires 11/30/2019.
2. New permit is issued for the period 12/1/2019 – 11/30/2024. Permit may state that treatment for ammonia nitrogen will be required starting with next permit, effective 12/1/2024.
3. New permit is issued for the period 12/1/2024 – 11/30/2029 which requires effluent to be treated for nitrogen.

D. Present and Future Challenges

So while the easy solution to our current clarifier capacity problem is to build an additional final clarifier now, the real possibility of having to treat for nitrogen in 2024 throws a wrench into that solution. If we build a final clarifier now and then end up having to treat for nitrogen in 2024 it is likely that much of the money spent could be wasted because the treatment technology will likely require changes to all of the clarifiers. I sought a second opinion from Bolton & Menk, consultants that have done work with us on the plant in the past, and both Bolton & Menk and SEH agree to not build a third final clarifier until a Total Nitrogen limit has been established by the MPCA for the city's plant.

As an aside, if and when a new nitrogen limit needs to be meet there will likely also be other improvements needed to be made to the plant in addition to the final clarifiers. Total costs to meet a nitrogen limit could likely be in the $10-$12 million range.

Summary

Let's bring it back to REUs and development. We currently have about 6,500 REUs flowing into the plant and we now know that this exceeds MPCA design guidelines, but we have been able to consistently meet our discharge limits. However, we also know that as flows increase to the plant the risk of exceeding those limits increases. We cannot continue to add unlimited REUs without a game plan while we look at designing and constructing the necessary plant improvements.

As long as we meet our discharge limits the MPCA does not become involved. However, a request for expanded flow discharge beyond the design values will trigger an analysis from the MPCA. Any project that proposes to extend a sanitary sewer main into an unsewered area requires a MPCA permit – example would be a proposed housing facility on an unsewered vacant parcel.

In addition to the 6,500 REUs coming into the plant right now we also have a long list of projects and developments that are in the approval process that will be directing flow to the facility upon their completion. That list is attached and rough numbers show that these projects will be adding another 150 – 200 REUs to the city's plant.

Staff's goal is to figure out ways at the WWTF to deal with the increase in flow that is coming from the proposed developments and continue to accept any future development that may come into the city, although there are certainly no guarantees. There could be a point where accepting development could cause us to exceed our effluent limits during our scheduled maintenance periods.

Staff recommends that the city should not consider extending sanitary sewer mains to unsewered areas within the city or the JPB areas until the permanent improvements are made at the plant.

assessed based upon the estimated maximum potential daily wastewater flow, which is in turn based upon the usage of individual properties. Single family houses, townhouses, condominiums, duplex units, and most apartments each equal one SAC per dwelling unit, while commercial, industrial, and retail spaces are evaluated based on the gross square footage of buildings and varies by use. This allows developed non-residential wastewater contributors to be evaluated based on the number of residential equivalent units (REUs), or the number of households required to generate an equivalent wastewater flow. Table 1 summarizes the future service locations, anticipated connection years, and REUs based on number of household equivalents.

Table 1 – Future Service Area Locations and REUs per Future Service Area

Future Service Area Location	Sheet	Developed Service Area (REU)	Undeveloped Service Area (REU)
Gene Dillion Elementary School	Sheet 1	113	
Keupers Development Parcel	Sheet 2		172
Irvine Ave and Algoma St	Sheet 3	42	
NW Lake Bemidji Sewer Extension	Sheet 4	78	
North of Lake Bemidji	Sheet 5	64	
Arrowwood Circle Area	Sheet 6	58	
North of 15th St East of Adams Ave	Sheet 7	48	7
North Side of Anne Street	Sheet 8	75	
Industrial Park Expansion	Sheet 9		186[1]
Froyd Property East of Lake Avenue	Sheet 10	10	14
East Avenue NE	Sheet 11	43	
Lakeshore along Lavinia Rd	Sheet 12	289	
Lakeshore along Waville Rd	Sheet 13	206	
1st Street East and Lake Avenue	Sheet 14	20	
Mag Seven Court Area	Sheet 15	31	7
Hidden Trail Court Area	Sheet 16	52	
Old Pinnacle Mall Development	Sheet 17	4	494[1]
Red Barn Development	Sheet 18		297
Area West of New Industrial Park	Sheet 19	52	578[1]
South Lake Irving and East of Yellowhead Road	Sheet 20	10	
South Lake Irving and West of Yellowhead Road	Sheet 21	16	
Rail Corridor Area	Sheet 22	1	103
Subtotal Potential REU by Development		1,212	1,858
Total Potential REU[2]		3,070	

Notes:

1 REU units were determined using a wastewater flow per acre of green field development. 800 gallons per acre (gpa) was assumed for dry industrial development, 800 gpa was assumed for commercial development, and 1,152 gpa was assumed for 6 units/acre medium density residential development. One REU is equivalent to one residential equivalent unit at average flow and load.

2 A Delta Dental facility is planned in an area east of the Bemidji Regional Airport. It has been determined this facility is 20 REUs. These REUs are not included in the total potential REUs shown in the table above.

Table 9 depicts whether or not the existing processes have sufficient capacity for all future service areas or if additional capacity may be needed. If it is determined that insufficient treatment capacity exists to handle the addition of all future service areas, those treatment process will be discussed in further detail in subsequent report sections.

Table 9 – Capacity Evaluation

Process Unit	Suitability for Current Flow and Load Conditions	Suitability for Future Flow and Load Conditions (additional 3,070 REUs)	REUs until Capacity is Reached
Fine Screening Equipment	Sufficient	Sufficient	
Aerated Grit Chamber [1]	Sufficient	Insufficient	2,100, Hydraulic Limited
Raw Wastewater Pumping Station	Sufficient	Sufficient	
Primary Clarifiers	Sufficient	Sufficient	
Activated Sludge System	Sufficient	Sufficient [3]	
Final Clarifiers [2]	Insufficient	Insufficient	0, Hydraulic Limited
Granular Media Filtration System	Sufficient	Sufficient	
Ultraviolet Disinfection System	Sufficient	Sufficient	
Chemical Phosphorus Removal System	Sufficient	Sufficient	
Dissolved Air Flotation Thickening	Sufficient	Sufficient	
Anaerobic Digestion System	Sufficient	Sufficient	
Biosolids Storage Capacity [4]	Sufficient	Sufficient	

Notes:

1 1983 operations and maintenance (O&M) manual states peak flow capacity of existing aerated grit chamber to be 5.4 MGD which would be sufficient under future conditions, however the hydraulic retention time exceeds 3-5 minute recommendations. Air flowrate is sufficient at future peak flows.

2 Final clarifier capacity determined by recommended surface overflow rate of 900 gpd/ft^2 for chemical phosphorus removal facilities, which is less than typical 1,200 gpd/ft^2. The original clarifiers were likely designed for without the need to remove phosphorus.

3 Activated Sludge system is sufficient while the facility does not need to meet an ammonia-nitrogen effluent limit.

4 Biosolids storage capacity calculations were based on the minimum thickened solids concentration of 4% being achieved. Reduced biosolids storage capacity could be seen if concentrations fall below the targeted minimum thickened solids concentration.

List of Current Projects

Projects that are currently under construction that will be completed in 2019:

- Auto Shack
- Bemidji Ambulance Center
- Bemidji Community Arena (Second sheet of ice)
- Black Bear Dental
- Cedar Pointe
- Delta Dental
- Fastenal Expansion
- Gold Pine Homes Assisted Living
- L&M Supply Expansion
- Northern Access Dental
- Northern Engineering
- Top Line Group

New Projects anticipated in 2019:

- GSA Building
- Veterans Home
- St. Philips School expansion
- Stoney Ridge Apartments Phase II – (another 26 studio apartments) – located off of Norton Ave
- Headwaters Unitarian Church
- Sanford Heart Center

SEH PowerPoint Presentation

Capacity Evaluation

Bemidji Wastewater Treatment Facility

City of Bemidji
January 22, 2019

Introduction

Purpose is to determine:

- the **CAPACITY** of the treatment units
- the capacity currently **UTILIZED**.
- The capacity **REMAINING**.
- Future **DEMAND** for additional services.
- Identify treatment units with **INSUFFICIENT** capacity.

WWTF – Preliminary Treatment

WWTF – Preliminary Treatment

- Fine screening
- Grit removal

Aerated Grit Chamber

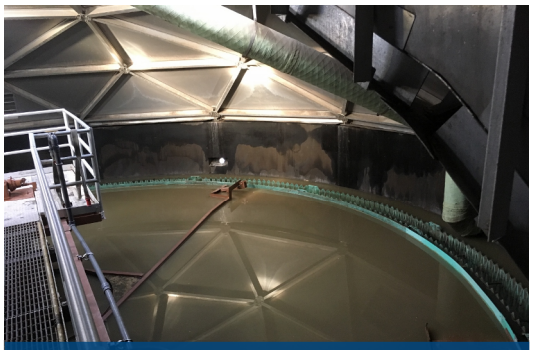
Mechanical Fine Screen

WWTF – Primary Treatment

Processes:
Preliminary Treatment
Primary Treatment

WWTF – Primary Treatment

- Primary clarifiers



Primary Clarifier

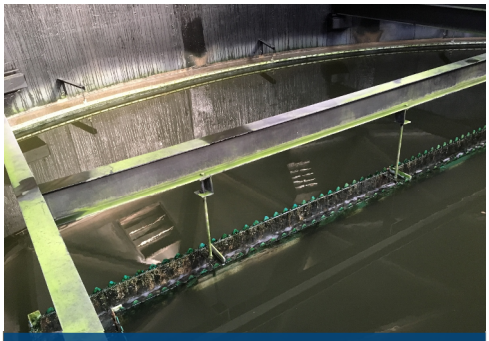
WWTF – Secondary Treatment

Processes:
Preliminary Treatment
Primary Treatment
Secondary Treatment

WWTF – Secondary Treatment

- Activated Sludge Aeration Basins
- Final Clarifiers

Activated Sludge Basin



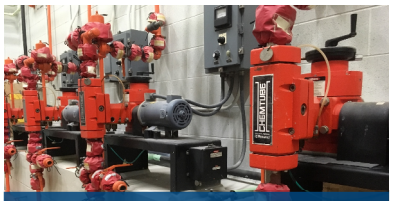
Final Clarifier

WWTF – Advanced Treatment

Processes:
Preliminary Treatment
Primary Treatment
Secondary Treatment
Advanced Treatment

WWTF – Advanced Treatment

- Chemical Feed System
- Sand Filters
- Ultraviolet Disinfection



Chemical Feed System

UV Disinfection

Sand Filters

WWTF – Solids Treatment and Disposal

Processes:
Preliminary Treatment
Primary Treatment
Secondary Treatment
Advanced Treatment
Solids Treatment and Disposal

WWTF – Solids Treatment and Disposal

- Anaerobic Digesters
- Biosolids Storage Tank
- Land Application

Digester Complex

What is a REU?

Residential Equivalent Unit (REU): portion of a user's facility that has an impact on the wastewater system equivalent to a single family residence.

1 REU = 1 Single-Family Home

What is a REU?

Methodology:

- Count of developed or undeveloped **single family** homes or units in a **multi-family** building.
- Flow for **undeveloped non-residential** based on gross area at residential strength.

  i.e. 800 gallons per acre for dry industrial development
- Sewer Availability Charge (SAC) flow determination for **developed non-residential areas** based on plumbing fixtures or land use and building size.

Example on following slide

Developed Non-Residential Example

Region 1 DNR Office Example

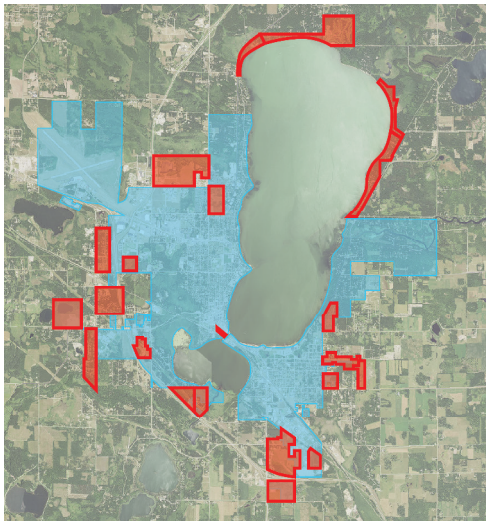
Determine Square Footage:

- Building 1: 5,000 sqft
- Building 2: 3,000 sqft
- **Total: 8,000 sqft**

Calculate Flow based on SAC:

- 8,000 sqft / 2,650 sqft per REU
- About **3 REUs** for both office buildings

22 Future Service Locations



Location	Developed Service Area (REU)	Undeveloped Service Area (REU)
Location 1	113	
Location 2		172
Location 3	42	
Location 4	78	
Location 5	64	
Location 6	58	
Location 7	48	7
Location 8	75	
Location 9		186[1]
Location 10	10	14
Location 11	43	
Location 12	289	
Location 13	206	
Location 14	20	
Location 15	31	7
Location 16	52	
Location 17	4	494[1]
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Location 20	10	
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Location 22	1	103
Subtotal Potential REU by Development	1,212	1,858
Total Potential REUs	3,070	

Notes:
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Current Service Population

Data used from Minnesota State Demographic Center.

2017 Population:	15,549
Persons per household:	2.16
Households not serviced:	620
Total service population:	**14,209**

Current Flows and Loads

Sampling data at WWTF is used to determine future flows and loads.

- Using the current service population, all flows and loads can be looked at on a **per capita basis.**
- Using the per capita basis, future flows and loads can be determined by knowing the **REUs.**

1 REU equals:

Flow		146.0 gpd
Carbonaceous Biochemical Oxygen Demand	(cBOD)	0.48 ppd
Total Suspended Solids	(TSS)	0.96 ppd
Total Kjeldahl Nitrogen	(TKN)	0.08 ppd
Total Phosphorus	(TP)	0.01 ppd

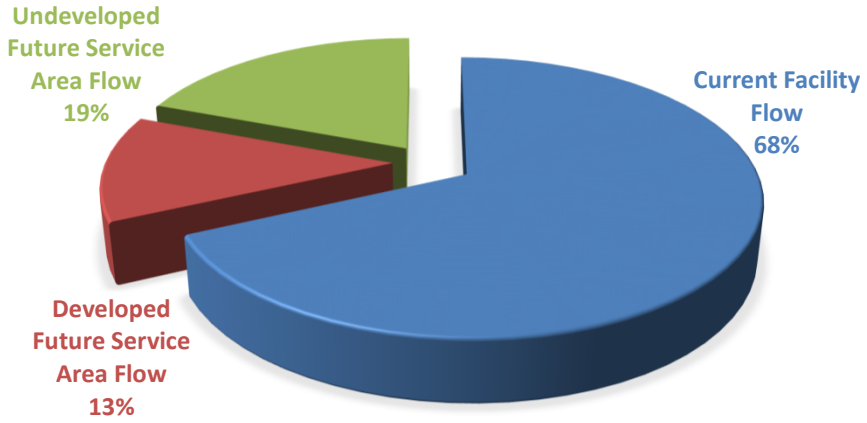
Future Flows and Loads

Flow Conditions	Future Service Area Flow (MGD)	Current and Future Service Area Flow (MGD)
Average Dry Weather	0.426	1.338
Calendar Average Day	0.448	1.409
Average Wet Weather	0.514	1.617
Peak Hourly Wet Weather	1.256	3.947

Load Parameters	Future Service Area Average Day (ppd)	Current and Future Service Area Average Day (ppd)
Carbonaceous Biochemical Oxygen Demand	1,604	5,084
Total Suspended Solids	3,183	10,116
Total Kjeldahl Nitrogen	258	813
Total Phosphorus	39	123

Future Flows and Loads

Wastewater contribution from existing and future service areas



Slide 18 of 27 | Building a Better World for All of Us® | Capacity Evaluation, Bemidji Wastewater Treatment Facility

Capacity Evaluation

Each unit process was evaluated for:

- Hydraulic capacity,
- Organic capacity,
- Solids capacity, and
- Redundancy.

Existing process performance taken into consideration, and reference calculations in Appendix C of the report.

Capacity Evaluation Results

Process Unit	Suitability for Current Flow and Load Conditions	Suitability for Future Flow and Load Conditions (3,070 REUs added)	REUs until Capacity is Reached
Fine Screening Equipment	Sufficient	Sufficient	
Aerated Grit Chamber	**Sufficient**	**Insufficient**	**2,100, Hydraulic Limited**
Raw Wastewater Pumping Station	Sufficient	Sufficient	
Primary Clarifiers	Sufficient	Sufficient	
Activated Sludge System	Sufficient	Sufficient *	
Final Clarifiers	**Insufficient**	**Insufficient**	**0, Hydraulic Limited**
Granular Media Filtration System	Sufficient	Sufficient	
Ultraviolet Disinfection System	Sufficient	Sufficient	
Chemical Phosphorus Removal System	Sufficient	Sufficient	
Dissolved Air Flotation Thickening	Sufficient	Sufficient	
Anaerobic Digestion System	Sufficient	Sufficient	
Biosolids Storage Capacity	Sufficient	Sufficient	

Aerated Grit Removal

Hydraulic retention time (HRT) exceeded at:

2,100 future REUs

Grit removal will still occur after exceedance, but removal efficiency will decline.

Aerated Grit Chamber

Activated Sludge Aeration Basins

The current activated sludge system is **SUFFICIENT** for all future service locations for cBOD removal only.

---However---

The system is **INSUFFICIENT** at approximately 2,000 future REUs if the facility is required to meet **AMMONIA-NITROGEN** limits.

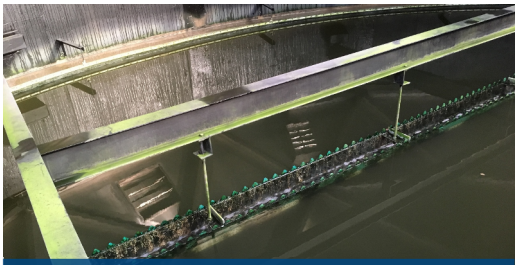
The current NPDES permit has cBOD limit only.

Activated Sludge Basin

Final Clarifiers

Redundancy:

- MPCA redundancy requirements state that the final clarifiers must meet surface overflow and solids loading criteria with one basin out of service.

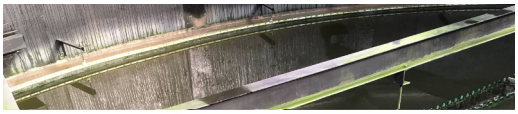


Final Clarifier

Final Clarifiers

Final clarifiers **do not** exceed criteria when <u>two basins are in service</u> for both current and future conditions.

Final clarifiers **do** exceed criteria when <u>one basin is out of service</u> for both current and future conditions.



Risk exceeding effluent limits increases as flows increase.

Final Clarifier

Improvements for Capacity

For the purpose of the report, same technology as current system used to determine costs.

Alternatives to existing technology are briefly discussed, but no cost information provided.

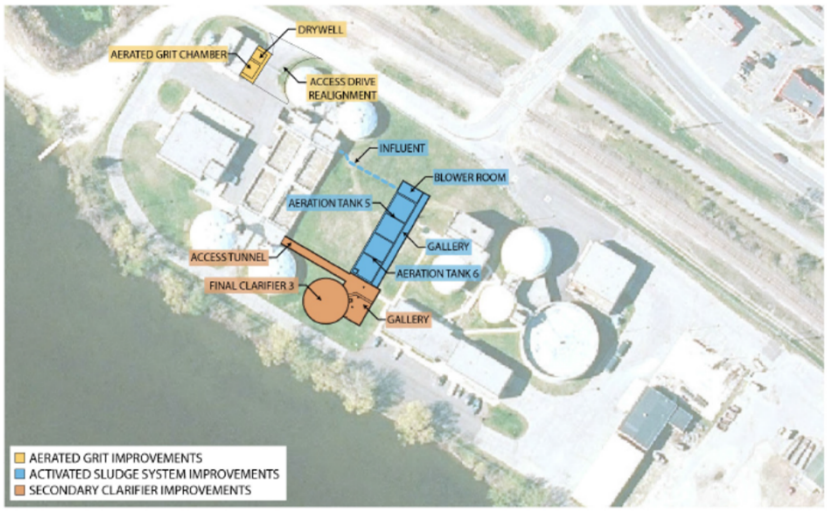
Cost estimates provided include:

- Construction cost,
- Contingency,
- Materials testing,
- Administrative costs, and
- Contractor costs.

Cost Estimates for Improvements

Preliminary Opinion of Probable Cost for Improvements	
Aerated grit - tankage, piping, and blowers	$2,312,000
Final Clarifier - tankage, mechanism, piping, and pumps	$5,408,000
Total for **ALL IMPROVEMENTS** for additional 3,070 REUs	**$7,720,000**
Activated Sludge - tankage, blowers and piping (potential future ammonia-nitrogen limit)	$5,030,000
Total for **ALL IMPROVEMENTS** for additional 3,070 REUs (potential future **AMMONIA-NITROGEN** limit)	**$12,750,000**

Questions?


DRYWELL
AERATED GRIT CHAMBER
ACCESS DRIVE REALIGNMENT
INFLUENT
BLOWER ROOM
AERATION TANK 5
GALLERY
ACCESS TUNNEL
AERATION TANK 6
FINAL CLARIFIER 3
GALLERY
AERATED GRIT IMPROVEMENTS
ACTIVATED SLUDGE SYSTEM IMPROVEMENTS
SECONDARY CLARIFIER IMPROVEMENTS