OTSEGO WASTEWATER MASTER PLAN

FEBRUARY 2018

WASTEWATER MASTER PLAN

FOR

CITY OF
Otsego
MINNESOTA

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

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AE2S

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Otsego Wastewater Treatment Master Planning

Acronym List

Otsego Wastewater Treatment Master Planning

AACE	Association for Advancement of Cost Engineering International
ADF	Average Daily Flow
ADWDF	Average Dry Weather Daily Flow
Ammonia-N	Ammonia as nitrogen (also NH_3-N)
AnMBR	Anaerobic Membrane Bioreactors
AWW/AWWF/ AWWDF/PM	Average Wet Weather/Average Wet Weather Flow/Average Wet Weather Daily Flow/Peak Month (All Meanings Equivalent)
BOD	Biochemical Oxygen Demand
cBOD	Carbonaceous Biochemical Oxygen Demand
cfs	Cubic Feet per Second
CY	Cubic Yards
EL1	East Liquid Phase 1
EL2	East Liquid Phase 2
EL3	East Liquid Phase 3
EPA	Environmental Protection Agency
ES1a	East Solids Phase 1a
ES1b	East Solids Phase 1b
ES2	East Solids Phase 2
ES3	East Solids Phase 3
ES4	East Solids Phase 4
ES5	East Solids Phase 5
DMR	Discharge Monitoring Report
DO	Dissolved Oxygen
gpcd	Gallons per capita per day
gpd	Gallons per day
gpm	Gallons per minute
IFAS	Integrated Fixed-film Activated Sludge
I/I	Infiltration and Inflow
kg	Kilogram
kW	Kilowatt
L	Liter
lb.	Pound
MBR	Membrane Bioreactor
MGD	Million Gallons per Day
mg/L	Milligram per Liter
mJ	Millijoule

Acronym List (continued)

Otsego Wastewater Treatment Master Planning

ML	Megaliter
MLSS	Mixed Liquor Suspended Solids
mm	Millimeter
MOP	Manual of Practice
MPCA	Minnesota Pollution Control Agency
ng	Nanogram
NPDES	National Pollutant Discharge Elimination System
NPW	Net Present Worth
OD	Oxidation Ditch
O&M	Operations and Maintenance
OM&R	Operations, Maintenance, and Repair
org	Organisms
PE	Population Equivalent
PEL	Preliminary Effluent Limits
pH	Negative Logarithm of the Hydronium Ion (Acidity)
ppcd	Pounds per capita per day
ppd	Pounds per day
PH	Peak Hour
PTB	Preliminary Treatment Building
Q	Flow
R&R	Rehabilitation and Replacement
RAS	Return Activated Sludge
RECs	Residential Equivalent Connections
SBR	Sequencing Batch Reactors
SCADA	Supervisory Control And Data Acquisition
SRT	Solids Retention Time
TKN	Total Kjeldahl Nitrogen
TKN-N	Total Kjeldahl Nitrogen as Nitrogen
TM	Technical Memorandum
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
TWAS	Thickened Waste Activated Sludge
um	Microns
UV	Ultraviolet

Acronym List (continued)

Otsego Wastewater Treatment Master Planning

VSS	Volatile Suspended Solids
WAS	Waste Activated Sludge
WEF	Water Environment Federation
WL1	West Liquid Phase 1
WL2	West Liquid Phase 2
WL3	West Liquid Phase 3
WS0	West Solids Phase 0
WS1	West Solids Phase 1
WS2	West Solids Phase 2
WS3	West Solids Phase 3
WWTF	Wastewater Treatment Facility

Executive Summary: Otsego Wastewater Treatment Master Planning

1 SUMMARY OF RECOMMENDATIONS

AE2S performed an evaluation of the City of Otsego's West and East Wastewater Treatment Facilities (WWTFs), including short-term and long-term projections of future needs, projects, and costs for each facility to meet treatment capacity and regulatory requirements.

1.1 LONG-TERM PLANNING AND PROJECTIONS

AE2S prepared a Basis of Design for the West and East WWTFs based on available data, land use and population projections, and typical wastewater characteristics. These values were used as the basis for the long-term projections for future regulatory projections and capacity phasing needs of each WWTF. Details on the preparation of these values is included in the Basis of Design Technical Memorandum (TM). A summary of the service populations used with these projections is included in Table 1.1.1. Population equivalents have been used in the wastewater planning process to relate the projected flow to the current flows. The table also includes a "true" population number that corresponds with the City's population growth documents.

Table 1.1.1 – Existing and Projected Service Populations for West and East WWTFs

Population Condition	Total Service Population	West Service Population	East Service Population			
			Total	Base	City Center	Existing Septic
[-]	[PE]	[PE]	[PE]	[PE]	[PE]	[PE]
Existing [PE]	6,144	3,468	2,676	-	-	-
Projected [PE]	82,003	39,856	42,147	37,258	642	4,247
Existing [Population (Approx.)]*	4,495	2,538	1,958	-	-	-
Projected [Population (Approx.)]*	60,000	29,162	30,838	27,261	470	3,108

*Corrected from PE and assuming consistent population distribution between all areas.

A screening of reasonable liquid and solids treatment alternatives was performed, and several alternatives selected for further, in-depth analysis based on the results. The pre-screened alternatives were evaluated based on cost (capital, operations & maintenance, and net present worth) and non-cost criteria through a Kepner-Tregoe analysis to provide weighted scoring. The results of the Kepner-Tregoe analysis aligned with the cost analysis for recommended alternatives. The total cost summaries for each liquid and solids alternative are presented in Figures 1.1.1 and 1.1.2. Additional details for each alternative and the respective evaluation are located in their respective TMs.

AE2S recommends the construction of phased membrane bioreactor (MBR) liquid treatment at each WWTF, and the construction of consolidated biosolids chemical (lime) stabilization at the East WWTF for biosolids from both WWTFs. Figures 1.1.3 and 1.1.4 detail phasing initiation and operation triggers for years 2017-2037. For the line labels:

- First letter indicates facility: W = West WWTF; E = East WWTF
- Second letter indicates liquid or solids improvement: L = Liquid; S = Solids
- Number indicates phase number
- Example: WS2 = West WWTF Solids Phase 2

Phase initiation is assumed to occur when 80 percent of process capacity has been achieved. Operational requirements assume three years from initiation and should be confirmed with growth conditions at the time the initiation trigger is reached. The corresponding TM regarding phasing contains additional details. Additionally, AE2S recommends performing a pilot study of the recommended lime stabilization system with biosolids from the existing facilities to confirm sizing, cost, and operation of the recommended system.

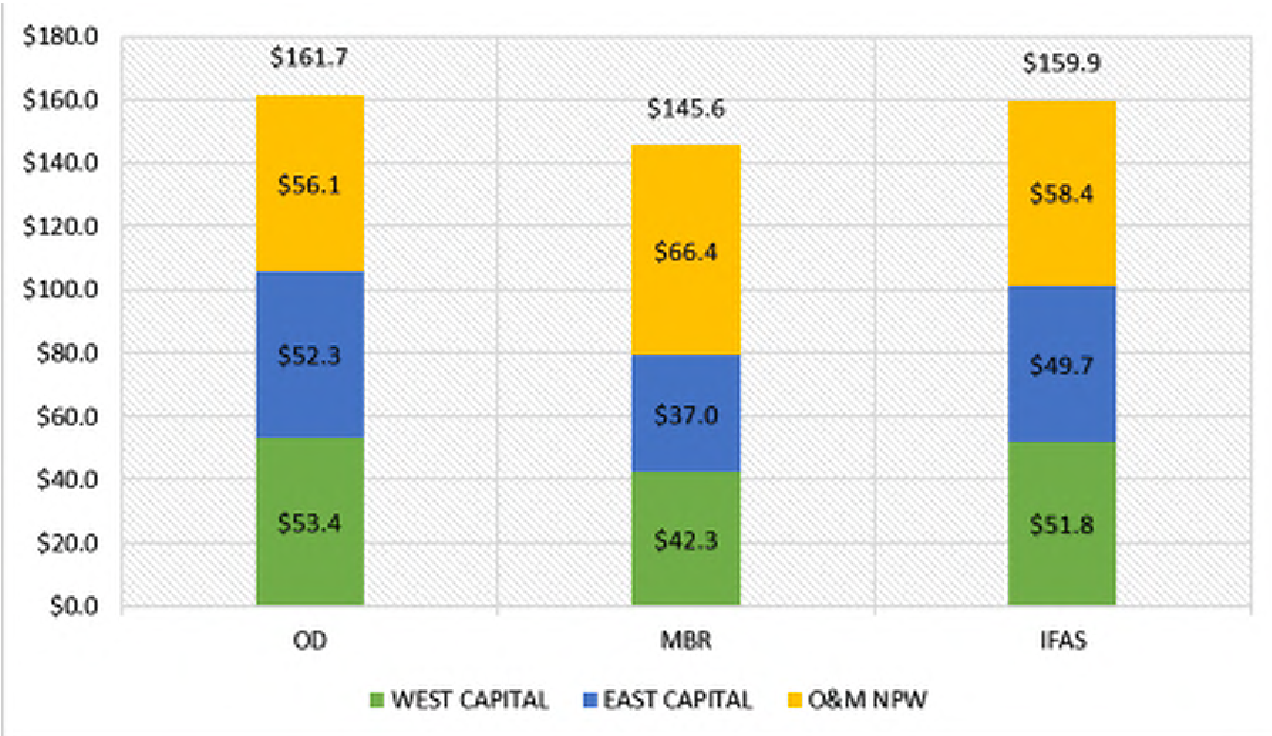

Figure 1.1.1 – Alternative Cost Summary – Liquid Treatment ($millions)

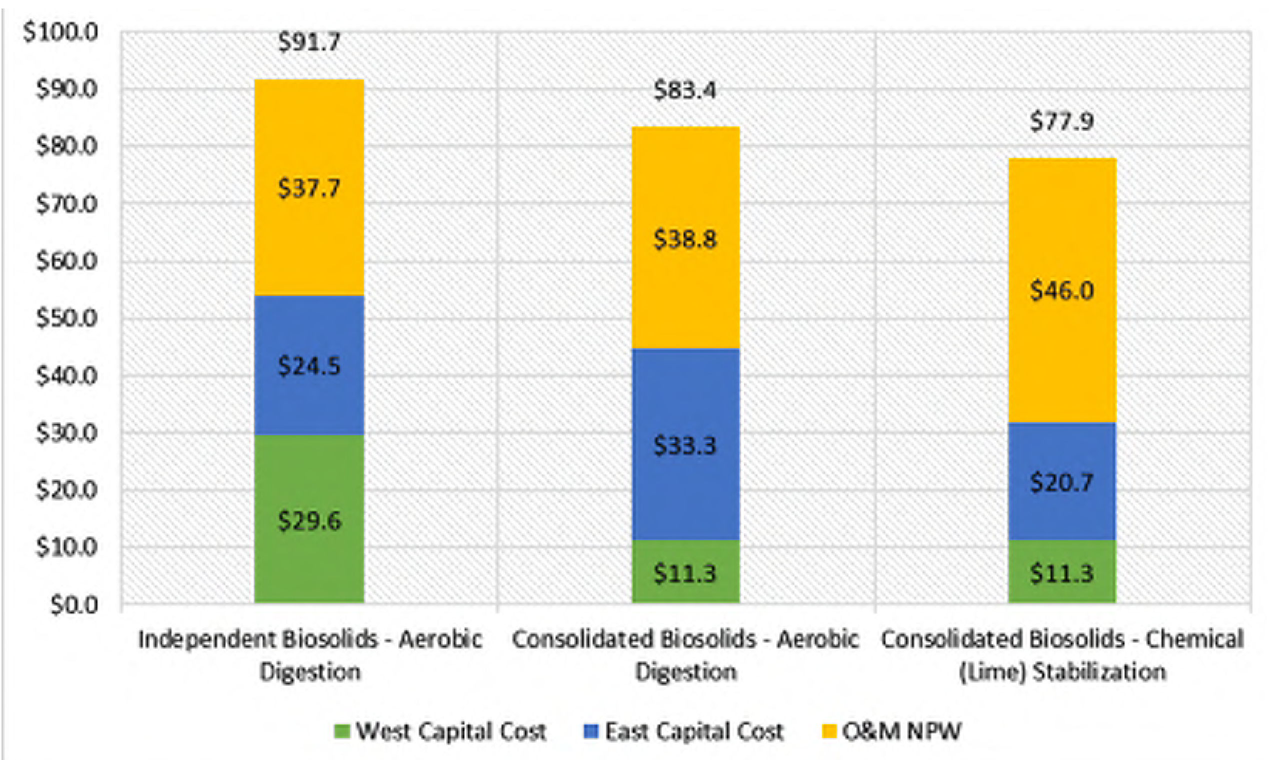

Figure 1.1.2 – Alternative Cost Summary – Solids Treatment ($millions)

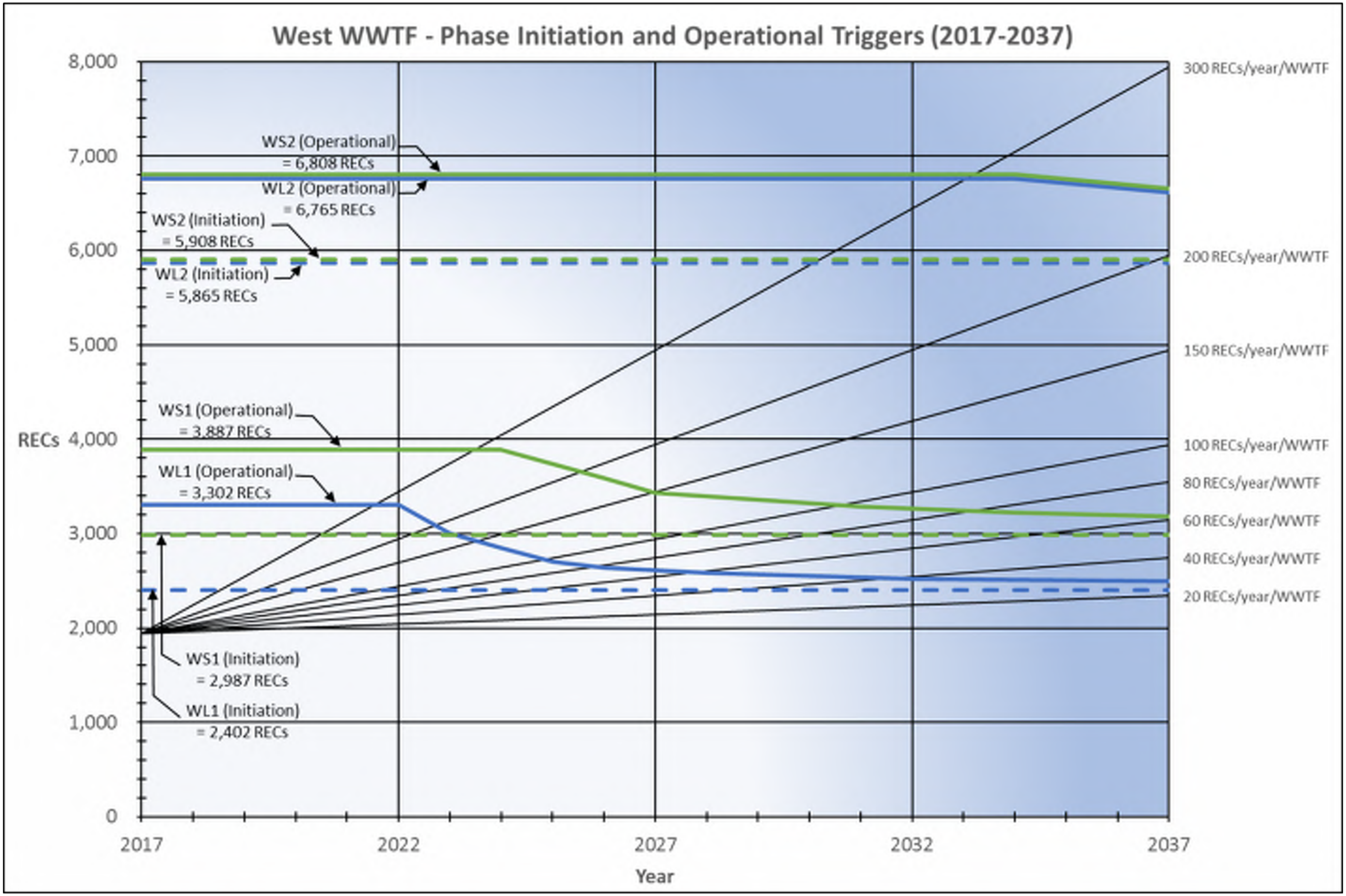

Figure 1.1.3 – West WWTF – Phase Initiation and Operational Triggers (2017-2037)

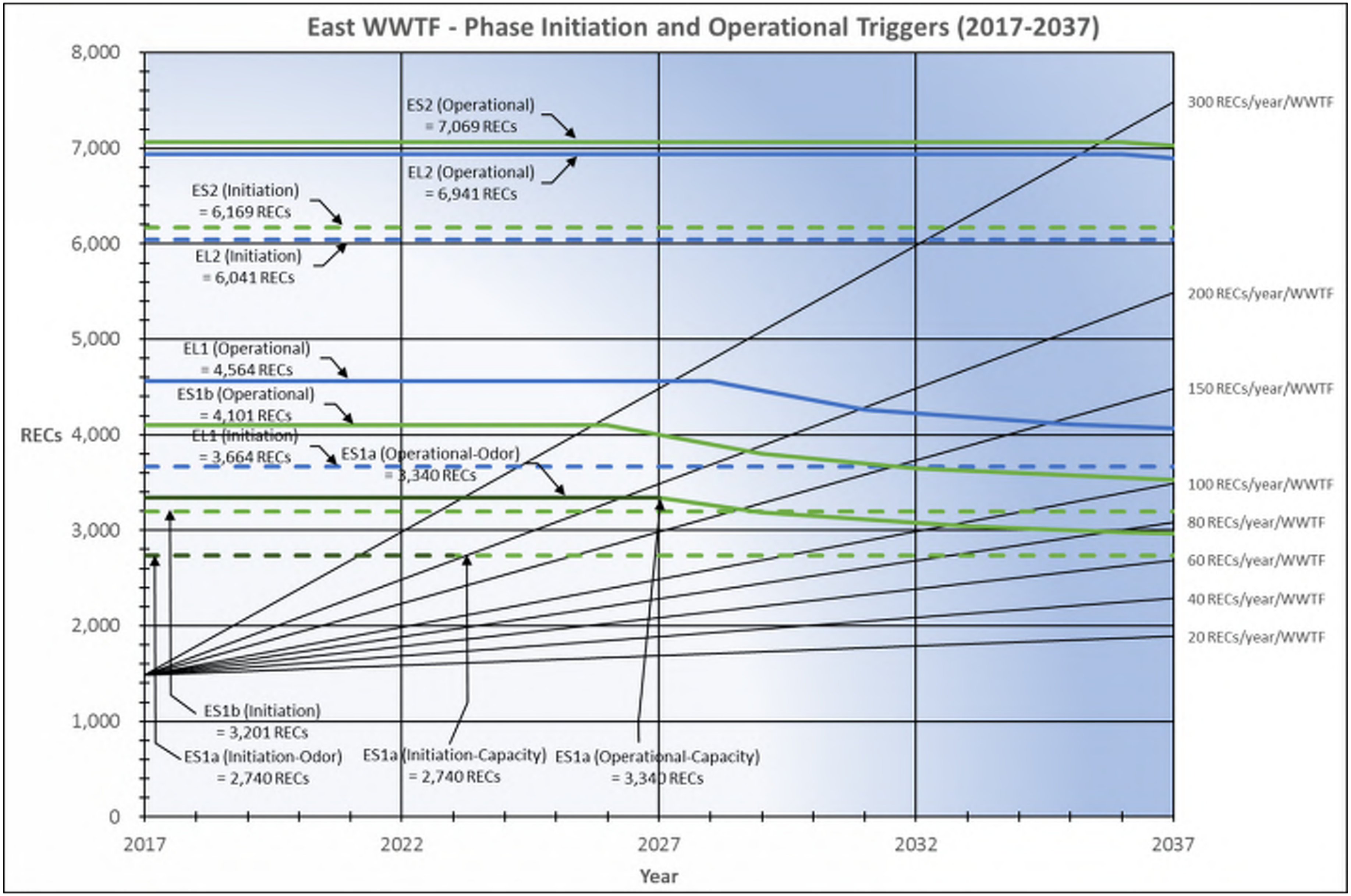

Figure 1.1.4 – East WWTF – Phase Initiation and Operational Triggers (2017-2037)

1.2 SHORT-TERM PLANNING AND PROJECTIONS (2017-2037)

A phasing plan was developed for the selected MBR liquid and consolidated chemical stabilization of biosolids alternatives. Complete phasing plans and details of the improvements are included in the respective TMs. Table 1.2.1 details the projected phases and improvements to occur within the 20-year planning horizon based on population growth projections, as well as projected project initiation dates and costs.

Table 1.2.1 – Opinion of Probable Project Capital Costs – 2017-2037

Phase	Projected Project Design Initiation Year	Projected Cost (2017 Dollars)
East Solids – Interim Digester Improvements	2018	$35,000
East Solids Phase 1 (ES1)		
Phase 1a Only (ES1a)	*2018-2021*	*$7,500,000*
Phase 1b Only (ES1b)	*2026*	*$4,750,000*
Phase 1a+1b (ES1 – Constructed in Single Phase)	*2018-2026*	*$12,100,000*
West Liquid Phase 1 (WL1)	2021 (2024)	$22,300,000
East Liquids Phase 1 (EL1)	2030 (2047)	$20,750,000

Years in parentheses indicated "slow growth" projection of 75 RECs/year/WWTF.

AE2S also evaluated existing equipment at each WWTF based on existing equipment age, condition, and projected life. Based on the analysis, AE2S projected the following short-term (2017–2020) improvements to be completed to maintain satisfactory operation of each facility (Figures 1.2.1 and 1.2.2, and Table 1.2.2). The following notes apply to these short-term, rehabilitation and replacement (R&R) projections:

- The analysis and projections apply only to the WWTFs. No street, fleet, or other facilities or equipment were included.
- R&R curves are independent of capital phasing. Changes to these costs may also occur due to large capital projects if the projects may incorporate planned R&R items, or eliminate items entirely if specific equipment is removed from use. This also means that new equipment may be added.
- Like all projections in the Master Plan, the R&R values may vary if growth occurs faster or slower than projected rates. This can result in the potential for equipment to undergo more or less wear than typical, or require removal/replacement due to new capital projects occurring prior to R&R requirements.
- Additional notes and assumptions for the short-term R&R projections are included in the respective TM.

Table 1.2.2 – Short-Term Equipment Replacement Priority List (2017 Dollars)

Item No.	WWTF	Short-Term Equipment Replacement	Quantity	Total Approximate Cost (2017 Dollars)
1	East	SCADA & Controls Rehabilitation/Replacement	-	$150,000
2	East	Preliminary Treatment Building Mechanical HVAC	1	$50,000 (Specific unit cost TBD)
3	East	Effluent Sampler	1	$30,000
4	West	Influent Sampler	1	$30,000
5	East	Sludge Storage Tank No. 1 thru 4 Submersible Mixers	4	$40,000
6	East	Drain Lift Station Pumps	2	$20,000
7	East	Effluent DO Probe	1	$2,500
8	East	Preliminary Treatment Building Odor Control Unit	1	$100,000
9	West	RAS Pumps	3	$30,000
10	West + East	Polymer Feed System	1 each	$160,000
11	East	Grit Equipment - Pump and Cyclone	1	$125,000
Other	West + East	East Post-Aeration Tank No. 1 Fine Bubble Diffusers; East Post-Aeration Blowers; West Rotary Screen; West Thickened Sludge Pump	-	$315,000 aggregate

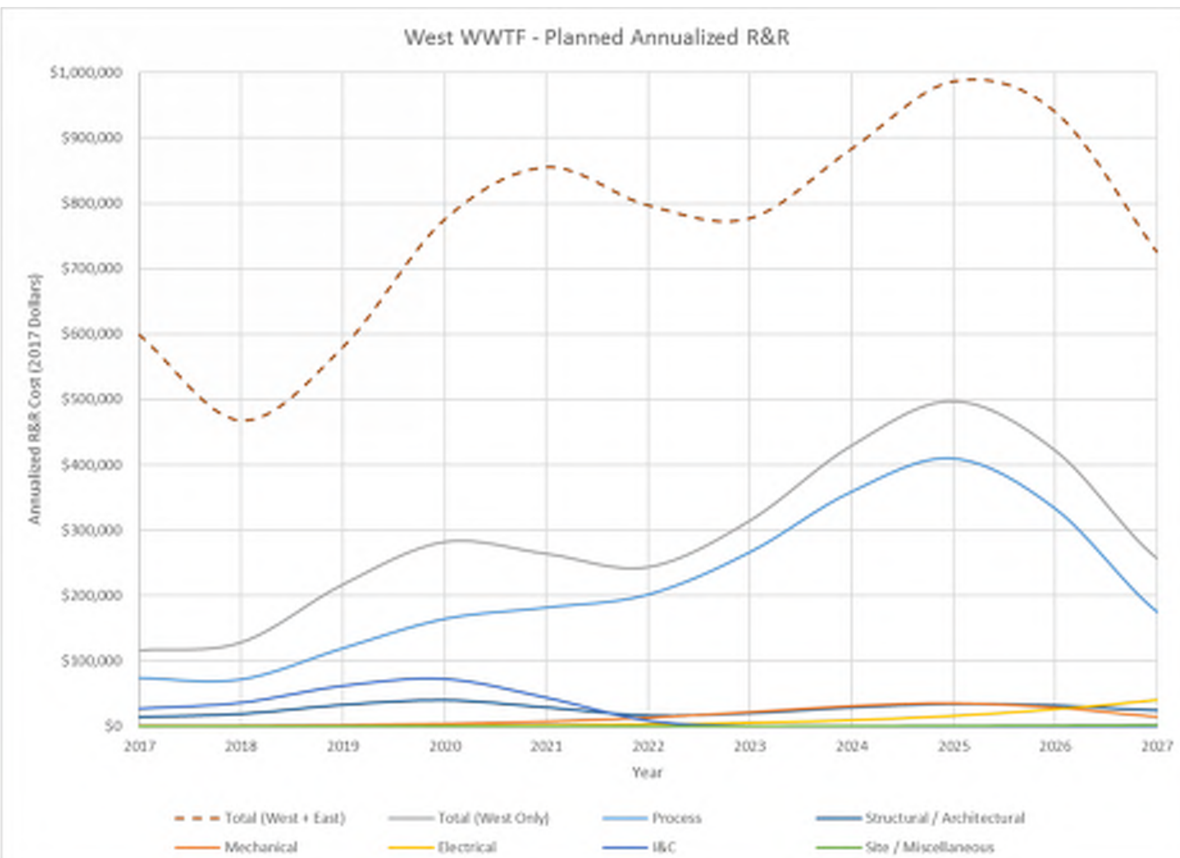

Figure 1.2.1 – Short-Term Equipment Replacement – West WWTF (2017 Dollars)

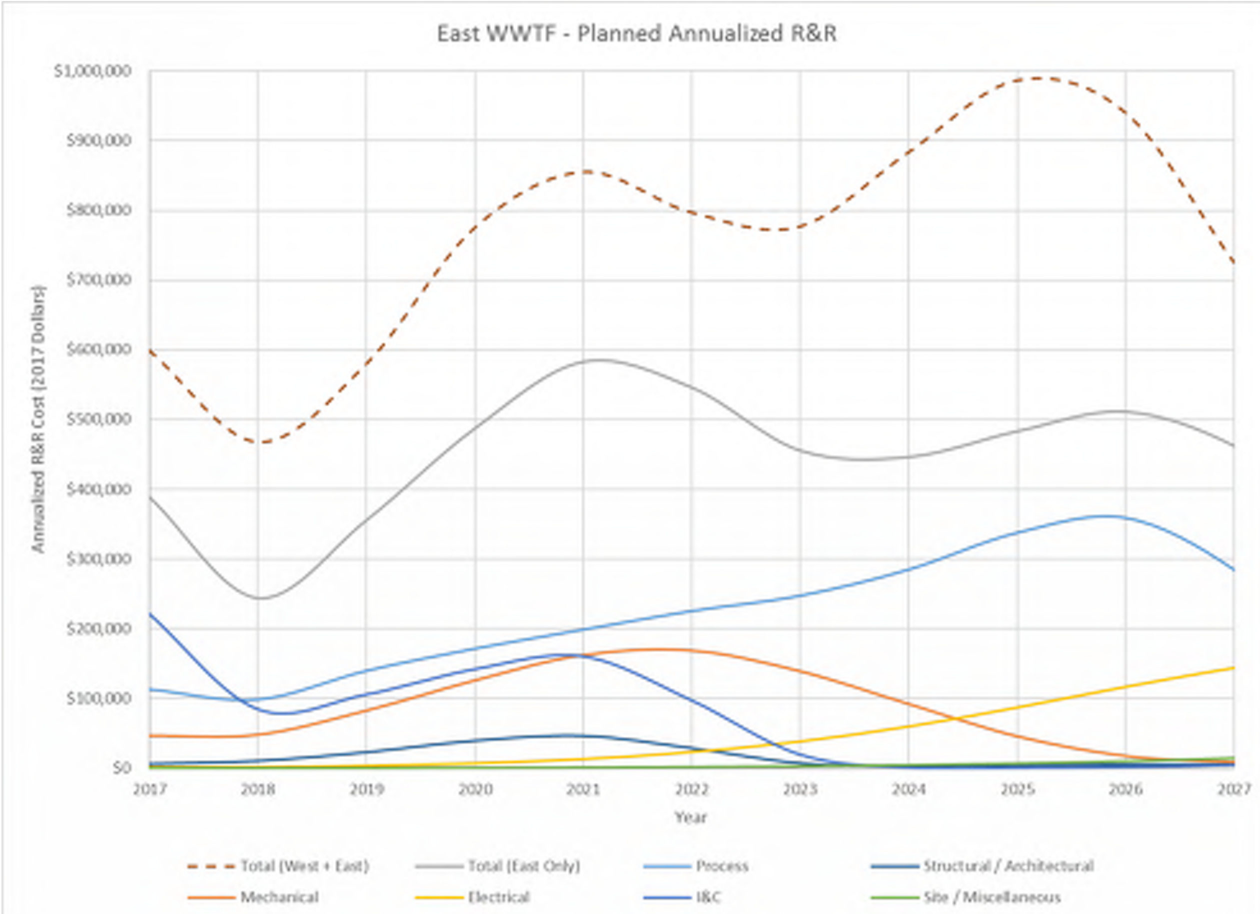

Figure 1.2.2 – Short-Term Equipment Replacement – East WWTF (2017 Dollars)

Technical Memorandum: Basis of Design

Otsego Wastewater Treatment Master Planning

To: Kurt Neidermeier
Utility Manager
City of Otsego

From: Scott Schaefer, PE
Jayme Klecker, PE
Matt Madson, PE
AE2S

Date: January 8, 2018

Project No: P05409-2013-002

1 SUMMARY

The basis of design technical memorandum (TM) is used to establish current and projected flows and constituent loadings at the West and East Wastewater Treatment Facilities (WWTFs). Data provided by the City was analyzed for use in establishing these flows and loads. The flow data was used to confirm existing conditions, but a combination of flow factors was used for projections because the future flows are disproportionately large compared to the existing flows. Where data was not suitable or available, industry standard equations and typical value ranges were used to provide a reasonable determination of existing and projected loads. For flows, in which suitable data was available, these industry standard equations and typical value ranges were used as a supplement to the data to provide a firm basis for flow calculations as the system grows and matures. Population data was provided through a land use and planning portion of the study completed by the City Engineer and City Planner.

A summary of the flows and loads for both the West WWTF and the East WWTF is included in Table 1.1.

Table 1.1 – Existing and Projected Flows and Loads Summary

Parameter	Units	WEST FACILITY/SERVICE AREA			EAST FACILITY/SERVICE AREA		
		Existing Capacity	Current (2016)	Projected Buildout	Existing Capacity	Current (2016)	Projected Buildout
Population	[PE]	-	3,468	39,856	-	2,676	42,147
AVERAGE ANNUAL							
Flow	[MGD]	0.60	0.34	3.90	1.00	0.26	4.12
BOD	[ppd]	1,020	763	8,768	2,080	589	9,272
TSS	[ppd]	1,200	867	9,964	2,080	669	10,537
TKN-N	[ppd]	120	111	1,275	250	86	1,349
TP	[ppd]	-	26	303	56	20	320
PEAK MONTH							
Flow	[MGD]	0.72	0.47	5.04	1.10	0.36	5.32
BOD	[ppd]	1,446	1,095	11,335	2,860	855	11,957
TSS	[ppd]	1,813	1,332	13,495	3,055	1,042	14,229
TKN-N	[ppd]	204	190	1,921	410	148	2,026
TP	[ppd]	-	44	453	90	34	477
AVERAGE DRY WEATHER							
Flow	[MGD]	0.54	0.23	2.85	0.90	0.18	3.02
PEAK DAY							
Flow	[MGD]	-	0.50	5.45	-	0.38	5.76
BOD	[ppd]	2,506	1,915	18,406	4,851	1,506	19,384
TSS	[ppd]	2,947	2,179	21,028	4,911	1,713	22,148
TKN-N	[ppd]	348	323	3,118	687	254	3,285
TP	[ppd]	-	85	813	170	67	857
PEAK HOUR							
Flow	[MGD]	1.92	1.15	9.20	3.29	0.91	9.61

2 LAND USE, POPULATION PROJECTIONS, AND PLANNING PERIOD

Land use planning and corresponding projected flow rates were completed by Hakanson Anderson Associates, Inc. (HAA). Projected service populations for each of the respective WWTFs was determined based on these land use planning efforts. Existing service populations were determined through an examination of existing facility flow rates combined with the design per capita flow determined in the land use and population planning. The land use and population planning was determined to be occurring over an extended period, close to 80 years (much longer than the typical 20 to 30 year planning period for facilities); however, this approach is necessary to address potential concerns over land constraints as the facilities are located in developed residential neighborhoods with little additional available space. These constraints have the potential to affect numerous variables including final location of treatment unit processes or the selected technology.

The land use planning documents identified a central "City Center" area that could feasibly be served by either wastewater facility. This area has a relatively small service population; however, it has the potential to add approximately 0.5 million gallons per day (MGD) to the facility selected to service this area. Based on preliminary discussions with regulatory agencies, it was determined that because of potential total phosphorus treatment requirements, this additional flow should be directed to the

East WWTF. Also identified by the land use planning documents in the East service area is an "Existing Septic" area. This area exists as septic with the caveat from regulatory agencies that the entire flow from the area must be accommodated by a wastewater facility if, in the future, the septic systems cause issues. Because there are concerns with land availability for the facilities, it was decided that this population and the resulting flows and loads would be included in the East service projected design to take a conservative approach when determining WWTF footprints. It is also noted that the East WWTF serves a small portion of the City of Dayton, and that there is a utility service agreement between the two Cities. Dayton provided funding for a portion of the original East WWTF capital cost, but the service population has remained essentially unchanged since the initial connection to the East WWTF. Dayton is primarily located in Hennepin County and will be provided wastewater service by the Metropolitan Council Environmental Services wastewater system. No additional capacity needs are anticipated for Dayton. The existing and projected service populations are included in Table 2.1. Population equivalents have been used in the wastewater planning process to relate the projected flow to the current flows. The table also includes a "true" population number that corresponds with the City's population growth documents.

Table 2.1 – Existing and Projected Service Populations for West and East WWTFs

Population Condition	Total Service Population	West Service Population	East Service Population			
			Total	Base	City Center	Existing Septic
[-]	[PE]	[PE]	[PE]	[PE]	[PE]	[PE]
Existing [PE]	6,144	3,468	2,676	-	-	-
Projected [PE]	82,003	39,856	42,147	37,258	642	4,247
Existing [Population (Approx.)]*	4,495	2,538	1,958	-	-	-
Projected [Population (Approx.)]*	60,000	29,162	30,838	27,261	470	3,108

*Corrected from PE and assuming consistent population distribution between all areas.

3 FLOWS AND LOADINGS (LIQUID)

The determination of flowrates and mass loading variations is an important factor in the planning and design of wastewater treatment facilities. The analysis involves determining constituent concentrations, flowrate variations, and the resulting mass loadings. The mass loading is defined as the constituent concentration multiplied by the flowrate and is given in units of mass per unit time (i.e., pounds per day, lbs/d (ppd)). The mass loadings are determined by analyzing historical flowrate data as well as constituent concentrations. Constituents of concern include 5-Day Biochemical Oxygen Demand (BOD_5), Total Suspended Solids (TSS), Total Kjeldahl Nitrogen (TKN; Ammonia), and Total Phosphorus (TP). These constituents are defined as follows:

- **BOD_5:** The amount of oxygen required to stabilize biodegradable organic matter under aerobic conditions within a five day period.
- **TSS:** A portion of the total solids retained on a filter (1.58 um).
- **TKN:** Total of the organic and ammonia nitrogen.
- **TP:** Total of the organic and inorganic phosphorus compounds.

Various flowrates were examined and are defined as follows:

- **Annual Average Flow:** The average flowrate occurring over a 24 hour period based on annual flowrate data.
- **Minimum Flow:** The minimum flow to the WWTF.
- **Maximum/Peak Month:** The average of the maximum daily flows sustained for a period of 30 consecutive days. Also referred to as the Average Wet Weather Flow (AWWF) for regulatory purposes.
- **Maximum/Peak Day:** The average of the peak flows sustained for a period of 24 hours.
- **Maximum/Peak Hour:** The average of the peak flows sustained for a period of one hour.

3.1 HISTORIC FLOWS AND LOADS

Historic flows and loads were available for both facilities located within the study area. The data provided was collected as part of Discharge Monitoring Report (DMR) requirements for regulatory agencies. In many instances data provided for these studies is adequate for accurately determining existing flows and loads under average and peak conditions, and it can be used in conjunction with accepted industry equations and typical values to determine flow and load peaking factors for both existing and design service populations. The data provided was evaluated for use in determining existing and projected flow and load values. Through evaluation of the data, AE2S determined that the load/concentration data included some questionable characteristics for use in long term projections including the following:

- The loading data were inconsistent with expectations based on typical values and equation derived values. It is acknowledged that not all facilities will follow typical or equation derived values; however, in these instances there is also typically an explanation related to the influent source that provides explanation for the deviation. Influent concentration deviation is not uncommon, but per capita loading is relatively consistent. Further, in these instances it would be expected that there would be some consistency within the loading data itself.
- Loading data from the City of Otsego facilities were highly variable without an obvious explanation such as a high-load wet industry. Peaking factors up to four times typical were determined using the loading data. Attempting to eliminate outliers by using 99^{th} percentile data, at times, brought the peaking factors back to typical ranges; however, at other times, it did not change the data or only resulted in a partial decrease towards typical. Further, the loading data did not always reveal high peaking factors; in several instances peaking factors far lower than typical were calculated from the loading data.
- Loading data between the two WWTFs was also inconsistent with respect to each other. Given that the WWTFs service adjacent populations with similar land use, the expectation is that the data from the two WWTFs should be relatively consistent with each other; however, examination of the data indicated that in some instances, constituent loading on a per capita basis was nearly double at one WWTF.

- It is known that, at times, the WWTFs have had issues with constituent sampling for the influent, potentially leading to the high variability in the data. Additionally, the overall conditions of the sampling are not well known. While in some instances the timing of the sampling is known, details such as potential recycle streams, high/lower influent flow, etc. are additional unknown factors that could contribute to the variability in the data. Because the influent data has little basis for regulatory compliance, there is less emphasis on influent sampling compared to effluent sampling, which does have a direct impact on regulatory compliance.
- The overall lack of explanation for deviations in the data ultimately makes selection of accurate load peaking factors based on the data difficult. This could lead to the over/under design of planned facilities.
- An analysis of the flow data indicated significantly reduced variability when compared to the loading data. The analysis indicated that an approach that accounts for the data, typical values, and equation derived values is appropriate.

As the loading data was unfortunately deemed unreliable for long-term projections, it was determined that the existing and projected loading for various constituents would be determined using a "greenfield" site approach where no data is available. Typical loads to a WWTF can be estimated based on the population served, and this approach will be taken for the study area in this planning document. Flows were determined using a combination approach involving analysis of available data along with typical and equation derived values. Loads were projected by using land use and population information along with typical per capita values as defined in wastewater literature. As the new development area will require all new construction, it is assumed that little infiltration and inflow (I/I) into the system will be observed. However, it will also be noted that as the young system ages I/I to a certain extent may become more prevalent and that sump pump flows may continue to be an I/I factor. No wet industries or heavy water users are anticipated in the land planning process and, thus, no elevated flows or loads above typical values are expected.

3.2 FLOW PROJECTIONS

As previously mentioned, the flows and loads included in this planning document are those expected in the anticipated design area. The flows and loads presented will detail the expectations of the new development areas.

Average Annual Flows

The Recommended Standards for Wastewater Facilities from the Great Lakes – Upper Mississippi River Board of State and Provincial Health and Environmental Managers (Ten States Standards) provides recommendation for sizing wastewater treatment facilities based on an average daily flow of 100 gallons per capita per day (gpcd). The Minnesota Pollution Control Agency (MPCA) uses the Ten State Standards for planning and design of wastewater systems. Through evaluation existing flows and the land planning documents from HAA, and assuming both WWTFs are treated equally, an average daily flow of 97.9 gpcd was determined based on population after a correction from the non-residential connections. This value is in line with the 100 gpcd outlined by Ten State Standards and was used in determining annual average flows presented in Table 3.2.1. This approach results in slightly conservative flow numbers when compared to the land planning documents from HAA. Additionally, the projections used for the wastewater facility are based on population equivalent (PE) values.

Table 3.2.1 – Annual Average Flow Projections

Parameter	Units	WEST FACILITY/SERVICE AREA			EAST FACILITY/SERVICE AREA		
		Existing Capacity	Current Flows	Projected Flows	Existing Capacity	Current Flows	Projected Flows
Population	[PE]	-	3,468	39,856	-	2,676	42,147
Average Annual Per Capita Flow	[gpcd]	-	97.9	97.9	-	97.9	97.9
Average Annual Flow	[MGD]	0.60	0.34	3.90	1.00	0.26	4.12

The annual average flow rates are one aspect of the design flow development required for planning expansion of an existing WWTF or planning a new WWTF. The treatment and permitted capacity for the treatment system are based upon a peak month average wet weather (30-day) flow. Other peak flows, such as peak hourly and peak instantaneous flows, are used for sizing particular facility components; these flows are considered in the design of most components to provide a system that will not fail under extreme conditions. However, in general, the peak month average wet weather flow is considered the design flow for many biological treatment systems.

To establish the peak design flows for a WWTF, peaking factors are typically applied to the average flows. These factors are generally derived from historic flow data, or from industry standard equations for peak hour and peak day flows. The results of these projections follow.

Average Wet Weather Flow (Peak Month)

Historic flow data were available for both of the WWTFs and the data were deemed suitable for use in evaluation of peak month conditions. Peaking factors for current flows were determined using this data. Additionally, peaking factors based on industry standard equation (reference: WEF MOP8, 5th Edition [2010] Chapter 3) were also determined for current and projected flows. The results of the data analysis and calculated peaking factor were used to determine the peak month factor for use in calculating per capita and daily flow rates. Peaking factors derived using the industry equation were greater than both the peaking factors used for the existing facility design and the peaking factors determined from the current data, but that is attributed to the "textbook" peaking factors being based upon older collection systems with more I/I susceptible materials of construction. Though I/I may remain minimized due to new infrastructure, it is anticipated that some increase to peaking events may occur as the system ages and joints become less tight, etc. Based on these factors, the selected peaking factor was a blend of existing data and industry standard values.

Peak month per capita flows ranged from 134 gallons per capita per day at existing conditions to 129 gallons per capita per day at projected when using the selected peaking factor. Note that the peaking factors generally decrease as the size of a system increases because the factors that cause peaks are more spread and are not necessarily aligned within the same time periods. The equation is as follows and the results detailed in Table 3.2.2.

$$PF = -0.033Ln(x) + 1.38$$
$$PF = peak\ wet\ weather\ (month)\ factor$$
$$x = flow\ in\ ML/d$$

Table 3.2.2 – Peak Wet Weather Flow Projections

Parameter	Units	WEST FACILITY/SERVICE AREA			EAST FACILITY/SERVICE AREA		
		Existing Capacity	Current Flows	Projected Flows	Existing Capacity	Current Flows	Projected Flows
Population	[PE]	-	3,468	39,856	-	2,676	42,147
Peak Wet Weather (Month) Factor							
Per Data	[-]	-	1.23	-	-	1.13	-
Per Equation	[-]	-	1.37	1.29	-	1.38	1.29
Selected	[-]	1.20	1.37	1.29	1.10	1.38	1.29
Peak Month Per Capita Flow	[gpcd]	-	134	126	-	135	126
Peak Month Flow	[MGD]	0.72	0.47	5.04	1.10	0.36	5.32

Average Dry Weather Flow

In addition to the annual average flow and average wet weather (peak month) flow for a WWTF, the average annual dry weather flow is used to examine seasonal variations in WWTF operating conditions. The average dry weather flow is typically the average flow during the winter months when the ground is frozen and groundwater levels are lower. Infiltration is typically at its lowest point during these months as there are limited inflow sources when compared to wet weather conditions. In the case of this plan, the average dry weather flow is not expected to vary by a significant amount from the annual average flow as the new construction will limit the I/I in the system. This expectation is confirmed by analysis of the flow data and is presented in Table 3.2.3 below where dry weather peaking factors based on available data were 0.90 and 0.98 for the West and East WWTFs, respectively.

While historic flow data is available for this location, an additional peaking factor was determined using an equation from WEF MOP8, 5th Edition (2010) Chapter 3 to more accurately represent a system that may be subjected to additional I/I as it ages. The peaking factor resulting from this formula was ultimately selected for this reason, and these peaking factors for peak dry weather flow conditions were used to calculate per capita and daily flow rates. Peak month per capita flows ranged from 66 gallons per capita per day, at initial design, to 72 gallons per capita per day, at ultimate. The equation is as follows, and the results detailed in Table 3.2.3.

$$PF = 0.023Ln(x) + 0.67$$
$$PF = peak\ dry\ weather\ factor$$
$$x = flow\ in\ ML/d$$

Table 3.2.3 – Average Dry Weather Flow Projections

Parameter	Units	WEST FACILITY/SERVICE AREA			EAST FACILITY/SERVICE AREA		
		Existing Capacity	Current Flows	Projected Flows	Existing Capacity	Current Flows	Projected Flows
Population	[PE]	-	3,468	39,856	-	2,676	42,147
Peak Dry Weather Factor							
Per Data	[-]	-	0.90	-	-	0.98	-
Per Equation	[-]	-	0.68	0.73	-	0.67	0.73
Selected	[-]	0.90	0.68	0.73	0.90	0.67	0.73
Average Dry Weather Per Capita Flow	[gpcd]	-	66	72	-	66	72
Average Dry Weather Month Flow	[MGD]	0.54	0.23	2.85	0.90	0.18	3.02

Peak Day and Peak Hour Flow

Peak day and peak hour flow factors can be important to certain aspects of a WWTF. These flow peaks are typically more dependent upon population, with larger populations experiencing a smaller peaking factor due to a more distributed peak and a larger/longer collection system. Historic flow data is available for these facilities; however, the applicability of the data to peak day and peak hour flows should be questioned as the provided data is limited to a single flow reading each day. As a result, it is not able to be determined if the true peak day and peak hour points were captured by the data, and the following equation from Ten States Standards was used to supplement the data and determine a peak hour factor.

$$PF = \frac{18 + \sqrt{\frac{P}{1000}}}{4 + \sqrt{\frac{P}{1000}}}$$

PF = peak hour factor
P = contributing population

After determining the peak hour factor for each of the contributing populations, the factor was multiplied by the corresponding average annual flow rate.

Peak day factors are lower than peak hour factors but follow a similar relationship. Peak day factors were determined from the following equation in WEF MOP8, 5th Edition (2010) Chapter 3 to supplement the data. The results of the determination of the peak day and peak hour flows are included in Table 3.2.4 and 3.2.5.

$$PF = -0.027Ln(x) + 1.47$$
$$PF = peak\ day\ factor$$
$$x = flow\ in\ ML/d$$

Table 3.2.4 – Peak Hour Flow Projections

Parameter	Units	WEST FACILITY/SERVICE AREA			EAST FACILITY/SERVICE AREA		
		Existing Capacity	Current Flows	Projected Flows	Existing Capacity	Current Flows	Projected Flows
Population	[PE]	-	3,468	39,856	-	2,676	42,147
Peak Hour Factor							
Per Data		-	-	-	-	-	-
Per Equation		-	3.39	2.36	-	3.48	2.33
Selected		3.20	3.39	2.36	3.29	3.48	2.33
Peak Hour Per Capita Flow	[gpcd]	-	332	231	-	341	228
Peak Hour Flow	[MGD]	1.92	1.15	9.20	3.29	0.91	9.61

Table 3.2.5 – Peak Day Flow Projections

Parameter	Units	WEST FACILITY/SERVICE AREA			EAST FACILITY/SERVICE AREA		
		Existing Capacity	Current Flows	Projected Flows	Existing Capacity	Current Flows	Projected Flows
Population	[PE]	-	3,468	39,856	-	2,676	42,147
Peak Day Factor							
Per Data		-	1.58	-	-	1.38*	-
Per Equation		-	1.46	1.40	-	1.47	1.40
Selected		-	1.50	1.40	-	1.47	1.40
Peak Day Per Capita Flow	[gpcd]	-	143	137	-	144	137
Peak Day Flow	[MGD]	-	0.50	5.45	-	0.38	5.76

*99th percentile data point. Value per all data was 2.74.

Peak Instantaneous Flow

The peak instantaneous flow can be important in sizing facility components, but is not really a factor in overall treatment capacity. In addition, the peak instantaneous flow can be difficult to predict, especially with no historical data available in a resolution to determine peak instantaneous flow. For this reason, peak instantaneous flows and peaking factors were not determined for the populations in the new development areas. The peak hour flows determined in this plan are conservative and will be used for determining the hydraulic conveyance needs for the facility plan. Further, most collection systems provide some degree of flow attenuation that allows the peak hour and peak instantaneous flow to be nearly the same in practice provided that significant inflow (such as stormwater cross-connections) is not experienced by the system.

Summary

The following table provides a summary of the flow projections for the planning horizons for the new development areas.

Table 3.2.6 – Summary of Flow Projections

Parameter	Units	WEST FACILITY/SERVICE AREA			EAST FACILITY/SERVICE AREA		
		Existing Capacity	Current Flows	Projected Flows	Existing Capacity	Current Flows	Projected Flows
Population	[PE]	-	3,468	39,856	-	2,676	42,147
Average Annual Flow	[MGD]	0.60	0.34	3.90	1.00	0.26	4.12
Peak Month Flow	[MGD]	0.72	0.47	5.04	1.10	0.36	5.32
Average Dry Weather Flow	[MGD]	0.54	0.23	2.85	0.90	0.18	3.02
Peak Day Flow	[MGD]	-	0.50	5.45	-	0.38	5.76
Peak Hour Flow	[MGD]	1.92	1.15	9.20	3.29	0.91	9.61

3.3 LOAD PROJECTIONS

Typical values were used to determine the loading projections for the new development areas due to inconsistent data as previously discussed in this TM. Per the land use plan, no major wet industries are expected to contribute to the new development area in such a manner that they would significantly change the characteristics of the wastewater influent stream. Should industrial or other high strength load contributions arise during the planning horizons, it is possible that they may be accounted for as needed, but since no such sources are expected at this time, standard values will provide adequate load projections. If a high strength wet industry does locate in Otsego, pre-treatment requirements would likely be used to minimize the impact of load changes to the wastewater treatment system.

Typical 5-day biochemical oxygen demand (BOD_5) values for domestic wastewater range from 110 to 350 milligrams per liter (mg/L) where 190 mg/L is considered medium strength. Per capita loading rates for BOD_5 range from 0.11 to 0.26 pounds per capita per day (ppcd) with a typical value of 0.22 ppcd. Typical total suspended solids (TSS) values for domestic wastewater range from 120 to 400 mg/L where 210 mg/L is considered medium strength. Per capita loading rates for TSS range from 0.13 to 0.33 ppcd with a typical value of 0.25 ppcd. Typical total Kjeldahl nitrogen as nitrogen (TKN-N) values, defined as the quantity of ammonia and organic nitrogen, range from 20 to 70 mg/L where 40 mg/L is considered medium strength. Per capita loading rates for TKN-N range from 0.020 to 0.048 ppcd with a typical value of 0.032 ppcd. Typical total phosphorus as phosphorus (TP) values range from 4 to 12 mg/L where 7 mg/L is considered medium strength. Per capita loading rates for TP range from 0.006 to 0.010 ppcd with a typical value of 0.0076 ppcd. Typical per capita values provided assume use of in-sink garbage grinders, which are typical of kitchens for new construction. Wastewater concentrations can vary greatly due to influences of infiltration and inflow (I/I) or other contributions. In the case of the two Otsego facilities, I/I is anticipated to be limited due to the newly constructed nature of the majority of the collection system and the materials of construction; however, as the system ages additional I/I may occur. Current and projected load information was based on assumptions for average domestic waste strengths. A summary of typical loading values as detailed above and per Table 11 of WEF MOP8, 5th Edition (2010), and peak month and day factors per Metcalf and Eddy, 4th Edition (2003) is presented in Table 3.3.1. The table also includes typical values without the use of garbage grinders.

Table 3.3.1 – Summary of Typical Loading Values and Peak Month Factors for Selected Wastewater Constituents

Constituent	Average Daily Range	Typical - Without Ground-Up Kitchen Waste	Typical - With Ground-Up Kitchen Waste	Peak Month Factor Range	Peak Day Factor Range
[-]	[ppcd]	[ppcd]	[ppcd]	[-]	[-]
BOD_5	0.11 - 0.26	0.18	0.22	1.26 - 1.33	2.00 - 2.21
TSS	0.13 - 0.33	0.20	0.25	1.31 - 1.40	2.01 - 2.22
TKN-N	0.020 - 0.048	0.029	0.032	1.26 - 1.33	2.00 - 2.21
TP	0.006 - 0.010	0.007	0.0076	1.26 - 1.33	2.00 - 2.21

The peak month and peak day loads are important for WWTFs. Determining the peak month and day loads can be beneficial when sizing various physical and biological treatment processes. Peak month and peak day loading factors were determined for the new development area using the following equations from Viessman and Hammer, 4th Edition (1985). The peaking factors for TKN-N and TP were assumed to be the same values as determined for the BOD_5 peak loading factors as it is typical for these values to correlate. The peaking factors were multiplied by the average daily loading to determine peak loadings. Peak hour factors were not determined for these parameters as the values are not used as design conditions for wastewater treatment facilities. While additional constituents are shown in the following tables, peak day values for BOD_5 and TSS are typically the only peak day values that are considered in the design of wastewater treatment facilities.

$$B_{PFm} = \left(\frac{1.91}{B^{0.0430}}\right)$$

$$B_{PFd} = \left(\frac{4.08}{B^{0.0732}}\right)$$

$$S_{PFm} = \left(\frac{2.18}{S^{0.05170}}\right)$$

$$S_{PFd} = \left(\frac{4.08}{S^{0.0716}}\right)$$

$$B = average\ annual\ BOD\ load, \frac{lb}{day}$$

$$S = average\ annual\ TSS\ load, \frac{lb}{day}$$

$$B_{PFm}, S_{PFm} = average\ value\ during\ the\ peak\ month$$

$$B_{PFd}, S_{PFd} = average\ value\ during\ the\ peak\ day$$

BOD5

A value of 0.22 pounds per capita per day of BOD_5 was used to calculate and project the average annual, peak month, and peak day loading projections in pounds per day. The following table details these projections.

Table 3.3.2 – Average Annual, Peak Month, and Peak Day BOD_5 Projections

Parameter	Units	WEST FACILITY/SERVICE AREA			EAST FACILITY/SERVICE AREA		
		Existing Capacity	Current Flows	Projected Flows	Existing Capacity	Current Flows	Projected Flows
Population	[PE]	-	3,468	39,856	-	2,676	42,147
AVERAGE ANNUAL							
Per Capita Loading	[ppcd]	-	0.22	0.22	-	0.22	0.22
Loading	[ppd]	1,020	763	8,768	2,080	589	9,272
PEAK MONTH							
Peak Month Factor (Per Equation)	[-]	1.42	1.44	1.29	1.38	1.45	1.29
Per Capita Loading	[ppcd]	-	0.32	0.28	-	0.32	0.28
Loading	[ppd]	1,446	1,095	11,335	2,860	855	11,957
PEAK DAY							
Peak Month Factor (Per Equation)	[-]	2.46	2.51	2.10	2.33	2.56	2.09
Per Capita Loading	[ppcd]	-	0.55	0.46	-	0.56	0.46
Loading	[ppd]	2,506	1,915	18,406	4,851	1,506	19,384

TSS

A value of 0.25 pounds per capita per day of TSS was used to calculate and project the average annual, peak month, and peak day loading projections in pounds per day. The following table details these projections.

Table 3.3.3 – Average Annual, Peak Month, and Peak Day TSS Projections

Parameter	Units	WEST FACILITY/SERVICE AREA			EAST FACILITY/SERVICE AREA		
		Existing Capacity	Current Flows	Projected Flows	Existing Capacity	Current Flows	Projected Flows
Population	[PE]	-	3,468	39,856	-	2,676	42,147
AVERAGE ANNUAL							
Per Capita Loading	[ppcd]	-	0.25	0.25	-	0.25	0.25
Loading	[ppd]	1,200	867	9,964	2,080	669	10,537
PEAK MONTH							
Peak Month Factor (Per Equation)	[-]	1.51	1.54	1.35	1.47	1.56	1.35
Per Capita Loading	[ppcd]	-	0.38	0.34	-	0.39	0.34
Loading	[ppd]	1,813	1,332	13,495	3,055	1,042	14,229
PEAK DAY							
Peak Month Factor (Per Equation)	[-]	2.46	2.51	2.11	2.36	2.56	2.10
Per Capita Loading	[ppcd]	-	0.63	0.53	-	0.64	0.53
Loading	[ppd]	2,947	2,179	21,028	4,911	1,713	22,148

TKN-N

A value of 0.032 pounds per capita per day of TKN-N was used to calculate and project the average annual, peak month, and peak day loading projections in pounds per day. The following table details these projections.

Table 3.3.4 – Average Annual, Peak Month, and Peak Day TKN-N Projections

Parameter	Units	WEST FACILITY/SERVICE AREA			EAST FACILITY/SERVICE AREA		
		Existing Capacity	Current Flows	Projected Flows	Existing Capacity	Current Flows	Projected Flows
Population	[PE]	-	3,468	39,856	-	2,676	42,147
AVERAGE ANNUAL							
Per Capita Loading	[ppcd]	-	0.032	0.032	-	0.032	0.032
Loading	[ppd]	120	111	1,275	250	86	1,349
PEAK MONTH							
Peak Month Factor (Per Equation)	[-]	1.70	1.71	1.51	1.64	1.73	1.50
Per Capita Loading	[ppcd]	-	0.055	0.048	-	0.055	0.048
Loading	[ppd]	204	190	1,921	410	148	2,026
PEAK DAY							
Peak Month Factor (Per Equation)	[-]	2.90	2.91	2.45	2.75	2.97	2.44
Per Capita Loading	[ppcd]	-	0.093	0.078	-	0.095	0.078
Loading	[ppd]	348	323	3,118	687	254	3,285

TP

A value of 0.0076 pounds per capita per day of TP was used to calculate and project the average annual, peak month, and peak day loading projections in pounds per day. The following table details these projections.

Table 3.3.5 – Average Annual, Peak Month, and Peak Day TP Projections

Parameter	Units	WEST FACILITY/SERVICE AREA			EAST FACILITY/SERVICE AREA		
		Existing Capacity	Current Flows	Projected Flows	Existing Capacity	Current Flows	Projected Flows
Population	[PE]	-	3,468	39,856	-	2,676	42,147
Average Annual							
Per Capita Loading	[ppcd]	-	0.0076	0.0076	-	0.0076	0.0076
Loading	[ppd]	-	26	303	56	20	320
Peak Month							
Peak Month Factor (Per Equation)	[-]	-	1.66	1.49	1.61	1.68	1.49
Per Capita Loading	[ppcd]	-	0.013	0.011	-	0.013	0.011
Loading	[ppd]	-	44	453	90	34	477
Peak Day							
Peak Month Factor (Per Equation)	[-]	-	3.21	2.69	3.04	3.27	2.67
Per Capita Loading	[ppcd]	-	0.024	0.020	-	0.025	0.020
Loading	[ppd]	-	85	813	170	67	857

4 SOLIDS HANDLING

The solids handling requirements for wastewater facilities is a function of the flows and loading entering the liquid treatment portions of the facility. The specific liquid treatment processes can also affect the solids handling requirements. The Solids Basis of Design assumes all liquid treatment process alternatives produce a similar quantity of solids for treatment in the solids handling portion of the facility.

4.1 BASIS OF DESIGN ASSUMPTIONS

Table 4.1.1 details the design assumptions used in determining the sizing of each of the respective unit processes based on the solids treatment technologies selected for evaluation. These design assumptions are based on engineering experience, equipment manufacturer information, and accepted values from various literature resources including Design of Municipal Wastewater Treatment Plants MOP8 (WEF, 2010) and Ten States Standards.

Table 4.1.1 – Solids Handling Design Assumptions

Parameter	Units	Aerobic Digestion Alternatives	Chemical (Lime) Stabilization Alternative
Design Assumptions			
Waste Activated Sludge			
Sludge Yield	[lb VSS / lb BOD]	0.90	0.90
Preliminary Treatment BOD Removal	[%]	0	0
Volatile Solids Fraction	[-]	0.67	0.67
Percent Solids	[%]	0.75	0.75
Thickening			
Discharge Percent Solids	[%]	3.5	5.5
Percent Capture	[%]	95	95
Aerobic Digestion			
Percent Solids	[%]	3.5	-
Volatile Solids Reduction	[%]	30	-
Dewatering			
Discharge Percent Solids	[%]	20	20
Percent Capture	[%]	95	95
Chemical (Lime) Stabilization			
Discharge Percent Solids	[%]	-	35
Percent Capture	[%]	-	100

The following notes provide additional clarification of the values in Table 4.1.1:

- No preliminary treatment BOD removal occurs due to the lack of primary clarifiers in the liquid treatment alternatives selected for in-depth evaluation.
- Thickening and Aerobic Digestion Assumptions
    - The thickening "performance" is curtailed to avoid the solids becoming too thick in the aerobic digester, although the thickening equipment could achieve a higher percent solids.
- Dewatering and Chemical (Lime) Stabilization Assumptions
    - The thickening unit percent solids for the Chemical (Lime) Stabilization alternative is higher than the aerobic digestion alternatives. This is because the selected chemical stabilization process requires a thickened/dewatered sludge at approximately 20-percent to be fed into the stabilization unit and involves the transfer of sludge directly from thickening/dewatering processes to the stabilization unit while the aerobic digestion designs are based around feeding the digesters at approximately 3.5-percent.
    - The alternative does not make use of an aerobic digestion unit process and, therefore, no design assumptions for percent solids or volatile solids reduction have been made.

- o Dewatering will occur to approximately 20-percent regardless of alternative; however, only the chemical alternative involves an additional stabilization unit process that results in a further thickened sludge. Therefore, no design assumptions for the aerobic digestion alternatives are included for these items.

4.2 BASIS OF DESIGN

Using the assumptions above, the resulting flows and loads through the solids treatment process were determined and are included in Table 4.2.1. Calculations for both average annual and peak month values have been completed. Various solids handling unit processes must use either/both of these values in design considerations. Additional discussion of specific unit process sizing will be provided in other Technical Memorandums.

Table 4.2.1 – Solids Handling Basis of Design

Parameter	Units	WEST FACILITY/SERVICE AREA		EAST FACILITY/SERVICE AREA		INDEPENDENT BIOSOLIDS - AEROBIC DIGESTION		CONSOLIDATED BIOSOLIDS - AEROBIC DIGESTION		CONSOLIDATED BIOSOLIDS – CHEMICAL (LIME) STABILIZATION	
		Existing Capacity	Current Flows	Existing Capacity	Current Flows	West WWTF	East WWTF	West WWTF	East WWTF	West WWTF	East WWTF
Population	[PE]	-	3,468	-	2,676	39,856	42,147	39,856	42,147	39,856	42,147
Basis of Design Values											
Influent BOD Loading											
Average Annual	[ppd]	1,020	763	2,080	589	8,768	9,272	8,768	9,272	8,768	9,272
Peak Month	[ppd]	1,446	1,095	2,860	855	11,335	11,957	11,335	11,957	11,335	11,957
Sludge Production											
Average	[ppd]	918	687	1,872	530	7,891	8,345	7,891	8,345	7,891	8,345
Annual	[gpd]	14,676	10,978	29,928	8,475	126,158	133,410	126,158	133,410	126,158	133,410
Peak	[ppd]	1,301	986	2,574	770	10,202	10,761	10,202	10,761	10,202	10,761
Month	[gpd]	20,806	15,755	41,151	12,302	163,094	172,043	163,094	172,043	163,094	172,043
Thickening Discharge											
Average	[ppd]	872	652	1,778	504	7,497	7,928	7,497	7,928	7,497	7,928
Annual	[gpd]	2,988	2,235	6,092	1,725	25,682	27,158	25,682	27,158	16,343	17,283
Peak	[ppd]	1,236	936	2,445	731	9,691	10,223	9,691	10,223	9,691	10,223
Month	[gpd]	4,235	3,207	8,377	2,504	33,201	35,023	33,201	35,023	21,128	22,287
Aerobic Digestion Discharge											
Average	[ppd]	697	521	1,421	402	5,990	6,334	5,990	6,334	-	-
Annual	[gpd]	2,387	1,786	4,868	1,378	20,520	21,700	20,520	21,700	-	-
Peak	[ppd]	988	748	1,954	584	7,743	8,168	7,743	8,168	-	-
Month	[gpd]	3,384	2,563	6,693	2,001	26,528	27,983	26,528	27,983	-	-
Dewatering Discharge											
Average	[ppd]	665	498	1,356	384	5,718	6,046	5,718	6,046	7,156	7,567
Annual	[gpd]	399	298	813	230	3,428	3,625	3,428	3,625	4,290	4,537
Peak	[ppd]	943	714	1,865	558	7,392	7,797	7,392	7,797	9,251	9,759
Month	[gpd]	565	428	1,118	334	4,431	4,675	4,431	4,675	5,546	5,851
Cake / Chemical (Lime) Stabilization Discharge											
Average	[ft^3/day]	53	39	107	30	451	477	451	477	611	629
Annual	[CY/day]	1.9	1.5	4.0	1.1	16.7	17.7	16.7	17.7	22.6	23.3
Peak	[ft^3/day]	74	56	147	44	584	616	584	616	705	728
Month	[CY/day]	2.8	2.1	5.5	1.6	21.6	22.8	21.6	22.8	26.1	27.0

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Technical Memorandum: Collection System

Otsego Wastewater Treatment Master Planning

To: Kurt Neidermeier
Utility Manager
City of Otsego

From: Scott Schaefer, PE
Jayme Klecker, PE
Matt Madson, PE
AE2S

Date: January 8, 2018

Project No: P05409-2013-002

1 LAND USE AND POPULATION PROJECTIONS

Land use planning and corresponding projected flow rates were completed by the City Engineer: Hakanson Anderson Associates, Inc. (HAA). The land use planning documents identified a central "City Center" area that could feasibly be served by either wastewater facility. This area has a relatively small service population; however, it has the potential to add approximately 0.5 million gallons per day (MGD) to the wastewater treatment facility (WWTF) selected to service this area. Also, identified by the land use planning documents in the East service area is an "Existing Septic" area. This area exists as septic with the caveat from regulatory agencies that the entire flow from the area must be accommodated by a wastewater facility if, in the future, the septic systems cause issues.

2 COLLECTION SYSTEM SPLIT

2.1 INITIAL PLANNING

Preliminary planning for the required expansion of each WWTF presented potential concerns with land availability. These concerns were related to both facilities; however, there was greater concern over availability at the West WWTF due to the existing available space and proximity to neighbors and public spaces. Based partially on this information, an initial decision was made to add the aforementioned "City Center" flow entirely to the East WWTF. The permitted phosphorus discharge load is also higher at the East WWTF.

2.2 FINAL PLANNING

Additional planning efforts and preparation of site layouts revealed that both sites are tight but not space limited for most combinations of liquid and solids treatment alternatives. Adequate land is available at each facility to accommodate the additional 0.5 MGD from the "City Center"; however, the best alternative remains to convey all City Center flow to the East WWTF based on the following:

- While the West facility is not technically site limited at ultimate buildout, the infrastructure requirement for flows without the "City Center" flow addition is already tight, especially with the addition of biosolids handling infrastructure. The addition of another ~12.5-percent of flow will constrain the site further and could lead to difficulties in facility operations. This same infrastructure requirement at the East WWTF does not result in such tight circumstances leaving the site better suited to handle additional flow than the West WWTF.
- The biosolids resulting from the West WWTF require transport away from the site (transport requirements vary based on alternative). The site would require additional thickened solids transport and/or dewatered cake biosolids transport based on the additional 0.5 MGD influent. This increase in biosolids handling requirements goes against the effort to minimize biosolids handling at the West facility due to neighbor proximity, although a new entrance road from the west will help to mitigate this concern.
- Based on preliminary discussions with regulatory agencies:
    - The East facility is better suited to handle the potential total phosphorus treatment requirements from the additional flow.
    - If a "worst case", unanticipated scenario occurs with the implementation of chloride limits at the West facility, it is possible that the West facility effluent would require transfer to the East facility for discharge or directly to the Mississippi River. If the "City Center" flow is conveyed to the West facility and this chloride limit scenario occurs, the 0.5 MGD flow (in addition to the planned base flow) would require additional transport when compared to being conveyed directly to the East facility for treatment. This additional transport could potentially include the conveyance of the West facility effluent (including the "City Center" flow) to the East facility or directly to the Mississippi River for discharge
- It should be noted that these determinations are based on the assumption that conveying equal flows to either facility would result in the same cost to the collection system, regardless of facility. This assumption is deemed valid due to the central nature of the flow split.

2.3 POTENTIAL COLLECTION SYSTEM MODIFICATIONS

Because both sites are not space limited based upon the population considered for the planning period, the WWTF site footprints do not force modifications to the current collection system plan.

Technical Memorandum: Reasonable Alternatives Screening - Liquid

Otsego Wastewater Treatment Master Planning

To: Kurt Neidermeier
Utility Manager
City of Otsego

From: Scott Schaefer, PE
Jayme Klecker, PE
AE2S

Date: January 8, 2018

Project No: P05409-2013-002

1 SUMMARY

Several alternatives were considered for addressing the long-term wastewater treatment needs for the City of Otsego. Liquid treatment alternatives focus on improvements to meet future treatment and hydraulic needs. Six liquid stream treatment alternatives (three at each existing WWTF site) were deemed reasonable and will be carried forward for detailed evaluation for providing long-term wastewater treatment for the City. They are:

1. Expansion of oxidation ditch treatment at West WWTF
2. Expansion of oxidation ditch treatment at East WWTF
3. Membrane bioreactor treatment at West WWTF
4. Membrane bioreactor treatment at East WWTF
5. Integrated fixed film activated sludge treatment at West WWTF
6. Integrated fixed film activated sludge treatment at East WWTF

Alternatives that were considered but determined not to be feasible and, therefore, eliminated from further evaluation are as follows:

7. No action
8. Consolidation of treatment at existing East WWTF
9. Alternative disposal means for treated effluent
    a. Alternative discharge location – West WWTF
    b. Spray irrigation/Rapid infiltration basins
10. Sequencing batch reactors
11. Primary clarifiers with secondary treatment

12. Trickling filters
13. Anaerobic membrane bioreactor

2 ALTERNATIVE SCREENING FACTORS

Minnesota Rules, Chapter 7077, require an analysis of all feasible treatment alternatives that are capable of meeting the applicable effluent, water quality, and public health requirements for 20 years. Factors to be considered when addressing the feasibility of alternatives include:

- Site suitability
- Regulatory requirements
- Economic impacts
- Technological capacity
- Environmental effects
- Availability of infrastructure
- Social and political acceptability
- Jurisdictional boundaries

All of these factors were considered during screening of alternatives; however, site suitability, regulatory requirements, and economic impacts factors were given more weight during the screening process.

The site suitability factor pertains to the existing site having adequate open land for structures and equipment to meet future needs.

The regulatory requirements factor pertains to the proposed treatment technology's ability to meet current and future effluent and biosolids disposal requirements. Preliminary effluent limits for both the East and West WWTFs were provided by the Minnesota Pollution Control Agency (MPCA) and are provided in Appendix A. Due to anti-backsliding, new nutrient standards, anti-degradation, and other regulatory requirements, both the East and West facility will require secondary and tertiary treatment processes to meet stringent effluent limits. Note that the 2016 "Regulatory Certainty" rulemaking allows permittees to negotiate for 20-year effluent limits for phosphorus and nitrogen, but this planning anticipates buildout conditions beyond the 20-year timeframe where limits may be even more stringent. Future nitrogen limits are vague right now, and MPCA currently indicates that nitrate (aquatic toxicity based) limits are likely in the coming years but that total nitrogen limits are not likely. The broader nitrogen picture and the hypoxia issues in the Gulf of Mexico make it prudent to plan for the possibility that total nitrogen limits could be at or near the "best available technology" limits, which are currently around 3 mg TN/L to 5 mg TN/L. These potential TN effluent limits will be included in the footprint planning.

The economic impacts factor pertains to the overall capital costs of providing the necessary infrastructure and the long-term costs for operation and maintenance of the infrastructure.

Screening of alternatives was conducted to determine reasonable alternatives for further evaluation. Detailed evaluation of reasonable alternatives will be provided in subsequent Technical Memoranda.

3 ALTERNATIVES ANALYSIS

Several alternatives for addressing the future wastewater needs for the City of Otsego were considered. This section discusses the feasible alternatives that would provide for the purpose and need, including those alternatives that were considered but eliminated from further consideration.

Alternative analysis was conducted using future wastewater flow estimates provided by the City's Engineer and Planner. Total buildout wastewater flow for the community is projected to be approximately 7.5 million gallons per day (mgd). Based on the information provided by the City, there will be an approximately even flow split between the existing East and West treatment facilities, with the exception of approximately 0.5 mgd that could go to either facility. Due to slightly less restrictive effluent limits for the East facility (particularly for phosphorus load limits), we recommend planning for an average daily flow of 4.0 mgd to the East facility, and the remaining 3.5 mgd to the West facility. These average annual flow rates were used as the flow basis for the alternatives analysis.

Influent wastewater characteristics were detailed in the Basis of Design tech memo using the City's flow information and typical domestic strength loadings with respect to Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), Total Kjeldahl Nitrogen (TKN), and Total Phosphorus (TP).

3.1 ALTERNATIVE 1: EXPANSION OF OXIDATION DITCH TREATMENT AT WEST WWTF

The existing West WWTF has an average dry weather treatment capacity of 0.480 mgd, an annual average flow of 0.60 mgd, and an average wet weather flow treatment capacity of 0.720 mgd. Secondary treatment is provided using oxidation ditches. Discharge from the West WWTF is to an unnamed creek (often referred to as Otsego creek) that flows to the Mississippi River. The reach of the Mississippi River that the unnamed creek flows into is considered an Outstanding Resource Value Water (ORVW). The MPCA requires new or expanded dischargers to waters that flow into an ORVW be controlled so as to assure no deterioration in the quality of the downstream outstanding resource value water. Since the annual low flow dilution factor will be over 1,000 parts of Mississippi River water to one part Otsego West effluent, and the WWTF will have effluent limitations stricter than normal secondary limits, the ORVW water is being properly protected.

Due to the lack of dilution in the unnamed creek at the regulatory basis of critical low flow, it is likely that a variance for salty discharge will be necessary for expanded discharge from the West WWTF.

For this alternative, process components to expand and upgrade the WWTF to meet future flow and load conditions would include the following:

- Headworks improvements
  - Influent measurement
  - Fine screening (6mm)
  - Grit removal
  - Biofilter Odor Control

- Oxidation ditch improvements
    - Additional oxidation ditches for biological treatment
    - Five-stage biological nutrient removal process (anaerobic-anoxic-oxic-anoxic-oxic)
    - 24-hour total hydraulic retention time in first oxic stage
- Final clarifiers
    - Additional clarifiers for settling/solids separation
    - Associated pumping to return sludge to the biological process or to biosolids treatment
- Tertiary filtration
    - Reactive media filtration
    - TSS and TP control
    - Option for total nitrogen (TN) control with expanded filter area
- Disinfection
    - Ultraviolet (UV) disinfection
- Effluent Aeration
- Chemical feed
    - Metal salts for additional TP control
    - Carbon source for TN control
    - pH control

Preliminary analysis of this alternative indicates the necessary facilities would fit with the existing sites, the process would have the capability to meet future regulatory requirements, and the alternative is economically viable.

3.2 ALTERNATIVE 2: EXPANSION OF OXIDATION DITCH TREATMENT AT EAST WWTF

The existing East WWTF has a permitted average dry weather treatment capacity of 1.35 mgd, and average annual flow of 1.5 mgd, and an average wet weather flow treatment capacity of 1.65 mgd. Secondary treatment is provided using oxidation ditches. Discharge from the East facility is to the main branch of the Crow River that flows into the Mississippi River. The reach of the Mississippi River that the Crow River flows into is consider an Outstanding Resource Value Water (ORVW). The MPCA requires new or expanded dischargers to waters that flow into an ORVW be controlled so as to assure no deterioration in the quality of the downstream outstanding resource value water. Since the annual low flow dilution factor will be over 1,000 parts of Mississippi River water to one part Otsego East effluent, and the WWTF will have effluent limitations stricter than normal secondary limits, the ORVW water is being properly protected.

Due to the proximity of a downstream water treatment plant intake (Minneapolis Water Works), year-round disinfection will be required for the East WWTF.

For this alternative, process components to expand and upgrade the facility to meet future flow and load conditions would include the following:

- Headworks improvements
  - Influent measurement
  - Fine screening (6mm)
  - Grit removal
  - Biofilter Odor Control
- Oxidation ditch improvements
  - Additional ditches for biological treatment
  - Five-stage biological nutrient removal process (anaerobic-anoxic-oxic-anoxic-oxic)
  - 24-hour total hydraulic retention time in first oxic stage
- Final clarifiers
  - Additional clarifiers for settling/solids separation
  - Associated pumping to return sludge to the biological process or to biosolids treatment
- Tertiary filtration
  - Reactive media filtration
  - TSS and TP control
  - Option for TN control with expanded filter area
- Disinfection
  - UV disinfection
- Effluent Aeration
- Chemical feed
  - Metal salts for additional TP control
  - Carbon source for TN control
  - pH control

Preliminary analysis of this alternative indicates the necessary facilities would fit in the existing site, the process would have the capability to meet future regulatory requirements, and the alternative is economically viable.

3.3 ALTERNATIVE 3: MEMBRANE BIOREACTOR AT WEST WWTF

Membrane bioreactors (MBR) combine activated sludge with membrane filtration to produce a high-quality effluent. MBRs operate at high mixed liquor suspended solids concentrations (MLSS) in the range of 8,000 to 14,000 mg/L. Semi-permeable membranes separate the solids from the treated effluent. Due to the high MLSS content and membrane separation technology, MBR facilities have smaller footprints than conventional oxidation ditch treatment facilities. In additional, MBRs do not require final clarification or effluent reactive media filtration for TP control. They do require finer influent screening, permeate pumping, and chemical membrane cleaning equipment that is not required with oxidation ditch systems.

Due to the lack of dilution in the unnamed creek, it is likely that a variance for salty discharge will be necessary for expanded discharge from the West WWTF.

For this alternative, process components to expand and upgrade the facility to meet future flow and load conditions would include the following:

- Headworks improvements
    - Influent measurement
    - Fine screening (2mm)
    - Grit removal
    - Biofilter Odor Control
- Membrane bioreactors
    - MBR biological treatment
    - Five-stage biological nutrient removal process (anaerobic-anoxic-oxic-anoxic-oxic)
    - 8 to 10-hour total hydraulic retention time in first oxic stage
- Option for TN control with denite filters
- Disinfection
    - UV disinfection
- Effluent Aeration
- Chemical feed
    - Metal salts for additional TP control
    - Carbon source for TN control
    - pH control
    - Membrane cleaning

Preliminary analysis of this alternative indicates the necessary facilities would fit in the existing site, the process would have the capability to meet future regulatory requirements, and the alternative is economically viable.

3.4 ALTERNATIVE 4: MEMBRANE BIOREACTOR AT EAST WWTF

The MBR for the East WWTF would be similar to the West WWTF with the exception that the tank volume of the existing oxidation ditches will be utilized instead of all-new construction.

Due to the proximity of a downstream water treatment plant intake, year-round disinfection will be required for the East facility.

For this alternative, process components to expand and upgrade the facility to meet future flow and load conditions would include the following:

- Headworks improvements
    - Influent measurement
    - Fine screening (2mm)
    - Grit removal
    - Biofilter Odor Control
- Membrane bioreactors
    - MBR biological treatment
    - Five-stage biological nutrient removal process (anaerobic-anoxic-oxic-anoxic-oxic)
    - 8 to 10-hour total hydraulic retention time in first oxic stage
- Option for TN control with denite filters

- Disinfection
    - UV disinfection
- Effluent Aeration
- Chemical feed
    - Metal salts for additional TP control
    - Carbon source for TN control
    - pH control
    - Membrane cleaning

Preliminary analysis of this alternative indicates the necessary facilities would fit in the existing site, the process would have the capability to meet future regulatory requirements, and the alternative is economically viable.

3.5 ALTERNATIVE 5: INTEGRATED FIXED FILM ACTIVATED SLUDGE AT WEST WWTF

Integrated fixed-film activated sludge (IFAS) systems combine activated sludge (suspended growth) with submerged attached growth using fixed film media. The fixed-film media is added to an aeration basin to increase the overall microbial population which reduces the overall aeration basin volume requirements. IFAS media could be added to the existing oxidation ditches to increase their treatment capacity; however, different aeration and mixing may be necessary to accommodate and retain the IFAS media. IFAS systems require final clarification, return and waste activated sludge pumping, finer influent screening to avoid media plugging/blinding, and tertiary filters for effluent TSS and TP control. Note that due to retention of biomass on the fixed-film media, the final clarifiers are less susceptible to solids overloading at higher RAS flowrates.

Due to the lack of dilution in the unnamed creek, it is likely that a variance for salty discharge will be necessary for expanded discharge from the West WWTF.

For this alternative, process components to expand and upgrade the facility to meet future flow and load conditions would include the following:

- Headworks improvements
    - Influent measurement
    - Fine screening (2mm or 3mm)
    - Grit removal
    - Biofilter Odor Control
- Integrated fixed film activated sludge improvements
    - Additional tankage for biological treatment
    - Five-stage biological nutrient removal process (anaerobic-anoxic-oxic-anoxic-oxic)
    - 12 to 14-hour total hydraulic retention time in first oxic stage
- Final clarifiers
    - Additional clarifiers for settling/solids separation
    - Associated pumping to return sludge to the biological process or to biosolids treatment

- Tertiary filtration
    - Reactive media filtration
    - TSS and TP control
    - Option for TN control
- Disinfection
    - UV disinfection
- Effluent Aeration
- Chemical feed
    - Metal salts for additional TP control
    - Carbon source for TN control
    - pH control

Preliminary analysis of this alternative indicates the necessary facilities would fit in the existing site, the process would have the capability to meet future regulatory requirements, and the alternative is economically viable.

3.6 ALTERNATIVE 6: INTEGRATED FIXED FILM ACTIVATED SLUDGE AT EAST WWTF

IFAS for the East WWTF has similar characteristics to the West WWTF, although there is more opportunity to reuse the existing oxidation ditch tanks for IFAS volume.

Due to the proximity of a downstream water treatment plant intake, year-round disinfection will be required for the East facility.

For this alternative, process components to expand and upgrade the facility to meet future flow and load conditions would include the following:

- Headworks improvements
    - Influent measurement
    - Fine screening (2mm or 3mm)
    - Grit removal
    - Biofilter Odor Control
- Integrated fixed film activated sludge improvements
    - Additional tankage for biological treatment
    - Five-stage biological nutrient removal process (anaerobic-anoxic-oxic-anoxic-oxic)
    - 12 to 14-hour total hydraulic retention time in first oxic stage
- Final clarifiers
    - Additional clarifiers for settling/solids separation
    - Associated pumping to return sludge to the biological process or to biosolids treatment
- Tertiary filtration
    - Reactive media filtration
    - TSS and TP control
    - Option for TN control
- Disinfection
    - UV disinfection

- Effluent Aeration
- Chemical feed
    - Metal salts for additional TP control
    - Carbon source for TN control
    - pH control

Preliminary analysis of this alternative indicates the necessary facilities would fit in the existing site, the process would have the capability to meet future regulatory requirements, and the alternative is economically viable.

3.7 ALTERNATIVE 7: NO ACTION

Under the no action alternative, no construction or improvements would be performed at either treatment facility. This is not a practical solution for the City in light of the anticipated growth in the community and the need for increased wastewater treatment capacity. No action would restrict development, lead to increased potential for treatment plant upsets, and potential water quality violations. For these reasons, no action is deemed not a feasible alternative.

3.8 ALTERNATIVE 8: CONSOLIDATION OF TREATMENT AT EXISTING EAST WWTF

Under this alternative, all of the City's wastewater would be pumped to the East facility for treatment. Approximately 3.5 mgd of wastewater would still flow to the West facility; however, the West WWTF would be replaced by a lift station and force main to the East WWTF. The East WWTF has more open space for expansion, and discharges to a higher-flow receiving water (Crow River). A MBR treatment system would be constructed at the East WWTF to minimize the footprint of new facilities.

Due to the proximity of a downstream water treatment plant intake, year-round disinfection will be required for the East facility.

For this alternative, process components to expand and upgrade the facility to meet future flow and load conditions would include the following:

- Lift station and force main from West facility to East facility
- Headworks improvements
    - Influent measurement
    - Fine screening (2mm)
    - Grit removal
    - Biofilter Odor Control
- Membrane bioreactors
    - MBR biological treatment
    - Five-stage biological nutrient removal process (anaerobic-anoxic-oxic-anoxic-oxic)
    - 8 to 10-hour total hydraulic retention time in first oxic stage
- Option for TN control with denite filters
- Disinfection
    - UV disinfection
- Effluent Aeration

- Chemical feed
    - Metal salts for additional TP control
    - Carbon source for TN control
    - pH control
    - Membrane cleaning

Significant adverse regulatory and economic factors exist when considering this alternative. Mass-based limits on the effluent would become some of the most restrictive in the entire State. Effluent concentration limits would be difficult, if not impossible, to consistently meet. This alternative would also require construction of a lift station and force main to the East facility. Construction of a lift station would be economically reasonable. However, force main construction would be at least six miles long and cross two major thoroughfares resulting in a costly pipeline. The force main would also experience long retention times, particularly in the earlier years of operation, which would result in odor issues or costly chemical additions to avoid anaerobic conditions in the force main. Furthermore, the in-place assets at the West WWTF would be abandoned, resulting in significant capital dollars of infrastructure investment being left unused.

For these reasons, consolidation of treatment at the existing East facility is deemed not a feasible alternative.

3.9 ALTERNATIVE 9: ALTERNATIVE DISPOSAL MEANS FOR TREATED EFFLUENT

Two alternatives were considered; one, routing effluent from the West facility directly to the Mississippi River; and two, spray irrigation/rapid infiltration basins.

Discharge of the West facility directly to the Mississippi River is deemed not feasible due to regulatory and economic factors. The reach of the Mississippi closest to the West facility is an ORVW, and significant environmental hurdles would need to be cleared before this action is permitted. In addition, permit conditions would be very restrictive due to the proposed discharge going to an ORVW. Albertville is considering this alternative, but the Albertville discharge maintains a better regulatory position because its permitted discharge existed prior to the ORVW designation. Economically, the high cost of a lift station and force main for pumping to the Mississippi River and the advanced treatment necessary to discharge to an ORVW make this alternative not feasible. The effluent pipeline may need to be revisited if a variance for chloride is not possible, but that analysis can be independent of the other West WWTF alternatives since other discharge permit parameters would not be anticipated to be relaxed.

Spray irrigation/rapid infiltration basins would also require effluent pumping and force main. Land acquisition, winter storage requirements, and potential groundwater mounding in the vicinity of these type of facilities are significant enough factors to deem this alternative not feasible.

3.10 ALTERNATIVE 10: SEQUENCING BATCH REACTORS

Sequencing batch reactors (SBRs) offer the advantage of not requiring separate final clarifiers, and therefore, they have a smaller footprint than conventional activated sludge processes. They would fit within the footprint of either facility. As implied by their name, SBRs operate in a batch cycle. Each batch cycle consists of three main stages; react (aeration), settle, and decant. Additional stages can be added for anoxic (mixed stage) conditions, and flow arrangement with a pre-react zone and recycle loop can add a bio-P function. These additional stages and configuration produce an SBR layout that becomes similar to a traditional activated sludge layout. Each of the stages occurs for a specifically designed duration and requires automatic controls to operate valves and equipment at specific times.

SBRs are capable of biological nutrient removal, but do not offer the finite control of other systems being considered to fine-tune the biological nutrient removal. Due to the strict effluent limits proposed for both facilities, SBRs would not be an ideal fit for the biological treatment step. In addition to potential regulatory concerns, the “batch” discharge from the reactors requires up-sizing of downstream process units in order to handle the peak flows or post-SBR equalization if less than four SBR trains are online. Tertiary filtration, disinfection, effluent aeration, and some chemical feed processes would need to be upsized to accommodate the “batch” discharges, thus, increasing the cost of these facilities. Due to these regulatory and economic factors, SBRs are deemed not feasible.

3.11 ALTERNATIVE 11: PRIMARY CLARIFIERS WITH SECONDARY TREATMENT

Currently, neither facility uses primary clarifiers ahead of the oxidation ditches. Primary settling of normal domestic wastewater can be expected to remove approximately one-third of the influent BOD when operating at recommended overflow rates. This removal of BOD upstream of the aerobic treatment process has two significant impacts. One, the downstream aeration system size can be reduced to account for the BOD removal. Two, sludge collected in the primary clarification process is high in organic content and is typically treated with anaerobic digestion for energy recovery.

Primary clarifiers with secondary treatment would reduce the aeration system size. However, neither facility has adequate space available for primary clarifiers along with addition of downstream treatment units. Additionally, the high organic content primary sludge lends itself to anaerobic digestion with potential for energy recovery. Currently, both facilities have aerobic sludge treatment, and conversion to anaerobic digestion would be expensive and difficult to justify for these WWTFs.

Due to site suitability and economic factors, primary clarification with secondary treatment is deemed not feasible.

3.12 ALTERNATIVE 12: TRICKLING FILTERS

Trickling filters are a fixed film process with microbial growth occurring on an unsubmerged fixed media. Two stage trickling filters, with the first stage for BOD removal and the second stage for nitrification, have been successful in controlling effluent BOD, TSS, and ammonia. However, trickling filters are rarely used for denitrification or biological phosphorus removal because of the difficulty maintaining an anaerobic/anoxic environment using the relatively little carbon typically found in municipal wastewater (Aerobic Fixed-Growth Reactors, WEF, 2000). Therefore, trickling filters are deemed not feasible.

3.13 ALTERNATIVE 13: ANAEROBIC MEMBRANE BIOREACTOR

Anaerobic membrane bioreactors (AnMBR) are similar to MBRs in that they use membranes for separation of liquids and solids. AnMBR treatment systems do not use oxygen to stabilize influent organic matter; they use anaerobic processes to stabilize the organic matter. AnMBRs show promise for full liquid-stream treatment; however, they are an emerging technology. Until a successful operating history can be established, they are deemed not a feasible alternative, particularly for this cold weather region.

Technical Memorandum: Reasonable Alternatives Screening - Solids

Otsego Wastewater Treatment Master Planning

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From: Scott Schaefer, PE
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AE2S

Date: January 8, 2018

Project No: P05409-2013-002

1 SUMMARY

Several alternatives were considered for addressing the long-term wastewater treatment needs for the City of Otsego. Solids treatment alternatives focus on improvements to meet future treatment and disposal needs. Three (3) solids stream treatment alternatives were deemed reasonable for further evaluation for providing long-term wastewater treatment for the City. They are:

1. Split aerobic digestion and dewatering at both the West and East Wastewater Treatment Facilities (WWTFs) for respective projected flows and loads
2. Transport of West WWTF thickened waste activated sludge (TWAS or thickened WAS) for consolidated aerobic digestion and dewatering at the East WWTF
3. Transport of West WWTF TWAS for consolidated dewatering and chemical stabilization at the East WWTF

Alternatives that were considered but eliminated from further evaluation are as follows:

4. No action (current Class B land application with existing equipment / capacity)
5. Expansion of current biosolids handling approach
6. Split aerobic digestion with mobile dewatering press
7. Split aerobic digestion with consolidated permanent dewatering at either the West WWTF or East WWTF
8. Transport of thickened WAS to West WWTF for consolidated aerobic digestion or chemical stabilization and dewatering.

9. Off-site, centralized stabilization and/or dewatering
10. Combined or split anaerobic digestion in any combination:
    a. With primary clarifiers at both WWTF.
    b. Without primary clarifiers at both WWTF and digestion of thickened WAS

2 ALTERNATIVE SCREENING FACTORS

Minnesota Rules, Chapter 7077, require an analysis of all feasible treatment alternatives that are capable of meeting the applicable effluent, water quality, and public health requirements for 20 years. Factors to be considered when addressing the feasibility of alternatives include:

- Site suitability
- Regulatory requirements
- Economic impacts
- Technological capacity
- Environmental effects
- Availability of infrastructure
- Social and political acceptability
- Jurisdictional boundaries

All of these factors were considered during screening of alternatives; however, site suitability, regulatory requirements, and economic impacts factors were given more weight during the alternative pre-screening process as these factors provided more differentiation between alternatives.

The site suitability factor pertains to the existing site having adequate open land for structures and equipment to meet future needs.

The regulatory requirements factor pertains to the proposed treatment technology's ability to meet current and future effluent and biosolids disposal requirements. It also extends to the potential impact of solids recycle streams on the liquid treatment process, and thus, effluent limits. Discussion of these limits is provided in the Liquid Treatment Alternative Screening Technical Memorandum. Biosolids regulatory considerations include "503 regulations" for land application of biosolids (Class A and Class B requirements) and landfilling requirements.

The economic impacts factor pertains to the overall capital costs of providing the necessary infrastructure and the long-term costs for operation and maintenance of the infrastructure.

Screening of alternatives was conducted to determine reasonable alternatives that warrant further evaluation. Detailed evaluation of reasonable alternatives will be provided in a subsequent Technical Memorandum.

3 ALTERNATIVES ANALYSIS

Several alternatives for addressing the future wastewater solids treatment needs for the City of Otsego were considered. This section discusses the feasible alternatives that would provide for the purpose and need, including those alternatives that were considered but eliminated from further consideration.

Alternative analysis was conducted using future population and wastewater flow projections provided by the City's planning department to provide an initial basis for anticipated required solids treatment infrastructure and footprints. A discussion of the wastewater flow projections is included in the Basis of Design Technical Memorandum. Refined analysis of solids treatment requirements will be performed based on the liquid treatment alternatives selected for additional review as solids production will be somewhat dependent on technology.

3.1 ALTERNATIVE 1: SPLIT AEROBIC DIGESTION AND DEWATERING AT BOTH WWTF SITES

Under this alternative, thickening, aerobic digestion, and dewatering processes would be expanded and/or installed at each WWTF. While this alternative does increase the number of facilities and quantity of equipment, the size of the equipment will be reduced and the requirement to haul thickened WAS, as required by other considered alternatives, is removed. Hauling of dewatered cake solids from each facility are the only biosolids hauling requirements. Equipment at each WWTF would also be similar, allowing familiarity between the two systems. This alternative becomes more feasible due to the potential re-use of significant portions of tankage at the West WWTF.

For this alternative, process components to expand and upgrade the facility to meet future flow and load conditions would include the following:

- West WWTF
  - Waste Activated Sludge (WAS) Storage and Thickening Improvements
    - Capacities for several solids handling/treatment components will be completed through expansion of the existing sludge thickening building. This would include:
      - Expanded aerated WAS storage with potential for re-use of existing infrastructure (existing final clarifiers)
      - Additional thickening unit(s)
      - Expanded TWAS storage with potential for re-use of existing infrastructure (existing WAS storage)
      - Additional and/or higher capacity pumps and blowers for solids transport and aeration
  - Aerobic Digestion Improvements
    - Process capacity expansion using existing infrastructure (i.e. digested sludge storage tank) and potential available space remaining for new infrastructure after liquid treatment process expansion
    - Additional and/or higher capacity blowers and/or pumps for the expanded digestion process, as well as additional building footprint to house equipment

- Dewatering Infrastructure
  - Equipment including feed/transfer pumps and permanent dewatering units
  - Loadout area for transfer of dewatered biosolids to transport to ultimate disposal
  - Building to house all equipment, electrical, loadout, etc.
- Odor Control
  - Biological odor control was assumed for aerobic digestion, thickening, and dewatering as the basis for facility footprint evaluation

- East WWTF
  - Waste Activated Sludge (WAS) Storage and Thickening Improvements
    - Capacities for several solids handling/treatment components will be completed through expansion of the existing sludge thickening building. This may include:
      - Expanded aerated WAS storage with potential for re-use of existing infrastructure (i.e. existing final clarifiers)
      - Additional thickening unit(s)
      - Expanded TWAS storage with potential for re-use of existing infrastructure
      - Additional and/or higher capacity pumps and blowers for solids transport and aeration
  - Aerobic Digestion Improvements
    - Process capacity expansion through construction of new infrastructure on-site
    - Additional and/or higher capacity blowers and/or pumps for the expanded digestion process, as well as building area to house equipment
  - Dewatering Infrastructure
    - Equipment including feed/transfer pumps and permanent dewatering units.
    - Loadout area for transfer of dewatered biosolids to transport to ultimate disposal
    - Building to house all equipment, electrical, loadout, etc.
  - Odor Control
    - Biological odor control was assumed for aerobic digestion, thickening, and dewatering as the basis for facility footprint evaluation
- Additional Requirements for Both Facilities
  - Vehicles for transport of dewatered biosolids, unless operations are contracted out; vehicles or contracting for transport of thickened or digested biosolids for redundancy purposes will also be considered

Preliminary analysis of this alternative indicates the necessary facilities would fit in the existing sites, the process would have the capability to meet future regulatory and disposal requirements, and the alternative is economically viable compared to other alternatives. Note that the West WWTF site becomes increasingly congested for this solids alternative if the oxidation ditch liquid treatment alternative is selected, and that combination of alternatives may need to be eliminated from consideration.

3.2 ALTERNATIVE 2: TRANSPORT OF WEST WWTF THICKENED WAS TO EAST WWTF FOR CONSOLIDATED AEROBIC DIGESTION AND DEWATERING

Under this alternative, thickening processes at each WWTF would be expanded. Aerobic digestion and permanent dewatering would be provided only at the East WWTF. More restrictive liquid treatment requirements for phosphorus are being projected for the West WWTF. Therefore, providing dewatering only at the East WWTF is advantageous due to the potential for high phosphorus concentrations in the dewatering recycle stream. However, the restrictive requirements of both facilities do not make this a deciding factor in locating consolidated solids treatment at the East WWTF only. Due to limited footprint at the West WWTF, combined with the need to significantly expand the liquid treatment processes at the West WWTF, the capacity of solids treatment expansion, specifically aerobic digestion, may be limited to re-use of existing infrastructure (tanks) and limited land areas. Providing aerobic digestion at only the East WWTF will reduce infrastructure requirements at the space limited West WWTF and will consolidate processes (aerobic digestion, dewatering) at a single facility. Providing expanded thickening at the West WWTF facility is necessary to reduce solids transport costs (i.e. haul less water).

For this alternative, process components to expand and upgrade the facility to meet future flow and load conditions would include the following:

- West WWTF
    - Waste Activated Sludge (WAS) Storage and Thickening Improvements
        - Capacities for several solids handling/treatment components will be completed through expansion of the existing sludge thickening building. This may include:
            - Expanded WAS storage including re-use of existing aerobic digester infrastructure as storage and potential reuse of existing clarifiers and/or the existing digested solids storage
            - Additional thickening unit(s)
            - Expanded TWAS storage with potential for re-use of existing aerobic digester infrastructure as storage if there is no aerobic digestion at West WWTF
            - Additional and/or higher capacity pumps and blowers for solids transport and aeration
- East WWTF
    - Waste Activated Sludge (WAS) Storage and Thickening Improvements
        - Capacities for several solids handling/treatment components will be completed through expansion of the existing sludge thickening building. This may include:
            - Expanded WAS storage with potential for re-use of existing infrastructure
            - Additional thickening unit(s)
            - Expanded TWAS storage with potential for re-use of existing infrastructure
            - Additional and/or higher capacity pumps and blowers for solids transport and aeration

- Aerobic Digestion Improvements
    - Process capacity expansion through construction of new infrastructure on-site
    - Additional and/or higher capacity blowers and/or pumps for the expanded digestion process, as well as building area to house equipment
  - Dewatering Infrastructure
    - Equipment including feed/transfer pumps and permanent dewatering units
    - Loadout area for transfer of dewatered cake biosolids to transport to ultimate disposal
    - Building to house all equipment, electrical, loadout, etc.
- Additional Requirements for Both Facilities
  - Vehicles for transport of thickened and/or dewatered biosolids unless operations are contracted out (i.e. roll-off dumpsters for dewatered cake)

Preliminary analysis of this alternative indicates the necessary facilities would fit in the existing sites, the process would have the capability to meet future regulatory and disposal requirements, and the alternative is economically viable compared to other alternatives.

3.3 ALTERNATIVE 3: TRANSPORT OF THICKENED WAS FOR CONSOLIDATED CHEMICAL STABILIZATION/DEWATERING AT THE EAST WWTF

This alternative includes chemical lime stabilization of the biosolids. The Schwing Bioset is an example of a lime stabilization system capable of meeting the time and temperature requirements for Class A biosolids; it is used as the basis of this alternative. The system can also be used at a higher through-put to achieve Class B stabilization. Pathogen inactivation is achieved by addition of lime and sulfamic acid. Raising the temperature and pH effectively inactivates the pathogens and creates an environment that will not support regrowth. The biosolids and chemicals are mixed through a twin auger mixer and pumped with a piston pump into an insulated reactor. All odorous gasses that are produced (primarily off-gassed ammonia due to the high pH) are removed with a wet scrubber. The process requires the biosolids being fed to the system to be approximately 18-percent solids or higher with less lime required at elevated cake solids content (i.e. less water to heat). The biosolids leave the reactor at approximately 35-percent solids due to the increase in mass from the lime additions. Little volatile solids destruction occurs as the pathogens are inactivated by using heat instead of biological processes. The major pieces of equipment associated with the Bioset system include a lime feed system, acid feed system, screw conveyor, twin auger mixer, reactor feed pump, reactor, and ammonia/odor scrubber.

The City is not actively pursuing alternatives resulting in the production of Class A biosolids based on the decision to pursue ultimate disposal of biosolids in landfills and avoid land application; however, this alternative would provide the flexibility in ultimate disposal methods. Additionally, unlike other stabilization alternatives considered in this Technical Memorandum, this alternative eliminates all other digester infrastructure and combines the stabilization process with dewatering in a single East WWTF location.

For this alternative, process components to expand and upgrade the facility to meet future flow and load conditions would include the following:

- West WWTF
  - Waste Activated Sludge (WAS) Storage and Thickening Improvements similar to Alternative 2
- East WWTF
  - Waste Activated Sludge (WAS) Storage and Thickening Improvements similar to Alternative 2
  - Stabilization/Dewatering
    - Chemical stabilization unit(s) with all appurtenances as outlined above including dewatering and stabilization items
    - Solids loadout facilities may be required; however, facilities may be simplified due to dry nature of the solids to containers unloaded at required time intervals
  - Additional Requirements for Both Facilities
    - Vehicles for transport of thickened/stabilized/dewatered biosolids unless operations are contracted out

Preliminary analysis of this alternative indicates the necessary facilities would fit in the existing sites; the process would have the capability to meet future regulatory and disposal requirements. Capital costs are likely lower than other alternatives, although operating costs may be higher due to chemical requirements. Further analysis will confirm economic viability on a net present worth basis.

3.4 ALTERNATIVE 4: NO ACTION (CURRENT CLASS B LIQUID WITH LAND APPLICATION WITH EXISTING EQUIPMENT / CAPACITY)

Under the No Action alternative, no construction or improvements would be performed at either WWTF. This is not a practical solution for the City due to the anticipated growth in the community and the need for increased capacity. No action would significantly restrict development, and this alternative was quickly eliminated from consideration due to the significant gap in existing capacity compared to the future required capacity.

3.5 ALTERNATIVE 5: EXPAND CURRENT CLASS B LIQUID WITH LAND APPLICATION

This Technical Memorandum is also considering the continuation of land application for *any* alternative as an expansion of the current Class B biosolids (aerobic stabilization) and liquid land application alternative. The City has indicated they do not wish to pursue land application alternatives for biosolids treatment, and brief analysis confirms that it is not in the City's best interest to pursue land application as a primary disposal method for the following reasons:

- City does not wish to pursue this alternative; the City desires landfill as the ultimate disposal method.
- Under the majority of scenarios, significant additional infrastructure (primarily biosolids storage infrastructure) and additional equipment would be required to meet regulatory requirements for land application. This would lead to increases in both capital and

operations, maintenance, and repair (OM&R) costs, additional regulatory testing and reporting requirements, additional odor potential (from storage), additional WWTF footprint requirement, and potentially, more complex systems.
- Land application is likely to become more difficult as the City expands and as other cities, including the greater Twin Cities area, expand towards the City. The anticipated growth would result in significant hauling distances for land application (50 miles or more per round trip) as agricultural land continues to be converted to residential housing.

Alternatives with stabilization, such as aerobic digestion and chemical stabilization where solids are treated for land application, may be considered due to landfill requirements and other factors, but ultimately, all analysis will assume landfill as the primary disposal method.

3.6 ALTERNATIVE 6: SPLIT AEROBIC DIGESTION WITH MOBILE DEWATERING PRESS

Split aerobic digestion with a mobile dewatering press has been eliminated through the screening process.

- This alternative would require the construction of aerobic digesters at each facility location for stabilization. This additional capital cost to be incurred at each facility makes this mobile alternative less attractive than alternatives that combine the stabilization/dewatering processes (permanent or mobile).
- The alternative would still require thickening expansion to occur at each facility.
- The use of a single mobile dewatering unit would require additional upstream storage at *both* facilities in the event that the mobile dewatering unit is undergoing maintenance. If the mobile dewatering unit is out of service and no additional storage provided, additional transport/disposal costs would be incurred. In other alternatives, where each facility has a dedicated dewatering unit, the storage requirement may be less due to the ability to haul solids to the other facility for final treatment/disposal. These additional storage requirements could be significant.
- The use of a single dewatering unit would require construction of a solids loadout process at each facility. Additionally, based on the quantity of biosolids to be dewatered, permanent chemical (polymer) equipment would require installation at each facility.

Based on the above, this alternative would require construction of nearly everything required by a permanent installation with the exception of a second dewatering unit. Further, the argument for construction of a permanent dewatering facility is bolstered when considering the transport of the mobile dewatering unit including capital costs for vehicles, labor costs, etc. This alternative is inferior to other permanent and mobile alternatives for many reasons including economic impact, site suitability, and overall operations.

3.7 ALTERNATIVE 7: SPLIT AEROBIC DIGESTION WITH CONSOLIDATED DEWATERING AT WEST OR EAST WWTF

Split aerobic digestion with consolidated dewatering at the West or East WWTF has been eliminated through the screening process for the following primary reasons:

- There is potential that the West WWTF does not have sufficient land for consolidated dewatering. The truck hauling routes for the West WWTF are less favorable to transport dewatered cake to the likely landfill disposal location in Elk River.
- The East WWTF would have sufficient land available, either through selection of one of the more compact liquid treatment technologies or through acquisition of nearby/adjacent land, to maintain adequate buffer between the facility and neighbors.
- The production of aerobically digested solids from two (2) separate sources may not provide a consistent stabilized sludge. Although significant differences in the digested biosolids from the two WWTFs are not anticipated, there will be differences that could have implications for dewatering optimization (primarily, polymer dosing requirements, and potentially, sludge conditioning [ferric] requirements).
- Split digestion does not result in a reduction in the hauled biosolids volume. The pre- and post- digestion volumes are essentially the same, and there is limited opportunity for further thickening through decanting due to the post-digestion solids concentration anticipated to remain above 2-percent solids.
- Considering potential inconsistencies between the biosolids produced from different systems, and considering the alternative from an economic and process perspective, it is recommended that separate aerobic digester systems not be further pursued. However, it should be noted that the components for this alternative will be further evaluated as components of selected detailed evaluation alternatives. This will allow for a high level look at whether the alternative should be revisited and considered if a large enough economic driver emerges. If aerobic digestion alternatives are not the recommended alternative, this alternative will not require revisiting.
- MPCA has projected that more restrictive effluent phosphorus limits will remain in place for the West WWTF. Because the dewatering recycle stream has the potential to contain elevated concentrations of phosphorus, it has been determined that any consolidated dewatering process should not be placed at the West WWTF, if considered as an option.

The alternative was ultimately eliminated due to site suitability/availability, regulatory requirements, and economic impacts. However, it is the alternative most likely to receive further evaluation from all eliminated options.

3.8 ALTERNATIVE 8: TRANSPORT OF THICKENED WAS TO WEST WWTF FOR CONSOLIDATED AEROBIC DIGESTION AND DEWATERING (OR CHEMICAL STABILIZATION/DEWATERING)

Transport of TWAS, with consolidated aerobic digestion/chemical stabilization and dewatering at the East WWTF, is being considered as a viable alternative (as referenced in Alternatives 2 and 3). However, installation of the consolidated aerobic digestion/chemical stabilization and dewatering at the West WWTF has been eliminated through the screening process:

1. The East WWTF will have a larger volume of solids to process which would result in higher solids transport costs from East to West.
2. The West WWTF does not have the available land for consolidated aerobic digestion/chemical stabilization and dewatering.
3. MPCA has projected that more restrictive effluent phosphorus limits will be placed on the West WWTF. Because the dewatering recycle stream has the potential to contain elevated concentrations of phosphorus, it has been determined that any consolidated dewatering process should be placed at the East WWTF to avoid causing additional concern meeting these effluent requirements.

Overall, the alternative was eliminated due to site suitability/availability, regulatory requirements, and economic impacts.

3.9 ALTERNATIVE 9: OFF-SITE, CENTRALIZED STABILIZATION AND/OR DEWATERING

Off-site, centralized stabilization and/or dewatering has been considered and eliminated.

While this alternative offers the ability to locate these processes away from residential areas, there are significant costs to do so. Improvements to the existing processes would still be required at each of the existing facilities to meet capacity and treatment requirements for existing unit operations. This alternative would require the purchase of additional land separated from both treatment facilities. Separation of the stabilization and/or dewatering processes from the existing facilities would result in additional infrastructure/equipment costs to convey biosolids to the off-site location, and return filtrate and recycle streams to the existing facilities. Furthermore, this separation results in a third WWTF location requiring travel, staff, and maintenance when the City is already managing two wastewater facilities.

As a result, this alternative was eliminated due to economic impacts and site suitability.

3.10 ALTERNATIVES 10A AND 10B: COMBINED OR SPLIT ANAEROBIC DIGESTION IN ANY COMBINATION WITH/WITHOUT PRIMARY CLARIFIERS

The use of anaerobic digestion is typically coupled with the use of primary clarifiers. Currently, neither facility uses primary clarifiers. Primary settling of normal domestic wastewater can be expected to remove approximately one-third of the influent BOD when operating at recommended overflow rates. This removal of BOD upstream of the aerobic treatment process has two significant impacts. One, the downstream aeration system size can be reduced to account for the BOD removal. Two, sludge collected in the primary clarification process is high in organic content; typically, it is treated with anaerobic digestion for energy recovery.

As discussed in the liquid treatment alternative screening, primary clarifiers with secondary treatment would reduce the aeration system size for liquid treatment. However, neither facility has adequate space available for primary clarifiers and the addition of downstream treatment units. Microscreens, or chemically enhanced primary clarifiers, could be used in place of traditional primary clarifiers to reduce the required footprint. The phasing issues mentioned below would still apply, in addition to, requiring a more operationally complex system. The high organic content primary sludge lends itself to anaerobic digestion with potential for energy recovery. Currently, both facilities have aerobic sludge treatment, and conversion to anaerobic digestion would be expensive. Conversion would involve the installation and operation of more complex systems, particularly the biogas handling and use systems. There is potential for anaerobic digesters to be installed without primary clarifiers in a system where the digesters are fed with only TWAS. However, the systems required for this set-up would be even more complex (pre-acidification reactor(s) recommended for TWAS) and would have less potential for energy recovery due to removal of much of the organic content in the liquid treatment processes.

Finally, anaerobic digestion is typically not considered for facilities operating at an annual average flow of less than five MGD as the pay back provided by the energy recovery is not worth the capital and operations and maintenance costs associated with the equipment. To achieve these flows, the facilities would need to be fully combined (i.e. flow consolidated on one site). Additionally, it is not expected that these flows will be reached for some time. Furthermore, hauling of raw primary solids would have a high odor potential; this rules out the option to maintain two WWTF sites with consolidated anaerobic digestion. As a result, until buildout of the facility as detailed by this report, the facility would be overly complicated and operating inefficiently when compared to other alternatives. The alternative would also present major phasing issues.

Due to site suitability, economic factors, and overall fit of the process, anaerobic digestion with or without primary clarification was deemed not feasible.

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Technical Memorandum: Liquid Treatment Alternative Development

Otsego Wastewater Treatment Master Planning

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From: Scott Schaefer, PE
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Date: January 8, 2018

Project No: P05409-2013-002

1 ALTERNATIVES EVALUATION – LIQUID TRAIN TREATMENT ALTERNATIVE DEVELOPMENT AND OBJECTIVES

The primary objectives of the treatment alternatives are to provide a treatment system to accommodate current/projected design service populations. Due to the extensive array of potential treatment alternatives available for both liquids and solids, treatment alternatives for each will be broken down and presented. This section focuses on the discussion of liquid treatment alternatives.

A phased approach was used for evaluating treatment alternatives. A phased approach to improvements has the following benefits:

- Lowers initial investment;
- Delays operation, maintenance and repair/replacement costs;
- Reduces construction duration;
- Provides flexibility for unforeseen growth patterns, either slower or faster than anticipated; and,
- Provides flexibility to accommodate future regulatory requirements.

All liquid train alternatives were evaluated to meet the projected ultimate flows and loads for the West and East WWTFs assuming phased expansions would occur at key population triggers for each facility. A detailed phasing plan will be provided for the recommended liquid train treatment alternative.

As discussed in the Collection System TM and the Basis of Design TM, existing land use plans, watershed basins, and historic flow and load data was used to establish current and projected flows and constituent loadings at the West and East Wastewater Treatment Facilities (WWTFs). Population, flow, and load projections for the West and East WWTFs are summarized in Table 1.1.

Table 1.1 – Existing and Projected Flows and Loads Summary

Parameter	Units	WEST FACILITY/SERVICE AREA			EAST FACILITY/SERVICE AREA		
		Existing Capacity	Current (2016)	Projected Buildout	Existing Capacity	Current (2016)	Projected Buildout
Population	[PE]	-	3,468	39,856	-	2,676	42,147
AVERAGE ANNUAL							
Flow	[MGD]	0.60	0.34	3.90	1.00	0.26	4.12
BOD	[ppd]	1,020	763	8,768	2,080	589	9,272
TSS	[ppd]	1,200	867	9,964	2,080	669	10,537
TKN-N	[ppd]	120	111	1,275	250	86	1,349
TP	[ppd]	-	26	303	56	20	320
PEAK MONTH							
Flow	[MGD]	0.72	0.47	5.04	1.10	0.36	5.32
BOD	[ppd]	1,446	1,095	11,335	2,860	855	11,957
TSS	[ppd]	1,813	1,332	13,495	3,055	1,042	14,229
TKN-N	[ppd]	204	190	1,921	410	148	2,026
TP	[ppd]	-	44	453	90	34	477
AVERAGE DRY WEATHER							
Flow	[MGD]	0.54	0.23	2.85	0.90	0.18	3.02
PEAK DAY							
Flow	[MGD]	-	0.50	5.45	-	0.38	5.76
BOD	[ppd]	2,506	1,915	18,406	4,851	1,506	19,384
TSS	[ppd]	2,947	2,179	21,028	4,911	1,713	22,148
TKN-N	[ppd]	348	323	3,118	687	254	3,285
TP	[ppd]	-	85	813	170	67	857
PEAK HOUR							
Flow	[MGD]	1.92	1.15	9.20	3.29	0.91	9.61

Liquid train treatment alternatives were also selected to be evaluated based on their ability to meet current and projected regulatory limits. The Minnesota Pollution Control Agency (MPCA) was requested to prepare a Preliminary Effluent Limits (PEL) determination for the ultimate flows and loads to both the West and East facilities. The MPCA PEL document is attached in Appendix C. Due to anti-degradation rules, mass discharge amounts are essentially capped at the existing permitted levels. Therefore, as discharge flow rates increase, the allowable pollutants concentrations decrease in order to keep the same mass discharge limit. Table 1.2 summarizes the PEL allowable mass loading limits and the effluent concentration limits for the projected average wet weather design flows of the West and East Facilities. In addition to the limits in the following table, the MPCA has stated that permitted facilities will likely receive Total Nitrogen (TN) limits within the next ten years. Prudent planning requires the alternatives under evaluation not only meet the limits in the PEL, but additionally, they have the capability for removal of TN in the future.

Table 1.2 – PEL Mass Loading and Concentration Limits

Category	Units	Otsego West WWTF		Otsego East WWTF	
		PEL Allowable Discharge (mg/L or lbs/day)	PEL Conc at Q_{AWWF}	PEL Allowable Discharge (mg/L or lbs/day)	PEL Conc at Q_{AWWF}
Current AWWDF	[MGD]	0.72	-	1.65	-
Current ADWDF	[MGD]	0.48	-	1.35	-
cBOD5 Limits	[mg/L, Monthly]	15	-	15	-
Ammonia Limits (Jun-Sep)	[mg/L, Monthly]	3	-	3	-
Ammonia Limits (Oct-Nov)	[mg/L, Monthly]	2.4	-	10.8	-
Ammonia Limits (Dec-Mar)	[mg/L, Monthly]	5	-	5	-
Ammonia Limits (Apr-May)	[mg/L, Monthly]	1.4	-	25.8	-
Ammonia Limits (Jun-Sep)	[kg/day, Monthly]	68	3.6	62	3.1
Ammonia Limits (Oct-Nov)	[kg/day, Monthly]	54.4	2.8	87	4.3
Ammonia Limits (Dec-Mar)	[kg/day, Monthly]	113	5.9	31	1.5
Ammonia Limits (Apr-May)	[kg/day, Monthly]	31.8	1.7	585	29
CBOD Limits (Jun-Sep)	[kg/day, Monthly]	40.8	2.1	104	5.2
CBOD Limits (Oct-Nov)	[kg/day, Monthly]	40.8	2.1	104	5.2
CBOD Limits (Dec-Mar)	[kg/day, Monthly]	40.8	2.1	62	3.1
CBOD Limits (Apr-May)	[kg/day, Monthly]	40.8	2.1	104	5.2
Dissolved Oxygen, Min	[mg/L, Monthly]	6	-	6	-
Total Suspended Solids	[mg/L, Daily]	30	-	30	-
Total Suspended Solids	[kg/day, Daily]	54.4	2.8	187	9.3
Fecal Coliform	[org/100ml, Apr-Oct]	200	-	200	-
Chlorine, Total Residual	[mg/L, Daily Max]	0.038	-	0.038	-
Chloride	[mg/L, Monthly Avg]	229	-	614	-
Bicarbonate	[mg/L, Monthly Avg]	342	-	-	-
Total Dissolved Solids	[mg/L, Monthly Avg]	734	-	-	-

Specific Conductance	[mg/L, Monthly Avg]	1064	-	-	-
Mercury, Total	[ng/L, Daily Max]	6.9	-	6.9	-
pH	[SU]	6.0 - 9.0	-	6.0 - 9.0	-
Phosphorus (Lake Pepin)	[kg per 12 month moving total]	995	0.14	1824	0.28
Phosphorus (Surface Discharge Restriction)	[mg/L 12 Month moving Average]	1	-	1	-
Phosphorus (River Eutrophication Standard)	[kg/day (Jun-Sep)]	-	-	3.5	0.17

Alternatives were also evaluated based on their ability to fit on the existing treatment facility site to eliminate land purchase, and best professional judgement. All alternatives will require increased utility services (power, natural gas, water) to the sites over the course of time. Costs for extending these utility services are not included in the analysis conducted in this TM.

The following factors were used for evaluating and sizing liquid treatment facilities:

- Pumping and conveyance systems were sized to accommodate projected peak flow rates (including internal recycle flows and firm pumping capacity).
- Screening and grit removal were sized to accommodate projected peak flows and manufacturer requirements for maximum allowable screen slot openings.
- Aeration equipment capacities were sized to meet the maximum aeration demand with the largest aeration unit out of service.
- Aeration tank volumes and clarifier surface areas and depths were based on sizing recommendations provided in Ten States Standards.
- Filtration, ultraviolet disinfection, and effluent aeration were sized based on recommendations provided in Ten States Standards.
- Odor control systems were sized based on building air exchange requirements and associate airflow volumes.

Liquid biological treatment is the heart of the wastewater treatment process. The liquid treatment process is used to remove pollutants, such as organic matter, nutrients, and solids. There are essentially four key elements in the liquid process that are necessary to provide treatment to meet effluent limitations. The key elements can be depicted using the acronym "HOME", which stands for the following:

H – Home: The tanks (selectors, aeration basins, and clarifiers) in the liquid process provide a "home" for the microorganisms. It is in this "home" where the microorganisms responsible for removing the pollutants are introduced to the wastewater and are given time to remove these pollutants.

O – Oxygen: Mechanical aeration equipment (blowers and diffusers, turbines, rotors, etc.) are used in the liquid treatment process to inject oxygen into the wastewater stream. The microorganisms use the oxygen for respiration while they stabilize the pollutants in the wastewater.

M – Microorganisms: An activated sludge system provides an environment that promotes the growth of desired microorganisms. These organisms include a mixture of bacteria, protozoa, and some metazoan; they are the "workers" of the treatment system. The microorganisms convert biodegradable, organic wastewater materials into new cell mass and other byproducts which are subsequently removed from the system by solids/liquid separation.

E – Energy: Energy for the metabolism of the microorganisms is provided by the biodegradable materials in the raw wastewaters.

2 ALTERNATIVES CONSIDERED BUT ELIMINATED

Alternatives that were considered but determined not to be feasible and, therefore, eliminated from further evaluation are as follows. Additional information is provided in the Reasonable Alternatives Screening – Liquid TM.

- No action
- Consolidation of treatment at existing East WWTF
  - Alternative disposal means for treated effluent
  - Alternative discharge location – West WWTF: The existing discharge from the West WWTF is into an ephemeral stream (an un-named creek with a 0.0 cfs low flow). Based on conversations with the MPCA and the Preliminary Effluent Limits document prepared by the MPCA, relocating the discharge of the West WWTF to a higher flow stream (likely the Mississippi River) does not present a significant advantage in terms of allowable discharge concentrations and mass. However, West WWTF effluent monitoring does indicate a reasonable potential for exceeding water quality standards due to high salt concentrations. The MPCA is conducting rulemaking for salty discharges, and pending the promulgation of salty discharge regulations, action may need to be taken at the West WWTF to meet the salty discharge effluent requirements. Additional treatment of either the wastewater flow, community drinking water supply, or both, may be necessary in order to address high salts. A water quality variance could also be sought by the City, delaying the permit limits to allow the community to more fully assess its ability to meet effluent limits before investing in expensive technology, or to wait for anticipated less-expensive control technology to become available. Alternatively, relocation of the West WWTF may be pursued if a variance is not granted or control technologies prove to be more expensive than relocating the outfall.
- Spray irrigation/Rapid infiltration basins
- Sequencing batch reactors
- Primary clarifiers with secondary treatment
- Trickling filters
- Anaerobic membrane bioreactor

3 ALTERNATIVES FURTHER EVALUATED

Alternatives that were screened and deemed reasonable are further evaluated in this TM. These alternatives include:

- Expansion of oxidation ditch treatment at West WWTF
- Expansion of oxidation ditch treatment at East WWTF
- Membrane bioreactor treatment at West WWTF
- Membrane bioreactor treatment at East WWTF
- Integrated fixed film activated sludge treatment at West WWTF
- Integrated fixed film activated sludge treatment at East WWTF

4 EXPANSION OF OXIDATION DITCH TREATMENT AT WEST WWTF

A process flow diagram of a typical oxidation ditch treatment facility is presented in Appendix A. A conceptual site plan for the West WWTF with oxidation ditches is presented in Figures C5/C6 in Appendix B. Additional details of process components for the facility follow:

4.1 INFLUENT PUMPING

Influent is currently pumped from the collection system into a rotary screen located in the existing preliminary treatment building. A collection system hydraulic profile and pumping analysis is not included in this study; however, increased pumping capacity in the collection system will be necessary to accommodate future flows. This evaluation does not include review of components and costs associated with collection system improvement. It is assumed that influent will continue to be pumped to the West WWTF and wastewater will flow by gravity through the liquid process treatment trains.

4.2 PRELIMINARY TREATMENT BUILDING

Multiple capacity improvements to the existing preliminary treatment building will be necessary to meet the projected needs, including:

- A multi-level, 4,600 square foot building addition. Lower level space will continue to be used for RAS/WAS pumping (discussed below);
- Two 6-mm opening fine screens, each with a peak hour flow capacity of approximately 9.2 MGD;
- Screenings washing, dewatering, compaction, and transportation equipment;
- Grit removal equipment with a peak hour flow capacity of approximately 9.2 MGD. No grit removal redundancy would be provided;
- Grit washing, dewatering, and transportation;
- Influent flow measurement and sampling; and,
- Treatment building exhaust odor control equipment.

4.3 OXIDATION DITCH/CLARIFIERS

Expansion of the oxidation ditches and final clarifiers will be necessary to meet the ultimate projected flows and loads. Note that the existing West WWTF oxidation ditches are not designed to achieve nitrification at current design flows/loads as the facility does not currently have an ammonia limit. Going forward (when the average wet weather design flow increases above 1.0 mgd) the facility will receive an ammonia limit, and the capacity of the existing ditches would need to be reduced. Therefore, the existing oxidation ditches will be abandoned as plant capacity needs expand. A five-stage treatment process (anaerobic → anoxic → aerobic → post-anoxic → re-aeration) will be required to meet stringent effluent limits in the future. The following capacity improvements are included in this liquid train treatment alternative evaluation:

- Convert the two existing oxidation ditch tanks into anaerobic selector tanks;
- Construct three new oxidation ditches with anoxic, aerobic, post-anoxic, and re-aeration stages. Each oxidation ditch would be approximately 285 feet long by 75 feet wide by 16 foot sidewater depth, providing approximately 24-hours of detention time in the aerobic zone during the peak month flow; and,
- Construct three new final clarifiers. Each clarifier would be 90-foot diameter and 16-feet deep, with covers, full-radius scum removal, and spiral rake sludge collection mechanisms.

4.4 TERTIARY TREATMENT EXPANSION

In order to reliably meet the projected carbonaceous Biochemical Oxygen Demand (cBOD), Total Suspended Solids (TSS), Total Phosphorus (TP), and Total Nitrogen (TN) limits, advanced tertiary treatment will be necessary at the WWTF. The West facility will also be required to provide seasonal disinfection from April through October and maintain an effluent dissolved oxygen concentration of 6 mg/L. Tertiary filters, UV disinfection, blowers, controls, and electrical equipment would be located inside a building. For planning purposes, the size of the building to house this equipment was estimated to be 200-feet long by 100-feet wide. Effluent aeration tankage would be located outside.

TP/TN Filters

Tertiary filtration for polishing of effluent TP and TN would be provided by continuous backwash, up-flow, reactive media filtration. Six filter cells, with five modules each (total 30 modules) would be provided. A chemical carbon feed would be included to provide a carbon source for denitrification (total nitrogen removal). Phosphorus reactive media, along with a metal salt feed system, would be included for TP control. The reactive media filters would continuously backwash to the head of the WWTF, and treated effluent would flow to the ultraviolet (UV) disinfection system. The filtration system would be designed to provide an effluent TP of less than 0.2 mg/L and an effluent TN of less than 5 mg/L.

UV Disinfection

UV disinfection would be provided downstream of the TP/TN filters. A 48-bulb, low pressure, high output, 2-channel UV system delivering a 30mJ dose would be provided to meet the proposed 200 CFU/100 ml fecal coliform limit.

Effluent Aeration

Following disinfection, effluent aeration would be provided to meet the proposed 6 mg/L dissolved oxygen limit. Effluent aeration would provide 30 minutes of detention time at peak hour flow, along with fine-bubble diffusers and blowers for air supply.

4.5 RAS/WAS PUMPING

Additional RAS/WAS pumping capacity will be required to meet the projected capacity demands. Adequate space is available in the lower level of the existing preliminary treatment building for the additional pumps. Three additional RAS pumps and two additional WAS pumps will be necessary to meet the projected capacity demands.

4.6 ODOR CONTROL

Air exhaust from the preliminary treatment building will be directed to a biofilter for odor control. The biofilter would have a footprint of approximately 3,800 square feet, and it would be located near the preliminary treatment building.

4.7 ADMINISTRATION BUILDING

An administration building at the West WWTF was included in the conceptual site plan. The building would provide space for administrative personnel, record keeping, and other functions. For planning purposes, the building size was projected to be 50-feet by 100-feet.

5 EXPANSION OF OXIDATION DITCH TREATMENT AT EAST WWTF

A process flow diagram of a typical oxidation ditch treatment facility is presented in Appendix A. A conceptual site plan for the East WWTF with oxidation ditches is presented in Figure C14 in Appendix B. Additional details of process components for the facility follow:

5.1 INFLUENT PUMPING

Influent is conveyed to the East WWTF via forcemains from Otsego and Dayton. A collection system hydraulic profile and pumping analysis is not included in this study; however, increased pumping capacity in the collection system will be necessary to accommodate future flows. This evaluation does not include review of components and costs associated with collection system improvement. It is assumed that influent will continue to be pumped to the East WWTF and wastewater will flow by gravity through the liquid process treatment trains.

5.2 PRELIMINARY TREATMENT BUILDING

Multiple capacity improvements to the existing preliminary treatment building will be necessary to meet the projected needs, including:

- A multi-level, 4,600 square foot building addition;
- Two 6-mm opening fine screens, each with a peak hour flow capacity of approximately 9.6 MGD;
- Screenings washing, dewatering, compaction, and transportation equipment;

- Grit removal equipment with a peak hour flow capacity of approximately 9.6 MGD. No grit removal redundancy would be provided;
- Grit washing, dewatering, and transportation;
- Influent flow measurement and sampling; and,
- Treatment building exhaust odor control equipment.

5.3 OXIDATION DITCH/CLARIFIERS

Expansion of the oxidation ditches and final clarifiers will be necessary to meet the ultimate projected flows and loads. A five-stage treatment process (anaerobic → anoxic → aerobic → post-anoxic → re-aeration) will be required to meet stringent effluent limits in the future. The following capacity improvements are included in this liquid train treatment alternative evaluation:

- Convert the existing oxidation ditch tank number one into an anaerobic selector tank;
- Existing oxidation ditches two and three, and sludge storage tank six (future oxidation ditch two) will be used as anoxic/aerobic reactors as intended in the original design. These three ditches will provide, in total, approximately 1.1 MGD of treatment capacity.
- Construct three new oxidation ditches with anoxic, aerobic, post-anoxic, and re-aeration stages. Each oxidation ditch would be approximately 215 feet long by 75 feet wide by 16 foot sidewater depth, providing approximately 24-hours of detention time in the aerobic zone during the peak month flow; and,
- Construct three new final clarifiers. Each clarifier would be 90-foot diameter and 16-feet deep, with covers, full-radius scum removal, and spiral rake sludge collection mechanisms.

5.4 TERTIARY TREATMENT EXPANSION

In order to reliably meet the projected carbonaceous Biochemical Oxygen Demand (cBOD), Total Suspended Solids (TSS, Total Phosphorus (TP), and Total Nitrogen (TN) limits, advanced tertiary treatment will be necessary at the WWTF. The East facility will also be required to provide year-round disinfection, and maintain an effluent dissolved oxygen concentration of 6 mg/L. Tertiary filters, UV disinfection, blowers, controls, and electrical equipment would be located inside a building. For planning purposes, the size of the building to house this equipment was estimated to be 200-feet long by 100-feet wide. Effluent aeration tankage would be located outside.

TP/TN Filters

Tertiary filtration for polishing of effluent TP and TN would be provided by continuous backwash, up-flow, reactive media filtration. Six filter cells, with five modules each (total 30 modules) would be provided. A chemical carbon feed would be included to provide a carbon source for denitrification (total nitrogen removal). Phosphorus reactive media, along with a metal salt feed system, would be included for TP control. The reactive media filters would continuously backwash to the head of the WWTF, and treated effluent would flow to the UV disinfection system. The filtration system would be designed to provide an effluent TP of less than 0.2 mg/L and an effluent TN of less than 5 mg/L.

UV Disinfection

UV disinfection would be provided downstream of the TP/TN filters. A 48-bulb, low pressure, high output, 2-channel UV system delivering a 30mJ dose would be provided to meet the proposed 200 CFU/100 ml fecal coliform limit.

Effluent Aeration

Following disinfection, effluent aeration would be provided to meet the proposed 6 mg/L dissolved oxygen limit. Effluent aeration would provide 30 minutes of detention time at peak hour flow, along with fine-bubble diffusers and blowers for air supply.

5.5 RAS/WAS PUMPING

Additional RAS/WAS pumping capacity will be required to meet the projected capacity demands. Additional building footprint will be necessary to accommodate future RAS/WAS pumping needs. The preferred location for expansion of the RAS/WAS pump building footprint is next to the existing control building. A multi-level, 60-foot by 25-foot building is projected for RAS/WAS pumping, along with three additional RAS pumps and two additional WAS pumps.

5.6 ODOR CONTROL

Air exhaust from the preliminary treatment building will be directed to a biofilter for odor control. The biofilter would have a footprint of approximately 3,800 square feet, and it would be located near the preliminary treatment building.

5.7 ADMINISTRATION BUILDING

An administration building at the East WWTF was included in the conceptual site plan. The building would provide space for administrative personnel, record keeping, and other functions. For planning purposes, the building size was projected to be 60-feet by 125-feet.

6 MEMBRANE BIOREACTOR (MBR) TREATMENT AT WEST WWTF

A process flow diagram of a typical MRB treatment facility is presented in Appendix A. A conceptual site plan for the West WWTF with MBR is presented in Figures C3/C4 in Appendix B. Additional details of process components for the facility follow.

6.1 INFLUENT PUMPING

Influent is currently pumped from the collection system into a rotary screen located in the existing preliminary treatment building. A collection system hydraulic profile and pumping analysis is not included in this study; however, increased pumping capacity in the collection system will be necessary to accommodate future flows. This evaluation does not include review of components and costs associated with collection system improvement. It is assumed that influent will continue to be pumped to the West WWTF and wastewater will flow by gravity through the liquid process treatment trains.

6.2 PRELIMINARY TREATMENT BUILDING

Multiple capacity improvements to the existing preliminary treatment building will be necessary to meet the projected needs, including:

- A multi-level, 4,600 square foot building addition. Lower level space will continue to be used for RAS/WAS pumping (discussed below);
- Two 2-mm opening fine screens, each with a peak hour flow capacity of approximately 9.2 MGD;
- Screenings washing, dewatering, compaction, and transportation equipment;
- Grit removal equipment with a peak hour flow capacity of approximately 9.2 MGD. No grit removal redundancy would be provided;
- Grit washing, dewatering, and transportation;
- Influent flow measurement and sampling; and,
- Treatment building exhaust odor control equipment.

6.3 MEMBRANE BIOREACTOR

Expansion of the liquid biological treatment process will be necessary to meet the ultimate projected flows and loads. A five-stage treatment process (anaerobic → anoxic → aerobic → post-anoxic → re-aeration) will be required to meet stringent effluent limits in the future. The typical MBR system consists of suspended growth bioreactor tanks with fine bubble aeration integrated with a membrane filtration system. The membrane filtration system is immersed directly into the mixed liquor, and a permeate pump draws treated water through the membranes. A separate air header supplies coarse bubble air directly below the bottom of the membranes to scour the outer surface of the membranes, helping to keep them clean. Separate final clarifiers will not be necessary; separation of the liquid and microbial solids is performed by the membrane filtration units. The following capacity improvements are included in this liquid train treatment alternative evaluation:

- Convert the two existing oxidation ditch tanks into anaerobic selector tanks;
- Construct three new MBR reactor trains with anoxic, aerobic, and post-anoxic stages. Each MBR reactor train would be approximately 160 feet long by 40 feet wide by 18 foot sidewater depth, providing approximately 7-hours of detention time in the aerobic zone during the peak month flow;
- Construct three new MBR membrane cassette trains for the MBR membranes and air scour system. These three trains provide re-aeration after the post-anoxic stage, which adds dissolved oxygen back into the wastewater and strips nitrogen gas from the wastewater. The membranes will also separate the liquids and solids. Each cassette train would be approximately 30 feet long by 20 feet wide by 13 foot sidewater depth;
- Construct a MBR process building to house the aeration and MBR blowers, permeate pumps, backpulse pumps and equipment, chemical cleaning systems, air compressors and dryers, and electrical and controls; and,
- Chemical addition systems for coagulant addition (for phosphorus control) and supplemental carbon addition (for total nitrogen control). In lieu of tertiary filtration for TP and TN control, metal salts would be added directly to the MBR system for TP control (in addition to the TP removal that can be reached with biological phosphorus removal) and a supplemental carbon source would be added to the post-anoxic treatment stage to spur denitrification and subsequent removal of nitrogen.

6.4 TERTIARY TREATMENT EXPANSION

A significant advantage of the MBR system is it will reliably meet the projected carbonaceous Biochemical Oxygen Demand (cBOD), Total Suspended Solids (TSS), Total Phosphorus (TP), and

Total Nitrogen (TN) limits without requiring separate tertiary treatment (TP/TN filters). The West facility will still be required to provide seasonal disinfection, and maintain an effluent dissolved oxygen concentration of 6 mg/L. The UV disinfection, blowers, controls, and electrical equipment would be located inside a building. For planning purposes, the size of the building to house this equipment was estimated to be 80-feet long by 100-feet wide. Additional footprint will be reserved for future building expansion with denitrifying filters as a precaution if TN limits become even more restrictive than predicted. Effluent aeration tankage would be located outside.

UV Disinfection

UV disinfection would be provided downstream of the TP/TN filters. A 48-bulb, low pressure, high output, 2-channel UV system delivering a 30mJ dose would be provided to meet the proposed 200 CFU/100 ml fecal coliform limit.

Effluent Aeration

Following disinfection, effluent aeration would be provided to meet the proposed 6 mg/L dissolved oxygen limit. Effluent aeration would provide 30 minutes of detention time at peak hour flow, along with fine-bubble diffusers and blowers for air supply.

6.5 RAS/WAS PUMPING

Depending on system configuration and treatment plant kinetics (to be determined during design), a portion of the mixed liquor may be returned to the anaerobic tanks to enhance biological phosphorus removal. This RAS would likely be pulled from of the end of the pre-anoxic treatment phase in order to limit the nitrate concentration in the recycle. WAS pumping would be used to remove excess biosolids from the treatment process. Adequate space for RAS/WAS pumping would be available inside the preliminary treatment building (PTB) lower level.

6.6 ODOR CONTROL

Air exhaust from the preliminary treatment building will be directed to a biofilter for odor control. The biofilter would have a footprint of approximately 3,800 square feet, and it would be located near the preliminary treatment building.

6.7 ADMINISTRATION BUILDING

An administration building at the West WWTF was included in the conceptual site plan. The building would provide space for administrative personnel, record keeping, and other functions. For planning purposes, the building size was projected to be 50-feet by 100-feet.

7 MEMBRANE BIOREACTOR AT EAST WWTF

A process flow diagram of a typical MBR treatment facility is presented in Appendix A. A conceptual site plan for the East WWTF with MBR is presented in Figures C11/C12/C13 in Appendix B. Additional details of process components for the facility follow.

7.1 INFLUENT PUMPING

Influent is conveyed to the East WWTF via forcemains from Otsego and Dayton. A collection system hydraulic profile and pumping analysis is not included in this study; however, increased pumping capacity in the collection system will be necessary to accommodate future flows. This evaluation does not include review of components and costs associated with collection system improvement. It is assumed that influent will continue to be pumped to the East WWTF and wastewater will flow by gravity through the liquid process treatment trains.

7.2 PRELIMINARY TREATMENT BUILDING

Multiple capacity improvements to the existing preliminary treatment building will be necessary to meet the projected needs, including:

- A multi-level, 4,600 square foot building addition;
- Two 2-mm opening fine screens, each with a peak hour flow capacity of approximately 9.6 MGD;
- Screenings washing, dewatering, compaction, and transportation equipment;
- Grit removal equipment with a peak hour flow capacity of approximately 9.6 MGD. No grit removal redundancy would be provided;
- Grit washing, dewatering, and transportation;
- Influent flow measurement and sampling; and,
- Treatment building exhaust odor control equipment.

7.3 MEMBRANE BIOREACTORS

Expansion of the liquid biological treatment process will be necessary to meet the ultimate projected flows and loads. A five-stage treatment process (anaerobic → anoxic → aerobic → post-anoxic → re-aeration) will be required to meet stringent effluent limits in the future. The typical MBR system consists of suspended growth bioreactor tanks with fine bubble aeration integrated with a membrane filtration system. The membrane filtration system is immersed directly into the mixed liquor, and a permeate pump draws treated water through the membranes. A separate air header supplies coarse bubble air directly below the bottom of the membranes to scour the outer surface of the membranes, helping to keep them clean. Separate final clarifiers will not be necessary; separation of the liquid and microbial solids is performed by the membrane filtration units. The following capacity improvements are included in this liquid train treatment alternative evaluation:

- Convert the existing oxidation ditch tank number one into anaerobic selector tanks;
- Convert the existing oxidation ditches two and three and sludge storage tank six (future oxidation ditch four) into anoxic, aerobic and post-anoxic reactors, providing approximately 7-hours of detention time in the aerobic zone during the peak month flow. The existing vertical turbine aerators would be replaced with fine-bubble diffused air aeration systems;
- Construct three new MBR membrane cassette trains for the MBR membranes and air scour system. These three trains provide re-aeration after the post-anoxic stage, which adds dissolved oxygen back into the wastewater and strips nitrogen gas from the wastewater. The membranes will also separate the liquids and solids. Each cassette train would be approximately 30 feet long by 20 feet wide, with a 13 foot sidewater depth;

- Construct a MBR process building to house the aeration and MBR blowers, permeate pumps, backpulse pumps and equipment, chemical cleaning systems, air compressors and dryers, and electrical and controls; and,
- Chemical addition systems for coagulant addition (for phosphorus control) and supplemental carbon addition (for total nitrogen control). In lieu of tertiary filtration for TP and TN control, metal salts would be added directly to the MBR system for TP control (in addition to the TP removal that can be reached with biological phosphorus removal) and a supplemental carbon source would be added to the post-anoxic treatment stage to spur denitrification and subsequent removal of nitrogen.

7.4 TERTIARY TREATMENT EXPANSION

A significant advantage of the MBR system is it will reliably meet the projected carbonaceous Biochemical Oxygen Demand (cBOD), Total Suspended Solids (TSS), Total Phosphorus (TP), and Total Nitrogen (TN) limits without requiring separate tertiary treatment (TP/TN filters). The East facility will still be required to provide year-round disinfection, and maintain an effluent dissolved oxygen concentration of 6 mg/L. The UV disinfection, blowers, controls, and electrical equipment would be located inside a building. For planning purposes, the size of the building to house this equipment was estimated to be 80-feet long by 100-feet wide. Additional footprint will be reserved for future building expansion with denitrifying filters as a precaution if TN limits become even more restrictive than predicted. Effluent aeration tankage would be located outside.

UV Disinfection

UV disinfection would be provided downstream of the TP/TN filters. A 48-bulb, low pressure, high output, 2-channel UV system delivering a 30mJ dose would be provided to meet the proposed 200 CFU/100 ml fecal coliform limit.

Effluent Aeration

Following disinfection, effluent aeration would be provided to meet the proposed 6 mg/L dissolved oxygen limit. Effluent aeration would provide 30 minutes of detention time at peak hour flow, along with fine-bubble diffusers and blowers for air supply.

7.5 RAS/WAS PUMPING

Depending on system configuration and treatment plant kinetics (to be determined during design), a portion of the mixed liquor may be returned to the anaerobic tanks to enhance biological phosphorus removal. This RAS would likely be pulled from of the end of the pre-anoxic treatment phase in order to limit the nitrate concentration in the recycle. WAS pumping would be used to remove excess biosolids from the treatment process. Additional building footprint will also be necessary to accommodate future RAS/WAS pumping needs. The preferred location for expansion of the RAS/WAS pump building footprint is next to the existing control building. A multi-level, 60-foot by 25-foot building is projected for RAS/WAS pumping.

7.6 ODOR CONTROL

Air exhaust from the preliminary treatment building will be directed to a biofilter for odor control. The biofilter would have a footprint of approximately 3,800 square feet, and it would be located near the preliminary treatment building.

7.7 ADMINISTRATION BUILDING

An administration building at the East WWTF was included in the conceptual site plan. The building would provide space for administrative personnel, record keeping, and other functions. For planning purposes, the building size was projected to be 60-feet by 125-feet.

8 INTEGRATED FIXED-FILM ACTIVATED SLUDGE (IFAS) TREATMENT AT WEST WWTF

A process flow diagram of a typical IFAS treatment facility is presented in Appendix A. A conceptual site plan for the West WWTF with IFAS is presented in Figure C1/C2 in Appendix B. Additional details of process components for the facility follow:

8.1 INFLUENT PUMPING

Influent is currently pumped from the collection system into a rotary screen located in the existing preliminary treatment building. A collection system hydraulic profile and pumping analysis is not included in this study; however, increased pumping capacity in the collection system will be necessary to accommodate future flows. This evaluation does not include review of components and costs associated with collection system improvement. It is assumed that influent will continue to be pumped to the West WWTF and wastewater will flow by gravity through the liquid process treatment trains.

8.2 PRELIMINARY TREATMENT BUILDING

Multiple capacity improvements to the existing preliminary treatment building will be necessary to meet the projected needs, including:

- A multi-level, 4,600 square foot building addition. Lower level space will continue to be used for RAS/WAS pumping (discussed below);
- Two 3-mm opening fine screens, each with a peak hour flow capacity of approximately 9.2 MGD;
- Screenings washing, dewatering, compaction, and transportation equipment;
- Grit removal equipment with a peak hour flow capacity of approximately 9.2 MGD. No grit removal redundancy would be provided;
- Grit washing, dewatering, and transportation;
- Influent flow measurement and sampling; and,
- Treatment building exhaust odor control equipment.

8.3 IFAS/CLARIFIERS

Expansion of the liquid biological treatment process and final clarifiers will be necessary to meet the ultimate projected flows and loads. A five-stage treatment process (anaerobic → anoxic → aerobic → post-anoxic → re-aeration) will be required to meet stringent effluent limits in the future. The following capacity improvements are included in this liquid train treatment alternative evaluation:

- Convert the two existing oxidation ditch tanks into anaerobic selector tanks;
- Construct three new IFAS reactors with anoxic, aerobic, post-anoxic, and re-aeration stages. Each IFAS reactor would be approximately 150 feet long by 50 feet wide by 18 foot sidewater depth, providing approximately 9-hours of detention time in the aerobic zone during the peak month flow; and,
- Construct three new final clarifiers. Each clarifier would be 90-foot diameter and 16-feet deep, with covers, full-radius scum removal, and spiral rake sludge collection mechanisms.

8.4 TERTIARY TREATMENT EXPANSION

In order to reliably meet the projected carbonaceous Biochemical Oxygen Demand (cBOD), Total Suspended Solids (TSS, Total Phosphorus (TP), and Total Nitrogen (TN) limits advanced tertiary treatment will be necessary at the WWTF. The West facility will also be required to provide seasonal disinfection from April through October, and maintain an effluent dissolved oxygen concentration of 6 mg/L. Tertiary filters, UV disinfection, blowers, controls, and electrical equipment would be located inside a building. For planning purposes, the size of the building to house this equipment was estimated to be 200-feet long by 100-feet wide. Effluent aeration tankage would be located outside.

TP/TN Filters

Tertiary filtration for polishing of effluent TP and TN would be provided by continuous backwash, up-flow, reactive media filtration. Six filter cells, with five modules each (total 30 modules) would be provided. A chemical carbon feed would be included to provide a carbon source for denitrification (or total nitrogen removal). Phosphorus reactive media, along with a metal salt feed system, would be included for TP control. The reactive media filters would continuously backwash to the head of the WWTF, and treated effluent would flow to the UV disinfection system. The filtration system would be designed to provide an effluent TP of less than 0.2 mg/L and an effluent TN of less than 5 mg/L.

UV Disinfection

UV disinfection would be provided downstream of the TP/TN filters. A 48-bulb, low pressure, high output, 2-channel UV system delivering a 30mJ dose would be provided to meet the proposed 200 CFU/100 ml fecal coliform limit.

Effluent Aeration

Following disinfection, effluent aeration would be provided to meet the proposed 6 mg/L dissolved oxygen limit. Effluent aeration would provide 30 minutes of detention time at peak hour flow, along with fine-bubble diffusers and blowers for air supply.

8.5 RAS/WAS PUMPING

Additional RAS/WAS pumping capacity will be required to meet the projected capacity demands. Adequate space is available in the lower level of the existing preliminary treatment building for the additional pumps. Three additional RAS pumps and two additional WAS pumps will be necessary to meet the projected capacity demands.

8.6 ODOR CONTROL

Air exhaust from the preliminary treatment building will be directed to a biofilter for odor control. The biofilter would have a footprint of approximately 3,800 square feet, and it would be located near the preliminary treatment building.

8.7 ADMINISTRATION BUILDING

An administration building at the West WWTF was included in the conceptual site plan. The building would provide space for administrative personnel, record keeping, and other functions. For planning purposes, the building size was projected to be 50-feet by 100-feet.

9 INTEGRATED FIXED FILM ACTIVATED SLUDGE (IFAS) TREATMENT AT EAST WWTF

A process flow diagram of a typical IFAS treatment facility is presented in Appendix A. A conceptual site plan for the East WWTF with IFAS is presented in Figures C8/C9/C10 in Appendix B. Additional details of process components for the facility follow:

9.1 INFLUENT PUMPING

Influent is conveyed to the East WWTF via forcemains from Otsego and Dayton. A collection system hydraulic profile and pumping analysis is not included in this study; however, increased pumping capacity in the collection system will be necessary to accommodate future flows. This evaluation does not include review of components and costs associated with collection system improvement. It is assumed that influent will continue to be pumped to the East WWTF and wastewater will flow by gravity through the liquid process treatment trains.

9.2 PRELIMINARY TREATMENT BUILDING

Multiple capacity improvements to the existing preliminary treatment building will be necessary to meet the projected needs, including:

- A multi-level, 4,600 square foot building addition;
- Two 3-mm opening fine screens, each with a peak hour flow capacity of approximately 9.6 MGD;
- Screenings washing, dewatering, compaction, and transportation equipment;
- Grit removal equipment with a peak hour flow capacity of approximately 9.6 MGD. No grit removal redundancy would be provided;
- Grit washing, dewatering, and transportation;
- Influent flow measurement and sampling; and,
- Treatment building exhaust odor control equipment.

9.3 IFAS/CLARIFIERS

Expansion of the liquid biological treatment process and final clarifiers will be necessary to meet the ultimate projected flows and loads. A five-stage treatment process (anaerobic → anoxic →

aerobic → post-anoxic → re-aeration) will be required to meet stringent effluent limits in the future. The following capacity improvements are included in this liquid train treatment alternative evaluation:

- Convert oxidation ditch tank number one into anaerobic selector tanks;
- Convert the existing oxidation ditches two and three and sludge storage tank six (future oxidation ditch four) into anoxic and aerobic stages. The IFAS system will include incorporation of diffused air and IFAS media inside of the existing oxidation ditches. This retrofit will provide approximately 9-hours of detention time in the aerobic zone during the peak month flow;
- Construct new post-anoxic and re-aeration tanks separate from the existing oxidation ditch structures; and,
- Construct three new final clarifiers. Each clarifier would be 90-foot diameter and 16-feet deep, with covers, full-radius scum removal, and spiral rake sludge collection mechanisms

9.4 TERTIARY TREATMENT EXPANSION

In order to reliably meet the projected carbonaceous Biochemical Oxygen Demand (cBOD), Total Suspended Solids (TSS, Total Phosphorus (TP), and Total Nitrogen (TN) limits advanced tertiary treatment will be necessary at the WWTF. The East facility will also be required to provide year-round disinfection, and maintain an effluent dissolved oxygen concentration of 6 mg/L. Tertiary filters, UV disinfection, blowers, controls, and electrical equipment would be located inside a building. For planning purposes, the size of the building to house this equipment was estimated to be 200-feet long by 100-feet wide. Effluent aeration tankage would be located outside.

TP/TN Filters

Tertiary filtration for polishing of effluent TP and TN would be provided by continuous backwash, up-flow, reactive media filtration. Six filter cells, with five modules each (total 30 modules) would be provided. A chemical carbon feed would be included to provide a carbon source for denitrification (or total nitrogen removal). Phosphorus reactive media, along with a metal salt feed system, would be included for TP control. The reactive media filters would continuously backwash to the head of the WWTF, and treated effluent would flow to the UV disinfection system. The filtration system would be designed to provide an effluent TP of less than 0.2 mg/L and an effluent TN of less than 5 mg/L.

UV Disinfection

UV disinfection would be provided downstream of the TP/TN filters. A 48-bulb, low pressure, high output, 2-channel UV system delivering a 30mJ dose would be provided to meet the proposed 200 CFU/100 ml fecal coliform limit.

Effluent Aeration

Following disinfection, effluent aeration would be provided to meet the proposed 6 mg/L dissolved oxygen limit. Effluent aeration would provide 30 minutes of detention time at peak hour flow, along with fine-bubble diffusers and blowers for air supply.

9.5 RAS/WAS PUMPING

Additional RAS/WAS pumping capacity will be required to meet the projected capacity demands. Additional building footprint will also be necessary to accommodate future RAS/WAS pumping needs. The preferred location for expansion of the RAS/WAS pump building footprint is next to the existing control building. A multi-level, 60-foot by 25-foot building is projected for RAS/WAS pumping, along with three additional RAS pumps and two additional WAS pumps.

9.6 ODOR CONTROL

Air exhaust from the preliminary treatment building will be directed to a biofilter for odor control. The biofilter would have a footprint of approximately 3,800 square feet, and it would be located near the preliminary treatment building.

9.7 ADMINISTRATION BUILDING

An administration building at the East WWTF was included in the conceptual site plan. The building would provide space for administrative personnel, record keeping, and other functions. For planning purposes, the building size was projected to be 60-feet by 125-feet.

10 OPINIONS OF PROBABLE COSTS – LIQUID TREATMENT ALTERNATIVES

10.1 CAPITAL COSTS

The construction cost and operation and maintenance cost estimates presented are based on 2017 dollars. Detailed financial analysis should provide an inflation factor, which is checked and adjusted annually through the life of the facility. The conceptual opinion of probable cost was developed based on previous project data and RS Means cost estimating manuals. This cost opinion represents a Class 4 Estimate based on the definitions of the Association for Advancement of Cost Engineering (AACE) International. This level of cost opinion is appropriate for planning level evaluations made with incomplete information. The cost opinion at this level of engineering is considered to have an accuracy range of +50/-30 percent. Actual costs will not be determined until a bidding process has been completed at the time of construction.

The alternatives presented do not require the procurement of additional land. Engineering (design, bidding, and construction) and legal/administrative were assumed to be approximately 20 percent of construction costs. Construction contingency was assumed to be 15 percent.

A summary of probable construction and capital costs for liquid treatment alternatives are presented Table 10.1.1. The MBR alternative was the lowest capital cost alternative. The IFAS and Oxidation Ditch alternatives were the second and third capital cost alternatives, respectively.

Table 10.1.1 – Opinion of Probable Construction and Capital Costs – Liquid Treatment ($millions)

DESCRIPTION	West Oxidation Ditch	East Oxidation Ditch	West MBR	East MBR	West IFAS	East IFAS
Mobilization	$1.840	$1.802	$1.458	$1.274	$1.786	$1.713
Site Work	$1.947	$1.907	$1.363	$1.191	$1.890	$1.812
Influent Pump System	TBD	TBD	TBD	TBD	TBD	TBD
Preliminary Treatment Building	$2.337	$2.337	$2.507	$2.507	$2.507	$2.507
Convert Existing OD to Anaerobic Selector	$0.113	$0.101	$0.113	$0.101	$0.113	$0.101
Anoxic/Aerobic or MBR (*)	$8.763	$6.572	$12.170	$9.730	$7.876	$5.216
Final Clarifiers	$3.840	$3.840	TBD	$0.000	$3.840	$3.840
RAS/WAS Pump Building	$0.237	$1.937	TBD	$0.000	$0.237	$1.937
Tertiary Treatment Building	$7.678	$7.678	$3.300	$3.300	$7.678	$7.678
Effluent Aeration	$0.460	$0.460	$0.460	$0.460	$0.460	$0.460
Administration Building	$0.625	$0.625	$0.625	$0.625	$0.625	$0.625
PTB Biofilter Odor Control	$0.290	$0.290	$0.290	$0.290	$0.290	$0.290
Electrical	$3.944	$3.862	$3.124	$2.731	$3.827	$3.670
Mechanical	$3.155	$3.090	$2.499	$2.184	$3.062	$2.936
Instrumentation and Controls	$1.577	$1.545	$1.250	$1.092	$1.531	$1.468
SUBTOTAL	**$36.806**	**$36.046**	**$29.159**	**$25.485**	**$35.722**	**$34.253**
Construction Contingencies	$5.521	$5.407	$4.374	$3.823	$5.358	$5.138
Undeveloped Design Details	$3.681	$3.605	$2.916	$2.549	$3.572	$3.425
CONSTRUCTION SUBTOTAL	**$46.008**	**$45.058**	**$36.449**	**$31.857**	**$44.652**	**$42.816**
Engineering, Legal, Admin	$7.361	$7.209	$5.832	$5.097	$7.144	$6.851
TOTAL OPINION OF PROBABLE COST	**$53.369**	**$52.267**	**$42.281**	**$36.954**	**$51.796**	**$49.667**
COMBINED EAST-WEST	**$105.636**		**$79.235**		**$101.463**	

(*) No RAS, Final Clarifiers, Denite/TP Filters for MBR

10.2 OPERATION AND MAINTENANCE AND O&M NET PRESENT WORTH

Operation, maintenance and repair (OM&R) costs are a significant portion of the total annual cost of wastewater treatment. They are essential to include in evaluations and analyses of planned alternatives. In many instances, an analysis of the OM&R costs reveals significant enough annual costs to justify the selection of a more expensive capital cost alternative. In other instances, it allows a less expensive capital cost alternative to be selected while planning for future OM&R costs.

Major OM&R costs include labor, power, equipment maintenance and repair, lab testing and chemical costs. Some of the alternatives presented in this report require more operator attention and thus, carry a higher estimated labor cost.

Labor requirements were determined using the *Northeast Guide for Estimating Staffing at Publicly and Privately Owned Wastewater Treatment Plants* (2008). This document provides an update and expansion to a 1973 EPA Guide for labor requirements, and it provides more detailed information for biosolids treatment processes. An average cost of $89,000 per year per employee was used and includes all wages and benefits.

Power costs are based on a unit cost of $0.07 per kW-hr. Equipment maintenance/repair costs are based on equipment lifetime repairs. Annual maintenance costs were calculated based on the value and complexity of the equipment.

A simple net present worth (NPW) analysis for the O&M costs were completed to compare the cost of each of the alternatives in 2017 dollars. The analysis uses anticipated O&M costs discussed previously. The present worth analysis was prepared over 20 years and assuming 80-percent of projected buildout annual costs to account for phased construction.

Operations, maintenance, and repair costs and a 20-year simplified NPW for the OM&R costs for the liquid treatment alternatives are presented in Table 10.2.1. The Oxidation Ditch alternative is the lowest O&M/O&M NPW alternative. The IFAS and MBR alternatives were second and third, respectively.

Table 10.2.1 – Opinion of Probable Operations, Maintenance, and Repair Costs – Liquid Treatment ($millions)

Description (1)	OD	MBR	IFAS
Labor	$1.602	$1.780	$1.602
Power	$0.940	$1.154	$0.868
Maintenance	$0.492	$0.740	$0.712
Laboratory	$0.062	$0.062	$0.062
Chemical	$0.408	$0.412	$0.408
Annual Total	**$3.504**	**$4.148**	**$3.652**
20-year NPW (2)	**$56.064**	**$66.368**	**$58.432**

(1) Combined O&M for West and East Faciliities

(2) 80% of projected build out O&M annual cost

10.3 ALTERNATIVE COSTS SUMMARY

A summary of the presented costs is included in Figure 10.3.1. This figure details the capital and O&M NPW values summed.

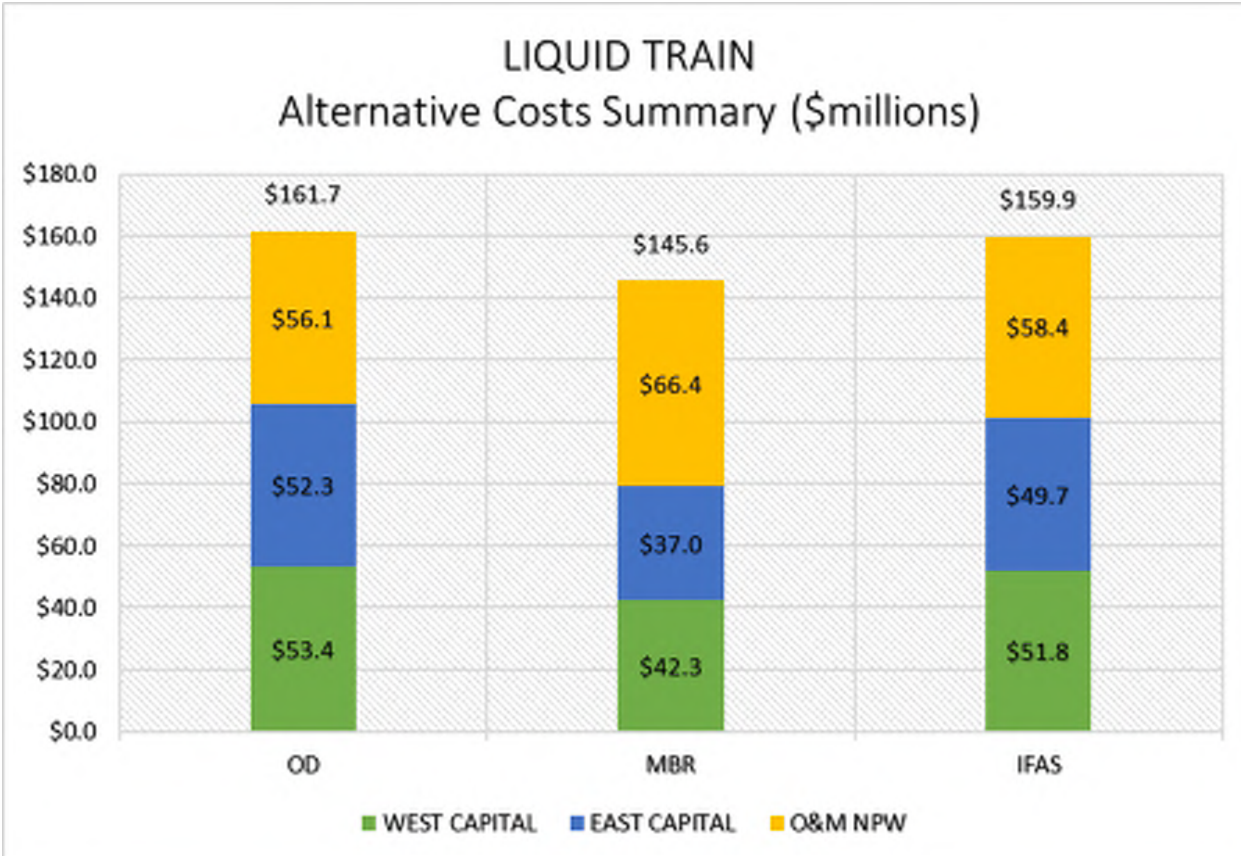

Figure 10.3.1 – Alternative Costs Summary – Liquid Treatment ($millions)

11 KEPNER-TREGOE ANALYSIS AND RESULTS

A Kepner-Tregoe decision making process was used in evaluating the liquid train treatment alternatives. The process began by determining a list of criteria to rank the alternatives. The criteria were selected to cover a wide range of important categories including costs, stakeholder acceptance, and operations. A total of twenty-one criteria were chosen. These criteria were then ranked in terms of their importance on a scale of one to ten. The ability of each liquid treatment alternative to satisfy the respective criteria was then assigned using a scale of one to ten. A weighted value for each criterion was determined based on the criteria importance and alternative's ability to satisfy – this was performed by multiplying the criteria performance by the ability to satisfy. These values were then weighted using the top performing alternative for each category and the overall category significance to provide values used in the final analysis. Table 11.1 and Figure 11.1 detail the categories, criteria, and results.

Table 11.1 – Kepner-Tregoe Analysis – Liquid Train

	Criteria Importance (1-10)		Ranking - Ability To Satisfy Criteria (1-10)			Individual Weight		
CATEGORY 1 (STAKEHOLDER) (10%)	**Public**	**Design Team**	**OD**	**MBR**	**IFAS**	**OD**	**MBR**	**IFAS**
Aesthetics	6.0	4.0	6.0	10.0	8.0	144	240	192
Public Safety	8.3	7.0	8.0	8.0	8.0	467	467	467
Minimize Odor Potential	10.0	10.0	7.0	10.0	7.0	700	1000	700
Minimize Noise Potential	6.9	8.0	7.0	9.0	8.0	387	498	443
Minimize Trucking	2.7	3.0	6.0	6.0	5.0	48	48	40
Energy Efficiency	6.8	7.0	9.0	6.0	8.0	431	287	383
Environmental Stewardship	6.1	5.0	7.0	7.0	7.0	213	213	213
Totals	-	-	50.0	56.0	51.0	2389	2753	2437
Weighted Value	-	-	8.93	10.00	9.11	8.68	10.00	8.85
Category Weighted Value	-	-	-	-	-	0.87	1.00	0.89
CATERGORY 2 (COST) (60%)	**Public**	**Design Team**	**OD**	**MBR**	**IFAS**	**OD**	**MBR**	**IFAS**
Capital Cost	-	7.0	7.5	10.0	7.8	53	70	55
O&M Cost	-	5.0	10.0	8.4	9.6	50	42	48
Phasing of Facility	-	4.0	7.0	9.0	9.0	28	36	36
Totals	-	-	24.5	27.4	26.4	131	148	139
Weighted Value	-	-	8.94	10.00	9.64	8.82	10.00	9.36
Category Weighted Value	-	-	-	-	-	5.29	6.00	5.62
CATEGORY 3 - O&M (30%)	**Public**	**Design Team**	**OD**	**MBR**	**IFAS**	**OD**	**MBR**	**IFAS**
Ease of Operations	-	8.0	8.0	6.0	9.0	64	48	72
Minimize Maintenance	-	7.0	8.0	6.0	8.0	56	42	56
Minimize working environment odor	-	5.0	8.0	10.0	9.0	40	50	45
Minimize working environment noise	-	5.0	9.0	7.0	7.0	45	35	35
Minimize chemical use	-	4.0	9.0	7.0	9.0	36	28	36
Flexibility for future regulatory changes	-	9.0	4.0	10.0	8.0	36	90	72
Redundancy of Processes	-	9.0	6.0	8.0	7.0	54	72	63
Staffing Requirements	-	7.0	9.0	6.0	9.0	63	42	63
Operator Safety	-	10.0	7.0	8.0	7.0	70	80	70
Potential Effluent Reuse Opportunities	-	6.0	9.0	9.0	9.0	54	54	54
NPDES Permit Compliance Flexibility	-	9.0	6.0	9.0	7.0	54	81	63
Totals	-	-	83.0	86.0	89.0	572	622	629
Weighted Value	-	-	9.33	9.66	10.00	9.09	9.89	10.00
Category Weighted Value	-	-	-	-	-	2.73	2.97	3.00
TOTAL WEIGHTED VALUES						**OD**	**MBR**	**IFAS**
Weighted Value	-	-	-	-	-	8.89	9.97	9.50

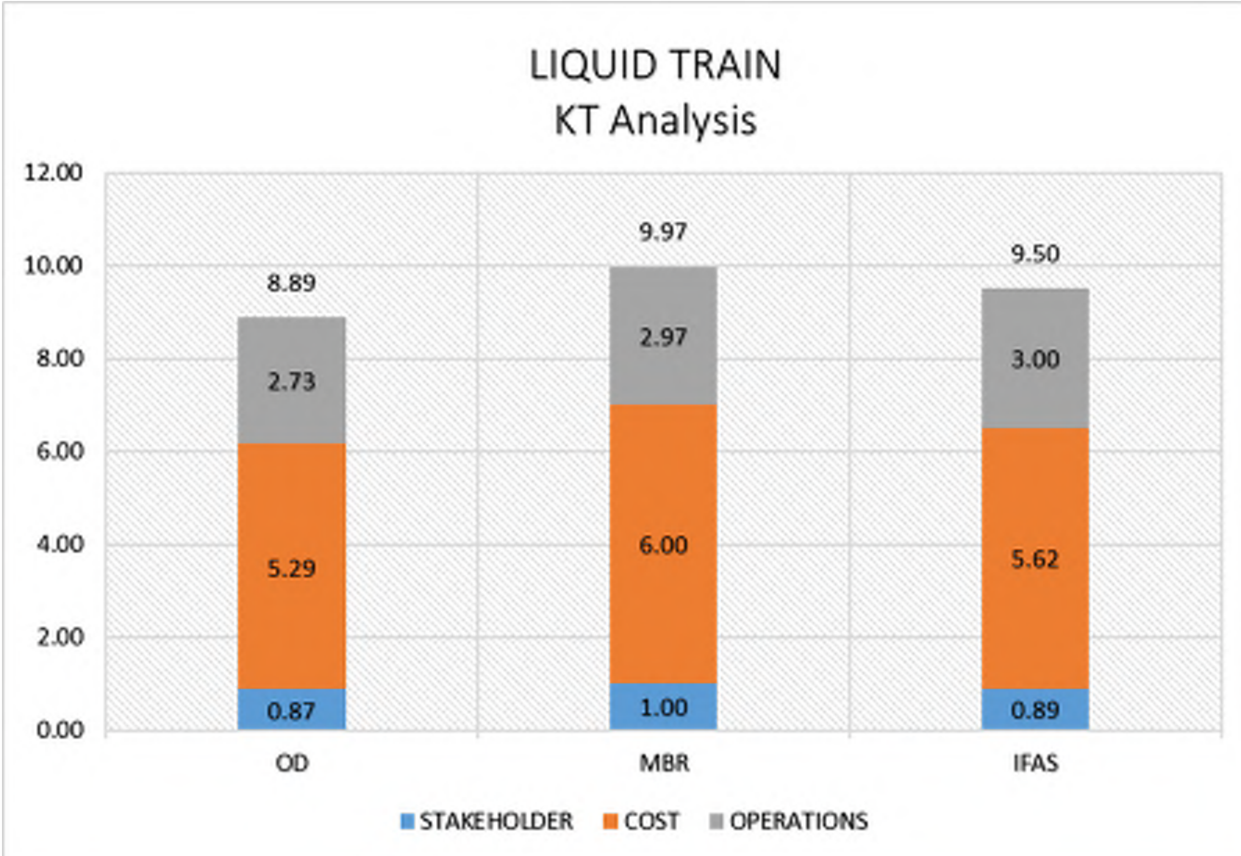

Figure 11.1 – Kepner-Tregoe Analysis – Liquid Train

12 RECOMMENDATION

Based on the presented costs and Kepner-Tregoe analysis, AE2S recommends that the MBR liquid treatment alternative be selected. While operation and maintenance costs are elevated, the MBR alternative provides the lowest capital cost, the lowest total net present worth cost, and highest ranked Kepner-Tregoe alternative.

Technical Memorandum: Solids Treatment Alternative Development

Otsego Wastewater Treatment Master Planning

To: Kurt Neidermeier
Utility Manager
City of Otsego

From: Scott Schaefer, PE
Matt Madson, PE
AE2S

Date: January 8, 2018

Project No: P05409-2013-002

1 Alternatives Evaluation – Solids Train Treatment Alternative Development and Objectives

The primary objectives of the treatment alternatives are to provide a treatment system to accommodate current/projected design service populations. Due to the extensive array of potential treatment alternatives available for both liquids and solids, treatment alternatives for each will be broken down and presented. This section focuses on the discussion of solids treatment alternatives.

A phased approach was used for evaluating treatment alternatives. A phased approach to improvements has the following benefits:

- Lowers initial investment;
- Delays operation, maintenance and repair/replacement costs;
- Reduces construction duration;
- Provides flexibility for unforeseen growth patterns, either slower or faster than anticipated; and,
- Provides flexibility to accommodate future regulatory requirements.

All solids train alternatives were evaluated to meet the projected ultimate flows and loads for the West and East WWTFs assuming phased expansions would occur at key population triggers for each facility. A detailed phasing plan will be provided for the recommended solids train treatment alternative.

Historic flow and load data was used in other TMs to establish current and projected flows and constituent loadings at the West and East Wastewater Treatment Facilities (WWTFs). This information has been presented in other TMs and is used in sizing the liquid train alternatives. One of the functions of a wastewater treatment facility (WWTF) is to remove solids from the wastewater flow. These solids typically consist of grit, rags, paper, plastics, fecal matter, etc. The larger solids and particles are screened and removed at the head of the WWTF with mechanical screens and grit removal. These solids are disposed of in a landfill. As the wastewater is treated, additional biological solids are generated as microorganisms stabilize soluble organic matter. These solids, called waste activated sludge (WAS), are eventually collected in clarifiers or in other separation processes (e.g., filters) and wasted to sludge processing facilities for treatment and ultimately disposal. Sludge is typically termed biosolids following the appropriate treatment. Based on the selected liquid train alternatives and existing facility operations, solids treatment train flows and loads were determined to form a solids basis of design. These values are summarized in Table 1.1 for existing capacities, values at current facility flows, and projected values for all solids treatment alternatives selected for further evaluation. These values correspond to the sizing of the equipment discussed later in this TM.

Table 1.1 – Existing and Projected Solids Summary

Parameter	Units	WEST FACILITY/SERVICE AREA		EAST FACILITY/SERVICE AREA		INDEPENDENT BIOSOLIDS - AEROBIC DIGESTION		CONSOLIDATED BIOSOLIDS - AEROBIC DIGESTION		CONSOLIDATED BIOSOLIDS – CHEMICAL (LIME) STABILIZATION	
		Existing Capacity	Current Flows	Existing Capacity	Current Flows	West WWTF	East WWTF	West WWTF	East WWTF	West WWTF	East WWTF
Population	[PE]	-	3,468	-	2,676	39,856	42,147	39,856	42,147	39,856	42,147
Basis of Design Values											
Influent BOD Loading											
Average Annual	[ppd]	1,020	763	2,080	589	8,768	9,272	8,768	9,272	8,768	9,272
Peak Month	[ppd]	1,446	1,095	2,860	855	11,335	11,957	11,335	11,957	11,335	11,957
WAS Production											
Average Annual	[ppd]	918	687	1,872	530	7,891	8,345	7,891	8,345	7,891	8,345
	[gpd]	14,676	10,978	29,928	8,475	126,158	133,410	126,158	133,410	126,158	133,410
Peak Month	[ppd]	1,301	986	2,574	770	10,202	10,761	10,202	10,761	10,202	10,761
	[gpd]	20,806	15,755	41,151	12,302	163,094	172,043	163,094	172,043	163,094	172,043
Thickening Discharge											
Average Annual	[ppd]	872	652	1,778	504	7,497	7,928	7,497	7,928	7,497	7,928
	[gpd]	2,988	2,235	6,092	1,725	25,682	27,158	25,682	27,158	16,343	17,283
Peak Month	[ppd]	1,236	936	2,445	731	9,691	10,223	9,691	10,223	9,691	10,223
	[gpd]	4,235	3,207	8,377	2,504	33,201	35,023	33,201	35,023	21,128	22,287
Aerobic Digestion Discharge											
Average Annual	[ppd]	697	521	1,421	402	5,990	6,334	5,990	6,334	-	-
	[gpd]	2,387	1,786	4,868	1,378	20,520	21,700	20,520	21,700	-	-
Peak Month	[ppd]	988	748	1,954	584	7,743	8,168	7,743	8,168	-	-
	[gpd]	3,384	2,563	6,693	2,001	26,528	27,983	26,528	27,983	-	-
Dewatering Discharge											
Average Annual	[ppd]	665	498	1,356	384	5,718	6,046	5,718	6,046	7,156	7,567
	[gpd]	399	298	813	230	3,428	3,625	3,428	3,625	4,290	4,537
Peak Month	[ppd]	943	714	1,865	558	7,392	7,797	7,392	7,797	9,251	9,759
	[gpd]	565	428	1,118	334	4,431	4,675	4,431	4,675	5,546	5,851
Cake / Chemical (Lime) Stabilization Discharge											
Average Annual	[ft^3/day]	53	39	107	30	451	477	451	477	611	629
	[CY/day]	1.9	1.5	4.0	1.1	16.7	17.7	16.7	17.7	22.6	23.3
Peak Month	[ft^3/day]	74	56	147	44	584	616	584	616	705	728
	[CY/day]	2.8	2.1	5.5	1.6	21.6	22.8	21.6	22.8	26.1	27.0

Alternatives were also evaluated based on their ability to meet current and projected regulatory limits for the desired final disposal method for biosolids, ability to fit on the existing treatment facility site to eliminate land purchase, and best professional judgement. All alternatives will require increased utility services (power, natural gas, water) to the sites over the course of time. Costs for extending these utility services are not included in the analysis conducted in this TM.

All solids treatment equipment and processes were sized to accommodate the peak month flows/loads presented. This is a standard practice in the industry, meets several design and regulator requirements (i.e., Ten States Standards, Minnesota Pollution Control Agency), and allows for operational flexibility in the solids treatment train while still meeting treatment requirements. The factors leading to sludge production rates are not affected by peak day, or greater, events making their inclusion unnecessary. Additional design considerations specific to each unit process are included in the discussion of solids alternative selected for detailed analysis.

2 ALTERNATIVES CONSIDERED BUT ELIMINATED

Alternatives that were considered but determined not to be feasible and, therefore, eliminated from further evaluation are as follows. Additional information is provided in the Reasonable Alternatives Screening – Solids TM.

- No action (current Class B land application with existing equipment / capacity)
- Expansion of current biosolids handling approach
- Split aerobic digestion with mobile dewatering press
- Split aerobic digestion with consolidated permanent dewatering at either the West WWTF or East WWTF
- Transport of thickened solids to West WWTF for consolidated aerobic digestion or chemical stabilization and dewatering
- Off-site, centralized stabilization and/or dewatering
- Combined or split anaerobic digestion in any combination:
    - With primary clarifiers at both WWTF
    - Without primary clarifiers at both WWTF and digestion of thickened WAS

3 ALTERNATIVES FURTHER EVALUATED

Alternatives that were screened and deemed reasonable are further evaluated in this TM. These alternatives include:

- Split aerobic digestion and dewatering at both the West and East WWTFs for respective projected flows and loads
- Transport of West WWTF thickened WAS for consolidated aerobic digestion and dewatering at the East WWTF
- Transport of West WWTF thickened WAS for consolidated dewatering and chemical stabilization at the East WWTF

4 SPLIT AEROBIC DIGESTION AND DEWATERING AT BOTH THE WEST AND EAST WWTFs FOR RESPECTIVE PROJECTED FLOWS AND LOADS

A process flow diagram of a typical aerobic digestion treatment facility is presented in Appendix A. Conceptual site plans for the West and East WWTF with split aerobic digestion and dewatering (with various liquid treatment alternatives) are presented in Figures C1/C3/C5/C9/C12/C14 in Appendix B. Additional details of process components for the facility follow:

4.1 WEST WWTF

Unthickened WAS Storage

Unthickened WAS storage, to provide, at a minimum, three days of redundant storage volume at projected peak month flows, will be provided through expansion and repurposing of existing infrastructure and construction of new standalone infrastructure. This is typical for unthickened WAS storage to provide a wide spot in the biosolids treatment process, allowing for longer periods of time to pass between operation of downstream unit processes such as thickening, dewatering, and stabilization. This time can be due to either long weekends, equipment maintenance, or preferences in operation of downstream equipment. Additional storage time beyond three days is desirable for flexibility.

For the purposes of planning, fine bubble diffusion was assumed as the aeration/mixing method for all WAS storage, and 0.75-percent solids were used. Blowers will be located in an expansion of the existing thickening building. Unthickened WAS storage is only required for solids wasted from the West WWTF. Table 4.1.1 details the infrastructure improvements and corresponding WAS storage available projected peak month conditions.

Table 4.1.1 – West WWTF-Independent Biosolids Unthickened WAS Storage Improvements and Storage Time

Description	Storage Available	
	[gallons]	[days]
Existing Final Clarifier No. 1 (Repurposed)	97,154	0.60
Existing Final Clarifier No. 2 (Repurposed)	97,154	0.60
Existing WAS Tank No. 1	57,797	0.35
New WAS Tank No. 2 (Located in Expanded Thickening Building)	57,797	0.35
New WAS Tank No. 3	187,000	1.15
New WAS Tank No. 4	187,000	1.15
Total	683,902	4.15
Total (Firm)	496,902	3.00

Thickening and Thickened WAS Storage

Additional thickening operations and thickened WAS storage will be provided at the West WWTF. These expanded operations will be located in an expansion of the existing thickening building, including:

- A multi-level, approximately 10,000 square foot building addition.
- Lower level space will continue to be used WAS/TWAS storage, and solids processing pumps (thickening feed, aerobic digester feed, and digested sludge pumps).
  - An expansion of the existing TWAS storage was evaluated and deemed to provide sufficient TWAS storage. TWAS storage is typically sized simply to provide a slight wide spot in the process to allow for better control when feeding downstream stabilization processes.
  - Replacement and expansion of the existing pump operations will be performed to provide adequate capacities and redundancies.

- Upper levels will be used to accommodate additional thickening units and process blowers.
    - Three 200 gpm gravity belt thickening units will be provided for projected conditions, including replacement of the existing unit. The units are sized such that thickening can be completed in a 40 hour work week with only two units in operation. Thickening units feeding aerobic digestion processes are assumed to thicken to 3.5% to prevent overloading of downstream digester.
    - Two polymer skids with redundant pumps will be provided to supply polymer to the thickening system. Liquid polymer will be supplied in a drum to prevent polymer storage time from exceeding 30 days. Approximately 40 pounds per day of polymer will be required at projected buildout (equivalent to ten pounds per dry ton). The polymer will be blended with water into a polymer solution by a polymer blending skid for injection into the thickening feed.
    - Process blowers for WAS and TWAS storage, and aerobic digestion will be located in the thickening building expansion. In addition to replacement of the existing WAS storage and aerobic digester blowers, it is projected that five 75-horsepower blowers will be required to feed the aerobic digestion expansion outlined in later sections.

Aerobic Digestion

Aerobic digestion expansion will be required by this alternative and will include the following work:

- The existing aerobic digesters constructed in 2016/2017 will be re-used.
- The existing sludge storage tank will be re-purposed into four aerobic digester tanks by adding walls to split the structure into quarters. This arrangement provides for more flexibility in design and operation of the tanks (i.e., redundancy and smaller blower sizes). Aerobic digester equipment will be the Ovivo M-TAD equipment (or equal) matching what is installed in the existing aerobic digesters to allow for aerobic digestion of thickened sludge.
- Solids will enter the digester at 3.5-percent solids, undergo 30% solids reduction, and discharge at 2-percent solids. Aerobic digestion alternatives were evaluated on meeting a 60 day solids retention time (SRT) to meet Class B biosolids treatment at 15°C, and meeting all applicable Ten States Standards requirements. At projected conditions, a total volume of approximately 960,000 gallons is required to meet Ten States Standards (adjusted for 3.5-percent solids), and 1.2 million gallons will be available. Full redundancy will be provided.
- The existing digesters, with bubble diffusers, will be re-purposed. Digested sludge will be transferred for short-term storage into these structures prior to feeding into downstream dewatering units. Similar to TWAS storage, this provides a system wide spot for operational flexibility, and it provides a potential chemical dosing location.

Dewatering, Loadout, and Disposal

Dewatering and loadout capabilities will be added to the West WWTF for this alternative, including:

- A new multi-level, approximately 6,000 square foot building.
- Two dewatering units with full solids processing redundancy will be provided. Three dewatering feed pumps and redundant chemical coagulant dosing systems will also be provided. The dewatering units will discharge at approximately 20-percent solids into a loadout. The solids will discharge to a waiting truck or loadout bin for pickup. Two garage bays will be supplied in the loadout area to allow for drive-through of one bay, and loading or storage in the second bay.
- Two polymer skids with redundant pumps will be provided to supply polymer to the dewatering system. Liquid polymer will be supplied in a drum to prevent polymer storage time from exceeding 30 days. Approximately 96 pounds per day of polymer will be required at projected buildout (equivalent to 32 pounds per dry ton). The polymer will be blended with water into a polymer solution by a polymer blending skid for injection into the dewatering feed.
- A loadout road entering the facility from the southwest corner of the site will be constructed. This loadout route runs through City-owned land. The final connection to main streets will need to meet county restrictions; however, the proposed routing is an improvement over the existing facility access. The proposed routing removes travel through a park and reduces the distance traveled through residential areas. The loadout road is detailed in Figure C7 in Appendix B.
- For this treatment alternative, primary disposal of biosolids will be via landfill. No on-site storage will be provided due to odor potential.

Odor Control

Air exhaust from aerobic digesters and the dewatering building will be directed to biofilters for odor control. The aerobic digester biofilter would have a footprint of approximately 2,700 square feet, and it would be located near the new aerobic digesters. The dewatering building biofilter would have a footprint of approximately 2,600 square feet, and it would be located near the new dewatering building.

4.2 EAST WWTF

Unthickened WAS Storage

Unthickened WAS storage, to provide, at a minimum, three days of redundant storage volume at projected peak month flows, will be provided through expansion and repurposing of existing infrastructure. This is typical for unthickened WAS storage to provide a wide spot in the biosolids treatment process, allowing for longer periods of time to pass between operation of downstream unit processes such as thickening, dewatering, and stabilization. This time can be due to either long weekends, equipment maintenance, or simply preferences in operation of downstream equipment. Additional storage time beyond three days is desirable for flexibility.

For the purposes of planning, fine bubble diffusion was assumed as the aeration/mixing method for all WAS storage, and 0.75-percent solids were used. Blowers for Existing Digesters 2 and 3 will be re-used, if still in good operating condition, but they will eventually require reinstallation (or new blowers) in an expansion of the Preliminary Treatment Building (PTB) to allow for the Blower Building to be re-used for other purposes. Blowers for the repurposed Final Clarifiers as WAS storage will be located in adjacent liquid treatment structures (nearest structure is liquid process dependent). Unthickened WAS storage is only required for solids wasted from the East WWTF. Table 4.2.1 details the infrastructure improvements and corresponding WAS storage available projected peak month conditions. Existing Digester No. 1 is not listed for re-use as unthickened WAS storage; however, it may be included for additional storage, if desired, with minimal site piping changes.

Table 4.2.1 – East WWTF-Independent Biosolids Unthickened WAS Storage Improvements and Storage Time

Description	Storage Available [gallons]	Storage Available [days]
Existing Final Clarifier No. 1 (Repurposed)	259,103	1.51
Existing Final Clarifier No. 2 (Repurposed)	259,103	1.51
Existing WAS Tank No. 1	44,925	0.26
Existing Digester No. 3 (Repurposed)	102,374	0.60
Existing Digester No. 4 (Repurposed)	102,374	0.60
Total	767,879	4.48
Total (Firm)	508,776	2.97

Thickening and Thickened WAS Storage

Additional thickening operations and thickened WAS storage will be provided at the East WWTF. These expanded operations will re-use the existing Thickening and Blower Buildings

- The existing Thickening Building will remain as-is with replacement of the existing thickening unit.
- The existing Blower Building will be repurposed as an additional thickening building.
  - The existing blowers will be relocated to an expansion of the existing PTB.
  - The building will be structurally reinforced to allow for installation of up to two additional thickening units (for a total of three thickening units). Three 200 gpm gravity belt thickening units will be provided for projected conditions. The units are sized such that thickening can be completed in a 40 hour work week with only two units in operation. Thickening units feeding aerobic digestion processes are assumed to thicken to 3.5% to prevent overloading of downstream digester.
  - Chemical storage will require installation in an expansion of the existing PTB, or in an expansion of the Thickening Buildings. Two polymer skids with redundant pumps will be provided to supply polymer to the thickening system. Liquid polymer will be supplied in a tote to prevent polymer storage time from exceeding 30 days. Approximately 42 pounds per day of polymer will be required at projected buildout (equivalent to ten pounds per dry ton). The polymer will be blended with water into a polymer solution by a polymer blending skid for injection into the thickening feed.
  - The existing unthickened WAS Storage Tank No. 2 will be repurposed as a thickened WAS storage tank.
  - Existing sludge transfer/thickening feed pumps will be replaced to accommodate the change in head and flow conditions.

Aerobic Digestion, Dewatering, Loadout, and Disposal

Thickened WAS from the expanded thickening processes will be transferred to a new Solids Processing Building that includes aerobic digesters and associated equipment, and dewatering unit processes. The Solids Processing Building will include:

- A new multi-level, approximately 7,600 square foot Solids Processing Building with two new aerobic digester tanks. The building will be constructed to allow for potential future expansion, and ability for the East WWTF to be transitioned to the consolidated aerobic digestion alternative detailed in other sections of this TM.
- Two new aerobic digesters will be constructed. Aerobic digester equipment will be the Ovivo M-TAD equipment (or equal) installed in the existing aerobic digesters to allow for aerobic digestion of thickened sludge. Three 75-horsepower blowers will be supplied for use with the aerobic digesters and installed in the Solids Processing Building.
- Solids will enter the digester at 3.5-percent solids, undergo 30% solids reduction, and discharge at 2-percent solids. Aerobic digestion alternatives were evaluated on meeting a 60 day solids retention time (SRT) to meet Class B biosolids treatment at 15°C, and meeting all applicable Ten States Standards requirements. At projected conditions, a total volume of approximately 1.0 million gallons is required to meet Ten States Standards (adjusted for 3.5-percent solids), and new tanks will be constructed accordingly using a 20-foot sidewater depth. Tanks for planning purposes have been assumed to be 95'-0"x45'-0" each.
- New dewatering feed pumps will provide flow to two new dewatering units with full solids processing redundancy. Three dewatering feed pumps, and redundant chemical coagulant dosing systems will also be provided. The dewatering units will discharge at approximately 20-percent solids into a loadout. The solids will discharge to a waiting truck or loadout bin for pickup. Two garage bays will be supplied in the loadout area to allow for drive-through of one bay, and loading or storage in the second bay.
- Two polymer skids with redundant pumps will be provided to supply polymer to the dewatering system. Liquid polymer will be supplied in totes to prevent polymer storage time from exceeding 30 days. Approximately 101 pounds per day of polymer will be required at projected buildout (equivalent to 32 pounds per dry ton). The polymer will be blended with water into a polymer solution by a polymer blending skid for injection into the dewatering feed.
- For this treatment alternative, primary disposal of biosolids will be via landfill. No on-site storage will be provided due to odor potential.

Odor Control

Biofilter(s) for the Solids Processing Building (aerobic digesters and dewatering) will be provided for odor control. The biofilter(s) will be located near the Solids Processing Building, and it will have a footprint of approximately 3,200 square feet.

5 TRANSPORT OF WEST WWTF THICKENED WAS FOR CONSOLIDATED AEROBIC DIGESTION AND DEWATERING AT THE EAST WWTF

A process flow diagram of a typical aerobic digestion treatment facility is presented in Appendix A. Conceptual site plans for the West and East WWTF with consolidated aerobic digestion and dewatering (with various liquid treatment alternatives) are presented in Figures C2/C4/C6/C8/C11/C14 in Appendix B. Additional details of process components for the facility follow:

5.1 WEST WWTF

Unthickened WAS Storage

Unthickened WAS storage, to provide, at a minimum, three days of redundant storage volume at projected peak month flows, will be provided through expansion and repurposing of existing infrastructure and construction of new standalone infrastructure. This is typical for unthickened WAS storage to provide a wide spot in the biosolids treatment process, allowing for longer periods of time to pass between operation of downstream unit processes such as transport, thickening, dewatering, and stabilization. This time can be due to either long weekends, equipment maintenance, or preferences in operation of downstream equipment. Additional storage time beyond three days is desirable for flexibility.

For the purposes of planning, fine bubble diffusion was assumed as the aeration/mixing method for all WAS storage, and 0.75-percent solids were used. Blowers will be located in an expansion of the existing thickening building. Unthickened WAS storage is only required for solids wasted from the West WWTF. Table 5.1.1 details the infrastructure improvements and corresponding WAS storage available projected peak month conditions.

Table 5.1.1 – West WWTF-Consolidated Biosolids (Aerobic Digestion) Unthickened WAS Storage Improvements and Storage Time

Description	Storage Available	
	[gallons]	[days]
Existing WAS Tank No. 1	57,797	0.35
New WAS Tank No. 2 (Located in Expanded Thickening Building)	57,797	0.35
Existing Sludge Storage Tank No. 1 (1/2 of Tank Repurposed for WAS Storage)	469,982	2.88
Total	496,902	3.58
Total (Firm)	683,902	0.70*

*Sludge Storage Tank No. 1 will be repurposed in a manner such that operational flexibility is maintained. The 2nd half of the tank may also be expanded as desired.

Thickening, Thickened WAS Storage, and Loadout

Additional thickening operations and thickened WAS storage will be provided at the West WWTF to reduce required solids transport volumes. These expanded operations will be located in an expansion of the existing thickening building, including:

- A multi-level, approximately 9,000 square foot building addition.
- Lower level space will continue to be used WAS/TWAS storage, and solids processing pumps (thickening feed, and solids loadout pumps).
  - TWAS storage will be expanded in the lower level of the thickening building expansion. Additionally, TWAS will be transferred to aerated holding in the existing aerobic digesters. Storage in this location will aid in the reduction of odors, and it will allow for more flexibility in storage times and transport frequency to the East WWTF for further treatment.
  - Replacement and expansion of the existing pump operations will be performed to provide adequate capacities and redundancies.
- Upper levels will be used to accommodate additional thickening units and process blowers.
  - Three 200 gpm gravity belt thickening units will be provided for projected conditions, including replacement of the existing unit. The units are sized such that thickening can be completed in a 40 hour work week with only two units in operation. Thickening units feeding aerobic digestion processes are assumed to thicken to 3.5% to prevent overloading of the East WWTF digester after transfer.
  - Two polymer skids with redundant pumps will be provided to supply polymer to the thickening system. Liquid polymer will be supplied in a drum to prevent polymer storage time from exceeding 30 days. Approximately 40 pounds per day of polymer will be required at projected buildout (equivalent to ten pounds per dry ton). The polymer will be blended with water into a polymer solution by a polymer blending skid for injection into the thickening feed.
  - Process blowers for WAS storage will be located in the thickening building expansion. Replacement of the existing WAS/aerobic digester blowers will be necessary.
- Loadout capabilities will be added to the West WWTF for this alternative, including:
  - A loadout road entering the facility from the southwest corner of the site will be constructed. This loadout route runs through City-owned land. The final connection to main streets will need to meet county restrictions; however, the proposed routing is an improvement over the existing facility access. The proposed routing removes travel through a park, and it reduces the distance traveled through residential areas. The loadout road is detailed in Figure C7 in Appendix B.
- For this treatment alternative, thickened WAS is transferred to the East WWTF for stabilization and dewatering. No on-site storage will be provided due to odor potential.

Odor Control

Air will be exhausted from the repurposed TWAS tanks and pass through an existing odor control unit.

5.2 EAST WWTF

Unthickened WAS Storage

Unthickened WAS storage, to provide, at a minimum, three days of redundant storage volume at projected peak month flows, will be provided through expansion and repurposing of existing infrastructure and construction of new standalone infrastructure. This is typical for unthickened WAS storage to provide a wide spot in the biosolids treatment process, allowing for longer periods of time to pass between operation of downstream unit processes such as thickening, dewatering, and stabilization. This time can be due to either long weekends, equipment maintenance, or preferences in operation of downstream equipment. Additional storage time beyond three days is desirable for flexibility.

For the purposes of planning, fine bubble diffusion was assumed as the aeration/mixing method for all WAS storage, and 0.75-percent solids were used. Blowers for Existing Digesters 2 and 3 will be re-used, if still in good operating condition, but will eventually require reinstallation (or new blowers) in an expansion of the Preliminary Treatment Building (PTB) to allow for the Blower Building to be re-used for other purposes. Blowers for the repurposed Final Clarifiers as WAS storage will be located in adjacent liquid treatment structures (nearest structure is liquid process dependent). Unthickened WAS storage is only required for solids wasted from the East WWTF. Table 5.2.1 details the infrastructure improvements and corresponding WAS storage available projected peak month conditions. Existing Digester No. 1 is not listed for re-use as unthickened WAS storage; however, it may be included for additional storage if desired with minimal site piping changes.

Table 5.2.1 – East WWTF-Independent Biosolids Unthickened WAS Storage Improvements and Storage Time

Description	Storage Available [gallons]	Storage Available [days]
Existing Final Clarifier No. 1 (Repurposed)	259,103	1.51
Existing Final Clarifier No. 2 (Repurposed)	259,103	1.51
Existing WAS Tank No. 1	44,925	0.26
Existing Digester No. 3 (Repurposed)	102,374	0.60
Existing Digester No. 4 (Repurposed)	102,374	0.60
Total	767,879	4.48
Total (Firm)	508,776	2.97

Thickening and Thickened WAS Storage

Additional thickening operations and thickened WAS storage will be provided at the East WWTF. These expanded operations will re-use the existing Thickening and Blower Buildings

- The existing Thickening Building will remain as-is with replacement of the existing thickening unit.
- The existing Blower Building will be repurposed as an additional thickening building.
    - The existing blowers will be relocated to an expansion of the existing PTB.
    - The building will be structurally reinforced to allow for installation of up to two additional thickening units (for a total of three thickening units). Three 200 gpm gravity belt thickening units will be provided for projected conditions. The units are

sized such that thickening can be completed in a 40 hour work week with only two units in operation. Thickening units feeding aerobic digestion processes are assumed to thicken to 3.5% to prevent overloading of downstream digester.
    - Chemical storage will require installation in an expansion of the existing PTB, or in an expansion of the Thickening Buildings. Two polymer skids with redundant pumps will be provided to supply polymer to the thickening system. Liquid polymer will be supplied in a tote to prevent polymer storage time from exceeding 30 days. Approximately 42 pounds per day of polymer will be required at projected buildout (equivalent to ten pounds per dry ton). The polymer will be blended with water into a polymer solution by a polymer blending skid for injection into the thickening feed.
    - The existing unthickened WAS Storage Tank No. 2 will be repurposed as a thickened WAS storage tank. While the storage volume is large for a thickened WAS tank, the additional volume allows for an adequate location to comingle the East WWTF thickened WAS, and the thickened WAS from the West WWTF prior to stabilization.
    - Existing sludge transfer/thickening feed pumps will be replaced to accommodate the change in head and flow conditions.

Aerobic Digestion, Dewatering, Loadout, and Disposal

Thickened WAS from the expanded thickening processes will be transferred to a new Solids Processing Building that includes aerobic digesters and associated equipment, and dewatering unit processes. The Solids Processing Building will include:

- A new multi-level, approximately 9,000 square foot Solids Processing Building with four new aerobic digester tanks.
- Four new aerobic digesters will be constructed. Aerobic digester equipment will be the Ovivo M-TAD equipment (or equal) installed in the existing aerobic digesters to allow for aerobic digestion of thickened sludge. Five 75-horsepower blowers will be supplied for use with the aerobic digesters and installed in the Solids Processing Building.
- Solids will enter the digester at 3.5-percent solids, undergo 30% solids reduction, and discharge at 2-percent solids. Aerobic digestion alternatives were evaluated on meeting a 60 day solids retention time (SRT) to meet Class B biosolids treatment at 15°C, and meeting all applicable Ten States Standards requirements. At projected conditions, a total volume of approximately 1.97 million gallons is required to meet Ten States Standards (adjusted for 3.5-percent solids), and new tanks will be constructed accordingly using a 20-foot sidewater depth. Tanks for planning purposes have been assumed at 95’-0”x45’-0” each.
- New dewatering feed pumps will provide flow to two new dewatering units with full solids processing redundancy. Three dewatering feed pumps, and redundant chemical coagulant dosing systems will also be provided. The dewatering units will discharge at approximately 20-percent solids into a loadout, where solids will be discharged to a waiting truck or loadout bin for pickup. Two garage bays will be supplied in the loadout area to allow for drive-through of one bay, and loading or storage in the second bay.

- Two polymer skids with redundant pumps will be provided to supply polymer to the dewatering system. Liquid polymer will be supplied in totes to prevent polymer storage time from exceeding 30 days. Approximately 197 pounds per day of polymer will be required at projected buildout (equivalent to 32 pounds per dry ton). The polymer will be blended with water into a polymer solution by a polymer blending skid for injection into the dewatering feed.
- For this treatment alternative, primary disposal of biosolids will be via landfill. No on-site storage will be provided due to odor potential.

Odor Control

Biofilter(s) for the Solids Processing Building (aerobic digesters and dewatering) will be provided for odor control. The biofilter(s) will be located near the Solids Processing Building, and it will have a footprint of approximately 4,800 square feet.

6 TRANSPORT OF WEST WWTF THICKENED WAS FOR CONSOLIDATED DEWATERING AND CHEMICAL (LIME) STABILIZATION AT THE EAST WWTF

A process flow diagram of a typical chemical (lime) stabilization treatment facility is presented in Appendix A. Conceptual site plans for the West and East WWTF with consolidated dewatering and chemical (lime) stabilization (with various liquid treatment alternatives) are presented in Figures C2/C4/C6/C10/C13/C14 in Appendix B. Additional details of process components for the facility follow:

6.1 WEST WWTF

Unthickened WAS Storage

Unthickened WAS storage, to provide, at a minimum, three days of redundant storage volume at projected peak month flows, will be provided through expansion and repurposing of existing infrastructure and construction of new standalone infrastructure. This is typical for unthickened WAS storage to provide a wide spot in the biosolids treatment process, allowing for longer periods of time to pass between operation of downstream unit processes such as transport, thickening, dewatering, and stabilization. This time can be due to either long weekends, equipment maintenance, or simply preferences in operation of downstream equipment. Additional storage time beyond three days is desirable for flexibility.

For the purposes of planning, fine bubble diffusion was assumed as the aeration/mixing method for all WAS storage, and 0.75-percent solids were used. Blowers will be located in an expansion of the existing thickening building. Unthickened WAS storage is only required for solids wasted from the West WWTF. Table 6.1.1 details the infrastructure improvements and corresponding WAS storage available projected peak month conditions.

Table 6.1.1 – West WWTF-Consolidated Biosolids (Chemical (Lime) Stabilization) Unthickened WAS Storage Improvements and Storage Time

Description	Storage Available	
	[gallons]	[days]
Existing WAS Tank No. 1	57,797	0.35
New WAS Tank No. 2 (Located in Expanded Thickening Building)	57,797	0.35
Existing Sludge Storage Tank No. 1 (1/2 of Tank Repurposed for WAS Storage)	469,982	2.88
Total	496,902	3.58
Total (Firm)	683,902	0.70*

*Sludge Storage Tank No. 1 will be repurposed in a manner such that operational flexibility is maintained. The 2nd half of the tank may also be expanded as desired.

Thickening, Thickened WAS Storage, Loadout, and Disposal

Additional thickening operations and thickened WAS storage will be provided at the West WWTF to reduce required solids transport volumes. These expanded operations will be located in an expansion of the existing thickening building, including:

- A multi-level, approximately 9,000 square foot building addition.
- Lower level space will continue to be used WAS/TWAS storage, and solids processing pumps (thickening feed, and solids loadout pumps).
    - TWAS storage will be expanded in the lower level of the thickening building expansion. Additionally, TWAS will be transferred to aerated holding in the existing aerobic digesters. Storage in this location will aid in the reduction of odors, and it will allow for more flexibility in storage times and transport frequency to the East WWTF for further treatment.
    - Replacement and expansion of the existing pump operations will be performed to provide adequate capacities and redundancies.
- Upper levels will be used to accommodate additional thickening units and process blowers.
    - Three 200 gpm gravity belt thickening units will be provided for projected conditions, including replacement of the existing unit. The units are sized such that thickening can be completed in a 40 hour work week with only two units in operation. Thickening units feeding chemical (lime) stabilization processes are assumed to thicken to 5.5%. The thicker TWAS is acceptable for feeding to the East WWTF chemical stabilization unit, and it provides a significant reduction in transport costs by reducing TWAS volume.
    - Two polymer skids with redundant pumps will be provided to supply polymer to the thickening system. Liquid polymer will be supplied in a tote to prevent polymer storage time from exceeding 30 days. Approximately 59 pounds per day of polymer will be required at projected buildout (equivalent to fifteen pounds per dry ton). The polymer will be blended with water into a polymer solution by a polymer blending skid for injection into the thickening feed.
    - Process blowers for WAS storage will be located in the thickening building expansion. Replacement of the existing WAS/aerobic digester blowers will be necessary.

- Loadout capabilities will be added to the West WWTF for this alternative, including:
    - A loadout road entering the facility from the southwest corner of the site will be constructed. This loadout route runs through City-owned land. The final connection to main streets will need to meet county restrictions; however, the proposed routing is an improvement over the existing facility access. The proposed routing it removes travel through a park, and it reduces the distance traveled through residential areas. The loadout road is detailed in Figure C7 in Appendix B.
- For this treatment alternative, thickened WAS is transferred to the East WWTF for stabilization and dewatering. No on-site storage will be provided due to odor potential.

Odor Control

Air will be exhausted from the repurposed TWAS tanks and pass through an existing odor control unit.

6.2 EAST WWTF

Unthickened WAS Storage

Unthickened WAS storage, to provide, at a minimum, three days of redundant storage volume at projected peak month flows, will be provided through expansion and repurposing of existing infrastructure and construction of new standalone infrastructure. This is typical for unthickened WAS storage to provide a wide spot in the biosolids treatment process, allowing for longer periods of time to pass between operation of downstream unit processes such as thickening, dewatering, and stabilization. This time can be due to either long weekends, equipment maintenance, or simply preferences in operation of downstream equipment. Additional storage time beyond three days is desirable for flexibility.

For the purposes of planning, fine bubble diffusion was assumed as the aeration/mixing method for all WAS storage, and 0.75-percent solids were used. Blowers for Existing Digesters 2 and 3 will be re-used if still in good operating condition, but will eventually require reinstallation (or new blowers) in an expansion of the Preliminary Treatment Building (PTB) to allow for the Blower Building to be re-used for other purposes. Blowers for the repurposed Final Clarifiers as WAS storage will be located in adjacent liquid treatment structures (nearest structure is liquid process dependent). Unthickened WAS storage is only required for solids wasted from the East WWTF. Table 6.2.1 details the infrastructure improvements and corresponding WAS storage available projected peak month conditions. Existing Digester No. 1 is not listed for re-use as unthickened WAS storage; however, it may be included for additional storage if desired with minimal site piping changes.

Table 6.2.1 – East WWTF-Independent Biosolids Unthickened WAS Storage Improvements and Storage Time

Description	Storage Available	
	[gallons]	[days]
Existing Final Clarifier No. 1 (Repurposed)	259,103	1.51
Existing Final Clarifier No. 2 (Repurposed)	259,103	1.51
Existing WAS Tank No. 1	44,925	0.26
Existing Digester No. 3 (Repurposed)	102,374	0.60
Existing Digester No. 4 (Repurposed)	102,374	0.60
Total	767,879	4.48
Total (Firm)	508,776	2.97

Thickening and Thickened WAS Storage

Additional thickening operations and thickened WAS storage will be provided at the East WWTF. These expanded operations will re-use the existing Thickening and Blower Buildings

- The existing Thickening Building will remain as-is with replacement of the existing thickening unit.
- The existing Blower Building will be repurposed as an additional thickening building.
    - The existing blowers will be relocated to an expansion of the existing PTB.
    - The building will be structurally reinforced to allow for installation of up to two additional thickening units (for a total of three thickening units). Three 200 gpm gravity belt thickening units will be provided for projected conditions. The units are sized such that thickening can be completed in a 40 hour work week with only two units in operation. Thickening units feeding dewatering/chemical stabilization processes are assumed to thicken to 5.5% to reduced transport and dewatering costs.
    - Chemical storage will require installation in an expansion of the existing PTB, or in an expansion of the Thickening Buildings. Two polymer skids with redundant pumps will be provided to supply polymer to the thickening system. Liquid polymer will be supplied in a tote to prevent polymer storage time from exceeding 30 days. Approximately 42 pounds per day of polymer will be required at projected buildout (equivalent to ten pounds per dry ton). The polymer will be blended with water into a polymer solution by a polymer blending skid for injection into the thickening feed.
    - The existing unthickened WAS Storage Tank No. 2 will be repurposed as a thickened WAS storage tank. While the storage volume is large for a thickened WAS tank, the additional volume allows for an adequate location to comingle the East WWTF thickened WAS, and the thickened WAS from the West WWTF prior to stabilization.
    - Existing sludge transfer/thickening feed pumps will be replaced to accommodate the change in head and flow conditions.

Dewatering, Chemical (Lime) Stabilization, Loadout, and Disposal

Thickened WAS from the expanded thickening processes will be transferred to a new Solids Processing Building that includes dewatering and chemical (lime) stabilization unit processes. The Solids Processing Building will include:

- A new single-level, approximately 5,900 square foot Solids Processing Building.
- Two small dewatering units, and two large dewatering units will be installed and receive thickened WAS flow from both West and East WWTF. The capacity of two small units will equal the capacity of one large unit. Solids will enter the dewatering units at 5.5-percent solids and discharge at approximately 20-percent solids. Redundancy of the units will be supplied with increased operation hours.
- New dewatering feed pumps will provide flow to the new dewatering units with full solids processing redundancy. Three dewatering feed pumps, and redundant chemical coagulant dosing systems will also be provided.
- Two polymer skids with redundant pumps will be provided to supply polymer to the dewatering system. Liquid polymer will be supplied in totes to prevent polymer storage time from exceeding 30 days. Approximately 197 pounds per day of polymer will be required at projected buildout (equivalent to 32 pounds per dry ton). The polymer will be blended with water into a polymer solution by a polymer blending skid for injection into the dewatering feed.
- Two chemical (lime) stabilization units will be installed. Unit capacities will be such that chemical stabilization can meet all projected flows with extended hours of operation with one unit out of service. Chemical dosing equipment will be supplied in a redundant manner; however, storage and other non-critical components will not be provided redundancy. Solids will enter the chemical stabilization units at 20-percent solids and discharge at approximately 35-percent solids. Approximately 6,336 pounds per day of lime and 42 pounds per day of sulfamic acid addition are required.
- The solids will discharge to a waiting truck or loadout bin for pickup. Two garage bays will be supplied in the loadout area to allow for drive-through of one bay, and loading or storage in the second bay.
- The process results in a Class A biosolids. For this treatment alternative, the biosolids have flexibility in their disposal; however, based on discussions with the City, it is currently anticipated that the biosolids – like the Class B aerobic digestion alternatives – will be landfilled. If landfilled, Class A biosolids may have the ability to be used as final top fill, providing a reduced cost (or potential income stream) for the biosolids disposal. For the purposes of planning, no income stream was assumed. No on-site storage will be provided due to odor potential.

Odor Control

Biofilter(s) for the Solids Processing Building (aerobic digesters and dewatering) will be provided for odor control. The biofilter(s) will be located near the Solids Processing Building, and it will have a footprint of approximately 4,800 square feet.

7 OPINIONS OF PROBABLE COSTS – SOLIDS TREATMENT ALTERNATIVES

7.1 CAPITAL COSTS

The construction cost and operation and maintenance cost estimates presented are based on 2017 dollars. Detailed financial analysis should provide an inflation factor, which is checked and adjusted annually through the life of the facility. The conceptual opinion of probable cost was developed based on previous project data and RS Means cost estimating manuals. This cost opinion represents a Class 4 Estimate based on the definitions of the Association for Advancement of Cost Engineering (AACE) International. This level of cost opinion is appropriate for planning level evaluations made with incomplete information. The cost opinion at this level of engineering is considered to have an accuracy range of +50/-30 percent. Actual costs will not be determined until a bidding process has been completed at the time of construction.

The alternatives presented do not require the procurement of additional land. Engineering (design, bidding, and construction) and legal/administrative were assumed to be approximately 20 percent of construction costs. Construction contingency was assumed to be 15 percent.

A summary of probable construction and capital costs for solids treatment alternatives are presented Table 7.1.1. The Consolidated Biosolids at East – Chemical (Lime) Stabilization alternative was the lowest capital cost alternative. The Consolidated Biosolids at East – Aerobic Digestion and West/East Independent Biosolids alternatives were the second and third capital cost alternatives, respectively.

Table 7.1.1 – Opinion of Probable Construction and Capital Costs – Solids Treatment ($millions)

Description	West Independent Biosolids	East Independent Biosolids	Improvements at West for Consolidated Biosolids	Consolidated Biosolids at East - Aerobic Digestion	Consolidated Biosolids at East - Chemical (Lime) Stabilization
Mobilization	$1.020	$0.844	$0.390	$1.150	$0.713
Site Work	$0.940	$0.789	$0.350	$1.075	$0.666
West WWTF Loadout Road	$0.225	-	$0.225	-	-
WAS Storage	$1.210	$0.618	$0.900	$0.618	$0.618
Thickening Building	$5.920	$1.680	$4.080	$1.680	$1.680
Aerobic Digesters	$2.810	$3.952	-	$6.786	-
Dewatering (and Stabilization) Building	$3.050	$4.555	-	$5.453	$6.794
Biofilter - Aerobic Digester	$0.210	$0.209	-	$0.516	-
Biofilter - Dewatering Building	$0.200	$0.251	-	$0.297	$0.429
Electrical	$2.180	$1.808	$0.830	$2.464	$1.528
Mechanical	$1.750	$1.446	$0.670	$1.971	$1.222
Instrumentation and Controls	$0.870	$0.723	$0.330	$0.986	$0.611
Subtotal	**$20.385**	**$16.875**	**$7.775**	**$22.996**	**$14.261**
Construction Contingencies	$3.058	$2.531	$1.166	$3.449	$2.139
Undeveloped Design Details	$2.039	$1.688	$0.778	$2.300	$1.426
Construction Subtotal	**$25.482**	**$21.094**	**$9.719**	**$28.745**	**$17.826**
Engineering, Legal, Admin	$4.077	$3.375	$1.555	$4.599	$2.852
Total Opinion of Probable Cost	**$29.559**	**$24.469**	**$11.274**	**$33.344**	**$20.678**
Combined - West+East	**$54.028**		**-**	**$44.618**	**$31.952**

7.2 OPERATION AND MAINTENANCE AND O&M NET PRESENT WORTH

Operation, maintenance and repair (OM&R) costs are a significant portion of the total annual cost of wastewater treatment and are essential to include in evaluations and analyses of planned alternatives. In many instances, an analysis of the OM&R costs reveals significant enough annual costs to justify the selection of a more expensive capital cost alternative. In other instances, it allows a less expensive capital cost alternative to be selected while planning for future OM&R costs.

Major OM&R costs include labor, power, equipment maintenance and repair, lab testing and chemical costs. Some of the alternatives presented in this report require more operator attention, and thus, they carry a higher estimated labor cost.

Labor requirements were determined using the *Northeast Guide for Estimating Staffing at Publicly and Privately Owned Wastewater Treatment Plants* (2008). This document provides an update and expansion to a 1973 EPA Guide for labor requirements, and provides more detailed information for biosolids treatment processes. An average cost of $89,000 per year per employee was used and includes all wages and benefits.

Power costs are based on a unit cost of $0.07 per kW-hr. Equipment maintenance/repair costs are based on the equipment lifetime repairs, and annual maintenance costs were calculated based on the value and complexity of the equipment.

A simple net present worth (NPW) analysis for the O&M costs were completed to compare the cost of each of the alternatives in 2017 dollars. The analysis uses anticipated O&M costs discussed previously. The present worth analysis was prepared over 20 years and assuming 80-percent of projected buildout annual costs to account for phased construction.

Operations, maintenance, and repair costs and a 20-year simplified NPW for the OM&R costs for the solids treatment alternatives are presented in Table 7.2.1. The West/East Independent Biosolids – Aerobic Digestion alternative is the lowest O&M/O&M NPW alternative. The Consolidated Biosolids – Aerobic Digestion and Consolidated Biosolids – Chemical (Lime) Stabilization alternatives were second and third, respectively.

Table 7.2.1 – Opinion of Probable Operations, Maintenance, and Repair Costs – Solids Treatment ($millions)

Description (1)	Independent Biosolids - Aerobic Digestion	Consolidated Biosolids - Aerobic Digestion	Consolidated Biosolids - Chemical (Lime) Stabilization
Labor	$0.446	$0.534	$0.534
Operations & Maintenance	$0.312	$0.267	$0.311
Biosolids Truck Hauling	$0.134	$0.267	$0.223
Power and Heat	$0.383	$0.392	$0.232
Maintenance and Repair	$0.392	$0.326	$0.368
Laboratory	$0.008	$0.005	$0.005
Chemical	$0.545	$0.545	$0.948
Biosolids Handling	$0.580	$0.622	$0.787
Transport	$0.034	$0.076	$0.071
Disposal	$0.546	$0.546	$0.716
Annual Total	**$2.354**	**$2.424**	**$2.874**
20-year NPW (2)	**$37.664**	**$38.784**	**$45.984**

(1) Combined O&M for West and East Facilities

(2) 80% of projected build out O&M annual cost

7.3 ALTERNATIVE COSTS SUMMARY

A summary of the presented costs is included in Figure 7.3.1. This figure details the capital and O&M NPW values summed.

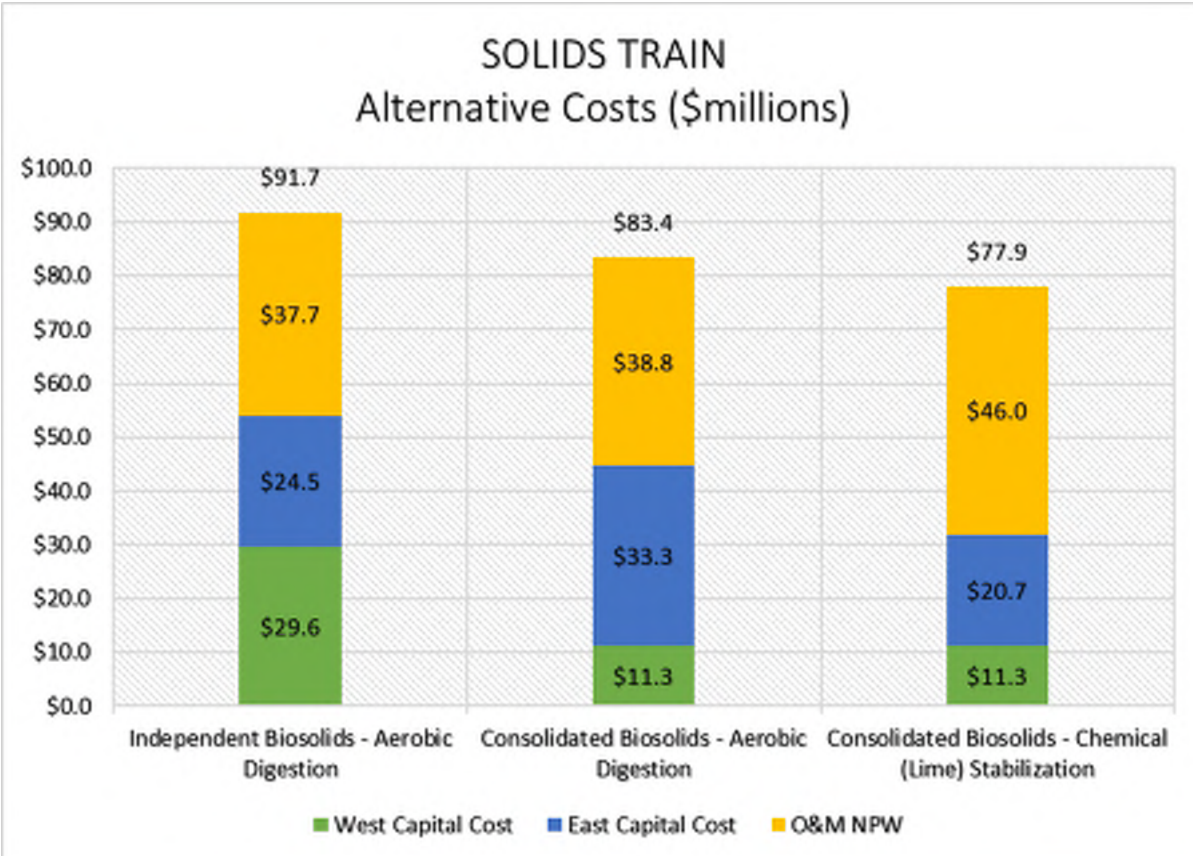

Figure 7.3.1 – Alternative Costs Summary – Solids Treatment ($millions)

8 KEPNER-TREGOE ANALYSIS AND RESULTS

A Kepner-Tregoe decision making process was used in evaluating the solids train treatment alternatives. The process began by determining a list of criteria to rank the alternatives. The criteria were selected to cover a wide range of important categories including costs, stakeholder acceptance, and operations. A total of twenty-one criteria were chosen. These criteria were then ranked in terms of their importance on a scale of one to ten. The ability of each solids treatment alternative to satisfy the respective criteria was then assigned using a scale of one to ten. A weighted value for each criterion was determined based on the criteria importance and alternative's ability to satisfy – this was performed by multiplying the criteria performance by the ability to satisfy. These values were then weighted using the top performing alternative for each category and the overall category significance to provide values used in the final analysis. Table 8.1 and Figure 8.1 detail the categories, criteria, and results.

Table 8.1 – Kepner-Tregoe Analysis – Solids Train

	Criteria Importance (1-10)		Ranking - Ability To Satisfy Criteria (1-10)			Individual Weight		
CATEGORY 1 (STAKEHOLDER) (10%)	**Public**	**Design Team**	**Independent Biosolids - Aerobic Digestion**	**Consolidated Biosolids - Aerobic Digestion**	**Consolidated Biosolids - Chemical (Lime) Stabilization**	**Independent Biosolids - Aerobic Digestion**	**Consolidated Biosolids - Aerobic Digestion**	**Consolidated Biosolids - Chemical (Lime) Stabilization**
Aesthetics	6.0	4.0	8.0	8.0	8.0	192	192	192
Public Safety	8.3	7.0	9.0	9.0	8.0	525	525	467
Minimize Odor Potential	10.0	10.0	8.0	9.0	8.0	800	900	800
Minimize Noise Potential	6.9	8.0	9.0	9.0	9.0	498	498	498
Minimize Trucking	2.7	3.0	9.0	7.0	6.0	72	56	48
Energy Efficiency	6.8	7.0	7.0	8.0	9.0	335	383	431
Environmental Stewardship	6.1	5.0	8.0	8.0	9.0	243	243	274
Totals	-	-	58.0	58.0	57.0	2665	2797	2709
Weighted Value	-	-	10.00	10.00	9.83	9.53	10.00	9.69
Category Weighted Value	-	-	-	-	-	0.95	1.00	0.97
CATERGORY 2 (COST) (60%)	**Public**	**Design Team**	**Independent Biosolids - Aerobic Digestion**	**Consolidated Biosolids - Aerobic Digestion**	**Consolidated Biosolids - Chemical (Lime) Stabilization**	**Independent Biosolids - Aerobic Digestion**	**Consolidated Biosolids - Aerobic Digestion**	**Consolidated Biosolids - Chemical (Lime) Stabilization**
Capital Cost	-	7.0	5.9	7.2	10.0	41	50	70
O&M Cost	-	5.0	10.0	9.7	8.2	50	49	41
Phasing of Facility	-	4.0	9.0	8.0	8.0	36	32	32
Totals	-	-	24.9	24.9	26.2	127	131	143
Weighted Value	-	-	9.51	9.50	10.00	8.91	9.14	10.00
Category Weighted Value	-	-	-	-	-	5.35	5.49	6.00

Table 8.1 continued on following page.

Table 8.1 – Kepner-Tregoe Analysis – Solids Train (Continued)

CATEGORY 3 - O&M (30%)	Public	Design Team	Independent Biosolids - Aerobic Digestion	Consolidated Biosolids - Aerobic Digestion	Consolidated Biosolids - Chemical (Lime) Stabilization	Independent Biosolids - Aerobic Digestion	Consolidated Biosolids - Aerobic Digestion	Consolidated Biosolids - Chemical (Lime) Stabilization
Ease of Operations	-	8.0	9.0	9.0	9.0	72	72	72
Minimize Maintenance	-	7.0	7.0	9.0	9.0	49	63	63
Minimize working environment odor	-	8.0	9.0	9.0	8.0	72	72	64
Minimize working environment noise	-	7.0	9.0	9.0	9.0	63	63	63
Minimize chemical use	-	6.0	8.0	8.0	6.0	48	48	36
Flexibility for future regulatory changes	-	9.0	9.0	9.0	10.0	81	81	90
Redundancy of Processes	-	9.0	9.0	9.0	9.0	81	81	81
Staffing Requirements	-	7.0	9.0	8.0	8.0	63	56	56
Operator Safety	-	10.0	9.0	9.0	8.0	90	90	80
Hauling	-	8.0	6.0	8.0	7.0	48	64	56
Regulatory Documentation Complexity	-	9.0	9.0	10.0	10.0	81	90	90
Totals	-	-	93.0	97.0	93.0	748	780	751
Weighted Value	-	-	9.59	10.00	9.59	9.59	10.00	9.63
Category Weighted Value	-	-	-	-	-	2.88	3.00	2.89
TOTAL WEIGHTED VALUES						**Independent Biosolids - Aerobic Digestion**	**Consolidated Biosolids - Aerobic Digestion**	**Consolidated Biosolids - Chemical (Lime) Stabilization**
Weighted Value	-	-	-	-	-	9.18	9.49	9.86

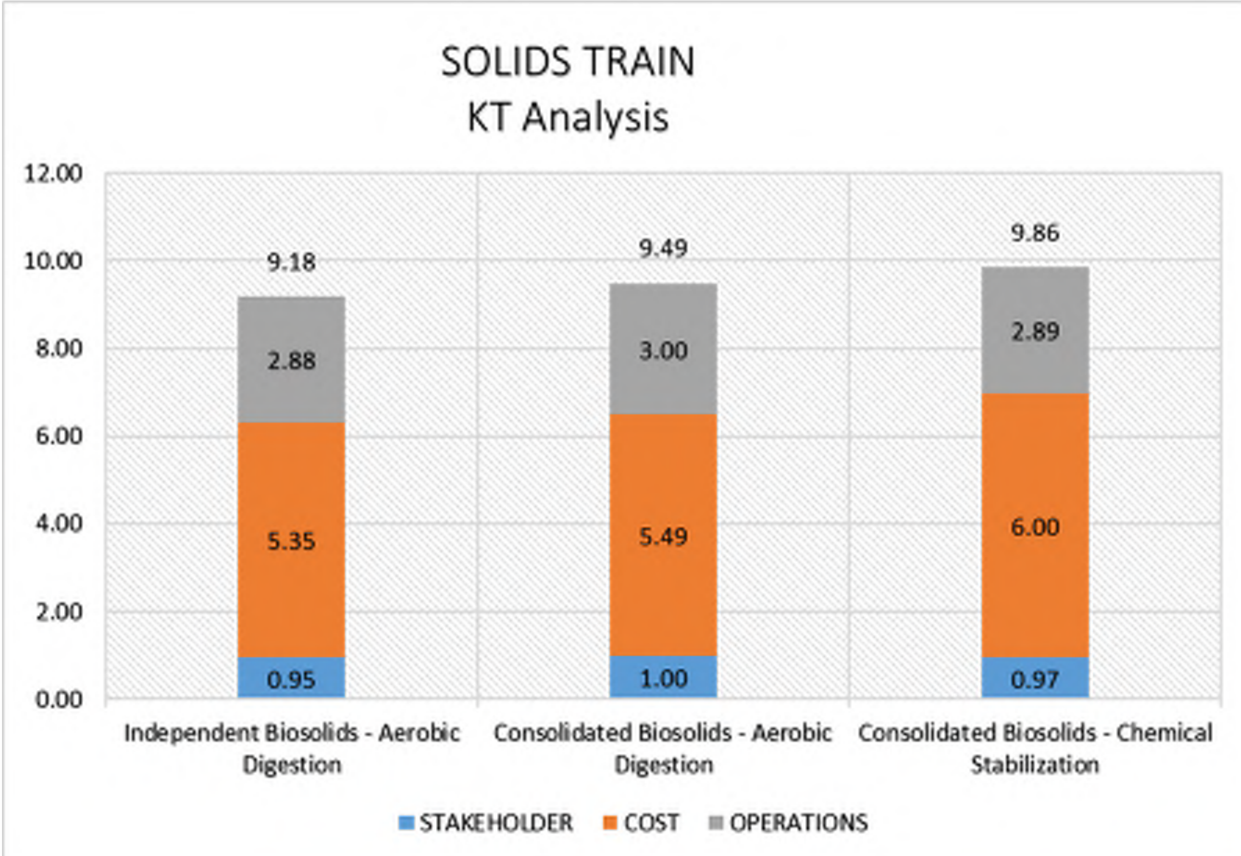

Figure 8.1 – Kepner-Tregoe Analysis – Solids Train

9 RECOMMENDATION

Based on the presented costs and Kepner-Tregoe analysis, AE2S recommends that the consolidated chemical (lime) stabilization treatment alternative be selected. While operation and maintenance costs are elevated, the chemical (lime) stabilization alternative provides the lowest capital cost, the lowest total net present worth cost, and highest ranked Kepner-Tregoe alternative. Additionally, AE2S recommends performing a pilot study of the recommended system with biosolids from the existing facilities to confirm satisfactory operation of the system.

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Technical Memorandum: WWTF Improvements Phasing

Otsego Wastewater Treatment Master Planning

To: Kurt Neidermeier
Utility Manager
City of Otsego

From: Scott Schaefer, PE
Matt Madson, PE
AE2S

Date: January 8, 2018

Project No: P05409-2013-002

1 Summary

The previous technical memorandums detailed information for multiple alternatives including costs (capital, operations & maintenance, net present worth), advantages/disadvantages, City input, and professional judgement. Based on the information presented in these technical memorandums, specific alternatives for the East and West Wastewater Treatment Facilities (WWTFs) liquids and solids alternatives were recommended and selected for phasing discussion. The specific selected alternatives were as follows:

- Liquid Treatment:
  - Membrane bioreactor treatment at the West WWTF
  - Membrane bioreactor treatment at the East WWTF
- Solids:
  - Transport of West WWTF thickened WAS for consolidated dewatering and chemical (lime) stabilization at the East WWTF

A discussion of the phasing plan for each facility is detailed by this technical memorandum and includes capital costs for phases projected to occur within the next 20 years.

2 Phasing Factors

After selection of the specific alternatives, the following factors were the primary considerations in determining when specific equipment and phase initiations were required for each facility:

- **Capacity**: Any time a critical unit process approaches capacity, a new phase is required (unless it is determined with certainty that no additional growth will occur). Capacity is not the only phasing factor; however, it is the primary driver for many phase initiations.
- **Regulatory**: While it is possible that regulatory phasing factors may coincide with capacity requirements, regulatory requirements on their own are a factor. They can dictate the decision to move to a new technology or add a unit process in an earlier phase rather than expand using existing technology. Additionally, regulatory expectations can allow for specific items to be planned for, but not provided/built until later phases.
- **Odor Control**: As discussed in previous technical memoranda, odor control is a major concern due to the location of the WWTFs and their proximity to residential areas. For this reason, odor impacts phasing with regards to the installation of odor control equipment in earlier phases and incorporating phases that provide for better odor control and management even if not required by other drivers such as capacity or regulatory (particularly for biosolids).
- **Miscellaneous**: Additional drivers, such as current deficiencies or deficiencies that develop between phases, may exist and require smaller scale, interim projects to address outside of the major phases. Discussion of these items is limited in this memorandum to existing issues.
- **Age/Condition**: The age and condition of older WWTFs can be a driver for capital projects, particularly when an outdated technology does not fit the needs of the future. The East and West WWTFs are relatively new compared to many WWTFs. Age/condition will be a trigger for equipment maintenance, but they are not a primary driver for major phases of capital expenditure.

3 Phasing Plan

The following assumptions were used in the development of the phasing plan for the WWTFs:

- "Phase Initiation" is defined as the beginning of Preliminary Design and/or Preliminary Engineering Report.
- Projections were developed assuming 125 RECs/WWTF/year through 2021, with 200 RECs/WWTF/year for 2022 and later based upon potential growth projections. Secondary "slow-growth" projection values using 75 RECs/WWTF/year have been included in select tables to provide supplemental information on the effect of slower than anticipated growth on more near-term project initiation dates; however, these values were not discussed beyond these tables.
- Phase Initiations are assumed to begin when a facility and/or unit process has reached 80 percent of capacity.
- All flow values presented are Average Wet Weather (AWW) unless explicitly noted otherwise; these values will dictate the design of the majority of the unit processes. Peak Hour (PH) flows are also noted for some unit processes.
- All listed capacities for process equipment incorporate redundancy unless noted.

- Note that values included in the tables may have minor inconsistencies due to rounding or capacities being exceeded during a calendar year.
- Items considered incidental to an improvement (e.g., piping, site civil, and electrical) are not explicitly included in the summary tables.
- Preliminary hydraulic analysis of each of the requirements indicates that the items presented by these Phases and Technical Memorandum(s) can be successfully incorporated at the existing sites; however, a detailed hydraulic evaluation will be required during preliminary design phases to confirm.
- These phasing improvements do not include an assessment of the need to replace equipment, as required by condition, over time. A separate rehabilitation and replacement analysis was conducted for the existing equipment.
- Tables 3.1 and 3.2 below detail the regulatory limit projections for the West and East WWTFs. These limits have the potential to cause initiation of a project/improvement prior to capacity concerns. Phase initiation due to regulatory requirements are noted in the phase plan following the figures.

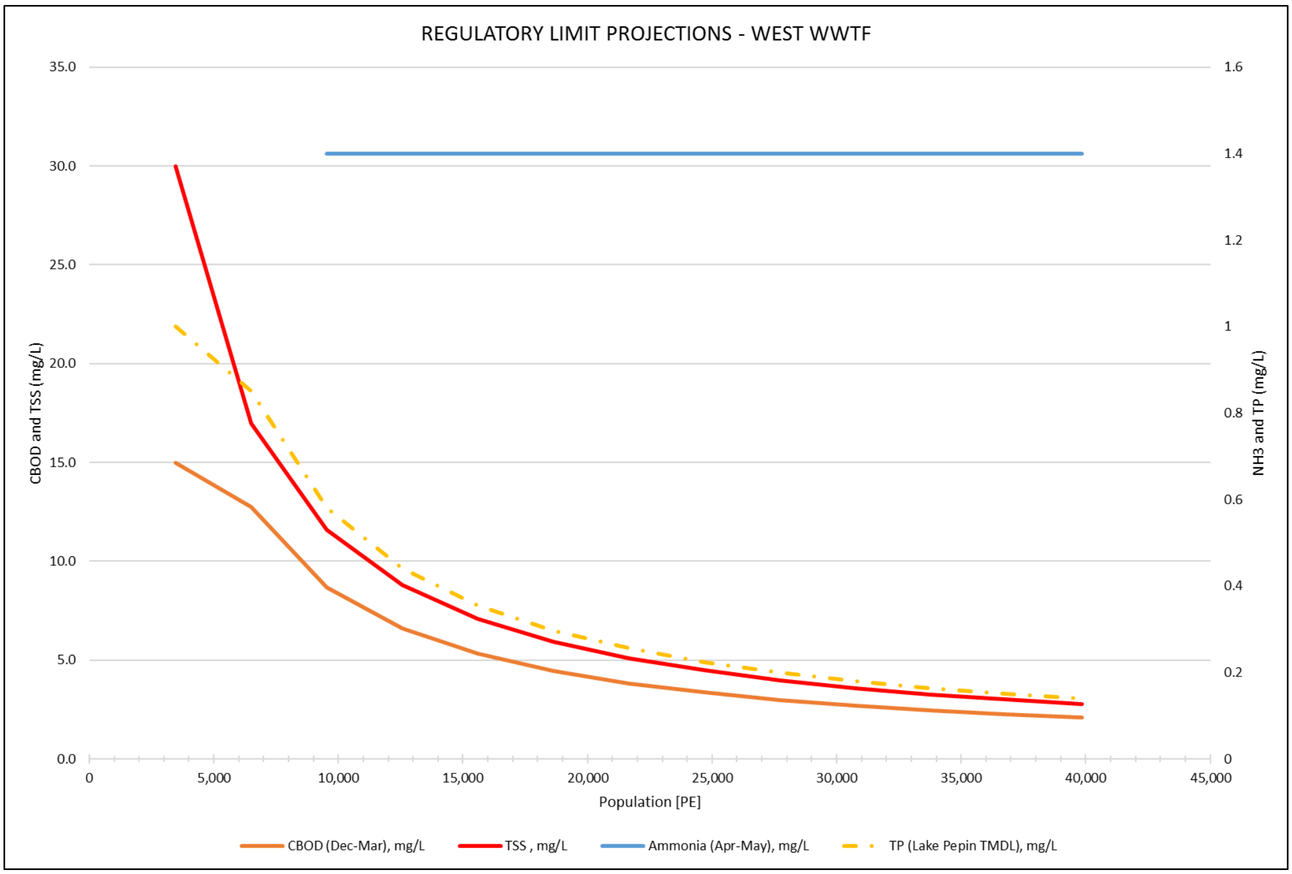

Figure 3.1 – Regulatory Limit Projections – West WWTF

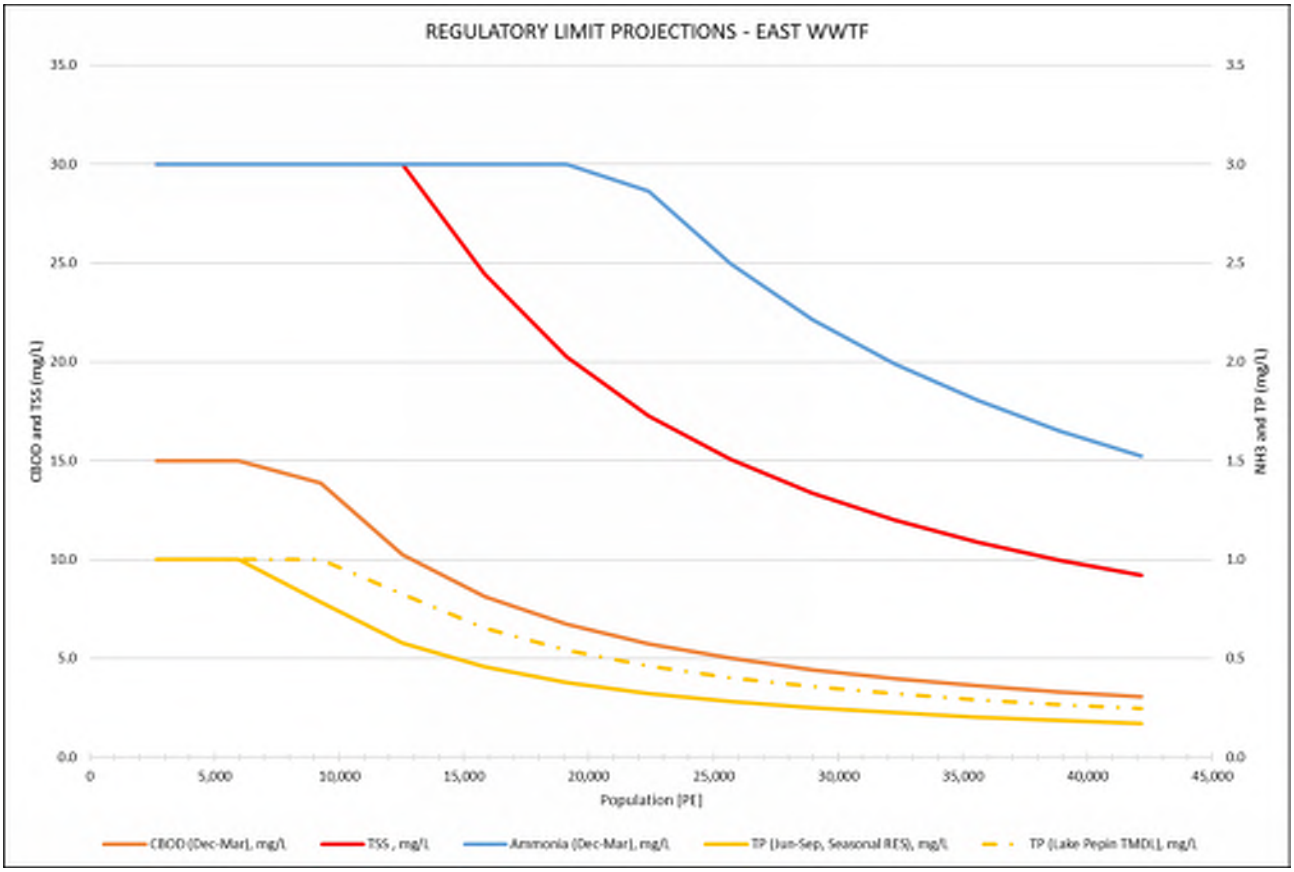

Figure 3.2 – Regulatory Limit Projections – East WWTF

3.1 MEMBRANE BIOREACTOR (MBR) AT THE WEST WWTF

Table 3.1.1 provides a summary of phased improvements with specific phase initiation values, quantities, and updated capacities.

West Liquid Phase 1 (WL1)

Initial liquid treatment improvements are projected to occur first at the West WWTF as the flows/loads to the WWTF approach existing capacities. While general capacity of all unit processes is the cause for phase initiation, it is the regulatory requirement that has driven the technology selection outlined by previous technical memoranda. Further, because these regulatory requirements will be realized during this first expansion, the regulatory limits require that initial phasing begin with the final technology to be installed (MBRs). The regulatory driver in this instance will be total phosphorus effluent limit at approximately 0.44 mg/L. It is anticipated that the initial start-up of the MBR process may need to be supplemented by chemicals to achieve adequate phosphorus removal, in addition to, the conversion of the existing oxidation ditches to anaerobic selector tanks.

Improvements to pretreatment will also occur to protect the new MBR process. A new drum screen will replace the existing screen, and a second drum screen added to provide redundancy. A second vortex grit unit will be added to provide adequate removal and redundancy. New fine screens will be installed in a new building downstream of the existing preliminary treatment building due to space limitations in the existing building to incorporate these screens. It is anticipated that this initial building will be small and possibly temporary; however, further analysis during the preliminary design phase of this project phase will determine the specifics of this structure and its potential expansion. A new odor control biofilter sized for buildout will be installed at the preliminary treatment building in this phase to control odors.

Disinfection improvements will also be required. An initial analysis of the UV disinfection system indicates expansion of the existing system through the installation of additional lamps in existing channels/building will be adequate to reach the design capacity of Phase WL1. Effluent aeration does not currently exist at the WWTF, and it is expected to be required when the WWTF rated capacity is above 1.0 MGD. The existing effluent discharge piping is hydraulically adequate for all flows through buildout.

West Liquid Phase 2 (WL2)

WL2 involves expansions due to capacity deficiencies. This phase will provide construction of a new preliminary treatment building that incorporates the fine screens and footprint from WL1. This phase will require new coarse screens and grit removal that will be installed in the new preliminary treatment building. A new MBR tank and equipment will be added adjacent to the MBR installed in WL1.

The existing UV building will no longer be adequate for the projected flows, and a new building with new UV equipment will be required. The effluent aeration installed in WL1 will be expanded. A new administration building will be constructed to accommodate the additional staff and equipment requirements for the facility.

West Liquid Phase 3 (WL3)

Similar to WL2, WL3 involves expansions due to capacity deficiencies and to provide adequate redundancy for all processes. Additional coarse screens, fine screens, and grit removal will be installed in the pretreatment building to provided capacity through projected buildout.

Similar redundancy requirements are required and will be met by installing equipment for the MBR system, UV disinfection, and effluent aeration.

Table 3.1.1 – West Liquid Improvements Phasing Plan

Phase	Phase Initiation: AWW Flow/Projected Year/Projected RECs	Required Improvements: Unit Process	Required Improvements: Action	New Units	New AWW Capacity (Influent Flow Basis, MGD)
West Liquid 1 (WL1)	0.58 MGD 2021 (2024) 2,402 RECs	Preliminary Treatment	Replace drum screen with new 3/8 - 1/2" coarse drum screen and install one new drum screen.	2	3.59
			New (2nd) vortex grit channel.	1	3.59
			New fine screening building downstream of existing preliminary treatment building.	1	3.59
			New 2 mm fine screens.	2	3.59
			New odor control biofilter.	1	>= 5.20
		Secondary Biological Treatment	Convert all existing oxidation ditches to anaerobic selectors.	2	>= 5.20
			New MBR equipment building.	1	>= 5.20
			New MBR tank and equipment.	1	1.75
		UV Disinfection	New UV equipment in existing building.	1	1.75 (Peak Hour: 4.00)
		Effluent Aeration	New effluent aeration.	1	1.75
West Liquid 2 (WL2)	1.40 MGD 2039 5,865 RECs	Preliminary Treatment	New preliminary treatment building	1	>= 5.20
			New 3/8 - 1/2" coarse screens.	2	3.50
			New grit removal.	1	3.50
		Secondary Biological Treatment	New MBR tank and equipment.	1	3.50
		UV Disinfection	New UV building.	1	>= 5.20
			New UV equipment.	1	3.50 (Peak Hour: 6.30)
		Effluent Aeration	Expand effluent aeration.	1	3.50
		Administration	New administration building.	1	-
West Liquid 3 (WL3)	2.80 MGD 2069 11,973 RECs	Preliminary Treatment	New 2 mm fine screen.	1	>= 5.20
			New 3/8 - 1/2" coarse screen.	1	>= 5.20
			New grit removal.	1	>= 5.20
		Secondary Biological Treatment	New MBR tank and equipment.	1	>= 5.20
		UV Disinfection	New UV equipment.	1	>= 5.20 (Peak Hour: >= 9.59)
		Effluent Aeration	Expand effluent aeration.	1	>= 5.20

Years in parentheses indicate "slow growth" projection of 75 RECs/year/WWTF.

3.2 MEMBRANE BIOREACTOR AT THE EAST WWTF

Table 3.2.1 provides a summary of all improvements with specific phase initiation values, quantities, and updated capacities.

East Liquid Phase 1 (EL1)

Initial liquid treatment improvements are projected to occur in 2031 due to higher existing capacity than the West WWTF. EL1 improvements will not add significant flow capacity to many of the unit processes; however, the EL1 improvements are driven primarily by regulatory considerations. EL1 will maximize the re-use of existing infrastructure and provide new technology to reliably meet more stringent phosphorous removal requirements.

EL1 will consist of major improvements to all critical liquid treatment processes. A new preliminary treatment building will provide for treatment and protection of the new downstream secondary treatment process. Upgrades will include a new structure, new coarse screens, new grit removal, and new fine screens. An odor control biofilter will also be installed to minimize odor potential for the process.

Similar to WL1, EL1 will transition the facility to MBRs for secondary biological treatment due to regulatory drivers. Based on initial permit projections for a total phosphorus limit of 0.90 mg/L, the WWTF should be able to perform adequate for phosphorus removal through the current "equipped" average wet weather design flow of 1.1 MGD. Nearing the design capacity, the system may require additional chemical dosages to reliably meet phosphorus removal requirements. The new MBR system will include conversion of existing Oxidation Ditch No. 1 to an anaerobic selector. Existing Sludge Storage Tank No. 6 (future Oxidation Ditch No. 4) will be converted to anoxic, aerobic, and post-anoxic tanks for the biological treatment portion of the MBR process. By the year EL1 is required, Sludge Storage Tank No. 6 will no longer be required for sludge storage, and thus, it provides an ideal method to convert to MBR treatment while maintaining treatment and redundancy of the other existing oxidation ditches. A new MBR building to house equipment will be constructed along with new tanks. It is anticipated that much of the existing yard piping connecting into the oxidation ditch structures will not have adequate capacity for the required flows by the MBR and will require up-sizing.

Tertiary treatment improvements will also be required. An initial analysis of the UV disinfection system indicates expansion through the installation of additional lamps in the existing channels/building will be adequate to reach the intended capacities of this phase. Effluent aeration currently exists at the facility; however, the existing tanks have inadequate depth and footprint to provide the required effluent aeration. A new structure with new equipment will be required to provide 30 minutes of aeration at peak hour flows. The existing effluent discharge piping is hydraulically adequate for all flows through buildout.

East Liquid Phase 2 (EL2)

EL2 involves expansions due to capacity deficiencies. Additional new screens will be provided in the preliminary treatment building. Existing Oxidation Ditch No. 3 will be converted to biological treatment including anoxic, aerobic, and post-anoxic tanks. New MBR tank and equipment will be installed adjacent to those in EL1.

The existing UV building will no longer be adequate for the projected flows; a new building with new UV equipment will be required. The effluent aeration installed in EL1 will be expanded. A new administration building will be constructed to accommodate the additional staff and equipment requirements for the facility.

East Liquid Phase 3 (EL3)

Similar to EL2, EL3 involves expansions due to capacity deficiencies for specific unit processes to meet projected buildout conditions. Existing Oxidation Ditch No. 2 will be converted to biological treatment including anoxic, aerobic, and post-anoxic tanks. Additional UV disinfection and effluent aeration equipment will be installed.

Table 3.2.1 – East Liquid Improvements Phasing Plan

Phase	Phase Initiation	Required Improvements		New Units	New AWW Capacity (Influent Flow Basis, MGD)
	AWW Flow/Projected Year/Projected RECs	Unit Process	Action		
East Liquid 1 (EL1)	0.88 MGD 2030 (2047) 3,664 RECs	Preliminary Treatment	New preliminary treatment building.	1	>= 5.40
			New 3/8 - 1/2" coarse screens.	2	1.80
			New 2 mm fine screens.	2	1.80
			New grit removal.	1	>= 5.40
			New odor control biofilter.	1	>= 5.40
		Secondary Biological Treatment	Convert existing Oxidation Ditch No. 1 to anaerobic selector.	1	>= 5.40
			Convert existing Sludge Storage Tank No. 6 (future Oxidation Ditch No. 4) to biological treatment including anoxic, aerobic, and post-anoxic tanks.	1	1.80
			New MBR equipment building.	1	>= 5.40
			New MBR tanks and equipment.	2	1.80
		UV Disinfection	Add new UV equipment in existing building.	1	1.80 (Peak Hour: 4.00)
		Effluent Aeration	New effluent aeration. Existing structure is inadequate due to lack of footprint and depth.	1	1.80
East Liquid 2 (EL2)	1.44 MGD 2042 6,329 RECs	Preliminary Treatment	New screens.	1	>= 5.4
		Secondary Biological Treatment	Convert existing Oxidation Ditch No. 3 to biological treatment including anoxic, aerobic, and post-anoxic tanks.	1	3.80
			New MBR tanks and equipment.	1	>= 5.40
		UV Disinfection	New UV building.	1	>= 5.40
			New UV equipment.	1	3.80 (Peak Hour: 6.55)
		Effluent Aeration	Expand effluent aeration.	1	3.80
East Liquid 3 (EL3)	3.04 MGD 2077 13,041 RECs	Secondary Biological Treatment	Convert existing Oxidation Ditch No. 2 to biological treatment including anoxic, aerobic, and post-anoxic tanks.	1	>= 5.40 (Peak Hour: >= 9.80)
		UV Disinfection	Add additional equipment.	1	>= 5.40
		Effluent Aeration	Expand effluent aeration.	1	>= 5.40

Years in parentheses indicate "slow growth" projection of 75 RECs/year/WWTF.

3.3 TRANSPORT OF WEST WWTF THICKENED WAS FOR CONSOLIDATED DEWATERING AND CHEMICAL (LIME) STABILIZATION AT THE EAST WWTF

West WWTF Solids Phasing

Table 3.3.1 provides a summary of all improvements with specific phase initiation values, quantities, and updated capacities.

West Solids Phase 0 (WS0)

WS0 does not involve the construction of any new infrastructure or unit processes at the West WWTF. The phase is included to identify that at 0.72 MGD AWW flow, the existing aerobic digester system capacity will be exhausted and require an operational change because the selected alternative does not involve the expansion of biosolids stabilization at the West WWTF. The operational change may involve hauling excess thickened WAS to the East WWTF for treatment, or use of the digester as thickened WAS storage and transferring all thickened WAS to the East WWTF for treatment. It is recommended that if Phase ES1b has been completed, that digester operations at the West facility cease; thus, the City will have a single, consistent final cake biosolid for disposal. If Phase ES1b has not yet been completed, both facilities will still be producing an aerobically digested final liquid biosolid. It should be noted that ES1a/b are anticipated to be complete prior to the West WWTF reaching the rated solids capacity.

West Solids Phase 1 (WS1)

Phase WS1 is the first solids phase that requires infrastructure and equipment improvements at the West WWTF. The existing thickening building will be expanded to provide room for additional equipment including an additional thickener and appurtenances (e.g., chemicals, pumps), and aeration blowers for the WAS/TWAS processes. WAS and thickened WAS storage will be expanded by this phase. The existing aerobic digesters will be converted to thickened WAS storage/loadout holding, and they will provide adequate TWAS storage through ultimate buildout phases. A new thickening unit will be provided for an increase in capacity. The addition of the thickening unit will provide “half redundancy” at the capacity listed in the table. That is, if one thickening unit is out of service at phase capacity, the run-time of the other unit must be increased by 1.5 times. Full redundancy is provided in later phases.

West Solids Phase 2 (WS2)

Conversion of one-half of the existing large (1.0 million gallon) storage tank to unthickened WAS storage and associated equipment is the only improvement to occur in WS2. The improvement will provide adequate unthickened WAS storage through ultimate buildout phases.

West Solids Phase 3 (WS3)

WS3 details the addition of a new thickening unit to provide additional system redundancy. The timing of this addition is in the far future; however, it is identified as variable. Its installation will rely heavily on the growth rate of the service area as well as operating preference of the operators (hours/week, days/week, etc.).

Table 3.3.1 – West Solids Improvements Phasing

Phase	Phase Initiation: AWW Flow/Projected Year/Projected RECs	Required Improvements: Unit Process	Required Improvements: Action	New Units	New AWW Capacity (Influent Flow Basis, MGD)
West Solids 0 (WS0)	0.72 MGD 2024 2,987 RECs	Aerobic Digesters	Existing digester operational capacity exhausted at 0.60 MGD ADF. Begin hauling excess to East WWTF (if not before).	-	-
West Solids 1 (WS1)	1.40 MGD 2039 5,865 RECs	WAS/TWAS Storage & Thickening	New thickening building for thickening and aeration equipment.	1	>= 5.20
			Expanded Unthickened WAS Storage	1	3.50
			Expanded Thickened WAS Storage in new thickening building and convert existing aerobic digesters to TWAS storage and loadout holding.	1	>= 5.20
			New thickening unit in expanded thickening building.	1	5.20
West Solids 2 (WS2)	2.81 MGD 2070 12,017 RECs	WAS Storage	Convert 1/2 of existing large storage tank to unthickened WAS storage.	1	>= 5.20
West Solids 3 (WS3)	Variable	Thickening	New thickening unit as required by expansion of the City and operator preference.	1	>= 5.20

East WWTF Solids Phasing

Table 3.3.3 provides a summary of all improvements with specific phase initiation values, quantities, and updated capacities.

The East WWTF solids phasing is more complex than previously discussed phasing due to the selected alternatives resulting in the conveyance of thickened WAS from the West WWTF to the East WWTF. This phasing complexity reflects both the West and East WWTFs approaching capacity for the biosolids processes and drivers, like odor control, causing accelerated phase initiation. Note that the capacity listings in the table can exceed the capacity of a single facility. The East WWTF is planned to handle all biosolids dewatering and stabilization; therefore, the value may reference a total flow from each facility.

East Solids Phase 1a and 1b (ES1a and ES1b)

Phase ES1a and ES1b are being presented independently; technically can be pursued as separate projects due to different drivers for the phase initiation. However, it is recommended for both portions of ES1 to be completed together.

ES1a primarily consists of the construction of a new dewatering/chemical stabilization building and associated dewatering equipment. New thickened WAS/dewatering unit feed pumps will be installed in the existing Thickening Building to accommodate new pumping hydraulic requirements. Two “small” dewatering units and appurtenances (e.g., chemicals) will be installed to provide a level of “half redundancy” at the capacity listed in the table. That is, if one dewatering unit is out of service at phase capacity, the weekly run-time of the other unit must be increased by 1.5 times. Full redundancy is provided in later phases. The dewatering process phase initiation is driven by a combination items including:

- Lack of adequate biosolids storage (both due to lack of current volume and future volume when the biosolids storage tank is converted for liquid treatment)
- Odor control (the existing biosolids storage tank is not equipped for odor capture or treatment)

Phase ES1a could be implemented without Phase ES1b only while adequate aerobic digestion capacity is available at both WWTFs to meet landfill pathogen reduction requirements.

Phase ES1b involves the installation of one chemical (lime) stabilization unit at the discharge of the two dewatering units. Phase ES1b is recommended to be completed at the same time as Phase ES1a to allow the East WWTF to accommodate all thickened WAS transferred from the West WWTF and produce a single stabilized biosolids product for disposal. Further, immediate installation of the stabilization process is possible as it is an integral part of the dewatering process, and the footprint for the system will already be constructed in Phase ES1a. Finally, immediate construction of Phase ES1b provides for a further reduction in odor potential by decreasing the reliance on the existing aerobic digesters at both the West and East facilities. This odor potential is, ultimately, the controlling factor in recommending phase initiation between 2018 and 2021. Phase ES1b also calls for the conversion of existing Aerobic Digesters 2 and 3 to unthickened WAS storage; this is an operational change only as all equipment and piping currently exists.

If the odor control driver is removed from consideration, additional ES1a/b phase initiation years based on capacity limitations are as follows:

Table 3.3.2 – East Solids Phase 1 (Non-Odor Potential Triggers)

Phase	Source of Solids Flow to East WWTF for Stabilization/Digestion and Disposal	Phase Initiation (Year)	Trigger
ES1a	All West WWTF + East WWTF	2017	East WWTF solids storage exhausted.
	West WWTF Excess Capacity* + East WWTF	2025	East WWTF solids storage exhausted.
	East WWTF Only	2026	EL1 use of solids storage.
ES1b	All West WWTF + East WWTF	2019	East WWTF Digester capacity exhausted.
	West WWTF Excess Capacity* + East WWTF	2027	East WWTF Digester capacity exhausted.
	East WWTF Only	2030	East WWTF Digester capacity exhausted.

*Excess capacity are all solids when West WWTF AWW influent flow exceeds 0.72 MGD.

Haul trucks may be required at start-up of Phase ES1 if the City desires to self-perform transfer and/or disposal work. Construction of the new entrance road at the West WWTF should also be completed if West WWTF solids are being transferred. To accommodate the storage/wash-down of these vehicles and other storage needs, the design of the dewatering/stabilization building will have two loadout bays. One loadout bay is required for Phase ES1; the second loadout bay could be used for storage purposes until a larger storage/administration building can be constructed in Phase ES2 (or at a date determined by the City).

East Solids Phase 2 (ES2)

Phase ES2 involves the installation of new "large" dewatering unit equal in capacity to the two "small" dewatering units. A new chemical stabilization system, equal in capacity to the ES1b phase, will also be provided for the dewatering unit. This system will provide full redundancy through the associated capacity. The installation of these items is driven by capacity requirements.

Additionally, a new administration building may be constructed during this phase. In providing the additional dewatering/stabilization units, both loadout bays may be required for biosolids handling. The administration building would provide a new dedicated storage and staff location.

East Solids Phase 3 (ES3)

ES3 improvements are all related to further solids handling capacity expansion. One existing final clarifier – no longer in use due to the MBR system – will be converted to unthickened WAS storage. Associated blower equipment will be installed in the MBR equipment building. The existing blower building will be converted into an additional thickening building. The existing blowers will be relocated to the new preliminary treatment building where space is intended to be set aside in the liquid treatment phases. The existing unthickened WAS storage tank will be converted to thickened WAS storage, and it will accommodate all thickened WAS flows from the West and East WWTF. The building will be rehabilitated to allow installation/removal and support of thickening units on the main level. One unit will be installed in this phase to provide "half redundancy" in the thickening unit process at the capacity listed in the table. That is, if one thickening unit is out of service at phase capacity, the weekly run-time of the other unit must be increased by 1.5 times. Full redundancy is provided in later phases.

East Solids Phase 4 (ES4)

ES4 improvements are primarily equipment installation related to solids handling capacity expansion. One additional existing final clarifier, no long in use due to the MBR system, will be converted to unthickened WAS storage. Associated blower equipment will be installed in the MBR equipment building.

East Solids Phase 5 (ES5)

ES5 details the addition of thickening, chemical stabilization, and dewatering units/equipment as required for system redundancy. These improvements would involve the addition of single units and, if installed, the units should match the previously sized equipment to provide full redundancy. The timing of these additions are well into the future; however, they are identified as variable because the installations will rely heavily on the growth rate of the service area as well as operational staffing levels for solids handling (hours/week, days/week, etc.).

Table 3.3.3 – East Solids Improvements Phasing

Phase	Phase Initiation	Required Improvements		New Units	New AWW Capacity (Influent Flow Basis, MGD)
	AWW Flow/Projected Year/Projected RECs	Unit Process	Action		
East Solids 1a (ES1a)	0.70 MGD*+ 2018-2021* 2,949 RECs*+	Dewatering	New thickened sludge/dewatering feed pumps in existing Thickening Building.	3	5.40
			New dewatering/chemical stabilization building including loadout.	1	5.40
			New small dewatering units.	2	3.80
			New odor control biofilter.	1	>= 10.60
East Solids 1b (ES1b)	0.93 MGD*+ 2018-2021* 3,873 RECs*+	Unthickened WAS Storage	Convert existing Digesters 2 and 3 to WAS storage. Operational change only.	2	4.78
		Chemical stabilization	New lime stabilization unit and associated chemical equipment and loadouts installed in dewatering building.	1	3.80
East Solids 2 (ES2)	3.04 MGD+ 2042 12,805 RECs+	Administration	New administration building.	1	>= 10.60
		Dewatering	New large dewatering unit equal to size of two small dewatering units in Phase 1.	1	3.80
		Chemical stabilization	New lime stabilization unit equal in size to Phase 1.	1	3.80
East Solids 3 (ES3)	2.29 MGD (4.65 MGD from East & West) 2059 9,929 RECs (19,746 RECs from East & West)	Unthickened WAS Storage	Convert one final clarifier to unthickened WAS storage.	1	>= 5.40
		Thickened WAS Storage	Convert existing Unthickened WAS Storage Tank No. 2 to Thickened WAS Storage.	1	>= 10.60
		Thickening	New thickening unit in existing blower building. Relocate blowers to new preliminary treatment building.	1	5.40
East Solids 4 (ES4)	5.30 MGD > 2128 > 23,359+ RECs	Unthickened WAS Storage	Convert second final clarifier to unthickened WAS storage.	1	>= 5.40
East Solids 5 (ES5)	Variable / As Needed	Multiple	Add Thickening, Chemical Stabilization, and Dewatering equipment as desired for system redundancy. Additions will require single equipment additions and depend on development of populations and operator preferences; no structure improvements.	1	>= 10.60

*Presenting values based on Engineer recommendations. Values are variable (see discussion).
+Based on total solids to East WWTF from all sources (i.e., A flow exceeding West WWTF capacity by 0.10 MGD contributes 0.10 MGD (and corresponding RECs) towards East WWTF solids.).

3.4 PHASE INITIATION AND OPERATIONAL TRIGGERS

Figures 3.4.1, 3.4.2, 3.4.3, and 3.4.4 detail the projected years at which the previously presented liquid and solids phases must be initiated and completed for the West and East WWTFs based on different constant growth rates.

- Figures for the West and East WWTFs have been prepared separately for clarity and because the WWTFs have different starting service RECs. Two short-term and two long-term planning figures are provided to adequately detail short and long-term triggers.
- The values detailed by the plots will be slightly different than the previously presented tables. These figures do not use values of 125 and 75 RECs/year/WWTF through 2021 as AE2S was directed to use for those projections. These figures assume constant growth throughout.
- As previously discussed, phase initiation is required to occur when 80 percent of process unit capacity has been achieved. This is reflected in the figures by dashed lines. The solid operational lines presented in the figures are limited to 3 years after phase initiation. As a result, these "operational by" lines may not indicate the point at which 100 percent process capacity is achieved, and the line adjusts to the slower growth projections. Initial REC conditions are indicated in the figures. Ultimately, the phase initiation trigger is more important to the planning process to protect against sudden high growth (especially following slow growth) and ensure proper planning time is available. As the phase initiation triggers in the figures are reached, it is necessary to re-evaluate near-term growth projections to verify if a project must proceed immediately, or whether existing growth conditions can be confirmed as slow enough to allow delay.
- The figure for the East WWTF includes darker and lighter lines for Phase ES1a. The darker line indicates the time period at which the project would be initiated/operational due to odor control based factors. The point at which the dark line ends and light line begins is where the phase must occur for capacity reasons (i.e., phase initiation transitions from a "recommended" to a "must"). As the dark line approaches the light line, it is more likely that the WWTF could suffer from odor issues due to decreasing capacities.
- For line labels:
  - First letter indicates facility: W = West WWTF; E = East WWTF
  - Second letter indicates liquid or solids improvement: L = Liquid; S = Solids
  - Number indicates phase number
  - Example: WS2 = West WWTF Solids Phase 2

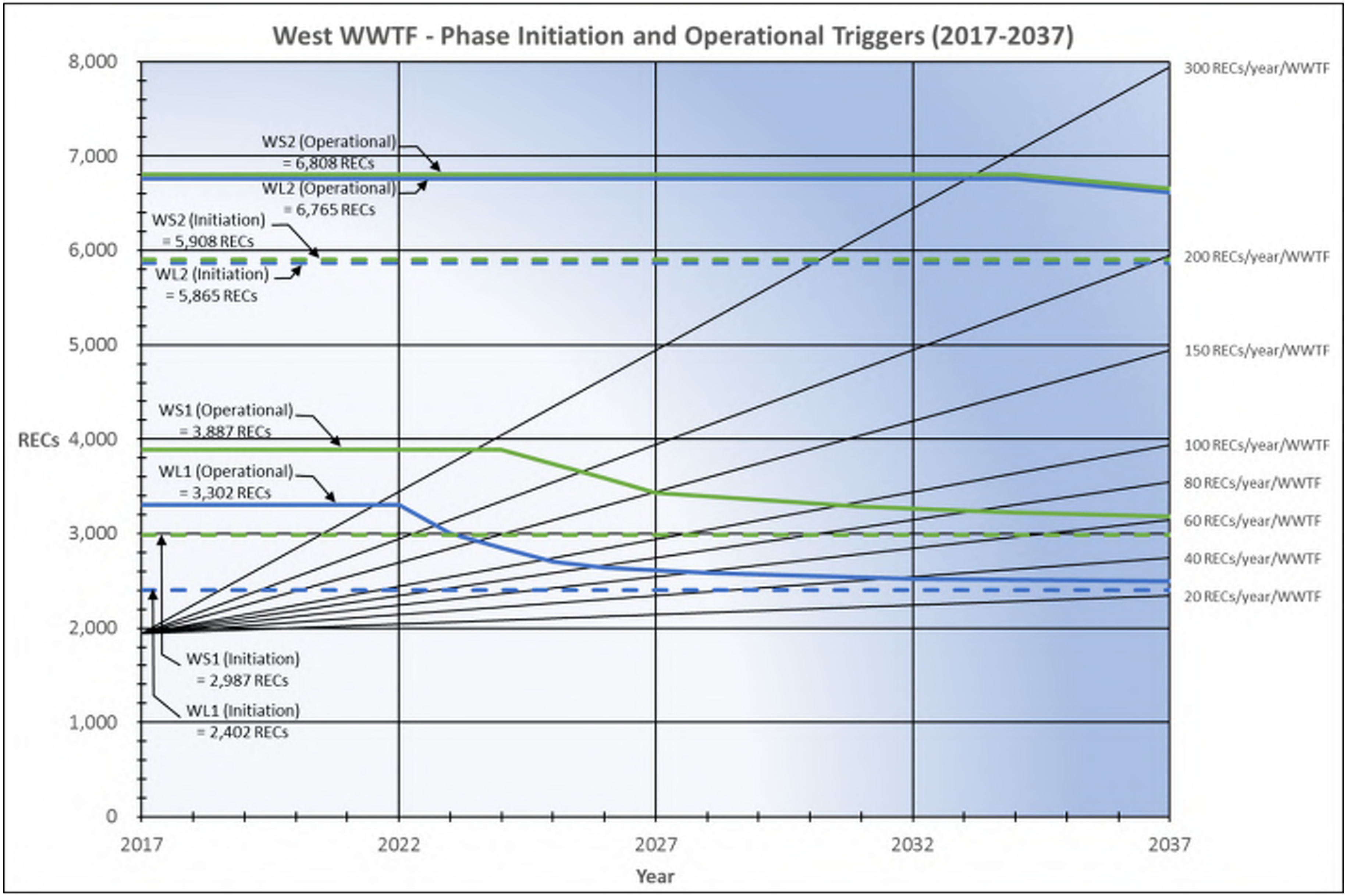

Figure 3.4.1 – West WWTF – Phase Initiation and Operational Triggers (2017-2037)

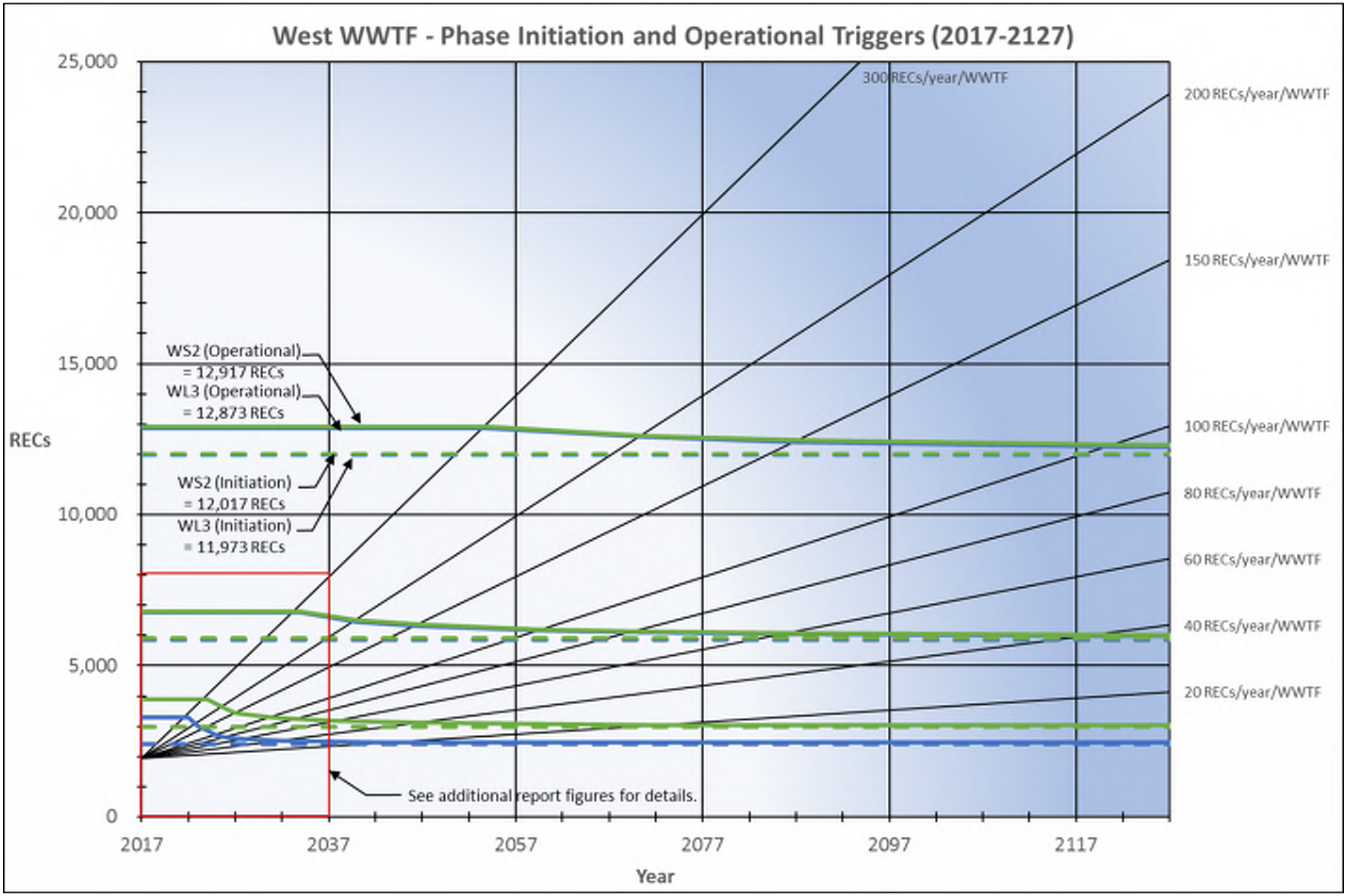

Figure 3.4.2 – West WWTF – Phase Initiation and Operational Triggers (2017-2127)

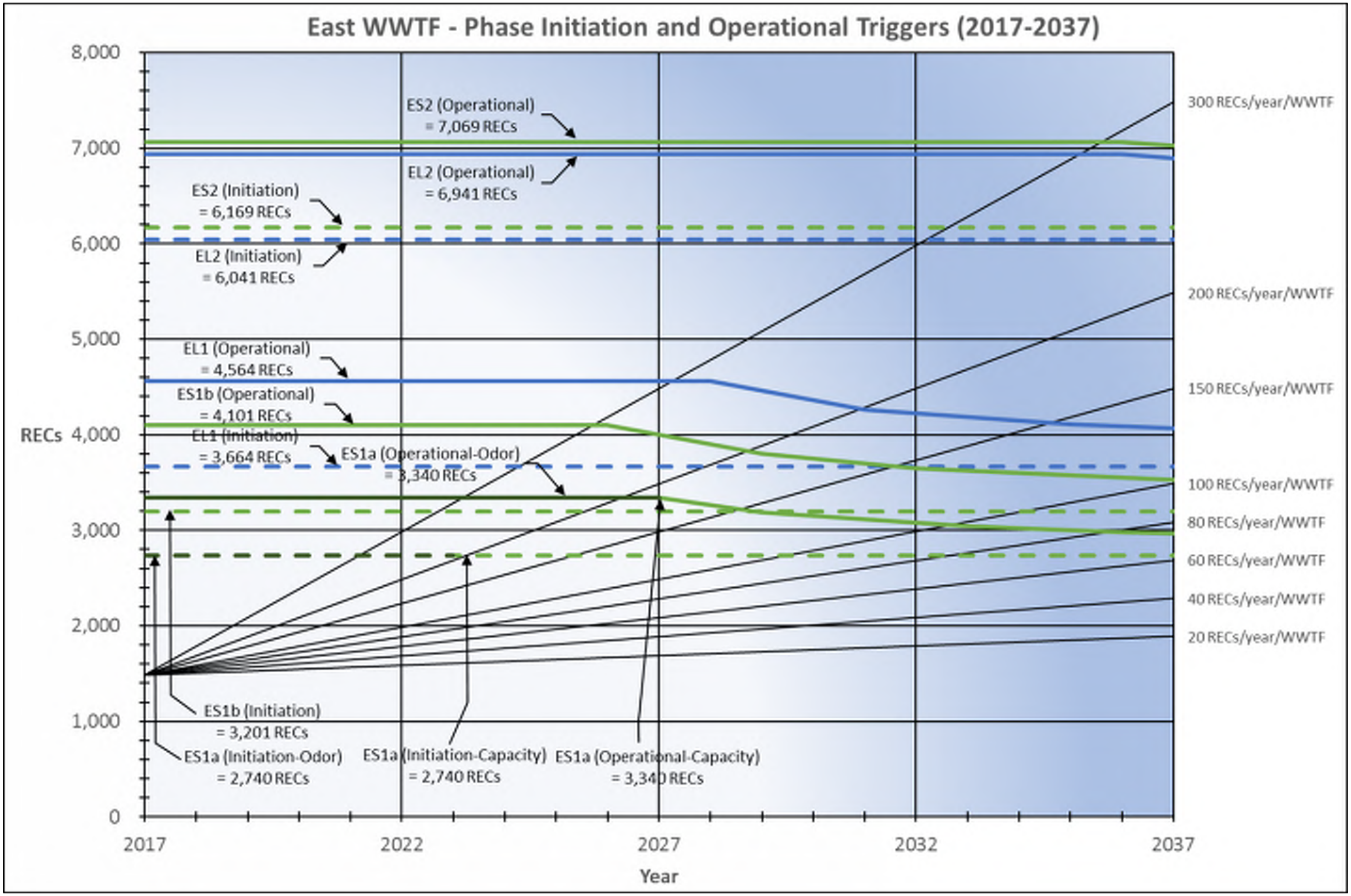

Figure 3.4.3 – East WWTF – Phase Initiation and Operational Triggers (2017-2037)

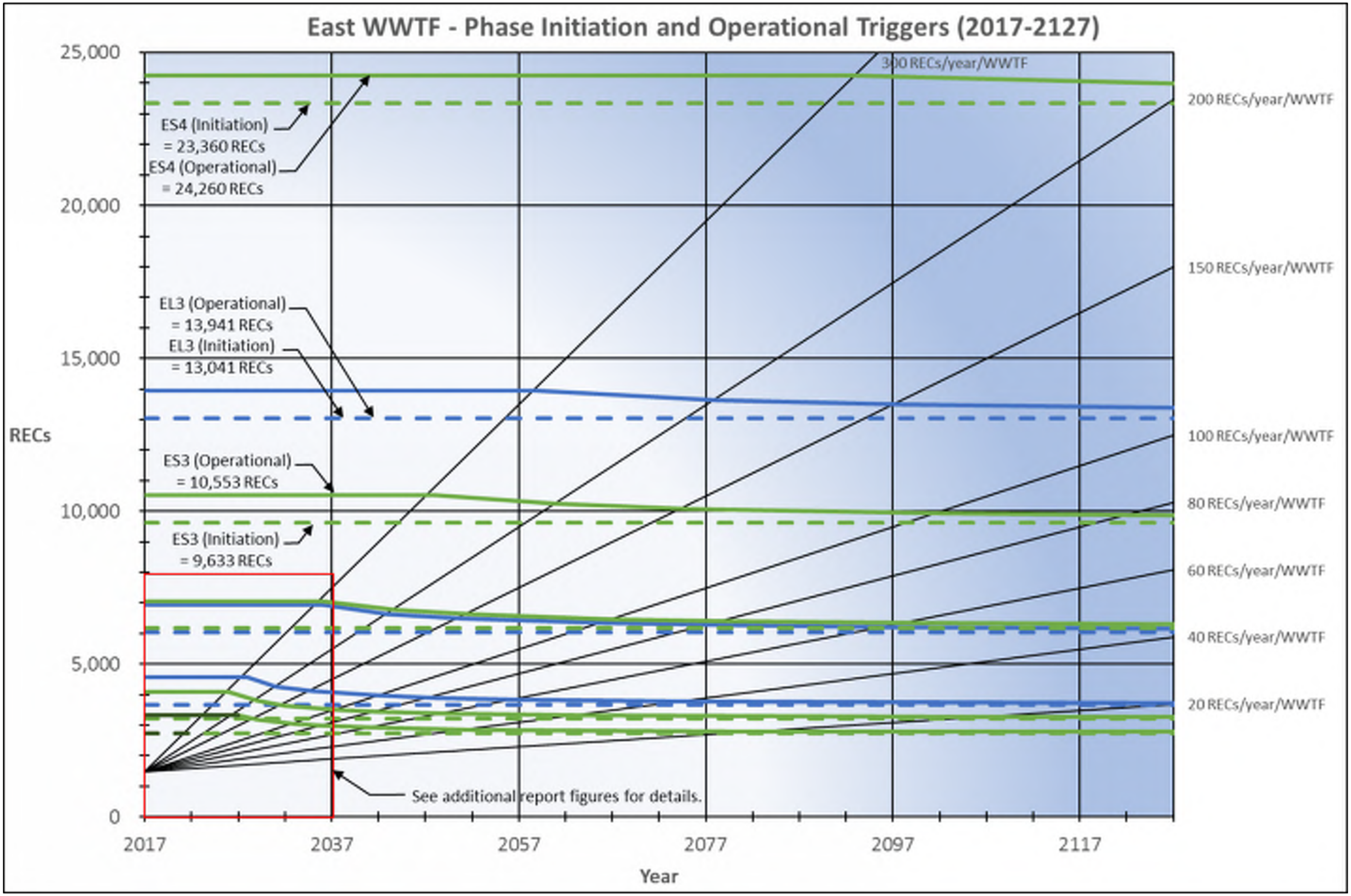

Figure 3.4.4 – East WWTF – Phase Initiation and Operational Triggers (2017-2127)

3.5 SLUDGE AND BIOSOLIDS TRUCK HAULING

The selected biosolids alternative requires truck hauling for both transfer of thickened waste activated sludge (TWAS) from the West to East WWTF (tankers), and final disposal of the dewatered/stabilized biosolids from the East WWTF (dump truck). Figure 3.5.1 details the required number of truck trips per week for each of these transport requirements as a function of the total RECs serviced by the facilities. The intent of the figure is to detail the number of trips required through various areas of the City and to detail the difference in quantity of trips required for both 3,000 and 6,000 gallon tankers for the TWAS. (Information provided by the City indicates they are currently capable of self-performing for the 3,000 gallon tanker, but not a 6,000 gallon tanker). The City can use the information to determine if they need to transition to larger transport trucks to reduce overall number of trips if the (primary) driver is to reduce total number of trips. The figure assumes a simple linear increase for truck trips with RECs (no "plateaus" or "jumps" caused by capital improvement projects), and it assumes equal growth of the East and West WWTF service areas.

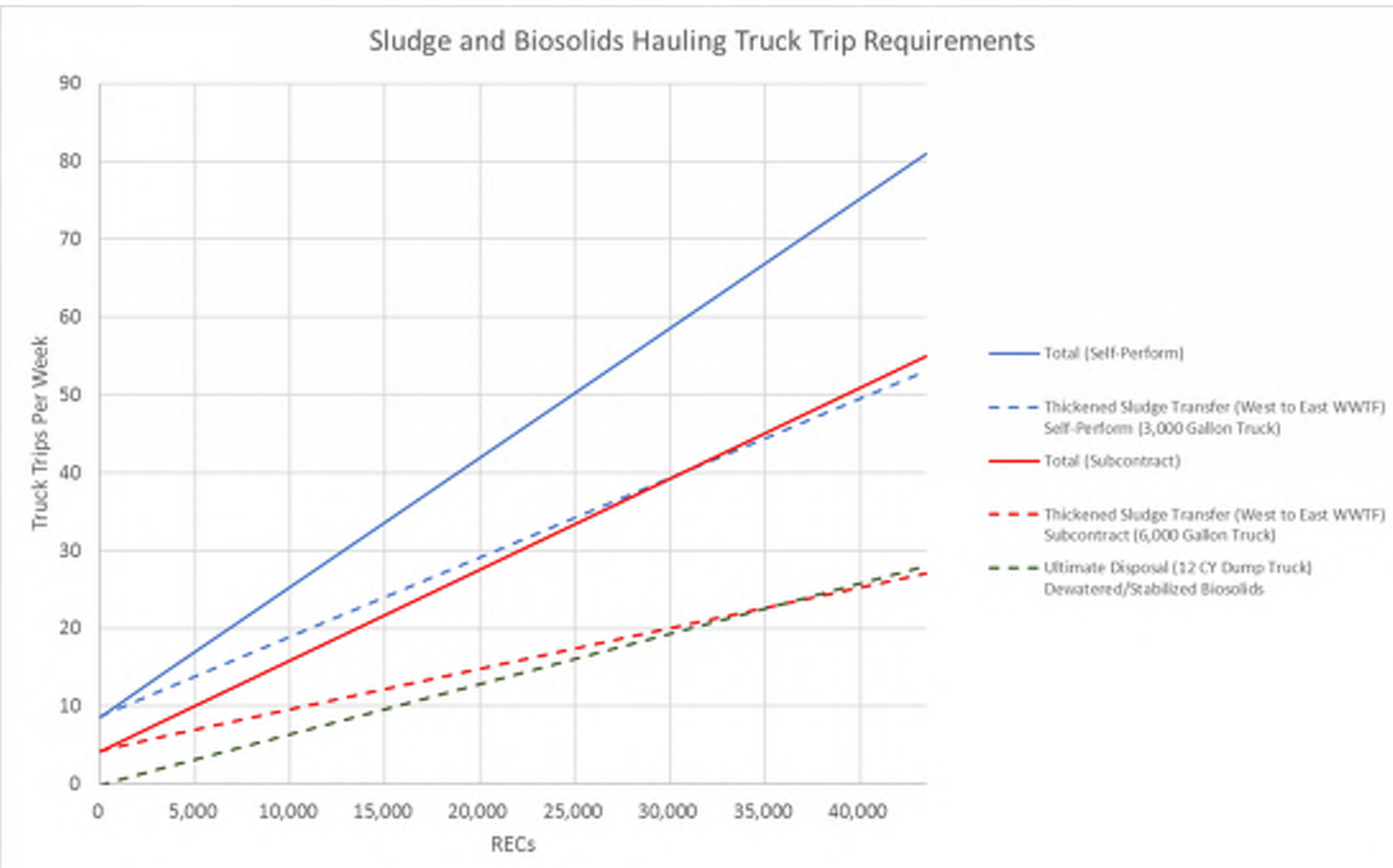

Figure 3.5.1 – Sludge and Biosolids Hauling Truck Trip Requirements

3.6 PHASING 20-YEAR CAPITAL COSTS

Table 3.6.1 presents the capital costs in 2017 dollars of the phases projected to occur within 20 years. It should be noted that these initial project phases, like many multi-phase projects, are more expensive than later phases. Initial phases constitute a larger percentage of buildout capacity costs because much of the infrastructure installed is intended to last for the projected time period with equipment additions occurring at later dates.

Additionally, the table identifies an interim project cost to be completed in the near future. This project will allow for effective operations of the existing East digester capacity. Currently, the existing air distribution piping for the digester system does not allow independent control of the air to each digester. Water level fluctuations in the digesters lead to uneven air distribution due to the change in backpressure; this leads to more air going to digester units that have a lower water surface elevation over the diffusers. This condition is often the opposite of what is needed for process control; the "more full" digester typically needs more air. A temporary air reconfiguration has been discussed that would connect one of the effluent aeration blowers to Digester 1. This would alleviate most of the issue with using Digester 1 by making it independent of the larger Digesters 2 and 3. This interim fix would generally be useable when all blowers are in working condition (i.e. full blower redundancy would not be available for the "modified" configuration, although redundancy would be maintained via valves for the "existing" configuration). The initial cost opinion of this work is $35,000. This would be an interim project to assist the existing system until the East Biosolids Upgrades are completed.

Table 3.6.1 – Opinion of Probable Project Capital Costs – 2017-2037

Phase	Projected Project Initiation Year	Projected Cost (2017 Dollars)
East Solids – Interim Digester Improvements	2018	$35,000
East Solids Phase 1 (ES1)		
Phase 1a Only (ES1a)	*2018-2021*	*$7,500,000*
Phase 1b Only (ES1b)	*2023*	*$4,750,000*
Phase 1a+1b (ES1 – Constructed in Single Phase)	*2018-2023*	*$12,100,000*
West Liquid Phase 1 (WL1)	2022 (2026)	$22,300,000
East Liquids Phase 1 (EL1)	2031 (2050)	$20,750,000

Years in parentheses indicated "slow growth" projection of 75 RECs/year/WWTF.

Technical Memorandum: Existing Equipment Rehabilitation & Replacement Analysis

Otsego Wastewater Treatment Master Planning

To: Kurt Neidermeier
Utility Manager
City of Otsego

From: Scott Schaefer, PE
Matt Madson, PE
AE2S

Date: January 8, 2018

Project No: P05409-2013-002

1 SUMMARY

A rehabilitation and replacement (R&R) evaluation of the existing equipment at the Otsego West and East WWTFs was performed to determine the R&R reinvestment requirements for each facility in the short-term (5 to 10 years). The analysis was performed to supplement the additional costs projected to occur as part of more major capital improvements projects as detailed by the Master Planning process.

2 MODEL DEVELOPMENT

The basis for the R&R evaluation first involved detailing all major process equipment currently installed at each WWTF. This inventory identified the year installed, typical equipment life, equipment life remaining, equipment condition, size of equipment (i.e., horsepower), and estimated equipment cost (2017 dollars).

- Existing equipment, installation date, condition, and other properties were determined from Record Documents, Pay Applications obtained from previous project Contractors, City Input, and engineering experience.
- City staff provided confirmation of the above information, and provided corrections (as required). City staff also provided an assessment of the equipment condition on a scale of 1 to 5. Ratings were weighted to reflect expected equipment condition relative to typical equipment life. Equipment life remaining was adjusted based on the condition of the equipment.

- o 5: Excellent/New
- o 4: Like new
- o 3: As expected for equipment age
- o 2: Worse than expected for equipment age
- o 1: Immediate replacement required (less than 2 years)

Planned R&R was developed using a Weibull Distribution. The distribution is a statistical method to estimate probability of failure in a given year provided typical equipment life and characteristics. Based on probability of failure in a given year, an annualized R&R value is returned for the equipment/items. As a piece of equipment/infrastructure approaches typical life, the probability of failure rises significantly indicating that the probability of expenditures on R&R for that item is higher and should be budgeted appropriately. The following assumptions and comments were used in the development of the model:

- All items are presented in 2017 dollars.
- Existing equipment, installation date, condition, and other properties were determined from Record Documents, Pay Applications obtained from previous project Contractors, City Input, and AE2S experience.
- 2017 costs include estimate R&R costs from 2014-2016 based on the model. This is necessary to capture complete replacement costs of items to be replaced in the near future (less than 3 years).
- The 5-year costs should be considered conservative, but realistic, pending actual equipment life. Costs have been provided beyond 5 years for reference; however, the items included for these costs may change significantly and should be re-evaluated regularly.
- Changes to these costs may also occur due to large capital projects. These projects may incorporate planned R&R items, or eliminate items entirely if specific equipment is removed from use. This also means that new equipment may be added.

3 RESULTS

Results of the model are presented in Tables 3.1 and 3.2. Annualized and cumulative costs are presented for both WWTFs. Figures 3.1 and 3.2 detail the annualized cost only. The presented costs detail the approximate projected budget requirements for R&R of existing equipment at the facilities.

As detailed by the tables and figures, the costs for each year are not consistent from year-to-year and have variable peaks and valleys. The Otsego WWTFs are relatively young; however, they are both entering an age where much of the supplied equipment will be reaching the end of typical life, which coincides with the re-investment peaks. It should also be noted that because the West WWTF was constructed primarily in a single phase, the peak is more abrupt with lower costs building up to the peak. The East WWTF was constructed in multiple phases, thus distributing the costs over several years and providing distributed re-investment projections. However, there are still peaks where phases of equipment will reach typical end-of-useful-life. Additionally, the East WWTF will have more upcoming R&R expenditures due to the facility age and size being greater than the West WWTF.

Table 3.1 – West WWTF Planned R&R Costs (2017 Dollars)

Year	Annualized	Cumulative
2017	$121,000	$121,000
2018	$133,000	$254,000
2019	$221,000	$475,000
2020	$285,000	$760,000
2021	$269,000	$1,029,000
2022	$246,000	$1,275,000
2023	$318,000	$1,593,000
2024	$434,000	$2,027,000
2025	$500,000	$2,527,000
2026	$426,000	$2,953,000
2027	$261,000	$3,214,000

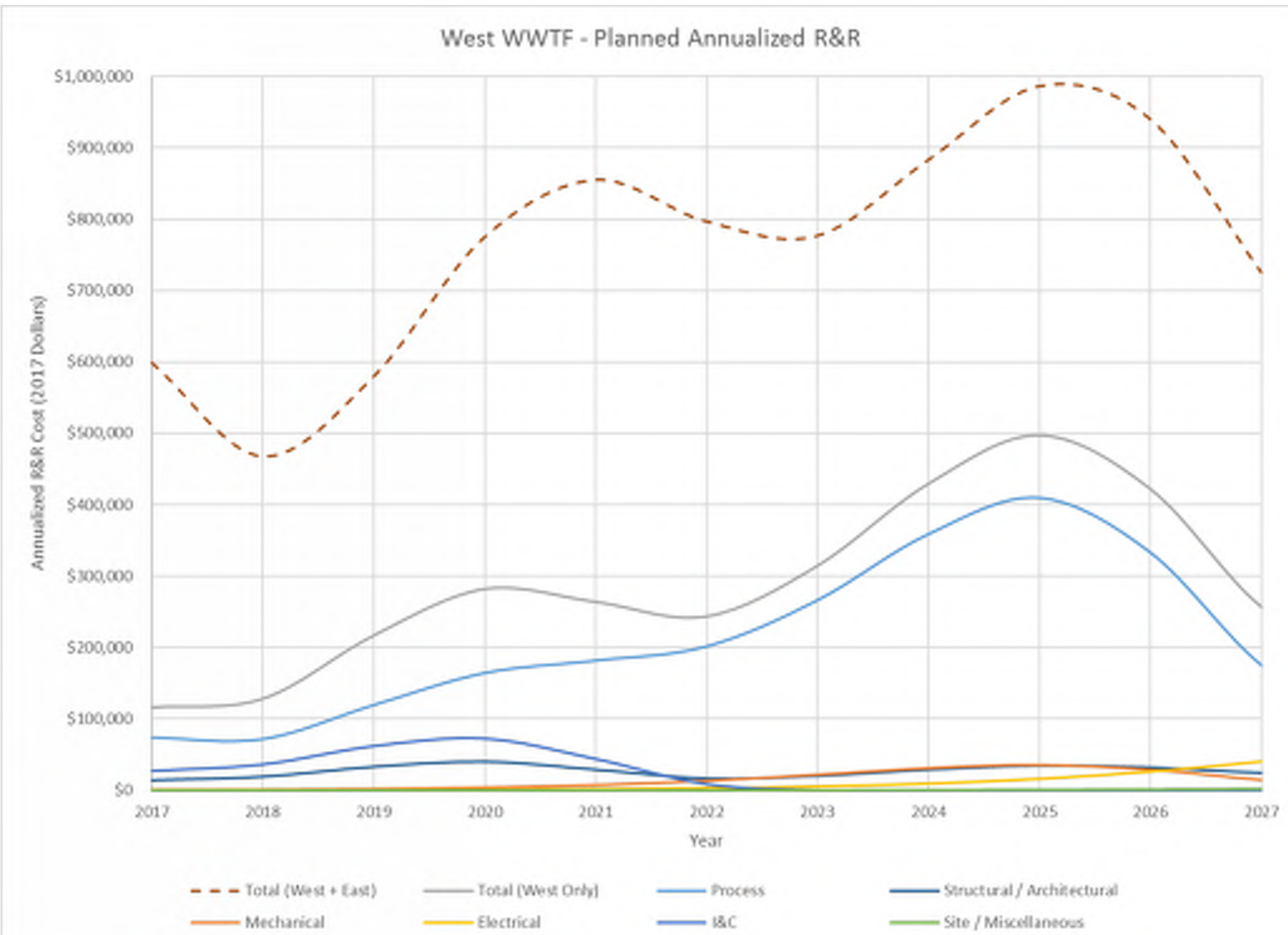

Figure 3.1 – West WWTF Planned R&R Costs (2017 Dollars)

Table 3.2 – East WWTF Planned R&R Costs (2017 Dollars)

Year	Annualized	Cumulative
2017	$478,500	$478,500
2018	$335,500	$814,000
2019	$359,000	$1,173,000
2020	$490,000	$1,663,000
2021	$586,000	$2,249,000
2022	$551,000	$2,800,000
2023	$459,000	$3,259,000
2024	$449,000	$3,708,000
2025	$486,000	$4,194,000
2026	$514,000	$4,708,000
2027	$465,000	$5,173,000

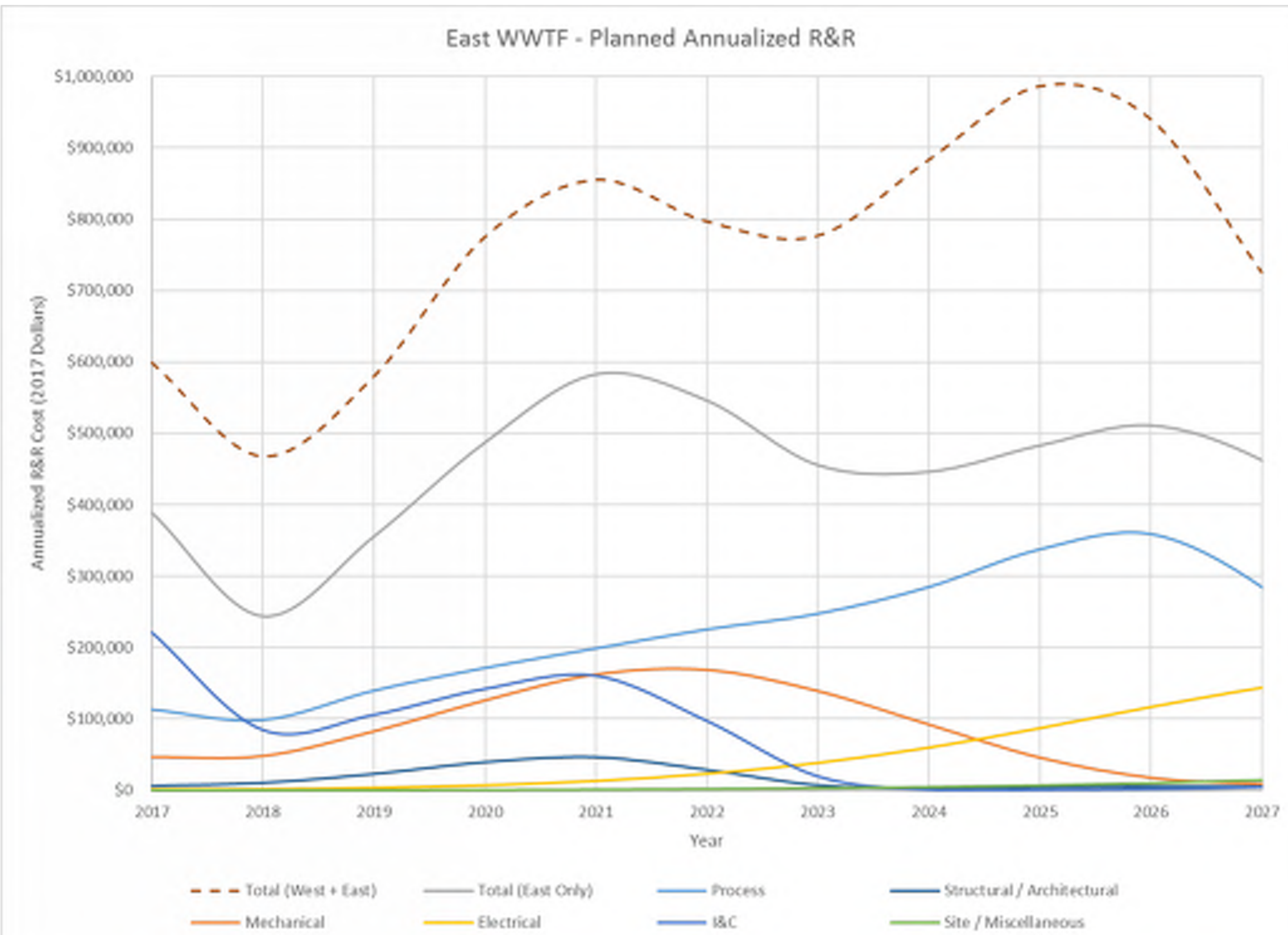

Figure 3.2 – East WWTF Planned R&R Costs (2017 Dollars)

4 SHORT-TERM EQUIPMENT REPLACEMENT PRIORITY

AE2S used the analysis and discussions with the City to identify an abbreviated, short-term equipment replacement priority list. The priority list was developed for inclusion in short-term planning documents and to address WWTF infrastructure (at both facilities) potentially requiring replacement in the next two to three years due to current conditions. Results are presented in Table 4.1.

Table 4.1 – Short-Term Equipment Replacement Priority List (2017 Dollars)

Item No.	WWTF	Short-Term Equipment Replacement	Quantity	Total Approximate Cost (2017 Dollars)
1	East	SCADA & Controls R&R	-	$150,000
2	East	Preliminary Treatment Building Mechanical (Air Exchange Unit)	1	Specific unit cost not included.
3	East	Effluent Sampler	1	$30,000
4	West	Influent Sampler	1	$30,000
5	East	Sludge Storage Tank No. 1 thru 4 Submersible Mixers	4	$40,000
6	East	Drain Lift Station Pumps	2	$20,000
7	East	Effluent DO Probe	1	$2,500
8	East	Preliminary Treatment Building Odor Control Unit	1	$100,000
9	West	RAS Pumps	3	$30,000
10	West + East	Polymer Feed System	1 each	$160,000
11	East	Grit Equipment - Pump and Cyclone	1	$125,000
Other	West + East	East Post-Aeration Tank No. 1 Fine Bubble Diffusers; East Post-Aeration Blowers; West Rotary Screen; West Thickened Sludge Pump	-	$315,000 aggregate

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APPENDIX A

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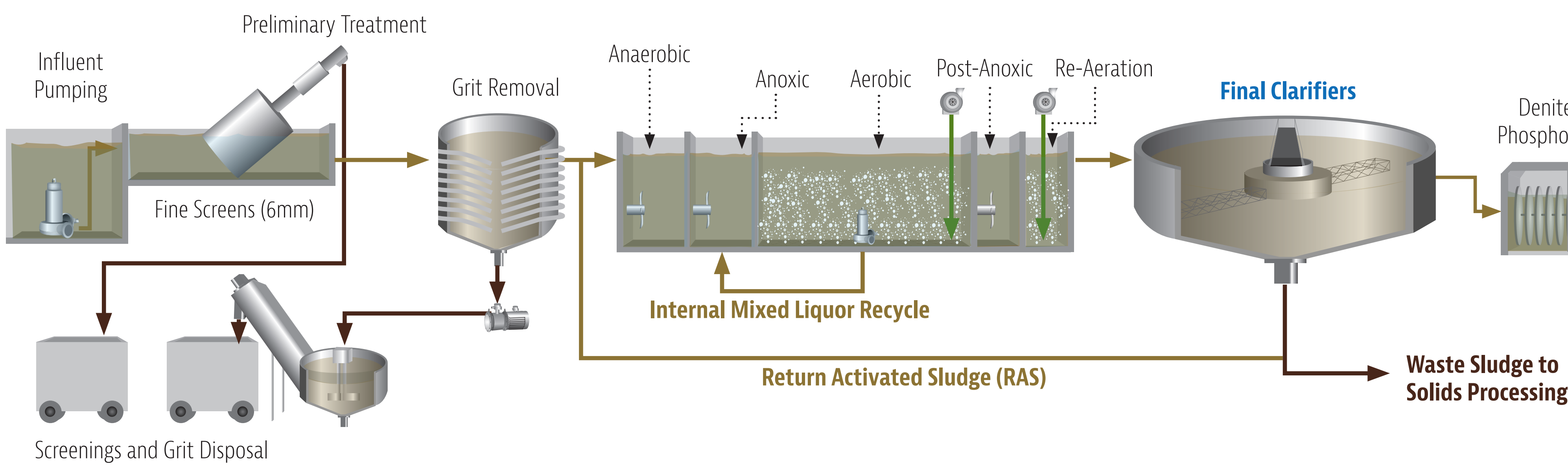
City of Otsego Wastewater Treatment Master Plan

LIQUID TREATMENT OPTIONS

OXIDATION DITCH



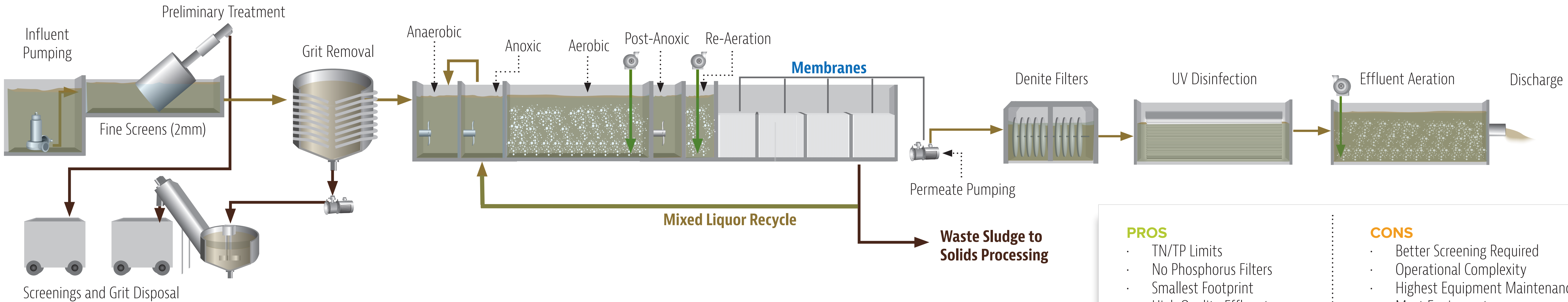
PROS

- TN/TP Limits
- Relative Ease of Operations
- Forgiving System
- Stable Solids
- Familiarity
- Low Sludge Yield

CONS

- Larger Footprint
- Requires Most Concrete
- Limits Site Flexibility

MEMBRANE BIOREACTOR



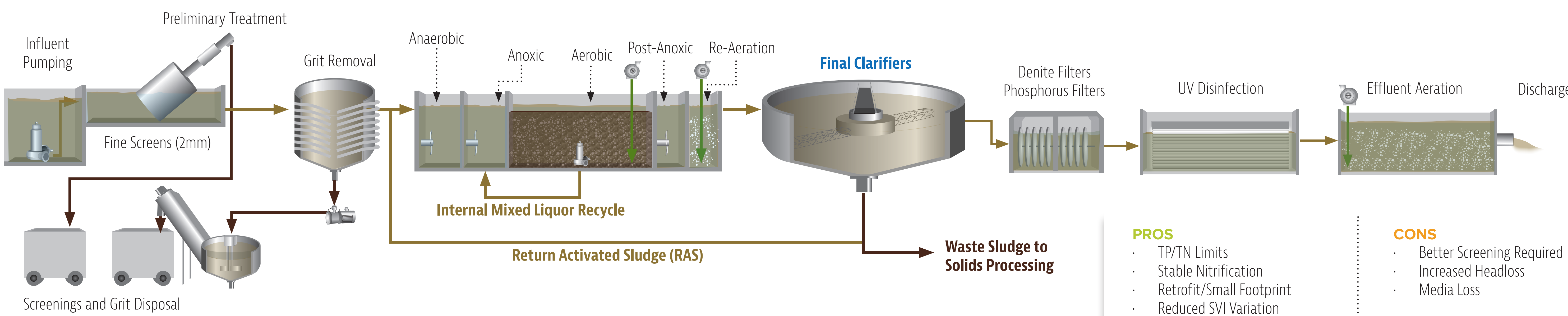
PROS

- TN/TP Limits
- No Phosphorus Filters
- Smallest Footprint
- High Quality Effluent
- Perfect Clarifier
- Reuse Potential

CONS

- Better Screening Required
- Operational Complexity
- Highest Equipment Maintenance
- Most Equipment
- Chemical Cleaning

INTEGRATED FIXED-FILM ACTIVATED SLUDGE



PROS

- TP/TN Limits
- Stable Nitrification
- Retrofit/Small Footprint
- Reduced SVI Variation

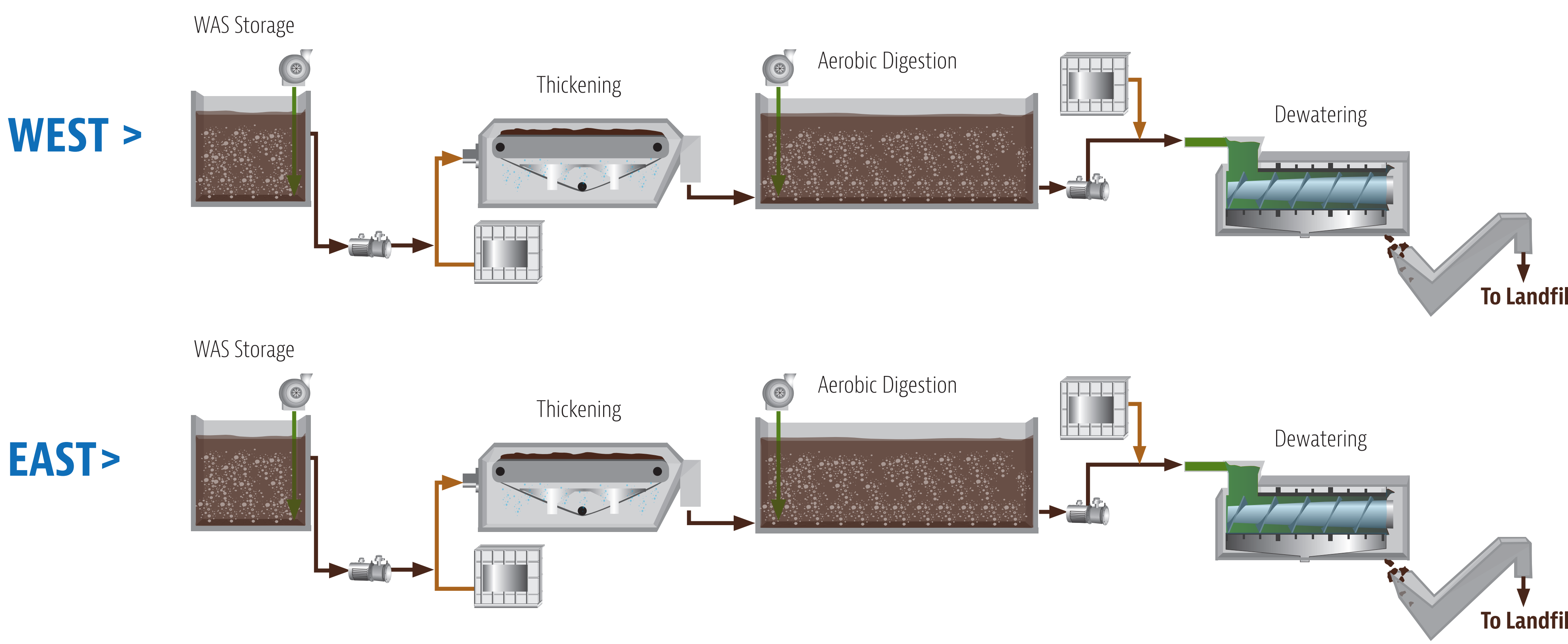
CONS

- Better Screening Required
- Increased Headloss
- Media Loss

SOLID TREATMENT OPTIONS

- From Secondary Treatment Process and/or Final Clarifiers

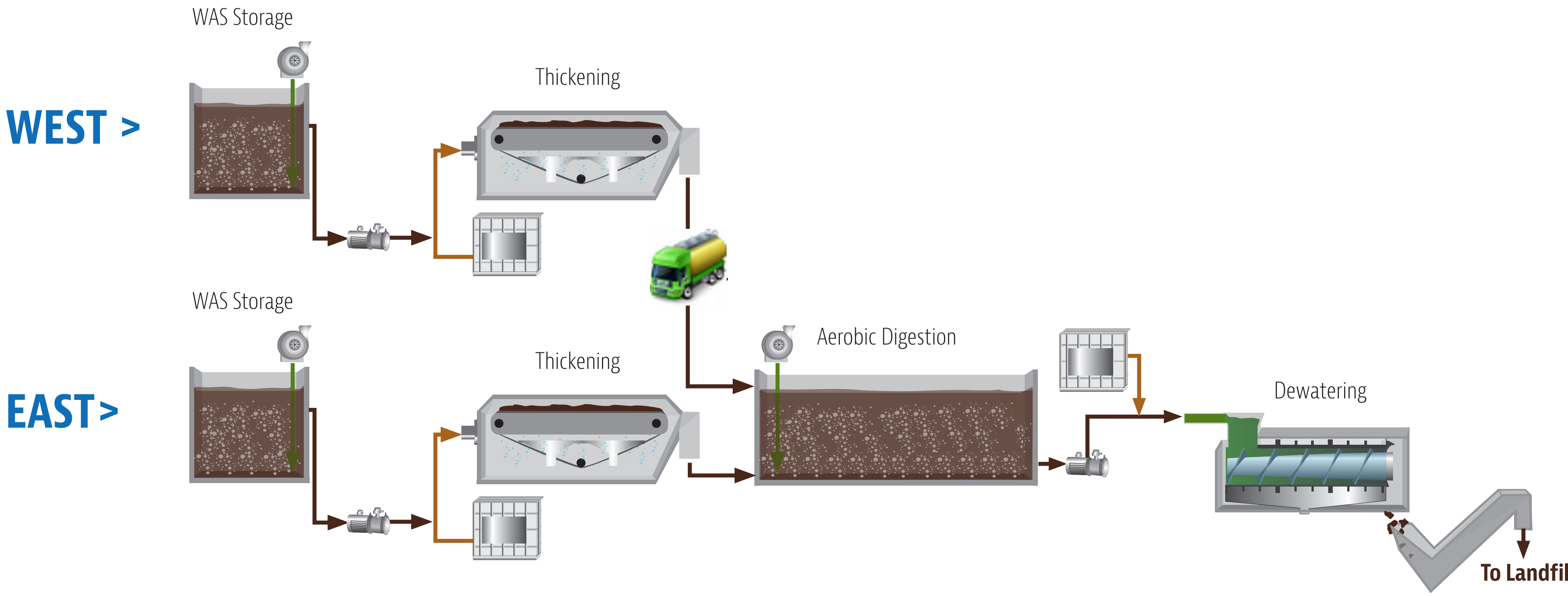
AEROBIC DIGESTION AND DEWATERING AT BOTH FACILITIES



PROS
- Proven technologies
- Technology is similar, if not the same, as existing
- Similar, dedicated technology at each facility
- Reduces overall hauling requirements due to no thickening sludge transport
- Significant re-use of infrastructure available at both facilities
- Spreads footprint requirements between two facilities

CONS
- Extra equipment required to maintain redundancy at both facilities
- Infrastructure for all technologies required at both sides
- Additional labor requirements due to multiple solids treatment processes
- Large overall footprint requirement due to repetition of processes at multiple facilities

CONSOLIDATE AEROBIC DIGESTION AND DEWATERING AT EAST WWTF



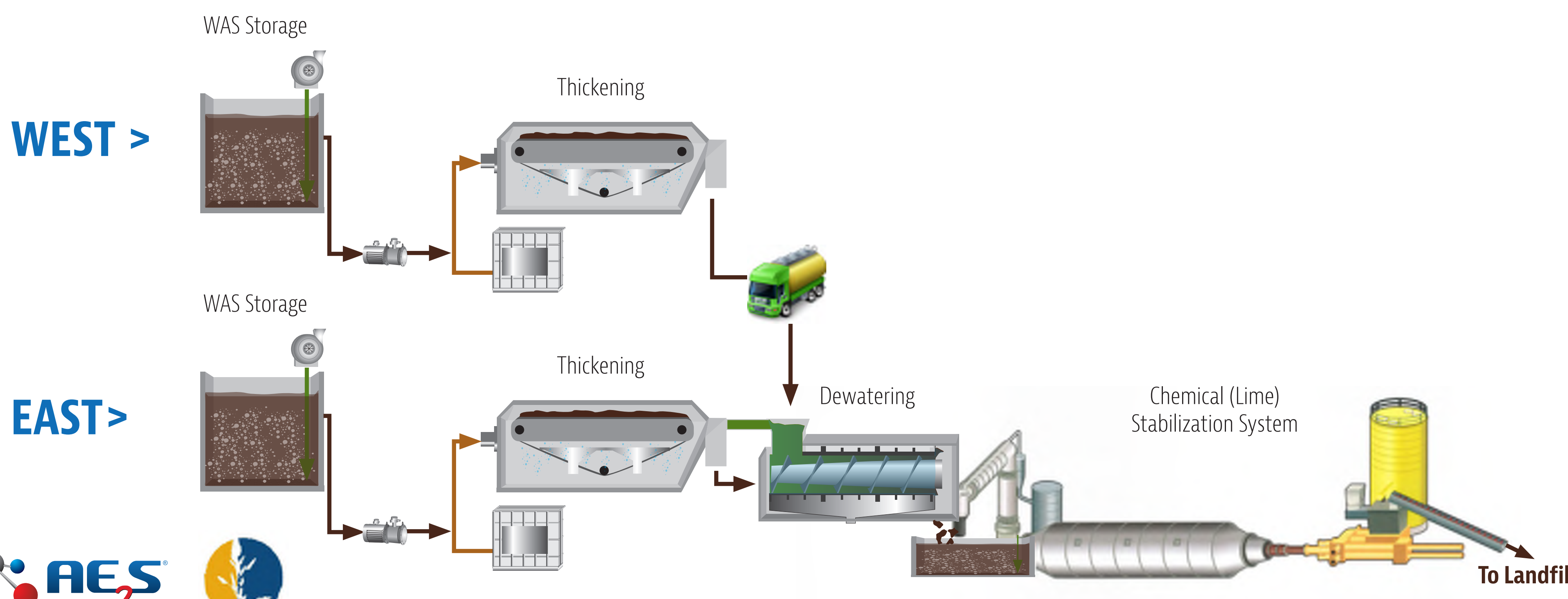
PROS

- Reduces two aerobic digestion and dewatering processes into combined processes at a single facility, reducing overall footprint, equipment, infrastructure, and labor requirements
- Proven technologies
- Technology similar, if not the same, as existing
- Similar, dedicated technology at each facility where required
- Significant re-use of infrastructure available at both facilities

CONS

- Added hauling costs for transport of thickened solids from West to East WWTF
- Large overall footprint requirement at a single facility (East) to handle solids addition from West WWTF

CONSOLIDATE DEWATERING AND CHEMICAL (LIME) STABILIZATION AT EAST WWTF



PROS

- Reduces two dewatering and stabilization processes into combined processes at a single facility, reducing overall footprint and equipment
- Reduced infrastructure requirements through elimination of aerobic digestion in favor of chemical stabilization process
- Proven technology
- Similar, dedicated technology at each facility where required
- Significant re-use of infrastructure available at both facilities
- Class A biosolids for added ultimate disposal flexibility

CONS

- Added hauling costs for transport of thickened solids from West to East WWTF
- Large overall footprint requirement at a single facility (East) to handle solids addition from West WWTF
- Technology new to City staff
- Chemical dependent process

APPENDIX B

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1 C1 **IFAS - WEST CONCEPTUAL SITE PLAN**

50' 0 50' 100'

NORTH

LEGEND

- LIQUID TRAIN
- SOLIDS TRAIN
- LIQUIDS PIPE
- SOLIDS PIPE
- EXISTING PIPE
- ADMINISTRATIVE

PROPOSED IMPROVEMENTS

MARK	DESCRIPTION
1	IFAS TRAIN No. 1
	-ANOXIC CHAMBER
	-AEROBIC CHAMBER
	-POLISH CHAMBER
	-POST-ANOXIC CHAMBER
	-RE-AIR CHAMBER
2	IFAS TRAIN No. 2
	-ANOXIC CHAMBER
	-AEROBIC CHAMBER
	-POLISH CHAMBER
	-POST-ANOXIC CHAMBER
	-RE-AIR CHAMBER
3	IFAS TRAIN No. 3
	-ANOXIC CHAMBER
	-AEROBIC CHAMBER
	-POLISH CHAMBER
	-POST-ANOXIC CHAMBER
	-RE-AIR CHAMBER
4	FINAL CLARIFIER No. 1
5	FINAL CLARIFIER No. 2
6	FINAL CLARIFIER No. 3
7	NEW PTB BUILDING
8	CONVERSION TO ANAEROBIC SELECTORS
9	TERTIARY TREATMENT BUILDING
	-DE-NITRIFICATION FILTERS
	-TOTAL PHOSPHORUS FILTERS
	-EFFLUENT AERATION
	-BLOWERS
	-CHEMICAL FEED
	-UV DISINFECTION
10	RE-PURPOSE INTO AEROBIC DIGESTERS
11	RE-PURPOSE AS WAS STORAGE
12	DEWATERING BUILDING
	-SLUDGE PUMPS
	-DEWATERING UNITS
	-LOADOUT
13	EXPAND EXISTING SLUDGE THICKENING BUILDING
	-BLOWERS
	-WAS / TWAS PUMPS
	-THICKENERS
	-EXPANDED WAS / TWAS STORAGE
14	NEW WAS STORAGE TANKS
15	DIGESTER / DEWATERING FEED TANK
16	AEROBIC DIGESTER
17	BIOFILTER
18	ADMINISTRATION BUILDING

PRELIMINARY
NOT FOR CONSTRUCTION

OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA
IFAS WEST CONCEPTUAL SITE PLAN WITH INDEPENDENT SOLIDS

DRAWING TYPE	PRELIMINARY
PREPARED BY	SAS
CHECKED / APPROVED	### / ###
DATE	MARCH 2017
PROJECT NUMBER	P05409-2013-002
SHEET	1 of 14
DRAWING	C1

Advanced Engineering and Environmental Services, Inc. ● Water Tower Pl Business Ctr 6901 E Fish Lake Rd Ste 184 Maple Grove, MN 55369 ● (t) 763-463-5036 (f) 763-463-5037 ● www.ae2s.com

Layout: SITE
File: W:\Otsego\05409-2013-002\CAD Dwgs\01-Civil\Design\IFAS West Site Plan Concept with Consolidated Solids.dwg

1 / C2 **IFAS - WEST CONCEPTUAL SITE PLAN WITH CONSOLIDATED SOLIDS**

50' 0 50' 100'

NORTH

LEGEND

- LIQUID TRAIN
- SOLIDS TRAIN
- LIQUIDS PIPE
- SOLIDS PIPE
- EXISTING PIPE
- ADMINISTRATIVE

PROPOSED IMPROVEMENTS

MARK	DESCRIPTION
1	IFAS TRAIN No. 1
	-ANOXIC CHAMBER
	-AEROBIC CHAMBER
	-POLISH CHAMBER
	-POST-ANOXIC CHAMBER
	-RE-AIR CHAMBER
2	IFAS TRAIN No. 2
	-ANOXIC CHAMBER
	-AEROBIC CHAMBER
	-POLISH CHAMBER
	-POST-ANOXIC CHAMBER
	-RE-AIR CHAMBER
3	IFAS TRAIN No. 3
	-ANOXIC CHAMBER
	-AEROBIC CHAMBER
	-POLISH CHAMBER
	-POST-ANOXIC CHAMBER
	-RE-AIR CHAMBER
4	FINAL CLARIFIER No. 1
5	FINAL CLARIFIER No. 2
6	FINAL CLARIFIER No. 3
7	NEW PTB BUILDING
8	CONVERSION TO ANAEROBIC SELECTORS
9	TERTIARY TREATMENT BUILDING
	-DE-NITRIFICATION FILTERS
	-TOTAL PHOSPHORUS FILTERS
	-EFFLUENT AERATION
	-BLOWERS
	-CHEMICAL FEED
	-UV DISINFECTION
10	RE-PURPOSE AS WAS STORAGE
11	RE-PURPOSE AS THICKENED WAS STORAGE
12	EXPAND EXISTING SLUDGE THICKENING BUILDING
	-BLOWERS
	-WAS / TWAS PUMPS
	-THICKENERS
	-EXPANDED WAS / TWAS STORAGE
13	BIOFILTER
14	ADMINISTRATION BUILDING

PRELIMINARY
NOT FOR CONSTRUCTION

AE2S

OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA
IFAS WEST CONCEPTUAL SITE PLAN WITH CONSOLIDATED SOLIDS

DRAWING TYPE	PRELIMINARY
PREPARED BY	SAS
CHECKED / APPROVED	### / ###
DATE	MARCH 2017
PROJECT NUMBER	P05409-2013-002
SHEET	2 of 14
DRAWING	C2

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1 / **C3** **MBR - WEST CONCEPTUAL SITE PLAN WITH INDEPENDENT SOLIDS**

50' 0 50' 100'

NORTH

LEGEND

- LIQUID TRAIN
- SOLIDS TRAIN
- LIQUIDS PIPE
- SOLIDS PIPE
- EXISTING PIPE
- ADMINISTRATIVE

PROPOSED IMPROVEMENTS

MARK	DESCRIPTION
1	MEMBRANE BIO REACTOR (MBR)
	-FLOW SPLITTER
	-ANOXIC CHAMBER
	-AERATION CHAMBER
	-POST-ANOXIC CHAMBER
	-MEMBRANE CASSETTE CHAMBER
2	NEW PTB BUILDING
3	CONVERSION TO ANAEROBIC SELECTORS / FERMENTER
4	TERTIARY TREATMENT BUILDING
	-DENITRIFICATION FILTERS (FUTURE)
	-EFFLUENT AERATION
	-BLOWERS
	-CHEMICAL FEED
	-UV DISINFECTION
5	RE-PURPOSE INTO AEROBIC DIGESTERS
6	RE-PURPOSE AS WAS STORAGE
7	DEWATERING BUILDING
	-SLUDGE PUMPS
	-DEWATERING UNITS
	-LOADOUT
8	EXPAND EXISTING SLUDGE THICKENING BUILDING
	-BLOWERS
	-WAS / TWAS PUMPS
	-THICKENERS
	-EXPANDED WAS / TWAS STORAGE
9	BIOFILTER
10	DIGESTER/DEWATERING FEED TANK
11	MBR PROCESS BUILDING
12	NEW WAS STORAGE
13	AEROBIC DIGESTER
14	ADMINISTRATION BUILDING

PRELIMINARY
NOT FOR CONSTRUCTION

AE2S

OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA

MBR WEST CONCEPTUAL SITE PLAN WITH INDEPENDENT SOLIDS

DRAWING TYPE	PRELIMINARY
PREPARED BY	SAS
CHECKED / APPROVED	### / ###
DATE	MARCH 2017
PROJECT NUMBER	P05409-2013-002
SHEET	3 of 14
DRAWING	C3

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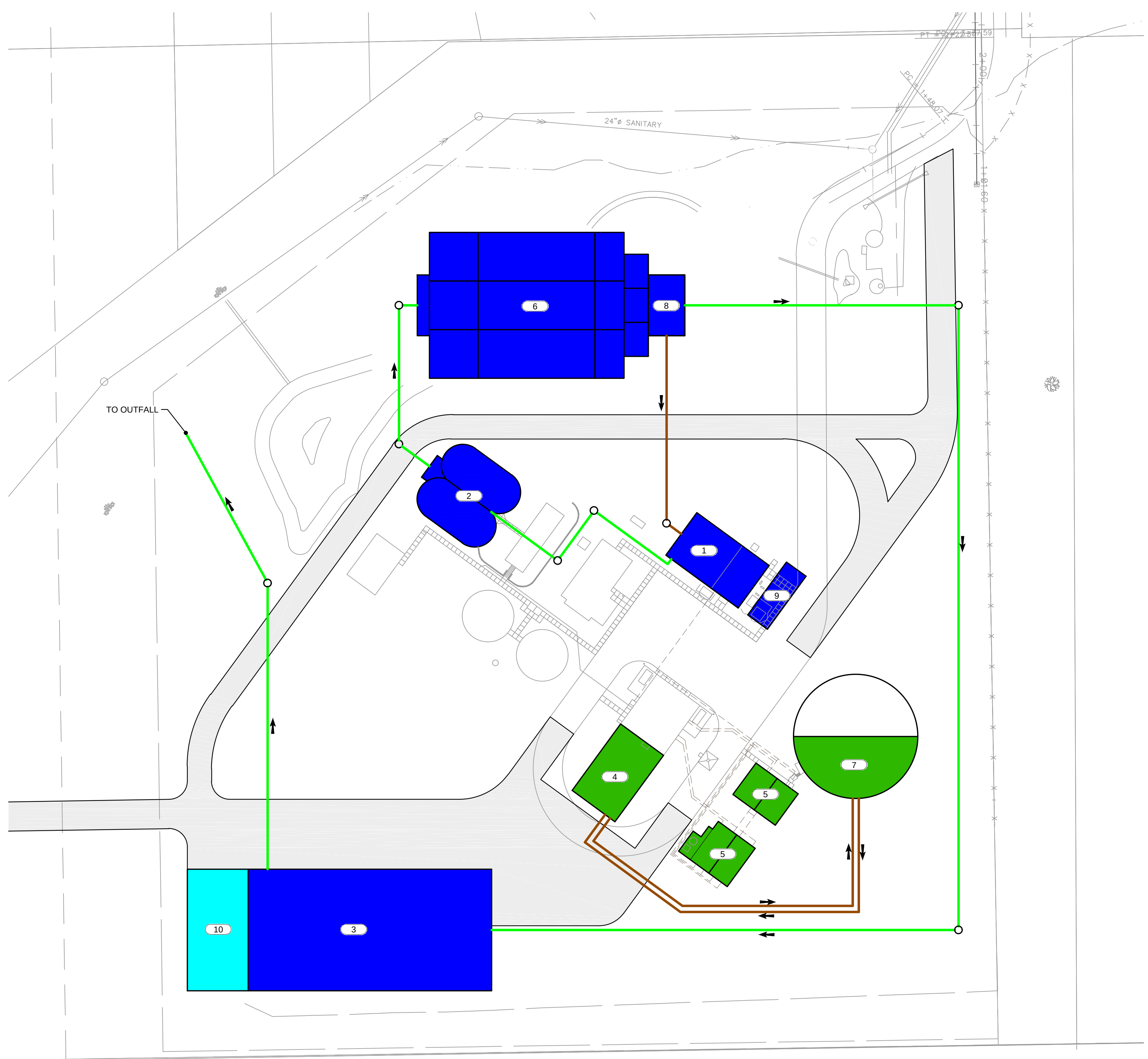

LEGEND

- ADMINISTRATIVE
- LIQUID TRAIN
- SOLIDS TRAIN
- LIQUIDS PIPE
- SOLIDS PIPE
- EXISTING PIPE

PRELIMINARY
NOT FOR CONSTRUCTION

PROPOSED IMPROVEMENTS

MARK	DESCRIPTION
1	NEW PTB BUILDING
2	CONVERSION TO ANAEROBIC SELECTORS / FERMENTER
3	TERTIARY TREATMENT BUILDING -DE-NITRIFICATION FILTERS (FUTURE) -EFFLUENT AERATION -BLOWERS -CHEMICAL FEED -UV DISINFECTION
4	EXPAND EXISTING SLUDGE THICKENING BUILDING -BLOWERS -WAS / TWAS PUMPS -THICKENERS -EXPANDED WAS / TWAS STORAGE
5	RE-PURPOSE AS THICKENED WAS STORAGE
6	MEMBRANE BIO REACTOR (MBR) -FLOW SPLITTER -ANOXIC CHAMBER -AERATION CHAMBER -POST-ANOXIC CHAMBER -MEMBRANE CASSETTE CHAMBER
7	REPURPOSE AS WAS STORAGE
8	MBR PROCESS BUILDING
9	BIOFILTER
10	ADMINISTRATION BUILDING

OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA
MBR WEST CONCEPTUAL SITE PLAN WITH CONSOLIDATED SOLIDS

DRAWING TYPE: PRELIMINARY
PREPARED BY: SAS
CHECKED / APPROVED: ### / ###
DATE: MARCH 2017
PROJECT NUMBER: P05409-2013-002
SHEET: 4 of 14
DRAWING: C4

1 / C4 MBR - WEST CONCEPTUAL SITE PLAN WITH CONSOLIDATED SOLIDS

50' 0 50' 100'

NORTH

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File: W:\Otsego\05409-2013-002\CAD Dwgs\01-Civil\Design\OD West Site Plan Concept.dwg
Layout: SITE

1 C5 OD - WEST CONCEPTUAL SITE PLAN WITH INDEPENDENT SOLIDS

50' 0 50' 100'

NORTH

LEGEND

- LIQUID TRAIN
- SOLIDS TRAIN
- LIQUIDS PIPE
- SOLIDS PIPE
- EXISTING PIPE
- ADMINISTRATIVE

PRELIMINARY
NOT FOR CONSTRUCTION

PROPOSED IMPROVEMENTS

MARK	DESCRIPTION
1	OD TRAIN No. 1
	-ANOXIC CHAMBER
	-POST-ANOXIC CHAMBER
2	OD TRAIN No. 2
	-ANOXIC CHAMBER
	-POST-ANOXIC CHAMBER
3	OD TRAIN No. 3
	-ANOXIC CHAMBER
	-POST-ANOXIC CHAMBER
4	FINAL CLARIFIER No. 1
5	FINAL CLARIFIER No. 2
6	FINAL CLARIFIER No. 3
7	NEW PTB BUILDING
8	CONVERSION TO ANAEROBIC SELECTORS
9	TERTIARY TREATMENT BUILDING
	-DE-NITRIFICATION FILTERS
	-TOTAL PHOSPHORUS FILTERS
	-EFFLUENT AERATION
	-BLOWERS
	-CHEMICAL FEED
	-UV DISINFECTION
10	RE-PURPOSE INTO AEROBIC DIGESTERS
11	RE-PURPOSE AS WAS STORAGE
12	DEWATERING BUILDING
	-SLUDGE PUMPS
	-DEWATERING UNITS
	-LOADOUT
13	EXPAND EXISTING SLUDGE THICKENING BUILDING
	-BLOWERS
	-WAS / TWAS PUMPS
	-THICKENERS
	-EXPANDED WAS / TWAS STORAGE
14	NEW WAS STORAGE TANKS
15	DIGESTER / DEWATERING FEED TANK
16	AEROBIC DIGESTER
17	BIOFILTER
18	ADMINISTRATION BUILDING

OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA
OD WEST CONCEPTUAL SITE PLAN WITH INDEPENDENT SOLIDS

DRAWING TYPE	PRELIMINARY
PREPARED BY	SAS
CHECKED / APPROVED	### / ###
DATE	MARCH 2017
PROJECT NUMBER	P05409-2013-002
SHEET	5 of 14
DRAWING	C5

Plotted By: Randy Leppala Date: Monday, June 12, 2017
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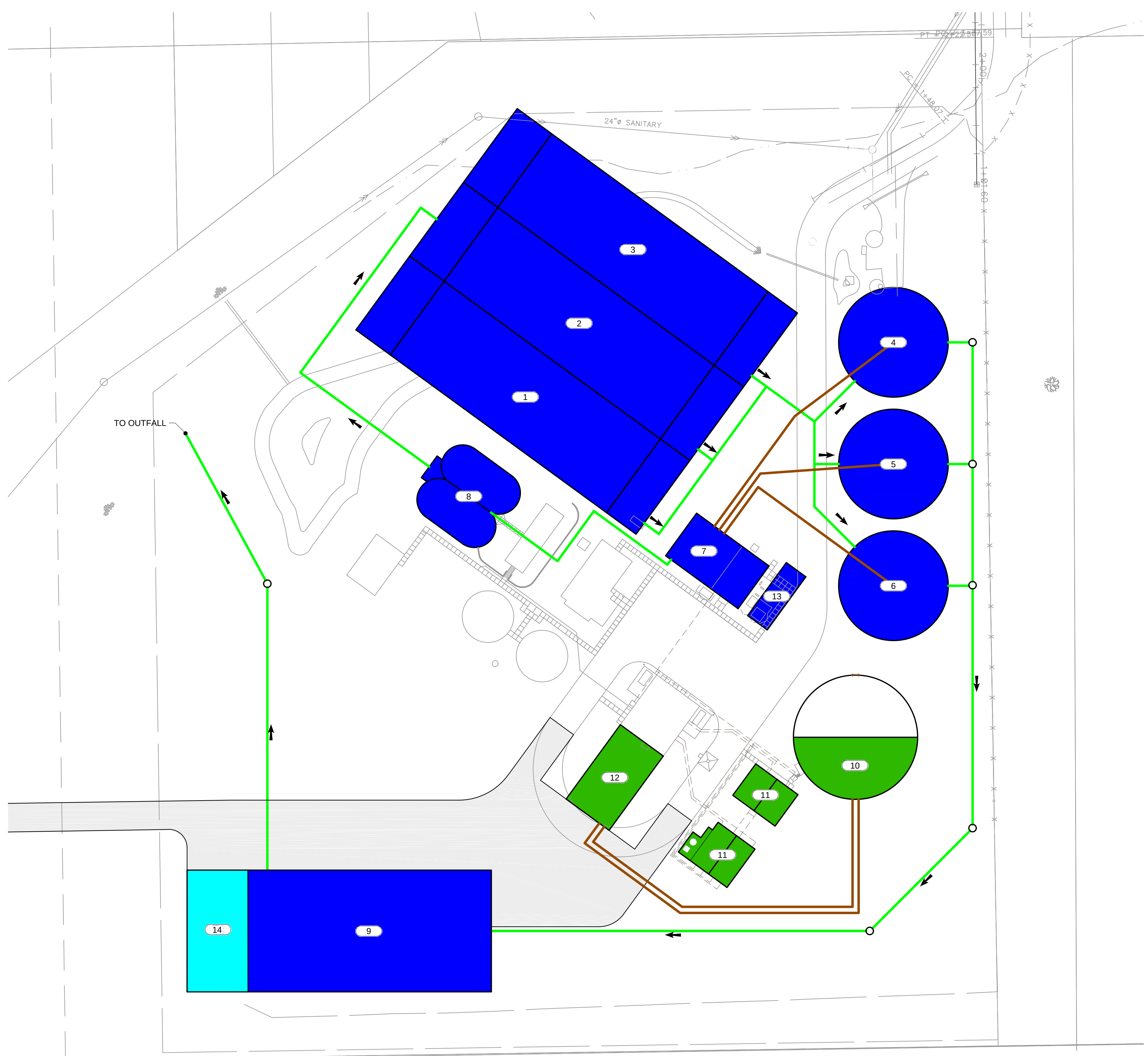

1 / C6 **OD - WEST CONCEPTUAL SITE PLAN WITH CONSOLIDATED SOLIDS**

50' 0 50' 100'

NORTH

LEGEND

(blue)	LIQUID TRAIN
(green)	SOLIDS TRAIN
(green line)	LIQUIDS PIPE
(brown line)	SOLIDS PIPE
(dashed line)	EXISTING PIPE
(cyan)	ADMINISTRATIVE

PROPOSED IMPROVEMENTS

MARK	DESCRIPTION
1	OD TRAIN No. 1
	-ANOXIC CHAMBER
	-POST-ANOXIC CHAMBER
2	OD TRAIN No. 2
	-ANOXIC CHAMBER
	-POST-ANOXIC CHAMBER
3	OD TRAIN No. 3
	-ANOXIC CHAMBER
	-POST-ANOXIC CHAMBER
4	FINAL CLARIFIER No. 1
5	FINAL CLARIFIER No. 2
6	FINAL CLARIFIER No. 3
7	NEW PTB BUILDING
8	CONVERSION TO ANAEROBIC SELECTORS
9	TERTIARY TREATMENT BUILDING
	-DE-NITRIFICATION FILTERS
	-TOTAL PHOSPHORUS FILTERS
	-EFFLUENT AERATION
	-BLOWERS
	-CHEMICAL FEED
	-UV DISINFECTION
10	RE-PURPOSE AS WAS STORAGE
11	RE-PURPOSE AS THICKENED WAS STORAGE
12	EXPAND EXISTING SLUDGE THICKENING BUILDING
	-BLOWERS
	-WAS / TWAS PUMPS
	-THICKENERS
	-EXPANDED WAS / TWAS STORAGE
13	BIOFILTER
14	ADMINISTRATION BUILDING

PRELIMINARY
NOT FOR CONSTRUCTION

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OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA
OD WEST CONCEPTUAL SITE PLAN WITH CONSOLIDATED SOLIDS

DRAWING TYPE	PRELIMINARY
PREPARED BY	SAS
CHECKED / APPROVED	### / ###
DATE	MARCH 2017
PROJECT NUMBER	P05409-2013-002
SHEET	6 of 14
DRAWING	C6

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Layout: SITE
File: W:\Otsego\05409-2013-002\CAD Dwgs\01-Civil\Design\West Site Plan Concept Access Road.dwg

1 / C7 **WEST CONCEPTUAL ACCESS ROAD PLAN**

100' 0 100' 200'

NORTH

PRELIMINARY
NOT FOR CONSTRUCTION

AE2S

OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA

WEST SITE CONCEPT ACCESS ROAD PLAN

DRAWING TYPE	PRELIMINARY
PREPARED BY	SAS
CHECKED / APPROVED	### / ###
DATE	MARCH 2017
PROJECT NUMBER	P05409-2013-002
SHEET	7 of 14
DRAWING	C7

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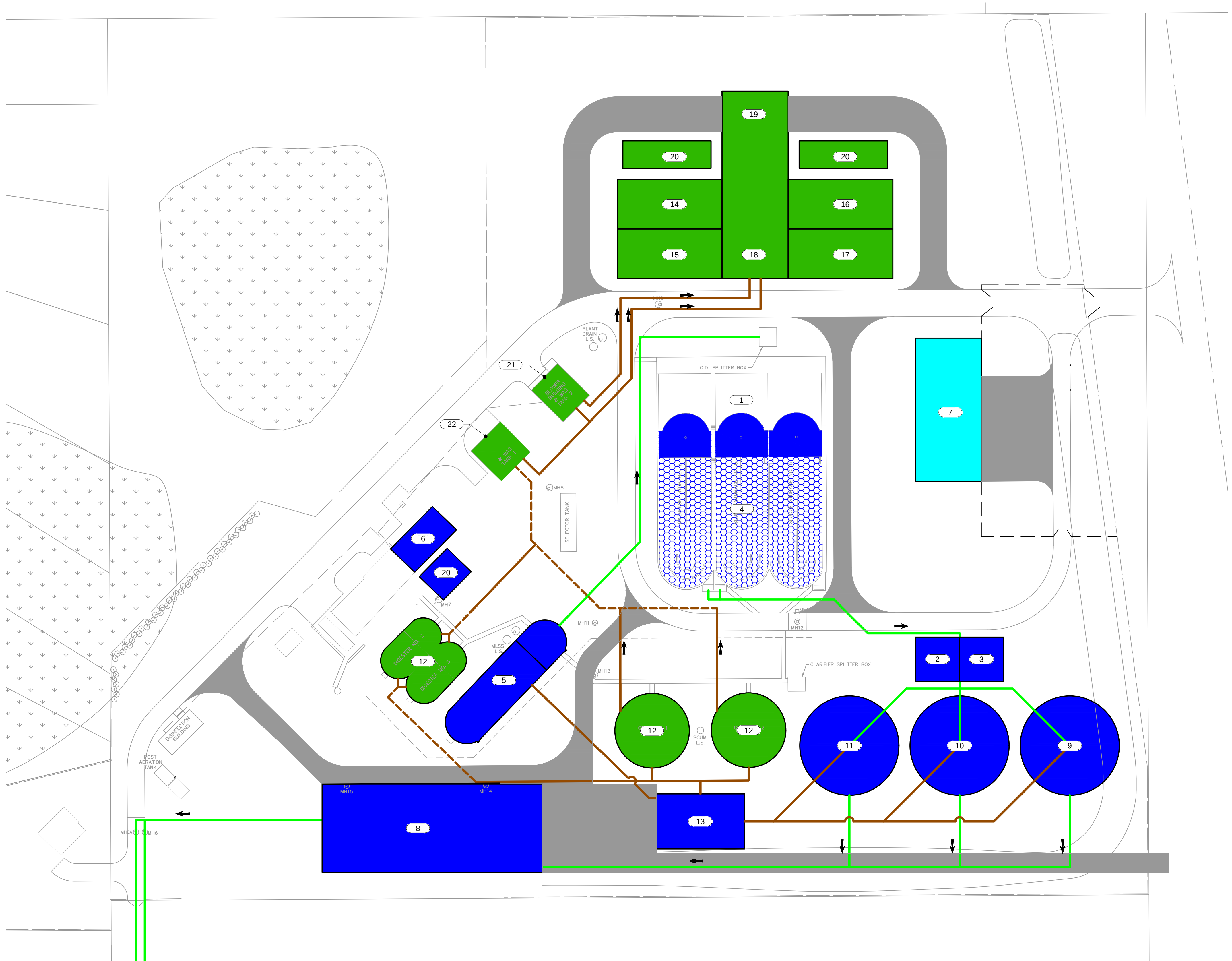

1 / C8 **IFAS - EAST CONCEPTUAL SITE PLAN WITH CONSOLIDATED SOLIDS**

50' 0 50' 100'

NORTH

LEGEND

- ADMINISTRATIVE
- LIQUID TRAIN
- SOLIDS TRAIN
- LIQUIDS PIPE
- SOLIDS PIPE
- EXISTING PIPE

PROPOSED IMPROVEMENTS

MARK	DESCRIPTION
1	ANOXIC ZONES
2	POST-ANOXIC TANK
3	RE-AERATION TANK
4	IFAS WITH NEW MEDIA
5	RE-PURPOSE INTO ANAEROBIC SELECTOR STRUCTURE
6	EXPANSION OF PRE-TREATMENT BUILDING
7	ADMINISTRATION BUILDING
8	TERTIARY TREATMENT BUILDING (DE-NITRIFICATION FILTERS, TOTAL PHOSPHORUS FILTERS, ULTRA VIOLET DISINFECTION, EFFLUENT AERATION, BLOWERS, AND CHEMICAL FEED)
9	FINAL CLARIFIER 1
10	FINAL CLARIFIER 2
11	FINAL CLARIFIER 3
12	RE-PURPOSE INTO WAS STORAGE
13	RAS / WAS PUMP STATION
14	DIGESTER No. 1
15	DIGESTER No. 2
16	DIGESTER No. 3
17	DIGESTER No. 4
18	SOLIDS PROCESSING AND EQUIPMENT BUILDING
19	TRUCK LOADOUT
20	BIOFILTER
21	EXISTING BLOWER BUILDING CONVERTED TO ADDITIONAL THICKENING AND TWAS STORAGE
22	EXISTING THICKENING BUILDING TO REMAIN

PRELIMINARY
NOT FOR CONSTRUCTION

OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA
IFAS EAST CONCEPTUAL SITE PLAN WITH CONSOLIDATED SOLIDS

DRAWING TYPE	PRELIMINARY
PREPARED BY	SAS
CHECKED / APPROVED	### / ###
DATE	MARCH 2017
PROJECT NUMBER	P05409-2013-002
SHEET	8 of 14
DRAWING	C8

File: W:\Otsego\05409-2013-002\CAD Dwgs\01-Civil\Design\IFAS East Site Plan Concept with Consolidated Solids.dwg Layout: SITE

Plotted By: Randy Leppala Date: Monday, June 12, 2017 Last Saved By: Randy Leppala Date: Monday, June 12, 2017 10:38:34 AM

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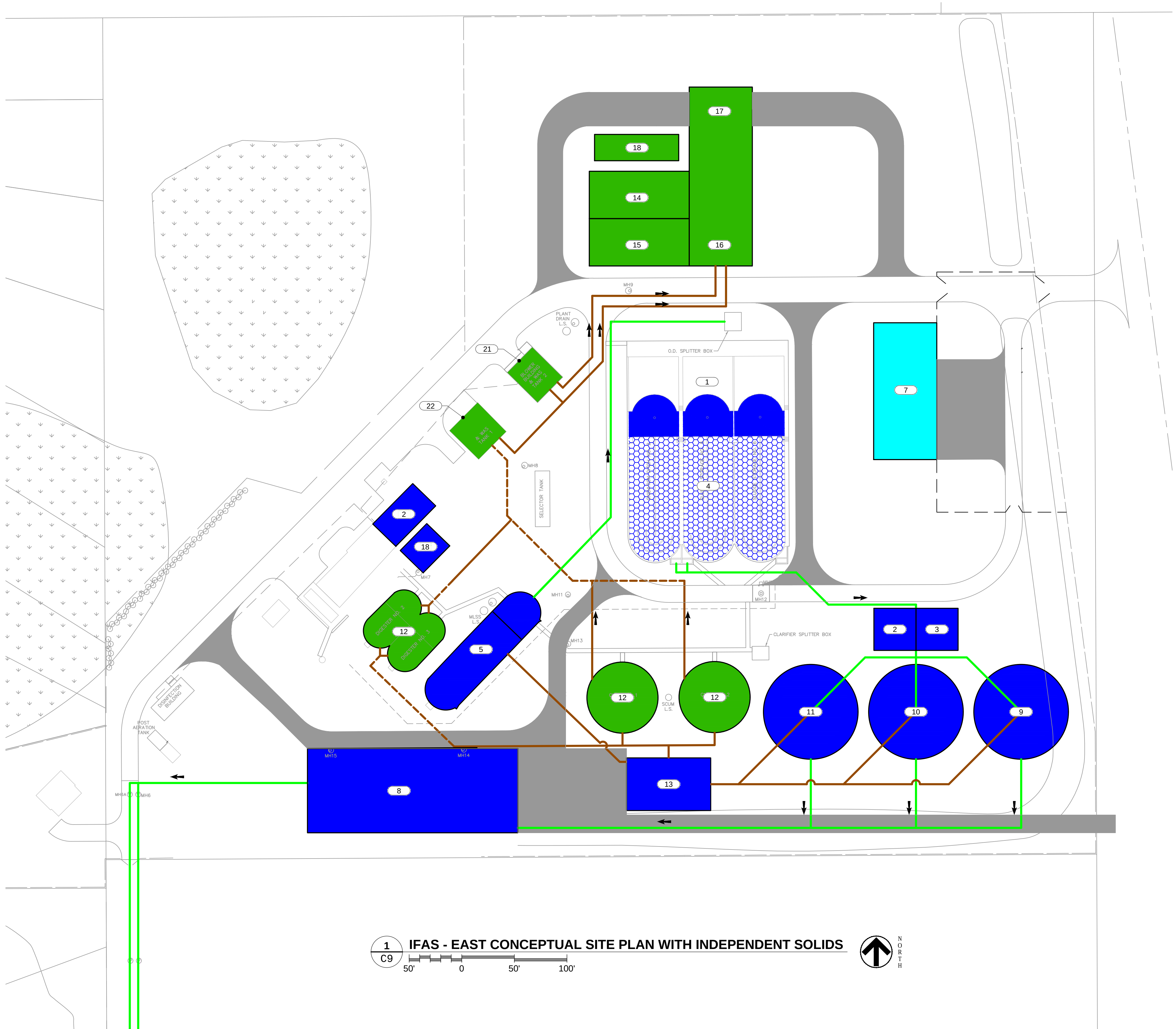

1 C9 IFAS - EAST CONCEPTUAL SITE PLAN WITH INDEPENDENT SOLIDS

50' 0 50' 100'

NORTH

LEGEND

- ADMINISTRATIVE
- LIQUID TRAIN
- SOLIDS TRAIN
- LIQUIDS PIPE
- SOLIDS PIPE
- EXISTING PIPE

PROPOSED IMPROVEMENTS

MARK	DESCRIPTION
1	ANOXIC ZONES
2	POST-ANOXIC TANK
3	RE-AERATION TANK
4	IFAS WITH NEW MEDIA
5	RE-PURPOSE INTO ANAEROBIC SELECTOR STRUCTURE
6	EXPANSION OF PRE-TREATMENT BUILDING
7	ADMINISTRATION BUILDING
8	TERTIARY TREATMENT BUILDING (DE-NITRIFICATION FILTERS, TOTAL PHOSPHORUS FILTERS, ULTRA VIOLET DISINFECTION, EFFLUENT AERATION, BLOWERS, AND CHEMICAL FEED)
9	FINAL CLARIFIER 1
10	FINAL CLARIFIER 2
11	FINAL CLARIFIER 3
12	RE-PURPOSE INTO WAS STORAGE
13	RAS / WAS PUMP STATION
14	DIGESTER No. 1
15	DIGESTER No. 2
16	SOLIDS PROCESSING AND EQUIPMENT BUILDING
17	TRUCK LOADOUT
18	BIOFILTER
21	EXISTING BLOWER BUILDING CONVERTED TO ADDITIONAL THICKENING AND TWAS STORAGE
22	EXISTING THICKENING BUILDING TO REMAIN

PRELIMINARY
NOT FOR CONSTRUCTION

OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA
IFAS EAST CONCEPTUAL SITE PLAN WITH INDEPENDENT SOLIDS

DRAWING TYPE	PRELIMINARY
PREPARED BY	SAS
CHECKED / APPROVED	### / ###
DATE	MARCH 2017
PROJECT NUMBER	P05409-2013-002
SHEET	9 of 14
DRAWING	C9

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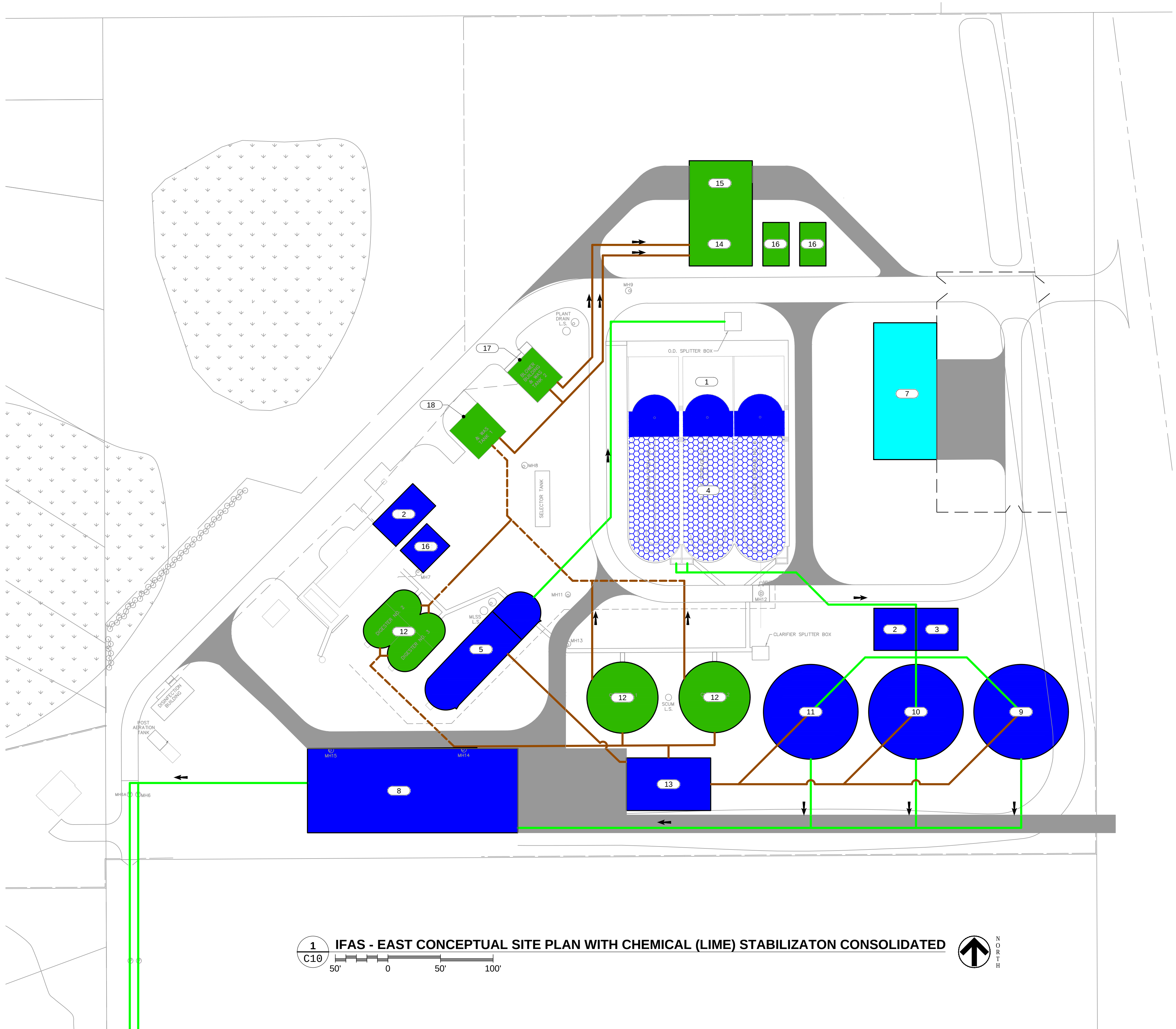
Layout: SITE
File: W:\Otsego\05409-2013-002\CAD Dwgs\01-Civil\Design\IFAS East Site Plan Concept with Schwing Bioset.dwg



LEGEND

- ADMINISTRATIVE
- LIQUID TRAIN
- SOLIDS TRAIN
- LIQUIDS PIPE
- SOLIDS PIPE
- EXISTING PIPE

PRELIMINARY
NOT FOR CONSTRUCTION

PROPOSED IMPROVEMENTS

MARK	DESCRIPTION
1	ANOXIC ZONES
2	POST-ANOXIC TANK
3	RE-AERATION TANK
4	IFAS WITH NEW MEDIA
5	RE-PURPOSE INTO ANAEROBIC SELECTOR STRUCTURE
6	EXPANSION OF PRE-TREATMENT BUILDING
7	ADMINISTRATION BUILDING
8	TERTIARY TREATMENT BUILDING (DE-NITRIFICATION FILTERS, TOTAL PHOSPHORUS FILTERS, ULTRA VIOLET DISINFECTION, EFFLUENT AERATION, BLOWERS, AND CHEMICAL FEED)
9	FINAL CLARIFIER 1
10	FINAL CLARIFIER 2
11	FINAL CLARIFIER 3
12	RE-PURPOSE INTO WAS STORAGE
13	RAS / WAS PUMP STATION
14	SOLIDS PROCESSING AND EQUIPMENT BUILDING
15	TRUCK LOADOUT
16	BIOFILTER
17	EXISTING BLOWER BUILDING CONVERTED TO ADDITIONAL THICKENING AND TWAS STORAGE
18	EXISTING THICKENING BUILDING TO REMAIN

OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA

IFAS EAST CONCEPTUAL SITE PLAN WITH CHEMICAL STAB. CONSOLIDATED

DRAWING TYPE	PRELIMINARY
PREPARED BY	SAS
CHECKED / APPROVED	### / ###
DATE	MARCH 2017
PROJECT NUMBER	P05409-2013-002
SHEET	10 of 14
DRAWING	C10

1 / C10 **IFAS - EAST CONCEPTUAL SITE PLAN WITH CHEMICAL (LIME) STABILIZATON CONSOLIDATED**

50' 0 50' 100'

NORTH

Plotted By: Randy Leppala Date: Monday, June 12, 2017
Last Saved By: Randy Leppala Date: Monday, June 12, 2017 2:42:15 PM

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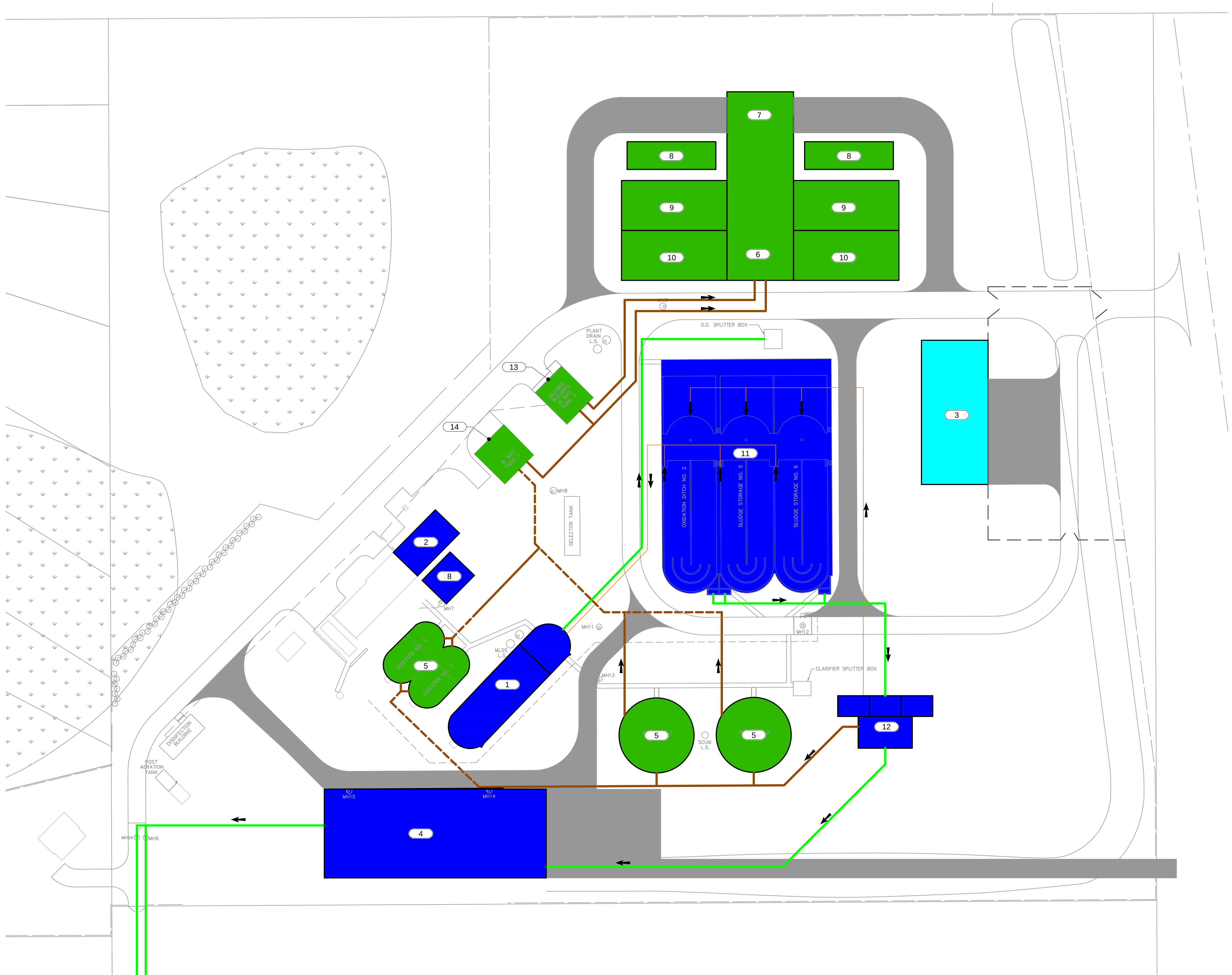

1 / C11 **MBR - EAST CONCEPTUAL SITE PLAN WITH CONSOLIDATED SOLIDS**

50' 0 50' 100'

NORTH

LEGEND

- ADMINISTRATIVE
- LIQUID TRAIN
- SOLIDS TRAIN
- LIQUIDS PIPE
- SOLIDS PIPE
- RECYCLE PIPE
- EXISTING PIPE

PROPOSED IMPROVEMENTS

MARK	DESCRIPTION
1	RE-PURPOSE INTO ANAEROBIC SELECTOR STRUCTURE
2	EXPANSION OF PRE-TREATMENT BUILDING
3	ADMINISTRATION BUILDING
4	TERTIARY TREATMENT BUILDING (FUTURE DE-NITRIFICATION FILTERS, ULTRA VIOLET DISINFECTION, EFFLUENT AERATION, BLOWERS, AND CHEMICAL FEED)
5	RE-PURPOSE INTO WAS STORAGE
6	SOLIDS PROCESSING AND EQUIPMENT BUILDING
7	TRUCK LOADOUT
8	BIOFILTER
9	DIGESTER No. 1
10	DIGESTER No. 2
11	MEMBRANE BIO REACTOR (MBR) - PART 1
	-ANOXIC CHAMBER
	-POST-ANOXIC CHAMBER
12	MEMBRANE BIO REACTOR (MBR) - PART 2
	-MEMBRANE CASSETTE CHAMBER
	-MBR PROCESS BUILDING
13	EXISTING BLOWER BUILDING CONVERTED TO ADDITIONAL THICKENING AND TWAS STORAGE
14	EXISTING THICKENING BUILDING TO REMAIN

PRELIMINARY
NOT FOR CONSTRUCTION

AE2S

OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA
MBR EAST CONCEPTUAL SITE PLAN WITH CONSOLIDATED SOLIDS

DRAWING TYPE	PRELIMINARY
PREPARED BY	SAS
CHECKED / APPROVED	### / ###
DATE	MARCH 2017
PROJECT NUMBER	P05409-2013-002
SHEET	11 of 14
DRAWING	C11

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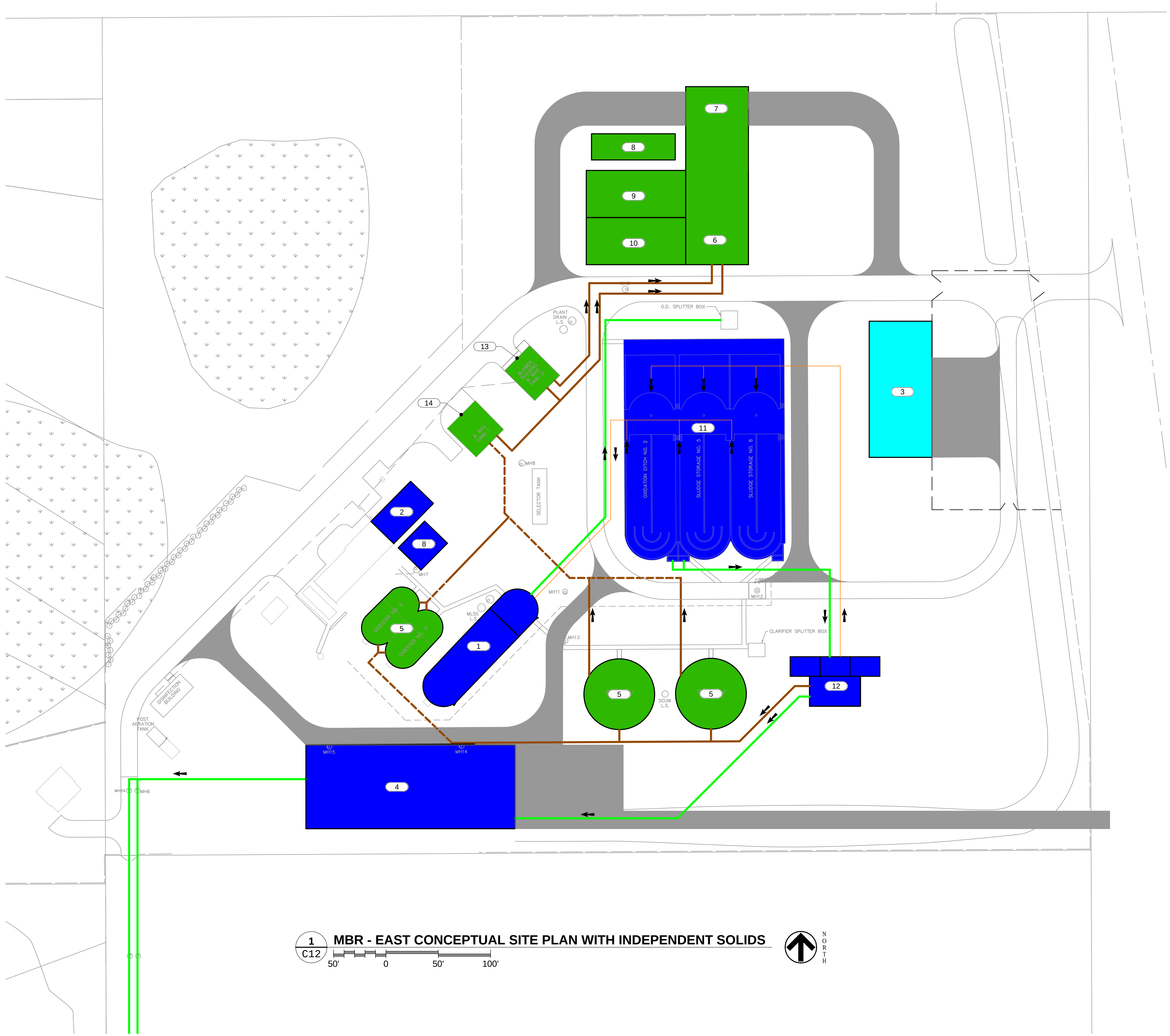
Layout: SITE
File: W:\Otsego\05409-2013-002\CAD Dwgs\01-Civil\Design\MBR East Site Plan Concept with Independent Solids.dwg



LEGEND

(cyan)	ADMINISTRATIVE
(blue)	LIQUID TRAIN
(green)	SOLIDS TRAIN
(green line)	LIQUIDS PIPE
(brown line)	SOLIDS PIPE
(orange line)	RECYCLE PIPE
(dashed line)	EXISTING PIPE

PRELIMINARY
NOT FOR CONSTRUCTION

PROPOSED IMPROVEMENTS

MARK	DESCRIPTION
1	RE-PURPOSE INTO ANAEROBIC SELECTOR STRUCTURE
2	EXPANSION OF PRE-TREATMENT BUILDING
3	ADMINISTRATION BUILDING
4	TERTIARY TREATMENT BUILDING (FUTURE DE-NITRIFICATION FILTERS, ULTRA VIOLET DISINFECTION, EFFLUENT AERATION, BLOWERS, AND CHEMICAL FEED)
5	RE-PURPOSE INTO WAS STORAGE
6	SOLIDS PROCESSING AND EQUIPMENT BUILDING
7	TRUCK LOADOUT
8	BIOFILTER
9	DIGESTER No. 1
10	DIGESTER No. 2
11	MEMBRANE BIO REACTOR (MBR) - PART 1
	-ANOXIC CHAMBER
	-POST-ANOXIC CHAMBER
12	MEMBRANE BIO REACTOR (MBR) - PART 2
	-MEMBRANE CASSETTE CHAMBER
	-MBR PROCESS BUILDING
13	EXISTING BLOWER BUILDING CONVERTED TO ADDITIONAL THICKENING AND TWAS STORAGE
14	EXISTING THICKENING BUILDING TO REMAIN

OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA

MBR EAST CONCEPTUAL SITE PLAN WITH INDEPENDENT SOLIDS

DRAWING TYPE	PRELIMINARY
PREPARED BY	SAS
CHECKED / APPROVED	### / ###
DATE	MARCH 2017
PROJECT NUMBER	P05409-2013-002
SHEET	12 of 14
DRAWING	C12

1 / C12 — MBR - EAST CONCEPTUAL SITE PLAN WITH INDEPENDENT SOLIDS

50' 0 50' 100'

NORTH

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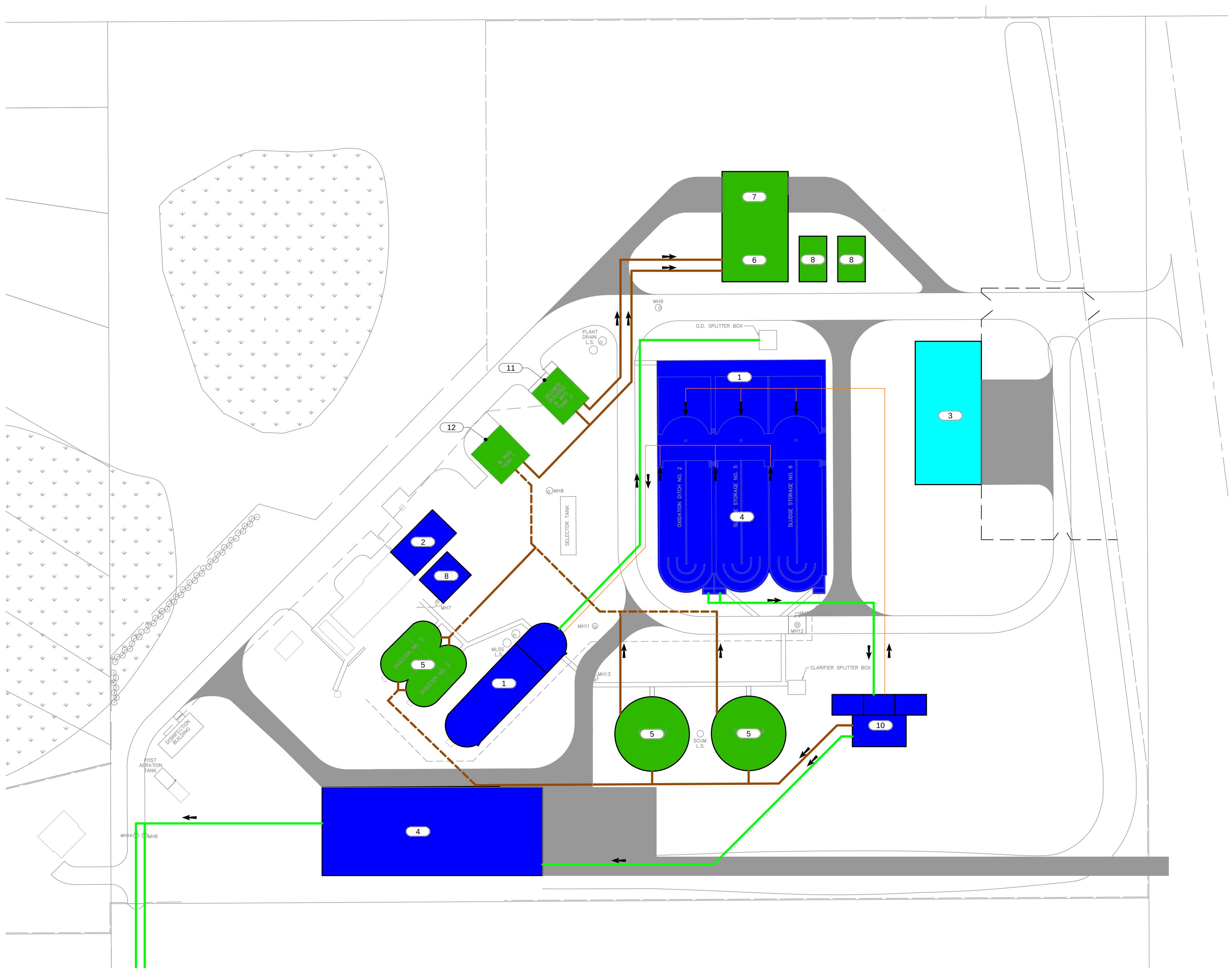
Layout: SITE
File: W:\Otsego\05409-2013-002\CAD Dwgs\01-Civil\Design\IFAS East Site Plan Concept with Chemical Stabilization.dwg



LEGEND

(cyan)	ADMINISTRATIVE
(blue)	LIQUID TRAIN
(green)	SOLIDS TRAIN
(green line)	LIQUIDS PIPE
(brown line)	SOLIDS PIPE
(orange line)	RECYCLE PIPE
(dashed line)	EXISTING PIPE

PROPOSED IMPROVEMENTS

MARK	DESCRIPTION
1	RE-PURPOSE INTO ANAEROBIC SELECTOR STRUCTURE
2	EXPANSION OF PRE-TREATMENT BUILDING
3	ADMINISTRATION BUILDING
4	TERTIARY TREATMENT BUILDING (FUTURE DE-NITRIFICATION FILTERS, ULTRA VIOLET DISINFECTION, EFFLUENT AERATION, BLOWERS, AND CHEMICAL FEED)
5	RE-PURPOSE INTO WAS STORAGE
6	SOLIDS PROCESSING AND EQUIPMENT BUILDING
7	TRUCK LOADOUT
8	BIOFILTER
9	MEMBRANE BIO REACTOR (MBR) - PART 1 -ANOXIC CHAMBER -AERATION CHAMBER -POST-ANOXIC CHAMBER
10	MEMBRANE BIO REACTOR (MBR) - PART 2 -MEMBRANE CASSETTE CHAMBER -MBR PROCESS BUILDING
11	EXISTING BLOWER BUILDING CONVERTED TO ADDITIONAL THICKENING AND TWAS STORAGE
12	EXISTING THICKENING BUILDING TO REMAIN

1 / C13 — MBR - EAST CONCEPTUAL SITE PLAN WITH CHEMICAL (LIME) STABILIZATION CONSOLIDATED

50' 0 50' 100'

NORTH

PRELIMINARY
NOT FOR CONSTRUCTION

AE2S

OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA

IFAS EAST CONCEPTUAL SITE PLAN WITH CHEMICAL STAB. CONSOLIDATED

DRAWING TYPE	PRELIMINARY
PREPARED BY	SAS
CHECKED / APPROVED	### / ###
DATE	MARCH 2017
PROJECT NUMBER	P05409-2013-002
SHEET	13 of 14
DRAWING	C13

Plotted By: Randy Leppala Date: Monday, June 12, 2017
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1 / C14 — OD - EAST CONCEPTUAL SITE PLAN WITH SOLIDS

50' 0 50' 100'

NORTH

LEGEND

- LIQUID TRAIN
- SOLIDS TRAIN
- LIQUIDS PIPE
- SOLIDS PIPE
- EXISTING PIPE
- ADMINISTRATIVE

PROPOSED IMPROVEMENTS

MARK	DESCRIPTION
1	OXIDATION DITCH No. 3
2	OXIDATION DITCH No. 4
3	OXIDATION DITCH No. 5
4	ANOXIC CHAMBER
5	RE-PURPOSE INTO ANAEROBIC SELECTOR STRUCTURE
6	EXPANSION OF PRE-TREATMENT BUILDING
7	ADMINISTRATION BUILDING
8	TERTIARY TREATMENT BUILDING (DE-NITRIFICATION FILTERS, TOTAL PHOSPHORUS FILTERS, ULTRA VIOLET DISINFECTION, EFFLUENT AERATION, BLOWERS, AND CHEMICAL FEED)
9	FINAL CLARIFIER 1
10	FINAL CLARIFIER 2
11	FINAL CLARIFIER 3
12	POST ANOXIC CHAMBER
13	RE-PURPOSE INTO WAS STORAGE
14	RAS / WAS PUMP STATION
15	BIOFILTER
11	EXISTING BLOWER BUILDING CONVERTED TO ADDITIONAL THICKENING AND TWAS STORAGE
12	EXISTING THICKENING BUILDING TO REMAIN

PRELIMINARY
NOT FOR CONSTRUCTION

OTSEGO MASTER PLAN
CITY OF OTSEGO
OTSEGO, MINNESOTA
OD EAST CONCEPTUAL SITE PLAN WITH SOLIDS

DRAWING TYPE	PRELIMINARY
PREPARED BY	SAS
CHECKED / APPROVED	### / ###
DATE	MARCH 2017
PROJECT NUMBER	P05409-2013-002
SHEET	14 of 14
DRAWING	C14

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APPENDIX C

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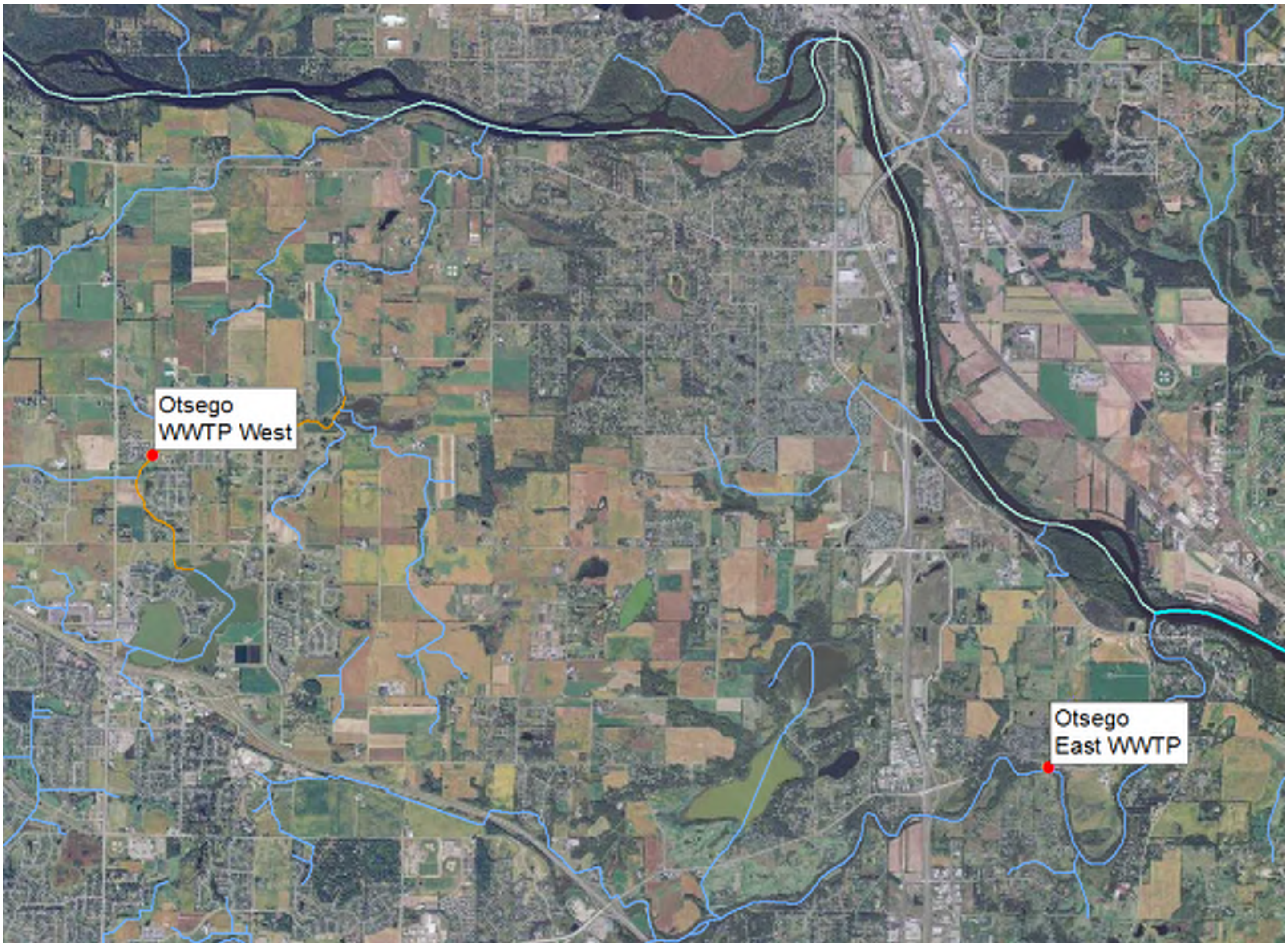
ISSUE STATEMENT

The City of Otsego has applied for a preliminary effluent limit review for an expanded discharge at either their Otsego East or Otsego West facilities. The city is planning a phased expansion with a final average wet weather flow of 7.0 million gallons per day (mgd) and the average dry weather flow of 6.0 mgd. Effluent limitations are calculated using the final expanded flow rate of 6.0 mgd for each facility.

The proposed project would require an anti-degradation review for each parameter with a net increase in loading because of the increase in flow rate. The anti-degradation flow rate for both locations would be 0.0 mgd.



Preliminary Effluent Limits

		Otsego East	Otsego East	Otsego West	Otsego West
Option Number	Unit	A	B	A	B
Current AWWDF	MGD	1.65	1.65	0.72	0.72
Current ADWDF	MGD	1.35	1.35	0.48	0.48
Proposed AWWDF	MGD	7	7	7	7
Proposed ADWDF	MGD	6	6	6	6
cBOD5 Limits	mg/L, Monthly	15	5	15	5
Ammonia Limits (Jun-Sep)	mg/L, Monthly	3	2.8	3	0.8
Ammonia Limits (Oct-Nov)	mg/L, Monthly	10.8	10.8	2.4	2.4
Ammonia Limits (Dec-Mar)	mg/L, Monthly	5	28.1	5	7.7
Ammonia Limits (Apr-May)	mg/L, Monthly	25.8	25.8	1.4	1.4
Ammonia Limits (Jun-Sep)	kg/day, Monthly	41[D]	41[D]	68	68
Ammonia Limits (Oct-Nov)	kg/day, Monthly	58[D]	58[D]	54.4	54.4
Ammonia Limits (Dec-Mar)	kg/day, Monthly	21[D]	21[D]	113	113
Ammonia Limits (Apr-May)	kg/day, Monthly	585	585	31.8	31.8
Dissolved Oxygen, Min	mg/L, Monthly	6	6	6	6
Total Suspended Solids	mg/L, Daily	30	30	30	30
Total Suspended Solids	kg/day, Daily	153.1[D]	153.1[D]	54.4[D]	54.4[D]
Fecal Coliform	org/100ml, Apr-Oct	200[A]	200[A]	200	200
Chlorine, Total Residual	mg/L, Daily Max	0.038[B]	0.038[B]	0.038[B]	0.038[B]
Chloride	mg/L, Monthly Avg	614[C]	614[C]	229	229
Bicarbonate	mg/L, Monthly Avg			342[F]	342[F]
Total Dissolved Solids	mg/L, Monthly Avg			734[F]	734[F]
Specific Conductance	mg/L, Monthly Avg			1064[F]	1064[F]
Mercury, Total	ng/L, Daily Max	6.9[E]	6.9[E]	6.9[E]	6.9[E]
pH	SU	6.0 - 9.0	6.0 - 9.0	6.0 - 9.0	6.0 - 9.0
Phosphorus (Lake Pepin)	kg per 12 month moving total	1824	1824	995	995
Phosphorus (Surface Discharge Restriction)	mg/L 12 Month moving Average	1.0	1.0	1.0	1.0
Phosphorus (River Eutrophication Standard)	kg/day (Jun-Sep)	3.5	3.5		

A – Year Round Disinfection is required
B- Chlorine limit applicable only if chlorine is used for disinfection.
C- This is a target design limit that is protective of the 230 mg/L chloride water quality standard.
D- These are final limits currently in the permit. If the discharge complies with these limits, an anti-degradation review for mercury and TSS is not needed.
E - This is a target design limit that is protective of the 6.9 ng/L mercury water quality standard.
F – A chloride limit could be used as a surrogate for these limits using the chloride linkage.

Crow River Discharge - Otsego East Expansion

The main branch of the Crow River is not a "listed" water in Minn. R. 7050.0470, Subpart 4 (the list of classified waters in the Upper Mississippi River drainage basin). Under Minn. R. 7050.0430 such "unlisted" waters are classified as 2B (Aquatic Life and Recreation), 3B (Industrial Consumption), 4A (Crop Irrigation), 4B (Livestock and Wildlife Watering), 5 (Aesthetic Enjoyment and Navigation), and 6 (Other Uses) waters. The quality of such water should permit the propagation and maintenance of a healthy community of cool or warm water fish and their related habitat. These waters should also be safe for direct body contact.

The main branch of the Crow River is formed by the junction of the North and South Forks at Greenfield. The Crow River flows into the Mississippi River at Otsego. The 7Q10 flow rate at the point of discharge is 19.5 cfs and the 7Q10 of the Mississippi river is at least 1485 cfs.

The North and South Forks and this reach of the Mississippi River are listed as waters having fish consumption advisories due to there being too much mercury in the local fish. There is no mercury advisory for the main branch. The reason for this is not that fish in the Crow River's main branch are safe to eat without limit, but that insufficient sampling has been done in the main branch to declare a fish consumption advisory. For the purposes of this review, mercury is considered a problem pollutant in the main branch of the Crow River.

The reach of the Mississippi River that the Crow River flows into is also listed as state outstanding resource value water (ORVW). Under Minn. R. 7050.0180 subp. 9 (Upstream dischargers to ORVWs), "the agency shall require new or expanded dischargers to waters that flow into outstanding resource value waters be controlled so as to assure no deterioration in the quality of the downstream outstanding resource value water." Since the annual low flow dilution factor will be over 1,000 parts of Mississippi River water to one part Otsego East effluent, and the treatment plant will have effluent limitations stricter than normal secondary limits, the ORVW water is being properly protected.

Under Minn. R. 7050.0211, subp. 1 wastewater treatment plant dischargers that are within 25 miles upstream of drinking water treatment plant intakes must provide continuous disinfection. This treatment plant's discharge is just barely within the 25 mile restriction of the Minneapolis water treatment plant intake. Therefore year-round disinfection is required.

The lower Crow River downstream of Delano is an area of rapid urban growth. The agency considers the resulting increased water quality impacts from both point and nonpoint wastewater discharges to the lower Crow River an issue of serious concern.

The increase in the number of continuous discharges poses a potential winter dissolved oxygen (DO) problem. Winter discharges have the potential to create lengthy DO impact zones. Due to freezing temperatures in the receiving water, organic pollutants decay at a much lower rate than in summer, but they still decay. In decaying they consume oxygen. Under winter conditions (freezing temperatures, days of weak sunlight, ice and snow cover on the river surface) aquatic vegetation is either dormant or produces insignificant amounts of oxygen. The river's ice cap is a physical barrier that prevents replenishment from atmospheric oxygen. Under such conditions, when a stream's DO is depressed, it takes 20-40 miles for the DO to recover. This contrasts with only 3-6 miles for typical summer low dilution ratio conditions.

The impact zones from the future lower Crow River discharges will overlap and probably result in a cumulative impact. Because of this cumulative impact, more stringent summer and winter effluent limitations than secondary were recommended for these discharges. Therefore, all dischargers along the lower Crow River are assigned stringent effluent limits using the cBOD5/Ammonia linkage permitting concept. It is hoped that this procedure will protect both the summer and winter DO water quality standard.

The facility would have reasonable to exceed the chloride water quality standard if the facility were to discharge chloride at a concentration greater than 614 mg/L. The facility does not currently monitor for salty parameters and consequently there is no data to evaluate reasonable potential to exceed the chloride water quality standard. It is likely that the facility has high effluent chloride because Otsego West has high effluent chloride.

Phosphorus effluent limits were calculated as shown in the Greater Crow Phosphorus memo that is attached.

Crow River Discharge - Otsego West Expansion

Otsego West discharges to an unnamed class 7 reach that flows 1.5 miles into an unnamed 2B reach. The 7Q10 flow rate at both reaches is 0.0 cfs and limits were set to protect class 2B aquatic life standards in the unnamed 2B reach.

Effluent limits were set using the cBOD5/Ammonia linkage. Year round disinfection is not required for this discharge.

Salty parameter limits could be set using the chloride linkage if the permittee chooses that option. If the facility chooses the chloride linkage they would only receive a chloride limit that is protective of the other salty parameter limits. The chloride linkage requires the facility commit to specific compliance strategies. Contact the MPCA if you would like more information about the chloride linkage and chloride compliance strategies.

Phosphorus effluent limits were calculated as shown in the Mississippi River – St. Cloud phosphorus memo that is attached.

Antidegradation

An antidegradation review will be required for both discharges for every parameter that will have a net increase in loading to the surface water.

In order to comply with non-degradation requirements for mercury, the permittee must choose one of the two following options. The mass limits associated with each option can be found in Table 2 and are identified with the D qualifier in the limits table.

1. "Freeze" mass and concentration total suspended solids limits at their current levels in lieu of a non-degradation review for mercury. The AWWDF would be allowed to increase to the flow specified in Table 2 for each option.
2. Submit an anti-degradation review that meets the anti-degradation requirements in Minn. R. 7050.0185 for mercury.

A full non-degradation review must be completed and approved in order to determine the limits for the option 2 for mercury. A non-degradation review is a substantial review that must consider all beneficial uses of the receiving water, potential economic impact, all other possible treatment options and all potential environmental degradation for every pollutant triggers the need for an anti-degradation review.

Regulatory Certainty

In response to listening session comments, a proposed, voluntary option — part of the Governor's Community Water Infrastructure bonding investment package — could provide up to 20 years of regulatory certainty for wastewater treatment facilities that are willing to design, construct, and fully operate a biological nutrient removal (BNR) treatment system. BNR systems remove both phosphorous and nitrogen, and are considered the best available technology for wastewater treatment. Indeed, BNR is the only known cost-effective wastewater removal technology for nitrogen.

Once the BNR system is in place, the facility would not be required to comply with any new phosphorous or nitrogen limits, beyond those in their discharge permit, for the estimated useful life of new BNR system. The proposal is linked to a bonding request for water infrastructure grants, and is intended to incentivize facility upgrades to BNR systems.

Communities that volunteer to participate by installing BNR systems would no longer have to speculate what future nitrogen water quality standards might mean for them. Rather than needing to upgrade to meet phosphorus limits now and potentially upgrade again to meet nitrogen limits in five or ten years, communities that install a BNR system would comprehensively address all nutrients for up to 20 years and obtain regulatory certainty. Over time, communities could also save money by reducing both energy usage and the purchase of chemicals for phosphorus removal. Water quality in Minnesota lakes and rivers would also benefit from more treatment plants converting to the best available technology. Notably, we could get a jump on reducing nitrogen in state waters, years ahead of when we can institute a new nitrogen standard. And because Minnesota is home to the headwaters of the Mississippi River, the Great Lakes, and the Red River of the North, the impact of reducing phosphorus and nitrogen in the state will be felt in all our downstream waters, including the Hudson Bay, the Gulf of Mexico, and all the Great Lakes.

Please contact me with any questions,

Scott Kyser
Minnesota Pollution Control Agency
651-757-2665
Scott.Kyser@state.mn.us
October 4th, 2016

DEPARTMENT : POLLUTION CONTROL AGENCY

STATE OF MINNESOTA

SF-00006-05(4/86)

Office Memorandum

DATE : December 21, 2017

TO : File

FROM : Liz Kaufenberg
Effluent Limits Unit
Environmental Analysis and Outcomes Division

PHONE : 651-757-2481

SUBJECT : Total phosphorus effluent limit review: Mississippi River – St. Cloud Watershed

VERSION: 1.1 Added executive summary and edited formatting
1.0 Performed phosphorus limit review for Mississippi River – St. Cloud Watershed

Table of contents

Overview: Mississippi River – St. Cloud Watershed

- Existing total phosphorus (TP) limits for wastewater treatment facilities (WWTFs) are presently sufficient to protect the immediate receiving waters from eutrophication.
- However, 14 of the 18 active WWTFs have the reasonable potential (RP) to cause or contribute to eutrophication in a downstream lake and, thus, have received a water quality based effluent limit (WQBEL)

Executive summary

Algae are an important part of aquatic food webs, but too much algae is not good. When algae become dense in lakes or rivers they turn these waters green and may cause the suffocation of fish and other biota. Furthermore, lakes and rivers with high algal densities become smelly and murky, making them unpleasant for canoeing, swimming, and other recreation.

In Minnesota's lakes and rivers, availability of the nutrient, phosphorus, typically drives the growth of algae. Thus, controlling phosphorus concentrations in these water bodies is essential for preventing eutrophication, a state of a water body where excess nutrients has resulted in excess algae.

In 2008, Minnesota approved lake eutrophication standards (LES), targets to reduce TP and algae in these waters. In 2015, Minnesota adopted rules that include such standards for rivers and streams, river eutrophication standards (RES). At that time, the Minnesota Pollution Control Agency (MPCA) also began setting TP limits on a watershed basis, ensuring that all TP contributors do their "fair share" to reduce phosphorus in the watershed. The MPCA worked with the U.S. Environmental Protection Agency for multiple years to develop its procedures for implementing effluent limits to meet the TP and algae standards. When TP levels and algal levels are too high, the MPCA is required by law to develop a plan to reduce levels of TP, which reduce algae levels in tandem.

This memorandum discusses the MPCA's watershed-based review of TP effluent limits for National Pollutant Discharge Elimination System (NPDES) facilities (i.e., WWTFs) that discharge to the Mississippi River – St. Cloud Watershed. Since 2000, WWTFs within the Upper Mississippi River Basin have made significant reductions in phosphorus being discharged to this basin's waterways. This was possible due to partnership, hard work, and a mutual commitment to protecting and improving Minnesota's water resources. We thank you for being a part of these substantial efforts. Presently, new TP limits to protect for RES are not needed. However, limits are needed to protect for LES in downstream lakes. Of the 18 active permittees in the watershed, existing limits for eight will remain, new limits for another six will be required, new monitoring requirements will be applied to another two permittees, and facility-specific TP WQBELs will be considered for the remaining two permittees following further investigation (Executive Table 1).

We do not create any new seasonal TP limits based on RES since we find that this watershed's WWTFs do not have the RP to cause or contribute to eutrophication in rivers or streams. Algae need particular conditions to multiple and flourish. It is relatively common in Minnesota for a river to have high levels of TP, but low levels of chlorophyll-a (Chl-a), indicative of algal biomass, due to poor conditions for algal growth (e.g., low light availability or high stream flow). At present in the Mississippi River – St. Cloud Watershed, the environmental state of the immediate receiving waters of WWTF discharges is such that excessive algal growth, indicated by measurements of biological oxygen demand (BOD_5) and dissolved oxygen (DO) flux in addition to Chl-a concentrations, has not been occurring under the currently permitted effluent discharges. We summarize our conclusions on TP limits (Executive Table 1):

- **The WWTFs in the Mississippi River – St. Cloud Watershed do not presently have reasonable potential to cause or contribute to a river eutrophication impairment in this watershed given currently permitted effluent discharges.**
- **Existing TP effluent limits are sufficient for protecting rivers and streams in this watershed from eutrophication.**

- **Fourteen of the 18 facilities require a WQBEL since they have the reasonable potential to cause or contribute to eutrophication of a downstream lake.**
    - **The WQBEL is new as of this memo for six WWTFs.**
    - **In most cases, the WQBEL is protective of Lake Pepin, but for some WWTFs it is protective of Orono Lake (Aspen Hills WWTF, Becker WWTF, and Zimmerman WWTF) or Big Elk Lake (Foley WWTF and Gilman WWTF).**
- **At this time, TP monitoring has been recommended rather than a WQBEL for two of the five industrial facilities: Elk River Municipal Utilities and Sysco Western MN.**
- **For two industrial facilities, Xcel - Monticello Nuclear Generating Plant and Xcel - Sherburne Generating Plant, facility-specific TP WQBELs will be addressed following further investigation into these facilities' chemical additives and flow.**
- **Importantly, TP limits may be altered or applied to any Mississippi River – St. Cloud Watershed WWTFs following the completion of the Lake Pepin TMDL study and additional water quality monitoring results.**

Executive Table 1. Summary of applicable annual (January – December) TP limits for facilities in the St. Cloud Watershed. Note, *WLA* abbreviates *wasteload allocation*. Bold values represent newly recommended total phosphorus effluent limits, while non-bold values indicate previously established effluent limits.

Facility	Permit ID	Permit Action/Limit	SDR Limit[a] (mg/L)	Lake Limit (kg/yr)[b]	River WLA (mg/L)	River Limit (mg/L)
Domestic						
Albertville WWTF	MN0050954	Limit	–	**1,284**[c]	–	–
Aspen Hills WWTF	MN0066028	Limit	1.0[d]	27[e,f]	–	–
Becker WWTF[g]	MN0025666	Limit	1.0[d]	903	–	–
Big Lake WWTF	MN0041076	Limit	–	1160[f]	–	–
Clear Lake/Clearwater WWTF	MN0047490	Limit	1.0	669	–	–
Elk River WWTF	MN0020788	Limit	**1.0**	**2,431**	–	–
Foley WWTF	MN0023451	Limit	–	1,026[h]	–	–
Gilman WWTF	MNG580021	Limit	–	**124**[h]	–	–
Monticello WWTF	MN0020567	Limit	–	**2,608**	–	–
Otsego WWTF West	MN0066257	Limit	1.0	995	–	–
Riverbend Mobile Home Park WWTF	MN0042251	Limit	–	290	–	–
St. Cloud WWTF	MN0040878	Limit	1.0	19,783	–	–
Zimmerman WWTF	MN0042331	Limit	1.0	**419**[e]	–	–
Industrial						
Elk River Municipal Utilities[i]	MNG250016	Monitoring	–	–	–	–
Great River Energy - Elk River Station	MN0001988	Limit	–	**98**	–	–
Sysco Western MN (formerly Appert's Inc)[i]	MN0052728	Monitoring	–	–	–	–
Xcel - Monticello Nuclear Generating Plant	MN0000868	Monitoring	–	NA[j]	–	–
Xcel - Sherburne Generating Plant	MN0002186	Monitoring	–	NA[j]	–	–

[a]State discharge restriction (SDR) limits based upon Minn. R. 7053.0255 and are 12-month moving average limits unless otherwise noted.
[b]This is a 12-month moving total limit unless otherwise noted.

[c]This Mass limit is sufficient for Lake Pepin for either proposed alternative discharge location, Alternative #1 or Alternative #2. If Albertville does not move SD002 to either alternative location, previous 0.06 mg/L TP WQBEL required as determined for School Lake (Weiss, 2010). Additionally, this facility has a 661 kg/yr calendar year-to-date total limit.
[d]This facility's SDR is a calendar month average limit.
[e]This mass limit is consistent with Mississippi River (St. Cloud) Watershed TMDLs (Determan et al., 2014) WLA
[f]This is a calendar year-to-date total (kg/yr) limit.
[g]The TP WQBEL is 3.2 kg/day. The daily mass limit was originally assigned due to nondegradation from historical expansion. The annual mass WQBEL is compatible with assumption of Mississippi River (St. Cloud) Watershed TMDLs (Determan et al, 2014) WLA and protective for Upper and Lower Orono Lake.
[h]Mass limit consistent with Elk River Watershed Association TMDL (Wenck, 2012) WLA
[i]TP monitoring recommended alternatively to a TP WQBEL
[j]Facility-specific TP WQBELs will be addressed upon further investigation into chemical additives and flow

Introduction

The purpose of this memorandum is to determine TP effluent limits for NPDES facilities discharging to the Mississippi River – St. Cloud Watershed (St. Cloud Watershed). There are 18 active NPDES WWTFs in this watershed that currently discharge via a surface discharge station (Table 1 and Figure 1). This review supplements the TP effluent limit review specific to the Upper Mississippi River portion of the watershed, located upstream of the confluence of the Mississippi River with the Elk River (Kaufenberg, 2016), by addressing applicable TP limits for the entire St. Cloud Watershed. The St. Cloud Watershed memo is broken into three sections: Upper Mississippi River, Lower Mississippi River, and Elk River Subwatersheds. This memorandum will review applicable state discharge requirements and eutrophication standards for receiving waters to establish TP effluent limits for all 18 WWTFs.

Recently implemented phosphorus limits have contributed to the consistent reduction in point source phosphorus loading to the Mississippi River. This equated to an average loading of 35,803 kg/yr from 2005 – 2008 compared to an average loading of 24,942 kg/yr during 2009 – 2014 (Appendix A) within the St. Cloud Watershed. The difference suggests an approximate 30% average reduction of phosphorus loading from point sources in the St. Cloud Watershed.

Table 1. Active wastewater treatment facilities discharging to a surface water within the St. Cloud Watershed.

Wastewater Treatment Facility	Permit #
Albertville WWTF	MN0050954
Sysco Western MN (formerly Appert's Inc)	MN0052728
Aspen Hills WWTF	MN0066028
Becker WWTF	MN0025666
Big Lake WWTF	MN0041076
Clear Lake/Clearwater WWTF	MN0047490
Elk River Municipal Utilities	MNG250016
Elk River WWTF	MN0020788
Foley WWTF	MN0023451
Gilman WWTF	MNG580021
Great River Energy - Elk River Station	MN0001988
Monticello WWTF	MN0020567
Otsego WWTF West	MN0066257
Riverbend Mobile Home Park WWTF	MN0042251
St. Cloud WWTF	MN0040878
Xcel - Monticello Nuclear Generating Plant	MN0000868
Xcel - Sherburne Generating Plant	MN0002186
Zimmerman WWTF	MN0042331

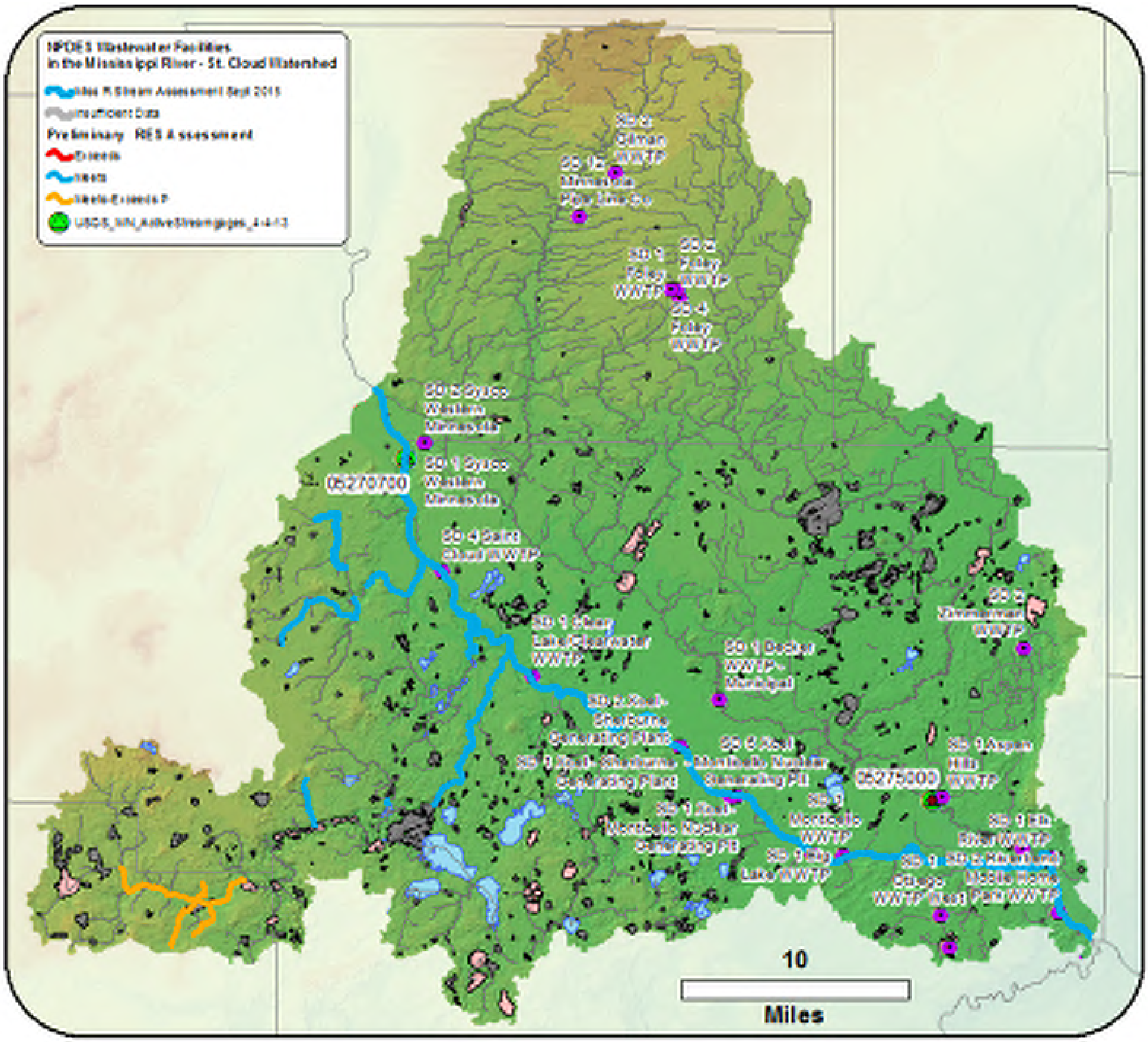


Figure 1. Mississippi River - St. Cloud Watershed NPDES WWTFs.

Mississippi River – St. Cloud Watershed

The St. Cloud Watershed drains 1,080 square miles in the south-central part of the Upper Mississippi River Basin. Much of this stretch of the Mississippi River has been designated as a wild and scenic river with forested bluffs, river access and rest areas, and abundant wildlife. In addition, there is high quality recreational fishing. As part of the MPCA's watershed approach, the St. Cloud Watershed underwent intensive watershed monitoring in 2009. A number of monitoring and assessment, and strategy development reports were developed as part of the effort. There are a number of areas within the watershed identified for projects directed to improve water quality; included are those areas within the watershed with elevated phosphorus. The next intensive watershed monitoring is expected to begin in 2019.

River eutrophication standards

Minnesota has numeric LES, and recently adopted RES. The Mississippi River is located in the Central River Nutrient Region (RNR) and has standards of ≤ 100 µg/L (0.100 mg/L) TP, ≤ 18 µg/L (0.018 mg/L) Chl-a, 3.5 mg/L BOD_5, and 2.0 mg/L DO flux (Minn. R. 7050.0222, Heiskary, 2013).

There are two river reaches with sufficient river eutrophication data down stream of WWTFs in this subwatershed. Both reaches are sections of the Mississippi River, 07010203-728 and 729 (Figure 1). These reaches, which have active upstream NPDES surface discharges, indicate RES criteria are being met (Table 2).

Table 2. St. Cloud Watershed summer (June – September) average TP, Chl-a, and BOD_5 concentrations in the Mississippi River from 2004 to 2014, and applicable Central River Nutrient Region RES criteria. Total phosphorus, Chl-a, and BOD_5 is meeting the applicable criteria. DO flux data were not available.

Summer Water Quality				
AUID	TP (mg/L)	Chl-a (mg/L)	BOD_5 (mg/L)	DO flux (mg/L)
07010203-728	0.064	0.007	1.4	NA
07010203-729	0.063	0.008	1.4	NA
RES Criteria				
Region	TP (mg/L)	Chl-a (mg/L)	BOD_5 (mg/L)	DO flux (mg/L)
Central RNR	0.100	0.018	3.5	2.0

Federal law [40 CFR 122.44(d)] restricts mass increases upstream of impaired waters and requires permits for all NPDES dischargers that have RP to cause or contribute to downstream impaired waters to contain a WQBEL for the pollutant of concern. RES based effluent limits will be based on river monitoring locations with sufficient data for both the cause criterion and at least one response criterion. A RES effluent limit analysis will be completed for WWTFs upstream of these monitoring locations. When both the cause and a response criteria are exceeded (i.e. exceeds RES), the cause criterion becomes the basis for establishing effluent limits and **RP analysis** is completed. When neither the cause nor response criteria are exceeded, the focus is on protecting for the cause criterion, and a **protection analysis** is completed. The most complicated situation for effluent limit reviewers is when the cause criterion is exceeded and the response criterion is not exceeded. In such cases, effluent limit reviewers will complete a **response potential analysis** and consider downstream surface waters (MPCA, 2015).

Protection analyses, following this methodology were conducted for the St. Cloud Watershed to determine if additional limits were appropriate for RES protection. The following is a summary of the analyses conducted for the individual subwatershed.

Upper Mississippi River Subwatershed

The Upper Mississippi River – St. Cloud Subwatershed (Upper Subwatershed) (highlighted portion in Figure 2) includes those WWTFs that discharge to the Mississippi River upstream of where it joins with the Elk River (Table 3).

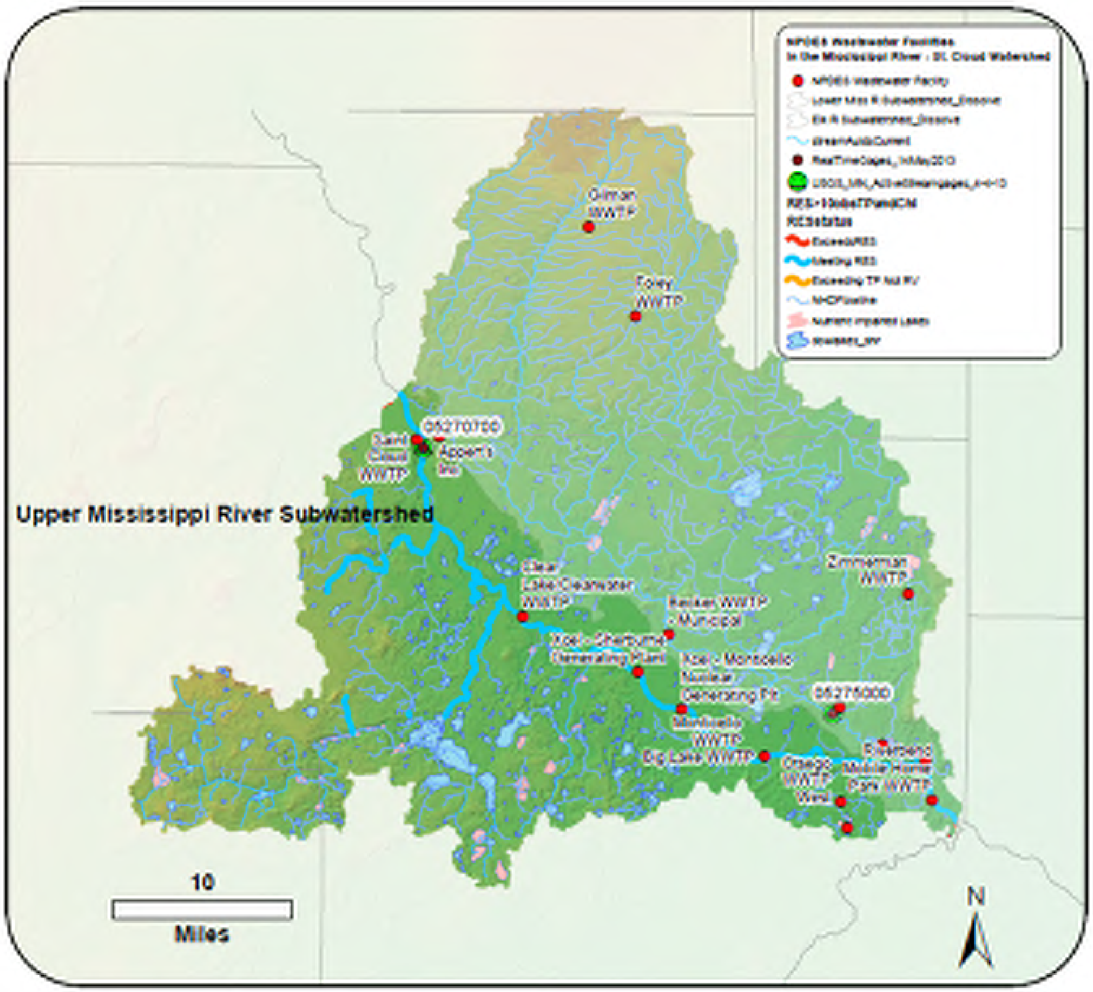


Figure 2. Upper Mississippi River – St. Cloud Subwatershed and NPDES WWTFs.

Table 3. NPDES permitted facilities included in the Upper Subwatershed portion of the Mississippi River – St. Cloud Watershed phosphorus review. This list includes those facilities that discharge to the Mississippi River upstream of the confluence with the Elk River.

Wastewater Treatment Facility	Permit #
Albertville WWTF	MN0050954
Sysco Western MN (formerly Appert's Inc)	MN0052728
Big Lake WWTF	MN0041076
Clear Lake/Clearwater WWTF	MN0047490
Monticello WWTF	MN0020567
Otsego WWTF West	MN0066257
St. Cloud WWTF	MN0040878
Xcel - Monticello Nuclear Generating Plant	MN0000868
Xcel - Sherburne Generating Plant	MN0002186

Upon completion of RES analysis, it was determined current State Discharge Restriction (SDR) (Minn. R. 7053.0255) and Lake Pepin WQBELs are appropriate to protect for water quality standards (Table 4). An overview of this analysis can be found in Kaufenberg (2016).

Table 4. Summary of applicable annual (January – December) TP limits for the Upper Subwatershed facilities and corresponding time-period.

	State Discharge Restriction[a]	Lake Pepin
Facility Domestic	12 - month moving average (mg/L)	12 - month moving total (kg/yr)
Albertville WWTF		1,284[b]
Sysco Western MN (formerly Appert's Inc)[c]		
Big Lake WWTF		1,160
Clear Lake/Clearwater WWTF	1.0	669
Monticello WWTF		2,608
Otsego WWTF West	1.0	995
St. Cloud WWTF	1.0	19,783
Xcel - Monticello Nuclear Generating Plant		NA[d]
Xcel - Sherburne Generating Plant		NA[d]

[a]State discharge restriction limits based upon Minn. R. 7053.0255

[b]Mass limit sufficient for Lake Pepin for either proposed alternative discharge location, Alternative #1 or Alternative #2. If Albertville does not move SD002 to either alternative location, previous 0.06 µg/L TP WQBEL required as determined for Hunters Lake (Weiss, 2010). See Upper Mississippi River – St. Cloud Watershed (Kaufenberg, 2016) memo for details.

[c]TP monitoring recommended alternatively to a TP WQBEL

[d]Facility – specific TP WQBELs will be addressed upon further investigation into chemical additives and flow

Elk River Subwatershed

The Elk River Subwatershed (highlighted portion in Figure 3) includes those WWTFs that discharge to the Elk River upstream of where it joins with the Mississippi River (Table 5). The Mississippi River (St. Cloud) Watershed Total Maximum Daily Load and Elk River Watershed Association TMDL reports are applicable for the Elk River Subwatershed WWTFs listed in Table 5. The reports set wasteload allocations for Aspen Hills, Becker, and Zimmerman WWTFs protective of Upper and Lower Orono Lake as well as Foley and Gilman WWTFs protective of Big Elk Lake. The annual wasteload allocations were translated into WQBELs. In this case, the wasteload allocations are the same as the WQBELs. Insufficient water quality data prohibits RES analysis along individual river reaches in the Elk River Subwatershed. However, because LES are more restrictive than RES in this watershed, downstream waters are sufficiently protected.

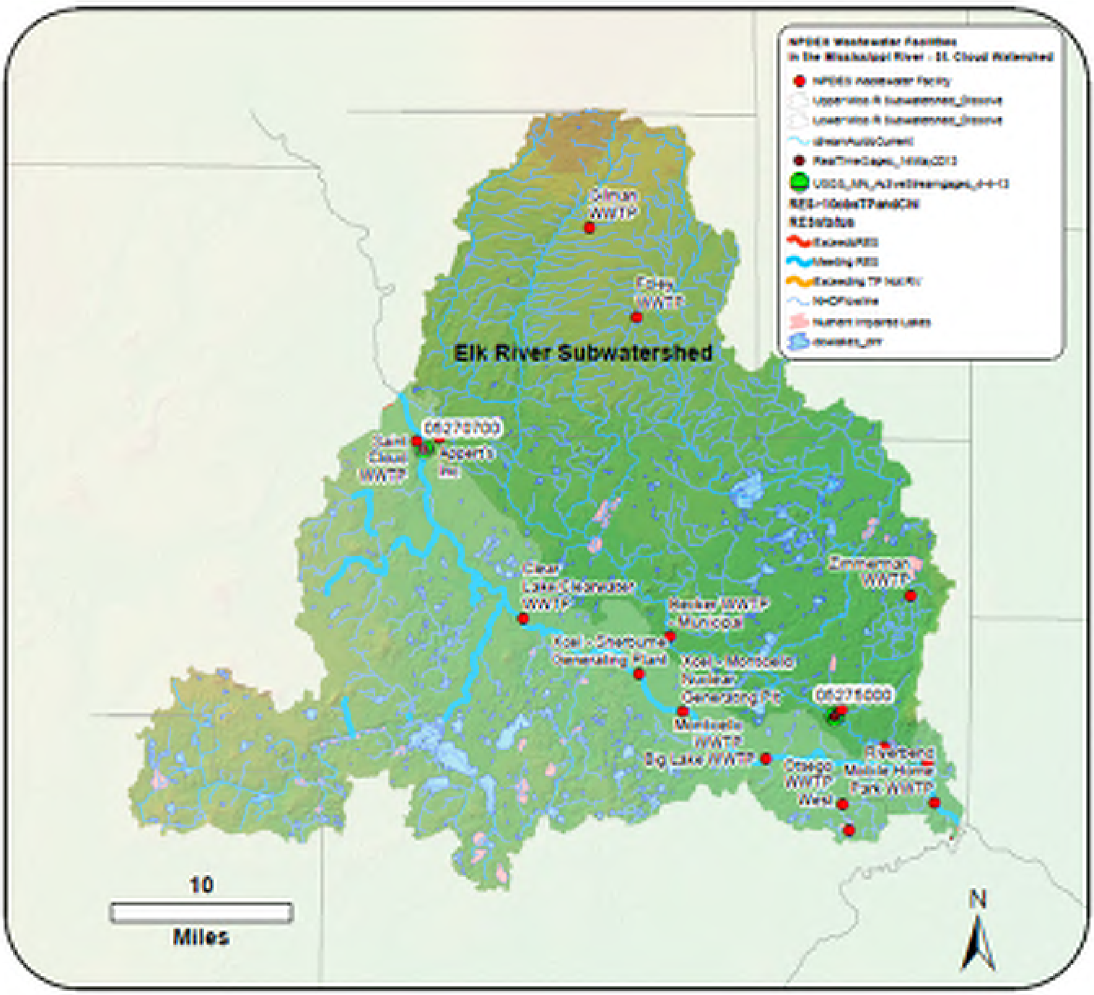


Figure 3. Elk River Subwatershed and NPDES WWTFs within Mississippi River - St. Cloud Watershed.

Table 5. NPDES permitted facilities included in the Elk River Subwatershed portion of the Mississippi River – St. Cloud Watershed phosphorus review. This list includes those facilities that discharge to the Elk River upstream of the confluence with the Mississippi River.

Wastewater Treatment Facility	Permit #
Aspen Hills WWTP	MN0066028
Becker WWTF	MN0025666
Foley WWTF	MN0023451
Gilman WWTF	MNG580021
Zimmerman WWTF	MN0042331

An overview of all applicable TP limits, and respective time-periods, for the facilities within the Elk River Subwatershed can be found in Table 6.

Table 6. Summary of applicable annual (January –December) TP limits for the Elk River Subwatershed facilities and corresponding time-period.

	State Discharge Restriction[a]		Lake Eutrophication Standards		
Facility Domestic	calendar month average (mg/L)	12 - month moving average (mg/L)	calendar year-to-date total (kg/day)	calendar year-to-date total (kg/yr)	12 - month moving total (kg/yr)
Aspen Hills WWTF	1.0			27	
Becker WWTF	1.0		3.2[b]		903[d]
Foley WWTF					1,026[c]
Gilman WWTF					124[c]
Zimmerman WWTF		1.0			419[d]

[a]State discharge restriction limits based upon Minn. R. 7053.0255
[b]TP WQBEL is 3.2 kg/day. Daily mass limit was originally assigned due to nondegradation from historical expansion. The WQBEL is compatible with assumption of Mississippi River (St. Cloud) Watershed TMDLs (Determan et al, 2014) WLA and protective for Upper and Lower Orono Lake.
[c]Mass limit consistent with Elk River Watershed Association TMDL (Wenck, 2012) WLA and eutrophication standards
[d]Mass limit consistent with Mississippi River (St. Cloud) Watershed TMDLs (Determan et al., 2014) WLA

Lower Mississippi River Subwatershed

The Lower Mississippi River – St. Cloud Subwatershed (Lower Subwatershed) (highlighted portion in Figure 4) includes those WWTFs (collectively referred to as The Facilities) that discharge to the Mississippi River downstream of where it joins with the Elk River (Table 7).

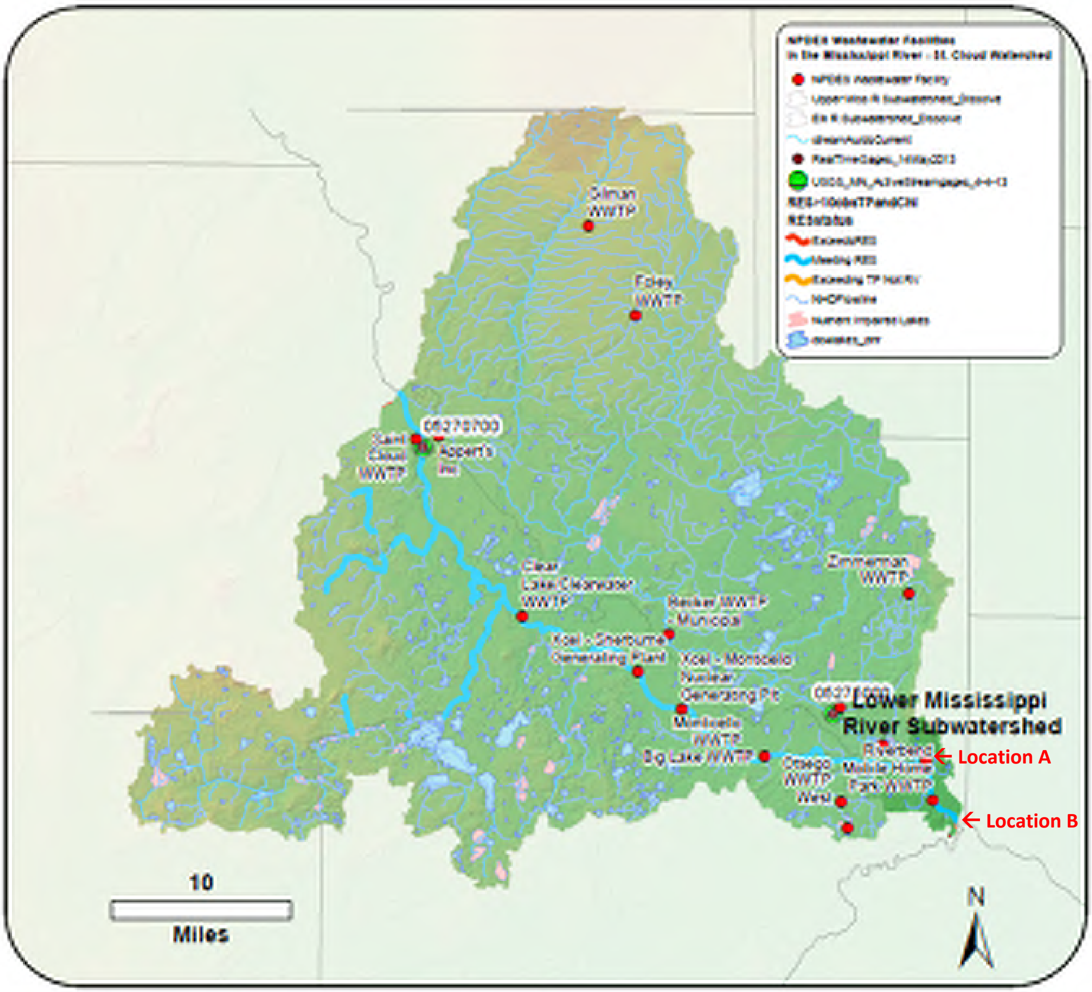


Figure 4. Lower Mississippi River Subwatershed and NPDES WWTFs within Mississippi River - St. Cloud Watershed.

Table 7. NPDES permitted facilities included in the Lower Subwatershed portion of the Mississippi River – St. Cloud Watershed phosphorus review. This list includes those facilities that discharge to the Mississippi River below the confluence with the Elk River.

Wastewater Treatment Facility	Permit #
Elk River Municipal Utilities	MNG250016
Elk River WWTF	MN0020788
Great River Energy - Elk River Station	MN0001988
Riverbend Mobile Home Park WWTF	MN0042251

As mentioned above, a RP analysis, following methodology described in MCPA, 2015, was conducted for the Lower Subwatershed to determine if additional limits were appropriate for RES protection. This was done by evaluating the potential of WWTFs to contribute to an exceedance of the TP RES under permitted conditions. An illustration of the iterative review process (Figure 5) and a brief description of the analysis conducted for the Lower Subwatershed is outlined below.

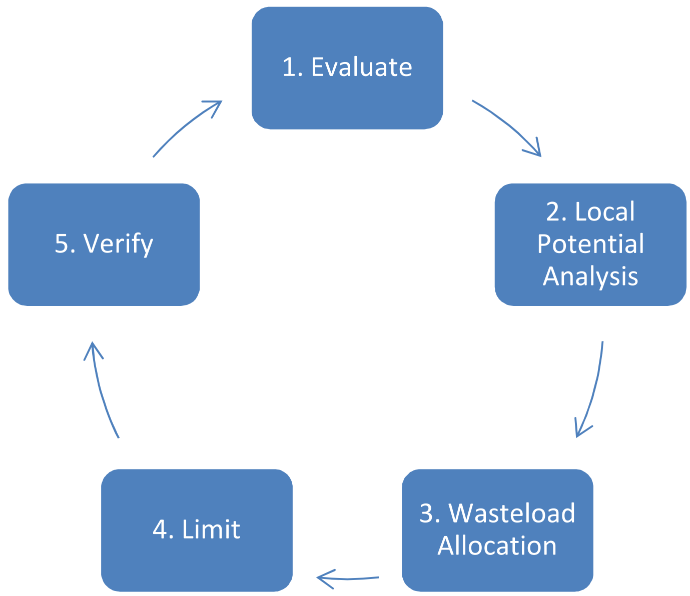


Figure 5. Overview of RES analysis and NPDES limit determination for Lower Mississippi River Subwatershed.

1. Evaluate

TP and Chl-a concentrations (0.065 mg/L and 9.0 µg/L, respectively) meet RES criteria (100 µg/L (0.1 mg/L) and 18 µg/L, respectively) in the Mississippi River at AUID 07010203-729 (Figure 1). To better understand the impacts on receiving waters from point sources, load duration curves were developed for phosphorus (Figures 6) and Chl-a (Figure 7). These load duration curves capture one of the four-water chemistry stations selected for this review along AUID 07010203 – 729 in the Mississippi River. Due to the lack of water quality data below the confluence of the Mississippi and Elk Rivers, water quality stations upstream of the confluence were used. Additional load duration curves illustrate point source impacts at the other three water chemistry stations all along (Appendix B). All four water quality stations used are located within 30 miles of the Elk River - Mississippi River confluence, with three located within approximately 12 miles of the confluence. Point sources can have a disproportionate impact on receiving waters during summer (June – September) low flow conditions. The 80th percent flow exceedance (when, on average, 80% of the flow exceeds the respective flow value) has been selected as the target flow to represent low flow conditions (MPCA, 2015). All load duration curves representing historical water quality from 2004 – 2014 indicate water quality meets RES during the 80th percent flow exceedance condition.

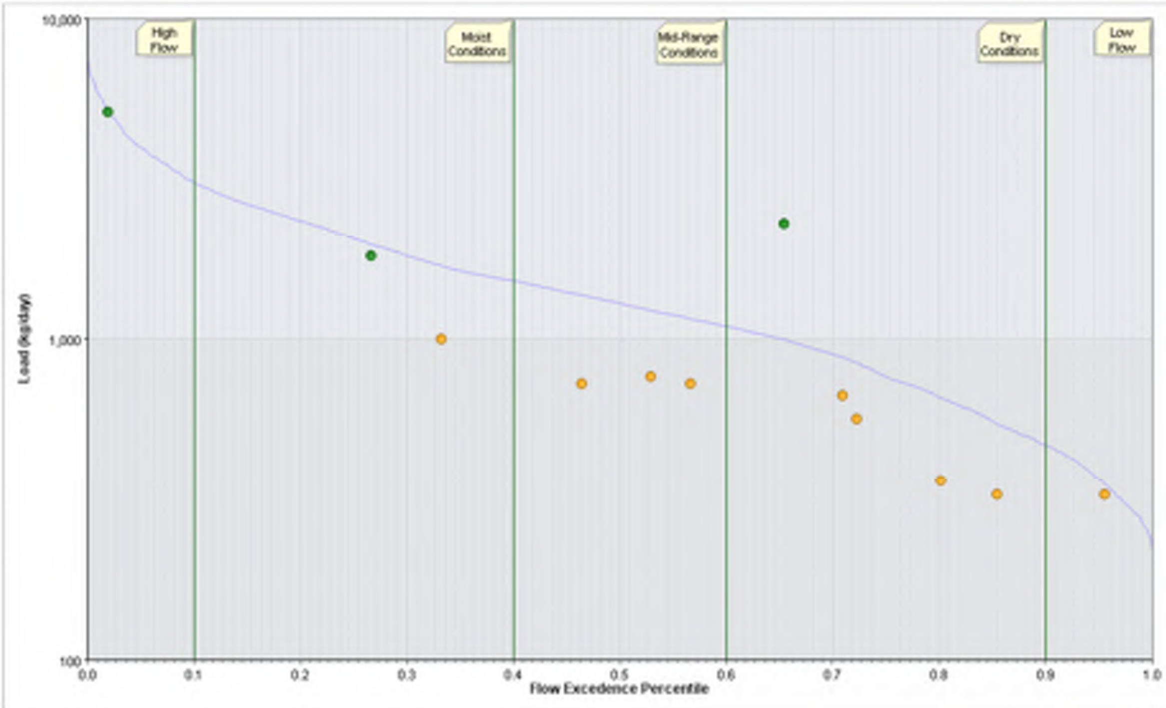


Figure 6. Monitored daily summer TP loads to the Mississippi River (07010203-728) from 2004 – 2010 (station S000-221). Flow exceedance percentile based on flow conditions collected from 1988 – 2015 Mississippi River continuous flow gage 05270700. Colors indicate seasonality of sampling as follows: green = June, yellow = July – September. Red line is flow at 80th percent flow exceedance. Red line is flow at 80th percent flow exceedance. Average TP concentration at 80th percent flow exceedance is 0.084 mg/L. Blue line is the maximum load under various flow conditions to still meet the respective phosphorus RES criterion. Individual daily loads above the blue line are due to daily concentrations exceeding 0.100 mg/L.

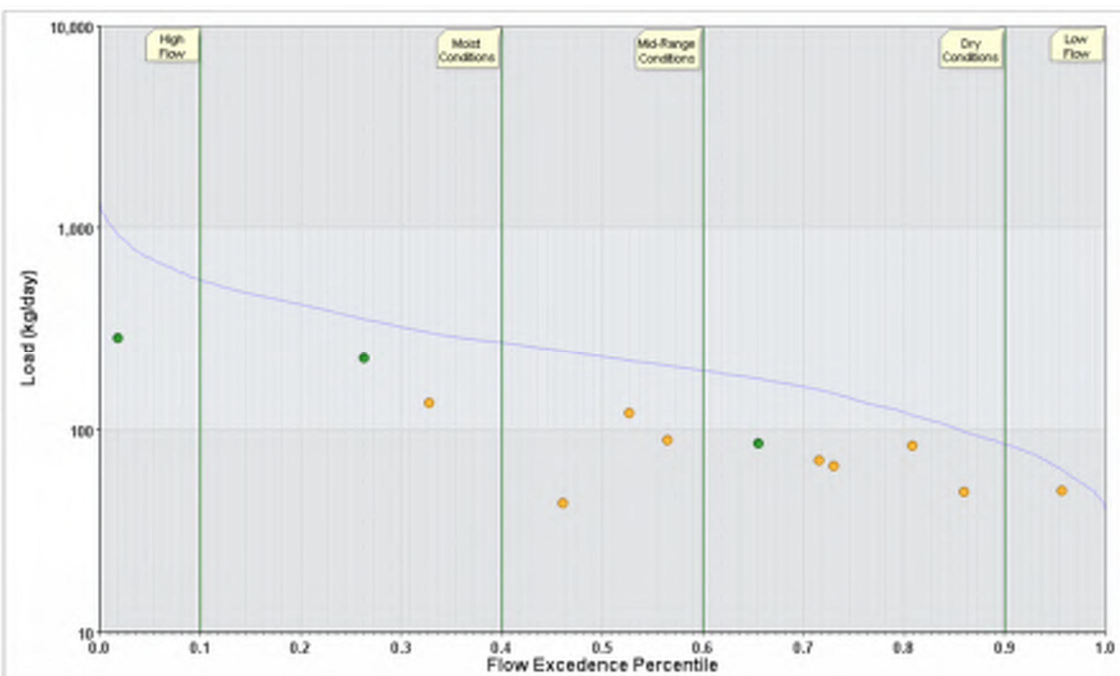


Figure 7. Monitored daily summer Chl-a loads to the Mississippi River (07010203-728) from 2005 – 2010 (station S000-221). Flow exceedance percentile based on flow conditions collected from 1988 – 2015 Mississippi River continuous flow gage 05270700. Colors indicate seasonality of sampling as follows: green = June, yellow = July – September. Red line is flow at 80th percent flow exceedance. Red line is flow at 80th percent flow exceedance.

Average Chl-a concentration at 80th percent flow exceedance is 0.009 mg/L. Blue line is the maximum load under various flow conditions to still meet the respective phosphorus RES criterion. Individual daily loads above the blue line are due to daily concentrations exceeding 0.018 mg/L.

2. Local potential analysis

When the receiving water meets the TP RES criterion, there are "real-world" data demonstrating that the current performance of WWTFs in the watershed is sufficient to protect the receiving water. The existing data do not represent the potential impact of facilities at 70% of AWWDF (MPCA, 2015). To evaluate whether increased flows from the WWTFs would drive the TP concentration above the RES TP criterion, TP protection potential analyses were completed for the Mississippi River. Existing monitoring data for Chl-a indicate that algal response is limited in the Mississippi River. Given the large size of the Mississippi River and relatively clear condition of the water, it is reasonable to assume that concentrations above the 0.100 mg/L TP criterion may lead to increased algal production in the river. Smaller streams in the central portion of the state typically do not grow suspended algae resulting in Chl-a concentrations above 0.018 mg/L.

The following equation was used to calculate the protection analyses of the two river locations (A and B, Figure 4) with WWTFs at current permitted discharge conditions. Detailed below are the values used to complete each calculation and the resulting calculated expected TP concentration in the receiving water under low flow summer conditions.

Equation 1. TP concentration of Mississippi River based on permitted flow for The Facilities.

$$Cr = \frac{QsCs + QeCe}{Qr}$$

Cr = downstream TP concentration of river at critical flow (80th percent flow exceedance)
Qr = downstream river flow (80th percent flow exceedance)
Qs = flow of river without WWTFs
Cs = concentration of river without WWTFs
Qe = design flow of WWTFs
Ce = mass based concentration limit using either Lake Pepin categorical limits or facility-specific concentration limit

Location A – confluence of Mississippi and Elk Rivers
This analysis estimates the TP concentration in the Mississippi River at the point where the Elk River joins it. Impacts from WWTFs are inherently included as well. Mississippi River conditions before the confluence are represented by Qs and Cs. Elk River conditions are represented as Qe and Ce. Note impacts from the Elk River Subwatershed assume TMDL conditions are met. Conditions of the combined river are represented by Qr and Cr.

Qr = 1,561 mgd; based on permitted flow values and using Qr = Qs + Qe
Qs = 1,504 mgd; 80th percent flow exceedance from USGS gage 05270700 along Mississippi River including WWTFs at 70% average wet weather design flow (AWWDF)
Cs = 0.058 mg/L; concentration in Mississippi River from Upper Subwatershed RP analysis during low flow conditions (refer to Scenario 1 or 2 Cr in Kaufenberg, 2016)
Qe = 57 mgd; 80th percent flow exceedance from USGS gage 05275000 along Elk River near confluence of Mississippi River with WWTFs at 70% AWWDF
Ce = 0.06 mg/L; Upper and Lower Orono Lake TMDL standard
Cr = 0.058 mg/L TP ⟶ **less than RES TP criterion**

Location B – outlet of St. Cloud Watershed (approximately 5 miles downstream of the Elk and Mississippi River confluence)
For this analysis, the Mississippi River (below confluence with Elk River) is represented by Qs and Cs. These variables use the analysis from Part 1 (Qr and Cr) and include WWTFs discharging downstream of the confluence, represented by Qe and Ce.

Qr = 1,563 mgd; based on permitted flow values and using Qr = Qs + Qe

Qs = 1,561 mgd; 80th percent flow exceedance along Mississippi River below confluence including WWTFs upstream of confluence at 70% AWWDF (based on Qr from Part 1)
Cs = 0.058 mg/L; concentration in Mississippi River below confluence (based on Cr from Part 1)
Qe = 1.8 mgd; 70% of permitted design flow from WWTFs discharging downstream of Mississippi and Elk River confluence and upstream of outlet of St. Cloud Watershed
Ce = 0.79 mg/L; mass based concentration limit using either Lake Pepin categorical limits or facility-specific concentration limit
Cr = 0.059 mg/L TP ⟹ less than TP criterion

Facilities are considered to potentially cause or contribute to a downstream impairment if, while operating at capacity, they: 1) discharge at TP concentrations higher than the applicable eutrophication standard, and 2) the calculated TP concentration of the water of interest at the 80% flow value exceeds RES.

The calculated concentration of the Mississippi River at the outlet of the St. Cloud watershed is 0.059 mg/L TP. Because Cr meets RES criteria (TP ≤100 µg/L), it was determined there is no RP for The Facilities to cause or contribute to a nutrient impairment in the Lower Subwatershed. Consequently, Step 3 (Wasteload Allocation) conducted for limit determination is not necessary. Step 4 (Limit) and 5 (Verify) will review current and Lake Pepin limits, in addition to current actual effluent concentrations when necessary, and confirm if existing controls are protective of waters downstream of the St. Cloud Watershed.

3. Limit

The RP analysis demonstrates The Facilities do not need to have additional limits to protect for RES in the St. Cloud Watershed. Nonetheless, current concentration and mass limits, based on SDR (Minn. R. 7053.0255) and LES are still applicable.

4. Verify

The first river reach downstream of the Upper Subwatershed with sufficient water quality data for RES analysis is the Mississippi River – Crow River to Upper St. Anthony Falls reach, near Anoka (07010206 – 805). This reach has RES criteria of 100 µg/L TP and 18 µg/L Chl-a. Any improvements in the Mississippi River near Anoka will require the Greater Crow River to improve dramatically.

The original scope of the draft Lake Pepin TMDL was to reduce controllable sources of TP in the Lake Pepin Watershed regardless of the local water quality in a given subwatershed. Due to the sequencing of eutrophication standards in Minnesota, Lake Pepin based limits were established before river eutrophication standards were adopted. Pool 2 along the Mississippi River (AUID 07010206-806) has site-specific RES criteria of 125 µg/L TP and 35 µg/L Chl-a (Heiskary and Wasley, 2012). Lake Pepin limits (discussed in further detail below) applied to facilities upstream of Pool 2 are sufficient to meet water quality standards in both Pool 2 (Wasley, 2014a, b) and the Mississippi River in the Mississippi River – St. Cloud Watershed.

Lake Pepin

Effluent from NPDES WWTFs in the St. Cloud Watershed is discharged upstream of Lake Pepin, a riverine lake on the Mississippi River. In 2002, Lake Pepin was placed on the federal Clean Water Act Section 303(d) list of impaired waters due to excess nutrients. A TMDL study for Lake Pepin is currently delayed, but a significant portion of the modeling analysis has been completed. Phosphorus is the primary nutrient responsible for excess algal growth in Lake Pepin. Federal law [40 CFR 122.44(d)] restricts mass increases upstream of impaired waters and states that all NPDES dischargers that have RP to cause or contribute to downstream impaired waters are required to have a WQBEL. When determining RP, the Code of Federal Regulations also requires the use of procedures, which account for existing controls on point and nonpoint sources of pollution. Permitees are found to have RP for TP if: 1) they discharge upstream of a nutrient impaired waterbody, 2) they discharge at TP concentrations greater than the ambient target (i.e. 0.100 mg/L), and 3) there is no geographical barrier capable of trapping a significant mass of nutrients between the outfall and the impairment during most streamflow conditions. For all reasons listed above, facilities discharging in the St. Cloud Watershed are found to have RP for

TP upstream of Lake Pepin; and therefore required to have a WQBEL. WQBELs in the St. Cloud Watershed, in combination with other point and nonpoint source reductions throughout the Lake Pepin Basin, are sufficient to meet draft eutrophication standards, established to support the designated uses, in Lake Pepin.

A computer water-quality model for Lake Pepin was developed by MPCA modeling consultant, LimnoTech, to evaluate site-specific eutrophication criteria and the reductions necessary to achieve these criteria (LimnoTech, 2009). Using the best available science, draft standards for Lake Pepin were determined to be 100 µg/L (0.1 mg/L) for TP and 28 µg/L (0.028 mg/L) for Chl-a (Heiskary and Wasley, 2012). Within the model, all major sources of TP upstream of Lake Pepin were considered, and 21 separate scenarios were developed. Scenario 21 achieved compliance with the draft criteria and predicted that the following TP reductions from tributaries would be necessary: HSPF modeled reductions from the Minnesota River, 50% from the Cannon River, 20% from the Mississippi River upstream of Lock and Dam 1 and 20% from the St. Croix River. During the modeling process, MPCA staff simultaneously developed draft WLAs, compatible with reductions in scenario 21 for all NPDES dischargers within the contributing basin of Lake Pepin. All simulations represented point sources on a 12-month basis.

Categorical WQBELs using AWWDF or maximum design flow (MDF) were developed for NPDES WWTFs in the Lake Pepin Basin using the general formula below.

General Formula:
Facility WLA = (AWWDF or MDF x categorical concentration mg/L TP x 3.785 L/gal x 365 days/yr)

Categorical concentration multipliers are applied to design flows to derive annual wasteload allocations. The limits require more reductions for larger WWTFs (Table 8). These values are then implemented in permits as 12 month rolling total kg/day mass values (Table 9). Limits are evaluated on a monthly basis to ensure compliance.

In total, SDR and Lake Pepin limits are applicable for St. Cloud Watershed WWTFs in order to meet water quality standards in receiving waters. A summary of all appropriate TP limits and respective time frames is summarized in Table 9.

Table 8. Draft municipal and industrial WWTF categories and associated multipliers for Lake Pepin WQBELs. Note not all St. Cloud Watershed WWTFs will receive a Lake Pepin WQBEL.

Facility (AWWDF or MDF*)	Components of mass limit to meet Lake Pepin WQBEL
Continuous > 20.0 mgd	AWWDF x 0.3 mg/L
Continuous 1.0 – 20.0 mgd	AWWDF x 0.8 mg/L
Continuous 0.2 – 1.0 mgd, Ponds > 0.301 mgd	AWWDF x 1.0 mg/L
Continuous <0.2 mgd	Maintain current discharge**
Stabilization ponds <0.301 mgd	Maintain current discharge**
WWTFs at conc. Below RES	Maintain current discharge***
Industrial Discharge with concentration > 1.0 mg/L	MDF x 1.0 mg/L
Industrial Discharge with concentration < 1.0 mg/L	Current load x 1.15
Other Industrial	Limits specified on a site specific basis

* MDF = Maximum Design Flow --> common value used to evaluate industrial discharges.
**Mass limits based on categorical concentration and AWWDF
***Expansion of these WWTFs may be permitted assuming effluent concentration remains below RES

Table 9. Summary of applicable annual (January – December) TP limits for facilities in the St. Cloud Watershed and corresponding time-period.

	State Discharge Restriction[a]		Lake Eutrophication Standards	
Facility	calendar month average	12 - month moving average	calendar year-to-date total	12 - month moving total
Domestic	(mg/L)	(mg/L)	(kg/yr)	(kg/yr)
Albertville WWTF			661	1,284[b]
Aspen Hills WWTF	1.0		27[g]	
Becker WWTF[c]	1.0			903
Big Lake WWTF			1,160	
Clear Lake/Clearwater WWTF		1.0		669
Elk River WWTF		1.0		2,431
Foley WWTF				1,026[d]
Gilman WWTF				124[d]
Monticello WWTF				2,608
Otsego WWTF West		1.0		995
Riverbend Mobile Home Park WWTF				290
St. Cloud WWTF		1.0		19,783
Zimmerman WWTF		1.0		419[g]
Industrial				
Elk River Municipal Utilities[e]				
Great River Energy - Elk River Station				98
Sysco Western MN (formerly Appert's Inc)[e]				
Xcel - Monticello Nuclear Generating Plant				NA[f]
Xcel - Sherburne Generating Plant				NA[f]

[a]State discharge restriction limits based upon Minn. R. 7053.0255
[b]Mass limit sufficient for Lake Pepin for either proposed alternative discharge location, Alternative #1 or Alternative #2. If Albertville does not move SD002 to either alternative location, previous 0.06 µg/L TP WQBEL required as determined for School Lake (Weiss, 2010)
[c]TP WQBEL is 3.2 kg/day. Daily mass limit was originally assigned due to nondegradation from historical expansion. The annual mass WQBEL is compatible with assumption of Mississippi River (St. Cloud) Watershed TMDLs (Determan et al, 2014) WLA and protective for Upper and Lower Orono Lake.
[d]Mass limit consistent with Elk River Watershed Association TMDL (Wenck, 2012) WLA
[e]TP monitoring recommended alternatively to a TP WQBEL
[f]Facility - specific TP WQBELs will be addressed upon further investigation into chemical additives and flow
[g]Mass limit consistent with Mississippi River (St. Cloud) Watershed TMDLs (Determan et al., 2014) WLA

Summary

This analysis demonstrates WWTFs do not have RP to cause or contribute to a river eutrophication impairment in the Mississippi River – St. Cloud Watershed, under permitted effluent conditions. As such, existing limits are sufficient for the immediate receiving waters. There are a number of impaired lakes along the Elk River Subwatershed. The facilities that have RP to cause or contribute to a nutrient impairment to those lakes are therefore required to have a WQBEL for the respective lake eutrophication impairment. Downstream of the St. Cloud Watershed, a number of facilities have RP to cause or contribute to the excess nutrient impairment in Lake Pepin, and therefore, are required to have a WQBEL. The recommended Lake Pepin TP effluent limits (Table 9) are draft TMDL derived WQBELs. An overview of all appropriate TP limits and respective time frames is summarized in Table 9. Finally, the permitees should be informed that more restrictive TP limits may be necessary following the completion of the Lake Pepin TMDL study and additional water quality monitoring.

References

Determan, T., F. Larson, F. Gerde, R. Kluckhohn, J. Strom, E. Megow, C. Loewen, J. Jacobs, P. Votruba. 2014. Mississippi River (St. Cloud) Watershed TMDLs DRAFT. Sherburne Soil and Water Conservation District, Wenck Inc., Clearwater River Watershed District, Wright Soil and Water Conservation District, and Minnesota Pollution Control Agency. 81 pp

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Kaufenberg, L. 2015. Total phosphorus effluent limit review: Upper Mississippi River – St. Cloud Watershed. MPCA St. Paul 14 pp

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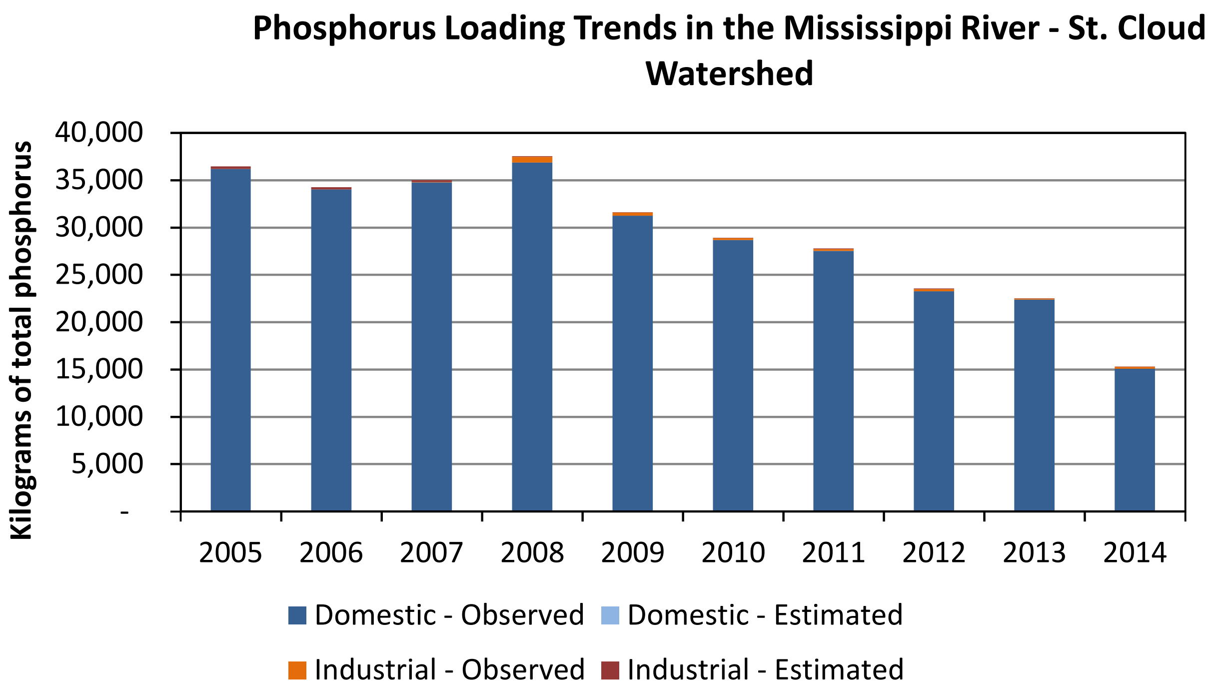
Wasley, D.M. 2014a. Draft: MCES total phosphorus umbrella permit allocations, monthly and annual limits. MPCA St. Paul 9 pp

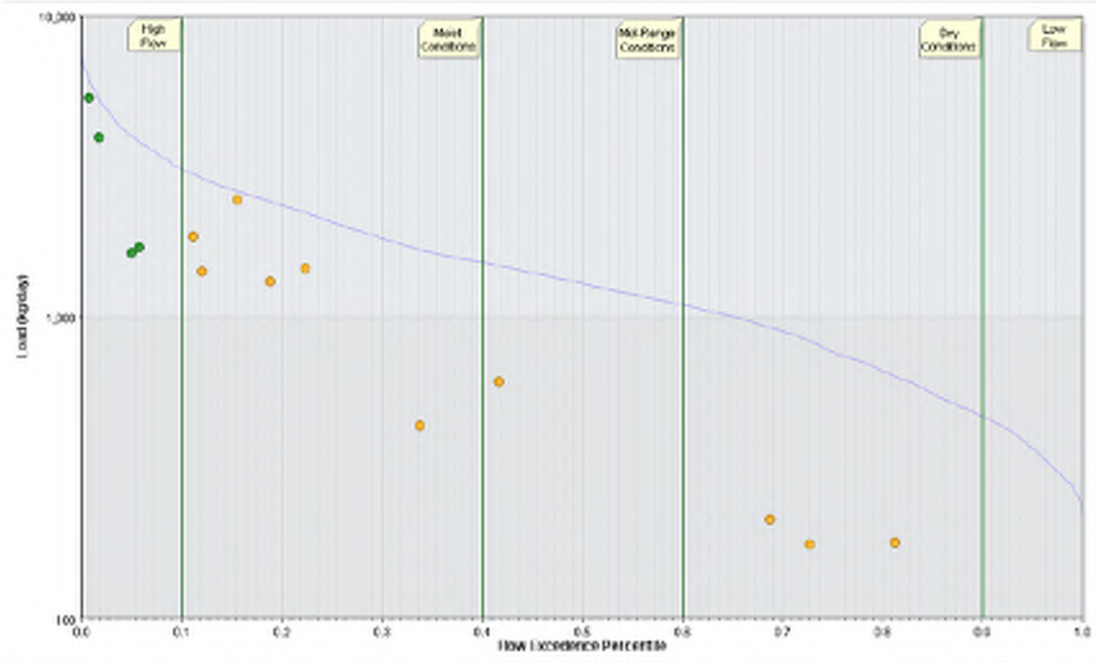
Wasley, D.M. 2014b. Total Phosphorus Effluent Limit Review: Mississippi River – Twin Cities Watershed (portion upstream of Minnesota River confluence). MPCA St. Paul 16 pp

Wenck Associates, Inc. 2012. Elk River Watershed Association TMDL Report for the Elk River Bacteria Impairment, Elk River Turbidity Impairment, Big Elk Lake Nutrient Impairment, Mayhew lake Nutrient Impairment. Prepared for MPCA. Maple Plain 108 pp

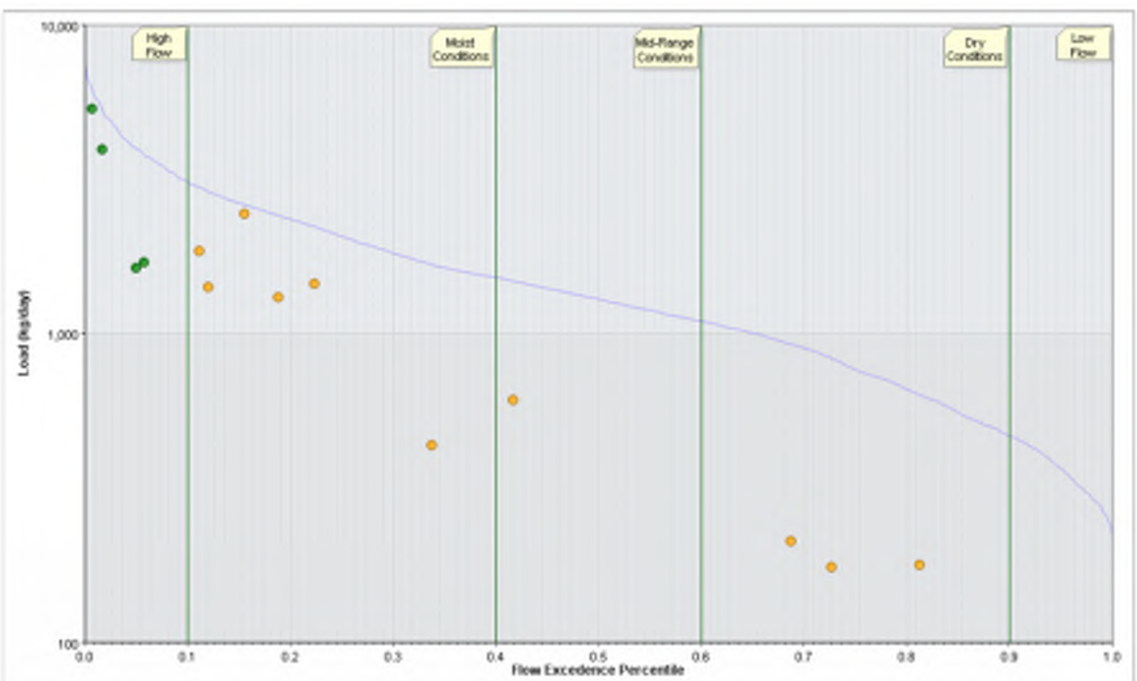
Appendix A


Phosphorus Loading Trends in the Mississippi River - St. Cloud Watershed
Kilograms of total phosphorus
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Domestic - Observed
Domestic - Estimated
Industrial - Observed
Industrial - Estimated

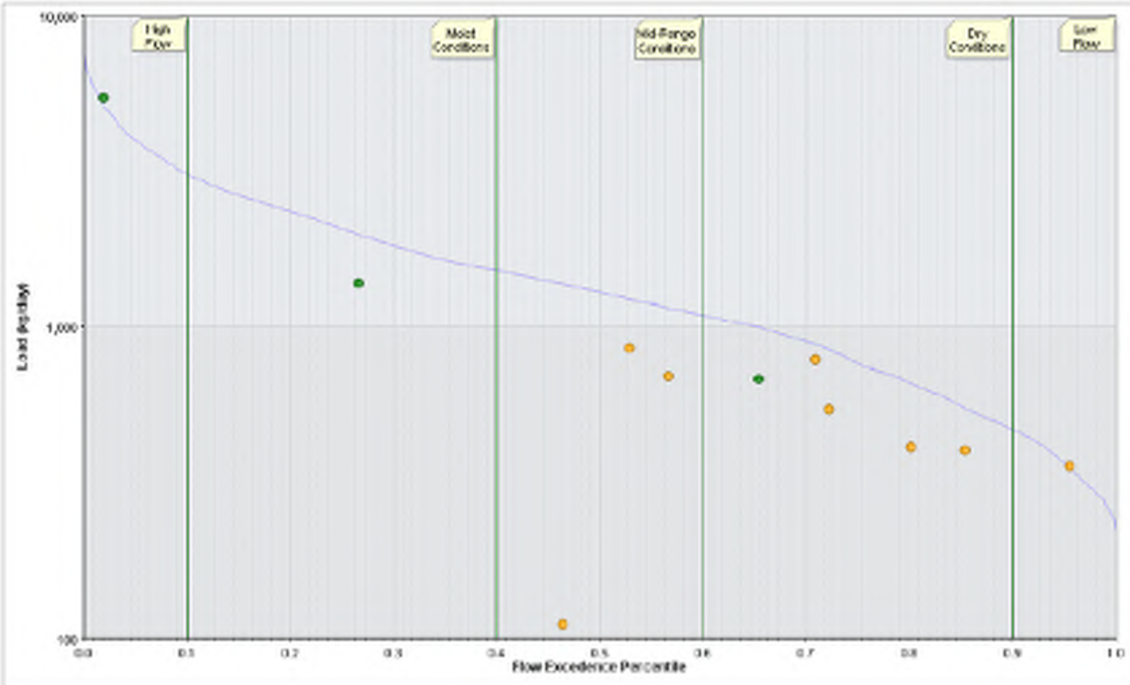
Appendix B



Load duration curve representative of 2013 – 2014 water quality (station S004 – 308) and flow conditions from 1988 – 2015 Mississippi River continuous flow gage (AUID 07010203-574). Colors indicate seasonality of sampling as follows: green = June, yellow = July – September.



Load duration curve representative of 2013 – 2014 water quality (station S007 – 335) and flow conditions from 1988 – 2015 Mississippi River continuous flow gage (AUID 07010203-574). Colors indicate seasonality of sampling as follows: green = June, yellow = July – September.



Load duration curve representative of 2004 – 2010 water quality (station S000 – 148) and flow conditions. Colors indicate seasonality of sampling as follows: green = June, yellow = July – September. Flow data collected from 1988 – 2015 Mississippi River continuous flow gage.

APPENDIX D

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AFFIDAVIT OF PUBLICATION

STATE OF MINNESOTA) ss
COUNTY OF SHERBURNE

Darlene MacPherson being duly sworn on an oath, states or affirms that he/she is the Publisher's Designated Agent of the newspaper(s) known as:

Star News

with the known office of issue being located in the county of:
SHERBURNE
with additional circulation in the counties of:
WRIGHT
and has full knowledge of the facts stated below:

(A) The newspaper has complied with all of the requirements constituting qualification as a qualified newspaper as provided by Minn. Stat. §331A.02.

(B) This Public Notice was printed and published in said newspaper(s) once each week, for 1 successive week(s); the first insertion being on 01/13/2018 and the last insertion being on 01/13/2018.

MORTGAGE FORECLOSURE NOTICES
Pursuant to Minnesota Stat. §580.033 relating to the publication of mortgage foreclosure notices: The newspaper complies with the conditions described in §580.033, subd. 1, clause (1) or (2). If the newspaper's known office of issue is located in a county adjoining the county where the mortgaged premises or some part of the mortgaged premises described in the notice are located, a substantial portion of the newspaper's circulation is in the latter county.

By: D. MacPherson
Designated Agent

Subscribed and sworn to or affirmed before me on 01/13/2018 by Darlene MacPherson.

Mary E. Knapp
Notary Public

MARY ELIZABETH KNAPP
Notary Public-Minnesota
My Commission Expires Jan 31, 2018

Rate Information:
(1) Lowest classified rate paid by commercial users for comparable space:
$23.00 per column inch

Ad ID 773874

CITY OF OTSEGO
NOTICE OF HEARING
ON WASTEWATER
MASTER PLAN

Notice is hereby given that the City Council of Otsego will meet in the Council Chambers at 8899 Nashua Avenue NE, Otsego, MN 55330, on January 22, 2018 at 7:00 p.m. to consider, and possibly adopt the Otsego Wastewater Master Plan (the Plan).

The hearing will provide an opportunity for the City Council to receive comments and feedback on the Plan. The Plan can be summarized as regulatory and population projections through buildout. The Plan also includes recommended improvements for membrane bio-reactor (MBR) liquid treatment dewatering with chemical stabilization bio solids treatment. The Plan recommends phased implementation at both of the City's wastewater treatment facilities. The Plan is available for review at the Otsego City Hall.

Such persons desiring to be heard with reference to the Plan will have such an opportunity at this meeting. Written support or objections will also be considered, and can be submitted to the City Clerk. If there are detailed questions on the Plan, please call City Administrator Adam Flaherty, who can provide contact information for the City's Wastewater Engineer.

Dated: January 13, 2018
Tami Loff, City Clerk

Published in the
Star News
January 13, 2018
773874

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APPENDIX E

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OTSEGO CITY COUNCIL MEETING
OTSEGO PRAIRIE CENTER
JANUARY 22, 2018
7:00 PM

Call to Order.
Mayor Stockamp called the meeting to order at 7:09 PM.

Roll Call:
Mayor Jessica Stockamp; Councilmembers: Vern Heidner, Corey Tanner, Tom Darkenwald and Jason Warehime. Staff: Adam Flaherty, City Administrator/Finance Director; Daniel Licht, City Planner; Ron Wagner, City Engineer; and Tami Loff, City Clerk.

Pledge of Allegiance: Mayor Stockamp led in the Pledge of Allegiance.

1. Open Forum.
Keith Knutson, 6630 Odean Avenue, said that the City workers are plowing too close to his property and that his paper box was hit. He also stated that the lawn has been torn up in the past. Mr. Knutson was directed to talk to Street Operations Manager Kevin Lamson who was present.

2. Consider Agenda Approval.
City Administrator Flaherty requested to add Item 6.4 and City Clerk Loff requested to add Item 3.8.
CM Heidner motioned to approve as amended. Seconded by CM Tanner. All in favor. Motion carried.

3. Consent Agenda. (Non-controversial items).
3.1 Approve Claims List.
3.2 Approve City Council Meeting Minutes.
A. January 8, 2018 Meeting.
3.3 Approve Resolution 2018-05 Declaring Certain City Property Surplus Property and Authorizing Sale.
3.4 Approve Agreement Delegating Federal Contracts through MnDot.
3.5 Approve Submission of 2018 Pay Equity Compliance Report.
3.6 Motion to Call Board of Appeal & Equalization Meeting on April 23, 2018 at 5:30 PM.
3.7 Approve Highway Easement for the CSAH 38 Reconstruction Project.
3.8 Motion to call Work sessions on February 9 and 10, 2018 for Strategic Planning.
CM Heidner motioned to approve. Seconded by CM Tanner. All in favor. Motion carried.

4. Public Hearing.
4.1 Wastewater Master Plan.
A. Presentation by AE2S Engineer Scott Schaefer.
B. Mayor to open the Public Hearing.
C. Close the Public Hearing.
D. Approve Resolution 2018-06.

AE2S Engineer Scott Schaefer presented the Wastewater Master Plan. CM Darkenwald reiterated that we are holding this public hearing to be eligible for the Clean Water Revolving Fund consideration. Mr. Schaefer said correct which could result in some savings to the City which is why going through this process is worthwhile. Mayor Stockamp opened the Public Hearing at 7:23 PM. Hearing no public comments Mayor Stockamp closed the Public Hearing at 7:24 PM. CM Heidner stated the reason we did this plan is make sure we have enough land at the current two treatment plants to meet the cities needs when the city gets fully built out and it appears we do.

CM Darkenwald motioned to approve Resolution 2018-06 adopting the Otsego Wastewater Master Plan. Seconded by CM Warehime. All in favor. Motion carried.

4.2 Lot 8, Block 1, Norin Landing, Vacation of Existing Drainage and Utility Easement.

A. Comments by City Planner.
B. Mayor to open the Public Hearing.
C. Close the Public Hearing.
D. Approve Resolution 2018-07.

City Planner Licht presented the staff report. To accommodate the proposed single family dwelling, the builder has been working with the City Engineer on vacation of a portion of the drainage and utility easement within the rear yard. CM Warehime asked for clarification if this easement is just specific to this property. City Planner Licht said yes. Mayor Stockamp opened the Public Hearing at 7:26 PM. Hearing no public comments Mayor Stockamp closed the Public Hearing at 7:27 PM.
CM Warehime motioned to adopt Resolution 2018-07 vacating existing drainage and utility easement within Lot 8, Block 1 Norin Landing. Seconded by CM Tanner. All in favor. Motion carried.

4.3 Lot 1, Block 4, Wilson Preserve, Vacation of Existing Drainage and Utility Easement.

A. Comments by City Planner.
B. Mayor to open the Public Hearing.
C. Close the Public Hearing.
D. Approve Resolution 2018-08.

City Planner Licht presented the staff report. Mayor Stockamp opened the Public Hearing at 7:34 PM. Hearing no public comment Mayor Stockamp closed the Public Hearing at 7:34 PM.
CM Darkenwald motioned to adopt Resolution 2018-08 vacating existing drainage and utility easement within Lot 4, Block 1 Wilson Preserve. Seconded by CM Heidner. All in favor. Motion carried.

5. Public Works.

5.1 Approve Feasibility Study for Mississippi Shores Street Renewal and Set Public Hearing.

City Engineer Wagner presented the feasibility report. CM Warehime said in the past there has been issues with radius corners at other locations within the city; and asked if this will this be addressed here. City Engineer Wagner explained the steps and said yes that will be looked at with this project.
CM Darkenwald motioned to approve Resolution 2018-09 receiving report on the improvement of streets within Mississippi Shores 1st Addition through the 8th Addition and a portion of Antelope Park and calling a Public Hearing for property owners to be presented project scope and possible assessment costs. Seconded by CM Tanner. All in favor. Motion carried.

5.2 Approve Riverbend North Escrow Agreement.

CM Darkenwald said he will be abstaining from this item. City Engineer Wagner presented the staff report. City Attorney MacArthur has drafted the attached agreement for the developer to reimburse all costs related to completion of the traffic study. City staff has requested the developer provide a $10,000 escrow prior to authorization for the traffic study to begin.
CM Heidner motioned to approve an escrow agreement between the City of Otsego and Otsego Apartments, LLC for reimbursement of a traffic study of CSAH 42 to be undertaken by SRF, Inc. at the direction of Wright County and the City. Seconded by CM Tanner. Motion carried 4-0. CM Darkenwald abstained.

6. Administration.

6.1 Approve January 8, 2018 Special Meeting Minutes.

CM Darkenwald was not present at the January 8 special meeting and said he will be abstaining from this item.
CM Heidner motioned to approve as written. Seconded by CM Tanner. Motion carried 4-0. CM Darkenwald abstained.

6.2 Receive Fire Study Proposals.
City Administrator/Finance Director Flaherty said City staff is looking for direction on how to prepare for the special meeting on February 12 where the City Council will review the RFP's received for the fire study. After discussion the City Council concurred they would review the RFP they received and bring their top three candidates. City Administrator/Finance Director Flaherty also stated he would be sending in the grant application that is due by January 31.

6.3 Set City Administrator Review.
City Administrator/Finance Director Flaherty said the employment agreement for the City Administrator outlines a review on a semi-annual basis for the first two years. He further stated that if the city Council agrees he would be agreeable to defer to the annual review in August. The City Council concurred.

6.4 Resolution 2018-10 Supporting the use of Corridors of Commerce funding to expand Interstate 94 between St. Michael and Albertville.
City Administrator/Finance Director Flaherty presented the staff report.
CM Heidner motioned to approve Resolution 2018-10 supporting the use of Corridors of Commerce funding to expand Interstate 94 between St. Michael and Albertville. Seconded by Mayor Stockamp. All in favor. Motion carried.

7. City Council Reports and Updates.
CM Heidner stated Albertville just approved turning over 70th Street. City Engineer Wagner said yes that is correct and confirmed the City of Otsego did the same approximately a month ago.

CM Warehime distributed to the City Council the quarterly meeting minutes of the Albertville Fire Department. CM Warehime further discussed the Standard Operating Procedures (SOP) of the department and noted that he can provide if other Council members are interested.

8. Staff Reports and Updates.
City Administrator/Finance Director Flaherty gave an update on the last WCAT Board meeting he attended. He also said the WCAT JPA amendment the City Council recently approved is again being revised and will be brought back to a future meeting for Council approval. He also reminded the City Council of the Corridor Coalition I-94 Legislative breakfast to be held on February 16 at 8 am in Rogers.

City Engineer Wagner said that Wright County did a speed study on CSAH 38. Posted speeds will range between 50-55 mph and that the County will be posting the new signage soon.

Mayor Stockamp called for a short recess at 8:18 PM. The meeting continued at 8:27 PM.

9. Closed Session; This Portion of the Meeting to be Closed in Accordance with Minnesota Statute 13D.05, Subdivision 3, c, 3 to Develop or Consider Offers for the Purchase of Real Property.

Mayor Stockamp stated this portion of the meeting will be closed in accordance with MN Statute 13D.05, Subdivision 3, c, 3 to develop or consider offers for the purchase of real property. City Attorney MacArthur joined the meeting via conference call.

CM Darkenwald motioned to close the regular meeting to a closed session at 8:27 PM. Seconded by CM Warehime. All in favor. Motion carried.

CM Darkenwald motioned to adjourn the closed session at 8:47 PM. Seconded by CM Warehime. All in favor. Motion carried.

CM Darkenwald motioned to reopen the regular meeting at 8:47 Seconded by CM Warehime. All in favor. Motion carried.

CM Darkenwald motioned to retain law firm of Campbell Knutson regarding eminent domain proceedings related to MacIver and 85th Street City project. Seconded CM Warehime. All in favor. Motion carried

10. Adjourn.
CM Darkenwald motioned to adjourn. Seconded by CM Warehime. All in favor. Motion carried. Adjourned at 8:48 PM.

____
Mayor Jessica Stockamp

ATTEST: ________________________
Tami Loff, City Clerk

APPENDIX F

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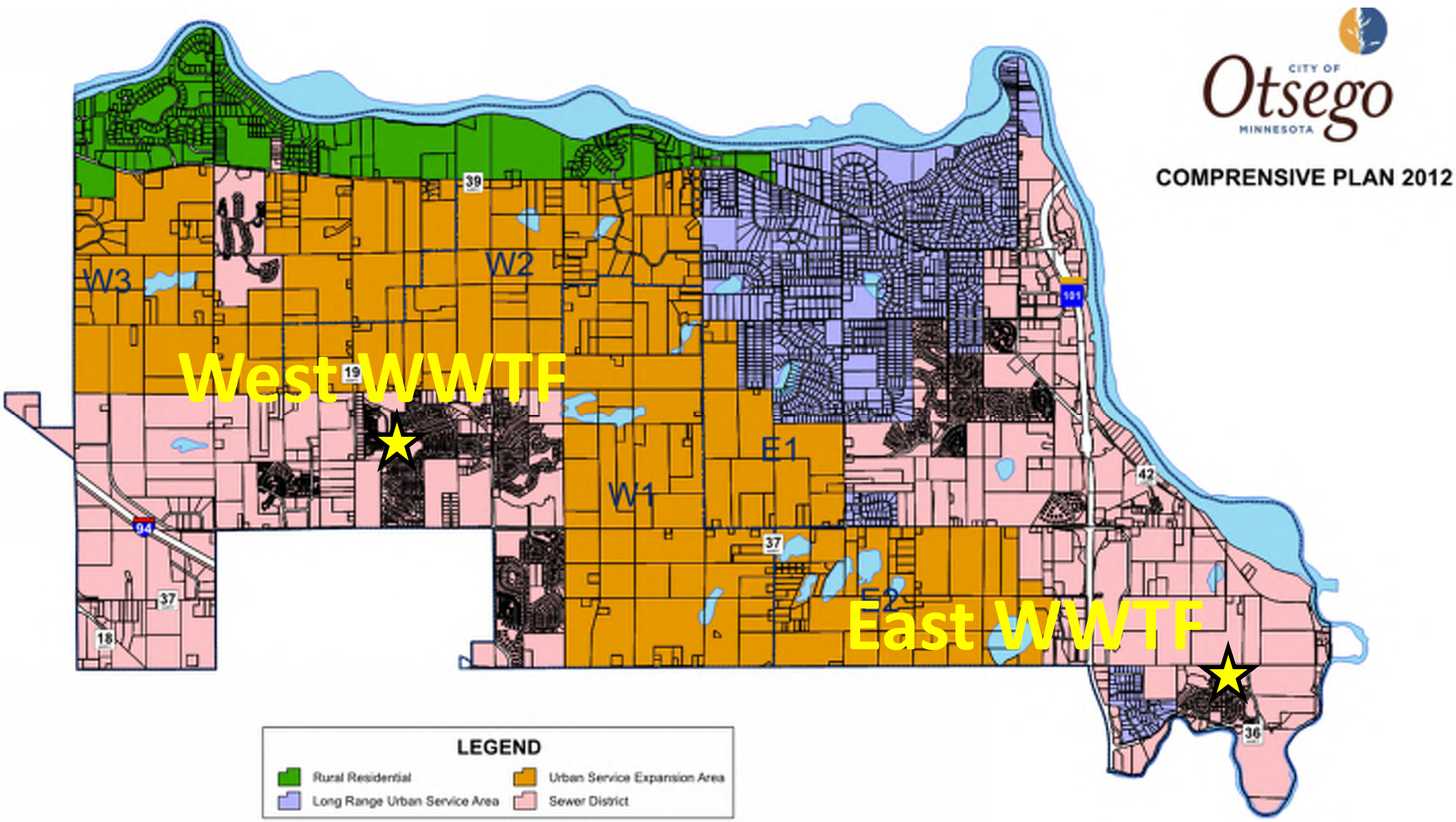
WASTEWATER MASTER PLAN PUBLIC MEETING

City of Otsego

January 22nd, 2018

Presented by: Advanced Engineering and Environmental Services, Inc. (AE2S)

SERVICE AREAS



POPULATION AND FLOW

	West WWTF	East WWTF
Current Service Population	~3,700	~3,000
2017 Flow, MGD	0.34	0.29
Permitted Capacity, MGD	0.72	1.1 / 1.65
Future Population	29,200	30,800
Future Flow, MGD	3.9	4.1

FUTURE PROJECT DRIVERS

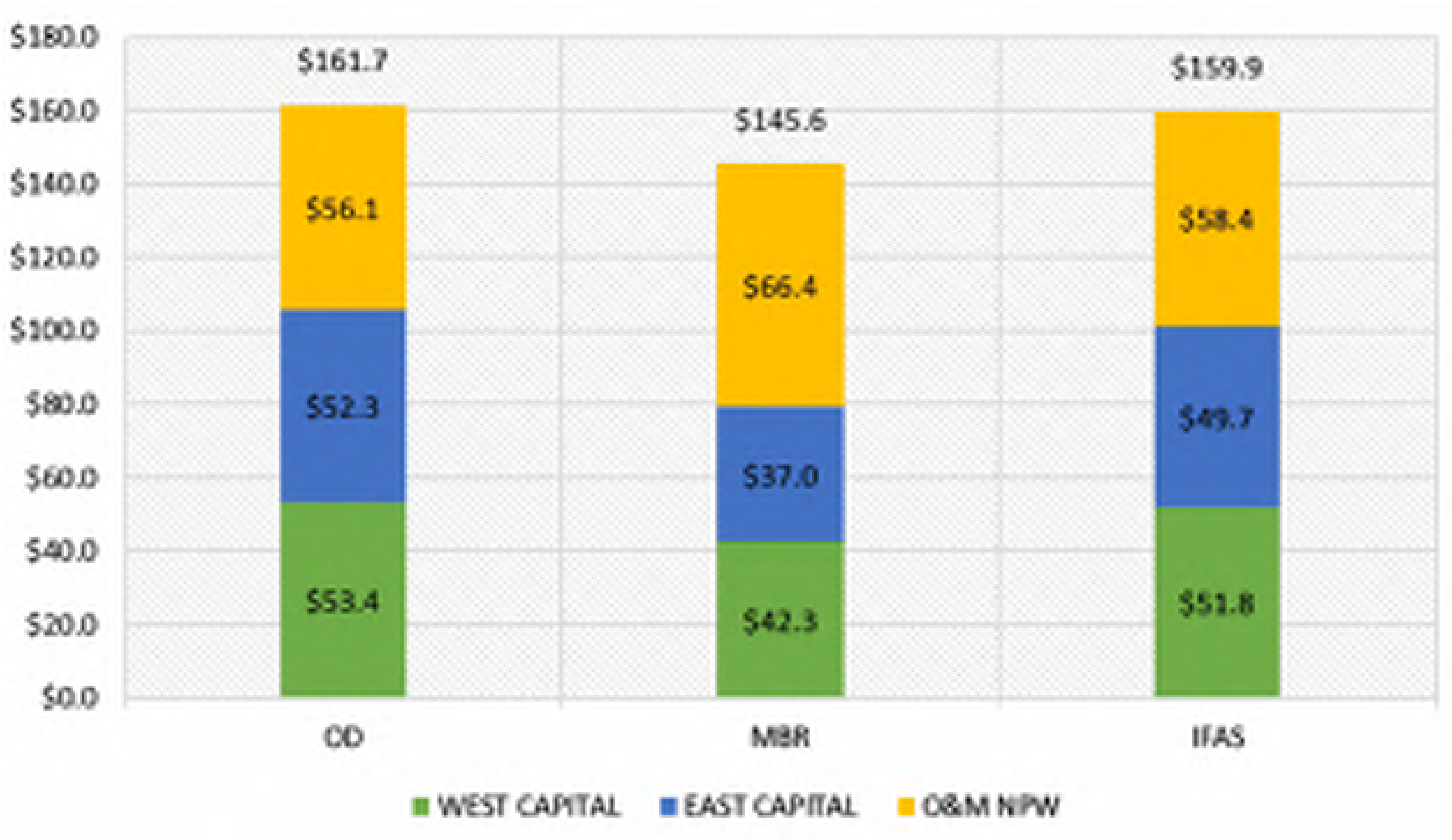
- **Capacity**
- **Regulations**
- **Age/Condition**

SURVEY – INCORPORATED PRIORITIES

- Aesthetics
- Public Safety
- Minimize Odor Potential
- Minimize Trucking
- Energy Efficiency
- Environmental Stewardship

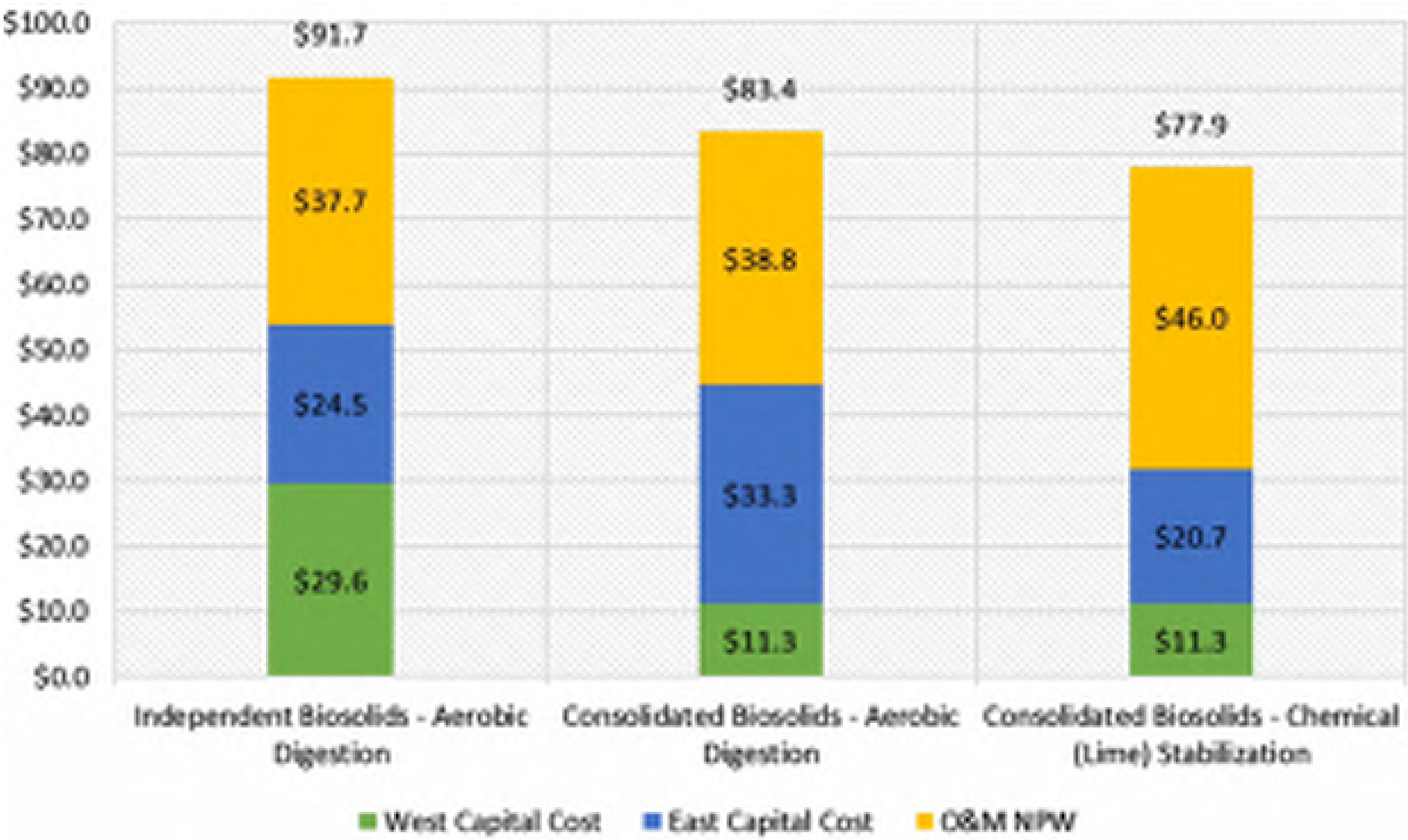
LIQUID TREATMENT ALTERNATIVES

- **Considered 13 Alternatives**
- **Narrowed to 3 Alternatives**



SOLIDS TREATMENT ALTERNATIVES

- **Considered 10 Alternatives**
- **Narrowed to 3 Alternatives**

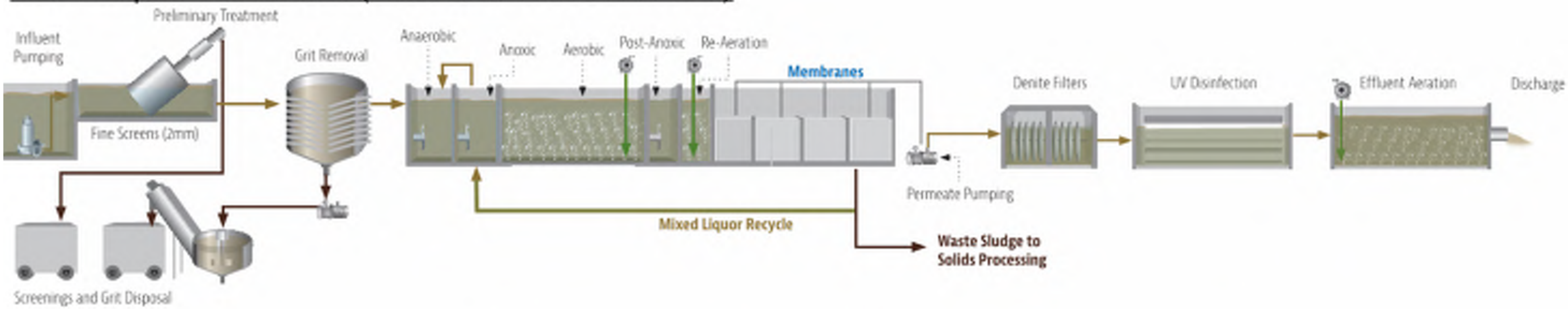


RECOMMENDATIONS - WHY

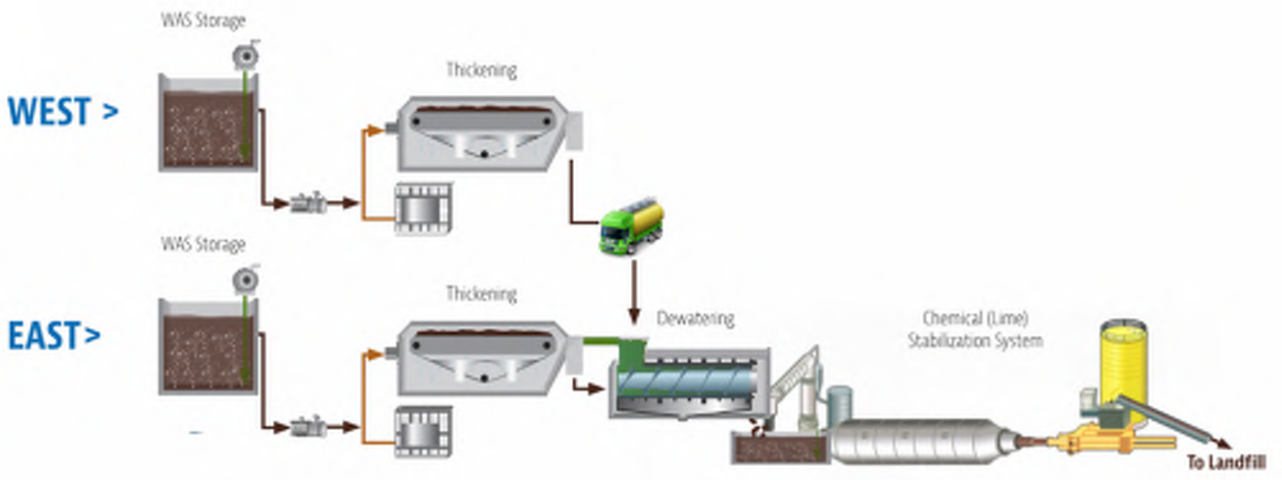
- MBR
  - Restrictive effluent limits
  - Maintains familiar activated sludge approach
  - Combines clarification/filtration = small footprint
  - Lowest NPW
- Consolidated Biosolids – Chem. Stabilization
  - Rural to urban conversion = landfilling
  - Use existing infrastructure; add new process
  - Small footprint
  - Class A = flexible
  - Lowest NPW

PROCESS FLOW DIAGRAMS

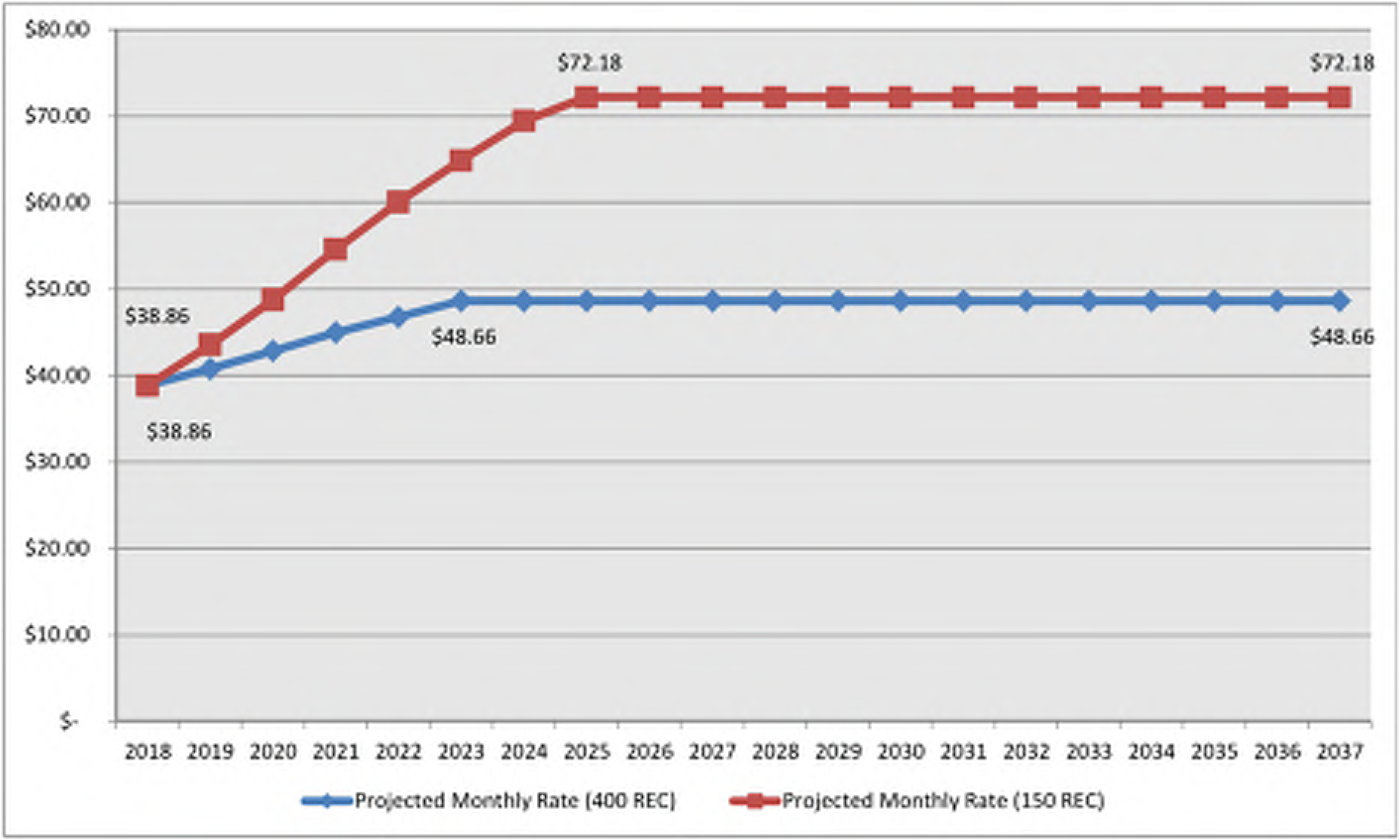
MBR Liquid Treatment (East and West WWTFs)



Consolidate Solids Treatment: Dewatering and Chemical Stabilization at East WWTF



PROJECTED RATE IMPACT

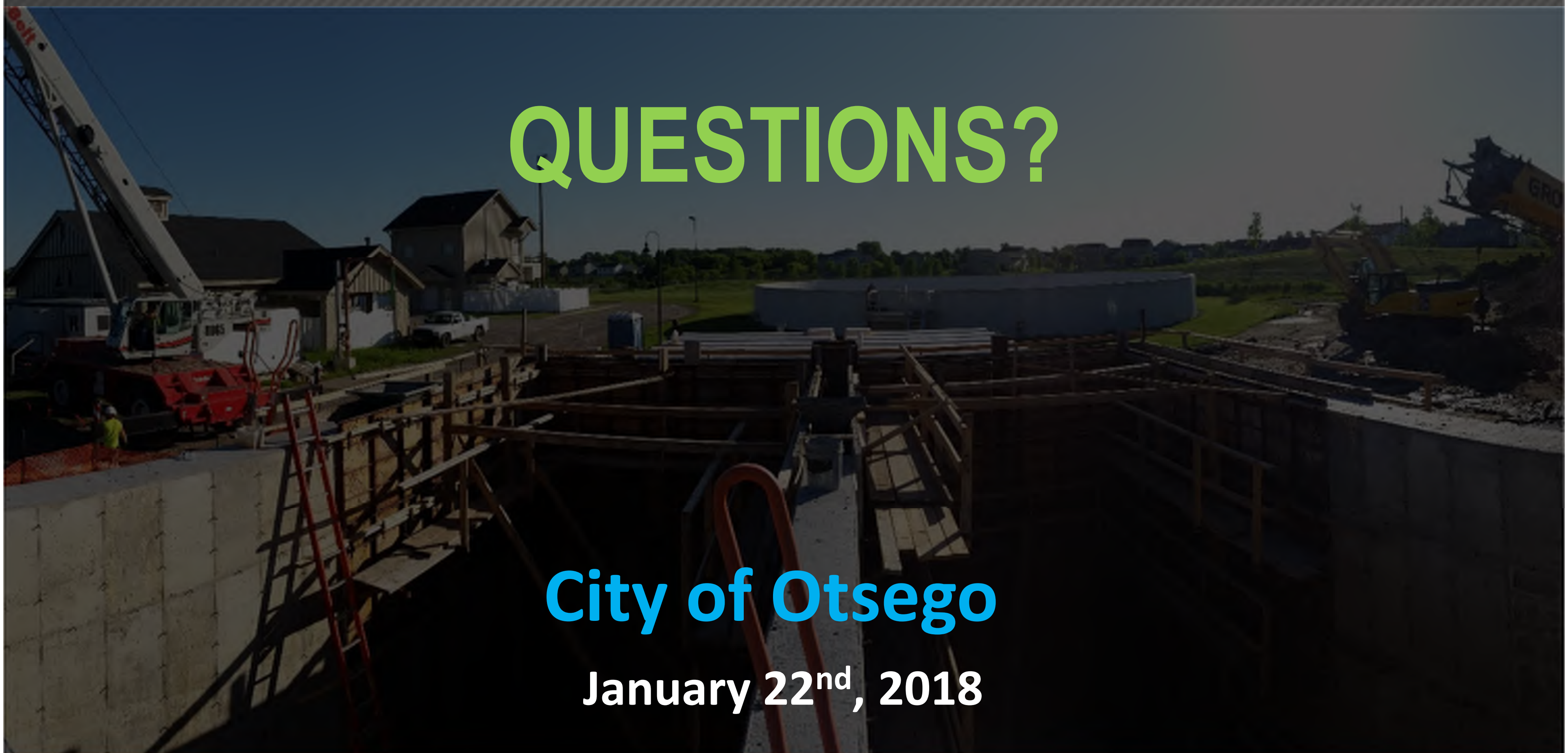


CAPITAL PHASING

Phase	Projected Project Initiation Year	Projected Cost (2017 Dollars)
East Solids Phase 1 (ES1)		
Phase 1a Only (ES1a)	2018-2021	$7,500,000
Phase 1b Only (ES1b)	2023	$4,750,000
Phase 1a+1b (ES1 – Constructed in Single Phase)	2018-2023	$12,100,000
West Liquid Phase 1 (WL1)	2022 (2026)	$22,300,000
East Liquids Phase 1 (EL1)	2031 (2050)	$20,750,000
Years in parentheses indicated "slow growth" projection of 75 RECs/year/WWTF.		

NEXT STEPS

- **Next Steps**
  - **Adopt Plan**
  - **Submit to MPCA – SRF eligibility**
  - **Annual Capital Review**
  - **Project Initiation**
  - **Design**
  - **Construction**
  - **Start-Up**



QUESTIONS?

City of Otsego

January 22nd, 2018

Presented by: Advanced Engineering and Environmental Services, Inc. (AE2S)

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APPENDIX G

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CITY OF OTSEGO
COUNTY OF WRIGHT
STATE OF MINNESOTA

RESOLUTION NO: 2018-06

ADOPTING THE OTSEGO WASTEWATER MASTER PLAN

WHEREAS, after due Notice of Public Hearing on the draft Master Plan for the City of Otsego, Minnesota Wastewater System, a hearing on said Master Plan was duly held; and

WHEREAS, the Otsego City Council heard all persons desiring to be heard on the matter and fully considered the same; and

WHEREAS, it is necessary to submit the Wastewater Master Plan to the Minnesota Pollution Control Agency for approval in order to be eligible for Clean Water State Revolving Fund consideration; and

WHEREAS, the City intends to submit the initial Biosolids project for the Project Priority List.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF OTSEGO, MINNESOTA:

1. The Otsego Wastewater Master Plan is adopted.
2. That City staff with assistance from Advanced Engineering and Environmental Services, Inc. (AE2S), are authorized to proceed with submitting the adopted Wastewater Master Plan to the Minnesota Pollution Control Agency, and that the Mayor and City Administrator are authorized to execute the same.

ADOPTED by the Otsego City Council this 22nd day of January, 2018.

CITY OF OTSEGO

Jessica Stockamp, Mayor

ATTEST:

Tami Loff, City Clerk

MOTION made by Council Member Darkenwald and **SECONDED** by Council Member Warehime.

IN FAVOR: Stockamp, Darkenwald, Warehime, Heidner, Tanner

OPPOSED: None

APPENDIX H

Note: The Environmental Information Worksheet (EIW) is not being submitted with this Master Plan. Multiple projects will result from this Master Plan, and the timing of the first project is dependent upon development and population growth. It is anticipated that Facility Plan Amendment(s) will be submitted as the project(s) approach implementation, and the appropriate EIW will be included with those more specific amendment(s).