APPENDIX 3-1
Lakewood Utility Funding

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Technical Memorandum

Prepared for: City of Lakewood

Project Title: Utility Funding

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Technical Memorandum 1

Subject: Lakewood Utility Funding

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Limitations:

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Section 1: Summary

This Technical Memorandum (Tech Memo 1) describes the development of the estimated capital needs for the City of Lakewood (City) over the next 40 years. The evaluation included reviewing existing City materials, interviewing City personnel, and developing costs for the City wastewater treatment plant, wastewater collection system, and water distribution system (a summary of materials reviewed is included in Attachment A). Findings from the evaluation are show annually for the first 5 years, then in five-year increments over the remainder of the 40-year planning horizon.

The scope of work for Brown and Caldwell (BC) for the Utility Funding and Affordability project included collecting relevant data for the capital needs assessment, interviewing key personnel, leading a policy workshop with the City, identifying capital needs based compiled information, and developing a long-term, planning level capital improvement plan (CIP).

Section 2: System Overview

The first phase of this analysis included a review of the City's Water Distribution, Wastewater Collection, and Wastewater Treatment systems. BC provided a data request to the City to inquire about the availability of asset and planning data for each of the systems. The data request is attached to this report in Attachment A – Data Collection and Review Materials.

Data review also included interviews with key City staff and a group workshop to gain an understanding of current system operations and maintenance activities, identify any known system deficiencies, determine any capital improvements currently underway, and document future challenges and opportunities not addressed in existing reports for the three divisions. The BC team created a presentation to facilitate discussion during the workshop, which is included in Attachment A.

The data review and subsequent discussions with key staff helped the BC Team gain an understanding of the drivers for future capital investment. The City was clear that there were two main drivers. The first was managing the wet weather conditions to meet regulation, most of which these needs are included in a separate but related effort to determine capital needs associated with the City's Integrated Wet Weather Plan. The second driver was adequately managing their aging assets. Therefore, the BC Team created a methodology that would focus on creating short- and long-term reinvestment strategies for the wastewater collection, wastewater treatment, and water distribution systems. The results of this analysis included a determination of the adequacy of the current reinvestment rate and identification of additional assessment, repair, and replacement needs annual for the next five years and in five-year increments for the next 35 years.

The information included in this section of the report is based on the data provided by the City, and are not purported to be a completely accurate representation of the assets in the City's system. The information was used to determine short- and long-term capital needs for the City.

2.1 Wastewater Collection

Information for the wastewater collection system came from the City's GIS as shapefiles, outfall report, and select other resources provided by the City. The validity of the data was confirmed through interviews with City personnel.

2.1.1 Pipes

The pipes within the City's collection system (Figure 2-1) are comprised of sanitary, combined and storm pipes, ranging in size from 6 to 120 inches in diameter (Table 2.1). The approximate length of wastewater pipes in GIS is 913,000 feet (Table 2.2).

Table 2.1. Pipe Size Summary

Shape	Size (inches)	Count
CIRCULAR	6-18	2608
CIRCULAR	20-22	138
CIRCULAR	24-120	791
FILLED_CIRCULAR	8-18	13
FILLED_CIRCULAR	24-72	12
ARCH	65-85	31
EGG	31-56	80
HORIZ_ELLIPSE	12	1
HORIZ_ELLIPSE	53-85	6
RECT_CLOSED	57-81	7
VERT_ELLIPSE	33-110	48

Table 2.2. Pipe Footage Summary

Diameter	Combined (feet)	Sanitary (feet)	Storm (feet)
Small Diameter (less than 24 inches)	113,059	326,224	230,124
Midsize Diameter	9,458		18,469
Large Diameter (greater than 60 inches)	83,276	25,870	106,654

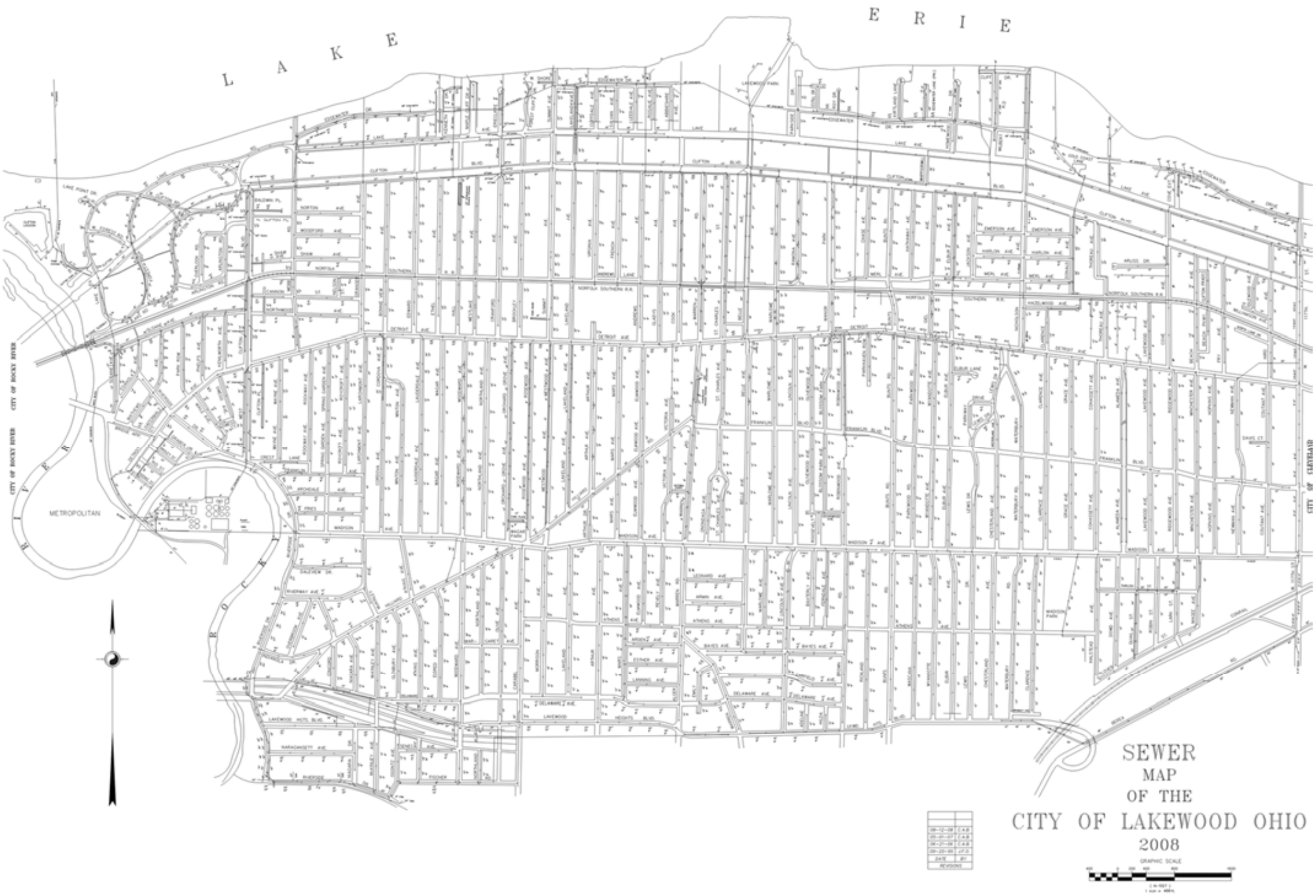
2.1.2 Manholes

There are approximately 3,600 manholes in the collection system. The vast majority of the manholes are less than 25 feet deep. A few are deeper—up to 108 feet in depth. (See Table 2.3.)

Table 2.3. Manhole Summary

Depth	Number
Shallow (<25 feet)	3527
Mid (25 to 50 feet)	40
Deep (>50 feet)	4

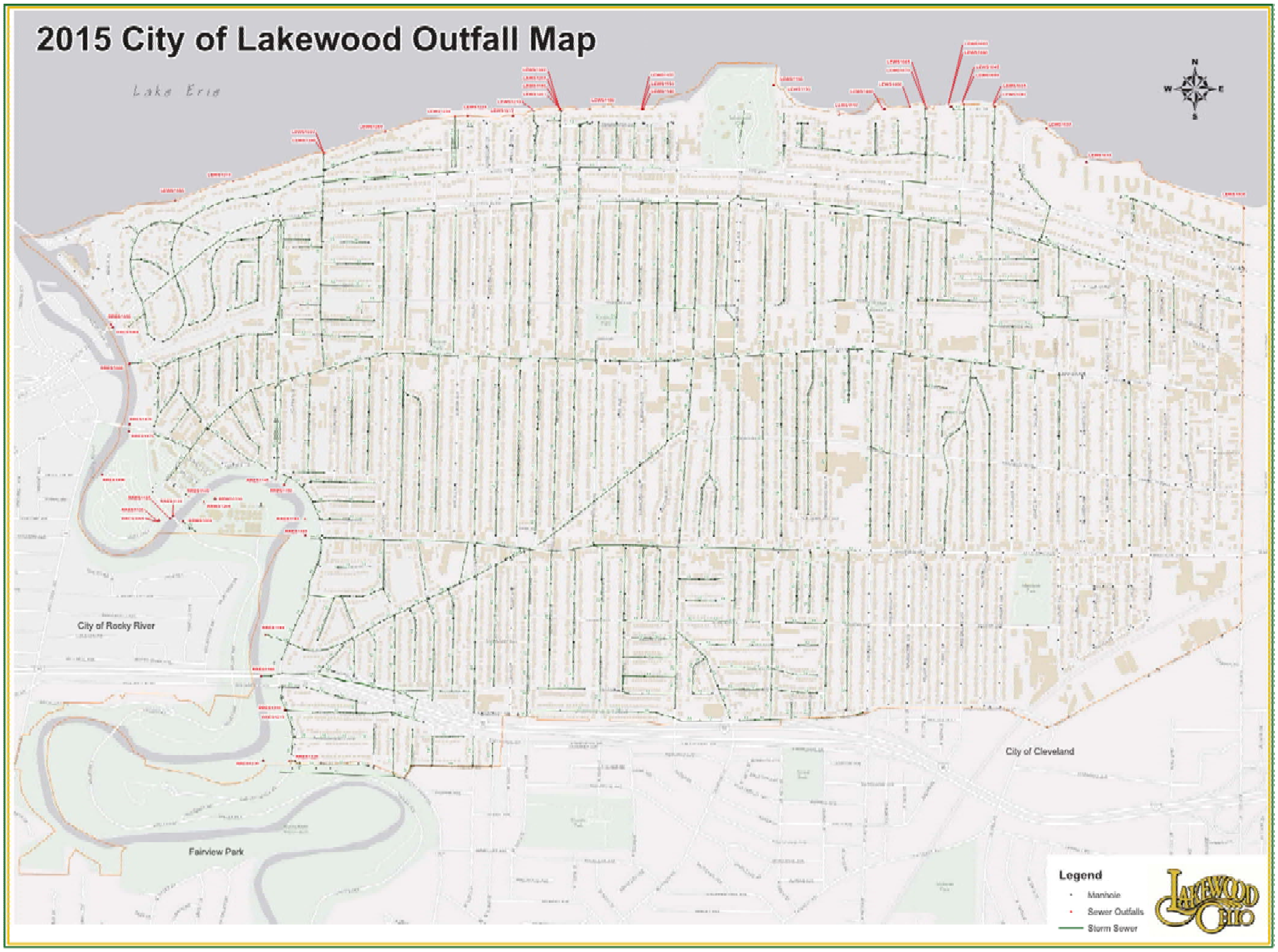
Figure 2-1. Lakewood Sewered Areas (2008)



2.1.3 Outfalls

The City provided an assessment report of the outfalls performed by a consultant. The findings from the report were used to estimate long-term needs. There are 39 outfalls listed in the City's GIS, and are shown in Figure 2-2.

Figure 2-2. Lakewood Outfall Areas (2015)



2.2 Wastewater Lift Stations

The City owns and operates four lift stations/well. Facility information is summarized in Table 2.4. Year installed indicates the year the asset was installed or overhauled to reset its expected life.

	Table 2.4. Lift Stations Summary	
Station	**Description**	**Year Installed**
West Lift Station	Pumps with VFDs • Pump motor HP – 15 • Pump capacity - 550 gallons per minute (gpm) • Pump Type - centrifugal screw pump, dry pit style, vertical pump	2014

Table 2.4. Lift Stations Summary

Station	Description	Year Installed
Clifton Lagoon Lift Station	Pumps with VFDs • Pump motor HP – 10 • Pump capacity - 80 gpm • Pump Type - centrifugal, dry pit style, vertical pump	2017
Process Well (Operations Building Basement)	Submersible Pumps with VFDs • Pump motor HP – 15 • Pump capacity - 400 gpm • Pump Type - submersible centrifugal	Pumps - 2005 VFDs - 2016
East Lift Station (near Animal Shelter)	Submersible Pumps (no VFDs) • Pump motor HP – 5 • Pump capacity - 100 gpm • Pump Type - submersible centrifugal	2014

2.3 Wastewater Treatment Plant

The City owns and operates one wastewater treatment plant (WWTP) located on Cleveland Metro Park Drive. The plant was built in the 1960s and has been expanded and modified over the years. Its current average daily flow is 5-6 million gallons per day (mgd), with a maximum flow capacity of 40 mgd. Facility information is shown in Figure 2-3, and summarized in Table 2.5. Year installed indicates the year the asset was installed or overhauled to reset its expected life.

Figure 2-3. Lakewood Wastewater Treatment Plant process areas

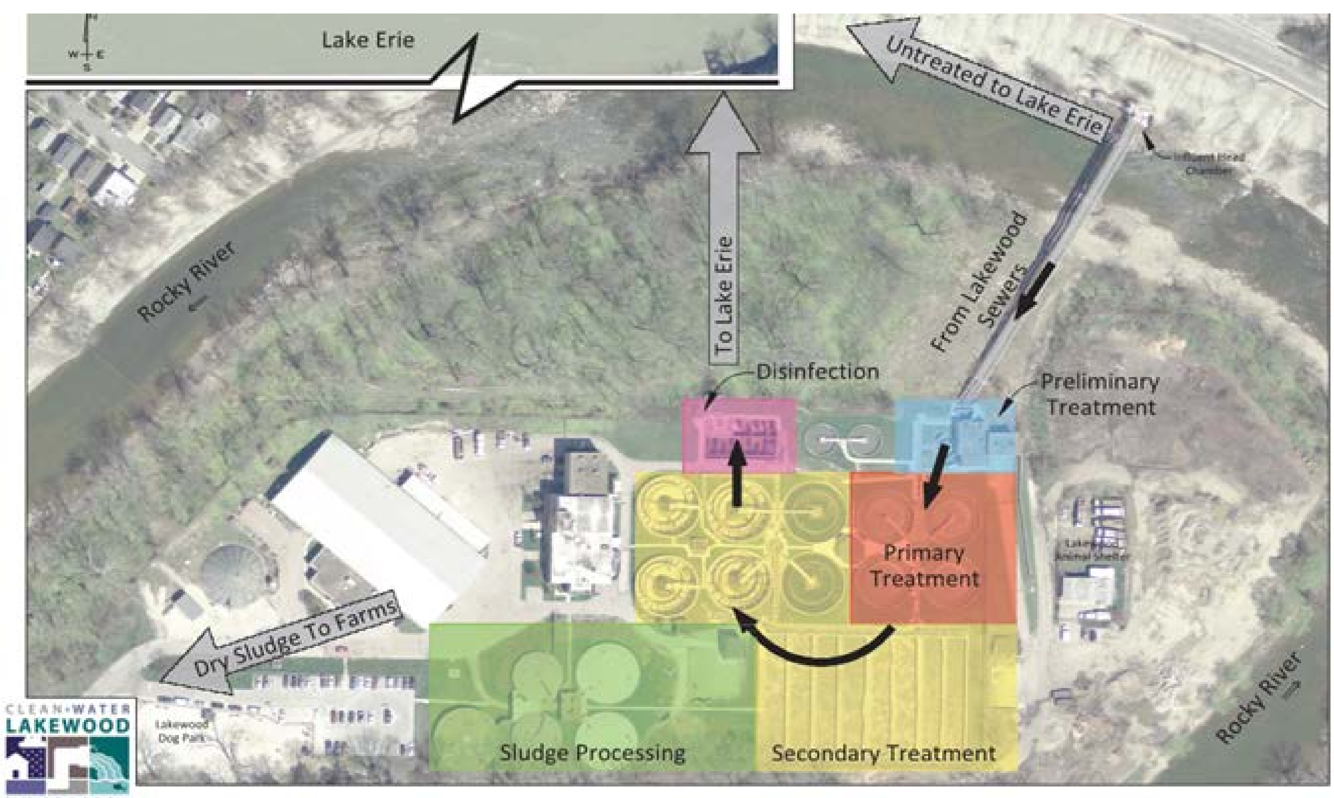


Table 2.5. WWTP Asset Summary				
Process	Description	Quantity	Year Installed	Notes
Preliminary Treatment	Bar Screens	2	2003	Screens and compactors
Preliminary Treatment	Vortex Grit Tanks	2	2003	Drive Units - 2003
Preliminary Treatment	Grit Pumps	2	2014	
Preliminary Treatment	Cyclones	2	2003	Rebuilt - 2003
Preliminary Treatment	Grit Classifiers	1	2003	
Primary Treatment	Primary Settling Tanks	4	1983	
Primary Treatment	Drive Units	4	1983	Cast Iron Drive Units - 1983
Primary Treatment	Primary Sludge Pumps with VFDs (800 gpm)	2	2002	
Primary Treatment	Primary Scum Pumps (no VFDs)	2	1983	
Secondary Treatment	Aeration Tanks	8	1983	Ceramic Air Diffusers - 1983
Secondary Treatment	Aeration Tank Blowers	3	2013	
Secondary Treatment	Secondary Clarifiers (4 installed 1965, 2 added/installed 1983; floors refurbished 2017/2018)	6	1983*	*floor refurbishment in 2017/2018 extends RUL
Secondary Treatment	Secondary Clarifiers Mechanism	6	1983	
Secondary Treatment	Drive Units	6	1983	
Secondary Treatment	RAS Pumps (800-1500 gpm) (VFDs)	5	2010	Pumps 2006/ VFDs 2016
Secondary Treatment	Dewatering Pumps (gravity fed) (VFDs)	3	2017	Pumps/VFDs - 2017
Secondary Treatment	Secondary Scum Pumps (no VFDs)	4	1983	
Secondary Treatment	Spray Water Pumps (for hosing down tanks) (no VFDs)	3	1983	
Disinfection	Disinfection Tanks		2003	Upgraded - 2003
Disinfection	Sodium Aluminate Storage Tank	1	2011	
Disinfection	Sodium Aluminate Feed Diaphragm Pumps (VFDs)	2	2011	
Disinfection	Ultraviolet Light Bulbs		2021	(slated to be upgraded with new HRT design in the next 3-5 years)
Sludge Processing	Gravity Sludge Thickening Tanks	2	1965	
Sludge Processing	Collectors	2	1965	
Sludge Processing	Drive Units	2	2010	
Sludge Processing	Sludge Thickening Pumps (sludge to digesters) (VFDs)	2	2015	
Sludge Processing	Primary Digester Tanks (Anaerobic)	2	2019	In design-build
Sludge Processing	Secondary Digester Tanks (Anaerobic)	2	1938	Tanks - 1938 Tank Lids Replaced - 2010
Sludge Processing	Sludge Recirculation Pumps (300 gpm)	2	2007	
Sludge Processing	Sludge Grinders	2	2007	
Sludge Processing	Secondary Digester Mixing Pumps (1500 gpm)	2	2010	
Sludge Processing	Sludge Transfer Pump	1	2010	
Sludge Processing	Boilers and Heat Exchangers (to keep sludge in temp)	2	2019	

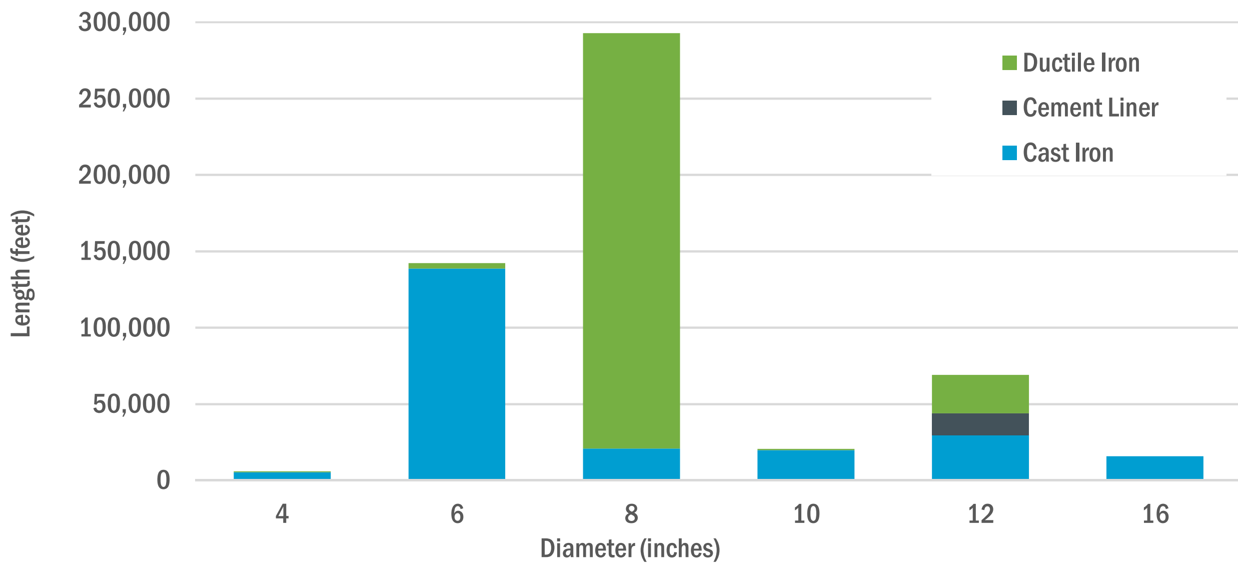
Table 2.5. WWTP Asset Summary				
Process	**Description**	**Quantity**	**Year Installed**	**Notes**
Sludge Processing	Methane Gas Meters (for measuring gas produced)	5	2012	
Sludge Processing	Sludge Storage Tank	1	1983	Tank is not in use
Sludge Processing	Belt Filter Press (sludge dewater process)	2	2007	
Sludge Processing	Sludge Conveyor Belt	1	2007	
Sludge Processing	Polymer Feed Pumps	4	2007	
Sludge Processing	Polymer Batch Tank	1	2007	
Sludge Processing	Polymer Holding Tank	1	2007	
Other	Emergency / Backup Generator	1	2007	
Other	Digester GenSet (future)	1	2019	
Other	Electric Boilers (booster boiler for hot water for bldgs.)	1	1990	
Other	Hot water pumps to circulate water throughout plant	Mult.	1983	
Other	Freight Elevator (no structural/cable issues, only control)	1	1965	
Other	HVAC System - Operations & Screenings/Grit Buildings	Mult.	1983	
Other	HVAC System - Digester Building	Mult.	1991	
Other	LED Lighting	Mult.	2016	
Other	Miscellaneous (arch enhancements)	Mult.	1965	
Other	Electrical infrastructure	Mult.	1965	
HRT	Screens	2	2021	
HRT	Grit Removal	2	2021	
HRT	Grit Pumps	3	2021	
HRT	Actiflow System	1	2021	
HRT	Actiflow Polymer Tank	1	2021	
HRT	UV Disinfection (2 banks)	1	2021	
HRT	Slide Gates	12	2021	

2.4 Water Distribution

The City of Lakewood owns and operates 546,2000 linear feet of water main in the water distribution system, serving an area of 6.5 square and approximately 52,000 people. The average day water demand is 3.85 mgd and the City purchases this water from the City of Cleveland via 18 interconnections into the City's water distribution system. The average age of the water distribution main network is approximately 50 years. Over the past decade, the City has invested $18.6 million into replacement of aging water main in the distribution system, replacing approximately and at average rate of 4,500 liner feet or 0.8 percent of the water distribution system per year.

The city provided a combination of worksheets and databases to provide a comprehensive inventory of the City's water distribution mains. The inventory includes location, diameter size, length, installation year, material, and break history. Figure 2-4 provides a summary of the water distribution mains by diameter and material.

Figure 2-4. Water Main Inventory by Diameter



As shown, the distribution system is made up of predominately 6-inch and 8-inch diameter pipe. Pipe with an age older than the average (50 years) is cast iron. Ninety-one percent (91 percent) of the pipe with an age younger than the average (50 years) is ductile iron, the remaining 9 percent is cast iron or plastic pipe.

Figure 2-5 shows the water mains broken into four age groups; pipe younger than 35 years, pipe between 36–55 years, pipe between 55–86 years, and pipe older than 86 years. Approximately 35 percent of the City's water distribution main is over 86 years old.

Figure 2-5. Water Main Inventory by Age

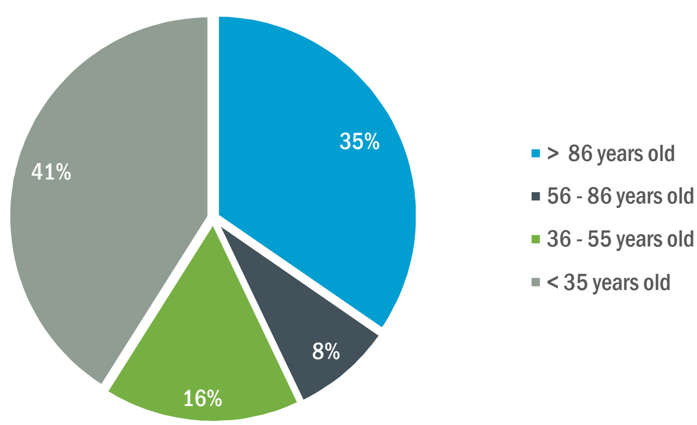


Figure 2-6 shows the location of each water main by installation year in the City's water distribution system, using installation year groups that coincide with age groups shown above. Assuming a standard 100-year useful life and discounting any condition data, the City's reinvestments are shown in Figure 2-7. This figure shows that the City has 100,000 linear feet of water main that is over 100 years old.

Figure 2-6. Water Main by Installation Year

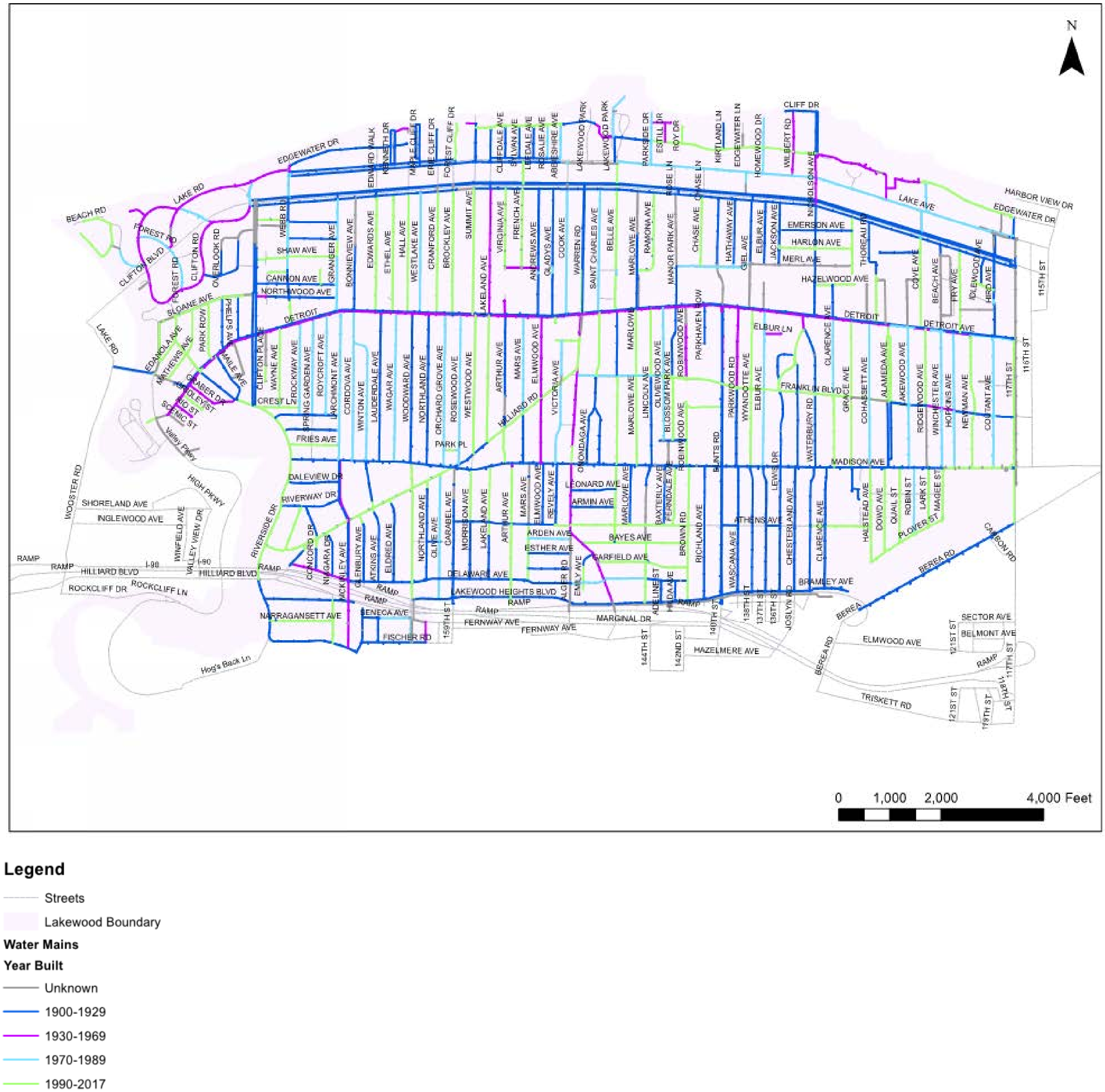


Figure 2-7. Water Main Replacement Needs

(based on 100- year useful life)

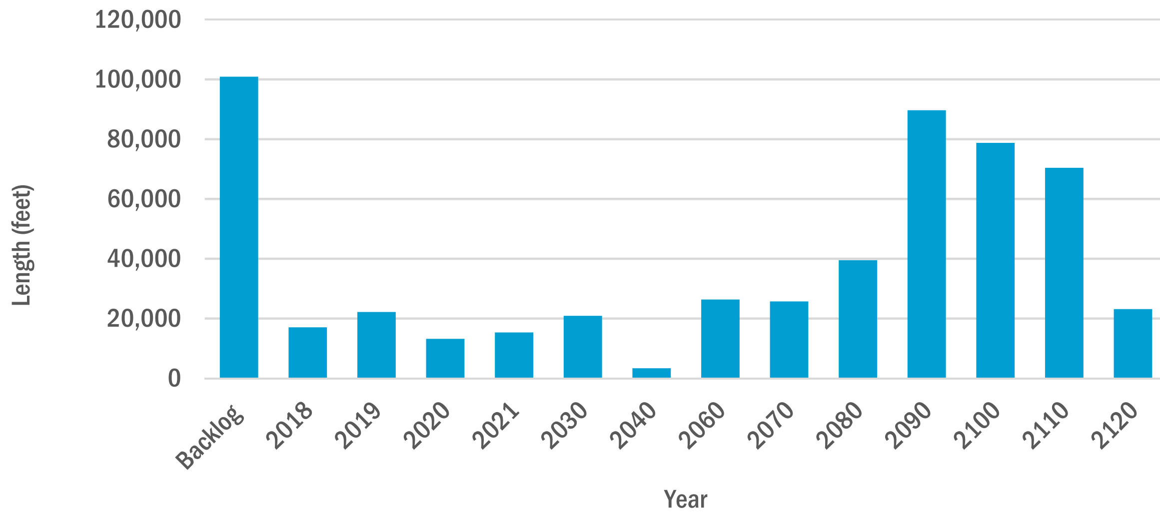


Figure 2-7 is useful in gaining a quick overview of the reinvestment needs based on useful life. However, it does not address the performance of the assets or how to prioritize the replacement of the oldest 100,000 linear feet of pipe.

Currently, the City's uses a weighted formula including remaining useful life (10 percent), diameter (30 percent), and break history (60 percent) to assign a Water Condition Rating (WCR) to each main. The WCR ranges from 0–100. The City also assumes that mains with diameter of 6-inch and smaller are to be prioritized for replacement. Currently, the WCR is used to prioritize annual water main replacement. Based on Figure 2-4, it appears that 6-inch and smaller mains are replaced with 8-inch mains when replaced. This explains why most of the remaining 6-inch diameter main is older, cast iron main and that it looks like there has been less reinvestment in this group of pipes than of the others.

Figure 2-8 breaks down water main by Water Condition Rating and age. There are 125,000 linear feet of main with a condition rating less than 60, and 91 percent of main with a rating less than 60 is also greater than 86 years old.

Figure 2-9 shows the location of the oldest pipe, and the location of the poorest performing pipe. The performance is shown as a highlight so an overlap between the two parameters can be visualized. The next section will summarize the assumptions and methodology used to develop the short and long-term replacement plan.

Figure 2-8. Water Condition Rating and Age

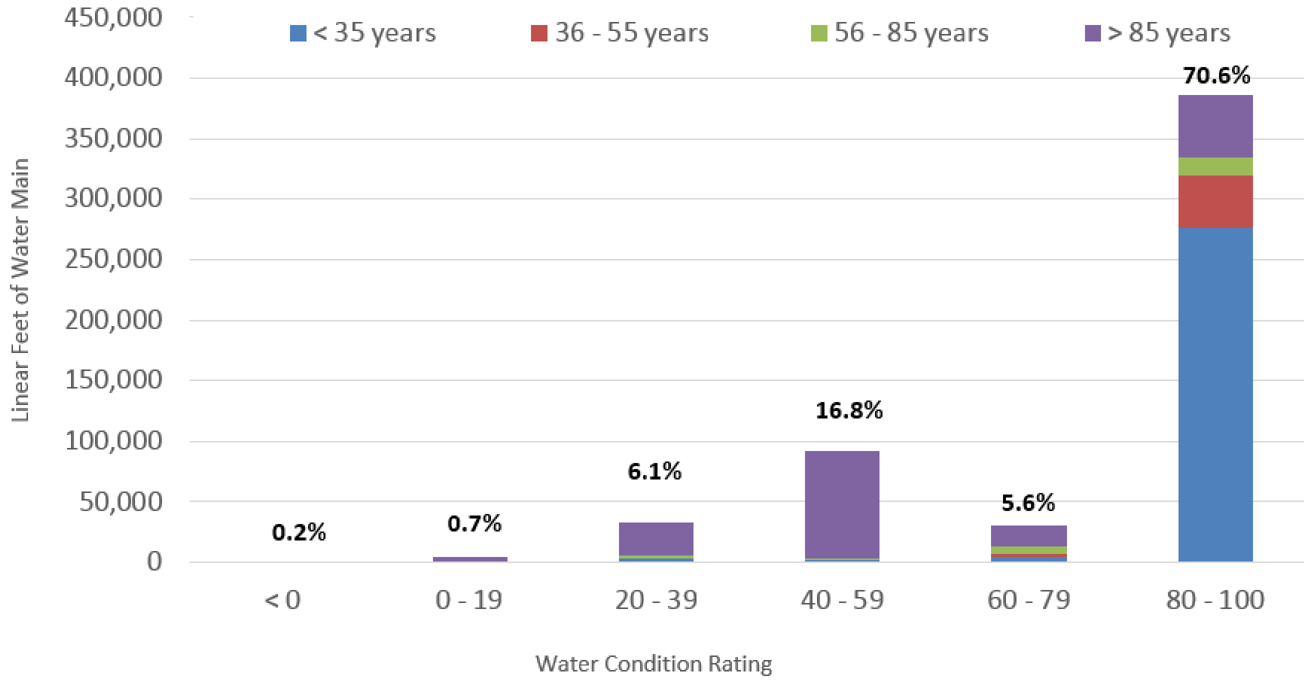


Figure 2-9. Oldest Water Main (> 86 years old) with Overlay of Main Break Data

Section 3: Assumptions

Since there was limited data for the assets, several broad assumptions were made regarding the system. If additional information is available in the future, it could help refine the estimates and the timing of the expenditures.

3.1 Integrated Wet Weather Plan

Capital costs for assets included in the IWWP were included in the analysis to the extent that the upfront capital investment in new assets will need to be maintained over the 40-year analysis. Therefore, the assets that will need refurbished and replaced periodically are included in the long-term costs.

3.2 Wastewater Collection

While the data attributes for the pipes did include depth, diameter and length, it did not include material and age, which are needed for the needs assessment. Assumptions for the collection system pipes, manholes and outfalls are included in the following tables and figures.

Table 3.1. Pipe Attributes Assumptions	
Age	• No data provided indicating age of pipes in the asset shapefiles (GIS). Based on overlaying GIS with consultant (CT) pdf of 1920 and 1945 sewer maps. Based on those pdfs of the sewer maps for pipes added in 1920 and 1945 provided by Lakewood, it is assumed that most pipes were built in 1920. Those first appearing in 1945 were updated as such. (See Figure 3-1 and Figure 3-2) • Material. No data provided indicating material. The type of material assumptions is based on the categories of size and shape of the collection system pipes. Circular pipes with diameters ranging from 6 to 18 in are assumed to be vitrified clay pipes (VCP), as well as diameters 20 to 22 inches, although these are nonstandard sizes. Circular pipes with diameters 24 to 120 inches are assumed to be made of brick. Pipes with a shape indicated as "FILLED_CIRCULAR" were found to be in regular circular lines, so it is assumed diameters 8 to 18 inches are VCP and 24 to 72 inches are brick. It is assumed that arch and egg pipes are made of brick, while rectangular and ellipse pipes are assumed to be concrete.

Cost	• Estimated cost per inch diameter to maintain during the 40-year analysis
	• Rehabilitation and replacement capital needs were based on following a rehab/replace ratio
	  • Combined and sanitary ratio of 80/20
	  • Storm ration 90/10
	• Assumes a ramp up in costs over the first two years as GIS and CMMS systems functionality are improved

Useful Life	• Estimated based on material. brick, concrete or VCP: 100 years. • Remaining useful life calculated based on assumed age, expected useful life, following bell curve for the longer the asset has been in the ground the longer it is anticipated to live • Annual R/R estimate average of total needs over 40-year analysis period.

Figure 3-1. Lakewood Sewered Areas (1920)

Figure 3-2. Lakewood Sewered Areas (1945)

Table 3.2. Manhole Attributes Assumptions	
Age	• Based on the estimated age of the corresponding sewer.
Cost	• Rehabilitation and replacement capital needs were based on following 80/20 rehab/replace ratio. • Manholes less than 50 feet in depth: $165/VF • Manholes greater than 50 feet in depth: $208/VF • Assumes a ramp up in costs over the first two years as GIS and CMMS systems functionality are improved.
Useful Life	• Manhole expected useful life: 100 years---same life as pipes, and would be fixed at same time.

Table 3.3. Outfall Attributes Assumptions	
Age	• Based on the recommendations for longer-term rehab in the KS 2017 Outfall Inspection Coastal Engineering Report.
Cost	• Based on average costs of similar rehab needs provided in the KS 2017 Outfall Inspection Coastal Engineering Report. • Outfalls given rehab costs (priority A) are not included.
Useful Life	• Based on the recommendations for longer-term rehab in the KS 2017 Outfall Inspection Coastal Engineering Report.

3.3 Lift Stations

Assumptions used in the analysis for the lift stations are included in Table 3.4

Table 3.4. Lift Station Attributes Assumptions	
Age	• Ages established from City personnel.
Cost	• Costs estimated based on industry similar items, and knowledge of local systems. • General cost established for periodic overhaul of stations—every 15 years.
Useful Life	• Overhaul of stations every 15 years.

3.4 Wastewater Treatment Plant

Assumptions used in the analysis for the treatment plant are included in Table 3.5 Additional details about age, costs and replacement assumptions can be found in Attachment B.

Table 3.5. Wastewater Treatment Plant Attributes Assumptions	
Age	• Ages established from City personnel and available drawings.

Table 3.5. Wastewater Treatment Plant Attributes Assumptions	
Cost	• Costs estimated based on industry similar items, and knowledge of local systems. • Electrical and architectural costs spread over 10 years. • Replacement costs estimated to bring asset back to useful condition and meet regulatory requirements—replacement in-kind not assumed.
Useful Life	• Estimated based on asset type.

3.5 Water Distribution

The following table summarizes the attribute assumptions used to develop the short and long-term water distribution main replacement needs (Table 3.6).

Table 3.6. Water Distribution System Attributes Assumptions	
Age	• Calculated based on installation date. Data was provided in workbook and GIS
Cost	• Costs estimated based on available recent water main replacement costs and represent Class 5 Planning Level estimates. Unit rates for LF replacements by diameter were calculated and compared to industry standards.
Useful Life	• 100 years. Performance, specifically break history, and age are used to prioritize short-term reinvestment needs.

Data collected and summarized in the previous section was used to develop a pipe replacement schedule that will increase from the current replacement rate of 0.8 percent per year (4,500 LF) to 2 percent per year (11,000 LF) over the next 5 years. At a reinvestment rate of 2 percent per year, the City should be able to replace 80 percent of the 125,000 linear feet of main that is noted as poor performing aging pipe in Figure 2-8 in the next 10 years.

Table 3.7 shows the type and age of the mains recommended for replacing first over the first five years—highlighted in yellow. A detailed table listing of the specific projects can be found in Attachment C – Water Main Replacement Tables. The table also shows water main that is still existing in inventory as poor performing, that are not identified as priority replacement. These mains were removed because in discussions with the City it was suggested that they have been replaced but the inventory was not updated to reflect the recent replacement. A table of these projects is also shown in Attachment C.

Table 3.7. Linear Feet (LF) by Material, Age, and Breaks per 1,000 LF													
Cast Iron													
Breaks per 1,000 LF	0	1	2	3	4	5	6	7	8	9	10	12	16
< 35 years old	4,778	3,650	1,550	0	700	0	1,550	1,300	0	0	0	0	0
36 - 55 years old	3,200	0	600	0	0	0	0	0	0	0	0	0	0

Table 3.7. Linear Feet (LF) by Material, Age, and Breaks per 1,000 LF													
56 -86 years old	9,300	2,600	4,950	2,480	1,590	1,900	350	0	0	0	0	0	0
> 86 years old	54,400	42,440	35,645	25,750	15,960	8,087	2,704	0	2,000	650	300	1,100	0
Cast Iron Sub-Total	71,678	48,690	42,745	28,230	18,250	9,987	4,604	1,300	2,000	650	300	1,100	0
Ductile Iron													
Breaks per 1,000 LF	0	1	2	3	4	5	6	7	8	9	10	12	16
< 35 years old	255,052	16,850	0	0	0	0	500	0	0	0	0	0	1,250
36 - 55 years old	30,690	7,100	3,770	0	0	400	0	450	596	0	0	0	0
Ductile Iron Sub-Total	285,742	23,950	3,770	0	0	400	500	450	596	0	0	0	1,250
TOTAL	357,420	72,640	46,515	28,230	18,250	10,387	5,104	1,750	2,596	650	300	1,100	1,250

Mains recommended for replacing first over the first five years.

Section 4: Capital Needs

The main output of this task is the capital project schedule for each system (water distribution, wastewater collection, and wastewater treatment): year-by-year for the short-term capital improvements needed (2019 - 2023); and a capital program schedule for each system in 5-year increments for the long-term capital improvement needs. The projects identified to meet long-term system needs are conceptual in nature, and all identified costs are planning level estimates.

There is greater definition of capital needs in the early stages of the capital plan with five-year increments and less definition towards the end of the 40-year plan. This is because predictions in farther in the future are less certain, and there could be deviations from predictions. Using this approach, triggers or thresholds are discussed that would prompt revisiting the analysis and costs of system improvements to be implemented.

4.1 Wastewater Collection

Total planning-level estimates for capital costs are included in Table 4.1.

Triggers that would prompt reevaluation to modify expected remaining useful life, and therefore refurbishment year include:

- Identification of installation/refurbishment year data for the assets
- Identification of material, which could adjust remaining useful life of the assets
- Inclusion of condition data, which can be used to modify the remaining useful life of the assets

Table 4.1. Wastewater Collection Estimated Capital Costs (million dollars)

Asset Type	2019	2020	2021	2022	2023	2024 to 2028	2029 to 2033	2034 to 2038	2039 to 2043	2044 to 2048	2049 to 2053	2054 to 2058
Combined and Sanitary Pipes	1.59	1.59	1.59	1.59	1.59	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Storm Pipes	1.26	1.26	1.26	1.26	1.26	6.32	6.32	6.32	6.32	6.32	6.32	6.32
Manholes	0.12	0.12	0.12	0.12	0.12	0.61	0.61	0.61	0.61	0.61	0.61	0.61
Outfalls	*	*	*	*	*	3.37	3.37	3.37	3.37			
Capital equipment (jet trucks, vac truck, CCTV truck, water truck)						1.37		1.37		1.37		1.37

**KS report with estimates for "A" priority outfalls*

4.2 Lift Stations

Total planning-level estimates for capital costs are included in Table 4.2.

Table 4.2. Lift Stations Estimated Capital Costs (million dollars)

Process Area	2019	2020	2021	2022	2023	2024 to 2028	2029 to 2033	2034 to 2038	2039 to 2043	2044 to 2048	2049 to 2053	2054 to 2058
West Lift Station							0.11			0.11		
Clifton Lagoon Lift Station							0.05			0.05		
Process Well (Operations Building Basement)						0.09			0.09			0.09
East Lift Station (near Animal Shelter)							0.05			0.05		

4.3 WWTP

Total planning-level estimates for capital costs are included in Table 4.3.

Triggers that would prompt reevaluation to modify expected remaining useful life, and therefore refurbishment year include:

- Inclusion of condition data, which can be used to modify the remaining useful life of the assets

Table 4.3. Wastewater Treatment Plant Estimated Capital Costs (million dollars)

Process Area	2019	2020	2021	2022	2023	2024 to 2028	2029 to 2033	2034 to 2038	2039 to 2043	2044 to 2048	2049 to 2053	2054 to 2058
Preliminary Treatment	0.02		0.02		0.53	0.50	0.09	0.09	0.59	0.11	0.53	0.11
Primary Treatment	0.20				1.40	0.01	0.08	0.06	0.20	0.04	0.13	0.01
Secondary Treatment	0.25	0.23			5.79	0.24	4.39	0.11	4.92	0.22	2.26	0.42
Disinfection			0.03	0.03		0.05	0.07	0.05	0.08	0.65	0.09	0.05
Sludge Processing	0.65	0.38	0.01	0.03	0.01	1.45	0.46	0.60	1.49	1.48	2.59	0.45
Other	2.80	1.10	1.56	1.76	1.66	4.32	1.32	2.77	4.42	2.32	1.57	2.52
HRT				0.02	0.02	0.10	0.34	0.10	2.16	0.10	0.34	0.10

4.4 Water Distribution

Total planning-level estimates for capital costs are included in Table 4.4.

Table 4.4. Water Distribution Estimated Capital Costs (million dollars)											
Asset Type	2019	2020	2021	2022	2023	2024 to 2028	2029 to 2033	2034 to 2038	2039 to 2043	2044 to 2048	2049 to 2053	2054 to 2058
Water Mains	2.28	2.73	3.26	4.03	4.03	20.13	8.75	8.75	8.75	8.75	8.75	8.75

4.5 CIP Summary

A summary of the collection system, wastewater treatment plant and water distribution planning-level estimates for capital costs are included in Table 4.5.

Table 4.5. Summary of Estimated Capital Costs (million dollars)												
Process Area	2019	2020	2021	2022	2023	2024 to 2028	2029 to 2033	2034 to 2038	2039 to 2043	2044 to 2048	2049 to 2053	2054 to 2058
Collection System	2.98	2.98	2.98	2.98	2.98	19.61	18.24	19.61	18.24	16.25	14.88	16.25
WWTP	3.92	1.71	1.62	1.84	9.41	6.67	6.76	3.79	13.86	4.92	7.51	3.67
Pump Stations	-	-	-	-	-	0.09	0.21	-	0.09	0.21	-	0.09
Water Distribution	2.28	2.73	3.26	4.03	4.03	20.13	8.75	8.75	8.75	8.75	8.75	8.75
Total	9.18	7.42	7.86	8.85	16.42	46.5	33.96	32.15	40.94	30.13	31.14	28.76

Attachment A: Data Collection and Review Materials

To the extent that the data request in this list is not available, the BC team will work with the City and best data available for this effort. Any information, documents, or insights that the City can provide regarding the topics below will be helpful to our analysis and development of future capital needs for the City's Water Distribution Wastewater Collection, and Wastewater Treatment Divisions.

- Water Distribution System Master Plan
- Water Distribution System Hydraulic Model
  - Current Water System Demands (Billing Data), if not already in hydraulic model
  - Minimum Fire Flow Requirements (Flow and Pressure)
  - Wholesale Agreements with City of Cleveland for purchase of water
  - Location of meters / interconnections with City of Cleveland
- Wastewater Collection System Hydraulic Model/s
- Historical water audit results (past 5 years), if available, and most recent Water Conservation Plan and Water Loss Reduction Plan
- GIS data for the Water and Wastewater Collection systems including data layers with attributes for pipes, valves, hydrants, appurtenances, pump stations, storage facilities, etc.
- Integrated Wet Weather Improvement Plan / Long-Term Control Plan and any other available Master Plan for the Wastewater Collection and Wastewater Treatment Divisions
- Asset Management Plans for the Water Distribution, Wastewater Collection, and Wastewater Treatment Divisions
- Projected Growth for the City of Lakewood, including residential/commercial re-development plans, if known
- Historical (past 5-years) and current Capital Improvement Plans (CIP) for the Water Distribution, Wastewater Collection, and Wastewater Treatment Divisions
- Historical (past 5 years) footage of water main replacement and sewer pipe replacement and total cost, if not included in the CIP
- CMMS asset attribute data for Wastewater Treatment assets
- Industrial User charges/surcharges

Attachment B: Wastewater Analysis Assumptions Table

Lakewood WWTP
1699 Cleveland Metro Park Drive, Cleveland, OH 44107
Avg. Daily Flow: 5-6 mgd; Max. Flow Capacity: 40 mgd

analysis year 2019

		Quantity	Year Installed / Replaced	Life of Equipment (years)	Replacement Year	RUL	Total Replacement C	Notes	Refurbishment Description	Refurbishment interval	Perecent of replacement cos	Refurbishment Cost	Refurbishment Description	Refurbishment interval	Perecent of replacement cost	Refurbishment Cost
Preliminary Treatment	Bar Screens	2	2003	25	2028	10	$450,000	(screens/compactors)	Refurb	10	10%	$ 45,000				
Preliminary Treatment	Vortex Grit Tanks	2	2003	20	2023	5	$500,000	Drive Units - 2003	Coating	5	1%	$ 5,000	Rehabilitation / Crack Repair	8	3%	$ 15,000
Preliminary Treatment	Grit Pumps	2	2014	20	2034	16		incl. above	Refurbish	5		$ 4,000				
Preliminary Treatment	Cyclones	2	2003	20	2023	5		incl. above Rebuilt - 2003	Refurbish	10		$ 10,000				
Preliminary Treatment	Grit Classifiers	1	2003	20	2023	5		incl. above (new screws every 2	Replace screws	2		$ 20,000				
Primary Treatment	Primary Settling Tanks	4	1983	40	2023	5	$1,400,000	$400,000 (collectors) $1,000,000 (structure)	Coating	5	1%	$ 14,000	Rehabilitation / collectors	10	5%	$ 70,000
Primary Treatment	Drive Units	4	1983	20	2003	0	$120,000	Cast Iron Drive Units - 1983								
Primary Treatment	Primary Sludge Pumps with VFDs (800 gpm)	2	2002	15	2017	0	$50,000	(no current problems)								
Primary Treatment	Primary Scum Pumps (no VFDs)	2	1983	25	2008	0	$30,000									
Secondary Treatment	Aeration Tanks (structure)	8	1983	40	2023	5	$2,500,000	$2,500, 000 (structure)	Coating	5	1%	$ 25,000	Rehabilitation / Crack Repair	8	3%	$ 75,000
Secondary Treatment	Aeration Tanks (existing ceramic air diffusers)		1983	40	2023	5	$2,000,000	$2,000,000 (new membrane diffusers)	Rehabilitation	8	3%	$ 60,000				
Secondary Treatment	Aeration Tanks air diffuser piping)		1983	50	2033	15	$2,000,000									
Secondary Treatment	Aeration Tank Blowers	3	2013	20	2033	15	$2,000,000		Bearings, seals, and major maintenance	10	30%	$ 600,000				
Secondary Treatment	Secondary Clarifiers (4 installed 1965, 2 added/installed 1983, partial refurbish in 2017/2018---extends RUL by ~15 yrs)	6	1983	40	2040	22	$3,750,000	$3,750,000 (structure) Rehab: concrete work and Floors Replaced - 2017 for $1.2 M for 4 of 6. Remaining 2 to be done in 2018)	Coating	5	1%	$ 37,500	Rehabilitation	10	5%	$ 187,500
Secondary Treatment	Secondary Clarifiers mechanism	6	1983	40	2023	5	$690,000	$ 690,000 (collectors) Collector Mechanisms - 1983	Rehabilitation / collectors	10	1%	$ 6,900				
Secondary Treatment	Drive Units	6	1983	20	2003	0	$180,000									
Secondary Treatment	RAS Pumps (800-1500 gpm) (VFDs)	5	2010	15	2025	7	$175,000	Pumps 2006/ VFDs 2016								
Secondary Treatment	Dewatering Pumps (gravity fed) (VFDs)	3	2017	20	2037	19	$45,000	Pumps/VFDs - 2017								
Secondary Treatment	Secondary Scum Pumps (no VFDs)	4	1983	25	2008	0	$20,000									
Secondary Treatment	Spray Water Pumps (for hosing down tanks) (no VFDs)	3	1983	20	2003	0	$45,000									
Disinfection	Disinfection Tanks		2003	40	2043	25		Upgraded - 2003 Tanks will no longer be used once new HRT is designed (had $692,000 in for replacement cost)	Coating	5	1%	$ -	Rehabilitation / Crack Repair	8	3%	$ -
Disinfection	Sodium Aluminate Storage Tank	1	2011	20	2031	13	$15,000		Coating	5	1%	$ 150	Rehabilitation / Crack Repair	8	3%	$ 450
Disinfection	Sodium Aluminate Feed Diaphragm Pumps (VFDs)	2	2011	10	2021	3	$28,000									
Disinfection	Ultraviolet Light Bulbs		2021	25	2046	28	$650,000	(slated to be upgraded with new HRT design in the next 3-5 years) $500,000 (equipment) $150,000 (structure)	Bulb replacement	3		$ 25,000				
Sludge Processing	Gravity Sludge Thickening Tanks	2	1965	40	2005	0	$454,000	$100,000 (collectors) $454,000 (tanks)	Coating	5	1%	$ 4,540	Rehabilitation / Crack Repair	8	3%	$ 13,620
Sludge Processing	Collectors	2	1965	20	1985	0	$100,000									
Sludge Processing	Drive Units	2	2010	20	2030	12	$60,000									
Sludge Processing	Sludge Thickening Pumps (sludge to digesters) (VFDs)	2	2015	10	2025	7	$50,000									
Sludge Processing	Primary Digester Tanks (Anaerobic)	2	2019	40	2059	41	$4,500,000	This is design build now (2017)...$4.5 M	Coating	5	1%	$ 45,000	Rehabilitation / Crack Repair	8	3%	$ 135,000
Sludge Processing	Secondary Digester Tanks (Anaerobic)	2	2010	40	2050	32	$2,000,000	Original Tanks - 1938 Major Rehab - 2010 (rehab was >$1M and incl. tank lids replaced)	Coating	5	1%	$ 20,000	Rehabilitation / Crack Repair	8	3%	$ 60,000
Sludge Processing	Secondary Digester Tank (Anaerobic) Mixers	2	2010	10	2020	2	$50,000					$ -				$ -
Sludge Processing	Sludge Recirculation Pumps (300 gpm)	2	2007	10	2017	0	$40,000		Refurb	2		$ 10,000				
Sludge Processing	Sludge Grinders	2	2007	10	2017	0	$60,000									
Sludge Processing	Secondary Digester Mixing Pumps (1500 gpm)	2	2010	10	2020	2	$40,000									
Sludge Processing	Sludge Transfer Pump	1	2010	10	2020	2	$30,000									
Sludge Processing	Boilers and Heat Exchangers (to keep sludge in temp)	2	2019	20	2039	21	$600,000		Refurb	10	10%	$ 60,000				
Sludge Processing	Methane Gas Meters (for measuring gas produced)	5	2012	10	2022	4	$25,000									
Sludge Processing	Sludge Storage Tank	1	1983	40	2023	5		Tank is not in use (would be ~$450,000)	Coating	5	1%	$ -	Rehabilitation / Crack Repair	8	3%	$ -
Sludge Processing	Belt Filter Press (sludge dewater process)	2	2007	20	2027	9	$800,000		Bearings, seals, and major maintenance	7	30%	$ 240,000				
Sludge Processing	Sludge Conveyor Belt	1	2007	20	2027	9	$150,000		Belt replacement	5	5%	$ 7,500				
Sludge Processing	Polymer Feed Pumps	4	2007	20	2027	9	$150,000		Refurb	10		$ 7,500				
Sludge Processing	Polymer Batch Tank	1	2007	20	2027	9		incl. above								
Sludge Processing	Polymer Holding Tank	1	2007	20	2027	9		incl. above								
Other	Emergency / Backup Generator	1	2007	20	2027	9	$1,000,000		Refurb	10	20%	$ 200,000				
Other	Digester GenSet (future)	1	2019	15	2034	16	$250,000									
Other	Electric Boilers (booster boiler for hot water for bldgs.)	1	1990	20	2019	1	$300,000	Spread each item over next 5 years (maybe one item per year) (may not need electric boilers in future)								
Other	Hot water pumps to circulate water throughout plant		1983	20	2020	2	$100,000									
Other	Freight Elevator (no structural/cable issues, only control)	1	1965	20	2021	3	$300,000									
Other	HVAC System - Operations & Screenings/ Grit Buildings		1983	20	2022	4	$500,000									
Other	HVAC System - Digester Building		1991	20	2023	5	$400,000									
Other	LED Lighting		2016	20	2036	18	$1,000,000									
Other	Miscellaneous (architectural enhancements)		1965	1	2021	0	$263,158	~~Phase CIPs over x years~~ No cost for initial 2 years and phase CIPs over remaining 38 years. Electrical $1M/yr next 7 years (was $10M for misc, and $13.3M for elec)								
Other	Electrical infrastructure		1965	40	2019	0	$1,000,000									
Other	SCADA System		1965	20	2017	0	$1,500,000									
HRT	Screens	2	2021	20	2041	23	$480,000	HRT (2017 thru 2021) HRT only used 10-15x per year (based on usage)								
HRT	Grit Removal	2	2021	20	2041	23	$315,000									
HRT	Grit Pumps	3	2021	20	2041	23	$30,000		Refurbish	5		$ 6,000				
HRT	Actiflow System	1	2021	40	2061	43	$3,950,000		Refurbish, replace pumps, etc	10	5%	$ 197,500	Maint (exercise equip)	1	0.50%	$ 19,750
HRT	Actiflow Polymer Tank	1	2021	20	2041	23	$10,000									
HRT	UV Disinfection (2 banks)	1	2021	20	2041	23	$650,000									
HRT	Slide Gates	12	2021	20	2041	23	$180,000									
HRT	Emergency / Backup Generator	1	2021	20	2041	23	$200,000		Refurb	10	20%	$ 40,000				

Brown AND Caldwell

Attachment C: Water Main Replacement Projects

- Water Main Replacement Priorities 2018 - 2022
- Water Mains that Require Update in the Water Main Inventory

Water Main Replacement Priorities 2018 - 2022

Projects highlighted in blue require additional investigation. The age and performance of the pipe are inconsistent.

line_no	Street_Name	Limits	Length	Age	Material	Main Breaks per 1000 LF	WCR
585	Lincoln	Madison to Franklin	1454	99	Cast Iron	6	22.961073
428	Scenic	Detroit to South End	350	100	Cast Iron	6	25.714286
644	Webb	Northwood to R.R. Tracks	550	110	Cast Iron	5	26.272727
240	Estill Drive	Edgewater to North End	350	79	Cast Iron	6	27.814286
429	Seneca	Ogontz to Woodward	900	88	Cast Iron	6	27.866667
565	Kenneth (east side)	Lake to North End	550	92	Cast Iron	5	28.072727
278	Hathaway	Merl to Clifton	1300	93	Cast Iron	5	28.392308
378	Northland	Delaware to Margaret	750	91	Cast Iron	5	28.9
344	Mars	Athens to Madison	1187	97	Cast Iron	5	29.971441
315	Lakewood Hts. Blvd.	Riverside to McKinley	1600	95	Cast Iron	5	30.5
256	*French*	*Andrews Ln to Clifton Blvd*	*1550*	*6*	*Cast Iron*	*6*	*30.690323*
381	Northland	Fischer to South Marginal	400	84	Cast Iron	5	31.6
143	Bonnieview	Detroit to Clifton Blvd.	2150	103	Cast Iron	5	31.793023
629	Summit	Clifton to Lake	450	110	Cast Iron	4	32.333333
631	Thoreau	R.R. Tracks to 750' S Clifton Blvd.	450	95	Cast Iron	4	33.833333
127	Atkins	Delaware to Hilliard	910	97	Cast Iron	4	33.926374
340	Marlowe	Athens to Madison	1150	99	Cast Iron	4	34.013043
306	Lakeland	Delaware to Madison	2100	102	Cast Iron	4	34.085714
164	Chesterland	Madison to Franklin	1400	100	Cast Iron	4	34.285714
400	Parkwood	Franklin to Detroit	1500	76	Cast Iron	5	34.4
346	Mars	Madison to Hilliard	950	103	Cast Iron	4	34.436842
607	Nicholson	Detroit to Clifton Blvd.	2100	108	Cast Iron	4	36.342857
106	Andrews Ave.	Detroit to Clifton Blvd.	2400	110	Cast Iron	4	36.5
326	Lewis Drive	Madison to Lkwd Hts.	2650	99	Cast Iron	4	37.458491
327	Lewis Drive	Madison to Franklin	1400	100	Cast Iron	4	38.571429
655	Woodward	Fischer to Seneca	450	37	Ductile Iron	7	56.3
645	Webb	Detroit to Northwood	500	13	Ductile Iron	6	62.7
575	Lake Ave.(north side)	Erie Cliff to Maple Cliff	400	43	Ductile Iron	5	65.7
144	Bramley	Waterbury to East End	450	57	Cast Iron	4	67.633333
460	Warren	Hilliard to Detroit	1140	59	Cast Iron	4	73.047368
151	*Bunts*	*Detroit to Merl*	*700*	*7*	*Cast Iron*	*4*	*73.585714*
TOTAL LF			**34,191**				

Water Mains that Require Update in the Water Main Inventory

line_no	Street_Name	Limits	Length	Age	Material	Main Breaks per 1000 LF	WCR
447	Sylvan	Lake to Edgewater	650	101	Cast Iron	9	4.515385
547	Fischer	Woodward to Northland	300	87	Cast Iron	10	31.3
566	Kenneth (west side)	Lake to North End	600	92	Cast Iron	12	-9.2
506	Athens	Mars to Reveley	500	91	Cast Iron	12	-11.1
325	Lewis Drive	Franklin to Waterbury	1250	5	Ductile Iron	16	3.5
182	Clifton Road (north)	Clifton Blvd. To Lake Rd.	596	41	Ductile Iron	8	45.56443
Total			**3,896**				

APPENDIX 3-2
1997 Financial Capabilities Assessment

City of Lakewood

Integrated Wet Weather Improvement Plan Phase II

1997 Financial Capabilities Assessment

This ten-step approach to evaluating a utility's financial capability was first presented in the 1997 CSO Guidance for Financial Capability Assessment and Schedule Development (1997 Guidance). The methodology described in this publication is divided into two phases: the first calculates the financial impact of wastewater and CSO controls on individual households, and the second focuses on the City's debt, socioeconomic and financial conditions. The results from the first and second phase are combined to give an overall assessment of the City's financial capabilities. The information presented below describes each step and the referenced line numbers refer to the numbering system used in the 1997 Guidance document.

Phase One – Customer Rate Burden (The Residential Indicator)

The first step is determining the cost to operate the system per household. The EPA guideline recommends splitting the total annual debt service and operating and maintenance expenses, current and projected, between the number of households' in the system's service area to approximate the cost each household is responsible for. The current annual debt service and operations and maintenance (O&M) expenses are based on the 2019 adopted budget. The annual O&M for 2019 are approximately $8.99 million and the total debt service cost is projected to be approximately $2.29 million.

While there are likely to be some incremental operating costs related to the IWWIP and asset management capital investments, no additional and incremental operating costs have been added to the assessment (line 103).

The projected costs are based on the joint capital investment needed to support the IWWIP and the necessary asset management and repair and replacement (R&R) investments. The IWWIP costs include a total investment of $177,133,175. This includes construction of the currently underway high-rate treatment facility because no debt service is currently included in the existing debt service (line 101). The asset management and R&R costs needed to rehabilitate the aging sewer system are projected to be $161,534,000 based on a thirty-year planning period. The total capital investment included in the financial capability assessment is $338,667,175. The estimated debt service payment for this investment is based on a 30-year loan with a 5.50% interest rate and is projected to be $23,802,182 annually (line 104).

The total of the current and projected costs is $34,528,612 (line 106). Based on US Census information, the total number of households within the City's service area is 24,354. The City's billing system does not report on the number of residential customers and commercial customers. Based on property tax information, approximately 93% of Lakewood parcels are zoned residential, which includes multi-family properties. Due to the significant prevalence of multi-family properties throughout the City, it was assumed that a reasonable number for the residential share of costs is 95%. The resulting cost per household is $1,337 for the sewer system.

WORKSHEET 1 - COST PER HOUSEHOLD		
Line No.	Current Costs	
100	Annual Operations and Maintenance Expenses (Excluding Depreciation)	$ 8,997,144
101	Annual Debt Service (Principal and Interest)	$ 2,229,341
102	Subtotal	$ 11,226,485
	Projected Costs	
103	Estimated Annual Operations and Maintenance Expenses (Excluding Depreciatio	$ 0
104	Annual Debt Service (Principal and Interest)	$ 23,302,127
105	Subtotal	$ 23,302,127
106	Total Costs (Excludes revenue from counties as an offset)	$ 34,528,612
107	Residential Share of Total Costs	$ 32,802,182
108	Total Number of Households in Service Area	24,534
109	Cost Per Household	$ 1,337

Once the cost per household is determined, a residential indicator score is then calculated. The score is based on the cost per household as a percentage of the service area's median household income (MHI). According to 2017 US Census data, the MHI for the City of Lakewood was $48,701. The average annual change in the consumer price index for the past five years was 1.46%. This value is used as an annual escalation rate that is applied to the 2017 MHI to yield a $49,412 adjusted MHI. The cost per household represents 2.71% of adjusted household income, as shown below.

WORKSHEET 2 - RESIDENTIAL INDICATOR		
Line No.	Median Household Income	
201	Census Year MHI	$ 48,701
202	MHI Adjustment Factor	101.46%
203	Adjusted MHI	$ 49,412
204	Annual Cost Per Household	$ 1,337
205	**Residential Indicator Score**	**2.706%**

Phase Two – Community Financial Strength (Permittee Financial Capability Indicators)

The second phase of the 1997 Guidance focuses on three general categories of financial capability indicators in an assessment of the community financial strength. The permitee indicators examine the community's debt burden, socioeconomic conditions, and financial operations.

The first indicator is the bond rating. The City received an updated credit rating from Moody's rating agency on February 25, 2019. Moody's re-affirmed the City's Aa2 rating in relation to its 2019 bond issue (Line 302). This rating is considered strong. The City does not have enterprise fund credit ratings.

WORKSHEET 3 - BOND RATING		
Line No.		
301	Most Recent General Obligation Bond Rating	Aa2
	Date	9/28/2018
	Rating Agency	Moody's
302	Most Recent Revenue (Water or Sewer) Bond Rating	
	Date	
	Rating Agency	
	Bond Insurance	
303	Summary Bond Rating	AA

The net system debt as a percent of full market property value of property (FMV) measures the debt burden on residents and the ability of the System to issue additional debt. The debt included in the calculation "excludes general obligation bonds that are payable from some dedicated user fees or specific revenue source other than the general tax revenues" (EPA, p 24). Taken from the CY 2017 Comprehensive Annual Financial Report for the City of Lakewood (CAFR), the total general obligation debt outstanding is $31.7 million (Line 401). From the same report, the FMV of real property in 2017 was $901 million (Line 404). The resulting indicator is 3.52%; any value between 2% and 5% is considered mid-range.

WORKSHEET 4 - OVERALL NET DEBT AS A PERCENT OF FULL MARKET PROPOERT VALUE		
Line No.		
401	Direct Net Debt	$ 31,762,253
	(G.O. Bonds Excluding Double-Barreled Bonds)	
402	Debt of Overlapping Entities	$ 0
	(Proportionate Share of Multijurisdictional Debt)	
403	Overall Net Debt	$ 31,762,253
404	Market Value of Property	$ 901,369,840
405	Net Debt as Percent of FMV	3.52%

Unemployment rates are used to assess the general well-being of residential users in the System's service area. The unemployment rate is taken from the December 2018 Bureau of Labor Statistics unemployment data. The City of Lakewood had an unemployment rate of 3.8% (Line 501); the national average was 3.9% (Line 503). The City has an unemployment rate that is 0.1% below the national average which is considered a mid-range indicator.

WORKSHEET 5 - UNEMPLOYMENT RATE		
Line No.		
501	Unemployment Rate - Permittee	3.80%
502	Unemployment Rate - County	5.00%
	(If Permittee's Rate is unavailable)	
503	Benchmark - US National Unemployment Rate	3.90%

The next indicator compares system MHI relative to the national median household income to analyze a community's earning capacity. The national MHI for 2017 was $57,652. As mentioned previously, the five-year average increase in the CPI was used to apply an escalation of 1.46% was used to adjust the MHI resulting in an adjusted national MHI of $58,494. The difference between the national and city MHI ($49,412) is 18.4%. An income variance within 25% of the national average is considered mid-range.

WORKSHEET 6 - MEDIAN HOUSEHOLD INCOME		
Line No.		
601	Median Household Income - Permittee	$ 49,412
602	Census Year National MHI	$ 57,652
603	MHI Adjustment Factor	101.46%
604	Adjusted National MHI	$ 58,494

Worksheet 7 measures the tax revenue generated from a system's full market value of real property. The same full market value used to determine the debt burden (line 404) is also used for this calculation. Ad Valorem taxes collected in 2017 were $15.63 million (Line 702) based on the City's 2017 Comprehensive Annual Financial Report. The tax revenue equates to 1.73% of the full market value. Any indicator below 2.0% is considered strong.

WORKSHEET 7 - PROPERTY TAX REVENUES AS A PERCENT OF FULL MARKET PROPERTY VALUE		
Line No.		
701	Full Market Value of Real Propoerty	$ 901,369,840
702	Property Tax Revenue	$ 15,626,283
703	Tax Revenue as Percent of FMV	1.73%

The tax collection rate is used as an indicator of tax collection efficiency. As mentioned, in 2017 $15.63 million of Ad Valorem taxes were collected. This compares to $16.21 million in Ad Valorem taxes that were levied (Line 802) which results in a property tax collection rate of 96.38% (Line 803). The collection rate between 94.0% and 98.0% is considered a mid-range indicator.

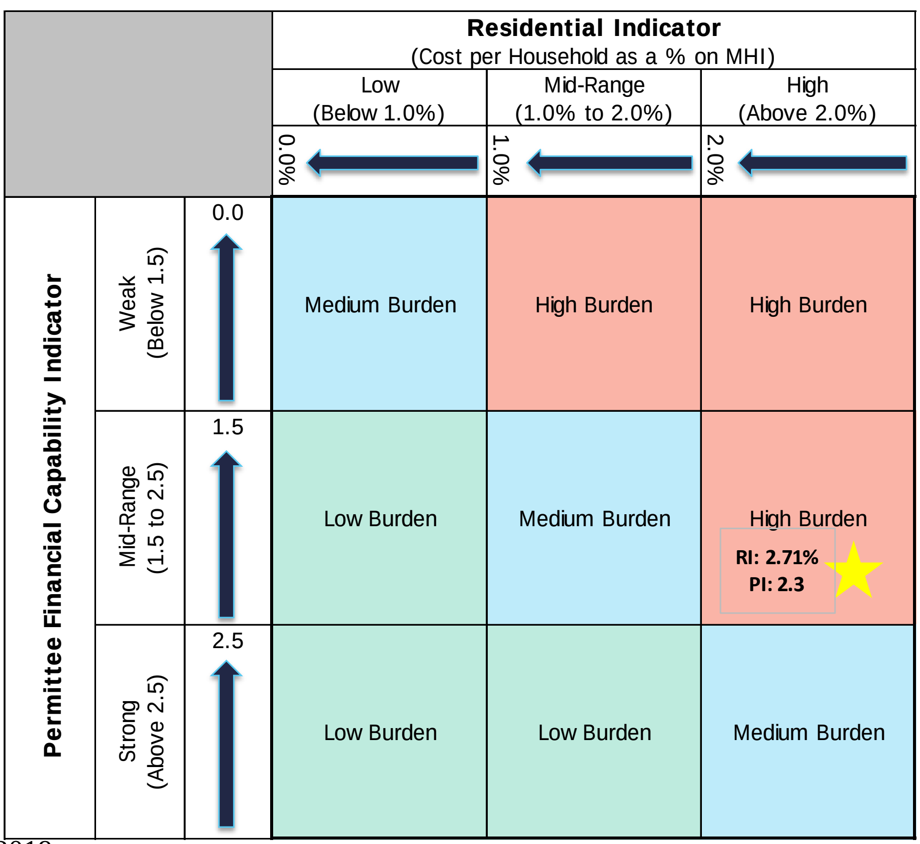
WORKSHEET 8 - PROPERTY TAX REVENUE COLLECTION RATE		
Line No.		
801	Propoerty Tax Revenue Collected	$ 15,626,283
802	Property Taxes Levied	$ 16,213,190
803	Property Tax Collection Rate	96.38%

To arrive at the overall Permittee Financial Capability Indicator, we combine the six indicators on a common scale. A weak indicator is allocated one point, a mid-range indicator is allocated two points, and a strong indicator is allocated three points. The City of Lakewood has strong indicators for their bond rating and tax revenue as a percent of FMV. Overall net debt as percent of FMV, median household income, unemployment rate, and property tax collection rate, all calculate as mid-range. The average of these, and the Permittee Financial Capability Indicator, is 2.3.

WORKSHEET 9 - SUMMARY OF PERMITTEE FINANCIAL CAPABILITY INDICATORS			
		Column A	Column B
Line No.	Indicator	Actual Value	Score
901	Bond Rating	AA	3.0
902	Overall Net Debt as a Percent of FMV	3.52%	2.0
903	Unemployment Rate	3.80%	2.0
904	Median Household Income	$ 49,412	2.0
905	Tax Revenue As Percent of FMV	1.73%	3.0
906	Property Tax Collection Rate	96.38%	2.0
907	**Permittee Financial Capability Indicators Score**		**2.3**

The final step of the 1997 Guidance is to combine the residential indicator and the permitee score using the matrix provided in the document. The final calculations for the City of Lakewood's financial capability assessment are presented below. The residential indicator is well above the high burden threshold of 2.0% and the permitee score of 2.3 is mid-range. These values are plotted on the matrix as well.

WORKSHEET 10 - FINANCIAL CAPABILITY MATRIX SCORE		
Line No.		
1001	Residential Indicator Score	2.706%
1002	Permittee Financial Capability Indicators Score	2.3
1003	**Financial Capability Matrix Category**	**High Burden**



APPENDIX 3-3
Lakewood Draft Financial Plan

City of Lakewood
Utility Funding and Affordability Analysis
Summary of Water System Cash Flows

	CY 2018 Actual	CY 2019 Budget	CY 2020 Projected	CY 2021 Projected	CY 2022 Projected	CY 2023 Projected	CY 2024 Projected	CY 2025 Projected	CY 2026 Projected	CY 2027 Projected	CY 2028 Projected
Water System Revenues											
Water User Charges	$ 10,954,894	$ 11,441,839	$ 11,950,429	$ 12,481,625	$ 13,036,434	$ 13,615,903	$ 14,018,934	$ 14,433,894	$ 14,861,137	$ 15,301,027	$ 15,753,937
Miscellaneous User Fees	130,530	130,530	130,530	130,530	130,530	130,530	130,530	130,530	130,530	130,530	130,530
Other Miscellaneous Revenue	254,309	254,309	254,309	254,309	254,309	254,309	254,309	254,309	254,309	254,309	254,309
Total Water System Revenues	$ 11,339,733	$ 11,826,678	$ 12,335,268	$ 12,866,465	$ 13,421,273	$ 14,000,742	$ 14,403,773	$ 14,818,733	$ 15,245,977	$ 15,685,866	$ 16,138,777
Water System Revenue Requirements											
Operating Expenses											
Salaries and Benefits	$ 1,287,721	$ 1,302,666	$ 1,347,054	$ 1,393,012	$ 1,440,599	$ 1,489,874	$ 1,540,900	$ 1,593,741	$ 1,648,466	$ 1,705,143	$ 1,763,846
Contractual Services	922,339	732,400	760,653	790,004	820,497	852,177	885,089	911,642	938,991	967,161	996,176
Materials & Supplies	330,780	352,400	362,972	373,861	385,077	396,629	408,528	420,784	433,408	446,410	459,802
Purchased Water	5,058,671	6,020,000	6,200,600	6,386,618	6,578,217	6,775,563	6,978,830	7,188,195	7,403,841	7,625,956	7,854,735
Other	515,638	652,023	671,584	691,731	712,483	733,858	755,874	778,550	801,906	825,964	850,742
Utilities	52,825	59,150	60,925	62,752	64,635	66,574	68,571	70,628	72,747	74,929	77,177
Subtotal: Operating Expenses	$ 8,167,975	$ 9,118,639	$ 9,403,787	$ 9,697,979	$ 10,001,507	$ 10,314,674	$ 10,637,792	$ 10,963,540	$ 11,299,359	$ 11,645,563	$ 12,002,478
Debt Service											
Existing Debt Service	$ 1,026,943	$ 963,816	$ 953,075	$ 856,002	$ 859,692	$ 786,827	$ 718,608	$ 702,199	$ 703,699	$ 698,899	$ 698,499
Future Debt Service	-	163,125	634,930	684,474	810,576	849,210	1,003,405	1,050,661	1,226,650	1,280,608	1,466,997
BAN Interest Payments	178,215	86,310	42,404	67,208	46,530	82,170	56,830	93,766	61,038	99,282	63,712
Subtotal: Debt Service	1,205,158	1,213,251	1,630,408	1,607,683	1,716,797	1,718,207	1,778,844	1,846,627	1,991,386	2,078,789	2,229,209
Capital and Other Expenditures											
CIP Paygo	2,400,000	566,100	1,093,300	1,409,800	1,459,400	1,754,500	1,786,400	1,818,300	1,850,200	1,882,100	1,914,000
Capital Leases	416,209	416,820	373,165	342,175	301,843	241,315	231,323	231,323	231,323	231,323	155,690
Subtotal: Capital and Other Expenditures	2,816,209	982,920	1,466,465	1,751,975	1,761,243	1,995,815	2,017,723	2,049,623	2,081,523	2,113,423	2,069,690
Total Water System Revenue Requirements	$ 12,189,342	$ 11,314,810	$ 12,500,660	$ 13,057,637	$ 13,479,547	$ 14,028,697	$ 14,434,358	$ 14,859,790	$ 15,372,268	$ 15,837,774	$ 16,301,377
Annual Cashflow: Surplus/(Deficit)	$ (849,609)	$ 511,868	$ (165,392)	$ (191,172)	$ (58,274)	$ (27,955)	$ (30,585)	$ (41,056)	$ (126,291)	$ (151,908)	$ (162,600)
% Revenue Shortfall	8%		1%	2%	0%	0%	0%	0%	1%	1%	1%
% Change Total Water System Revenue	5%	4%	4%	4%	4%	4%	3%	3%	3%	3%	3%
% Change Total Water System Revenue Requirements	25%	-7%	10%	4%	3%	4%	3%	3%	3%	3%	3%
Operating Cash Reserves	$ 7,490,741	$ 8,002,609	$ 7,837,218	$ 7,646,046	$ 7,587,771	$ 7,559,816	$ 7,529,231	$ 7,488,174	$ 7,361,883	$ 7,209,975	$ 7,047,375
Days Cash On Hand	330 days	316 days	300 days	284 days	273 days	264 days	255 days	246 days	235 days	223 days	211 days
Total Debt Coverate Ratio	2.63x	2.23x	1.80x	1.97x	1.99x	2.15x	2.12x	2.09x	1.98x	1.94x	1.86x
Water Rate Escalation (Manual Entry)	5.00%	5.50%	5.50%	5.50%	5.50%	5.50%	4.00%	4.00%	4.00%	4.00%	4.00%
Required Water Rate Escalation	8.00%		1.00%	2.00%	0.00%	0.00%	0.00%	0.00%	1.00%	1.00%	1.00%

City of Lakewood
Utility Funding and Affordability Analysis
Actual and Budget Input

Water System O&M	CY 2018 Budget	CY 2019 Budget	CY 2020 Projected	CY 2021 Projected	CY 2022 Projected	CY 2023 Projected	CY 2024 Projected	CY 2025 Projected	CY 2026 Projected	CY 2027 Projected	CY 2028 Projected
Fund 501 (Water Operating Expenses)											
Water Administration											
Salaries and Wages	$ 153,195	$ 156,448	$ 161,141	$ 165,975	$ 170,955	$ 176,083	$ 181,366	$ 186,807	$ 192,411	$ 198,183	$ 204,129
Personnel Benefits	70,861	72,688	75,959	79,377	82,949	86,681	90,582	94,658	98,918	103,369	108,021
Uniform and Clothing	-	-	-	-	-	-	-	-	-	-	-
Travel and Transportation	-	-	-	-	-	-	-	-	-	-	-
Other Employee Benefits	-	-	-	-	-	-	-	-	-	-	-
Professional Services	134,500	175,000	182,000	189,280	196,851	204,725	212,914	219,302	225,881	232,657	239,637
Communications	80,850	91,850	94,606	97,444	100,367	103,378	106,479	109,674	112,964	116,353	119,843
Public Works Enterprise A	-	-	-	-	-	-	-	-	-	-	-
Rents and Leases	950	1,200	1,236	1,273	1,311	1,351	1,391	1,433	1,476	1,520	1,566
Items Purchased for Resale	-	-	-	-	-	-	-	-	-	-	-
Intra-Governmntl Services	17,500	17,500	18,025	18,566	19,123	19,696	20,287	20,896	21,523	22,168	22,834
Printing and Reproduction	50,000	50,000	51,500	53,045	54,636	56,275	57,964	59,703	61,494	63,339	65,239
Contractual Services	1,800	1,800	1,854	1,910	1,967	2,026	2,087	2,149	2,214	2,280	2,349
Office Supplies	600	600	618	637	656	675	696	716	738	760	783
Operating Supplies	2,100	2,100	2,163	2,228	2,295	2,364	2,434	2,508	2,583	2,660	2,740
Repair Parts & Supplies	500	500	515	530	546	563	580	597	615	633	652
Repair Service	-	-	-	-	-	-	-	-	-	-	-
Service Agreements	2,200	2,200	2,266	2,334	2,404	2,476	2,550	2,627	2,706	2,787	2,871
Utilities	2,650	2,650	2,730	2,811	2,896	2,983	3,072	3,164	3,259	3,357	3,458
Inter Fund Activity	15,252	-	-	-	-	-	-	-	-	-	-
Inter Departmntl Services	-	-	-	-	-	-	-	-	-	-	-
Public Works Enterprise B	325,600	403,773	415,886	428,363	441,214	454,450	468,084	482,126	496,590	511,488	526,832
Construction	-	-	-	-	-	-	-	-	-	-	-
Improvements	-	-	-	-	-	-	-	-	-	-	-
Machinery and Equipment	-	-	-	-	-	-	-	-	-	-	-
Computer Equipment	-	-	-	-	-	-	-	-	-	-	-
Debt Service	5,187,606	7,553,055									
Subtotal: Water Administration	$ 6,046,164	$ 8,531,363	$ 1,010,498	$ 1,043,773	$ 1,078,169	$ 1,113,727	$ 1,150,486	$ 1,186,360	$ 1,223,370	$ 1,261,555	$ 1,300,952
Water Distribution											
Salaries and Wages	$ 439,338	$ 474,282	$ 488,510	$ 503,165	$ 518,260	$ 533,808	$ 549,823	$ 566,317	$ 583,307	$ 600,806	$ 618,830
Personnel Benefits	145,123	152,728	159,600	166,782	174,287	182,130	190,326	198,891	207,841	217,194	226,968
Uniform and Clothing	2,000	2,200	2,266	2,334	2,404	2,476	2,550	2,627	2,706	2,787	2,871
Travel and Transportation	-	-	-	-	-	-	-	-	-	-	-
Other Employee Benefits	-	-	-	-	-	-	-	-	-	-	-
Professional Services	634,000	452,000	470,080	488,883	508,439	528,776	549,927	566,425	583,418	600,920	618,948
Communications	1,325	2,050	2,112	2,175	2,240	2,307	2,377	2,448	2,521	2,597	2,675
Public Works Enterprise A	-	-	-	-	-	-	-	-	-	-	-
Rents and Leases	-	-	-	-	-	-	-	-	-	-	-
Items Purchased for Resale	6,000,000	6,000,000	6,180,000	6,365,400	6,556,362	6,753,053	6,955,644	7,164,314	7,379,243	7,600,620	7,828,639
Intra-Governmntl Services	100,000	100,000	103,000	106,090	109,273	112,551	115,927	119,405	122,987	126,677	130,477
Printing and Reproduction	-	-	-	-	-	-	-	-	-	-	-
Contractual Services	201,750	1,500	1,545	1,591	1,639	1,688	1,739	1,791	1,845	1,900	1,957
Office Supplies	500	600	618	637	656	675	696	716	738	760	783
Operating Supplies	193,000	170,100	175,203	180,459	185,873	191,449	197,193	203,108	209,202	215,478	221,942
Repair Parts & Supplies	128,500	144,500	148,835	153,300	157,899	162,636	167,515	172,541	177,717	183,048	188,540
Repair Service	-	-	-	-	-	-	-	-	-	-	-
Service Agreements	5,000	5,050	5,202	5,358	5,518	5,684	5,854	6,030	6,211	6,397	6,589
Utilities	37,500	49,500	50,985	52,515	54,090	55,713	57,384	59,106	60,879	62,705	64,586
Inter Fund Activity	-	-	-	-	-	-	-	-	-	-	-
Inter Departmntl Services	25,000	25,000	25,750	26,523	27,318	28,138	28,982	29,851	30,747	31,669	32,619
Public Works Enterprise B	-	-	-	-	-	-	-	-	-	-	-
Construction	-	-	-	-	-	-	-	-	-	-	-
Improvements	2,100,000	10,625,000	10,943,750	11,272,063	11,610,224	11,958,531	12,317,287	12,686,806	13,067,410	13,459,432	13,863,215
Machinery and Equipment	185,000	244,000	251,320	258,860	266,625	274,624	282,863	291,349	300,089	309,092	318,365
Computer Equipment	-	-	-	-	-	-	-	-	-	-	-
Debt Service	-	-									
Subtotal: Water Distribution	$ 10,198,035	$ 18,448,509	$ 19,008,775	$19,586,134	$ 20,181,108	$ 20,794,240	$ 21,426,087	$ 22,071,724	$ 22,736,860	$ 23,422,083	$ 24,128,003
Water Metering											
Salaries and Wages	$ 299,392	$ 317,076	$ 326,589	$ 336,386	$ 346,478	$ 356,872	$ 367,578	$ 378,606	$ 389,964	$ 401,663	$ 413,713
Personnel Benefits	124,474	128,445	134,225	140,265	146,577	153,173	160,065	167,268	174,795	182,661	190,881
Uniform and Clothing	1,600	1,600	1,648	1,697	1,748	1,801	1,855	1,910	1,968	2,027	2,088
Travel and Transportation	-	-	-	-	-	-	-	-	-	-	-
Other Employee Benefits	1,000	1,000	1,030	1,061	1,093	1,126	1,159	1,194	1,230	1,267	1,305
Professional Services	-	1,050	1,092	1,136	1,181	1,228	1,277	1,316	1,355	1,396	1,438
Communications	75,300	8,050	8,292	8,540	8,796	9,060	9,332	9,612	9,900	10,197	10,503
Public Works Enterprise A	-	-	-	-	-	-	-	-	-	-	-
Rents and Leases	-	-	-	-	-	-	-	-	-	-	-
Items Purchased for Resale	25,000	20,000	20,600	21,218	21,855	22,510	23,185	23,881	24,597	25,335	26,095
Intra-Governmntl Services	-	-	-	-	-	-	-	-	-	-	-
Printing and Reproduction	40,000	-	-	-	-	-	-	-	-	-	-
Contractual Services	2,400	2,400	2,472	2,546	2,623	2,701	2,782	2,866	2,952	3,040	3,131
Office Supplies	500	500	515	530	546	563	580	597	615	633	652
Operating Supplies	6,700	8,200	8,446	8,699	8,960	9,229	9,506	9,791	10,085	10,388	10,699
Repair Parts & Supplies	25,300	25,300	26,059	26,841	27,646	28,475	29,330	30,210	31,116	32,049	33,011
Repair Service	-	-	-	-	-	-	-	-	-	-	-
Service Agreements	25,200	40,200	41,406	42,648	43,928	45,245	46,603	48,001	49,441	50,924	52,452
Utilities	6,000	7,000	7,210	7,426	7,649	7,879	8,115	8,358	8,609	8,867	9,133
Inter Fund Activity	-	-	-	-	-	-	-	-	-	-	-
Inter Departmntl Services	-	-	-	-	-	-	-	-	-	-	-
Public Works Enterprise B	-	-	-	-	-	-	-	-	-	-	-
Construction	-	-	-	-	-	-	-	-	-	-	-
Improvements	-	-	-	-	-	-	-	-	-	-	-
Machinery and Equipment	-	-	-	-	-	-	-	-	-	-	-
Computer Equipment	-	-	-	-	-	-	-	-	-	-	-
Debt Service	-	-									
Subtotal: Water Metering	$ 632,865	$ 560,821	$ 579,583	$ 598,995	$ 619,080	$ 639,863	$ 661,368	$ 683,610	$ 706,628	$ 730,448	$ 755,102
Subtotal: Fund 501	$ 16,877,065	$ 27,540,694	$ 20,598,857	$ 21,228,901	$ 21,878,357	$ 22,547,830	$ 23,237,942	$ 23,941,695	$ 24,666,858	$ 25,414,087	$ 26,184,058
Total: Water System O&M	$ 16,877,065	$ 27,540,694	$ 20,598,857	$ 21,228,901	$ 21,878,357	$ 22,547,830	$ 23,237,942	$ 23,941,695	$ 24,666,858	$ 25,414,087	$ 26,184,058

City of Lakewood
Utility Funding and Affordability Analysis
Water System Debt Service

	CY 2018	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025	CY 2026	CY 2027	CY 2028
Existing Water Debt Service											
Water Bonds Debt Service											
Water Main Mortgage Revenue Bonds - 1995	-	-	-	-	-	-	-	-	-	-	-
2016A Go Bonds	44,681	45,077	35,736	35,363	35,613	35,035	35,618	-	-	-	-
2016 LTGO BONDS-REFUNDING	606,260	605,160	603,760	604,260	607,700	600,100	608,100	605,600	607,100	602,300	601,900
Subtotal Existing Water Bonds Debt Service:	$ 650,941	$ 650,237	$ 639,496	$ 639,623	$ 643,313	$ 635,135	$ 643,718	$ 605,600	$ 607,100	$ 602,300	$ 601,900
Water Loans Debt Service											
OPWC; CA21A; 1997 Water Mains	62,423	-	-	-	-	-	-	-	-	-	-
OPWC; CA08B; 1998 Water Mains	97,201	97,201	97,201	-	-	-	-	-	-	-	-
OPWC; CA18D; 2000 Water Mains	49,731	49,731	49,731	49,731	49,731	24,865	-	-	-	-	-
OPWC; CA15E; 2001 Water Mains	79,642	79,642	79,642	79,642	79,642	39,821	-	-	-	-	-
OPWC; CA09G; 2003 Belle Ave Water Main	24,232	24,232	24,232	24,232	24,232	24,232	12,116	-	-	-	-
OPWC; CA11R/CA12R; 2014 Water Mains	62,774	62,774	62,774	62,774	62,774	62,774	62,774	62,774	62,774	62,774	62,774
Subtotal Existing Water Loans Debt Service	$ 376,002	$ 313,579	$ 313,579	$ 216,379	$ 216,379	$ 151,692	$ 74,890	$ 96,599	$ 96,599	$ 96,599	$ 96,599
Total Existing Water Debt Service:	$ 1,026,943	$ 963,816	$ 953,075	$ 856,002	$ 859,692	$ 786,827	$ 718,608	$ 702,199	$ 703,699	$ 698,899	$ 698,499
Projected Debt Service											
Future GO/Revenue Bonds	$ -	$ 163,125	$ 385,410	$ 434,954	$ 561,056	$ 599,691	$ 753,886	$ 801,142	$ 977,130	$ 1,031,089	$ 1,217,478
Future SRF Loans	-	-	249,519	249,519	249,519	249,519	249,519	249,519	249,519	249,519	249,519
Total: Projected Debt Service	$ -	$ 163,125	$ 634,930	$ 684,474	$ 810,576	$ 849,210	$ 1,003,405	$ 1,050,661	$ 1,226,650	$ 1,280,608	$ 1,466,997
Total Existing and Future Water Debt Service:	$ 1,026,943	$ 1,126,941	$ 1,588,005	$ 1,540,475	$ 1,670,267	$ 1,636,037	$ 1,722,013	$ 1,752,860	$ 1,930,349	$ 1,979,507	$ 2,165,496
Water System Capital Lease Debt Service											
2011 Equipment Lease (Schedule 4)	75,909	75,909	31,629	-	-	-	-	-	-	-	-
2013 Equipment Lease (Schedule 7)	81,972	81,972	81,972	81,972	40,986	-	-	-	-	-	-
2014 Equipment Lease (Schedule 2 & 3)	140,455	141,066	141,691	142,330	142,983	123,442	113,450	113,450	113,450	113,450	37,817
2015 Equipment Lease (Schedule 1)	117,873	117,873	117,873	117,873	117,873	117,873	117,873	117,873	117,873	117,873	117,873
Current Capital Lease Debt Service	$ 416,209	$ 416,820	$ 373,165	$ 342,175	$ 301,843	$ 241,315	$ 231,323	$ 231,323	$ 231,323	$ 231,323	$ 155,690
Future Capital Lease Debt Service	-	-	-	-	-	-	-	-	-	-	-
Total Capital Lease Debt Service	$ 416,209	$ 416,820	$ 373,165	$ 342,175	$ 301,843	$ 241,315	$ 231,323	$ 231,323	$ 231,323	$ 231,323	$ 155,690

City of Lakewood
Utility Funding and Affordability Analysis
Capital Improvements Plan & Financing

	CY 2018	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025	CY 2026	CY 2027	CY 2028
Capital Improvement Projects											
2017 Watermain Replacement Project	$ 4,342,420	$ -									
2018 Watermain Replacement Project	2,560,333	1,200,082									
2019 Watermain Replacement Project		8,000,000									
2020 Watermain		75,000	75,000								
Distribution Lines	520,340	-	-	-	-	-	-	-			
Storage Tanks	-	-	-	-	-	-	-	-	500	500	500
Vehicles & Fleet	223,153	140,000	-	185,000	-	-	-	-			
Other Miscellaneous	36,000	-	-	-	-	-	-	-			
Water and Sewer asset management software		50,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
2019 Water Main Design		340,000									
Additional Capital Needs	-	-	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
Recurring Watermain Replacement (Long-Term R&R)		-	1,702,500	2,040,000	2,452,500	2,940,000	2,940,000	2,940,000	2,940,000	2,940,000	2,940,000
Total: Capital Improvement Projects	$ 7,682,246	$ 9,805,082	$ 2,052,500	$ 2,500,000	$ 2,727,500	$ 3,215,000	$ 3,215,000	$ 3,215,000	$ 3,215,500	$ 3,215,500	$ 3,215,500
Annual Cost Inflation	0.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Cumulative Inflation Rate	100.0%	102.0%	104.0%	106.0%	108.0%	110.0%	112.0%	114.0%	116.0%	118.0%	120.0%
Total: Capital Improvement Projects (Nomial Doll	$ 7,682,300	$ 10,001,200	$ 2,134,600	$ 2,650,000	$2,945,700	$3,536,500	$3,600,800	$3,665,100	$3,730,000	$ 3,794,300	$3,858,600
Long-Term R&R Needs		-	2,270,000	2,720,000	3,270,000	3,920,000	3,920,000	3,920,000	3,920,000	3,920,000	3,920,000
Capital Financing Plan											
Net Capital Financing Needs	$ 7,682,300	$ 10,001,200	$ 2,134,600	$ 2,650,000	$2,945,700	$3,536,500	$3,600,800	$3,665,100	$3,730,000	$ 3,794,300	$3,858,600
Capital Financing Sources											
OPWC Grant	$ 1,660,415	$ 2,040,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPWC Loan	-	4,080,000	-	-	-	-	-	-	-	-	-
Bond Anticipation Notes (BANs)	2,315,500	3,315,100	1,041,300	1,240,200	1,486,400	1,782,000	1,814,400	1,846,800	1,879,800	1,912,200	1,944,600
Other Misc. Grants & Contributions	1,300,000	-	-	-	-	-	-	-	-	-	-
Cash Financing of Construction (PAYGO)	2,400,000	566,100	1,093,300	1,409,800	1,459,400	1,754,500	1,786,400	1,818,300	1,850,200	1,882,100	1,914,000
Subtotal: Capital Financing Sources	$ 7,675,915	$ 10,001,200	$ 2,134,600	$ 2,650,000	$ 2,945,800	$ 3,536,500	$ 3,600,800	$ 3,665,100	$ 3,730,000	$ 3,794,300	$ 3,858,600
Capital Financing Shortfall	$ 6,385	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Construction/Bond Fund											
Beginning Balance											
Additions:											
Bond Proceeds	$ (36,250)	$ 32,366	$ -	$ 25,203	$ -	$ 30,814	$ -	$ 35,162	$ -	$ 37,231	$ -
BAN Funding	2,315,500	3,315,100	1,041,300	1,240,200	1,486,400	1,782,000	1,814,400	1,846,800	1,879,800	1,912,200	1,944,600
SRF Loan Proceeds	1,660,415	6,120,000	-	-	-	-	-	-	-	-	-
PAYGO Funding	2,400,000	566,100	1,093,300	1,409,800	1,459,400	1,754,500	1,786,400	1,818,300	1,850,200	1,882,100	1,914,000
From Other Funds & Operating Budget	-	-	-	-	-	-	-	-	-	-	-
Subtractions:											
Capital Improvements	$ (7,682,300)	$ (10,001,200)	$ (2,134,600)	$ (2,650,000)	$ (2,945,700)	$ (3,536,500)	$ (3,600,800)	$ (3,665,100)	$ (3,730,000)	$ (3,794,300)	$ (3,858,600)
Bond Issuance Costs	(36,250)	(32,366)	-	(25,203)	-	(30,814)	-	(35,162)	-	(37,231)	-
Loan Issuance Costs	-	-	-	-	-	-	-	-	-	-	-
Ending Balance	$ (1,378,885)	$ -	$ -	$ -	$ 100	$ -	$ -	$ -	$ -	$ -	$ -
BAN Issuances											
Outstanding BANs	$ 3,475,000	$ 2,315,500	$ 1,078,875	$ 2,120,175	$ 840,094	$ 2,326,494	$ 1,027,123	$ 2,841,523	$ 1,172,081	$ 3,051,881	$ 1,241,020
Proposed BANs	$ 2,465,500	$ 2,000,000	$ 1,041,300	$ 1,240,200	$ 1,486,400	$ 1,782,000	$ 1,814,400	$ 1,846,800	$ 1,879,800	$ 1,912,200	$ 1,944,600
Subtotal: BANs Outstanding	$ 5,940,500	$ 4,315,500	$ 2,120,175	$ 3,360,375	$ 2,326,494	$ 4,108,494	$ 2,841,523	$ 4,688,323	$ 3,051,881	$ 4,964,081	$ 3,185,620
Interest Rate	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Interest Payment	$ 178,215	$ 86,310	$ 42,404	$ 67,208	$ 46,530	$ 82,170	$ 56,830	$ 93,766	$ 61,038	$ 99,282	$ 63,712
Bonds Issued	$ 3,625,000	$ 3,236,625		$ 2,520,281		$ 3,081,370		$ 3,516,243		$ 3,723,061	
Updated BAN Balance	$ 2,315,500	$ 1,078,875	$ 2,120,175	$ 840,094	$ 2,326,494	$ 1,027,123	$ 2,841,523	$ 1,172,081	$ 3,051,881	$ 1,241,020	$ 3,185,620

City of Lakewood
Utility Funding and Affordability Analysis
Calculation of Future Debt Service

	CY 2018	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025	CY 2026	CY 2027	CY 2028
Projected Future Debt Service											
Projected Revenue Bonds											
Series 2018 Revenue Bonds	$ -	$ 163,125	$ 223,579	$ 223,626	$ 223,674	$ 223,725	$ 223,778	$ 223,834	$ 223,892	$ 223,953	$ 224,016
Series 2019 Revenue Bonds	$ -	$ -	$ 161,831	$ 211,329	$ 211,368	$ 211,409	$ 211,452	$ 211,497	$ 211,545	$ 211,595	$ 211,647
Series 2020 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Series 2021 Revenue Bonds	$ -	$ -	$ -	$ -	$ 126,014	$ 164,557	$ 164,587	$ 164,619	$ 164,653	$ 164,688	$ 164,725
Series 2022 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Series 2023 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ 154,069	$ 201,192	$ 201,229	$ 201,268	$ 201,309
Series 2024 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Series 2025 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 175,812	$ 229,586	$ 229,628
Series 2026 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Series 2027 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 186,153
Subtotal: Projected Revenue Bonds	$ -	$ 163,125	$ 385,410	$ 434,954	$ 561,056	$ 599,691	$ 753,886	$ 801,142	$ 977,130	$ 1,031,089	$ 1,217,478
Projected OPWC Loans											
2018 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2019 OPWC Loan	$ -	$ -	$ 249,519	$ 249,519	$ 249,519	$ 249,519	$ 249,519	$ 249,519	$ 249,519	$ 249,519	$ 249,519
2020 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2021 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2022 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2023 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2024 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2025 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Subtotal: Projected SRF Loans	$ -	$ -	$ 249,519	$ 249,519	$ 249,519	$ 249,519	$ 249,519	$ 249,519	$ 249,519	$ 249,519	$ 249,519
Projected OPWC Grants											
2018 OPWC Grant	$ -	$ 83,021	$ 83,021	$ 83,021	$ 83,021	$ 83,021	$ 83,021	$ 83,021	$ 83,021	$ 83,021	$ 83,021
2019 OPWC Grant	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2020 OPWC Grant	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2021 OPWC Grant	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2022 OPWC Grant	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2023 OPWC Grant	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Subtotal: Projected SRF Loans	$ -	$ 83,021	$ 83,021	$ 83,021	$ 83,021	$ 83,021	$ 83,021	$ 83,021	$ 83,021	$ 83,021	$ 83,021
Total: Projected Future Debt	$ -	$ 246,146	$ 717,951	$ 767,495	$ 893,596	$ 932,231	$1,086,426	$1,133,682	$1,309,670	$ 1,363,629	$1,550,018

City of Lakewood
Utility Funding and Affordability Analysis
Summary of Revenue Requirements

	CY 2018	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025	CY 2026	CY 2027	CY 2028
	Actual	Budget	Projected	Projected	Projected	Projected	Projected	Projected	Projected	Projected	Projected
Water System Revenue Requirements											
Operating Expenses											
Salaries and Benefits	$ 1,287,721	$ 1,302,666	$ 1,347,054	$ 1,393,012	$ 1,440,599	$ 1,489,874	$ 1,540,900	$ 1,593,741	$ 1,648,466	$ 1,705,143	$ 1,763,846
Contractual Services	922,339	732,400	760,653	790,004	820,497	852,177	885,089	911,642	938,991	967,161	996,176
Materials & Supplies	330,780	352,400	362,972	373,861	385,077	396,629	408,528	420,784	433,408	446,410	459,802
Purchased Water	5,058,671	6,020,000	6,200,600	6,386,618	6,578,217	6,775,563	6,978,830	7,188,195	7,403,841	7,625,956	7,854,735
Other	515,638	652,023	671,584	691,731	712,483	733,858	755,874	778,550	801,906	825,964	850,742
Utilities	52,825	59,150	60,925	62,752	64,635	66,574	68,571	70,628	72,747	74,929	77,177
Subtotal: Operating Expenses	$ 8,167,975	$ 9,118,639	$ 9,403,787	$ 9,697,979	$ 10,001,507	$ 10,314,674	$ 10,637,792	$ 10,963,540	$ 11,299,359	$ 11,645,563	$ 12,002,478
Debt Service											
Existing Debt Service	$ 1,026,943	$ 963,816	$ 953,075	$ 856,002	$ 859,692	$ 786,827	$ 718,608	$ 702,199	$ 703,699	$ 698,899	$ 698,499
Future Debt Service	-	163,125	634,930	684,474	810,576	849,210	1,003,405	1,050,661	1,226,650	1,280,608	1,466,997
BAN Interest Payments	178,215	86,310	42,404	67,208	46,530	82,170	56,830	93,766	61,038	99,282	63,712
Subtotal: Debt Service	$ 1,205,158	$ 1,213,251	$ 1,630,408	$ 1,607,683	$ 1,716,797	$ 1,718,207	$ 1,778,844	$ 1,846,627	$ 1,991,386	$ 2,078,789	$ 2,229,209
Capital and Other Expenditures											
CIP Paygo	2,400,000	566,100	1,093,300	1,409,800	1,459,400	1,754,500	1,786,400	1,818,300	1,850,200	1,882,100	1,914,000
Capital Leases	416,209	416,820	373,165	342,175	301,843	241,315	231,323	231,323	231,323	231,323	155,690
Subtotal: Capital and Other Expenditures	$ 2,816,209	$ 982,920	$ 1,466,465	$ 1,751,975	$ 1,761,243	$ 1,995,815	$ 2,017,723	$ 2,049,623	$ 2,081,523	$ 2,113,423	$ 2,069,690
Total: Water System Revenue Requirements	$ 12,189,342	$ 11,314,810	$ 12,500,660	$ 13,057,637	$ 13,479,547	$ 14,028,697	$ 14,434,358	$ 14,859,790	$ 15,372,268	$ 15,837,774	$ 16,301,377
% change	25.4%	-7.2%	10.5%	4.5%	3.2%	4.1%	2.9%	2.9%	3.4%	3.0%	2.9%
% change - O&M	-0.6%	11.6%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%
Estimated Rate Calculation											
Total Revenue Requirements	$ 12,189,342	$ 11,314,810	$ 12,500,660	$ 13,057,637	$ 13,479,547	$ 14,028,697	$ 14,434,358	$ 14,859,790	$ 15,372,268	$ 15,837,774	$ 16,301,377
Less: Miscellaneous Revenue	(384,839)	(384,839)	(384,839)	(384,839)	(384,839)	(384,839)	(384,839)	(384,839)	(384,839)	(384,839)	(384,839)
Net Revenue from User Charges	$ 11,804,503	$ 10,929,971	$ 12,115,820	$ 12,672,797	$ 13,094,708	$ 13,643,858	$ 14,049,519	$ 14,474,951	$ 14,987,429	$ 15,452,935	$ 15,916,537
Estimated Water Sales	1,620,067	1,603,866	1,587,828	1,571,950	1,556,230	1,540,668	1,525,261	1,510,008	1,494,908	1,479,959	1,465,160
Water Rate ($/ccf)	$ 7.29	$ 6.82	$ 7.64	$ 8.07	$ 8.42	$ 8.86	$ 9.22	$ 9.59	$ 10.03	$ 10.45	$ 10.87
Actual Rate	$ 6.76	$ 7.13	$ 7.53	$ 7.94	$ 8.38	$ 8.84	$ 9.19	$ 9.56	$ 9.94	$ 10.34	$ 10.75

City of Lakewood
Utility Funding and Affordability Analysis
Summary of Wastewater System Cashflows

	CY 2018 Actual	CY 2019 Budget	CY 2020 Projected	CY 2021 Projected	CY 2022 Projected	CY 2023 Projected	CY 2024 Projected	CY 2025 Projected	CY 2026 Projected	CY 2027 Projected	CY 2028 Projected
Wastewater System Revenues											
Wastewater User Charges	$ 10,701,789	$ 11,654,248	$ 12,691,476	$ 13,821,017	$ 15,051,088	$ 16,390,635	$ 16,875,798	$ 17,375,321	$ 17,889,631	$ 18,419,164	$ 18,964,371
Miscellaneous User Fees	94,254	94,254	94,254	94,254	94,254	94,254	94,254	94,254	94,254	94,254	94,254
Other Miscellaneous Revenue	384,591	384,591	384,591	384,591	384,591	384,591	384,591	384,591	384,591	384,591	384,591
Total: Wastewater System Revenues	$ 11,180,634	$ 12,133,093	$ 13,170,321	$ 14,299,862	$ 15,529,933	$ 16,869,480	$ 17,354,642	$ 17,854,166	$ 18,368,475	$ 18,898,009	$ 19,443,216
Wastewater System Revenue Requirements											
Operating Expenses											
Salaries and Benefits	$ 11,850	$ 3,398,406	$ 3,514,940	$ 3,635,627	$ 3,760,619	$ 3,890,079	$ 4,024,170	$ 4,163,067	$ 4,306,949	$ 4,456,001	$ 4,610,418
Contractual Services	406,026	1,675,545	1,737,239	1,801,241	1,867,638	1,936,522	2,007,987	2,068,226	2,130,273	2,194,181	2,260,007
Materials & Supplies	2,548,302	468,550	482,607	497,085	511,997	527,357	543,178	559,473	576,257	593,545	611,351
Purchased Water	-	-	-	-	-	-	-	-	-	-	-
Other	4,475,392	1,044,465	1,075,799	1,108,073	1,141,315	1,175,555	1,210,821	1,247,146	1,284,560	1,323,097	1,362,790
Utilities	-	272,000	280,160	288,565	297,222	306,138	315,323	324,782	334,526	344,561	354,898
Subtotal Operating Expenses	$ 7,441,569	$ 6,858,966	$ 7,090,745	$ 7,330,590	$ 7,578,792	$ 7,835,651	$ 8,101,478	$ 8,362,695	$ 8,632,565	$ 8,911,386	$ 9,199,465
Debt Service											
Existing Debt Service	$ 1,760,991	$ 1,768,204	$ 1,693,631	$ 1,695,625	$ 1,661,744	$ 1,372,236	$ 1,382,077	$ 1,123,543	$ 1,120,185	$ 1,117,432	$ 1,119,518
Future Debt Service	-	199,305	769,017	920,734	1,807,534	2,562,049	3,067,574	4,066,353	4,590,554	4,901,717	5,624,444
BAN Interest Payment	432,120	261,832	127,972	179,488	96,644	166,308	124,026	207,054	141,406	236,798	191,746
Subtotal: Debt Service	2,193,111	2,229,341	2,590,621	2,795,848	3,565,921	4,100,593	4,573,677	5,396,950	5,852,145	6,255,947	6,935,708
Capital and Other Expenditures											
CIP Paygo	1,926,100	1,815,600	5,881,200	4,446,700	2,710,800	3,510,700	4,212,900	4,179,900	4,589,600	4,799,100	6,746,400
Capital Leases	288,035	322,578	200,374	106,845	254,426	57,618	44,105	11,026	-	-	-
Subtotal: Capital and Other Expenditures	2,214,135	2,138,178	6,081,574	4,553,545	2,965,226	3,568,318	4,257,005	4,190,926	4,589,600	4,799,100	6,746,400
Total Wastewater System Revenue Requirements	$ 11,848,815	$ 11,226,485	$ 15,762,939	$ 14,679,983	$ 14,109,939	$ 15,504,562	$ 16,932,160	$ 17,950,571	$ 19,074,310	$ 19,966,433	$ 22,881,573
Annual Cashflow: Surplus/(Deficit)	$ (668,181)	$ 906,608	$ (2,592,619)	$ (380,121)	$ 1,419,993	$ 1,364,918	$ 422,482	$ (96,405)	$ (705,835)	$ (1,068,424)	$ (3,438,357)
% Revenue Shortfall	6%		20%	3%				1%	4%	6%	18%
% Change Total wastewater System Revenue	-7%	9%	9%	9%	9%	9%	3%	3%	3%	3%	3%
% Change Total Water System Revenue Requirements	2%	-5%	40%	-7%	-4%	10%	9%	6%	6%	5%	15%
Operating Cash Reserves	$ 10,708,705	$ 11,615,313	$ 9,022,694	$ 8,642,573	$ 10,062,567	$ 11,427,485	$ 11,849,967	$ 11,753,561	$ 11,047,727	$ 9,979,302	$ 6,540,946
Days Cash On Hand	518 days	610 days	458 days	424 days	478 days	525 days	527 days	506 days	461 days	403 days	256 days
Total Debt Coverate Ratio	1.70x	2.37x	2.35x	2.49x	2.23x	2.20x	2.02x	1.76x	1.66x	1.60x	1.48x
Wastewater Rate Escalation	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	4.00%	4.00%	4.00%	4.00%	4.00%
Required Wastewater Rate Escalation	6.00%		20.00%	3.00%				1.00%	4.00%	6.00%	18.00%

City of Lakewood
Utility Funding and Affordability Analysis
Actual and Budget Input

Wastewater System O&M	CY 2018 Budget	CY 2019 Budget	CY 2020 Projected	CY 2021 Projected	CY 2022 Projected	CY 2023 Projected	CY 2024 Projected	CY 2025 Projected	CY 2026 Projected	CY 2027 Projected	CY 2028 Projected
Fund 510 (Wastewtr Coll System Fund)											
Wastewtr Collection Crew											
Salaries and Wages	$ 857,173	$ 861,810	$ 887,665	$ 914,294	$ 941,723	$ 969,975	$ 999,074	$ 1,029,046	$ 1,059,918	$ 1,091,715	$ 1,124,467
Personnel Benefits	339,435	345,870	361,434	377,699	394,696	412,457	431,017	450,413	470,682	491,862	513,996
Uniform and Clothing	4,800	4,800	4,944	5,092	5,245	5,402	5,565	5,731	5,903	6,080	6,263
Travel and Transportation	1,050	950	979	1,008	1,038	1,069	1,101	1,134	1,168	1,203	1,240
Other Employee Benefits	-	-	-	-	-	-	-	-	-	-	-
Professional Services	151,750	1,012,250	1,052,740	1,094,850	1,138,644	1,184,189	1,231,557	1,268,504	1,306,559	1,345,755	1,386,128
Communications	2,150	2,625	2,704	2,785	2,868	2,954	3,043	3,134	3,228	3,325	3,425
Public Works Enterprise A	-	-	-	-	-	-	-	-	-	-	-
Rents and Leases	-	-	-	-	-	-	-	-	-	-	-
Items Purchased for Resale	-	-	-	-	-	-	-	-	-	-	-
Intra-Governmntl Services	-	-	-	-	-	-	-	-	-	-	-
Printing and Reproduction	-	-	-	-	-	-	-	-	-	-	-
Contractual Services	2,004,200	204,100	210,223	216,530	223,026	229,716	236,608	243,706	251,017	258,548	266,304
Office Supplies	500	550	567	583	601	619	638	657	676	697	718
Operating Supplies	53,600	73,000	75,190	77,446	79,769	82,162	84,627	87,166	89,781	92,474	95,248
Repair Parts & Supplies	53,500	79,500	81,885	84,342	86,872	89,478	92,162	94,927	97,775	100,708	103,729
Repair Service	-	-	-	-	-	-	-	-	-	-	-
Service Agreements	-	2,500	2,575	2,652	2,732	2,814	2,898	2,985	3,075	3,167	3,262
Utilities	11,000	12,500	12,875	13,261	13,659	14,069	14,491	14,926	15,373	15,835	16,310
Inter Fund Activity	1,600	-	-	-	-	-	-	-	-	-	-
Inter Departmntl Services	12,000	18,000	18,540	19,096	19,669	20,259	20,867	21,493	22,138	22,802	23,486
Public Works Enterprise B	-	529,609	545,497	561,862	578,718	596,080	613,962	632,381	651,352	670,893	691,020
Construction	-	-	-	-	-	-	-	-	-	-	-
Improvements	250,000	1,260,000	1,297,800	1,336,734	1,376,836	1,418,141	1,460,685	1,504,506	1,549,641	1,596,130	1,644,014
Machinery and Equipment	130,000	205,000	211,150	217,485	224,009	230,729	237,651	244,781	252,124	259,688	267,479
Computer Equipment	-	-	-	-	-	-	-	-	-	-	-
Debt Service	6,741,089	8,820,761	-	-	-	-	-	-	-	-	-
Subtotal: Wastewtr Collection Crew	$ 10,613,847	$ 13,433,825	$ 4,766,767	$ 4,925,719	$ 5,090,105	$ 5,260,115	$ 5,435,947	$ 5,605,490	$ 5,780,411	$ 5,960,884	$ 6,147,088
Subtotal: Fund 510	$ 10,613,847	$ 13,433,825	$ 4,766,767	$ 4,925,719	$ 5,090,105	$ 5,260,115	$ 5,435,947	$ 5,605,490	$ 5,780,411	$ 5,960,884	$ 6,147,088

Wastewater System O&M	CY 2018 Budget	CY 2019 Budget	CY 2020 Projected	CY 2021 Projected	CY 2022 Projected	CY 2023 Projected	CY 2024 Projected	CY 2025 Projected	CY 2026 Projected	CY 2027 Projected	CY 2028 Projected
Fund 511 (Wastewater Treatment Fund)											
Wastewater Imprmt											
Salaries and Wages	$ 1,421,625	$ 1,564,464	$ 1,611,398	$ 1,659,740	$ 1,709,532	$ 1,760,818	$ 1,813,642	$ 1,868,051	$ 1,924,093	$ 1,981,816	$ 2,041,270
Personnel Benefits	577,539	626,262	654,444	683,894	714,669	746,829	780,436	815,556	852,256	890,608	930,685
Uniform and Clothing	8,000	8,000	8,240	8,487	8,742	9,004	9,274	9,552	9,839	10,134	10,438
Travel and Transportation	2,250	1,900	1,957	2,016	2,076	2,138	2,203	2,269	2,337	2,407	2,479
Other Employee Benefits	-	-	-	-	-	-	-	-	-	-	-
Professional Services	1,028,316	130,520	135,741	141,170	146,817	152,690	158,798	163,561	168,468	173,522	178,728
Communications	3,500	3,110	3,203	3,299	3,398	3,500	3,605	3,714	3,825	3,940	4,058
Public Works Enterprise A	-	-	-	-	-	-	-	-	-	-	-
Rents and Leases	975	975	1,004	1,034	1,065	1,097	1,130	1,164	1,199	1,235	1,272
Items Purchased for Resale	-	-	-	-	-	-	-	-	-	-	-
Intra-Governmntl Services	-	-	-	-	-	-	-	-	-	-	-
Printing and Reproduction	250	-	-	-	-	-	-	-	-	-	-
Contractual Services	196,000	311,000	320,330	329,940	339,838	350,033	360,534	371,350	382,491	393,965	405,784
Office Supplies	1,000	1,500	1,545	1,591	1,639	1,688	1,739	1,791	1,845	1,900	1,957
Operating Supplies	218,900	230,500	237,415	244,537	251,874	259,430	267,213	275,229	283,486	291,991	300,750
Repair Parts & Supplies	79,750	83,500	86,005	88,585	91,243	93,980	96,799	99,703	102,694	105,775	108,949
Repair Service	-	-	-	-	-	-	-	-	-	-	-
Service Agreements	14,200	14,200	14,626	15,065	15,517	15,982	16,462	16,956	17,464	17,988	18,528
Utilities	290,000	272,000	280,160	288,565	297,222	306,138	315,323	324,782	334,526	344,561	354,898
Inter Fund Activity	75,000	-	-	-	-	-	-	-	-	-	-
Inter Departmntl Services	-	-	-	-	-	-	-	-	-	-	-
Public Works Enterprise B	365,000	475,471	489,735	504,427	519,560	535,147	551,201	567,737	584,769	602,312	620,382
Construction	2,000,000	7,000,000	7,210,000	7,426,300	7,649,089	7,878,562	8,114,919	8,358,366	8,609,117	8,867,391	9,133,412
Improvements	-	-	-	-	-	-	-	-	-	-	-
Machinery and Equipment	200,000	270,000	278,100	286,443	295,036	303,887	313,004	322,394	332,066	342,028	352,289
Computer Equipment	-	-	-	-	-	-	-	-	-	-	-
Debt Service	5,340,148	8,013,639	2,663,023	2,723,205	3,723,703	3,991,903	4,493,756	5,200,923	5,710,739	6,019,149	6,743,962
Subtotal: Wastewater Imprmt	$ 11,822,452	$ 19,007,041	$ 13,996,925	$ 14,408,299	$ 15,771,020	$ 16,412,828	$ 17,300,038	$ 18,403,099	$ 19,321,214	$ 20,050,722	$ 21,209,842
Subtotal: Fund 511	$ 11,822,452	$ 19,007,041	$ 13,996,925	$ 14,408,299	$ 15,771,020	$ 16,412,828	$ 17,300,038	$ 18,403,099	$ 19,321,214	$ 20,050,722	$ 21,209,842
Total: Wastewater System O&M	$ 22,436,299	$ 32,440,866	$ 18,763,692	$ 19,334,018	$ 20,861,125	$ 21,672,942	$ 22,735,984	$ 24,008,590	$ 25,101,626	$ 26,011,606	$ 27,356,930
Excluding Debt and Interfund	10,355,063	15,606,466	16,100,670	16,610,813	17,137,421	17,681,039	18,242,228	18,807,667	19,390,887	19,992,457	20,612,968

City of Lakewood
Utility Funding and Affordability Analysis
Wastewater System Debt Service

	CY 2018	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025	CY 2026	CY 2027	CY 2028
Existing Wastewaster Debt Service											
Wastewater Bonds Debt Service											
Refunding Sewer Plant Improvements (GO 2003) (Fund 510)	139,062	138,642	138,180	138,726	138,159	-	-	-	-	-	-
Refunding GO Sewer Construction Bonds-2005 (Fund 510)	152,663	154,013	122,096	120,823	121,679	119,705	121,691	-	-	-	-
Refunding Sewer Revenue Bonds 2006 to GO (Fund 510)	692,633	696,512	695,769	698,039	694,572	692,592	697,709	696,677	694,407	692,427	693,747
Sewer GO (Fund 510)	257,147	257,655	256,926	257,755	257,631	257,609	257,034	257,973	257,366	257,012	257,498
Refunding Sewer Plant Improvements (GO 2003) (Fund 511)	145,684	145,244	144,760	145,332	144,738	-	-	-	-	-	-
Refunding GO Sewer Plant Improvement-2005 (Fund 511)	171,280	172,795	136,986	135,557	136,518	134,303	136,532	-	-	-	-
Refunding Sewer Revenue Bonds 2006 to GO (Fund 511)	146,617	147,438	147,281	147,761	147,028	146,608	147,691	147,473	146,993	146,573	146,853
Placeholder	-	-	-	-	-	-	-	-	-	-	-
Subtotal: Existing Wastewater Bonds Debt Service	$ 1,705,085	$ 1,712,298	$ 1,641,998	$ 1,643,993	$ 1,640,324	$ 1,350,816	$ 1,360,657	$ 1,102,123	$ 1,098,766	$ 1,096,012	$ 1,098,098
Wastewater Loans Debt Service											
OPWC; CA01C; West Clifton Storm Sewer	4,273	4,273	-	-	-	-	-	-	-	-	-
OPWC; CA23C; Edgewater Drive Sewer	30,213	30,213	30,213	30,213	-	-	-	-	-	-	-
OPWC; CA08Q/CA09Q : West End Sewer Separation	21,420	21,420	21,420	21,420	21,420	21,420	21,420	21,420	21,420	21,420	21,420
Placeholder	-	-	-	-	-	-	-	-	-	-	-
Placeholder	-	-	-	-	-	-	-	-	-	-	-
Total Existing Wastewater Loans Debt Service:	$ 55,906	$ 55,906	$ 51,633	$ 51,633	$ 21,420	$ 21,420	$ 21,420	$ 21,420	$ 21,420	$ 21,420	$ 21,420
Total Existing Wastewater Debt Service	$ 1,760,991	$ 1,768,204	$ 1,693,631	$ 1,695,625	$ 1,661,744	$ 1,372,236	$ 1,382,077	$ 1,123,543	$ 1,120,185	$ 1,117,432	$ 1,119,518
Projected Debt Service											
Future GO/Revenue Bonds	$ -	$ 199,305	$ 769,017	$ 920,734	$ 1,260,864	$ 1,365,028	$ 1,680,257	$ 1,776,880	$ 2,169,413	$ 2,289,758	$ 2,738,724
Future SRF Loans	-	-	-	-	546,670	1,197,021	1,387,316	2,289,473	2,421,140	2,611,959	2,885,720
Total: Projected Debt Service	-	199,305	769,017	920,734	1,807,534	2,562,049	3,067,574	4,066,353	4,590,554	4,901,717	5,624,444
Total Existing and Future Wasterwaste Debt Service	$ 1,760,991	$ 1,967,509	$ 2,462,649	$ 2,616,360	$ 3,469,277	$ 3,934,285	$ 4,449,651	$ 5,189,896	$ 5,710,739	$ 6,019,149	$ 6,743,962
Wastewater System Capital Lease Debt Service											
Phase 1 Lease Division of WWC (Fund 510)	-	-	-	-	-	-	-	-	-	-	-
Phase 2 Lease (Backhoe) (Fund 510)	-	-	-	-	-	-	-	-	-	-	-
2011 Equipment Lease (Schedule 4A) (Fund 510)	64,654	64,654	26,939	-	-	-	-	-	-	-	-
2011 Equipment Lease (Schedule 4B) (Fund 510)	85,621	85,621	35,675	-	-	-	-	-	-	-	-
2014 Equipment Lease (Schedule 2) (Fund 510)	25,600	25,600	25,600	25,600	58,701	8,494	-	-	-	-	-
2015 Equipment Lease (Schedule 4) (Fund 510)	52,996	52,996	52,996	22,082	-	-	-	-	-	-	-
2016 Equipment Lease (Schedule 6 - sewer cleaning truck) (Fund 510)	44,105	78,648	44,105	44,105	180,666	44,105	44,105	11,026	-	-	-
2014 Equipment Lease (Schedule 2) (Fund 511)	15,059	15,059	15,059	15,059	15,059	5,020	-	-	-	-	-
Placeholder	-	-	-	-	-	-	-	-	-	-	-
Placeholder	-	-	-	-	-	-	-	-	-	-	-
Current Capital Lease Debt Service	$ 288,035	$ 322,578	$ 200,374	$ 106,845	$ 254,426	$ 57,618	$ 44,105	$ 11,026	$ -	$ -	$ -
Future Capital Lease Debt Service	-	-	-	-	-	-	-	-	-	-	-
Total Capital Lease Debt Service	$ 288,035	$ 322,578	$ 200,374	$ 106,845	$ 254,426	$ 57,618	$ 44,105	$ 11,026	$ -	$ -	$ -

City of Lakewood
Utility Funding and Affordability Analysis
Capital Improvements Plan & Financing

Capital Improvement Projects	CY 2018	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025	CY 2026	CY 2027	CY 2028
Outfall Repairs Construction (Summit)	-		900,000	-	-	-	-	-	-	-	-
Sewer Vehicle #823 1-ton dump with plow	-	-	80,000	-	-	-	-	-	-	-	-
Outfall Repairs Design (Cliff Dr)	-		100,000	-	-	-	-	-	-	-	-
Sewers #818 Camera truck	-	-	400,000	-	-	-	-	-	-	-	-
Outfall Repairs Construction (Clifff Dr)	-	-	-	700,000	-	-	-	-	-	-	-
Outfall Repairs Design (TBD)	-	-	-	-	25,000	-	-	-	-	-	-
Concrete Restoration (BANs)	600,000	-	-	-	-	-	-	-	-	-	-
Concrete Restoration (Paygo)	21,300	-	-	-	-	-	-	-	-	-	-
Thermophilic Digestion Conversion and Primary D	5,000,000	3,055,400	-	-	-	-	-	-	-	-	-
Effluent Tunnel Repair	55,000	-	-	-	-	-	-	-	-	-	-
HRT design and permitting, Sewer & WWTP Impi	1,000,000	-	-	-	-	-	-	-	-	-	-
HRT design and permitting, Sewer & WWTP Impi	262,175	-	-	-	-	-	-	-	-	-	-
Electric Backup Generator Clifton Lagoon Pump S	27,000	75,000	-	-	-	-	-	-	-	-	-
High Rate Treatment Construction (OPWC Grant)	-	-	-	3,000,000	-	-	-	-	-	-	-
High Rate Treatment Construction (OPWC Loan)	-	-	-	-	3,366,425	-	-	-	-	-	-
High Rate Treatment Construction (WPCLF)	-	4,000,000	10,633,575			-	-	-	-	-	-
WWTP Vehicle #801 Pickup Truck w/ Plow	-	-	-	40,000	-	-	-	-	-	-	-
Early Action Sewer Separation		100,000	900,000	1,000,000				-	-	-	-
Final Clarifier Deflector Rings and Sweep Arm Cleaning/Re-coating		45,000						-	-	-	-
Thickener Tank Deflector Rings		50,000						-	-	-	-
Water and Sewer asset management software		50,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
Waterline to HRT		250,000						-	-	-	-
Rehab of 8 Manholes		1,000,000						-	-	-	-
HVAC controls replacement			150,000								
Placeholder											
Misc. Placeholder											
Relief to Interceptor picking up all CSOs and manage at 059.		-	-	-	-	-	-	-	-	2,220,000	5,550,000
Above Ground Storage at WWTP		-	-	-	1,150,000	3,450,000	16,100,000	2,300,000	-	-	-
Underground Tank Storage (storage to manage also LEWS 1040 an		-	-	-	-	-	-	-	3,280,000	4,100,000	820,000
Close off and convey more to Interceptor and manage at 059		-	-	-	-	-	-	-	480,000	600,000	120,000
Source Control, Diversion Sewer, Pump Station, storm sewer		-	-	-	-	-	-	-	-	-	160,000
Source Control, Sewer Separation, Regulator Modification, Green In		-	-	-	-	-	-	-	-	-	-
Source control, relief sewer, storm sewer		-	-	-	-	-	-	-	-	-	-
Source Control, GI, Relief Sewer, Regulator Modifications		-	-	-	-	-	-	-	-	-	-
Belle Storage Tunnel, Lakewood Park Storage Basin		-	-	-	-	-	-	-	-	530,000	530,000
Sewer separation		-	-	-	-	-	-	-	-	-	-
Diversion sewer		-	-	-	-	-	-	-	-	-	-
Bulkhead interceptor connection, add pump station to serve area		-	-	-	-	-	-	-	-	-	-
Source Control, Green Infrastructure, Relief Sewer, Regulator Modif		-	-	-	-	-	-	-	-	-	-
Relief Sewer, Regulator Modification		-	-	-	-	-	-	-	-	-	-
Source control		-	-	-	-	-	-	-	-	-	-
Regulator modification		-	-	-	-	-	-	-	-	-	-
Source control, Green Infrastructure		-	-	-	-	-	-	-	-	-	-
Long-Term R&R Capital Placeholder - Collection			1,980,000	2,980,000	2,980,000	1,980,000	3,930,000	2,930,000	3,930,000	2,930,000	3,930,000
Long-Term R&R Capital Placeholder - Outfall Repairs			-	-	100,000	1,000,000	100,000	1,000,000	100,000	1,000,000	100,000
Long-Term R&R Capital Placeholder - WWTP			4,220,000	1,880,000	1,840,000	3,353,000	3,353,000	3,353,000	3,353,000	1,334,000	1,334,000
Long-Term R&R Capital Placeholder - Lift Stations		-	-	-	-	-	90,000	-	-	-	-
Total: Capital Improvement Projects	$ 12,407,602	$ 8,835,400	$ 19,388,575	$ 9,625,000	$ 9,486,425	$ 9,808,000	$ 23,598,000	$ 9,608,000	$ 11,168,000	$ 12,739,000	$ 12,569,000
Annual Cost Inflation	0.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Cumulative Inflation Rate	100.0%	102.0%	104.0%	106.0%	108.0%	110.0%	112.0%	114.0%	116.0%	118.0%	120.0%
Total: Capital Improvement Projects (Nomi	$12,407,700	$ 9,012,200	$20,164,200	$10,202,500	$10,245,400	$10,788,800	$26,429,800	$10,953,200	$12,954,900	#######	$15,082,800

	CY 2018	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025	CY 2026	CY 2027	CY 2028
Capital Financing Plan											
Net Capital Financing Needs	$ 12,407,700	$ 9,012,200	$ 20,164,200	$ 10,202,500	$ 10,245,400	$ 10,788,800	$ 26,429,800	$10,953,200	$12,954,900	#######	$15,082,800
Capital Financing Sources											
OPWC Grant	$ -	$ -	$ -	$ 3,180,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPWC Loan		-	-	-	4,877,800	3,795,000	18,032,000	2,622,000	3,804,800	5,463,400	1,620,000
WPCLF Loan		4,080,000	11,059,000	-	-	-	-	-	-	-	-
Bond Anticipation Notes (BANs)	9,281,400	3,116,600	3,224,000	2,575,800	2,656,800	3,483,200	4,184,900	4,151,400	4,560,600	4,769,600	6,716,400
Other Misc. Grants & Contributions		-	-	-	-	-	-	-	-	-	-
Cash Financing of Construction (PAYGO)	1,926,100	1,815,600	5,881,200	4,446,700	2,710,800	3,510,700	4,212,900	4,179,900	4,589,600	4,799,100	6,746,400
Subtotal: Capital Financing Sources	$ 11,207,500	$ 9,012,200	$ 20,164,200	$ 10,202,500	$ 10,245,400	$ 10,788,900	$ 26,429,800	$ 10,953,300	$ 12,955,000	$ 15,032,100	$ 15,082,800
Capital Financing Shortfall	$ 1,200,200	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Construction/Bond Fund											
Beginning Balance											
Additions:											
Bond Proceeds	$ 43,850	$ 98,187	$ -	$ 67,308	$ -	$ 62,366	$ -	$ 77,645	$ -	$ 88,799	$ -
BAN Proceeds	9,281,400	3,116,600	3,224,000	2,575,800	2,656,800	3,483,200	4,184,900	4,151,400	4,560,600	4,769,600	6,716,400
SRF Loan Proceeds	-	4,080,000	11,059,000	3,180,000	4,877,800	3,795,000	18,032,000	2,622,000	3,804,800	5,463,400	1,620,000
PAYGO Funding	1,926,100	1,815,600	5,881,200	4,446,700	2,710,800	3,510,700	4,212,900	4,179,900	4,589,600	4,799,100	6,746,400
From Other Funds & Operating Budget	-	-	-	-	-	-	-	-	-	-	-
Subtractions:											
Capital Improvements	$ (12,407,700)	$ (9,012,200)	$ (20,164,200)	$ (10,202,500)	$ (10,245,400)	$ (10,788,800)	$ (26,429,800)	$ (10,953,200)	$ (12,954,900)	$ (15,032,100)	$ (15,082,800)
Bond Issuance Costs	(43,850)	(98,187)	-	(67,308)	-	(62,366)	-	(77,645)	-	(88,799)	-
Loan Issuance Costs	-	-	-	-	-	-	-	-	-	-	-
Ending Balance	$ (1,200,200)	$ -	$ -	$ -	$ -	$ 100	$ -	$ 100	$ 100	$ -	$ -
BAN Issuance											
Outstanding BANs	$ 8,789,000	$ 9,975,000	$ 3,174,600	$ 6,398,600	$ 2,175,400	$ 4,832,200	$ 2,016,400	$ 6,201,300	$ 2,509,700	$ 7,070,300	$ 2,870,900
Proposed BANs	$ 5,615,000	$ 3,116,600	$ 3,224,000	$ 2,575,800	$ 2,656,800	$ 3,483,200	$ 4,184,900	$ 4,151,400	$ 4,560,600	$ 4,769,600	$ 6,716,400
Subtotal: BANs Outstanding	$ 14,404,000	$ 13,091,600	$ 6,398,600	$ 8,974,400	$ 4,832,200	$ 8,315,400	$ 6,201,300	$ 10,352,700	$ 7,070,300	$ 11,839,900	$ 9,587,300
Interest Rate	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Interest Payment	$ 432,120	$ 261,832	$ 127,972	$ 179,488	$ 96,644	$ 166,308	$ 124,026	$ 207,054	$ 141,406	$ 236,798	$ 191,746
BANs Refunded	$ 4,385,000	$ 9,818,700		$ 6,730,800		$ 6,236,550		$ 7,764,525		$ 8,879,925	
Issuance Costs	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%
Total Bonds Issued	$ 4,429,000	$ 9,917,000	$ -	$ 6,799,000	$ -	$ 6,299,000	$ -	$ 7,843,000	$ -	$ 8,969,000	$ -
Updated BAN Balance	$ 9,975,000	$ 3,174,600	$ 6,398,600	$ 2,175,400	$ 4,832,200	$ 2,016,400	$ 6,201,300	$ 2,509,700	$ 7,070,300	$ 2,870,900	$ 9,587,300

City of Lakewood
Utility Funding and Affordability Analysis
Calculation of Future Debt Service

	CY 2018	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025	CY 2026	CY 2027	CY 2028
Projected Future Debt Service											
Projected GO/Revenue Bonds											
Series 2018 Revenue Bonds											
Series 2018 Revenue Bonds	$ -	$ 199,305	$ 273,167	$ 273,224	$ 273,284	$ 273,346	$ 273,411	$ 273,479	$ 273,550	$ 273,624	$ 273,701
Series 2019 Revenue Bonds	$ -	$ -	$ 495,850	$ 647,510	$ 647,630	$ 647,756	$ 647,888	$ 648,026	$ 648,172	$ 648,325	$ 648,485
Series 2020 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Series 2021 Revenue Bonds	$ -	$ -	$ -	$ -	$ 339,950	$ 443,927	$ 444,009	$ 444,095	$ 444,186	$ 444,281	$ 444,380
Series 2022 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Series 2023 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ 314,950	$ 411,280	$ 411,356	$ 411,436	$ 411,520
Series 2024 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Series 2025 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 392,150	$ 512,093	$ 512,187
Series 2026 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Series 2027 Revenue Bonds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 448,450
Subtotal: Projected Revenue Bonds	$ -	$ 199,305	$ 769,017	$ 920,734	$ 1,260,864	$ 1,365,028	$ 1,680,257	$ 1,776,880	$ 2,169,413	$ 2,289,758	$ 2,738,724
Projected OPWC Loans											
2018 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2019 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2020 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2021 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2022 OPWC Loan	$ -	$ -	$ -	$ -	$ 243,890	$ 243,890	$ 243,890	$ 243,890	$ 243,890	$ 243,890	$ 243,890
2023 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ 189,750	$ 189,750	$ 189,750	$ 189,750	$ 189,750
2024 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 901,600	$ 901,600	$ 901,600	$ 901,600
2025 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 131,100	$ 131,100	$ 131,100
2026 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 190,240	$ 190,240
2027 OPWC Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 273,170
Subtotal: Projected OPWC Loans	$ -	$ -	$ -	$ -	$ 243,890	$ 243,890	$ 433,640	$ 1,335,240	$ 1,466,340	$ 1,656,580	$ 1,929,750
Projected WPCLF Loans											
2018 WPCLF Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2019 WPCLF Loan	$ -	$ -	$ -	$ -	$ 81,600	$ 256,871	$ 257,018	$ 257,168	$ 257,321	$ 257,477	$ 257,636
2020 WPCLF Loan	$ -	$ -	$ -	$ -	$ 221,180	$ 696,260	$ 696,658	$ 697,065	$ 697,479	$ 697,902	$ 698,334
2021 WPCLF Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2022 WPCLF Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2023 WPCLF Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2024 WPCLF Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2025 WPCLF Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2026 WPCLF Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2027 WPCLF Loan	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Subtotal: Projected WPCLF Loans	$ -	$ -	$ -	$ -	$ 302,780	$ 953,131	$ 953,676	$ 954,233	$ 954,800	$ 955,379	$ 955,970
Subtotal: Projected OPWC Grants	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total: Projected Future Debt	$ -	$ 199,305	$ 769,017	$ 920,734	$ 1,807,534	$ 2,562,049	$ 3,067,574	$ 4,066,353	$ 4,590,554	$ 4,901,717	$ 5,624,444

	CY 2018	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025	CY 2026	CY 2027	CY 2028
	Actual	Budget	Projected	Projected	Projected	Projected	Projected	Projected	Projected	Projected	Projected
Wastewater System Revenue Requirements											
Operating Expenses											
Fund 510											
Salaries and Benefits	$ 4,250	$ 1,207,681	$ 1,249,099	$ 1,291,994	$ 1,336,419	$ 1,382,432	$ 1,430,092	$ 1,479,460	$ 1,530,600	$ 1,583,578	$ 1,638,463
Contractual Services	137,757	1,218,850	1,265,538	1,314,032	1,364,401	1,416,719	1,471,063	1,515,195	1,560,651	1,607,470	1,655,694
Materials & Supplies	2,247,882	153,050	157,642	162,371	167,242	172,259	177,427	182,750	188,232	193,879	199,696
Purchased Water	-	-	-	-	-	-	-	-	-	-	-
Other	1,256,963	555,984	572,664	589,843	607,539	625,765	644,538	663,874	683,790	704,304	725,433
Utilities	-	-	-	-	-	-	-	-	-	-	-
Subtotal: Fund 510	$ 3,646,852	$ 3,135,565	$ 3,244,942	$ 3,358,239	$ 3,475,600	$ 3,597,175	$ 3,723,119	$ 3,841,278	$ 3,963,273	$ 4,089,231	$ 4,219,286
Fund 511											
Salaries and Benefits	$ 7,600	$ 2,190,726	$ 2,265,841	$ 2,343,633	$ 2,424,201	$ 2,507,647	$ 2,594,079	$ 2,683,607	$ 2,776,349	$ 2,872,423	$ 2,971,955
Contractual Services	268,268	456,695	471,701	487,209	503,237	519,803	536,924	553,031	569,622	586,711	604,312
Materials & Supplies	300,420	315,500	324,965	334,714	344,755	355,098	365,751	376,723	388,025	399,666	411,656
Purchased Water	-	-	-	-	-	-	-	-	-	-	-
Other	3,218,428	488,481	503,135	518,229	533,776	549,790	566,283	583,272	600,770	618,793	637,357
Utilities	-	272,000	280,160	288,565	297,222	306,138	315,323	324,782	334,526	344,561	354,898
Subtotal: Fund 511	$ 3,794,717	$ 3,723,402	$ 3,845,803	$ 3,972,351	$ 4,103,192	$ 4,238,476	$ 4,378,359	$ 4,521,416	$ 4,669,292	$ 4,822,155	$ 4,980,179
Subtotal: Operating Expenses	$ 7,441,569	$ 6,858,966	$ 7,090,745	$ 7,330,590	$ 7,578,792	$ 7,835,651	$ 8,101,478	$ 8,362,695	$ 8,632,565	$ 8,911,386	$ 9,199,465
Debt Service											
Existing Debt Service	$ 1,760,991	$ 1,768,204	$ 1,693,631	$ 1,695,625	$ 1,661,744	$ 1,372,236	$ 1,382,077	$ 1,123,543	$ 1,120,185	$ 1,117,432	$ 1,119,518
Future Debt Service	-	199,305	769,017	920,734	1,807,534	2,562,049	3,067,574	4,066,353	4,590,554	4,901,717	5,624,444
BAN Interest Payments	432,120	261,832	127,972	179,488	96,644	166,308	124,026	207,054	141,406	236,798	191,746
Subtotal: Debt Service	$ 2,193,111	$ 2,229,341	$ 2,590,621	$ 2,795,848	$ 3,565,921	$ 4,100,593	$ 4,573,677	$ 5,396,950	$ 5,852,145	$ 6,255,947	$ 6,935,708
Capital and Other Exoenditures											
CIP PayGo	1,926,100	1,815,600	5,881,200	4,446,700	2,710,800	3,510,700	4,212,900	4,179,900	4,589,600	4,799,100	6,746,400
Capital Leases	288,035	322,578	200,374	106,845	254,426	57,618	44,105	11,026	-	-	-
Subtotal: Capital and Other Exoenditures	$ 2,214,135	$ 2,138,178	$ 6,081,574	$ 4,553,545	$ 2,965,226	$ 3,568,318	$ 4,257,005	$ 4,190,926	$ 4,589,600	$ 4,799,100	$ 6,746,400
Total: Wastewater System Revenue Requirements	$ 11,848,815	$ 11,226,485	$ 15,762,939	$ 14,679,983	$ 14,109,939	$ 15,504,562	$ 16,932,160	$ 17,950,571	$ 19,074,310	$ 19,966,433	$ 22,881,573
% change	1.8%	-5.3%	40.4%	-6.9%	-3.9%	9.9%	9.2%	6.0%	6.3%	4.7%	14.6%
% change - O&M	33.9%	-7.8%	3.4%	3.4%	3.4%	3.4%	3.4%	3.2%	3.2%	3.2%	3.2%
Estimated Rate Calculation											
Total Revenue Requirements	$ 11,848,815	$ 11,226,485	$ 15,762,939	$ 14,679,983	$ 14,109,939	$ 15,504,562	$ 16,932,160	$ 17,950,571	$ 19,074,310	$ 19,966,433	$ 22,881,573
Less: Miscellaneous Revenue	(478,845)	(478,845)	(478,845)	(478,845)	(478,845)	(478,845)	(478,845)	(478,845)	(478,845)	(478,845)	(478,845)
Net Revenue from User Charges	$ 11,369,970	$ 10,747,640	$ 15,284,095	$ 14,201,138	$ 13,631,094	$ 15,025,717	$ 16,453,316	$ 17,471,726	$ 18,595,465	$ 19,487,588	$ 22,402,728
Estimated Wastewater Sales	1,569,177	1,553,485	1,537,951	1,522,571	1,507,345	1,492,272	1,477,349	1,462,576	1,447,950	1,433,470	1,419,136
Wastewater Rate ($/ccf)	$ 7.25	$ 6.92	$ 9.94	$ 9.33	$ 9.05	$ 10.07	$ 11.14	$ 11.95	$ 12.85	$ 13.60	$ 15.79
Actual Rate	$ 6.82	$ 7.50	$ 8.25	$ 9.08	$ 9.99	$ 10.98	$ 11.42	$ 11.88	$ 12.36	$ 12.85	$ 13.36
	6.3%	-7.8%	20.5%	2.8%	-9.4%	-8.3%	-2.5%	0.6%	4.0%	5.8%	18.2%

APPENDIX 5-1
Actiflow and Bioactiflo Pilot Study

LAKEWOOD WASTEWATER TREATMENT PLANT – ACTIFLO AND BIOACTIFLO PILOT STUDY

Prepared for:

Prepared by:

Project No. 14797

November 2015

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1.0 EXECUTIVE SUMMARY

1.1 TECHNOLOGY TESTED

The City of Lakewood conducted a six-week pilot testing program to assess the performance of High Rate Treatment (HRT) technologies. The ACTIFLO® / BIOACTIFLO wet weather High Tate Treatment system, presented by Kruger-Veolia manufacturer was piloted during 6 weeks period from June 3 through July 19. The ACTIFLO® process is a high-rate chemical and physical clarification process that involves the formation of suspended solids onto a ballast particle (microsand) followed by lamellar settling. The BIOACTIFLO® is biological configuration by the addition of the contact tank for mixing raw influent with return activated sludge prior to the ACTIFLO unit.

The BIOACTIFLO® biological and/or regular (physical-chemical) ACTIFLO® processes (ballasted flocculation) were tested to determine and demonstrate the viability of for treating high hydraulic and organic loads during wet weather conditions.

An ACTIFLO pilot unit and a biological Contact Tank were brought onsite and setup on the asphalt sidewalk between the Primary Clarifiers and the Aeration Tanks for testing. The Contact Tank included a 3 mm drum screen, coarse bubble diffuser and a blower for aeration. The pilot trailer included:

- Supervisory control and data acquisition (SCADA) system;
- Pumps and injection system for adding process chemicals and recirculation;
- Pumps and valve skid for bringing in wastewater and return activated sludge (RAS) to the Contact Tank at target proportions;
- UV disinfection system.

During normal dry weather conditions, primary effluent was pumped to the pilot system, whereas during wet weather conditions, primary influent was used as feed the pilot system.

1.2 TESTING GOALS AND OBJECTIVES

The goal of this pilot study was to evaluate the ACTIFLO and BIOACTIFLO units and determine efficiencies for primary and primary + secondary treatment, respectively. The pilot study was designed to:

a. Evaluate system performances by assessing their ability to remove CBOD, TSS, E. coli and total phosphorus.
b. Determine the optimum combination of coagulant and polymer doses for primary treatment and the ideal MLSS concentration for biological treatment and secondary treatment.
c. Evaluate the process based on operation and maintenance considerations such as chemical and energy requirements, labor, and ease and duration of startup.
d. Estimate the sludge production rates and quality of the waste solids production (TSS concentration), and estimate additional disposal costs.
e. Develop/confirm system design parameters to be used in the preparation of preliminary designs and capital costs estimates;
f. Develop estimated O&M costs associated with meeting the effluent limit in a full-scale installation.
g. Confirm CBOD, TSS, and pathogen removal efficiencies under various flow and loading conditions.

The target performance goal for the High Rate Treatment pilot study was to evaluate treated effluent quality to achieve:

a. effluent requirements specified in the North East Ohio Regional Sewer District (NEORSD) consent decree:
    - 40 mg/L for total suspended solids (TSS) across seven consecutive activations
    - 40 mg/L for total 5 day carbonaceous biochemical oxygen demand $CBOD_5$ across seven consecutive activations,
    - 126 colony forming units (CFU)/100 mL (recreational season geometric mean) for E. coli
    - 284 CFU/100 mL (rolling geometric mean for each 7-day period) for E. coli.
b. NPDES permit requirements for weekly loadings on TSS, CBOD and Phosphorus for blended wastewater treated effluent from HRT system and the secondary effluent from the Lakewood WWTP. The maximum loading rate for TSS, CBOD, and Phosphorus was calculated based on the pilot plant performance data and maximum combined effluent flow rate of 65 MGD. Refer to Section 2 below.

1.3 RESULTS AND RECOMMENDATIONS

Following is a summary of the pilot testing results:

a. Effluent TSS and CBOD levels were consistently within the target limit of 40 mg/L, meeting the NEORSD Consent Decree requirements.

b. Final effluent E. Coli levels after UV disinfection was well within 284 CFU/100 mL expressed as a 7-day rolling geometric mean~~.~~, meeting the NEORSD and NPDES permit requirements.

c. All chemicals used in the pilot testing were compatible to the treatment processes in Lakewood WWTP.

d. During sodium aluminate ($NaAlO_2$) based BIOACTIFLO testing, the pH value of the effluent (8.6 to 8.8) was higher than that of the influent (7.6 to 7.9) and the sludge structure, and effluent turbidity were not satisfactory.

e. During the CSO wet weather event and simulated wet weather flow, BIOACTIFLO and ACTIFLO runs were conducted with Alum ($Al_2(SO_4)_3$) and Polyaluminum Chloride (PACL) coagulants in conjunction with flocculent to evaluate optimum chemical dosages.

1) For BIOACTIFLO™ mode of operation, optimum dosages for Alum and Polyaluminum Chloride (PACL) are summarized in the table below:

Contact Tank MLSS	Coagulant 1 / Flocculent Concentrations		Coagulant 2/ Flocculent Concentrations	
	Alum, $Al_2(SO_4)_3$	Hydrex 3596	PACL	Hydrex 3596
800 mg/L	90 mg/L	3.6 mg/L	60 mg/L	3.2-4.8 mg/L
1200 mgL	100 - 115 mg/L	5.0 mg/L	80 mg/L	0.3 mg/L

Compared "Coagulant/Flocculent" concentrations at different MLSS concentrations indicate that combination of PACL coagulant with Hydrex 3596 flocculent is the most effective choice of chemical.

2) For regular ACTIFLO® mode of operation, optimal dosages of Alum and PACL are summarized in the table below.

	Coagulant 1 / Flocculent		Coagulant 2 / Flocculent	
	Alum, $Al_2(SO_4)_3$	Hydrex 3596	PACL	Hydrex 3596
Concentrations	70- 90 mg/L	1.2- 2.0 mg/L	60 mg/L	1.2 mg/L

i. Compared "Coagulant/Flocculent" combinations during ACTIFLO optimization runs, produced very close effective concentration values.

ii. During ACTIFLO steady state testing, the effluent TSS, CBOD and phosphorus limits, at provided coagulant and flocculent concentrations, consistently met the requirements of the NEORSD Consent Decree and NPDES permit.

iii. All the coagulants achieved effluent phosphorus concentrations less than 0.5 mg/L.

iv. According to the Chemical Usage Present Worth analysis, operational cost of Alum is half of PACL cost. Refer to Appendix 2. Therefore, Alum is recommended choice of chemical for HRT full scale treatment.

f. Operating cost for running ACTIFLO and BIOACTIFLO is estimated at $850-1,500 / MG based on the pilot study results at 35 to 45 MGD range.

2.0 INTRODUCTION

The focus of this project was to assess a technology that had the potential to minimize the footprint, environmental impacts, and costs of producing plant wastewater effluent, combined secondary treated effluent and HRT wet weather flow effluent flow that meets the discharge NPDES permit limits.

The objective of this report is to present a summary of the findings of the ballasted flocculation (ACTIFLO and BIOACTIFLO) pilot tests. The pilot facility was configured to receive raw wastewater: (a) primary influent; (B) primary effluent; and (c) return activated sludge (RAS) stream. Primary effluent was used to simulate wet weather conditions during dry weather and primary influent during the wet weather conditions. RAS was the source of MLSS when the system was run as BIOACTIFLO.

2.1 NPDES PERMIT REQUIREMENTS

The City of Lakewood WWTP is complying with NPDES permit, which in the effect from August 2015 to January 2019. The target effluent quality for the full scale ACTIFLO HRT system was based on the NPDES permit effluent limits as shown in Table 1. The effluent loadings listed in this table are calculated based on average design wastewater flow of 18 MGD.

Table 1: Final Effluent Limits, Monitoring and Basis for Lakewood WWTP Outfall NPDES Permit No. 3PE00004001

Parameter	Concentration, mg/L		Loading (lbs/day)	
	Monthly	Weekly	Monthly	Weekly
TSS	20.0	30.0	3002.40	4503.60
$CBOD_5$	15.0	23.0	2251.80	3452.76
Phosphorus	1.0	1.5	150.12	225.18
pH	6.5 – 9.0			
E. coli (summer only)	126 #/100 mL	284 #/100 mL	--	--

The HRT pilot study showed that the effluent limits outlined in NPDES permit were achieved consistently during the wet weather testing period. The summary of the data from the actual and simulated wet weather events can be found in Table 2. Based on the pilot study results and projections for the full HRT system designed to treat 35 MGD wet weather flow, estimated effluent loading rates are in compliance with the weekly NPDES permit requirements.

Table 2: Summary of Pilot Study Average Treated Effluent Parameters

Parameters	ACTIFLO Effluent	Loading, lbs/day
TSS	13.0±1.6 mg/L	3794.5
$CBOD_5$	12.0±1.3 mg/L	3502.08
Phosphorus	0.17±0.06 mg/L	49.62
E. Coli	15.0±4.2 CFU/100 mL	-

During wet weather events, flows higher than 30 MGD to the WWTP will be diverted to the ACTIFLO HRT system. The effluent from the HRT will be combined with the secondary effluent from Lakewood WWTP and passed through a common UV disinfection system, which will be upgraded to treat peak hour flow of 65 MGD.

Estimated weighted average solids loadings rate during the wet weather event is shown in Table 3 and is based on the following:

a. The WWTP primary and secondary treatment:
   1) Peak Hourly Flow: 30 MGD
   2) Treated effluent solids loading rates are based on weekly loads of TSS, $CBOD_5$ and Phosphorus as shown in Table 1 above,

b. Actiflo HRT system:
   1) Max wet weather flow rate: 35 MGD
   2) Treated effluent solids loading rates for TSS, $CBOD_5$ and Phosphorus are as shown in Table 2 above.

Table 3: Summary of Estimated WWTP Treated Effluent Solids Loadings for 65 MGD Peak Hourly Wet Weather Flow

WWTP Treatment	Flow Rate, MGD	Weighted Average	7-Day Solids Loadings					
			TSS,		CBOD,		Phosphorus,	
			mg/L	lbs/day	mg/L	lbs/ day	mg/L	lbs/day
Primary+Secondary	30	46%	8.3	2072	6.3	1588	0.1	25
Actiflo	35	54%	7	2049	6.5	1891	0.4	104
Total	65	-	7.6	4121	6.4	3479	0.24	129

Therefore, peak hourly wet-weather increase to 65 MGD will not adversively affect receiving stream, since the total suspended and organic loadings are well below the 7-day NPDES permit requirements.

3.0 SCREENING OF TECHNOLOGIES

The City and their Design Professionals have compared four high rate treatment (HRT) technologies offered by the four different manufacturers (Kruger-Veolia, Evoqua, Infilco and WWETCO). The technologies were assessed based on the following information:

- Soliciting pilot plant study proposals;
- Conducting interviews and manufacturer's presentations;
- Site visits.

The information gathered from the candidate HRT processes is summarized in Table 4, with brief description of the HRT technologies provided below.

From the information collected, The City and their Design Professional have selected two manufactures, Kruger-Veolia and Infilco Dgrement, to perform a side by side pilot study at the Lakewood WWTP. However, Infilco Degremenot, Inc. has declined participation in the pilot study due to the piloting unit unavailability. Therefore, only ACTIFLO/BIOACTIFLO High Rate Treatment system, presented by Kruger-Veolia manufacturer was piloted at the Lakewood WWTP.

3.1.1 Ballasted Flocculation using Sand Medium (ACTIFLO/BIOACTIFLO)

The ACTIFLO® process is a high-rate chemical and physical clarification process that involves the formation of suspended solids onto a ballast particle (microsand) followed by lamellar settling. It allows solids to settle out more quickly, thereby requiring a smaller footprint than conventional clarification. BIOACTIFLO configuration is obtained by adding a contact tank ahead of the ACTIFLO unit.

3.1.2 Ballasted Flocculation using Magnetite Medium (COMAG/BIOMAG)

The COMAG™ process uses conventional chemical coagulation and flocculation along with the addition of finely ground magnetite as a ballasting agent. The dense magnetite significantly increases the weight and settleability of chemical flocs, resulting in high-rate sedimentation. Approximately 85 percent of the settled sludge is recycled to provide nucleation sites for floc development. Excess sludge is passed through a shear mill followed by a magnetic recovery drum to recover the magnetite before the nearly magnetite-free sludge is further processed. The recovered magnetite is returned to the process. BIOMAG™ is a similar process using magnetite addition directly to the activated sludge process to improve biological floc settleability.

3.1.3 High Rate Solids Contact Clarification (DENSADEG)

The DENSADEG® process is a high-rate chemical and physical clarification process that combines sludge ballasted clarification and lamella filtration. The DENSADEG® process starts with the addition of a coagulant to destabilize suspended solids. The flow enters the rapid-mix tank for flash mixing to allow the coagulant to take effect then overflows into the reactor tank where sludge and polymer are added.

3.1.4 High Rate Compressible Media Filter (WWETCO)

The WWETCO FlexFilter™ and Bio-FlexFilter™ use a synthetic fiber media bed that is passively compressed from the sides by the head of the incoming water. The lateral compression forms a cone-shaped porosity gradient that allows the stratification and removal of large and small particles from the top to the bottom of the media bed. The porosity gradient through the media bed, with its ability to handle heavy solids loading, gives the technology a wide range of uses: (a) produce a reuse quality effluent as a tertiary filter; (b) increase the organic removal capacity of the facility, and/or reduce its power consumption; and, (c) treat excess wet-weather flow including biological treatment, as appropriate.

3.2 DESCRIPTION OF THE HIGH RATE TREATMENT TECHNOLOGY

3.2.1 ACTIFLO® Process Description

ACTIFLO® is a high performance and compact clarification system that uses micro-sand ballasted flocculation and settling (Figure 1). In this process, a coagulant is added to the influent wastewater before entering the coagulant tank. From the coagulation tank, wastewater overflows into the maturation tank where micro-sand and polymer are added. The micro-sand acts as ballast by providing a large surface area, enhancing the settling of the agglomerated particle. The destabilized suspended solids will bind to the microsand particles via polymer bridging. High mixing energy from the draft tube surrounding the maturation mixer enhances coagulation of the newly formed floc particles. These floc particles agglomerate and grow into high density, microsand ballasted floc. The flocculated particles then flow with the surrounding water under the stilling baffle of the maturation tank into the settling tank.

In the settling tank, the flocculated sludge settles to the individual lamella plates. From there they move down to discharge to the bottom of the clarifier. The capacity of the settling tank is further enhanced by the use of inclined lamella plates. The ballasted sludge collected at the bottom of the settling tank is pumped to hydrocyclones. In the hydrocyclone, the sludge is separated from the microsand by the centrifugal force. From here, the recovered clean microsand is recycled to the maturation tank and the separated sludge is discharge continuously as the final sludge stream.

The following is a summary of benefits of this physical/chemical process as reported by the manufacturer:

- The process offers a high degree of flexibility since it has a short start-up time and reaches steady-state performance quickly.
- The high concentration of micro-sand and injection tank mixing intensity allows the process to handle sudden variations in flow and water quality (such as turbidity or temperature) without compromising effluent quality.
- Chemical (coagulant and polymer) feed can be adjusted to accommodate variations in feed water quality.

Due to the compact nature of this clarification and short hydraulic retention time (less than 10 min), the startup time is short and can accommodate fluctuations in flow rate quickly. Addition of microsand allows the process to handle sudden variations in turbidity, color and temperature.

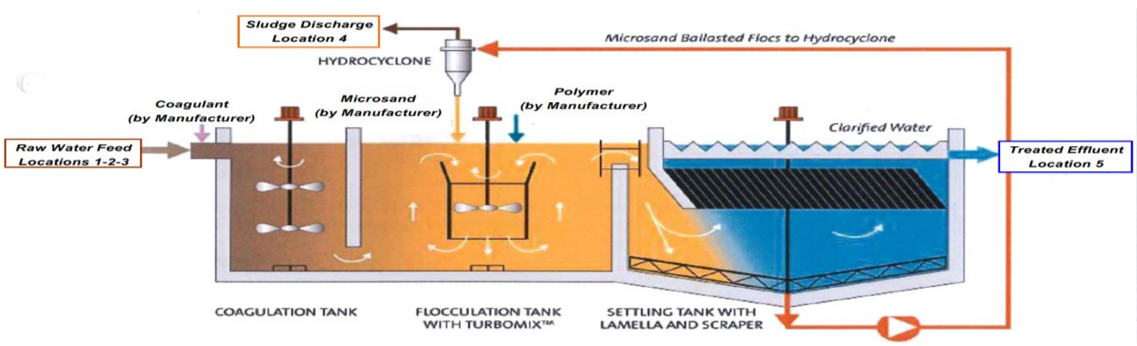

FIGURE 1: ACTIFLO® PROCESS FLOW DIAGRAM

Table ~~2~~4: Summary of the presented Chemically Enhanced HRT Technologies

Manufacturer	Foot Print, LxWxH, ft	Pretreatment Requirements	Effluent Quality	Chemicals required	Sludge Production & Concentrations	Pilot Plant Requirements	Seasonal Impact
Kruger/Veolia, ActiFlo BioActiflo	▪ 39'x 6.5' x 23' height	▪ Screen: 5/8"- required; ▪ Grit removal - recommended	▪TSS: 50-10 mg/L (85-95% removal); ▪BOD: 10-40 mg/L (40-60% removal); ▪UV will work.	▪ Coagulants: Alum & Ferric based; ▪ HMW anionic polymer; ▪ Sand	▪ Sludge Production 5% of the influent flow; ▪ Solids Concentration - 0.2-0.6%	▪ Trailer: 53'x8'x 13.5' ▪ Contact Tank: 6,000 gal ▪ Actiflo 150 amps + 60 amps for Contact Tank; ▪ Capacity: 202-310 gpm ▪ 2-4 gpm potable water	▪ During dry weather: 20 min. every 2 weeks; ▪ During winter: run some flow through the HRT system or heated mixers to mitigate freezing.
Evoqua, CoMag™ & BioMag™	▪ Tanks, total of 2, each: 17.5'x 17.5'x 17.5' ▪ Clarifier: ø45-ft or Lamella Clarifier 27'x 27'	▪ Screen: 1/2"- required; ▪ Grit removal - required	▪TSS: ~ 80% removal; ▪BOD: 56% removal; ▪UV capable.	▪ Coagulant: Alum (2 mg/L), $FeCl_3$; ▪ Dry polymer (1 mg/L)	▪ TSS 19,000 lb/day ▪ Solids Concentration: 1.5 - 2.0%	▪ Trailer mounted ▪ 10-15% of clarifier underflow is returned to mixing chamber	-
Infilco Degremont, DensaDeg & DensaDeg XRC	▪ Tanks, 2 units, each: 59' x 55' x 6.5'	▪ Screen: 1/2"- required; ▪ Grit removal - recommended	▪TSS: 80-90% removal; ▪BOD: 10-40 mg/L (40-60% removal); ▪UV with < 30/30 effluent.	▪ Alum 30-40 ppm or ferric ▪ Polymer 1-2 ppm	▪ 2% sludge for alum; ▪ Produces 6-10 times less sludge than ballasted system.	▪ Trailer: 54' x 9' x 25' (H) ▪ Capacity:150 -275 gpm, ▪ Power: 90 amps ▪ Lab testing & basic monitoring.	No performance impact - mixer speeds/increase polymer - equipment pumps in controlled environment
WWETCO, FlexFilter™ & Bio-FlexFilter™	▪ 5 cells - 3' W x 30' L ▪ 108' L x 62'W x 15" H ▪ 5 cells with 3 bladders each @ 540 SF each cell	▪ Screen: 1/2"- required;	▪TSS: ~ 80% removal; ▪BOD: 38% removal); ▪ UV capable	▪ Disinfection	▪ 4 mgd @ 1,400 mg/l TSS	▪ 10 gpm / sf. @ 30 gpm ▪ Power: 120/240/1-ph	None

3.2.2 BIOACTIFLO™ Process Description

The BIOACTIFLO® process (Figure 2) is a high-rate treatment process that combines biological treatment with the ACTIFLO® ballasted flocculation high-rate clarification process described in the previous section. Biological treatment is provided by a solids contact basin which is used ahead of the ACTIFLO® high rate clarification. This basin has a short hydraulic retention time (20 min) and a lower mixed liquor suspended solids (MLSS) concentration than conventional aeration basins. Biomass in the return activated sludge (RAS) is pumped here so that the microorganisms in the RAS can contact the soluble biochemical oxygen demand (sBOD) in the influent. The target concentration of MLSS in the contact basin is maintained by using a portion of the RAS stream in addition to concentrated sludge from the ACTIFLO® high-rate clarification process.

The MLSS is aerated for rapid BOD uptake by the biomass. From the contact tank, wastewater flows to the ACTIFLO process. The result is a process that provides high removal efficiency of BOD as well as suspended solids, thereby achieving biological treatment of excess flows while preserving the integrity of plant processes and mitigating washout of biomass.

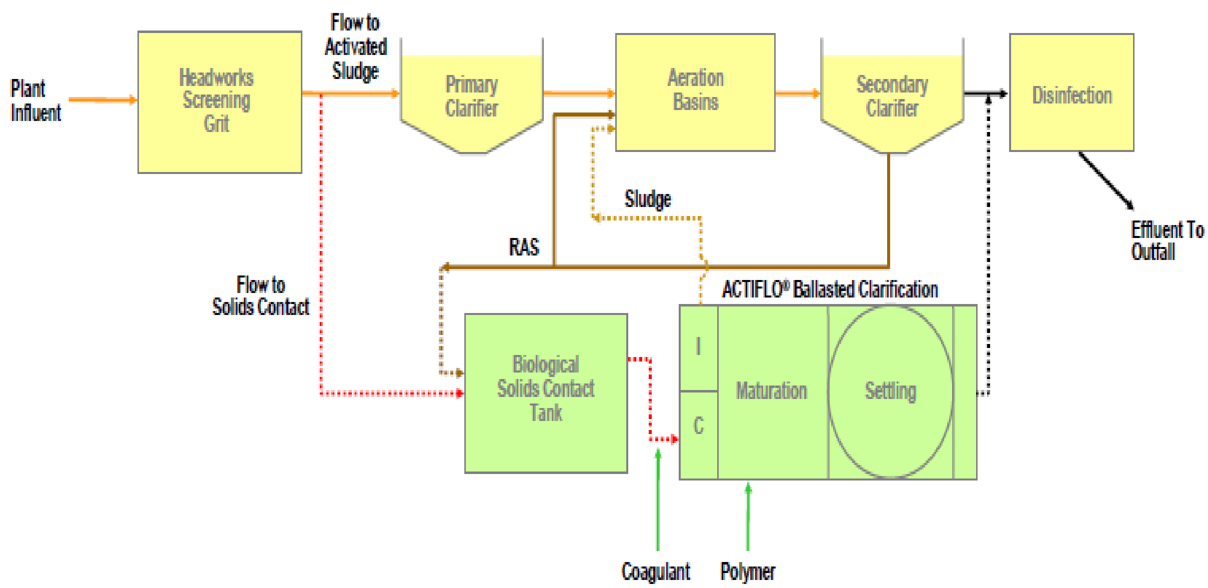

FIGURE 2: BIOACTIFLO™ PROCESS FLOW DIAGRAM

3.3 COMPARISON OF ACTIFLO® AND CONVENTIONAL TREATMENT

The primary difference between conventional clarifier and sand-ballasted high rate settling technology of ACTIFLO are as follows:

a. Smaller footprint and basin requirements: Surface overflow rates of the ACTIFLO process are 25 to 41 times greater than for conventional primary clarification. The higher loading rates significantly decrease basin volume and surface area requirements.

b. Ability to compensate for influent variability: Due to the high concentration of micro-sand relative to influent particulates, the ACTIFLO process has the ability to accommodate variations in flow and influent quality without compromising effluent quality.

c. ACTIFLO and BIOACTIFLO process performed better than conventional primary clarification in terms of measured CBOD and TSS removal efficiencies.

d. Capital cost to treat a unit volume of wastewater with ACTIFLO and BIOACTIFLO is significantly higher than that of the conventional primary clarifier.

b. The ACTIFLO process requires much less space than primary clarifiers.

4.0 PILOT TESTING

4.1 PILOT PLANT LAYOUT

The container system for an ACTIFLO/BIOACTIFLO pilot unit, supplied by Kruger/Veolia (HRT vendor), consisted of a self-contained tractor trailer as shown in Figure 3. The pilot unit was located on the asphalt strip between the aeration tank train and the primary clarifiers as shown in Figure 4. Submersible pumps were dropped into the channel before and after the primary clarifier as sources to pump influent to the pilot unit.

The ACTIFLO unit, both in regular as well as biological mode of operation was operated from 180 – 210 gpm. These flow rates yielded hydraulic retention times between 0.96 and 1.12 minutes, respectively, in the coagulation tanks 1 and 2. Coagulant was dosed inline into the 4-inch influent pipe inside the trailer followed by a static mixer before entering the first mixing tank (coagulation tank) of the process. Polymer was dosed into the maturation tank. The maturation tank blade used was a 110° pitched hydrofoil blasé to increase mixing energy within the draft tube. The coagulation and injection mixers as well as the maturation mixer were run at 100%.

FIGURE 3: ACTIFLO®/BIOACTIFLO® PROCESS SETUP

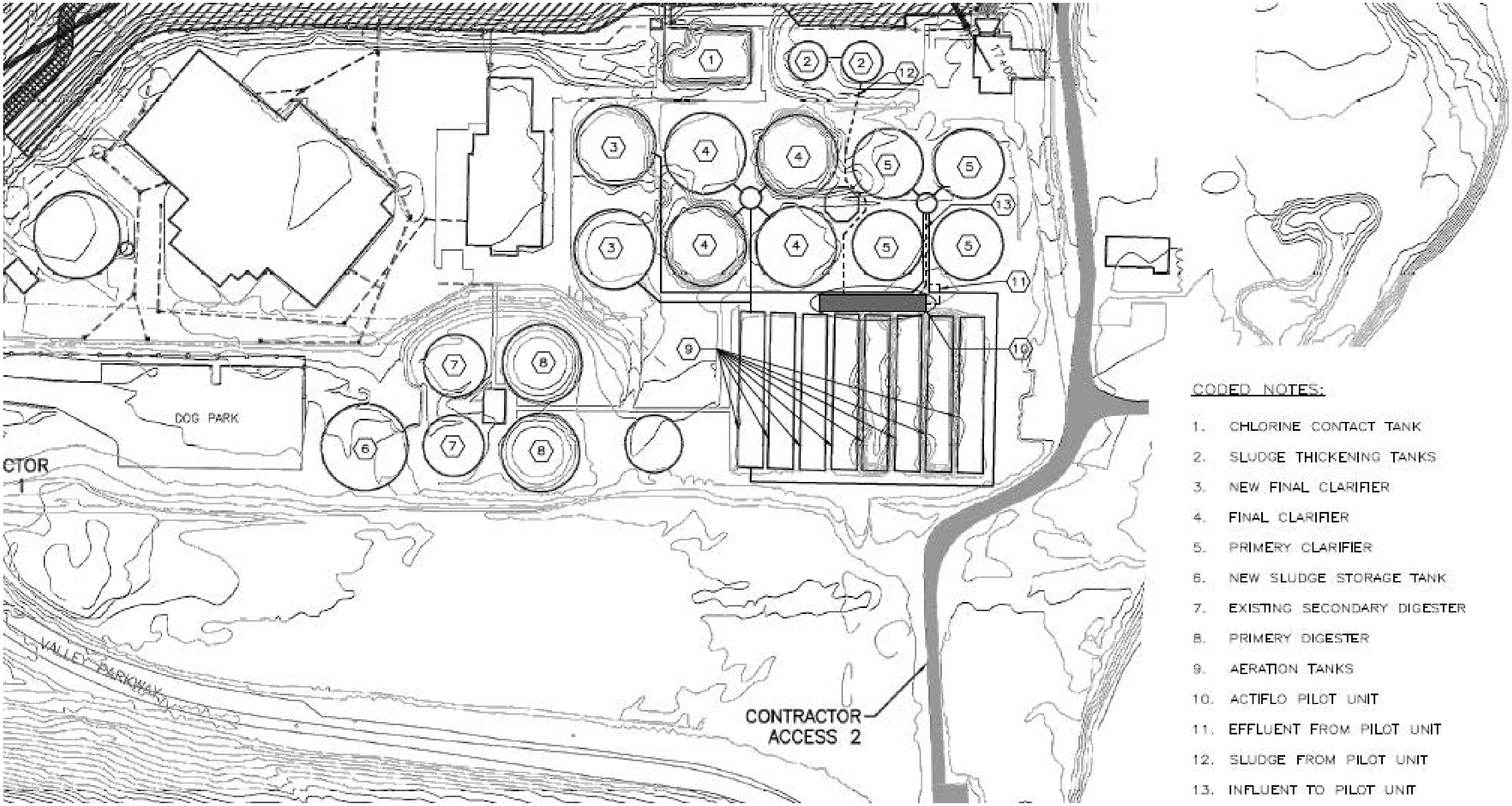

FIGURE 4: PILOT PLANT LOCATION

CT Consultants
engineers | architects | planners

4.2 ACTIFLO® PILOT UNIT DESCRIPTION

ACTIFLO® pilot unit can be used for simulating regular ACTIFLO® process or BIOACTIFLO® by adding a contact tank before the pilot unit. Details on the pilot unit are provided in Table 5.

Table 5: ACTIFLO® and BIOACTIFLO™ Pilot Unit Specification

Parameter	Unit	Value
Coagulation Tank – 1		
Volume	Gal	200
Length	In.	30
Height	In.	53
Width	In.	29
Coagulation Tank – 2		
Volume	Gal	207
Length	In.	30
Height	In.	53
Width	In.	30
Maturation Tank		
Volume	Gal	596
Length	In.	46
Height	In.	53
Width	In.	56
Settling Tank		
Volume	Gal	473
Surface Area	Ft^2	5.8
Krebs Hydrocyclone		
Recirculation Rate	GPM	21
Overflow/Sludge	GPM	16.8
Underflow/Sand Slurry	GPM	4.2
Contact Tank		
Volume	Gal	5,485
Length	In.	75.8
Height	In.	55
Width	In.	60

Hydraulic detention times available in each section of the pilot unit at various influent flow rates are summarized in Table 6.

Table 6: ACTIFLO® Pilot Unit Hydraulic Retention Times

Flow Rate (gpm)	Recirculation Rate (gpm)	Rise Rate (gpm/ft^2)	Coagulation Zone 1 (min)	Coagulation 2 (min)	Maturation (min)	Settling (min)	Total HRT (min)
202	21	32	0.99	1.02	3.03	2.43	7.48
190	21	60	1.05	1.09	3.23	2.58	7.95

4.3 COAGULANT CHEMICAL DATA

Coagulants evaluated during the pilot study were as follows:

- Sodium Aluminate, $NaAlO_2$: 32% w/w, active S. G. = 1.33
- Aluminum Sulfate, $Al_2(SO4)_3 \cdot 14H_2O$: 48% w/w, S. G. = 1.33
- Polyaluminum Chloride , $Al_2(OH)_xCl_{6-x}$: 30% w/w, S. G. = 1.37

4.3.1 Coagulant Limitation – Non Ferric

ACTIFLO/BIOACTIFLO units have been reported to perform very well when aluminum and iron based coagulants were used at optimum concentrations. However, ferric or ferrous ions are not to be used in the pilots because of their incompatibility with the type of diffusers installed at LWWTP.

The coagulants selected for testing in the pilot study were aluminum based. Among them, sodium aluminate has been currently used by the LWWTP as coagulant in the primary clarifier.

4.4 POLYMER TYPE INFORMATION USED FOR PILOT STUDY AND ITS COMPATIBILITY

Three types of dry, anionic polymers, manufactured by Crown Solution were evaluated during the pilot study. The dry polymer was made up as 0.3% w/w solution (3 g/L). These polymers are:

- Hydrex 3502
- Hydrex 3596
- Hydrex 3572

The polymer current used at the LWWTP for dewatering sludge on belt filter presses is dry cationic type, CLARIFLOC CE-1040, by Polydyne, Inc. If ACTIFLO sludge is co-settled in the primary clarifier, no significant interaction between the current polymer and those to be tested during pilot study is noticed.

4.5 MICROSAND DATA

The microsand utilized during the pilot study was #65 (effective size 134 um, uniformity coefficient of 1.69) manufactured by Manlet Brothers of Indiana, Inc.

The microsand concentration was measured every day to ensure the designed microsand concentration was retained in the system. The recycle rate is typically designed for a flow rate of 10 – 17% of the ACTIFLO® process influent, depending on the application. The hydrocyclone splits the influent slurry with approximately 20% returning to the system (underflow) and 80% exiting as sludge (overflow). Ideally, the 20% is limited to sand recycle.

Sampling is performed using a graduated cylinder to capture one liter of underflow from the hydrocyclone apex (Figure 5). The micro-sand should be allowed to settle out in the cylinder for 60 seconds. Once settled, the volume of sand (settled) is measured. The concentration of microsand is calculated using the bulk density of microsand (1.77 g/mL), the volume of microsand that settled out in the cylinder, and the total sample volume. The ACTIFLO® process influent and hydrocyclone influent flow rates are also needed for calculating the microsand concentration as shown in Equation 1:

$$C = \frac{V_S}{V_T} * \frac{Q_R}{Q_I} * \frac{X}{100} * 1.77$$

Eq. 1

where,

C – Microsand concentration, g/mL
V_S – Volume of settled microsand after 60 seconds, mL
V_T –Tank sample volume, L
Q_R – Hydrocyclone flow rate, gpm
Q_I – Influent flow rate, gpm
X – Recycle percentage, % (if 20%, then X= 20)
1.77 – Bulk density of microsand, g/mL

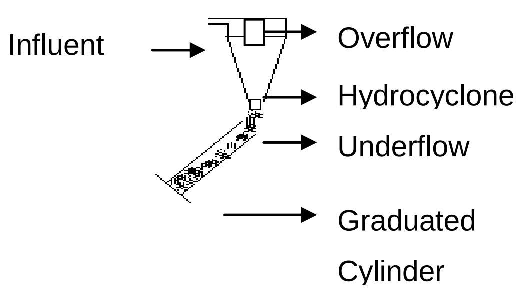

Figure 5: Schematic of Hydrocyclone and Sampling Location

4.6 CHEMICAL DOSE CALCULATIONS

All chemical dosages are determined by performing the drawdowns on calibration columns attached to feed tubing. A drawdown is the measured volumetric flow rate of the chemical being dosed into the system. Drawdowns (mL/sec) require an accurate measuring column and a stopwatch. With the chemical in the column, the chemical is drawn out at the desired pump speed for at least 1 minute (the longer the drawdown, the more accurate the calibration).

4.6.1 Coagulant Dose

The coagulant dose takes into account the percent activity and the density of the compound. The ACTIFLO® process influent flow rate (gal/hr) and the measured drawdown (mL/sec) are also needed in the calculation. The coagulant dose rate is calculated using Equation 3:

$$X_C = \frac{C}{100} * \rho * \frac{1000mg}{g} * \frac{Q_C}{Q_I} * \frac{3600\ sec}{hour} * \frac{1\ gal}{3.785\ L} \qquad \text{Eq. 3}$$

Where:

X_C – Coagulant dose, mg/L

C – Activity of coagulant, % (if 30%, then C = 30)

ρ - Density of coagulant, g/mL

Q_C – Coagulant feed rate, mL/sec

Q_I – Influent flow rate, gal/hr

4.6.2 Polymer Dose

First, the concentration of the batched polymer has to be calculated. This is done on either a mass or volume basis. For example, if the polymer is prepared by mixing 3 grams of dry polymer or 3 mL of emulsion per one liter of water, then the resulting polymer concentration is 0.3%. In order to calculate the polymer dose the drawdown (mL/min) and the influent flow rate (gal/hr) are needed. The polymer dose rate is calculated using Equation 2 below:

$$X_P = C * \frac{1000mg}{g} * \frac{Q_P}{Q_I} * \frac{3600\ sec}{hour} * \frac{1\ gal}{3.785\ L} \qquad \text{Eq. (2)}$$

Where:

X_P – Polymer dose, mg/L

C – Concentration of polymer solution, g/L

Q_P – Polymer feed rate, mL/sec

Q_I – Influent flow rate, gal/hr

4.6.3 Mols of Metal Dosed per Mol of Phosphorus Removed

The mols of metal dosed per mol of prhosphorus removed is a function of sludge recycle and non-sludge recycle samples. The ratio is calculated using Equation 4:

$$\frac{\frac{C_I * X}{MW_M}}{\frac{C_{Pinf} - C_{Peff}}{MW_P}} = \frac{mol\ metal\ dosed}{mol\ P\ removed} \qquad \text{Eq. 4}$$

Where:

C_I – Coagulant dose, mg/L

MW_M – Molecular weight of metal ion, g/mol

C_{Pinf} C_{Peff} – Amount of P removed, mg/L

MW_P – Molecular weight of P, g/mol

X – Conversion factor for metal ion weight Vs. coagulant weight:

$$X\ for\ aluminum\ sulfate:\ 0.0908 = \frac{molecular\ weight\ of\ Al_2}{molecular\ weight\ of\ Al_2(SO_4)_3 \cdot 14H_2O}$$

$$X\ for\ sodium\ aluminate:\ 0.6576 = \frac{molecular\ weight\ of\ Al_2}{molecular\ weight\ of\ NaAlO_2}$$

$$X\ for\ polyaluminum\ chloride:\ 0.309 = \frac{molecular\ weight\ of\ Al_2}{molecular\ weight\ of\ Al(OH)_n Cl_6 - n \cdot XH_2O}$$

4.7 FIELD INSTRUMENT CALIBRATIONS

Calibrations of the field instruments were conducted accordingly to the following procedure (Table 7):

a. The bench top turbidity meter (Hach model 2100N) was calibrated using the Stabcal method found on pages 20 – 23 of the Hach manual for 2100N
b. Bench top pH meter (Orion 3-Star) was calibrated using the recommended method on page 19 of the Manual for Bench top pH/ISE meters; this is a three point manual calibration buffer method.
c. The online pH meters (GLI International, model 53P) were calibrated using the recommended method in Sections 5.2 on pages 58-67 of the instruction manual.

d. The online influent/effluent turbidity meters, TSS meter and DO probes (SOLITAX) were calibrated using the recommended calibration method, which can be found on pages 37-39 of the Hach Company Manual for SOLITAX sc turbidimeters.

Table 7: Pilot Unit Field Testing Instruments and Methods

Parameter	pH	Alkalinity (mg/L as $CaCO_3$)	Turbidity (NTU)	UV_{254}
Instrument	Orion 3-Star	Test kit, model AL-AP	Hach 2100N	RealTech P200 TOC analyzer
Method	Epoxy body refillable pH/ATC triode	Drop count titration with sulfuric acid	US EPA method 180.1	Hach method 10054

e. The portable UV_{254} meter was calibrated using the recommended Hach method 10054. UV_{254} is a measure of ultraviolet absorption at a wavelength of 254 nm. This parameter is a surrogate measure for natural organic matter present in water. One of the benefits of monitoring UV254 is that it is an important factor in identifying the "optimal" coagulant dose.

4.8 DAILY STARTUP AND SHUTDOWN PROCEDURE

During the pilot testing period, the pilot unit was operated on a continuous mode for 8 – 9 hours a day. In general, daily startups consisted of manually starting process equipment and instruments and verifying the metering accuracy of the chemical feed pumps.

Shutdown consisted of reversing the startup procedure and allowing the sand pump to run for a period of ten minutes after all the equipment had been shutdown to remove sand from the settling tank hopper.

4.9 SAMPLING SCHEME

Samples were split and sent for analyses in two different external labs except for E. coli analyses. Samples collected were divided into two containers and sent one each to CWM laboratory and WLI laboratory for analyses. E. coli analyses were performed by WLI Laboratories only.

Testing parameters analyzed as part of the pilot testing, and the corresponding reference methodologies are summarized in Table 8. The following overall sampling approaches were implemented during the pilot testing:

1. During storm events or simulated storm related flow conditions, grab samples were taken from the influent and effluent streams, once every 30 to 60 minutes;
2. During dry weather flow conditions, grab samples were taken as described for the storm conditions. However, the samples were composited. The decision on whether or not to composite the samples were made by the pilot unit operator based on the influent flow to LWWTP and the influent turbidity values recorded at the time of sampling.

Table 8: Testing Methodology and Sample Type for Core and Supplemental Parameters

Parameter	Reference or Methodology	Influent	Effluent	Dry Weather	Storm Weather
TSS	EPA 160.2 / SM 2540 D	X	X	C	G
VSS	EPA 160.4		X	C	G
$CBOD_5$	EPA 405.1 / SM 5210 B	X	X	C	G
E. coli	EPA 1603	X	X	C	G
pH[(a)]	EPA 150.1	X	X	C	G
Temperature[(a)]	EPA 170.1	X		C	G
Turbidity[(a)]	EPA 180.1 / SM 2130 B	X		C	G
Alkalinity	EPA 310.2	X		C	G
UV Transmittance			X	C	G
Phosphorus	EPA 365.1	X	X	C	G

Notes:

(a) In-line analysis with instruments.

C – Composite sample

G – Grab sample

In-line monitoring (for pH, temperature and turbidity) and sampling was provided. The pilot plant operator took readings from the in-line monitoring.

Flow monitoring of influent and final effluent was carried out continuously. The flow totalizers were provided for influent flow and RAS flow. Details of the flow monitoring methods, calibration procedures, and the data analysis, evaluation and QA/QC procedures were documented by the pilot operator.

5.0 PILOT TESTING – CHEMICAL DOSAGE OPTIMIZATION

Chemical optimization tests were performed on the influent with various coagulant and flocculent chemicals in order to understand their ability to remove suspended solids. Suspended solids concentrations in the raw and treated samples were analyzed by measuring their turbidity because it is instantaneous. In order to understand how well the turbidity values can be related to their TSS, TSS analytical results from the two external laboratories were compared with the corresponding turbidity values for various samples (Figure 6).

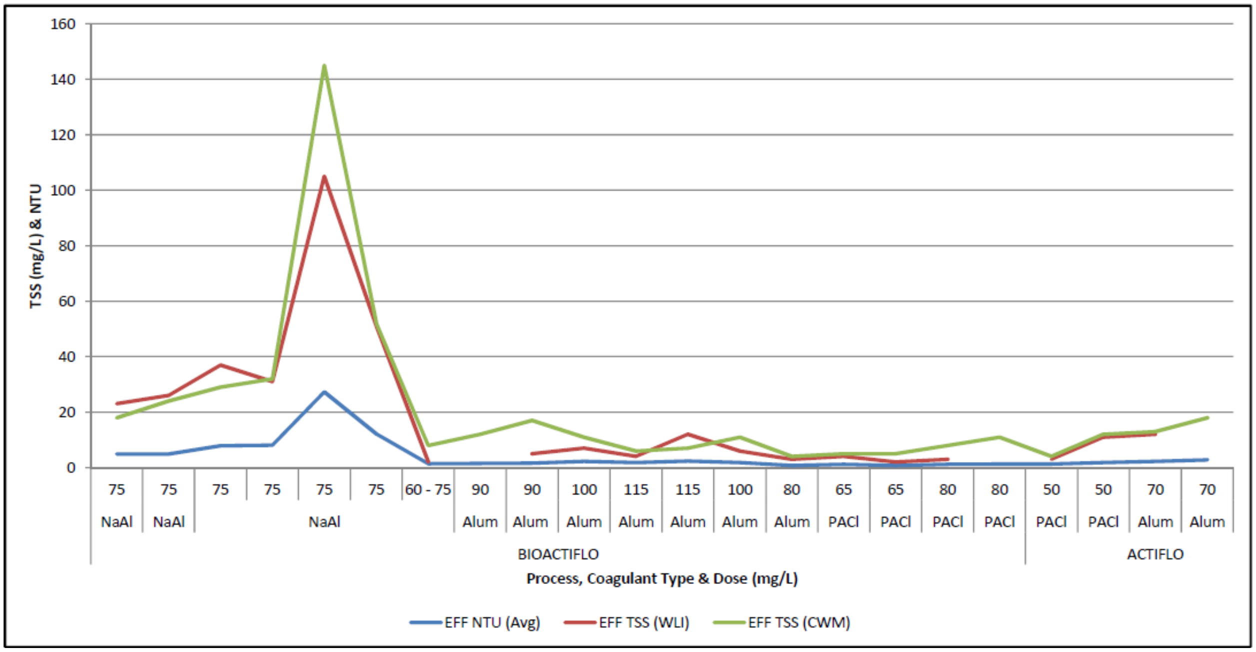

Figure 6: Turbidity and suspended solids values from Pilot Effluent Samples

It must be noted that TSS analysis was completed only on composite samples. Since composite NTU data were not collected, grab sample NTU values were averaged and compared with TSS. The data from the pilot shows a ratio of 4.4-5.0 mg/L TSS to 1 NTU comparing both outside lab data.

5.1 BIOACTIFLO®

After the initial setup, the pilot unit was operated in BioACTIFLO mode during the first phase of testing. For the first two days, testing was performed to optimize coagulant dose and polymer dose before testing rise rate. Optimal condition for mixed liquor suspended solids (MLSS) concentrations, contact tank retention times, and ACTIFLO® hydraulic loading rates were set based on the pilot plant operator experience. Continuous runs were performed using sodium aluminate, alum, and polyaluminum chloride at varying polymer and MLSS concentrations.

Sodium aluminate ($NaAlO_2$) was selected as a candidate coagulant because (a) it is being used by the WWTP, and (b) ferric or ferrous based coagulants are not compatible with the type of diffusers at the WWTP. Aluminum sulfate ($Al_2(SO_4)_3$)and Polyaluminum Chloride (PACL) were selected as the other non-ferrous coagulants. The BIOACTIFLO™ was operated while the plant was experiencing CSO wet weather events. Operating conditions and the results of samples collected during BIOACTIFLO™ testing are provided in the following sub-sections.

5.1.1 Sodium Aluminate

Initial testing of the BIOACTIFLO mode of pilot testing began on June 3, 2015 in order to develop optimization curves for the process chemicals and parameters. For this purpose, samples collected were analyzed by bench-top analytical instruments and in-line analyzers only. TSS is correlated to readings from in-line turbidity analyzers for the influent and effluent streams. CBOD removal is proportional to the amount of biomass it comes in contact with in the contact tank.

Varying doses of coagulants and polymer were tested to determine the minimum chemical doses required in order to achieve the effluent TSS and CBOD limits. This optimization step was repeated each time the MLSS concentration in the Contact Tank was changed (800 and 1,200 mg/L target concentrations were tested). As a coagulant, sodium aluminate was tested at dosages in the range of 55 to 90 mg/L. At the same time, dry anionic polymer Hydrex 3596 was used at doses ranging from 2.8 to 3.66 mg/L. Effluent samples were collected at the various conditions. The ACTIFLO® portion of the train was operated with a hydraulic loading rate of 32 gpm/ft^2. After each parameter change, NTU, UV_{254}, and visual observations were used as an onsite means of judging effluent quality. This field data provided fairly instant feedback and aided in parameter change decisions. Data from the optimization is outlined in Table 9.

For a contact tank MLSS concentration of 1200 mg/L, a dose of 75 mg/L sodium aluminate and 3.6 mg/L Hydrex 3596 polymer are most effective at reducing effluent turbidity to an optimal level. At a contact tank MLSS concentration of 800 mg/L, a slightly lower dose of both sodium aluminate and Hydrex 3596, 60 mg/L and 3.3 mg/L respectively, give the optimal effluent turbidity level. *The sodium aluminate reduced turbidity to an adequate level, but at the expense*

<u>*of pH increasing to above 8.5 in the effluent*</u>. After two days of optimization testing, the pilot unit was shifted to steady state run.

Table 9: BIOACTIFLO Sodium Aluminate Optimization Data (Kruger Lab Analysis)

Date	Time	Contact Tank		Coagulant	Polymer	pH		Turbidity		
		HRT (min)	MLSS (mg/L)	$NaAlO_2$ (mg/L)	3596 (mg/L)	Inf	Eff	Inf (NTU)	Eff (NTU)	Removal (%)
6/3/2015	13:45	21.6	**1,200**	60	2.8	7.76	8.50	36.7	12.7	65.4
	14:15	21.4		70		7.76	8.57	39.50	10.30	73.9
	14:45	22.1		80		7.81	8.64	41.70	9.09	78.2
	15:15	21.2		90		7.80	8.68	42.90	31.10	27.5
	15:45	21.2		75		7.79	8.56	43.10	39.20	9.0
	16:25	21.9			3	7.78	8.56	44.70	11.50	74.3
	16:45	21.6			3.2	7.77	8.58	45.50	9.86	78.3
	17:05	21.7			3.4	7.74	8.57	45.60	5.95	87.0
	17:25	21.3			3.6	7.74	8.56	45.40	5.53	87.8
6/11/2015	9:00	23.3	**800**	60	3.7	7.67	8.84	48.90	5.57	88.6
	9:30	23.2			3.5	7.70	8.84	35.60	5.16	85.5
	10:00	23.6			3.3	7.60	8.82	259.00	5.34	97.9
	11:00	22.4		55	3.5	7.79	8.78	91.40	6.69	92.7
	12:00	22.5		65		7.86	8.79	57.80	6.05	89.5
	12:30	23.0		70		7.82	8.84	39.20	5.82	85.2

5.1.2 Aluminum Sulfate

BIOACTIFLO™ pilot testing with aluminum sulfate began on Monday June 15th, 2015. During the optimization testing with aluminum sulfate, MLSS concentrations of 400, 800 and 1200 mg/L were maintained in the contact tank. Aluminum sulfate was used as coagulant and tested at doses ranging from 70 - 110 mg/L. After testing various doses of alum, anionic polymer Hydrex 3596 was tested with doses ranging from 3.0 – 5.0 mg/L. After testing each combination of alum and polymer doses, samples were collected and tested in Veolia lab. The ACTIFLO® portion of the train was operated with a hydraulic loading rate of 32 gpm/ft^2. After each parameter change, NTU, UV_{254}, and visual observations were used as an onsite means of judging effluent quality. This field data provided fairly instant feedback and aided in parameter change decisions. Data from the optimization is outlined in Table 10. The results of this testing presented below:

a. At a contact tank concentration of 800 mg/L: A dose of 90 mg/L of aluminum sulfate and and 3.7 mg/L of Hydrex 3596 polymer was most effective at reducing effluent turbidity to an optimal level.

b. At a contact tank concentration of 1200 mg/L: A slightly higher dose of both aluminum sulfate and Hydrex 3596 , 100 mg/L and 5.0 mg/L respectively, gave the optimal effluent turbidity level. Hydrex 3596 polymer was most effective at reducing effluent turbidity to an optimal level.

c. At a 400 mg/L contact tank concentration: An aluminum sulfate dose of 90 mg/L and a Hydrex 3596 polymer dose of 3.0 mg/L gave an optimal effluent turbidity.

Table 10: BIOACTIFLO™ Aluminum Sulfate Optimization Data

Date	Time	Contact Tank		Coagulant	Polymer	pH		Turbidity		
		HRT (min)	MLSS (mg/L)	Alum (mg/L)	3596 (mg/L)	Inf	Eff	Inf (NTU)	Eff (NTU)	Removal (%)
6/15/2015	14:15	22.9	800	70	3.7	7.65	6.72	103.00	1.78	98.3
	14:55	24.4		80		7.43	6.74	96.90	1.53	98.4
	15:25	30.3		90		7.63	6.61	94.70	1.07	98.9
	15:55	31.2		100		7.23	6.50	86.60	1.03	98.8
	16:25	21.2		110		7.43	6.57	87.70	1.53	98.3
6/18/2015	8:45	20.4	1,200	90	3.6	7.72	6.81	27.90	1.53	94.5
	9:15	20.4		100		7.74	6.88	29.40	4.53	84.6
	9:45	20.1		90	3.8	7.63	6.93	36.30	21.10	41.9
	11:00	20.9		100	5	7.64	6.89	36.90	1.62	95.6
6/24/2015	9:20	23.1	400	90	3.2	7.58	6.85	26.50	1.77	93.3
	9:40	22.4			3.3	7.57	7.00	36.20	2.54	93.0
	10:00	22.7			3	7.61	6.97	41.20	2.05	95.0
	11:30	22.5		100	3.4	7.60	6.85	33.10	2.27	93.1
	11:50	22.4			3.6	7.60	7.08	31.70	2.58	91.9
	12:10	22.6			3.2	7.63	6.99	32.20	1.99	93.8
	12:30	22.6			3	7.59	6.92	31.30	1.74	94.4

During optimization testing, the effluent turbidity averaged 3.2 mg/L with a standard deviation of 4.9 mg/L. This high standard deviation was caused by the turbidity value of 21 mg/L measured in the sample collected on June 18th, from testing with 1,200 mg/L MLSS, 90 mg/L alum and 3.8 mg/L polymer. This data point is considered an outlier because it is more than three standard deviations farther from the mean effluent turbidity value. This high value can be due to an error in reporting of the results or due to sample contamination.

After the completion of the optimization tests, dose-performance curves developed from the optimization test results were used to perform steady state operation at the desired contact tank concentration.

5.1.3 Polyaluminum Chloride (PACL)

BIOACTIFLO™ pilot testing with PACL began on Friday June 26th, 2015 with the generation of coagulant and flocculent dose based optimization plots. During optimization testing with PACL, a MLSS concentration of 800 mg/L was targeted in the contact tank. PACL was used as coagulant and tested at doses ranging from 50 - 80 mg/L. Dry anionic polymer Hydrex 3596 was used at a dose of 3.6 mg/L, and samples were collected. The ACTIFLO® portion of the train was operated with a hydraulic loading rate (HLR) of 32 gpm/ft^2. After each parameter change, NTU, UV_{254}, and visual observations were used as an onsite means of judging effluent quality. This field data provided fairly instant feedback and aided in parameter change decisions. Data from the optimization is outlined in Table 11.

Table 11: BIOACTIFLO™ Polyaluminum Chloride Optimization Data

Date	Time	Contact Tank		Coagulant	Polymer	pH		Turbidity		
		HRT (min)	MLSS (mg/L)	PACL (mg/L)	3596 (mg/L)	Inf	Eff	Inf (NTU)	Eff (NTU)	Removal (%)
6/26/2015	9:00	22.0	**800**	50	3.6	7.57	6.62	16.40	1.48	91.0
	9:30	22.0		60		7.65	6.84	16.30	1.20	92.6
	10:00	22.0		70		7.67	6.71	19.50	1.20	93.8
	11:00	21.3		80		7.65	6.74	21.60	2.81	87.0

A contact tank concentration of 800 mg/L, a dose of 70 mg/L PACL, and 3.6 mg/L Hydrex 3596 polymer were found to be the most effective at reducing effluent turbidity to the optimal level. The days following creation of the optimization curves were used to perform steady state operation at the desired contact tank concentration.

5.2 ACTIFLO®

During the second portion of the pilot study (July 7th – 14th) the RAS flow was cut off and the system was operated as an ACTIFLO® process. Coagulant and polymer doses were varied throughout the week to provide a wide range of data. Hydrex 3596 polymer was compared to Hydrex 3502 and aluminum sulfate and PACL were tested as coagulants. A summary of operating conditions and the results of samples collected during ACTIFLO™ pilot testing can be found in the subsections below.

5.2.1 Aluminum Sulfate ($Al2(SO_4)_3$) and Polyaluminum Chloride Optimization (PACL)

After initial operation of the pilot unit as BIOACTIFLO®, the ACTIFLO® pilot testing began on Tuesday July 7, 2015. A few days of testing was dedicated to varying chemical doses to determine the best operating parameters for meeting the TSS and CBOD effluent goals. During this period of testing the following ACTIFLO® parameters were used:

- Hydraulic loading rate was 60 gpm/ft^2
- PACL was dosed from 40 – 60 mg/L
- Aluminum sulfate was tested at 60 – 70 mg/L
- Hydrex 3596 and Hydrex 3502 polymers were tested at doses from 1.0 – 2.0 mg/L.

A summary of results from samples collected during the optimization of ACTIFLO® testing is presented in Table 12.

Table 12: ACTIFLO™ Aluminum Sulfate and Polyaluminum Chloride Optimization Data

Date	Time	Coagulant (mg/L)	Polymer (mg/L)	pH Inf (s.u.)	pH Eff (s.u.)	Turbidity Inf (NTU)	Turbidity Eff (NTU)	Turbidity Removal (%)
1. PACL			**3596**					
7/7/2015	9:45	50	1.2	7.67	6.88	30.60	1.37	95.5
	10:15	45		7.65	7.10	27.50	1.59	94.2
	10:45	40		7.60	7.08	29.30	1.88	93.6
	11:15	55		7.62	6.80	31.10	1.42	95.4
	11:45	60		7.63	6.84	33.00	1.36	95.9
	13:15	50	1.1	7.58	7.00	35.30	1.59	95.5
	13:45		1.0	7.58	6.94	40.40	2.10	94.8
	14:15		1.3	7.50	7.02	41.60	2.25	94.6
2. PACL			**3502**					
7/9/2015	9:00	50	1.2	7.29	6.62	53.00	1.12	97.9
	9:30		1.3	7.40	6.87	49.60	1.27	97.4
	10:00		1.4	7.21	6.79	54.30	1.24	97.7
	10:30		1.1	7.42	7.17	43.50	2.01	95.4
	11:15		1.2	7.27	7.13	41.60	1.80	95.7
3. Alum			**3596**					
7/13/2015	12:00	60	1.2	7.46	6.82	51.70	2.21	95.7
	12:30	70		7.43	6.87	44.10	1.30	97.1

During the optimization of ACTIFLO® testing the turbidity was used as a process control by the ACTIFLO operator. The conclusions based on the results presented in the table above are as follows:

a. The ACTIFLO system performance is not greatly affected by the type of the coagulant. Both coagulants, the PACL and aluminum sulfate, were found to reduce turbidity to an optimal level.

b. Hydrex 3596 and Hydrex 3502 were both extremely effective at reducing the turbidity. Hydrex 3502 allowed more carry over compared to Hydrex 3596. The Hydrex 3502 is a lower molecular weight polymer than Hydrex 3596. When there is a sudden fluctuation in solids through the ACTIFLO® process, the Hydrex 3596 performs more effectively.

c. Dosages of 50 mg/L PACL, 60 mg/L aluminum sulfate, and 1.2 mg/L Hydrex 3596 and Hydrex 3502 were found to be the effective at reducing turbidity to an optimal level.

6.0 PILOT TESTING - PERFORMANCE

6.1 BIOACTIFLO®

After completing the optimization testing with each of the three coagulants selected, steady-state tests were run with the corresponding coagulant. In the Contact Tank, MLSS concentration was targeted to be at 400, 800 and 1,200 mg/L for a certain number of days for each coagulant. During this steady-state run, samples were composited during dry weather events, and kept as grab samples during wet weather events. Samples were split and sent to two different laboratories for analysis, except for E. coli. For those parameters that were analyzed in two different laboratories, the result was expressed as the average.

The testing results for TSS, CBOD and phosphorus, when operated BIOACTIFLO in steady state mode with various coagulants are shown in Appendix A, 7-12, also summarized in Table 13 below.

Table 13: BIOACTIFLO Steady State Operation Results

Type of Coagulant	BIOACTIFLO Effluent Concentrations				
	TSS, mg/L	$CBOD_5$, mg/L	$sCBOD_5$, mg/L	Phosphorus, mg/L	E. Coli
Sodium Aluminate, $NaAlO_2$	21-52	9-13	4-9	0.37 -0.42	65 CFU/100 mL
Alum, $Al_2(SO_4)_3$	5-9	4-15	3-11	0.07-0.2	
PACL	2-4	5-11	4-9	0.07-0.09	

Following, is a summary of BIOACTIFLO steady state pilot testing results:

a. The NEORSD Consent Decree and NPDES permit requirements for TSS, CBOD and phosphorus effluent concentrations were met consistently with Alum and PACL coagulants.
b. The Alum and PACL coagulants resulted in very similar effluent concentrations.
c. All three coagulants were able to achieve effluent phosphorus below 0.5 mg/L under steady state continuous operation.
d. Sodium aluminate is the least effective coagulant.
e. The TSS removal rate was observed in the range of 50 to 95%. Refer to Appendix A, Figure 9.
f. The average amount of CBOD load removed by the BIOACTILO per unit mass of MLSS maintained in the Contact Tank is 0.20 ± 0.11 lb of CBOD per lb of MLSS. The relationship between the amount of influent CBOD removed and the amount of MLSS maintained in the Contact Tank is shown in Appendix A, Figure 14.

g. Effluent E. coli concentration in the effluent reached 312 CFU/100 mL on one occasion when sodium aluminate was used. Refer to Appendix A, Figure 23.

6.2 ACTIFLO

ACTIFLO® steady state testing, dosing PACL as coagulant, began on Wednesday July 8, 2015. The feed source was Primary Effluent, and PACL coagulant dosed at 50 mg/L and Hydrex 3596 polymer dosed at 1.2 mg/L. The hydraulic loading rate (HLR) was maintained at 60 gpm/ft^2. The second composite sample with PACL began on July 9, 2015, the PACL coagulant was dosed at 50 mg/L and Hydrex 3502 polymer was dosed at 1.2 mg/L.

The first effluent composite sample, with aluminum sulfate as the coagulant, began on Monday July 13th, 2015. The feed source was Primary Effluent, and aluminum sulfate coagulant and Hydrex 3596 polymer were dosed at 70 mg/L and 1.2 mg/L, respectively. The aluminum sulfate coagulant was dosed at 70 mg/L for the second day of continuous testing and 90 mg/L for the third day. The aluminum sulfate dose was varied due to changing influent conditions. Hydrex 3596 polymer was dosed at 1.2 mg/L on the second day and 1.5 mg/L on the third day. A full range of lab samples were taken, split and sent to the two third-party labs. The data from the five test runs (composite samples) can be found in Table 14 and also viewed on Appendix A, Figures 19-22.

Table 14: ACTIFLO™ Aluminum Sulfate and Polyaluminum Chloride Steady State Data

Date	Time	Coag't	TSS			$CBOD_5$			$sCBOD_5$			Phosphorus		
			Inf	Eff	RE	Inf	Eff	RE	Inf	Eff	RE	Inf	Eff	RE
7/8/15	11:45	PACL	298	11	96%	62.4	6.9	89%	11.3	6.8	40%	4.1	0.10	97%
7/9/15	15:30	PACL	37	4	89%	14.4	3.7	74%	5.7	4.1	28%	0.7	0.06	91%
7/13/15	15:30	Alum	16	12	25%	54.1	9.8	82%	15.9	7.6	52%	2.0	0.13	93%
7/14/15	11:00	Alum	83	13	84%	43.6	9.6	78%	12.1	6.2	49%	2.9	0.22	92%
	14:45	Alum	81	18	78%	20.5	13.5	34%	14.8	8.4	43%	2.6	0.19	93%

Note: RE –removal efficiency.

The testing results for TSS, CBOD, phosphorus, when operated ACTIFLO in steady state mode with various coagulants, are shown in Appendix A, Figures 19-21, and also summarized in Table 15 below.

Table 15: ACTIFLO Steady State Operation Results

Type of Coagulant	ACTIFLO Effluent Concentrations				
	TSS, mg/L	$CBOD_5$, mg/L	$sCBOD_5$, mg/L	Phosphorus, mg/L	E. Coli
Alum, $Al_2(SO_4)_3$	12-14	11-13	8-9	0.13-0.21	X CFU/100 mL
PACL	4-10	8-11	6-11	0.13-0.62	

Based on the overall summary of effluent data presented in Tables 14 and 15, obtained from ACTIFLO steady state pilot testing, the conclusions are drawn as follows:

a. The NEORSD Consent Decree and NPDES permit requirements for TSS, $CBOD_5$ and phosphorus effluent concentrations were met consistently with Alum and PACL coagulants.

b. The PACL and aluminum sulfate coagulants were effective and resulted in similar effluent concentrations for TSS, CBOD, and phosphorus.

c. Both aluminum sulfate and polyaluminum chloride were able to achieve effluent phosphorus below 0.7 mg/L under steady state continuous operation.

d. Observed TSS removal rate was ranging between 74 to 97%. Refer to Appendix A, Appendix A, Figure 20.

e. E. Coli samples were sent to WLI laboratory for analysis. The results of the composite samples taken are shown in in Table 16.

Table 16: E. Coli Sample Analysis Results

Date	E. coli (CFU/100 mL)		
	Raw	Inf. to UV	Eff. from UV
6/8/2015		770,000	23
6/9/2015		1,500,000	65
6/10/2015		2,500,000	310
6/16/2015	590,000	116,000	2
6/17/2015		170,000	12
6/22/2015		134,000	5
6/23/2015		17,740	4
6/24/2015		250,000	32
6/25/2015		260,000	20
6/29/2015		91,000	<1
6/30/2015		78,000	4
7/1/2015		35,000	16
7/6/2015		68,000	2
7/9/2015		11,610	8
7/13/2015		270,000	10
7/14/2015		1,070,000	20

During operation of the BIOACTIFLO® and ACTIFLO™ at the Lakewood WWTP, the effluent from the ACTIFLO® was passed through a portable UV system. Samples were taken before and after the UV unit for E. Coli analyses. The goal for removal is to achieve 126/100 mL E. coli (recreational season geometric mean) and 284/100 mL E. coli (rolling seven days of activation geometric mean).

The E. Coli reduction through the UV system, after being treated by both the ACTIFLO® and BIOACTIFLO™ processes, met the removal goal of 126/100 mL recreational season geometric mean for all but one of the samples taken (Appendix A, Figure 23). The 284/100 rolling seven day geometric mean was met over the entire duration of the study (Appendix A, Figure 24).

7.0 EVALUATION OF BIOACTIFLO AND ACTIFLO

7.1 DISCHARGE PERFORMANCE

Target performance goals and continuous run trial results at optimum chemical doses are summarized in Table 17. Values shown in Table 17 are based on an average of all continuous trials performed at optimum chemical doses. Total and soluble CBOD and TSS are included in the Table for comparison purposes.

Table 17: Effectiveness of Process to Achieve Performance Goals

Parameter	Unit	Target		Measured Performance		
		NEORSD	NPDES 7-day	Sodium Aluminate	Alum	PACL
BIOACTIFLO™						
Effluent $CBOD_5$	mg/L	<40	23	11.3±1.9	8.3±4.0	9.5±3.0
Effluent $sCBOD_5$	mg/L	N.E.	NA	6.7±2.0	6.0±3.3	7.3±2.9
Total $sCBOD_5$ removal	%	N.E.	NA	59.3	72.2	76.8
Effluent TSS	mg/L	<40	30	30±15	7.4±2.2	3.0±0.8
Effluent Total P	mg/L	N.E.	0.7	0.39±0.02	0.12±0.04	0.12±0.10
Effluent E. coli	CFU/100mL	<126[a]	<126	133±155	12.5±11.6	6.2±6.1
		<284[b]	<284	--	10.9±4.8	6.5±6.1
ACTIFLO®						
Effluent $CBOD_5$	mg/L	<40	23	--	12.0±1.3	9.3±1.7
Effluent sol. $CBOD_5$	mg/L	NE	NA	--	8.5±0.2	8.3±2.8
Total $sCBOD_5$ removal	%	NE	NA	--	70.8	89.2
Effluent TSS	mg/L	<40	30	--	13.0±1.6	6.7±3.1
Effluent Total P	mg/L	NE	0.7	--	0.17±0.06	0.32±0.27
Effluent E. coli	CFU/100mL	<126[a]	<126	--	15.0±4.2	5.0±4.2
		<284[b]	<284	--	--	--

Notes:
NE.: Performance goal was not established in the NEORSD consent decree for HRT pilot.
a - Geometric mean for each day in which a discharge occurs.
b - Rolling geometric mean for each seven-day period.

Based on the overall summary of effluent data presented in Table 17 above, it can be inferred that BIOACTIFLO and ACTIFLO can achieve effluent that meets the discharge standards consistent with both NEORSD consent decree for pilot testing as well as the secondary standards for $CBOD_5$, TSS, and phosphorus based the current NPDES permit for Lakewood WWTP.

The BIOACTIFLO mode of operation was able to achieve better effluent quality than ACTIFLO. However, the overall effluent quality achieved with ACTIFLO only is sufficient to meet target effluent quality. *Therefore, the investment for contact tank required in order to operate as BIOACTIFLO is not justified*.

7.2 COAGULANT AND POLYMER PERFORMANCES

During BIOACTIFLO™ testing, pilot unit was operated at a hydraulic loading rate (HLR) of 32 gpm/ft^2 and MLSS concentration in the contact tank above 800 mg/L, the effluent goals were met by using following chemicals (refer to Figure 6):

a. Sodium aluminate ($NaAlO_2$) was found not very effective and with a drastic effect on pH. Sodium aluminate raises the effluent pH to about 8.9 when it is dosed as a coagulant. Each mole of sodium aluminate produces one mole of sodium hydroxide as shown in the equation below:

$$2\ NaAlO_2 + 4H_2O \rightarrow 2\ NaOH + 2\ Al(OH)_3$$

In order to neutralize pH, acid such as sulfuric acid must be added. For the optimum sodium aluminate dose of 75 mg/L, volume of concentrated sulfuric acid needed to neutralize is calculated to be 0.35 mL per 1 gallon of effluent.

The use of sodium aluminate ($NaAlO_2$) as a coagulant did not achieve consistent TSS removal sufficient to meet NPDES limit. Based unsatisfactory quality of sludge flocculation and requirement for acid to neutralize final effluent, the sodium aluminate *is not* recommended for use as coagulant.

b. PACL and aluminum sulfate coagulants with Hydrex 3596 as polymer was found to be effective in BOD removal even at high influent concentrations associated with the first flush wet weather flow.

As shown in Table 18, the cost per unit volume treated (per 1 MGD) associated with PACL is significantly higher than those associated with aluminum sulfate. Due to inadequate level of performance, sodium aluminate is not considered during regular ACTIFLO run.

Table 18: Comparison of Process Chemical Costs

Chemical	Optimum Dose (mg/L)	Unit Cost ($/lb)	Daily Chemical Cost ($/day/MGD)
BIOACTIFLO™			
Sodium Aluminate-$NaAlO_2$	60	0.23	115
Aluminum Sulfate -$Al_2(SO_4)_3$	100	0.50	417
PACL	65	1.80	976
Hydrex 3592	3	2.25	56
Sulfuric Acid (H_2SO_4)	175	0.14	204
Ballast Sand	3	0.10	2.50
ACTIFLO®			
Aluminum Sulfate	100	0.50	417
PACL	65	1.80	976
Hydrex 3592	1.0	2.25	19
Ballast Sand	2.5	0.10	2.10

Overall, the performance level of Alum and PACL are comparable and both these coagulants were able to achieve the target effluent quality:

a. Effluent CBOD in the BIOACTIFLO was well within the target of 40 mg/L, ranging from 8.3 to 11.3 mg/L for the three coagulants tested. With alum and PACL, the soluble fraction of the BOD (72% and 77%, respectively) is much higher than that with sodium aluminate (59%).

b. Analysis of the amount of biomass added to the Contact Tank and the amount of CBOD removed showed a relatively consistent 0.2 lb CBOD removal per lb of MLSS present in the system. This indicates that some biological removal of CBOD is possible even though the contact time is only about 27 minutes.

c. Phosphorus removal is more effective with alum and polyaluminum chloride (90 – 95%) compared to times when sodium aluminate (80 – 85%) was added as a coagulant. For the entire BIOACTIFLO run, the effluent phosphorus remained less than 0.5 mg/L regardless of the metal salt used for coagulation.

d. During ACTIFLO® testing the goals were met using either PACL or aluminum sulfate as coagulant, Hydrex 3596 and Hydrex 3502 as polymers, and operating at a hydraulic loading rate of 60 gpm/ft^2. This higher overflow rate was achieved by inserting inclined plates in the clarifier tank. Testing during wet weather flow was more representative because of the influent wastewater characteristics that would be realized during the full scale application of each process.

e. The maximum influent total CBOD observed was 73 mg/L. Total CBOD removal efficiency was observed in the range of 50 to 85%. $CBOD_5$ reduction is totally related to solids removal accomplished and thereby any oxygen demand exerted by the organic portion of those solids. As shown in Appendix A, Figure 19, the $CBOD_5$ removal efficiency is proportional to its influent concentration. Overall, the effluent total and soluble CBOD were similar and remained in the range of 8 to 12 mg/L, indicating that the final effluent is mostly soluble CBOD.

f. Phosphorus removal also appears to be dependent on the particulate fraction in the influent. The influent phosphorus during the ACTIFLO run ranged from 1.1 to 6.3 mg/L. The effluent phosphorus concentrations ranged from 0.2 to 0.6 mg/L (Appendix A, Figure 21). This result indicates that almost all phosphorus removal occurs because of chemical precipitation, and no significant biological uptake.

Based on these findings and the unit cost, the most favorable coagulant for this application appears to be Alum.

7.3 SLUDGE GENERATION AND HANDLING

Due to the higher TSS removal efficiency, the ACTIFLO process will generate more sludge than the conventional primary treatment process. At the same time, the ACTIFLO sludge stream has a significantly lower solids concentration. Based on the observations during the pilot study, ACTIFLO sludge stream concentrations ranged between 1,000 and 21,000 mg/L during the pilot study. Based on the average sludge concentration of 8,000 mg/L, ACTIFLO sludge flow rates are estimated to be up to 30 gDS/gal of wastewater treated.

An intermediate thickening process would be required between the ACTIFLO and sludge digestion processes.

7.4 COST ANALYSIS

Present worth analysis of chemical usage for ACTIFLO and BIOACTIFLO options to treat 35 MGD and 45 MGD of wet weather flow are presented in Appendix B. The annual operating costs for the alternatives were based on the assumption that the full scale HRT unit will be operated for 23 days each year. This is based on the number of days overflow was observed during the summer of 2015. During each day of operation, the system is assumed to operate at full capacity the entire day. In reality, the chemical dosing system is capable of changing the dosage according to the actual pollutant load entering the HRT unit.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Lakewood WWTP pilot testing results indicate that both ACTIFLO® and BIOACTIFLO™ modes of operation are viable options for treating wet weather flows. Other relevant comments are as follows:

a. ACTIFLO system is recommended over BIOACTIFLO as the preferred HRT because it can achieve the desired effluent quality at lower cost.

b. Sodium aluminate is not a preferred coagulant because of its poor floc structure, high effluent pH (very close to the upper end of the discharge limit), and its inability to consistently maintain effluent TSS below 40 mg/L during wet weather conditions. Feeding acid can achieve neutral pH. However, this means adding a hazardous chemical inventory to the HRT building which is not desirable.

c. During CSO weather and simulated CSO weather BIOACTIFLO™ operation, the TSS and CBOD limits of < 40 mg/L were met during every run using PACL and aluminum sulfate. Optimal dosages for PACL, aluminum sulfate, and Hydrex 3596 polymer at the two optimal tank concentrations of 800 and 1200 mg/L are as follows:

d. Best performance occurred at 800 mg/L MLSS, 3.7 mg/L of Hydrex 3596 polymer, and 70 – 110 mg/L of alum. The above mentioned parameters consistently achieved 78.3% – 98.9% of TSS removal.

Contact Tank	Coagulant 1/ Flocculent Concentrations		Coagulant 2 / Flocculent Concentrations	
	PACL	Hydrex 3596	$Al_2(SO_4)_3$	Hydrex 3596
MLSS 800 mg/L	60 mg/L	3.2 – 4.8 mg/L	90 mg/L	3.6 mg/L
MLSS 1200 mgL	80 mg/L	3 mg/L	100 - 115 mg/L	5.0 mg/L

e. During CSO weather and simulated CSO weather ACTIFLO® operation the TSS and CBOD limits of < 40 mg/L were met during every run using PACL and aluminum sulfate. Optimal dosages form PACL, and aluminum sulfate during ACTIFLO® operation are as follows:

- PACL dosed at 50 mg/L and Hydrex 3596 polymer dosed at 1.2 mg/L.
- Aluminum Sulfate dosed at 70 - 90 mg/L and Hydrex 3596 polymer dosed at 1.2 - 2.0 mg/L. It must be noted that the TSS removal efficiency with aluminum sulfate did not change significantly with higher doses.

f. PACL in combination with polymer 3502 provided the highest and most consistent turbidity removal efficiencies, although all coagulants tested were able to achieve effluent compliance.

g. Aluminum sulfate is the optimum choice of coagulant based on its lower unit cost than PACL and its ability to achieve the target effluent parameters.

h. During both ACTIFLO® and BIOACTIFLO™ modes of operation, effluent E. Coli concentration remained well below the rolling 7-day geometric mean limit of 284 CFU/100 mL. On June 10, 2015 (first wet weather flow during the pilot study), the effluent E. Coli exceeded the maximum daily mean value of 126 CFU/100 mL.

i. During BIOACTIFLO™ and ACTIFLO® operation, the effluent phosphorus was consistently below 0.2 mg/L when alum and PACL were used as coagulant. On one occasion, during the wet weather flow on June 10, 2015, the effluent phosphorus exceeded 2 mg/L after 1.5 hours of operation with sodium aluminate as coagulant.

j. ACTIFLO® HRT system proved to be sufficient to consistently achieve the NEORSD Consent Decree and NPDES effluent limits for TSS, $CBOD_5$, Phosphorus and E.coli as show in the table below.

Parameter	Units	NEORSD Limit	NPDES Limit		ACTIFLO Effluent[a]
			Monthly Avg	Weekly Maximum	
TSS	mg/L	40	20	30	13.0±1.6
$CBOD_5$	mg/L	40	15	23	12.0±1.3
Phosphorus	mg/L		1.0	1.5	0.17±0.06
E. COLI[b]	CFU/100 mL	126	126	-	15.0±4.2
E. COLI[c]	CFU/100 mL	284	284	-	-

a- Alum as coagulant and Hydrex 3596
b- Recreational seasonal geometric mean
c- E.coli below 284 CFU/100 mL as a 7-day rolling geometric mean

APPENDIX A

BIOACTIFLO & ACTIFLO STEADY STEATE PILOT RUNS

FIGURES 7-24

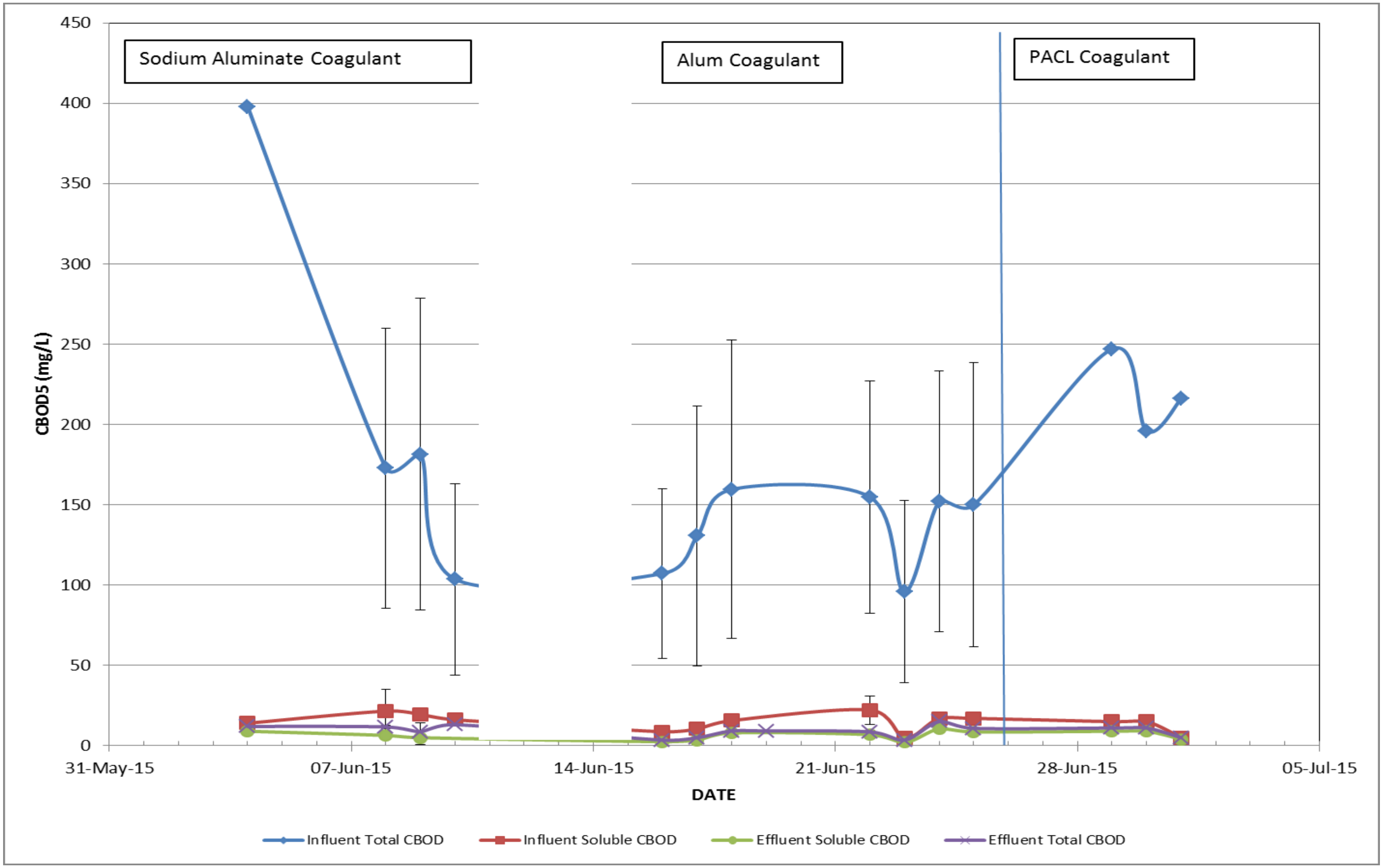

FIGURE 7: BIOACTIFLO® PILOT RUN – TOTAL AND SOLUBLE CBOD$_5$

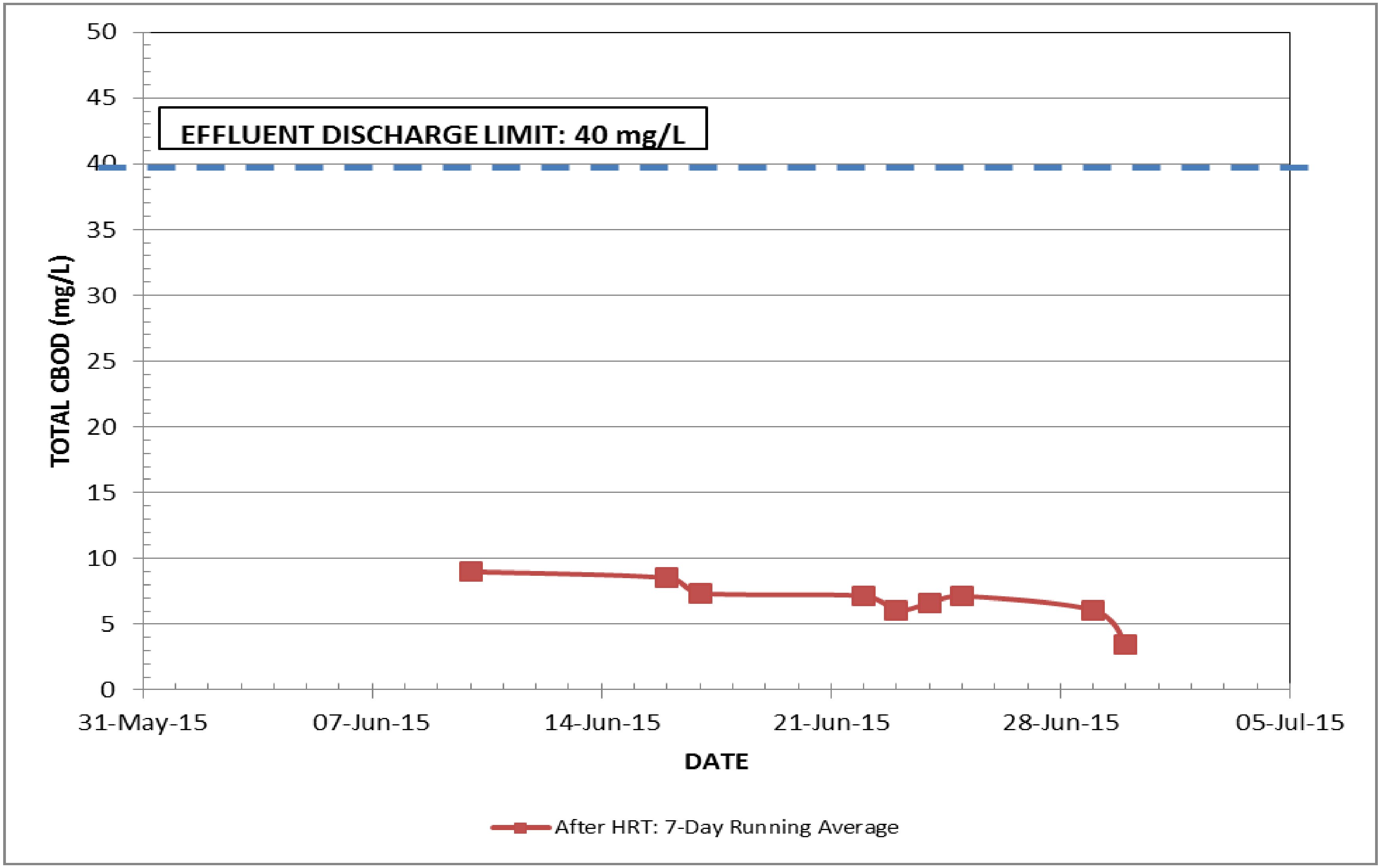

FIGURE 8: BIOACTIFLO® PILOT RUN – EFFLUENT TOTAL CBOD 7-DAY RUN AVERAGE OF FLOW WEIGHTED ARITHMETIC MEAN

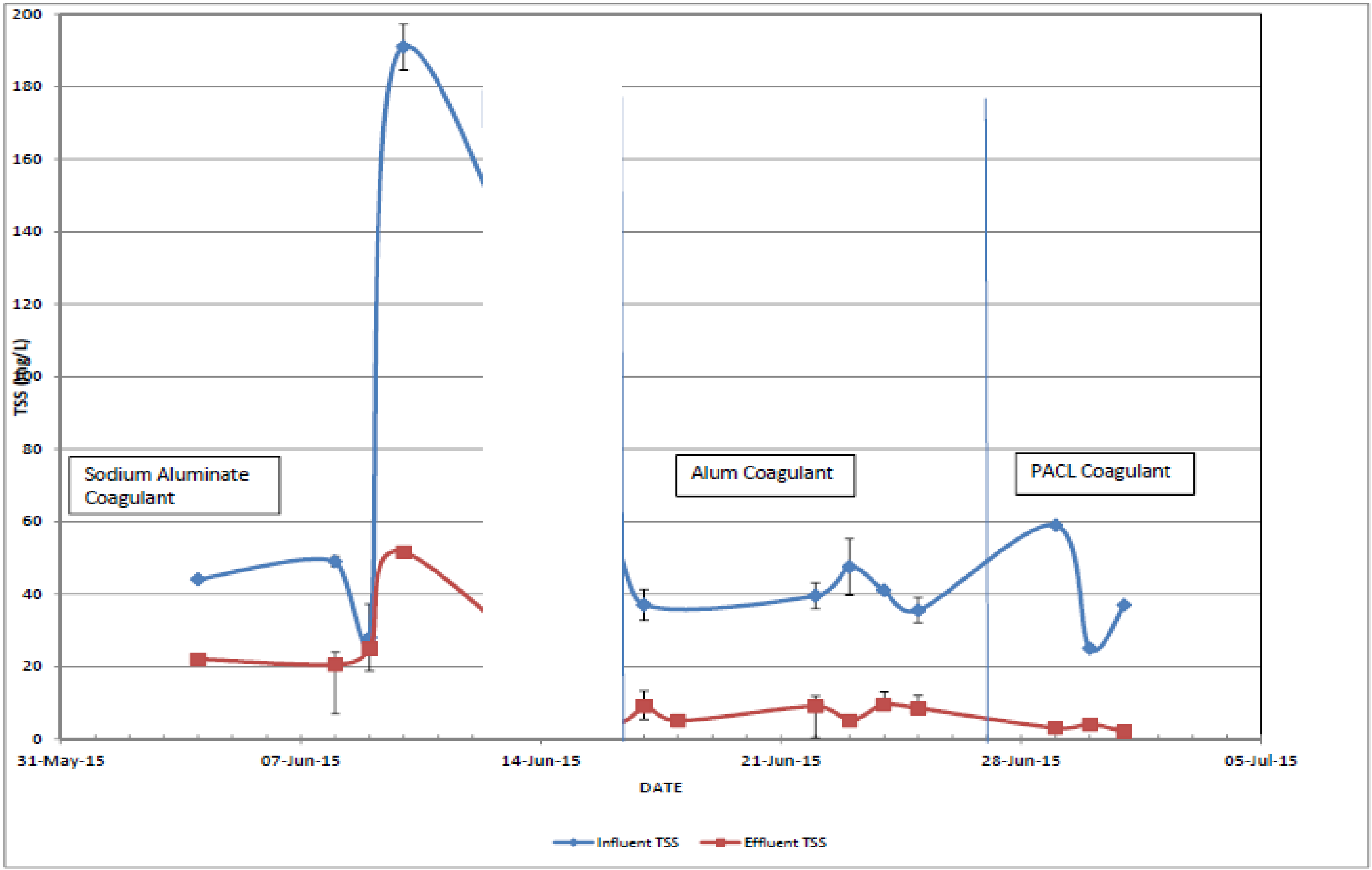

FIGURE 9: BIOACTIFLO® PILOT RUN – INFLUENT AND EFFLUENT TSS

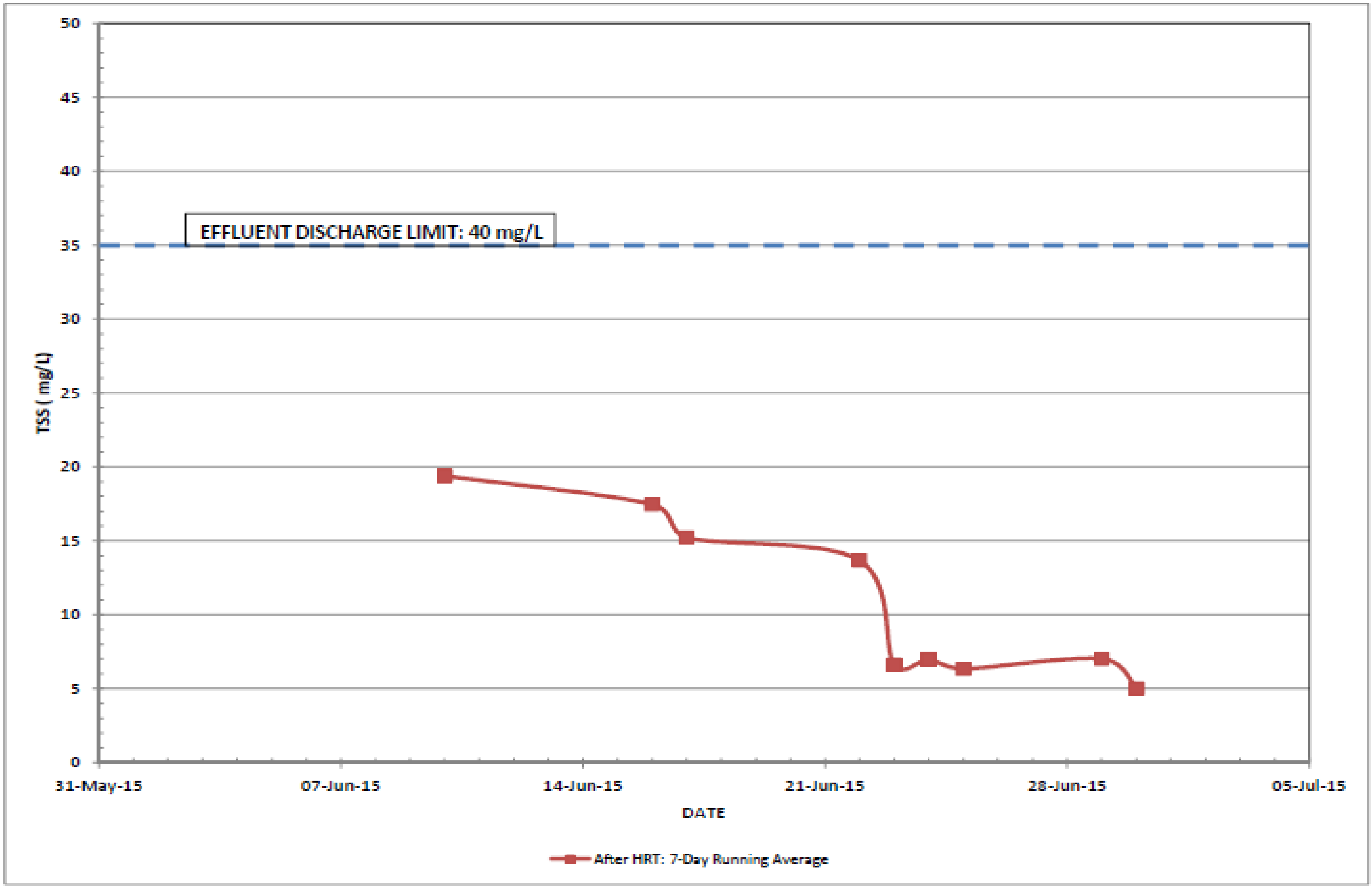

FIGURE 10: BIOACTIFLO® PILOT RUN – EFFLUENT TSS 7-DAY RUN AVERAGE OF FLOW WEIGHTED ARITHMETIC MEAN

CT Consultants
engineers | architects | planners

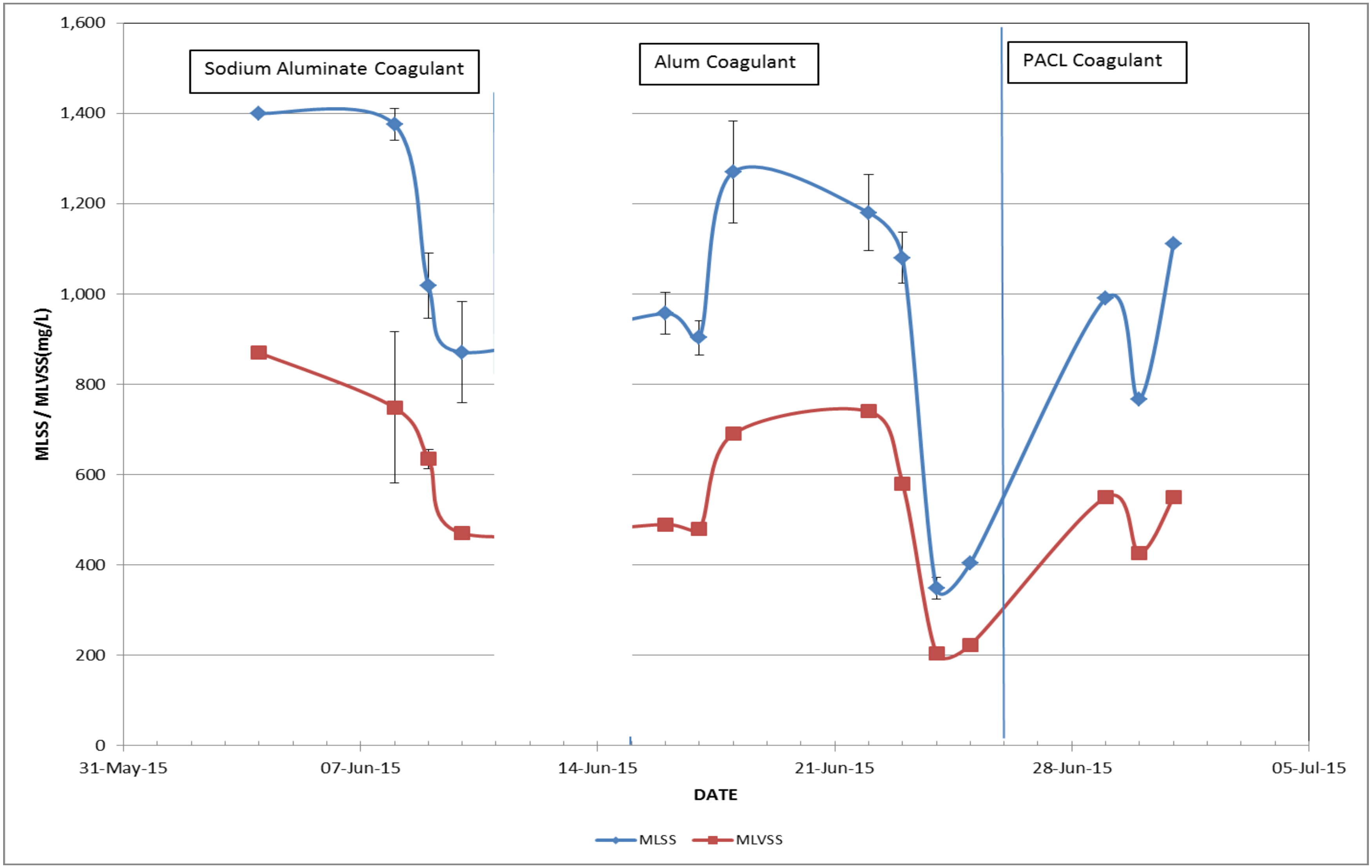

FIGURE 11: BIOACTIFLO® PILOT RUN – CONTACT TANK MLSS AND MLVSS

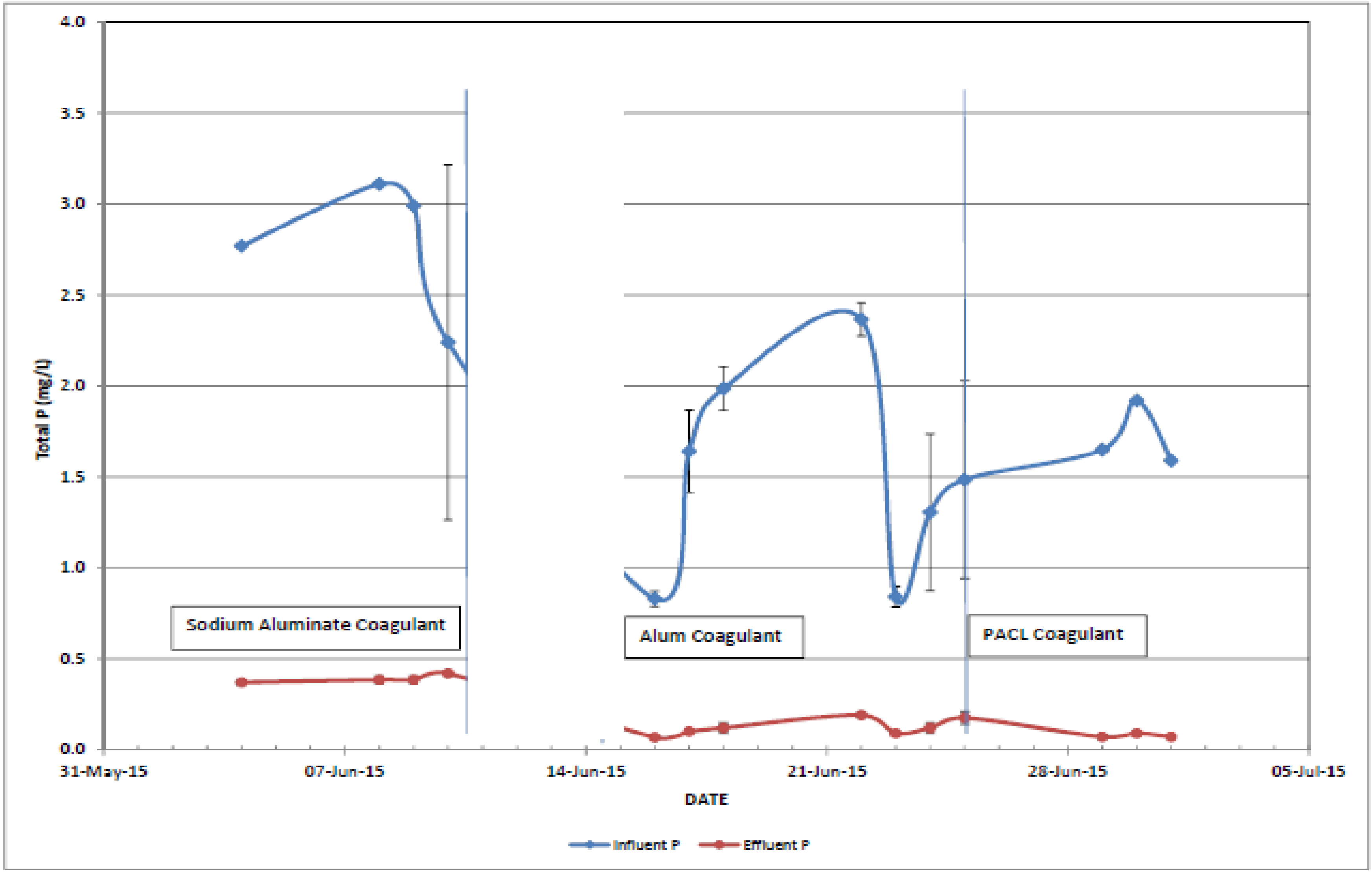

FIGURE 12: BIOACTIFLO® PILOT RUN – INFLUENT AND EFFLUENT TOTAL PHOSPHORUS

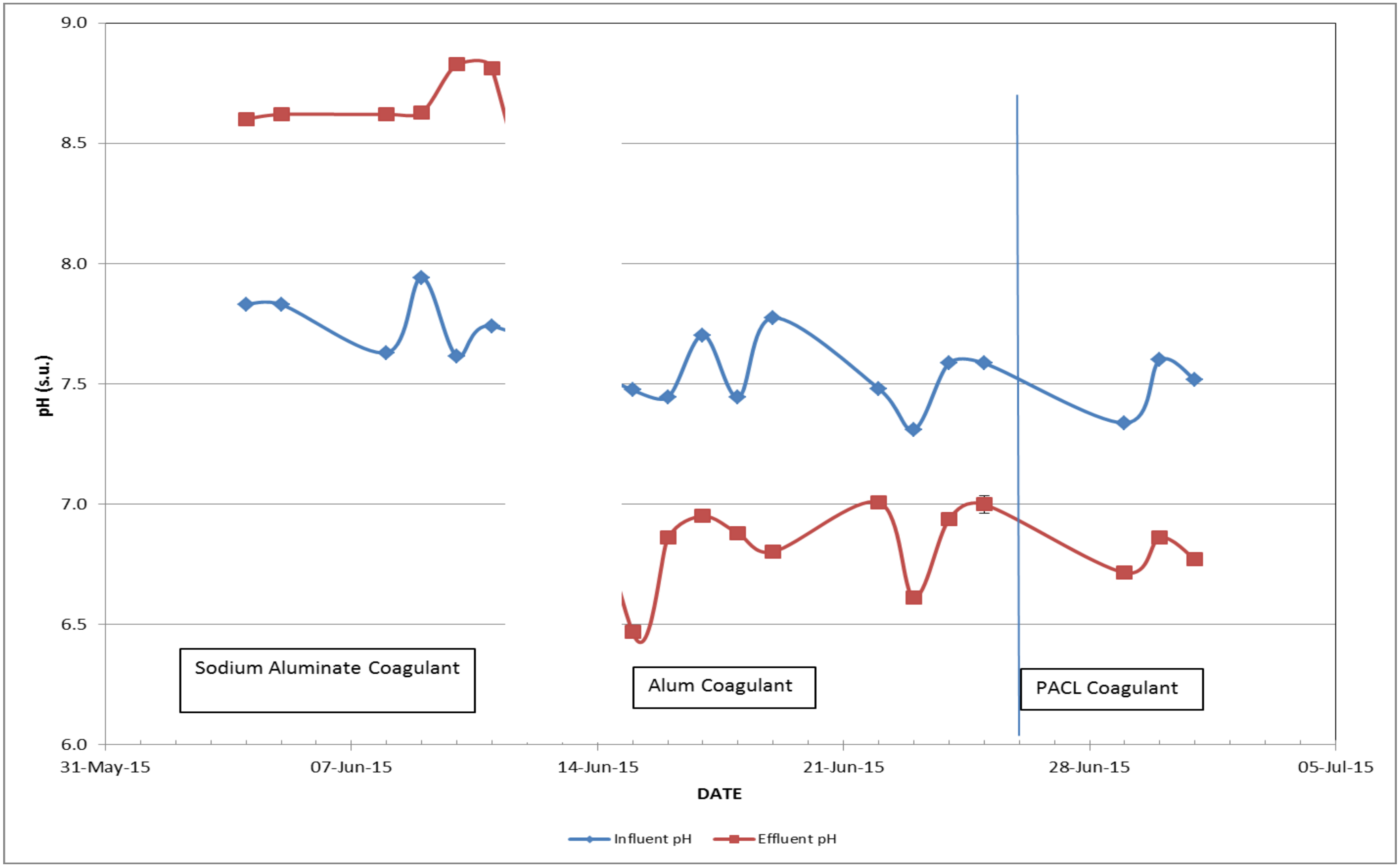

FIGURE 13: BIACTIFLO® PILOT RUN – INFLUENT AND EFFLUENT pH

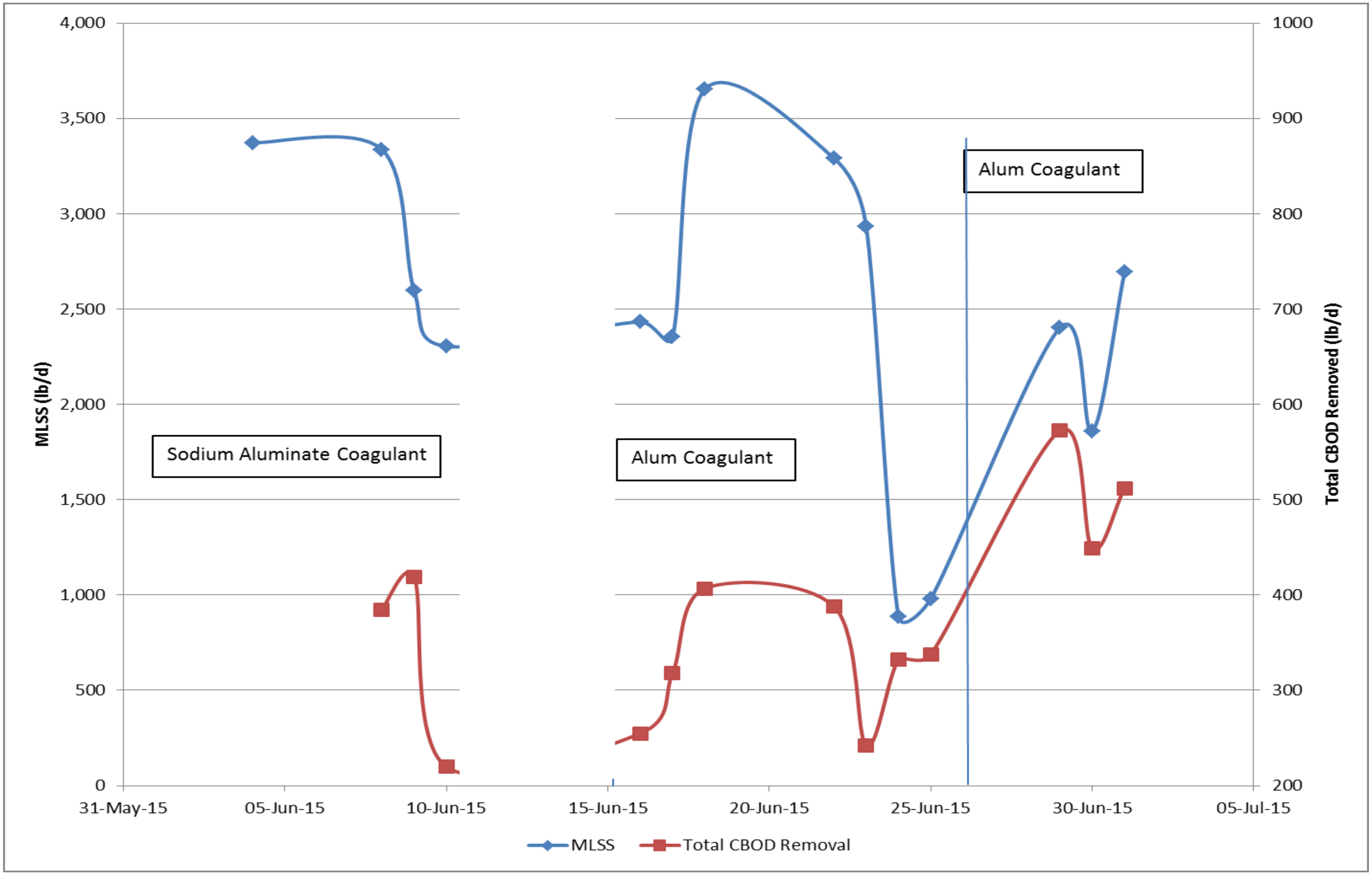

FIGURE 14: BIOACTIFLO® PILOT RUN – CBOD REMOVAL AND MLSS

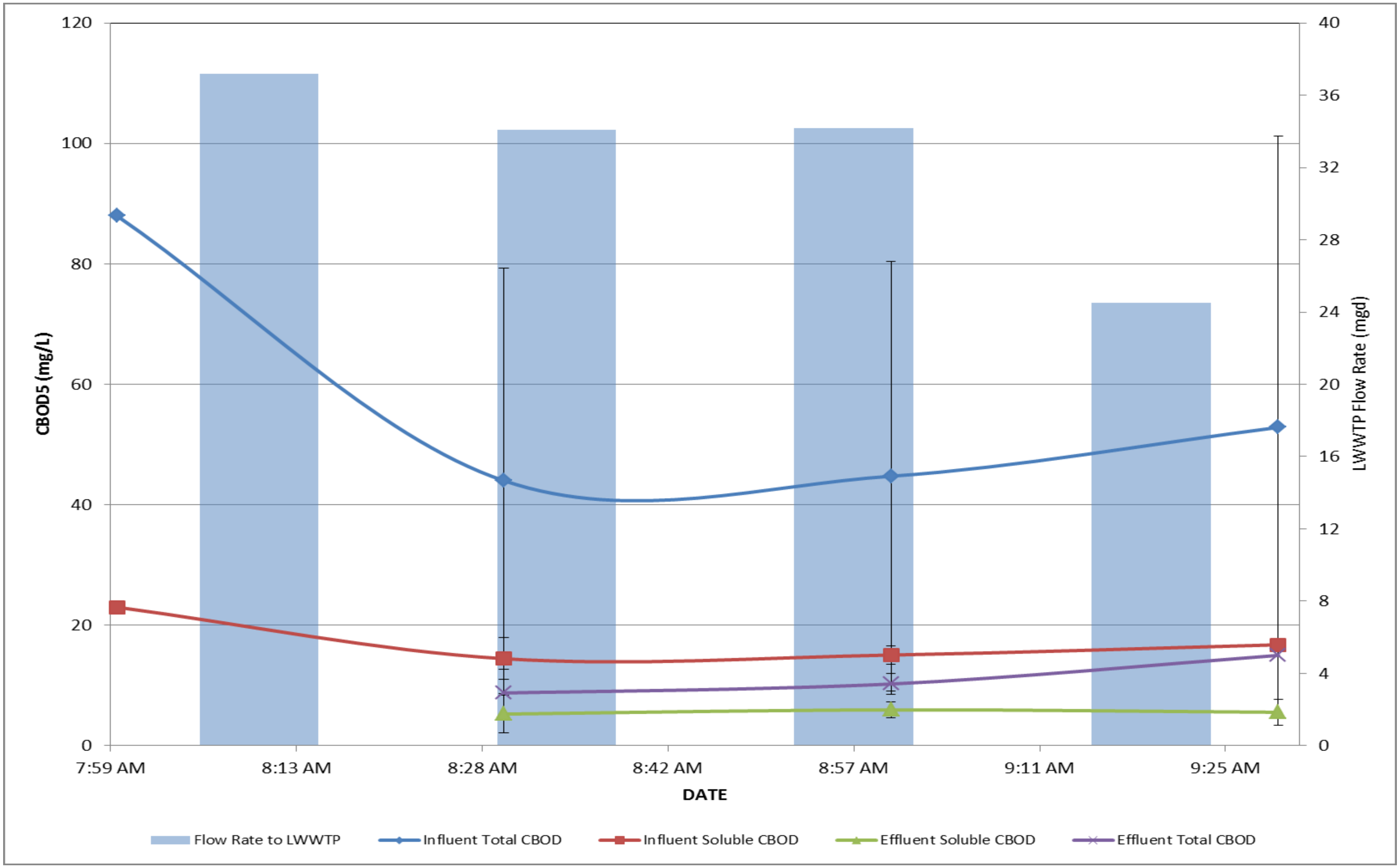

FIGURE 15: WET WEATHER BIOACTIFLO PILOT RUN ON JUNE 10 2015 - TOTAL AND SOLUBLE CBOD

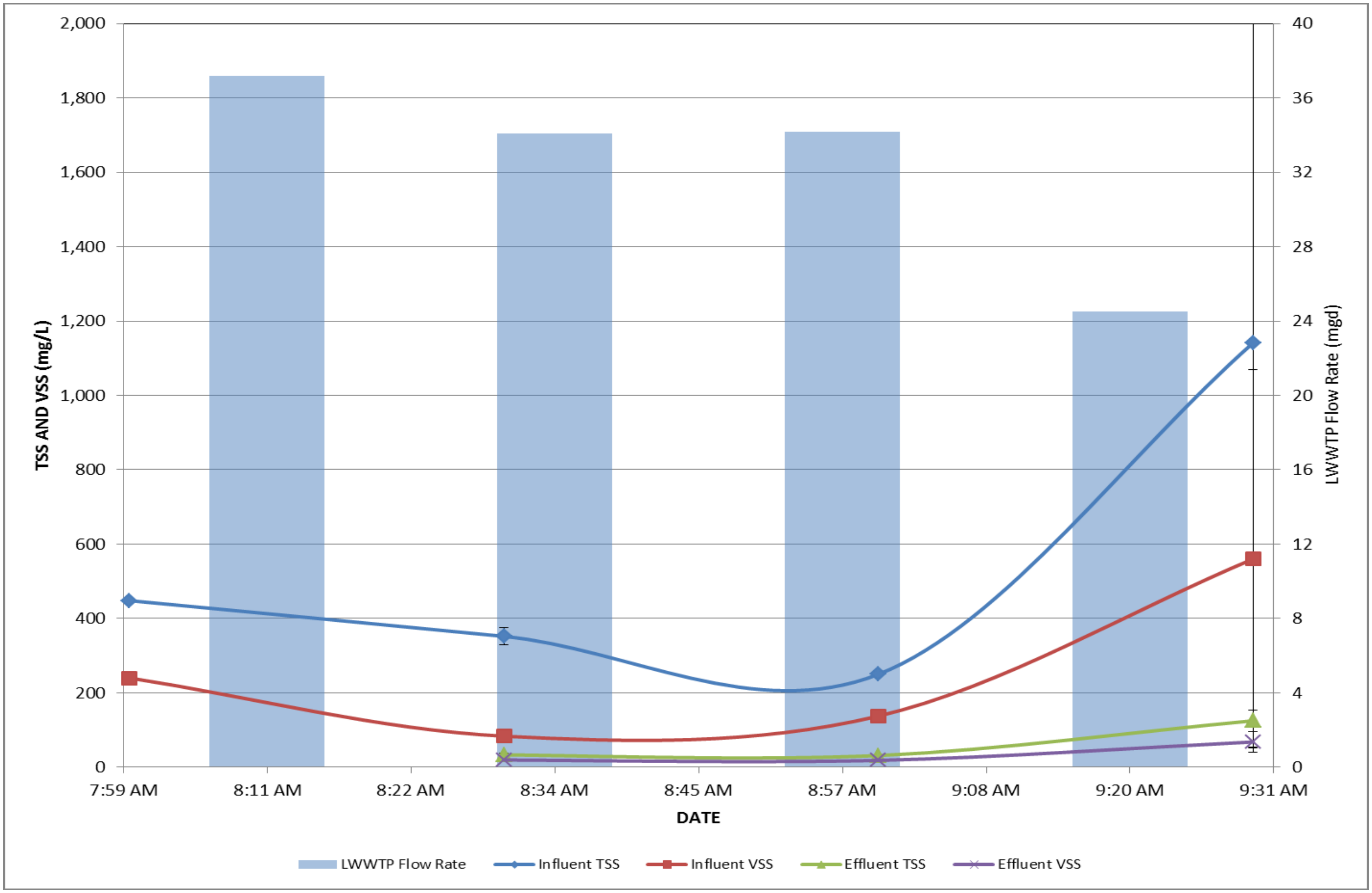

FIGURE 16: WET WEATHER BIOACTIFLO PILOT RUN ON JUNE 10 2015 – TSS AND VSS

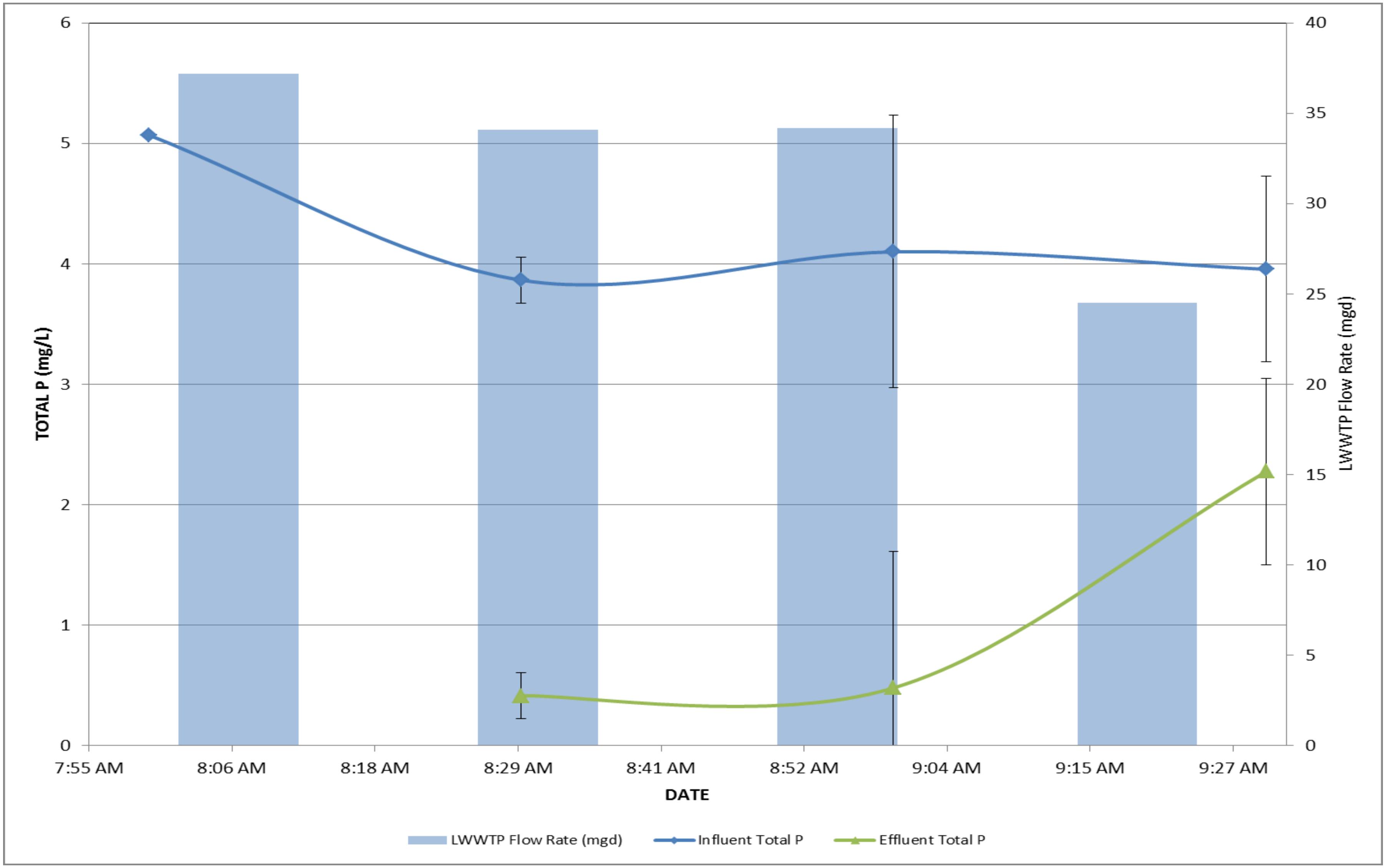

FIGURE 17: WET WEATHER BIOACTIFLO PILOT RUN ON JUNE 10 2015 – TOTAL PHOSPHORUS

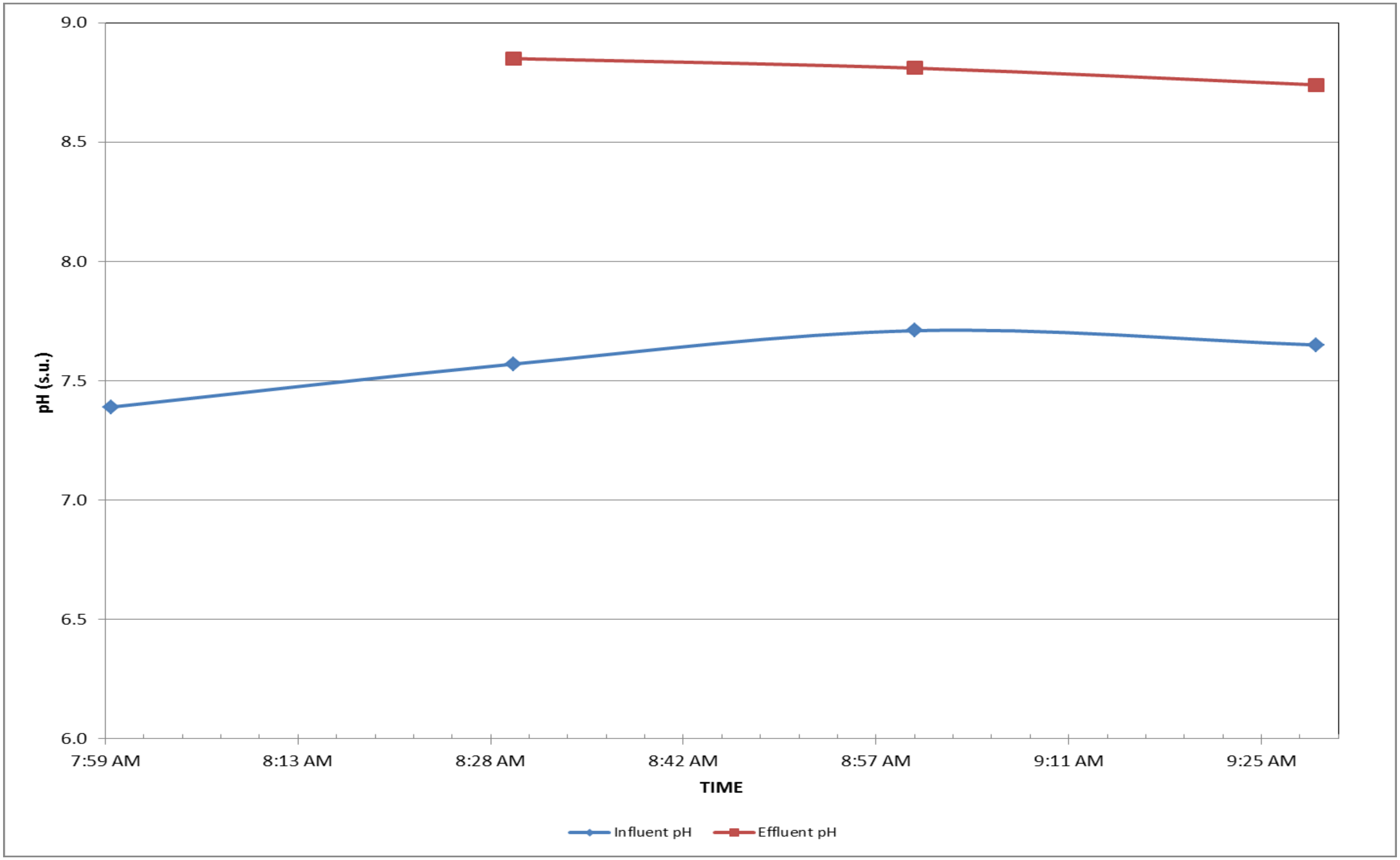

FIGURE 18: WET WEATHER BIOACTIFLO PILOT RUN ON JUNE 10 2015 – INFLUENT AND EFFLUENT pH

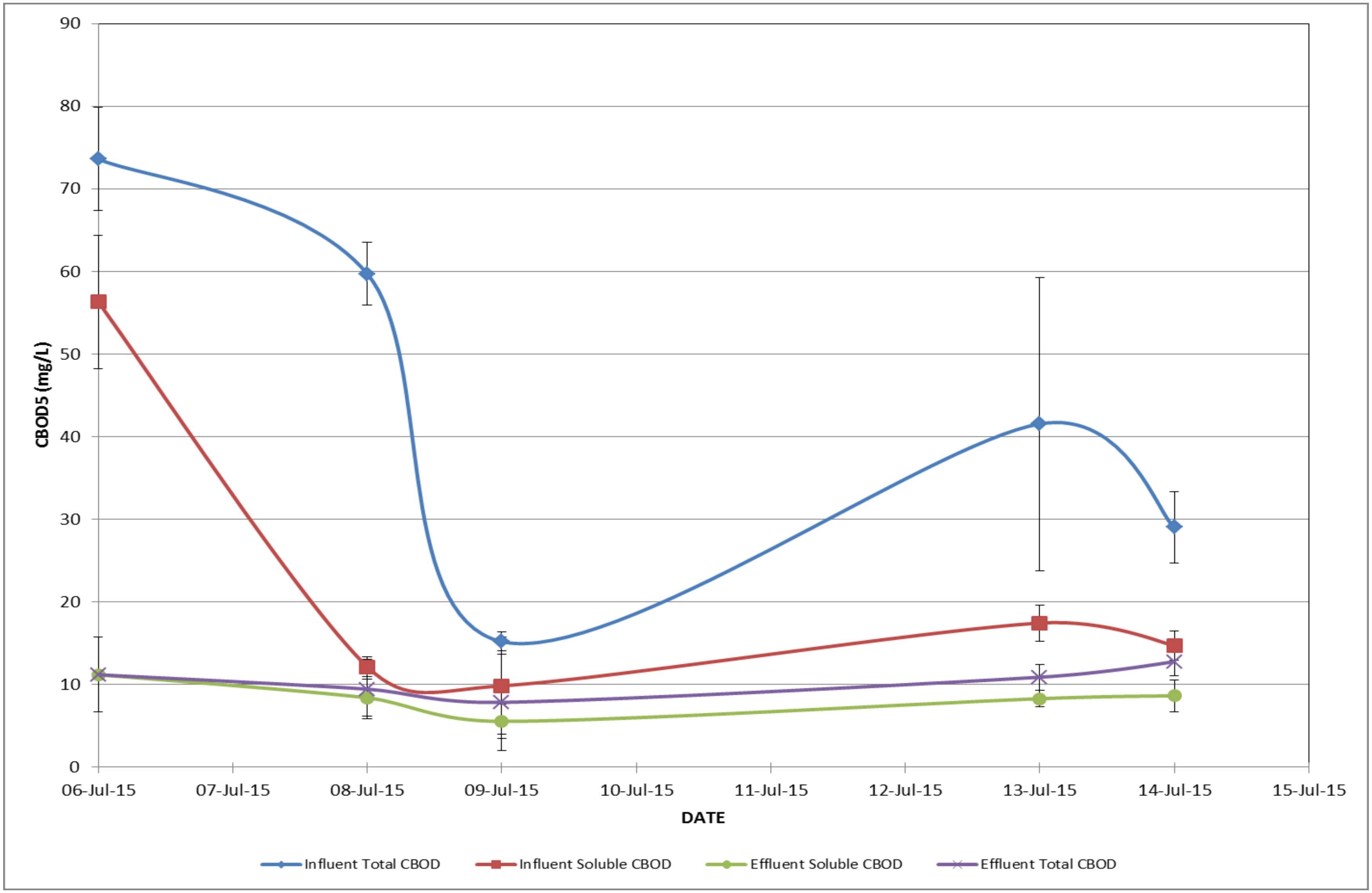

FIGURE 19: ACTIFLO PILOT RUN – TOTAL AND SOLUBLE CBOD

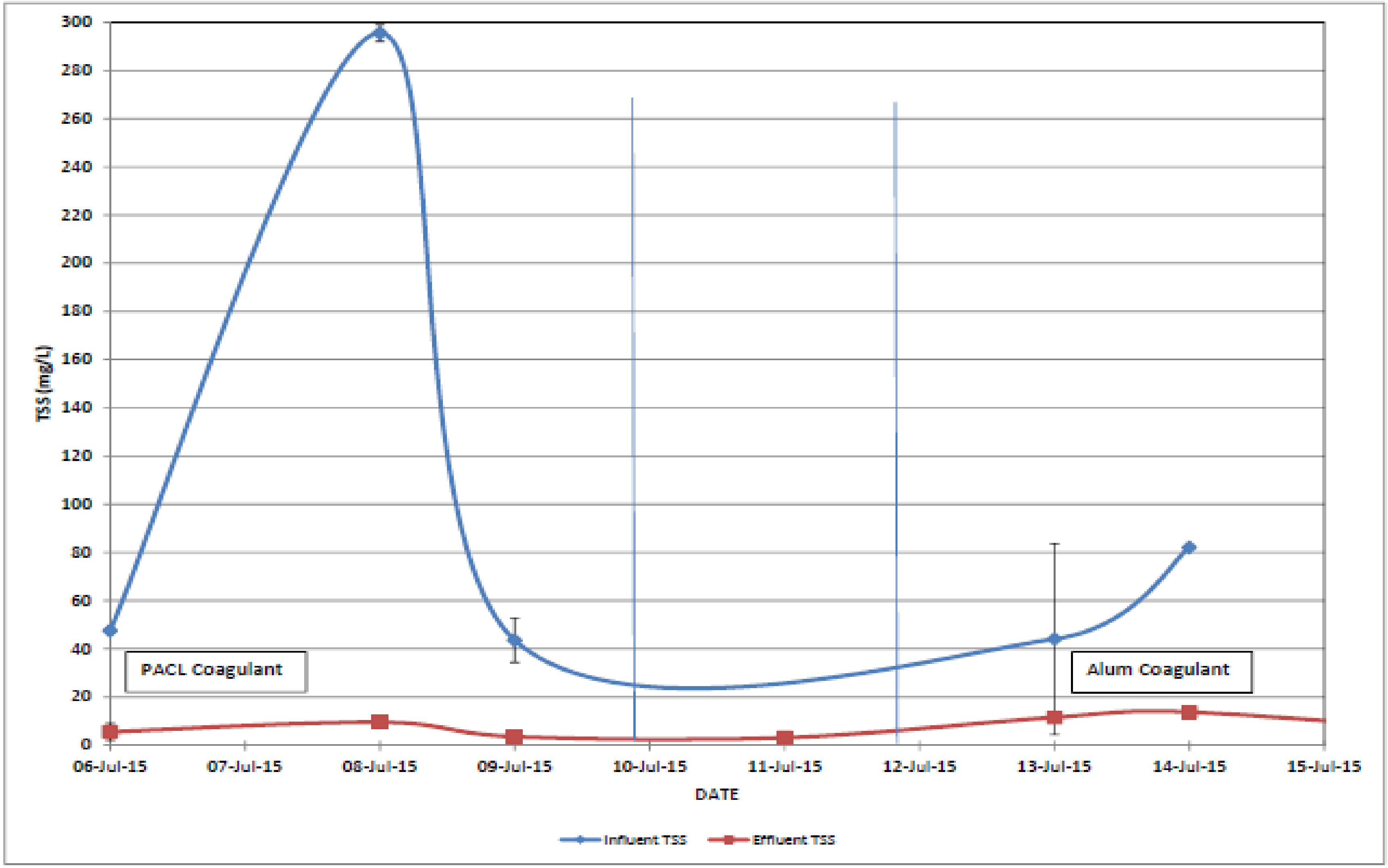

FIGURE 20: ACTIFLO PILOT RUN – INFLUENT AND EFFLUENT TSS

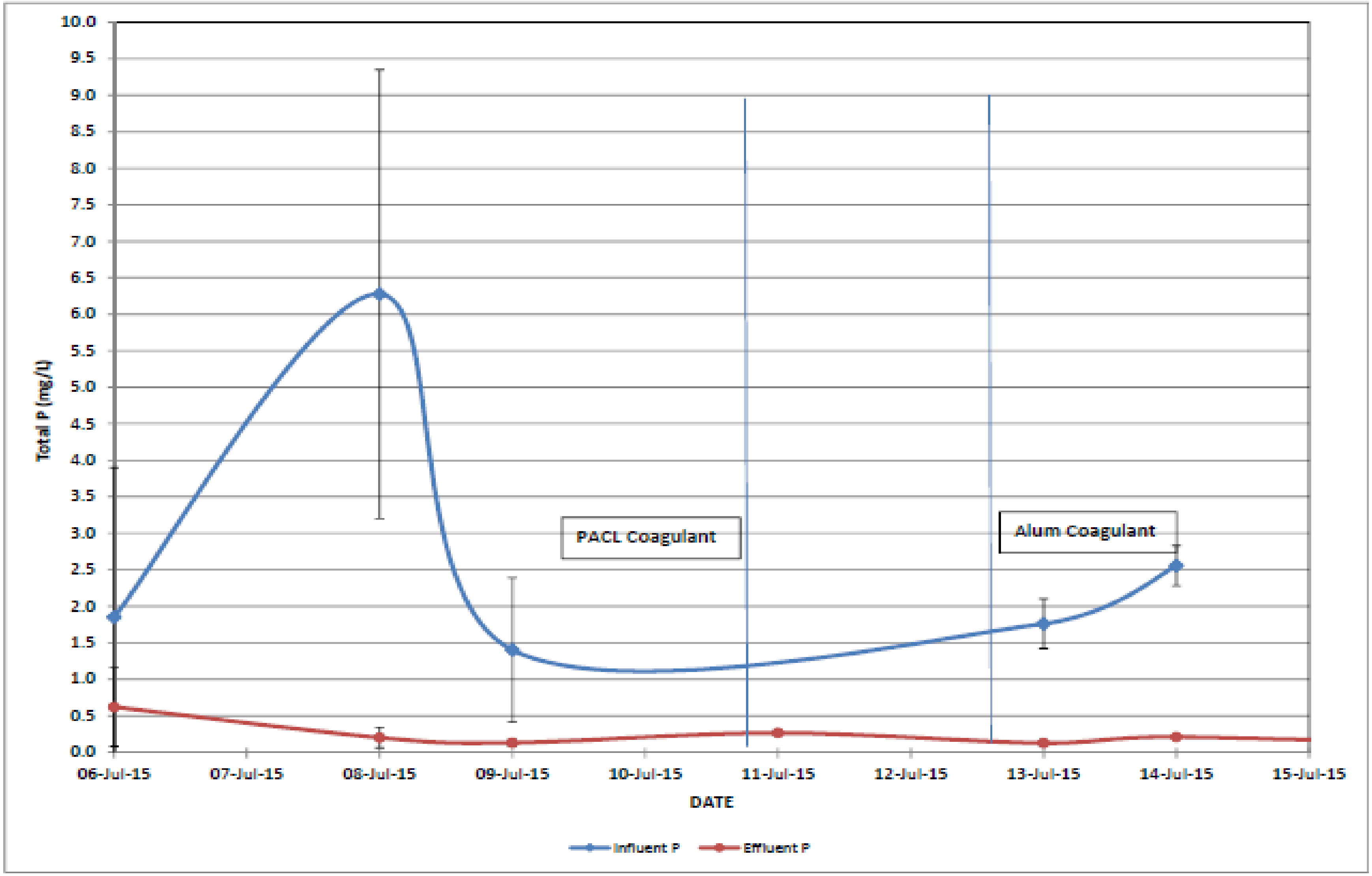

FIGURE 21: ACTIFLO PILOT RUN – INFLUENT AND EFFLUENT TOTAL PHOSPHORUS

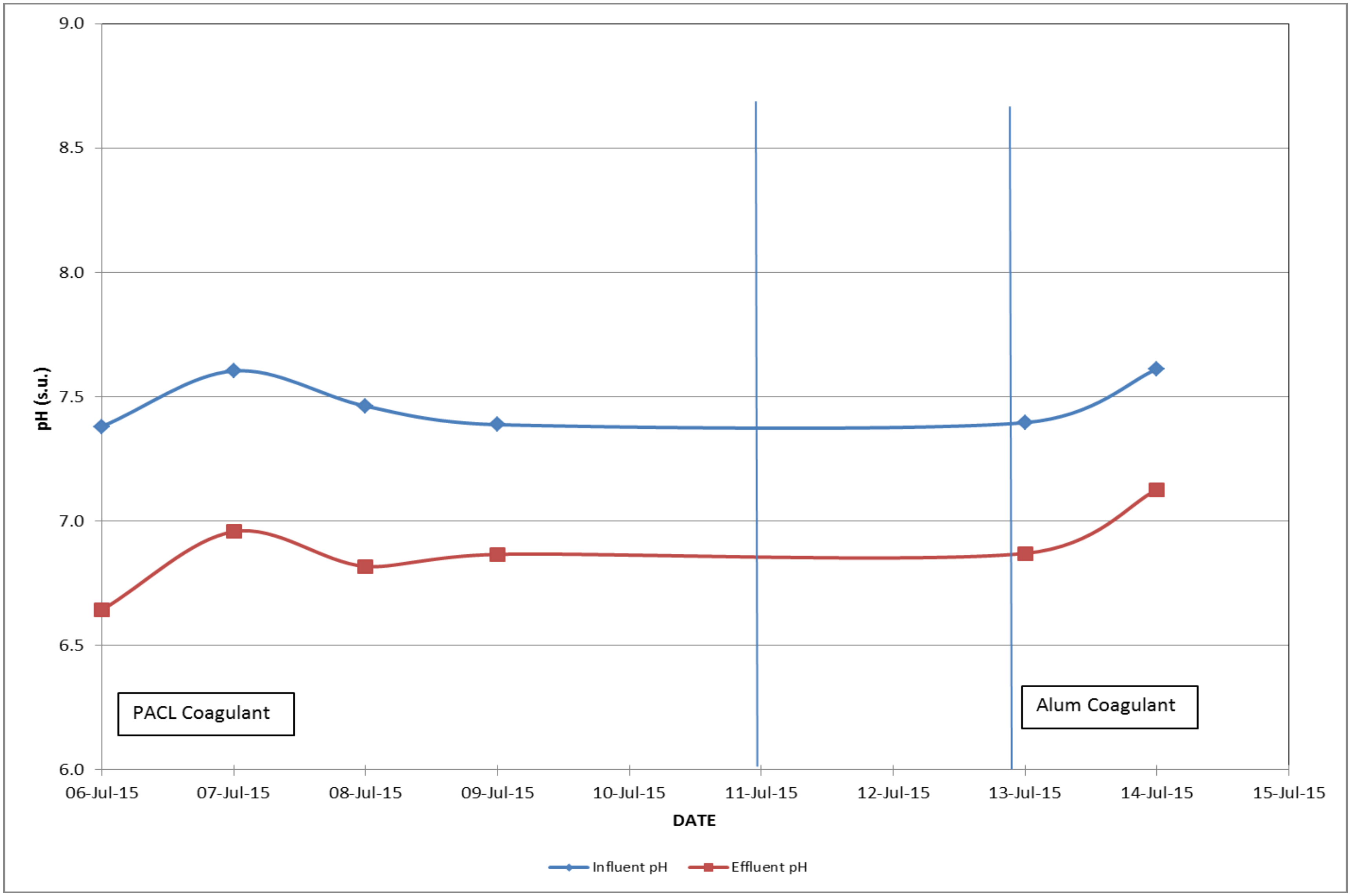

FIGURE 22: ACTIFLO PILOT RUN – INFLUENT AND EFFLUENT pH

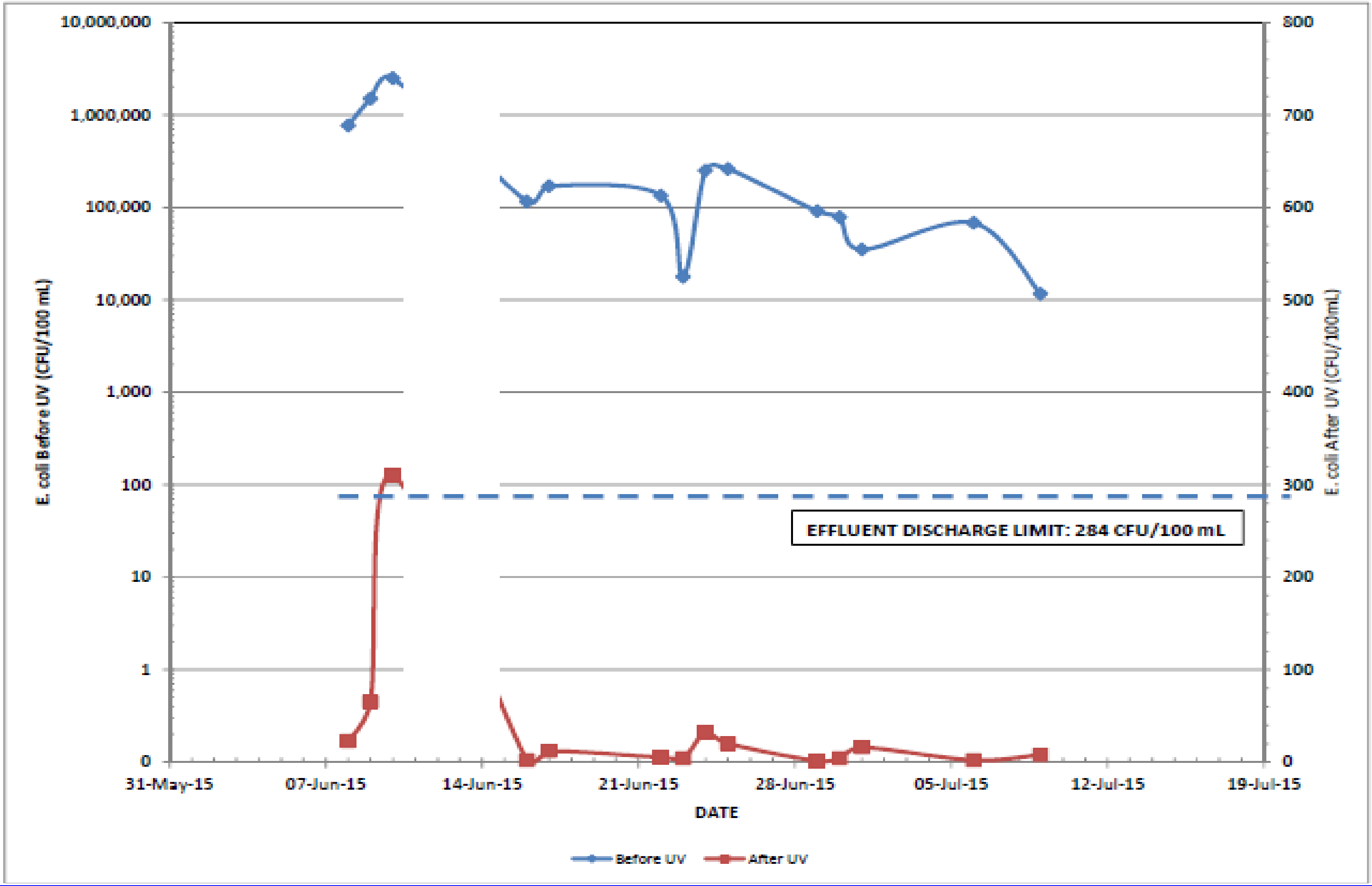

FIGURE 23: BIOACTIFLO/ACTIFLO PILOT RUN – E. COLI DAILY VALUE

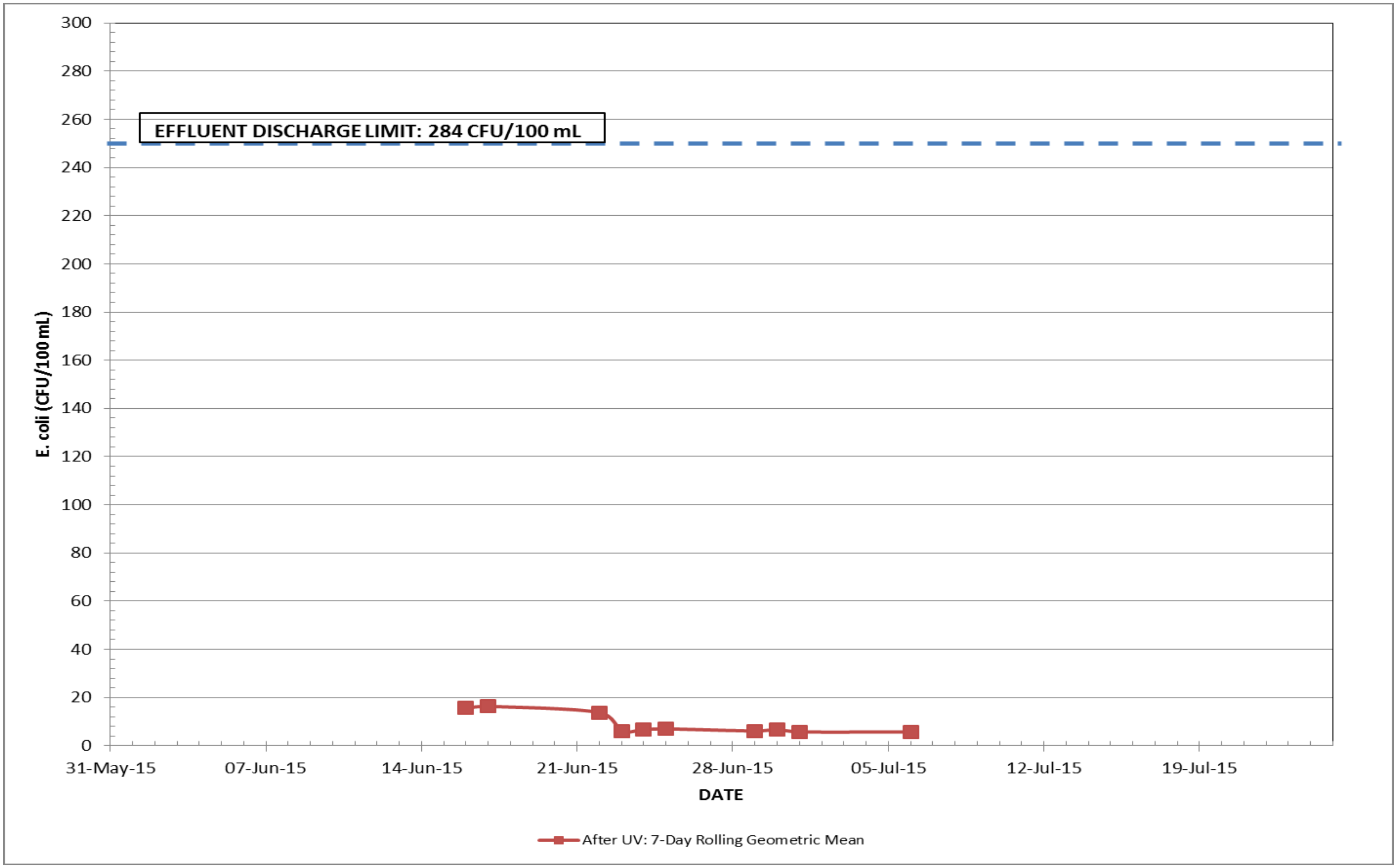

FIGURE 24: BIOACTIFLO/ACTIFLO PILOT RUN – E. COLI 7-DAY ROLLING GEOMETRIC MEAN

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APPENDIX B

PRESENT WORTH ANALYSIS OF BIOACTIFLO & ACTIFLO HIGH RATE TREATMENT SYSTEMS

PRESENT WORTH (PW) ANALYSIS OF CHEMICAL USAGE FOR BIOACTIFLO AND ACTIFLO ALTERNATIVES

Present worth analysis is based on 20 years of equipment service life and 3% interest rate /year .

Alternative	Description	Chemical Dosage						Unit Chemical Cost						Daily Chem Cost	PW of Annual Chemicals[b]
		$NaAlO_2$ (lb/d)	Alum (lb/d)	PACL (lb/d)	Polymer (lb/d)	H_2SO_4 (gal/d)	Sand (lb/d)	$NaAlO_2$ ($/lb)	Alum ($/lb)	PACL ($/lb)	Polymer ($/lb)	H_2SO_4 ($/gal)	Sand ($/lb)		
1. BIOACTIFLO															
35 MGD	-NaAlO2[a]										2.25	2.15	0.10	13,375	3,937,000
	- ALUM	17,514	26,271	17,514	1,168	3,308	876	0.23	0.50	1.80	2.25		0.10	15,850	4,543,200
	- PACL				1,051						2.25		0.10	33,977	9,739,000
45 MGD	-NaAlO2						1126	0.23	0.50		2.25	2.15	0.10	17,660	5,061,900
	- ALUM	22,518	33,777	22,518	1,501	22,518				1.80	2.25		0.10	20,379	5,841,200
	- PACL				1,351						2.25		0.10	43,685	12,521,500
2. ACTIFLO															
35 MGD	- ALUM		29,190	18,974	467		876	--	0.50	1.80	2.25		0.10	15,733	4,509,700
	- PACL				350						2.25		0.10	35,028	10,040,100
45 MGD	- ALUM	-	37,530	24,395	600	-	1,126	--	0.50	1.80	2.25		0.10	20,229	5,798,200
	- PACL				450						2.25		0.0	45,036	12,908,700

Notes:

(a) Sodium aluminate.

(b) Overflow events assumed to occur 23 days in a year.

(c) ACTIFLOOverflow sludge from the full scale unit is assumed to be brought back to LWWTP and removed along with its primary sludge.

APPENDIX C

VEOLIA PROPOSAL FOR PILOT STUDY – MAY 20, 2015

APPENDIX D

PILOT PLANT PROTOCOL – JUNE 2, 2015

APPENDIX 5-2
Basis of Design Memorandum of High Rate Treatment Facility

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engineers
architects
planners

BASIS OF DESIGN MEMORANDUM OF HIGH RATE TREATMENT FACILITY

CITY OF LAKEWOOD, OHIO
WASTEWATER TREATMENT PLANT (LWWTP)

CT CONSULTANTS

614.885.1700
www.ctconsultants.com

ISSUED: August 2016

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CHAPTER 1 - INTRODUCTION

1.1 Purpose

The purpose of this Basis of Design Memorandum is to provide initial design parameters for a High Rate Treatment Facility (HRT system) for treatment of the wet-weather flow at the City of Lakewood WWTP, Ohio. The City of Lakewood (City) was issued a National Pollutant Discharge Elimination System (NPDES) Permit by the Ohio Environmental Protection Agency (OEPA) regarding discharges to the waters of the State of Ohio from the City's Wastewater Treatment Plant (WWTP). The City of Lakewood is required by the Ohio NPDES permit to address the CSO overflows, particularly CSO 002, outfall 3PE00004002 located nearest to the plant.

The City of Lakewood is committed to provide the HRT system for treatment of flows in excess of the WWTP hydraulic capacity, which occur during wet-weather conditions. As a part of the effort to develop of basis of design for a HRT system to control overflows, the City has initiated and completed the following steps:

A. Conducted unified selection process based on five (5) leading Wet Weather High Rate Treatment systems manufactures presentations. From these presentations, the City and their Design Professionals have selected two (2) manufacturers each with two (2) treatment processes: Veolia-Kruger with ACTIFLO® and BIOACTIFLO® and Infilco Degremont, Inc. with DensaDeg® and DensaDeg XRC™, and invited them to perform side-by-side pilot studies at the LWWTP. The manufacturer Infilco Degremont, Inc. declined participation in the pilot study so the City of Lakewood has chosen the ACTIFLO® and BIOACTIFLO® processes for further study.

B. Developed a Pilot Plant Protocol for piloting ACTIFLO® and BIOACTIFLO® systems, presented by the manufacturer Veolia-Kruger.

C. Conducted a pilot testing program during a six (6) week period from June 3 through July 19, 2015 to assess the performance of ACTIFLO® and BIOACTIFLO® wet weather HRT systems.

D. Reviewed collected data during the Pilot Plant testing and provided a Pilot Plant Report assessing the performance of the ACTIFLO® and BIOACTIFLO® HRT processes.

E. Developed and evaluated six (6) HRT system layout alternatives.

1.2 High Rate Treatment Facility Basis of Design

The LWWTP is an activated sludge based wastewater treatment plant. It is designed to treat an average day designed flow of 18 MGD (dry-weather flow), and the sustained peak primary and secondary treatment capacity for wet-weather flows of 30 MGD. The LWWTP influent parameters are provided in Table 1.1.

Table 1.1: Lakewood WWTP Influent Parameters

Parameter	Units	Annual	Wet Weather
ADDF	MGD	18	-
ADF	MGD	7.33	16
MDF	MGD	38.25	38.25
TSS	mg/L	140	67
CBOD	mg/L	110	48.2

The flow rate to be handled by the wet weather HRT system has been estimated using the Storm Water Management Model (SWMM). The full-scale HRT system design capacity is sized to handle 35 MGD and located within the LWWTP.
During wet-weather events, flows in excess of 30 MGD will be diverted to the ACTIFLO® HRT facility. Therefore, combined wet-weather treatment capacity at City of Lakewood WWTP and proposed HRT facility will be rated 65 MGD.

The LWWTP wet stream processes consist of fine screening, grit removal, primary clarification, aeration and coagulation, conventional activated sludge, secondary clarification, and UV disinfection. Solids streams process for the primary solids and secondary waste activated sludge consist of solids thickening tank, primary and secondary anaerobic digesters. The LWWTP flow diagram is shown on Figure 1.1.

The City of Lakewood WWTP is complying with NPDES permit, which in the effect from August 2015 to January 2019. The target effluent quality for the full scale ACTIFLO® HRT system is based on the NPDES permit effluent limits as shown in Table 1.2. The effluent loadings listed in this table are calculated based on average design wastewater flow of 18 MGD.

Table 1.2: Lakewood WWTP Final Effluent Limits, Outfall NPDES Permit No. 3PE00004001

Parameter	Concentration, mg/L		Loading (lbs/day)	
	Monthly	Weekly	Monthly	Weekly
TSS	20.0	30.0	3002.40	4503.60
CBOD5	15.0	23.0	2251.80	3452.76
Phosphorus	1.0	1.5	150.12	225.18
pH	6.5 – 9.0			
E. coli (summer only)	126 #/100 mL	284 #/100 mL	--	--

The HRT pilot study showed that the effluent limits outlined in NPDES permit were achieved consistently during the wet weather testing period (Refer to the Pilot Study Report).

The pilot study showed that HRT system effluent quality, tested during the wet weather period, consistently achieves the effluent requirement specified in the North East Ohio Regional Sewer District (NEORSD) Consent Decree and in the NPDES permit (refer to the Pilot Study Report). The summary of the data from the actual and simulated wet weather events along with NEORSD Concent Decree and NPDES permit requirements are provided in Table 1. 3.

Table 1.3: Summary of Pilot Study Average Treated Effluent Parameters

Parameters	Effluent Quality		
	ACTIFLO®	NEORSD	NPDES(2)
TSS, mg/L	13.0±1.6	40	30
$CBOD_5$, mg/L	12.0±1.3	40	15
Phosphorus, mg/L	0.17±0.06	-	1
E. Coli, CFU/100 mL	15.0±4.2	126 / 284(1)	126 / 284(1)

Notes:

1) E.Coli: 126 colony forming units (CFU)/100 mL during recreational season geometric mean and 284 CFU/100 mL of rolling geometric mean for each 7-day period.
2) NPDES permit requirements for weekly loadings on TSS, CBOD and Phosphorus for blended wastewater treated effluent from HRT system and the secondary effluent from the Lakewood WWTP.

The estimated weighted average loading rate, obtained during the wet weather events for the combined total flow of 65 MGD, LWWTP and HRT facilties, is shown in Table 1.4 and is based on the following:

1. The WWTP primary and secondary treatment:
   a. Peak Hourly Flow: 30 MGD
   b. Treated effluent solids loading rates are based on weekly loads of TSS, CBOD5 and Phosphorus as shown in Table 1.2 above.
2. ACTIFLO® HRT system:
   a. Max wet weather flow rate: 35 MGD
   b. Treated effluent solids loading rates for TSS, $CBOD_5$ and Phosphorus are as shown in Table 1.3 above.

Table 1.4: Summary of Estimated WWTP Treated Effluent Solids Loadings for 65 MGD Peak Hourly Wet Weather Flow

WWTP Treatment	Flow Rate, MGD	Weighted Average	7-Day Loadings					
			TSS,		CBOD,		Phosphorus,	
			mg/L	lbs/day	mg/L	lbs/ day	mg/L	lbs/day
Primary+Secondary	30	46%	8.3	2,072	6.3	1,588	0.1	25
ACTIFLO®	35	54%	7	2,049	6.5	1,891	0.4	104
Total	65	-	7.6	4,121	6.4	3,479	0.24	129

Based on the pilot study results and projections for the full HRT system designed to treat 35 MGD wet weather flow, estimated effluent loading rates are in compliance with

NEORSD and weekly NPDES permit requirements. The summary of the HRT influent and effluent parameters are provided below:

Table 1.5: Lakewood Wet Weather HRT Influent / Effluent Design Parameters

Parameter	Units	Influent	Effluent, NPDES
Max Wet Weather Flow	MGD	35	-
Average TSS, mg/L	mg/L	100	30
Average $CBOD_5$, mg/L	mg/L	37	15
Phosphorus, mg/L	mg/L	4	1
E. Coli, CFU/100 mL	-	-	126 / 284

1.3 HRT System Implementation

The HRT system is designed as a high-rate physical/chemical ACTIFLO® process, capable of treating wastewater during dry-weather flows, operating as nutrient removal facility, and also treating peak wet-weather flows during wet weather periods. The ACTIFLO® process is capable of intermittent operation with short start up and shut down times, and designed with two parallel trains which will provide maximum operational flexibility of running one or both trains depending on the wastewater flow.

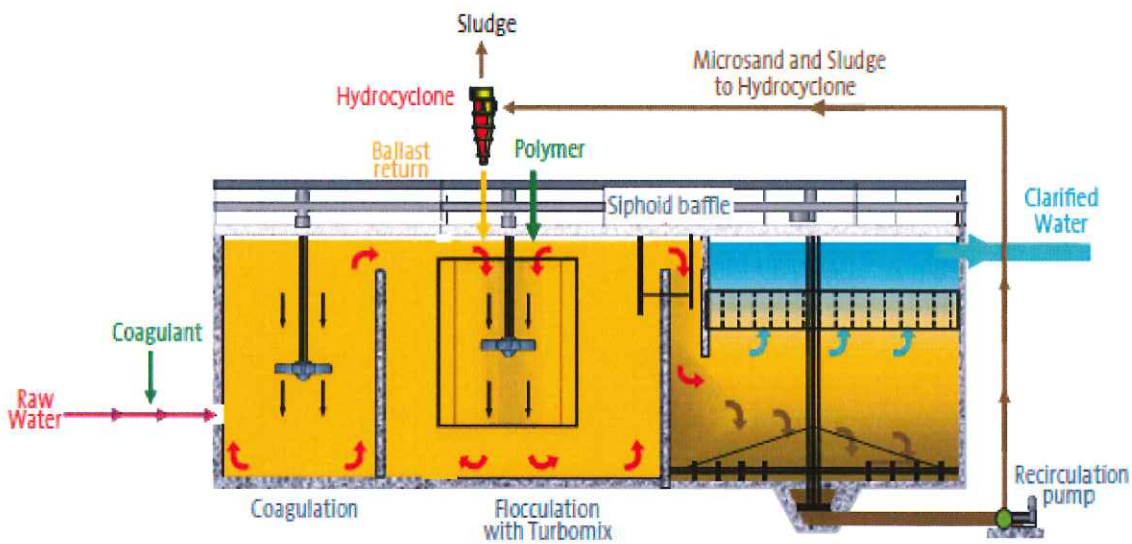

Figure 1.1: Veolia's ACTIFLO® High Rate Treatment Process

The ACTIFLO® process combines two water treatment technogies: ballasted flocculation and plate settling. The six (6) HRT system alternatives were reviewed and evaluated based on the location and number of ACTIFLO® trains. The HRT system in Alternatives No 1-5 was located on the northwest side of the existing Headworks Building, and in Alternative No 6 on the east side.

First, the ACTIFLO® and BIOACTIFLO® HRT treatment options were evaluated based on treatment efficiency, capital and Operation & Maintenance costs, and constructability economic analysis and with biological treatment, the BIOACTIFLO® process which combines biological treatment with the ACTIFLO® ballasted flocculation high-rate clarification. Biological treatment is provided by a solids contact basin which is used ahead of the ACTIFLO® high-rate clarification.

The variations for each developed HRT system alternative were as follows:

1. BIOACTIFLO® and single train of ACTIFLO®, located on northwest side.
2. BIOACTIFLO® with two (2) trains of ACTIFLO® system, located on northwest side.
3. BIOACTIFLO® with three (3) train ACTIFLO® system, located on northwest side.
4. ACTIFLO® with a single train, located on northwest side.
5. ACTIFLO® with two (2) parallel trains, located on northwest side.
6. ACTIFLO® with two (2) parallel trains, located on east side

Each of these alternatives included a new headworks building with the screen and grit removal processes prior to BIOACTIFLO®/ACTIFLO® treatment and new UV disinfection. The limitations of these alternatives were:

- Space constraints, preventing from future expansion
- Potential problem for influent flow splitting between the WWTP and new HRT system.
- Hydraulics
- HRT system constructability near existing processes equipment.
- Accessibility

Alternative No. 6 is the preferred, with the HRT system located directly east of the existing Headworks Building, with the new Headworks Building mirroring the existing Headworks Facility. Refer to Figures 1.1 through 1.3. This option includes:

- New influent mixing chamber
- New Headworks Facility with the screen and grit removal
- ACTIFLO®, 2 parallel trains
- UV Disinfection
- Effluent Diversion Chamber
- New siphon piping

Based on HRT Pilot Study Report stating that ACTIFLO® achieves the desired effluent quality at lower operational cost than BIOACTIFLO®, has smaller footprint and smaller maintenance cost. The ACTIFLO® system is recommended over BIOACTIFLO® as preferred HRT system (Alternative 6A).

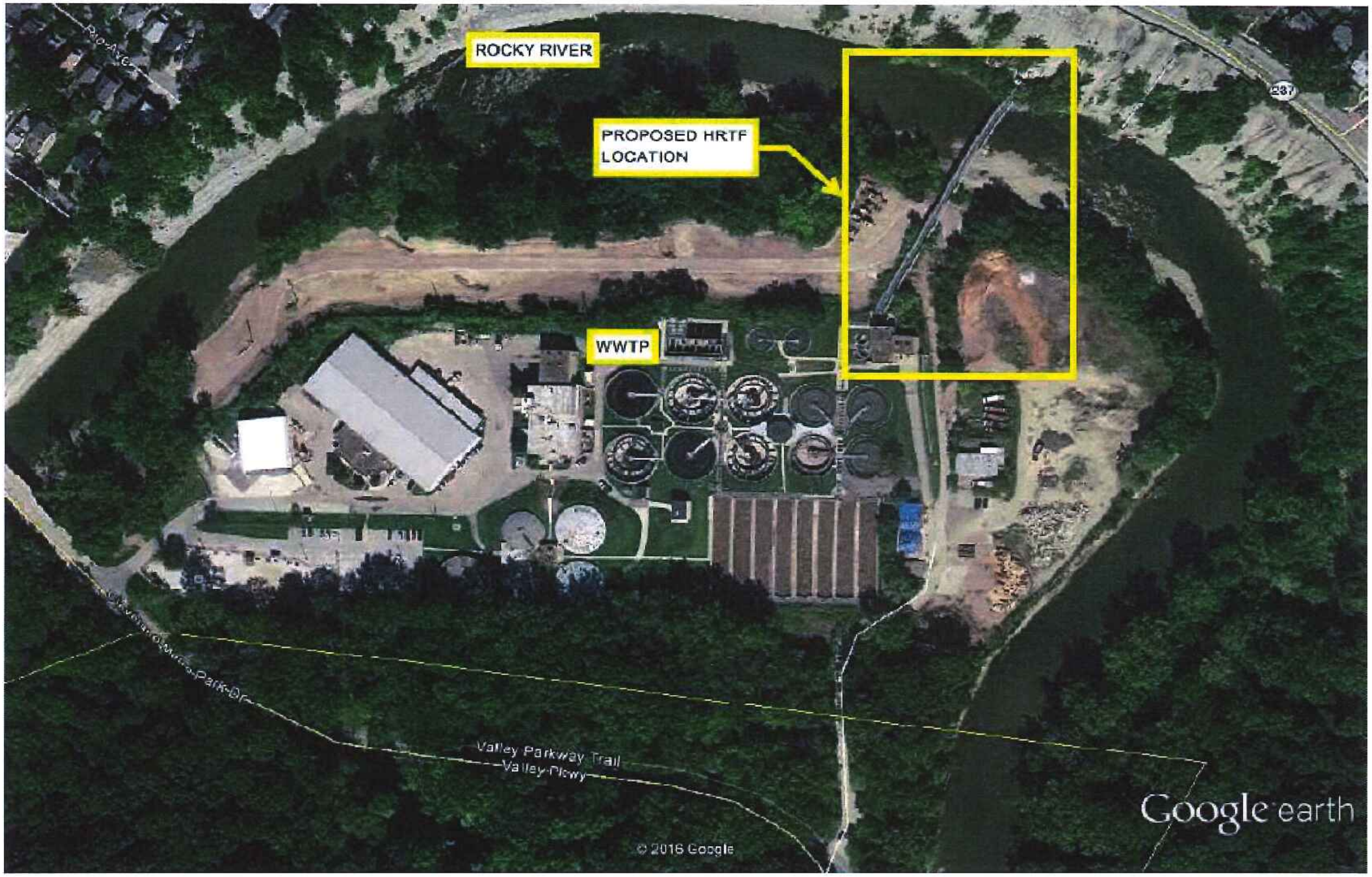

Figure 1.2: Aerial View of Lakewood WWTP with Proposed HRT System Location

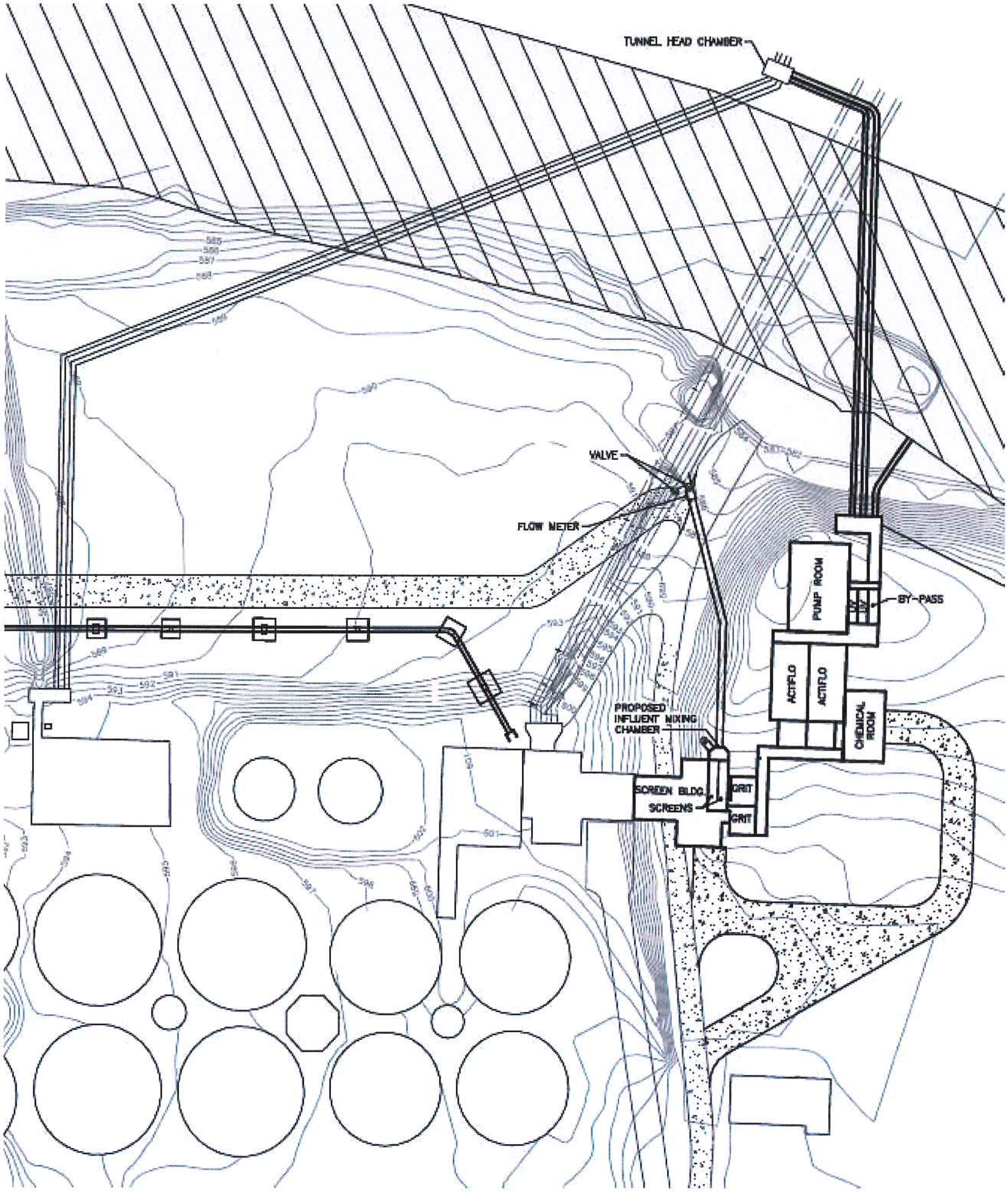

Figure 1.3: Alternative No. 6 HRT System Layout

The Alternative No. 6A offers the most operational flexibility by providing two (2) parallel treatment trains and convenience of construction. Three options are being considered to divert the high rate storm flows to the HRT system. Two options involve an installation of a new 48" diameter aerial sewer from the existing aerial sewer and the other would be a channel or pipe from the Influent Mixing Chamber. Refer to Chapter 3 for detailed discussion.

The new Headworks Facility includes dual screen influent channels with self-cleaning mechanical screens (Aqua Guard® UltraClean™ by Parkson Corporation) installed in each channel with a dedicated washer compactor unit (Aqua WashPress® by Parkson Corporation) under each screen. This arrangement is similar to the existing headworks facility and also provides redundancy for operation. The choice of equipment will also match existing plant equipment for operation and maintenance ease. Each screen capacity is sized to handle a peak flow of 35 MGD. Slide gates will be installed upstream and downstream of each screen to provide flow control and isolation of each screen during its maintenance. Ultrasonic level transducers will be provided to control screen and washer compactor operation (cleaning/washing cycle).

The screened wastewater flow after the screens is directed to the Grit Facility. The Grit Facility will consist of two hydraulically driven grit removal systems (Eutek HeadCell® by Hydro International). The separation of grit from the influent is accomplished using a series of polyethylene conical plates that are stacked to allow for a large amount of surface area in a small footprint. The polyethylene settling trays are submerged in a concrete chamber. Wastewater is introduced to each settling tray tangentially by a distribution header that provides equal distribution of flow. The induced vortex flow pattern causes solids to settle on the trays which then direct the solids to a collection sump for removal. Degritted wastewater flows out of the trays and into the grit chamber where it then flows over an effluent weir. Volatile solids are typically too large to settle on the trays and pass through the system. The settling trays have a hydrophobic surface that minimizes grease buildup and keeps them clean. Figure 1.4 below shows an illustration of the HeadCell® equipment.

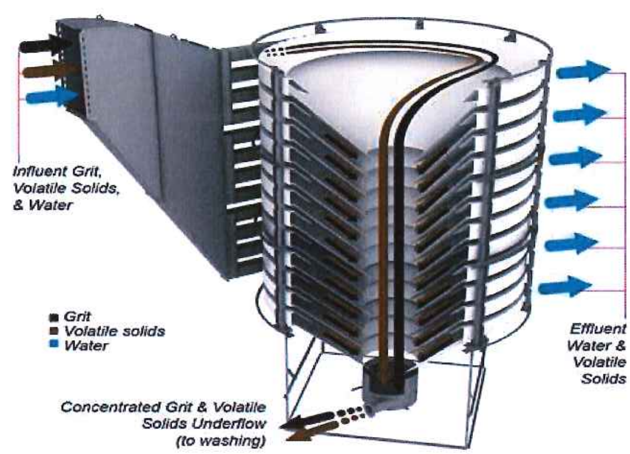

Figure 1.4: Headcell® Grit Removal System

The Eutek HeadCell® provides high removal efficiency, removing:

- 99.5% of 150 mesh size grit particles,
- 60% and more of total solids removal and
- 15% or less of volatile solids removal.

The HeadCell® has low energy consumption, accommodates high turndown rations, has no internal particles, and with small process footprint provides large surface area.

The HRT system general equipment list, process equipment capacities and estimated power requirements is provide in Table 1.8 below.

1.4 HRT System Solids Handling

The HRT system is expected to generate a solids flow rate of 0.515 MGD (360 GPM) at the 35 MGD treatment rate with a 1% peak solids content. The peak solids content is based on the maximum generated from the pilot testing conducted by Viola-Kruger during June of 2015. The average solids content was estimated to be 0.8% during the pilot study.

Since the sludge flow generated by the HRT system has already been screened and de-gritted it could be sent directly to the Primary Setting Tanks. The LWWTP sustained peak primary and secondary treatment capacity for wet-weather flows will be 30.0 MGD. If the HRT system solids are transferred directly to the Primary Settling Tanks the flow rate through the primaries will only increase 1.7%.

Table 1.6: HRT Sludge Flow to Primary Tanks

Maximum Flow	MGD	GPM	Percent
Existing WWTP Influent	30.0	20,833	98.3
HRT System Sludge	0.515	360	1.7
Total	30.515	21,193	100.0

Table 1.7: HRT Effect on Primary Clarifiers Surface Overflow Rate (SOR)

Flow Source	SOR (GPD/SF)	SOR 10-States Standards at PHF Rate (GPD/SF)
Existing WWTP Influent	2,260	-
HRT System Sludge	39	-
Total	2,299	2,000

The Primary Setting Tanks have a calculated peak Surface Overflow Rate (SOR) of 2,260 gallons per day per square foot (GPD/SF) based on 30 MGD. The HRT system sludge flow will contribute an additional 39 GPD/SF yielding a total of 2,299 GPD/SF. The calculated SOR exceeds the 10-States Standards recommended design standard of 2,000 GPD/SF. However, a stress test conducted in 2007 concluded that the clarifiers could handle a sustained flow rate of 3,014 GPD/SF with no notable increase in solids carry-over.

The 0.8% average dry weight solids estimated to be generated by the HRT system is equivalent to 30 grams dry solids per gallon or 0.0661 pounds dry solids per gallon. At the 35 MGD (360 GPM) flow rate the additional solids will be 24 pounds dry solids per minute or 17.3 tons dry solids per day. This will be the estimated average additional load sent to the Anaerobic Digesters when the HRT system is in operation.

Table 1.8: HRT System General Equipment List

№	Equipment	No. of Trains	No. of Units per Train	Size	Capacity, per unit	Drive, Hp		Manufacturer
						per Unit	Total	
1.	Screening							
	Screen	2	1	5.5' x 13'x 75deg Openings spacing: 6 mm	35 MGD	2	4	Parkson, Aquaguard: AGUC-MN-A
	Screen Press	2	1			2	4	Parkson, Aqua Press: AWP8-4
2.	Grit Removal							
	Grit Tanks	2	1	12'-dia x 19' H	27 MGD	-		HydroGrit
	Grit Pump	2	1	-	250 gpm	15	30	--
	Grit Classifier	1	-	-		1	1	--
	Solids Conveyor	1	-	-		1	1	--
3.	ACTIFLO System							
	ACTIFLO	2	1		17.5 MGD	-	-	Kruger
	Coagulation Tank Mixer	2	1	20' x 20' x 28'	-	12.5	25	--
	Maturation Tank Mixer	2	1	11.4' x 20' x 28'	-	1-5	30	--
	Settling Tank Scraper	2	1	29.5' x 20' x 28'	-	5	10	--
	Sand Recirculation/Sludge Flow Pump	2	3	-	550 gpm	50	300	--
4.	Disinfection System							
	UV Disinfection	2	1	13.5'(L)x4.3'(W) x 7.5'(D) 2 banks per channel, 72 lamps total	17.5 MGD	13.4	26.8	Trojan

CHAPTER 2 – IDENTIFICATION OF AFFECTED UTILITIES

2.1 Utility Interferences

A thorough review was conducted of existing WWTP drawings from past and current projects. The site plans in the following drawing sets were reviewed:

- Improvements to Sewage Treatment Plant, August 1938 (MacDowell)
- Sewage Treatment Plant Improvements, 1961 (Woodruff)
- Disinfection Improvements, June 1993 (Benza)
- Aerial Sewer and Headworks Improvements, December 2001 (URS)
- Secondary Digester Improvements, 2009 (CT Consultants)
- West End CSO Elimination Project, 2015 (CT and AECOM)

The review indicates that there will be no interferences presented by existing WWTP piping or other public utilities. However, the Ohio Utilities Protection Service (OUPS) should be contacted prior to any excavation in the proposed HRT system area.

2.2 Existing Plant Utilities

Existing plant utilities that will be needed for all of the HRT system process systems are Spray Water, Plant Water, Tank Drain (WWTP sewerage), and electrical power. The Spray Water is final clarifier effluent that is collected and pumped back through the WWTP to uses in various processes.

2.3 Water Requirements

The mechanical screens have spray cleaning systems and will need 35 GPM at 40 PSI each when they are in operation.

The washer compactor has a wash zone to remove organics and will need 10 GPM at 60 PSI each when in operation.

The grit removal systems will need fluidizing water injected into the bottom of the grit collection tanks. The amount required is 20 GPM at 50 PSI each.

The ACTIFLO® process will require up to 35 GPM for diluting and about 45 GPM for delivering coagulating, flocculating, and de-foaming chemicals to the process. A maximum of 80 GPM of good, clean water will be required.

Table 2.1: Estimated Water Requirements

Description	Quantity	Spray Water (gallons)	Plant Water (gallons)
Screens[1]	2	72	-0-
Washer/Compactors[1]	2	20	-0-
Grit Removal Tanks[2]	2	40	-0-
ACTIFLO process[2]	2	-0-	75
Total[3]		132 (0.2 mgd)	75 (0.1 mgd)

Notes:
1 – Peak but intermittent water requirement.
2 – Continuous water maximum requirement.
3 – Maximum water flow added to the process is 207 GPM (0.3 MGD)

The WWTP Spray Water will require filtering before use. A common filtering system can be installed on the main supply pipe entering the HRT system. It is recommended the filter has an automatic backwashing feature.

It is not known at this writing if there will be environmental facilities (such as restrooms) within the HRT system requiring a potable water supply.

2.4 Tank Draining

Floor drains and provisions for draining all channels and tanks will be provided. The existing tank draining system will be investigated in detail to see if it can accommodate the HRT system. If the existing tank draining system cannot then a new wet well with a pumping system may be needed. It may be possible to utilize the grit removal pumps if this becomes a necessity. Floor drains can drain back into the wastewater channels.

2.5 Electrical Power

Electrical power requirements are discussed in more detail in another section below.

Chapter 3 – Site and Civil Design Issues

3.1 HRT System Influent Sewer

Three options are being considered to divert the high rate storm flows to the HRT system. Two options involve a new aerial sewer from the existing aerial sewer and the other would be a channel or pipe from the Influent Mixing Chamber. See Appendix C for plan details of the influent sewer options.

3.2 Aerial Influent Sewer with Splitter Box

The aerial sewer will span from the existing east side 48" aerial influent sewer over to the RTF's Influent Chamber.

The pipe will be approximately 155' long, 48" in diameter, and will require at least two piers for support. It would be advisable to construct as few piers as possible in the floodway. The existing aerial influent sewer piers, specifically Piers 2 and 3 will be analyzed to see if they will be able to support the new pipe junction.

Pipe material selection for the aerial sewer will be determined once a final supporting method is selected. Ultraviolet (UV) protection and watertight joints will be necessary since the pipe will be exposed to the elements and will be adjacent to a natural waterway. A maintenance walkway and access port will be built into the structure for long-term inspections and maintenance. Pipe materials to be considered include reinforced concrete pipe (RCP), centrifugally cast fiberglass reinforced polymer mortar pipe (CCFRPMP), ductile iron pipe (DIP), and lined steel pipe. The 10 State Standards recommends DIP with mechanical joints for aerial crossings.

In order to maintain the option of bringing flow into either the AATP or the HRT system a means of flow diversion is required. Valves or a diversion structure (splitter box) would be needed. Valves will not be considered here as they are cost prohibitive. They would cost around $150,000 each and weigh 10 tons apiece requiring a rather large and robust supporting structure. An elevated structural concrete splitter box with two motor operated slide gates will be considered for flow control.

Similar to the other river crossings, flow in the aerial sewer will need to be protected from freezing temperatures. The sewer will be designed with insulation to reduce the potential for freezing, specifically for dry weather flows. The aerial sewer pipe will be designed with at least one maintenance access port.

3.3 Dedicated Influent Sewer

This option would use the same aerial sewer pipe as described above but it would be without the diversion structure. The HRT system influent would come directly from the Influent Head Chamber without the option of directing flow to the WWTP. The remaining aerial sewer into the WWTP would be abandoned. Flow to the HRT system would be controlled at the Influent Head Chamber with the existing slide gates and/or a new flow control weir.

3.4 Sewer from WWTP Influent Mixing Chamber

An open channel flume or a pipe may direct flow from the WWTP's Influent Mixing Chamber to the HRT system influent point. A flume could also serve as a location to measure the flow rate into the HRT system. The means to divert flows beyond 30 MGD to the HRT system will need to be incorporated in the Influent Mixing Chamber.

3.5 High Rate Treatment Facility

The HRT system will consist of eight main structures that will be mostly constructed out of reinforced structural concrete and concrete masonry units. The structures are an influent chamber, two screening channels in a building, two grit removal tanks, a chemical building, the ACTIFLO® process tanks in two multi-chambered trains, two ultraviolet disinfection channels with a by-pass channel, two effluent channels, and an effluent diversion chamber.

The site's underlying soils will need to be investigated for their ability to support these structures. Approximately five soil borings are recommended to be performed under the HRT system footprint. The borings should penetrate to at least 15' below the deepest structure. This will require several of the borings to be approximately 25' to 30' deep. A geotechnical firm will be consulted to investigate the subsurface soils and provide structural foundation recommendations.

In addition to the structures identified above additional site features such as access drive(s), side walk(s), signage, landscaping, and yard fencing and lighting will need to be considered.

3.6 River Crossing Effluent Siphons

The HRT system's effluent will be discharged from the Effluent Diversion Chamber to the WWTP's existing Tunnel Head Chamber on the other (north) side of the river. The river crossing will consist of two pipes placed under the river in a depressed sewer, more commonly referred to as a siphon sewer. There will be two pipes utilized depending on the discharge flow rate. The pipes are estimated to be 30 inch and 36 inch in diameter and each are expected to be approximately 400 ft long.

Pipe material selection for the siphon sewers will be determined once a subsurface soils investigation has been completed. Pipe materials to be considered include pre-stressed reinforced concrete pipe (PRCP), centrifugally cast fiberglass reinforced polymer mortar pipe (CCFRPMP), and ductile iron pipe (DIP).

Approximately the first 100 ft and last 50 ft of these pipes can be installed by traditional open cut methods. The middle 250 ft of river crossing pipe will require jack-and-bore installation requiring jacking and receiving pits with a driven steel casing.

3.7 Overflow Pipe

The overflow pipe will discharge from the Effluent Diversion Chamber to the Rocky River. The pipe is 54 inch in diameter and will be approximately 125 ft long. Pipe materials to be considered include reinforced concrete pipe (RCP) and centrifugally cast fiberglass reinforced polymer mortar pipe (CCFRPMP). This pipe can be installed by traditional open cut method.

The pipe outlet will require a reinforced concrete headwall and some form of stream bed protection such as a concrete pad or large diameter rock channel protection. The outfall point will also need to be identified with a sign printed with the required National Pollutant Discharge Elimination System (NPDES) permit information.

CHAPTER 4 – ELECTRICAL DISTRIBUTION

4.1 Existing Conditions

The LWWTP electric service is provided by the Cleveland Electric Illuminating Company (C.E.I.). Existing plant drawings show a 750 KVA pad-mounted transformer with 480V, 3Phase, 3 Wire secondary. The transformer feeds the Main Switch Gear with a bus rating of 3000A, protected by a set of 2000A fuses.

Power is distributed to motor control centers around the plant from the Main Switch Gear via underground electric feeders in conduit. Some of the conduits pass through the existing tunnels. The existing motor control center closest to the proposed HRT facility is MCC-SG, located in the existing Headworks Building. This motor control center is fed via 600A feeder from the main switch gear. Per the 2001 Headworks Upgrade drawings, the connected load at MCC-SG is 333A.

4.2 Analysis

The Electrical Demand data for the last five years shows that the peak power demand for the plant is 778 kVA, at 94% PF, which equates to 936A at 480V, 3phase, and approximately 47% plant wide load diversity. This data shows that the main plant switch gear has adequate capacity to handle a substantial increase in electrical load that may be expected with a plant upgrade. The 750 kVA transformer, however, may be undersized already and consideration should be given to replacement. As part of the future construction project coordination with the power utility will be necessary. The design engineer will communicate the projected load increase to C.E.I. and the utility will perform the transformer upgrade, if necessary. Applying the plant wide diversity figure of 47% to the MCC-SG gives 157A of expected electrical demand at that motor control center. This shows that MCC-SG will be able to support the connection of the new loads associated with the HRT upgrade.

4.3 Proposed Approach

As part of the HRT system a new electric/control room will be constructed where the electrical distribution equipment and control panels for the new equipment will be housed. It is expected that a multi-section motor control center will be used for power distribution and control for the majority of the new equipment. The projected connected load for the HRT system is 300 kVA. This includes all of the process equipment, lighting, HVAC and other miscellaneous loads.

A new fused disconnect switch will be installed inside the MCC-SG and a new three phase feeder will be routed to the new HRT system electric room.

CHAPTER 5 – INSTRUMENTATION AND CONTROL PHILOSOPHY

HRT will be utilized to treat wet weather flow during storm events and maintenance of HRT will require weekly operation of the system. The system is designed such that it is to be operated in two parallel trains. Each train consists of a screen, a headcell, an ACTIFLO train and a UV channel. The operation of the two trains will be based on the level of flow into the system. Each train will treat up to 17.5 MGD, giving the system a total flow capacity of 35 MGD.

Automatic electrical gates will be used to control the path of the flow therefore gates will control which train the flow enters. From start-up to 17.5 MGD, flow will proceed through 1 train. When the flow exceeds 17.5 MGD, both trains will be used.

5.1 HRT Start-Up Procedure (Auto Mode)

A. Prior (8-12 hours) the wet weather event:

1. Open the Influent line to HRT
2. Select the Train 1/2
3. Establish the flow path
   a. Train 1:
      - Open gates: SG-#1, SG-#3, SG-#5, SG-#7, SG-#9, SG-#11
      - Close gates: SG-#2, SG-#4, SG-#6, SG-#8, SG-#10, SG-#12, SG-#13
   b. Train 2:
      - Open gates: SG-#2, SG-#4, SG-#6, SG-#8, SG-#10, SG-#12
      - Close gates: SG-#1, SG-#3, SG-#5, SG-#7, SG-#9, SG-#11, SG-#13
   c. Check gate positions

B. HRT Start-Up of selected train occurs when flow level in the Influent Mixing chamber reaches a pre-set water level, then selected train starts operation:

1. Screen No. 1/2 – Auto Start
2. Grit system No. 1/2 – Auto Start
3. ACTIFLO system No. 1/2 - Auto Start
   a. Coagulation and polymer injection, recirculation pump
4. UV Disinfection No.1/2 – Auto Start
5. If water level in the Influent Mixing Chamber continues to rise, reaching Water Level elevation equivalent to 17.5 MGD influent flow, the second train shall be activated in Auto Start mode.

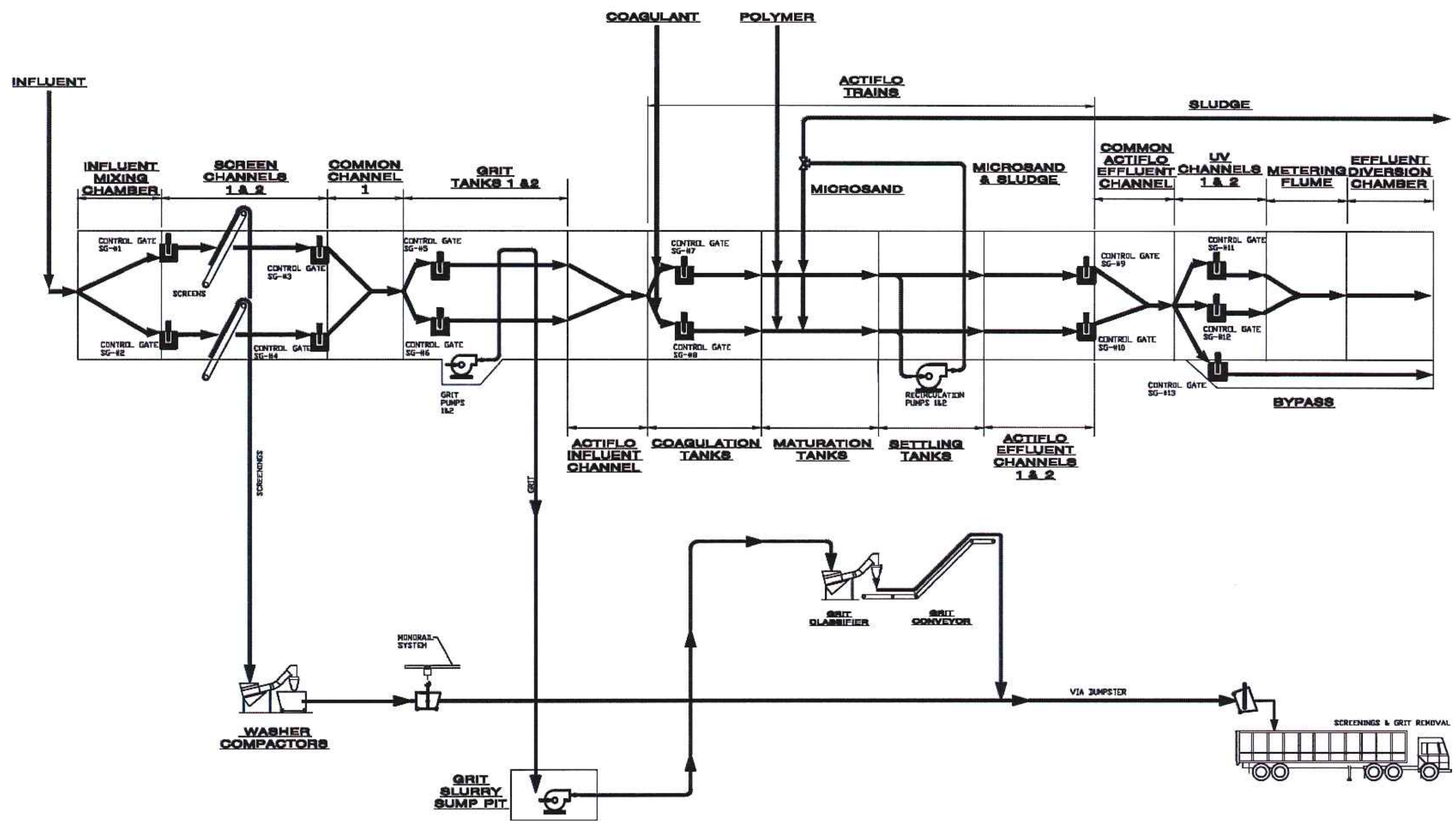

Figure 5.1: Instrumentation and Control Diagram

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Table 5.1: Slide Gates List

Gate Number	Control
SG # 1	flow from the influent mixing chamber to Screen Channel 1
SG # 2	flow from the influent mixing chamber to Screen Channel 2
SG # 3	flow from Screen Channel 1 to common channel 1
SG # 4	flow from Screen Channel 2 to common channel 1
SG # 5	flow from common channel 1 to grit tank 1
SG # 6	flow from common channel 1 to grit tank 2
SG # 7	flow from common ACTIFLO influent channel to ACTIFLO Train No. 1
SG # 8	flow from common ACTIFLO influent channel to ACTIFLO Train No. 2
SG # 9	flow from ACTIFLO train 1 to common ACTIFLO effluent channel
SG # 10	flow from ACTIFLO train 2 to common ACTIFLO effluent channel
SG # 11	flow from common ACTIFLO effluent channel to UV channel 1
SG # 12	flow from common ACTIFLO effluent channel to UV channel 2
SG # 13	flow from common ACTIFLO effluent channel to bypass channel

CHAPTER 6 – COST-BENEFIT ANALYSIS

A Cost-Benefit Analysis comparing operational and maintenance cost with pollutant reduction rate was performed using information provided by the Viola- Kruger pilot testing, the various equipment manufacturers, and professional experience with the various processes involved.

6.1 Operating Cost

Operating costs are based on the 35 MGD maximum daily flow rate and the pollutant load encountered during the pilot testing conducted by Veolia-Kruger during June of 2015.

The major portion of the operating costs comes from just the operation of the ACTIFLO® process. Table 6.1 presents a breakdown of the operating costs at 35 MGD.

Table 6.1: **Estimated ACTIFLO® System Operating Cost at 35 MGD**

Item	Estimated Average Dose[1]	Estimated Unit Cost[2]	Estimated Daily Operating Cost[4]
Polymer	1.00 mg/L (dry)	$ 4500 / ton	$656.78
Sand Loss	2.0 mg/L	$ 200 / ton	$58.38
Coagulant (Aluminum Sulfate)	75 mg/L (dry)	$ 450 / ton	$4,925.81
Power Consumption	123 Hp	$ 0.08 / kW-hr	$158.49
Total Estimated Daily Operating Cost[4]			$5,799.46
Operating Cost per 1,000 Gallons			$0.166

Notes:

1) Total operating HP used to calculate kW-hr assumes power draw of 90% of total nameplate HP and does not include standby equipment.
2) Dosages based on Kruger pilot testing during CSO wet weather events (6/16, 6/29) to achieve NPDES limits for CBOD, TSS, and Phosphorus.
3) Estimated chemical and power costs may vary based on regional contract pricing.
4) For nominal capacity operating 24 hours per day.

The ancillary operating costs during HRT system operation consists of both of the screens and washer compactors in operation as well as the solids transfer conveyor, both grit pumps, the grit classifier, and the UV disinfection system. Table 6.2 presents a breakdown of the ancillary equipment operating costs at 35 MGD.

Table 6.2: **Estimated Ancillary System Operating Cost at 35 MGD**

Equipment	No of Units	Total, Hp	Cost
Screens	2	2	$2.58
Washer Compactor	2	2	$2.58
Solids Conveyor	1	1	$1.29
Grit Classifier	1	1	$1.29
Grit Pumps	2	15	$19.33
UV Disinfection (as HP)	2	26.8	$34.53
Total Requirements[1] per Day:		47.8	$62
Total per 1,000 Gallons:		0.00144	0.0018
Power Cost: $ 0.08 / kW-hr			
1) Total operating HP assumes power draw of 90% of total nameplate HP and does not include standby equipment.			

The estimated cost to operate the HRT system during the peak flow event of 35 MGD is $6,448 per day or $0.13 per 1,000 gallons of inflow treated. Table 6.3 presents the total operating cost summary for the HRT system operating at 35 MGD.

Table 6.3: **Estimated Total Operating Cost at 35 MGD**

Description	Daily Cost	Cost per 1,000 gallons
Screening, Grit Removal, UV[1]	$62	$0.002
ACTIFLO® [1,2]	$5,800	$0.166
Total Operating Cost	$5,862	$0.168
with Contingency at 10%	$6,448	$0.18

Notes:

1) Power costs at 0.08 per kilowatt-hour
2) ACTIFLO® chemical dosages based on Kruger pilot testing during CSO wet weather events (6/16, 6/29) to achieve NPDES limits for CBOD, TSS, and Phosphorus.

6.2 Maintenance Cost

An attempt has been made to try and quantify annual maintenance costs even though they are rather minor when compared to the overall operating costs of the HRT system. Maintenance items taken into consideration include regular inspections, tank cleaning after events, equipment lubrication, screen chain replacement, and UV disinfection bulb replacement.

Weekly inspections will take approximately an hour or two. At an employee hourly rate of $50/hour the annual cost will be $5,200.

The HRT system will need to be operated for a short period of time on an approximately weekly basis to ensure timely operation at the beginning of storm events. The weekly operation will ensure that the system is in a "stand-by" position. Taking the daily operating cost as mentioned in the previous section above and operating the system for 8 hours (1/3 of a day) once a week yields a weekly cost of $1,954 or an annual cost of $101,608.

Tank cleaning and general clean-up after HRT system operational events would occur approximately ten times per year. With two employees taking eight hours to conduct cleaning activities that yields 160 hours/year. At an employee hourly rate of $50/hour the annual cost will be $8,000.

Equipment requiring lubrication includes the screens, the washer-compactor, the grit classifier, and the solids transfer conveyor. Since this equipment will never be in continuous operation it may only need serviced once or twice per year. A conservative estimate would be no more than 16 hours/year. At an employee hourly rate of $50/hour the annual cost will be $800.

The UV bulbs should last a long time because they will only be operated periodically. A worst case scenario would be five bulbs failing per year. At an approximate cost of $300 each that yields a total annual cost of $1,500.

Miscellaneous items such as general building maintenance (HVAC, plumbing, etc.), housekeeping, chemical inventory accounting, etc. will need to be performed. Estimating approximately two hours per week for such tasks and at an employee hourly rate of $50/hour the annual cost will be $5,200.

Table 6.4: **Estimated Maintenance Costs**

ITEM	ANNUAL COST	DAILY COST	COST PER 1,000 GALLONS
Inspections	$5,200	$14.25	$0.0004
Weekly Operation	$101,608	$278.38	$0.0080
Cleaning	$8,000	$21.92	$0.0006
Lubrication	$800	$2.19	$0.0001
UV Bulb Replacement	$1,500	$4.11	$0.0001
Miscellaneous	$5,200	$14.25	$0.0004
TOTAL	**$122,308**	$335	$0.0096

In summary the annual maintenance cost for the HRT system will be approximately $122,308 and the cost for 1,000 gallons of treatment is approximately $0.01.

6.3 Cost per Pollutant Load Removed

The total of the Daily Operating and Maintenance costs, $6,448.00 and $355.00 respectively, estimated in the previous sections is $6,803.00.

Table 6.5: **Estimated Total O&M Cost at 35 MGD**

Description	Daily Cost	Cost per 1,000 gallons
Operations	$6,448	$0.18
Maintenance	$335	$0.01
Total Operating Cost	$6,803	$0.19

The primary pollutants to be removed by the HRT system are total suspended solids (TSS), biochemical oxygen demand (CBOD), and phosphorus (P). The projected amounts of those pollutants to be removed on a daily basis at the 35 MGD flow rate and the estimated costs to remove them are presented in the following table.

Table 6.6: **Estimated Total Daily Operating Cost at 35 MGD**

Parameters	Influent		Effluent		Solids Removed	Total Daily Operating Cost, $/day
	mg/L	ppd	mg/L	ppd	ppd	
TSS	100	29,190	30	8,757	20,433	0.18
CBOD	37	10,800	15	4,378	6,422	0.06
Phosphorus	4	1,168	1	292	876	0.008
Totals		41,158		13,427	27,731	**0.25**

The estimated total cost to remove a pound of the pollutants is $0.25. Estimated daily operating cost of TSS, CBOD and Phosphorus removal individually was calculated based as a fraction of total solids removed (27,731 ppd) and estimated total daily operating cost ($0,25 /day).

CHAPTER 7 – COMMUNITY/STAKEHOLDERS ISSUES

CHAPTER 8 – HYDRAULIC MODELING

CHAPTER 9 – PERMITTING ISSUES

Various environmental and construction permits are going to be required to complete the proposed effluent siphon sewer under the Rocky River. At least five (5) government agencies have been identified that may have some jurisdiction over the project. The individual agency involvement is explained in more detail below.

9.1 Ohio Department of Natural Resources, Office of Coastal Management (OCM)

The land under the Rocky River was historically submerged and is within the State of Ohio's Designated Coastal Management Area. The existing effluent siphon sewer was probably granted permission by the State to cross the river by what is called a Submerged Land Lease. The OCM has been given legislative authority to administer the Submerged Land Lease program.

A Submerged Lands Lease is required for the area occupied by wharfs, docks, marinas, piers, boat ramps, seawalls, breakwaters, stone revetments, groins, jetties, water intakes, utility lines, and any other structures or artificially placed fills that extend past the natural shoreline.

Ohio's Designated Coastal Management Area extends from the international boundary line in Lake Erie between the United States and Canada, and from the boundary lines in Lake Erie between Ohio and Michigan on the west and Ohio and Pennsylvania on the east, landward to the extent necessary to include shorelands which have a direct and significant impact on coastal waters. It includes the waters of Lake Erie, the islands in the lake, and the lands under and adjacent to the lake, including transitional areas, wetlands and beaches.

Ohio's Designated Coastal Management Area includes land and water areas from the counties of Lucas, Wood, Ottawa, Sandusky, Erie, Lorain, Cuyahoga, Lake and Ashtabula. Of these nine counties all but Wood County are adjacent to Lake Erie. A portion of the Maumee River and its riparian areas in Wood County are included in the designated area. Sandusky Bay and Maumee Bay are considered part of Lake Erie.

A new sewer line under the river may require either a new submerged land lease or a modification of a possibly existing submerged land lease that will accommodate the new sewer. It is possible that this existing submerged land lease could be modified to include the new sewer line; however, since the legal description for any existing lease is specific to the existing sewer line, the procurement of a new submerged land lease may be the best option. A new lease requires the completion of an application, a survey and legal description of the area proposed to be leased, a resolution from the municipal authority governing the area to be leased, construction drawings for the structure to be placed within the leased area, and a copy of the deed for the owner's property adjacent to the leased area.

In addition to the Submerged Land Lease, the City may also have to submit a Coastal Consistency Certification Statement ("Coastal Consistency") to OCM as a part of the permit process. This is a requirement of the Coastal Zone Management Act, which requires that federal actions having reasonably foreseeable effects on any land or water use or natural resources of Ohio's designated coastal management area must be consistent with the enforceable policies of the Ohio Coastal Management Program. Due to the fact that this project will also require a U.S. Army Corps of Engineers (USACE) Section 10 Permit, it will trigger the federal action nexus referenced above. The Coastal Consistency form is a brief document requiring basic project information and listing all other permits, licenses, leases and other authorizations required in conjunction with the project.

One additional permit that may also be required of OCM in conjunction with this project is a Shore Structure Permit. These permits are required of OCM for projects that involve the construction of any feature intended to control erosion, wave action or flooding along or near the shoreline with Lake Erie. As such, if the sewer line will require the construction of a headwall or similar structure adjacent to or near the shoreline in order to prevent erosion of or around the sewer line, a Shore Structure Permit may be necessary.

It is estimated that OCM permitting, not inclusive of surveying activities, will be less than $10,000.

9.2 United States Department of Defense, Army Corp of Engineers (USACE)

The USACE has legislative jurisdiction over all activities conducted in navigable waters and wetlands in the United States. A construction permit will be required by Section 10 of the Rivers Harbors Act. Such a permit requires completion of an Application for Department of the Army Permit, construction drawings, site mapping and cross sections, aquatic resource assessments and quantification of impacts, avoidance/minimization summary, and proposed mitigation, if necessary.

Depending on the method required to install the new sewer line, permits may also be required under Sections 404 and 401 of the Clean Water Act if fill material will either be dredged or discharged into waters of the U.S., including Lake Erie. If dredging or filling activities are required for the project, it may qualify for a Nationwide 12 Permit (Utility Line Activities), if certain conditions are met, including the project resulting in less than a 0.5-acre loss in waters of the U.S. This permit requires disturbed site restoration to preconstruction conditions and USACE approval (sign-off) after construction completion. Nationwide Permits are less rigorous and typically result in a faster review period than an Individual Permit.

As a part of the ecological analysis for the project it is important to keep in mind that linear projects, such as a water line, are analyzed by USACE and/or Ohio EPA in their entirety. That means that if there will also be streams or wetlands, including isolated wetlands that will be crossed or impacted by the water line on land, that such impacts should also be included within the water quality certification package. Those additional impacts, if any, will also be included within the analysis of whether a Nationwide Permit or Individual Permit is warranted.

The USACE District Engineer will make a decision determining their degree of jurisdiction over the project and what permits may ultimately apply.

If Section 10, 404 and 401 permits are all required for this project, permitting costs are estimated to be between $35,000 and $50,000. This includes the cost to do the ecological assessments, but it does not include the costs to do specialized endangered species surveys, such as freshwater mussel surveys, if required and as further discussed below. The above cost range also does not include the cost to do species relocations or resource mitigation of any type, if required by the regulatory agencies. Such estimates cannot be developed until the scale of the ecosystem impacts, if any, are determined.

9.3 United States Fish and Wildlife Service (FWS)

USACE will have to formally consult with the USFWS as a part of the permitting process, as required under the provisions of section 7(a)(2) of the Endangered Species Act (ESA), in order to determine that issuance of the permits will not lead to actions that are likely to jeopardize the continued existence of any listed species.

As a part of the Section 10 and 401/404 water quality certification package, the City will have to do a preliminary assessment of endangered species that could be affected by the project. These include, but are not limited to Indiana and Northern Long-Eared Bats, freshwater mussels, migratory birds and near-shore plant species. The terrestrial component of the project would definitely be within the area of the Indiana and Northern Long-Eared Bats. As such, any potential roost trees that could be affected by the project would be noted by the ecological consultant during field activities. The project is not located within the boundaries of the Lake Erie Water Snake (LEWS), which should not be of concern to the project. It is possible that USFWS may request additional field surveys if certain species, such as freshwater mussels, are believed to exist within the project area.

If listed species are present, the USFWS will ultimately determine if the water line development activities would affect them. If it is determined that the water line is not likely to adversely affect such species (e.g., the effects are beneficial, insignificant, or discountable), no further consultation is required.

If it is determined that the new sewer line is likely to adversely affect a listed species or designated critical habitat, a formal consultation is initiated. The ESA requires that consultation be completed within 90 days, and the regulations allow an additional 45 days for the USFWS to prepare a biological opinion. The analysis of whether or not the proposed action is likely to jeopardize the continued existence of the species or adversely modify designated critical habitat is contained within the biological opinion. If a jeopardy or adverse modification determination is made, the biological opinion must identify any reasonable and prudent alternatives that could allow the project to move forward, make a determination as to whether or not a permit will be required, or prohibit the project from taking place.

For example, if an endangered freshwater mussel species is present within the path of the proposed water line, USFWS may seek the relocation of the water line or, if that is not feasible, they may require the relocation of the mussel beds themselves. Additional, off-site mitigation is sometimes required in such circumstances. If is worthwhile to note that it is rare that USFWS would altogether prohibit the issuance of a permit for a project such as this.

It is also important to note that the ODNR Division of Wildlife (DOW) has established statewide in-water work exclusion dates, which vary across Lake Erie and which can be modified annually. It will be important to schedule in-water construction activities so as not to coincide with these exclusion dates.

The anticipated costs above include the cost to do a preliminary endangered species analysis of the project area. If such species are likely to be present and if USFWS requires additional and specialized surveys for them, such costs would have to be determined on an individual basis.

9.4 State of Ohio, State Historic Preservation Office (SHPO)

The SHPO will need to be notified because there are many nearby sites that have been designated historical by the National Park Service's National Register of Historic Places. One critical area to note is the Clifton Park Lakefront which is about one-mile down river. The SHPO is the state agency that oversees historic preservation efforts in Ohio.

The anticipated costs above include the cost to do a preliminary cultural resources review within the project area. If additional or more specialized cultural resources surveys or studies are required by SHPO in conjunction with this project, the cost estimates for those activities would need to be determined on a case by case basis.

9.5 Ohio Environmental Protection Agency (OEPA), Division of Surface Water

The OEPA has legislative authority requiring all construction plans for all public wastewater systems to be approved by their agency. An application package will need to be prepared and submitted for their review. The submittal will consist of an application fee, a completed "Permit to Install" (PTI) form, constructions plans, and technical specifications.

The package will then be submitted to the Northeast District Office in Twinsburg and upon plan approval the OEPA Director will issue a letter authorizing construction.

The WWTP's National Pollutant Discharge Elimination System (NPDES) permit will require modification because the HRT system will require an overflow discharge outfall to the Rocky River. This modification may be submitted concurrently with the PTI application or submitted separately at an early date.

The OEPA also has legislative authority requiring that all construction activities that disturb over one (1) acre of ground must get a permit to discharge storm water from the construction site. It has been estimated that construction activities to build the HRT system will disturb approximately 0.75 acres of ground so a discharge permit may not be needed.

To get permit coverage, if necessary, a Storm Water Pollution Prevention Plan (SWP3) will need to be developed for the construction site and a Notice of Intent (NOI) requesting coverage for discharges under the general permit will need to be completed and submitted to OEPA. Then the OEPA approval letter stating that construction activities are covered under the storm water general permit must be received before construction commences.

CHAPTER 10 – PLANNING LEVEL CONSTRUCTION COST ESTIMATE

10.1 Cost Estimate

A planning level cost estimate was developed for the two-train HRT system employing the ACTIFLO® process. The estimate includes all site work, tank and channel structural concrete, building masonry, grating and stairs metal fabrications, process equipment, electrical, mechanical, and plumbing costs. The costs for the various process equipment components were obtained directly from the manufacturers in the form of recommendations with budgetary costs.

The largest portion of the Site Construction cost is made up of the influent and effluent sewers. They account for about two-thirds of the total site work cost. The largest Concrete item cost is the ACTIFLO® process concrete tanks, accounting for over half of the total concrete cost. The ACTIFLO® process pumps and control room accounts for about one-third of the building Masonry costs. The largest Metal Fabrications cost is for all of the flooring plate and supporting structure that will be needed to cover most of all of the process tanks.

The largest portion of the Process cost is for the ACTIFLO® process equipment. It accounts for three-fourths of the equipment cost and is the largest single item cost for the project, approximately two-fifths of the total project cost.

The table below summarizes the planning level construction cost estimate for the 35 MGD two-train ACTIFLO® HRT system. Itemized cost details can be found in the appendix.

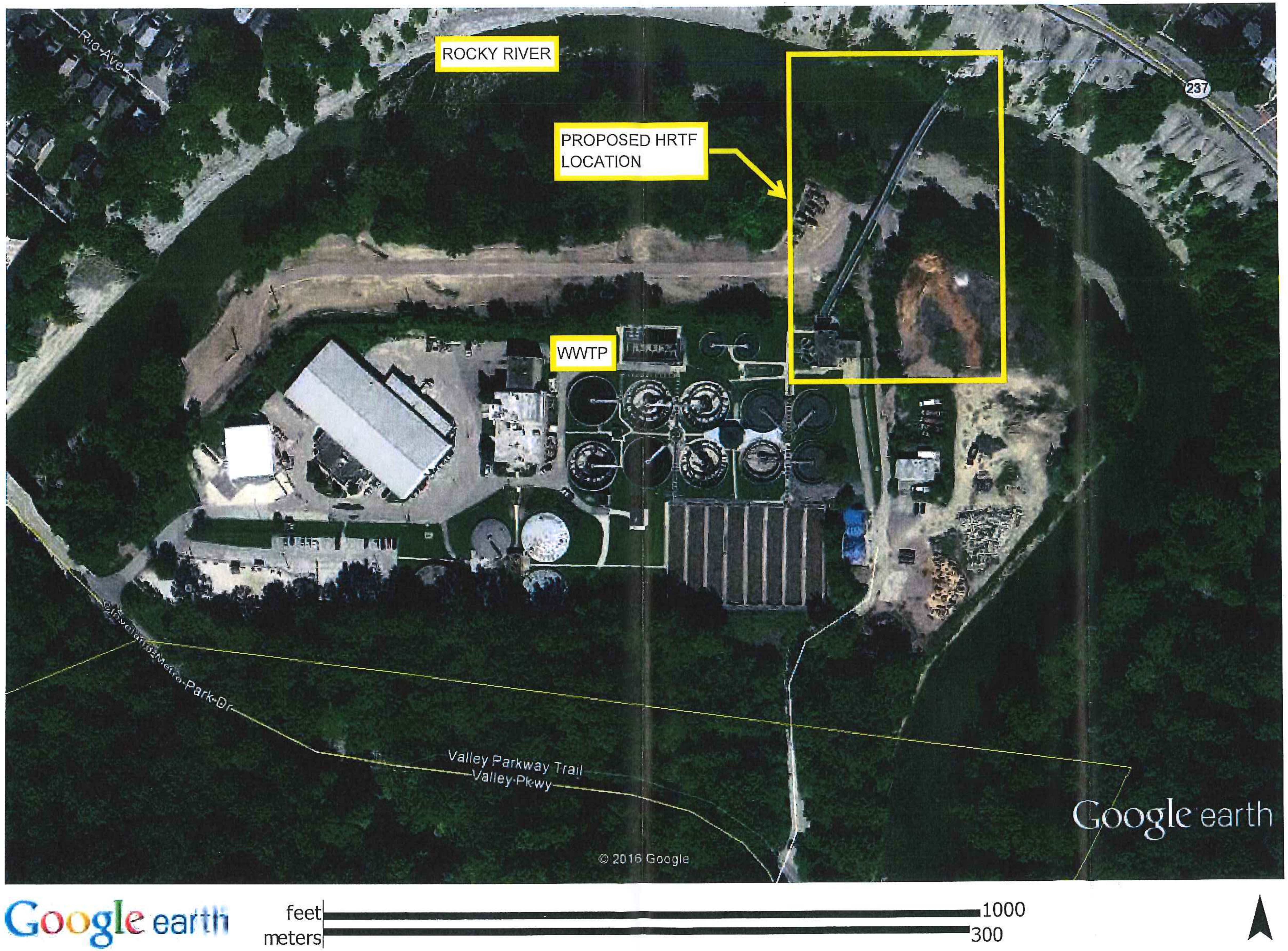
Table 10.1: Planning Level Construction Cost

Description	Cost
Site Construction – Div. 02	$ 970,580.00
Concrete – Div. 03	$ 1,280,000.00
Masonry – Div. 04	$ 1,176,000.00
Metal Fabrications – Div. 05	$ 367,550.00
Process – Div. 11	$ 7,948,800.00
Subtotal Divisions 15 & 16	$ 2,055,030.00
Total Capital Cost	$ 13,797,960.00
Contingency @ 10%	**$ 15,177,760.00**

APPENDICES

APPENDIX A

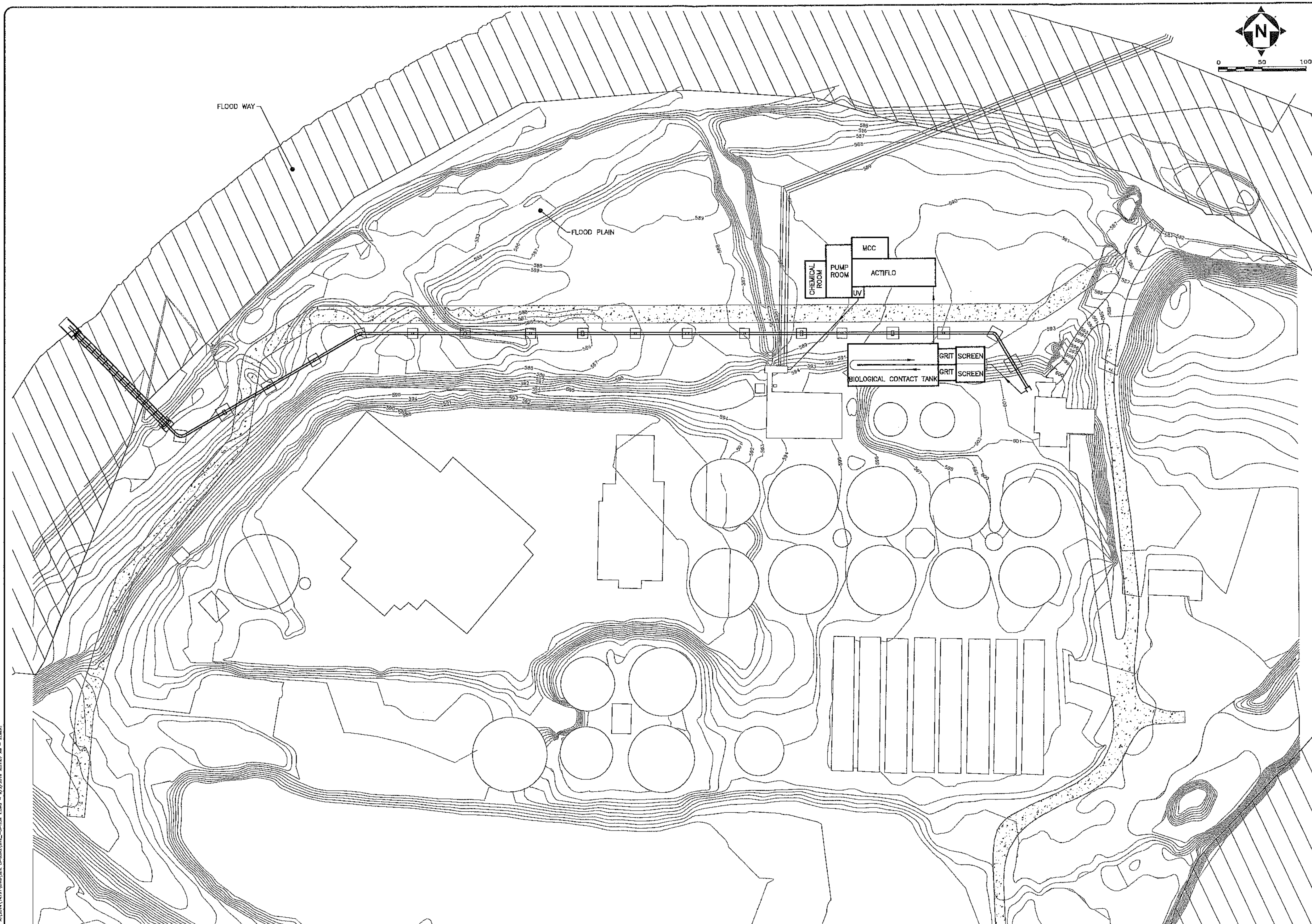
Project Site Map



ROCKY RIVER
PROPOSED HRTF LOCATION
WWTP
Rio Ave
237
Cleveland Metro Park Dr
Valley Parkway Trail
Valley Pkwy
© 2016 Google
Google earth
Google earth
feet
1000
meters
300

APPENDIX B

HRT Alternatives 1-6



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NO.	REVISION	DATE

DRAWING SCALE:
- HORZ: 1" = 50'
- VERT: N/A

DATE: 08/02-2016

DESIGNED BY: JDZ

DRAWN BY: RE

CHECKED BY: MAK

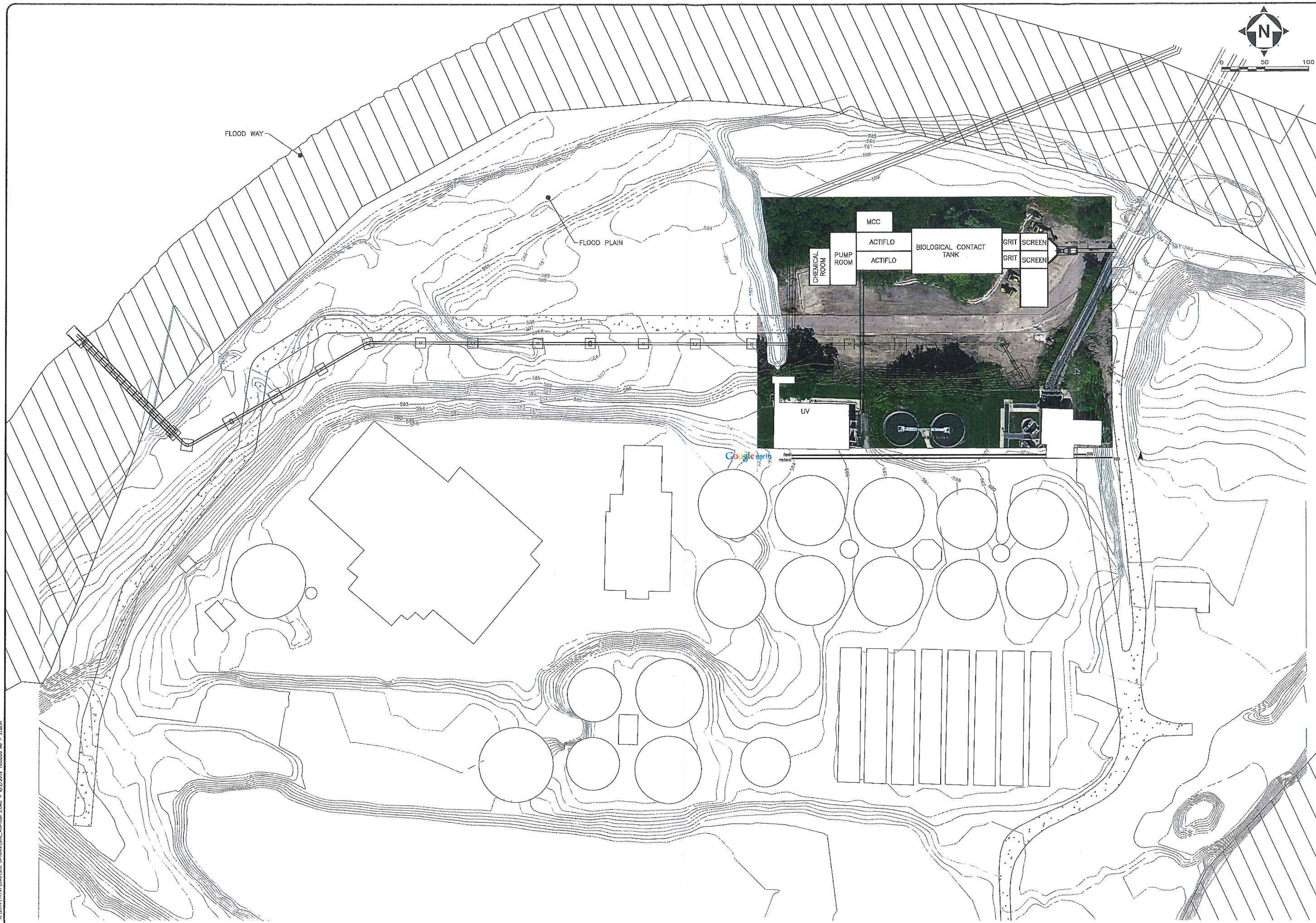
CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

SITE LAYOUT OPTION 1

PROJECT NO: 14797

DRAWING NAME: C-1

SHEET 1 OF 7



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DATE: 08/02-2016
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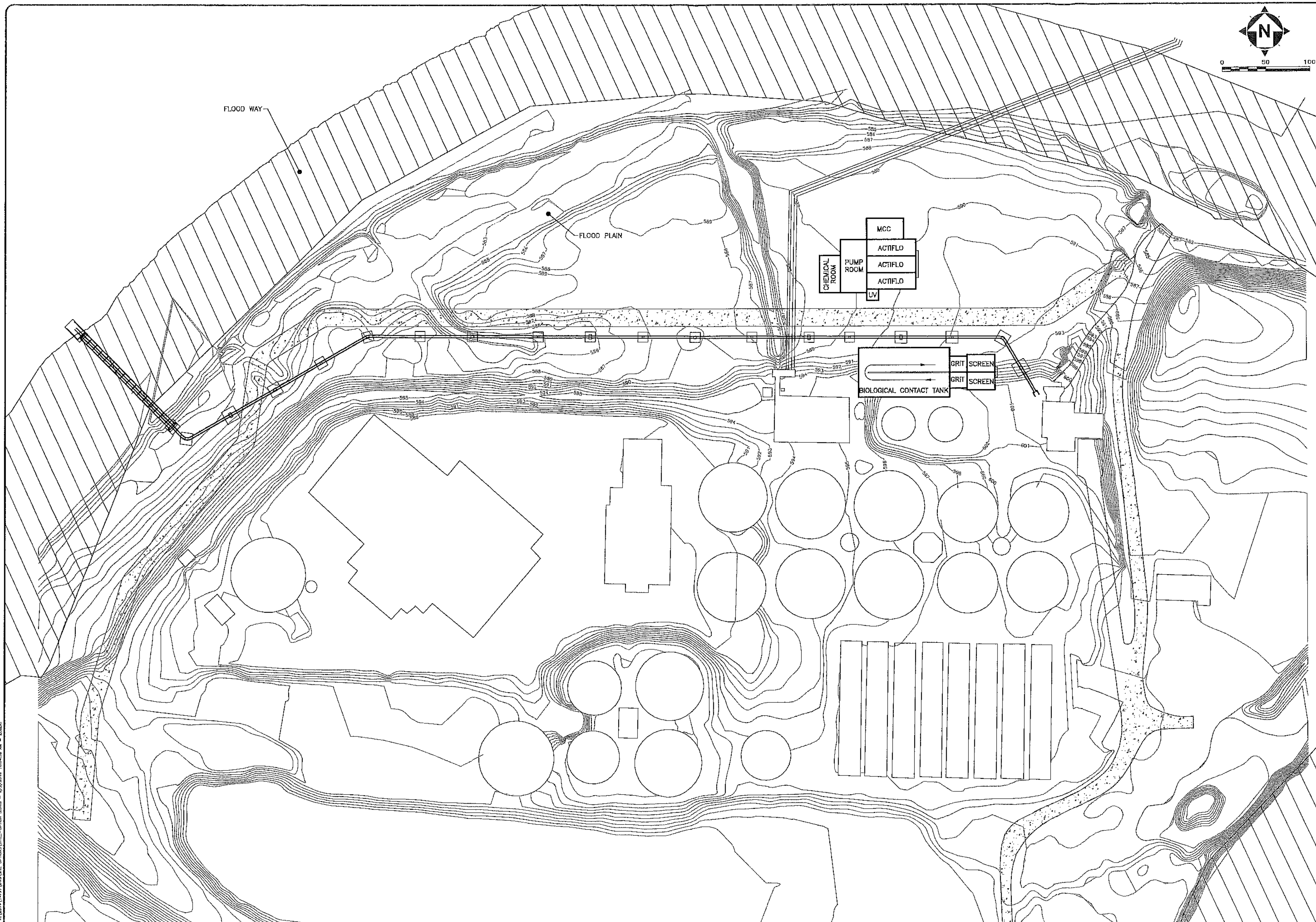
CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

SITE LAYOUT OPTION 2

PROJECT NO: 14797
DRAWING NAME: C-2
SHEET 2 OF 7



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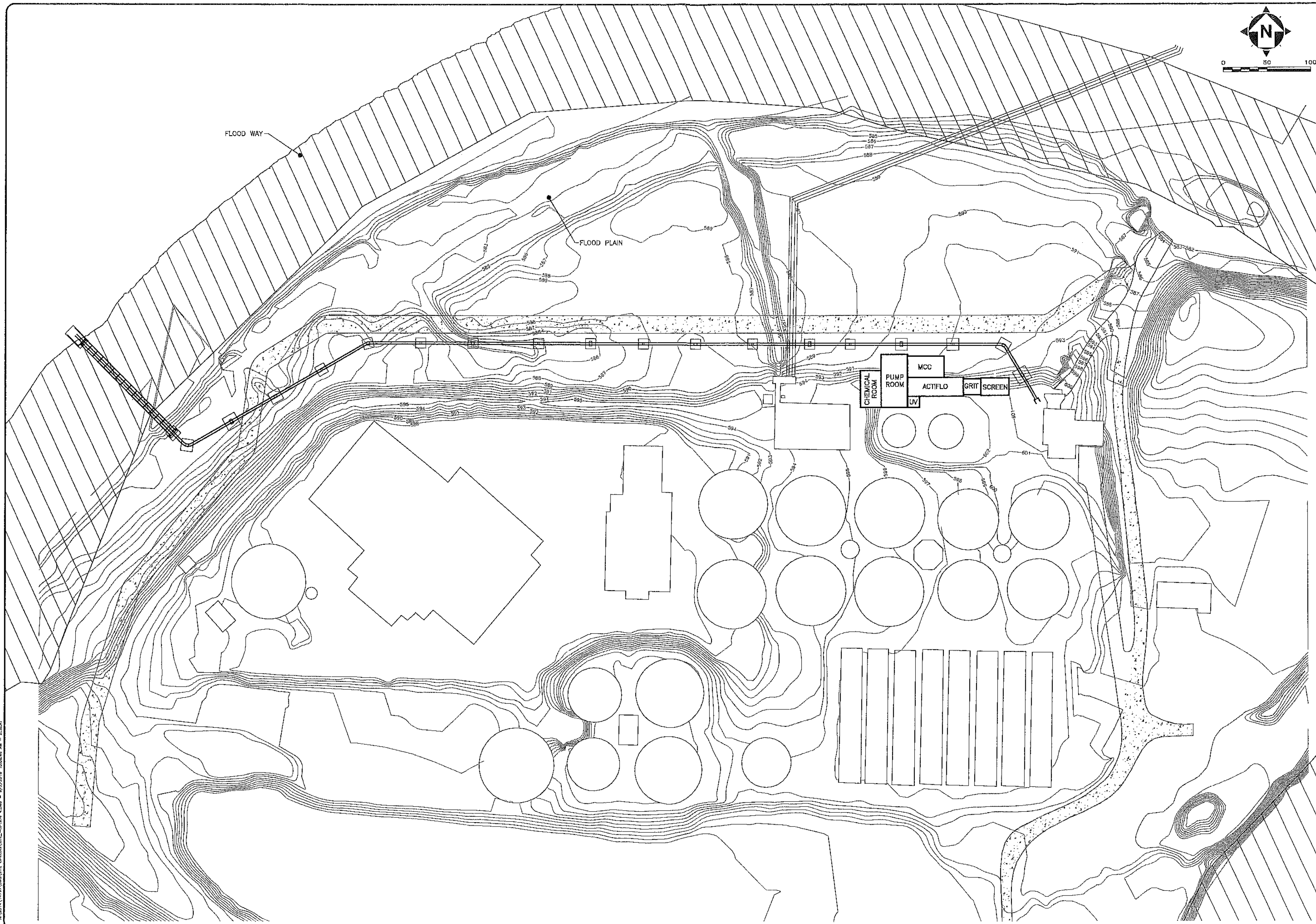
CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

SITE LAYOUT OPTION 3

PROJECT NO: 14797
DRAWING NAME: C-3
SHEET 3 OF 7



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• VERT: N/A
DATE: 05/04–2016
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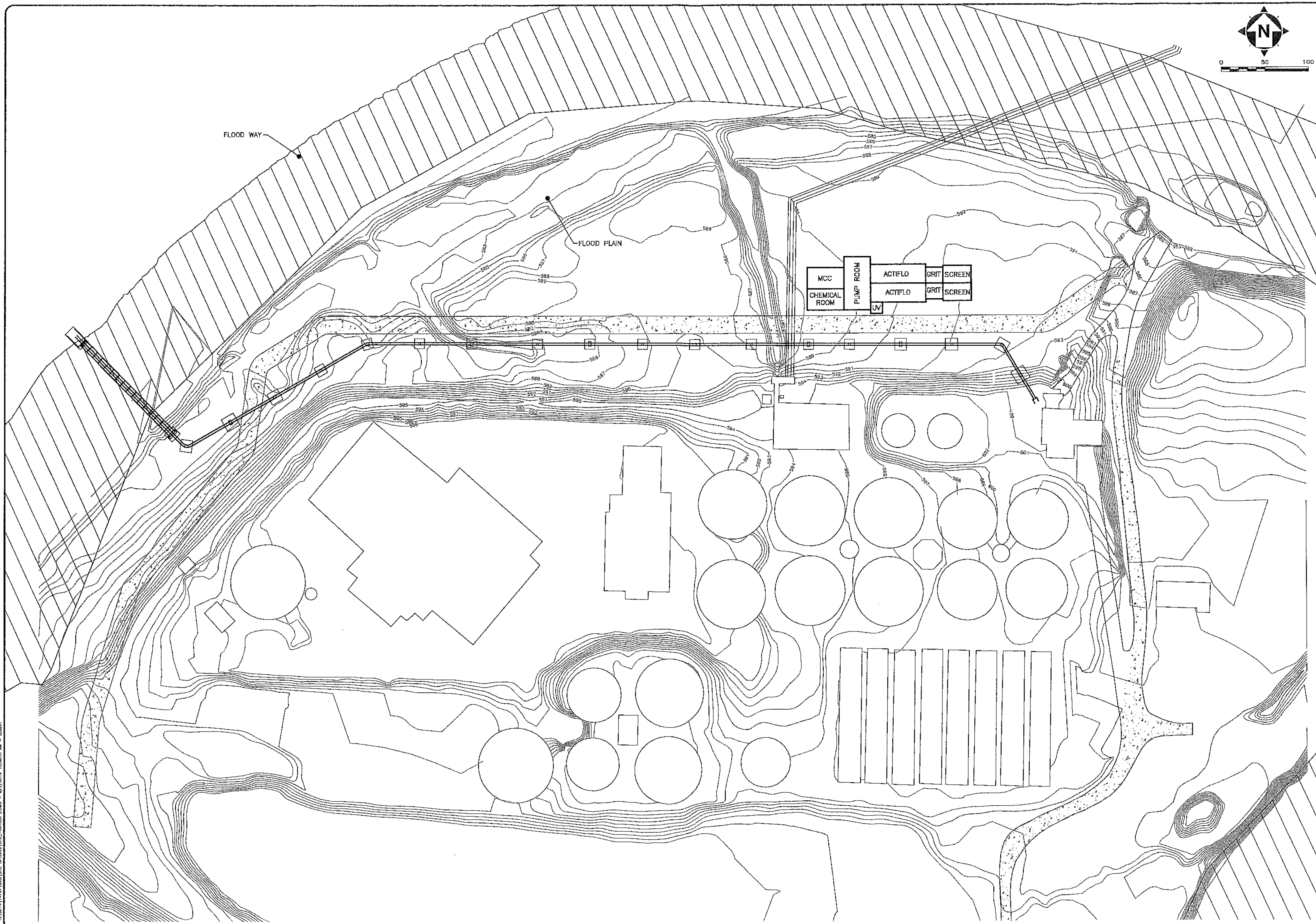
CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

SITE LAYOUT OPTION 4

PROJECT NO: 14797
DRAWING NAME: C-4
SHEET 4 OF 7



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DATE	REVISION	NO.

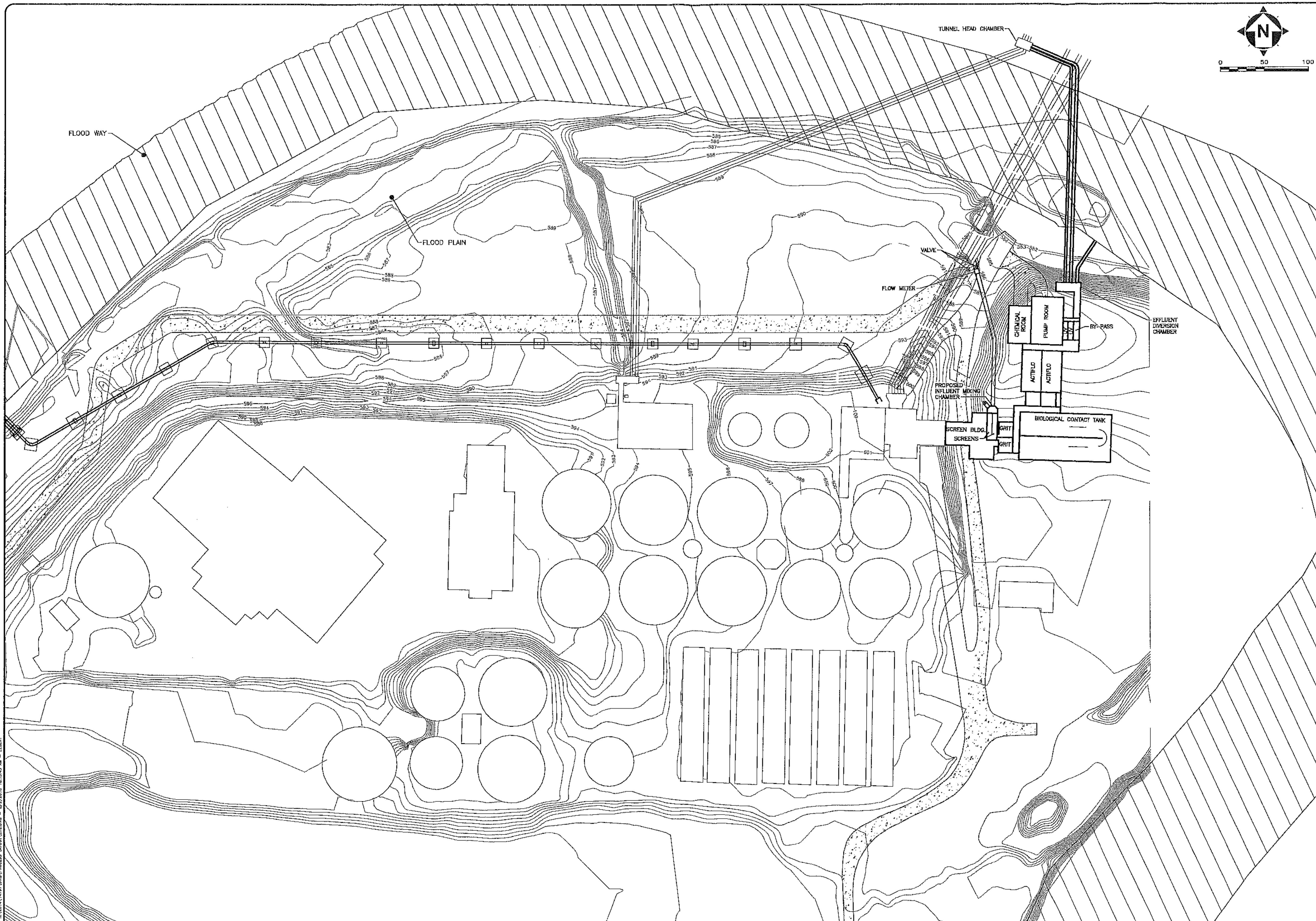
DRAWING SCALE:
- HORZ: 1" = 50'
- VERT: N/A

DATE: 08/02-2016
DESIGNED BY: JDZ
DRAWN BY: RE
CHECKED BY: MAK

CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

SITE LAYOUT OPTION 5

PROJECT NO: 14797
DRAWING NAME: C-5
SHEET 5 OF 7



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NO.	REVISION	DATE

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: VERT: N/A
DATE: 08/02-2016
DESIGNED BY: JDZ
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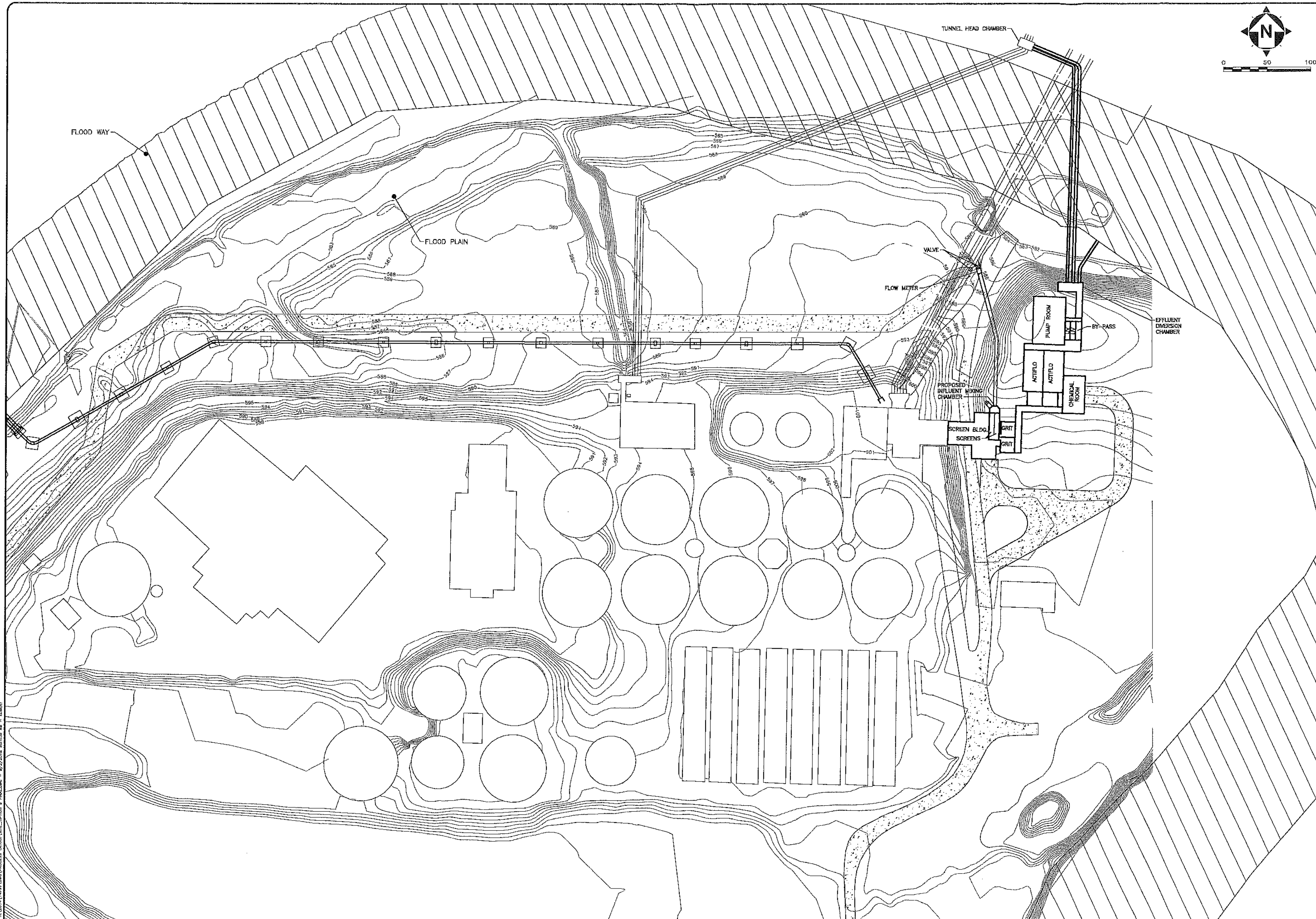
CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

SITE LAYOUT OPTION 6

PROJECT NO: 14797
DRAWING NAME: C-6
SHEET 6 OF 7



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DRAWING SCALE:
• HORZ: 1" = 50'
• VERT: N/A
DATE: 08-02-2016
DESIGNED BY: JDZ
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CHECKED BY: MAK

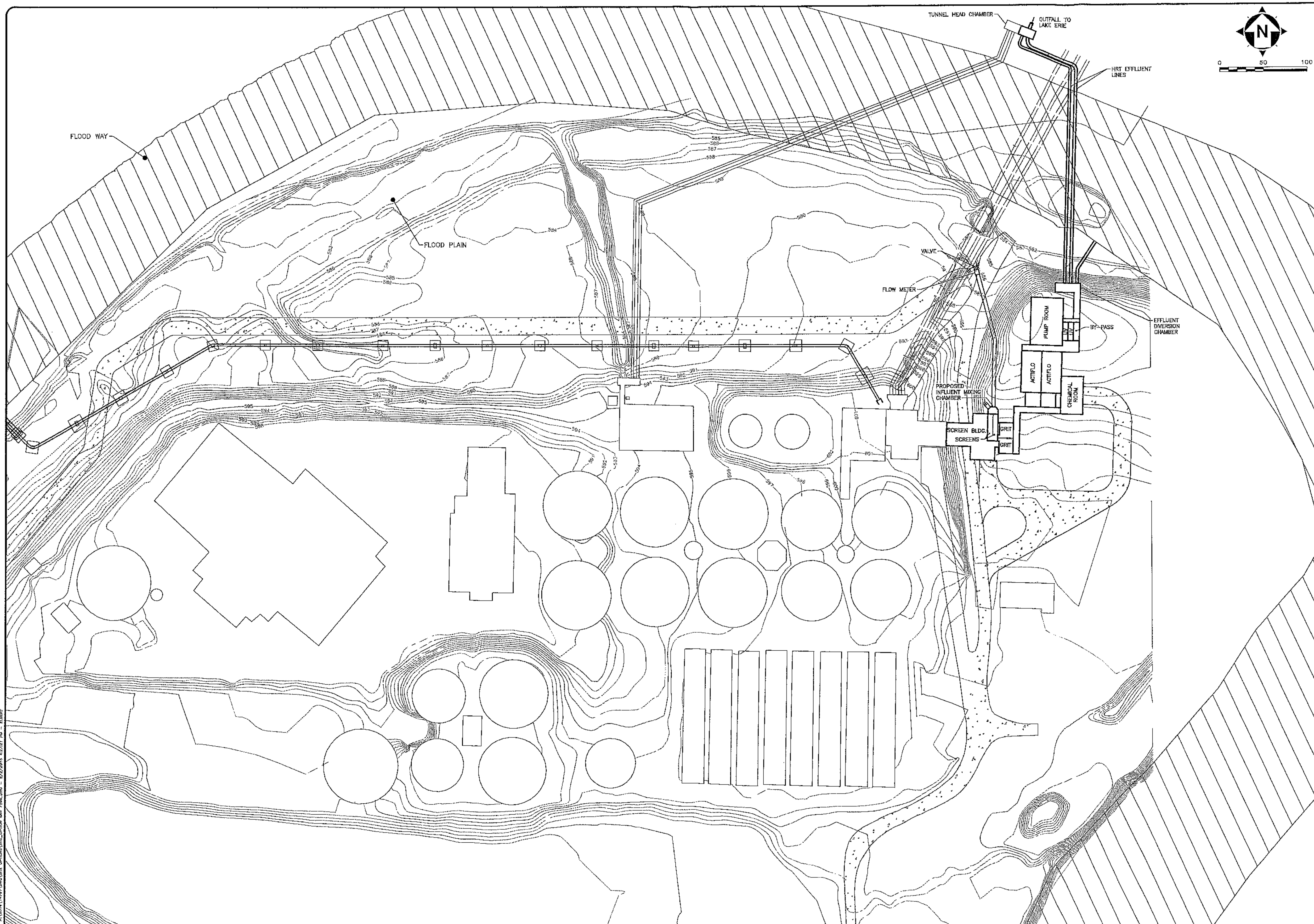
CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

SITE LAYOUT OPTION 6

PROJECT NO:
14797
DRAWING NAME
C-6A
SHEET 7 OF 7

APPENDIX C

Proposed Alternative 6A



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DRAWING SCALE:
• HORZ: 1" = 50'
• VERT: N/A

DATE: 09-02-2016
DESIGNED BY: JDZ
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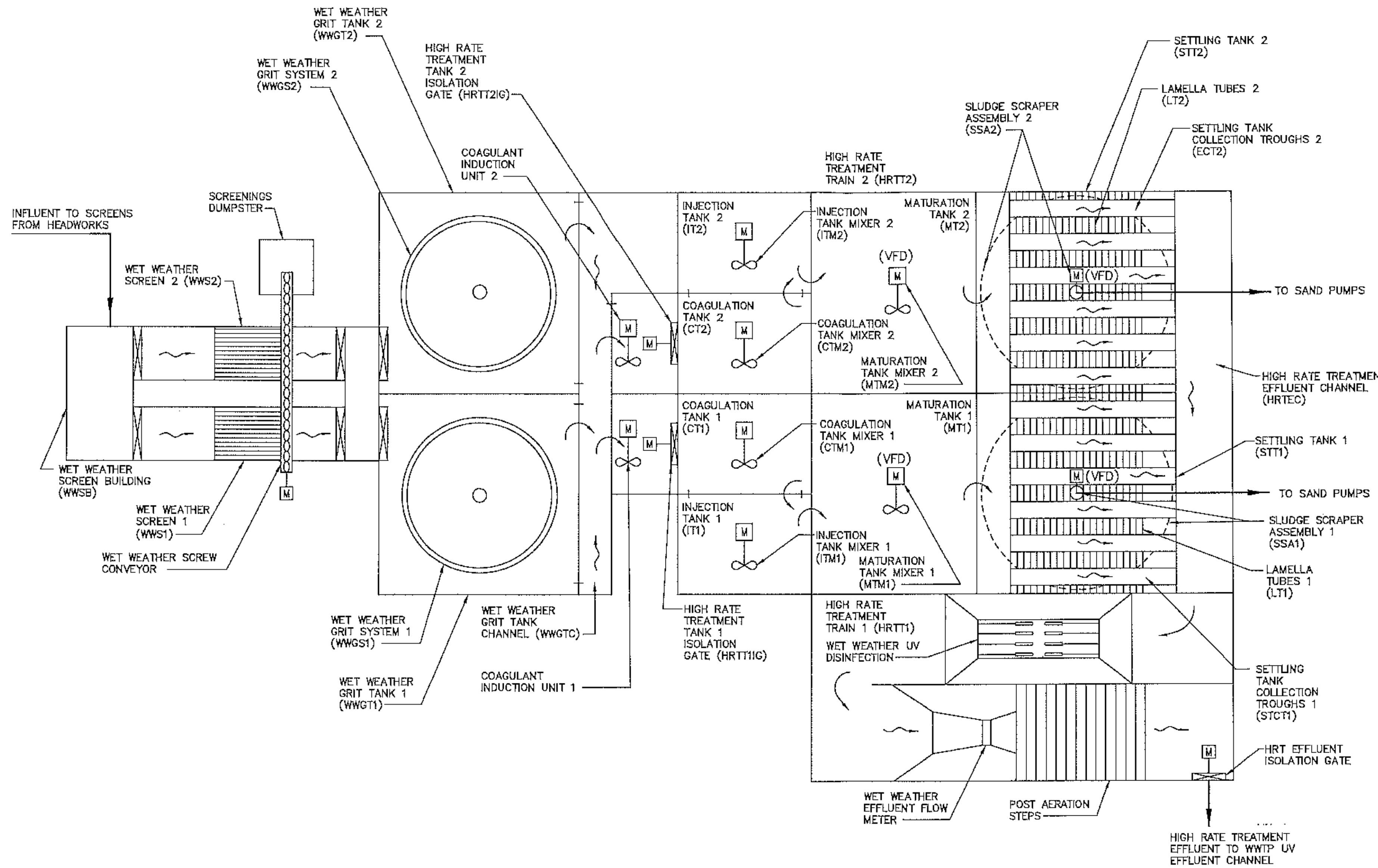
CHECKED BY: MAK

CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

SITE LAYOUT OPTION 6

PROJECT NO: 14797
DRAWING NAME: C-6A
SHEET 7 OF 7



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NO.	REVISION	DATE	BY	CHKD

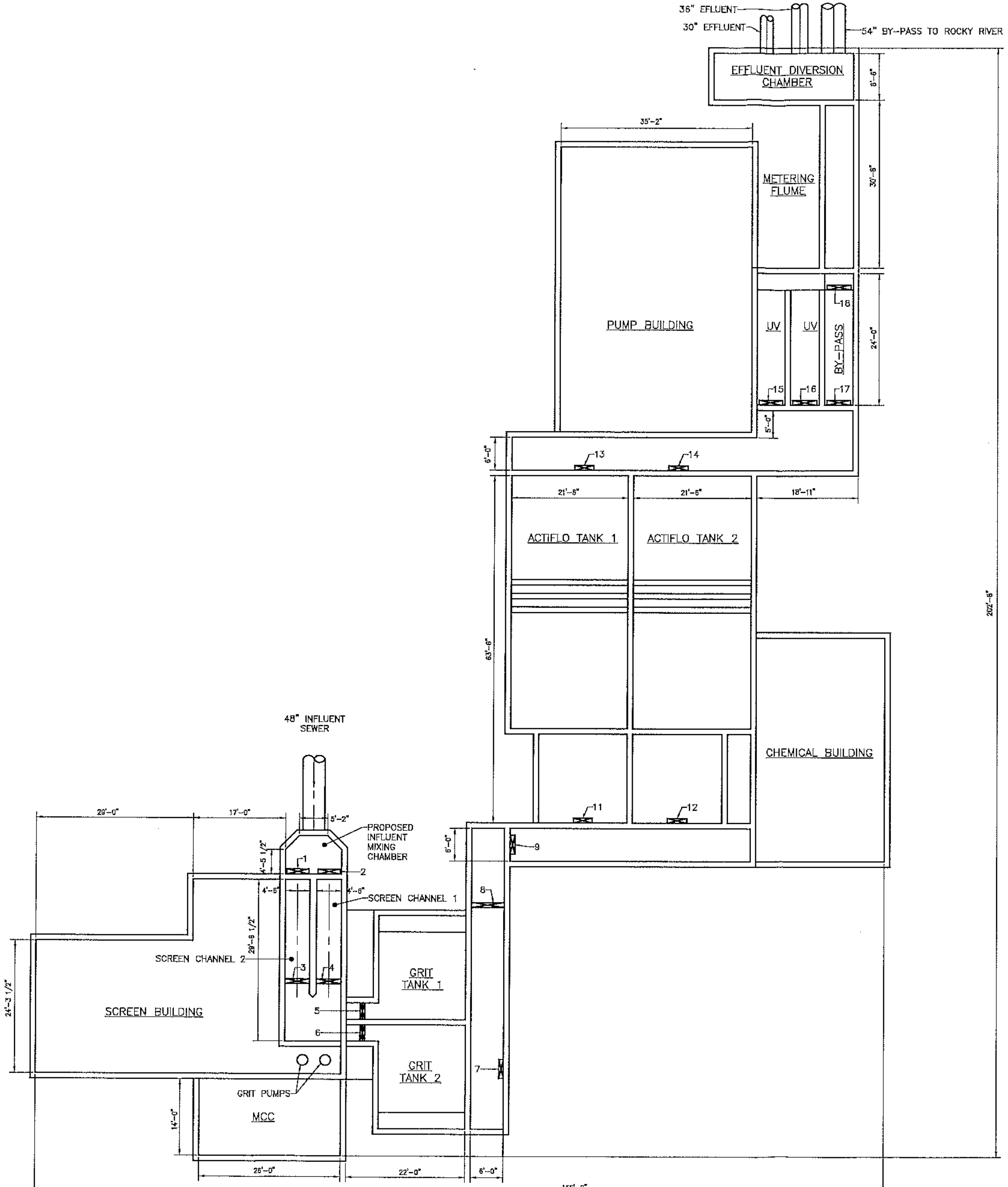
CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

DRAWING SCALE:
• HORZ: N/A
• VERT: N/A
DATE: 08-01-2016
DESIGNED BY: JDZ
DRAWN BY: RE
CHECKED BY: MAK

WET STREAM PROCESS FLOW SCHEMATIC FOR TWO BIO-ACTIFLO TRAINS

PROJECT NO: 14797
DRAWING NAME: G-1
SHEET 1 OF 1

PRELIMINARY



PLAN

GATE SCHEDULE

NO	GATE TYPE	SIZE INCH	OPERATOR	SEATING HEAD	UNSEATING HEAD
1	SLUICE	48			
2	SLUICE	48			
3	SLUICE	54			
4	SLUICE	54			
5	SLUICE	36			
6	SLUICE	36			
7	SLUICE	42			
8	SLUICE	72			
9	SLUICE	42			
10	–	–			
11	SLUICE	42			
12	SLUICE	42			
13	SLIDE	42			
14	SLIDE	42			
15	SLUICE	54			
16	SLUICE	54			
17	SLIDE	54			
18	SLIDE	54			

NOTE:

ASSUME 1 FOOT WIDE WALLS.

BAR SCALE
2' 0' 4' 8' 12'
SCALE: 3/32"=1'-0"

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NO	REVISION	DATE

SCALE: AS SHOWN
DATE: 06-14-16
DESIGNED BY: MJS
DRAWN BY: RE
CHECKED BY: MAK

CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

PROCESS LAYOUT OPTION 6A

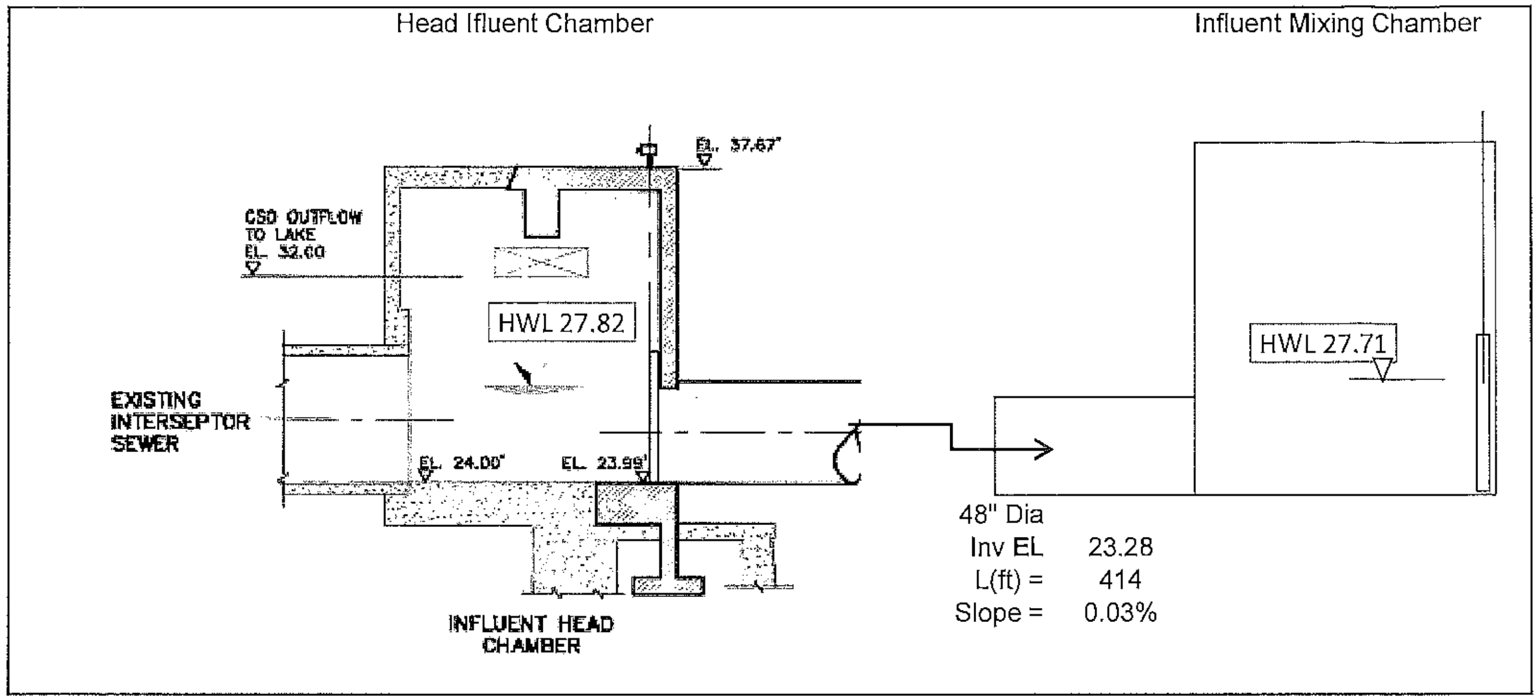
PROJECT NO: 14797
DRAWING NAME: P-1
SHEET 1 OF 1

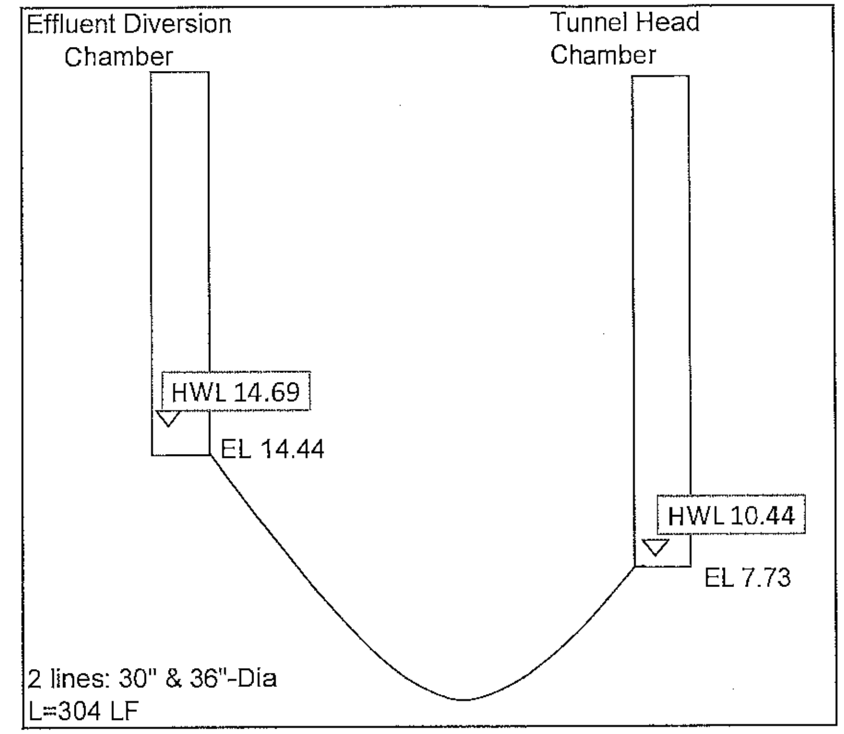
APPENDIX D

Hydraulic Profile

LAKEWOOD WWTP
ACTIFLO HRT

EXISTING PLANT INFLUENT AND EFFLUENT





	Influent Head Chamber		Influent Mixing chamber		Effluent Diversion Chamber		Tunnel Head Channel	
	Relative	Absolute	Relative	Absolute	Relative	Absolute	Relative	Absolute
Inv EL	23.99	598.21	23.28	597.5	14.44	588.66	7.73	581.95

1980 Set, Sheet G5:	Bench Mark: Top of Slab of Influent Metering Vault EL	28.99	Plant
		603.9	USGS EL
	Conversion Factor from Plant EL to USGS =	574.91	

URS 2001 23.28 = 597.5

Total L = 5344 from Treatment Plant to Lake Erie
L syphon = 675 from Treatment Plant to Tunnel Head Chamber

LAKEWOOD WWTP
ACTIFLO HRT

1) Pure water headlossed calculated based on Hazen Williams equiation:

$$h_f = \frac{(10.44)(L)(Q)^{1.85}}{(C)^{1.85}(d)^{4.8655}}$$

where: L = pipe length or equivalent length (feet)
Q = flow (gpm)
C = Hazen Williams coefficient
C = 100
d = pipe dia (inches)

2) Minor head losses are calculated as follows:

$$h_m = k\,\frac{v^2}{2g}$$

where: k = factor
v = velocity (ft/s)
g = 32.2 ft/s/s

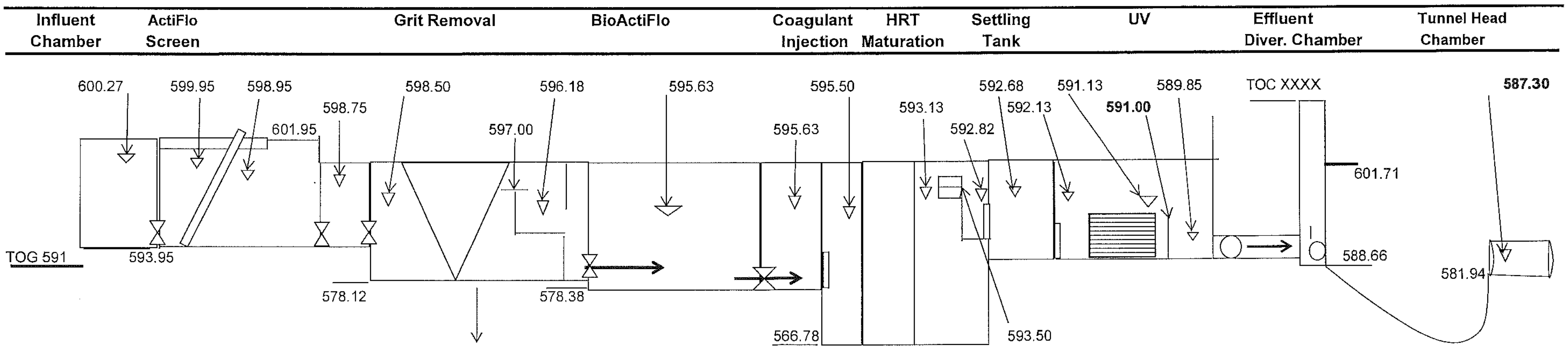
TOTAL PLANT FLOW			MGD	7.0	12.0	35.0		
			gpm	4,861	8,333	24,306		
			cfs	10.83	18.57	54.15		
Pipe Diameter	36		inch					
Pipe Diameter	30		inch					
Area (sft) of 36" dia pipe =	7.07		sft					
Area (sft) of 30" diam pipe =	4.91		sft					
Flow Split ration for 36" dia =	0.61	0	gpm	0,000	5,083	14,826		- Vary split value no. to obtain equal headloss in each pipe
			cfs	0.00	11.32	33.03		
Flow Split ration for 30" dia =	0.39	1	gpm	4,861	3,250	9,479		
			cfs	10.83	7.24	21.12		
Velocity in 36 " dia pipe =			fps	0.00	1.60	4.68		
Velocity in 30 " dia pipe =			fps	2.21	1.48	4.30		
V^2/(2g) for 36" pipe =			ft/s^2	0.00	0.04	0.34		
V^2/(2g) for 30" pipe =			ft/s^2	0.08	0.03	0.29		
h/100 in 36" dia pipe =			ft/100 ft	0.00	0.04	0.29		- Flow spilit Ratio is atjusted to obtain close headloss values
h/100 in 30" dia pipe =			ft/100 ft	0.09	0.04	0.31		
(Q,cfs/Area,sft) for 36" dia pipe =			cfs/sft	0.00	1.60	4.68		
(Q,cfs/Area,sft) for 30" dia pipe =			cfs/sft	2.21	1.48	4.30		
1. Calculate Friction Loss in the Syphon								
Dia = 30-in L = 400 ft C: 100			k					
Gravity Line				0.36	0.17	1.23		
90 degree bend (SR)	EA: 3		0.38	0.09	0.04	0.33		
entrance loss	EA: 1		1	0.08	0.03	0.29		
exit loss	EA: 1		0.75	0.06	0.03	0.22		
Total Friction Losses in 30-inch line				**0.58**	**0.27**	**2.06**		
Dia = 36-in L = 400 ft C: 100			k					
Gravity Line				0.00	0.16	1.16		
90 degree bend (SR)	EA: 3		0.38	0.00	0.05	0.39		
entrance loss	EA: 1		1	0.00	0.03	0.29		
exit loss	EA: 1		0.75	0.00	0.03	0.22		
Total Friction Losses in 36-inch line				**0.00**	**0.26**	**2.05**		
Static Head:				6.72 ft	6.72 ft	6.72 ft		
Syphon Head-available:				-6.72 ft	-6.46 ft	-4.67 ft		
72" dia outfall		Absolute	WL, ft	584.66				72"ø outfall to Lake Erie
WL in Diversion chamber:		Absolute	WL, ft	-	-	588.91		

B. ELEVATIONS

	Existing		Proposed	
	Relative	Absolute	Absolute	
Tunnel Access Chamber Invert EL	5.00	579.22		
Tunnel Head Chamber-Siphon Pipe Invert EL	7.72	**581.94**	**587.3**	at 63 MGD - SWMM Model
Tunnel Head Chamber WL	10.44	584.66		
Effluent Diversion Chamber Bottom Slab EL	14.44	588.66	**588.66**	
Effluent Diversion Chamber WL EL @ 35 MGD	14.69	588.91	**588.91**	
UV Effluent WL	14.82	589.04		
UV Effluent Wier Top EL	17.75	591.97		
Final Clarifier Effluent Weir EL	12.6	586.82		

Existing relative elevations obtained from URS 1980 plan set.

URS 1980	CT 2015
23.28 =	597.5



LAKEWOOD WWTP
ACTIFLO HRT

TOTAL PLANT FLOW			MGD	7.0	12.0	35.0	
			gpm	4,861	8,333	24,306	
No. of Trains		1	cfs	10.83	18.57	54.15	
		2	cfs	5.41	9.28	27.07	
Select Diameter for Proposed Piping:							
Assumed Pipe Diameter (inch) =		42					
Area (sft) =		9.62					
Velocity =			fps	1.13	1.93	5.63	
V^2/(2g) =			ft/s^2	0.02	0.06	0.49	
1. Effluent Diversion Chamber							
Effluent Weir EA: 1 Length, ft =		4.5	ft	**0.24**	**0.41**	**1.19**	$Q = K \cdot L \cdot H^{1.5}$ Assume 2 parrallel Channels
Slope	1.15%						
Channel Length (ft) =	22						
Channel Width, ft =	4.50 ft						$Q = \frac{1.49 \cdot A \cdot R^{2/3} \cdot S^{1/2}}{n}$
Channel Depth (D), ft =	7.00						
Hydraulic Depth (d), ft =	6	1.93					
d/D =	0.86	0.28					
n =	0.13						
Wetted Perimeter, ft =	-	8.35					
A/D^2 =	0.70	2.34					
Area of flow (A), sft	34.12	8.66					
(R/D) =	0.297	0.539					
Hydraulic Radius (R), ft	2.08	1.037					
Calculated Flow cfs	68.53	10.91					Isco Open Channel, p 130 and Table 6-2
Calculated Flow MGD	44.30	7.05					page 141,
Ground Elevation, ft =		**601.71**					
Effluent Diversion Chamber Slab SET EL, ft =		**588.66**					- Estimated EL based on URS Drawings
WL in the UV Effluent Channel =			ft	588.90	589.07	589.85	
2. UV							
Serpantine Weir SET EL, ft =		**591.00**					
Rectangular weir w/o end contractions K =			3.33				
Total Serpantine Weir Length, ft =			325				
H_f =			ft	**0.05**	**0.07**	**0.13**	
WL after UV modules =				591.05	591.07	591.13	
Assumed H_f thru UV (channel, UV modules) =			**1**				
WL in UV Channel =				592.05	592.07	592.13	
H_f - UV Influent Sluice Gate-015H EA: 1 Dia (in) =		42	ft	**0.02**	**0.06**	**0.55**	Orifice in Reservoir
Flow thru Orifice Area (sft) =		9.62					$Q = C_d A \sqrt{2gh}$
WL in UV Influent Channel =				592.07	592.13	592.68	
UV Bottom EL =	4.00	587.13					

LAKEWOOD WWTP
ACTIFLO HRT

3. Settling Tank Headloss								
			TOTAL FLOW	MGD	7.0	12.0	35.0	
				MGD	7.0	12	17.5	
				gpm	4,861	8,333	12,153	
				cfs				
H_f - ActiFlo Effluent Sluice Gate-013/14H	EA: 1	Dia (in) =	42	ft	**0.02**	**0.06**	**0.14**	
Flow thru Orifice		Area (sft) =	9.62					
WL in ActiFlo Effluent Channel =					592.09	592.19	592.82	
Rectangular Weir Nos. 1-6	EA: 1	Length, ft =	2.875	ft	**0.32**	**0.47**	**0.31**	
ActiFlo Effluent WL at Rectangular Wier				ft	592.41	592.66	593.13	
Bottom of Notch SET EL, ft =			**593.50**	ft				
HRT Bottom EL =		26.72	566.78	ft				Kruger, Sheet 6 of 9
Settling Tank Headloss								
Settling Tank Influent Weir			29.67	ft				
HRT Maturation Tank Effluent Opening 5.9'H x 29.67'(W)								
Coagulation Injection Tank								
Assumed H_f thru Actiflo =				**2**	595.50	595.50	595.50	
H_f - ActiFlo Influent Sluice Gate-011/12H	EA: 1	Dia (in) =	42	ft	**0.02**	**0.06**	**0.14**	
Flow thru Orifice		Area (sft) =	9.62					
WL in ActiFlow Inffluent Channel =					595.52	595.56	595.63	
4. Headloss from Actiflo to Bioactiflo								
BioAF Effluent Sluice Gate-010H	EA: 0	Dia (in) =	42	ft	**0.00**	**0.00**	**0.00**	
Flow thru Orifice		Area (sft) =	9.62					
WL in BioActiflow Tank =					595.52	595.56	595.63	
Tank Size: 104'x48'x17.25' (SWD)		Tank Volume =	86,112	cft				
			644,204	gal				
		Detention Time =		min	132.52	77.30	26.50	
Bottom of Tank EL =		17.25	578.38	ft				
5. Grit Removal								
BioAF Influent Sluice Gate-009H	EA: 1	Dia (in) =	42	ft	**0.02**	**0.06**	**0.55**	Grit Removal Effluent Channel to BioActiflo
Flow thru Orifice		Area (sft) =	9.62					- Full flow
WL in Grit Effluent Channel =					595.54	595.63	596.18	
Effluent 5-ft Weir SET EL, ft =			**597.00**	ft				
Grit Eff't Weir, Slide Gates - 007/008H	EA: 1	Length=	5		**0.29**	**0.67**	**1.37**	
Total H_f - HeadCell Unit (inch) =				**1.5**	597.42	597.79	598.50	
HeadCell Bottom EL =		20.375	578.12	ft				

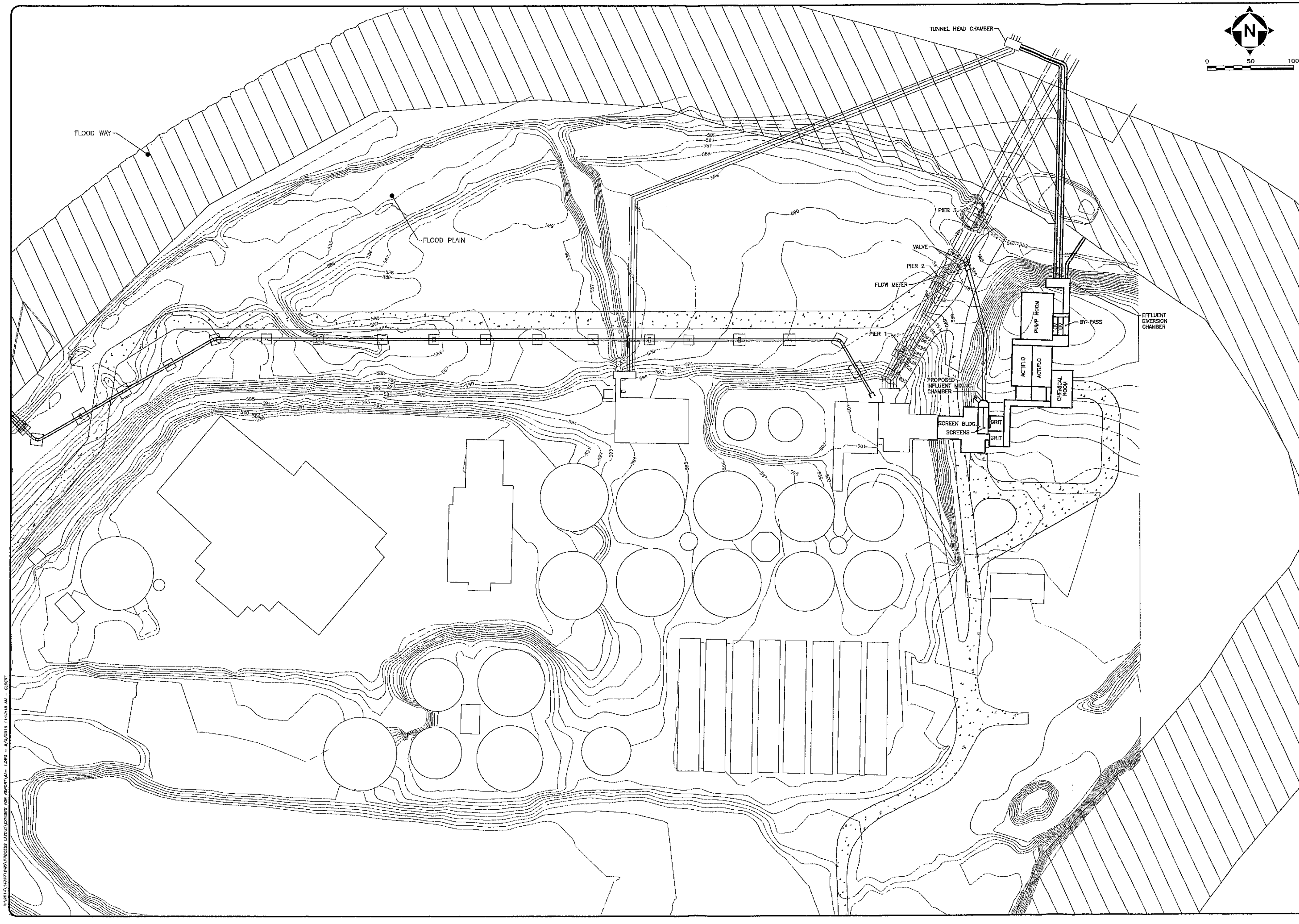
Q = Flow in cfs
C_d = Coefficient of Dischsrge = 0.95
A = Area of opening (ft^2)
h = Differential Head (loss)

6. Screen								
Grit Influent Sluice Gate-005/006H	EA: 1	Dia (in) =	36		**0.01**	**0.03**	**0.25**	
Flow thru Orifice		Area (sft) =	7.07					
		Effluent Screen Channel WL =		ft	597.43	597.82	598.75	
Screen Effluent Sluice Gates-003/004H	EA: 1	Dia (in) =	54		**0.01**	**0.02**	**0.20**	- One screen, Total flow
Flow thru Orifice		Area (sft) =	15.90					
		Downstream of Screen =			597.43	597.85	598.95	
Upstream of Screen		Asumed Head Losses (ft) =		**1**	598.43	598.85	599.95	
Screen Channel Top Slab		Freeboard (ft) =	2	ft			601.95	
Screen Channel Bottom EL		Chennel Depth (ft) =	8	ft			593.95	
Screen Influent Sluice Gates-001/002H	EA: 1	Dia (in) =	48		**0.01**	**0.04**	**0.32**	
Flow thru Orifice		Area (sft) =	12.56					
		WL in Influent Mixing Chamber			**598.45**	**598.88**	**600.27**	
7. Headloss from Screen to HRT Influent Chamber								

	Units	Total h_f
HRT, 35 MGD	ft	9.27
Existing Plant, 23 MGD, 1980	ft	12.21
Efluent Div. Chamber Bottom Slab EL	ft	588.66

APPENDIX E

Influent Sewer Options



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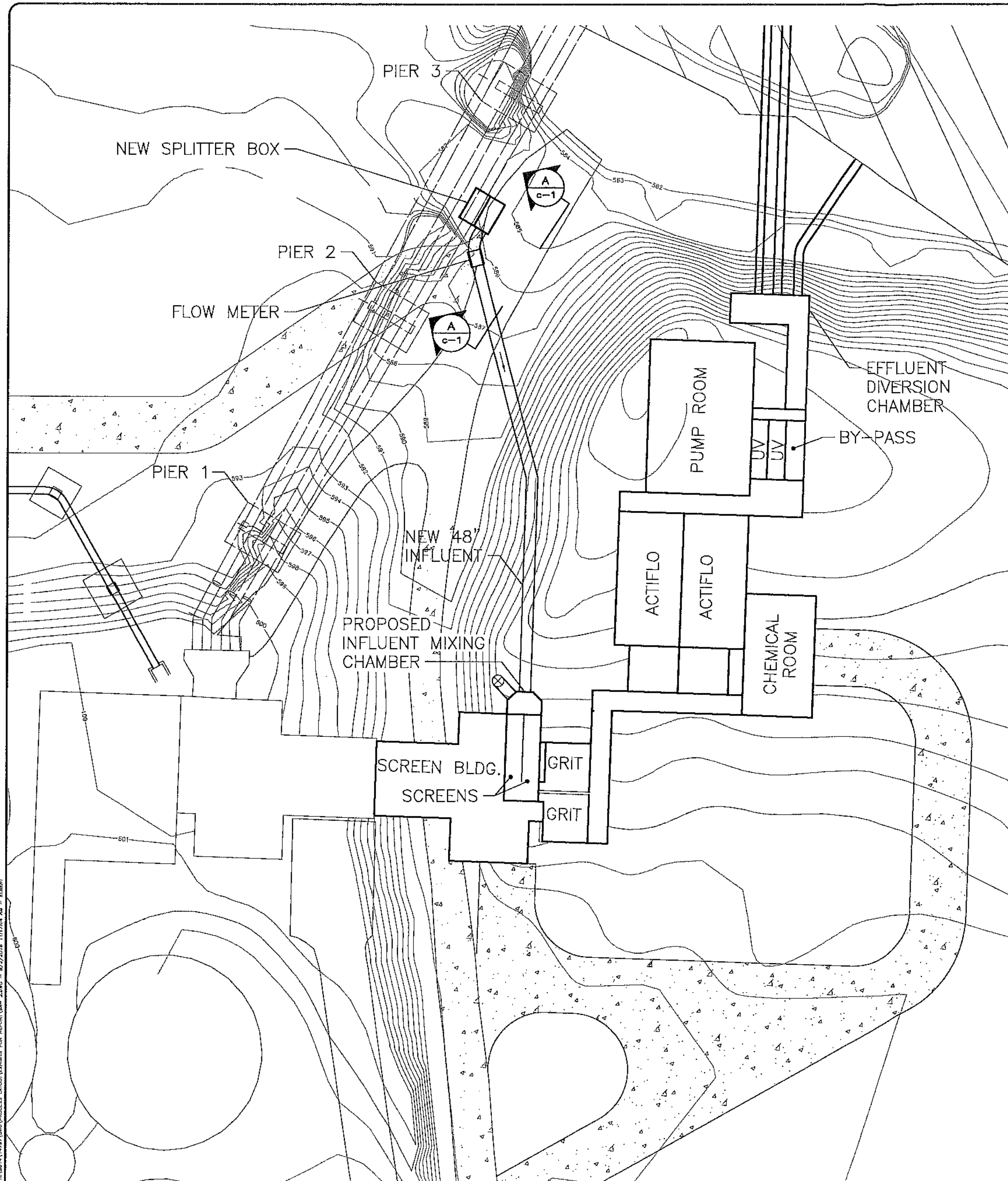
NO.	REVISION	DATE

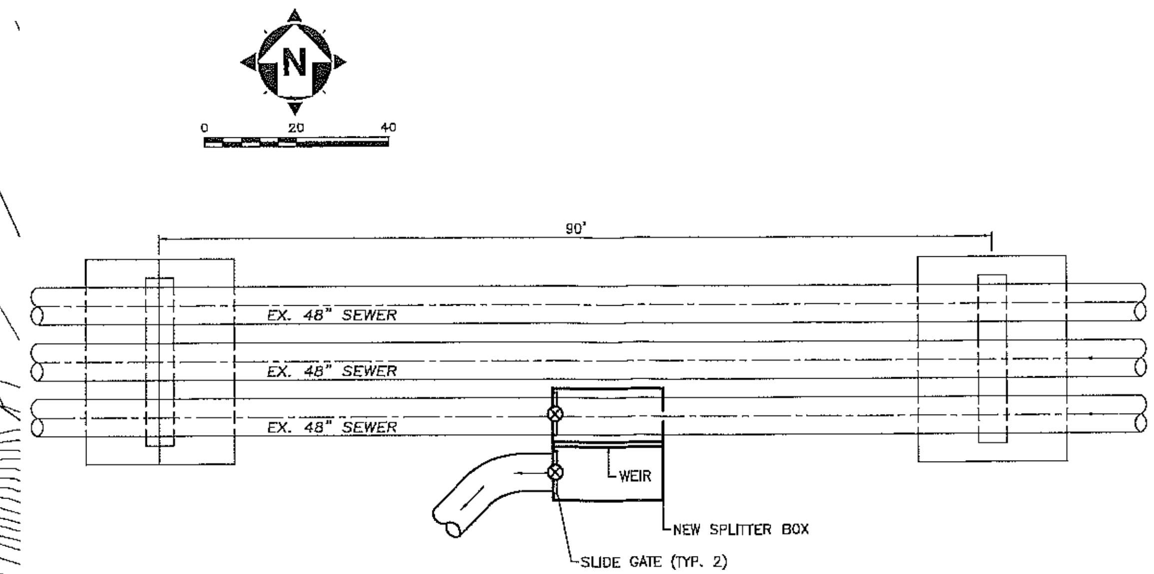
DRAWING SCALE:
• HORZ: 1" = 50'
• VERT: N/A
DATE: 08-02-2016
DESIGNED BY: JDZ
DRAWN BY: RE
CHECKED BY: MAK

CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

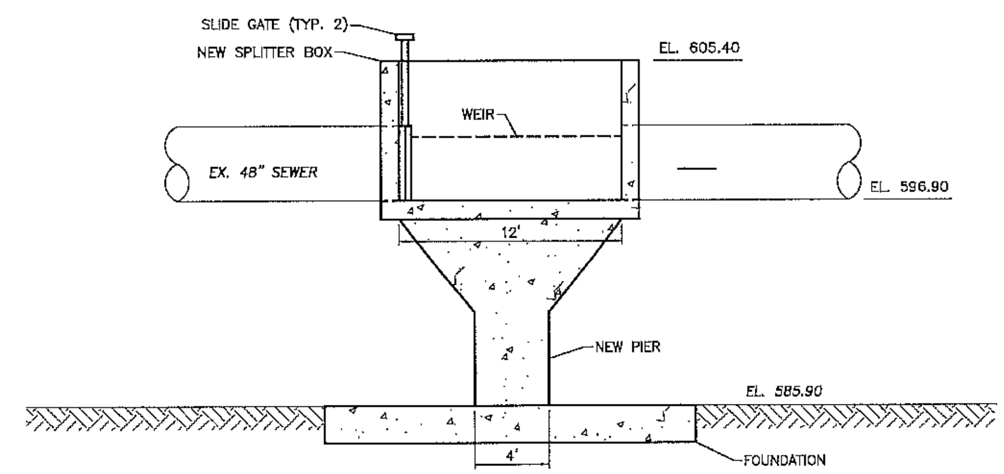
OPTION 6A - NEW AERIAL SEWER WITH VALVES

PROJECT NO: 14797
DRAWING NAME: C-6A
SHEET 1 OF 3





PLAN VIEW
SCALE: 1"=10'



SECTION A / C-1
SCALE: 1"=5'

NOTES:

1. DIVERT FLOW FROM THE 48" ARIAL SEWER WITH AN ELEVATED CONCRETE SPLITTER BOX AND KEEP THE EXISTING SEWER TO THE PLANT.
A. NEW SLIDE GATES FOR FLOW CONTROL OR,
B. NEW WEIR AND GATE COMBINATION FOR FLOW CONTROL.
2. THE SPLITTER BOX SHOWN WITH 12" THICK WALLS. THE WALLS THICKNESS MAY BE DIFFERENT AFTER DESIGN.

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NO.	REVISION	DATE

DRAWING SCALE: • HORZ: AS SHOWN • VERT: N/A
DATE: 08/02-2016
DESIGNED BY: JDZ
DRAWN BY: RE
CHECKED BY: MAK

CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

OPTION 6A - NEW SPLITTER BOX FLOW CONTROL

PROJECT NO: 14797
DRAWING NAME: C-6A
SHEET 2 OF 3

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NO.	REVISION	DATE

DRAWING SCALE:
• HORZ: 1" = 20'
• VERT: N/A
DATE: 08/02-2016
DESIGNED BY: JDZ
DRAWN BY: RE
CHECKED BY: MAK

CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

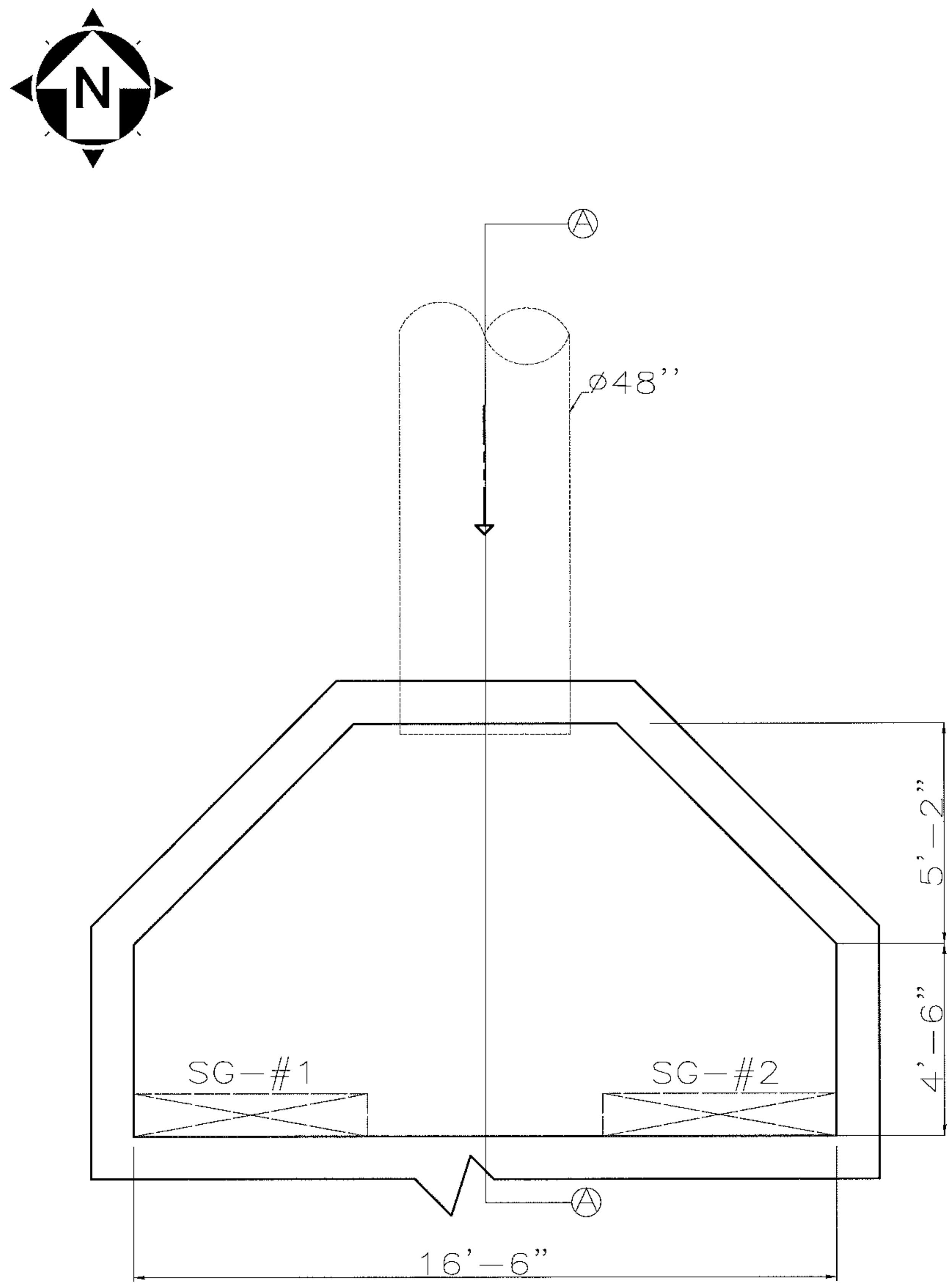
OPTION 6A - CHANNEL OR PIPE FROM EX. INFLUENT CHAMBER

PROJECT NO: 14797
DRAWING NAME: C-6A
SHEET 3 OF 3

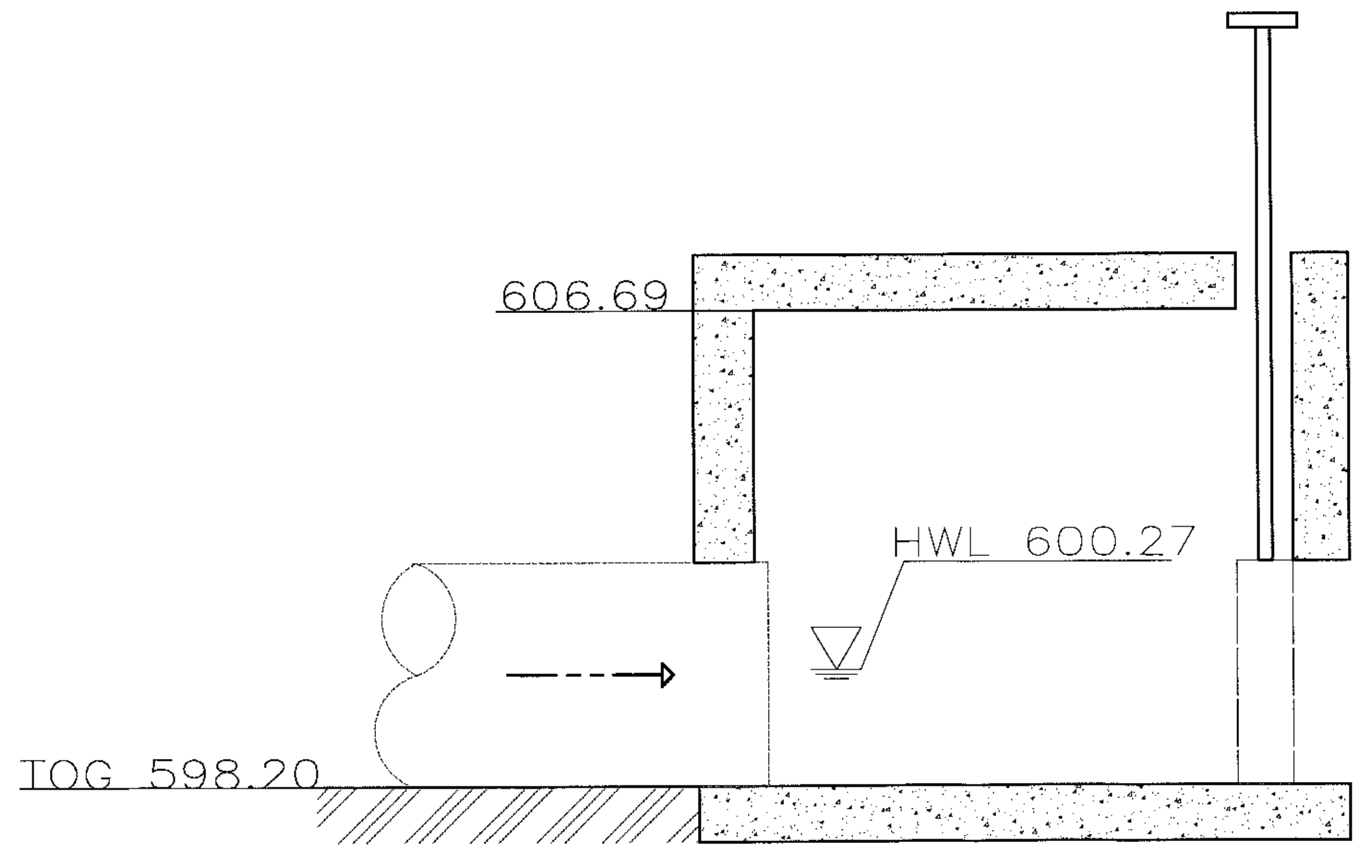
APPENDIX F

Proposed HRT System Preliminary Layout

Figures 1-10



PLAN VIEW



Section A-A

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NO.	REVISION	DATE

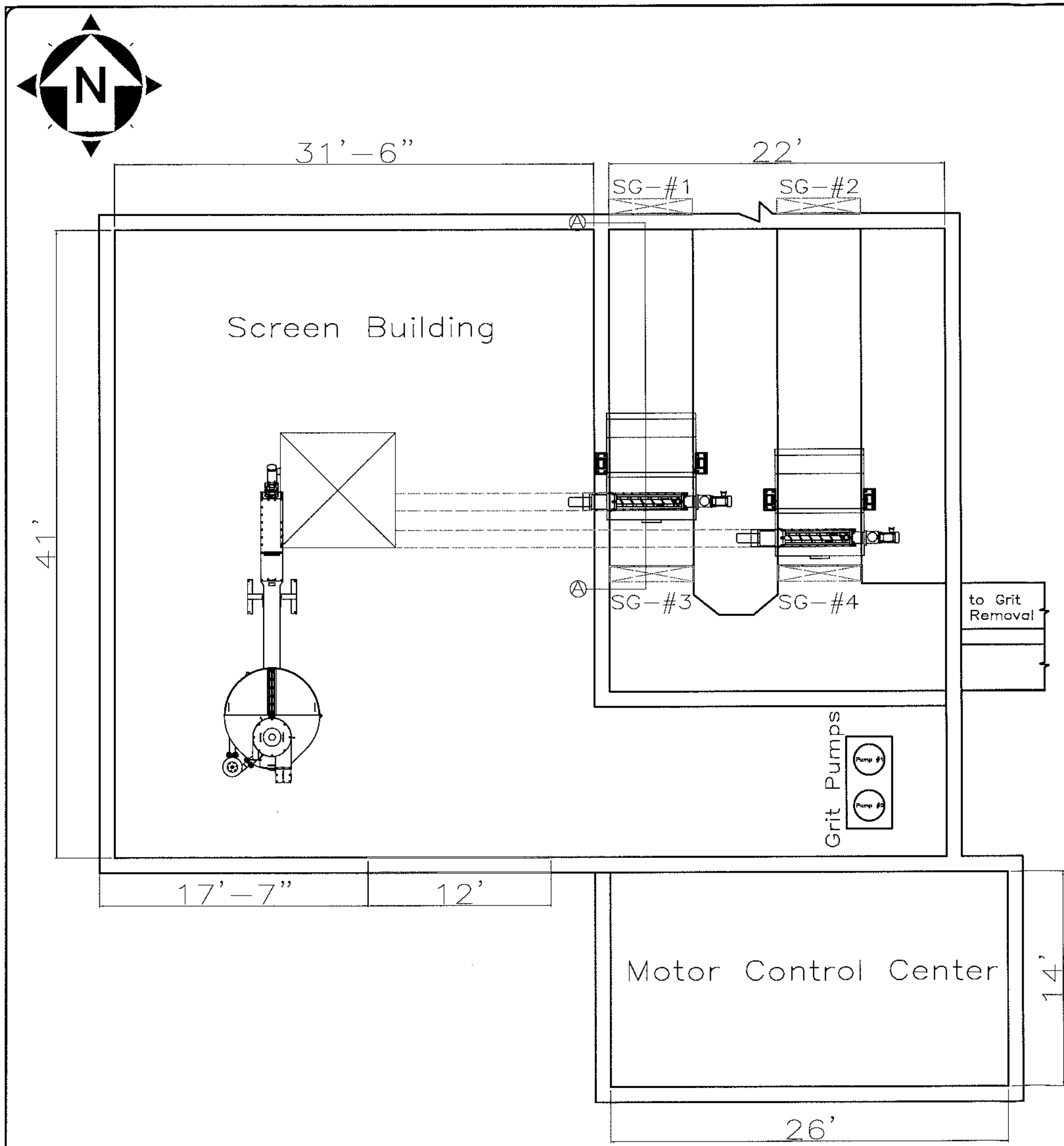
DRAWING SCALE: • HORZ: • VERT: N/A
DATE:
DESIGNED BY:
DRAWN BY:
CHECKED BY:

CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

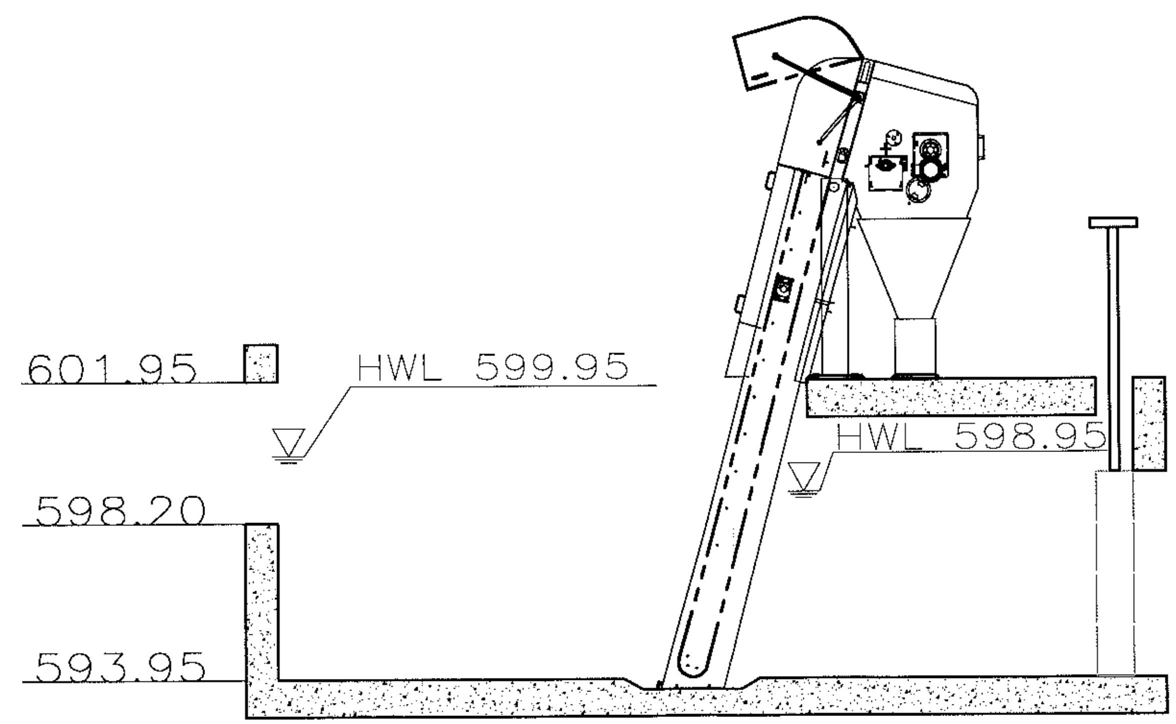
Influent Mixing Chamber

PROJECT NO: 14797
DRAWING NAME:
SHEET OF

Attachment F
Figure 1



PLAN VIEW



Section A-A

Attachment F
Figure 2A

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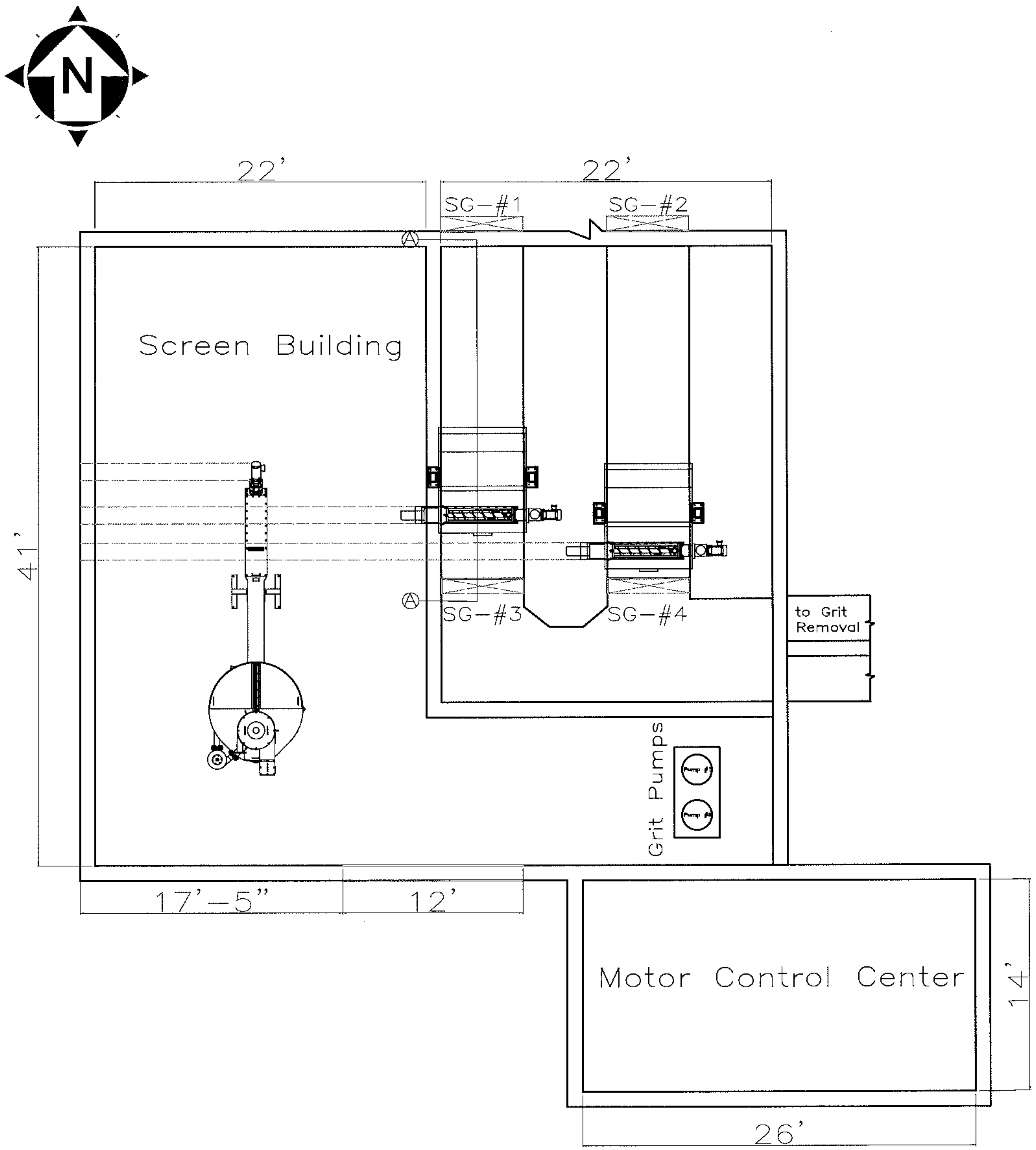
CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

Option 1 - Screen Building & Solids Dumpster

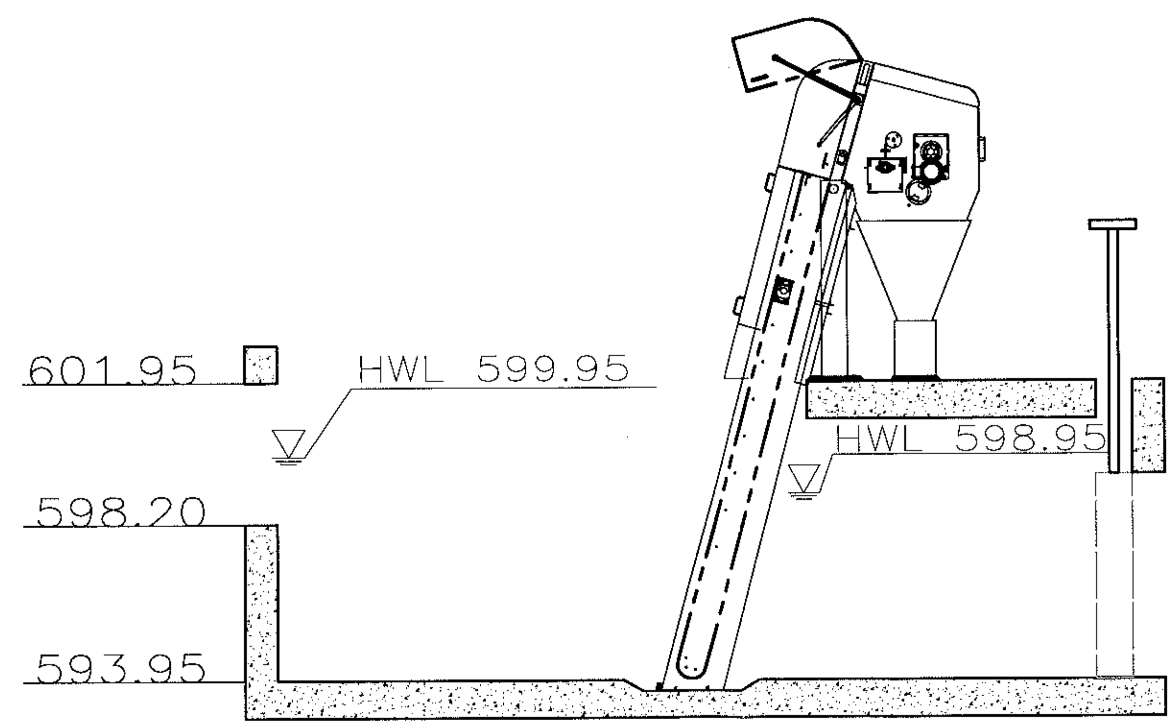
NO. | REVISION | DATE

DRAWING SCALE: • HORZ: • VERT: 1"40'
DATE:
DESIGNED BY:
DRAWN BY:
CHECKED BY:

PROJECT NO: 14797
DRAWING NAME
SHEET OF



PLAN VIEW



Section A-A

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DRAWING SCALE:
• HORZ:
• VERT: N/A
DATE:
DESIGNED BY:
DRAWN BY:
CHECKED BY:

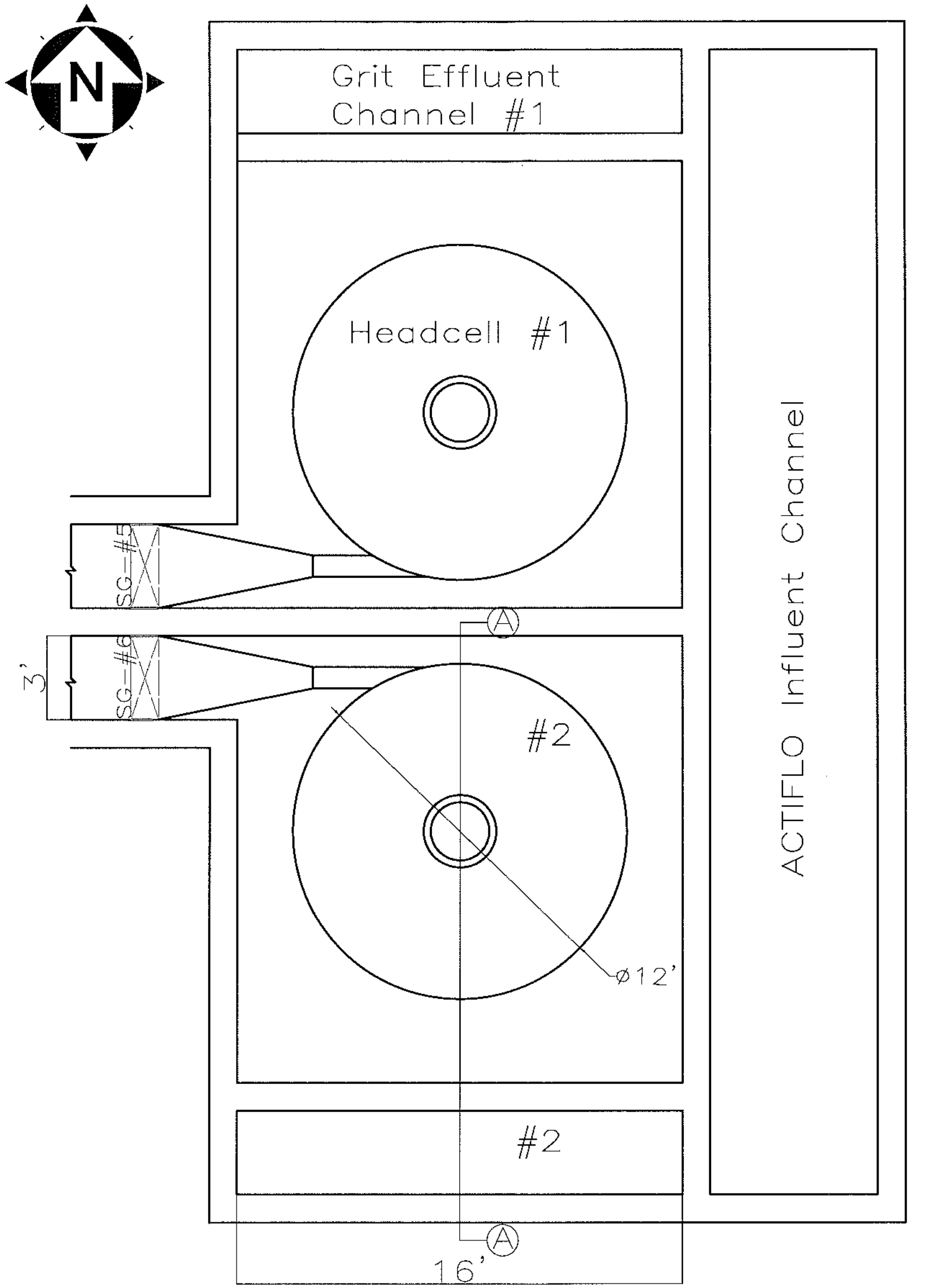
CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

Option 2 - Screen Building & Utilization of Existing Dumpster

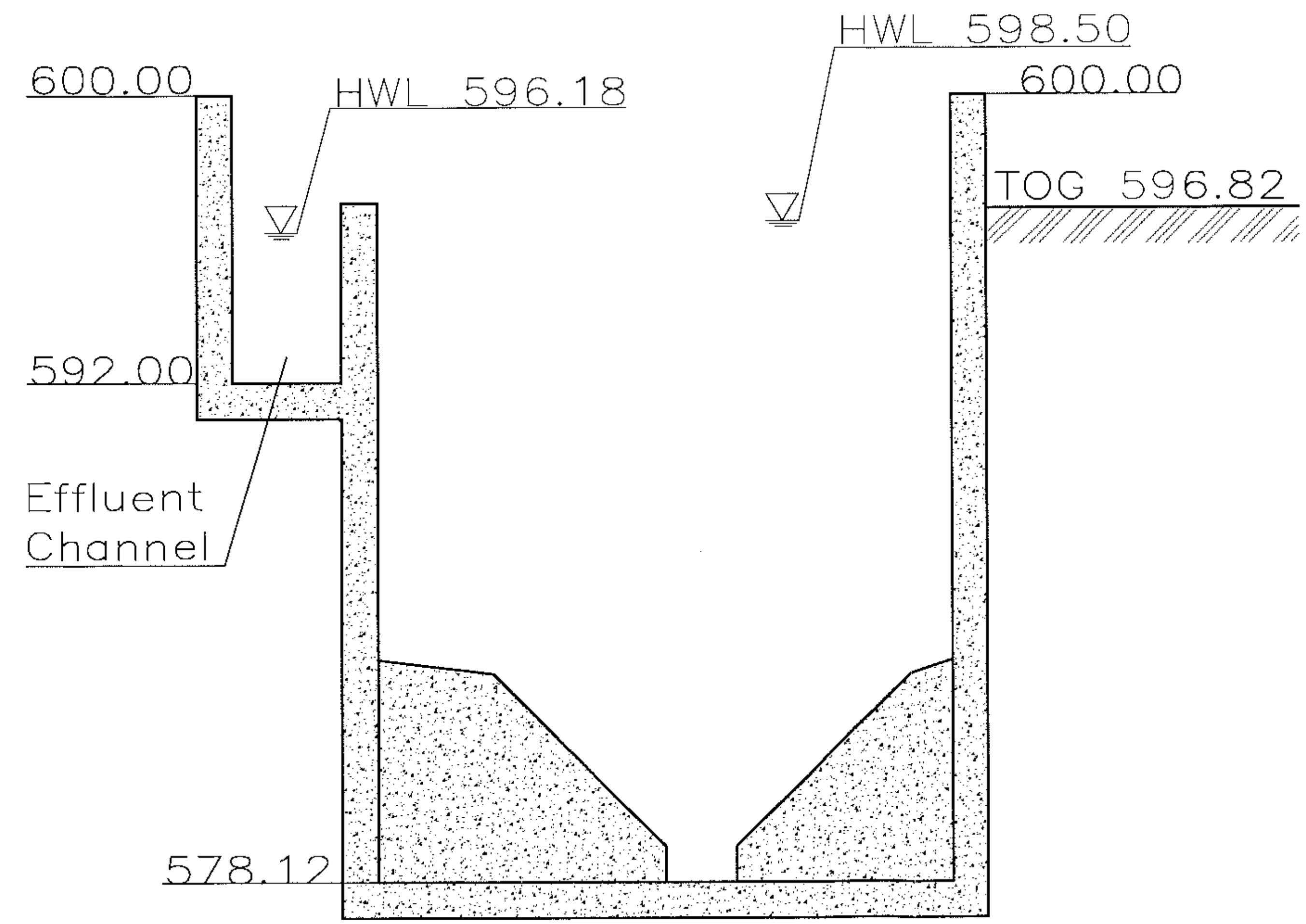
PROJECT NO:
14797
DRAWING NAME

SHEET OF

Attachment F
Figure 2B



PLAN VIEW



Section A-A

Attachment F
Figure 3

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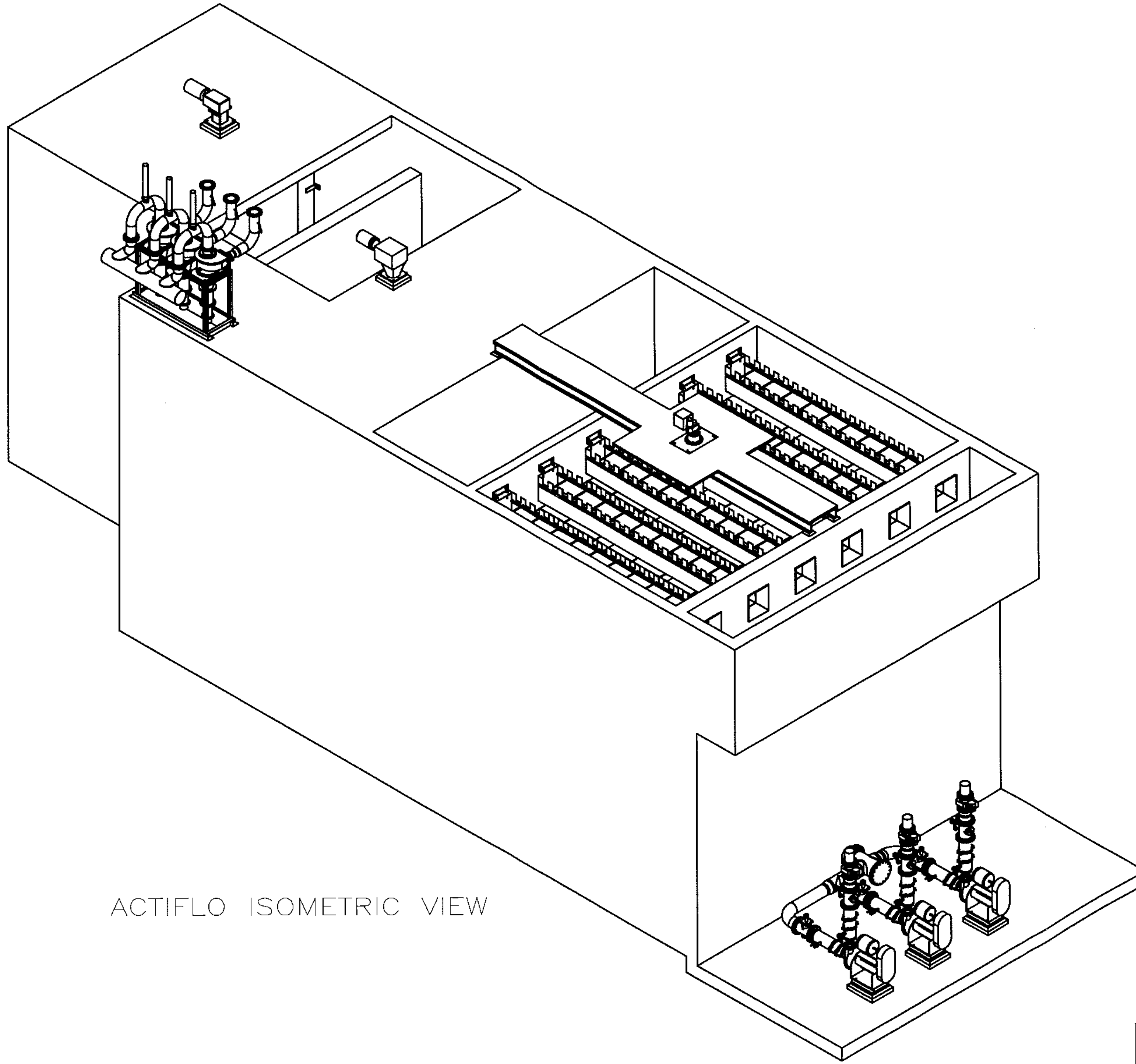
DRAWING SCALE:
• HORIZ: N/A
• VERT:
DATE:
DESIGNED BY:
DRAWN BY:
CHECKED BY:
NO.

CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

Grit Tanks

PROJECT NO:
14797
DRAWING NAME
SHEET OF



ACTIFLO ISOMETRIC VIEW

Attachment F
Figure 4

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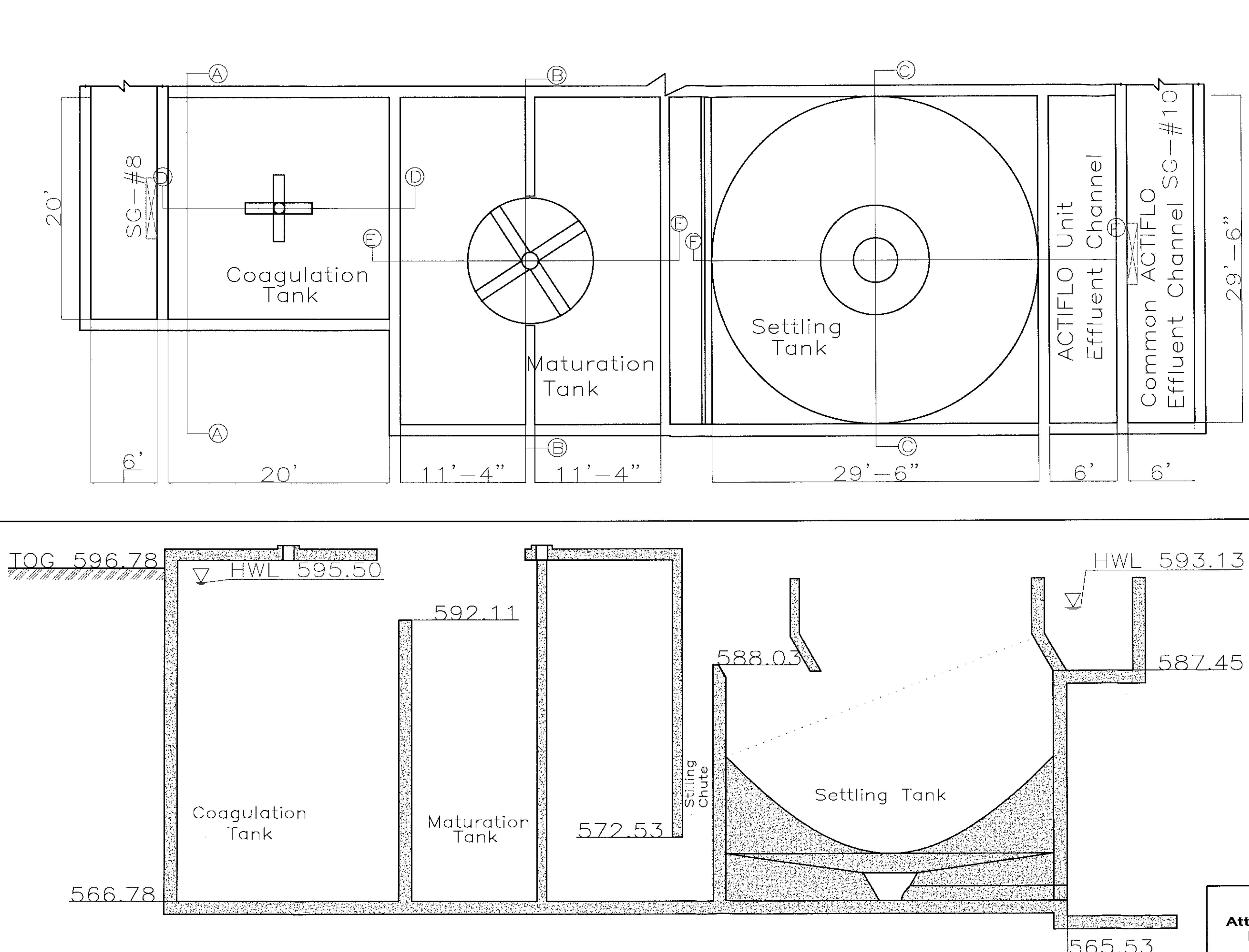
• VERT: N/A
DATE:
DESIGNED BY:
DRAWN BY:
CHECKED BY:

CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

ACTIFLO Unit

PROJECT NO:
14797
DRAWING NAME

SHEET | OF



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CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

ACTIFLO Trains

DRAWING SCALE: • HORZ: N/A • VERT:

DATE:

DESIGNED BY:

DRAWN BY:

CHECKED BY:

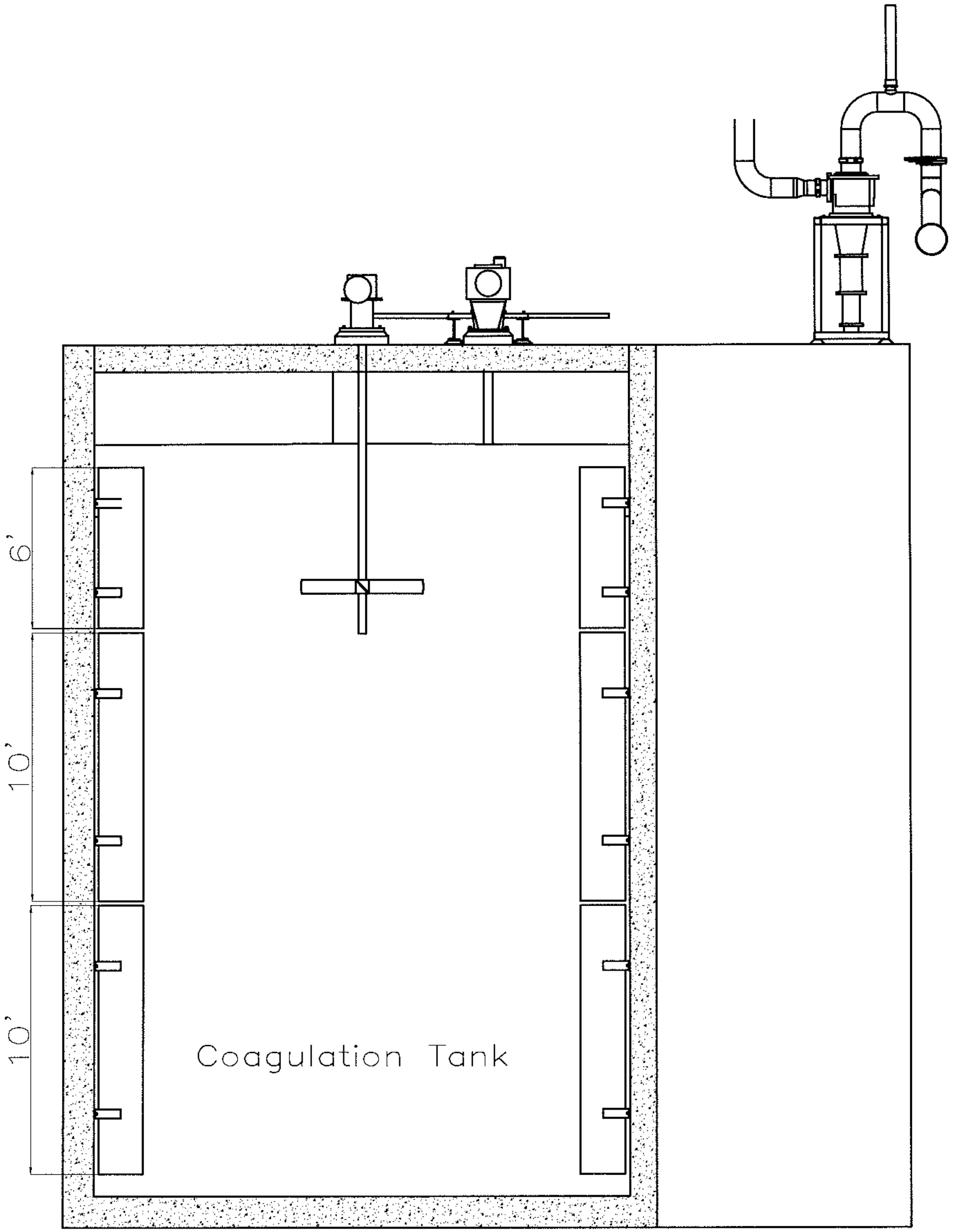
NO.

PROJECT NO: 14797

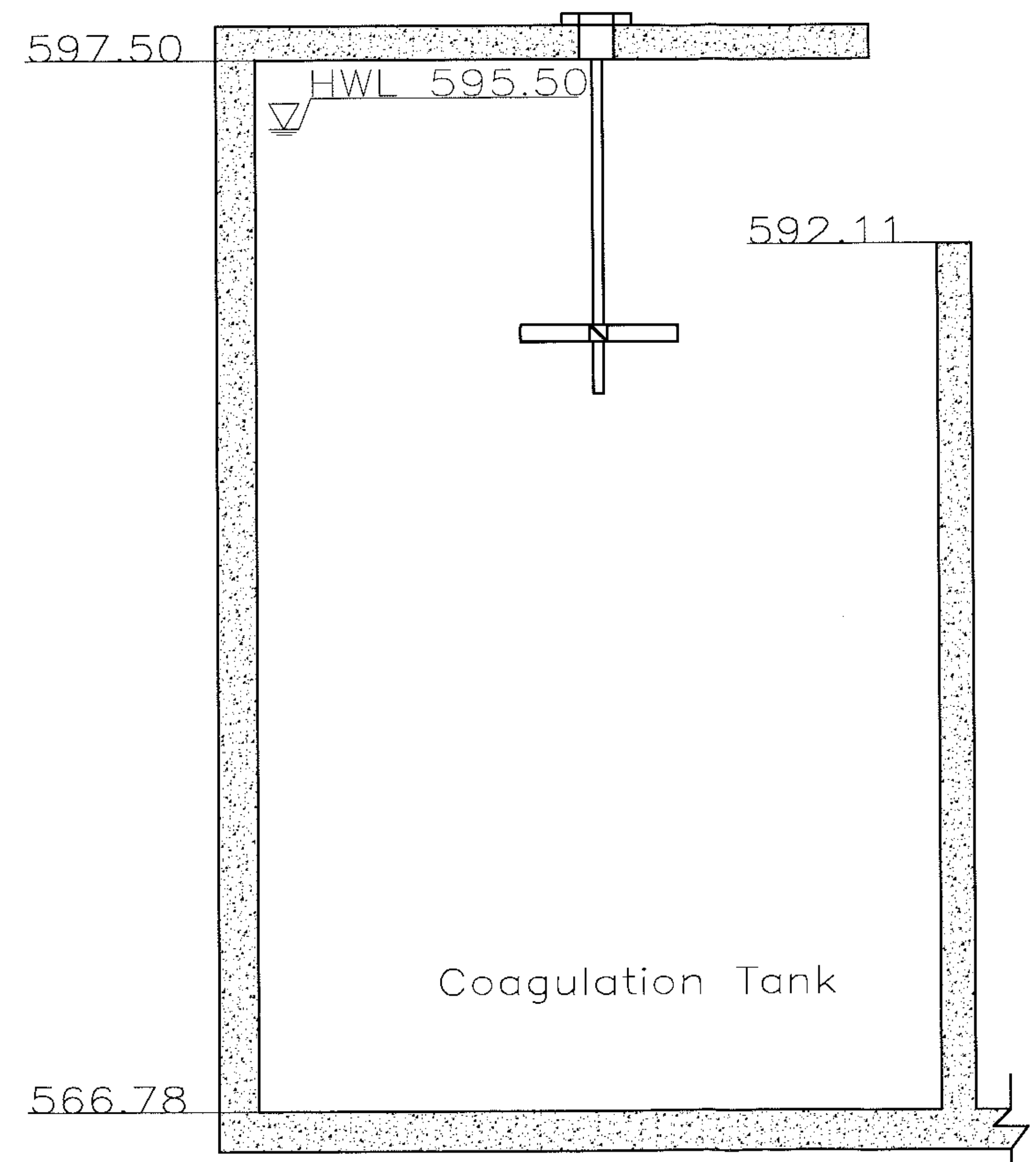
DRAWING NAME

SHEET OF

Attachment F
Figure 5



Section A–A



Section D–D

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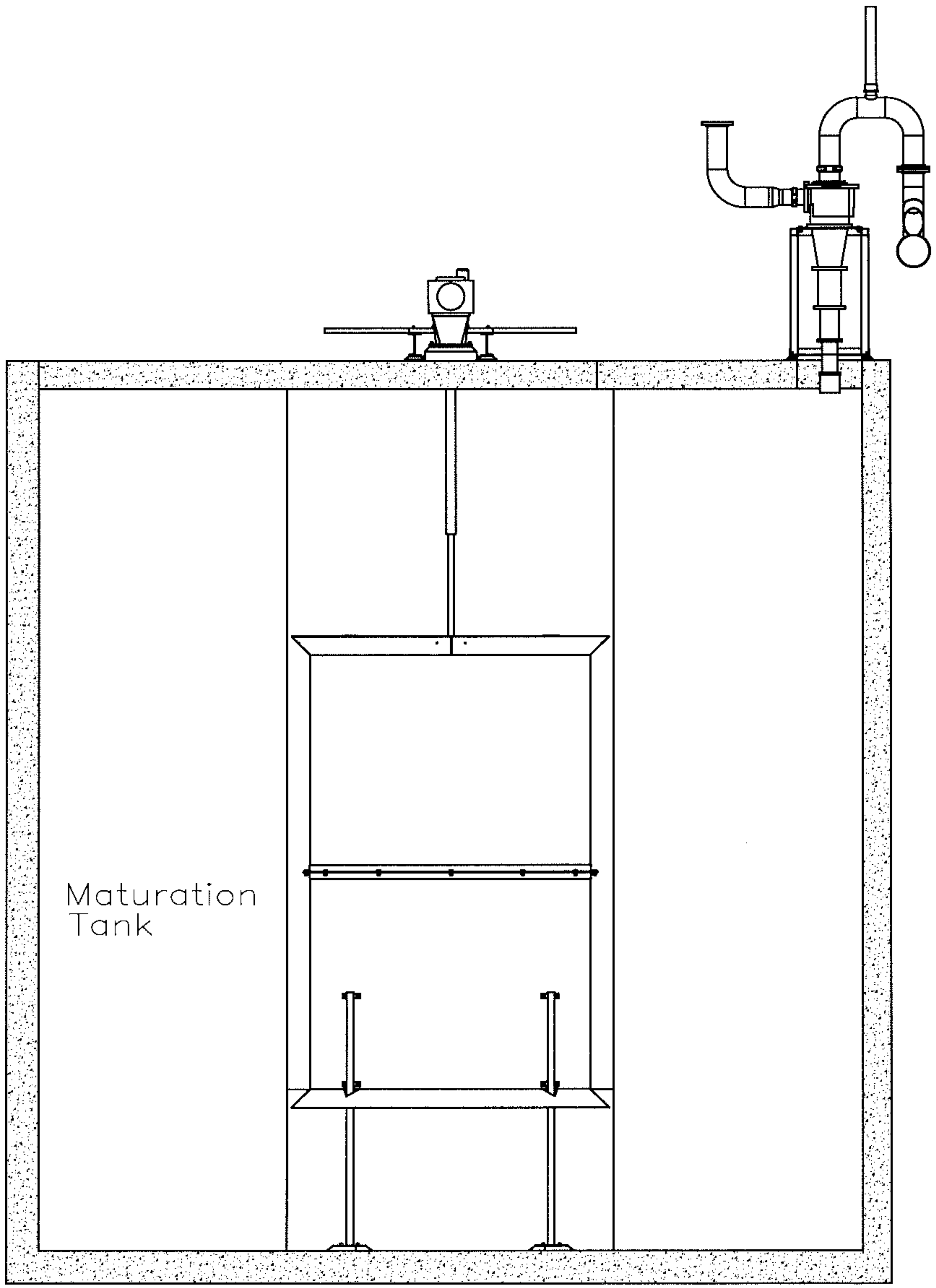
CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

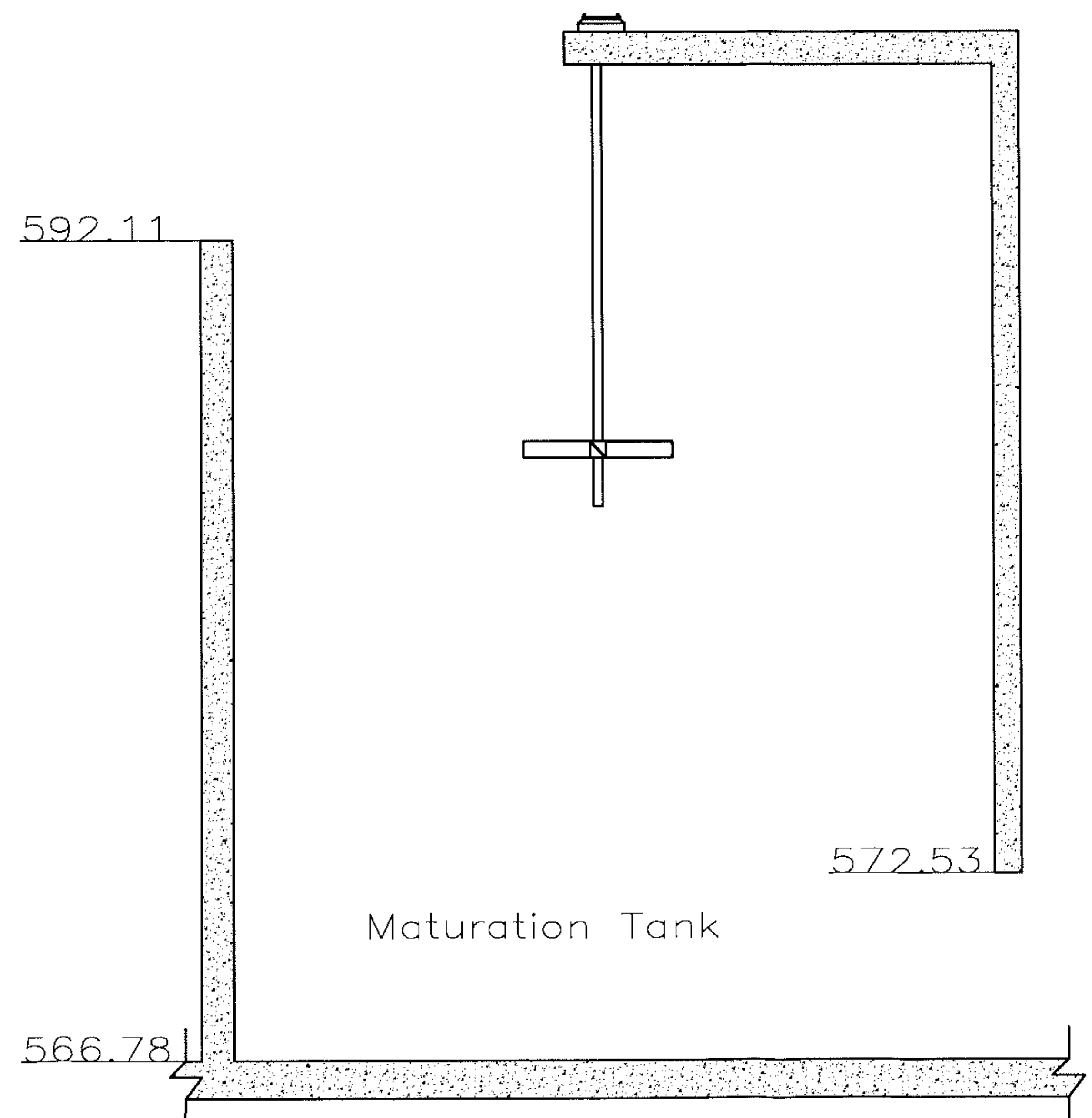
Coagulation Tank

DRAWING SCALE: HORZ: VERT:	N/A
DATE:	
DESIGNED BY:	
DRAWN BY:	
CHECKED BY:	
NO.	
PROJECT NO:	14797
DRAWING NAME	
SHEET	OF

Attachment F
Figure 6



Section B–B



Section E–E

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DRAWING SCALE:
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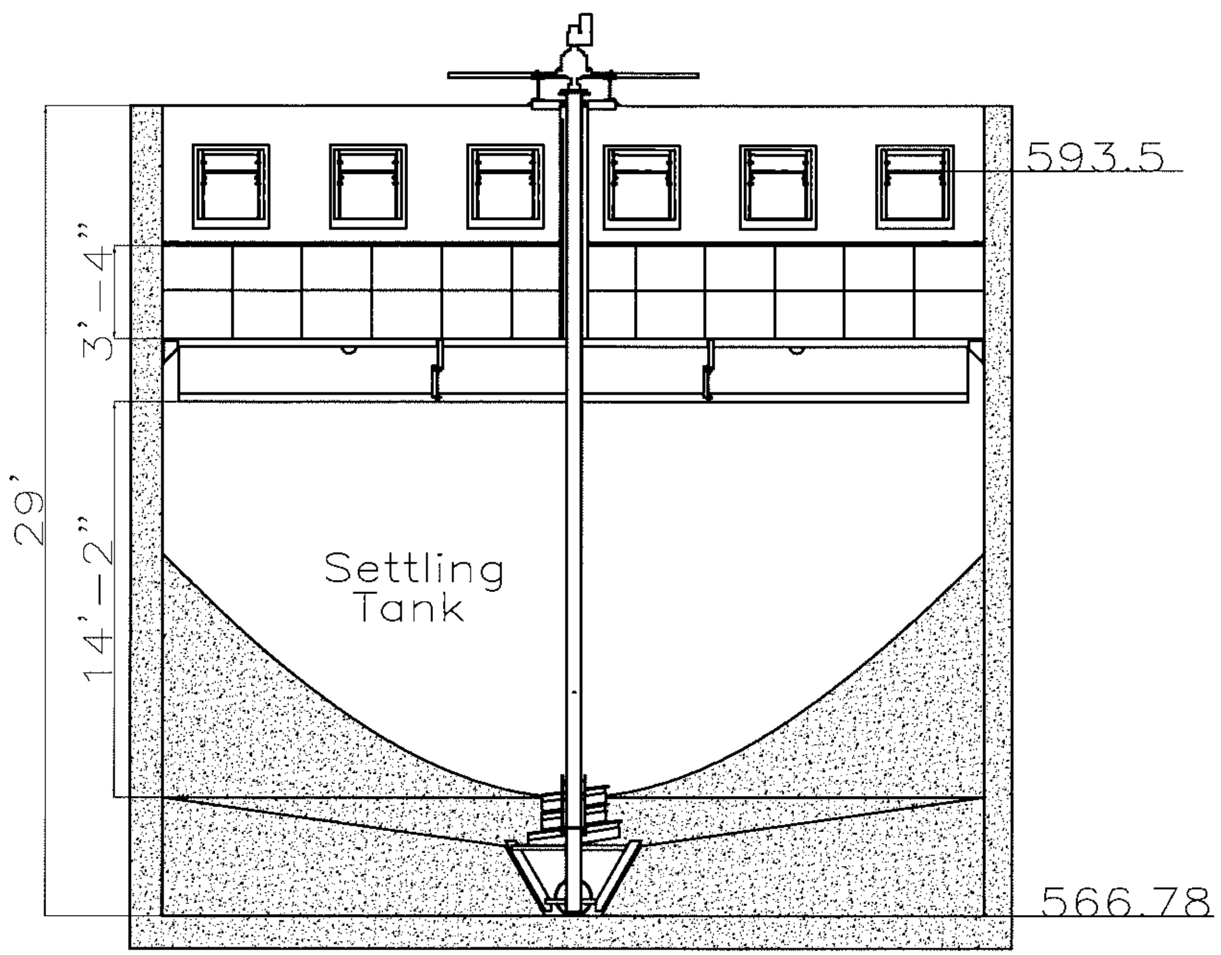
• VERT: N/A
DATE:
DESIGNED BY:
DRAWN BY:
CHECKED BY:

CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

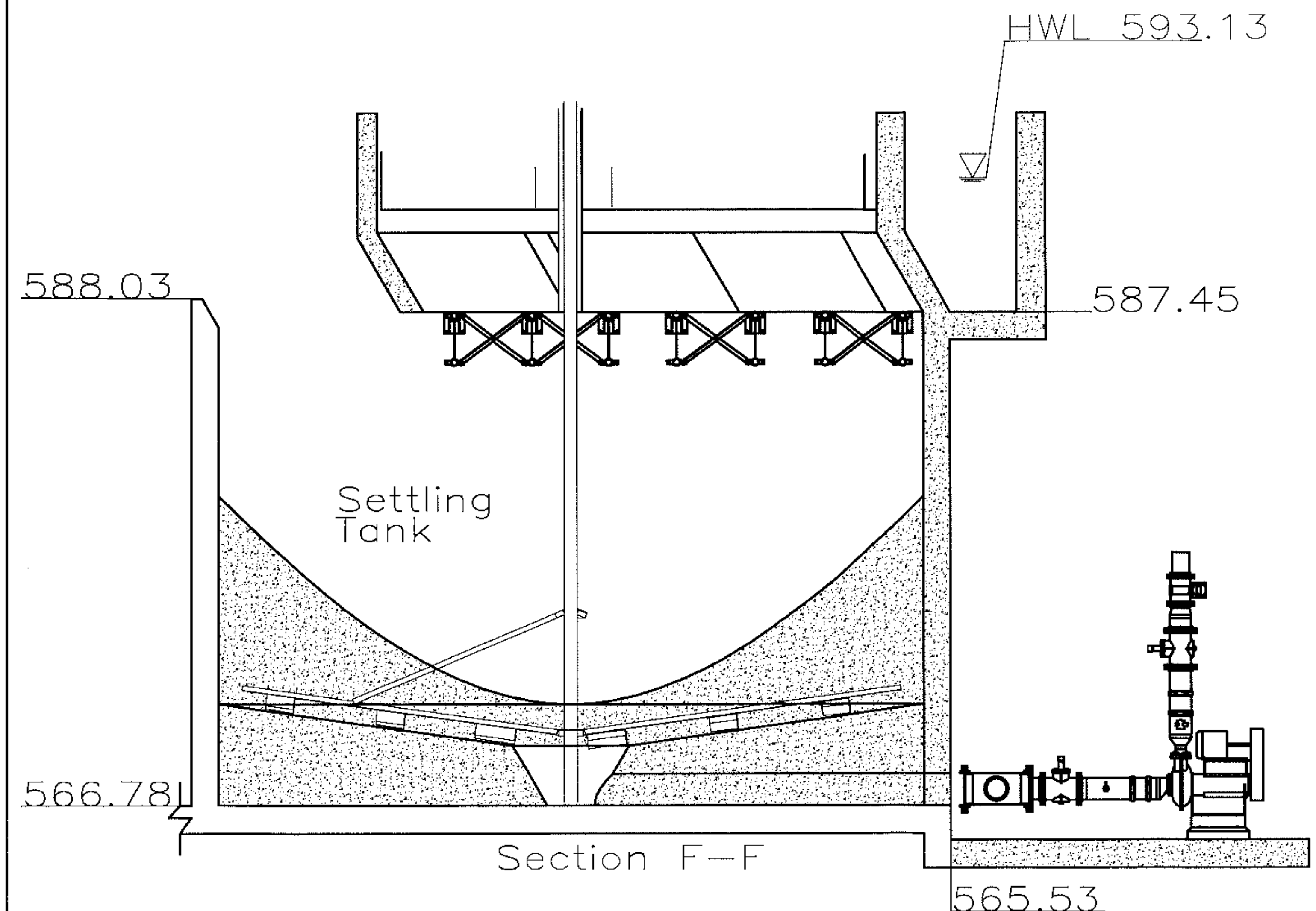
Maturation Tank

PROJECT NO:
14797
DRAWING NAME
SHEET OF

Attachment F
Figure 7



Section C–C



Section F–F

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CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

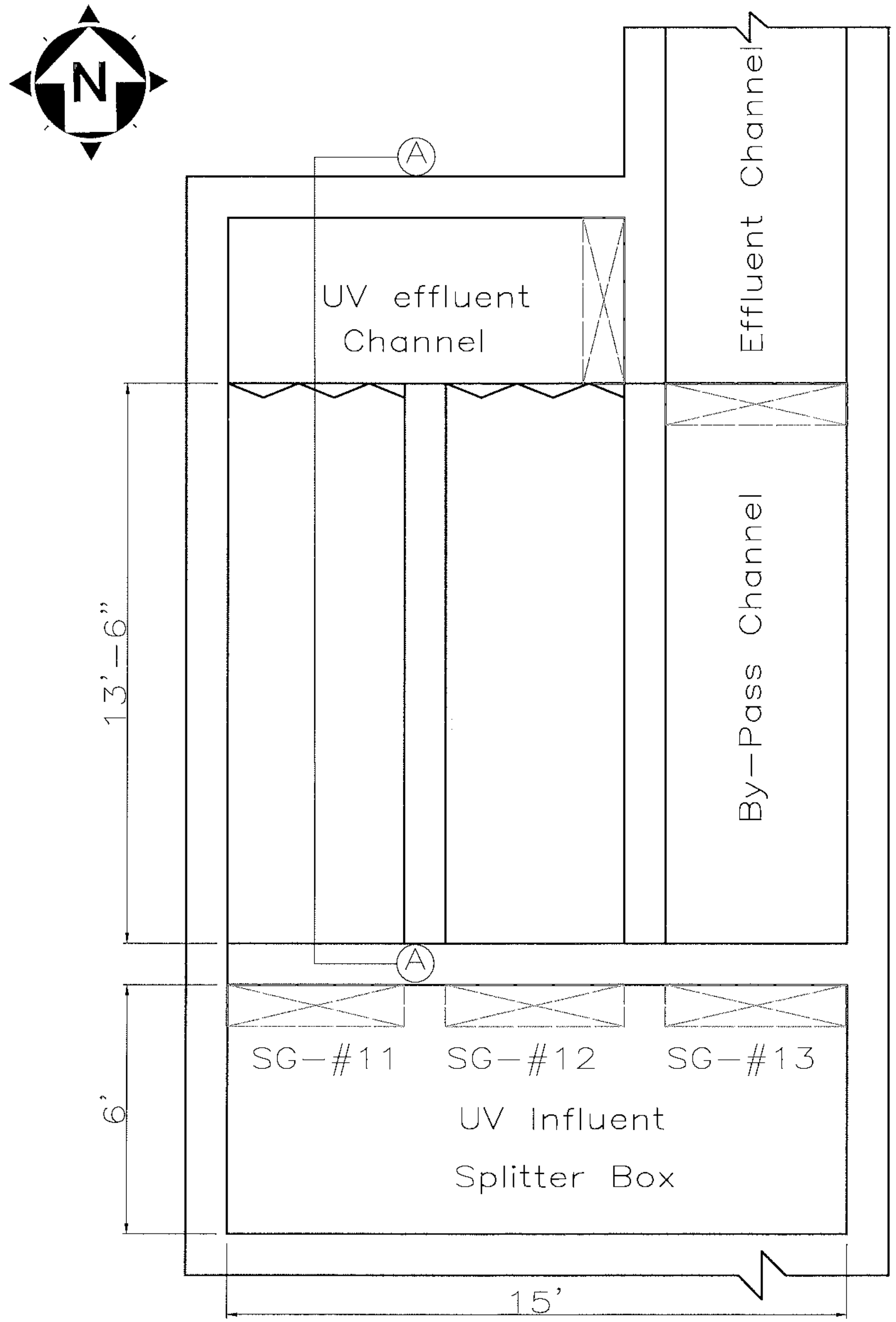
Settling Tank

NO. | REVISION | DATE

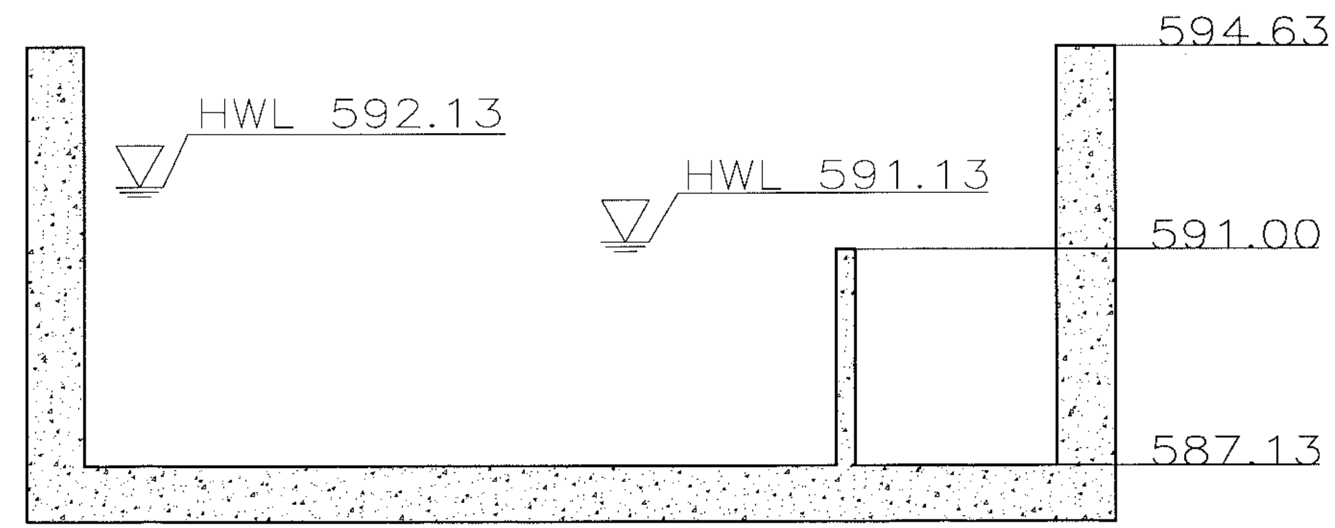
DRAWING SCALE: • HORZ: • VERT: N/A
DATE:
DESIGNED BY:
DRAWN BY:
CHECKED BY:

PROJECT NO: 14797
DRAWING NAME
SHEET OF

Attachment F
Figure 8



PLAN VIEW



Section A-A

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Phone: 614.885.7700 · Fax: 614.885.7701 · www.ctconsultants.com

NO.	REVISION	DATE

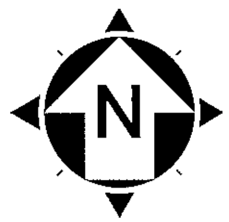
DRAWING SCALE: • HORZ: • VERT: N/A
DATE:
DESIGNED BY:
DRAWN BY:
CHECKED BY:

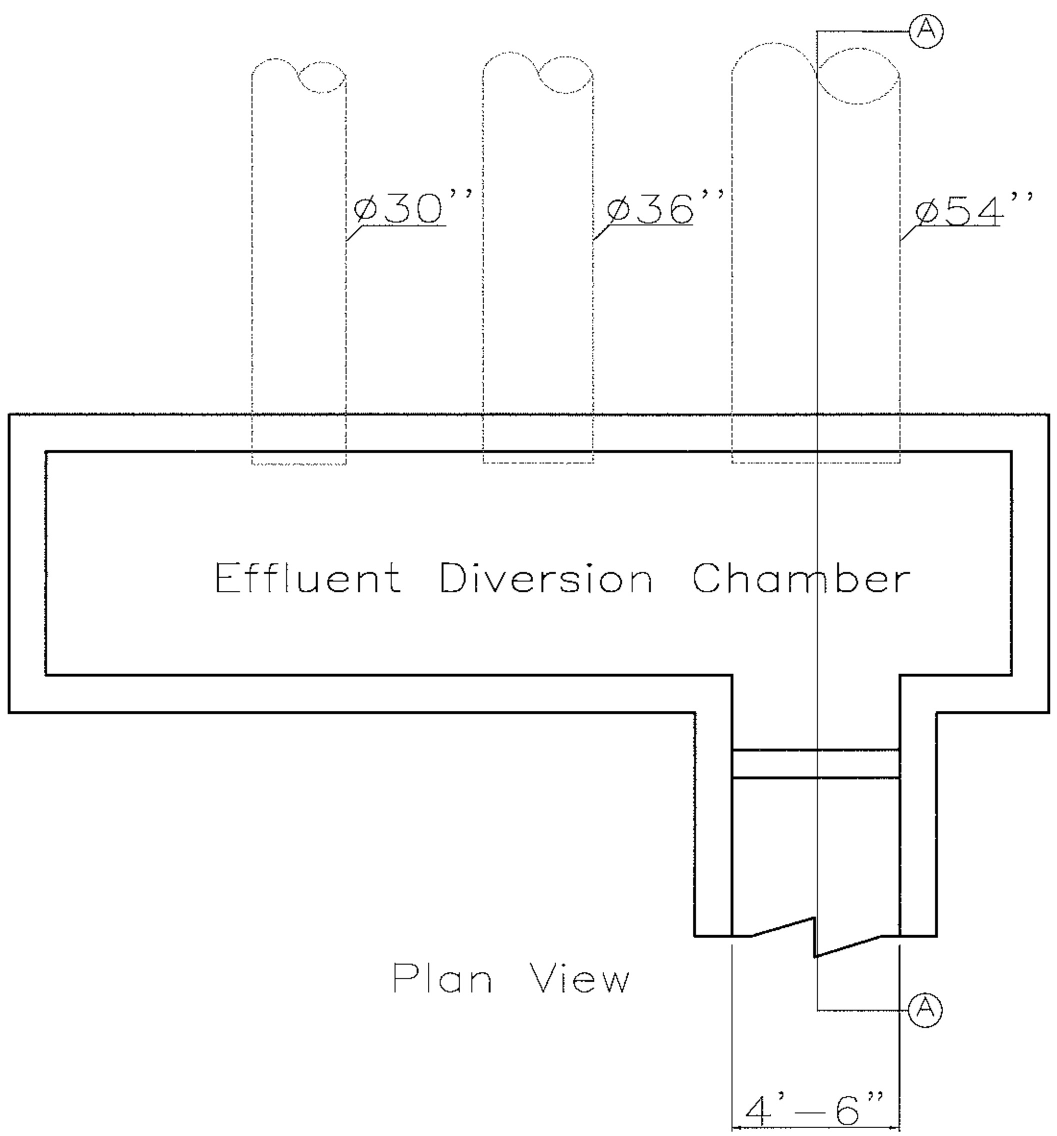
CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

UV & By-Pass Channels

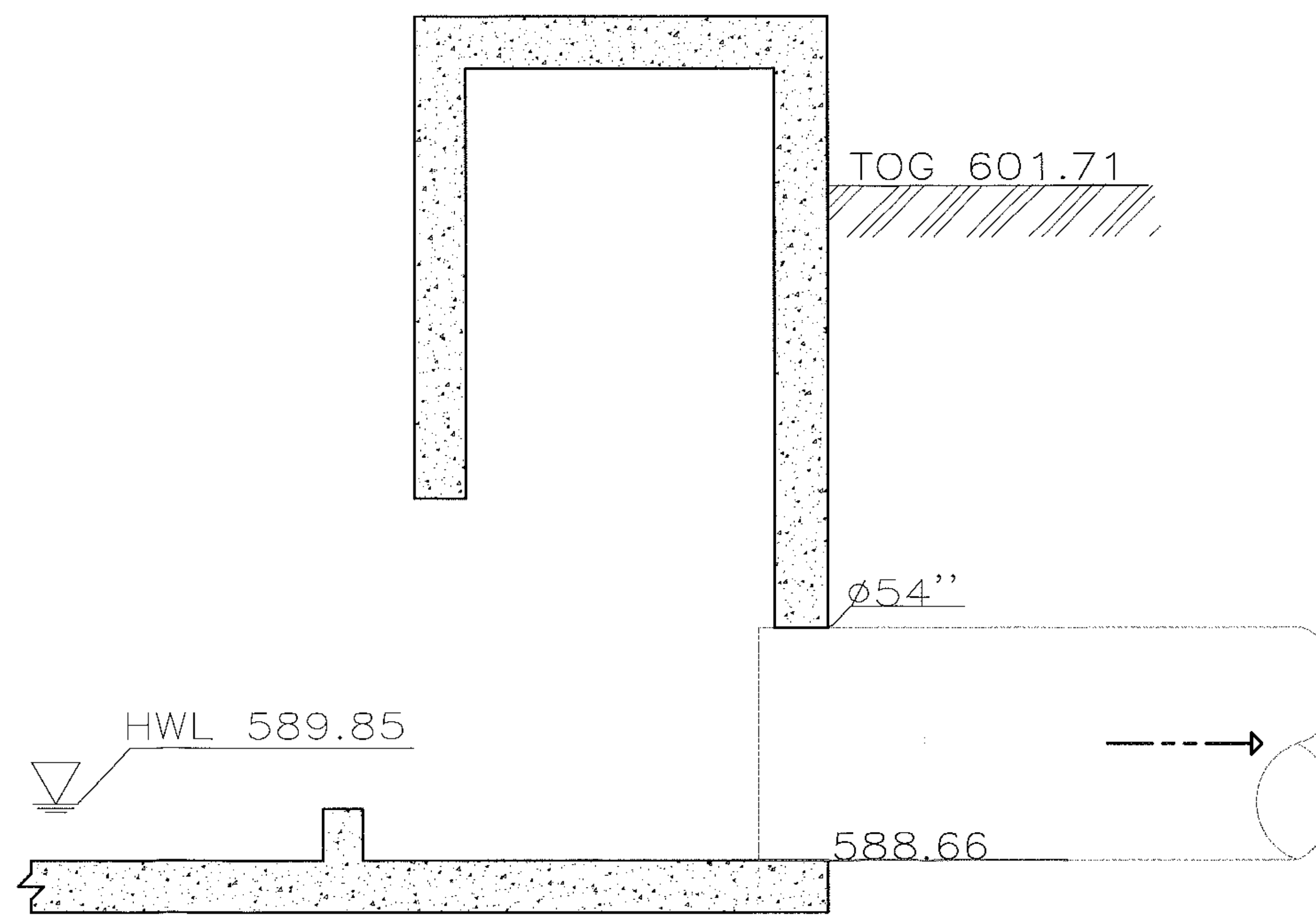
PROJECT NO: 14797
DRAWING NAME
SHEET OF

Attachment F
Figure 9





Plan View



Section A-A

Attachment F
Figure 10

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CITY OF LAKEWOOD OHIO
WET WEATHER IMPROVEMENTS FOR WWTP

Effluent Diversion Chamber

DRAWING SCALE: • HORZ: • VERT: N/A
DATE:
DESIGNED BY:
DRAWN BY:
CHECKED BY:
NO.

PROJECT NO: 14797
DRAWING NAME
SHEET OF

APPENDIX G

Detailed Construction Cost Estimate

CITY OF LAKEWOOD, OHIO
WWTP HIGH RATE TREATMENT (HRT) SYSTEM
CONSTRUCTION COST ESTIMATE

08/01/2016

TWO TRAIN, 35 MGD ACTIFLOW SYSTEM

ITEM	QUANTITY	UNIT	MATERIAL COST		LABOR COST		TOTAL COST
			PER UNIT	TOTAL	PER UNIT	TOTAL	
SITE CONSTRUCTION - DIV 02							
MOBILIZATION	1	LS	$ -	$ -	$ 40,000.00	$ 40,000.00	$ 40,000.00
EROSION CONTROL	1	LS	$ 2,500.00	$ 2,500.00	$ 2,500.00	$ 2,500.00	$ 5,000.00
SITE DEWATERING	1	LS	$ 900.00	$ 900.00	$ 9,100.00	$ 9,100.00	$ 10,000.00
PROCESS / SELECTIVE DEMO	1	LS	$ 5,000.00	$ 5,000.00	$ 15,000.00	$ 15,000.00	$ 20,000.00
SITE CLEARING	1	LS	$ -	$ -	$ 2,000.00	$ 2,000.00	$ 2,000.00
BOLLARDS	8	EA	$ 330.00	$ 2,640.00	$ 165.00	$ 1,320.00	$ 3,960.00
CONCRETE SIDE WALK	800	SF	$ 5.00	$ 4,000.00	$ 5.00	$ 4,000.00	$ 8,000.00
SOIL EXCAVATION, FILL & COMPACTION	5000	CY	$ 3.00	$ 15,000.00	$ 6.00	$ 30,000.00	$ 45,000.00
MISC. PROCESS YARD PIPING, VALVES	1	LS	$ 15,000.00	$ 15,000.00	$ 5,000.00	$ 5,000.00	$ 20,000.00
48" STEEL AERIAL INFLUENT SEWER ON PIERS	170	LF	$ 1,000.00	$ 170,000.00	$ 500.00	$ 85,000.00	$ 255,000.00
30" RCP EFFLUENT SIPHON SEWER	400	LF	$ 270.00	$ 108,000.00	$ 280.00	$ 112,000.00	$ 220,000.00
36" RCP EFFLUENT SIPHON SEWER	400	LF	$ 290.00	$ 116,000.00	$ 280.00	$ 112,000.00	$ 228,000.00
54" RCP EFFLUENT OVERFLOW SEWER	125	LF	$ 330.00	$ 41,250.00	$ 100.00	$ 12,500.00	$ 53,750.00
HAULING	4000	CY	$ 0.75	$ 3,000.00	$ 1.78	$ 7,120.00	$ 10,120.00
BEDDING GRAVEL No. 57	175	CY	$ 40.00	$ 7,000.00	$ 30.00	$ 5,250.00	$ 12,250.00
FINISH GRADING	10000	SF	$ 0.50	$ 5,000.00	$ 0.50	$ 5,000.00	$ 10,000.00
SITE PAVING & IMPROVEMENTS	1	LS	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 20,000.00
LANDSCAPING (YARD PIPE, PUMP STA'S, FC)	500	SY	$ 5.00	$ 2,500.00	$ 10.00	$ 5,000.00	$ 7,500.00
SUBTOTAL							**$ 970,580.00**
CONCRETE - DIV 03							
SCREEN BUILDING	110	CY	$ 600.00	$ 66,000.00	$ 400.00	$ 44,000.00	$ 110,000.00
GRIT TANKS (2)	300	CY	$ 600.00	$ 180,000.00	$ 400.00	$ 120,000.00	$ 300,000.00
ACTIFLOW TANKS (2 TRAINS)	810	CY	$ 600.00	$ 486,000.00	$ 400.00	$ 324,000.00	$ 810,000.00
UV DISINFECTION	60	CY	$ 600.00	$ 36,000.00	$ 400.00	$ 24,000.00	$ 60,000.00
SUBTOTAL							**$ 1,280,000.00**
MASONRY - DIV 04							
SCREEN BUILDING (FLOOR SF)	1440	SF	$ 100.00	$ 144,000.00	$ 100.00	$ 144,000.00	$ 288,000.00
CHEMICAL ROOM (FLOOR SF)	1320	SF	$ 100.00	$ 132,000.00	$ 100.00	$ 132,000.00	$ 264,000.00
PUMP ROOM (FLOOR SF)	1800	SF	$ 100.00	$ 180,000.00	$ 100.00	$ 180,000.00	$ 360,000.00
MCC ROOM (FLOOR SF)	1320	SF	$ 100.00	$ 132,000.00	$ 100.00	$ 132,000.00	$ 264,000.00
SUBTOTAL							**$ 1,176,000.00**
METAL FABRICATIONS - DIV 05							
ALUMINUM GRATING AND SUPPORTS	400	SF	$ 45.00	$ 18,000.00	$ 12.00	$ 4,800.00	$ 22,800.00
ALUMINUM DIAMOND PLATE AND SUPPORTS	4500	SF	$ 50.00	$ 225,000.00	$ 12.00	$ 54,000.00	$ 279,000.00
ALUMINUM RAILING	300	LF	$ 46.00	$ 13,800.00	$ 11.50	$ 3,450.00	$ 17,250.00
ALUMINUM STAIRS	40	TR	$ 500.00	$ 20,000.00	$ 125.00	$ 5,000.00	$ 25,000.00
SLUDGE SCRAPER SUPPORT BRIDGE	1	LS	$ 10,000.00	$ 10,000.00	$ 2,000.00	$ 2,000.00	$ 12,000.00
HATCHES	4	EA	$ 2,500.00	$ 10,000.00	$ 375.00	$ 1,500.00	$ 11,500.00
SUBTOTAL							**$ 367,550.00**
PROCESS - DIV 11							
SCREENS (2 UNITS) - PARKSON	2	EA	$ 240,000.00	$ 480,000.00	$ 72,000.00	$ 144,000.00	$ 624,000.00
GRIT REMOVAL (2 UNITS) - HYDRO-INT'L	1	LS	$ 315,000.00	$ 315,000.00	$ 94,500.00	$ 94,500.00	$ 409,500.00
GRIT PUMPS (3 PUMPS)	3	EA	$ 10,000.00	$ 30,000.00	$ 3,000.00	$ 9,000.00	$ 39,000.00
ACTIFLOW SYSTEM (2 TRAIN2 X 17.5MGD) - KRUGER	1	LS	$ 3,950,000.00	$ 3,950,000.00	$ 1,777,500.00	$ 1,777,500.00	$ 5,727,500.00
ACTIFLOW POLYMER TANK (1 - 4,000 GAL)	1	EA	$ 10,000.00	$ 10,000.00	$ 1,500.00	$ 1,500.00	$ 11,500.00
UV DISINFECTION (2 BANKS) - TROJAN	1	LS	$ 650,000.00	$ 650,000.00	$ 260,000.00	$ 260,000.00	$ 910,000.00
SLIDE GATES	12	EA	$ 15,000.00	$ 180,000.00	$ 3,000.00	$ 36,000.00	$ 216,000.00
HYDROSTATIC PR VALVES - 4"	20	EA	$ 200.00	$ 4,000.00	$ 40.00	$ 800.00	$ 4,800.00
FLOW METER (1 - ULTRASONIC CLAMP-ON)	1	EA	$ 6,000.00	$ 6,000.00	$ 500.00	$ 500.00	$ 6,500.00
SUBTOTAL							**$ 7,948,800.00**
SUBTOTAL DIVISIONS 02-11							**$ 11,742,930.00**
ELECTRICAL - 10%	1	LS					$ 1,174,300.00
HVAC - 2.5%	1	LS					$ 293,580.00
PLUMBING - 5%	1	LS					$ 587,150.00
SUBTOTAL DIVISIONS 15 & 16							**$ 2,055,030.00**
TOTAL CAPITAL COST							**$ 13,797,960.00**
CONTINGENCY @ 10%							**$ 15,177,760.00**

Appendix H

Vendor Information

PARKSON CORPORATION

MN--MN--MN--MN--MN--MN--MN--MN--MN--MN--MN

AQUA GUARD PRELIMINARY SIZING

MN--MN--MN--MN--MN--MN--MN--MN--MN--MN--MN

DATE:	5/9/16
PROJECT:	LAKEWOOD, OH
ENGINEER:	CT CONSULTANTS

MODEL: AGUC-MN -A

FLOW RATE:	**35**	(MGD)	SCREEN WIDTH:	**5.5**	(FEET)
CHANNEL WIDTH:	**5.5**	(FEET)	DISCHARGE HT:	**13.0**	(FEET)
CHANNEL DEPTH:	**8**	(FEET)	UPSTREAM W.L.:	5.49	(FEET)
SCREEN ANGLE:	**75**	(DEG)	FREEBOARD:	**2.51**	(FEET)
ELEMENT SIZE:	**6**	(mm)	HYD. HEADLOSS:	**11.88**	(INCHES)
W.L. DOWNSTREAM:	4.5	(FEET)	TOTAL HEADLOSS:	**11.88**	(INCHES)
RECESS:	**0.292**	(FEET)	APPROX. WEIR HT:	29.3	(INCHES)
DEAD SPACE:	0	(FEET)	**V** (upstream) :	**1.79**	FT/SEC
HEIGHT ABV FLOOR:	**4.708**	(FEET)	**V** (downstream) :	**2.19**	FT/SEC
			V1 (screen) :	**2.53**	FT/SEC

****

SCREEN RECOMMENDATION: **AGUCMN -A-5.5' x 13.0' x 75 DEG x 6 mm**

****

AQUC SCREEN NOTES:

1. SCREEN SPEED 7 FPM.
UNIT WEIGHT: XXXX LBS.

2. OVERLOAD PROTECTION – SSAC CURRENT MONITOR.

3. X'-X" CLEARANCE REQUIRED ON ONE SIDE OF MACHINE TO DISASSEMBLE SCREEN. USE SERVICE FIXTURE (ITEM #) TO HOLD SCREEN IN PLACE WHEN DISASSEMBLING.

4. MOUNT LEVEL SENSOR TO SUIT. LEVEL SENSORS SUPPLIED WITH CONTROL PANEL. 1" NOMINAL PIPE SUPPLIED BY OTHERS THAN PARKSON.

~~5. CONTRACTOR TO FIELD VERIFY ALL DIMENSIONS PRIOR TO INSTALLATION.~~

6. LOCAL E-STOP SUPPLIED MOUNTED TO DRIVE SIDE OF THE MACHINE. CUSTOMER TO MOUNT IN THE FIELD TO AN APPROPRIATE LOCATION.

7. MINIMUM EMBEDMENT DEPTHS SHOWN ON ANCHOR DETAIL (SHEET 1) IS FOR USE WITH HILTI HY-200MAX ADHESIVE SYSTEM (EPOXY BY OTHERS).

8. (1) 2-WAY SOLENOID VALVE (ITEM #XX) IS SHIPPED LOOSE FOR CUSTOMER TO INSTALL ON THE WATER LINE THAT FEEDS THE SPRAY WASH. PARKSON RECOMMENDS THAT A GATE VALVE & PRESSURE GUAGE BE INSTALLED UPSTREAM OF SOLENOID VALVE TO CONTROL WATER FLOW AND MEASURE THE PRESSURE. IF NON-POTABLE WATER IS USED, A STRAINER IS RECOMMENDED. GATE VALVE, PRESSURE GUAGE & STRAINER ARE NOT INCLUDED IN PARKSON'S SCOPE OF SUPPLY.

9. X-X" CLEARANCE REQUIRED ON DRIVE SIDE OF SCREEN TO DISASSEMBLE AND REPLACE BRUSH ASSEMBLY DURING MAINTENANCE.

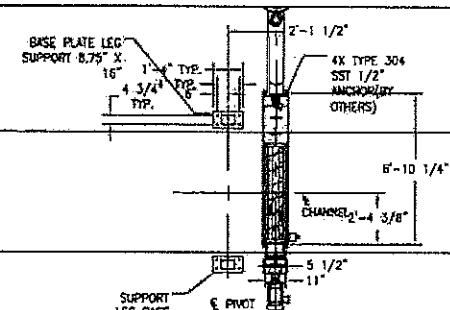
10. WATER REQUIREMENT:
SPRAY WASH – XXGPM @ 40PSI/ XXGPM @ 60PSI

AMP NOTES:

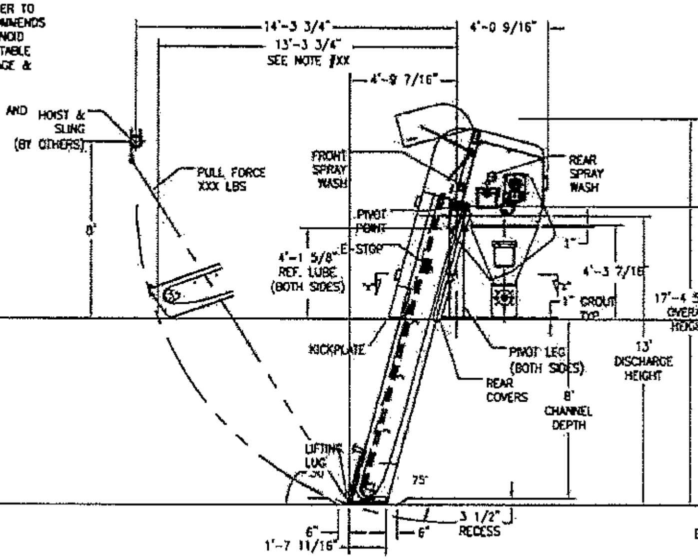
1. MODEL XXX BEING PROVIDED.
UNIT WEIGHT: XX LBS.

2. LOCAL E-STOP SUPPLIED MOUNTED TO DRIVE END SUPPORT BRACKET

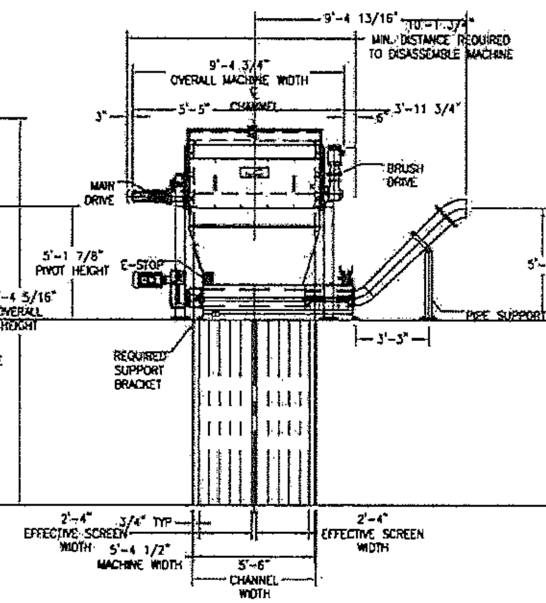
3. WATER REQUIREMENT.
~~WASH SPRAY – 10 GPM @ 60 PSI~~
FLUSH SPRAY – 15 GPM @ 60 PSI



PLAN VIEW X-X



SIDE ELEVATION



REAR ELEVATION

This drawing and all appurtenant matter contains information proprietary to PARKSON CORPORATION [illegible]

REV	DESCRIPTION	DATE	BY

__PRELIMINARY X APPROVAL
__INFORMATION __CERTIFIED

THIS DRAWING IS LIMITED TO FUNCTIONAL DESIGN, GENERAL ARRANGEMENT AND CLEARANCE. NO RESPONSIBILITY IS ACCEPTED BY PARKSON CORPORATION FOR OTHER DIMENSIONS, QUANTITIES, OR COORDINATION WITH OTHER EQUIPMENT OR DRAWINGS EXCEPT AS STATED IN PURCHASE ORDER.

DRAWN BY	DATE
DFT	MM/DD/YY
CHECKED BY	DATE
ENG	MM/DD/YY
SCALE	SIZE
1/X"=1"	B

Parkson

PROJECT NAME
PROJECT NUMBER
PROJECT NAME
PROJECT LOCATION

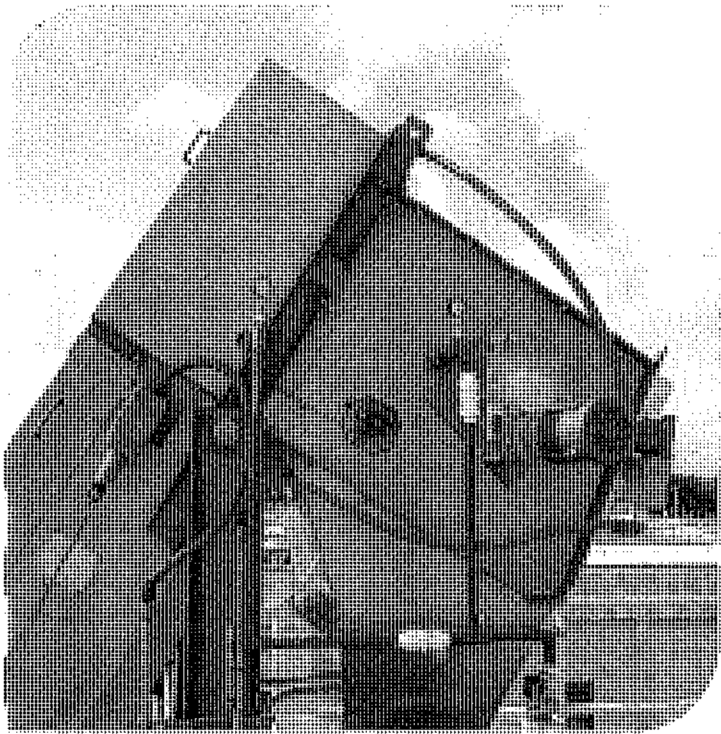
REFERENCE INFORMATION
SPECIFICATION SECTION
REFERENCE INFORMATION

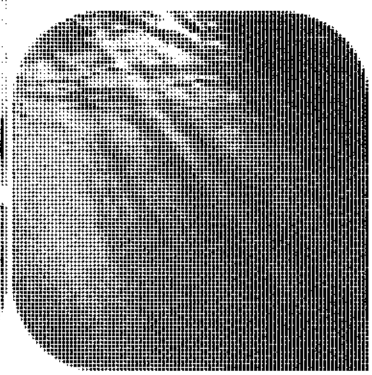
TITLE
MODEL NUMBER
MODEL® NAME™

DRAWING NO
8888-888

REV

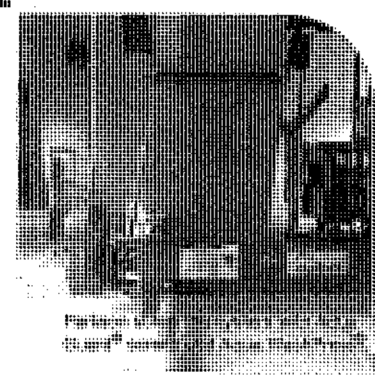
SHEET 1 OF 1





Parkson
Treating Water Right

Aqua Guard® UltraClean™



Self-Cleaning Moving Media Channel Screen

The new Aqua Guard® UltraClean™ screen outperformed the standard Aqua Guard® screen in side-by-side capture rate tests by over 50%. The new upper UltraClean "head" design makes the Aqua Guard® UltraClean™ superior and it is available for new units or can be rebuilt on existing ones.

The Aqua Guard® UltraClean™ screen, a self-cleaning in-channel screening device, utilizes a unique filter element system designed to automatically remove solids larger than element spacing. Aqua Guard® screen filter elements form an underwater grid that ensures better capture rates when compared to rake bar screens that utilize only vertical bars for screening.

A specific configuration of filter elements is mounted on a series of parallel shafts to form an endless moving belt that collects, conveys and discharges solids for further processing or disposal.

Features

- UltraClean design
- Low power consumption (1.0 HP or less)
- Self-cleaning with independent brush drive (0.5 HP)
- Dual spray bars assist cleaning brush
- No submerged bearings
- All moving parts can be accessed and serviced above water level
- Coarse and fine screening in one unit
- Flows to 100 MGD in a single unit
- Delivered fully assembled
- No attachment to sides or bottom of channel

Benefits

- Improved solids capture
- Less screen and plant maintenance
- Quick-release side brush removal
- UltraClean brush with brush drive
- Low operation costs and ease of maintenance
- High capacity
- Ease of installation

Principle of Operation

Solids contained in a wastewater flow are captured on the filter elements and carried upward on the belt assembly to discharge at the rear of the unit. Two-stage screening is achieved which results in minimal headloss. Coarse filtration occurs on the forward screen face and fine filtration on the recessed face.

As the rake tip of one row of filter elements passes between the shank arm of the lower row, the elements automatically clean themselves. The unit is equipped with water sprays and a rotating brush that provides additional removal of solids.

Design Parameters

Standard screen widths are 1.0' to 9.0' depending on the model with flow rates up to 100 MGD with a single unit. Two frame styles are available depending on space and channel depth requirements. Type A is a pivoting design and Type T is a stationary design.

The Aqua Guard® UltraClean™ screen can be installed at angles 60°, 75° and 85° depending on the frame and model selected. For maximum efficiency of operation, greater flow rate and higher solids removal, the recommended angle of inclination is 75°.

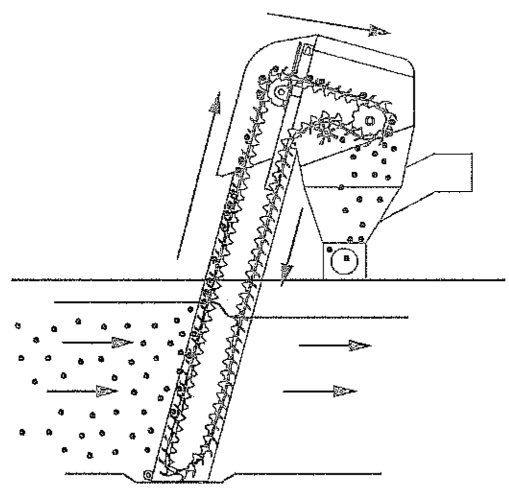
The screen conveys solids up and out of the channel at a speed of 7ft/min. The maximum amount of debris, in cubic yards per hour, that can be removed from the stream is a function of model and angle.

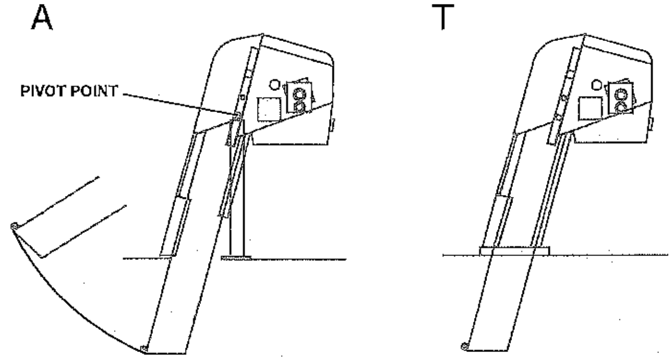
Movement of the screen can be continuous or intermittent. However, intermittent operation is recommended. This allows a mat of solids to build up on the filter-rake elements which increases the solids capture rate.

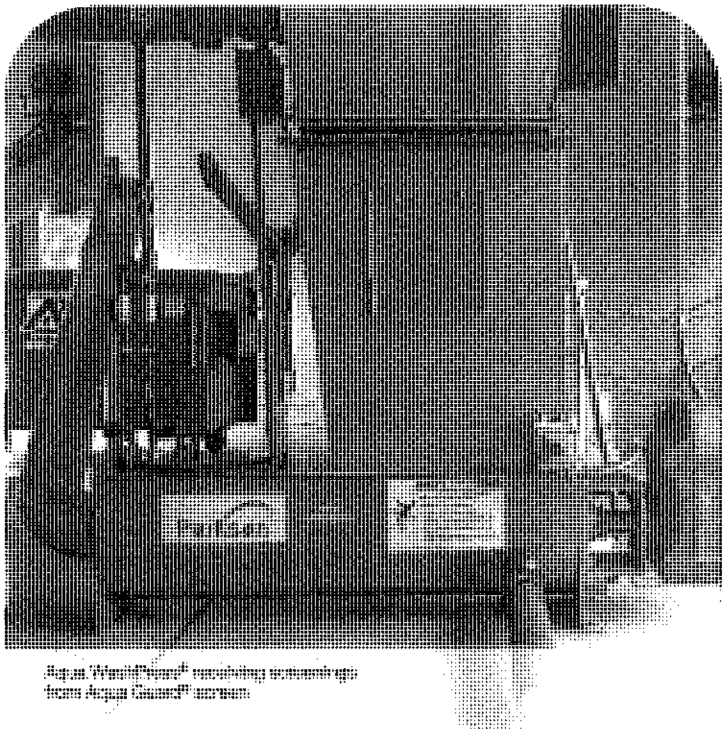
Added Capacity Using Aqua Guard® UltraClean™

Design Parameters	Model MN (Standard)	Model S* (Heavy Duty)
Minimum Channel Width (in.)	12	24
Maximum Screen Width (in.)	66	108
Maximum Design Headloss (in.)	10	20
Element Spacing (mm.)	1-15	1-30

* Model S UltraClean available soon

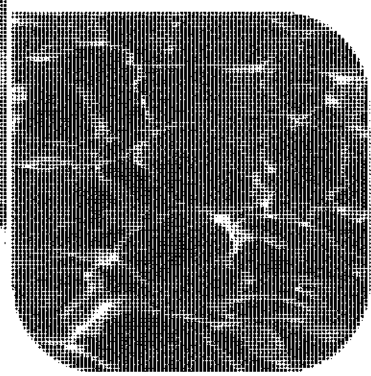


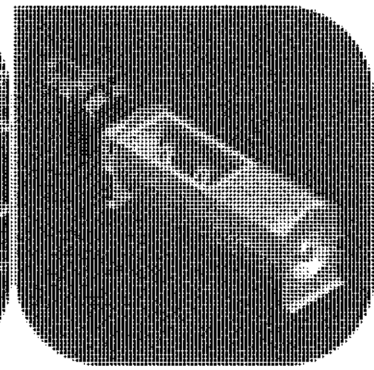




Aqua WashPress® receiving screenings from Aqua Guard® screen

Parkson™
Treating Water Right





Aqua WashPress®

Reduce odors and disposal costs

Organics and biosolids are commonly caught along with screened solids. If not removed, these elements retain water, inhibit drainage, emit odors and result in excessive disposal costs.

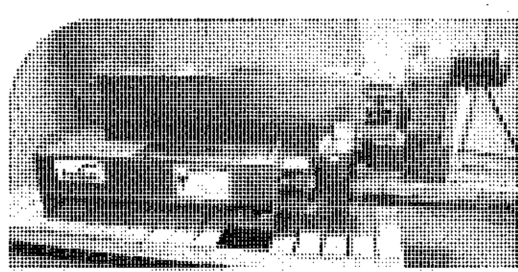
The solution is screenings washing, and the Aqua WashPress® (AWP) handles the job economically. The unit is the perfect complement to any screen, particularly if cost-effective screenings washing and compaction is your objective.

Principle of Operation

The operation is simple. Screenings enter the press from a hopper and are conveyed by a slowly rotating screw to a wash zone where water is added to support the separation process. This is followed by compacting and dewatering in a press zone.

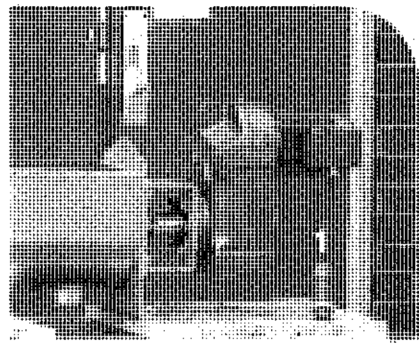
A stainless steel housing encompasses an inner cylinder where washing and compacting occurs. This design completely encloses the screenings, prevents spills, contains odors and provides a hygienic work environment.

Following the wash section, the Aqua WashPress® dewaters solids to reduce the volume and weight prior to disposal. The Aqua WashPress® delivers significant volume and weight reductions compared to unwashed and dewatered solids.



The AWP 17 is the largest diameter WashPress on the market

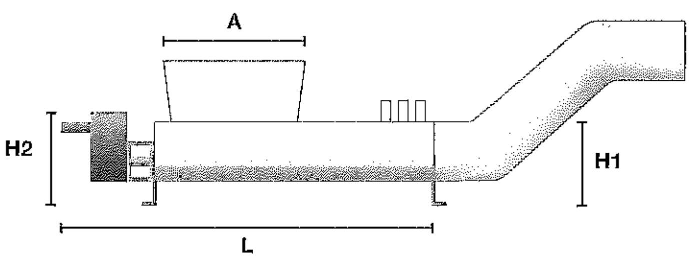
The organics, which are washed out of the screenings, are returned to the influent, where they can be treated as part of the normal plant process. The Aqua WashPress® is an effective way to improve plant processes and its compact size fits easily under a screen.



Drive assembly with reliable Eurodrive gearmotor and packing gland

Features

- Improves plant operation – washes organics from the screenings and returns them to the process where they belong; reduces odors caused by entrained organics
- Low maintenance – only one moving part, the screw drive; all wear parts are easy to replace without welding
- Economic to operate – a low horse-power motor drives the entire unit which only runs on demand
- Custom length/height of discharge piping
- Variable length inlet hopper
- Optional bagging device at discharge



Unit Model	8	10	12	17
Spiral Diameter	8"	10"	12"	17"
Height (H1)	18"	20"	20"	32.5"
Width	13.5"	17"	17"	23.5"
Gearmotor Height (H2)	26"	26"	26"	42"

AWP Models			Hopper Length "A"	Unit Length "L"	
				8, 10, 12	17
8,10,12		-1.0	1'3"	6'5"	
8,10,12		-1.5	1'9"	6'11"	
8,10,12	17	-2.0	2'3"	7'5"	9'8"
8,10,12		-2.5	2'9"	7'11"	
8,10,12	17	-3.0	3'3"	8'5"	10'8"
8,10,12		-3.5	3'9"	8'11"	
8,10,12	17	-4.0	4'3"	9'5"	11'8"
8,10,12		-4.5	4'9"	9'11"	
8,10,12	17	-5.0	5'3"	10'5"	12'8"

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50 YEARS 2010

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Dubai
Mumbai

1.888.PARKSON
technology@parkson.com
www.parkson.com

Marina Sher

From:	Chris Kushner <CKushner@HPThompson.com>
Sent:	Monday, May 09, 2016 1:03 PM
To:	John Zaleha
Cc:	Michael Kravtsov; Marina Sher; Rebecca Lee
Subject:	Lakewood, OH. Parkson UltraClean Aquaguard Screens
Attachments:	Aqua-Guard-UltraClean.pdf; Aqua Washpress Brochure-579.pdf; Lakewood, OH AGUC.doc; Lakewood, OH AGUC-AWP.dwg; Lakewood, OH AGUC-AWP.pdf

John,

Please find attached budgetary information for the Parkson Aquaguard Screens proposed for Lakewood, OH. wet weather project.

I have enclosed a preliminary design with example drawing for Aqua Guard Ultra Clean screens with Aqua Wash Press units for the above referenced project. The Aqua Guard Ultra Clean screens would be similar to the existing Aqua Guard screens at their WWTP, however they would include the Ultra Clean features that provide better removal of captured solids and easier maintenance. The City looked at the screens at Newark and liked the UltraClean arrangement on the screens that they have.

To be able to handle a peak flow of 35 MGD using our MN design units, we would propose a 5.5' wide channel. Downstream water level at the peak flow of 35 MGD must be 4.5' in order to insure an appropriate headloss. Because the channels will need to be wider to accommodate the flows, we would require a washer compactor unit under each screen. This also provided redundancy for operation.

Estimated price for 2 Aqua Guard Ultra Clean screens model AGUC-MN-A 5.5' wide x 13' discharge height in 304 SS construction with 2 Aqua Wash Press units model AWP8-4 is $400,000.

Please review and advise if there are any questions or if any additional information is required.

Regards,

Chris Kushner
The Henry P. Thompson Company
(614) 512-1054
ckushner@hpthompson.com

Marina Sher

From: Chris Kushner <CKushner@HPThompson.com>
Sent: Friday, July 08, 2016 10:40 AM
To: John Zaleha
Subject: FW: Lakewood, OH. CT Consultants

John,

Please see below response from Parkson on the washwater requirements. Let me know if you have any questions.

Thank You,

Chris Kushner
The Henry P. Thompson Company
(614) 512-1054
ckushner@hpthompson.com

From: Joe Nagel [mailto:JNagel@parkson.com]
Sent: Friday, July 08, 2016 10:18 AM
To: Chris Kushner
Cc: Paul Mahoney; Thomas Steinke
Subject: RE: Lakewood, OH. CT Consultants

Chris,

Each screen would use 36 GPM of washwater at 40 psi pressure, in use whenever the screen is in operation.

Each wash press unit has 2 spray connections, a wash zone spray using 10 GPM at 60 psi pressure and a trough flush spray using 15 GPM at 60 psi pressure. These do not operate simultaneously in the normal sequence of operation.

They will need to provide Y-strainers for the feed water lines if they are going to consider using effluent water for the spray wash. The strainer should have a 100 micron filter.

Regards,
Joe Nagel | Municipal Sales | Parkson | 847/837-4952 | www.parkson.com

---

From: Chris Kushner [mailto:CKushner@HPThompson.com]
Sent: Friday, July 08, 2016 7:42 AM
To: Joe Nagel <JNagel@parkson.com>
Subject: FW: Lakewood, OH. CT Consultants

Joe,

Can you please advise what the washwater requirements would be for this proposal? I will need flow rates and pressure. Also, the engineer has asked is they could use secondary clarifier water as spray wash for the equipment. Can you also please advise your thoughts on this?

Thank You,

Chris Kushner
The Henry P. Thompson Company
(614) 512-1054
ckushner@hpthompson.com

From: Joe Nagel [mailto:JNagel@parkson.com]
Sent: Monday, May 09, 2016 12:41 PM
To: Chris Kushner
Cc: Paul Mahoney; Thomas Steinke
Subject: RE: Lakewood, OH. CT Consultants

Chris,

I have enclosed a preliminary design with example drawing for Aqua Guard Ultra Clean screens with Aqua Wash Press units for the above referenced project. The Aqua Guard Ultra Clean screens would be similar to the existing Aqua Guard screens at their WWTP, however they would include the Ultra Clean features that provide better removal of captured solids and easier maintenance.

To be able to handle a peak flow of 35 MGD using our MN design units, we would propose a 5.5' wide channel. Downstream water level at the peak flow of 35 MGD must be 4.5' in order to insure an appropriate headloss. Because the channels will need to be wider to accommodate the flows, we would require a washer compactor unit under each screen. This also provided redundancy for operation.

Estimated price for 2 Aqua Guard Ultra Clean screens model AGUC-MN-A 5.5' wide x 13' discharge height in 304 SS construction with 2 Aqua Wash Press units model AWP8-4 is $380,000.

Please review and advise if there are any questions or if any additional information is required.

Regards,
Joe Nagel| Municipal Sales | Parkson | 847/837-4952 | www.parkson.com
Please consider the environment before printing this email

From: Chris Kushner [mailto:CKushner@HPThompson.com]
Sent: Wednesday, May 04, 2016 2:45 PM
To: Joe Nagel
Cc: Paul Mahoney
Subject: Lakewood, OH. CT Consultants

Joe,

I am working with CT Consultants in Columbus, OH. for wet weather treatment for Lakewood OH. project. This is just getting started but they would like us to size (2) Parkson Aquaguard Screens with 6 mm spacing. Each UltraClean screen will need to be rated for 35 MGD. The channel will be new, so start with a clean slate. Sewer is above ground so depth does not matter. They are mostly interested in headloss, size and budget price right now. They would like to utilize (1) compactor for both screens.

Please provide budget pricing when you have a chance. If possible please advise when you think you may get to this, so I can advise engineer.

Thank You,

Chris Kushner
The Henry P. Thompson Company
(614) 512-1054
ckushner@hpthompson.com

Water & Wastewater Solutions

Hydro International®

April 27, 2016

Mr. Michael Kravtsov
CT Consultants
7965 N High St. #340
Columbus, OH 43235

RE: Headworks Grit Removal Unit
Lakewood, OH CSO
File #16-3151-A

Dear Mr. Kravtsov:

Thank you for your interest in Hydro International. We are pleased to present our proposal for a Eutek HeadCell® Grit Removal Unit. Hydro International is dedicated to providing innovative, high performance grit removal equipment through superior engineering, high-quality products and unmatched customer service. Our extensive experience includes thousands of installations throughout the world.

Grit is continually introduced into collection systems, but is not uniformly carried to treatment facilities. As flows increase, the grit load entering the plant elevates. Once in the treatment plant, where velocities are slower than in the collection system, grit will deposit in processes, disrupting systems, decreasing equipment longevity, and increasing maintenance costs. The Eutek HeadCell® Grit Removal Unit offers many benefits over conventional grit removal systems including:

- Removing fine grit protects equipment and processes from abrasive wear and sedimentation
- All-hydraulic design with no moving parts, minimizing operating and maintenance costs
- Small footprint system capable of high efficiency solids capture and removal
- Robust design allowing long component life with minimal wear
- Complete grit system with no weak link through capture to washing/classification to dewatering
- Minimal headloss at peak flows fits most existing flow profiles
- Structured flow ensures maximum utilization of tray surface area and equal surface loading rates throughout the system
- Large surface area with short settling distances ensures higher performance in a smaller footprint
- Compact, yet expandable design capable of high efficiency solids capture and removal
- Continuous boundary layer flow over hydrophobic surfaces prevents grease build-up

We sincerely appreciate your interest in our equipment and look forward to working with you on this project. As you progress with the design, we can quickly generate CAD drawings, budget updates, and specifications as well as review equipment layouts and specifications for your particular application. Reference lists are available through your local representative. If you have any questions or concerns, do not hesitate to contact us.

Regards,
Hydro International

Dara Rolfe
Applications Engineer

Performance Objective

Hydro International is pleased to propose the following Eutek HeadCell® grit removal unit to be installed in an existing plant which has a peak flow of 35 mgd. The grit removal unit is designed to remove 95% of all grit 106 micron or better at the component flows listed below.

Proposed Equipment Summary

Eutek HeadCell® Grit Concentrator

The Eutek HeadCell® is an all-hydraulic grit concentrator, which uses vortex flow and a stacked tray design to efficiently capture and settle fine grit via large surface area and short settling distances. The unit can be installed into the process flow, downstream of screening, in any system where limited head is available. The unit requires no external power source, has no internal moving parts, is self-cleaning, and has a compact modular construction. Wide turndown ratios can be accommodated in the Eutek HeadCell® when it is combined with Hydro's high performance washing system.

Quantity:	2
Size:	12' diameter
Number of Trays per Unit:	10
Surface Area/Unit:	1,130 ft^2
Loading rate at Peak Flow:	10.8 gpm/ft^2
Performance:	95% removal of all grit (specific gravity 2.65) ≥ 106 microns @ peak flow
Peak Flow/Unit:	27 mgd with 12" headloss
Discharge:	Weir
Underflow Connection:	4"
Underflow Rate/Unit:	250 gpm
NPW Connection:	1" NPT
NPW Requirement/Unit:	Continuous 20 gpm @ 50 psig (contact Hydro for alterative options)
Materials of Construction:	304 SS Support Structure/Duct/Underflow
	Low Density Polyethylene Trays
Weight Dry (approximate):	5,700 lbs

System Hydraulics

System hydraulics is the responsibility of the design engineer. Hydro International can provide information on Eutek HeadCell® hydraulics and piping FAQ's to assist the engineer in determining system hydraulics and pump requirements, upon request.

Design Recommendations

- 1/2" or finer screening prior to the grit removal system
- Velocity through bar screen openings/slots/apertures should not exceed 4 ft/s at peak flow as recommended by industry design manuals.
- All piping connected to Hydro equipment must be supported by other means than the Hydro equipment

Contacts

Local Representative:
Mr. Mike Murphy
Bergren Associates
17076 Maple Drive
Chagrin Falls, OH 44023
Phone: 440-591-5248
Fax: 440-591-5248
Email: mikemurphy@bergren.com

Engineering Representative:
Mr. Chris Kushner
The Henry P. Thompson Company
3540 Edgewater Dr
Vermillion, OH 44089
Phone: (513) 248-3229
Fax: (614) 337-0230
Email: ckushner@hpthompson.com

Hydro International®

North American Grit Gradations

Hydro International is pleased to announce the availability of national and regional grit gradation data. This data, which has been compiled from over 120 tests across North America, contains average physical size data as well as settling velocity (SES) data, making it the most comprehensive information available on grit and its behavior.

Virtually all conventional grit removal processes rely on gravity sedimentation to achieve the separation of grit from wastewater. Most conventional grit removal processes are designed based on the assumption that grit is spherical and has a specific gravity 2.65. However, not all grit maintains a specific gravity of 2.65 and other factors such as shape and encapsulation by fats, oils and grease significantly impact its settling velocity. Therefore, the best means to analyze grit is to determine the settling velocity for given particle size ranges. Settling velocity data can be correlated to the measured settling velocity of a clean sand sphere. The settling velocity is expressed as the Sand Equivalent Size (SES), which is the sand particle size having the same settling velocity as the more buoyant grit particle. The correlated particle size, or Sand Equivalent Size can then be used for design of the grit removal process.

When settling velocity is considered in the design actual removal efficiency of grit particles can be estimated more realistically.

Data is available for the following regions:

Region	States / Provinces Included
Northeast	ME, VT, NH, MA, RI, NY, CT
Mid-Atlantic	PA, NJ, MD, DE, DC, VA, WV
Southeast	NC, SC, GA, AL, FL, MS
North Central	MO, KS, KY, IN, OH, IL, MI, WI, IA, MN, ND, SD, NE
South Central	TN, AR, OK, TX, LA
West	WA, OR, CA, AK, HI, AZ, NV, NM, CO, ID, MT, UT, WY
Western Canada	AB, MB, SK
Ontario Canada	ON

State data is available for individual states where more than 5 data points are available; those states currently include: Georgia, Texas, Florida, California, and Virginia.

Hydro International – Water & Wastewater
2925 NW Aloclek Suite 140, Hillsboro, OR 97124
Tel: (503) 615-8130 Fax: (503) 615-2906 Web: www.hydro-int.com

Standard Terms and Conditions of Sale

1. **DEFINITIONS.** "Hydro" is Hydro International with an address of 2925 NW Aloclek Drive #140 in Hillsboro, Oregon. "Buyer" is the party purchasing the goods from Hydro.

2. **ENTIRE AGREEMENT.** Hydro's agreement is based on these terms and conditions of sale. This document, together with any additional writings signed by Hydro, represents a final, complete, and exclusive statement of the agreement between the parties and may not be modified, supplemented, explained, or waived by parol evidence, Buyer's purchase order, any course of dealing, Buyer's payment or acceptance, or in any other way except in writing signed by Hydro through its authorized representative. These terms and conditions are intended to cover all activity of Hydro and Buyer hereunder, including sales and use of products, parts, and work, and all related matters (references to products include parts and references to work include construction and installation). Hydro's obligations hereunder are expressly conditioned on Buyer's assent to these terms and conditions. Hydro objects to any terms that are different from, or additional to, these terms and conditions. Any applicable detail drawings and specifications are hereby incorporated and made a part of these Terms and Conditions of Sale insofar as they apply to the material supplied hereunder.

3. **SPECIFICATIONS.** Products are supplied in accordance with information received by Hydro, or its duly authorized agent, from Buyer. Hydro shall have no responsibility for products created or sold based upon inaccurate and/or incomplete information supplied to it. Buyer shall ensure that Hydro receives all relevant information in time to enable it to supply the appropriate products.

4. **INSTALLATION AND APPLICATION OF PRODUCTS.** Products supplied hereunder shall be installed and used only in the particular application for which they were specifically designed. Buyer should not presume that any products supplied by Hydro may be utilized for any applications other than those specified; nor shall Hydro's obligations, including, without limitation, any warranty obligations, survive Buyer's transfer of products supplied hereunder to third parties unless the products are transferred with Hydro's consent. In addition, Buyer shall not use any product supplied hereunder at any location other than at the location for which Hydro has previously received notice from Buyer. Any breach of any of the foregoing restrictions may amount to an infringement of the patent for the products in question and will in any event void all express or implied warranties relating to the products supplied hereunder.

5. **PURCHASE PRICE AND PAYMENT TERMS.** All prices are in U.S. dollars and all payments shall be made in U.S. dollars. Payment terms are as follows:

	Incremental Payment	Cumulative Payment
Upon Approval of Shop Drawings	10%	10%
Upon Delivery of Equipment to Site	80%	90%
Upon Final Acceptance or 45 days following completion of equipment start up	10%	100%

If payments are not made in conformance with the terms stated herein, any unpaid balance shall be subject to interest at a rate 1½% per month, but not to exceed the maximum amount permitted by law. If shipment is delayed by Buyer, the previously agreed date of readiness for shipment shall be deemed to be the date of shipment for payment purposes. If manufacture is delayed by Buyer, a payment shall be made based on purchase price and percentage of completion, with the balance payable in accordance with the terms as stated. If at any time in Hydro's judgment Buyer may be or may become unable or unwilling to meet the terms specified, Hydro may require satisfactory assurance or full or partial payment as a condition to commencing, or continuing manufacture, or in advance of shipment.

Until payment in full has been received by Hydro, this Standard Terms and Conditions of Sale shall constitute a security agreement and Buyer hereby grants Hydro a purchase money security interest in and to the products produced by Hydro hereunder, and any products or proceeds thereof. In particular:

(i) Hydro will retain an express purchase money security interest in and to the products and all proceeds thereof.

(ii) Until full payment for the products is received by Hydro, Hydro reserves the right to retake possession of the products at any time and for this purpose Buyer authorizes Hydro or its duly authorized agent to enter upon land or premises where it believes the product may be.

(iii) Proceeds of any disposal of the products shall be held in trust for Hydro pursuant to the terms of the Maine Uniform Commercial Code.

(iv) Buyer grants Hydro a power of attorney for the purpose of filing a UCC-1 financing statement in the name of Buyer to evidence Hydro's security interest in the products.

6. **BACKCHARGES.** In the event that Buyer is required to make repairs, corrections or modifications to the goods supplied by Hydro, it shall only do so upon written approval from Hydro. Backcharges shall be limited to the costs directly associated in making the repairs, corrections or modifications to the goods supplied by Hydro. The costs of such backcharges shall be subject to approval by Hydro and shall be limited to: (1) directly related labor and material costs, (2) directly related equipment and tool rental at prevailing rates in the project location and (3) Buyer's overhead & supervision costs to make repairs, corrections or modifications to the goods supplied by Hydro. Buyer shall submit complete documentation to Hydro's satisfaction including but not limited to labor time sheets, material lists, and rental fees detailing the nature of the back charges. Backcharges shall be in the form

reason beyond its control, including, but not limited to, acts of God, casualty, civil disturbance, labor disputes, strikes, transportation or inability to obtain materials or services, any interruption of its facilities, or act of any governmental authority. The time for delivery shall be extended during the continuance of such conditions. The total liability of Hydro to Buyer in the form of liquidated damages for any loss, indemnity, damage or delay of any kind will not under any circumstances exceed 25% of the Contract Sum.

15. **INTELLECTUAL PROPERTY.** Hydro shall retain sole ownership of all of its intellectual property used or produced in connection with the Project, including but not limited to all drawings, specifications, software, written materials, manuals, marks, business methods, and all other property that is capable of protection by a patent, copyright or trademark (whether or not such protection has actually been sought). Buyer shall not use such intellectual property except for the purpose of confirming the quality of design and/or manufacturing of the products and services set forth in the Proposal. Buyer shall not photocopy, duplicate or in any way copy such intellectual property except for the Buyer's internal purposes only (but not for rendering services or selling products to third persons). Buyer shall not sell, license, assign or transfer the intellectual property protected by this paragraph to anyone. Buyer shall ensure that Owner is in possession of valid licenses for all third-party software (not provided by Hydro) used for the Project, and shall indemnify and hold harmless Hydro against all claims by licensors of such software. Hydro makes no warranty regarding the effect of such third-party software on the performance of the software to be developed by Hydro for the Project and Hydro shall be released from any warranties given to Buyer to the extent that such software causes or contributes to problems. Following acceptance and final payment to Hydro, Hydro will grant to the Owner a non-transferable, non-exclusive license to use the software for the Owner's internal purposes only in the form of the license agreement attached as Exhibit A.

16. **TAXES.** Prices stated herein do not include any tax, excise, duty or levy now or hereafter enacted or imposed, by any governmental authority on the manufacture, sale, delivery and/or use of any item delivered. An additional charge will be made therefore and paid by Buyer unless Hydro is furnished with a proper exemption certificate relieving Hydro of paying or collecting the tax, excise, duty or levy in question.

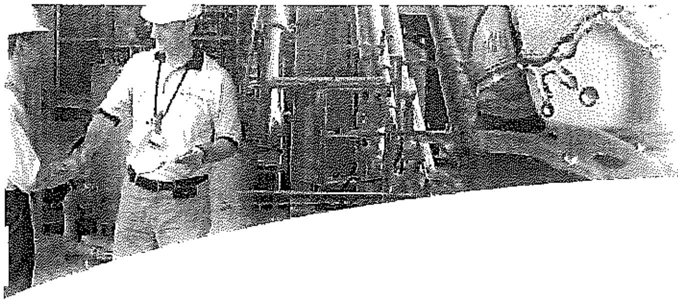
17. **INTERPRETATION OF CONTRACT.** This contract shall be construed according to the laws of the State of Maine.

18. **CHOICE OF FORUM.** Buyer and Hydro hereby consent and agree that the United States District Court for the District of Maine or the District Court or Superior Court located in the City of Portland, County of Cumberland, Maine will have exclusive jurisdiction over any legal action or proceeding arising out of or relating to the contract documents, and each party consents to the personal jurisdiction of such Courts for the purpose of any such action or proceeding. Buyer and Hydro further hereby consent and agree that the exclusive venue for any legal action or proceeding arising out of or relating to the contract documents will be in the County of Cumberland, Maine. Each party hereby waives all rights it has or which may hereafter arise to contest such exclusive jurisdiction and venue.

19. **ATTORNEYS' FEES.** If any judicial or non-judicial proceeding is initiated for the purpose of enforcing a provision of this contract, the prevailing party shall be awarded reasonable attorneys' fees in addition to all other costs associated with the proceeding, whether or not the proceeding advances to judgment.

20. **SEVERABILITY.** If any provisions of this contract are held invalid by a court of competent jurisdiction, the remainder of this contract shall not be rendered invalid, and such invalid provisions shall be modified, in keeping with the letter and spirit of this contract, to the extent permitted by applicable law so as to be rendered valid.

21. **ANTI-BRIBERY.** Hydro International will not engage in any form of bribery or corruption. The offering, giving or receiving of bribes is contrary to Hydro International's values and can play no part in the way in which it carries out its business. Hydro requires you to support our approach and implement provisions consistent with our policy through your own organization and your supply chain. Please find a copy of our Anti-Bribery and Corruption Policy on our website at http://plc.hydro-intl.com/content/view/296/247/



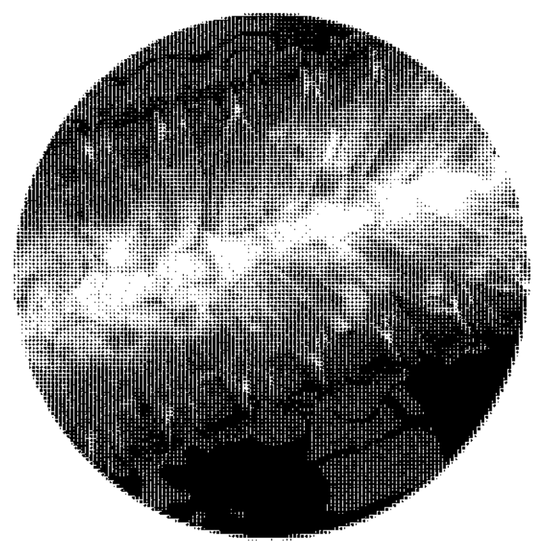
CT Consultants

Lakewood, OH

8/24/2015

BIOACTIFLO Proposal

Kruger Project No.: 5700135507



Submitted to:

Gunaseelan Alagappan, P.E.
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7965 North High Street
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Submitted by:

Thomas Perry
Product Manager, ACTIFLO® Systems
I Kruger Inc.
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Introduction

I Kruger Inc (Krüger) is pleased to present this budgetary BIOACTIFLO™ System proposal for a potential Wet Weather WW treatment project for Lakewood, OH. Kruger's expertise in this type of application is found in the knowledge gained from the existing 20 US ACTIFLO Wet Weather installation references plus the results for the recent pilot testing at the Lakewood treatment facility.

Enclosed is the preliminary process description, design summary, scope of supply, design options, procurement schedule, and price estimate for the following options:

<u>Option 1: 1 x 35 MGD BIOACTIFLO™ System</u>

<u>Option 2: 1 x 45 MGD BIOACTIFLO™ System</u>

We appreciate the opportunity to provide this proposal to you. If you have any questions or need further information, please contact our local Representative Ken Rogozinski, or our Regional Product Manager, Andy Szekeress, at 715-432-6852; andy.szekeress@veolia.com.

cc: Sales/Process Dept, project file (Kruger)
Ken Rogozinski (BissNuss)

Revision	Date	Process Eng.	Comments
0	8/24/2015	CW	Initial request for 1x35 and 1x45 MGD BIOACTIFLO systems with chemical feed and inline mixer.

We Know Water

I. Kruger Inc. (Kruger) is a water and wastewater solutions provider specializing in advanced and differentiating technologies. Kruger provides complete processes and systems ranging from biological nutrient removal to mobile surface water treatment. The ACTIFLO® Microsand Ballasted Clarifier, BioCon® Dryer, BIOSTYR® Biological Aerated Filter (BAF) and NEOSEP™ MBR are just a few of the innovative technologies offered by Kruger. Kruger is a subsidiary of Veolia Water, a world leader in engineering and technological solutions in water treatment for industrial companies and municipal authorities.

Veolia Water Solutions & Technologies, the fully-owned subsidiary of **Veolia Water**, is the world leader in water and wastewater treatment with over 155 years of experience. As an experienced design-build company and a specialized provider of technological solutions in water treatment, Veolia combines proven expertise with unsurpassed innovation to offer technological excellence to our industrial customers. Based on this expertise, we believe that we have developed the best solution for your application. Below is a brief description of the proposed project.

Energy Focus

Kruger, along with Veolia Water Solutions & Technologies (VWS) is dedicated to delivering sustainable and innovative technologies and solutions.

We offer our customers integrated solutions which include resource-efficient technology to improve operations, reduce costs, achieve sustainability goals, decrease dependency on limited resources, and comply with current and anticipated regulations.

Veolia's investments in R&D outpace that of our competition. Our focus is on delivering

- neutral or positive energy solutions
- migration towards green chemicals or zero chemical consumption
- water-footprint-efficient technologies with high recovery rates

Our carbon footprint reduction program drives innovation, accelerates adoption and development of clean technologies, and offers our customers sustainable solutions.

Kruger is benchmarking its technologies and solutions by working with our customers and performing total carbon cost analysis over the lifetime of the installation.

By committing to the innovative development of clean and sustainable technologies and solutions worldwide, Kruger and VWS will continue to maximize the financial benefits for every customer.

Process Description

ACTIFLO® Process

The ACTIFLO® process is a compact clarification system that utilizes microsand as a seed for floc formation. The microsand serves several important roles in the ACTIFLO® process such as forming a seed which promotes the formation of large stable, high-density floc, dampens the effects of changes in the raw water quality due to its high concentration within in the process, and is effectively removed from the chemical sludge and reused in the process due to its chemically inert qualities. This floc has considerably higher settling velocities than conventional floc and allows significantly higher clarifier overflow rates. The higher overflow rates possible with ACTIFLO® translate directly into reduced process volume, reduced system footprint, and significant reductions in total civil cost. Overall, these factors provide a process that is extremely efficient in the treatment of "difficult" waters, stable with changes in raw water quality, and relatively easy to operate and optimize. ACTIFLO designs result in system footprints that are between 5 and 20 times smaller for water and 5 to 50 times smaller for wastewater applications when compared to conventional clarification systems of similar capacity.

In wastewater treatment, the ACTIFLO® process is appropriate for use in any application that would benefit from physical-chemical treatment including coagulation, flocculation and settling. It can be applied to primary and tertiary wastewater treatment where either better performance or cost reduction is desired. It is ideally suited for storm water treatment including CSO, SSO or storm water flows due to its high performance, small footprint, and extremely short start-up time. The process consistently displays efficient removals of TSS, BOD, Total P, COD, metals, fecal coliform, and other typical wastewater contaminants, which can be removed by physical-chemical processes.

BIOACTIFLO™ is an ACTIFLO system that is preceded by an aerated/mixed biological contact tank. The biological contact tank receives Return Activated Sludge (RAS) and screened wet-weather wastewater at a ratio to achieve a pre-determined mixed liquor suspended solids concentration (MLSS) in the contact tank. The aerobic biomass contained in the RAS enables soluble BOD/CBOD removal via rapid adsorption. Following the biological contact tank, the flow and RAS are then clarified by the ACTIFLO® process. Including the biological contact tank allows for increased sBOD reductions which in turn results in exceptional BOD reductions (> 85%) matching or exceeding secondary treatment standards.

The ACTIFLO® process is currently in operation worldwide in small communities as well as large metropolitan areas.

Design Summary

Tables 1 through 3 summarize the design criteria and preliminary process parameters for the proposed design option(s).

Table 1: General Design Summary

Parameter	Unit	Option 1 Values (1x35MGD)	Option 2 Values (1x45MGD)
ACTIFLO System Trains	#	1	1
Total Influent Flow per BIOACTIFLO Train	MGD	35	45
Total Influent Flow to BIOACTIFLO System	MGD	39.4[1]	50.6[2]
Total Effluent Flow per BIOACTIFLO Train	MGD	35.6	45.8
Total Effluent Flow per BIOACTIFLO System	MGD	35.6	45.8
Average Influent TSS[3]	mg/L	100	100
Average Influent cBOD[3]	mg/L	37	37
Average Soluble Portion of Influent cBOD[3]	mg/l	13	13
True Soluble cBOD Portion of solBOD	%	TBD	TBD
Plant Elevation	ft.	TBD	TBD
Expected Effluent TSS	mg/L	≤ 20	≤ 20
Expected Effluent BOD	mg/L	≤ 25	≤ 25

[1] Given the 35 MGD event flow, a Return Activated Sludge (RAS) flow of 4.4 MGD from the main plant is required in order to obtain a MLSS concentration of 1000 mg/L in the contact basin (assuming a RAS MLSS of 0.9%).
[2] Given the 45 MGD event flow, a Return Activated Sludge (RAS) flow of 5.6 MGD from the main plant is required in order to obtain a MLSS concentration of 1000 mg/L in the contact basin (assuming a RAS MLSS of 0.9%).
[3] Average based on results from both labs during wet weather events on June 10, 16 and 29.

Table 2: ACTIFLO SINGLE TRAIN Design Criteria

Parameter	Unit	Option 1 Values (35 MGD)	Option 2 Values (45MGD)
Coagulation Tank HRT	min	3.0	3.0
Maturation Tank HRT	min	5.0	5.0
Settling Tank HLR	gpm/sf	40.0	40.0
Sand Recirculation Flow (per pump) +/- 10%	gpm	1100	1400
Estimated Total Sludge Waste Flow +/- 10%	gpm	2640 (3 Duty Pumps)	3360 (3 Duty Pumps)

Estimated Sludge Solids Concentration	%	0.1 - 1.0	0.1 – 1.0
ACTIFLO Train Dimensions	---	See General Arrangement DWG	See General Arrangement DWG

Table 3: Biological Contact Basin[1,2] (20 Minute HRT)

Parameter	Unit	Option 1 Values (35 MGD)	Option 2 Values (45 MGD)
Total Basins	#	1	1
Length/Contact Zone[3, 4]	ft	78.25	87.25
Width/Contact Zone[3]	ft	52.0	60.0
Side Water Depth[3]	ft	18.0	18.0
Total Influent Design Flow	MGD	35.0	45.0
HRT	min	20.0	20.0
Volume	MGal	0.55	0.70
MLSS[1, 2 (Above)]	mg/L	1000	1000
Actual Oxygen Requirement per Basin	lbs. O2/h	146	188
Total Required Airflow Rate per Basin	SCFM	1978	2543
Diffuser Type	---	12" SS	12" SS
Number of Diffuser	Total	180	220
Number of Blowers (By Others)	Total	By Others	By Others

[3] The biological contact basin is designed on the assumption that the main plant has a long sludge retention time (SRT.)

[4] Contact basin length/widths shown can be modified to better accommodate site layouts. Please contact Kruger to discuss possible options.

Scope of Supply

Kruger is pleased to present our scope of supply which includes process engineering design, package plant fabrication, equipment procurement, and field services required for the proposed treatment system. The work will be performed to Kruger's high standards under the direction of a Project Manager. All matters related to the design, installation, or performance of the system shall be communicated through the Kruger representative giving the Engineer and Owner ready access to Kruger's extensive capabilities.

Process and Design Engineering

Kruger will provide process engineering and design support for the system as follows:

- Equipment specifications for equipment supplied by Kruger
- Technical instructions for operation and start-up of the system
- Equipment drawings and installation instructions
- Project specific O&M manuals

Field Services

Kruger will furnish a Service Engineer as specified at the time of start-up to inspect the installation of the system, place the system in initial operation, and to instruct operating personnel on the proper use of the equipment. Specifically, Kruger will provide:

- Field Service Engineer/Technician – Fifteen (15) man days on site in not more than four (4) site visits to assist with inspection check-out, start-up, and operator training.

Equipment Supply

ACTIFLO System General Equipment	Option 1 Quantity (Details)	Option 2 Quantity (Details)
Biological Contact Tank		
Blower: TEFC 460/3/60 motor, centrifugal type, noise enclosure, intake filter-silencer, check valve, spring loaded pressure relief valve	By Others	By Others
Diffuser Sets: 12" coarse bubble, stainless steel, drop pipe, submerged headers, and mounting brackets	180	220
Fine Screens		
Fine screen with ¼" perforations installation of 45 degrees, 304 SS with CS chains, control system with intelligent relay and local station included.	1	1

ACTIFLO System General Equipment	Option 1 Quantity (Details)	Option 2 Quantity (Details)
In-Line Mechanical Mixer		
In-line rapid mixer: TEFC 460/3/60 premium efficient – inverter duty – AC induction motor, low pressure stuffing box type seal, 316 SS internal baffles, dual chemical injection ports, epoxy-coated carbon steel body, 316 SS radial flow turbine impellers, 316 SS shaft.	1 (7.5 HP est)	1 (10 HP est)
Coagulation Tank (s)		
Top Entering Type Mixer: TEFC 460/3/60 premium efficient – severe duty - AC induction motor. 304 SS shaft and hydrofoil impeller.	1 (25 HP est)	1 (30 HP est)
Anti-Vortex Baffle Set: 304 SS	1	1
Maturation Tank (s)		
Top Entering Type Mixer: TEFC 460/3/60 premium efficient – inverter duty - AC induction motor, 304SS shaft and draft tube impeller.	1 (30 HP est)	1 (40 HP est)
TURBOMIX Draft Tube: 304 SS with supports, flux converter cells	1	1
Settling Tank(s)		
Scraper Drive: TEFC 460/3/60 premium efficient –inverter duty – AC induction motor, hydrostatic primary reducer, final reduction planetary gearbox, torque indication and overload protection	1 (10 HP est)	1 (10 HP est)
Scraper Assembly: 304 SS torque tube shaft, 304 SS rake arms, 304 SS blades, 304SS shaft protector and 304 SS squeegees.	1	1
Lamella Settler Set: Polystyrene tube modules	1	1
Lamella Settler Support Set: 304 SS tube type supports	1	1
Lamella Tube Tie-down Assembly: Appurtenances including wire rope, clips	1	1

ACTIFLO System General Equipment	Option 1 Quantity (Details)	Option 2 Quantity (Details)
Effluent Collection Trough Set: 304 SS troughs and supports	1	1
Microsand Recycle Circuits		
Microsand Recirculation Pumps: TEFC, 460/3/60 premium efficient – severe duty – AC induction motor, centrifugal, cast iron body, with rubber-lined volute and closed-vane impeller, dry gland seal, drip pan, with V-belt and pulley drive.	3 duty + 1 standby (Per Train) (50 HP est)	3 duty + 1 standby (Per Train) (60 HP est)
Discharge Side Pump Isolation Valve: Manual eccentric plug type	4 (10")	4 (10")
Suction Side Pump Isolation Valve: Manual eccentric plug type	4 (10")	4 (10")
Flush Connection Valve: Ball valve, 304 SS, manual.	4 (2")	4 (2")
Microsand Recirculation Pump Pressure Transmitter Isolation Valve: Ball valve, 304 SS, manual.	4 (0.5")	4 (0.5")
Sand Sampling Valve: Ball valve, 304 SS, manual.	4 (0.5")	4 (0.5")
Hydrocyclone Recycle Equipment		
Hydrocyclones: Urethane body	3 duty + 1 standby (Per Train)	3 duty + 1 standby (Per Train)
Hydrocyclone Support Stand: 304 SS	4	4
Sand Concentration Sampling Device: Imhoff Cone, plastic	2	2
Commissioning Consumables		

ACTIFLO System General Equipment	Option 1 Quantity (Details)	Option 2 Quantity (Details)
Microsand Ballast (Tons)	35	45
Polymer Flocculant (lbs)	1000	1000

ACTIFLO System Spare Parts	Option 1 Quantity (Details)	Option 2 Quantity (Details)
Mechanical Spare Parts		
Inline Mechanical mixer bearings and seals set	1	1
Coagulation Tank mixer bearings and seals set	1	1
Maturation Tank mixer bearings and seals set	1	1
Microsand Pump V-belt sets	4	4
Hydrocyclone Apex Tip	4	4

ACTIFLO System Controls	Option 1 Quantity (Details)	Option 2 Quantity (Details)
Control Panels		
NEMA 12 Painted Steel (for indoor use only) Panel, to control the ACTIFLO® System based on operator setpoints, completely assembled, tested, and programmed for the required functionality	1	1
Back Panel for Control Panel	1	1
Panelview Plus 6 1000 Color Touchscreen Operator Interface w/Ethernet – ALLEN BRADLEY	1	1
Control Logix PLC Processor – ALLEN BRADLEY	1	1
UPS 850VA 120VAC Input/ 120VAC Output – SOLA	1	1
PLC Control Panel I/O + 20% "LIVE" spare wired signals for additional signal interface - KRUGER	1	1
Complete Set of Control Panel Internals per Kruger Standard Scope - KRUGER	1	1
PLC and Operator Interface Programming – KRUGER	1	1

ACTIFLO System Controls	Option 1 Quantity (Details)	Option 2 Quantity (Details)
PLC site Start-Up and Testing – KRUGER	1	1

ACTIFLO System Instrumentation	Option 1 Quantity (Details)	Option 2 Quantity (Details)
Instrumentation		
Influent Pipe Turbidity/TSS (pre-chem feed): NTU/TSS Sensor, Pipe Insertion Mounting (Hach Solitax NTU Analyzer LVX424), Controller (SC200)	1	1
Influent Pipe TSS (RAS): TSS Sensor, Pipe Insertion Mounting (Hach Solitax TSS Analyzer LVX424), Controller (SC200)	1	1
Influent Pipe pH (pre-chem feed): pH Sensor Pipe Insertion Mounting (Hach DPD1P1), Controller (SC200)	1	1
Settling Tank Turbidity/TSS (post chem feed): NTU/TSS Sensor, Tank Immersion Mounting (Hach Solitax NTU Analyzer LVX423), Controller (SC200)	1	1
Contact Tank TSS (post RAS feed): TSS Sensor, Tank Immersion Mounting (Hach Solitax TSS Analyzer LVX423), Controller (SC200)	1	1
Settling Tank pH (post-chem feed): pH Sensor, Immersion Mounting (Hach DPD1P1), Controller (SC200)	1	1
Contact Tank DO (post RAS feed): LDO Sensor, Tank Immersion Mounting (Hach Solitax LDO probe), Controller (SC200)	1	1
Sand Recirculation Pumps Pressure Indicating Transmitter: Ceramic Diaphragm (E+H PMC71)	4	4

ACTIFLO System Instrumentation	Option 1 Quantity (Details)	Option 2 Quantity (Details)
Sand Recirculation Pump Discharge Flowmeter: Magnetic flowmeter (E+H ProMag W), Controller (ProMag 50)	4	4

Ancillary Equipment – Chemical Feed Systems	Option 1 Quantity (Details)	Option 2 Quantity (Details)
Auto Dry Polymer Preparation Systems		
Dry polymer processing system, complete with feeder hopper, volumetric feeder, wetting chamber, transfer pump, mixing/aging tank, level controls, and control panel.	1	1
Bulk bag unloader (frame) for the support and storage of 2,000 – 3,000 lb supersacks, complete with carbon steel bag rack and support frame, lower cone section, 1.5 HP 460/3/60 vibrator, side guides, neoprene inlet seal, and dust cover	1	1
Auto Polymer Metering Pumps		
Volumetric metering pumps, Progressive Cavity type, corrosion resistant skid mounted, complete with pump bases, variable speed drives, pressure relief valves, back pressure valves, check valves, calibration columns, isolation ball valves, flush connections, strainers, electric motors, piping and fittings.	2 duty + 1 standby (Per Train)	3 duty + 1 standby (Per Train)
Secondary dilution water piping for polymer dilution, PVC piping and fittings, including check valves, rotameters, flow regulators, solenoid valves, isolation ball valves and fittings.	3	4
Auto Coagulant Metering Pumps		

Ancillary Equipment – Chemical Feed Systems	Option 1 Quantity (Details)	Option 2 Quantity (Details)
Volumetric metering pumps, Diaphragm type, corrosion resistant skid mounted, complete with pump bases, variable speed drives, pressure relief valves, back pressure valves, check valves, calibration columns, isolation ball valves, flush connections, strainers, electric motors, piping and fittings.	2 duty + 1 standby	2 duty + 1 standby

Notable Scope of Supply Items BY INSTALLER/PURCHASER

- General Installation of all equipment and materials provided by Krüger Inc.
- Provisions for pH/Alkalinity adjustment
- Reliable and accurate flow signal for each ACTIFLO System Train for chem feed pacing
- Pre-screening equipment (10 mm) prior to ACTIFLO System (if not provided by Kruger)
- All VFDs for ACTIFLO Equipment (Mixers, Scrapers, Recirculation Pumps)
- Scraper support bridge design/supply
- Dispersion Device (If not supplied by Kruger), for properly dispersing Coagulant upstream of the ACTIFLO system
- Water Heater, for maintaining potable polymer solution make-up water temperature between 55 – 90 °F
- Turbidimeter sensors which require angled tap/weld to influent piping
- If the Influent Turbidimeter is to be installed in Ductile Iron Pipe a Stainless Steel spool piece with flanged ends will be required
  - Turbidimeter flanged adapter will require welding to the spool piece
  - Supply, installation and welding of the described spool piece
- Bulk storage tanks, pads, and supports including the concrete basins required for the ACTIFLO® system
- Provide all concrete work for the ACTIFLO® tankage, including all corner fillets.
- Install and terminate all motor control centers, motor starters, panels, transformers, instrumentation, and VFD's.
- Supply and install all electrical power and control wiring and conduit to the equipment served plus interconnection between the ACTIFLO® Supplier's furnished equipment as required, including wire, cable, junction boxes, fittings, conduit, etc.
- Provide all chemicals (not provided by Kruger), lubricants, glycol, oils, or grease and other supplies required for equipment start-up or plant operation.
- Provide all anchor bolts and mounting hardware.
- Labor and material for winterizing the ACTIFLO® System (insulating/heat tracing piping for example). Provisions for insulating the hydrocyclone may also be required.
- Supply and install all sunshields and/or additional enclosures as needed when installing ACTIFLO® equipment and instrumentation outdoors.

- Plumbing/interconnecting piping, weather protection, electrical connections, access platforms, grating & handrails
- Control Panels are shipped loose and require installation and field wiring
- Field Instruments are shipped loose and require installation and field wiring
- All other necessary equipment and services not otherwise listed as specifically supplied by Kruger Inc.

Design Options

In addition to the proposed system as detailed herein, Kruger is able to further incorporate our equipment, process, and controls expertise into treatment plants, allowing municipalities to meet stringent effluent requirements and future plant upgrades. Kruger is able to offer the following, providing clients single source responsibility:

- Customized plant-wide SCADA system
- Motor Control Center (MCC) design
- Chemicals
- Rotary drum thickeners
- Equipment installation service
- Commissioning services

Please contact Kruger if the options above are of interest or are to be included in the current proposed system or future upgrades. ***Please note that the Design Options listed above are not included in the pricing noted herein.*

Schedule

- Shop drawings will be submitted within 6-8 weeks of receipt of an executed contract by all parties.
- All equipment will be delivered within 18-20 weeks after receipt of written approval of the shop drawings.
- Installation manuals will be furnished upon delivery of equipment.
- Operation and Maintenance Manuals will be submitted within 90 days after receipt of approved shop drawings.

Pricing

The pricing for the ACTIFLO System offerings as defined herein, including process and design engineering, field services, and equipment supply is:

Option 1: 1 x 35 MGD BIOACTIFLO™ System: $3,540,000

Option 2: 1 x 45 MGD BIOACTIFLO™ System: $4,100,000

Pricing is FOB shipping point, with freight allowed to the job site. This pricing does not include any sales or use taxes. In addition, pricing is valid for ninety (90) days from the date of issue and is subject to negotiation of a mutually acceptable contract.

Please note that the above pricing is expressly contingent upon the items in this proposal and are subject to I. Kruger Inc. Standard Terms of Sale detailed herein.

Kruger Standard Terms of Payment

The terms of payment are as follows:

- 10% on receipt of fully executed contract
- 15% on submittal of shop drawings
- 75% on the delivery of equipment to the site

Payment shall not be contingent upon receipt of funds by the Contractor from the Owner. There shall be no retention in payments due to I. Kruger Inc. All other terms per our Standard Terms of Sale are attached.

All payment terms are net 30 days from the date of invoice. Final payment not to exceed 120 days from delivery of equipment.

I. Kruger Inc. Standard Terms of Sale

1. Applicable Terms. These terms govern the purchase and sale of the equipment and related services, if any (collectively, "Equipment"), referred to in Seller's purchase order, quotation, proposal or acknowledgment, as the case may be ("Seller's Documentation"). Whether these terms are included in an offer or an acceptance by Seller, such offer or acceptance is conditioned on Buyer's assent to these terms. Seller rejects all additional or different terms in any of Buyer's forms or documents.

2. Payment. Buyer shall pay Seller the full purchase price as set forth in Seller's Documentation. Unless Seller's Documentation provides otherwise, freight, storage, insurance and all taxes, duties or other governmental charges relating to the Equipment shall be paid by Buyer. If Seller is required to pay any such charges, Buyer shall immediately reimburse Seller. All payments are due within 30 days after receipt of invoice. Buyer shall be charged the lower of 1 ½% interest per month or the maximum legal rate on all amounts not received by the due date and shall pay all of Seller's reasonable costs (including attorneys' fees) of collecting amounts due but unpaid. All orders are subject to credit approval.

3. Delivery. Delivery of the Equipment shall be in material compliance with the schedule in Seller's Documentation. Unless Seller's Documentation provides otherwise, Delivery terms are F.O.B. Seller's facility.

4. Ownership of Materials. All devices, designs (including drawings, plans and specifications), estimates, prices, notes, electronic data and other documents or information prepared or disclosed by Seller, and all related intellectual property rights, shall remain Seller's property. Seller grants Buyer a non-exclusive, non-transferable license to use any such material solely for Buyer's use of the Equipment. Buyer shall not disclose any such material to third parties without Seller's prior written consent.

5. Changes. Seller shall not implement any changes in the scope of work described in Seller's Documentation unless Buyer and Seller agree in writing to the details of the change and any resulting price, schedule or other contractual modifications. This includes any changes necessitated by a change in applicable law occurring after the effective date of any contract including these terms.

6. Warranty. Subject to the following sentence, Seller warrants to Buyer that the Equipment shall materially conform to the description in Seller's Documentation and shall be free from defects in material and workmanship. The foregoing warranty shall not apply to any Equipment that is specified or otherwise demanded by Buyer and is not manufactured or selected by Seller, as to which (i) Seller hereby assigns to Buyer, to the extent assignable, any warranties made to Seller and (ii) Seller shall have no other liability to Buyer under warranty, tort or any other legal theory. If Buyer gives Seller prompt written notice of breach of this warranty within 18 months from delivery or 1 year from beneficial use, whichever occurs first (the "Warranty Period"), Seller shall, at its sole option and as Buyer's sole remedy, repair or replace the subject parts or refund the purchase price therefore. If Seller determines that any claimed breach is not, in fact, covered by this warranty, Buyer shall pay Seller its then customary charges for any repair or replacement made by Seller. Seller's warranty is conditioned on Buyer's (a) operating and maintaining the Equipment in accordance with Seller's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Seller. Seller's warranty does not cover damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Seller). THE WARRANTIES SET FORTH IN THIS SECTION ARE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND ARE SUBJECT TO SECTION 10 BELOW. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.

7. Indemnity. Seller shall indemnify, defend and hold Buyer harmless from any claim, cause of action or liability incurred by Buyer as a result of third party claims for personal injury, death or damage to tangible property, to the extent caused by Seller's negligence. Seller shall have the sole authority to direct the defense of and settle any indemnified claim. Seller's indemnification is conditioned on Buyer (a) promptly, within the Warranty Period, notifying Seller of any claim, and (b) providing reasonable cooperation in the defense of any claim.

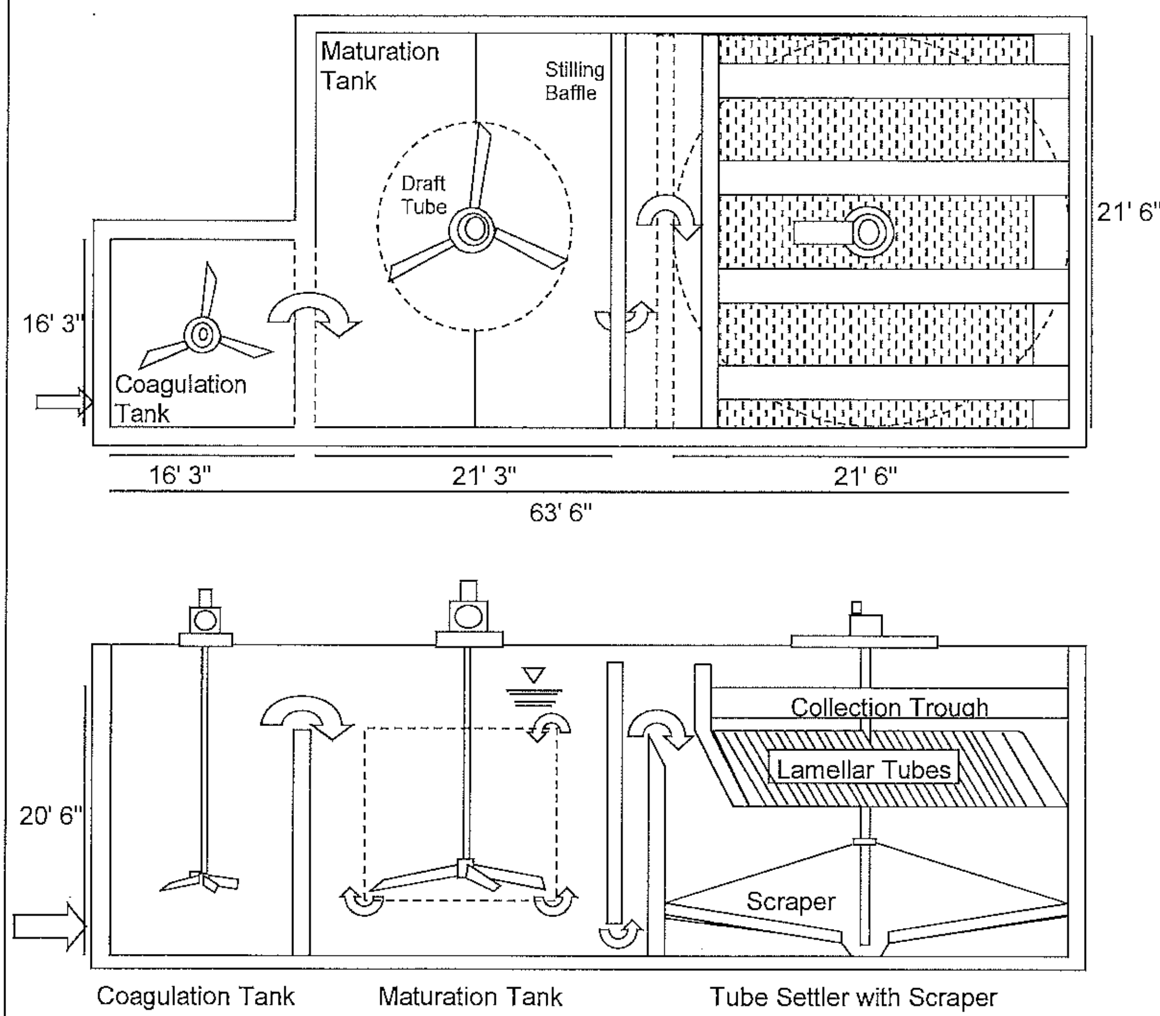
8. Force Majeure. Neither Seller nor Buyer shall have any liability for any breach (except for breach of payment obligations) caused by extreme weather or other act of God, strike or other labor shortage or disturbance, fire, accident, war or civil disturbance, delay of carriers, failure of normal sources of supply, act of government or any other cause beyond such party's reasonable control.

9. Cancellation. If Buyer cancels or suspends its order for any reason other than Seller's breach, Buyer shall promptly pay Seller for work performed prior to cancellation or suspension and any other direct costs incurred by Seller as a result of such cancellation or suspension.

10. LIMITATION OF LIABILITY. NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SELLER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE EQUIPMENT SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE EQUIPMENT. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY.

11. Miscellaneous. If these terms are issued in connection with a government contract, they shall be deemed to include those federal acquisition regulations that are required by law to be included. These terms, together with any quotation, purchase order or acknowledgement issued or signed by the Seller, comprise the complete and exclusive statement of the agreement between the parties (the "Agreement") and supersede any terms contained in Buyer's documents, unless separately signed by Seller. No part of the Agreement may be changed or cancelled except by a written document signed by Seller and Buyer. No course of dealing or performance, usage of trade or failure to enforce any term shall be used to modify the Agreement. If any of these terms is unenforceable, such term shall be limited only to the extent necessary to make it enforceable, and all other terms shall remain in full force and effect. Buyer may not assign or permit any other transfer of the Agreement without Seller's prior written consent. The Agreement shall be governed by the laws of the State of North Carolina without regard to its conflict of laws provisions.

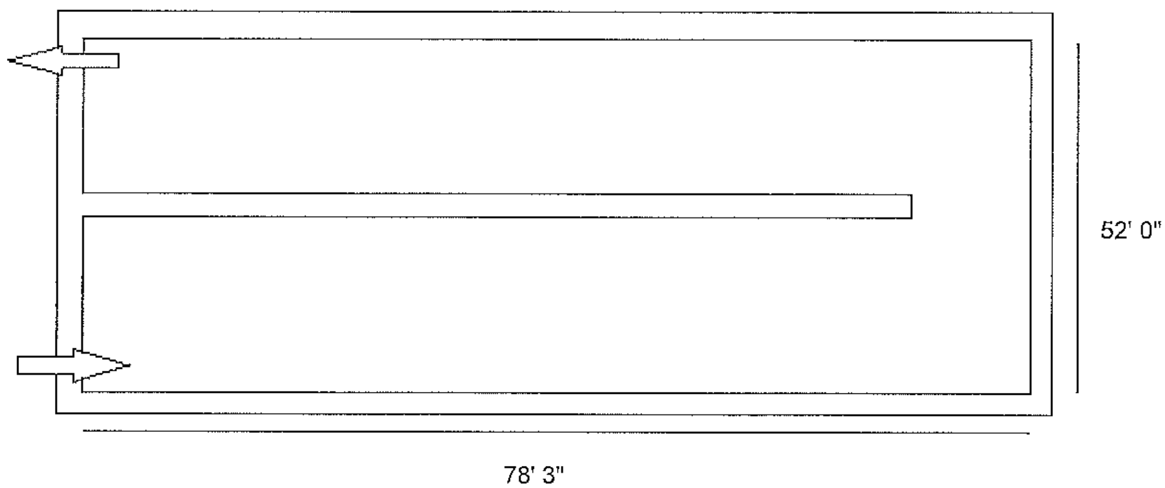
Preliminary ACTIFLO Single Train Layout
Lakewood 35 MGD BioActiflo
Total Capacity = 35 MGD
Capacity per Train: 2 x 17.5 MGD

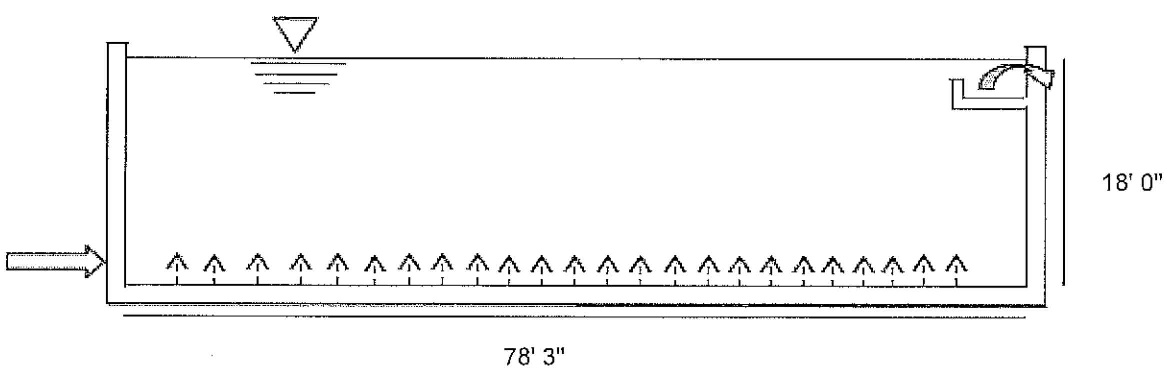


Preliminary BIOACTIFLO Contact Tank Layout

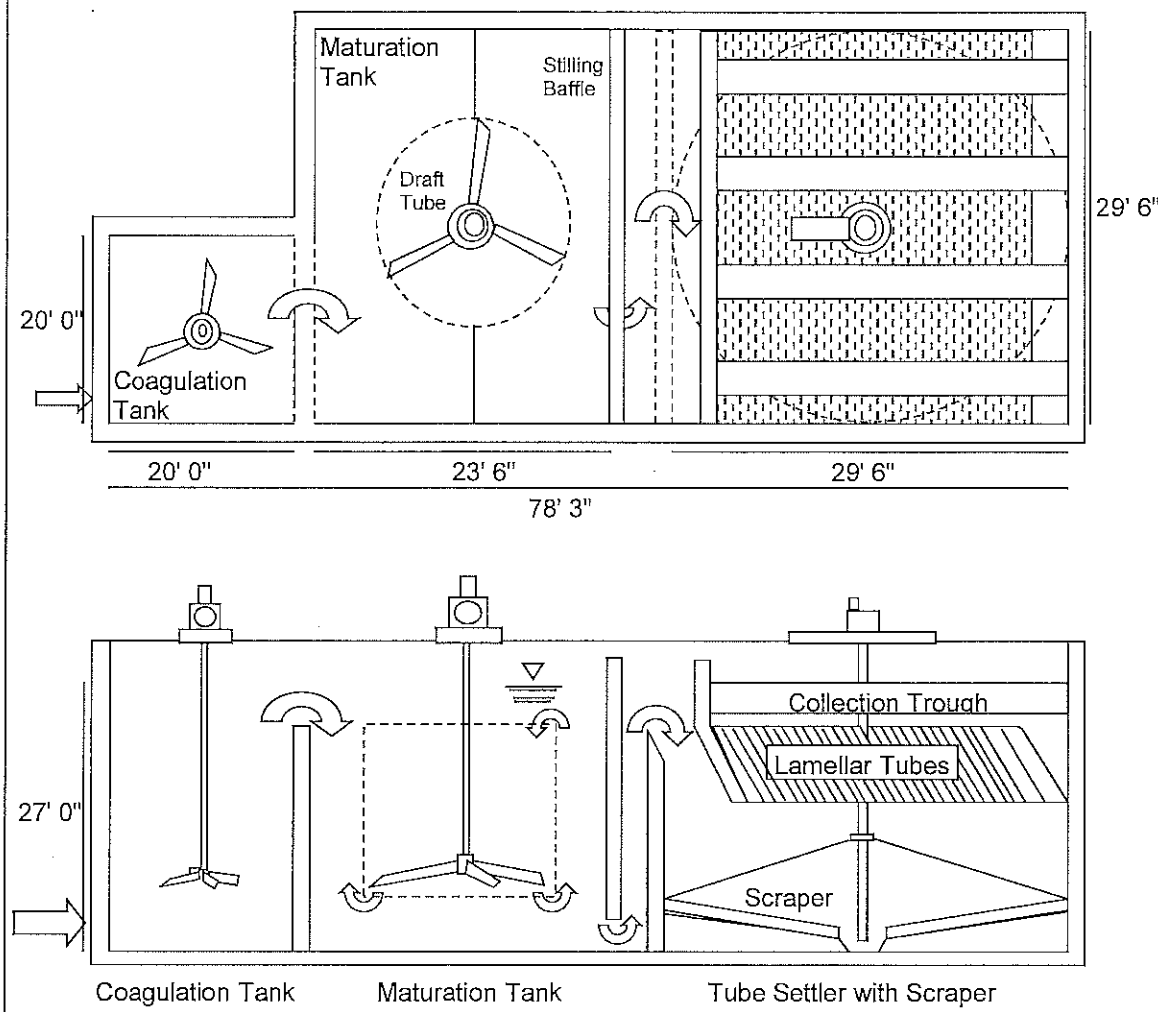
Total Capacity = 35 MGD

Lakewood OH - 35 MGD





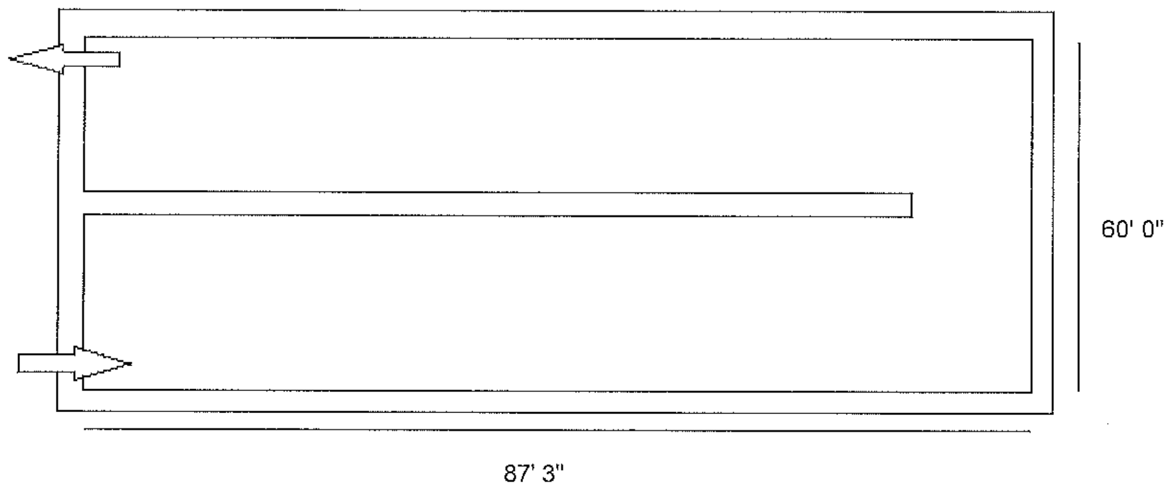
Preliminary ACTIFLO Single Train Layout
Lakewood, OH BIOACTIFLO
Total Capacity = 35 MGD
Capacity per Train: 1 x 35 MGD

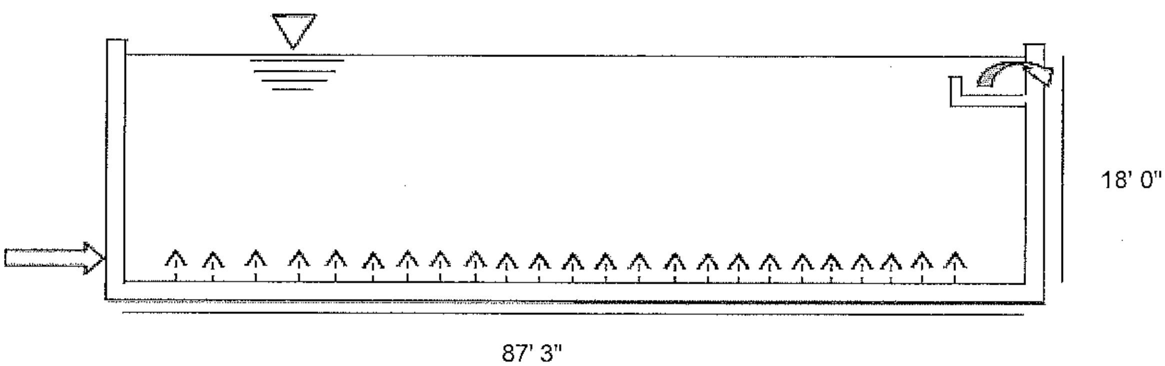


Preliminary BIOACTIFLO Contact Tank Layout

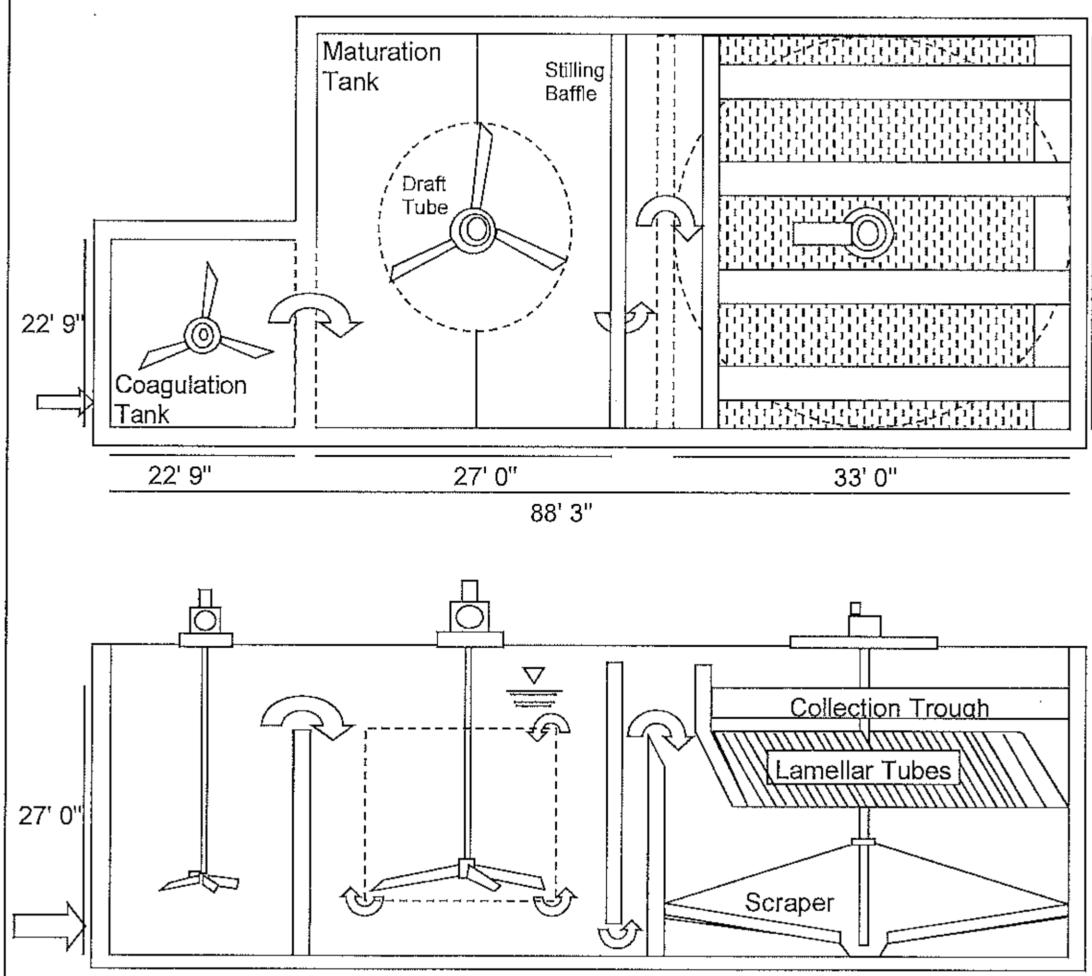
Total Capacity = 45 MGD

Lakewood OH - 45 MGD

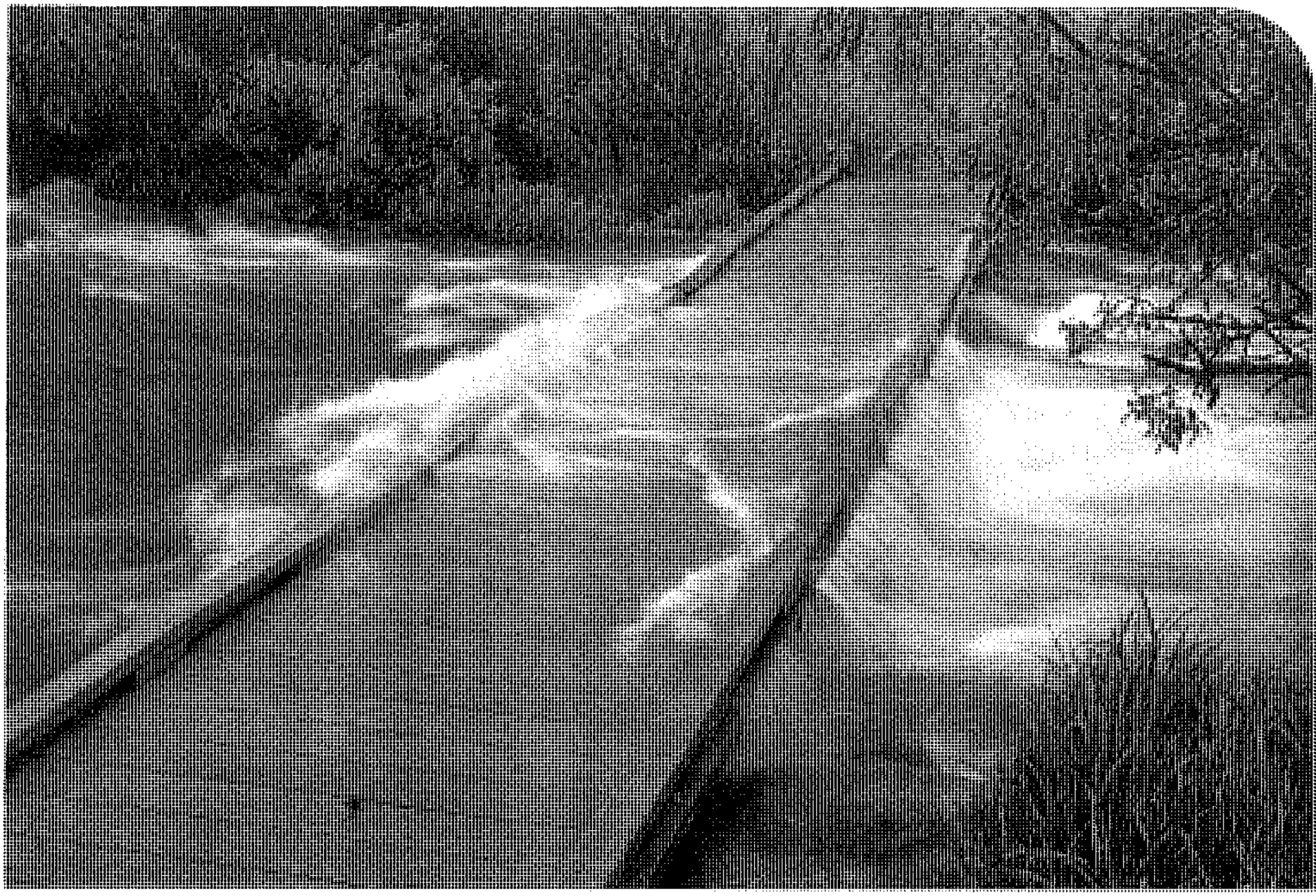




Preliminary ACTIFLO Single Train Layout
Lakewood OH BIOACTIFLO
Total Capacity = 45 MGD
Capacity per Train: 1 x 45 MGD



Coagulation Tank Maturation Tank Tube Settler with Scraper



VEOLIA

ACTIFLO® Process

For Wet Weather and Wastewater Treatment

WATER TECHNOLOGIES

ACTIFLO®
Microsand Ballasted Clarification Process

Actiflo is a high rate, compact process developed by Veolia Water Technologies. The process operates with microsand which enhances floc formation and acts as a ballast to aid in rapid settlement of coagulated material.

The Actiflo process can be used at various stages of wastewater treatment including: enhanced primary treatment, wet weather clarification, high rate secondary clarification and final polishing for the removal of solids, phosphorus and metals.

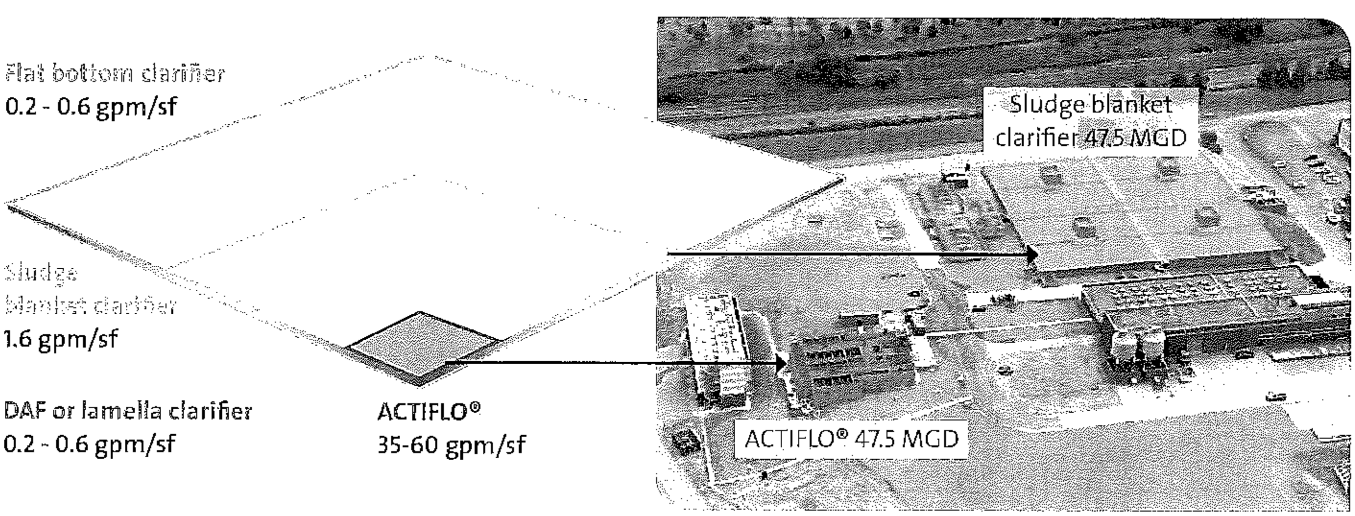
Typical ACTIFLO Performance

Application	Loading Rate (gpm/sf)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wet weather	60	0.5 - 1.5	10 - 20	< 30	< 20	50 - 70
[illegible]	45	0.1 - 1.0	1 - 10	< 20	< 15	60 - 70
Secondary	20	0.5 - 1.5	1 - 10	< 10	< 10	65 - 75
Tertiary	45	as low as 0.05	< 10	< 10	≤ 5	75 - 90

*Pathogen removal, post disinfection, is equivalent to or exceeds that of a conventional activated sludge plant

ACTIFLO Compactness Displaying Its True Potential

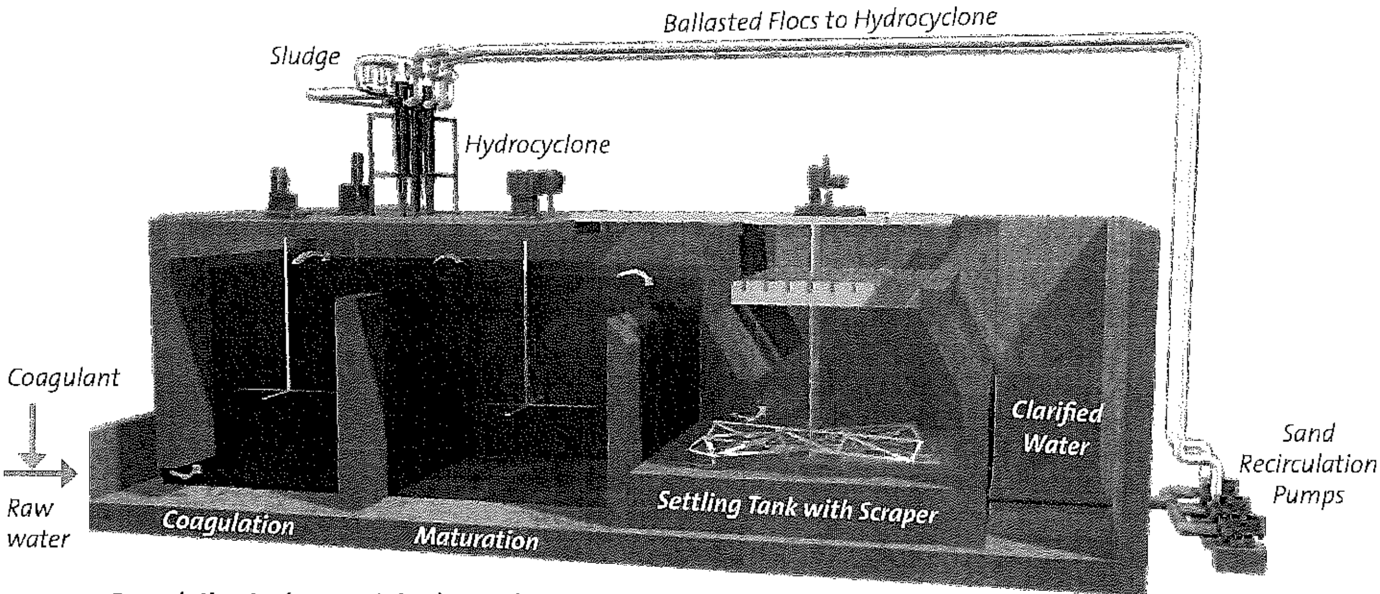
The microsand ballasted flocs display unique settling characteristics, which allow for clarifier designs with very high overflow rates and short retention times. These designs result in footprints that are 5 times smaller lamella clarifiers or dissolved air flotation (DAF) and up to 20 times smaller than conventional clarification systems.



*Surface water treatment reference

CSO/SSO Parallel Treatment with ACTIFLO

Recirculation: *settled material is pumped to the hydrocyclone for separaration and microsand recovery*



Coagulation tank: *pin floc formation*

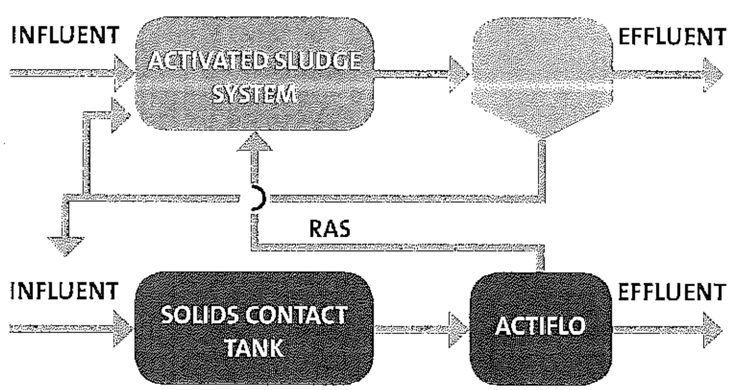
Injection tank: *ballasted floc formation begins and microsand is re-injected*

Maturation tank: *ballasted floc formation continues with optimum mixing gradients*

During peak wet weather flow conditions, many plants need to divert a portion of the total plant flow around their biological treatment process. To achieve high levels of TSS and particulate BOD removal of these diverted excess flows, the Actiflo process can be installed at the treatment plant or at a satellite facility within the collection system. The Actiflo process can be fully automated and the process train(s) can sit idle for extended periods of time and still be fully operational within 15 minutes of start-up.

CSO/SSO Treatment BIOACTIFLO™

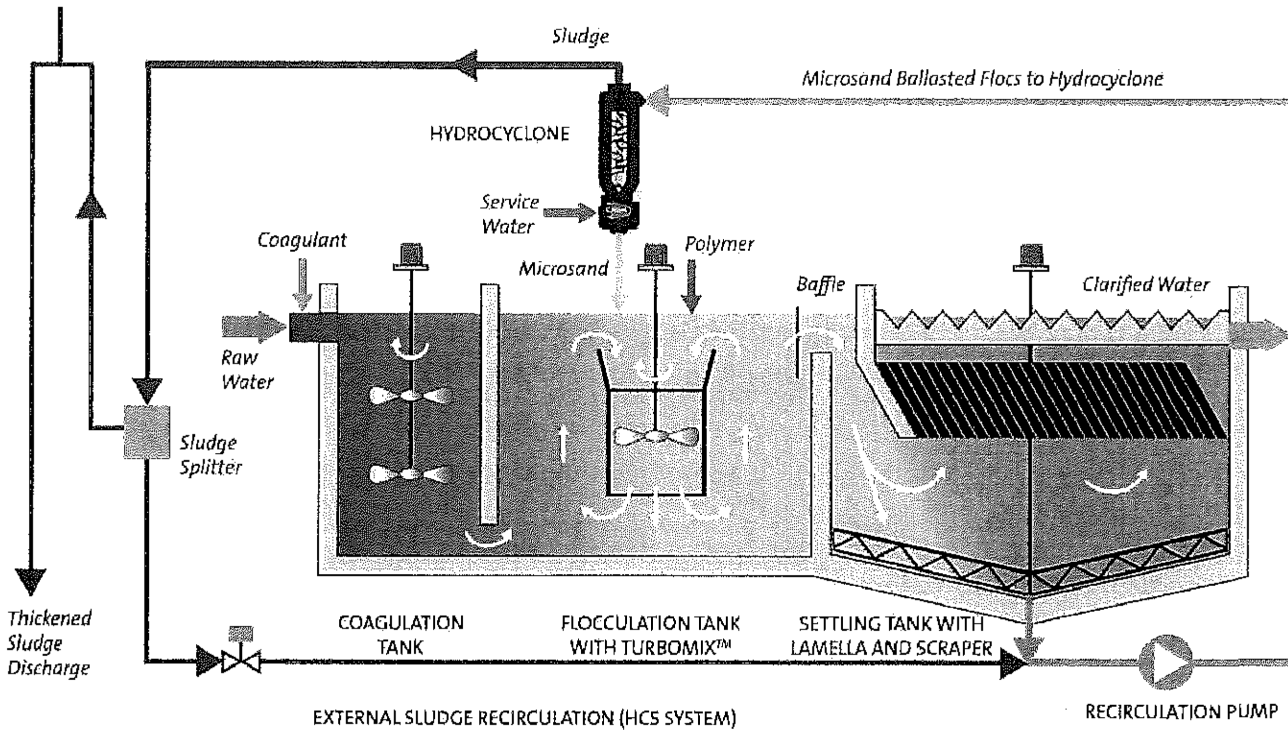
If flow diversion is not an option or the TSS and particulate BOD removal with Actiflo alone are not enough, a biological solids contact tank can be incorporated into the treatment flow path to improve soluble BOD removal through the system.



Return activated sludge (RAS) from the existing clarifiers is combined with the excess flows into a solids contact tank. A targeted mixed liquor suspended solids (MLSS) concentration is maintained in the contact tank to facilitate rapid uptake of soluble biological oxygen demand (BOD) via contact stabilization. Clarification with ACTIFLO follows, producing exceptional TSS and total BOD removal rates that allow for efficient disinfection.

Tertiary Treatment with ACTIFLO

With tighter discharge limits being imposed on wastewater treatment plants the need for a cost effective, flexible process has evolved. Over the years, the Actiflo process has proven its effectiveness in meeting extremely low phosphorus, metals and TSS limits.



Process Benefits

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

For tertiary treatment applications, the Actiflo process offers:

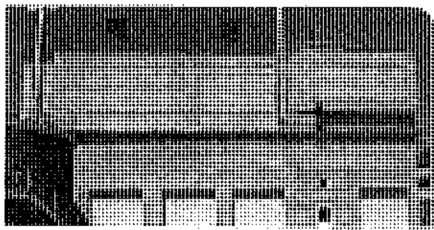
- Ability to treat a wide range of influent phosphorus levels to extremely low limits
- Flexibility to meet future limits (phosphorus, metals) without modifying the process train
- The same tertiary treatment trains can also be used to treat wet weather flows
- Treatment of flows with high solids concentration without impacting effluent quality (solids washout from secondary clarifiers during peak flow)
- Reduction in sludge volume by incorporating a HCS system

Worldwide References

The Actiflo process is currently in operation worldwide in small communities and large metropolitan areas, as well as in various installations for the treatment of industrial process water and effluents.

Syracuse, NY
Onondaga County wastewater treatment plant

[illegible]



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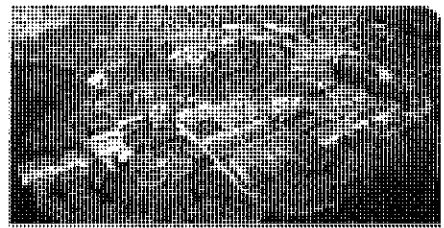
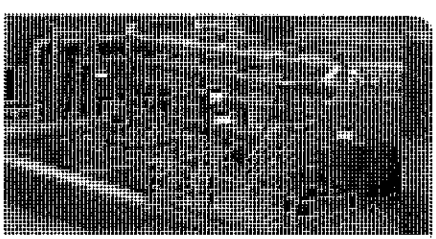


Geneva, Switzerland

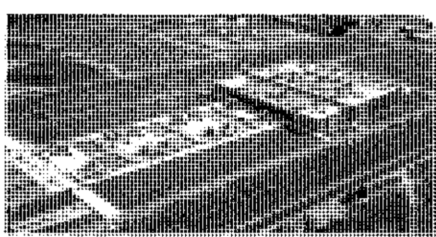
[illegible]

Barcelona, Spain

[illegible]

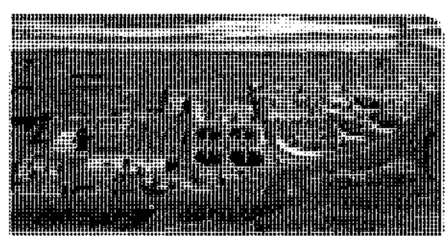


[illegible]



Paris, France
Seine Aval wastewater treatment plant

[illegible]



Sydney, Australia

[illegible]

Resourcing the world

ACTIFLO US Wet Weather Installation List

Jan-15

Installation Number	Name	EPA Region	Application	Location	Year Startup	Total Capacity (MGD)	Number of Trains
1	St. Bernard, LA	6	ACTIFLO	At WWTP	2001	10	1
			BIOACTIFLO	At WWTP	2011	7.5	1
2	Bremerton, WA	10	ACTIFLO	Satellite	2001	10	1
3	Lawrence, KS	7	ACTIFLO	At WWTP	2003	40	2
4	Fort Smith, AR (P Street)	6	ACTIFLO	At WWTP	2004	31	1
5	Port Clinton, OH	5	Dual Mode ACTIFLO	At WWTP	2004	24	2
6	Greenfield, IN	5	Dual Mode ACTIFLO	At WWTP	2004	8	2
7	Fort Worth, TX	6	ACTIFLO	At WWTP	2005	110	2
8	Port Orchard, WA	10	ACTIFLO	At WWTP	2006	6.7	1
9	Cincinnati SSO 700, OH	5	ACTIFLO	Satellite	2006	15	1
10	Heart of the Valley (HOV) Kaukauna, WI	5	ACTIFLO	At WWTP	2007	60	2
11	Salem, OR	10	ACTIFLO	Satellite	2007	50	2
12	Cincinnati, OH Sycamore Creek	5	ACTIFLO	At WWTP	2008	32	2
13	Tacoma, WA	10	ACTIFLO	At WWTP	2008	76	2
14	Geneva, NY	2	ACTIFLO	Satellite	2008	23	1
15	Nashua, NH	1	ACTIFLO	At WWTP	2008	60	2
16	Fort Smith, AR (Sunnymede Pump Station)	6	ACTIFLO	Satellite	2010	25	1
17	Newark, OH	5	ACTIFLO	At WWTP	2011	28	2
18	Wilson Creek, TX	6	Dual Mode BIOACTIFLO	At WWTP	2012	32	1
19	Lowell, IN	5	ACTIFLO	At WWTP	2013	10	1
20	Knoxville, TN	4	BIOACTIFLO	At WWTP	2013	11	2
21	Cox Creek, MD (under construction)	3	BIOACTIFLO	At WWTP	2015	12	1
22	Terre Haute, IN (under construction)	5	ACTIFLO	Satellite	2015	16.3	1
23	DC Water (under construction)	3	ACTIFLO	At WWTP	Est 2017	250	3

Marina Sher

From: Chris Kushner <CKushner@HPThompson.com>
Sent: Tuesday, May 03, 2016 8:30 PM
To: Marina Sher; John Zaleha
Cc: Michael Kravtsov
Subject: FW: Lakewood, OH BIOACTIFLO Updated Budget Pricing and Sizes(2x17.5MGD, 3x11.7MGD)
Attachments: prop.1x35mgd1x45mgdBio.LakewoodOH.TAP.pdf; ACTIFLO WW Brochure.pdf; BIOACTIFLO 11.7MGD GA DWG.pdf; BIOACTIFLO 17.5MGD GA DWG.pdf

Marina and John,

Thank You again for your time today. Attached is information for 2 and 3 train Bio-Actiflo systems. Pricing for each is listed below. Also, the original budget proposal for the 35 MGD Bio Actiflo is attached. Let me know what questions you may have.

John,

I was incorrect about CAD drawings being available for the previous drawings. Those drawings were never created in CAD.

Regards,

Chris Kushner
The Henry P. Thompson Company
(614) 512-1054
ckushner@hpthompson.com

---------- Forwarded message ----------
From: **Austria, Daniel** <daniel.austria@veolia.com>
Date: Tue, May 3, 2016 at 12:47 PM
Subject: Lakewood, OH BIOACTIFLO Updated Budget Pricing and Sizes(2x17.5MGD, 3x11.7MGD)
To: Andy Szekeress <andy.szekeress@veolia.com>
Cc: Tom Perry <tom.perry@veolia.com>, Michele Kline <michele.kline@veolia.com>

Budget Pricing is as follows:
Design 1: 2x17.5MGD BIOACTIFLO System: $4,300,000.
Design 2: 3x11.7MGD BIOACTIFLO System: $4,900,000.

Both above designs assume single 35MGD BIO Contact Tank and same general scope as attached previously submitted 1x35MGD BIOACTIFLO System proposal.

Attachments:
*1x35MGD BIOACTIFLO Aug 2015 Proposal w/ GA DWG for BIO TANK
*17.5MGD BIOACTIFLO GA DWG

*11.7MGD BIOACTIFLO GA DWG
*WW Brochure

Marina Sher

From: Chris Kushner <CKushner@HPThompson.com>
Sent: Friday, April 22, 2016 7:40 PM
To: Michael Kravtsov; Marina Sher; John Zaleha
Cc: Rebecca Lee
Subject: Lakewood, OH Trojan U.V.

Ladies and Gentlemen,

Please see below for preliminary dimensions and pricing for Trojan UV system for Lakewood.

Regards,

Chris Kushner
The Henry P. Thompson Company
(614) 512-1054
ckushner@hpthompson.com

As a high-level preliminary draft, using 65% UVT, typical TSS of <30 mg/L, we'd be looking at 2 channels with 2 banks per channel, 72 lamps total.

Each channel approximately 13.5 ft long (not including level control device – options include: downward motorized gate, weir troughs, serpentine weir), 4.3 ft wide and approximately 7.5 ft deep. Each channel could be separated by a 1 – 2 ft wall. Ballpark budget cost is roughly $650,000.

We could alternatively do all 35 MGD in one channel if the space requires it and the Owner is open to a one-channel approach. Roughly 18 ft (same level control options as noted above) X 5.2 ft X 7.5 ft. Ballpark budget closer to $540,000.