CDM

Technical Memorandum No. 1

To: *Bernie Sisson*

From: *Vincent Apa*

Date: *April 1, 2008*

Project: *City of Schenectady*
NYSDEC SPDES Permit & Consent Order Support Services

Subject: *Gravity Thickening of Primary Sludge or Combined Primary and Waste Activated Sludge (WAS)*

Introduction

Per Amendment No. 1 of the NYSDEC SPDES Permit & Consent Order Support Services, CDM is to include a conceptual desk top analysis of sending primary sludge or a combination of primary sludge and WAS to a gravity thickener. This work is for planning purposes to improve the treatment and overall operations of the plant and help the City prioritize future capital improvements. The feed to the anaerobic digesters has been historically less than 3% solids and is primarily attributed to the primary sludge not being properly thickened. The amount of dilute sludge or water in the digesters limits the capacity of the digesters for stable operation and potential to receive additional solids in the future, with the ultimate goal being maximizing digester gas production for reuse.

In May 2006, CDM and Veolia Water developed and prioritized items for the 2007 budget and future items for 2008 and 2009. One of the items identified was the possibility of gravity thickening primary sludge. At this time, it was noted that the existing dissolved air flotation thickener (DAFT) room has no ventilation and is severely corroding. The possibility of abandoning the DAFTs and sending WAS along with primary sludge to new gravity thickener or a converted former digester (existing holding tank) was proposed.

This technical memorandum is specifically related to summarizing the options of:

- Gravity thickening primary sludge in a new concrete tank
- Gravity thickening primary sludge and WAS in converted sludge holding tank (former digester)

Background

There are 9 primary settling tanks; however only 6 are in operation. This is due to potentially plugged primary sludge piping or limited suction lift of the primary sludge pumps. The three tanks (Tanks 7-9) off-line are the farthest from the primary sludge pumps, which are located in the basement of the Screenings Building.

Chain-and-flight sludge collectors scrape the settled solids to hoppers located at the influent end of the tanks. Slide gate valves are opened for a preset time, based on the sludge blanket levels in the tanks at the operator's discretion. Sludge is withdrawn from the hoppers through an 8-inch primary sludge header that is connected to the suction piping of the primary sludge pumps. This allows sludge to flow by gravity to the primary pumps which are run intermittently. A magnetic flow meter in the discharge piping of the primary pumps is used to measure and record the pumped flow. Grab samples are taken twice per shift and are analyzed for the solids content of the primary sludge.

From the data previously reviewed (from 9/30/03 to 9/30/05), the solids content of the primary sludge is slightly greater than 3%. However, based on a review of the sampling procedures and the mass balances developed by CDM, it is estimated that the percent solids is actually closer to 2%. Typically, a grab sample is taken when the pumps are turned on, which is when the sludge concentration is the highest. The existing primary clarifiers do not have cross collectors to condition the sludge in the hoppers and the potential for drawing clean water does exist. However, the addition of cross collectors in the existing primary clarifier sumps would be expensive, difficult to construct and not worth the cost to simply condition the sludge.

Currently, waste activated sludge (WAS) is sent from the final clarifiers to the dissolved air flotation thickening (DAFT) tanks where it is thickened to 3-5% solids. A portion of the raw sludge from the primary settling tanks and all of the thickened WAS from the DAFT tanks is pumped to an unmixed sludge holding tank and then to two mesophilic anaerobic digesters.

Digested sludge and a portion of the raw primary sludge are sent to the blend tanks. Combined sludge from the blend tanks is pumped to the centrifuge for dewatering.

The use of gravity thickening to thicken either primary sludge or a combination of primary sludge and WAS was proposed as a simple, low-operational cost option. This method of thickening does not require the use of chemical conditioning. Sludge can be pumped continuously or intermittently.

Calculations

Mass balances were developed for the following three scenarios to evaluate the solids loading to the digesters and dewatering unit (centrifuge). The basic assumptions of each scenario are listed in Table 1.

Table 1 – Scenarios Evaluated

Scenario 1 **Existing**	**Scenario 2** **Gravity Thickening primary sludge**	**Scenario 3** **Gravity Thickening primary sludge & WAS**
No thickening of primary sludge	New gravity thickener tank for primary sludge	Convert sludge hold tank (former digester) into gravity thickener
Existing DAFT units to remain to thicken WAS	Existing DAFT units to remain to thicken WAS	Existing DAFT units to be abandoned
~40% primary sludge and 100% TWAS sent to digestion and then to centrifuge ~60% primary sludge bypasses digestion and ultimately to centrifuge	100% thickened primary sludge and WAS sent to digestion and ultimately to centrifuge	Gravity thickening 100% primary sludge and WAS together to be sent to digestion and ultimately to centrifuge

For further explanation of the three scenarios, refer to the attached process flow diagrams.

In each of the three mass balances performed, average daily sampling results was taken from the time period 9/30/02 to 9/30/05, or was calculated as noted. An assumption used for all three mass balances was that a 40% total suspended solids (TSS) reduction will be achieved through anaerobic digestion upon completion of the cleaning and digester mixing system upgrades.

Also, it was assumed that primary sludge alone would be gravity thickened to 7% solids, and the combined primary sludge and WAS would be gravity thickened to 5% solids. The latter is a reasonable estimate considering the blend of WAS and primary sludge.

A summary of the results related to the solids sent to digestion and dewatering for each of the mass balances is shown in Table 2.

Table 2 - Results of Mass Balances*

Scenario	Feed to Digesters (lb TSS/d)	Feed Solids to Digesters (%)	Feed to Centrifuge (lb TSS/d)	Feed Solids to Centrifuge (%)	Flow Rate to Centrifuge (gpd)	Cake from Centrifuge (lb TSS/d)
1	15,791	2.8	13,901	2.1	79,000	12,026
2	19,695	4.7	11,817	4.7	30,000	10,635
3	19,685	5.0	11,811	5.0	29,000	10,630

*All data is represented on an average daily basis.

Discussion

Results of the preliminary mass balance calculations presented above show roughly a 12% decrease in cake produced by thickening and digesting it, and a major reduction in the flow rate delivered to dewatering. Although the solids loading sent to digestion is increased in Scenarios 2 and 3, it is still within recommended ranges at average day and at an assumed maximum month condition. The digester solids retention time (SRT) would likely be improved substantially by removing a large portion of water occupying a set digester tank volume.

According to these preliminary calculations, it may also be possible to reduce the centrifuge operation from 4 to 3 days per week if the centrifuge can handle a slightly higher solids concentration and type of sludge (i.e., 100% digested). The existing Niro HD54 centrifuge is rated for 1,100 lb TSS/hr (220 gpm @ 1% feed solids or 44 gpm @ 5% feed solids). Historically, the unit is fed approximately 100 gpm @ 2 to 3% solids. This equates to a solids loading rate of approximately 1,000 to 1,500 lb TSS/hr.

If the upgrades presented in Scenario 3 were implemented, the solids loading rate to the centrifuge would be 1,175 lb/hr assuming:

- Flow rate of 29,000 gpd (or 47 gpm based on 3 day per week cycle and 5% solids)

Records from the initial centrifuge pilot testing in March 1995 indicated that a blend of primary sludge and digested (primary sludge + WAS) dewatered much better than a straight blend of 100% digested primary sludge and WAS in the winter. Historically, a significant waste load was discharged to the plant by a local cheese producer in the winter months. This load produced a significant amount of biological sludge which when digested and fed to the centrifuge did not dewater well. It was believed this was due to the low solids feed concentration and high volatile solids content. Now that the waste load from the cheese producer has been drastically reduced and the sludge composition has changed, additional pilot testing would be recommended upon completion of the thickening upgrades to determine the optimum dewaterability of this sludge. The target cake solids produced from the centrifuge would be 25% to minimize the amendment needed to support the composting operation.

In summary there are many advantages for implementing some form of thickening as presented including:

- Increased digester capacity (SRT)
- Increased biogas production in digester for potential reuse
- Reduced solids load sent to dewatering and composting system
- Reduced operational costs for dewatering system (labor, electricity, and polymer)
- Reduced amendment for composting if cake solids sent to composting is > 25%

Scenarios 2 and 3 from above were further evaluated with respect to capital costs, along with general advantages and disadvantages to aide the City in future planning. A summary of the evaluation of each alternative is presented below.

Scenario 2 – Gravity Thickening Primary Sludge in New Tank

In general, gravity thickening of primary sludge alone can present problems due to sludge becoming too thick and being difficult to pump. Proper suction piping layout and flooded pump suction is required to prevent problems from occurring.

For this scenario, the installation of a new concrete tank for thickening primary sludge was evaluated. The location of the new gravity thickener would be in the open space between primary settling tanks 1-6 and 7-9.

Based on the estimated average day and maximum month conditions, a 25′ diameter concrete tank with 10′ side water depth is recommended (see attached calculations). The overall depth of the tank would be 16′, due to the 5′ cone depth and 1′ freeboard required. Based on the existing elevations, the sludge withdrawn from the primary clarifiers would have to be pumped into the new gravity thickener. A separate wet well would have to be constructed for installation of new pumps to convey primary sludge to the gravity thickener. Piping modifications would also be required for the gravity thickener overflow back into the primary settling tanks and for connecting new thickened sludge piping to the existing primary sludge pumps. The anticipated cost for these modifications along with the operational concerns (e.g., pumping thick sludge) resulted in this option not being considered any further at this time.

Scenario 3 – Gravity Thickening Primary Sludge and WAS in Existing Digester Tank

Based on the attached calculations, the use of the existing digester tank (holding tank) is suitable for being modified into a gravity thickener. The gravity thickener would receive both primary sludge and WAS. No polymer would be needed for this type of thickening system and an estimated 38% increase (or an increase in ~ 110kW in electrical power) in digester gas production is possible.

As part of this modification, new gravity thickener equipment, including a new center column, feedwell, drive cage, drive unit with platform, rake arms, and effluent weir would be installed inside the existing holding tank.

Two new plunger pumps are included to replace the existing pumps that were installed in the mid 1970s and have been repaired over the years. These pumps convey primary sludge from the primary clarifier sumps to the gravity thickener.

A new inboard launder (FRP or steel) would need to be constructed to allow for the gravity thickener overflow. The recommended height of the launder would be 3', resulting in a side water depth of 13'. A sludge blanket of 3' to 6' is usually required to maintain a thick underflow (thickened sludge concentration). Therefore, this depth should provide sufficient thickening capacity.

Typically, primary sludge is pumped on a more frequent basis to remove all settled solids in the primary settling tanks and to prevent septic conditions from occurring in the gravity thickener. A provision for chlorinating the sludge should be considered as control method for potential odors or rising sludge in the warmer months.

The piping would need to be modified along with the installation of a few additional valves in the basement near the DAFT area so that WAS could be pumped from the WAS pumps directly to the gravity thickener. Piping modifications would also be necessary to allow for a side inlet to a thickener feed well. It may be possible for a center feed from the bottom. Provisions for the thickener overflow piping would have to be further evaluated and whether the return stream could flow by gravity or need to be pumped to the head of the plant.

The existing floating cover would be lifted and placed in the out of service digester and a new aluminum flat panel cover with guardrails would be installed down in the tank, but would require structural angle supports tied into the inner walls to contain potential odors. The new cover could also be installed on the top of the existing walls, but would require rehabilitation of the existing concrete and new guard rails around the perimeter. For either option of the new cover, based on the span, trusses on top of the cover are recommended and not beams.

A summary of the basis of design for this option is listed in Table 3.

Table 3 – Basis of Design

Parameter	Design Value	Design Criteria
Type of sludge	Primary sludge and WAS	
Feed sludge	0.5-1.5% total solids	
Hydraulic overflow rate	123 gpd/ft^2 (average day) 212 gpd/ft^2 (max month)	380–760 gpd/ft^2 (primary sludge) 100-200 gpd/ft^2 (WAS)
Sludge loading rate	6.6 lb/d/ft^2 (average day) 12.2 lb/d/ft^2 (max month)	5-14 lb/d/ft^2 (at listed feed solids)
Predicted thickened sludge concentration	5% total solids	
Flow of thickened sludge	48,000 gpd (average day) 88,000 gpd (max month)	
Diameter	~62 ft (inside)	70-80 ft (max)
Side water depth	13 ft	10-13 ft
Floor slope	2:10	2:12 to 3:12

Notes: Design criteria taken from WEF Manual of Practice No. 8, Design of Municipal Wastewater Treatment Plants, Fourth Edition.

With only one gravity thickener, the existing DAFTs could be used as a back-up for thickening WAS only. Primary sludge would have to be pumped from the primary settling tanks as is currently done.

An opinion of probable project costs was performed for the upgrades listed in Scenario 3. CDM's opinion of probable project costs are based on our experience and qualifications and represent our best judgment as an experienced and qualified professional generally familiar with the construction industry. These planning level costs are presented in Table 4.

The cost estimates do not include a provision for an interior concrete coating. This option should be further evaluated to determine the cost benefit based on the age and condition of the concrete.

Table 4 - Project Cost Estimates

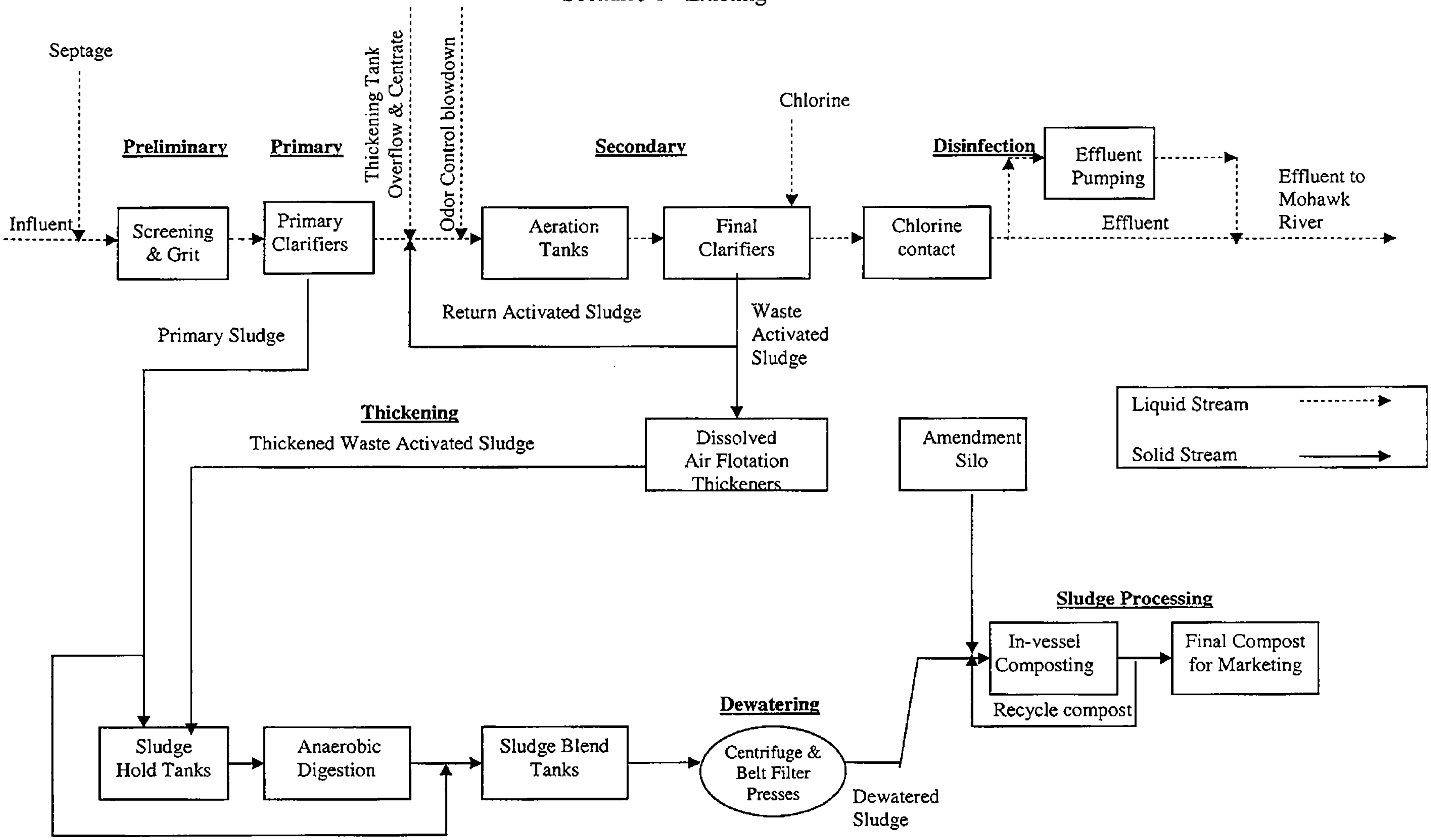
Rehab Holding Tank to Gravity Thickener	$ 40,000	$ -
Plunger pumps (primary sludge)	$ 75,000	$ -
Relocate existing floating cover	$ 10,000	$ -
Gravity Thickener mechanism	$217,400	$ -
Fiberglass effluent launder and weirs	$ 60,900	$ -
Electrical & Controls	$ 20,000	$ -
Piping Modifications	$ 43,750	$ -
Aluminum flat panel cover	$166,000	
	$ -	$ 633,050
		$ -
SUB TOTAL	**$ -**	**$ 633,050**
Contractor's Overhead and Profit (15%)	**$ -**	**$ 94,958**
SUB TOTAL	**$ -**	**$ 728,008**
Construction Contingency (25%)	**$ -**	**$ 182,002**
SUB TOTAL	**$ -**	**$ 910,009**
Engineering, Permitting, Construction Admin (15%)	**$ -**	**$ 136,501**
TOTAL (ROUNDED)	**$ -**	**$1,047,000**

Summary

The conceptual analysis shows that there are benefits to further evaluating the details in Scenario 3. The benefits include a more stable digester operation, potential to receive additional solids in the future, additional gas production for reuse, and no capital needed to upgrade existing DAFT room. The additional gas production could result in ~$87,000 in electrical savings (assuming $0.10/kW*hr), along with operational savings by not running the DAFTs (polymer and electricity). In summary, CDM recommends a more thorough analysis with recent data be analyzed, a preliminary design with layouts be developed and this information be used to develop the life cycle cost for the recommended improvements. Once developed this additional information would provide the City with sufficient information to justify whether to move forward with the recommended improvements to the sludge thickening and treatment systems contained herein.

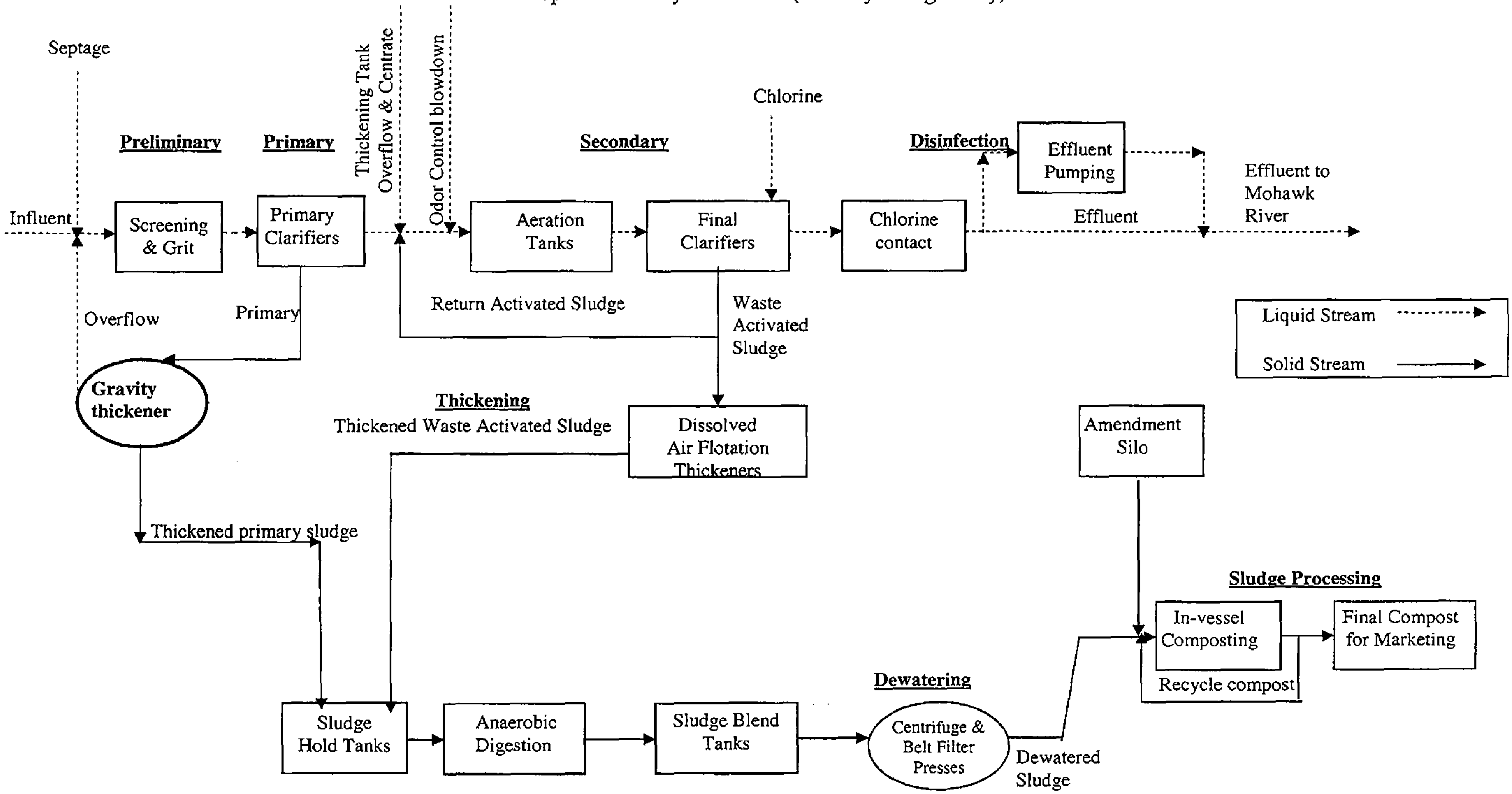
cc: Dan Durfee – CDM
Mike Miller - CHA

City of Schenectady, NY
Water Pollution Control Plant
Process Flow Schematic
Scenario 1 - Existing



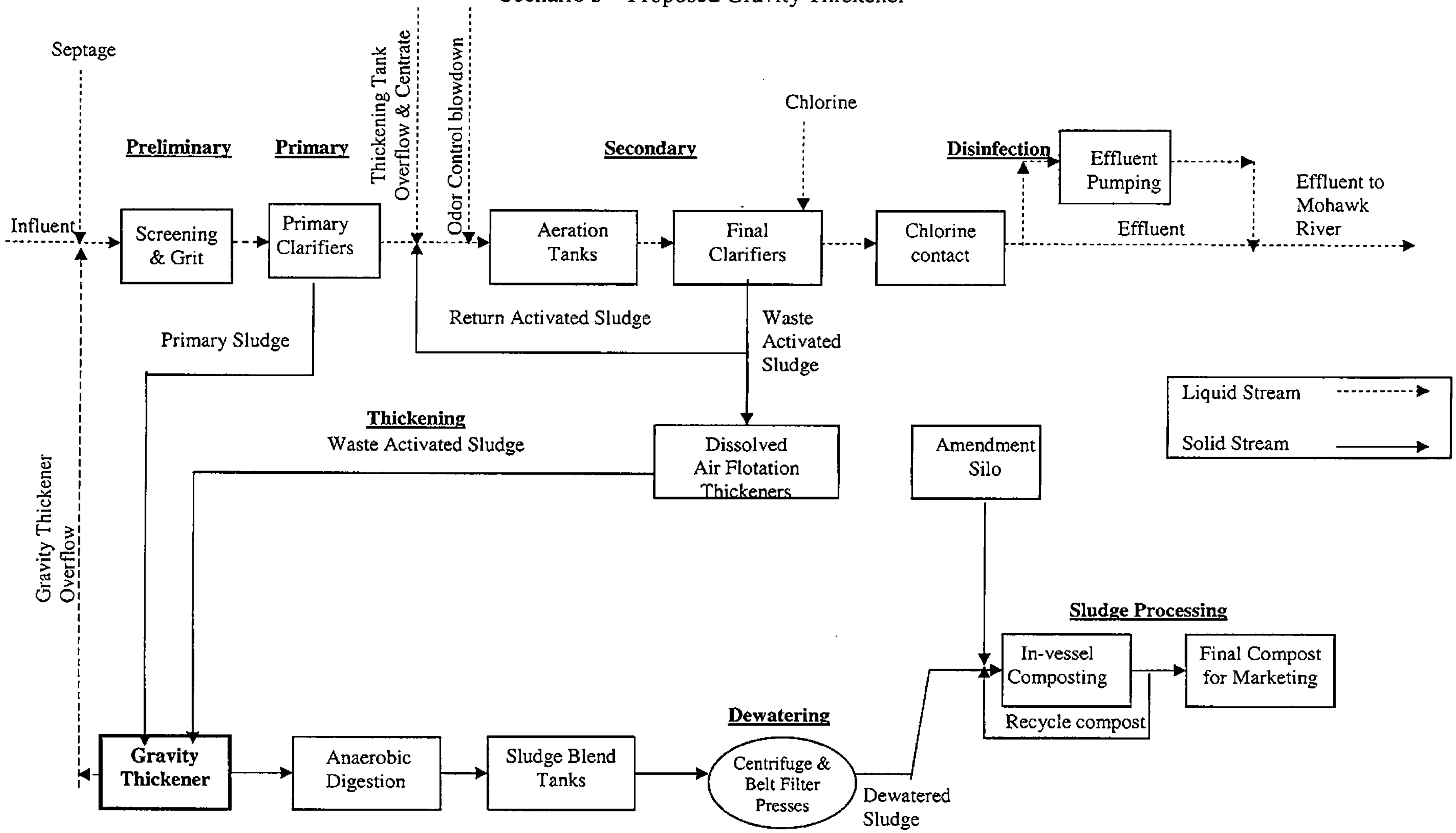
CDM

City of Schenectady, NY
Water Pollution Control Plant
Process Flow Schematic
Scenario 2 – Proposed Gravity Thickener (Primary Sludge Only)



CDM

City of Schenectady, NY
Water Pollution Control Plant
Process Flow Schematic
Scenario 3 – Proposed Gravity Thickener



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ASSUMES EXISTING EQUIPMENT

	A	B	C	D	E	F	G	H	I
1	City of Schenectady WPCP								37797-47751
2	Mass Balance								
3	Scenario 1 - Existing Conditions								
4	Average Day								
5									
6		ITERATIONS							
7		1	2	3	4	5	6	7	Notes
8	RAW INFLUENT								
9	Flow (mgd)	14.83	14.83	14.83	14.83	14.83	14.83		Ops data from Sept 30, 2002 - Sept 30, 2005.
10	Concentrations (mg/L)								
11	CBOD	113	113	113	113	113	113		Ops data from Sept 30, 2002 - Sept 30, 2005.
12	TSS	132	132	132	132	132	132		Ops data from Sept 30, 2002 - Sept 30, 2005.
13	CBOD/BOD	0.80	0.80	0.80	0.80	0.80	0.80		Ops data from Sept 30, 2002 - Sept 30, 2005.
14	Loads (lb/d)								
15	CBOD	14,015	14,015	14,015	14,015	14,015	14,015		Calculated.
16	TSS	16,385	16,385	16,385	16,385	16,385	16,385		Calculated.
17									
18	COMBINED SIDESTREAMS								DAFT overflow + Centrate + Odor control blowdown.
19	Flow (mgd)		0.988	0.988	0.988	0.988	0.988		
20	Concentrations (mg/L)								
21	CBOD		7	7	7	7	7		Calculated.
22	TSS		111	112	112	112	112		Calculated.
23	Loads (lb/d)								
24	CBOD		54	54	54	54	54		DAFT overflow + Centrate + Odor control blowdown.
25	TSS		915	921	921	921	921		DAFT overflow + Centrate + Odor control blowdown.
26									
27	PRIMARY EFFLUENT								
28	Removals (%)								
29	CBOD	29	29	29	29	29	29		Ops data from Sept 30, 2002 - Sept 30, 2005; used BOD, since CBOD not measured here.
30	TSS	44	44	44	44	44	44		Ops data from Sept 30, 2002 - Sept 30, 2005.
31	Flow (mgd)	14.77	14.77	14.77	14.77	14.77	14.77		Influent - Primary sludge.
32	Concentrations (mg/L)								
33	CBOD	81	81	81	81	81	81		Calculated.
34	TSS	75	75	75	75	75	75		Calculated.
35	Loads (lb/d)								
36	CBOD	9,968	9,968	9,968	9,968	9,968	9,968		Calculated.
37	TSS	9,237	9,237	9,237	9,237	9,237	9,237		Calculated.
38									

	A	B	C	D	E	F	G	H	I
6		ITERATIONS							
7		1	2	3	4	5	6	7	Notes
39	PRIMARY SLUDGE								
40	Flow (mgd)	0.063	0.063	0.063	0.063	0.063	0.063		Ops data from Sept 30, 2002 - Sept 30, 2005 (avg V246 + V247).
41	Concentrations (mg/L)								
42	CBOD	7,759	7,759	7,759	7,759	7,759	7,759		Calculated.
43	TSS	13,702	13,702	13,702	13,702	13,702	13,702		Calculated.
44	Loads (lb/d)								
45	CBOD	4,047	4,047	4,047	4,047	4,047	4,047		Raw influent - primary effluent load.
46	TSS	7,148	7,148	7,148	7,148	7,148	7,148		Raw influent - primary effluent load.
47									
48	SECONDARY EFFLUENT								
49	Flow (mgd)	14.46	15.45	15.45	15.45	15.45	15.45		Primary effluent + sidestreams - WAS.
50	Concentrations (mg/L)								
51	CBOD	7	7	7	7	7	7		Ops data from Sept 30, 2002 - Sept 30, 2005.
52	TSS	16	16	16	16	16	16		Ops data from Sept 30, 2002 - Sept 30, 2005.
53	Loads (lb/d)								
54	CBOD	832	888	888	888	888	888		Calculated.
55	TSS	1,920	2,051	2,051	2,051	2,051	2,051		Calculated.
56									
57	SECONDARY SOLIDS PRODUCED								
58	Net yield (lb TSS/lb CBOD applied)	1.43	1.43	1.43	1.43	1.43	1.43		Took actual of 1.79 lb TSS/lb BOD and mult by 0.8 to convert to CBOD based yield.
59	Volatile fraction	0.83	0.83	0.83	0.83	0.83	0.83		Ops data from Sept 30, 2002 - Sept 30, 2005.
60	Flow (mgd)	14.46	15.45	15.45	15.45	15.45	15.45		Primary effluent + sidestreams - WAS.
61	Concentrations (mg/L)								
62	CBOD								
63	TSS								
64	Loads (lb/d)								
65	CBOD								
66	TSS	14,254	15,246	15,253	15,253	15,253	15,253		(Primary effluent + sidestream CBOD load) x Net yield + sidestreams TSS load.
67									
68	WASTE ACTIVATED SLUDGE								
69	Flow (mgd)	0.31	0.31	0.31	0.31	0.31	0.31		Ops data from Sept 30, 2002 - Sept 30, 2005 (used avg).
70	Concentrations (mg/L)								
71	TSS	4,799	5,134	5,136	5,136	5,136	5,136		Calculated.
72	Loads (lb/d)								
73	TSS	12,334	13,195	13,202	13,202	13,202	13,202		Secondary solids produced - secondary effluent load.
74									

	A	B	C	D	E	F	G	H	I
6		ITERATIONS							
7		1	2	3	4	5	6	7	Notes
75	THICKENED WASTE ACTIVATED SLUDGE								
76	Capture (%)	99	99	99	99	99	99		Assumed, no DAFT overflow TSS data to determine capture.
77	Flow (mgd)	0.044	0.044	0.044	0.044	0.044	0.044		Ops data from Sept 30, 2002 - Sept 30, 2005 (used avg + 15%).
78	Concentrations (mg/L)								
79	TSS	33,504	35,843	35,860	35,860	35,860	35,860		Calculated.
80	Loads (lb/d)								
81	TSS	12,211	13,063	13,070	13,070	13,070	13,070		WAS load x capture.
82									
83	DAFT OVERFLOW								
84	Flow (mgd)	0.264	0.264	0.264	0.264	0.264	0.264		WAS - TWAS flow.
85	Concentrations (mg/L)								
86	TSS	56	60	60	60	60	60		Calculated.
87	Loads (lb/d)								
88	TSS	123	132	132	132	132	132		WAS - TWAS load.
89									
90	FEED TO SLUDGE HOLD TANKS TO ANAEROBIC DIGESTERS								TWAS and portion of primary sludge.
91	Flow (mgd)	0.068	0.068	0.068	0.068	0.068	0.068		(Primary sludge flow above x % to Hold Tank from Ops data from Sept 30, 2002 - Sept 30, 2005) + TWAS flow from calculation above.
92	Concentrations (mg/L)								
93	TSS	26,520	28,033	28,045	28,045	28,045	28,045		
94	Loads (lb/d)								
95	TSS	14,932	15,784	15,791	15,791	15,791	15,791		TWAS load + (primary sludge load x % to Hold Tank).
96									
97	ANAEROBICALLY DIGESTED SLUDGE								
98	VSS Destruction (%)	45.00	45.00	45.00	45.00	45.00	45.00		Assumed value after new digester mixing and heat exchanger sludge pumps are installed.
99	TSS Reduction	0.40	0.40	0.40	0.40	0.40	0.40		Assumed value after new digester mixing and heat exchanger sludge pumps are installed.
100	Concentrations (mg/L)								
101	TSS	26,520	28,033	28,045	28,045	28,045	28,045		Used values from digester feed.
102	Loads (lb/d)								
103	TSS	8,959	9,471	9,474	9,474	9,474	9,474		Hold Tank load x (1-TSS reduction).
104									
105	FEED TO SLUDGE BLEND TANKS								Digested sludge and a portion of primary sludge.
106	Flow (mgd)	0.079	0.079	0.079	0.079	0.079	0.079		Digested sludge flow + (primary sludge flow x % to Blend Tanks).
107	Concentrations (mg/L)								
108	TSS	20,254	21,027	21,033	21,033	21,033	21,033		
109	Loads (lb/d)								
110	TSS	13,386	13,897	13,901	13,901	13,901	13,901		Digester sludge load + (primary sludge load x % to Blend Tanks).

	A	B	C	D	E	F	G	H	I
6		ITERATIONS							
7		1	2	3	4	5	6	7	Notes
111									
112	FEED TO DEWATERING								Centrifuge is mainly used, due to age and condition of BFPs.
113	Flow (mgd)	0.079	0.079	0.079	0.079	0.079	0.079		Used flow to Blend Tanks.
114	Concentrations (mg/L)								
115	TSS	20,254	21,027	21,033	21,033	21,033	21,033		
116	Loads (lb/d)								
117	TSS	13,386	13,897	13,901	13,901	13,901	13,901		Used load to Blend Tanks.
118									
119	CAKE FROM DEWATERING								
120	Capture (%)	86.51	86.51	86.51	86.51	86.51	86.51		Ops data from Sept 30, 2002 - Sept 30, 2005.
121	Flow (mgd)	0.006	0.006	0.006	0.006	0.006	0.006		Calculated. No correction for specific gravity of cake.
122	Concentrations (mg/L)								
123	TSS	247,847	247,847	247,847	247,847	247,847	247,847		Ops data from Sept 30, 2002 - Sept 30, 2005.
124	Loads (lb/d)								
125	TSS	11,580	12,023	12,026	12,026	12,026	12,026		Calculated.
126									
127	CENTRATE								
128	Flow (mgd)	0.074	0.073	0.073	0.073	0.073	0.073		Flow to dewatering - cake.
129	Concentrations (mg/L)								
130	TSS	1,200	1,200	1,200	1,200	1,200	1,200		Assumed value.
131	Loads (lb/d)								
132	TSS	737	735	735	735	735	735		Flow to dewatering - cake.
133									
134	ODOR CONTROL BLOWDOWN								
135	Flow (mgd)	0.65	0.65	0.65	0.65	0.65	0.65		From US Filter Draft Report - Nutrient and Cation Study, dated 10/13/03.
136	Concentrations (mg/L)								
137	CBOD	10	10	10	10	10	10		Assumed.
138	TSS	10	10	10	10	10	10		Assumed.
139	Loads (lb/d)								
140	CBOD	54	54	54	54	54	54		Calculated.
141	TSS	54	54	54	54	54	54		Calculated.

	A	B	C	D	E	F	G	H	I
1	City of Schenectady WPCP								37797-47751
2	Mass Balance								
3	Scenario 2 - Future Scenario with Primary Sludge Gravity Thickener								
4	Average Day								
5									
6		ITERATIONS							
7		1	2	3	4	5	6	7	Notes
8	RAW INFLUENT								
9	Flow (mgd)	14.83	14.83	14.83	14.83	14.83	14.83		Ops data from Sept 30, 2002 - Sept 30, 2005.
10	Concentrations (mg/L)								
11	CBOD	113	113	113	113	113	113		Ops data from Sept 30, 2002 - Sept 30, 2005.
12	TSS	132	132	132	132	132	132		Ops data from Sept 30, 2002 - Sept 30, 2005.
13	CBOD/BOD	0.80	0.80	0.80	0.80	0.80	0.80		Ops data from Sept 30, 2002 - Sept 30, 2005.
14	Loads (lb/d)								
15	CBOD	14,015	14,015	14,015	14,015	14,015	14,015		Calculated.
16	TSS	16,385	16,385	16,385	16,385	16,385	16,385		Calculated.
17									
18	COMBINED SIDESTREAMS								Gravity thickener overflow + DAFT overflow + Centrate + Odor control blowdown.
19	Flow (mgd)		0.958	0.957	0.957	0.957	0.957		
20	Concentrations (mg/L)								
21	CBOD		7	7	7	7	7		Calculated.
22	TSS		57	58	58	58	58		Calculated.
23	Loads (lb/d)								
24	CBOD		54	54	54	54	54		DAFT overflow + Centrate + Odor control blowdown.
25	TSS		458	462	462	462	462		Gravity thickener overflow + DAFT overflow + Centrate + Odor control blowdown.
26									
27	PRIMARY EFFLUENT								
28	Removals (%)								
29	CBOD	29	29	29	29	29	29		Ops data from Sept 30, 2002 - Sept 30, 2005; used BOD, since CBOD not measured here.
30	TSS	44	44	44	44	44	44		Ops data from Sept 30, 2002 - Sept 30, 2005.
31	Flow (mgd)	14.77	14.77	14.77	14.77	14.77	14.77		Influent - Primary sludge.
32	Concentrations (mg/L)								
33	CBOD	81	81	81	81	81	81		Calculated.
34	TSS	75	75	75	75	75	75		Calculated.
35	Loads (lb/d)								
36	CBOD	9,968	9,968	9,968	9,968	9,968	9,968		Calculated.
37	TSS	9,237	9,237	9,237	9,237	9,237	9,237		Calculated.
38									

	A	B	C	D	E	F	G	H	I
6		ITERATIONS							
7		1	2	3	4	5	6	7	Notes
39	PRIMARY SLUDGE								
40	Flow (mgd)	0.063	0.063	0.063	0.063	0.063	0.063		Ops data from Sept 30, 2002 - Sept 30, 2005 (avg V246 + V247).
41	Concentrations (mg/L)								
42	CBOD	7,759	7,759	7,759	7,759	7,759	7,759		Calculated.
43	TSS	13,702	13,702	13,702	13,702	13,702	13,702		Calculated.
44	Loads (lb/d)								
45	CBOD	4,047	4,047	4,047	4,047	4,047	4,047		Raw influent - primary effluent load.
46	TSS	7,148	7,148	7,148	7,148	7,148	7,148		Raw influent - primary effluent load.
47									
48	THICKENED PRIMARY SLUDGE (TPS)								
49	Capture (%)	99	99	99	99	99	99		Assumed for new gravity thickener.
50	Flow (mgd)	0.012	0.012	0.012	0.012	0.012	0.012		Calculated based on assumed new gravity thickener will produce 7% solids.
51	Concentrations (mg/L)								
52	CBOD	7,759	7,759	7,759	7,759	7,759	7,759		Assumed no change from primary sludge.
53	TSS	70,000	70,000	70,000	70,000	70,000	70,000		Assumed value.
54	Loads (lb/d)								
55	CBOD	8	8	8	8	8	8		TPS load x capture.
56	TSS	7,076	7,076	7,076	7,076	7,076	7,076		TPS load x capture.
57									
58	GRAVITY THICKENER OVERFLOW								
59	Flow (mgd)	0.050	0.050	0.050	0.050	0.050	0.050		Primary sludge - thickened primary sludge flow.
60	Concentrations (mg/L)								
61	TSS	170	170	170	170	170	170		Calculated.
62	Loads (lb/d)								
63	TSS	71	71	71	71	71	71		Primary sludge - thickened primary sludge load.
64									
65	SECONDARY EFFLUENT								
66	Flow (mgd)	14.46	15.42	15.42	15.42	15.42	15.42		Primary effluent + sidestreams - WAS.
67	Concentrations (mg/L)								
68	CBOD	7	7	7	7	7	7		Ops data from Sept 30, 2002 - Sept 30, 2005.
69	TSS	16	16	16	16	16	16		Ops data from Sept 30, 2002 - Sept 30, 2005.
70	Loads (lb/d)								
71	CBOD	832	887	887	887	887	887		Calculated.
72	TSS	1,920	2,047	2,047	2,047	2,047	2,047		Calculated.
73									
74	SECONDARY SOLIDS PRODUCED								
75	Net yield (lb TSS/lb CBOD applied)	1.43	1.43	1.43	1.43	1.43	1.43		Took actual of 1.79 lb TSS/lb BOD and mult by 0.8 to convert to CBOD based yield.
76	Volatile fraction	0.83	0.83	0.83	0.83	0.83	0.83		Ops data from Sept 30, 2002 - Sept 30, 2005.
77	Flow (mgd)	14.46	15.42	15.42	15.42	15.42	15.42		Primary effluent + sidestreams - WAS.
78	Concentrations (mg/L)								
79	CBOD								
80	TSS								
81	Loads (lb/d)								
82	CBOD								
83	TSS	14,254	14,790	14,793	14,793	14,793	14,793		(Primary effluent + sidestream CBOD load) x Net yield + sidestreams TSS load.
84									

	A	B	C	D	E	F	G	H	I
6		ITERATIONS							
7		1	2	3	4	5	6	7	Notes
85	WASTE ACTIVATED SLUDGE								
86	Flow (mgd)	0.31	0.31	0.31	0.31	0.31	0.31		Ops data from Sept 30, 2002 - Sept 30, 2005 (used avg).
87	Concentrations (mg/L)								
88	TSS	4,799	4,958	4,959	4,959	4,959	4,959		Calculated.
89	Loads (lb/d)								
90	TSS	12,334	12,743	12,746	12,746	12,746	12,746		Secondary solids produced - secondary effluent load.
91									
92	THICKENED WASTE ACTIVATED SLUDGE								
93	Capture (%)	99	99	99	99	99	99		Assumed, no DAFT overflow TSS data to determine capture.
94	Flow (mgd)	0.038	0.038	0.038	0.038	0.038	0.038		Ops data from Sept 30, 2002 - Sept 30, 2005 (used avg).
95	Concentrations (mg/L)								
96	TSS	38,530	39,807	39,817	39,817	39,817	39,817		Calculated.
97	Loads (lb/d)								
98	TSS	12,211	12,616	12,619	12,619	12,619	12,619		WAS load x capture.
99									
100	DAFT OVERFLOW								
101	Flow (mgd)	0.270	0.270	0.270	0.270	0.270	0.270		WAS - TWAS flow.
102	Concentrations (mg/L)								
103	TSS	55	57	57	57	57	57		Calculated.
104	Loads (lb/d)								
105	TSS	123	127	127	127	127	127		WAS - TWAS load.
106									
107	FEED TO SLUDGE HOLD TANKS TO ANAEROBIC DIGESTERS								TWAS and portion of primary sludge.
108	Flow (mgd)	0.050	0.050	0.050	0.050	0.050	0.050		Thickened primary sludge flow + TWAS flow from calculation above.
109	Concentrations (mg/L)								
110	TSS	46,028	46,994	47,002	47,002	47,002	47,002		Calculated.
111	Loads (lb/d)								
112	TSS	19,287	19,692	19,695	19,695	19,695	19,695		TPS + TWAS load (assumes all primary sludge goes to Holding Tank, none to Blend Tank).
113									
114	ANAEROBICALLY DIGESTED SLUDGE								
115	VSS Destruction (%)	45.00	45.00	45.00	45.00	45.00	45.00		Assumed value after new digester mixing and heat exchanger sludge pumps are installed.
116	TSS Reduction	0.40	0.40	0.40	0.40	0.40	0.40		Assumed value after new digester mixing and heat exchanger sludge pumps are installed.
117	Concentrations (mg/L)								
118	TSS	46,028	46,994	47,002	47,002	47,002	47,002		Used values from digester feed.
119	Loads (lb/d)								
120	TSS	11,572	11,815	11,817	11,817	11,817	11,817		Hold Tank load x (1-TSS reduction).
121									

	A	B	C	D	E	F	G	H	I
6		ITERATIONS							
7		1	2	3	4	5	6	7	Notes
122	FEED TO SLUDGE BLEND TANKS								Digested sludge only; assumes no primary sludge directly.
123	Flow (mgd)	0.030	0.030	0.030	0.030	0.030	0.030		Digested sludge flow.
124	Concentrations (mg/L)								
125	TSS	46,028	46,994	47,002	47,002	47,002	47,002		
126	Loads (lb/d)								
127	TSS	11,572	11,815	11,817	11,817	11,817	11,817		Digested sludge load (calculated).
128									
129	FEED TO DEWATERING								Centrifuge is mainly used, due to age and condition of BFPs.
130	Flow (mgd)	0.030	0.030	0.030	0.030	0.030	0.030		Used flow to Blend Tanks.
131	Concentrations (mg/L)								
132	TSS	46,028	46,994	47,002	47,002	47,002	47,002		
133	Loads (lb/d)								
134	TSS	11,572	11,815	11,817	11,817	11,817	11,817		Used load to Blend Tanks.
135									
136	CAKE FROM DEWATERING								
137	Capture (%)	90.00	90.00	90.00	90.00	90.00	90.00		Assumed value.
138	Flow (mgd)	0.005	0.005	0.005	0.005	0.005	0.005		Calculated. No correction for specific gravity of cake.
139	Concentrations (mg/L)								
140	TSS	247,847	247,847	247,847	247,847	247,847	247,847		Ops data from Sept 30, 2002 - Sept 30, 2005.
141	Loads (lb/d)								
142	TSS	10,415	10,634	10,635	10,635	10,635	10,635		Calculated.
143									
144	CENTRATE								
145	Flow (mgd)	0.025	0.025	0.025	0.025	0.025	0.025		Flow to dewatering - cake.
146	Concentrations (mg/L)								
147	TSS	1,000	1,000	1,000	1,000	1,000	1,000		Assumed value.
148	Loads (lb/d)								
149	TSS	209	209	209	209	209	209		Flow to dewatering - cake.
150									
151	ODOR CONTROL BLOWDOWN								
152	Flow (mgd)	0.65	0.65	0.65	0.65	0.65	0.65		From US Filter Draft Report - Nutrient and Cation Study, dated 10/13/03.
153	Concentrations (mg/L)								
154	CBOD	10	10	10	10	10	10		Assumed.
155	TSS	10	10	10	10	10	10		Assumed.
156	Loads (lb/d)								
157	CBOD	54	54	54	54	54	54		Calculated.
158	TSS	54	54	54	54	54	54		Calculated.

	A	B	C	D	E	F	G	H	I
1	City of Schenectady WPCP								37797-47751
2	Mass Balance								
3	Scenario 3 - Future Scenario with Gravity Thickening of Primary Sludge and WAS by converting sludge holding tank (former digester)								
4	Average Day								
5									
6		ITERATIONS							
7		1	2	3	4	5	6	7	Notes
8	RAW INFLUENT								
9	Flow (mgd)	14.83	14.83	14.83	14.83	14.83	14.83		Ops data from Sept 30, 2002 - Sept 30, 2005.
10	Concentrations (mg/L)								
11	CBOD	113	113	113	113	113	113		Ops data from Sept 30, 2002 - Sept 30, 2005.
12	TSS	132	132	132	132	132	132		Ops data from Sept 30, 2002 - Sept 30, 2005.
13	CBOD/BOD	0.80	0.80	0.80	0.80	0.80	0.80		Ops data from Sept 30, 2002 - Sept 30, 2005.
14	Loads (lb/d)								
15	CBOD	14,015	14,015	14,015	14,015	14,015	14,015		Calculated.
16	TSS	16,385	16,385	16,385	16,385	16,385	16,385		Calculated.
17									
18	COMBINED SIDESTREAMS								Gravity thickener overflow + Centrate + Odor control blowdown.
19	Flow (mgd)		0.934	0.934	0.934	0.934	0.934		
20	Concentrations (mg/L)								
21	CBOD		7	7	7	7	7		Calculated.
22	TSS		57	58	58	58	58		Calculated.
23	Loads (lb/d)								
24	CBOD		54	54	54	54	54		Gravity thickener overflow + Centrate + Odor control blowdown.
25	TSS		441	449	449	449	449		Gravity thickener overflow + Centrate + Odor control blowdown.
26									
27	PRIMARY EFFLUENT								
28	Removals (%)								
29	CBOD	29	29	29	29	29	29		Ops data from Sept 30, 2002 - Sept 30, 2005; used BOD, since CBOD not measured here.
30	TSS	44	44	44	44	44	44		Ops data from Sept 30, 2002 - Sept 30, 2005.
31	Flow (mgd)	14.77	14.77	14.77	14.77	14.77	14.77		Influent - Primary sludge.
32	Concentrations (mg/L)								
33	CBOD	81	81	81	81	81	81		Calculated.
34	TSS	75	75	75	75	75	75		Calculated.
35	Loads (lb/d)								
36	CBOD	9,968	9,968	9,968	9,968	9,968	9,968		Calculated.
37	TSS	9,237	9,237	9,237	9,237	9,237	9,237		Calculated.
38									

	A	B	C	D	E	F	G	H	I
6		ITERATIONS							
7		1	2	3	4	5	6	7	Notes
39	PRIMARY SLUDGE								
40	Flow (mgd)	0.063	0.063	0.063	0.063	0.063	0.063		Ops data from Sept 30, 2002 - Sept 30, 2005 (avg V246 + V247).
41	Concentrations (mg/L)								
42	CBOD	7,759	7,759	7,759	7,759	7,759	7,759		Calculated.
43	TSS	13,702	13,702	13,702	13,702	13,702	13,702		Calculated.
44	Loads (lb/d)								
45	CBOD	4,047	4,047	4,047	4,047	4,047	4,047		Raw influent - primary effluent load.
46	TSS	7,148	7,148	7,148	7,148	7,148	7,148		Raw influent - primary effluent load.
47									
48	SECONDARY EFFLUENT								
49	Flow (mgd)	14.46	15.40	15.40	15.40	15.40	15.40		Primary effluent + sidestreams - WAS.
50	Concentrations (mg/L)								
51	CBOD	7	7	7	7	7	7		Ops data from Sept 30, 2002 - Sept 30, 2005.
52	TSS	16	16	16	16	16	16		Ops data from Sept 30, 2002 - Sept 30, 2005.
53	Loads (lb/d)								
54	CBOD	832	885	885	885	885	885		Calculated.
55	TSS	1,920	2,044	2,044	2,044	2,044	2,044		Calculated.
56									
57	SECONDARY SOLIDS PRODUCED								
58	Net yield (lb TSS/lb CBOD applied)	1.43	1.43	1.43	1.43	1.43	1.43		Took actual of 1.79 lb TSS/lb BOD and mult by 0.8 to convert to CBOD based yield.
59	Volatile fraction	0.83	0.83	0.83	0.83	0.83	0.83		Ops data from Sept 30, 2002 - Sept 30, 2005.
60	Flow (mgd)	14.46	15.40	15.40	15.40	15.40	15.40		Primary effluent + sidestreams - WAS.
61	Concentrations (mg/L)								
62	CBOD								
63	TSS								
64	Loads (lb/d)								
65	CBOD								
66	TSS	14,254	14,772	14,780	14,780	14,780	14,780		(Primary effluent + sidestream CBOD load) x Net yield + sidestreams TSS load.
67									

	A	B	C	D	E	F	G	H	I
6		ITERATIONS							
7		1	2	3	4	5	6	7	Notes
68	WASTE ACTIVATED SLUDGE (WAS)								
69	Flow (mgd)	0.31	0.31	0.31	0.31	0.31	0.31		Ops data from Sept 30, 2002 - Sept 30, 2005 (used avg).
70	Concentrations (mg/L)								
71	TSS	4,799	4,952	4,955	4,955	4,955	4,955		Calculated.
72	Loads (lb/d)								
73	TSS	12,334	12,728	12,736	12,736	12,736	12,736		Secondary solids produced - secondary effluent load.
74									
75	THICKENED PRIMARY SLUDGE & WAS								Assumes converting existing sludge holding tank (former digester) into a gravity thickener.
76	Capture (%)	99	99	99	99	99	99		Assumed.
77	Flow (mgd)	0.047	0.048	0.048	0.048	0.048	0.048		Calculated based on assumed gravity thickener will produce 5% solids.
78	Concentrations (mg/L)								
79	TSS	49,500	49,500	49,500	49,500	49,500	49,500		Calculated.
80	Loads (lb/d)								
81	TSS	19,287	19,678	19,685	19,685	19,685	19,685		(Primary sludge load + WAS load) x capture.
82									
83	GRAVITY THICKENER OVERFLOW								
84	Flow (mgd)	0.261	0.261	0.261	0.261	0.261	0.261		(PRIMARY SLUDGE + WAS) - (THICKENED PRIMARY SLUDGE + TWAS) flow.
85	Concentrations (mg/L)								
86	TSS	89	91	92	92	92	92		Calculated.
87	Loads (lb/d)								
88	TSS	195	199	199	199	199	199		(PRIMARY SLUDGE + WAS) - (THICKENED PRIMARY SLUDGE + TWAS) load.
89									
90	ANAEROBICALLY DIGESTED SLUDGE								
91	VSS Destruction (%)	45.00	45.00	45.00	45.00	45.00	45.00		Assumed value after new digester mixing and heat exchanger sludge pumps are installed.
92	TSS Reduction	0.40	0.40	0.40	0.40	0.40	0.40		Assumed value after new digester mixing and heat exchanger sludge pumps are installed.
93	Concentrations (mg/L)								
94	TSS	49,500	49,500	49,500	49,500	49,500	49,500		Used values from digester feed.
95	Loads (lb/d)								
96	TSS	11,572	11,807	11,811	11,811	11,811	11,811		Hold Tank load x (1-TSS reduction).
97									

	A	B	C	D	E	F	G	H	I
6		ITERATIONS							
7		1	2	3	4	5	6	7	Notes
98	FEED TO SLUDGE BLEND TANKS								Digested sludge only; assumes no primary sludge directly.
99	Flow (mgd)	0.028	0.029	0.029	0.029	0.029	0.029		Digested sludge flow.
100	Concentrations (mg/L)								
101	TSS	49,500	49,500	49,500	49,500	49,500	49,500		
102	Loads (lb/d)								
103	TSS	11,572	11,807	11,811	11,811	11,811	11,811		Digested sludge load (calculated).
104									
105	FEED TO DEWATERING								Centrifuge is mainly used, due to age and condition of BFPs.
106	Flow (mgd)	0.028	0.029	0.029	0.029	0.029	0.029		Used flow to Blend Tanks.
107	Concentrations (mg/L)								
108	TSS	49,500	49,500	49,500	49,500	49,500	49,500		
109	Loads (lb/d)								
110	TSS	11,572	11,807	11,811	11,811	11,811	11,811		Used load to Blend Tanks.
111									
112	CAKE FROM DEWATERING								
113	Capture (%)	90.00	90.00	90.00	90.00	90.00	90.00		Assumed value.
114	Flow (mgd)	0.005	0.005	0.005	0.005	0.005	0.005		Calculated. No correction for specific gravity of cake.
115	Concentrations (mg/L)								
116	TSS	247,847	247,847	247,847	247,847	247,847	247,847		Ops data from Sept 30, 2002 - Sept 30, 2005.
117	Loads (lb/d)								
118	TSS	10,415	10,626	10,630	10,630	10,630	10,630		Calculated.
119									
120	CENTRATE								
121	Flow (mgd)	0.023	0.023	0.023	0.023	0.023	0.023		Flow to dewatering - cake.
122	Concentrations (mg/L)								
123	TSS	1,000	1,000	1,000	1,000	1,000	1,000		Assumed value.
124	Loads (lb/d)								
125	TSS	192	196	196	196	196	196		Flow to dewatering - cake.
126									
127	ODOR CONTROL BLOWDOWN								
128	Flow (mgd)	0.65	0.65	0.65	0.65	0.65	0.65		From US Filter Draft Report - Nutrient and Cation Study, dated 10/13/03.
129	Concentrations (mg/L)								
130	CBOD	10	10	10	10	10	10		Assumed.
131	TSS	10	10	10	10	10	10		Assumed.
132	Loads (lb/d)								
133	CBOD	54	54	54	54	54	54		Calculated.
134	TSS	54	54	54	54	54	54		Calculated.

	A	B	C	D	E
1	**CDM**		Calc By:	Vincent Apa	
2	Client:	City of Schenectady	Date:	2/28/08	
3	Project:	47751	Checked By:	VLA	
4	Facility:	WWTP Evaluation	Date:	2/28/08	
5	Detail:	Gravity Thickening of 1º Sludge (Avg Day)	Revision#	2	
6					
7					
8	Assumptions		Notes		
9					
10	1º sludge flow (mgd)	0.063	Data from Sept. 30, 2002 - Sept. 30, 2005		
11	1º sludge concentration (mg/L)	13,702	Assumed from mass balances and data.		
12	1º sludge load (lb/d)	7,148			
13	WAS flow (mgd)	0.00	Assumed no WAS flow.		
14	WAS concentration (mg/L)	0			
15	WAS load (lb/d)	0			
16	Total sludge to gravity thickener (lb/d)	7,148			
17					
18	Hydraulic overflow rate	127	Reference from M&E WW Eng., 4th Edition (range is 380 to 760 gpd/sf).		
19	Number of gravity thickeners	1			
20	Diameter of gravity thickener (ft)	25			
21	Surface area of gravity thickener (sf)	491			
22	Sludge loading to gravity thickener (lb/d/sf)	14.6	Just below recommended ranges of 20-30 lb/d/sf.		
23	Predicted concentration of thickened solids (%)	7	Reference from M&E WW Eng., 4th Edition (range is 5-10%).		
24	Flow of thickened sludge (gpd)	12,244			
25					
26	**NOTES**				
27	1. Calculations evaluate the use of the new gravity thickener.				
28	2. Hydraulic overflow rate is lower than recommended and pumping rate may need to be increased to prevent septic conditions from occurring.				
29					
30					
31					

	A	B	C	D	E
1	**CDM**		Calc By:	Vincent Apa	
2	Client:	City of Schenectady	Date:	12/30/06	
3	Project:	47751	Checked By:	VLA	
4	Facility:	WWTP Evaluation	Date:	2/28/08	
5	Detail:	Gravity Thickening of 1º Sludge & WAS (Avg Day)	Revision#	2	
6					
7					
8	Assumptions		Notes		
9					
10	1º sludge flow (mgd)	0.063	Data from Sept. 30, 2002 to Sept. 30, 2005.		
11	1º sludge concentration (mg/L)	13,702	Assumed from mass balances and data.		
12	1º sludge load (lb/d)	7,148	Average day condition.		
13	WAS flow (mgd)	0.31	Data from WWTP Draft Report Jan 2006.		
14	WAS concentration (mg/L)	4,979	Calculated from mass balances and data.		
15	WAS load (lb/d)	12,873	Average day condition.		
16	Total sludge to gravity thickener (lb/d)	20,021			
17					
18	Hydraulic overflow rate	123	Reference from M&E WW Eng., 4th Edition (range is 150 to 300 gpd/sf).		
19	Surface area of gravity thickener (sf)	3,018	Based on 62' diameter of existing digester (holding tank).		
20	Sludge loading to gravity thickener (lb/d/sf)	6.6	Within recommended ranges of 5-14 lb/d/sf.		
21	Predicted concentration of thickened solids (%)	5	Reference from M&E WW Eng., 4th Edition (range is 4-6%).		
22	Flow of thickened sludge (gpd)	48,011			
23					
24	**NOTES**				
25	1. Calculations evaluate converting the existing holding tank (former anaerobic digester) to a gravity thickener.				
26	2. Recommended solids loading range is based on unthickened solids concentration of 0.5-1.5%.				
27					
28					
29					