Delaware County Tartan Fields
WWTP Evaluation Report
FINAL REPORT

Stantec

Prepared for:
Delaware County

Prepared by:
Stantec Consulting Services Inc.

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Sign-off Sheet

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Prepared by ______________________________

(signature)

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 BACKGROUND

1.1 EXISTING CONDITIONS

The Delaware County Tartan Fields Wastewater Treatment Plant (WWTP) is an extended aeration wastewater treatment plant with an Ohio EPA rated capacity of 0.25 million gallons per day (MGD). Process tanks are in a pole barn style building and constructed of pre-cast concrete components. The Tartan Fields WWTP is part of a wastewater irrigation system to the adjacent Tartan Fields Golf Course. The system was placed into operation in 1999 and has been in continuous operation since. Treatment systems at the Tartan Fields WWTP include screening, three aeration tanks, two final clarifiers, a tertiary filtration system featuring disc filters, liquid disinfection, pumping, and sludge wasting, pumping, and holding. Final effluent is then directed to a storage impoundment for land irrigation on the adjacent golf course. Waste sludge is continually aerated, held, and trucked to the Olentangy Environmental Control Center (OECC) for further processing.

The Basis of Design, provided in the Permit to Install (PTI) issued by the Ohio EPA on May 2, 1997 was 615 single family homes, 1 golf course clubhouse with a population of 200, and one school with a population of 650. The Design flow was established at 0.25 MGD.

Currently the system operates at 57% of its "rated capacity," based on the original design capacity of 0.25 MGD. The existing waste strength composition at 140 mg/l is lower than the original design basis for $CBOD_5$ at 200 mg/l. The Ohio EPA modified the NPDES permit in the last few years to include an effluent limit for Total Inorganic Nitrogen effluent limit of 10 mg/l. To meet the DIN limit, Delaware County installed an anoxic mixing zone in the Center Tank. The anoxic zone has helped the County meet the Total Inorganic Nitrogen limit and alleviate a filamentous bacteria problem due to *Microthrix parvicella*. Operations staff have adopted a strategy to maintain the Mean Cell Retention Time (MCRT) long enough to have nitrification and meet the limit for Total Nitrogen, through the MLE (Modified Ludzak Ettinger) process but not so long as to encourage the growth of *Microthrix parvicella*.

The Tartan Fields WWTP experiences infiltration and inflow (I/I) from the sanitary sewer system during wet weather periods, particularly when ground soil moisture conditions are elevated. For the year 2015, the Tartan Fields WWTP received an average annual flow of 0.142 MGD with a low of 0.114 MGD in February 2015 and a high of 0.171 MGD in June 2015. It should be noted that the average flows for June 19-21, 2015 were all recorded as 0.264 MGD. This flow causes the walls of the aeration tank to overflow the top of wall elevation at 1008.2 feet MSL. This condition coincides with a condition when two raw sewage pumps and one (1) return activated sludge (RAS) pump are running. To combat this, operations personnel divert excess flow into Aeration Tank 1 (south tank) and if needed, one empty final clarifier. Delaware County identified the inability to run flow through the plant as a major performance limiting factor, limiting the plant's ability to service additional customers.

2.0 OBJECTIVES

In 2014, Stantec performed a high-level process evaluation of the Tartan Fields WWTP in response to discussions with the County and a developer's request for additional connections tributary to the system. A summary report with recommendations was prepared in February 2014.

The objective of this study is to prepare a deliverable to document the hydraulic limitations at the plant. The County wishes to identify both immediate and long term improvements.

2.1 SCOPE OF INVESTIGATION

The purpose of this investigation is to use the 2014 report as a basis for further investigations to improve the Tartan Fields WWTP to receive additional flows. This investigation included the following:

- Preparation of a detailed hydraulic profile of the existing WWTP based on actual measurements, observed conditions and interviews with operations personnel. The purpose of this analysis will be to determine baseline existing hydraulic capacity.
- Using the findings of this hydraulic analysis to identify and prioritize the impact of points of significant hydraulic restrictions (e.g. bottlenecks) under normal and wet weather flow conditions. Based on the 2014 investigation, Stantec was aware that the outlet pipes from the aeration tanks impose a hydraulic restriction due to their overall configuration, and that transfer pipes between tanks also impose hydraulic restrictions.
- Evaluate how to best use the currently empty Aeration Tank 1. Of paramount concern is to address the key problems but maintain operational flexibility pertaining to how flows are routed though the tanks.
- One of Stantec's discussion points in 2014 was to lower the weirs and thus improve the hydraulic grade line through the wet stream. Based on the installation of the filter system and discussions with the County initial emphasis should be on the aeration tanks.
- Preparation of a summary and recommendations report.

This photograph provided above illustrates the impact of normal typical daily morning flows on the Aeration Tanks 2 and 3. This photo shows less than six (6) inches of freeboard currently available. Normal design practice allows for at least 18-24 inches of freeboard under all peak flow conditions.

3.0 HYDRAULIC ANALYSIS

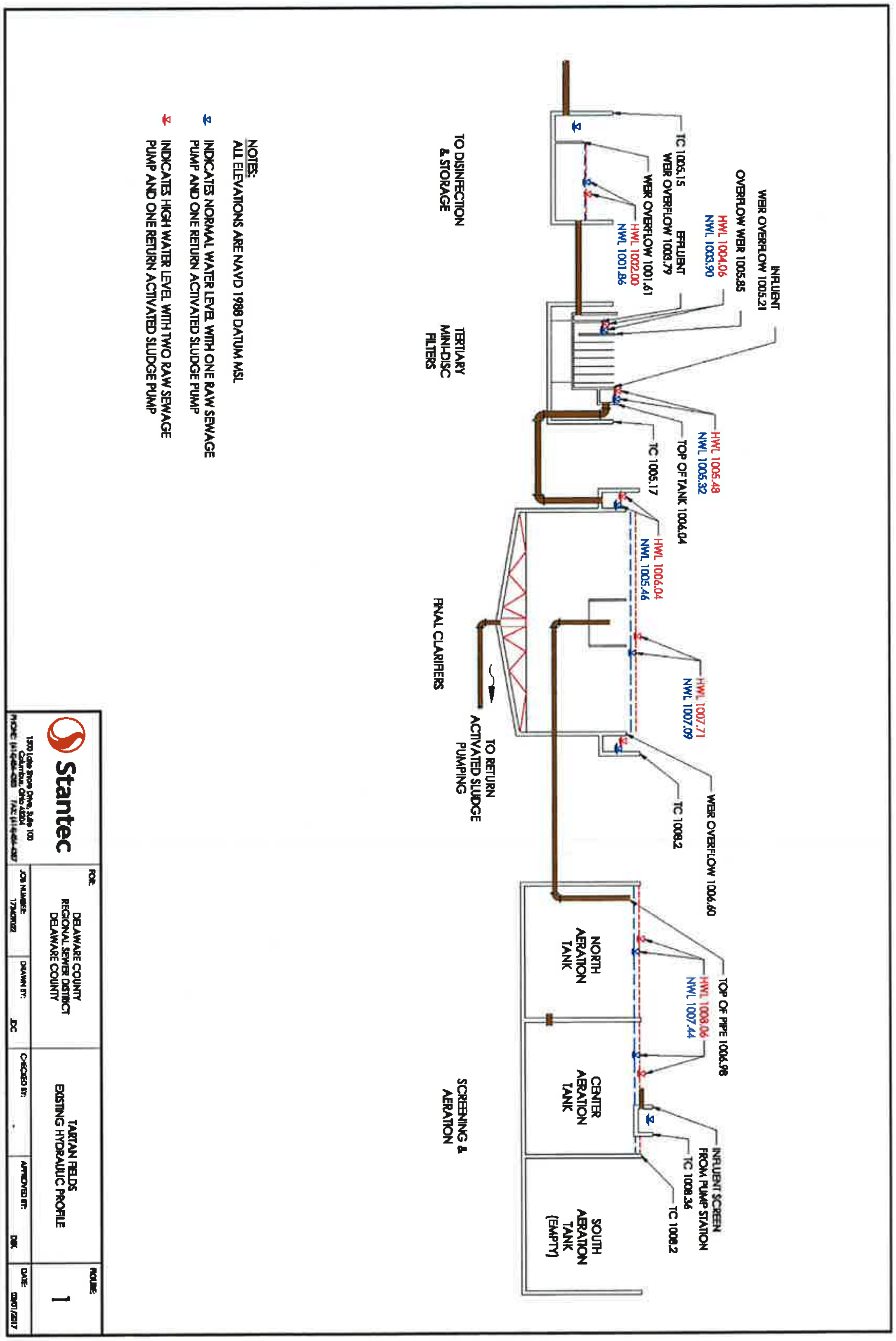
3.1 DESIGN FLOWS

Unlike most other manufactured style wastewater treatment plants similar in size, Tartan Fields WWTP does not include flow equalization or leveling prior to the biological process. The design hydraulic peaking factors in the design was reported to be 3.5 consistent using the approach prescribed in *Ten States Standards*. In addition, the mixed liquor (MLSS) conduit between the aeration tanks and final clarifiers must can carry a flow of 0.875 MGD + 0.25 MGD x 1.5 = 1.25 MGD without experiencing problems. Given that no flow equalization exists at the Tartan Fields WWTP all systems must handle the peak flow of 0.875 MGD forward flow. The aeration tank and final clarifiers must be able to handle additional RAS flow, which is an additional 0.375 MGD for a total flow of 1.25 MGD. A point of comparison is that plants with flow equalization are usually designed to handle a process peaking factor of 2.0, which for the Tartan Fields WWTP would be 0.50 MGD.

Design Flow:	250,000 GPD
Peaking Factor:	2,500 population equivalent or 2.5 Thousand people *Ten States Standards* formula for PF PF = (18 + P^0.5)/(4 + P^0.5) PF = (18 + 2.5^0.5)/(4 + 2.5 ^0.5) = 3.5
Peak Flow:	3.5 x 250,000 GPD = 875,000 GPD (600 GPM)
Raw Sewage Pumps:	3 Pumps with 2 Duty and 1 Standby Each pump is 300 GPM (0.668 CFS) Each pump is operated at Constant Speed and Level Control
RAS Flow:	1.5 x 250,000 GPD = 375,000 GPD (260 GPM) 2 Pumps with 1 Duty and 1 Standby Each pump is 260 GPM (0.579 CFS) RAS pumps are operated at Constant Speed and Level Control

3.2 HYDRAULIC ANALYSIS FINDINGS

The hydraulic gradeline is presented in Figure 1



INFLUENT WEIR OVERFLOW 1005.21
OVERFLOW WEIR 1005.85
HWL 1004.06
NWL 1003.90
EFFLUENT WEIR OVERFLOW 1003.79
TC 1005.15
WEIR OVERFLOW 1001.61
HWL 1002.00
NWL 1001.86
TO DISINFECTION & STORAGE
TERTIARY MINI-DISC FILTERS
HWL 1005.48
NWL 1005.32
TOP OF TANK 1006.04
TC 1005.17
HWL 1006.04
NWL 1005.46
FINAL CLARIFIERS
HWL 1007.71
NWL 1007.09
TO RETURN ACTIVATED SLUDGE PUMPING
WEIR OVERFLOW 1006.60
TC 1008.2
TOP OF PIPE 1006.98
HWL 1008.06
NWL 1007.44
NORTH AERATION TANK
CENTER AERATION TANK
SOUTH AERATION TANK (EMPTY)
SCREENING & AERATION
INFLUENT SCREEN FROM PUMP STATION
TC 1008.36
TC 1008.2
NOTES:
ALL ELEVATIONS ARE NAVD 1988 DATUM MSL.
INDICATES NORMAL WATER LEVEL WITH ONE RAW SEWAGE PUMP AND ONE RETURN ACTIVATED SLUDGE PUMP
INDICATES HIGH WATER LEVEL WITH TWO RAW SEWAGE PUMP AND ONE RETURN ACTIVATED SLUDGE PUMP
Stantec
FOR:
DELAWARE COUNTY REGIONAL SEWER DISTRICT DELAWARE COUNTY
TARTAN FIELDS EXISTING HYDRAULIC PROFILE
FIGURE: 1

Table 1
Tartan Fields WWTP HGL Aeration Tanks To Final Clarifiers-Current Situation

Final Clarifier Weir	Segment	Elevation	Final Elevation	AT Wall	Over AT Wall?	Freeboard
	1 Pump Running with no RAS (Normal Operations)					
1006.6						
	MLSS Conduit FC*	0.132				
	Main MLSS Conduit	0.147				
	AT Outlet	0.390				
	Total	**0.669**	**1007.269**	1008.2	No	0.931
	1 Pump Running + RAS (Normal Operations)					
Final Clarifier Weir	**Segment**	**Elevation**	**Final Elevation**			
1006.6						
	MLSS Conduit FC*	0.544				
	Main MLSS Conduit	0.572				
	AT Outlet	0.131				
	Total	**1.247**	**1007.847**	1008.2	On Verge	0.353
	2 Pump Running with no RAS (Wet Weather)					
Final Clarifier Weir	**Segment**	**Elevation**	**Final Elevation**			
1006.6						
	MLSS Conduit FC*	0.527				
	Main MLSS Conduit	0.554				
	AT Outlet	0.150				
	Total	1.231	**1007.821**	1008.2	On Verge	0.379
	2 Pump Running + RAS (Wet Weather)					
Final Clarifier Weir	**Segment**	**Elevation**	**Final Elevation**			
1006.6						
	MLSS Conduit FC*	1.212				
	Main MLSS Conduit	1.128				
	AT Outlet	0.304				
	Total	**2.644**	**1009.244**	1008.2	Yes	**-1.044**

Key findings related to flow conditions at the Tartan Fields WWTP are as follows:

1. The Raw Sewage Pump Station has three pumps. Two are duty and one is standby. Each raw sewage pump is required to deliver one half of the total flow or 0.4375 MGD (300 GPM). The pump station is not equipped with variable speed control. As the pumps cycle, flow surges delivered over a few minutes are conveyed to the screen box ahead of the aeration tanks. The standard operation during normal dry weather conditions is one Raw Sewage Pump on and one RAS pump on. It has been observed that the RAS pump cycles more frequently on/off than the raw sewage pump. This is due to the presence of scum entering the Ras Pump Station from the final clarifiers.

2. Both Raw Sewage and RAS pumping systems utilize submersible centrifugal pumps. Depending upon how these pumps operate on the system head curves, they may deliver more flow than stated capacity. The forcemain for the Raw Sewage Pump Station is short, and most of the total dynamic head (TDH) is static lift.

3. There are two RAS pumps, each rated for 150% of the design capacity or 375,000 GPD (260 GPM) "on paper." However, the actual operating "duty point of the pumps, provided by Xylem, indicate that they operate at about 310 GPM (446,400 GPM). This is 178% of the rated capacity of the Tartan Field WWTP, based on 0.25 MGD. Based on the current flow rate of 0.142 MGD the RAS return rate is 314% of forward flow. The pumps were sized based on recommendations in *Ten States Standards*. A 30 Minute settling test revealed 380 ml, which means that the sludge compresses well in a final clarifier and that RAS rates may be reduced. This would have a positive impact by reducing recycle flows.

4. Flow is currently run into the Aeration Tank 2 and transitions through a submerged six (6) inch diameter port into Aeration Tank 3. Hydraulic head losses can be modeled by the formula = K V^2/2g. Head loss can be computed as follows:

   = 0.6 x (Q/A)^2/2g
   = 0.6 ((1.25/0.349)^2/2 x 32.2
   = 0.120 feet (1.4 Inches)

   With two raw sewage pumps on, head loss through this transition will increase as follows:

   = 0.6 x (Q/A)^2/2g
   = 0.6 ((1.92/0.349)^2/2 x 32.2
   = 0.120 feet (1.4 Inches)
   = 0.282 feet (3.4 Inches)

   This limitation can be corrected, but correction efforts may require that two tanks be taken off line to create a supplemental opening between Tanks 2 (center) and 3 (north).

5. Operations personnel have noted that during periods when higher than normal flows are experienced, the hydraulic capacity of the Aeration Tanks is exceeded. During these events, excess flow is diverted into the largely empty Aeration Tank 1. This tank serves as a de-facto Flow Equalization Chamber.

6. Overtopping walls or flowing into the Aeration Tank 1 is dampened recruiting approximately 20,000 gallons of capacity on top of the tanks. This capacity decreases he already limited freeboard.

7. The plant is subject to some I/I, which requires the use of both duty pumps at the Raw Sewage Pump Station. The combined capacity of both raw sewage pumps generates flow pulses of 0.875 MGD.

8. The plant is currently operated using two cells in series: Aeration Tank 2 to Tank 3. From here, flow passes into a MLSS conduit into the final clarifiers. Only one final clarifier is in service.

9. Elevations of key control points depict a very flat profile through the entire WWTP. The one exception immediately downstream of the mini disc filter system, where there is at least 1 foot of additional drop beyond that required to move flow through the WWTP. The following are important elevations that dictate the hydraulic profile at the Tartan Fields WWTP.

   The finished floor elevation is 1004.22 feet MSL and the top of concrete for the aeration tank is 1008.20 feet MSL.

   Key hydraulic control points at the WWTP are as follows:

North Aeration Tank outlet pipe	1006.98 feet
Final Clarifier Weir	1006.60 feet
Filter Influent Weir	1005.21 feet
Filter Effluent Weir	1003.79 feet
Effluent Weir	1001.61 feet

   The elevation of the outlet pipe in the North Tank is 1006.98. At no flow, this elevation provides only 1.24 feet of freeboard between the "no flow" water surface and the top of the concrete wall.

   The top of weir elevation for the final clarifier is 1006.60 feet. The hydraulic drop between the top of pipe in the North Aeration Tank and the Final Clarifier weir is 0.38 feet (4.6 inches).

10. The filters are a mini disc system, which was placed into service in 2015. According to J. Dwight Thompson, each unit is sized at 400,000 GPD and both provide 800,000 GPD.

11. Hydraulic challenges at the Tartan Fields WWTP are due to the following:

    a. Aeration Tank 3 exhibits poor outlet control. Not only is the outlet configured as a standpipe, but the hydraulic regime behaves as an orifice with a vortex. This limits flow and promotes air entrainment. To release entrapped air, the County has added several air release pipes from the conduit to above the hydraulic grade line; however, these pipes are small.

b. The MLSS conduit from the Aeration Tank System to the Final Clarifiers exhibits high head loss at peak flows. During normal flow conditions, line velocities drop below 1 FPS, which may contribute to build up of debris in the line during low flow conditions. Flow surges during the day in conjunction with the new mechanical fine screen should help reduce this problem.

c. The hydraulic gradeline between the Aeration Tank System to the Final Clarifiers is very flat. There is only 0.38 feet of drop between the Aeration Tank, which is less than ideal. Normal design practice is to provide a non-submerged weir, with an aerated nappe of at least three (3) inches under the weir, to promote good hydraulic control and allow a minimum of three (3) inches of head build up on top of the weir.

4.0 PLANT OPERATIONS

4.1 CURRENT CONDITIONS

Table 2 is a summary of the current Final Table NPDES permit requirements for parameters of interest.

Table 2
Delaware County Tartan Fields WWTP
NPDES Permit Requirements

Month	Concentration	Notes
$CBOD_5$	40 mg/l	Monthly Value
Total Suspended Solids	45 mg/l	Monthly Value
Total Inorganic Nitrogen	10 mg/l	Monthly Value
Chlorine Residual	10	Daily Maximum
E. coli	126 Counts/100 ml	Daily Maximum

The most restrictive parameter in Table 2 is Total Inorganic Nitrogen). To achieve a value of 10 mg/l, the Tartan Fields WWTP must first nitrify, which means that it must provide a high degree of treatment. Only after the plant nitrifies, can it then de-nitrify.

Table 3 summarized the monthly average flows for the Tartan Fields WWTP for the year 2015.

Table 3
Delaware County Tartan Fields WWTP
Reported Monthly Average Flow for 2015

Month	Flow in MGD	Notes
January	0.121	
February	0.114	
March	0.134	
April	0.146	
May	0.137	
June	0.171	6/19 - 6/21 recorded 0.264 MGD each day
July	0.164	
August	0.139	
September	0.156	
October	0.128	
November	0.132	
December	0.161	
Average	**0.142**	

Delaware County monitors MLSS concentration in the aeration tanks using the spin test. Typically, solids in the aeration tank run at 2.0-2.5%. The 30-minute setting test runs at about 300-350 ml. While the correlation between spin test results and actual MLSS is not precise and can vary, it can be assumed that the MLSS is maintained at about 2,000 mg/l to 2,500 mg/l.

Table 4								
Tartan Fields WWTP Correlation of Spin Tests to MLSS Concentration for March 2017								
	Flow Rate		Spin		WAS		MLSS Aeration	MLSS Anoxic
	MGD							
Date	Measurement	Comment	Measurement	Comment	Measurement	Comment		
			Aeration/Anoxic spins					
03/01/2017	**0.196**				**11,250**			
03/02/2017	0.142		2.0/1.25		6,750			
03/03/2017	0.102		2.2/1.3		9,000			
03/06/2017	0.142		2.5/1.6		4,500			
03/07/2017	0.193				16,650			
03/08/2017	0.149				9,000			
03/09/2017	0.109		2./1.2		9,000			
03/10/2017	0.095		1.9/1.1		6,750			
03/13/2017	0.057		2.6/1.3		-			
03/14/2017	0.13				4,500			
03/15/2017	0.082				6,750			
03/16/2017	0.098		2.5/1.3		15,750			
03/17/2017	0.094		2.0/1.1		-			
03/20/2017	0.107		2.6/1.5		9,000			
03/21/2017	0.108		2.5/1.0		9,000			
03/22/2017	0.103		2.2/1.2		9,000			
03/23/2017	0.095				9,000			
03/24/2017	0.076		2.4/1.2		9,000			
03/27/2017	0.079		2.225/1.4		13,500			
03/28/2017	0.068				13,500			
03/29/2017	0.085		1.5/1.0		9,000			
03/30/2017	0.114		1.5/1.0		0			
03/31/2017	0.132				-			
4/3/2017	0.093		1.9/1.5		**6,000**		**1900MLSS**	**1300MLSS**
Min.	0.057				0			
Max.	0.196				16,650			
Avg.	0.111130435				9,045			
Count	31		23		31			

Operations personnel have noted a range of $CBOD_5$ values entering the plant from about 90 mg/l to 140 mg/l. Assuming the $CBOD_5$ entering the plant is 140 mg/l, the following Solids Retention Time (SRT) can be estimated:

$CBOD_5$ 140 mg/l
Average Flow (Q) = 0.141 MGD
MLSS = 1,900 mg/l
MLVSS = 1,435 mg/l
Reactor Volume (Total) = 0.1388 MG (two tanks)
Reactor Volume (Oxic) = 0.121 MG (two tanks with anoxic zone in Tank 2)
Food = 140 mg/l x 8.34 x 0.142 MGD = 166 Pounds

Micro-organism Inventory = 1,435 mg/l x 8.34 x 0.123 MGD* = 1,462 lbs MLVSS

F/M = 166 Pounds/1,462 Pounds = 0.113 Days $^{-1}$

k_d = endogenous decay assumed to be negligible for high SRT

*Reactor volume is computed based on oxic volume only.

Compute Solids Retention Time (SRT)

$1/SRT = F/M - k_d$

$1/SRT = 0.11 – 0 = 0.081$ Days $^{-1}$

SRT = 9 Days

Delaware County Operations personnel report that the system nitrifies and that approximately 9,000 gallons per day (GPD) of sludge wasted. The current sludge holding tank system provides approximately 47,500 gallons to provide 15 days of liquid sludge storage, based on the 1997 Permit to Install (PTI) application. At the current sludge wasting rate, the volume provides only 5 days of retention time. To provide sludge digestion and storage consistent with the original PTI application, a volume of 135,000 gallons would be needed. It should be noted that one of the existing aeration tanks provides 69,444 gallons.

Operations personnel also note that the concentration of sludge wasted is 0.6%. Decant thickening to double the concentration to 1.2% would reduce the sludge holding requirement to 67,500 gallons. One of the existing aeration tanks operated in tandem with the existing sludge digestion tank system would meet this requirement.

4.2 FUTURE CONDITIONS

Delaware County stated that the future conditions for the Tartan Fields WWTP include the following:

Future Homes: 200 homes x 290 GPD/Home =	58,000 GPD
Union County:	25,000 GPD
Total	83,000 GPD
Existing 2015	142,000 GPD
Total Future	**… …..225,000 GPD**

Based on 2015 flow conditions, this would increase the average annual flow of the Tartan Fields WWTP as calculated below.

Reactor Capacity is 0.121 MG based on two functioning aeration tanks at 69,444 Gallons each and deducting the size of the anoxic zone (computed to be 17,361 Gallons) or 69,444 Gallons x 2 – 0.25 x 69,444 Gallons – 121,000 Gallons

Food of 140 mg/l $CBOD_5$ is typically at high end of concentrations sampled at the Tartan Fields WWTP and represents a conservative basis for evaluation.

Food = 140 mg/l x 8.34 x 0.225 MGD = 263 Pounds

Micro-organism Inventory = 1,600 mg/l x 8.34 x 0.121 MG* = 1,615 lbs MLVSS

F/M = 263 Pounds/1,615 Pounds = 0.16 Days $^{-1}$

k_d = endogenous decay assumed negligible

Compute Solids Retention Time (SRT)

1/SRT = F/M - k_d

Assume k_d = 0.03 Days $^{-1}$

1/SRT = 0.16 – 0.03 = 0.15 Days $^{-1}$

SRT = 7.7 Days

This SRT is less than 9 days and not considered sufficient for sustained nitrification under colder weather temperatures.

At these flows and loading conditions, a practical maximum loading would be consistent with a flow of approximately

1/SRT = 0.16 – 0.03 = 0.13 Days $^{-1}$

F/M = 0.13 = Food/MLSS Inventory
Food/1,615 lbs

Food = 0.13 x 1,615 lbs = 210 lbs

Based on the current waste strength of 140 mg/l, then the remaining capacity in the existing Tartan Fields WWTP is computed as follows:

Future Allowable Flow = 210 lbs/ (8.34x 140 mg/l)

Existing Rated Capacity = 0.18 MGD

This capacity is based on the existing current configuration of the Tartan Fields WWTP where two reactor tanks are in operation. Under the current operational configuration, Aeration Tank 1 used for flow surge to keep Aeration Tank 1 and 2 from overflowing during peak flow conditions and performs as a de-facto flow equalization tank. Given this, Aeration Tank 1 can not be used as a process reactor tank.

For the capacity of the Tartan Fields WWTP to be increased above 0.18 MGD, additional reactor capacity is needed. This is discussed in Sections 7 and 9.

There is 38,000 GPD of capacity remaining in the current Tartan Fields WWTP remaining at this time. At 290 GPD/Home, this is equivalent to 131 homes.

5.0 CONCLUSIONS

Based on information presented in a meeting on January 30, 2017, there are several **performance-limiting factors at the existing Tartan Fields WWTP**, which prevent it from realizing its rated capacity of 0.25 MGD. The current issues at the Tartan Fields WWTP are as follows:

1. Free board on aeration tanks is insufficient to provide hydraulic driving force to move flow from the aeration tanks to the final clarifiers. Outlet hydraulics for MLSS and the MLSS conduit can be improved, but it would be ideal to increase the allowable freeboard for the aeration tanks. Good design practice would be to have more than one (1) foot of vertical drop between all treatment units.

2. Sludge digestion capacity is limited to aerated holding in one tank. From here, liquid sludge is transported to one of the WWTPs. It is important to review Tartan Fields WWTP operations from the context of the overarching solids wasting strategy to de-couple the wet stream from the solids stream and not have one dependent on the other. Now, operations staff waste sludge in an unorthodox way. The plant needs the capabilities to waste the right mass of solids at the right time to maintain a target MCRT. Also, aerated waste sludge storage should be linked to the County's desired hauling schedule.

3. The size of the raw sewage pumps and RAS pumps contributes to the hydraulic problems experienced. Both pumping systems are oversized based on current operating conditions. Neither system is equipped with VFDs to reduce flow.

4. Operations personnel should continue to monitor the removal rates for Total Inorganic Nitrogen against the requirement of the NPDES permit. Modifications to level flow and reducing RAS pumping rates may help improve the removal efficiency of Total Inorganic Nitrogen by reducing load surges through the plant.

5. The aeration tanks system (bio-reactor) is being operated in the MLE (Modified Ludzak Ettinger) mode to achieve Total Inorganic Nitrogen removal. The anoxic zone in the Aeration Tank 2 has also reduced *Microthrix parvicella*, which has been noted in the past.

6. Operations staff believes that the new fine screen has improved performance but that bypassing of stringy solids may still occur.

7. Operations staff report that the RAS well also has a skimmer flow going into it, and when the clarifier is subject to high flow conditions, high skimmer flow enters the RAS well.

6.0 IMMEDIATE ACTION IMPROVEMENTS

During the study process, Delaware County stated that they do not wish to change the current treatment process flow with the anoxic zone up front and want to correct the lack of free board and hydraulic head from the aeration basin to the clarifier.

As for the improvements needed, the following have been identified as **immediate action improvements** to possibly be performed by plant staff:

1. Reduce RAS pump size to bring capacity in line with the current flows being treated. The 30-minute settling test suggests that the sludge blanket compresses to 380 ml in a five-minute period. This indicates that the capacity for the RAS pumps can be reduced to a more acceptable range. For this report, a reasonable range would be approximately 75 GPM at 21 feet TDH. This would reduce the return rate from 314% to 108%.

2. Increase the diameter of the entire MLSS line including gate valves to 12-inch diameter. A clean out should also be added to facilitate cleaning this line upon need.

3. Screen RAS return with the understanding that care must be taken to avoid adding hydraulic load to the system, which operations personnel say can overflow when three pumps are on. Hydraulic modifications to the box may be required to handle the additional RAS flow. The diameter of the outlet pipes should be increased by at least one standard size.

4. The outlet for Aeration Tank 3 should be modified to reduce head loss and air entrainment in the MLSS conduit.

5. Lower the final clarifier weirs by three (3) inches. After further evaluation, the County no longer believes this to feasible due to the presence of two 90-degree bends in the MLSS piping to the feed well. Any modifications to the effluent weir would also have to consider modifying influent piping.

6. Lower the weirs of the mini discs by three (3) inches per instructions of the manufacturer. More information is required by the vendor on the means and methods to accomplish this.

7.0 LONG TERM IMPROVEMENTS

The recommendations section, below, provides several optimization strategies along with more substantial improvements to the Tartan Fields WWTP for the Long Term. Two general alternatives were identified:

1. Raise the Aeration Tank Walls

2. Construct Flow Equalization

a. Re-purposing Aeration Tank 1
b. New Exterior Tank

7.1 ALTERNATIVE 1: RAISE AERATION TANK WALLS

This option involves devising a method to increase the height of the aeration tank walls, re-setting the screen chamber, and modifying piping.

Alternative 1 was identified as the primary remedy to address the observed insufficient hydraulic grade line. The initial objective was to determine if the walls could be raised by two (2) feet by adding to the top of the existing wall. Unfortunately, structural analysis of the system, which included the construction of a computer model, determined this to not be possible.

Stantec's analysis considered the longest sludge holding exterior pre-cast wall, pre-cast struts and cast-in-place wall cap. This wall was chosen because it contained the longest unsupported wall lengths and would, by inspection, produce the highest level of stresses in all structural elements. Two models were created, one to recreate the existing conditions and the other with a new wall extending 2 feet above the wall cap.

Results of the analysis show that the increase in water pressure causes a 50%-90% increase in forces within the wall structural elements. To provide an example of this change in forces this modeled wall has two pre-cast concrete struts that span from one wall to an interior wall. These struts are used to help hold the top of the walls together. The existing model estimated a force of about 19 kips. In the proposed model this force jumped to 35.5 kips. All structures are designed with some reserve capacity however it would be highly unusual for a precast tank design to include over 50% reserve capacity into their design.

In addition, Stantec also evaluated increasing the height of the wall by only one (1) foot; however, this still causes an increase of 30%-50%. A compromise may be a solution that is independent of the Aeration Tank. A retaining wall could be designed and constructed along the perimeter of the tank. This wall would be self-supporting on its own strip foundation. The wall could, in theory, provide any amount of free board desired. The downside of this solution is that this wall would not be able to divide the internal cells of the Aeration Tank and only provide additional freeboard for the outer perimeter.

It should be noted that Delaware County enlisted the assistance of Arcadis to provide a preliminary structural analysis of the system. They came to the same conclusion reached by Stantec that the walls cannot be raised without risking failure.

An option identified by both Stantec and Arcadis is to pour the concrete walls within the original footprint of the aeration tanks within the building and modify the foundation as needed. The tank walls could be increased in height. The construction effort would be substantial and likely require that the roof structure and or building be removed during construction to provide access to the tanks.

An important aspect to be considered is providing appropriate access and walking surfaces across the tank with a structurally modified system. A determination would be necessary during design if the same walkway areas should be maintained or of new walks in a north-south direction be erected on top of the walls. Process piping would have to be relocated and supported temporarily during construction and permanently afterwards.

One advantage to raising the tanks walls, though constructing new walls within the same footprint as the existing system is that the plant would be provided with opportunity to improve the piping arrangement within the aeration tanks with respect to flow transfers between tanks and providing multiple acceptable flow patterns. This is important since that there is only one flow pattern currently in use: Aeration Tank 2 to Aeration Tank 3.

A disadvantage of this option is construction sequencing to maintain the existing tank system in operation, particularly if two tanks would be out of service. In addition, the height of the roof in the building is only 18 feet to the bottom of the support system, and it would be difficult to perform extensive modifications in the building without removing part of the building superstructure for access.

7.2 ALTERNATIVE 2: CONSTRUCT FLOW EQUALIZATION IN SEPARATE TANK SYSTEM

The addition of flow equalization will provide three (3) principal benefits for the Tartan Fields WWTP.

1. Flow equalization will provide a hydraulic buffer between the WWTP and the sanitary sewer system, which will minimize the peak flow surges that now plague the plant. This will allow flow to be controlled to a maximum peaking factor of 2.0.

2. Flow equalization will level loadings surges delivered into the wet stream process train. At present, loads are delivered intermittently. Not only does this exacerbate hydraulic limitations already present, but it also encourages bleed through of ammonia-nitrogen and nitrate-nitrogen.

3. Flow equalization will allow the facility to be operated using the intended capacity for treatment.

It should be noted that this option along with others located out of doors would likely require a cover to control potential odor.

7.2.1 Overview

There are several ways to incorporate flow equalization into the Tartan Fields WWTP. The first is to re-purpose Aeration Tank 1 to provide flow equalization and if desired additional sludge storage to provide for a better wasting regimen. The benefit is that this involves modifications to existing tanks. A drawback is that this would permanently de-rate the original rated capacity of the WWTP. This also requires that both Aeration Tanks 2 and 3 be modified to flow in both series and parallel if one tank is off line. In conclusion, Stantec views this as an interim strategy rather than a Long-Term solution.

A second alternative is to construct a new flow equalization tank system outside. The facility would require power, blowers, aeration diffusers, and pumps. The exact size would need to be determined by further evaluation but initial evaluation suggests that it should provide similar capacity to one of the existing aeration tanks, which is 70,000 Gallons.

7.2.2 Alternative 1

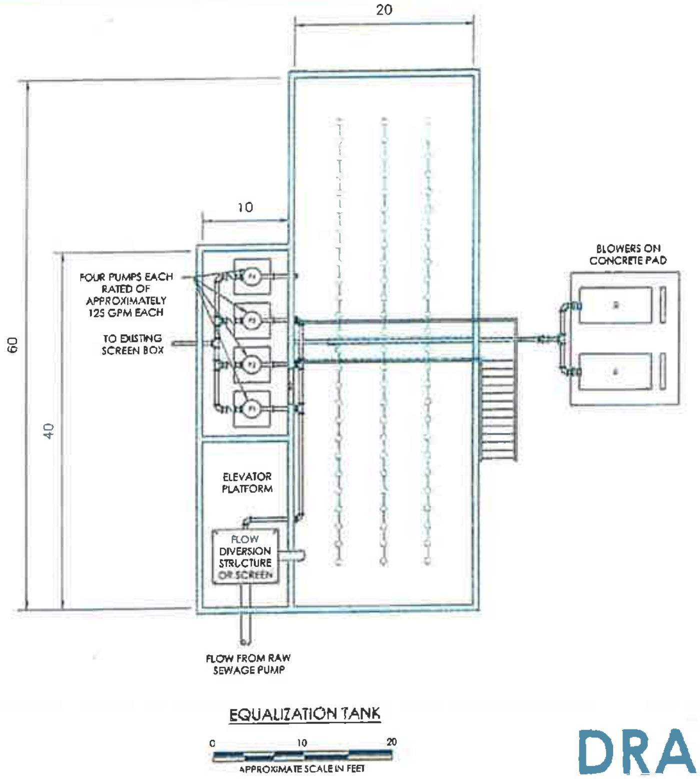
Alternative 1 will construct new flow equalization outside and utilize the existing system within the building in a manner consistent with its original purpose. This alternative was consistent with the improvement concepts discussed in the past. The proposed facilities would sit outside, and feed into the screening box ahead of the screen using new pumps.

7.2.3 Alternative 2

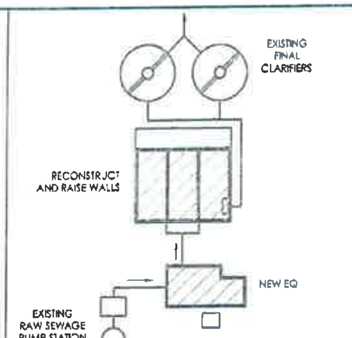
Alternative 2 is different from Alternative 1, but uses the same concept of flow equalization. Alternative 2 was never discussed in the past, but developed during this report after reviewing the existing facilities in more detail. Under Alternative 2, the existing aeration tanks would be used for flow equalization and sludge storage. A new aeration tank system would be constructed outside. The size would be customized based on anticipated maximum flows and determined by Delaware County.

The benefit of Alternative 2 is that it recognizes limitations of the building and existing system and construct a new wet stream reactor outside. Part of the work would be to re-purpose the existing system for flow equalization and additional sludge storage. In this manner, the existing facilities within the building remain intact, as they are now, while the new wet stream bioreactor will be sized to provide treatment outside. In that manner, the existing tanks would remain similar to that existing today.

This alternative is presented in Section 9.0 for the Long-Term Improvement Plan for the Tartan Fields WWTP.

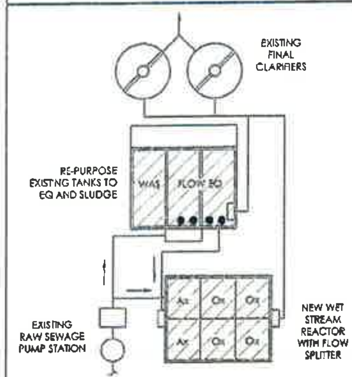


EQUALIZATION TANK



LONG-TERM ALTERNATIVE NO. 1

NOT TO SCALE



LONG-TERM ALTERNATIVE NO. 2

NOT TO SCALE

DRAFT

Stantec	FOR DELAWARE COUNTY TARTAN FIELDS WWTP 9341 JEROME ROAD DUBLIN, OHIO		EQUALIZATION TANK CONCEPT PLAN & LONG TERM ALTERNATIVES	FIGURE 2
	JOB NUMBER:	DRAWN BY:	CHECKED BY: DK	DATE:

8.0 SUMMARY

The following discussion is presented to provide Delaware County with our insights on the operation of the different treatment systems at the Tartan Fields WWTP.

Raw Sewage Pump Station:
During a progress meeting on January 30, 2017, there was discussion to modify the size of the raw sewage pumps. This could be done by selecting smaller pumps to meet low end demands. However, there is concern that a reduction in pumping capacity may subject the sanitary sewer system to backups during high flow conditions and result in basement flooding, which is not acceptable. Therefore, a decision was made to not modify this system now, and rely instead on other improvement strategies.

Flow Equalization:
A flow equalization system shall be implemented as part of the Long-Term recommendations for Tartan Fields WWTP. In the short term, Aeration Tank 1 could be recruited for this function; however, for the WWTP to realize its full potential, an external system should be constructed adjacent to the existing WWTP building. The exact location of this system can be optimized based on space constraints and the needs to access the WWTP.

Screening Structure:
A new Parkson Aqua guard screen was purchased and installed in 2016. The new system has been an improvement over the previous system.

One recommendation is to re-screen RAS flow as this may be a source of long term ragging and clogging of conduits. For this to occur, it is important for the capacity of the screening chamber to be evaluated and outlet pipes be increased in size to allow for the proper flow through the screen. At a minimum, Stantec recommend that the size of the outlet pipes to the aeration tanks be increased by at least one standard pipe size.

Aeration Tank System/Operational Flexibility:
From the perspective of operational flexibility, Stantec recommends that the Tartan Fields WWTP be modified to operate in two different modes. The present mode, which works well, is feasible if both Aeration Tanks 2 and 3 are in service. If one of these tanks is out of service, an alternative operational strategy must be devised.

The existing blower and air delivery system also experiences problems. Two blowers are in service to meet aeration demands. Unfortunately, the two existing blowers are centrifugal and require a narrow pressure range of operation to avoid surge. To currently allow for two blowers to be in service and avoid surge, excess air is diverted into Tank 1. Stantec recommends that a new blower system be provided, which can provide air based on demand. To provide maximum flexibility, at least three (3) blowers are recommended. One unit would be for average demand and the second for peak demand. The other would serve as a redundant unit.

DELAWARE COUNTY TARTAN FIELDS WWTP EVALUATION REPORT
FINAL REPORT

SUMMARY
June 22, 2017

Aeration Tank/Wall Height:
The top of concrete wall elevations for the aeration tanks and final clarifiers are the same elevation, and the hydraulic control elevations for the aeration tank and the final clarifiers weirs differ by only four (4) inches, there is not sufficient hydraulic gradient to move flow from the aeration tanks through the final clarifiers. The only way to measurably improve the hydraulic grade line is to raise the walls by several feet; however, analysis by Arcadis and Stantec has shown that the existing wall system cannot support additional loading due to "moment failure." A new structural support system will be needed.

Aeration Tank/Outlet Control and MLSS Line:
The on/off operation of the raw sewage pumps and RAS pumps creates surges of flow through the WWTP, which include headloss through the MLSS line from the aeration tank to the final clarifiers. Two problems were observed. The first pertains to an outlet restriction at the top of the aeration tank. The second issue pertains to undersized portions of the MLSS line. Stantec recommends that the 8 inch portions be replaced with a new 12-inch line. Operations personnel have devised a strategy to modify the launder and remove the two 90-degree bends to allow the 12-inch line to be fully extended.

Another improvement to the MLSS line is to install a clean out or means to clean out the line to remove debris from the screening operation. One or more cleanouts would be beneficial at the 90-degree bends on the MLSS line closest to the final clarifiers. A part of these modifications would be to cap the aeration diffusers within a few feet of the aeration tank outlet to avoid air entrainment in the MLSS conduit.

Final Clarifiers Weir Lowering:
The County has determined it possible to lower the final weirs a few inches between the aeration tanks and final clarifiers by modifying the launder and removing the two 90-degree bends. This improvement will increase the hydraulic gradeline by several inches.

Final Clarifiers/RAS Pumps:
Each of the two current RAS pumps is designed to deliver 260 GPM of flow, which is 150% of the rated capacity of the plant per *Ten States Standards*. The actual pump curves from Xylem show a duty point of 310 GPM at 21 feet Total Dynamic Head (TDH). Therefore, one raw sewage pump station duty pump and one RAS pump will deliver approximately 878,000 GPD.

Given that only one final clarifier is needed, the sludge settling rate is non-bulking and within an acceptable range, and that the reactor removes Total Nitrogen. The traditional objective of maintaining a target hydraulic detention time of less than eight hours in the final clarifiers is not as critical. Therefore, it is recommended that the size of the RAS pumps be reduced by at least 50% to reduce the overall hydraulic loading on the aeration tanks and final clarifiers. In addition, found that by reducing RAS rates, the effective detention time in the aeration tanks results in better treatment.

One problem noted by operations personnel pertains to the scum return line. The hydraulics of the system flood out the scum line during high flow conditions and overload the RAS pump station. One solution being considered is to raise the elevation of the scum collection pipe to reduced flow.

Tertiary Filters/Inlet and Outlet Weirs:
The tertiary filters were installed recently as a much-needed improvement, and by all accounts, a successful project. One minor improvement is to lower and/or expand the length of the inlet and outlet weirs to avoid backing up flow into the final clarifiers. Review by Aqua Aerobics indicates that the hydraulic levels in the filter system may be reduced by up to three (3) inches. Information provided to Stantec by the vendor is in the Appendix.

Electrical System Capacity:
Any improvements, which add pumps and blowers, will require an upgrade to the overall electrical system. It must be assumed that the existing system does not have adequate capacity for new equipment.

A detailed evaluation would need to be performed during detailed design to determine if the electrical system needs to be upgraded to accommodate the new blowers for both the three aeration tanks and the flow equalization surge chamber. It is important that this analysis be comprehensive to address all areas of the system that are to be improved. The electrical portion of this evaluation should be part of the project to add flow equalization.

The Delaware County Sanitary Engineering Department wishes to perform modifications using their own in house resources to save cost. They recognize that larger efforts such as flow equalization and electrical, and aeration tank system improvements would be best addressed using capital improvement projects. Table 5 provides a summary of all proposed improvement efforts including the proposed timeframe, the anticipated benefit and project delivery method.

9.0 TARTAN FIELDS WWTP LONG TERM PLAN

The Long-Term plan for the Tartan Fields WWTP is intended to be a future initiative for Delaware County. The Long-Term Plan must be preceded with an engineering study to evaluate alternatives, and then presented to the County for them to select the best option.

As discussed, the Tartan Fields WWTP is plagued by a host of hydraulic limitations, which when combined are performance limiting. Any future improvements must include efforts to improve the hydraulic grade line between tank systems. Presently, the hydraulic drop is only a few inches, when it should be at 12-18 inches between each wet stream process unit.

Also, the lack for flow equalization and means to limit flow pulses into the plant is also a performance limiting factor. This limitation can be improved by flow equalization and better means to level flow surges delivered into the wet stream process system. Flow pumping improvements should include variable frequency drives.

The existing Tartan Fields WWTP is housed in a pre-fabricated building, which is poorly insulated, prone to freezing in the winter, has low ceiling height, and limited access on the north side of the structure near Tank 3. The existence of blowers and electrical equipment on the south side of this building suggests that the environment would be rated as Class I, Division 1 for NFPA 820. The shared air space of open top process tanks and electrical equipment suggests that the building may be NFPA 820 non-complaint.

One possible plan would be to raise the walls of the aeration tanks. The feasibility of this option was evaluated by both Stantec and Arcadis, and found not feasible due to potential "moment failure" of the walls. The proposed solution would require that new walls be cast in place inside of the existing wall structure. There are three challenges to this approach, which were not evaluated in detail in this study.

1. This is an active wastewater treatment plant, which requires two reactor tanks to be on line to meet current treatment process demands of the system. The only way to achieve this plan and meet the requirements of continuous treatment in the NPDES permit is to construct flow equalization tanks out of doors and recruit these tanks for temporary service as aeration reactors.

2. The plant is in a building. To provide access, a portion of the superstructure must be removed. Determinations on how the structure was constructed, and how much of it can be removed without destabilizing the system was outside of the scope of this evaluation.

3. Pouring walls inside the footprint of the existing system requires that the foundation be adequate to support the additional loading. This would require additional evaluation.

To present Delaware County with a concept plan, which is feasible and straightforward for initial conceptualization, Stantec developed an approach, which would entail constructing new reactor tanks outside and using the existing three aeration tanks inside the building for flow storage and sludge treatment. The benefits of this plan are as follows:

1. The existing pump station, screen structure and flow tanks will be maintained as they are now. The existing plant could be maintained in its current configuration throughout construction without a rigorous sequencing of operations. Furthermore, the existing screen system would be left in place.

2. No significant structural modifications to the existing tanks could be performed other than those to optimize them for sludge storage and flow equalization. Depending on piping configurations related to return activated sludge (RAS), some reactor volume may be dedicated to anoxic treatment for the removal of Total Inorganic Nitrogen.

3. For sludge digestion and holding, the tanks should allow for decant thickening.

4. New blowers would be required to address variable level flow and eliminate "surge" problems experienced with the two tanks.

5. The aeration tanks will outlet into a new flow splitter structure to provide positive flow splitting between the existing final clarifiers. Pipes would be run to each final clarifier.

6. Since exterior flow equalization tanks are not required, the same space could be used for external aeration tanks. They will be covered and provided odor control.

7. Raw sewage pumps will be installed inside two of the aeration tanks to provide pumping. These tanks will transport flow from flow equalization to the new aeration tanks.

8. The existing capacity of two aeration tanks is approximately 140,000 Gallons, which is sufficient for the Tartan Fields WWTP. New tanks should be constructed of a greater capacity to allow for new customers.

9. Significant work within the building could be omitted until a time when Delaware County decides if they wish to keep the exiting building due to NFPA 820 compliance considerations as part of their study.

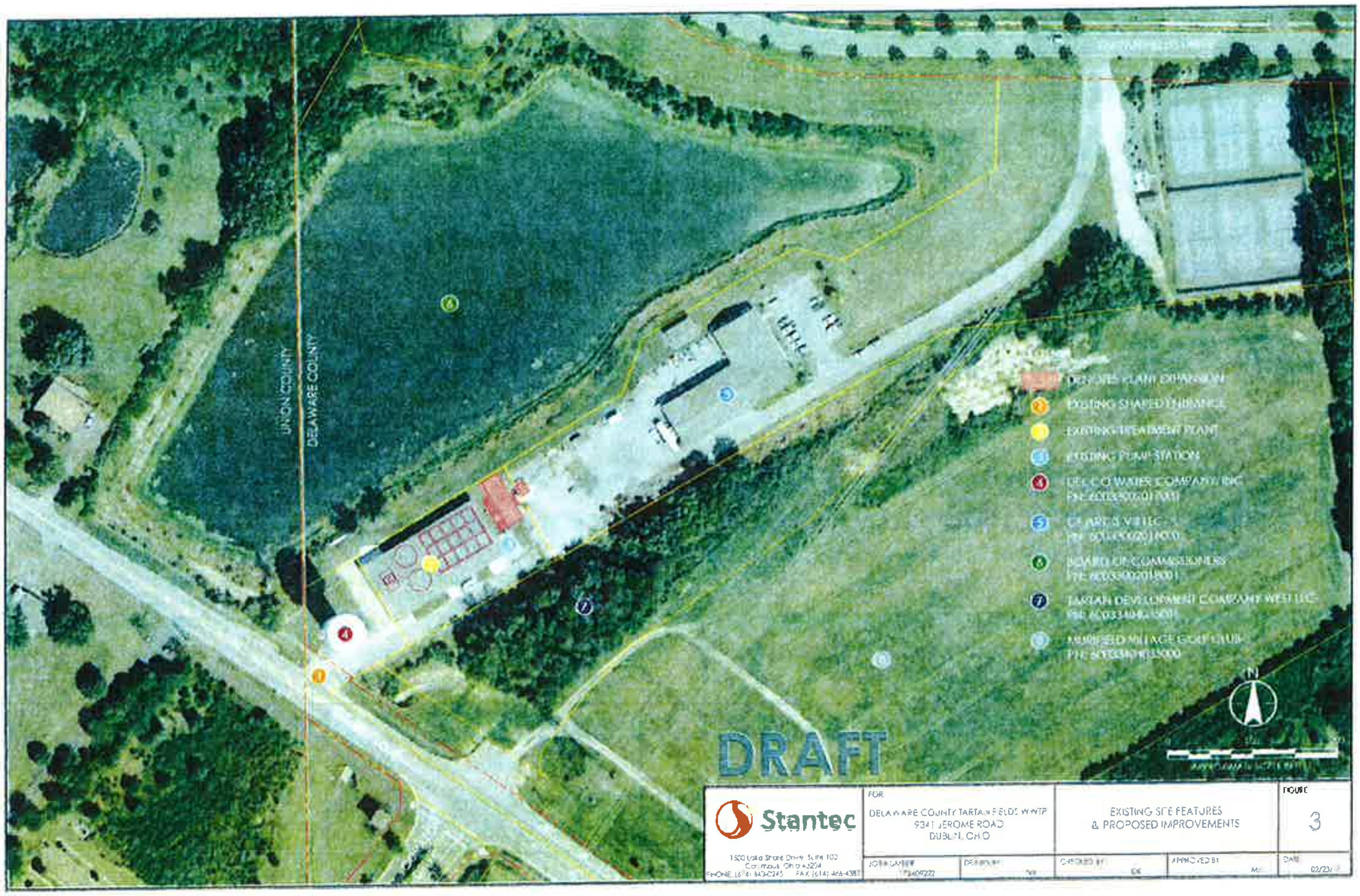
10. From the standpoint of flow, all flow is pumped through the screen and be captured in one or two of the tanks, probably Aeration Tanks 2 and 3. From here, flow would be equalized and then repumped to aeration tanks. From here, flow would be split between two existing final clarifiers and then flow into the tertiary filter system.

11. Aeration Tank 1 would be dedicated for sludge holding, digestion and aeration.

12. Aeration Tanks 2 and 3 could be used to receive skimmings lines from the final clarifiers, which currently increase the hydraulic pumping requirements for the RAS pumps.

13. As part of a Long-Term strategy, some wet weather inflow and infiltration may be reduced by implementing micro monitoring to focus on smaller diameter residential sewers.

It is important to note that a high-level concept estimate of most probable cost is in the range of $1.5 to $2.5 Million. This does not include the acquisition of property or professional services for planning, design, and construction administration.


UNION COUNTY
DELAWARE COUNTY
EXISTING TREATMENT PLANT
EXISTING PUMP STATION
DRAFT
Stantec
FOR
DELAWARE COUNTY TARTAN FIELDS WWTP
9341 JEROME ROAD
DUBLIN, OHIO
EXISTING SITE FEATURES
& PROPOSED IMPROVEMENTS
FIGURE
3
APPROVED BY
DATE

Cost Estimate Assumptions:

It is important to note that any items in the attached table include a combination of efforts that may be performed as "In House" projects, which may be performed with local contractors used to small size "task style" projects. The project delivery method will be different than those, which are traditionally design-bid-build.

It is important to note that it is challenging to provide an estimate for small initiatives, which involve piping, the installation of a weir collection box, and other miscellaneous improvements. Costs for labor, mobilization and sequencing are best and most accurately determined by contractor bids after doing a detailed site evaluation and interview with Delaware County.

Another challenging aspect of the project to modify the MLSS pipe and the installation of the outlet weir box for Tank 3 is maintaining the plant in operation. Temporary piping may be needed.

The best and most accurate cost is to get an actual bid for these services from several local contractors. While material costs are not significant, labor and mobilization for nontraditional endeavors, including access to the north side of the aeration tanks is difficult to estimate.

Table 5
Delaware County Tartan Fields WWTP
Summary of Recommended Improvements

Improvement	Timeframe	Benefit	Project Delivery	Estimate of Potential Probable Cost
Aeration Pipe upgrade and new effluent weir box	Immediate	Better outlet hydraulics	Small Project	$ 46,855
Clarifier # 1 rehab including new epoxy paint on drive collector and lowering weirs	Immediate	Reduction in debris by screening RAS	In House	$ 49,855
Long Term Solution to improve Hydraulic Gradeline	Long Term	Improvement to hydraulic grade line between aeration tanks and final clarifiers	Capital Improvement Project (CIP)	$2.0 Million
RAS Pump Size Reduction	Possible future	Reduction in recycle flow	To be determined	To be determined
To be determined	Future	Address blower surge problems experienced with the aeration tanks	To be determined	To be determined
To be determined	Future	Reduction in wet weather flow by Micro Monitoring	To be determined	To be determined

Appendix A

A. Equipment Vendor Information

B. Estimate of Probable Construction Cost xylem

Xylem Water Solutions USA, Inc.
Flygt Products

1615 State Route 131
Milford, Ohio 45150
Tel 513/831-7867
Fax 513/831-7868

March 2, 2017

Stantec
1500 Lake Shore Dr Suite 100
Columbus Ohio 43204
Estimate # 2017-CIN-0190
Re:Tartan Fields Pump Budget Quote

Xylem Water Solutions USA, Inc. is pleased to provide a quote for the following Flygt equipment.

Flygt Pumps

Qty	Part Number	Description	Unit Price	Extended Price
2	3057.091-YYYY	Flygt Model CP-3045.091 2" volute Submersible pump equipped with a 460 Volt / 3 phase / 60 Hz 1.8 HP 3550 RPM motor, 252 impeller, 1 x 50 Ft. length of SUBCAB 4G2,5+2x1,5 submersible cable, FLS leakage detector, Explosion proof	$ 1,077.00	$ 2,154.00
2	486 55 01	CONNECTION,DISCH 2X2"NPT CI	$ 255.00	$ 510.00
2	669 77 00	BRACKET,GUIDE BAR U. 3/4" 316	$ 136.00	$ 272.00
60	14-48 71 13	CHAIN,3/16" 316L	$ 35.00	$ 2,100.00
2	14-58 72 08	KIT,CHAIN FITTING 3067-3127+ 316SS	$ 101.00	$ 202.00
2	14-58 95 45	HARDWARE,DISC CONN ASSY 304SS	$ 147.00	$ 294.00
2	14-59 00 00	KIT,HARDWARE 3/8IN SS (2X)	$ 49.00	$ 98.00
2	14-58 91 06	HOOK,SAFETY ASSEMBLY SS	$ 111.00	$ 222.00
4	582 88 30	SENSOR,ENM-10 0.95-1.1 40'	$ 335.00	$ 1,340.00
2	14-40 71 29	MINI-CASII/FUS 120/24VAC,24VDC	$ 486.00	$ 972.00
2	14-40 70 97	SOCKET,11 PIN OCTAL DIN MOUNT	$ 46.00	$ 92.00
1	14-69 00 09	START UP CHARGE FLYGT 1-TP MODELS: 3000,7000,8000	$ 1,171.00	$ 1,171.00
		Total Project Price		**$ 9,427.00**
		Freight Charge		**$ 259.00**
		Total Project Price		**$ 9,686.00**

Terms & Conditions

This order is subject to the Standard Terms and Conditions of Sale – Xylem Americas effective on the date the order is accepted which terms are available at http://www.xyleminc.com/en-us/Pages/terms-conditions-of-sale.aspx and incorporated herein by reference and made a part of the agreement between the parties.

Purchase Orders: Please make purchase orders out to: Xylem Water Solutions USA, Inc.
Freight Terms: 3 DAP - Delivered At Place 08 - Jobsite (per IncoTerms 2010)

FLYGT
a xylem brand

See Freight Payment (Delivery Terms) below.

Taxes: State, local and other applicable taxes are not included in this quotation.

Back Charges: Buyer shall not make purchases nor shall Buyer incur any labor that would result in a back charge to Seller without prior written consent of an authorized employee of Seller.

Shortages: Xylem will not be responsible for apparent shipment shortages or damages incurred in shipment that are not reported within two weeks from delivery to the jobsite. Damages should be noted on the receiving slip and the truck driver advised of the damages. Please contact our office as soon as possible to report damages or shortages so that replacement items can be shipped and the appropriate claims made.

Taxes: State, local and other applicable taxes are not included in this quotation.

Terms of Delivery: PP/Add Order Position

Time of Delivery: Approx. XX working weeks after receipt of order.

Validity: This Quote is valid for ninety (90) days.

Terms of Payment: 100% N60 after invoice date.
Xylem's payment shall not be dependent upon Purchaser being paid by any third party unless Owner denies payment due to reasons solely attributable to items related to the equipment being provided by FLYGT.

Warranty: Xylem Water Solutions USA, Inc.offers a commercial warranty to the original end purchaser against defects in workmanship and material.

Terms & Conditions: Order is subject to credit approval. Net60 days after date of invoice or 100% payable before start up of equipment, whichever comes first. A charge of 1.5% per month will be added to all balances unpaid 60 days after invoice date. Pricing is firm based on our receiving complete approval and release for production four (4) weeks after drawings have been submitted by Xylem Water Solutions USA, Inc. Partial billing will be made on any partial shipments. Equipment returns are subject to approval and possible re-stocking fees. Special order items (i.e. Control Panels, hatch covers) will not be accepted for return.

Exclusions: This Quote includes only the items listed specified above.

Schedule: Please consult your local Flygt Branch Office to get fabrication and delivery lead times.

Thank you for the opportunity to provide this quotation. Please contact us if there are any questions.

Sincerely,

Steve Ellington
Sales Representative

steve.ellington@xyleminc.com

FLYGT
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xylem

Xylem Water Solutions USA, Inc.
Flygt Products

Customer Acceptance

This order is subject to the Standard Terms and Conditions of Sale – Xylem Americas effective on the date the order is accepted which terms are available at http://www.xyleminc.com/en-us/Pages/terms-conditions-of-sale.aspx and incorporated herein by reference and made a part of the agreement between the parties.

A signed copy of this Quote is acceptable as a binding contract.

Purchase Orders: Please make purchase orders out to: Xylem Water Solutions USA, Inc.

Quote #:	2017-CIN-0190
Customer Name:	Stantec
Job Name:	
Total Amount: (excluding freight)	$ 9,427.00

Signature: ______________________ Name: ______________________ (PLEASE PRINT)

Company/Utility: ______________________ PO: ______________________

Address: ______________________ Date: ______________________

______________________ Phone: ______________________

______________________ Email: ______________________

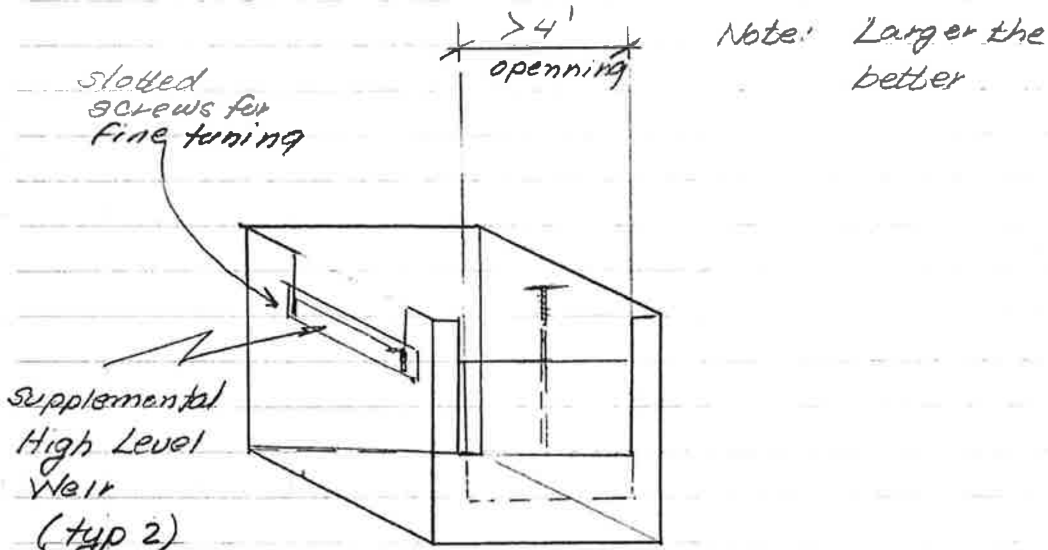
______________________ Fax: ______________________

FLYGT
a xylem brand

Delaware County Tartan Fields WWTP 3-23-2017

Weir Box Aeration Tank 3

Based on information provided 3-22-2017



> 4' - Again the larger the better

Governing Equation

$Q = 3.33 L H^{3/2}$

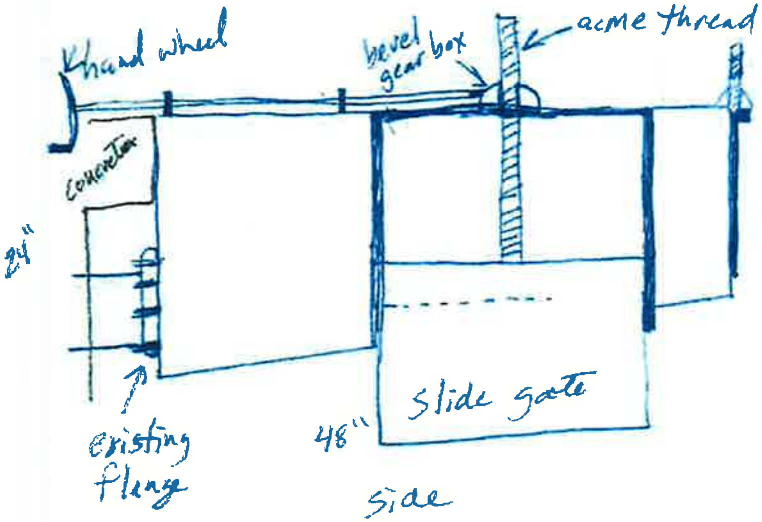
Raw Sewage Pump 300 GPM ea
2 @ 300 GPM = 600 GPM

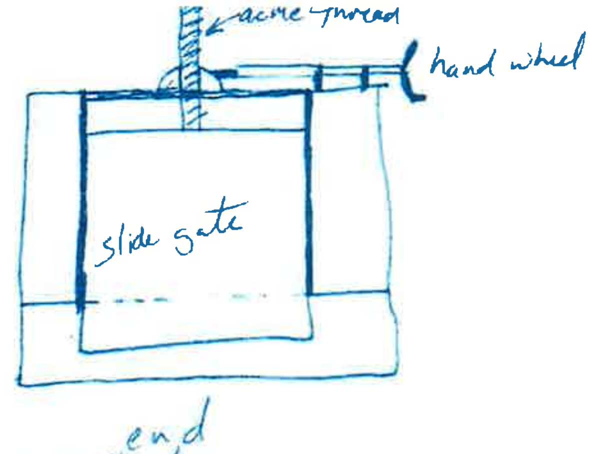
RAS Pump 1 @ 310 GPM = 310 GPM

Total Flow = 910 GPM (Peak)
1.31 MGD
2.0 CFS

$\frac{2 \text{ CFS}}{3.33 \times (0.33)^{3/2}} = L \Rightarrow 3.2 \text{ ft.}$ ⇒ Recommend minimum of 4 ft (accounts for end contractions)

Allowable head (assumed)





* water will flow over the top
* other two sides will be flat stainless
* one piece of stainless angle will be added to the corner or two pieces spanning over the tank connected to the sides for added support. Whichever customer prefers

- acme thread on slide gates
- Stainless steel construction
- Stainless steel bevel gearboxes
- Stainless steel anchors to concrete
- With design none of the existing piping will be distrubed. If design does not help as thought 90° fitting could be reinstalled and design of plant would not be altered

Hub City Product Search, Selection and Configurator

To begin, select & search the model you wish to configure. Please note that you must LOG IN (BELOW) before you will be able to download a 3D model. However, you may use each configuration tool to select, configure and view each model before downloading.

NOTE: If this page is not displaying correctly, please confirm that your web browser is at least version IE8 or higher. Or you may also try viewing it with Firefox (also works well when doing 3D the Configurator)

powered by PARTsolutions

0220-54001

Sizing Options

Model Number

790

Ratio

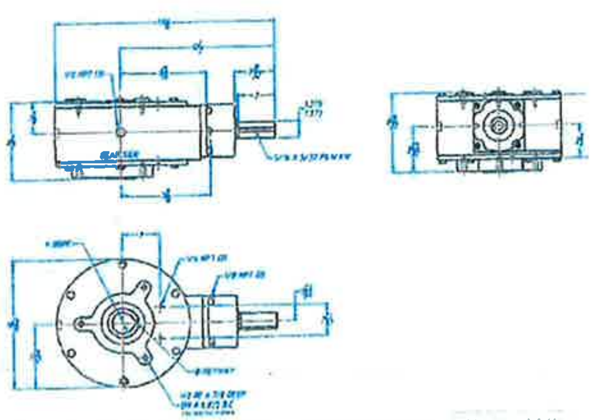
2/1

Output Diameter

1 1/2 [INCH]

3D Preview | 2D View | CAD Download | Help

Dimensions Assembly Styles



Dashed Solid Center Dimension Fit to Win

Bevel Gear Drives - Dimensional Data

Part Number	Style	Gear Type	Frame Size	Description	Product Type	Product Line	Input Type	[INC Input Di
0220-54001	STD	ST	N/A	790 2/1 STD ST 1.500	Bevel	Bevel Gear Drives	Shaft	1.37

Part# **0220-54001** (790 2/1 STD ST 1.500)

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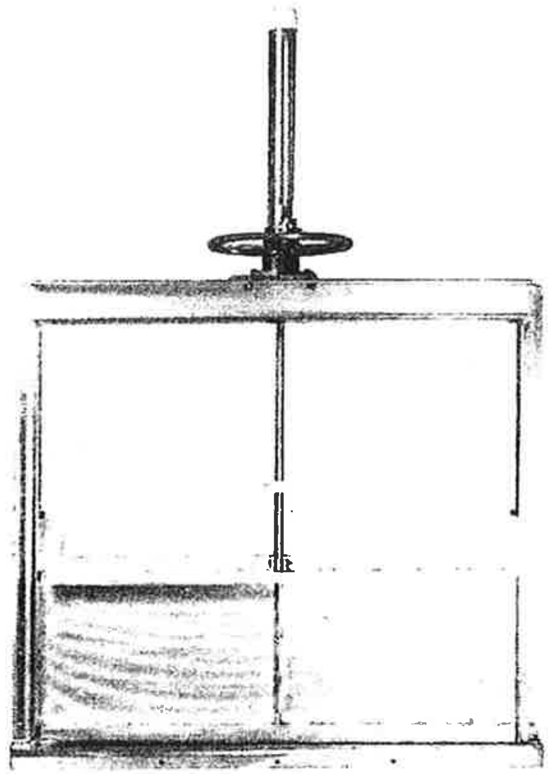
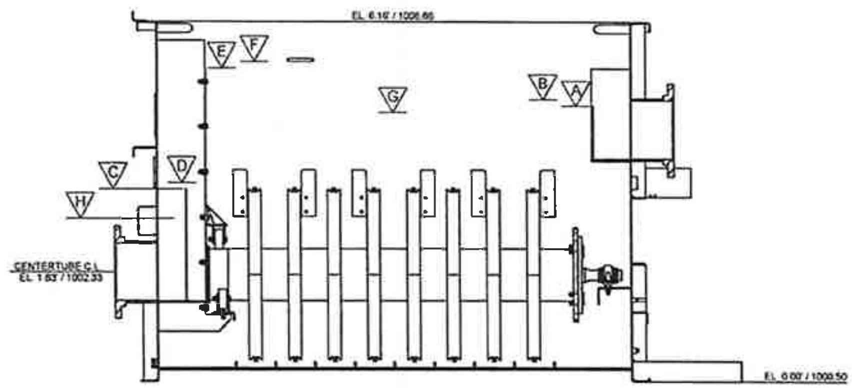


FILTER TANK



SECTION C-C

AVERAGE FLOW RATE

A	4.71' / 1005.21	INFLUENT WEIR ELEVATION
B	4.82' / 1005.32	NAPPE OVER INFLUENT WEIR
C	3.29' / 1003.79	EFFLUENT WEIR ELEVATION
D	3.40' / 1003.90	NAPPE OVER EFFLUENT WEIR
E	5.35' / 1005.85	OVERFLOW WEIR ELEVATION
F	5.47' / 1005.97	NAPPE OVER OVERFLOW WEIR
G	4.58' / 1005.08	BACKWASH INITIATE LEVEL
H	2.79' / 1003.29	MAXIMUM AVAILABLE LIQUID LEVEL FOR EFFLUENT CONVEYANCE

MAXIMUM FLOW RATE

A	4.71' / 1005.21	INFLUENT WEIR ELEVATION
B	4.98' / 1005.48	NAPPE OVER INFLUENT WEIR
C	3.29' / 1003.79	EFFLUENT WEIR ELEVATION
D	3.56' / 1004.06	NAPPE OVER EFFLUENT WEIR
E	5.35' / 1005.85	OVERFLOW WEIR ELEVATION
F	5.62' / 1006.12	NAPPE OVER OVERFLOW WEIR
G	4.59' / 1005.09	BACKWASH INITIATE LEVEL
H	2.79' / 1003.29	MAXIMUM AVAILABLE LIQUID LEVEL FOR EFFLUENT CONVEYANCE

HYDRAULIC PROFILE IS BASED ON THE FOLLOWING:

- AN AVERAGE FLUX RATE OF 0.81 GPM PER SQUARE FOOT (0.20 MGD) THROUGH (2) FILTER TANKS
- A MAXIMUM FLOW RATE OF 3.01 GPM PER SQUARE FOOT (0.75 MGD) THROUGH (2) FILTER TANKS

NOTE: EACH FILTER TANK IS CAPABLE OF THE FOLLOWING

- AN AVERAGE FLOW RATE OF 3.25 GPM PER SQUARE FOOT (0.40 MGD).
- A MAXIMUM FLOW RATE OF 6.50 GPM PER SQUARE FOOT (0.81 MGD).

WEIR LENGTHS

INFLUENT = 2.50'
EFFLUENT = 2.50'
OVERFLOW = 2.50'

TARTAN FIELDS WTF FILTER REPLACEMENT
DELAWARE, OH

REV	ECN	DATE	BY	DESCRIPTION
A	-	2015-02-16	TWA	SUBMITTAL
B	R15261	2015-03-07	TWA	RELEASE TO PRODUCTION

TANK ASSEMBLY, 8 DISK, LH

AQUA-AEROBIC SYSTEMS, INC

DO NOT SCALE DRAWING

M-ADFSP-22
ADFSP-11
DRAWN BY: TWA
DATE: 2015-02-16
WEIGHT: 4500 LB
DRAWING NUMBER: 91121156001
SCALE: 1:12
SIZE: D

Kocarek, Dale

From: marc@jdtco.com
Sent: Thursday, February 23, 2017 4:19 PM
To: Kocarek, Dale
Subject: FW: Delaware County Tartan Fields Mini Disc Filter Head Loss - 112115

Dale,

Thanks for calling. Here is Aqua's response, abbreviated to include only the upstream side of the filter and it's influent weir.

Let me know if you have any questions.

Marc C. Nusser
Vice President
J. Dwight Thompson Co.
513-800-9009

From: Dave Smith [mailto:DSmith@aqua-aerobic.com]
Sent: Thursday, February 23, 2017 3:47 PM
To: marc@jdtco.com
Cc: Dan Durdan <DDurdan@aqua-aerobic.com>; Tatiana Mazzei <TMazzei@aqua-aerobic.com>; Mark Hughes <MHughes@aqua-aerobic.com>; Steve Stanish <SStanish@aqua-aerobic.com>; Kevin Heasley <KHeasley@aqua-aerobic.com>; File Archive <Archive@aqua-aerobic.com>; Thomas Fenton <TFenton@aqua-aerobic.com>
Subject: RE: Delaware County Tartan Fields Mini Disc Filter Head Loss - 112115

Marc,

In the below email, it isn't clear whether or not the 3" of head loss reduction is to be ahead of or after the filters. The following answers for either condition.

If ahead of the filters, the influent weir elevation may be reduced by 3" without adverse effect. The backwash elevation should also be reduced to prevent backing up into the influent weir. Per our hydraulic profile, the backwash start is 4.59' while the influent weir is 4.71'. Lowering the influent weir by 3" puts it at 4.46'. Reducing the backwash start to 4.40' would leave just 3/4" between backwash start and the influent weir. This is on the edge of the level sensor accuracy range. A slight push on the influent weir causes the filter no issues, and the backwash start elevation could be bumped down an additional 0.1' if you find the water pushing against the influent weir. Dropping the backwash start elevation does affect the filter, though this effect is slight. The basic package unit goes up to 10 disks, with 1 MGD capacity at peak. Just by virtue of having 8 disks and a peak rating of 0.8 MGD, we've got a bit of spare head inside the unit. Depending on actual flow through the unit, you may see a very minor increase in backwash frequency, though I doubt a noticeable effect.

Please review, and let me know if you have any related questions or require further clarification.

Best Regards,

Dave Smith
Mechanical Engineering Manager

AQUA-AEROBIC SYSTEMS, INC.

Tartan Fields

Wastewater Treatment Plant Flow Aeration Improvements

High Level Concept Estimate for Long Term Improvements

April 17, 2017

Spec / Description	Qty	Unit	Unit Cost	Amount
	CURRENT CONFIGURATION Two 80'X60' Primary Aeration Tanks W/ Associated Pumps and Equipment			
01 General Requirements				
Division 1 - General Requirements				
Construction Layout Staking	1	LS	$ 2,500.00	$ 2,500.00
Environmental Controls	1	LS	$ 1,200.00	$ 1,200.00
Materials Testing	1	LS	$ 1,000.00	$ 1,000.00
01 General Requirements Totals				$ 4,700.00
02 Site Work				
02220-Excavation, Backfilling, and Compacting				
Aeration Tank - Excavation	200	CY	$ 10.00	$ 2,000.00
Aeration Tank - Backfill	40	CY	$ 27.68	$ 1,107.20
Blower Pad - Excavation	24	CY	$ 10.00	$ 240.00
Blower Pad - Backfill	8	CY	$ 27.68	$ 221.44
General Site Grading and Fine Grading	100	CY	$ 6.25	$ 625.00
Mounding of Excess Spoils	176	CY	$ 2.00	$ 352.00
02514-Concrete Sidewalks				
Sidewalk with Base	150	SF	$ 8.00	$ 1,200.00
02924-Seeding				
Seed Site	1	LS	$ 6,000.00	$ 6,000.00
02 Site Work Totals				$ 11,745.64
03 Concrete				
03300-Cast-in-Place Concrete with Reinforcement				
Aeration Tank Exterior Walls	110	CY	$ 1,304.00	$ 143,440.00
Blower Pad	9	CY	$ 485.00	$ 4,365.00
Screen and Pump Box Walls	18	CY	$ 1,304.00	$ 23,472.00
Aeration Tank Foundation	153	CY	$ 568.00	$ 86,508.00
Foundations for Steps	6	CY	$ 975.00	$ 5,850.00
03 Concrete Totals				$ 263,725.00
04 Masonry				
04065 Masonry Mortaring & Grouting				
Aeration Tank Wall and Floor Grout	1	LS	$ 2,700.00	$ 2,700.00
04 Masonry Totals				$ 2,700.00
05 Metals				
05120-Structural Steel				
Aeration Tanks - W Shape, A992 Steel, W14x74	90	LF	$ 107.35	$ 9,661.50
05502-Miscellaneous Metals				
Stainless Steel Tank Cover	2,560	SF	$ 40.00	$ 102,400.00
05510 Metal Stairs				
Aeration Tank	15	Riser	$ 461.14	$ 6,917.10
05522 Type II Aluminum Handrails and Railings				
Aeration Tank (w/kick plate)	441	LF	$ 49.00	$ 21,609.00
Aluminum Grating	180	SF	$ 47.00	$ 8,460.00
05 Metals Totals				$ 149,047.60
09 Finishes				
09900 Painting				
Paint Pipe	80	LF	$ 4.80	$ 384.00
Misc Items	1	LS	$ 4,000.00	$ 4,000.00
09 Finishes Totals				$ 4,384.00
11 Equipment				
11211-Pumps				
Transfer Pump	4	EA	$ 50,000.00	$ 200,000.00
Miscellaneous Starters	7	EA	$ 2,000.00	$ 14,000.00
11290 Odor Control System				
Odor Control	1	LS	$ 150,000.00	$ 150,000.00
11300 Fine Bubble Diffuser System				
Air Diffusers	2	EA	$ 35,000.00	$ 70,000.00
11350 Anoxic Mixing System				
Anoxic Mixers	2	EA	$ 25,000.00	$ 50,000.00
11371 Blowers, Positive Displacement				
Blower VFD Package, 400 cfm each	3	EA	$ 35,000.00	$ 105,000.00
11 Equipment Totals				$ 589,000.00
14 Conveyance Systems				
14630-Cranes				
Monorail Crane and Hoist	1	EA	$ 10,000.00	$ 10,000.00
Portable Gantry Crane	1	EA	$ 3,000.00	$ 3,000.00
14 Conveyance Systems Totals				$ 13,000.00
15 Mechanical				
15061 Ductile Iron Pipe				
Exposed Ductile Iron Pipe	40	LF	$ 40.00	$ 1,600.00
Exposed Ductile Iron Fittings	1	LOT	$ 8,000.00	$ 8,000.00
Buried Ductile Iron Pipe	120	LF	$ 45.00	$ 5,400.00
Buried Ductile Iron Fittings	3	LOT	$ 5,000.00	$ 15,000.00
15068 Stainless Steel Pipe				
Sched 10 for Aeration	200	LF	$ 150.00	$ 30,000.00
15100- Process Valves				
Exposed Ductile Iron Valves	4	EA	$ 5,000.00	$ 20,000.00
Buried Ductile Iron Valves	1	EA	$ 1,200.00	$ 1,200.00
15 Mechanical Totals				$ 111,200.00
Estimated Labor and Material Costs				$ 1,149,502.24
Miscellaneous Items				
Power Utility Allowance	1	LS		$ 20,000.00
Interior Tank Modifications Allowance	1	LS		$ 100,000.00
Electrical and Instrumentation	1	20%		$ 229,900.45
Building & HVAC Modifications	1	LS		$ 100,000.00
Bonds, Insurance and Mobilization	1	5%		$ 57,475.11
Construction Contingency	1	25%		$ 287,375.56
ESTIMATED CONSTRUCTION COST - LOW END				$ 1,944,253.36
Note that land acquisition costs are not included in this estimate				