ATP Digester

January 8, 2019

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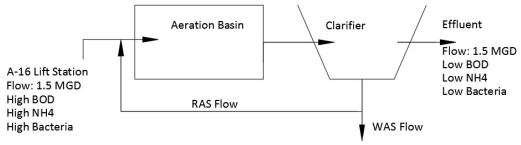
Activated Sludge - Process Diagram



Aeration Basin: Biological Treatment
Clarifier: Gravity Separation
RAS Flow: Return Activated Sludge
WAS Flow: Waste Activated Sludge

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Oxidation Basin and Clarifier

- I got some review points and clarifications from last presentation. (sorry)

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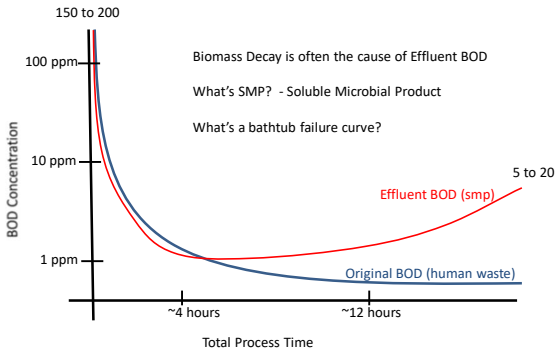
Recap - Aerobic Basin – Oxidation of BOD



4

What happens when??

Initial condition: (BOD_{in} ~175, TSS_{in} ~90)

Aerators Good Clarifier Off	Aerators Off Clarifier Good	Aerators Good Clarifier Good
BOD_{out} = 45	BOD_{out} = 120	BOD_{out} = 15
TSS_{out} = 35	TSS_{out} = 25	TSS_{out} = 10

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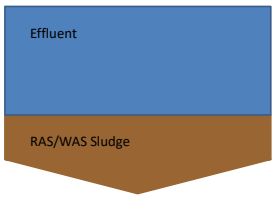
Recap - Clarifier

- Gravity Settler
- No Reactions Preferred
- Heavy Sludge Settles



- Plant Influent: 160 mg/L
- Plant Effluent: 15 mg/L
- VSS Production Ratio: 0.4

- (160 mg/L * 0.4 – 15mg/L)* 1.5MGD = 600 new pounds a day of VSS
- Or 12,500 gallons per day at 0.6% solids

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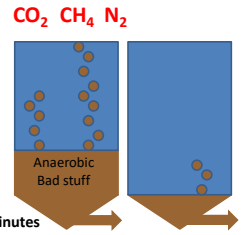
Recap - Clarifier – Effect on Residence Time
3 feet of sludge blanket

- Volume of 2' of Cylinder:
  - 3.14 x R x R x H = Volume
  - 40'x40'x3.14x2' x 7.5 gal/cf = 76,000 gallons
- Volume of 1' of Cone:
  - 3.14 x R x R x (1/3) H = Volume
  - 40'x40'x3.14x(1/3) H' x 7.5 gal/cf = 12,000 gallons
- RAS Pull = 1,200 gpm
- At 3' of sludge blanket (Cyl+Cone)
  - Volume 88,000 gallons / 1,200 gpm = **73 minutes**
- At 1' of sludge blanket (Cone)
  - Volume 12,000 gallons / 1,200 gpm = **10 minutes**
  - (sludge blanket should range between 1' to 2')



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Rising / Bolting Sludge – Degassing Bubbles

Example Picture.

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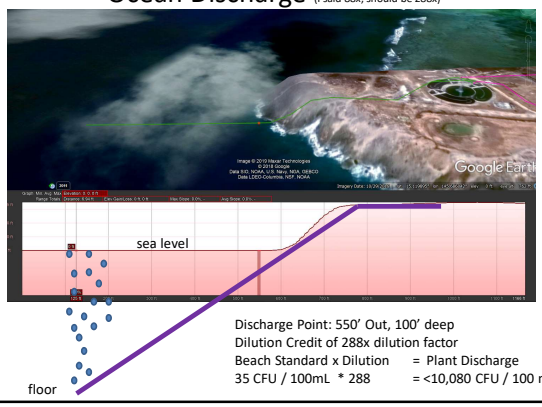
Ocean Discharge (I said 88x, should be 288x)



Discharge Point: 550' Out, 100' deep
Dilution Credit of 288x dilution factor
Beach Standard x Dilution = Plant Discharge
35 CFU / 100mL * 288 = <10,080 CFU / 100 mL

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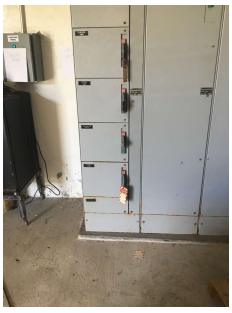
Improvements on Original Design
(not that many)



Mount the Control Panel Threshold higher than the pump pedestal.
& all the pumps are over-sized.

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ATP Pump Room – Clarifier Scum Sump

Open Vault inside Pump Control Room
- Subject to Flooding
- Odor and Vector – (gross)

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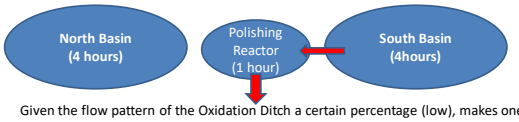
ATP Polishing Reactor



Given the flow pattern of the Oxidation Ditch a certain percentage (low), makes one pass and out.

A polishing reactor would stabilize Enterococcus Populations (lower standard deviation)

250 feet travel / 0.3 fps = 13 minutes per lap

6 hour residence time / 13 minutes per lap = 30 laps average
- The average may be 30, but about 2% of the water makes one pass
- (2.2 cfs inflow) / (25'x15'x0.3 fps basin flow) = ~2%

Example: Current Setup: ~2% bypass, i.e. one lap
Polishing Reactor: ~2% bypass x ~5% bypass = 0.1% bypass
(south) x (polishing) = (total)

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Why is ATP sized at 3.0 MGD for average daily??

"packaged design plant"
1993 Flow: ~1.0 MGD
2019 Flow: ~1.5 MGD

Benefits:
You won't have to expand it.
Retrofit costs are high.

Detriments:
Increased pumping and aeration electrical costs.

For plants built today:
VFD controls have all but eliminated problems for new plants.
3-PH VFD 50 hertz
(50/60)^3 = 58% of original power

Conclusion: Building a big robust plant is money well spent.

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ATP Digester

January 3, 2020

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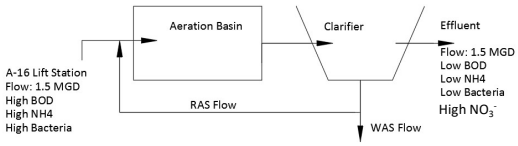
Activated Sludge - Process Diagram



Aeration Basin:	Biological Treatment
Clarifier:	Gravity Separation
RAS Flow:	Return Activated Sludge
WAS Flow:	**Waste Activated Sludge**

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ATP Pump Room

WAS Pump

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WAS Pump

Source: Clarifier RAS/WAP Sump

Destination: Digester

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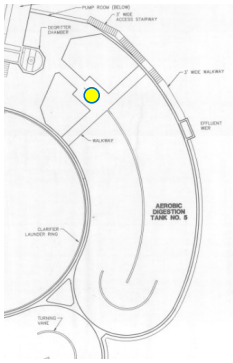
ATP - Digester



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ATP-Digester

- Contents:
  - 2% Thin Sludge
  - Bio-mass
    - Inert Solids
    - Volatile Solids
- Size:
  - 6,300 sq.ft.
  - 15 ft deep
  - 0.7 Million Gallons

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Food Source

- None
- Biomass Decay

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ATP - Digester

- Purpose
  - Aerobic Digestion of Solids
    - Volatile Solids turning into Inert Solids
    - >60% Volatile Suspended Solids (VSS) to <40% VSS
    - https://www.youtube.com/watch?v=iAiRNq8JXw8
    - (similar to soil composting but with water)
    - 0.7 MG / 0.1 MGD Flow = 72 days (very big)
    - (good design parameter = 20 to 30 days
  - Concentration of Solids
    - 0.6% RAS/WAS Flow converted to >2.0% Thin Sludge Flow

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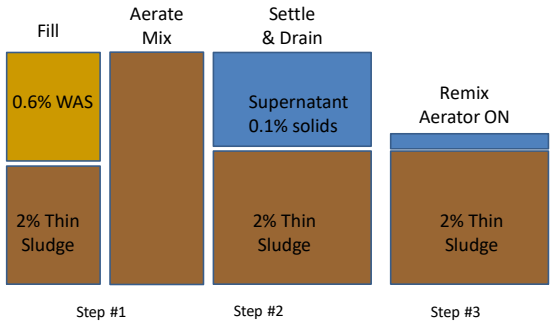
Digester - Thin Sludge Concentration



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ATP Digester Layers – Aerator OFF

Floating Layer: Floating Solids that are 0.1' to 0.5' thick that contains foam, grease balls, oil, and garbage. Contents should remain in digester to be digested.

Clear Water Layer: ~2' to 7' thick. Needs to be removed periodically to thicken sludge.
Digester Supernatant Pump removes at rate of 500 gpm to the headworks.
Operators currently using a trash pump because of bad ineffective design.

Thin Sludge Layer: ~3' to 8' thick. New thin sludge pump will withdraw sludge at 15 gpm. Thin sludge sent to screw press to be made into solids.

Bottom Grit Layer: ~0' to 1' thick. Grit should always remain in the digester. The digester should be drained and cleaned out every 5 to 20 years.

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WAS – Why you have to?

- Maintain steady-state conditions – Aeration Basin
  - Keep the clarifier sludge blanket to 1' to 2'
- Purge out Inactive Biomass – Aeration Basin
  - Old bacteria die
- Helps control bio-diversity – Aeration Basin
  - Prevent denitrification bacteria from accumulating
  - Solids retention time = sludge age = 10 to 20 days

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Aeration Basin

CONVERSION EXAMPLE

Assume: Solids Retention Time (SRT) = 30 days
Mixed Liquor Suspended Solids (MLSS) = 3,500 mg/L
Aeration Basin Volume (V) = 1.5 MG
Waste Sludge Concentration (RSS) =10,000 mg/L

$$WastedSludge(lbs/day) = \frac{(MLSS)(V)(8.34)}{SRT} = \frac{(3{,}500mg/L)(1.5MG)(8.34)}{30days} = 1{,}459(lbs/day)$$

Conversion to gallons per day (gpd) for setting of wasting pumps:

$$WastedSludge(gpd) = \frac{WastedSludge(lbs/day)}{(RSS)(8.34)} = \frac{(1{,}459lbs/day)(1{,}000{,}000)}{(10{,}000mg/L)(8.34)} = 17{,}500(gpd)$$

Based on the above listed conditions, you would waste 17,500 gpd to maintain a 30 day SRT. Any SRT can be achieved using this method.

From the aerator O&M manual

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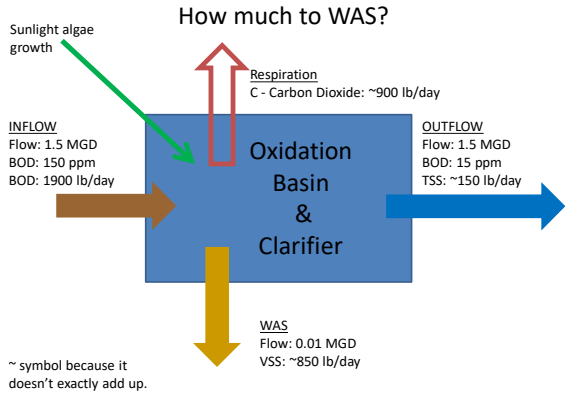
How much to WAS?



~ symbol because it doesn't exactly add up.

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WAS Pumping Rate

- Flow: 10,000 gpd @ 650 gpm = ~ < 15 minutes
- WAS Pump: Gorman Rump 7.5 HP Super-T Series
- So this pump is a bit oversized…

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Digester – Biological Reactor

Oxygen Supply
- 50 HP Aerator
- 24 hours per day
- ~3.0 # O_2 per (HP-Hr)

= 3,600 # O_2 per Day

VSS Loading
- ~850 lb/day VSS
- ~2.0 # O_2 per 1.0 # VSS

= ~1,700 # O_2 per Day

Solution: Run Aerator enough to keep smell away.

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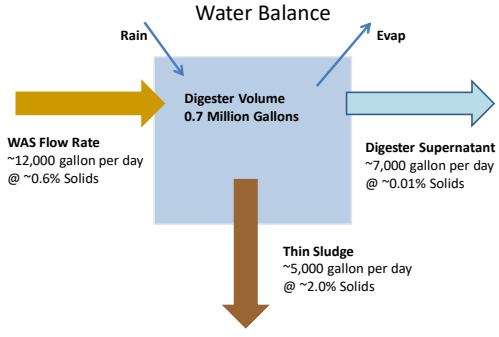
ATP Digester Flow Rates Water Balance



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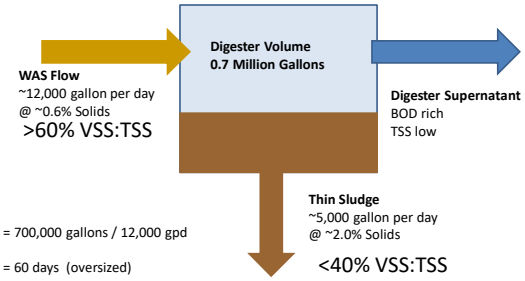
ATP Digester Flow Rates Waste Character



= 700,000 gallons / 12,000 gpd

= 60 days (oversized)

Volatile suspended solids (VSS) is a water quality measure obtained from the loss on ignition of the mass of measured total suspended solids.[1] This ignition generally takes place in an oven at a temperature of 550 °C[2] to 600 °C. It represents the amount of volatile matter present in the solid fraction of the measured solution.

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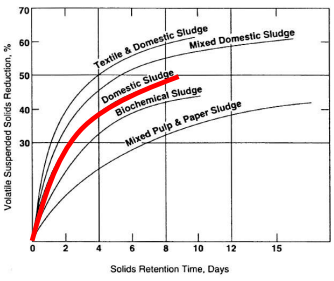

FIGURE 20.50 Relative solids destruction of several sludges by aerobic digestion.

Law of Diminishing Returns
A large volume digester is marginally better than a small one.

Aerobic Digestion, WEF 2006.

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ATP Digester Layers

Floating Layer: 6" thick
- Yuck
- FOG Balls
- Rising Sludge
- Scum / Floating Trash

Clear Water Layer: 2' to 7' thick
- High BOD
- Low TSS

Thin Sludge Layer: 3' to 8' thick
- High BOD
- High TSS
- Good VSS to TSS ratio
  - VSS – Volatile Suspended Solids
  - TSS – Total Suspended Solids

Bottom Grit Layer: 6" thick
- High Sand / Silt
- Lost Wrenches / Storm Debris

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Supernatant Character

TABLE 20.19 Characteristics of supernatant from aerobic digestion systems.

Parameter[a]	Range	Typical value
pH	5.9–7.7	7.0
BOD_5, mg/L	9.0–1 700	500
Filtered BOD_5, mg/L	4.0–183	50
COD, mg/L	288.0–8 140	2 600
Suspended solids, mg/L	46.0–11 500	3 400
Kjeldahl nitrogen, mg/L	10.0–400	170
NO_3–N, mg/L	—	30
Total phosphorus, mg/L	19.0–241	100
Soluble phosphorus, mg/L	2.5–64	25

[a] BOD_5 = five-day biochemical oxygen demand; COD = chemical oxygen demand; and NO_3–N = nitrate-nitrogen.

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ATP Digester Pumps

WAS Flow Inflow Pump	Digester Supernatant Outflow Pump	Thin Sludge Feed Outflow Pump
7.5 HP Gorman Rupp	7.5 HP Gorman Rupp	5.0 HP Gorman Rupp
~500 gpm	~500 gpm	~300 gpm
~15 minutes per day	~10 minutes per day (more like 1 or 2 hours per cycle to remove as much as possible)	~8 minutes per day (more like 8 hours per cycle to have a shift where we produce solids)

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ATP Pump Room

WAS Pump

Size: 7.5 HP

Source: Clarifier Sump
RAS/WAS Solids

Character:
0.6% TSS
High fraction of VSS to TSS

Destination:
Digester

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WAS Pump

Source: Clarifier RAS/WAP Sump

Destination: Digester

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ATP Pump Room

Digester Supernatant Pump

Size: 7.5 HP

Source:
Middle Height of Digester

Character:
0.1% TSS, clear

Destination:
Headworks

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Digester Supernatant Pump

Source: Digester Clear Water Zone

Destination: Headworks

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ATP Pump Room

Thin Sludge Feed

Source:

Size: 5 HP

Lower Layer Digester
Digested Solids

Character:
2.0% TSS and
Low fraction of VSS to TSS

Destination:
Belt Press Filter

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Thin Sludge Feed

Source: Digester – Thin Sludge Zone

Destination: Sludge Press

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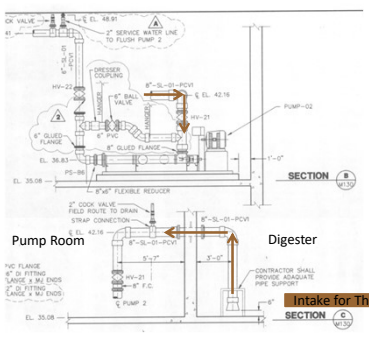
Thin Sludge (Section C of M131)



- Thin Sludge Pump is 6" from the bottom to reduce the amount of grit pumped to the belt filter press.

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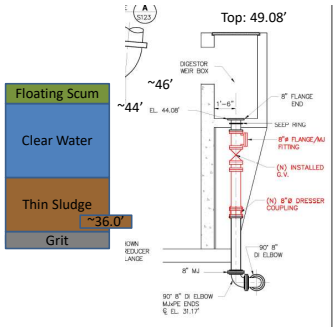
Digester Weir Box Section.



Digester Supernatant:

- This setup does not work.
- It's ridiculous to overflow the floating scum layer to the process and only to elevation 46'.
- Operators stick a dewatering pump suction line and pull from the clear water layer instead.

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Digester Weir Box Picture

Digester Weir Box:

- Water at elevation 46' overflows into the box. Box is drained by the digester supernatant pump.
- Since the operators don't want to drain of the floating scum layer. They haven't used the pump much.

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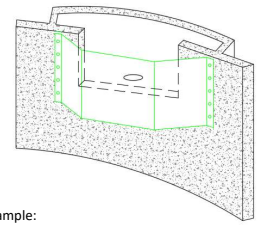
Digester Weir Baffle – Potential Solution



Example:
Clearwater starting at 43' and ending at 47'. Run supernatant pump for 5 hours and check again.

#1 – Remove concrete weir wall so it is a square box.

#2 – Put on a 12 gauge stainless steel sheet, 6' x 9' and anchor bolt it to the wall.

Digester water level adjustable from:
~48' Max water Level
~44.5' Min water level.

Drain off 3' of supernatant, and maintain 9' of sludge.

Floating scum is separated by the baffle.

0.9 cfs / 4 sq.ft = 0.25 fps entrance velocity or 15 fpm. Could be mitigated by horizontal plate beneath it.

This might be best.

You are just going to have to maintain 9' of sludge with this solution. Then you can drain off about 3' of clearwater max.

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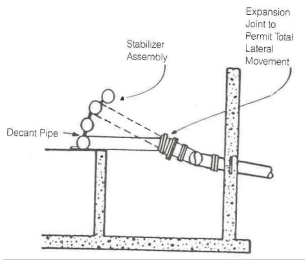
Other Solutions



- Floating Decanters

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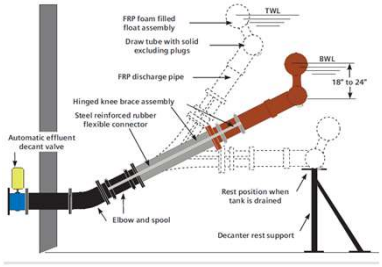

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Submerged Baffled Weir

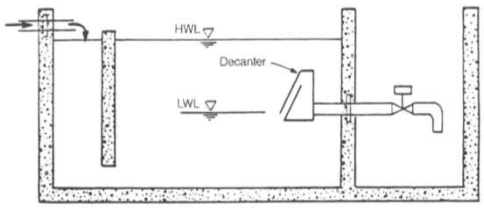

Figure 11.61 Eldora decant system in one tank.

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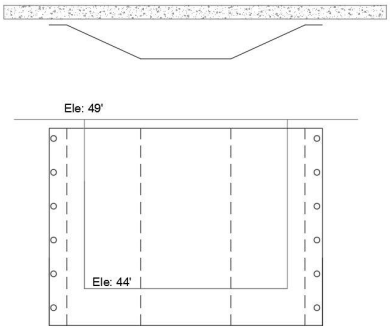
Digester Weir Baffle



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ATP Digester Aerator

- Is this aerator meant to run of one constant level?
  - They put the Elevation Wall at 46' so that the level will always be touching the impeller of the aerator. Is this important? Not really. We would drain off to 44' but then fill it back up to 47' almost immediately.
- For this construction, we will have to drain and clean the digester. Probably a good thing.
  - Is the grit in the aeration basin or the digester?
  - How much grit do we have stored in the digester?
    - 1.5 cu ft per MG x 1.5 MGD x 365 days x 10 years = 8,000 cubic feet ???
      = 300 cubic yards ???
- 8,000 cubic feet / 6,500 sq ft. = 1.25 feet depth
- Answer: We will find out when we take the digester offline

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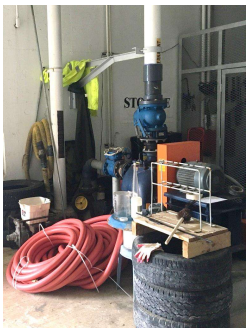
Digester Supernatant Pump

All this work so that the digester supernatant pump goes from a storage area, to a working pumping again.

The 400 gpm, I got from the design plans, and without a bunch of further information, that seems about right.

It would be better than setting up a gas powered trash pump on the concrete deck and running that.



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Common Operational Problems

- Nuisance Odors
  - Check loading and aeration run time
- Excessive Foaming
  - Add chemical, spray water,
  - press biosolids, or wait it out
- Solids Deposition
  - Fillets in concrete corners
  - Check if under mixed (HP required)
  - remove grit first
- Low pH
  - Check loading, add lime.

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