EST 1808
CITY OF
DELAWARE
OHIO

PRIME AE®

Presentation for

SEOWEA Seminar

May 30, 2019

AGENDA

- Background
- Original Traveling Bridge Sand Filters
- Preliminary Alternative Evaluations
- Equipment Selection
- Detailed Design
- Construction & Startup

Background

- Discharges to the Olentangy River
- 10 MGD Design Capacity (currently at 5 MGD ADF)
- 10-15 MGD Peak Day Flows
- Occasional 20-30 MGD Peak Hour Flows
- Filters Installed in 1985 and Replaced in 2005 - Rated for 5 MGD
- Sand was Replaced in 2014 and Underdrains were Repaired
- OEPA Compliance Schedule Required Repair/Replace & 10 MGD

Background

Plant Consists of the Following:

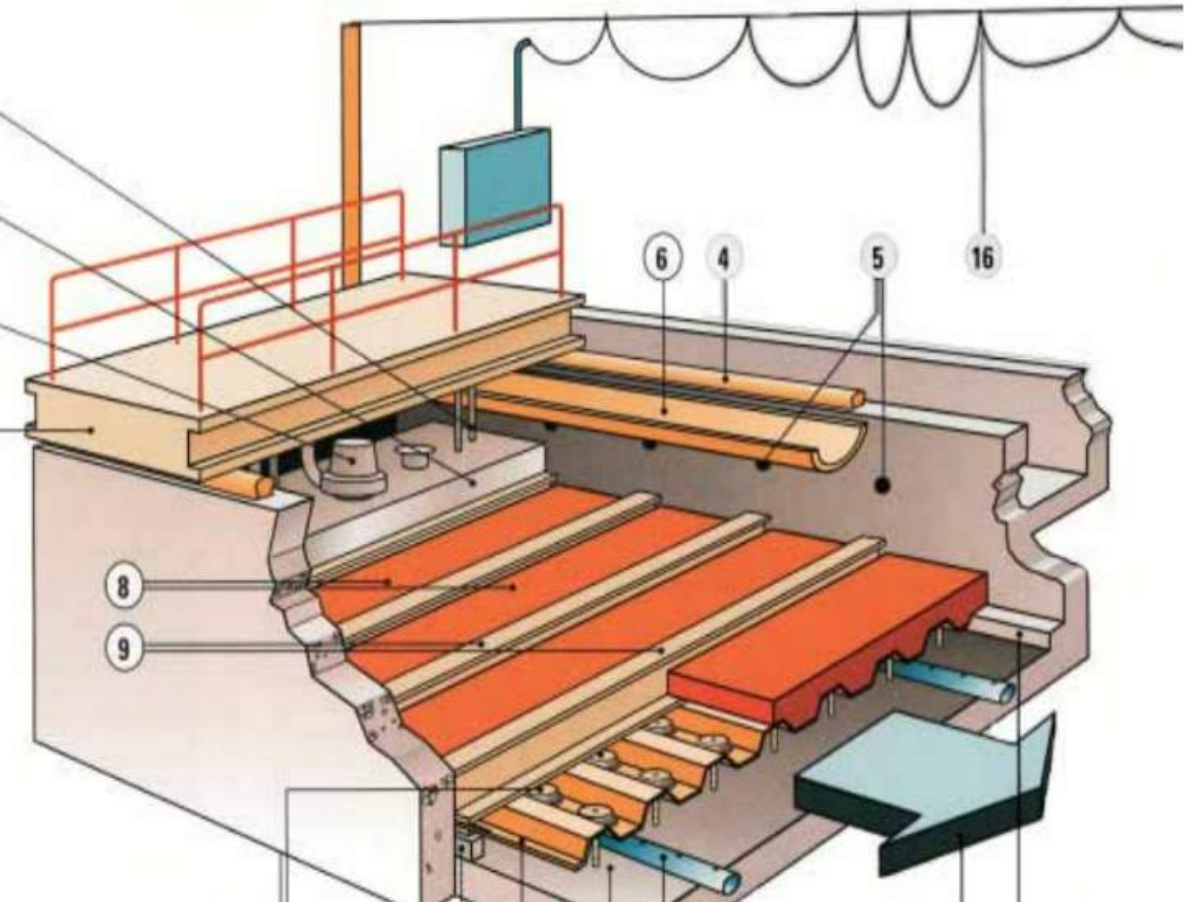
- ✓ EQ Basin
- ✓ Influent Pumping & Septage Receiving
- ✓ Mechanical Fine Screens & Vortex Grit Removal Tank
- ✓ Primary Settling Tanks
- ✓ Activated Sludge Biological Treatment & Secondary Clarifiers
- ✓ Tertiary Screw Pumps and Tertiary Filters
- ✓ UV Disinfection
- ✓ Post Aeration
- ✓ Aerobic Digestion
- ✓ Sludge Dewatering & Odor Control System


42
Waste Water
Tertiary Filters
Hayes St
Olentang

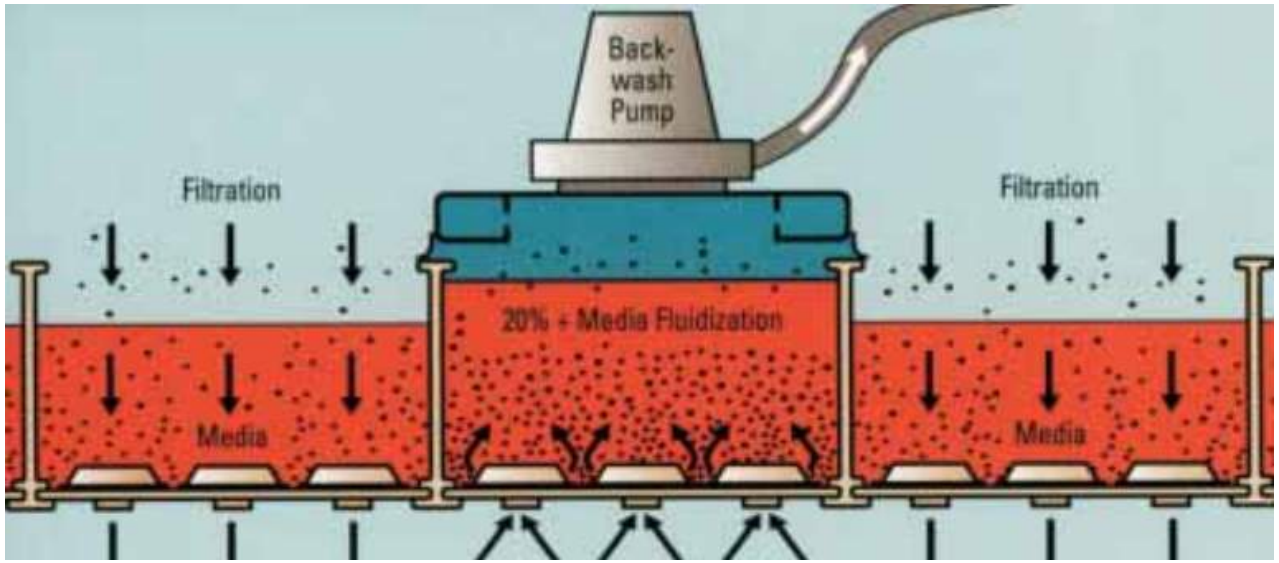
Traveling Bridge Filters

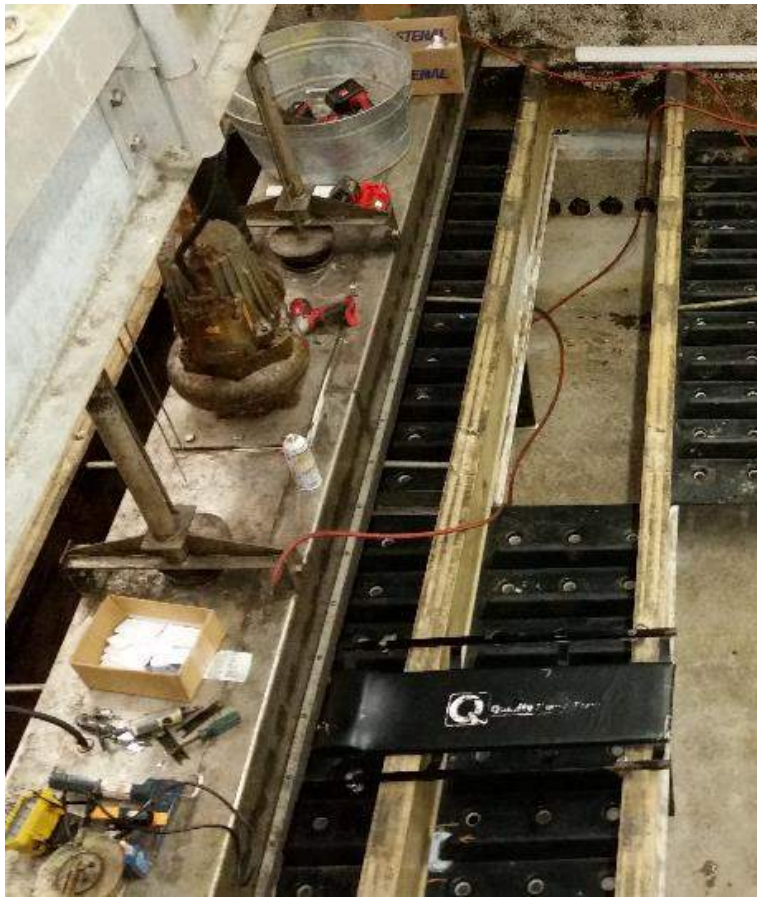
- Filter Flies
- Sand Gets Lost through Segmented Underdrains and in Backwash
- Mechanical Issues - Bridge Alignment
- No TSS Reduction
- Sand is Blinded - Backwashes Continuously - Large Waste Volume

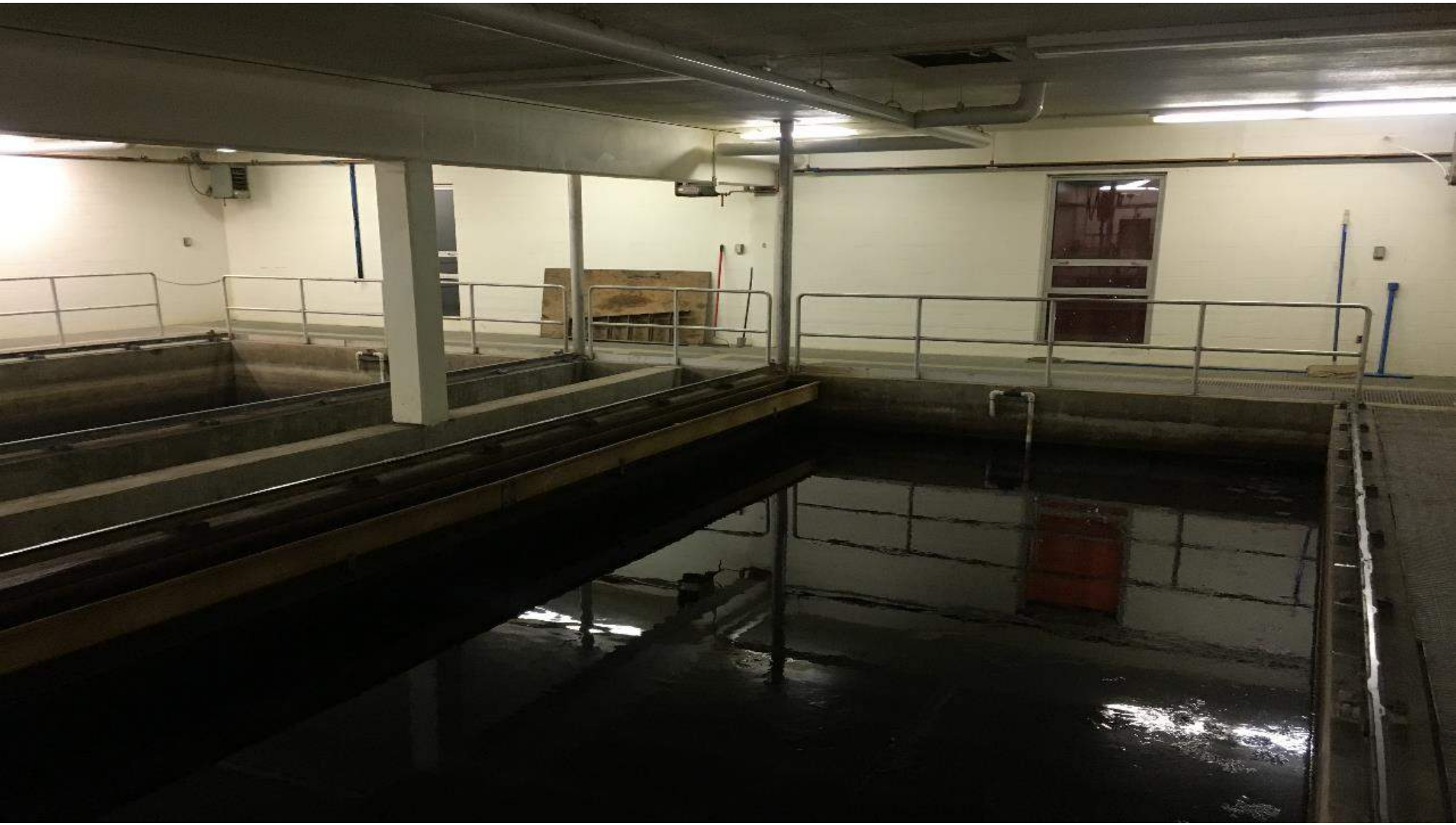
Traveling Bridge Sand Filters

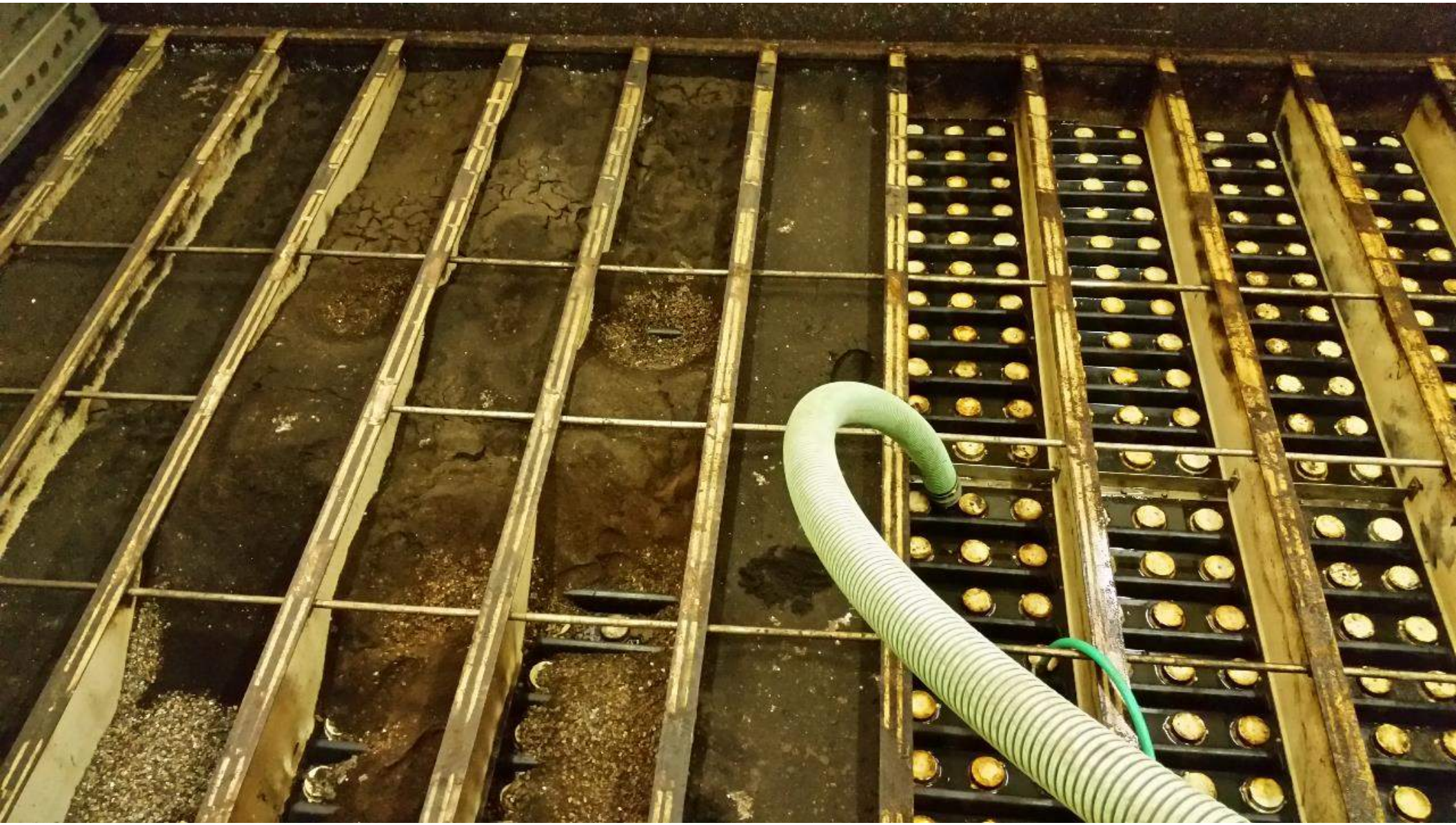


Traveling Bridge Sand Filters









Equipment Selection

- City Issued an RFP to Manufacturers
- Selection Based on Capital and Operating Cost, Quality, Experience, Warranty and References (and Site Visits)
- Present Worth Analysis
  - Electrical Costs
  - Chemical Costs
  - Labor
  - Replacement costs

Preliminary Alternative Evaluations

- Proposals were Received from the Following (all are approved under California Title 22):
  - Kruger Hydrotech
  - WesTech SuperDisc
  - Nova Quantum Disk Filter
  - Aqua-Aerobics Systems (AquaDisk and AquaDiamond)

KRUGER HYDROTECH

- Polyester Woven Cloth Filter Elements (10 to 60 microns)
- Inside-Out Flow Pattern
- Up to 6.0 gpm/SF Loading Rate
- Requires less than 17.4 inches of head for operation
- Housing material: ABS
- Available in 2.2 meter or 2.6 meter Diameter
- Driven by a VFD Gear Motor with a Belt Drive via a SS Drive Chain
- Owned by Veolia with operations in Vandalia, Ohio

KRUGER HYDROTECH

Type 1, tank version

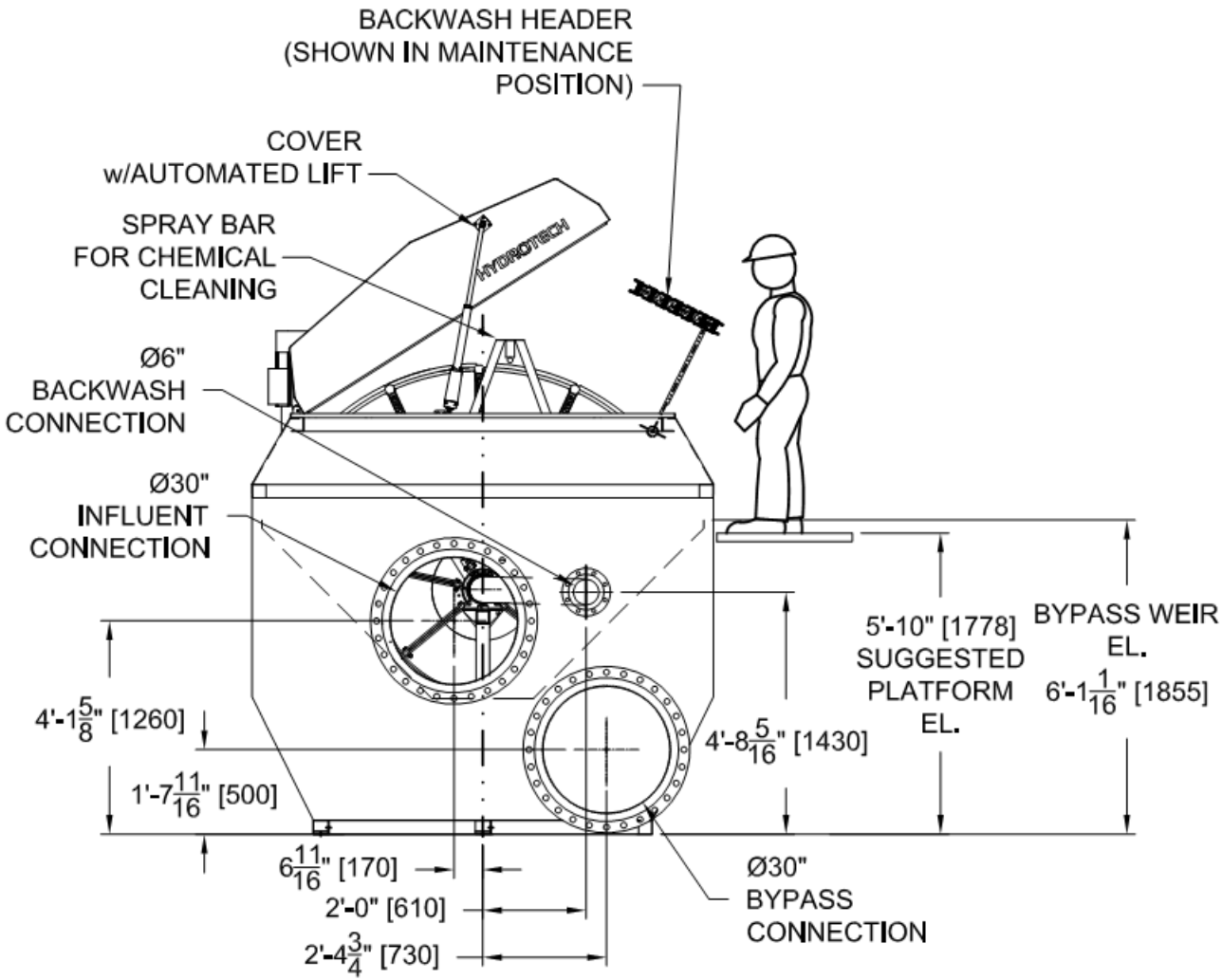
1. Inlet
2. Outlet
3. Backwash outlet
4. Rinse water conn.
5. Filter discs
6. Drive unit

Type 2, without tank

The tank version of Hydrotech Discfilter is provided with an internal emergency by-pass and a level weir to maintain the water level after the filter.

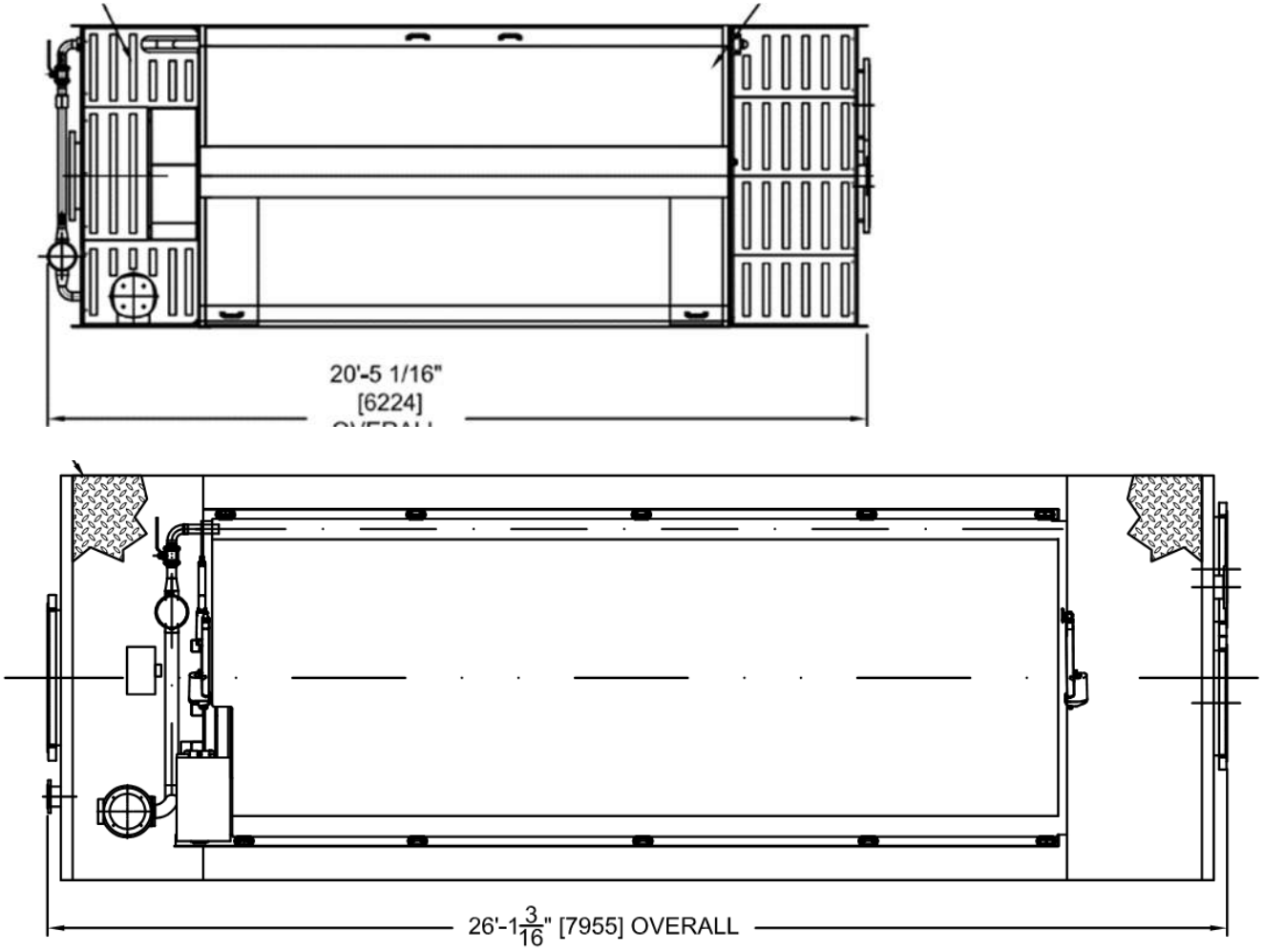
The versions without tanks are designed for installation in a concrete channel or basin.

KRUGER HYDROTECH



INFLUENT SIDE VIEW
RH BACKWASH

KRUGER HYDROTECH



PLAN VIEW

KRUGER HYDROTECH

KRUGER HYDROTECH

Advantages:

- Oscillating Backwash Spray Bar Reduces Water/Energy Consumption
- Low Head Loss (approximately 12 inches)
- Numerous Installations and Retrofits (400 in US and 1900 Worldwide)

Disadvantages:

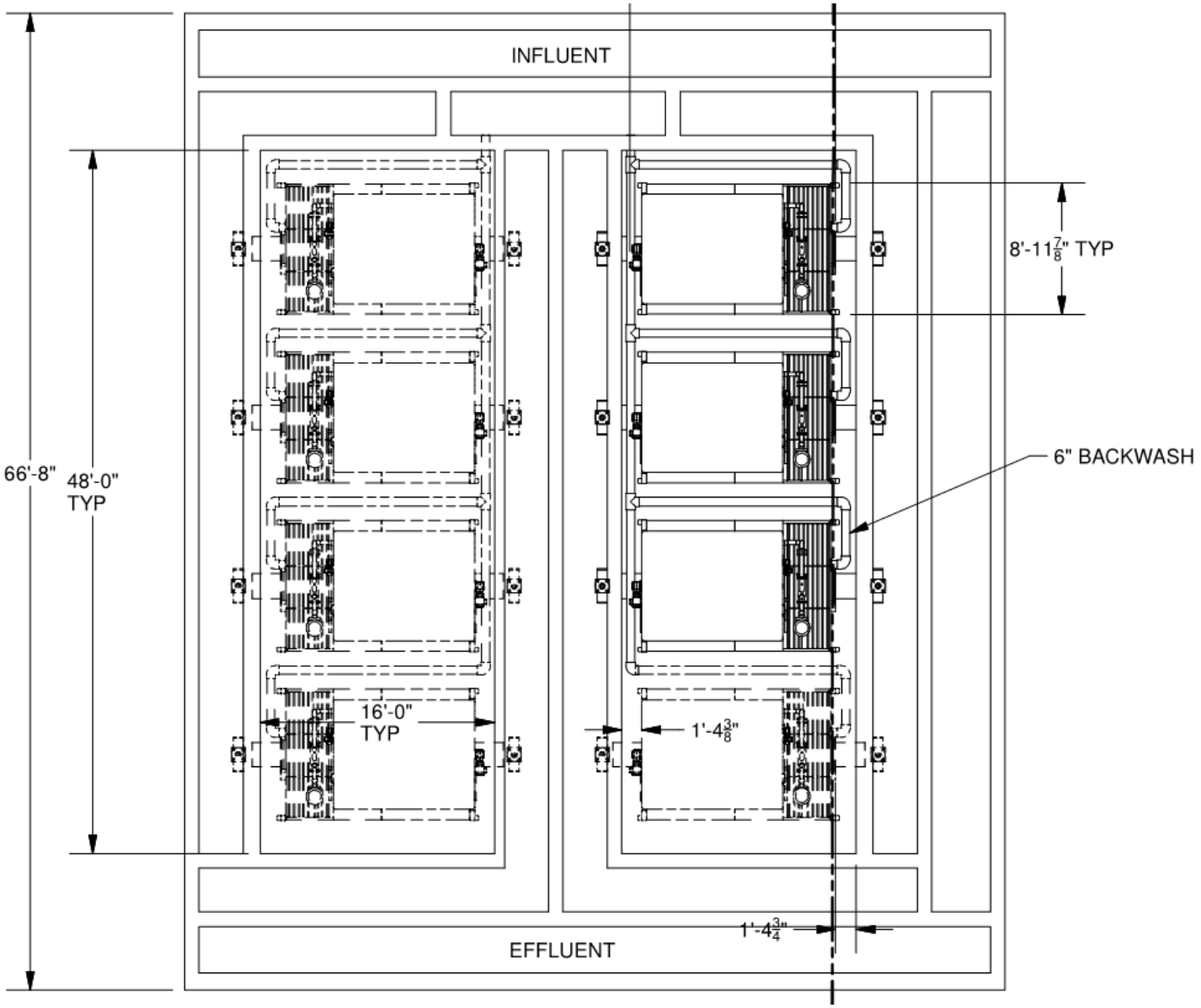
- Too Long for Existing Tanks - Only 1-10 MGD Unit Fits
- Lower hydraulic loading rate (6.0 gpm/sf)
- Fabric Screen Not as Resistant to Damage as SS or Cloth
- Lots of Nozzles to Clean
- Screens can get Clogged with Solids or Algae
- Higher maintenance cost than some of the other tertiary filter systems

WesTech SuperDisc

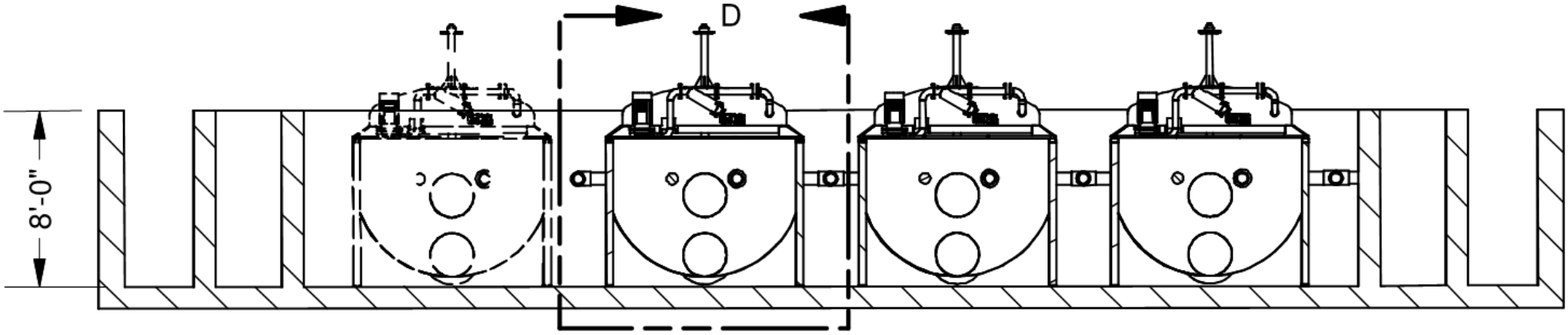
- Polyester woven media
- Up to 6.5 gpm/SF Loading Rate
- Requires less than 17.4 inches of head for operation
- Filter media options from 10 to 60 micron
- Housing material: FRP frame
- Sizes available: Diameter: 1.9 meters or 2.4 meters
- The rotation of the disc filter is driven by a helical-bevel gear drive via a non-corrosive synchronous cog belt

WesTech SuperDisc

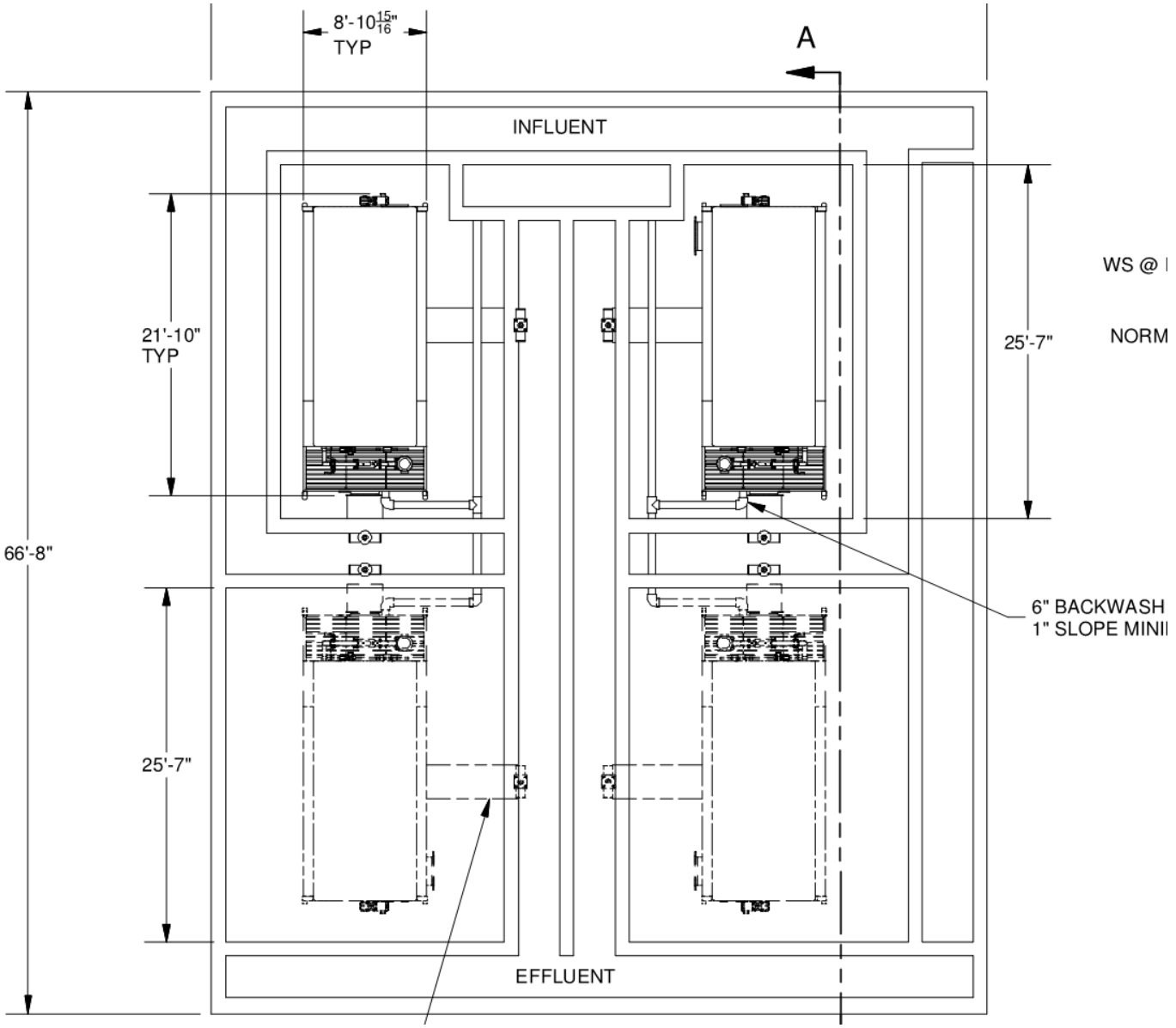
WesTech SuperDisc



WesTech SuperDisc



WesTech SuperDisc



WesTech SuperDisc

Advantages:

- 8 - 5 MGD Units Fit in Existing Tanks (35 MGD firm capacity)
- Oscillating Backwash Spray Bar Reduces Water Consumption
- Low Head Loss (approximately 12 inches)
- Numerous Installations and Retrofits (140) over 20 years

Disadvantages:

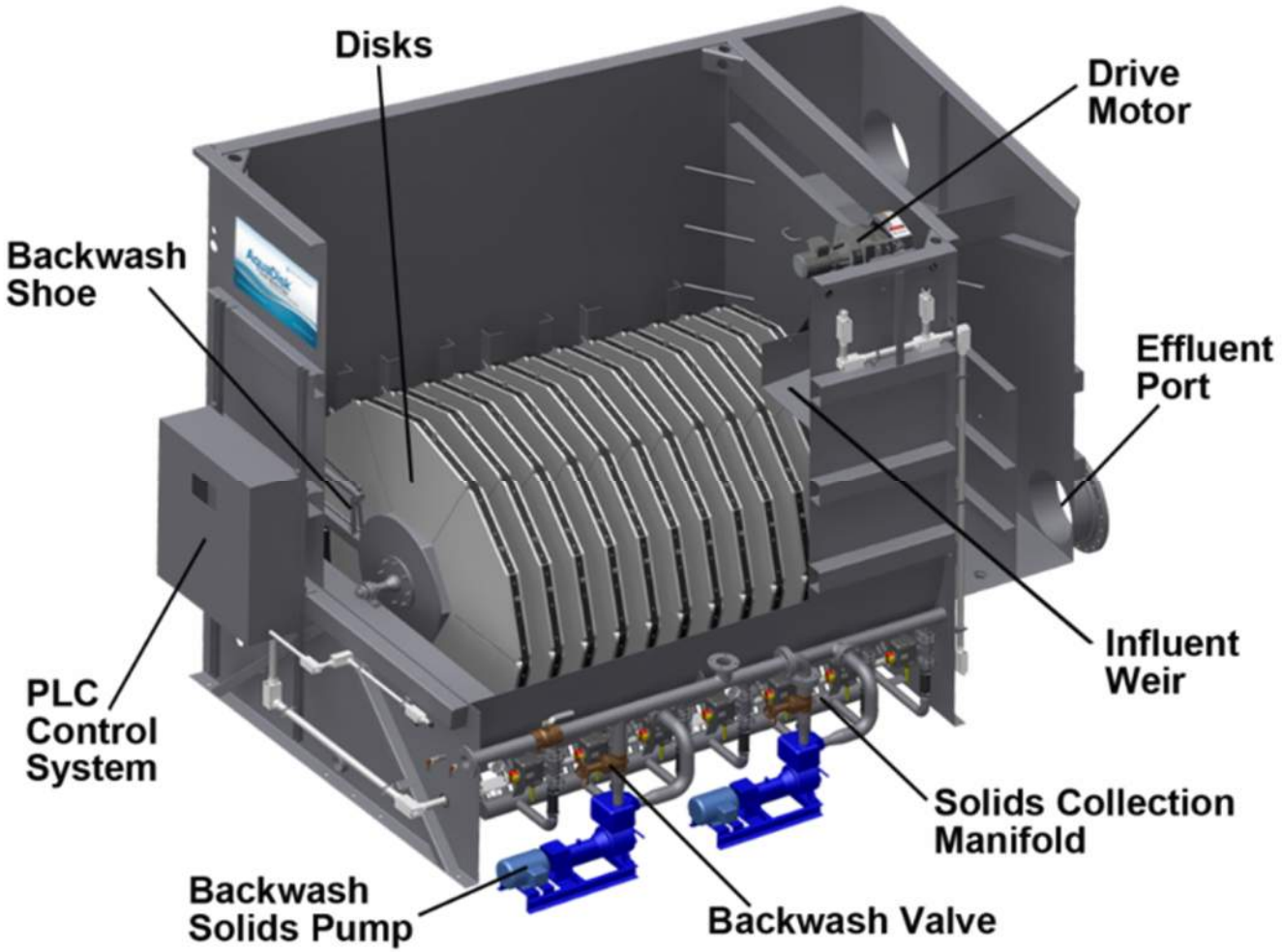
- Only 1 -10 MGD Unit Fit in each Tank
- Lower hydraulic loading rate (6.5 gpm/sf)
- Fabric Screen Not as Resistant to Damage as SS or Cloth
- Lots of Nozzles to Clean
- Screens can get Clogged with Solids or Algae
- Higher maintenance cost than some of the other tertiary filter systems

Aqua Aerobics - AQUADISK

Pile Cloth Media

- Outside-In Flow Pattern
- Provisions for Removing Scum and Floatables
- Allows Solids to Settle to Bottom to be Removed
- Depth of Media Provides Increased Solids Storage
- 7 gpm/SF (testing 16 gpm/SF) Loading Rate
- Backing Support Offers Durability and Longer Media Life
- Variable Speed Drive for Bridge and Backwash Pump
- Advanced drive and tracking system prevents misalignment

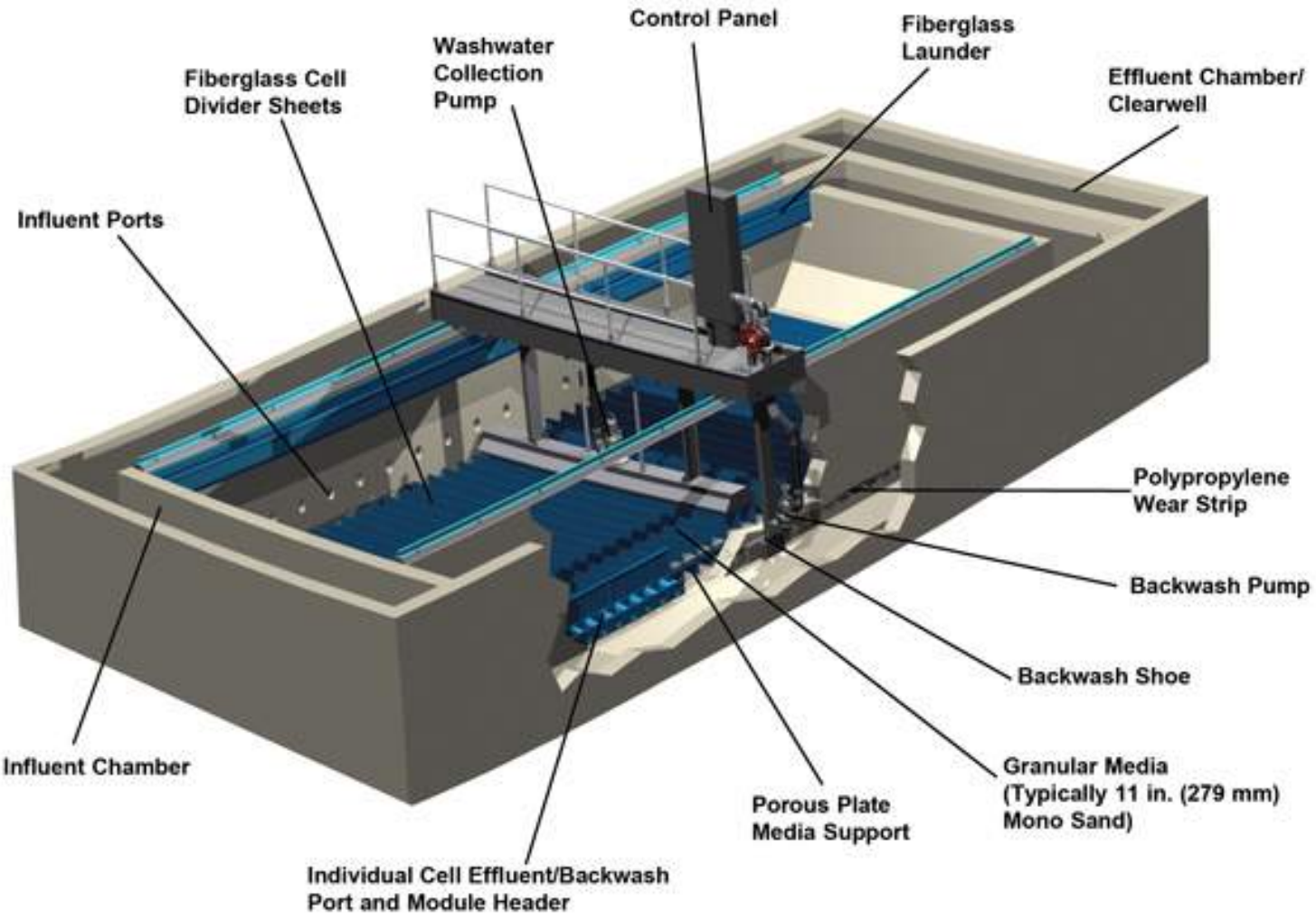
Aqua Aerobics - AQUADISK



Aqua Aerobics – AQUA MiniDisk

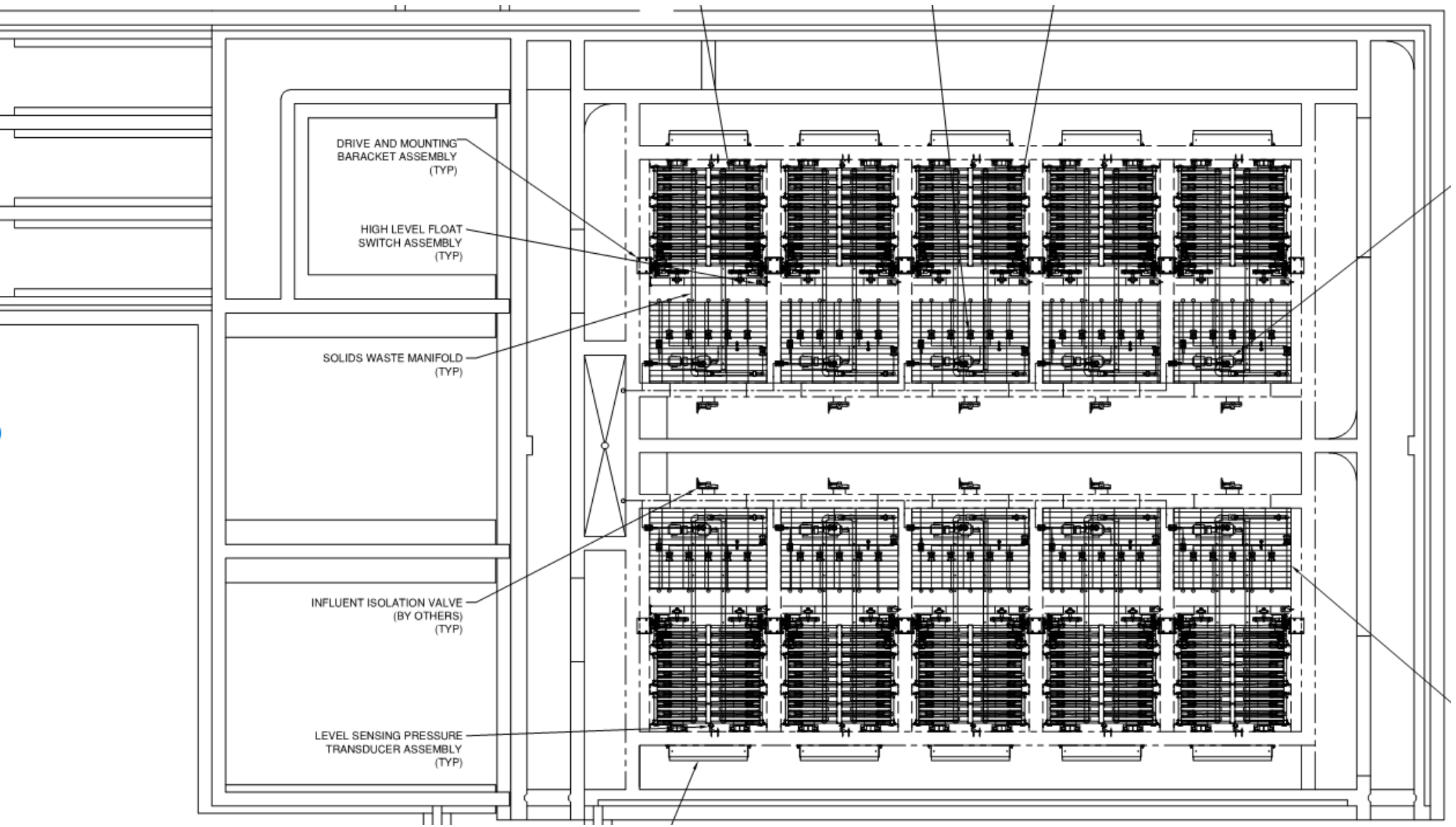
Aqua Aerobics -

AQUADIAMOND



Aqua Aerobics -

AQUADIAMOND


DRIVE AND MOUNTING BARACKET ASSEMBLY (TYP)
HIGH LEVEL FLOAT SWITCH ASSEMBLY (TYP)
SOLIDS WASTE MANIFOLD (TYP)
INFLUENT ISOLATION VALVE (BY OTHERS) (TYP)
LEVEL SENSING PRESSURE TRANSDUCER ASSEMBLY (TYP)

Aqua Aerobics - AQUADISK

Advantages:

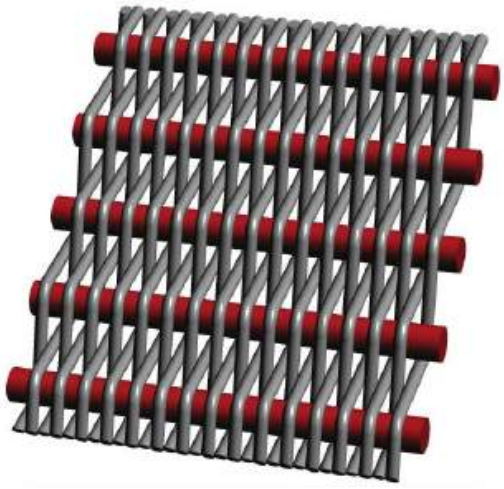
- Does not Backwash as Often
- No Nozzles to Clean
- Fouling Not as Bad and Doesn't Require Manual Spraying
- Resistant to Slug Loadings of Solids
- Up to 7.0 gpm/SF Loading Rate
- 2, 5, 10 (or larger) Micron Ratings for > TSS and Phosphorous Removal

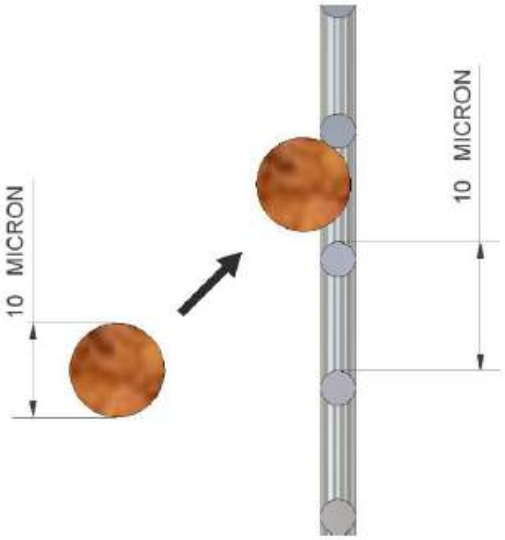
Disadvantages:

- The MinDisk is only Expandable to 16 MGD in the Existing Space
- The Diamond can Handle 20 MGD in the Existing Tanks
- Traveling Bridge Design
- Need Taken Out of Service to Remove Biological Growth (Bleach)
- Higher Capital Cost

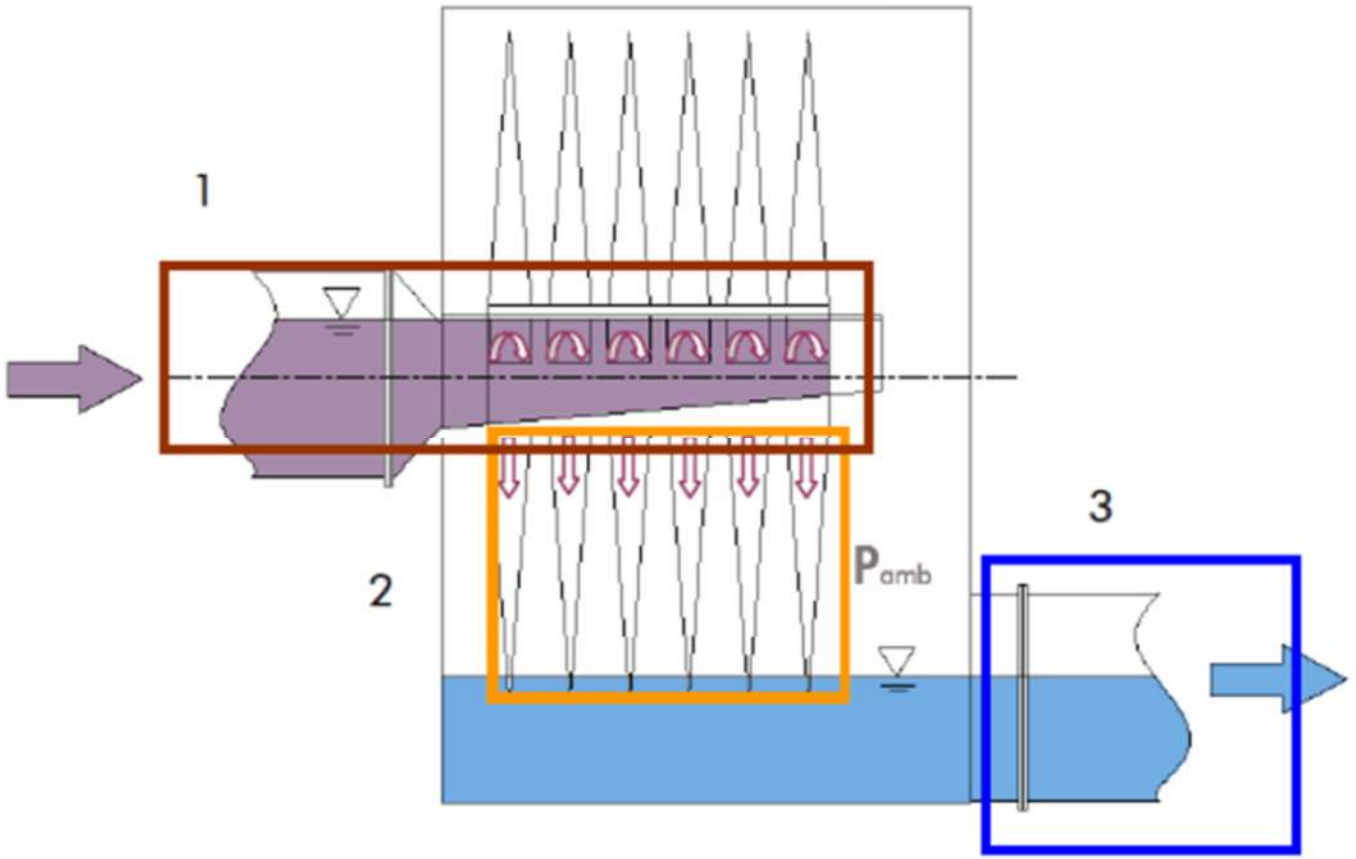
NOVA – Quantum II

- 316 SS Microscreen with a Dutch weave
- Screens Rotate Continuously
- 20 micron Openings Rated to Remove 10 micron Particles using Advanced Dynamic Tangential Filtration (ADTF)
- Entire Screen Area is Used in Hydraulic Load Calculations instead of Wetted Area

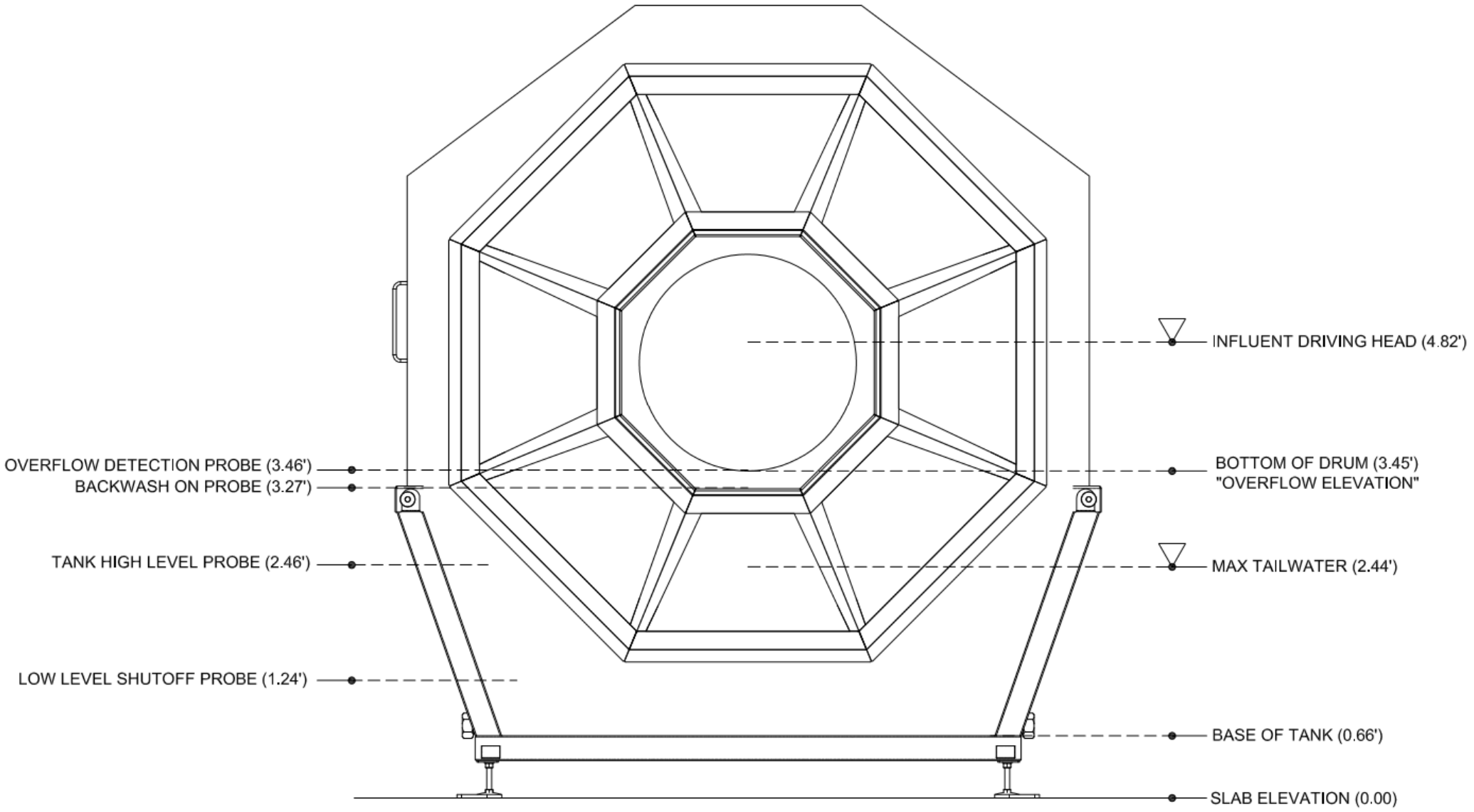




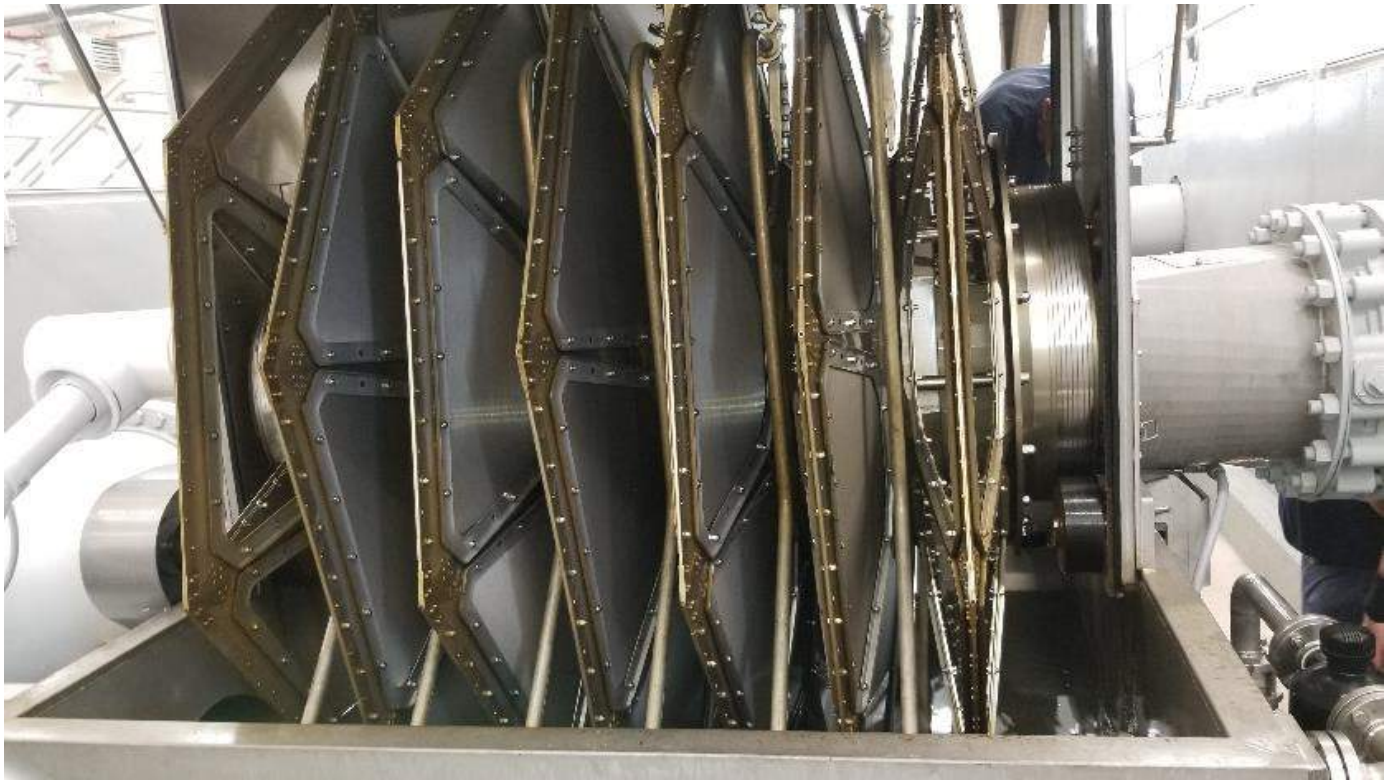
NOVA – Quantum II



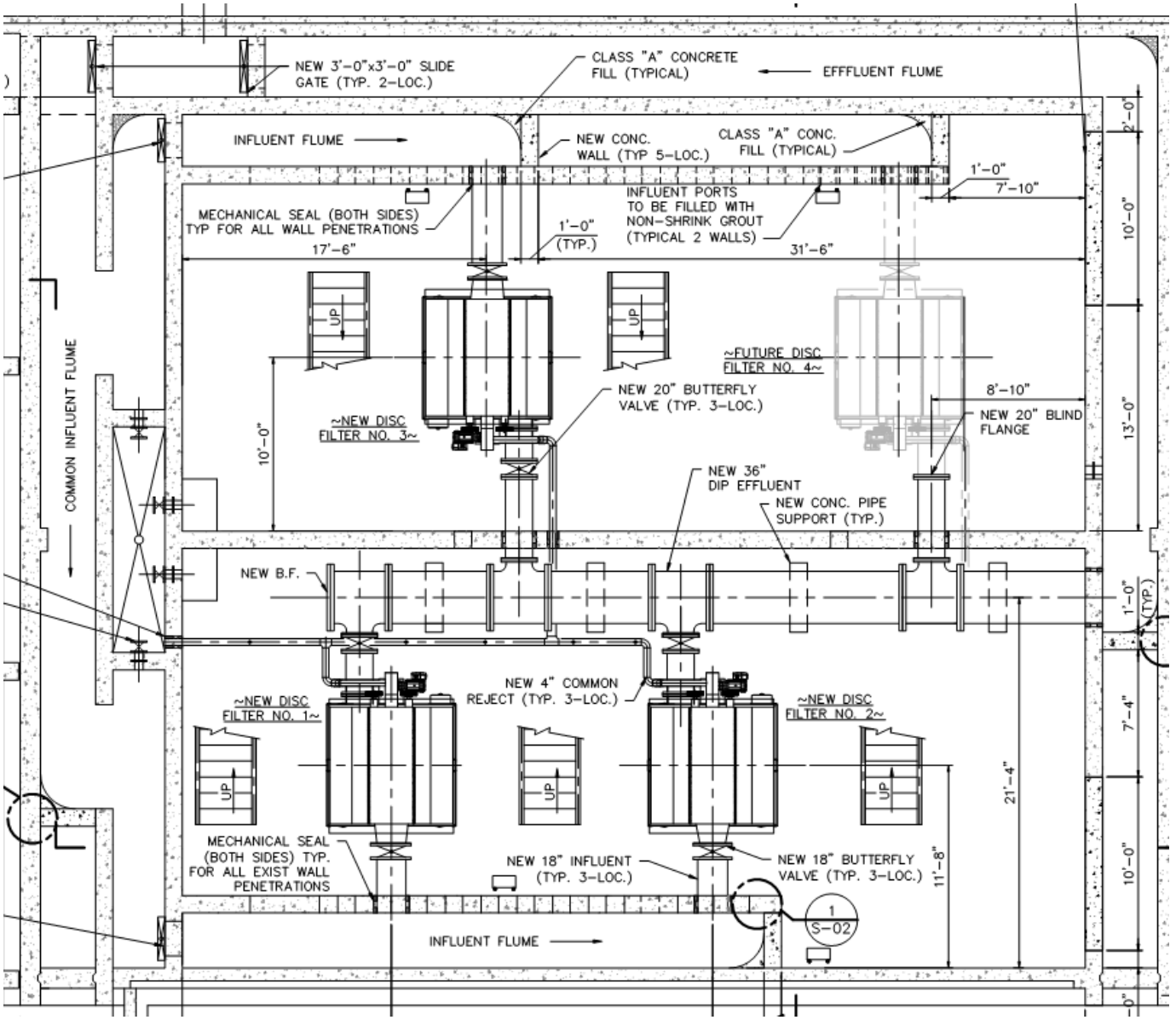
NOVA – Quantum II

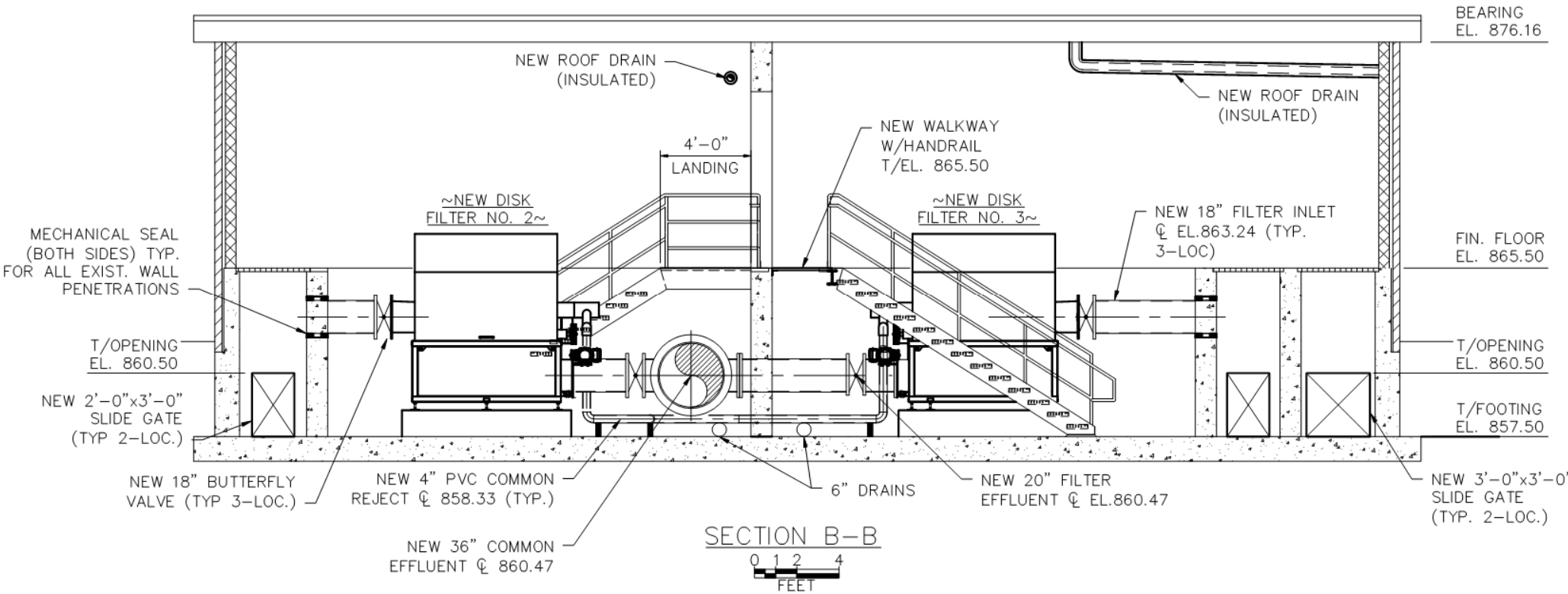

INFLUENT DRIVING HEAD (4.82')
OVERFLOW DETECTION PROBE (3.46')
BACKWASH ON PROBE (3.27')
BOTTOM OF DRUM (3.45')
"OVERFLOW ELEVATION"
TANK HIGH LEVEL PROBE (2.46')
MAX TAILWATER (2.44')
LOW LEVEL SHUTOFF PROBE (1.24')
BASE OF TANK (0.66')
SLAB ELEVATION (0.00)


2
2



NOVA – Quantum II





SECTION B-B

0 1 2 4
FEET

NOVA – Quantum II

Advantages:

- 6-5 MGD units can fit in the existing tanks (25 MGD firm) or 4-10 MGD units can fit for a firm capacity of 30 MGD
- Highest hydraulic loading rate (16.0 gpm/sf)
- Least amount of square footage
- All SS construction - longest life media (estimated 10 years)

Disadvantages:

- Only 12 installations of the newer model (74 installations total)
- Cleaning Backwash Nozzles (100 for 5 MGD unit, 200 for 10 MGD unit)
- Chemical Cleaning with bleach is required every 3 to 6 months
- Screens can get Clogged with Solids or Algae
- Higher operation and maintenance cost

Preliminary Alternative Evaluations

Pros and Cons of Different Filter Technologies

- Hydraulic loading & solids loading rates
- Filter backwash rates, pressures, frequency
- Head loss & impact on existing hydraulic grade line
- Failure modes
- Maintenance
- Nozzles vs Vacuum Backwash Shoe
- Need for Chemical Cleaning

Equipment Selection

- City Chose NOVA based on Present Worth Analysis
  - Electrical Costs
  - Chemical Costs
  - Labor
  - Replacement costs
- However, Overriding Factor was the Capital Cost
- PRIME Prepared Detailed Design & Bidding Documents

Filter Configurations & Basic Information								
	Kruger Hydrotech Discfilter (Option A - 5 MGD Units)	**Kruger Hydrotech Discfilter (Option B - 10 MGD Units)**	**WesTech SuperDisc (5 MGD Units)**	**WesTech SuperDisc (10 MGD Units)**	**Nova Quantum Disk Filter (5 MGD Units)**	**Nova Quantum Disk Filter (10 MGD Units)**	**Aqua-Aerobics AquaDisk**	**Aqua-Aerobics AquaDiamond**
Filter Media	PET monofilament woven fabric		Polyester woven media		316 SS microscreen		Pile cloth (chlorine resistant and non-chlorine resistant options plus a micro fiber option to meet future limits)	
Particle Size Removal Rating	10 micron				10 micron (nominal) - uses Advanced Dynamic Tangential Filtration (ADTF), screen rotates while filtering.		5 micron	
Flow Direction	inside-out						outside-in	
# of Filters for 10 MGD	3	2	3	2	3	2	6	2
# of Filters in Service for 10 MGD	2	1	2	1	2	1	5	1
# of Filters for 20 MGD	5	3 (not enough space to have a redundant filter)	5	3	5	3	Only Expandable to 16 MGD	3 (not enough space to have a redundant filter)
# of Filters for 30 MGD	7 (not enough space to have a redundant filter)	4 (not enough space)	7	4	7 (only space for 6)	4	Not enough space	4 (not enough space)
# of Discs/Wheels or Rows per Filter	18	27	15	30	5	10	20	8
Wheel Diameter	2.2 m	2.6 m	2.4 m	2.4 m	1.8 m	1.8 m	3.0 ft	-
SF per Disc/Wheel/Row	60.2	81.8	72	72	47.14	47.14	10.8	133.3
Total Area per Filter	1083.6	2208.6	1080	2160	235.7	471.4	216	1066.5
% Submerged	65.00%	65.00%	64.31%	64.31%	60% but uses 100% in Hydraulic Loading Calcs		100.00%	100.00%

Process Design Parameters								
	Kruger Hydrotech Discfilter (Option A - 5 MGD Units)	**Kruger Hydrotech Discfilter (Option B - 10 MGD Units)**	**WesTech SuperDisc (5 MGD Units)**	**WesTech SuperDisc (10 MGD Units)**	**Nova Quantum Disk Filter (5 MGD Units)**	**Nova Quantum Disk Filter (10 MGD Units)**	**Aqua-Aerobics AquaDisk**	**Aqua-Aerobics AquaDiamond**
Proposed Hydraulic Loading Rate for 5 MGD Filter, gpm/sf	2.46	2.42	2.50	2.50	7.37	7.37	3.22	3.26
Hydraulic Loading Rate at 10 MGD (1 Filter Out of service), gpm/sf	4.93	4.84	5.00	5.00	14.73	14.73	6.43	6.51
Hydraulic Loading Rate at 10 MGD (all Filters ON), gpm/sf	3.29	2.42	3.33	2.50	9.82	7.37	5.36	3.26
Title 22 Approved Hydraulic Loading Rate, gpm/sf	6.0 gpm/sf	6.0 gpm/sf	6.5 gpm/sf	6.5 gpm/sf	16 gpm/sf	16 gpm/sf	7.0 gpm/sf (currently testing 16 gpm/sf)	
Filter Head Loss	12"		17.4"		24"		12" to 18"	
Solids Loading Rate	20 mg/l design; shuts down/ bypasses during upsets if blinded.		20 mg/l design; shuts down/ bypasses during upsets if blinded.		18 mg/l design; shuts down/ bypasses during upsets if blinded.		3.25 Lb/SF or 20 mg/l - but can handle upsets. Solids settle in tank. Floatables can be skimmed off.	
Backwash Interval	More frequent due to the thin filtration surface.						Less frequent due to the depth of filtration on the pile cloth.	
Backwash Flow Rate, gpm (5 MGD Filter/10 MGD Filter)	260 gpm	126 gpm	126 gpm	235 gpm	95.2 gpm	190 gpm	130 gpm	400 gpm
Backwash Sludge Production at 5 MGD	0.48% or 23,900 gpd	0.51% or 25,700 gpd	<1.0% or 50,000 gpd	<1.0% or 50,000 gpd	1% or 50,000	1% or 50,000	1%-3% 50,000-150,000 gpd	1%-3% 50,000-150,000 gpd
Backwash Pressure	110 psi	110 psi	109 psi	109 psi	64 psi	64 psi	5.2 psi (12 ft)	31 psi
Backwash HP required (5 MGD Filter/10 MGD Filter)	15 HP, Full Voltage	30 HP	15 HP	25 HP	7.5 HP	15 HP	2 HP	20 HP
Backwash Header Motor	?	?	0.25 HP SEW 480V	3.0 HP SEW 480V	NA	NA	NA	NA
# of Backwash Nozzles	180 per filter	378 per filter	180 per filter	360 per filter	100 per filter	200 per filter	NA	NA

Equipment Features/Options								
	Kruger Hydrotech Discfilter (Option A - 5 MGD Units)	**Kruger Hydrotech Discfilter (Option B - 10 MGD Units)**	**WesTech SuperDisc (5 MGD Units)**	**WesTech SuperDisc (10 MGD Units)**	**Nova Quantum Disk Filter (5 MGD Units)**	**Nova Quantum Disk Filter (10 MGD Units)**	**Aqua-Aerobics AquaDisk**	**Aqua-Aerobics AquaDiamond**
Filter Configuration	Rotating Discs (Intermittent) with ABS frame and discs 60% submerged.		Rotating Discs (Intermittent) with FRP frame and discs 60% submerged.		Rotating Discs (continuous) with SS frame and discs 60% submerged.		Stationary Discs (rotate during backwash) with ABS frame and discs fully submerged.	Traveling Bridge with stationary diamond shaped rows of filters fully submerged.
Retrofit Options	With or without self-contained tank.		With or without self-contained tank.		Only with self-contained tank.		With or without self-contained tank.	Installed in ex. Concrete Tank (small mods. req'd).
Retrofit Note:	Gratings/platforms and possibly additional concrete walls are required with or without the self-contained tank. Inlet and effluent valves for each filter are required and could be provided with electric actuators for automated switchover and to put more filters online as flows increase.							
Option Included in Bidder's Proposal.	Self-contained tank.		Self-contained tank.		Self-contained tank.		Without tank (needs concrete walls).	Installed in ex. Concrete Tank (small mods. req'd).
Building Access	Knock out wall or roof		Knock out wall or roof		Knock out wall or roof		Knock out wall or roof	Knock out wall
Backwash Configuration	Oscillating Spray Bar and pump (w/strainer) using filtered water.		Oscillating Spray Bar and pump (w/strainer) using filtered water.		Stationary spray bar and pump (w/strainer) using filtered water.		Liquid suction backwash shoe and non-clog pump because it pumps the backwash waste (no strainer required).	
Chemical Cleaning System	Provided		Not Provided		Not Provided		Can be cleaned by adding bleach to isolated tank (w/1 addt'l valve).	
Drum Drive	1.5 HP SEW Drive with VFD		3.0 HP SEW Helical-Bevel Gear Belt-Drive with VFD		2 @ 3.0 HP SEW Belt-Drive with VFD		Nord Gear Drive	Variable speed direct drive for bridge
Belt/Chain Type	SS		Non-metallic					NA - Bridge
Approx. Dimensions	20.42'x7.5'x8.12'H	26.1'x8.99'x9.81'H	13.04'x8.99'x 8.86'H	20.82'x8.99'x 8.86'H	9.83'x7.44'x 8.28'H	14.04'x8.98'x 8.29'H	8.5'x16'	10 MGD unit fits in existing tank
Dry Weight, Lbs.	14,220	7,165	7,165	10,913	6,000	12,000	Components delivered separately - see drawing in bid.	Platform - 7,500 Lbs.
Control Info	MicroLogix, 7" PanelView		MicroLogix, 8" PanelView		MicroLogix, 6.5" PanelView		CompactLogix, 6.5" PanelView	

Operation & Maintenance Comparison

	Kruger Hydrotech Discfilter	WesTech SuperDisc	Nova Quantum Disk Filter	Aqua-Aerobics AquaDisk	Aqua-Aerobics AquaDiamond
Media Life	5 years	5 years	10 years	7 years	
Potential Media Failure Modes	Fabric can tear.	Fabric can tear.	SS can corrode from cleaning chemicals and/or fatigue failure.	Cloth wears out at top edge where the brake shoe engages.	
Potential Maintenance Issues	- Fabric blind and nozzles can clog. - Chains (SS) and roller bearings can break.	- Fabric blind and nozzles can clog. - Chains (non-metallic) and roller bearings can break.	-Fabric blind and nozzles can clog. - Chains (non-metallic) and roller bearings can break. - Backwash strainer can clog.	-Chains (non-metallic) and roller bearings can break. - Springs on the brake shoes can wear out. - Valve actuators can fail.	-Springs on the brake shoes can wear out. - Traveling bridge components can fail - Non-clog pump maintenance.
Routine Maintenance Requirements	- Weekly cleaning of nozzles (4 hours each). - Major cleaning every 3-6 months (8 hours each). - Lubricate backwash pump(s), gear box, motor.		- One day of cleaning every 3-4 weeks. - Lubricate backwash pump(s), gear box, motor.	- Lubricate backwash pump(s), gear box, motor.	
Access Around Filter	Everything is maintained from the top.		Need access to lower level (ladder between each filter).	Everything except the trunnion shaft bearing and media replacement is maintained from the top.	Everything except media replacement is maintained from the top.
Warranty	2 years for equipment and 3 years for media	2 years, 5 years for drum belt	12-18 Months	12-18 Months	

Present Worth Analysis								
	Kruger Hydrotech Discfilter (Base Option A - 5 MGD Units)	Kruger Hydrotech Discfilter (Base Option B - 10 MGD Units)	WesTech SuperDisc (5 MGD Units)	WesTech SuperDisc (10 MGD Units)	Nova Quantum Disk Filter (5 MGD Units)	Nova Quantum Disk Filter (10 MGD Units)	Aqua-Aerobics AquaDisk (2 MGD Units)	Aqua-Aerobics AquaDiamond (10 MGD Units)
Equipment Capital Cost	$ 879,300	$ 948,700	$ 574,000	$ 558,000	$ 514,063	$ 682,212	$ 720,392	$ 1,202,815
Annual Electrical Costs	$ 4,987	$ 2,371	$ 4,438	$ 5,095	$ 7,428	$ 15,076	$ 412	$ 392
Annual Chemical Costs	$ 27.00	$ 63.00	$ 27.00	$ 36.00	$ 52.50	$ 70.00	$ -	$ -
Cost of Replacement Media/ Panel	$ 89.00	$ 123.00	$ 46.68	$ 46.68	$ 330.00	$ 330.00	$ 240.00	$ 2,690.00
Maintenance Costs	See schedule in Bid		See schedule in Bid		See schedule in Bid		See schedule in Bid	
Present Worth of O&M Costs	**$ 283,346**	**$ 256,813**	**$ 266,663**	**$ 226,829**	**$ 307,233**	**$ 287,433**	**$ 168,204**	**$ 107,243**
Estimated Construction Cost (incl. equip.)	**$ 2,437,000**	**$ 2,600,000**	**$ 1,926,000**	**$ 1,888,000**	**$ 1,714,000**	**$ 2,063,000**	**$ 2,200,000**	**$ 2,912,000**
Present Worth (20-yr@6%)	**$ 2,720,346**	**$ 2,856,813**	**$ 2,192,663**	**$ 2,114,829**	**$ 2,021,233**	**$ 2,350,433**	**$ 2,368,204**	**$ 3,019,243**

Detailed Design

- Additional Screw Pump
- Implications on existing building
- City Decided to Replace the Roof
- Upgrade of electrical equipment (MCCs and LED lighting)

Screw Pump

Screw Pump

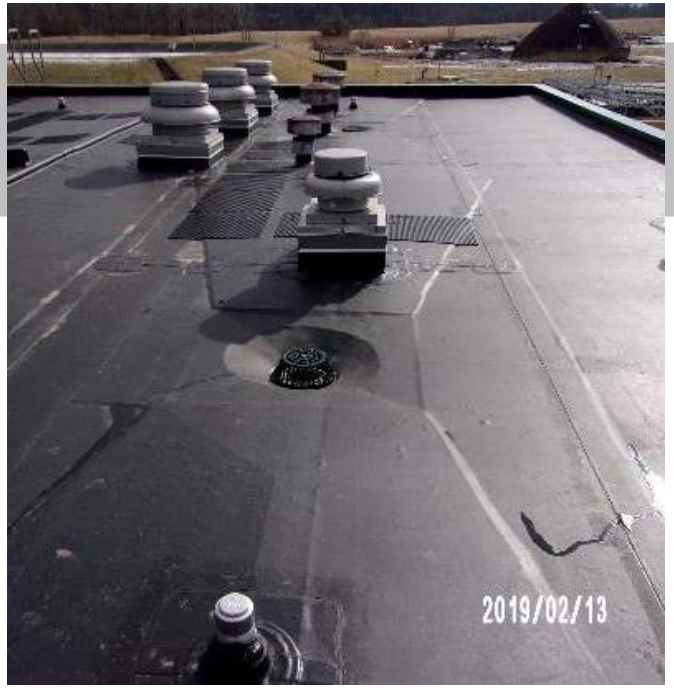

POTABLE WATER


Roof Inspection

Architectural



Roof Replacement



Roof Complete

Construction Issues

- Issues caused by poor as-builts
  - ✓ Concrete Channels were not Water-Tight (no waterstops)
  - ✓ Holes from Old Underdrain Laterals
  - ✓ Electrical & SCADA changes
  - ✓ Reused Old Soft Starters (too deep for new MCC)

Construction Issues - Getting Filters in Building

Construction Issues - Getting Filters in Building

Water-Proofing Channels

Construction Issues - Electrical

Startup Issues

- New Filter Design
  - ✓ Roller Bearing Failures (changed materials of construction)
  - ✓ Spray Bar Misalignment (improper assembly)
- Frequent Backwashes - Possible Reasons for Fouling:
  - Iron
  - Polymer
  - Biological Growth/Algae
  - FOG

NOVA – Quantum II

NOVA – Quantum II

Defect Allowing Backwash to Enter Influent

SUMMARY

- Background
- Original Traveling Bridge Sand Filters
- Preliminary Alternative Evaluations
- Equipment Selection
- Detailed Design
- Construction & Startup

Questions / Answers