AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Primary and Primary Effluent Filtration Using AquaPrime™ Cloth Media Filtration

Introduction

Primary and Primary Effluent Cloth Media Filtration are emerging technologies in wastewater treatment. The goal of these technologies is to reduce the organic loading to the secondary treatment process, which saves energy and can increase capacity. This is achieved by diverting Biological Oxygen Demand (BOD_5) and Volatile Suspended Solids (VSS) from raw wastewater prior to main biological treatment and the anaerobic digestion process, reducing activated sludge loading and increasing gas production in the digestion process. Figure 1 and Figure 2 show typical plant schematics for primary filtration and primary effluent filtration, respectively. In primary filtration, the cloth media filter replaces the primary clarifier. In primary effluent filtration, the cloth media filter follows the primary clarifier and before the secondary process.

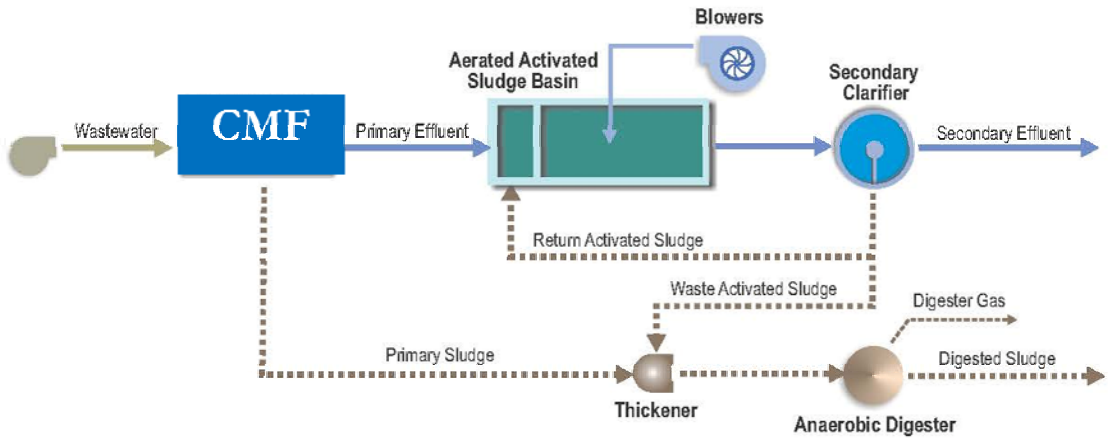

Figure 1: Plant Layout for Primary Filtration

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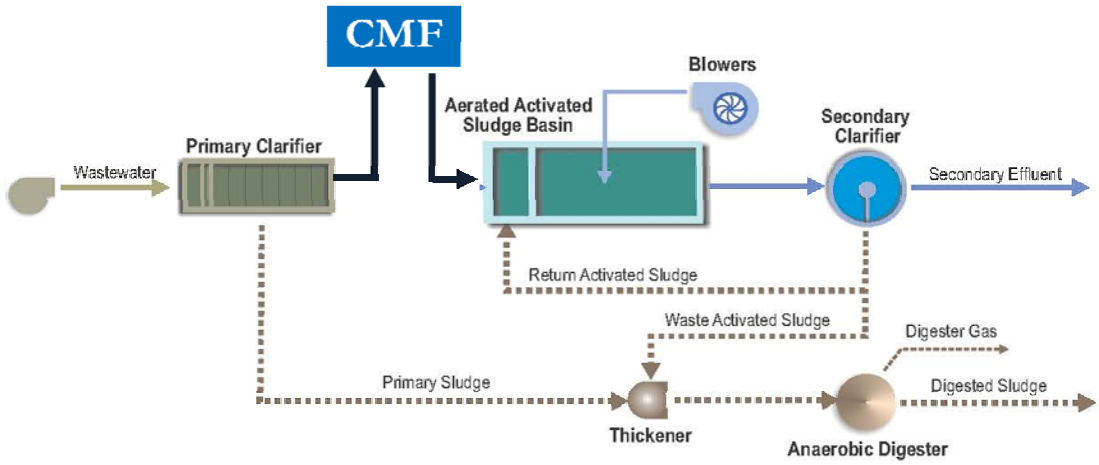

Figure 2: Plant Layout for Primary Effluent Filtration

An additional application may consist of filtration of Gravity Thickener Overflow (GTO) and centrate sidestreams as a pre-treatmentstep to remove solids and debris. This has the potential to decrease operation and maintenance costs by reducing the BOD_5andTSS/ VSS load. Capturing solids and diverting TSS/VSS and BOD_5 from the proposed sidestream biological treatment to the anaerobic digesters has the same potential to reduce aeration demand and operational costs.

Background

Aqua-Aerobic Systems became involved with primary effluent filtration in 2013 with a study funded by the California Energy Commission (CEC) and Kennedy Jenks Consultants. Five technologies were selected to participate in this study. The cloth media filter performance exceeded expectations. The unit ran the entire two years with 99% uptime and no cloth wear. TSS was reduced by 50-60% to the aeration basin. By the end of the study, the Aqua MiniDisk® cloth media filter was one of only two technologies remaining.

Below are TSS and Chemical Oxygen Demands (COD) removal rates during the year, plus phase 1 of the CEC study:

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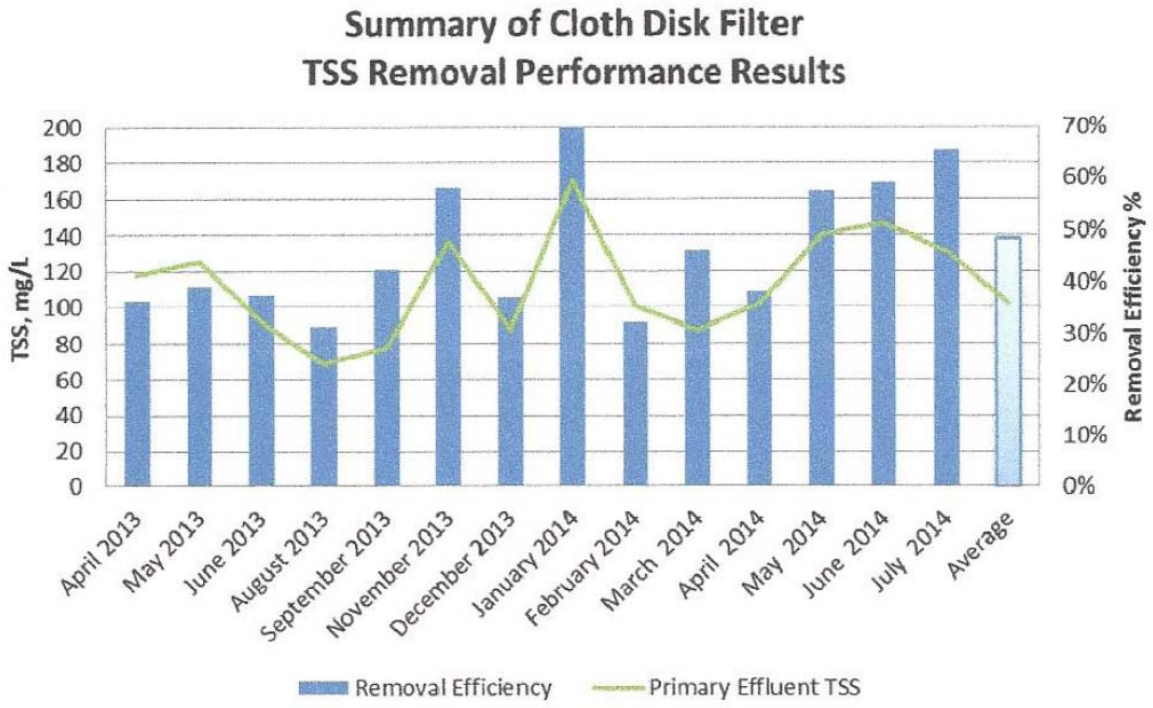

Figure 3: TSS Removal in CEC Study for the Cloth Disk Filter

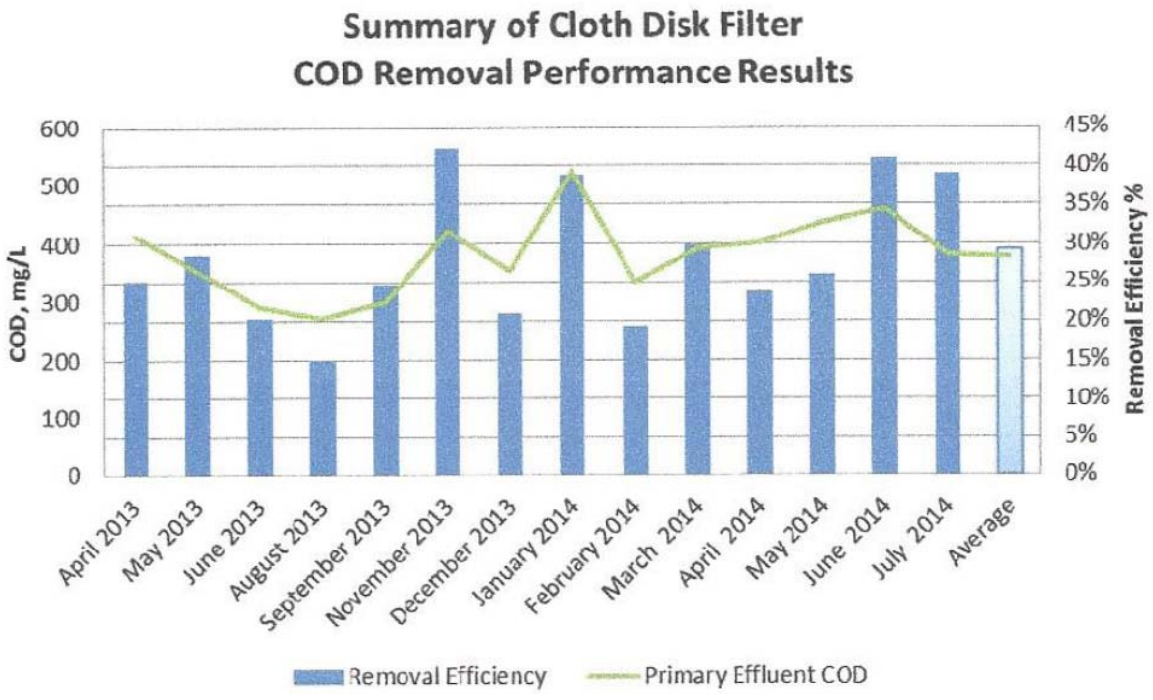

Figure 4: COD Removal in CEC Study for the Cloth Disk Filter

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Based on the success from the California Energy Commission Study, Aqua-Aerobic Systems decided to conduct independent testing of primary filtration at the Rock River Water Reclamation District in Rockford, IL. This testing was conducted over six months using water pumped from before the primary clarifier. The process schematic is shown in Figure 3. The performance of the primary clarifier was compared to the performance of the cloth media filter. OptiFiber PA2-13® Cloth Filtration Media and OptiFiber PES-14® Cloth Filtration Media were tested during this study with success.

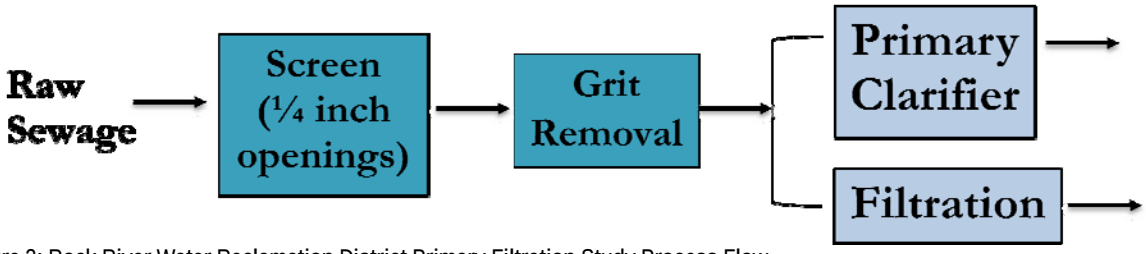

Figure 3: Rock River Water Reclamation District Primary Filtration Study Process Flow

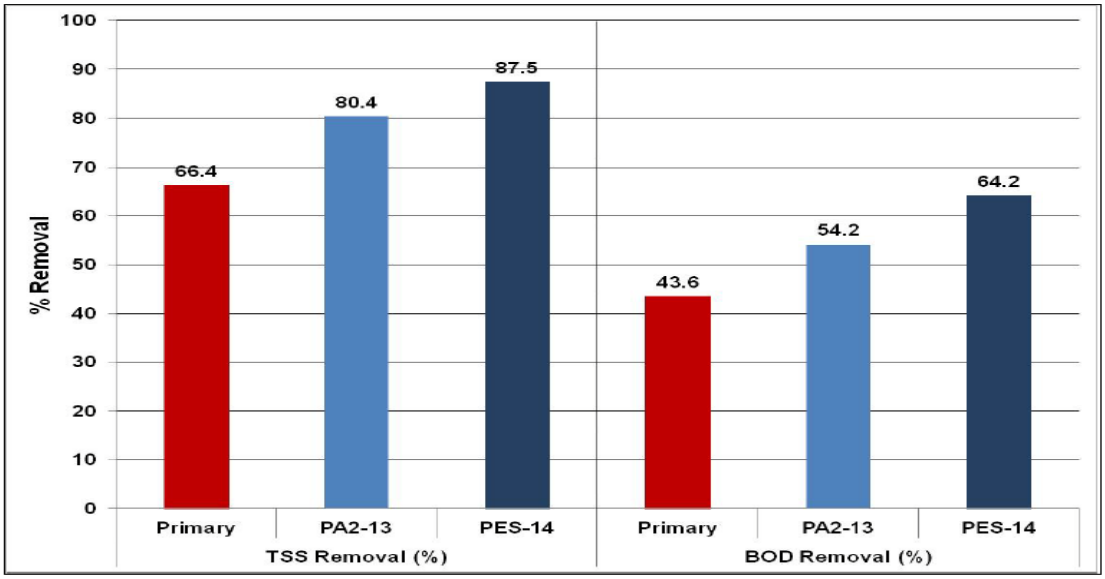

Figure 5: TSS and BOD Removal across Primary Clarifier, PA2-13 Cloth, and PES-14 Cloth in Rock River Water Reclamation District Study

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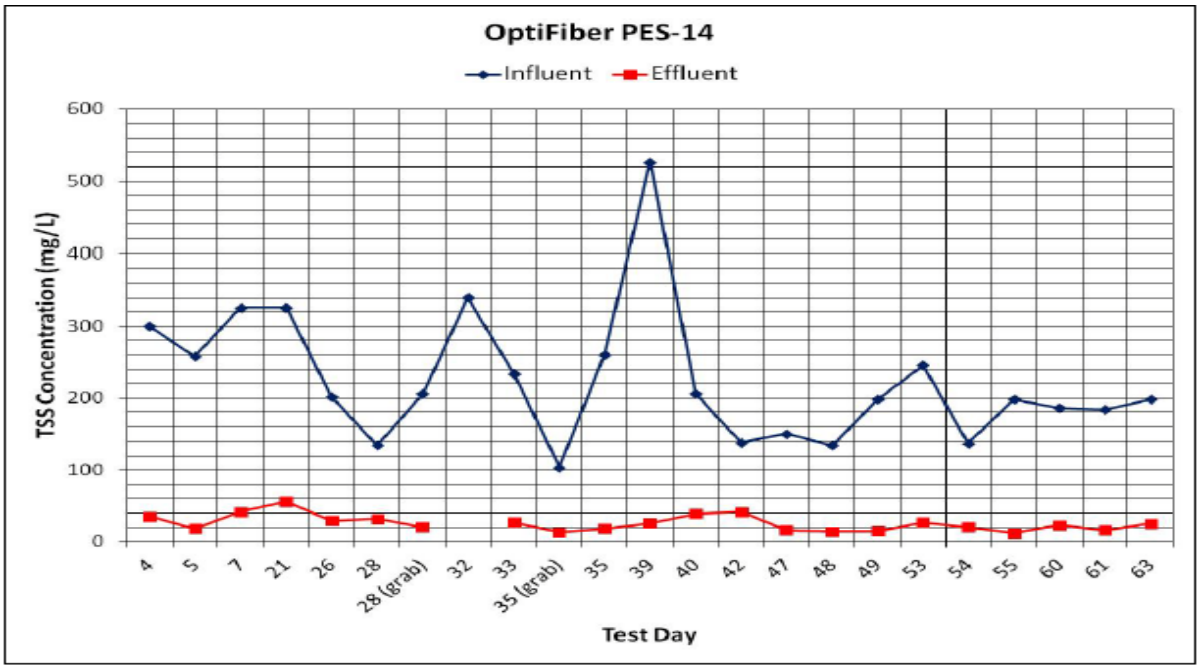

Figure 6: TSS Removal across Primary Clarifier PES-14 Cloth in Rock River Water Reclamation District Study

Based on successful testing, Aqua-Aerobic Systems developed several pilot units.

AquaPrime™ Cloth Media Filter Unit Design

The filter tested at the California Energy Commission and Rock River Water Reclamation District studies was designed for tertiary treatment. Based on the success of these studies, Aqua-Aerobic Systems evaluated ways to improve performance in primary filtration and primary effluent filtration applications. One of the key differences between these applications and tertiary applications is the type and quantity of solids.

The outside-in flow path of the AquaPrime cloth media filter allows for three zones of solids removal. These three zones become even more critical in primary applications due to the high solids environment in primary filtration and wet weather treatment applications. These zones are shown in Figure 7.

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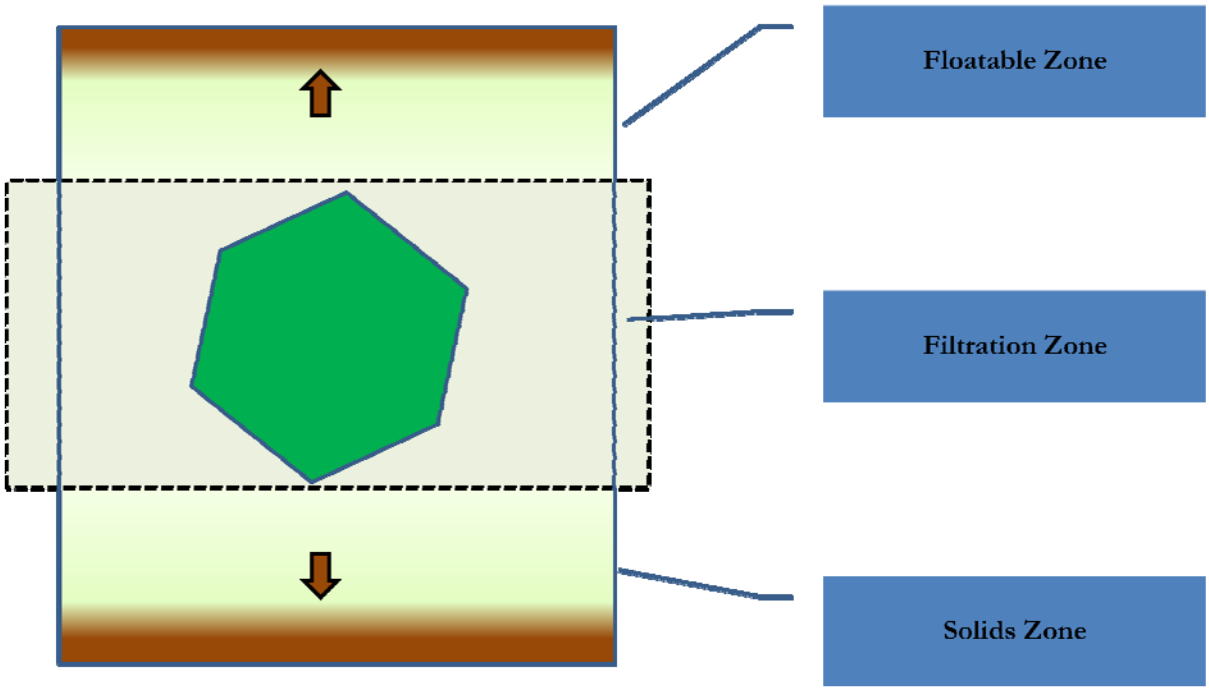

Figure 7: Three Zones for Solids Removal in a Cloth Media Filter

Floatable Zone

The top zone is called the floatable zone. This zone is where there can be buildup of scum or other floating materials. The floatable material is removed typically 1 to 3 times per day by opening a valve and allowing floating materials to flow over a weir at the top of the unit.

Filtration Zone

The middle zone is called the filtration zone where most of the solids are removed by filtration. The solids are collected on the filter surface until there is about 1 foot of head built up. Then, the solids are removed by backwashing. The backwash shoe makes direct contact with the cloth media and solids are vacuumed from the surface. During backwash, fibers fluidize to provide an efficient release of stored solids deep with the fiber depth as shown below in Figure 8.

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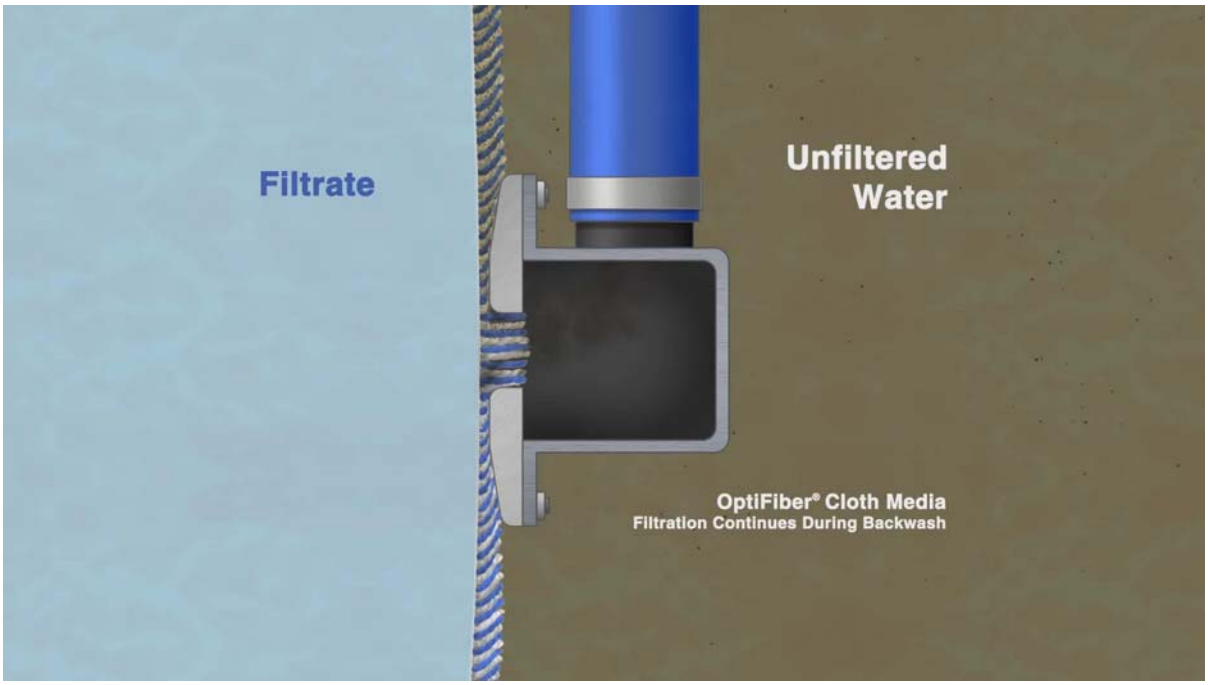

Figure 8: Backwashing of the cloth media.

Solids Zone

The bottom zone is called the solids zone where heavier solids that settle to the bottom of the tank are collected in hopper collection laterals. Solids are removed periodically. r using a backwash/solids pump.

AquaPrime™ Cloth Media Filter Arrangement

With knowledge of the three zones, Aqua-Aerobic Systems looked for ways to further improve solids removal. A floatable baffle and valve were added to remove floatable/scum that accumulate in the floatable zone of the tank. The filtration zone worked well in the previous testing and was not changed. The solids zone was enhanced by adding more of a hopper bottom design and an enhanced solids collection manifold. Other changes including the elevated tank height, moving the influent baffle, and raising the centertube made the changes possible.

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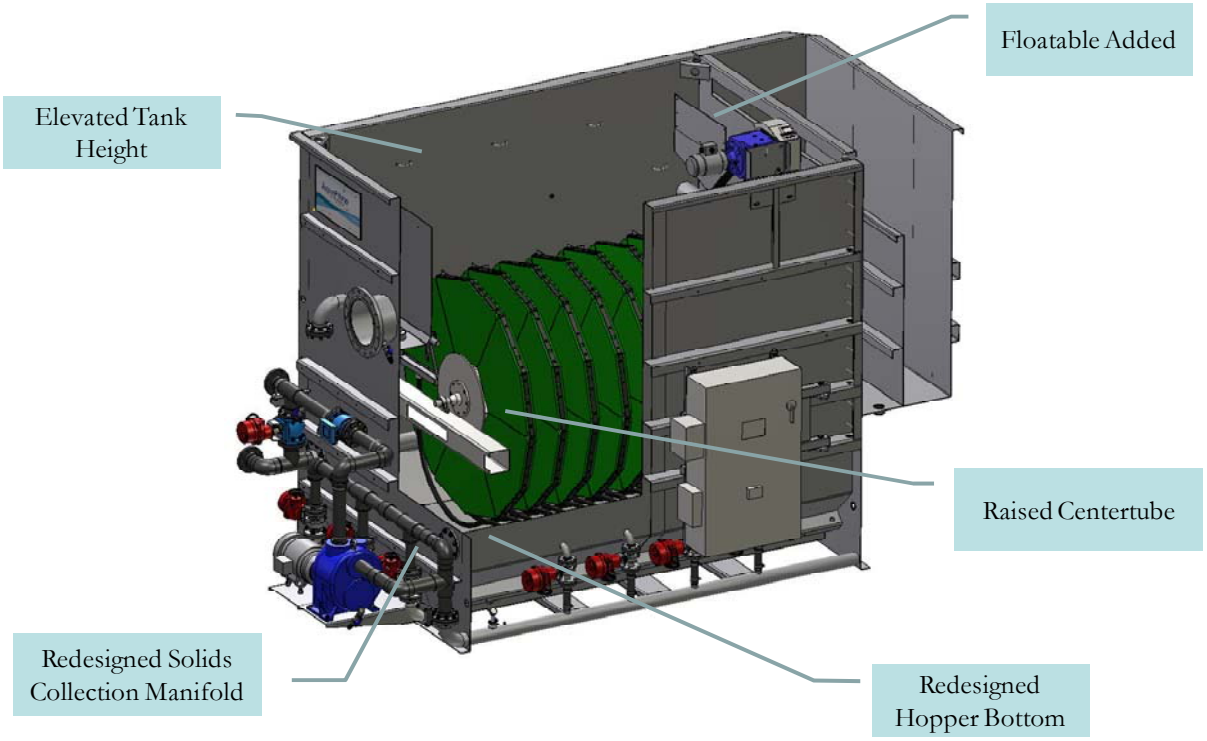

Figure 9: Tank Modifications for Primary Filtration and Primary Effluent Filtration

Key Benefits and Advantages

- High quality effluent
- Simple to operation and maintain
- No chemical usage or ballast material required to produce high quality effluent
- Small footprint and reduced construction costs compared to othermethods
- More solids for increased digester gas production
- Reduced energy costs on the secondary produce due to a reduction in organic loading

Pilot Testingand Case Studies

Aqua-Aerobic Systems has constructed a pilot trailer and three stand alone units specifically designed for primary filtration and wet weather filtration applications. The unit is shown in Figure 10. The cloth media filter in this pilot unit features the modifications that are described above. The unit is currently traveling the country and collecting data at various plants.

Figure 10: Primary Filtration and Wet Weather Pilot System

Pilot Results

Aqua-Aerobic Systems has completed primary filtration studies at five (5) sites. The results from these studies are summarized in Table 1 and Table 2. The percent TSS removal is consistently between 80 and 88% in these studies. Variations in BOD removal are due to differences in the fraction of BOD that is soluble among these sites.

Table 1: TSS Removal Using Primary Filtration

	Media	Influent (mg/L)	Effluent (mg/L)	Removal (%)
RRWRD	PA2-13	253	44	80%
RRWRD	PES-14	221	26	88%
Oak Hill, WV	PES-14	176	31	81%
The Dalles, OR	PES-14	206	40	80%
Ashville, NC	PES-14	188	24	87%
TRA Central, TX	PES-14	273	33	88%

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Table 2: BOD Removal Using Primary Filtration

	Media	Influent (mg/L)	Effluent (mg/L)	Removal (%)
RRWRD	PA2-13	220	95	54%
RRWRD	PES-14	169	59	64%
Oak Hill, WV	PES-14	242	149	40%
The Dalles, OR	PES-14	168	65	59%
Ashville, NC	PES-14	184	112	40%

Primary Filtration Pilot Results

Below are some primary influent results from some of the studies:

Figure 11: Oak Hill, WV – Primary Filtration - TSS

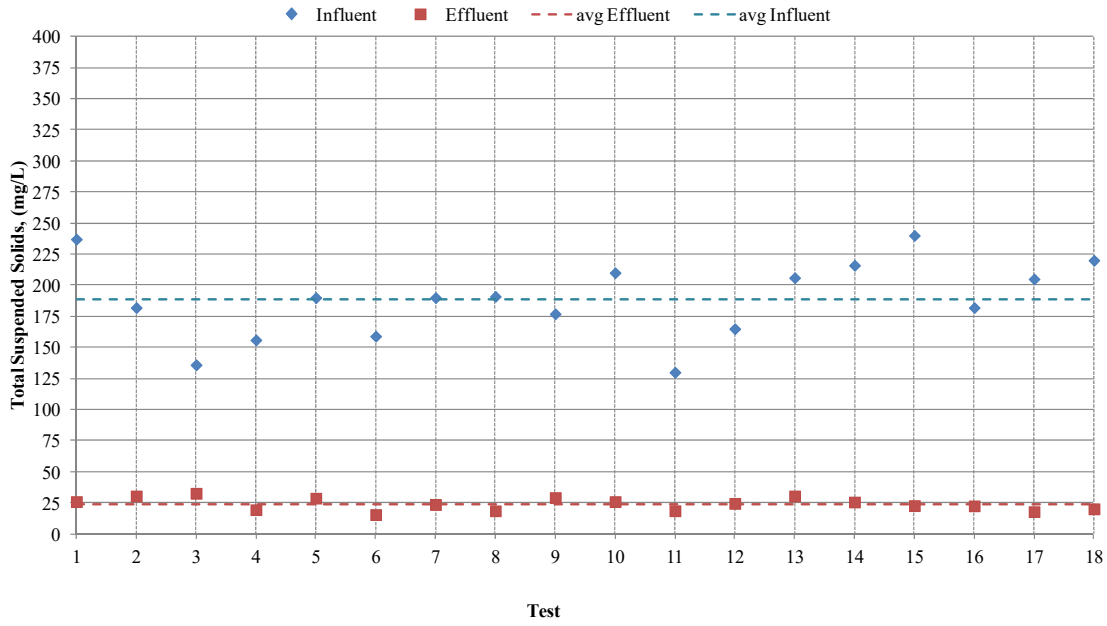

Figure 12: Asheville, NC – Primary Filtration - TSS

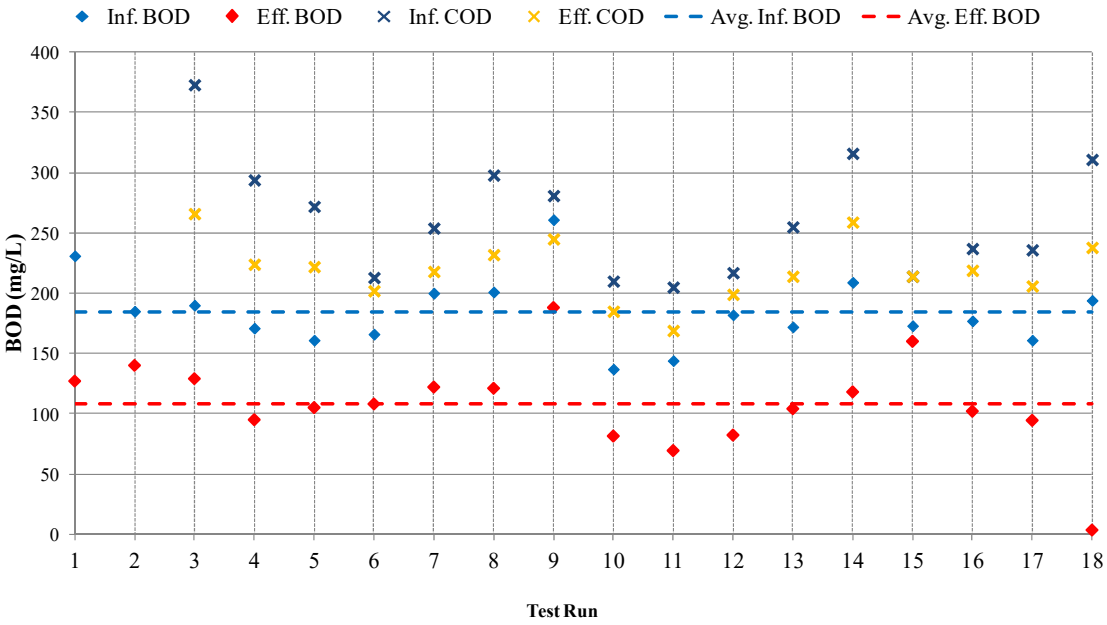

Figure 13: Asheville, NC – Primary Filtration - BOD

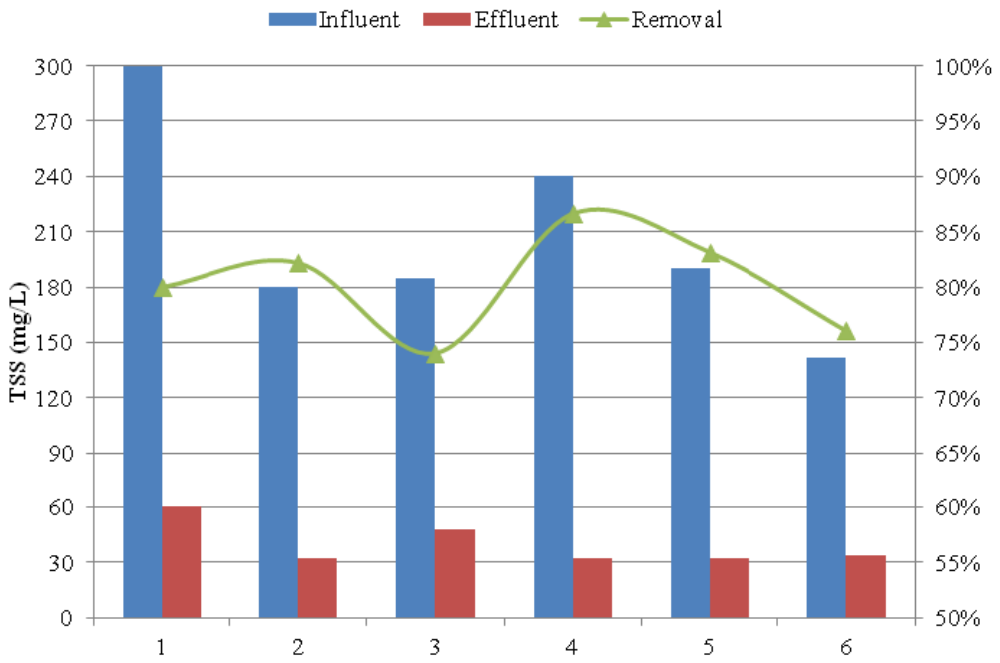

Figure 14: Dalles, OR – Primary Filtration – TSS

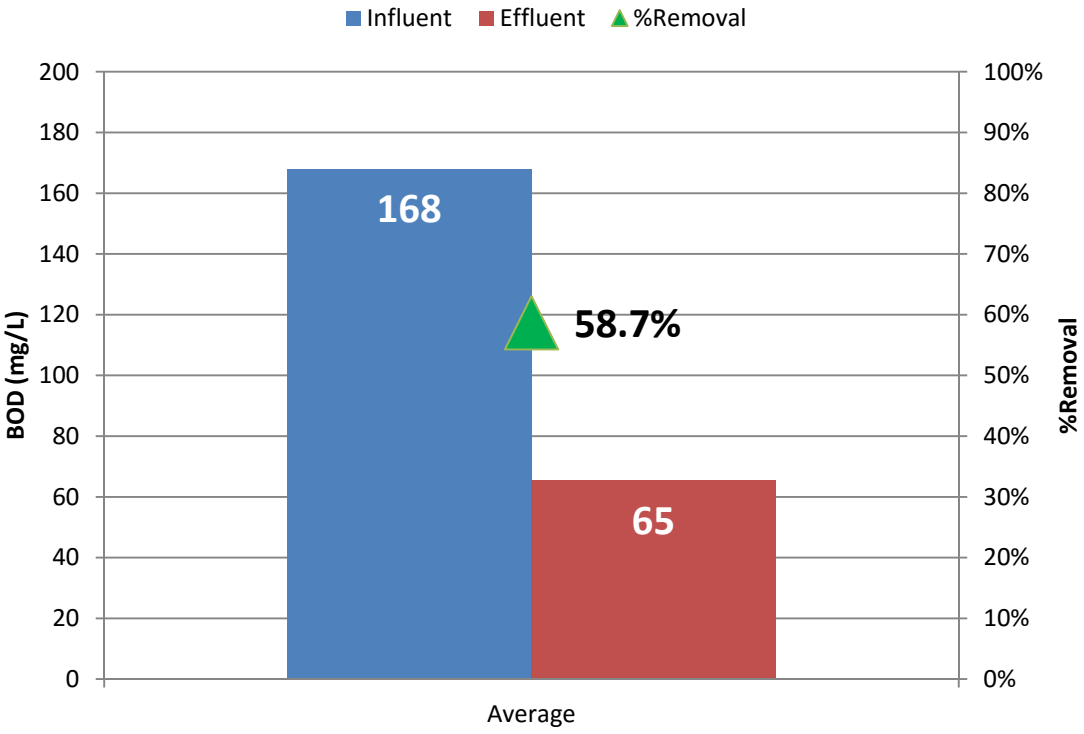

Figure 15: Dalles, OR – Primary Filtration – BOD Reduction

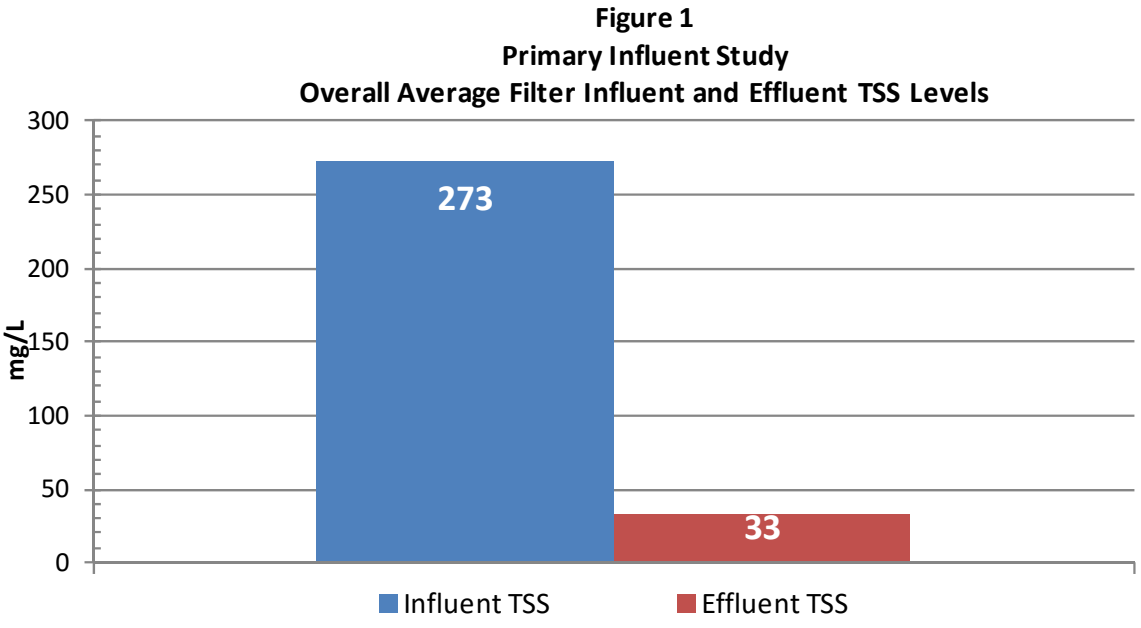

Figure 16: TRA Central, TX – Primary Filtration

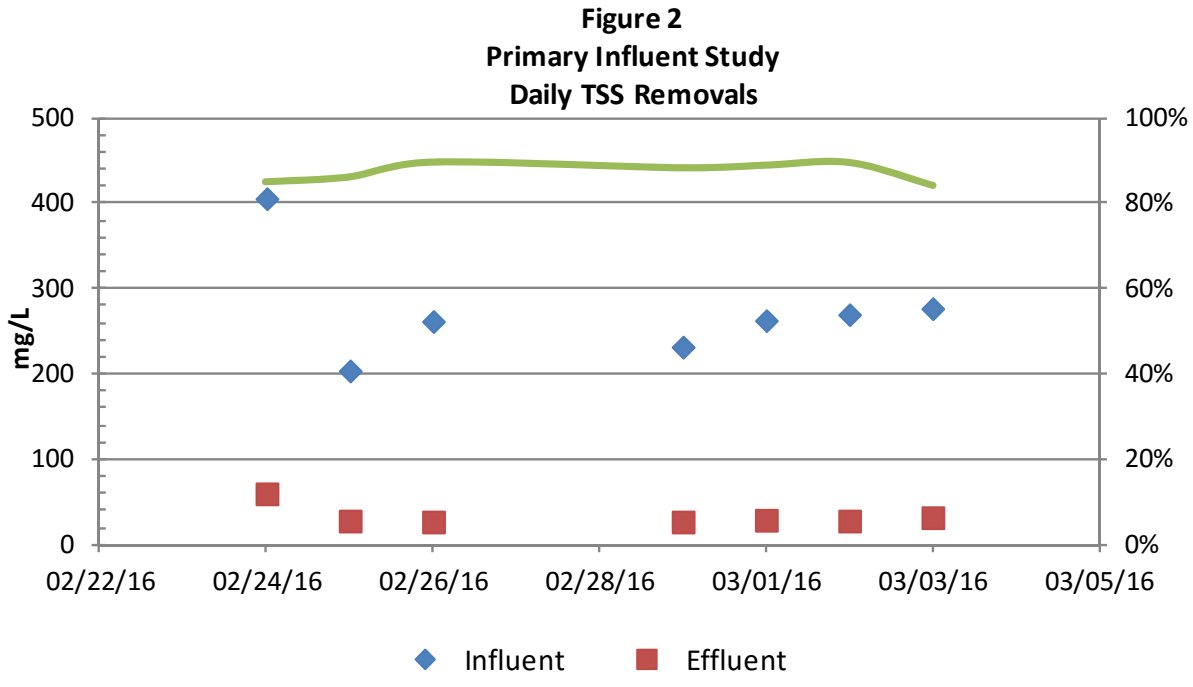

Figure 17: TRA Central, TX – Primary Filtration – TSS Removal

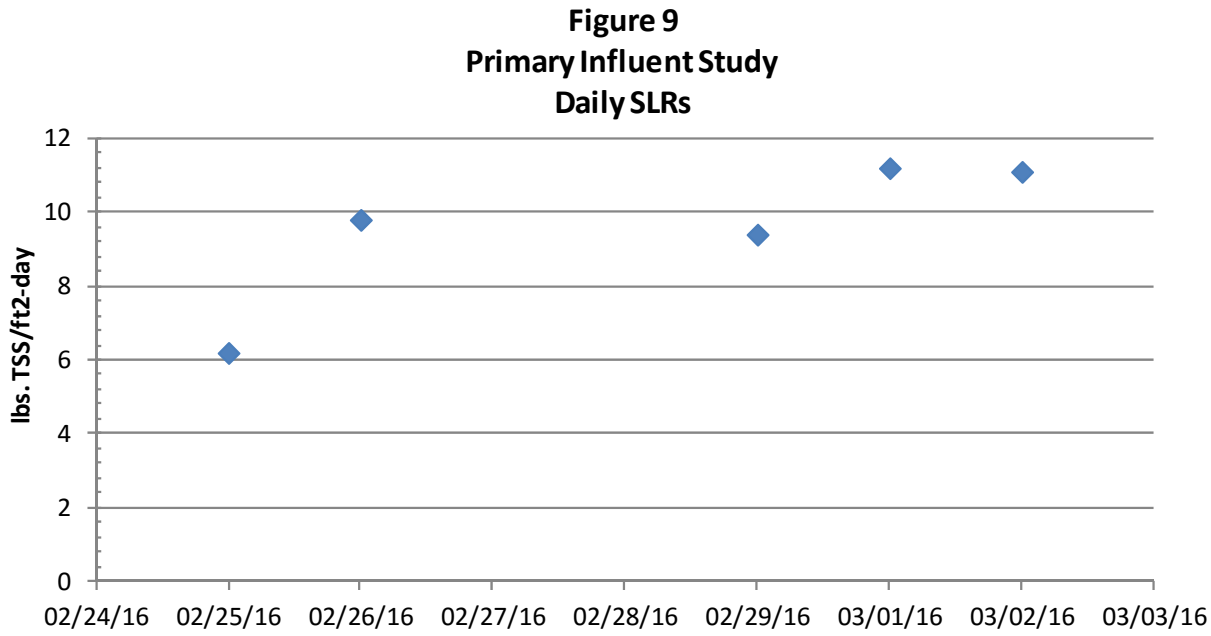

Figure 18: TRA Central, TX – Primary Filtration – Solids Loading Rate

Primary Effluent Filtration Pilot Results

Below are some primary influent results from some of the studies:

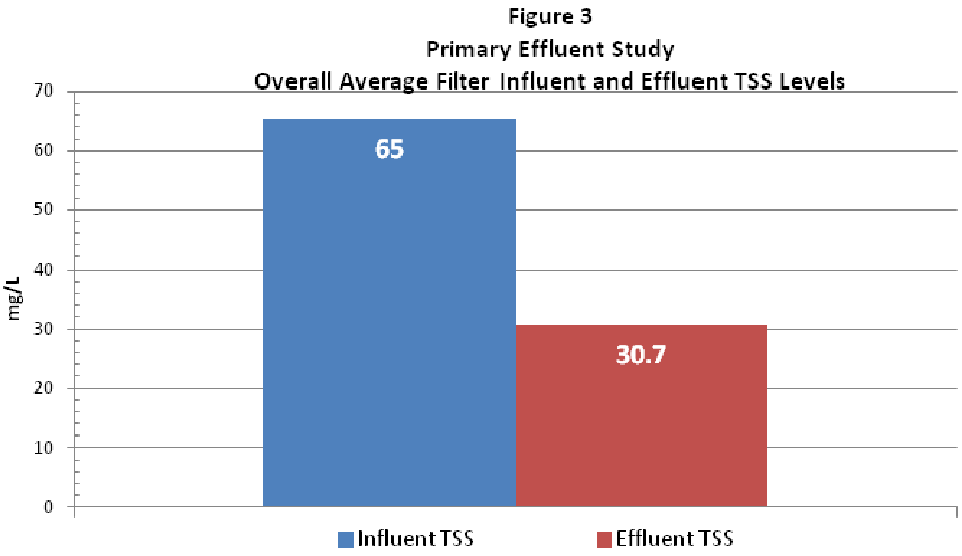

Figure 19: TRA Central, TX – Primary Effluent Filtration – TSS

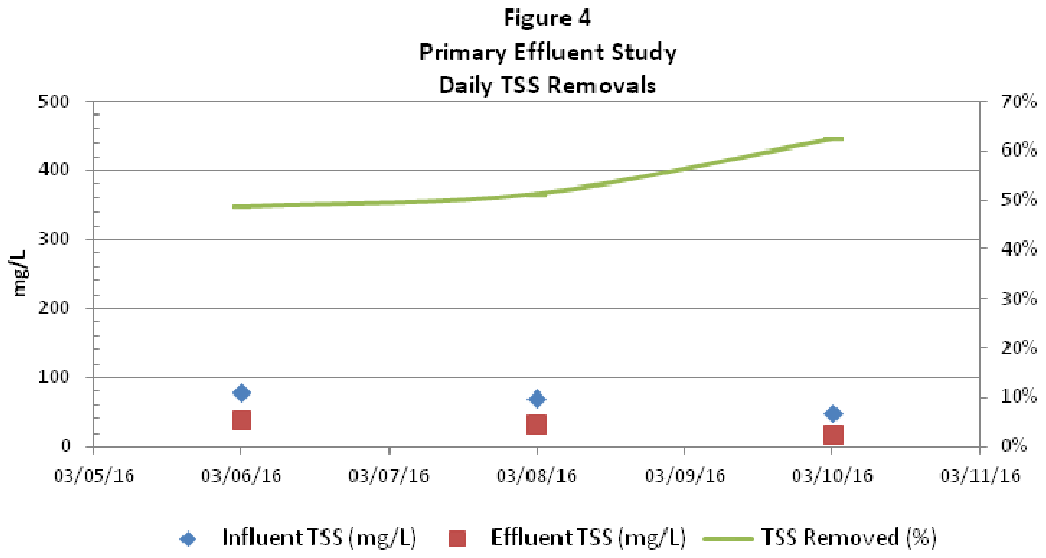

Figure 20: TRA Central, TX – Primary Effluent Filtration – TSS

Full Scale Testing

Following the success of the first California Energy Commission study, a second study has been approved to assess the full-scale impact of primary filtration over a three year period in Linda County, CA. The current plant has two trains designed for 1 MGD each. During the study, the primary clarifier in one of the two trains will be replaced with an AquaDisk® cloth media filter. These two trains will be operated independently and carefully monitored for differences in performance and microorganism populations. The biological process has an Modified Ludzak-Ettinger (MLE) configuration for nitrogen removal, which will help to answer how primary filtration impacts nutrient removal. This study is set to start up in spring 2016.

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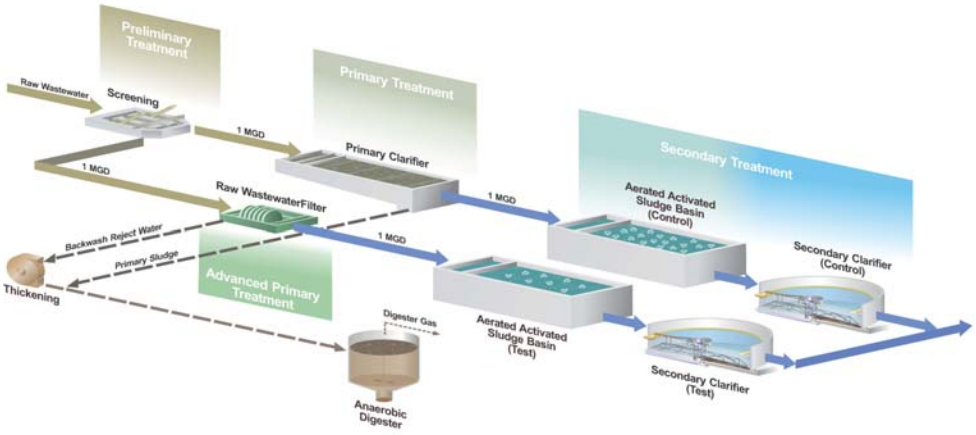

Figure 21: CEC #2 Plant Layout

Frequently Asked Questions

What is the impact on carbon for biological nutrient removal?

One current hypothesis is that impact will be minimal since the carbon left in the water is readily accessible for nutrient removal. However, if it is found that too much carbon is removed through this process, a fraction of the forward flow can bypass the filter or backwash water that is rich in carbon can be step fed into the process at the appropriate locations. In addition, the impact of carbon removal will be assessed fully in the upcoming California Energy Commission Phase 2 Study.

What is the backwash as a percent of forward flow?

The total waste fraction on the current pilot studies is between 10 and 15% of the forward flow. Operational changes are being tested to further reduce this volume.

What is the change in cloth life?

There was no visible cloth wear at the end of the two-year California Energy Commission Study on primary effluent filtration. The pilot studies up to this point have shown a similar result. Aqua-Aerobic does not expect a significant reduction in cloth life due to this process.

What is the impact of fats, oils, and grease?

Fats, oils, and grease have not impacted operation or removal performance in any of the studies conducted. In addition, the floatable/scum weir setup will prevent buildup in the tank.

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References

Caliskaner, Onder, Tchobanoglous, George, Young, Ryan and Laybourne, Sarah (2014) *Demonstration of Primary Effluent Filtration for Carbon Diversion to Save Energy and Increase Plant Capacity*, Proceeding WEFTEC 2014, New Orleans, LA

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