Grit

It’s Not Just for Breakfast Anymore

Rusty Schroedel, P.E., BCEE, WEF Fellow

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Jim Dandy
ENRICHED
QUICK GRITS
COOKS IN 5 MINUTES!
Bob's Red Mill
SOUTHERN-STYLE
WHITE CORN GRITS
CORN GRITS
POLENTA
Calcium & Iron
QUAKER
Instant
GRITS
Original
LAKE SIDE
YELLOW GRITS
NET WT. 2 LBS.
QUAKER
Instant
GRITS
Flavor Variety
3 Original
3 Cheddar Cheese
2 Country Bacon
GLUTEN FREE
CORN GRITS
Bob's Red Mill
SOY GRITS
Jim Dandy
ENRICHED
REGULAR
GRITS
SOUTHEASTERN Mills
PEPPERED
GRAVY MIX
QUAKER
INSTANT
GRITS
Original
Bob's Red Mill
CORN GRITS
POLENTA
QUAKER
GRITS
Cooks in 5 minutes
GLUTEN FREE
POLENTA
CORN GRITS
GEECHIE BOY MILL
WHITE GRITS
EDISTO ISLAND, SC
QUAKER
GRITS
2048 x 1536 · jpeg newinnola.com
CHARLESTON FAVORITES
STONE GROUND GRITS
WHITE
QUAKER
Instant
GRITS
Super Family Size
Original


ENRICHED
QUICK
GRITS
COOKS IN 5 MINUTES!
NET WT 2 LB (32 OZ) 907g

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Topics

– What is Grit?

– Why Do We Care?

– How Do We Remove Grit?

– Case Histories

– Conclusions and Recommendations

What is Grit?

What is Grit ?

– Grit is inorganic settleable solids ranging in size from 50 to 1,000 microns.

– Grit removal is necessary to protect downstream equipment from wear and avoid grit accumulation in downstream unit processes.

– Grit is identical in size to sand and the design guide-lines for many years have been based on 90% removal of 210 micron particles with a specific gravity of 2.65 (like sand).

Studies at the Hyperion Plant in California found that 10 times more grit was being removed in the anaerobic digesters than in the grit chambers. The grit chambers were only removing 6% of the grit.

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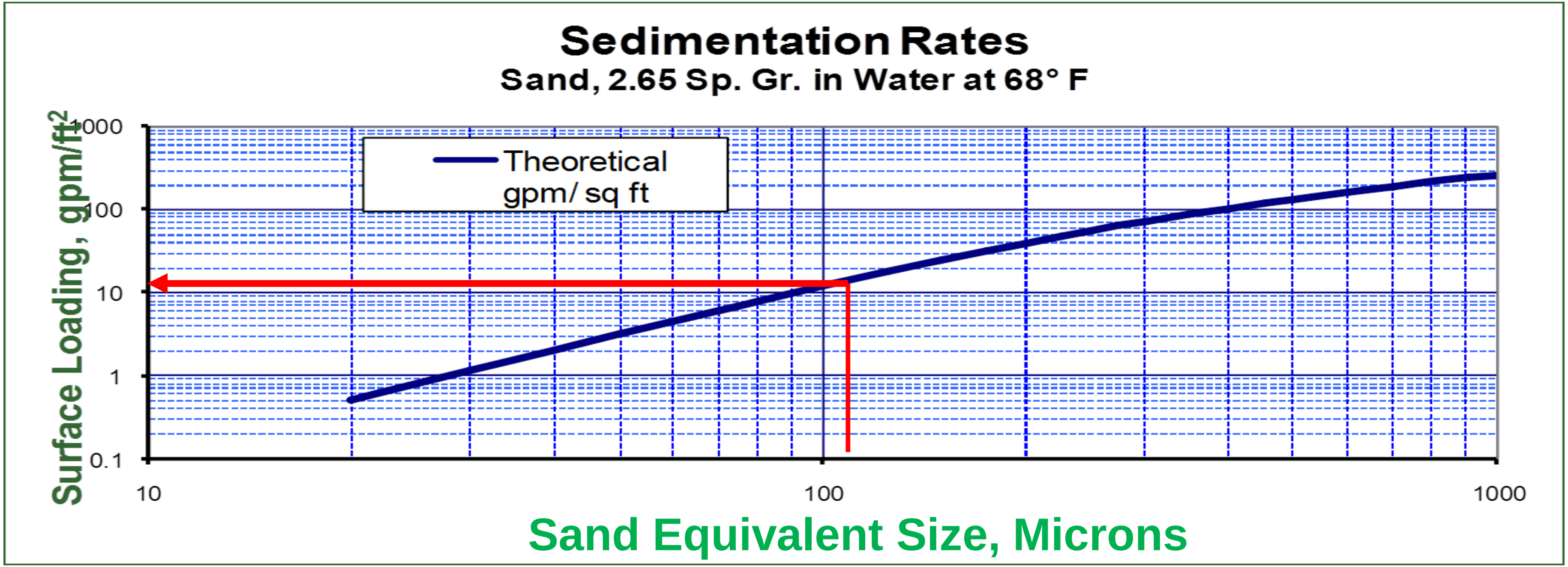
Grit Sedimentation Rates



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In Reality :

Grit is not sand and most grit particles settle slower than sand.

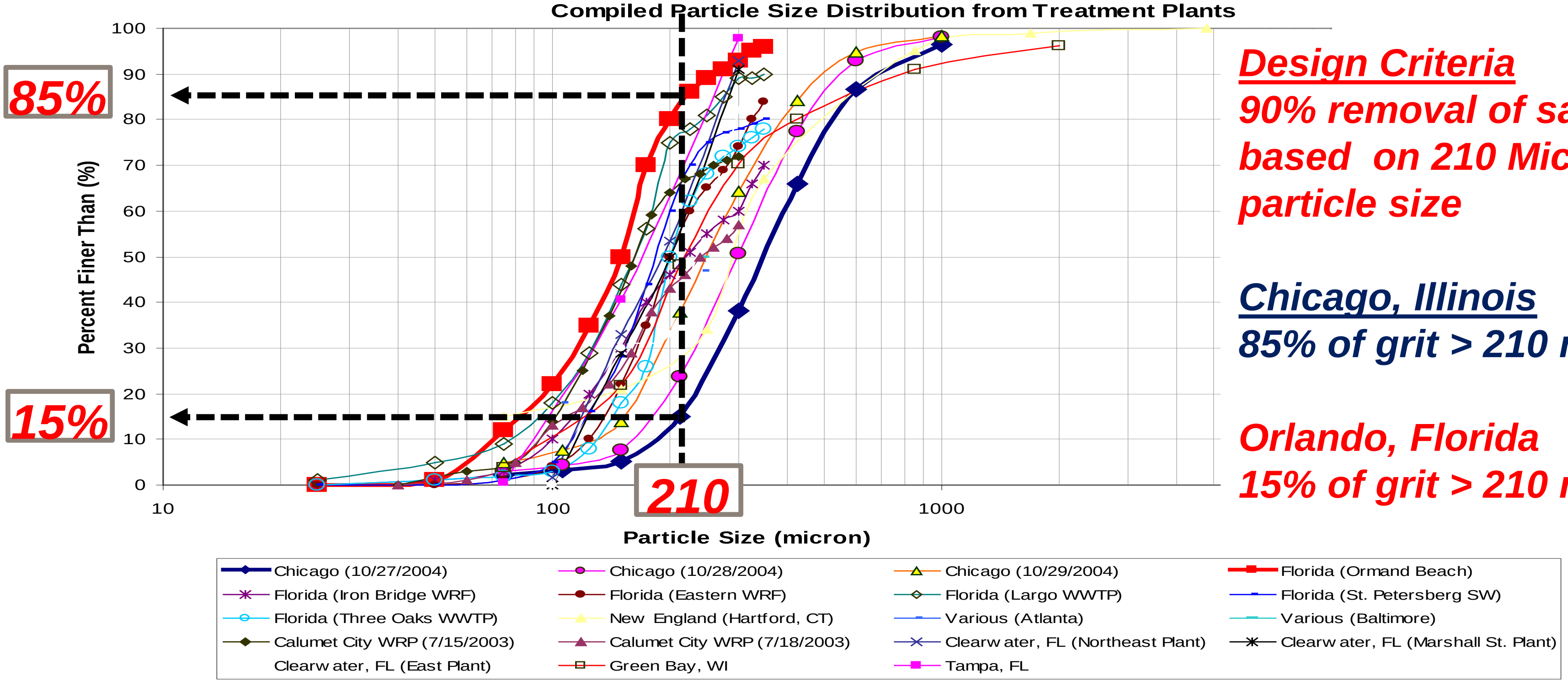
East Bay Municipal Utility District WWTP, CA
SG: 1.24 – 1.61, Average 1.35
> 1mm 1.04 SG

Deer Island Treatment Plant, Boston, MA
SG: 1.22

Green Bay WWTP, WI
SG: 1.53

Particle Size (microns)	Aggregate Class	Time Required to Settle 1’ SG = 2.65	Time Required to Settle 1’ SG = 1.35
100	Very Fine Sand	38 Seconds	2 min. 48 sec.

Physical Size Distribution



Design Criteria

90% removal of sand based on 210 Micron particle size

Chicago, Illinois

85% of grit > 210 micron

Orlando, Florida

15% of grit > 210 micron

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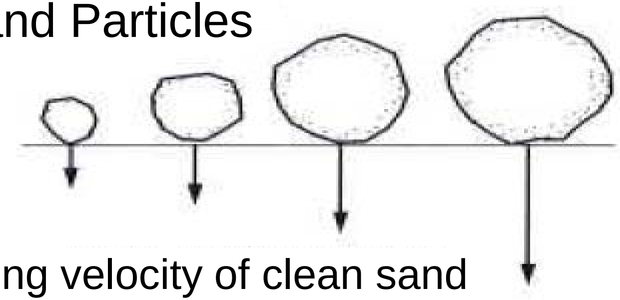
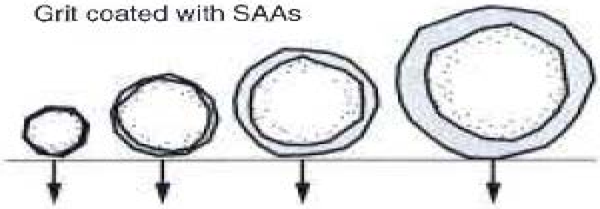
Impact of surface active agents (SAAs)

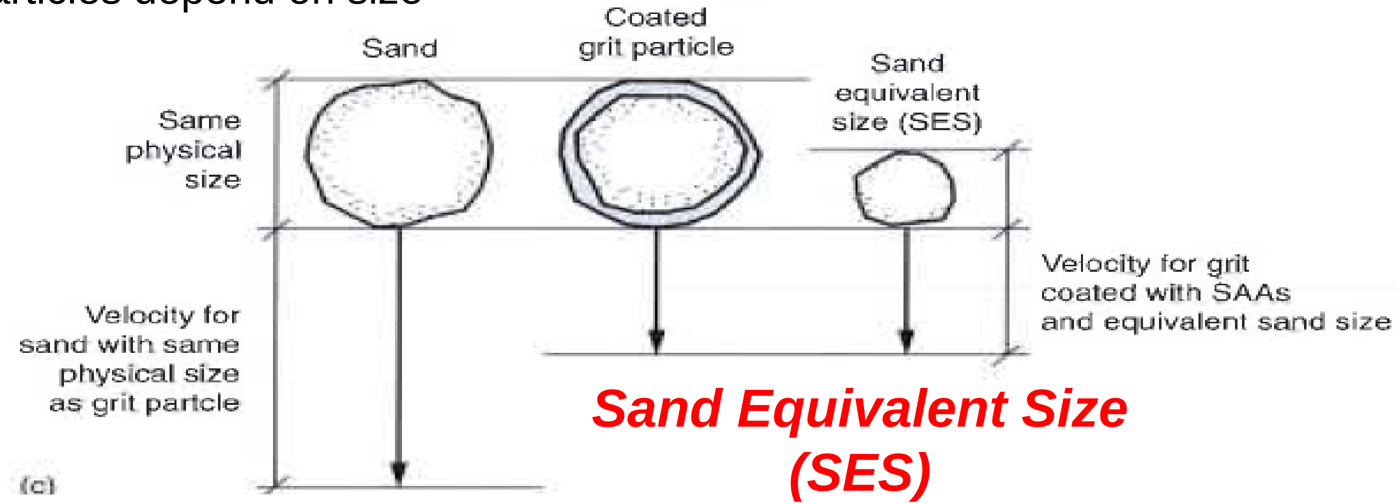
Clean Sand Particles



Settling velocity of clean sand particles depend on size



Settling velocity of grit coated with SAAs is independent of particle size

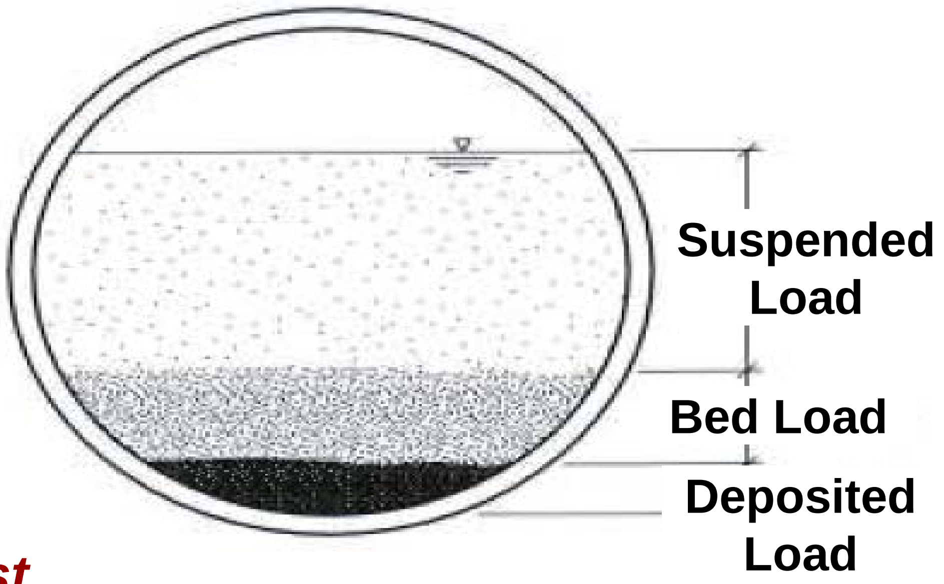


Sand Equivalent Size (SES)

Sediment Transport Basics

- Grit remains in the collection system until transported to the plant
- Flow/velocity suspends grit
- Low flow moves only small and light grit
- First flush significantly increases grit load

Effective grit removal systems must function at peak flow and peak grit load



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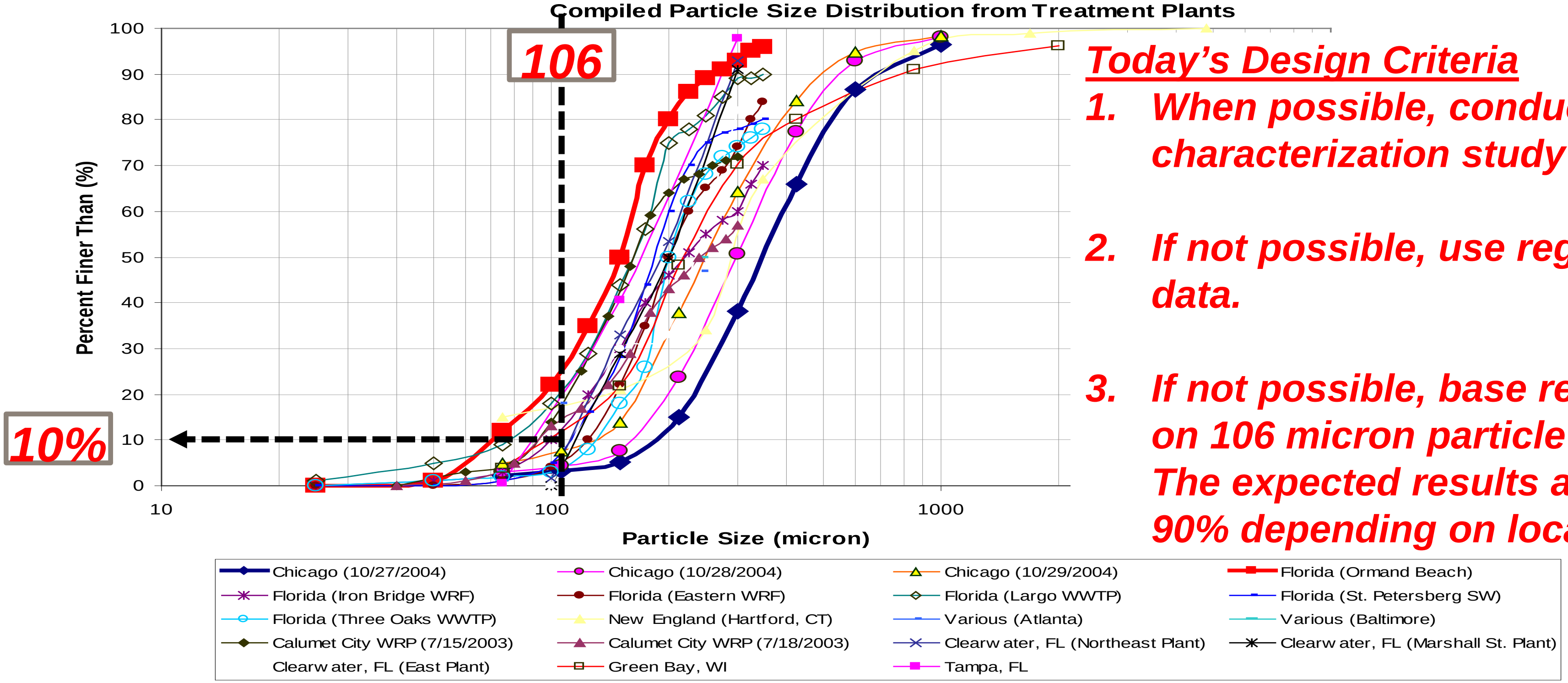
Impacts of Poor Grit Removal

- Many of the older systems have been proven to be ineffective.

- Designed to remove 210 micron SAND, 210 micron GRIT is much lighter and passes through the grit chamber.

Physical Size Distribution



Today's Design Criteria

1. ***When possible, conduct grit characterization study***
2. ***If not possible, use regional data.***
3. ***If not possible, base removal on 106 micron particle size. The expected results are 80 to 90% depending on location.***

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Why Do We Care?

Impacts of Poor Grit Removal

If grit is not captured in the grit removal units, biological activity will strip the organic SAAs from the inorganic core.

Impacts of Poor Grit Removal

With Primary Settling – You have a digester cleaning problem!

Without Primary Settling – You have an aeration tank cleaning problem!

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How Do We Remove Grit?

Trends in Grit Removal Technology Selection

- Better understanding of grit characteristics and grit system removal performance

- Manufacturers have developed some new technologies that treat grit removal as a total process that includes:
  - Removing grit from the wastewater
  - Separating organics from the inert grit particles of the collected grit
  - Drying collected grit

<u>Earlier Technologies</u>

- Horizontal-Flow Grit Chambers
  - Constant Velocity
  - Detritors
- Aerated Grit Chambers

<u>More Recent Technologies</u>

- Vortex Grit Removal Units
- Multi-Plate Grit Removal Units

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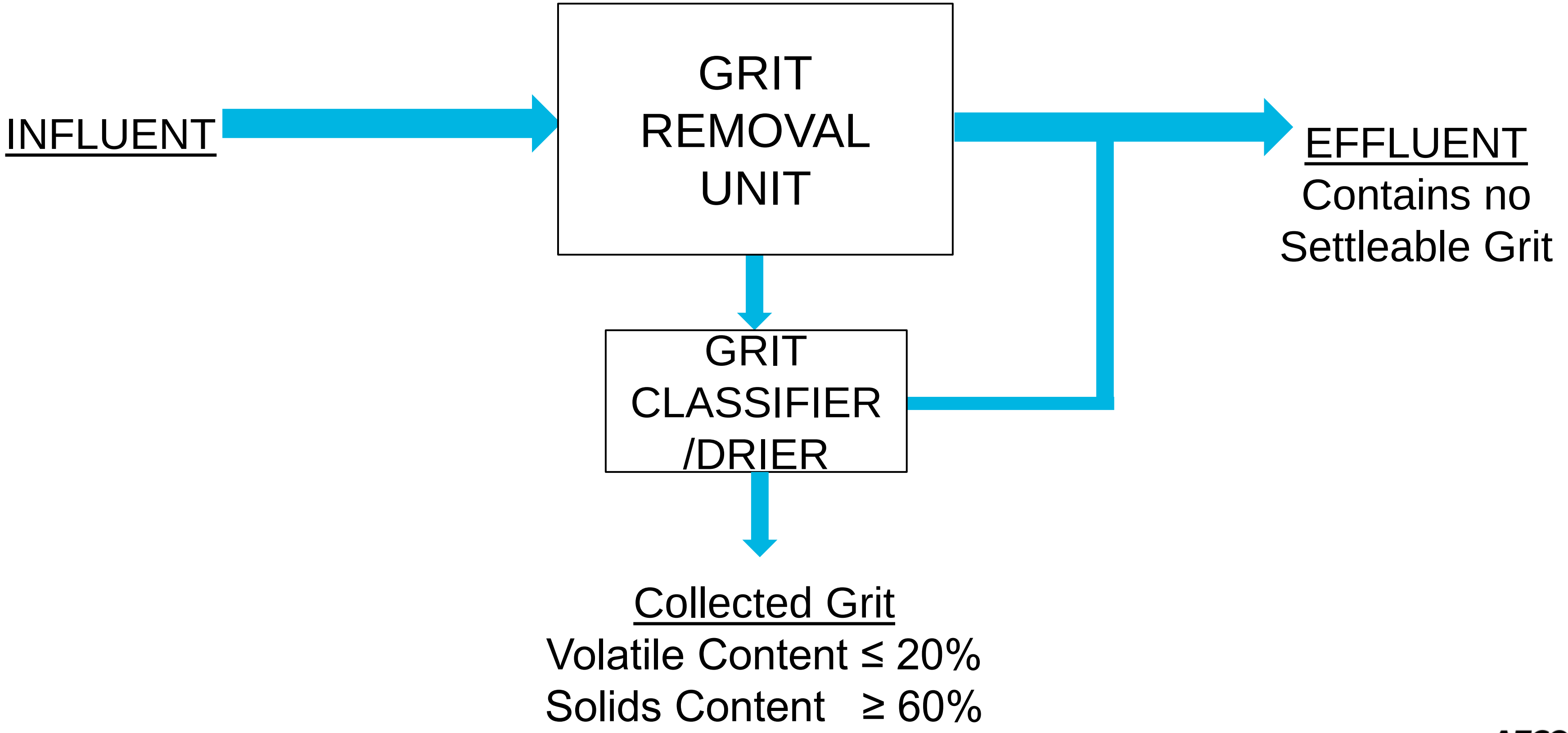
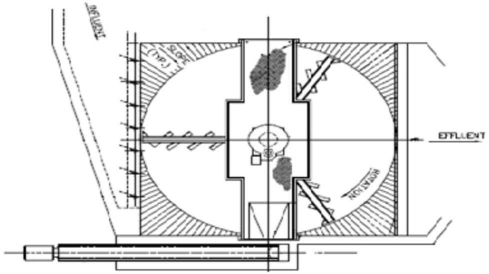
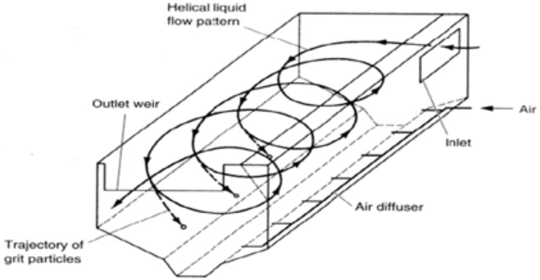
Modern Grit Removal Systems

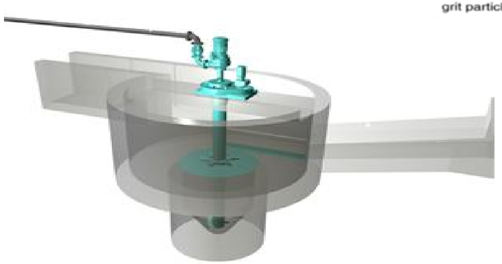


Grit Removal Units

- <u>Horizontal Flow</u>
  - ✓ Rectangular (Constant Velocity)
  - ✓ Detritor (Square Type)
- <u>Aerated</u>
  - ✓ Conventional
  - ✓ w/ Grease Removal
- <u>Vortex Type</u>
  - ✓ Hydraulically Induced
  - ✓ Mechanically Induced
  - ✓ Accelerated Gravity
  - ✓ Multi tray







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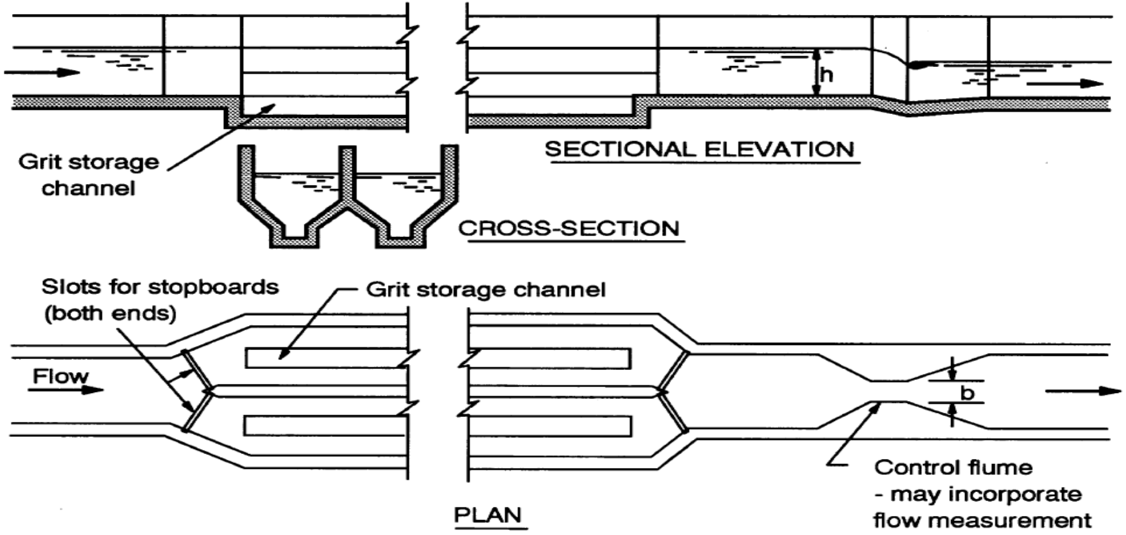
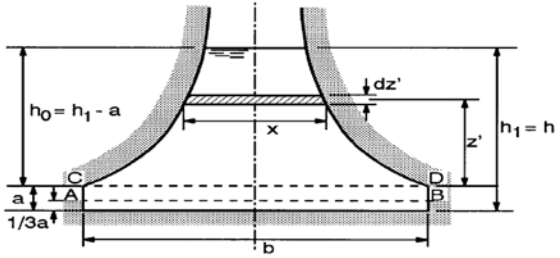
Rectangular (Constant Velocity Grit Chamber)

- Long narrow settling tank
- Velocity controlled by proportional weir or flume
- Length governed by depth required for settling velocity
- Cross sectional area governed by flow rate





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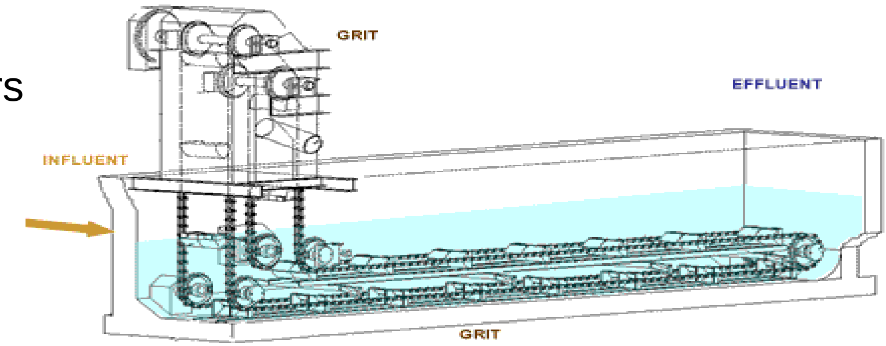
Horizontal Flow Grit Tanks

Controlled Velocity Disadvantages

- Difficult to maintain velocity of 1 fps over wide range of flows
- Mechanically cleaned system have submerged chain and sprockets
- Washing of grit may be required where flow control is an issue
- Bottom scour can occur using proportional weirs
- High headloss



Square Horizontal Flow (Detritus Tank)

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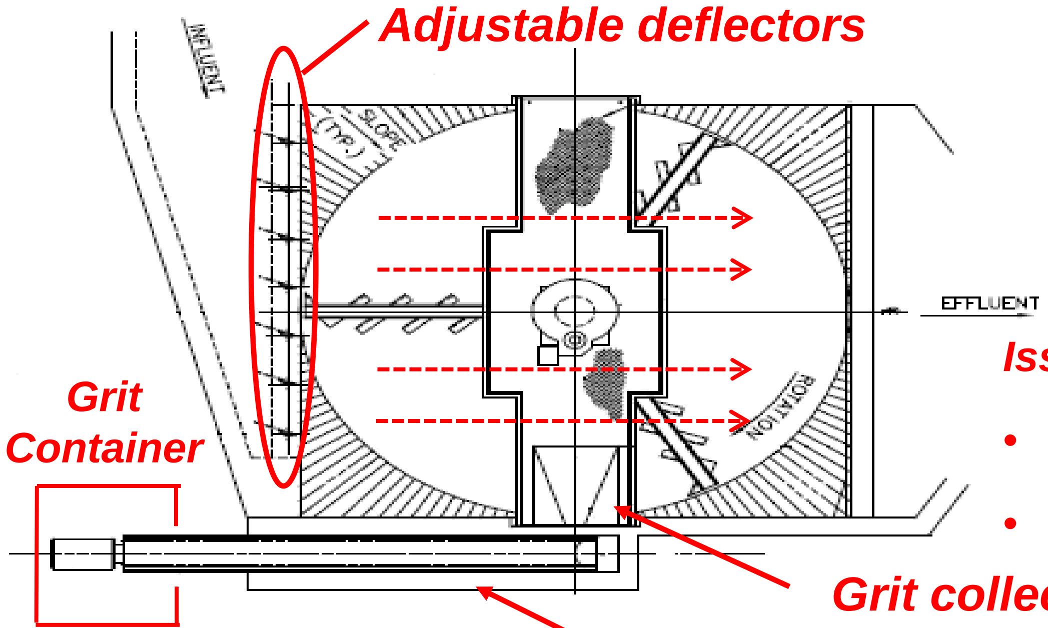
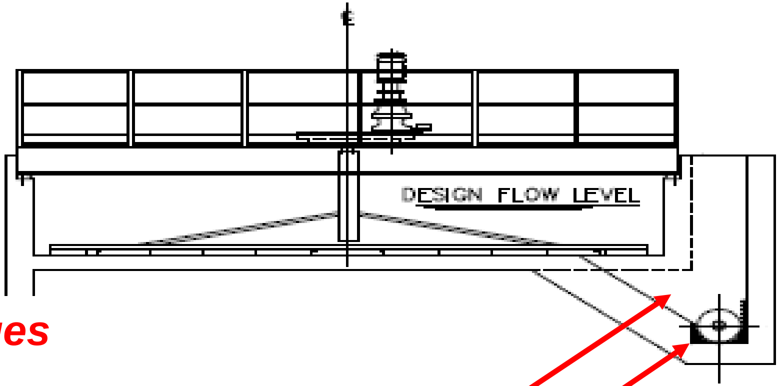
Square Horizontal Flow (Detritus Tank or Detritor)





Issues

- *Difficult to get uniform flow*
- *Mechanisms obstructs flow pattern*
- *Typically removes large amounts of organics and washing and classifying is critical*

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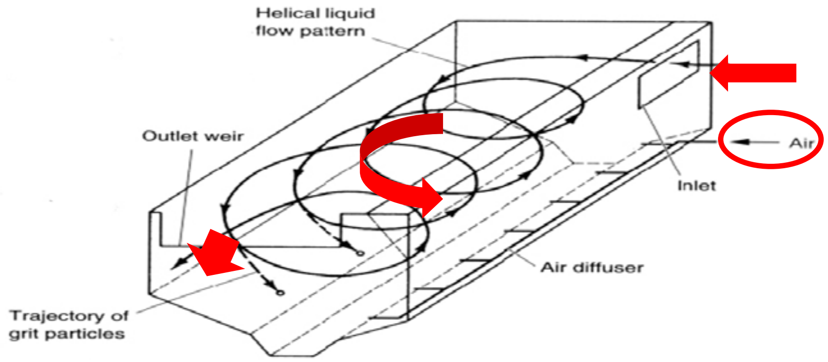
Aerated Grit Chambers



- Flow enters from side to start spiral
- Air is introduced along one side of a rectangular ta
- Grit particles settle to the bottom and the spiral roll sweeps grit to the collection channel
- The velocity of roll governs the size of particles removed and moves grit to hopper
- Grit removed by clamshell buckets, screw conveyor, grit pumps or airlift

- ***Air must be carefully controlled – Too much air washes out grit***
- ***Aeration can strip out H_2S – Covers may be necessary***
- ***Difficult to effectively remove grit from tank***
- ***Grit can have high organic content attracting insects***

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Aerated Grit Chambers – Grit Removal Techniques:

<u>Removal Mechanisms</u>

- Chain and Bucket
- Bottom Screw and Bucket Elevator
- Clamshell Bucket
- Screw Conveyor
- Traveling Bridge with Pumps
  - ✓ Air Lift
  - ✓ Submersible Recessed Impeller
  - ✓ Cantilever Recessed impeller
- Traveling Bridge with Scraper and External Pumps

Clamshell Bucket

Traveling Bridge w/ Cantilever Pumps

Traveling Bridge w/ Submersible Pumps

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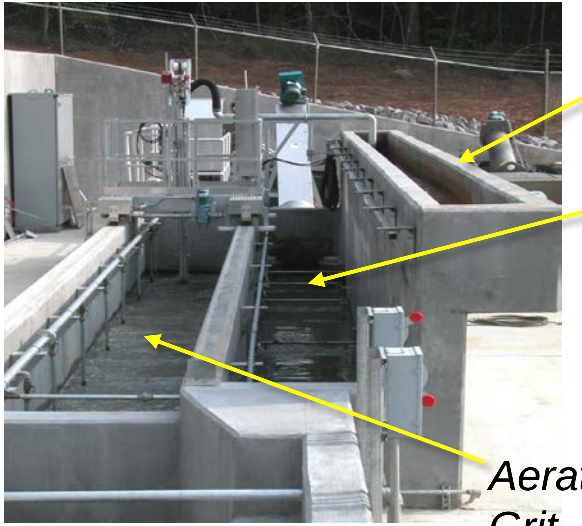
Traveling Bridge Aerated Grit Chambers
Grit and Grease Removal:

Grit Removal Mechanisms

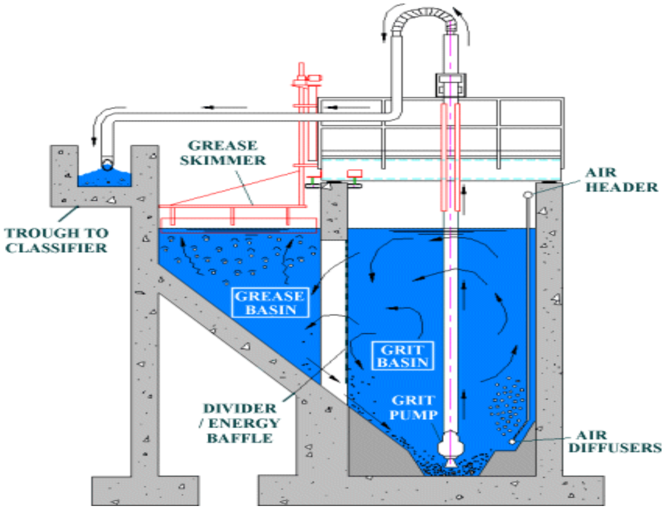
- ✓ Air Lift Pump
- ✓ Submersible Recessed Impeller Pump
- ✓ Cantilever Recessed impeller Pump



Grit Trough

Grease Channel

Aerated Grit Channel



Traveling Bridge Collector w/ Grease Removal Channel

Grease Removal Mechanisms

- ✓ Air Lance and Screw Conveyor
- ✓ Surface Collector and Screw Conveyor
- ✓ Surface Collector w/ Hopper and Pumps

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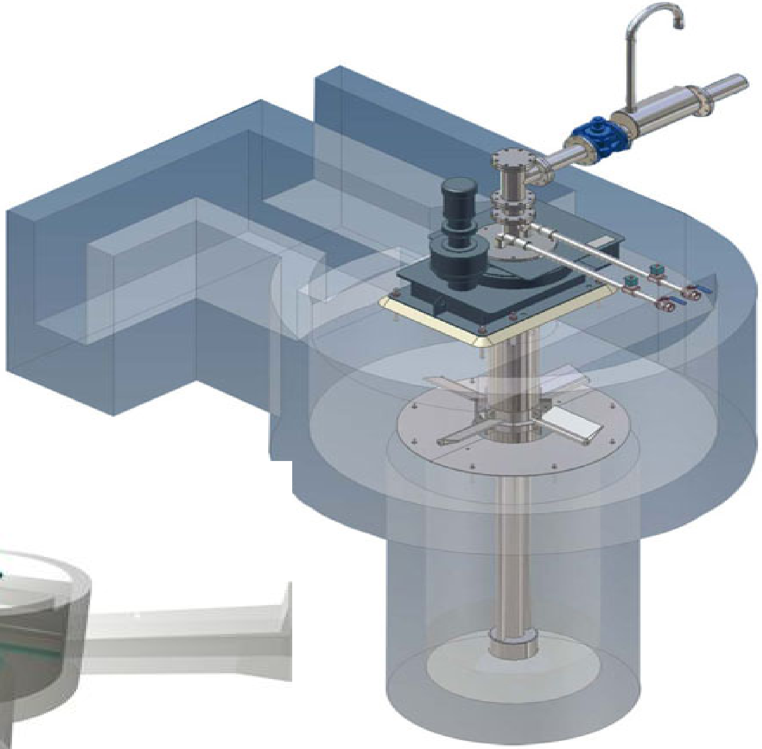
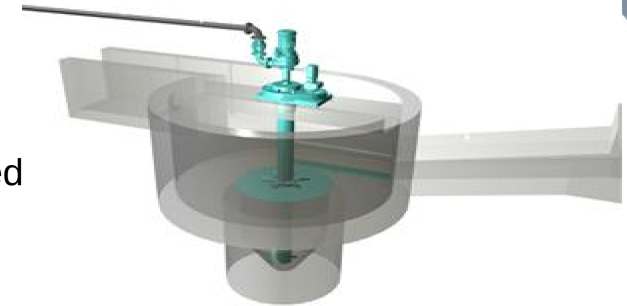
Centrifugal Separator (Vortex type w/ Mixer)

- Influent Channel tangentially feeds grit chamber
- Mixer to mechanically induce vortex and lift and separate organics
- Grit Removal
  - ✓ Air Lift Pumps
  - ✓ Vacuum Primed Recessed Impeller Pumps
  - ✓ Self Priming Pumps
  - ✓ Dry Pit Recessed Impeller Pumps
- Low headloss
- Scouring of grit hopper required
- Small space requirements

<u>Disadvantages</u>

- Have proven to be effective in smaller sizes but larger sizes may have reduced performance
- Baffling system reported to improve performance





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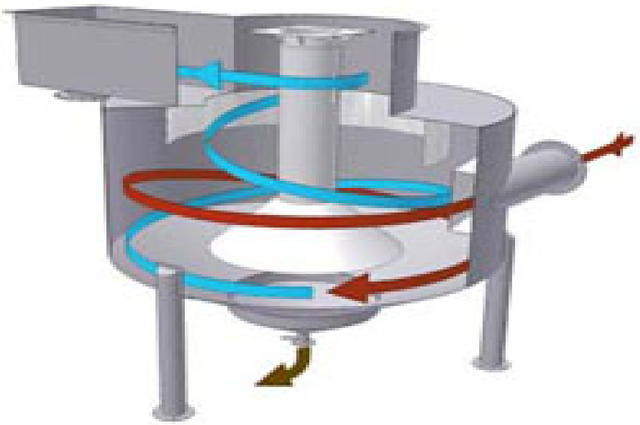
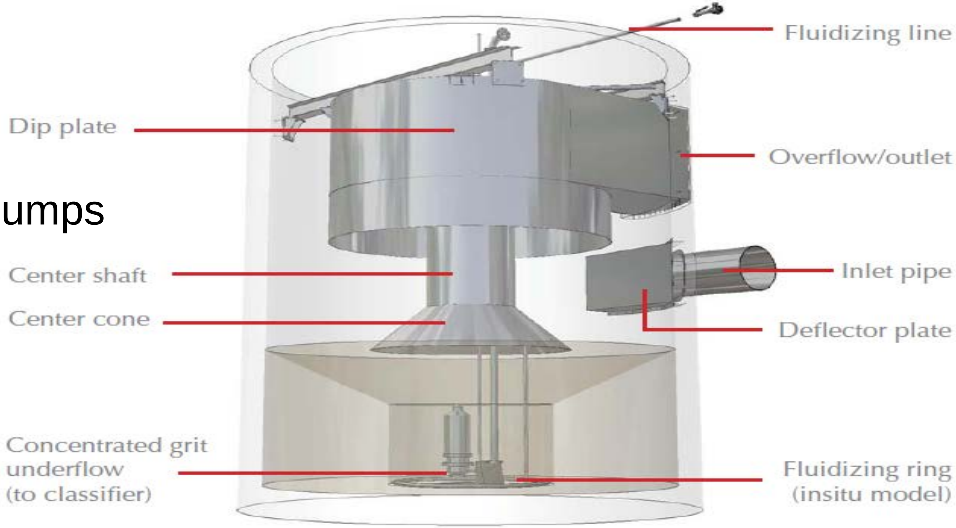
Centrifugal Separator (Hydraulically Induced Vortex)

- Influent channel tangentially feeds grit chamber
- Internal non rotating mechanism
- Grit Removal
  - ✓ Air Lift Pumps
  - ✓ Submersible Recessed Impeller Pumps
- Low headloss
- Small space requirements





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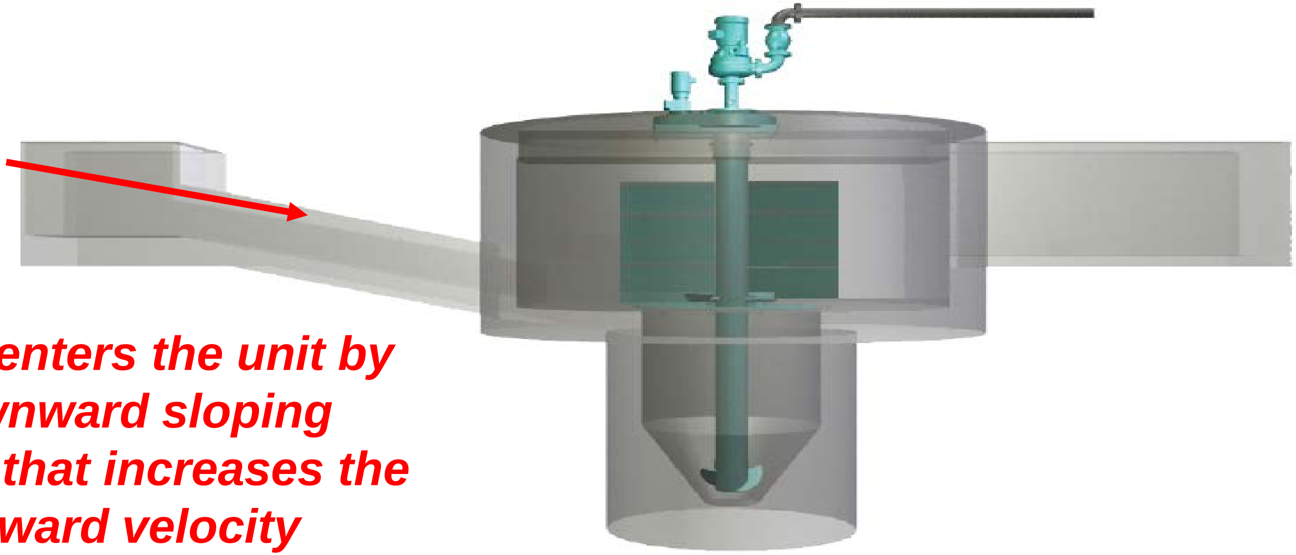
Centrifugal Separator (Accelerated Gravity)



Flow enters the unit by a downward sloping ramp that increases the downward velocity above simple gravity settling

Based on these modification the manufacturer claims higher grit removals than conventional mechanically induced vortex units.

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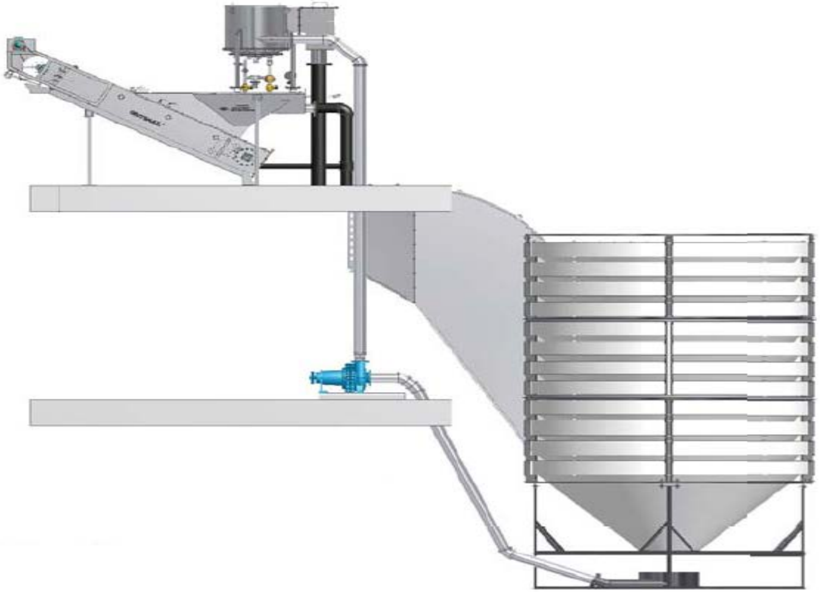
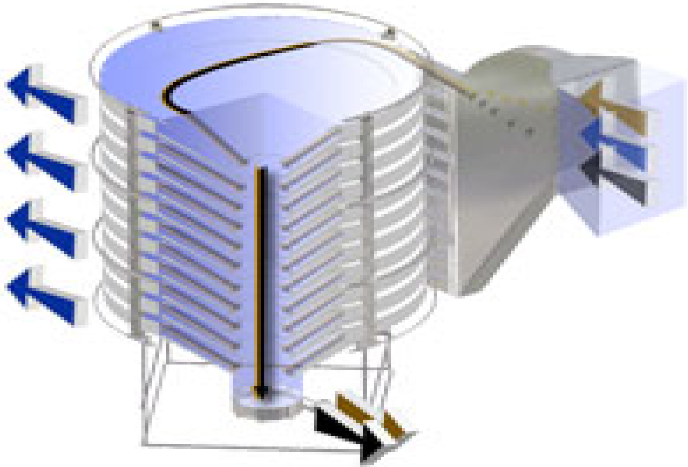
Centrifugal Separator (Hydrodynamic Multiple Tray Type – Head Cell)

- Influent Channels tangentially feeds multiple vortex grit trays
- Internal non rotating mechanism
- Grit Removal
  - ✓ Recessed Impeller Pumps
  - ✓ Self-Priming Pumps
- Small space requirements





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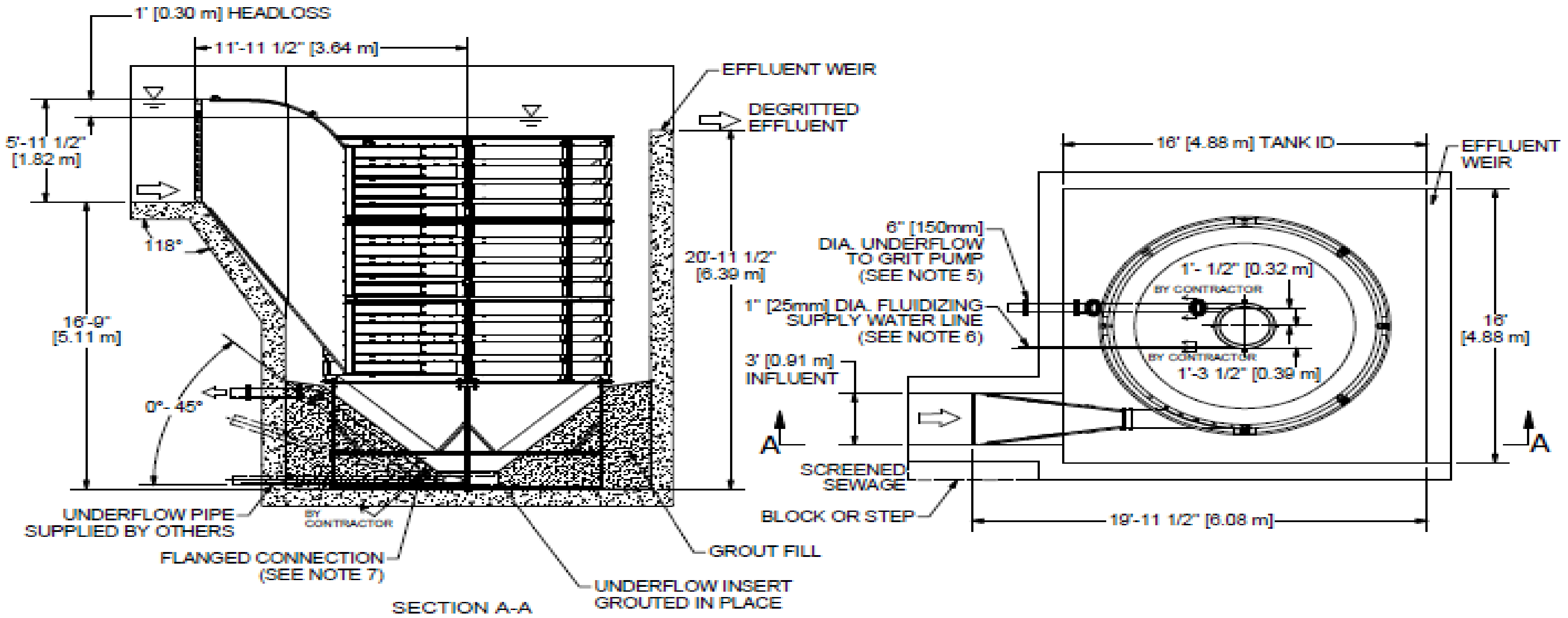
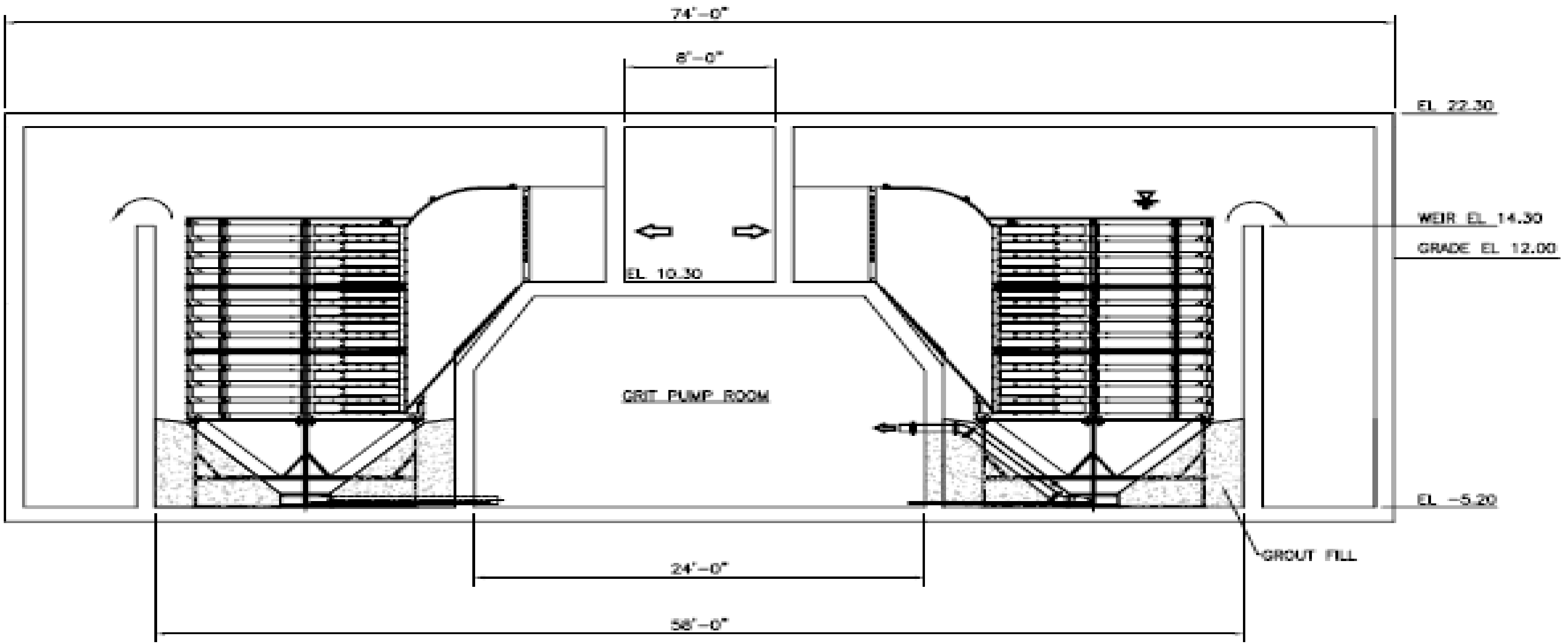
Centrifugal Separator (Hydrodynamic Multiple Tray Type – Head Cell)



Centrifugal Separator (Hydrodynamic Multiple Tray Type – Head Cell)



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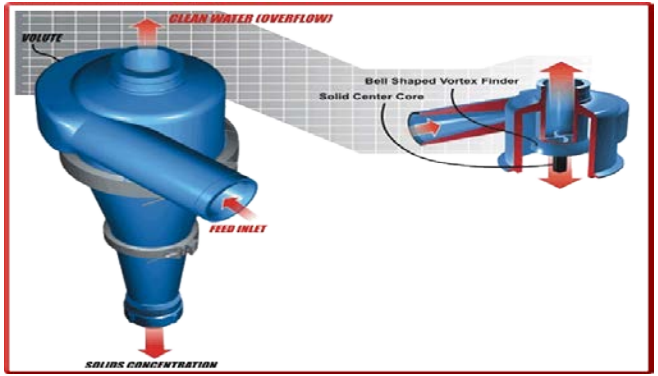
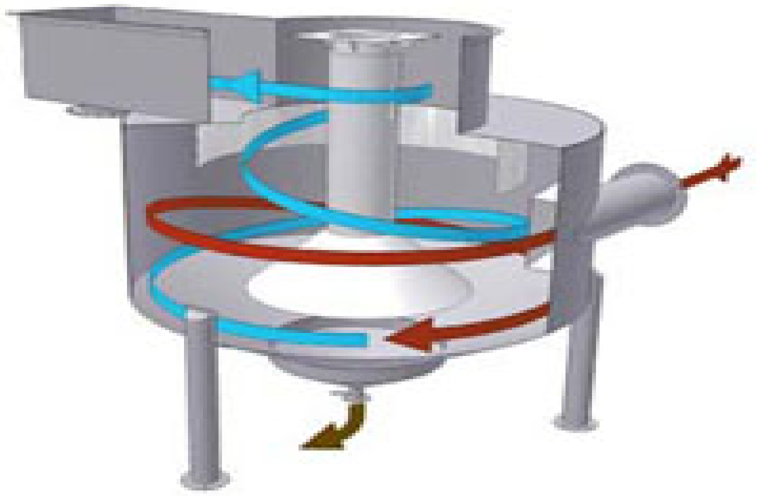
Secondary Grit Separators

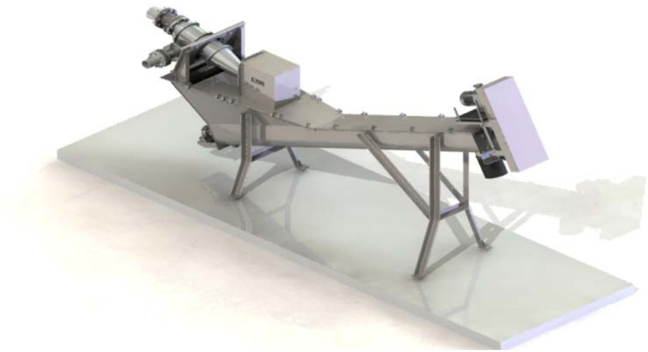
- Used for grit separation after vortex type chambers
- Hydrocyclone type or hydrodynamic type
- Provides grit washing and organics removal
- 2% to 5% of forward flow



Typical pressure required at inlet: 5 to15 psi



Hydrodynamic Type

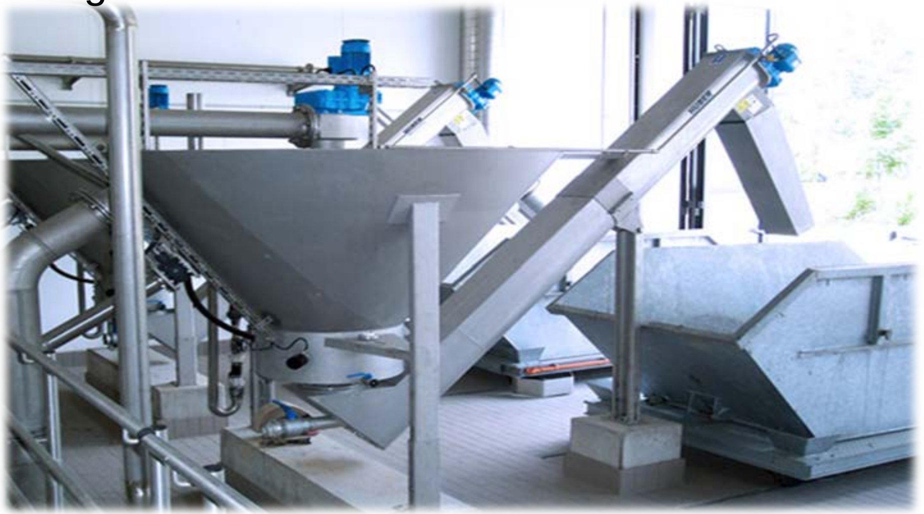


Hydrocyclone and Classifier Type

Grit Treatment – Grit Washers

Receives grit slurry from the grit chamber

- Performance: Less than 3% organics in washed grit
- Enclosed for odor control



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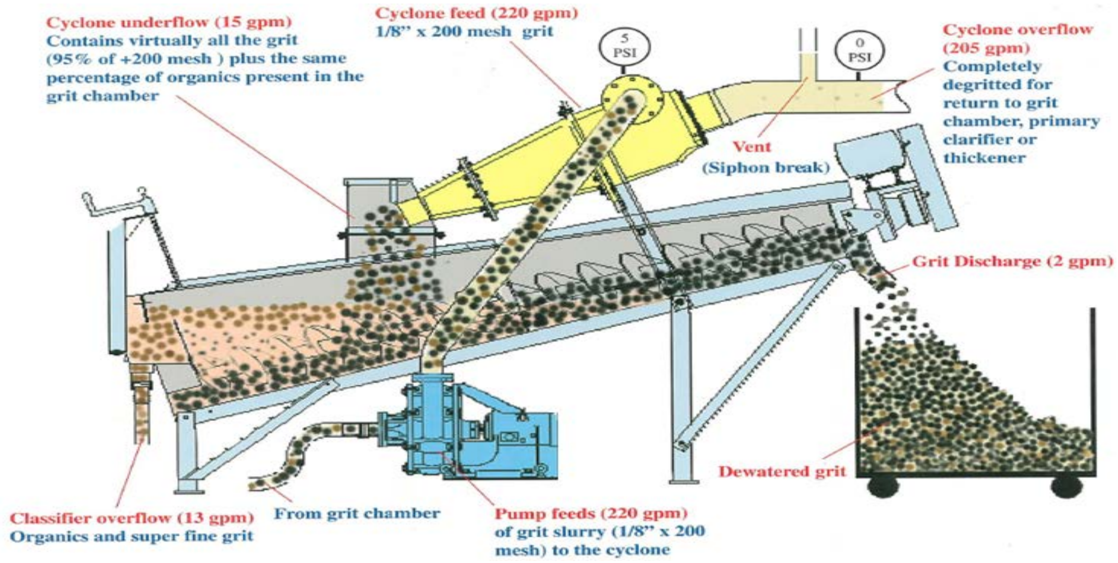
Primary Sludge Degritting - Centrifugal Separator & Classifier

Used for primary sludge degritting but sludge must be pumped at about 1% solids



Typical Primary Sludge Degritting System

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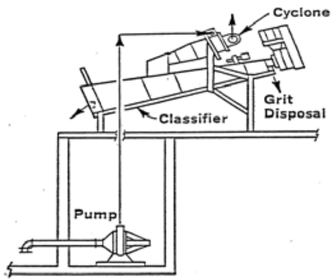
Grit Pump and Piping Systems

- ✓ Keep suction piping as short as possible, approximately 10 to 15 feet (3 to 4.5 meters)
- ✓ Pipeline Velocity: 6 to 8 fps (1.8 to 2.4 m/sec)
- ✓ Provide cleanouts and flushing connections
- ✓ Provide flushing water in pump suction piping
- ✓ Avoid the use of check valves
- ✓ For isolation valves use full port abrasion resistant pinch valves
- ✓ Use hard metal recessed impeller pumps for pumping abrasives
- ✓ Use 4” (100 mm) minimum diameter piping
- ✓ Use a piping system that is abrasion resistant like glass lined ductile iron or abrasion resistant and light enough for removal such as ceramic lined FRP
- ✓ Use long radius 90 deg bends or 45 deg bends
- ✓ Use dedicated suction and discharge piping runs for multiple pump systems



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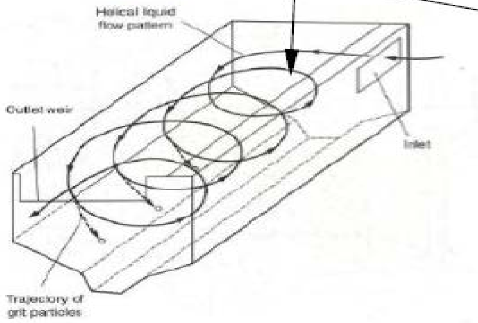
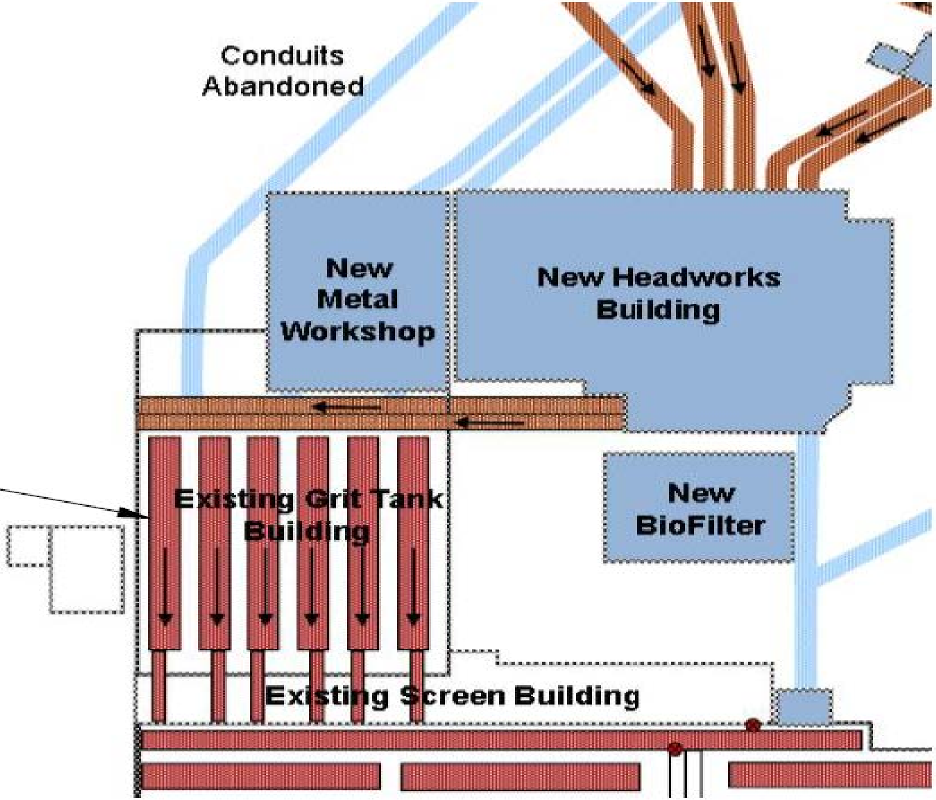
Case Histories

Ashbridges Bay WWTP, Toronto CA

Spiral roll pattern resulted in high velocity during high flow





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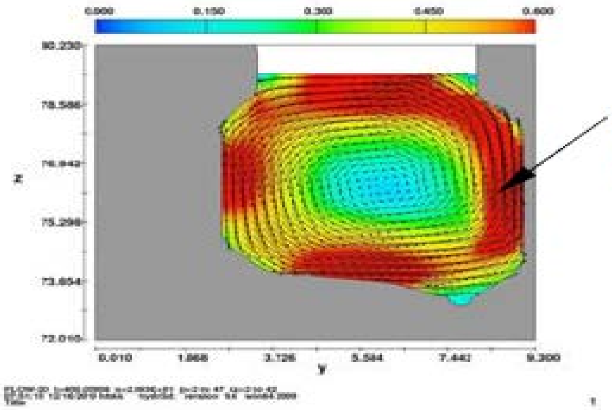
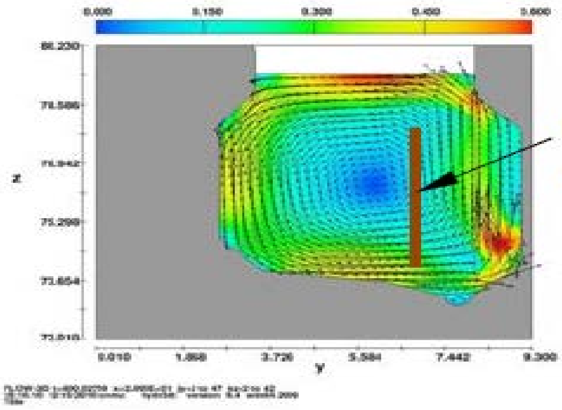
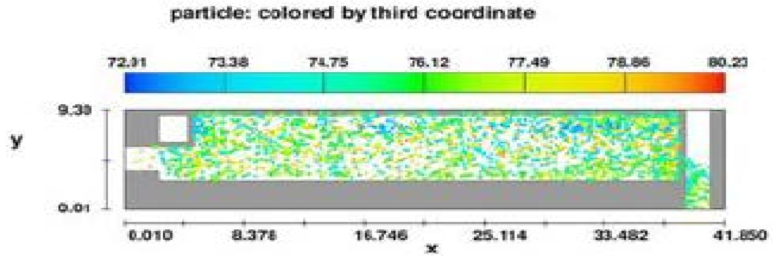
CFD modeling for hydraulic analysis

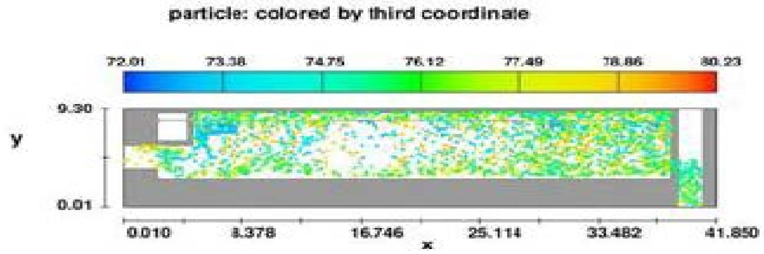


High velocity w/o baffle



Baffle reduced velocities





Ashbridges Bay WWTP, Toronto, Canada

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Naperville IL Springbrook WRC

Existing aerated grit tanks

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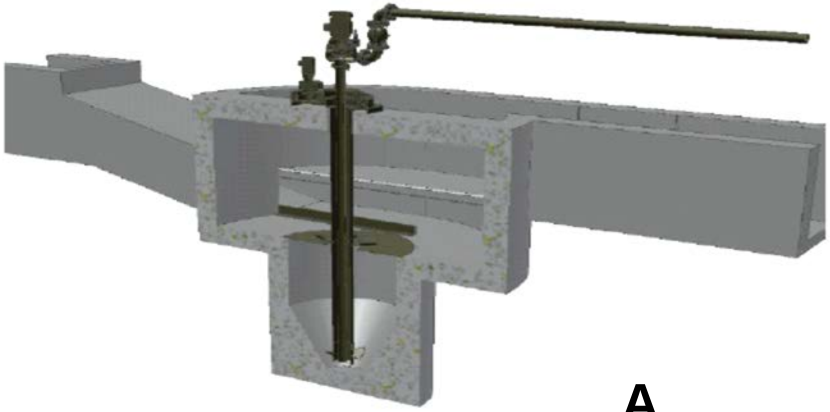
Naperville IL Springbrook WRC



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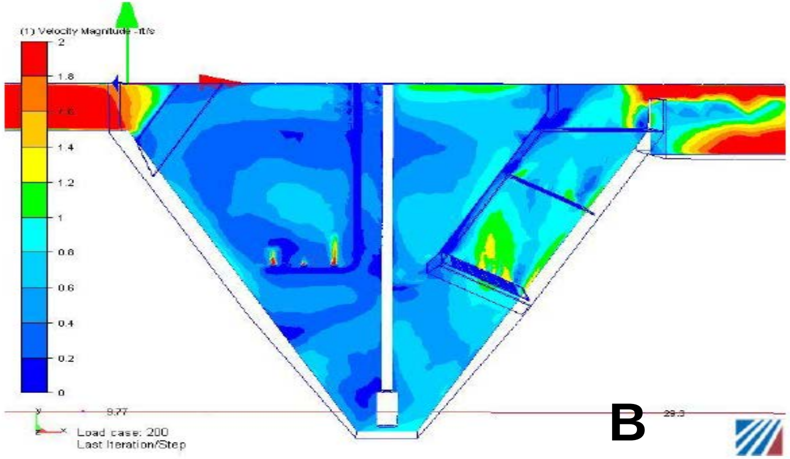

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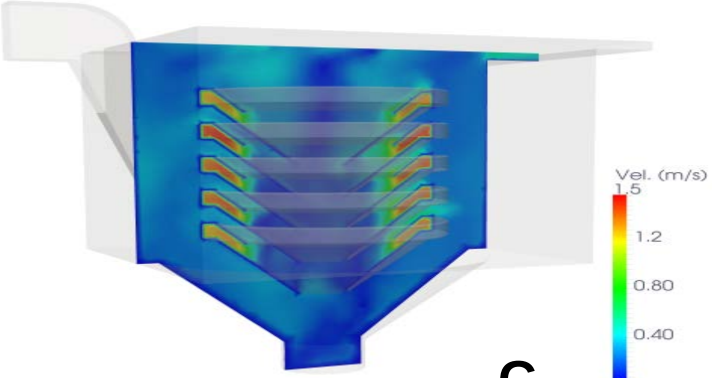

C

<u>Grit technologies considered:</u>

A – Vortex Tanks *(example shown: Smith & Loveless)*

B – Aerated Tanks *(example shown: WSG)*

C – Headcells *(example shown: Hydro International)*

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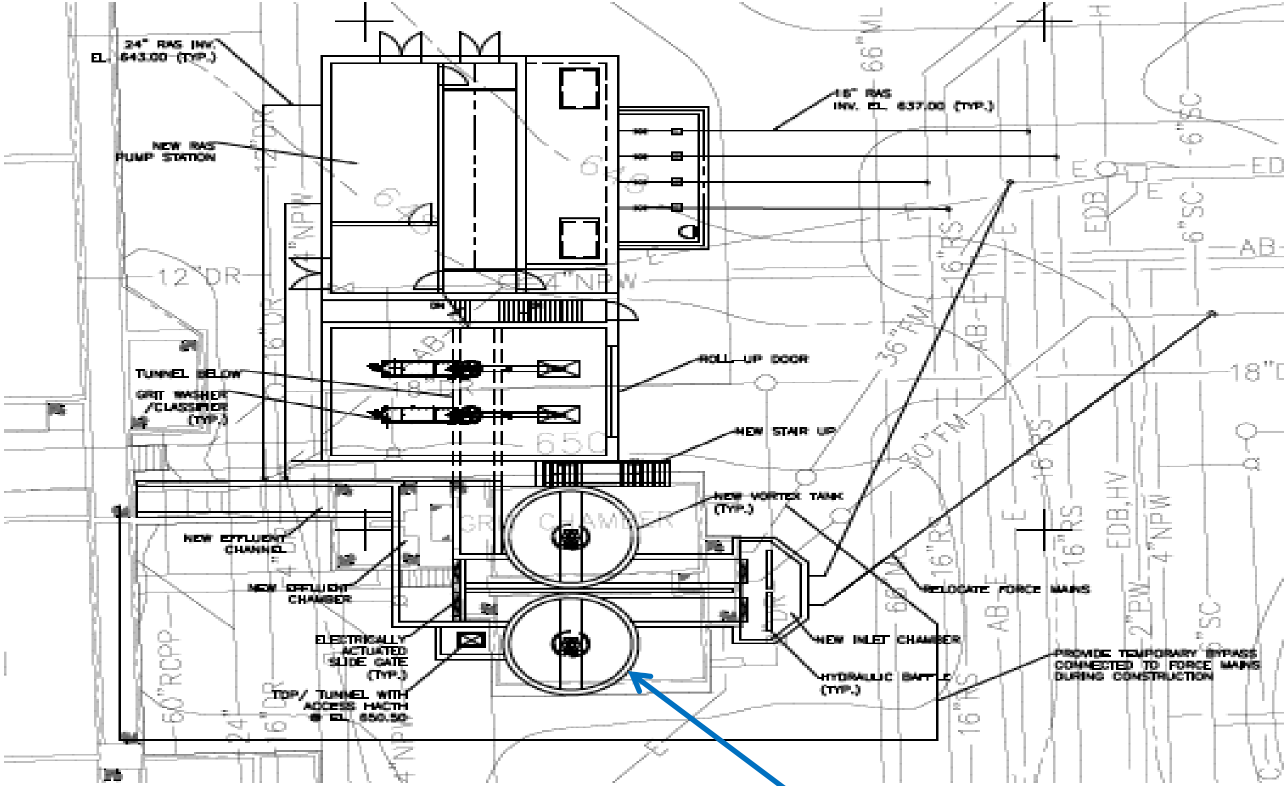
Naperville IL Springbrook WRC



Option A, Vortex Tanks Recommended

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Urbana Champaign IL Sanitary District

Start of construction of
new grit tanks

Urbana Champaign IL Sanitary District

New tanks include compartments w/ FRP baffles

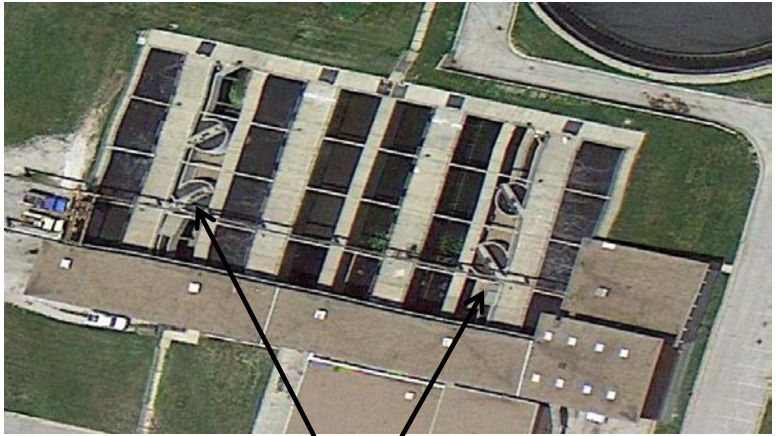
Planned phasing required bulkheads to minimize time for bypass pumping to complete tie-ins and demolition

Urbana Champaign IL Sanitary District

Covered aerated grit tanks

Odor control system

Kansas City, MO Blue River WWTP



Existing aerated grit tanks

Retrofit with vortex grit tanks

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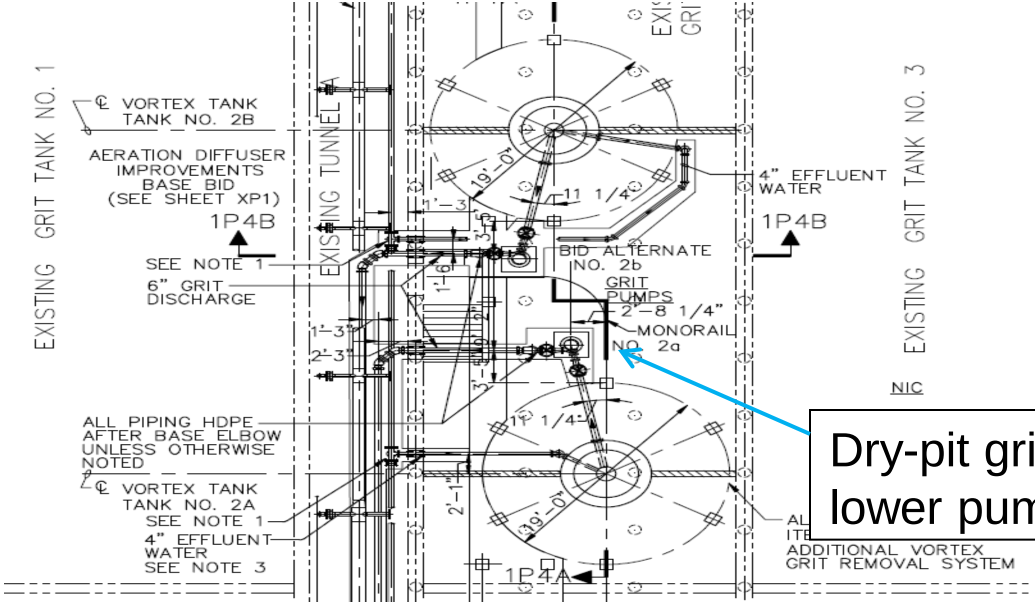
Kansas City, MO Blue River WWTP

Vortex grit tanks constructed within existing aerated grit tanks



Dry-pit grit pumps in lower pump room

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Genesee County MI proposed expansion

Proposed vortex tank outside of building

Existing vortex tank inside of building

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Benton Harbor St. Joseph MI Joint WWTP

Existing rectangular grit tanks

Existing proportional flow parabolic effluent weir

Proposed location of new screen and grit facility

Conclusions and Recommendations

Analysis of Existing Grit Systems

– Evaluate records of grit quantities, if available

– Assess quality of grit including seasonal variations

– Sample primary sludge for grit carry over

– Assess build up in channels, aeration tanks, and digesters

– Assess hydraulic velocities and flow patterns

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Considerations for Grit Removal Criteria

– Percent of fine grit particles

– Seasonal variations

– Organic material from industrial sources

– Is removal of fine grit necessary?

Typical Improvement Alternatives

– Physical modifications to improve performance

– New system for average flow with existing process for supplement at high flow

– New processes retrofitted within existing processes

– Space permitting consider entirely new process to simplify construction

Grit System Considerations

Item	Discussion
Understand the collection system	Combined or separate sewers
Understand flow patterns	Hydraulics and flow splitting. First flush effect?
Understand the grit type implications	Grit characterization or use regional data. If no data available, design to remove 106 micron grit particle.
Assess and quantify existing grit problems	Excessive digester or aeration tank cleaning.
Identify downstream processes (existing and future) impacted by grit	Membrane bioreactors, anaerobic digesters, aeration tanks.
Assess performance of existing grit removal equipment	Upgrade with new technology or re-purpose (Capture First Flush)

Conclusions and Recommendations

- Grit characteristics – Determine if removal of fine grit is appropriate
- Assess hydraulics – Laminar flow and equal flow distribution optimize performance
- Carefully analyze retrofits to avoid features that may compromise performance
- Consider impacts on future processes such as BNR or membrane systems

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Thank You

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Questions?