Grit Happens

You Don't Know What You're Missing

Indiana Water Environment Federation
Indianapolis, IN
November 16, 2010

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Presentation Objectives

- Why target fine grit
- Designing the optimum Grit Removal System
- Why efficiency in all three steps is key

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What is Grit?

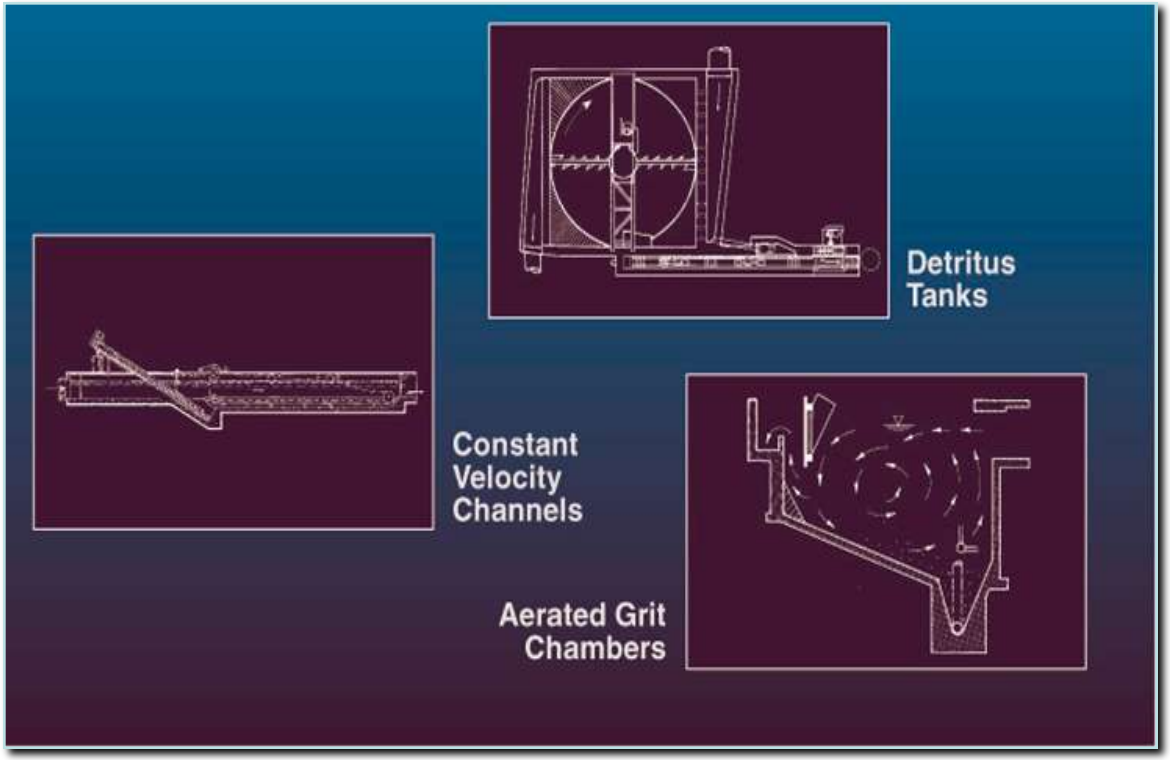
- High Density, Inert Solids
- Non-putrescible
- Sand, gravel, minerals, cinders, other heavy solid materials
- Settling velocity greater than organic putrescible solids

Impact of Poor Grit Mgmt

- **Takes up volume in process tanks**
  - ***Primaries, aeration, digesters, incinerators***
  - ***Manual labor to remove and dispose (time & cost)***
- **Accelerates wear on equipment**
  - ***Sludge transfer pumps***
  - ***Digester mixing components***
  - ***Sludge dewatering feed pumps***
  - ***Centrifuges***
  - ***Collectors and screws***
  - ***Maintenance operator time and parts (time & cost)***

Conventional Process Design

- Remove heavy grit (> 210 micron, 2.65 SG)
- Pass organics (Reduce odors & simplify disposal)
- Problem: Typically capture <50% of influent grit



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Conventional Results

Aeration Basins

Digesters

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Understanding Grit

Grit is a common and serious problem for many Wastewater Treatment Plants

- **Grit is often assumed to behaves like clean sand in clean water and fine material is often overlooked.**
- **However, municipal grit DOES NOT behave (settle) like clean sand and many plants have a significant volume of fine material.**
- **Improving our understanding of grit will serve to improve the success of our designs.**

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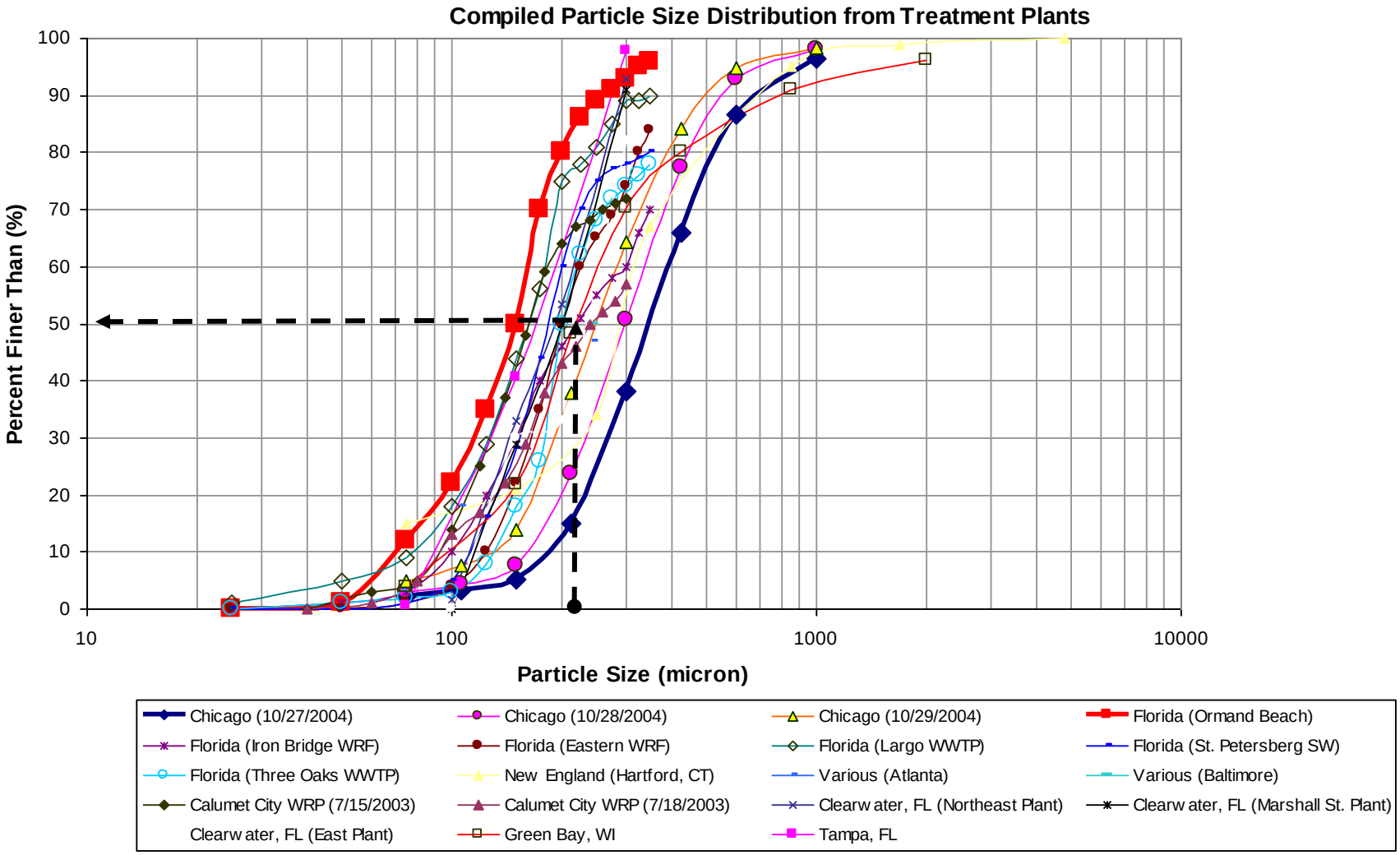
Understanding Grit

Assumptions	Reality
All silica sand	*Variety of material types*
2.65 specific gravity	*Range of specific gravity*
Perfect spheres	*Variety of shapes*
Quiescent basin	*Basins not quiescent*
Clean sand in clean water	*Fats, oils, greases, soap, scum in collection system*

Distribution of Grit at WWTPs



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Specific Gravity

Specific Gravity of Various Materials			
Quartz Sand	1.2	Earth	1.4
Limestone	1.55	Granite	1.65
Clay	1.8	Red Brick	1.9
Sand, wet	1.92	Gravel	2.0
Asphalt	2.2	Concrete	2.4

Specific Gravity

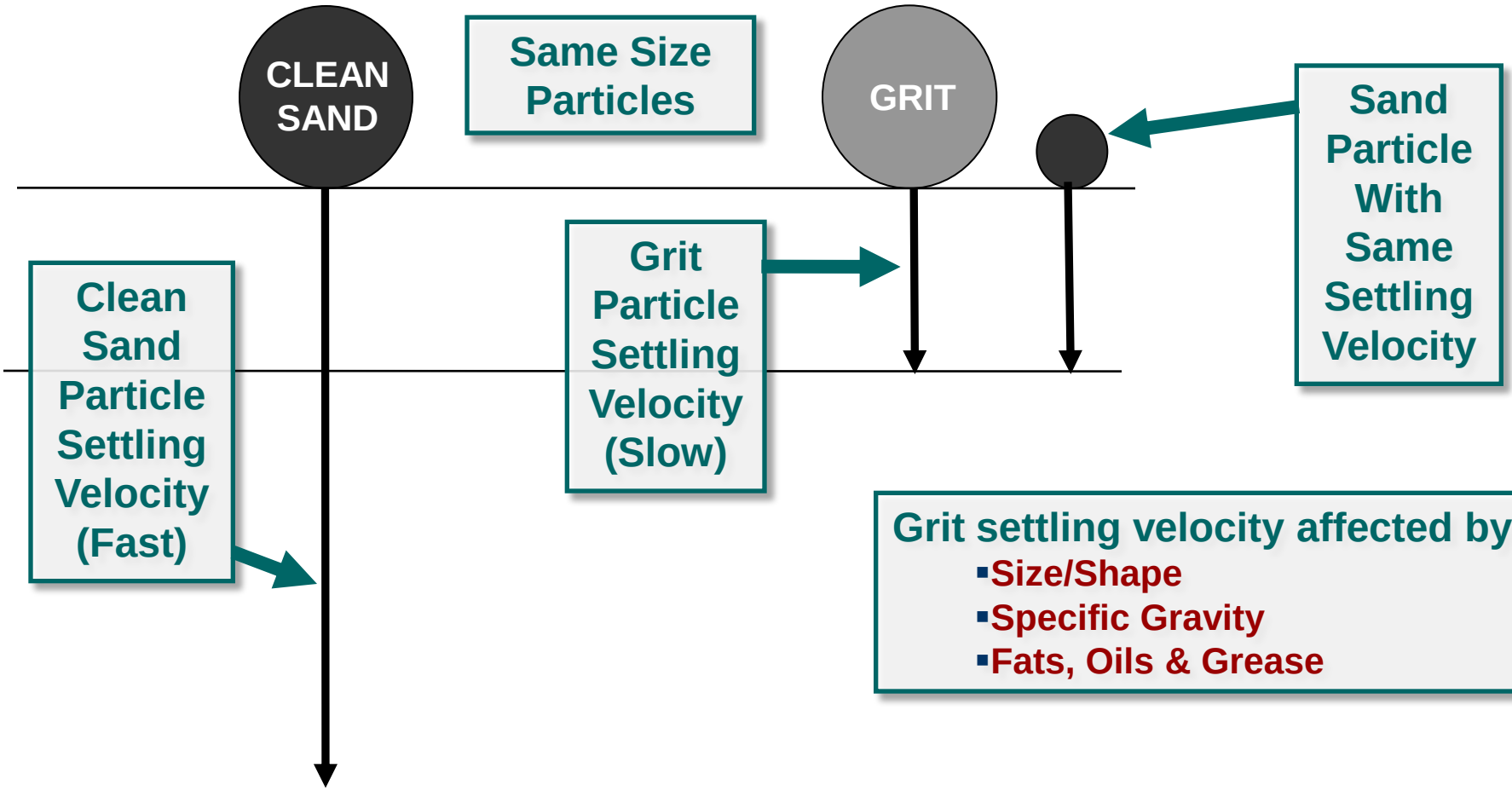
Deer Island Treatment Plant, Boston, MA
SG: 1.22

East Bay Municipal Utility District WWTP, CA
SG: 1.24 – 1.61, Average 1.35

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.

Settling Velocity



Grit settling velocity affected by:

- Size/Shape
- Specific Gravity
- Fats, Oils & Grease

Sand Equivalent Size (SES) Of Grit

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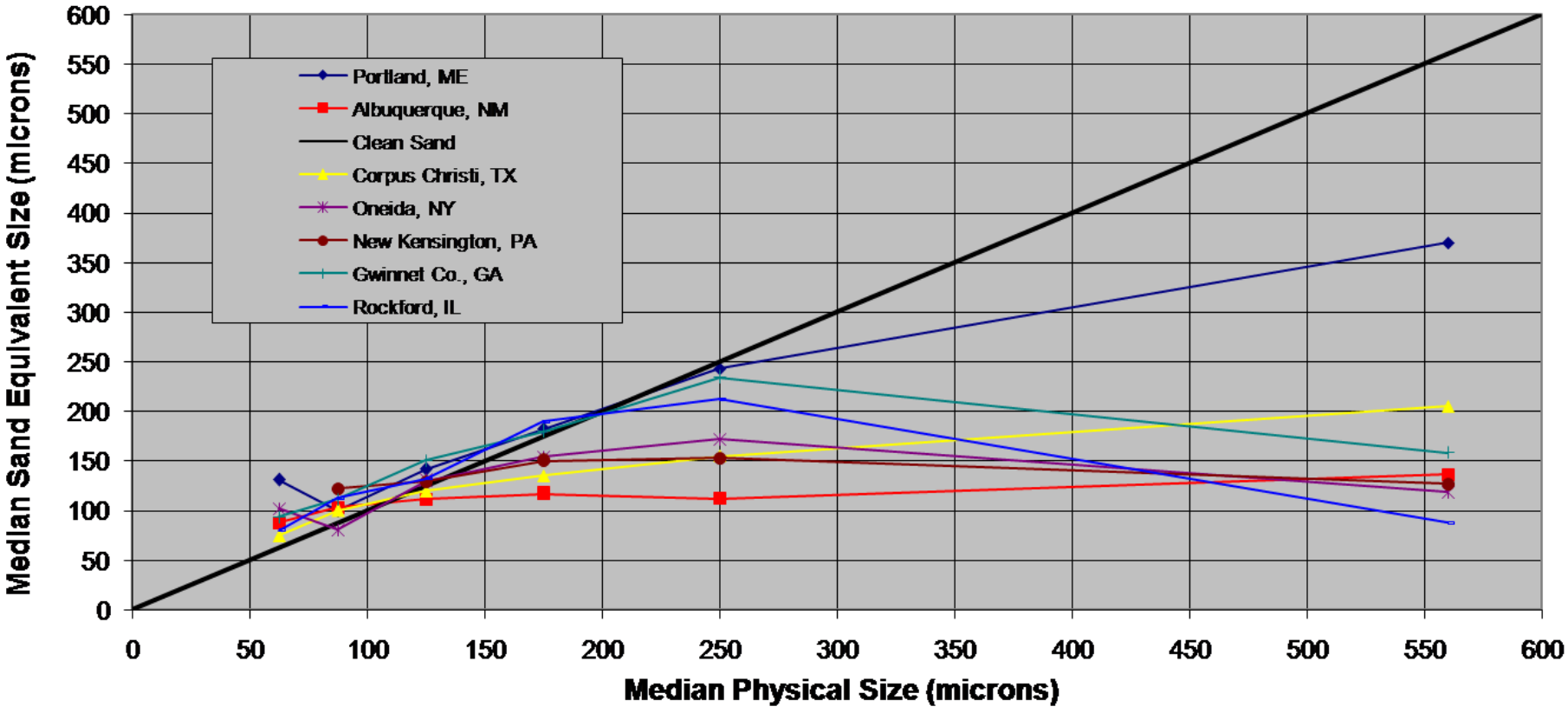
Average Median Size Distribution of Grit



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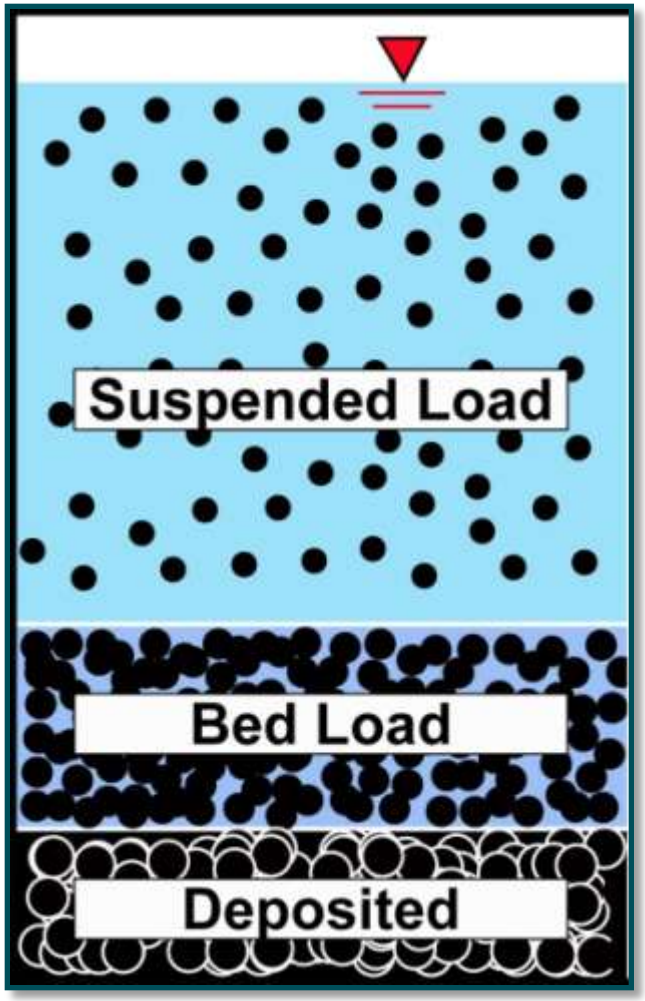
Collection System Basics

- Grit remains in the collection system until transported to the plant
- Low flow moves only small and light grit
- Increased flow/velocity suspends grit
- First flush significantly increases grit load (10 – 40X avg.)

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



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Designing a Grit Removal System That Works

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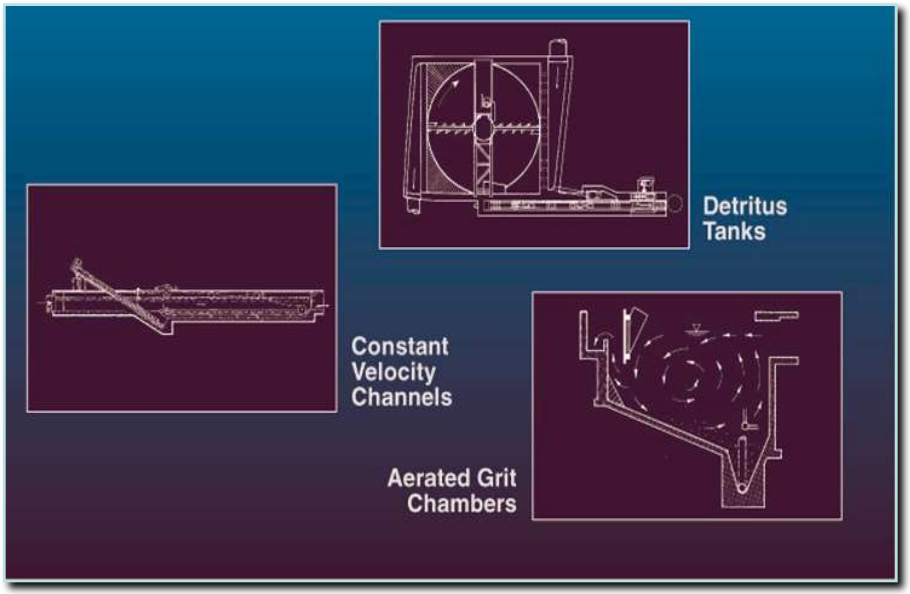
Design Guideline

- **Define Design Requirements:**
  - ***Grit Particle Size Analysis***
  - ***Settleability (SES)***
  - ***Required System Efficiency***
  - ***Screening Requirements***
- **Evaluate Equipment**
  - ***Removal Efficiency/Performance***
  - ***Equipment Design/Features***
  - ***Space***
  - ***Headloss***
  - ***Cost: Capital, Installation, Operational***
  - ***Maintenance Requirements***

Types of Grit Removal

- Gravity Sedimentation
  - *Detritor Tanks*
  - *Velocity Channels*
- Aerated Grit Chambers
- Vortex Grit Systems
  - *Open Vortex or Free Vortex*
  - *Forced Vortex (Mechanical or Hydraulic)*



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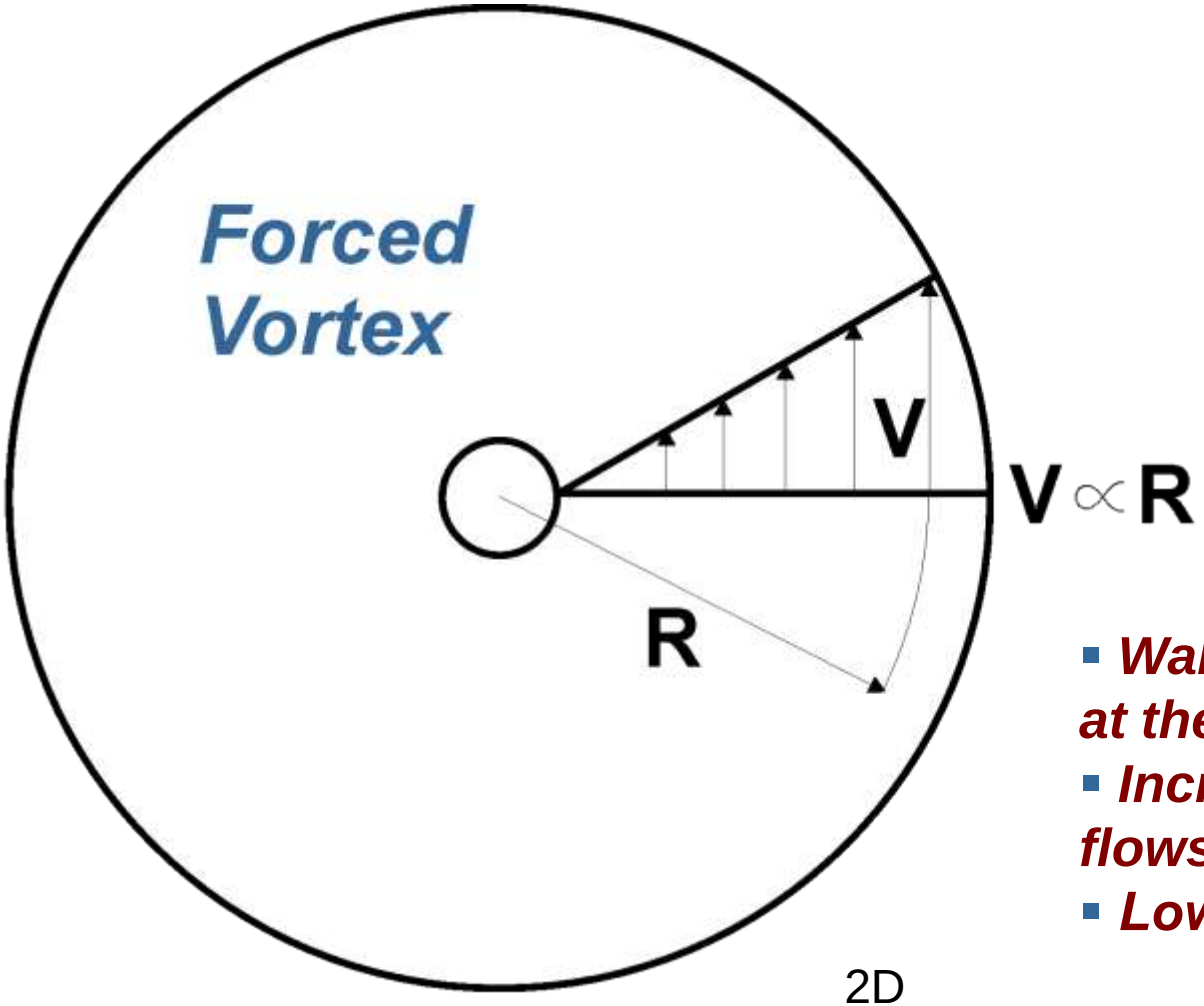
Forced Vortex



2D

- *Wall velocity is greater than at the center*
- *Increasing performance as flows decrease (lower SLR)*
- *Low headloss < 12”*

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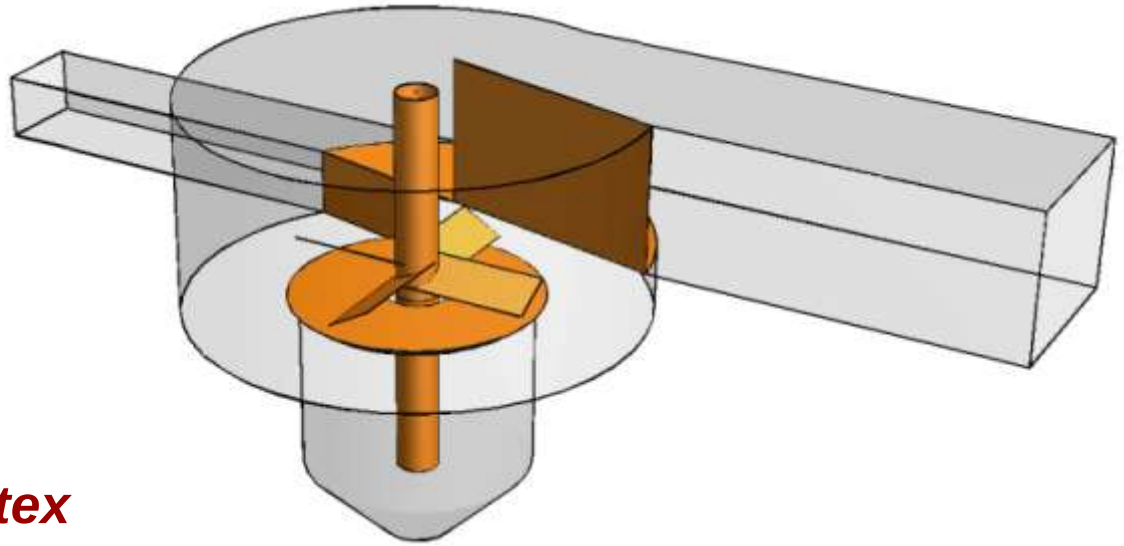
Forced Vortex Systems

Vortex Type	Headloss		Removal Efficiency	Cut Point Particle
Hydraulic Forced Vortex	Medium	6-12”	95%	75 + micron
Mechanical Forced Vortex	Low	< 6”	95%	300 + micron

Mechanically Induced Vortex

- **Performance:**
  - ***95% removal of 300 micron particle***
  - ***85% removal of 212 micron particle***
  - ***65% removal of 150 micron particle***
- **Low headloss**
- **Mechanical vortex**
  - ***Paddle maintains vortex***
- **Power required**
- **Inlet / Outlet limitations**
  - ***270° & 360°***
- **Hundreds of installations**



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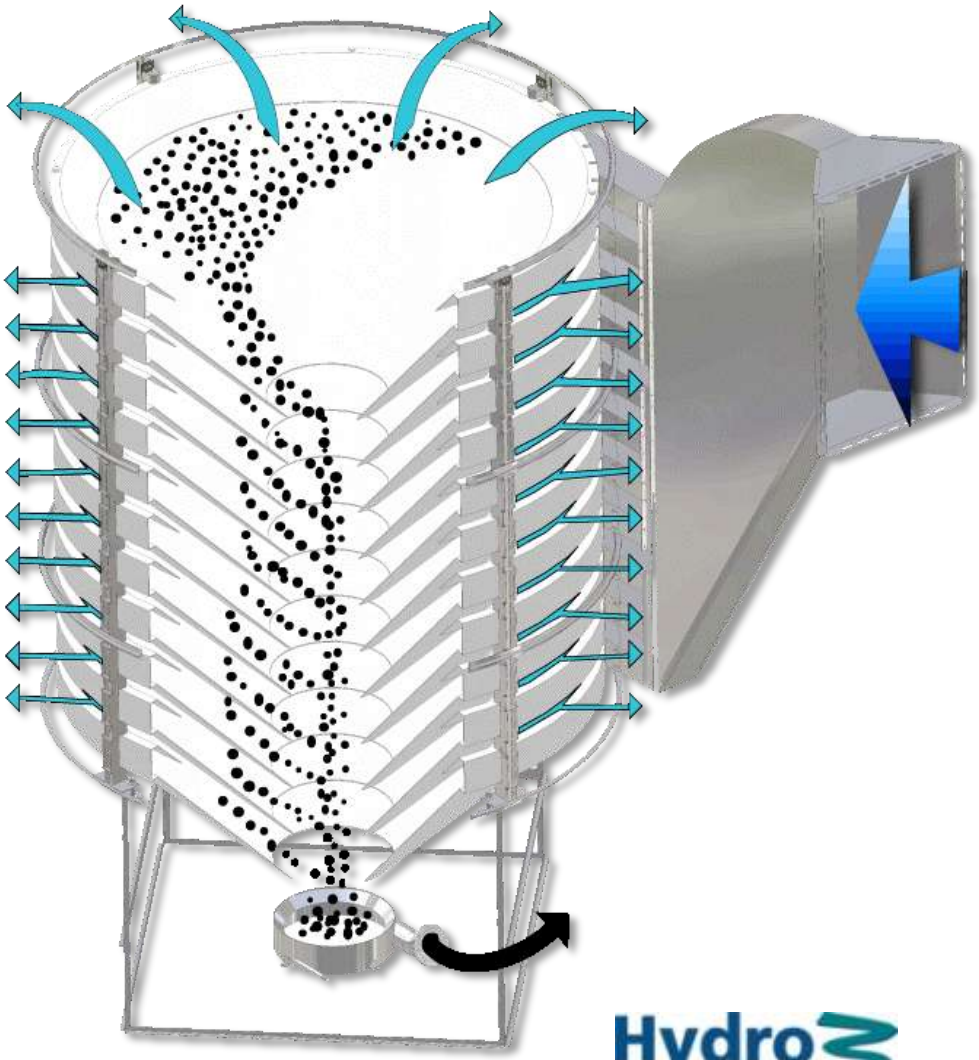
Stacked Tray Vortex

- **Performance:**
  - ***95% removal down to 75 micron particle***
- **Large surface area in a small footprint**
- **Short settling distance**
- **Handles wide flow ranges**
- **Sized for peak flow and grit load**
- **No moving parts (in-basin)**
- **Ideal for retrofitting into existing basins**
- **Proven Track Record**
  - **> 100 US installations**



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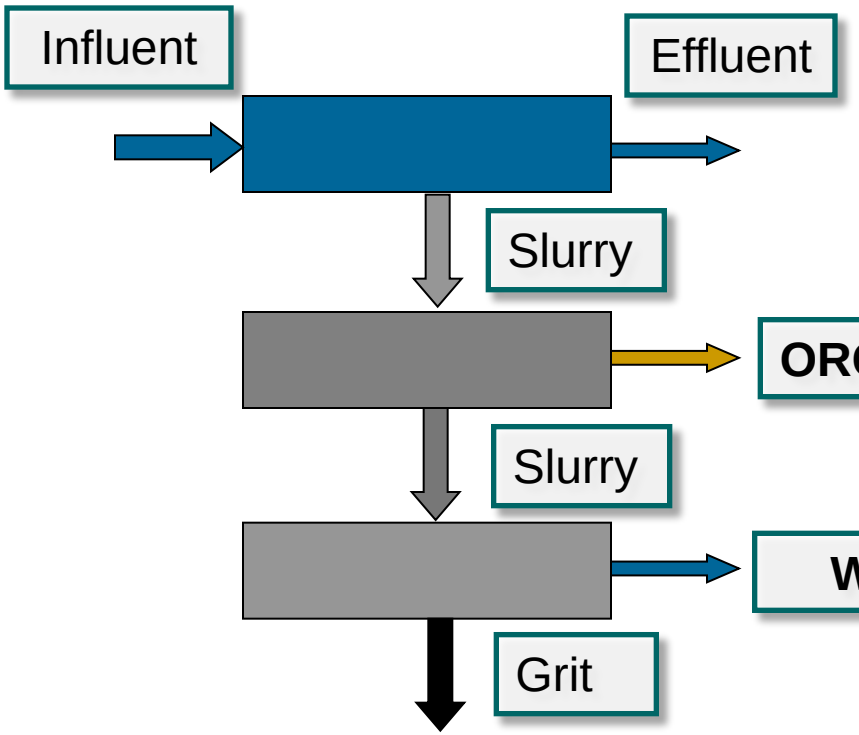
Unit Processes of Grit Separation



- **Collection**
- **Washing**
- **Dewatering**

System is only as strong as it's weakest link

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Conventional Washing/Dewatering

Liquid Cyclone

- ❑ "Borrowed" from the mining industry
- ❑ Centrifugal separator/concentrator
- ❑ Capable of removing grit ≥ 150 µm
- ❑ Apex valve size minimized to reduce output volume to classifier (not adjustable)
- ❑ Requires constant pressure drop to achieve separation
  - *Cannot handle grit concentration spikes*

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Conventional Washing/Dewatering

Screw Classifier

- Settling tank with screw
- Typically sized based on screw conveying capacity
- Clarification capacity typically not a sizing criteria
- Hydraulic load washes fine grit out of the unit causing recirculation issues

Fox Lake, IL
System Comparison

Performance	Aerated Grit Basin with Cyclone/Screw	HeadCell™/ SlurryCup™/ Grit Snail™
Separator Capture	58%	95%
Washing/Dewatering Capture	17%	93%
Overall System Capture	10%	88%
Grit Quality	5 lb FS/ft^3	65 lb FS/ft^3

Aerated Grit Basin – 225 micron
HeadCell System – 100 micron

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High Efficiency Washing & Dewatering

SlurryCup™

Grit Snail

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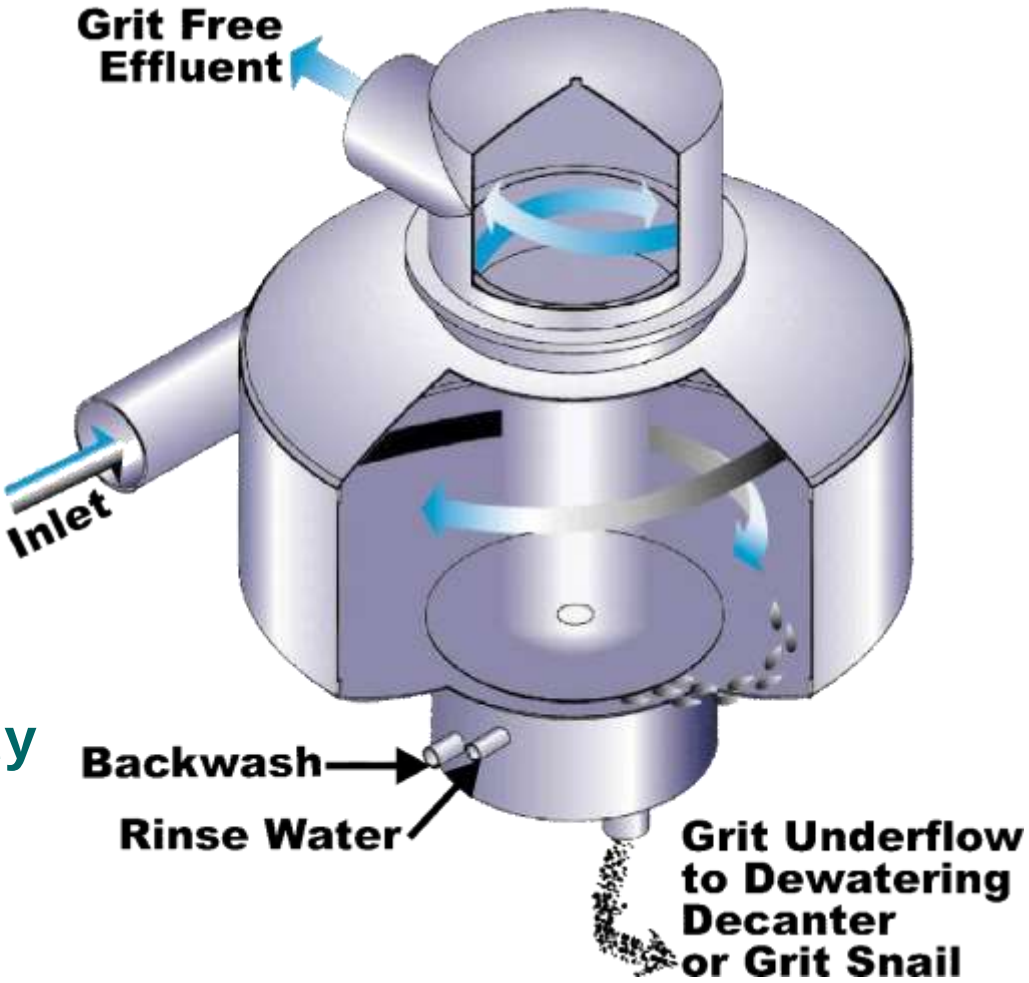
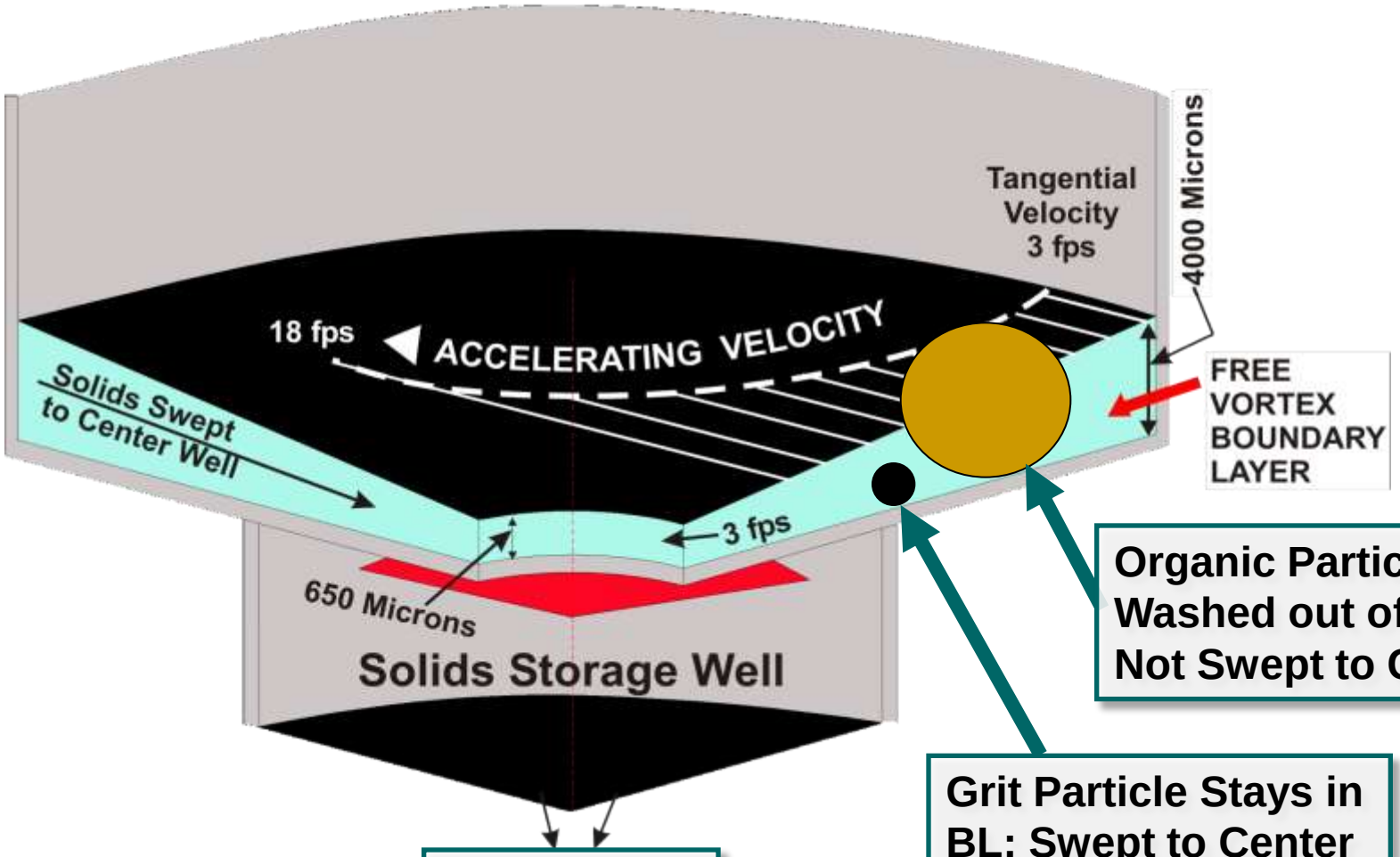
Eutek SlurryCup™

- Guaranteed performance:
  - *95% removal down to 50 micron particle*
  - *<15% organics*
- Boundary layer separation plus secondary wash
- Increasing performance as flow increases
- All Hydraulic
- No moving parts within body



Boundary Layer Separation by Size



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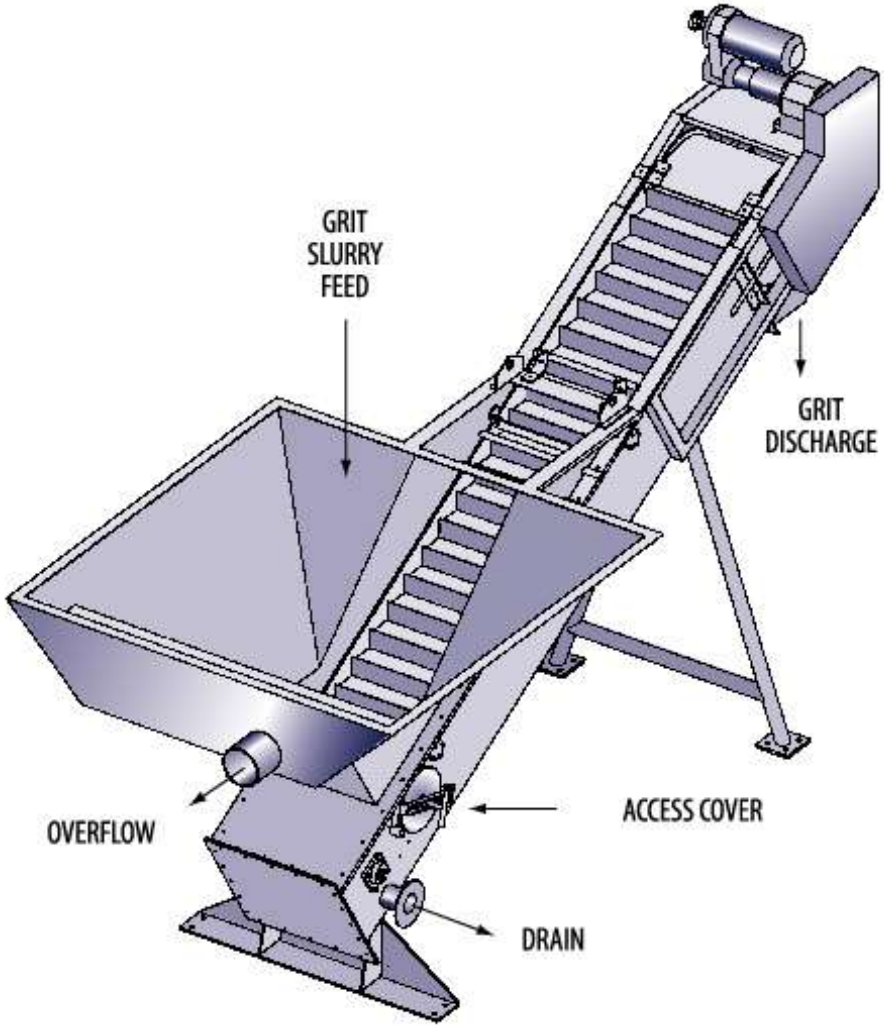
Eutek Grit Snail™

- **Quiescent Dewatering Escalator**
  - ***Large clarifier area***
  - ***3.2 GPM/FT^2***
  - ***Slow moving belt (1-2 FPM)***
  - ***Guaranteed 95% removal of 50 micron grit***
  - ***Guaranteed 60%TS dry grit***
  - ***Durable construction – long product life***



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Overview

- Base design on native grit behavior
- Target fine grit
- Define design requirements
- Consider efficiency of each step

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