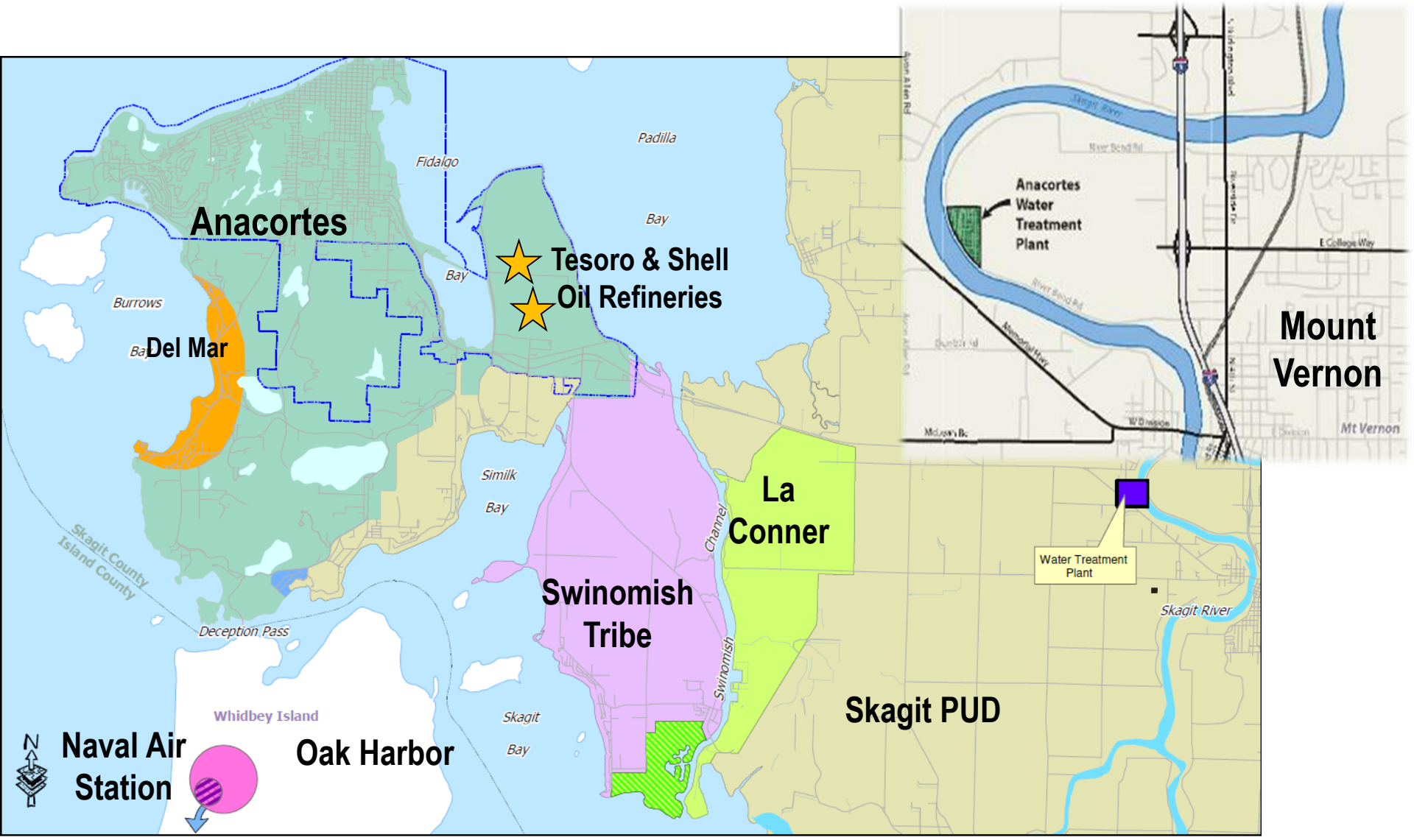
Optimizing the Ballasted Sedimentation Process at the Anacortes Water Treatment Plant

- Jeff Marrs – Plant Manager
- Greg Pierson - HDR

Presentation Overview

- Project drivers and objectives
- Raw water quality
- Treatment process system overview
- Optimization of ballasted sedimentation

Anacortes Water System Service Area



Project Drivers – Challenges/Limitations

- Floodplain elevation
- Challenging Raw Water Quality
  - Dramatic fluctuations of Turbidity and Color
- Ineffective Pre-treatment
- Need to Expand Treatment Capacity
  - 2007 max. day demand: 29 MGD
  - 2030 max. day demand: 40.7 MGD
- Condition of existing structures
- Reliability and Redundancy needed for continuous operations

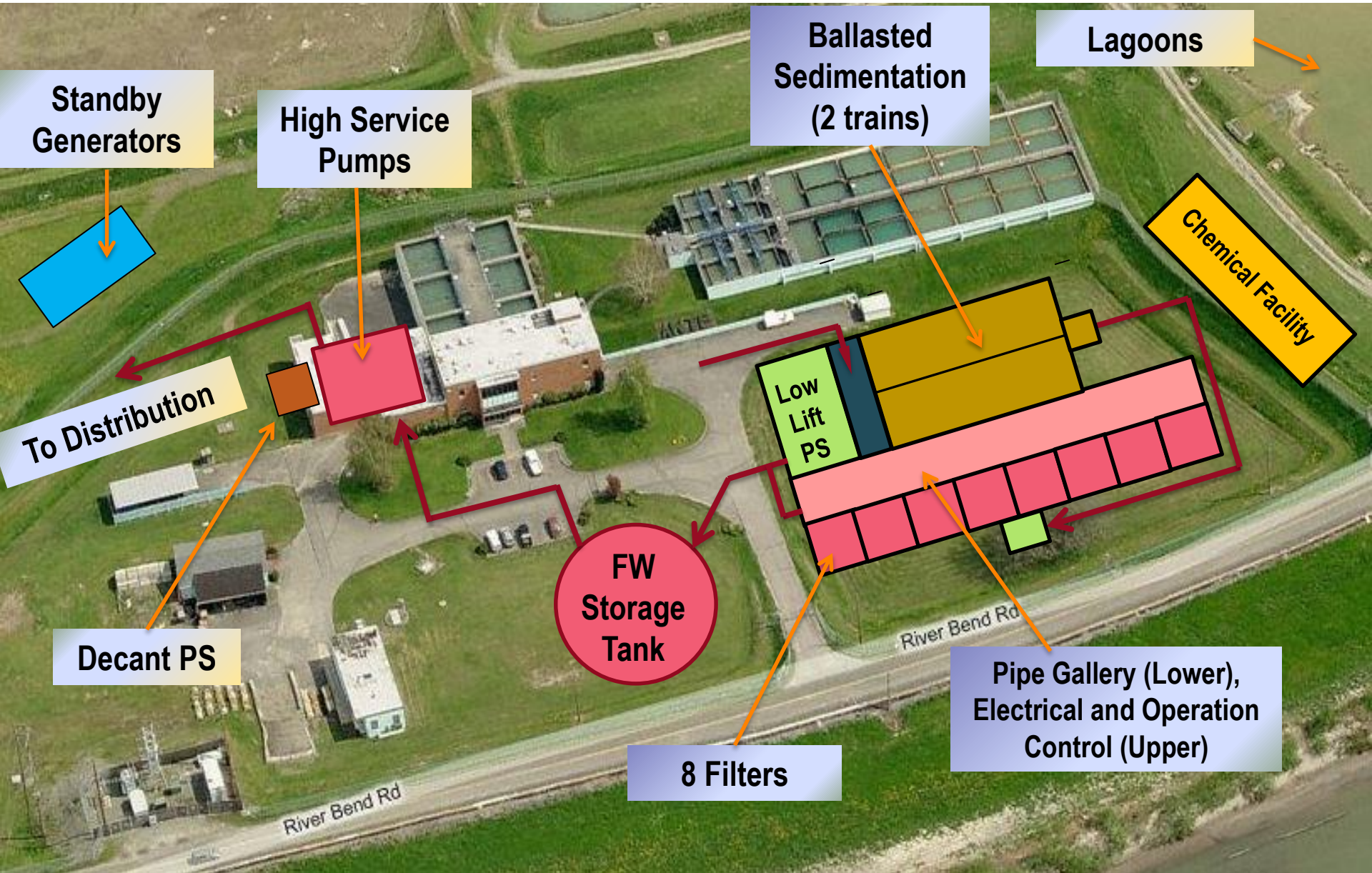
Raw Water Quality (2003-2008)

- Turbidity
  - Average: 28 NTU
  - 95th-%: 81 NTU
  - 98th-%: 164 NTU
  - Maximum: 5475 NTU
- Color: 1 – 4872 Pt Co
- pH: 6.5 - 7.8
- Alkalinity: 16-38 mg/L
- TOC 0.5 to 3.0 mg/L

Treatment Scheme

- Ballasted sedimentation
- Rapid sand filtration
- Chlorine contacting – CT compliance
- Finished water pH adjustment

Treatment Facilities General Arrangement

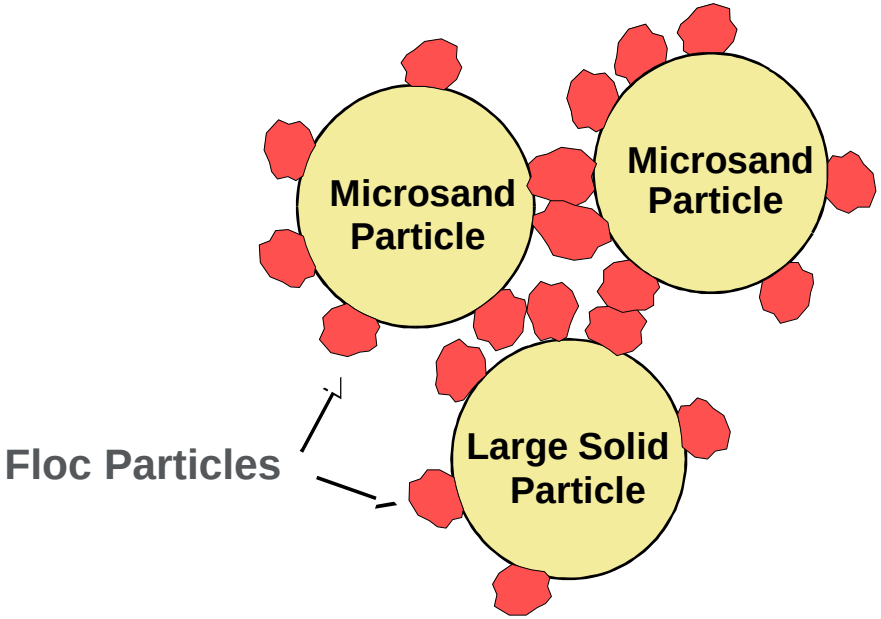


Design Production Requirements

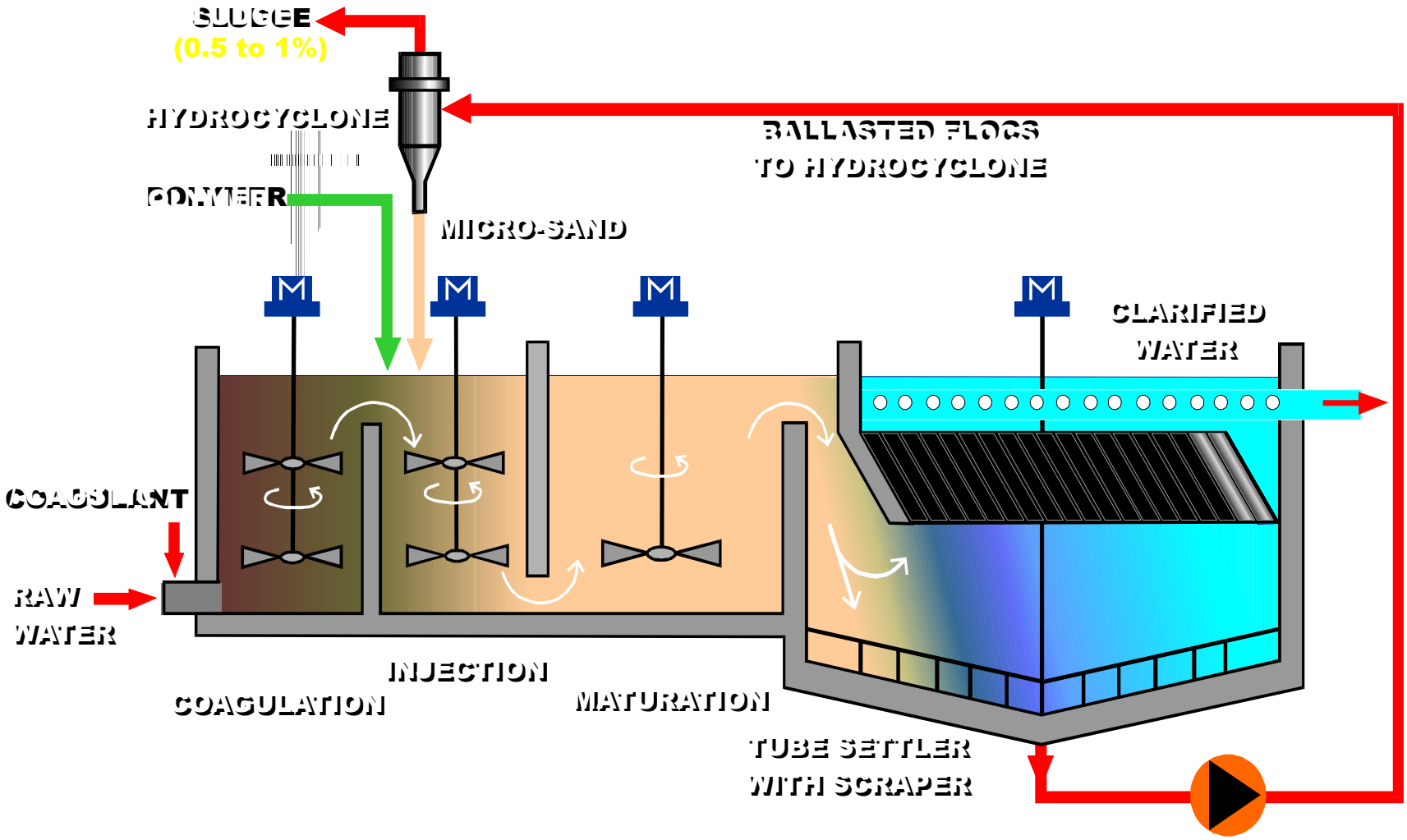
- Treatment capacity – 42 MGD
- Future expansion capacity – 55 MGD
- Emergency conditions treatment capacity – 21 MGD

Ballasted Sedimentation Process

- Add Coagulant to Grow Large Floc particles
- Flocculate
- Add Ballast and Polymer
- Ballasted Flocculation
- Settling – use plate settlers to enhance separation



Ballasted Sedimentation - Actiflo



Manufacturer: Kruger

Key Design Parameters from Pilot Testing

Raw Turbidity (NTU)	Coagulant Dose (mg/L)	Polymer Dose (mg/L)	Target Settled Water pH with Lime Dose	Mixing Speed (Hz)	Hydraulic Loading Rate (HLR) (gpm/ft^2)
Low (< 15)	18	0.4	Not Required	90	18 - 43
High (up to 2200)	50*	0.5	7.55	90	18 - 43

Treatment Goals for Ballasted Sedimentation

Raw Water Turbidity Range	Settled Water Turbidity
Less than or equal to 200 NTU	Less than or equal to 2 NTU
Between 201 NTU and 500 NTU	Less than or equal to 3 NTU
Greater than 500 NTU	Less than 5 NTU

Settled Water Quality Performance Requirements

Parameters	Settled Water Quality Criteria
Turbidity (NTU)	Target: Not greater than 1 NTU
	95th percentile: Not greater than 2 NTU*
	98th percentile: Not greater than 5 NTU

* Washington Department of Health (DOH) Treatment Optimization Program turbidity goal

Ballasted Sedimentation System

Two parallel trains with 27 MGD capacity each

Ballasted Sedimentation Equipment

Micro-sand Recycle Pumps

Ballasted Sedimentation - Equipment

Mixer Drives

Hydrocyclones

Filtration System

8 cells, each with 2 bays

Residuals Handling

Three lagoons:

- One in-service
- One in standby
- One out-of-service

- Floating decanter each lagoon
- Decant water booster pumps for high river level conditions

Optimization

Optimization

- Aluminum Sulfate
  - Range from 5 – 40 mg/L depending on river changes
- Coagulant Polymer
  - Ranges from 0.40-0.50 mg/L
  - Not frequently adjusted
  - Carry over to filters
- Caustic Soda
  - Used for pH control when raw water does not meet treatment requirements.
  - Ranges from 1.0 – 6 mg/L

Chemical injection and in-line rapid mix for ballasted sedimentation trains

Optimization

- Microsand
  - Maintain 3-6 grains per liter. (manufacturers recommendation)
  - Rarely add sand due to high sediment in source water
  - Regular monitoring with infrequent adjustments.
  - Highest amount of maintenance required.
- Soda Ash
  - Used for alkalinity control
  - Not regularly used

Optimization

- Following year 1 of operation, operators began experimenting with chemical dose ranges
- Resulted in reduced chemical costs with improved results
- Added laboratory analysis for quality control

Laboratory Charge Analyzer vs. Jar Testing

Operator Challenges

- Frequent changes in source water conditions
- Imbalance in chemical doses in pre-treatment process affects filter operations
- Changes can occur in minutes due to short detention time (This is a good and bad thing)
- Due to high flow demand and limited storage operators have little time to correct any problems

Typical Results

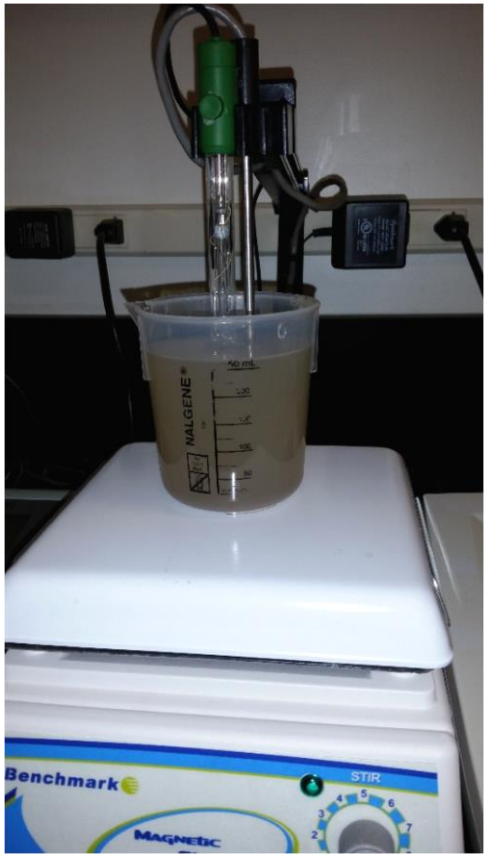
- Raw Water
  - 5 – 1100 NTU
  - 7.00 -7.40 pH
  - Alkalinity is 15 – 30 mg/L

- Settled Water
  - Target is less than 1.0 NTU at all times. Typical is less than 0.50 NTU. 95% or greater removal typical.
  - pH range is 6.80 -7.20
  - Alkalinity is 15-25 mg/L

Typical Results - Filtration

- Alum is added to aid in filter performance (1.0-1.5 mg/L)
- Filter Aid Poly is added for enhanced performance
- Typical run time varies but normally is 72-96 hours
- Finished water turbidity is typically 0.020 NTU or less

Results



1050 Raw Water NTU
0.90 NTU Settled
99.9 % Removal