Filter Operation & Maintenance

PNWS AWWA Water Treatment Committee and
Cascade to Coast Sub-Section
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Partnership for Safe Water Acknowledgements

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Key Points

- The learning objectives of this presentation are:
  - Why should operators optimize filtration
  - What are the important parameters
  - What tools and techniques are needed?
  - The skills necessary to assess filter efficiency.
- The parameters used for comparison
  - Graph results for database!

Acronyms In Presentation

- UFRV's – Unit Filter Run Volume is the total amount of water through each square foot of filter media between backwashes.
- Combined Filter effluent (CFE) and Individual Filter Effluent (IFE)
- Nephelometric turbidity unit (ntu)

FILTER EVALUATIONS

- Parameters to Examine
  - Filter Inspections
  - Filter Backwash
  - Filter Operations
- What do these parameters tell us?
  - In Good times
  - In Bad times

FILTER INSPECTIONS

- Inspections With Drained Filter
- Surface Sweeps
- Backwash Under Drain PSI
- Bed Depth

Filter Inspections

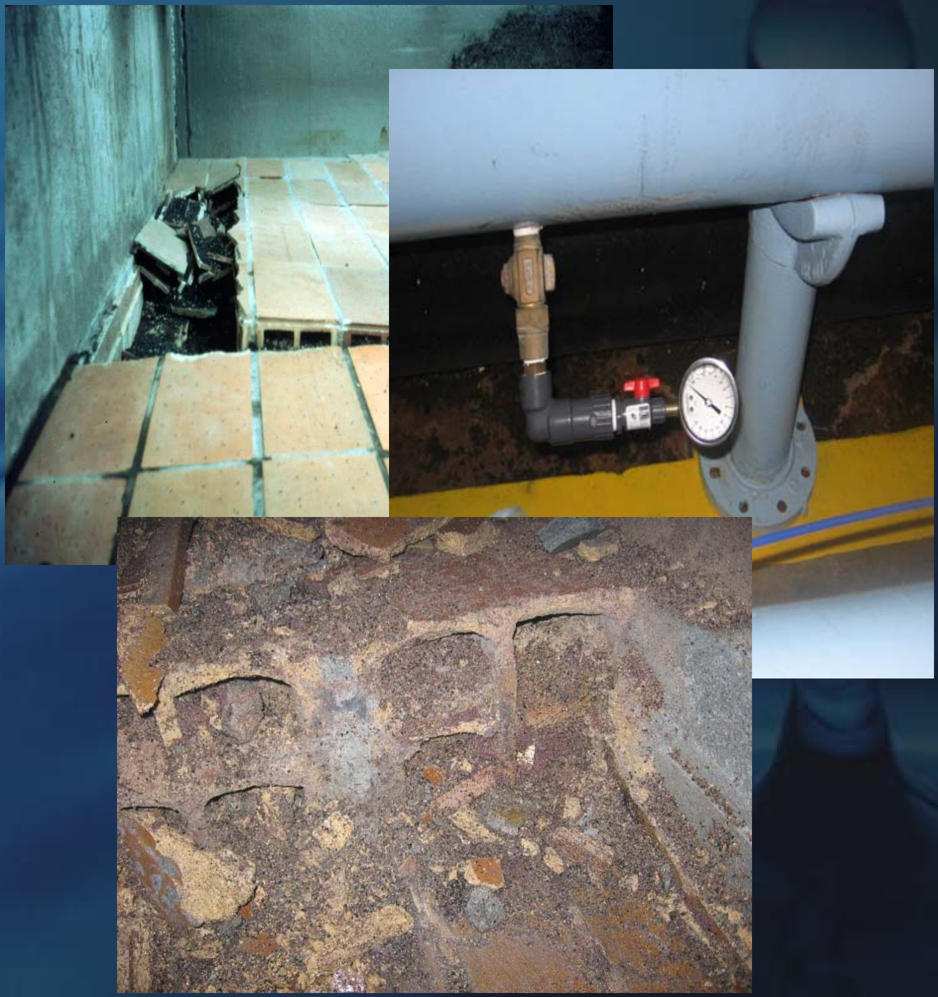
- Take a look at your media when the filter is drained.
  - Look for abnormalities such as
    - Mud Balls
    - Craters
    - Mounding
    - Cracks
    - media pulling away from the filter walls.

Surface Sweep Operation

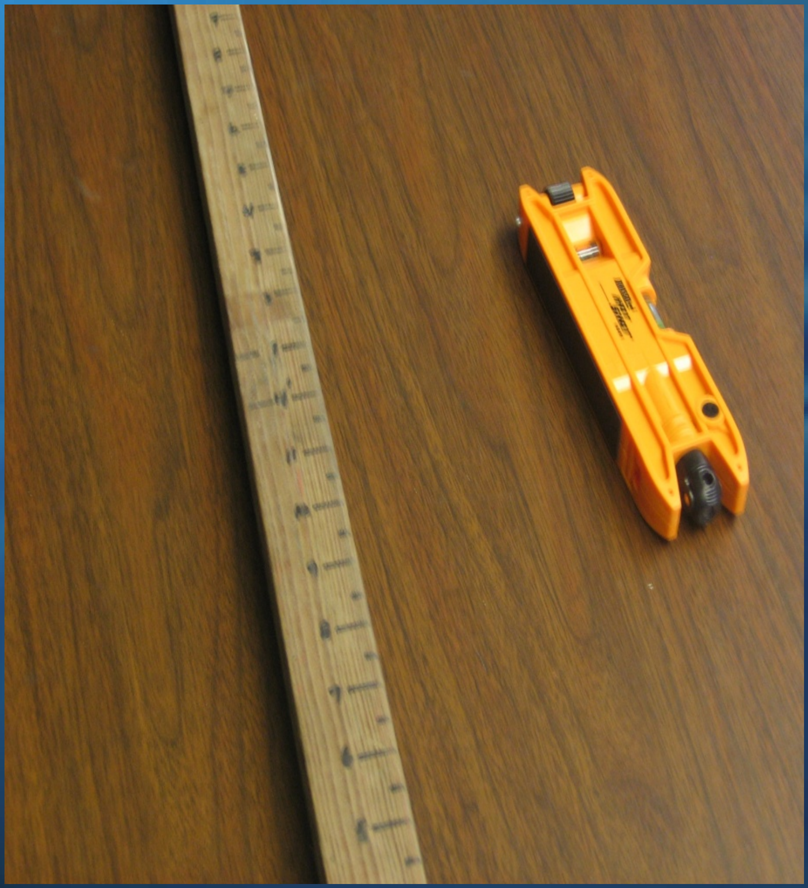
- Verify the sweeps rotate freely.
- Check media Elevation to determine Proper Distance of sweep from media.
- Check the nozzles for plugged condition.
- Replace rubber caps Every Other Year

Under Drain System

- Although it's difficult to see what's happening below the filter media. There are some indications:
  - Irregular or uneven flow across the basin.
  - More aggressive action in some spots and less in other areas.
  - Monitor & Record Backwash piping pressure changes.



Media depth measurement tools



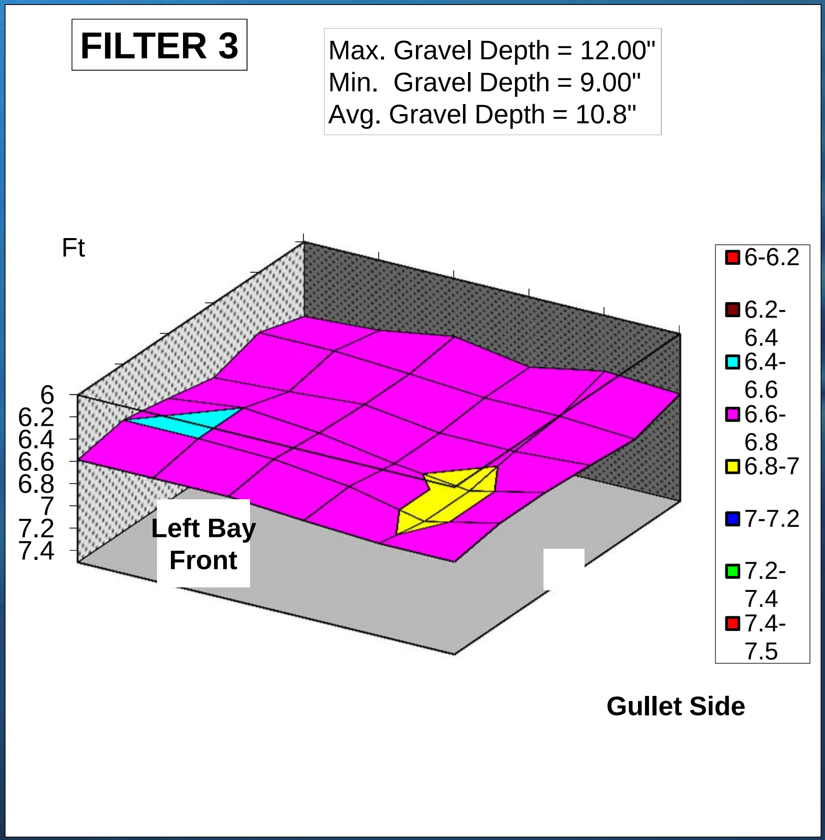
Media depth measurement

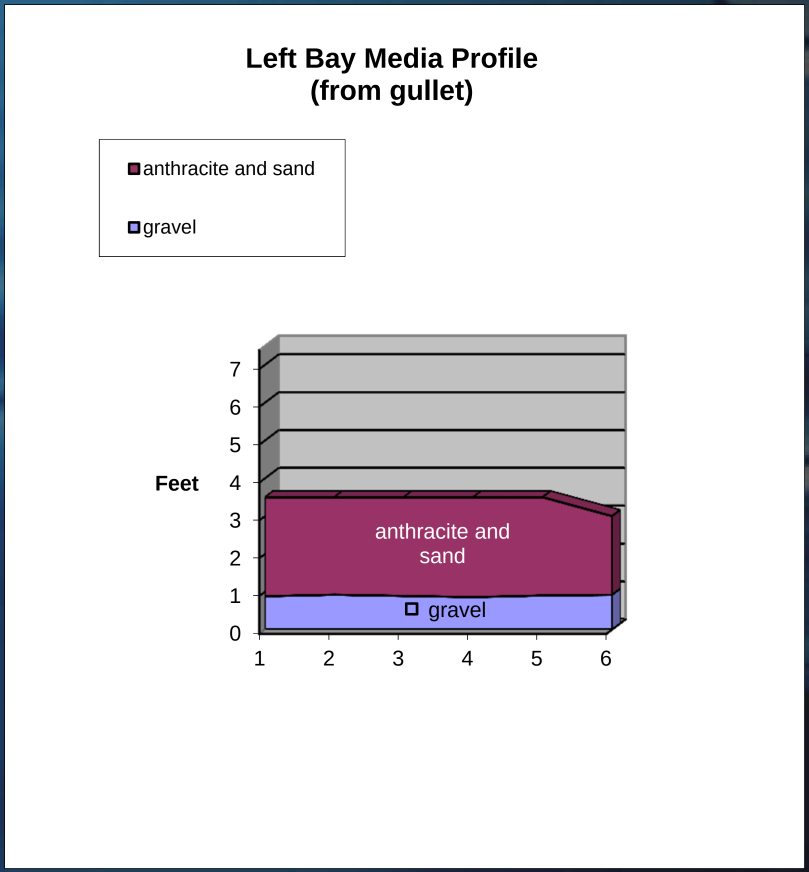
- Bed Depth Measurement (Drained Bed)
  - Know original specs - Effective size -
  - Check to see if troughs are level
  - measure distance from trough to bed - check for mounding
- Bed Depth Measurement (Wet)
  - Measure bed depth after backwash
  - Use measuring device to determine media level.

MD measurement Bench Sheet

		Left Bay							Right Bay				
		Measurements		Date	Additions				Measurements		Date	Additions	
		far	near						far	near			
top of sweep arm depth					(ft^3)	Bags	top of sweep arm depth					(ft^3)	Bags
Media Depth							Media Depth						
PSI Check							PSI Check						
B/W Flow Rate							B/W Flow Rate						
	gpm							gpm					
Check/Clean Sweep Nozzles							Check/Clean Sweep Nozzles						
Check For Loose Bolts							Check For Loose Bolts						
Skimmed Surface of Media							Skimmed Surface of Media						
Clean filter Walls							Clean filter Walls						
Disinfect Filter Cell							Disinfect Filter Cell						

Plot Your depth measurements





FILTER BACKWASHING

- Bed Expansion
- Water Temperature
- B/W Turbidity Analysis
- Solids Retention

Bed Expansion

- Bed Expansion Measurement with Expansion Tool
  - position and tie down the expansion tool so that it rests on top of the bed
  - rewash bed under normal conditions and observe amount of expansion

Bed Expansion Calculation

- Bed depth measured at 42 inches
- Bed expansion tool captured 10 inches
- Bed Expansion Measurement calculations
  - 10 inches divided by 42 inches = 24% approx

Backwash Rate Temp Correction

- The Backwash Flow Rate will depend on the ratio between media size, bed depth, and the specific gravity for you plant filters.

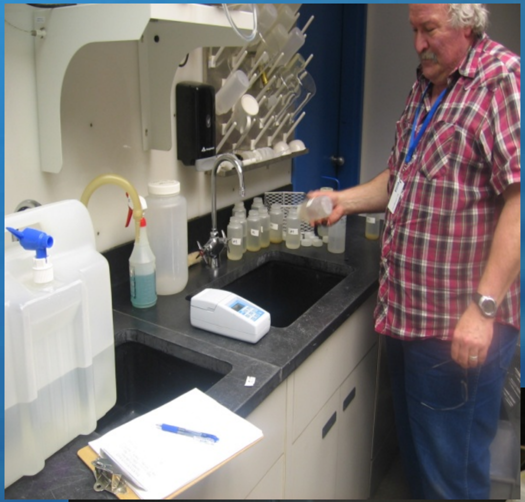
- Backwash Flow Rate with Temperature Corrections
  - For 24% Bed Expansion

Temperature ©	MULTIPLIER	B/W Flow Rate GPM
5	1	5048
6	1.02	5145
7	1.04	5250
8	1.06	5351
9	1.08	5452
10	1.1	5553
11	1.13	5704
12	1.15	5805
13	1.17	5906
14	1.2	6058
15	1.22	6159
16	1.24	6260
17	1.27	6411
18	1.29	6512
19	1.32	6663
20	1.35	6815
21	1.37	6916
22	1.39	7017

Back Wash water Sampling

- Wash water Analysis
  - Too little or too much washing is a common problem
  - Measure wash water turbidity for the length of the wash
    - Sample at 30 second intervals, and graph results as NTU vs. time
  - Note amount used, rates, ramping intervals, operator habits, flow irregularities, “hot spots”

Washwater Turbidity Analysis'



B/W Sampling Data Sheet

BACKWASH FLOW RATE

Turbidity Profile Data

Date: ______ **Filter #:** ______ **Bay:** ______

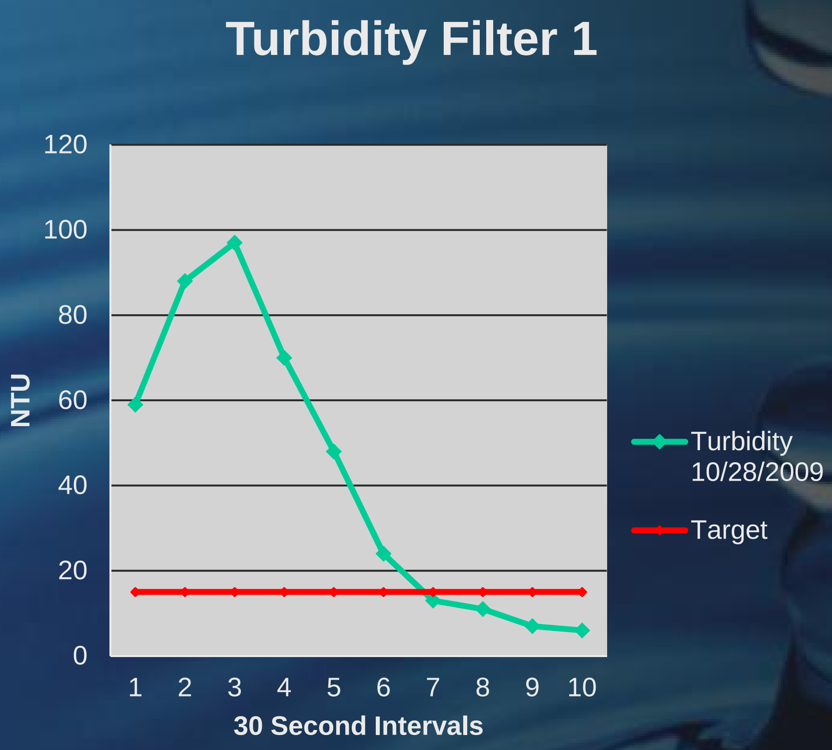
Hdls: ______ **B/W time:** ______ **H2O Temp.:** ______ **RawNTU:** ______

At end of run   Seconds   Deg. C

Time	NTU	B/W Flow SP
#1 -		
#2 -		
#3 -		
#4 -		
#5 -		
#6 -		
#7 -		
#8 -		
#9 -		
#10 -		

Wash water Turbidity Plot

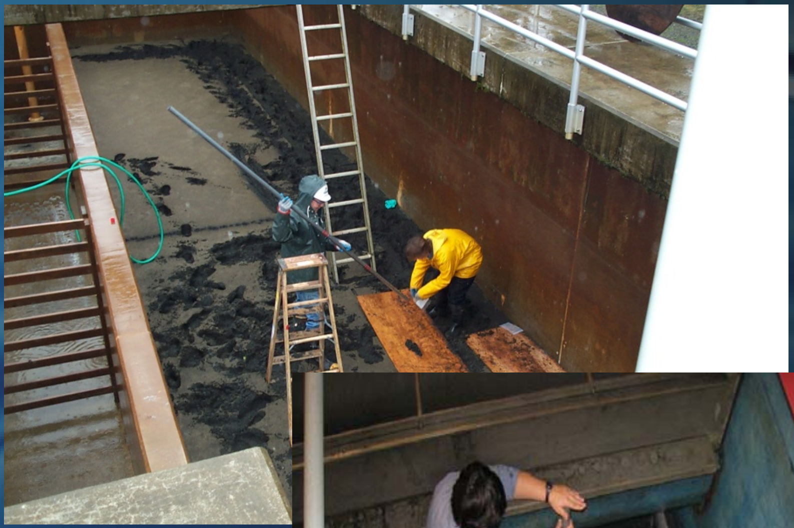
- Graph results for database!
- Wash water Turbidity vs. Time
- Helps prevent Excessive washing
  - Wastes wash water
  - Strips ripening
- Goal of 15 ntu
- This filter washed too long



Media Core Sampling Tools for Solids Retention

Core Sampling for Solids Retention

- Solids retention analysis best way to determine backwash effectiveness
- Core Sampling
  - Use core sampling tool to obtain samples of the filter strata
    - Take samples at 0-2 inches, 2-6, 6-12, 12-18, 18-24, etc., until all bed strata are sampled
    - Sample before and after washing the bed



Floc Retention Sampling Data Sheet

FLOC RETENTION DATA SHEET

FILTER #:_____ DATE:________

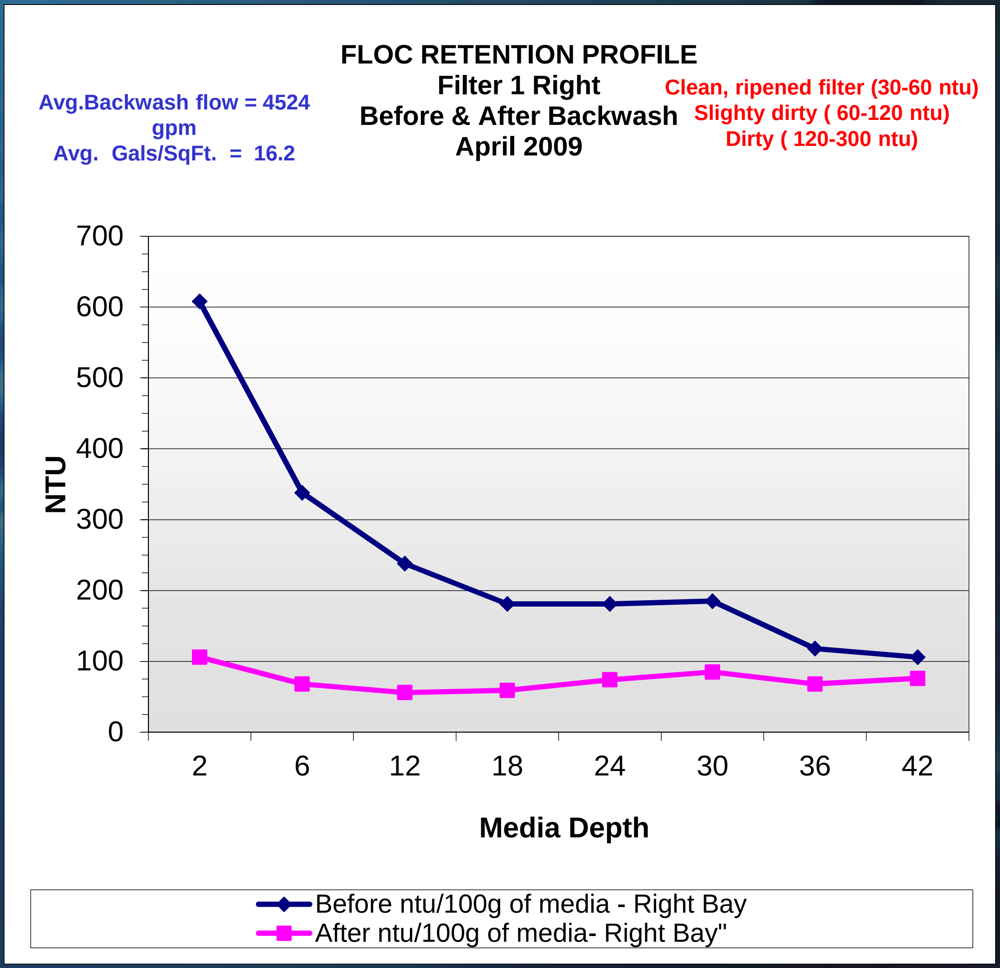
FILTER BAY:______________

BACKWASH

DEPTH	BEFORE NTU MEASURED	AFTER NTU MEAS
2"		
6"		
12"		
18"		
24"		
30"		
36"		
42"		

Solids Retention

- Measures the effectiveness of backwash
- Can show too little or to much backwash
- Change in historical solids retention is cause for concern
- Graph results for database!



Comparison of Filter Wash Procedures

- Combined air-water first; then water rinse
  - most effective
  - air must be out of water before washwater overflows
- Air-only followed by water rinse
  - not as good as combined air-water
- Water wash with surface scour
  - about equal to air followed by water
- Water wash with no auxiliary scour obsolete

FILTER OPERATIONAL PRACTICES

- Filter Optimization
- Filters In Service
- Rate Increases
- Data Collection and Review

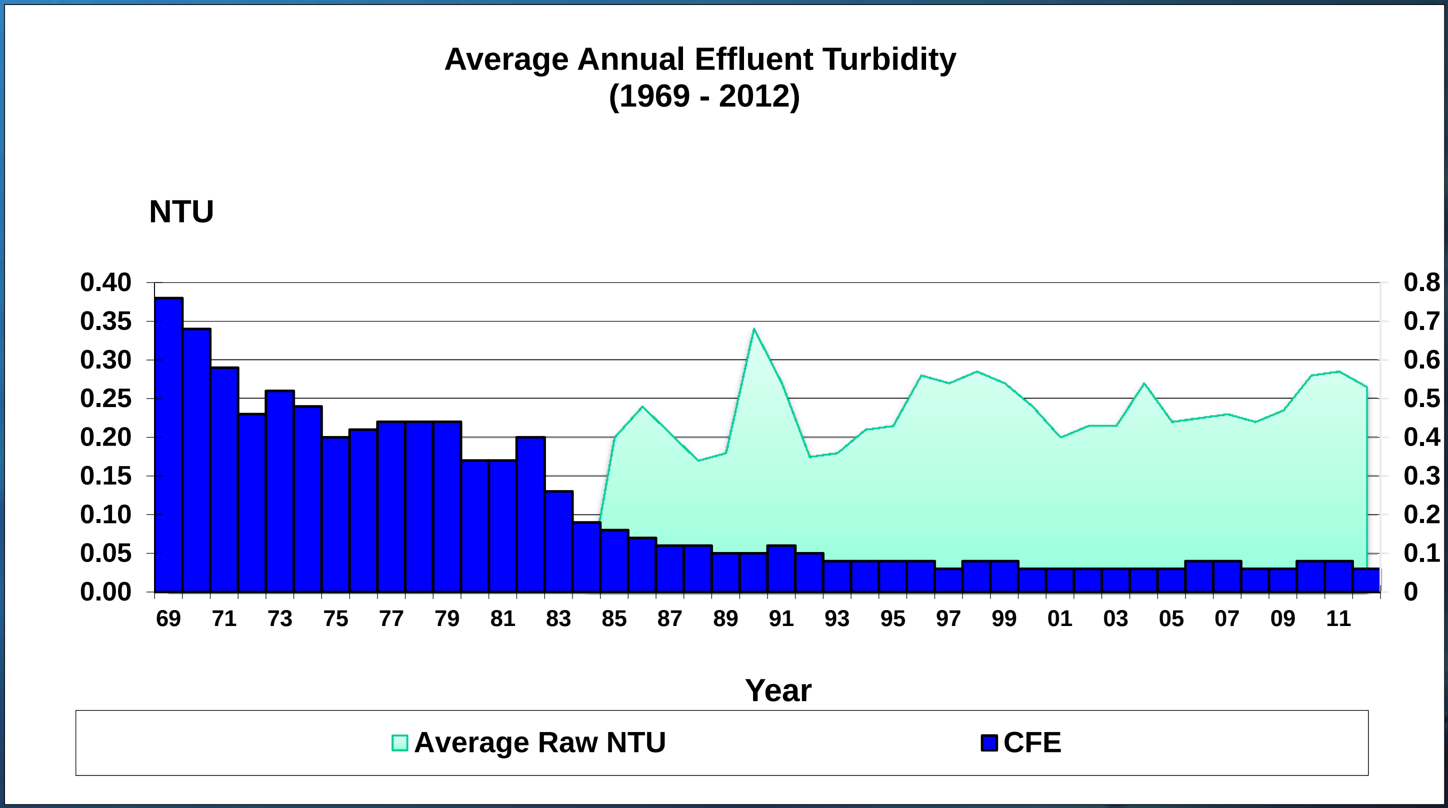
Why Optimize Filters

- Filters are major barrier against pathogen passage.
  - Optimizing filter operation has been shown to reduce finished water turbidity
- Filters provide flexibility to operators
  - More Filters – More flexibility in plant operations:
    - Down side - Bad Filters may go Unnoticed
  - Less Filters – Less flexibility for operations:
    - Other filters stressed when one O.O.S.
- Filters are designed well but deteriorate with use
  - Poor maintenance leads to poor performance

Turbidity improvements through optimization

CFE turbidity values	95% NTU	Largest spike NTU
B4 Optimization	0.38	0.55
After Optimization	0.04	0.09

CFE Annual Turbidity Optimization



My perspective of filter theory

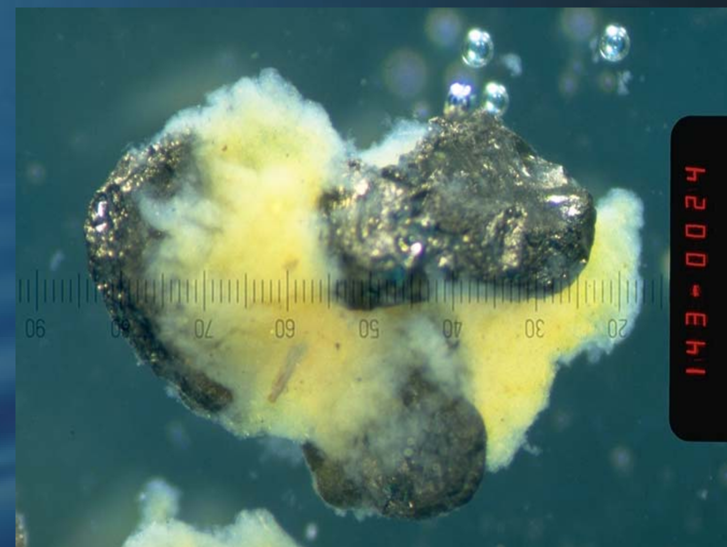
- Filter is particle storage device – not just particle removal device
  - During storage phase – gentle handling needed
  - During removal phase – vigorous handling needed
- Filters these days are dual-media units or mono-media units
  - provides deeper bed filtration
  - longer runs
- Good filtration depends on good pretreatment –
  - poorly treated water won't filter well at typical filtration rates

Backwashing Filters and Returning Filters to Service are Key Operations

- Combined air-water first; then water rinse
  - most effective
  - air must be out of water before wash water overflows
- Delay Starting Filter after Backwash for Several Hours if Possible
- If Equipped, Filter to Waste to help Ripen the Filter
- Gradual Start of filter effluent flow over several minutes.
- Adding Coagulants or polymer in Backwash Water

Filtration Rate Increases and Filtrate Quality

- Particle removal occurs by attachment
- Rate increases can detach particles. Factors are:
  - weak floc, not held in bed (filter aid may remedy this)
  - large magnitude of rate increase
  - abrupt increase in rate
  - high filter head loss during rate increase



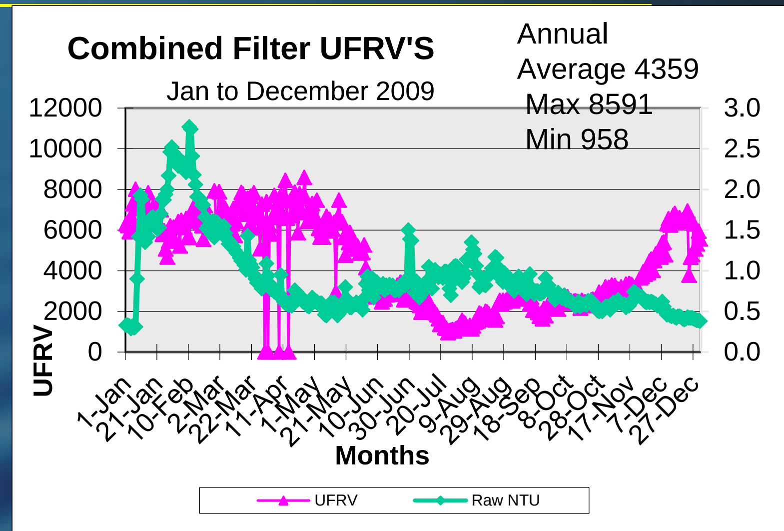
See Cleasby, Williamson, and Baumann; *JAWWA* July, 1963, pp. 869-877.

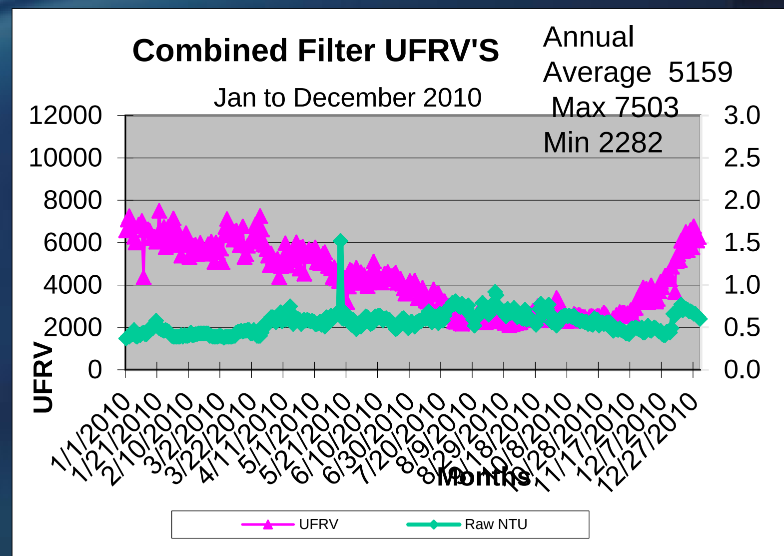
To Minimize Turbidity Increase When Increasing Filtration Rate:

- Place idle filters into service
- Use slow, gradual increase - not abrupt increase
- If valve won't not open slowly and continuously, use multiple small steps, not a big step
- Don't increase rate more than necessary – We usually do 100 gpm per day
- Perform pretreatment so floc strength is adequate

Unit Filter Run Volume

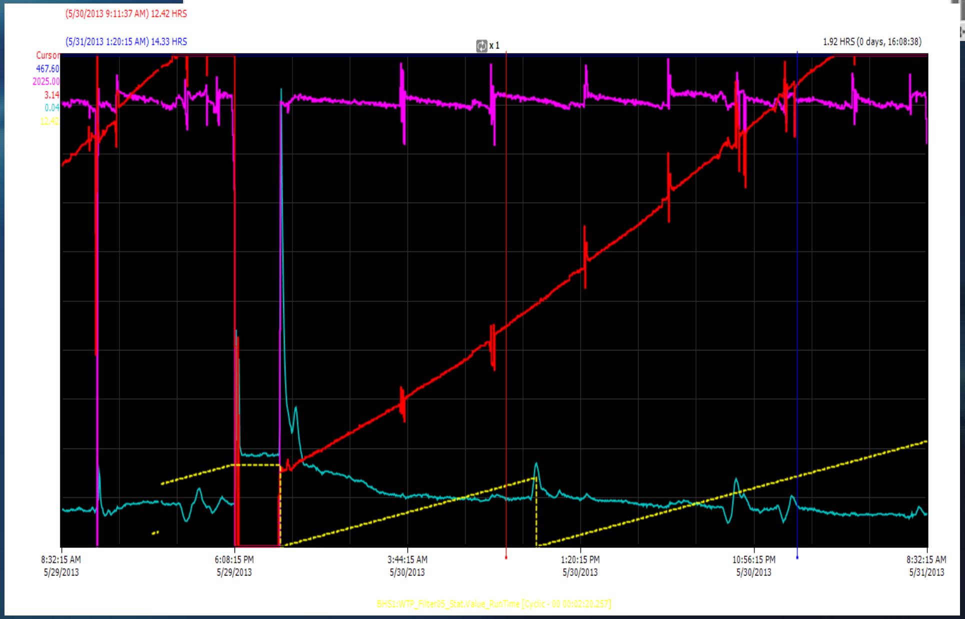
- Graph results for database!
- UFRV - amount of water that is filtered during the filter run time
  - should be determined for every filter run
  - Goal - UFRV of 5,000 gallons per square foot per run
    - Same at low rate or high rate
  - Change in historical UFRV cause for concern





Filter Run Profile

- Graphical summary of filter performance for entire run.
- Usually done with turbidity measurements and particles counts if used.
- A picture can be worth a 1000 words



In conclusion

- Know characteristics and flexibility of your filters.
- Know history of your filters when times are good.
- Don’t rely on one or two pieces of information.
- Manage rate increases to minimize detachment.
- Remember – Poor maintenance usually leads to poor performance.

Questions?

Ten States Standards for WTP Pipe identification color coding

- What Color would a Raw Water Pipe be painted.
  - Olive Green
- What Color would a Settled or clarified water pipe be painted.
  - Aqua
- What Color would a Finished or potable Water Pipe be painted.
  - Dark Blue
- What Color would a Alum chemical feed pipe be painted.
  - Orange
- What Color would a Chlorine Gas Pipe be painted.
  - Yellow
- What Color would a Fluoride feed Pipe be painted.
  - Light Blue w/ red band

Ten States Standards for WTP Pipe identification color coding

- What Color would a Ozone feed Pipe be painted.
  - Yellow w/ orange band
- What Color would a Soda Ash feed pipe be painted.
  - Light green w/ orange band
- What Color would a Potassium Permanganate feed Pipe be painted.
  - Violet
- What Color would a Caustic chemical feed pipe be painted.
  - Yellow w/ green band
- What Color would a Backwash Waste Pipe be painted.
  - Light Brown
- What Color would a Natural Gas feed Pipe be painted.
  - Red