SouthwestSection
American Water Works Association

Filter Surveillance – Digging Into the Details

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Central Arkansas Water

Central Arkansas Water
Essential & Exceptional

Hazen

HW HAWKINS WEIR ENGINEERS, INC.

Presentation Outline

- Filtration Fundamentals
- Backwash
- Tools and Techniques
- Case Study
- Conclusions

The Need to Remove Particles

Health Reasons

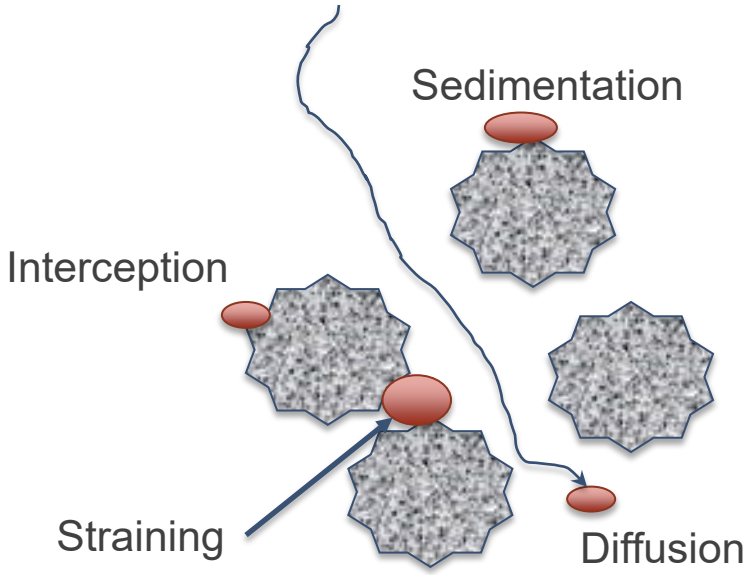
- Surrogate for pathogens
- Interfere with disinfection

Aesthetic Reasons

- Particles impart color, taste, and/or odor to water making it less palatable for the customer
- Stability of treatment process

Filtration Fundamentals
Particle Capture & Storage

- Depth penetration desired
  - Diffusion and interception
  - Straining okay, but at depth
  - NOT sedimentation
- Dependent on
  - Particle size
  - Void space / media size
  - Particle charge
  - Media condition
  - Filter flow / hydraulic force



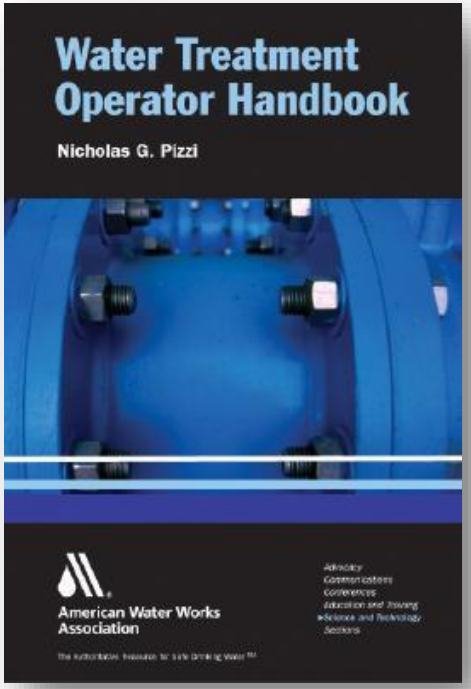
Operator Perspective

Filter is particle STORAGE device

- During storage phase – *gentle & smooth*
- During removal phase – *vigorous agitation*

Good filtration depends on good pretreatment

- Remember **multiple barriers**
- Short run times = poor efficiency, lots of backwash



Backwash

- **Enough water**
- **Right rate**
- **Right amount of time**

Factors Affecting Filter Performance

- Good pre-treatment e.g. the chemical and physical conditioning of the particles
- Physical attributes
  - Hydraulic loading rate
  - Flow and level control
  - Filter box configuration
  - Media size, configuration, and depth
- *Ability to adequately backwash and clean media*
  - *Restore solids storage capacity*

Typical Backwash Sequence

Drain

- Make sure level is low enough to maximize energy and minimize media loss

Surface wash or air wash

- 3 to 4 minutes is usually sufficient

Low rate – initiates expansion

High rate – expands media, temp dependent

Low rate - restratification

Factors Affecting Backwash & Frequency

- Poor hydraulics – BW supply, or washwater discharge
- Uneven distribution of air or water
- Not adjusting for water temperature
- Valve sequencing and open/close speeds
  - Desire smooth transitions
  - Minimize intermixing of layers
  - Restratify media layers
- Over or under washing the media

REQUIRES REGULAR FILTER INSPECTIONS!

Filter Surveillance

Tool & Techniques

More Than Meets the Eye

- When operational, filters are covered with water
- Traditionally, only indicators
  - Water quality data
  - Visual observations
- Must literally dig into them to improve understanding

Before You Start, Know Filter Specifics

- Media
  - Design depth and configuration
  - Effective size (ES)
  - Uniformity coefficient (UC)
- Underdrain type
  - Avoid damages when measuring depth and collecting samples
- Filter dimensions
- Loading rate
  - 4 to 6 gpm/sf typical
- Review backwash sequence

Filter Surveillance Techniques

- Visual observations of surface and components
- Probing media / depth measurement
- Floc retention analysis
- Spent filter backwash assessment
- Filter Expansion

Tools for Surveillance

- HEALTH & SAFETY REQUIREMENTS
- Communications
- Review AWWA Standard B100
- Review filter design – media
- Ladder and support for access
- Measurement tools

  Level, 3/8 inch rod, tape measure
- Coring tool and supplies

  1.5 inch PVC conduit, 4-8 foot length, baggies, marker
- Expansion Tool

  One-inch interval tubes or cups
- Laboratory instruments and tests

  Turbidimeter, glassware, balance, sample bottles

Wilson Filters Drained

Visual Inspection – Power of Observation

- Know how long it takes to drain
- Algal growth
- Media surface
- Media inspection: angularity
- Trough level
- Concrete issues
- Media Loss
- Observe and ask questions
- Investigate irregularities

Floc Retention Analysis

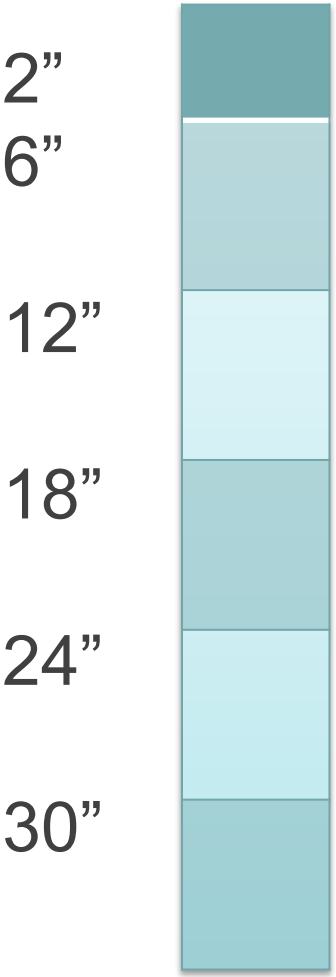
- Operate filter at design loading rate to terminal headloss, if possible
- BEFORE BW – shows where solids are stored
- AFTER BW - measures backwash effectiveness
- Can show too little or too much backwash
- Note changes in historical solids retention results
- Graph results for database

NOTE – in some cases, the top 2 to 6 inches are doing all the work

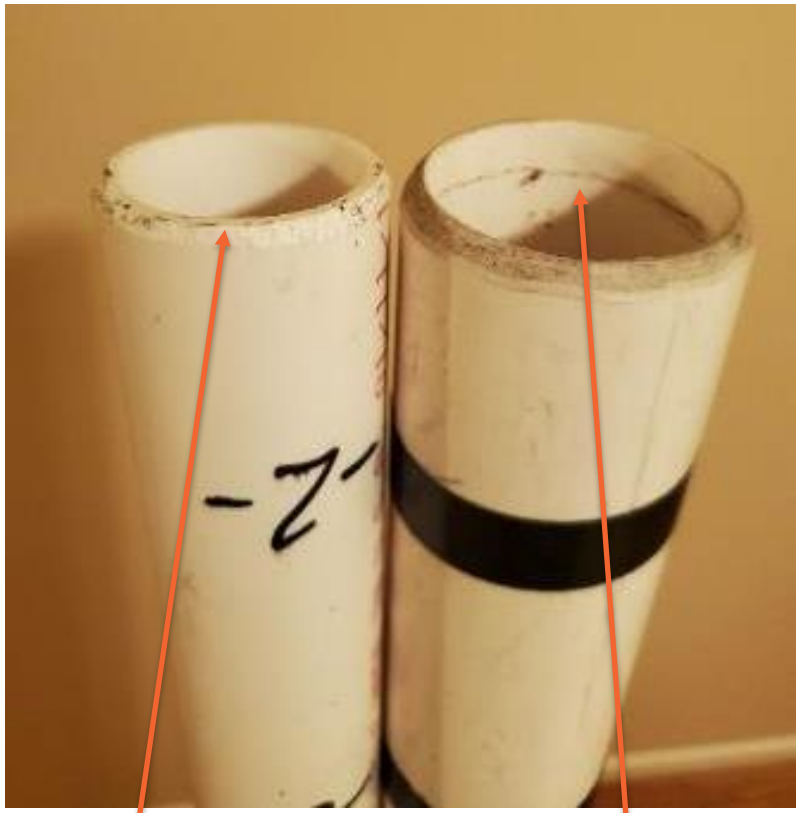
Depth Core Sampling

Wilson WTP Media Profile Shown

- Use core sampling tool to obtain measured depth samples
- Take samples 0-2”, 2-6”, every 6” after
- Sample before and after backwash
- Wash 50 gms of each sample with 5 successive 100 mL washes of lab water
- Measure turbidity
- Plot data
- Observe color of jars



Coring Tool – Sch 40 PVC



1.5” or 2” diameter

Electrical tape marks increments

Bevel end using file or grinder.

Inside scored to help retain media

Media Samples Ready for Processing


0 - 2
2 - 6
6 – 12
12-18
18-24
24-30
30-36
36-42

Guidelines – After Backwash

< 30 NTU

Bed is too clean - examine wash rate and length - this bed may not ripen quickly

30 - 60 NTU

Well cleaned and ripened bed - no need for action

60 - 120 NTU

Slightly dirty bed - reschedule retention analysis soon

> 120 NTU

Dirty bed - evaluate filter wash system and procedures

> 300 NTU

Mudball problem - rehab bed

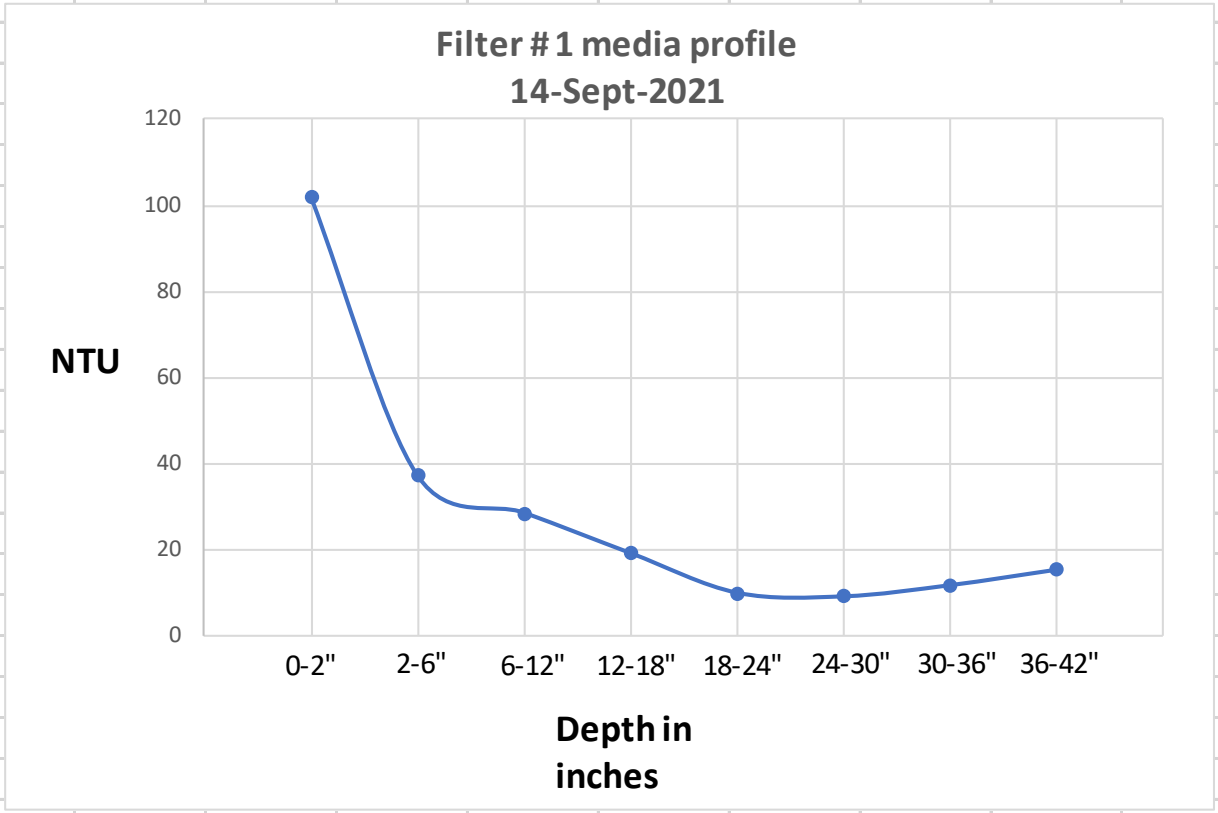
Floc Retention Analysis

50.0g washed 5x w100ml of water

Raw Water temperature 27.3C

	14-Sep-21		7-Jan-20
	Alum		**Alum**
	120hrs		120hrs
Depth	Filter # 1		**Filter # 1**
inches	NTU		**NTU**
0-2	102		**90.1**
2-6	37.3		**81.9**
6-12	28.7		**34.5**
12-18	19.3		**23.8**
18-24	10.1		**9.74**
24-30	9.29		**7.3**
30-36	11.9		**6.92**
36-42	15.5		**9.14**

Air scour 7.0min

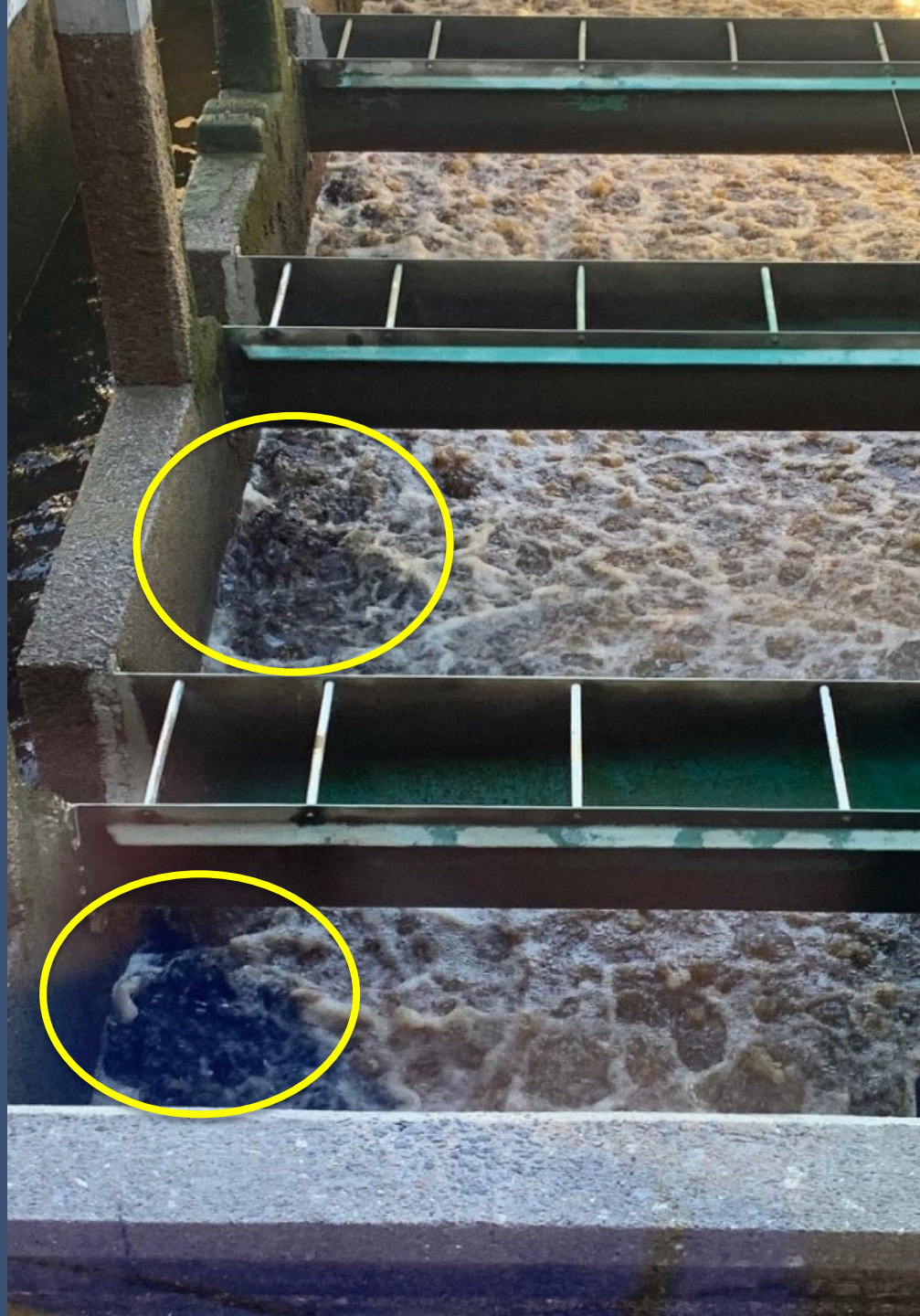


Observe Backwash Sequence

- Underdrain Issues
  - Boils, excessive turbulence, dead areas
- Levelness – enters all troughs at once
- Clarity – should be even, no “marbling”
- Be curious
- Make sure filter is successfully making it through backwash sequence
  - Unique to each plant SCADA

What's Wrong Here?

- Air Scour step



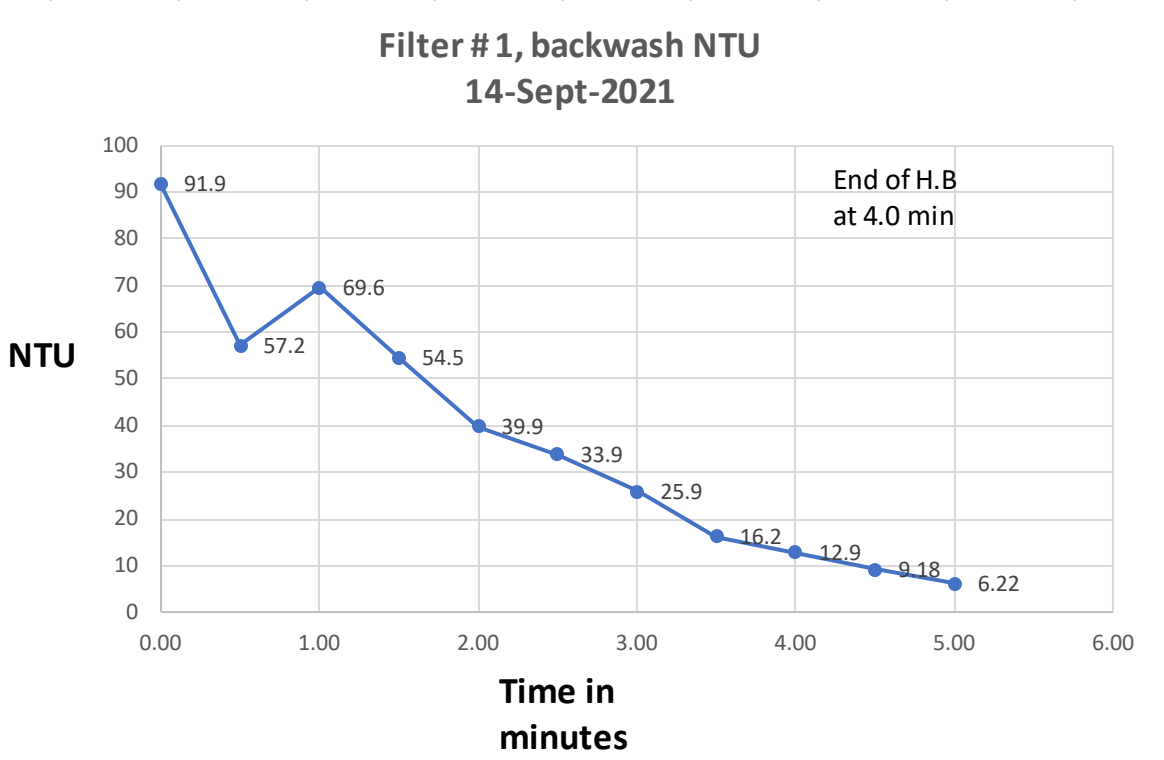
Hazen

Spent Filter Backwash Turbidity Analyses

- Collect sample from gullet or end of trough
  - Not as it flows into trough
- Sample at 30 second intervals for entire wash
- Graph results as NTU vs. time
- Record all data
  - Volume of backwash, rates
  - Ramping intervals, operator habits
- Too little / too much washing is common
  - Turbidity spikes after backwash, poor ripening
- DO NOT USE AS ONLY BACKWASH GUIDE

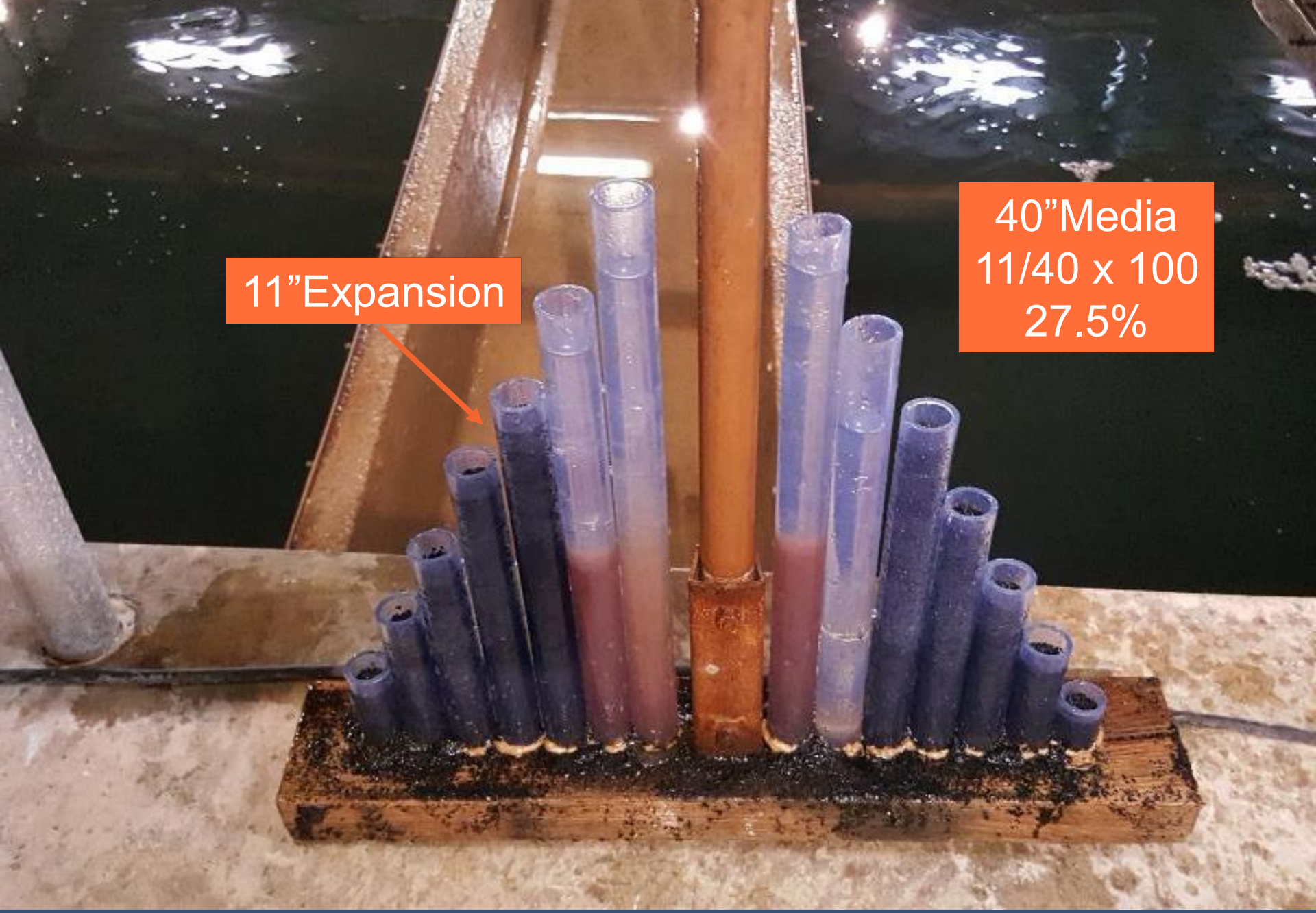
Spent Backwash Turbidity

45MGD		RT=120HRS
4.0HB 3.0LB		
Time	Filter # 1	
minutes	NTU	
0.00	91.9	
0.50	57.2	
1.00	69.6	
1.50	54.5	
2.00	39.9	
2.50	33.9	
3.00	25.9	
3.50	16.2	
4.00	12.9	
4.50	9.18	
5.00	6.22	
5.50		
6.00		
Air scour 4.0min		



Bed Expansion

- Wash bed under normal conditions and observe amount of expansion
- Seasonally adjust for temperature
- Position expansion tool so that it rests on top of the bed before BW
- Insert during high rate
- Desire 20 – 30% expansion


11”Expansion
40”Media
11/40 x 100
27.5%


70021 230195K
DWV NSF

Case Study

Challenges

- Partnership for Safe Water Turbidity Goals
- Controlling algae growth in passive biological filters

Jack H. Wilson WTP - 133 mgd

Return to Service Turbidity - Before

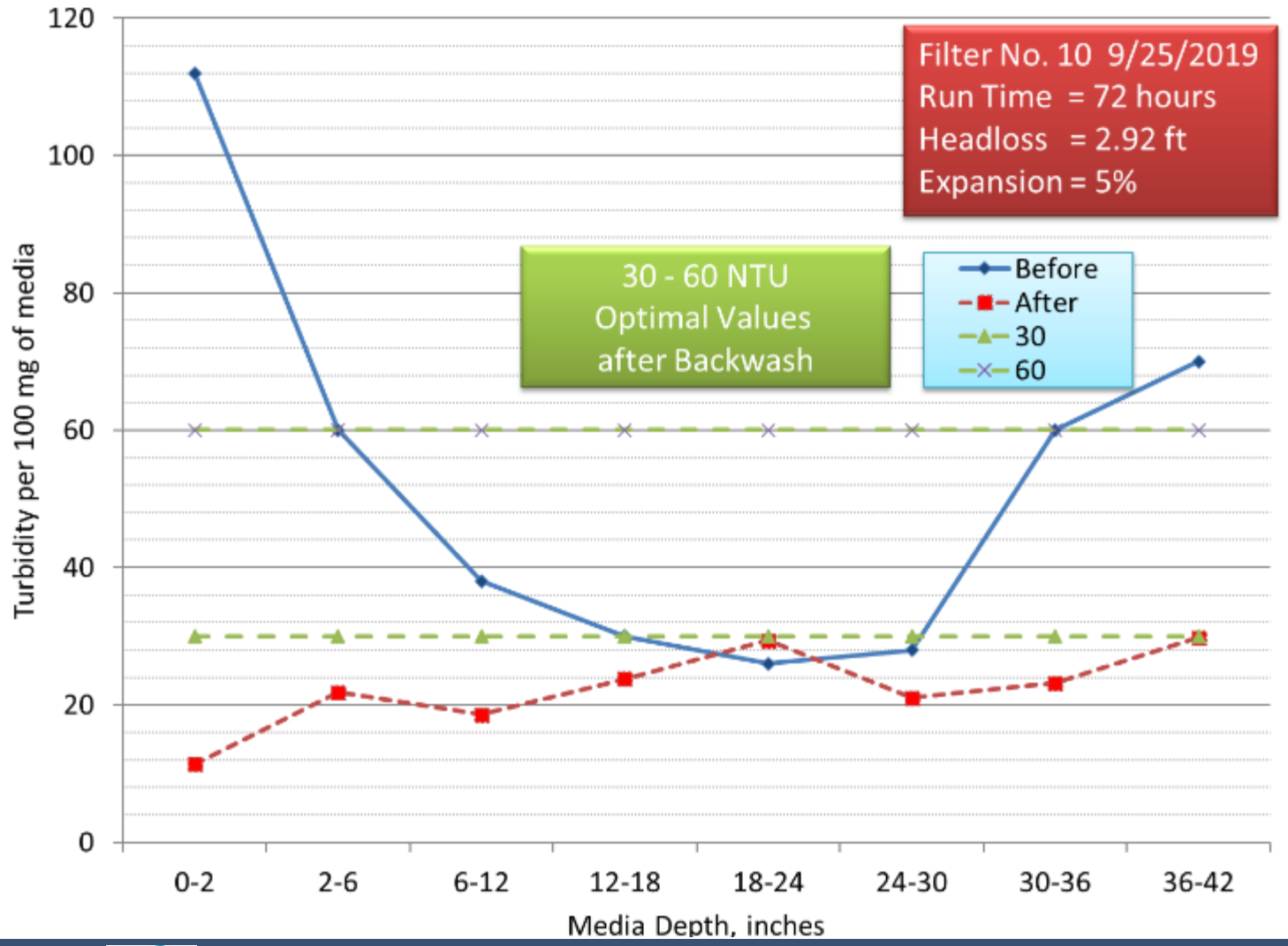
- Yellow – >0.10, < 0.30 NTU
- Red - > 0.30 NTU
- Long time to reduce IFE turbidity
- Shorter than desired run times
- Alum does higher than jar tests
- Trouble meeting PfSW goals

Wilson Filter Turbidity Report

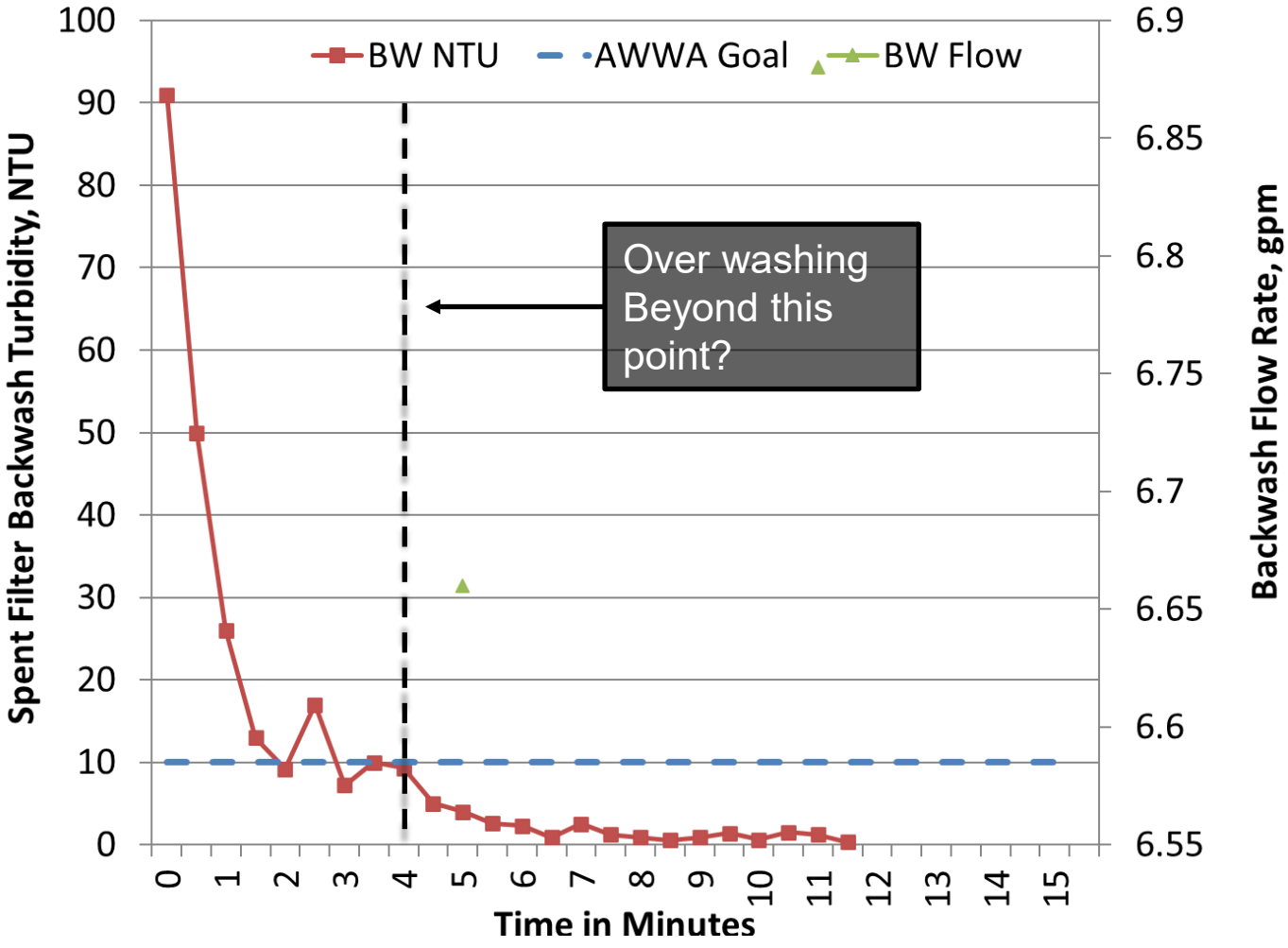
Friday, September 13, 2019

Time	Filter 9	Filter 10	Filter 11	Filter 12	Filter 13	Filter 14	Filter 15	Filter 16
06:15 AM	0.05	0.04	0.04	0.03	0.17	0.11	0.17	0.17
06:30 AM	0.05	0.04	0.06	0.03	0.20	0.11	0.16	0.16
06:45 AM	0.05	0.04	0.07	0.03	0.17	0.10	0.16	0.16
07:00 AM	0.05	0.04	0.09	0.03	0.19	0.09	0.16	0.16
07:15 AM	0.05	0.04	0.13	0.03	0.17	0.08	0.16	0.16
07:30 AM	0.05	0.04	0.14	0.04	0.17	0.08	0.17	0.17
07:45 AM	0.05	0.04	0.13	0.03	0.47	0.09	0.18	0.18
08:00 AM	0.05	0.04	0.10	0.03	0.22	0.11	0.18	0.19
08:15 AM	0.05	0.04	0.13	0.03	0.26	0.10	0.19	0.20
08:30 AM	0.05	0.04	0.11	0.03	0.36	0.11	0.20	0.20
08:45 AM	0.05	0.04	0.08	0.03	0.37	0.13	0.20	0.20
09:00 AM	0.05	0.04	0.06	0.03	0.35	0.14	0.20	0.21
09:15 AM	0.05	0.04	0.05	0.03	0.34	0.15	0.21	0.21
09:30 AM	0.05	0.04	0.09	0.03	0.33	0.14	0.21	0.21
09:45 AM	0.05	0.04	0.12	0.03	0.33	0.12	0.21	0.21
10:00 AM	0.05	0.04	0.15	0.03	0.32	0.12	0.21	0.21
10:15 AM	0.05	0.05	0.18	0.03	0.32	0.08	0.21	0.21
10:30 AM	0.06	0.26	0.19	0.03	0.36	0.06	0.21	0.21
10:45 AM	0.05	0.19	0.17	0.03	0.45	0.06	0.21	0.21
11:00 AM	0.05	0.15	0.18	0.03	0.38	0.07	0.21	0.21
11:15 AM	0.06	0.09	0.18	0.03	0.36	0.06	0.21	0.20
11:30 AM	0.06	0.09	0.19	0.03	0.34	0.07	0.20	0.20
11:45 AM	0.06	0.10	0.19	0.03	0.34	0.07	0.20	0.20
12:00 PM	0.07	0.08	0.20	0.03	0.33	0.07	0.20	0.20
12:15 PM	0.07	0.06	0.21	0.03	0.34	0.07	0.20	0.20

Floc Retention Analysis



Spent Filter Backwash Turbidity



Immediate Changes Implemented

- High-rate backwash time was reduced
  - 12 to 4 minutes
- Increased high backwash rate → expand bed
  - 35 MGD to 45 MGD
- Stepped up high backwash rate
  - Gradual expansion, minimize intermixing media layers
- Drainage issues discovered
  - Address during upgrades
- Scheduled drying rotation
  - Algae management on filter walls
- Air scour with BW water
  - To not cause veins

Return to Service Turbidity - One Year Later

- High-rate backwash reduced to 3.5 minutes
- Backwash rate increased to improve bed expansion
- Filter run times increased 72 hours to 120 hours
- Reduced coagulant dose ~10%
- Saving ~ 200 Mgal annually in backwash water
- Consistently meet PfSW goals

PARTNERSHIP FOR SAFE WATER®

Wilson Filter Turbidity Report

Sunday, September 6, 2020

Time	Filter 9	Filter 10	Filter 11	Filter 12	Filter 13	Filter 14	Filter 15	Filter 16
12:00 AM	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
12:15 AM	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.02
12:30 AM	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
12:45 AM	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
01:00 AM	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
01:15 AM	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
01:30 AM	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
01:45 AM	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
02:00 AM	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
02:15 AM	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
02:30 AM	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.02
02:45 AM	0.04	0.03	0.08	0.03	0.03	0.03	0.03	0.02
03:00 AM	0.03	0.03	0.07	0.03	0.03	0.03	0.03	0.02
03:15 AM	0.03	0.03	0.08	0.03	0.03	0.03	0.03	0.02
03:30 AM	0.03	0.03	0.08	0.03	0.03	0.03	0.03	0.02
03:45 AM	0.03	0.03	0.06	0.03	0.03	0.03	0.03	0.02
04:00 AM	0.04	0.03	0.05	0.03	0.03	0.03	0.03	0.02
04:15 AM	0.03	0.03	0.05	0.03	0.03	0.03	0.03	0.02
04:30 AM	0.04	0.03	0.04	0.03	0.03	0.03	0.03	0.02
04:45 AM	0.04	0.03	0.04	0.03	0.03	0.03	0.03	0.02
05:00 AM	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.02
05:15 AM	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.02
05:30 AM	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.02
05:45 AM	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.02
06:00 AM	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.02

CAW Results

- Saved water → increased production efficiency
- Lower operational costs $$$
- Greater operator awareness
- Routine filter evaluations
- Continuous optimization
- Quantification of Treatment
  - Data
  - Increased toolkit to troubleshoot

Recommended Filter Surveillance Frequency

Once per quarter (per season)

- Adjust high flow rate for temperature
- Check media expansion and freeboard
- Review unit filter run volume data
- Review all filter profiles

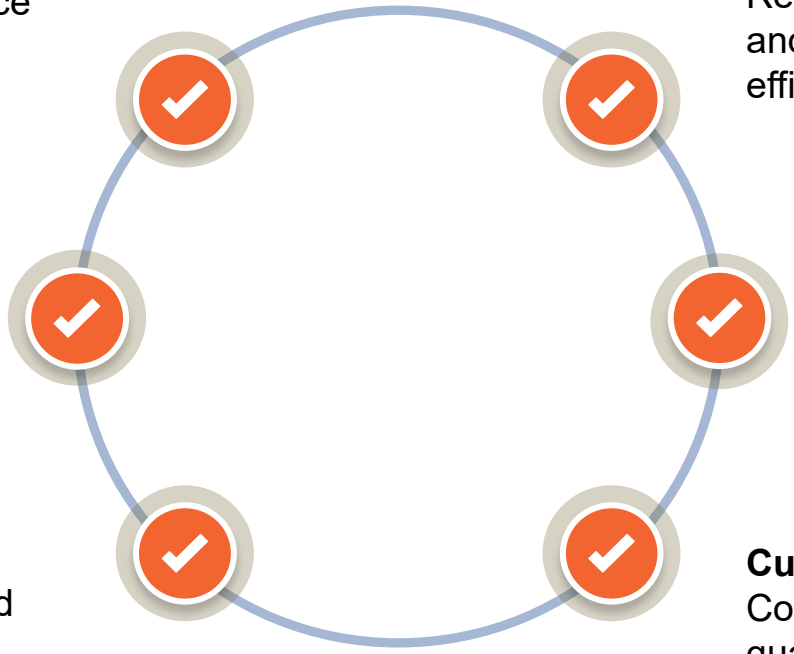
Once per year

- Check media depth
- Core the filter – solids retention
- Send media to lab for sieve analysis
- Add media if necessary
- BUT – know why it's being lost

Why Filter Surveillance?

Capital Benefits
Extend media life and reduce media loss by optimizing backwash rates

Maximize Efficiency
Reduce backwash water use and increase production efficiency



Staff Empowerment
Increase the knowledge and skills of plant staff / standardize operations

Reduce Chemical Demand
Potentially reduce chemical demand due to improved media condition

Regulatory Compliance
Continuously meet or exceed effluent quality goals

Customer Satisfaction
Continuous delivery of high-quality water to all customers

SouthwestSection
American Water Works Association

Thank you!

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