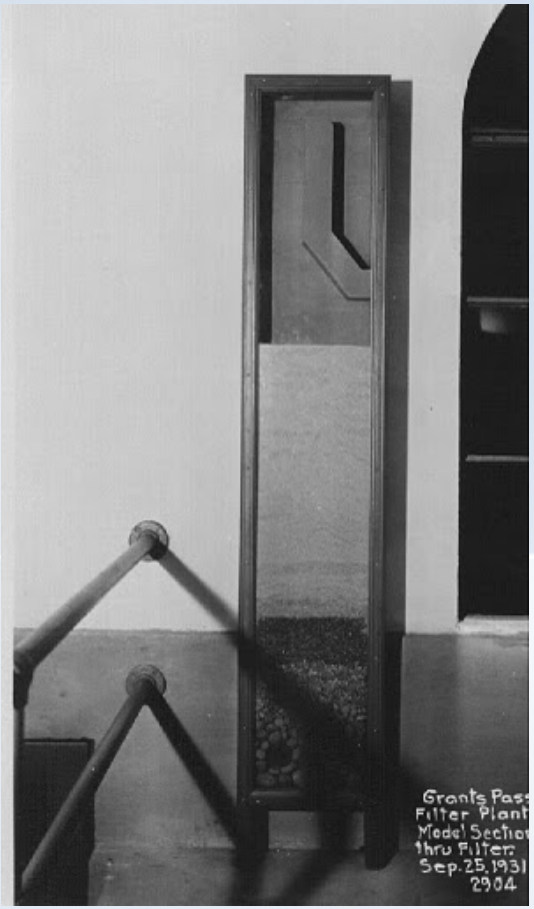
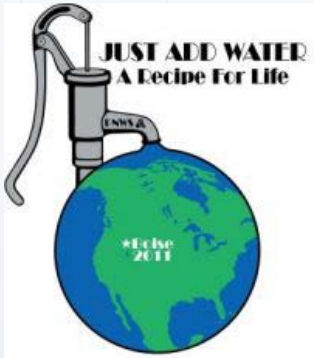
Mixed Media Filter Operations and Maintenance

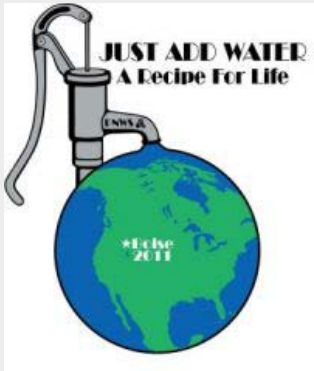
for Water Treatment Plant Operators





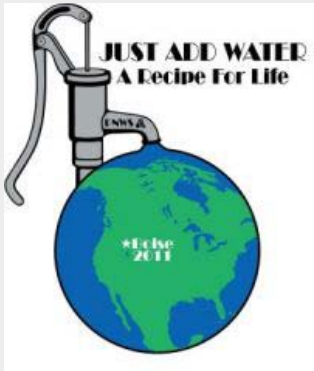
A Little About Me…

- Water Treatment Plant Superintendent for the City of Grants Pass
  - 15 years of water treatment experience.
    - DHS-DWP Grade IV with Filtration Endorsement
  - Experience in filter operations and controls.
    - Included programming filter and backwash controls
    - Instrument verification, calibration and repair
  - Survived two filter rehabilitation projects in that 15 years (one successful, one not).



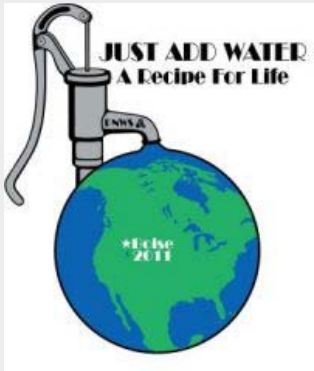
OBLIGATORY DISCLAIMER:

- It is important to remember that filters are a critical barrier in the fight against microbial contamination of finished water. It is crucial that all precautions are taken and that proper disinfection procedures are followed when performing any of the maintenance procedures discussed in this program.

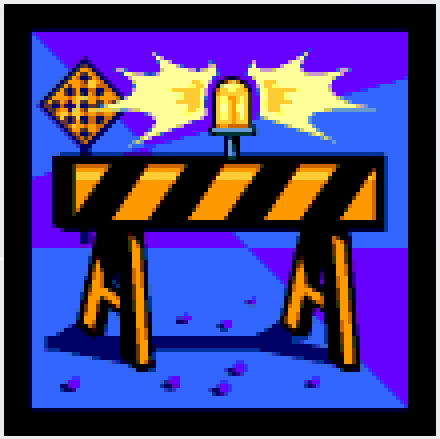


Do I have a problem Filter?

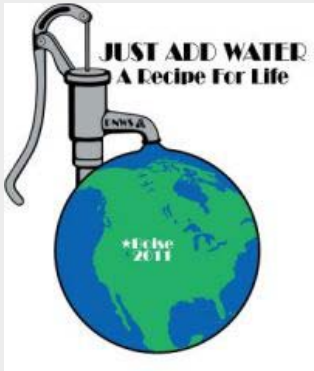
- Question sounds easy, but…
  - High turbidity throughout filter run, or turbidity breakthrough after short filter run.
  - Builds headloss very quickly
  - Sensitive to flow changes
  - Uneven media surface
  - Cracking in filter media surface
- One filter or all?
  - If all filters exhibit similar symptoms, problem most likely pretreatment or design related.



Safety is Job # 1!

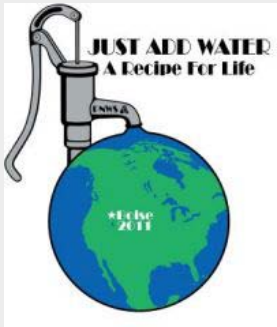


- Slippery surfaces, sharp edges
- Poor air flow
- Slips, Trips and Falls (ORS ***437-002-0125***)
  - Ladders for entering and exiting
  - Climbing over handrails, etc…
  - Washwater troughs
- Filters are a potential confined space
  - (OR-OSHA 1910-146 subpart J)
  - http://www.cbs.state.or.us/external/osha/pdf/pubs/2864.pdf



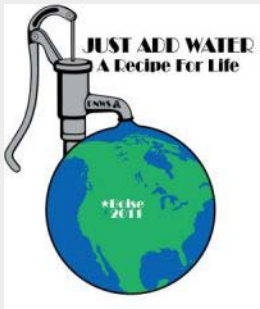
Safety is Job # 1!

- Safety – NOT just your s but your customers too
  - Disinfection!!!
    - AWWA – C653-03 Standard for Disinfection of Water Treatment Plants
    - http://apps.awwa.org/WaterLibrary/ShowAbstract.aspx?an=0057958
  - Be as clean as possible and realize that most disinfection occurs POST filtration, **but**…
    - If pre-chlorination is not practiced microbial growth can occur in the filter
    - Bacteria can grow and pass into the finished water supply.



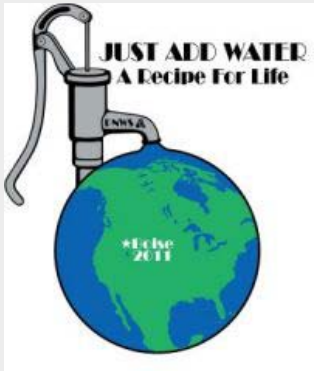
So lets figure out what's wrong…

- Visual Inspection – never underestimate your eyes
  - Is the surface uneven? >1" – 2" may indicate disruption in the underdrain system.
    - Best accomplished by draining to the media surface
  - Cracks in the media at the end of a filter run?
    - In the middle of a filter? Along the edges?
  - Large amounts of detritus?
    - Especially problematic with outside filters and large trees
    - Can lead to mudball problems if they are not removed or backwashed out.



So lets figure out what's wrong…

- Visual Inspection – During/After the backwash cycle
  - Are there visible boils in the filter media? Some boiling is normal, but should move around the filter.
  - Is uncontrolled air released from the filter bed during the backwash cycle? (excluding air scour systems)
  - Visible mudballs/ detritus after the cycle is complete?
  - Is the filter level after the backwash cycle?

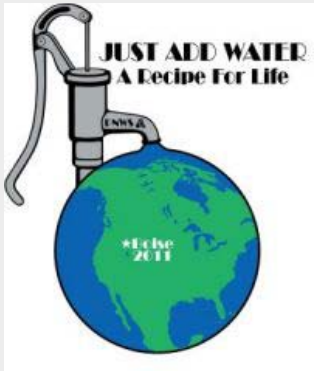


Working in your Filters…

- Working in the filter – protecting your investment
  - Filter Media is expensive! Do not damage it by walking on it.
    - Media specs – as they breakdown, UC increases and will lead to higher initial headloss and shorter filter runs.
  - While not always practical, try to walk on plywood when working in the filter.
    - Boards will distribute weight of worker over a larger area than a foot print.

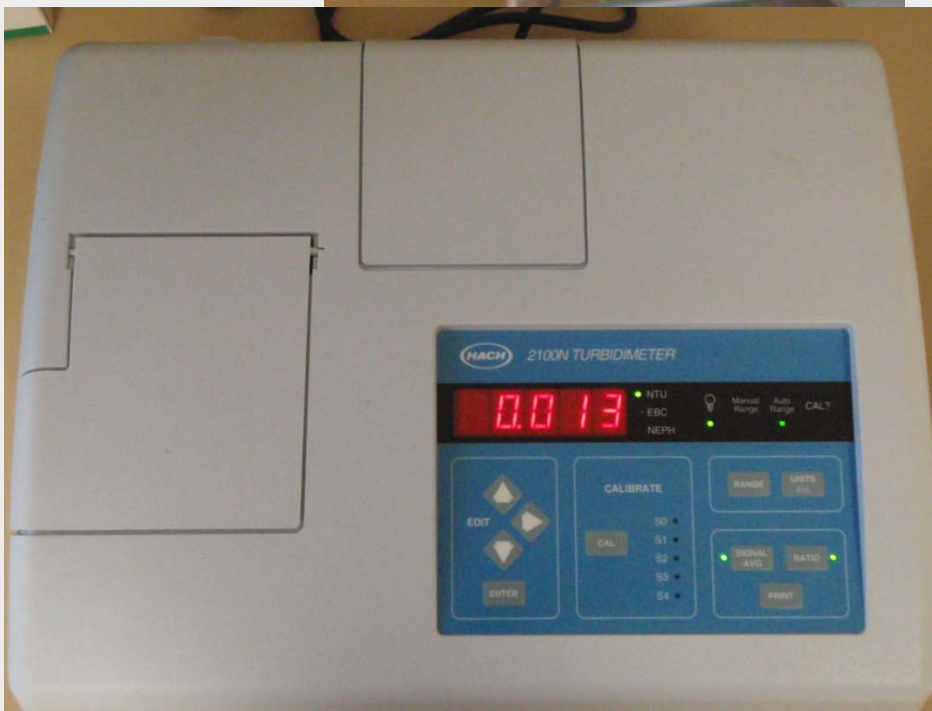
Filter Surveillance Tests

- Least Invasive to Most Invasive
  - Visual inspection
  - Backwash turbidity profile
  - Bed expansion test
  - Floc retention test



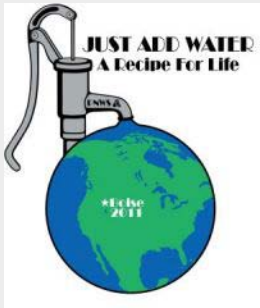
Tools of the Trade

- Backwash Turbidity Profile
  - Sample collection jars
  - "dip-stick"
  - Bench turbidimeter
  - Data Collection Worksheet
  - Stopwatch



Finally! Something to do!

- Backwash Turbidity Profile
  - Samples taken 30 seconds after water starts flowing over the wash water trough
    - 30 second intervals thereafter.
  - Two person task
    - One to collect samples – one to hand labeled sample bottle and keep time
  - Analyze samples as soon as they are taken
    - Time on the X axis, Turbidity on the Y axis
  - Should show high peak, with slow taper to low turbidity.



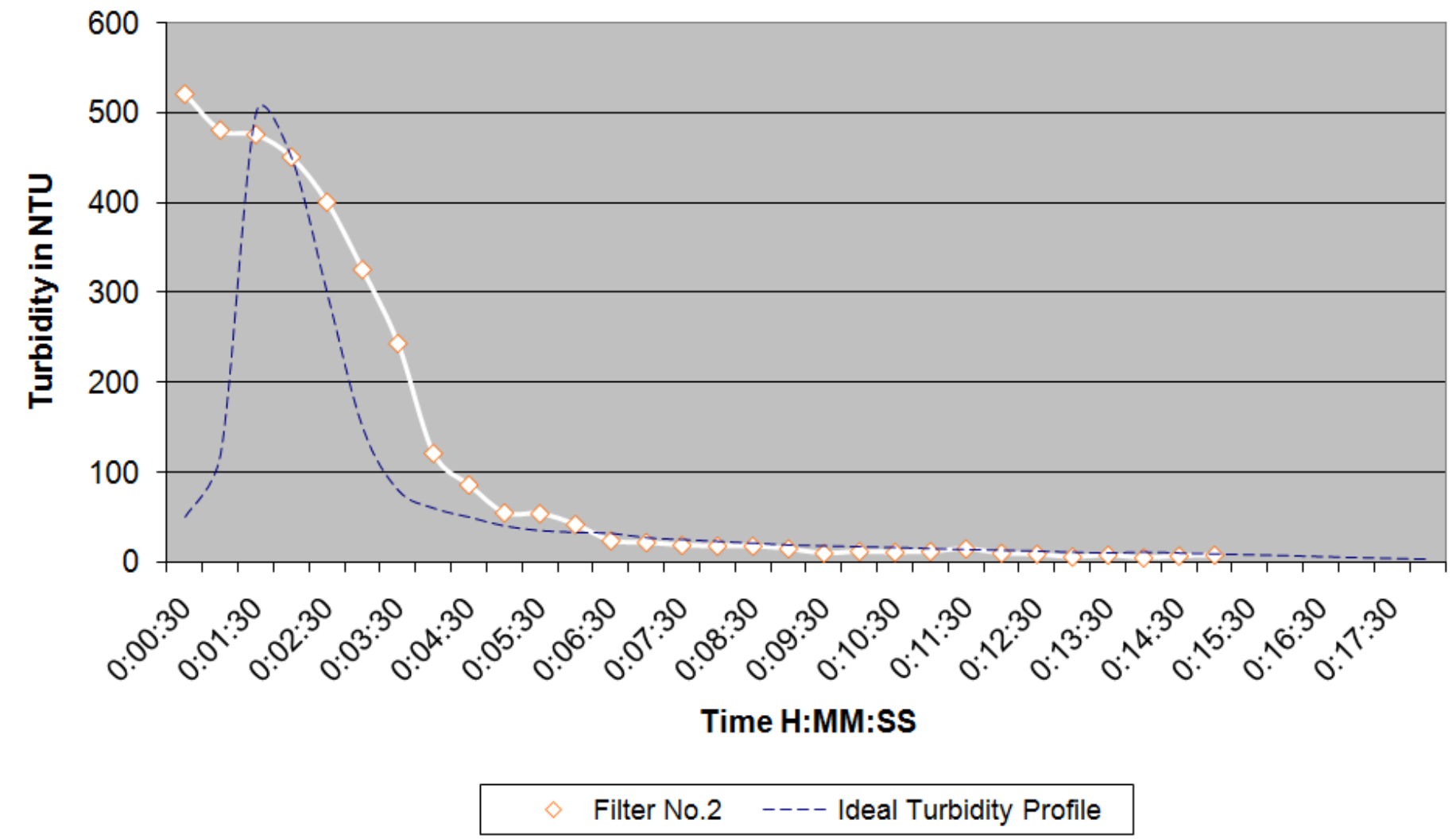
Backwash Turbidity Profile

Filter No. _____
Date: _____
Sampler: _____

Time:	Sample Jar No.	Turbidity	
0:00:30			1
0:01:00			2
0:01:30			3
0:02:00			4
0:02:30			5
0:03:00			6
0:03:30			7
0:04:00			8
0:04:30			9
0:05:00			10
0:05:30			11
0:06:00			12
0:06:30			13
0:07:00			14
0:07:30			15
0:08:00			16
0:08:30			17
0:09:00			18
0:09:30			19
0:10:00			20
0:10:30			21
0:11:00			22
0:11:30			23
0:12:00			24
0:12:30			25
0:13:00			26
0:13:30			27
0:14:00			28
0:14:30			29

NOTES:

BW Turbidity Profile Examples



What to do if the data is not favorable…

- Does the curve deviate from the "ideal" curve significantly?
  - Increase/decrease backwash rate or duration
    - Be sure not to exceed the design capacity of the underdrain system or media!
      - Engineering support or mfg specs.
    - Follow up with floc retention analysis if backwash effluent is remaining turbid at the end of BW cycle to further interpret.

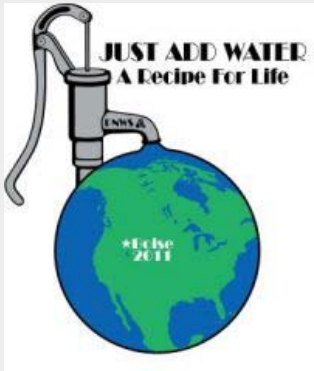
Tools of the Trade

- Filter Bed Expansion Test
  - "pipe organ" or simplified single pipe system
  - Clamps
  - Tape Measure
  - Bright Disk
  - Stick

JUST ADD WATER
A Recipe For Life

Finally! We get to do some work…

- Media Expansion Test
  - Wash the filter as normal
    - Perhaps combine with backwash turbidity profile test
  - Install the pipe organ tester or single pipe at the 20% expansion level
  - Backwash the filter as normal WITHOUT surface wash or air scour.
  - Log the expansion of the media and calculate the bed expansion



Finally! We get to do some work…

- Media Expansion Test - Examples

$$\text{Expansion} = 5 \text{ inches}$$

$$\text{Filter bed} = 18 \text{ inches}$$

$$\text{What is the percentage of bed expansion?}$$

$$\%\ \text{Expansion} = \frac{\text{Inches of Expansion}}{\text{Inches of Media Depth}} \times 100$$

$$(\frac{5}{18}) \times 100 = 27.7\%$$

$$\text{How much bed expansion should you have with 30" of Anthracite}$$

$$\text{Reccomended Expansion is 25\%}$$

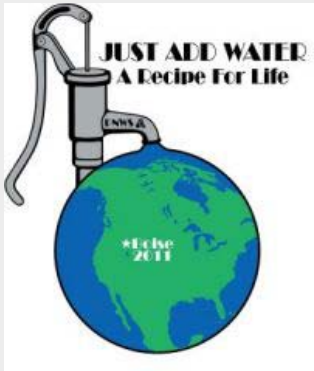
$$\%\text{Expansion} = (\frac{\text{Expansion in Inches}}{\text{Media depth in Inches}}) \times 100$$

$$25\% = (\frac{X}{30})$$

$$.25 = (\frac{x}{30})(\frac{30}{1})$$

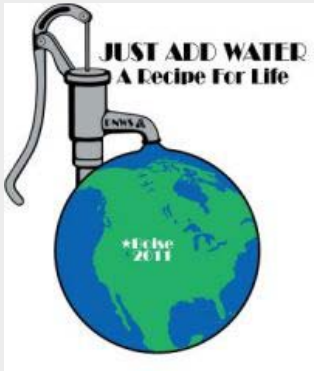
$$.25(\frac{30}{1}) = x$$

$$(.25)(30) = 7.5$$



What to do if the media is not expanding…

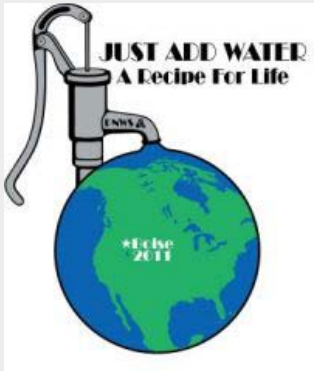
- This may not be a problem…
  - Not enough expansion?
    - Do the results of the backwash turbidity profile and floc retention analysis look favorable?
      - If so don't sweat this parameter!
  - Too much expansion?
    - Is filter media being lost (washed over the wash water troughs?)
    - Is media breaking down? (I.E. getting smaller at a fairly fast rate?)



Still Have a problem?

- Floc retention Analysis
  - Plan on this test taking all day! Wise to combine with the visual analysis testing as the filter has to be drained below the media level.

- Warning!!
  - This test is very disruptive to your filter and all precautions should be taken to ensure that it is performed carefully and to the letter of the procedure.



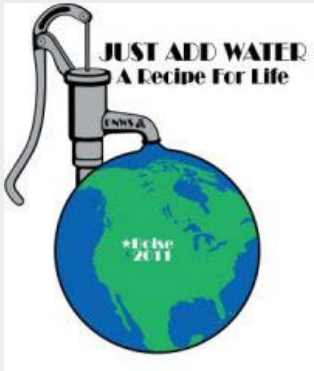
Tools of the Trade

- Floc retention analysis
  - Plywood
  - Filter coring tool
  - Rubber mallet
  - Plastic bags Ziploc preferred (Lots!)
  - 50 ml graduated cylinder (plastic)
  - 250 mL wide mouth flask
  - Bench turbidimeter
  - Vortex Mixer (optional, but…)

JUST ADD WATER
A Recipe For Life

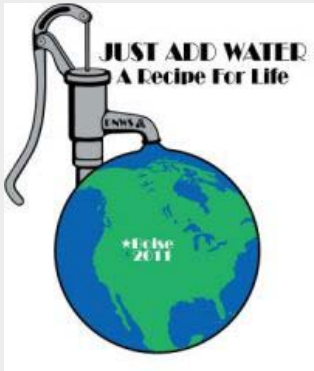
Floc Retention Analysis…

- Floc Retention Analysis
  - Fill out the Floc Retention Worksheet
    - Pick several locations that represent an average of the filter
  - Drain the filter to below the media.
    - Try not to drain it below the level of the underdrain if possible
      - Minimizes air trapped in the filter
  - Work quickly so filter media remains moist
    - It will adhere to the sampling tube better



Floc Retention Analysis (cont'd)…

- Floc retention Analysis
  - Working from plywood take core samples
    - 0″ – 2″, 2″ – 6″, 6″ – 12″, 12″ – 18″, 18″ – 24″, 24″ – 30″ and 30″ – 36″ (more if filter is deeper).
    - Place each sample into a separate numbered bag.
    - Sample carefully so as to not cross contaminate core samples (I.E. dirty sample from the top ending up in a relatively clean sample from the bottom of the filter)
  - Fill the filter with backwash water and let it set for 30 minutes or so. (for air to escape)

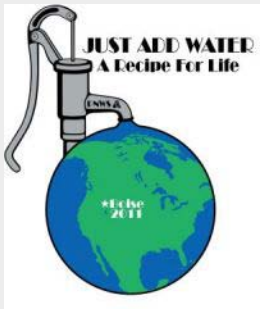


Floc Retention Analysis (cont'd)…

- Floc retention Analysis
  - Backwash the filter like normal and drain
  - Resample the filter in the same locations into a second set of zip lock bags.
- Prepare the samples for processing
  - This can be done in a day, but samples can be preserved if tightly sealed to maintain moisture!
  - Prepare data worksheet

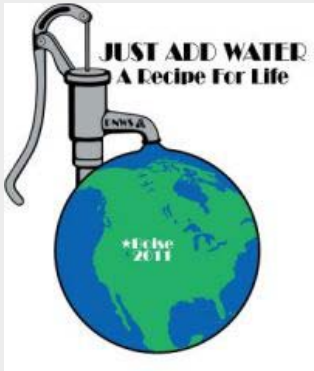
Floc Retention Analysis (cont'd)…

- Pack 50 mL into the graduated cylinder
- Transfer to the 250-500 mL wide mouth erlenmeyer flask
- Fill the 50 mL Graduated cylinder with tap water to rinse it, transfer the water to the graduate cylinder. Do this twice.
  - The flask now contains 50 mL of media, and 100 mL of tap water.
- Shake/mix "vigorously" for 30 seconds
- Drain the water (not the media) into a 500-1000 mL beaker



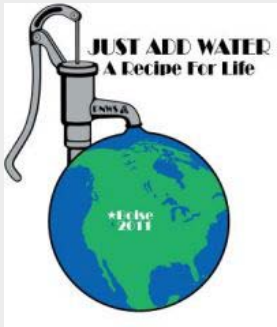
Floc Retention Analysis (cont'd)…

- Repeat 4 more times so that a total of 500 mL of sample has been collected.
- Gently stir the 500 mL sample to keep the turbidity suspended.
- Fill a turbidity sample vial from the beaker and read the turbidity. Read at least 3 samples and average the results
- The final turbidity reading will be multiplied by 2 so the data will be tabulated based on a 100 mL sample.

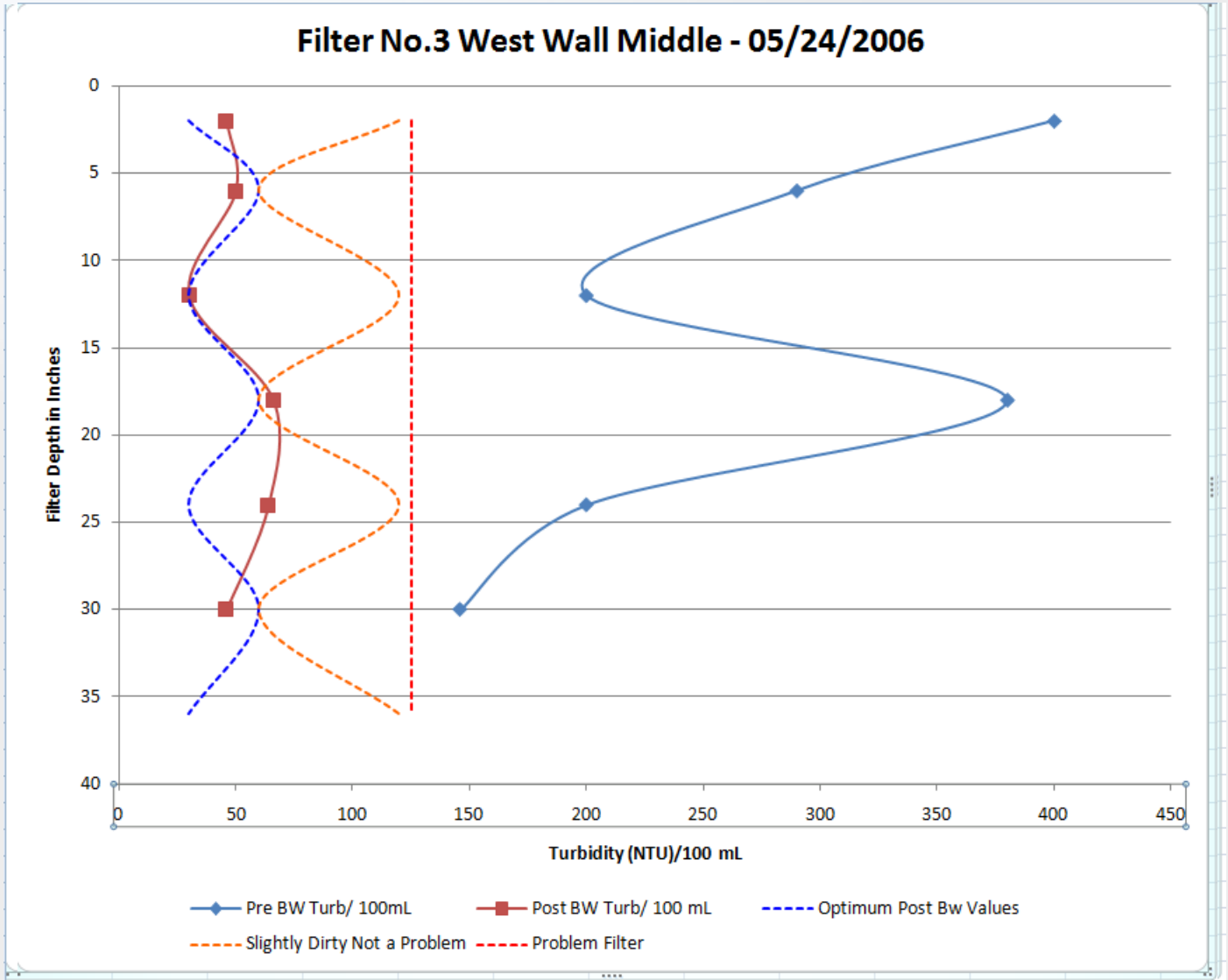


What does it all mean?!

- Floc retention Analysis - Data
  - Spreadsheet is available upon request.
    - jcanady@pnws-awwa.org
  - After Backwash:
    - 30 – 60 NTU indicates a clean, ripened bed.
    - 60 – 120 NTU indicates a slightly dirty filter.
    - 120 + NTU indicates a dirty filter and the backwash regimen needs to be looked at.
    - >300 NTU could mean that there is a problem with mudballs.

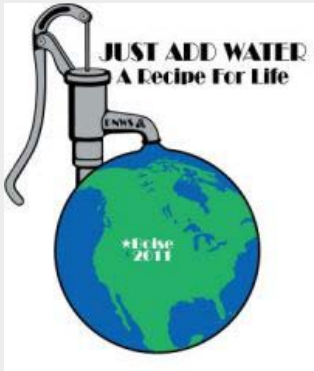


What the Data Will Look Like



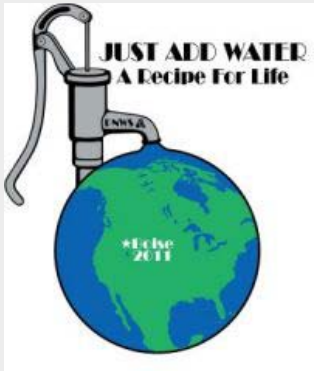
What to do if the data is not favorable…

- Possible causes –
  - Improper backwash flow rates
  - Filter-aide dosage too high
  - Improper coagulation
  - Air scour/ surface wash not operated at the correct time/rate or not functioning as designed
    - Plugged nozzles?
- Solutions –
  - Filter "Lancing" (should not be considered long term solution – but may be…)
  - Modify backwash rate/ regimen (where possible)
  - Shock chlorinate filter media



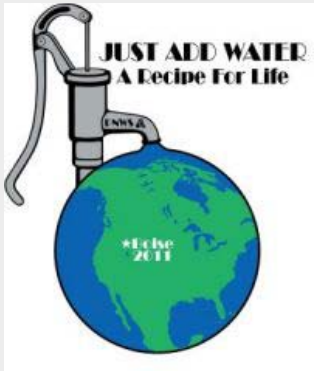
Post Filter Entry Disinfection

- "Tools of the trade"
  - Disinfection
    - Plastic bug sprayer
      - Metal parts (especially brass) do not hold up well to high concentrations of bleach!
    - Injector pump or HTH for shock chlorination of filter.
      - Beware of inert solids with HTH!
    - De-chlorination agent
      - Calcium thiosulfate
      - Consider your situation on this one…
        - » NPDES Permit issues?



Laboratory Media Analysis…

- Why have a lab analyze your filter media
  - What is the ES and UC of the media in your filter
  - Can be used as an indicator for when to replace your media
  - If adding media "topping off" it is best to try and match as close as possible
    - In general the original spec should be ok, but if the media is severely degraded it cause an even bigger problem!
- Who does this:
  - Anthratech U.S.
    - Not cheap! But there are potential savings



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