Preparing for Wildfires in the Colorado Front Range – City of Westminster Case Study

2022 MSSC Annual Salinity Summit

Tim Rynders, P.E.
Ryan Decker, P.E.

February 24th, 2022

CDM Smith

Agenda

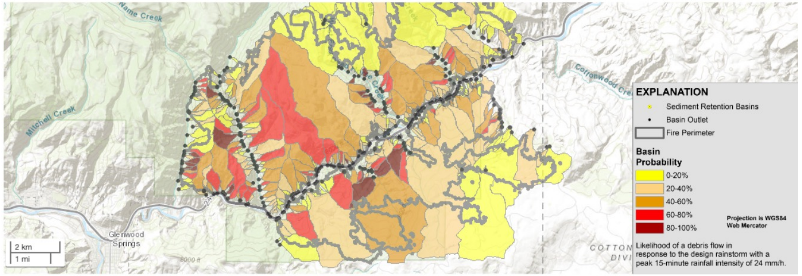
- Why are we preparing for wildfires in Colorado?
- Can we defend preparing for “unprecedented”?
- What impacts do we see from wildfires?
- Pilot Testing approach
- Pilot Testing results
- Questions

Photo courtesy of Art Messal via Estes Park Trail-Gazette

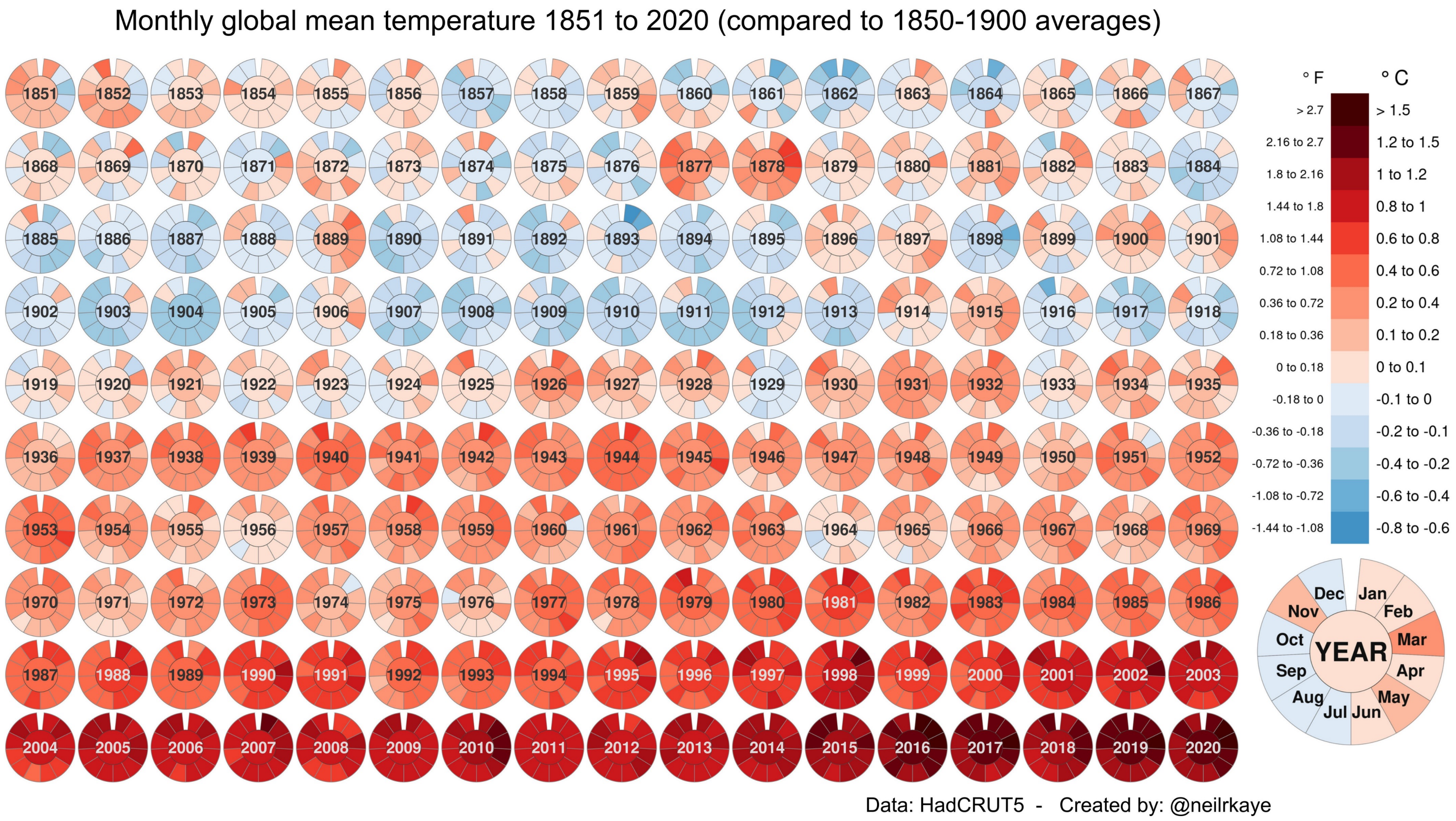
Why are we preparing for wildfires in Colorado (and most everywhere, too)?

Grizzly Creek Fire, Colorado, Post-fire Debris-flow Hazard Map

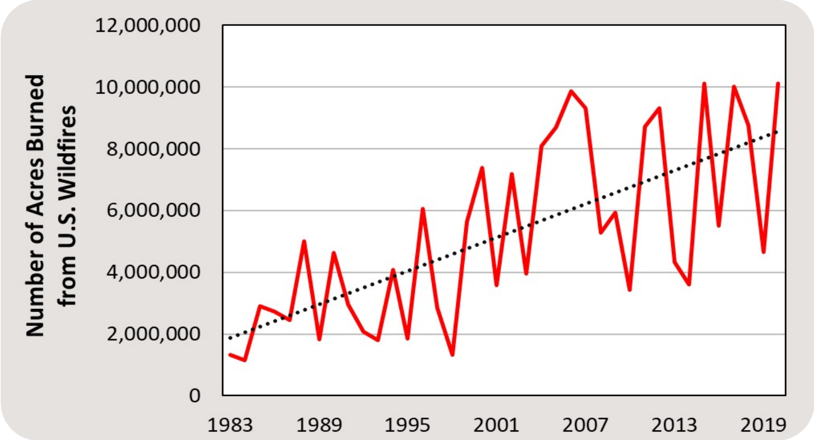
By Landslide Hazards AUGUST 10, 2020



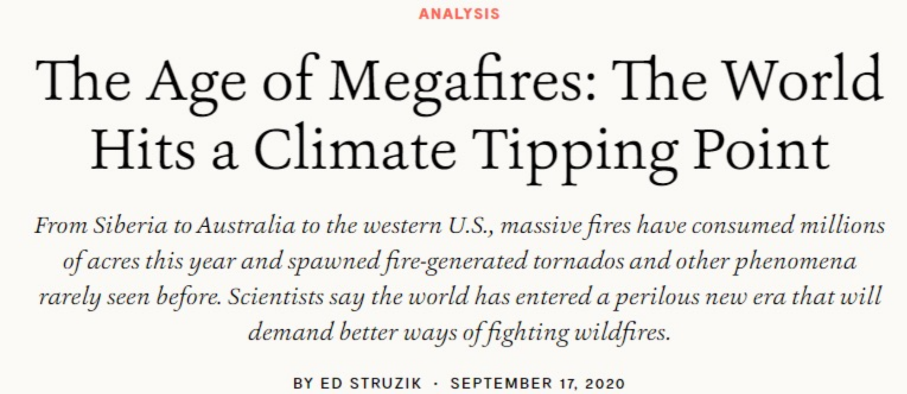
Global climate snapshot



Increased prevalence and unstoppable “mega” fires



U.S. Wildfire Data from 1983-2020
(Source: National Interagency Fire Center)

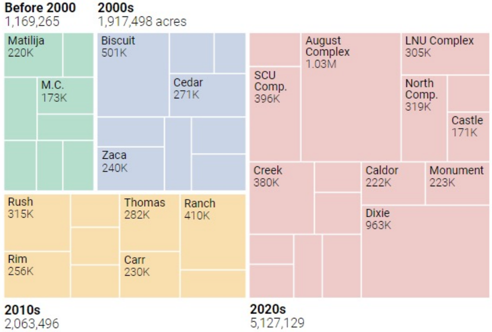


ANALYSIS

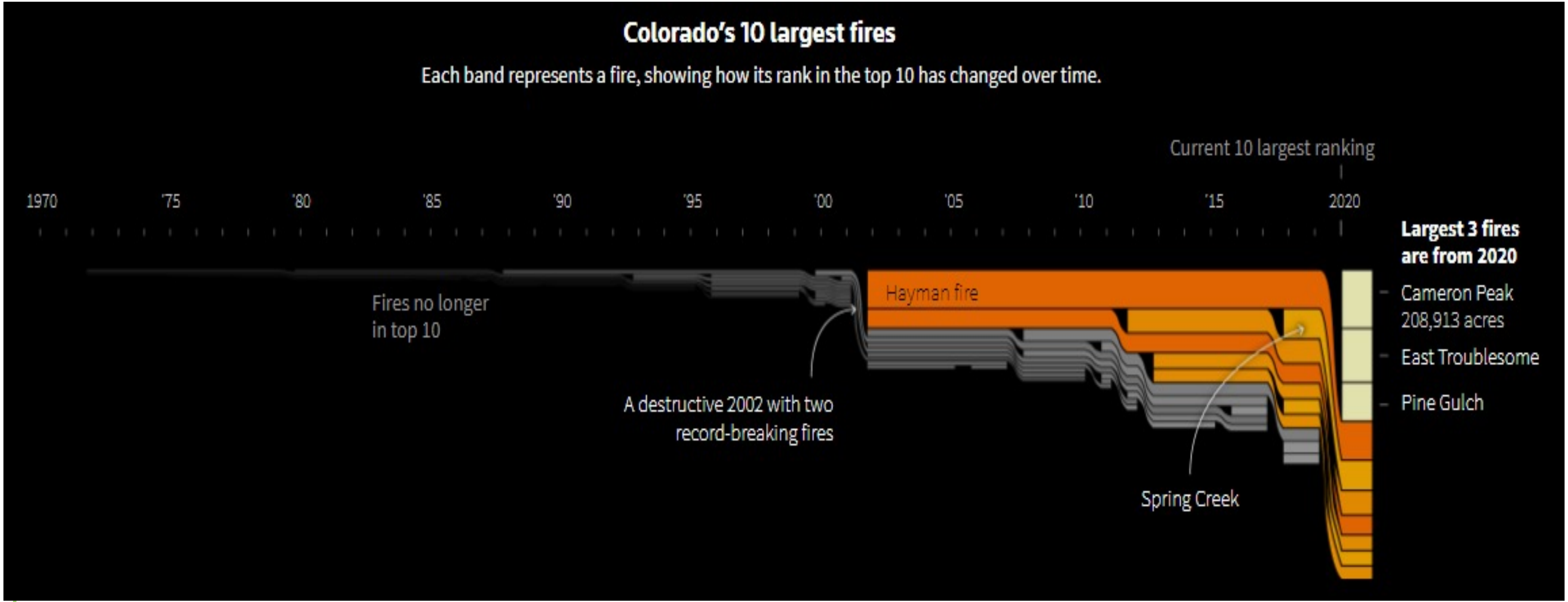
The Age of Megafires: The World Hits a Climate Tipping Point

From Siberia to Australia to the western U.S., massive fires have consumed millions of acres this year and spawned fire-generated tornados and other phenomena rarely seen before. Scientists say the world has entered a perilous new era that will demand better ways of fighting wildfires.

BY ED STRUZIK · SEPTEMBER 17, 2020



My my, how things have changed.

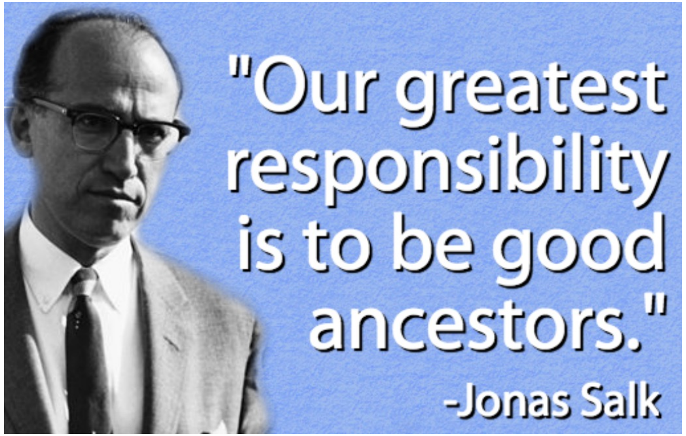


Source: Reuters

Can (and should) we seek to prepare for “Unprecedented”?

New “unprecedented” challenges from this year

- Wildfire “season” expanding
- $1B insurance loss on Dec 30
- When can we do low demand improvements to WTPs?

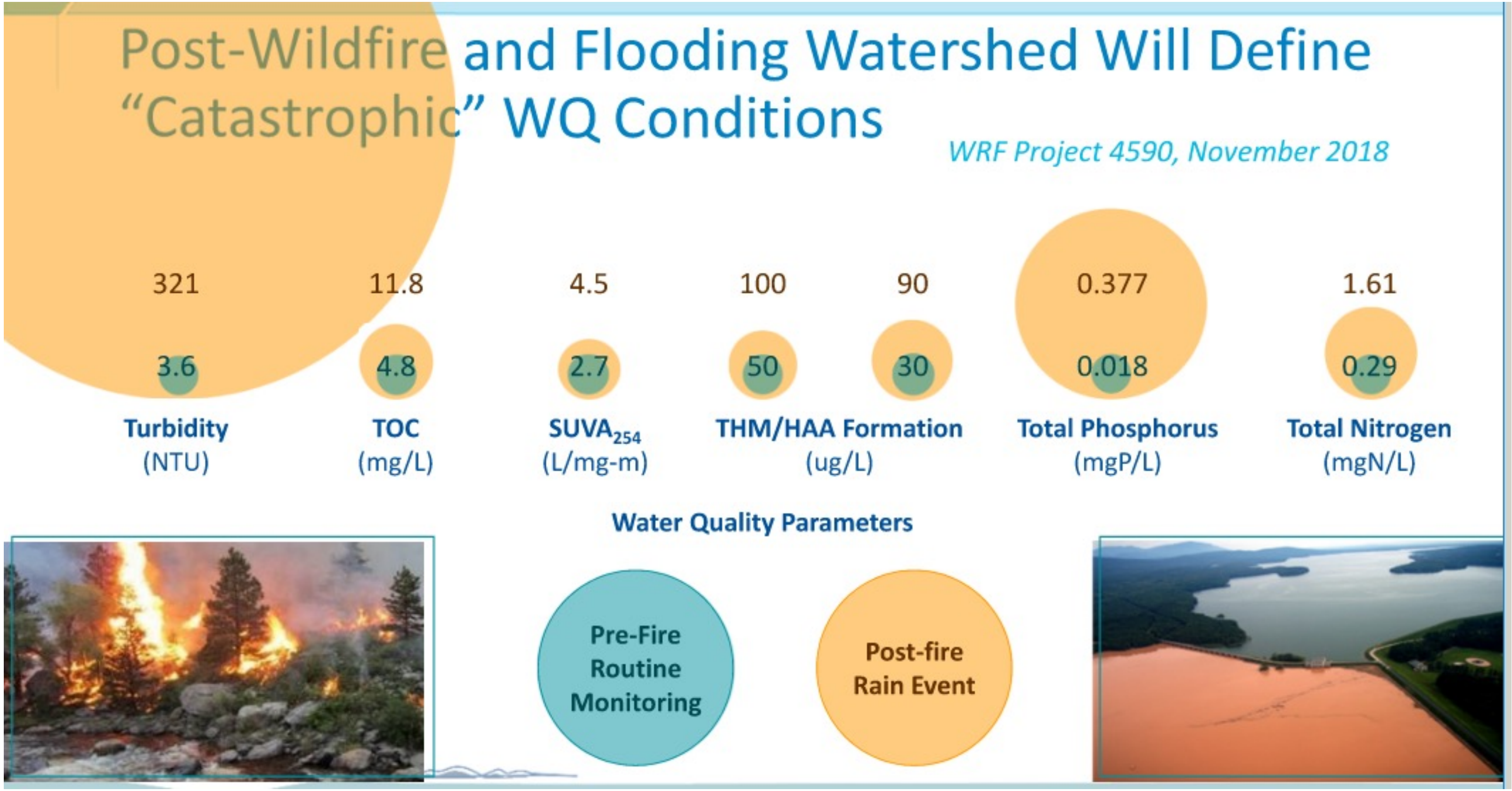


After Catastrophic Fire, Colorado Fights a New Hazard: 10 Inches of Snow Source: NYT

Those whose homes survived huge fires were struggling against new threats from cold and ice. At least three people were missing and feared dead as the authorities confirmed 991 houses destroyed.

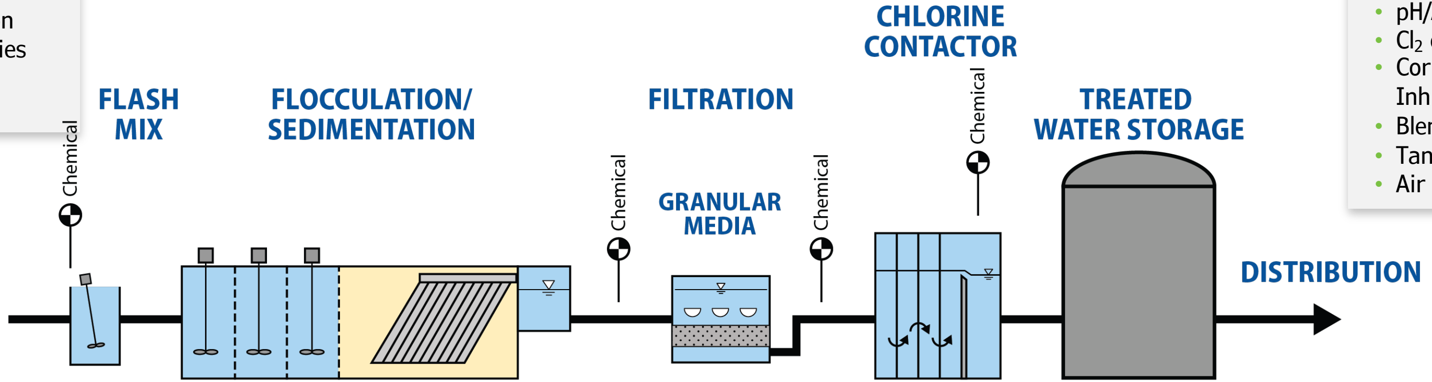
What impacts do we see from wildfires in our watersheds?

Research shows wildfires impact key water constituents



What tools do we have to meet these challenges?

1. Source Management
- Multiple Intakes/Depths
- Aeration/Oxygenation
- Pre-Sedimentation
- Infiltration Galleries
- Alternatives
- Blending



8. Post-Treatment
- pH/Alkalinity
- Cl_2 or NH_2Cl
- Corrosion Inhibitors
- Blending
- Tank Mixing
- Air Stripping

2. Ion Exchange
- MIEX™
- SIX™

3. Preoxidants
- Cl_2
- NH_2Cl
- ClO_2
- MnO_4-
- O_3 or O_3-H_2O_2
- ➢ PAC

4. Coagulation, pH and Alkalinity
- Lime
- CO_2
- NaOH
- Na_2CO_3
- ACH, PACl, Polymers
- H_2SO_4
- Acidified Alum, $FeCl_3$, $Fe_2(SO_4)_3$

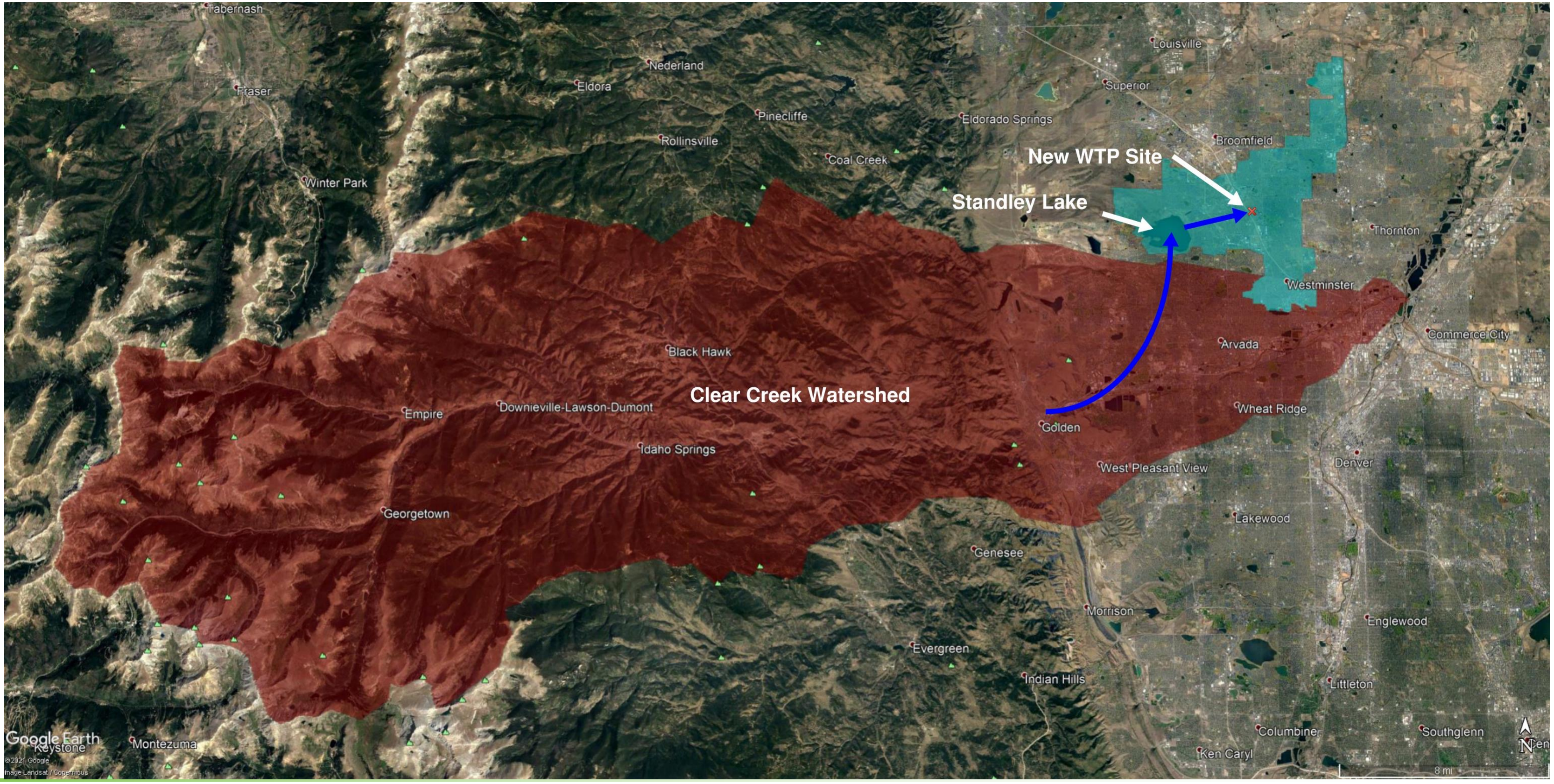
5. Clarification
- Lamella Plates
- Ballasted Flocculation
- DAF

6. Filtration
- Biologic Anthracite/Sand
- Biologic GAC/Sand
- MF/UF Membranes
- Ceramic Membranes

7. Advanced Treatment
- Ion Exchange
- Nanofiltration
- Reverse Osmosis
- UV-AOP

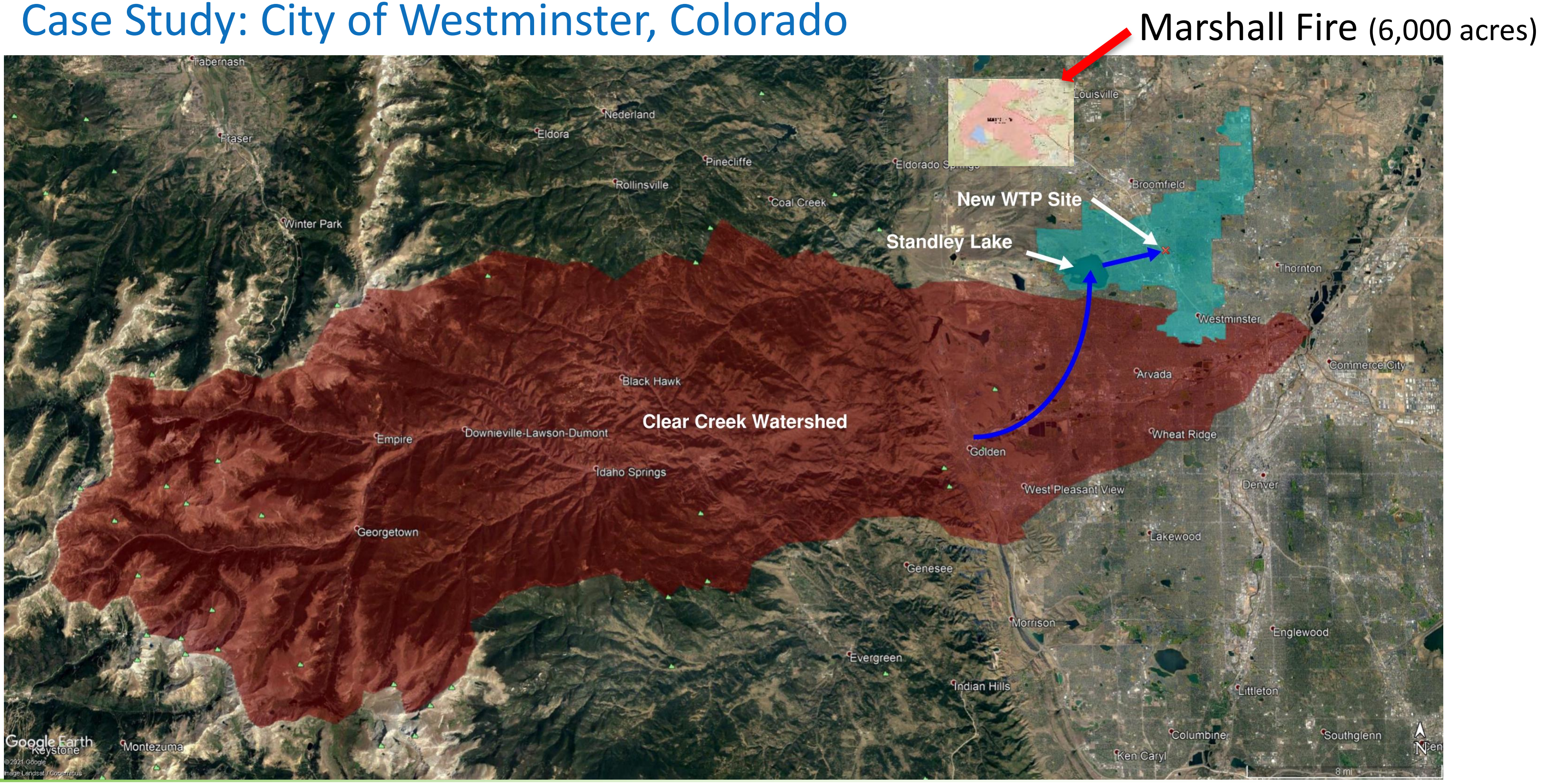
Wildfire Impacts on Treatment

Case Study: City of Westminster, Colorado



Wildfire Impacts on Treatment

Case Study: City of Westminster, Colorado



City of Westminster, CO
Pilot Testing Approach

Pilot Project Background

- City of Westminster, CO – Pop ~120,000
- Two existing water plants:
  - Semper WTP (1969) – 44mgd Conventional
  - Northwest WTF (2001) – 15mgd MF

Figure 1. Source water quality conditions for process train selection

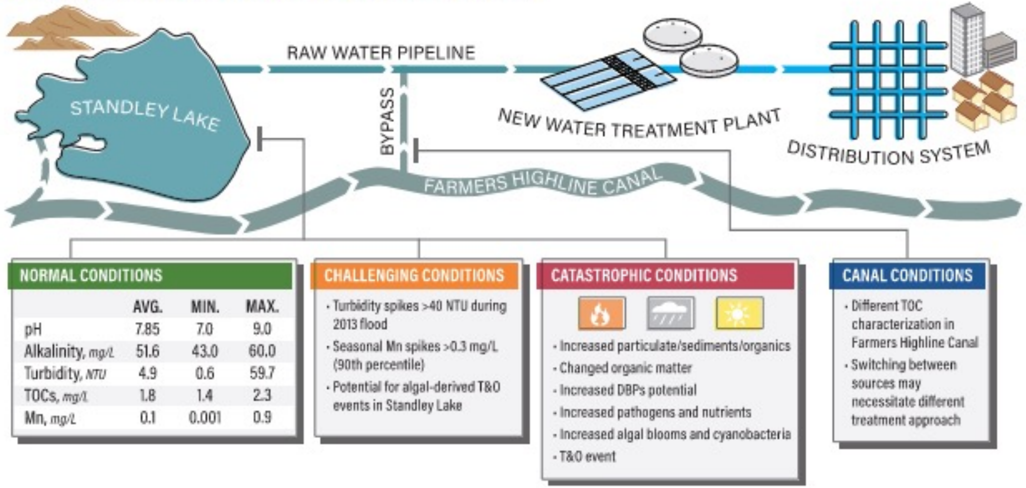
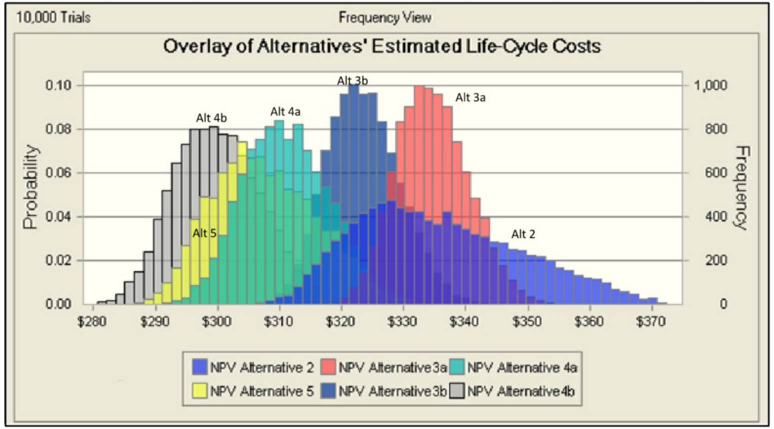


Table 3-2. Benchmarked Raw Source Water Quality for Normal, Challenging, and Catastrophic Conditions

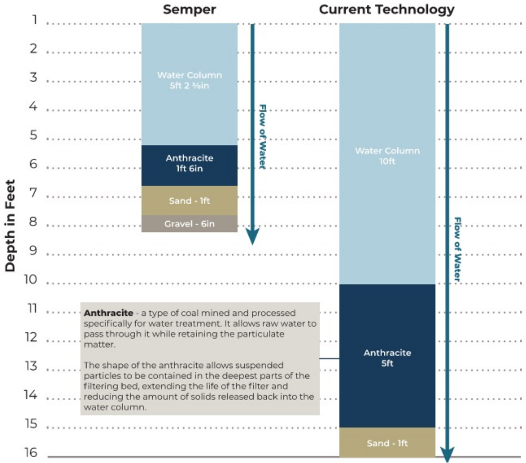
	Normal	Challenging	Catastrophic
Source of Information	5th and 95th Percentile Values for Standley Lake (2017-2018)	Min or Max Values for Standley Lake (2017-2018; Sep 2013 Flood) FHL Canal First-Flush Event (Day 2)	Min or Max Values for Standley Lake (2017-2018; Sep 2013 Flood) Post-Wildfire Rain Event
Turbidity, NTU	1 to 6.4	<60	<300
TOC, mg/L	1.4 to 2.6	<3.3	<12
UV254, 1/cm	0.03 to 0.04	0.06	<0.54
SUVA (L/mg-m)	1.5 to 2.1	<1.8	<4.5
Alkalinity, mg/L	50 to 60	<48	<48
pH	7.2 to 8.2	<7.1	<7.1
Manganese, mg/L	0.01 to 1.2	<1.6	<1.6
Temperature, deg F	40 to 70	40 to 70	>70
Hydrogen Sulfide	None	High	Very High
Cyanotoxins	Below Detection	Exceeds HALs	Exceeds HALs
Taste and Odors	< 3 TON No objectionable T&O year-round	>10 ng/L Geosmin/MIB	>100 ng/L Geosmin/MIB
Cryptosporidium Bin Classification per LT2ESWTR	Bin 1	Bin 1	Possibly Bin 2 or Higher

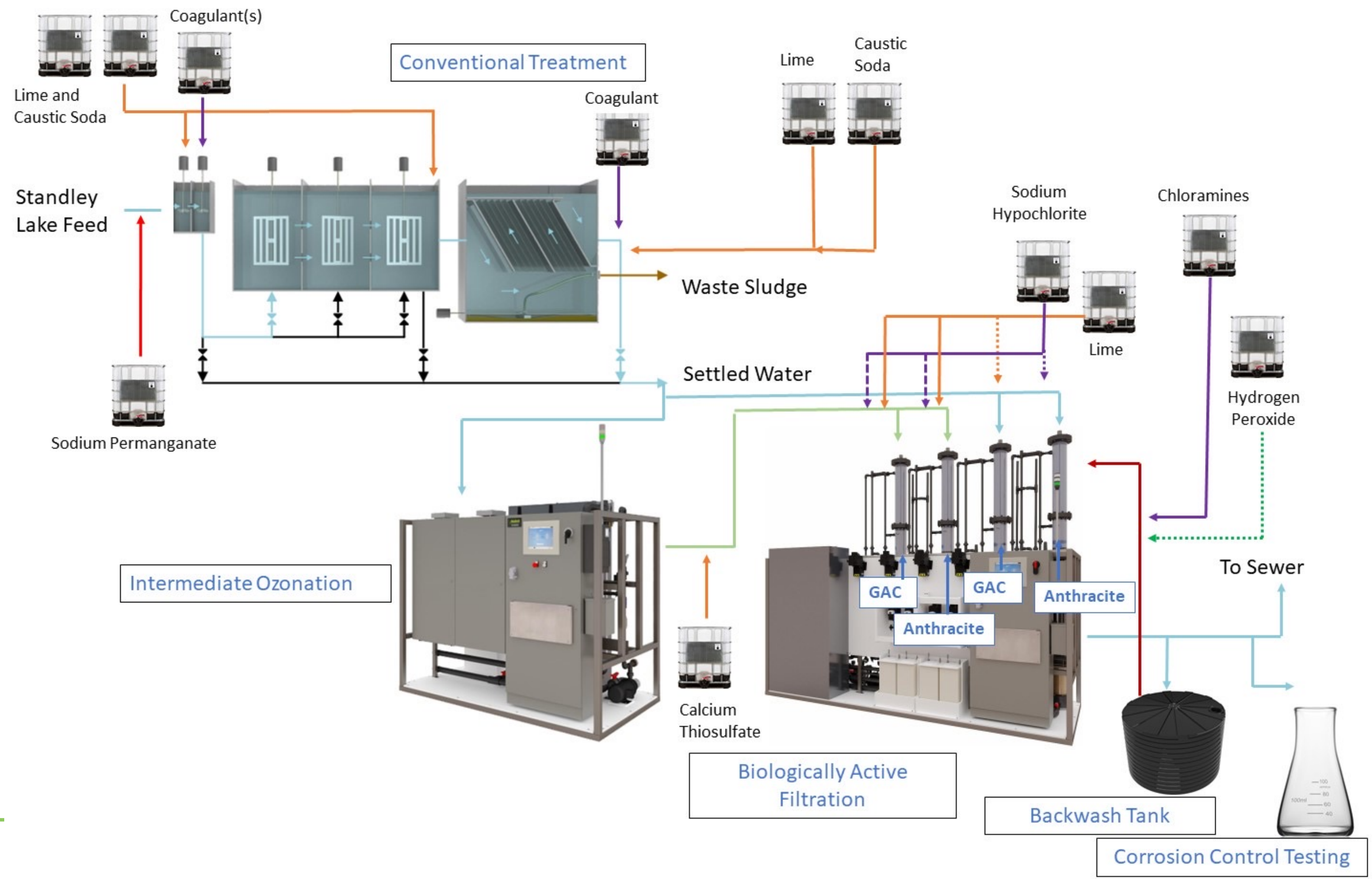
Pilot Drivers for Westminster

- Reduce cost of new WTP by increasing filter surface loading rate to reduce size of filters
- Select preferred course media (exhausted GAC or anthracite)
- Evaluate potential impact of a fire in the watershed
- Validate a robust treatment plant design

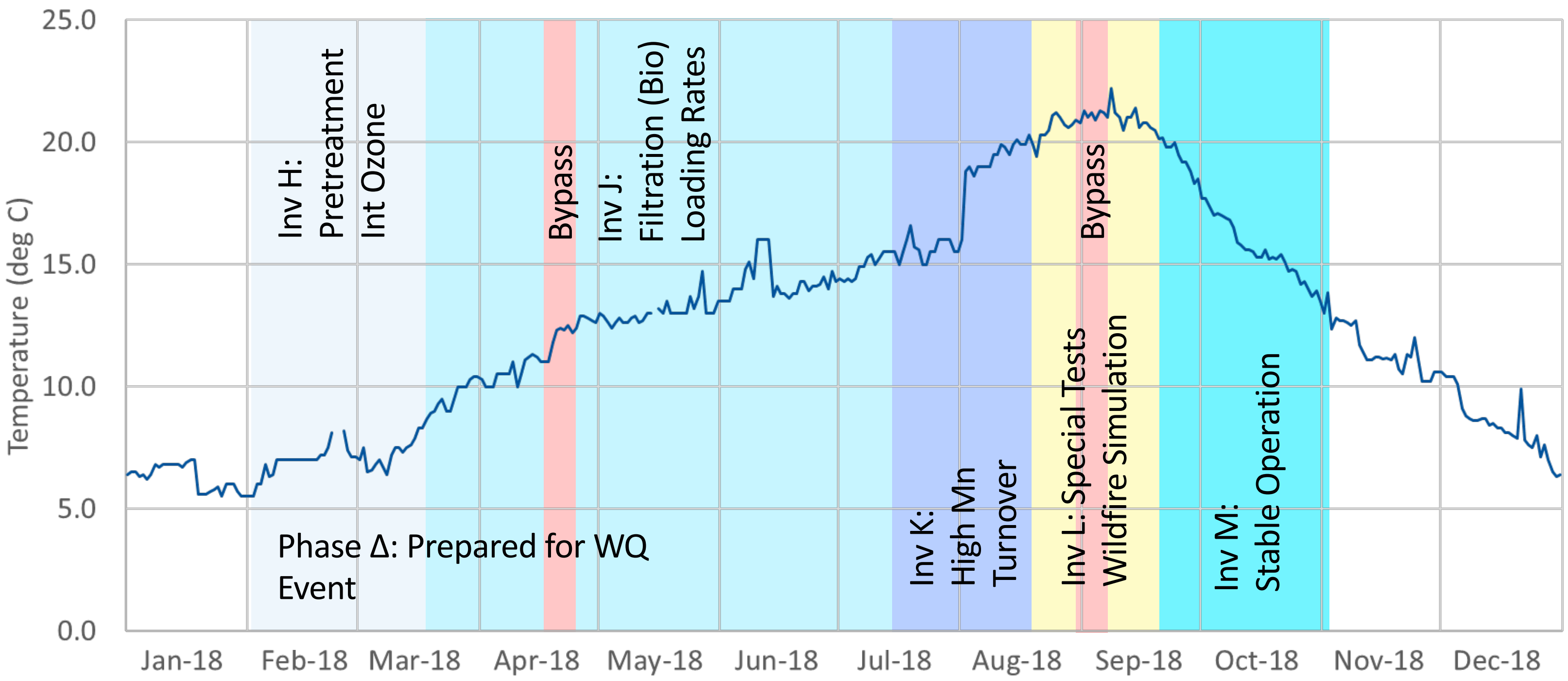


:he Monte Carlo Simulations for All Alternatives

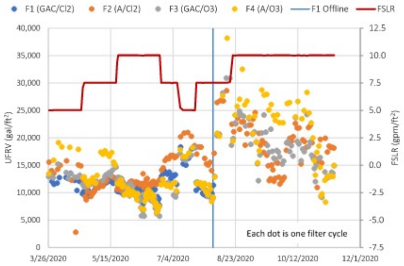


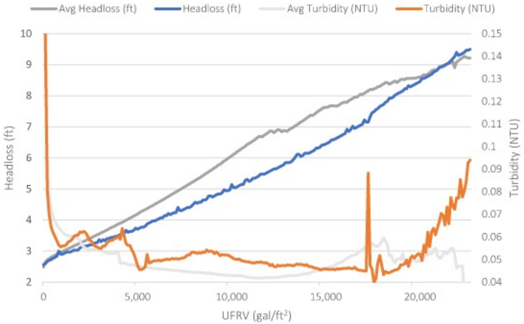

Coagulant(s)
Lime and
Caustic Soda
Conventional Treatment
Coagulant
Lime
Caustic
Soda
Standley
Lake Feed
Waste Sludge
Sodium
Hypochlorite
Chloramines
Lime
Settled Water
Sodium Permanganate
Hydrogen
Peroxide
GAC
GAC
Anthracite
Anthracite
Intermediate Ozonation
To Sewer
Calcium
Thiosulfate
Biologically Active
Filtration
Backwash Tank
Corrosion Control Testing

Major Pilot Phases Aligned with Temperature



Pilot Testing Results





Wildfire Runoff Spike Tests

- Create concentrated spike solution, mix with raw water at up to 1:10 ratio
- Received recent wildfire ash from USFS (6.5kg)
- Mixed in 1,100 L raw water for 24-hours to dissolve/suspend materials

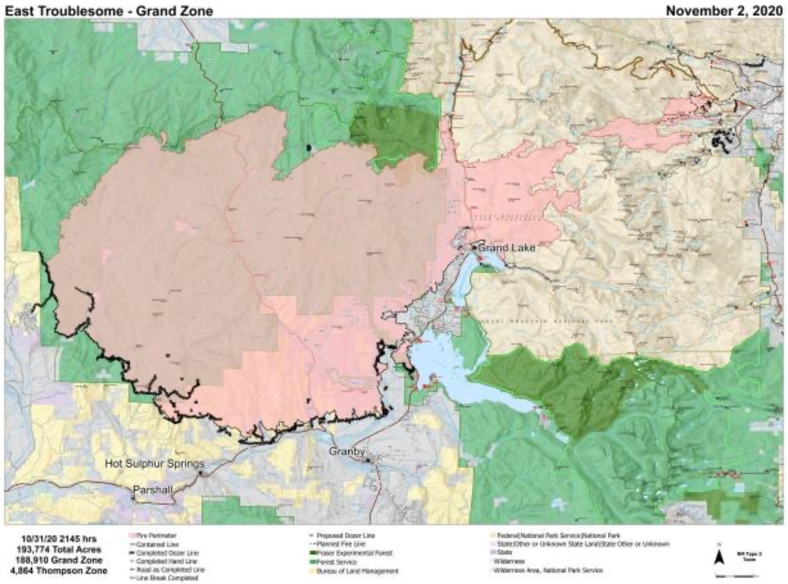
Concentrate: 22mg/L TOC, 115 NTU
Feed: 4mg/L TOC, 20 NTU

→ System sailed through test…

Wildfire Runoff Spike Tests – Why didn't it work?

- Clear Creek Watershed
  - ~350,000 acres
- Cameron Peak and East Troublesome Fires
  - ~200,000 acres
- Ash collected for pilot
  - ~10 ft^2

→ Runoff from a burn area concentrates the fine material from thousands of acres



Wildfire Runoff Spike Tests

- New plan: Compost and odorant. Turbidity, TOC, T&O.
- 500 lbs of composted manure
- 1 gal of liquid smoke

Feed > 100 NTU, 12 mg/L TOC

→ Filter UFRVs dropped to ~10,000… But filtrate turbidity and TOC remained ~average

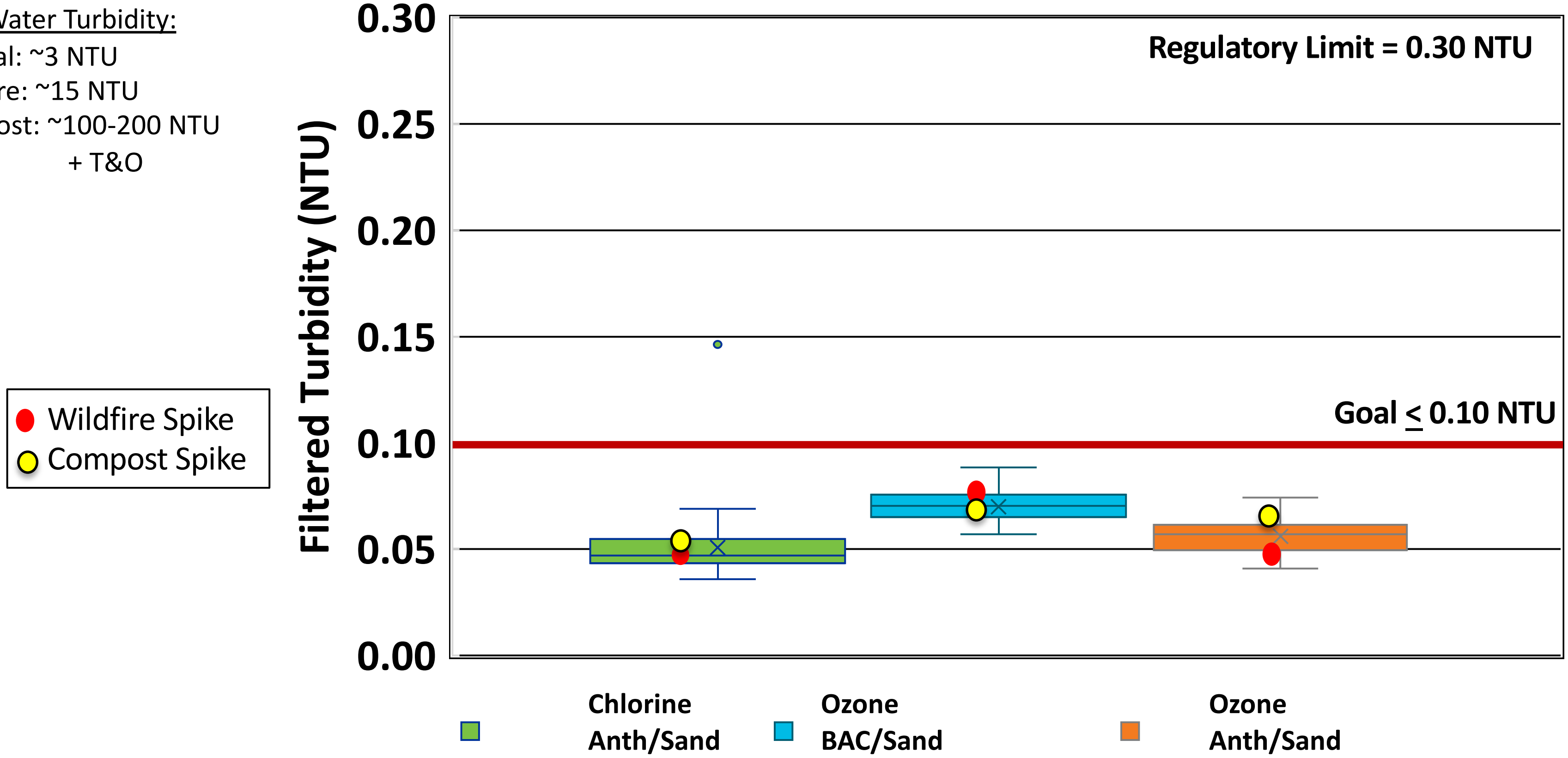
Pilot testing evaluated chlorine, ozone, and ozone-BAC for turbidity removal—All were effective

Raw Water Turbidity:

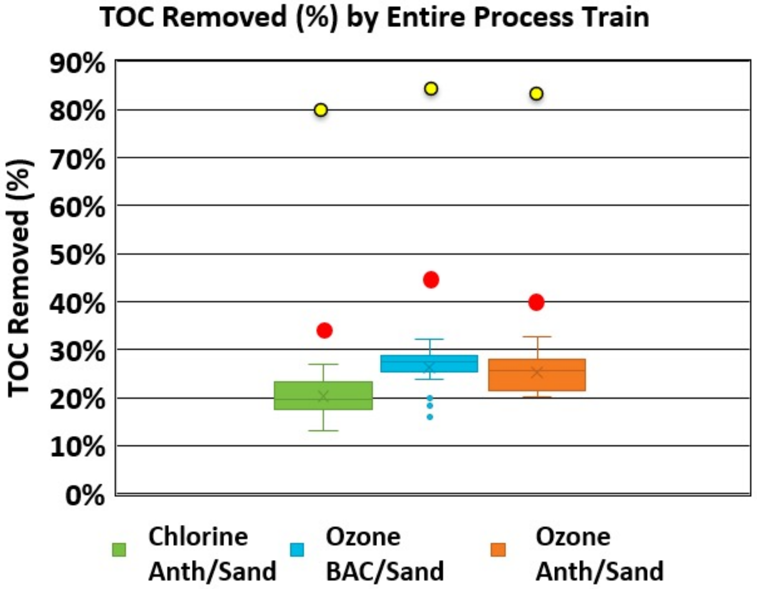
Normal: ~3 NTU

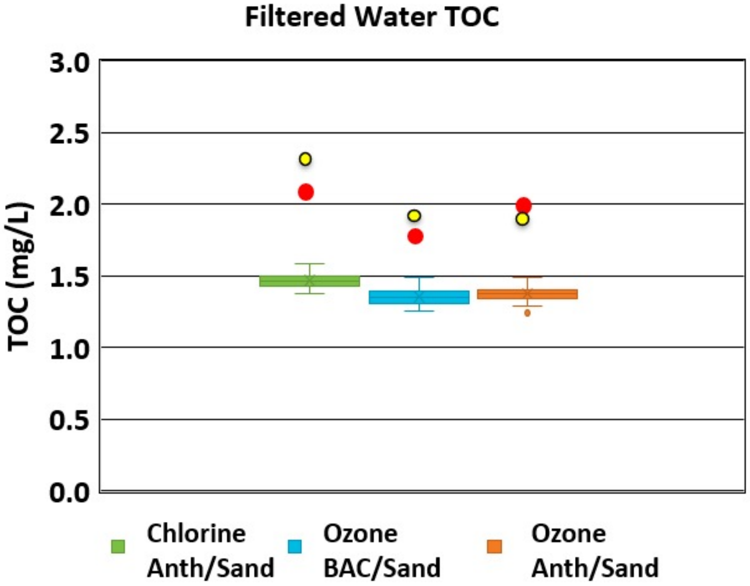
Wildfire: ~15 NTU

Compost: ~100-200 NTU
+ T&O



Impacts of chlorine, ozone, and ozone-BAC on TOC removal

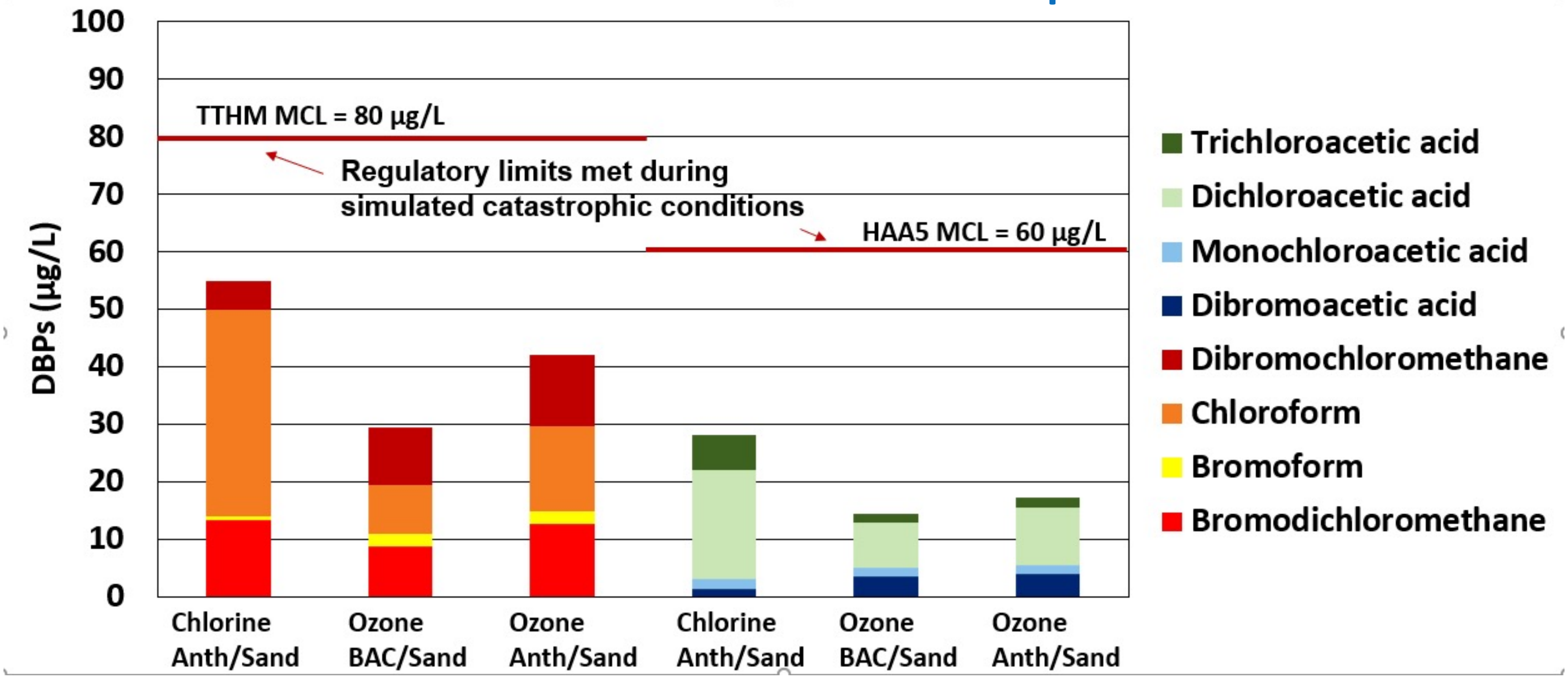




<u>Raw water TOC:</u>
Normal: 1.8-2.0 mg/L
Wildfire: ~3.4 mg/L
Compost: ~12 mg/L + T&O

● Wildfire Spike
○ Compost Spike

Impacts of chlorine, ozone, and ozone-BAC on SDS-DBPs for simulated wildfire spike



Taste and Odor Panel Screening on Simulated Wildfire Spike Test

FILTER 2

Cl_2-Anth/Sand

“Smells like an ashtray.”

“Intense smoke / VOC. Would definitely result in customer complaints.”

“Smoky residue, strong odor.”

FILTER 3

O_3-GAC/Sand

“Smells the cleanest. Light musty smell.”

“Very slight musty odor. Essentially non-detect.”

“No smell apparent, very clean.”

FILTER 4

O_3-Anth/Sand

“Slightly more musty smell. Not very strong.”

“Very low-level smoke or VOC odor. Detectable but not overwhelming at low temp.”

“Possible slight odor, hard to tell.”

Summary—Implications of Pilot Plant Results for Process Train Selection

Treatment Process	UFRV (>15k)	Turbidity (<0.1)	Mn (<0.015)	TOC Removal	T&O
Chlorine-Anth/Sand	=	+	+	=	-
Ozone-GAC/Sand	=	+	+	+	+
Ozone-Anth/Sand	+	+	+	+	=

- All pilot filters meet requirements at all tested loading rates.
- Ozone-Biofilters offer improved organics reduction and T&O removal.
- GAC offers slight improvement over anthracite for organics and T&O.

Summary—Implications of Pilot Plant Results for Process Train Selection

Filter	UFRV (>15k)	Turb (<0.1)	Mn (<0.015)	TOC Removal	T&O
F2 (Anthracite/Cl2)	Good	Best	Best	Good	Worst
F3 (GAC/O3)	Good	Good	Best	Best	Best
F4 (Anthracite/O3)	Best	Best	Best	Best	Good

- All tested filters meet requirements at all tested FSLRs.
- Ozone-Biofilters offer improved organics reduction and T&O removal.
- GAC offers slight improvement over anthracite for organics and T&O, but slightly worse UFRV and turbidity.

Summary—Preparing for Wildfire Runoff

1. Source Water quality protection measures (forest management, multiple raw water sources, early warning/bypass SOPs, storage)

2. Solids handling and residuals management can be the weak link – and a significant investment for catastrophic condition sizing

3. Taste and odor can be most difficult element to mitigate with conventional treatment approaches

4. Long term effects particularly concerning from increased nutrient loading => algal impacts

Questions?

Tim Rynders

rynderst@cdmsmith.com

CDM Smith