

Amherst , MA, Drinking Water System

Atkins Water Treatment Plant

- Planned by:
 - Ad Hoc Citizen's Advisory Committee, Amherst DPW and Consultant (Tighe & Bond, Inc)
- Water Source: Atkins Reservoir
- Design Flow: 1.5 million gallons per day
- On-line: February 1994
- Treatment:
 - Coagulation (addition of caustic soda and polymer)
 - Ozonation (2 locations; raw & filtered)
 - Trident upflow clarification
 - Filtration
 - Disinfection

David Reckhow For more on the plant see paper by [Dumais et al.](#) 1

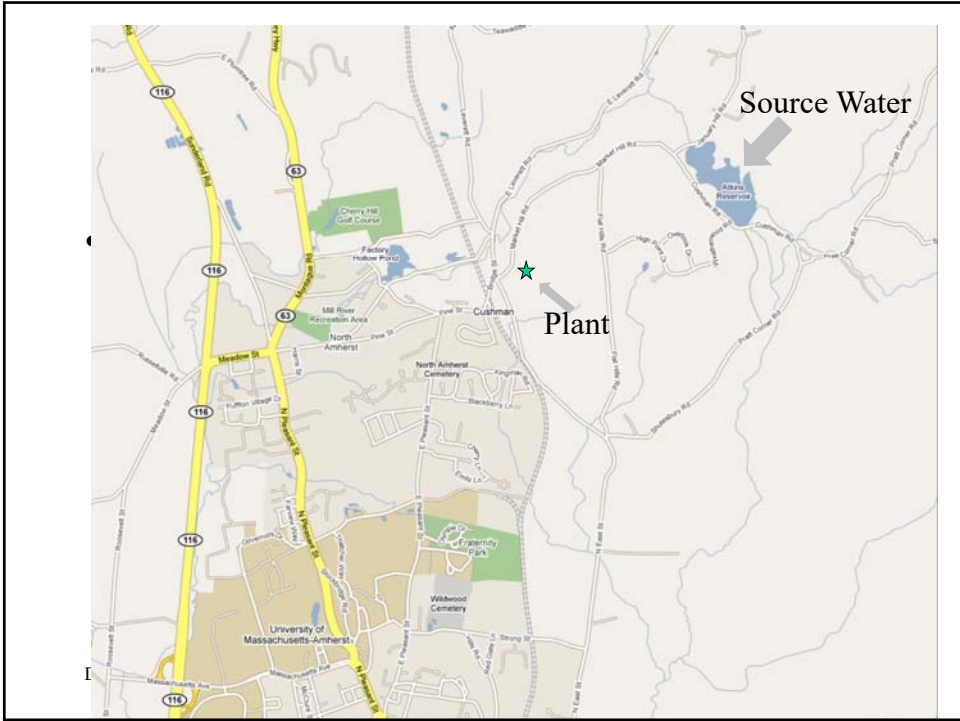
Directions to Atkins WTP

- 31 Market Hill Road, Amherst, MA
- see following maps and directions
 - Take N or E. Pleasant up to Pine St.
 - Right on Pine
 - Left on Bridge
 - Right on Market Hill Road
 - Right to Atkins WTP Parking lot

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2



Close-up of driveway

- To



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4

Overall View



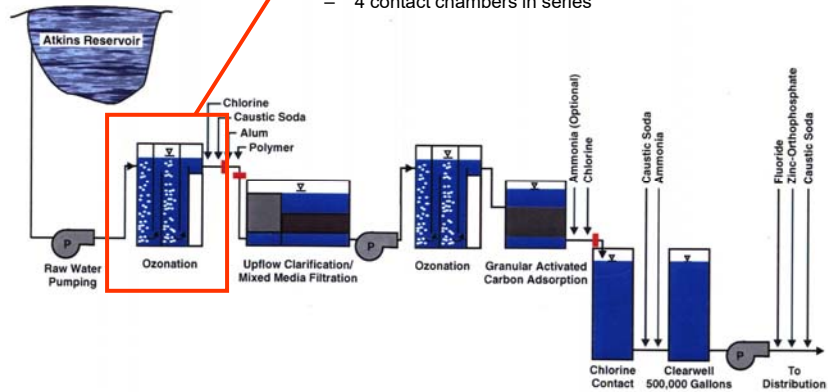
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Atkins Reservoir Water Treatment Plant Process Flowchart

- Pre-Trident Ozonation
 - control of taste and odor, color removal
 - Disinfection (CT credits achieved)
 - 2.5 mg/L ozone added
 - 4 contact chambers in series



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Ozonation

2 Generators

With Air preparation system



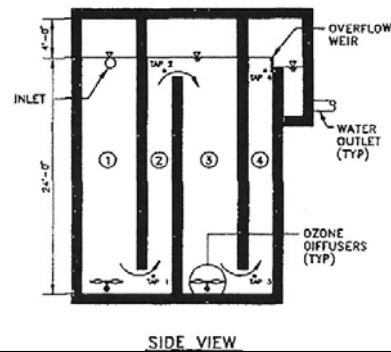
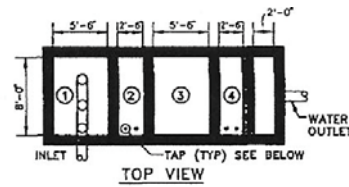
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Amherst Ozone Contactors

- Pre and Post contactors are identical
- Four chambers
 - Under/over baffled

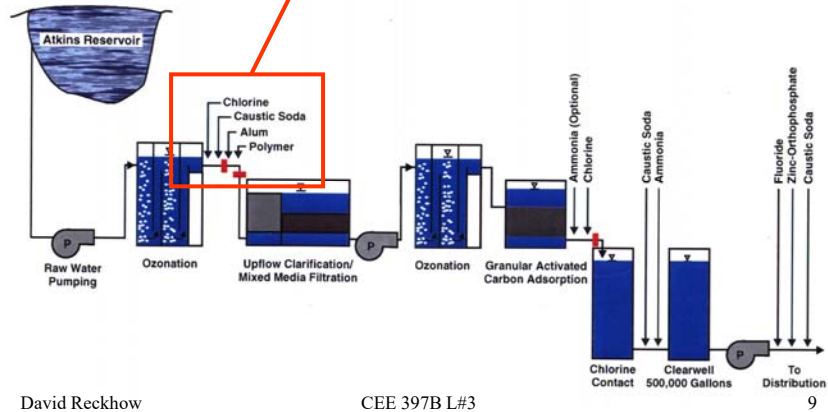


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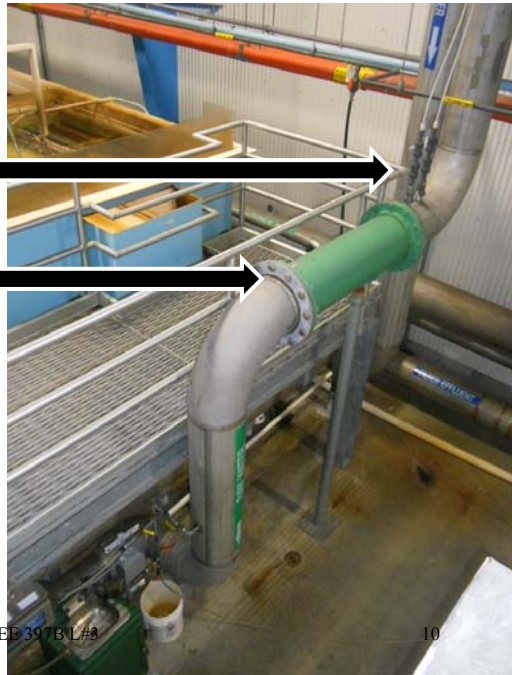
Atkins Reservoir Water Treatment Plant Process Flowchart

- Pre-Trident Chemical Addition
 - coagulant addition (alum and cationic polymer)
 - pH adjustment for optimization of Coagulation



Rapid Mixing

- Chemical injection point
- Static Mixer
 - Internal vanes that cause turbulent mixing



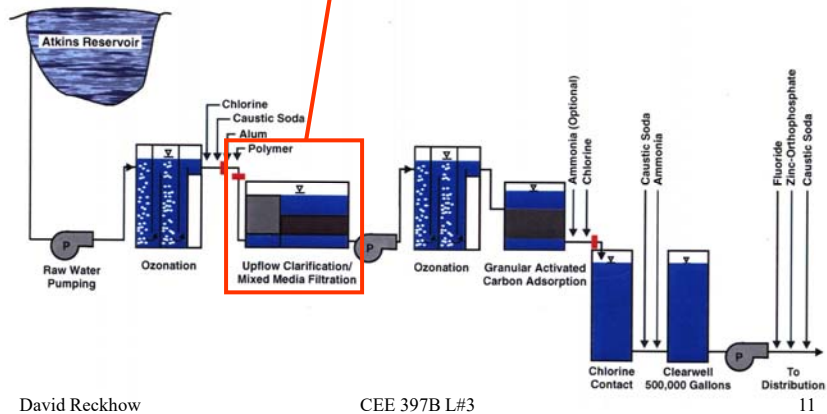
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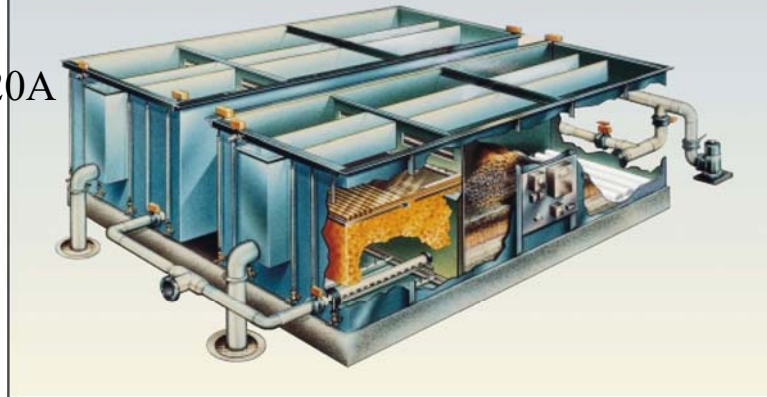
Atkins Reservoir Water Treatment Plant Process Flowchart

- Trident Filtration Process
 - 3 factory fabricated steel tanks, 0.75 MGD each
 - buoyant plastic media in upflow clarifier
 - conventional media filtration (anthracite coal and sand)



Trident Clarification/Filtration Unit

- TR 420A



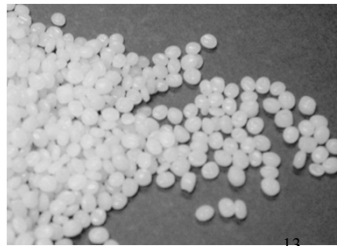
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MODEL	TR-105A	TR-210A	TR-420A	TR-840A	TR-105-1P	TR-210-1P	TR-420-1P	TR-840-1P	
Typical Design Flow	GPM*	350	700	1400	2800	350	700	1400	2800
Dimensions (each tank)	Length	10' 1"	14' 5 1/2"	27' 10"	39' 10"	9' 1"	12' 11 1/2"	24' 9"	35' 6"
	Width	6' 11"	8' 11"	8' 11"	11' 11"	6' 11"	8' 11"	8' 11"	11' 11"
	Height	8' 5"	8' 5"	8' 5"	10' 1"	7' 6"	7' 6"	7' 6"	8' 6"

* Design flow is for a two-tank system. Being modified allows us to provide a (1 1/2) TR-210A to treat 1050 gpm with 3 tanks, or a (2) TR-840A for 5,600 gpm, etc.

Adsorption Clarifier Media

- AC Media Technical Details:
 - Buoyant Media
 - Specific gravity slightly < 1.0
 - Allows for complete fluidization
 - Effective size ~ 2.5 mm
 - Rolled and scarified media
 - Lasts for life of plant
 - No maintenance required

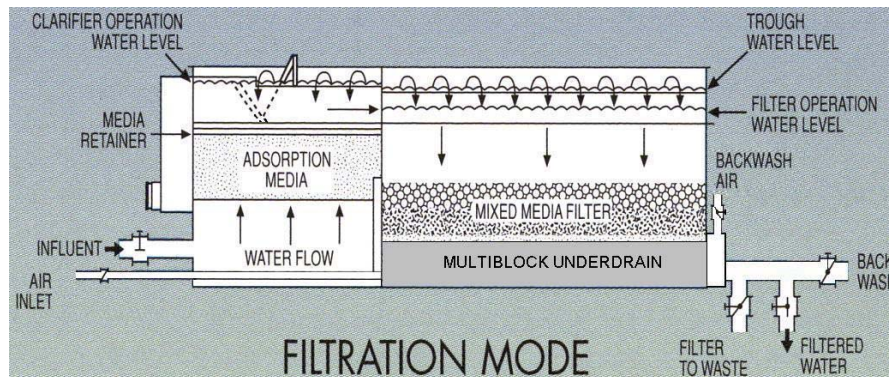


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13

Operation: Filtration

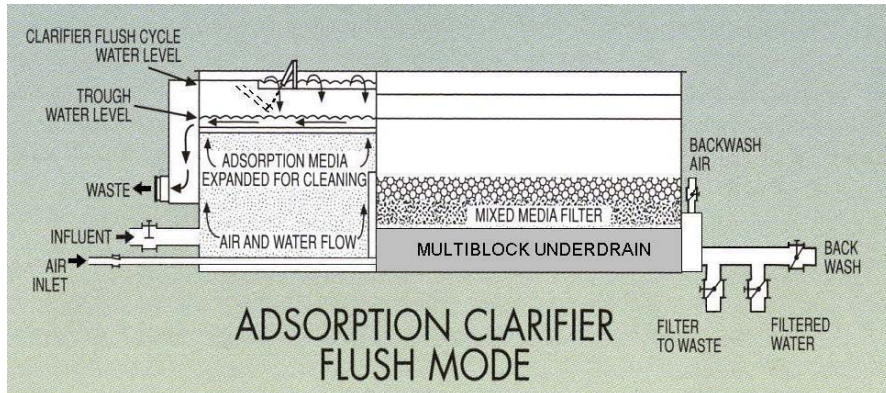


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14

Operation: Clarifier Flush



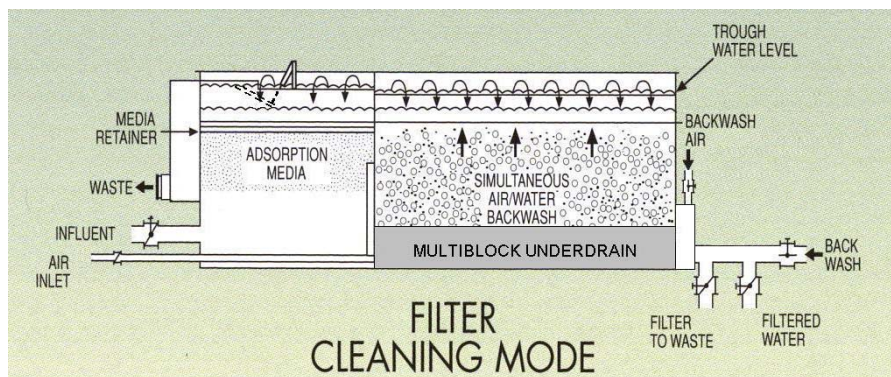
- AC typically cleans 2 to 4 times per every filter backwash

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Operation: Filter Backwash



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16

Clarification & Filtration

Normal Operation

Backflush



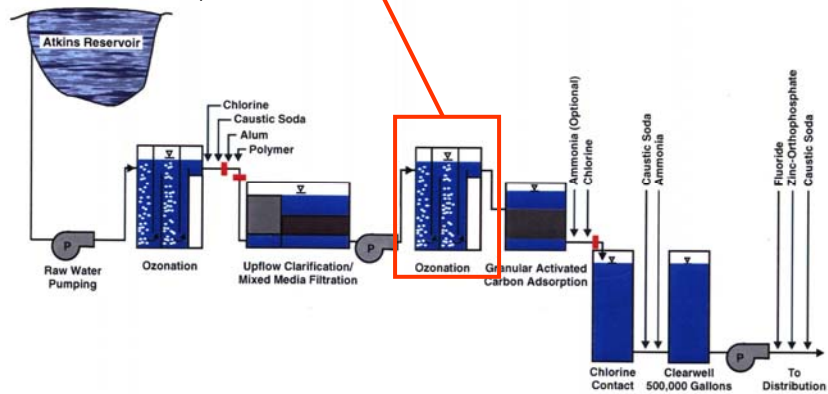
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17

Atkins Reservoir Water Treatment Plant Process Flowchart

- Post-Trident Ozonation
 - redundancy for pre-Trident ozonation
 - removal of dissolved organic carbon
 - 1.5 mg/L ozone added
 - Identical to pre-ozone contactor



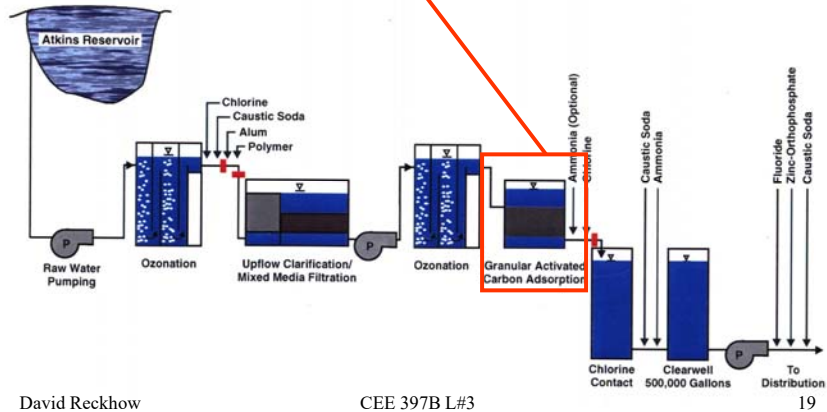
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Atkins Reservoir Water Treatment Plant Process Flowchart

- Granular Activated Carbon (GAC) Adsorption
 - reduced taste and odor, chlorination byproduct precursors
 - improved removal of DOC
 - reduced chlorine demand, potential for bacterial regrowth



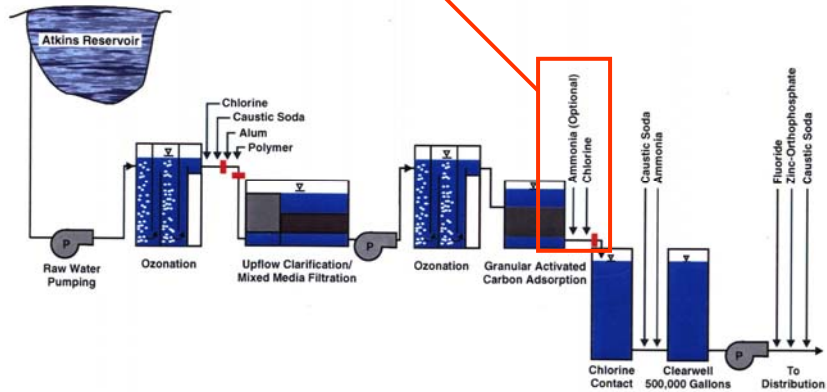
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Atkins Reservoir Water Treatment Plant Process Flowchart

- Chlorine / Ammonia Addition
 - Dose necessary to keep residuals in system
 - ammonia is optional (chloramines)



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Chlorination

Chlorine Storage

- pressurized tanks of Cl_2



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Chlorine Contact Tank

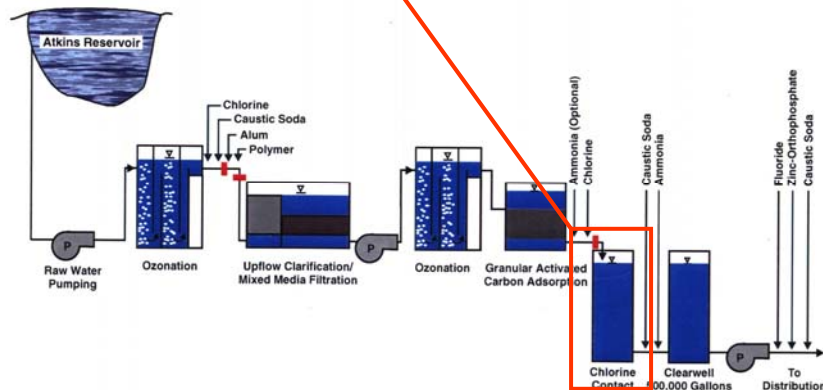
- Tank below floor



21

Atkins Reservoir Water Treatment Plant Process Flowchart

- Chlorine Contact Tank
 - 22.5 ft depth, L/W ratio = 14
 - with 5 redwood perforated baffles
 - Backup for disinfection (CT requirement)



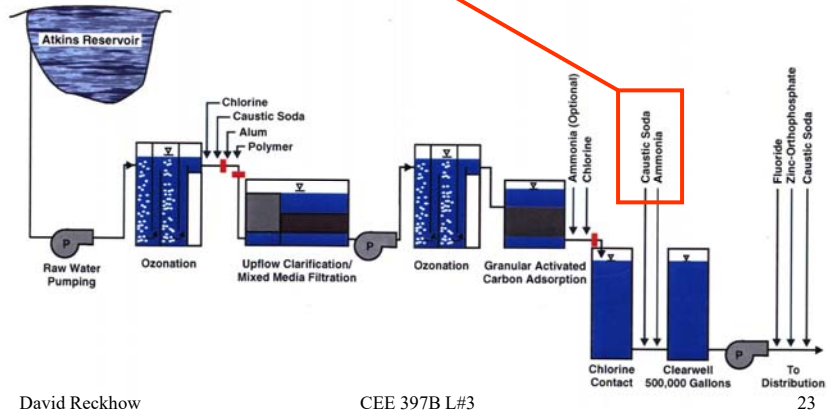
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Atkins Reservoir Water Treatment Plant Process Flowchart

- Caustic Soda Addition (raise pH)
 - corrosion control in distribution system
- Ammonia Addition (convert chlorine to chloramines)
 - control of trihalomethanes, other disinfectant residuals



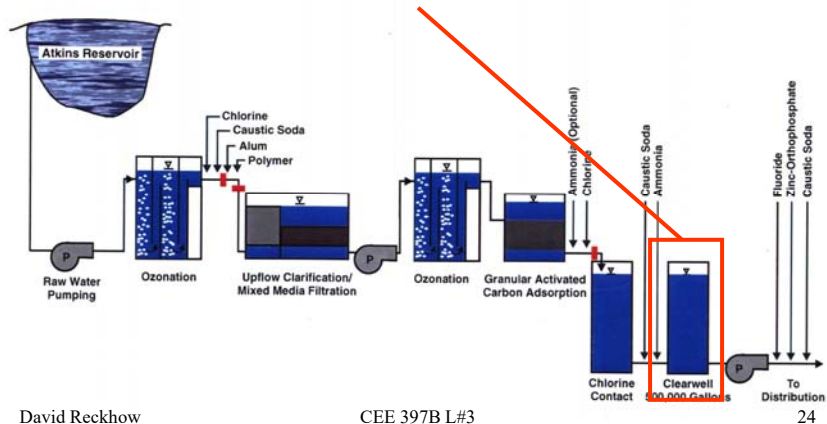
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Atkins Reservoir Water Treatment Plant Process Flowchart

- Clearwell Storage Tanks
 - additional disinfectant contact time
 - flow equalization and backwash control
 - 2 tanks with 250,000 gallon capacity each



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Support Equipment

Chemical Storage

- Polymer, alum, fluoride, etc.

High Lift Pumps

- Sending water on to the distribution system



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25

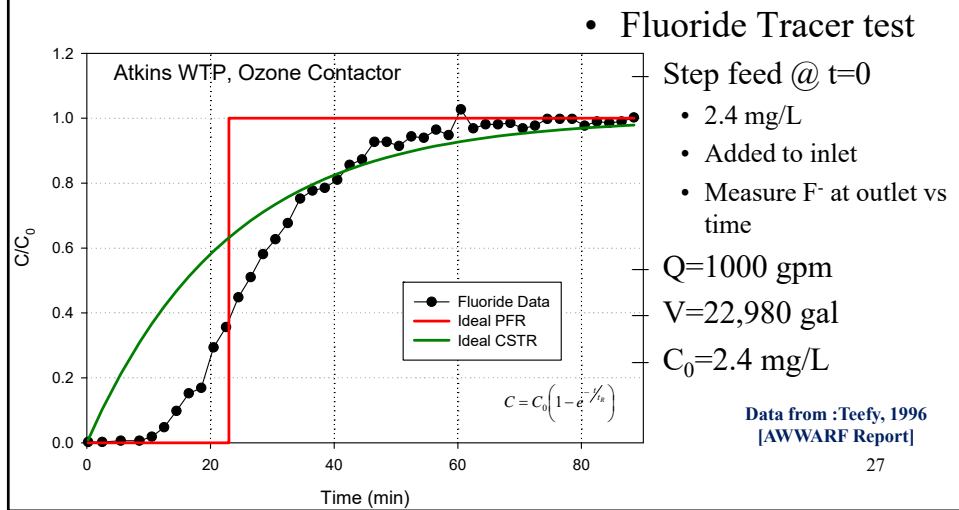
The End

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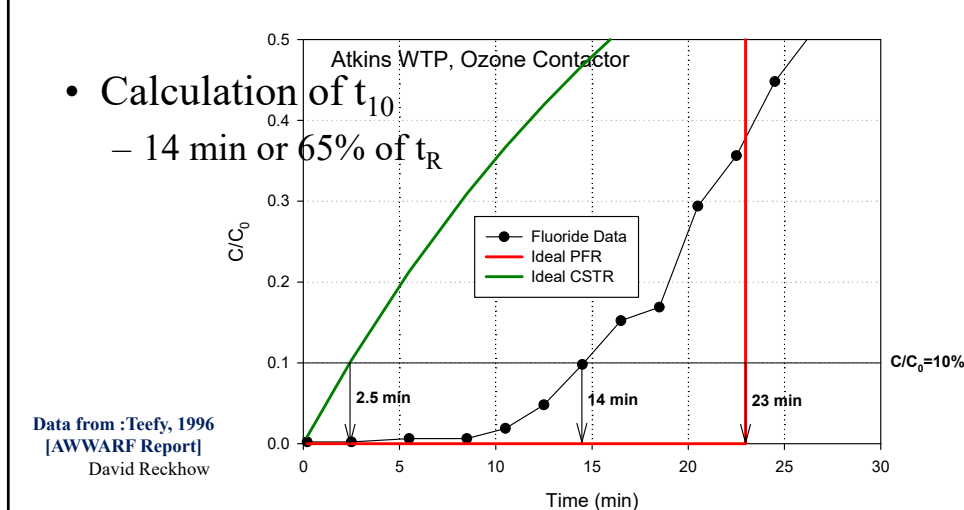
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26

Amherst O₃ Contactor II



Amherst O₃ Contactor III



Ct values for Viruses

- For Viruses at various temperatures
 - pH 6-9

H&H Table 7-5, pg 245

	LOG INACTIVATION	WATER TEMPERATURE				
		0.5°C [(mg/l) · min]	5°C [(mg/l) · min]	10°C [(mg/l) · min]	15°C [(mg/l) · min]	20°C [(mg/l) · min]
Free chlorine	2.0	6	4	3	2	1
	3.0	9	6	4	3	2
	4.0	12	8	6	4	3
Preformed chloramine	2.0	1200	860	640	430	320
	3.0	2100	1400	1100	710	530
Chlorine dioxide	2.0	8.4	5.6	4.2	2.8	2.1
	3.0	25.6	17.1	12.8	8.6	6.4
Ozone	2.0	0.9	0.6	0.5	0.3	0.2
	3.0	1.4	0.9	0.8	0.5	0.4

Source: Adapted from *Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources*. U.S. Environmental Protection Agency.

Amherst O₃ Contactor IV

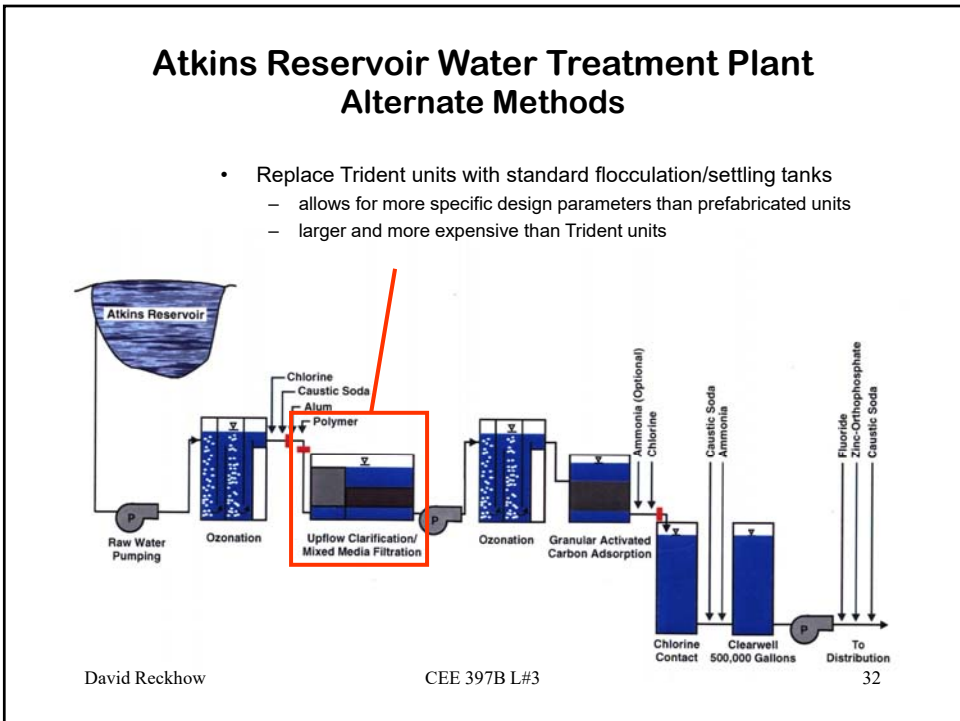
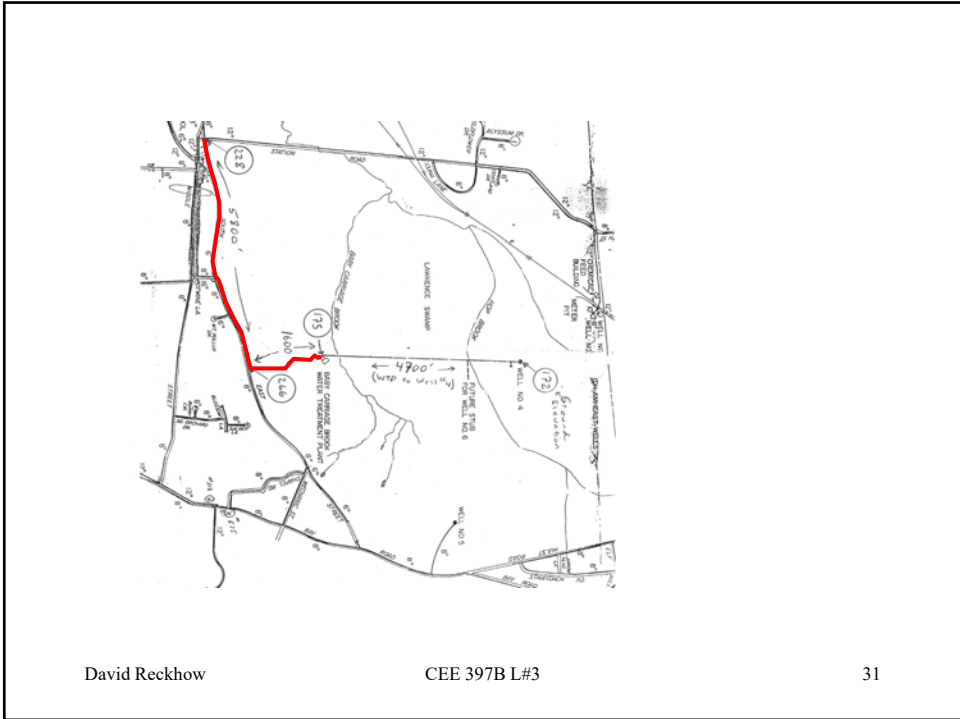
- Use of t_{10} for disinfection compliance
 - Conventional treatment requires 2 log virus inactivation by disinfection
 - For ozone 0.9 mg/L – min is worst case (0.5°C, in H&H table 7-5)
 - With a if $t_{10} = 14$ min, then we need to have 0.065 mg/L ozone residual at outlet of tank

$$C_{\min} = \frac{(Ct)_{\text{required}}}{t_{10}} = \frac{0.9 \frac{\text{mg}}{\text{L}} \text{ min}}{14 \text{ min}} = 0.065 \frac{\text{mg}}{\text{L}}$$

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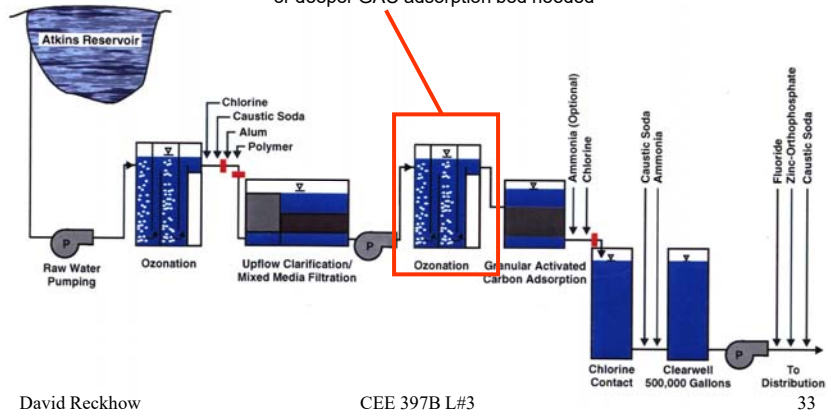
30

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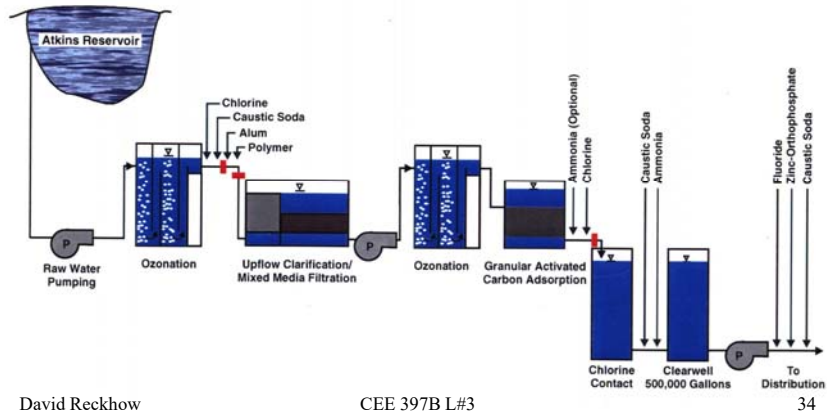


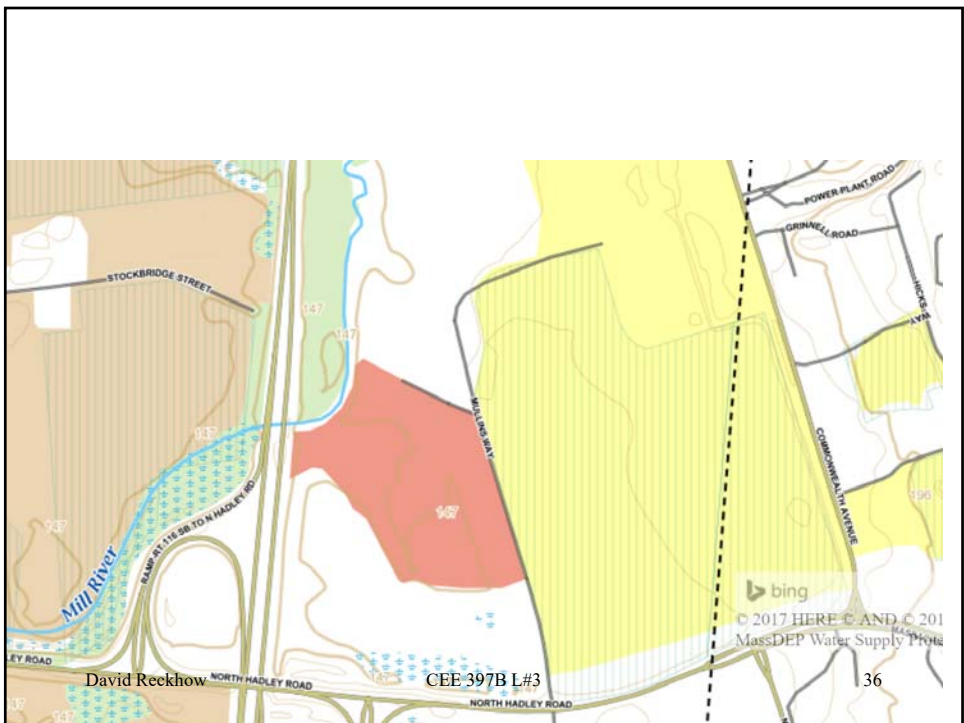
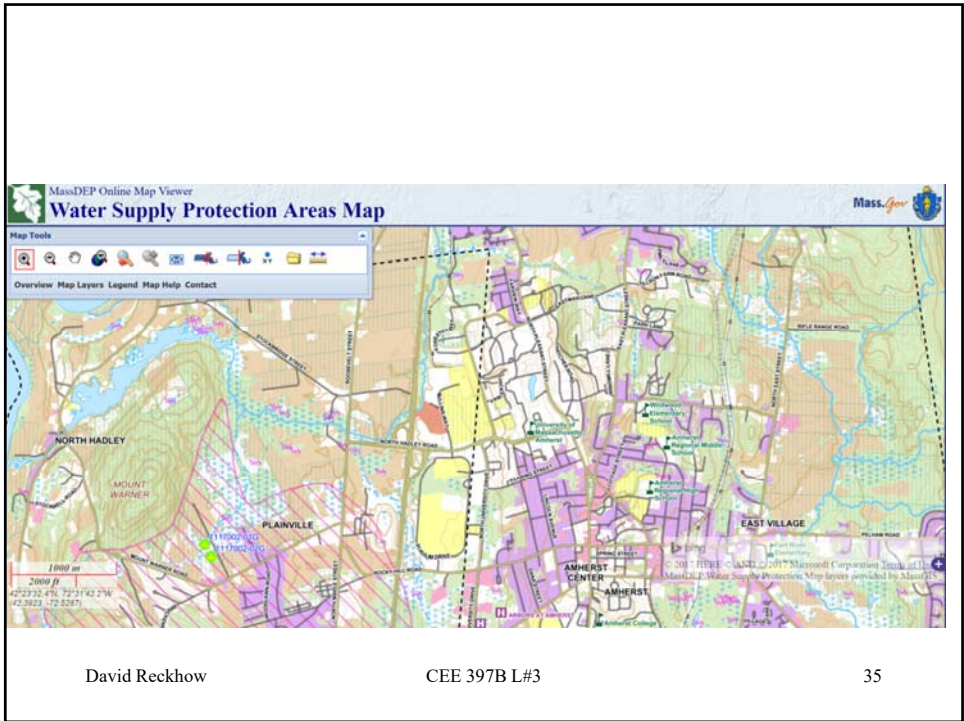
Atkins Reservoir Water Treatment Plant Alternate Methods

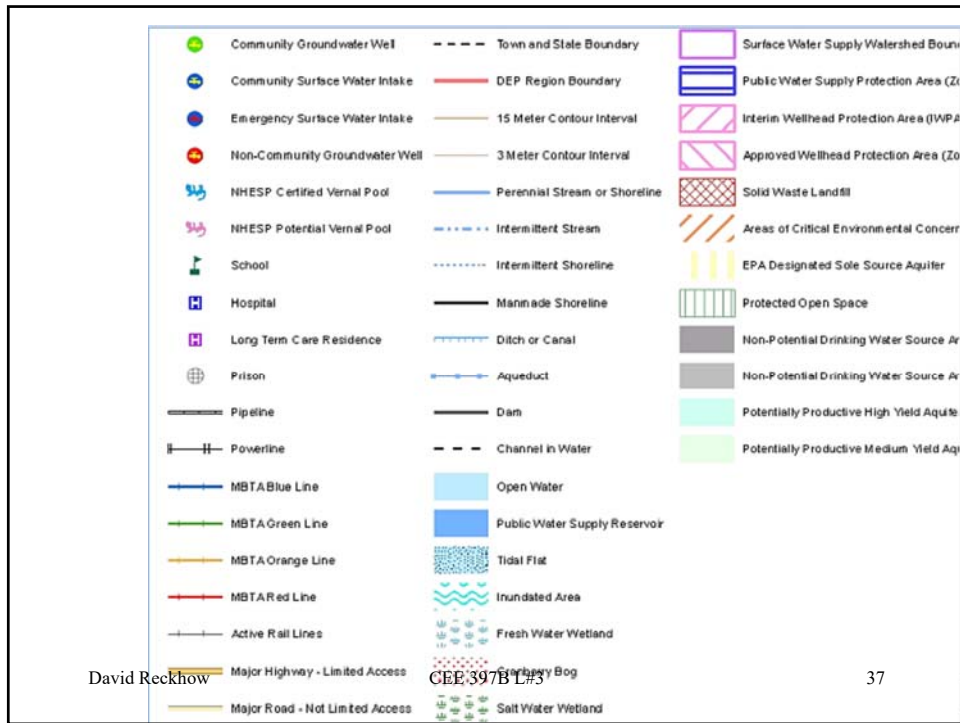
- Eliminate post-Trident ozonation
 - GAC adsorption can remove organic carbon, taste, odor
 - GAC adsorption may not be as efficient without ozonation
 - more CT needed (larger tanks or higher concentration of chlorine) or deeper GAC adsorption bed needed



Atkins Reservoir Water Treatment Plant overall







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37