CHAUTAUQUA COUNTY HEALTH DEPARTMENT

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Fredonia's Water Supply: Understanding the Source & Treatment

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Chautauqua County Health Department

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CHAUTAUQUA COUNTY HEALTH DEPARTMENT

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Shared Interest in Community Health

Prevent Contamination & Illness

- Provide guidance to ensure operators and officials understand the regulations for their facilities.
- Verify that monitoring samples are submitted and that public water supplies are maintained and operated in accordance with health and safety regulations.

Promote Reliable Infrastructure and Community Awareness

- Encourage communities to prepare for their average daily needs and for emergencies.
- Improve capacity for economic growth.
- Encourage a better understanding of public health systems.

Protect Public Health

- Ensure a safe and reliable water supply is available.

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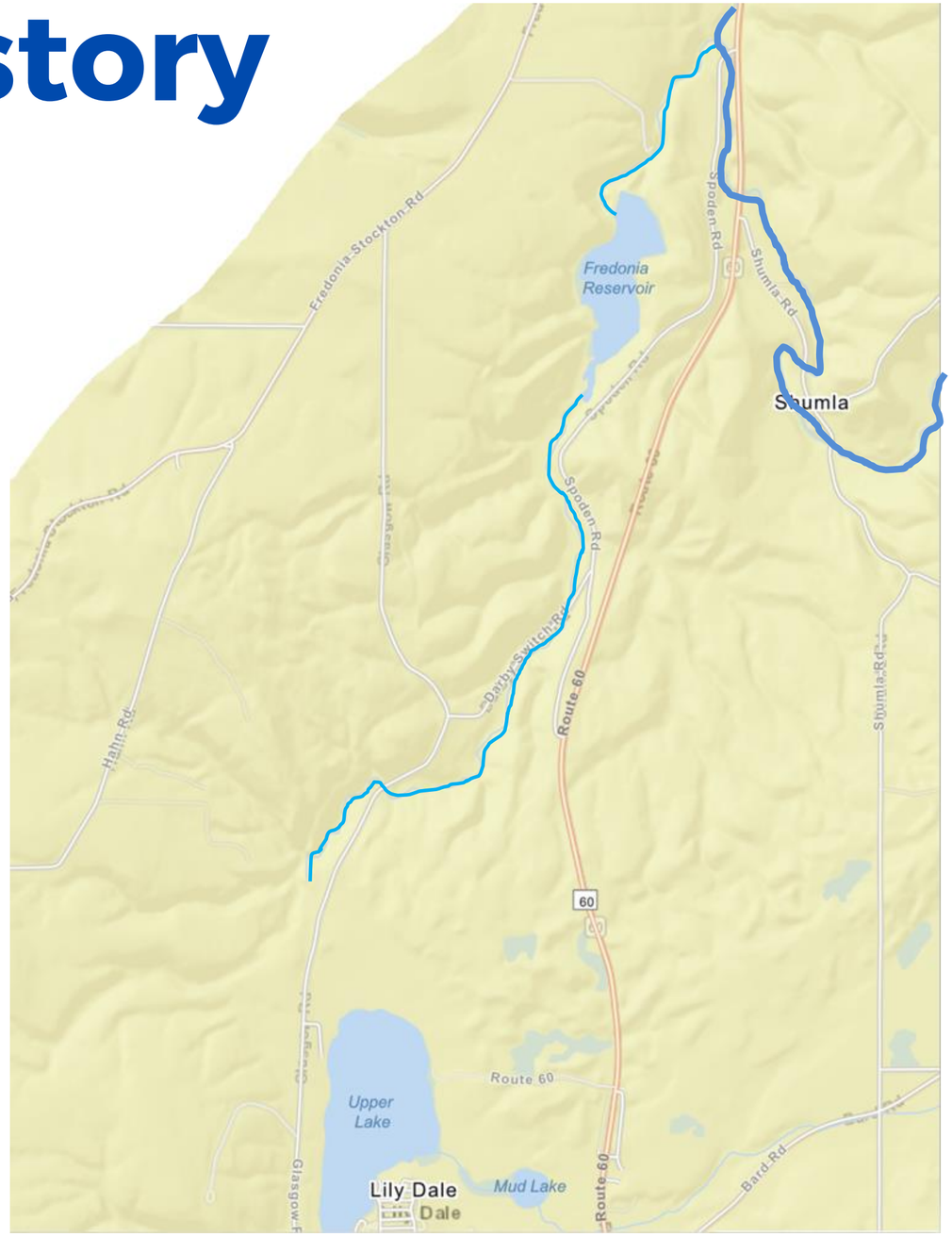
Fredonia Reservoir History

Not a naturally occurring water body.

1884 - Small reservoir (10 Million Gallons) created by damming an upper branch of Canadaway Creek.

1938 – Dam and spillway built to increase reservoir volume (332 MG) to supply growing Village.



Fredonia Reservoir Water Sources

0% from groundwater / springs feeding the reservoir directly.

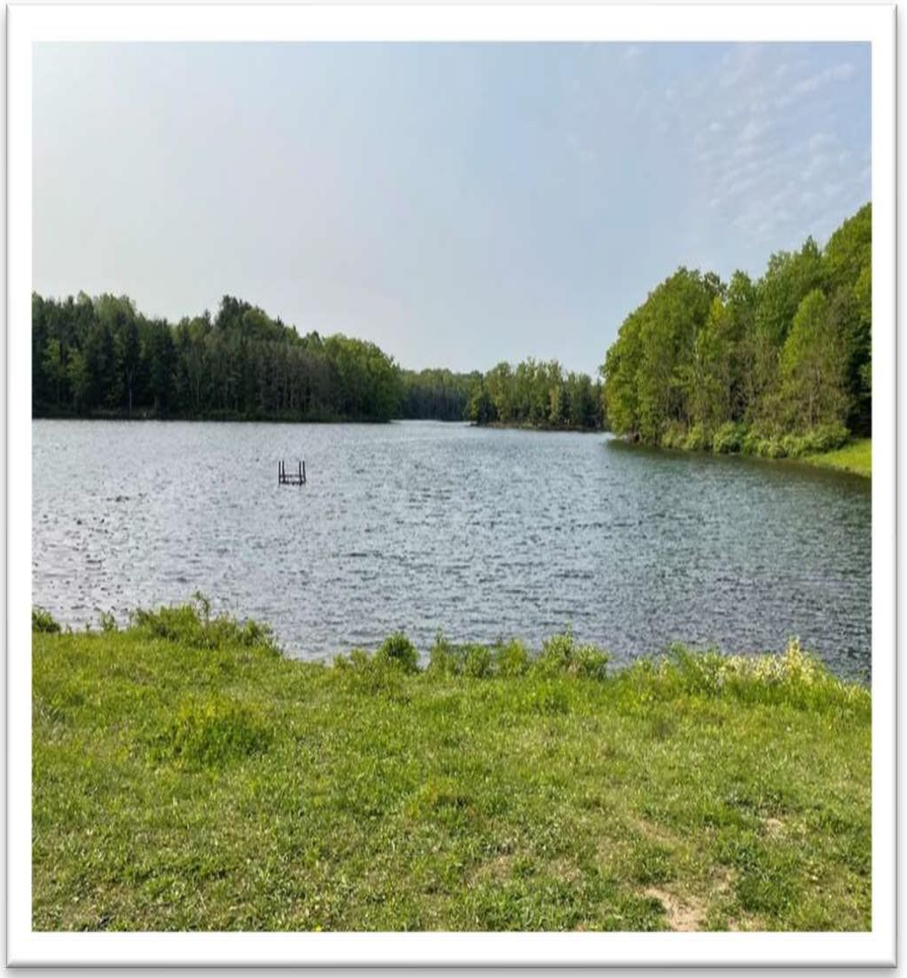
1% from rain / snow that falls directly on the reservoir.

99%

from watershed runoff.

***A watershed is the area of land that drains into a body of water. ***

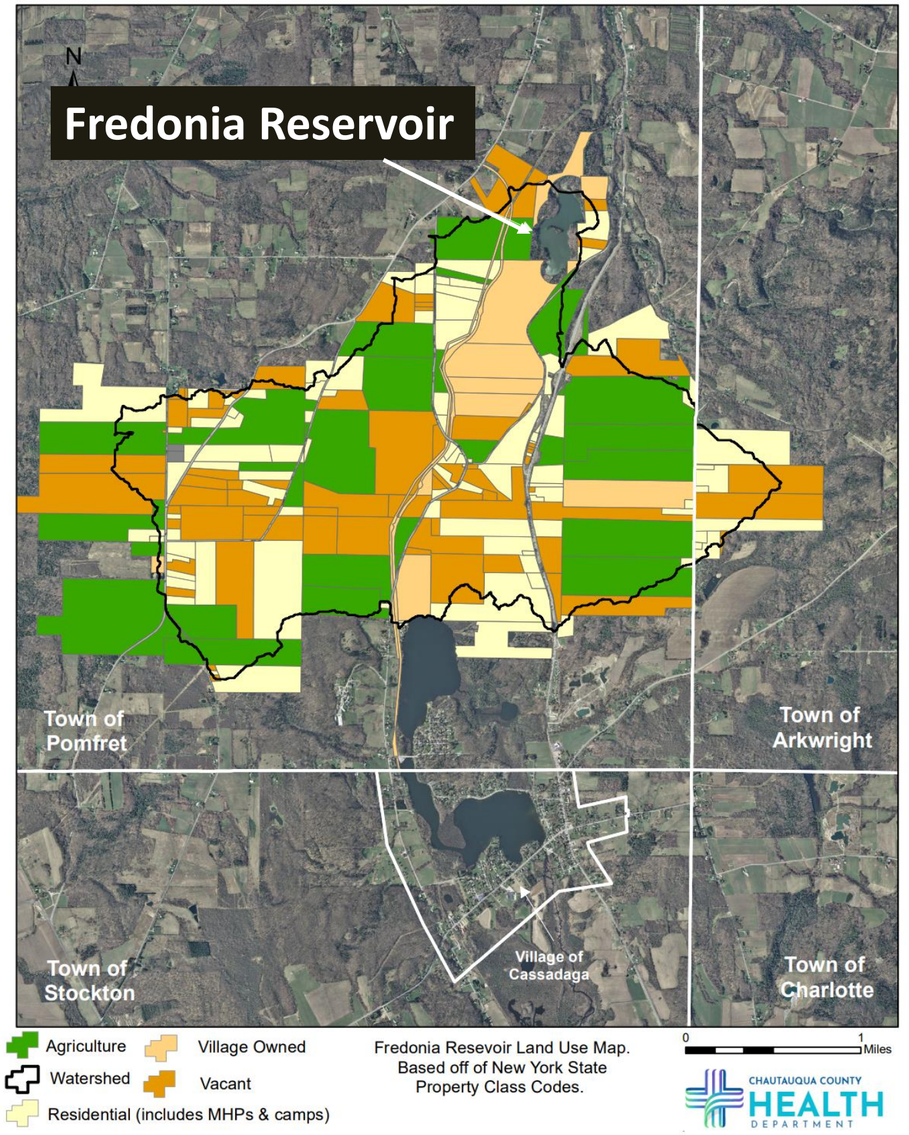
(*2008 report from Dr. Mike Wilson SUNY Fredonia Geology*)



Reservoir Watershed & Runoff

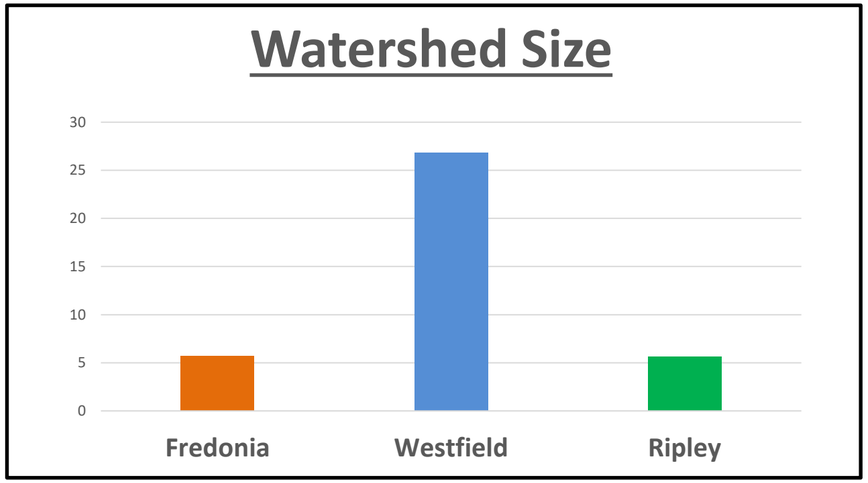
Forest / Vacant (81.5%)	Plant debris Sediment runoff from erosion
Agricultural (13.1%)	Plant debris Sediment runoff from erosion Fertilizer / pesticide / manure / pathogens
Residential/ Commercial (3%) *includes Campgrounds & Mobile Home Parks	Onsite Wastewater Treatment Systems / Septic Systems (22 permitted systems, #? unknown) Residential runoff (pesticide, fertilizer, heavy metals)
Roadways	Road salt Vehicle fluids (leaky vehicles & accidents) Potential Hazmat accidents

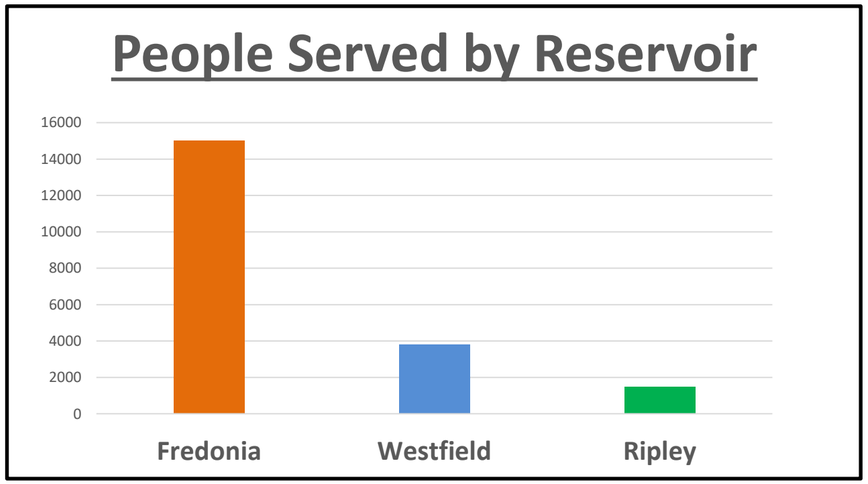
(Percentages based on NYSDEC Lake Classification and Inventory study 2016)



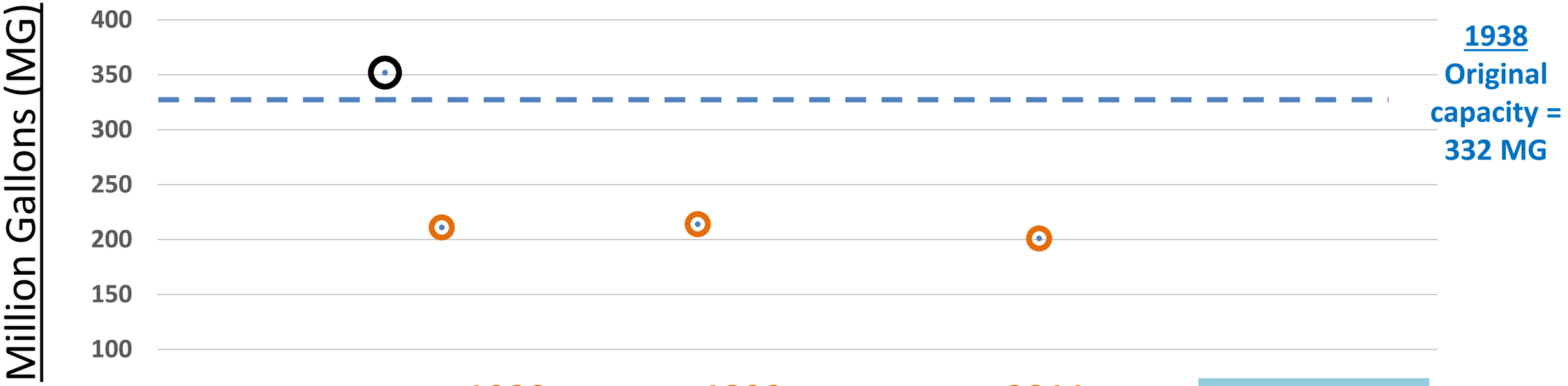
Comparing Reservoir Watershed Sizes

Fredonia	**5.7 sq miles**	**15,000 people** *(maximum when SUNY Fredonia is in session)*
Westfield	**26.8 sq miles**	**3,800 people**
Ripley	**5.6 sq miles**	**1,500 people**





Fredonia Reservoir Capacity



1988
Potential capacity = 352 MG
(spillway was raised to increase total volume)

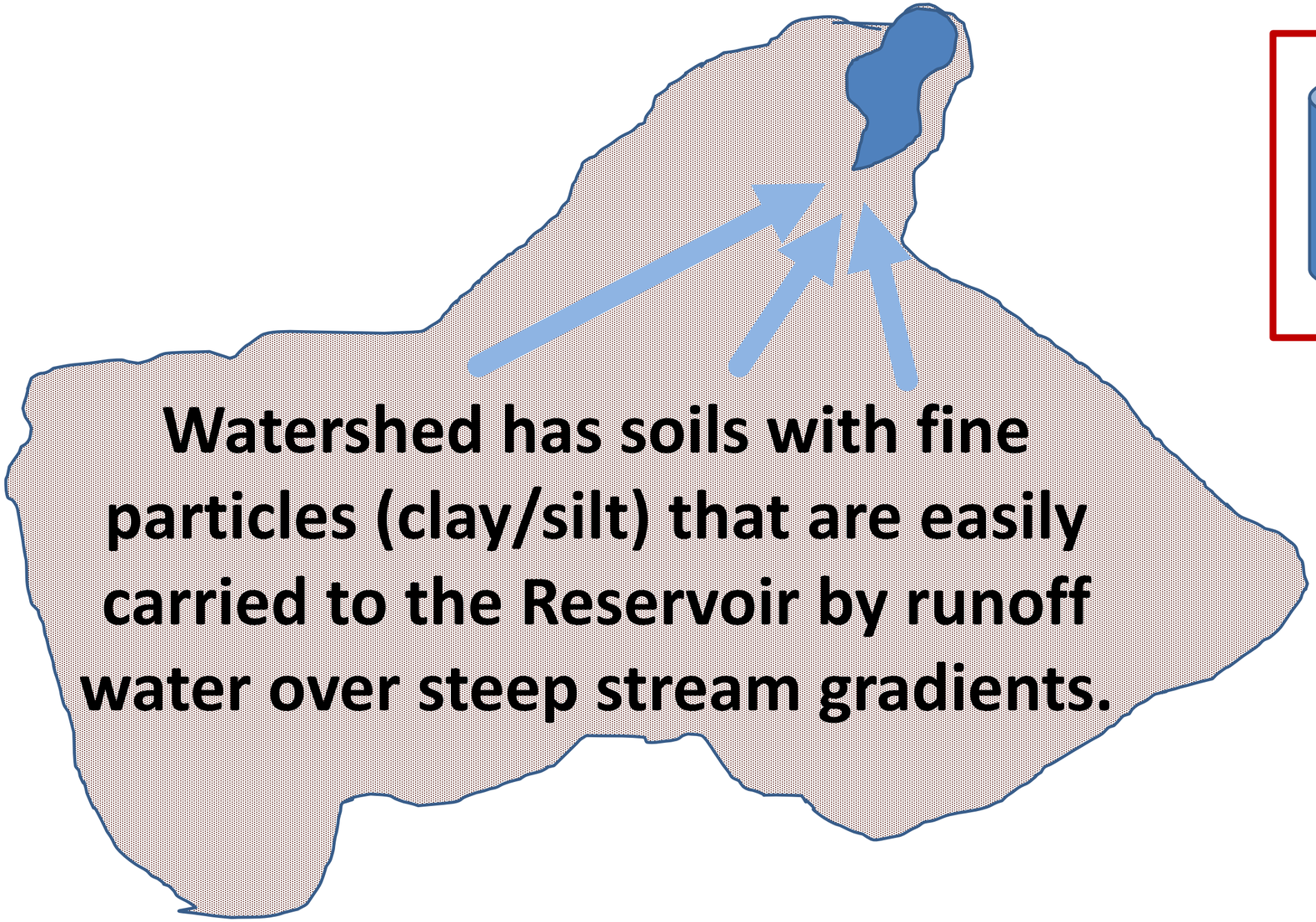
1990
Usable water = 211 MG
(Pieczonka Engineering)

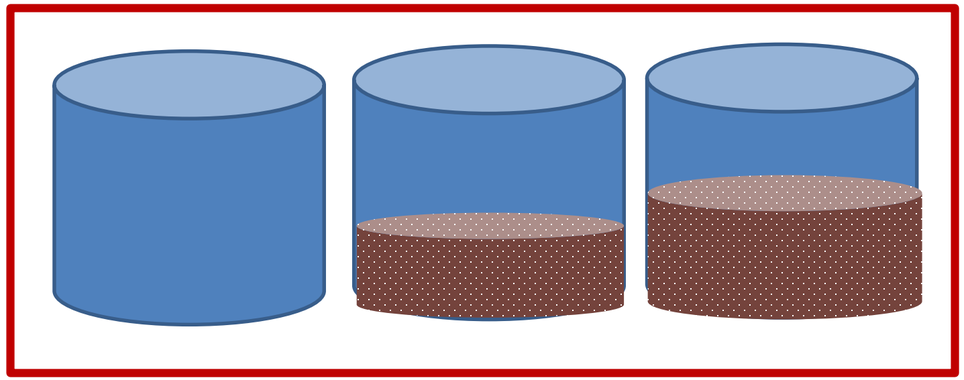
1999
Usable water = 214 MG
(Harza Engineering)

2011
Usable water = 201 MG
(O'Brien & Gere Engineering)

2024
Usable Water = ??? MG

Sedimentation in the Reservoir

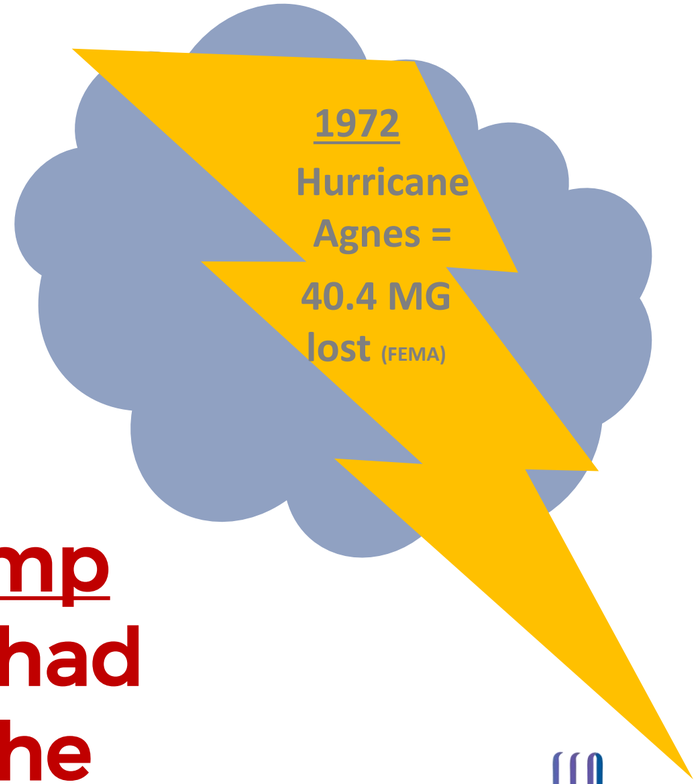




The reservoir water is calm so fine particles settle out of the water and “fill in” the reservoir.

Dredging: Important Now & in Future

- Dredging maintains the volume of usable water in the reservoir.
- Dredging reduces the amount of sediment that can cause turbidity problems at water treatment plant.
- Extreme weather events increase amount of sediment flowing into reservoir.



2011 O'Brien and Gere estimated

43% of original usable reservoir volume was lost due to sedimentation.

=

Roughly 50,000 dump trucks (15 yd³) of soil had been washed into the reservoir.

Fredonia Reservoir Dredging History

Plans to dredge were in place in 1965, 1972, 1999, & 2001.

2001 - Basic Karpinski engineering report included plans and permit applications to dredge *once per year (1/yr) for 10 years to return reservoir capacity* as part of NYSDEC required maintenance.

Despite plans and permits approved by NYSDEC, the Reservoir has never been dredged.

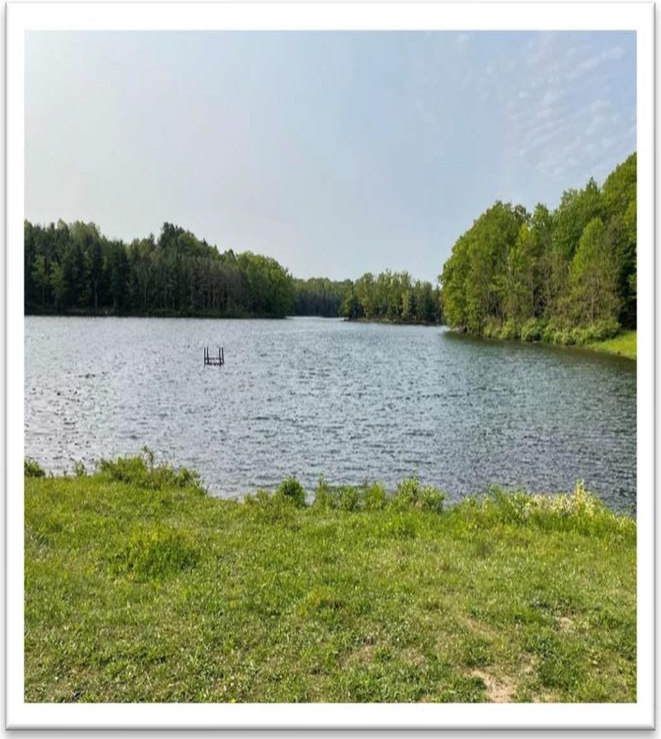
Fredonia Reservoir Water Levels

Reservoir Receives Water

- Rain/snow in watershed runs off to Reservoir.
- Rain/snow falls directly on Reservoir surface.

Usable Reservoir Water Reduced

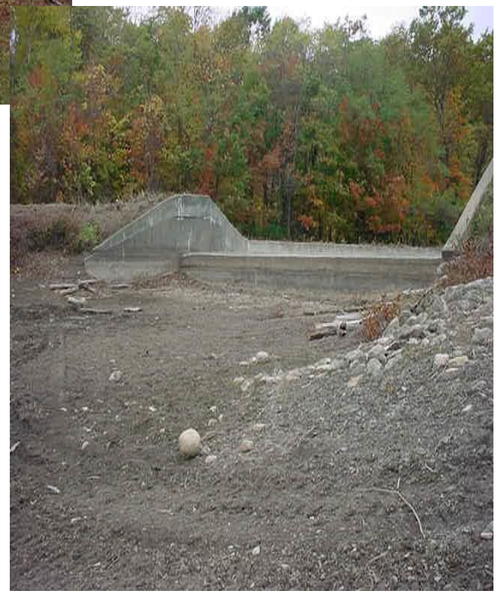
- Fredonia Water Treatment Plant constantly pulls water to keep up with customer demand.
- Water evaporates from Reservoir surface.



Part 5 NYS Sanitary Code Appendix 5-A section 3.1.1.1:

"The quantity of the source water shall be adequate to meet the maximum projected water demand based on a 1 in 50 year drought or extreme drought of record."

Reservoir Drought History



1991 - Reservoir depleted by 95%

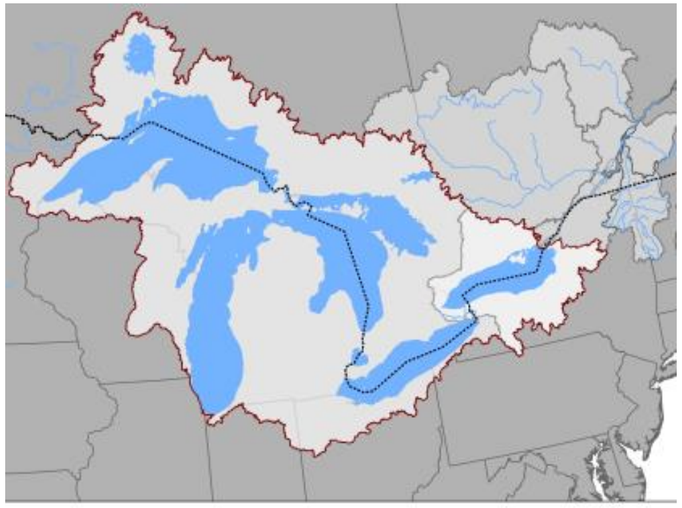
1998 / 1999 – Reservoir depleted by 78%

2007 – Reservoir depleted by 60%

Reservoir Drought Concerns

1991 & 1998 / 1999 – NYSDEC granted emergency permit to pull water from Cassadaga Lakes.

- As part of NYSDEC's 1998 / 1999 emergency permit, Village was mandated to develop a permanent alternative source (*to supplement as needed*).
- Fredonia Reservoir and Cassadaga Lakes are not in the same water system. Future use permits are not guaranteed.



Great Lakes / St. Lawrence Watershed

Changing Weather Patterns & Extreme Weather

Average snowfall = 70 inches / year (since beginning of record)

- 2022 - 2023 snowfall = 55 inches
- 2023 - 2024 snowfall = 24 inches

Reservoir Dam & Spillway

New York State Department Environmental Conservation (NYSDEC) regulates wetlands, water channels, and water bodies.

Class “C” or “High Hazard” Dam (https://extapps.dec.ny.gov/docs/water_pdf/togs315.pdf)

“A dam failure may result in widespread or serious damage to home(s); damage to main highways, industrial or commercial buildings, railroads, and/or important utilities, including water supply, sewage treatment, fuel, power, cable or telephone infrastructure; or substantial environmental damage; such that the loss of human life or widespread substantial economic loss is likely.”

Reservoir has an Earthen Dam

Built by compacting layers of earth/soil. Soils that don’t hold water, or let water move through easily, form the core of the dam. Soils that allow water to seep in/out easily were used on the upstream and downstream sides of the dam.

Reservoir Dam & Spillway

1980 – Dam inspected by NYSDEC - Deemed "Unsafe, Non-emergency"

Spillway inspected by NYSDEC – Deemed "seriously inadequate"

(https://apps.dtic.mil/sti/tr/pdf/ADA090940.pdf)

2017 - Dam inspected by NYSDEC – Deemed "Unsound – Fair"

(https://wwe1.osc.state.ny.us/localgov/dams/damsalldata.cfm)

2023 – Dam inspected by NYSDEC – Deemed "Unsound – Fair"

- "Condition rating… due to its lack of spillway capacity and inadequate structural stability."
- "… deficiencies … are of such a nature that the safety of the dam cannot be assured."
- "… the dam is expected to perform adequately under normal loading conditions."

Fredonia Reservoir Summary

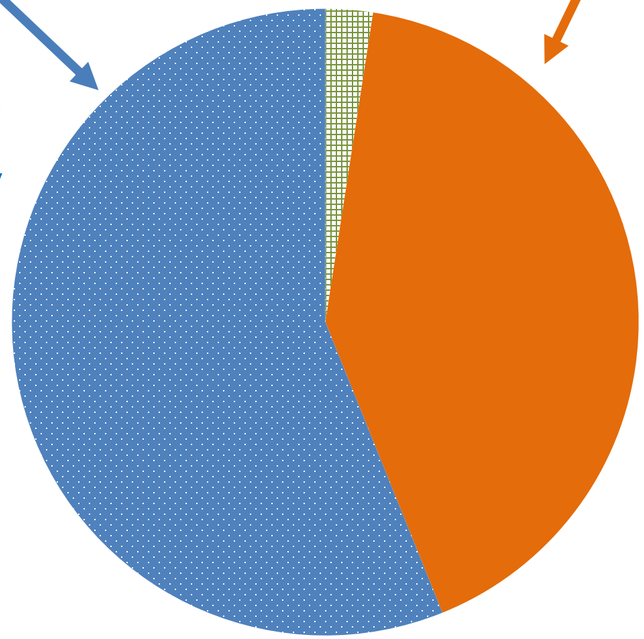
- Current volume of usable reservoir water is unknown. The last estimated measurement of usable water did not meet NYSDOH requirements.
- Reservoir will need immediate and long term dredging plan if it remains in operation.
- An alternative connection was mandated by NYSDEC to prepare for drought events.
- Dam and spillway must be maintained; risks of failure are reduced if the reservoir volume is drawn down.
- Concerns about Reservoir capacity, need for regular dredging / maintenance and long term outlook first documented in 1965.

Where Do Reservoir Inputs Go?

2% lost to evaporation

34% to the water treatment plant

64% flows over the spillway & back to the creek



Safe Yield - Amount of water that can be taken out of the Reservoir while maintaining the overall volume of water in the reservoir and the quality of the water.

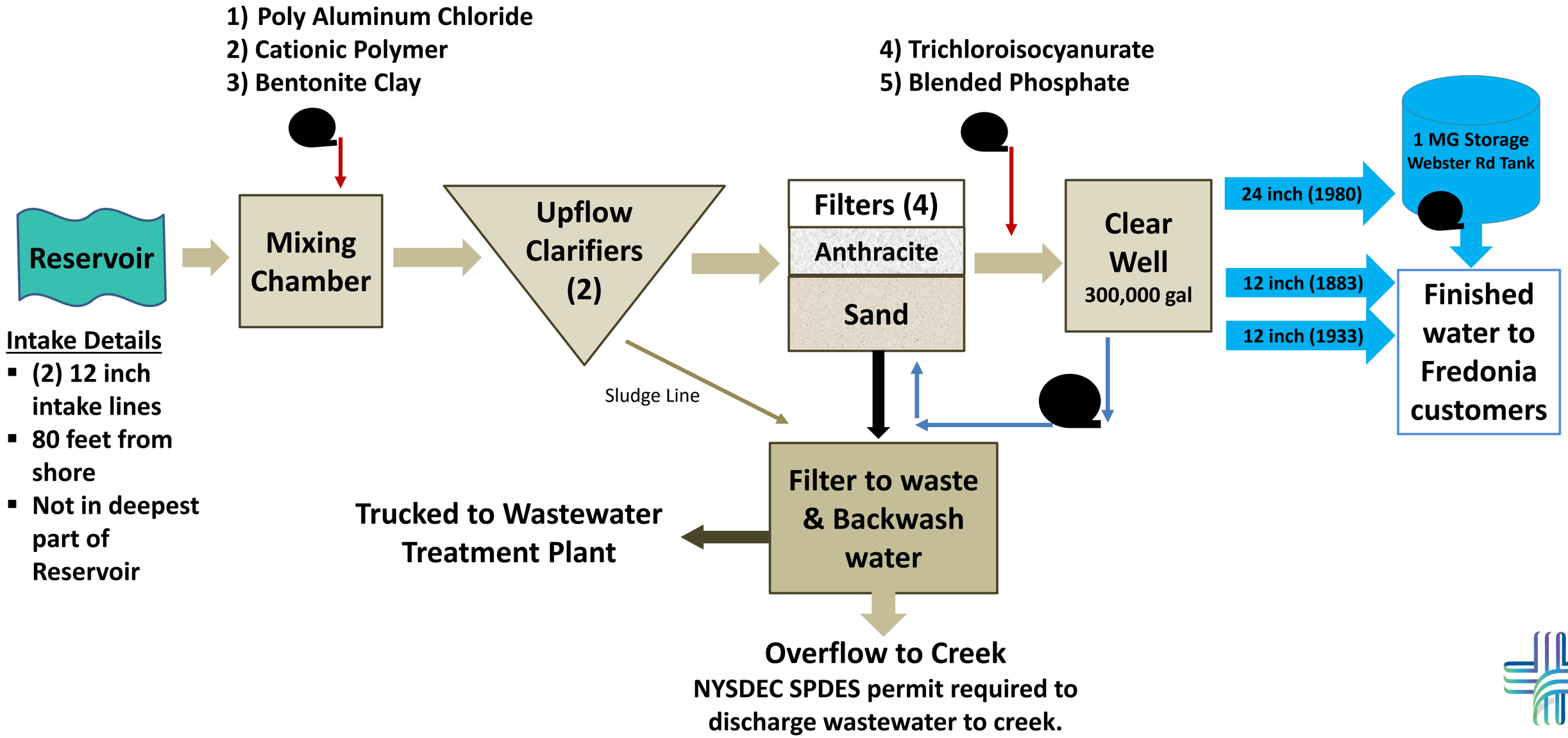
2011 Safe Yield = 1.1 - 1.5 Million Gallons per Day

(2011 O'Brien and Gere)

2024 Average Day Production = 1.4 - 1.6 MGD

(Percentages from 2006 Fredonia Reservoir Water Budget, Dr. Mike Wilson, SUNY Fredonia)

Fredonia Water Treatment Plant



Intake Details

- (2) 12 inch intake lines
- 80 feet from shore
- Not in deepest part of Reservoir

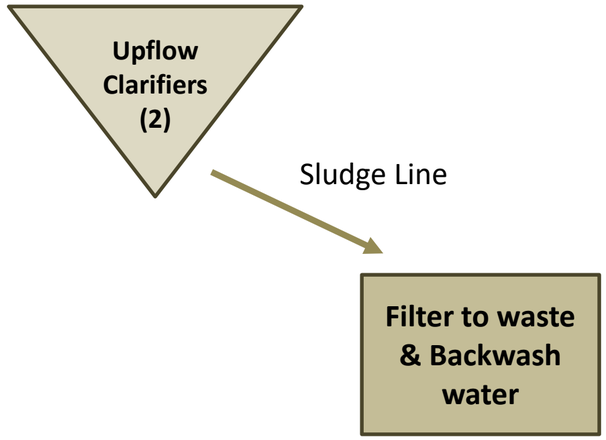
WTP Concerns & Deficiencies

- Stream bank erosion & undercutting
  - Clarifiers are on the other side of the wall.
  - Clarifiers hold 250,000 gallons of water, weighing 1,050 tons.
- Cross Connection between backwash water & finished water lines
- Security of facility
- Operator safety
  - Area where chemicals are mixed does not have adequate ventilation and isolation.

Cross Connection between backwash & finished water lines

WTP Concerns & Deficiencies

- Clarifier sludge line blocked
- Generator not working
- General condition of the water treatment plant building
  - Cracked walls
  - Color coded labels and directional arrows on water lines are faded / deteriorated
  - Limited size / space for upgrades and back-up equipment / parts



WTP Concerns & Deficiencies

Mixing Chamber

Chemicals needed for treatment are not mixed adequately with incoming water.

Upflow Clarifiers (2)

Existing clarifiers are too small to properly remove organic material and other solids.

Excess organic matter contributes to:

- High levels of disinfection by-products.
- High turbidity of the water, which disrupts disinfection process.

Plant material washes into the reservoir.
Plants & Algae grow in the reservoir.

WTP Concerns & Deficiencies

- Complexity of disinfection process
- Switching from primary to secondary chemical feed pumps is not automated
- Lack of redundancy
  - Plant has to operate 24 / 7 / 365 days of the year to meet system demand.
  - Difficult to near impossible to schedule time for the WTP to stop operating to allow repairs.
  - Reservoir dredging will be difficult because it will create turbid water that will get pulled into WTP.

Water Treatment Plant must be staffed 24 / 7.

April 15th WTP Maintenance

Clear well must be vacuumed to remove sediment build-up

- Lack of Redundancy → Plant must continue to operate to keep up with demand

Steps to try to Avoid a Boil Water Order on April 15th

1) Fill Webster Rd water tank ahead of maintenance and supply Village from the tank during work at WTP.
2) Conserve water order for customers to make Webster Rd tank supply last as long as possible.

If Webster Rd tank supply cannot satisfy the Village's demand for water while WTP maintenance occurs, then water will have to be supplied from the Fredonia WTP or the existing connection with Dunkirk… A Boil Water Order will likely be required.

Fredonia WTP Summary

- Streambank stabilization needed to prevent structural damage to WTP building.
- WTP requires significant equipment upgrades to provide redundancy.
- Continued routine maintenance and upgrades will be required to maintain the plant for future use.
- WTP must continue to operate and be staffed 24 / 7 unless significantly more storage is added to hold finished water and more automation is added to the WTP process.

Finished Water Storage in Fredonia

Required Storage Capacity = **(1.4 MGD)** Minimum Average Day's Use + **Fire Response Demands** (typical hydrants = **500 - 1,500 gpm;** *Fredonia hydrants release more because the pressure in the water lines is so high*)

Fredonia Current Storage Capacity = 1.0 MG

Distribution System & Main Breaks

Fredonia's Gravity Fed System

Challenges

- Elevation change causes north part of the system to be 140-150 psi (normal working pressure should be 60-80 psi).
- Distribution system doesn't have a way to reduce / regulate the pressure.
- High pressure makes old lines more susceptible to breaks.
- High pressure causes problems for home appliances with waterlines (washing machines, dishwashers, etc.).
- Water from the Webster Rd water tank must be pumped out to reach high elevation customers; this means lower elevation customers receive excessive high pressure.

Benefit

- Limited number of pumps needed to move water in system.

Fredonia Boil Water Orders

June 2020 - Water main break

September 10 – 30, 2020 – Taste and odor issue likely due to algal bloom in reservoir, appropriate treatment complicated by filter bed replacement work in progress

February 2023 – Chlorine pump failure, back-up equipment not present at WTP

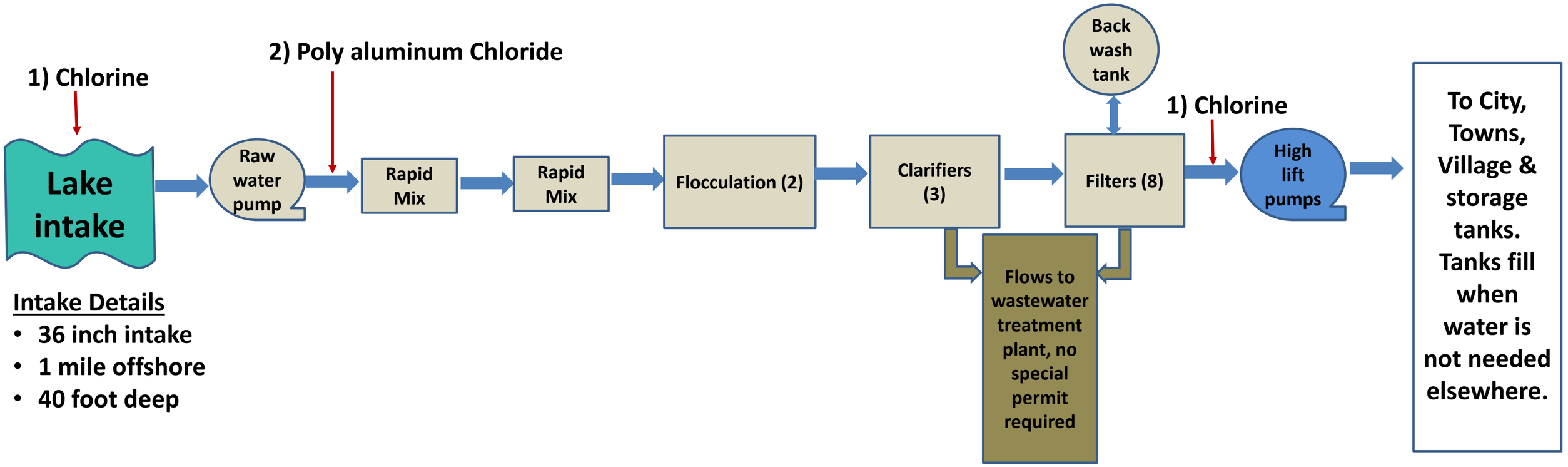
June 2023 – Turbidity exceedance led to treatment technique violation

February 2024 – Inadequate disinfection due to equipment problem at WTP

Current connection to Dunkirk *CANNOT* supply the whole Village.

- Line from Dunkirk is not big enough.
- Pumps cannot lift water to highest point / elevation in Fredonia's system.
- Opening line would likely result in Boil Water Order.

Dunkirk Water Treatment Plant



Intake Details

- 36 inch intake
- 1 mile offshore
- 40 foot deep

Key Treatment Differences

Fredonia – 5 chemicals in treatment

- Cannot use pretreatment oxidation to remove organics which cause disinfection by-products; would exceed disinfection by-products.
- Has up-flow clarifiers
- Filter media – anthracite and sand
  - Cannot remove disinfection by-product precursors.
- Routine samples collected for HAB toxin testing by NYS lab.
- Water is corrosive to pipes so a blended phosphate solution is added to help keep lead and copper levels within regulatory limits as water moves through distribution system.

Dunkirk – 2 chemicals

- Uses pretreatment oxidation to remove organics including disinfection by-product precursors.
- Has sedimentation basins
- Filter media – Granular Activated Carbon (GAC) and gravel absorbs / removes organics including:
  - Disinfection byproducts and precursors.
  - Polyflorinated chemicals – PFOS, PFOA, PFNA.
  - Gasoline and oils.
- Water is not corrosive, so no additional treatment needed to preserve distribution lines.

Treated Water Quality Compared

Detected Contaminant		Fredonia Level	Dunkirk Level	Regulatory Limit *(MCL, unless labeled)*
MICROBIOLOGICAL CONTAMINANTS	Turbidity (Max)	0.39 NTU	0.129 NTU	Value must be <1.0 NTU
	Turbidity	**93.75% were <0.3**	100% were < 0.3	≥95% of samples must be <0.3
	Distribution Turbidity (Max)	0.37 NTU	0.88 NTU	>5 NTU
INORGANIC CONTAMINANTS	Lead	7.8 ug/L Range = ND - 25.0	6.1ug/L Range = ND - 15.3	Action Level = 15 ug/L
	Copper	Average = 0.224 mg/L Range = 0.0098 – 0.427	Average = 0.0803 mg/L Range = 0.002 - 0.131	Action Level = 1.3 ug/L
	Barium	0.0545 mg/L	0.021 mg/L	2 mg/L
	Chromium	0.56 ug/L	Not Detected	100 ug/L
	Nitrate	0.23 mg/L		10 mg/L
	Thallium	0.023 ug/L		2 ug/L
	Nickel	0.23 ug/L		*n/a*
SECONDARY INORGANIC CONTAMINANTS	Manganese	0.023 mg/L	Analysis not required.	0.300 mg/L
	Iron	0.020 mg/L		0.300 mg/L
	Chloride	16.3 mg/L		250 mg/L
	Sulfate	13.7 mg/L		250 mg/L
	Sodium	9.4 mg/L		*based on dietary restriction*
STAGE 2 DISINFECTION BYPRODUCTS *Fredonia must sample 4x / quarter due to continuiously higher levels. Dunkirk samples 2x / quarter.*	Haloacetic Acids	Average = 19.85 ug/L Range = 5.0 – 39.7	Average = 4.7 ug/L Range = 3.4 - 5.6	60 ug/L
	Total Trihalomethanes	Avg.= 46.7 ug/L Range = 20.1 – 76.1	Avg.= 23.12 ug/L Range = 11.3 - 38.2	80 ug/L
SYNTHETIC ORGANIC CONTAMINANTS (including pesticides & herbicides)				
	1,4 Dioxane	Not Detected	0.056 ug/L	1 ug/L

Based on 2022 Annual Water Quality Report data
Exceedance noted in red

Emerging Contaminants

Unregulated Contaminant Monitoring Rule (UCMR)

- Samples collected every 5 years to gather data for contaminants that:
  - Are suspected to be present in drinking water.
  - Have known health concerns.
  - Do not have current health-based standards under the Safe Drinking Water Act.
- EPA may pay for testing at small systems like Fredonia serving <10,000 people.
- Large systems like Dunkirk serving >10,000 people must cover their own costs.

Many contaminants including

PFOS, PFOA, PFNA (poly and perfluorinated alkylated substances)

were identified by the UCMR process.

Emerging Contaminants

PFOS, PFOA, PFNA (poly and perfluorinated alkylated substances)

Initial testing performed once per quarter for 1 year.

- If detected, testing continues quarterly.
- If not detected, testing occurs once every 18 months.

Fredonia

- No existing treatment process to address future contaminants if necessary.
- Not able to add activated carbon. “Filter bed depth is insufficient to absorb organics with activated carbon” *(O’Brien & Gere 2013)*.
- No available space at WTP to add treatment options.

Dunkirk

- Activated Carbon already exists in current process to address future contaminants.
- Has space at WTP to expand treatment options if needed.

Additional Water Quality Concerns

Microplastic Pollution

- No existing regulations to monitor public water supplies for microplastics.
- Sampling, testing and treatment must be standardized; difficult process because there are many different types and sizes.
- Microplastics are spread throughout the environment in water runoff to streams, rivers, lakes and oceans.
- Microplastics are spread throughout the environment in the air on wind currents.
- Found in water ways around the world, in protected wild areas, in sea ice, and at the Antarctic Tundra.
- Microplastics in our diet:
  - Bottled water
  - Beer
  - Sea salt
  - Fish and Wildlife

Additional Water Quality Concerns

Microplastics Not Under Unregulated Contaminant Monitoring Rule (UCMR)

- No approved sampling method.
- No approved testing method.
- Strategies to remove microplastics from water, or treat water containing microplastics, are still being developed and reviewed.
- Information on health effects is not known.
- Risk/benefit analysis must be completed to determine level of health risk and cost of treatment to address health risk.

Additional Water Quality Concerns

Blue-green Algae and Harmful Algal Blooms (HABs)

(Blue-green Algae is the common name for Cyanobacteria)

- Native organism, present for over 3 billion years.
- Growing concern in Chautauqua County and around the world.
- HABs are more likely in warm water that has a lot of nutrients.
- HABs may produce cyanotoxins which are harmful to human and animal health.

Chautauqua Lake

Findley Lake

Toxin Testing in Public Water Supplies

- **Fredonia tests samples every other week** (summer and fall) due to previous evidence of blue-green algal growth in reservoir.
- **Dunkirk does not require routine testing.** Lake Erie's Eastern basin has less potential for HABs compared to the Western basin near Cleveland / Toledo. Dunkirk's intake pipe is 40 feet deep.

Role of Chautauqua County Health Department (CCHD)

Enforce NYSDOH and federal regulations that define source water requirements, water treatment plant structural requirements, and sampling requirements.

- Title 10. Department Of Health
  Chapter I. State Sanitary Code Part 5. Drinking Water Supplies Subpart 5-1. Public Water Systems
- Recommended Standards for Water Works “Ten State Standards”

https://regs.health.ny.gov/volume-title-10/content/part-5-drinking-water-supplies

https://www.health.ny.gov/environmental/water/drinking/regulations/docs/2018_recommended_standards.pdf

CCHD Enforcing Violation Timelines

July 15, 2023 - CCHD sent report noting significant deficiencies of the Fredonia Water system to Village of Fredonia following May 2023 inspection.

Per NYSDOH Part 5, Fredonia was required to:

- Submit a written plan to address significant deficiencies within 30 days (August 15, 2023).
- Submit a corrective action plan and be in compliance with the action plan within 120 days (November 15, 2023).

August 14, 2023 - CCHD received correspondence from Village of Fredonia indicating no major corrective actions until LaBella Engineering report is completed.

Communication did not satisfy NYSDOH Part 5 requirements so CCHD reached out to Village officials to explain requirements and corrective action plan.

September 5, 2023 - Fredonia officials invited CCHD to present at Village Board meeting.

CCHD Enforcing Violation Timelines

Village Still Needed a Corrective Action Plan

- CCHD assisted Village to determine which significant deficiencies should be prioritized for safety or could be resolved quickly. Other deficiencies would require larger investment (time and finances) and may not be needed if Fredonia was considering other options.
- Fredonia had already engaged LaBella Engineering for a study of Fredonia's system. Village officials revised original scope of work for LaBella and requested study of Fredonia's existing system and possible alternatives.
- CCHD extended date for corrective action plan because the involvement of LaBella showed Village's efforts to comply and develop a corrective action plan.
- To develop a corrective action plan the Village had to choose if they intended to address all deficiencies cited for the existing Reservoir and WTP or consider alternative sources.

Chautauqua County Health Department will continue to work with Village officials, water operators and DPW staff in the interest of protecting public health in the community.

Thank you Village of Fredonia Officials & Opera House for hosting this event.

Thank you Fredonia water customers for taking time to learn about your water system and the work that goes into maintaining it.

Thank you Fredonia water operators and DPW staff for protecting public health in your community.

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