



CAMBRIDGE WATER DEPARTMENT

# WATERSHED, DISTRIBUTION, TREATMENT, WATER QUALITY, COSTS, THE FUTURE

**“Provide a safe, uninterrupted water supply of the highest quality to the citizens of Cambridge”**

City Council: HEALTH and ENVIRONMENT COMMITTEE

OCTOBER 12, 2022



# AGENDA

- CAMBRIDGE WATER SYSTEM
  - HISTORY
  - WATERSHED, DISTRIBUTION and TREATMENT
- WATER QUALITY
  - PFAS (Per and Polyfluoroalkyl substances)
  - LEAD
  - DISINFECTION BY-PRODUCTS
  - CHLORIDES
  - HARDNESS
  - TOTAL DISSOLVED SOLIDS (TDS) - minerals
- WATER SYSTEM COSTS vs. MWRA (Massachusetts Water Resources Authority)
- FUTURE - GO FORWARD STRATEGY

# CAMBRIDGE WATER SYSTEM

## PROVIDING A CLEAN and RELIABLE SUPPLY OF DRINKING WATER

- IN THE MID 1800s IT BECAME APPARENT THAT THERE WAS NOT AN ADEQUATE LOCAL SUPPLY OF FRESH DRINKING WATER TO MEET THE RAPIDLY GROWING POPULATION AND COMMERCIAL DEVELOPMENT
- CAMBRIDGE'S GOVERNING BODY WERE PROACTIVE AND WANTED TO PROVIDE A CONSISTENT AND RELIABLE SOURCE OF FRESH CLEAN DRINKING WATER TO MEET THE DEMANDS OF THE CITY'S OWN GROWING POPULATION AND HELP STRENGTHEN AND ENCOURAGE ITS ECONOMIC GROWTH INITIATED THE CENTURIES LONG COMMITMENT TO CREATE AN INDEPENDENT WATER SYSTEM TO MEET THOSE NEEDS
- ACQUIRED LAND/EASEMENTS:
  - FROM MULTIPLE TOWNSHIPS AND BUILT DAMS TO CREATE THE HOBBS BROOK AND STONY BROOK RESERVOIRS THAT NOW MAKE UP CAMBRIDGE'S INDEPENDENT SOURCE WATER SUPPLY
  - WITHIN WALTHAM AND WATERTOWN ALLOWING THE CONSTRUCTION OF THE STONY BROOK CONDUIT TO CONVEY WATER TO FRESH POND
- CONSTRUCTED A WATER TREATMENT PLANT IN 1923 TO CLEAN AND DISINFECT THE RAW WATER REMOVING ORGANICS AND ADDING CHLORINE TO KILL COMMON WATER BORNE DISEASES SUCH AS CHOLERA, TYPHOID AND HEPATITIS

# CAMBRIDGE WATER SYSTEM

## CONTINUOUS COMMITMENT to CLEAN and RELIABLE DRINKING WATER

- ACQUIRED LAND IN BELMONT CREATING THE PAYSON PARK RESERVOIR TO STORE A LARGE VOLUME OF TREATED WATER TO SUPPLY BY GRAVITY AN UNINTERRUPTED ON DEMAND SOURCE OF CLEAN DRINKING WATER AND FIRE PROTECTION TO THE CITY
- CONTINUED LAND ACQUISITION TO BETTER PROTECT THE SOURCE WATER SUPPLY FROM URBAN DEVELOPMENT AND ENCROACHMENT
- CONTINUOUS MONITORING OF THE UP-COUNTRY RESERVOIRS AND FRESH POND RESERVATION AS SOURCE WATER PROTECTION
- CONTINUOUS UPGRADES TO THE DISTRIBUTION SYSTEM PIPING ENSURING RELIABLE SUPPLY FOR ADEQUATE FIRE PROTECTION AND DOMESTIC WATER AT EVERY TAP
- BECAME A FULL MEMBER/CONNECTED TO THE MDC (NOW MWRA) WATER SUPPLY FOR FULL REDUNDANCY
- CONSTRUCTION OF THE STATE-OF-THE-ART WJ SULLIVAN PLANT IN 2001 AS A SAFEGUARD AGAINST INCREASING REGULATORY REQUIREMENTS AND NEW EMERGING CONTAMINANTS OF CONCERN

# CAMBRIDGE WATER SYSTEM

- THE CAMBRIDGE WATER SYSTEM IS A VERY ROBUST SYSTEM
- MULTIPLE BARRIERS AND PROTECTION SYSTEMS *via* TREATMENT OPTIONS
  - WATERSHED PROTECTION
  - FILTRATION, PRE AND POST TREATMENT *and* MULTIPLE DISINFECTION STEPS
- RESILIENCY *and* REDUNDANCY
  - MWRA AS A BACK-UP SUPPLY
- MAINTAIN CONTROL OF OUR FUTURE
- LOWEST COST OPTION FOR RESIDENTS AND BUSINESSES

# CAMBRIDGE WATER SYSTEM

- CAMBRIDGE WATER DEPARTMENT is an ENTERPRISE FUND
  - WATER RATES PAY FOR ALL OPERATIONS AND CAPITAL EXPENDITURES INCLUDING DEBT SERVICE
  - \$8.7M WATER FUND BALANCE AS OF 6/30/2022 (FY22)
  - \$19M ANNUAL BUDGET
    - 3 DIVISIONS, 59 POSITIONS
- FULL MEMBER OF MASSACHUSETTS WATER RESOURCES AUTHORITY (MWRA)
  - PERMANENT CONNECTIONS' TO MWRA WATER SYSTEM
  - FOLLOW MWRA DROUGHT MANAGEMENT PLAN vs. STATE PLAN
  - ACCESS TO THE MWRA SYSTEM PROVIDES A LEVEL OF REDUNDANCY and RESILIENCY UNIQUE IN THE METROPOLITAN BOSTON AREA

# A MULTI-BARRIER APPROACH MAKES THE CAMBRIDGE WATER SYSTEM VERY ROBUST

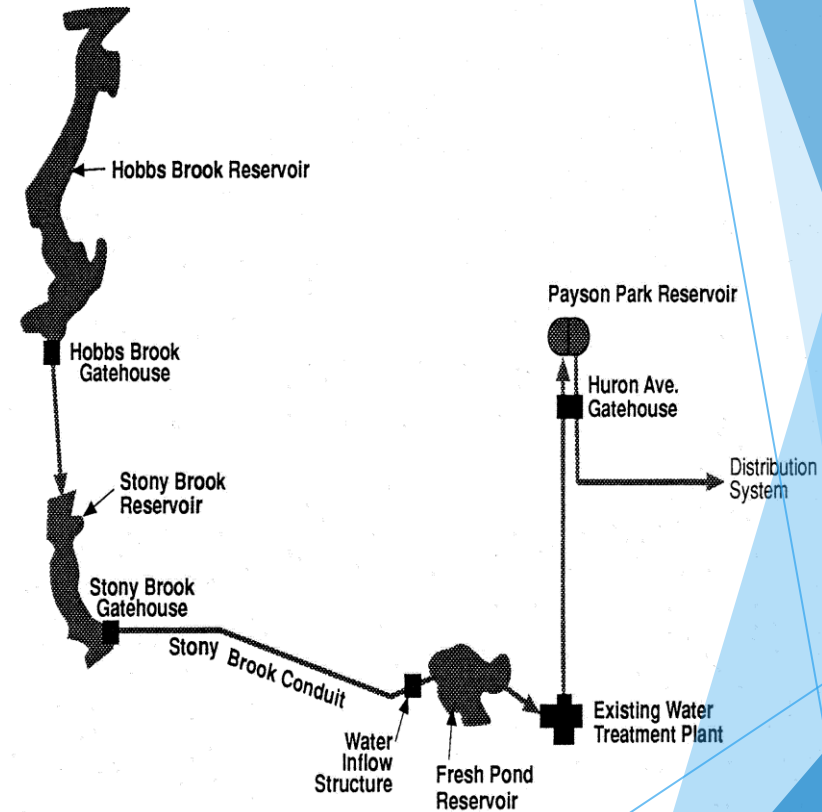
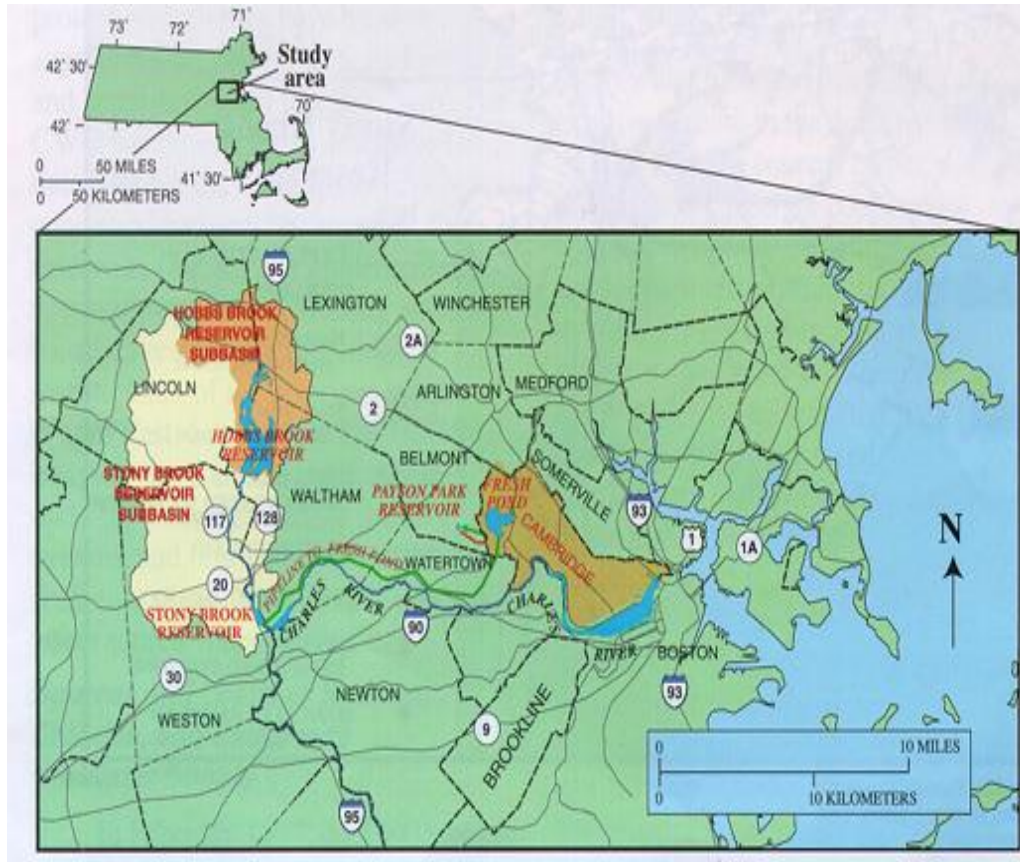
## Cambridge Water Supply and Treatment



## MWRA Water Supply and Treatment



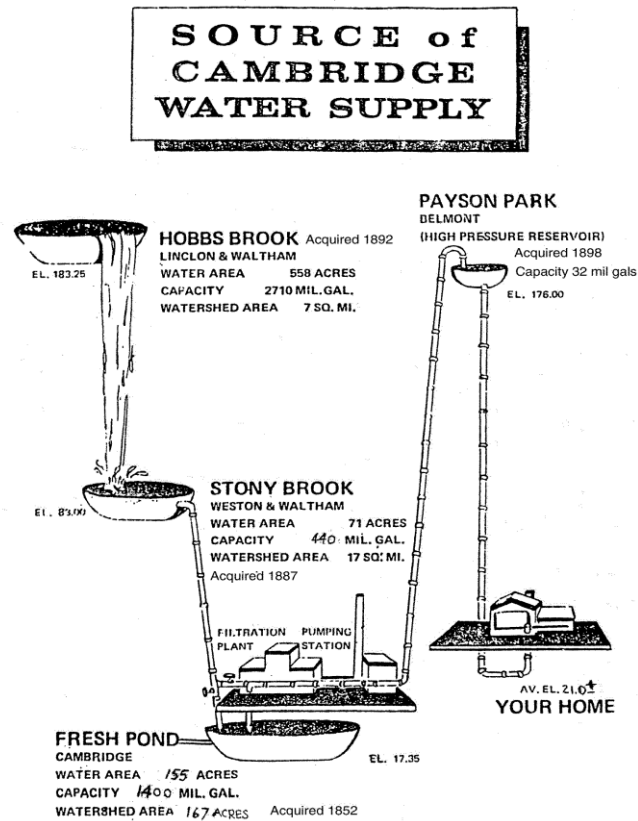
# CAMBRIDGE WATER SYSTEM



“SIGNIFICANT LOCAL ENVIRONMENTAL BENEFIT TO THE WATERSHED COMMUNITY BY MANAGING OUR 24 SQUARE MILE WATERSHED AS A “CLASS A” WATER”



# CAMBRIDGE WATER SYSTEM



## STORAGE VOLUMES

- HOBBS BROOK: ~2.5 BILLION GALLONS
- STONY BROOK: ~ 400 MILLION GALLONS
- FRESH POND: ~1.4 BILLION GALLONS
- PAYSON PARK: ~32 MILLION GALLONS

## CONDUIT

- ~ 7 MI IN LENGTH
- 63" DIAMETER CONCRETE



# CAMBRIDGE WATERSHED



- ~24 SQUARE MILE (SM) TOTAL WATERSHED
- ~17 SM - Stony Brook
- ~7 SM Hobbs Brook
- 13 USGS Gauging Stations (continuous)
- 21 Manual Monitoring Stations (reservoirs and tributaries)



# CAMBRIDGE WATERSHED

HOBBS BROOK RESERVOIR



STONY BROOK RESERVOIR



# CAMBRIDGE WATERSHED

## Fresh Pond Reservation



- WATER QUALITY OF FRESH POND, BLACK'S NOOK, LITTLE FRESH POND, AND NORTH POND
- GROUNDWATER MONITORING
- RESERVATION MONITORING
- IMPROVEMENT/RESTORATION PROJECTS – TO IMPROVE RAW WATER QUALITY

Examples: TREATMENT FACILITY, LITTLE FRESH POND, NORTHEAST SECTOR, GLACKEN SLOPE AND PERIMETER PATH

- STORMWATER MANAGEMENT and CONTROL
- EROSION CONTROL
- WETLAND VEGETATION
- NATIVE LANDSCAPE



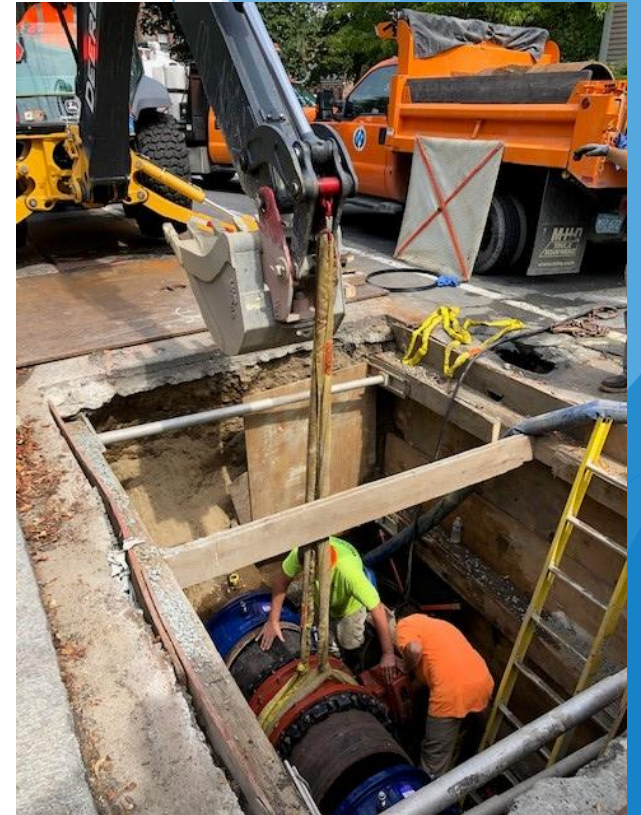
# DISTRIBUTION SYSTEM

- ~ OVER 200 MILES OF UNDERGROUND WATER MAINS
  - 6 THRU 63 INCHES IN DIAMETER
  - CAST AND DUCTILE IRON, CONCRETE
- ~15,000 SERVICES, ~4500 VALVES, 1750 HYDRANTS
- AVERAGE OF 1.75 MILES OF PIPE REPLACED ANNUALLY
- ~ 17 MILES OF NEW WATER MAIN INSTALLED IN THE PAST DECADE
- CURRENT CAPITAL IMPROVEMENT PLAN (CIP) - APPROXIMATELY 2.5 MILES OF WATER MAIN REPLACEMENT CURRENTLY ON GOING OR UNDER CONTRACT TO BEGIN IN FY23



# DISTRIBUTION SYSTEM

- INITIATED LEAD SERVICE LINE REPLACEMENT IN EARLY 90s
  - STARTED WITH ~11,000 LEAD SERVICE LINES
  - CURRENTLY 1,935 LEAD SERVICE LINES
  - ON-LINE DATA BASE
- IN 2000 INITIATED PURCHASING “NO LEAD” WATER WORKS MATERIALS
  - < 0.25% LEAD CONTENT BY WEIGHT
- MassDEP DID NOT PASS “LEAD FREE” REGULATORY LIMIT UNTIL 2014



# CAMBRIDGE TREATMENT



Main Process Floor

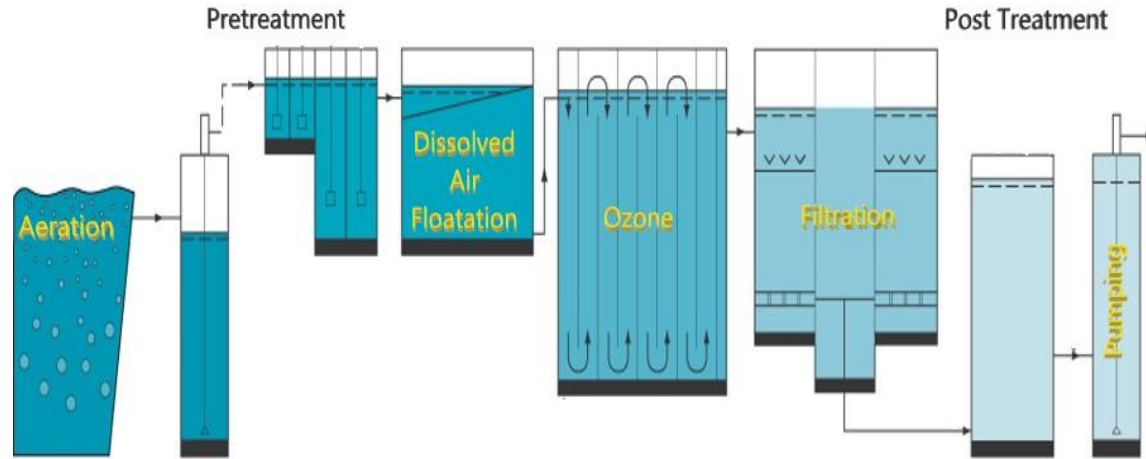


- ~119,000 RESIDENTS (2020 Census)
- Treatment Capacity: 24 Million Gallons/Day (MGD)
- AVERAGE DAILY CONSUMPTION: 12.1 MGD (2021)
- PER CAPITA WATER USAGE: ~39 GPD/P (gallons per day per person) 2021

Control Room

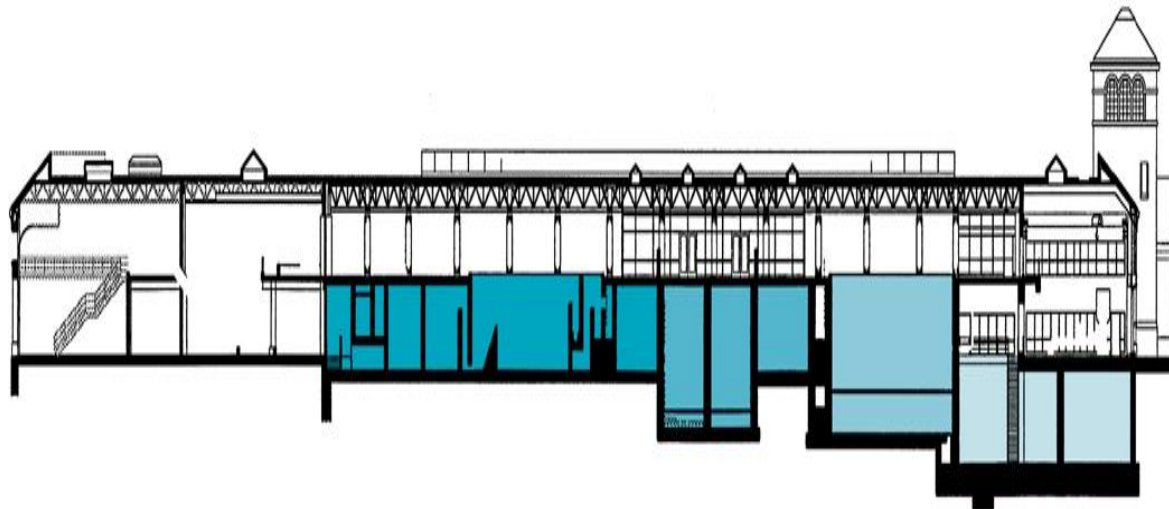


# CAMBRIDGE TREATMENT



## TREATMENT PROCESS TRAIN

- Fresh Pond Aeration
- Pretreatment:
  - Pre-Ozonation
  - Dissolved Air Flotation
- Disinfection: Ozone and Free Chlorine
- Filtration: GAC Filter media
- Post Treatment:
  - pH Adjustment/Chloramination
- Pumping
- Finished Water Storage: Payson Park

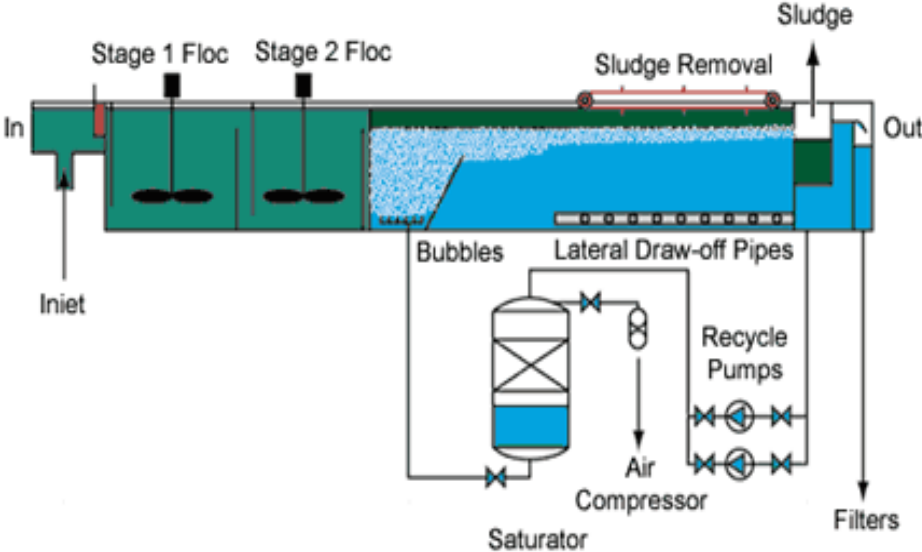




# CAMBRIDGE TREATMENT



TYPICAL DAF INSTALLATION



Dissolved Air Flotation - PRETREATMENT

# CAMBRIDGE TREATMENT



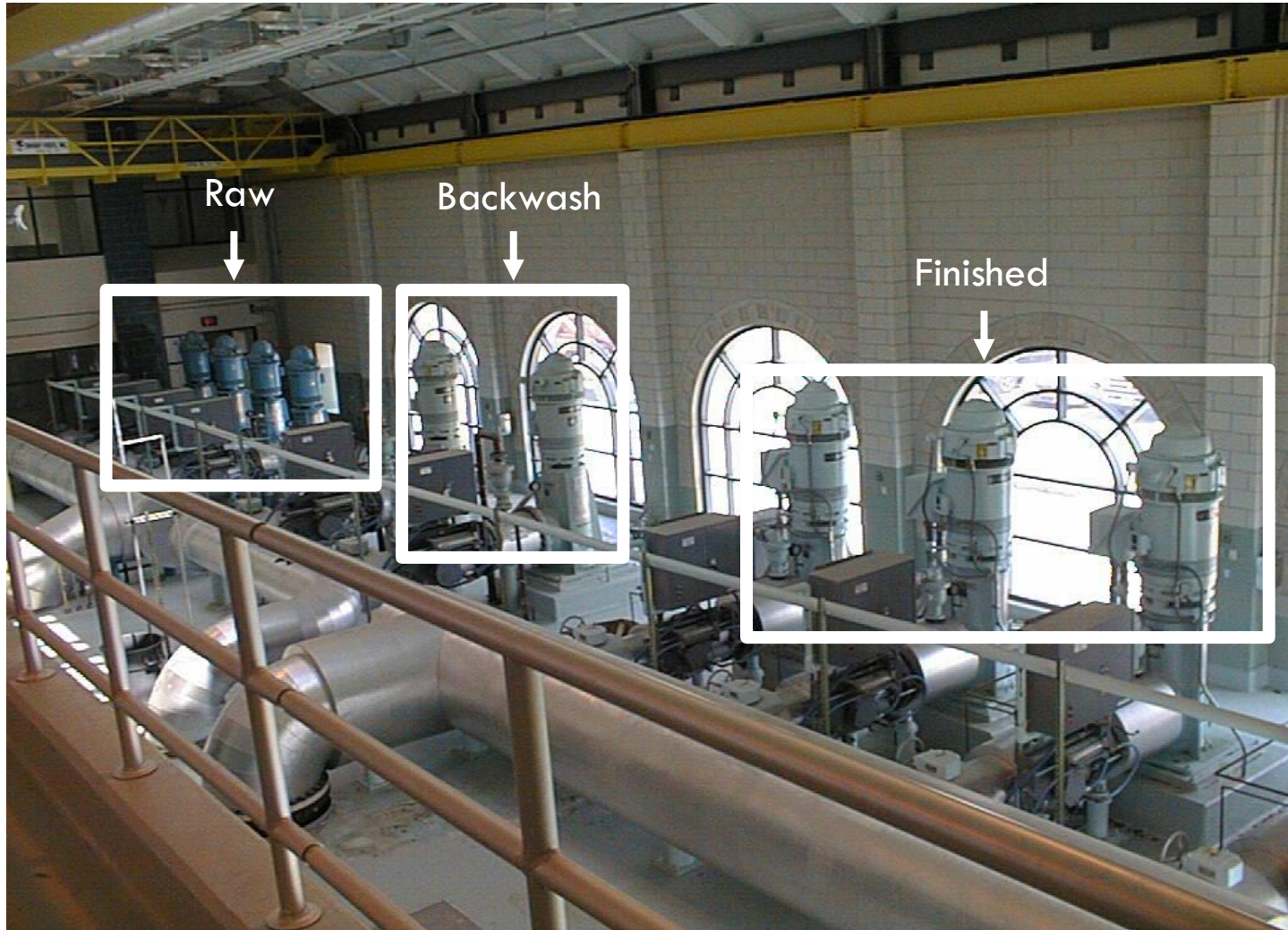
## **FILTRATION:** Filters

- Granular Activated Carbon (GAC)  
Filter Media





# CAMBRIDGE TREATMENT



## PUMPS:

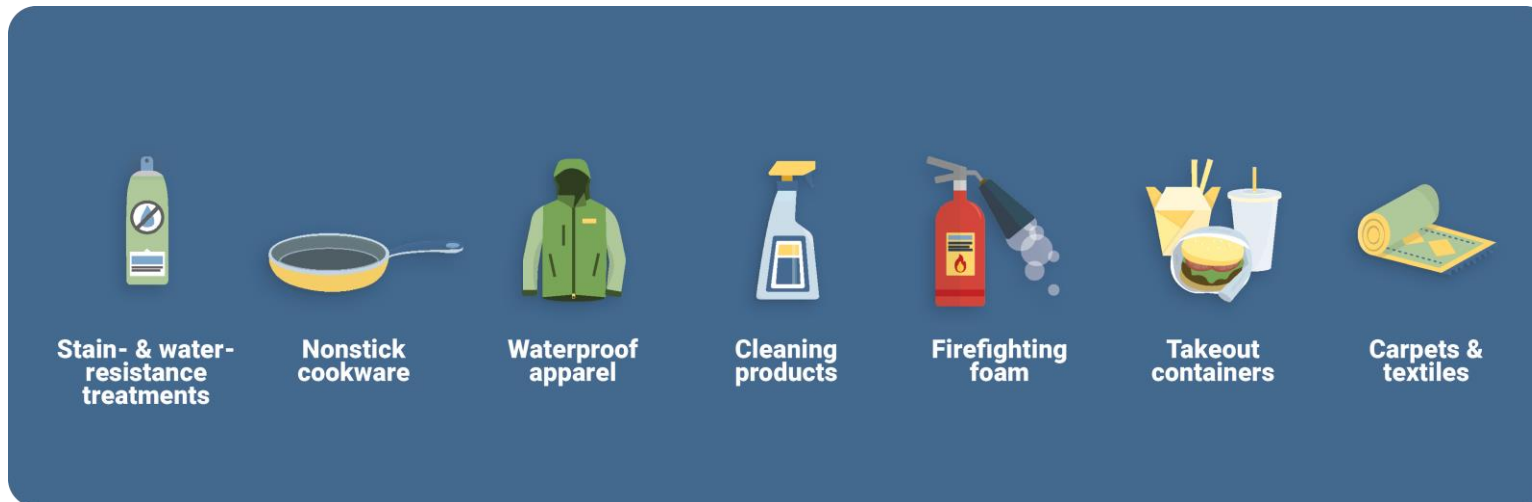
- Raw Water
- Backwash Water
- Finished Water

# CAMBRIDGE WATER QUALITY

- THE CAMBRIDGE WATER SYSTEM QUALITY SURPASSES ALL MassDEP and USEPA REGULATIONS
- STATE CERTIFIED LABORATORY for Microbiology and Chemistry
  - FREE CAMBRIDGE WATER QUALITY TESTING – Lead Testing Most Frequent Request
  - RAPID TURNAROUND FOR “REAL TIME” RISK IDENTIFICATION AND PROCESS OPTIMIZATION
- PARTICIPATE IN EPA’s “UNREGULATED CONTAMINANT MONITORING RULE” (UCMR) PROGRAM

# WATER QUALITY: PFAS (Per and Polyfluoroalkyl Substances)

- PFAS IS A “WATER REPELLANT” USED IN MANY EVERYDAY PRODUCTS



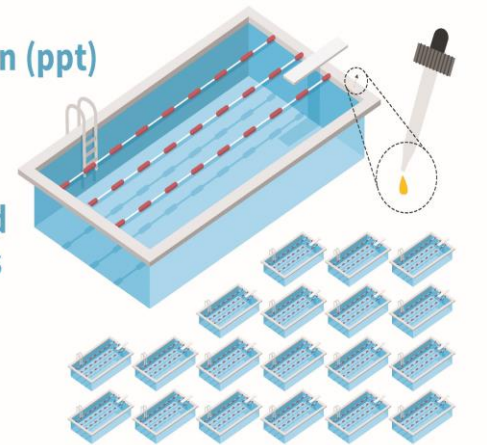
# WATER QUALITY: PFAS

- MassDEP REGULATION EFFECTIVE JANUARY 1, 2021 FOR 6 PFAS COMPOUNDS
  - 1) PFOA, 2) PFOS, 3) PFNA, 4) PFDA, 5) PFHxS and 6) PFHpA
    - QUARTERLY AVERAGE NOT TO EXCEED 20ppt
- USEPA HEALTH ADVISORY (HA) – JUNE 2022
  - PFOS: HA – 4 parts per quadrillion (ppq) INTERIM
  - PFOA: HA – 0.002 ppq INTERIM
  - NOT A REGULATION and is NOT ENFORCEABLE
- CANNOT ANALYTICALLY TEST TO THE LEVELS PROPOSED – PARTS PER QUADRILLION
  - TESTING CAPABILITIES: 2 ppt (parts per trillion) for PFAS compounds

**1 part per trillion (ppt)**

IS EQUIVALENT TO A  
SINGLE DROP OF  
WATER IN

**20 olympic-sized  
swimming pools**

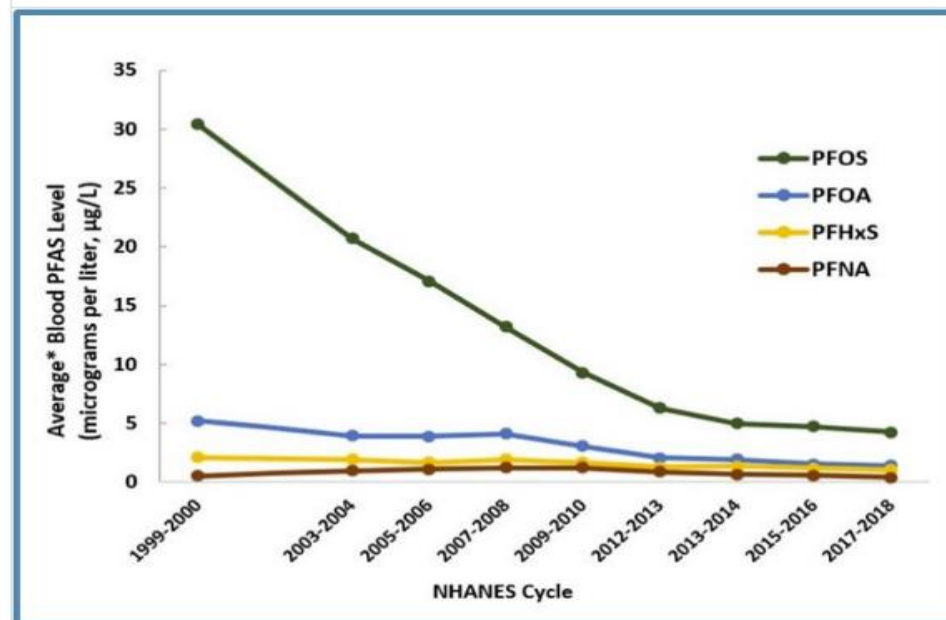


# WATER QUALITY: PFAS

- MOST COMMON SOURCES OF PFAS EXPOSURE
  - FISH
  - FOOD PACKAGING
  - TREATED UPHOLSTERY
  - NON-STICK COOKWARE
  - FOOD CHAIN (PLANTS/ANIMALS)
  - DIRECT CONTACT W/ CONTAMINATED SOIL
  - DRINKING WATER
- MOST HAZARDOUS PFAS PHASED-OUT IN U.S. 2000-2015 (SUBSTITUTES BEING EVALUATED)
- KEY PFAS LEVELS IN US RESIDENTS HAVE DROPPED SIGNIFICANTLY SINCE 2000



Blood Levels of the Most Common PFAS in People in the United States Over Time



\* Average = geometric mean

ATSDR, 2022



# WATER QUALITY: PFAS

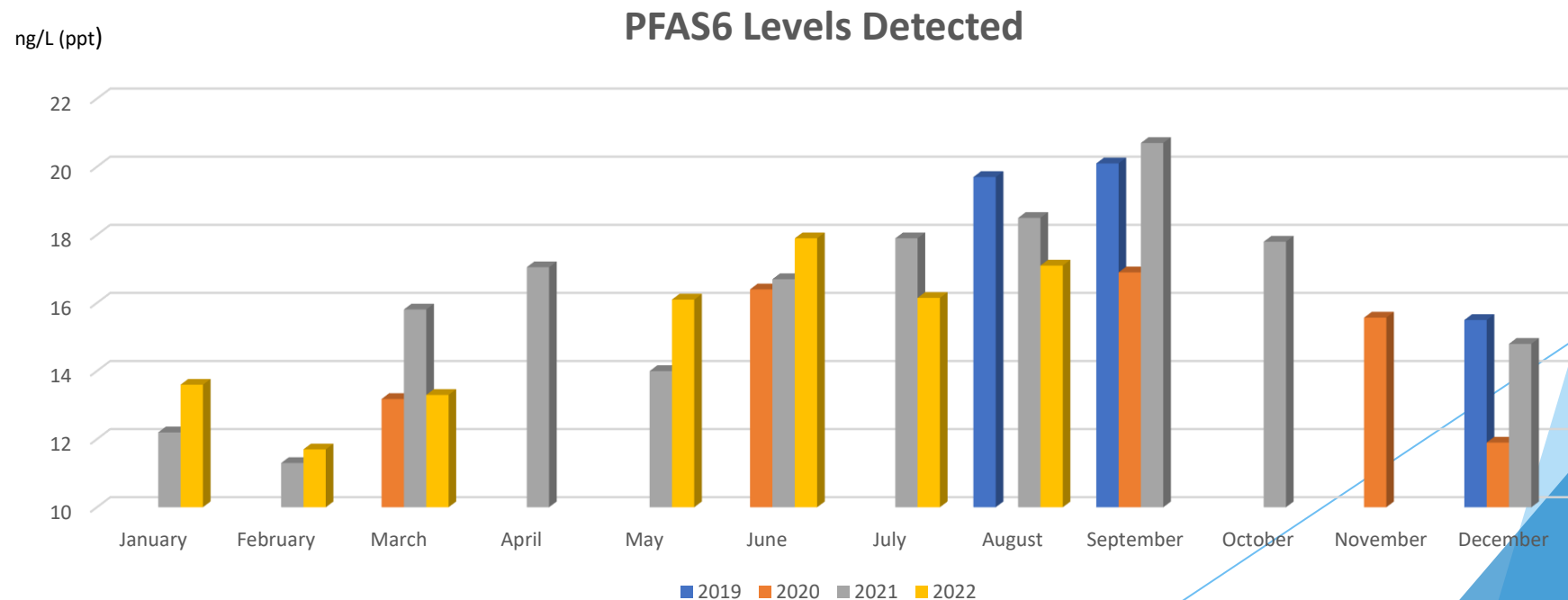
## **MassDEP LIMITS AND USEPA HEALTH ADVISORIES ARE HIGHLY PRECAUTIONARY**

- HUMAN AND ANIMAL STUDIES PROVIDE A STARTING POINT FOR DETERMINING SAFE LIMITS
  - NO OBSERVED EFFECTS LEVEL (NOEL)
  - LOWEST OBSERVED EFFECTS LEVEL (LOEL)
  - DOSE-RESPONSE CURVE AT RELEVANT EXPOSURE LEVELS
- GAPS IN PUBLISHED HEALTH EFFECTS DATA LOWER LIMITS BY **1,000 AS A SAFETY BUFFER**
  - MISSING OR INCOMPLETE MECHANISTIC MODEL (METABOLIC PATHWAYS, METABOLISM, DISTRIBUTION, ELIMINATION RATES IN SPECIFIC TISSUES)
  - DIFFERENCES BETWEEN EFFECTS SEEN IN SUBJECT ANIMALS VS. HUMANS
  - VARIATION IN POPULATION RISKS: PREGNANCY, YOUNG AGE, IMMUNE STATUS
- HEALTH ADVISORIES DO NOT INCLUDE ALL MITIGATING FACTORS, SO ARE OFTEN LOWER



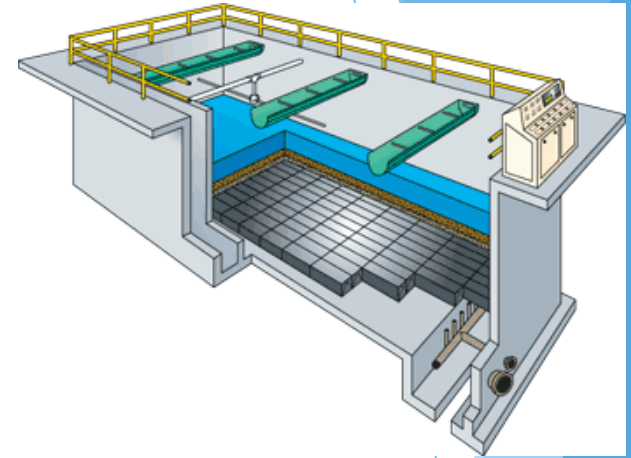
# WATER QUALITY: PFAS

- IN 2020 MassDEP ADOPTED AMONG STRICTEST PFAS STANDARDS IN THE US
- MassDEP WILL REVIEW USEPA HEALTH ADVISORY LIMITS
- EPA PROPOSED REGULATORY SCHEDULE
  - PROPOSE REGULATION BY 12/2022
  - PROMULGATE A REGULATION BY 12/2023



# WATER QUALITY: PFAS

- AUGUST 2019 thru SEPTEMBER 2022
  - JANUARY 2021: NEW PFAS6 REGULATIONS IN EFFECT
    - ACTION REQUIRED FOR PFAS6 QUARTERLY AVERAGE ABOVE 20ppt
  - IN FULL COMPLIANCE WITH MassDEP GUIDELINES AND REGULATIONS
  - PILOT STUDY PERFORMED, COMPLETED AND APPROVED (2020)
  - DEVELOPED BID SPECIFICATION, BID OUT AND AWARDED CONTRACT FOR CHANGEOUT OF GRANULAR ACTIVATED CARBON (GAC) FILTER MEDIA
- OCTOBER 2022: CHANGEOUT OF GAC FILTER MEDIA TO START OCTOBER 11, 2022 – 2 Filters
- NOVEMBER 2022: CHANGEOUT CONTINUES – 2 more Filters
- DECEMBER 2022: COMPLETE FILTER CHANGEOUTS (Last 2 Filters/Total of 6)



# WATER QUALITY: PFAS

- OPERATING PLAN:
  - AFTER 2 FILTERS CHANGED OUT – CONFIRM PFAS REMOVAL via TESTING
    - INITIATE WTP PRODUCTION TO REDUCE MWRA WATER QUANTITY
  - AFTER 2<sup>ND</sup> SET OF FILTERS CHANGED OUT – CONFIRM PFAS REMOVAL via TESTING
    - INCREASE WATER PRODUCTION TO REDUCE or ELIMINATE MWRA WATER USAGE
  - AFTER ALL FILTERS CHANGED OUT – CONFIRM PFAS REMOVAL via TESTING
  - TERMINATE MWRA WATER USAGE IF NOT ALREADY DONE SO
- PERFORM ROUTINE PFAS TESTING TO CONFIRM/DETERMINE GAC FILTER MEDIA CHANGEOUT FREQUENCY – ANTICIPATED TO BE 12 MONTHS

# WATER QUALITY:

## LEAD

- NO LEAD IN RAW WATER
- INITIATED CORROSION CONTROL PROGRAM IN 1991
  - pH OF WATER: 9.0-9.5 and USE CHLORAMINES AS SECONDARY DISINFECTANT
- 90<sup>TH</sup> PERCENTILE CONTENT IS 4 ppb 2020 (action level 15 ppb)

## DISINFECTION BY-PRODUCTS

- SIGNIFICANTLY BELOW REGULATORY STANDARDS
  - TRIHALOMETHANES (THMs/2021): 17 ppb (LIMIT 80 ppb)
  - HALOACETIC ACIDS (HAAs/2021): 12 ppb (LIMIT 60 ppb)

# WATER QUALITY:

## CHLORIDES: SODIUM, CALCIUM and MAGNESIUM

- AESTHETIC LEVEL 250 ppm (Secondary MCL)
- W/MassDOT TO UPDATE 1984 SALT STUDY – ON GOING
  - IN 1984 STUDY ~70% OF SALT WAS FROM MassDOT DEICING TREATMENT OF HIGHWAYS
  - WORKING WITH MassDOT, TOWNS AND BUSINESSES TO BETTER CONTROL DEICING PRACTICES
- HARDNESS: 68 ppm (Calcium and Magnesium)/ 4 GRAINS PER GALLON
- TOTAL DISSOLVED SOLIDS (TDS)/MINERALS - AESTHETIC LEVEL 500 ppm (Secondary MCL)
- HOT WATER SYSTEMS:
  - NEED TO DESIGN YOUR HOT WATER SYSTEM BASED ON WATER QUALITY
  - FLUSH/DRAIN/CLEAN HOT WATER HEATER AT LEAST ANNUALLY per manufacturers recommendation

# CAMBRIDGE WATER SYSTEM COSTS

## COSTS BASED on FY23 WATER DEPARTMENT BUDGET: **\$19.5M**

- OPERATING: \$13.5M, CAPITAL: \$6M
- COST TO PRODUCE WATER: \$7.4M OR \$1,593.53/MILLION GALLONS (MG)
- COST OF MWRA WATER in FY23: \$4,628.12/MG (~2.9 times our cost)
- FY23 BUDGET IF PURCHASING 100% OF MWRA WATER: **\$37.4M**

	FY23 Adopted Budget	\$19.5 m
Reduction in operating expenses (ENERGY, CHEMICALS and MAINTENANCE) and staff		(\$3.5 m)
	Cost to purchase MWRA water	<u>\$21.4 m</u>
	Total revised budget	\$37.4 m

- **91.6%** INCREASE IN WATER RATE TO CUSTOMERS

# CAMBRIDGE WATER SYSTEM COSTS

- BASIS: FY23 WATER DEPARTMENT BUDGET/WATER RATES
- **91.6%** WATER RATE INCREASE IF PURCHASING 100% OF WATER FROM MWRA

	FY23/UNIT	FY23/UNIT (w/MWRA)	INCREASE/UNIT (91.6%)
BLOCK 1:	\$3.11	\$5.96	\$2.85
BLOCK 2:	\$3.33	\$6.38	\$3.05
BLOCK 3:	\$3.54	\$6.78	\$3.24
BLOCK 4:	\$3.76	\$7.21	\$3.45
BLOCK 5:	\$4.08	\$7.82	\$3.74

	<u>FY22 Average</u>	<u>FY23 projected</u>	<u>FY23 projected w/MWRA water</u>	<u>Difference</u>	
single family	\$ 200.48	\$ 204	\$ 391	\$ 187.16	91.6%
two family	\$ 257.08	\$ 262	\$ 502	\$ 240.10	91.6%
three family	\$ 379.08	\$ 387	\$ 741	\$ 354.05	91.6%



# FUTURE - GO FORWARD STRATEGY

- THE CAMBRIDGE WATER SYSTEM IS A VERY ROBUST SYSTEM by DESIGN
- MULTIPLE BARRIERS via WATERSHED PROTECTION, TREATMENT and DISTRIBUTION
- ABILITY TO REMOVE **PFAS** AND OTHER POTENTIAL FUTURE CONTAMINANTS
- RESILIENCY and REDUNDANCY
  - MWRA AS A BACK-UP SUPPLY
- MAINTAIN CONTROL OF OUR FUTURE AND DESTINY
- LOWEST COST OPTION FOR RESIDENTS, BUSINESSES, INSTITUTIONS AND UNIVERSITIES

