

# Avon Memorial Water Filtration Plant

A Small System  
Solution for Manganese Removal

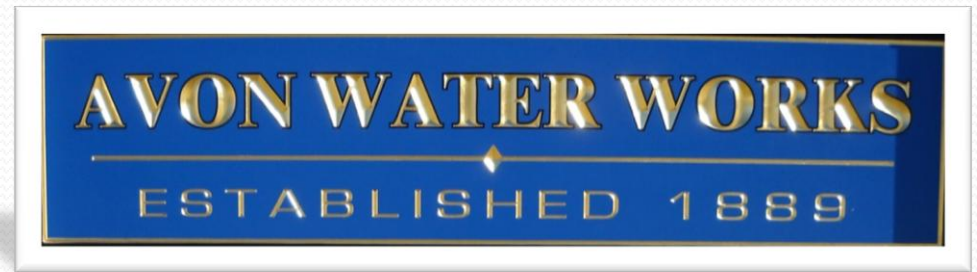


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# Presentation Outline

- Avon Background & Historic Water Quality
- Pilot Study
- WTP Design & Construction
- Results & Operational Procedures
- Conclusion

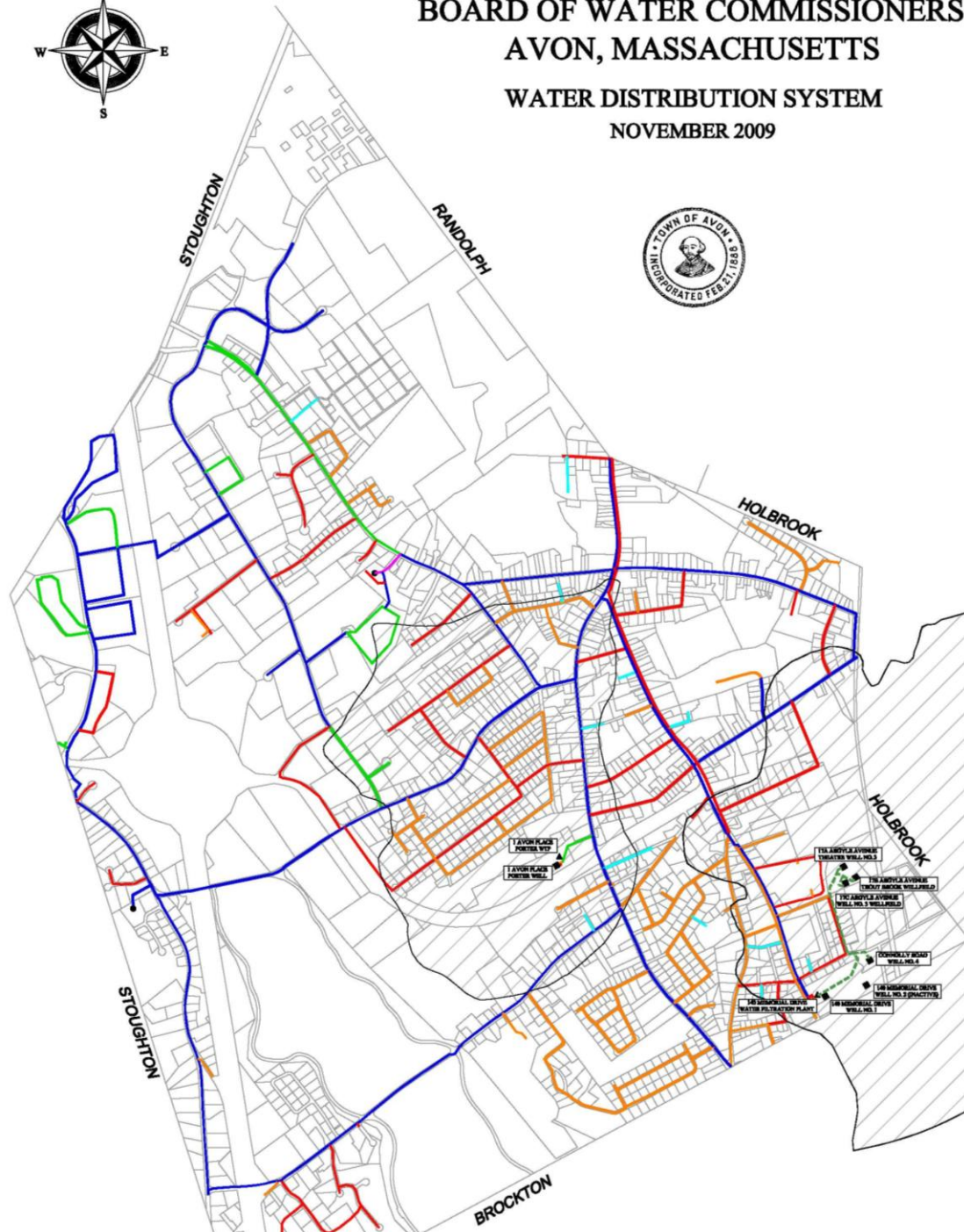


# Background

- Location
  - North of Brockton and East of Stoughton
- Distribution System
  - Population Served – 4,400
  - Active Well Supplies – 6 (All Groundwater)
  - Water Storage Facilities – 2 (Total of 2.5 MG)
  - 43 Miles of Distribution Watermains
  - All well supplies in Taunton River Basin
  - Avg. Day Demand – 0.43 MGD
  - Max Day Demand – 0.61 MGD



# BOARD OF WATER COMMISSIONERS AVON, MASSACHUSETTS WATER DISTRIBUTION SYSTEM NOVEMBER 2009



# Background

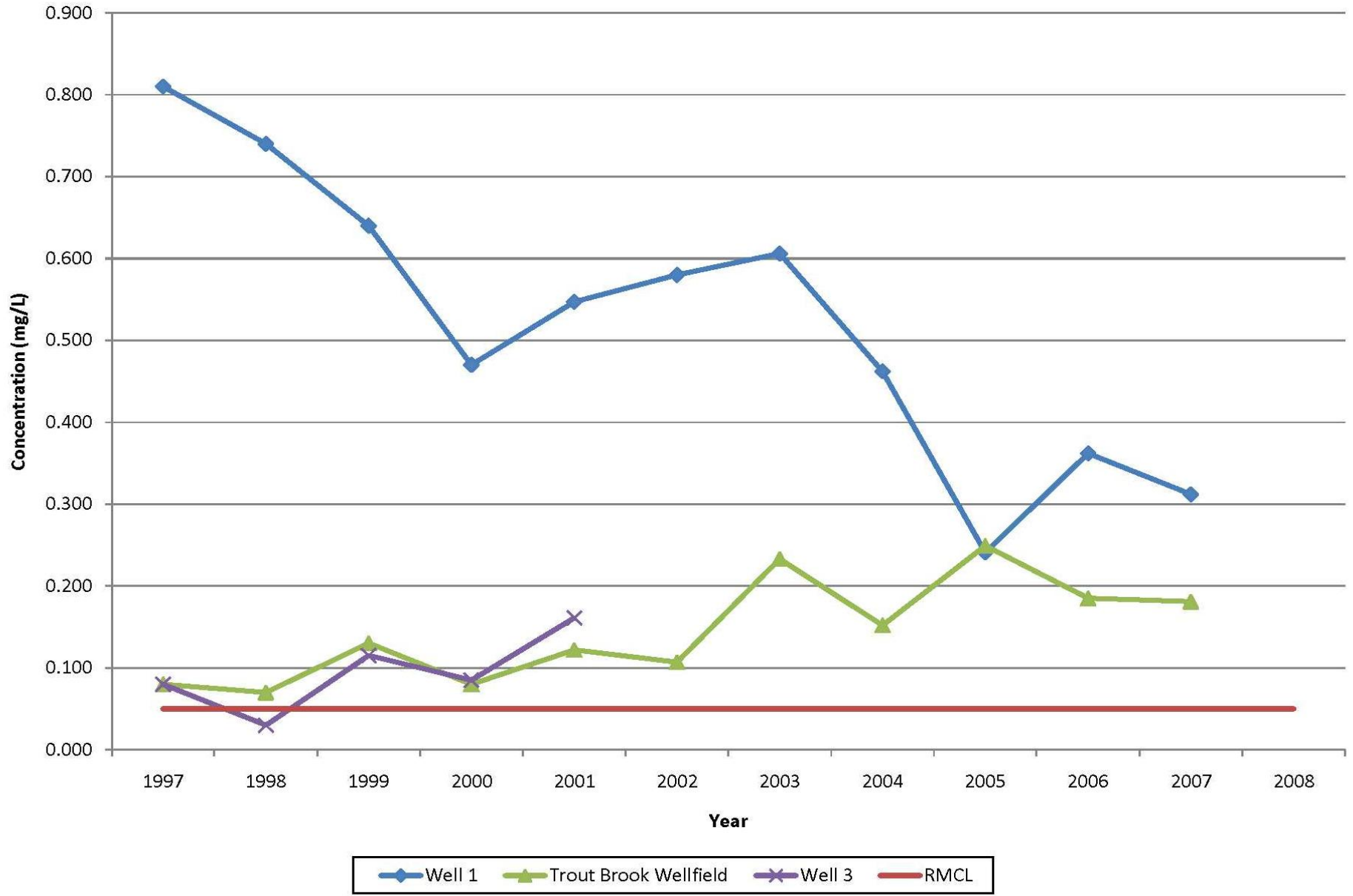
- Distribution System (cont.)
  - Well Supplies
    - Porter Well – Oldest dug well in the United States
    - Well No. 1
    - Well No. 2 (Inactive)
    - Well No. 3 (Emergency)
    - Well No. 4
    - Trout Brook Wellfield
    - Wellfield No. 3
  - All wells in Trout Brook Aquifer except Porter Well

# Background

- Historic Water Quality – Trout Brook Aquifer
  - Groundwater is Corrosive - pH of about 5.8
  - Excessive Manganese Levels – 0.05 to 1.4 mg/L
    - Secondary Maximum Contaminant Level – 0.05 mg/L
  - Iron Levels OK – 0.01 to 0.07 mg/L
  - MTBE Levels – ND to 29 µg/L
    - Secondary Maximum Contaminant Level – 20 to 40 µg/L
      - The secondary MCL for MTBE is based on the Drinking Water Advisory set by EPA and is based on taste and odor considerations.



# Historic Manganese Concentrations



# Background

- Historic Water Quality – Trout Brook Aquifer (cont.)
  - Poorest Water Quality – Well 1
    - Mn Levels 0.21 to 0.81 mg/L
    - pH 5.9
    - MTBE Levels ND - 29 µg/L
    - Adjacent to gasoline contamination in Brockton
- Decision to Proceed with Pilot Testing
  - Loss of public confidence in drinking water
  - Reduction of frequent flushing
  - Appropriation of funds in 2006



# Pilot Study

- Conducted in Spring/Summer 2006
- Four treatment processes selected for Mn removal
  - Membrane Filtration
    - Koch Membrane Systems
    - Zenon Environmental (now GE)
  - Pressure Filtration
    - Hungerford & Terry
    - Layne Christensen

# Pilot Study

- MTBE removal piloted concurrently
  - Selected process - GAC
  - GAC filter furnished by Norit Americas
  - Hungerford & Terry ran the process concurrent with their pilot
- Well No. 1 raw water utilized for all piloted processes
  - Raw water quality throughout testing
    - Mn Concentrations – 0.3 mg/L
    - MTBE Concentrations – 7 µg/L



# Pilot Study

- Goals
  - Reduce Mn concentration to  $\leq 0.03$  mg/L
  - Reduce MTBE concentration to non-detect
  - Optimize production and chemical dosage
  - Minimize capital cost of full-scale treatment



# Pilot Study

- Koch Membrane Systems
  - Ultrafiltration hollow-fiber membranes
  - Raw water pH raised to 7.7
  - Potassium Permanganate utilized as oxidant
    - Dosage rate about 0.96 mg/L
  - “Inside-out” – Clean water forced across membranes to outside under slight positive pressure to inside of fibers
  - Oxidized manganese discharged to waste



# Pilot Study

- Zenon Environmental
  - Ultrafiltration hollow-fiber membranes
  - Raw water pH raised to 7.7
  - Potassium Permanganate utilized as oxidant
    - Dosage rate about 0.96 mg/L
  - “Outside-In” – Clean water forced across membranes to inside under slight negative pressure on fibers
  - Oxidized manganese discharged to waste





# Pilot Study

- Hungerford & Terry
  - Pressure filtration
  - Raw water pH raised to 7.2
  - Sodium hypochlorite utilized as oxidant
    - Dosage rate about 1.5 mg/L
  - Media – 18” GreensandPlus  
18” Anthracite
  - Backwash interval – 5 days



# Pilot Study

- Layne Christensen
  - Pressure filtration
  - Raw water pH raised to 7.2
  - Sodium hypochlorite utilized as oxidant
    - Dosage rate about 1.0 mg/L
  - Media – 48” of LayneOx
  - Backwash interval – 5 days





# Pilot Study - Results

- Water Quality
  - Results consistent for each process
    - Raw water Mn concentrations 0.25 mg/L to 0.40 mg/L
    - Finished water Mn concentrations 0.06 mg/L to non-detect
  - MTBE concentrations reduced from 5 to 7  $\mu\text{g/L}$  in raw water to non-detect in finished water
- Process Efficiency – Goal 95%
  - Membrane Process – Koch, 95%; Zenon, 97%
  - Pressure Filtration – H&T, 98%; Layne, 99%
- Process Equipment Cost
  - Membranes significantly more expensive

# WTP Design

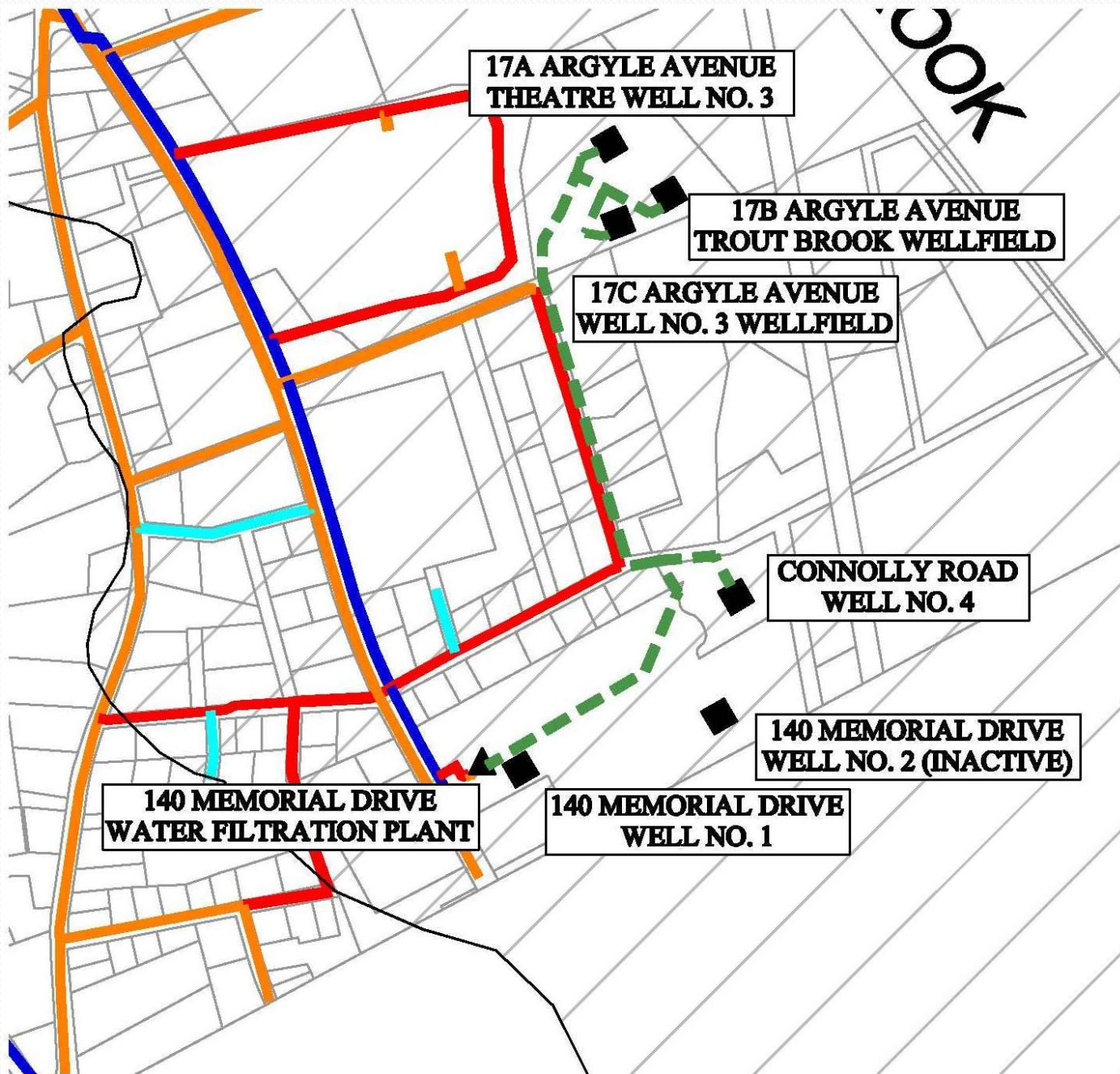
- Selection of Treatment Processes
  - Pressure filtration for Mn removal
  - GAC for MTBE removal
- Procurement of Process Equipment
  - Equipment footprints vary by manufacturer
  - Building design and process piping dependent on selected manufacturer
- Selection of Manufacturer
  - H&T selected for Mn removal
  - Calgon Carbon for MTBE removal

# WTP Design

- H&T System
  - Two 9-ft. diameter pressure filters
  - 4-ft. of filter media
    - 1-ft. gravel support bed
    - 1.5-ft. anthracite
    - 1.5-ft. GreensandPlus
  - GreensandPlus
    - Higher differential pressure
    - Longer run times
    - Reduced backwash frequency

# WTP Design

- Site Selection
  - Two Town-owned parcels in proximity to Trout Brook aquifer
- Argyle Avenue
  - Located adjacent to Operations Center
  - Close to 3 out of 5 wells
  - Unfavorable soils, challenging site design
- Memorial Avenue – Selected Site
  - Located adjacent to Well No. 1
  - Favorable soils, ground grades



**17A ARGYLE AVENUE  
THEATRE WELL NO. 3**

**17B ARGYLE AVENUE  
TROUT BROOK WELLFIELD**

**17C ARGYLE AVENUE  
WELL NO. 3 WELLFIELD**

**CONNOLLY ROAD  
WELL NO. 4**

**140 MEMORIAL DRIVE  
WELL NO. 2 (INACTIVE)**

**140 MEMORIAL DRIVE  
WELL NO. 1**

**140 MEMORIAL DRIVE  
WATER FILTRATION PLANT**

**COOK**

# WTP Design

- Transmission Main
  - Conveys water from Wells 3 & 4 and Trout Brook and Well 3 wellfields
  - Partially directionally drilled through wetlands
- Corrosion Control Facilities
  - Utilized existing facilities to continue to raise pH and add sodium hypochlorite as an oxidant



# WTP Design

- Building
  - 52-ft. x 70-ft. pre-engineered metal building
- Office/Control Room
- Chemical Feed System
  - Sodium hypochlorite fed in plant discharge
- Clearwell
  - 13,000 gallon capacity
  - 2 High-lift pumps



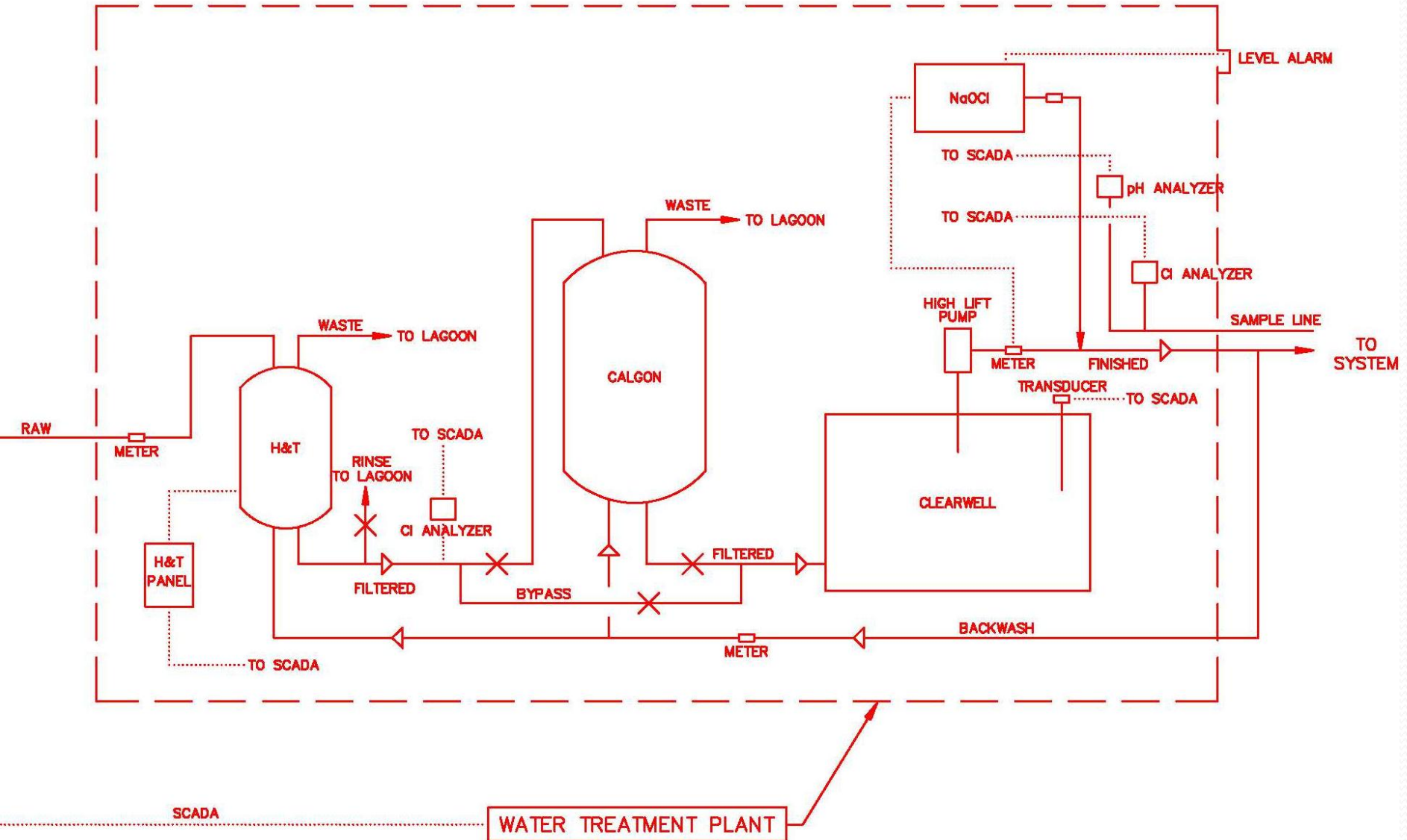


# WTP Design

- Calgon Carbon – MTBE removal
  - System can be bypassed
- Two-Tiered Lagoon System
- Standby Power – Natural Gas Generator
- Instrumentation System
- Security System



# WTP Process Flow Diagram





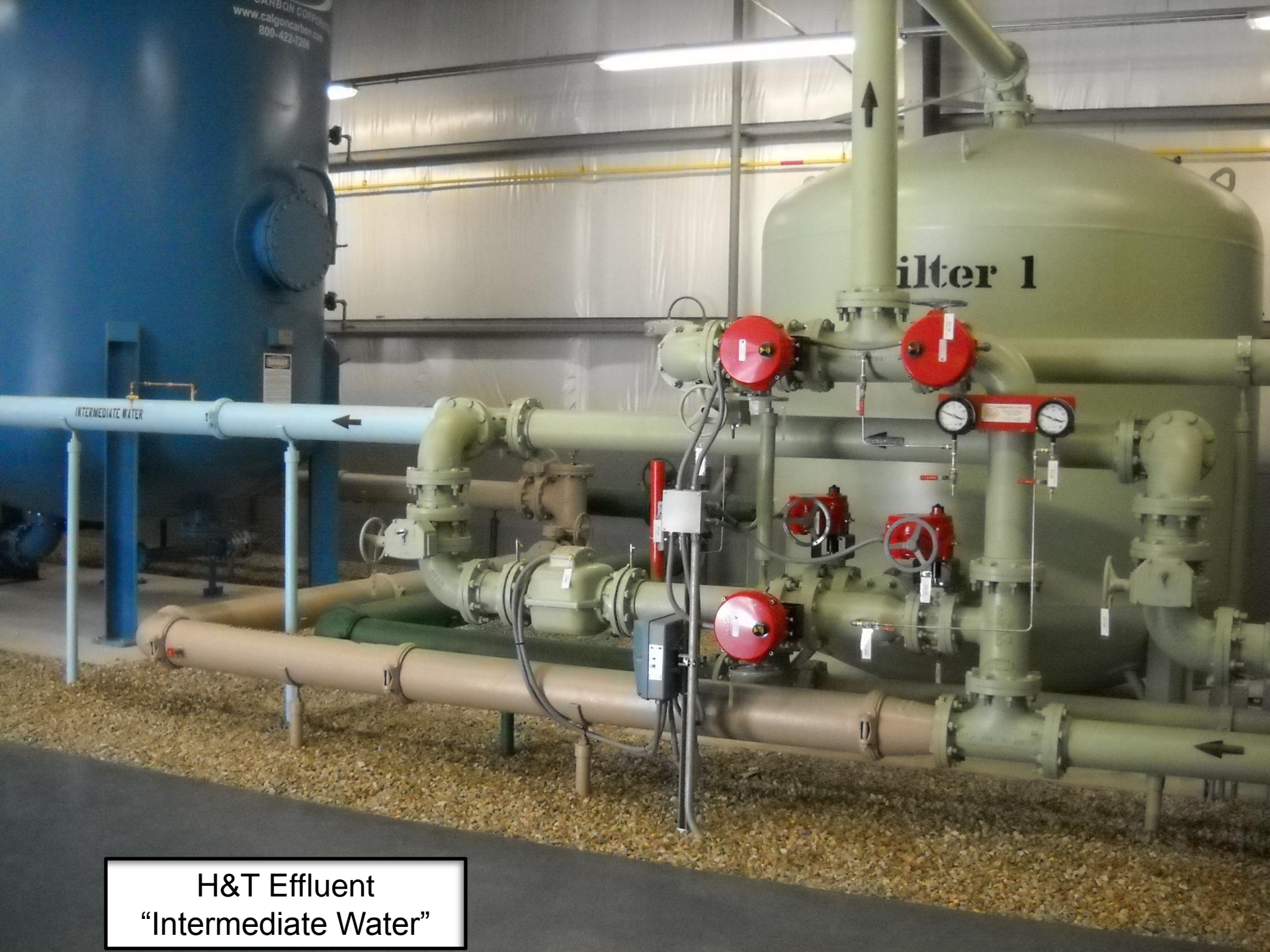


**Filter 1**

**Filter 2**

**H&T Pressure Filters**





H&T Effluent  
"Intermediate Water"





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www.calgoncarb.com  
800-422-7268

**CALGON**  
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LINED TANK - DO NOT  
WELD/BURN OR TAP

LINED TANK - DO NOT  
WELD/BURN OR TAP

INTERMEDIATE WATER

INTERMEDIATE WATER

**Calgon Carbon System**





High-Lift Pumps

Clearwell



Sodium Hypochlorite  
Feed System



**DANGER**  
SODIUM  
HYPOCHLORITE

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Backwash & Waste  
Water Mains



A photograph of a water treatment facility. In the foreground, there is a concrete area with four red pipe caps. Behind this is a large, flat, brownish area labeled 'Upper Lagoon Sand Filter Bed'. Above the sand filter bed is a wide, shallow channel filled with grey gravel, labeled 'Lower Lagoon'. To the right, there is a large, blue, arched metal building. The background consists of a dense line of trees, some evergreen and some bare, under a clear blue sky.

Lower Lagoon

Upper Lagoon  
Sand Filter Bed



# Results & Operational Procedures

- WTP Online October 30, 2009
- Instrumentation/Security System
- Water Quality Testing
  - Reduction of distribution system entry points
- Blending of Water
  - Reduction of influent Mn concentrations
  - Prolonged backwash cycles

# Results & Operational Procedures

- Backwash Frequency
  - Default setting - differential pressure of 10 psi
  - Town reset to 5 psi
  - Backwash once every 3 days
  - Backwash also initiated by runtime
  - Fully automated
- Calgon Carbon System
  - Manual backwash system
  - Backwash once per year

# Results & Operational Procedures

- Monitoring
  - Influent and effluent Mn concentrations
  - Differential pressures for both H&T and Calgon systems
  - Raw and finished water pH
  - Raw and finished water chlorine concentration
  - Intermediate water chlorine concentration

# Conclusions

- Manganese Concentrations
  - Goal  $\leq 0.03$  mg/L
  - Finished water often non-detect
- Plant Efficiency
  - Goal 95%
  - Currently 97.4%
- Total Cost: \$2.3 million
- Meeting water quality expectations!

# Questions?

- Contact Information

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