Policy and Planning to Address Impacts of Forest Fires to Source Water Quality

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City of Phoenix
Water Services
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(Water Quality)

October 28, 2011

Story Table of Contents

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- The Plan
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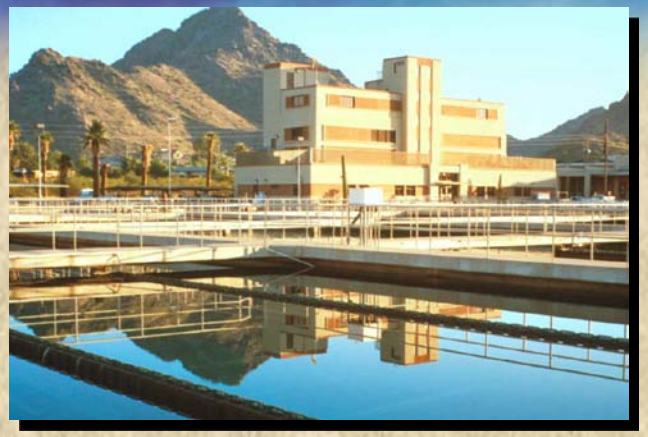
City of Phoenix Background

- Six Surface Water Treatment Plants
  - Two water sources
  - 100 Billion Gallons per year
- 540 Square Miles of Service Area
  - 400,000 Accounts
  - 7,000 miles of distribution mains
- System Conditions
  - Periods of elevated TOC Levels
  - Higher Temperature
  - 77 Major Pressure Zones
    - Water Age (5+ days)
    - Chlorine Residual



Colorado River (CAP)

43%

Groundwater

3%

Verde River

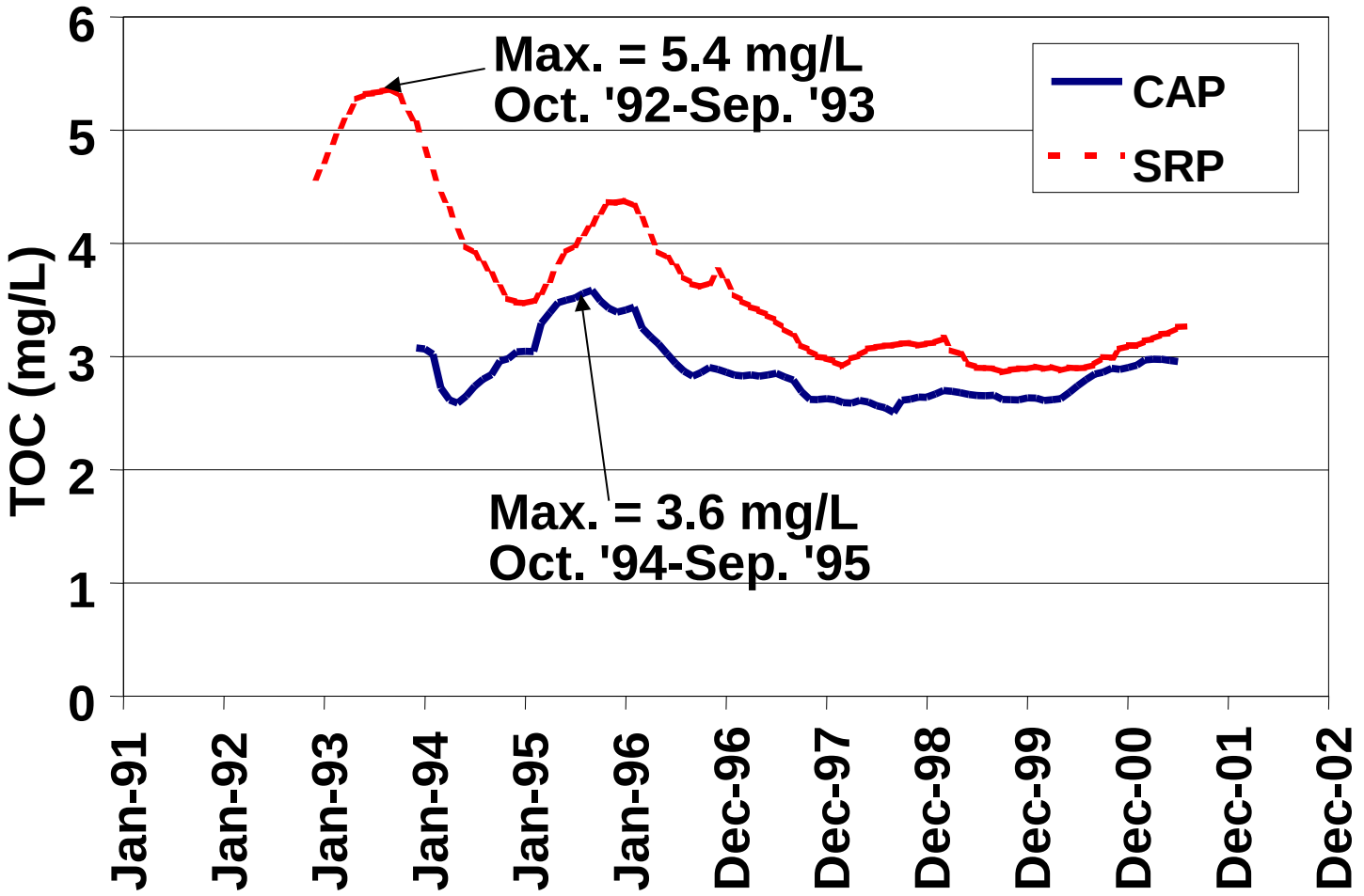
49%

Combined

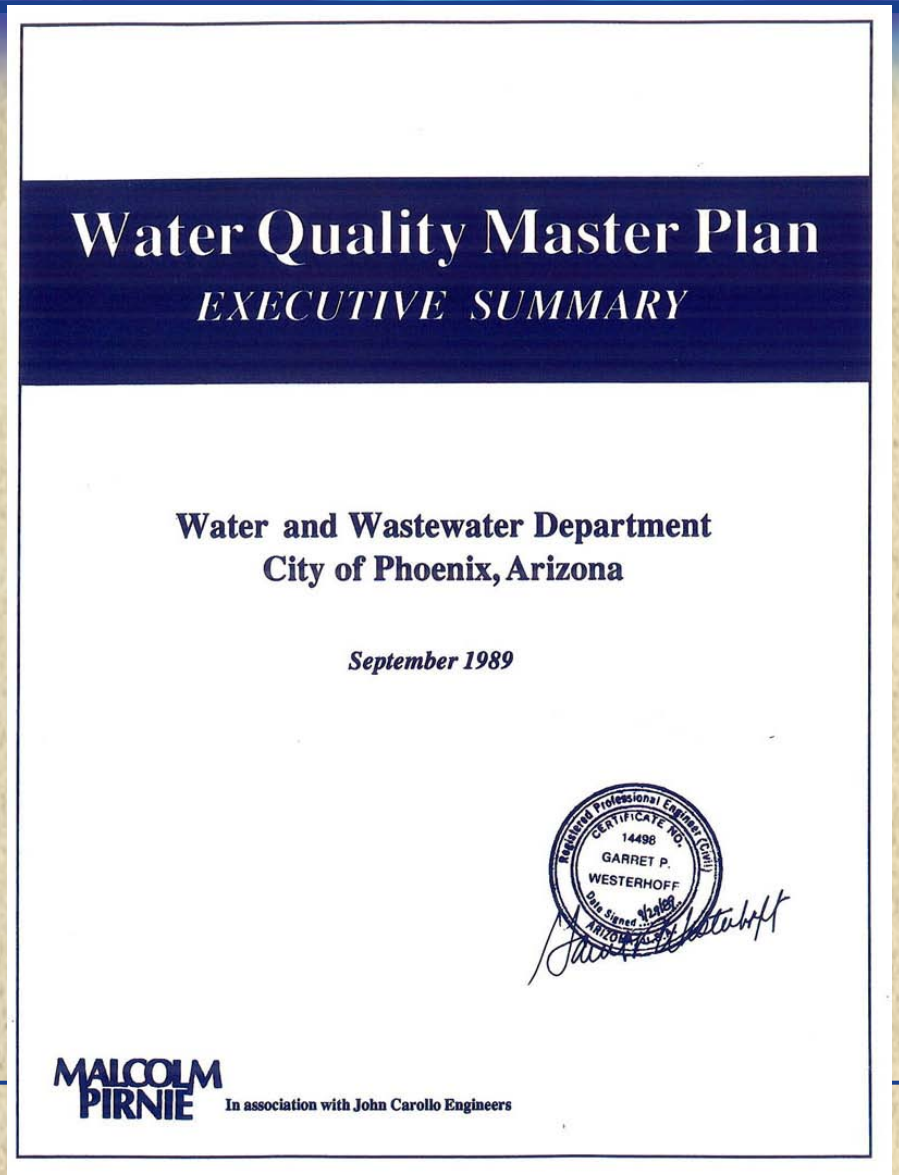
Reclaimed Wastewater

Salt River

Historical Total Organic Carbon in Source Waters (up to 2001)



Chapter 1 - The Plan (1989)



Water Quality Master Plan

EXECUTIVE SUMMARY

Water and Wastewater Department
City of Phoenix, Arizona

September 1989

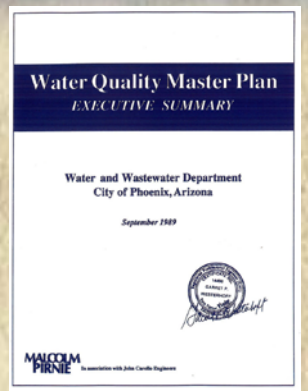
Registered Professional Engineer (Civil)
CERTIFICATE NO.
14498
GARRET P.
WESTERHOFF
Date Signed 9/29/89
ARIZONA U.S.A.

MALCOLM PIRNIE In association with John Carollo Engineers

City of Phoenix

D1

First Water Quality Master Planning Effort



1970 1980 1990 200 0 2010 2020

SDWA

SDWA

THM Rule

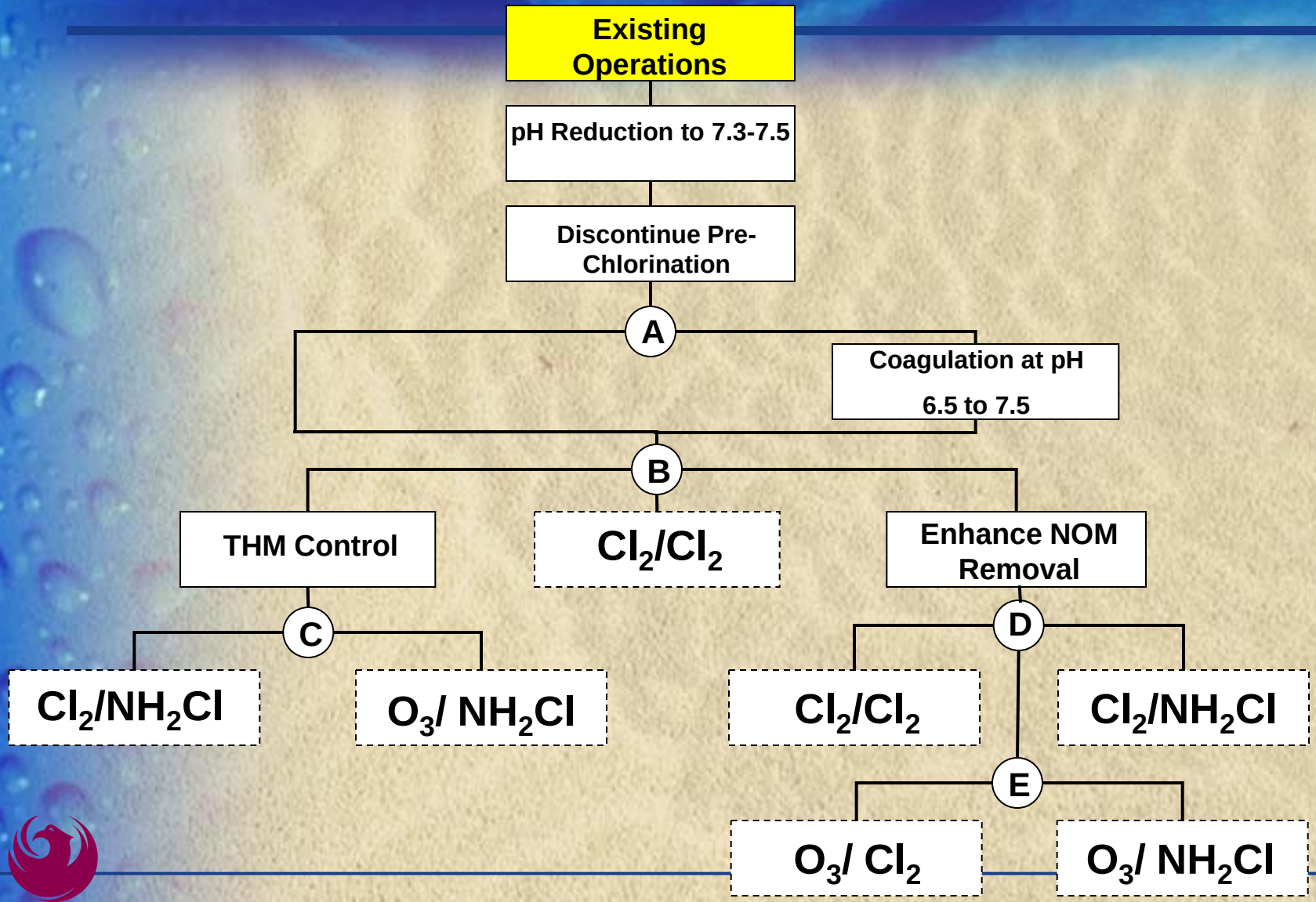
Purpose of 1989 Water Quality Master Plan

- Identify water quality improvement options for City's potable water delivery
  - Consider changing/uncertain regulatory environment
  - Provide healthful and best quality water to customers
  - Robust multiple barriers for multitude of contaminants
- Recommend long-term strategies for treatment process upgrades
- Identify key decision points

Highlights of 1989 Water Quality Master Planning Approach

- Seek advice of leading water industry experts to gage regulatory direction and best approach for compliance
- Conduct extensive bench and pilot-scale evaluation of potential treatment strategies
- Analyze treatment options for feasibility and cost
- Develop a road map with identified decision points
- Recommend short-term and long-term CIP strategies

Roadmap from 1989 Plan



1989 WQMP Recommendations

- Maintain chlorine usage
  - Primary and Secondary
- Reduce dissolved organics within existing design
  - Enhanced Coagulation
- Optimize distribution system to reduce water age

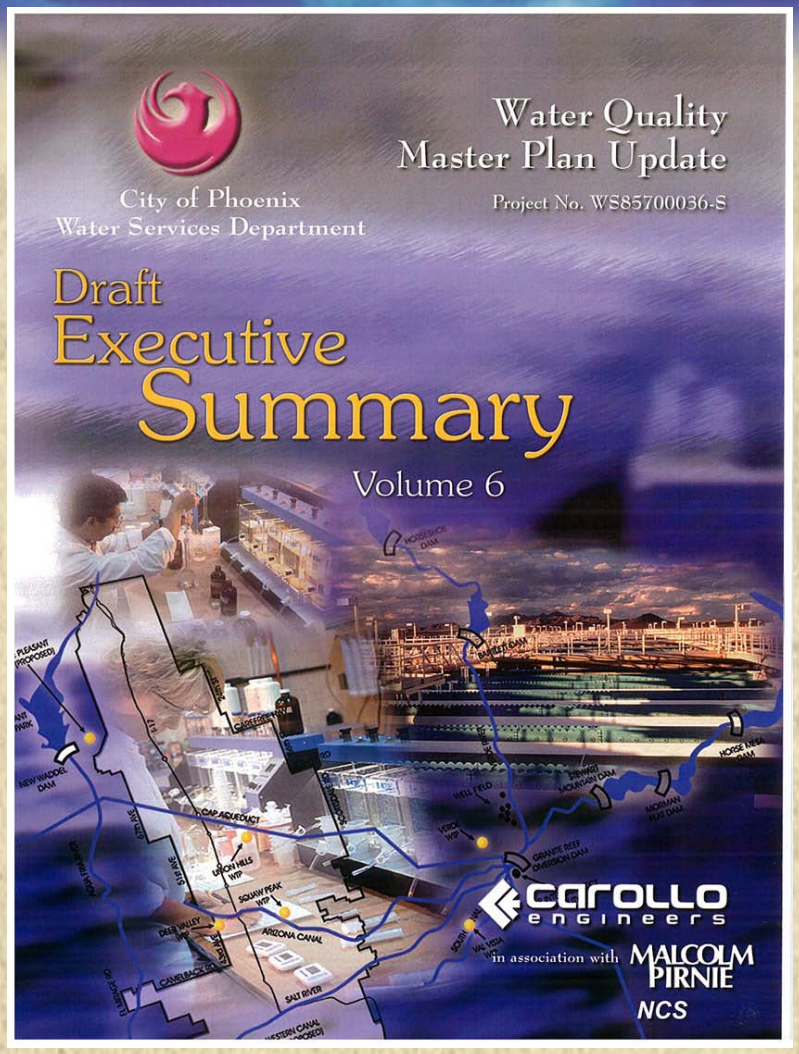
1989 WQMP Recommendations cont.

"At such time removal of TOC is required beyond capability of the plants, as designed, a choice will need to be made."

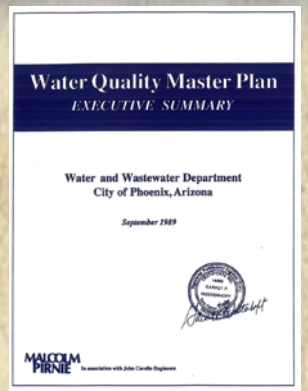
Options to be evaluated in future

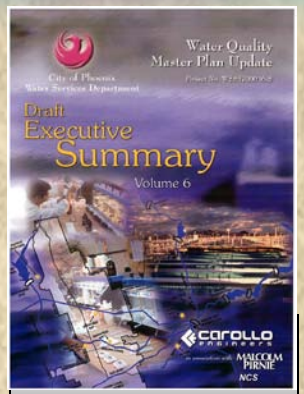
- Enhanced TOC removal through GAC
- Change from free chlorine to chloramines

Chapter 2 - The Plan Update (2006)



New Regulatory Drivers for Water Quality Planning





1970 1980 1990 200 0 2010 2020

SDWA

SDWA

SDWA

THM Rule

Stage 1 DBP Rule

Stage 2 DBP Rule

City of Phoenix

D2

Stage 2 DBP Rule

- Aimed at reducing customer exposures to harmful disinfection by products (Trihalomethanes and Haloacetic Acids)
  - DBPs have been regulated since 1979
  - New Rule does not allow averaging over the entire system
  - Compliance is required beginning 2nd Q 2012
- City of Phoenix challenges for compliance with this rule include:
  - Elevated water temperatures
  - Long water age

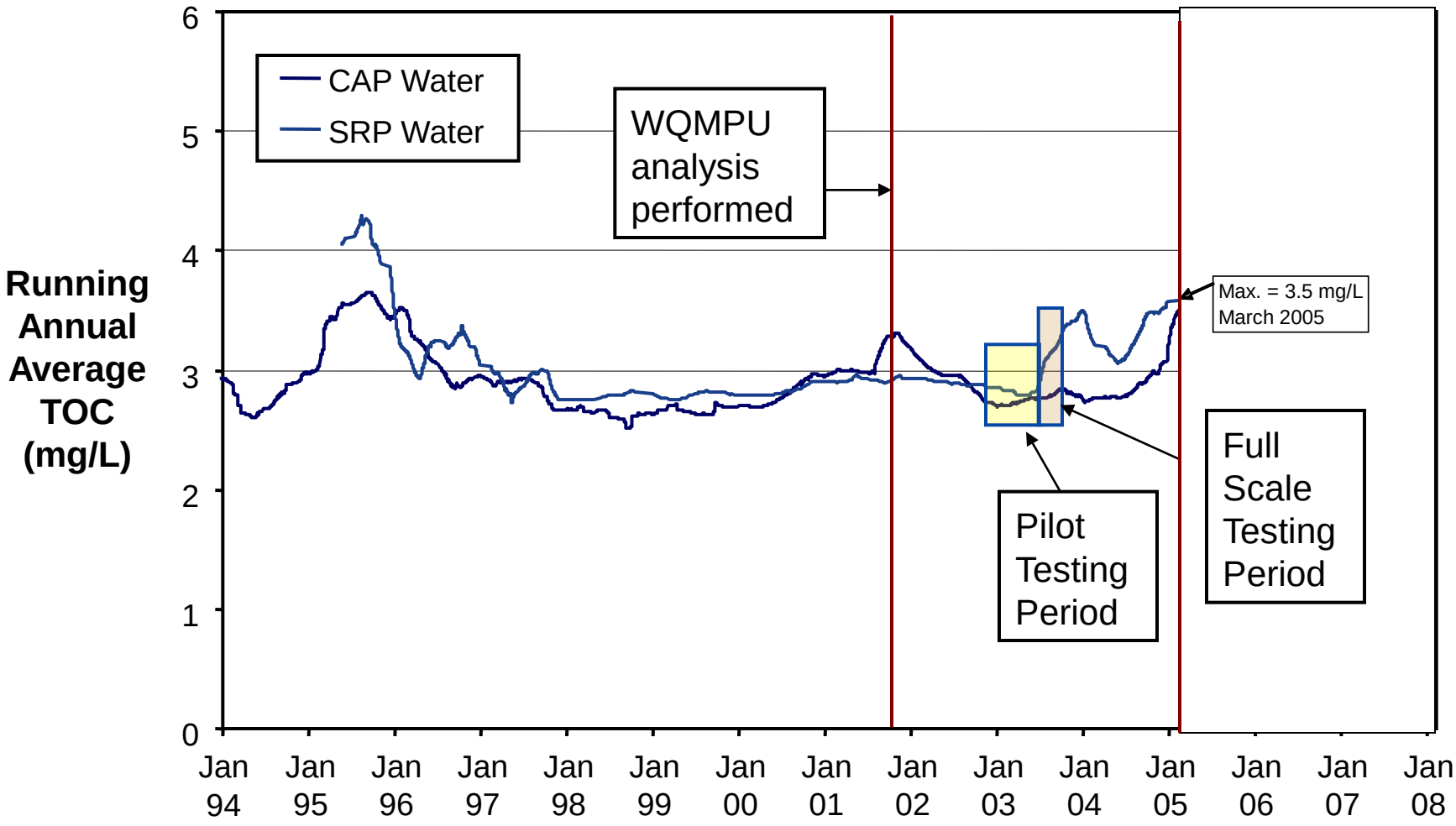
Purpose of 2006 Water Quality Master Plan Update

- Re-assess water quality goals and underlying philosophy of potable water treatment
  - Consider water quality parity
  - Consider improvements in treatment technology
  - Incorporate new information about disinfection, DBPs, and other contaminants
- Recommend treatment process upgrades needed for the known and emerging regulations

Highlights of 2006 Water Quality Master Planning Approach

- Stakeholder input from various City divisions to develop a consensus about potential strategies
- Examine chloramination
- Perform scenario planning to address future uncertainties
- Conduct extensive pilot-scale
  - GAC
  - Chloramination, and Ozonation

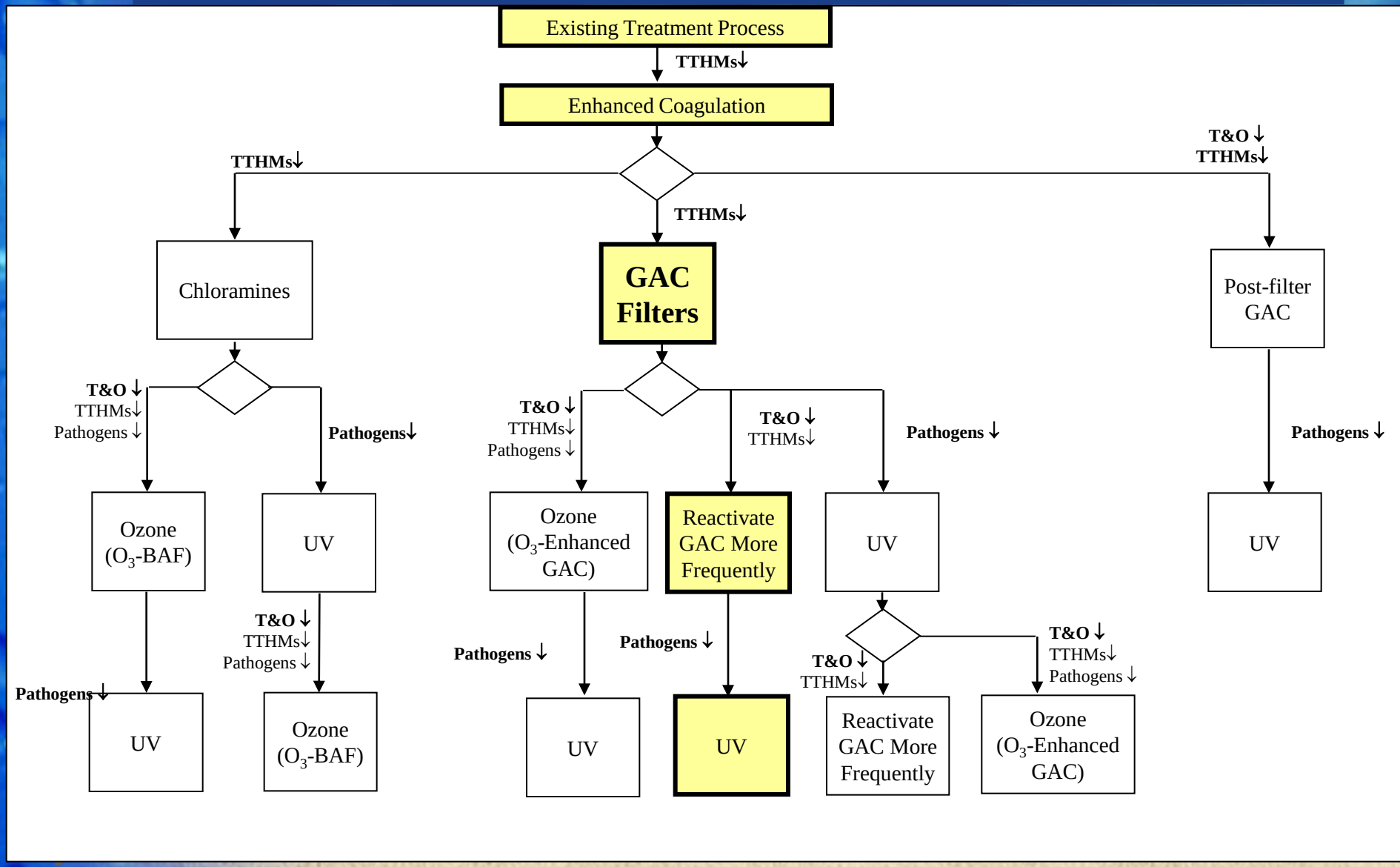
Historic TOC Values



CAP water data compiled from Union Hills WTP and Pyramid Peak WTP (Glendale) raw water data

SRP water data compiled from 24th Street WTP and Cholla WTP (Glendale) raw water data

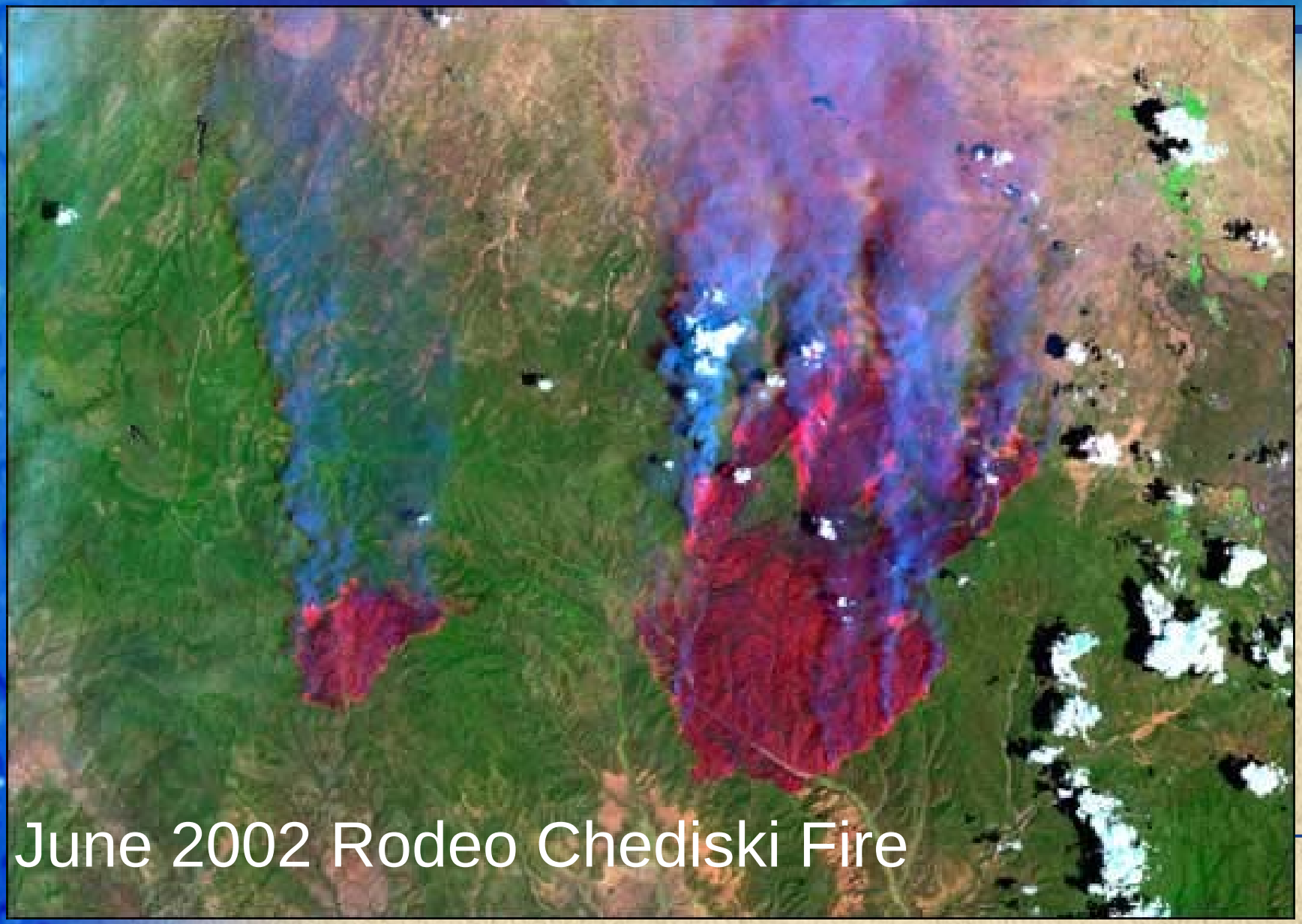
Results of Alternatives Evaluation



Recommendations from 2006 Water Quality Master Plan

- Implement GAC Filter Adsorbers at all WTPs based on:
  - Additional cost of GAC is still within the comfort zone in light of the fact that the risks of exposure to contaminants is greatly minimized with GAC treatment
- Chlorine dioxide is recommended
  - Preoxidant to precipitate iron and manganese
  - Allows for the elimination of prechlorination

Chapter 3 - The Event

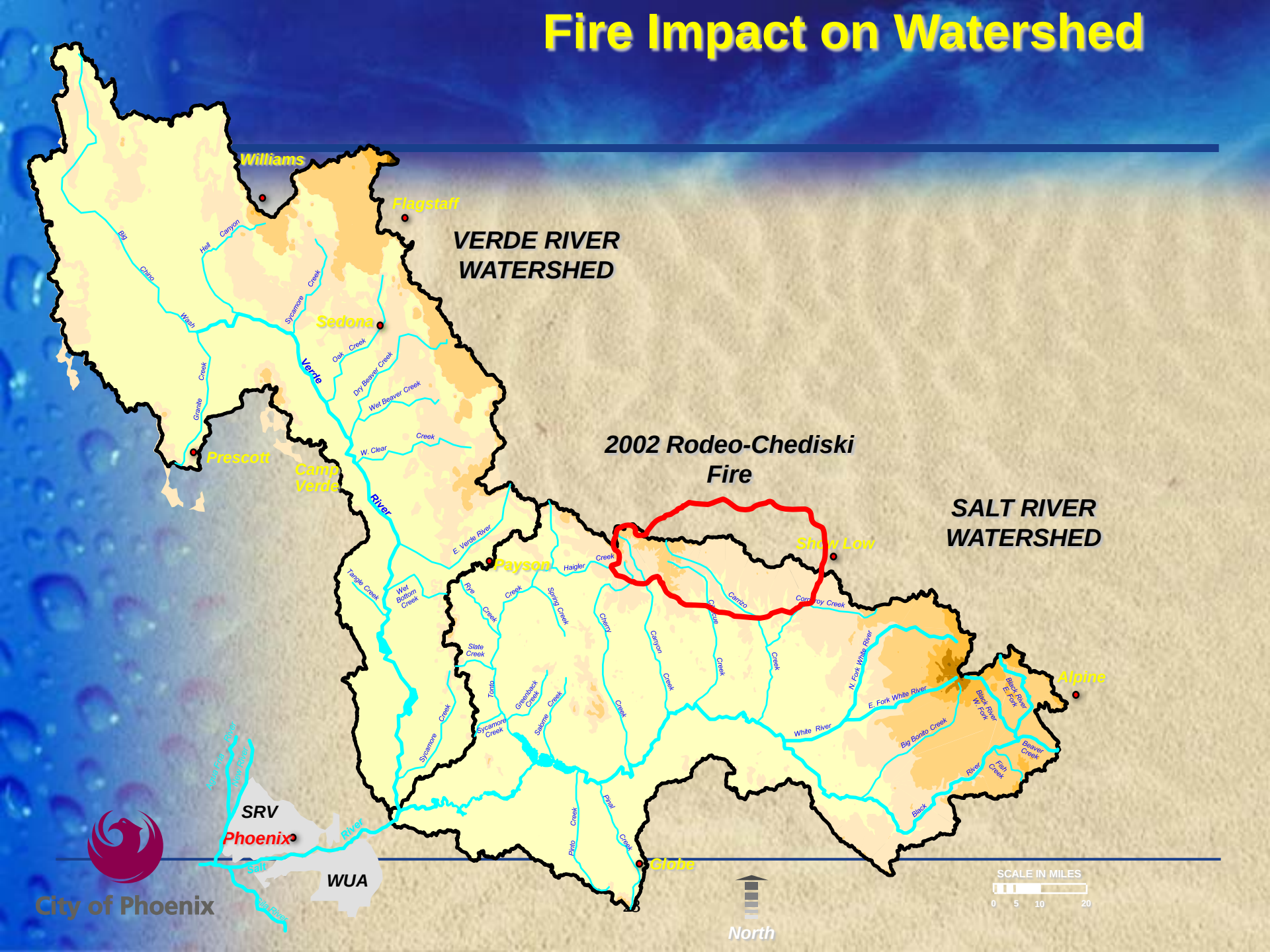


June 2002 Rodeo Chediski Fire

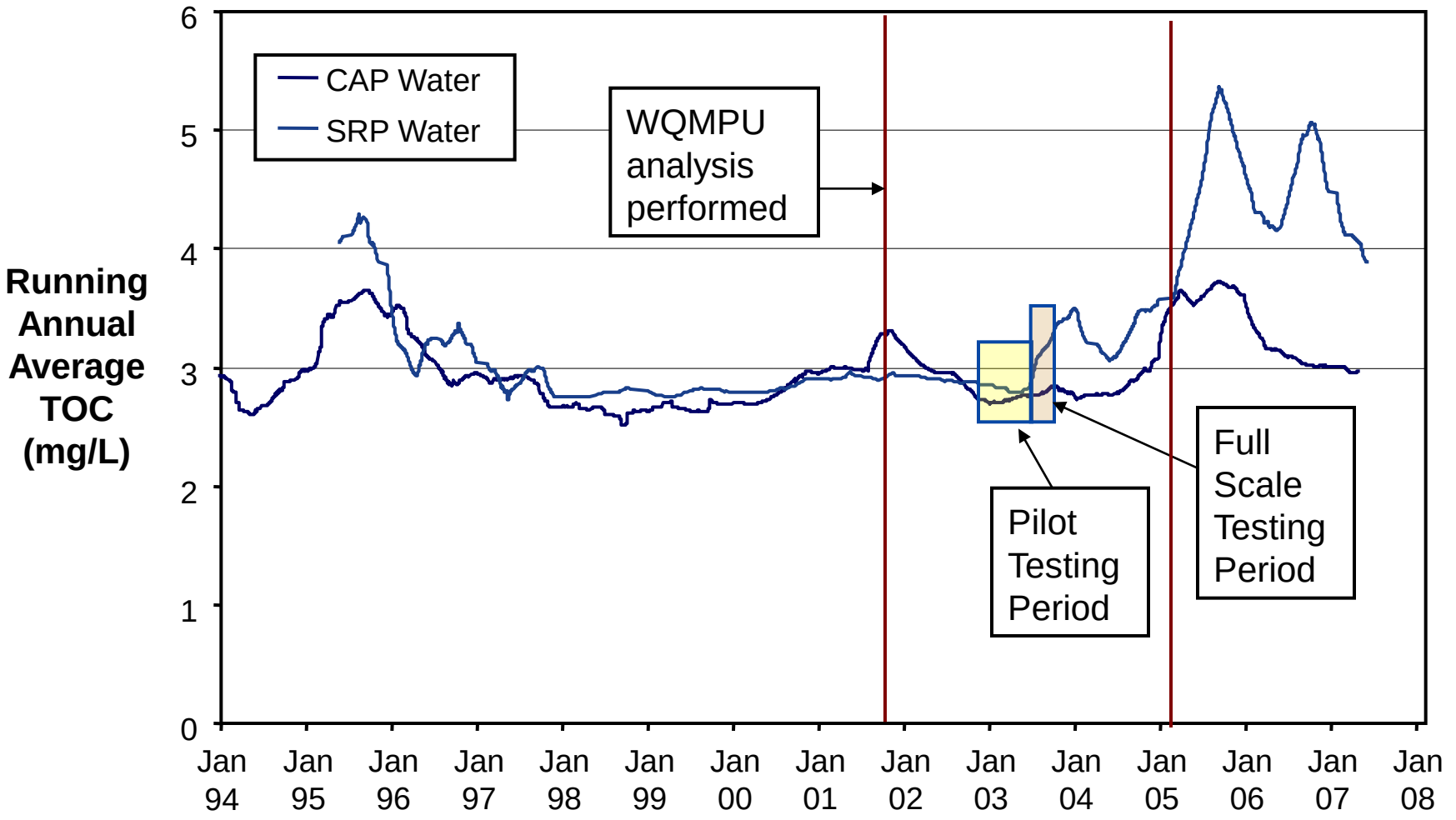
Rodeo-Chediski Fire
468,638 acres
June 2002

Standing dead trees on the Rodeo-Chediski Fire area.

Fire Impact on Watershed



Changes in Source Water Quality



CAP water data compiled from Union Hills WTP and Pyramid Peak WTP (Glendale) raw water data

SRP water data compiled from 24th Street WTP and Cholla WTP (Glendale) raw water data

Chapter 4 -Question the Plan (Take a Trip)

GAC

UV

KMnO4

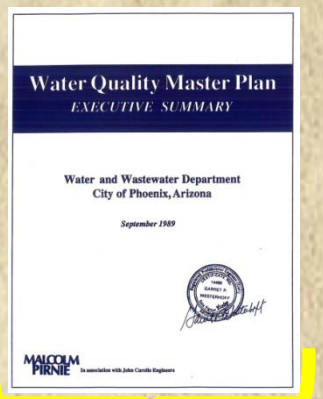
Enhanced Coagulation

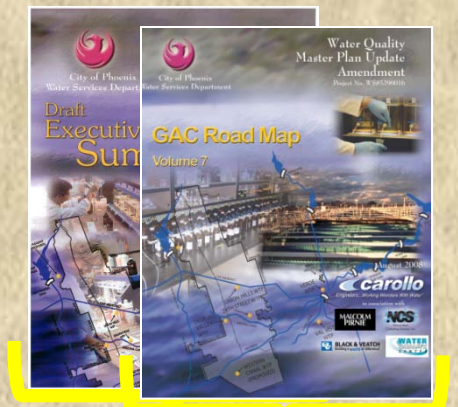
Membrane

Ozone

MIEX

Initiation of GAC Roadmap





- *WQMP Updates*
- *GAC Roadmap*

1970 1980 1990 2000 2010 2020

SDWA

THM Rule

SDWA Amendment

SDWA Amendment

Elevated TOC

age 2 P Rule

City of Phoenix

D3

Primary Reasons for Concerns about the recommended approach

- Prolonged period of elevated TOC would require frequent replacement of GAC resulting in:
  - Operational hardship
  - Financial hardship

What Changed?

- Re-evaluation of Water Quality Philosophy
  - DBP Rule Compliance (Primary Focus) While Maintaining Flexibility to Implement Long-Term Water Quality Goals
  - Allow 90% TTHM MCL
  - Allow for WTP Specific TOC Targets
  - Allow for Seasonal TOC Targets
    - 1st and 4th Quarter - 56 ug/L TTHM
    - 2nd and 3rd Quarter – 88 ug/L TTHM
- Reduce life cycle costs of GAC Program

GAC Road Map Project Considered Alternatives (Lower Life cycle costs)

GAC

UV

KMnO4

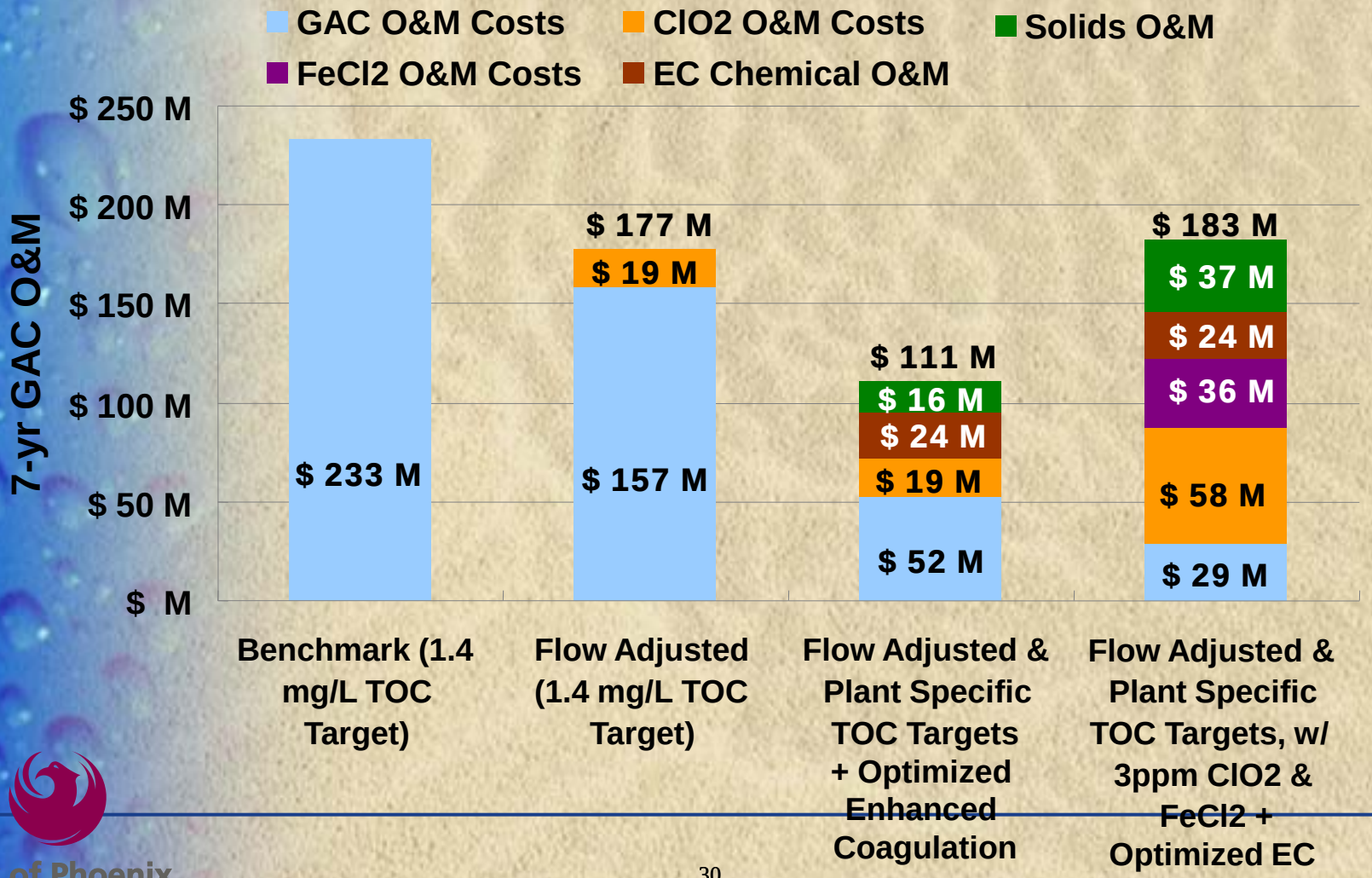
Enhanced Coagulation

Membrane

Ozone

MIEX

7-Yr Cycle GAC O&M Costs plus ClO2 + FeCl2 O&M Costs



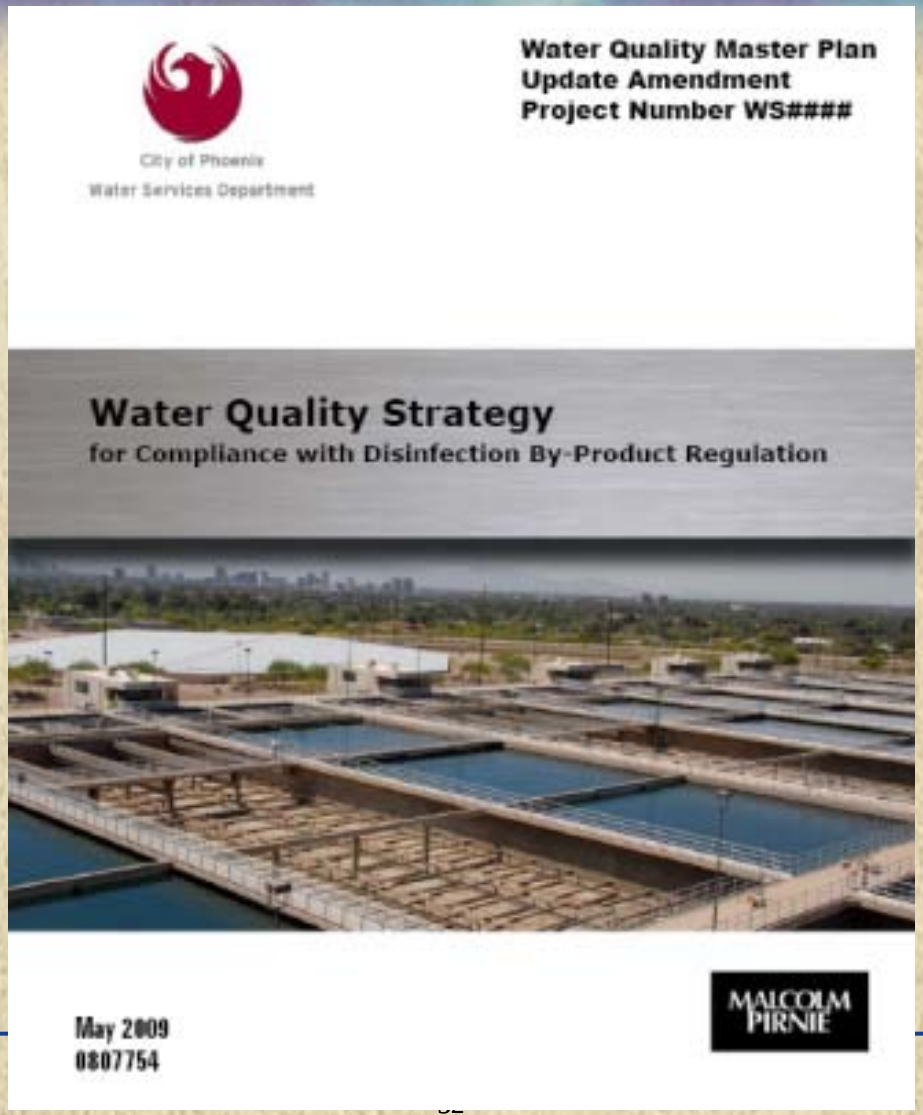
City of Phoenix

D3

GAC Road Map Results

- Continue with GAC Program
  - GAC Filter Adsorbers
    - VV WTP and DV WTP
  - Filter Contactors
    - 24th Street WTP
  - Biologically Active GAC Filters
    - UH WTP
- Chlorine Dioxide
  - Pre-Oxidant at 1 ppm max
- Optimize Enhanced Coagulation

Chapter 5 - The New Plan – High Rate Chlorine Dioxide



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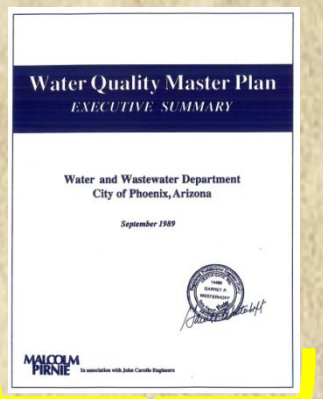
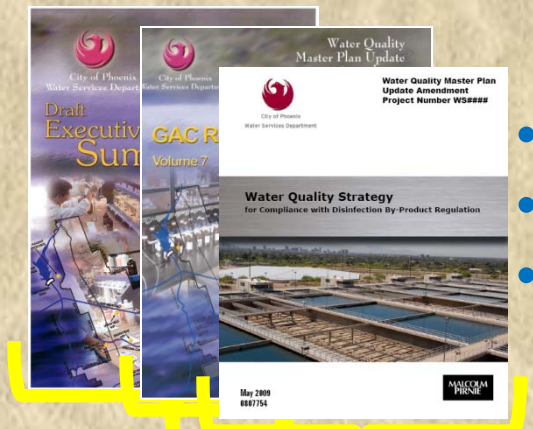
D4-D5

Revised Water Quality Strategy





- *WQMP Updates*
- *GAC Roadmap*
- *WQ Strategy*

1970 1980 1990 2000 2010 2020

SDWA

THM Rule

SDWA Amendment

SDWA Amendment

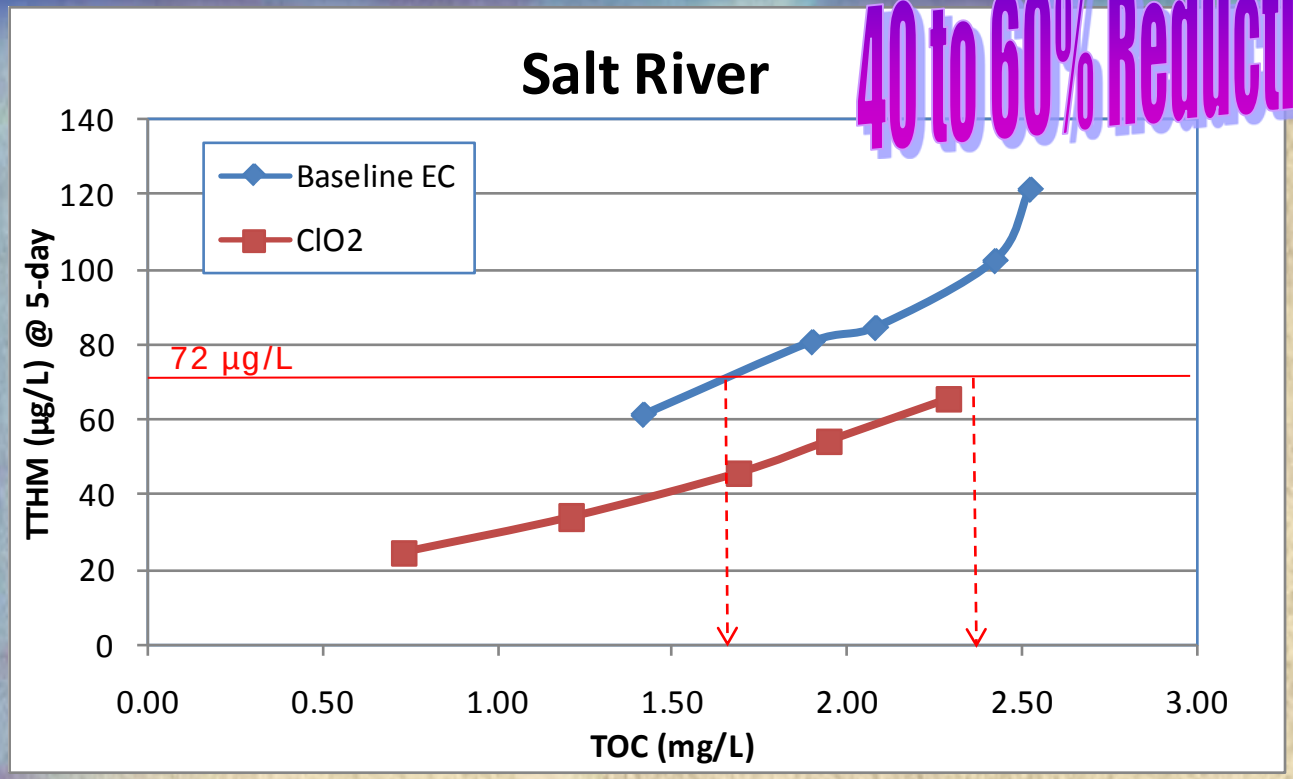
Stage 1 DBP Rule

Stage 2 DBP Rule

Key Factors Considered

- Operational Flexibility
  - Multiple tools
  - Technologies can be switched “on/off”
  - Opportunities for operational cost savings
- Maximize Future Options
  - Adaptability to future regulatory changes
- Life Cycle Cost
  - Total costs of the compliance strategy

Chlorine Dioxide RSSCTs – SDS DBP Testing



TOC target increases when ClO_2 is applied:

- 1.60 mg/L for Baseline EC
- 2.40 mg/L for ClO_2 pre-treatment

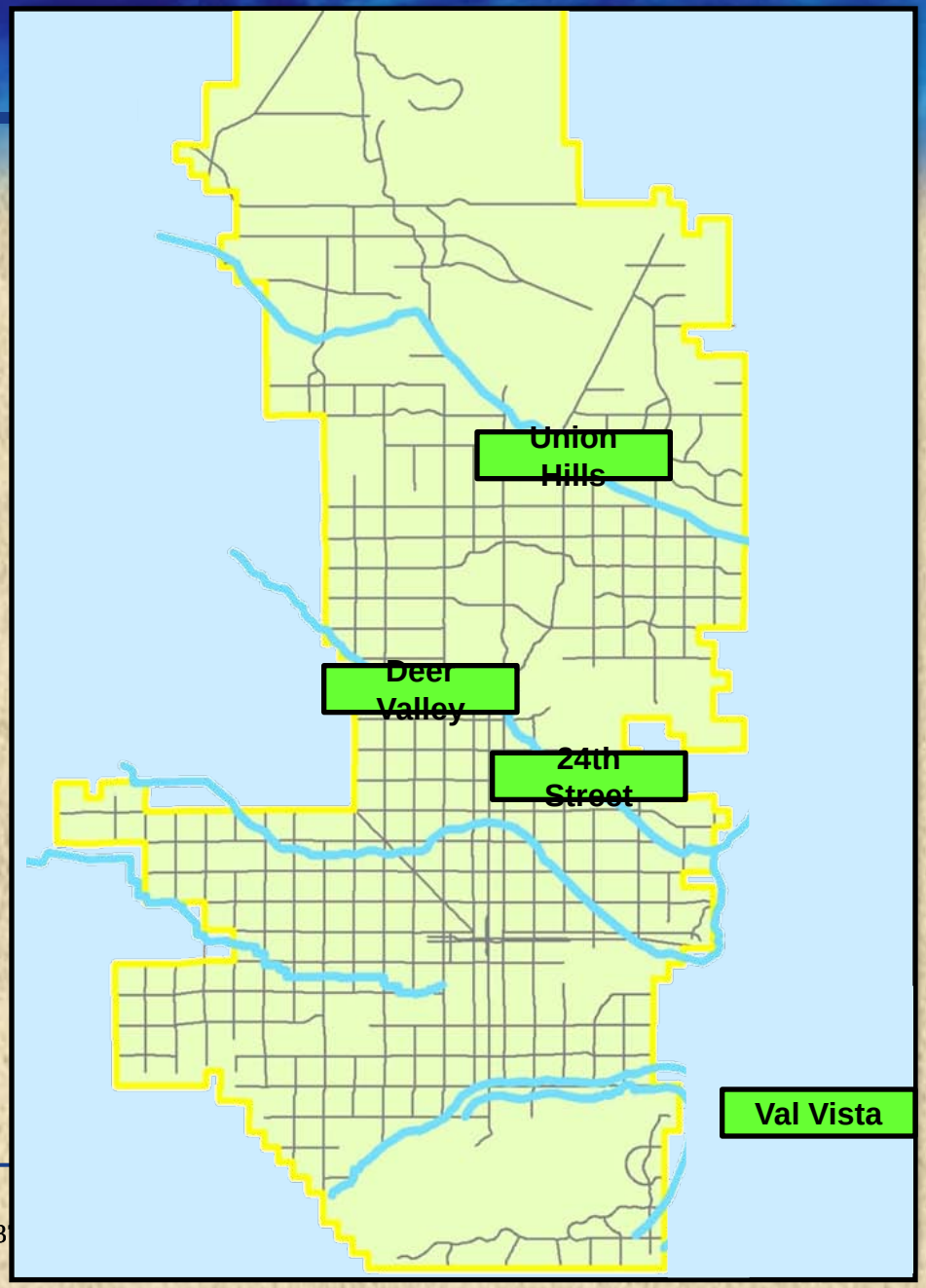
Compliance Strategy

- Initial Strategy
  - Granular Activated Carbon (GAC) Filters — *Removes THM precursors*
- **Revised Strategy**
  - **GAC Filters** — *Removes THM precursors*
  - **High Rate Chlorine Dioxide** — *Reduces formation of THMs*
  - **Distribution System Optimization** — *Reduces water age*

Various combinations of these tools resulted in 11 alternative operating scenarios that are evaluated in detail

Features of Selected Alternative

- Post-Filter Contactors at Val Vista
- Filter Adsorbers at Deer Valley
- 3 ppm Chlorine Dioxide at all WTPs
- Distribution system optimization



Cost Comparison

Original Program

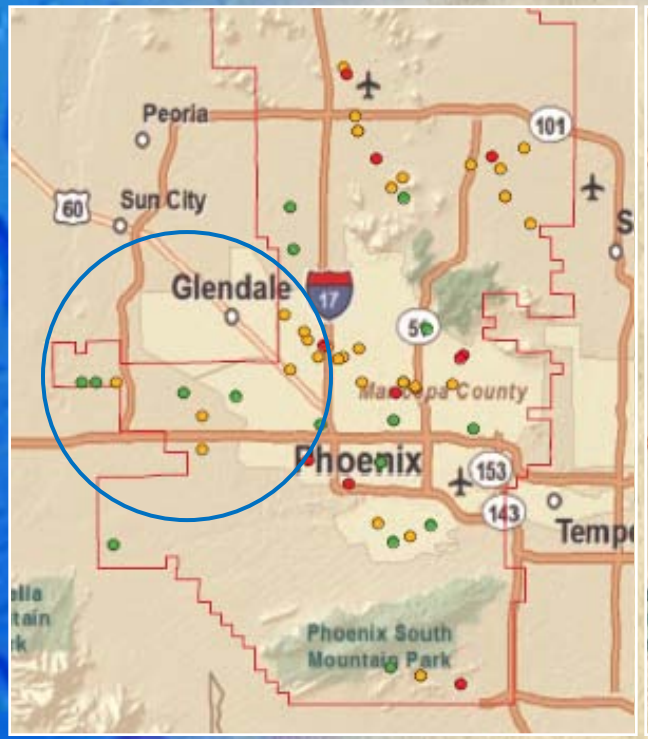
- ***Capital Cost = $243M***
- ***O&M Cost = $31M/Yr to $46M/Yr***

Revised Strategy

- *Capital Cost = $238M*
- *O&M Cost = $25M/Yr to $34M/Yr*

Unintended Consequences- Customer Concerns

Startup



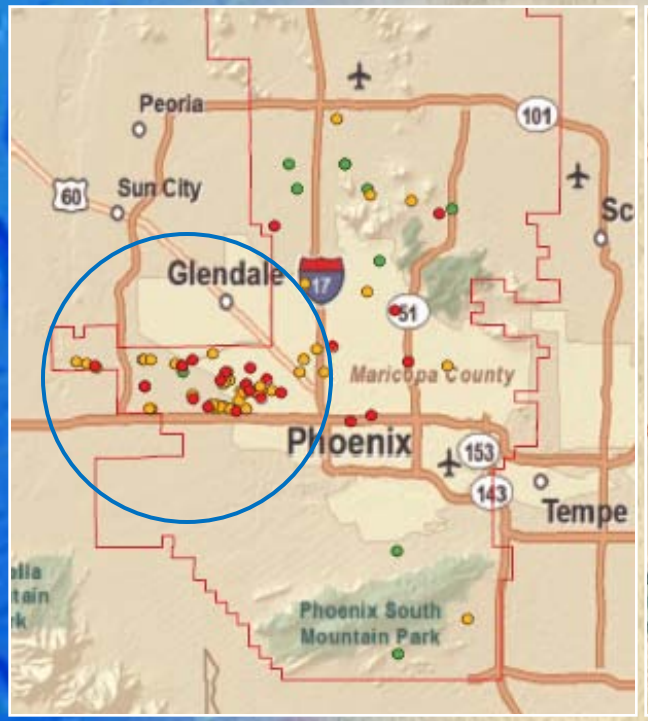
C1 ON

C1 OFF

- Rusty Water
- Milky/Dirty
- Bad Taste/Odor

Unintended Consequences- Customer Concerns

C2 ON



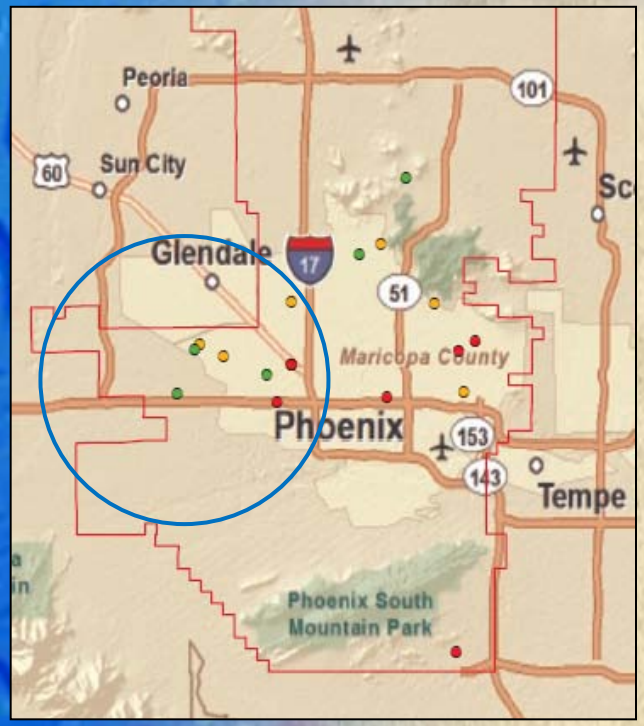
C2 OFF

C3 ON

- Rusty Water
- Milky/Dirty
- Bad Taste/Odor

Unintended Consequences- Customer Concerns

C3 OFF

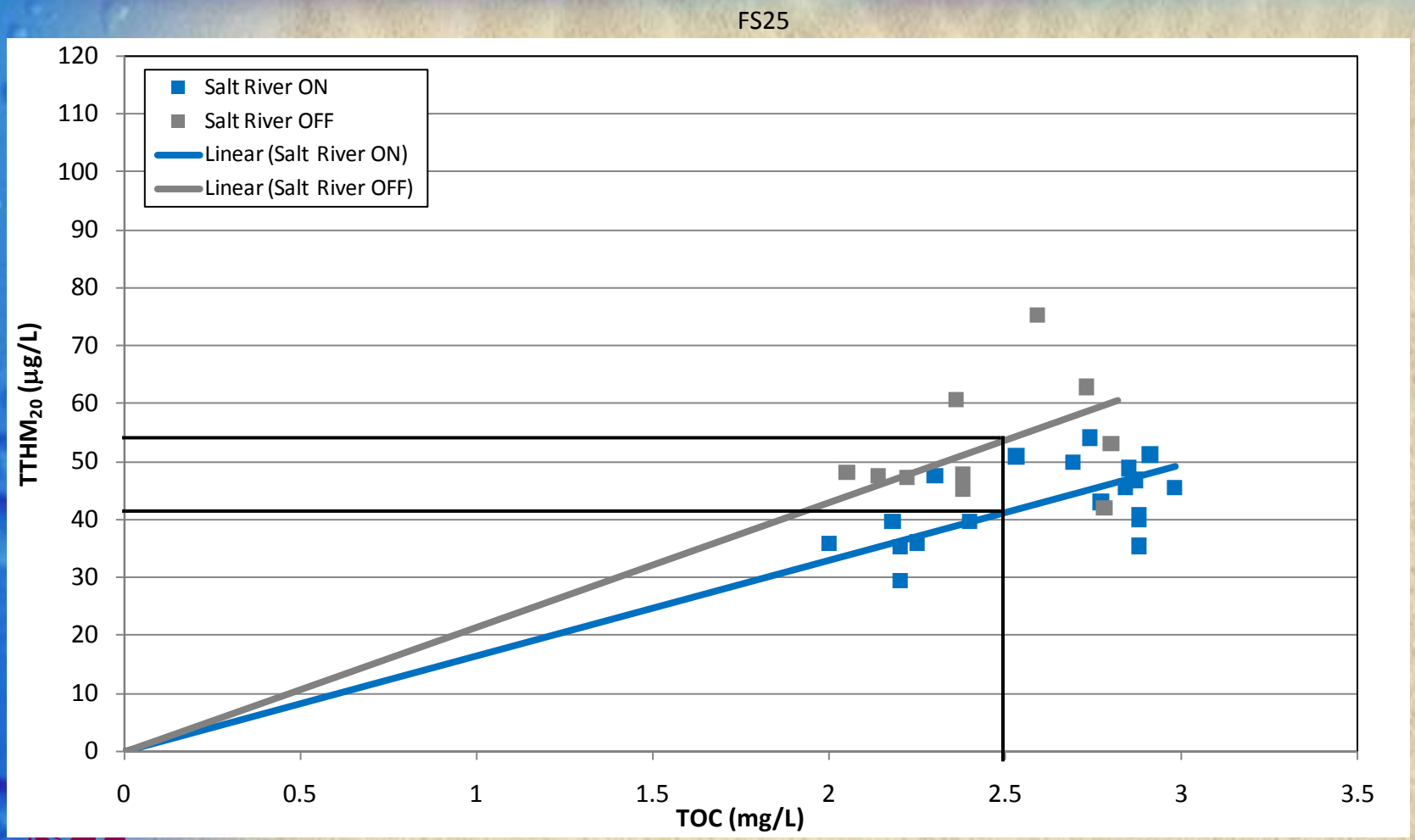


C4 ON

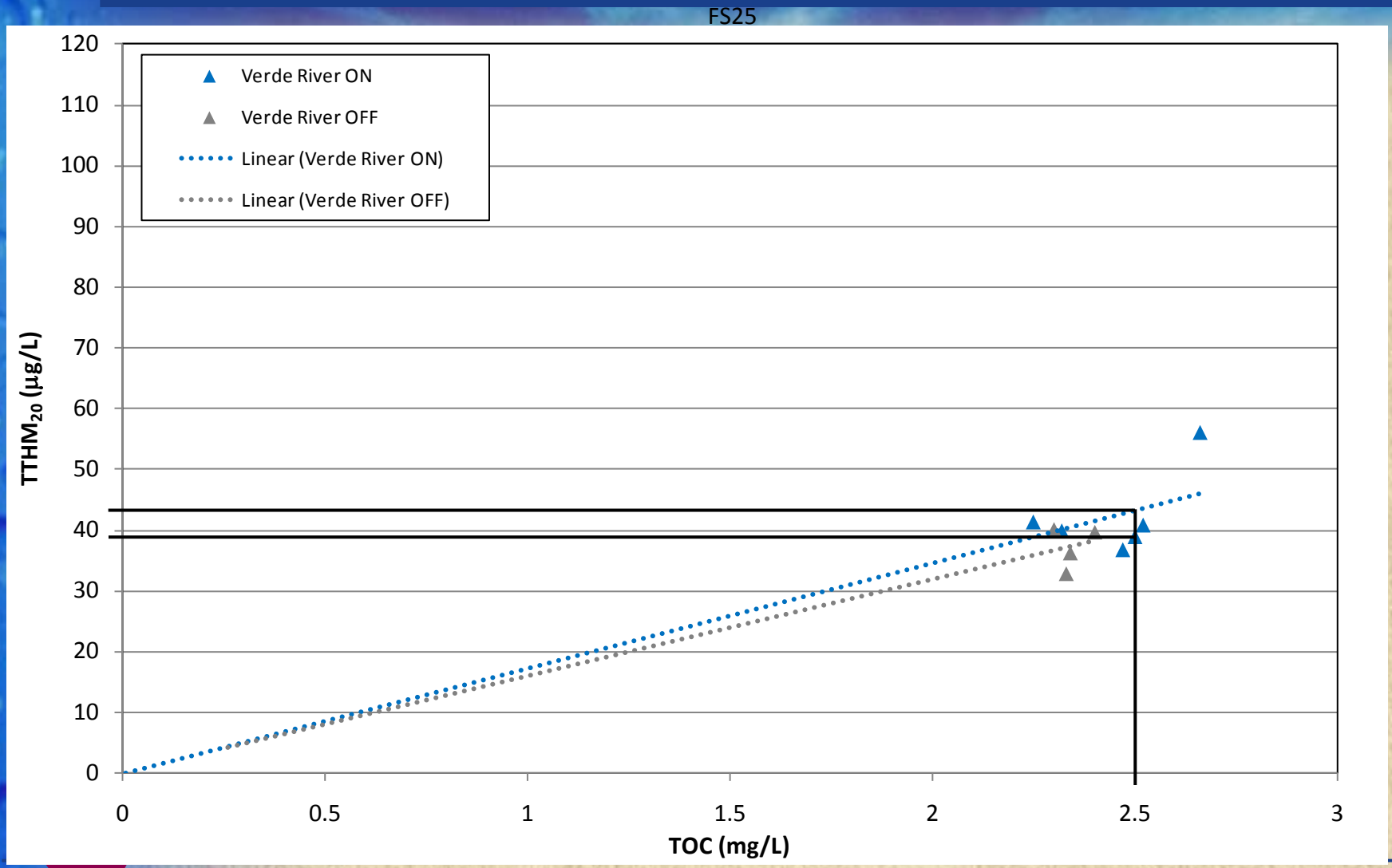
Non-Issue

- Rusty Water
- Milky/Dirty
- Bad Taste/Odor

Accounting for TOC and Temp, Salt River TTHM Formation Decreased by 16-35%



No Reduction in TTHM formation was Observed for Verde River Water



Chapter 6 - The New Old Plan (Oct. 2010)

- Stop Design and Construction of 3 mg/l Chlorine Dioxide
- Implement GAC at all WTPs and 1 mg/l Chlorine Dioxide
  - Val Vista WTP GAC Contactors
  - Deer Valley WTP GAC Filter Adsorbers
  - Union Hills and 24th Street WTPs Biological GAC Filters
    - Previously designed filter adsorber plans modified
- Distribution System Optimization

An Optimized Plan

- Distribution System Aeration Treatment
- Reduced Water Age
  - Piping and Reservoir Reconfiguration
- Optimization of Reservoirs on WTPs Sites
  - pH Control thru CT Reservoirs
  - Chlorine Control thru CT Reservoirs

Steps for the Future

- Continue to optimize system
  - Addition of system Aeration treatment
  - System piping modifications
- Regional GAC Regeneration
- System GAC Treatment
- Water Quality Monitoring

The Moral of the Story – Our plan included a robust treatment system that allowed for flexibility. We believe that we can handle future Water Quality challenges.

Questions