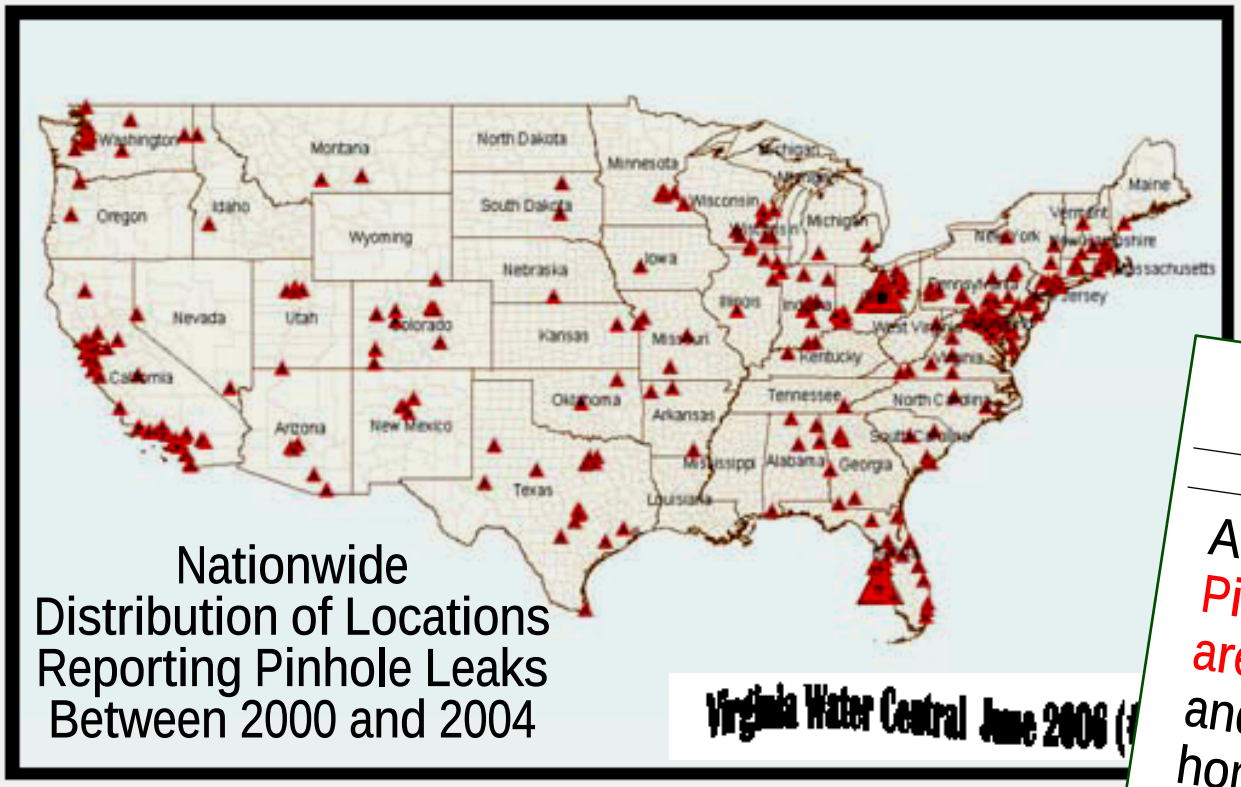
The City of Marco Island

A Worldwide Problem Comes to Marco

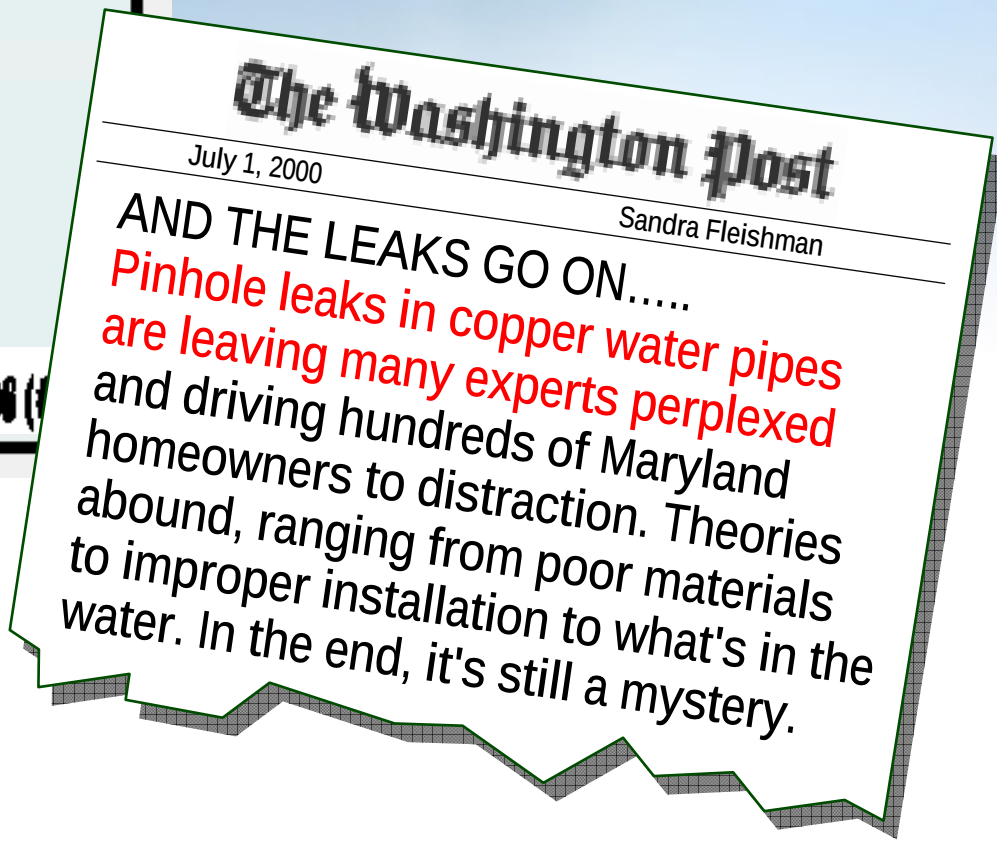
Copper Pipe Pinhole Leaks

March 19, 2007

A Worldwide Problem Comes to Marco Island...



Nationwide Distribution of Locations Reporting Pinhole Leaks Between 2000 and 2004



The Washington Post

July 1, 2000

Sandra Fleishman

AND THE LEAKS GO ON.....

Pinhole leaks in copper water pipes are leaving many experts perplexed and driving hundreds of Maryland homeowners to distraction. Theories abound, ranging from poor materials to improper installation to what's in the water. In the end, it's still a mystery.

A Worldwide Problem Comes to Marco Island...

The Washington Post

July 2000 WSSC

"The Washington Suburban Sanitary Commission (WSSC) experts believe that pinhole leaks are not the result of corrosive water but of dissimilar metals interacting and starting a battery of reactions that just consume the pipe. Otherwise, dissolving of the copper would be a widely spread problem."
(Washington Post, July 2000)

Sarasota County

Pinhole leaks in copper plumbing are a widespread problem that affects property owners throughout the United States and elsewhere in the world. Although much research has been conducted around the issue, no definitive cause has been determined to date. As the leaks were discovered in our area, Sarasota County Utilities was quick to establish a local task force to research the problem and potential solutions.

Where Have Leaks Been Detected?

- A nationwide issue
  - EPA studies
  - AWWA studies

St. Petersburg Florida

Pin hole leaks in copper piping have reached alarming proportions, and seems to be gaining momentum. Much has been written on this subject. Some say the pin hole pox is due to inferior grades or imported copper tubing. Some have CopperKnight.com published such scholarly works on the subject that would leave world class Rocket Scientists scratching their heads.

There have been many methods tried over the years in an attempt to deal with this problem. They all had one thing in common: each attempted to deal with the effects of the problem instead of the cause.

Where Have Leaks Been Detected?

FLORIDA WATER RESOURCES JOURNAL

February 1997

Richard A. Dunham and Clifford A. Russell

Pinholes in copper plumbing are a major problem in Central Florida as well as other parts of the state and the country. Why do they occur in certain areas and not in others? Perhaps more important, what can be done to prevent the problem in the first place? The Water Quality Laboratory at Orlando Utilities Commission began examining the problem in 1984. In 1991 it began a more in-depth study.....

Beginning Research

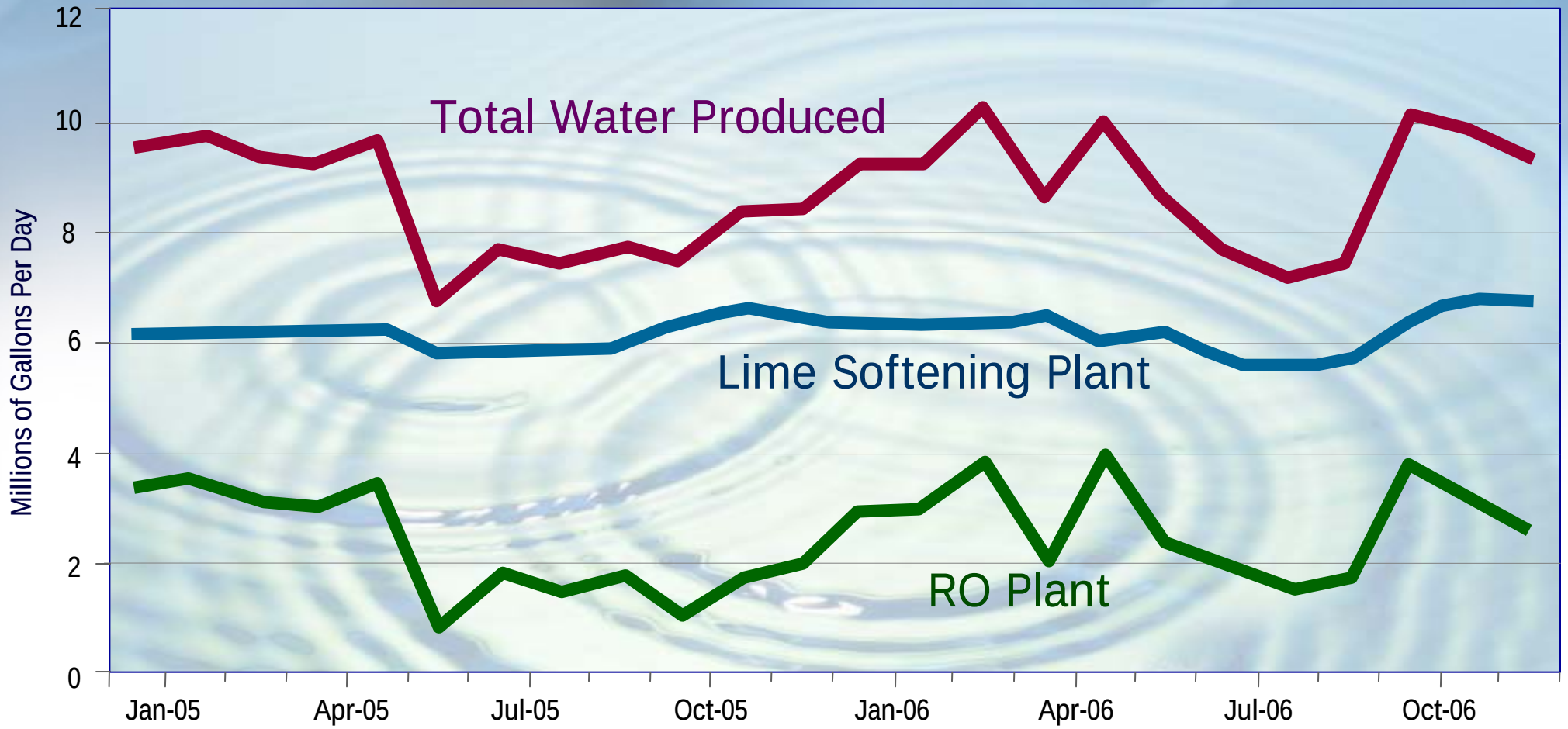
In 1991 Orlando Utilities and CH2M-HILL engineers started a research project sponsored by the American Water Works Association Research Foundation. The purpose of the study was to study the effects of electrical grounding on water quality. One of the long held theories of pinhole leaks is that they are caused by electrolysis, i.e., stray currents conducted along copper plumbing. Stray currents are caused by load imbalance between the two conductors in a 220- volt system. The imbalance is transferred to the plumbing at various points in a home. Grounding of the electrical system to the cold water system allows the phenomenon to occur.

Water Treatment Plant Locations

North Plant
Lime Softening

South Plant
RO Membrane

Drinking Water Production 2005 & 2006



Time: Jan 05 - Dec 06

Water Distribution

North Plant
Lime Softening

South Plant
RO Membrane
(Blended)

Where Have Leaks Been Detected?

- Area served by the North Plant (Lime softening)
- Cold water and horizontal copper pipe
- Type M copper pipe
- Predominately homes-condos built from 1987-1996
- Seasonal

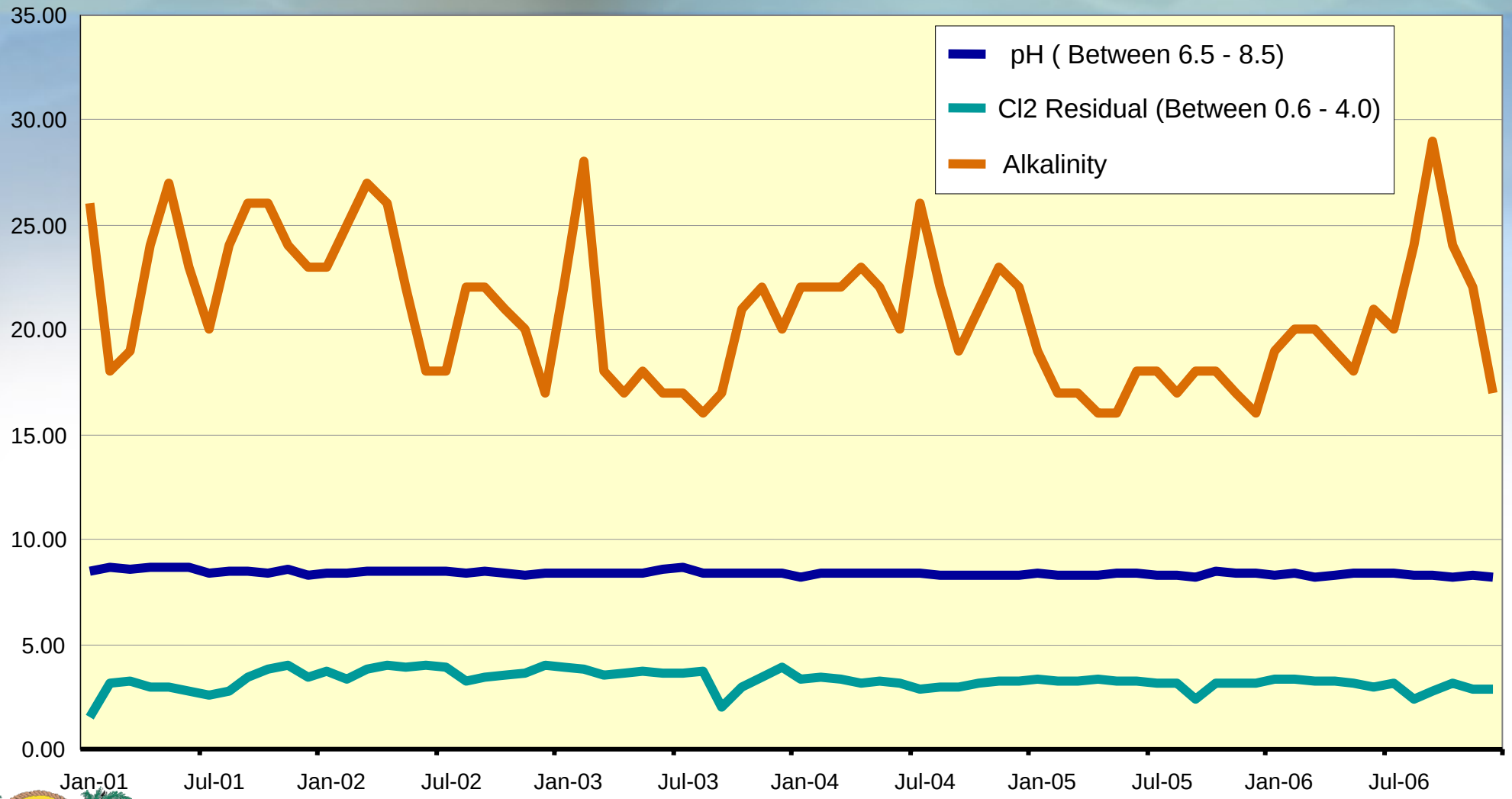
Tallwood Condos – 2 Buildings
1985 – L Type – no problem
1989 – M Type – 10 leaks

		ameter ¾”
		0.032
L (medium wall)	0.040	0.045
K (heavy wall)	0.049	0.065

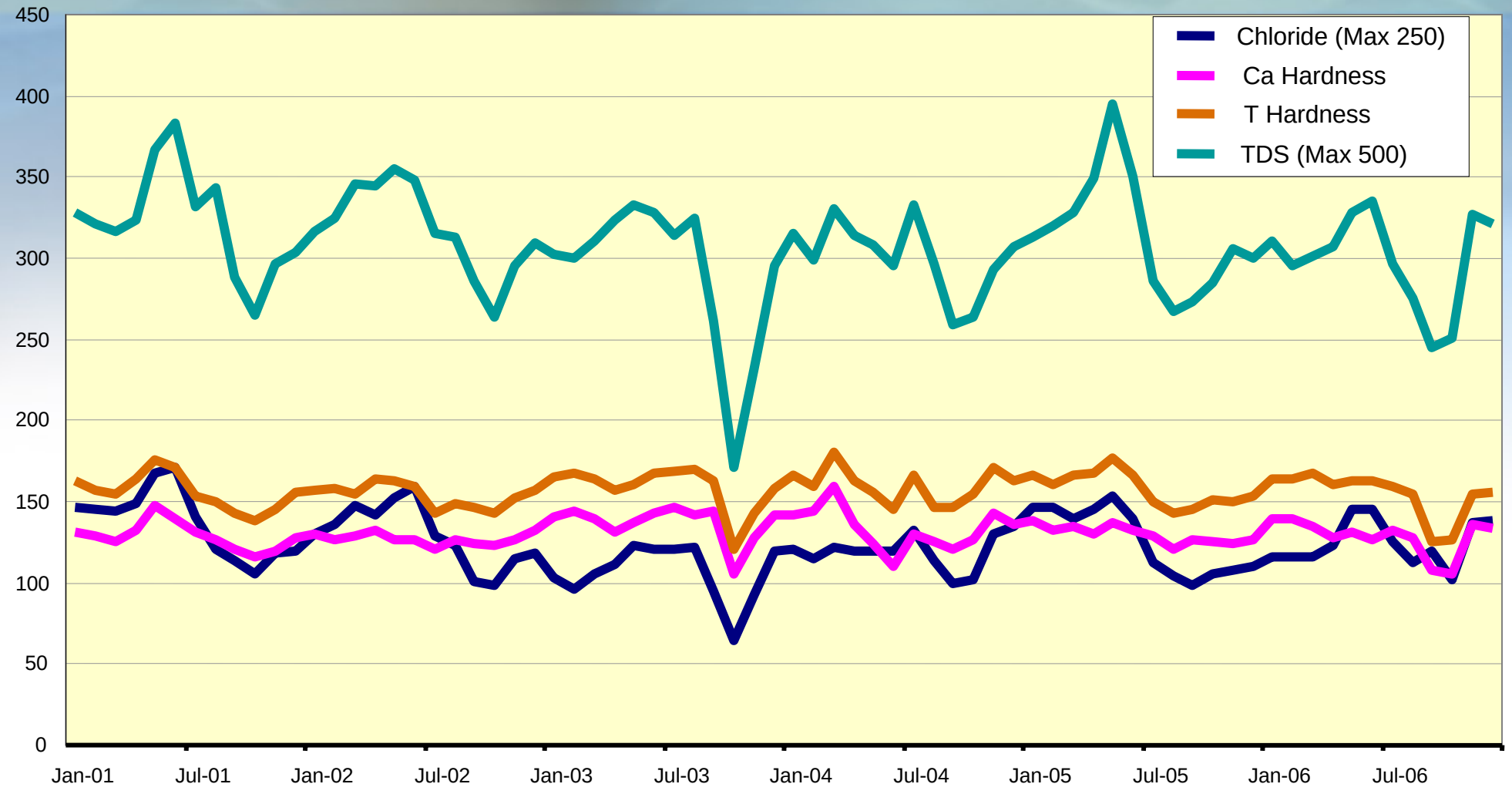
Water Treatment System

- EPA (early 90's) required removal of most natural occurring soluble organics that coat copper pipes
- Use an inorganic corrosion inhibitor (orthophosphate and polyphosphate)
- Lime plant pH 8.31
- RO plant pH 8.29

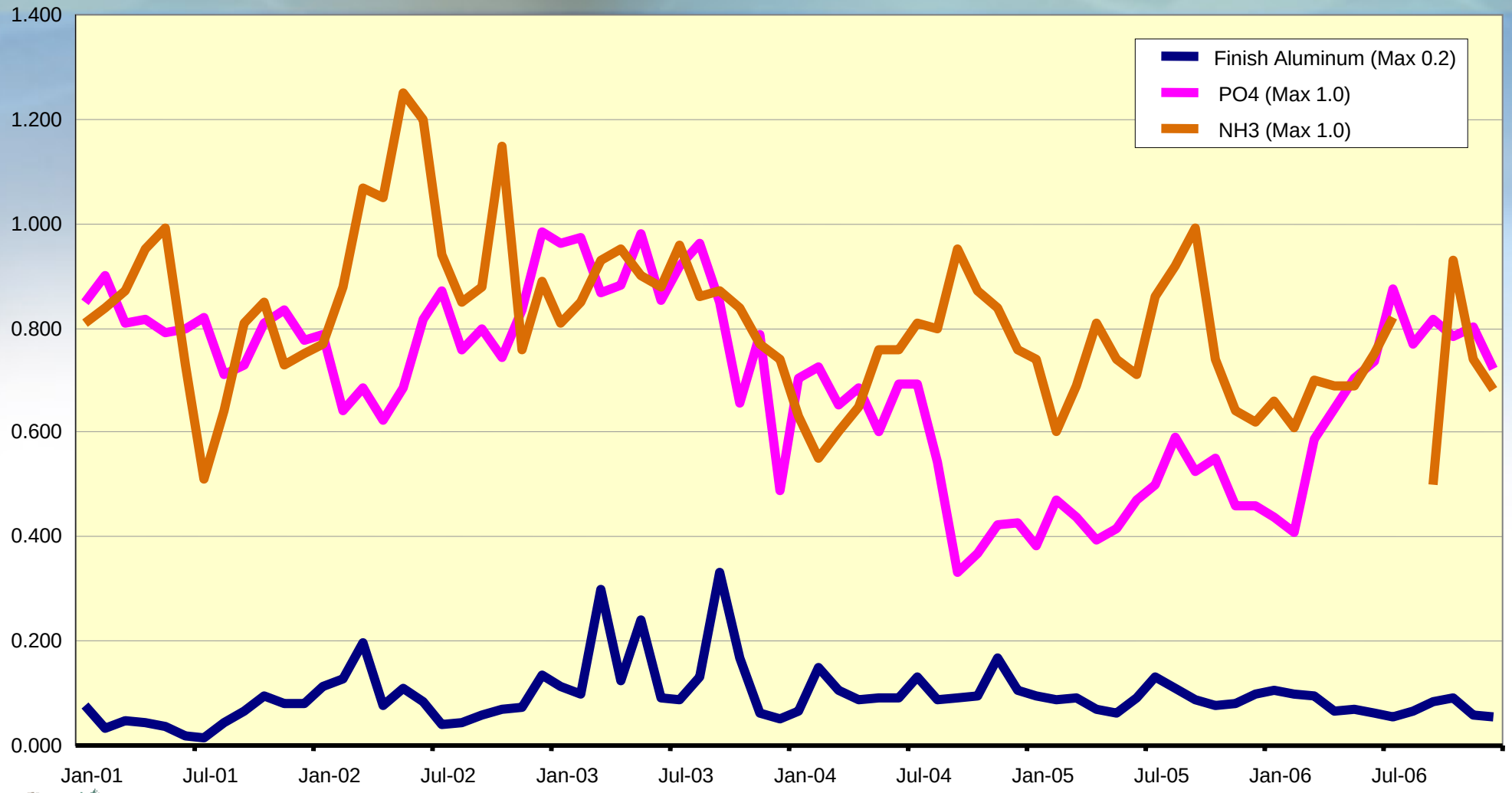
North WTP 2001 - 2006



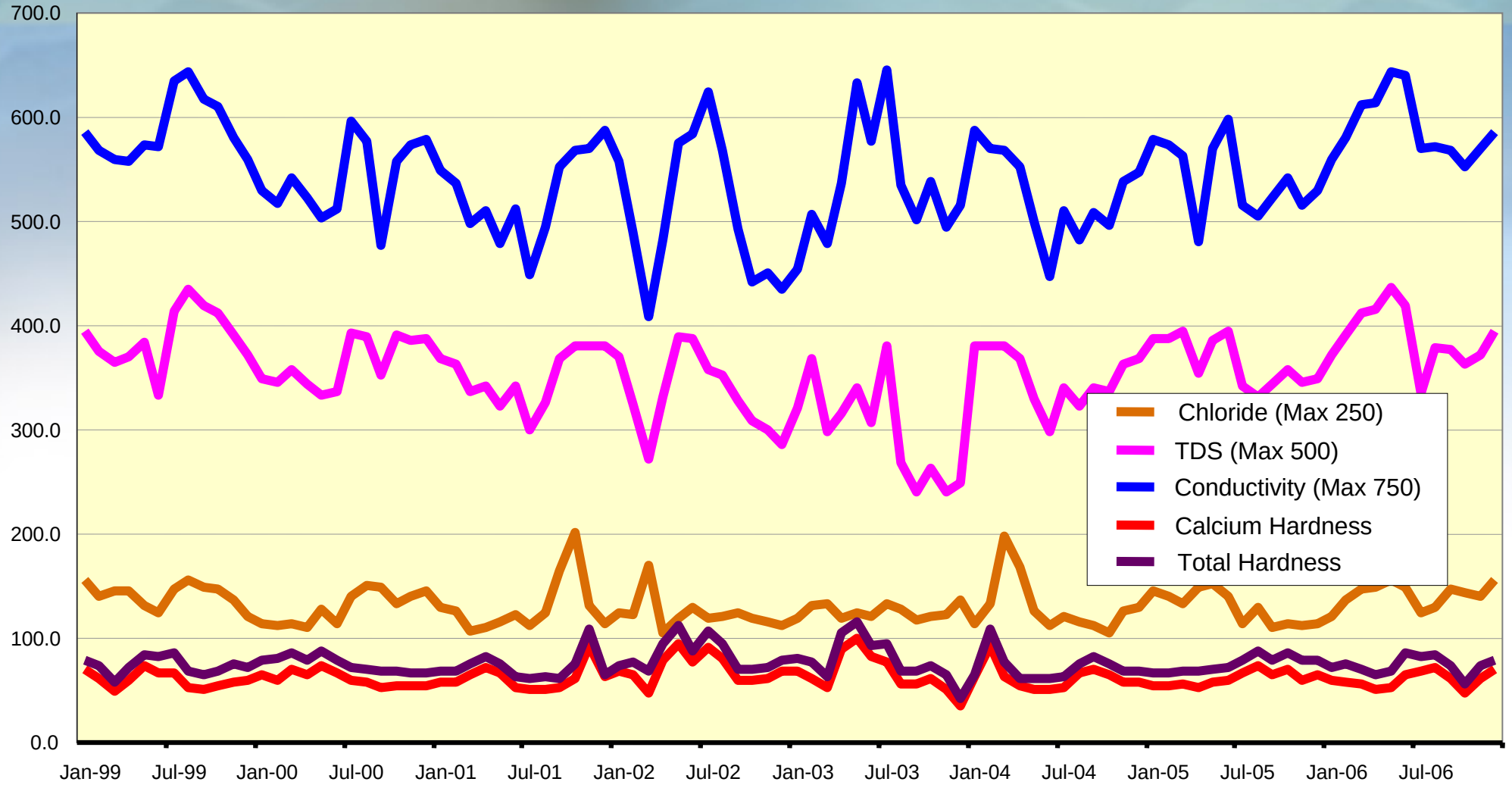
North WTP 2001 - 2006



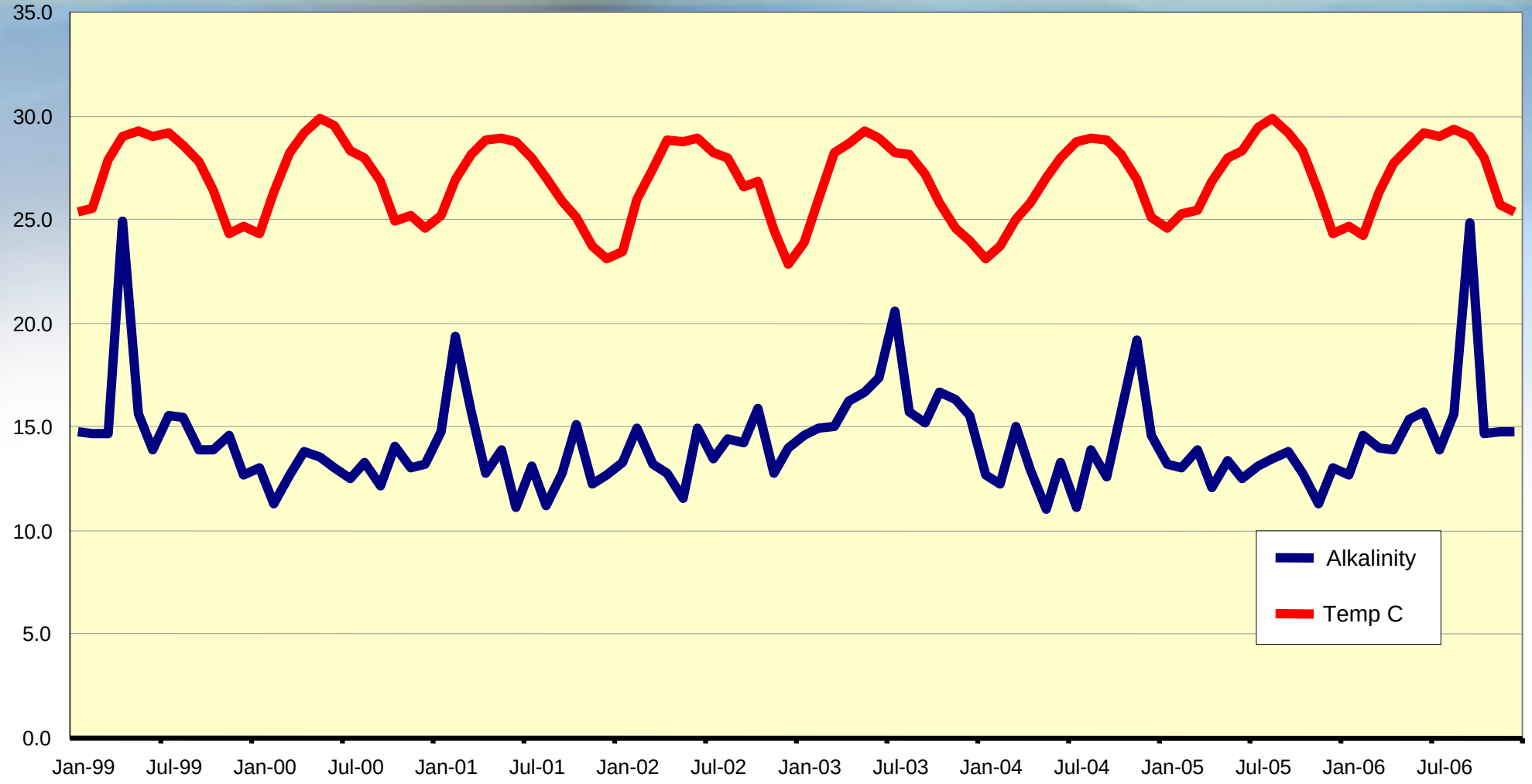
North WTP 2001 - 2006



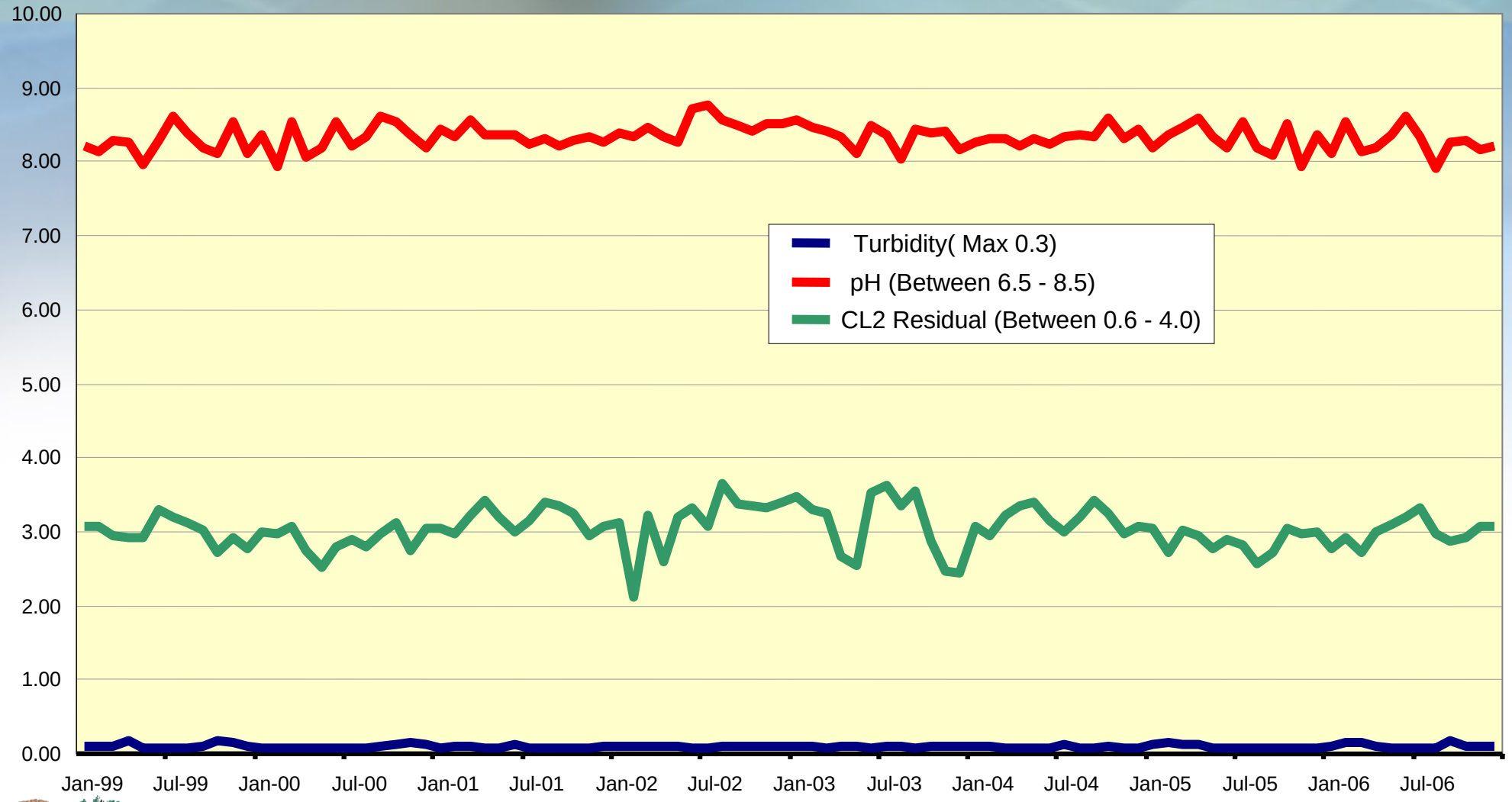
South WTP 1999 - 2006



South WTP 1999 - 2006



South WTP 1999 - 2006



Where is Pitting Occurring?

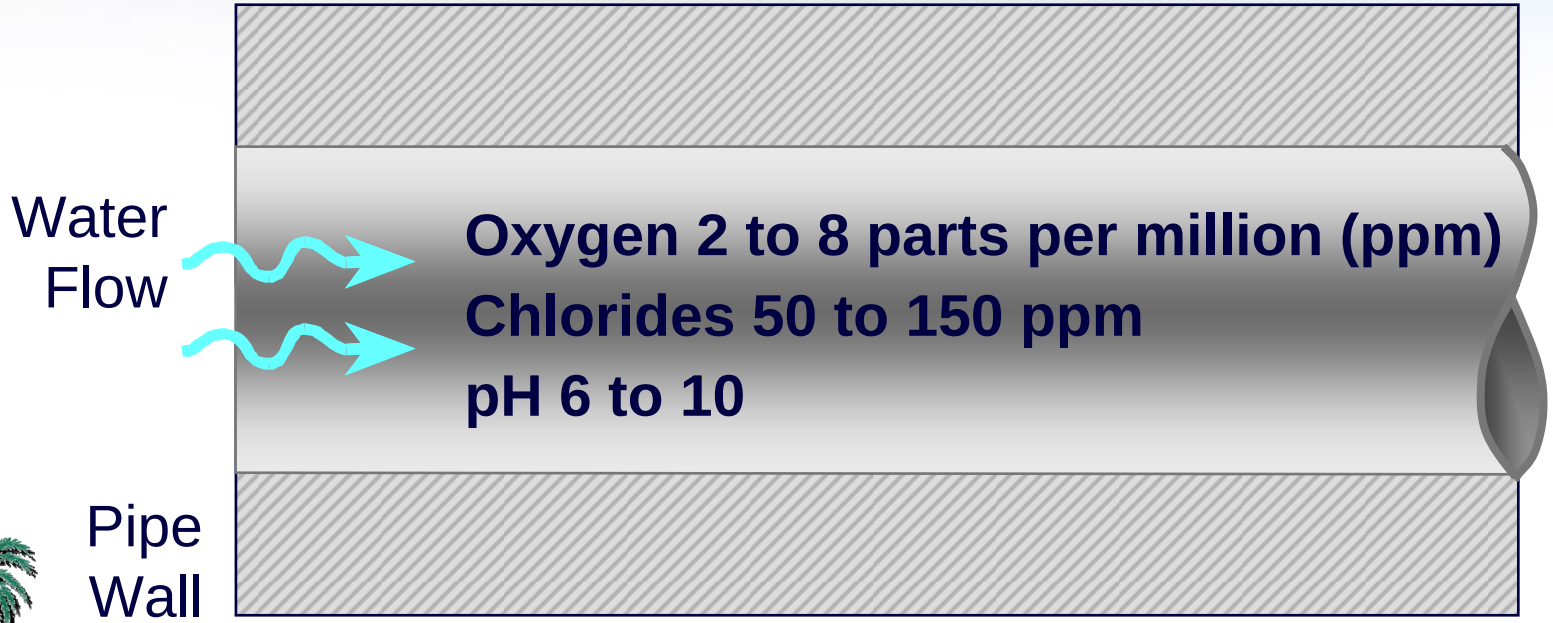
- Inside
- Outside

Causes of Corrosion in Copper Pipe

- Surface imperfection (during manufacturing)
- Dirt or particle/impurities that get into the pipe (during installation)
- Impurities pipe wall (during manufacturing)
- Stray electrical currents
- Stagnant water in pipes
- Low pH water (below 7) “soft” water
- Pipe touching concrete (exterior pipe pitting)

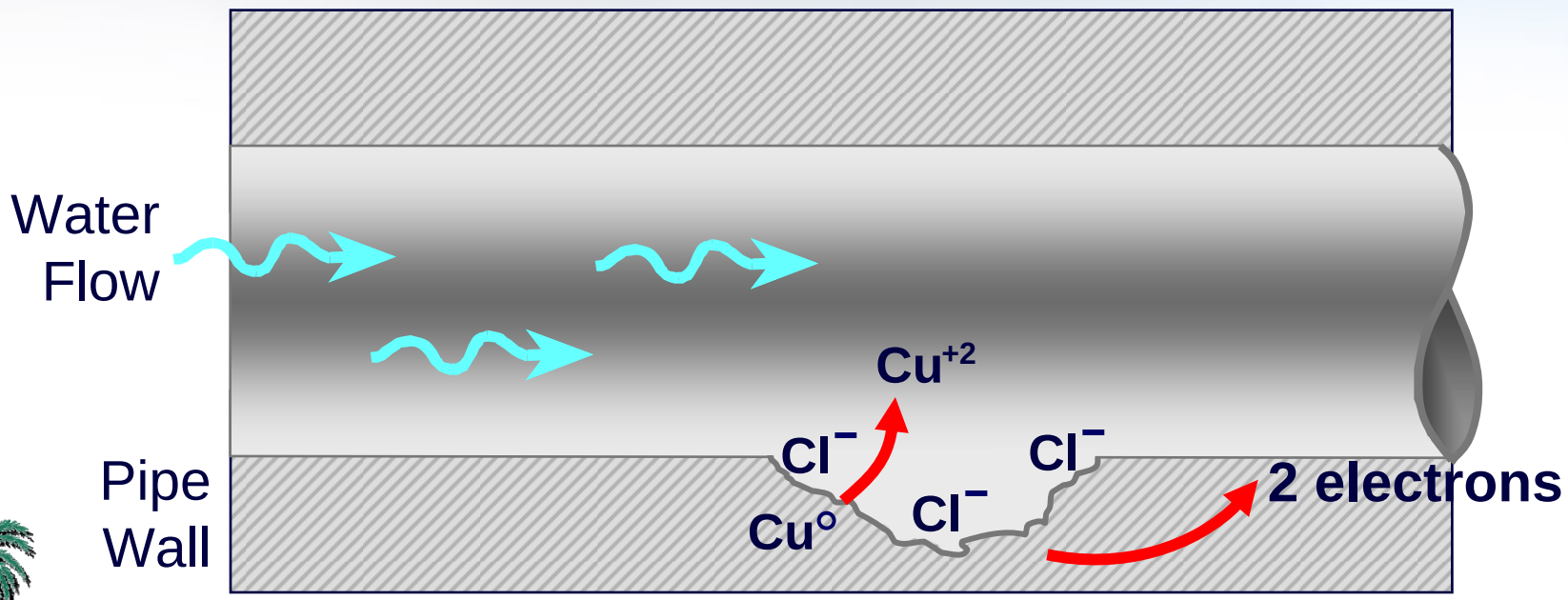
Perfect Copper Pipe

- No pits or cracks
- No dirt particles
- Uniform copper composition
- No pitting
- Components of copper pipe – 99.9% Cu & Ag Plus 0.04% P



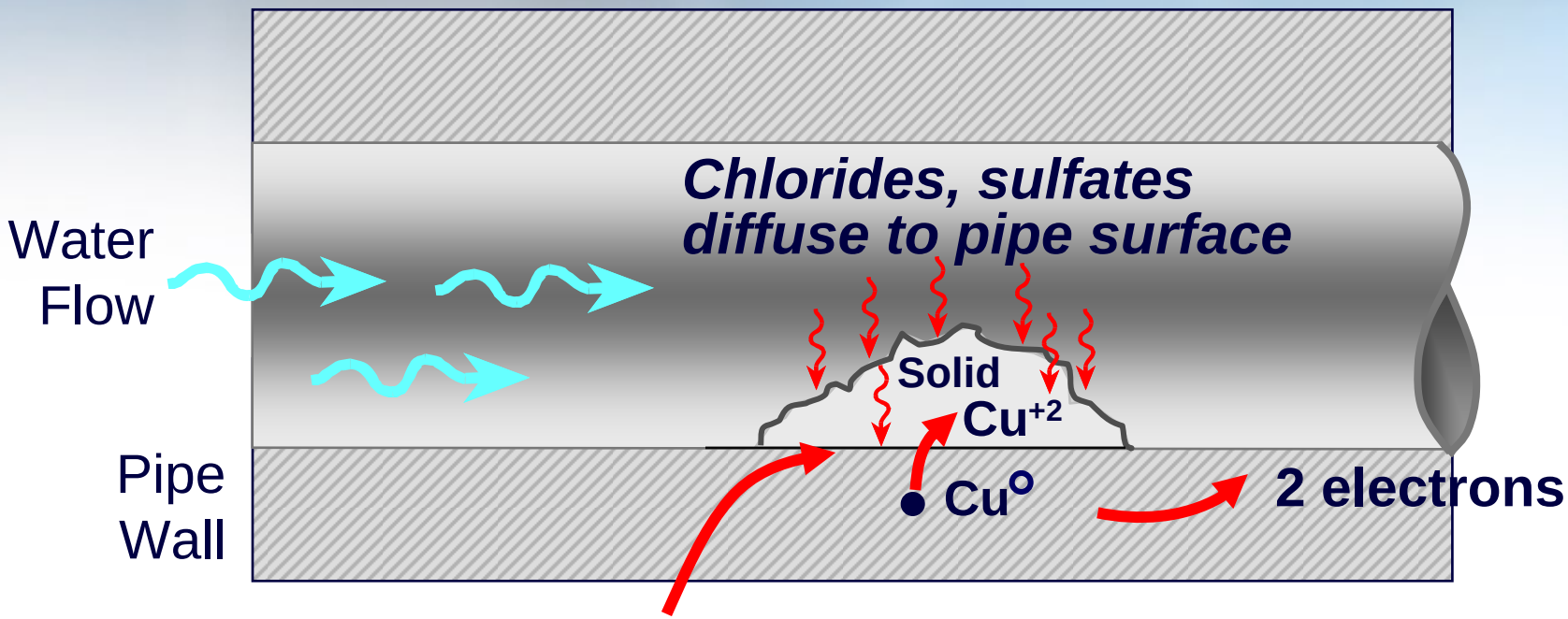
Surface Imperfection Inside Pipe

- A surface imperfection inside the pipe allows chlorides and sulfates to concentrate at a point promoting copper pit corrosion



Particle on Wall

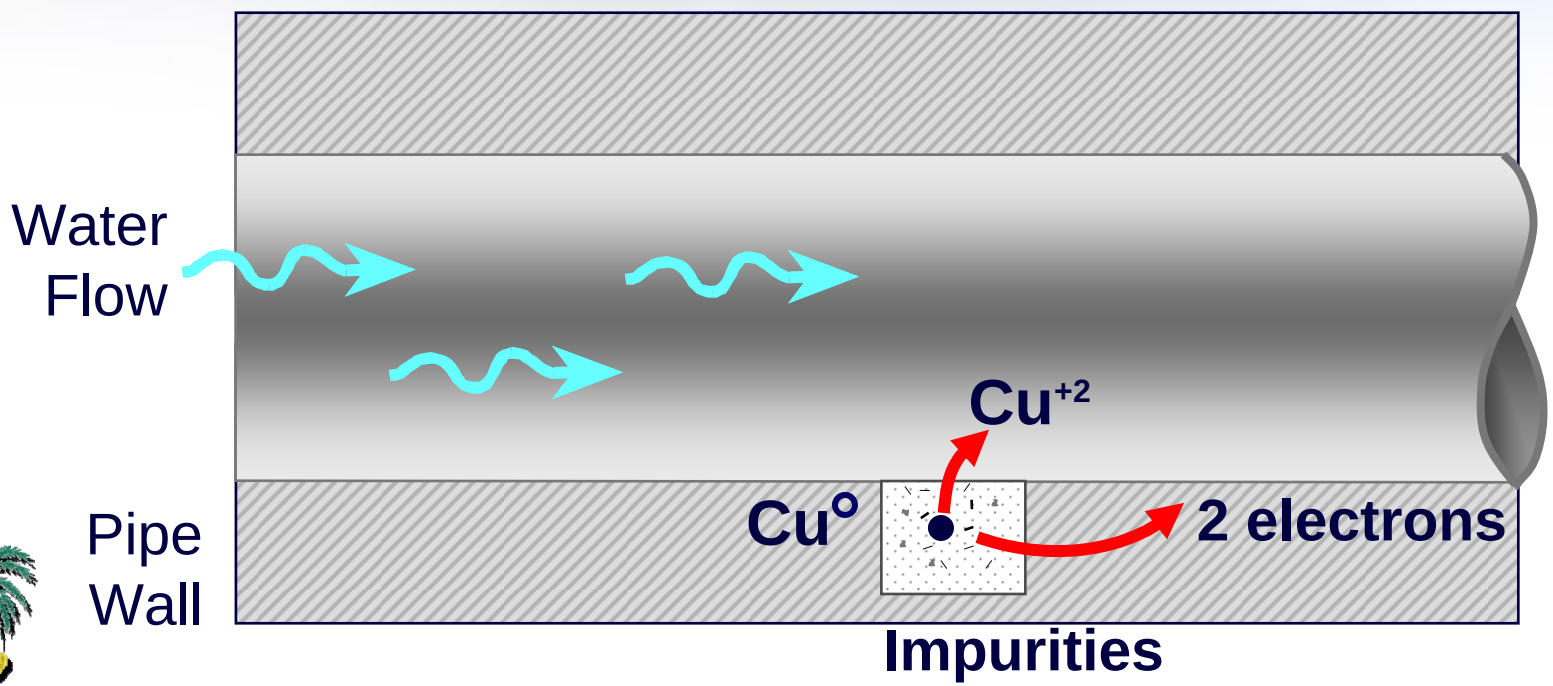
- Particle on wall causes concentration changes allowing copper pipe to dissolve



Dissolved Oxygen → Lower
Chlorides → Increase
Sulfates → Increase

Impurity in the Copper Pipe

- Impurity point is anodic where copper dissolves



Pitting Inside Copper Pipe

- Metallic copper dissolves at one point

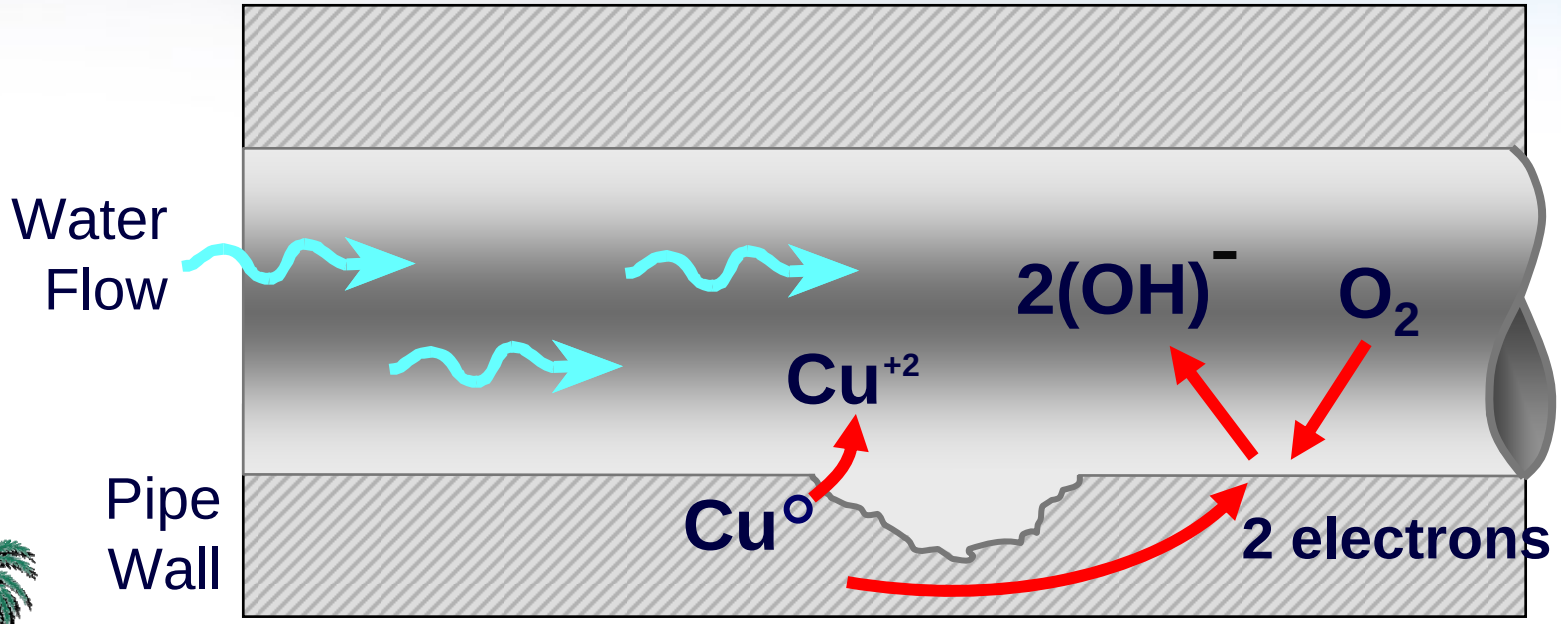
$$Cu^{o} \xrightarrow{\text{Dissolves}} Cu^{+2} + 2 \text{ electrons}$$

Copper pipe → *Copper dissolved in water* + *2 electrons travel in pipe from pit (i.e. anode)*

- Dissolved oxygen diffuses to pipe wall

$$\tfrac{1}{2} O_2 + H_2O + 2 \text{ electrons} \longrightarrow 2(OH)^{-}$$

Dissolved in water

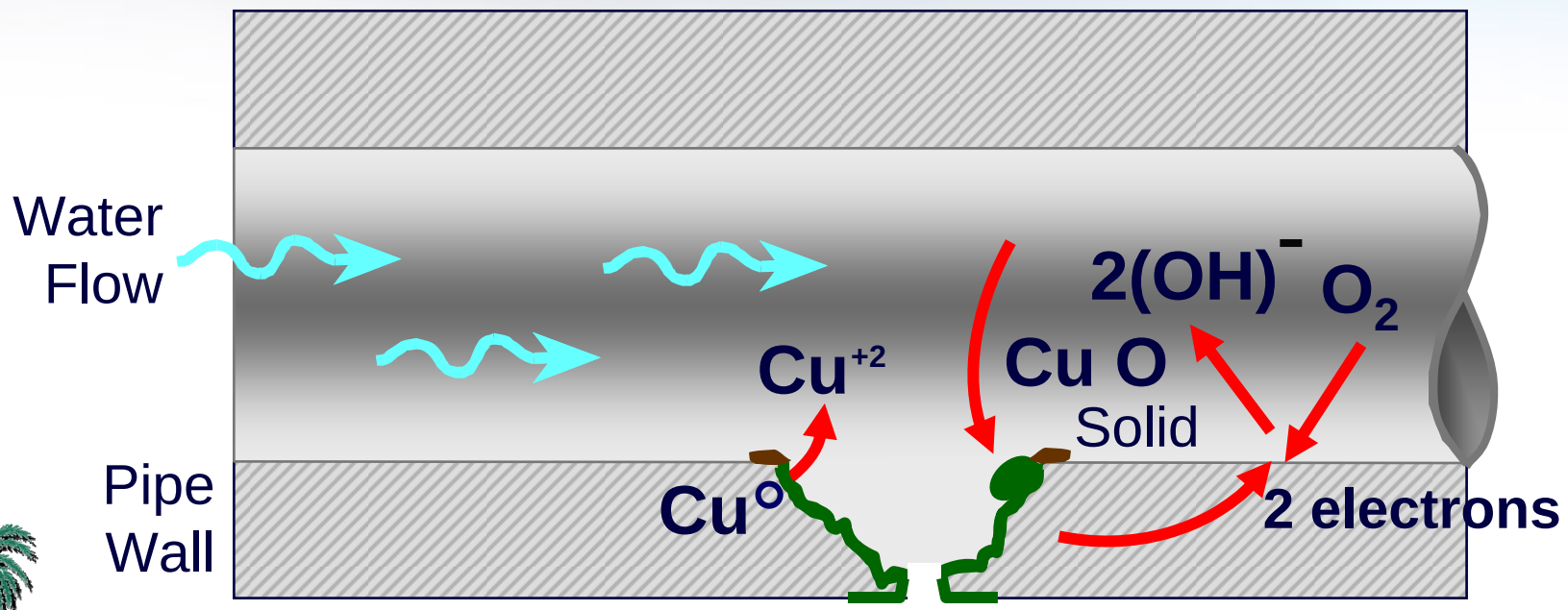


Pitting in Copper Piping

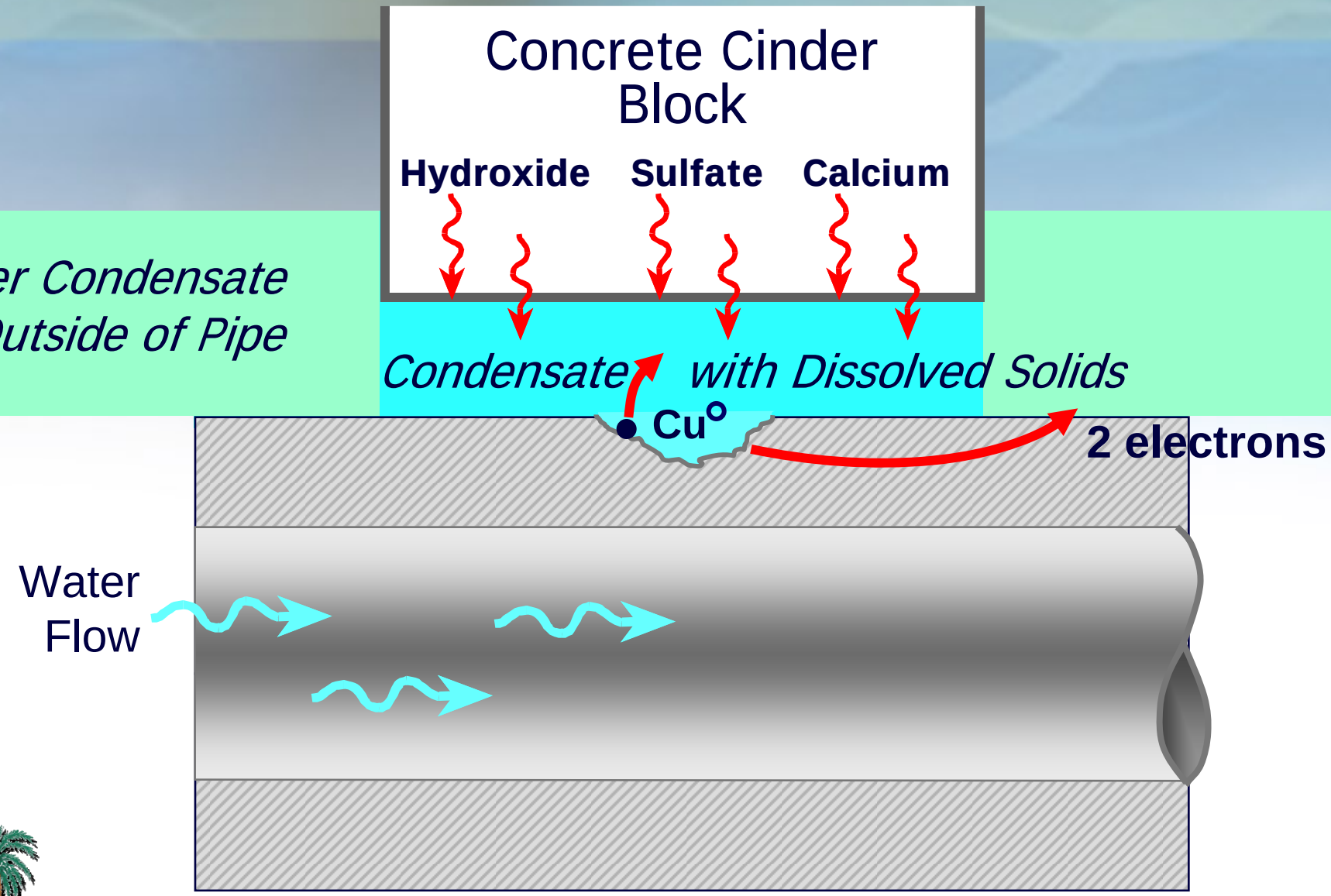
- Dissolved copper and hydroxide ions react to form hydroxide copper oxide, a solid that attaches to the pipe wall by the pit

$$Cu^{+2} + 2(OH)^{-} \longrightarrow Cu\ (OH)_2$$

Dissolved *Solid*



Corrosion From Outside of Pipe



City's Action

- Retained Professor Steve Medlar, P.E.
  - Rutgers University
  - Water treatment expert
  - Published Books, Manuals, Papers on corrosion

City's Action

- Evaluate any water quality modifications/adjustments to decrease any potential pitting may include:
  - Increase pH above 8.5-Must get DEP approval
  - Modify the current method for pH adjustment by using CO2
  - Evaluate the current use of phosphate for coating

City's Action

- Evaluate the copper vs. plastic piping
  - Surface imperfection (during manufacturing)
  - Dirt or particle/impurities that get into the pipe (during installation)
  - Impurities pipe wall (during manufacturing)
  - Stray electrical currents

City's Action

- Continue Flushing in dead-end points
  - Stagnant water in pipes
- Educate Homeowners on impacts of individual household water systems
  - Low pH water (below 7) "soft" water
- Continue to evaluate the location and installation of pipes
  - Pipe touching concrete (exterior pipe pitting)
- Continue to review electrical grounding with LCEC

Drinking water quality is a complex science. We are committed to continue to provide the highest quality water to you.

The City with various experts and agencies are continuing to evaluate the possibilities of adjusting water quality to aid in eliminating this problem that exists worldwide.

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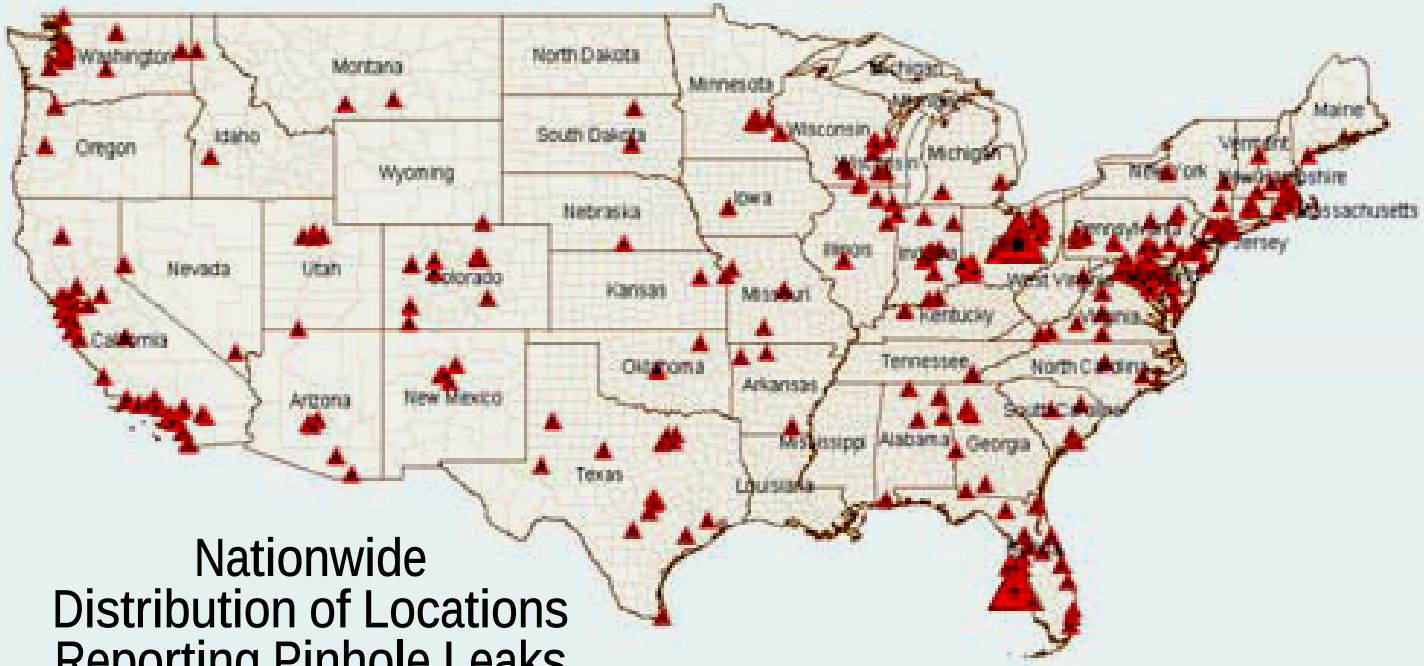
Q & A



Nationwide
Distribution of Locations
Reporting Pinhole Leaks
Between 2000 and 2004

Virginia Water Central June 2006 (#38)