

# Equilibration of Distribution Systems

Presented by:

Charles Cullen

Co-Authors: Jorge Arevalo, Zijian Tang,  
Syed Imran, David Webb

UCF Civil/Environmental Engineering

# Objectives

- Predicting Blend Effects
- Water Quality Characterization
- Need for Pilot Studies
- Pilot System Equilibration

# Blends

- Conventional Groundwater
- CSF Ozone BAC Surface Water
- RO Desalinization
- Softened Groundwater
- Softened Blend
- Nanofiltration (NF) Blend
- CSF NF Blend

# Blending Waters

- Film release is complex
- Single indicator is desirable
- Langelier Saturation Index

# Langelier Saturation Index (LSI)

- Uses pH and  $\text{CaCO}_3$  Saturation
- Positive LSI  
Supersaturation of  $\text{CaCO}_3$

# Spreadsheet calculations

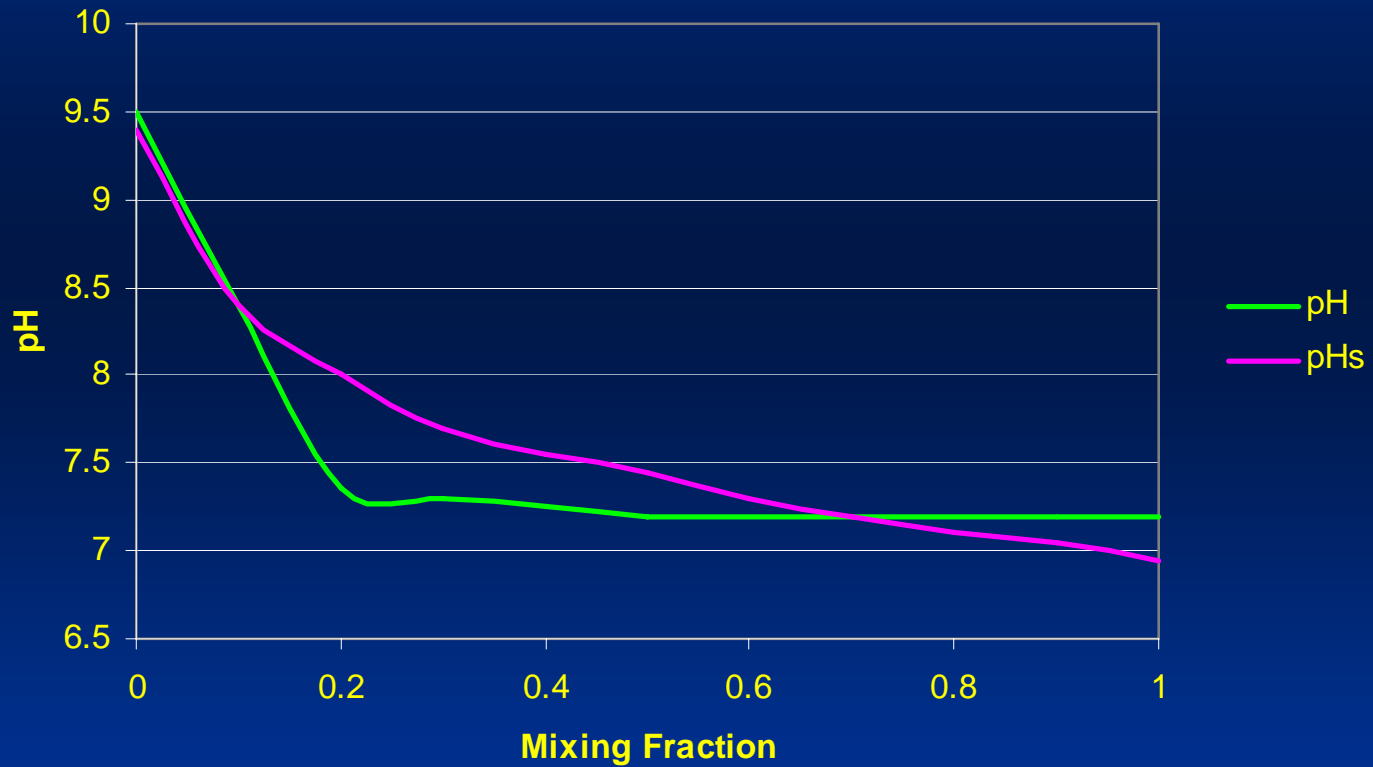
- Facilitate calculation of:
  1. pH of blends
  2. LSI
  3. Buffering Capacity

# Spread Sheet Calculation

pH	Alkalinity	$C_T$	Ca	pHs	Mixture Percent	
	(mg/L)				(N)	(mg/L)
7.28	317	0.0069	380	6.74	100	0
7.31	257	0.0056	308	6.92	80	20
7.37	197	0.0043	236	7.14	60	40
7.47	138	0.0029	164	7.45	40	60
7.82	79	0.0016	92	7.93	20	80
9.60	19	0.0003	20	9.36	0	100

(Trussell, 1971)

# LSI of Blended Water



# LSI Limitations

- Non-uniform calcium deposit
- Polyphosphates

# Pilot Distribution Systems

- LSI only indicator
- Pilot scale to quantify effects on water quality
- Measure full-scale

# Project Description

- To quantify effects of blending
- To identify pipe material influences

# Distribution Systems

- Pipe Types Excavated from Service Area:
  1. PVC
  2. Lined Ductile Iron
  3. Unlined Cast Iron
  4. Galvanized

# Distribution Systems

- 18 individual systems
- 14 contain all 4 pipe materials
- 4 single material systems

# Pilot Distribution Systems



# Preliminary Findings

- 3 Months Required to Stabilize Iron, Turbidity, and Color
- Consistent with studies at Tucson

# Parameters Needing Equilibration

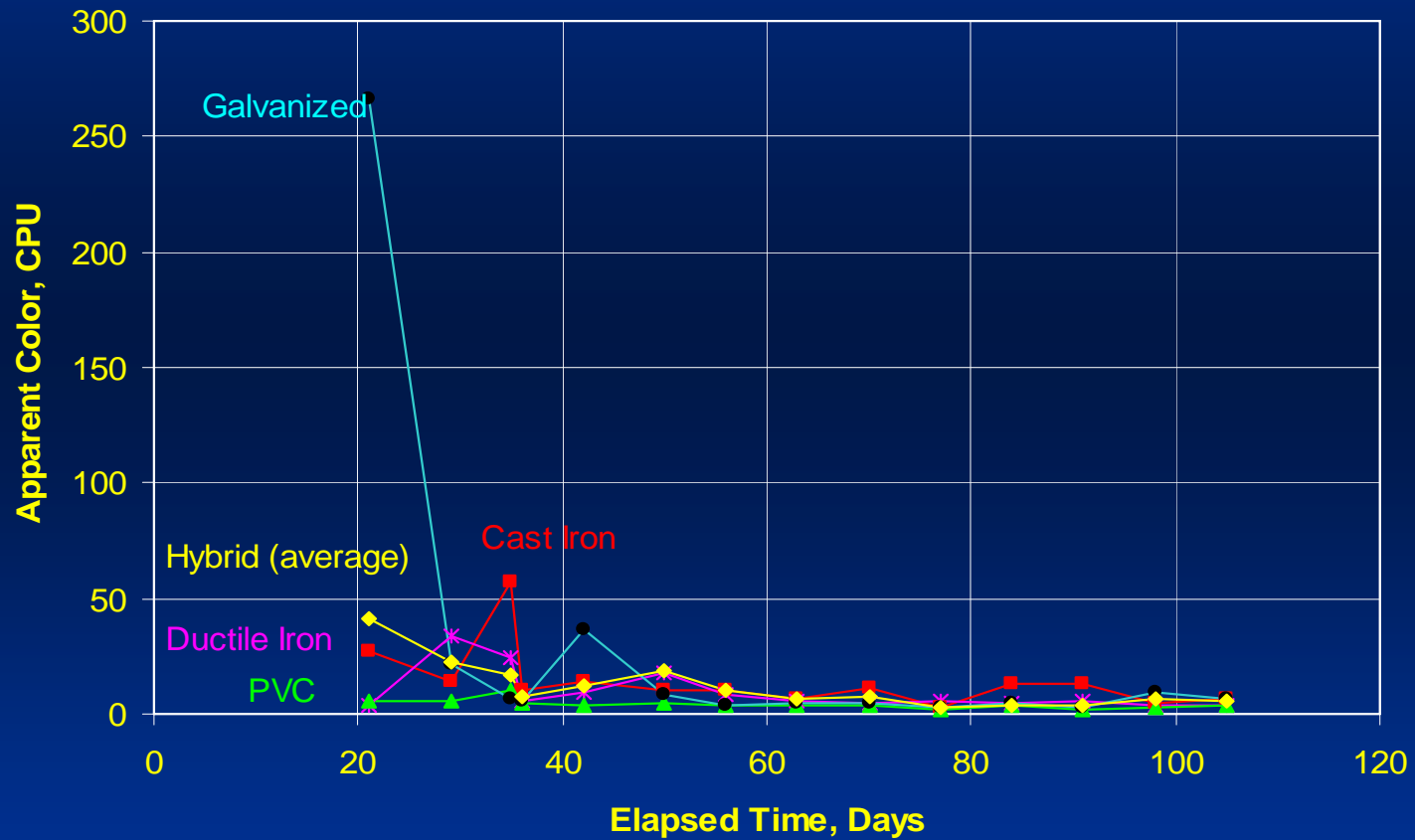
- Apparent Color
- Turbidity
- Iron

# Other Parameters Unaffected

- Alkalinity
- Calcium
- UV-254
- pH
- Conductivity
- Magnesium

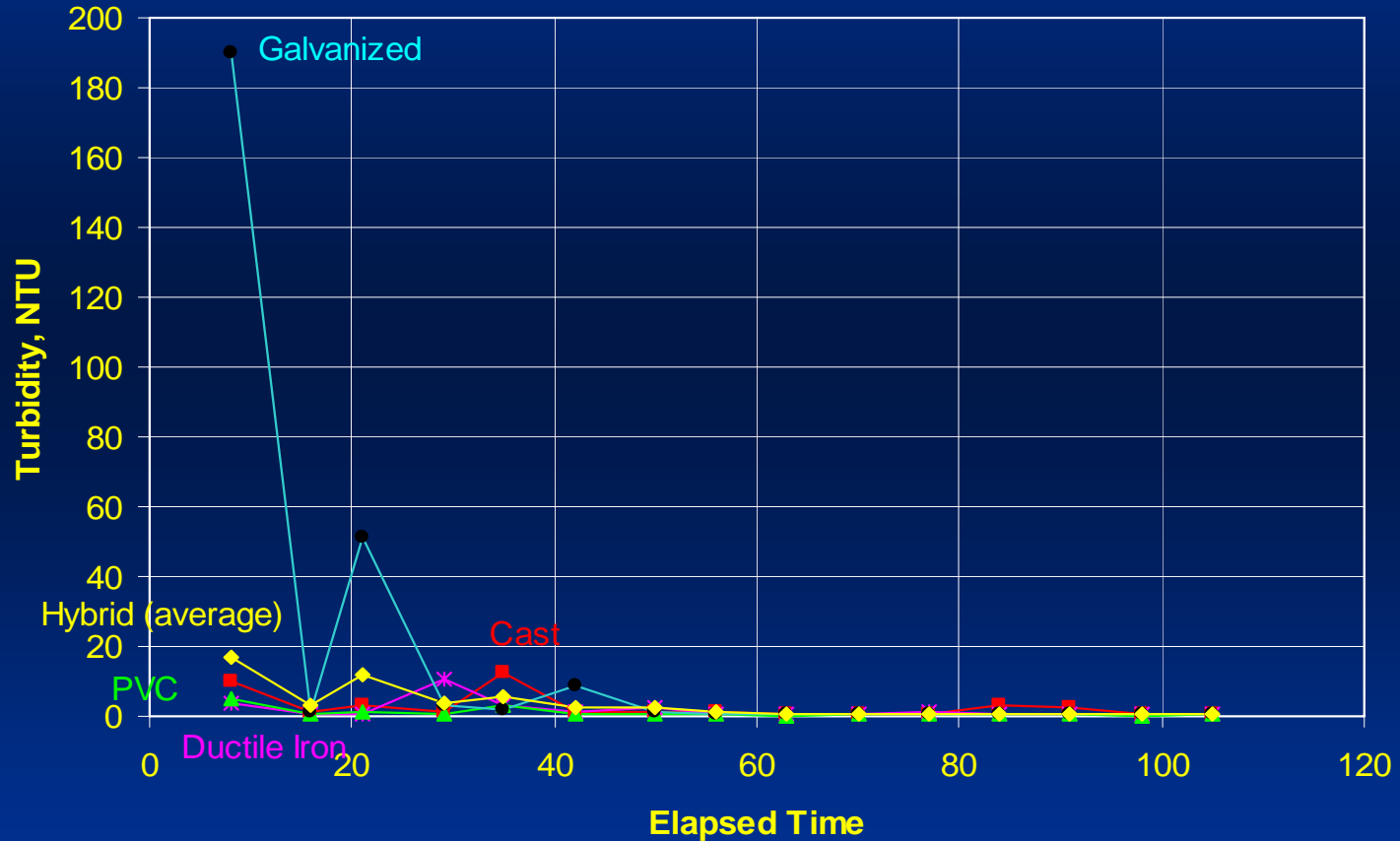
# Apparent Color

feed average = 4.8 CPU



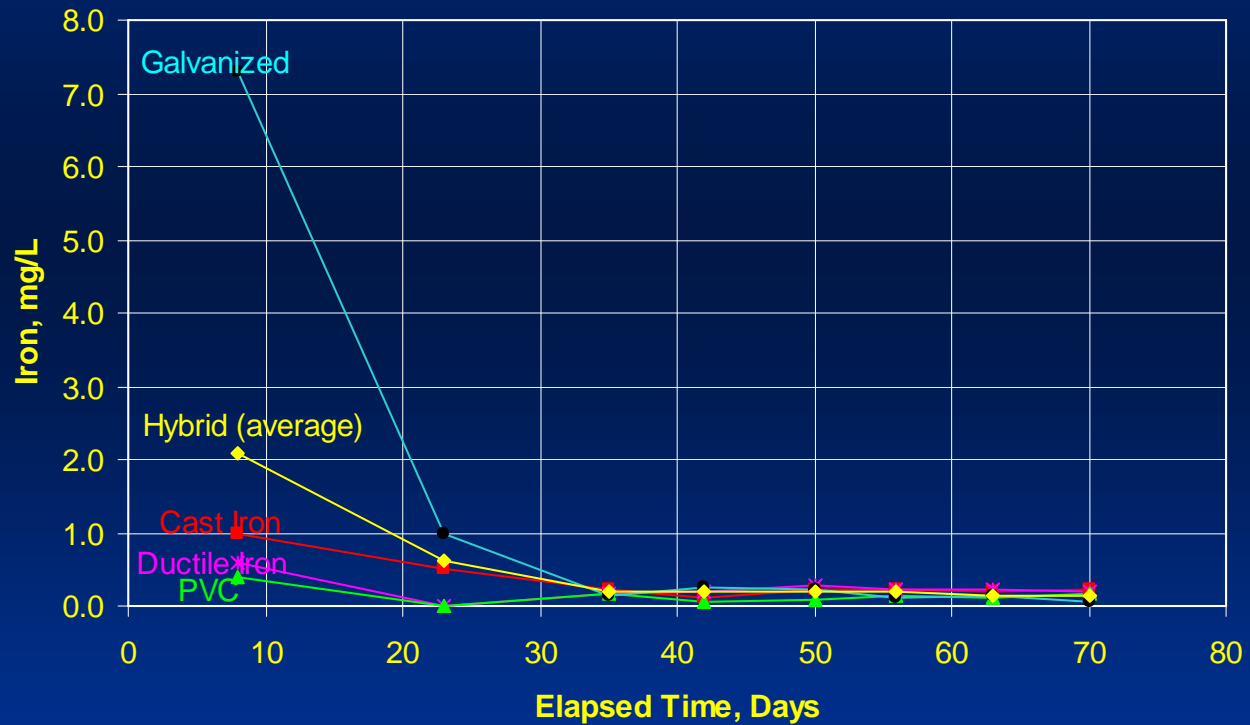
# Turbidity

feed average = .55 NTU

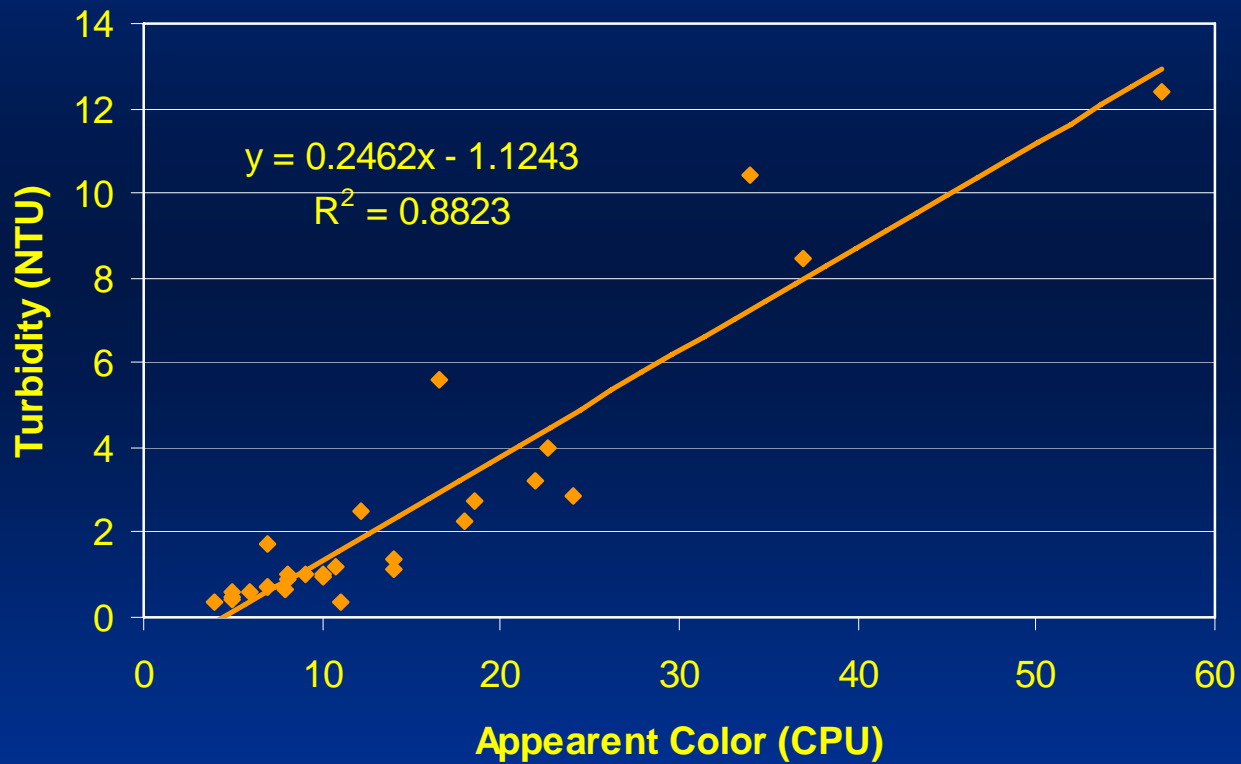


# Iron

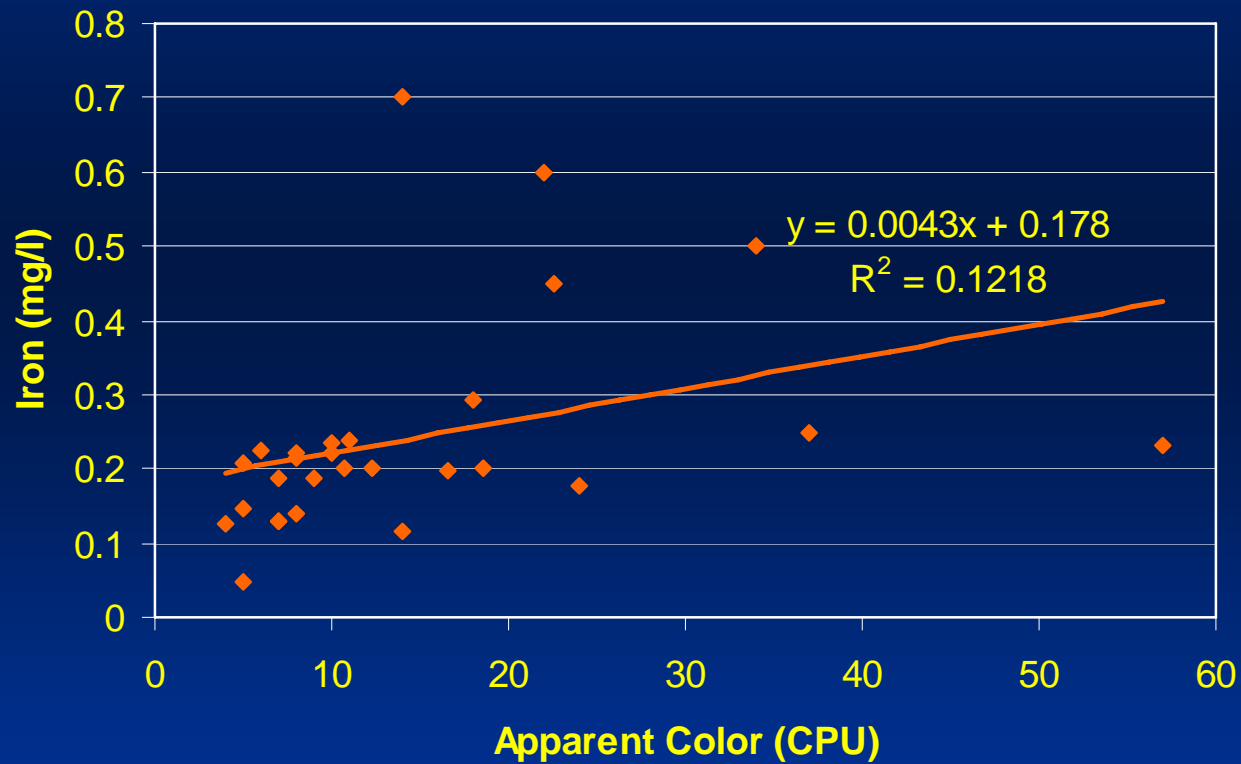
feed average = .185 mg/L



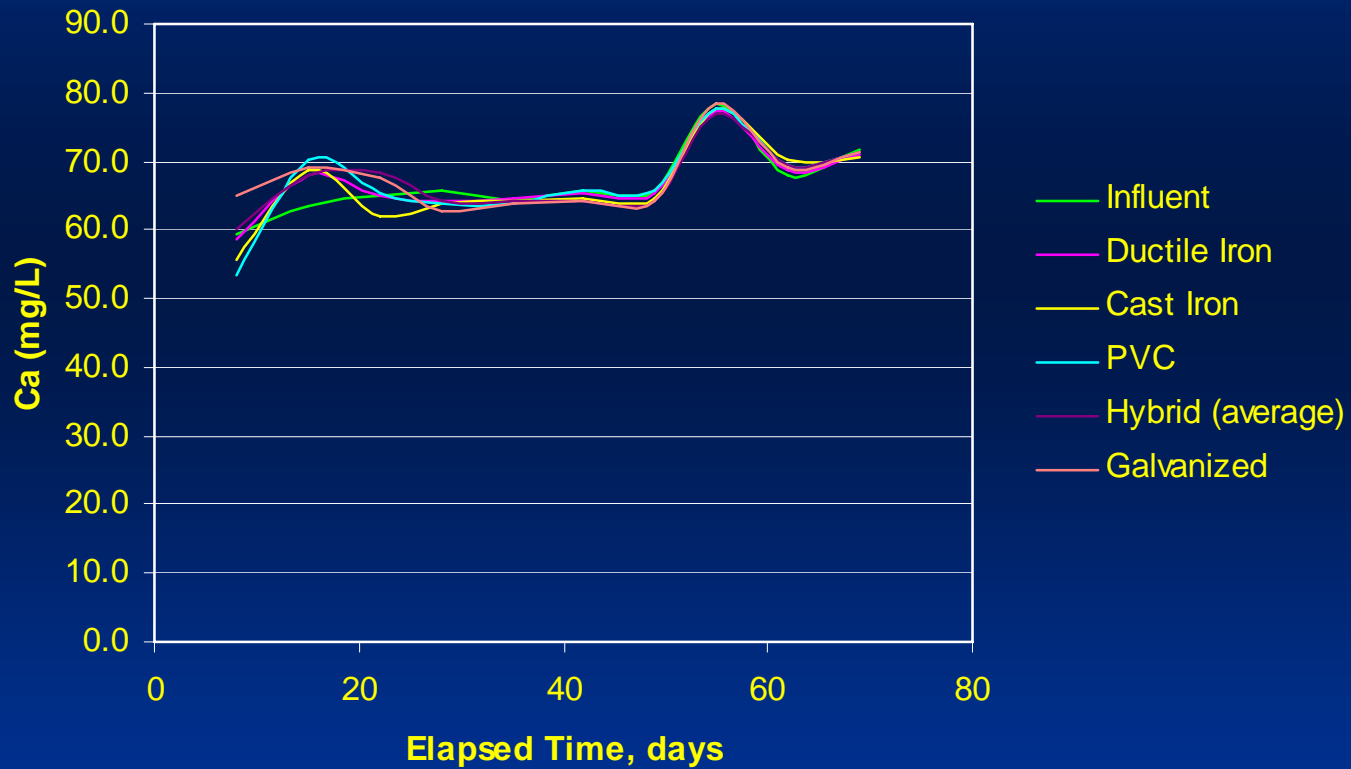
# Apparent Color – Turbidity Correlation



# Apparent Color- Iron Correlation



# Calcium



# Cause of Disruption

- Extraction and Construction
- Minimization of disruption:
  1. Pipes kept wet from excavation to delivery
  2. Pipes staged to receive flow during construction

# After Equilibration

- Analyze blending effects
- Verify in full-scale

# Conclusions

- LSI used as indicator
- Pilot scale needed
- 3 month Equilibration Period for Iron, Color and Turbidity

# Acknowledgements

- The financial support of Tampa Bay Water Authority and the American Water Works Research Foundation is gratefully acknowledged.