Kennedy/Jenks Consultants

Engineers & Scientists

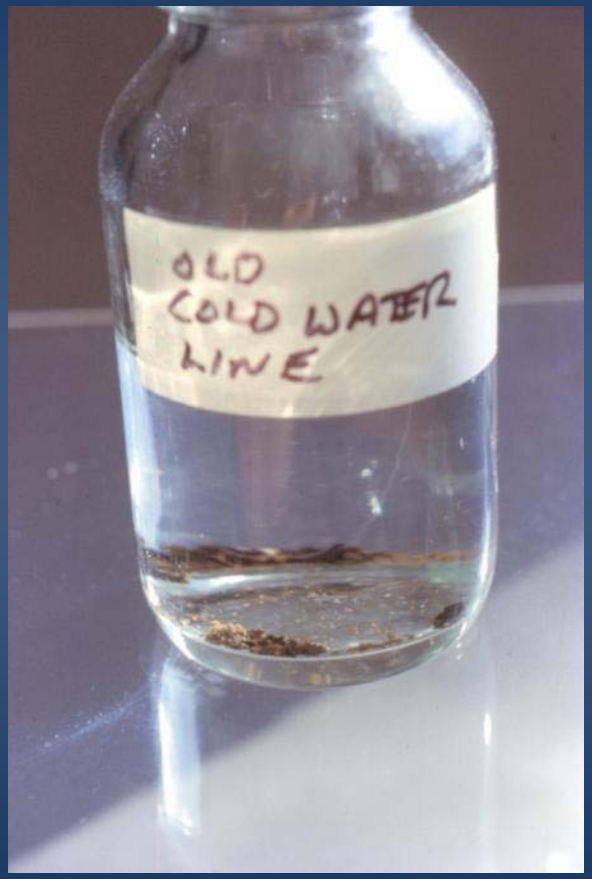
Responding to Customer Complaints about Particles

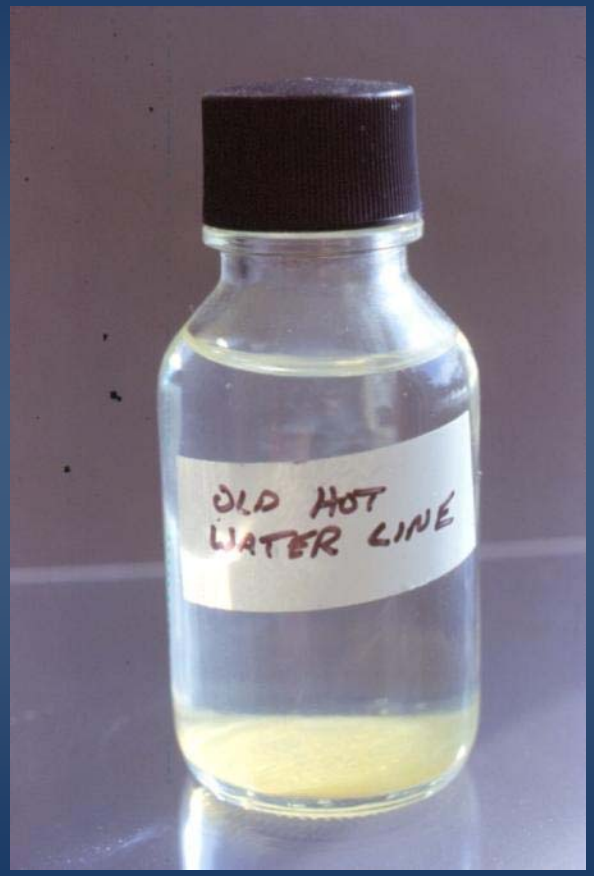
Stephen Booth, PhD

Blaise Brazos

pnws • awwa WATER WORKS conference 2010 • May 12-14 tacoma

Particulate Matter

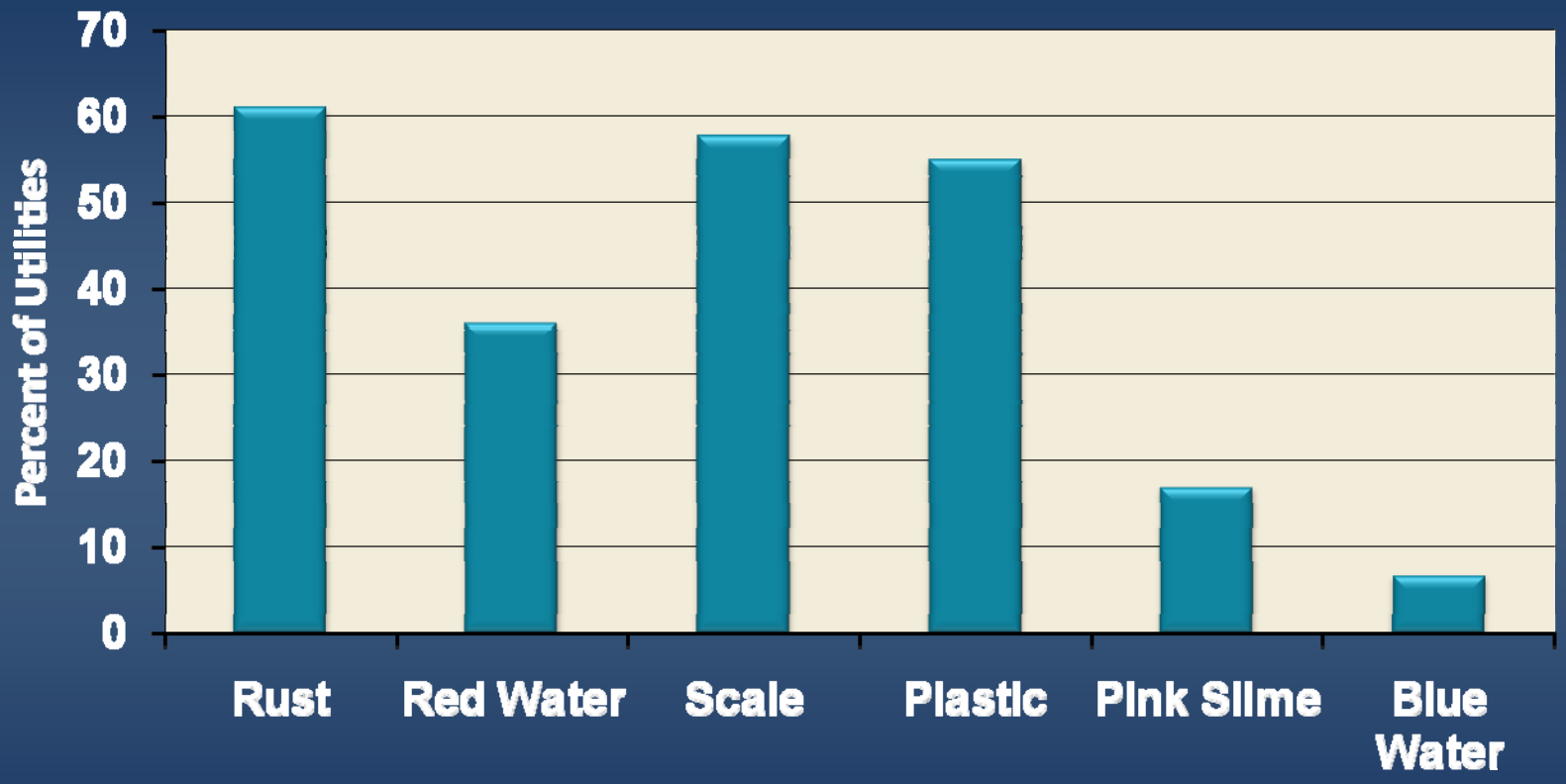




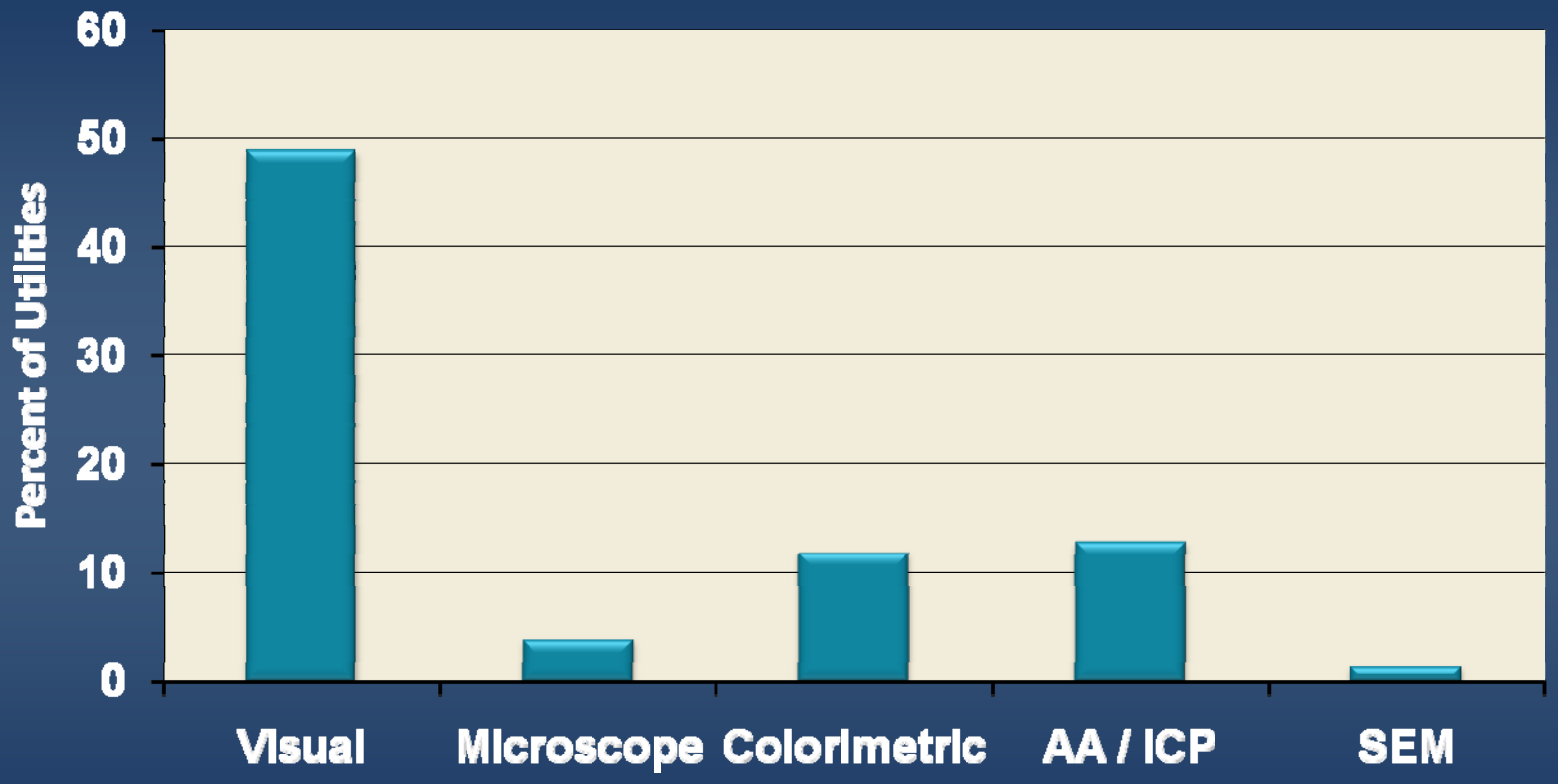
Overview of Survey Results

- 100% reported finding particulate matter in their system
- 75% of particulate matter was found by customers

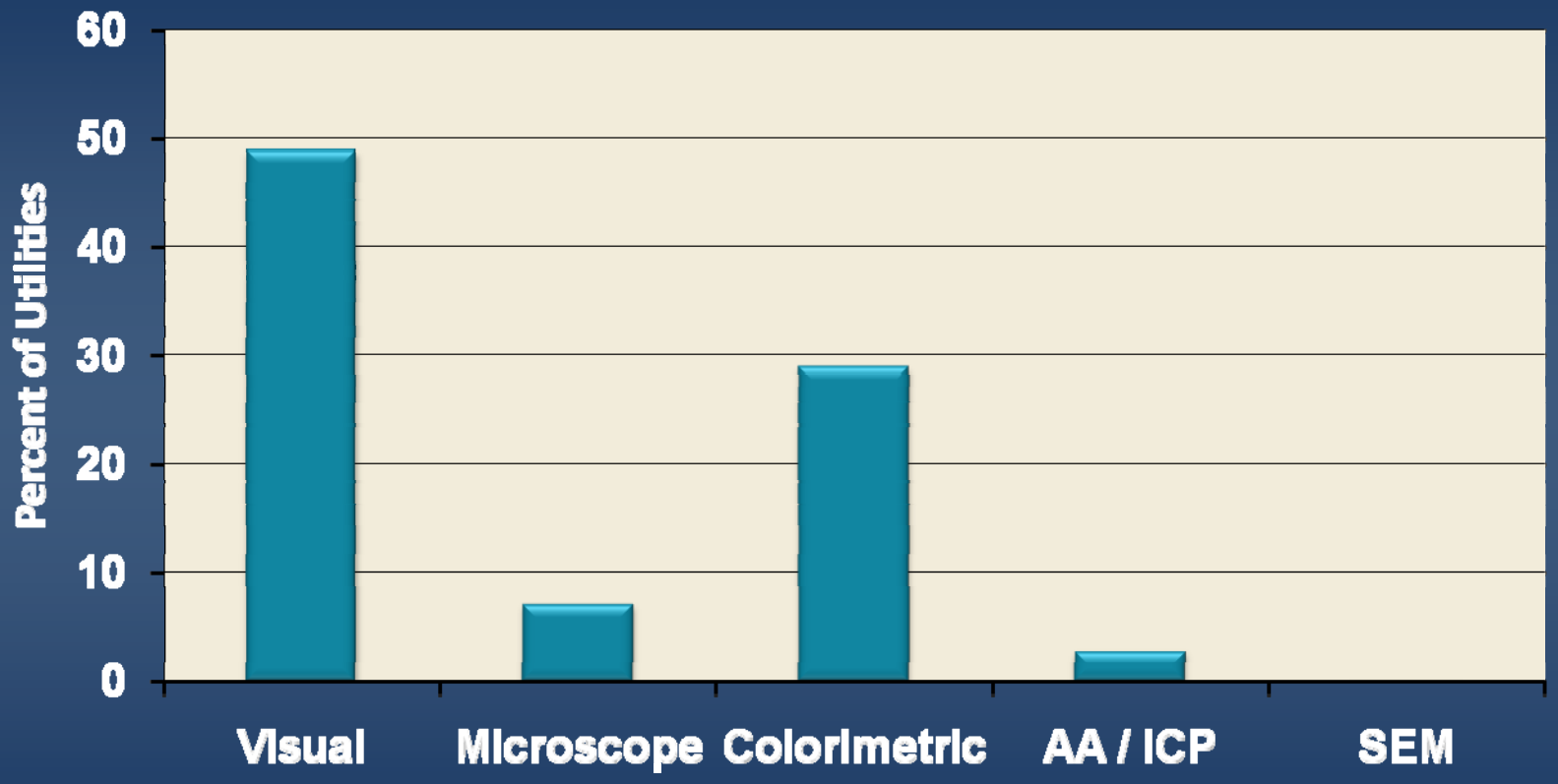
Survey: Particle Types Reported



Survey: Methods to Identify Rust



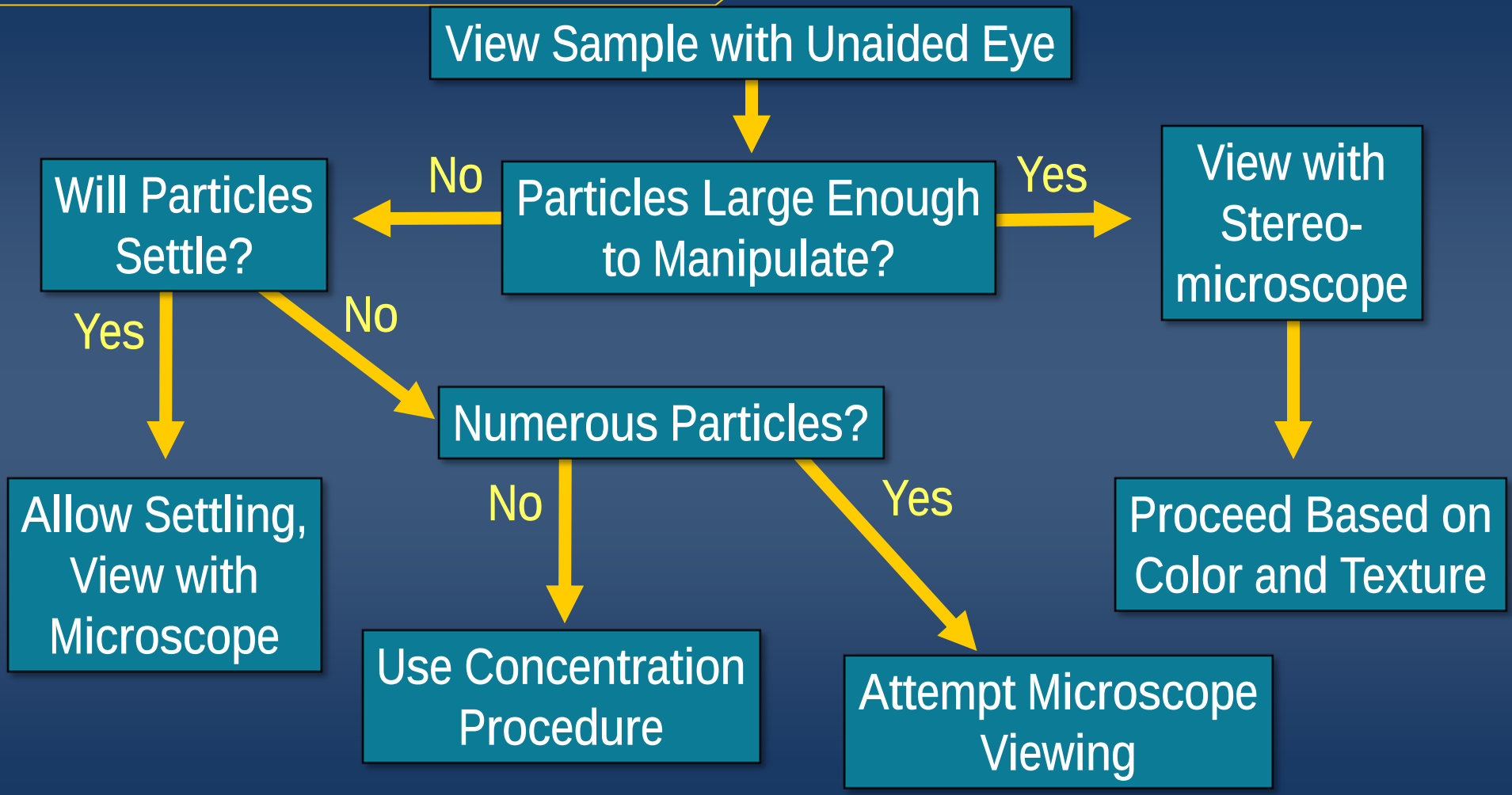
Survey: Methods to Identify Scale



"You can see a lot by looking"

- Yogi Berra, 1964

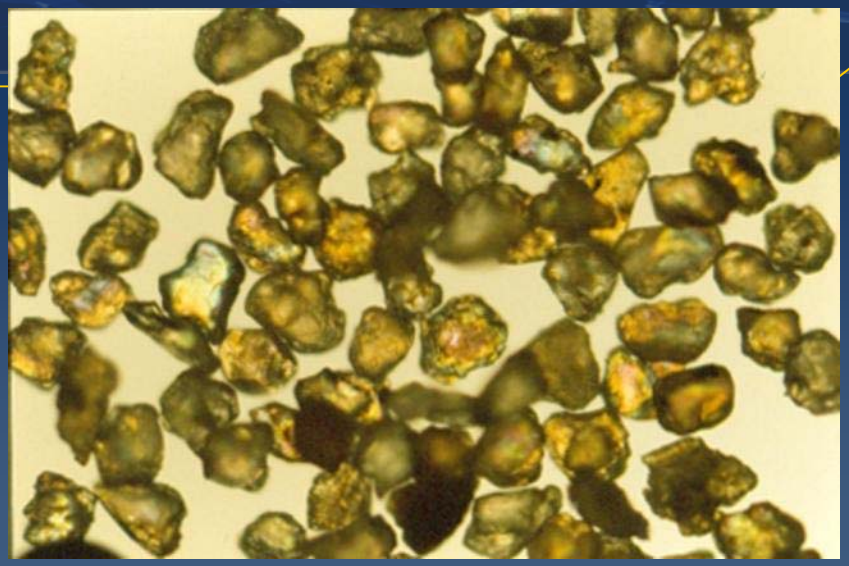
Method Decision Tree: Initial Identification



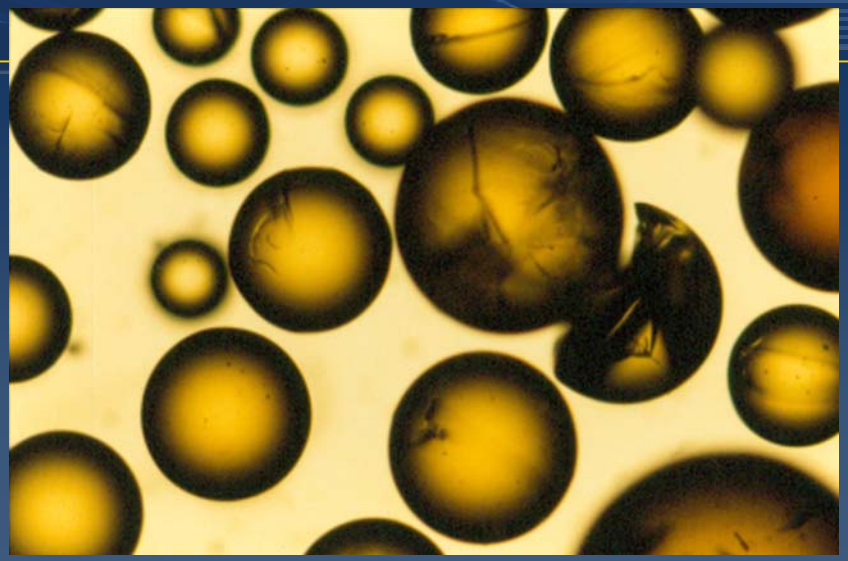
Low Magnification Microscope

Particulate Matter Type	Observations
Sand	Vitreous, irregular shape
Zeolite (ion exchange) resin	Spherical shape, amber color
Glass chips	Sharp edges, transparent appearance

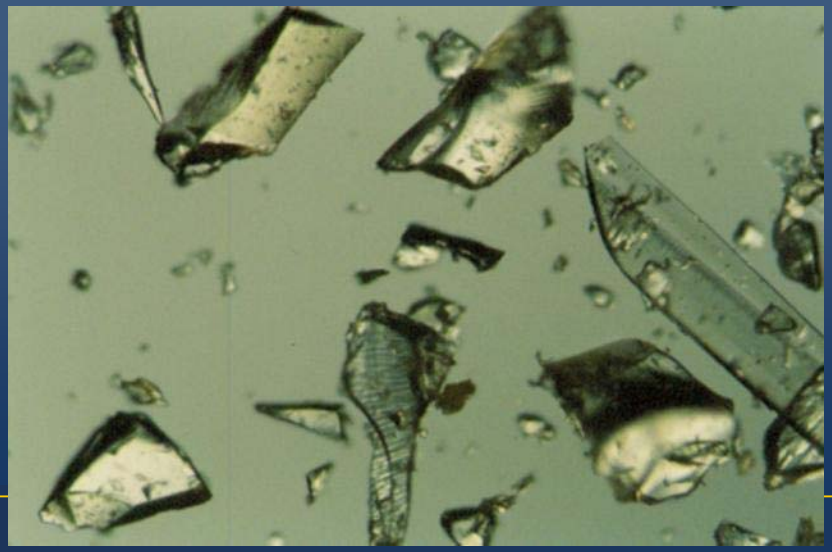
Photos are Preferred to Text



Sand

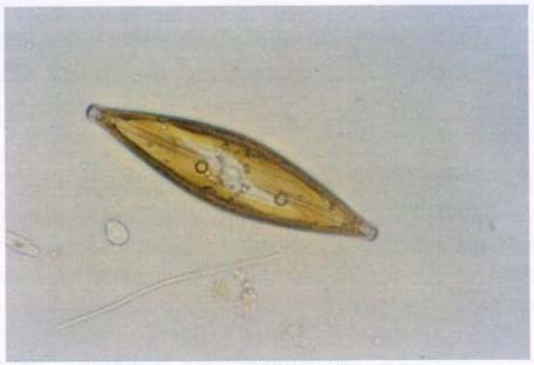


Zeolite Resin



Glass Chips

Microscopy Types

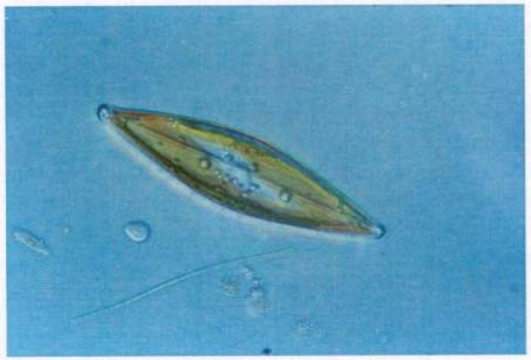


Compound microscopy, bright-field, 300X

(a) Bright-field illumination

Compound microscopy, phase contrast, 300X

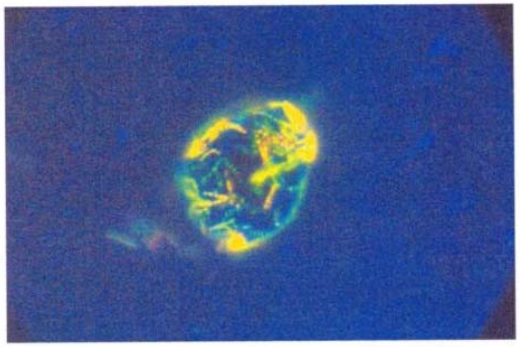
(b) Phase contrast illumination



Compound microscopy, DIC, 300X

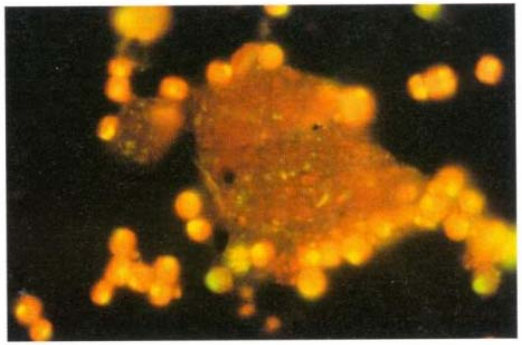
(c) DIC illumination

Example Micrographs



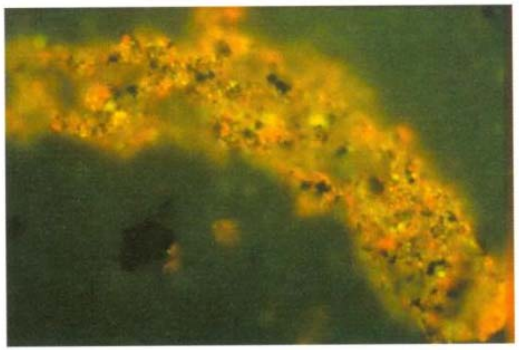
Compound microscopy, epifluorescent light, 900X

(g) Micrograph of an oil droplet



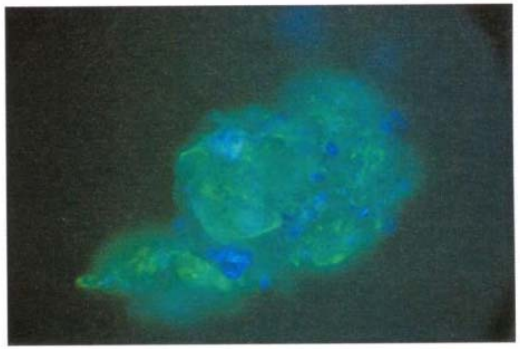
Compound microscopy, epifluorescent light, 900X

(h) Micrograph of microfloc collected from a drinking water treatment plant effluent



Compound microscopy, epifluorescent light, 900X

(i) Micrograph of microfloc with particle-associated bacteria and powdered activated carbon fines



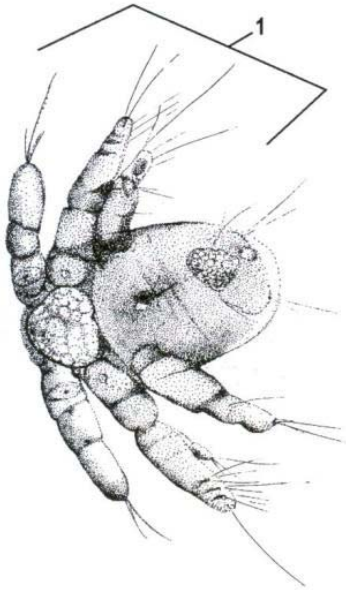
Compound microscopy, epifluorescent light, 500X

(j) Micrograph of a mineral

Copepod

Phylum: Arthropoda
Subphylum: Crustacea
Class: Copepoda

Active larva of an immature codepod. First stage nauplius of six naupliar stages. Typical life cycle consists of the egg, six nauplius stages, five to seven copepodid stages, and the adult.



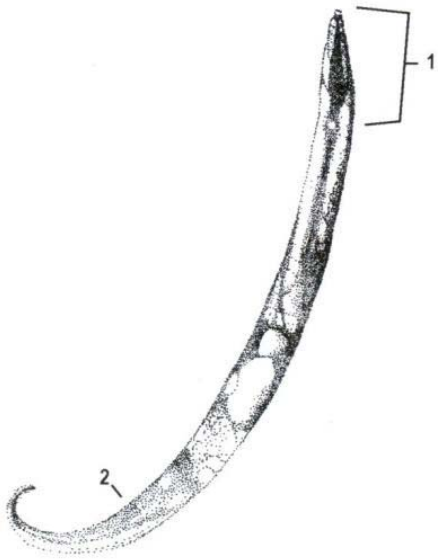
1. Three pairs of abbreviated appendages

Compound microscopy, DIC, 300X

Nematode

Phylum: Nematoda

Unsegmented worms with body cavity and complete alimentary tract. Generally less than 1 cm in length. Whip-like movements that form c- and s-shaped movements.



Compound microscopy, bright-field, 170X

1. Esophagus
2. Tapered tail

References

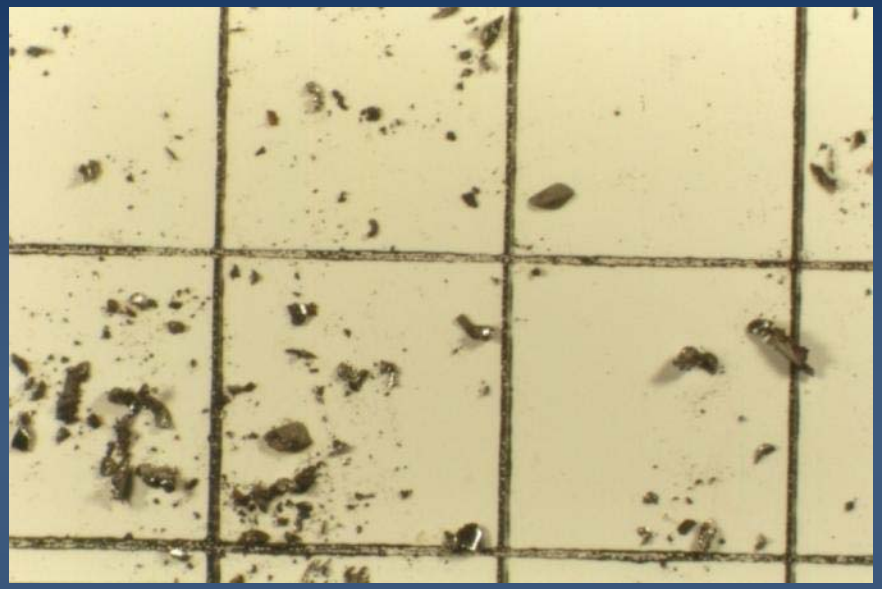
"What's that Stuff in My Tap Water"
Jameel Rahman and Gary Burlingame.
Opflow, Vol. 29, No. 2 (Feb 2003)

ASTM D1245-84 (1999). Standard Practice for Examination of Water-Formed Deposits by Chemical Microscopy.

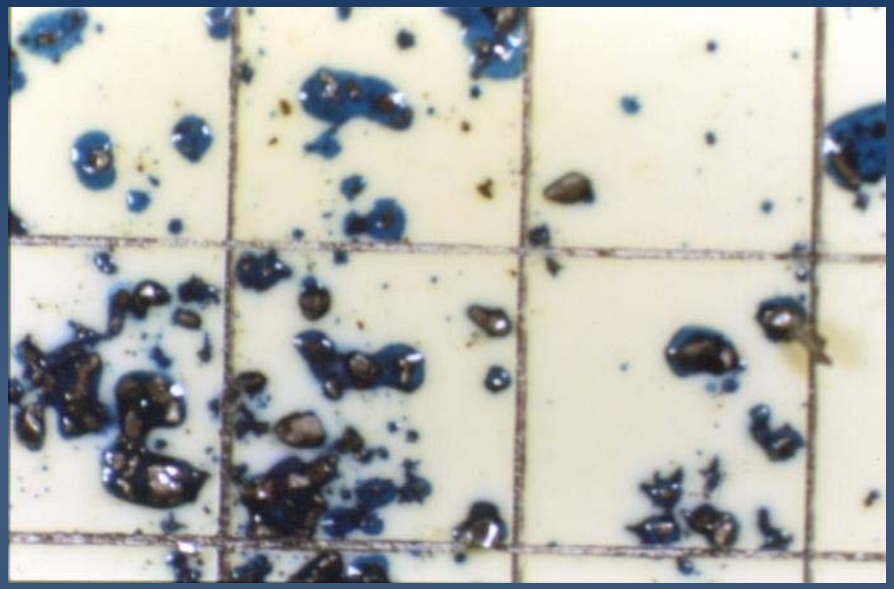
Walker A.P. (1985). The Microscopy of Consumer Complaints. *J. Inst. Wat. Eng. Sci*. 37:3:200-212.

Iron Particles Drawn to Magnet

Identification of Iron

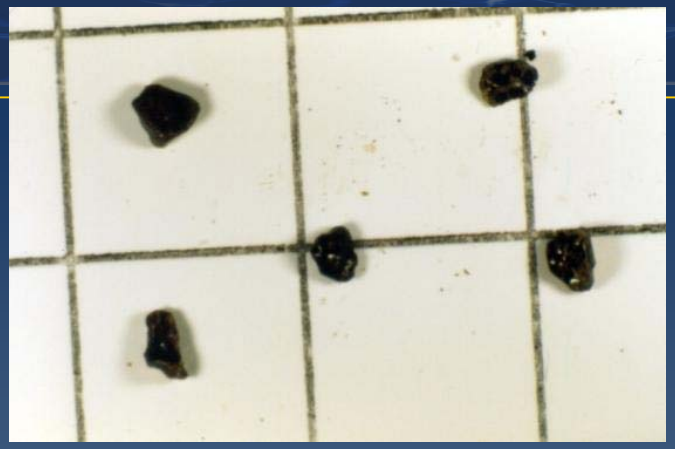


Iron Pieces

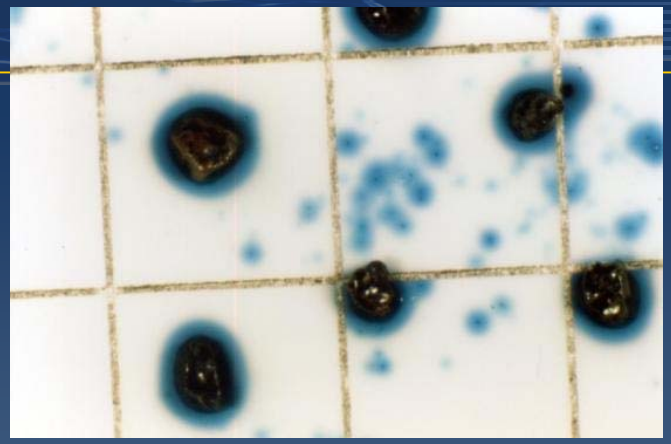


+ Potassium Ferrocyanide

Manganese Identification



Manganese-Rich Sand



+ Leucomalachite Green

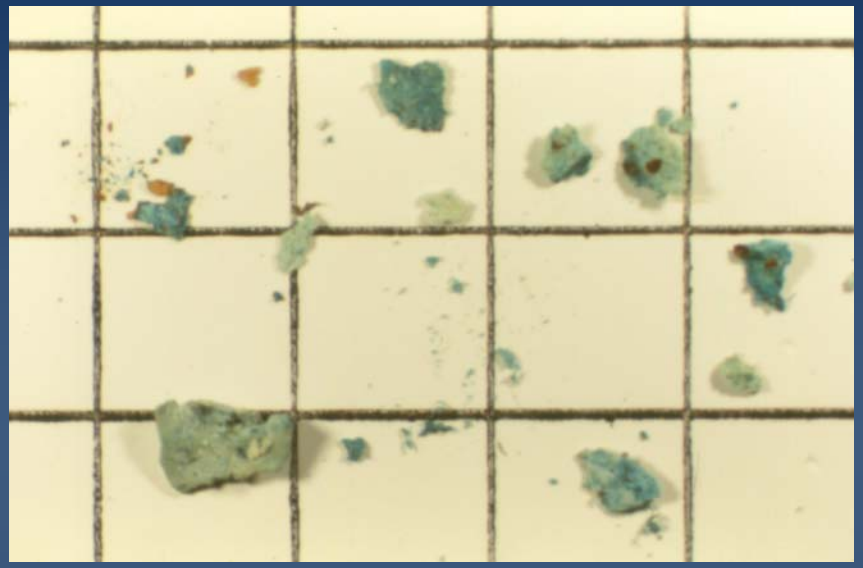
Filter with Manganese + Leucomalachite Green

Hach Iron Test (Ferrover Reagent)

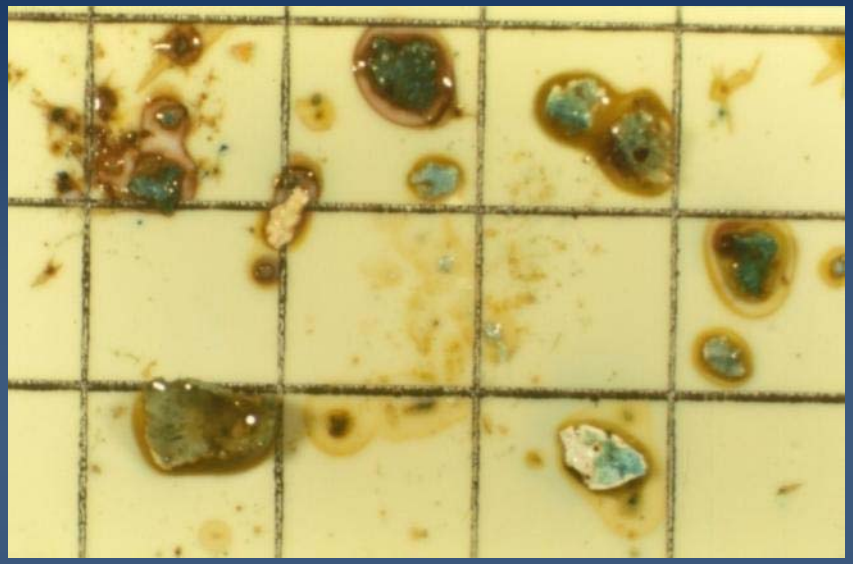
Manganese Test (Chromazurol S)

Hach Manganese Test (Periodate Oxidation)

Identification of Copper Patina



Patina



+ Potassium Ferrocyanide

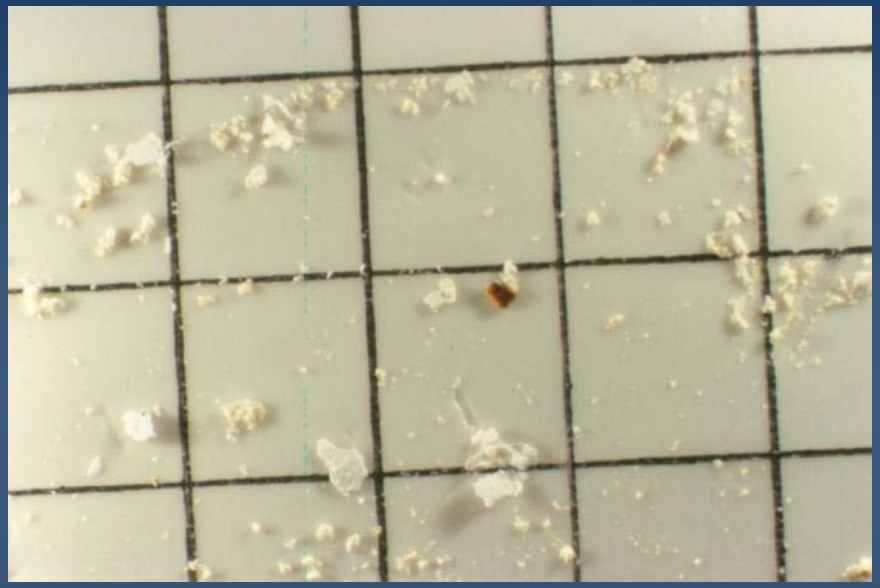
Hach Copper Test (CuVer 1 Reagent)

Calcium Carbonate Identification

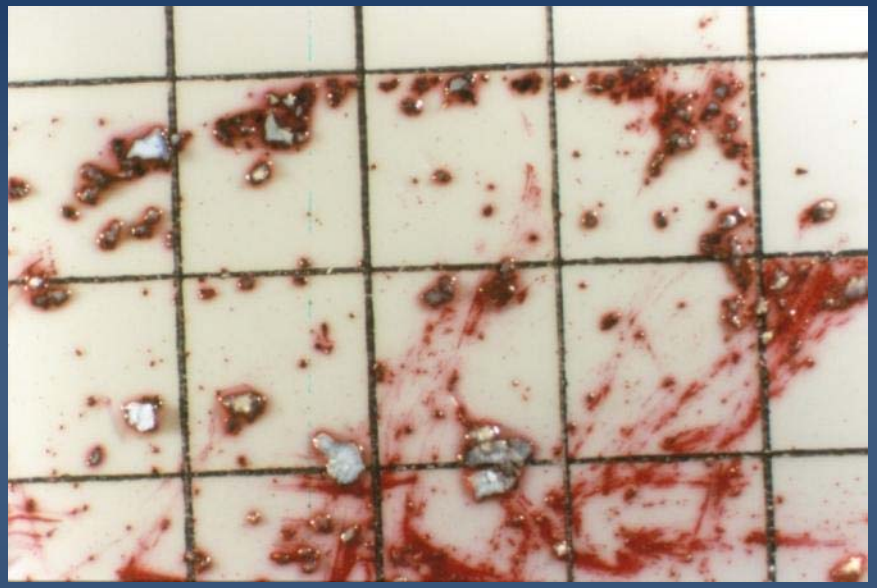
Scale

+ Hydrochloric Acid

Identification of Lead



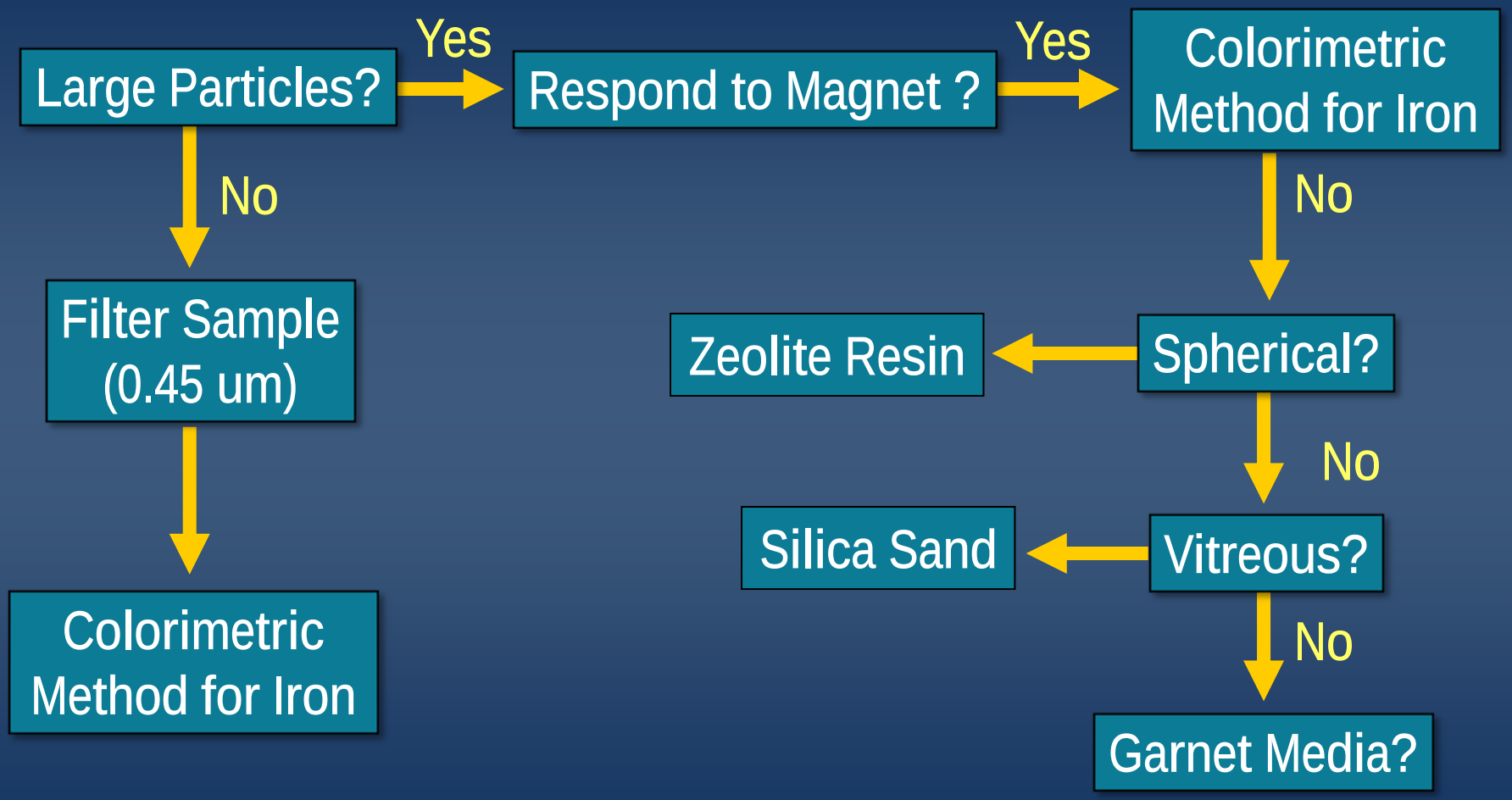
Lead Carbonate



+ Rhodizonic Acid

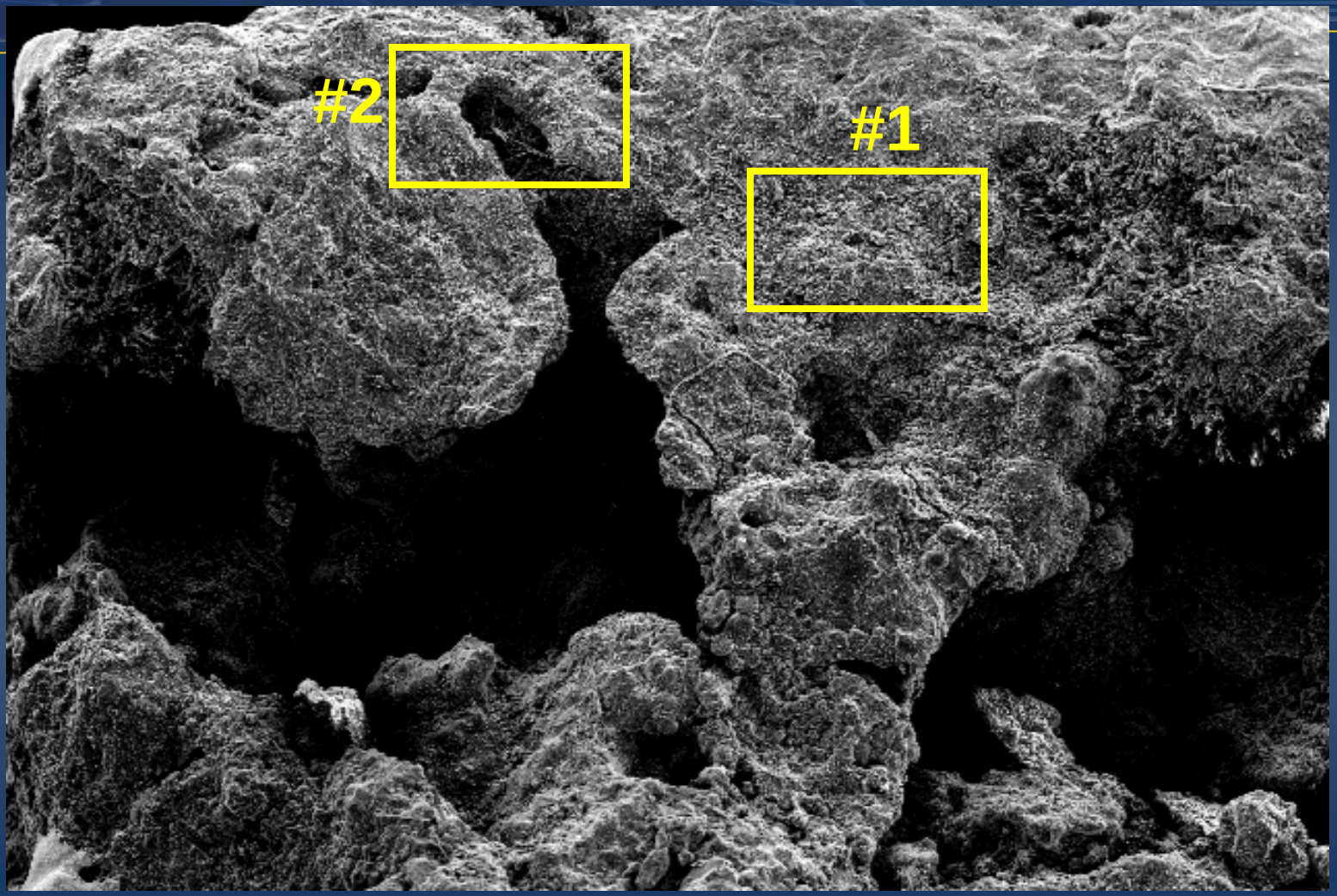
and Tartaric Acid

Decision Tree: Brown Particles

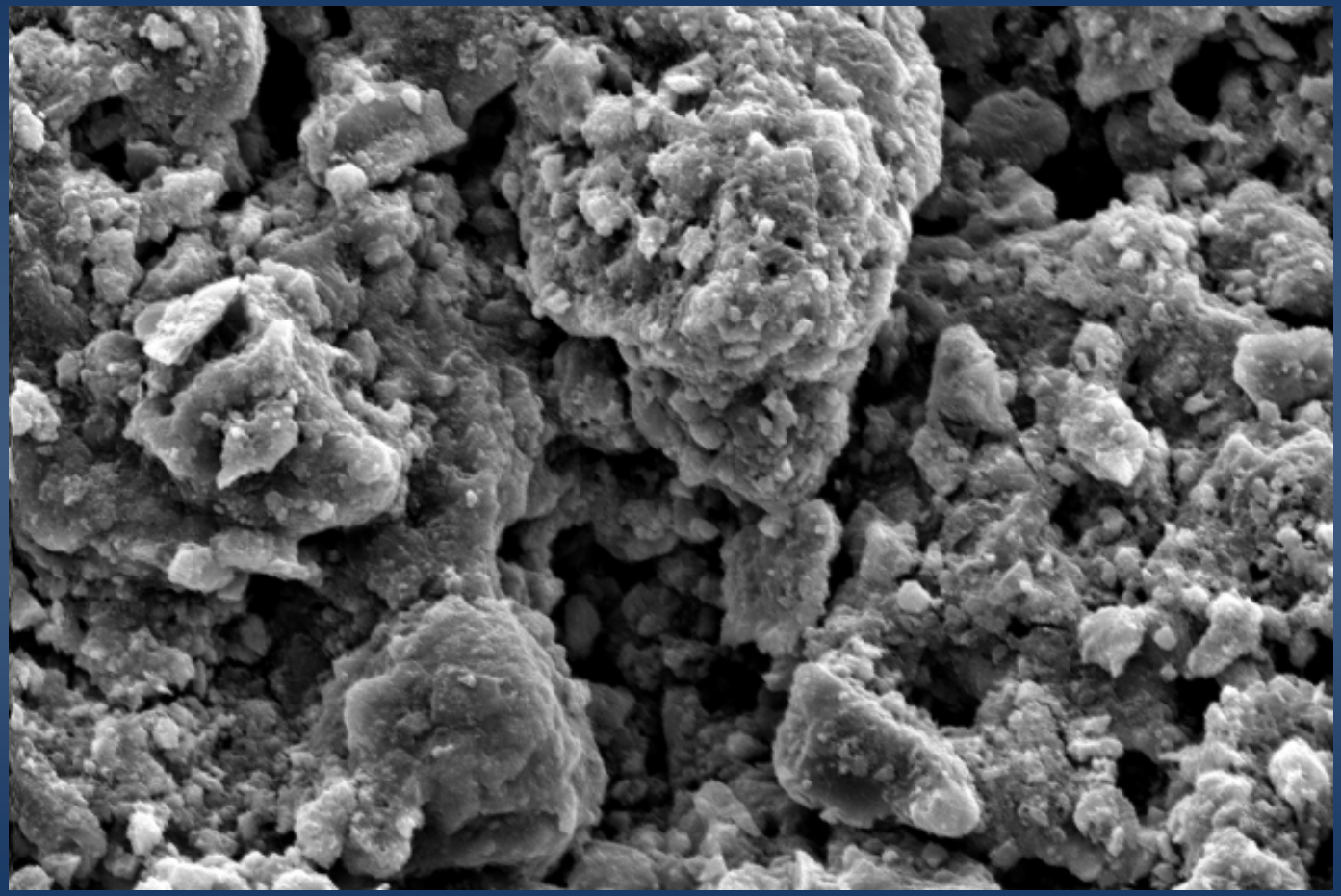


Pipe Tubercle

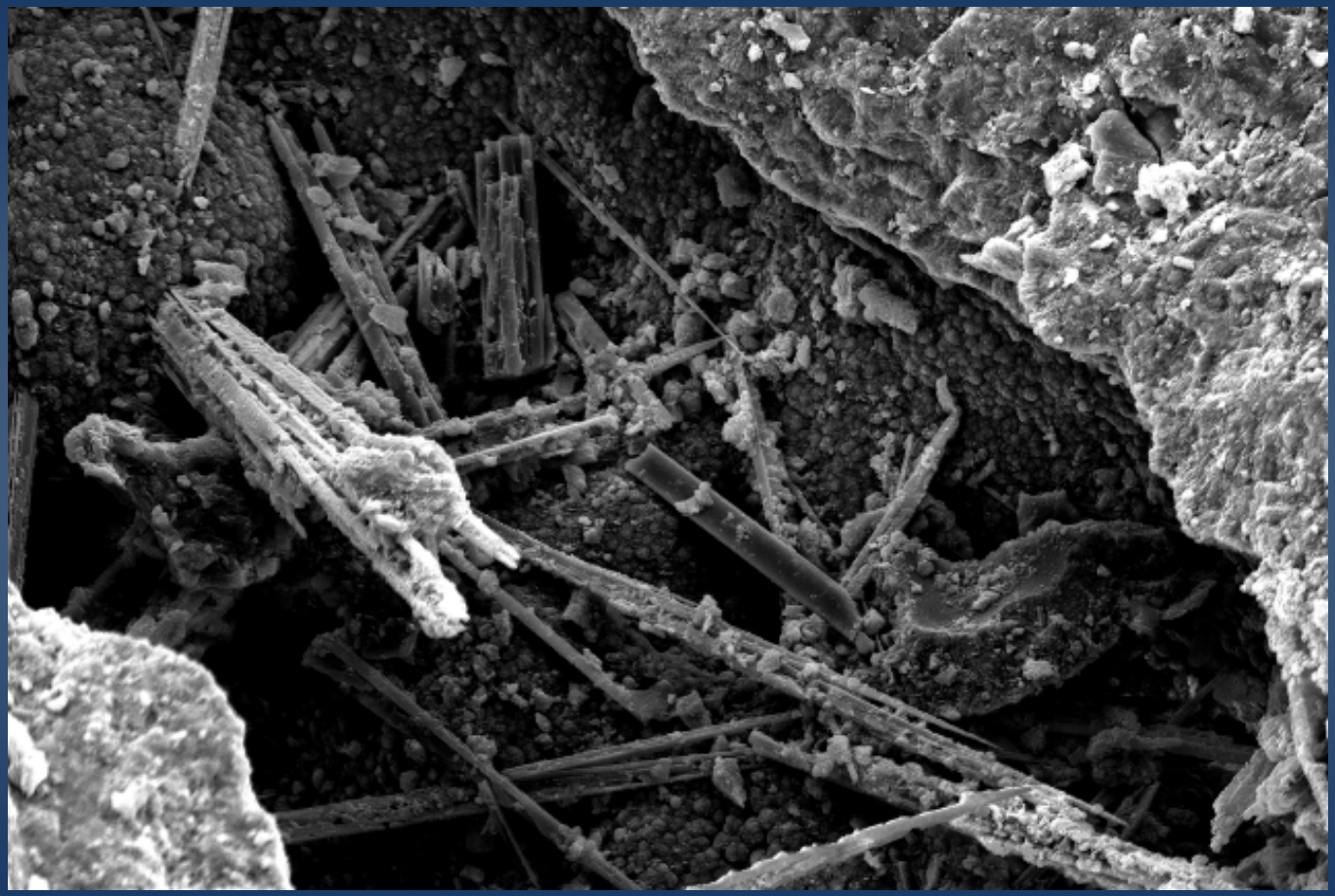
Pipe Tubercle



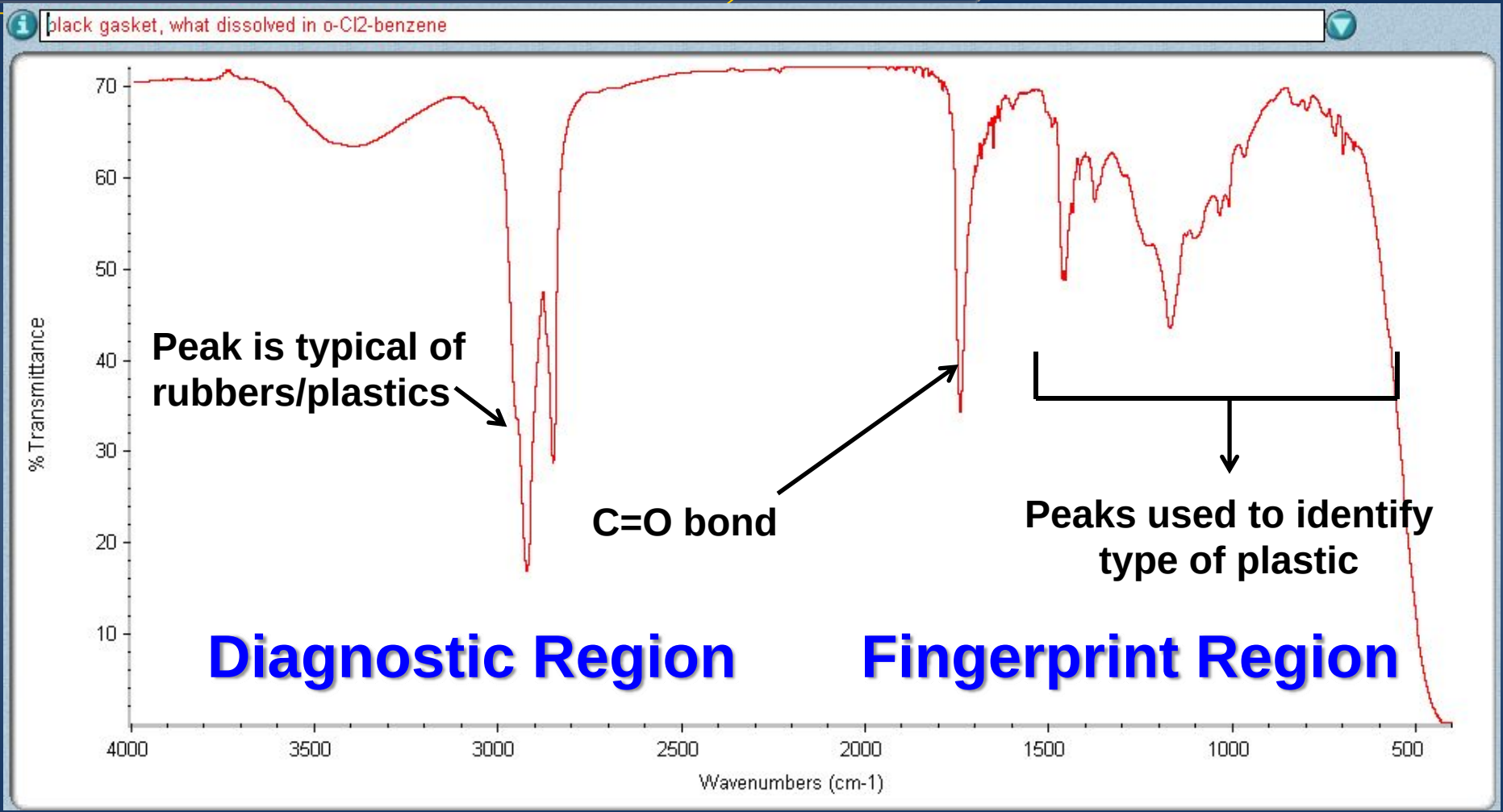
Area #1: Calcium Carbonate and Iron Oxide



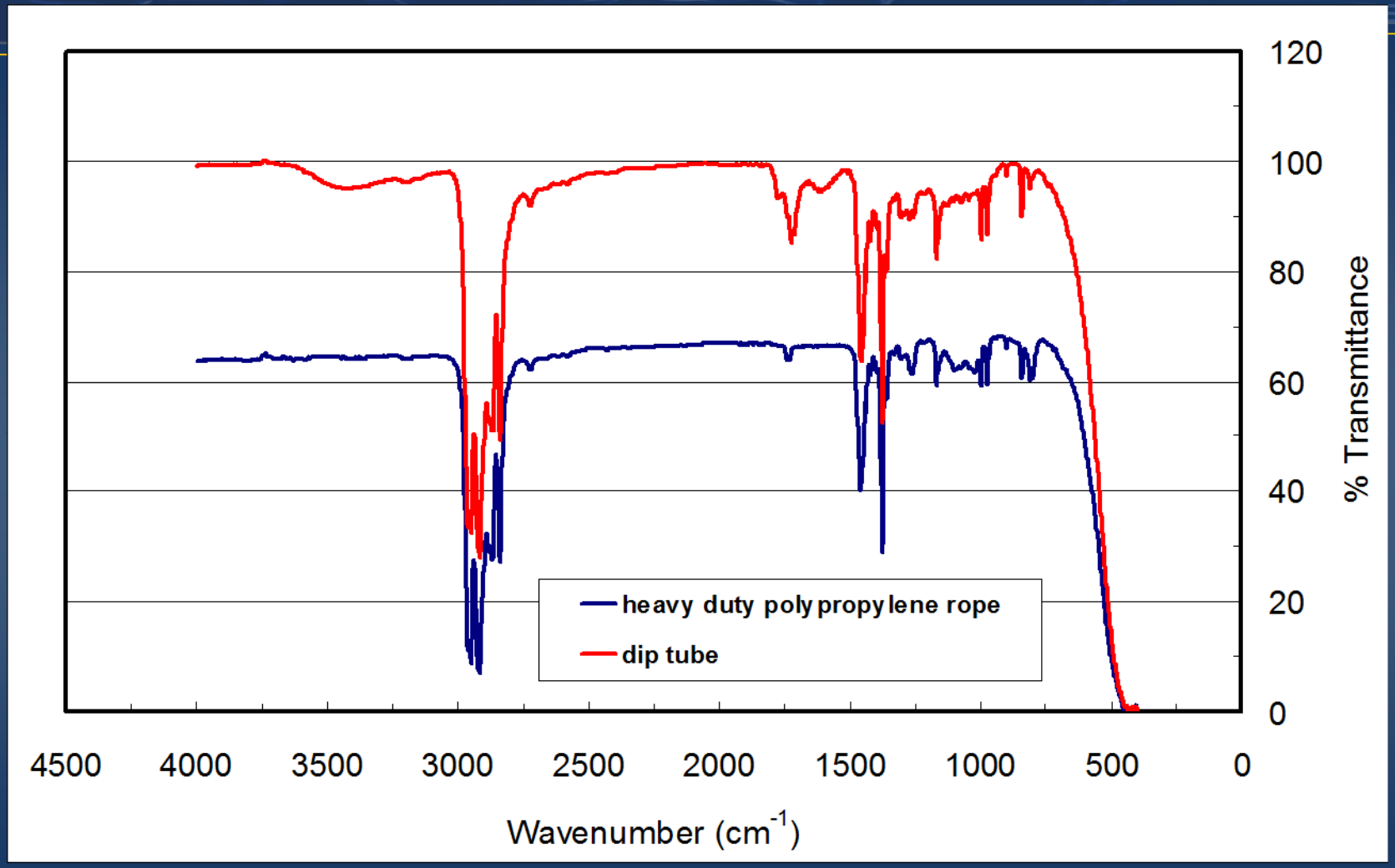
Area #2: Calcium Carbonate Rods



Fourier Transform Infrared Spectroscopy



Identification of Dip Tube Plastic



Elements Identified by ICP

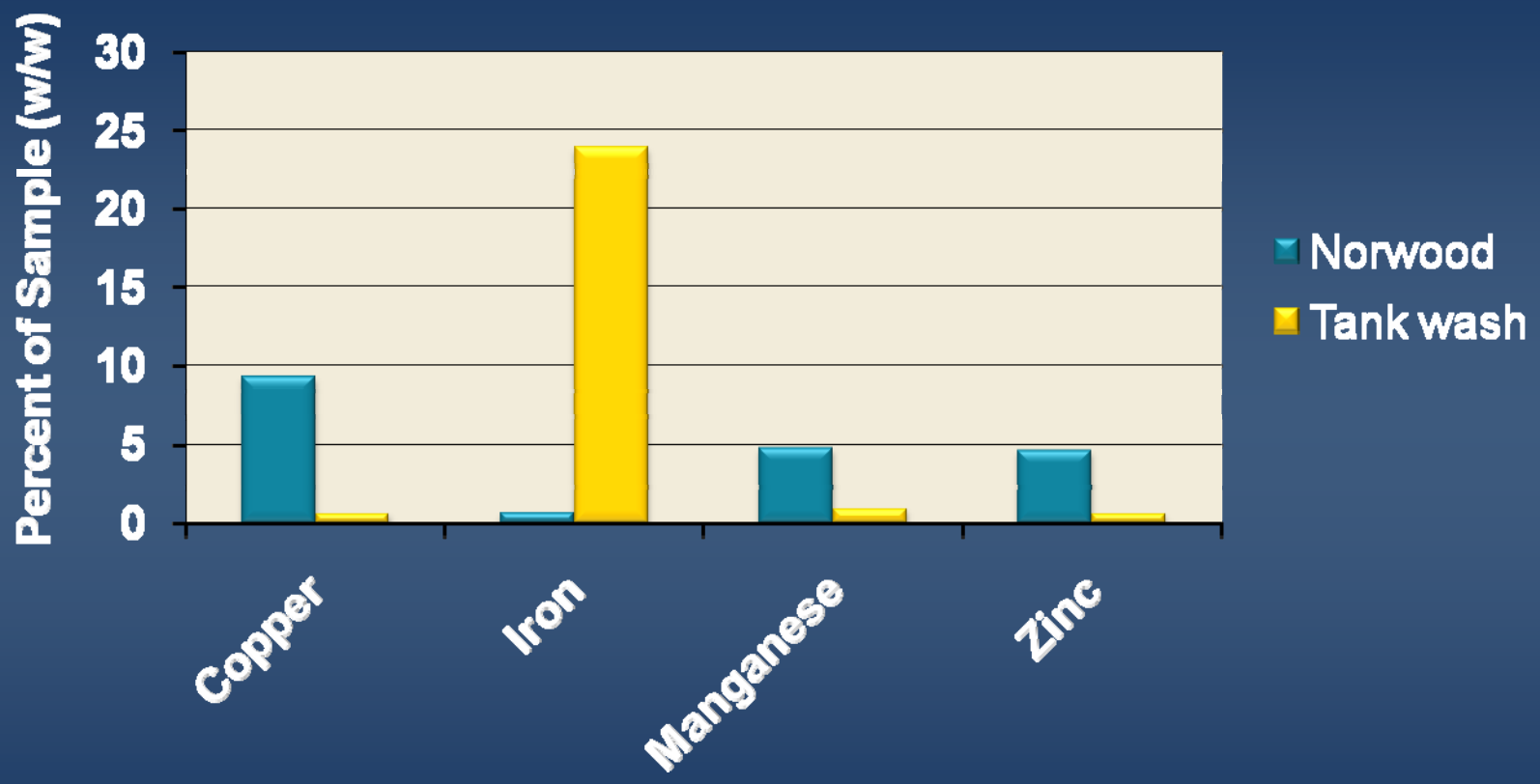
- Aluminum
- Boron
- Barium
- Beryllium
- Calcium
- Cadmium
- Chromium
- Copper
- Iron
- Potassium
- Magnesium
- Manganese
- Lead
- Strontium
- Zinc

Powdery, Particulate Matter Samples

Norwood

Tank Wash

Comparison of ICP Results for Two Samples of Similar Appearance



Summary

- Final report is a manual of methods
- Decision tree framework to guide method selection
- Techniques illustrated with photos

Acknowledgements

- AWWARF
  - Jennifer Warner, Project Manager
- PAC Members
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