Columbia Analytical Services INC

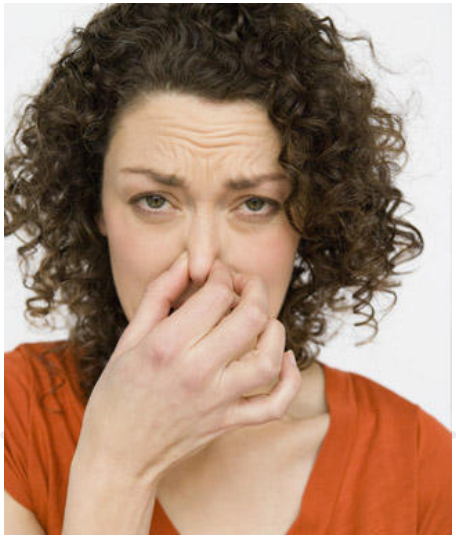
Laboratory Approach to Water Quality Issues

Howard Boorse

Water Quality

Common Complaint

- Bad Taste
- Bad Odor



Columbia Analytical Services™

Water Quality

Common Complaint

- Colored Water
- Particulate in Water

Columbia Analytical Services™

Taste and Odor in Drinking Water

- How Taste and Odor problems are produced
- How Taste and Odor are evaluated
- How Chemicals associated with Taste and Odor are analyzed in the lab

Columbia Analytical Services™

Color & Particulate in Drinking Water

- Typical source of water color
- Typical particles and their sources
- Laboratory approach to identification of color and particulates

Columbia Analytical Services™

Water Quality

Sewage Intrusion

- Reservoir Water
- Aquifer Intrusion
- Well Contamination

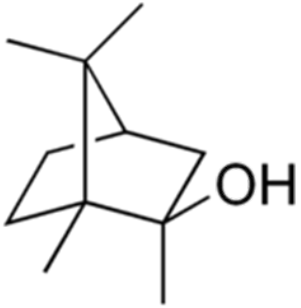
Columbia Analytical Services™

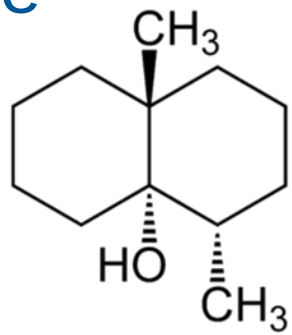
Taste and Odor in Drinking Water

- Chlorinous
- Sulfurous
- Solvent, Petroleum
- Salty
- Metallic
- Earthy, Musty, Fishy

How Taste and Odor are Produced

- Cyanobacteria (Blue-Green Algae)
  - Can be other colors, not just blue-green
  - Found in water with high nutrient content
  - Shallow reservoirs
  - Methyl-isoborneol (MIB) and Geosmin are released as the bacteria die
- Have a earthy moldy smell

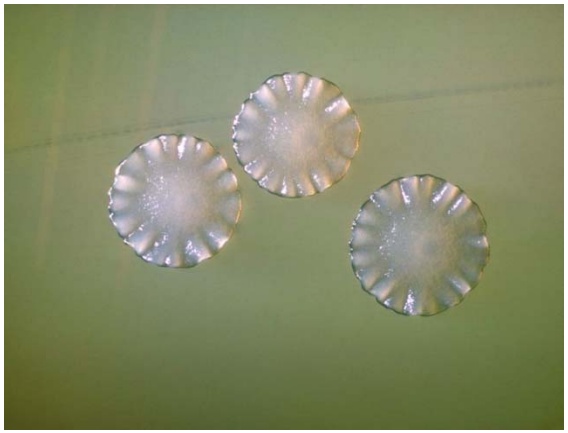




This dense bloom of cyanobacteria (blue-green algae) occurred in the Potomac River estuary downstream of Washington, D.C. Photo courtesy of W. Bennett, U.S. Geological Survey.

Columbia Analytical Services™

How Taste and Odor are Produced



- Actinomycetes
  - Closely related to Cyanobacteria
  - Spore-forming Bacteria
  - Can live in water or soil
  - Aquatic varieties have been found in mud, decaying vegetation and zebra muscle excrement
  - Degrades cellulose
  - Also creates MIB, Geosmin

How Taste and Odor are Produced

- Other Algal and Natural Sources
  - Green Algae can produce grassy/fishy odors
  - Golden brown Algae can produce cucumber, melon or fishy odors
  - Biological and chemical activity can produce many other compounds with fishy, musty or rancid odors

Taste – Measurement and Regulation

- Can be a useful indicator of water quality
- Finished Waters only
  - Multiple methods available for Taste measurement including Standard Methods and ASTM techniques
- Not regulated by USEPA for drinking water
- Odor is the regulated alternative

Columbia Analytical Services™

Odor - Measurement and Regulation

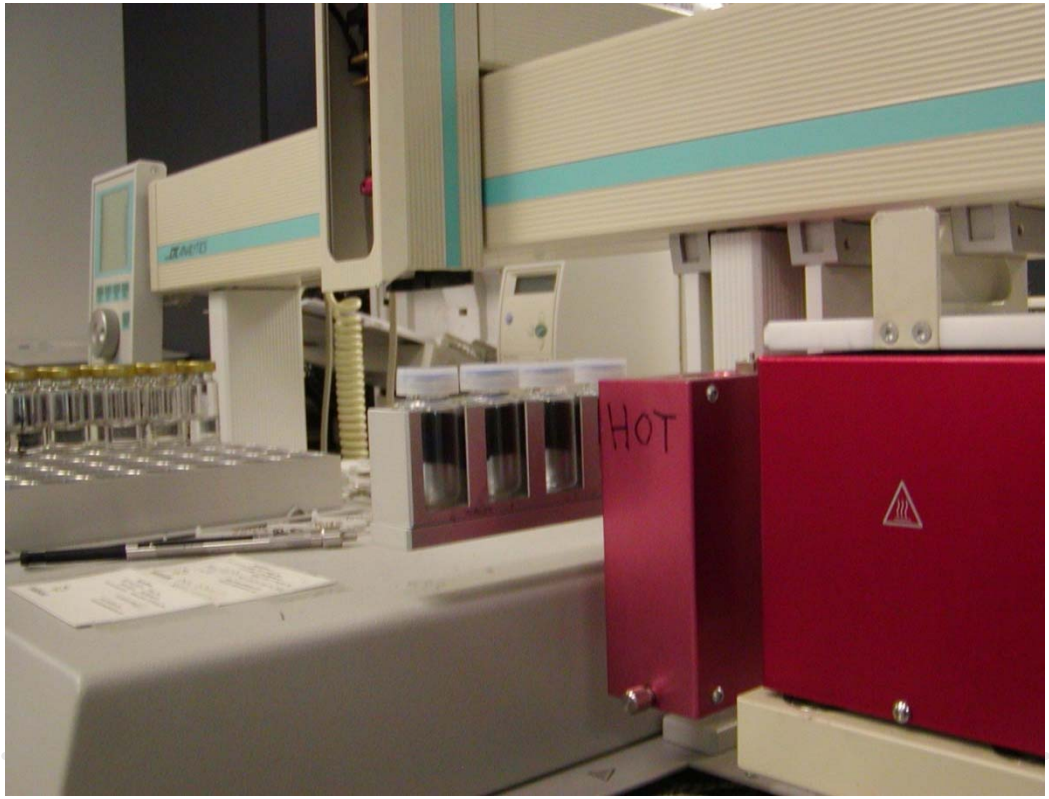
- Odor falls under EPA's secondary standard regulations
- USEPA DW limit is 3 TON (at 60 deg C)
- Standard Methods 2150B - Human nose is the detector
  - Single individual or panel if reading is in question
- SM 2170 (Flavor Profile Analysis)
  - Provides 23 odor reference standards
  - Requires a trained panel
  - Differentiates both the type and intensity of odors

- TON = threshold odor number

Columbia Analytical Services™

Chemical Analyses

- Organic Compounds Causing Odor & Taste Problems



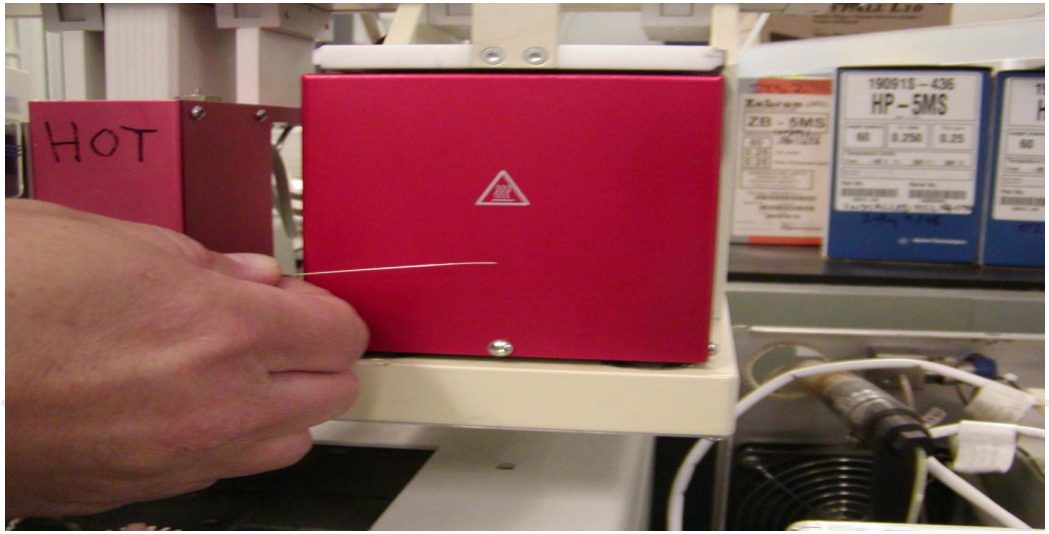
Columbia Analytical Services™

Chemical Analyses

- Determination of MIB and Geosmin
  - SM 6040D - Solid Phase Microextraction (SPME)
  - Detection limits around 1-5 ng/L
  - Fiber placed in the heated sample headspace
  - Allowed to equilibrate and inserted directly into GC/MS
  - Selective Ion Monitoring for Quantitation

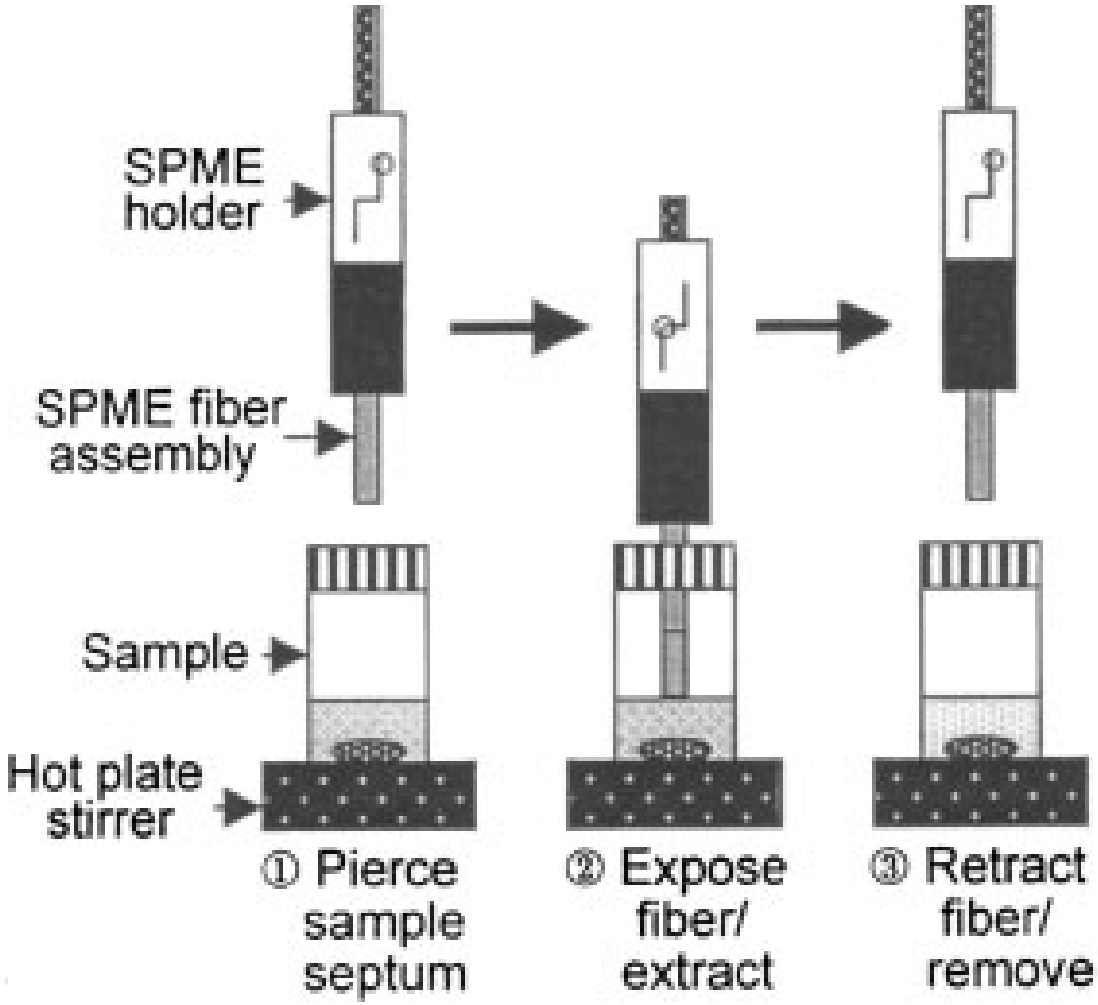
Chemical Analyses

- SPME fiber is at the end of the needle shown



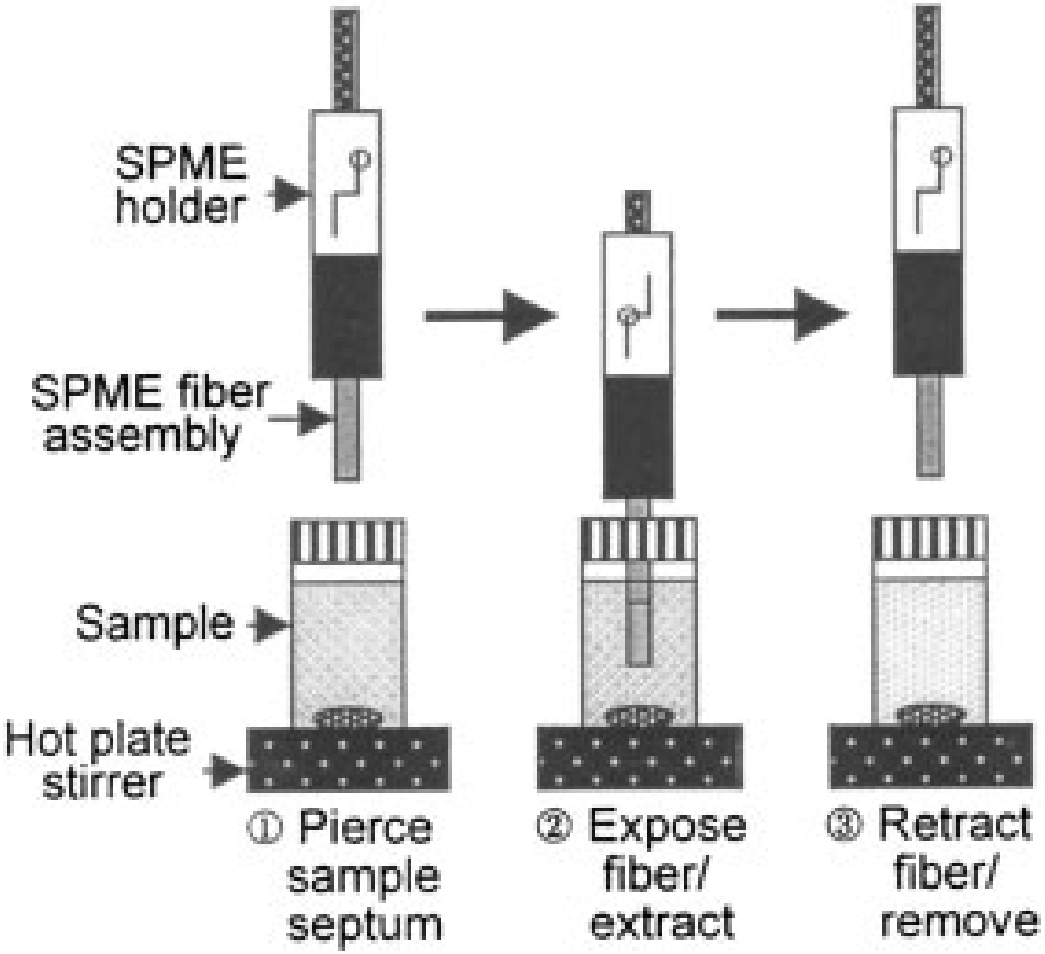
Columbia Analytical Services™

Chemical Analyses



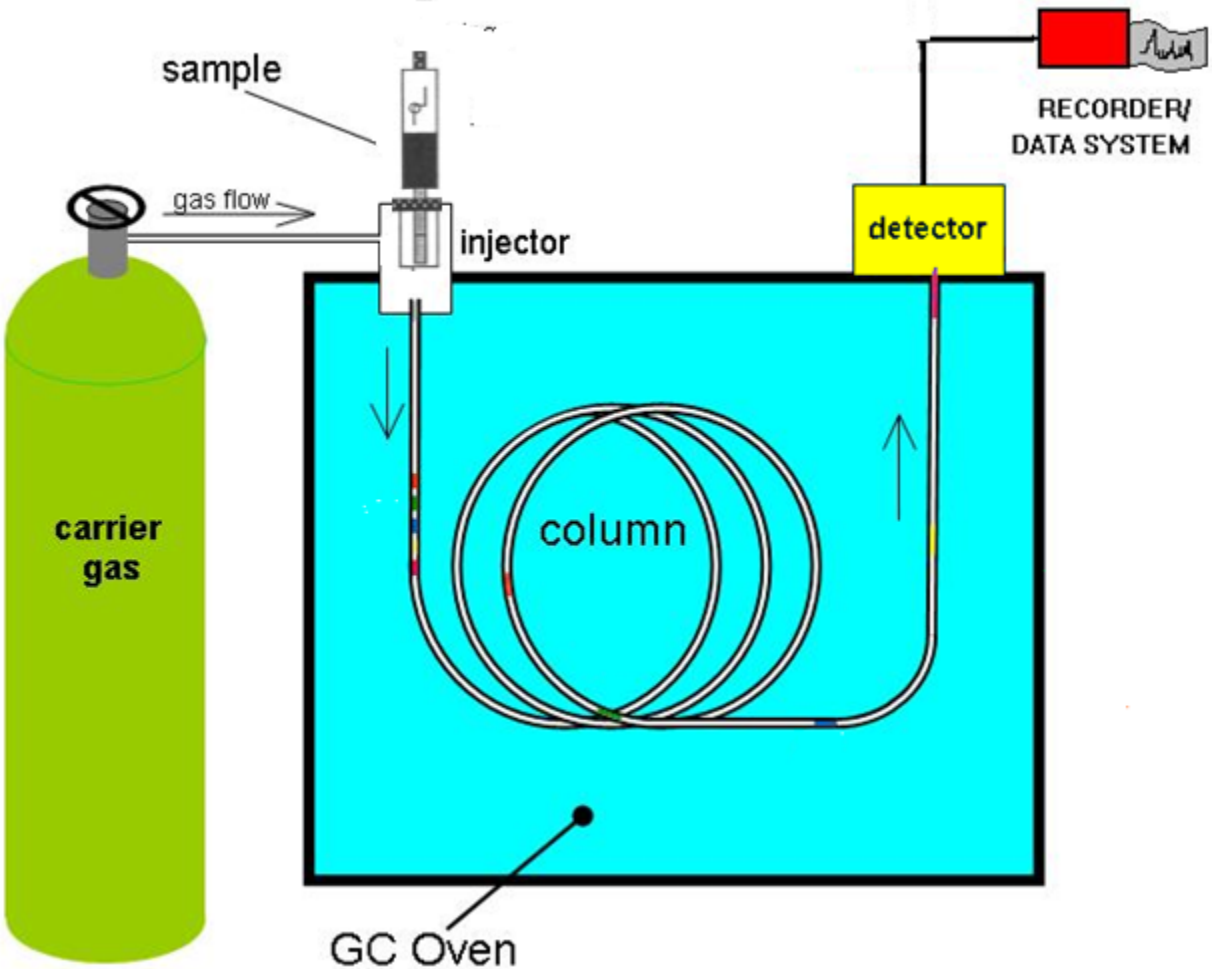
Columbia Analytical Services™

Chemical Analyses



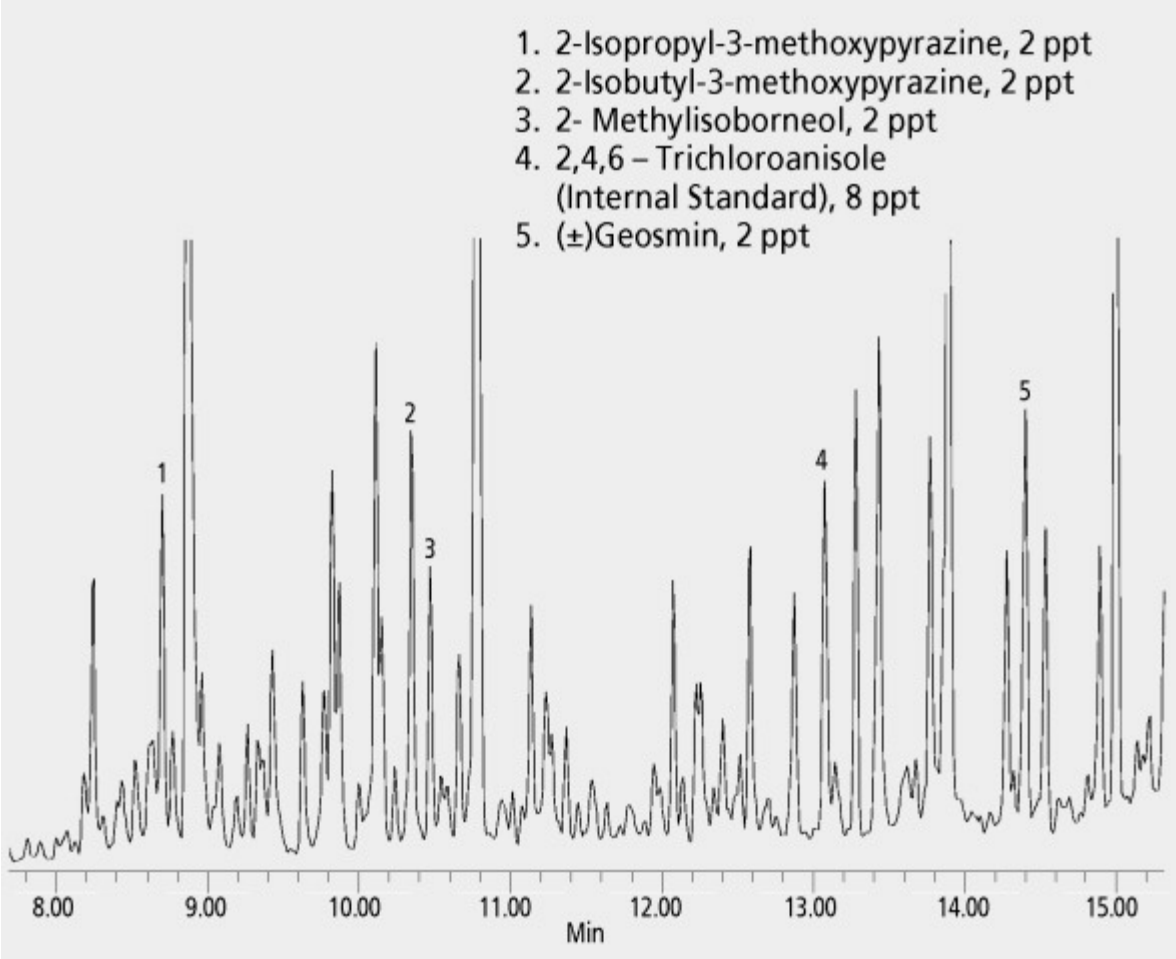
Columbia Analytical Services™

Chemical Analyses



Columbia Analytical Services™

Chemical Analyses



Columbia Analytical Services™

Chemical Analysis

- Other Taste and Odor Compounds
  - Trichloroanisole earthy, moldy
  - Tribromoanisole earthy, moldy
  - Cis- or Trans-2,6-Nonadienal cucumber
  - 1-Penten-3-one fishy
  - 2,4-heptadienal cod liver oil like odor
  - Cis-3-hexen-1-ol grass like

Chemical Analyses

GC/MS with Olfactory Port

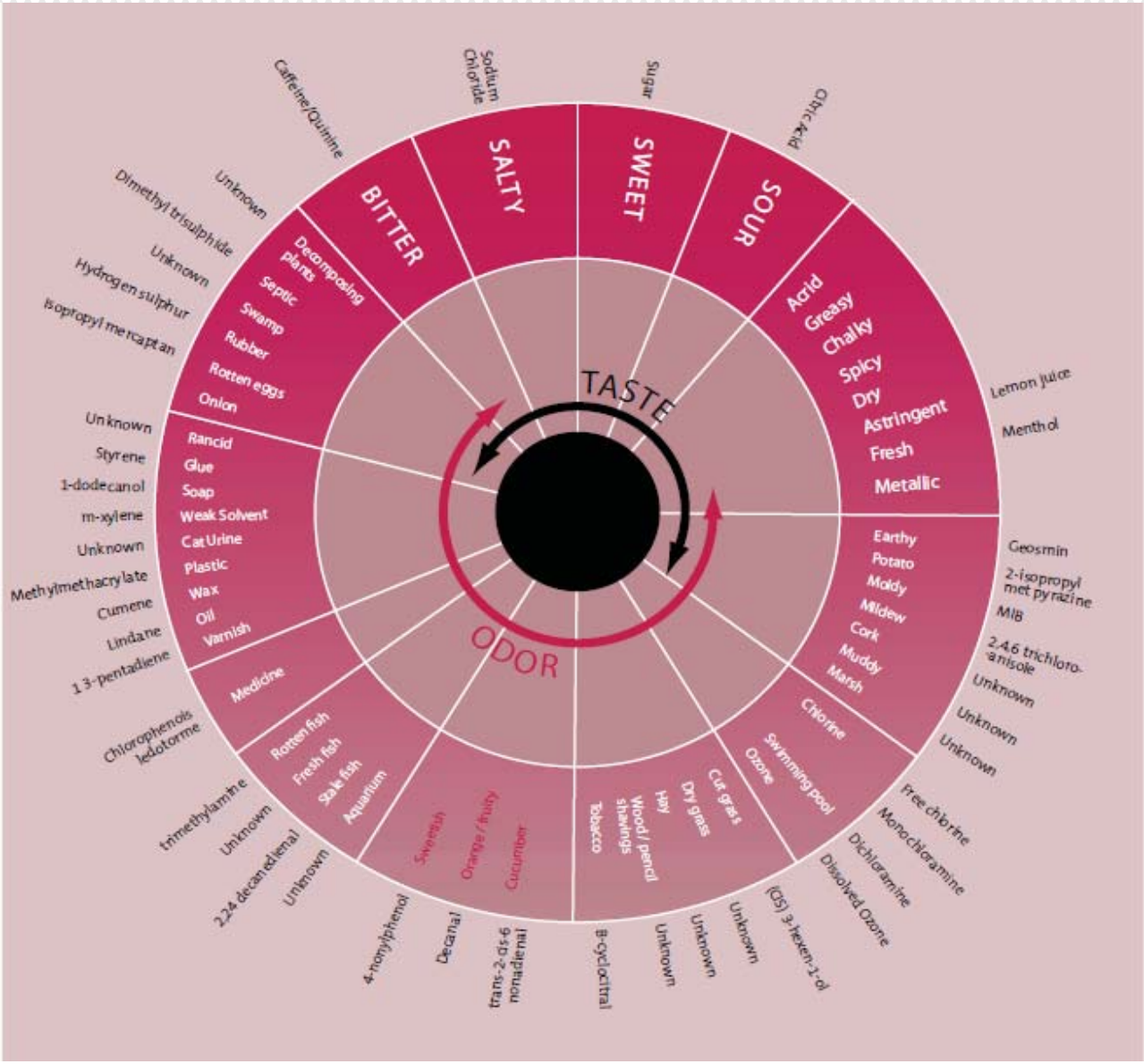
Columbia Analytical Services™

Chemical Analyses

GC/MS with Olfactory Port

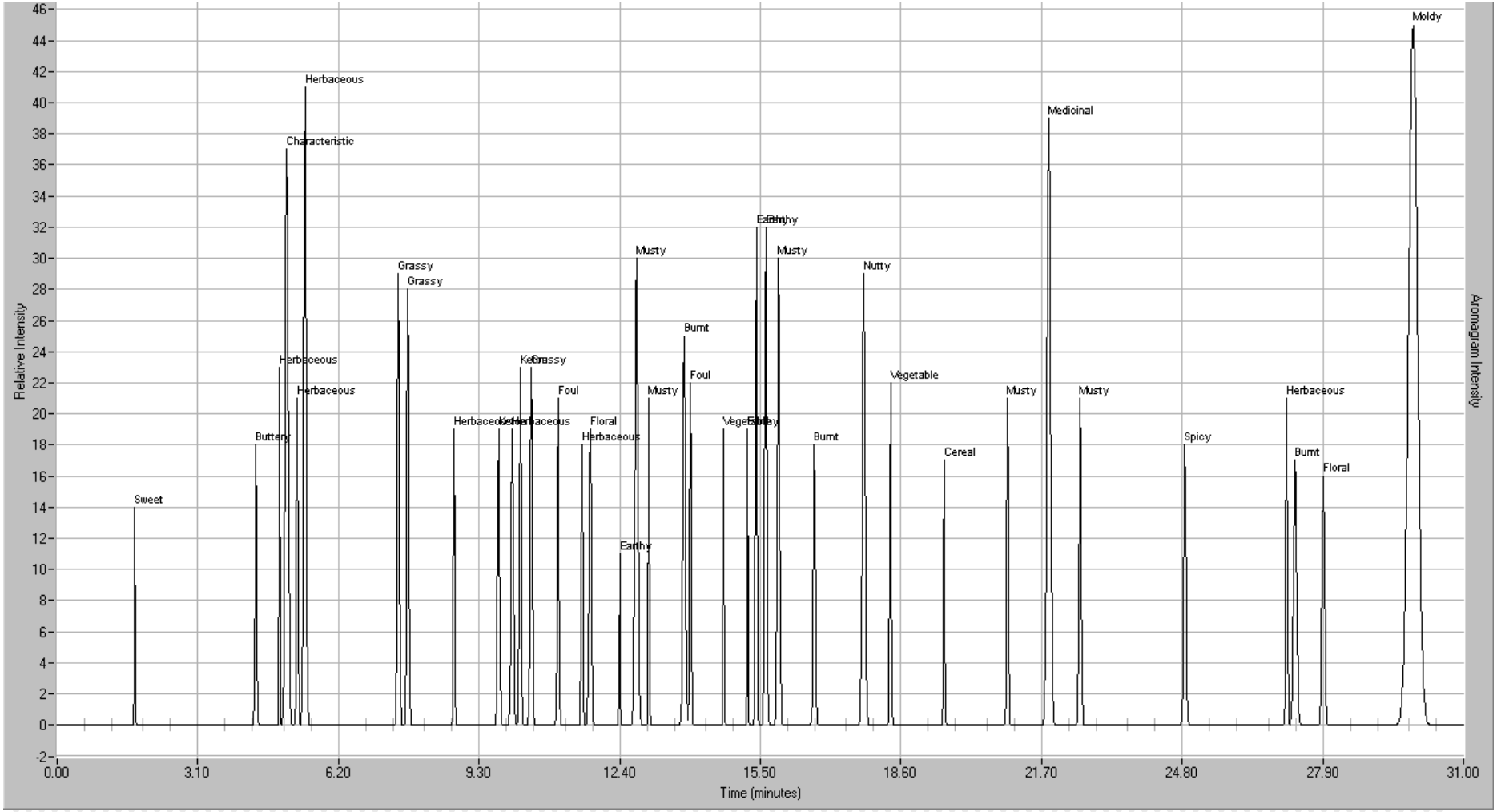
Columbia Analytical Services™

Chemical Analyses



Columbia Analytical Services™

Chemical Analysis



Columbia Analytical Services™

Cause of Colored Water

- Brownish, Red or Yellowish
  - Iron rust
  - Sometimes manganese
  - Colloidal silt
  - Dissolved organic mater
- Greenish colored water
  - Copper corrosion
- White cloudy water
  - Air in the water

Columbia Analytical Services™

Chemical Analyses

- Metals analysis by ICP-OES
- Dissolved organic matter
  - NOM
  - Humic or Fulvic acid
  - Analysis by TOC or DOC

Columbia Analytical Services™

Particulate

- Rust
- Iron loving bacteria
- Diatoms
- Algae
- Films (biological and clay)
- Pink stain (bacterium Serratia marcesens)
- Degraded washer, gasket, dip tubes

Columbia Analytical Services™

Particulates

Columbia Analytical Services™

Particulate

Iron Bacteria

Columbia Analytical Services™

Particulate

Gallionella

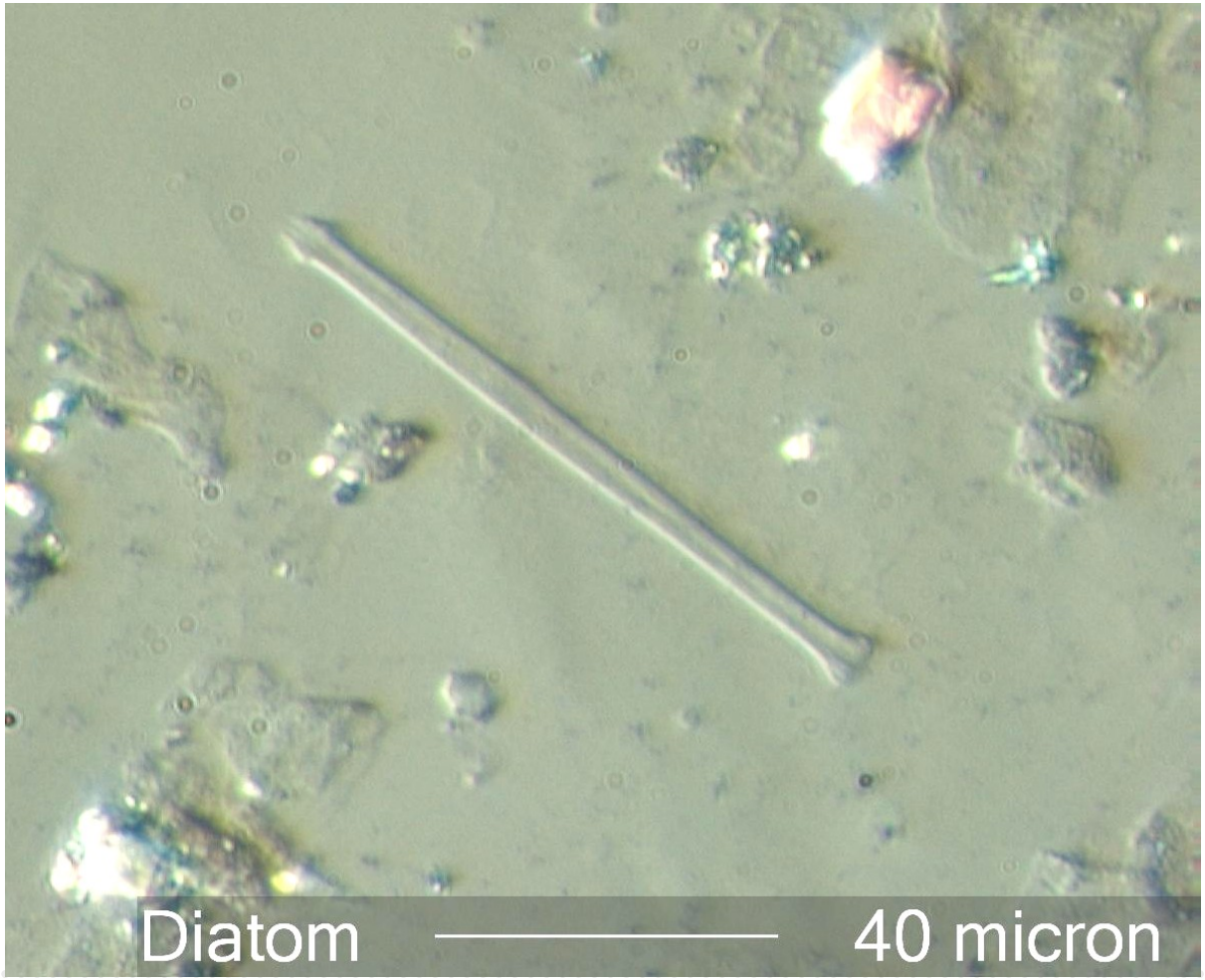
Columbia Analytical Services™

Particulate

Leptothrix

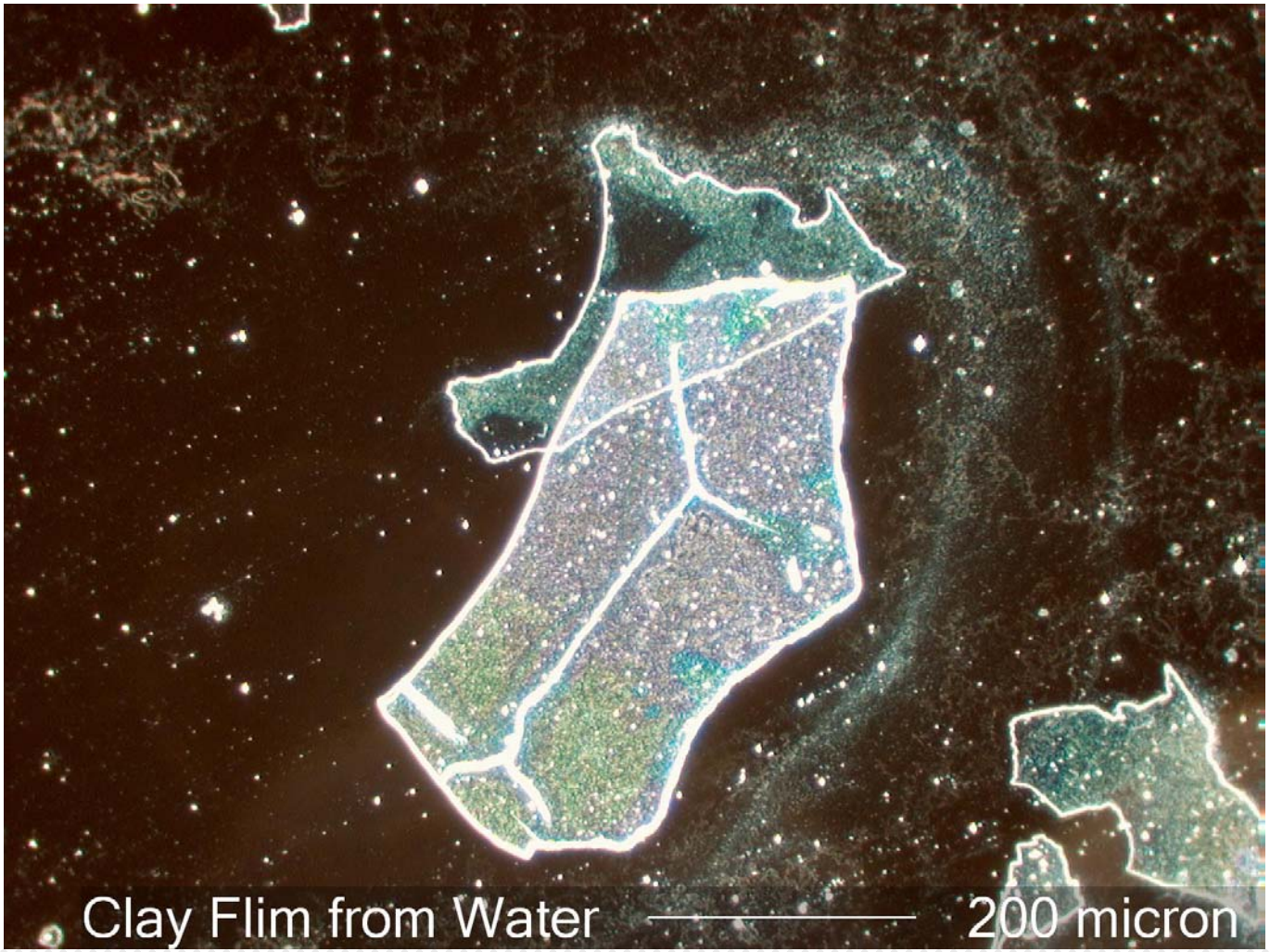
Columbia Analytical Services™

Particulates



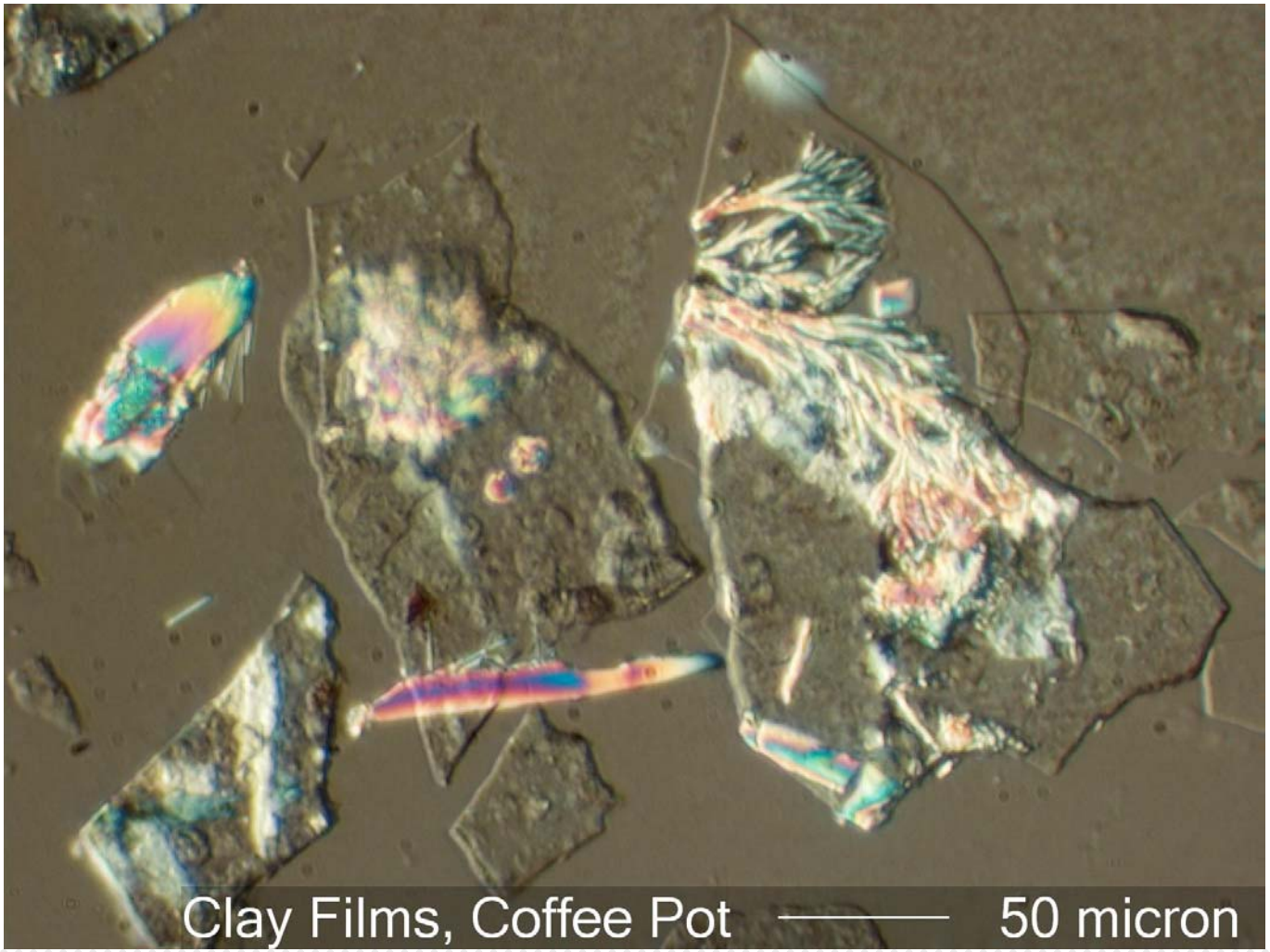
Columbia Analytical Services™

Particulates



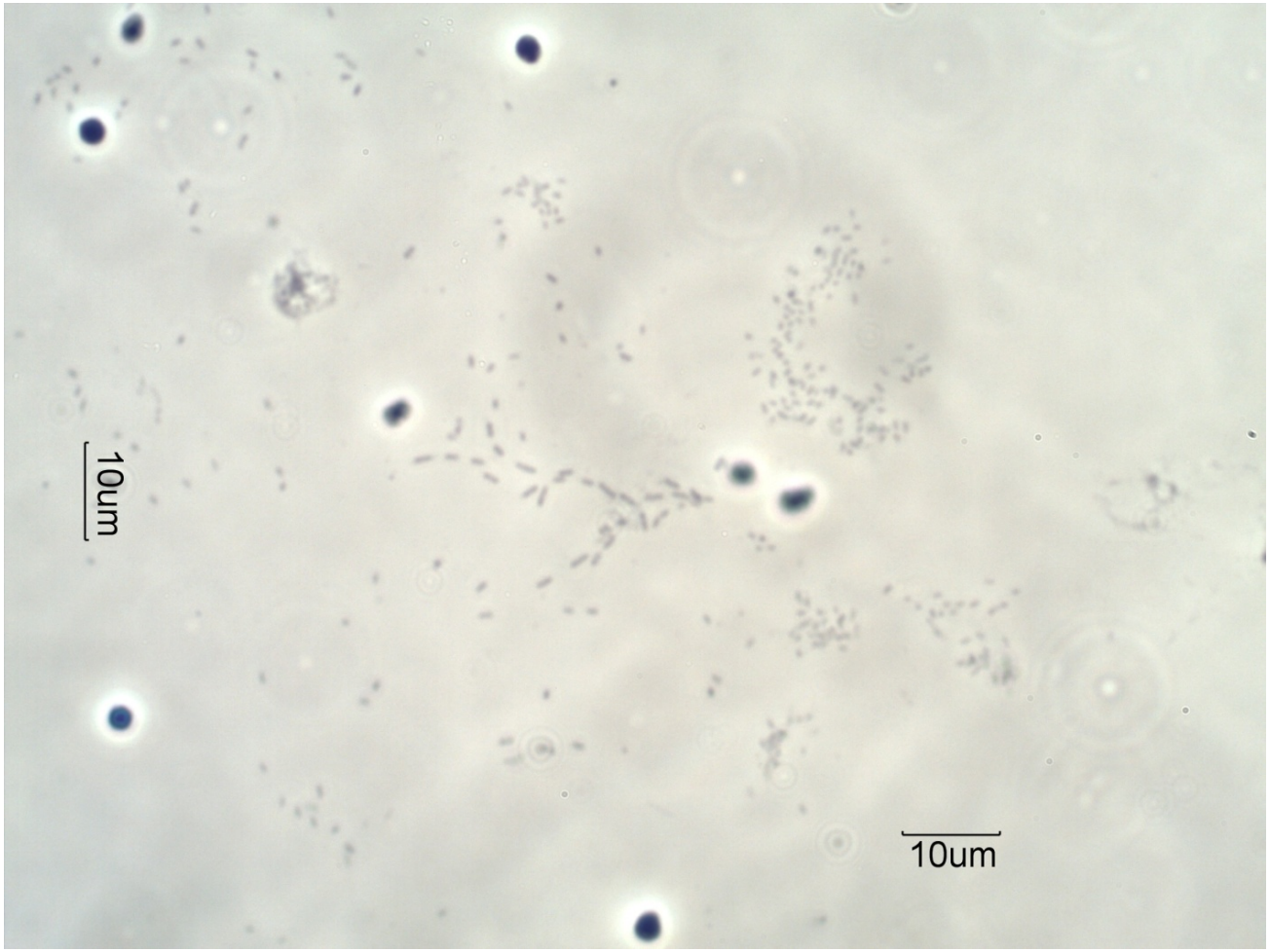
Columbia Analytical Services™

Particulates



Columbia Analytical Services™

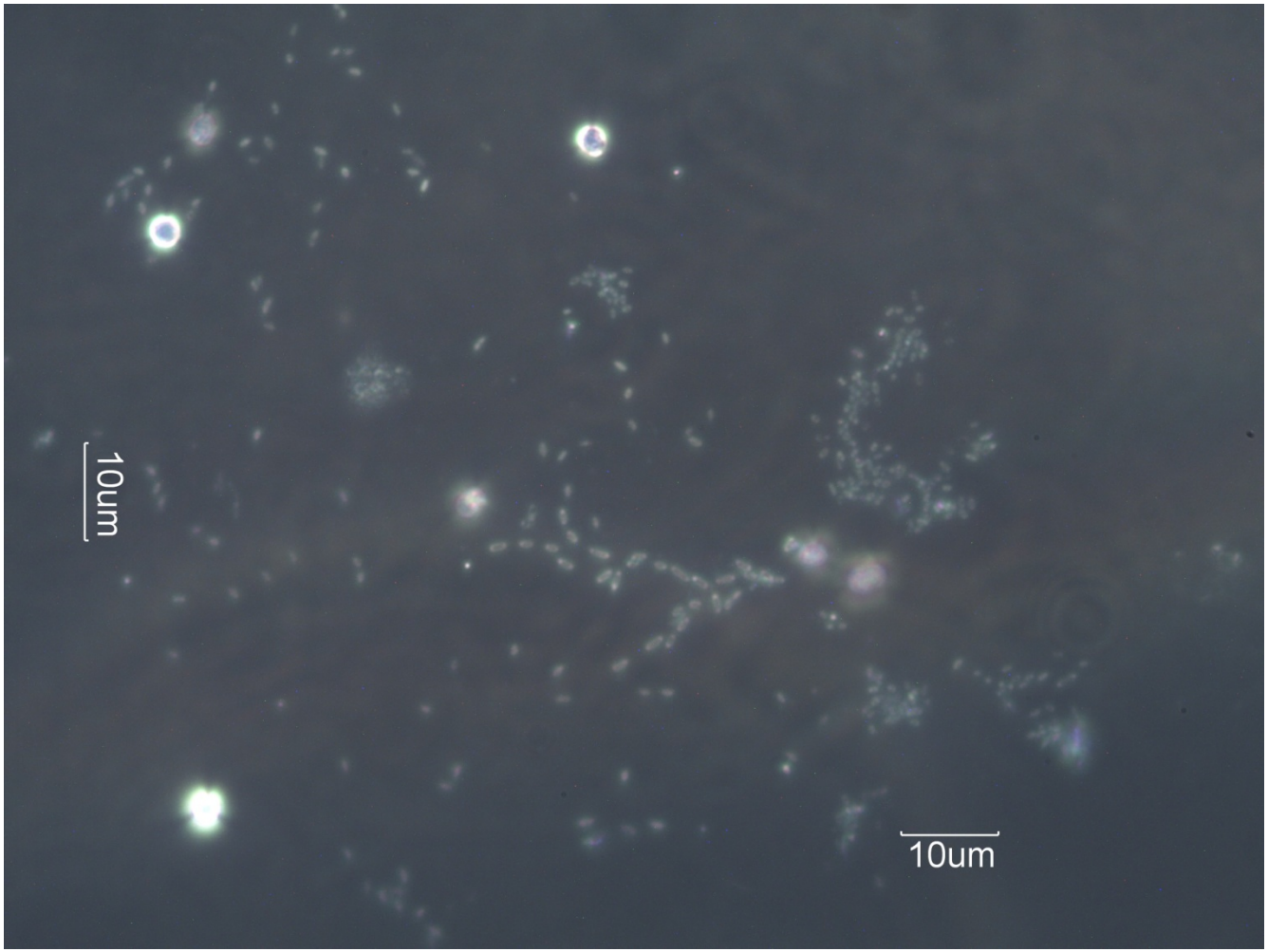
Particulates



Biofilm

Columbia Analytical Services™

Particulates



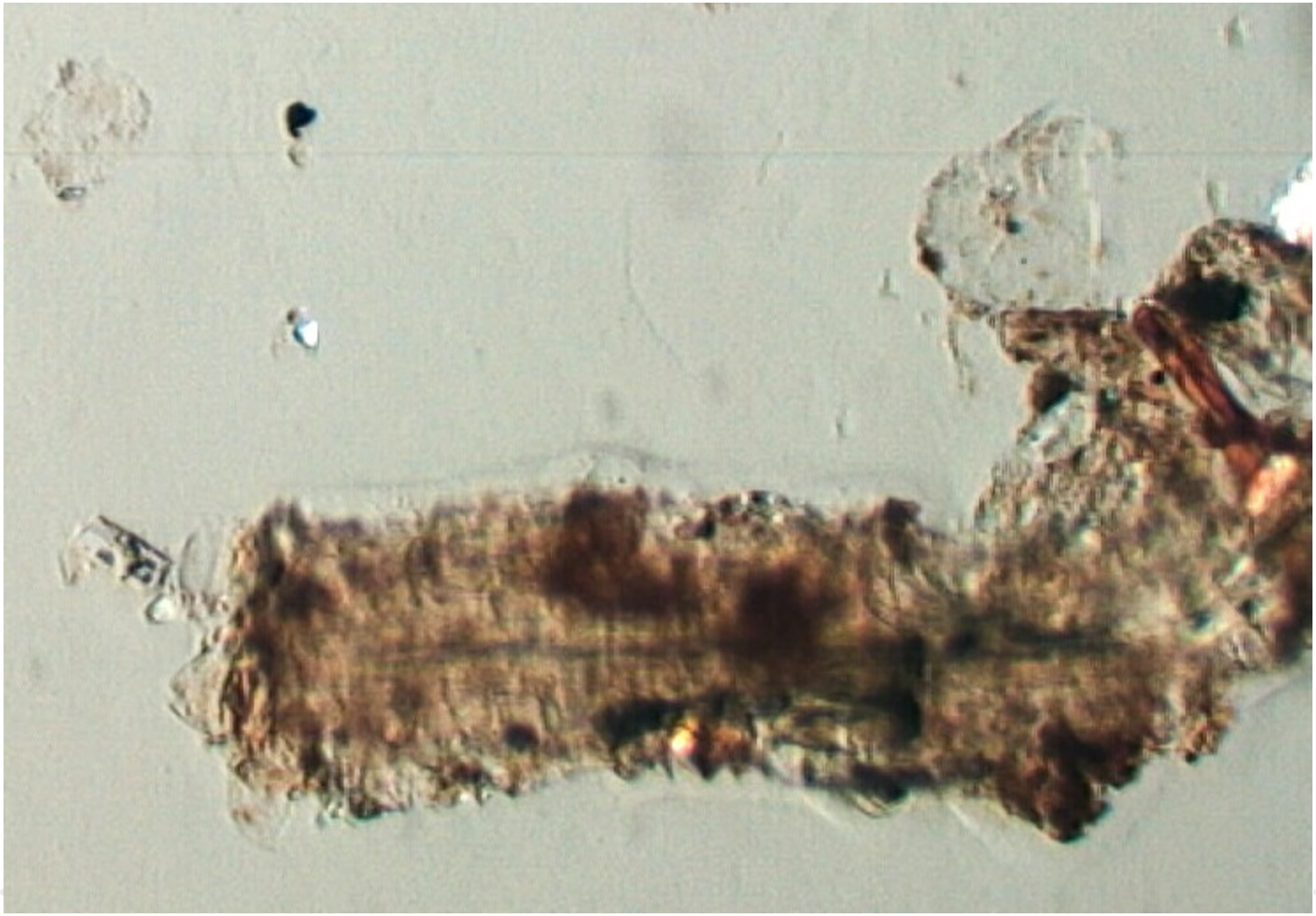
Biofilm

Columbia Analytical Services™

Particulates

Columbia Analytical Services™

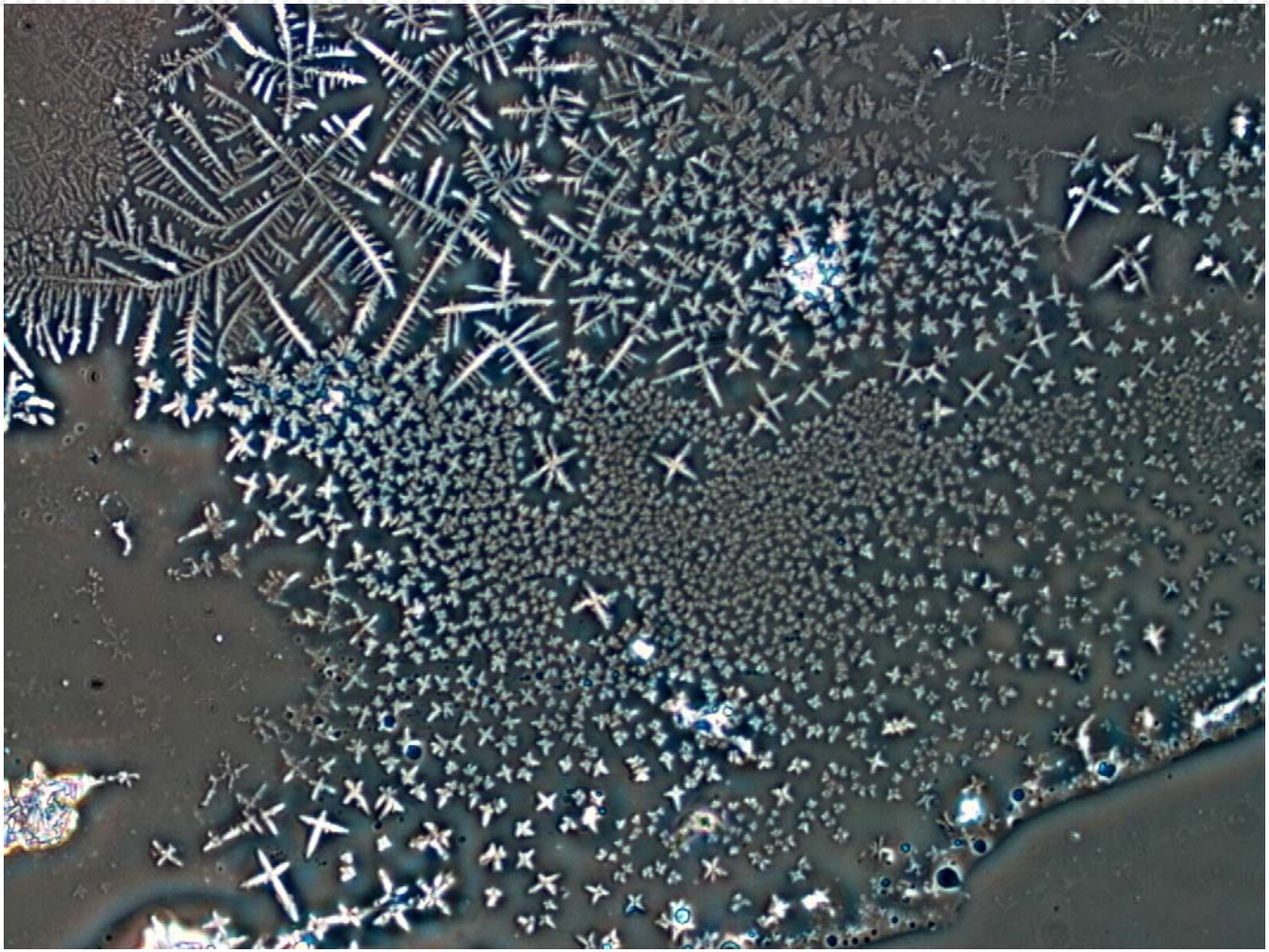
Particulates



Humus

Columbia Analytical Services™

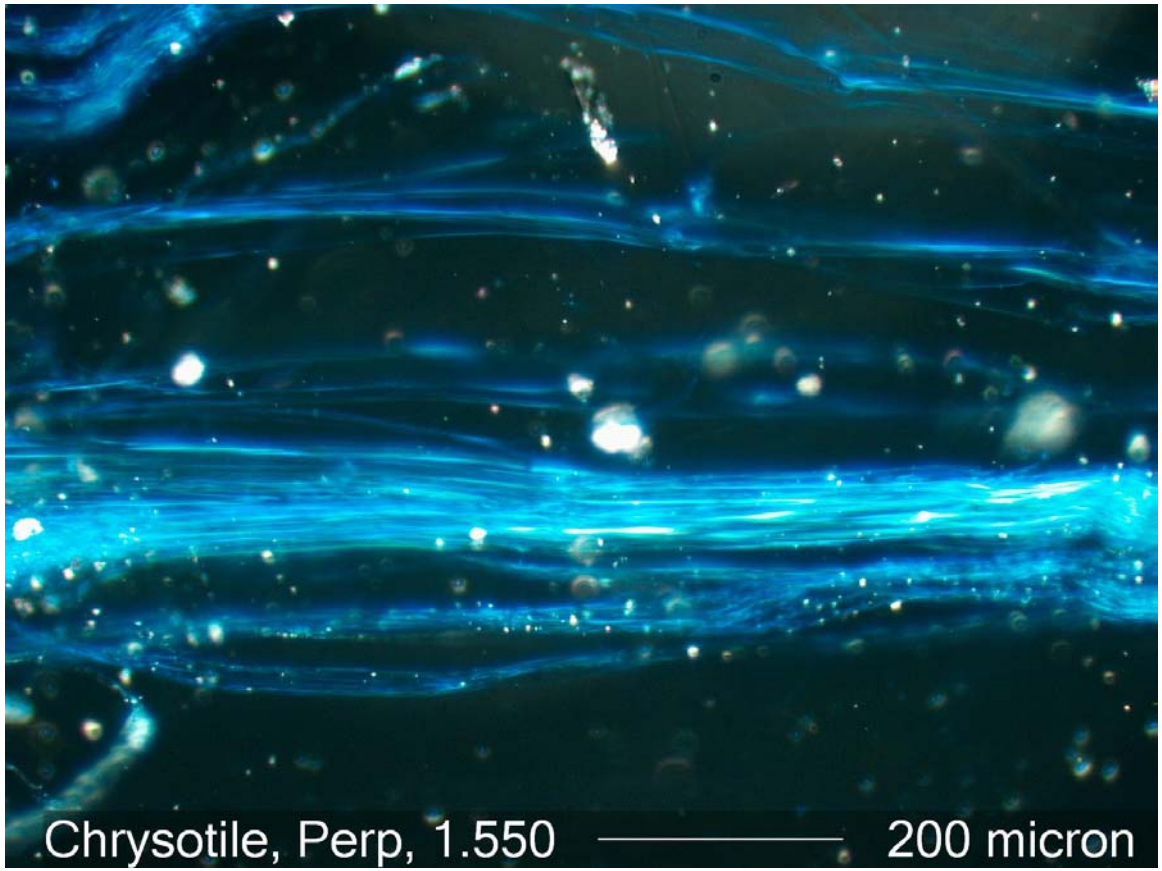
Particulates



Sodium Chloride

Columbia Analytical Services™

Particulates



Columbia Analytical Services™

Sewage Contamination

- **Pharmaceuticals and Personal Care Products (PPCPs)**
  - Chemical markers and tracers
  - Detect sewage intrusion
  - Assist in ID of source

PPCPs What Are They?

- Prescription medications
- Over The Counter medication
- Steroidal hormones
- Illicit drugs
- Nutraceutical food supplements
- Detergents, shampoo, perfume, insect repellent, sunscreen
- Veterinary pharmaceuticals

Columbia Analytical Services™

Typical Samples

- Surface water
- Aquifer recharge water
- River water
- Groundwater
- Finished drinking water

CAS Analyte List

- 35 PPCP/EDC analytes
- Diverse group of PPCPs including steroids and pesticides
- Many are the most commonly found and used
- EPA Method 1694

Columbia Analytical Services™

PPCPs

Analyte	Application	MRL (ng/L)
17α-estradiol	Estrogen	1.0
17α-ethynylestradiol	Ovulation Inhibitor	2.0
17β-estradiol	Estrogen	2.0
Androstenedione	Androgen	10
Estrone	Estrogen	1.0
Estriol	Estrogen	1.0
Testosterone	Androgen	10
Progesterone	Ovulation Inhibitor	10

Columbia Analytical Services™

PPCPs

Analyte	Application	MRL (ng/L)
Diazepam (Valium)	Psychiatric drug	1
Fluoxetine (Prozac)	Antidepressant	1.0
Methadone	Opiate	5.0
Meprobamate	Anti-anxiety drug	5.0
Carbamazepine	Anti-seizure drug	1
Dilantin	Antiepileptic drug	1.0
Trimethoprim	Antibiotic	1.0
Sulfamethoxazole	Antibiotic	1

Columbia Analytical Services™

PPCPs

Analyte	Application	MRL (ng/L)
Diethylstilbestrol	Syn-estrogen (treat prostate cancer)	1
Gemfibrozil	Lipid regulator	1
Acetominophen	Analgesic	10
Hydrocodone	Cough suppression	1.0
Pentoxifylline	Improve blood flow	1.0
Triclosan	Antimicrobial	10
Naproxen	Anti-inflammatory	1
Diclofenac	Anti-inflammatory	2.0

Columbia Analytical Services™

PPCPs

Analyte	Application	MRL (ng/L)
Oxybenzone	Sun Screen	2.0
DEET (N,N-diethyl-meta-toluamide)	Insect repellent	5.0
Salicylic Acid	Skin care	10
Caffeine	Stimulant	5.0
Atrazine	Herbicide	1.0
Iopromide	Contrast enhancer (Angiography)	1.0
Bisphenol A	Industrial Chemical	10

Columbia Analytical Services™

Procedure

- Sample Collection
  - 1000mL amber bottle
  - Acidified to pH 2 with H_2SO_4
- Solid Phase Extraction (SPE)
  - Within 7 days of collection
  - Waters HLB cartridge)
- HPLC/MS/MS
  - Thermo Finnigan TSQ Quantum System
  - API 5000
  - EPA Method 1694 using isotope dilution

Columbia Analytical Services™

Water Solvent Extraction & Concentration

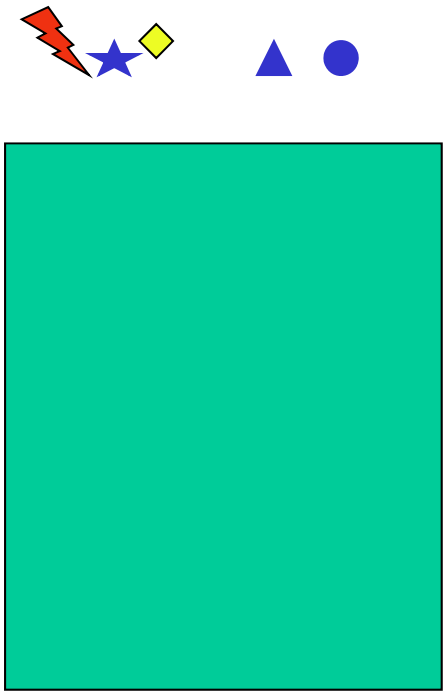
Solid Phase Extraction

Services™

Water Solvent Extraction & Concentration

- Solid Phase Extraction

Solid Phase Extraction



- Condition column
- Extract sample
- Wash column
- Elute analytes of interest
- Concentrate extract

Columbia Analytical Services™

Instrumentation

API 5000

Triple Quadrupole LC/MS/MS

Columbia Analytical Services™

Groundwater Intrusion Study

Analyte	Application	MRL (ng/L)
Iopromide	Contrast enhancer (Angiography)	30
Dilantin	Antiepileptic drug	80
Gemfibrozil	Lipid regulator	40
Triclosan	Antimicrobial	10
Sulfamethoxazole	Antibiotic	15
Trimethoprim	Antibiotic	30
Oxybenzone	Sun Screen	87
DEET	Insect repellent	20
Caffeine	Stimulant	45
Carbamazepine	Anti-seizure drug	40

Columbia Analytical Services™

Any Questions?

MWH Laboratories

- Ed Wilson
  - ed.wilson@mwhglobal.com

Microlabs Northwest

- Russ Crutcher
- russ.c@microlabnw.com

Columbia Analytical Services™

Thank you

Any Questions?

Howard Boorse
(360) 430-7733
hboorse@caslab.com

Columbia Analytical Services™