



Pooled Monitoring Initiative's Restoration Research Award Program

*Influence of historic and current land use
practices on PCB contamination of soils and
stormwater sediments in the Chesapeake
Bay watershed*

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Acknowledgements



Janis Markusic Douglas Griffith



Elizabeth Sklaire – Suyue Cao



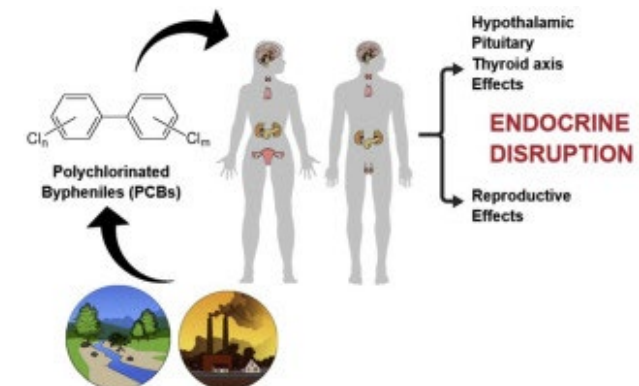
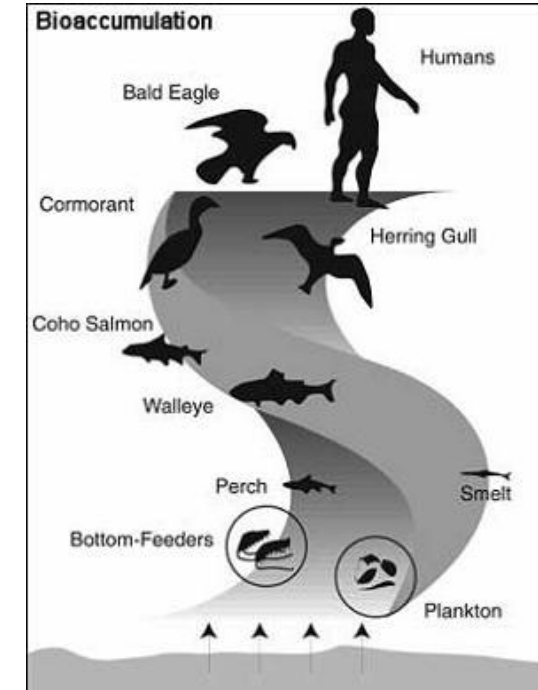
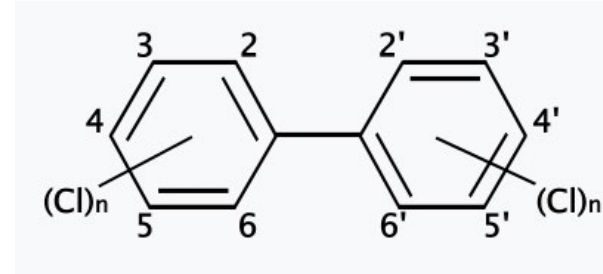
Allen P. Davis



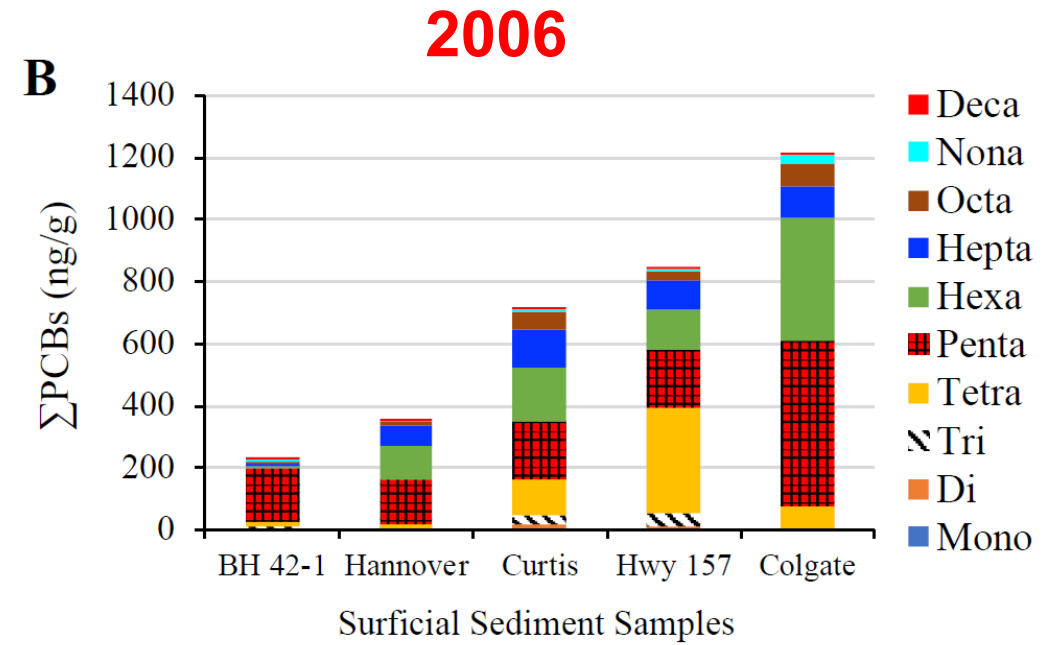
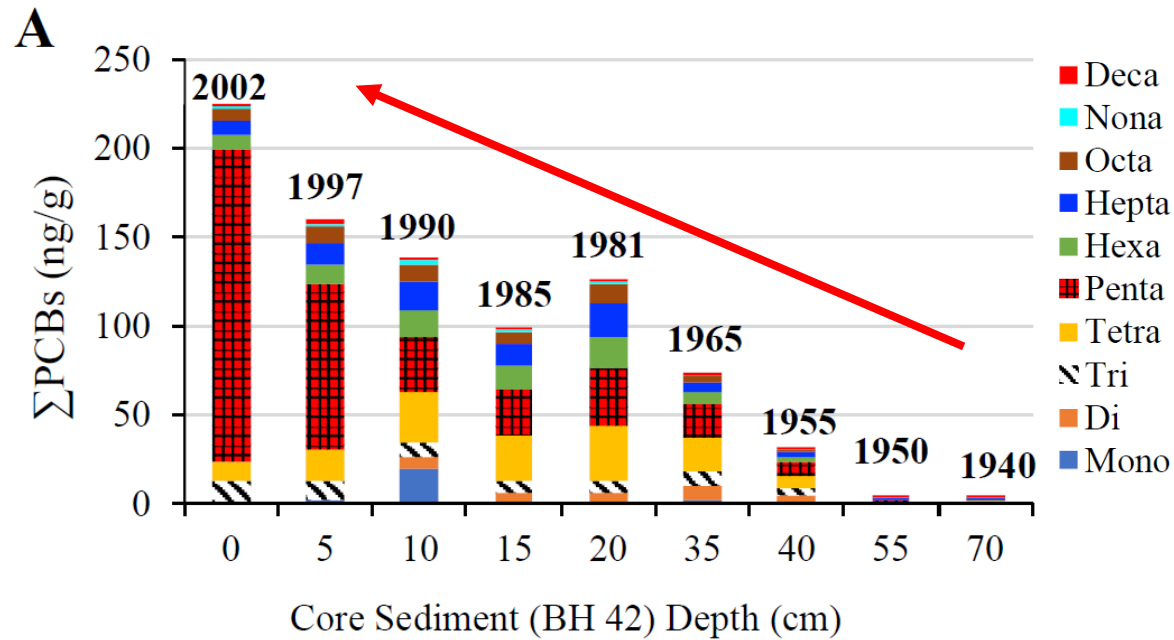
Birthe V. Kjellerup

Background

- PolyChlorinated Biphenyls (PCBs)
- A group of organic chlorine compounds: 209 congeners; 10 homologues
- Persistent Organic Pollutants: Bioaccumulate and biomagnify in the food chain
- Toxic health effects including cancer and reproductive issues
- Banned in 1979 in the US – still present in the environment
- In Maryland, Urban-related runoff/stormwater is considered as an important source of PCB pollution



Legacy contamination or current sources?



Conclusion:

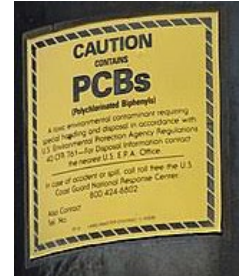
Not only legacy PCBs (Example of Baltimore Harbor)

⇒ **Current sources** are increasing the contamination level

⇒ **TMDLs in place** for watersheds in the Chesapeake Bay

Research questions from RFP (2022):

- Are there significant **differences in PCB loadings** across different land use types, industry types, and eras of development?
- What are the **removal capabilities** of different stormwater management designs on reducing toxic contaminant loads?

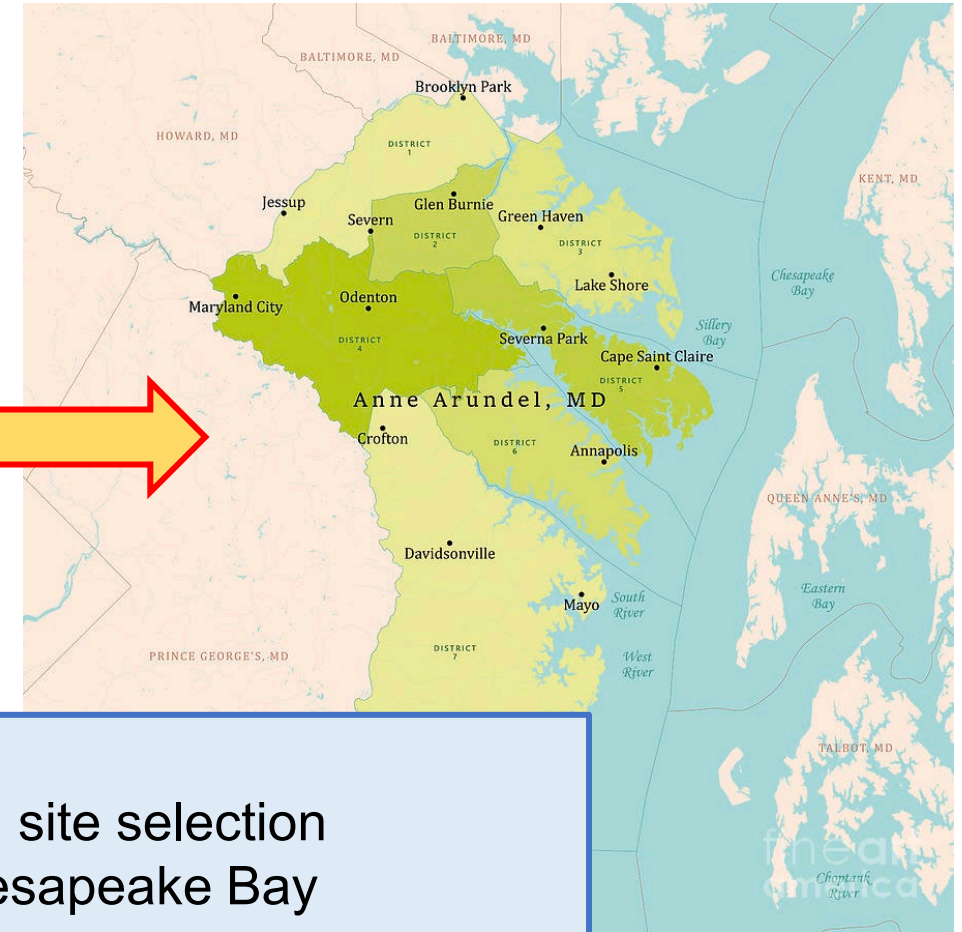
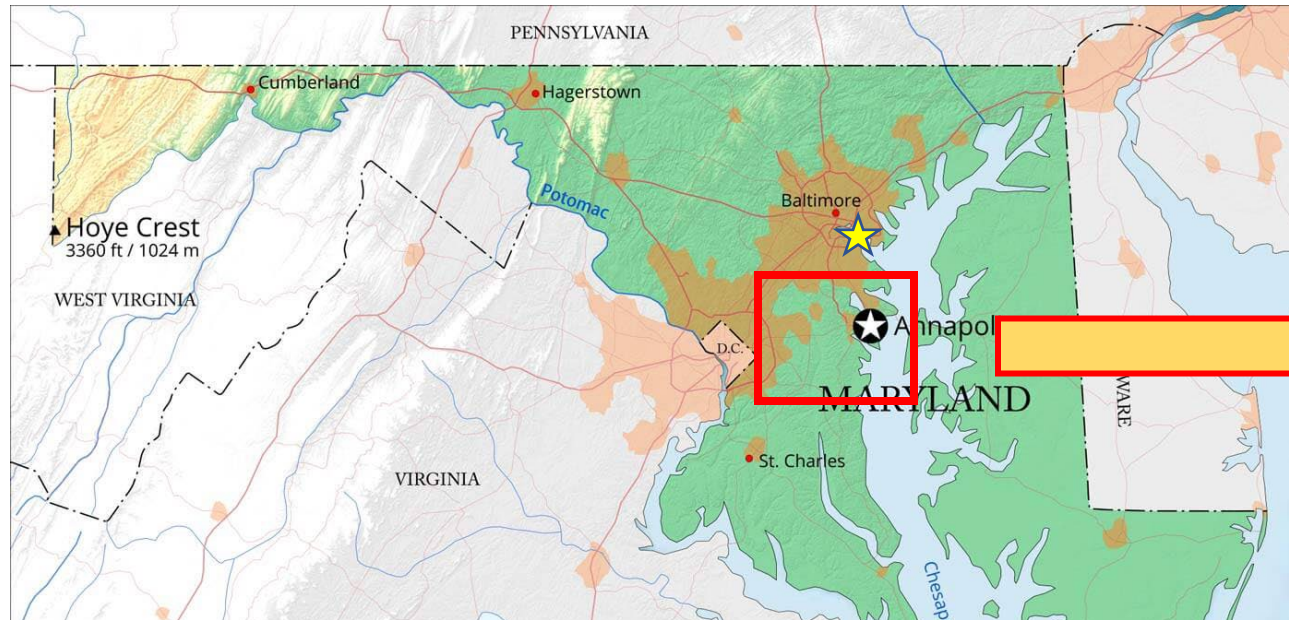


Specific research question in this project:

- Is there a relationship between PCB presence and....
 - *Land-use types (residential, commercial, industrial, greenspace, institutional, etc.)?*
 - *Development eras (before 1970s, after 1970s – when PCBs were banned) ?*



Sample locations: Anne Arundel County



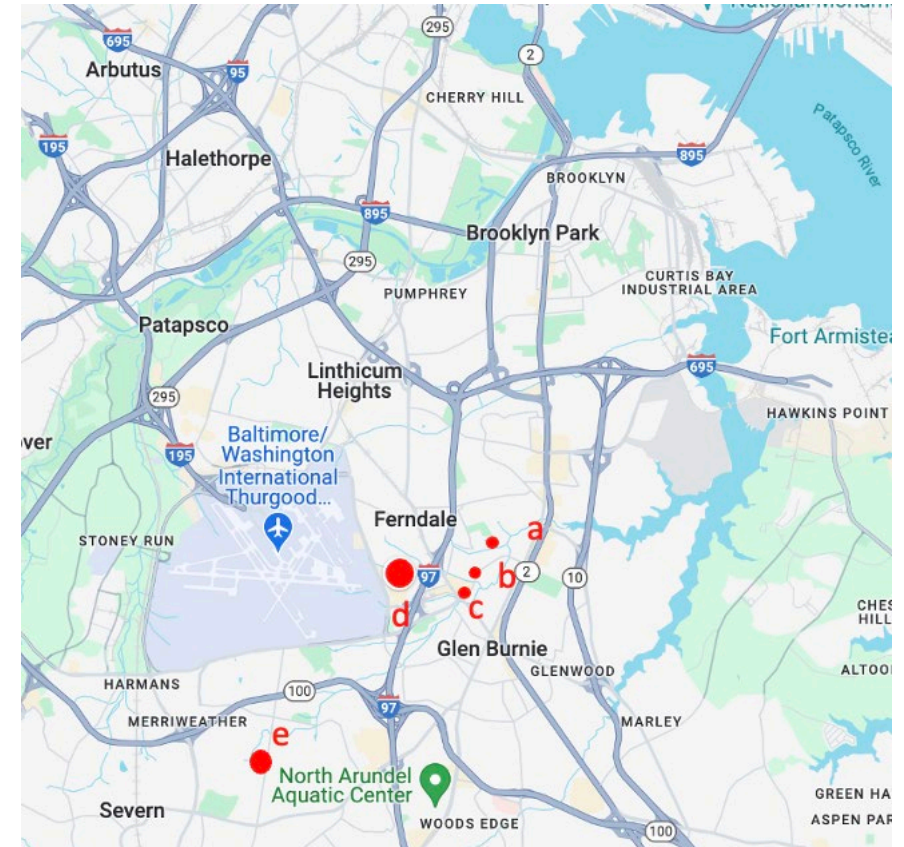
Why Anne Arundel County:

- Willing and responsive county staff that could help with site selection
- Land uses are similar to other counties around the Chesapeake Bay
- Results can be transferred to other end users
- PCB permit requirements exist for some areas of the county

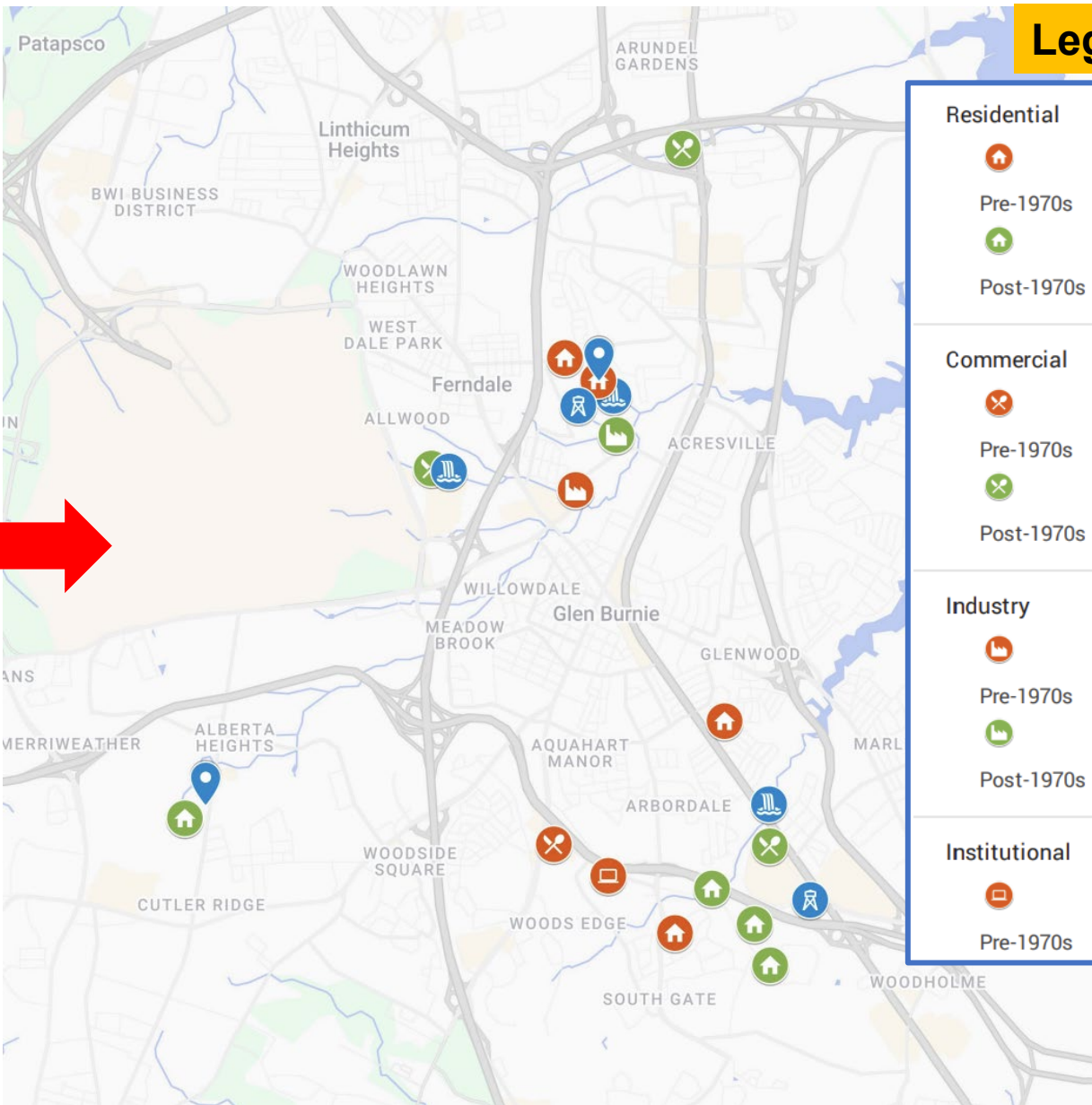
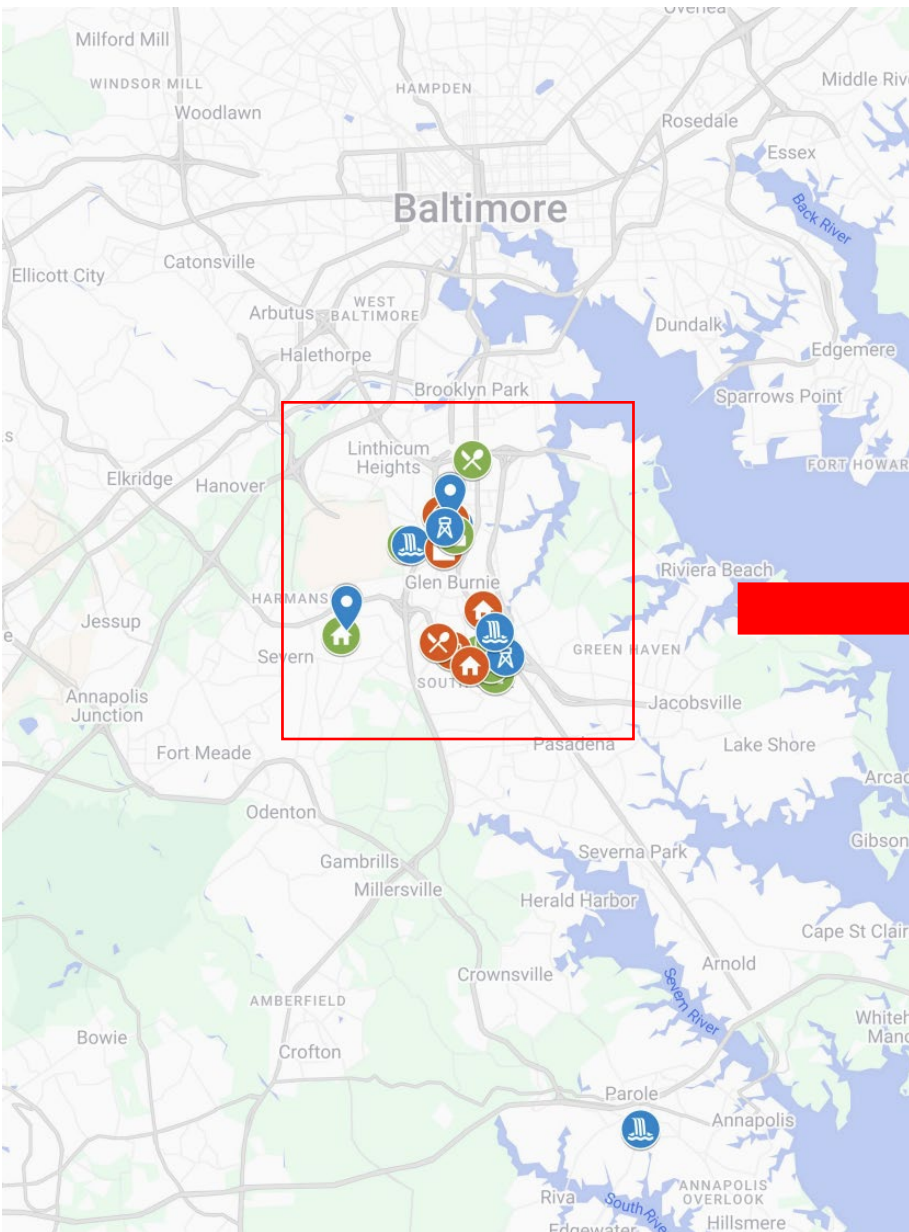
Site Selection



Abbreviation	Meaning
RA	Residential Area: Neighborhood
IA	Industry Area: Metal scrap yard, Automotive sales industry
CA	Commercial Area: Retail Shop
-70	Developed before 1970s (before PCB banned)
+70	Developed after 1970s (after PCB banned)



Site Selection



Legends

Residential Pre-1970s Post-1970s	Stormwater Stream
Commercial Pre-1970s Post-1970s	Energy producer
Industry Pre-1970s Post-1970s	Dry pond + Core samples
Institutional Pre-1970s	

Experimental Process: PCB extraction



Sample Collection



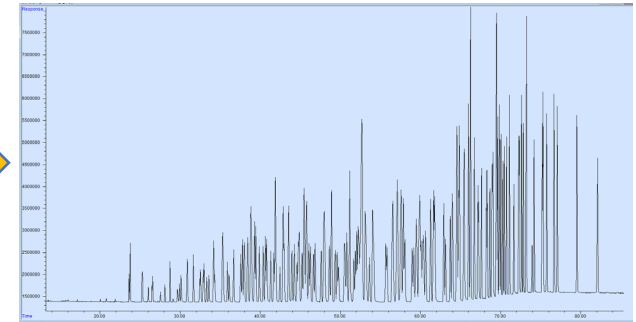
Microwave extraction



Clean up

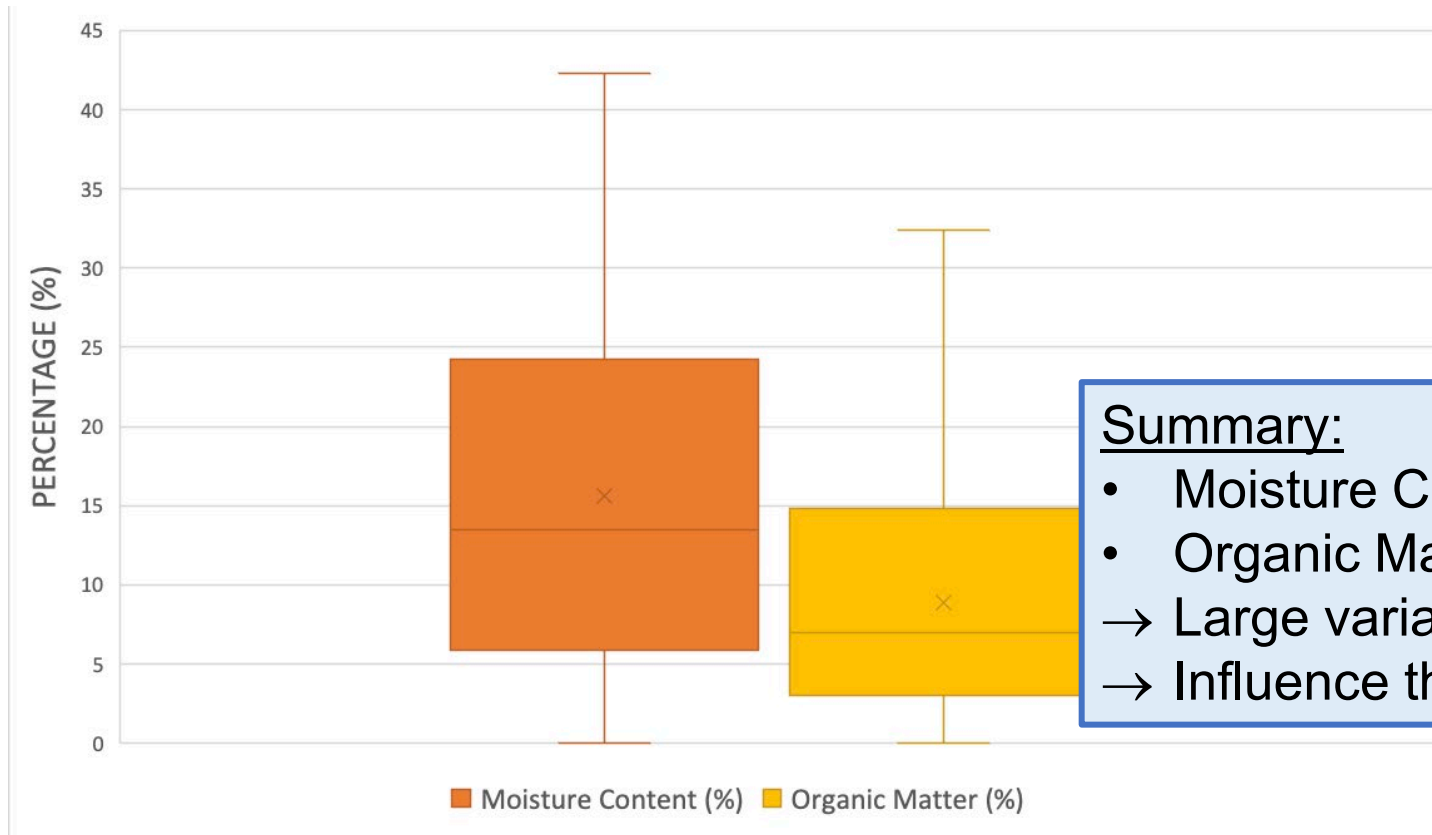


Gas Chromatography analysis



Data analysis

Variation in soil moisture content & organic matter



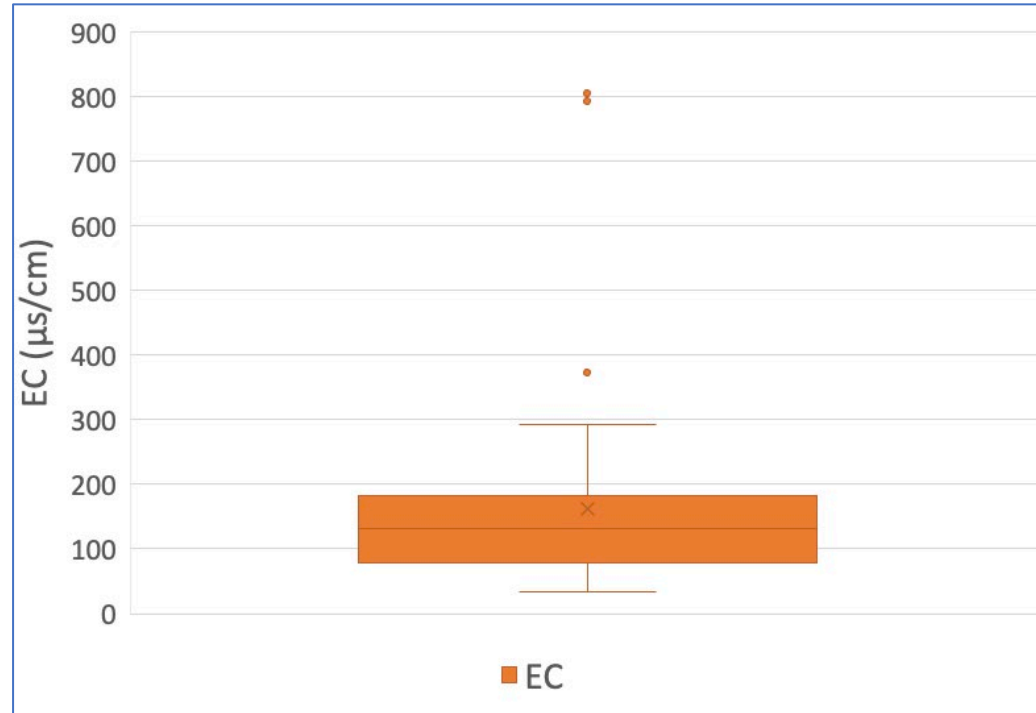
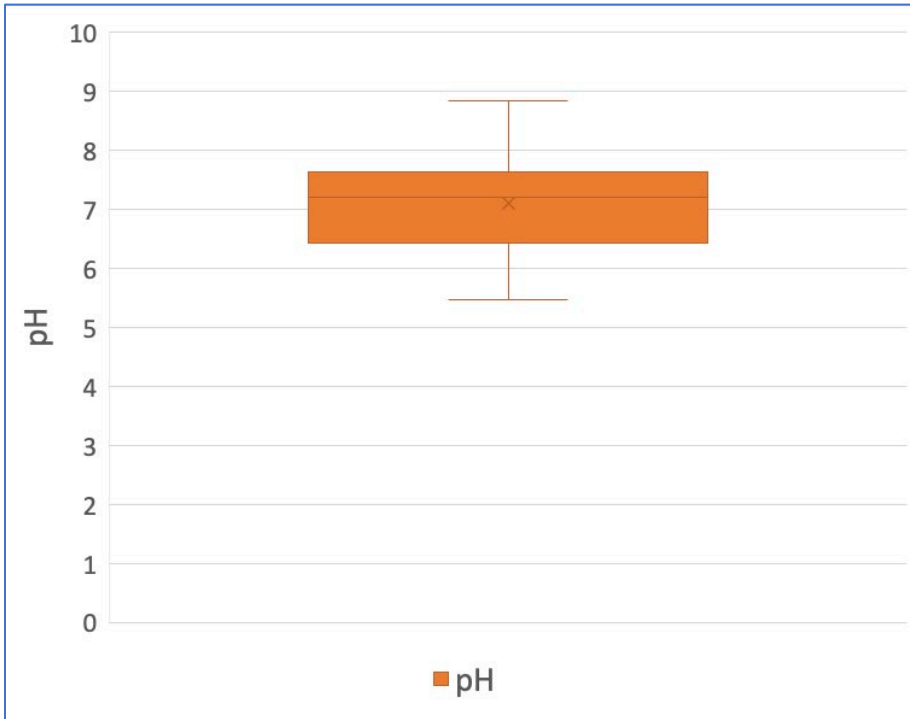
54 samples:

- Moisture Content
- Organic Matter

Summary:

- Moisture Content: Average = 14% (range: 6-24%)
- Organic Matter: Average = 7% (range 3-15%)
- Large variation in soil/sediment characteristics
- Influence the presence and mobility of PCBs

Variation in soil pH & electrical conductivity



- pH
- Electrical conductivity

Summary:

- pH: Average = 7.3 (range 6.5-7.7)
 - Electrical conductivity: Average = 140 $\mu\text{S/cm}$ (range 90-190 $\mu\text{S/cm}$)
- Impacts potential for biodegradation of PCBs

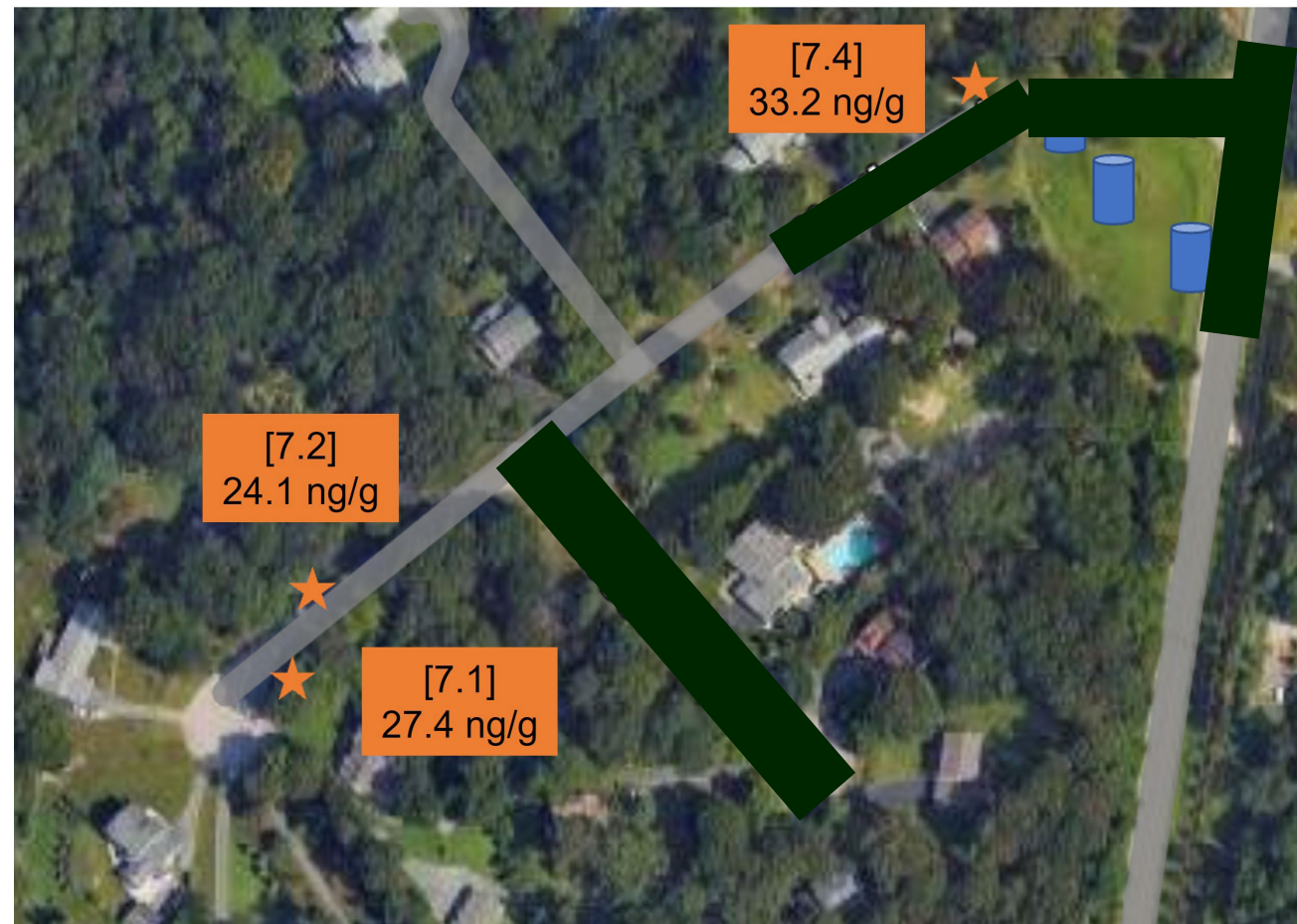
Medium PCB presence: Residential **Post** 1970s

6 sampling locations in this neighborhood:

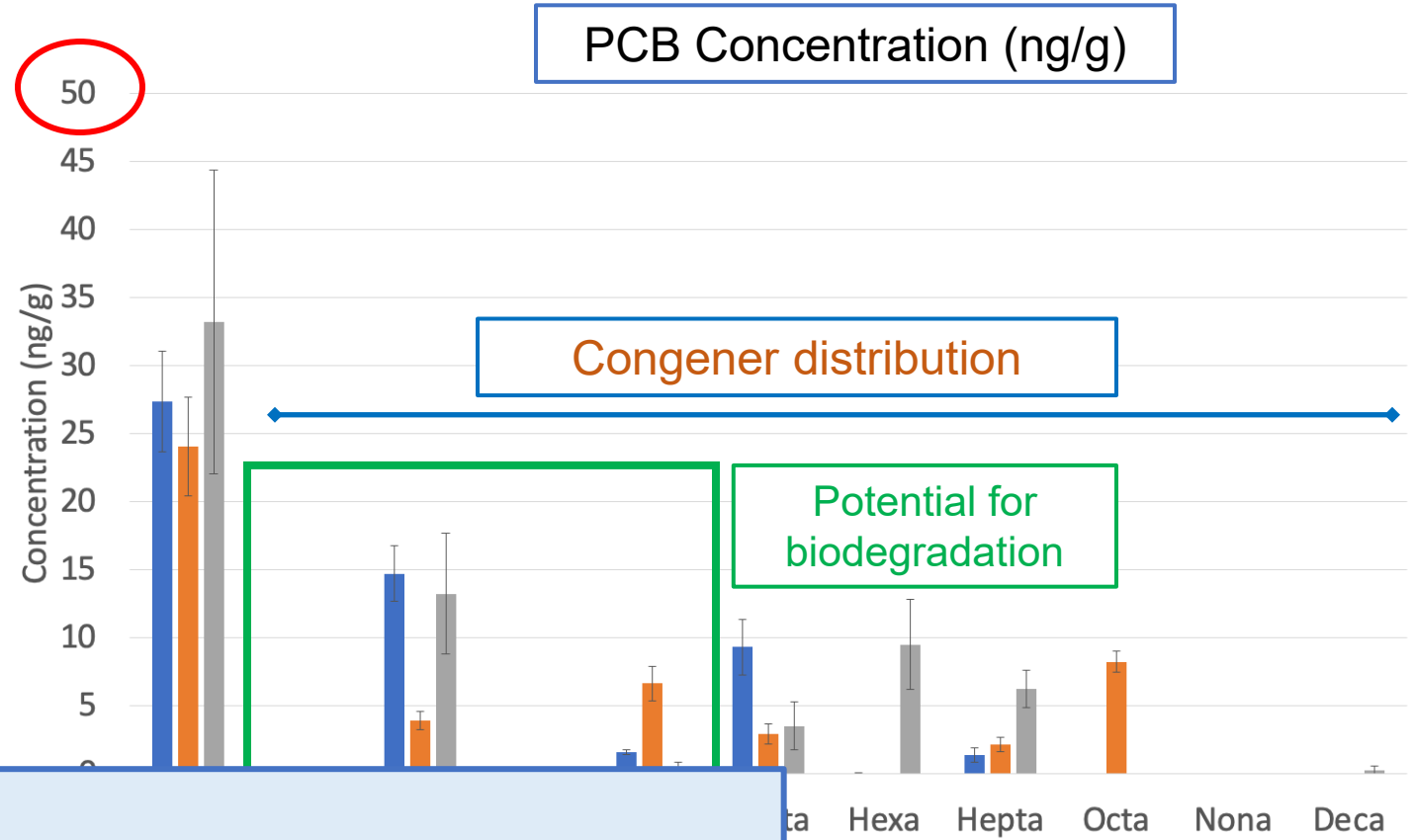
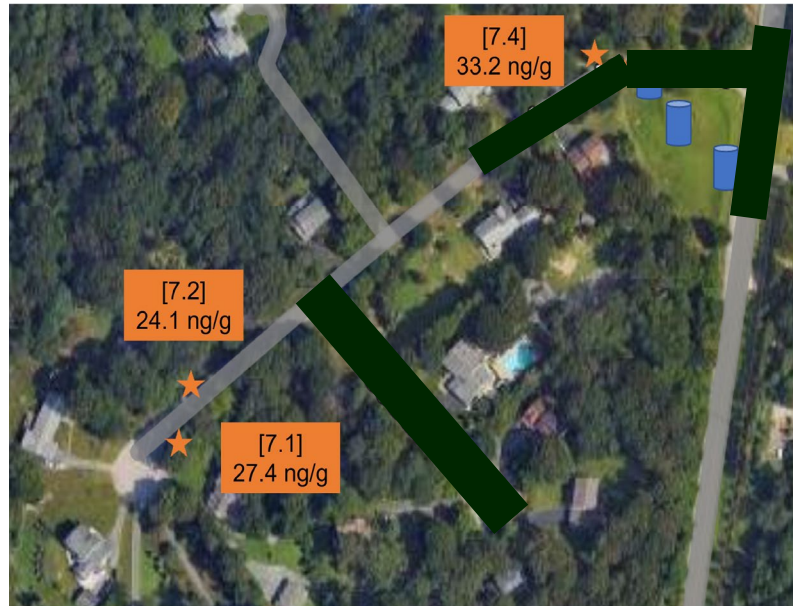
- Along the side of the streets (3)
- Core samples in the dry pond (3)

Practical questions:

1. Would street sweeping help?
2. Will PCBs stay in the dry pond?
3. Higher PCB conc. in **Post** 1970es neighborhood?



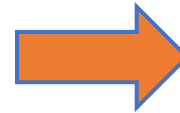
Medium PCB presence: Residential **Post** 1970s



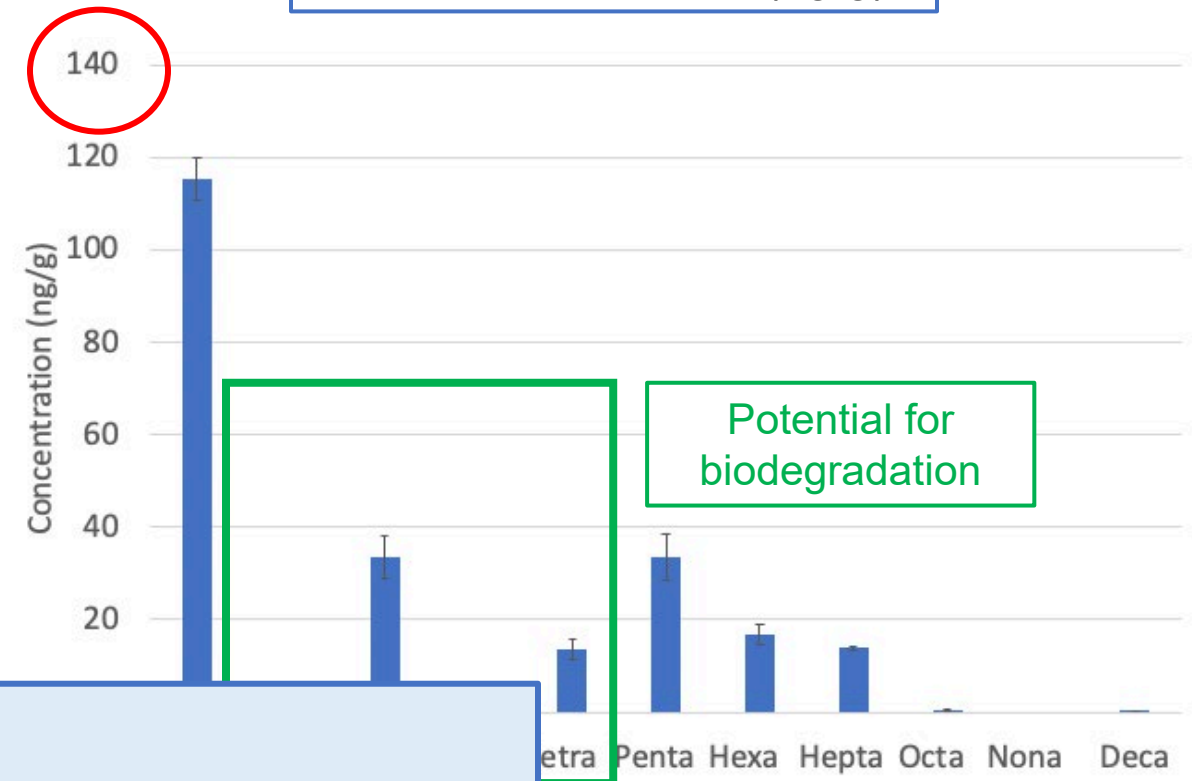
Summary:

- Total PCB concentration: Average = 24-33 ng/g
- Congener distribution: Does not appear to be from Aroclor
- Di, tri and tetra chlorinated PCBs: Potential for biodegradation

Medium PCB presence: Residential **Pre** 1970s



PCB Concentration (ng/g)

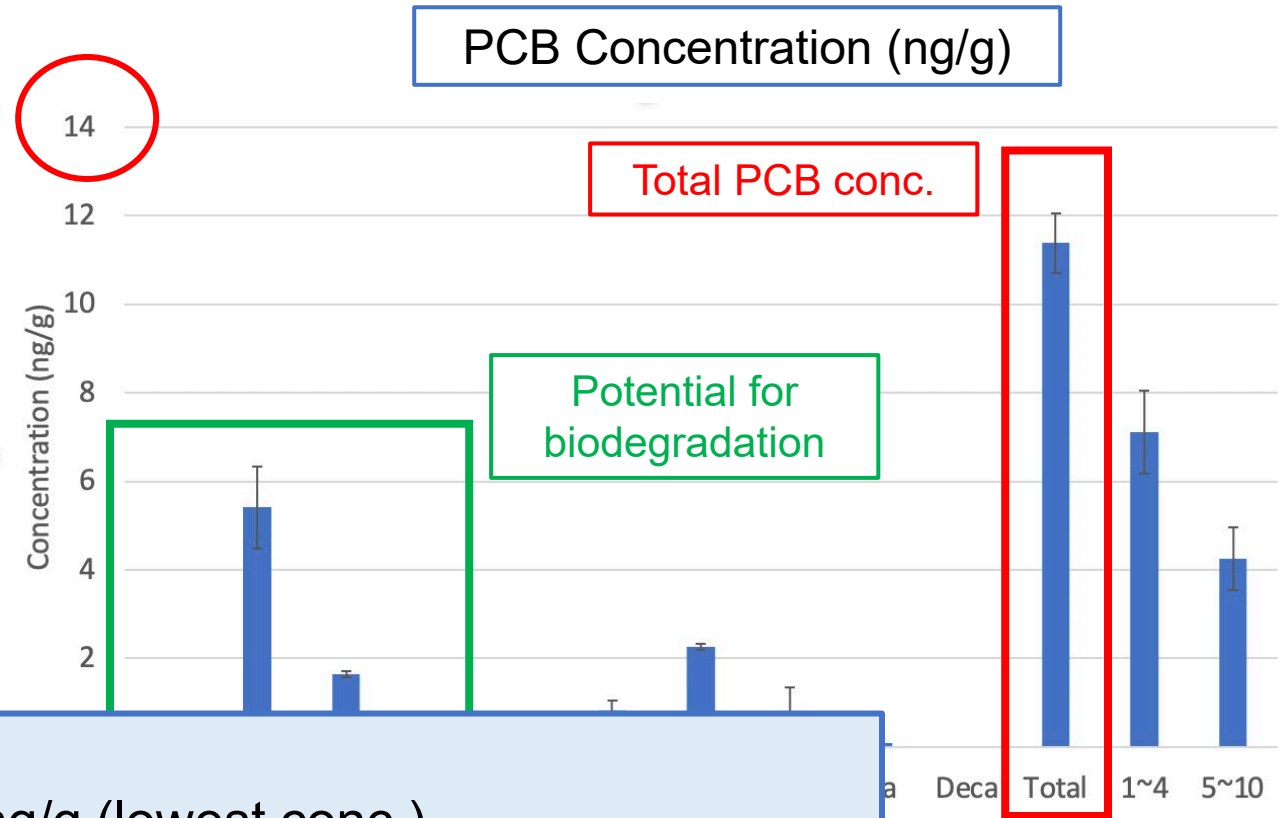
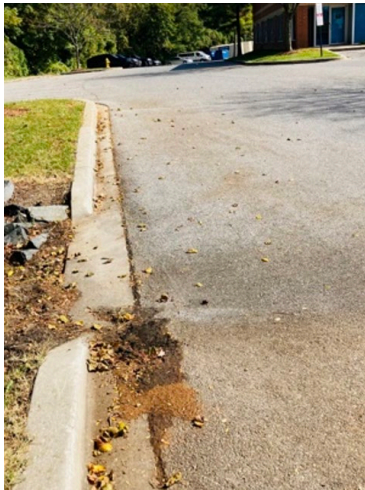


Summary:

- Total PCB concentration: Average = 115 ng/g
- Congener distribution: Does not appear to be Aroclor
- Di, tri and tetra chlorinated PCBs: Potential for biodegradation

Low PCB presence: Commercial **Post** 1970es

Commercial area: Retail stores, Restaurants

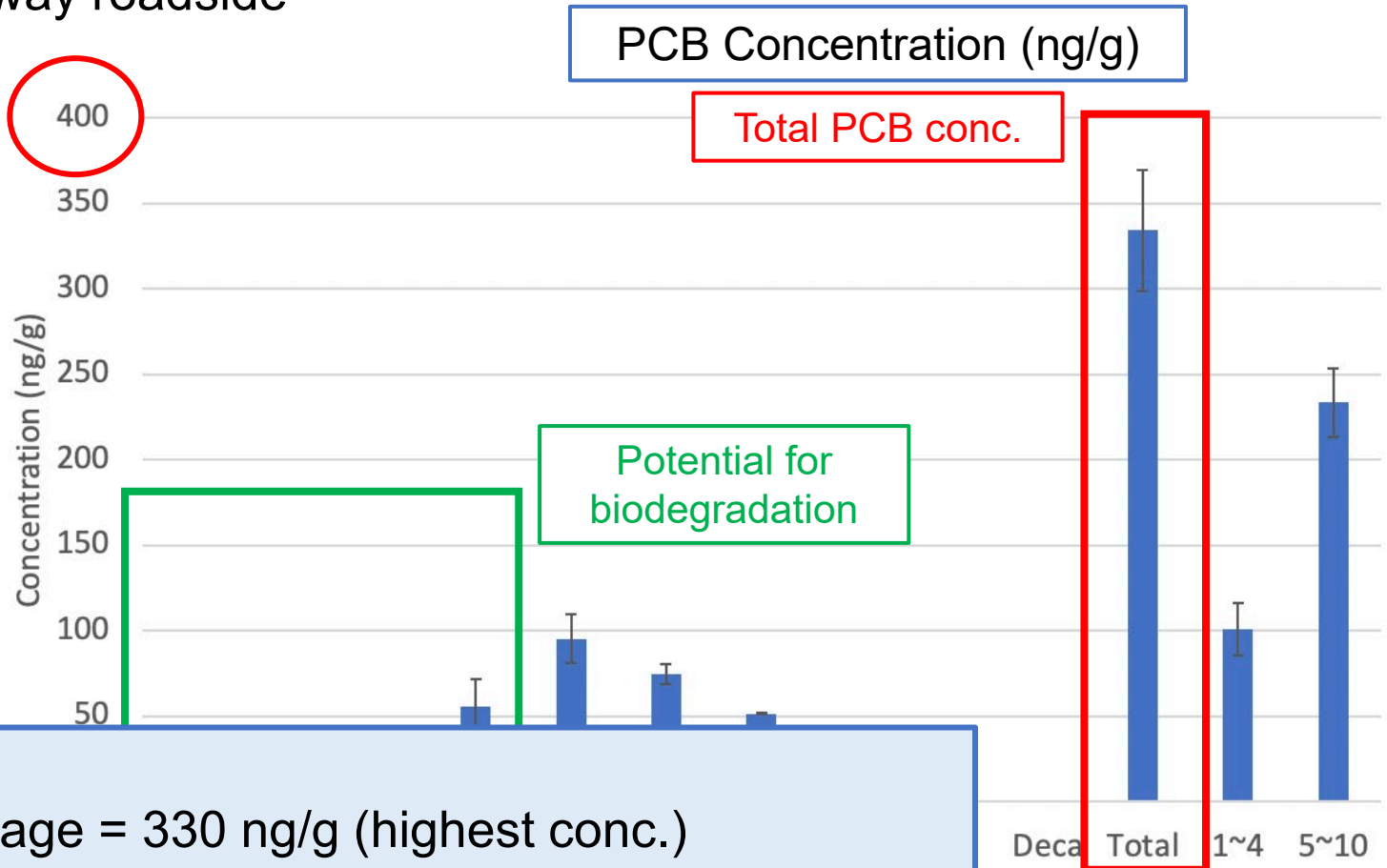


Summary:

- Total PCB concentration: Average = 11 ng/g (lowest conc.)
- Congener distribution: Different from residential and industrial areas
- Di and tri chlorinated PCBs: Higher potential for biodegradation

High PCB presence: Industrial **Pre** 1970es

Industrial site: Scrap yard, Highway roadside



Summary:

- Total PCB concentration: Average = 330 ng/g (highest conc.)
- Congener distribution: Different from residential areas
- Di, tri and tetra chlorinated PCBs: Lower potential for biodegradation

Medium PCB presence: Industrial **Post** 1970s

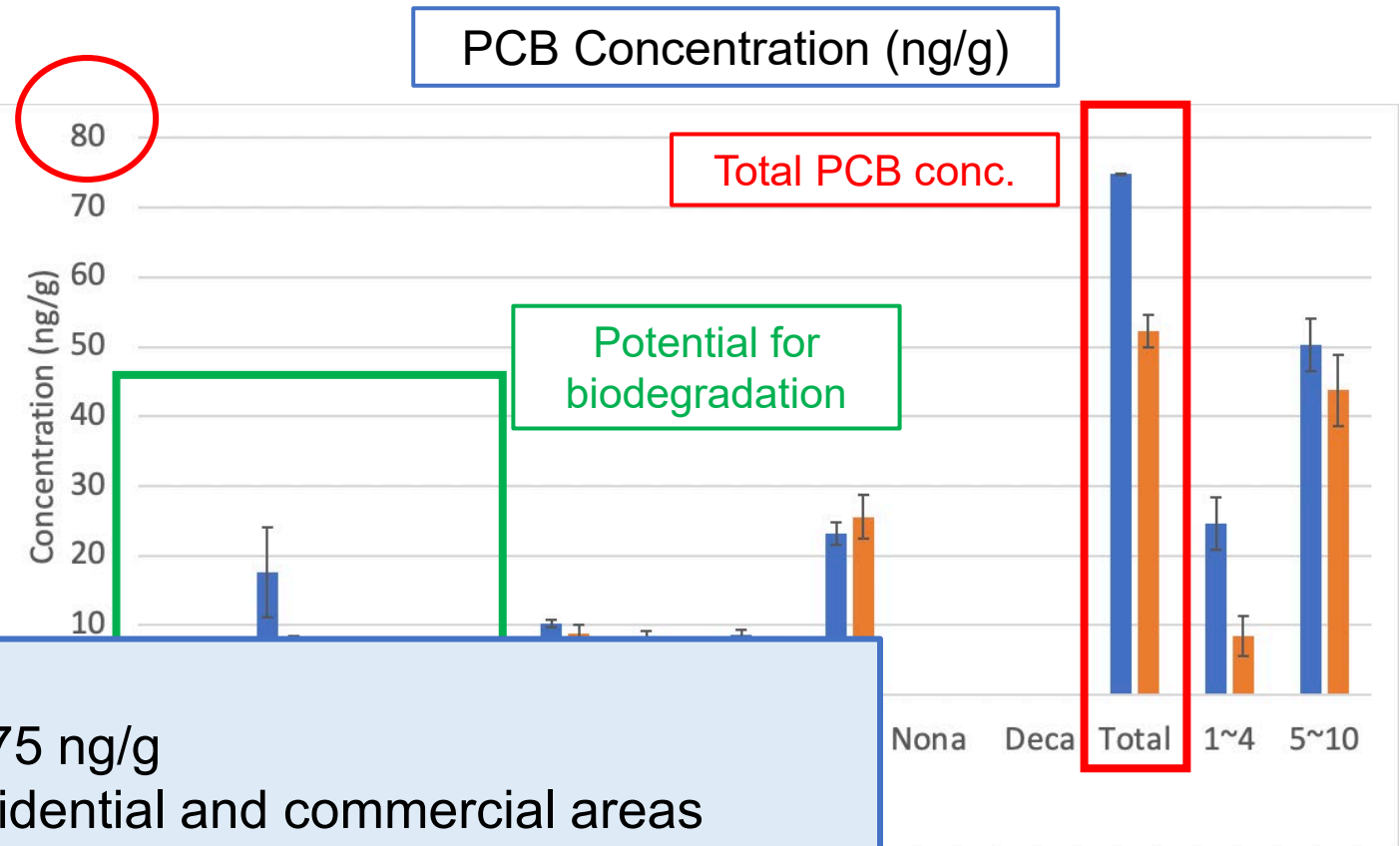
Automotive sales industry Area



1: Drainage point



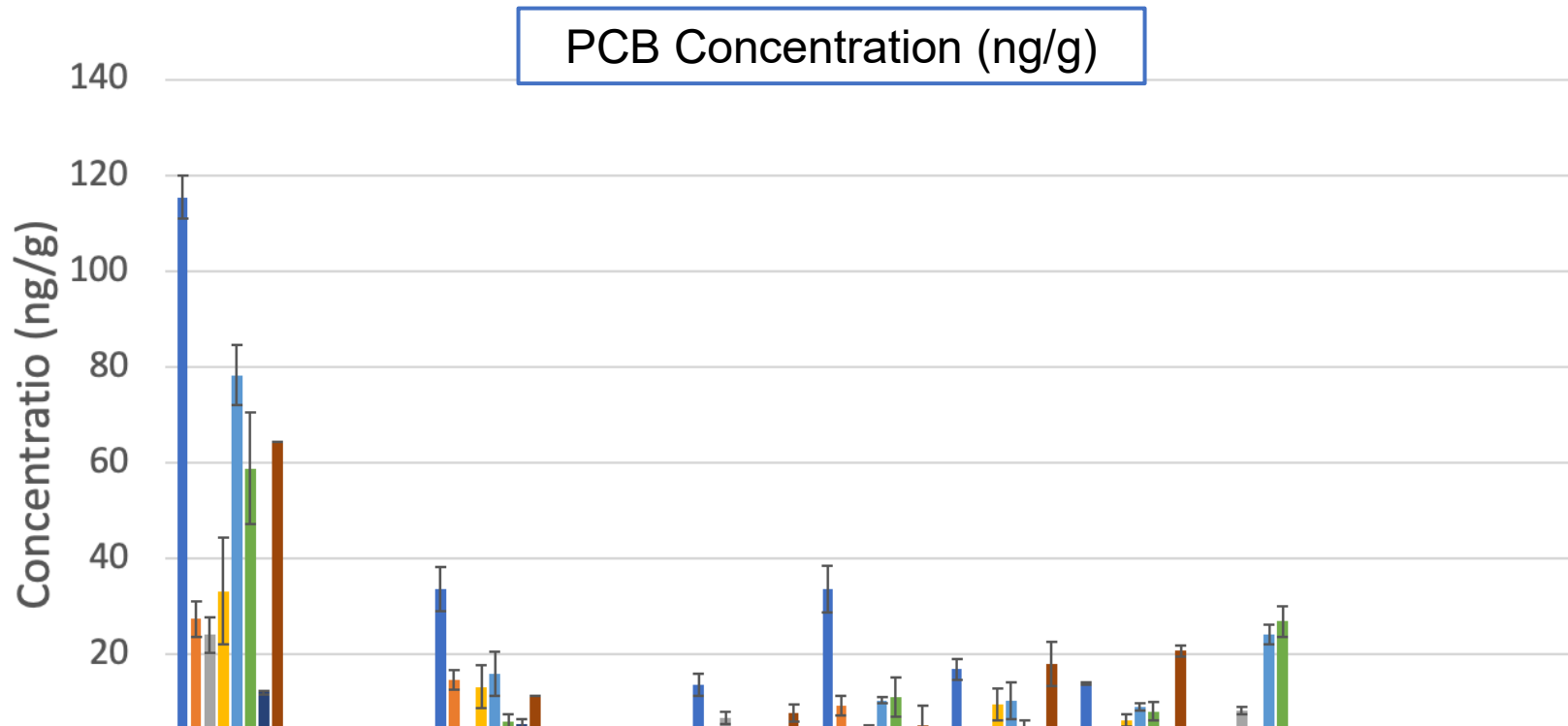
2: Parking lot side



Summary:

- Total PCB concentration: Average = 52-75 ng/g
- Congener distribution: Different from residential and commercial areas
- Mono, di, tri and tetra chlorinated PCBs: Potential for biodegradation, but low concentration.

Results: Comparisons based on land-use

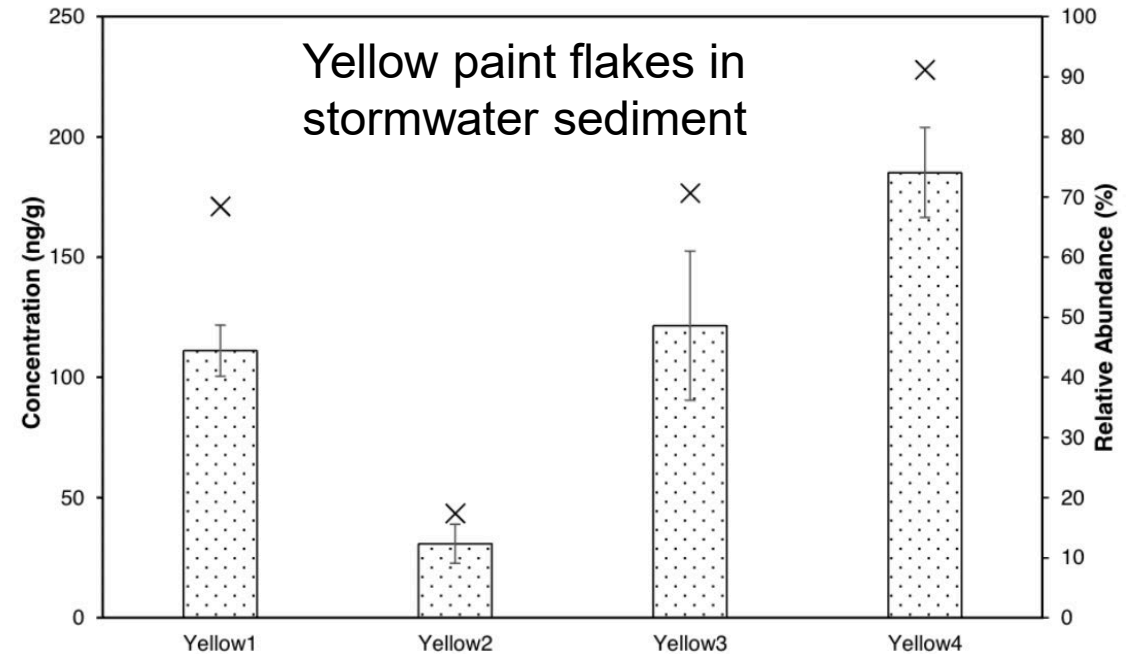
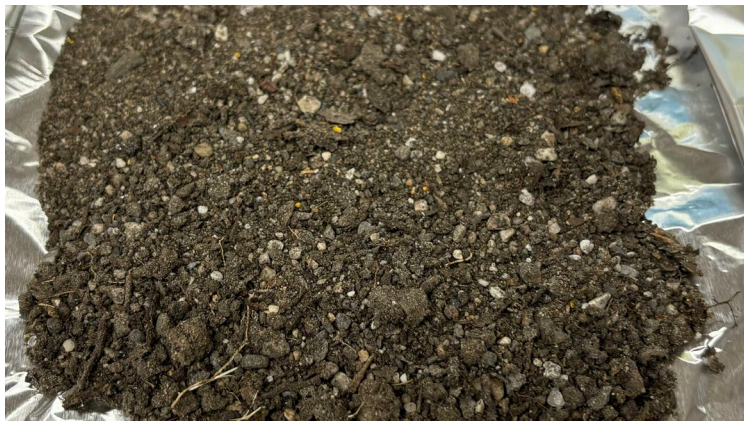
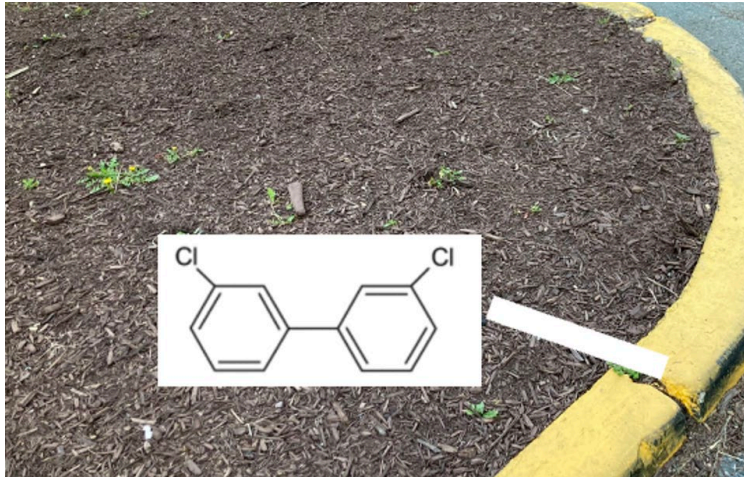


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Land Development Comparison:

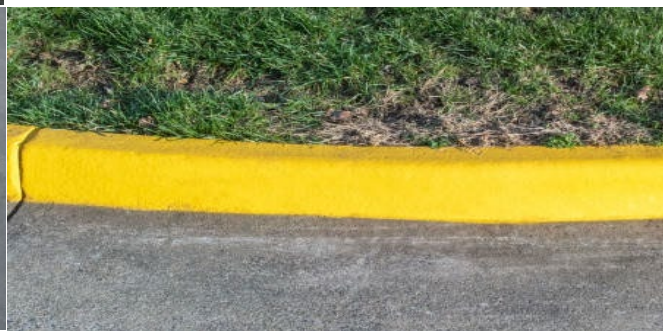
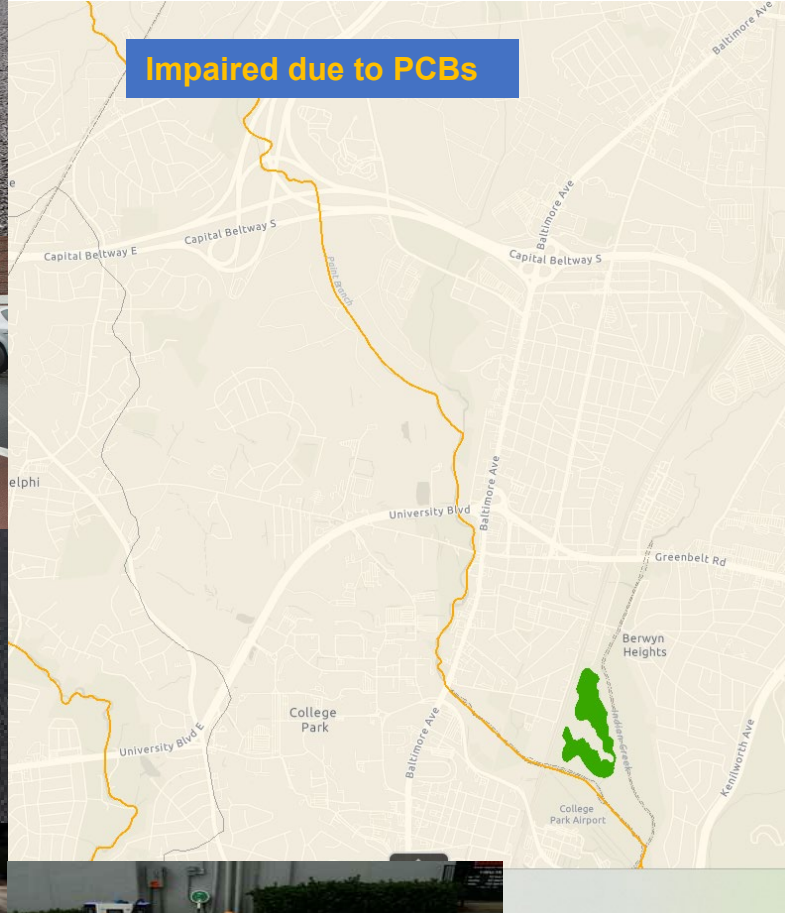
- In the same land use area, land development **before** 1970s has higher concentrations
- Post 1970s comparison: Industry > Energy site > Residential > Commercial areas
- Variability: Residential sites ~ similar; Industrial sites: large variability
- Land development and use: Important role in PCB presence and variability

PCBs in road paint – Past study



PCB 11 was detected in all samples

- PCB 11 conc. ranged from 17-91% of total PCB conc.
- More colors will be collected: Yellow, green red, blue, etc,



CAPSTONE: PCBs in Road Paints

Objectives:

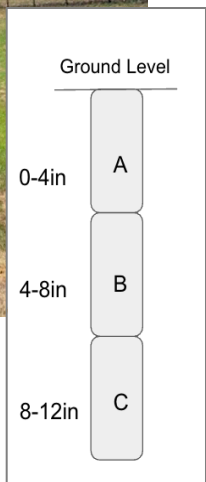
- 1) Develop a framework that can determine the area of each road paint in a watershed
- 2) Estimate the amount of PCBs that can leach out from the different types of road paint (white, yellow, green, blue, red) in the watershed
- 3) Develop solutions that prevent PCBs from road paint in reach stormwater runoff
- 4) Assess the risk associated with the PCBs in road paint
- 5) Communicate the findings to involved/interested stakeholders

Lessons learned (so far)

- Land use and land development impacts PCB concentrations and congener patterns in stormwater sediments
 - *In the same land use area, land development **before** 1970s has higher concentrations*
 - ***Post** 1970s comparison: Industry > energy site > Residential > Commercial areas*
 - *Variability: Residential sites ~ similar; Industrial sites: large variability*
 - *Land development and use: Important role in PCB presence and variability*
- Potential remedial actions
 - *Reduction at industrial and energy sites will provide **large reduction per site** (fewer sites)*
 - *Reduction at residential sites will provide **large overall reduction** (low reduction per site)*
 - ***Potential actions:** Street sweeping and establishment of stormwater BMPs*
 - ***Biodegradation** can reduce PCB mass in bioretention cells (not industrial sites)*

Future Work

- All conclusions are preliminary, analyses are ongoing
- More samples will be collected depending on land-use and land development
- Importance of soil type on PCB presence (sandy soil, loam soil)
- Assessment of biodegradation potential
- Continuation of road paint study



Acknowledgements



Janis Markusic Douglas Griffith



Elizabeth Sklaire – Suyue Cao



Allen P. Davis



Birthe V. Kjellerup

Translation Slides

What are the take home points?
What does this mean for me?

Translation Slides by Sadie Drescher, Chesapeake Bay Trust

What does this mean for me?

- PCB sampling and analysis is complex/time-consuming (best left to professionals and cost is a factor in any study)
- Wide range of PCB congeners exist
- PCB concentrations in soil were higher in land developed before 1970 (the PCB ban was in 1979)
- Residential PCB soil concentrations were similar to sites with industrial land use and higher than commercial land use sites – Why?
- Yellow paint (and likely other colors) used for roads/parking lot surfaces can contain PCBs
- Need more information to determine how to best predict and/or manage sites with high PCB concentrations

What does this mean for me?

What do I take from this if I am a practitioner:

- Industrial land uses from pre 1970 could have PCB contamination
- If PCB is a known soil contaminant, determining what congener is present will help with practice(s) selection

What do I take from this if I am a regulator:

- Banning PCBs helped reduce its sediment concentrations
- Need more information and potential collaboration with municipalities, researchers, practitioners, etc. to determine what solutions will be most effective



Ask Questions:

- Use chat
- Raise hand & unmute

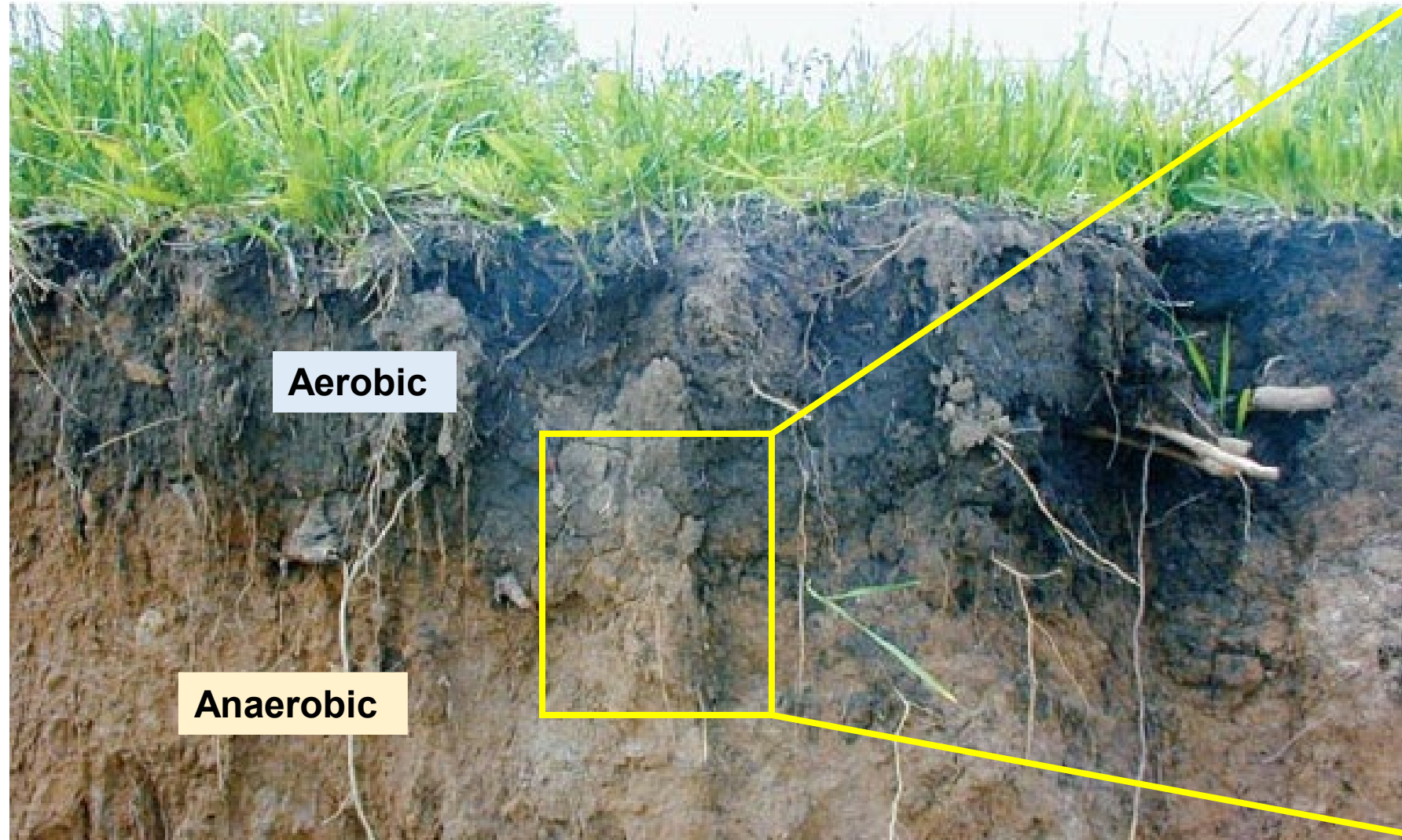


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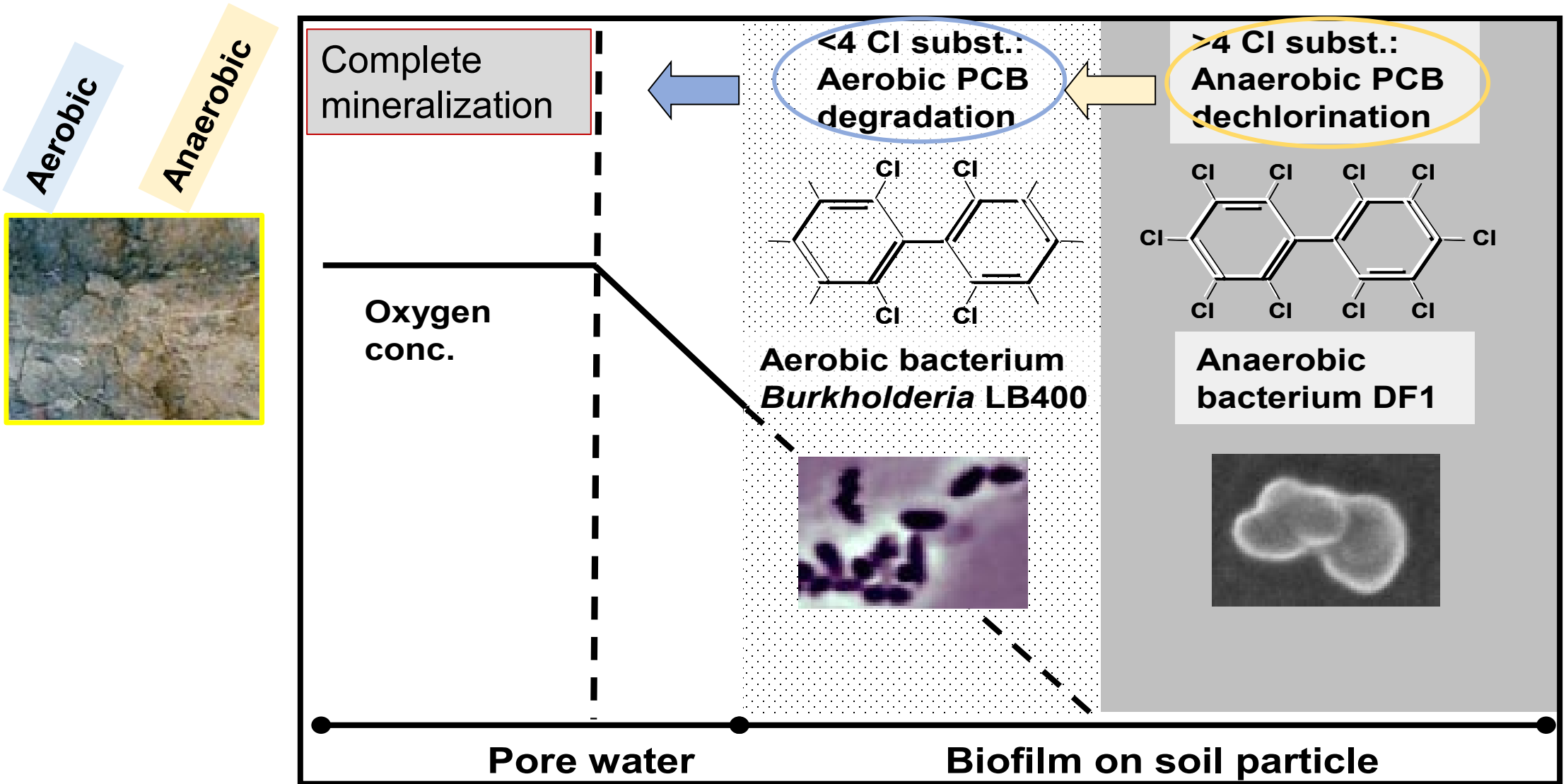


EXTRA SLIDES

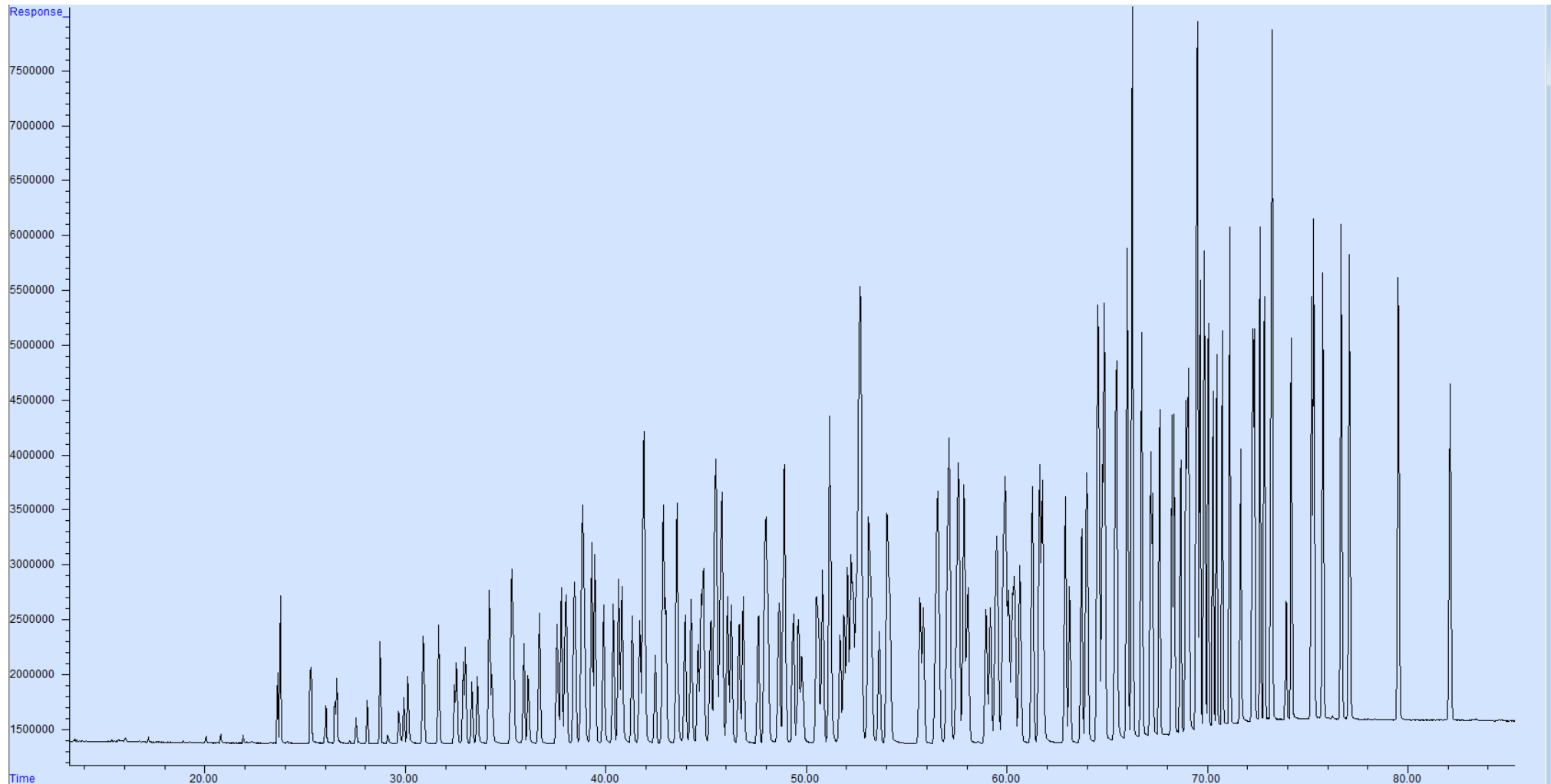
The Microbial Fate of PCBs in biofilms



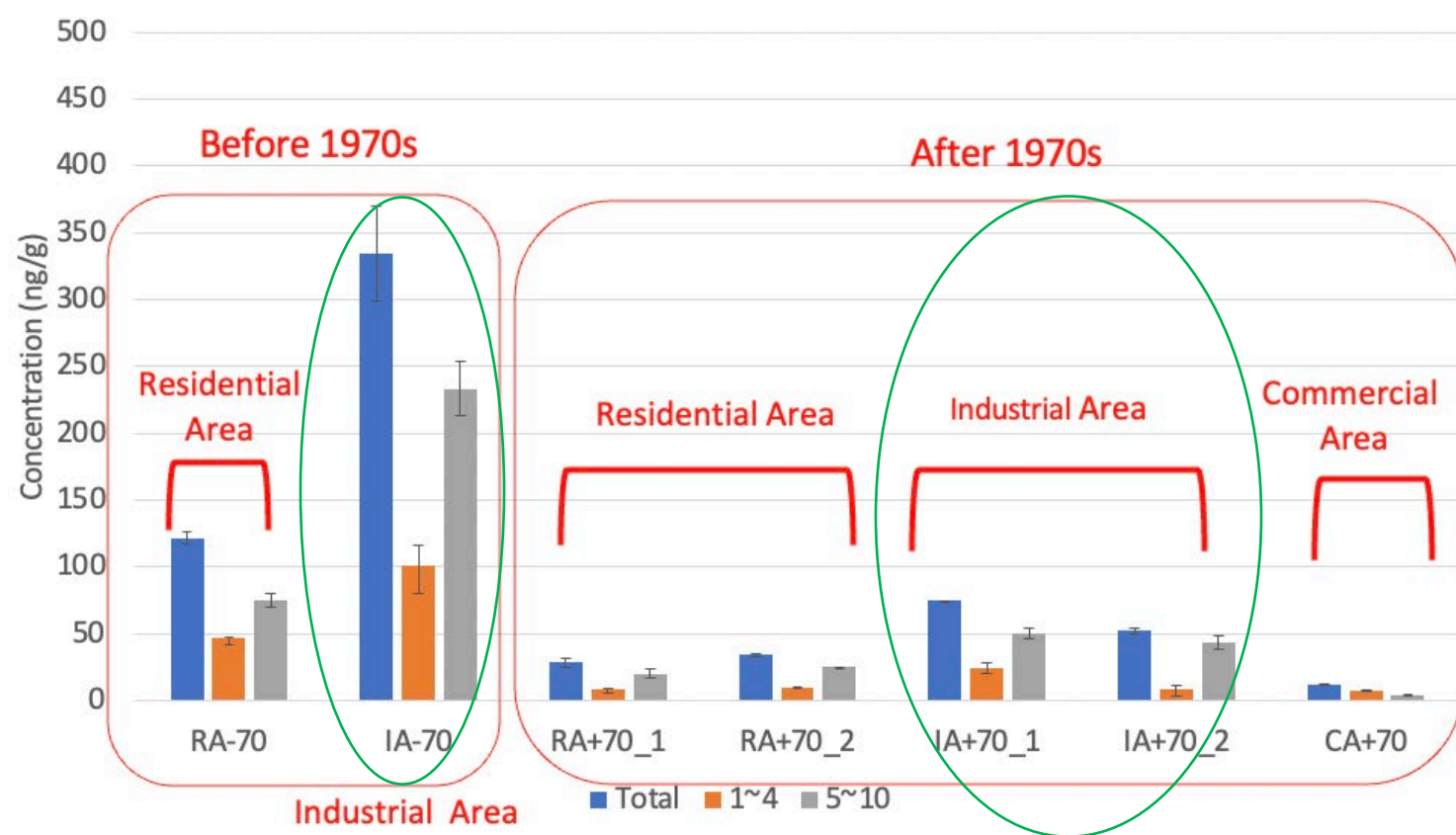
The Microbial Fate of PCBs in biofilms



Gas Chromatogram: PCB analysis



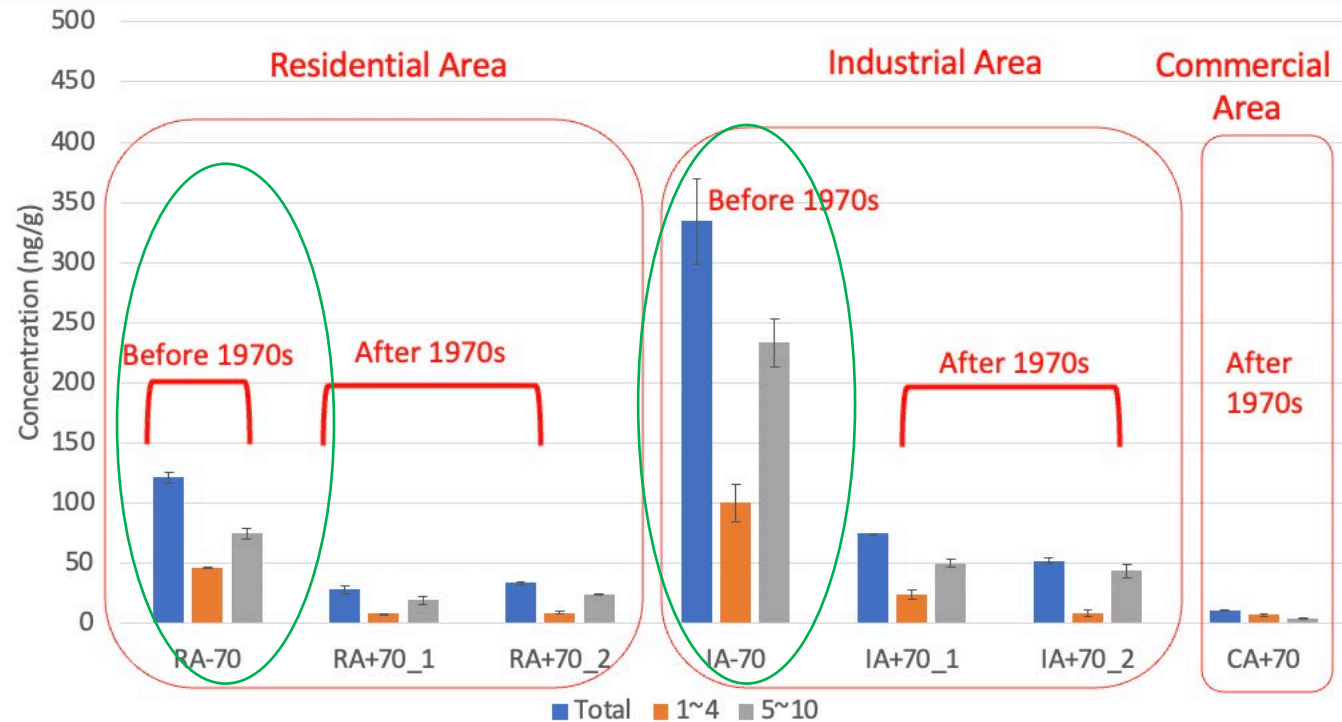
Sites grouped by land development



Land Use Comparison:

- Industrial areas: Highest conc. 'before 1970s' and 'after 1970s'.
- Land use plays a role in PCB concentration and congener distribution.

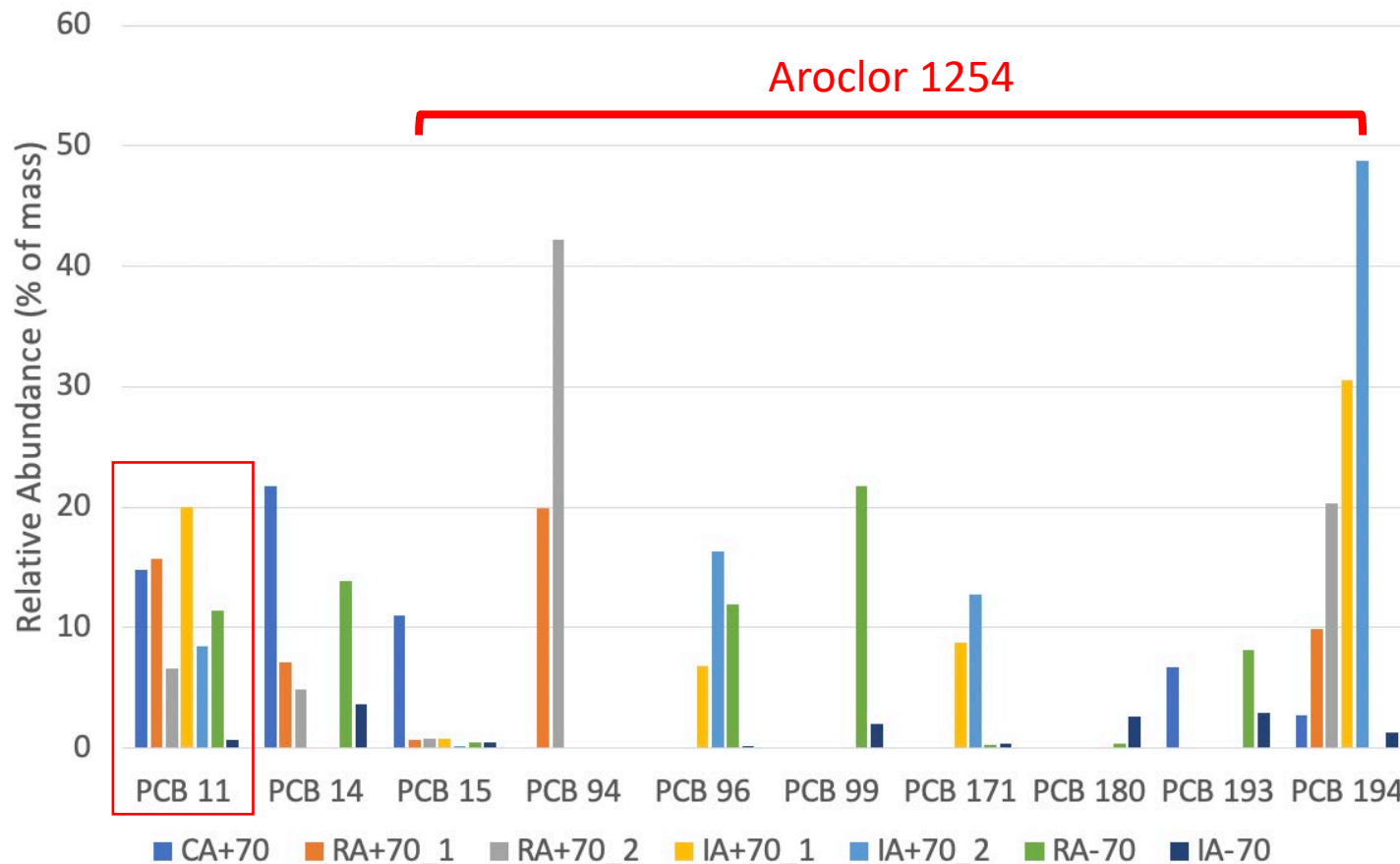
Sites grouped by land use



Land Development Comparison:

- In the same land use area, land development **before** 1970s has higher concentrations
- Land development play a big role in PCB concentration distribution

Mass % of dominant congeners at different sites compared to Aroclor 1254



Summary:

- A1254: Commonly manufactured Aroclor in the US
- Non-Aroclor congener PCB-11 was frequently detected in all samples
- PCB 11 is a by-product from manufacturing of diarylide derived yellow pigments contamination (road paint).