PCB: the Pollution Prevention Approach

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Presentation to USEPA

April 27, 2017

Commitment

SRRTTF Established by Memorandum of Agreement 2012.

Members of the community, stewards of the river.

The Problem:

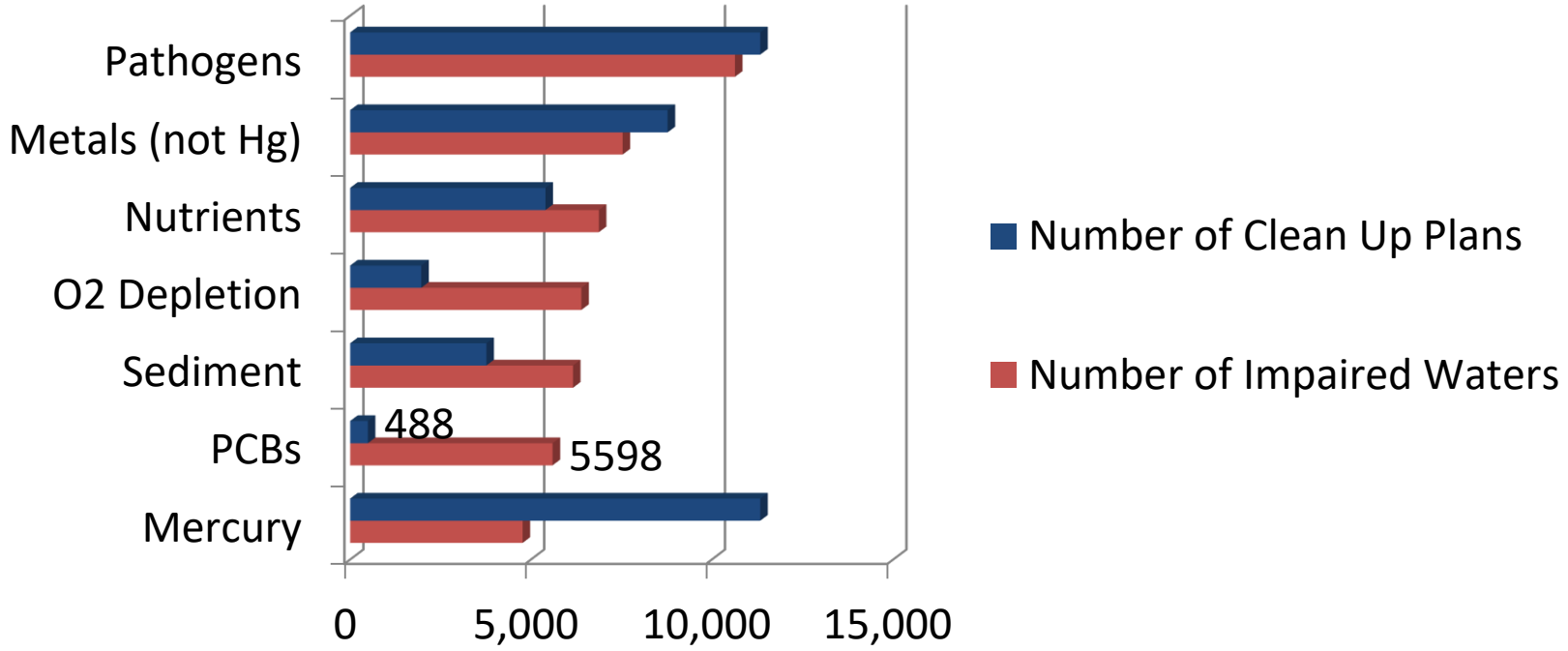
- The Spokane River does not meet the Water Quality Standards for polychlorinated biphenyls and other toxics.
- > 98% reduction in PCB loading is needed.
- Permitted discharges have a disproportionate responsibility for cleanup.
- End of pipe clean up is expensive and may not be possible.
- Using Pollution Prevention principles is the only viable option.

Can We Achieve our WQS?

- Assume all PCB from pigments becomes available to the river.
  - (trash, decomposition, burning, wastewater, stormwater, etc.)
- 225 cf/s average annual flow into Long Lake
  - $7x10^{12}$ kg water/yr.
- PCB Concentrations in the river:
  - From pigments alone: 2×10^{-7} ppm
  - Current WQS target: 0.07×10^{-7} ppm

Why this is important

PCB is a national water quality concern



EPA Watershed Assessment, Tracking and Environmental Database

The Moving Pieces

Waste Management Hierarchy

- Prevent Waste Generation
- Minimize Waste Generation
- Reuse Waste Materials
- Recycle Wastes: Doesn't work for PCB!
- Utilize for Energy Recovery
- Disposal

In Other Words:

- Don't make it
- Don't use it
- Use less of it
- Manage it better
- Dispose of it properly
- Clean up and/or Treat at End of Pipe

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In Other Words:

- Don't make it: Stop or reduce inadvertent production.
- Don't use it: Regulatory & market incentives.
- Use less of it: Public awareness.
- Manage it better: Enforcement of rules.
- Dispose of it properly.
- Clean up and/or Treat at End of Pipe.

End

But, Is This Really a Problem?

- Color Pigments Manufacturers Association (2010):
  - 90 million lbs pigments imported/manufactured in US.
  - Estimated 1000-2000 lbs PCB/year.
- Estimated amount released in Spokane metro area based on per capita consumption.
  - 2000/lb x 0.5 million Spokane/ 316 million USA
  - **1435** g/yr "inadvertently produce PCB" potentially enters the Spokane River watershed.
- Correlation with the 2005 loading assessment:
  - Total PCBs at Long Lake: **3664** mg/day = **1337** g/year.

Why this is important

PCB is a Spokane River health concern.

Source Reduction Strategies

Six strategies to achieve source reduction:

- Toxic chemical substitution
- Production process modification
- Finished product reformulation
- Production modernization
- Improvements in operations and maintenance
- In-process recycling of production material

Green Chemistry Solutions

- Green Chemistry is doing chemistry the way nature does:

" the design, development and implementation of chemical products or processes that reduce or eliminate the generation of hazardous substances"

- PCB – free pigments are a green chemistry opportunity.

References

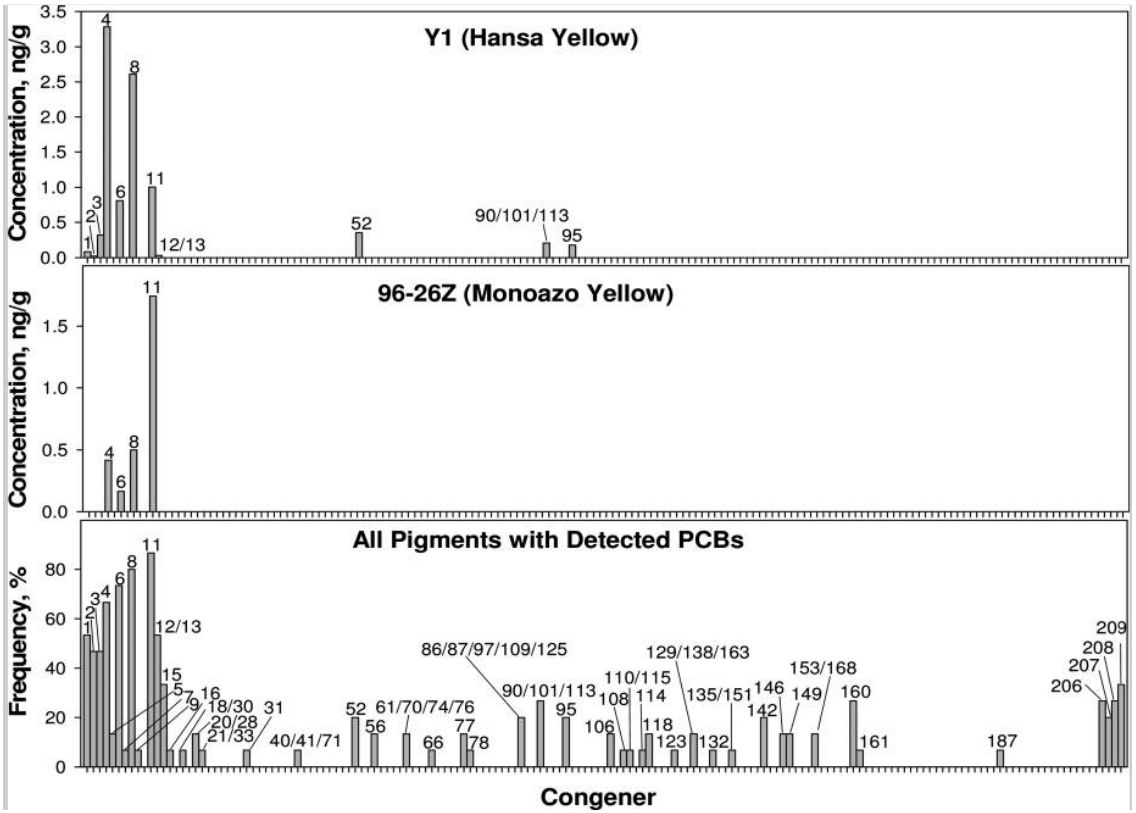
PCB in Paint Pigments

33 commercial pigments

> 50 PCB congeners

Several dioxin-like

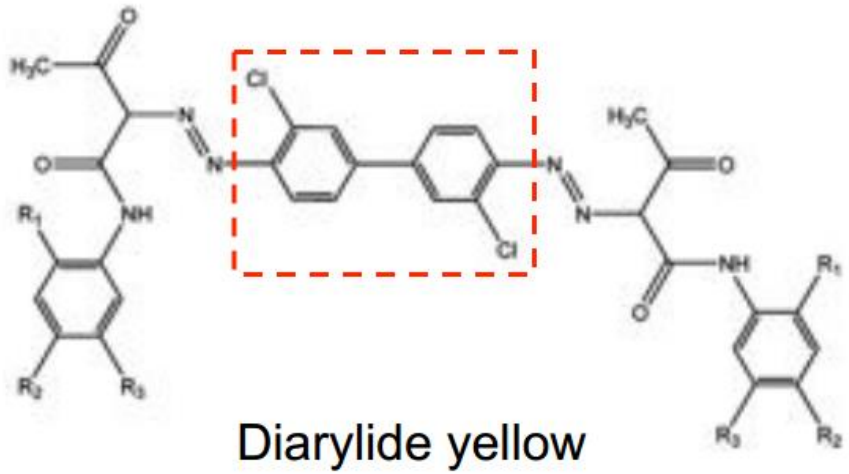
Pigments also used in
- Inks
- Textiles
- Paper
- Cosmetics
- Leather
- Plastics
- Food



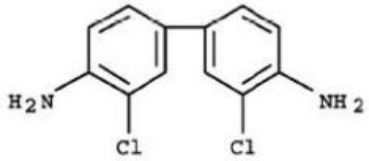
Hu and Hornbuckle, 2010: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2853905/figure/fig2/

Yellows, Oranges, Reds

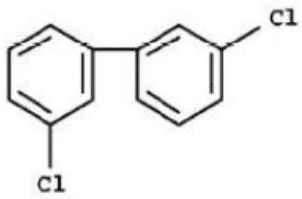
PCB 11 from Diarylide Yellows



Diarylide yellow



3,3'-dichlorobenzidine



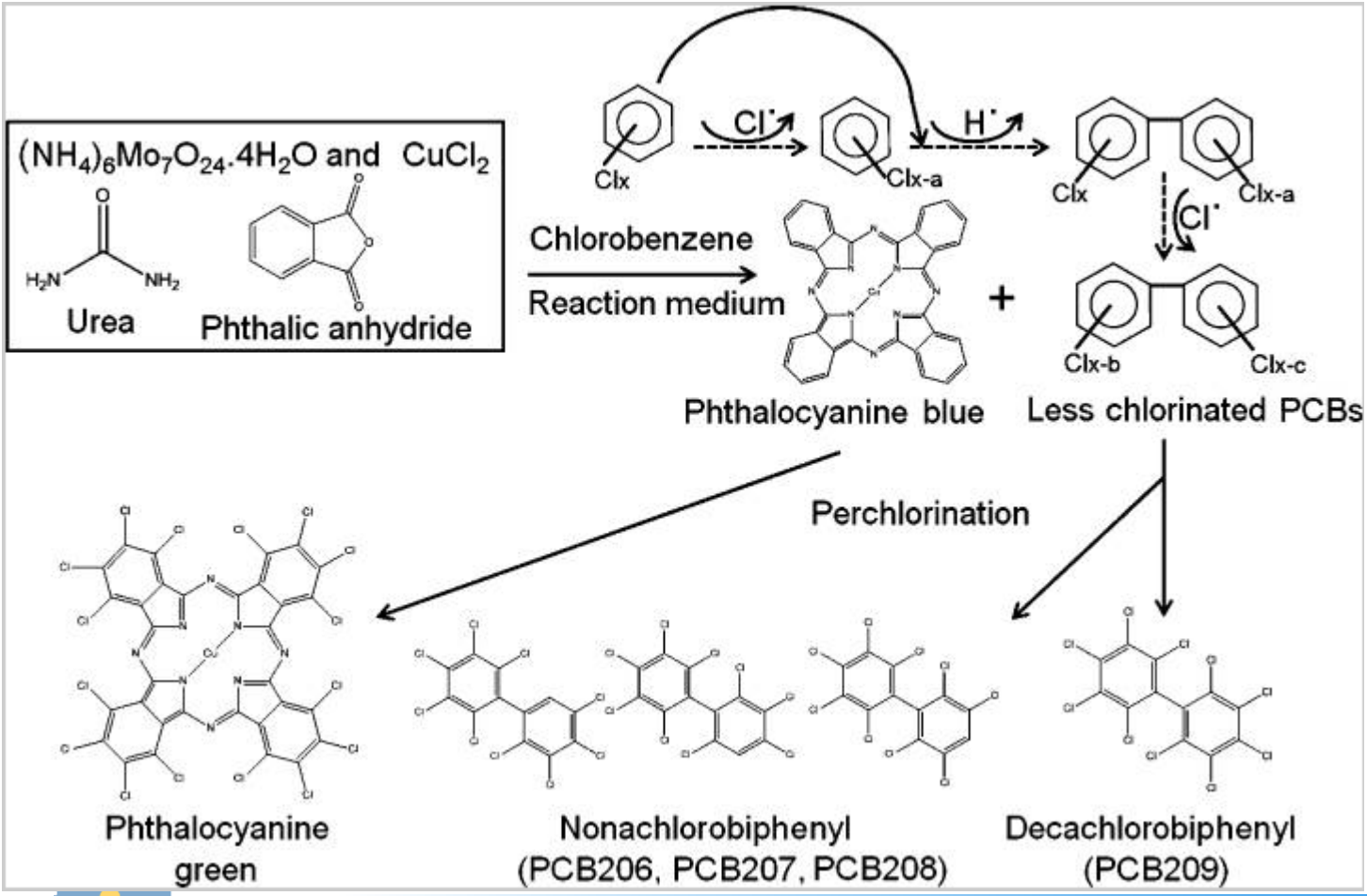
PCB 11 (3,3'-diCB)

R_1,R_2,R_3 = H	Pigment yellow 12
R_1,R_2 = CH_3, R_3 = H	Pigment yellow 13
R_1 = OCH_3, R_2, R_3 = H	Pigment yellow 17
R_1,R_3 = OCH_3, R_2 = Cl	Pigment yellow 83

→ All listed in EPA's Toxic Substances Control Act (TSCA) inventory

Baso et al. 2009 in Guo, Praipipat, and Rodenburg: http://www.p2.org/wp-content/uploads/june-27-pcbs-webinar.pdf

Blues and Greens



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Whites

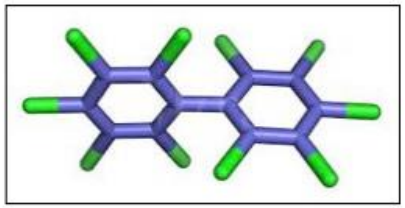
PCBs 206, 208, 209

Produced inadvertently during the making of titanium tetrachloride

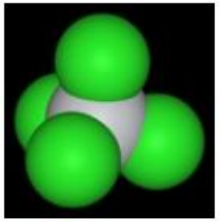
Often sold to water treatment plants as a flocculant

$$2\ FeTiO_3 + 7\ Cl_2 + 6\ C \rightarrow 2\ TiCl_4 + 2\ FeCl_3 + 6\ CO$$

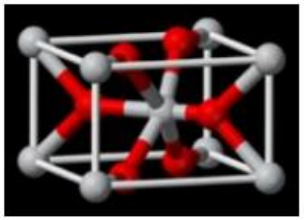
This carbon is chlorinated to form PCBs



Most $TiCl_4$ is then used to make TiO_2 (white pigment)



$$TiCl_4 + O_2 \rightarrow TiO_2 + 2Cl_2$$



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