Sources of Contaminants of Concern to the Newark Bay Estuary

Fourth Passaic River Symposium
Montclair State University, Montclair, NJ
June 22, 2010
Multiple Sources of Dioxin, Furans and Dioxin-like PCBs to NBE Sediments Known to Exist

- What is Dioxin?
- Sources of Dioxins
  - Where does Dioxin come from?
  - Sources in the Newark Bay Estuary
- Characterizing Sources of Dioxin
  - Do we look for Dioxin?
  - Examples of Dioxin-Contaminated Sites in the Newark Bay Estuary
- The Need for Further Investigation
What is Dioxin?

• Family (or class) of compounds: Dibenzo-p-dioxins
• Dioxin-like compounds: Furans and PCBs

• USEPA publications regarding dioxin typically address compounds in the following chemical classes:
  – polychlorinated dibenzo-p-dioxins (PCDDs or CDDs)
  – polychlorinated dibenzofurans (PCDFs or CDFs)
  – polybrominated dibenzo-dioxins (PBDDs or BDDs)
  – polybrominated dibenzofurans (PBDFs or BDFs)
  – polychlorinated biphenyls (PCBs)

• Compounds in the classes contain 210 congeners of dioxins and furans, in addition to 209 PCBs.
17 congeners and 12 PCBs have *Dioxin-like toxicity*:

<table>
<thead>
<tr>
<th>CDDs:</th>
<th>CDFs:</th>
<th>PCBs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,3,7,8-TCDD</td>
<td>2,3,7,8-TCDF</td>
<td>PCB-77</td>
</tr>
<tr>
<td>1,2,3,7,8-PeCDD</td>
<td>1,2,3,7,8-PeCDF</td>
<td>PCB-81</td>
</tr>
<tr>
<td>1,2,3,4,7,8-HxCDD</td>
<td>2,3,4,7,8-PeCDF</td>
<td>PCB-105</td>
</tr>
<tr>
<td>1,2,3,6,7,8-HxCDD</td>
<td>1,2,3,4,7,8-HxCDF</td>
<td>PCB-114</td>
</tr>
<tr>
<td>1,2,3,7,8,9-HxCDD</td>
<td>1,2,3,6,7,8-HxCDF</td>
<td>PCB-118</td>
</tr>
<tr>
<td>1,2,3,4,6,7,8-HpCDD</td>
<td>1,2,3,7,8,9-HxCDF</td>
<td>PCB-123</td>
</tr>
<tr>
<td>OCDD</td>
<td>2,3,4,6,7,8-HxCDF</td>
<td>PCB-126</td>
</tr>
<tr>
<td></td>
<td>1,2,3,4,6,7,8-HpCDF</td>
<td>PCB-156</td>
</tr>
<tr>
<td></td>
<td>1,2,3,4,7,8,9-HpCDF</td>
<td>PCB-157</td>
</tr>
<tr>
<td></td>
<td>OCDF</td>
<td>PCB-167</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCB-169</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCB-189</td>
</tr>
</tbody>
</table>

**Others Proposed:** PBDD/Fs, PBBs, PBDEs, PCNs
Dioxin-like Toxicity

- Toxicity Equivalency Factors (TEFs) have been developed to compare the toxicity of each compound.

- Appear as mixtures in the environment – thus:
  \[ \text{TEQ} = \text{the sum of each congener concentration multiplied by its TEF} \]

- TEQ is *the amount of 2,3,7,8-TCDD it would take to equal the combined toxic effect of all the dioxins and dioxin-like compounds found in the mixture.*

  (USEPA, 2003 DRAFT Reassessment)
Why is This Important: PR Site Example

- Multi-party Site discharges to Passaic River. Site soil contaminated with numerous hazardous substances.

- Max 2,3,7,8 TCDD concentration detected at site = 2.83 ppb.

- When detected congeners (dioxins and dioxin-like compounds) are aggregated within a sample at the site, a max TEQ of 911 ppb can be calculated.

- Therefore, the risks posed by this sample at this site are the same as a detected 2,3,7,8-TCDD concentration of 911 ppb.
Sources of Dioxins: Where does it come from?

- **Unintended byproducts** of various chemical processes, combustion, and high-temperature operations.

- USEPA and others have published extensively on the formation of dioxins and its sources to the environment:
  - Early: focused on sources of 2,3,7,8-TCDD - prior to TEFs and TEQ approach
    - Class I and II Organics and Pesticides; Class III Organics and Precursors
  - Later: categorical sources of dioxins and dioxin-like compounds
    - consistent with the TEQ approach.
      - Chemical Manufacturing and Processing Sources
      - Combustion, Incineration and Other High-Temperature Operations
Sources of Dioxins:  
**Class I and II Compounds**

- Many former manufacturing facilities subject of EPA and NJDEP evaluation during the 1980s to assess the existence of on-site dioxin contamination.

- Focused only on 2,3,7,8-TCDD – only congener analyzed for.

- A number of these sites contaminated with 2,3,7,8-TCDD; detection limit and data quality issues.

- Most still not characterized for other dioxins, dioxin-like furans or PCBs – thus no calculation of TEQ.
Site Example: *Long Term PR Manufacturing Site*

- Site soil, groundwater and Passaic River sediments contaminated with numerous hazardous substances, including 2,3,7,8-TCDD.

- Facility manufactured Hexachlorophene from 1945 to 1984 at the Site; also manufactured own 2,4,5-TCP from 1945 – 1949.

- Site first characterized for dioxin in 1980s; contaminated with 2,3,7,8-TCDD. Other dioxins, furans and PCBs were *not characterized*.

- Site typical for this timeframe; little TEQ data exists. Others not adequately characterized, data quality issues, etc.
Sources of Dioxins:  
*Class III / Precursor Compounds*

- Class III Organic Chemicals Related to Dioxin Formation consist of other chemicals originally purported as “having the potential, but less likelihood,” of dioxin formation.

- USEPA has also reported that certain chemicals can serve as “precursors” to dioxin. (40 CFR766)

- These sites typically not characterized in 1980s efforts

- Few of these sites have been characterized today
Site Examples: “Class III” Organic Chemicals

• **Former Manufacturing Sites, Kearny**
  - Chlorinated benzenes and naphthalene products
  - Elevated levels of 2,3,7,8-TCDD and TEQ detected on Sites
  - NJDEP identified the Dichlorobenzene distillation pot as the likely source of the dioxins on Site.

• **Former Manufacturing Site, Newark**
  - Likely Dichlorobenzene production by several prior Site owners; other potential sources due to historic Site Operations.
  - Elevated levels of 2,3,7,8-TCDD and TEQ detected on Site
  - Elevated dioxins co-located with elevated levels of Dichlorobenzenes
**Site Example: Former Manufacturing Site, Newark**

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>H8:3.5.4.0R</th>
</tr>
</thead>
</table>

### Sum of TEQ

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Total</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. 2,3,7,8-TCDF</td>
<td>53.6</td>
<td>1.04%</td>
</tr>
<tr>
<td>B. 1,2,3,7,8-PECDF</td>
<td>4.695</td>
<td>0.09%</td>
</tr>
<tr>
<td>C. 2,3,4,7,8-PECDF</td>
<td>25.4</td>
<td>4.92%</td>
</tr>
<tr>
<td>D. 1,2,3,4,7,8-HXCD</td>
<td>400.5</td>
<td>77.59%</td>
</tr>
<tr>
<td>E. 1,2,3,6,7,8-HXCD</td>
<td>38.2</td>
<td>7.40%</td>
</tr>
<tr>
<td>F. 1,2,3,7,8,9-HXCD</td>
<td>46.9</td>
<td>0.91%</td>
</tr>
<tr>
<td>G. 2,3,4,6,7,8-HXCD</td>
<td>14.0</td>
<td>2.71%</td>
</tr>
<tr>
<td>H. 1,2,3,4,6,7,8-HPCD</td>
<td>183.3</td>
<td>3.56%</td>
</tr>
<tr>
<td>J. OCDF</td>
<td>2.449</td>
<td>0.05%</td>
</tr>
<tr>
<td>K. 2,3,7,8-TCD</td>
<td>57.6</td>
<td>1.12%</td>
</tr>
<tr>
<td>L. 1,2,3,7,8-PECDD</td>
<td>2.1</td>
<td>0.04%</td>
</tr>
<tr>
<td>M. 1,2,3,4,7,8-HXCD</td>
<td>1.91</td>
<td>0.04%</td>
</tr>
<tr>
<td>N. 1,2,3,7,8,9-HXCD</td>
<td>2.06</td>
<td>0.04%</td>
</tr>
<tr>
<td>O. 1,2,3,6,7,8-HXCD</td>
<td>6.01</td>
<td>0.12%</td>
</tr>
<tr>
<td>P. OCDD</td>
<td>0.0776</td>
<td>0.00%</td>
</tr>
<tr>
<td>Q. 1,2,3,4,6,7,8-HPCDD</td>
<td>2.12</td>
<td>0.04%</td>
</tr>
<tr>
<td>R. 1,2,3,4,6,7,8,9-HPCDF</td>
<td>18</td>
<td>0.36%</td>
</tr>
</tbody>
</table>

Grand Total: 5161.8216

100.00%
Sources of Dioxins:
*Chemical Mfg. Process and High Temp Operations*

Pulp/Paper mills
Dyes, Pigments, and Printing Inks
Chlorine manufacture
Chlorophenols, mono- to tetra-
Pentachlorophenol
Chlorobenzenes
Railway and Utility Runoff
ED, VC,PVC
PCBs
Tall oil-based liquid soaps
2,4-Dichlorophenoxy acetic acid
Other aliphatic chlorinated compounds
Wastewater treatment plants /
municipal sludge

Municipal Waste Incineration
Metal smelting and refining
**Drum and barrel reclamation**
Scrap electric wire recovery
Sewage sludge incineration
Cement kilns
Asphalt mixing plants
Petroleum refining catalyst regeneration
Crematoria
Uncontrolled PCB combustion
Fires (buildings, etc.)
Boilers / Industrial furnaces
Landfill fires
Coal combustion
Sources of Dioxins: 
Sources in the Newark Bay Estuary

• More than 200 entities / PRPs identified to date in the Newark Bay Estuary whose historic and/or present day operations are associated with the formation of Dioxins.
  – 44 PRPs with Class I and II Organic Chemical or Pesticide use or production.
  – 33 PRPs with Class III Organic Chemical or Dioxin Precursor chemical use or production.
  – 142 PRPs with Chemical Manufacturing, Processes and or High-temperature Operations associated with the formation of dioxins.

• Locations range throughout Passaic River and entire Newark Bay Estuary – including all tributaries to Newark Bay. (refer to figure)
Sources of Dioxins:
Sources in the Newark Bay Estuary
Characterizing Sources of Dioxins: 

*Do we look for It?*

- Dioxins not typically sampled and analyzed for:
  - Fear factor, cost factor, lack of enforcement

- 20 Sites identified to date as contaminated with Dioxin in the NBE, of the 200+ identified potential sources.
  - Where Dioxin and Dioxin-like congeners have been sampled for, Dioxins have *always* been detected.
  - Where only the 2,3,7,8-TCDD congener has been sampled for, it has not always been detected.
  - Most have *never been sampled* for Dioxins
# Examples of Dioxin Contaminated Sites in the Newark Bay Estuary

<table>
<thead>
<tr>
<th>PRP / SITE NAME:</th>
<th>TYPE OF SOURCE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing Site, Clifton</td>
<td>Class I and II Organic Chemicals</td>
</tr>
<tr>
<td>Manufacturing Site, Newark</td>
<td>Class I and II Organic Chemicals</td>
</tr>
<tr>
<td>Formulation Site, Newark</td>
<td>Class I and II Organic Chemicals</td>
</tr>
<tr>
<td>Manufacturing Site, Newark</td>
<td>Class I and II Organic Chemicals</td>
</tr>
<tr>
<td>Manufacturing Site, Newark</td>
<td>Class I and II Organic Chemicals</td>
</tr>
<tr>
<td>Manufacturing, Linden</td>
<td>Class I and II Organic Chemicals</td>
</tr>
<tr>
<td>Manufacturing Sites, Kearny</td>
<td>Class III Organic Chemicals</td>
</tr>
<tr>
<td>Manufacturing Site, Elizabeth</td>
<td>Class III Organic Chemicals</td>
</tr>
<tr>
<td>Drum Reconditioning Site, Newark</td>
<td>Combustion, Incineration, and High Temp Source</td>
</tr>
<tr>
<td>Drum Reconditioning Site, Newark</td>
<td>Combustion, Incineration, and High Temp Source</td>
</tr>
<tr>
<td>Municipal Landfill, Kearny</td>
<td>Process Source</td>
</tr>
<tr>
<td>Municipal Landfill, Kearny</td>
<td>Process Source</td>
</tr>
</tbody>
</table>

Refer to figure for locations
Sources of Dioxins:
Sources in the Newark Bay Estuary
Conclusions: Sources of Dioxin to the Newark Bay Estuary

• Multiples sources of Dioxin to the Newark Bay Estuary exist.

• Many are not identified nor confirmed as sources.

• There is a need for further investigation and sampling of these Sites.
Acknowledgements

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dfarley@intell-group.com

• Work reflected herein conducted on behalf of Tierra Solutions, Inc. and is part of USEPA’s public record for the LPRSA and NBSA Sites.

• Work reflected herein has been compiled from publicly available records.