OCTOBER 5, 2010

A PRESENTATION of the Regional Monitoring Program for Water Quality in the San Francisco Estuary

RECENT ADVANCES IN BAY AREA STORMWATER SCIENCE

LESTER McKEE, SAN FRANCISCO ESTUARY INSTITUTE
Take home messages

• Sediment information is improving and remains the basis for estimation and tracking contaminants

• Sediment grainsize influences the quality of the sediment resource and our ability to manage contamination

• Monitoring takes different tools and effort and each watershed scale

• Mercury is found on small particles and in dissolved phase under lower flow conditions

• Source control show promise for PCBs (and Hg) - treatment control may be more suitable for PCBs
The need for information

- The Bay is listed as impaired

- “Create a functional connection between beneficial uses of the Bay and efforts to identify, eliminate, and prevent sources of pollution”

- Cu/Ni, Hg Total Maximum Daily Loads (TMDL) clean up plans began to be developed in the late 90s

- 1999 – The Sources Pathways and Loading Workgroup established
Some things don’t change

• Atmospheric Deposition Pilot Study
  – Relatively small magnitude established

• Wastewater treatment quantification
  – Improved analyte list and detection limits
  – Relatively small magnitude established

• Water Budget for San Francisco Bay

<table>
<thead>
<tr>
<th></th>
<th>Volume (Mm$^3$)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Rivers</td>
<td>24900</td>
<td>92</td>
</tr>
<tr>
<td>Small Tributaries</td>
<td>918</td>
<td>3.4</td>
</tr>
<tr>
<td>Municipal Wastewater</td>
<td>800</td>
<td>3.0</td>
</tr>
<tr>
<td>Rainfall</td>
<td>381</td>
<td>1.4</td>
</tr>
<tr>
<td>Industrial Wastewater</td>
<td>36</td>
<td>0.13</td>
</tr>
</tbody>
</table>
Some knowledge has really changed

- Sediment budget
- Polychlorinated Biphenyl (PCB) budget
- Mercury budget
- Information about sources and treatment options improving
Sediment knowledge prior to year 2000

- Smith, 1965 based on data from Porterfield et al., 1961
- Krone, 1966

1.4 M metric t
Central Valley suspended sediment loads
(McKee et al., 2002; 2006; David et al., 2009; RMP Pulse, 2010)

Average = 1 M metric t
Spatially resolved suspended sediment loads estimates

(Lewicki and McKee, 2009)
Useful information?

- Estimates of relative particle concentrations
## Loads from small tributaries by Bay segment

<table>
<thead>
<tr>
<th>RMP Bay Segment</th>
<th>Load (t/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rivers</td>
<td>27,353</td>
</tr>
<tr>
<td>Suisun Bay</td>
<td>203,453</td>
</tr>
<tr>
<td>Carquinez Strait</td>
<td>25,693</td>
</tr>
<tr>
<td>San Pablo Bay</td>
<td>281,789</td>
</tr>
<tr>
<td>Central Bay</td>
<td>246,170</td>
</tr>
<tr>
<td>South Bay</td>
<td>270,202</td>
</tr>
<tr>
<td>Lower South Bay</td>
<td>214,940</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,269,606</strong></td>
</tr>
</tbody>
</table>

*Note “Rivers” is the name of the northeastern most RMP Bay segment and is not referring to input from the Sacramento or San Joaquin River.*
Summary of allochthonous suspended sediment loads

- Predictions of Ray Krone seem to have become reality

- Bay sediment supply has switched from **Central Valley dominated** to local small tributary dominated

1960 Average

3 M t
76%
Summary of allochthonous suspended sediment loads

- Predictions of Ray Krone seem to have become reality
- Bay sediment supply has switched from Central Valley dominated to local small tributary dominated

2000 Average
1 M t
44%
Temporally resolved suspended sediment loads (Million metric t)

Key
- **Sacramento River at Mallard Island**
- **Local Small Tributaries draining the 9-county Bay Area**
Estimated suspended sediment supply

- **Large Rivers**
- **Small tributaries**

**RMP monitoring (18 years)**

**Suspended sediment supply (Million metric t)**

**Water Year**

- 1970
- 1972
- 1974
- 1976
- 1978
- 1980
- 1982
- 1984
- 1986
- 1988
- 1990
- 1992
- 1994
- 1996
- 1998
- 2000
- 2002
- 2004
- 2006
- 2008
Sediment grainsize

Implications for

- Source control
- Treatment control
- Turbidity as a surrogate
- Trapping in reservoirs and flood channels
Sediment as a resource

Alameda flood control channel example

• D50: mostly fine – medium sand
  – Some samples >50% gravel

• 14% is <62.5 micron
Monitoring contaminant loads
Where have we been monitoring?

Sacramento River at Mallard Island
154,000 km²

Gellert Park Recreational Facility
0.016 km²
Challenges of scale in monitoring?

- Gellert Park Rec Facility (12 mins)
- Sacramento River At Mallard Island (3-4 days)

Graph showing response time vs. watershed area.
Sacramento River at Mallard Island
Zone 4 Line A in Hayward
North Richmond Pump Station
Gellert Park recreational facility, Daly City
How do we scale up from local to regional?

- PCB TMDL – simple climate and area scaling
- Future – calibrated modeling

\[
\text{Runoff area} \times \text{EMC} = \text{Load}
\]
Loading information continues to improve - PCBs

2000
- 76 kg
- Large rivers 54%
- Small tributaries 43%

2010
- 53 kg
- Large rivers 21%
- Small tributaries 47%
- In-Bay erosion 27%
Loading information continues to improve - Hg

- **2000**
  - 1,334 kg
  - Large rivers 46%
  - Small tributaries 9%
  - Guadalupe 4%

- **2010**
  - 1068 kg
  - Large rivers 20%
  - Small tributaries 18%
  - Guadalupe 13%
Mercury speciation - Guadalupe

- HgD(%) = 15%
- MeHgT(%) = 2%
Mercury speciation – Urban Zone 4 Line A

- HgD(%) 59%
- MeHgT(%) 15%
Mercury particle size relations

Total Mercury (mg/kg)

Grain Size (mm)
Knowledge for managers:

Tracking and abating - the PCB example
### Tracking and abating: What did we use PCBs for?

<table>
<thead>
<tr>
<th>Category</th>
<th>Metric t used in the Bay Area</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Completely&quot; closed systems</td>
<td>7,400 (60%)</td>
<td>Large transformers, fluorescent light ballasts</td>
</tr>
<tr>
<td>Nominally closed systems</td>
<td>1,200 (10%)</td>
<td>Vacuum pumps, consumer appliances</td>
</tr>
<tr>
<td>Open-ended</td>
<td>3,700 (30%)</td>
<td>Waxes, caulking compounds, plasticizers</td>
</tr>
</tbody>
</table>
Tracking and abating: What did we use PCBs for?

- Old factory transformers
- PG&E facilities
- Household appliances
- Floor polish
- Caulking
- Fluorescent light ballast
Tracking and abating: How can we identify PCBs at their source?

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arochlor</td>
<td>Monsanto</td>
</tr>
<tr>
<td>Asbestol</td>
<td></td>
</tr>
<tr>
<td>Askarel</td>
<td></td>
</tr>
<tr>
<td>Bakota</td>
<td></td>
</tr>
<tr>
<td>Chlorextol</td>
<td>Allis-Chalmers</td>
</tr>
<tr>
<td>Hydol</td>
<td></td>
</tr>
<tr>
<td>Inerteen</td>
<td>Westinghouse</td>
</tr>
<tr>
<td>N0-Flamol</td>
<td></td>
</tr>
<tr>
<td>Pyranol</td>
<td>General Electric</td>
</tr>
<tr>
<td>Saf-T-Khol</td>
<td></td>
</tr>
<tr>
<td>Therminol</td>
<td></td>
</tr>
</tbody>
</table>
Tracking and abating: PCBs still in **legal** use

<table>
<thead>
<tr>
<th>Company</th>
<th>Address</th>
<th>City</th>
<th>Number of transformers</th>
<th>Mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USS-POSCO Industries</td>
<td>900 Loveridge RD.</td>
<td>Pittsburg</td>
<td>105</td>
<td>203802</td>
</tr>
<tr>
<td>Quebecor Printing San Jose, Inc.</td>
<td>696 East Trimble Road</td>
<td>San Jose</td>
<td>5</td>
<td>32094</td>
</tr>
<tr>
<td>NASA</td>
<td>Ames Research Center</td>
<td>Moffett Field</td>
<td>17</td>
<td>7052</td>
</tr>
<tr>
<td>Gaylord Container Corp</td>
<td>2301 Wilbur Ave.</td>
<td>Antioch</td>
<td>2</td>
<td>6078</td>
</tr>
<tr>
<td>General Chemical</td>
<td>510 Nichols Road</td>
<td>Pittsburg</td>
<td>3</td>
<td>4800</td>
</tr>
<tr>
<td>Rhodia Inc.</td>
<td>100 Mococo Road</td>
<td>Martinez</td>
<td>3</td>
<td>2807</td>
</tr>
<tr>
<td>NASA Ames Research Center</td>
<td>M/S 218-1; Building N229, Room 156</td>
<td>Moffett Field</td>
<td>2</td>
<td>1916</td>
</tr>
<tr>
<td>Pacific Custom Materials, Inc.</td>
<td>9000 Carquinez Scenic Dr.</td>
<td>Port Costa</td>
<td>2</td>
<td>1590</td>
</tr>
<tr>
<td>DOT Maritime Administration Suisun Bay Reser</td>
<td>2595 Lake Herman Rd.</td>
<td>Benicia</td>
<td>3</td>
<td>1048</td>
</tr>
<tr>
<td>Hollywood Park Land Company, LLC</td>
<td>4 Embarcadero Center, Suite 3300; Grandstand Building at Tunnel #4 Inside C-Vault Electrical Room</td>
<td>San Francisco</td>
<td>1</td>
<td>927</td>
</tr>
<tr>
<td>Hollywood Park Land Company, LLC</td>
<td>1200 Park Place, Suite 200; Grandstand Building at Tunnel #4 Inside C-Vault Electrical Room</td>
<td>San Mateo</td>
<td>1</td>
<td>927</td>
</tr>
<tr>
<td>Macaulay Foundry, Inc.</td>
<td>811 Carleton St.</td>
<td>Berkley</td>
<td>1</td>
<td>913</td>
</tr>
</tbody>
</table>
### Tracking and abating: Mapping sediment / soil contamination

<table>
<thead>
<tr>
<th>Number of sites in patch</th>
<th>PCB concentration (mg/kg)</th>
<th>Patch description (centroid x-streets)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Minimum</td>
</tr>
<tr>
<td>6</td>
<td>3.45</td>
<td>0.00</td>
</tr>
<tr>
<td>5</td>
<td>3.37</td>
<td>0.00</td>
</tr>
<tr>
<td>99</td>
<td>2.70</td>
<td>0.00</td>
</tr>
<tr>
<td>9</td>
<td>1.72</td>
<td>0.15</td>
</tr>
<tr>
<td>11</td>
<td>1.49</td>
<td>0.00</td>
</tr>
<tr>
<td>40</td>
<td>1.37</td>
<td>0.00</td>
</tr>
<tr>
<td>42</td>
<td>0.89</td>
<td>0.00</td>
</tr>
<tr>
<td>49</td>
<td>0.86</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>0.80</td>
<td>0.35</td>
</tr>
<tr>
<td>54</td>
<td>0.74</td>
<td>0.00</td>
</tr>
<tr>
<td>14</td>
<td>0.65</td>
<td>0.00</td>
</tr>
<tr>
<td>12</td>
<td>0.44</td>
<td>0.03</td>
</tr>
<tr>
<td>8</td>
<td>0.41</td>
<td>0.00</td>
</tr>
<tr>
<td>4</td>
<td>0.36</td>
<td>0.00</td>
</tr>
<tr>
<td>10</td>
<td>0.29</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Tracking and abating: How do PCBs to get into stormwater or wastewater?
Tracking and abating: Institutional controls?

- Changes to laws
- Clean up of illicit waste dumps
- Industrial inspection and education programs
- Clean up of contaminated sites
  - Enforcement actions
  - Volunteer
- Building demolition and remodeling
  - Public buildings
  - Private

- Caulking
- Light ballast
- Wall coverings ceiling tiles
- Floor wax
- Floor finish
- Heavy electric wiring
- Lift motors
- Paint
- Appliances
Tracking and abating: Better treatment control design

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hg</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2 min</td>
<td>3%</td>
<td>12%</td>
<td>7%</td>
</tr>
<tr>
<td>&lt;20 min</td>
<td>10%</td>
<td>28%</td>
<td>17%</td>
</tr>
<tr>
<td><strong>PCB</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2 min</td>
<td>14%</td>
<td>46%</td>
<td>31%</td>
</tr>
<tr>
<td>&lt;20 min</td>
<td>27%</td>
<td>72%</td>
<td>53%</td>
</tr>
</tbody>
</table>
Take home messages

• Sediment information is improving and remains the basis for estimation and tracking contaminants

• Sediment grainsize influences the quality of the sediment resource and our ability to manage contamination

• Monitoring takes different tools and effort and each watershed scale

• Hg is found on small particles and in dissolved phase under lower flow conditions

• Source control shows promise for PCBs (and Hg) - treatment control may be more suitable for PCBs
Next steps

2011
1. Watershed loads reconnaissance study
   - Pick 16 watersheds
     - Distributed amongst the county programs
     - Old industrial areas
     - Imperviousness
2. Complete a literature review and EMC based spreadsheet model

2012
3. Resume loads monitoring a selected watersheds
4. Further EMC model development
Acknowledgements

• **Funding**
  – Regional Monitoring Program for Water Quality in SF Bay (RMP)
  – Prop 13 Stormwater Non-point Source Program
  – Santa Clara Valley Water District (SCVWD)
  – Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)
  – Alameda County Flood Control and Water Conservation District

• **Collaborations**
  – Bay Area Stormwater Management Agencies Association (BASMAA)
  – Geosyntec (Oakland office)

• **Contributing SFEI authors**
  – Don Yee
  – Nicole David
  – Jon Leatherbarrow (late)
  – Alicia Gilbreath
  – Michelle Lent
  – Kat Ridolfi
  – Data management group