Existing Knowledge of PCB Delivery Pathways
Objective

• Summarize all known information on the magnitudes of various PCB loading pathways
  – upstream Lake Coeur d’Alene, WWTPs, stormwater, groundwater, tributaries
• Reconcile Task Force estimate of loads with that of prior Ecology assessment Serdar et al (2011)
• Assess how much is known about “unknown” loads
Reconciling Serdar with Recent Studies

• Results of Ecology 2011 loading assessment appear much different than recent Task Force studies – e.g. 57% of the load is unknown

• Why?
Reconciling Serdar with Recent Studies

Loading Pyramid

• Serdar loading assessment was summarized in terms of a pyramid
Reconciling Serdar with Recent Studies
The Pie Chart

- Serdar loading pyramid has been condensed into a pie chart
Reconciling Serdar with Recent Studies
Deconstructing the Pie Chart

• Back-calculate unknown load by reach

<table>
<thead>
<tr>
<th>Reach</th>
<th>In-River Load (mg/day)</th>
<th>External Load (mg/day)</th>
<th>Unknown Load (mg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stateline</td>
<td>477</td>
<td>2.9+65+45=112.9</td>
<td>537.5 -477 -112.9 = -52.4</td>
</tr>
<tr>
<td>Upriver</td>
<td>537.5</td>
<td>690</td>
<td>1413 -690 -537.5 =185.5</td>
</tr>
<tr>
<td>Monroe</td>
<td>1413</td>
<td>194</td>
<td>2281 -141 - 194 =6 74</td>
</tr>
<tr>
<td>Nine Mile</td>
<td>2281</td>
<td>97</td>
<td>3664 -2281 -97 = 1286</td>
</tr>
<tr>
<td>Long Lake Dam</td>
<td>3664</td>
<td></td>
<td>2093.1</td>
</tr>
</tbody>
</table>

Total

2093.1
Deconstructing the Pyramid

- Numbers in pyramid directly translate to numbers in pie chart

<table>
<thead>
<tr>
<th>Category</th>
<th>Load (mg/day)</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stormwater</td>
<td>690</td>
<td>19%</td>
</tr>
<tr>
<td>Municipal and Industrial</td>
<td>306.9</td>
<td>8%</td>
</tr>
<tr>
<td>Idaho</td>
<td>477</td>
<td>13%</td>
</tr>
<tr>
<td>Tributaries</td>
<td>97</td>
<td>3%</td>
</tr>
<tr>
<td>Unknown</td>
<td>2093.1</td>
<td>57%</td>
</tr>
<tr>
<td>Total</td>
<td>3664</td>
<td></td>
</tr>
</tbody>
</table>

### In-River Load Breakdown

<table>
<thead>
<tr>
<th>Reach</th>
<th>In-River Load (mg/day)</th>
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<tr>
<td>Monroe</td>
<td>1413</td>
<td></td>
<td>1413-690+537.5=185.5</td>
</tr>
<tr>
<td>Nine Mile</td>
<td>2281</td>
<td>97</td>
<td>2281-141+194=674</td>
</tr>
<tr>
<td>Long Lake Dam</td>
<td>3664</td>
<td></td>
<td>3664-2281-97=1286</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3664</strong></td>
<td></td>
<td><strong>2093.1</strong></td>
</tr>
</tbody>
</table>
Reconciling Serdar with Recent Studies
Summary Comparison

• Why are there differences from the Task Force findings?
  – Spatial domains don’t match
    • Majority of Serdar unknown load occurs outside of area considered by Task Force studies
  – Seasonal periods don’t match
  – Sampling methodology doesn’t match
Reconciling Serdar with Recent Studies
Spatial Domains Don’t Match

• Serdar
  – State line to Long Lake Dam
  – Instream load estimates at:
    • Upriver Dam, Monroe St. and Nine Mile

• Task Force
  – 2014: Lake Coeur d’Alene to Nine Mile
  – 2015: Barker Rd. to Spokane USGS Gage
  – 2018: Barker Rd. to Nine Mile
  – Instream load measurements at:
    • Barker Rd. Mirabeau, Plante’s Ferry, Greene St.
Reconciling Serdar with Recent Studies
Comparison to 2014 SRRTTF

2014 SRRTTF

Idaho

Washington

Spokane County = 105

City of Spokane = 105

Kaiser = 135

USGS Gage 2 = Latah Creek

918 + Trent + Barker

80 = Inland Empire

Unknown Load

 unspecified

-6

-52

181

186

674

1286

Serdar

Spokane River

Liberty Lake WWTP = 2.9

Inland Empire = 45

Upper Dams (RM 80.2)

Mooroe Street (Upper Falls Dam RM 74.5)

Spokane WWTP = 194

Little Spokane River = 97

Niamele Dam (RM 58.1)

Long Lake Dam (RM 33.9)
Reconciling Serdar with Recent Studies
Comparison to 2015 SRRTTF
Reconciling Serdar with Recent Studies
Comparison to 2018 SRRTTF
Reconciling Serdar

- Side-by-side comparison of four primary studies

<table>
<thead>
<tr>
<th>River Location</th>
<th>Unknown Load from 2014 Synoptic</th>
<th>Unknown Load from 2015 Synoptic</th>
<th>Unknown Load from 2018 Data</th>
<th>Unknown Loads from Serdar Pyramid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake CdA</td>
<td>-0.56</td>
<td>Not Assessed</td>
<td>Not Assessed</td>
<td>-52.4</td>
</tr>
<tr>
<td>Post Falls</td>
<td>-13.45</td>
<td>3.24</td>
<td>-0.44</td>
<td></td>
</tr>
<tr>
<td>Barker</td>
<td>180.69</td>
<td>131.48</td>
<td>129.91</td>
<td></td>
</tr>
<tr>
<td>Trent</td>
<td>-5.95</td>
<td>-22.15</td>
<td>-41.61</td>
<td>185.5</td>
</tr>
<tr>
<td>Greene</td>
<td>-4.02</td>
<td>-40.45</td>
<td>-45.45</td>
<td></td>
</tr>
<tr>
<td>USGS Gage</td>
<td>Not Assessed</td>
<td>Not Assessed</td>
<td>51.39</td>
<td>674</td>
</tr>
<tr>
<td>Nine Mile</td>
<td>Not Assessed</td>
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</tbody>
</table>
Reconciling Serdar

- The majority of the unknown Serdar load occurs outside of the Task Force study area
  - Apples to oranges
- Task Force studies consistently conclude a large groundwater source between Barker and Trent
- Serdar shows larger unknown load downstream of Upriver Dam
Reconciling Serdar with Recent Studies Comparing Observed Concentrations

- Serdar has higher upstream concentration
  - >100 vs. 20 pg/l
  - Explains absence of unknown load in Barker-Trent region
- Serdar has much higher concentration at Nine Mile
  - Explains larger unknown load in downstream reach
Potential Explanations for Remaining Discrepancies

• Things have changed since 2003-2004

• Unknown loads vary seasonally
  – Serdar sampled Fall through Spring; Task Force in August
  – Task Force monthly monitoring results could be interpreted as supporting an additional unknown load
    • Consistently higher load at Nine Mile than sum of upstream sources
    • Study not designed to assess mass balance

• Monitoring methods aren’t comparable
Summary of Existing Loading Pathways

• Re-visit Comprehensive Plan assessment of wastewater loads
• Supplement with more recent Task Force work
Summary of Existing Loading Pathways
Summary of Existing Loading Pathways

- Key unknowns
  - Contribution of sources up-gradient of Kaiser
  - Groundwater/other interactions between Plante’s Ferry and Greene St.
  - Groundwater loading between Greene St. and USGS gage
  - Groundwater loading USGS gage and Nine Mile
  - Wet weather loading
Key Unknowns
Contribution of Sources Up-Gradient of Kaiser

• Analysis conducted in 2018
• Samples from Kaiser Plume and River Wells are similar and dominated by a pattern that resembles Aroclor 1248
• Largest contributor to the background wells resembles Aroclor 1254, and also appears in River Wells
• Rough estimate exists of load from up-gradient wells, but confounded by spikiness of data PCB
Key Unknowns
Contribution of Sources Up-Gradient of Kaiser

• Next steps identified in 2017
  – See what results of 2018 synoptic survey showed
    • No evidence of groundwater loading at Mirabeau
  – See what results of 2018 biofilm sampling showed
Key Unknowns
Groundwater/Other Interactions between Plante’s Ferry and Greene St.

- Mass balance shows consistent results across synoptic surveys
  - Loss of di- through tetra-homologs
  - Gain of penta- through hepta-homologs
Key Unknowns
Groundwater/Other Interactions between Plante’s Ferry and Greene St.

• Three theories have been proposed
  – Preferential loss of lower-chlorinated homologs
    • Transport to groundwater
    • Volatilization at Upriver Dam
  – Groundwater interaction more complicated than currently assumed
Key Unknowns

Groundwater/Other Interactions between Plante’s Ferry and Greene St.

• Groundwater interaction more complicated than assumed
• Mass balance approach currently assumes that a losing reach is purely losing

• More complicated flow pattern could confound mass balance
Key Unknowns
Groundwater Loading between Greene St. and USGS Gage

- Analysis conducted in 2018
- Samples from Kaiser Plume and River Wells are similar and dominated by a pattern that resembles Aroclor 1248
- Largest contributor to the background wells resembles Aroclor 1254, and also appears in River Wells
- Rough estimate exists of load from up-gradient wells, but confounded by spikiness of data PCB
Key Unknowns
Groundwater Contribution Downstream of Greene St.

- Homolog-specific mass balances
- Less consistent patterns seen from Greene St. to Nine Mile
  - Gain of penta- homolog between Green and USGS Gage
  - Only one year of data for USGS Gage to Nine Mile
Summary of Existing Loading Pathways