Four Corners States Biomonitoring Consortium: 
The Benefits and Challenges of a Multi-state Biomonitoring Program

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Arizona Colorado New Mexico Utah
Why?

• 4-State Power
  – Total population is 16.9 million people
  – Living in 797 cities, towns or villages
  – With a population range of 24 people to 1,445,632
  – Sitting within 271.7 million acres of land
  – With similar residential, occupational, socio-economic, demographic and environmental concerns

• Similar Regional Problems
  – 35% of land is in agriculture with over 92,500 farms and ranches
  – 33% of land is forested areas
  – 7 shared aquifers
  – 884 active mines, 471 active mine processing plants, and 119,000 abandoned mines
  – 730 CERCLIS sites, 57 NPL sites, and 735 TRI sites
Why?

• **Experience and Desire**
  – Environmental Public Health Tracking Network
  – Collaboration desirable to enhance depth of professional resources

• **Efficiency**
  – 4-state public health labs collaborating
  – 4-state environmental epidemiology programs collaborating
Goal

• Apply combined resources of the PH Environmental laboratories and environmental epidemiology programs of the 4-states to address persistent EH concerns common to the 4-states

  • Develop and enhance regional collaboration between states’ laboratories and environmental epidemiologists to implement biomonitoring activities relevant to state and regional needs
  • Develop increased capability and capacity to conduct biomonitoring in the region
  • Complement on-going PHEP/CT activities
  • Complement on-going EPHTN activities
  • Science based knowledge about environmental exposure to respond to PH concerns in the region
  • Empower communities, public health policy makers, state legislatures to make science-based PH policy & programs to mitigate health concerns

• **Evaluation Criteria:**
  
  – 14 chemicals/groups evaluated
  – Hypothesized known health effects
  – Number of people exposed or plausibly exposed
  – Capacity for intervention
  – Synergistic objectives with PHEP/CT grant
  – Level of public concern or perceived need
  – Input from PH partners
  – Feasibility for study
  – Balance between addressing public exposure concerns and establishing on-going surveillance systems
### Surveillances Needs

<table>
<thead>
<tr>
<th>Contaminant of Concern</th>
<th>Analytes of Interests</th>
<th>Related Health Outcome</th>
<th>Public Health Surveillance Justification</th>
<th>Population</th>
<th>Expected Public Health Actions or Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routine PH surveillance</td>
<td>Heavy metals in ground drinking water</td>
<td>Arsenic, Mercury, Uranium, Cadmium, Manganese, Selenium</td>
<td>cancer; central and peripheral neuropathy; cardiovascular damage/disease; kidney damage; osteomalacia; electrolyte imbalance;</td>
<td>Previous ground water inventory testing has indicated that ground water in these states can have high concentrations for some or all of these metals. Some states have no or limited requirements for regular testing of private owned drinking water wells that are using ground water.....</td>
<td>Statewide and high risk population targeted sampling. High risk population based on known suspected regions of heavy metal contamination.</td>
</tr>
</tbody>
</table>

### Emerging PH concern

<table>
<thead>
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<th>Public Health Surveillance Justification</th>
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<th>Expected Public Health Actions or Outcomes</th>
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</thead>
<tbody>
<tr>
<td>2,4-D domestic use herbicide</td>
<td>2,4-DCP</td>
<td>cancer; adverse birth outcomes</td>
<td>The four-corner state residential areas are typically single unit dwellings with large yards dominated by lawns and gardens. 2,4-DCP absorbs through the skin...</td>
<td>Statewide sampling</td>
<td>States will use this data to exemplify cautions regarding residential use of herbicides. Science-based policy making: May use data to support regulation of 2,4-D....</td>
</tr>
<tr>
<td>p-DCB (1,4-DCB) containing disinfectants, deodorants and pesticides</td>
<td>2,5-DCP</td>
<td>weight gain and obesity; possibly type 2 diabetes, insulin resistance; chronic fatigue</td>
<td>2,5-DCP is a byproduct of a number of waste treatment and industrial processing activities. 2,5-DCP can also be absorbed through the skin or by ingestion. In acute high dose exposures, 2,5-DCP is cytotoxic by disrupting the cellular ability to manufacture ATP.</td>
<td>Statewide sampling</td>
<td>Science-based policy making: States may use this data to support regulation of 2,5-DCP containing products in environments that can lead to dermal exposure or ingestion...</td>
</tr>
<tr>
<td>pyrethroid containing pesticides used near residential areas</td>
<td>3-PBA and more</td>
<td>neurotoxicity</td>
<td>Pyrethroid pesticides are used domestic insect control. The nationwide emergency of West Nile Virus lead to increased use of pyrethroids in residential area for mosquito abatement...</td>
<td>Statewide sampling</td>
<td>Science-based health education and intervention actions by public health. States will use this data to adjust advisory levels...</td>
</tr>
<tr>
<td>Phthalates</td>
<td>Metabolites of phthalates (16)</td>
<td>Possibly: breast cancer; endocrine disruption; asthma; adverse reproductive outcome; obesity.</td>
<td>Phthalates are a collection of dialkyl or aryl esters derived from phthalic acid. Phthalates are used in a large variety products including plastic manufacturing, pharmaceuticals...</td>
<td>Statewide sampling</td>
<td>Provide a basis for public inquire. Science-based health education and intervention actions by public health....</td>
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<tr>
<td></td>
<td>1st Year</td>
<td>2nd Year</td>
<td>3rd Year</td>
<td>4th Year</td>
<td>5th Year</td>
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<td>Phthalates Metabolites</td>
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<td>2,4-DCP</td>
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<tr>
<td></td>
<td>2,5-DCP</td>
<td>2,5-DCP</td>
<td>2,5-DCP</td>
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<td>2,5-DCP</td>
</tr>
<tr>
<td></td>
<td>Pyrethroid metabolites</td>
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</tr>
</tbody>
</table>
Organize!
Consortium Communication - How?

Essential for building a team:

• Conference calls every 2-4 weeks
• Biannual face to face meetings at each 4 states throughout the years
  - discuss progress
  - discuss challenges
  - brainstorm solutions to problems
  - plan next steps
  - hear from chemists and epidemiologists from each state
Divide and Conquer

**Laboratory**
- Training for analytical methods
- QA/QC, standardize, and validate methods
- Maintain analytical equipment
- Participate in PT programs
- CLIA
- Interstate shipping
- Assist in sample collection
- Report results to epi

**Epidemiology**
- Institutional Review Board (IRB)
- Participant enrollment process
- Exposure assessment tools
- Data collection and management system
- Process for reporting results back to participants
- FAQ for exposures and health concerns
Who does what?

Metals
Pyrethroid Metabolites
Creatinine

Metals
Arsenic Speciation
2,4-DCP & 2,5-DCP
Creatinine

Metals
Arsenic Species
Phthalate
Metabolites
Creatinine

Metals
Pyrethroid Metabolites
<table>
<thead>
<tr>
<th>Analyte</th>
<th>Technique</th>
<th>Equipment Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metals</td>
<td>ICP-MS</td>
<td>Perkin Elmer ELAN DRC II Perkin Elmer NexION</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agilent 7500</td>
</tr>
<tr>
<td>As-Speciation</td>
<td>HPLC-ICP-MS</td>
<td>Agilent LC-7500 ICP-MS Perkin Elmer ELAN DRC II</td>
</tr>
<tr>
<td>Phthalate Metabolites</td>
<td>LC-MS/MS</td>
<td>Applied Biosystems API 4000</td>
</tr>
<tr>
<td>2,4-DCP 2,5-DCP</td>
<td>LC-MS/MS</td>
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</tr>
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<td>Pyrethroid Metabolites</td>
<td>LC-MS/MS</td>
<td>Agilent1260 LC Agilent6460 MSMS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Applied Biosystems API 4000</td>
</tr>
</tbody>
</table>
The Big POINT: All states utilized PHEP/Chemical Threat Equipment and existing laboratory equipment!

No major equipment purchased with Biomonitoring grant funds.
Where?
Communities sampled (UT):

- Petersboro
- Mendon
- Salt Lake
- Mosquito Abatement
- Redmond
- Duchesne
- Roosevelt
- Castle Valley
- Moab
- Blanding
- Bluff
- White Mesa
- Saratoga Springs
- Poca
- Sevier County
- Monticello/Eastland
- Beaver
- Spanish Fork
Partnerships

- Council of Local Environmental Health Administrators
- Epidemiology Affiliate Group
Partnership with White Mesa Utes
# State Progress

<table>
<thead>
<tr>
<th>State</th>
<th>Number of participants/urine samples</th>
<th>Number of water samples</th>
<th>Number of communities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>207</td>
<td>207</td>
<td>11</td>
</tr>
<tr>
<td>Colorado</td>
<td>205</td>
<td>125</td>
<td>1</td>
</tr>
<tr>
<td>New Mexico</td>
<td>283</td>
<td>218</td>
<td>4</td>
</tr>
<tr>
<td>Utah</td>
<td>365</td>
<td>124</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>1060</td>
<td>674</td>
<td>35</td>
</tr>
</tbody>
</table>
Summary statistics for Metals

<table>
<thead>
<tr>
<th>Measure</th>
<th>Arsenic</th>
<th>Cadmium</th>
<th>Manganese</th>
<th>Mercury</th>
<th>Selenium</th>
<th>Uranium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threshold of Concern (μg/L) [see note for MCL and SMCL]</td>
<td>10</td>
<td>5</td>
<td>50</td>
<td>2</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>Number of Samples for Consortium</td>
<td>269</td>
<td>269</td>
<td>257</td>
<td>257</td>
<td>269</td>
<td>243</td>
</tr>
<tr>
<td>Number of Samples with Measurable Levels</td>
<td>204 (75.8%)</td>
<td>6 (2.2%)</td>
<td>97 (36.1%)</td>
<td>2 (0.8%)</td>
<td>71 (26.4%)</td>
<td>142 (58.4%)</td>
</tr>
<tr>
<td>Number of Samples with Levels above Threshold of Concern</td>
<td>31 (11.5%)</td>
<td>0</td>
<td>12 (4.5%)</td>
<td>0</td>
<td>0</td>
<td>3 (1.2%)</td>
</tr>
<tr>
<td>Arithmetic Mean Level (μg/L)</td>
<td>6.01</td>
<td>0.14</td>
<td>15.54</td>
<td>0.08</td>
<td>1.38</td>
<td>3.22</td>
</tr>
<tr>
<td>Sample 95\text{th} Percentile (μg/L)</td>
<td>17.16</td>
<td>0.25</td>
<td>30.56</td>
<td>0.13</td>
<td>4.40</td>
<td>12.70</td>
</tr>
</tbody>
</table>
## Summary statistics for Metals

<table>
<thead>
<tr>
<th>Urine Samples</th>
<th>Arsenic</th>
<th>Cadmium</th>
<th>Manganese</th>
<th>Mercury</th>
<th>Selenium</th>
<th>Uranium</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHANES 95th Percentile for All Population (µg/g) [see note NHANES]</td>
<td>50.4</td>
<td>0.907</td>
<td>0.548</td>
<td>1.75</td>
<td></td>
<td>0.029</td>
</tr>
<tr>
<td>NHANES 95th Percentile for Children (µg/g) [see note NHANES]</td>
<td>91.2</td>
<td>0.235</td>
<td>0.633</td>
<td>1.62</td>
<td></td>
<td>0.031</td>
</tr>
<tr>
<td>NHANES 95th Percentile for Adults (µg/g) [see note NHANES]</td>
<td>49.7</td>
<td>0.977</td>
<td>0.545</td>
<td>1.95</td>
<td></td>
<td>0.029</td>
</tr>
<tr>
<td>Number of Samples for Consortium</td>
<td>533</td>
<td>424</td>
<td>424</td>
<td>533</td>
<td>316</td>
<td>533</td>
</tr>
<tr>
<td>Number of Samples with Measurable Levels</td>
<td>431 (80.%)</td>
<td>277 (65.3%)</td>
<td>216 (50.9%)</td>
<td>317 (59.5%)</td>
<td>313 (99.1%)</td>
<td>306 (57.4%)</td>
</tr>
<tr>
<td>Number of Samples with Levels above NHANES 95th Percentile</td>
<td>20 (3.8%)</td>
<td>113 (26.7%)</td>
<td>125 (29.5%)</td>
<td>13 (2.4%)</td>
<td>20 (3.8%)</td>
<td></td>
</tr>
<tr>
<td>Geometric Mean Level (µg/g)</td>
<td>8.6</td>
<td>0.360</td>
<td>0.341</td>
<td>0.26</td>
<td>41.6</td>
<td>0.019</td>
</tr>
<tr>
<td>IQR Range (µg/g)</td>
<td>4.25</td>
<td>0.151</td>
<td>0.154</td>
<td>0.152</td>
<td>37.1</td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>17.18</td>
<td>0.544</td>
<td>0.647</td>
<td>0.456</td>
<td>81.8</td>
<td>0.031</td>
</tr>
</tbody>
</table>
Sample Shipment

To date: 1,680 samples shipped to and from 4CSBC labs

We followed protocols from LRN-SPaSE training and from compliance training for Safe Transport of Division 6.2 materials and dry ice.
Benefits and Challenges
Benefits to the Lab

Create regional capacity:

- Distribute workload, avoid overload on one state
- Build upon unused lab capacity (CT)
- State scientists develop strong relationship, learn from each other
- Share experiences with others
- Share research, training, troubleshoot experiences
- Help each other as needed
- Additional learning through interactions with each other and with epis’
Benefits to the Region

Create regional capacity:

- 4 states functioning as a team with unified regional goals while meet individual state goals
- New biomonitoring capability and capacity
- New Collaboration established
Challenges

• *Results Return and Risk Management - What is the Best way?*
  – Mail
  – Email
  – Telephone
  – Face to face
  – Other?
Document Sharing: 4CSBC

Shared Drive
The 4CSBC

The state public health agencies of Arizona, Colorado, New Mexico, and Utah organized the “Four Corners States Biomonitoring Consortium” (4CSBC), to apply combined resources of the public health environmental laboratory and environmental epidemiology programs of the four states, to address persistent environmental health concerns that are common to the four states. The 4CSBC has adopted some of the framework developed by the Rocky Mountain Biomonitoring Consortium (2001-2008), of which all the 4CSBC states were members.

The primary objective of the 4CSBC is to generate science-based information that will lead to relevant public health policy to address several Healthy People 2020 Environmental Health objectives to improve air quality, ensure safe drinking water, reduce pesticide exposure, and reduce exposure to metals including arsenic, cadmium and mercury.

The 4CSBC plans to use data collected through this biomonitoring project to:

1. develop and enhance regional collaboration between the states’ laboratories and environmental epidemiologists to implement...
Data Management

- What/Where/who
- Laboratory results
- Survey results
- Individual state/consortium
  - Laboratory
  - Respective state environmental epidemiologist
  - Utah

- Reporting levels
  - Individual
  - Summary

- Sharing data
Other Challenges

– Establishing partnerships may take longer than realized
– Seasonal samples are a challenge
– Lab readiness and epi-collection times may not always align
– Distribution of funds
– Coordination and monitoring of activities among states
– Sharing data outside state boundary
Acknowledgement and Disclaimer

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