Biosolids: Putting Regulators & Researchers in Touch with YOU ... the Practitioner
January 18 & 19, 2011
CWEA

Biosolids Research – Where are We Going?
Alan Hais, Program Director
What are the issues?

- Metals – mostly behind us
- Pathogens – a current focus, but being overshadowed by trace organics
- Trace organics – a real “hot button”
- Big cities vs. rural communities
- Minority opposition – organized & vocal but still relatively localized
- Climate change/sustainability/energy concerns – will it drive future practice?
Trends

- Is land application increasing?
  - 20 states report that land application is increasing
  - 25 states report no increase in land application
  - 5 states not heard from

- Overall numbers show % of biosolids recycled relatively constant over the last 10 years
Past and Ongoing WERF Biosolids Projects

- 50+ completed projects
  - Valued >$17 million
- 10 ongoing projects and Research Challenges
  - Valued >$4 million
- >30% of WERF research portfolio
- > 50% when include “optimization” research
Today’s Presentation

- Recently completed WERF research
- Ongoing research
  - “Legacy” projects
  - Research Challenges
    - Pathogen risk assessment and communications
    - Optimization
    - Trace organics
Research Reports
Recently Published

• Protocol for the Timely Investigation of Reported Health Incidents Associated with Biosolids Applied to Land (06HHE5PP)
• Fate of Estrogenic Compounds During Municipal Sludge Stabilization and Dewatering (04HHE6)
• Evaluation of Best Management Practices for Sustainable Groundwater Protection at Biosolids Land Application Sites (05CTS5T)
Protocol for the Timely Investigation of Potential Health Incidents Associated with Biosolids Applied to Land

- Top ranked priority from Biosolids Research Summit;
- Applicable to all soil amendments, including commercial fertilizers and animal manures
- Draft protocol published 2008
- Most likely users are local and state health agencies (coordinated w/responsible environmental agencies)
Protocol for the Timely Investigation of Potential Health Incidents Associated with Biosolids Applied to Land (cont’d)

Investigation Guide

- Health questionnaire
- Site identification
- Biosolids generator questionnaire
- Biosolids applier questionnaire
- Report of on-site inspection
Pilot Testing: Epidemiologic Surveillance and Investigation of the Illness Reported by Neighbors of Biosolids Land Application and other Soil Amendments
What success will look like

- Field-tested protocol local, state and federal officials to effectively responded reports of symptoms associated with land application (available 2Q 2011)
- Widespread and sustained use of the protocol to collect a large sample of quality, unbiased, and standardized data on that could be used to design studies to improve our understanding of the relationship between land application of biosolids and other soils amendments and alleged health effects
Fate of Estrogenic Compounds During Municipal Sludge Stabilization and Dewatering

- Evaluate the fate of estrogenic and other trace organic compounds through commonly used sludge and solids treatment processes
- Chemical Analysis
  - Anthropogenic wastewater indicators (59 compounds)
  - Pharmaceuticals (24 compounds)
  - Hormones (19 compounds)
- Two types of bioassay
Fate of Estrogenic Compounds During Municipal Sludge Stabilization and Dewatering

- 4 study plants – 33 sample points
  - Thickening
  - Stabilization
  - Chemical conditioning
  - Dewatering (centrifugation)
  - Composting & pelletization
- Good information, but difficulty closing mass balances
- More estrogenicity in solids than effluent, but overall reduction across the entire plant

- Evaluate effectiveness of land application BMPs to mitigate potential risk of groundwater contamination
- Apply recent improvements in risk assessment methodologies and compare monitoring data with risk assessment predictions
- Product is a computerized tool to calculate a site-specific hazard index for metals regulated metals in Part 503
- Can be expanded to evaluate other chemicals
Continuing Research on Regrowth, Odors and Sudden Increase (ROSI)

- Evaluation of Bacterial Pathogen and Indicator Densities After Dewatering of Anaerobically Digested Biosolids (04CTS3T)
- Biosolids Processing Modifications for Cake Odor Reduction (03CTS9T)
- Evaluation of Aluminum and Iron Addition During Conditioning and Dewatering for Odor Control (03CTS9a)
- Effect of Aluminum and Iron on Odors, Digestion Efficiency and Dewatering Properties (03CTS9b)
- Web-based Biosolids Odor Reduction Decision Tool (03CTS9c)
Biosolids Odor Reduction Roadmap Tool
Wastewater Treatment Plant Design and Operations Modifications to Improve Management of Biosolids Odors and Sudden Increases of Indicator Organisms (SRSK4T08) – Phase 1

- Develop a method for enumerating non-culturable fecal coliform and *E. coli* and evaluate if the destruction of these organisms are representative of pathogenic *Salmonella* (including time-temperature curves in Phase 2)

- Evaluate odorants other than total volatile organic sulfur compounds (TVOSCs)

- Develop a mechanistic understanding of odor and pathogen reduction methods wherever possible or practical
Wastewater Treatment Plant Design and Operations Modifications to Improve Management of Biosolids Odors and Sudden Increases of Indicator Organisms (SRSK4T08) – Phase 2

- Evaluate effect of biosolids processing and upstream parameters on odors, SI, and regrowth to develop new approaches and solutions
- Field-test new approaches and solutions
- To be completed by end of 2011; interim results available along the way
Applying Advances in Pathogen Risk Assessment to Land Application of Biosolids & Communicating the Results (SRSK2R08, SRSK3R08)

- Facilitate use of biosolids pathogens risk assessment methodologies to make them generally available to users at the local, state and national level
- Develop an integral methodology for risk communications methodology to be applied simultaneously
- Products available 1Q & 2Q 2011
Spreadsheet Microbial Assessment of Risk: Tool for Biosolids (SMART Biosolids)

- Respond to local issues and select appropriate sites (e.g. formulate setback requirements)
- Respond to unanticipated exposures
- Priority is on flexibility
  - Spreadsheets are more easily modified than compiled programs
  - But require some training and knowledge
Pathways of Exposure

1. Inhalation of aerosols
2. Consumption of groundwater
3. Incidental ingestion of biosolids in soil
4. Ingestion of plants grown on biosolids-amended fields
5. Consumption of surface water
## Site specific assessments

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface water</td>
<td>Wet weather events</td>
</tr>
<tr>
<td>Air</td>
<td>Setback distance</td>
</tr>
<tr>
<td>Direct ingestion</td>
<td>Scenarios of possible concern</td>
</tr>
</tbody>
</table>
Example 1: Interpreting Indicators

- It rains after an application
- Did biosolids contaminate a pond?
- Realistically monitoring for pathogens is difficult and expensive
- Run model
  - Input soil type, slope, distance to pond, biosolids application amount, etc.
Surface Water Recreation Risk

- Risk < 1:10^4: Acceptable
- Risk > 1:10^4: Concern

(Regli et al., 1991; Annual risk of infection)

Risk > 1:10^4
- => Concern

Risk < 1:10^4
- => Acceptable
Strategic Risk Communications

- A purposeful process of effective interaction with stakeholders
  - Identify key stakeholders and developed hypotheses
  - Conduct Mental Models Research
  - Develop guidance, communications plans and materials
- Enable decision makers and stakeholders to make well-informed decisions
Case Study Applications
Tulsa Biosolids Team: Stakeholder Map

Audiences

Active Interests

Decision-Makers/Regulators

Transactors

Land Owners*

Near Neighbors*

*High priority for the purpose of the case study opportunity.
VA Biosolids Team: Stakeholder Map

**Audiences**
- National Public
- Community Citizens
- University Researchers
- WERF
- WEF
- Green Sustainability Planners/Groups
- Other Utility And City Depts.
- Developers
- Local Media
- National Biosolids Partnership
- University Ag Ext.
- Local Elected Officials
- Employees
- Contractors
- Wastewater Utility Mgt.
- State DEQ
- State/Local Public Health Depts.*
- National Biosolids Partnership
- EPA
- State OH&S
- Governor
- Land Owners
- ENGO-Local Chapters:
- Organic food industry
- Other End Users
- Food producers
- Food Consumer
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**Near Neighbors**
- Communities through which Biosolids are transported
- County Monitors
- State OH&S
- Governor
- Land Owners
- ENGO-Local Chapters:
- Organic food industry
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- Food producers
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*High priority for the purpose of the case study opportunity.*
Communications Plan

Key Elements of Tulsa Plan:
- Frame bio solids as a beneficial product.
- Process for communicating with neighbors about biosolids land application.
- Pre-test draft process and materials.
- Guidance on risk communications with landowners.

Key Elements of VA Plan:
- Coordinate among key biosolids partners.
- Guiding principles for stakeholder engagement.
- Recommendations on current VBC materials.
- Draft signage.
Beneficial Use of Biosolids

This field is benefiting from biosolids produced and land applied by the City of Tulsa.

Approximate Date of Application: March 31, 2010

Please stay off this field while the sign is posted.

For more information about the City of Tulsa Biosolids Program, please visit our website at www.cityoftulsa.org/biosolids or contact us at (918) 596-9453.
“Optimization” Challenge

Energy Management

Resource Recovery

Solids Volume Reduction

- Assessment of domestic & international practices
- Technical, capital cost and O&M cost information for numerous technologies in various stages of development
- Uses “triple bottom line” approach to look at social, economic and environmental considerations
Examples of Ongoing “Optimization” Activities

- Integrated methods for wastewater treatment plant upgrading
- Co-digestion of organic waste & wastewater solids
- Processes to reduce waste activated sludge volumes
- Nitrifying fuel cell for sustainable wastewater treatment
- Greenhouse nitrogen emissions from wastewater treatment
Trace Organics

The problem

- Trace organics is today’s hot topic – food supplies, drinking water, ambient water, ecosystems
- Expensive and hard to measure
- New chemicals on a daily basis
- Health and environmental effects not well understood
- Since wastewater solids concentrate contaminants, the numbers look high
- EPA survey found pharmaceuticals, steroids and flame retardants in all samples – some in ppm range, but could not speculate on the significance
Trace Organics

The reality

- Biosolids are a “secondary source”
- Human exposure through biosolids likely to be minimal
- Ecological effects likely the greatest concern (bioaccumulation)
- Some degradation may occur at treatment plant, but source control likely will be needed if risks are significant
- Need definitive answers, not speculation and extrapolation
- Research is expensive and time consuming
WERF Research Initiative – Evaluation of Fate and Exposure for Trace Organics in Biosolids-Amended Soils

- Requested by WERF subscribers
- Data needed for exposure/risk assessment regulatory decisions
Trace Organic Chemicals in Biosolids-Amended Soils
State-of-the-Science Review
(SRSK5T08)
### Table ES-3. Summary of Data Availability for the High Priority Trace Organic Chemicals.

<table>
<thead>
<tr>
<th>Chemical Class</th>
<th>Occurrence</th>
<th>Mobility</th>
<th>Persistence</th>
<th>Bioavailability</th>
<th>Toxicity</th>
<th>Microbial Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brominated Flame Retardants (BFRs)</td>
<td>Tier 3</td>
<td>Tier 1</td>
<td>Tier 1</td>
<td>Tier 2</td>
<td>Tier 0</td>
<td>Tier 0</td>
</tr>
<tr>
<td>Perfluorochemicals (PFCs) and PFC Precursors</td>
<td>Tier 1</td>
<td>Tier 2</td>
<td>Tier 1</td>
<td>Tier 0</td>
<td>Tier 0</td>
<td>Tier 0</td>
</tr>
<tr>
<td>PPCPs: Antimicrobials</td>
<td>Tier 3</td>
<td>Tier 2</td>
<td>Tier 3</td>
<td>Tier 3</td>
<td>Tier 0</td>
<td>Tier 1</td>
</tr>
<tr>
<td>PPCPs: Antibiotics</td>
<td>Tier 3</td>
<td>Tier 2</td>
<td>Tier 1</td>
<td>Tier 0</td>
<td>Tier 2</td>
<td>Tier 0</td>
</tr>
<tr>
<td>PPCPs: Musks</td>
<td>Tier 3</td>
<td>Tier 2</td>
<td>Tier 3</td>
<td>Tier 2</td>
<td>Tier 1</td>
<td>Tier 0</td>
</tr>
<tr>
<td>PPCPs: Other</td>
<td>Tier 3</td>
<td>Tier 0</td>
<td>Tier 0</td>
<td>Tier 0</td>
<td>Tier 2</td>
<td>Tier 0</td>
</tr>
<tr>
<td>Plasticizers</td>
<td>Tier 3</td>
<td>Tier 2</td>
<td>Tier 0</td>
<td>Tier 0</td>
<td>Tier 1</td>
<td>Tier 0</td>
</tr>
<tr>
<td>Steroidal Chemicals</td>
<td>Tier 3</td>
<td>Tier 2</td>
<td>Tier 1</td>
<td>Tier 0</td>
<td>Tier 2</td>
<td>Tier 0</td>
</tr>
<tr>
<td>Surfactants</td>
<td>Tier 3</td>
<td>Tier 2</td>
<td>Tier 0</td>
<td>Tier 0</td>
<td>Tier 1</td>
<td>Tier 0</td>
</tr>
</tbody>
</table>

### Generic Interpretation of Data Availability:

<table>
<thead>
<tr>
<th>Tier 0</th>
<th>Essentially no data were available of this type for this class or subclass of TORCs, including data that could be used for modeling.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1</td>
<td>For the majority of TORCs in this class or subclass, some data were available, but available data are likely of limited utility or are limited to modeled systems only (i.e., not directly derived from experimental studies).</td>
</tr>
<tr>
<td>Tier 2</td>
<td>Useful data from experimental systems are available for a majority of TORCs in this class or subclass, but most of the data are not directly applicable to biosolids-amended soils.</td>
</tr>
<tr>
<td>Tier 3</td>
<td>Substantial data of this type directly relevant for biosolids-amended soils are available, though some gaps in data may exist for specific TORCs. For this class or subclass of TORCs, data are available that have been measured in real world systems with biosolids-borne TORCs and reasonable biosolids application rates, and/or in long-term field-based studies with appropriate attention to study design and QA/QC.</td>
</tr>
</tbody>
</table>
Trace Organics in Biosolids
New WERF Research Challenge

- Exploratory Team formed
- Challenge Statement: Define the data needs and develop data for the fate, transport and toxicity of selected trace organics/emerging contaminants in biosolids-amended soils in order to inform risk assessments and support risk management decisions by wastewater utilities, land appliers, manufacturers and regulatory agencies.
Trace Organics in Biosolids
New WERF Research Challenge

- Collaborative effort with wastewater utility partners (MWRDGC, DC-Water, HRSD, Austin) and EPA
- EPA Database and Prioritization Tool will narrow the list of chemicals and data needs; will help define scope and coverage of research
  - Data from WERF State-of-the-Science Review
  - Additional data from short-term WERF study - seeking partners for funding & data
    - Manufacturers
    - Databases – REACH, HPV, others
    - Gray literature
Trace Organics in Biosolids
New WERF Research Challenge

- Additional funding from various stakeholders
  - Wastewater utilities (WERF subscribers and others)
  - Industry (PhRMA, ACI, ACC and others)
  - Federal agencies – USEPA, USGS, others?
- A multi-year, multi-million dollar study
- Cost-sharing is essential
For additional information, please contact:

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