NATIONAL biosolids PARTNERSHIP

Recognizing A Resource:

biosolids

A Roadmap for State & Regional Biosolids Coordinators

and other interested parties

Part 3: Trends & Drivers – Focusing on *Resource Recovery*

This and the other parts of this presentation are available at http://www.wef.org/Biosolids/page.aspx?id=7522

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Audience

This presentation is intended for:

- U.S. EPA biosolids program staff
- U.S. EPA regional biosolids coordinators
- State biosolids regulatory agency staff (e.g. state biosolids coordinators)
- Managers of biosolids
- Wastewater treatment facility staff
- Biosolids program design engineers
- Distributers & users of biosolids products
- Other interested parties

Purpose

This presentation is intended to:

- Summarize the history and current status of federal and state biosolids regulations in the United States (U.S.)
- Summarize the state of the science & experience with biosolids management
- Summarize current trends & what can be expected in the future

So that all involved in setting policy & regulations and implementing biosolids management programs *recognize this resource.*

Sustainable biosolids management requires maximizing the utilization of resources in biosolids and minimizing landfill disposal & combustion without energy recovery.

Contents

This presentation, produced by the National Biosolids Partnership, consists of the following 3 parts:

NATIONAL biosolids PARTNERSHIP

Charting the Future

A workshop & 2011 report convened by the National Biosolids Partnership

"How can solids managers prepare for the future, positioning their programs to both address the current and emerging challenges and leverage opportunities?"

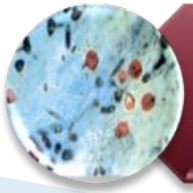
The *Charting the Future* Discussion

Regulation and Policy

Technology

Operations and Management

Communications & Training



Research

Charting the Future

Overall Drivers Influencing Biosolids Trends

- Strong public support for environmental stewardship
- Scrutiny of land application, incineration, and landfilling
- More stringent wastewater, biosolids, and air regulations
- Increased value for soil amendment, fertilizer, and renewable energy

Charting the Future: Findings

- **Regulation & Policy-**
  - Increasingly stringent & complex
  - Some state regulations are diverging from Part 503
  - Creates uncertainty for biosolids management programs
  - Regulations need to catch up on current management options, such as co-digestion
  - Some regulations driven by pubic perceptions
  - Need improved communications, including cross-media (e.g. air & water departments)
  - State biosolids coordinators & regulatory programs need support & training, such as regulator workshop
- **Technology –**
  - Increasing diversity and complexity of treatment techniques and technologies
  - New technologies are creating opportunity
  - Driven by stronger sustainability issues (e.g. greenhouse gas emissions, finite supply of phosphorus)
  - Research needed on cost-benefits, efficiencies of energy and resource recovery from biosolids
- **Operations & Maintenance –**
  - Aging infrastructure; needs for continual maintenance
  - Increasing complexity of technologies and work environments
  - Increasing diversity of operations, including electricity generation, etc.
  - Increasing need to collaborate and interact with outside parties (e.g. electric utilities, public-private partnerships)
  - Ongoing need to effectively communicate with stakeholders & public about solids management
- **Communications & Training**
  - Public perception frequently drives regulatory policy (strong science is not enough!)
  - Proactive communications about solids management is required; continue to move away from reactive
  - Operate with best practices and make high quality products
  - Communication research findings, both old and new
  - Retiring expertise
  - Recruiting, training
- **Research**

Charting the Future

Our Changing View of Solids Management

Sludge Disposal

Biosolids Beneficial Use

Bioenergy

Resource Recovery

1970 1993 2000 2005 2010

Charting the Future

Our Changing View of Beneficial Use

1991:

"Beneficial Use means any application of sludge on land specifically designed to take advantage of the nutrient and other characteristics of this material to improve soil fertility or structure and thereby further some natural resource management objective."

Proposed 2007:

"Putting a particular biosolids product to its best and highest use by maximizing the utilization of nutrients, organic matter, moisture, and/or other qualities – including extracting the maximum amount of energy possible."

Source: NEBRA, 2007

Charting the Future

Our Changing View of Wastewater Treatment Plants

There is growing awareness that wastewater treatment plants are not waste disposal facilities or polluters, but rather water resource recovery facilities that produce clean water, recover nutrients (such as phosphorus and nitrogen), and have the potential to reduce the nation's dependence upon fossil fuel through the production and use of renewable energy.

Charting the Future

What's in municipal biosolids?

- **Water** ~ 5% (heat dried pellets) to ~ 95% (liquid biosolids)
- **Organic matter** ~ 20% to 70% dry weight biological molecules from foods, human waste, runoff, etc., including lipids, proteins, sugars, starches, etc., dissolved and suspended, *which contain…*
- **Nutrients** ~ 12% dry weight N, P, K, Ca, Fe, & micro-nutrients (Cu, Zn, etc.)
- **Binding Sites** reducing bioavailability of Pb, As, etc.
- **Energy** ~ 5,000-10,000 Btu/d lb. (when dry, similar to low grade coal)

Also:

- Inert sand, silt, grit, and synthetic particles
- Trace elements (mostly in compounds)
- Pathogenic micro-organisms
- Synthetic and natural organic chemical compounds (e.g. including polymers)

Charting the Future

What's ideal for sustainability?

MAXIMIZE *RESOURCE RECOVERY* OF CONSTITUENTS

Constituent	Benefits	Concerns
Water	valuable in agriculture in arid climate	cost of transport
Organic matter	vital to soils	putrescible, odors
Nutrients	food for soil, plants & animals	impacts to water
Energy	renewable, displaces oil/gas	air emissions, maybe no use of nutrients & organic matter

MINIMIZE POTENTIAL RISKS OF CONSTITUENTS

Reduce/control/mitigate trace elements (e.g. metals), pathogens, synthetic and natural organic chemical compounds

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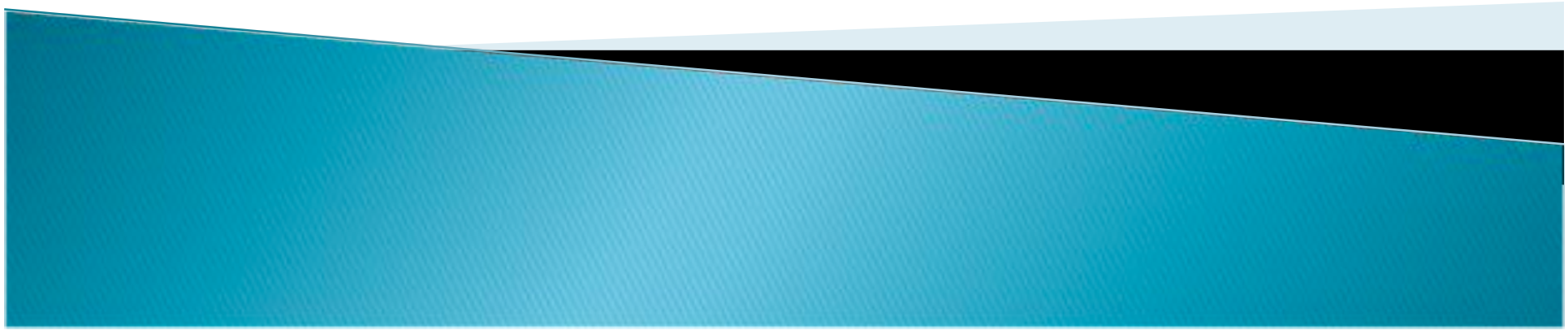
Trends and Drivers

Regulation and Policy



Regulation & Policy

Status of federal & state regulations

- **EPA considers the Part 503 Rule to be mature & stable:**
  - the highest-risk concerns have been addressed (heavy metals, many chemicals of concern, pathogens, radioactivity, nutrients, stability, odors, etc.)
  - EPA continues to reduce involvement – fewer staff, end of funding for state regulator workshop and National Biosolids Partnership
  - EPA continues some monitoring & evaluation of emerging concerns
- **State biosolids regulatory programs have been advancing and many are also mature and stable, while others continue to develop.**
- **Many states now take the lead in regulating biosolids.**
- **State regulatory programs need support & ongoing training on emerging issues, as well as history** (e.g. the annual regulator workshop helped address this need in the past and is needed in the future).

Regulation & Policy

However, there are challenges that limit resource recovery.

- **Increasingly stringent & complex regulations**
- **Some state regulations are diverging from Part 503**
- **These create uncertainty for biosolids management programs**
- **Regulations need to catch up on current management options, such as co-digestion**
- **Some regulations are driven by pubic perceptions**
  - Many regulatory agencies are not providing much education about biosolids management.
  - There are continuing intermittent and generally local challenges to land application, incineration, and other biosolids management activities.
  - Biosolids managers are left with responsibility for providing outreach & education about biosolids.
  - Need improved intra- and inter-agency communications, including cross-media (e.g. air & water departments)

(See more on communications & training, below.)

Regulation & Policy

The odor challenge

- **Public perception** of biosolids management will continue to be closely associated with odors from processing, handling, and end use/disposal.
- **Odor concerns** drive state and local regulatory activities, including odor management plans and, in some locales, “zero tolerance” approaches to biosolids odors.
- In addressing this issue, biosolids managers note that compliance with Part 503 does not necessarily mean that product odor will be acceptable and suggested that modifications to current stabilization criteria might be warranted.
- In the meantime, **adherence to best management practices** and self-enforcement on odor management are critical!

Regulation & Policy

What's at stake?

Failure to proactively manage current biosolids concerns (odors, phosphorus (P), microconstituents, emerging pathogens, overall public perception,) **and regulate them appropriately, with flexibility that does not create obstacles, could substantially negatively impact biosolids management in the future.**

This could mean:

- An even more fragmented, state-by-state regulatory framework that increasingly drifts from the federal Part 503 baseline
- The introduction of more restrictive management practices such as fence line setbacks and incorporation requirements; increased risk & liability
- Greater uncertainty around the viability of technology and programmatic choices
- Substantially greater complexity associated with obtaining and maintaining management options
- A substantial increase in management costs that results in more biosolids sent to landfills without resource recovery

Maximum *resource recovery* from biosolids will only be possible if such concerns are addressed.

Regulation & Policy

How biosolids managers and regulators can help

Communication – and coordination – will become increasingly important – with researchers, conservation groups, and other stakeholders. Be sure to communicate with EPA departments and state level agencies/departments that have not historically been involved in biosolids management, but are now getting involved.

- For example, EPA Office of Air & Radiation was relatively unfamiliar with unique issues associated with wastewater solids incineration in the U.S. when it developed the new 2011 SSI regulations.

- Understandably, similar issues can arise at the state level.

- Cross media issues will continue to complicate the biosolids regulatory landscape.

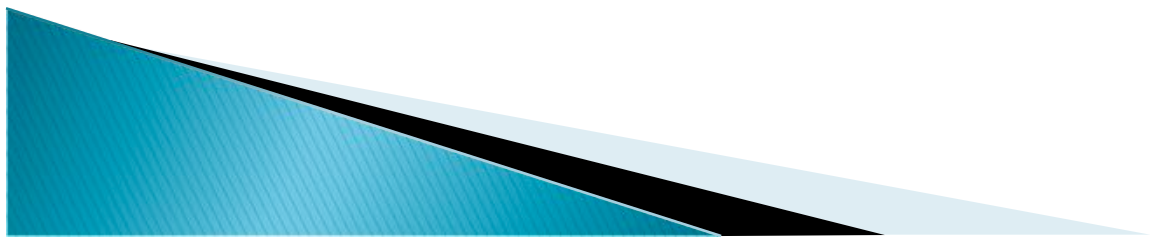
Regulation & Policy

How biosolids managers and regulators can help

- As the biosolids sector increasingly deals with cross-media regulatory impacts, it will be critical to **emphasize the concept of "maximum environmental benefit"** in regulatory development.

- Biosolids managers should **encourage development of a multi-agency regulatory coordination strategy,** including a comparative risk, cross-media approach to regulatory development.

- Biosolids managers and other experienced professionals will need to **work with regulators** as new products emerge from wastewater and biosolids processing, and questions arise as to how (or if) those products should be regulated.



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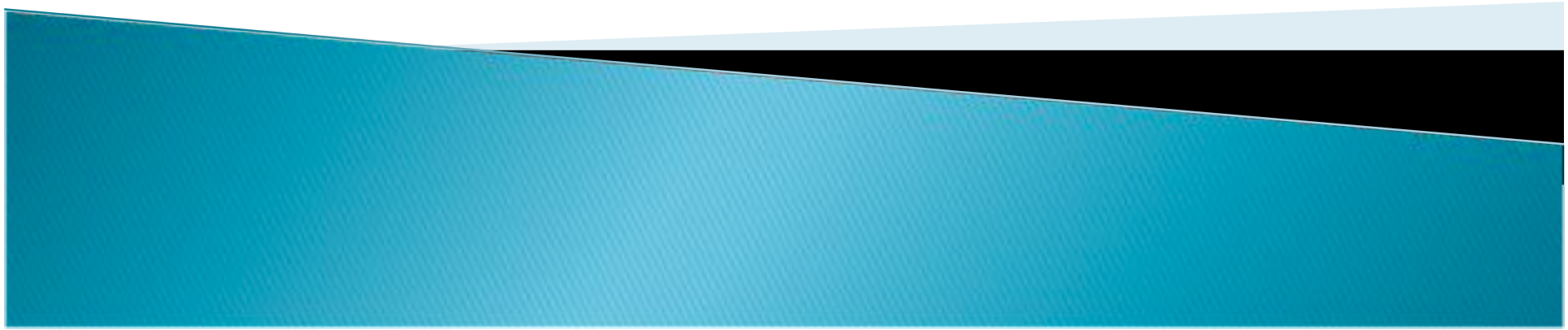
Trends and Drivers

Technology



Technology is responding to drivers, resulting in:

- Integrated wastewater and solids treatment
- High quality marketable biosolids products
- Energy recovery from solids
- Sustainable environmental stewardship
- Continued options for biosolids management

Technology

Technologies today are producing higher quality products and recovering more energy from biosolids.

Thickening

Anaerobic Digestion

Dewatering

Biosolids

Compost

Soil Amendment

Drying

Fertilizer

Gasification

Ash

Dewatering

Incineration with Energy Recovery

Ash

Technology

What's new?

Improved technologies for higher quality solids.

- **Finer influent screens**
- **Thickened-sludge screens**
- **Protection of downstream equipment**

Photo Courtesy of Huber

Technology

What's new? Improved Composting

- **Enclosed batch reactors**
- **Membrane covers**
- **Better odor control**

Photos Courtesy of Engineered Compost Systems

Moncton, NB

Technology

What's new? More & improved dryer options

Making more marketable products for fertilizer or combustion uses.

Low Temperature Belt Dryer
Barcelona, Spain

Rotary Drum, Direct Dryer
Carlsbad, CA

Technology

What's New? Improved dewatering technologies

- **Belt filter presses and centrifuges were the dominant mechanical dewatering technologies for many years.**
- **These have been improved, and new technologies have spread in the past decade:**
  - Rotary drum press
  - Rotary screw press (inclined or horizontal)
  - Solar drying with mechanized turner
- **Choice of dewatering technology can result in savings by…**
  - maximizing cake solids
  - reducing need for maintenance/operator attention
  - reducing recycle loadings
  - reducing electricity consumption
  - reducing polymer dosage
  - containing odors.

Technology

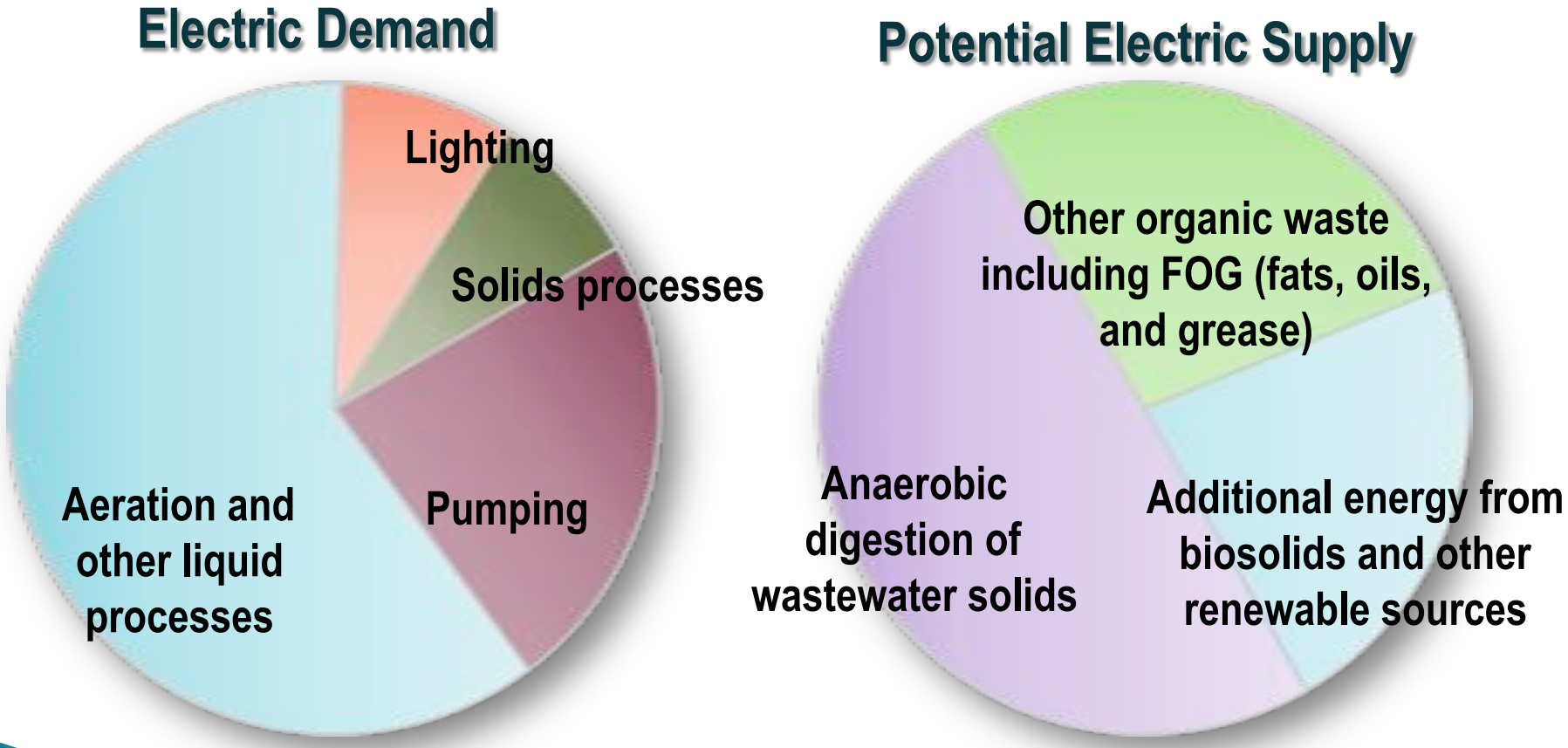
What's new? More energy from wastewater

Energy derived from wastewater treatment is being recognized as a renewable energy resource. Energy generated from water resource recovery processes can include:

- **Digester gas (biogas)** – electrical energy, heat, or biomethane [digester gas consists mainly of methane (natural gas) and carbon dioxide]
- **Thermal conversion** (combustion, incineration) – Electrical energy and heat. Includes electrical energy and heat from biosolids products used by other entities (e.g., pellets used in power plants, cement kilns, or industrial furnaces)
- **Heat pump** – Heating or cooling energy using plant influent or effluent as heat source or sink
- **Hydropower** – capturing some of the kinetic energy in flowing wastewater

Technology

One way wastewater treatment plants can meet their electricity demands

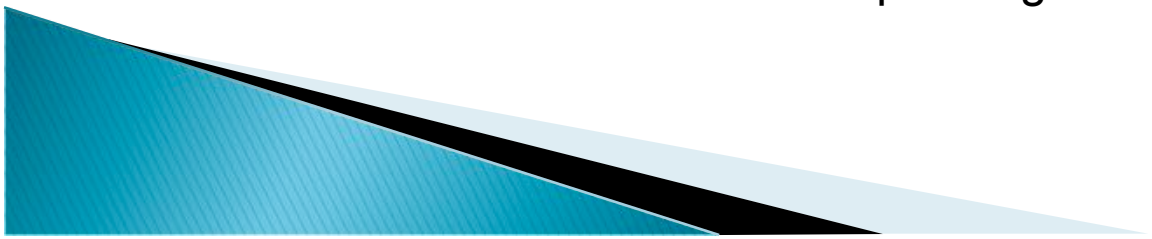


Source: David L. Parry, CSWEA, Oct. 2010

Technology

Anaerobic Digestion (AD)

- Anaerobic digestion decomposes and stabilizes organic material in the absence of oxygen, and produces biogas that consists mainly of methane (natural gas) and carbon dioxide.
- Anaerobic digestion is recognized by EPA as an accepted technology for biosolids stabilization allowing its beneficial use as fertilizer or energy production.
- Numerous facilities employ anaerobic digestion to achieve waste solids reduction and stabilization.
- Anaerobic digestion has much lower energy costs than aerobic digestion, another prevalent solids stabilization technology, because it does not require oxygen.
- A typical anaerobic digestion system converts 35 to 50 percent of the biomass into biogas, thus reducing downstream energy and hauling costs by reducing the volume of biosolids to be handled post-digestion.



Technology

The potential of AD & biogas use

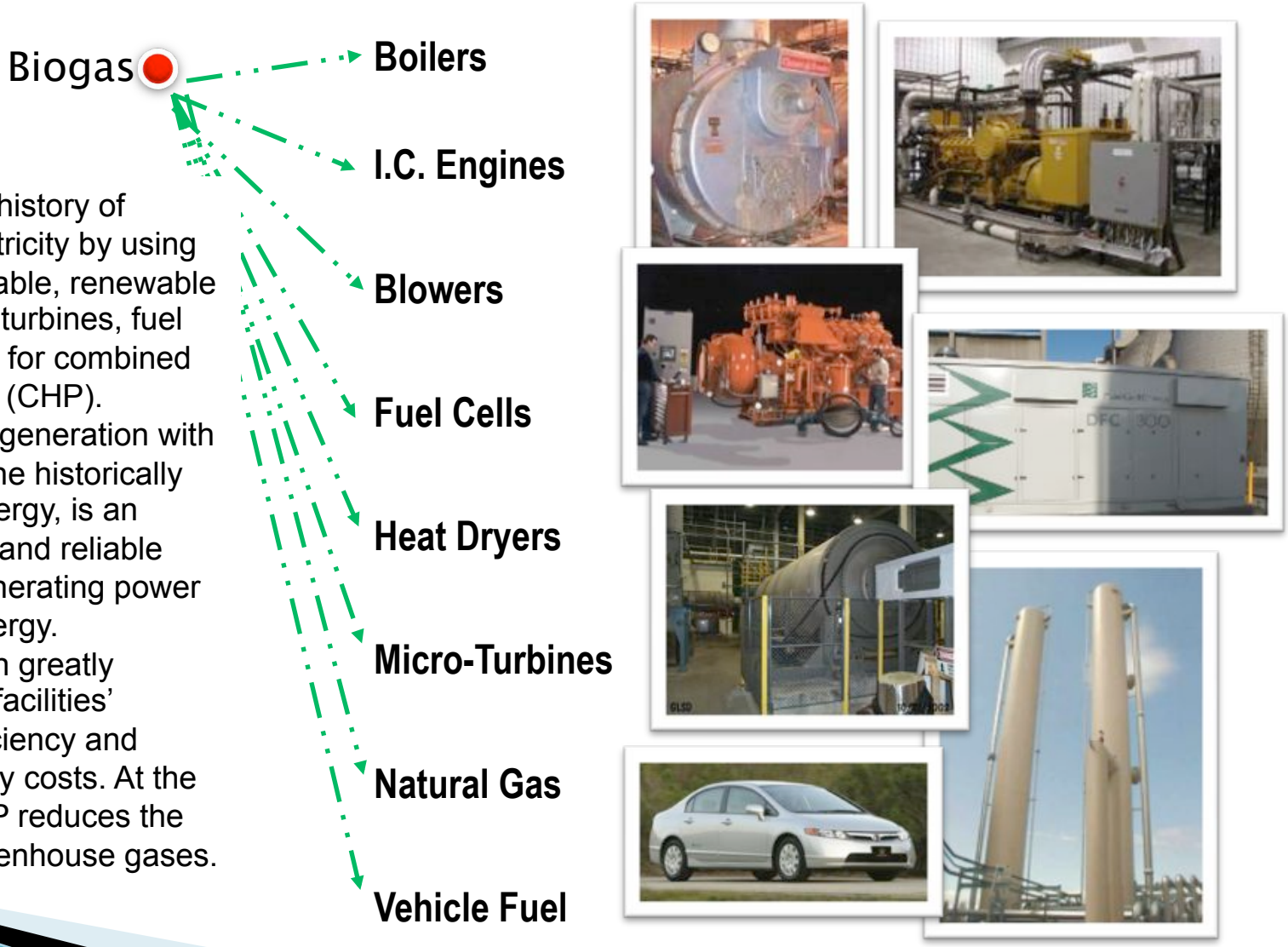
3%	Approximate total of U.S. electricity consumption used by water and wastewater operations (~100 billion kWh annually)
35%	Amount of municipal energy consumption used by water / wastewater systems
~17,000	POTWs in the U.S. (< 4000 produce 90%+ of U. S. solids)
40,000,000,000	Gallons of wastewater treated in the U.S. every day
8,000,000	Approximate amount of dry tons of biosolids generated per year by U.S. POTWs
730,000	Amount of cars equivalent to offset emissions if digestion facilities installed energy recovery*
600	MW of CHP Potential from POTWs over 1 MGD*

**EPA CHPP, 2007 and January 2011 (Draft)*

Technology

Renewable energy from biogas

- There is a long history of generating electricity by using biogas as a reliable, renewable fuel in engines, turbines, fuel cells, as well as for combined heat and power (CHP).
- CHP, electricity generation with the capture of the historically wasted heat energy, is an efficient, clean, and reliable approach to generating power and thermal energy.
- Biogas CHP can greatly increase many facilities' operational efficiency and decrease energy costs. At the same time, CHP reduces the emission of greenhouse gases.



Technology

What's New? Optimizing AD!

- Enhanced mixing
- Continuous feeding
- High solids loading
- High rate mesophilic
- High temperature (thermophilic)
- Separate phases (e.g. acid gas, staged meso-thermo)
- Extended solids retention times
- Solids pretreatment (e.g. hydrolysis)
- Co-digestion

Technology

Technologies to increase digestion performance, biogas production, dewatering performance, and biosolids quality

Examples:

- Thermal Hydrolysis (with pasteurization)
- Biological Hydrolysis (Acid Phase Digestion)
- Mechanical Hydrolysis
- Chemical Hydrolysis

CAMBI thermal hydrolysis installation near London, UK

Technology
Co-digestion

- **Greenhouse Gas Emissions Mitigation** – Avoids the release of methane from landfills that occur from food decomposition and contributes on-site electrical generation of renewable energy, offsetting conventional fossil fuel generated electrical energy use.

- **Economic Benefits** – Using available digestion capacity for co-digestion enables cost recovery from producing on-site power, collecting a tipping fee, and reducing maintenance costs associated with collection systems.

- **Diversion Opportunities** – Municipalities are investing to divert organic materials away from landfills. Water resource recovery facilities offer the opportunity to accept food waste (14 percent of the total municipal solid waste stream in the U.S) to generate renewable energy.

- **Provides solution for FOG management** – Wastewater treatment plants are impacted by fats, oils, grease (FOG) blocking sewers. Removing it a its source (e.g. restaurant grease traps) and feeding it to anaerobic digesters protects sewers, the WWTP, and boosts energy production.

Technology

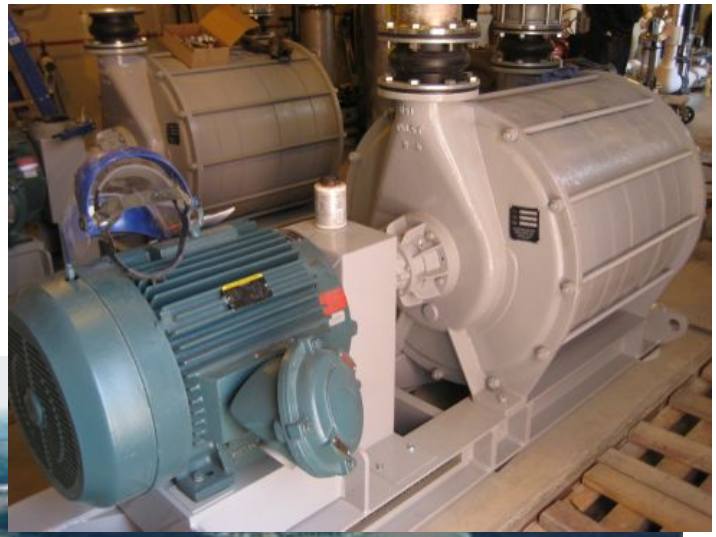
FOG control ordinances can be key…

Installed AGRD

Typical grease trap

- Most require installation of some kind of grease trap with basic BMPs
- More cutting edge ordinances include:
  - Restaurants must install/upgrade to Automatic Grease Recovery Devices (AGRDs) within 3 years
  - AGRDs ensure daily recovery, dewatered grease, easy collection
  - AGRDs must be serviced & inspected every 90 days
  - All recovered FOG must be beneficially reused

Co-Digestion Example: Des Moines, IA



Other well-known co-digestion programs:

East Bay MUD, Oakland, CA (large facility)
Gloversville-Johnstown, NH (mid-size)
Essex Junction, VT (small)

Technology

Co-digestion presents challenges too

- Where is preprocessing of added waste done? Off-site? On-site? Is the waste pumpable? Truckable?
- Need to control and monitor incoming wastes / may need to establish permit program
- Pretreatment of wastes may be needed to remove debris and protect equipment
- Must ensure sufficient digester capacity
- Potential for process upsets – need to provide uniform feed
- There may be effects on biosolids and their dewaterability, other treatment processes, and end use
- There may be effects on the nutrient content in side-stream
- There is odor potential at receiving area and during maintenance
- Public outreach is needed to ensure public support of this form of recycling.

Technology

Of course, there are barriers to biogas use

- The most significant barriers to biogas use are economic:
  - higher priority demands on limited capital resources
  - perceptions that economics do not justify investments
- Outside agents like power utilities can be barriers
- Air permitting can be a significant barrier in specific geographies/permitting situations
- Public agencies' decision-making practices often hinder biogas use

See the WERF report: *Barriers to Biogas Use for Renewable Energy*
http://www.werf.org/a/ka/Search/ResearchProfile.aspx?ReportId=OWSO11C10
…and the follow-up document "Reframing the Economics of Combined Heat & Power Projects" (available from WERF)

Technology

Overcoming barriers to biogas use

- Use alternative feedstocks to increase biogas production
- Consolidate solids handling
- Re-frame economics – use more complex & accurate modeling
- Investigate alternative sources of funding
- Simplify O&M
- Highlight risk of status quo to decision-makers
- Leverage current relationships with third parties
- Use chemical precipitation of phosphorus or deammonification or other solutions to sidestream and other technical issues
- Having a project project champion helps!
- State & federal policy should create incentives (e.g. renewable portfolio standards, renewable energy credits) and reduce unnecessary regulations that impede projects.

See the WERF fact sheet on overcoming barriers to biogas use: http://www.werf.org/WERFDownload.aspx?ContentKey=96058379-ed4b-4ae8-82da-a59bb749bf2b&ContentItemKey=183879fc-4dfc-4dc4-81d7-f0727e954afc

Technology

What's New? Removing N & P

- **Nitrogen and phosphorous recovery at the treatment plant**
- **Turning a struvite problem into a resource**
- **Reducing side-stream loading on Biological Nutrient Removal (BNR) process streams**
- **Protecting effluent quality**
- **Creating better nutrient balance in biosolids products**
- **Implementing may require federal and/or state regulatory updates**

Photo Courtesy of Ostara

Technology

Thermal conversion (combustion)

- The process of converting biosolids to energy is either through anaerobic digestion as presented above or through thermal conversion.
- Thermal oxidation (incineration), the complete oxidation of organics (biomass) to carbon dioxide and water in the presence of excess air, is a well-established technology.
- Other methods, such as gasification and pyrolysis, are emerging technologies.

Technology

What's New in Thermal Conversion?

- Improved emission controls
- Increased energy recovery
- Different combustion technologies
- Emerging gasification & pyrolysis technologies

Technology

Pyrolysis & Gasification

• **Pyrolysis** is a thermal process that uses high temperature and pressure in the absence of air to decompose organic material in the biosolids into gas, liquid, and solid (or char). The process yields a product that can be pelletized into solid fuel which can be used with coal in power plants. Currently, pyrolysis has limited application for biosolids, but the future for potential energy recovery is promising.

- **Gasification** is the partial oxidation of organics (biomass) and conversion to carbon monoxide, hydrogen, and methane (syngas) in the presence of limited air. This process powered coal gas lights in the 1700s and has been used for decades in Europe and Japan for converting biomass to energy. It is an emerging technology in the U.S., limited to one or two operating facilities.

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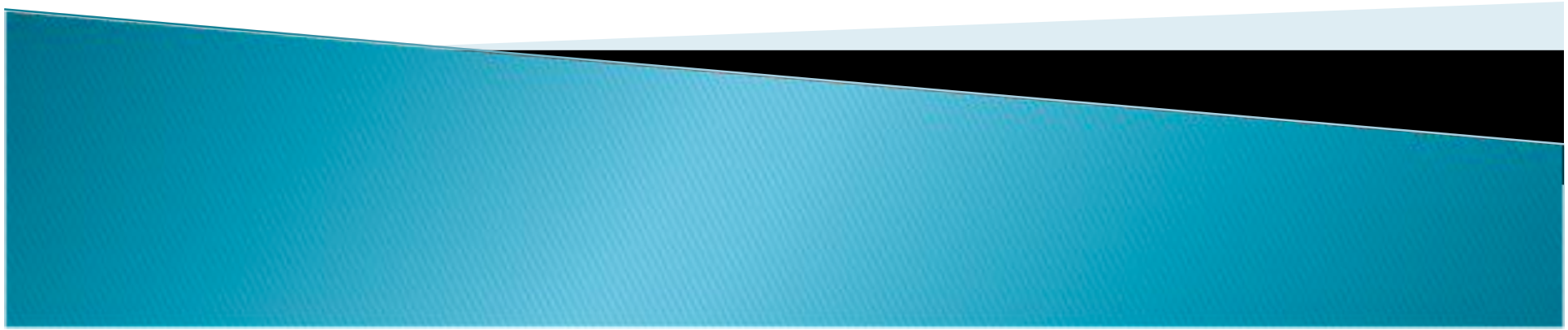
Trends and Drivers

Operations & Maintenance



Operations & Maintenance – Drivers and Trends

- **Private Enterprise** (e.g. working with biosolids contractors, energy utilities)
- **ESCOs** (working with energy services companies)
- **Other municipal departments** (e.g. coordinating with sewer managers, pretreatment, and city departments using biosolids

- **Outreach** (proactive communications to ensure public support)

- **NBP, ABC Certification**
- **Best Practices**

(e.g. Environmental Mgt. Systems, land applier certifications)

- **Outlets** (e.g. ensuring available markets for products, to avoid having to landfill)

Operations & Maintenance

Complexity is increasing.

Biosolids managers and regulators are working in more complex situations these days. It's no longer a matter of just operating the plant. Now there's…

- More complex regulatory environment, e.g. with cross-media regulatory impacts and more burden on the biosolids generator
- Greenhouse gas emissions and other "new" technical concerns to pay attention to
- Interaction with "non-traditional" regulators, contractors, and utilities (e.g. dealing with electric utilities and air emissions regulators)
- The push to move beyond regulatory minimums; operate with best practices
- An increased focus on product quality (e.g. focus on source reduction)
- The focus on the triple bottom line (social, economic, & environmental)
- The flexibility and diversification of biosolids management to reduce risk
- The push toward more public/private partnerships, which can be cost-efficient but are more complex
- The option of regionalization and shared biosolids management
- The need for wastewater treatment staff to do more communications in support of their biosolids management programs
- The need for increased training to ensure staff are ready for all this!

Operations & Maintenance

And expertise is retiring.

- The original wave of U. S. wastewater treatment operators and engineers, who started their careers during the 1980s boom in construction of treatment plants, are reaching retirement age.

- This represents a critical loss of institutional knowledge.
  - Will drive need for more documentation, etc.
  - Increased emphasis on training.

- Federal & state regulatory agencies are experiencing the same loss; they need support & training too (e.g. annual state regulator workshop).

Operations & Maintenance

And, on top of all that, budgets are tight!

- Federal construction grant funding is long past.
- State Revolving Funds (SRF) are underfunded.
- The Clean Watersheds Needs Survey shows very large demand for infrastructure upgrades nationwide.
- Local communities are squeezed by long recession.
- There are many competing priorities for capital.
- This is increasing use of creative funding structures and public/private partnerships.
- Operators are doing more with less.
- Computerization and automation are more necessary.

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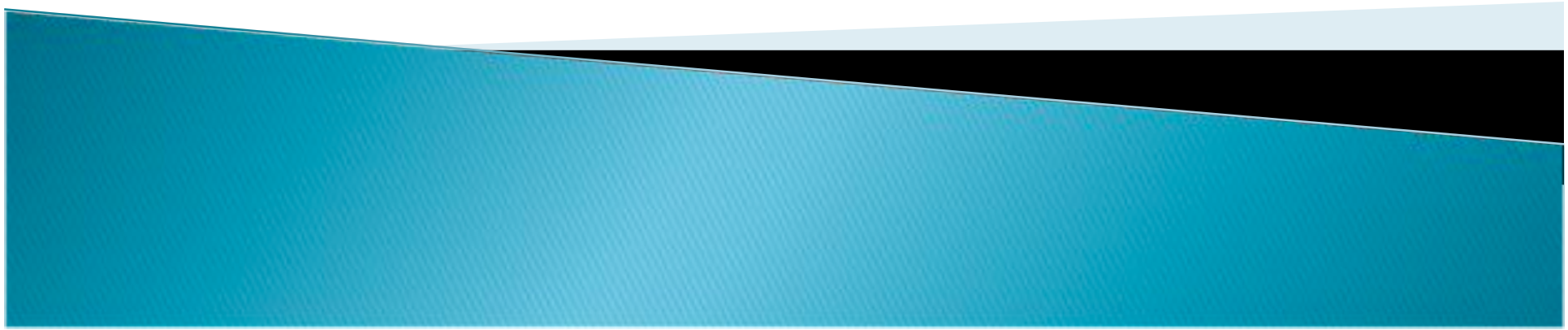
Trends and Drivers

Communications & Training



Communications & Training

Biosolids managers and regulators have more explaining to do!

- The new technologies and the complexity of operations requires more and better communications, both inside organizations and between organizations and with the public.
- Successful biosolids management requires proactive, continual communications and outreach.
- “Flying under the radar” is not a viable option.
- There are many tools now available to help with communications and outreach.
- And, more than ever, successful biosolids management depends on well-trained and knowledgeable staff who are committed to best management practices & quality products.
- Regulatory agencies need support & training too

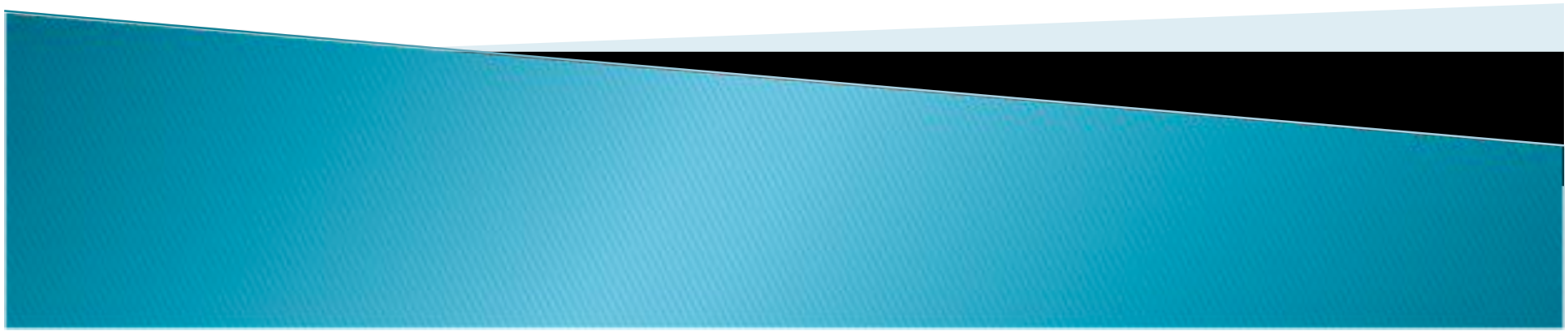
(e.g. the annual regulator workshop)

Why is there still public concern?

- Biosolids will always have some uncertainties: *e.g.* "what ifs" regarding trace chemicals, pollutants, pathogens
- It's hard to communicate complex science
- Effective tapping of concerns by organized opposition to beneficial use
- Limited regulatory resources (strong regulatory oversight boosts public confidence)
- Use of biosolids outside area where they are generated (and other outrage factors)
- Odor or other nuisance events, poor quality management
- Disregard for and/or lack of thoughtful communications with stakeholders

"People think it's dangerous because they're upset, not the opposite."

– Peter Sandman, WEF Residuals & Biosolids Management Conference, 2/27/2000, Boston



Communications & Training

Public perception of biosolids: "Persistent uncertainties remain"

- **Survey of state biosolids coordinators found that public perception was the greatest pressure on biosolids programs** (NEBRA, 2007)
- **Survey showed only 14% of public knew what "biosolids" are** (NEBRA, 2004)

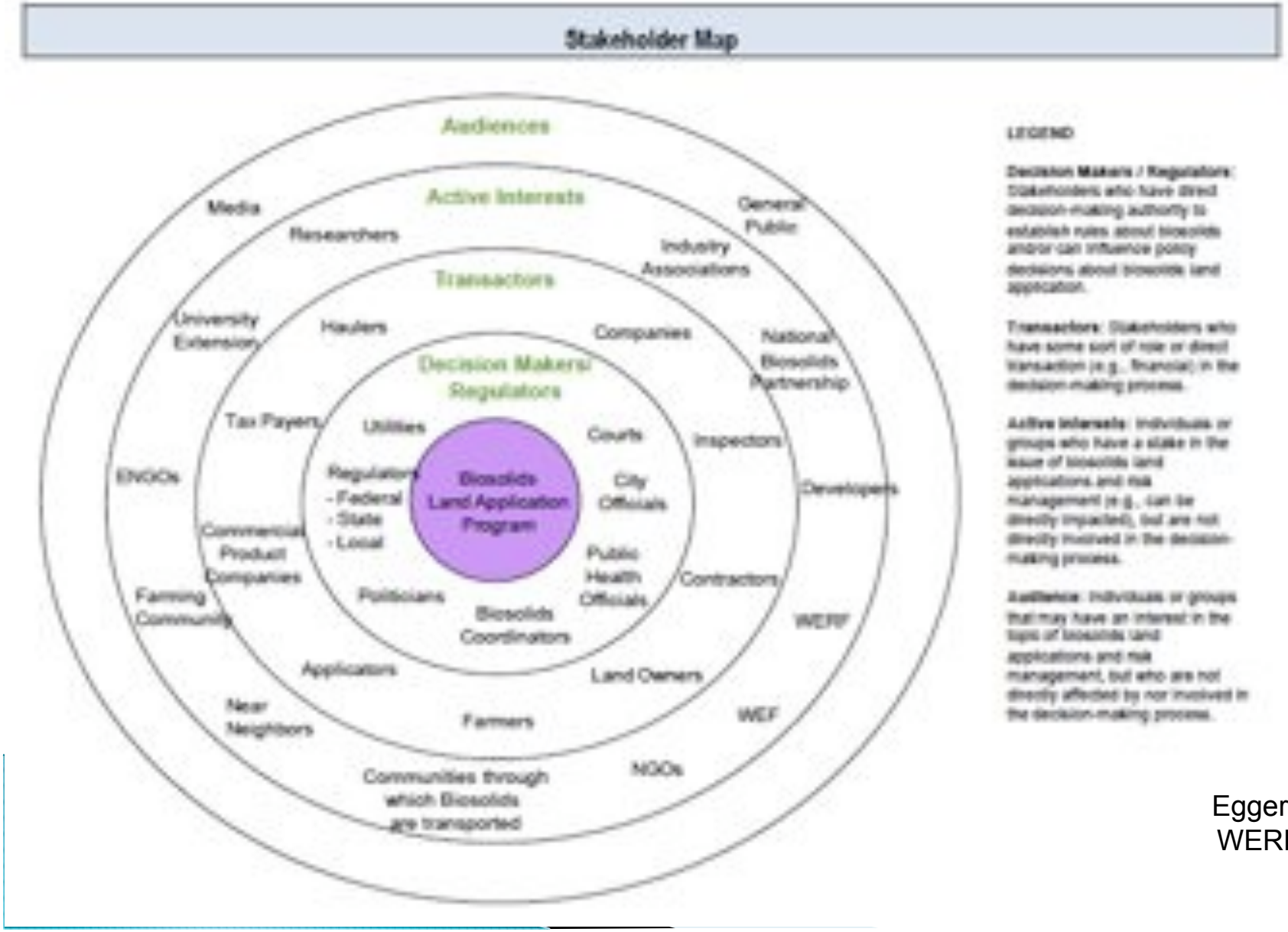
Communications & Training

More proactive communication is needed.

- Be systematic:
  - Have crisis communication materials ready to go
  - Develop school curricula
  - Improve relationships with environmental, farm, and other groups
  - Follow best practices, exceed expectations for performance
  - Build trust
- Build upon existing communication networks (WEF, NBP, NACWA, regional groups, biosolids committees, utilities)

Communications & Training

Pay attention to the stakeholders



Eggers et al., WERF, 2011

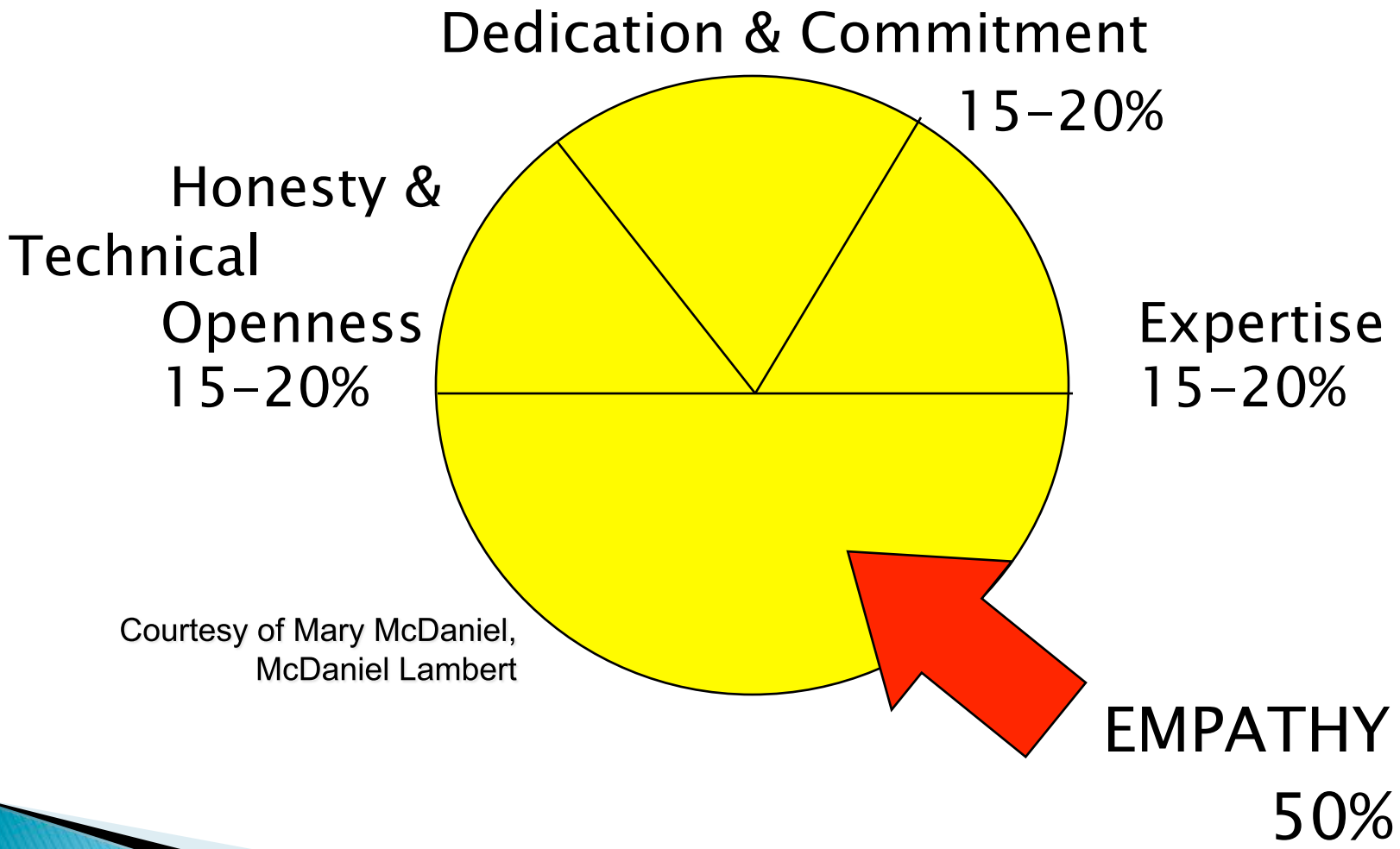
Communications & Training

The #1 factor is TRUST.

- More trust = less afraid; less trust = more afraid
- Don’t over-reassure, instead, set appropriate expectations: “we will reduce the risk as much as possible.”
- Trust builds from the communicator (a more senior staff person is more trusted), the organization, its past history, and the process of operations and communications (is it fair and credible?).
- Trust is built on demonstrations of honesty, shared control, competence, openness, fairness, and all your actions – whether you do what you say)
- You have to earn trust.

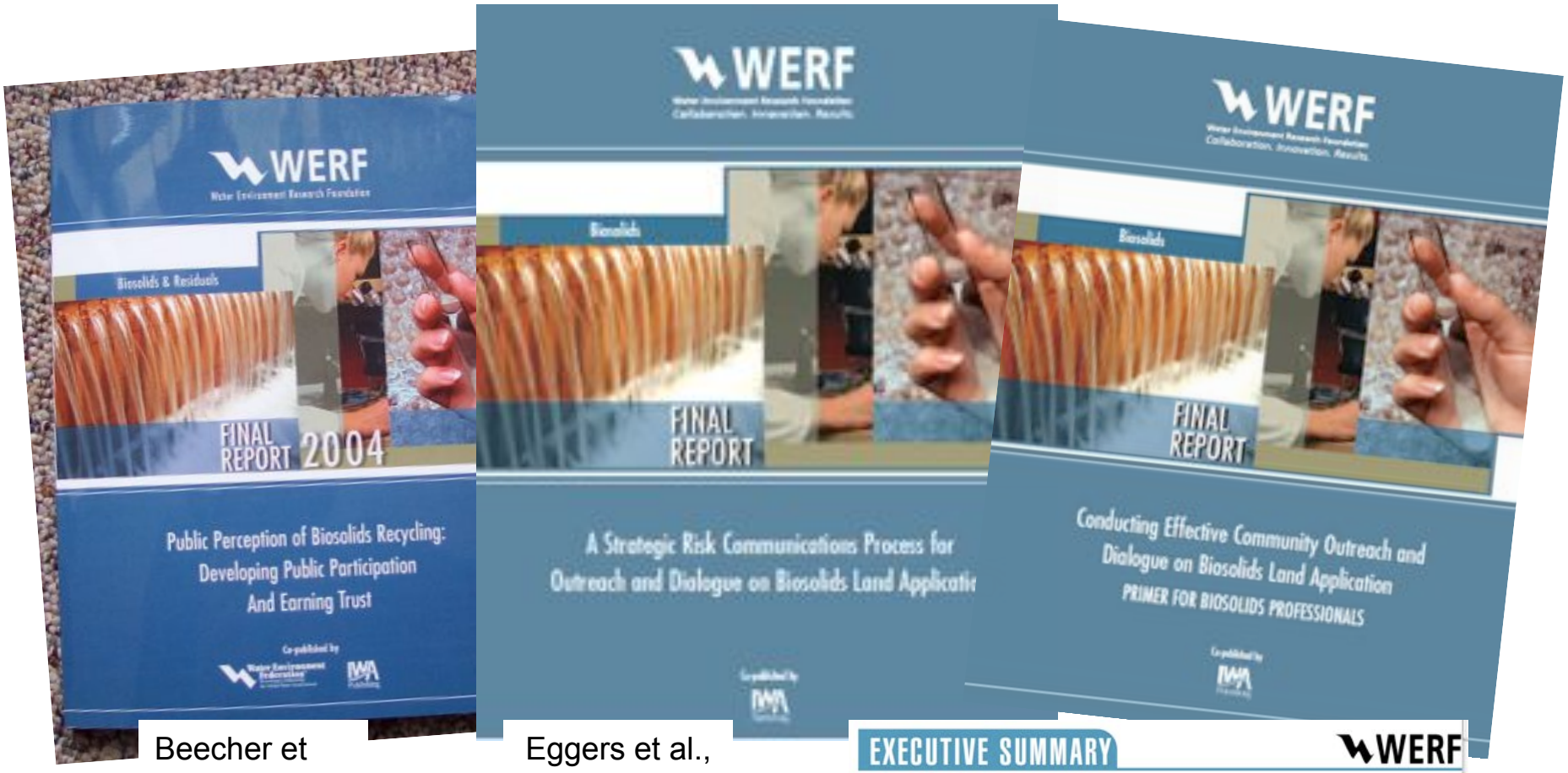
Communications & Training

What makes a person credible…



Courtesy of Mary McDaniel,
McDaniel Lambert

Resources: WERF Reports on Biosolids Public Perception & Strategic Risk Communications

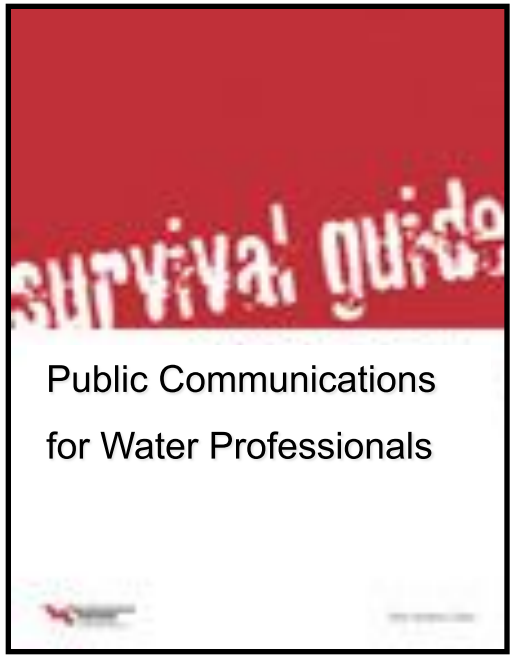


Beecher et al., 2009

Eggers et al., 2011

Deeb et al., 2009

Resource



Available at www.wef.org

Contents

Training

We have talented people, *but…*we need more!

- Retirements result in experience & knowledge leaving the field
- Increase peer-to-peer mentoring
- Increase recruitment
- Increase training

It's more complex, demanding more training…

- There are more diverse options; continuing uncertainties
- With energy demands, biosolids are an expanding resource, requiring new skills/knowledge (do you know how to run a microturbine yet?)
- More & diverse regulations to deal with (e.g. air regulations)
- Poorly-run programs need to be weeded out. Keep the bar high with more training & certifications (ABC Land Applier certification, EMS/BMP etc.).

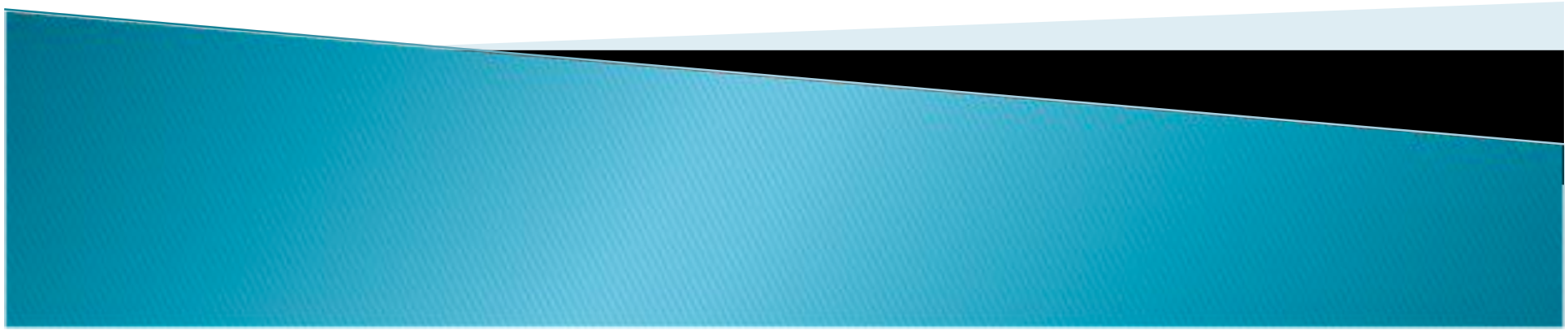
Professional and Training Tools

- **Tools**
  - Conferences and seminars
  - Web-based delivery
  - Certification programs
  - Design/practice manuals
  - Fact sheets/Technical Practice Updates
  - “Biosolids Libraries”
  - Annual state regulator workshop (needed)

NATIONAL biosolids PARTNERSHIP

Trends and Drivers

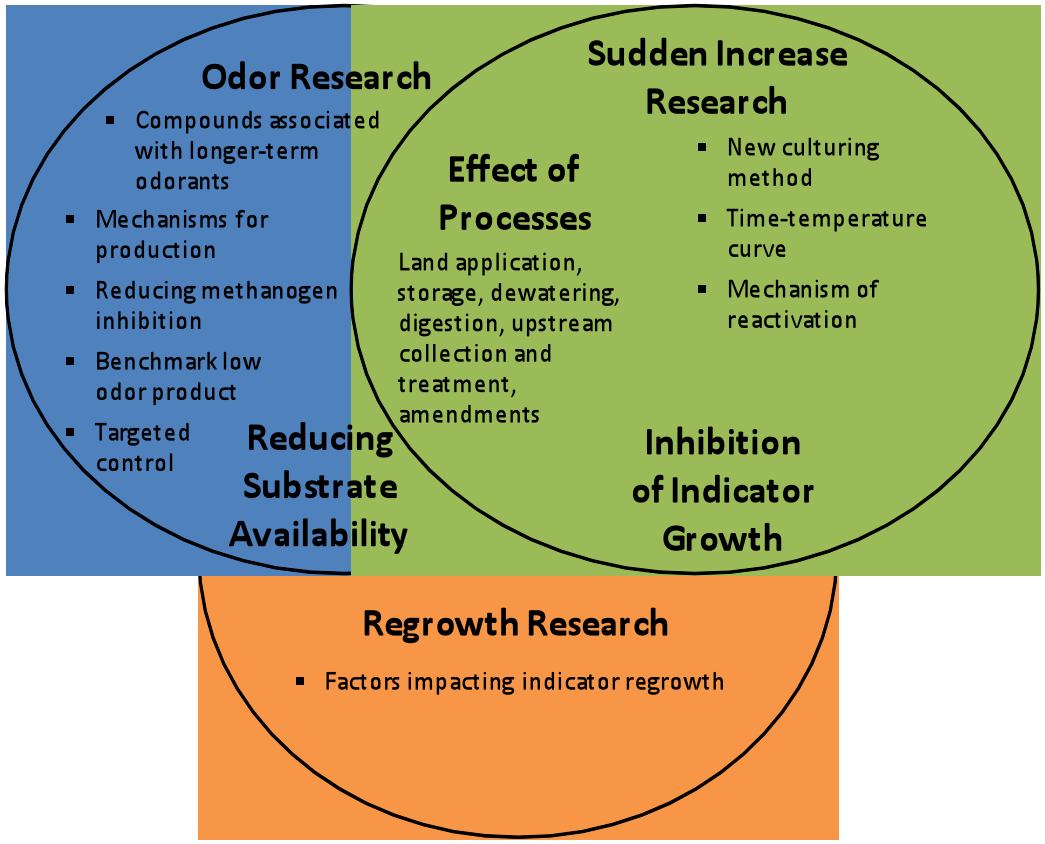
Research



Charting the Future

What are the emerging issues and research needs?

- Microconstituents / trace organics / PPCPs
  - Fate, transport, & impacts
  - Bioassays
- Pathogen indicator regrowth, odors and sudden increase (ROSI)
- Emerging pathogens
  - Fate, transport, & impacts
- Co-digestion
- Energy efficiency
- Greenhouse gas emissions
- Biofuel generated by using carbon and nutrients in wastewater for growing algae
- Microbial fuel cells



Source: Higgins, et al., 2010

Research

Cost efficiency in research is critical.

- Targeted collaborative research is a growing model (used by WERF)
- Research centers (e.g. U of AZ)

Increasing communications about research:

- "State of the Science" forums
- Reviews of older research, to keep the next generation current on it.

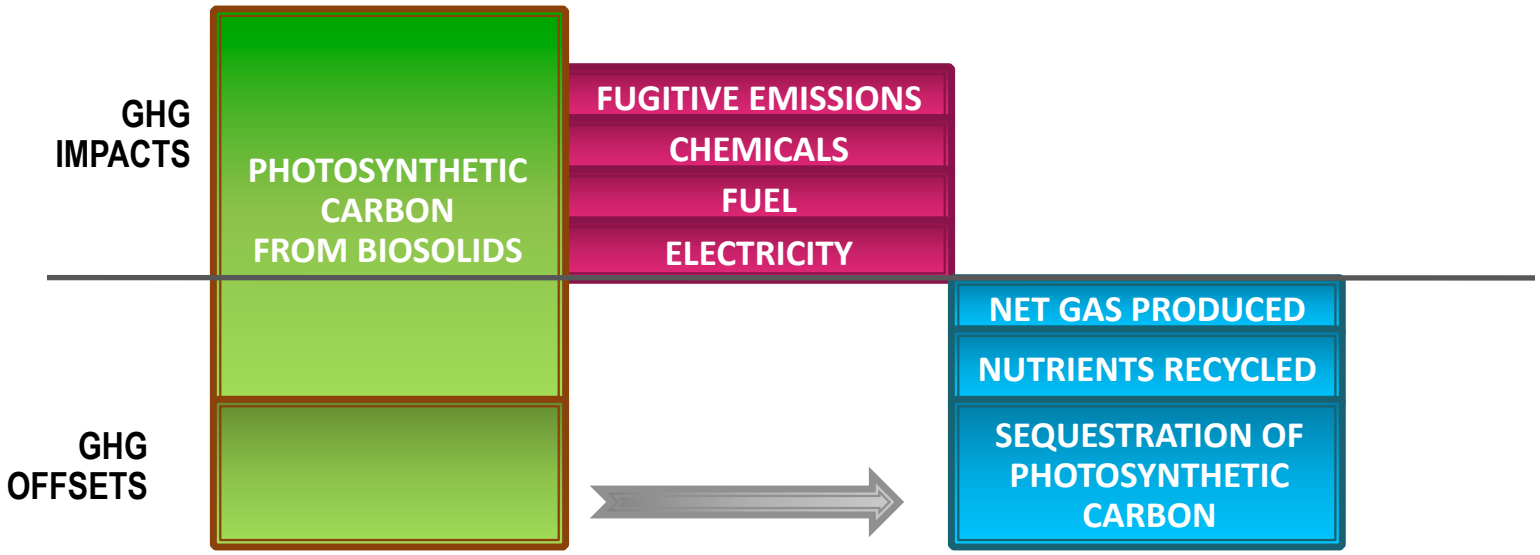
Charting the Future

Specific research topics that rose to the top:

- Emerging pollutants/Microconstituents
- Phosphorus limits
- Stability & odors
- Energy production & efficiency
- Greenhouse gases mitigation

Charting the Future

Biosolids and Climate Change: Opportunities & Challenges

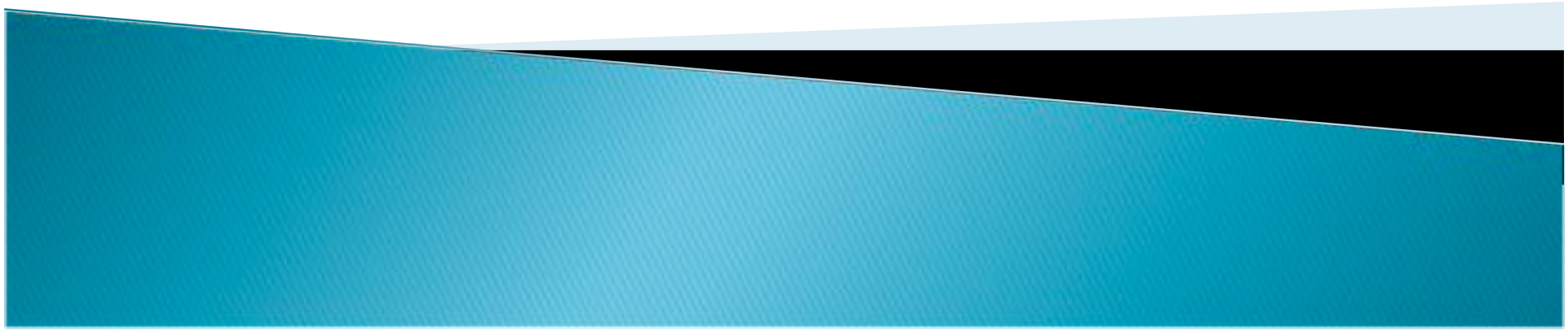


- Need biosolids-specific, standard protocols to quantify carbon footprints (building on The Climate Registry, BEAM, etc.)
- Incentives for renewable energy (e.g state & federal policies & incentives)

NATIONAL biosolids PARTNERSHIP

Trends and Drivers

Current Challenges



Current challenge: New 2011 SSI Regulations

- Some sewage sludge incinerators (SSIs) will have to spend much money to comply with new MACT standards.
- Increasing interest in energy recovery from SSIs needs policy & regulatory support & incentives (e.g. RPS, RECs)
- Other SSIs are closing, resulting in large volumes of wastewater solids having to be managed by other means – a challenge to the biosolids management markets and a potential pressure toward mismanagement of some solids and increased landfill disposal. Where this is happening (e.g. MA), this is an important and tricky transition time.

Multi-venturi scrubber

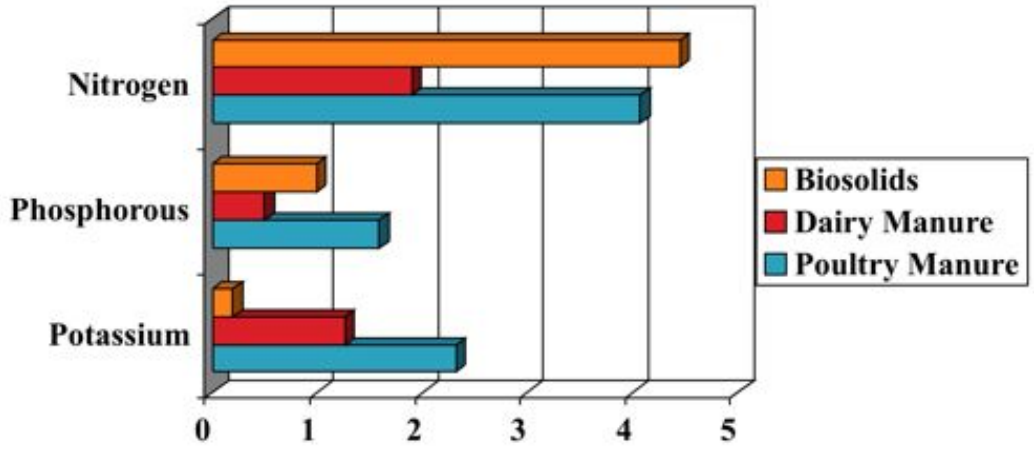
For more about the new SSI regulations, see Part 1 & Resources below.

Flue gas recirculation fan

Current challenge: Managing P in land-applied residuals

Challenge: Many biosolids and manures have relatively high levels of phosphorus (P), so that, when applied in accordance with the agronomic rate for nitrogen (N), more P is applied than is taken up by the crop. Thus, sites to which these materials have long been applied will have high levels of P in the soil, which is a concern for surface water quality.

Relative amounts of macro-nutrients in biosolids and animal manures.



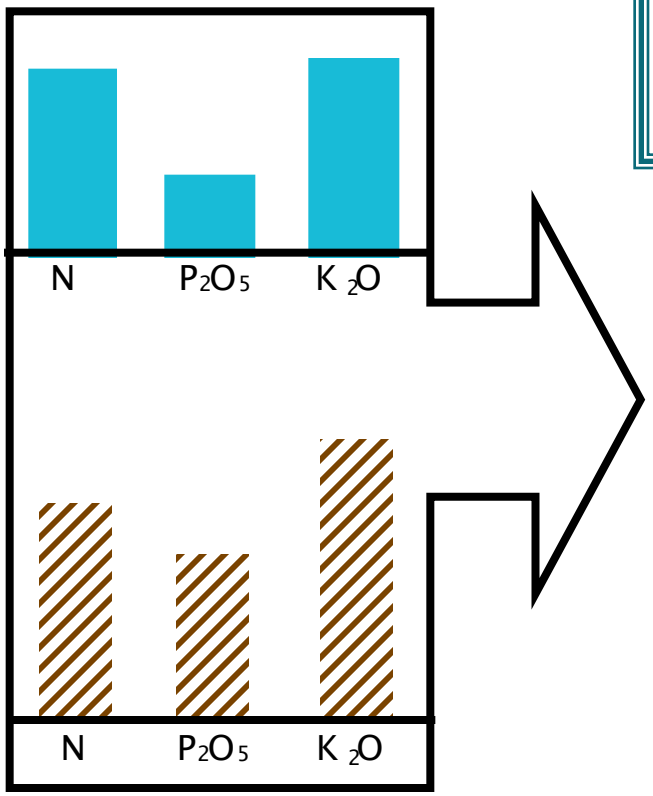
For more about regulation of P in fertilizers, see Part 1.

Current challenge: Managing P in land-applied residuals

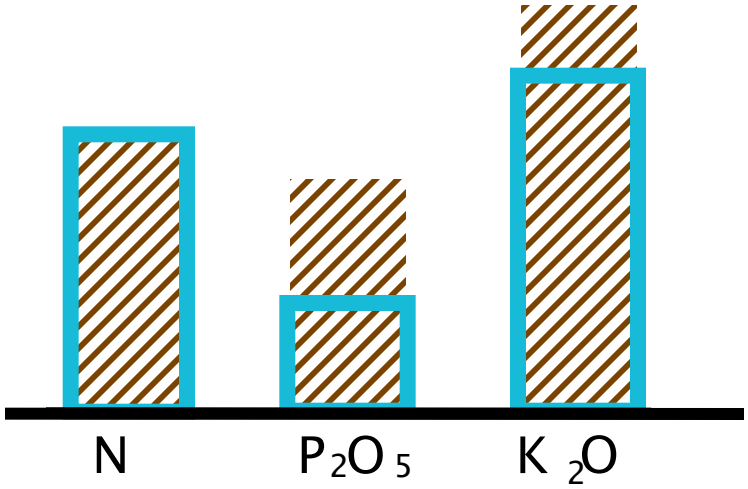
Typical nutrient imbalance

Corn Silage Nutrient Requirement

Dairy Manure Nutrient Content



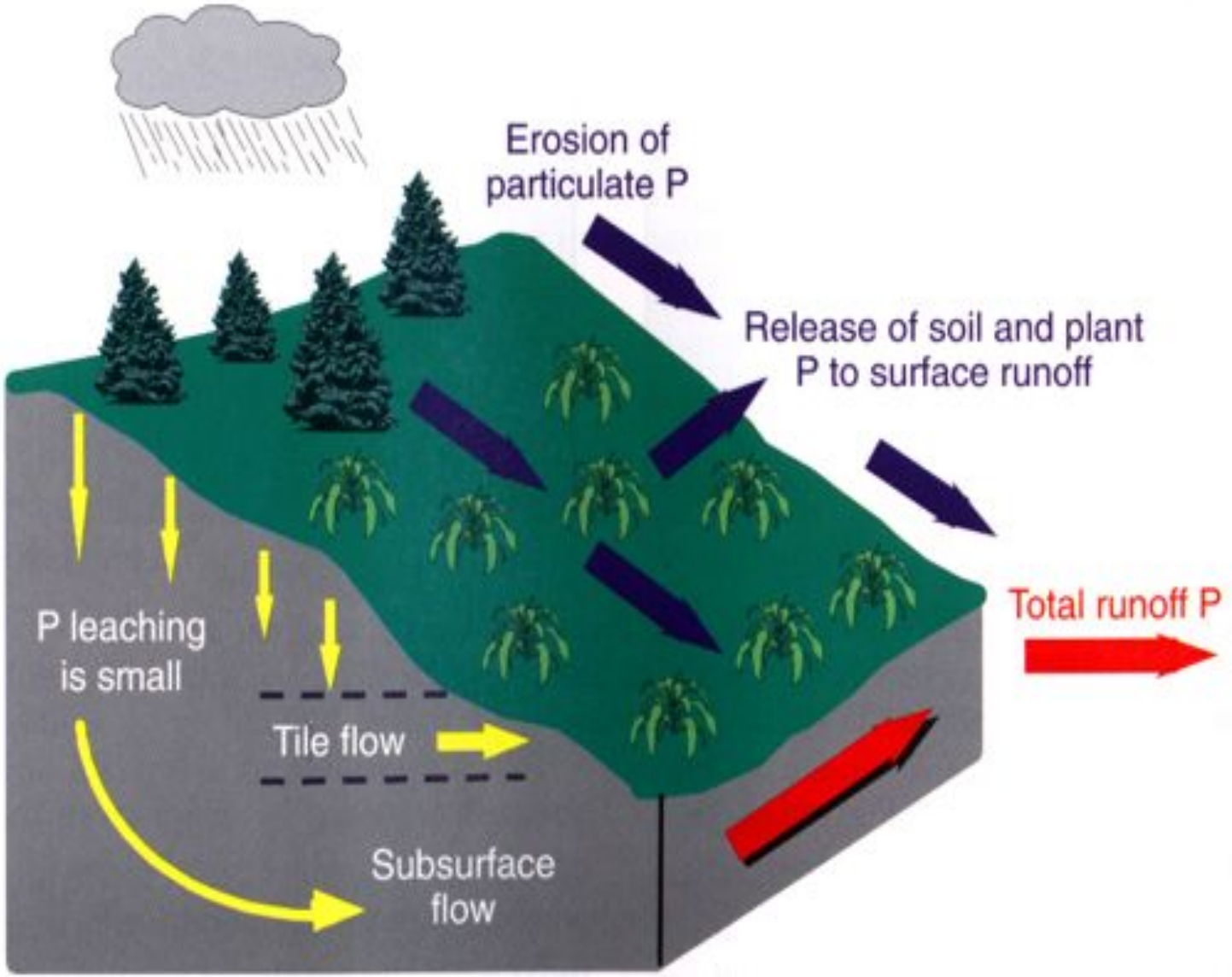
Most Common Approach



Manure application to meet N requirement results in excess P.

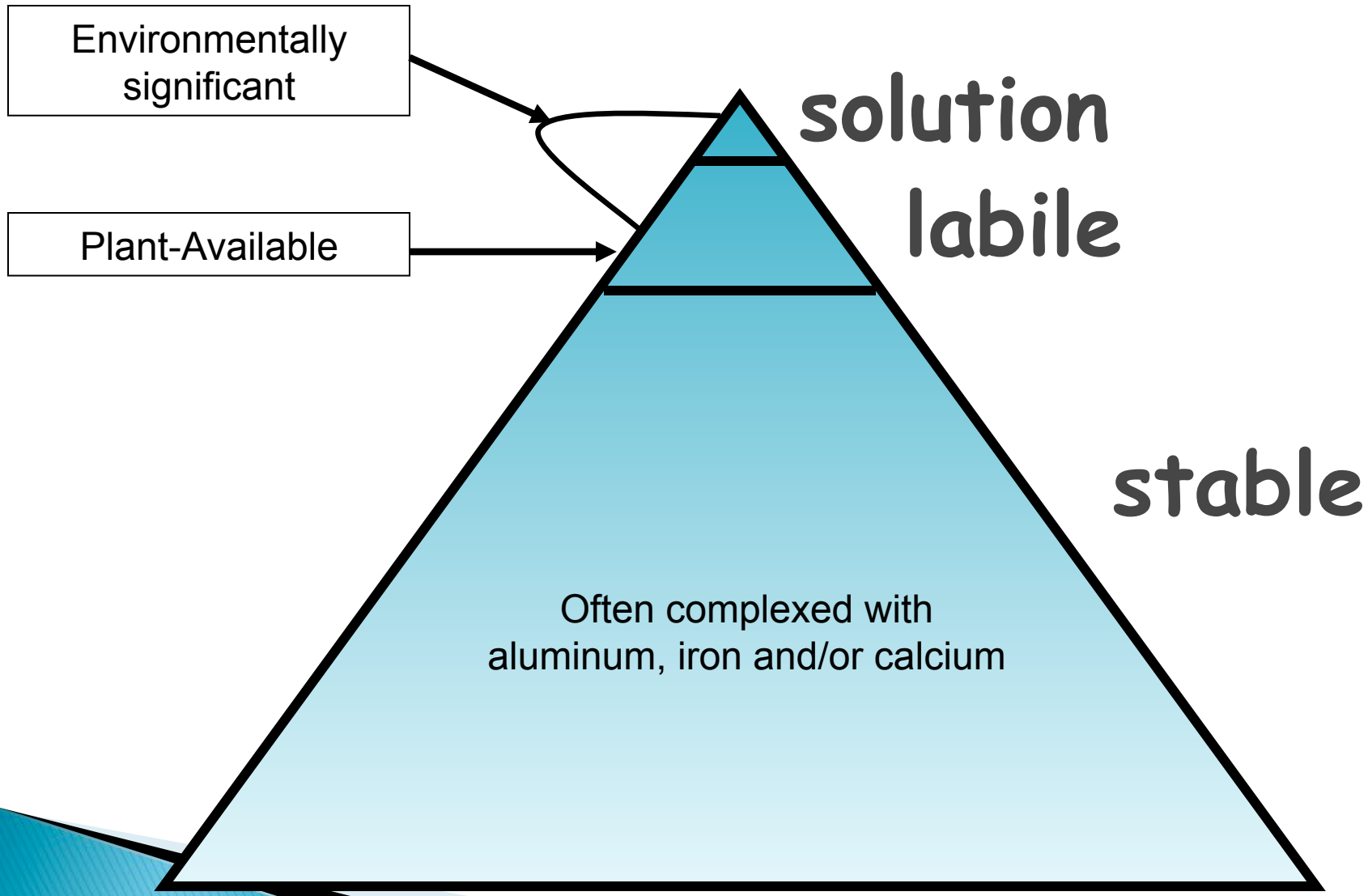
Current challenge: Managing P in land-applied residuals

Typical P transport



Current challenge: Managing P in land-applied residuals

Excess *Total* P in soil may not be a problem; much is not available.



From Craig Cogger, WSU, then brazenly adulterated by Northern Tilth

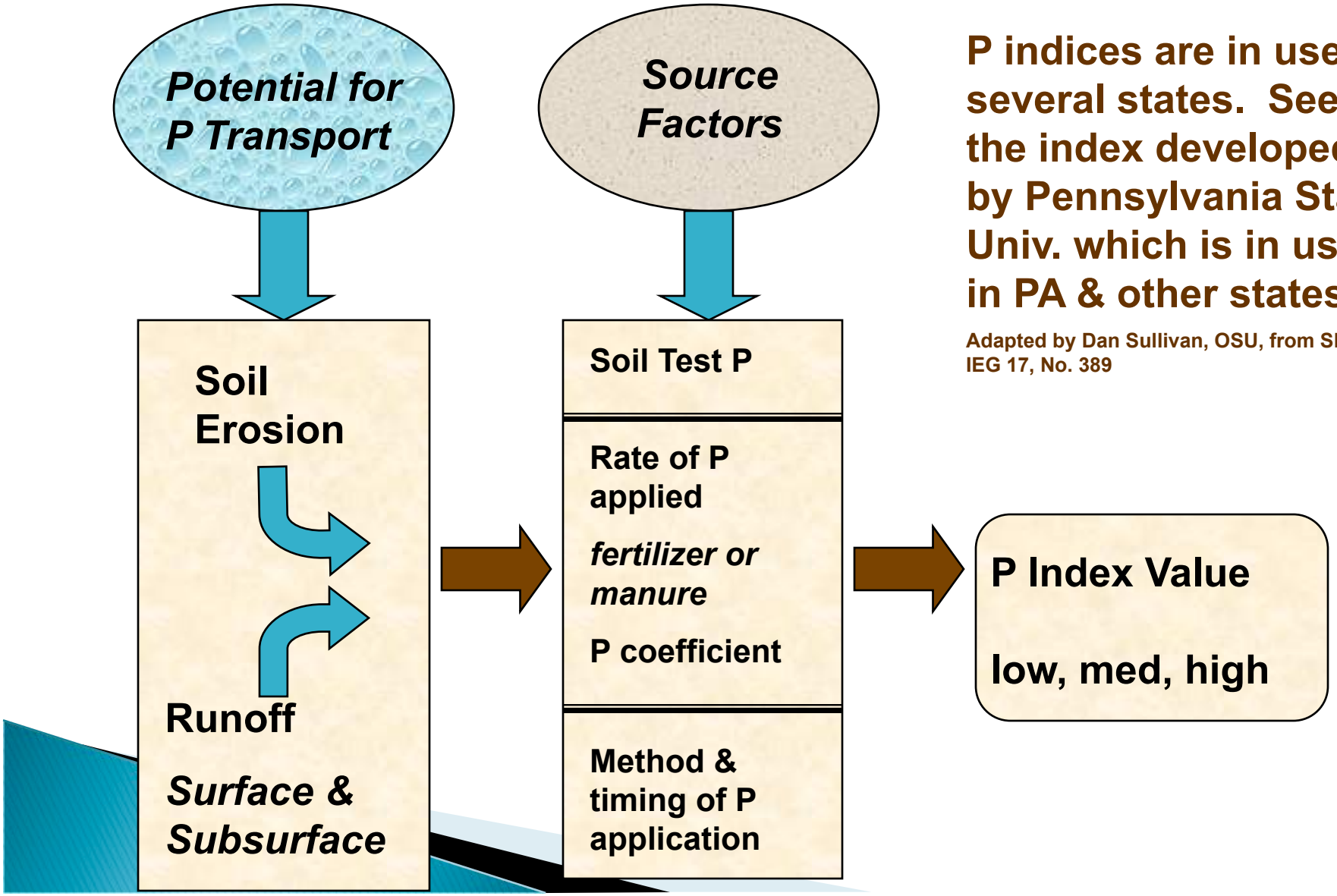
Current challenge: Managing P in land-applied residuals

Developing Solutions…

- Use well-established agricultural practices to control run-off: low slopes, cross-slope rows, mulching, conservation tillage, vegetated buffers, set-backs from surface water.
- Manage manures & biosolids with attention to amount of bioavailable P.
- Use P coefficients in P index to calculate appropriate application rate, which takes into account the amount of non-bioavailable (bound) P.
- Good option: Reduce P bioavailability with hydrosolids (water treatment residuals containing alum) or other amendments.
- Best option: Reduce P in biosolids by removing it at WWTP and creating a concentrated P fertilizer that can be used at appropriate sites.
- Recognize that P is a valuable, limited resource.

Current challenge: Managing P in land-applied residuals

Phosphorus Index

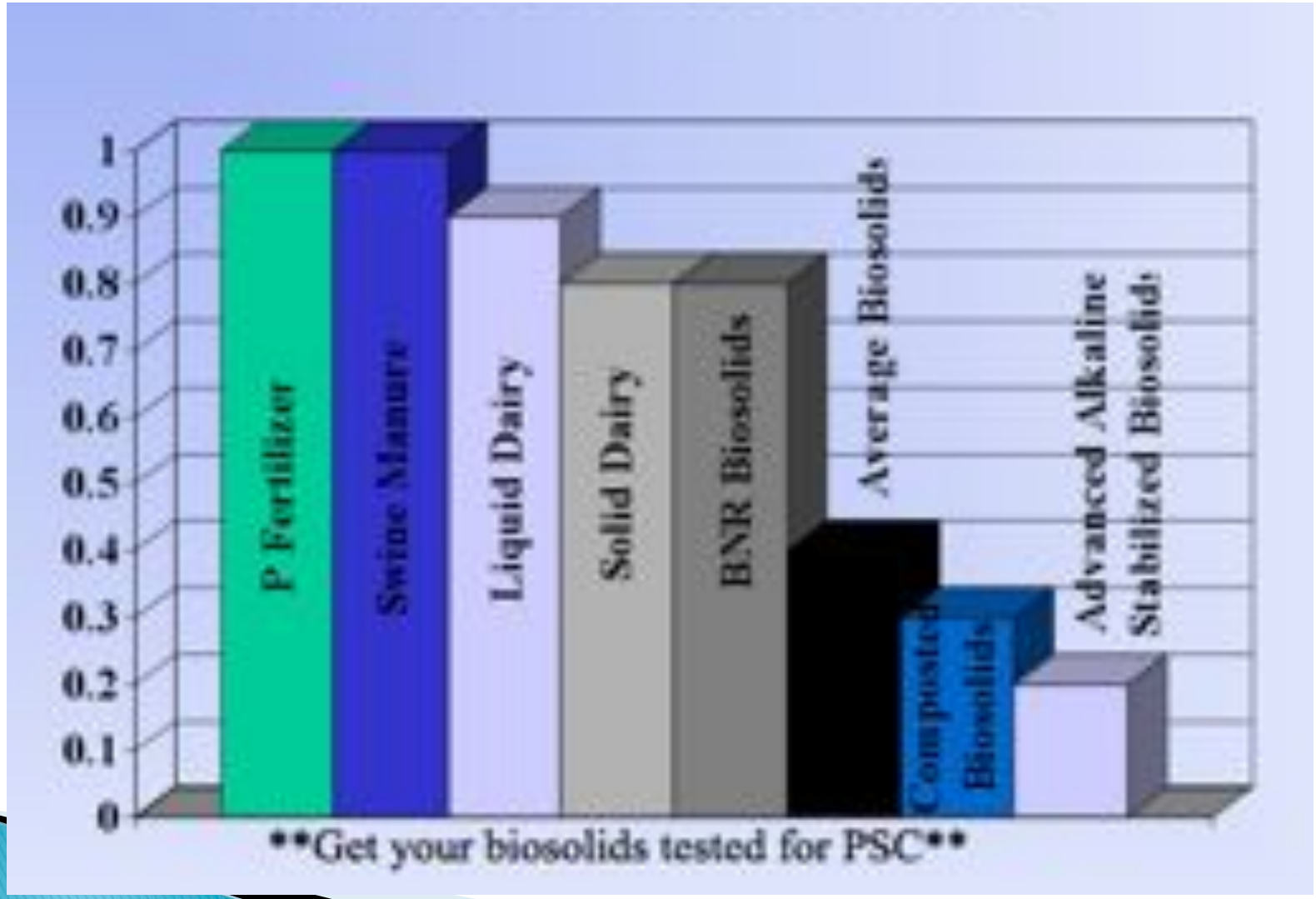


P indices are in use in several states. See the index developed by Pennsylvania State Univ. which is in use in PA & other states.

Adapted by Dan Sullivan, OSU, from SERA-IEG 17, No. 389

Current challenge: Managing P in land-applied biosolids

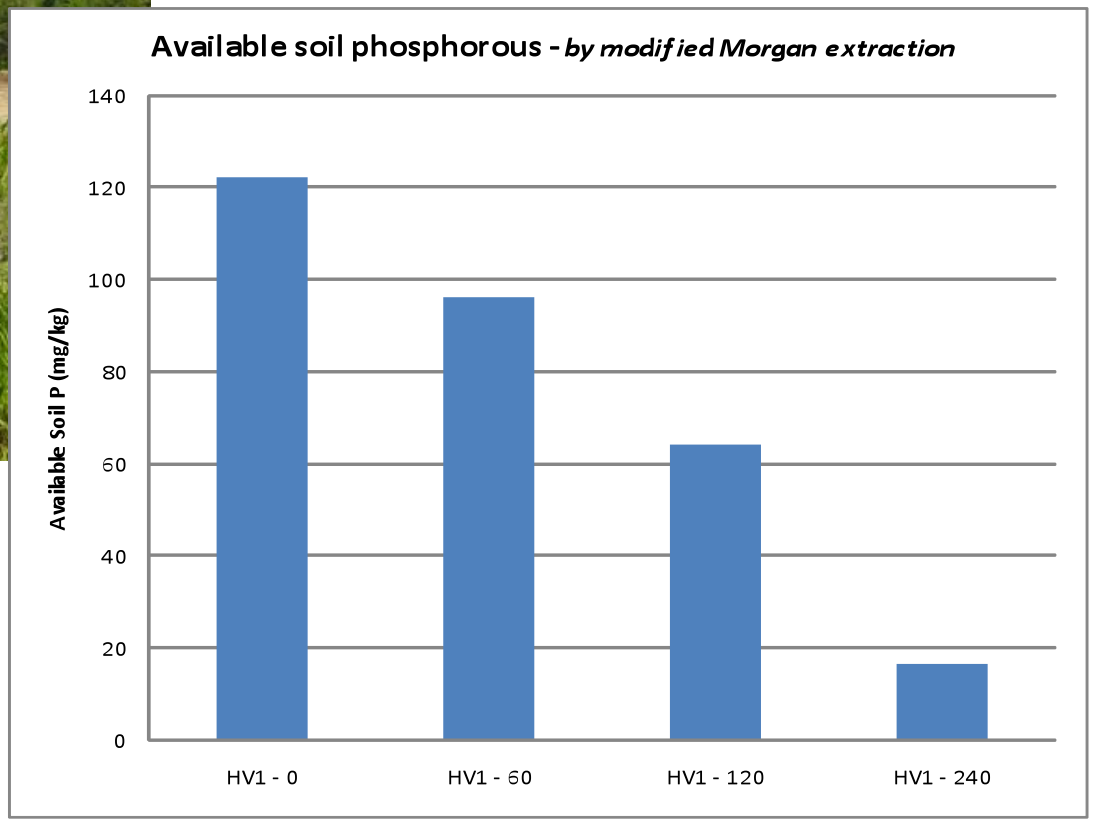
Phosphorus (P) Coefficient



Current challenge: Managing P in land-applied residuals

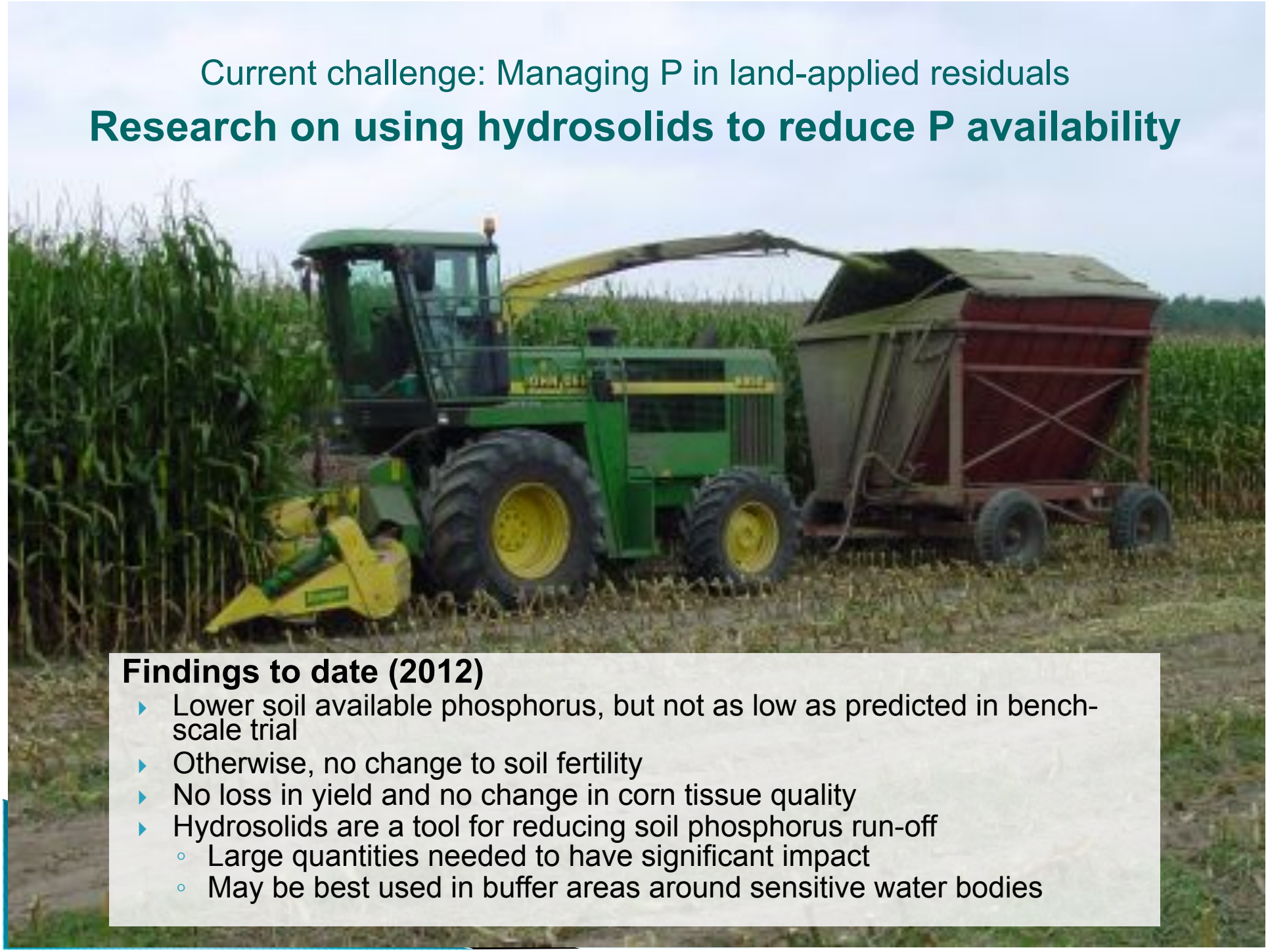
Using hydrosolids to reduce P availability

Hydrosolids, usually alum-rich, are residuals from water treatment processes.



Current challenge: Managing P in land-applied residuals

Research on using hydrosolids to reduce P availability



Findings to date (2012)

- Lower soil available phosphorus, but not as low as predicted in bench-scale trial
- Otherwise, no change to soil fertility
- No loss in yield and no change in corn tissue quality
- Hydrosolids are a tool for reducing soil phosphorus run-off
  - Large quantities needed to have significant impact
  - May be best used in buffer areas around sensitive water bodies

Current challenge: Managing P in land-applied residuals

Best option: Remove P at WWTP

Struvite and other P minerals can be precipitated at wastewater treatment plants, usually by a treatment process applied to a digestate dewatering side-stream.

Current challenge: Managing P in land-applied residuals

Recognize that P is a valuable, limited resource!

Minable P – World Supply

- Estimated 90 year supply of economically recoverable phosphorus at current rate of use
- Population pressures will likely increase demand
- Geopolitical concentration of phosphate rock deposits
- Possibility of increased environmental risks with untapped deposits

Current challenge: Managing P in land-applied residuals

USDA NRCS provides guidance

- Non-regulatory, landowner participation is voluntary
- Conservation plans
- Provide financial assistance (e.g., EQIP) for implementing conservation practice standards (e.g., Nutrient Management))
- Conservation practice standards are based on best science available from Land Grant Universities.

Resources:

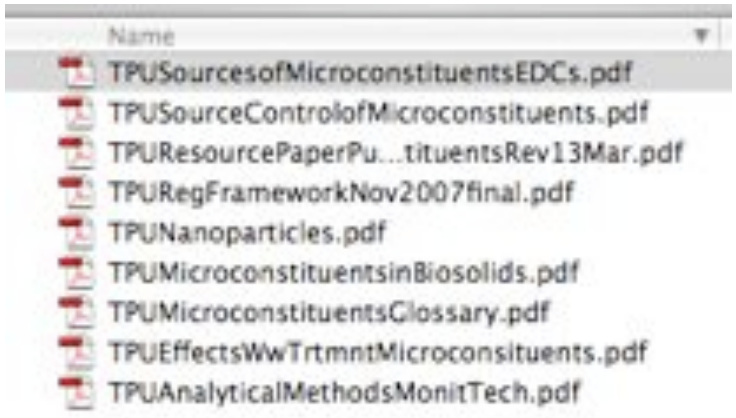
- Nutrient Management (Code 590)
- Residue Management—No Till (Code 329)
- Cover Crop (Code 340)
- Strip-cropping (Code 585)
- Conservation Crop Rotation (Code 328)

Look for Nutrient Management, Code 590, and other guidance at http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/landuse/crops/npm/ and/or http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/fotg/

Avoid this!

Current challenge: Microconstituents Historic perspective

- Trace chemicals in biosolids are not new
- There is 30+ years of research on chemicals in biosolids & soils dating to before Part 503 (e.g. PCBs, priority pollutants)
- Late 1990s – now: pharmaceuticals & personal care products (PPCPs) and other chemicals measured in surface waters, effluent, biosolids, soils – due to improved testing technology
- EPA dioxin risk assessment (early 2000s)
- 2006-08: WEF Microconstituents Technical Practice Updates
- March 2008: AP news story increased public attention
- 2000s – now: Research continues



Current challenge: Microconstituents

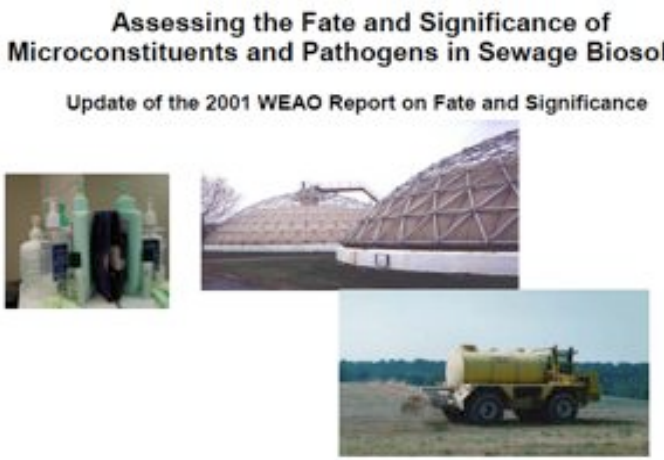
Research on microconstituents in biosolids

- Xia et al., 2005 (state-of-science of land application conference, U. Florida): many unknowns
- Buyuksonmez and Sekeroglu, 2005: composting certainly degrades microconstituents
- Heidler et al. / Halden 2006: TCC up to 50 mg/kg in biosolids
- Kinney et al. 2006: USGS analyses of presence (http://toxics.usgs.gov/highlights/biosolids.html)
- Kinney et al. 2008: USGS study on fate: trace organics from biosolids & swine manure in worms (http://toxics.usgs.gov/highlights/earthworms.html)
- 2009: EPA Targeted Sewage Sludge Survey included microconstituents
- Topp et al., 2009: "PPCPs are detected in tile drainage and in surface runoff, sometimes months after application. Maximum concentrations of PPCPs detected in effluent are generally lower following application of DMB than application of LMB. Incorporation of LMB eliminates the potential for loss via runoff. Application of LMB using an Aerway device reduces contamination via tile drainage, compared to surface applied and incorporated. The mass transport (fraction of chemical applied that is exported) varied widely. Maximum concentrations of PPCPs detected in effluents were generally far below toxic thresholds for a variety of endpoints drawn from the literature."
- Hundal et al. 2009, Chicago: "The data suggest limited mobility of biosolids borne TCC, TCS, total PBDEs, and 4-NP in biosolids-amended soils. Although the concentrations of, TCC, TCS, 4-NP, and total PBDEs in soil were greater in the biosolids-amended plots than in the Control plots, the contaminants had no detrimental effects on the soil biota. Indeed, microbial community studies showed that the microbial populations were more diverse and much more biologically active in the biosolids-amended plots than in the control plots."
- Wu et al., 2010: Soybean uptake study in greenhouse; soil was spiked with fresh contaminants; significant uptake was observed, but real-world effects were over-estimated; past research on trace metals and chemicals shows similar over-estimation of effect.


Uptake of Pharmaceutical and Personal Care Products by Soybean Plants from Soils Applied with Biosolids and Irrigated with Contaminated Water

Current challenge: Microconstituents

Summaries of the state of the science



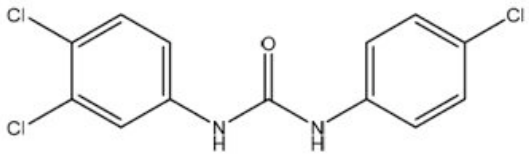
Hydromantis, 2010
Available free at
www.weao.org

WERF, 2010; see
http://www.werf.org/i/a/k/Search/ResearchProfile.aspx?ReportId=SRSK5T09

Scroll down at
http://www.nebiosolids.org/index.php?page=science for NEBRA coverage of topic.

Current challenge: Microconstituents

What does it mean?



All chemicals added to soils are subject to the same reactions/ processes, including solid phase retention/release, degradation, bioaccumulation, volatilization, runoff, and leaching. The reactions/ processes of organics have been studied for decades and the corresponding risk to human and environmental health assessed/ estimated. Examples of organic chemicals so studied include pesticides, priority pollutants, and others with chemical and physical properties similar to many of today's "emerging chemicals of concern", also know as "microconstituents."

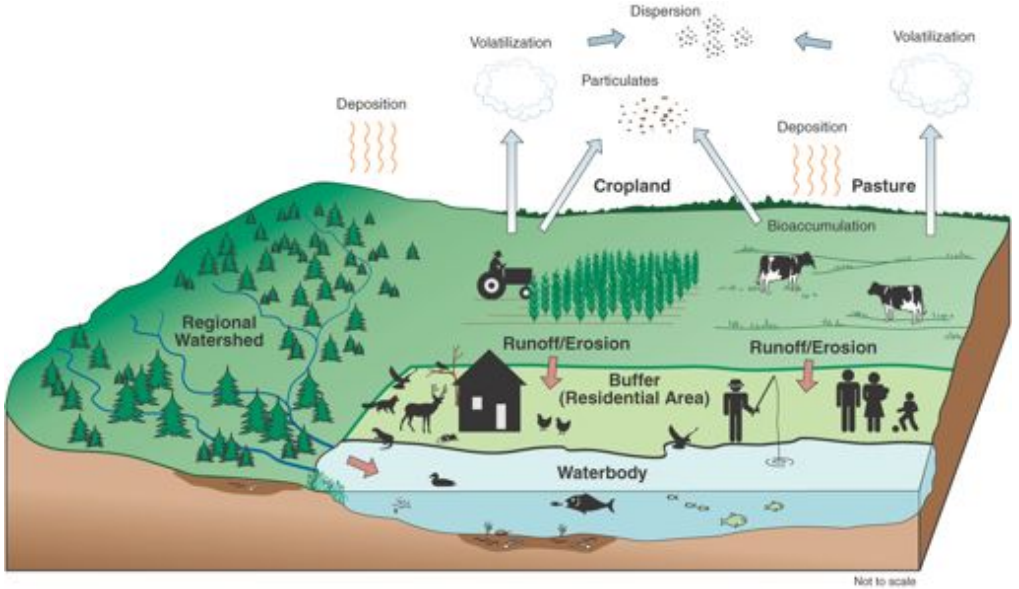
– O'Connor, 2009, WEF Residuals and Biosolids Conference

See Dr. O'Connor's video slide presentation on this topic at http://e2.ma/click/xa2ks/dz7he/1pc6si

Current challenge: Microconstituents

How to proceed with the research?

- Research… chemical by chemical and apply risk assessments…



- And… bioassays (Bioassays & biosolids workshop at WEF Residuals & Biosolids Conference, May 23, 2011, Sacramento: http://www.nebiosolids.org/index.php?page=applying-bioassays-to-biosolids-2)

Current challenge: Microconstituents

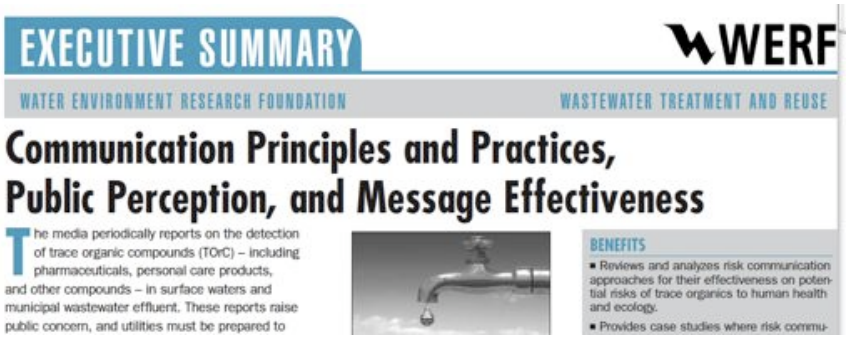
Recent bioassays of biosolids land application

- 2010: University of Guelph – fate of endocrine disruption during biosolids treatment processes
- 2010: College of William and Mary: bioavailability of PDBEs using earthworms and crickets in a laboratory
- 2011 Tom Young (UC Davis): TCS has “little relative impact on on overall community composition,” but reduces ammonia oxidizing activity and shows up in runoff
- 2011 Lynda McCarthy (Ryerson): lab bioassays in Ontario using earthworms, springtails, *Brassica rapa*, beans, corn: “sub-acute, acute, chronic, and reproductive bioassays indicated no deleterious impact of selected biosolids on selected biota under controlled, laboratory conditions.”

Current challenge: Microconstituents

How to proceed?

Communications are needed to ensure proper perspective on the potential risks of microconstituents in biosolids.



EXECUTIVE SUMMARY

WERF

WATER ENVIRONMENT RESEARCH FOUNDATION

WASTEWATER TREATMENT AND REUSE

Communication Principles and Practices, Public Perception, and Message Effectiveness

The media periodically reports on the detection of trace organic compounds (TOrC) – including pharmaceuticals, personal care products, and other compounds – in surface waters and municipal wastewater effluent. These reports raise public concern, and utilities must be prepared to

BENEFITS

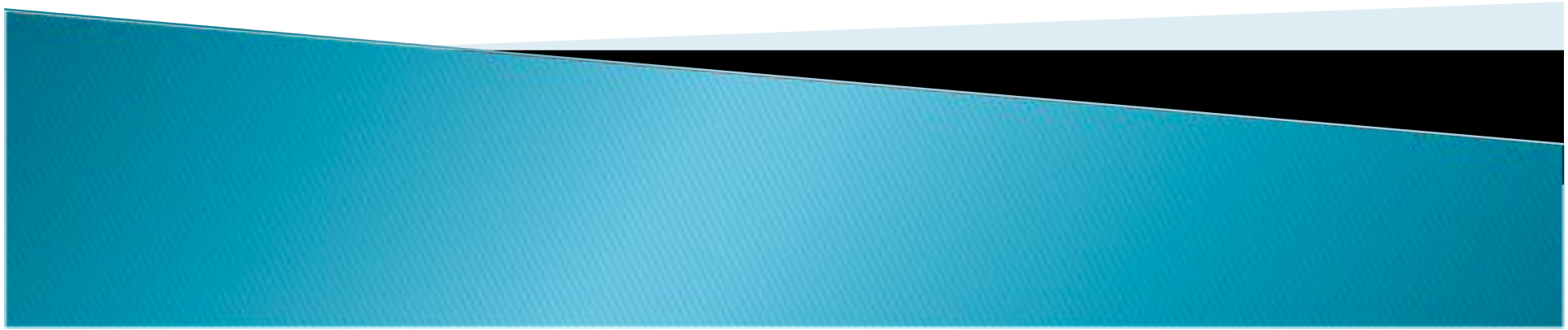
- Reviews and analyzes risk communication approaches for their effectiveness on potential risks of trace organics to human health and ecology.
- Provides case studies where risk commu-

Deeb et al., 2009, WERF

Communication framework

NATIONAL biosolids PARTNERSHIP

Focus on Resource Recovery



Resource Recovery

Our Changing View of Solids Management

Sludge Disposal

Biosolids Beneficial Use

Bioenergy

Resource Recovery

1970 1993 2000 2005 2010

Resource Recovery

Wastewater treatment plants are not waste disposal facilities or polluters.

They are water resource recovery facilities that produce clean water, recover nutrients, and have the potential to reduce the nation's dependence upon fossil fuel through the production and use of renewable energy.

NEW! Upcoming NBP publication (February 2013)

Enabling the Future of Biosolids Management

Resources

Resources

Biosolids Use & Trends

Charting the Future of Biosolids Management

A report from the National Biosolids Partnership
http://www.wef.org/cfbm_finalreport/

A National Biosolids Regulation, Quality, End Use, & Disposal Survey

A collaborative report by NEBRA, NBMA, *BioCycle*, and WI Dept. of Natural Resources

Report (with Executive Summary):
http://www.nebiosolids.org/uploads/pdf/NtlBiosolidsReport-20July07.pdf

State-by-state details (regulations & data):

Alabama – Missouri
http://www.nebiosolids.org/uploads/pdf/NtlBiosldsRpt-AppD-AL-MO.pdf

Montana - Wyoming
http://www.nebiosolids.org/uploads/pdf/NtlBiosldsRpt-AppD-MT-WY.pdf

Resources

EPA Biosolids Program / Part 503

Part 503 regulations & EPA regulatory activities

(Office of Water – Science & Technology)
http://water.epa.gov/scitech/wastetech/biosolids/#br

Part 503 & EPA biosolids program guidance

(Office of Water – Wastewater Program)
http://water.epa.gov/polwaste/wastewater/treatment/biosolids/

NAS / National Research Council Reviews of Part 503

1996: Use of Reclaimed Water and Sludge in Food Crop Production
2002: Biosolids Applied to Land: Advancing Standards and Practices

Resources

Other U. S. Government Regulations, Guidance, & Policy

U. S. Food & Drug Agency

Guidance for Industry: Guide to Minimize Microbial Food Hazards for Fresh Fruits and Vegetables (1998)
http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/ProduceandPlanProducts/ucm064574.htm

NEW! 2013 Food Safety Regulations (include biosolids):
http://www.fda.gov/Food/FoodSafety/FSMA/default.htm

CDC – National Institute for Occupational Safety and Health (NIOSH)

Guidance for Controlling Potential Risks to Workers Exposed to Class B Biosolids (2002)
http://www.cdc.gov/niosh/docs/2002-149/

U.S. Dept. of Agriculture: National Organic Program

National Organic Program website
http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateA&navID=NationalOrganicProgram&page=NOPNationalOrganicProgramHome&resultType=&topNav=&leftNav=NationalOrganicProgram&acct=nop

7 CFR Part 205 – National Organic Program Regulations
http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=89420dada951a542e98f097da8b8a214&rgn=div5&view=text&node=7:3.1.1.9.32&idno=7

Resources

Other U. S. Government Regulations, Guidance, & Policy

U. S. EPA Office of Air & Radiation

Greenhouse Gas (GHG) Emissions Reporting Program
http://www.epa.gov/ghgreporting/index.html

Greenhouse Gas (GHG) Prevention of Significant Deterioration (PSD) & Title V Tailoring Rule
On the following website, see under “2010” and more recent actions:
http://www.epa.gov/nsr/actions.html

Resources

WERF Biosolids Research

http://www.werf.org/c/KnowledgeAreas/Biosolids/Biosolids_Research_at_a_Glance.aspx

Find WERF reports, tools, and updates on ongoing projects. At this time, presentations and other WERF documents may be found by browsing our Knowledge Areas.

- biosolids land application,
- compounds of emerging concern,
- emerging contaminants, endocrine disrupting compounds, energy production,
- green infrastructure,
- microconstitutents, odors and aerosols,
- pathogen detection & indicators,
- pharmaceuticals & personal care products,
- residuals management,
- resource recovery,
- solids disinfection, solids reduction, solids treatment, risk communication

Research reports >2 years old are available for free download at http://www.werf.org

Resources

WEF General Resources

WEF Technical Practice Updates (TPUs):
http://www.wef.org/TPUs/

WEF No Charge Webcasts:
http://www.wef.org/OnlineEducation/page_webcasts.aspx?id=124

WEFTEC Proceedings: Hosted on the IngentaConnect website
Proceedings of the Water Environment Federation is an archival library of the papers presented at the annual WEF Technical Exhibition and Conference (WEFTEC) and other conferences held between 2000 and 2010. These proceedings are not peer-reviewed. No charge for WEF members.

This Week in Washington from WEF: No charge
http://www.wef.org/GovernmentAffairs/ThisWeekInWashington/

Resources:

- NBP webpage: http://www.wef.org/biosolids/
- NBP Webcasts: http://www.wefnet.org/nbp/
- NBP Biosolids Resources – Biosolids News Center: + Monthly E-Newsletter http://www.wef.org/biosolidsnews/
- NBP Biosolids Management Program Documents: http://www.wef.org/Biosolids/page.aspx?id=7554
- NBP Technical Resources: http://www.wef.org/Biosolids/page.aspx?id=7522
- Anaerobic digestion and biogas production: http://www.biogasdata.org
- NEBRA information on greenhouse gas emissions and biosolids management http://www.nebiosolids.org/index.php?page=biosolids-management-greenhouse-gas-emissions

WEF Information Exchange Capacity

- Possible uses of WEFCOM - http://wefcom.wef.org/Home/
- WEFCOM is available for all WEF members- Discussion group, upload reports and documents into the library for Residuals & Biosolids Committee community and other WEF communities, post messages, view discussions in all committees
- Video conferencing;
- WEF Biosolids Access Water Knowledge Channel - http://www.wef.org/AWK/pages_cs.aspx?id=1062
- WEF Biosolids Communications Resources - http://www.wef.org/biosolidscommresources/

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NATIONAL biosolids PARTNERSHIP

Recognizing A Resource:

biosolids

A Roadmap for State & Regional Biosolids Coordinators

and other interested parties

This has been Part 3; see also:

Part 1: **Federal & State Regulations**

Part 2: **40+ Years of Research & Experience**

Available at:
http://www.wef.org/Biosolids/page.aspx?id=7522