Opportunities and Challenges to Biosolids Beneficial Use Activities

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Clean Water Act (CWA)

Enacted October 18, 1972 (PL 92-500)

Section 405 sets the framework for sewage sludge regulations (i.e., Part 503)

- **Requires EPA to establish standards for proper treatment, use and disposal of sewage sludge**
- **Also requires EPA to conduct biennial reviews to determine if additional pollutants should be regulated**

40 CFR Part 503

Standards for the Use or Disposal of Sewage Sludge

Enacted February 1993

Solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works

Applies to a limited number of pollutants

Specifies requirements for three management options:

- **Land application**
- **Incineration**
- **Surface disposal**

Rules and Standards

40 CFR Part 503

Requirements focus on the generator, user, disposer of sewage sludge

- General requirements
- **Numeric limits**
- **Management practices**
- **Operational standards**
- **Monitoring**
- **Recordkeeping**
- **Reporting**

40 CFR Part 503

Self-implementing rule

Federally enforceable without a permit

Essentially all states have adopted Part 503

- Some state laws are more restrictive
- Sensitive environmental conditions (e.g., ground water)

Choice of use or disposal practice remains a local decision

Effective management practices help support the needs of local communities

- Renewable resource
- Too valuable to waste

40 CFR Part 503
Heavy Metals

- **Heavy Metals limits**
  - ✓ Risk based
  - ✓ Arsenic, Cadmium, Chromium[1], Copper, Lead, Mercury, Molybdenum[2], Nickel, Selenium, Zinc

- **Regulatory limits**
  - ✓ Ceiling concentration limits (CCL)
  - ✓ Pollutant concentration limits (PCL)
  - ✓ Cumulative pollutant loading rate (CLPR)
  - ✓ Annual pollutant loading rate (APLR)

[1] 1995 amendment deleted land application limits
[2] 1994 amendment only retained CCL

40 CFR 503
Pathogens and Indicator Organisms

- **Microbial standards**
  - ✓ **Technology based**
  - ✓ ***Salmonella* sp., fecal coliforms, enteric viruses, viable helminth ova**

- **Class A:**
  - ✓ **<1000 fecal coliform MPN / g (dry weight) <u>or</u> <3 *salmonellae* MPN / 4 g (dry weight)**
  - ✓ **<1 PFU enterovirus / 4 g (dry weight)**
  - ✓ **<1 viable helminth ova / 4 g (dry weight)**

- **Class B:**
  - ✓ **Use of a PSRP or equivalent process <u>or</u> <2 million fecal coliform / g (dry weight)**

Class B Biosolids Land Applied

Public access:

- 30 days – public access when there is a low potential for exposure
- 1 year – public access restriction when there is a high potential for exposure (e.g., turf)

Harvest:

- 30 days – food, feed, fiber crops harvest
- 14 to 38 months – depending on type of food crop and likelihood of touching amended soil

Grazing:

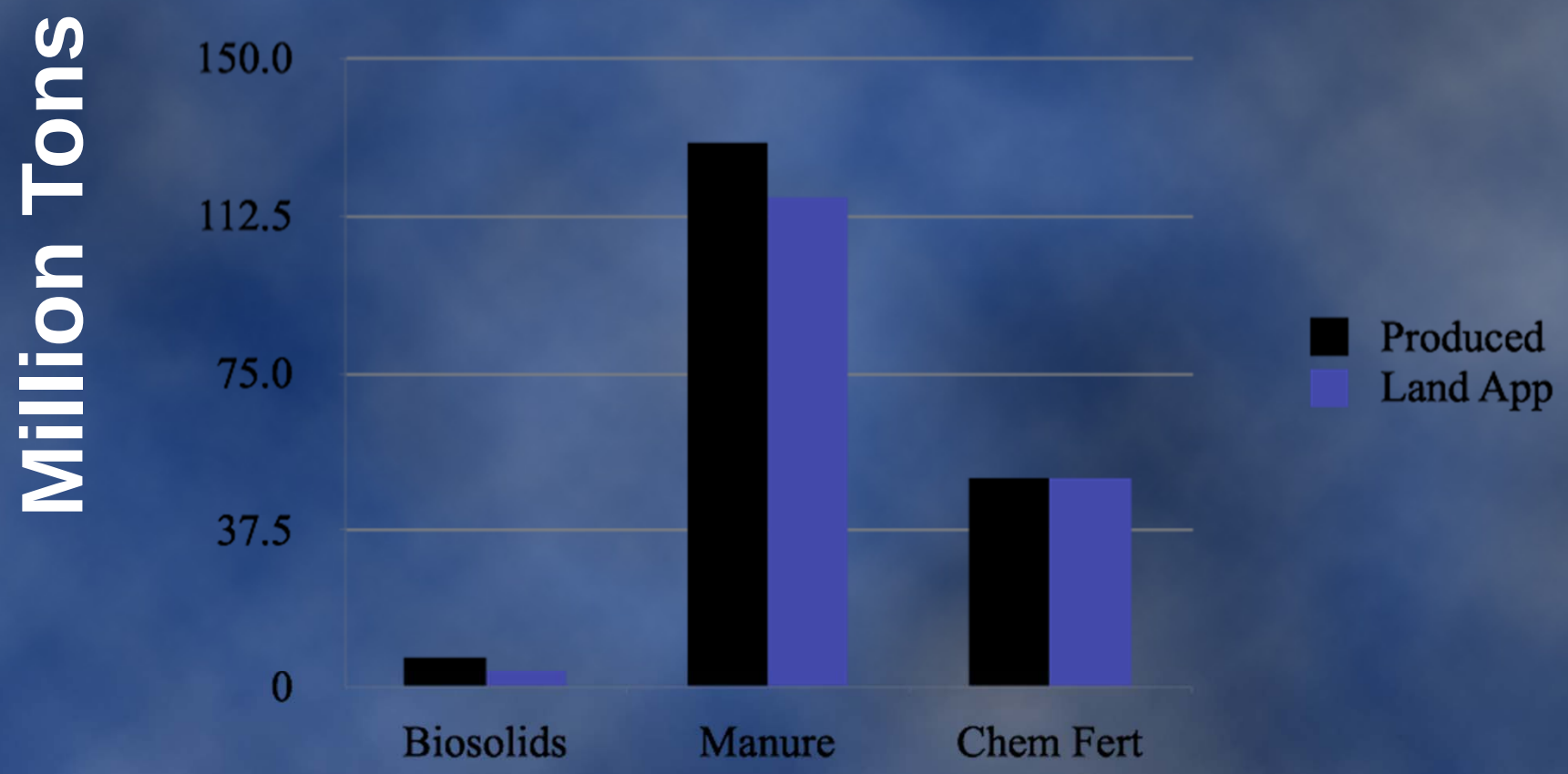
- 30 days – animals not allowed to graze

Vector Attraction Reduction

Employing one of the following:

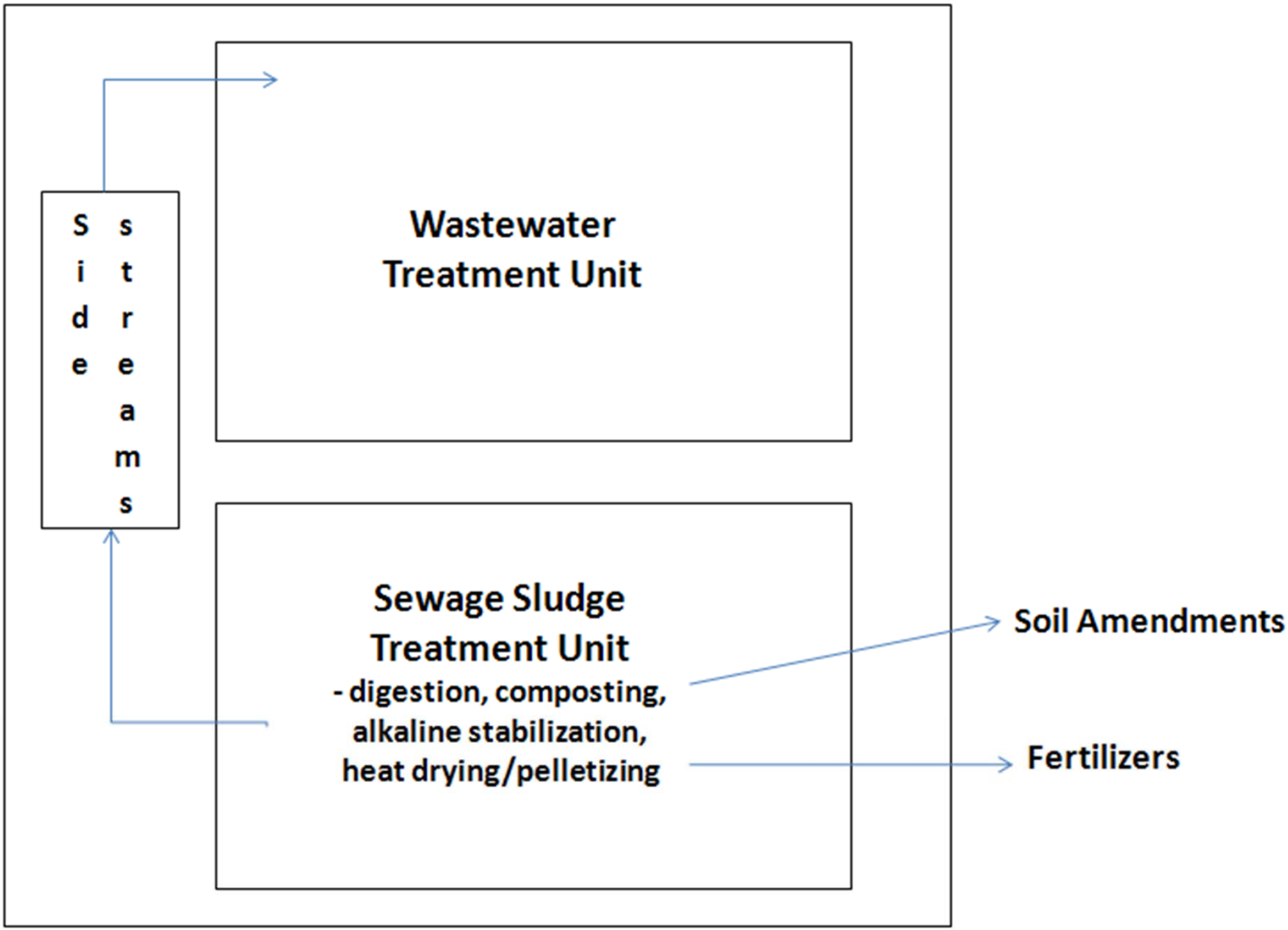
- Biological processes which break down volatile solids, reducing available nutrients for microbial activities and odor producing potential
  - 38 % VS reduction via treatment
- Chemical or physical conditions which stop microbial activity
  - Alkali to raise pH to at least 12
- Physical barriers between vectors and volatile solids in the sewage sludge
  - Soil barrier

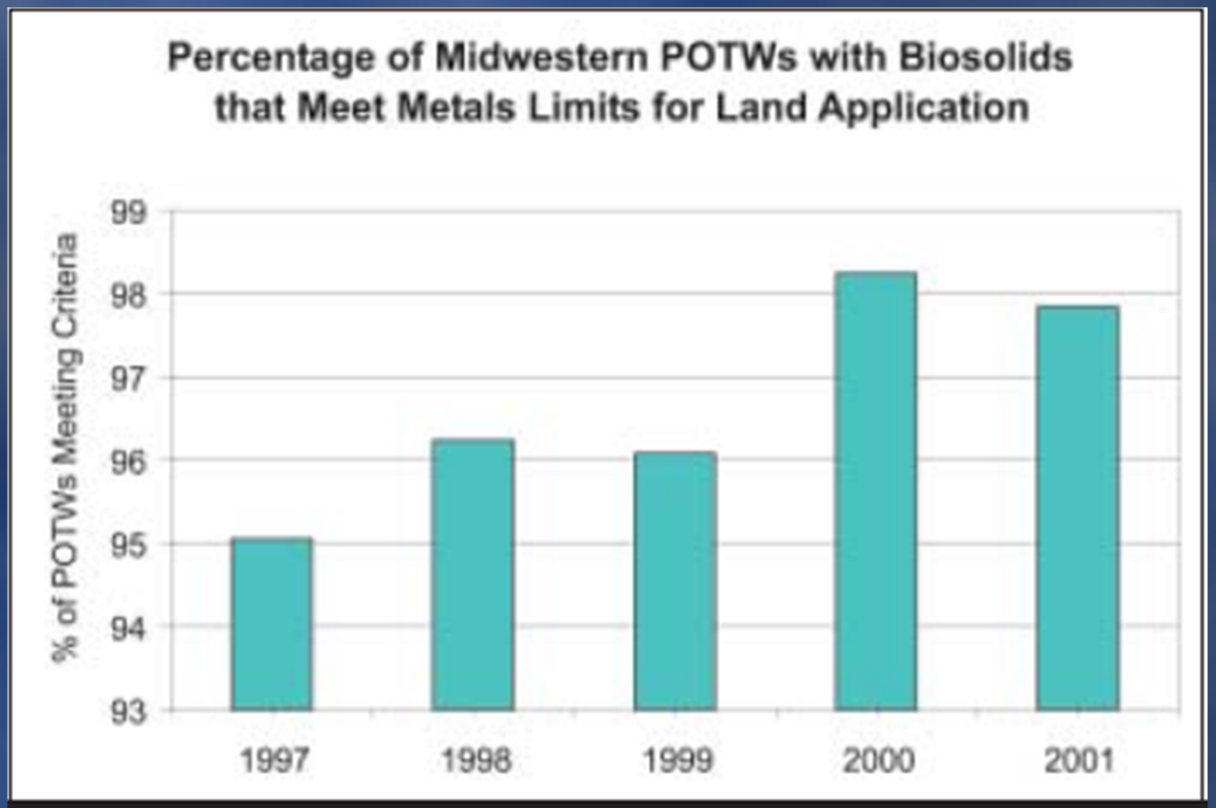
Materials Applied to Land in the US



NEBRA 2007; WERF 99PUM-1

Treatment System fence line

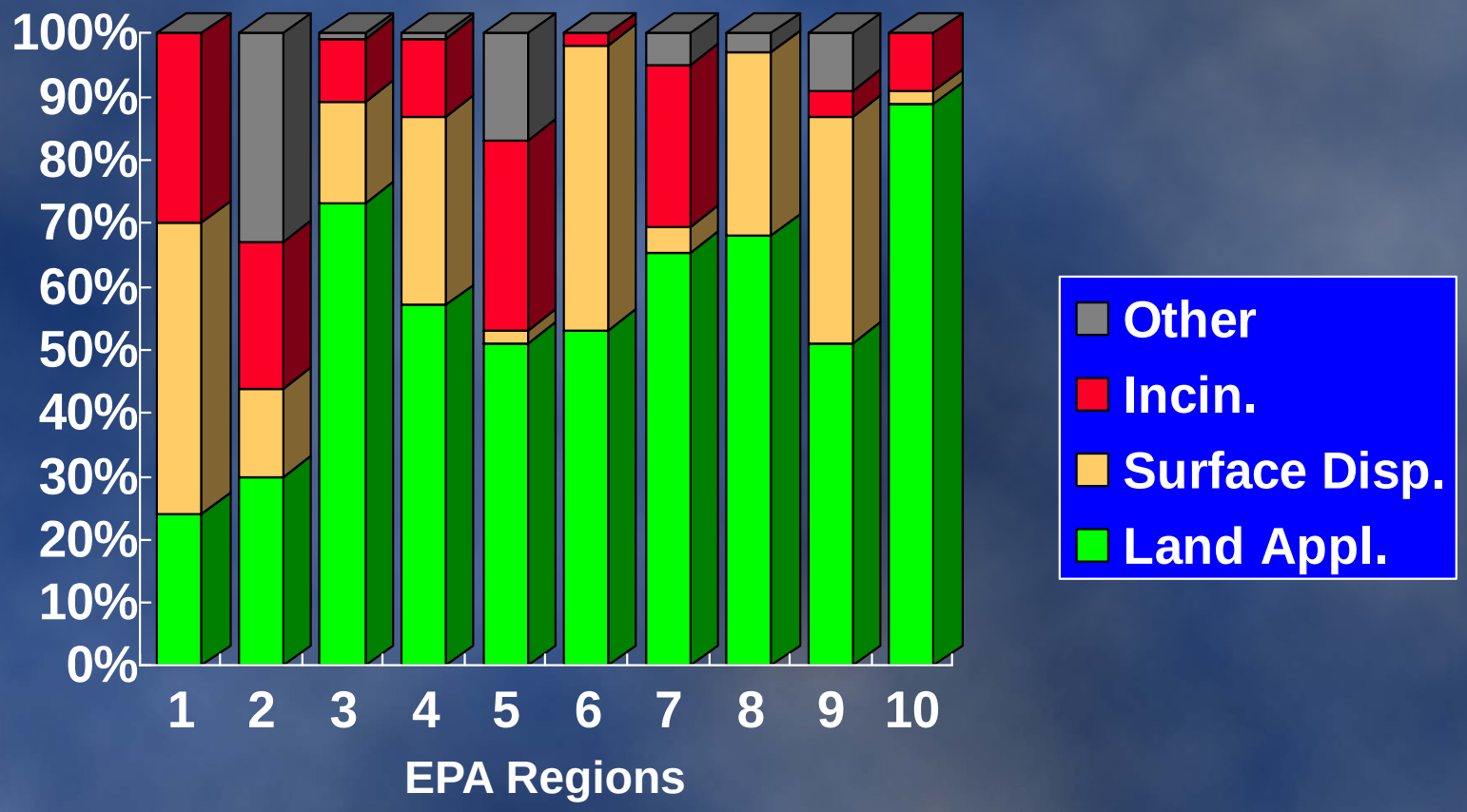




Data obtained from EPA's Permit Compliance System, representing information reported to EPA by POTWs in Illinois, Michigan, Minnesota, Ohio, and Wisconsin.

EPA's National Pretreatment Program, 1973–2003: Thirty Years of Protecting the Environment

Biosolids Use/Disposal Practices by EPA Region



Typical Application Practices

Injecting

Spraying

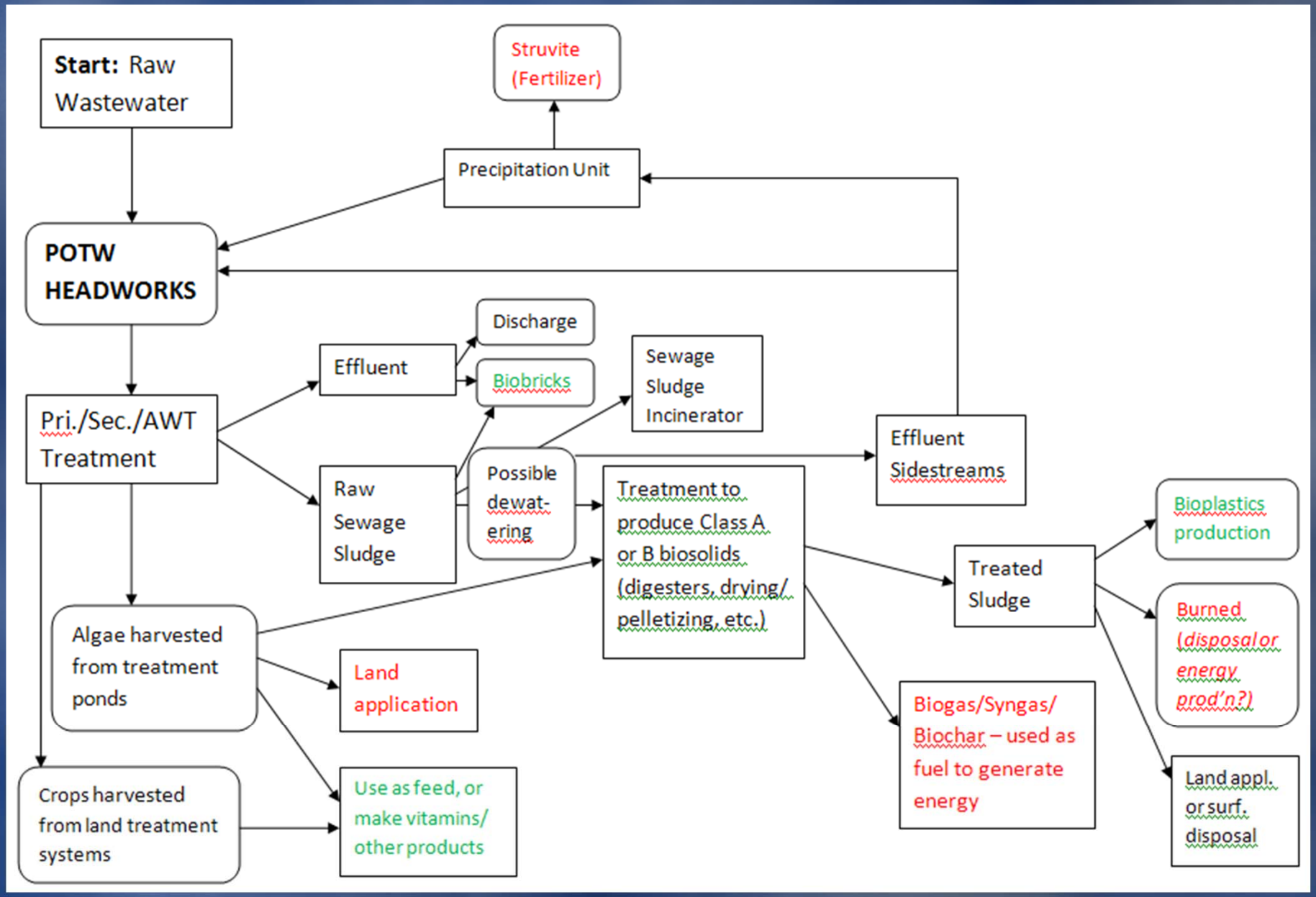
Spreading

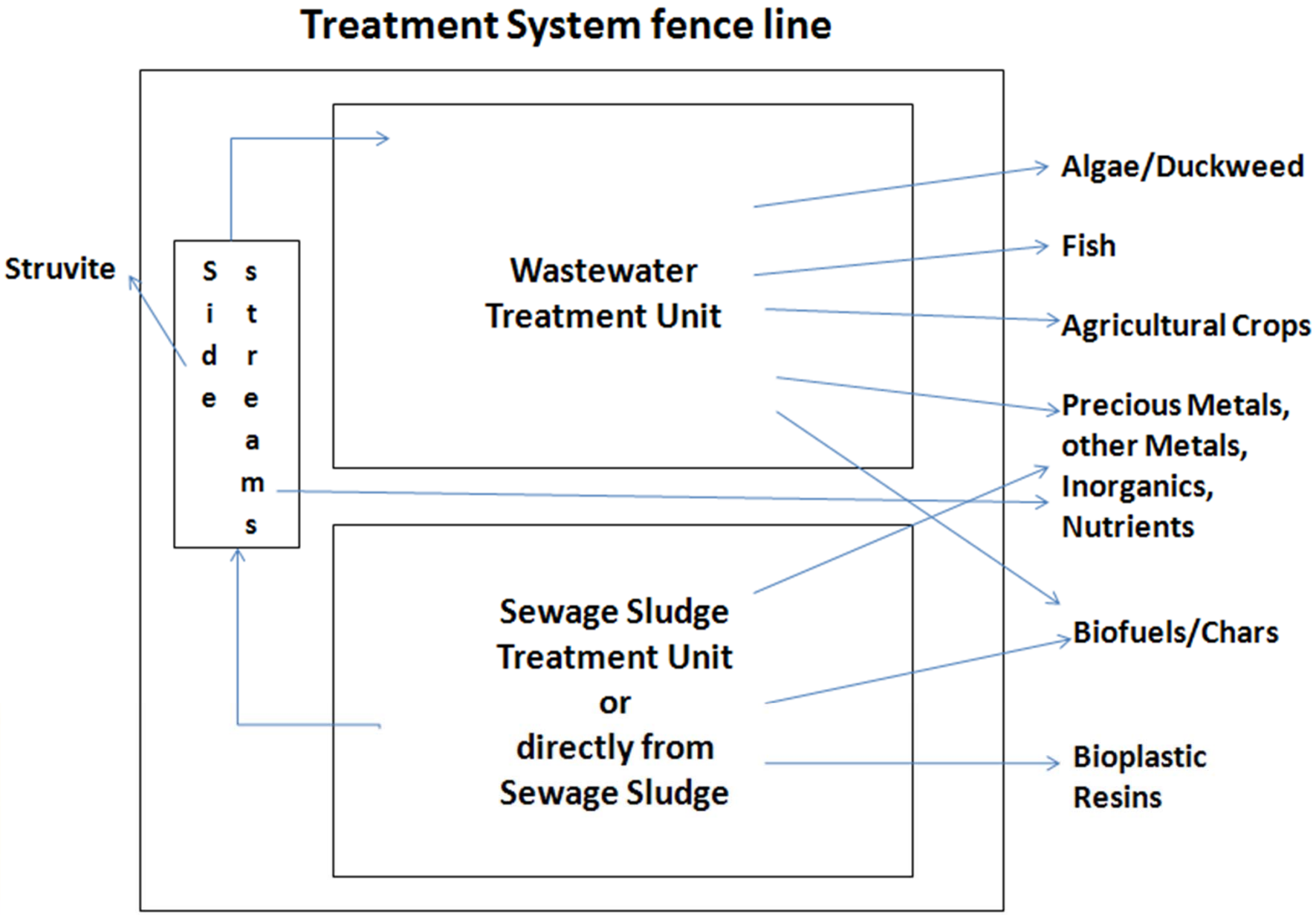
Slinging

THE
NATURAL ORGANIC
Milorganite®
FERTILIZER
6-2-0
ACTIVATED SEWAGE SLUDGE
Read directions and precautions on back panel carefully before using
For use on lawns, shrubs and ornamentals
Not for vegetables
Long lasting
Will not burn
The golf course choice for fine turf
All organic, naturally
Processed Only By
Milwaukee Metropolitan Sewerage District
Milwaukee, Wisconsin

Mulch

AGRO


Start: Raw Wastewater
Struvite (Fertilizer)
Precipitation Unit
POTW HEADWORKS
Discharge
Effluent
Biobricks
Sewage Sludge Incinerator
Pri./Sec./AWT Treatment
Effluent Sidestreams
Raw Sewage Sludge
Possible dewat-ering
Treatment to produce Class A or B biosolids (digesters, drying/ pelletizing, etc.)
Bioplastics production
Treated Sludge
Burned (disposal or energy prod'n?)
Algae harvested from treatment ponds
Land application
Biogas/Syngas/ Biochar – used as fuel to generate energy
Land appl. or surf. disposal
Crops harvested from land treatment systems
Use as feed, or make vitamins/ other products


Treatment System fence line
Struvite
Side streams
Wastewater Treatment Unit
Sewage Sludge Treatment Unit or directly from Sewage Sludge
Algae/Duckweed
Fish
Agricultural Crops
Precious Metals, other Metals, Inorganics, Nutrients
Biofuels/Chars
Bioplastic Resins

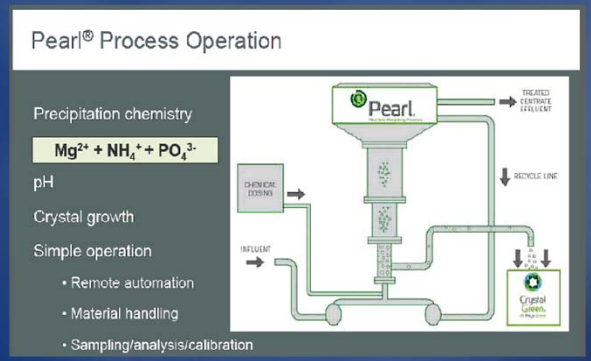
Struvite

(Magnesium Ammonium Phosphate) recovery from digester supernatant and sludge dewatering liquid

MULTIFORM HARVEST

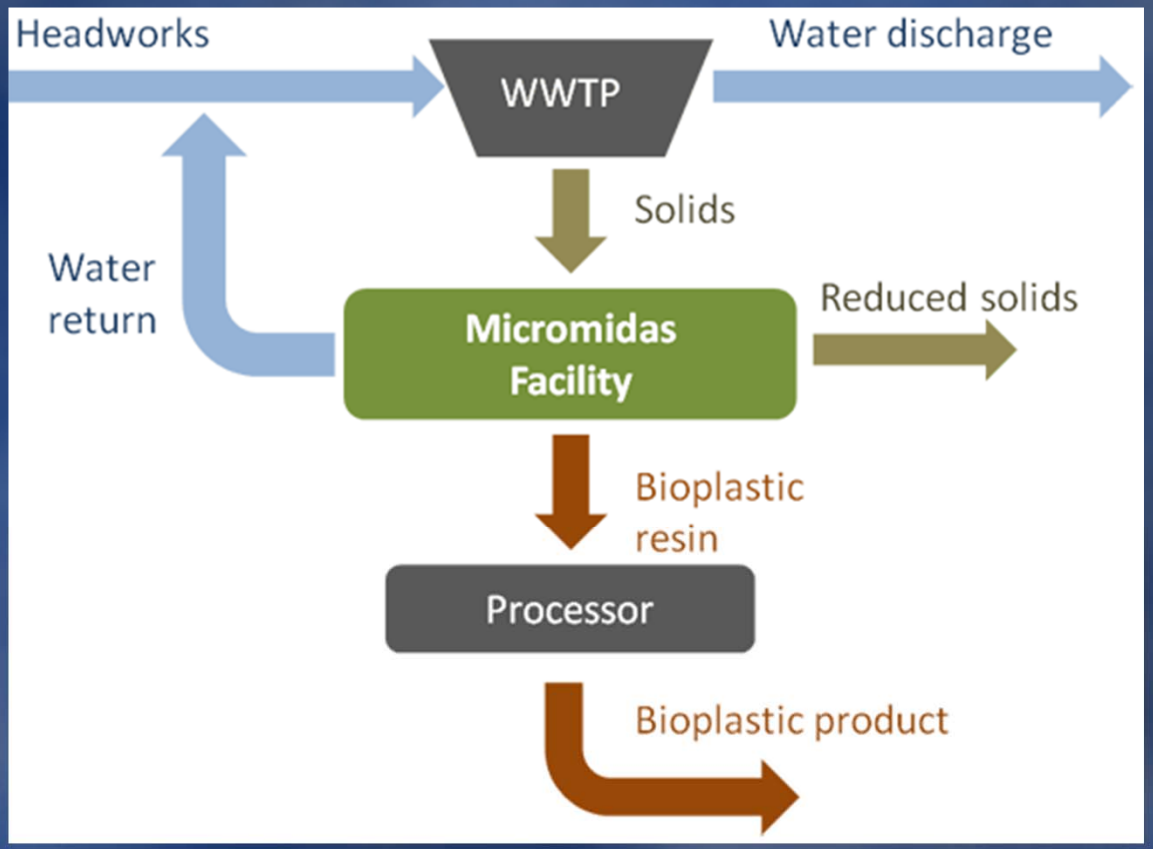
Crystal Green®
(5-28-0 +10 Mg)

… a 99.9 percent pure, slow release form of nitrogen, phosphorus and magnesium

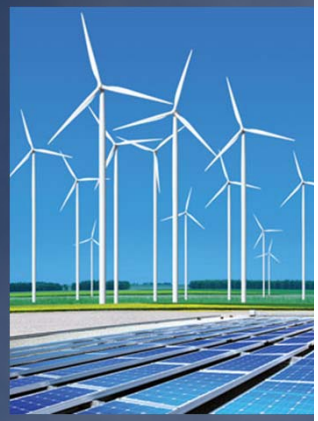


Micromidas - Initial commercialization effort is the production of polyhydroxyalkanoates— bio-degradable, renewably-derived plastics.

The Process

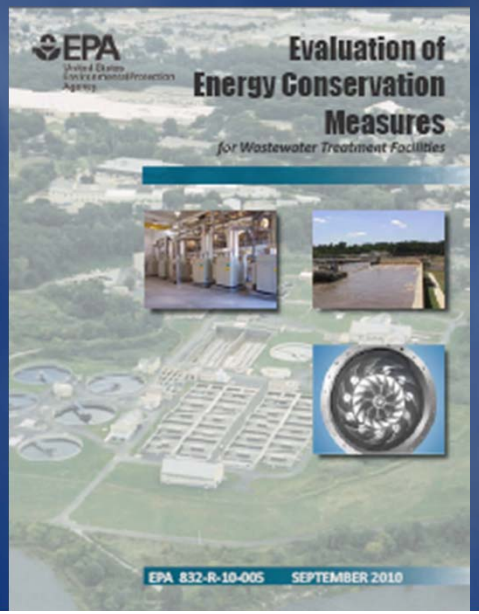


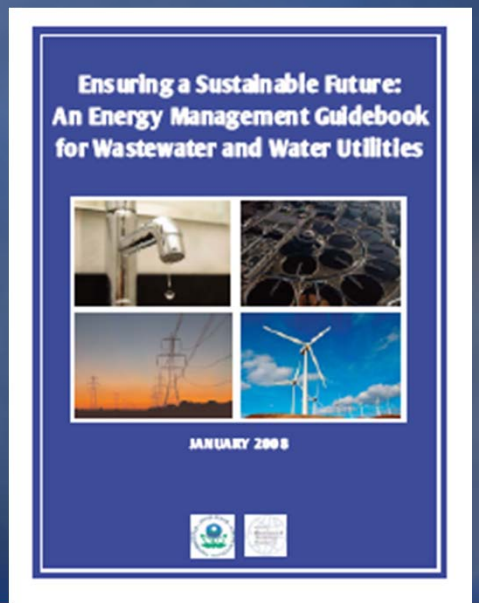
Current/Future Focus

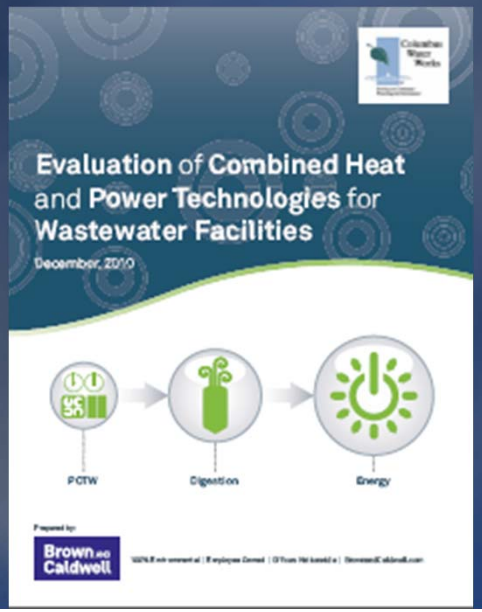


- ENERGY
  - IMPROVED ENERGY EFFICIENCY
  - ENERGY SELF SUFFICIENT
    - ONSITE HEAT & POWER PRODUCTION
    - ALTERNATIVE ENERGY SOURCES
  - NET EXPORTERS OF ENERGY?

Portfolio Manager







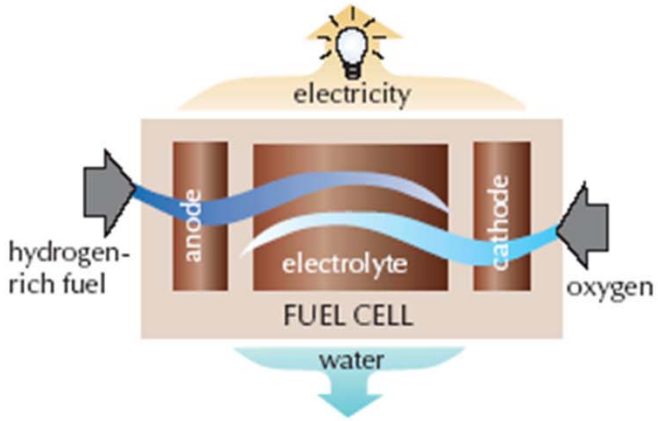
New-Generation Lean Burn Cogeneration Engine – Cummins Power Generation

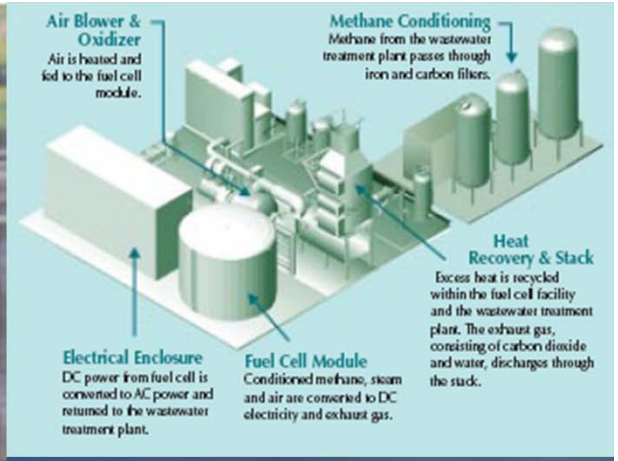
Combustion Turbine

Steam Turbine

Microturbine

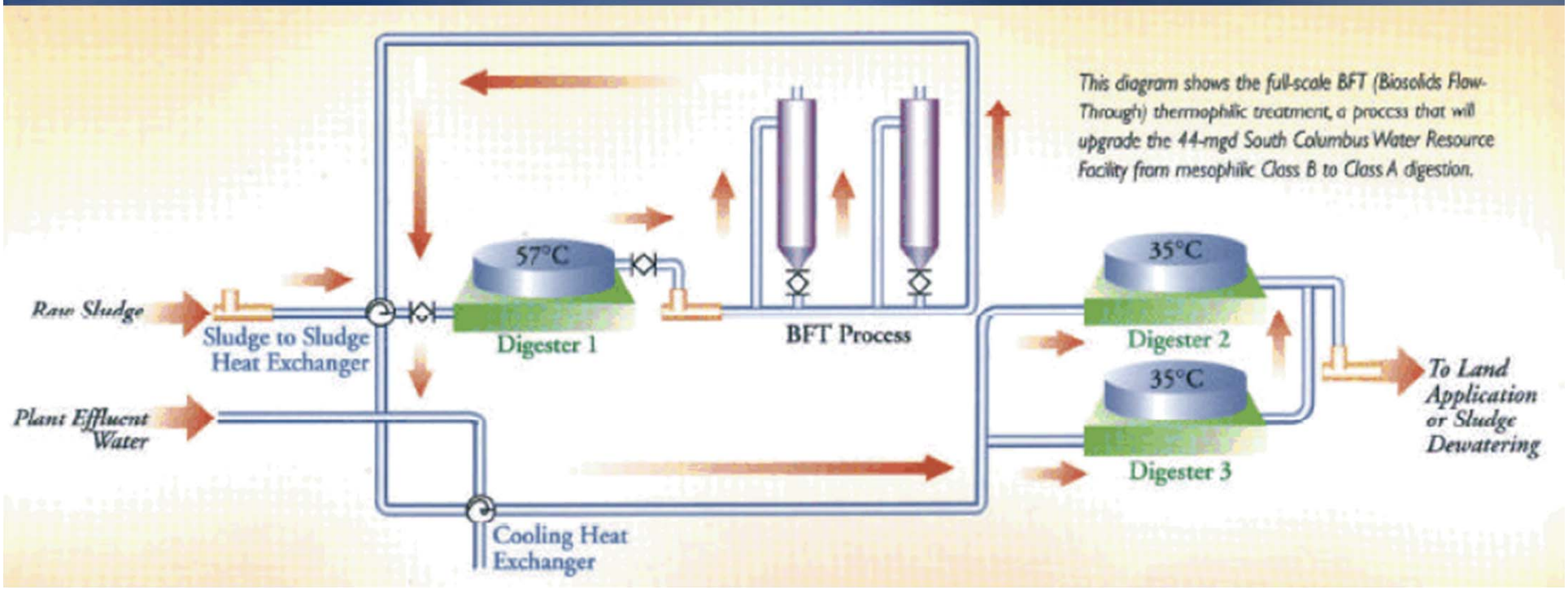
Molten Carbonate Fuel Cell

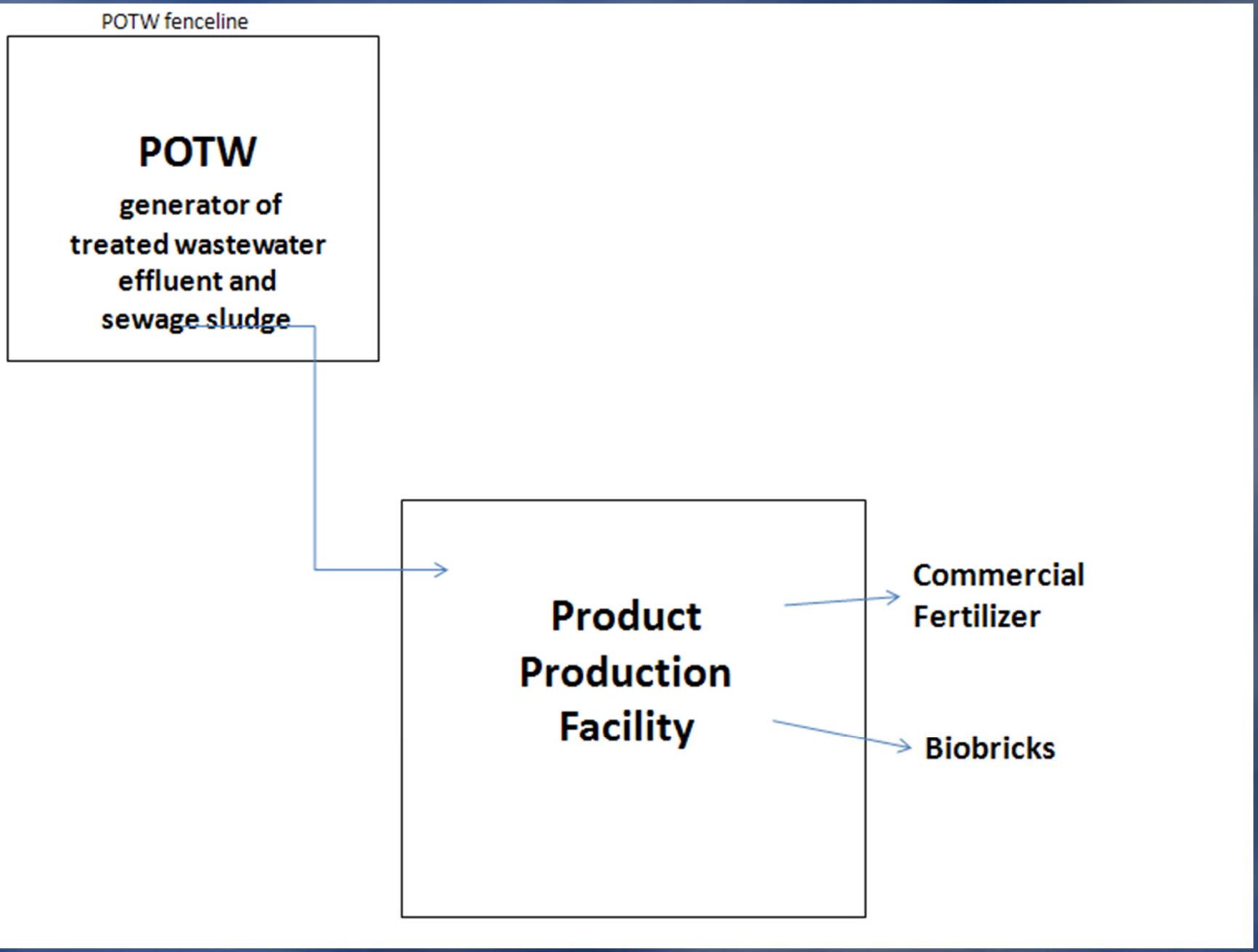




http://www.kingcounty.gov/environment/wastewater/EnergyRecovery/FuelCellDemonstration.aspx

http://www.cwwga.org/subpages1.asp?pageid=14

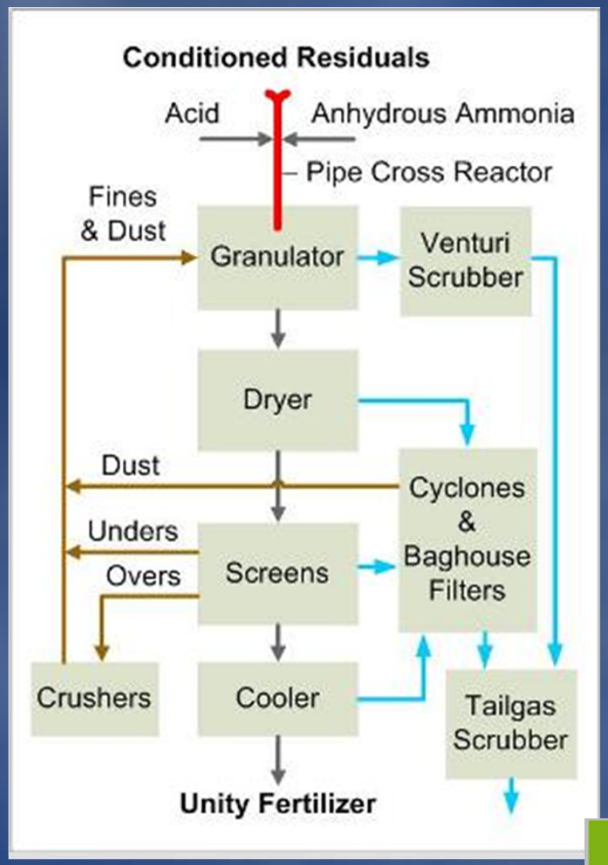



POTW fenceline
POTW
generator of treated wastewater effluent and sewage sludge
Product Production Facility
Commercial Fertilizer
Biobricks

UNITY envirotech

Safe Residuals Management. Sustainable Crop Nutrition.

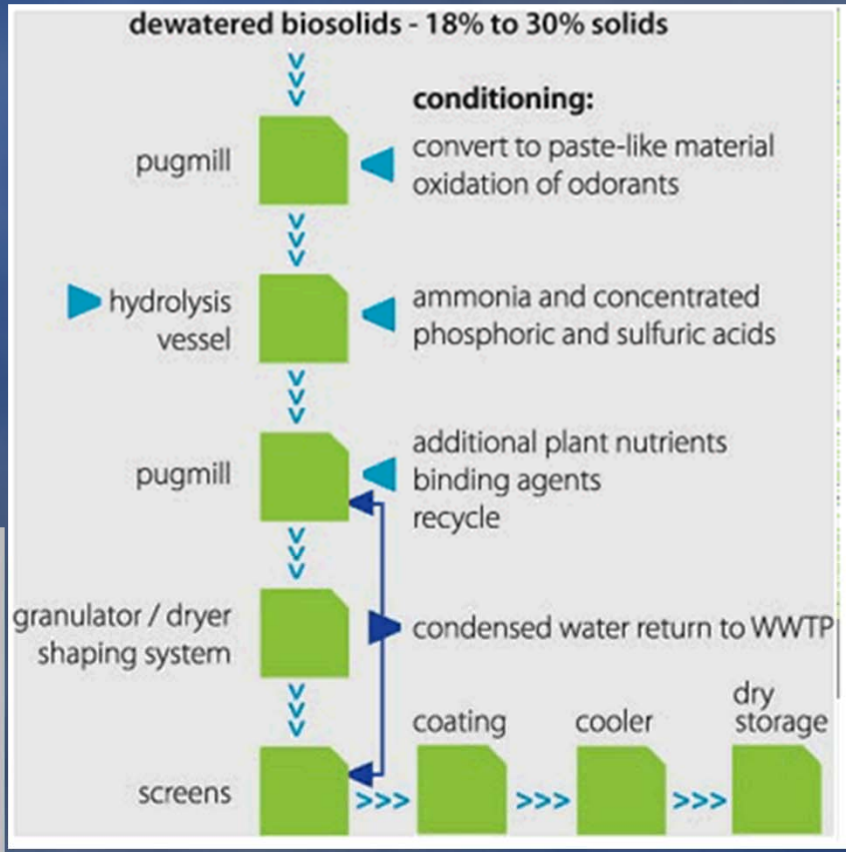
Fertilizer Granulation



VitAGcorp

A Beneficial Useable Technology

VitAG Technology



- Looks, smells, and handles like a traditional fertilizer

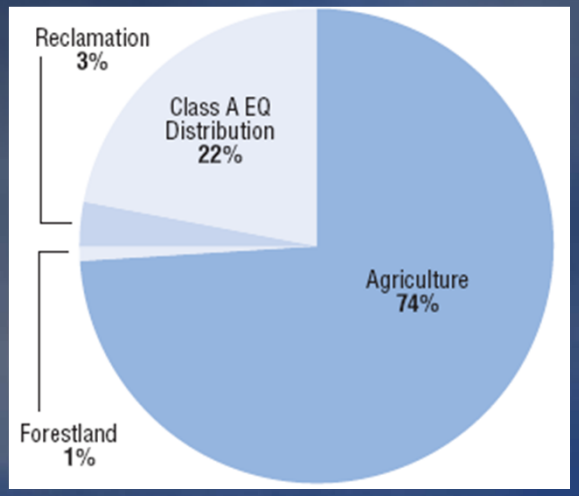
Applying all of the Biosolids produced to cropland as a partial replacement of commercial fertilizer?

Assume:

- **8 million dry U.S. tons of biosolids per year**
- **406,429,909 acres of cropland in the U.S.**
- **309,607,601 acres of harvested cropland**
- **applying biosolids at 2 tons/acre ….**

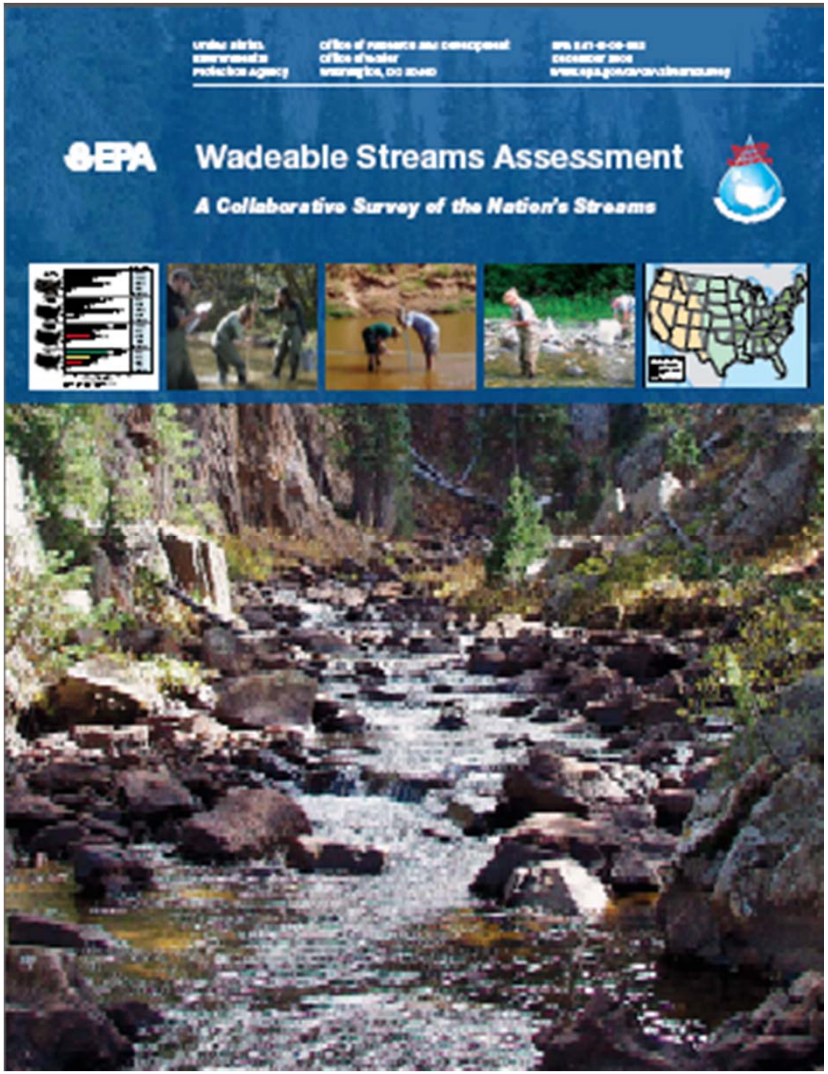
Would only require:

- **4 million acres**
- **~1% of the total cropland**
- **~1.4% of the harvested cropland**

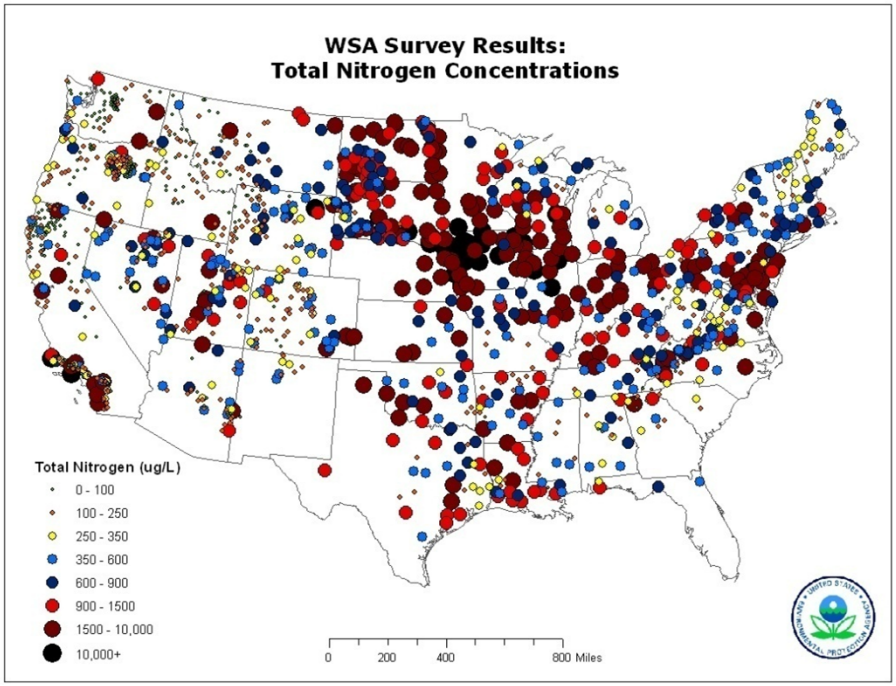


National Scope of Nutrient Water Quality Problem

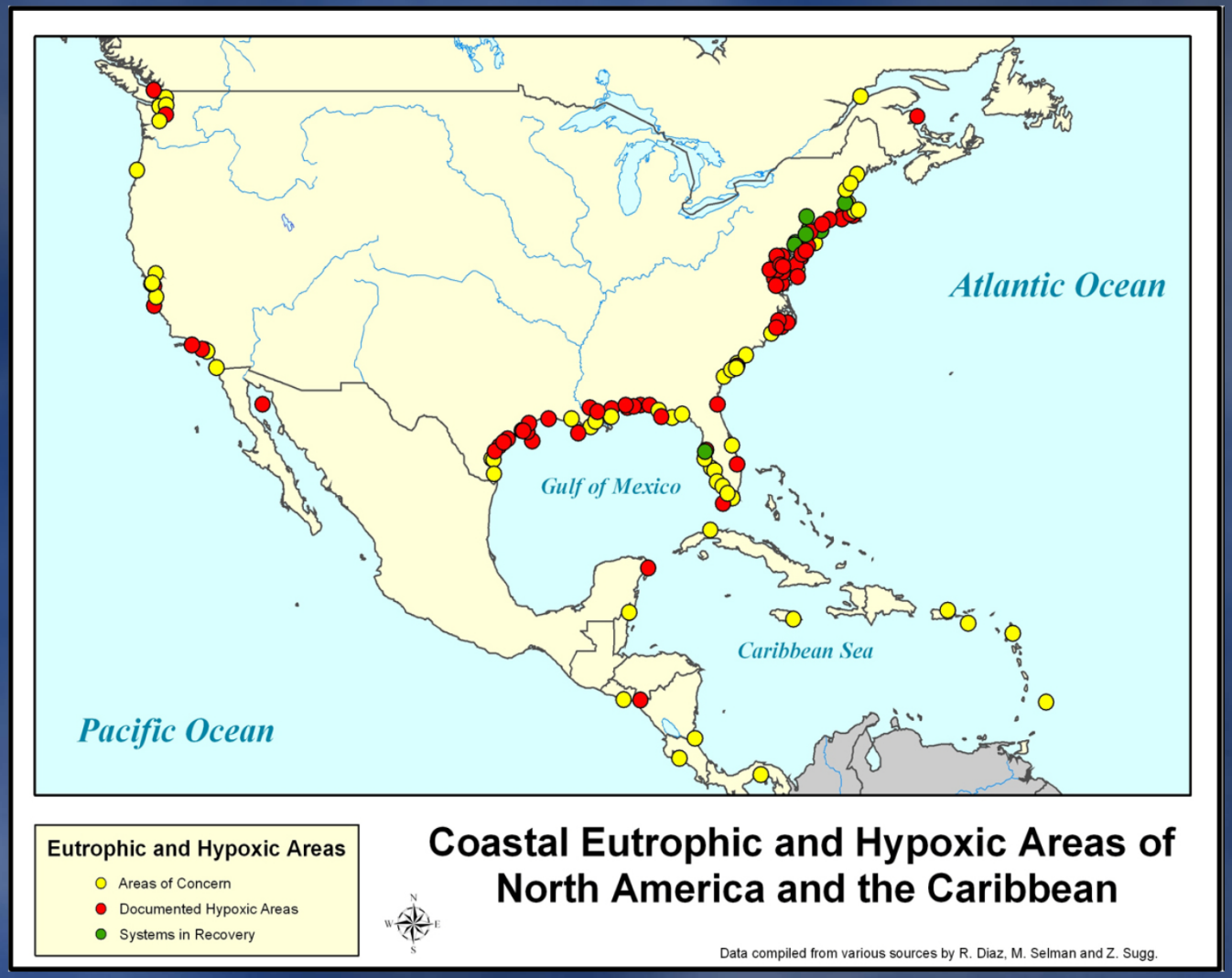
- 14,000 Nutrient-related Impairment Listings in 49 States
  - 2.5 Million Acres of Lakes and Reservoirs
  - 80,000 Miles of Rivers and Streams
  - And This is an Underestimate . . .
- Over 47% of Streams Have Medium to High Levels of Phosphorus and Over 53% Have Medium to High Levels of Nitrogen
- 168 Hypoxic Zones in U.S. Waters
- 78% of Assessed Continental U.S. Coastal Area Exhibits Eutrophication Symptoms



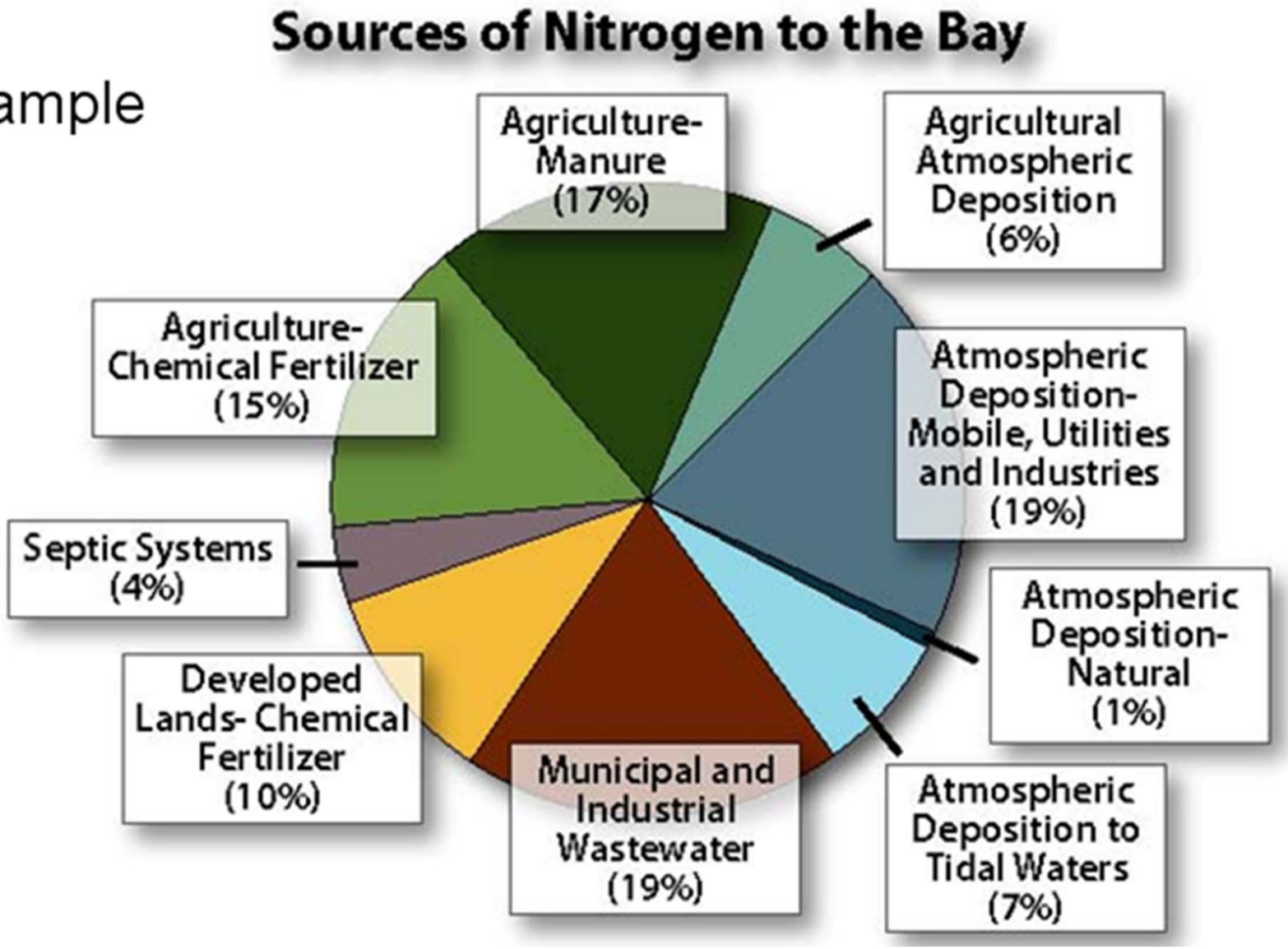
Concentrations of Nitrogen Nationally



Hypoxic Zone Locations

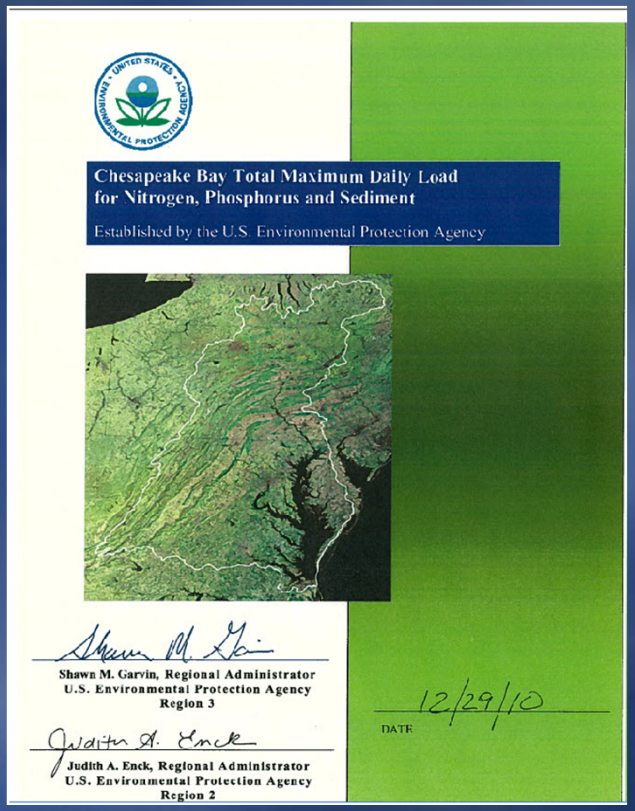


An Example


Sources of Nitrogen to the Bay
Agriculture-Manure (17%)
Agricultural Atmospheric Deposition (6%)
Atmospheric Deposition-Mobile, Utilities and Industries (19%)
Atmospheric Deposition-Natural (1%)
Atmospheric Deposition to Tidal Waters (7%)
Municipal and Industrial Wastewater (19%)
Developed Lands- Chemical Fertilizer (10%)
Septic Systems (4%)
Agriculture-Chemical Fertilizer (15%)

As of Dec'2010 … the TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus …

- **Nitrogen pollution to the Chesapeake Bay must be reduced by 25%**
- **Phosphorus pollution must be reduced by 24%**



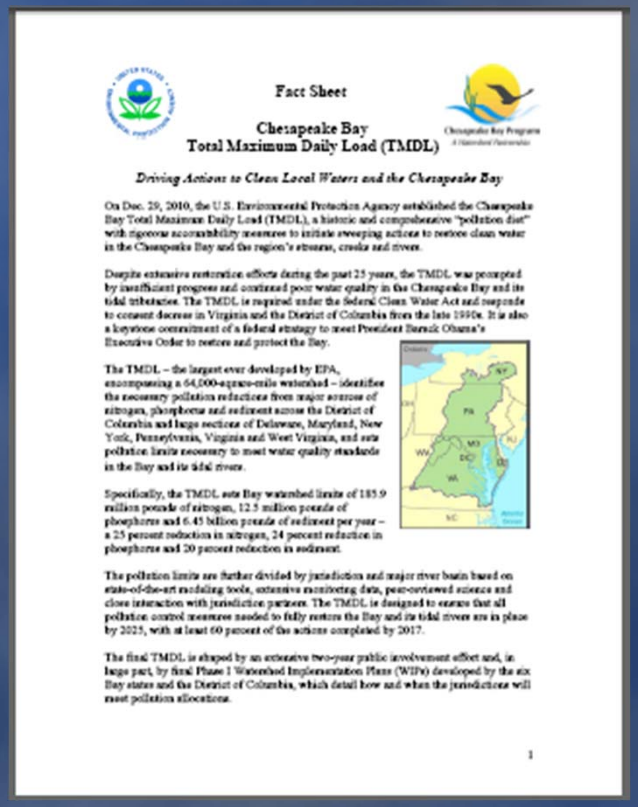
Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment

Established by the U.S. Environmental Protection Agency

Shawn M. Garvin, Regional Administrator
U.S. Environmental Protection Agency
Region 3

Judith A. Enck, Regional Administrator
U.S. Environmental Protection Agency
Region 2

12/29/10
DATE



Fact Sheet

Chesapeake Bay
Total Maximum Daily Load (TMDL)

Driving Actions to Clean Local Waters and the Chesapeake Bay

On Dec. 29, 2010, the U.S. Environmental Protection Agency established the Chesapeake Bay Total Maximum Daily Load (TMDL), a historic and comprehensive "pollution diet" with rigorous accountability measures to initiate sweeping actions to restore clean water in the Chesapeake Bay and the region's streams, creeks and rivers.

Despite extensive restoration efforts during the past 25 years, the TMDL was prompted by insufficient progress and continued poor water quality in the Chesapeake Bay and its tidal tributaries. The TMDL is required under the federal Clean Water Act and responds to consent decrees in Virginia and the District of Columbia from the late 1990s. It is also a keystone commitment of a federal strategy to meet President Barack Obama's Executive Order to restore and protect the Bay.

The TMDL – the largest ever developed by EPA, encompassing a 64,000-square-mile watershed – identifies the necessary pollution reductions from major sources of nitrogen, phosphorus and sediment across the District of Columbia and large sections of Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia, and sets pollution limits necessary to meet water quality standards in the Bay and its tidal rivers.

Specifically, the TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year – a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment.

The pollution limits are further divided by jurisdiction and major river basin based on state-of-the-art modeling tools, extensive monitoring data, peer-reviewed science and close interaction with jurisdiction partners. The TMDL is designed to ensure that all pollution control measures needed to fully restore the Bay and its tidal rivers are in place by 2025, with at least 60 percent of the actions completed by 2017.

The final TMDL is shaped by an extensive two-year public involvement effort and, in large part, by final Phase I Watershed Implementation Plans (WIPs) developed by the six Bay states and the District of Columbia, which detail how and when the jurisdictions will meet pollution allocations.

1

Role of Water Reuse and Biosolids in meeting nutrient management requirements

- Water Reuse and Biosolids Use in Agriculture to replace inorganic fertilizer as a strategy for reducing nutrients in receiving waters
  - Wastewater as an alternative water supply
  - Biosolids as a Nitrogen & Phosphorus fertilizer source
- Water/Wastewater/Biosolids Management Systems designed for multiple benefits taking advantage of ecosystem services

13Dec2010 NRCS DM 9500-012

DM 9500-012
United States
Department of
Agriculture
Office of the Chief
Information Officer

GRASSLAND RESERVE PROGRAM
DM 9500-012

U.S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C. 20250

GRASSLAND RESERVE PROGRAM

PROGRAM PURPOSE

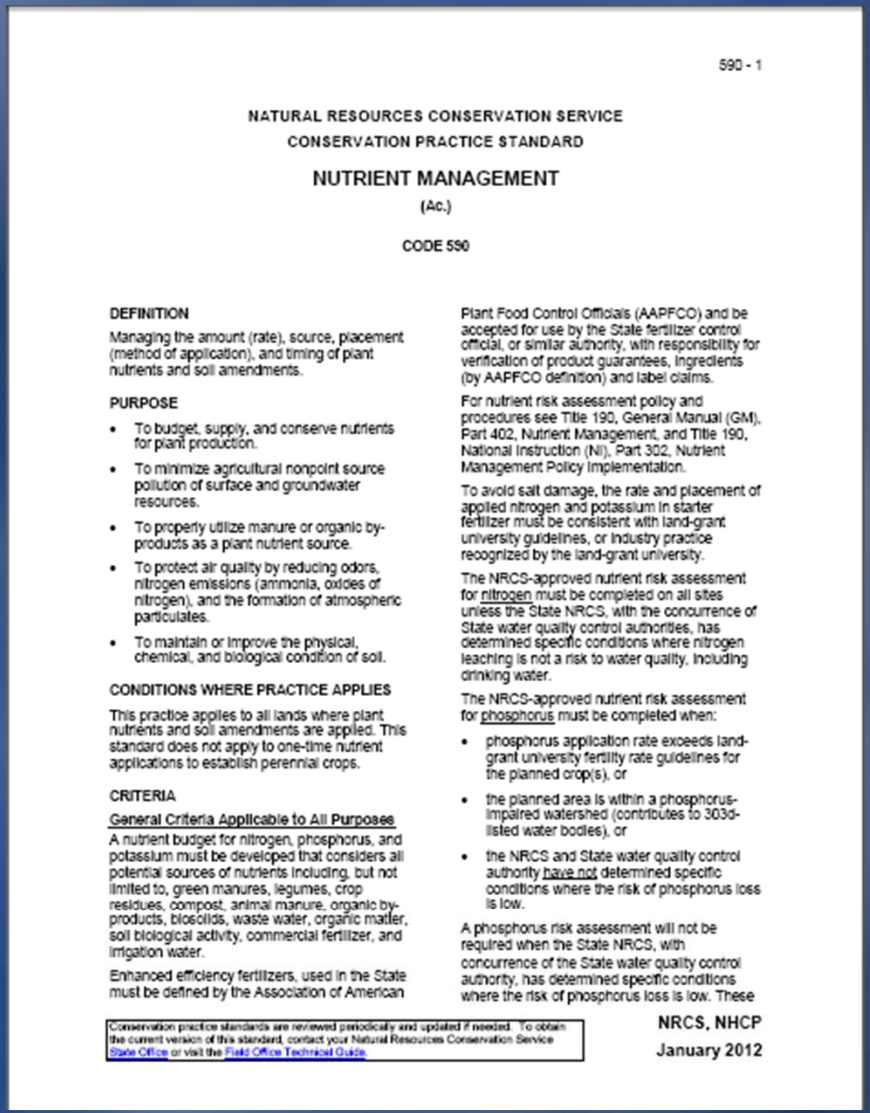
The purpose of the Grassland Reserve Program (GRP) is to provide assistance to landowners and operators to protect grazing uses and related conservation values on eligible private range and pasture lands.

16. PROHIBITED ACTIVITIES

Trash Dumping.

Dumping, collecting, recycling, or storing of trash, refuse or waste is prohibited, except that animal waste may be applied as fertilizer at rates recommended in the GRP Management plan. Sewage sludge is not allowed.

January 2012 NRCS CODE 590



590 - 1

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT
(Ac.)

CODE 590

DEFINITION

Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE

- To budget, supply, and conserve nutrients for plant production.
- To minimize agricultural nonpoint source pollution of surface and groundwater resources.
- To properly utilize manure or organic by-products as a plant nutrient source.
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates.
- To maintain or improve the physical, chemical, and biological condition of soil.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

CRITERIA

General Criteria Applicable to All Purposes

A nutrient budget for nitrogen, phosphorus, and potassium must be developed that considers all potential sources of nutrients including, but not limited to, green manures, legumes, crop residues, compost, animal manure, organic by-products, biosolids, waste water, organic matter, soil biological activity, commercial fertilizer, and irrigation water.

Enhanced efficiency fertilizers, used in the State must be defined by the Association of American Plant Food Control Officials (AAPFCO) and be accepted for use by the State fertilizer control official, or similar authority, with responsibility for verification of product guarantees, ingredients (by AAPFCO definition) and label claims.

For nutrient risk assessment policy and procedures see Title 190, General Manual (GM), Part 402, Nutrient Management, and Title 190, National Instruction (NI), Part 302, Nutrient Management Policy Implementation.

To avoid salt damage, the rate and placement of applied nitrogen and potassium in starter fertilizer must be consistent with land-grant university guidelines, or industry practice recognized by the land-grant university.

The NRCS-approved nutrient risk assessment for nitrogen must be completed on all sites unless the State NRCS, with the concurrence of State water quality control authorities, has determined specific conditions where nitrogen leaching is not a risk to water quality, including drinking water.

The NRCS-approved nutrient risk assessment for phosphorus must be completed when:

- phosphorus application rate exceeds land-grant university fertility rate guidelines for the planned crop(s), or
- the planned area is within a phosphorus-impaired watershed (contributes to 303d-listed water bodies), or
- the NRCS and State water quality control authority have not determined specific conditions where the risk of phosphorus loss is low.

A phosphorus risk assessment will not be required when the State NRCS, with concurrence of the State water quality control authority, has determined specific conditions where the risk of phosphorus loss is low. These

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact your Natural Resources Conservation Service State Office or visit the Field Office Technical Guide.

NRCS, NHCP
January 2012

U.S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C. 20250

CONSERVATION PRACTICE STANDARD NUTRIENT MANAGEMENT

CODE 590

PURPOSE

- To budget, supply, and conserve nutrients for plant production.
- To minimize agricultural nonpoint source pollution of surface and groundwater resources.
- To properly utilize manure or organic by-products as a plant nutrient source.
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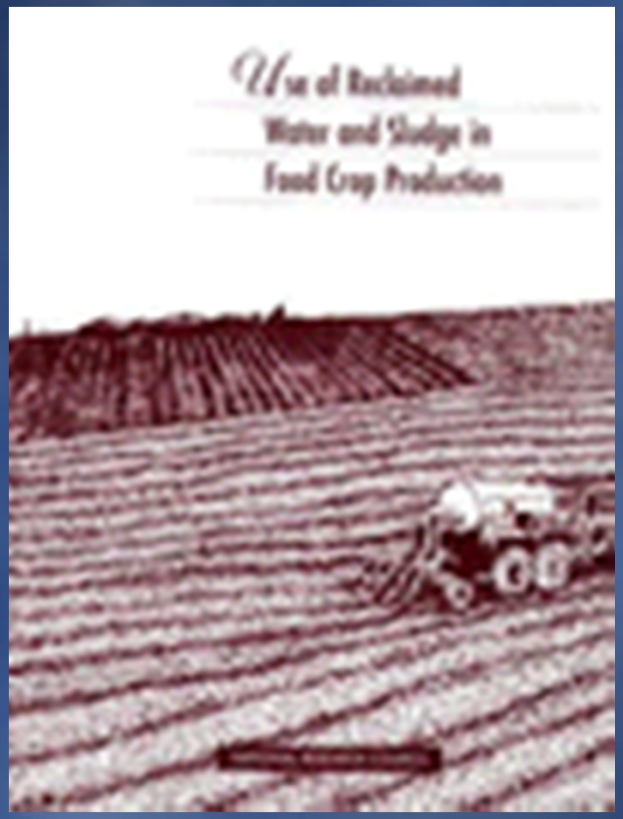
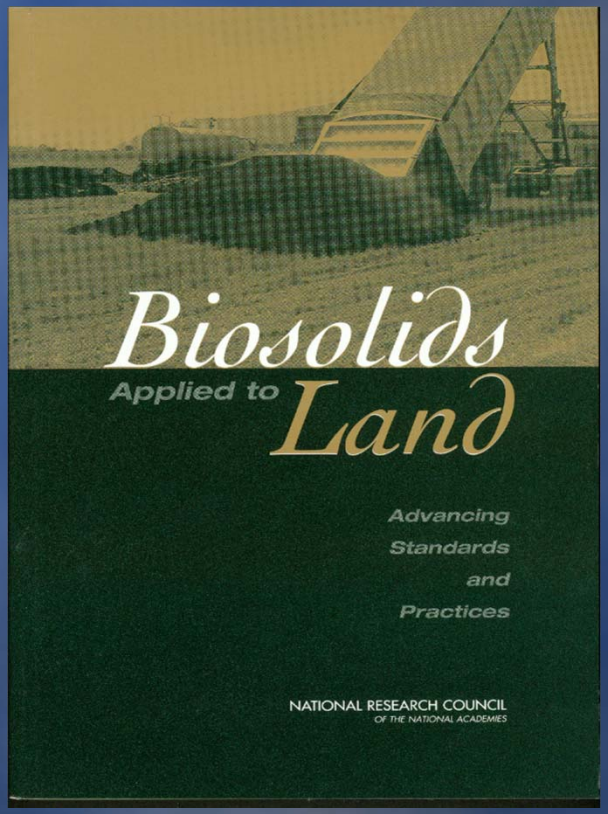
Organic Labeling and Marketing

NRC/NAS Reviews

1996



2002



GHG Emissions - Wastewater Treatment/Biosolids Management

- Basically part of the short term carbon cycle
- Biosolids management can impact the carbon cycle …
  - By making or using energy
  - By replacing products that require energy to produce
  - By replacing products that emit GHGs
  - By emitting gases other than CO_2 … CH_4 & N_20
  - By sequestering carbon
- Biosolids can be a significant source of GHG credits

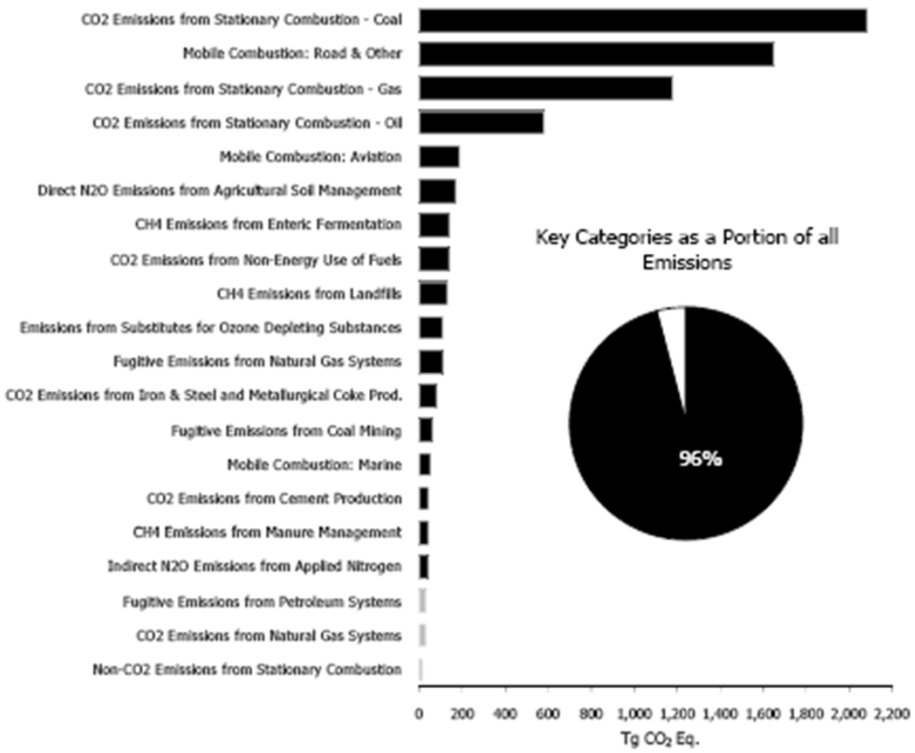


Figure ES-16: 2007 Key Categories
Notes: For a complete discussion of the key source analysis, see Annex 1.
Black bars indicate a Tier 1 level assessment key category.
Gray bars indicate a Tier 2 level assessment key category.

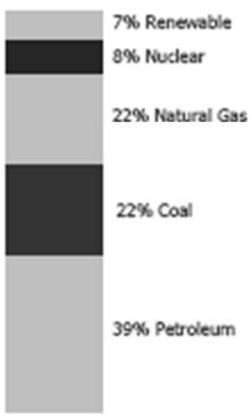


Figure ES-12: 2007 U.S. Energy Consumption by Energy Source

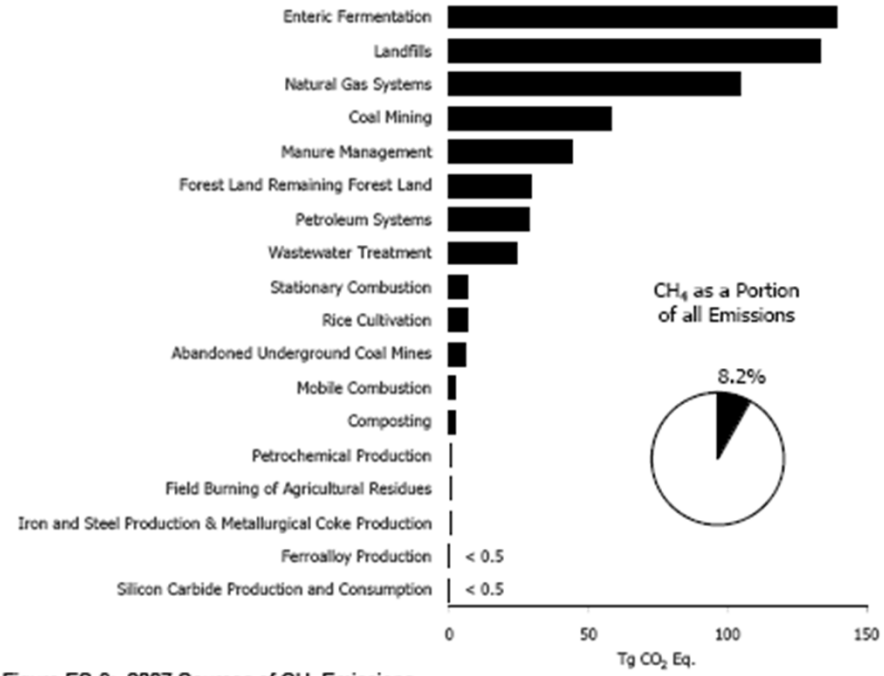


Figure ES-8: 2007 Sources of CH_4 Emissions

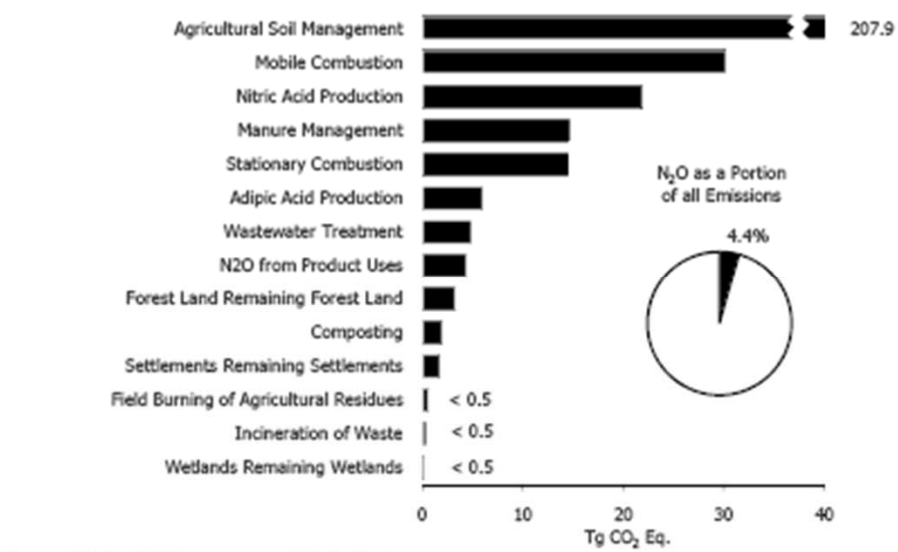
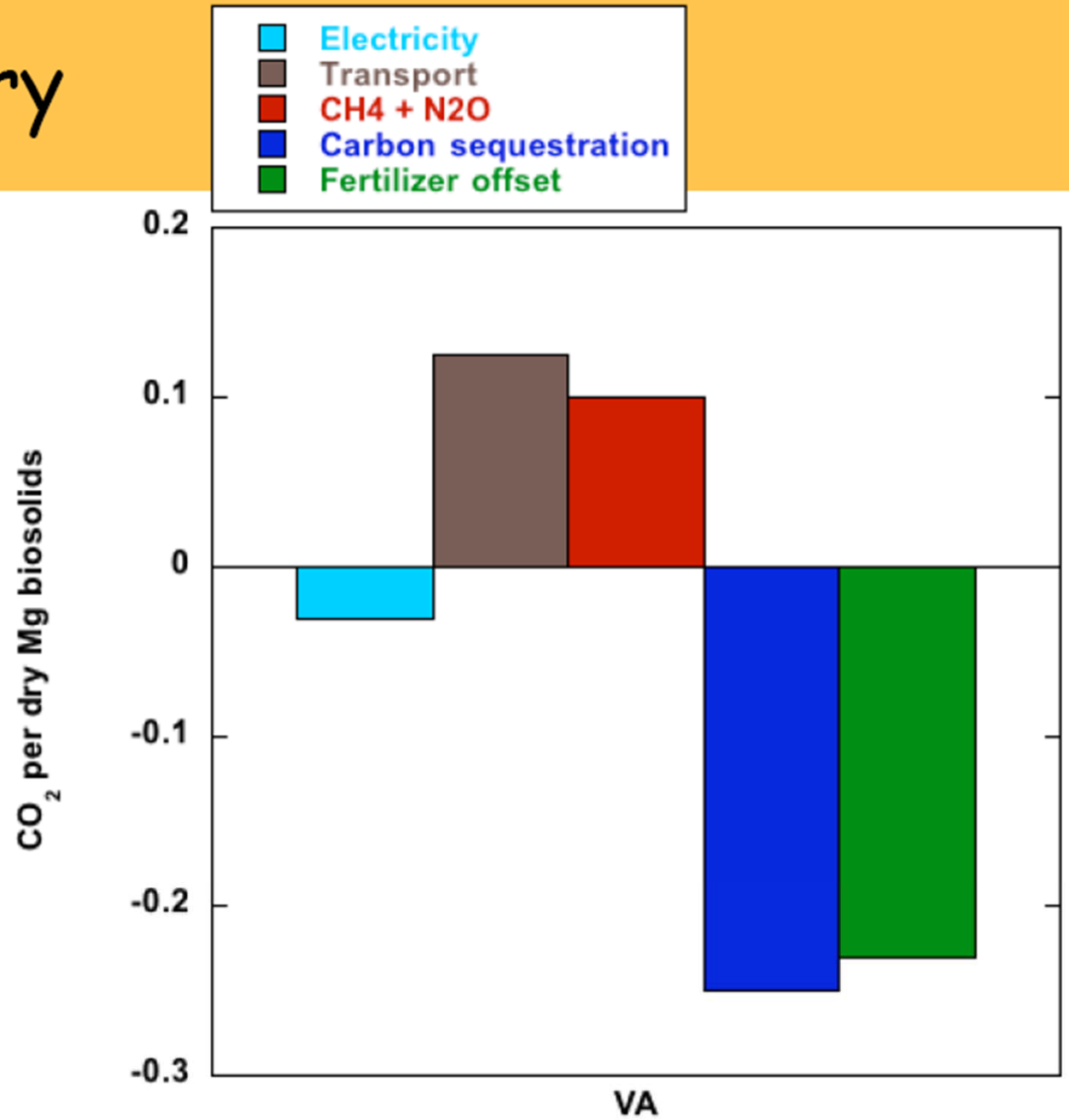
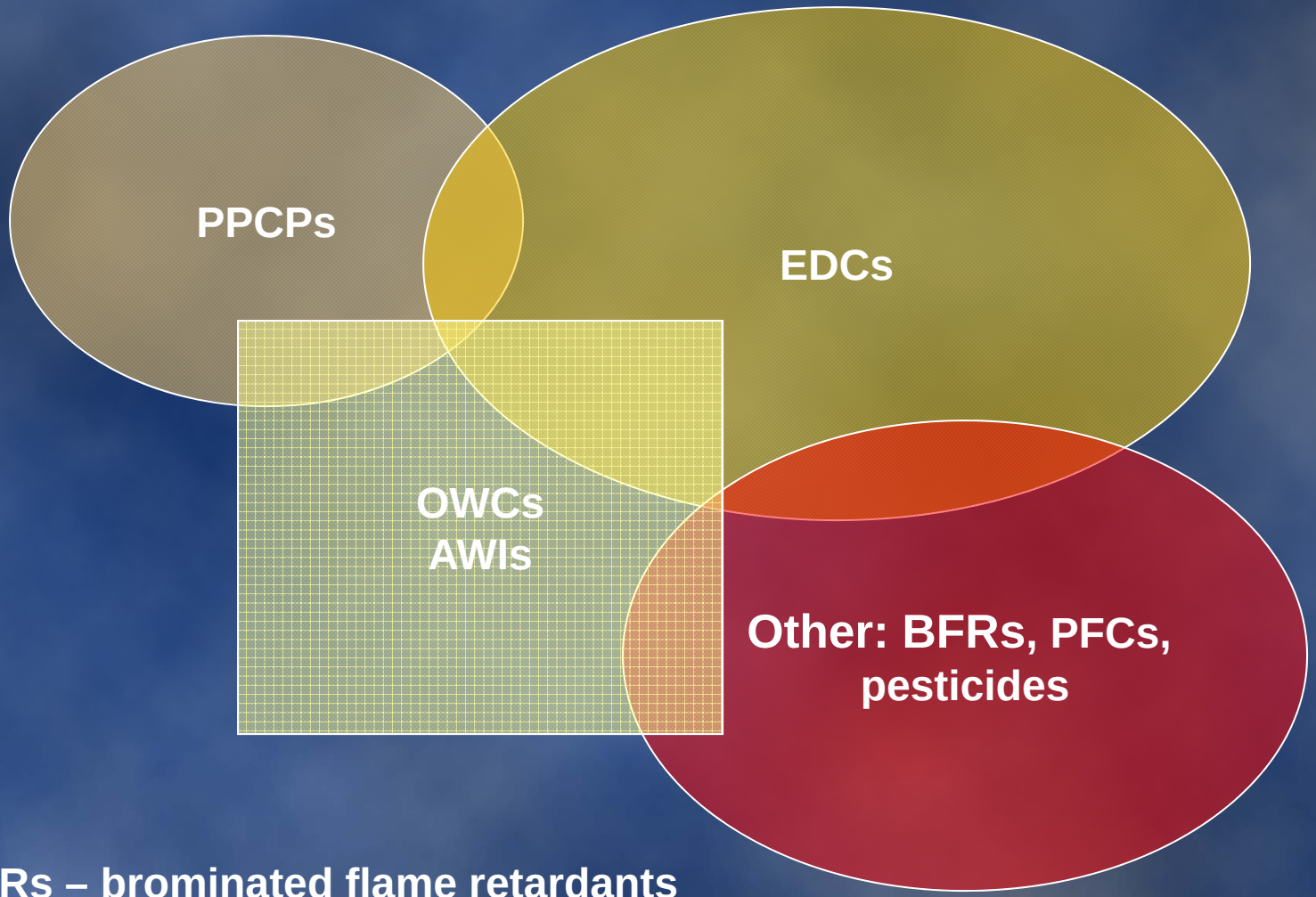


Figure ES-9: 2007 Sources of N_2O Emissions

VA summary

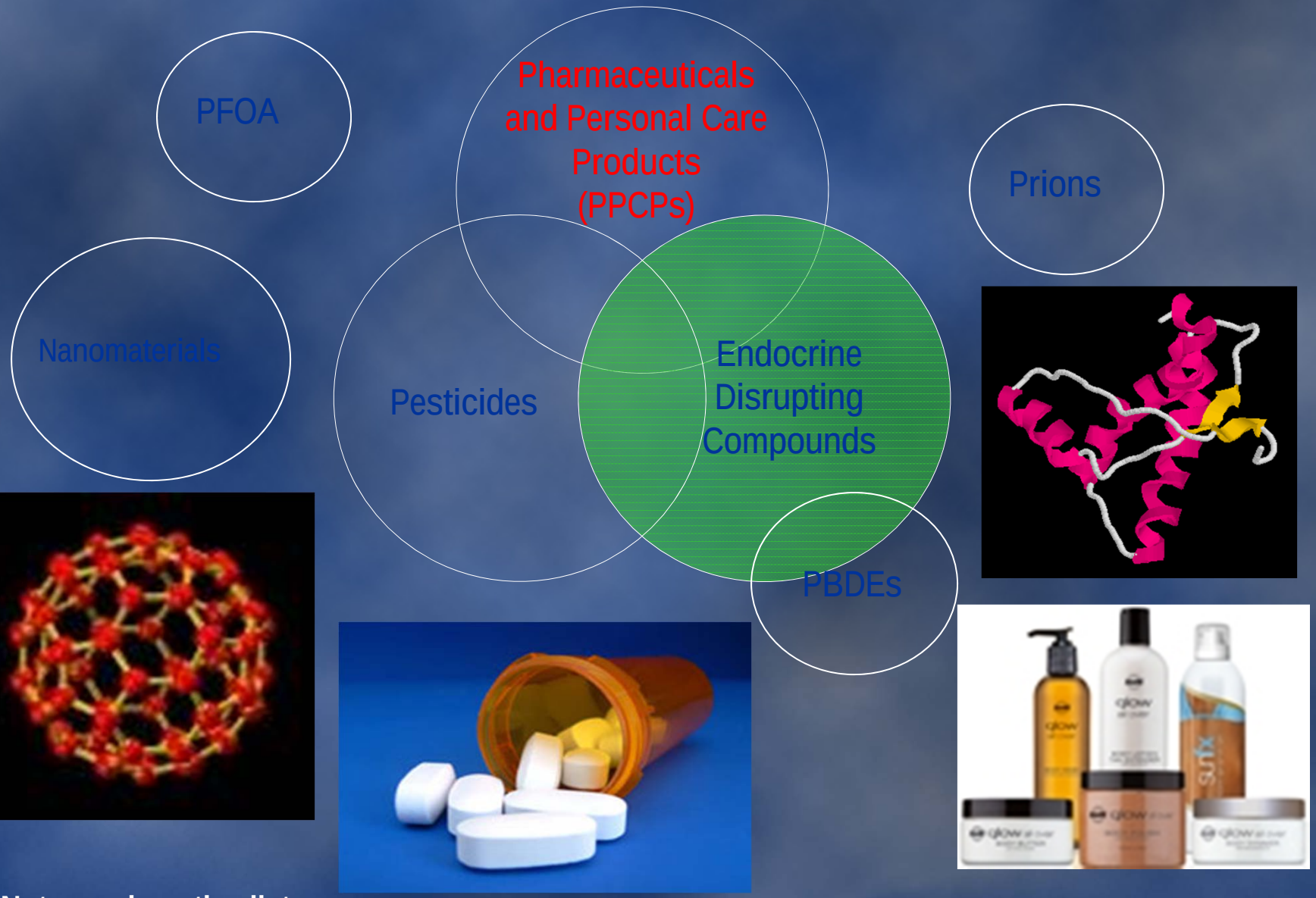

Electricity
Transport
CH4 + N2O
Carbon sequestration
Fertilizer offset
0.2
0.1
0
-0.1
-0.2
-0.3
CO2 per dry Mg biosolids
VA

Emerging Contaminants



BFRs – brominated flame retardants
PFCs – perfluorinated compounds

*Contaminants of Emerging Concern in Water**



***Not an exhaustive list.**

Emerging Contaminants

- Male fish producing eggs in Potomac River - Male fish with female characteristics found in Potomac tributaries (Sept'06)

NATIONAL GEOGRAPHIC NEWS
REPORTING YOUR WORLD DAILY

NATIONALGEOGRAPHIC.COM

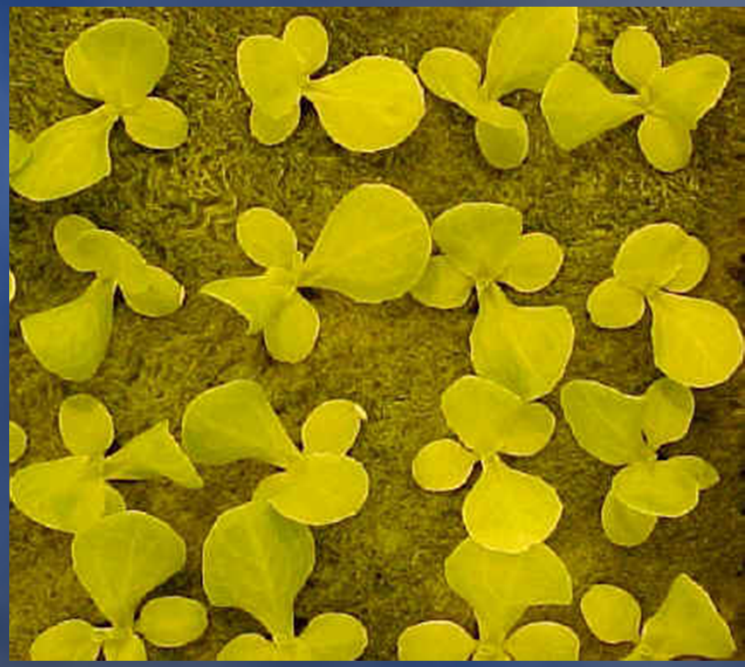
- Man-Made Chemicals May Put Strain on Fish (Mar'08)

washingtonpost.com

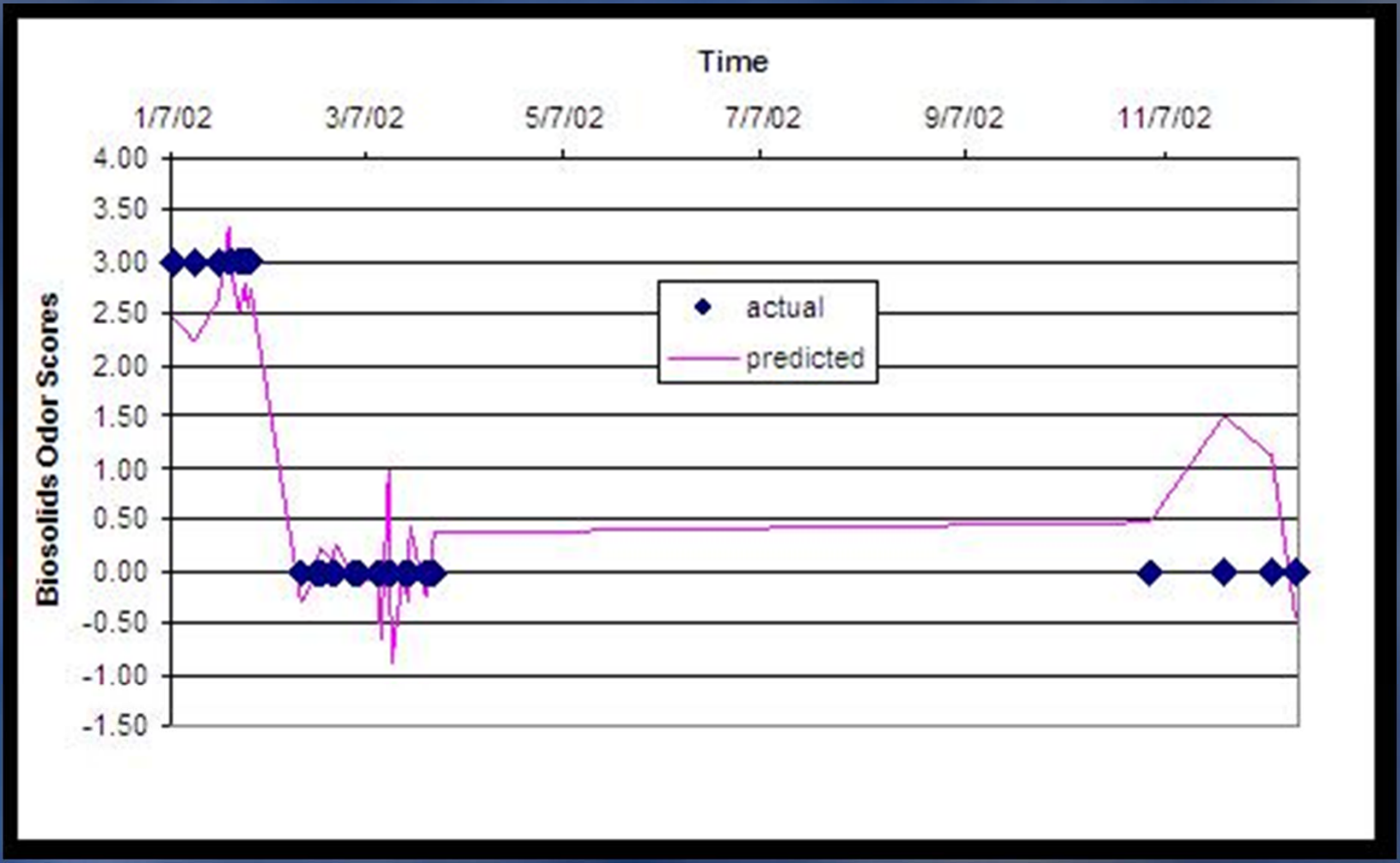
- "EPA Fails to Meet Mandate on Endocrine -Disruptors" … *Our Stolen Future*

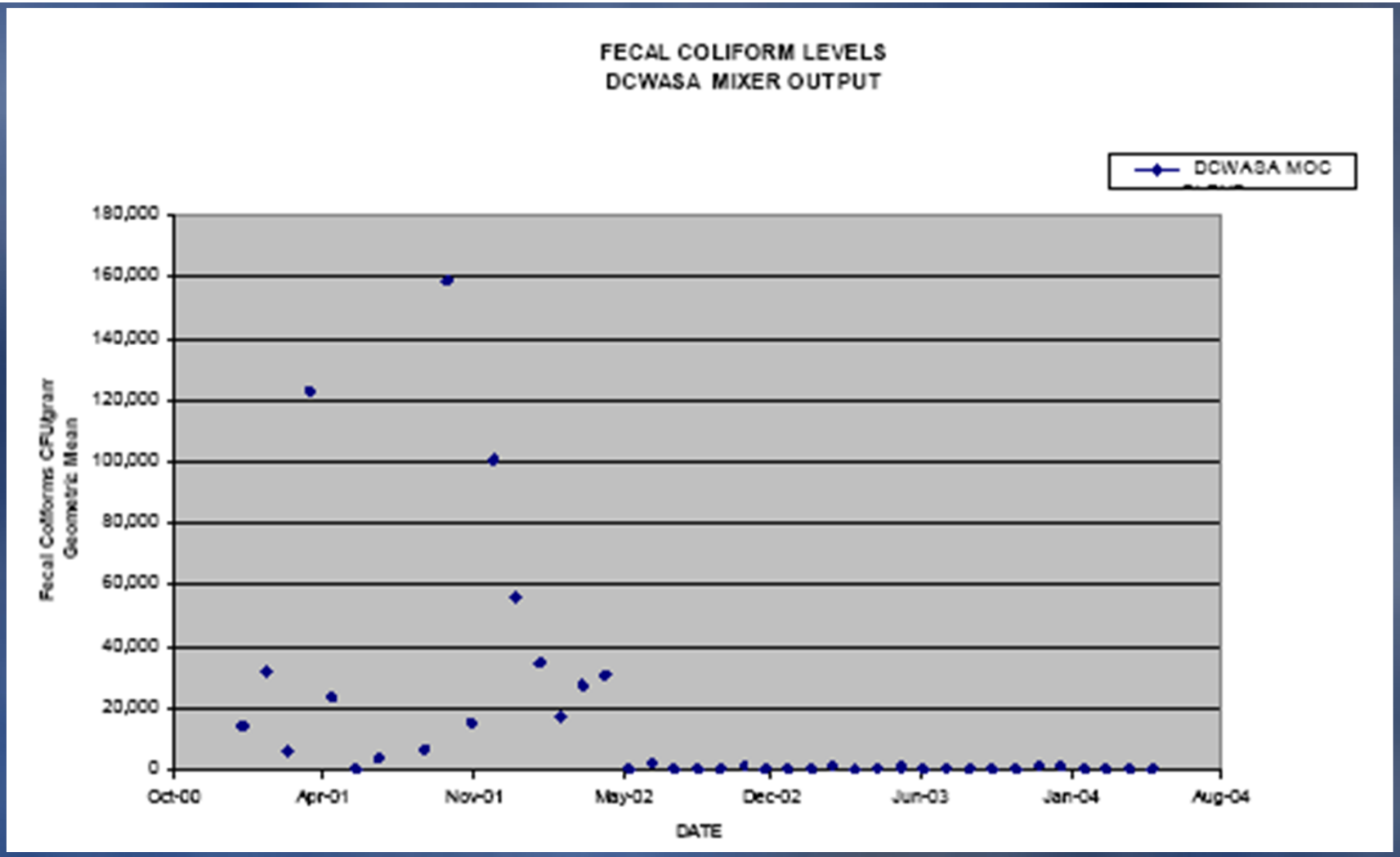
  by Theo Colborn, Dianne Dumanoski & John Peterson Myers

- Senate Subcommittee on Transportation Safety, Infrastructure Security, and Water Quality hearing on "*Pharmaceuticals in the Nation's Water: Assessing Potential Risks and Actions to Address the Issue*." (April 15, 2008)
- Chicago letter to EPA AX requesting an end to the use of TCC & TCS in consumer products to avoid build-up in biosolids.

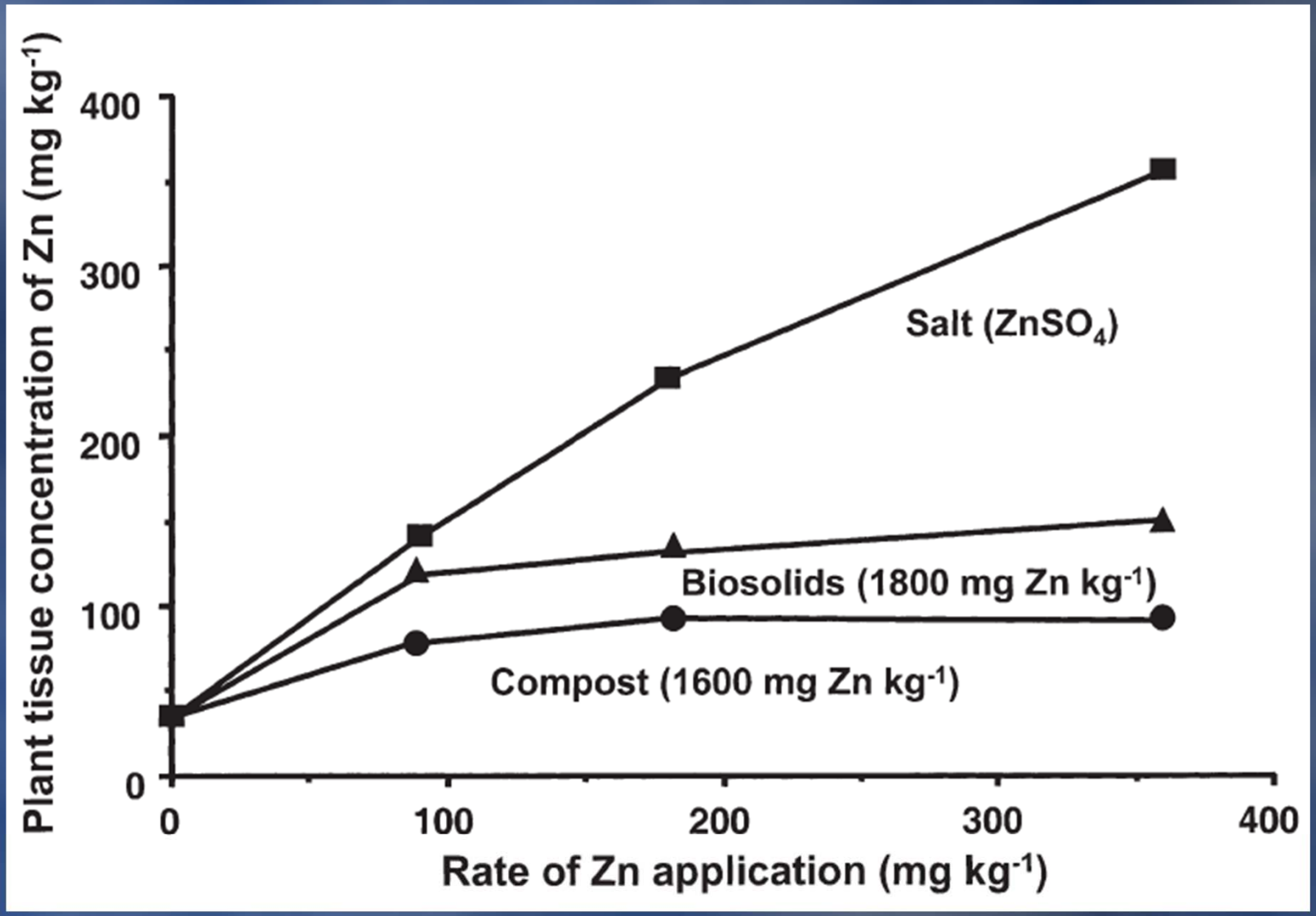


Actual vs Predicted Odor Levels

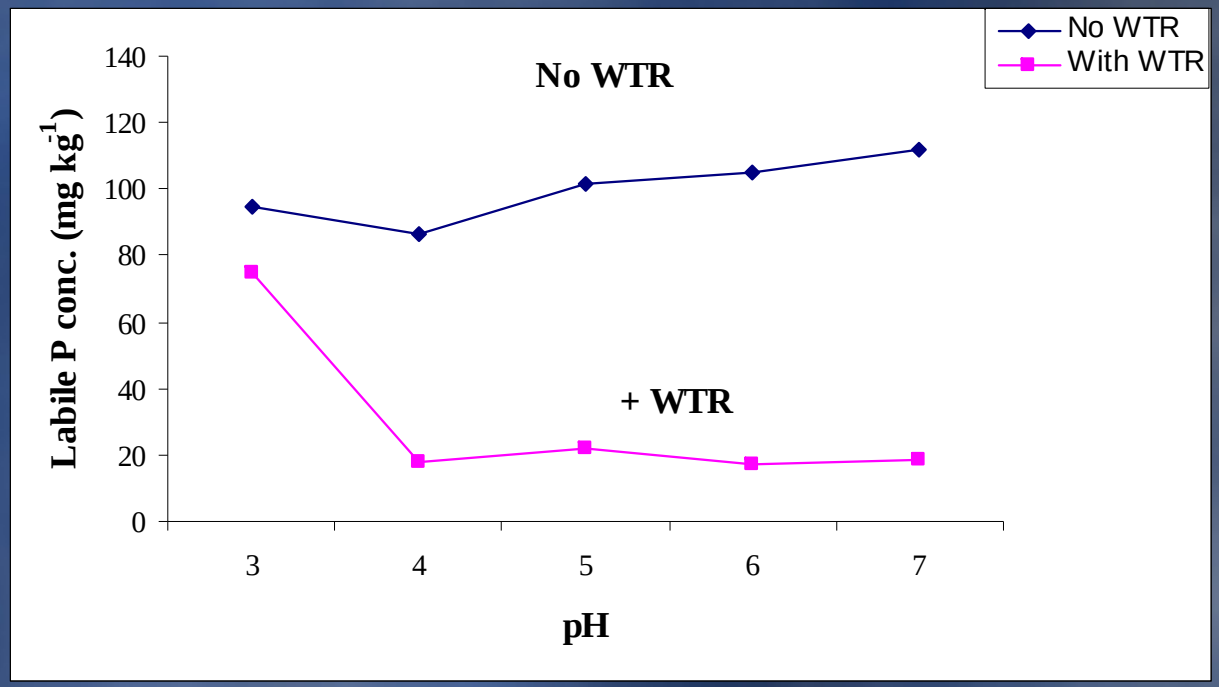


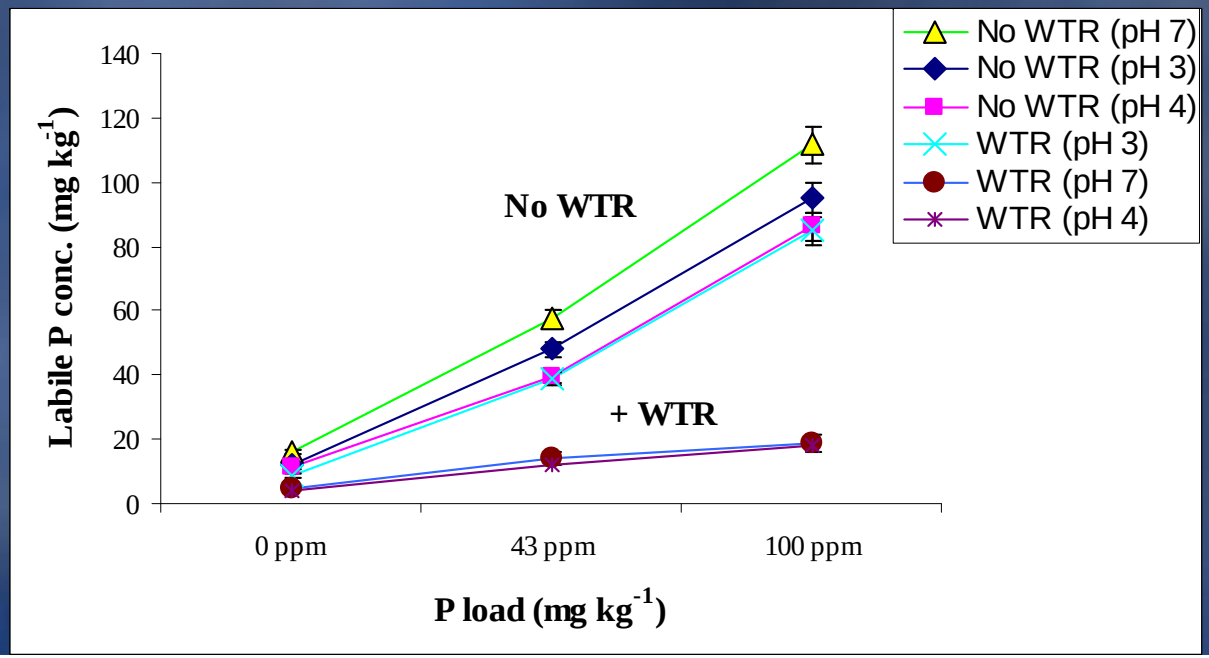


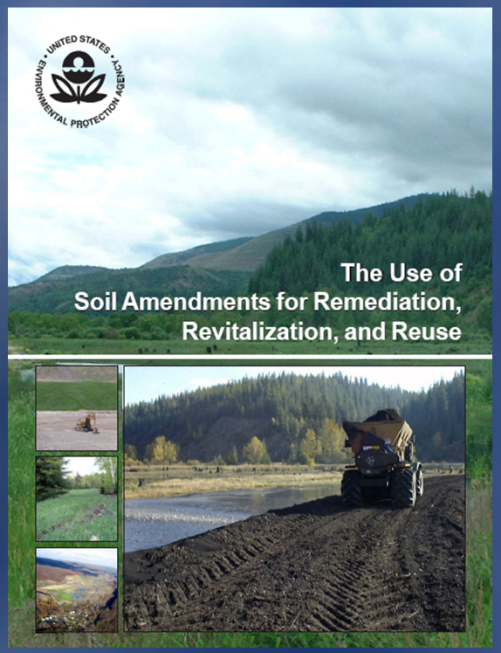
Improvements in lime mixing by DCWASA resulted in more consistent product quality, reduced odors, consistent Fecal coliform results (<1,000 mpn/g dry weight – Class A standard for fecal coliforms), and cost savings of ~$1M/yr.

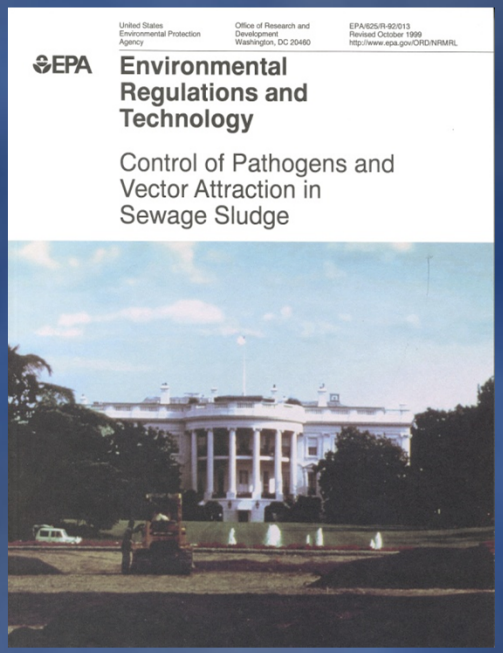


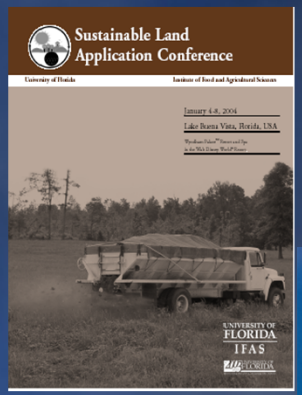
Effect of source of Zn addition on plant tissue concentration during a 5-yr field experiment


No WTR
With WTR
No WTR
+ WTR
Labile P conc. (mg kg-1)
140
120
100
80
60
40
20
0
3
4
5
6
7
pH

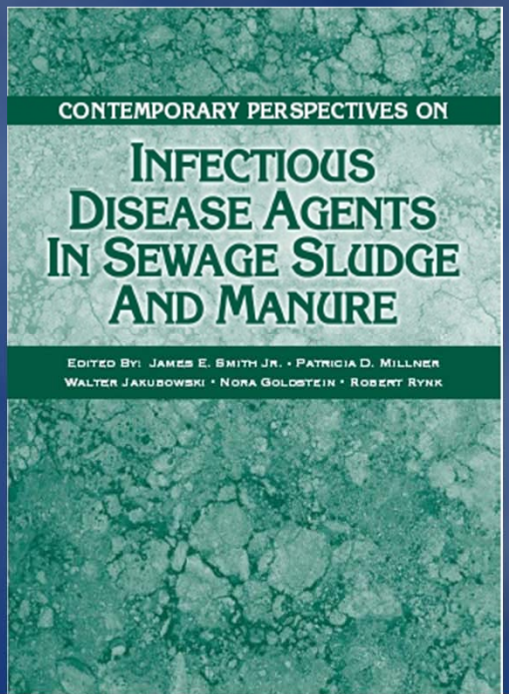

No WTR (pH 7)
No WTR (pH 3)
No WTR (pH 4)
WTR (pH 3)
WTR (pH 7)
WTR (pH 4)
No WTR
+ WTR
Labile P conc. (mg kg-1)
140
120
100
80
60
40
20
0
0 ppm
43 ppm
100 ppm
P load (mg kg-1)

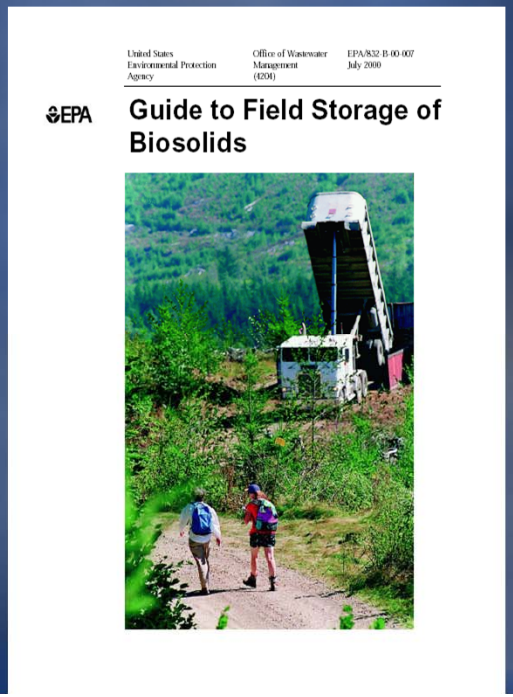

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
The Use of
Soil Amendments for Remediation,
Revitalization, and Reuse

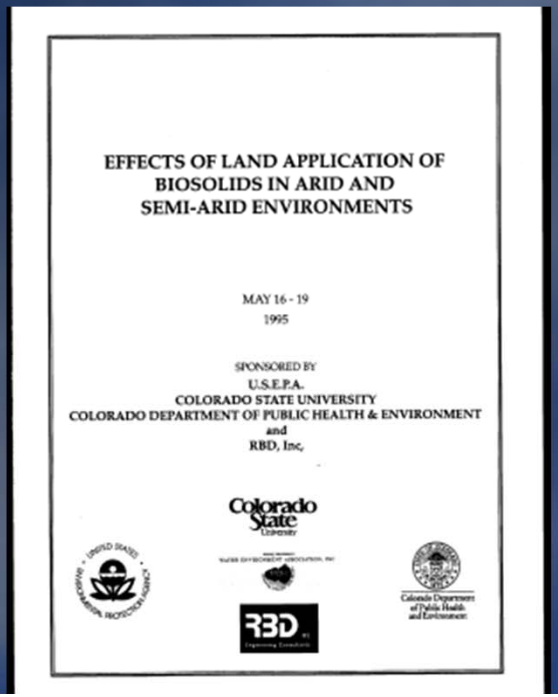

United States Environmental Protection Agency
Office of Research and Development Washington, DC 20460
EPA/625/R-92/013 Revised October 1999 http://www.epa.gov/ORD/NRMRL
EPA
Environmental Regulations and Technology
Control of Pathogens and Vector Attraction in Sewage Sludge


Sustainable Land Application Conference
University of Florida
Institute of Food and Agricultural Sciences
January 4-8, 2004
Lake Buena Vista, Florida, USA
UNIVERSITY OF FLORIDA
IFAS

JEQ
Journal of Environmental Quality
Ecosystem Function in Alluvial Tailings after Biosolids and Lime Addition


CONTEMPORARY PERSPECTIVES ON
INFECTIOUS DISEASE AGENTS IN SEWAGE SLUDGE AND MANURE
EDITED BY: JAMES E. SMITH JR. • PATRICIA D. MILLNER
WALTER JAKUBOWSKI • NORA GOLDSTEIN • ROBERT RYNK


United States Environmental Protection Agency
Office of Wastewater Management (4204)
EPA/832 B-00-007 July 2000
EPA
Guide to Field Storage of Biosolids


EFFECTS OF LAND APPLICATION OF BIOSOLIDS IN ARID AND SEMI-ARID ENVIRONMENTS
MAY 16 - 19
1995
SPONSORED BY
U.S.E.P.A.
COLORADO STATE UNIVERSITY
COLORADO DEPARTMENT OF PUBLIC HEALTH & ENVIRONMENT
and
RBD, Inc.
Colorado State University
RBD

Stafford Airport Reclamation

The Airport Authority faced importing topsoil at cost of several million dollars for the 300+ acres of acidic (pH ~2) soil at the new Stafford County Airport in 2001. In the first season after biosolids application, grass began to grow, then became so long, the Airport Authority now has to worry about wildlife and mowing.

Current/Future Focus

- CARBON FOOTPRINT / GHG EMISSIONS
  - REDUCED FOOTPRINT
  - ZERO CARBON FOOTPRINT
  - CARBON NEUTRAL THRU OFFSETS
- MULTIPLE BENEFITS / RESOURCE RECOVERY
  - WATER REUSE
  - WETLANDS / HABITAT RESTORATION
  - CARBON SEQUESTRATION
  - SOIL ENHANCEMENT
  - BIOFUELS, FERTILIZER RECOVERY
- INTEGRATED WATER RESOURCES MGNT.

FINAL REPORT

July 20, 2007

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P. O. Box 422, Tamworth, NH 03886
phone 603-323-7654, email info@nebiosolids.org
www.nebiosolids.org

nebra

BioCycle

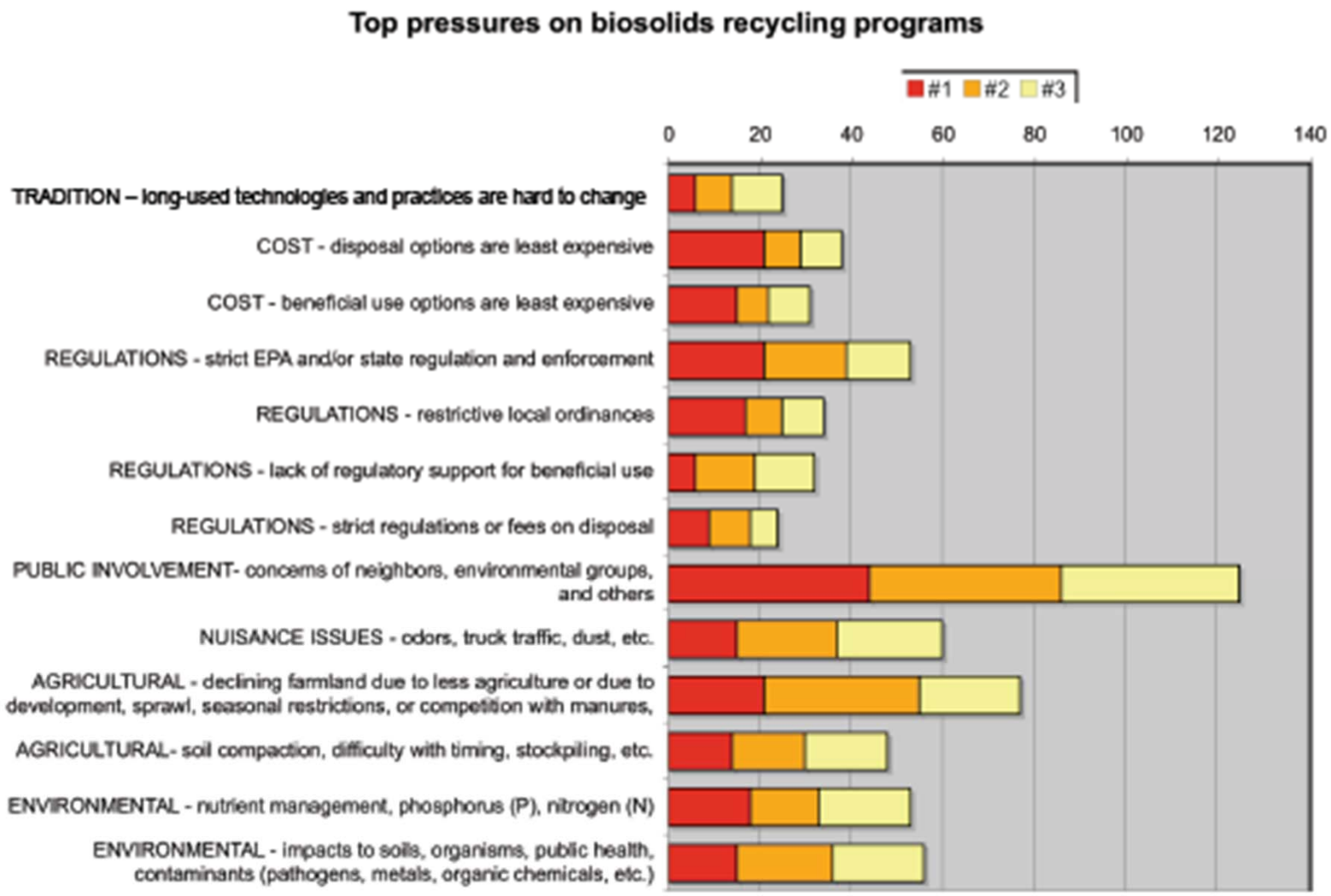
Northwest Biosolids Management Association

EPA
United States
Environmental Protection
Agency

Pressures on biosolids recycling …

Online survey of individual TWTDS asked respondents to identify the three most important pressures on biosolids recycling. Figure 12 is a compilation of the ~250 responses from around the nation. The #1 priority responses appear in the darkest color; the #3 priority responses appear in the lightest color.

Figure 12



Legislative or regulatory activities happening or imminent pertaining to biosolids …

State biosolids coordinators were asked to indicate if any state legislative or regulatory activities that would affect biosolids management were happening or were imminent. Figure 13 displays their responses: half of the states are not experiencing such activities.

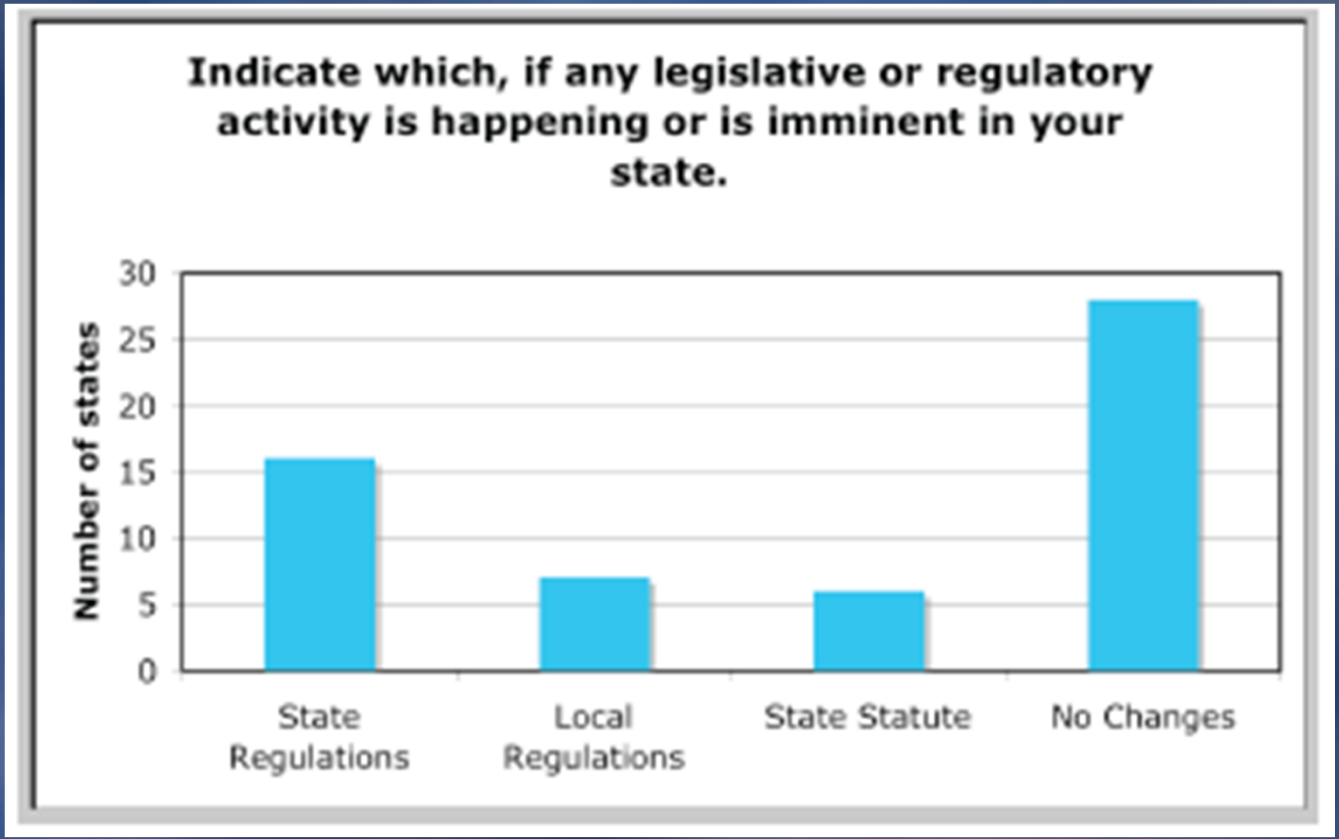



Figure 13