

Review of United States Guidance and Regulations For Sludge Disinfection and Stabilization including a Future Projection

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"From 503 to Infinity!"
biosolids resource
recovery takes off...

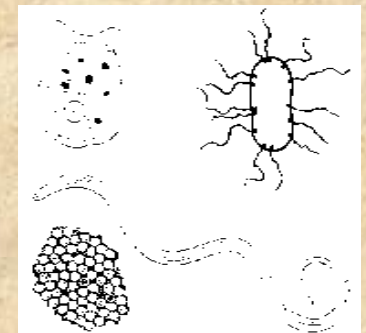


North East Biosolids
& Residuals Conference
October 29 & 30, 2013
Concord, New Hampshire

Presentation Overview



- **Early WWTP Residuals Management, Disinfection and Stabilization Guidance**
- **Development of Sludge Management Regulations**
 - 40CFR257
 - 40CFR503
- **PFRP and PSRP Process Equivalency**
- **A look into future Requirements**
 - Disinfection, Stabilization and Product Quality



From Earliest Times

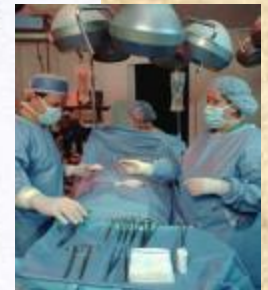
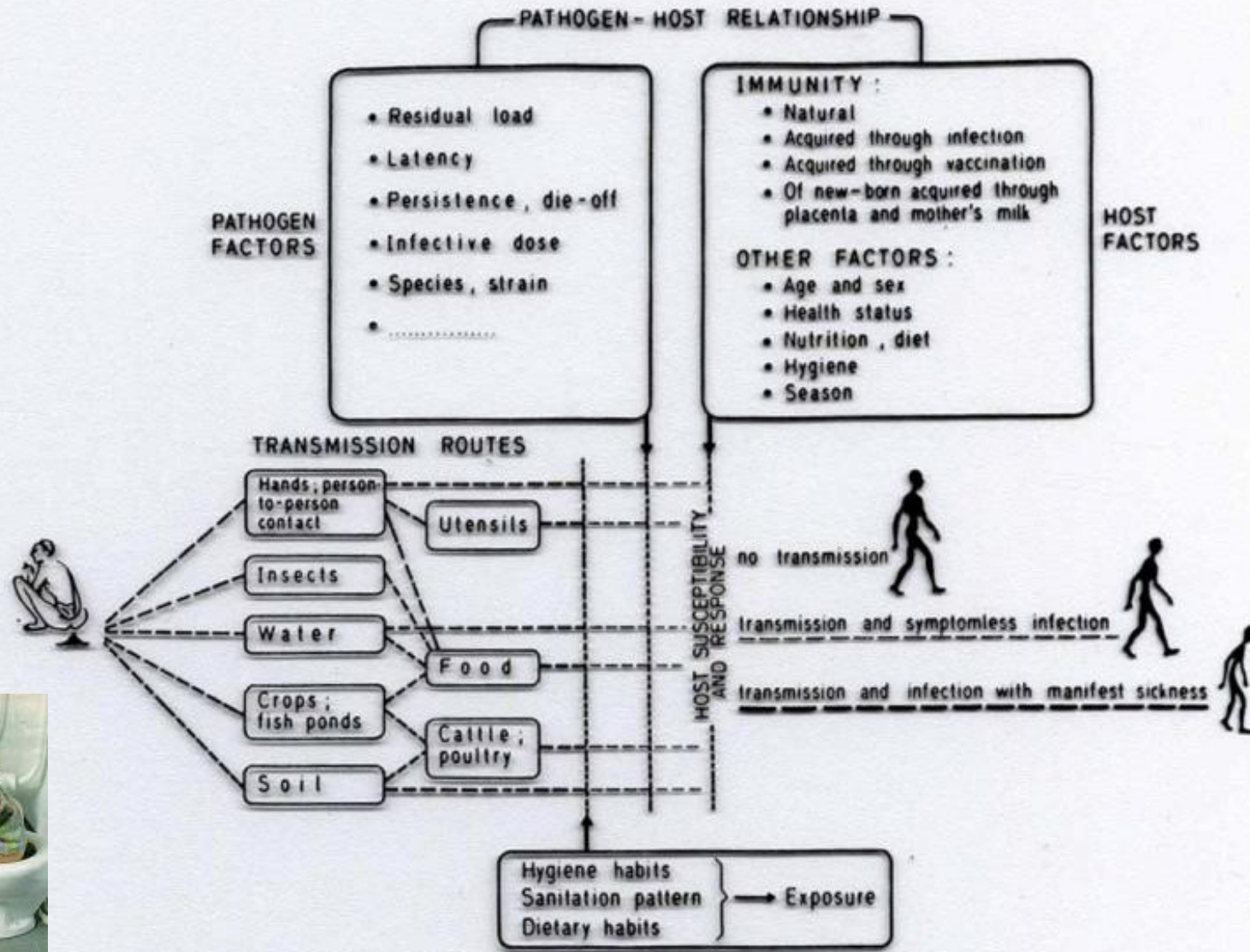
Beneficial Use of Wastes



Application of Disinfection Techniques



CONNECTION BETWEEN PATHOGENS & HUMAN HOST

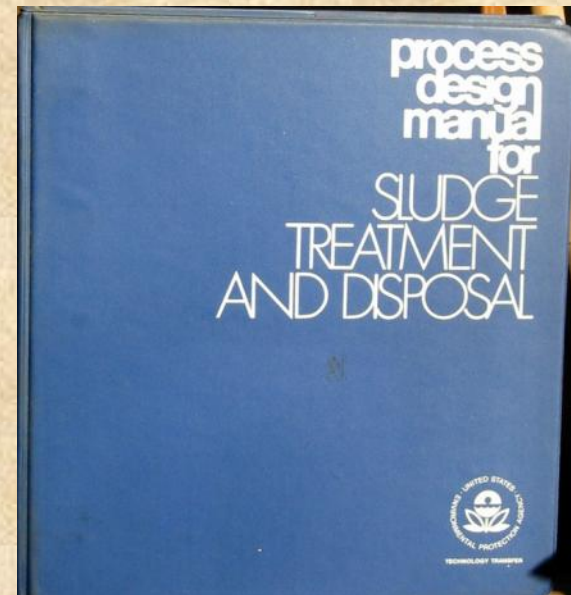
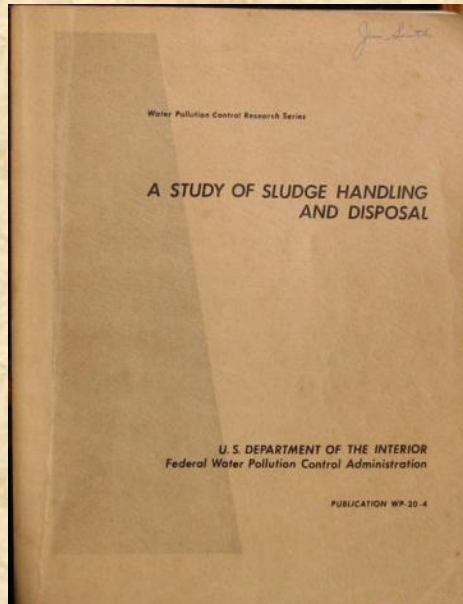


Significant Federal Actions

- 1972 (PL 92-500) & 1977 (PL 95-217) – Provided for establishment of sludge management regulations; pretreatment standards and R&D
- 1976 – RCRA
- 1979 - 40CFR257 addressed land application of sludges [PSRP & PFRP]
- 1985 – Creation of PEC
- 1993 – 40CFR503



EARLY OUTPUTS/OUTCOMES OF SLUDGE/BIOSOLIDS R&D PROGRAM



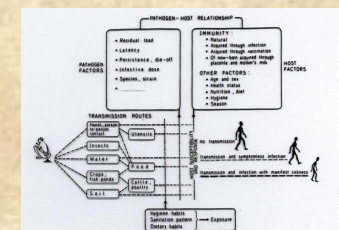
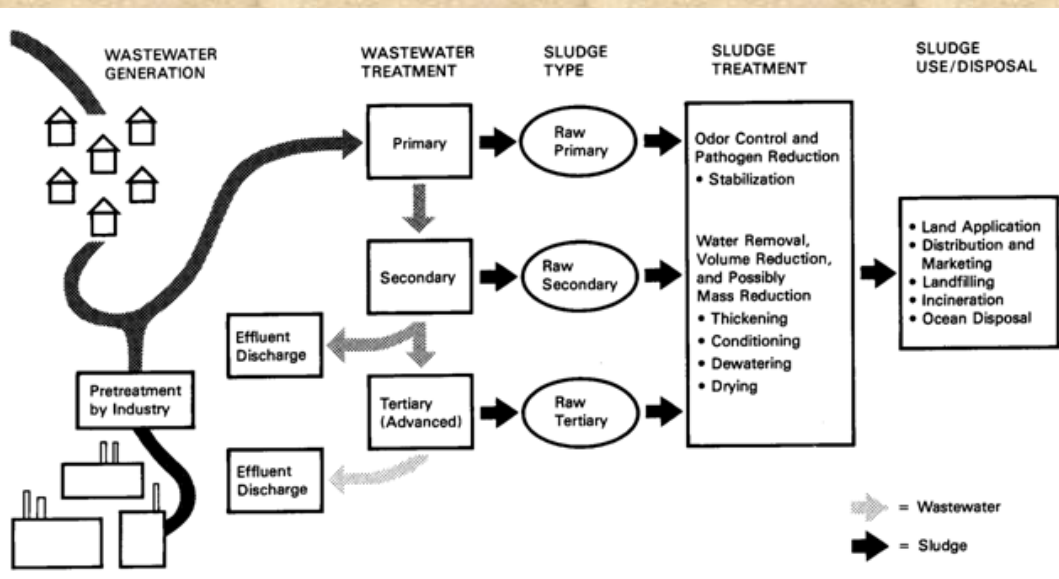
Pathogenic Microorganisms Possibly Present in Sludge

PATHOGEN CLASS	EXAMPLES	DISEASE
Bacteria 	<i>Salmonella sp.</i>	Bacillary dysentery
	Enteropathogenic- <i>Escherichia coli</i>	A variety of gastroenteric diseases
Viruses 	Hepatitis A	Infectious hepatitis
	Norwalk virus	Acute gastroenteritis
Protozoa 	<i>Giardia lamblia</i>	Giardiasis (gastroenteritis)
	<i>Cryptosporidium sp.</i>	Cryptosporidiosis (gastroenteritis)
Helminths 	<i>Ascaris sp.</i>	Ascariasis (roundworm infection)
	<i>Taenia sp.</i>	Taeniasis (tapeworm infection)

Regulatory Approach of USA



Residences & People



Processes to Further Reduce Pathogens (PFRPs)

Composting: Using the within-vessel or static aerated pile composting method, the waste is maintained at operating conditions of 55°C or greater for 3 days. Using the windrow composting method, the waste attains a temperature of 55°C or greater for at least 15 days and there will be a minimum of five turnings of the windrow.

Heat Drying: Dewatered sludge cake is dried by direct or indirect contact with hot gases, and moisture content is reduced to 10% or lower. Sludge particles reach temperatures well in excess of 80°C, or the wet bulb temperature of the gas stream in contact with the sludge at the point where it leaves the dryer is in excess of 80°C.

Heat Treatment: Liquid sludge IS heated to temperatures of 180°C for 30 minutes.

Thermophilic Aerobic Digestion: Liquid sludge is agitated with air or oxygen to maintain aerobic conditions at residence times of 10 days at 55°C to 60°C, with a volatile solids reduction of at least 38%.

Equivalent Processes

Processes to Significantly Reduce Pathogens (PSRPS)

Aerobic Digestion: 60 days at 15°C to 40 days at 20°C, with a volatile solids reduction of at least 38%.

Air Drying: Liquid sludge is allowed to drain and/or dry on underdrained sand beds, or on paved or unpaved basins in which the sludge depth is a maximum of 9 inches. A minimum of 3 months is needed, for 2 months of which temperatures average on a daily basis above 0°C.

Anaerobic Digestion: 60 days at 20°C to 15 days at 35°C to 55°C, with a volatile solids reduction of at least 38%.

Composting: Using the within-vessel, static aerated pile, or windrow composting methods, the solid waste is maintained at minimum operating conditions of 40°C for 5 days. For 4 hours during this period the temperature exceeds 55°C.

Lime Stabilization: Sufficient lime is added to produce a pH of 12 after 2 hours of contact.

Other Methods: Other methods or operating conditions may be acceptable if pathogens and vector attraction of the waste (volatile solids) are reduced to an extent equivalent to the reduction achieved by any of the above methods.

Access & Cropping **Restrictions**

- **Public access restricted for \geq 12 months**
- **Grazing of animals restricted for \geq 1 month**
- **Growing of crops to be consumed raw by humans could not be grown for 18 months from time of application unless assurance could be given that edible portion would not come in contact with the sludge.**

THE INTERIM: 1979-1993

- How to demonstrate equivalency
 - Pathogen equivalency committee formed
 - PEC function: advise regulatory staff
- Research continued: e.g., dieoff in soil, process performance
- Deliberations on how the regulation could be improved



PEC Pathogen Reductions Required for Equivalency

PSRP

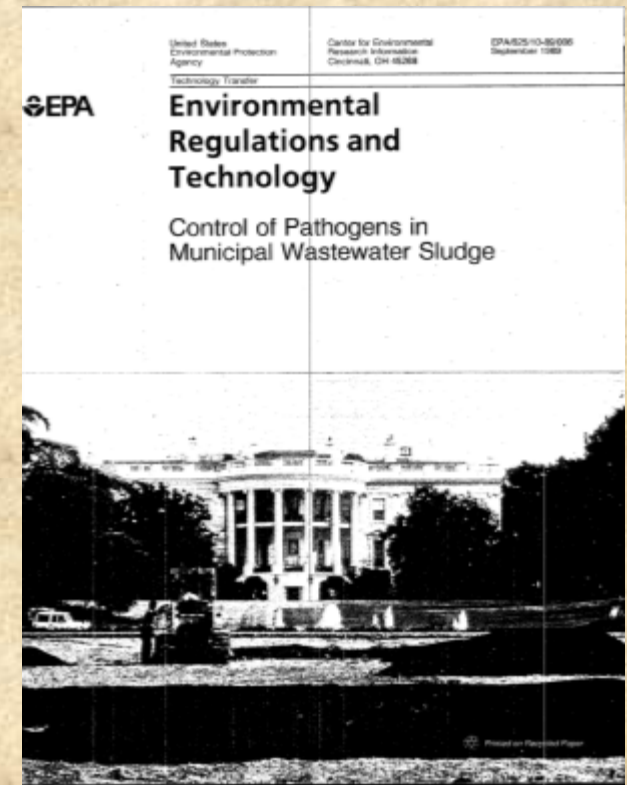
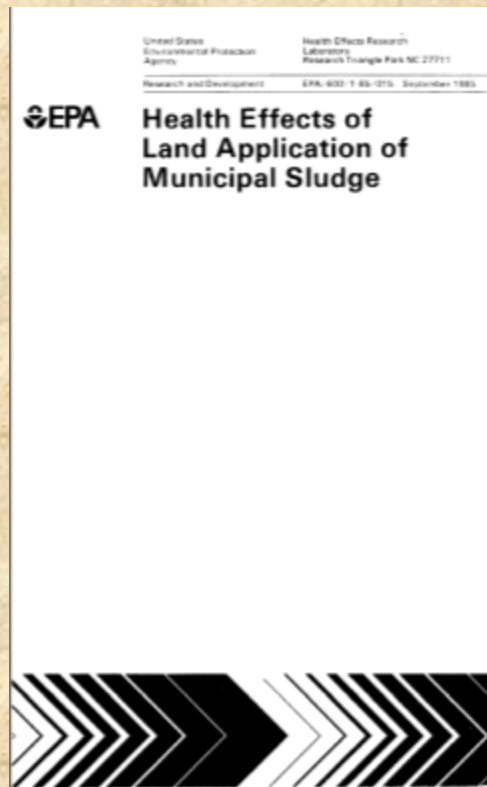
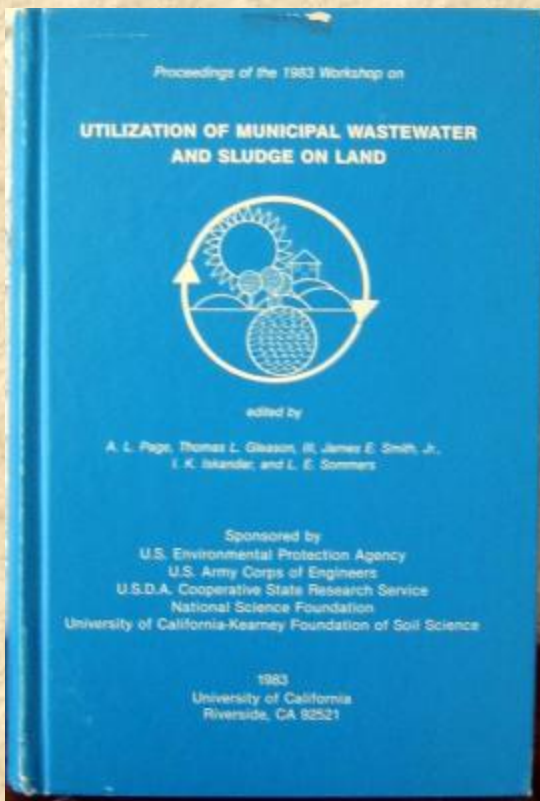
- *Salmonella* sp.: > 1 log reduction
- Enterovirus: > 1 log reduction
- Helminth eggs: no requirement



PFRP

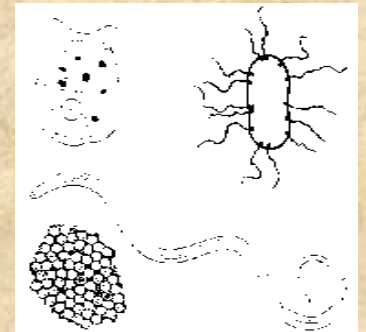
- *Salmonella* sp.: > 3 logs reduction
- Enterovirus: > 3 logs reduction
- Viable helminth eggs > 2 logs reduction

OUTPUTS/OUTCOMES OF SLUDGE/BIOSOLIDS R&D PROGRAM



Improving the 1979 Regulation

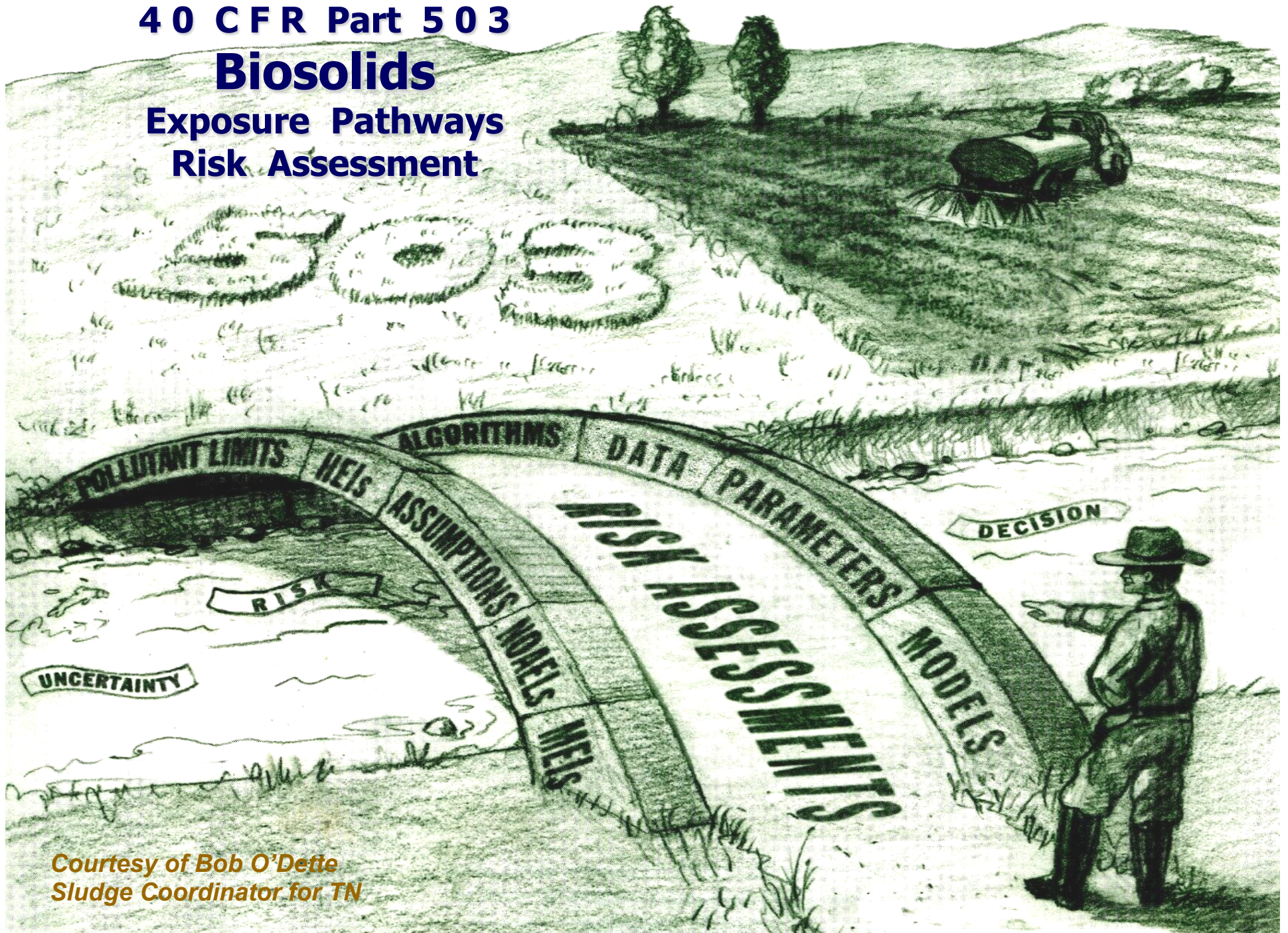
- Separate VAR from pathogen reduction
- Retain two classes of treatment (A & B) but set quantitative microbiological standards for the product
- Set quantitative standards for VAR
- Require VAR to occur with or follow Class A treatment
- Refine the PSRP/Class B restrictions
- Inadequate information was available for a Risk based approach



40 CFR Part 503

Biosolids

**Exposure Pathways
Risk Assessment**



*Courtesy of Bob O'Dette
Sludge Coordinator for TN*

40 CFR 503

Pathogens / Indicator Organisms

Microbial standards

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

Class A:

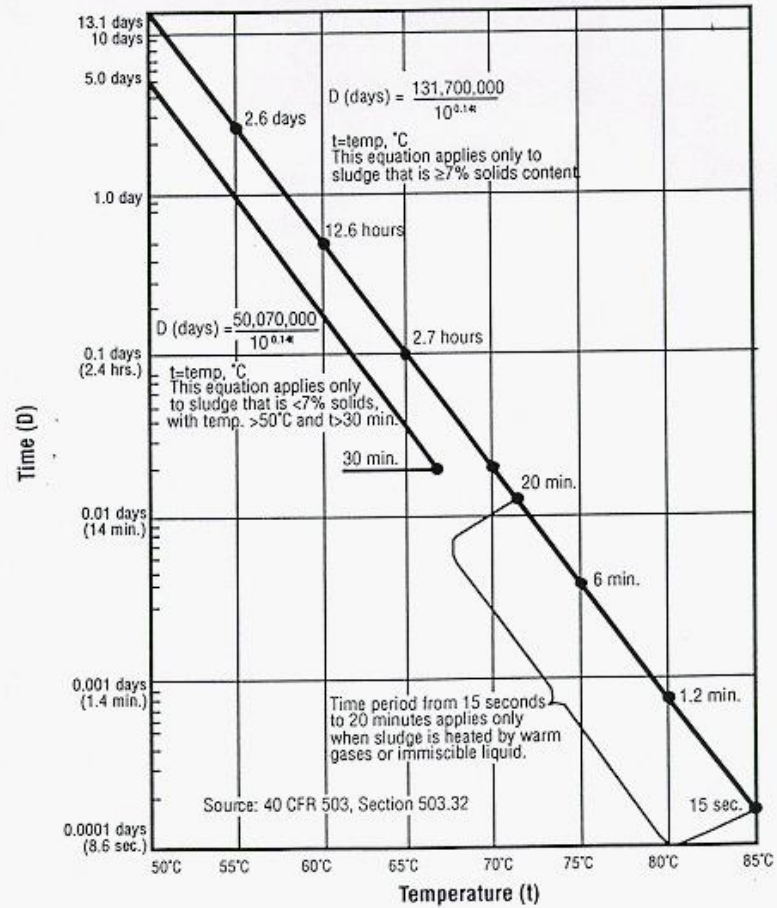
- ✓ <1000 fecal coliform MPN / g (dry weight) or
<3 *salmonellae* MPN / 4 g (dry weight) and
PFRP, defined process, PFRP equivalent,
or pre/post to show;
- ✓ <1 PFU enterovirus / 4 g (dry weight)
- ✓ <1 viable helminth ova / 4 g (dry weight)

Class B:

- ✓ Use of a PSRP or equivalent process or
<2 million fecal coliform / g (dry weight)



Time / Temperature Relationships for Class A Pathogen Reduction





Class B Biosolids
Land Applied
B + Management = A



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

Requirements for Demonstrating Equivalency

<u>PSRP Equivalency</u>	<u>PFRP Equivalency</u>
> 1 log reduction of <i>Salmonella</i> sp. or > 2 log reduction of fecal coliforms	≥ 3 log reduction of enteroviruses
> 1 log reduction of enteroviruses	≥ 2 log reduction of viable <i>Ascaris</i> sp. ova
Final product contains < 2,000,000 fecal coliforms/g	Final product contains < 1000 fecal coliforms or < 3 <i>Salmonella</i> sp./4 g; < 1 pfu/4g of entericviruses and < 1 helminth ova/ 4g

Detailed information on demonstrating equivalency can be found at:

<http://www.epa.gov/nrmrl/pec/> .

Vector Attraction Reduction

Employ one of ten options (8 process) designed as:

- 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

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>



Environmental Regulations and Technology

Control of Pathogens and Vector Attraction in Sewage Sludge



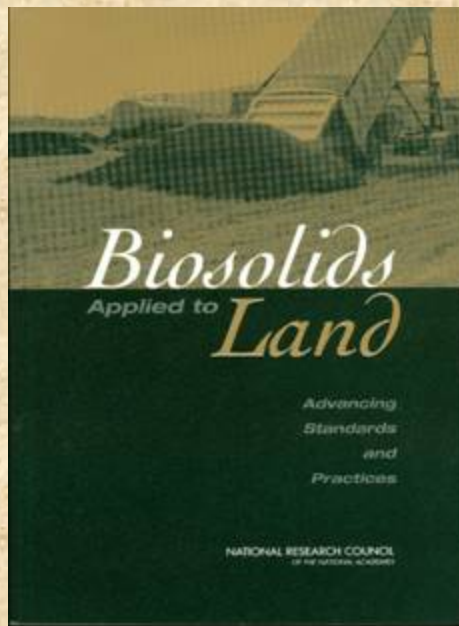


NAS report (2002)

- No documented evidence to indicate that Part 503 has failed to protect public health
- However, additional scientific work is needed to reduce persistent uncertainty about the potential for adverse health effects from exposure to biosolids
- ~60 recommendations



...applying
science &
technology
to protect
water quality



The Agency developed an Action Plan in 2003:

- 14 projects
- Significant progress has been made

NAS / NRC Report, July 2002




Biosolids Projects Update

Project No.	Project Title	Status
3	Methods development, optimization, and validation for microbial pollutants in sewage sludge	3 Completed 1 Ongoing- <i>helminth</i>



...applying science & technology to protect water quality


 **Federal Register**

Monday,
March 26, 2007

Part III


Environmental Protection Agency

40 CFR Parts 136 and 505
Guidelines Establishing Test Procedures for the Analysis of Pollutants; Analytical Methods for Biological Pollutants in Wastewater and Sewage Sludge; Final Rule


 EPA
United States Environmental Protection Agency

EPA/600/R-07/118 | September 2007 | www.epa.gov/ord

Preliminary Comparative Study of Methods to Extract Virus from Raw and Processed Sewage Sludge



Office of Research and Development
National Exposure Research Laboratory, Cincinnati, OH

 EPA
United States Environmental Protection Agency

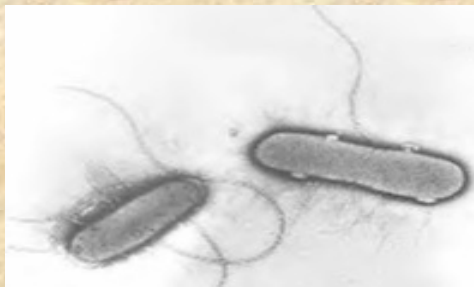
Assessment of the Effects of Holding Time on Fecal Coliform and Salmonella Concentrations in Biosolids

August 2006

METHODS WORK **COMPLETED TO DATE**

- **Methods 1680 & 1681: Fecal Coliforms in Biosolids by Multiple-Tube Fermentation Procedures**
- **Method 1682: Salmonellae in Biosolids**

Interlaboratory Validation Studies



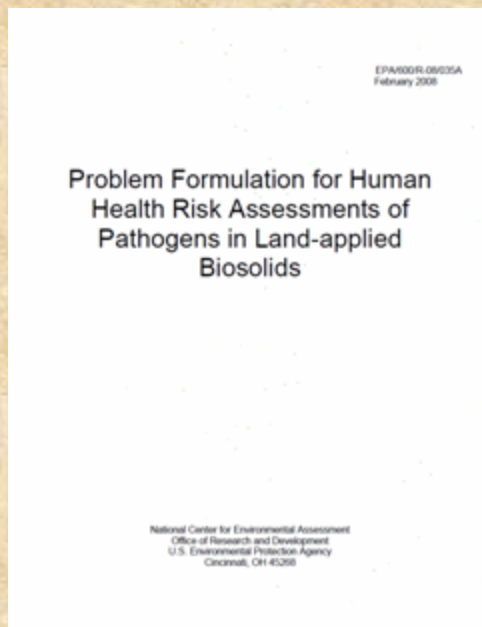


Biosolids Projects Update

Project No.	Project Title	Status
8	Assess the quality and utility of data, tools, and methodologies to conduct QMRA on pathogens	Completed



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Assessing the utility of various microbial risk assessment models
Next steps:

- assess relevant exposure pathways
- expand to other pathogenic organisms
- discuss policy implications with management and the science community

For more information contact Michael E. Troyer at 513-569-7399 Or Troyer.Michael@epamail.epa.gov



Biosolids Projects Update

Project No.	Project Title	Status
9	Support the PEC	Completed

- Applicants can now easily submit requests online
- More formal approach for evaluating equivalency
- Updating membership
- Numerous technologies are in different stages of receiving a recommendation of equivalency
- OST signature
- EPA support is ongoing



...applying science & technology to protect water quality

Emerging Pathogens

Bacteria	Viruses	Parasites
<i>E. coli-0157-H7</i>	<i>Picobinravirus</i>	<i>Toxacara</i>
<i>E. coli-enterohemorrhagic</i>	<i>Picotrinnaviruses</i>	<i>Baylisascaris</i>
<i>Listeria monocytogenes</i>	<i>Coronaviruses</i>	<i>Echinococcus</i>
<i>Leptospira spp.</i>	<i>Toroviruses</i>	<i>Toxoplasma</i>
	<i>Hepatitis E Virus</i>	<i>Microsporidia</i>
	<i>Caliciviruses</i>	
	<i>Myxoviruses</i>	



Future Direction



Key to Sustainable Biosolids Plan

- Pathogen destruction
- Stabilization
- Low odor potential



Public Acceptance!!!!



Montreal

“Public Acceptance will be the main obstacle to biosolids disposal/use viability” – WEF -

NBP

Major Driver = Regulation



CROP GROUP	UNTREATED SLUDGES	CONVENTIONALLY TREATED SLUDGES	ENHANCED TREATED SLUDGES
FRUIT	X	X	✓
SALADS	X	X (30 month harvest interval applies)	✓
VEGETABLES	X	X (12 month harvest interval applies)	✓
HORTICULTURE	X	X	✓
COMBINABLE & ANIMAL FEED CROPS	X	✓	✓
GRASS & FORAGE - <i>GRAZED</i> - <i>HARVESTED</i>	X	X (Deep injected or ploughed down only)	✓
	X	✓ (No grazing in season of application)	✓

Attenuation

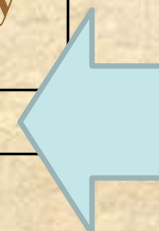
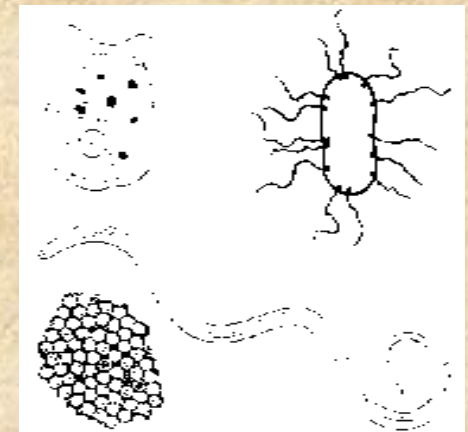
10 month harvest interval applies

3 week no grazing and harvest interval applies

3 week no grazing and harvest interval applies

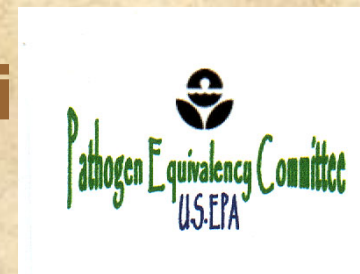
Monitoring Treatment Effectiveness – The Product

ORGANISM		LEVEL NOT TO EXCEED ??
<i>E.coli</i>		< 100 MPN/g dry solids
<i>Salmonella</i> sp.		Non Detect in 50 g dry solids
Add where significant levels of helminths and/or enteroviruses are known to be present.		
Helminth ova	Total ova	< 1 / 4 g dry solids
	Viable ova	Non Detectable
Enteroviruses		< 1 pfu / 4 g dry solids
ODOR TESTING ??		



Criteria for Demonstrating a Process' Disinfection Capability

- ≥ 3 log reduction of total enteric viruses
 - ≥ 2 log reduction of viable helminths (*Ascaris*) ova
- and
- ≥ 5 log reduction of fecal coliform bacteria



Note: *E. coli* or *Enterococcus* can be substituted for fecal coliform bacteria. Similarly, a 4 log reduction of *Salmonella* spp. Bacteria or 4 log reduction of somatic bacteriophages can be substituted for the 5 log reduction of fecal coliform bacteria.

<http://www.epa.gov/nrmrl/pec/>

Achieving Stability

Goals: a) Odors still present in biosolids are non offensive and
 b) biodegradable material remaining is minimal & vectors are not attracted.

TREATMENT METHOD	MEASURE OF EFFECTIVENESS
<i>Irreversible or Permanent Approaches</i>	
Aerobic digestion	SOUR is < 1.5 mg/h/g DS at 20°C VS destruction rate is minimal (leveled off)
Anaerobic digestion	Gas production rate is minimal (leveled off) VS destruction rate is minimal (leveled off)
Composting	Aerobic curing is ≥ 30 days and SOUR is minimal and/or CO ₂ evolution is minimal
<i>Reversible or Temporary Approaches</i>	
Reduce moisture content	Moisture is ≤ 25 % (Rewetting must be prevented)
Incorporation or injection of biosolids into the soil	Barrier is put into place





Take-home Messages

- As with any business biosolids managers should meet consumer demands with a “designed product” which
 - Meets time and temperature conditions for *good* disinfection
 - Is permanently or irreversibly stabilized unless temporary stabilization can be *justified*?
 - A well stabilized sludge may be the most important characteristic of a well accepted biosolids.
 - Meets monitoring requirements to insure *good* disinfection, and is
- Consider requiring the use of an odor classification system and/or monitoring to insure good public acceptance.
- Need for common analytical procedures!

Questions?

