



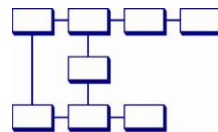
SIXTH FRAMEWORK PROGRAMME



Micropollutants in Biosolids

On-going Research In North America

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Consulting Engineers

Neptune workshop: Technical Solutions for Nutrient and Micropollutants Removal in WWTPs

Université Laval, Québec, March 25-26, 2010

Presentation Outline

- Historical focus of MPs in biosolids in Canada
- Some Canadian results
- Ongoing studies in Canada
- Studies in U.S./North America
- Brief summary

Historical Context in Canada

- Prior to mid-1970s, focus was on metallic pollutants and potential uptake in crops & livestock after biosolids amendment
- Mid-late 1970s, PCBs investigated for translocation from biosolids-amended soils to plant crops
- 1980s-1990s focused on “priority pollutants”, including solvents, pesticides, PAHs, phenolics and chlorinated aromatics
 - Publications of Webber and colleagues

More Recent History

- Starting about 2002-03, Dr. H-B (Bill) Lee and colleagues of Environment Canada began reporting concentrations of EDCs & PPCPs in biosolids
 - Mostly anaerobically digested solids
- Ca. 2005, Trent University (Dr. C. Metcalfe and colleagues) start reporting concentration data for PPCPs in biosolids

Bisphenol A in Canadian Sludges

	BPA Concentration (ng/g TS)	
	Raw Sludge	Digested Biosolids
# WWTPs	11	21
# Samples	12	23
Median	280	555
Range	130-39,800	130-11,100

(Lee and Peart, 2002)

Alkylphenol Ethoxylates

(Lee and Peart, 2002)

Compound	Concentration ($\mu\text{g/g TS}$)		Removal (%)
	Median raw	Median digested	
4-nonylphenol (NP)	91.5	413	-351% *
NP mono-EO (NP1EO)	61.9	83.7	-35%
NP di-EO (NP2EO)	35.2	24.8	29%
NP tri-EO (NP3EO)	13.8	6.9	50%
Higher NP-EOs NP(4-17)EO	43.5	11.3	74%
4-tert-octylphenol	4.75	10.4	-119% *

Triclosan

	Triclosan Concentration (ng/g TS)	
	Raw Sludge	Digested Biosolids
# WWTPs	11	21
# Samples	12	23
Median	10,600	14,450
Range	3,430-17,900	900-28,200

(Lee and Peart, 2002)

Fragrance Compounds (Lee et al., 2003)

Compound	Median Conc'n (ng/g TS)		Removal (%)
	Raw	Digested	
Galaxolide (HHCB)	11,850	14,500	-22.4
Tonalide (AHTN)	8010	12300	-53.7
Celestolide (ADBI)	175	320	-82.9
Phantolide (AHDI)	110	120	-9.1
Traesolide (ATII)	1345	1870	-39.0
Musk Xylene (MX)	19	3.3	82.6 *
Musk Ketone (MK)	145	4.5	96.9 *

Fragrance Compounds (Yang & Metcalfe, 2005)

Compound	Median Conc'n (ng/g TS)		Removal (%)
	Raw	Digested	
Galaxolide (HHCB)	3,300	6,790	-106
Tonalide (AHTN)	720	1,350	-88
Celestolide (ADBI)	23.6	51.2	-117
Phantolide (AHDI)	20.1	33.8	-68
Traesolide (ATII)	199	413	-108
Musk Xylene (MX)	76.6	95.1	-24
Musk Ketone (MK)	39.8	53.0	-33



Carbamazepine

Carbamazepine or Metabolite	Concentration (ng/g TS)		Removal %
	Raw sludge	Anaerobic digested sludge	
Carbamazepine	69.6 ±2.2 ^a	258 ±4.7	-271%
2-hydroxy-carbamazepine	1.9 ±1.1	3.4 ±0.9	-79%
3-hydroxy-carbamazepine	1.6 ±0.8	4.3 ±0.9	-169%



(n=3)

Miao *et al.* (2005)

^a mean ± standard deviation

Current Research Efforts

- Canada
 - CCME
 - Environment Canada
 - Water Environment Association of Ontario
- U.S. North America
 - Water Environment Federation
 - Water Environment Research Foundation
 - U.S. EPA

CCME – Who They Are & Mandate

- Canadian Council of Ministers of the Environment represents the 14 Environment Ministers of the Canadian federal government, 10 Provinces and 3 Territories
- CCME is responsible for the coordination of national environmental issues, such as:
 - harmonization of municipal effluent compliance,
 - acid rain policy, and
 - Codes of Practice (e.g. petroleum storage tanks).

CCME Efforts: Coordination of Micropollutant Research in WW & Biosolids

- Recognized that many academic institutions and agencies are involved in MP research
- Research funding is scarce, so duplication of efforts needs to be avoided
- Hosted a 1-day workshop Dec. 2 in Ottawa
- Sixty participants, attended, representing:
 - science research associations,
 - NGO's,
 - industry/business,
 - academia and
 - government

CCME Efforts: Coordination of Micropollutant Research in WW & Biosolids

- Science and research co-ordination activities of a new national body
 - Based on your organization's needs, what would be useful functions for a research co-ordination body?
 - Information co-ordination and dissemination;
 - Research priority-setting activities;
 - Active identification of collaboration opportunities;
 - Funding research in identified priority areas;
 - Other functions
 - What do you see as the current challenges to undertaking the above activities?

CCME Efforts: Coordination of Micropollutant Research in WW & Biosolids

- Governance and Funding
 - What would be the most workable governance structure for a research co-ordinating body?
 - Should the identified functions be undertaken by one body, or could they be divided among several organizations? New organization or existing?
 - Funding Options (who provides the funding?)

General consensus was to keep this process moving forward and not let it remain an academic exercise.

CCME Efforts: Concentrations of MPs and Effects of Biosolids Treatment

- No focused study has been completed yet on an inventory of MPs in Canadian biosolids
- Complete a targeted sampling program which will provide a basis for CCME to evaluate and manage the risks associated with MPs in biosolids with respect to:
 - managed land application,
 - land reclamation,
 - production of commercial soil amendments and
 - energy production

CCME Efforts: Concentrations of MPs and Effects of Biosolids Treatment

- **Year 1:** literature review of micropollutants in raw sludges and treated biosolids, and removal through treatment processes (complete)
 - 121 pages
 - Posted at:
http://www.ccme.ca/assets/pdf/pn_1440_contam_invt_rvw.pdf

CCME Efforts: Concentrations of MPs and Effects of Biosolids Treatment

- **Year 2:** field study of 11 sites across Canada using different techniques for producing solids for land amendment
 - Anaerobic digestion
 - Autothermal aerobic digestion
 - Composting
 - Alkaline stabilization
 - Heat drying
 - Dewatering by filter presses and by geotextile bags
- 57 Pharms and PCPs, fragrances, alkylphenols, metals
- Draft Report review complete and revisions in progress
- Report posted on CCME website in April or May (?)

Environment Canada Efforts

- Authorized by Chemicals Management Plan under Canadian Environmental Protection Act (CEPA)
- Monitoring of wastewater samples and solids for MPs
 - Alkylphenols, parabens, pharmaceuticals,
 - Perfluorinated organics, brominated flame retardants (PBDES + 4 others)
 - Volatile methyl siloxanes (D4, D5, D6)
 - 18 metals/metalloids

- 20 WWTPs across Canada
- Primary, secondary, advanced, and lagoon treatment
- About 10% of the Canadian population
- Two campaigns
 - Cold temperatures (January to May) ongoing
 - Warm temperatures (June to November) over
- Contact Shirley Anne Smyth
 - (905) 336-4509; ShirleyAnne.Smyth@ec.gc.ca

WEAO Effort

- Water Environment Assoc'n of Ontario
- Literature review of micropollutants (including pathogens) in biosolids and fate and effects in terrestrial environment
- Update of a review completed in 2001
- 200+ page report completed Dec. 2009
- Peer-reviewed by North American experts to confirm accuracy and completeness
- Will be posted on WEAO website (www.weao.org) after public consultation

- Microconstituent Community of Practice (COP)
- Chair: Joe Cleary, HydroQual, Inc.
- Issue Leaders
 - **Occurrence**: Dr. Tom Granato, Metro Chicago
 - **Analytical**: Akin Babatola, Santa Cruz, CA
 - **Treatment**: Rich Edwards, Pfizer, Inc.
 - **Fate and Transport**: Dr. Mary Buzby, Merck & Co.
 - **Communications**: Linda MacPherson, CH2M-Hill
 - **Effects**: Diana Eignor, U.S. EPA
- WEF Liaison: Bonnie Bailey

- Development of webcasts
- Development of Technical Practice Updates (TPUs)
- Sessions in WEFTEC10 Technical Program
- Development of Bi-annual Joint Micro-Con and Industrial Water Quality Conference
- Development of a collaborative outreach program with other organizations (e.g. SETAC, AWWA) to work together on topics of common interest.

- Oct 2009, *Joint Webcast with the Society of Environmental Toxicology and Chemistry (SETAC):*
Microconstituents in the Aquatic Environment: Impacts for Wastewater Utilities
- Dec 2009, Microconstituents in Biosolids
- 2010(?), Microconstituents in Water Reuse

WEF Microconstituent COP Technical Practice Updates (TPUs)

- Available at www.wef.org
 - Analytical Methods and Monitoring Technologies for MCs
 - Current Regulatory Framework for MCs in Water
 - Effects of Wastewater Treatment on MCs
 - **MCs in Biosolids**
 - Nanoparticles
 - Source Control of MCs
 - Sources of MCs and EDCs
 - MCs in the Water Environment – A Resource Paper for Public and Press

WEF COP TPU on MCs in Biosolids (July 2007)

- Contaminants reviewed were pharmaceuticals, brominated flame retardants, plastics & plasticizers, musks & fragrances
- Regulatory status in U.S. and EU
- Methodologies for assessing MCs in biosolids
- Summarized current research status and future directions

Water Environment Research Foundation (WERF)

- Fate of Estrogenic Compounds during Municipal Sludge Stabilization & Dewatering
 - WERF Project #04-HHE-6
- WERF Project Manager Alan Hais
 - (703) 684-2470; ahais@werf.org
- Work led by AECOM and US Geological Survey
 - Study is in progress

WERF Study of Estrogenic Compounds in Municipal Sludge Stabilization

- Establish identity, characteristics, concentrations, temporal/seasonal variations and estrogenic potency in biosolids during different treatment processes
- Examine effect of sludge treatment and dewatering processes on estrogenic compounds and estrogenic activity
- Targeted full- and pilot/bench-scale studies
- Phase II will examine other trace contaminants

- U.S Targeted National Sewage Sludge Survey (TNSSS)
- Released in 2009
 - 74 POTWs, >1 MGD, secondary treatment or better in contiguous U.S.
 - Tested for 25 metals, 11 PBDEs, 97 pharmaceuticals, steroids and hormones (and others) in 84 samples
- Project contact Rick Stevens
 - (202) 566-1135
 - stevens.rick@epa.gov

- Of 72 pharmaceuticals, 3 (ciprofloxacin, diphenhydramine and triclocarban) were found in all 84 samples; 9 were found in at least 80 of the samples
- 10 of 11 PBDEs were found in all samples
- 17- α -ethinyl-estradiol not found in any samples
- Reference:
www.epa.gov/waterscience/biosolids/tnsss-overview.html

Summary

- Concentrations and potential effects of MPs in biosolids are a concern in North America because land application is an important management alternative
- Substantial research effort is going on in Canada and the U.S.
- Occurrence of MPs in biosolids is becoming better characterized
 - Fate and effects of MPs in terrestrial environment are generally not well understood

The End

- Thank you for your attention!
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 - Monteith@hydromantis.com

