Results of Field and Lab Experiments on High Rate Land Application of Wastewater

*RIBS – Update on Current Research*

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- UD Water Resources Center – State Water Resources Research Institute
- DGS
- UD Dept. of Civil and Environmental Engineering
- USDA ARS Penn State
How to avoid or manage risks?

- Public and environmental health
- Problem mitigation
- Development & Income
- Costs for wastewater treatment and disposal
Ground Water Benefits and Risks

- Recharge does occur
- Potential for re-use
- Contamination of key water resource
- Site specific flow details uncertain

Monitoring is key risk management tool
Rapid Infiltration Basin Systems

- Complex system – components in series
- Wastewater treatment plant
- Infiltration basins – high rate disposal, 10x Spray, 100x natural recharge
- Vadose zone (natural) treatment
- Diffusion/dispersion of water and solutes in aquifers
Many misconceptions, miscommunications
Decades of operational history
Most common in arid areas, and locations that have fresh water supply issues
Potential part of water reuse system
High loading > smaller land requirement
Some design standards based on 1970’s work and national-scale considerations
Point source or non-point source regulation? What about ag standards?
Recharge of confined aquifer – Florida

Illustration source: Tuscon Water
RIBS Research

Phase I – Multi-state treatment plant performance, site visits, comparison of state regulatory programs

Phase II Field experiments - infiltration beds, vadose and saturated zones, characterization/monitoring systems, literature search

Phase II Modeling experiments – field site simulation, comparison of modeling approaches, GIS screening tools

Phase III Reporting and wrap up

Parallel SWRI project on vadose zone

Parallel UD/USDA project on chemical testing
Phase I Results

- Treatment plant performance shows mixed success – periodic plant “upsets”, some “lemons”, start up and capacity “gotcha’s”
- Other states have adapted engineering, regulation, and policy to water and development needs and environmental/public health risks
- DE public and environmental health risks are significant and different from other states
- DE regulatory and administrative programs are nearing completion, proposal to tighten treatment, engineering, design, and monitoring requirements
Infiltration beds

Phase II results

Small to large
When things go wrong…

It’s a show stopper!
Infiltration risks and planning

- Too slow or fast problems caused by...
- Inadequate site characterization & facility design – *MAGIC SAND* issue
- Poor quality effluent and application practices
- Maintenance
- Monitoring systems
- Alternate disposal plans common
Phase II Field Experiments
A “sophisticated research” monitoring system

MMR national research site, Cape Cod, MA – source USGS
One result .... Complex flow characterization
Research is affordable, but resource loss may not be!
To minimize risk – **know** where contaminants are moving.
Frequently sample effluent quality – don’t assume
Tracing Effluent in Groundwater

- Temperature (°C)
- Soil T at 10 ft
- 45-35
- 45-45
- 45-43

- Under
- 60 m
- Soil
- 25 m

Dates:
- 06/01/08
- 11/28/08
- 05/27/09
- 11/23/09
Tracing effluent in groundwater

Under
25 m
60 m

Nitrate-nitrogen (mg/L)

Temperature (degrees C)

0
5
10
15
20
25

0
5
10
15
20
25


Ni45-43
Ni45-35
Ni45-45
Ni45-43 TE
Ni45-35 TE
Ni45-45 TE

Under
Infiltration issues and risks

- Little to no contaminant removal once past this zone and in an aquifer!
- Breakthrough of applied contaminants, mobilization of pre-existing contaminants
- Very complex system – low risk design requires extensive work
- Problem diagnoses and fixes are costly
- 1970’s design does has little treatment benefit
Monitoring issues
Transport models are only a probabilistic tool, not the truth

P moving significant distances from disposal area
Simple monitoring systems & models routinely misinform

Infiltration basins

Water table

Sample locations and particle tracks
Let’s talk about P

- P is mobile in DE groundwater
- Environmental but not public health standards
- DE Nutrient Mgt Commission has adopted very explicit guidance about P application and spends millions of dollars on P capture & relocation
- Ag community spends many $ on P
- Is wastewater P getting the correct attention?
SUMMARY

- EPA guidance not appropriate for DE
- Contaminants not significantly attenuated
- Highly complex contaminant transport
- Mobilization of naturally occurring contaminants
- Monitoring very difficult to do correctly
- Modeling leaves false sense of security
- More results yet to come
Questions
Geologic Setting & Model Domain

- RIBS
- Dune deposits of Great Dune
- Spit and swamp/marsh deposits
- Marine deposits
- Spit complex swamp