Contamination and Disposal Issues of Stormwater Pond Sediment

John E. Weinstein

Department of Biology
The Citadel
Stormwater Detention Ponds

- **Common BMP**
  - enhance aesthetics and property values, open space

- **Protect natural receiving waters**
  - flood control structures
  - settling basins

- **Trap suspended sediment**
  - sediment from pond watershed
Sedimentation

36% decrease in storage capacity

Messersmith, 2007
Consequences of Sedimentation

- Reduction in efficiency
- Chemical contaminants bound to sediment
- Periodic sediment removal recommended
- No state requirement of testing for chemical or biological sediment contaminants
- Contaminant Concerns:
  - On-site disposal of excavated sediments may pose risks to humans
  - Sediment not removed may pose risks to wildlife
Critical Questions

• How contaminated are bottom sediments in typical coastal stormwater ponds?

• Do these contaminant levels have the potential to pose ecological and human health risks?
Stormwater Pond Sediment Project - Methodology

- Sampled 18 Ponds
  - June 2007
  - Classified based on land use

- Analyzed Sediments
  - PAHs
  - Metals
  - Pesticides
  - PBDEs
  - Fecal Coliforms
Stormwater Ponds

**Reference**
Willow Swamp Road (FMNF) (R1)
Dill Plantation (R2)

**Golf Course**
Indigo Run (80)
Arrow Head (62)
Traditions (57)

**Residential-LD**
Daniel Island (89)
Pawleys Place (31)
Whitehall Plantation (109)
Ashton Glenn (24)
Ricefields (38)

**Residential-HD**
Sable Palm Apts. (7)
Cantebury (44)

**Commercial**
Wal-Mart, James Is. (70)
Tanger Outlets, Bluffton (48)
M.B. Chevrolet (26)
Riverland Woods (68)
Toys R Us, M.B. (83)
NASCAR Café and Speed Track (87)
Polycyclic Aromatic Hydrocarbons
Polycyclic Aromatic Hydrocarbons (PAHs)

- Naphthalene
- Acenaphthylene
- Acenaphthene
- Fluorene
- Phenanthrene
- Anthracene
- Fluoranthenene
- Pyrene
- Benzo(a)anthracene
- Chrysene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(a)pyrene
- Dibenz(a,h)anthracene
- Benzo(g,h,i)perylene
- Indeno(1,2,3-cd)pyrene
ΣPAH_{LMW}
Metals

- Al, Cd, Cr, Cu, Fe, Pb, Zn
Copper

Copper (Cu) levels (mg/kg dry weight) measured at different locations:

- **Inlet**
- **Center**

Locations:
- REF
- GC
- RLD
- RHD
- COM

The graph shows the concentration of copper at each location, with bars indicating the range of values.
Pesticides

- Chlorpyrifos was the most commonly detected pesticide
  - widely used on golf courses
  - banned from residential use in 2001
- Infrequently detected pesticides included chlordane, DDD/DDE, endosulfan, and dichlorvos
Sediment Fecal Coliforms

- Commonly used as an indicator of fecal contamination (human and animal)
- Fecal coliform levels were generally similar to reference pond sediments
Sediment Fecal Coliform

FC (MPN/g dry weight)

Reference | Golf Course | Res. Low Density | Res. High Density | Commercial

Reference Res. Low Density Golf Course Commercial Res. High Density


19,400
Results

- Commercial ponds had higher levels of PAH, Cu, and Zn than various other land use classes.
- Residential and golf course ponds generally had levels of contaminants similar to reference ponds.
- Contaminants associated with vehicular use.
Screening Assessments

- Ecological
  - Consensus-Based Sediment Quality Guidelines (CB-SQC) (MacDonald et al., 2000)

- Human Health
  - Regional Screening Levels (USEPA, 2009)

In situ vs. ex situ contact with sediments

Cantebury Apartments, Myrtle Beach, SC
CB-SQG – $\Sigma$PAH$_{16}$

PEC = 28,800

TEC = 1,610

Ref Golf Course Low Density Residential High Density Residential Commercial
CB-SQG – Anthracene

Normalized Anthracene (ng/g dry weight)

PEC = 845

PEC = 845

TEC = 57.2

TEC = 57.2

Normalized Anthracene (ng/g dry weight)

R1  R2  100  80  62  57  67  89  31  109  24  38  7  44  37  48  70  26  68  83  87
Ref Golf Course Low Density Residential High Density Residential Commercial
CB-SQG – Fluoranthene

Normalized Fluoranthene (ng/g dry weight)

- PEC = 2230
- TEC = 423

Ref Golf Course Low Density Residential High Density Residential Commercial
Copper

Cu (mg/kg dry weight)

PEC=77.7
TEC=28
PEC = 77.7
TEC = 28

Indicates the use of copper products for weed control.

Copper levels in different areas:
- Reference
- Golf Course
- Res. Low Density
- Res. High Density
- Commercial

Cu (mg/kg dry weight)
Results – Ecological Screening Assessment

- PAHs are a contaminant of concern
- Commercial pond sediments exceeded the TEC values for most individual analytes
- Wildlife have a low/moderate risk of adverse effects resulting from *in situ* exposure to PAHs in commercial pond sediments
  - Risk is higher in Pond 87
- Copper is also a contaminant of concern
Human Health Screening Assessment

• Regional Screening Levels
  – Preliminary Remediation Goals (PRGs)
  – EPA Region IV and State of SC for residential soil limits
• Human health toxicity values combined with standard exposure factors
• Protective of human health following a lifetime of exposure
RSL - Anthracene

RSL = 1,700,000 ng/g

Anthracene (ng/g dry weight)

Ref  Golf Course  Low Density Residential  High Density Residential  Commercial

R1  10  80  62  57  109  24  38  7  44  37  48  70  26  68  83  87
R2
RSL – Benzo[a]anthracene

Benzo[a]anthracene (ng/g dry weight)

RSL = 150 ng/g

R1 R2 100 80 62 57 67 89 31 109 24 38 7 44 37 48 70 26 68 83 87

Ref Golf Course Low Density Residential High Density Residential Commercial
PAHs are a contaminant of human health concern in several commercial ponds:

- Sediments exceeded RSL values for several carcinogenic PAHs
- Excavated sediment would not meet guidelines for on-site disposal in several states
Other Considerations

• **Age of the pond**
  – Evidence suggests that sediment PAH levels increase with age

• **Frequency of sediment excavation**
  – Periodic excavation is not occurring as recommended

• **Coal tar-based sealcoats**
• Protect asphalt from oxidation, cracking, UV radiation
• Two types: Asphalt-based and Coal-tar based
  • Coal-tar is byproduct of steel industry
  • Contains up to 30% PAHs
  • Particles of sealcoat wear away over time, contaminating nearby water bodies
• Banned in several states and cities
Relative Concentrations - $\Sigma$PAH$_{16}$
Relative Concentrations - $\Sigma\text{PAH}_{16}$

Evidence of Recent Sealcoating Activity
How to Avoid Coal-tar Sealcoats

DIY Driveway Sealing

• Don’t trust labels
• Do your homework (Material Safety Data Sheet – CAS number 65996-93-2)
• Shop where it’s not... Lowe’s, Home Depot, Ace

Hiring someone

• Know the product
• Do your homework
Disposal Issues

Requirement to Remove Sediment Accumulation:
“5 to 10 year cycle, after 25% of the permanent pool volume is filled” (SC DHEC Storm Water Management BMP Field Manual, 2005)

Where does excavated material go?
- On-site disposal
- Treated as solid waste and sent to landfill
- Treated as hazardous waste and sent to hazardous waste facility

Is sampling required?
- No state requirement
Disposal Issues

Wisconsin – proactive legislative approach

- NR 528 – Management of Accumulated Sediment From Stormwater Management Structures

1. Evaluate land use surrounding pond to determine whether sediment sampling is necessary
2. If required, contract environmental professional to sample and analyze sediment
3. Have environmental professional conduct a risk analysis based on any contaminants found in sediment
4. Determine appropriate end use, which may include landfilling if risk level too high for other uses
Conclusions

• PAHs are a contaminant of concern in commercial ponds

• Risk Analysis for commercial ponds
  • Wildlife = low/moderate risk
  • Humans = increased cancer risk

• Periodic excavation and restrictions on the use of coal tar-based sealcoats should reduce risks to both wildlife and humans
Further Information…

- SC DHEC/SC Sea Grant Final Project Report
- Stormwater
  - http://www.stormh2o.com/SW/Articles/11069.aspx
- Wisconsin DNR
  - Publication WA 1375
Map depicting land cover in typical single residential pond, Daniel Island, SC
Designed bathymetry of single residential pond by Thomas and Hutton Engineering (permitted 1999)

Messersmith, 2007
Measured pond bathymetry of single residential pond (2006)

Messersmith, 2007
Accumulated Sediment Disposal/Use Flow Chart

Do you plan to dispose of sediment in a landfill?

Yes → Done. No certification form required. Comply with any applicable landfill testing requirements.

No → Is sediment from a “clean” site?

Yes → No sampling required. Complete certification form part A.

No → Do you have <100 cubic yards of coarse forebay material?

Yes → No sampling required. Complete certification form part D.

No → Perform initial sediment sampling.

Evaluate sediment data. Complete certification form parts B and C (if dedicated site).
Perform follow-up sampling, if necessary, and evaluate.

Is risk manageable?

No

Dispose of sediment in a licensed landfill.

No

Use sediment in compliance with:
- locational criteria
- performance standards
- runoff control measures
- extra management and monitoring requirements (if necessary)
- recordkeeping requirements

Yes

Note: Except as provided in Step 1, the sediment manager and environmental professional (if required) must complete and sign the certification form. The form will walk you through the applicable steps and procedures.
Studies: Health risk from toxic pavement sealant greater than previously believed

http://openchannel.msnbc.msn.com