Composted Paper Mill Residuals Use in Virginia DOT Environmental Restoration Projects

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Director, Technical Services
Royal Oak Farm LLC

FHWA/IRC Conference
“The Use of Industrial Materials in Highway and Road Construction”
Austin, Texas November 1-2, 2011
Resource Recovery Through Composting

A controlled aerobic biological decomposition process where microorganisms convert raw organic materials into relatively stable humus-like materials suitable as a soil amendment.
Bacteria on Grass Blade

Courtesy K.C. Das, 2004
The Partners

- Georgia-Pacific LLC
  - Big Island, VA Containerboard Mill
  - Makes Ultravantage® Linerboard and corrugating medium
  - Mill start-up in 1891
  - Decided to recycle short paper fiber sludge in 2005
  - Activated sludge wastewater treatment plant

- Royal Oak Farm LLC
  - Largest solid waste composting facility in VA
  - Fully permitted by Virginia Dept. of Env. Quality (# SWP-601)
  - Composting started in 1999, significantly expanded in 2008
  - Now helps nine (9) industries in VA and NC to recycle organics
GP Wastewater Treatment Facility

- Primary clarifier
- Two one acre equalization basins
- Extended aeration activated sludge system with one secondary clarifier
- 15-acre polishing pond
- Multi-port diffuser into the James River
- Belt filter press with sludge to composting
- Nominal 7 MGD
Royal Oak Farm – Feb. 2005

Windrows

9” Crushed Slag Pads

Backhus Turner

Orbit Deck Screen
 Royal Oak Farm

Farm is 115 acres

500-Ft buffer

Property Line
Composting Facility Upgrade

- Spring 2005 – signed 10-yr contract with GP to recycle short paper fiber sludge
- Short paper fiber sludge is a Virginia Dept. of Environmental Quality Category 4 waste
- DEQ wanted Royal Oak to obtain full Solid Waste Compost Facility permit
Upgrading The Facility

- Started: July 18, 2005
- Permit issued: Dec. 21, 2006
- Permit to Operate: March, 2008
- Reopened: April 14, 2008
- Permitting Cost: $140,000
- Upgrade Cost: $1.7 million
Compost Feedstocks - Now

- Short paper fiber from GP-Big Island
- Food wastes – Walmart/Sam’s Club, JMU, Kroger
- Cellulose acetate production sludge
- Production wastes and out-of-date dog foods from food processing industry
- Yard trimmings – Bedford County, others
- Leaves – Cities of Lynchburg & Altavista
- Misc. construction debris – wood, drywall
SPF sludge arriving from paper mill
Ingredients mixed with turner
Windrows turned 5 times in 15 days while temps > 55°C
(40CFR503 – Process to Further Reduce Pathogens)
Coarse Screening at 2”+ prior to curing
Final screening with trommel

½”, ¼” or ⅛” screen sizes
Products

- Composts
  - Three screen sizes: ½”, ¼”, ⅛”
- Rain Garden Substrate
  - Blend of compost, silica sand, quarry rock #10’s
- Topsoils
  - Customized to meet specs
  - Blend of compost and sand
- Root zone turf mix
  - 70% - 90% sand, 10% - 30% compost
- Erosion control media
  - Compost blankets
  - Compost berm/sock filter media
Compost Quality

- Nitrogen = 1.51%
- Phosphorus = 0.71% ($P_2O_5$)
- Potassium = 1.09% ($K_2O$)
- $pH = 7.3$
- Soluble Salts = 2.53 dS/m
- Fecal Coliform = 200 MPN/g
- Germination:
  - Emergence = 100%
  - Vigor = 100%

<table>
<thead>
<tr>
<th>EPA 503 Heavy Metals</th>
<th>Compliance Limit (mg/kg, dwb)</th>
<th>Blueblood™ Garden Compost 3/2011 test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>41</td>
<td>5.453</td>
</tr>
<tr>
<td>Cadmium</td>
<td>21</td>
<td>0.735</td>
</tr>
<tr>
<td>Copper</td>
<td>1500</td>
<td>67.93</td>
</tr>
<tr>
<td>Lead</td>
<td>300</td>
<td>24.43</td>
</tr>
<tr>
<td>Mercury</td>
<td>17</td>
<td>&lt;0.59</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>54</td>
<td>1.55</td>
</tr>
<tr>
<td>Nickel</td>
<td>420</td>
<td>16.22</td>
</tr>
<tr>
<td>Selenium</td>
<td>28</td>
<td>1.28</td>
</tr>
<tr>
<td>Zinc</td>
<td>2800</td>
<td>194.2</td>
</tr>
</tbody>
</table>
# Benefits of Compost Use

<table>
<thead>
<tr>
<th>Category</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical:</td>
<td>• Improves soil structure</td>
</tr>
<tr>
<td></td>
<td>• Moisture management</td>
</tr>
<tr>
<td>Chemical:</td>
<td>• Modifies and stabilizes pH</td>
</tr>
<tr>
<td></td>
<td>• Increases cation exchange capacity</td>
</tr>
<tr>
<td></td>
<td>• Supplies nutrients</td>
</tr>
<tr>
<td>Biological:</td>
<td>• Supplies soil biota</td>
</tr>
<tr>
<td></td>
<td>• Suppresses plant diseases</td>
</tr>
<tr>
<td>Other:</td>
<td>• Binds/degrades contaminants</td>
</tr>
<tr>
<td></td>
<td>• Binds nutrients</td>
</tr>
</tbody>
</table>
Compost can Improve Soils...

Healthy Soils mean Healthy Plants
VDOT Wetlands Projects

- **2007- Eagle Rock Mitigation Bank (ERMB)**
  - Intended to serve as internal wetlands bank
  - Located in Botetourt County VA on James River in Northern Shales Valleys ecoregion of Upper James
  - 86- acre floodplain terrace farm acquired in 2006; 5 headwater streams cross site to enter James River

- **2010 - Webb Wetlands Compensation Site**
  - Intended to offset wetlands impacts of US Hwy. 58 Bypass
    - Bypass is 5.2 mile long public-private partnership
  - Located in Carroll County VA on Little Reed Island Creek
  - 18.1 acre site, 16.8 acres amended with compost
Compost Use in Wetlands

- **ERMB**
  - 23,038 CY (~ 11,519 T) spread on 36 acres and along constructed streambanks prior to planting
    - 2” layer overlain on 6” of loosened soil to reach final grade
  - Used to raise soil organic matter to hydric levels

- **Webb Wetlands Compensation Site**
  - 11,289 CY (~ 5,644 T) ripped and chisel-plowed into 16.8 acres
  - Installed in 150 mm lifts to bring to final grade
  - Used as soil amendment to help plant growth
Eagle Rock Mitigation Bank

- ERMB consists of:
  - 21.09 acres of palustrine scrub-shrub wetlands
  - 4.23 acres of palustrine forested wetlands
  - 5.00 acres of palustrine seep wetlands
  - 4.55 acres of floodplain emergent/scrub-shrub wetlands
  - 0.82 acres of open water with emergent wetland fringe
  - Preservation of 5.01 acres of undisturbed/restored wetlands
  - Relocation and enhancement of 1468 linear feet of degraded stream channel
  - Establishment/restoration of 4013 linear feet of stream channel
  - Relocation and preservation of 610 linear feet of existing stream channel
  - Enhancement and preservation of 23.45 acres of upland riparian buffer
  - Establishment of 16.86 acres of vegetated riparian buffer.
## VDOT Compost Specs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>%</td>
<td>35 – 55</td>
</tr>
<tr>
<td>pH</td>
<td>Stnd. Units</td>
<td>5.5-8.0</td>
</tr>
<tr>
<td>Organic Matter</td>
<td>% dry wt.</td>
<td>&gt; 35%</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>gm/cc</td>
<td>&lt; 0.60</td>
</tr>
<tr>
<td>Soluble Salts</td>
<td>mmhos/cm</td>
<td>&lt; 3.0</td>
</tr>
<tr>
<td>Particle Size Analysis</td>
<td>-</td>
<td>95% thru 1” screen</td>
</tr>
<tr>
<td>Total N</td>
<td>% dry wt.</td>
<td>0.5 – 2.5</td>
</tr>
<tr>
<td>Phosphate (P$_2$O$_5$)</td>
<td>% dry wt.</td>
<td>0.2 – 2.0</td>
</tr>
<tr>
<td>Potash (K$_2$O)</td>
<td>% dry wt.</td>
<td>0.3 – 1.5</td>
</tr>
<tr>
<td>Heavy Metals</td>
<td>ppm</td>
<td>&lt; EPA 503</td>
</tr>
<tr>
<td>C:N Ratio</td>
<td>-</td>
<td>&gt; 16.1</td>
</tr>
</tbody>
</table>

- Specification is for composted yard waste
  - Other types can be approved
  - Must be at least one year old
  - Must pass maturity tests
  - Must be weed seed-free
  - Cannot have inorganic contaminants
Specifying Composts

- Composts can be made from a wide variety of industrial and commercial residuals
- Should be made at a State-permitted facility that is in compliance with all requirements
- Should be produced by a compost facility enrolled in the U.S. Composting Council’s Seal of Testing Assurance (STA) program
- Compost uses in highway work –
  - Soil amendment to encourage healthy vegetation
  - Erosion control blankets
  - Sediment filter socks
Seal of Testing Assurance Program

WHAT IS IT?
• Compost testing and information disclosure program (employing standardized practices)

PURPOSE...
• To assist compost end users purchase the product they require for their particular project
• To assure that compost end users know the characteristics of the compost products they purchase
• To improve overall customer confidence in compost selection and utilization
# COMPOST TECHNICAL DATA SHEET for Texas DOT

<table>
<thead>
<tr>
<th>Compost Parameters</th>
<th>Test Results</th>
<th>Reported as (units of measure)</th>
<th>TMECC Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic Matter Content</td>
<td>45.8</td>
<td>% dry weight basis</td>
<td>07.09-A Laboratory Analysis Organic Matter Method (OIM)</td>
</tr>
<tr>
<td>pH</td>
<td>6.28</td>
<td>Units</td>
<td>04.31-A1.5 Storm pH</td>
</tr>
<tr>
<td>Soluble Salts</td>
<td>2.98</td>
<td>g/L (milliequivalents)</td>
<td>04.10-A1.3 ASTM Method</td>
</tr>
<tr>
<td>Particle Size</td>
<td>97.0</td>
<td>% dry weight passing through</td>
<td>02.02-B Sample Sieving for Aggregate Size Classification</td>
</tr>
<tr>
<td></td>
<td>94.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stability Indicators (respiration)</td>
<td>0.43</td>
<td>mg CO₂/g x 0.045</td>
<td>05.08- B Carbon Dioxide Evolution Rate</td>
</tr>
<tr>
<td>CO₂ Evolution</td>
<td>0.43</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Maturity Indicators (respiration)</td>
<td>100</td>
<td>average % of control</td>
<td>05.05-A Germination and vigor</td>
</tr>
<tr>
<td>Percent Emergence</td>
<td>100</td>
<td>average % of control</td>
<td>05.05-A Germination and vigor</td>
</tr>
<tr>
<td>Relative Rooting Vigor</td>
<td>100</td>
<td>average % of control</td>
<td>05.05-A Germination and vigor</td>
</tr>
<tr>
<td>Select Pathogens (final cultures)</td>
<td>Pass</td>
<td></td>
<td>07.01-A Test for pathogens</td>
</tr>
<tr>
<td>Trace Metals</td>
<td>Pass</td>
<td></td>
<td>04.06-C Heavy Metals standard; and Hazardous Elements</td>
</tr>
</tbody>
</table>

Laboratory Batch Number: Nov.-1-03 Laboratory Number: 167017112034

Analyst: Frank Shields

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# COMPOST TECHNICAL DATA SHEET for Washington State DOT Projects

<table>
<thead>
<tr>
<th>Compost Parameters</th>
<th>Specification Requirements</th>
<th>Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size Classification</td>
<td>%, dry weight passing through</td>
<td>Sieve Size</td>
</tr>
<tr>
<td>TMECC 02-02-B</td>
<td></td>
<td>2&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3/8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1/4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum Particle Length</td>
</tr>
</tbody>
</table>

pH TMECC 01-11-A

1.5 starting pH

6.0 min. and 8.5 max.

Manufactured Inert Material TMECC 01-06-A

Less than 1.0%

Organic Matter Content TMECC 01-09-A

40% min.

Soluble Salt TMECC 01-10-A

Less than 4.0 mmol/cm²

Maturity Indicator TMECC 01-05-A

Germination: 80% or greater

Vigor: 80% or greater

Stability Indicator TMECC 01-08-B

Carbon Dioxide Evolution Rate 7 or below

Laboratory Batch Number: Laboratory Number: 8-06

* Check for special provisions in Columbia River Basin

Customized for DOT inspectors, project managers ....
Other Benefits

- Acts as a framework to allow the implementation of established numerical product specifications
  - State DOTs, other
- Assists in the implementation of an inspection or quality verification program
- Can serve a quality control function (and promotional benefits) for composters
- Standardizes a set of test parameters (and methods) for use in evaluating compost product quality
DOTs Specifying STA Compost

- California
- Georgia – Erosion Control only
- Oregon
- Texas
- Pennsylvania – Erosion Control only
- Washington State
- North Carolina
- South Carolina
- Iowa – Erosion Control only
AASHTO Erosion Control Specs

- MP-10 – Compost for Erosion Control Blankets
  - Can be used in up to 1:1 slope applications
  - Compost can be derived from industrial residuals
  - Compost quality standards specified
  - Application rates from ½” to 2” layer (vegetated) and 1” to 4” (unvegetated), depending on rainfall and soil erosivity index
  - Seeding mixes can be incorporated into compost as it is applied or added later
  - Compost must be tested using USCC’s Test Methods for the Examination of Compost and Composting (TMECC)
Compost Blankets

2” layer

Slide Courtesy of U.S. Composting Council
Synthetic Blankets Lack Intimate Contact

Compost Blankets follow the land, don’t bridge like erosion matting
Hold-down netting needed on steep slopes
AASHTO Erosion Control Specs

- MP-9 — Compost for Erosion Control — Filter Berms
  - Appropriate for flat areas and slopes up to 2:1 that have sheet flow runoff
  - Can be made from industrial residuals
  - Compost quality standards specified
  - Need at least 30% fines in compost for good filtration
  - Berm dimensions 1’ x 2’ to 2’ x 4’ depending on rainfall and soil erosivity index
  - Berms can be placed 15’ – 25’ apart on slopes, in conjunction with compost blankets and on the downhill side of silt fence
  - Product should be tested with TMECC methods
Compost Berm to Filter Sediment

Slide Courtesy of U.S. Composting Council
Compost Socks As Alternate to Berms

Slide Courtesy of U.S. Composting Council
Questions?

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