ANALYSES OF COMPOST

Recommendations of the FORCE Scientific Advisory Committee

George F. Fries
Rufus Chaney
Lewis Carr

July 23, 2002

Introduction

The FORCE Scientific Advisory Committee was charged with the task of recommending analytical procedures to insure the quality and safety of composts produced in the Sumter County composting facility. Organic feedstocks to be composted may include, but are not limited to such materials as municipal solid waste, yard trash, food processing waste, biosolids, and manures.

As a general rule, the analytical efforts should be devoted to the finished compost because this is the material that may lead directly to phytotoxicity in the area of application and to exposure of the general population to hazardous contaminants directly by contact or indirectly by entrance into the food chanin. Analyses of starting materials, or of materials at intermediate stages of the process, should only be conducted as part of a trace back effort to determine the origins of unacceptable concentrations of heavy metals, toxic organics, or pathogens in the finished compost.

The composts produced in this facility will be used for purposes similar to the uses of biosolids. Thus, the EPA Part 503 Rule on land application of biosolids provides the primary frame of reference for identifying the analyses required to insure an acceptable product. Useful reference materials on the Part 503 Rule include *A Guide to the Biosolids Risk Assessments for the EPA Part 503 Rule* (http://www.epa.gov/owm/mtb/biosolids/503rule) and *A Plain English Guide to the EPA Part 503 Biosolids Rule* (http://www.epa.gov/owm/mtb/biosolids/503pe).

Although the emphasis should be placed on the quality of the end product, collection of information on potential contaminants in the starting material may indicate the need for analyses to confirm that these compounds are degraded in the composting process. The possible presence of herbicides in yard waste, and prophylactic drugs and feed additives in manures are notable examples of compounds that should be identified in the materials used for composting. In most cases, these compounds will be degraded, but there have been exceptions such as the herbicide clopyralid. Some materials, such as wood that had been treated with pentachlorophenol or arsenic, should be prohibited from entering or removed from the waste stream used for composting.

The recommendations in this report will address the general areas of sample collection, nutrient management, pathogens, phytotoxins, heavy metals, and persistent organics.

Sample Collection

It is important to obtain a mixed compost samples as representative as possible. In a windrow or curing pile, 10 one-quart samples for a composite mix should be minimum. Sample at least 2 feet into the windrow or curing pile for each quart sample. Samples should be collected from the sides as well as the top. These may be blended together for a composite sample best by mixing on a small tarp by “rolling” the tarp in different directions. After mixing, make a 2-quart composite from the 10 quarts and grind to make

a homogenous sample for laboratory analysis and a second sample to be archived as a backup in the event the original sample is lost or questionable results are obtained.

It is noted that compost is currently sampled at every 20,000 tons as required under Florida regulations (DEP 62-709.530). Composites of larger lots may be used for compounds not covered in the regulations if the waste streams entering the process are relatively constant in composition, and if analytical experience indicates there is a low probability that a given contaminant will be detected.

Nutrient Management

The old rule of thumb of adding 50 to 60 ton or more of compost per acre may not be correct in present environment with the focus on nutrient management planning. The following steps should be taken to determine the amount of compost to apply.

Step 1: Determine the nutrient content of the composts that are to be applied..

Step 2: Determine the nutrient availability of these composts.

Step 3: Conduct a soil analysis.

Step 4: Determine the crop needs.

Step 5: Develop a nutrient management plan utilizing data from Steps 1-4. Determine the limiting nutrient, nitrogen or phosphorus, and the amount of compost required for the cropping system.

Step 6: Application equipment calibration is necessary. Make sure the application equipment is suitable for the compost application; not all application equipment will be suitable.

Step 7: Timing of application is important in order to maximize utilization of the nutrients in the compost. Typically, this will occur as close to planting as possible.

Pathogens

The EPA Part 503 Rule lists a number of methods suitable for meeting the requirements for pathogen reduction. A method appropriate for the process being studied should be adopted from the alternatives listed in Chapter 5, Tables 5-1 through 5-5, of *A Plain English Guide to the EPA Part 503 Biosolids Rule*. Particular attention is drawn to the composting time and temperature conditions listed in Table 5-4. All measurements required for the selected method should be made and recorded. Following current

practice, fecal coliform measurements should be made in accordance with State regulations.

Phytotoxicity Bioassays

Cress seed has been used to test for presence of toxins in composts following traditional bioassay methods. A somewhat different focus of the bioassay is needed with the new issues of chlorpyralid residues in compost. And use of faster growing, more uniform seed species will improve the reliability of bioassays. Both dicots and grasses are needed to detect toxicity from different classes of herbicides or unknown toxic materials in composts.

Radish and wheat are common test species that are more reliable than cress seed. Pepper and impatiens are very sensitive to the "anaerobic incubation of finished compost" toxic materials which must be identified. Fauci et al. (Bull. Environ.Contam. Toxicol. 68:79-85, 2002) have developed bioassays for chlorpyralid and picloram using pinto beans, cherry tomatoes and peas.

Salts can be high in many composts, and to conduct a phytotoxicity test with 100% compost media, one needs to leach the water soluble salts from the compost during seeding. A pore volume should be percolated thru the pot before planting. From 20 to 100 seeds are then placed near the surface of the pot. Pots are incubated in dark or light under temperature conditions relevant to the market areas. After a number of days have passed, the fractions of seeds that germinate are measured. This is usually repeated for some days, and plant growth followed until at least true leaves (not dependent on cotyledons for energy and nutrients) are generated and functioning without harm.

Heavy Metals

Properly sampled finished compost should be prepared for analysis following protocols as outlined in the EPA methods manual SW-846 (http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm). Sample size and preparation methods should be selected to provide appropriately small Coefficients of Variation of the analyses. The analyses should include the following inorganic compounds and elements.

Major nutrients:

Total nitrogen
Ammonia nitrogen
Nitrate nitrogen
Total Phosphate
Water-soluble phosphate
Potassium

Calcium
Magnesium

Microelements commonly measured to comply with the 503 regulations:

Zinc
Copper
Nickel
Cadmium
Lead
Arsenic
Molybdenum
Selenium

Micronutrients that should be run to characterize fertilizer value or potential toxicity:

Iron
Manganese
Water-soluble borate

Contaminant trace elements that could be run to identify opportunities for recovery valuable elements by FORCE cooperators:

Antimony
Thallium
Chromium
Barium
Vanadium
Silver

Persistent Organics

Concentrations of persistent organics are not subject to regulation under the Part 503 Rule. EPA considered regulation dioxins and related compounds, but the final decision was to not issue a regulation. The committee was requested to consider the compounds listed in Appendices I and II of EPA 40 CFR Part 258. Of the compounds listed, only the persistent organics such as the polychlorinated biphenyls (PCBs) and chlorinated hydrocarbon insecticides are of particular concern. These classes of compounds are no longer manufactured or used routinely, but residual sources may occasionally enter waste streams.

The remaining compounds listed in Appendices I and II are degraded in the composting process, or are not bioconcentrated because of high water solubility and/or high vapor pressure. These compounds are not of great concern when composts are utilized in the usual manner of land application.

EPA does not specifically require analysis of persistent organic compounds. However, periodic screening analyses of the dioxins, PCBs and chlorinated hydrocarbons insecticides are recommended in order to allay possible concerns and questions from the general public. The PCBs and chlorinated hydrocarbons can be readily determined by multi-residue gas chromatographic methods in which sample preparation and cleanup is common for all compounds. Appropriate preparation and cleanup methods are in the EPA methods manual SW-846 (http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm). As an alternative, consideration can be given to using the related methods for foods and feeds of low fat content in the Food and Drug Administration *Pesticide Analytical Manual* (http://www.cfsan.fda.gov/~frf/pami3.html).

The analysis of dioxin and related compounds is quite expensive if the complete array of toxic congeners is determined. However, at least one commercial laboratory provides a screening analysis of a limited set of congeners that includes 80% of the toxic equivalents in typical environmental samples (Triangle Laboratories, http://www.trianglelabs.com Citation of a specific laboratory is for illustrative purposes only. Other laboratories may provide comparable services.) The cost of the limited screen is approximately 25% of the cost required for a complete conger analyses.

The analysis program can be reduced in scale if experience demonstrates that the finished composts are free of significant concentrations of persistent organics. In this case one could composite samples from several 20,000-ton lots if the feedstock does not change significantly in composition.