2.1 BENEFITS TO COMPOST USE ON ROADSIDE APPLICATIONS

As mentioned earlier, there are a variety of benefits to using compost on roadside applications (Figure 1). In this section, these benefits are discussed in greater detail.

Improved Structure: Compost can greatly enhance the physical structure of soil. In fine-textured (clay, clay loam) soils, the addition of compost will reduce bulk density, improve friability (workability) and porosity, and increase its gas and water permeability, thus reducing erosion. When used in sufficient quantities, the addition of compost has both an immediate and long-term positive impact on soil structure. It resists compaction in fine-textured soils and increases water-holding capacity and improves soil aggregation in coarse-textured (sandy) soils. The soil-binding properties of compost are due to its humus content. Humus is a stable residue resulting from a high degree of organic matter decomposition. The constituents of the humus act as a soil 'glue,' holding soil particles together, making them more resistant to erosion and improving the soil's ability to hold moisture.

Moisture Management: The addition of compost may also provide greater drought resistance and more efficient water utilization. Therefore, the frequency and intensity of irrigation may be reduced. Since compost can hold many times it own weight in moisture, its use can greatly assist the establishment of roadside plantings. Recent research also suggests that the addition of compost in sandy soils can facilitate moisture dispersion by allowing water to more readily move laterally from its point of application.

Modifies and Stabilizes pH: The addition of compost to soil may modify the pH of the final mix. Depending on the pH of the compost and of the native soil, compost addition may raise or lower the pH of the final mix. Therefore, the addition of a neutral or slightly alkaline compost to acidic soil will increase soil pH if added in appropriate quantities. In specific conditions, compost has been found to affect soil pH even when applied at quantities as low as 10-20 tons per acre. The incorporation of compost also has the ability to buffer or stabilize soil pH, whereby it will more effectively resist pH change.

Increases Cation Exchange Capacity: Compost will also improve the cation exchange capacity of soils, enabling them to retain nutrients longer. It will also allow crops to more effectively utilize nutrients, while reducing nutrient loss by leaching. For this reason, the fertility of soils is often tied to their organic matter content. Improving the cation exchange capacity of sandy soils by adding compost can greatly improve the retention of plant nutrients in the root zone.

Provides Nutrients: Compost products contain a considerable variety of macro and micronutrients. Although often seen as a good source of nitrogen, phosphorous, and potassium, compost also contains micronutrients essential for plant growth. Since compost contains relatively stable sources of organic matter, these nutrients are supplied in a slow-release form. On a pound-by-pound basis, large quantities of nutrients are not typically found, in compost in comparison to most commercial fertilizers. However, compost is usually applied at much greater rates; therefore, it can have a significant cumulative effect on nutrient availability. The addition of compost can affect both fertilizer and pH adjustment (lime/sulfur addition). Compost not only provides some nutrition, but often makes current fertilizer programs more effective.

Provides Soil Biota: The activity of soil organisms is essential in productive soils and for healthy plants. Their activity is largely based on the presence of organic matter. Soil microorganisms include bacteria, protozoa, actinomycetes, and fungi. They are not only found within compost, but proliferate within soil media. Microorganisms play an important role in organic matter decomposition which, in turn, leads to humus formation and nutrient availability. Microorganisms can also promote root activity as specific fungi work symbiotically with plant roots, assisting them in the extraction of nutrients from soils.

Suppresses Plant Diseases: Disease incidence on many plants may be influenced by the level and type of organic matter and microorganisms present in soils. Research has shown that increased population of certain microorganisms may suppress specific plant diseases such as pythium and fusarium as well as nematodes. Efforts are being made to optimize the composting process in order to increase the population of these beneficial microbes.

Binds Contaminants: Compost has the ability to bind heavy metals and other contaminants, reducing both their leachability and absorption by plants (bioavailability). Therefore, sites contaminated with various pollutants may often be improved by amending the native soil with compost. The same binding affect allows compost to be used as a filter media for storm water treatment and has been shown to minimize leaching of pesticides in soil systems.

[Much of the information in section 2.1 has been adapted from 'The Field Guide to Compost Use' published by the US Composting Council 1996][3]

Figure 1 Benefits of Using Compost [4]

1. Improves the soil structure, porosity, and bulk density, thus creating a better plant root environment.
2. Increases infiltration and permeability of heavy soils, reducing erosion and runoff.
3. Improves water holding capacity in sandy soils, reducing water loss and leaching.
4. Supplies a variety of macro and micronutrients.
5. Controls or suppresses certain soil-borne plant pathogens and nematodes.
6. Supplies significant quantities of organic matter.
7. Improves cation exchange capacity (CEC) of soils, improving their ability to hold nutrients for plant use.
8. Supplies beneficial microorganisms to soils.
9. Improves and stabilizes soil pH.
10. Can bind and degrade specific pollutants.

Adapted from *'The Field Guide to Compost Use'*, US Composting Council 1996.

2.2 COMPOST APPLICATIONS

Although unable to be discussed in detail, there are a variety of potential roadside applications for compost (Figure 2). Today, the use of compost on roadsides has grown past the more typical landscape applications, discussed in later sections of this report, and now includes a variety of 'high tech' applications which include erosion and sediment control, reclamation, bioremediation, storm water management and wetland mitigation. In order to document the successful utilization of compost in a variety of applications, Section 3 provides various State DOT 'case studies' which were documented from throughout the country. It should be understood, however, that this document focuses on the use of compost in typical landscape applications. As mentioned in the previous section, the benefits of using compost in these applications are well understood and have been documented over a long period of time. Specifications developed for the proper use of compost in typical landscape applications is described in Section 4 of this document.

Figure 2 Potential 'Roadside' Applications for Compost

- Soil Incorporant
  - Turf establishment
  - Garden Bed Preparation
  - Reclamation / Remediation
  - Roadside Vegetation
  - Wetlands Establishment
- Growing Media Component
  - Landscape (e.g., rooftop, raised planters)
  - Backfill Mixes (tree and shrub planting)
  - Golf Course (e.g., tee, green, divot mixes)
  - Manufactured Topsoil
  - Wetland Establishment
- Surface Applied
  - Garden Bed Mulch
  - Erosion Control Blanket
  - Silt/Sediment Control Berm
  - Turf Topdressing

With so much interest in environmental sustainability in the proximity of roadsides, as well as 'low impact' design, we would be remiss to mention specific environmental applications where compost has shown great promise.

Erosion and Sediment Control

A very promising, and rapidly expanding, application for compost is as an erosion and sediment control material. Various research, as well as, field trials, has shown that compost can often out perform conventional slope stabilization methods, such as hydroseeding, hay/straw mulching, geotextile blankets, etc. Compost, composted mulches and compost blends are used as a soil 'blanket' or 'cover', and typically placed on up to a 2:1 slopes at an application rate of 2 to 4 inches. Lesser application rates are possible in areas of lower flow and on less severe slopes. This compost layer not only absorbs the energy of the rainfall, which causes the movement of soil particles, but can also absorb a substantial volume of moisture, as well as reduce its flow velocity, improving moisture percolation into the soil. These organic 'soil blanket' products are typically applied using a bulldozer, grading blade or pneumatic blower. The courser or woodier composts used in erosion control are often not seeded following application, but may be seeded at a later time, once the product stabilizes. Research performed for Portland Metro, an environmental regulatory body based in Portland, Oregon, further showed that yard trimmings compost was capable of not only controlling erosion, but also of filtering, binding and degrading contaminants from the storm water passing through the organic layer.[5]

Research and field experience has also shown that the use of compost filter berms, which can be placed at the base of slopes and around construction sites, are very effective in sediment control. These filter berms are typically 1 ? to 2 feet tall by 3 to 4 feet wide. They act as excellent sediment filters and can even be used in conjunction with silt/sediment fences in areas of heavy flow. Research completed by the New England Transportation Consortium found that even certain 'wood waste materials can be effective as mulch for erosion control or as a filter berm at construction sites, (used) to prevent eroded soil from leaving the site.'[6] Equipment now exists which can apply these products efficiently, and typically at a cost equal to or less than traditional methods (sediment fencing). The Portland Metro research also documented that compost filter berms (83% reduction) can be twice as effective as sediment fences (39% reduction) in reducing total solids (TS) in runoff.[7]

Reclamation

Compost has been used extensively in revegetation and reclamation of marginal and low quality soils. These problem sites benefit through improving soil quality, reducing erosion, enhancing plant establishment, immobilizing toxic metals and supplying microbes. In research performed by Dr. William Sopper of Penn State University, compost (and biosolids) were applied to a gravely site, possessing a low pH and organic matter content, and contaminated with zinc. Within fifteen months of the application, the hillside was covered by a combination of orchard grass, tall fescue and crown vetch. Newly planted trees showed a survival rate of over 70%.8 In this example, the compost not only supplied plant nutrition and moderated soil pH, but also established a nitrogen and organic matter cycle in the soil and immobilized heavy metals, by both reducing their leachability and absorption by plants.9 By establishing vegetation on soils contaminated with heavy metals, water erosion can be minimized, thus reducing the transfer of pollutants. The physical structure of the compost amended soil is also improved, increasing soil porosity and moisture infiltration, thus reducing run-off. This benefits both the environment and plant growth. Compost used is this application is often applied at soil inclusion rates of 20 to 50%, or at rates of 25 to 175 tons per acre.

Wetlands

Organic matter in the soils of wetlands in the United States has decreased steadily over the last three decades. According to Dr. Donald Hey, an expert in flood plain management, 'over 100 million acres of U.S. wetlands have been drained, and our wetlands now contain only about half the amount of organic matter they contained in the 17th century. As a result, annual floods have worsened, ground water quality has deteriorated, and wildlife diversity has declined. Compost, with its high organic matter content, can absorb up to four times its weight in water and can replace essential organic material in wetlands'10. As urbanization continues to expand, wetlands are often destroyed in the construction of roads and other structures. Today, environmental regulations are in place which require the re-establishment of wetlands as a means of improving water quality. The goal of any wetlands mitigation project is to develop a wetland that functions well in terms of hydrology, soil properties and plant community composition. Thereby, a highly organic, microbially active soil must be developed which possesses similar physical and chemical properties to those of native wetland soils.

Compost is an excellent component to manufactured wetland soils because of its high organic matter content, water holding capacity and microbial activity. Although used effectively throughout the country in wetland mitigation, to develop an effective wetlands media using compost, it is important to understand the soluble salt and nutrient levels of the compost and their relationship to the wetland plants being established. When developing wetland construction mixes, it is important to develop a blend which has similar characteristics to the surrounding soils, and for that reason, manufacturing wetlands mixes must be done on a case by case basis.[11]

[Much of the information in section 2.2 has been adapted from the 'Compost Markets Grow With Environmental Applications' article first published in the April, 1999 Biocycle Magazine, published by JG Press, Emmaus, PA.]