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Compost in Landscaping Applications

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Abstract

Compost, a product derived from organic waste material, is ideal for use in a wide variety of landscaping applications. This report describes ways in which landscapers can use compost to create cost-effective, high quality, and environmentally beneficial projects.

- 27.7 million tons of yard trimmings were generated in MSW in 2000.
- 15.8 million tons of yard trimmings were recovered for beneficial use in 2000.
- Roadside landscaping is a potential market for 31.5 million tons of yard waste feedstock.
- Golf course application is a potential market for 95.6 million tons of yard waste feedstock.
- Benefits from using compost in landscaping applications include cost savings and environmental benefits associated with reduced pesticide and fertilizer use, erosion control, water conservation, reduction of contaminants, diverting yard waste from landfills, and avoided leachate-related risks.

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1. Summary of Results

Compost Supply, Demand, and Potential Use - Compost from yard waste is produced at MSW composting facilities and at private facilities. In 2000, an estimated 27.7 million tons of yard trimmings were generated in municipal solid waste (MSW). Yard trimmings composting facilities recovered 15.8 million tons and the remaining 11.9 million tons were discarded. An additional 21.2 million tons of yard trimmings are source reduced each year (through backyard composting or the use of mulching lawnmowers).[1] The 11.9 million wet tons of discarded yard trimmings is equivalent to 20 million yd^3 of compost feedstock. The total amount of generated yard trimmings is equivalent to 46.6 million yd^3 of available compost feedstock. Compost made from a variety of other materials such as paper, food waste, and manure also has potential use in landscaping.

Landscaping applications that can use compost include roadside slope stabilization, roadside plantings of grass, native plants, or trees, golf course grass establishment and maintenance, and gardening projects. In 1996, landscaping accounted for 31% of the yard waste compost market.[2] In 2000, state highway departments used approximately 480,350 yd^3 of compost. A 1992 report of potential applications for compost identified landscaping and topsoil amendments as a potential market for 5.7 million yd^3 of compost.[3] Strong potential markets for yard waste compost include state highway departments (the market size depends on the project application rate but is between 9.3 million yd^3 and 56.1 million yd^3 of compost) and golf courses. An increase in the use of compost in landscaping applications would be enough to consume much of the yard waste that is currently discarded.

Benefits - Use of compost in landscaping projects provides physical, chemical, and biological benefits; it is often less expensive and less harmful than other options. We have developed multipliers that calculate benefits associated with increased use of compost in landscaping applications. The use of compost results in decreased project costs. Depending on the project, cost savings result from decreased use of erosion control materials, decreased use of soil disease suppression materials, and decreased use of fertilizer. Reducing the need for irrigation results in conservation of water resources and cost savings. Non-project specific cost savings and benefits of using compost result from avoiding landfill use; benefits include landfill space saving, avoided landfill methane generation, and avoided landfill leachate-related risks.

Project Size - Application rates for compost in landscaping applications are variable depending on the project. We have presented conversion factors that landscapers can use to determine the amount of compost necessary for a given application. Further, we have determined compost application rates for specific types of projects, such as erosion control and amending soil.

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[1] EPA. *Municipal Solid Waste in the United States: 2000 Facts and Figures.* (EPA530-R-02-001). June 2002.

[2] North Carolina Department of Environment and Natural Resources, Division of Pollution Prevention and Environmental Assistance. *Markets Assessment 1998, Organics: Yard Wastes Commodity Profile.* Online: < http://www.p2pays.org/ref/02/0162216.pdf > (March 13, 2003).

[3] EPA. *Organic Materials Management Strategies.* (EPA 530-R-99-016). July 1999. p.42-3.

In the following sections, we explain the current compost supply and demand structure as well as the potential for using compost in landscaping projects. Next, we present the benefits of using compost instead of conventional landscaping materials. The final section, a description of application recommendations and unit equivalents, will aid landscapers in calculating costs and benefits associated with using compost for a particular project.

2. Current Compost Generation, Recovery, Disposal, and Markets

An estimated 27.7 million tons of yard trimmings were generated in MSW in 2000. Yard trimmings composting facilities recovered 15.8 million tons, and the remaining 11.9 million tons were discarded. Through backyard composting and/or the use of mulching lawnmowers, an additional 21.2 million tons of yard trimmings are source reduced each year.[4]

If it had been composted, the 11.9 million wet tons of discarded yard trimmings would have yielded 20 million yd^3 of compost feedstock. The total amount of generated yard trimmings is equivalent to 46.6 million yd^3 of available compost feedstock.

Compost made from yard trimmings can be used in landscaping applications such as roadside slope stabilization, roadside plantings of grass, native plants, or trees, golf course grass establishment and maintenance, and gardening projects. A 1996 survey of compost market distribution found that landscaping accounted for 31% of the yard waste compost market.[5] The US Composting Council found that 31 state Departments of Transportation (DOTs) used approximately 480,350 yd^3 of compost in roadside applications in 2000. Specific details about the amount of compost used for each type of landscaping project (e.g., seeding for erosion control or seeding for aesthetics) were unavailable. Further, the type of feedstock that is used varies. Yard waste is included in 13 of 31 state DOT Compost Specifications. Other feedstocks include manure, wood residue, municipal solid waste and biosolids, and poultry litter.

3. Current Potential Use

An EPA report of potential applications for compost identified landscaping and topsoil amendments as a potential market for 5.7 million yd^3 of compost.[6] Strong potential markets for yard waste compost include state DOTs and golf courses. An increase in the use of compost in landscaping applications would be enough to consume much of the yard waste that is currently discarded.

[4] EPA. *Municipal Solid Waste in the United States: 2000 Facts and Figures.* (EPA530-R-02-001). June 2002.
[5] North Carolina Department of Environment and Natural Resources, Division of Pollution Prevention and Environmental Assistance. *Markets Assessment 1998, Organics: Yard Wastes Commodity Profile.* Online: < http://www.p2pays.org/ref/02/0162216.pdf > (March 13, 2003).
[6] EPA. *Organic Materials Management Strategies.* (EPA 530-R-99-016). July 1999. p.42-3.

There is strong potential for compost use in roadside landscaping projects. The U.S. Composting Council concludes that 139,160 acres of 'planted' landscaping areas could reasonably use compost under current conditions. Assuming a 1½-inch application rate, this represents a potential market for 12.6 million tons of finished compost. Since finished compost is at most 40% the weight of the initial feedstock,[7] roadside landscaping is a potential market for 31.5 million tons of yard waste trimmings. In 2000, 12 million wet tons of yard waste were discarded in MSW. The potential market for compost in roadside landscaping could utilize all the yard trimmings currently discarded.

Compost is currently used in golf course landscaping. Estimates for the number of acres of land that are used for golf courses in the United States range from 1.3 million[8] to 3.4 million[9]. Michigan State University researchers estimate that 150 cubic yards of organic matter is used to construct a 100,000 square foot golf course or athletic field.[10] Assuming compost is used to amend 1.3 million acres of golf course, golf courses represent a potential market for 95.6 million tons of yard waste feedstock. There are no statistics available for the total amount of compost that is currently being used on golf courses. However, over the past several years there has been both an increase in golf course construction and an increase in concern regarding the environmental implications of golf courses. Golf course superintendents are exploring techniques such as replacing hazardous soil amendments with compost as they attempt to develop environmentally sensitive construction and maintenance practices.[11] Golf courses represent a strong potential market for compost.

Compost has potential use in a variety of projects. It can replace fertilizers and pesticides when used as a soil amendment. It can be used for erosion control, water conservation, and as a filter to purify roadway stormwater runoff. Details about the benefits of using compost in each type of project as well as application recommendations for specific project sizes are included in the following sections.

4. Benefits

Soil Amendments

Pesticides and fertilizers are soil amendments used in landscaping activities such as roadside plantings and golf course maintenance. Pesticides are organic or inorganic poisons used to reduce or eliminate different types of pests (animal, plant, fungal, etc). In the environment, pesticides move through air, soil, and water and can "overwhelm the natural stability of an ecosystem leading to irreversible changes that result in serious

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[7] The Composting Council of Canada. *Setting the Standard: A Summary of Compost Standards in Canada.* Online: < http://compost.org/standard.html > (May 12, 2003).
[8] King, K.W. *Evaluation of an Agricultural Water Quality Model for Use in Golf Course Management.* Online: < http://www.ag.ohio-state.edu/~usdasdru/Staff/King/asae2009.pdf > (Jan. 8, 2003).
[9] Grounds Maintenance Magazine. *The Grounds Maintenance Advantage.* Online: < http://images.grounds-mag.com/files/35/GM03Advantage.pdf > (Jan. 8, 2003).
[10] Michigan Compost Markets. *Sports Turf.* Online: < http://www.recycle.com/pdf/sportsturf.pdf > (April 12, 2003).
[11] United States Golf Association. *USGA Green Section.* Online: < http://www.usga.org/green/index.html > (Jan. 13, 2003).

biological, economic, social, and aesthetic losses."[12] A study of pesticide application to roadside vegetation found that nearby water areas became contaminated with pesticides from roadside runoff both immediately and several months after the pesticide application.[13] Also, some toxic materials in pesticides remain in the food web because they "resist the normal processes that break contaminants in the body and the environment."[14] Fertilizers contain nutrients that improve soil productivity. If more nutrients are provided to the soil than it can hold, the excess fertilizer can leach or runoff into local water areas, including into groundwater. The presence of chemical fertilizers in rivers and lakes leads to increased algae growth and a subsequent decrease in water quality.

Biological and organic alternatives to chemical pesticides and fertilizers are gaining interest because of these human and environmental health concerns. Use of alternative amendments increases the amount of organic material and nutrients in the soil. The enriched soil has a subsequently reduced reliance on both pesticides and fertilizers. This reduced reliance often translates into reduced costs, especially in the long-term, due to avoided use of pesticides and fertilizers.

Reduced Pesticide Use

In 1997, 151 million pounds of pesticides were used in the "professional market" (includes pesticides applied by professional applicators to industrial, commercial and governmental facilities, buildings, sites, and land; plus custom/commercial applications to homes and gardens, including lawns).[15] Pesticide use in landscaping applications is targeted at a variety of problems including turfgrass diseases, weed management, and vegetation control. Improper soil composition, grass selection, mowing, watering, or soil nutrition all can influence turfgrass disease prevalence.[16]

Golf course landscapers and ground managers spend an estimated $352 million on pesticides annually (includes fungicides, herbicides, and insecticides).[17] In a study of pesticide use on Arizona golf courses, an average of 332 pounds of pesticides were applied annually per course.[18] Roadside landscaping projects also use pesticides to control weeds. In Minnesota, herbicides are applied to 5% of roadside vegetation areas

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[12] EPA. *Pesticides: Environmental Effects*. Online: < http://www.epa.gov/pesticides/ecosystem/index.htm > (Jan. 7, 2003).

[13] United States Geological Survey (USGS). *Herbicide Use in the Management of Roadside Vegetation, Western Oregon, 1999-2000: Effects on the Water Quality of Nearby Streams*. Online: < http://oregon.usgs.gov/pubs_dir/Pdf/01-4065.pdf > (Jan. 15, 2003).

[14] Goldstein, J. *Building a Safe Pesticides Industry with Bioproducts and Biomethods*. Online: < http://www.jgpress.com/BCArticles/1999/10995.html > (Jan. 7, 2003).

[15] EPA. *Pesticide Industry Sales and Usage: 1996 and 1997 Market Estimates*. (EPA 733-R-99-001). Online: < http://www.epa.gov/oppbead1/pestsales/> (Jan. 6, 2003).

[16] Elliott, M.L. and G. W. Simone. University of Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences. *Turfgrass Disease Management*. Online: < http://edis.ufl.edu/BODY_LH040 > (Jan. 8, 2003).

[17] Grounds Maintenance Magazine. *The Grounds Maintenance Advantage*. Online: < http://images.grounds-mag.com/files/35/GM03Advantage.pdf > (Jan. 8, 2003).

[18] Merrigan, S.D. et al. Arizona Cooperative Extension. *Arizona golf course pesticide use survey*. Online: < http://ag.arizona.edu/pubs/insects/az9524.pdf > (Jan. 8, 2003).

each year.[19] Using an approximate figure of 12 million acres of highway corridors in the United States,[20] up to 600,000 acres of roadside vegetation areas are treated with pesticides.

Compost is a suitable alternative to many of the pesticides used in landscaping applications. The application of compost results in a soil environment with a high organic content. Beneficial micro-organisms that thrive in this environment can prevent soil disease by outcompeting and suppressing detrimental pathogens found in soils where organic matter is low.[21] Compost amended soil is healthier because of "better aeration, reduction of soil compaction, deeper rooting depth, and improved soil structure."[22] A compost layer can provide weed control by acting as a barrier to underlying weed seeds.[23] Reduced disease incidence and reduced weed cover subsequently reduces or even eliminates the need for pesticide application. As compost is not a curative treatment, it cannot be substituted for those pesticides that control disease or act curatively.

The addition of compost to soil and turfgrass results in healthier sites with reduced disease prevalence. A layer of compost or mulch creates a barrier to weed and noxious plant growth. Several studies on golf courses have found that compost application suppressed disease (e.g., up to 80% reduction in dollar spot disease occurrence,[24] increased prevention of snow mold[25]) and increased the overall health of the turfgrass. In a study of compost application on roadside areas, yard waste compost-treated areas reduced weed growth (in conventional soils) by over 70 percent.[26] Further use of compost in golf course and roadside applications would result in a decrease in pesticide use and a decrease in the costs (monetary and environmental/health) that are associated with pesticide application.

Yard waste compost can also be added to peat to create an organic soil disease prevention material. One study found that when peat was supplemented with up to 40% yard waste compost (by weight), the resulting mixture successfully suppressed several soil-borne pathogens (both under controlled and practical conditions). The reduction in disease

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[19] Minnesota Department of Transportation. *MN/DOT Roadside Management and Pesticide Information*. Online: < http://www.dot.state.mn.us/environment/programs/MPRC.html > (Jan. 8, 2003).

[20] U.S. Department of Transportation, Federal Highway Administration. *Roadside Use of Native Plants*. Online: < http://www.fhwa.dot.gov/environment/rdsduse/rdsduse6.htm > (Jan. 8, 2003).

[21] EPA. *Organic Materials Management Strategies.* (EPA 530-R-99-016). July 1999. p.40.

[22] Chollak, T. and P. Rosenfeld. *Guidelines for Landscaping with Compost Amended Soils.* Online: < http://www.ci.redmond.wa.us/insidecityhall/publicworks/environment/pdfs/compostamendedsoils.pdf > (Jan. 8, 2003).

[23] Glanville, T. and T. Richard. *Using Compost for a Safer Environment: Project Results – Vegetation*. Online: < http://www.eng.iastate.edu/compost/results.vegetation.html > (Jan. 10, 2003).

[24] Audubon International. *Project Profile: North Shore Country Club Use of Composts to Improve Turf Ecology*. Online: < http://www.audubonintl.org/resources/casestudies/nrthshorecc.html > (Jan. 3, 2003).

[25] Cornell Chronicle. *Site of golf's U.S. Open is sharply reducing pesticide use, with CU help.* Online: < http://www.news.cornell.edu/Chronicle/02/6.13.02/golf-pesticides.html > (Jan. 3, 2003).

[26] Glanville, T. and T. Richard. *Using Compost for a Safer Environment: Project Results – Vegetation*. Online: < http://www.eng.iastate.edu/compost/results.vegetation.html > (Jan. 10, 2003).

incidence ranged from 30 to 80%, yet the disease conditions were severe (70 to 90% severity).[27]

Reduced Fertilizer Use

In 1999, 53.5 million tons of fertilizer were used in the US.[28] Information about the amount of fertilizer utilized in landscaping is limited to data released by state DOTs and golf courses. Fertilizer application rates described by several state DOTs ranged from 80 to 1,000 pounds of fertilizer per acre. An estimated 139,160 acres of roadside land were landscaped (planted) in 2000 by state DOTs.[29] In rough terms, this represents between 11.1 million and 139.2 million pounds of fertilizer use in roadside applications. Golf course landscapers/ground managers spend an estimated $299 million annually on fertilizers (includes combination fertilizer/pesticide products).[30] A survey of golf course superintendents found that the average rate of nitrogen application is 1 pound per 1,000 ft^2. Using the survey data, the estimated average area per golf course treated with nitrogen fertilizer in 2001 was 31 acres.[31]

Compost can be used as a substitute for fertilizer[32] because microorganisms in compost are able to fix nitrogen into a form that can be used by plants. Compost does not provide immediate nutrients to soil and crops (mineral fertilizers can rapidly provide nutrients due to the high levels of available nutrients). However, compost does release nutrients over time, and the nutrients in compost can adequately supply plants with the nutrients they need for proper establishment and growth.[33] This slow-release of nutrients is "less likely to impact groundwater through leaching than quickly-available products"[34] (e.g., fertilizer). In many projects, a combination of compost and fertilizer is used. Applying compost reduces the amount of fertilizer required, resulting in lower material and labor costs.

The soil in roadside areas frequently has a different composition from soil that develops and forms in place. Soils in roadside locations generally have lower nutrient and organic matter content and are variable in composition. These characteristics result in a soil in which it is difficult to establish vegetation. Several studies have noted that the lack of organic matter and nutrient availability in roadside soils is the primary difference

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[27] Bruns, C. and C. Schaler. "Suppressive Effects on Soil Borne Diseases of Yard Waste Composts in Organic Horticulture." 2002 International Symposium: Composting and Compost Utilization. Online: <http://www.oardc.ohio-state.edu/michel/diseasesuppression.htm> (Nov. 22, 2002).

[28] The Fertilizer Institute. *U.S. Fertilizer Use.* Online: < http://www.tfi.org/Statistics/USfertuse.asp > (April 7, 2003).

[29] Composting Council Research and Education Foundation and United States Composting Council. *Compost Use on State Highway Applications*.

[30] Grounds Maintenance Magazine. *The Grounds Maintenance Advantage*. Online: < http://images.grounds-mag.com/files/35/GM03Advantage.pdf > (Jan. 8, 2003).

[31] Bishop, D. M.; Golf Course Superintendents of America. Personal Communication: Jan. 9, 2003.

[32] Maynard, Abigail A. "Reducing Fertilizer Requirements in Cut Flower Production." *BioCycle* 44:3 (March, 2003): 43-45.

[33] EPA. *Organic Materials Management Strategies*. (EPA 530-R-99-016). July 1999.

[34] Bruneau, A.H. et al. *Water Quality and Golf Course Superintendents.* Online: < http://www.turffiles.ncsu.edu/pubs/wqwm154.html > (Jan, 3, 2003).

between roadside soils and natural soils.[35] Applying compost is an effective way to improve these aspects of soil condition to support vegetation. In one study site, several types of soil amendments, including yard waste compost, were applied to roadside plantings. The yard waste compost "always resulted in plant densities that were among the best at each location and time of sampling" and increased plant available nutrients (nitrogen, phosphoric oxide, and potash) more than the fertilizer treatment did.[36]

Erosion Control

The application of compost controls erosion and stabilizes slopes by retaining moisture and supporting growth of thick, healthy vegetation. Negative impacts of soil erosion and slope collapse include runoff and sedimentation of waterways. Compost can be used in erosion control measures. Compost use in place of alternative management techniques, including polymer-based covers and hydromulching with fertilizer, yields benefits by avoiding material and fertilizer use.

Silt fencing is a type of erosion control that uses fabric fencing (made of plastic or another synthetic material) and stakes to control erosion and water movement. The fencing is inexpensive and is often the technique that is specified on state and federal projects (including roadsides).[37] Some disadvantages of silt fencing are that the plastic must be produced using energy and non-renewable materials, the fencing can be difficult to install, the structure creates a barrier for wildlife, and the plastic must be discarded at some point.

Compost as erosion control is more effective than silt fencing. Effectiveness rates vary significantly from study to study. One compost manufacturer states that compost berms, which are usually used on steeper slopes with high erosion potential, can filter out "ten times the sediment of silt fencing."[38] A researcher's summary of compost as an erosion control found that the application of compost decreased the amount of "sediments reaching nearby surface waters … by 99 percent" when compared to silt fences.[39] The effectiveness of compost as an erosion control is increased due to the material's longevity. Compost usually does not have to be removed from the site after the erosion control is completed, and its integration into the soil continues to provide some erosion control. Silt fencing is only effective for approximately 6 months,[40] and must be removed from the site at some point. Table 1 presents example costs associated with silt

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[35] Evanylo, G. et al. *Soil Amendments for Roadside Vegetation in Virginia*. Online: <http://www.p2pays.org/ref/11/1015809.pdf> p.89.
[36] Evanylo, G. et al. *Soil Amendments for Roadside Vegetation in Virginia*. Online: <http://www.p2pays.org/ref/11/1015809.pdf > pp.91, 94.
[37] Kasperson, J. *Holding Something Back: Sediment Control Measures.* Online: <http://www.forester.net/ec_0005_holding.html#2> (Nov. 18, 2002).
[38] Carolina Mulch Plus. *Erosion Control.* Online: <http://www.carolinamulchplus.com/erosion.html> (Nov. 18, 2002).
[39] Risse, M. and B. Faucette. *Compost Utilization for Erosion Control*. Cooperative Extension Service, The University of Georgia College of Agricultural and Environmental Sciences. Online: <http://www.ces.uga.edu/pubcd/B1200.html> (Nov. 21, 2002).
[40] EPA. *Construction Site Storm Water Runoff Control: Silt Fence*. Online: < http://cfpub.epa.gov/npdes/stormwater/menuofbmps/site_30.cfm > (Jan. 6, 2003).

fences and compost filter berms as erosion controls. Total costs are also shown using an estimated 75% improved effectiveness from compost (versus silt fence).

Table 1. Costs of Silt Fences and Compost Filter Berms[41]

Application	Product Cost $/ft	Installation Cost $/ft	Total Cost $/ft	Total Cost Using Effectiveness Factor $/ft
Compost Filter Berm	2.37	2.96	5.33	1.33
Silt Fence	.60	.90	1.50	1.50
Cost Difference	1.77	2.06	3.83	-0.17

*Compost price is based on 6.75 linear feet of compost per yd^3

Each yd^3 of compost can replace 20 linear feet of a different erosion control (such as the silt fence). Table 2 presents the characteristics of silt fence usage that could be avoided by using compost as an erosion control.

Table 2. Silt Fence Use

Material	Estimated Annual Disposal per State	Potential Compost Use (As Substitute)
Silt Fence (synthetic fabric)	1 to 2 million feet	50,000 to 1000,000 yd^3

Because compost is generally a local product, when it is sold for about $2 per yd^3, the potential usage noted in Table 2 represents about $100,000 to $200,000 per state in revenue for local compost suppliers.[42]

A Texas DOT study examined the effectiveness of compost on slope stability by comparing compost with a synthetic blanket (the standard technique). The compost technique was as effective for erosion control as the synthetic blanket, and the compost also increased vegetation establishment. Table 3 shows the costs associated with each treatment in the study, which found that using compost instead of a synthetic blanket would save $3.07 per m^2.

[41] Tyler, R. et al. *Erosion Control and Environmental Uses for Compost.* Online: < http://www.p2pays.org/ref/11/1015810.pdf > (Nov. 18, 2002).
[42] Goldstein, N. "Compost Product Performance." *BioCycle* 43 (October, 2002): 29-31.

Table 3. Erosion Control Materials Costs[43]

Material	Cost per m^2
Compost	$ 0.97
Synthetic blanket	$ 3.90
Cost Difference	-$3.07

Water Conservation

Irrigation for all landscaping activities consumes billions of gallons of water each year. Golf course irrigation uses approximately 1.3% of the total water withdrawn for irrigation.[44] Golf course irrigation uses surface water, groundwater, effluent, and reclaimed water. A 1997 Irrigation Association estimate for annual golf course water use was approximately 627 billion gallons of water (does not include effluent or reclaimed water use).[45] The average acreage irrigated per golf course is 78 acres (or 70 percent of the managed course acreage). The average irrigation rate is 13.5 inches of water applied to irrigated areas annually.[46] The cost of irrigation is dependent on the price of water in the area and the costs associated with operating the irrigation system.

In landscaping systems that demand less water, cost savings result from conserving water resources. In addition, there are savings from reduced labor and irrigation system operating costs. There are several methods that help to increase the water holding capacity of turfgrass: amending the soil, planting grass species that do not demand large amounts of water, and mowing turfgrass appropriately.

Amending soil with compost increases the nutrient levels in the soil, which improves turf quality and results in reduced water needs and use.[47] Compost increases the soil's organic content, which increases soil water holding capacity and infiltration rates. The amended soil has reduced water losses from evaporation, runoff, and erosion. Amended soils are estimated to require up to 60% less water than is used on traditional turf.[48]

Table 4 presents the rate at which compost increases soil organic content and therefore increases soil water holding capacity. The amount of compost needed is dependent on both the initial and the optimal organic matter content of the soil.

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[43] Beverly, B. et al. *The Uses of Compost and Shreded Brush on Rights-of-Way for Erosion Control: Final Report,* Texas Transportation Institute, College Station, July, 1996, p.43. In Composting Council Research and Education Foundation. *A Watershed Manager's Guide to Organics.* March 1997. p.15.

[44] United States Geological Survey. *Estimated Use of Water in the United States in 1995: Irrigation.* Online: < http://water.usgs.gov/watuse/pdf1995/pdf/irrigation.pdf > (Jan. 10, 2003).

[45] Hawes, K. *Quenching Golf's Thirst.* Golf Course Management. Online: < http://www.gcsaa.org/gcm/1997/june97/06water.html > (Jan. 13, 2003).

[46] Golf Course Superintendents Association of America. *GCSAA examines management practices.* Online: < http://www.gcsaa.org/media/releases/2001/mar/performance.asp > (Jan. 13, 2003).

[47] Snow, J.T. *Water Conservation on Golf Courses.* Online: < http://www.usga.org/green/download/current_issue/water_conservation_on_golf_courses.html > (Jan. 13, 2003).

[48] Chollak, T. *Soil Amendment Use in Lawn Soils.* Online: < http://soilslab.cfr.washington.edu/esc311-507/1997/Tracy/soilam.htm > (Jan. 13, 2003).

Table 4. Increased Soil Water Holding Capacity From Compost Addition

Compost Addition (wet pounds per 1,000 ft^2)[49]	Increased Soil Organic Matter Content	Decreased Irrigation Needs (gallons of plant available water supplied by compost per acre of soil at 1 ft depth)[50]
1,800	1%	16,500
3,600	2%	33,000
5,400	3%	49.500
7,200	4%	66,000
9,000	5%	82,500

Reduction of contaminants from roadway stormwater runoff

Stormwater and other runoff from roads often contain various organic and inorganic pollutants. Contaminated water can flow to streams, lakes, and ponds, and can cause a decline in water quality. Conventional stormwater runoff treatment methods include detention ponds, grassy swales and sand filters. The application of yard trimmings compost to the roadside area, a newer method, has also been used successfully. The compost treatment method removes metals and other contaminants. One study found that compost stormwater filters "consistently remove[d] in excess of 85% of the oil grease … and 82% of the heavy metals."[51] Further, the compost filter surface area uses less than 10 percent of the land required by other methods.[52]

Divert yard waste from landfills

Every ton of yard waste used as compost in landscaping applications is a ton that is not discarded. Several benefits of diverting yard waste from landfills are shown in Table 5.

Table 5. Benefits from Use of Compost

Material Used	Methane Generation Avoided (MTCE/Dry Ton)	Landfill Space Saved* (Ft^2/Ton)	Net Material Management Savings ($/Dry Ton)
Yard Trimmings	0.20	45	22

*Including fill

[49] Flannery, R.L. and F. Flower. *Using Leaf Compost*. Online: < http://www.rce.rutgers.edu/pubs/pdfs/fs117.pdf > (Jan. 13, 2003).
[50] Agresource. *Protecting Local Water Resources by Amending Soil with Compost*. Online: < http://www.agresourceinc.com/soil_article.html > (Jan. 13, 2003).
[51] Idaho Department of Environmental Quality. *BMP #41 – Compost Stormwater Filter*. Online: < http://www.deq.state.id.us/water/stormwater_catalog/doc_bmp41.asp > (Jan. 3, 2003).
[52] EPA. *Organic Materials Management Strategies.* (EPA 530-R-99-016). July 1999.

Methane production, expressed in Table 5 in terms of metric tons of carbon equivalent (MTCE), is avoided through diversion of organics for composting. While the Environmental Protection Agency (EPA) has determined that most landfill methane production is offset by carbon sequestration, the creation of methane in a landfill is a dangerous risk that can be reduced through increased organics diversion. Landfill space is saved when material is diverted for composting rather than landfilled. Composting yard waste reduces the volume of the waste by 50 to 75%.[53] Finally, the cost of managing yard trimmings through a compost program rather than through landfilling yields net savings. The EPA report "Organic Materials Management Strategies" provides an estimation of these savings using average values for collection and disposal costs and revenues. Table 6 presents the savings estimates for yard trimmings composting.

Table 6. Yard Trimmings Composting Savings Estimate[54]

Strategy	Midrange Program Costs per Ton	Collection and Disposal Costs Saved per Ton	Revenues per Input Ton	Savings per Ton
Yard Trimmings Composting	$66	$61	$16	$11

Avoided leachate-related risks

Landfill leachate forms when liquid percolates through solid waste and mobilizes dissolved or suspended materials. Biological and chemical constituents are leached into solution from decomposing material. Some moisture leaves the landfill through evaporation or as part of landfill gas. The remainder is either held by the material in the landfill or emerges as leachate. The release of leachate can result in contamination of ground and surface water because the leachate contains dissolved and suspended material from the landfill. Composting yard waste instead of landfilling the material reduces the amount of organics present in the landfill. When organics are diverted, a "cleaner" landfill leachate is produced and there is a smaller risk of water pollution due to a landfill leachate release.

Landfill leachate contains organic carbon that can be measured in three ways. Total organic carbon (TOC) is the total organic carbon present whether it has been degraded or not, chemical organic demand (COD) is the organic content that can be oxidized chemically, and biological organic demand (BOD) is the organic content that can be degraded biologically. Since COD and BOD concentrations decrease as the landfill waste is degraded over time, their individual concentrations and the ratio between the two can be used as indicators of the degree of waste composition in landfills. There are no standard values for the rates and ratios of COD and BOD as indicators, and COD rates can be variable depending on the amount of inorganic components that contribute to

[53] Wilson, C.R. and J.R. Feucht. *Composting Yard Waste.* Colorado State University Cooperative Extension. Online: <http://www.ext.colostate.edu/pubs/garden/07212.html> (Nov. 19, 2002).
[54] EPA. *Organic Materials Management Strategies.* (EPA 530-R-99-016). July 1999.

COD.[55] However, Table 7 presents one set of suggested concentrations and ratios of COD and BOD for a landfill to be considered "stable," as well as sample organic concentrations in landfill leachates from older, methanogenic landfills.

Table 7. Landfill Leachate Organic Carbon Concentrations[56]

Case	BOD Concentration (mg/L)	COD Concentration (mg/L)	BOD:COD Ratio
Suggested for stable leachate	100	1000	.1
Average concentrations from 21-30 year old landfill (Germany)	290	1225	.24

5. Project Size

Application rates of compost in landscaping applications are variable depending on the type of project. In this section, specific application recommendations are given for using compost as a replacement for soil amendments and for erosion control. Landscapers can use the recommendations to estimate the amount of compost necessary for a specific project and to calculate costs and benefits of using compost.

Disease suppression

The amount of compost used in applications for disease suppression and prevention is based on the original characteristics of the soil. The compost must be incorporated according to the nutritional and micro-biological needs of the soil area. A study of compost application on a golf course found that a ⅛" topdressing application improved the turf density and quality and suppressed disease. Compost topdressing application depth is similar to traditional topdressing material depths.[57]

A published recommendation for amending soil with compost to achieve a variety of results including increased soil health and disease suppression calculates the amount of compost needed based on a targeted organic content of compost-amended soil. The optimal organic content is between 8 and 13 percent by soil weight. The recommendation notes that typical yard waste compost has an organic content of 50%, therefore 1 inch of compost spread over 1,000 ft^2 will increase the soil organic content by

[55] Barlaz, M. and M. Gabr. *Closing the Gaps in the Regulation of Municipal Solid Waste Landfills: Defining the End of the Post-Closure Monitoring Period and the Future Stability of Leachate Recirculation Landfills, Appendix A: Additional Detail: Leachate Composition*. Online: <http://www4.ncsu.edu/~barlaz/post_closure/pdf/app_A.pdf> (Nov. 11, 2002). p. 63-5.
[56] Ibid. p.65, 67.
[57] Audubon International. *Project Profile: North Shore Country Club Use of Composts to Improve Turf Ecology*. Online: < http://www.audubonintl.org/resources/casestudies/nrthshorecc.html > (Jan. 3, 2003).

approximately 2.5 to 3.5 percent.[58] Landscapers can use the original organic content of the soil with the organic content of the compost to calculate the amount of compost needed to improve soil health and increase disease prevention.

Fertilizer substitution

As a replacement for fertilizer, the amount of compost required is dependent on the specific soil type and condition. Levels of available nutrients in compost are sufficient for proper plant growth when applied at levels recommended for the soil properties. The mineralization rate of compost is a measure of the rate nutrients are converted to mineral forms suitable for plant uptake; it is dependent on factors such as temperature, soil type and moisture. If the compost contains 1% nitrogen, a 20% mineralization rate will supply 4 pounds of available nitrogen per ton of compost. A 1" application will supply 3.5 pounds of available nitrogen per 1,000 ft^2. Since the standard fertilizer recommendations is 2 to 6 pounds of nitrogen per 1,000 ft^2, this level of compost application is sufficient to provide plants with their nitrogen requirements.[59]

Researchers have developed a procedure for compost application rates and techniques in Florida DOT projects. The recommendation for topdressing (fertilizing) on Florida roadsides with compost that has a moisture content of 40% (by weight) is presented in Table 8.

Table 8. Recommendations for Compost Use as Fertilizer Topdressing on Florida Roadsides[60]

Compost Moisture Content (% by weight)	Bulk Density (lb/yd^3)	Weight (tons/acre)	Volume ($yd^3/100\ ft^2$)	Thickness of Layer (in)
40	700	74	.49	1.6
40	800	74	.43	1.4
40	900	74	.38	1.2
40	1,000	74	.34	1.1

These recommendations cannot be considered generic standards due to the variability of soil characteristics in different areas and the importance of these characteristics in calculating fertilizer usage.

[58] Chollak, T. and P. Rosenfeld. *Guidelines for Landscaping with Compost Amended Soils.* Online: < http://www.ci.redmond.wa.us/insidecityhall/publicworks/environment/pdfs/compostamendedsoils.pdf > (Jan. 8, 2003).
[59] EPA. *Organic Materials Management Strategies*. (EPA 530-R-99-016). July 1999.
[60] Kidder, G. and G.L. Miller. *Application Rates and Techniques for Using Composted Materials in Florida DOT Projects*. Online: < http://edis.ifas.ufl.edu/BODY_SS193.html > (Nov. 12, 2002).

Similar to roadside turfgrass applications, compost as golf course fertilizer topdressing is dependent on the existing soil type and condition. At one golf course in Illinois, compost is used at the rate of 7 tons of per acre to create a ⅛" topdressing layer.[61] A comparative study of different rates of compost application on Florida turf (such as the turf used on golf courses) found that "45 … tons of compost dry matter per acre was … sufficient to improve establishment and persistence."[62]

Erosion control

The EPA's basic guideline for compost application in erosion control is "a 2 to 3 inch layer of mature compost, screened to ½ to ¾ of an inch and placed directly on top of the soil."[63] The effectiveness is highest when the correct particle size compost is matched to the slope of the location being treated. A more detailed description of suggested compost specifications for erosion control using a compost blanket (layer of compost) is presented in Table 9. Compost berms have similar specifications but the application rate is slightly different and the suggested particle size ratio is 1:1.

[61] Audubon International. *Project Profile: North Shore Country Club use of Composts to Improve Turf Ecology*. Online: < http://www.audubonintl.org/resources/casestudies/nrthshorecc.htm > (Jan. 8, 2003).
[62] Golf Course Superintendents Association of America. *The Cutting Edge: Using Compost on Florida Utility Turf*. Online: < http://www.gcsaa.org/gcm/gcm_fr.html > (Jan. 10, 2003).
[63] EPA. *Innovative Uses of Compost: Erosion Control, Turf Remediation, and Landscaping*. (EPA 530-F-97-043). October 1997. Online: <http://www.epa.gov/epaoswer/non-hw/compost/erosion.pdf> (Nov. 18, 2002)

Table 9. Compost Specifications for Erosion Control[64]

Compost Specification	Suggestion for Erosion Control and Subsequent Plant Growth Support	Benefit/Importance of Specification (where applicable)
Particle size	Mix of fine and coarse grades, ratio 3:1	
	Fine: passes through a ¼ to ½ inch screen	Fine grade compost: penetrates soil surface, increases water infiltration, increases water holding capacity, essential for rapid vegetation establishment, long-term nutrient supply
	Coarse: passes through a 2-3 inch screen	Coarse grade compost: difficult to disturb by rainfall and storm runoff, filters (catches) soil particles already in motion
Moisture Content	20-50% water	Dry compost: absorbs more water, binds pollutants, less expensive than wet compost
Organic Matter Content	40-70% carbon based materials	Higher organic content: increased water holding capacity
PH	pH level 6.0-8.0	
Soluble salt content	3.0 to 6.0 mmhos/cm	
Human-made inerts	< 1.5% (by weight) foreign synthetic material	
Nutrient content	N: 1-3% Organic N: 1-3% Phosphorous: 1.5-2.5% Potassium: .5-2.0%	Choice is dependent on nutrient content of the soil and the nutrient uptake of the intended vegetation. Proper nutrient composition allows for efficient use of compost
Application rate	1 - 3 inches deep	Steeper slopes need deeper compost application, very gradual slopes could use ¾ inch application

As noted in Table 9, compost particle size is important in determining the compost's potential uses and applications. The coarser particle sizes (over ½") that are created during the compost production process have traditionally been reprocessed to reduce particle size. Reprocessing is an additional cost for compost production facilities. However, as some of the larger sized particles (½"to 2") can be used effectively as erosion control treatments, screening processes can be adapted and production costs can decrease. Separating out the larger sized particles decreases the volume of compost that has to be reprocessed in order for it to be useful. One yard trimmings company shifted to a screening process that separated out both the smallest particles and the particles that are appropriate for erosion control. This reduced the amount of compost that they had to

[64] Risse, M. and B. Faucette. *Compost Utilization for Erosion Control*. Cooperative Extension Service, The University of Georgia College of Agricultural and Environmental Sciences. Online: <http://www.ces.uga.edu/pubcd/B1200.html> (Nov. 21, 2002).

reprocess by 30 percent, and created a revenue source from sales of the compost for erosion control.[65]

Project cost

Table 10 presents some equivalents that can be used to determine the amount of compost that would be used in an application.

Table 10. Compost Application Rates

Application Details	Coverage per 1 yd^3 Compost	Compost Volume Needed for 1 Acre	Compost Weight Needed for 1 Acre (using 900 lbs/yd^3 as preferred bulk density)
3" deep	108 ft^2	403 yd^3	362,700 lbs
2" deep	162 ft^2	269 yd^3	242,100 lbs
1½" deep	217 ft^2	201 yd^3	180,900 lbs
1" deep	325 ft^2	134 yd^3	120,600 lbs
½" deep	648 ft^2	67 yd^3	60,300 lbs
No depth (e.g. use for erosion berm)	6.75 linear feet	124 yd^3 (for perimeter of acre)	111,600 lbs

A 2000 survey of composters (processing a wide variety of sources including yard waste) provides some basic information about wholesale and retail price ranges for compost products. The survey found that wholesale prices ranged from $2 to $18 per yd^3 (average - $9.87 per yd^3). Retail prices ranged from $5 to $25 per yd^3 (average - $17.08). Both prices do not include transportation of the compost to the purchaser.[66]

The costs involved with using compost in landscaping applications are varied. At the beginning of production, costs associated with disposing yard waste include costs of transportation to the processing site and any tipping fees that are applicable. Tipping fees are often part of the costs involved with creating compost products. One Massachusetts composting production facility charges a tipping fee for yard waste and other organic materials (the materials are then processed into compost products used for erosion control and for landscaping). The fees are $6 to $8 per yd^3 for landscaping materials (brush and grass) and up to $6 per yd^3 for leaves.[67] Once compost has been produced, there are costs associated with the application of the material.

[65] Goldstein, N. "Compost Product Performance." *BioCycle* 43 (October, 2002): 29-31.
[66] Alexander, R. "Compost Marketing Trends in the U.S." *BioCycle Magazine* (July, 2000).
[67] Block, D. "Mulch/Compost and the Marketplace." *BioCycle* 42 (September 2001): 44-45.