Composting Roadkill

Research and Implementation by the Virginia Department of Transportation

BRIDGET DONALDSON AND DAVID WILSON

Donaldson is Senior Research Scientist, Virginia Transportation Research Council, Charlottesville. Wilson is Environmental Program Manager, Virginia Department of Transportation, Richmond.

More than 1.2 million deer–vehicle collisions occurred in the United States in 2014. Removing and disposing of the deer carcasses and those of the millions of other animals killed in collisions with vehicles are essential services that transportation agencies provide.

According to a national survey in 2005, the 23 responding states predominantly managed roadkill with a combination of landfills and burial. Common shortcomings cited included the long travel distances to landfills, landfill restrictions, and a lack of viable burial areas (*1*).

Problem

Each year, vehicles in Virginia hit more than 56,000 deer. The Virginia Department of Transportation (DOT) spends more than $4 million to remove and dispose of the carcasses of deer and other wildlife. Road maintenance teams need roadkill management strategies that are viable, environmentally compliant, and cost-effective.

Composting roadkill is not common in the United States, although composting livestock carcasses is a frequent practice not only in the United States but worldwide. Under Virginia law, composting benign roadkill is subject to the same siting, construction, and testing requirements that apply to the disposal of sewage sludge and household waste. The actions necessary to adhere to the broader composting regulations are beyond the typical budgets and duties of a state DOT maintenance staff; as a result, the regulations could limit the adoption of a composting program in many states.

Solution

In 2009, the Virginia Transportation Research Council (VTRC) began a series of research projects to evaluate the environmental implications of composting roadkill and the utility of the practice as an option for managing the carcasses in a way that protects the environment and passes regulatory review. VTRC evaluated three methods (Figure 1, below); the criteria and results are shown in Table 1 (page 48).

Compost Windrows

Researchers constructed windrows with deer carcasses placed side by side between layers of wood chips, a source of carbon. The absorbent, bulky quality of the wood chips helped to maintain the proper moisture levels and oxygen flow for composting, and the high carbon content balanced the high nitrogen content of the animal carcasses.

Virginia's solid-waste management regulations aim to control the amount of leachate entering water sources from composting operations. Leachate is the product of precipitation that percolates through the compost and contains extracted or dissolved compost material. The VTRC researchers found that the

(*a*) (*b*) (*c*)

FIGURE 1 Compost methods evaluated: (*a*) static compost windrows, (*b*) forced aeration system, and (*c*) rotary drum.

TABLE 1 Evaluations of Compost Windrows and Vessels: Criteria and Research Findings

Criterion	Windrows	Vessels: Rotary Drum and Forced Air System
Compost temperatures	150°F and higher; met EPA criteria for pathogen destruction	150°F and higher; met EPA criteria for pathogen destruction
Pathogens[a]	Confirmed destruction	Confirmed destruction
Leachate volume	2 percent of the precipitation that fell on the windrow plots left the piles as leachate.[b]	Not applicable: leachate was contained.
Leachate contaminants	Filtration through soil reduced contaminants to nominal concentrations.	Not applicable: leachate was contained and recycled within the forced air system.
Operational performance	Not applicable: no operation required	Performed well with oversight and management
Plant germination and growth	Not tested	Plants grown with compost grew significantly larger by weight than those grown with soil.
Maturation time	11 to 12 months	2.5 to 4.5 months
Cost	Nominal—wood chips are free for some DOTs.	Ranges from $43,000 to $139,000, depending on vessel capacity; the forced-air system is the most expensive option evaluated but is cost-effective with sufficient carcass volume.

[a] *E. coli, Salmonella*, and ascarid ova (roundworm eggs).
[b] Low volumes of leachate are partly the result of the high absorption capacity of wood chips.

natural filtration through the soil reduced the leachate constituents to nominal concentrations (2). In addition, the windrows achieved high temperatures that quickly destroyed pathogens (Figure 2, below).

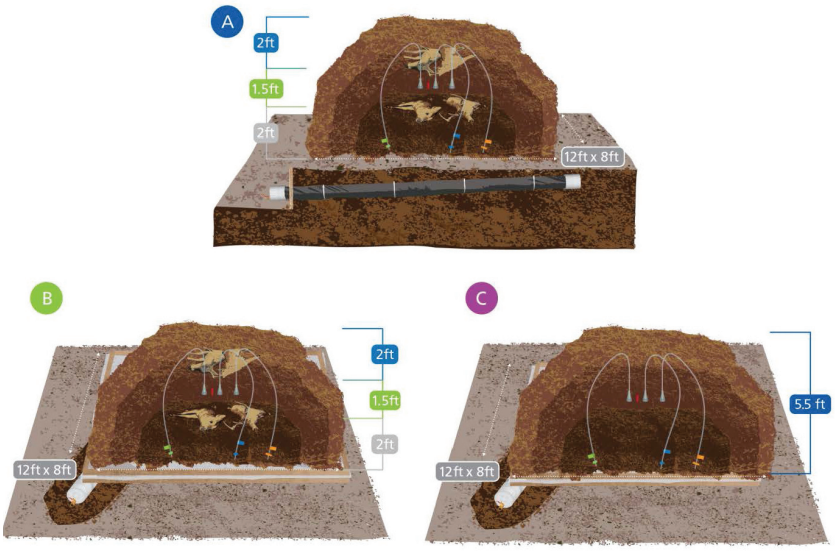

FIGURE 2 Illustrations of plot design, windrow construction, and placement of flasks containing pathogens: Windrow A, with leachate filtered through soil and collected in a buried lysimeter; Windrow B, with leachate not filtered through soil; and Control Pile C, containing no deer and with leachate not filtered through soil. A temperature data logger was placed between the pathogen flasks in all three piles.

Compost Vessels

Static compost windrows are economical and need little maintenance but require a large amount of space; if left unturned, the windrows produce mature compost in 10 to 11 months. The researchers therefore investigated rotary drum and forced-air systems, vessels that have smaller footprints and are designed to contain leachate; moreover, the compost matures relatively quickly.

Rotary drums operate with an electric motor that automatically rotates to aerate and mix the material. The drums also include an aeration system and wireless sensors for the temperature.

The forced-air system has two or more adjoining concrete containers—depending on the roadkill volume requirements for the area—and a three-walled, covered area for storage and curing. A mounted air pump forces air into the composting material through tubes in the container floor.

VTRC evaluated rotary drums and a forced-air system with the criteria listed in Table 1. The compost generated from both systems met all criteria, and with consistent management and oversight, the systems performed well from an operational perspective (3).

Application

The VTRC research established that the composting methods evaluated are effective and do not contaminate groundwater or surface water and do not spread pathogens. Virginia DOT and the state's Department of Environmental Quality executed a joint memoran-

dum of understanding (MOU) for composting animal remains from roadway maintenance operations (*4*).

The MOU outlines operational requirements for carcass composting—for example, the siting, construction, leachate capture, and compost testing. By increasing the prospects for Virginia DOT to implement composting, the agreement promotes the reuse of material that otherwise would be placed in a landfill.

VTRC recently completed guidelines for composting, including detailed descriptions of materials, the steps, and the time and the temperatures needed to achieve compost maturity. The guidelines also include beneficial applications for the finished compost.

Virginia DOT currently has five compost vessels that serve 15 maintenance areas. The agency plans to increase windrow composting throughout the state and to locate several additional composting vessels strategically.

The compost method chosen for an area depends on the volume of roadkill and the availability of space. Forced-air composting is the most prevalent method in Virginia, because the technique can handle a large volume of roadkill within a relatively small footprint.

Benefits

Research found that the compost methods that were evaluated provide Virginia DOT with a much-needed and more efficient alternative to the current practices for managing roadkill. Composting provides a viable option in maintenance areas that have long travel distances to disposal facilities or that no longer have landfills accepting animal remains. Composting also offers environmental benefits, potential savings, and a practical end product.

In contrast with disposal at a landfill, composting animal carcasses saves valuable landfill space and decreases the volume of organic byproducts, which are known sources of methane, a greenhouse gas.

VTRC researchers expect to find substantial cost savings from windrow composting, which requires no investment for areas that have a free source of wood chips. The initial investment for a compost vessel ranges from $43,000 to $139,000, but researchers found that a vessel can pay for itself if it replaces a lengthy drive to a landfill (*5*). Efforts to enhance the potential for greater savings from vessel composting are ongoing. Initiatives under way include the following:

- Ensuring that the size of the vessel matches the area's volume of carcasses,
- Pooling carcasses with other maintenance areas, and
- Applying finished compost in road projects.

Applications include compost blankets—a layer of composted material spread on the soil—and compost berms, which reduce erosion and stormwater runoff. Virginia DOT will use compost to establish vegetation for site restoration, aesthetics, or general landscaping.

For more information, contact Bridget Donaldson, Senior Research Scientist, Virginia Transportation Research Council, 434-293-1922; bridget.donaldson@vdot.virginia.gov.

PHOTO: ADAM FOSTER, FLICKR

Acknowledgments

The authors acknowledge Jimmy White, Audrey Moruza, Ed Wallingford, Robert Perry, and Ann Overton for their work on Virginia DOT's roadkill composting program.

References

1. Maryland State Highway Administration. *Summary of Responses to Maryland Survey on Animal Carcass Disposal*. American Association of State Highway and Transportation Officials, Washington, D.C., 2005. http://research.transportation.org/Pages/RACSurveyResultsOrganizedbyYear.aspx.
2. Donaldson, B. M., G. P. Smith, Y. J. Kweon, N. Sriranganathan, and D. L. Wilson. *Composting Animal Carcasses Removed from Roads: An Analysis of Pathogen Destruction and Leachate Constituents in Deer Mortality Static Windrow Composting*. Publication VCTIR 12-R12. Virginia Center for Transportation Innovation and Research, Charlottesville, 2012.
3. Donaldson, B. M., and J. W. White, Jr. *Composting Animal Mortality Removed from Roads: A Pilot Study of Rotary Drum and Forced Aeration Compost Vessels*. Publication VCTIR 13-R8. Virginia Center for Transportation Innovation and Research, Charlottesville, 2013.
4. Virginia Department of Environmental Quality and Virginia Department of Transportation. *Memorandum of Understanding Between the Virginia Department of Environmental Quality and the Virginia Department of Transportation: Composting Animal Road Mortality from VDOT Maintenance Roadway Operations*. Virginia Department of Environmental Quality, Richmond, 2015.
5. Moruza, A. K., and B. M. Donaldson. *An Evaluation of the Economics and Logistics of Animal Mortality Composting for the Virginia Department of Transportation*. Publication VCTIR 15-R18. Virginia Center for Transportation Innovation and Research, Charlottesville, 2015.

EDITOR'S NOTE: Appreciation is expressed to G. P. Jayaprakash, Transportation Research Board, for his efforts in developing this article.

Suggestions for Research Pays Off topics are welcome. Contact Stephen Maher, Transportation Research Board, Keck 486, 500 Fifth Street, NW, Washington, DC 20001 (202-334-2955; smaher@nas.edu).