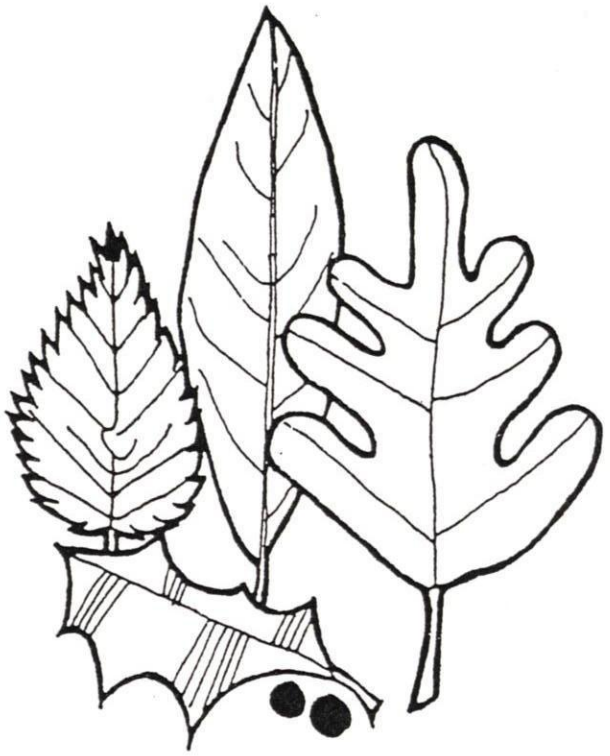
Operator's Notes for a Short Course on Municipal Leaf Composting

September, 1990



Presented by the

Connecticut Department of Environmental Protection

Waste Management Bureau

Recycling Program

and

Bethany Training Center

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WHAT IS COMPOSTING?

Composting is a controlled and managed process of aerobic decomposition that occurs through the natural breakdown of organic material, such as leaves, by macro and micro organisms which require oxygen, food and water.

Compost is the end product which resembles a darkened humus-like material which can be safely handled, stored and applied to land as a valuable soil conditioner and mulch.

WHY COMPOST LEAVES?

It's The Law!

After January 1, 1991, leaves will not be allowed into landfills or incinerators for disposal.

Saves Landfill Space!

Up to 10% of a town's total waste stream can be comprised of leaves.

Reduces Tip Fees!

Each cubic yard of leaves weighs approximately 450 pounds or about 1/4 ton.

Produces Beneficial End Product!

Leaf compost can be used for gardening, landscaping, erosion control and to enrich final landfill cover.

"WINDROW AND TURN"

Although there are other methods for composting a variety of organic materials, the **"windrow and turn"** technique has been used most often for leaf composting. This method strikes a good balance between efficiency and simplicity, and if done correctly, will process the leaves within a twelve month time period, thus freeing up the compost pad for the next season's leaves.

BASICS OF COMPOSTING

* **Micro-organisms:** Their function is to break down the leaves. **Aerobic bacteria** function in the presence of oxygen, are the good bacteria. However, **Anaerobic bacteria**, which function without oxygen, are the bad bacteria and cause severe odors.

* **Nutrients:** The proper ratio of carbon and nitrogen are important for the microorganisms. The optimum C:N ratio = **30:1**.

* **Oxygen:** The oxygen level in the windrows can be controlled by turning. The air we breath contains 21% oxygen. The optimum level for composting = **5%**.

* **Temperature:** Temperature in the windrows is also controlled by turning. The optimum range for composting = **100 to 140 degrees Fahrenheit**.

* **Moisture:** Micro-organisms need moisture to survive. The optimum moisture content for composting is between **40% and 60%**, or about the consistency of a wrung-out sponge.

* **pH:** pH should not be a problem in properly managed windrows. It will start out low and then stabilize as composting continues. Optimum range = **6.0 to 8.0**.

* **Particle Size:** Smaller particles = greater surface area = faster decomposition. However, too small particles may limit air flow and require more frequent turning.

* **Time:** For a properly managed windrow and turn operation = **8 to 12 months**. Composting can be accelerated by shredding, frequent turning, and the use of specialized windrow turning equipment.

PLANNING FOR A LEAF COMPOSTING OPERATION

* Estimate Volume of Leaves
* Select a Suitable Site
* Determine Leaf Collection System
* Identify End Users
* Determine Equipment and Staff Needs
* Prepare Budget
* Design Site
* Register Site with DEP
* Construct Site
* Train Personnel
* Begin Operations

FACILITY SITING CRITERIA

* Need approx. 1 acre for every 6,000 cubic yards of leaves to be composted

* Moderately well drained soil

* 2% slope

* ~~200~~-250 ft. from neighbors

* 100 ft. from property line

* 100 ft. from surface water

* ~~Suitable distance~~ 250 ft. from wells

* 5 ft. from high ground water or bedrock

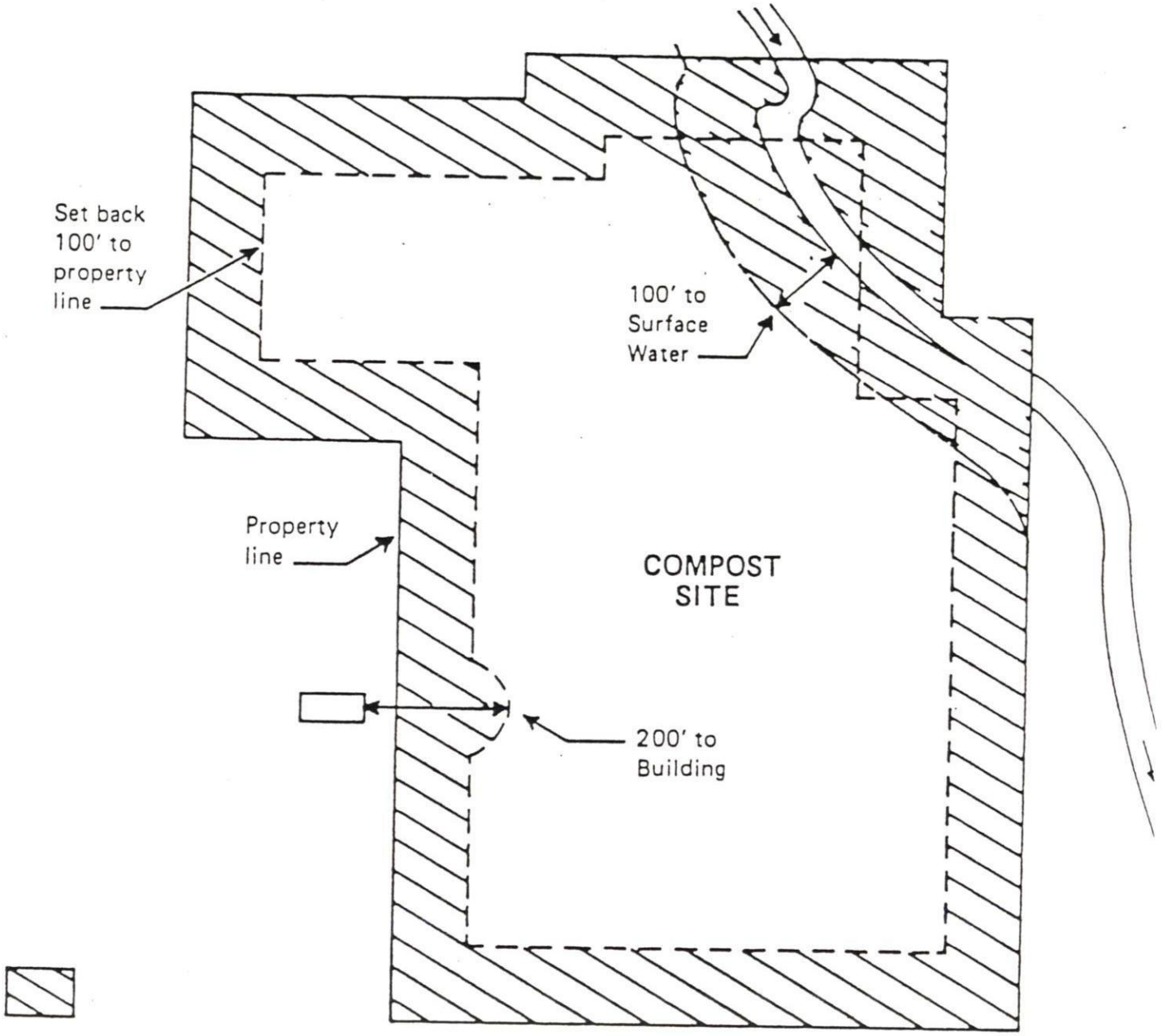
* At landfill areas (site specific evaluation which ~~requires~~ may a permit amendment)

Minimum 4 ft separation to garbage

SITE CONSTRAINTS

* Neighbors
* Wells
* Wet Soils (wetlands)
* Excessively Permeable Soils
* Flood Plains
* Surface Water
* Ground Water
* Bedrock

Site Setback Distances



Setback Area

ESTIMATING COMPOST PAD SIZE

For every 6000 cubic yards of leaves, approximately one acre of land will be required.

One can assume **four cubic yards for each ton of leaves;** however, experience has shown that this ratio can vary depending on the amount of yard waste, moisture, sand and dirt present or whether the leaves were shredded or compacted prior to delivery to the composting site.

Using existing records from past years is by far the best way to estimate the volume. If this information is unavailable, another way would be to take **6% of the municipality's total waste stream** and assume this to be the annual volume of leaves that will be generated.

The compost pad size, at a minimum, should reflect the volume of material that is to be deposited, composted and removed within one year. Due to constraints, a chosen site may not be able to accommodate all the leaves collected within a municipality. Thus, care should be taken in choosing a site of adequate size.

SITE PREPARATION

Once you have selected a suitable site that meets the recommended setback distances, soil conditions and size, you must prepare the area well in advance of receiving the first load of leaves. In most cases, this means having site preparation completed by **October 1st** of each year. You must consider:

* **Compost Pad Design and Construction**
* **Access Road Design and Construction**
* **Surface Drainage**
* **Water Supply**
* **Site Clearing**
* **Signs**
* **Security**

COMPOST PAD AND ROAD DESIGN AND CONSTRUCTION

* Proper pad design and construction is an essential first step for avoiding future problems from nuisance conditions (odor) and/or environmental impact (run-off or erosion).

* Design and construct pad and roads to avoid standing water, thereby avoiding anaerobic conditions which cause odor.

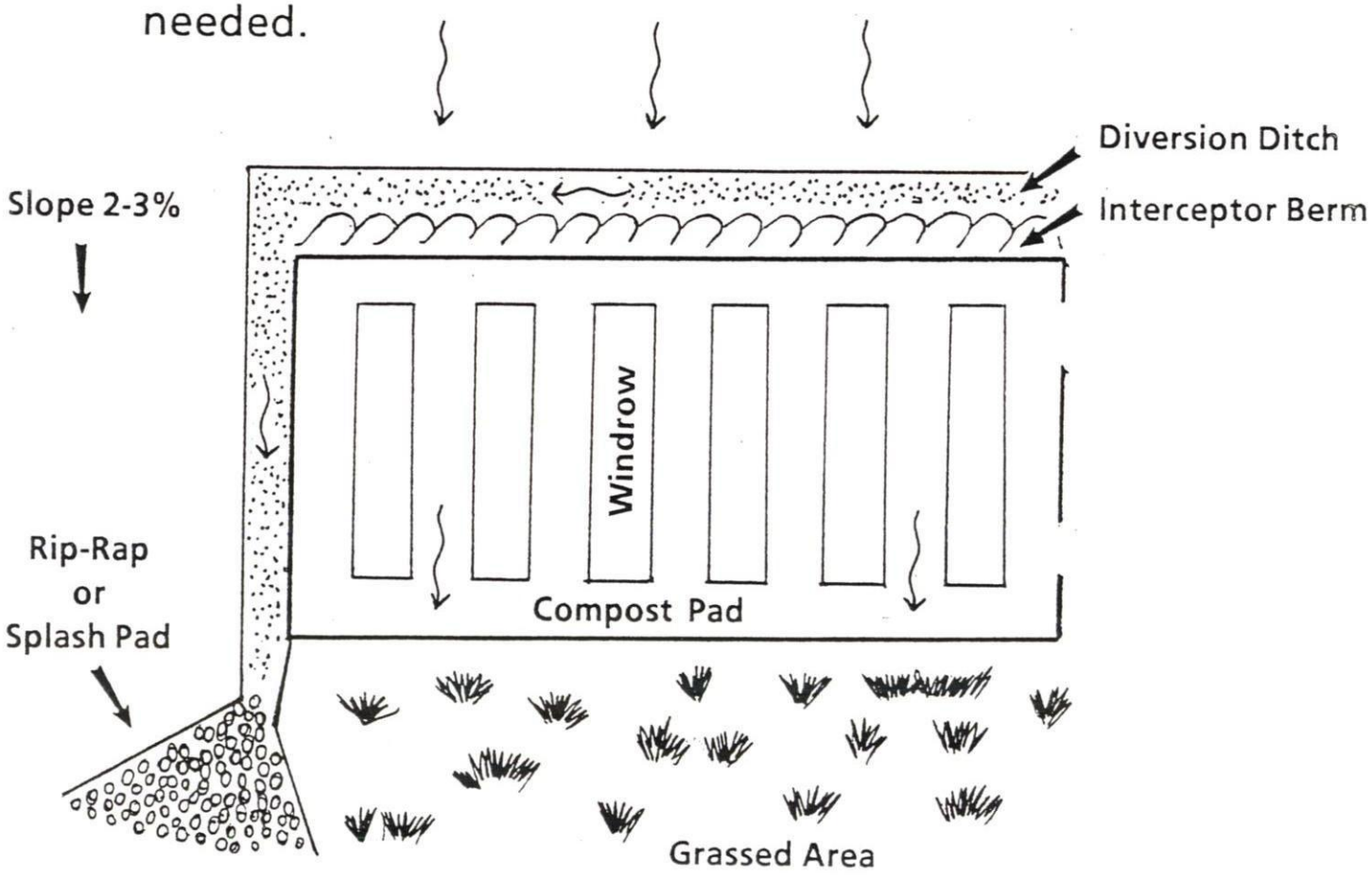
* Design and construct pad and roads to support machinery for all seasons of the year.

DRAINAGE CONTROL

* Grade pad to a **2%-3%** slope....**Do not exceed 5%!**

* Direct Surface drainage **away** from the compost pad, leaf storage and curing areas using a diversion ditch, interceptor berm or an interceptor drain.

* Install soil erosion and sedimentation controls as needed.



Generic Site Plan to Control Run-off and Run-on

WATER SUPPLY

* A source of water is needed for wetting the leaves, and provision for fire protection. Where a water source such as a pond or hydrant is not available, a water tank vehicle can be used. **Approximately 20-40 gallons of water are required for each cubic yard of leaves**, depending on how moist the leaves are upon arrival at the site. For large operations, an on-site water source may be necessary.

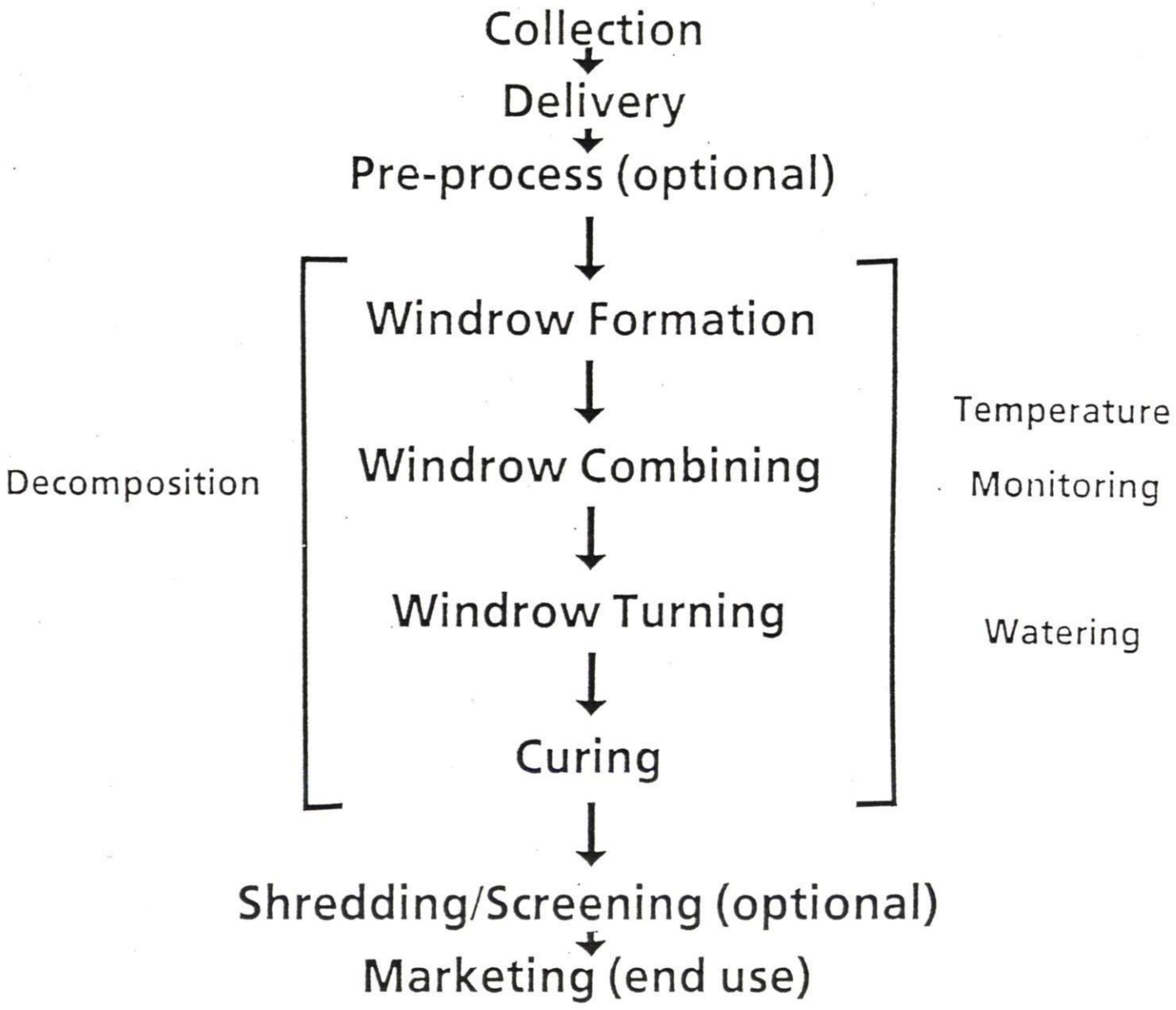
SITE CLEARING

* Before clearing land for the first year of operation, consider the need for a **buffer zone and visual screening.** Strategically leaving existing trees and vegetation could be beneficial.

* On successive years, clear the site of miscellaneous debris prior to using the site.

Composting is a Managed Process

Processing Steps



SIGNS AND SECURITY

* Post a sign at the entrance, identifying the facility and indicating hours of operation.

* Indicate that the facility is for "Leaves Only", thereby minimizing the dumping of extraneous debris.

* Post a sign at the receiving area so citizens know exactly where you want them to deposit leaves.

* Indicate that the citizens must de-bag their leaves (if they are using plastic garbage bags), thereby reducing labor costs. Supply container for bag disposal.

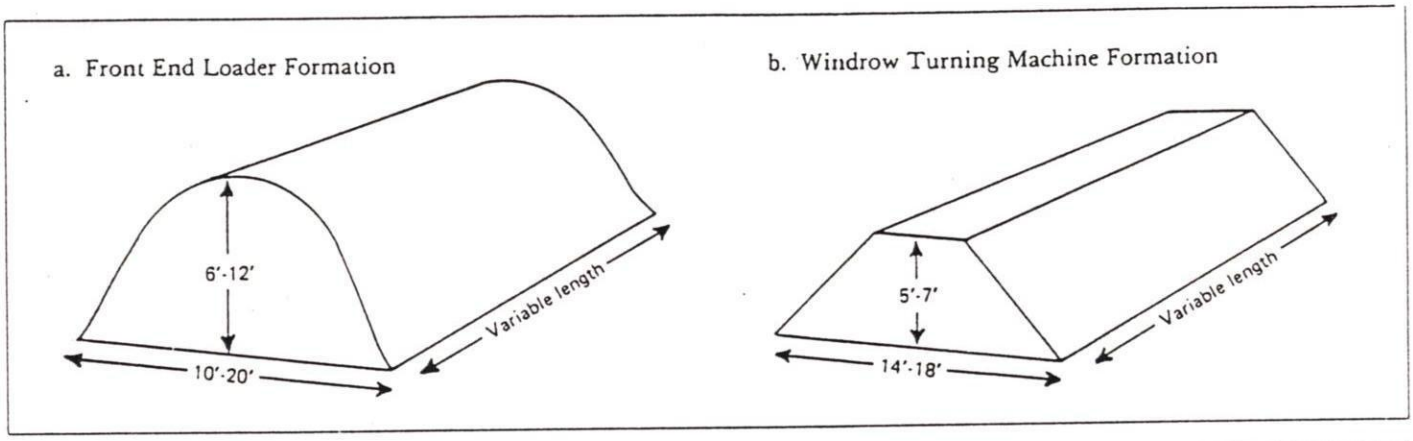
* Directional signs will be needed for traffic control.

* Control access roads so that illegal dumping and vandalism does not occur.

OPERATION AND MANAGEMENT "WINDROW AND TURN"

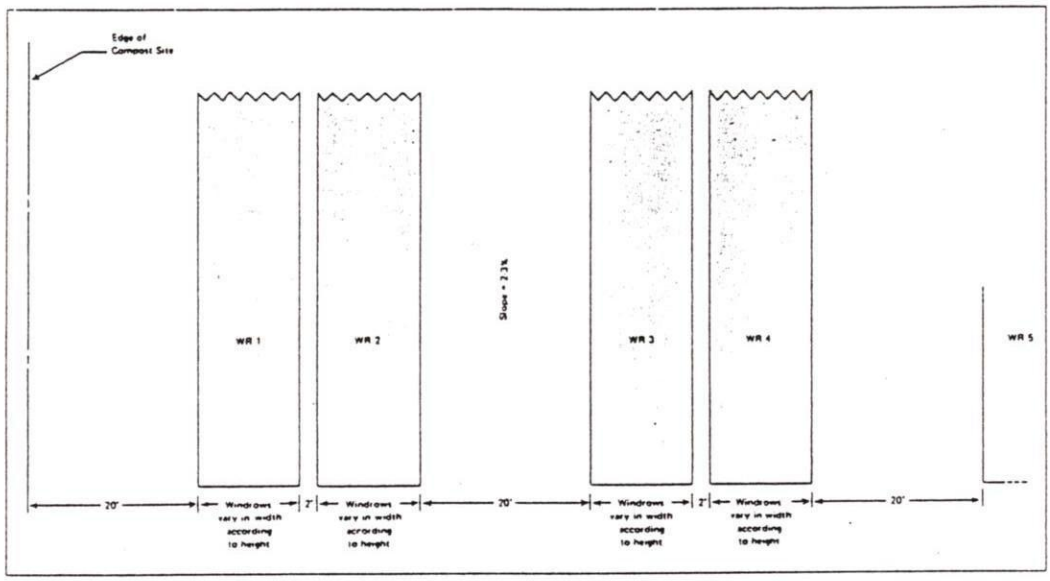
* Annual Site Preparation
* Processing Equipment
* Handling Incoming Leaves
* Leaf Wetting
* Windrow Formation
* Compost Process Monitoring
* Windrow Turning
* Compost Curing
* Finished Product Refining
* Record Keeping
* Quality Control

WINDROW FORMATION



Cascade the leaves from the bucket loader into windrows measuring approximately **10 feet high and 15 feet wide at the base, and as long as your site allows.** If vacuum trucks or packer trucks are being used for leaf collection, the leaves will be compacted when deposited. You **must break up those compacted clumps of leaves** to insure adequate aeration and water penetration. **Bulldozers are not the proper piece of equipment for windrow formation or turning,** as they will not allow leaves to be lifted and cascaded. **Front-end loaders are recommended.**

WINDROW SPACING



Combining

* Combine Windrows to insulate them during winter.

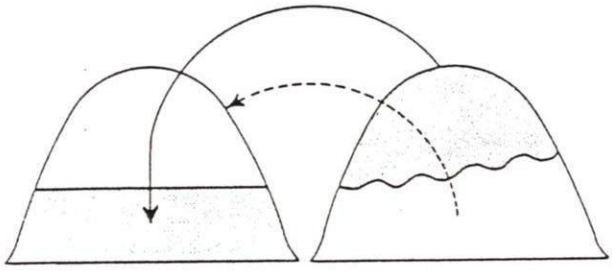
* Combine windrows to free-up pad space for new deposition of leaves.

Breakdown

* Break down windrows due to overheating
* Break down windrows due to compaction

WINDROW TURNING

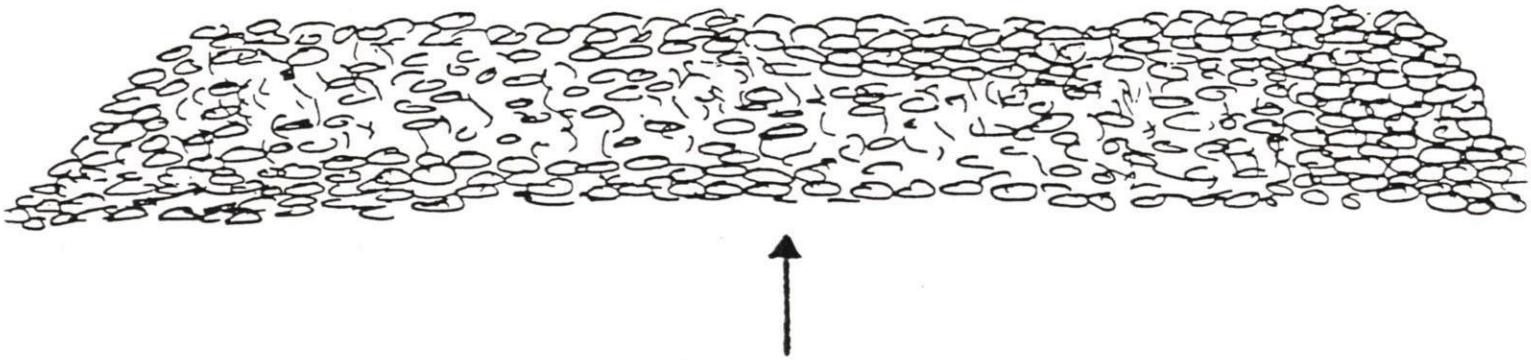
Lift leaves high with bucket loader and let leaves fall to new location to create a cascading (mixing) effect.



Note: The principle of the mixing technique is to move the top of the windrow to the bottom of the windrow being formed, mixing the leaves well during this process.

Turning not only aerates the pile, but also allows proper mixing. **Ideally, each time the windrows are turned, they should be turned twice in the same direction to insure thorough mixing. Leaves should be picked up high with the bucket loader and allowed to cascade into their new location.** This technique will allow those leaves on the outside of the pile to be mixed into the center of the windrow where micro-organisms can break down this material. If proper mixing does not occur, decomposition of the leaves will be slowed, and the leaves may need to stay on the composting pad for an additional amount of time. **This will interfere with getting the site cleared and prepared for next season's leaves. Bulldozers are not the proper piece of equipment for turning, as they will not allow the leaves to be lifted and cascaded. Use a front-end loader.**

DEBAGGING



Face of Pile

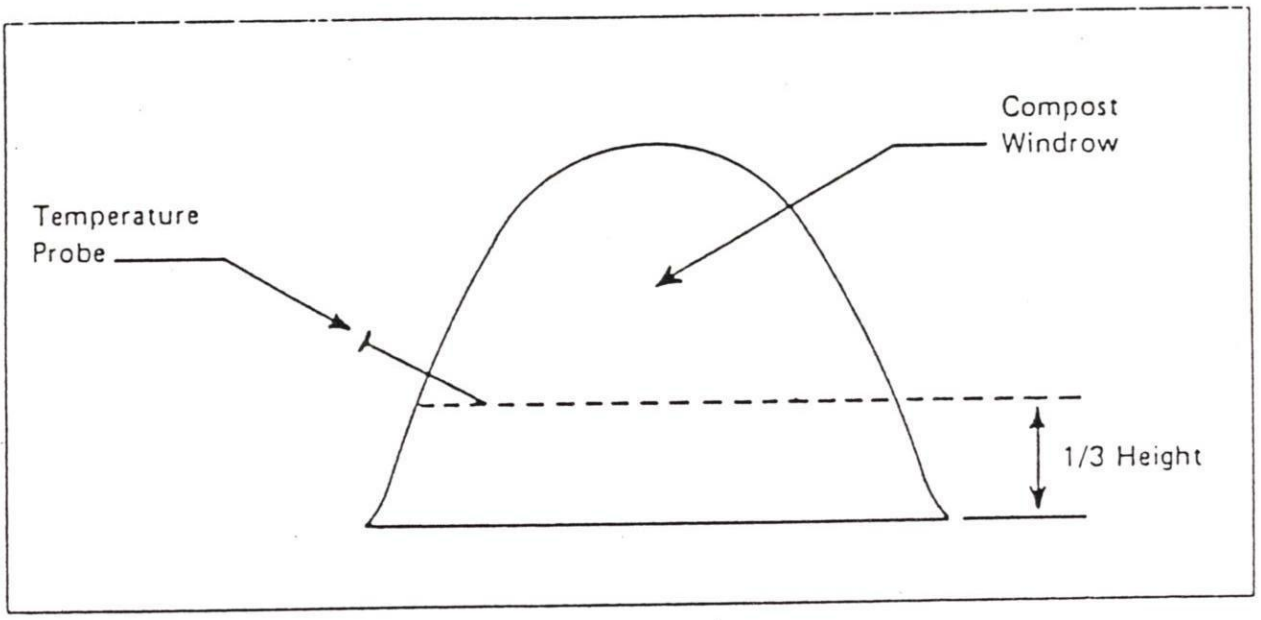
* Debaggers
* Bag Removal
* Leaf Removal

Debaggers should work on the face of the pile - not from the ends. Thus a greater number of people can work on one pile at a time.

Bag Removal should occur immediately so that the plastic bags and other non - compostable materials do not end up in the windrows. Containers should be provided for disposal of bags and other debris.

Leaf Removal should occur immediately so that debaggers have space to operate. The debagging operation should remain separate from the active compost pad.

TEMPERATURE



By keeping records of the temperature inside the windrows, the operator can see a trend or a general rate at which the decomposition process is moving.

Temperatures should be taken and recorded **twice a week** in the early stages of windrow decomposition. Each windrow should be monitored at locations approximately **50 - 70 feet apart** along the windrow, and as close to the **internal center** of the windrow as possible. **Optimum temperature** is between **100 and 140 degrees** Fahrenheit.

QUALITY CONTROL

Quality control is needed in order to avoid non-compostables or contaminants from showing up in the compost end product. The compost can have a variety of end uses, but only if it is kept **"clean"**.

Points in the compost process where quality control should occur are:

* Deposition
* Combining
* Turnings
* Bi-weekly inspections
* Screening/Shredding

STAFF

* A municipal composting operation requires **"dedicated" staff.**

* **Staff availability and performance will make the difference between a successful project and a series of potential nuisances and/or environmental problems.**

* The **staff** needs to understand both the material with which they are working and the process by which this material is made into compost.

* **Back-up staff** is recommended for those who have direct responsibility for compost operations.

Staff responsibilities can include:

* Attendance at Training Classes
* Leaf Deposition
* Windrow Combining and Turning
* Monitoring and Record Keeping
* Quality Control
* Final Compost Processing

OTHER CONCERNS

* **Aspergillus fumigatus** is a fungus spore that may be produced by the composting process and may be a cause of lung infections and allergic reactions in susceptible people. People with diseases causing immune suppression including arthritis, and people taking drugs that surpess the immune system like cyclosporin, should not work with compost. Simply wearing a dust mask may help reduce health risks.

* **Pesticides** used on trees will in most cases be applied early in the growing season and by the time the leaves fall, the pesticides will be significantly degraded.

* **Road Salt** has not been found to be a problem with regard to high concentrations in leaves for composting or in the finished product.

* **Lead** is sometimes found in finished compost, however, research in New Jersey indicates that relatively low levels should be expected.

* **Grass Clippings** may contain weed killers used in lawn maintenance programs and may take a few months to degrade. Nitrates from grass clippings may also cause pollution in ground and surface waters. Severe odors and difficulty in handling grass clippings have also been problems. Rutgars University is researching this topic and is expected to provide additional information.

END USES OF LEAF COMPOST

Leaf Compost is a soil-like material valued primarily as a soil amendment. The nutrient value is usually too low to consider it a fertilizer. Screening or shredding increases the value of the compost.

* Potential Uses

Municipalities: in parks, road jobs, landscaping, erosion control, final landfill cover enhancement.

Landscape Industry: as mulch, amendment.

Greenhouse/Nursery: as potting soil replacement, mulch.

Home Grounds/Gardening: in vegetable and flower gardens, mulch, landscaping.

Agriculture: to improve tilth and water holding capacity of fields.

* Distribution Method

Municipal

Give away

Bulk Sales

Retail

TROUBLE SHOOTING: ODOR

Siting:	Provide an adequate buffer
	Locate sites down wind of sensitive adjacent uses (neighbors, parks, etc).
Design:	Place windrows down (parallel to) the slope rather than across (perpendicular to) the slope.
	Place windrows on a properly designed pad so as to ensure water movement away from windrows.
Operation:	Build windrows to proper height and shape.
	Leaves should be mixed thoroughly and built into windrows promptly.
	Maintain proper temperatures, moisture and oxygen content.
	Turn windrows based on temperature and moisture monitoring.
	Schedule turnings to coincide with favorable wind conditions , time of day and during rain.
	Monitor incoming waste to limit amount of putrescible material in windrows.

TROUBLE SHOOTING: RUN-OFF

Siting: Comply with Ct. Inland Wetland and Watercourses Protection Act.

Avoid sites immediately adjacent to lakes, rivers, streams and reservoirs.

Avoid sites where high water table is less than 5 feet from the surface.

Avoid steep slopes.

Avoid both poorly drained and excessively permeable soils.

Avoid sites where bedrock is near to the surface.

Design: Design pad to divert run-off from compost, staging, and curing piles.

Design pad so run-off does not move off site and impact adjacent waters or land.

Operation: To limit the amount of contaminants, such as heavy metals, which could end up in the run-off, avoid material deposited at the compost site which is collected by street sweepers.

Plan for prompt disposal of non-compostable material.

TROUBLE SHOOTING: EROSION

Siting:

Avoid sites in close proximity of surface waters.

Avoid steep slopes

Choose a site with moderately permeable soils.

Design:

Grade the site properly with a 2-3% slope.

Retain as much vegetation as possible when clearing the site.

Design access and on-site roads properly.

Use diversion ditches and baled hay to contain run-off during and after site construction.

TROUBLE SHOOTING: WINDROW TEMPERATURE

Operation:

Low Windrow Temperature:

Turn windrows to provide aeration.

Combine windrows to retain heat.

Add water while turning windrows to provide moisture.

High Windrow Temperature:

Turn windrow to release heat.

Reduce windrow size to reduce heat.

TROUBLE SHOOTING: LITTER
(BLOWING LEAVES)

Siting:

Provide an adequate buffer zone.

Locate site downwind from sensitive land uses.

Design:

Retain perimeter vegetation or design berms to act as wind screen.

Install simple fence or screen, e.g. snow fencing, to limit movement of leaves off-site.

Control access to site to avoid illegal dumping.

Provide trash receptacle for bags and other litter.

Operation:

Form leaves into windrows immediately. The triangular haystack shape of the windrows helps prevent leaves from blowing.

Ensure leaves have proper moisture content.

Regularly collect litter from fences or tree line barriers and along roadways.

TROUBLE SHOOTING: FIRE

Siting: Site near hydrant or fire pond for use by fire equipment.

Design: Access and on-site roads should be designed to support fire equipment.

Design enough space around and between windrows for fire equipment access.

Control access to site in order to avoid vandalism.

Notify and educate fire department about composting.

Operation: Properly moisten leaves before building windrows.

Avoid smoking in areas of deposition and composting pad.

Avoid backing collection trucks with hot exhausts into deposited leaves.

* NOTE: Leaves with adequate moisture for composting should not combust spontaneously.

TROUBLE SHOOTING: DUST

Siting: Provide adequate buffer between the operation and sensitive land uses.

Locate the site downwind of sensitive land uses.

Design: Construct access roads with improved surfaces.

Operation: Maintain proper moisture content in the windrows.

Periodically, wet unimproved surfaces during episodes of extended dry weather.

TROUBLE SHOOTING: VECTORS
(RODENTS AND MOSQUITOES)

Operation: Maintain an effective composting process.

Properly mix and promptly create windrows of the incoming material.

Promptly remove and properly dispose of putrescibles that have been mixed with incoming leaves.

Grade site to prevent ponded water where mosquitoes may breed.

TROUBLE SHOOTING: ASPERGILLUS FUMIGATUS

Siting: Do not establish operation in close proximity to hospitals or nursing homes.

Operation: Adequate wetting and minimum disturbance of windrows.

Screen job candidates, who plan to be at the composting site, for allergic reactions, or compromised immune systems.

Wear a dust mask while turning windrows.

Sample Leaf Volume Data Sheet

Month_____ Year_____

DATE	Vehicle No._____ Type_____ Cap. Cu.Yd.		Vehicle No._____ Type_____ Cap. Cu.Yd.		Vehicle No._____ Type_____ Cap. Cu.Yd.		Vehicle No._____ Type_____ Cap. Cu.Yd.		TOTAL
	Loads	CY/Tons	Loads	CY/Tons	Loads	CY/Tons	Loads	CY/Tons	
1									
2									
3									
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25									
26									
27									
28									
29									
30									
31									
total									

Source: New Jersey Office of Recycling (Form OR-3A)

Sample Windrow Temperature Data Sheet

Data collected by:_____ Year:_____ Month:_____

Weather Information (Sunny, rain, etc.)_____

Wind direction (from Northeast, South, etc.)_____

Air Temperature: °F_____ Time of day:_____

Site Observation Comments (Water ponding, dust, etc.)_____

Windrow Moisture ("Hand squeeze" test observation) *circle item:* Needs moisture Satisfactory Excess

Odor *(circle item):* None Minimal Strong

Windrow temperature measurement location:	Temperature Observation, °F								
	Windrow Observation (See Sketch Below)								

Diagram

Actions Taken (turned windrow, graded, etc.): _____

Example of Completed Windrow Temperature Data Sheet

Data collected by: K. C. COMPOST Year: 1989 Month: FEB.

Weather Information (Sunny, rain, etc.) RAIN

Wind direction (from Northeast, South, etc.) N.E.

Air Temperature: °F 36°F Time of day: 10 a.m.

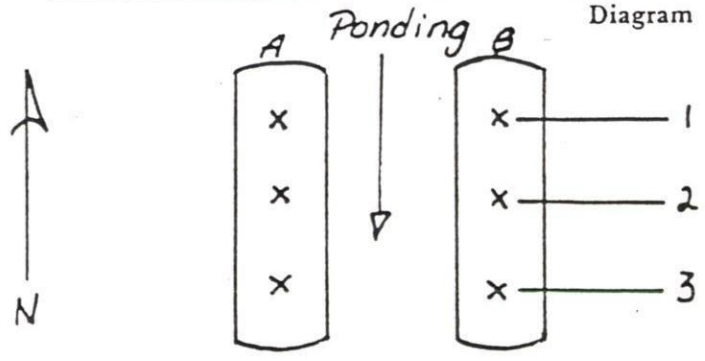
Site Observation Comments (Water ponding, dust, etc.) wet, cold, windy. Ponding between windrows A and B.

Windrow Moisture ("Hand squeeze" test observation) *circle item:* Needs moisture (Satisfactory) Excess

Odor *(circle item):* (None) Minimal Strong

Windrow temperature measurement location:	Temperature Observation, °F — Windrow Observation (See Sketch Below)								
	A	B							
1	115	106							
2	120	102							
3	118	110							

Diagram



Actions Taken (turned windrow, graded, etc.): Instructed operator to regrade between A and B.

NOTES

Printed on Recycled Paper