Composting 101: The Biology of Composting

Presented by Cindy Sterling, Organics Specialist

The Northeast Recycling Council

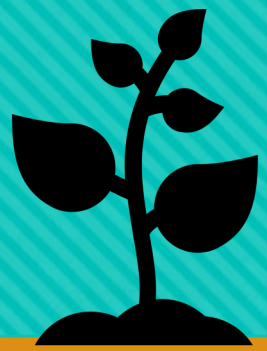
What is NERC

- Nonprofit focused on minimizing waste, conserving natural resources, & advancing a sustainable economy
- 11-state area of focus: New England, Delaware, Maryland, New Jersey, New York, & Pennsylvania
- *Membership organization*: municipal & regional governments, nonprofit & private sectors – **Consider Joining!**

NERC
NORTHEAST RECYCLING COUNCIL

Back to the Earth™

How to recycle organic material and how states are managing it in NH, VT and MA.



The Dirt on Dirt: Municipal Composting 101

Northeast Resource Recovery Association
2101 Dover Road, Epsom, NH 03234
603.736.4401 800.223.0150 www.nrra.net

Where Does It (Organics) Go?

Composting is:

http://organichealthadviser.com/archives/how-to-make-your-own-organic-compost

Taking organic matter (stuff that was once alive) …

https://organicforecast.org/2016/02/1829/

...and turning it into nutrient rich soil called *Humus,* which can be returned to the earth to grow new things.

Compost (käm’pōst)

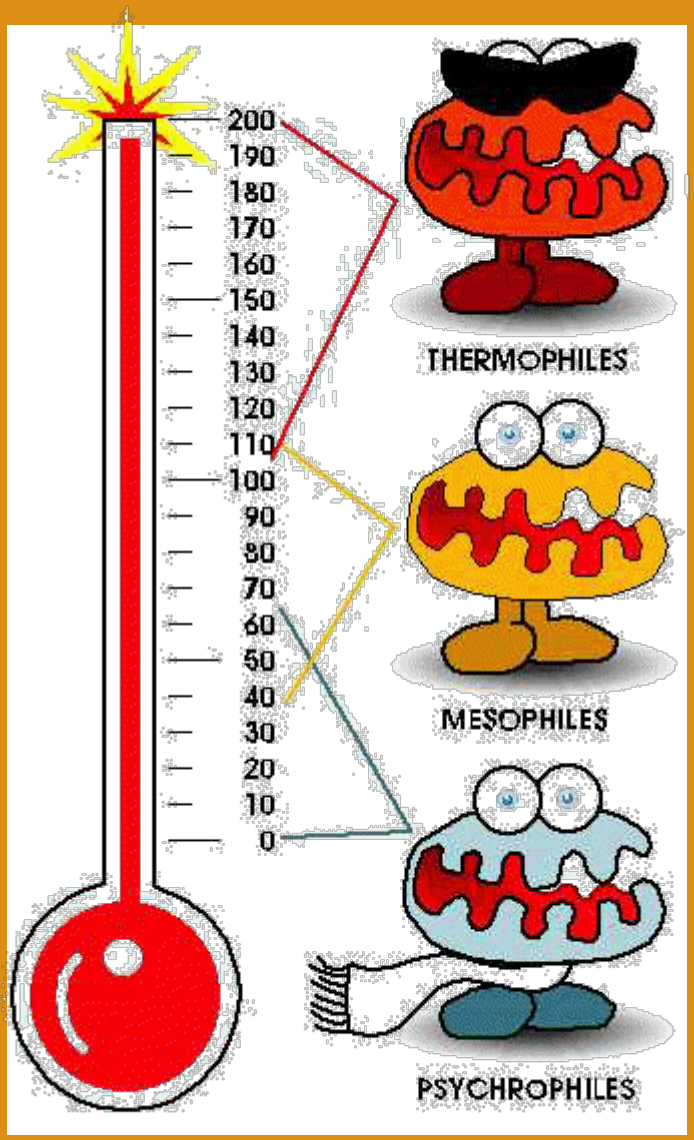
A mixture of decomposing vegetation for fertilizing soil.

or

http://www.epa.ie/livegreen/wasteprevention/

The aerobically decomposed remnants of organic matter.

Smallest Compost Critters



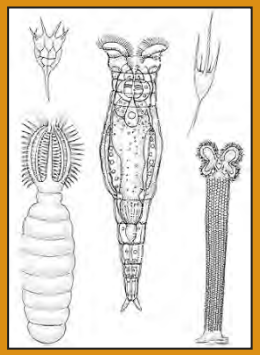
Microorganisms are the smallest Compost Critters.

These bacteria work at different temperatures.

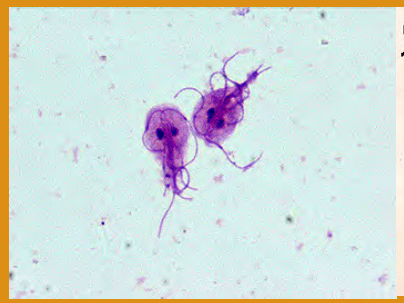
The most efficient Critters need temperatures around 150° F.

Smaller Compost Critters

Nematodes



Rotifera

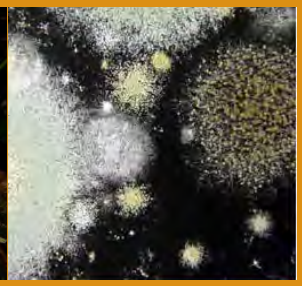


Protozoa

Bacteria, including Actinomycetes

Springtail

Fungus & Mold Mites



Fungi and Molds

Larger Compost Critters

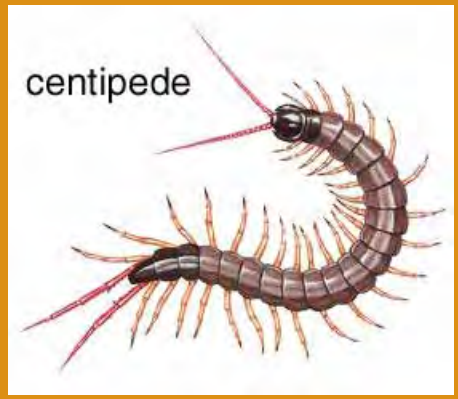
Diptera (Flys)

Slugs & Snails

Earthworms

Ground Beetles

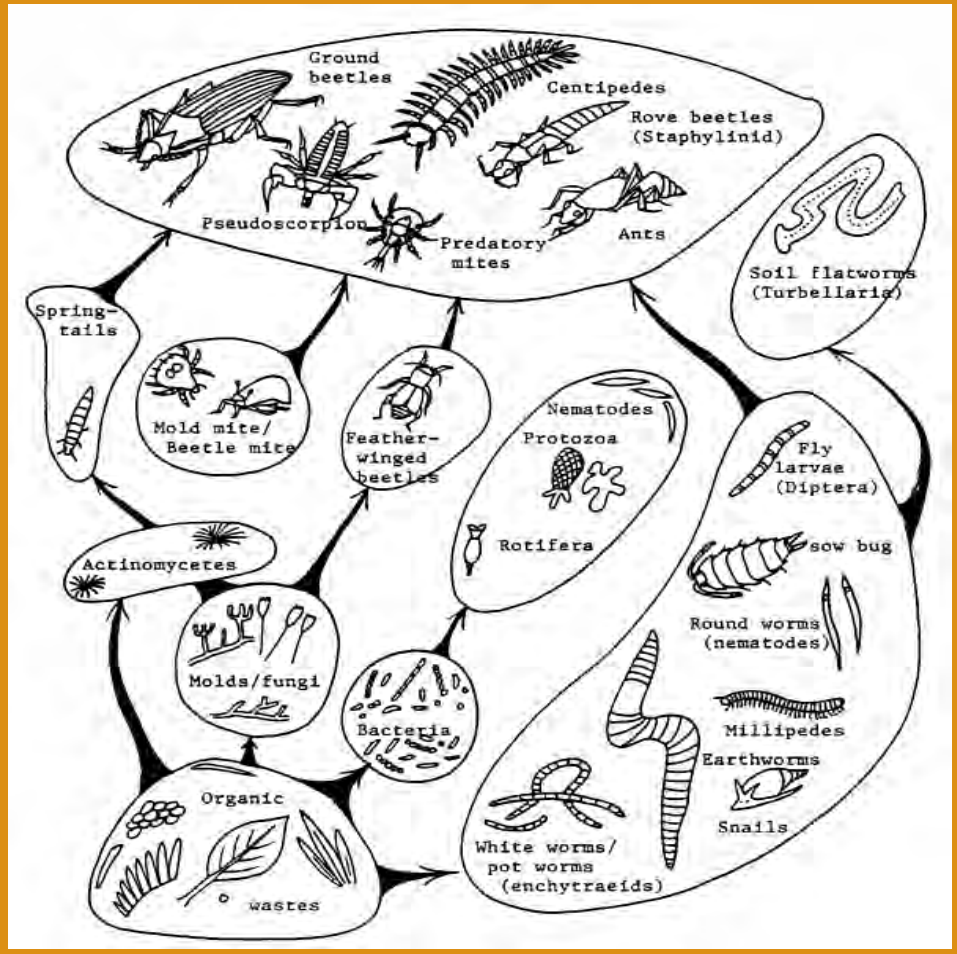
Pseudoscorpions



Millipedes & Centipedes

Ants

Compost Food Chain



http://www.fao.org/docrep/field/003/AB467E/AB467E05.htm

From the ground, up ...

Composting is easy!

http://www.farmnwt.com/sites/default/files/compost.jpg

Photo: Texas A&M University

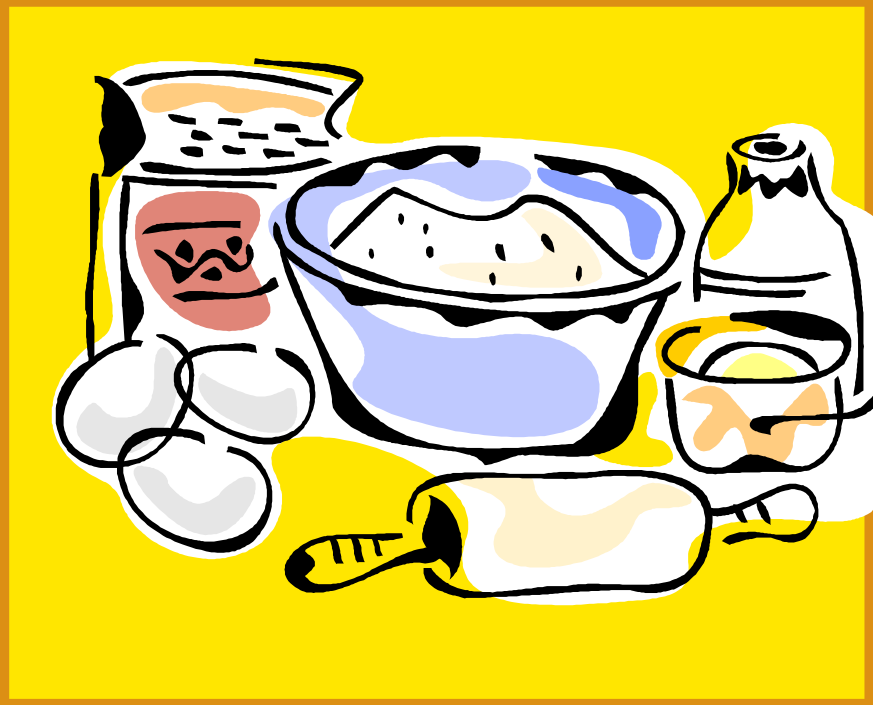
You <u>can</u> just pile up your organic materials and wait, and eventually…

…you'll get finished compost.

Making compost happen quickly can be harder...

But it's not much harder than baking a cake.

What do we need to know to bake a cake?



The ingredients and how to put them together.

Compost Ingredients

"Greens" = Protein

Things which are high in Nitrogen:

* Vegetable and Fruit Scraps
* Coffee Grounds
* Fresh Grass Clippings
* Manure

Compost Ingredients

"Browns" = Carbs

Things which are high in Carbon:

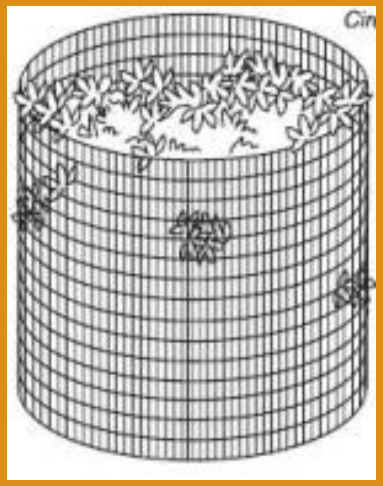
* Autumn Leaves
* Twigs & Wood Chips
* Hay/Straw/Dry Grass
* Paper Towels/Napkins
* Cardboard & Paper

https://piquaoh.org/city-departments/sanitation-department/yard-waste/

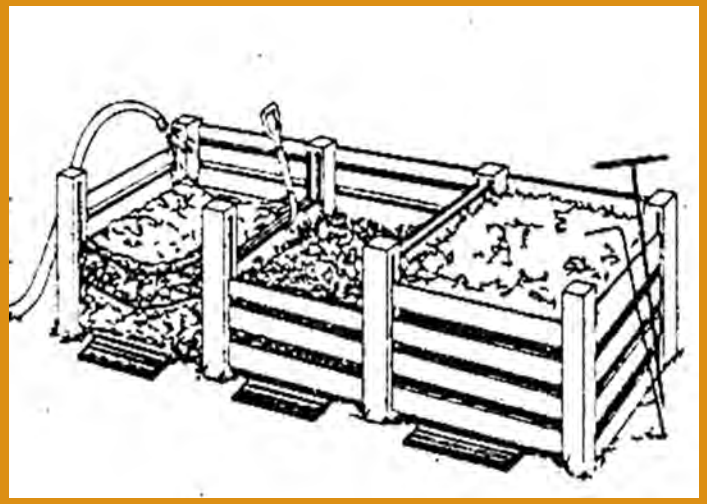
Putting it together…in Layers

Piles vs. Gadgets

Photo: Texas A&M University



https://nancyonthehomefront.com



NRRA Picture

http://www.farmnwt.com/sites/default/files/compost.jpg

Earth Machine

http://www.zerowasteamerica.org/Composting.htm

Windrows

http://smallfarms.oregonstate.edu/agricultural-composting-and-water-quality

Commercial Composting

Biocycle.net

Biocycle.net

Biocycle.net

Vermi-Composting (WORMS!)

NRRA Photo

NRRA Photo

Animal Feed

Courtesy of urbandigs.com

Courtesy of sfgate.com

Courtesy of treehugger.com

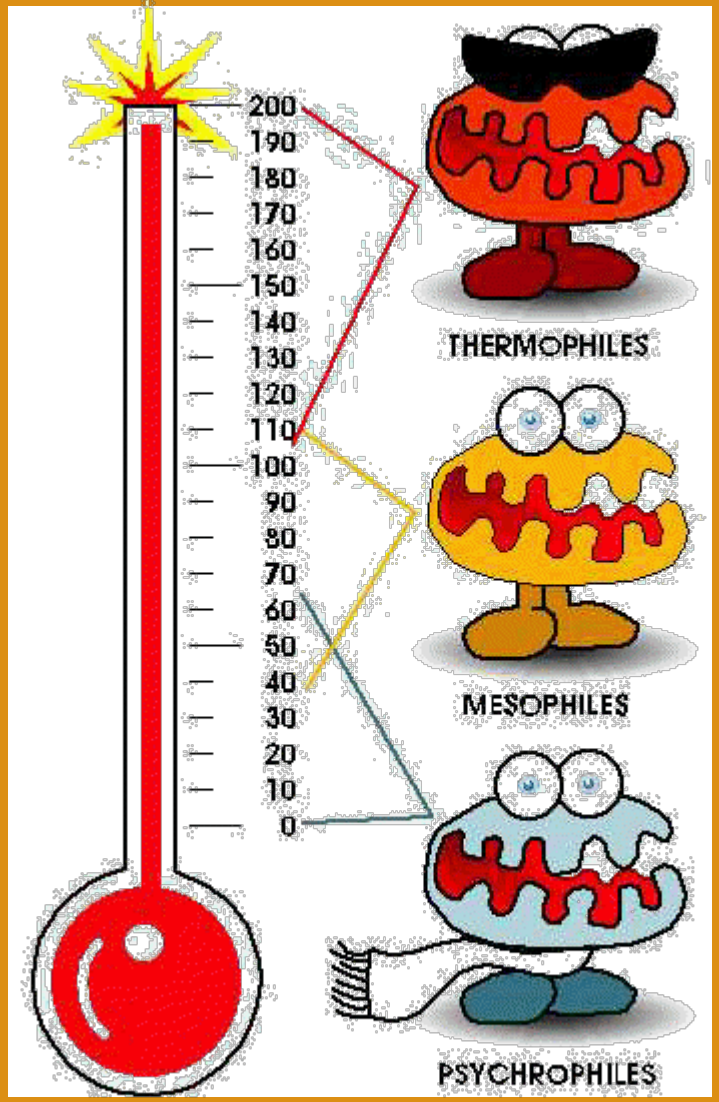
Why 3 - 4 ft.?

Not too big to turn and aerate easily…

http://www.cambridgegardenservices.co.uk/gardening-tips/article/995-SHRUBS-AND-TREE-ADVICE-IN-OCTOBER

…but, big enough to get WARM.

Why is that important?



Remember: Our Smallest Compost Critters Need Heat

These bacteria work at different temperatures.

The most efficient Critters need temperatures around 150° F.

Remember:

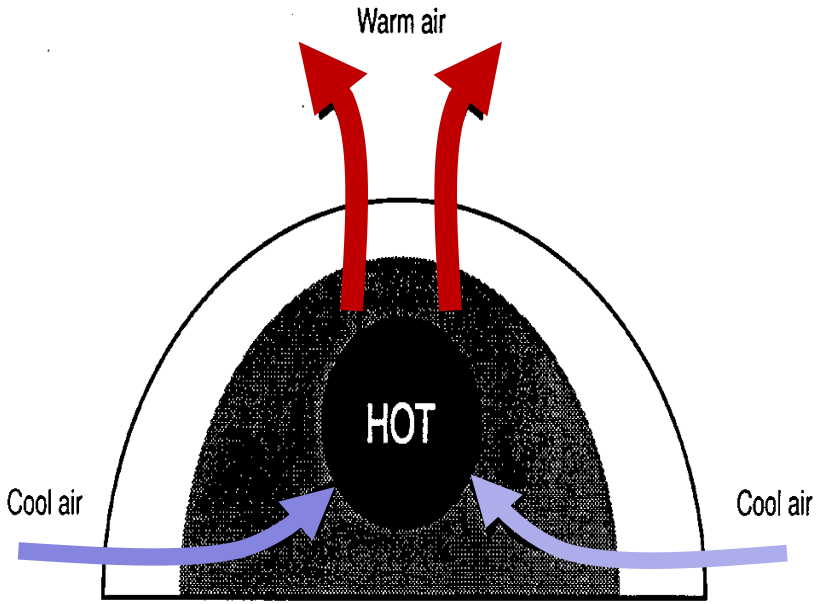
Composting happens naturally.

It can be done very easily.

or

With a little work, you can make composting happen faster.

Thermophilic Composting



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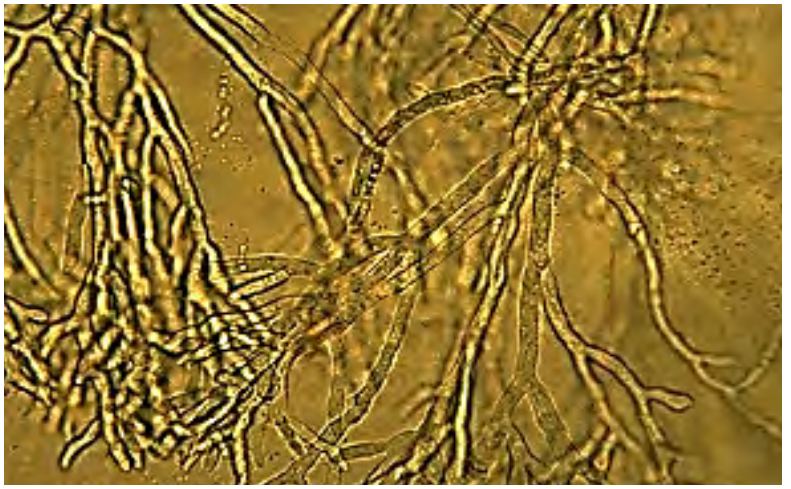
Fungi



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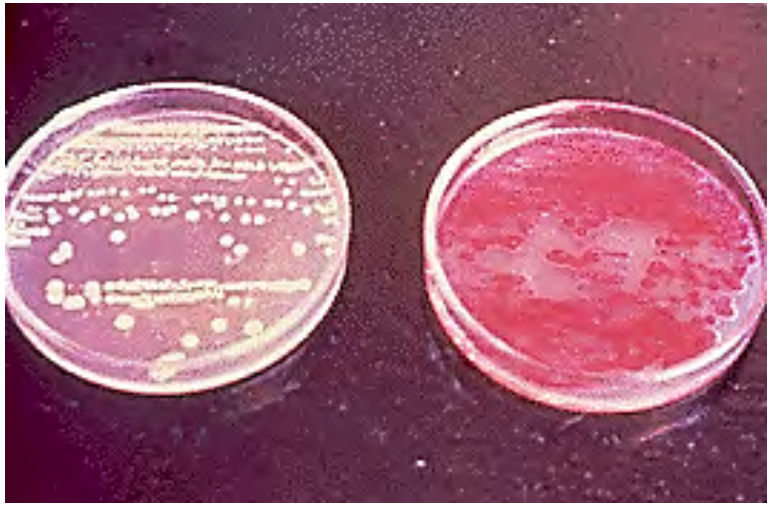
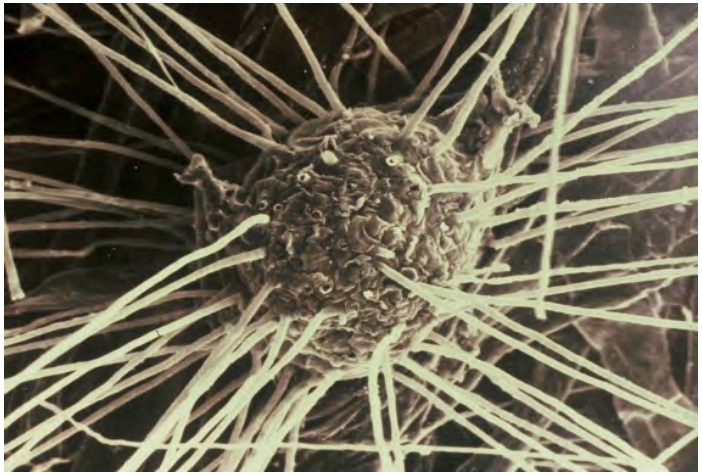
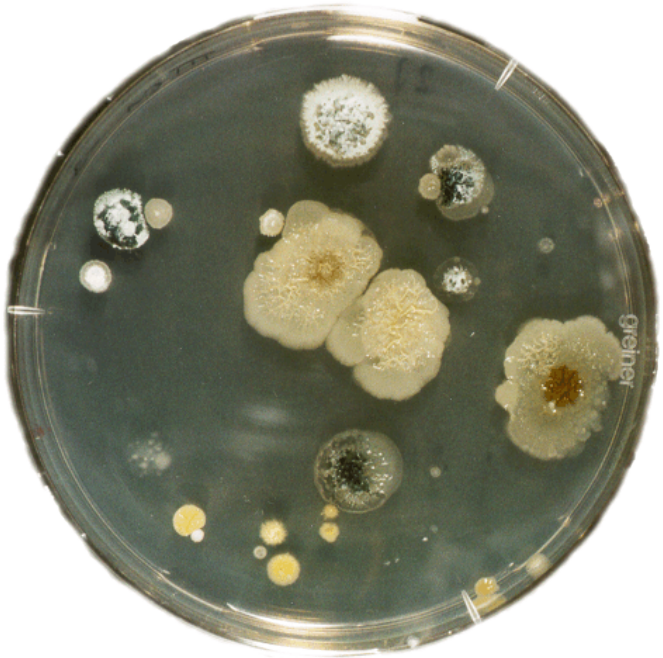
Bacteria





Actinomycetes



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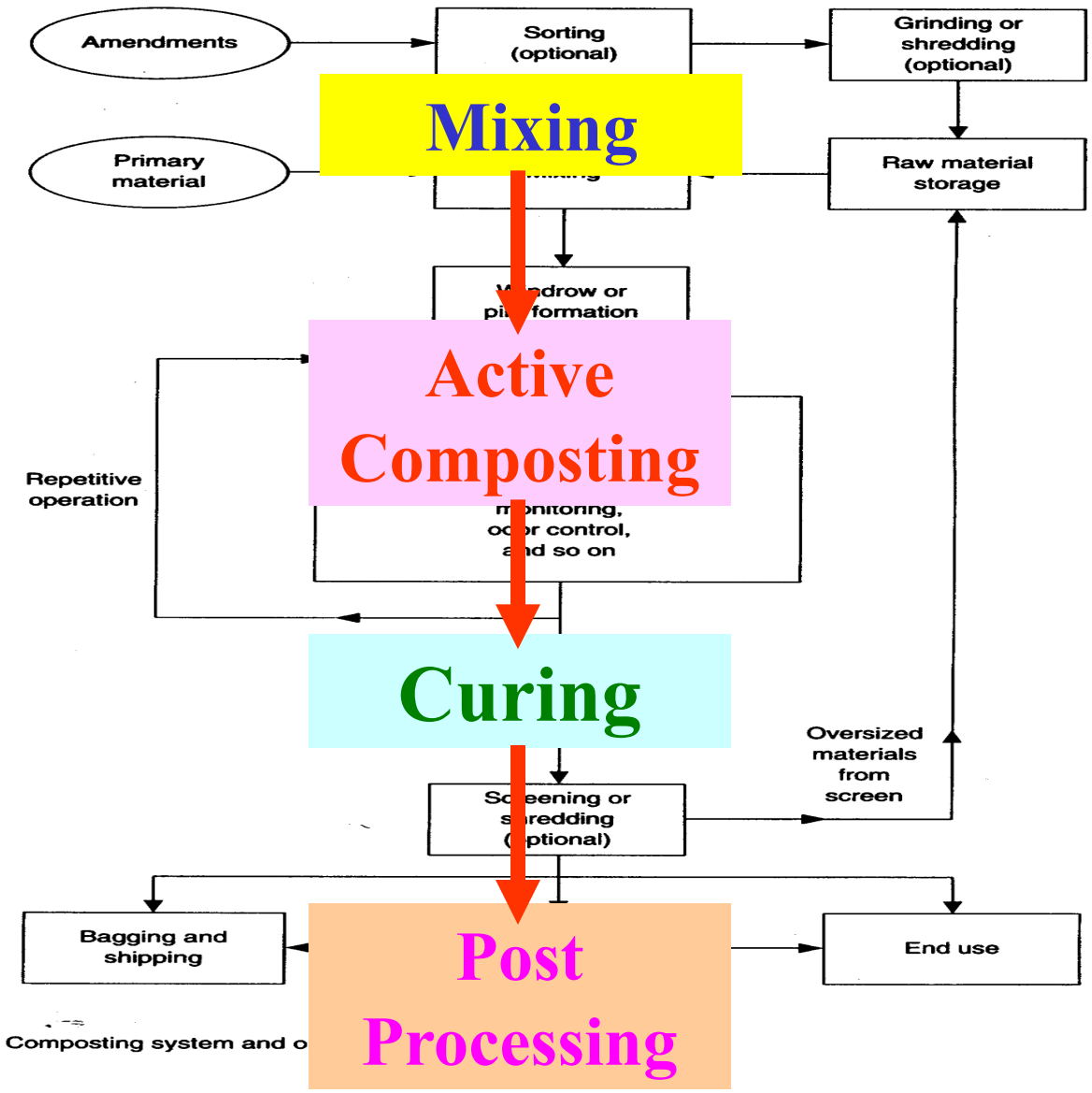
Composting Methodology



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Mixing:
Balancing Moisture & Oxygen

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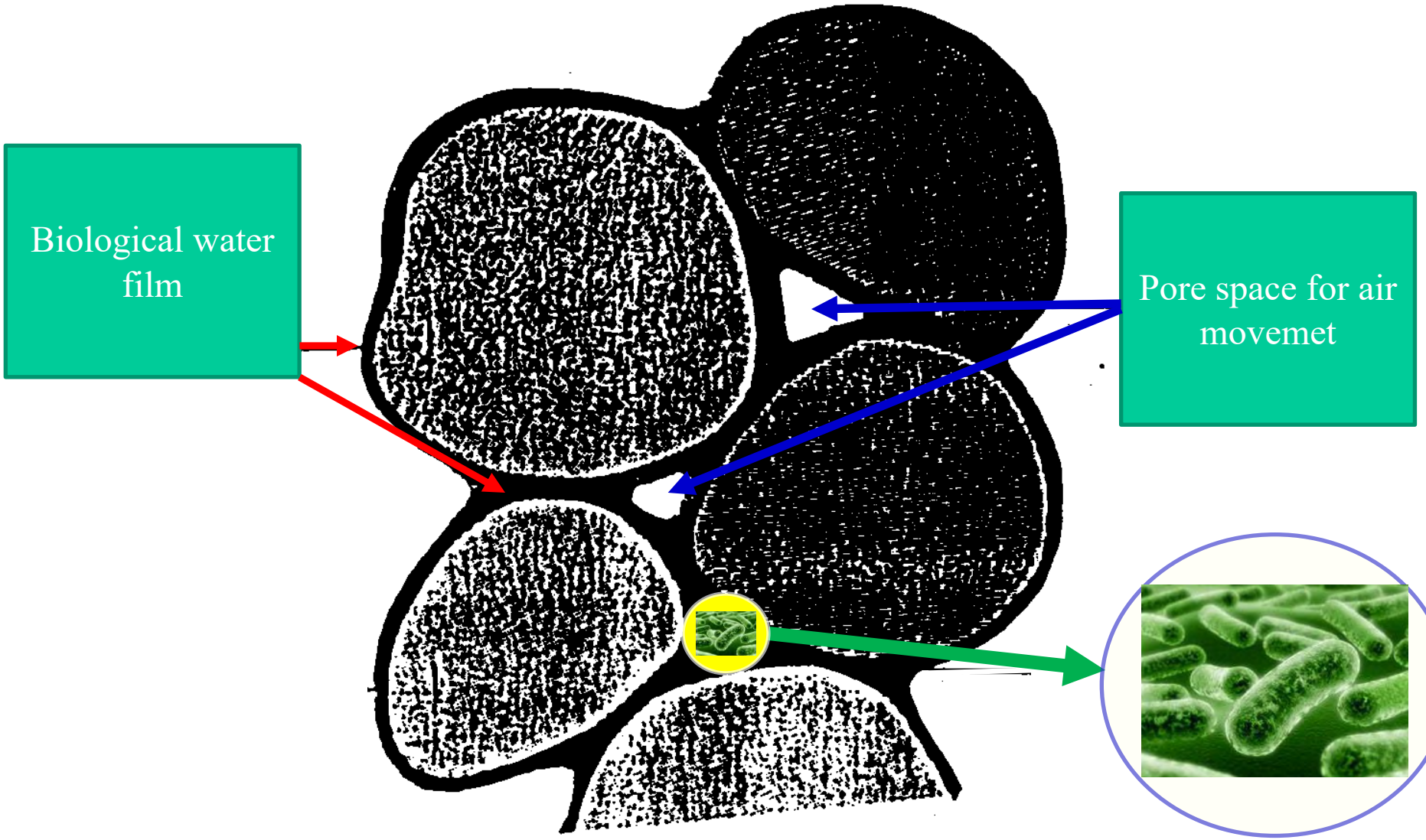
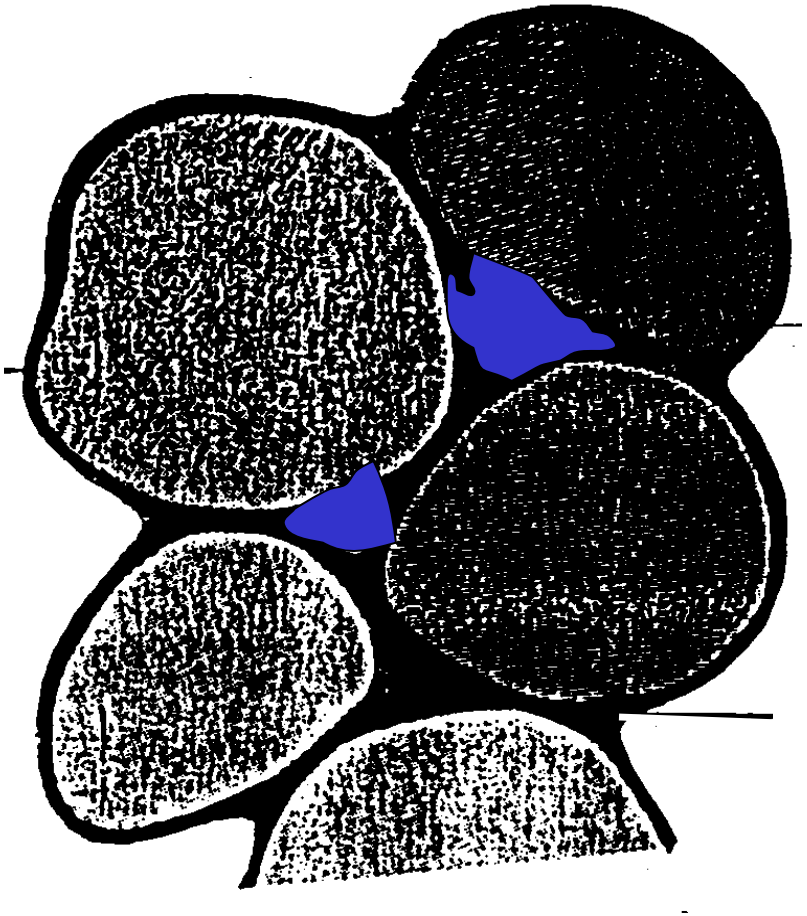
Need enough water



But not too much water



Recommended conditions for rapid composting

Condition	Reasonable range [a]	Preferred range
Carbon to nitrogen (C:N) ratio	20:1–40:1	25:1–30:1
Moisture content	40–65% [b]	50–60%
Oxygen concentrations	Greater than 5%	Much greater than 5%
Particle size (diameter in inches)	1/8–1/2	Varies [b]
pH	5.5–9.0	6.5–8.0
Temperature (°F)	110–150	130–140

[a] These recommendations are for *rapid* composting. Conditions outside these ranges can also yield successful results.

[b] Depends on the specific materials, pile size, and/or weather conditions.

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Mixing:
Balancing Nutrient Input

Balancing Nutrients

Carbon – Nitrogen Ratios

Material		C:N
Leaves		40 - 80:1
Grass Clippings		19:1
Sewage Sludge:	Activated	6:1
	Digested	16:1
Humus		10:1
Food Wastes		15:1
Cow Manure		20:1
Horse Manure		25:1
Fruit Wastes		35:1
Corn Stalks		60:1
Straw		80:1
Bark		100 - 130:1
Paper		170:1
Sawdust		500:1
Wood		700:1

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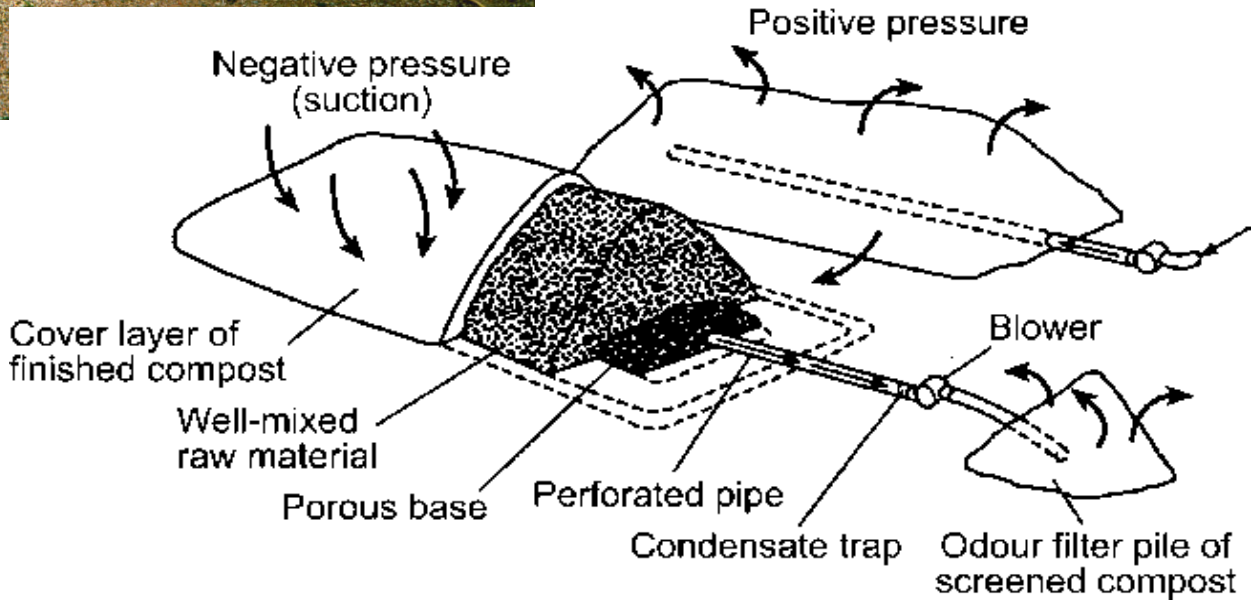
Choosing the Right Composting Methodology

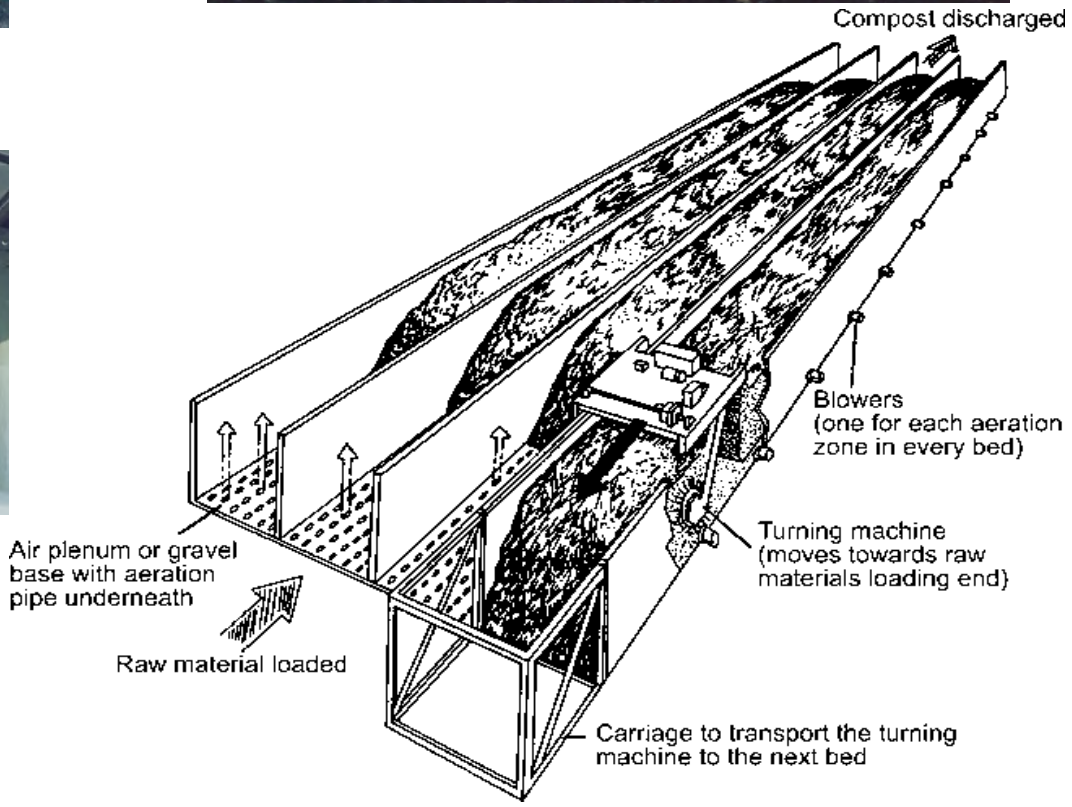
- Aeration
- Mixing
- Size-reduction
- Climate
- Site constraints
- Neighbors
- Cost

Windrow

Static Aerated Piles



In-Vessel


Compost discharged
Blowers
(one for each aeration
zone in every bed)
Turning machine
(moves towards raw
materials loading end)
Air plenum or gravel
base with aeration
pipe underneath
Raw material loaded
Carriage to transport the turning
machine to the next bed

Location Choice

Exclusionary Criteria Matrix

For Compost facilties				Criteria					
Name	Size of Site	Wetlands	Ground Water < 2 ft	Public Wells	Private Wells	Surface Water	Adjacent Facilities	Adjacent Ag-Land	Sensitive Habitat
WWTP south	X	X	X	-	-	-	-	-	-
WWTP north	-	-	-	-	-	-	-	-	-
McGuirk Stadium	X	X	X	-	-	-	-	-	-
Wysocki	-	-	-	-	-	-	-	-	-
Trailer Storage	-	-	-	-	-	-	-	-	-
Governor's Drive	-	-	-	-	-	-	-	-	-
Power Plant west	-	-	-	-	-	-	-	-	-
Power Plant east	-	-	-	-	-	-	-	-	-
Hadley farm	-	X	X	-	-	-	-	-	-
Belchertown	-	-	-	-	-	-	-	-	-
Deerfield	-	-	-	-	-	-	-	-	-

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Preferential Criteria Matrix

For Compost facilties

Name	Criteria							Total
	Traffic Safety	Adjacent Land Use	Visual Buffer	Noise Buffer	Odor Buffer	Wetlands Impact	Floodplain Impact	
WWTP north	3	2	2	2	2	2	2	15
Wysocki	1	2	2	2	2	3	3	15
Trailer Storage	2	3	3	3	3	1	3	**18**
Governors Drive	2	3	2	3	2	3	3	**18**
Old Power Plant west	2	1	2	2	2	3	3	15
Old Power Plant east	2	2	3	3	3	3	3	**19**
Belchertown	2	2	2	3	2	3	3	17
Deerfield	2	2	2	3	2	3	3	17
Existing Compost Site	2	1	3	2	1	3	3	15

Note: This preferential assessment did not take into account cost impacts as a criterion for comparison.

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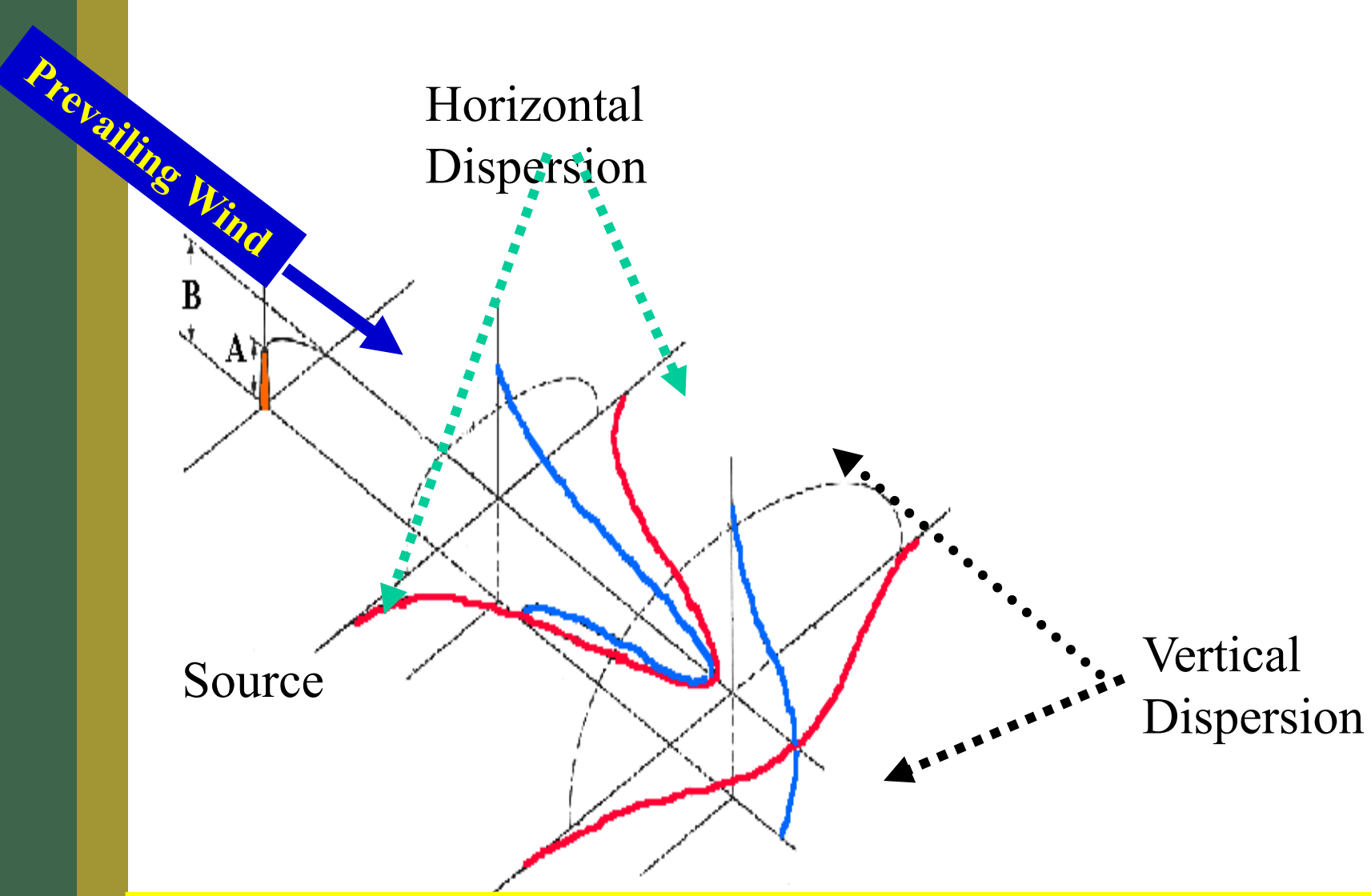

Odor Screening Model

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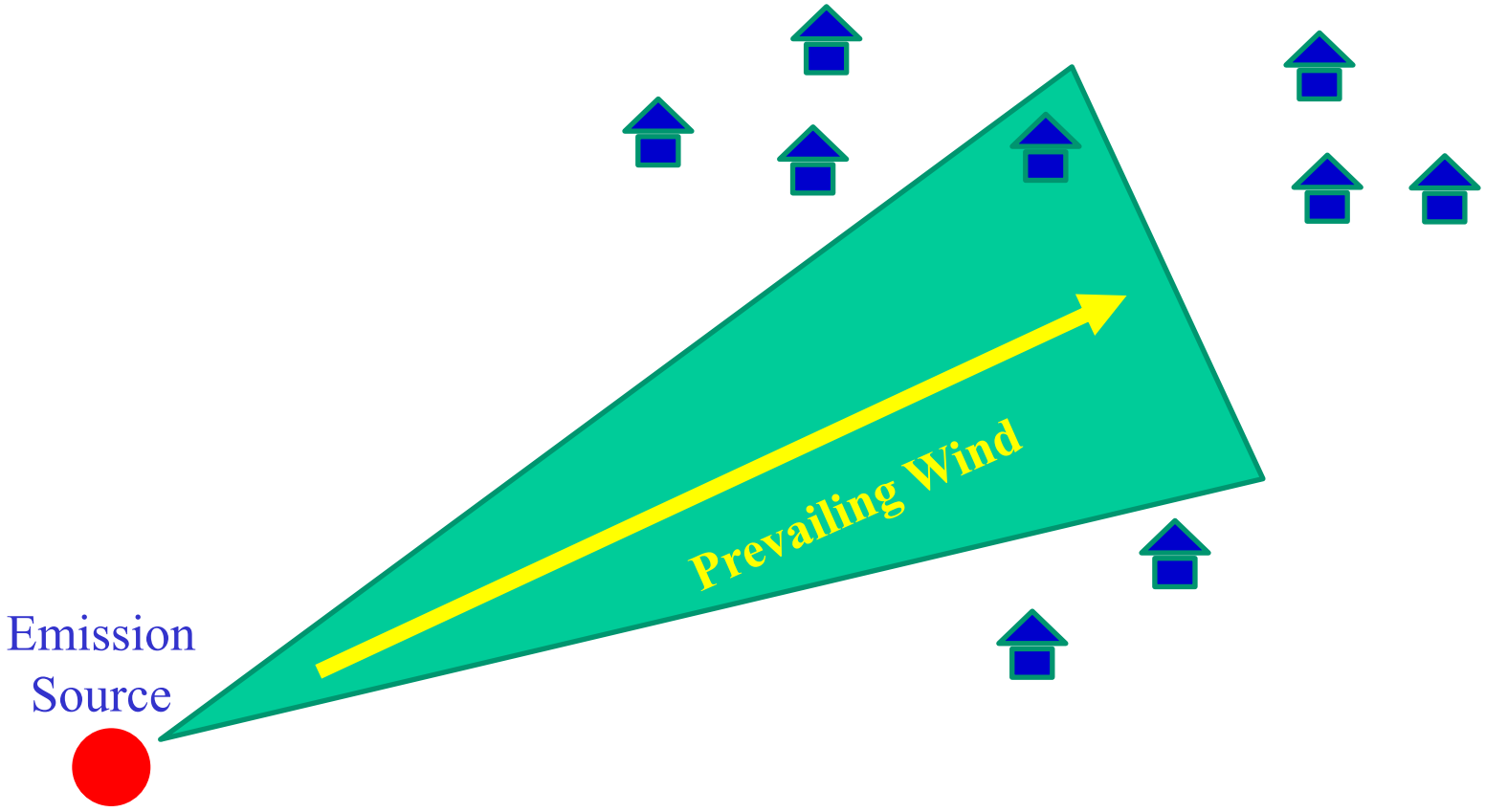
Odor Impact: Sensitive Receptors



= **Sensitive receptor**

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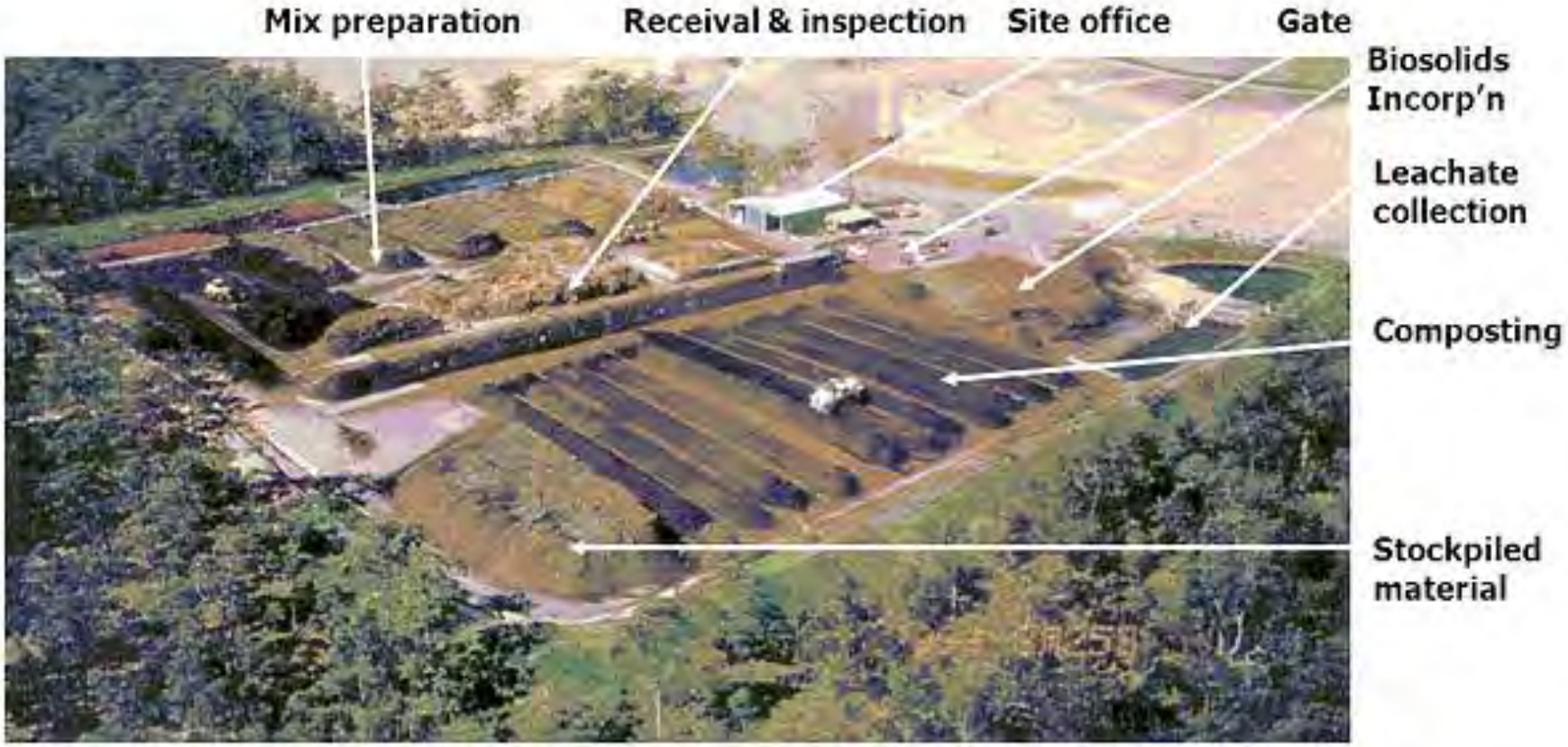
Site Design: **Appropriate Sizing**



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Traditional Community Compost Site Plan

1. Gate & Receiving/Inspection
2. Mix Preparation
3. Composting
4. Curing
5. Screening
6. "Bagging"

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Site Design: **Avoid Standing Water**

Managing the Through-put Rate

The Challenge:
When is the Compost Ready?

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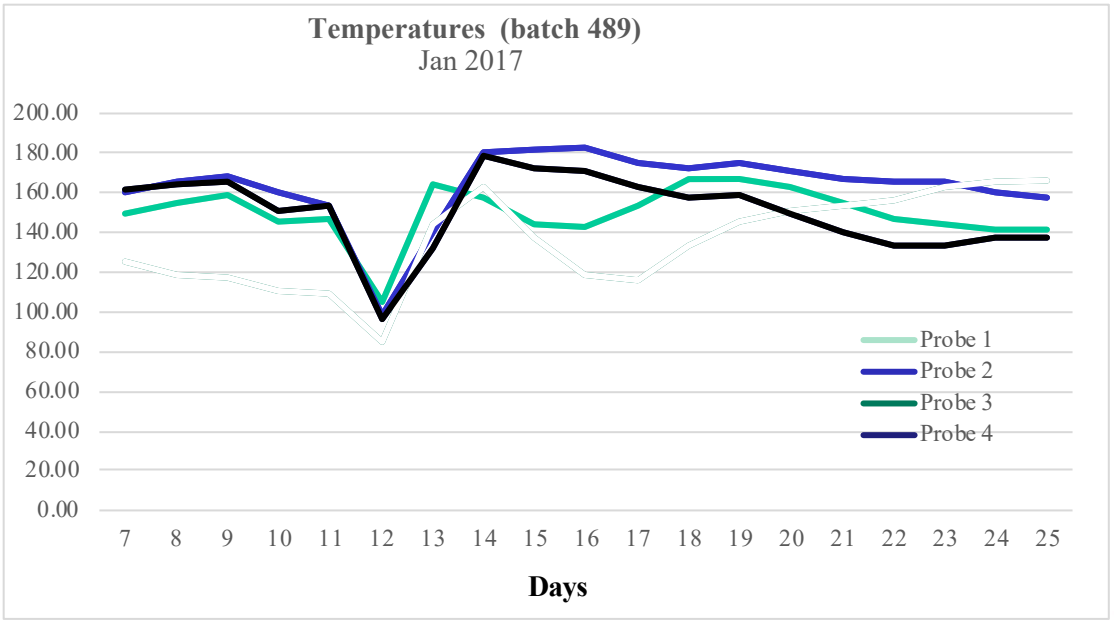
The Need to Monitor



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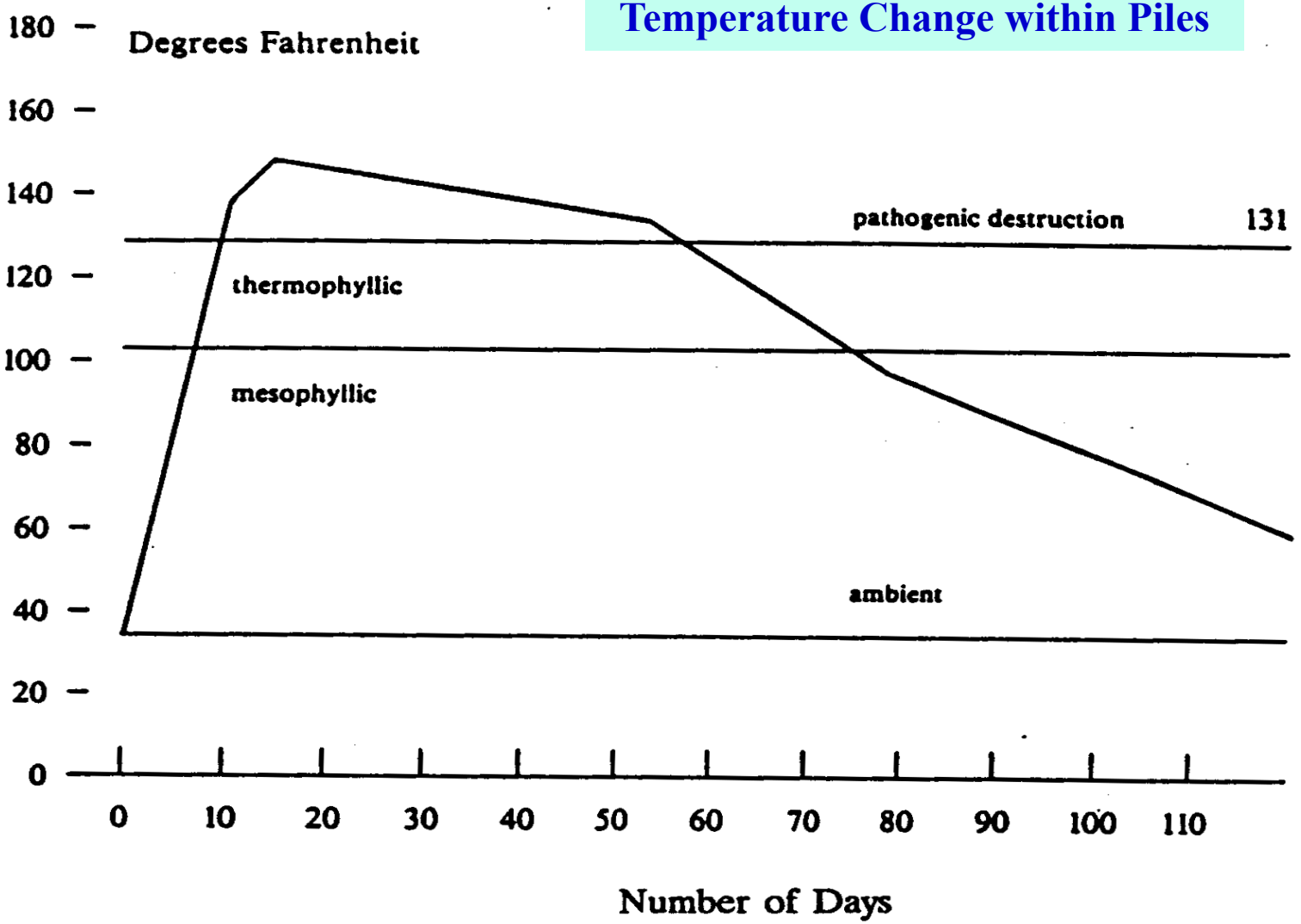
Generic Graphic Representation of Temperature Change within Piles



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The Challenge : Who Will Buy the Compost?

- End Uses
  - ✓Soil Amendment
  - ✓Growing Media Component
  - ✓Blended Topsoil Component
  - ✓Mulch
  - ✓Emerging Uses
- Markets
  - ✓Green Industries
  - ✓Bulk Wholesalers
  - ✓Public Agencies
  - ✓Agriculture
  - ✓Land Restoration

The Challenge : How to Stay Open

- Odor - Cause of Closure of Most Compost Facilities
- Site Constraints - More material throughput then is manageable by site size and compost methodology chosen
- Poor Business Plan - Either undercapitalized and/or product quality did not bring in projected revenue.

The Additional Challenge: Sources of **Carbon**

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Composting is a Controlled Process

MHS & Associates

Not only to decompose and stabilize the food waste,

but also do it in a way that:

MHS & Associates

Kills pathogens.

Avoids environmental & nuisance conditions.

Creates a compost that is safe to handle and use.

Allows for revenues to exceed costs.

The Compost End-Product

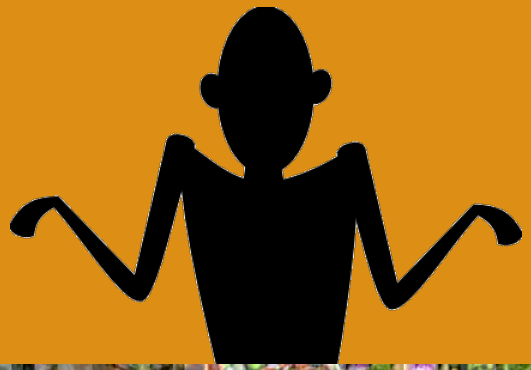
MHS & Associates

MHS & Associates

The quality of the compost end-product makes or breaks the economics of the composting facility…

…which is, in part, by the quality of the food waste being delivered.

Can I Compost?



https://www.theguardian.com/sustainable-business/2017/mar/02/we-grow-it-we-waste-it-we-dump-it-fighting-food-waste-one-click-at-a-time

- At Home?
- At School?
- Are there rules?

Yes!! With Some Rules …….

- Many states support backyard and community composting.
- Schools are beginning to catch on.
- High volume operations require permitting.

https://dgs.dc.gov/page/organics-recycling-program

NRRA Photo

A Word About Meat and Dairy

- There are some fears around composting meats and dairy products, including attracting wild animals, smell and the spread of vectors.
- Meat and dairy may be composted along with other organics in a “hot composting” system that is controlled either in vessel or reaches high enough temperatures for long enough periods.
- Generally not recommended for at home composting systems. [10]
- Commercial operations have the tools and capacity to compost “difficult” organics.

Biocycle.net

Biocycle.net

New Hampshire

- NH bans leaf and yard waste from the landfill but not food waste.
- 260 Permitted Solid Waste Facilities. [1]
- 134 Take Yard Waste. [1]
- 5 Landfills: Some are private
- 5 Permitted Commercial Compost [2] Facilities.

NH Landfills

New Hampshire

3-Tiered System of Certification

1. Permit Exemptions

- No "solid waste"
- No Meat and Dairy
- On-Site, closed to public facilities

Schools and farms allowed to compost on site.

2. Permit By Notification (PbN)

- <30 Tons/ Day
- No Meat or Dairy
- 20% cap on Food Scraps

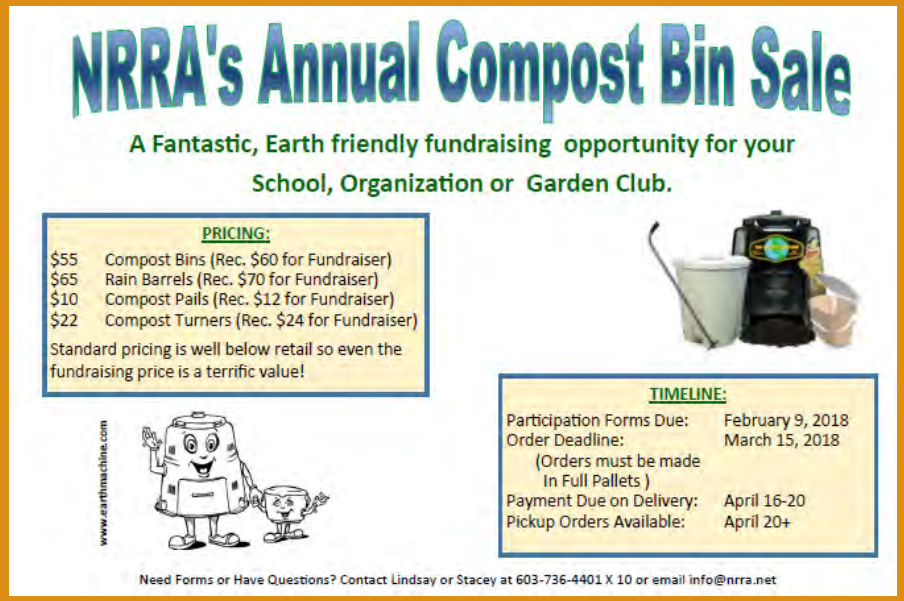
Option # 2 Transfer Station Compost Operation

3. Standard Permit

- >30 Tons/day
- Meat and Dairy Allowed
- Public Hearings, Operating and Closure Plans, etc.

New Hampshire

What to do with organic waste?



- Backyard Composting
- Community Composting (needs permit and permission from NHDES)
- Some Transfer Stations are experimenting with residential drop off (Tier 2!).
- Some towns have residential pick up (Keene, The Seacoast, Upper Valley)

New Hampshire

New Hampshire Department of Environmental Services : Backyard Composting
https://www.des.nh.gov/organization/divisions/waste/swrtas/documents/compost_flier.pdf

NHDES Food Waste Composting Best Management Practices
https://www.des.nh.gov/organization/divisions/waste/swmb/documents/bmp-food-composting.pdf

UNH Cooperative Extension Master Gardener Program
https://extension.unh.edu/programs/new-hampshire-master-gardeners

NRRA School Recycling CLUB
https://www.schoolrecycling.net/resources-new/composting-table-2-farm-programs/

Closing the Food Loop at School: An On-Site School Composting Guide

https://nerc.org/nerc-resources/search-for-resources

- Community Compost Food Scraps Sample Poster
- Community Compost Site Good Neighbor Tips
- Community Composting in Action Webinar Presentation
- Community Composting in NYC Presentation
- Community Composting Success Webinar_ Team Building
- Community Composting Webinar Presentation
- Community Food Scrap Composting Training Presentation
- Community Food Waste Composting Flier Sample

Upcoming Webinars & Workshop

Webinars

- March 19 – *Rethinking Recycling*, 1:30 - 3:00 p.m.
- March 31 – *Best Management Practices for Community Composting*, 1:30 - 3:00 p.m.

Workshop

April 15, *Using Recycled Content in Road & Infrastructure Projects*, Concord, NH

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