Practical Skills
Compost Workshop

Funded By:

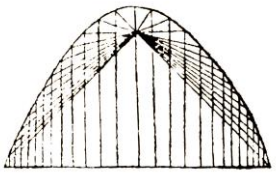
MassDEP

Hosted By:

RECYCLINGWORKS MASSACHUSETTS

CET CENTER FOR ECOTECHNOLOGY

Curriculum Presented by:



Compost Technical Services

Martin's Farm
Compost and Mulch

Workshop Goals:

1. Familiarize participants with the systems and management of a working food scrap composting operation in Massachusetts.
2. Provide hands on experience with compost recipe development, interpretation, blending, and pile formation.
3. Provide hands on experience with compost pile monitoring.
4. Answer questions and facilitate discussion.

Workshop Agenda:

1:40 – 2:00 Review & Intro to Exercises

- Compost Recipe

2:00 – 2:15 Break

2:15 – 2:45 Part 1: Site Tour with Adam Martin

2:45 – 3:45 Compost Recipe Exercise

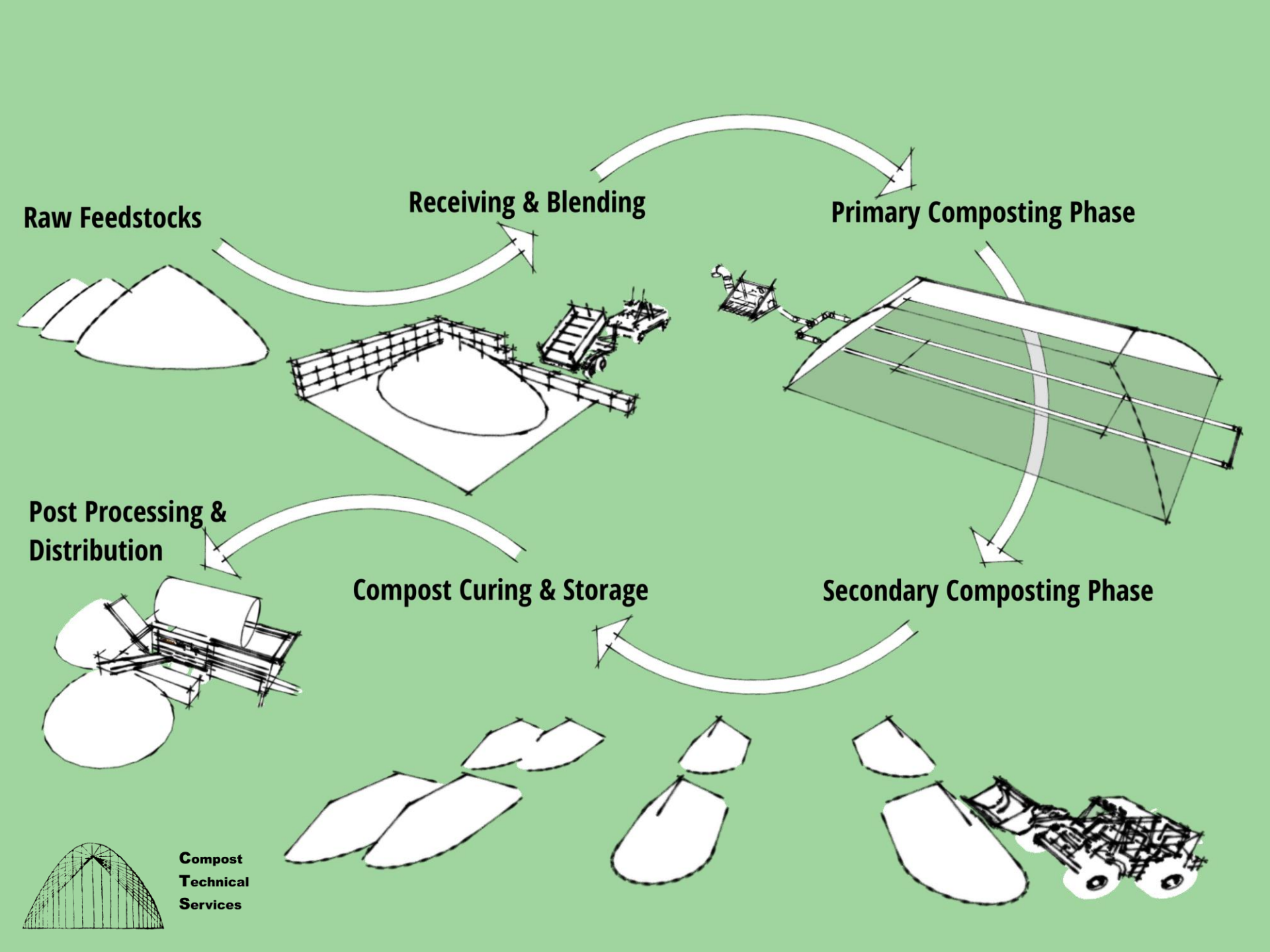
3:45 – 4:30 Site Management & Pile Monitoring Exercise

4:30 - 5:00 Part 2: Site Tour with Adam Martin

Managed Compost

The presence of oxygen *and oxygen loving organisms:*

- **Fast and complete decomposition**
- **Wider ranges of microbiological diversity**
- **Higher Temperatures** *needed to kill pathogens and weed seeds*
- **Minimal odors** *which are primarily caused by anaerobic organisms*


Raw Feedstocks
Receiving & Blending
Primary Composting Phase
Post Processing &
Distribution
Compost Curing & Storage
Secondary Composting Phase
Compost
Technical
Services

Managed Compost

Aerobic 5-15% Oxygen

Semi-Aerobic 2.5-5% Oxygen

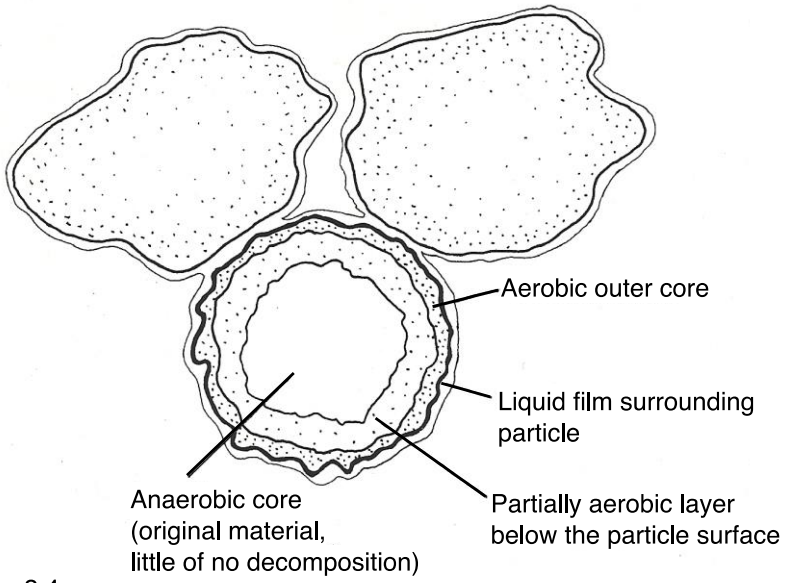


Figure 2.4
Decomposition of solid particles.

The Carbon to Nitrogen Ratio Throughout the Composting Process

- **Support microbial processes effectively**
  - *Carbon Provides Energy*
  - *Nitrogen Builds Proteins*
- **Ideal starting C : N ratio** *is 25 to 30:1 by weight*
- **Carbon Dioxide (CO_2) is released through respiration**
- **C : N ratio reduces** *(12:1-15 : 1 ideally)*

Managed Compost

Hot or Thermophylic

(All material reaches 131 F for a minimum of 3 days)

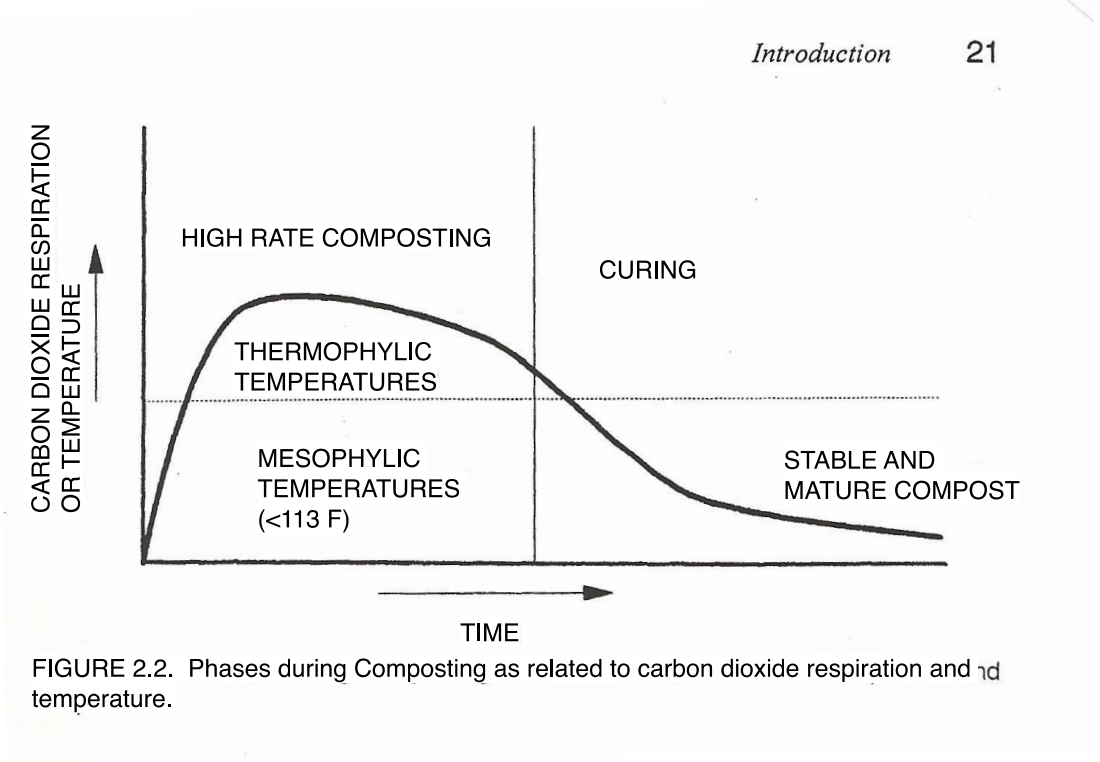


FIGURE 2.2. Phases during Composting as related to carbon dioxide respiration and temperature.

Compost Recipe Development

Do you predict that your recipe will make a good mix when real feedstocks are combined?

Compost Recipe Development

If you already create analytically based recipes at your operation, why do you find it valuable?

If the process is new to you, is this a practice your operation would see value in?

Why use a recipe?

- Create conditions favorable to aerobic and thermophilic organisms
  - Pathogen and weed seed inactivation
- Retention of carbon and nitrogen/nutrients
- Odor mitigation
- Your eyes can't perform chemical analysis
- To be in compliance with State & other regulations
- To have a reference point

Characteristics of a Proper Thermophilic Compost Pile Blend

All Parameters are critical to an effective recipe

- C:N Ratio of 20-40:1 with most ideal being 25-30:1
- Moisture Content of 50-65% with the most ideal being 55-60%
- Bulk Density Below 1200 lbs/yd^3 with ideal being 700-1000 lbs/yd^3
- pH between 6-8
- >40% Volatile Solids (or Organic Matter)
- Pore Space (30-33%) and Material Structure
- Stackability

What the formula won't tell you

Analytically based recipe development and **field evaluation** *of compost mixes go hand in hand.*

Observe "as is" mix characteristics *such as*:

- **Porosity vs Density**
- **Structure and stackability**
- **Readily available carbon**
- **Variable Moisture Content**

Things to watch out for

- Low Carbon availability materials
  - Woody
  - Old
- Larger particles are typically less absorbent
- Unrepresentative samples and book values
- Misleading dry matter readings

LAB ID:	SAMPLE ID:	REPORT DATE:	SAMPLE TYPE:	FEEDSTOCKS	COMPOSTING METHOD	COUNTY
C10487	2018 Mixed Food Scraps-Martin's Farm	05/03/2018	Feedstock			

COMPOST ANALYSIS REPORT

Compost Test 1A

Analyte	Results (As is basis) (Weight basis)	Results (As is basis) (Volume Basis*)	Results (Dry weight basis)
pH	4.9	—	—
Soluble Salts (1:20 w:w)	3.13 mmhos/cm	—	—
Bulk Density*	—	917 lb/yd^3	—
Solids	39.7 %	364 lb/yd^3	—
Moisture	60.3 %	553 lb/yd^3	—
Organic Matter	27.5 %	252 lb/yd^3	69.3 %
Total Nitrogen	1.18 %	11 lb/yd^3	3.0 %
Carbon	14.6 %	134 lb/yd^3	36.9 %
Carbon:Nitrogen Ratio	12.40	—	12.40

LAB ID:	SAMPLE ID:	REPORT DATE:	SAMPLE TYPE:	FEEDSTOCKS	COMPOSTING METHOD	COUNTY
C10484	2018 Cardboard-Martin's Farm	05/03/2018	Feedstock			

COMPOST ANALYSIS REPORT

Compost Test 1A

Analyte	Results (As is basis) (Weight basis)	Results (As is basis) (Volume Basis*)	Results (Dry weight basis)
pH	6.7	—	—
Soluble Salts (1:20 w:w)	1.60 mmhos/cm	—	—
Bulk Density*	—	211 lb/yd^3	—
Solids	37.3 %	79 lb/yd^3	—
Moisture	62.7 %	132 lb/yd^3	—
Organic Matter	34.4 %	72 lb/yd^3	92.2 %
Total Nitrogen	0.50 %	1 lb/yd^3	1.3 %
Carbon	23.7 %	50 lb/yd^3	63.7 %
Carbon:Nitrogen Ratio	48.00	—	48.00

LAB ID:	SAMPLE ID:	REPORT DATE:	SAMPLE TYPE:	FEEDSTOCKS	COMPOSTING METHOD	COUNTY
C10485	2018 Mixed Leaves-Martin's Farm	05/03/2018	Feedstock			

COMPOST ANALYSIS REPORT

Compost Test 1A

Analyte	Results (As is basis) (Weight basis)	Results (As is basis) (Volume Basis*)	Results (Dry weight basis)
pH	5.2	—	—
Soluble Salts (1:20 w:w)	0.06 mmhos/cm	—	—
Bulk Density*	—	27 lb/yd^3	—
Solids	78.1 %	21 lb/yd^3	—
Moisture	21.9 %	6 lb/yd^3	—
Organic Matter	70.5 %	19 lb/yd^3	90.2 %
Total Nitrogen	1.07 %	0 lb/yd^3	1.4 %
Carbon	40.6 %	11 lb/yd^3	52.0 %
Carbon:Nitrogen Ratio	37.80	—	37.80

LAB ID:	SAMPLE ID:	REPORT DATE:	SAMPLE TYPE:	FEEDSTOCKS	COMPOSTING METHOD	COUNTY
C10488	2018 Horse Manure-Martin's Farm	05/03/2018	Feedstock			

COMPOST ANALYSIS REPORT

Compost Test 1A

Analyte	Results (As is basis) (Weight basis)	Results (As is basis) (Volume Basis*)	Results (Dry weight basis)
pH	7.7	—	—
Soluble Salts (1:20 w:w)	0.87 mmhos/cm	—	—
Bulk Density*	—	680 lb/yd^3	—
Solids	41.6 %	283 lb/yd^3	—
Moisture	58.4 %	397 lb/yd^3	—
Organic Matter	27.1 %	184 lb/yd^3	65.2 %
Total Nitrogen	0.17 %	1 lb/yd^3	0.4 %
Carbon	15.6 %	106 lb/yd^3	37.6 %
Carbon:Nitrogen Ratio	89.90	—	89.90

Enter Data From Analysis

Calculated

Material	Cubic Yards Material	Moisture Content (%)	Total Carbon (% Dry Weight)	Total Nitrogen (% Dry Weight)	Bulk Density (Lbs/CY)	Carbon : Nitrogen Ratio	Material Weight (Lbs)	Notes
Food Scraps #1	0.0	60.3	36.9	3	917	12	0	MF Analysis 5/3/18 (Low Moisture)
Food Scraps #2	1.0	75	36.9	3	917	12	917	Same Analysis (Higher Moisture)
Fresh Grass	0.0	89.7	36.5	4.8	80	8	0	MF Analysis 5/3/18
Wood Chips	0.0	58.6	51	0.3	610	170	0	MF Analysis 5/3/18 (mostly softwood)
Horse Manure	1.0	58.4	37.6	0.40	680	94	680	MF Analysis 5/3/18
Shredded Cardboard (from food scraps)	4.0	62.7	63.7	1.3	211	49	844	MF Analysis 5/3/18 (delivered in food scraps)
Mixed Leaves	10.0	21.9	52	1.4	27	37	270	MF Analysis 5/3/18
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Recipe Parameter	Results	Ideal Range	Reasonable Range
Carbon:Nitrogen Ratio	33	25-30	20-40
Moisture Content (%)	62	55-60%	40-65%
Bulk Density (Lbs/ CY)	169	≤1000	≤1200

Continue a pattern into adjacent cells

Enter Data From Analysis

Calculated

Material	Cubic Yards Material	Moisture Content (%)	Total Carbon (% Dry Weight)	Total Nitrogen (% Dry Weight)	Bulk Density (Lbs/CY)	Carbon : Nitrogen Ratio	Material Weight (Lbs)	Notes
Food Scraps #1	0.0	60.3	36.9	3	917	12	0	MF Analysis 5/3/18 (Low Moisture)
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Wood Chips	1.0	58.6	51	0.3	610	170	610	MF Analysis 5/3/18 (mostly softwood)
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						#DIV/0!	0	
						#DIV/0!	0	
						#DIV/0!	0	
						#DIV/0!	0	

Recipe Parameter	Results	Ideal Range	Reasonable Range
Carbon:Nitrogen Ratio	40	25-30	20-40
Moisture Content (%)	61	55-60%	40-65%
Bulk Density (Lbs/ CY)	195	≤1000	≤1200

MANAGE FOOD SCRAPS FOR MOISTURE

- Often ≥80% Moisture Content
- As cell walls break down moisture is released
- Typically require 3-5 Units of carbon/dry matter to balance the recipe

FOOD SCRAP HAVE VARIABLE BULK DENSITY

- ~1,000 Pounds/Yard^3 as collected
- ≥1,200 Pounds/Yard^3 at site following tipping
- Wash water adds weight
- Paper products add bulk
- To test BD: fill ½ a 5 g bucket & drop 10x > fill ½ & drop 10x ≥ fill full & drop 10x > Fill Full. BD = weight X 40

Compost Pile Monitoring

Temperature
Moisture Content
Visual Observations
Olfactory Observations (Smells)
Management Activity

EACH COMPOST PILE SHOULD BE TRACKED THROUGHOUT THE PROCESS

Resource List

Books/Publications:

- BioCycle Magazine. *BioCycle.com*
- Paul, J & Geesing, D. Compost Facility Operator Manual. *Available through BioCycle.com*
- Rynk, R. The On-Farm Composting Handbook. *NRAES 54*. 1992.
- Dougherty, M. Field Guide To On-Farm Composting. *NRAES 114*. 1999.
- Alexander, R. The Practical Guide to Compost Marketing & Sales. *2010.*

Resource List

Free On-line Resources:

- Leaf & Yard Waste Composting Guidance Document. MA DEP. http://www.mass.gov/eea/docs/dep/recycle/reduce/06-thru-l/leafguid.pdf
- Guide to Agricultural Composting. MDAR. *2010http://www.mass.gov/eea/docs/agr/programs/compostguidetoagcomposting2011.pdf*
- Highfields Center for Composting Video Series – Recipe Development, Pile Monitoring & Turning, School Training – https://vimeo.com/highfieldscomposting
- Vermont Agency of Natural Resources Composter Resources – Developed by CTS. Site Planning & Management, School Composting, School Curriculums http://www.anr.state.vt.us/dec/wastediv/compost/resources.htm
- Online Materials Management & Tracking Tool http://goo.gl/7dqsZh

Resource List

Free On-line Resources:

- RecyclingWorks Source-Separation BMPs: http://www.recyclingworksma.com/local-health-department-guidance-for-commercial-food-waste-separation/
- MassDEP: http://www.mass.gov/eea/agencies/massdep/recycle/reduce/composting-and-organics.html