# Evaluation of Advanced Composting Technology's Enhanced Forced Aeration Composting System Complimented with Grinder/Mixer System

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Animal and Poultry Waste Management Center, North Carolina State University

***Abstract:*** *On farm composting of animal mortality is becoming more popular for economic, bio-security related, and nutrient recovery based reasons. There are several different technologies and methods available for composting animal mortality. This research will focus on a combination of forced air bin and static pile composting. These methods combined with a mixer/grinder system make up Advanced Composting Technology's (ACT) current system. For this evaluation the ACT system was operated within the guidelines provided for NRCS NC approval and ACT protocol (See Appendix A). A commercial broiler farm as well as a commercial sow farm were selected for ACT technology evaluation. Both farms use ACT grinding/mixing equipment to combine mortality with an appropriate carbon source prior to composting. Temperatures were recorded at both farms as the compost went through two heat cycles. The first cycle of 15 days for swine and 11 days for broilers were subject to forced aeration. The second cycle of 14 days for swine and 7 days for broilers were subject to static conditions in a pile. These evaluation times were based on reduction percentage compared to traditional static pile composting. In addition to the North Carolina State University monitored compost cycles, data and samples were collected from the recently completed compost cycles managed by the farm independently. Sample were collected and analyzed for nutrient, heavy metals, and pathogen reduction analysis. The ACT technology readily satisfies the requirements of NRCS Conservation Practice Standard (CPS) Code 316 at both of the evaluation sites.*

Composting is a natural biological process where organic matter decomposes into a nutrient rich, humus like material. The bacteria that drive the composting process require certain conditions to properly thrive; three of the most important being moisture, organic material with the proper composition of carbon and nitrogen, and oxygen. If any of these three conditions are not optimal, then the composting process is limited and/or stops. As the bacteria actively break down organic matter they generate heat, this heat is crucial for proper pathogen control that is needed for safe application and usage of mortality based compost. The United States Department of Agriculture (USDA) has criteria for composting systems to ensure properly finished compost. The criteria that apply to this evaluation of the technology come from the NRCS CPS Code 316. The evaluation focused on two provisions of the Standard; verifying that no visible pieces of soft tissue

are to be present in the finished compost and that the temperature be maintained at greater than 130F for at least 5 days as an average through the compost mass followed by a compatible time and temperature for secondary composting stage.

## Materials and Methods

### Evaluation Sites

The evaluation was conducted at two separate sites. The first site was at a contract sow farm in Walstonburg, Greene County, NC. Average ambient temperatures in this area were 90F during the day and 68F at night in this area during the time of the evaluation. The average elevation above sea level for this area is 111 feet. Temperature recordings for this evaluation were started on August 7th, 2018 and continued through September 5th, 2018 (Figures 1 and 2). Site number two was conducted at a commercial broiler facility located in Broadway, Lee Country, NC. Average ambient temperatures in this area were 82F during the day and 59F at night in this area during the time of the evaluation. Temperature recordings for this evaluation began on September 10th, 2018 and ended on October 2nd, 2018 (Figures 3 and 4). The average elevation above sea level for this area is 492 feet.

### Evaluation Design

Both evaluation sites were equipped with Advanced Composting Technology's (ACT) forced air bins and grinding/mixer systems. The first site was a commercial sow farm and the second site was a commercial broiler farm operation. The system includes grinding/mixing equipment, four composting bins capable of holding 12,000 pounds each, the capability for secondary treatment, and the ability for 60 days of storage. The entire system has a concrete floor and is under roof. At each site daily mortality was loaded into the grinder/mixer on a weight based mixture of 3:2:1 with bulking material/carbon source and finished (hot) compost material (See Appendix A and F). For both evaluations the bulking/carbon material consisted of fresh pine shavings. The grinder/mixer's intended purpose is to decrease overall mortality particle size and thoroughly mix in the carbon material. For any material to be composted, this grinding/mixing procedure occurs only once, as one of the earlier steps in the ACT composting process. Following this process the material mix is loaded, using a tractor mounted front end loader, into one of the forced air compost bins. The material is capped with a carbon material in a depth appropriate for covering any flesh. This cap is critical for vector and odor control. The material then composts while having air forced throughout from perforated pipes in the floor. This is called the primary composting process. ACT's protocol for the swine farm calls for this process to run for the duration of 14 days (See Appendix A) with temperatures recorded at depths of 6, 20, and 40 inches (Figure 5). One temperature probe is placed directly in the center on the bin with the other two equally apart on opposite sides, being sure to have at least 12" distance between the concrete wall and the probe. To minimize travel and scheduling conflicts swine compost material was actually held in the primary bin for 15

days prior to being moved to the secondary treatment area.

The secondary treatment uses static air composting as the material is formed into a pile (Figure 6). The shape of the compost pile creates a condition where the chimney effect pulls cooler, oxygen rich air from the sides and the bottom of the pile. As the bacteria driving the composting process generates heat, the warmer moist air exits through the top of the pile. A compost piles health and performance can quickly be determined with temperature measurements. This secondary treatment process was recorded for 14 days with temperatures taken at depths of 18 and 36 inches (Figure 6). The top dressing of carbon (carbon cap) is included in all temperature probe depth measurements.

The system evaluation at the poultry farm used similar protocol with the exception that per ACT's protocol, the compost time for temperatures for each stage were adjusted to 11 days for primary and 11 days for secondary stage. The one time grinding/mixing, placement of the temperature probes, and sampling methods are all identical to the methods disclosed for the evaluation at the swine farm.

Due to the impacts of Hurricane Florence and access to the farm, the poultry compost remained in the primary bin for 16 days rather than the specified 11 days prior to being moved to the secondary compost area for an additional 7 days. The mortality is mixed at the same ratio and loaded into the forced air bin. The material is then recorded for temperature at depths of 6, 20, and 40 inches for primary composting stage. The compost was moved for secondary treatment in a similar manner, using static air with the compost being formed into a pile on the concrete pad, under shelter. The temperature is then recorded for the secondary composting stage at depths of 18 and 36 inches. Farmer records at both sites were collected to verify acceptable performance from previous farm managed compost bins.

**Sample and Data Collection**

The final product from both evaluations were inspected for any visible soft tissue. Temperatures were recorded to ensure that USDA NRCS, CPS criteria from Animal Mortality Facility Code 316 were met. This criteria requires that the composting facility will have the capacity to maintain compost temperatures of 130F or greater for at least 5 days as an average throughout the compost mass followed by a compatible time for secondary composting. Temperatures were logged using Watchdog Series 1000 data logging equipment. The data loggers had the capability to record multiple temperatures using probes placed at desired depths. The loggers also have the ability to record relative humidity as well as ambient temperatures. After the desired time and temperature recordings the data is able to be downloaded from the loggers to a computer for farther analysis. Compost samples were taken throughout the process to be analyzed for nutrient content, heavy metals, and confirmation of pathogen reduction. Samples were taken from several locations of the compost bin or pile then mixed to ensure representative sampling. Any specific lab recommendation or guidelines were strictly followed. North Carolina Department of Agriculture labs were used for nutrient analysis and A&L

Great Lakes Laboratories were used for heavy metal and pathogen reduction testing.

## Results

During both evaluations mixer/grinder systems were observed being loaded with farm mortality, carbon material, and finished compost using a front end loader tractor. Farmer records and visual loading confirm bin capacity of 12,000 pounds when bins are loaded to operational levels. During the evaluations it was noted that there was no need for additional measures for leachate capture or control. There was no visible leachate noted during the primary or secondary composting stages.

### Time and Temperature

The primary and secondary composting masses more than exceeded NRCS-CPS Code 316 guidelines for time and temperature. Figure 1 shows temperature recordings from the primary composting bin during the swine farm evaluation. Figure 2 shows the temperature recordings from the secondary composting static pile during the swine farm evaluation. The swine primary bin from this evaluation measured an average temperature of 144.9F over 15 days of monitoring. The secondary composting stage of this evaluation met NRCS requirements as well by averaging 140.8F over the 14 days of monitoring. Figure 3 shows the primary bin temperatures from the poultry from evaluation. Figure 4 shows the secondary static compost temperatures from the poultry evaluation. The primary bin from the poultry farm evaluation also met NRCS requirements by having an average temperature of 155.8F over 16 days of monitoring. The poultry secondary static compost stage was shorted to 7 days in order to meet the objective for a total of 22 days of compost per ACT's protocol. The secondary compost also met the temperature requirements with an average of 151.6F over the 7 day monitoring period.

### Heavy Metals and Pathogen Reduction

Samples were taken from both evaluation sites and sent to A&L Great Lakes laboratories for analysis on heavy metal levels and pathogen reduction. Samples results from the monitored finished poultry compost can be seen in appendix C. The farmer managed poultry compost results can be seen in appendix B. The monitored swine compost results can be seen in appendix E. The farmer managed swine compost results can be seen in appendix D. The monitored and farmer managed finished compost from the swine and poultry evaluation sites were analyzed using the EPA 503 Metals Limits method/standard and passed. All finished compost from both poultry and swine sites were also analyzed for pathogen reduction using the 40 CFR 503 Class A Compost method/standard. For the purposes of this evaluation, this standard states that compost/bio-solids can only be classified as Class A material if Fecal Coliform density is less than 1,000 Most Probable Number (MPN) per gram of total dry solids (1,000 MPN/g TS) and has been treated based on time and temperature requirements described early. All finished compost passed with all showing less than 2 MPN/g dry of Fecal coliform. This is the lowest detection value capable of being recorded for this Analysis Method.

Figure 1

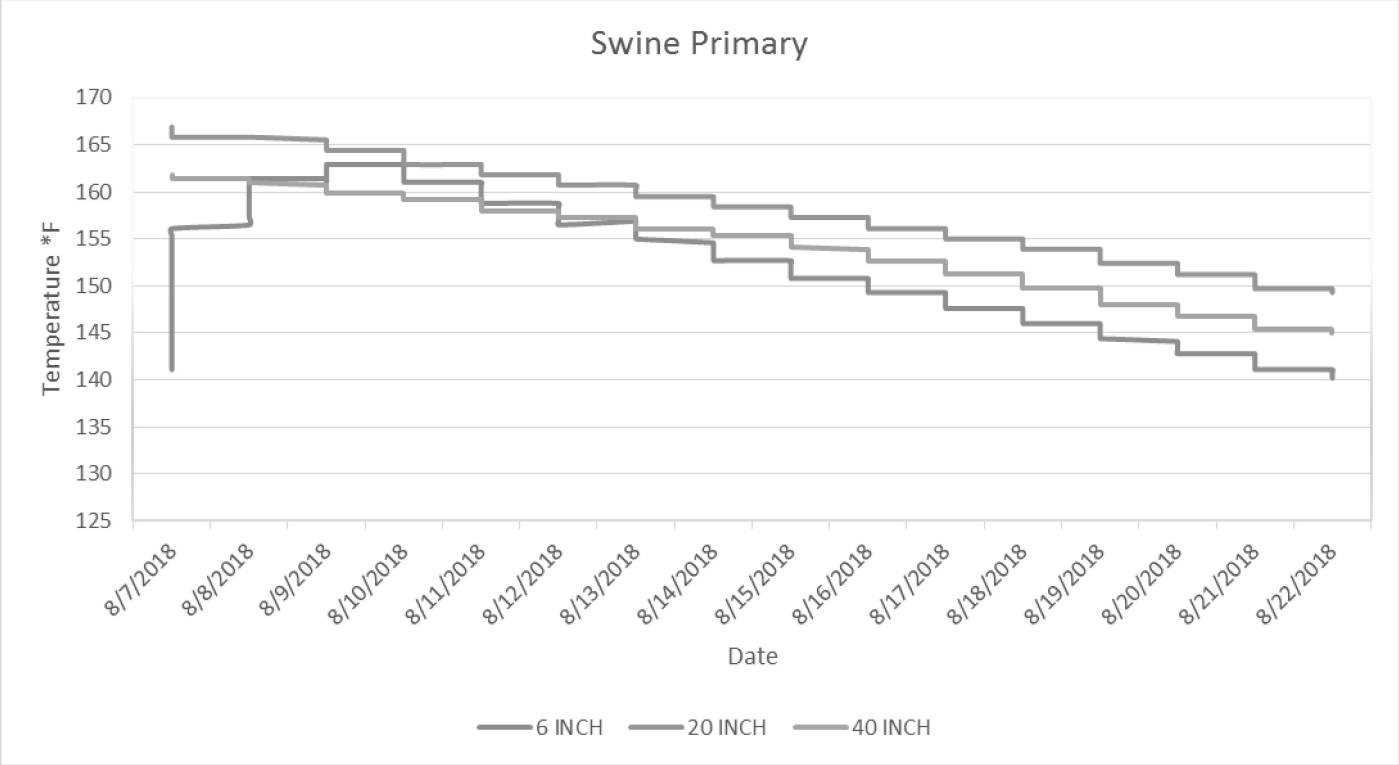


Figure 2

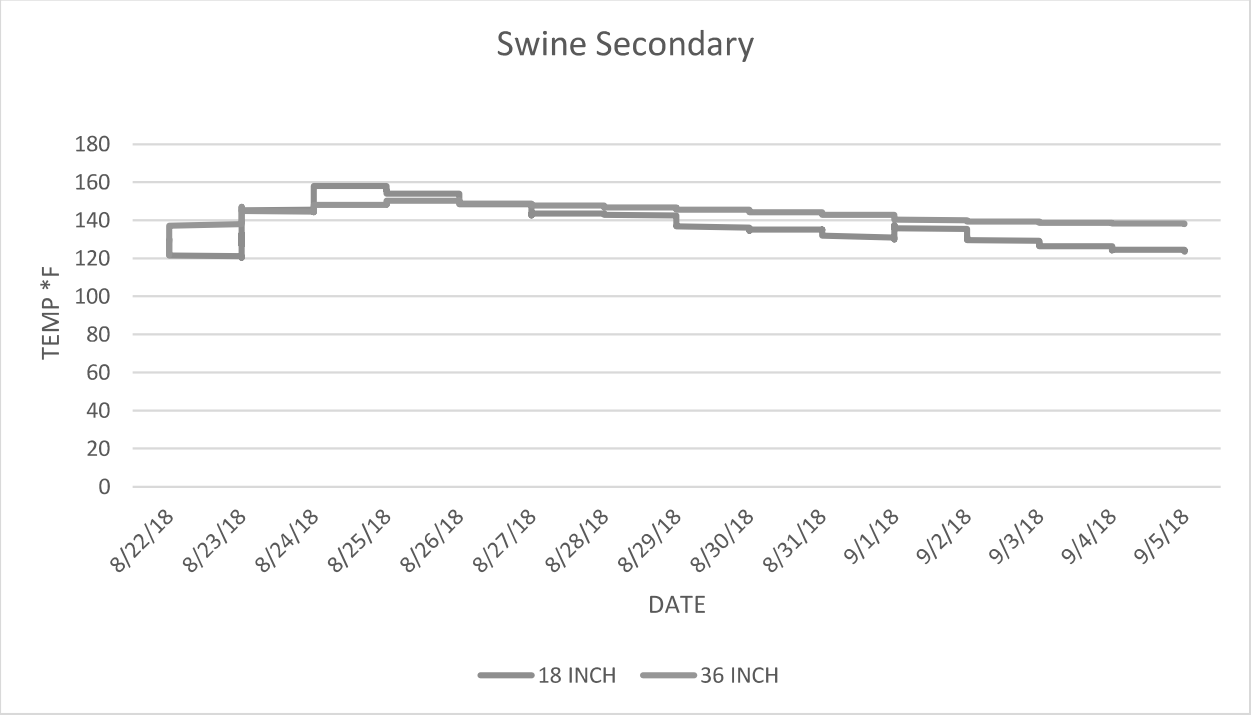

Figure 3

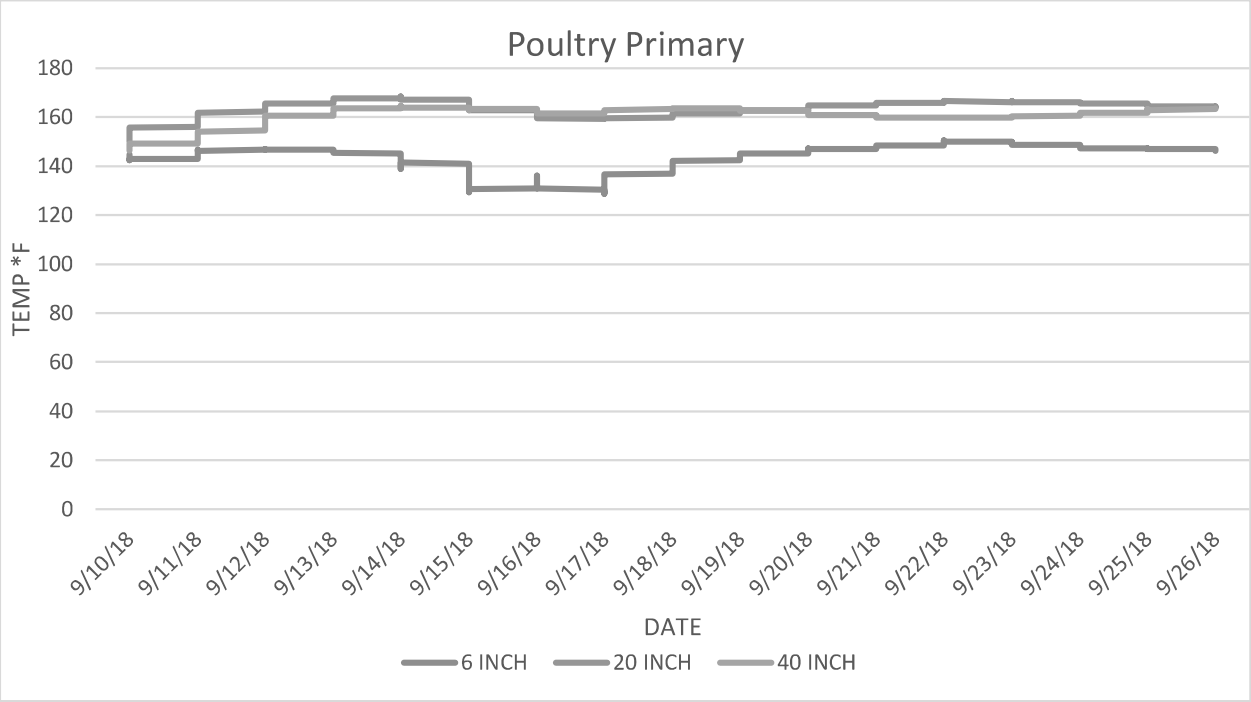


Figure 4

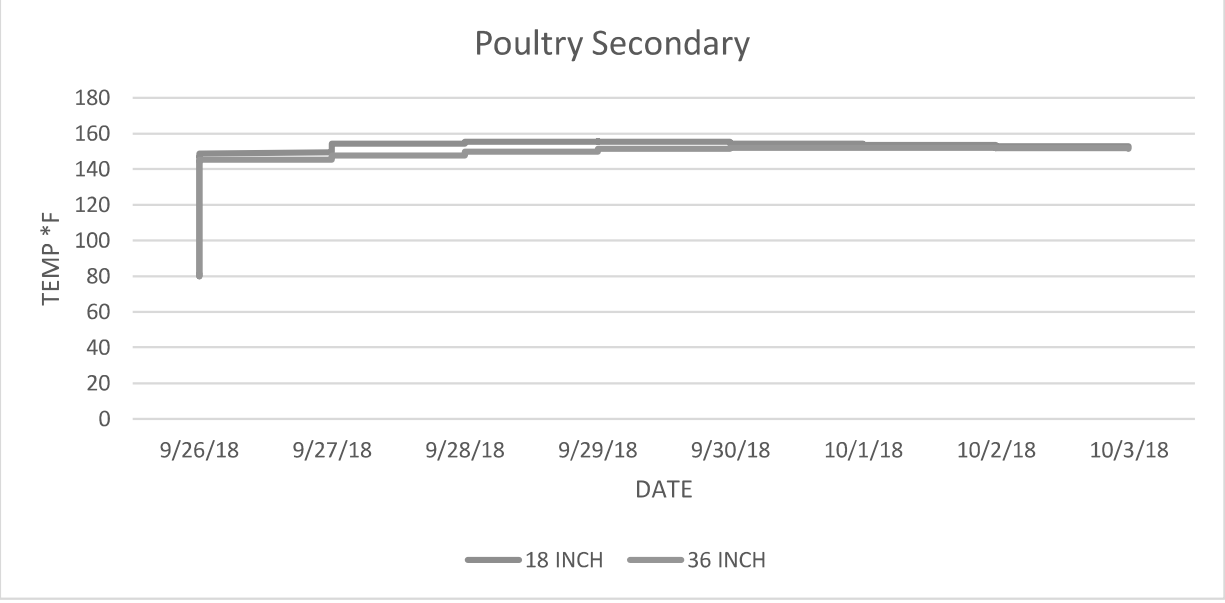

Figure 5 Primary Composting Temperature Probe Placement


Figure 6 Secondary Composting Temperature Probe Placement

Appendix A

*NRCS NC Approval for*

*Advanced Composting Technology's*
*Enhanced Forced Aeration Composting System*

The enhanced systems will consist of:

1. Mixer/grinder (specifically designed to process animal mortality) used on the front-end to mix and process the mortality, carbon material (bulking agent), and compost (hot) material, on a weight based mixture of 3:2:1. The mixer and unloading area will be under a roof.
2. Composter bin mortality loading rate of 12,000 pounds. (traditional system = 10,000 pounds)
3. Reduce composting treatment cycle time:
    a. Sow operations – 17 days primary & 16 days secondary (traditional system – 40 days P & 40 days S)
    b. Swine finishing - 14 days primary & 14 days secondary (traditional system – 35 days P & 35 days S)
    c. Swine nursery – 11 days primary & 10 days secondary (traditional system - 30 days P & 15 days S)
    d. Broiler - 11 days primary & 11 days secondary (traditional system - 30 days P & 20 days S)-
    e. Tom Turkey - 17 days primary & 16 days secondary (traditional system - 45 days P & 20 days S)
    f. Hen Turkey – 14 days primary & 14 days secondary (traditional system - 40 days P & 15 days S)
4. Elimination of the mechanical leachate collection system. (traditional system – required)

5. Using static bin rather than forced air in the secondary treatment phase. (Will offer secondary bin force air as an option for large swine operations) (traditional system – forced air in all bins)
6. Extend treatment bin from 12’ to 15’ but keep same storage volume (684cf) and installation of a gate rather than heavy bin doors.
7. Concrete bin walls.
   (Will offer wood walls as an option for swine nursery and broiler operations)
8. An 18” filter (bedding) is to be used in the primary treatment bins. (traditional system – 12” bedding)
9. Maintaining 60 days storage area.
   (Considered also tertiary treatment area for larger animals)
10. O&M Plan will be revised to reflect these changes and have specific instructions, by animal type, for type of litter, amount of sawdust, loading rate, mixing time and bin preparation.

Appendix B Finished Compost Results from Poultry Farmer Monitored Bin

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COPY: 919-921-1245

Purchase Order: 277-6511
Date Sampled: 10/3/2018
Date Received: 10/4/2018
Date Reported: 10/17/2018 Page: 1 of 6

Sample ID: ACT POULTRY BIN 2
Lab Number: 11828

## COMPOST ANALYSIS

| Analysis | Unit | Analysis Result | Dry Basis Result | Analysis Method |
|---|---|---|---|---|
| Moisture @ 70 C | % | 50.86 | | TMECC 03.09-A |
| Solids | % | 49.14 | | TMECC 03.09-A |
| Total Nitrogen (N) | % | 1.69 | 3.44 | TMECC 04.02-D |
| Phosphorus (P) | % | 0.33 | 0.67 | TMECC 04.03-A |
| Phosphate ($P_2O_5$) | % | 0.76 | 1.53 | TMECC 04.03-A |
| Potassium (K) | % | 0.32 | 0.65 | TMECC 04.04-A |
| Potash ($K_2O$) | % | 0.38 | 0.78 | TMECC 04.04-A |
| Magnesium (Mg) | % | 0.03 | 0.07 | TMECC 04.05-MG |
| Calcium (Ca) | % | 0.44 | 0.89 | TMECC 04.05-CA |
| Arsenic | mg/kg | < 0.242 | < 0.492 | US EPA SW846-6020 |
| Cadmium | mg/kg | < 0.242 | < 0.492 | US EPA SW846-6020 |
| Chromium | mg/kg | 0.71 | 1.45 | US EPA SW846-6020 |
| Copper | mg/kg | 7.2 | 14.6 | US EPA SW846-6010C |
| Mercury | mg/kg | < 0.281 | < 0.571 | US EPA SW846-6020 |
| Molybdenum | mg/kg | < 0.261 | < 0.531 | US EPA SW846-6020 |

TMECC - Test Methods for the Examination of Composting and Compost (TMECC), The U.S. Composting Council.

-COMPOST

Report Approved By: Greg Neyman - Vice President / COO

Approval Date: 10/17/2018

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Date Sampled: 10/3/2018
Date Received: 10/4/2018
Date Reported: 10/17/2018 

Sample ID: ACT POULTRY BIN 2
Lab Number: 11828

## COMPOST ANALYSIS

| Analysis | Unit | Analysis Result | Dry Basis Result | Analysis Method |
|---|---|---|---|---|
| Nickel | mg/kg | 0.265 | 0.539 | US EPA SW846-6020 |
| Lead | mg/kg | < 0.300 | < 0.610 | US EPA SW846-6020 |
| Selenium | mg/kg | < 0.56 | < 1.14 | US EPA SW846-6020 |
| Zinc | mg/kg | 20.5 | 41.7 | US EPA SW846-6010C |
| 503 Metals PASS/FAIL | pass/fail | | PASS | EPA 503 Metal Limits |
| pH | - | 7.6 | | TMECC 04.11-A |
| Soluble Salts | dS/m | 12.40 | | TMECC 04.10-A |
| Fecal Coliform/MPN | MPN/g dry | | < 2 | SM(20th)-9221E TMECC |
| Pathogen Reduction - PASS/FAIL | pass/fail | | PASS | 40 CFR 503 Class A Compost |
| Ash @ 550 C | % | 2.24 | 4.56 | TMECC 03.02-B |
| Organic Matter (LOI @ 550 C) | % | 46.90 | 95.44 | TMECC 05.07-A |
| Total Organic Carbon (C) | % | 23.45 | 47.72 | TMECC 04.01-A |
| Carbon:Nitrogen Ratio (C:N) | - | 13.9:1 | 13.9:1 | TMECC 05.02-A |
| Foreign Material | % | | 0.00 | TMECC 03.08-A |
| Germination - Emergence | % | 0.0 | | TMECC 05.05-A |

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Date Received: 10/4/2018
Date Reported: 10/17/2018 

Sample ID: ACT POULTRY BIN 2
Lab Number: 11828

## COMPOST ANALYSIS

| Analysis | Unit | Analysis Result | Dry Basis Result | Analysis Method |
|---|---|---|---|---|
| Germination - Vigor | % | 0.0 | | TMECC 05.05-A |
| Ave Ht of Seedlings in Control | centimeters | 7.4 | | TMECC 05.05-A |
| Ave Ht of Seedlings in Compost | centimeters | 0.00 | | TMECC 05.05-A |
| Respiration - CO2-C/g TS | mg CO2-C / g TS/Day | | 1.1 | TMECC 05.08-B |
| Respiration - CO2-C/g OM | mg CO2-C / g OM/Day | | 0.5 | TMECC 05.08-B |
| Compost Stability Index | - | | Very Stable | TMECC 05.08 |
| Retained on U.S. 2-inch Sieve | % | | 0.00 | TMECC 02.02-B |
| Retained on U.S. 1-inch Sieve | % | | 0.00 | TMECC 02.02-B |
| Retained on U.S. 5/8-inch Sieve | % | | 1.56 | TMECC 02.02-B |
| Retained on U.S. 3/8-inch Sieve | % | | 7.37 | TMECC 02.02-B |
| Retained on U.S. 1/4-inch Sieve | % | | 4.06 | TMECC 02.02-B |
| Retained on U.S. 5/32-inch | % | | 6.12 | TMECC 02.02-B |

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# Appendix C Finished Compost Results from NCSU Monitored Poultry Bin

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Purchase Order: 277-6511
Date Sampled: 10/3/2018
Date Received: 10/4/2018
Date Reported: 10/17/2018 Page: 4 of 6

Sample ID: ACT POULTRY BIN 3
Lab Number: 11829

## COMPOST ANALYSIS

| Analysis | Unit | Analysis Result | Dry Basis Result | Analysis Method |
|---|---|---|---|---|
| Moisture @ 70 C | % | 48.94 | | TMECC 03.09-A |
| Solids | % | 51.06 | | TMECC 03.09-A |
| Total Nitrogen (N) | % | 1.90 | 3.72 | TMECC 04.02-D |
| Phosphorus (P) | % | 0.22 | 0.44 | TMECC 04.03-A |
| Phosphate ($P_2O_5$) | % | 0.52 | 1.01 | TMECC 04.03-A |
| Potassium (K) | % | 0.32 | 0.62 | TMECC 04.04-A |
| Potash ($K_2O$) | % | 0.38 | 0.74 | TMECC 04.04-A |
| Magnesium (Mg) | % | 0.03 | 0.06 | TMECC 04.05-MG |
| Calcium (Ca) | % | 0.28 | 0.55 | TMECC 04.05-CA |
| Arsenic | mg/kg | < 0.252 | < 0.494 | US EPA SW846-6020 |
| Cadmium | mg/kg | < 0.252 | < 0.494 | US EPA SW846-6020 |
| Chromium | mg/kg | 0.71 | 1.39 | US EPA SW846-6020 |
| Copper | mg/kg | 5.9 | 11.6 | US EPA SW846-6010C |
| Mercury | mg/kg | < 0.293 | < 0.573 | US EPA SW846-6020 |
| Molybdenum | mg/kg | < 0.273 | < 0.534 | US EPA SW846-6020 |

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Purchase Order: 277-6511
Date Sampled: 10/3/2018
Date Received: 10/4/2018
Date Reported: 10/17/2018 

Sample ID: ACT POULTRY BIN 3
Lab Number: 11829

## COMPOST ANALYSIS

| Analysis | Unit | Analysis Result | Dry Basis Result | Analysis Method |
|---|---|---|---|---|
| Nickel | mg/kg | < 0.262 | < 0.514 | US EPA SW846-6020 |
| Lead | mg/kg | < 0.313 | < 0.613 | US EPA SW846-6020 |
| Selenium | mg/kg | < 0.59 | < 1.15 | US EPA SW846-6020 |
| Zinc | mg/kg | 23.5 | 46.1 | US EPA SW846-6010C |
| 503 Metals PASS/FAIL | pass/fail | | PASS | EPA 503 Metal Limits |
| pH | - | 6.5 | | TMECC 04.11-A |
| Soluble Salts | dS/m | 11.85 | | TMECC 04.10-A |
| Fecal Coliform/MPN | MPN/g dry | | < 2 | SM(20th)-9221E TMECC |
| Pathogen Reduction - PASS/FAIL | pass/fail | | PASS | 40 CFR 503 Class A Compost |
| Ash @ 550 C | % | 1.85 | 3.62 | TMECC 03.02-B |
| Organic Matter (LOI @ 550 C) | % | 49.21 | 96.38 | TMECC 05.07-A |
| Total Organic Carbon (C) | % | 24.61 | 48.19 | TMECC 04.01-A |
| Carbon:Nitrogen Ratio (C:N) | - | 13.0:1 | 13.0:1 | TMECC 05.02-A |
| Foreign Material | % | | 0.00 | TMECC 03.08-A |
| Germination - Emergence | % | 0.0 | | TMECC 05.05-A |

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Purchase Order: 277-6511
Date Sampled: 10/3/2018
Date Received: 10/4/2018
Date Reported: 10/17/2018 

Sample ID: ACT POULTRY BIN 3
Lab Number: 11829

## COMPOST ANALYSIS

| Analysis | Unit | Analysis Result | Dry Basis Result | Analysis Method |
|---|---|---|---|---|
| Germination - Vigor | % | 0.0 | | TMECC 05.05-A |
| Ave Ht of Seedlings in Control | centimeters | 7.4 | | TMECC 05.05-A |
| Ave Ht of Seedlings in Compost | centimeters | 0.00 | | TMECC 05.05-A |
| Respiration - CO2-C/g TS | mg CO2-C / g TS/Day | | 1.0 | TMECC 05.08-B |
| Respiration - CO2-C/g OM | mg CO2-C / g OM/Day | | 0.4 | TMECC 05.08-B |
| Compost Stability Index | - | | Very Stable | TMECC 05.08 |
| Retained on U.S. 2-inch Sieve | % | | 0.00 | TMECC 02.02-B |
| Retained on U.S. 1-inch Sieve | % | | 0.00 | TMECC 02.02-B |
| Retained on U.S. 5/8-inch Sieve | % | | 0.00 | TMECC 02.02-B |
| Retained on U.S. 3/8-inch Sieve | % | | 1.20 | TMECC 02.02-B |
| Retained on U.S. 1/4-inch Sieve | % | | 4.04 | TMECC 02.02-B |
| Retained on U.S. 5/32-inch | % | | 5.43 | TMECC 02.02-B |

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# Appendix D Finished Compost Results from Farmer Monitored Swine Bin

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Purchase Order: 240-6509
Date Sampled: 8/27/2018
Date Received: 8/28/2018
Date Reported: 9/19/2018 Page: 1 of 3

Sample ID: 8.27 2ND STAGE
Lab Number: 11014

## COMPOST ANALYSIS

| Analysis | Unit | Analysis Result | Dry Basis Result | Analysis Method |
|---|---|---|---|---|
| Moisture @ 70 C | % | 32.40 | | TMECC 03.09-A |
| Solids | % | 67.60 | | TMECC 03.09-A |
| Total Nitrogen (N) | % | 2.68 | 3.96 | TMECC 04.02-D |
| Phosphorus (P) | % | 0.70 | 1.03 | TMECC 04.03-A |
| Phosphate ($P_2O_5$) | % | 1.60 | 2.36 | TMECC 04.03-A |
| Potassium (K) | % | 0.40 | 0.59 | TMECC 04.04-A |
| Potash ($K_2O$) | % | 0.48 | 0.71 | TMECC 04.04-A |
| Magnesium (Mg) | % | 0.05 | 0.07 | TMECC 04.05-MG |
| Calcium (Ca) | % | 1.17 | 1.73 | TMECC 04.05-CA |
| Arsenic | mg/kg | < 0.329 | < 0.486 | US EPA SW846-6020 |
| Cadmium | mg/kg | < 0.329 | < 0.486 | US EPA SW846-6020 |
| Chromium | mg/kg | 1.56 | 2.31 | US EPA SW846-6020 |
| Copper | mg/kg | 12.5 | 18.5 | US EPA SW846-6010C |
| Mercury | mg/kg | < 0.381 | < 0.564 | US EPA SW846-6020 |
| Molybdenum | mg/kg | < 0.355 | < 0.525 | US EPA SW846-6020 |

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-COMPOST

Report Approved By: Greg T. Neyman
Greg Neyman - Vice President / COO
Approval Date: 9/19/2018

Report Number
F18240-6509
Account Number
99990

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3505 Conestoga Dr.
Fort Wayne, IN 46808
260.483.4759
algreatlakes.com

To: JOSEPH STUCKEY
4051 CHI ROAD
RALEIGH, NC 27603

Purchase Order: 240-6509
Date Sampled: 8/27/2018
Date Received: 8/28/2018
Date Reported: 9/19/2018

Sample ID: 8.27 2ND STAGE
Lab Number: 11014

## COMPOST ANALYSIS



| Analysis | Unit | Analysis Result | Dry Basis Result | Analysis Method |
|---|---|---|---|---|
| Nickel | mg/kg | 0.531 | 0.786 | US EPA SW846-6020 |
| Lead | mg/kg | 3.04 | 4.49 | US EPA SW846-6020 |
| Selenium | mg/kg | < 0.76 | < 1.13 | US EPA SW846-6020 |
| Zinc | mg/kg | 45.0 | 66.5 | US EPA SW846-6010C |
| 503 Metals PASS/FAIL | pass/fail | | PASS | EPA 503 Metal Limits |
| pH | - | 7.6 | | TMECC 04.11-A |
| Soluble Salts | dS/m | 9.45 | | TMECC 04.10-A |
| Fecal Coliform/MPN | MPN/g dry | | < 2 | SM(20th)-9221E TMECC |
| Pathogen Reduction - PASS/FAIL | pass/fail | | PASS | 40 CFR 503 Class A Compost |
| Ash @ 550 C | % | 5.25 | 7.76 | TMECC 03.02-B |
| Organic Matter (LOI @ 550 C) | % | 62.35 | 92.24 | TMECC 05.07-A |
| Total Organic Carbon (C) | % | 31.18 | 46.12 | TMECC 04.01-A |
| Carbon:Nitrogen Ratio (C:N) | - | 11.6:1 | 11.6:1 | TMECC 05.02-A |
| Foreign Material | % | | 0.00 | TMECC 03.08-A |
| Germination - Emergence | % | 7 | | TMECC 05.05-A |

TMECC - Test Methods for the Examination of Composting and Compost (TMECC), The U.S. Composting Council.

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Lab Number: 11014

## COMPOST ANALYSIS



| Analysis | Unit | Analysis Result | Dry Basis Result | Analysis Method |
|---|---|---|---|---|
| Germination - Vigor | % | 38 | | TMECC 05.05-A |
| Ave Ht of Seedlings in Control | centimeters | 6.8 | | TMECC 05.05-A |
| Ave Ht of Seedlings in Compost | centimeters | 3.0 | | TMECC 05.05-A |
| Respiration - CO2-C/g TS | mg CO2-C / g TS/Day | | 2.4 | TMECC 05.08-B |
| Respiration - CO2-C/g OM | mg CO2-C / g OM/Day | | 1.4 | TMECC 05.08-B |
| Compost Stability Index | - | | Stable | TMECC 05.08 |
| Retained on U.S. 2-inch Sieve | % | | 0.00 | TMECC 02.02-B |
| Retained on U.S. 1-inch Sieve | % | | 0.00 | TMECC 02.02-B |
| Retained on U.S. 5/8-inch Sieve | % | | 0.00 | TMECC 02.02-B |
| Retained on U.S. 3/8-inch Sieve | % | | 2.69 | TMECC 02.02-B |
| Retained on U.S. 1/4-inch Sieve | % | | 1.44 | TMECC 02.02-B |
| Retained on U.S. 5/32-inch | % | | 5.55 | TMECC 02.02-B |

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# Appendix E Finished Compost Results from NCSU Monitored Swine Bin

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To: JOSEPH STUCKEY
4051 CHI ROAD
RALEIGH, NC 27603

COPY: 919-921-1245

Purchase Order: 249-6509
Date Sampled: 9/5/2018
Date Received: 9/6/2018
Date Reported: 9/19/2018 Page: 1 of 3

Sample ID: ACT ROUND 2 FINISHED
Lab Number: 11209

## COMPOST ANALYSIS

| Analysis | Unit | Analysis Result | Dry Basis Result | Analysis Method |
|---|---|---|---|---|
| Moisture @ 70 C | % | 37.83 | | TMECC 03.09-A |
| Solids | % | 62.17 | | TMECC 03.09-A |
| Total Nitrogen (N) | % | 1.86 | 2.99 | TMECC 04.02-D |
| Phosphorus (P) | % | 0.30 | 0.48 | TMECC 04.03-A |
| Phosphate ($P_2O_5$) | % | 0.69 | 1.10 | TMECC 04.03-A |
| Potassium (K) | % | 0.28 | 0.45 | TMECC 04.04-A |
| Potash ($K_2O$) | % | 0.34 | 0.54 | TMECC 04.04-A |
| Magnesium (Mg) | % | 0.04 | 0.07 | TMECC 04.05-MG |
| Calcium (Ca) | % | 0.47 | 0.75 | TMECC 04.05-CA |
| Arsenic | mg/kg | < 0.312 | < 0.502 | US EPA SW846-6020 |
| Cadmium | mg/kg | < 0.305 | < 0.490 | US EPA SW846-6020 |
| Chromium | mg/kg | 1.18 | 1.90 | US EPA SW846-6020 |
| Copper | mg/kg | 4.20 | 6.76 | US EPA SW846-6010C |
| Mercury | mg/kg | < 0.39 | < 0.62 | US EPA SW846-6020 |
| Molybdenum | mg/kg | < 0.328 | < 0.528 | US EPA SW846-6020 |

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RALEIGH, NC 27603

COPY: 919-921-1245

Purchase Order: 249-6509
Date Sampled: 9/5/2018
Date Received: 9/6/2018
Date Reported: 9/19/2018

Sample ID: ACT ROUND 2 FINISHED
Lab Number: 11209

## COMPOST ANALYSIS



| Analysis | Unit | Analysis Result | Dry Basis Result | Analysis Method |
|---|---|---|---|---|
| Nickel | mg/kg | 0.390 | 0.627 | US EPA SW846-6020 |
| Lead | mg/kg | 0.90 | 1.44 | US EPA SW846-6020 |
| Selenium | mg/kg | < 0.71 | < 1.14 | US EPA SW846-6020 |
| Zinc | mg/kg | 25.8 | 41.5 | US EPA SW846-6010C |
| 503 Metals PASS/FAIL | pass/fail | | PASS | EPA 503 Metal Limits |
| pH | - | 6.2 | | TMECC 04.11-A |
| Soluble Salts | dS/m | 8.00 | | TMECC 04.10-A |
| Fecal Coliform/MPN | MPN/g dry | | < 2 | SM(20th)-9221E TMECC |
| Pathogen Reduction - PASS/FAIL | pass/fail | | PASS | 40 CFR 503 Class A Compost |
| Ash @ 550 C | % | 1.63 | 2.62 | TMECC 03.02-B |
| Organic Matter (LOI @ 550 C) | % | 60.54 | 97.38 | TMECC 05.07-A |
| Total Organic Carbon (C) | % | 30.27 | 48.69 | TMECC 04.01-A |
| Carbon:Nitrogen Ratio (C:N) | - | 16.3:1 | 16.3:1 | TMECC 05.02-A |
| Foreign Material | % | | 0.00 | TMECC 03.08-A |
| Germination - Emergence | % | 80 | | TMECC 05.05-A |

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Date Sampled: 9/5/2018
Date Received: 9/6/2018
Date Reported: 9/19/2018



Sample ID: ACT ROUND 2 FINISHED
Lab Number: 11209

## COMPOST ANALYSIS

| Analysis | Unit | Analysis Result | Dry Basis Result | Analysis Method |
|---|---|---|---|---|
| Germination - Vigor | % | 33 | | TMECC 05.05-A |
| Ave Ht of Seedlings in Control | centimeters | 6.8 | | TMECC 05.05-A |
| Ave Ht of Seedlings in Compost | centimeters | 2.0 | | TMECC 05.05-A |
| Respiration - CO2-C/g TS | mg CO2-C / g TS/Day | | 1.4 | TMECC 05.08-B |
| Respiration - CO2-C/g OM | mg CO2-C / g OM/Day | | 0.6 | TMECC 05.08-B |
| Compost Stability Index | - | | Very Stable | TMECC 05.08 |
| Retained on U.S. 2-inch Sieve | % | | 0.00 | TMECC 02.02-B |
| Retained on U.S. 1-inch Sieve | % | | 0.00 | TMECC 02.02-B |
| Retained on U.S. 5/8-inch Sieve | % | | 0.00 | TMECC 02.02-B |
| Retained on U.S. 3/8-inch Sieve | % | | 0.92 | TMECC 02.02-B |
| Retained on U.S. 1/4-inch Sieve | % | | 3.07 | TMECC 02.02-B |
| Retained on U.S. 5/32-inch | % | | 5.33 | TMECC 02.02-B |

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Appendix F

Advanced Composting Technology Equipment Operating and Maintenance Protocol

**Preprocessing of the mortality:**

- Open the door of the Compost Special Mixer to do a visual inspection to make sure the unit is free of any debris. Close back before filling.
- Turn on mixer by pressing the start button on the control panel; be sure the two green lights are shining.
- Turn on and zero out the scales when you first start a batch. Do not re-zero while reaching maximum weight of 3,000 lbs. or full batch. Turn scales on and off daily as needed to monitor loading weight.
- Load 1,000 lbs. of sawdust into the mixer (scales/display).
- Then load 1,500 lbs. of mortality in the mixer; all at one time or over an extended time period depending on mortality and animal type.
- Top off or load with 500 lbs. of first stage compost. Total batch weight of 3,000 lbs.
- Run the mixer approximately 1-3 minutes daily as you are reaching the 1500 lbs. of mortality and/or 25-30 minutes after the unit is full and before unloading.
- Visually inspect to see that the mixture is blended to a homogenous consistency before unloading.
- Do not mix too long (more than 30 minutes) or you will start seeing a balling effect and perhaps too wet. If you see this add 1 more bucket of the bulking agent or sawdust and mix for 3-5 minutes.
- Turn on conveyor.
- Open the door of the unit and empty into the catch bin. Open the door about 10-12" not to overload conveyor.
- Once the material is dumped into the catch bin prepare the aerated bins to receive this ground/mixed material.

**General operating procedures for aerated bins:**

- Be sure aeration pipes are connected and there are no air leaks at the pipe connections before filling of the bin.
- Be sure small holes in pipes are turned up and are thoroughly clean. The holes are 1/16$^{th}$".
- Check bins operating pressure to ensure it is between 5 -20 before filling.
- If pressures are higher than 20, poke holes with 1/16" tool. If the pressure remains high take the pipes apart and clean with a pressure washer or water hose; recheck pressure to be sure it is in the 5 – 20 psi range.
- If the pressures are 0 then check for broken or loose pipes. Fix or reconnect pipes.

**Filling bin with mortality mix:**

- Turn on compressor.
- Place 18" sawdust filter on floor of bin that will be receiving mortality.
- Load the bin placing compost mixture in the rear of the bin moving to the front. Fill to the height of the bin walls. Crown in the middle.
- When approaching the front stay back 3' from front of bin if you do not have doors. Place sawdust or bulking agent along the front to absorb any seepage.

- There should be approximately 8 mixer batches/loads (24,000 total lbs.) in each bin. During mortality spikes 10 loads or 30,000 total lbs. can be achieved if necessary.
- Wet the bin during filling to maintain 35- 50% moisture and wet as needed before you place a clean 1-2"sawdust cap on the bin to reduce flies when you have finished filling the bin. A fly control program is a must. Use granular or liquid fly bait/spay on an as needed basis to control flies during fly season.
- Monitor and record temperatures at least 3 times weekly after the bin is filled and capped to be sure temperatures are above 135 degrees. Our goal is to have temperatures above 150 degrees for the whole time. Call ACT personnel if temperatures are not reached.
- Leave mortality in the combined1st and 2nd stage forced air bin for a minimum of 21 - 40 days depending on the type of the mortality. See Chart #1.
- During high mortality spikes you can reduce cycle time to maximize aerated bin use. Temperature requirements must be met.
- Empty the bin after cycle times have been met or as needed. Place composted material in the storage area for a minimum of 60 days.
- Land-apply the stored compost according to your nutrient management plans.