



farm to plate
STRATEGIC PLAN

Chapter 3, Section 7:

Nutrient Management

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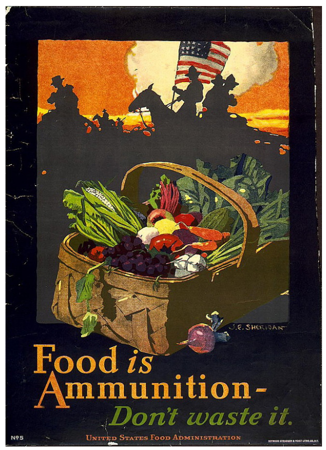
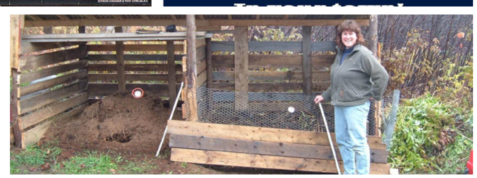
Version Date: March 2014







Vermont Sustainable Jobs Fund

A 10-YEAR STRATEGIC PLAN FOR VERMONT'S FOOD SYSTEM

CONTENTS

ANALYSIS OF VERMONT'S FOOD SYSTEM

Nutrient Management

How much food waste does Vermont generate? Is Vermont optimizing its use of nutrients to strengthen its food system?

Waste recycling turns out to be a hallmark of almost all complex systems, whether the man-made ecosystems of urban life, or the microscopic economies of the cell.

Steven Johnson, *The Ghost Map*

We live in a world of waste. One of the major dilemmas facing the modern world is how to deal with the magnitude of crinkly plastic wrappers, wadded up pieces of paper, and chicken bones sent to landfills, billions of daily toilet flushes, and the slurry of animal waste, fertilizer, and chemicals that runs off agricultural fields into water bodies, not to mention the daily emissions from one billion cars and countless other sources of waste and pollution.[1] Once upon a time, the waste generated by human societies was mostly biodegradable (i.e., organic material) and could be assimilated into the natural environment. For example, none other than George Washington, first president of the United States, used human waste from his outhouses in compost applied on gardens at his Mount Vernon estate.[2] As human population growth exploded over the past 200 years, societies developed increasingly complicated systems for moving waste away from where people live to "sinks" where it can rot, rust, and remain for as long as possible.

Photo Credit: Scott Sawyer

Human waste—humanure—from George Washington's outhouse was used in compost at Mount Vernon.

There are some forms of waste that will always have to be removed from human proximity (e.g., nuclear and other hazardous wastes). On the other hand, the U.S. Environmental Protection Agency, state governments, waste management districts, and other organizations are increasingly focusing on source reductions and more fully utilizing biodegradeable resources. For example, a significant amount of food is lost or wasted during production, postharvest and handling, processing, distribution, and consumption (e.g., spoilage at home). The Farm to Plate Strategic Plan is based on a soil-to-soil analysis of Vermont's food system that asks Vermonters to embrace the adage "waste equals food" by recycling and redistributing the nutrients we use, rather than overly relying on importing nutrients (e.g., fertilizers) or sending nutrient-rich food scraps to the landfill.

The goals of nutrient management are to provide sufficient nutrients for crop or animal growth throughout their life cycle, while minimizing the negative impacts of nutrient losses into the environment.[3] For example, biological decomposition—composting—recycles organic materials such as food scraps and animal manure for reuse as a valuable soil amendment and/or medium for growing plants. This section analyzes the nutrient management challenges and opportunities posed by food scrap diversion and on-farm nutrient management. This section also ties together food production, by looking at how Vermont manages the nutrients that go into producing food, and food consumption, and by examining how Vermont manages nutrients once they leave the farm as food, animal waste, and runoff.

GETTING TO 2020

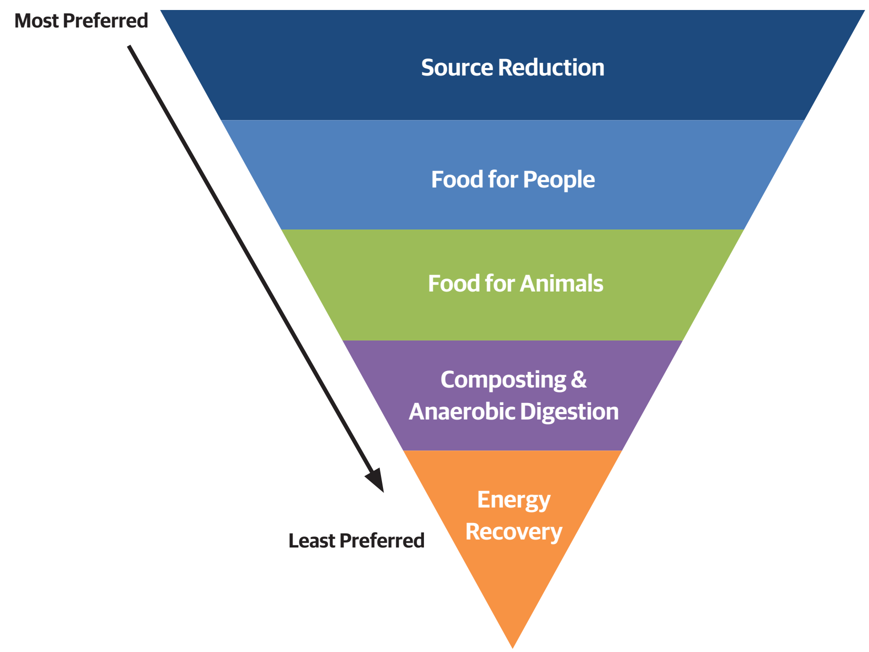
Goal 14 of the Farm to Plate Strategic Plan addresses the need to improve off and on farm nutrient management:

Goal 14: Organic materials from farms (e.g., livestock manure) and food scraps will be diverted from landfills and waterways and used to produce compost, fertilizer, animal feed, feedstock for anaerobic digesters, and other agricultural products.

CURRENT CONDITIONS

Over the past 35 years, the U.S. Environmental Protection Agency (EPA) and many states—including Vermont—began to adopt a hierarchy for solid waste management (Figure 3.7.1). Landfilling in many states and communities transitioned from being the first option to the last. Terms like "the 3 Rs," "diversion," "biological treatment," and "biodegradable resources" started replacing "trash," "waste," and "garbage."[3] With the

Figure 3.7.1: Act 148 Diversion Hierarchy



Source: Vermont Agency of Natural Resources

passage of Act 148, Vermont slightly amended the EPA hierarchy, putting composting and anaerobic digestion at the same priority level.

Despite this shift, we continue to live in a world of waste. **According to the EPA, Americans generated about 250 million tons of municipal solid waste (MSW) in 2011, equal to 4.4 pounds per person per day.[4]** Of this total, 65.3% (163.5 million tons) was discarded in landfills, with 11.2% (29.3 million tons) of that amount combusted for energy. About 35% (86.9 million tons) of the 250 million ton total was recycled or composted. Paper and paperboard and organic waste—comprised of yard trimmings (13.5%) and food scraps (14.5%)—make up the biggest portion of generated MSW at 28% each, followed by plastics at 12.7%. The EPA estimates that about 57% of yard trimmings were "recovered" (i.e., composted) in 2011, while only 3.9% of food scraps or other organics make their way to a compost pile. Factoring in these diversion rates, **food scraps make up the largest percentage of material discarded in MSW at 21.3% (34.9 of 163.5 million tons discarded).**

Act 148: Recyclable and Organic Material Diversion

Based on DSM Environmental Services, Inc. *State of Vermont Waste Composition Study* for the *Vermont Department of Environmental Conservation's Solid Waste Division*, **Vermonters throw away upwards of 60,000 tons of food scraps per year.** Though food scraps commonly end up in a landfill, composting is increasingly being utilized in Vermont by farmers, schools, homeowners, and others as a way to recover nutrients and recycle them, with significant environmental, economic, and community benefits.

With the passage of *Act 148: An act relating to establishing universal recycling of solid waste* in 2012, which requires that certain recyclable and organic materials, including leaf, yard, and food residuals, be diverted from landfills by 2020, composting infrastructure, programs, and educational efforts will need to be developed and utilized at an even greater rate. **Act 148's impacts on Vermont's food system will be significant because the law embeds the responsibilities of nutrient management from farm to plate.**

For example, because Act 148 emphasizes reduction at the source as its highest priority in the diversion hierarchy (Figure 3.7.1), greater attention will be given to consumer's food purchasing, storage, and preparation behaviors (e.g., meal planning and portion sizes). Food rescue and food security efforts stand to benefit as well from greater public awareness that will come as Act 148 is implemented, as diversion of food for feeding people is the second highest priority in the diversion hierarchy. Currently, there is confusion about "best-use" food labelling that results in edible food being thrown out rather than cooked or donated, and there is a lack of awareness about gleaning opportunities that can get unharvested food to those most in need.

The potential benefits to farms are significant: **if all of the food disposed of in Vermont landfills were captured and composted, the result would provide adequate nitrogen to fertilize roughly 6,400 acres of mixed vegetables (Vermont had over 7,100 acres of land in vegetables, orchards, and berries in 2007).** Additionally, food scraps are a good source of feed for poultry, especially laying hens. **Vermont's food scraps could meet the dietary requirements of up to roughly 124,000 laying hens.**

Photo Credit: Highfields Center for Composting

Ben Zabriskie unloading food scraps at Kingdom View Compost in Lyndonville, VT.

Act 148 even has implications for both electric and thermal energy production in Vermont, as the increased availability of food scraps will create new opportunities for the deployment of anaerobic digester and heat recovery technologies. Because Act 148 will be phased in over time, and effects larger institutions first, Vermont's large institutions will have an important role to play in establishing best practices and even innovating new ways to limit or repurpose food scraps.

Managing Farm Inputs

Nutrients for growing crops can be supplied and managed in a variety of ways (e.g., manufactured inorganic fertilizers, manure, compost, cover crops, and crop rotations). While fertilizing crops is essential to productivity and farm profitability, manure and fertilizer runoff—which can result from overapplication, soil compaction, and soil erosion— are partially responsible for the pollution of Lake Champlain and other waterways. Effective and efficient on-farm nutrient management has, consequently, become an issue that is critical to not only farm productivity and profitability—particularly as fertilizer costs increase and availability of phosphate rock declines—but ecosystem health.

A common practice on Vermont dairy farms, which operate 44% of all land in agriculture and 60% of total cropland in Vermont, is to spread readily available cow manure onto fields to provide feed crops with nutrients and organic matter. As a result, manure management is a particularly important aspect of nutrient management in Vermont. **Farm to Plate (F2P) researchers estimate that, using dairy production estimates from 2012 and livestock census data from 2007, that Vermont livestock produce about 4.4 million tons of manure.** Not all of the manure generated is captured for storage, since some livestock spend a significant amount of time outside, where the manure is directly applied to pasture as cows graze. We estimate that 3.1 million tons of manure are "available" for spreading, composting, or as a feedstock in anaerobic digesters, and that dairy cows generate about 99% (3 million tons) of this available manure (Table 3.7.19). It is important to note, as mentioned above, that uncaptured manure is effectively applied to fields as cows graze on pasture, and that this is a nutrient management strategy in itself. Of the 3.1 million tons of manure that are available for storage and spreading, a portion of the available total could be reduced by transitioning confinement operations to pasture based management.

Although synthetic fertilizers are not applied as frequently on Vermont farms as they are in some parts of the country, they are still used in large quantities and applied to significant portions of Vermont farmland. 6.7 million pounds of purchased nitrogen and 2.6 million pounds of purchased phosphorus fertilizer were estimated to be applied in 2007, and 228,040 acres were treated with a commercial fertilizer, lime, or soil conditioner.

The effective management and application of manure and synthetic fertilizers is strongly influenced by cropping practices and soil management. With excellent management, the need for synthetic application in particular can be greatly reduced. Many programs have been developed to improve nutrient management on Vermont farms but the ability of the *Vermont Agency of Agriculture, Food, and Markets* (VAAFM) and partner organizations to comprehensively monitor and interact with all farms is limited by staff and funding capacities. For example, there are 17 Large Farm Operations (LFOs, over 700 dairy cows) in Vermont and one LFO nutrient management coordinator. Vermont has three medium farm operation (MFO) coordinators for 142 MFOs (200-699 mature dairy cows). For the over 780 smaller dairy farms the VAAFM relies on assistance from the *Vermont Association of Conservation Districts* (VACD) and complaints from the public. VACD's Agricultural Resource Specialists (ARS) provide environmental assessments of farm operations, including manure management, and referrals for funding assistance and nutrient management planning services. The *USDA Natural Resources Conservation Service* (NRCS) also provides nutrient management planning and funding to farms participating in their various cost share programs to contract with a private technical service provider for such services. VAAFM has a number of incentive programs designed to improve soil health and limit water pollution, and provides grant funding for nutrient management plans through its *Nutrient Management Incentive Grant Program* (NMPIG).

For confined dairy and large livestock farms, anaerobic or methane digesters can be used in Vermont as a storage strategy within a nutrient management plan that generates additional revenue streams for the farm. Methane digesters are oxygen-free tanks or containers that use microorganisms (i.e., different types of bacteria) to transform biomass like cow manure into "biogas" (e.g., methane and carbon dioxide), while retaining the manure slurry. This biogas can then be fed to a gas engine to generate electricity, or to a boiler to generate heat. During this process, nutrient rich slurry is separated from dry biomass and can be used as a fertilizer, while the dry biomass can be used for animal bedding.

Methane digesters transform much of the nitrogen and phosphorus from slower releasing organic forms into more immediately available inorganic forms. The total amounts of nitrogen and phosphorus remain about the same, as does the total amount of biomass to handle after digestion takes place (5% reductions in mass are common). Methane digesters, consequently, still require a nutrient management plan that prescribes appropriate application of the nutrient rich digested slurry, and farms utilizing the technology can still benefit from cropping practices that limit nutrient runoff. Additionally, the cost of digesters can be prohibitive for many farms (systems can costs well over $1 million), and the technology for deployment on smaller herd farms is still in a research and development phase.

Two alternative manure storage techniques— on-farm composting or bedded pack systems—can assist nutrient management efforts. Composting manure creates a fertilizer for farms that is odorless, sterile, weed-free, and slow releasing—which reduces pollution to surface waters related to leaching—and a marketable product that can be sold off-farm. The compost can also be used as a bedding material.

Bedded pack systems use the principles of composting to create a loose housing area where cows comfortably rest when not being fed or milked. The pack is built up over time in an open or ventilated barn as bedding materials, such as straw or sawdust, are added to manure from resting cows. The bedding keeps the manure dry, and its carbon content creates the necessary nutrient ratios for decomposition to take place. Bedded pack systems make for efficient manure handling because the pack acts as both a comfortable bedding area for the cows and storage system for their manure which is later applied to hay fields or feed crops.

In summary, the topic of nutrient management covers these important dimensions:

MANAGING DIVERSION Pages 5-33	1. Reducing food waste at the source through more informed and improved food purchasing, storage, and preparation behaviors
	2. Limiting the amount of food unnecessarily being discarded in order to feed more people
	3. Feeding food scraps to animals to reduce feed demands
	4. Composting food scraps in order to reduce fertilizer demands while improving soil health and using food scraps for energy production either through methane digestion or heat recovery
MANAGING FARM INPUTS Pages 33-50	5. Applying and managing nutrients in a way that maintains soil productivity but does not diminish environmental quality

Food Waste Generation in the United States

Food is lost or wasted throughout the supply chain, from production (e.g., damage from insects or weather), postharvest, handling, and processing (e.g., damage), to distribution and consumption (e.g., spoilage at home).[5] **According to the *Food and Agriculture Organization of the United Nations* (FAO), about one-third of food produced for humans (1.3 billion tons) is lost or wasted throughout the world each year.[6]** The FAO says that industrialized countries waste more food on a per capita basis—209 to 254 pounds—than the developing world (6 to 24 pounds). **The *USDA Economic Research Service* has a higher estimate for the United States—414 pounds lost per person at just the retail and consumer levels—in 2008. This is equal to a loss of $165.6 billion, or 29% of food available at retail and consumer levels.[7]** The top three categories in terms of the value of food lost are meat, poultry, and fish; vegetables; and dairy products. This figure underestimates total food loss because it does not cover production and processing losses. Researchers at the *National Institute of Diabetes and Digestive and Kidney Diseases* estimate food waste in the United States has increased from about 30% of the available food supply in 1974 to 40% in 2003.[8]

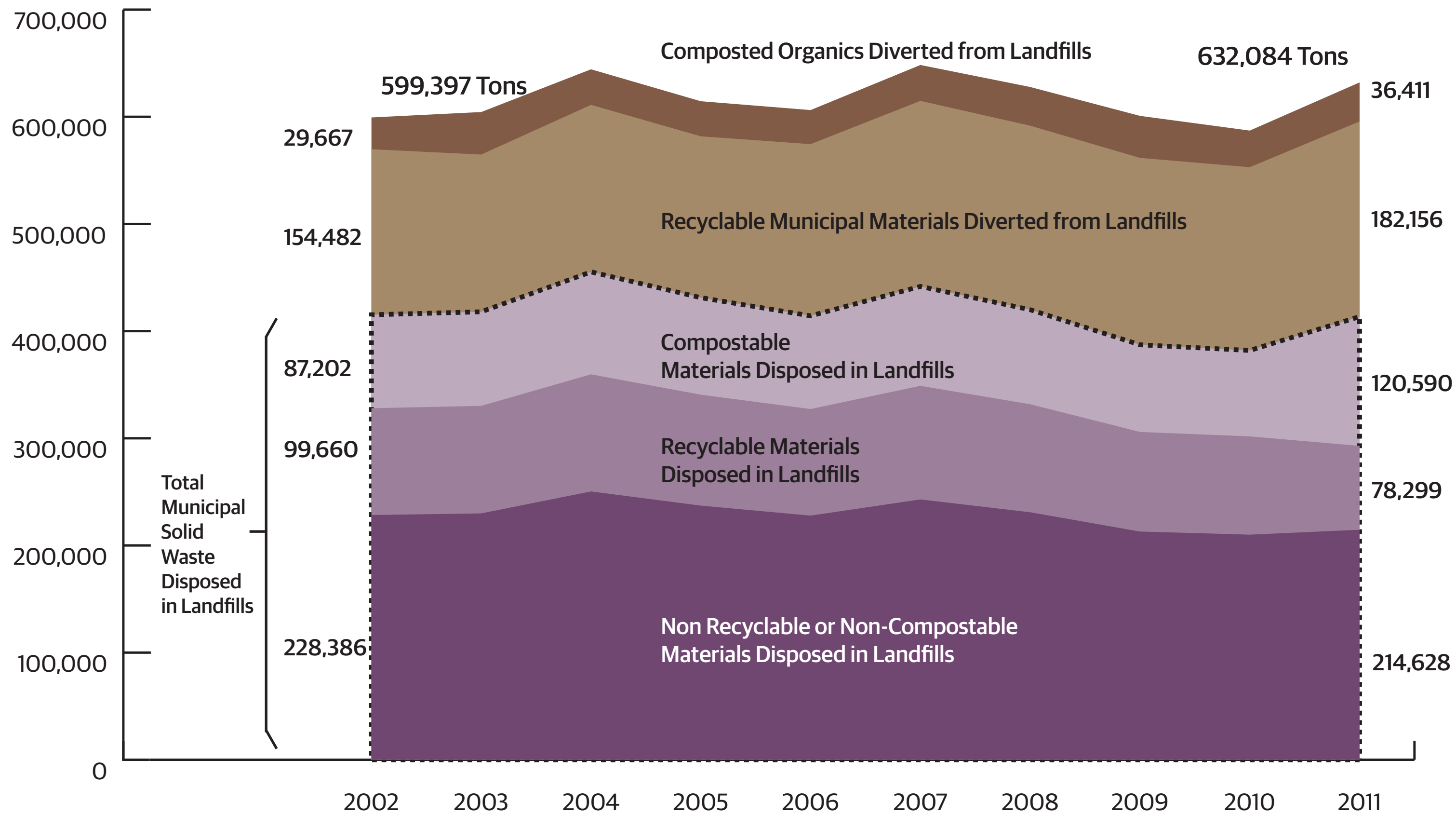
The *Natural Resource Defense Council* (NRDC) reports that 7% of planted fields are not harvested, up to 39% of total food loss occurs in the food manufacturing industry, 10% of the total food supply at the retail level is lost, 4 to 10% of food purchased by restaurants becomes kitchen loss before reaching the customer while 17% is left on the plate uneaten, 25% of food and beverages bought by American families is thrown away, and only 10% of available, edible wasted food is recovered each year in the United States.[9] Food wasted is energy wasted as well. Researchers have estimated that food waste in America wastes the energy equivalent of 350 million barrels of oil per year, which represents 2% of annual U.S. energy consumption.[10]

Food lost and wasted throughout the supply chain is a visible reminder of the inefficient utilization of the food we grow. These losses represent wastes of energy and natural resources, as well as lost opportunities for helping people that need food assistance. Gleaning, collecting perishables, nonperishables, prepared foods, improving purchasing, and training food preparers to utilize food inventory more efficiently at different stages in the supply chain can reduce considerable food waste in the food system.

Food Waste Generation in Vermont

In *Chapter 3, Section 1: Understanding Consumer Demand*, F2P researchers conservatively estimate that local food purchases amounted to 5-10% of all food purchases in 2010. That is, most of the food consumed by Vermonters and our animals is imported. Consequently, a significant amount of food is lost or wasted before it

Figure 3.7.2: Vermont's Municipal Solid Waste Generation and Diversion, 2002 to 2011



Source: Vermont Agency of Natural Resources Solid Waste Management *Annual Solid Waste Diversion & Disposal Reports*. **DSM Environmental Services Vermont Waste Composition Study** *2002* **and** *2013*.
Note: Years 2002 to 2010 use DSM's 2002 waste composition assumptions, while 2011 uses DSM's 2013 waste composition assumptions. Compostable materials increase in 2011, while recyclable materials decline, in part because of methodological differences between the two studies. The 2013 study breaks paper products into subcategories and includes an estimate for compostable paper, thus the sharp increase in compostable materials disposed in landfills in 2011.

crosses state lines. The waste, however, does not end at state lines. Upwards of 14% of Vermont's municipal solid waste stream is food scraps (i.e., including food imported from other places or grown in Vermont).

In their *2011 Solid Waste Diversion and Disposal Report*, the Waste Management Division of the Agency of Natural Resources (ANR) Vermont Department of Environmental Conservation estimated that **MSW in Vermont equaled 632,084 tons in 2011, a 2.9% increase from the previous 5 year average, and equal to about 1 ton of waste per person per year—or 5.53 pounds per day per person.** Of the 632,084 ton total, 218,567 tons were diverted from landfills. This represents a 35% diversion rate, 3% higher than the average rate from 2002 to 2010, but equal to the 2010 diversion rate (Figure 3.7.2).

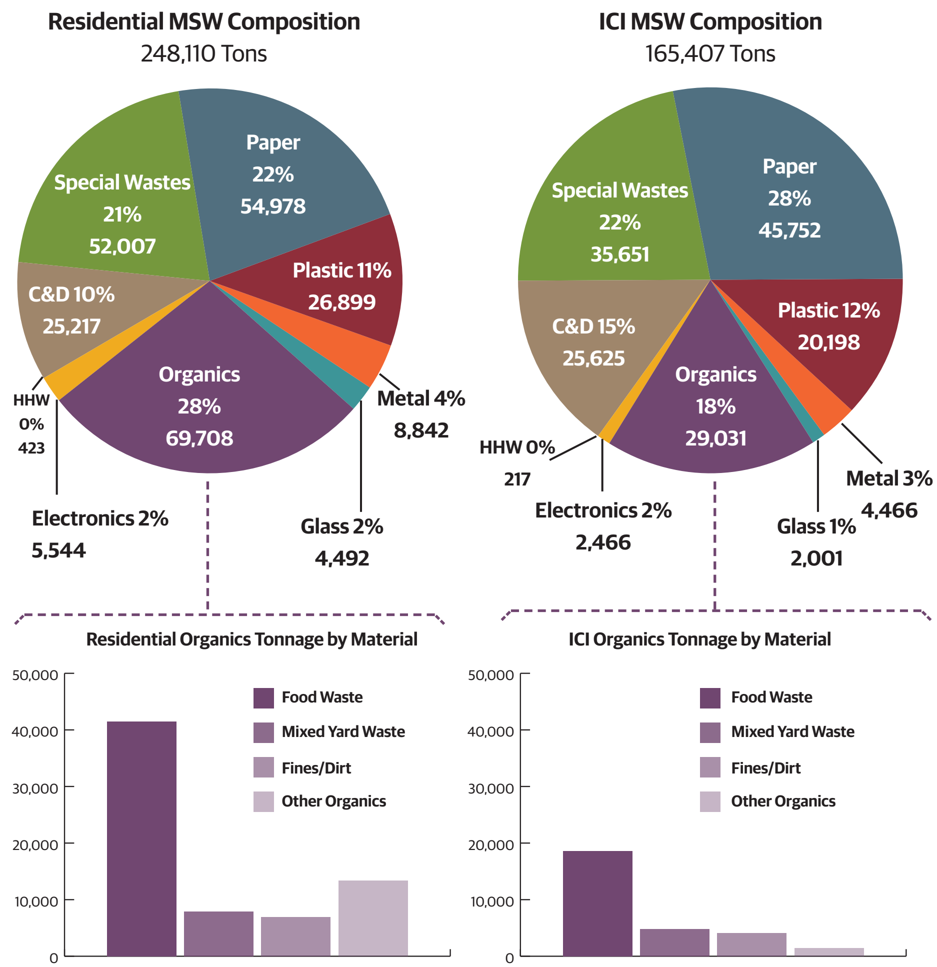
The Diversion and Disposal report provides breakdowns of diversion by category, revealing that 36,411 tons of organics were diverted from landfills in 2011, or about 17% of the total waste diverted from landfills. ANR base this figure on an estimate, taking estimates for MSW Material Codes for organics and adding it to an estimate for backyard composting. The report estimates that 23,925 tons of organics were composted in backyards (65.7% of total organics diverted). Material categorized as food waste diverted that was not composted in backyards was estimated at 3,114 tons (8.6% of total organics diverted).

Another report, DSM Environmental's Waste Composition Study, provides a detailed analysis of the materials ending up in Vermont's landfills. The study breaks MSW disposal into two categories, residential and commercial. Sampling for the study was carried out over two seasons (August 20-24, 2012 and November 12-16, 2012) at four permitted solid waste facilities in Williston, Highgate, Brattleboro, and Sunderland. Forty residential sources and 60 institutional / commercial / industrial (ICI) sources were sampled over the course of the two seasons. More ICI sources were sampled to achieve estimates comparable in precision to residential estimates due to the greater composition variability that is characteristic of ICI waste. Sample data for the study are not statistically significant by season or for individual sites, but are for statewide estimates of residential and commercial waste composition. Due to Vermont's rural nature, the study assumes that residential waste represents 60% (247,687 tons) of total MSW and ICI waste represents 40% (168,268 tons) of total MSW.

Organics composed 28% (69,708 tons using 2011 data from DEC's disposal and diversion report) of the landfilled residential MSW, and 18% (29,031 tons) of the ICI landfilled waste stream (Figure 3.7.3). Within the organics category, 59.4% of landfilled residential organics waste are food scraps, while 63.6% of landfilled ICI organics waste are food scraps. **From the perspective of total landfilled waste, 16.7% (41,486 tons) of total landfilled residential waste is food scraps and 11.2% (18,592 tons) of total landfilled ICI waste is food scraps.**

Using the DSM Environmental's 2013 Waste Composition Study estimate that 12,731 tons of yard waste were landfilled, and EPA's estimate that 57% of yard waste is diverted in the United States, we estimate that 16,875 tons of yard waste are composted in Vermont. 5,913 tons of yard waste are accounted for in DEC's material code estimate for organic diversion. Based on these calculations, the remaining estimated 10,962 tons of yard waste are composted in backyards. As a result, an estimated 12,963 tons of food scraps (23,925 tons of organics - 10,962 tons of yard waste) are composted in backyards.

Figure 3.7.3: Vermont's Disposed Municipal Solid Waste Composition, 2012



DSM Environmental Services' *2013 State of Vermont Waste Composition Study*.

Assuming that 12,963 tons of food scraps are composted in backyards, residential generators compost approximately 24% of food scraps. Thus we calculate the residential diversion rate is approximately 24% for food scraps.

Calculating the ICI diversion rate is more difficult, and the available data provides conflicting analyses. In 2009, *Stone Environmental* attempted to estimate institutional food scrap generation for the *Central Vermont Solid Waste Management District* and the Central Vermont Recovered Biomass Project. The project led to the creation of the *Vermont Statewide Compost & Biogas Feasibility Data Viewer*—a GIS-based website that identifies the locations of institutions, cafeterias, schools, hospitals, nursing/long term care, grocery/convenience stores, restaurants, and food manufacturers, and provides an estimate of the amount of food waste generated at these locations. The data for schools and restaurants is relatively strong, however the data for industrial and manufacturing generators proved challenging to capture. Additionally, health care facilities are not adequately represented as only hospitals are included while facilities like nursing homes are not. Prisons are not included in the analysis as well.

The Compost/Biogas Viewer, however, offers an assessment of the commercial sector that allows us a modest degree of extrapolation of food scraps generated from ICI sources. According to Stone Environmental's data, institutions in Vermont generate 68,488 tons of food scraps per year, though this number may be an underestimate for reasons cited above. If we were to use DSM's ICI waste composition data for organics and food scraps, which assumes that 40% of MSW waste is ICI waste, and that 11.2% of the landfilled ICI waste are food scraps (18,592 tons), Vermont's ICI food scrap diversion rate is 73% (49,896/68,488).

DSM's report considers Stone Environmental's estimates to be substantially higher than data from the Waste Composition Study and ANR's Disposal and Diversion reports suggest. The Diversion and Disposal Report, which DSM uses to calculate disposed tons, reports that 36,411 tons of organics were diverted in 2011. As discussed above, 23,925 of these tons are attributed to backyard composting, while we calculate that 12,963 of these tons are food scraps. The remaining 12,486 tons are attributed to a number of material code categories, with 866 tons considered exempt. Thus, ANR calculates that 11,620 tons of organics are processed at a full certification composting facility, with food waste only comprising 3,114 tons (27%). If we assume that the source of the 3,114 tons of food waste is from ICI generators, the ICI food scrap diversion rate is only 14%. This would also mean that the total food scrap generation from ICI sources is only 21,706 tons or 28.5% of total food scraps generation in Vermont. The implication of the disparity between Stone Environmental's ICI estimate and DSM and ANR's is that diversion efforts and programs for ICI generators in Vermont are either highly successful or highly deficient and/or ineffective.

Because there is a disparity between ICI estimates of food scrap generation, the total amount of food scraps generated by Vermonters varies depending on the assumptions adopted. The Vermont based estimates of food scrap generation leave us with a range from 76,155 to 122,937 tons of foods scraps generated each year. The EPA estimates that 14.5% of MSW is food scraps, which would result in 91,652 tons of food waste produced in Vermont in 2011. Researchers Jean Buzby and Jeffrey Hyman estimate, using USDA-ERS's Loss-Adjusted Food Availability data, that Americans waste 188.0 kg per capita at just the retail and consumer levels.[11] Adjusted to Vermont's population, their estimate would amount to 129,731 tons of food scrap generation per year—and this estimate does not account for on-farm, processing, or distribution losses. The EPA estimate is close to the mean value, 99,546, of the two Vermont based estimates, while the Buzby and Hyman estimate is close to the high-end Vermont based estimate. For the purpose of analysis in the following sections, we primarily use DSM estimates that are based on the most recently published Vermont data.

Table 3.7.1: Total Food Scrap Generation Estimates (Tons)

	Residential Generation	Institutional Generation	Total Generation
DSM/ANR	54,449	21,706	76,155
Stone/ANR	54,449	68,488	122,937
EPA	91,652		91,652
USDA-ERS	129,731		129,731

Source: DSM Environmental Services' *2013 State of Vermont Waste Composition Study* **and ANR's** *2011 Diversion and Disposal Report*. **Stone Environmental's Compost/Biogas Viewer. EPA's** *report on Municipal Solid Waste*. **USDA-ERS** *Total and per capita value of food loss in the United states*.

Act 148: Vermont's Response to Food Loss and Waste

Though the passage of *Act 148: An act relating to establishing universal recycling of solid waste* was relatively swift and surprisingly uncontroversial—the bill requires, through a phased implementation plan, that all food scraps be diverted from landfills by 2020—it was a long time in the making. Act 148 is the product of multiple committees, working groups, and stakeholder interests that coalesced around the goal of avoiding the needless waste of a valuable resource. In many respects, the cooperation and collaboration amongst stakeholders that brought about the passage of Act 148 will be equally needed in order for the implementation of Act 148 to be successful.

In 2008, a report completed by the Vermont Agency of Natural Resources (ANR), *Life Beyond Garbage: Vermont Waste Prevention and Diversion Strategies*, indicated that Vermont was losing the battle against waste:

"Waste from Vermont businesses, residents, and institutions (municipal solid waste) grew from 350,000 tons in 1987 to 606,276 tons in 2006, ***a 73 percent increase****. Although Vermont's population grew during this time period as well,* **Vermonters generate nearly twice as much waste (including trash and recyclable and compostable materials) per person as they did in 1987***. During this same period federal, state, regional, and local government spent countless resources attempting to curb this growth. Clearly, our strategies have not worked. (Page 1, emphasis in original)."*

The ANR report was the culmination of a broad stakeholder process spanning eight months involving waste generators and managers from a wide range of sectors (e.g., businesses, institutions, government, nonprofits, and consumers). Around the same time, in January 2008, the Solid Waste Working Group (SWWG) was convened by the Legislature under the auspices of ANR to examine ANR's *Solid Waste Report to the Vermont Legislature*. The SWWG met six times between June and December of 2008, reviewing recommendations not only from ANR's Solid Waste Report to the Legislature report but also from the Life Beyond Garbage report.

With the message from Life Beyond Garbage that the state's existing policies were failing fresh in the groups mind, the SWWG paid particular attention to potential legislation that would be necessary to implement ANR's purposed solid waste management strategies for the next tens years.[12] Building off of the work of the Waste Prevention Steering Committee, the SWWG offered a number of prescient recommendations that would eventually become the foundation of Act 148, namely:

- Implement programs and or legislation to improve waste diversion (Reuse, Recycling & Composting):
  - Mandatory "Pay as You Throw" or variable rate pricing
  - Mandatory parallel collection of recyclables
  - Bottle Bill
  - Organic waste management
  - State purchasing
  - Data Collection & analysis
- Improve solid waste infrastructure statewide;
- Complete a comprehensive solid waste management infrastructure needs assessment.

In October of 2010, the Vermont Solid Waste District Managers Association (VSWDM) drafted a position paper, supporting mandatory recycling statewide. Support from the VSWDM was significant, signaling to policy makers that state mandated universal recycling was considered desirable by the institutions responsible for implementing solid waste policy at the municipal level.

With policy consensus established amongst key solid waste stakeholders, the issue was ripe for consideration by the Vermont Legislature. As Jennifer Holliday, Compliance Program and Product Stewardship Manager for the *Chittenden Solid Waste District*, describes, the House Natural Resources Committee had heard a number of conversations and testimony on solid waste management in previous years, notably the report outlining the SWWG's recommendations. The Committee had a sound understanding of the solid waste landscape in the state, including the status of existing infrastructure. They ultimately saw an opportunity to introduce legislation that would be the most significant solid waste reform since the passage of Act 78 in 1987, which was the state's first solid waste law and created solid waste districts throughout the state.[13]

Holliday noted that ANR was very responsive to the major points of the SWWG's recommendations, playing an important role in orchestrating the SWWG's meetings, and provided key insights and language regarding how the legislation would be effective but also palatable to legislators, consumers, and businesses alike. She also reported that the two largest haulers in the state, [Casella Resource Solutions]() and [Myers Container Service](), both supported the bill.

In January 2012, the legislation that would ultimately become Act 148 was introduced by Rep. Tony Klein (East Montpelier), Rep. Margaret Cheney (Norwich), and Rep. Sarah Edwards (Brattleboro). The bill went through the House with relative ease. It was passed unanimously in the Senate after a proposed amendment to expanded the Bottle Bill was removed, and signed into law by Governor Shumlin on May 16, 2012.

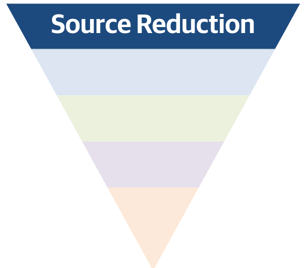
The content of Act 148 seeks to establish a framework that is built around "the three Cs": Convenience, choices, and consistency. The law will provide convenience and choices to solid waste generators at both the institutional and individual level, leading to more consistent statewide services. The key features of the bill as they pertain to the food system are the following:

- A solid waste plan revised once very fives years that will include:
    - An analysis of the volume and nature of wastes generated in the state, including a state-wide waste composition study;
    - An assessment of the feasibility and cost analyses of diverting each waste category from disposal;
    - A survey of existing and potential markets for each waste category
    - Measurable goals and targets for waste diversion for each category
    - A coordinated education and outreach component that advances the objective of the plan including source separation requirements related to disposal bans
    - An assessment of facilities and programs necessary at the state, regional or local level to achieve the waste reduction and recycling priorities identified in the plan.
- Parallel collection at facilities - Facility owners that offer services for managing trash must also offer services for managing:
    - Beginning July 1, 2015 offer to collect leaf and yard residual separated from other solid waste and deliver to a facility or use that is maintained and operated for the management of leaf and yard residual.
    - Beginning July 1, 2017 offer collection of source-seperated food residuals and deliver to a facility that is maintained and operated for the management of food residuals.
- Parallel collection at curbside – Haulers that offer services for managing trash must also offer services for managing:
    - Beginning July 1, 2016, offer to collect leaf and yard waste and deliver to a facility or use that is maintained and operated for the management of leaf and yard residual;
    - Beginning July 1, 2017 offer collection of source-separated food residuals and deliver to a facility that is maintained and operated for the management of food residuals.

On November 13, 2013, the Agency of Natural Resources unveiled its standardized symbols for recycling, food scraps, and trash as a way to raise public awareness about Act 148 and unify recycling and composting efforts across Vermont. The design of the symbols and the colors selected are meant to be consistent with the design and color scheme of organic diversion programs in other areas such as San Francisco and Seattle. The symbols are intended to be used freely by all, and are available for download in various forms on [ANR's Universal Recycling Symbols]() page.

ANR'S standardized Universal Recycling Symbols

Reduction at the Source



Source reduction is the first priority in the hierarchy adopted by Act 148. Source reduction refers to the prevention of food waste before it is created. Strategies for source reduction include improving purchasing of inventory to lower spoilage, substituting unpopular menu items that are often thrown away, improving the utilization of vegetable and meat scraps (e.g., for soups and soup stocks), and reducing portion size.

Though source reduction can occur at all stages of the supply chain, the retail stage has a significant role to play in reducing food waste both upstream at the production and distribution stages, and downstream at the stage of consumption. Source reduction in the kitchen or at the grocery store ultimately effects demand for food products, which can alter the production decisions of farmers. Retailers purchasing policies and quality standards also effect shipments stores receive from distributors. Additionally, source reduction at the retail level affects consumer consumption and behavior.

At the retail level, there are two general types of waste generation that can be addressed by source reduction strategies. Pre-Consumer waste, or "kitchen waste," is addressed by implementing management systems and protocols that provide staff with the tools to make sound purchasing decisions or reduce waste during food preparation. Post-consumer waste, or "plate waste," relies on consumer education combined with front of the house service design that influences consumer choice and behavior. **The USDA ERS food loss study estimated that foodservice and consumer food waste is the single largest source of food loss in the marketing chain.[14]** Their research estimated that in 2008, 57.2 million tons of food were lost by foodservice providers and consumers, equal to 29% of the edible food supply in the United States. Retail losses totaled 10% (19.5 million tons) of the available food supply, while consumer losses totaled 19% (37.7 million tons) of the available food supply. **Using per capita food loss estimates from this report, this would amount to $341 million per year of food in Vermont that is purchased but not consumed.**

Pre-Consumer Waste

Pre-Consumer waste takes many forms, from food preparation, to purchasing polices, to sales strategies. Grocery stores, for example, often overstock product display shelves under the assumption that it induces more consumer purchases. In the process, however, produce items can be damaged through overhandling by staff and customers, while items on the bottom are damaged from supporting overstocked items on top.[15] By overstocking, grocers are also knowingly purchasing more product than they intend sell, causing them to throw out more food than they would if they adjusted their purchasing to align with consumer demand. Some large grocery stores, such as Stop and Shop and Price Chopper, have saved considerable amounts by moving away from the overstock strategy, and in the process increased customer satisfaction.[16]

Another significant source of waste at grocery stores, and a source of confusion amongst consumers, is "sell-by" dates. Sell-by dates are meant as a management guide for store shelving and stocking decisions, while indicating to consumers that the item is fresh enough to take home and store for days or even weeks. **Sell-by dates, and the many forms they come in (e.g., "expired by," "use by," or "best before") are not**

Let's Make a Date

Date labels are confusing due to the lack of uniformity, and because unbeknownst to many consumers they are communicating information to businesses in the supply chain and not the consumer. A quick guide to clearing up some of the confusion:

"Sell by" date: Intended to help stores make decisions about their stock rotations, this is the manufacturer's suggestion for when the store should no longer sell the product. The date is designed by manufacturers to ensure grocery stores that if a product is sold by that date, it will be of good quality for a reasonable amount of time after purchase.[21]

"Best by" date: The manufacturer's estimate of when the food will no longer be at its highest quality.

"Use by" date: Similar to the "best by" date, usually a manufacturer's estimate of the last day a product will be at its peak quality.

required as a food safety measure by the FDA—with the exception of baby formula. That is, this information is provided at the discretion of the food manufacturer.[17] The issue is that many stores discard products days before the sell-by date, and many consumers discard products at home if they haven't eaten the item prior to the sell-by date, thinking that the item is no longer safe to eat.[18] For example, Journalist Kiera Butler of Mother Jones discovered that the perception among grocery store workers was that not removing a product until the day of the sell-by date was "sketchy."[19] Additionally, The United Kingdom based *Waste & Resources Action Programme* (WRAP) found that 20% of avoidable food waste was being thrown away because of confusion about date labels.[20]

Significant foodservice waste occurs in restaurants, cafeterias, fast food chains, and catering businesses. LeanPath, a pre-consumer foodservice company that sells automated food waste tracking systems, estimates that 4% to 10% of all food purchased by foodservice establishments is lost in the kitchen before it reaches the consumer. Foodservice food losses include overpreparation of menu items, expanded menu choices that make inventory management difficult leading to excess product or spoilage, trim waste either due to imprecise prep work or underutilization of trimmed food, and increased portion sizes that consumers are unable to finish.

The Dining Services at *Fletcher Allen Health Care* utilize a variety of tools and management approaches to reduce food waste. For example, the hospital uses a point of sale system to see what they buy and throw away, analyzes production and consumption totals for menu items and adjusts totals accordingly, and features day specials that use prepped ingredients from the day before that did not get used in its cook to order options. Fletcher Allen also purchases whole products like chicken, breaking them down to make not only primary dishes but soup stocks.

Post-Consumer Waste

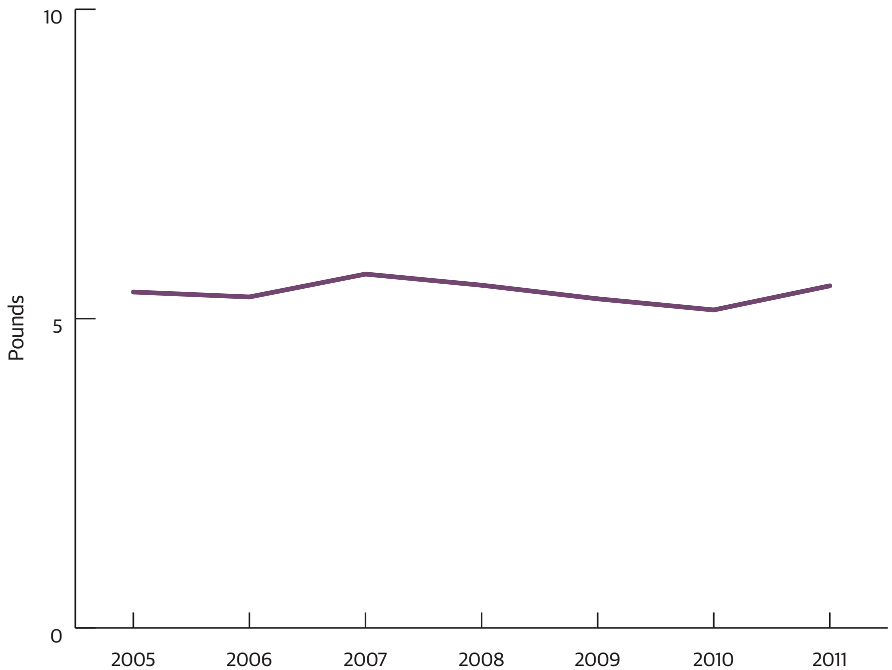
Post-consumer waste typically occurs in two forms: (1) food that spoils because it is not used in time and (2) food that is not consumed because too much was cooked or served. **Fresh fruits and vegetables comprise the largest consumer stage losses due to their tendency to spoil easily, followed closely by dairy products and meat/poultry/fish.** The Natural Resource Defense Council (NRDC) explains that the affordability and accessibility of food in industrialized countries leads to a lack of awareness about food waste and a general undervaluing of foods. NRDC also identifies improper or suboptimal storage, impulse and bulk purchasing behaviors, poor meal planning, over-preparation, and the previously mentioned confusion over label dates as contributors to post-consumer waste.

While post-consumer waste certainly occurs at home, Americans are increasingly purchasing their meals away from home. Consequently, post-consumer waste at food establishments has become of particular concern. As Americans eat out more, they have been exposed to ever increasing portion sizes. For example, from 1982 to 2002 the average pizza slice grew 70% in calories, the average chicken Caesar salad doubled in calories, and the average chocolate chip cookie quadrupled in calories. Additionally, portion sizes can be two to eight times larger than USDA or FDA standard serving sizes. Though it is difficult to draw direct causality, portion sizes at home have increased with portion sizes at food establishments, suggesting that increasing exposure to larger portion sizes at food establishments may be affecting portion control at home.[22]

Implementing portion control measures involves not only the reduction of the portion being served, but also the design of the service area that people are getting their food from. For example, institutions like the University of Vermont have utilized "tray-free" dining in their resident dining areas to reduce post-consumer waste. The elimination of trays means that students carry less food to their table, and must finish what they have prepared before going back to get more food. The initiative originally started with a one-week pilot in 2008, with results indicating a 42% reduction of food waste in comparison to days when trays were in use. Because of the resounding initial success, all dining areas eliminated trays at the start of the 2008/2009 academic year.[23]

Currently, it is difficult to know how many tons per year of food waste are being reduced through source reduction in Vermont. Unless more food establishments conduct yearly waste audits or implement tracking tools like LeanPath, the success of source reduction efforts can only be roughly approximated through per capita waste generation figures in ANR's annual Diversion and Disposal Report. From 2005—2011 Vermont has experienced year-to-year variation but little sustained progress in reducing per capita waste generation, with a high in 2007 of 5.72 pounds per day per capita, and a low in 2010 of 5.14 pounds per capita. In 2011 waste generation per capita rose from 2010 to 5.53 pounds per capita, slightly above the 2005-2011 average of 5.43 pounds per day per capita (Figure 3.7.4).

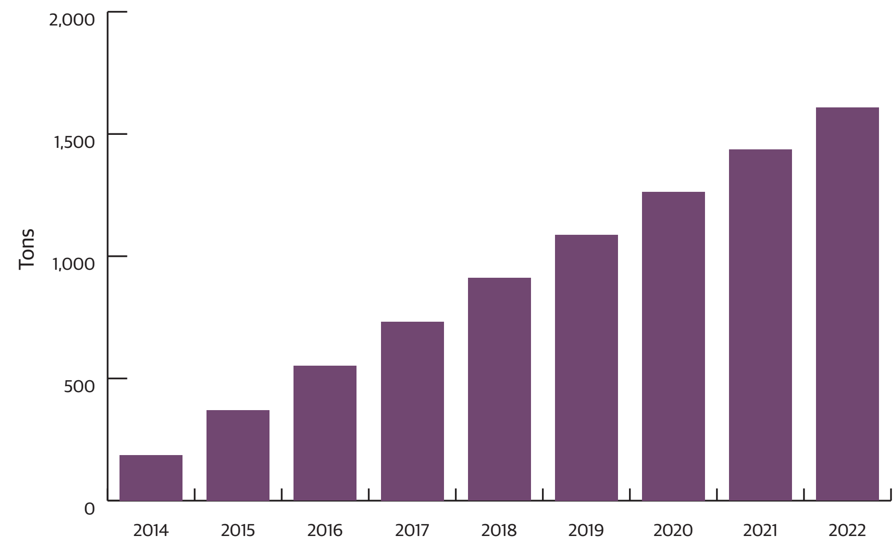
Figure 3.7.4: Vermont Per Capita Waste Generation, 2005 to 2011



Source: ANR *2011 Diversion and Disposal Report*.

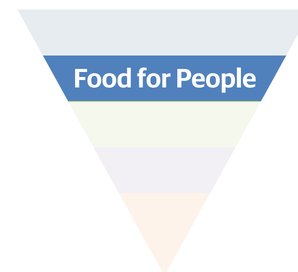
DSM's *Systems Analysis of the Impact of Act 148 on Solid Waste Management in Vermont* report projects 1% reductions per year from 2014 to 2022 in ICI waste resulting from source reduction efforts at the institutional level. Using DSM's assumptions, this would amount to 1,608 tons or 3,216,000 pounds of food waste being reduced through source reduction initiatives by the end of 2022. Reaching 1,608 tons of reduced ICI food scrap waste would be a significant accomplishment, equaling 9% of current ICI food scrap generation (Figure 3.7.5). For context of the scale of the reduction target, the *Vermont Foodbank* estimates that it rescued 1,000 tons or 2,000,000 pounds of food in 2013 from the Vermont food system.

Figure 3.7.5: Projected Source Reduction, 2014 to 2022



Source: DSM Environmental Services *Systems Analysis of the Impact of Act 148 on Solid Waste Management in Vermont*.

Food Rescue



Although source reduction is the highest priority in the Act 148 hierarchy, surplus food from overproduction, overordering, or overpreparation cannot be entirely eliminated. When food waste cannot be addressed through source reduction, the next step is to try to distribute the food to those in need. Food rescue entails the collection of safe, edible food that would otherwise go to waste—sourced from farms, processors, distributors, groceries/retailers, and individuals—for distribution to those who need it most. The rescue and distribution of food is a component of the charitable food system discussed in *Chapter 4, Section 1: Food Security in Vermont*.

Vermont's largest food rescue organization, the Vermont Foodbank, aggregates food from retailers, manufacturers, distributors, farmers, and communities and distributes the food to its Network Partners, including food pantries, soup kitchens, shelters, senior centers, and after-school programs. The Foodbank receives food from both federal commodity programs and Vermont based food enterprises. They estimate that in 2013, 1,000 tons of food were rescued from Vermont based food enterprises, including farms.[24] The Foodbank has seen gradual increases in tons rescued since 2011, when it rescued 600 tons of food from Vermont based food enterprises. The two largest contributors in the supply chain to the Foodbank are distributors and grocery stores/retailers.

Table 3.7.2: Food Rescued from Vermont Food Enterprises, 2011 to 2013 (Tons)

	Grocery/ Retailer	Processor	Distributor	Farm	Total
2011	175	100	250	75	**600**
2012	250	125	300	150	**825**
2013	300	150	350	200	**1,000**

Source: Vermont Foodbank

Food rescued from farms—at the point of production—is known as gleaning. Many farms have surplus crops after commercial harvest that do not make it to market either because it's not economical to recover crops left-over after the initial harvest or because the remaining crop does not meet commercial buyers standards due to blemishes. Surplus crops that are not gleaned get plowed back into the soil. The Vermont Foodbank has its own gleaning program, and also receives fresh produce from its own Kingsbury Farm. The Foodbank estimates that in 2013 they gleaned approximately 200 tons of surplus crops.

Salvation Farms, whose Executive Director Theresa Snow established the Vermont Foodbank's gleaning program, also gleans food from Vermont farms. Snow considers Salvation Farms a resource management organization that focuses on facilitating statewide connectivity of the capture and movement of agricultural surplus fruit, vegetables, and meat in Vermont. Salvation Farms has a vision to create a statewide gleaning collaborative, with regional gleaning programs that deliver professional services and are committed to reducing production level food waste. The organization is working towards the development of a Vermont Commodity Program (VCP) through either raw packing or light processing and freezing of surplus produce from Vermont farms. The light processing aspect of the VCP is critical because it allows for rescued fresh food to be made available to organizations, institutions, and individuals across the state who need it the most. Snow's vision is to have the VCP act as a complimentary system to the for-profit marketplace while simultaneously reducing dependence on commodity crops sourced from federal programs.

Photo Credit: Theresa Snow

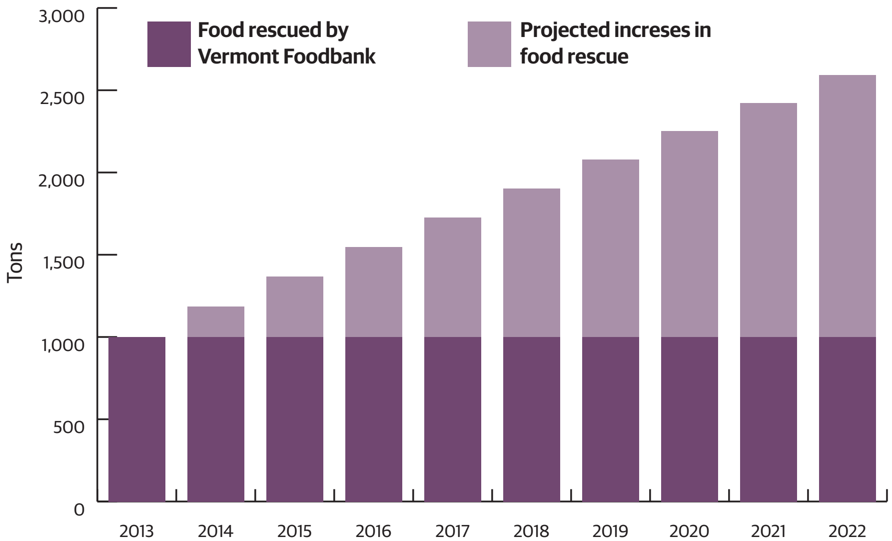
Chard and Spinach from Foggy Meadow Farm ready for delivery

In 2012, in partnership with Rutland Area Farm and Food Link (RAFFL) and Green Mountain College, Salvation Farms lightly processed 1,471 pounds of gleaned produce, and an additional 999 pounds from Westminster Organics. For a raw crop packing pilot, 33,260 pounds of potatoes were cleaned, graded and packed at the Southeast State Correctional Facility. In 2013, in partnership with Pete's Greens, the Vermont Foodbank, and the Vermont Food Venture Center, Salvation Farms processed 315 pounds of gleaned produce. The organization will be processing two more crops in partnership with the Vermont Food Venture Center for VCP product development, and anticipate receiving as much as 50,000 pounds of three crops from at least four farms for the raw crop packing pilot at the Southeast State Correctional Facility. Snow thinks that while Act 148 will have its largest impacts at the retail level, there are a number of public awareness benefits that the law will create because of its promotion of feeding people as the second priority in the diversion hierarchy.[25]

Estimating current gleaning totals without double counting is difficult because the Foodbank may receive gleaned product from other independent initiatives that they then distribute. For example, most of the 33,260 pounds (16.6 tons) of processed raw potatoes from the raw crop packing pilot were distributed to the Foodbank, and it's unclear if the Foodbank counted the pounds in its annual totals. However, assuming that it did, the Foodbank estimates that 75 tons of food were gleaned in 2011, 150 tons in 2012, and 200 tons in 2013.

DSM's Systems Analysis report projects 1% decreases per year in ICI food scrap generation totaling 1,592 tons (3,184,000 pounds) from 2014 to 2022 that is the result of increased ICI food rescue. **The DSM projection of additional food rescue is 59% greater than the Foodbank's total food rescued in 2013, and in combination with the 2013 Foodbank total would represent a 159% increase above the estimated current food rescue level provided by the Foodbank.** Also implicit in DSM's projections is the fact that they treat the opportunity for source reduction and food rescue exclusively at the institutional level (Figure 3.7.6).

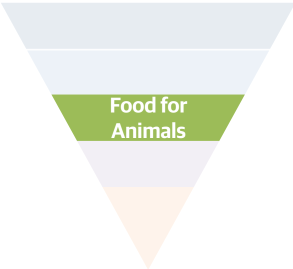
Figure 3.7.6: Current Food Rescue vs Projected Food Rescue, 2013 to 2022



Source: DSM Environmental Services *Systems Analysis of the Impact of Act 148 on Solid Waste Management in Vermont*.

The DSM estimate does not, however, account for reductions that would result from food gleaned from farms because food waste on farm is not landfilled but returned to the soil (on farm waste does not register into the ANR's Diversion and Disposal Report, and hence DSM's projections which use data from that report). Yet the opportunity for increased gleaning could make a significant contribution to Vermont's charitable food system and signify a more efficient utilization of the energy inputs needed to grow the gleaned crops. **Theresa Snow roughly estimates that there is an additional 2 million pounds of fruits and vegetables that are currently not being rescued from Vermont farms** (i.e., another FoodBank's worth of food that could distributed to Vermonters through gleaning).

Food for Animals



If food waste can't be reduced at the source, and edible food cannot be rescued and fed to people, the next priority of the Act 148 hierarchy is to feed food scraps to animals. Food scraps can be utilized as a source of feed for livestock, primarily pigs and chickens. Feed for livestock is the single largest production expense for Vermont farmers, and a variety of factors that have increased feed costs over the years are unlikely to abate (See *Chapter 3, Section 2, Farm Inputs: Animal Feed* for more information). Supplementing forage and grains with food scraps, therefore, presents an opportunity to reduce feed costs and improve overall farm resiliency and viability.

Food processors and large institutions can offer farms a consistent and large volume of food scraps for animal feed. Due to their highly omnivorous nature, pigs are an ideal animal to feed food scraps to as a source of feed. For example, food scraps and waste from breweries, bakeries, restaurants, schools, and dairies can all be integrated into pig diets. A common practice, which is utilized by *Sugar Mountain Farm*, *Willow Hill Farm*, and *Vermont Whey Fed Pigs* is to feed pigs leftover whey from cheese makers. The practice has a long history, and in Parma, Italy, it has supported the cured meat industry. Whey from the manufacture of Parmigiano-Reggiano is used to feed pigs that are raised to make the well-known prosciutto di parma.[26]

Due to the outbreak of Foot and Mouth Disease in the United Kingdom that originated from a "food-waste-feeding" swine farm—and concerns over transmitting other infectious or communicable diseases to pigs—legislation has emerged worldwide restricting or prohibiting the feeding of food scraps containing or contaminated by meat to pigs.[27] In Vermont, 6 VSA § 1671 prohibits the feeding of certain food waste to swine. The chapter defines "prohibited food waste" as "all waste material derived from the meat of any animal (including fish and poultry) and refuse of any character that has been association (handling, preparation, cooking, disposal, or consumption) with meat and meat products."[28]

VAAFM Policy on Swine Feeding

Due to confusion as to whether or not food scraps could be fed to pigs at all, on April 1, 2013, VAAFM released a guidance document clarifying the Agency's policy on feeding food scraps to swine. VAAFM's policy guidance strongly recommends that "high-risk" establishments should not provide their food scraps to farmers if the food scraps will be provided to pigs as a feed source. The document defines high-risk establishments as any establishment where meat (cooked or raw) is present or could be present, such as:

- Bakeries, because they often serve sandwiches or pastries containing meat
- Grocery stores through cross-contamination by workers who handle meat and then handle produce, dairy, or bakery products or by the placement o meat-containing products in containers/barrels with non-prohibited waste
- Cafeterias for the same reasons listed for grocery stores

VAAFM's policy goes on to state that establishments categorized as high-risk that do decide to provide food scraps for the use as pig feed should have policies and protocols in place that prevent contamination, and they should be in communication with VAAFM for review of prevention practices.

Another viable option for using food scraps as a feed source is feeding food scraps to laying hens. As Vermont Compost Company (VCC) has demonstrated, large flocks of laying hens can be successfully fed on food scraps, and the feeding set-up can also be integrated into commercial-scale composting. Chickens are excellent foragers, and will sort through food scraps, eating what they prefer and leaving the remainders for compost. VCC maintains a flock of approximately 1,300 Australorp chickens, of which about 900 to 950 are active laying hens. By using food scraps, which are sourced from food manufactures like Ben & Jerry's and area restaurants and institutions, VCC does not have to feed the flock any commercially purchased grain, which keeps feed costs down. As an added benefit, a large flock of chickens can turn a pile of compost as they dig and scratch, aerating the compost pile and cutting down on labor costs in the process. The model that VCC has created can be amendable to dairy operations, and could be a pathway to dairy diversification, as VCC uses dairy manure from the surrounding area as a significant input for composting. To date, VCC is the only large-scale egg producer using food scraps as a primary feed source.

Unlike pigs, there are no laws against feeding food scraps to chickens containing meat or that have been associated with meat. There may be at some point guidance on preferred practices for feeding food scraps to chickens issued by VAAFM and the State Veterinarian.[29]

Highfields Center for Composting has estimated that one ton of food scraps per year can sustain approximately 2 laying hens. Using DSM's *State of Vermont Waste Composition Study* disposed food scrap estimate, Vermont's 60,078 tons of unutilized food scraps could feed 120,156 laying hens. Using food availability per capita data from the USDA Economic Research Service, we can estimate the number of laying hens needed for Vermont to be egg self-sufficient. Food availability per capita is commonly used as a proxy for food consumption, even though it does not measure actual consumption. The ERS calculates food availability per capita by adding total annual national production, imports, and beginning stocks of a particular commodity and then subtracting exports, ending stocks, and nonfood uses. This number is then divided by population estimates for the area of interest to arrive at per capita estimates of available food for any particular year. The ERS also attempts to account for food losses, from farms to retailers to consumers (e.g., spoilage and waste). Across the F2P Strategic Plan we use the **consumer weight** to reflect the state of a product at the time of purchase.

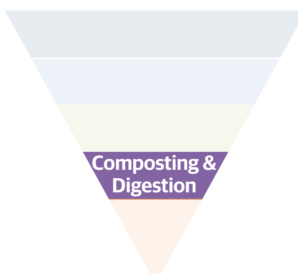
Using egg per capita availability data, we estimate in Chapter 3, Section 3, Food Production: Eggs that Vermont would need between 336,000 to 440,000 laying hens to become egg self-sufficient. The additional available feed from diverted food scraps could support at the lower end of the egg self-sufficiency assumptions 35.8% of the laying hens needed for Vermont to become egg self-sufficient, or at the higher end of assumptions 27.3% of the additional laying hens needed for egg self-sufficiency.

DSM's System Analysis report assumes that of the projected organics diverted from landfills, 30% of the organics management capacity will be low-technology on farm capacity. Using this assumption, we can calculate a more conservative range regarding the contribution of food scrap diversion's contribution to egg self-sufficiency. Thirty percent of DSM's food-scrap diversion estimate is 8,566 tons (28,554 tons x 0.30). If the full amount of the 30% was fed to chickens as feed, it could support 3.9% to 5.1% of the additional laying hens needed for egg self-sufficiency. If half of the 30% was fed to chickens as feed (4,283 tons), it could support 1.9% to 2.6% of the laying hens needed for egg self-sufficiency.

While food scraps can be a viable source of feed for livestock, monitoring the nutrient quality of the food scraps is important to creating a balanced ration that leads to healthy animals. Food scraps have lower dry matter content, which decreases nutrient intake.[30] Pigs fed imbalanced food scrap rations, for example, can have poor fat content or quality that Pete Colman of *Vermont Salumi* describes as "wet and moist and kind of flaccid."[31] For chickens, VCC provides late cut hay, a small amount of grain, and pasture based forage to supplement their food-scrap based diet.

Composting and Anaerobic Digestion

Compost



Unlike the original EPA hierarchy which placed anaerobic digestion above composting, Act 148's hierarchy places the two at the same level, below source reduction, feeding people, and feeding animals. Arguably, however, as VCC has demonstrated, composting and feeding animals are not mutually exclusive pursuits, and the use of compost to fertilize crops and create healthy soils contributes to our ability to feed people. Additionally, the solid digestates that are the result of anaerobic energy production can be used for composting. This is all to say that although composting is lower on the hierarchy and equal with anaerobic digestion, in practice, composting is often complementary to the other objectives defined by the Act 148 hierarchy.

A wide range of materials can be composted, from pre-consumer food residuals (e.g., unpurchased produce from a store or scraps from food preparation at a restaurant) to post consumer food residuals (e.g., uneaten or wasted food). Dead animals, manure, and food processing residuals (e.g., whey and other dairy, cheese making, and ice cream making residuals) can also be composted.

The Highfields Center for Composting, a technical assistance provider for on-farm composting and food waste recycling based in Hardwick, believes that composting is a valuable way to recover nutrients (e.g., food scraps and other organic material) and recycle them, with significant environmental, economic, and community benefits:

Environmental Benefits

- Reduced production and use of chemical fertilizers, reduced greenhouse gas emissions from fertilizer manufacture[32]
- Reduced long distance shipping of fertilizers and chemicals
- Reduced runoff of agrochemicals into watersheds
- Reduced greenhouse gas emissions compared to landfilling and anaerobic digestion[33]
- Reduced greenhouse gas emissions through carbon sequestration in soils[34]
- Reduced topsoil loss
- Increased soil quality with improved drought, disease and weed resistance
- Reduced toxic leachate from landfills

Farm Viability Benefits

- Increased soil fertility improved drought, disease and weed resistance
- Increased or diversified farm income through tipping fees for accepting food scraps and compost sales
- Potential decreased energy use with thermal recovery from compost
- Reduced or eliminated use of chemical fertilizers, herbicides, and pesticides
- Reduced or eliminated expenses for chemical fertilizers, herbicides and pesticides

- Reduced erosion and topsoil loss
- Reduced water runoff due to increased soil moisture retention

Community Benefits

- Increased number of jobs
- Increased community participation in resource management
- Increased local resource and dollar circulation
- Increased community soil and food security

Vermont's Compost Industry

Over the past 10 - 15 years, composting and the use of compost have increased. This change has largely occurred as a result of environmental concerns, farm economics, the development of sustainable food systems and agriculture, and a general rethinking of solid waste – including widespread agreement that we need to reduce the amount of material that goes to landfills.

Unfortunately, for the purposes of assessing the economic conditions of Vermont's composting industry, the U.S. Bureau of Labor Statistics does not provide detailed statistics for analysis. Under the *North American Industry Classification System* (NAICS), a composting operation can be coded under Chemical Manufacturing (NAICS code 325): Nitrogenous Fertilizer Manufacturing (325311), Fertilizer (Mixing Only) Manufacturing (325314); or under Waste Management and Remediation Services (562): Other Nonhazardous Waste Treatment and Disposal (562219). The definitions for the subcategories that a composting operation could be listed under are not well suited to the industry.[35] Based on the lack of establishments listed in each subcategory, it is unlikely that composting operations are using or even aware of the subcategory codes. It will continue to be difficult to determine the economic conditions and progress of the composting industry without a specific NAICS industry code.

However, we do know that there are at least *27 composting facilities* permitted by the Vermont Department of Environmental Conservation (DEC), and at least 9 additional operating sites identified on the Compost / Biogas Viewer and through other online sources (Table 3.7.3). Of the 27 certified composting facilities, 18 are certified to process food scraps, while the remaining facilities are limited to composting animal manure and carcasses. The number of certified facilities listed in Table 3.7.3 differs from numbers cited by DSM's System Analysis—which lists 16 state certified facilities, with 14 certified to process food scraps. The Vermont Compost Company has two facilities, one in Montpelier and one in East Montpelier, but only one is certified with the DEC. Because Vermont Compost Company feeds incoming food scraps to chickens at the Montpelier location, the Montpelier facility is treated as an agricultural operation and exempt from

Kingdom View Compost

Eric Paris' family has deep roots in farming. His family has been farming on its Lyndonville farm, *Tamarlane Farm*, since 1956. In 2003, after years of questioning the input intensive ways of conventional agriculture and searching for ways to improve the health of his dairy herd and the economic health of the farm, Tamarlane Farm became certified organic. Soon after, Paris and his family continued their diversification and opened the *Freighthouse Restaurant* in 2004. One night, while hauling a heavy bag of garbage from the restaurant to the dumpster, Paris decided to look at the contents of the bag. He discovered much of what was being thrown away was food scraps. Paris took the food scraps home and started composting them, building windrows and mixing the food scraps with cow manure from his dairy herd. Soon after, the restaurant began source separating food waste.

Paris quickly saw the potential of using the compost as a fertilizer for his farm. He created a landing area using a crushed glass base and gravel, and constructed a 3 sided receiving bay. Tom Gilbert, the former Director of Highfields, contacted Paris, inquiring if he would be interested in expanding his operation. With the help of Gilbert and Paul Tomasi, director of the NEKWMD, Paris started accepting food scraps from area schools and businesses participating in the Close the Loop! NEK program under the subsidiary Kingdom View Compost. Paris now receives about 7-8 tons a week of food scraps, and expects to be at 10 tons a week as soon as new CTL NEK participants begin being serviced. Paris receives a $25 a ton tipping fee for receiving the food scraps, and says that the zero waste mindset fits well with his decision to transition to organic production.

ANR jurisdiction. The Vermont Compost Company facility in Montpelier is a partnership with a local dairy farm, *Fairmont Farms*, and is certified under the Fairmont Farms name. At least one additional composting company, *CV Compost Co.*, two compost collection companies, *Earthgirl Composting* and *One Revolution Compost*, and one compost consultant, WASTE NOT Resource Solutions, were identified via web search. We do not know how many people these 35 to 40 businesses employ or what they generate in sales.

There are 16 Solid Waste Districts or planning groups that are also involved in food scrap diversion and composting. The programs vary by District, but may include creating and promulgating educational materials, selling composting supplies, providing technical assistance to composters, trucking, negotiating/scheduling with generators, collecting tip fees and paying the composter. The *Natural Resources Conservation Service* (NRCS) and the *Vermont Association of Conservation Districts* also offer technical assistance for siting manure management and compost production facilities, and for improving soil health.

Most of the Solid Waste Districts tend to partner with a farmer or landowner to take materials, but the Chittenden Solid Waste District took over composting operations for the Intervale Center in 2008 after concerns about disturbing Native American artifacts and flooding risks closed the original site. The replacement facility, the *CSWD Organics Processing Facility*, is now located in Williston. Additionally, most composting facilities are concentrated in the central and northern part of the state, with very little coverage in the southern part of the state.

Table 3.7.3: Vermont Compost Facilities

Facility	Town	Feedstocks Accepted
TAM Organics Compost Facility	Bennington	Food waste, leaf and yard, manure, wood waste, paper
Over The Hill Farm	Benson	Animal offal or carcasses, leaf and yard, wood waste, manure
Binding Site Facility	Benson	Animal offal or carcasses, wood waste, manure
Knoxland Farm - Highfields Center	Bradford	Food waste, leaf and yard, wood waste, manure
Greenwood Composting Facility	Braintree	Animal offal or carcasses, leaf and yard, wood waste, manure
Windham Solid Waste Management District	Brattleboro	Food waste, leaf and yard, manure, wood waste
Wise Worm Compost	Burke	Food waste, leaf and yard, manure, wood waste
Sandberg Farm - Highfields Center	Corinth	Food waste, leaf and yard, manure, wood waste
Fisk Haines Compost Facility	Danby	Food waste, leaf and yard, manure, wood waste
Fairmont Farms	East Montpelier	Food waste, manure, other
Essex Composting Facility	Essex	Leaf and yard
White Clover Farm	Fairfax	Animal offal or carcasses
Vermont Livestock Slaughter & Processing Company	Ferrisburgh	Animal offal or carcasses, leaf and yard, manure, wood waste
West Hill Farm; Highfields Center for Composting	Hardwick	Food waste, animal offal or carcasses, leaf and yard, manure, wood waste, other
Greater Upper Valley Solid Waste Management District	Hartford	Food waste, leaf and yard, manure, wood waste
Highfields Compost	Wolcott	Food waste, animal offal or carcasses, leaf and yard, manure, wood waste, other

Facility	Town	Feedstocks Accepted
Paris Farm	Lyndon	Food waste, leaf and yard, manure, wood waste
Foster Brothers Farm	Middlebury	Food waste, leaf and yard, manure, wood waste
Grow Compost of Vermont	Moretown	Food waste, leaf and yard, manure, wood waste
Mud City Maples Farm	Morristown	Food waste, leaf and yard, manure, wood waste
North Hollow Farm	Rochester	Animal offal or carcasses, wood waste, manure
LaPlatte River Angus Farm	Shelburne	Animal offal or carcasses, wood waste, manure
Green Mountain Soil, LLC/ Vermont Vermiculture	Stowe	Food waste, manure
Hudak Farm	Swanton	Food waste, manure, leaves
Brault's Market & Slaughterhouse	Troy	Animal offal or carcasses, wood waste, leaf and yard, manure
Dane Farm	West Charleston	Food waste, leaf and yard, manure, wood waste
CSWD Organics Processing Facility	Williston	Food waste, leaf and yard, manure, wood waste, paper
Locations Identified on the Compost/Biogas Viewer		
Fierce Bad Rabbit Farm	Arlington	Not specified
Masse Poultry Composting	Craftsbury	Not specified
Hayes Farm	Enosburg	Not specified
Powell/Bushway Composting	Grand Isle	Not specified
Footebrook Farm	Johnson	Not specified
Rankin Dairy Farm	Johnson	Not specified
Vermont Compost Company	Montpelier	Not specified
Locations Identified on the Compost/Biogas Viewer		
Donald Moore Composting Facility	St. Johnsbury	Not specified
Lemax Farm	Hartland	Manure
Additional Locations Identified via Web Search		
One Revolution Compost	Burlington	Food waste
CV Compost Co.	Charlotte	Manure
Earthgirl Composting	Chittenden County	Food waste

See Vermont Food System Atlas compost facility search for map of listed facilities/ haulers.

Composting Processing and Capacity

Although we do not have detailed economic data on Vermont's composting operations, we do have estimates for current tons processed, processing capacity, and additional capacity needed in the coming years to handle projected food scrap diversion due to Act 148.

ANR's 2011 Diversion and Disposal Report estimates that Categorical, or Full Certification, composting facilities processed 11,620 tons of organics. Of these 11,620 tons, food scraps comprised 3,144 tons (27%). DSM estimates the food scrap capacity of 14 of the 18 facilities certified to handle food scraps is 22,000 tons per year. Assuming that the 3,144 tons were processed at food scrap permitted composting facilities, these facilities are only operating at approximately 14% of their capacity and processing only 4% of generated food scraps. Additionally, at an operational capacity of 22,000 tons, existing facilities are only capable of processing—using DSM's food scrap generation assumptions—approximately 39% of the food scraps generated in Vermont. We assume that the 3,144 tons of food scraps are coming from institutional sources. Combining this amount with our estimate of backyard composting of 12,963 tons, we estimate that Vermont currently composts 16,107 tons of food scraps.

The Close the Loop Vermont! Strategic Plan 2012-2017, prepared by the Highfields Center for Composting, provides a separate analysis of Vermont's food scrap processing capacity. While DSM's assessment only includes the capacity of certified facilities, Highfields' assessment includes household capacity through backyard composting, on-farm capacity, anaerobic digesters, on-site institutional capacity, and large scale animal feeding capacity that is the result of food processing and manufacturing waste being converted to animal feed. For example, Highfields estimates that *Magic Hat Brewery* processes 165.4 tons/week (8,601 tons per year) of spent grain that is sold as animal feed. In total, Highfields projects that the current food scrap processing capacity is 35,000 tons per year, and is operating at approximately 81% capacity.

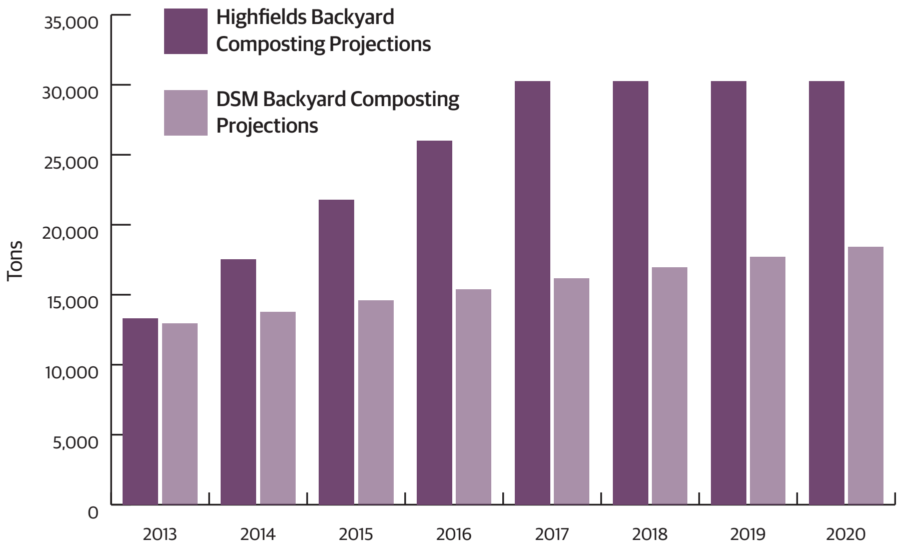
Highfields currently estimates that 22% of residential food scraps are composted in backyard systems. Their goal is to have 50% of residential food scraps composted in backyard systems by 2017. Highfields residential estimate is very close to Farm to Plate researchers residential backyard composting rate of 24%. Highfields 22% estimate equals approximately 13,312 tons, which means they estimate total residential food scrap generation at 60,509 tons. To reach their 50% backyard composting goal, Vermont residents would need to be backyard composting 30,255 tons of food scraps by 2017—a 127% increase above Highfields' current residential backyard composting estimate. Highfields believes that the 50% backyard composting rate is plausible because home composting programs are cost effective, saving residents money on garbage disposal costs, and because most Vermonters have backyard/garden space for composting and compost use—even those in more populated regions (Figure 3.7.6).

DSM's Systems Analysis report projects a much more conservative increase in backyard composting, with 2% increases per year in relation to available food scraps starting in 2014 and ending in 2020. Note that the number of additional tons backyard composted in each successive year in DSM's projections decreases, as it is assumed that each year's two percent increase lessons the number of food scrap tons available for composting and diversion in the next year. Using our baseline estimate of 12,963 tons that are currently being composted in residents' backyards, DSM's projections would amount to 18,434 tons of food scraps composted in backyards by 2020—for a backyard composting rate of approximately 34% of total residential food scrap generation. DSM justifies its conservative rate by reasoning that backyard composting has been available for many years under current solid waste management programs and so the growth rate is not likely to increase rapidly as Act 148 takes effect.

Photo Credit: Jonathan Kaplan

James McSweeney of Highfields Center for Composting explains the composting process to Governor's Institute students

Figure 3.7.7: Current and Projected Backyard Composting, 2013 to 2020

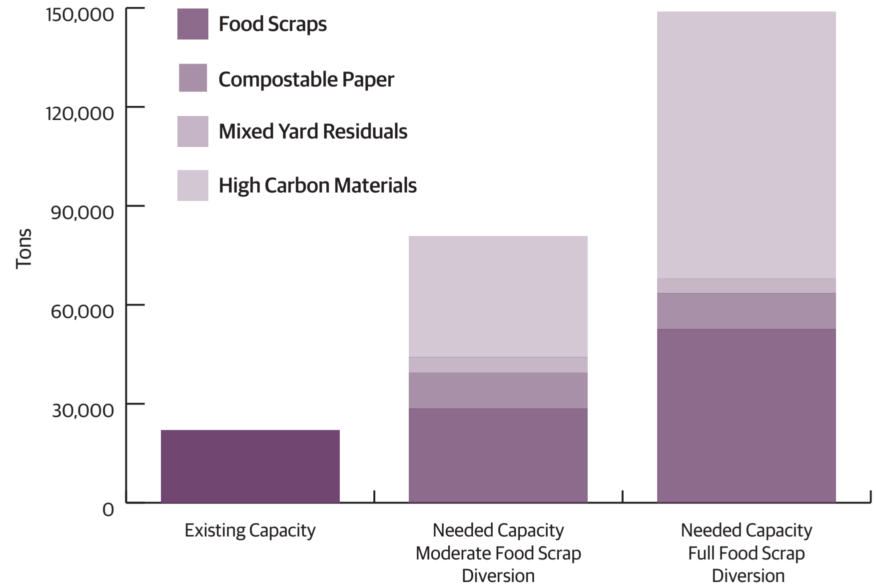


Source: DSM Environmental Services *Systems Analysis of the Impact of Act 148 on Solid Waste Management in Vermont*.

DSM estimates that additional residential composting that will take place from 2014 to 2020 will amount to a 13% reduction (5,471 tons) from current levels in food scrap disposal. Food scrap diversion from new residential collection programs from 2014 to 2020 will account for a 43% reduction (18,007 tons) from current levels in foodscrap disposal. DSM assumes that most of the 18,007 tons of diversion will occur in 2020, when Act 148's ban on all organics disposal goes into effect. Prior to the residential ban on organics disposal, DSM assumes that 10% of residential diversion outside of backyard composting will come from drop-off food scrap diversion programs or subscription to food-scrap curbside collection programs (Figure 3.7.7).

For institutions, DSM projects that 10,547 tons of ICI food scraps will be diverted from landfills from 2014 to 2020. As discussed in previous sections, DSM assumes that 1,608 tons of ICI food scraps will be reduced at the source and 1,592 tons of ICI food will be rescued to feed people, removing these food scraps from the diversion stream that requires off-site compost processing.

Figure 3.7.8: Existing vs Needed Food Scrap Processing Capacity



Source: DSM Environmental Services *Systems Analysis of the Impact of Act 148 on Solid Waste Management in Vermont*.

Together, DSM's ICI and residential food scrap diversion figures equal 28,554 tons of food scraps. At first glance, the gap between an existing processing capacity of 22,000 tons and the combined ICI and residential food scrap diversion tons does not seem far off. However, two factors expand the gap between current capacity and needed capacity in the coming years. First, food scraps will be collected and hauled with other organic materials, including compostable paper and mixed yard residuals. DSM estimates that by 2020, 10,926 tons of compostable paper and 4,610 tons of mixed yard residuals will be collected and require off-site processing along with the 28,554 tons of food scraps—for a total of 44,090 tons of diverted organics that will need off-site processing. Second, good compost requires a balanced mix of nitrogen and carbon. Dan Goosen, of Green Mountain Compost, reports that a good compost recipe is 35% food, 50% leaves, and 15% wood.[36] Based on projected organics diversion estimates, there will be a surplus of nitrogen and a deficit of carbon. Diverted food scraps will comprise 28,554 tons of high nitrogen material, while diverted yard residuals and compostable paper will comprise 15,536 tons of high carbon material. To achieve the right N to C balance prescribed by Dan Goosen, another 36,698 tons of carbon would be required by 2020. **The total processing capacity required by 2020 under these circumstances is 80,788 tons, a processing capacity gap of 58,788 tons (Figure 3.7.8).**

DSM estimates that the total estimated capital cost of constructing the needed processing capacity by 2020 is $26 million. They assume that roughly one-third of the needed processing capacity can be met through animal feeding, existing capacity, and the use of on-farm digesters equipped with food grinding capacity. DSM estimates that this leaves roughly $20 million in needed capital investment to process the roughly two thirds of remaining organics that are estimated to be diverted for off-site processing by 2020. DSM also estimates that approximately $10 million will be needed for new trucks, commercial dumpsters, and residential carts to fulfill the collection needs of Act 148. Approximately half of this amount, $5 million, will be needed for residential carts. **Total costs for Act 148 organics collection are estimated to be around $38 to $41 million by 2022.**

Photo Credit: Highfields Center for Composting

Nate Clark taking a temperature reading of a compost pile at Highfields.

Composting Education and Quality

In conjunction with state agencies, solid waste districts, and other groups, the *Composting Association of Vermont* (CAV) and the Highfields Center for Composting are the main vehicles for education, outreach, and technical assistance for composting awareness. For example, Highfields' Close the Loop program (CTL) is the state's first coordinated campaign to increase diversion of organics to composting. Highfields CTL program facilitates partnerships amongst solid waste districts, area businesses, schools, and composters.

Beyond facilitating program partnerships, Highfields provides technical assistance to stakeholders interested in starting community composting programs, ranging from trainings for students, to hauler training and route development, to composter site development and permitting, management plans, and recipe development. Participants of the CTL program receive 48-gallon totes for food scrap storage, sawdust to control odors, tote quantity tracking, free staff trainings, and promotional materials and opportunities. Program fees are collected based on weekly pick-ups and the size and number of totes used, with price per tote decreasing as more totes are used. The program is currently operating in 3 regions: (1) *The Northeast Kingdom*, (2) *St. Albans*, and (3) the *Lamoille Valley* in the greater Morrisville region. The Lyndon Town School, as part of Close the Loop NEK!, has worked with Highfields to integrate composting into the core curriculum—connecting classes on science, language arts, history, and math with composting. The Close the Loop St. Albans! program has helped to establish on-farm composting at the Hudak Farm. Overall, the CTL program has demonstrated how universal composting can work effectively in Vermont's rural areas without large centralized processing facilities.

CAV develops programs and workshops that provide compost technical assistance and education to a diversity of stakeholders that includes schools, farms, municipal officials, and Department of Transportation personnel. For example, *Compost 201: Best Practices for the Use of Compost in Vermont Towns* is a 4 hour workshop for Vermont decision-makers, professionals, and advocates that examines how communities can achieve environmental and economic benefits from the use of compost in development, road construction, landscaping, and land management projects. CAV has also helped conduct several stormwater and erosion control demonstration projects, such as the Jamaica restoration project along Old Route 8 which used compost blankets and filter socks to repair eroded and washed out roadside banks. CAV has turned its attention in recent years to working with Vermont Agency of Transportation crews to educate them on the use of compost products for transportation projects. The use of compost for transportation projects is an important market for compost products, and is a significant market driver in states such as Texas.

UVM Extension's Vermont Master Composter Program is an important educational program that is designed to not only teach participants about compost best practices, but to extend that knowledge to the public. The program runs every two years—dependent upon grant funding—and requires 20 hours of volunteer community project work. Additionally, in order to maintain certification a Vermont Master Composter must complete 5 hours per year of community outreach.

Because the Agency of Natural Resources has statewide reach, they are well positioned to set the foundations of organic diversion and compost awareness. In ANR's *Draft Materials Management Plan*, the agency has placed a significant emphasis on education and outreach, noting that in order to get rid of the "ick" factor more awareness is needed on the benefits of organic waste reduction and composting.[38] ANR has outlined an outreach and educational strategy that includes:

For schools:

- Tools and resources for teachers to impart the fundamentals of waste management at home, school, and on the go.
- The creation of designated School Waste Reduction Advisory Committees comprised of students, teachers, administrative staff, facilities/cafeteria staff, and parents that make decisions and recommendations for school organics programs and ensure the sustainability of waste reduction programs.
- A written school policy stating a commitment to school-wide organics program, that would include a waste audit.
- The development of a method to track waste diversion and track weekly gallons or pounds of food scraps diverted.

For businesses, institutions, and the general public:

- Education and outreach for the commercial sector and the general public about the benefits of reducing food waste and options for diversion including but not limited to: website materials, newsletters, mailings, and presentations at statewide, regional, and local stakeholder meetings.
- Creation of Accepted Compost Practices in collaboration with compost professionals and SWDs.

A Composting Study Committee, set up by the Legislature in 2007 to examine state regulations pertaining to composting, identified a diverse yet unevenly distributed set of composting programs in Vermont.[37] They include:

Master Composter Program

Paid print and radio ads

Community sustainability fairs

Composting Listserv

Vermont Organics Recycling Summit

Tours of composting facilities

Information Booths

Stakeholder and legislative planning efforts

Technical assistance / Business assistance

Website compost pages

Education and outreach publication creation and distribution

Waste audits

Compost book & video borrow libraries

Carbon Lite Lunch program for businesses

Direct mailings

School presentations

Free and discounted kitchen compost collectors or pails

E-newsletters

Worm composting programs for schools

Backyard composting demonstration sites

Press releases

School curricula

Drop-off organics collection

Business on-site organics collection

Compost collection container loaners for community and private events

On-farm composting demonstration sites & technical assistance

Promotion of use of compost

Sale of discount compost bins

On-farm composting including mortality composting workshops

The need for comprehensive and evenly distributed composting education is of growing importance as Act 148's 2020 residential mandate approaches, and as larger institutional generators such as schools will be required to divert food scraps within the next 5 years. It is important that there is an overall awareness of the organics diversion mandate, but it is equally important that households and institutions are utilizing best practices that ensure that food scraps that can be composted are being composted and that materials that might cause contamination are not included.

Plastics in Compost

Plastics in the organics stream are a particular concern for Vermont composters. Plastics that are commingled with organics don't break down—or those that do don't break down fast enough—and composters are left with the added costly step of sorting out the plastic material before being able to sell their product. Keeping plastics out of the organics stream can be difficult for consumers for a variety of reasons. Some paper-based food container products that consumers may think are safe to compost have plastic coatings that can keep the container from breaking down. Eco-Cycle, a Boulder Colorado based nonprofit resource conservation organization, conducted research showing that plastic coatings shed from the container and remain in the compost as micro-plastic fragments.[39] Little is known about how these micro plastics affect soil processes and soil based organisms. There are also concerns that micro-plastic fragments in compost will accumulate in soils and migrate into other land and aquatic ecosystems where they may pose risks to wildlife.

Another source of consumer confusion is caused by misconceptions about the terms "biobased" and "biodegradable" and poor product labeling standards that can give consumers the impression that a product is compostable when it is not. Biodegradability is a relative term that simply signifies whether or not the material breaks down in a timeframe that is closer to a year than it is to 1,000 years. Many people believe that a plastic that is biobased (i.e., a plastic made from a plant derived source such as corn, sugar, or starch rather than a petroleum-based plastic) is the same as a plastic that is biodegradable.[40] According to a study commissioned by the American Plastics Council (now the Plastics Division of the American Chemistry Council), 80% of consumers believe that packaging made from natural, biobased materials is more likely to biodegrade than packaging made from synthetic materials. However, not all biobased plastics will biodegrade because they are designed to behave like a traditional petroleum-based plastic (i.e., many of which have decomposition rates that are closer to a 1,000 years). Furthermore, a the conditions of biodegradation are contingent upon a material being in a specific environment (e.g., marine, soil, and compost facility). Therefore, **a material that is biodegradable is not necessarily compostable.** The American Society for Testing and Materials (ASTM) has developed testing standards for compostable plastics, and the ASTM standard is used by the Biodegradable Products Institute (BPI) to certify and label compostable products. The ASTM standard, known as the D6400 standard specification, has three provisions that must be met:

The Biodegradable Products Institute's compostable product certification label

1. The product must physically disintegrate to the extent that it cannot be "readily distinguishable" from the finished compost product.
2. The product must actually biodegrade (be consumed by microorganisms) at a rate comparable to known compostable materials.
3. The product cannot have adverse impacts on the ability of the compost to support plant growth.

In California, the use of the term "biodegradable" is prohibited, and only containers that meet the D6400 standard are permitted to use the term compostable.

An additional level of complexity is whether facilities in Vermont will accept certified compostable plastics, or bioplastics. Most Vermont composting facilities do not accept plastics of any kind, with the exception of Green Mountain Compost in Williston which does accept BPI certified compostable plastics. The reason most Vermont composting facilities do not accept bioplastics is because in 2012 the *USDA's National Organic Program* decided to not accept compostable bioplastics as a feedstock for certified organic applications. Organic producers in Vermont and the Northeast are an important market for Vermont's composting industry, so the need to keep a clean stream is critical. The price per yard for organic compost can be $10 more than uncertified compost.[41] Because Vermont's compost industry is in an early stage of development, it cannot afford to lose one of its largest agricultural clients. Vermont's organic growers' economic viability is at risk as well if they are unable to apply Vermont made compost products to their soils.

While not accepting plastics of any kind helps protect Vermont composters from the risk of losing organic certification and certified organic clients, there may eventually be pressure from consumers and haulers to accept compostable plastics. It has been claimed, and some anecdotal evidence from other composting initiatives supports the claim, that allowing residents to use compostable plastic liners increases composting program participation. According to this view, compostable plastic bags remove the "yuck factor" that people have about composting and conforms to the common practice of lining waste containers. The advantage for haulers is that liners can extend the life of containers and totes, and reduce cleaning requirements. The downside to using plastic liners is that they can mask contamination, as it's more difficult to see non-accepted materials within the bag, and it is difficult for haulers and processors to identify whether or not the bag is compostable.

It is conceivable that Vermont's compostable plastic policy will vary by region, with facilities serving larger population centers allowing the use of compostable plastics, as is the case with Green Mountain Compost. Noah Fishman, Program Manager at Highfields, says that so long as organic certification prohibits bioplastics in compost a strong market factor will influence what facilities accept. However, Fishman also notes that there is a strong push by the bioplastics industry to allow BPI certified plastics in certified organic compost. If the industry's lobbying is successful, Fishman foresees more facilities accepting food scraps with plastics.[42] Either way, there is a significant need to educate the public on best practices, and the emphasis on composting education is more pressing in areas where facilities will not be accepting compostable plastics.

Persistent Herbicides

As Green Mountain Compost discovered in the summer of 2012—much to their chagrin—persistent herbicides are another quality control issue facing the compost industry. Persistent herbicides are a class of herbicides that are used to control a wide variety of broadleaf weeds by affecting growth regulating hormones. They are formulated to persist over multiple years in certain growing environments, and their use has been promoted, in part, because they are ineffectual on mammals, reptiles, and birds—capable of passing unscathed through urine after treated grasses have been eaten. Yet, it is for this reason—the fact that they remain active for long periods until they come into contact with broad leaf plants—that persistent herbicides pose a risk to composters and farms that use compost. Most non-persistent herbicides and pesticides are degraded by the high temperature environment of an aerobic commercial compost pile. Persistent herbicides, however, can survive the prolonged heated composting process intact and will effect the growth of plants that contaminated compost is applied to.

The two persistent herbicides of concern are the Dow AgroSciences manufactured Clopyralid, created in 1978, and Aminopyralid, created in 2005. Both can have significant impacts at parts per billion (ppb) concentrations. Based on trials, Clopyralid has significant impacts as low as 3-10 ppb, while Aminopyralid has significant impacts as low as 0.2 ppb. Common plants effected by the two herbicides are the bean family (Leguminosae), potato/tomato family (Solonaceae), sunflower family (Compositae), along with many common flowers.[43] Symptoms of contamination include poor seed germination, twisted and stunted stems, curled leaves, and reduced and mis-shaped fruit. Tomatoes, for example, become considerably more oval with reduced fruit diameter.

The contamination was first reported and identified in two gardens on June 25, 2012. The Vermont Agency of Agriculture, Food and Markets (VAAFM) pathologist and pesticide chief confirmed that herbicides were the problem by the same afternoon. Green Mountain Compost suspended the sale of their bulk compost immediately after the state pathologist and pesticide chief confirmed the contamination. Three days after discovery, Green Mountain Compost created an online FAQ and reporting form. Over the course of just the first week, Green Mountain Compost had 196 documented cases of herbicide damage. In total, Green Mountain Compost had 510 confirmed cases of contamination and paid out 449 individual claims. The overall estimated cost of contamination to Green Mountain Compost was $792,000.

After 5 rounds of testing, VAAFM and GMC concluded that the source of the Aminopyralid was from horse manure and bedding, while Clopyralid came from not only horse manure and bedding but chicken manure, food residuals, and commercial grass clippings. The reason that both Aminopyralid and Clopyralid are in horse manure is because persistent herbicides are used to suppress broad leaf plants that make horses colicky—like clover, alfalfa and vetch—from pastures and hay that horses feed on. Though Aminopyralid is rarely used in Vermont (records indicate only one horse farm applied it in the last three years), it is applied more widely in other states where hay is grown for horse feed, particularly Kentucky. VAAFM Agrichemical Management Section Chief Cary Giguere believes that after Tropical Storm Irene, many horse farms had to purchase hay from out of state and this may have led to increased levels of Aminopyralid contamination in horse manure. Additionally, horse feeds include beet molasses from sugar beets— and roughly half of the Clopyralid applied nationally is used for sugar beets. This explains the high concentrations of Clopyralid in horse feed—in some cases as high as 100 ppb.

Chittenden Solid Waste District (CSWD) General Manager Tom Moreau reported that after analyzing chemical test results, CSWD staff concluded that they ***had*** an acute problem with Aminopyralid and ***have*** a chronic problem with Clopyralid. The reason is that though Aminopyralid is believed to be responsible for most of the problems experienced by growers, the residues only come from pasture use or hay and subsequently horse manure, so it is relatively easy to exclude from compost. Clopyralid is used on a wider variety of agricultural crops, including grains, and is thus found in a wider range of feedstocks. For example, Clopyralid residue has been found on pasta and bread food scraps, indicating that it persists through each stage of the food system. As Moreau sees it, Aminopyralid needs to be avoided while Clopyralid needs to be managed.[44]

Vermont composters are now focusing on developing techniques to detect and manage for persistent herbicide contamination. Some state and commercial labs can detect the presence of Clopyralid down to 1 ppb in compost and manure samples. Aminopyralid presently can only be analyzed down to 1 ppb in compost and manures by Dow's own lab, which is problematic because Aminopyralid is believed to have impacts on plants as low as 0.2 ppb. Lab tests can also be expensive, the tests are chemical specific, and selecting a representative sample can be difficult.

Composters do have other means available to them to reduce the risk of contamination. Karl Hammer of the Vermont Compost Company has been anticipating persistent herbicide contamination since 2002 when it occurred at a facility in Spokane, Washington. Hammer has been conducting bioassays since that time—which entails growing potted plants to test for chemical toxicity by comparing plants growing in a clean growing medium with plants that are growing in the medium being tested for contamination—with the hope of catching contamination in trials before marketing the compost. Hammer's longer curing period is also believed to reduce the effects of Clopyralid, and Green Mountain Compost has now moved to a longer curing process. Green Mountain Compost has also been running herbicide targeted bioassays since the fall of 2012, with one sample for every 100 cubic yards of product. Dan Goossen estimates that they will have 90 to 100 growing pots at any given time, requiring about 2-3 hours a week to maintain. The one drawback of using bioassays is that running a test takes 4-5 weeks to complete, so extra storage space may be needed to keep finished product before it goes to market as a facility awaits test results.[45]

Other measures to prevent persistent herbicide contamination are *feedstock acceptance*, *recipe management*, and *recipe amendment*.

Feedstock acceptance is simply whether or not a facility will accept a particular feedstock. Green Mountain Compost has stopped taking horse manure until a reliable testing method is developed, though other Vermont compost facilities are still cautiously accepting horse manure because of its favorable C:N ratio.[46] Green Mountain Compost also segregates out grass clippings, which tend to have high concentrations (10-50 ppb) of Clopyralid. Some concerns about Aminopyralid have been assuaged due to Dow voluntarily changing its labeling of Aminopyralid to restrict its use on pastures in the Northeast. Doing so will prevent Aminopyralid from being applied to hay fields in the Northeast that may supply horse farms. VAAFM has also made the herbicide known under the trade name "*Milestone*", which contains Aminopyralid, a Class A-Restricted Use herbicide. As a Class A-Restricted Use herbicide, *Milestone* can only be applied by a licensed applicator who is required to report the number of applications once a year to the state. With these requirements, the state can monitor its use and better track the potential sources of Aminopyralid contamination. Some composters, however, are still concerned about the inability to monitor and restrict online purchases of the chemical and purchases of feed that come from Canada and states outside of the Northeast.[47]

Recipe Management involves limiting the amounts of various feedstocks present in the recipe through mathematical formulation in order to achieve the targeted levels of carbon content, nitrogen content, moisture content, and persistent herbicide content. Facilities using horse manure in their recipe would aim to keep concentrations of Clopyralid below 10 ppb and Aminopyralid below 1 ppb based on the concentrations that are assumed to exist in horse manure and bedding (assuming no decay because the exact rates are not yet known).[48] Horse manure and bedding would not be added if the persistent herbicide concentrations were at or approaching their target levels.

Recipe Amendment involves the addition of a substance into the recipe that is intended to mitigate the effects of persistent herbicide contamination. Dan Goossen has found that high carbon wood ash can result in growth responses as good as control pots within 4 to 5 weeks.[49] The high carbon wood ash binds the herbicide into a carbon matrix that effectively makes it inert. The challenge of adding an amendment like wood ash is that the pH level can become too high, and as a result, essential nutrients are no longer available in soluble form to plants.

Composting Policy

According to CAV, Vermont's composting regulations have been crafted without the benefit of a comprehensive state policy framework, or a big picture perspective for composting. For example, the VAAFM's Accepted Agricultural Practices (AAPs) are typically used to define agricultural activities in Vermont, but regulatory oversight is shared between VAAFM, the Agency of Natural Resources (ANR) Solid Waste Management division, municipal zoning, and the solid waste districts. Act 250 rules may also pertain to composting activities. Act 141 created five Act 250 exemptions for commercial on-farm composting. In addition, an applicant can utilize the little known "Stonybrook" analysis, which would take the non-composting portion of the farm out of Act 250. Since the process of receiving an Act 250 permit adds time and costs to permitting a project, it is assumed that some potential compost operators are dissuaded from beginning in the first place. In the interest of clarifying the regulatory issues for handling, disposing, and recycling compostable materials, CAV released a white paper in 2007 that recommended a stakeholder process to improve regulations and the permitting process for composting facilities.

As a result, CAV convened a "Legal Compost" review process, involving stakeholders from the composting industry, government agencies, solid waste districts, and farm and environmental organizations. The Legal Compost report, Advancing Composting Through Stakeholder Involvement, reflects a series of meetings held in 2008 that provided a set of permitting and general compost support recommendations for policymakers and regulators.

Following the Legal Compost report, the Vermont Legislature ordered the formation of a Compost Study Committee (Act 130) to provide recommendations on rules for the construction, alteration, and operation of composting facilities. The committee proposed a 5-tier structure for regulating compost based on size, including backyard, on-farm, small-scale composting, medium-scale composting and large-scale composting. ANR has consolidated the backyard tier with some forms of on-farm composting to create 4 levels of regulation: exempt, small, medium, and large (See Table 3.7.4)

- Backyard composting that consists of 100 cubic yards or less of compost production a year would not fall under Act 250 regulation, and would not be subject to state oversight, since it is considered a low risk. On-farm composting exemptions for Act 250 were recommended to allow for greater flexibility for certain types of composting. The exemptions would be allowed if the compost was principally produced on the farm, used on the farm it was produced on, or made from manure produced on the farm and mixed with clean, high-carbon bulking agents from anywhere.

- Committee members agreed to allow on-farm composting of 1,000 cubic yards of food processing residuals without losing "On-farm" status, but did not support the composting of other pre-consumer food wastes and post-consumer food wastes under "on-farm" status. The VAAFM noted that a farm would not be prohibited from composting these food residuals, however, ANR would have regulatory jurisdiction over the management of the facility.

- The committee proposed that small-scale composting facilities would be regulated by ANR. The committee did not agree on whether a new Act 250 exemption should be created for small-scale facilities located on farms. Small-scale composting facilities would be governed under new On-farm and Small-Scale Facility Accepted Composting Practices (FSACPs), to be determined by ANR. FSACPs would be modeled on VAAFM's existing AAP program.
- The committee proposed that medium-scale composting facilities would continue to be regulated by ANR. As with small-scale facilities, there was no agreement reached on whether a new Act 250 exemption should be created for medium-scale composting facilities on farms. These facilities would be treated as categorically certified solid waste facilities. These certifications would be considered "minor" ANR permits and have established standards for the siting, design, and operations of the facility. In addition to solid waste jurisdiction, a facility operator would be required to apply for any other applicable permits (including stormwater, underground injection control, and indirect discharge).
- Finally, large-scale composting facilities should continue to be regulated by ANR and Act 250. Large composting facilities would be required to obtain a full solid waste certification, any other permit required by ANR, and an Act 250 permit.

H. 145, approved in 2009, required the Secretaries of ANR and VAAFM to propose rules for accepted composting practices by February, 2010 that addressed:

- Standards for construction, alteration and operation of a composting facility
- Standards for facility operation (e.g., odor control)
- Facility siting standards; composting processing standards
- Standards for run-off management
- Specific areas that are unsuitable/off limits for commercial composting
- Definitions on operations sizes (small permit seekers will not have to get a discharge, solid waste, or air emissions permit, while back yard composting would be exempt from all permits).

Table 3.7.4: Vermont Compost Regulations and Exemptions

4 Levels of Regulation			
Exempt	**Small (Registration Required)**	**Medium (Categorical Compost)**	**Large (Full Certification)**
• Composting <100cy/yr any feedstocks • Managing <3000 cy/yr leaf/yard/plant/wood and <20% is grass • Managing food residuals in a digester and <1% of design capacity is food • Composting only manure, bedding, and clean carbon bulking agent • Composting vegetative farm waste on a farm from any farm • Composting <1000 cy/yr food processing residuals on a farm • Composting animal mortalities and slaughterhouse waste from a farm on the farm	• Compost management area must be <4 acres, not including acreage required for liquid nutrients management • Composting <5,000 cy/yr feedstocks. Including not >2,000 cy food residuals/food processing residuals. No animal mortalities, slaughterhouse waste, or offal. • Compost <10,000 cy/yr of solely leaf, yard & untreated wood residuals	• Compost management area must be <10 acres, not including acreage required for liquid nutrients management • Composting <40,000 cy/yr feedstocks. Including not >5,000 cy food residuals/food processing residuals, and not >10 tons/month animal, offal, or butcher waste • Or composting >10,000 cy/yr of leaf and yard waste	• Compost management area >10 acres— not including acreage required for liquid nutrients management—or do not qualify for medium certification • Compost >40,000 cy/yr or <40,000 total but >5,000 cy/yr food residuals/food processing residuals, or >10 tons/month animal, offal, or butcher waste

Act 250 Exemptions and Regulations	
Exemptions	**Medium- and large-scale facilities**
Composting on a farm is exempt from Act 250 if: • Compost is principally produced on the farm; • Compost is principally used on the farm; • Compost is made only with manure produced on the farm and unlimited bulking agents; • Compost is made on a livestock or poultry farm, only with manure produced on the farm, up to 2,000 cy/yr of inputs approved in the Accepted Composting Practices (ACPs), including food residuals from any source or imported manure or both, and unlimited bulking agents; maximum size 10 acres or 10 percent of parcel, and gross income from farm exceeds that from composting; or • Compost is made on a cultivation or crop farm that complies with the ACPs, from up to 5,000 cy/yr total organic inputs allowed in the ACPs, including up to 2,000 cy/yr food residuals, maximum size four acres or 10 percent of parcel, gross income from farming exceeds that from composting, and obtains a Categorical Certification from DEC.	Act 250 permitting required for all medium- and large-scale composting facilities.

Finally, Act 141, following on the heels of the Legal Compost Report and the Compost Study Committee, was passed in 2010. Act 141 created tiers of permitting for small, medium and large composting facilities, regardless of where they are located (on or off a farm). The Act also made a distinction between agricultural composting, which is under the jurisdiction of VAAFM, and commercial composting, which is regulated by ANR. For on-farm commercial composting, the operator may or may not need an Act 250 permit depending on the volume and type of material being composted (see Table 3.7.4 for Act 250 exemptions for on-farm commercial composting). Under the Act, permits that may be required apply only to the parcel of land that has something to do with composting, not the rest of the farming operation.

ANR published new draft solid waste rules pertaining to composting in March 2011. The draft rules cover such topics as siting, operation standards, certification exemptions (e.g., as covered in Act 141), and other accepted composting practices, as well as proposing the jurisdiction boundaries for composting oversight between ANR and VAAFM.

Anaerobic Digestion

In the Act 148 hierarchy, anaerobic digestion is treated with equal preference to composting. Digesters can use slurried food residuals for energy generation, and the remaining solids from the digestion process can be used for animal bedding or composting.

Anaerobic digester systems have four basic components: a manure collection system; an anaerobic digester that optimizes "biogas" (e.g., methane and carbon dioxide) production through manure digestion; a biogas handling system, and a biogas use device (e.g., generator, boiler, heat exchanger) that combusts the biogas to generate electricity and/or heat. During the combustion process, methane is converted into carbon dioxide, a less potent greenhouse gas.[50] Digesters have been used in the United States since the 1970s, and can be found in operation on over 200 sites nationally. Vermont ranks 4th in the nation in installed anaerobic digesters[51] (behind Wisconsin, New York, and Pennsylvania), and the feasibility of many more systems is being explored. Byproducts of anaerobic digestion include reduced odor, a nitrogen rich liquid fertilizer, animal bedding that replaces purchased sawdust (which can be a substantial expense—as much as $120,000 for some larger dairy farms)[52], and a more closed-loop nutrient management system.

AgSTAR, a joint program of the U.S. Environmental Protection Agency, U.S. Department of Energy, and U.S. Department of Agriculture, is the federal government's education and outreach platform for promoting the use of methane for energy generation. In Vermont, the Green Mountain Power (GMP) Cow Power program, VAAFM, Vermont Clean Energy Development Fund, Vermont USDA Rural Development office, NRCS office, and other private consultants provide technical assistance and financial resources for anaerobic digester development.

Avatar Energy is Vermont's only anaerobic digester research and development and manufacturing business, with clients across the United States and British Columbia. Avatar's digester systems are geared toward small and medium sized farms. One system is currently operational in Vermont (at Keewaydin Farm in Stowe). Avatar has

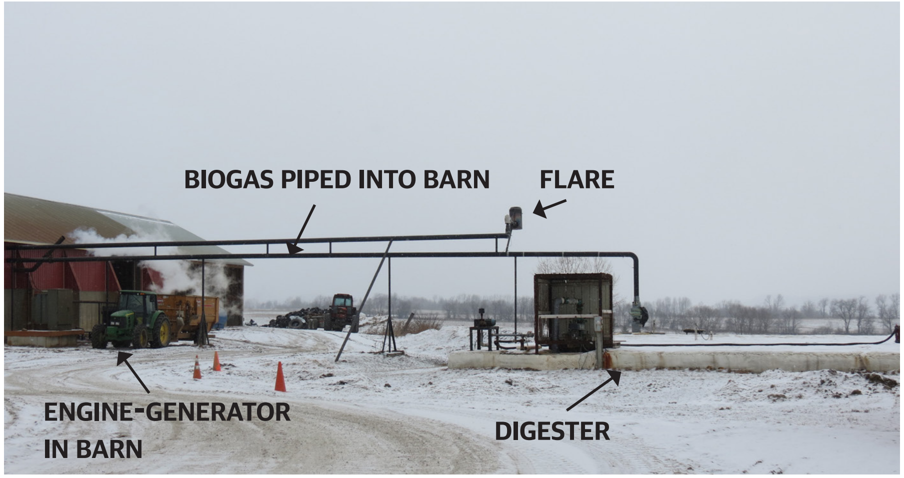


Photo Credit: Matt Maxwell

Anaerobic digester at Maxwell's Neighborhood Farm. The engine-generator is housed in the building at the left. To right is the digester, part of which can be seen protruding above the ground. A pipe emerging from the digester carries biogas to the engine, and another pipe can be seen leading to the flare, used to burn the biogas in case the engine is not able to take the biogas.

also developed a small scale organics digester for urban and institutional settings called the Compact Organic Reactor.

Vermont currently has 16 operating digesters, with a few nearing completion, and several others in planning stages. Vermont's first "community" anaerobic digester at Vermont Technical College is expected to be fully operational and producing biogas in early 2014. Operational digesters currently have the capacity to generate about 41,000 megawatt-hours per year, equal to 0.8% of Vermont's residential, commercial, and industrial electricity consumption in 2012 (5 million megawatt-hours).[53] Most existing and under development digesters are enrolled in the Sustainably Priced Energy Development Program (SPEED), which provides long term contracts for electricity production. For example, anaerobic digesters receive $135.9 per megawatt-hour of electricity produced in year one of their contract, and $142.2 per megawatt-hour of electricity produced in year ten. Anaerobic digesters, along with the heat produced by combined heat and power facilities, are the only energy producing technologies that keep their "renewable energy credits" (RECs) through the SPEED program.

Many of the existing or planned digesters are also part of the Green Mountain Power Cow Power program. Cow Power allows electricity consumers to voluntarily pay a 4 cents per kilowatt-hour premium on top of the regular retail rate to purchase digester produced electricity from Vermont farmers. The program functions like many utility offered green payment electricity programs that have emerged across the country in the last decade, in which the premium is used to purchase the renewable attributes of the energy source. GMP, therefore, uses the 4 cents to buy the renewable energy attributes of the farm digester generated energy.

Photo Credit: Vermont Agency of Ag

Guascor engines are commonly used with methane digesters in Vermont.

If the digesters are supplying more energy than what is demanded voluntarily by Vermont ratepayers, GMP sells the renewable attributes—in the form of RECs—into the New England REC market. In this case, the proceeds of the REC sale go to the farmer as well.[54] So long as there is demand in the New England REC market, and prices are equal to or higher than 4 cents per kilowatt-hour, the lack of local demand is not necessarily an immediate impediment to on-farm digester profitability. For example, though by the end of December 2012 digester production outstripped Vermont customer demand by 35%, RECs in the Connecticut market were selling for more than 4 cents per kWh.[55] However, GMP continues to work on growing the customer base in Vermont because relying exclusively on regional REC demand exposes farmers to price fluctuations, making digester investment and economic feasibility riskier over time.

A few digester systems are net metered, that is, they generate energy for farm needs but are also connected to the electricity grid so that excess electricity can be fed back to the utility. Net metered projects receive credits on their utility bills, rather than payments for electricity generated. In this case, the customer only pays the "net" amount of electricity used (energy used minus energy generated) and if energy generation is equal to or greater than energy used the customer pays nothing.

Eleven of the 16 (69%) anaerobic digesters in Vermont already receive significant streams of organics in the form of processing wastes such as ice cream and whey, brewery waste, and even liquid food residuals from food processors in the Boston area and Maine.[56] Food residuals are desirable because they can improve the energy output of the digester. According to Michael Raker of Agricultural Energy Consultants LLC, adding 10% slurried food residuals to a digester can potentially double energy output.[57] DSM reports, however, that Vermont food processors have been fully tapped for their pre-consumer liquid residuals, so there is not enough supply to meet current on-farm digester demand for pre-consumer liquid residuals.

Vermont's on-farm digesters need the organics in liquid form rather than in solid unprocessed form because they are not high solid dry fermentation digesters. The processing waste they receive has a solids content ranging from about 2% to 15%, while high solid digesters with a solids content of about 60% process organics in a mixture that is closer to that of compost.[58] DSM estimates that if 10% of the installed digester capacity were made available for liquid food residuals it would amount to over 50,000 tons per year, which is greater than their estimate of approximately 45,000 tons of food residuals per year that will need to be processed. Solid diverted food scraps would need to be pre-processed before being mixed into on-farm digesters, either at transfer stations where the liquid would then be hauled to farms, or on the farm itself. On farm processing would cost in the range of $50,000 to $100,000 for pulping equipment, a reception building, and storage tank.[59]

A preprocessing model exists in Massachusetts that may be replicable in Vermont. *AGreen Energy LLC*—a consortium of five dairy farms—participates in a joint venture model that includes Casella organics, in which the dairy farms digesters receive liquid food residuals that are hauled to the farms by Casella operated trucks. AGreen Energy is responsible for financing, siting, and constructing the digesters, and supplying cow manure once the digester is operational (thus far, one of five planned digesters has been constructed). Casella operates the facility, which includes responsibility for sourcing the food residuals and managing the recipe for optimal energy production.

VAAFM supports the preprocessing model, or what Senior Agriculture Development Coordinator Alex DePillis refers to as "Nutrient Management Centers" where food residuals would be centrally aggregated, processed, stored, and then regionally distributed. In comments submitted to ANR for DSM's Systems Analysis, VAAFM provided the following reasons for supporting this approach over a strategy dedicated to on-farm processing:

"The waste would be accepted only from known, certified sources. This allows the waste to be differentiated, which in turn leads to pre-processing options for farms, such as:

- Banning meat scraps or food scraps that was potentially in contact with meat
- Pasteurization, depending on type of waste
- Chopping and creating a slurry if necessary
- Potentially providing a "recipe" mix for a specific farm's needs
- Testing of material for nutrient content to help with a farm's nutrient management plans
- Holding the ANR solid waste permit and having this operation as its core business

Self-funded facilities handling the high-strength waste would decrease the $26-million cost…while doing so at lower cost than the concept presented…of each farm having storage, pasteurization, and grinding capacity."[60]

Another preprocessing option available for large institutions that could supply farm digesters with a steady supply of liquid residuals are food grinders like the *Grind2Energy* system that grinds food waste and pumps the slurry into an onsite tank. The stored slurry is then pumped out by a hauler who transports the liquid to a digestion facility.[61] The Blackwell Hotel, located on the Ohio State University Campus, uses a 10 ton (2,500 gallon) Grind2Energy system filling the tank every two weeks. The slurry is hauled to a Quasar Energy Group digester in Columbus, and is saving the hotel around $1,500 in comparison to composting program they were enrolled in prior to the Grind2Energy system installation.[62] Though installation costs would vary by system size, a system the size of the Blackwell Hotel's is estimated to cost $30,000 with basic installation.

Because fibrous solids remain after anaerobic digestion, farms with digesters are also candidates for the co-siting of compost facilities or backhauling of solids to nearby compost facilities. *Maxwell's Neighborhood Farm* in Newport currently composts a small amount of its separated solids in static piles, about 2%, and sells the compost to landscapers and greenhouses.[63] In recent years, a number of integrated organics recycling facilities have been constructed nationally that either co-site digester and compost facilities or transport separated solids to nearby compost facilities. These co-sited facilities are demonstrating how anaerobic digestion and composting can be complementary technologies, as well as the importance of partnerships (both public-private and private-private partnerships) in getting such facilities built. For example, Pennsylvania based organics recycling facility developer *Turning Earth LLC* has partnered with waste-to-energy company *Covanta Energy* to develop an anaerobic digestion and composting facility in Bristol, Connecticut in 2014. Covanta will divert municipal and commercial organic waste to a Turning Earth operated facility that uses *Aikan Technology's* high solids digester and in-vessel composting system. Similarly, an operational high solid digester in Monterey, California that is sited at a Monterey Regional Waste Management District facility but operated by *Zero Waste Energy* takes solid digestate, blends it with woody materials and other green waste, and sends it to an on-site windrow composting facility operated by Keith Day Composting.[64]

The digester at VTC could provide a model for how organics diversion and anaerobic digestion technologies can be paired in Vermont. The VTC digester uses a mixed substrate technology that has been popularized in Europe, and is capable of accepting food processing wastes and food residuals. VTC is accepting food residual feedstocks from area businesses and one local farm, and through a partnership with *Grow Compost* is accepting food scraps from a local collection route. VTC is also developing a regional nutrient management plan in partnership with 9 neighboring farms, offering planning services, digester nutrients, and application assistance to its farm partners. The college has started collecting field, soil, and crop data to develop the nutrient management plans, and expects that digester nutrients will be able to replace much of the commercial fertilizer needs of the partnering farms.

A number of factors need to be considered that effect the utilization of digesters for organics diversion. First, new digester development for organics diversion is capital intensive, with digester costs running anywhere from $1-$4.5 million. For existing digesters, aside from the capacity of the digester itself, other factors that may prevent an existing digester from accepting off-farm food residuals are whether or not they have sufficient storage in their lagoons for the liquid portion of the digestate, and whether or not they have the land base to eventually manage the nutrients contained in the liquid digestate. In this sense, the management of nutrients becomes an on-farm issue rather than an off-farm one.

Photo Credit: Mary O'Leary

The state's first mixed-substrate anaerobic digester is about to become operational at Vermont Tech in Randolph. The project will send electricity to the grid and provide a portion of the heat needed on campus.

On Farm Nutrient and Soil Management

Managing nutrients and soil quality has always been a key consideration for farmers, and an inherent part of farming. Plants need 17 elements for growth: the 3 non-mineral nutrients hydrogen, oxygen, and carbon, and the remaining 14 mineral nutrients. Mineral nutrients are divided into two groups: macronutrients and micronutrients. Macronutrients include the 3 primary nutrients of nitrogen, phosphorus, and potassium. These 3 nutrients have generally garnered the most attention of farmers and agronomists because they are used by plants in large amounts, and consequently tend to be the limiting factors on plant growth.

Soil conditions are also critical to plant growth. Soil tilth is a concept that describes the soil condition created by an integration of the physical, chemical, and biological processes occurring within the soil matrix. Favorable soil tilth has been recognized for many years as essential for sustainable production.[65] Many factors effect soil tilth, with soil organic matter considered a primary factor needed to sustain or improve soil tilth.[66] Soil organic matter is simply plant or animal matter that returns to soil through decomposition, and effects soil structure and porosity, water infiltration rates (which reduce rainfall related erosion) and moisture holding capacity, plant nutrient availability, and the type and biological activity of soil organisms.[67] As soil organic matter increases, soil fauna activity and pore space increases, improving water infiltration, air infiltration (soil oxygen promotes root growth), and the ability to hold nutrients. Arkansas soil scientists have reported that for every 1% of organic matter content added, soil can hold 16,500 gallons of plant available water per acre of soil down to one foot deep.[68] As a result, **healthy soil not only holds more water and nutrients while providing the right structure for root growth, which are all important for crop growth, but diminishes the effects of nutrient leaching, rain related erosion, and runoff as well.**

Without sufficient nutrients and healthy soils, the long term productivity and sustainability of food production is compromised. In this sense, on farm nutrient and soil management are critical components of farm viability. However, what happens to nutrients on farm also has impacts off the farm. Public concerns have grown in recent years over the negative impacts of nutrient losses into the environment from over-applied and mismanaged fertilizer and soil, both nationally due to dead-zones in the Gulf of Mexico and locally in Vermont due to algal blooms in Lake Champlain. **Effective and efficient nutrient management is, consequently, an issue that is critical to not only farm productivity and profitability, but also environmental health.**

The shift from human to fossil fuel based inputs has corresponded with the excess application and loss of nutrients into the environment (See *Chapter 3, Section 2: Farm Inputs* for more on fossil fuel dependency and agriculture). **With the introduction of abundant synthetic fertilizers, and national food policies emphasizing yield increases to maintain high export levels and provide cheap food, the dynamics and focus of on farm nutrient and soil management has changed considerably**. According to researchers Drinkwater and Snapp, nutrient management cycles have been decoupled since the pervasive adoption of synthetic fertilizers. **The interconnected cycling of nutrients that occurs naturally in a soil ecosystem is now often substituted by targeted application of externally produced nutrients. As a result, the need to foster internal nutrient cycling in soils—the fostering of a healthy soil ecosystem—has been marginalized with a corresponding simplification of cropping practices.[69]**

The drawback of nutrient management cycle decoupling and synthetic substitution is that productivity becomes more dependent upon external synthetic inputs, creating a "fertilizer treadmill" where greater and greater amounts of synthetic fertilizers are needed to supply the same level of productivity because the soil systems capacity to provide fertility itself is diminished.[70, 71] In other words, though there have been notable productivity gains since the introduction of manufactured inorganic fertilizers, the introduction has come at the loss of many of soil's inherent ecological functions that beneficially contribute to plant productivity and diminish environmental impacts.

Organic fertilizers pose problems of their own as well—specifically fresh wet manures—which can leach at similar or even greater rates under poor management than soluble inorganic fertilizers.[72] Indeed, in Vermont, organic animal manure application is the predominant form of fertilizer, particularly for nitrogen, and the focus of many of Vermont's nutrient management programs. For example, based on figures from the 2007 Census of Agriculture, the EPA estimates that animal manure supplied approximately 16 million pounds of nitrogen and 3 million pounds of phosphorus to Vermont farmland.[73] In contrast, the EPA—using data supplied by state fertilizer control offices—estimates that Vermont farmers applied 6.7 million pounds (58% less than manure supplied N) of purchased nitrogen and 2.6 million pounds (13% less than manure supplied P) of purchased phosphorus fertilizer in 2007.[74]

Yet, **synthetic fertilizers still supplement the majority of nutrient needs on Vermont cropland, supporting the nutrient management cycle decoupling that has moved management progressively away from internal soil system nutrient cycling practices.** This is evident by the fact that despite animal manure being used as the primary fertilizer of choice by Vermont farmers, purchased fertilizers were still applied in 2007 on 12,015 more acres than manure, and average nitrogen fertilizer purchases from 2002-2006 to 2007-2011 increased 17%. Additionally, in 2007 Vermont farmers spent $19,789,000 on fertilizer, lime, and soil conditioners, a 50% increase from 1997.[75] Dairy farms accounted for 77% of those purchases. Dairy farms also operated 77% of all agricultural acres treated with commercial fertilizers, lime, and soil amendments in 2007 (down from 80% in 2002 and 1997).

Therefore, on-farm nutrient management in Vermont requires not only the careful management and application of manure on farmland, but a shift towards practices that reestablish soils capacity to store and cycle nutrients. **The challenge facing Vermont farmers, technical service providers, and policymakers is the following: how can Vermont farmers successfully make this shift, adopting practices that maintain productivity and farm viability while simultaneously protecting the environment?**

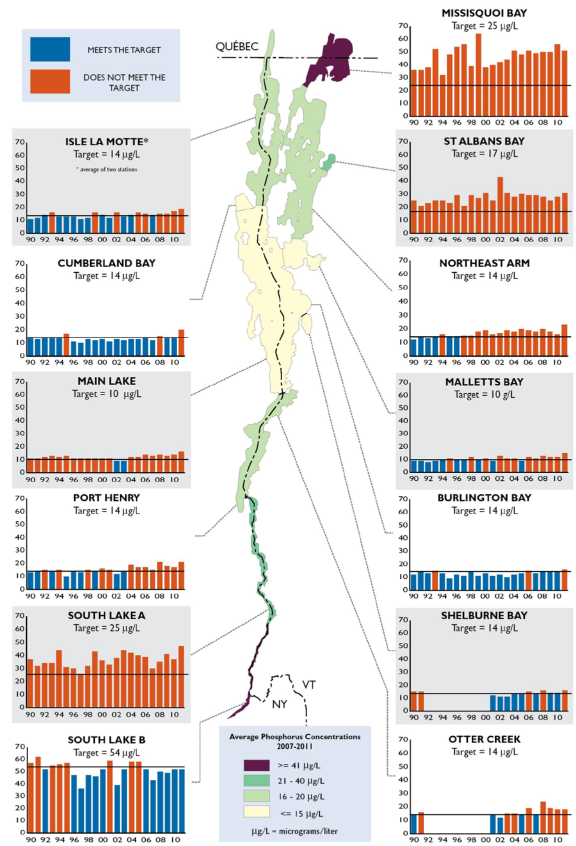
Water Quality

In Vermont, nutrient losses into the environment have perhaps their greatest environmental impacts on water quality, as algal blooms in Lake Champlain indicate. High levels of phosphorus or nitrogen in surface waters can lead to an accelerated process of eutrophication, a term that simply means the enrichment of water. The excess fertilizers that runoff into surface waters make the water so productive that algal populations rapidly increase, to the point that blooms occur—creating a classic example of too much of a good thing. The algal explosion causes a number of problems:

- Light penetration of the surface is decreased, which inhibits the productivity of plants in deeper waters and subsequently their production of oxygen
- The water in general becomes depleted of oxygen because as the abundant algae die, decomposers consume oxygen as they feed on the dead algae
- The species composition changes, as lowered oxygen levels cannot support fish that need high levels of dissolved oxygen such as trout, salmon, and other sport fish
- Some algal species—blue green algae or cyanobacteria—that bloom can also release water soluble neuro- and hepatotoxins that are capable of killing livestock, pets, and can pose serious health hazards to humans.[76, 77]

The *Lake Champlain Basin Program*, a multi-agency, multi-state, and international effort to protect Lake Champlain, estimates that agricultural activities (e.g., soil erosion, manure and fertilizer runoff, livestock access to waterways) account for 39% of total nonpoint phosphorus pollution in Lake Champlain.[78] The EPA estimates that 35.2% of the phosphorus comes from cropland and 3.8% from pasture land.[79]

Figure 3.7.9: Lake Champlain Phosphorus Concentration by Lake Segment



Source: Lake Champlain Basin Program, State of the Lake and Ecosystem Indicators, Report, 2012

In 2002, the EPA approved a Lake Champlain *total maximum daily load* (TMDL) that placed a cap on the amount of phosphorus allowed to enter the lake. A TMDL calculates the maximum amount of a pollutant that a waterbody can receive and still safely meet federal and state water quality standards.[80] However, in 2011 the EPA revoked its approval of the Vermont portion of the Lake Champlain TMDL after the *Conservation Law Foundation* challenged the decision in federal court. The EPA cited that Vermont's proposal did not provide reasonable assurances that non-point source reductions would actually be achieved and that the margin of safety to account for uncertainty was inadequate.[81] Vermont and the EPA are now in the final stages of completing the Lake Champlain Restoration Plan (Phosphorus TMDL), with the EPA releasing and the state implementing the final TMDL in the summer of 2014. Under the preliminary TMDL, Vermont will need to reduce its yearly phosphorus load by 190 metric tons per year (36%, from 533 mt/yr to 343 mt/yr). The state still has significant work to do prior to the final issuing of the TMDL. The EPA, for example, in a letter issued in January, 2014, asked the state to provide more details and specific policy commitments in its Lake Champlain restoration draft plan by March, 2014. **The letter also noted that the state's plan did not adequately account for higher intensity rainfall due to climate change.** If the state cannot satisfy EPA's request for more details and commitments, Vermont faces the prospect of having its authority to implement the TMDL revoked. If this were to happen, the EPA would aggressively regulate point source pollution under the Clean Water Act, requiring point source polluters to implement costly best available pollution abatement technologies. In the case of Vermont, EPA's point source regulations would essentially fall solely on wastewater treatment facilities, which only contribute about 3% of phosphorus pollution to Lake Champlain.

Phosphorus pollution from agriculture is also believed to be a major contributor to the impairment of Lake Memphremagog. The Vermont Department of Environmental Conservation (VTDEC) has been developing a total maximum daily load (TMDL) for Lake Memphremagog, with its completion still pending.

Water quality impacts of agriculture are not limited to Vermont's two major lakes. Every two years the EPA, under Section 303(d) of the Clean Water Act (CWA), requires states to update a list of waters (e.g., rivers, lakes, streams) that are impaired by one or more pollutants.[82] Impaired waters are those that reveal:

- An ongoing violation of one or more of the criteria in the EPA and State Water Quality Standards
- A pollutant of human or human-induced origin is the most probable cause of the violation.

Each water body identified on the 303(b) list is required to have TMDL developed. In 2012, agriculture was identified as the cause of impairment for 21 of the 86 (24.4%) waterbodies listed, a small decrease from the 2010 (29 of 107 or 27.1%) and 2008 (32 of 113 or 28.3%) listings (Table 3.7.5).

Table 3.7.5: Agriculturally Impaired Waters, 2008 to 2012

	Number of Agriculturally Impaired Waters	Total Impaired Waters	Percent of Total
2008	32	113	28.3%
2010	29	107	27.1%
2012	21	86	24.4%

Source: Vermont Water Quality Assessment 305(b) Report, multiple years.

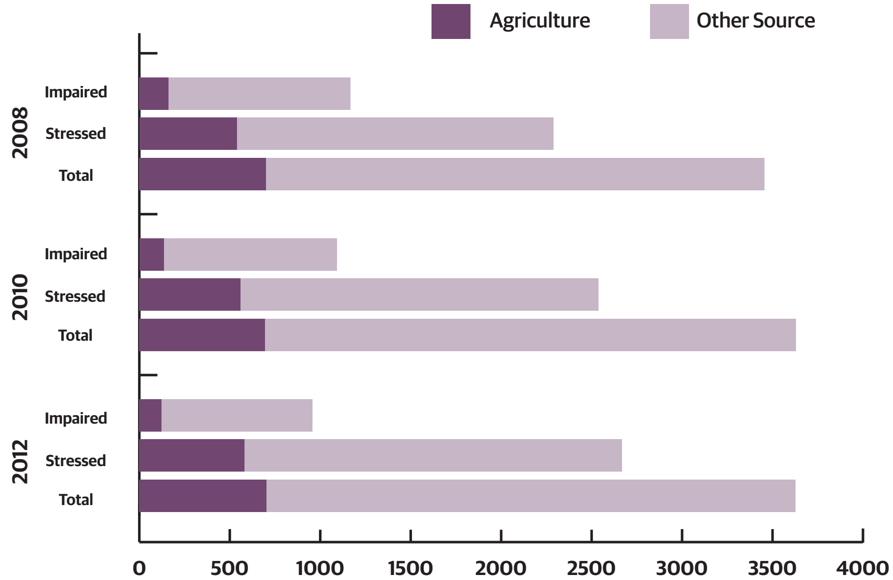
Every two years the EPA, under Section 305(b) of the CWA, also requires each state to submit a water quality report called the Water Quality Integrated Assessment Report. The 305(b) report documents the state's quality of state surface and ground waters, and includes information on miles of streams impaired and stressed. Stressed waters are those that:

- Have been disturbed to some degree by point or nonpoint sources of pollution of human origin, and the water may require some attention to maintain or restore its high quality
- The water quality and/or aquatic habitat may be at risk of not supporting uses in the future
- The structure or integrity of the aquatic community has been changed but not to the degree that the standards are not met or uses not supported

The VTDEC *State of Vermont 2012 Water Quality Integrated Assessment Report* reveals that agriculture impairs 123.1 miles of Vermont's rivers and streams (1.8% of total miles assessed, 12.9% of total miles impaired) and stresses an additional 580.7 miles (8.9% of total miles assessed, 21.8% of total miles stressed). According to the report, **in total, agriculture impacts 703.8 miles (10.8% of total miles assessed, 19.4% of total miles impaired or stressed) of rivers and streams.** Agricultures total impact on assessed rivers and streams has remained relatively stable, around 20%, since 2008.

Nitrogen runoff from agriculture into groundwater and drinking wells is another nutrient management water quality concern. In 1986, Vermont established an agricultural groundwater monitoring program to investigate the quality of groundwater

Figure 3.7.10: Impaired and Stressed River and Stream Miles, 2008 to 2012



Source: Vermont Water Quality Assessment 305(b) Report, multiple years.

and drinking water for farms and neighboring residents. The program is primarily funded through pesticide product registration fees collected by VAAFM. The program tests for nitrate and herbicide contamination, and since its inception has tested 2,110 wells and taken and analyzed a total of 6,325 samples. Nitrates in drinking water are a problem because when they are ingested they are converted into nitrite and combine with hemoglobin to form methemoglobin, which has a reduced oxygen carrying capacity.[83] This is particularly problematic for children, and can lead to nitrite poisoning or blue baby syndrome (due to a lack of oxygen, the child's skin turns a bluish color). According to VAAFM, nitrate is the primary contaminant of concern as there have been no violations of herbicide drinking water standards in the last decade.

VAAFM works with the Vermont Association of Conservation District's (VACD) Agricultural Resource Specialists to conduct water testing on farms. According to the *Ecosystem Restoration Program 2011 Annual Report*, in 2011 a total of 179 samples were taken, 135 from groundwater and 44 from surface water. Contamination results are were not provided in the 2011 report. The *2010 Annual Report* indicates that 143 wells were sampled, with nitrate detected in 53% of wells, and 10% (14) of wells showing nitrate levels above 10 ppm, which triggers further investigation to identify source contaminants in order to attempt to reduce the detected levels.[84] Nitrate contamination levels have decreased over the last decade, as a sampling period from 2002-2006 revealed that 14% of sampled wells had nitrate levels above 10 ppm.

Nutrient and Soil Management Practices

Although agriculture has significant impacts on water quality in Vermont, farmland per acre still contributes four times less than the amount of water pollution that runs off developed land. In fact, the contribution of agriculture to phosphorus pollution in Lake Champlain was adjusted downwards in part because original projections were based on outdated land use maps that showed agricultural land in places that had actually been developed. Equipped with the right blend of technical assistance and incentives, Vermont farms can be critical assets in protecting our environmental resources—and many already are.

A number of state and federal programs and regulations exist to either ensure or incentivize the adoption of practices that are designed to minimize water quality impacts and improve soil health and nutrient management. VAAFM, Vermont's Natural Resource Conservation Districts (VT-NRCD), VACD, USDA Natural Resource Conservation Service (NRCS), *U.S. Fish and Wildlife Service*, *USDA Farm Service Agency*, and *University of Vermont (UVM) Extension* all work together to deliver financial and technical assistance to farms interested or in need of nutrient and soil management assistance. All of these organizations, for example, recently contributed to VT-NRCD's recently published Conservation in *Vermont: Best Management Practices for Farm and Forest Owners*. The guide provides an overview of effective nutrient and soil management practices, addressing the "What, Why, How, Costs, and Benefits" of each practice and provides case studies of farms that have successfully implemented particular practices.

Important field related practices or management options (as opposed to physical infrastructure upgrades) pertaining to agriculture that are covered in the guide are the following:

Nutrient Management Planning

Before determining what practices to implement, farmers need to identify what inputs are needed, if at all, and where on the farm they should be applied in order to maximize yields, reduce input costs, and minimize nutrient runoff. Nutrient managements plans map a farm's assets (e.g., fields, acres, soil types, crops grown, and environmental areas like water ways) and from this mapping develop targeted nutrient and practice recommendations. The mapping also establishes a baseline record that will be tracked over time to help reconcile a farm's current practices and nutrient levels with recommended practices and nutrient levels. Record keeping is broken down into four main categories: Imported Nutrients, Exported Nutrients, Removed Nutrients, or Recycled Nutrients.

Currently in Vermont, all *medium farm operations* and *large farmer operations* are required to have a nutrient management plan, while it is recommended for small farm operations to develop one. NRCS offers nutrient management planning payments through the *Environmental Quality Incentives Program* (EQIP) in which farms must satisfy *NRCS's 590 nutrient management standard* to receive payments. The 590 standard determines the nutrient management practices a producer may or must implement in order to receive cost-share payments.

Conservation Tillage

Unlike conventional plowing, conservation tillage limits soil-disturbing activities through more precise seed planting and nutrient application. No-till, strip till, ridge-till, and mulch-till are different types of conservation tillage, and all involve keeping and planting into the previous year's crop residue, and either narrowly tilled strips or no tillage at all. Conservation tillage increases soil organic matter and infiltration, improves water retention at the root layer, reduces nitrous oxide emissions (a strong greenhouse gas emission), soil erosion, and soil compaction.

Conservation Crop Rotation

In contrast to monocropping (i.e., growing the same crop in the same place year after year), conservation crop rotation involves growing several different crops in a planned sequence, with the intent that the previous year's crop will benefit the crop that follows it. For example, different crops will utilize different amounts of nutrients in a way that does not deplete nutrients at a rapid rate or penetrate different layers of the soil profile to improve compaction and infiltration. Some crops, like legumes, will provide nitrogen to the soil—all of which improve overall soil health. In Vermont, a perennial hay crop is often grown in-between corn crops to prevent erosion and run-off. Crop rotations can also be used to suppress weed growth, reduce insect and disease pressures (i.e., by removing or alternating hosts, and through greater diversity introducing beneficial species), and reduce runoff and erosion.

Cover Cropping

Cover cropping is a practice that can be part of an overall crop rotation plan. Cover crops are seasonal plantings in between harvests that reduce erosion and runoff, improve organic matter content, provide fertility via nitrogen fixing, suppress weeds, and provide refuge for beneficial insects and soil microbes. Winter rye is commonly planted in Vermont, though the *Champlain Valley Crops Soil and Pasture Team* have been conducting numerous trials with cover-cropping mixes. Triticale—a hybrid of wheat and rye—is beginning to be more popular in Vermont because of its value as a forage crop. The timing of planting the cover crop makes a significant difference on the benefits, with an early September planting being ideal. The problem for many Vermont farms is that this optimal planting time is prior to October harvesting. Research by UVM Extension Agronomist Heather Darby has shown that winter rye biomass can decline from rates of 4 tons of dry matter per acre to less than 1 ton of dry matter per acre when planted in October rather than early September. Similarly, ground cover rates can decline from 80% to 40%.[85]

Strip Cropping

Strip cropping is the planting and growing of alternating strips of erosion resistant crops with strips of erosion prone annual crops such as corn. The orientation of the crops are as close to the contours of the land and perpendicular to wind and water erosion forces as possible.[86] Strip cropping reduces erosion and runoff, particularly sheet and rill erosion, while improving water infiltration, wildlife habitat, and the visual quality of the landscape.[87]

Rotational Grazing

Rotational grazing, or "management intensive rotational grazing" (MIRG), rotates livestock on permanent pasture by breaking the pasture into multiple "paddocks," allowing the animals to graze within each paddock for a period of time before rotating them to an adjacent paddock. By carefully rotating the animals from paddock to paddock, the paddocks are given time to recover and fully regrow before being grazed again. Also, by moving the animals in controlled intervals, manure is evenly distributed across the pasture. Well-managed pasture that is rotationally grazed reduces erosion, filters nutrients, improves water retention, and can provide wildlife habitat. Researchers in Minnesota found that MIRG was an important part of watershed management scenarios that had the greatest improvements in reduced sedimentation, nitrate pollution, phosphorus pollution, and improved fish health.[88] Research has shown that MIRG can be just as effective as buffer strips in rehabilitating streams and controlling erosion.[89]

Photo Credit: Jenn Colby

Dairy cows on pasture at Beidler Family Farm.

Grassed Waterways, Grass Filter Strips, and Riparian Forest Buffers

Grassed waterways are perennially vegetated channels designed to control concentrated runoff while providing drainage to outlet or receiving waterways, slowing and soaking up fast flowing water and in the process reducing erosion. Grass filter strips, similarly, are perennially vegetated areas that lie between cropland and waterways or wetlands. They are designed to filter and remove nutrients, sediment, organic matter, and pesticides that would otherwise runoff and pollute the adjacent waterbody. Riparian forest buffers are a more robust version of a grass filter strip. By establishing forest cover along the streambank, extending from 10 to 35 feet from the top of the bank to the crop field, the riparian forest buffer captures sediment, filters pesticide and fertilizer runoff, provides a wind break for crops and high quality fish and wildlife habitat, and reduces streambank erosion rates particularly during flood events.

The practices discussed above are supported by a variety of federal and state programs. Federal funding and programs including:

Conservation Reserve Enhancement Program (CREP): The Conservation Reserve Enhancement Program is an offshoot of the Conservation Reserve Program (CRP), which is the country's largest private-land conservation program. The CRP removes marginal lands from production and plants them with species that reduce soil erosion, reduce the loss of wildlife habitat, and improve water quality. Farms enrolled in CRP are paid a yearly rental rate for the land they enroll and take out of production, typically with a contract length of 10-15 years. CREP takes the basic elements of CRP, but targets high-priority conservation issues that have been identified by local, state, or tribal governments, giving local decision-makers greater control over the allocation of conservation dollars. Through the federal and state CREP agreement, both state and federal funds can be leveraged to offer farmers financial assistance that can cover up to 90% of the practice implementation costs, and the annual land rental payments that last over the course of the contract period (typically 15 years, but up to 30).

Vermont's CREP agreement is focused on establishing riparian tree buffers, filter strips, grassed waterways, and restoring wetlands in order to reduce phosphorus runoff into streams and rivers that flow into Lake Champlain. Minimum buffer distance is 25 feet for grass and 35 feet for trees, and phosphorus runoff reduction can be as high as 75%.[90] There are four partner agencies that cooperate on CREP: VAAFM, USDA NRCS, USDA Farm Service Agency, and the U.S. Fish & Wildlife Service. Technical Assistance support was increased in 2011 through support from the Great Lakes Fishery Commission which provided funding for a full-time three year position to work on CREP in the southern Lake Champlain region and three agronomists/conservation advisors tasked with educating farmers about the program.

Since 2002, Vermont has enrolled approximately 2,582 acres of farmland in CREP (Table 3.7.6), with the majority of acres converted to riparian forested buffers (2,314 acres). The original goal of the CREP program was to have 7,500 acres enrolled by 2009.

Table 3.7.6: Enrolled CREP Acres, 2002 to 2012

	Pasture/Hay Land Acres Enrolled	Crop Land Enrolled	Total
2002	586.5	95.3	681.8
2003	43.7	36.6	80.3
2004	110.9	67.9	178.8
2005	152.7	26.2	178.9
2006	58.1	9.3	67.4
2007	240.8	62.2	303
2008	246.5	92.2	338.7
2009	209.8	10.3	220.1
2010	234	30.5	264.5
2011	146	31	177
2012	60.6	30.8	91.4
Total	**2,089.6**	**492.3**	**2,581.9**

Source: Vermont Ecosystem Restoration Program 2011 Annual Report.

CREP enrollment was especially high in 2002 because of a backlog of participants who were waiting for the program to become available. Enrollment spiked again in 2007, after a lull in 2006, because farmers were waiting in 2006 for the rental rate to change. The rate that was finalized for 2007 was nearly double the rate in 2006. 2012 saw the programs lowest acreage enrollment since 2006, and represented the second year in a row that enrollment has decreased.

Eighty-one percent (2,090 of the 2,582 acres enrolled) of land enrolled in CREP is pasture or permanent hayland. Crop land comprises the remaining 19% (492 acres) of enrolled land. Crop land enrollment is important because, as a recent study of the Missisquoi Bay Basin has shown, permanent corn or minimal corn crop rotations are predominantly responsible for phosphorus loading in "Critical Source Areas" flowing into the lake. Program administrators have tried to improve crop land enrollment, but because Vermont has limited amounts of good crop land and thus its value is especially high to farmers in Vermont, it has proved difficult to get more crop land enrolled.

Environmental Quality Incentives Program (EQIP): The Environmental Quality Incentives Program is another federal conservation program that has been popular with Vermont farmers over the last decade. EQIP provides payments for natural resource conservation, including the reduction of soil erosion and sedimentation, and the promotion of at-risk species habitat conservation. In 2012 there were 522 EQIP contracts in Vermont—covering 42,986 acres and equal to $9 million—for technical assistance and implementation of conservation practices such as filter strips, riparian buffers, fences, and roof runoff management. Since 2009, the program has averaged approximately $10.6 million in incentives and 41,000 acres covered (Table 3.7.7).

Table 3.7.7: EQIP Contracts, Acres, and Financial Obligations, 2009 to 2012

	Number of Active and Completed Contracts	Total Acres on Active and Completed Con-tracts	Total Financial Obligations
2009	198	30,316	$9,382,800
2010	419	48,178	$11,191,200
2011	373	42,589	$12,922,000
2012	522	42,986	$9,053,200

Source: Natural Resources Conservation Service 2008 Farm Bill Report (FY 2009 through FY 2012).

Conservation Stewardship Program (CSP): The Conservation Stewardship Program is unique in that it not only provides payments for the adoption of new practices, but also for the maintenance or improvement of existing conservation practices. It is also unique in that it is the first USDA program that publicly recognizes the positive role farms could play in providing environmental public goods. While EQIP is focused on a conservation problem or threat, CSP rewards and incentivizes the highest levels of resource management.

CSP participants can earn up to $40,000 a year over 5 years. Payments are based on fulfilling clearly defined conservation conditions and for the provision of environmental services. **CSP is now the nation's largest conservation program, with over 50 million acres enrolled.**[91] CSP uses a ranking system to award contracts. Those with the highest ranked applications are awarded contracts first, with contracts awarded until the yearly allotted acreage is exhausted. Farmers that are willing to adopt new conservation practices, referred to as "enhancements," earn a higher ranking than those that are not. **CSP has been popular in Midwestern states, but has yet to be widely utilized in the Northeast.** For example, through 2009-2012 Minnesota had 3,200 CSP contracts at $283 million in obligated funding, while Vermont only had 9 completed contracts at $355,000 of obligated funding. Additionally, Vermont's only contract and enrolled acreage in 2012 was actually forestland and not farmland (Table 3.7.8).[92]

Table 3.7.8: CSP Contracts, Acres, and Financial Obligations, 2009 to 2012

	Total Contracts	Total Acres	Total Financial Obligations
2009	N/a	N/a	$40,700
2010	7	2,562	$126,600
2011	1	241	$88,200
2012	1	154	$99,000

Source: Natural Resources Conservation Service, Financial Information Vermont.

State regulatory and incentive programs created to improve nutrient management and cropping practices, and reduce pollution include:

Accepted Agricultural Practices (AAPs): Accepted Agricultural Practices set baseline practices that all farms in Vermont must comply with (e.g., 10 foot buffers of perennial vegetation between annual cropland and the top of the bank of adjoining surface water, setbacks from wells, manure management, animal mortality composting). VAAFM reports that the majority of complaints received are related to manure, although the number of violations identified by on-farm investigations has remained pretty low (about 20 a year), while the number of investigations has increased. In 2010, 152 AAP inspections were carried out, 68 in response to citizen complaints (45%), resulting in 5 formal enforcement actions for a violation rate of 3.3.%. Technically, there are more violations per year, but in cases where violations are discovered, VAAFM gives the farmer the opportunity to correct the violation before carrying out a formal enforcement action. In 2011, 139 AAP inspections were carried out, including 61 (44%) complaint driven inspections, resulting in 7 formal enforcement actions for a violation rate of 5.0% (Table 3.7.9).

Table 3.7.9: AAP Inspections and Violations, 2010 to 2011

	# of Inspections	In Response to Complaints	Field/ Office Staff inspections	Formal Enforcement Actions	Violation Rate
2010	152	68	84	5	3.3%
2011	139	61	78	7	5.0%

Source: Vermont Agency of Agriculture, Food and Markets Annual Water Quality Enforcement Report.

In many cases, complaints relate to odors, perceived spreading of manure during manure bans, storage of manures too close to waterways, or unsightly production areas that people think must be in violation of AAPs. Complaints are also received about livestock access to surface water, which under current regulations is permissible so long as the streambank is maintained in its native state and not being excessively trampled.

The Medium Farm Operation Program (MFO): The Medium Farm Operation program requires farms with 200-699 mature dairy cows, 300-999 cattle or cow/calf pairs, 300-999 youngstock or heifers, 150-499 horses, 16,500-54,999 turkeys, and 25,000-81,999 laying hens to have structures in place for manure management and to have nutrient management plans that prescribe the appropriate application of manure, compost, and synthetic fertilizers. An annual analysis is completed each year on manure, compost, and other wastes on farm, while soil samples are required for each field every three years. MFO regulations also require that calculated soil loss will not exceed tolerable soil loss for the dominant soil type, and 25 foot buffer zones between annual cropland and the top of the bank of adjoining surface waters. The buffer can be harvested as a perennial crop but no manure, compost, or other fertilizers can be applied within the buffer.

As of November 20, 2013, there were 142 farms in Vermont permitted as MFOs. VAAFM is required by law to inspect MFO permitted farms at least once every five years, though VAAFM visits MFO permitted farms more often due to compliance needs. In 2010, 65 inspections were carried out, 3 of which were in response to citizen complaints, resulting in 9 formal enforcement actions for a violation rate of 13.8%. In 2011 there were 29 inspections, 5 complaint driven, resulting in 6 formal enforcement actions for a violation rate of 20.7%.

Table 3.7.10: MFO Inspections and Violations, 2010 to 2011

	# of Inspections	In Response to Complaints	Field/ Office Staff inspections	Formal Enforcement Actions	Violation Rate
2010	65	3	62	9	13.8%
2011	29	5	24	6	20.7%

Source: Vermont Agency of Agriculture, Food and Markets Annual Water Quality Enforcement Report.

The Large Farm Operation Program (LFO): The *Large Farm Operation* program requires farms with more than 700 dairy cows, 1,000 beef cattle or cow/calf pairs, 1,000 youngstock or heifers, 500 horses, 55,000 turkeys, or 82,000 laying hens to have structures in place for manure management and to have nutrient management plans that prescribe the appropriate application of manure, compost, and synthetic fertilizers. An annual analysis is completed each year on manure, compost, and other wastes on farm, while soil samples are required for each field every three years. As with MFO regulations, LFO regulations require that calculated soil loss will not exceed tolerable soil loss for the dominant soil type, and 25 foot harvestable buffer zones between annual cropland and the top of the bank of adjoining surface waters. LFO rules have additional restrictions for controlling odor, noise, traffic, insects, flies, and other pests that MFO rules do not have. Each LFO must receive a permit from VAAFM.

As of November 20, 2013, there were 17 farms in Vermont permitted as LFOs. VAAFM inspects all LFOs annually, and conducts follow up inspections when necessary. In 2010, 29 inspections were carried out, 7 of which were in response to citizen complaints, resulting in 2 formal enforcement actions for a 6.9% violation rate. In 2011 there were 60 inspections, 6 complaint driven, and 2 formal enforcement actions for a violation rate of 3.3%.

Table 3.7.11: LFO Inspections and Violations, 2010 to 2011

	# of Inspections	In Response to Complaints	Field/ Office Staff inspections	Formal Enforcement Actions	Violation Rate
2010	29	7	22	2	6.9%
2011	60	6	54	2	3.3%

Source: Vermont Agency of Agriculture, Food and Markets Annual Water Quality Enforcement Report.

The Best Management Practice Program (BMP): The *Best Management Practice program* is used to ease the costs of structural production area construction and improvements, and is often referred to as the "production area practice program." The program is closely coordinated with EQIP, and significant amounts of EQIP funds have gone to structural production area projects. Because animal manure, hay, corn silage, and milkhouse waste are stored in production areas, the potential for production area discharges tend to be higher than those in the field, as do the costs of implementation. BMP not only defrays construction costs, but provides the farmer with technical assistance and professional engineering support to ensure that structures are optimally sited, designed, and managed.

State program expenditures since 2008 have totaled $5.8 million and averaged $1.45 million per year. Available EQIP data shows that federal contributions in 2010 and 2011 totaled $10.3 million. Since the inception of the program in 1995-96, farmers themselves have contributed $14.7 million to cover the costs of production area improvements.

Table 3.7.12: BMP Expenditures, 2008 to 2011

	State BMP Program Expenditures (In millions)	EQIP BMP Expenditures (In millions)
2008	$1.3	N/a
2009	$1.4	N/a
2010	$1.6	$4.8
2011	$1.5	$5.5
Total	**$5.8**	**$10.3**

Source: Vermont Ecosystem Restoration Program Annual Reports, *multiple years*.

VAAFM has estimated the remaining costs for major production area structure improvements that will fulfill water quality goals at $78 million. VAAFM estimates that the majority of these costs, $68 million (87%), are needed on small farm operations (SFOs). This is largely due to the fact that MFO and LFO storage and discharge regulations have required MFO and LFO permitted farms to make improvements and seek BMP and EQIP assistance. VAAFM estimates that a significant portion of the total estimated costs, $32 million (41%), will need to be devoted to Livestock Exclusion (See Tables 3.7.13 through 3.7.15 for cost estimates).

Table 3.7.13: SFO Best Management Practices Cost and Needs Estimate

Best Management Practice	Number of Farms	Cost of Implementation (per farm)	Total Cost SFOs
Liquid Manure Storage	193	$66,500.00	$12,838,500.00
Silage Leachate	257	$30,000.00	$7,710,000.00
Access to Surface Water	2900	$11,079.00	$32,129,100.00
Clean Water Diversion/ Barnyard Runoff	400	$19,950.00	$7,980,000.00
Nutrient Management Plan	536	$6,500.00	$3,484,000.00
Milkhouse Waste	261	$16,625.00	$4,346,875.00
Total Cost SFO BMP			**$68,488,475**

Source: Vermont Ecosystem Restoration Program *2011 Annual Report*.

Table 3.7.14: MFO Best Management Practices Cost and Needs Estimate

Best Management Practice	Number of Farms	Cost of Implementation (per farm)	Total Cost SFOs
Manure Storage Upgrade	48	$140,000.00	$6,720,000.00
Silage Leachate	49	$45,000.00	$2,205,000.00
Access to Surface Water	8	$11,079.00	$88,632.00
Clean Water Diversion/ Barnyard Runoff	19	$15,000.00	$285,000.00
Nutrient Management Plan	2	$17,258.00	$34,515.00
Milkhouse Waste	0	$16,625.00	$0
Total Cost MFO BMP			**$9,333,147**

Source: Vermont Ecosystem Restoration Program *2011 Annual Report*.

Table 3.7.15: LFO Best Management Practices Cost and Needs Estimate

Best Management Practice	Number of Farms	Cost of Implementation (per farm)	Total Cost SFOs
Manure Storage Upgrade	0	$140,000.00	$0
Silage Leachate	4	$45,000.00	$180,000.00
Access to Surface Water	0	$11,079.00	$0
Clean Water Diversion/ Barnyard Runoff	4	$15,000.00	$60,000.00
Nutrient Management Plan	0	$17,258.00	$0
Milkhouse Waste	0	$16,625.00	$0
Total Cost LFO BMP			**$240,000**

Source: Vermont Ecosystem Restoration Program *2011 Annual Report*.

The Farm Agronomic Practices Program (FAP): The Farm Agronomic Practices program provides cost-share to support the implementation of field practices such as cover cropping, crop rotation, strip cropping, no-till planting, soil aeration, and alternative manure application methods. The program caps payments at $5,000 per farm, which amounts to 167 at the cover-cropping rate (up to $30 an acre). The cap has prevented some larger farms from enrolling, or from enrolling their entire land base. However, VAAFM reports that farms that have reached the cap have still implemented FAP practices on additional land without programmatic assistance, and that many farms continue to utilize the practices after no longer receiving programmatic assistance.[93]

FAP over the years has become the state's most popular incentive program, as enrolled acreage has steadily grown since its inception in 2007. For example, in 2007 the program enrolled 1,572 acres with a financial commitment of $32,314. In 2011, the program enrolled 16,448 acres with a financial commitment of $340,078, **representing a 946% increase in acres enrolled and a 952% increase in financial commitment by the state**. Cover-cropping is the most widely adopted practice, though the program has gradually seen an increase in other practices enrolled as payments for these practices have become available and farmers have become aware of them (payments for cross slope tillage, strip cropping, and conservation tillage did not become available until 2009). Notably, acres enrolled in and financial commitments for conservation tillage increased 342% and 304% from 2010 to 2011. The increased enrollment in conservation tillage demonstrates that many Vermont farmers are interesting in implementing conservation tillage practices like no-till if some of the initial risk can be mitigated through incentive payments (See Table).

Using VAAFM's estimate that there are 96,000 acres of annual cropland grown for animal feed in Vermont, FAP thus far has enrolled approximately 39% (37,668 acres) of that total at a cost of $909,077 ($24 per acre). Unfortunately, currently there is no data indicating how much of the cropland enrolled in the program over the years is still being managed under the originally incentivized practice.

Table 3.7.16: FAP Acres Enrolled and Financial Commitments by Practice, 2007 to 2011

	# Farms Applying	# Farms Practices Implemented	Acres Enrolled	Financial Commitment
2007	**26**	**24**	**1,572**	**$32,314**
Cover Cropping			*1,398*	*$27,957*
Conservation Crop Rotation			*173*	*$4,358*
2008	**35**	**27**	**2,907.0**	**$59,031.00**
Cover Cropping			*2,728.0*	*$54,561.00*
Conservation Crop Rotation			*179.0*	*$4,470.00*
2009	**97**	**90**	**6,809.0**	**$202,983.00**
Cover Cropping			*6,549.0*	*$196,483.00*
Conservation Crop Rotation			*260.0*	*$6,500.00*
2010	**139**	**N/a**	**9,923.7**	**$274,671.00**
Cover Cropping			*8,455.4*	*$242,110.00*
Conservation Crop Rotation			*128.0*	*$3,200.00*
Cross-Slope Tillage			*0.0*	*$0.00*
Nurse Crop			*68.0*	*$1,700.00*
Alt Manure Incorporation			*485.6*	*$12,140.00*
Strip Cropping			*0.0*	*$0.00*
Conservation Tillage			*1,293.0*	*$15,521.00*
2011	**150**	**N/a**	**16,456.0**	**$340,078.00**
Cover Cropping			*8,257.5*	*$205,117.00*
Conservation Crop Rotation			*1,182.0*	*$29,560.00*
Cross-Slope Tillage			*131.0*	*$1,310.00*
Nurse Crop			*530.0*	*$13,250.00*
Alt Manure Incorporation			*966.4*	*$24,160.00*
Strip Cropping			*155.0*	*$3,875.00*
Conservation Tillage			*5,234.0*	*$62,806.00*
Totals			**37,668**	**$909,077**

Source: Vermont Ecosystem Restoration Program Annual Reports multiple years, and Nathaniel Sanders, Agriculture Water Quality Supervisor, VAAFM.

The Nutrient Management Grant Incentive Program (NMPIG): NMPIG provides financial and technical assistance for nutrient management plan development and updates. At one point farms could receive up to $14,000 over a four year period to develop and update a plan, but starting in 2013 the payment was been reduced to up to $9,500 for plan development and up to $2,000 for a plan update. Eligibility for the update incentive payment is dependent upon:

- Having completed a development grant (1 year of development and 3 years of maintenance) or;
- Having completed NRCS EQIP contractual requirements for a 590 standard nutrient management plan (2003 or later) and no longer receiving payment from any other source to update the plan.

VAAFM moved to a one year grant agreement structure because they were finding that farms entering into longer term agreements were not fulfilling requirements—either by not submitting a NMP for review or not submitting updated plans—and as a result VAAFM had to cancel a significant number of grants that were issued under NMPIG. By keeping the agreements to one year, VAAFM can continue to work with farms interested in the program without tying up excess funds over the long term to agreements that may go unfulfilled. For example, prior to the change VAAFM actually had to shift funding from NMPIG contracts that had not fulfilled their nutrient management planning requirements to FAP in order to meet the growing demand for FAP incentives.

All MFOs and LFOs are required to have a nutrient management plan, and part of NMPIG's original intent was to cover some of the upfront costs of coming into compliance with MFO and LFO regulations. According to Jeff Cook, VAAFM Financial Manager, at least 309 farms have applied for NMPIG cost-share assistance, but only 249 grantees have fulfilled the grant requirements, covering an estimated 124,000 acres statewide. From 2005 to 2009, when the majority of contracts were granted, the state committed $2,202,446 to developing nutrient management plans. 2013 saw an uptick in requests and committed funds, with 27 farms and $136,656 committed (approximately 60% increase from the previous 3 year average in funds committed). In total, from 2005 to 2013 the state has committed $2,594,464. Starting in 2010 and 2011, VAAFM gradually began to move from ensuring production area compliance with the nutrient management plan to field practice compliance. They had already undertaken this shift with LFOs, but not MFOs, due to the fact that LFOs have had nutrient management plans in place in some form for over 10 years. Compliance is still focused on production area practices for MFOs, with spot checks of some fields rather than thorough review.

Table 3.7.17: NMPIG Acres and Dollars Granted, 2005 to 2013

	Total Grants	Acres Requested	NMP Developed Acres	Dollars Granted
2005	29	15,169	13,758	$250,261
2006	67	42,557	34,269	$598,800
2007	80	38,840	31,083	$651,960
2008	62	33,123	27,896	$596,889
2009	11	5,060	2,950	$104,536
2010	9	7,055	4,081	$83,597
2011	13	2,852	2,057	$86,417
2012	11	3,622	1,867	$85,348
2013	27	7,846	6,100	$136,656
Totals	**309**	**156,124**	**124,061**	**$2,594,464**

Source: Jeff Cook, Financial Manager VAAFM.

The Vermont Agricultural Buffer Program (VABP): VABP is a state funded program that is modeled after CREP, but unlike CREP, allows farmers to harvest the 25 foot grassed buffer for on- or off-farm agricultural uses. Though the program offers per acre establishment payments, and yearly per acre payments—along with the economic value of the harvested grass—the program has had very low enrollment since its inception and currently has no active contracts.[94] One reason cited is that CREP payments have been so high in recent years that there is little incentive to enroll in VABP.[95]

Manure Management

Manure is a significant source of nutrients to Vermont farms. The sheer volume of manure that needs to be managed by Vermont farmers has drawn a lot attention and resources to developing manure management practices that work for farmers and for the environment.

Following the methodology described by Jeffrey E. Fehrs in the Vermont Methane Pilot Project Resource Assessment (2000), a report to the Vermont Department of Public Service and the Agency of Agriculture, Food, and Markets, we can estimate the amount of manure generated by Vermont's livestock. Fehr uses a figure of 3.1 pounds of wet manure per every pound of milk produced. USDA NASS estimates that Vermont dairy cows produced 2.648 billion pounds (308 million gallons) of fluid milk in 2012. Since the amount of time a dairy cow is confined varies from farm to farm, Fehr uses a conservative estimate that 77% of the manure can be collected for storage, including potential digester energy production. **Based on the latest available data, we arrive at a figure of 3,159,793 tons (6.3 billions pounds) of manure created by dairy cows in Vermont that currently needs to be managed in some form of storage facility (the estimate would change depending on if there was a shift to more pasture management).**

Table 3.7.18: Non-Dairy Livestock Manure Generation

Animal	Inventory (2007)	Typical Animal Weight (lbs)	Manure Generation Factor (lbs/ day/1000 lbs)	Manure Generation (tons/year)
Beef Cows	10,002	1,200	60	131,426
Hogs and Pigs	2,701	200	73	7,167
Horses and Ponies	13,285	1,100	50	133,348
Poultry	223,605	3	62	7,590
Goats	6,593	150	40	7,219
Sheep and Lambs	13,925	180	40	18,297
			Total	**305,047**

Table 3.7.18, based on Fehrs' conversion factors, shows manure generation estimates for other livestock types in Vermont, based on the Census of Agriculture inventory of animals in the state on December 31, 2007.

Many of these other livestock types spend a fair amount of time outside on pasture and their manure is not stored but rather directly applied to the land. Table 3.7.19 shows manure availability for each livestock type based on amount of time spent indoors or on hard surfaces.[96] The nutrient content in the total manure produced by Vermont livestock, in terms of nitrogen and phosphorus, in comparison to the total amount of available manure that needs to be managed is miniscule. Based on figures from the 2007 Census of Agriculture, the EPA estimates that animal manure supplied approximately 16 million pounds of nitrogen (0.25% of the total) and 3 million pounds of phosphorus (0.05% of the total) to Vermont farmland.

Table 3.7.19: Animal Manure Available for Anaerobic Digesters or Composting

Animal	Manure Generation (tons/year)	Time Spent in Barns and/or Hard Surfaces	Manure Potentially Available (tons/ year)
Dairy Cows	4,104,400	77%	**3,160,388**
Beef Cows	131,426	10%	**13,143**
Hogs and Pigs	7,167	50%	**3,584**
Horses and Ponies	133,348	10%	**13,335**
Poultry	7,590	80%	**6,072**
Goats	7,219	10%	**722**
Sheep and Lambs	18,297	10%	**1,830**
Total	**4,400,447**		**3,199,074**

Source: Jeffrey E. Fehrs, Vermont Methane Pilot Project Resource Assessment.

Manure generated by dairy cows is usually stored in lagoons or pits until it is spread on corn, hay, or other fields at different times of the year. The VAAFM has prohibitions on when and how manure can be spread (e.g., there is a winter spreading ban, although some exemptions are possible). **Dairy farms operated 83% of all acres treated**

with manure in 2007 (down from 85% in 2002).[97] Manure is also used to make compost (e.g. Vermont Natural Ag Products' line of *Moo Doo compost products*.

In addition to the nutrient and soil management programs and incentives that are utilized to improve manure management, Vermont has a variety of technical assistance resources specifically designed for manure management and often focused on Vermont's dairy farms. The Vermont NRCS office provides a wide range of technical assistance, education, and financing programs for manure management and soil conservation activities. The Vermont Association of Conservation Districts also provides statewide technical assistance and education to farmers and landowners, including the Agricultural Resource Specialist program, which provides technical assistance for manure management and water quality management. The University of Vermont conducts research and provides education and technical assistance on soil, nutrient, and manure management issues, as does Vermont Technical College through its *Dairy Farm Management Technology* program.

Ben & Jerry's "Caring Dairy" program, a collaboration with UVM Extension, dairy farmers, crop consultants, and others, seeks to improve the sustainability of dairy farms by inviting farmers in the *St. Albans Cooperative Creamery* (which supplies all of Ben & Jerry's domestic milk) to rate their farms according to 11 sustainability indicators. The program then works with farmers to improve their scores, thus improving the health and well-being of farms, farmers and animals. The 11 sustainability indicators are: animal husbandry, biodiversity, energy, farm economics, impact on local economy, nutrients, pest management, social human capital, soil fertility and health, soil loss and water.

The program is voluntary, but farmers are offered a monetary incentive to join, and receive recognition from the company for the work they are doing. As of June 2011, 71 farmers in the St. Albans Co-op were participating in Caring Dairy, representing 75% of Ben & Jerry's domestic milk volume. Once a farmer enters data into the Caring Dairy website, they receive a sustainability score. If they get a low score in certain areas, Ben & Jerry's helps them develop "process improvement plans." The farmer then enters their data the next year, to see if their scores have improved.

Vermont has two nonprofit farmer led organizations that work with dairy farmers to address environmental issues. The *Franklin and Grand Isle Farmer's Watershed Alliance* (FWA) was established to support farmers in improving farm practices to minimize runoff from farm fields adjacent to the Missisquoi watershed. The organization provides farm assessments to develop water quality protection plans. In 2009, the Legislature directed funding to VAAFM to purchase six soil aerators for use in the northern portion of the state. Through the FWA, and utilizing a $12 per acre incentive payment from the FAP program, area farmers were able to implement soil aeration on more than 13,000 acres. The aerators help maximize the amount of rainfall moving vertically into the soil, minimizing horizontal water runoff and erosion. According to Roger Rainville, chair of the FWA board, "Our goal was to show farmers that if you aerate your land before applying liquid manure, you can significantly reduce the potential for surface runoff. It did, and many other benefits were noticed also, such as better utilization of nitrogen. It goes in the soil and does not all volatilize into the air. The aerator breaks up compaction and loosens the top 8 inches of the soil for better water absorption. Many farmers saw up to a 100% crop yield increase. The aerators are being used for a $2.00 per acre fee by farmers."

Similar to the FWA, the *Champlain Valley Farm Coalition* is a group of farmers in the Lake Champlain Basin with a mission to demonstrate that a strong local farm economy and a clean Lake Champlain are not mutually exclusive goals. The Coalition formed in late 2012, and is looking to assist farmers in adopting and implementing best management practices to improve economic resiliency and improve environmental stewardship. The group also aims to give farmers a voice on determining the direction of water quality policy for agriculture.

Anaerobic Digesters

Prior to the passage of Act 148, the predominant discussion around anaerobic digesters in Vermont was focused around the management of nutrients on farm rather than those out in the food system. Specifically, digesters have been employed as a component of the on-farm management of manure, which is many Vermont farms' primary source of fertilizer.

Anaerobic digesters currently process substantial amounts of manure, but the potential for more development is significant as well. VAAFM Agricultural Engineer Stephanie Congo estimates that 10% of the dairy manure generated goes through an anaerobic digester, or about 410,000 tons of manure. Because manure from dairy cows comprises an estimated 98.7% of available manure for anaerobic digestion, it is unlikely that other livestock operations in Vermont will pursue anaerobic digestion as part of their nutrient management plan.

For confined or large dairy farms, anaerobic digesters can be used in Vermont as a storage strategy within a nutrient management plan that generates additional revenue streams for the farm. After the digestion process is complete, farms are left with a nutrient rich slurry that can be land applied as fertilizer and dry fibrous biomass that can be used for animal bedding or compost. During the digestion process, the form of nitrogen and phosphorus in the slurry shifts from slower releasing organic forms to more immediately available inorganic forms. The slurry itself still must be stored in a lagoon prior to land application, though a benefit of the digestion process is that the stored liquid has fewer odors than raw manure.[98]

Farmers with more readily available inorganic fertilizer, which has fewer odors, are in a better position to apply nutrients at times when predicted runoff and leaching are minimal without garnering complaints from neighbors. For example, it becomes easier to strategically apply nutrients in the summer with the digester liquid when conditions are dry and plant nutrient uptake is at its peak.[99] However, due to higher inorganic nutrient levels there is also the risk of greater runoff due to leaching and volatilization if conditions are not right during or shortly after application.[100]

Another important factor when looking at anaerobic digesters as a component of nutrient management is that the total amounts of nitrogen and phosphorus remain about the same, as does the total amount of mass to handle after digestion takes place (there is usually about a 5% reduction in mass). Some of the handling burden can be diminished by using the solids as animal bedding or by exporting them off farm as bedding, fertilizer, or compost feedstock. In fact, the **bedding benefits are often cited as the reason for investing in the digester, as competition for sawdust which is used for heating pellets has driven prices up significantly.** Some farms spend around $2,000 for a week's load of sawdust for bedding, and by using the digestate solids for bedding, can save over $100,000 a year on bedding costs.[101]

How the solids will be managed and whether or not there is adequate land base to apply the liquid fertilizer are factors that determine the feasibility of digester expansion, new construction, and acceptance of off-farm food scraps. Ultimately, anaerobic digesters still require a nutrient management plan that prescribes appropriate application of the digested slurry and its greater composition of inorganic phosphorus and nitrogen. Farms utilizing the technology still stand to benefit from adopting cropping practices that limit nutrient runoff and improve soil and water quality.

Bedded Packs and On-farm Composting

Bedded pack systems use the principles of composting to create a loose winter housing area where cows comfortably rest when not being fed or milked. The pack is built up over time in an open or ventilated barn as bedding materials, such as straw or sawdust, are added to manure from resting cows. The bedding keeps the manure dry, and its carbon content creates the necessary nutrient ratios for decomposition to take place. Because only the top layer of the pack is tilled daily, or not at all, lower portions do not decompose at a high enough rate to generate mature compost that can be marketed off-farm unless, upon removal, the bedding is turned in windrows. Jenn

Photo Credit: Jenn Colby

Cows relaxing in a bedded pack barn.

Colby, of the Vermont Pasture Network, reports that turning bedded packs with long fibered hay can be very difficult, and that a fully active composting bedded pack can actually get too hot—negating the comfort benefits the system provides to animals.[102]

Bedded pack systems make for efficient manure handling because the pack acts as both a comfortable bedding area for the cows and storage system for their manure, which is later applied to hay fields or feed crops. Bedded pack systems have also been shown to improve cow health, reducing sore hocks and stress, while increasing milk production.[103] The heat generated from decomposition also improves animal comfort in winter.[104] However, because the system is intended more for operations that have animals out on pasture in the spring, summer, and fall—frequent access to pasture is necessary. Some farms may not have the land base, or may need to convert cropland to pasture before exploring utilizing the practice. Packs are typically started between September and November and removed for composting between April and May.[105]

Even if the farm has no intention of selling compost off-farm, there are other compelling reasons to compost the bedded pack in windrows. Research has shown that composting spent bedded pack can reduce the mass of the material by as much as 63%.[106] Farms are left with less material to manage, and potentially do not need to export manure off farm or will not need to export as much. Additionally, the volume and mass that needs to be transported to farm fields is reduced. Both of these factors can lead to significant reductions in manure management related transportation costs.

Farms can receive cost-share assistance from NRCS to develop a bedded pack barn. NRCS first started offering the incentive in 2010-11. They had approximately 50 contracts the first year, but **site visits revealed that approximately 80% of farms were not using the barns appropriately and some water quality issues had actually been exacerbated.** NRCS placed a moratorium on the practice to determine how they could incentivize the practice while ensuring that it was utilized properly. In 2013 NRCS reinstated the practice, with the new requirement that farms looking to receive the cost-share must attend a training session on how to properly manage the pack. Currently NRCS partners with UVM Extension and Brian Jerose of Agrilabs to conduct the trainings. Jenn Colby says that the trainings are helpful because they introduce farmers to best practices, but also because the trainings help farmers understand the time and cost commitments of the practice. Some farmers go to the trainings and decide that the system is not best for them, which Colby says is a good thing as the practice can require around $80,000 of federal dollars and can have negative impacts if the farm does not implement the practice correctly.

Rotational Grazing

Vermont is often noted for its lush pastures and its overall suitability for pasture-based farming. As our manure estimate indicates, the need to manage manure with physical infrastructure changes considerably if more animals are out on pasture rather than confined indoors. Manure in pasture systems is deposited directly onto the land base, reducing storage needs and costs, and fuel and labor costs association with stored manure application. **Research has shown that costs of production associated with feed, labor, fuel, and veterinary expenses can all be lowered with grazing.** Additionally, infrastructure and machinery costs, the fixed costs of production, can be lowered in grazing systems.[107]

Kimberly Hagen and Juan Alves of UVM Extension's Pasture and Grazing Program report that converting to pasture is an incremental process, and can take anywhere from 1 to 3 years to master the management of pastures, animals, and pasture finances. It may take a few years alone for the pasture to optimally establish itself, developing deep roots and symbiotic relationships with mycorrizae and other beneficial soil organisms. Hagen says that conversion can be done in small steps by adding small rotational paddocks to reduce grain feeding and getting the cows to leave the barn and graze, allowing the farmer to train the animals to graze while getting comfortable with the new management system. Over time, more and more paddocks can be added, such that grazing becomes the primary management system on the farm.

Hagen says that grazing is very compatible with grain and silage production as well. Grain and silage can provide feed during the hot summer, when cool season grasses growth slows down and requires longer rest periods than in spring and early summer. Hagen also notes that several farms have started planting areas with feed crops like sorghum or sudangrass that love the midsummer heat. These crops can provide good feed until the cooler weather and precipitation of autumn returns. Hagen says this requires careful management and planning as sometimes seeds need to be planted in the previous autumn to the current year's grazing season.[108] Hay harvested during the growing season and other stockpiled forage are needed for the winter months, though some winter grazing is possible—a practice more common with beef cows than dairy cows. Winter manure, as mentioned above, can be managed in bedded pack barns.

Some additional changes necessary for converting cropland and confined management to pasture and grazing are:

- Electric polywire fencing to subdivide pasture
- Laneways for animals to access pasture
- Watering systems, consisting of either piped well water or storage tanks that can supply portable watering tanks that are placed in pasture paddocks
- Selection and planting of appropriate grass species combinations to maximize pasture production and meet animal's nutritional needs

Hagen says that the primary obstacle to converting to pasture management is the upfront cost of putting in the fencing and water system infrastructure, and the costs that are incurred to establish good high quality pasture. There is a lag time where the production costs of the conventional system are still in place, and where overall production drops because the pasture is not yet at high enough quality. Consequently, the farm faces a situation where production costs are the same but income is less. Hagen notes that until the pasture has really developed into high quality feed and the reduced costs of production from pasture management have set in, the financial strain can be daunting.

ANALYSIS

With the passage of Act 148 and the impending implementation of a new TMDL for Lake Champlain, Vermont is on the cusp of a dramatic and comprehensive shift in the way Vermonters will relate with and manage nutrients in the future. At every stage of the food system, universal recycling fundamentally changes the way we relate to food scraps. For farms, there are also many opportunities for synergies to emerge between the implementation of Act 148 and the implementation of water quality standards. Many challenges lie ahead to reduce phosphorus pollution from farmland, but there is also a tremendous opportunity to demonstrate that farm viability and environmental stewardship are not mutually exclusive pursuits. A wide range of market development needs that can help Vermont farmers reduce input costs from imported fertilizers and chemicals, while improving soil productivity, reducing pollution, and spending more dollars locally have been identified.

Identifying synergies through research, supporting them with technical assistance, and creating the space for them to mutually thrive through policy, investment, and infrastructure will decide whether or not the nutrient management shift we are undertaking is perceived as a period of food system innovation or indifferent compliance to a new regulatory regime.

Research

Research Needs for Organics Management

On September 25, 2013, the *Food Cycle Coalition* of the Farm to Plate Network hosted a webinar on Act 148 research needs and opportunities as a way to connect those in the research community with those who will be actively involved in the laws implementation. In general, an assessment of public awareness on Act 148 needs to be conducted, assessing public awareness of the basic requirements of the law, programs available to the public, current behaviors, and attitudes around food scrap diversion.

More specifically, a substantial list of research needs was identified for each element of the food diversion hierarchy:

Source Reduction
We need to determine how much food scraps are currently diverted through waste reduction initiatives in order to understand how effective these programs are and how their expanded implementation would effect available food scraps for other diversion paths in the hierarchy. Doing so would clarify infrastructure needs for other aspects of the hierarchy, and help determine the most cost effective strategies for diversion.

Food for People
We need to determine the percentage of food currently being rescued, and the amount being successfully utilized. We need to calculate the physical capacity of food shelves to store rescued food and cross reference their locations with possible food

rescue sources and determine transportation costs. Additionally, there is an interest in collecting data on the cost effectiveness of food rescue as an alternative to disposal in order to make a stronger case for food rescue to businesses.

Food for Animals
We need to conduct a needs assessment with farmers to assess the demand for food scraps as an animal feed, particularly for chickens. Additionally, we need to determine optimal feeding ratios and health issues of feeding food scraps to chickens such as pathogen transfer from food scraps to eggs.

Composting
Vermont's compost industry needs industry and market analysis, including an economic analysis of direct and indirect contributions that composting has on the overall economy. Not enough is known regarding the long-term benefits of the field application of compost, and how effectively it can reduce nutrient leaching, erosion, and runoff. We need to conduct feasibility studies on compost heat recovery systems and animal feeding operations, and develop better testing protocols and management strategies for reducing the impacts of persistent herbicide contamination. We need to inventory farms utilizing bedded packs, reference their locations with food scrap generators and regional volumes, and determine available capacity to handle food scraps.

Data on household back-yard composting is still rough and, beyond some smaller SWD surveys on composting rates (CSWD, for example, compiled composting rates to track progress for its Drop-Off Composting Program), there have been no statewide assessments of backyard composting. A statistically significant household composting survey should be conducted to determine backyard composting rates, with periodic updates to assess progress and efficacy of outreach efforts.

Anaerobic Digestion
We need to conduct a risk assessment of food scraps on manure digestate. We should inventory digester capacity to accept food scraps and still maintain effective on-farm nutrient management, and assess farmer willingness to accept food scraps. Finally, we should determine the feasibility of on- and off-farm pre-processing of food scraps for anaerobic digestion.

Research Needs for On-Farm Nutrient Management

There is a need for more research on how long it takes to convert cropland to healthy productive pasture, and what the best forages are for Vermont's climate. There's also a need to determine what animal breeds do best on pasture in the Northeast. The finances of some Vermont farms (all species of grazing animals) and their cost of production with a pasture based system should be compiled, and a database constructed to make comparisons with other systems to better guide TA and farmer decision making.

Natural Resource, Physical Infrastructure, and Technology

Based on DSM's capacity projections, we know more technology and physical infrastructure will be needed throughout the state to divert food waste from landfills, but stakeholders have expressed significant uncertainty about how to determine whether or not a particular region will require new facilities, and if there is a need, at what scale. Additionally, stakeholders are concerned that facilities will be built without proper consideration for existing capacity, efficient hauling routes, and viable market opportunities.

Without the proper tools, communities, state, and municipal officials will not be able to make the most informed decisions on infrastructure additions. The state is currently working on developing a mapping tool that identifies food waste generators and lists existing facilities, similar to what Stone Environmental's Compost/Biogas Viewer was designed to do but with a larger database and the expectation that it will be updated yearly. The tool will calculate food scrap generation within a defined area to assist stakeholders in determining how generation may meet or exceed area processing capacity. Universal Recycling stakeholders, using the state's mapping tool, should work with Regional Planning Commissions and municipal planning commissions to identify areas of facility development opportunity while devising ancillary community based strategies for source reduction, food rescue, and feeding animals.

Composting technologies vary widely by site, scale, and user. The ability to account for smaller scale infrastructure and on-farm capacity will be important for the state's mapping tool, and for stakeholders as they think about the needs of a region or community. As the DSM study has identified, on-farm composting is a cost effective approach to organics diversion. Identifying farms that have food scrap compatible infrastructure beyond just digesters, such as manure separators and bedded pack barns, should be a further consideration in siting decisions and prioritization. Co-production facilities that utilize heat recovery, using systems like *AgriLab Technologies Containerized Isobar Unit* that can be used to heat hot water for greenhouses and other agricultural applications should be actively promoted and incentivized.

Highfields currently offers services for navigating the siting and certification process, and ANR provides guidance documents on its website, but there is a lack of comprehensive and accessible information on site planning and logistics. Case studies outlining site planning, regulatory compliance, and construction costs should be created for different scales of compost processing to clarify the regulatory and economic commitments required for facility construction. Additionally, as Massachusetts has done, Vermont should conduct feasibility studies of state owned land that could host facilities (including digesters) and promote the development of these sites if they are well suited for organics diversion.

With a variety of pre-processing technologies and emerging small-scale digesters available for larger institutional generators (e.g. Avatar's Compact Organic Reactor), Vermont universities, prisons, hospitals, and other institutions have the potential to become important components of organics diversion infrastructure. Food waste dehydrators are another technology that can be integrated into institutional food services. The dehydrators can reduce food waste volume by up to 90%, which can result in reduced hauling fees for the institution. Through public-private partnerships, the state should explore ways to pilot these technologies, with assessments of costs and management logistics conducted (e.g., the logistics of locating users for processed slurry and digestate solids and the arrangement logistics of consistently hauling processed slurry and digestate solids).

Basic hauling, residential and commercial collection bins, and transfer station collection infrastructure will be needed to fulfill Act 148 diversion goals. **DSM estimates that approximately 40 new trucks will be needed to haul organics at a cost of $7,447,275.** Trucks will be a mix of roll-off and box trucks collecting from rolling carts (totes), front loaders collecting organics from dumpsters, and rear loading compactors collecting rolling totes. In rural areas, haulers and existing facilities may choose to sub-contract organics collection using less expensive technologies like the trailer mounted LeClerc cart lifter that is used by Highfields for their Close the Loop program in the NEK. Highfields owns the 5 ton capacity trailer and hires a subcontractor with a one ton truck to haul the trailer and do food scrap pick-ups.

Source reduction is first in the Act 148 hierarchy, and is often approached more from a behavioral standpoint than a technological one. However, with the development of systems like the *LeanPath 360 Food Waste Prevention System*, that may change in the coming years. Vermont's institutional generators should explore integrating and utilizing LeanPath's 360 Food Waste Prevention System. The system has been piloted with universities in other states, and the state should have a goal of having the system in place at every college and university in Vermont.

Infrastructure, such as cold storage, is needed to support Vermont's gleaning programs and ensure that agricultural surplus finds its way to those in need. Salvation Farms is attempting to expand its Vermont Commodity Program by renovating a building at the Southeast Correctional Facility, with the aim of constructing a loading dock, cold storage, and proper drainage.

Sales and Distribution

Basic information on the economic contribution of compost manufacturers in Vermont is lacking, including a comprehensive analysis of the state of existing compost markets and prospective markets. The elements of analysis needed are the following:

- Demand assessment for compost by volume by region and customer type (e.g., fruit, vegetable, and berry farms, landscapers, dairy farms)
- Demand assessment of compost products for water filtration, infilling, and green infrastructure for developed land non-point source pollution mitigation (including volume used per project, volume used statewide, and volume needed by season)
- Assessment of existing business models, with case studies, and prospective business models that could be utilized for composting
- Development of value added compost products for suppressing plant and livestock pathogens and pests

- Economic research on Vermont's composting businesses intended to collect baseline information on sales, how products are sold (e.g., bulk or in a bag? Retail or wholesale?), number of employees, employee wages, and so on should be combined with information from the market analysis elements mentioned above into a comprehensive industry report.

Due to the amount of bulking material required to create proper recipe mixes, as organic diversion increases there will be a need to distribute carbon materials to composting operations. State and utility employees working with chipped wood from storm blow downs and electrical line clearings, landscapers and contractors working with trimmings and wood waste, and forest product businesses with unders from chipped pallets and lumber not allocated for electricity use should be aware of composting facility locations to send their materials to and be encouraged through outreach to divert their carbon materials to composting facilities.

Marketing and Public Outreach

Because residential generators are the largest contributor of food scraps to landfills, providing consumers with the right information and tools will be critical in meeting the goals of Act 148. Renewed interest in source reduction has emerged in recent years, evoking a spirit of resource conservation that was commonly seen in the United States from World War I to World War II. For example, the EPA has successfully piloted the program, Food: Too Good To Waste—modeled after the United Kingdom's Love Food Hate Waste program—to reduce waste at the source. By having people measure the amount of food wasted, the program led to on average a 25% reduction in food waste over a 5 week period. The program demonstrated that waste aversion, a sense of loss and the negative emotions associated with loss, had greater impact on behavior than the joy people feel over saving money.[109] The Too Good To Waste program should be piloted in a number of Vermont communities. Methods and results from the pilot should be widely distributed and publicized upon completion.

Although ANR has released standardized symbols to create public awareness about Act 148, there is no agreed upon symbol for food rescue that could visually aid people to donate food. Additionally, information on gleaning should be included in outreach materials to residents offered by Universal Recycling stakeholders, and featured on agency websites to improve consumer literacy about gleaning.

Food is Ammunition poster from 1918 (left), and a recent Highfields poster channeling the same spirit.

Photo Credit: Library of Congress Prints and Photographs Division and Highfields Center for Composting

There is a degree of a "yuck factor" associated with food scraps and composting. By tapping into the loss aversion phenomenon described above, and highlighting how composting is inherent in "Yankee" resourcefulness, effective marketing and public outreach can help to change the image of composting. To reinforce positive associations, **composting should also be connected to the larger local food movement in outreach materials.** If consumer awareness studies are conducted statewide, Certified Master Composters can hold their required public educational events in areas that have relatively low composting or Act 148 literacy.

Best compost production practices, as well as uses and benefits of high quality Vermont compost products, should be widely distributed. Residents who utilize best practices are less likely to run into odor and pest issues—avoiding turning off neighbors and friends to the practice. Overall, consumers who know the benefits of compost are more likely to support Vermont composters, using their products for home gardens, lawns, and community gardens. Source separation education, modeled after school programs run by Highfields, should also be instituted at elementary and high schools to create awareness and normalize behavior across generations. Research has shown that socializing in households is bi-directional, as children influence parent attitudes, beliefs, and behaviors just as parents influence those of their children.

Technical Assistance and Business Planning

Technical Assistance and Business Planning for Organics Management

Vermont has a substantial pool of high quality composting practitioners, consultants, and technical assistance providers. One issue is how to offer affordable technical assistance on methods of producing contaminant-free compost, feedstock management, recipe development, variable condition leachate management, health and safety issues, application uses/rates, and basic "compost 101" to farmers. Through bedded pack trainings offered by NRCS and UVM Extension, participating farmers have been able to learn the basics of good composting practices from AgriLab's Brian Jerose. ANR has utilized the expertise of Highfields to run its Compost Operator Certification Course, a required certification course for current or prospective compost site operators who need solid waste approval for handling food scraps or animal mortalities at Small, Medium, or Large composting facilities. These training partnerships should be continued and expanded, with more offerings throughout the year across the state, specifically with the intention of developing more on-farm compost processing capacity.

Managing for persistent herbicides will be an ongoing technical assistance need for composters, as "co-existence" appears to be the regulatory reality. The University of Vermont Plant Diagnostic Clinic was awarded a $36,000 two year grant from ANR to conduct bioassays on compost to test for persistent herbicide contamination. The testing program should be supported by ANR until reliable industry contamination tests have been developed.

There is a notable lack of enterprise budget templates for compost production. Compost input, infrastructure, and labor costs are poorly documented for Vermont compost operations. In 1993, the Cornell Waste Management Institute produced a report of a project entitled "Agricultural Composting: A Feasibility Study of New York Farms." The study provided several case studies of composters that included detailed economic assessments of costs and revenues. A similar style assessment should be done for Vermont composters, with the economic analysis modelled after the benchmark analysis that UVM Extension's Mark Cannella is doing for wine, maple, and egg production. Canella's work will compare the financial performance of businesses in each sector and, in the process, identify how certain management choices affect financial performance. Providing a similar analysis to compost industry stakeholders would make it easier for those interested in on-farm composting to choose the system that works best for them, and for funders to understand relative risk in investing in a particular project.

Technical Assistance and Business Planning Needs for On-Farm Nutrient Management

From 2001 to 2003, UVM researchers evaluated 7 Vermont dairy farms participating in the Vermont Dairy Farm Sustainability Project, a precursor to the Caring Dairies program. Researchers collected baseline data on manure analysis, soil tests, crop yields, manure and fertilizer application rates, feed intakes, forage tests, and milk production and quality. Researchers identified several common problems:

> *On the cropping side of the operations, application of nutrients in excess of crop need on many fields and large field-to-field variability in soil test levels indicated a need to improve allocation of manure and fertilizer nutrients. In some cases, starter fertilizer was being applied to corn at excessive rates. Few farms used the Pre-sidedress Nitrate Soil Test (PSNT), a valuable tool to assure that N supply from manure and fertilizer is adequate but not excessive for corn production. On the animal side there were opportunities to improve nutrient efficiencies in the feed program. In some cases, the potential existed to reduce imported phosphorus sources; in other cases, increased precision in ration formulation could allow for increased efficiency of nitrogen utilization.*

Technical assistance providers then followed up with each farmer by providing improved nutrient management plans. Researchers found significant improvements after the new nutrient management plans were in place:

> *The data collected during the second year, after nutrient management plans were implemented, showed improved nutrient balances while sustaining or enhancing farm profits. One area was fertilizer use, which represents the greatest import of nutrients aside from feed. For example, two of the farms decreased annual imports*

of P2O5 by four and nine tons, respectively, by reducing starter fertilizer rate, resulting in savings of over $4,000 per farm. Reductions in dietary P led to improved feed P conversion efficiency (percent of intake nutrient converted to product nutrient) for 6 of 7 dairy farms without negatively affecting milk production. Ruminal N Balance and P Intake (% of required) were improved on all farms, with the exception of one farm that was already feeding P at 100% of the requirement.[110]

The Vermont Dairy Farm Sustainability Project reported that major nutrient management improvements could be made with greater precision and consistency in the application of fertilizer and feed inputs, and with collaboration between farmers, suppliers, and technical assistance providers. However, to take one example, there is a shortage in the number of technical assistance providers necessary to interact with all farms: According to the 2010 Clean and Clear Annual Report, the VAAFM has one large farm operation (LFO) coordinator, and three medium farm operation (MFO) coordinators. These four staff members are responsible for regulating roughly 170 farms. For the 800 smaller dairy farms the VAAFM relies on assistance from the Conservation Districts and complaints from the public. The VAAFM would like to develop the capacity to run an inspection based program for small farms, but significant additional resources would be required, and it is not clear where the funding would come from. VAAFM recently hired a small farm inspector and is hopeful to have 3 small farm inspectors within the next year or two. Laura DiPietro, Deputy Director of Agricultural Resource Management at VAAFM, acknowledges that VAAFM would like to have more than 3 small farm inspectors. She says that knowing there is limited funding to add more capacity is why self-certification is the goal, and that VAAFM will focus its resources on critical watersheds to reduce the number of farms it needs to directly inspect.

Photo Credit: Jenn Colby

Kimberly Hagen looks on as a group closely examines grass forage.

According to the 2011 Ecosystem Restoration Project Annual Report, VAAFM has 4.5 staff members dedicated to offering technical assistance for water quality improvements. They have one CREP position in northern Lake Champlain and 3.5 engineers—two that work statewide, one that works in Middlebury through an agreement with USDA, and a half time position jointly hired with NRCS to work in Franklin County. Through partnerships with NRCS and VACD, VAAFM funds 3 Land Treatment Planners and 3 Agriculture Resource Specialists as well. VAAFM does not have any dedicated staff to provide technical assistance for its FAP and NMPIG programs.

UVM has two technical assistance programs that have a strong focus on nutrient management and water quality. The 5 member Champlain Valley Crop, Soil & Pasture Team (CVCSP) provides conducts research and provides technical assistance to Vermont farmers in the Lake Champlain watershed. The UVM Center for Sustainable Agriculture's Pasture Program provides research, information, educational opportunities, and technical support to farmers interested in grass-based livestock farming. In 2012, Pasture Program Grazing Specialist Kimberly Hagen held a gathering in Waitsfield with farmers interested in converting to pasture who were hit hard by flooding along the Mad River. Grazing and perennial pasture have proven to be resilient land uses in areas of high flooding risk. The Pasture Program is a program that can fulfill many objectives for the state, helping to increase farm resiliency, improve on-farm nutrient management, and open up new market opportunities as grass-fed meat and milk products become more popular.

The Pasture Program, CVCSP, and VACD staff are all critical pieces to providing important nutrient management technical assistance services to Vermont farmers, and should be supported with stable long-term funding. Each conservation district, for example, receives only $10,000 from the state to carry out its programs. Staff raise money through grants and tree sales to keep the districts operational. This creates organizational instability and inconsistency of program delivery and development. If conservation districts had more dedicated state funding, they could focus time on service delivery to Vermont farms. UVM professor Josh Farley and his colleagues at the *GUND Institute for Ecological Economics* have argued that adequate technical assistance services for farmers is an essential component to improving and increasing the ecosystem services delivered by farmland.

Financing

Financing for Organics Management

DSM estimates that roughly 30% of projected organics diversion will be processed by on-farm technologies at a cost of approximately $6 million. The remaining 70% of projected organics diversion will be processed by centralized facilities at a cost of approximately $20 million. Additional capital costs for new trucks, residential carts, drop-off transfer capacity, and ICI dumpster and carts are estimated to be in the range $12 to $15 million. Capital requirements alone to implement Act 148 are then in the range of $38 to $41 million over the next six years, averaging about $6.5 million per year.

Though a percentage of capital investment will come from the private sector, there are a few ways that public dollars could contribute to capital needs. ANR has proposed raising the franchise fee from $6 to $12 to raise $3.3 million per year.[111] However, because the fee is on a per ton basis, the amount raised via the fee should diminish over time. If the fee is not raised, Act 148 will effectively be an unfunded mandate. Some stakeholders have proposed a packaging tax or fee on garbage or grocery bags as well.

The Working Lands Enterprise Initiative provides grants and loans for capital and infrastructure investments up to $75,000, with a 1:1 match in which at least half the amount is cash. The $75,000 amount is about half of the total investment for a commercial scale 10-ton per week on farm composting facility. WLEI infrastructure funds could serve as a financing instrument to establish more on-farm capacity.

Vermont's Clean Energy Development fund is a potential funding source that could be used for combined heat and power digester systems. Also, the CEDF should consider allowing the funding of compost heat recovery systems that do not produce electricity. Not only are thermal biomass energy projects in general more efficient than biomass power plants, but renewable thermal energy technologies like compost heat recovery can help offset regional dependence on fossil heating fuels (the Northeast alone accounts for 86% of national heating oil demand).[112]

The construction of composting pads—the surface of an outdoor facility constructed from gravel, concrete, sand, clay, or fabric that mitigates nutrient leaching where feedstocks are placed and composted—is a practice the NRCS supports. However, NRCS staff have indicated that a farm would need to make changes to their nutrient management plan if they were accepting off-site food scraps. As part of the process of changing the nutrient management plan, a farm would need to demonstrate the existence of an off-site market to export nutrients (i.e., finished compost) to if nutrients exceeded what could be appropriately field applied. NRCS staff have also noted that energy practices are good candidates for receiving funding, opening up the possibility for the funding of more heat recovery systems that can provide heat to buildings or facilities such as manure separators or greenhouses.

There's also the opportunity to utilize financing models that can reduce the amount of collateral farms have to put up to secure capital, and that delay principle payments in order to allow farms to process sufficient compost for sale. *Hudak Farm* built an on-farm composting facility for $35,000, $15,000 of which was covered by grants and $20,000 from a loan from the *Vermont Community Loan Fund* (VCLF). The loan was backed by the *Castanea Foundation*, and principle payments were deferred for 12 months to allow the farm to create compost sales before paying the principle.

Financing for On-Farm Nutrient Management

The cost of curtailing nutrient runoff and pollution into Vermont's surface waters will be substantial in the years ahead, leaving the state with important decisions about how to adequately fund water quality improvements. It should be noted that if the state is unable to meet TMDL targets, costs of remediation will likely be much more expensive as EPA will require all point source polluters regulated under the Clean Water Act to install best available technology.

In 2012, the Vermont Legislature passed Act 138 which directed ANR to prepare a report that examined the water quality remediation options available to the state and the associated costs of implementing each option. The *Water Quality Remediation, Implementation and Funding Report,* released on January 17, 2013, estimates that **the costs of reducing nonpoint source pollution from agriculture will cost $8,727,000 each year for tens years, for a total cost of $87 million.**

The Act 138 report outlines tools for financing a statewide Water Quality Trust Fund. Along with many broad based tax and fee options, the report proposes a few financing options that would specifically be intended to address non-point source pollution from agriculture:

- An excise tax on fertilizer and pesticide, particularly targeted at phosphorus and nitrogen-based fertilizers. A 1% excise tax would generate approximately $250,000 annually. As a recent controversy over the taxation of compost has demonstrated, there are potential problems with defining which fertilizers would be taxed. Also, determining whether or not the tax would be meant to raise funds or deter use is equally important. For example, a direct tax on fertilizers and pesticides could beneficially reduce usage, which would also reduce revenue generated.
- The Current Use Program is an existing mechanism in which enrolled land-owners receive a property tax reduction that the report suggest could have a stronger linkage between enrollment and compliance with the state's AAPs. While enrolled forest landowners are required to commit to certain land management practices through the development of a forest management plan, there is not a similar requirement for enrolled agricultural land. Requiring compliance with AAPs in exchange for state investment of tax revenue would be a way to leverage current state expenditures for greater environmental gain. An issue with this proposal is that in the program's early years, many farmers avoided enrollment for fear of being regulated through the program. Many were given assurances that the intent of the program was to keep land in agriculture and not to regulate agricultural lands.
- Create an incentive system for excellent stewardship that utilizes best management practices and goes beyond regulatory compliance with AAPs and MFO and LFO permit requirements. The report suggests that Current Use could once again be the mechanism for financing. In this instance, however, rather than using Current Use a compliance mechanism, it would be used to incentivize best practices. Greater property tax deductions would be granted for demonstrating excellent farmland stewardship.

The two Current Use proposals are not without precedent. The European Union has made changes in incentive payments that combines elements of the two Current Use proposals. To receive minimum subsidy support, producers must fulfill basic practice requirements similar to the AAPs, while adoption of approved practices that are beyond the baseline unlock additional incentive payments.[113]

Additionally, the Current Use proposals are close to the principles of a payment for ecosystem service (PES) model. The general idea of a PES program for agriculture is to compensate landowners who produce environmental benefits, such as water quality improvements, soil quality improvements, and biodiversity improvements (and in some instances, cultural and aesthetic improvements). Payments for services can occur in a privately created market, or can be managed by municipal or state governments. The watershed protection program that New York City created and runs in the Hudson River Valley is an oft cited example of a successful PES program. The program helped the city avoid the cost of building a $6 billion filtration plant, and the associated $250 million a year in facility maintenance costs.[114]

Although changing the Current Use Program is a complex political issue—and perceived to be a risky endeavour by stakeholders because change opens the door for weakening the program—there are ways that Current Use could be amended in order to help fulfill water quality, nutrient management, and overall land management goals of the state. Europe has implemented tiered incentive schemes that pay farmers more as they verifiably adopt more environmentally beneficial practices. The state should determine if its feasible to offer additional tax incentives for farms that can verify the use of practices that go beyond regulatory requirements. By increasing the tax incentive, such a change to Current Use would avoid the use of the program as a regulatory compliance mechanism, which some in the farming community have expressed concerns over, and ultimately strengthen the program.

Beyond Current Use, the state should broadly examine how it can develop incentive programs that encourage management approaches that not only fulfill but go beyond regulatory requirements. Based on yearly enrollment and the fact that the program expends all of its funds every year, Farm Agronomic Program funding and staff support should be increased. The program, and its incentives for adopting beneficial cropping practices like cover-cropping, is clearly in demand and has helped ease the risk farmers take on when adopting new practices. Because a practice like cover-cropping often helps to improve farm management and the bottom line, FAP is an ideally designed incentive program. FAP should be seen as a program stimulating cropping diversification and innovation. Additionally, pasture conversion should be incentivized with a fund to help ease transition costs. Much has been said about Vermont's suitability for pasture-based farming and the marketing value to the Vermont Brand that grass fed livestock has, but there has, to date, been no concerted effort to direct incentives to pasture conversion.

Additionally, though the payments are low per acre, the CSP program could be promoted more strongly in the state to producers already adopting good practices. The program could also be more closely tied with FAP, as farms implementing a practice through FAP one year would be in a position to qualify for CSP funding the next. **Overall, a more concise, synthesized menu of incentive options should be developed for farmers to make it easier to understand the financial incentives of a program and select the options that are best suited to their farm.**

As stakeholders consider how to finance the Water Quality Fund, explaining what the costs would be if the state failed to meet the TMDL and was forced to make waste water treatment upgrades with best available technologies could help to generate public interest and support for a more PES oriented financing approach for agriculture. In fact, a project piloted in 2013—*The Bobolink Project*—demonstrated that Vermonters are willing to pay for ecosystem services from farmland. The project, a nonprofit research program based out of the University of Connecticut and the University of Vermont, asked Champlain Valley residents to pay farmers to adopt practices that provide habitat for bobolinks—a migratory ground nesting songbird. In 2013, the program received $31,000 to pay out to 7 farms and cover 200 acres of hayfields. One participant, Phil Wagner of *Wagner Ranch* in Bridport, was able to use half of the payments to invest in a new feeding area designed to prevent manure from washing off into Lake Champlain. Having favorable incentives in place that promote good stewardship rather than solely regulating for bad behavior is another way to shift the paradigm of on-farm nutrient management in Vermont.

Network Development

Network Development for Organics Management

Implementing Act 148 will require substantial coordination between state, municipal, private, and nonprofit organizations. Two networks, the *Vermont Organics Partnership* (VOP) and the *Food Cycle Coalition Task Force* (FCC) of the Farm to Plate Network, have formed to bring stakeholders together to communicate needs, prioritize objectives, and coordinate activities. Both groups are trying to understand assets and needs at the state level, and are progressing towards more regionally focused coordination and implementation. Additionally, Highfields' Close the Loop Vermont campaign provides a growing opportunity to create cohesion under a statewide infrastructure network to capture and compost food scraps from across the state.

VOP was formed by ANR to create an open forum for stakeholders to discuss, disseminate, and share information about the diversion and management of organics in the state in response to Act 148. VOP meetings have importantly provided an avenue for ANR to communicate progress, test ideas, and establish partnerships with organic diversion stakeholders. The FCC is focused on how to connect the food system with the organics diversion mandate in order to support the local food system and ensure that no Vermonter goes hungry and no resource is wasted. The FCC is composed of many organizations that manage important food system networks themselves, such as the Foodbank which coordinates with the many food shelves across the state. The FCC sees Act 148 as an incredible opportunity to address multiple goals of the F2P Strategic Plan; namely, increasing food security, reducing fossil fuel dependence and greenhouse gas emissions, creating jobs, and protecting waterways and soil. The FCC has planned a strategic planning session in early 2014 to identify strengths and weaknesses, match organizational resources and needs with one another, and establish strategies and objectives. An area that both groups have grappled with is how to identify infrastructure needs and potential sites for development.

As Highfields' Community Compost Coordinator Noah Fishman has noted, these broad analyses are starting points, but community based approaches will need to be implemented that are based on the resources that exist on the ground in each community (i.e., nutrients, human and social capital, existing infrastructure). For example, the FCC should tap into producer association networks to identify farms that would be interested in developing on-farm processing capacity or having gleaning days. The VOP should work to provide a more concise analysis of regional infrastructure opportunities and reach out more to the hauling community to get input about route feasibility and logistics.

Network Development for On-Farm Nutrient Management

The Vermont Association of Conservation Districts operates as a network in close collaboration with VAAFM and NRCS. VACD staff serve an important role to both organizations, as they are able connect farmer needs with state and federal incentive and TA programs. In 2013, Conservation Districts statewide received funding from the legislature for the Agricultural Outreach Initiative. Through AOI, district staff meet with beginning, small, and medium farms to discuss short- and long-term goals and management objectives. Through these discussions, staff make conservation recommendations and provide information on resources and programs that could assist the farm in meeting its goals while protecting its natural resources. The *Conservation in Vermont: Best Management Practices for Farm and Forest Owners* was an additional product that came out of AOI. In the first year of the program, district staff reached out to over 200 farms.

While AOI demonstrates the strong networking that exists within the conservation community, some stakeholders have expressed a need for making a stronger connections between business planning and conservation planning resources. For example, there is uncertainty about how different conservation practices affect farm management and finances. VACD and NRCS staff are not equipped to make financial comparisons beyond costs for farms. If VACD and NRCS staff could provide financial analysis, whether it came through professional development via trainings with business planners or referral services that were integrated into their project management, the divide between conservation practices and farm viability could be bridged. AOI is, in many respects, already on this path, as its designed to talk about the farmers management objectives and growth projections.

Supporting farmer led networks will also be critical as new regulations and programs emerge to fulfill the requirements of Lake Champlain's TMDL. The Franklin and Grand Isle Farmer's Watershed Alliance has created a support network to help farmers improve water quality in the Lake Champlain Basin. Members receive technical support, including nutrient management planning and farm assessment, from the FWA's agronomic specialist. The FWA's approach is to establish trust with farmers, giving farms assistance without the fear of regulatory action. In doing so, the FWA can implement beneficial practices on farms that might not otherwise engage with state or federal programs. The Champlain Valley Farm Coalition is emerging as a strong voice for demonstrating that farm viability and environmental stewardship are not mutually exclusive pursuits. Similar to the FWA, the CVFC are looking to make change through building trust amongst farmers and utilizing peer learning.

This form of self-organization and self-regulation closely models developments by rural agricultural communities in Europe that have formed environmental cooperatives in order to integrate dairy farming with nature conservation and landscape management.[115] Supporting these producer led networks, along with other producer associations, may be an effective way to establish greater buy-in from the farming community and open up communication channels between producers and nutrient management TA providers and regulatory officials. For example, Jeff Carter of UVM Extension's Champlain Valley Crops, Soils & Pastures Team, is on the Board of Directors of the CVFC, and meetings have featured TA providers such as Julie Moore of Stone Environmental who discussed edge of field monitoring.

Education

Education for Organics Management

There are many opportunities to integrate organic diversion into K-12 school curriculums. Composting offers a way to introduce students to biological processes and ideas about sustainability. Source reduction and food rescue can introduce students to the concept of food justice, as well as resource and energy conservation. Vermont Tech is planning on integrating its new anaerobic digester into curriculum, introducing students to digester operation and engineering.

Workforce Development

A 2013 study from the Institute for Local Self-Reliance indicated that, on a per ton basis, compost production in Maryland creates two times more workers than landfilling and four times more workers than incineration.[116] It is unclear if this relationship is similar in Vermont, but it is reasonable to assume that as food scrap diversion increases in Vermont as Act 148 is implemented, more workers will be required for collecting, hauling, production, and delivering. CAV, Highfields, solid waste districts, and other industry stakeholders should identify the workforce development needs for the variety of potential careers in food diversion. Additionally, institutions will likely need to train or hire facility managers with a sound understanding of organic diversion options and practices.

Regulation and Public Policy

Regulation and Public Policy for Organics Management

To encourage food rescue through gleaning, the state should examine how farms that participate in gleaning programs can be compensated for their contributions, either through subsidized direct payments for the amount gleaned or through tax credits or deductions. Legislation would be needed to keep gleaned food designated as a donation in order to prevent sales tax collection and protections under good samaritan laws.[117]

A change to the tax code in 2007 inadvertently left compost off of a list of products exempt from sales tax when used for agriculture. New tax rules written in 2009 formally instituted the change, and in the same year, Karl Hammer of the Vermont Compost Company was informed by the Vermont Department of Taxes that he was being audited for failing to collect sales tax on compost sold since 2009. Days later, Hammer received another letter stating that he owed $394,000 in back taxes. Hammer has appealed the decision, but as current tax law stands, compost is treated differently than other tax exempt agricultural production inputs—including chemical fertilizer. Unfortunately, the exemption feeds the perception that compost use and production is not an agricultural activity, when in fact its use is integral to many Vermont farms and its production fulfills a critical role in Vermont's food system—closing the loop between food consumption and production. A legislative fix is in the works for 2014. The bill should be passed by the legislature to ensure consistency in tax policy and dispel the notion that composting is not a critical component of the food system.

Act 141 and new solid waste management rules will define the ways that composting can be done on farms. Compost industry stakeholders and regulators are using a collaborative approach to develop Vermont's composting infrastructure. In the interest of reaching Vermont's goals of reducing solid waste and strengthening the food system, refining Vermont's composting regulations should continue.

Act 250 and municipal regulatory exemptions only classify composting as an agricultural activity for composting of food scraps in small quantities, on limited acres, or when the sale of any on-farm created compost creates less gross income than other farming activities. Additionally, there is still hesitancy in the farming community to accept off-farm food scraps due to past legal run-ins and unclarity surrounding existing rules. There is a need to develop policy that cuts through traditional barriers between the regulatory frameworks for solid waste and agriculture, and recognizes the use of food scraps for on-farm composting as a farming practice. This will require establishing a regulatory framework that:

- Recognizes the oversight of solid waste regulators in the handling of food scraps;
- Ensures that farmers who source local inputs for soil health and fertility can do so, and remain within sanctioned agricultural practices.

In the interest of reaching Vermont's goals of reducing solid waste and strengthening the food system, continued negotiations, refinements, and education to the farming community regarding Vermont's composting regulations should take place. Meeting the goals of Vermont's Universal Recycling Bill (Act 148) may result in additional modifications to existing composting regulations.

Vermont does not have state level certifications for quality assurance, and does not require product ingredient disclosure. Having these two policies in place could lend legitimacy to compost as an agricultural product. Quality assurance enhances the marketability of Vermont compost products and contributes to the strength of the Vermont brand. Ingredient disclosure can help address concerns over persistent herbicide contamination. The disclosure of ingredients that are more likely to contain persistent herbicides, such as horse manure, allows customers to better assess application risks and select the product that best fits their needs. There is an existing certification program for compost approved for organic farming. Individual composters can voluntarily choose to participate in the *US Composting Council's Seal of Testing Assurance* program. As Vermont's composting sector grows the industry may develop its own quality assurance standards.

With the publication of the Waste Composition Study and System Analysis, ANR provided *a report of Act 148 implementation recommendations* on November 8, 2013. Relating to organics diversion, ANR recommends:

- The legislature adopt legislation that requires all towns in Vermont to be a part of a Solid Waste District. Such legislation would effect at a minimum 21 towns that are not part of a SWD or that don't have approved Solid Waste Implementation Plans (SWIPS). The requirement would allow for greater pooled resources for standardized education and outreach, and would help lower administrative costs.
- Eliminating a one ton curbside rating exemption for commercial haulers. With the exemption in place, one ton collection vehicles will not be required to comply with recycling and organics collection benchmarks. Removing the exemption would also improve tracking and analysis of overall waste management in the state.
- Funding for new recycling and organics infrastructure to seed initiatives and strategic investments. ANR recommends raising the franchise fee from $6 per ton to $12 per ton, which would generate an additional $3.3 million in revenue. The fee has not changed since it was established in 1987, and the proposed increase would amount to an additional cost to Vermonters of $4 per year per individual. The franchise fee was originally established in 1987 to fund grants/loan programs for private and public sector equipment investments to implement Act 78—Vermont's first solid waste law.

ANR's three organics related recommendations are all sensible policy changes. In particular, raising the franchise fee is consistent with the original intent of instituting the fee, as Act 148 is an expansion upon Vermont's original solid waste bill. It's also a small amount of money when considering the ambitious goals of Act 148. Organics stakeholders should carefully consider how they would use those dollars to implement Act 148 in order to refine the request for funding. It's conceivable that investment will be directed towards outreach and education in the early stages of implementation, with investment shifting to infrastructure projects as diversion increases and clarity around capacity needs crystallizes. ANR will also need the funding for staff support, particularly for enforcement. ANR needs to determine what kind of procedures they will institute to address plastics and other non-compostable product contamination in diverted residential organics. Maintaining high quality compost is important to many Vermont composters, and sorting and removing materials adds additional equipment and operational costs.

Additionally, in order to maximize the effectiveness of the Pay as You Throw (PAYT) requirement, true weight based trash pricing should be pursued, with a pilot comparing a weight based system with a volume based system. Volume based pricing, though easier to institute, indirectly addresses the problem. Organics are heavy, but don't necessarily take up the majority of trash volume, as they can be compressed into spaces that other trash items cannot. If PAYT was based on weight, there would be a greater and clearer incentive for residents to divert their organics from the trash, and they would save money in the process.

Vermont's lack of a mandated Renewable Portfolio Standard may be effecting the viability of anaerobic digester development. All of the other New England states have adopted an RPS, which creates mandatory renewable energy targets. Under a RPS, utilities must purchase the mandated percentage of renewable energy, and this percentage is accounted for by owning the corresponding percentage of RECs. With an RPS, there would exist an in state demand for REC purchases, alleviating some of the pressure to find voluntary customers through the Cow Power program or finding REC buyers out of state who are already operating under a RPS. An RPS would effectively create an in-state market for RECs which existing and prospective anaerobic digesters could sell into.

Regulation and Public Policy for On-Farm Nutrient Management

Significant regulatory and policy changes are expected to occur in agriculture as Vermont approaches EPA's expected issuing of the final TMDL in the summer of

2014. On November 20, 2013 Vermont released its draft proposal for cleaning Lake Champlain. The report includes the following recommendations for agriculture:

- The maintenance of adequate staffing to implement the MFO, LFO, and CAFO permit programs. VAAFM and VDEC will produce yearly compliance reports, which will include information on nutrient management plan compliance and reporting on any documented discharges.
- Modify current AAPs to include:
  - Whole farm inspections of small farms;
  - Initiate an AAP compliance certification process for small farms;
  - Require additional and improved farming management practices for annual cropland, such as 25 foot vegetated buffers along perennial streams, and 10 foot vegetative buffers along field ditches;
  - Require all farms to complete a nutrient management plan matrix, directing farms that meet specific thresholds to develop and implement an NRCS 590 standard nutrient management plan;
  - Requirement to stabilize field gully erosion caused by site-specific agricultural management practices;
  - Adopt a soil loss tolerance of T as defined by NRCS for the prevalent soil type and apply the standard to all farm fields in annual crop production.
- Implement a livestock exclusion incentive program with a declining cost share policy to encourage early adoption. The declining cost share would offer a 90% cost share the first year, declining to 75% and 50% in the subsequent two years maintaining a 50% cost share thereafter.
- Along with expanding nutrient management requirements to small farms, VAAFM proposes accepting exemptions to the winter spreading ban if winter spreading is approved by a third party Technical Service Provider during the development of a NMP. The winter spreading ban has forced many farms to apply excessive manure in the spring, when conditions are wet and the risk of runoff is increased.
- The proposed Small Farm Certification Program that would be instituted by revising the AAPs would require small farms to certify their compliance with AAPs every five years. Certification documents would require reporting on the number and type of animals and the acreage in agriculture.

Many of VAAFM's proposals will require increases in the agency's enforcement personnel, and additional personnel increases for organizations like VACD and UVM Extension that provide technical assistance. The Act 138 Water Quality Remediation, Implementation, and Funding Report estimates that to meet water quality goals the state will need to spend $653,000 more per year on technical assistance. To improve AAP compliance, the report estimates the state will need to spend $635,000 more per year. Livestock exclusion is estimated to be the most expensive regulation to implement, with an annual cost of $3.3 million over 10 years. What's clear is the need for greater staff capacity at VAAFM, as the state can no longer rely on a citizen complaint model for regulating smaller farms—and this need for change is compounded by the fact that the public is generally not aware of what the actual regulations are. VAAFM should explore using stocking densities rather than absolute animal numbers, similar to what is done in Pennsylvania, as a way to reasonably and cost effectively regulate smaller farming operations. Because the question is often whether or not the land base can adequately handle the nutrients applied to it, small farms with high stocking densities are most in need of nutrient management assistance.

GETTING TO 2020

A transition from a waste disposal paradigm to a soil-to-soil nutrient management paradigm for organic materials would fundamentally change how we handle these resources.

On-farm compost production provides Vermont with a way to divert organic wastes from landfills, and also give farmers the ability to utilize locally-available resources to improve their soils, provide necessary crop nutrients in a sustainable manner, and improve farm viability with less costly fertilizers. Integrated compost regulation, basic market research, infrastructure development, and public education are key steps to building the state's capacity to transition away from waste management toward nutrient management.

Shifts in public concern and interest in nutrient management, composting, and soil health, improvements in individual and organizational capacities to compost, and strengthened public policies to facilitate widespread composting will be necessary to achieve F2P Goal 14.

Table 3.7.20: Objectives and Strategies for Nutrient Management

OBJECTIVE	STRATEGY
Research Strategies	
To understand consumer awareness of Act 148, and food scrap diversion attitudes and behaviors.	A yearly statewide Act 148 awareness survey question should be administered to track progress of public outreach efforts before the 2020 residential mandate goes into effect.
	Consumer attitudes towards food scrap diversion should be studied to better understand how to best implement education efforts and administer diversion programs.
	Because little is known about consumer food scrap diversion behaviors outside of rough backyard composting approximations, a baseline survey should be conducted and updated in conjunction with the state's every five year waste composition study.
To identify the scope of food rescue capacity and utilization, and better understand the cost effectiveness of food rescue as an alternative to disposal.	Aggregate food rescue data, and determine the capacity of existing food rescue storage infrastructure—including food shelves— and cross reference their locations with potential food rescue sources, while calculating associated transportation costs.
	Conduct an analysis of food rescue costs for different sectors and scales, and compile the results in case studies that clearly demonstrate cost benefits and necessary administrative investments for succesful program implementation.
To identify farmer demand for food scraps as an animal feed.	A demand assessment should be conducted with farmers to determine their willingness to accept and utilize food scraps for animal feed, and the amount of food scraps that they could utilize for animal feed.
To study food safety and feed quality of food scraps to create a replicable foodscrap chicken feed model for egg production.	More certainty needs to exist around proper hen management and egg handling in flocks that use food scraps as a feedstock. Research should identify prospective food safety concerns and assist the development of appropriate food safety protocals to ensure the public that eggs produced in this environment are safe to eat, while preemptively reducing the risk of outbreaks that would compromise the viability of the foodscrap model. Hen health and nutritional needs should also be examined and provided to farmers.
To determine the direct and indirect contributions that composting has on Vermont's economy	Survey Vermont composters and determine sales, how products are sold (e.g., bulk or bag? Retail, or wholesale?), number of employees, employee wages, capital investment etc.
To understand the short and long term soil and water retention benefits of compost application.	Vermont specific research should be conducted examining the benefits of compost application to farm fields over other fertilizers and soil amendments, with a particular focus on how compost application mitigates soil erosiion and nutrient runoff. Results should be integrated into nutrient managment plans and help inform the debate over what constitutes a farm activity when on-farm composting accepts and utilizes consumer food scraps.

OBJECTIVE	STRATEGY
Research Strategies	
To understand how food scrap diversion and anaerobic digestion can be optimally paired to maximize returns on investment in digester infrastructure.	Because the energy of potential of food scraps is highly desirable for digesters, and by products of the digestion process can be utilzed by farms and composters, stakeholders need to better understand the feasability of on- and off- farm pre processing of food scraps for digestion, the capacity of digesters to accept food scraps, the willingness of farms with digesters to accept food scraps, and the potential digestate contamination risks when using consumer food scraps in digesters.
To understand the economics of pasture conversion and establishment.	The initial costs associated with the period of conversion from corn silage to pasture management can be the biggest impediment to pasture conversion. Research should be conducted to better understand conversion costs and the period of time required to reach optimally performing pastureland.
To conduct and consolidate research on the financial performance of pasture based operations to better guide technical assistance and farmer decision making.	Combined with national research, Vermont specific research should be conducted on different livestock pasture systems and diversified livestock pasture systems, and consolidated in one location to give technical service providers and farmers easy access to cost estimates and financial performance of these systems. Case studies should aslo be compiled comparing management systems to improve understanding of benefits and trade-offs.
Natural Resource, Physical Infrastructure, and Technology Strategies	
To utilize source reduction technologies such as the LeanPath Waste Prevention System at large institutional or commercial food service kitchens and restaurants.	Source reduction is not immediately associated with technology, but technologies like the LeanPath system are demonstrating how technology can be used to improve source reduction behavior. The LeanPath system should be piloted in Vermont's colleges and universities, with an associated inter-college source reduction challenge to raise the profile of source reduction and source reduction strategies. Results and financial savings should be widely disemminated.
To establish infrastructure for statewide gleaning programs.	The state should support the development of small regional cold storage and light processing facilities for gleaning programs to improve the distribution of gleaned foods and address food security.
To identify farms with food scrap compatible infrastructure and increase on farm processing capacity of diverted food scraps.	Many farms already have infrastructure or utilize practices that are compatible with accepting and composting food scraps. These farms should be identified. Stakeholders should examine if these farms are located in areas needing processing infrastructure, and the farmers interest in accepting and processing food scraps should be determined.
To install pre-processing technologies and small-scale digesters at Vermont's large institutional generators.	Vermont's large institutional food scrap generators will be the first to be effected by the Act 148 mandate. Institutions should be incentivized to pilot new pre-processing, dehydration, and small scale digester technologies to demonstrate their feasibility and establish infrastructure early in the implementation of Act 148.
To develop crowd source capabilities for ANR's proposed mapping tool.	As ANR develops its mapping tool to assist infrastructure planning and the identification food scrap generators and nearby facilities, it should allow for moderated crowdsourced submissions that can account for smaller community based infrastructure assets and keep data as current as possible as new infrastructure emerges across the state. that may not be identified immediately by state officials.

OBJECTIVE	STRATEGY
Sales and Distribution Strategies	
To analyze industry and market conditions of Vermont's compost industry in order to strengthen sales and expand markets.	As more feedstock becomes available to existing and prospective composters, the industry will need to better understand the demand for its products by region and customer type, and the demand for compost products for green infrastructure projects that it can fulfill as production volume increases.
	An assessment of existing and prospective business models from composting should be conducted, with case studies illustrating the characteristics that make a particular model successful or unsuccessful.
To establish consistent distribution of carbon resources to Vermont's compost facilities	Work with state and utility officials dealing with storm blow downs and electrical line clearings, landscapers and contractors, and forest proudct businesses to raise awareness about the need for carbon resources at compost facilities and negotiate the procurement of these resources for compost facilities.
Education Strategies	
To integrate organics diversion into K-12 and post secondary curricula.	Encourage the Vermont Agency of Education, the Farm to School Network, Composting Association of Vermont, and Highfields to develop STEM based organics diversion modules that mirror the diversion hierarchy for K-12 classes.
	Create composting and anaerobic digestion classes for career technical education centers as a part of CTE agricultural programs.
Workforce Development Strategies	
To identify workforce development needs for organics diversion.	Composting stakeholders such as CAV, Highfields, and Solid Waste Districts should identify the workforce development needs for the variety of potential careers in composting.
	Institutions that require facility managers should identify the workforce development needs for the variety of facility demands that will come from Act 148 and organics diversion.
Regulation and Public Policy Strategies	
To add compost to the list of sales tax exempt agricultural products.	Stakeholders should advocate the legislature to add compost to the list of sales tax exempt agricultural products.
To create the regulatory framework that allows for and recognizes the composting of food scraps on farm as an agricultural activity.	Continue to negotiate and refine Vermont's composting regulations to create regulatory protections on par with other farming practices for the acceptance of food scraps on farm and the subsequent application of composted food scraps for on-farm nutrient requirements.
To standardize organics diversion implementation for municipalities and commercial haulers.	Require all towns to be a part of a Solid Waste District in order to standardize education and outreach and lower administrative costs.
	Eliminate the one ton curbside rating exemption for commerical haulers in order to require universal hauler compliance with recycling and organics collection benchmarks.

OBJECTIVE	STRATEGY
Network Development Strategies	
To support the ongoing networking and coordination of the Food Cycle Coalition and the Vermont Organics Partnership.	The Food Cycle Coalition should network with Vermont's producer and processor associations to identify prospective farmers willing or interested in developing on-farm infrastructure for food scrap diversion.
	The Food Cycle Coalition and the Vermont Organics Partnership should continue to widen their networks, by engaging marketing professionals, haulers, farmers, conservation groups, economic development officials, and regional planners.
To evaluate and support farmer organized and led organizations and initiatives focused on diminishing the evironmental impacts of farming.	The environmental cooperative model being applied in some European countries should be analyzed, and concepts and lessons learned should be applied to similar farmer led initiatives in Vermont.
Marketing and Public Outreach Strategies	
To increase the adoption of effective source reduction behaviors.	Pilot the EPA's Food too Good To Waste program (or similar source reduction program) in communities across Vermont and widely distribute and publicize the results upon pilot completion.
To increase public awareness of food rescue, including gleaning at the point of production.	Develop a food rescue icon in alignment with the other universal recycling symbols and feature it in locations where food can be donated but also in business windows that contribute to food rescue efforts.
	Feature information on gleaning on agency and stakeholder outreach materials and websites, and provide resources and links to organizations that coordinate gleaning efforts across the state.
To diminish the "yuck factor" associated with food scraps and composting.	Tie in food scrap diversion outreach materials with the values of self-sufficiency and resourcefulness, and connect food scrap diversion efforts with the larger local food movement and system in outreach materials.
To promote best compost practices and the benefits of high quality compost products	Outreach materials should emphasize best compost practices to minimize the adverse effects of improper composting, and tout the uses and benefits of Vermont made compost products.
Technical Assistance and Business Planning Strategies	
To continue to offer and expand the opportunities for affordable compost operator training,	Along with the Compost Operator Certification training, support the offering of content specific trainings for compost heat recovery, persistent herbicide contamination management, chicken feeding, and marketing and business development.
To integrate farm viability and business planning technical assistance with conservation and stewardship technical assistance.	Bring together farm viability and business planning TA providers with conservation and stewardship TA providers to identify how prescribed soil and nutrient management practices effect financial performance and business management in order to improve conservation practice recommendations and integrate conservation and stewardship TA with farm viability and business planning.
	Continue to support the Agricultural Outreach Initiative, and utilize the AOI as a vehicle for delivering integrated business planning and conservation and stewardship technical assistance.

OBJECTIVE	STRATEGY
Technical Assistance and Business Planning Strategies	
To prevent the effects of persistent herbicide contamination in compost.	The Agency of Natural Resources should continue to support UVM's Plant Diagnostic Clinic's persistent herbicide contamination bioassay testing program until affordable and reliable industry tests have been developed.
	Organize persistent herbicide workshops to educate pesticide applicators and horse farmers about the regulatory restrictions and effects on composting of using Aminopyralid and Clopyralid and sourcing hay from regions where these pesticides may be used.
To improve the financial performance and viability of composting enterprises and on-farm composters.	Develop enterprise budgets for composting operations.
	Conduct benchmark analysis of different management systems to help improve management decisions and assist prospective composters in choosing the system that works best for their situation. Compile the results into case studies and create a publication modeled after the Cornell Waste Management Institute's "Agricultural Composting: A Feasibility Study of New York Farms".
To support the long term stability and statewide reach of nutrient management technical assistance programs.	Provide additional staff support to the LFO and MFO program coordinators at VAAFM.
	Support the creation of, at a minimum, 3 new small farm inspectors at VAAFM.
	Create dedicated agronomist support positions for the FAP and NMPIG programs at VAAFM.
	Secure long term funding for the Pasture Program and add at least one more pasture specialist to the Pasture Program at UVM.
	Increase the annual state allotment to conservation districts from $10,000 to $50,000 to ensure programmatic stability year to year and diminish the amount of staff time diverted from technical assistance to fundraising.
Financing Strategies	
To fund with public dollars the implementation of Act 148 education and outreach programs, and the development of food scrap diversion infrastructure.	Provide stable long term funding for Act 148 implemenation by raising the franchise fee from $6 to $12, and explore alternative financing and incentive mechanisms such as a packaging tax.
	Work with farms interested in adding food scrap diversion infrastructure to develop sound plans and proposals for Working Lands Enterprise Initiative infrastructure funding.

OBJECTIVE	STRATEGY
Financing Strategies	
To fund with public dollars the implementation of Act 148 education and outreach programs, and the development of food scrap diversion infrastructure.	Explore the use of CEDF funds for compost heat recovery systems.
To explore the institution of direct payments or tax credits for farms participating in gleaning programs.	Determine how either direct payments for donated products can be tax exempt or how to make donation tax credits easily accessible for farmers and non-competitive with cost of production tax credits.
To leverage federal dollars through NRCS cost share programs in order to develop food scrap diversion infrastructure.	Stakeholders should continue to work with NRCS staff to clarify cost share requirements for farms interested in composting food scraps and utilize NRCS expertise and outreach to the farming community to identify farms interested in developing diversion infrastructure.
To match farms interested in developing food scrap diversion infrastructure with the right capital providers on the capital continuum.	Creative financing models should be explored and developed as they were for Hudak Farm, and a financing forum bringing together Act 148 stakeholders working on the development of on-farm infrastructure, farmers, and capital providers should be held.
To increase funding for best managment practices programs.	Increase funding available to incentive programs like FAP, NMPIG and VABP that are focused on improving field-based management.
To investigate the creation of an incentive program for excellent stewardship that utilizes a payment for ecosystem services model.	Examine how the Current Use program could be modified to establish a tiered payment system where higher levels of adoption of farm practices with demonstrable benefits to water, soil, and wildlife recieve higher property tax reductions.
To investigate the creation of a pasture conversion fund.	When deciding to convert cropland to pasture, the initial costs of conversion often scare farmers off from making the transition. A conversion fund should be established, and leverage federal dollars, to increase pasture conversion.
Regulation and Public Policy Strategies	
To minimize compost contamination from plastics and other non-compostable products.	The Agency of Natural Resources in collaboration with compost stakeholders should establish a clear position on maintaining high quality compost, and develop sector specific procedures and guidelines for ensuring clean stream organics diversion to compost facilities.
To implement weight based Pay as You Throw pricing.	Although volume based PAYT pricing is logistically easier to implement, weight based pricing would create clearer price signals and consequently incentives for generators to reduce their disposal of food scraps into trash bins. Weight based technologies should be piloted to determine their efficacy, implementation costs, and logistical differences with volume based pricing systems.
To support the creation of a Renewable Portfolio Standard to advance anaerobic digestion development.	Establishing an RPS in Vermont would create an in state market for RECs, bolstering the economic viability of existing and prospective on-farm digesters.

OBJECTIVE	STRATEGY
Regulation and Public Policy Strategies	
To create a regulatory environment for nutrient management and water quality that is fair and consistent for farms of all sizes.	Explore the use of stocking densities rather than number of animals to regulate small farm operations in a targeted and cost effective manner.
	Create graduated cost-share payments for livestock exclusion for smaller farms that phase out over time.

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ANALYSIS OF VERMONT'S FOOD SYSTEM

Nutrient Management

Credits

3.7 Nutrient Management was prepared by Jake Claro.

Special thanks to Juan Alvez, Jenn Colby, Jeff Cook, Laura DiPietro, Noah Fishman, Ed Fox, Kimberly Hagen, Jennifer Holliday, Wendy Houston-Anderson, Josh Kelly, Bryn Oakleaf, Pat Sagui, Nathaniel Sands, and Theresa Snow for providing helpful comments and data.

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farm to plate STRATEGIC PLAN

farm to plate NETWORK

VERMONT FOOD SYSTEM ATLAS

On the Cover: School composting structure: Highfields Center for Composting; Cows out on Pasture: Beidler Family Farm; Examining pasture forage: Jenn Colby; Spinach and chard ready for delivery: Salvation Farms; Anaerobic digester: Vermont Technical College; Gleaning cucumbers: Salvation Farms; Delivering foodscraps: Kingdom View Compost; Small scale on-farm compost: Everlasting Herb Farm; Food is Ammunition poster: Library of Congress; We Can Compost poster: Highfields Center for Composting.