12-2015

Responsible Wastewater Management: Whiting Farm Wastewater System Design and Feasibility Analysis

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Community- Engaged Research ENVR- 417
Bates College, Lewiston, Maine

Fall 2015

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Introduction:

The purchase of Whiting Farm by John F. Murphy Homes in 2014 did not include a wastewater management system. Due to this lack of infrastructure, the farm currently uses portable toilets to treat human waste. The aim of this project was to research and design appropriate wastewater management systems for the farm stand and greenhouse. Our secondary aim was to research sustainable water management systems, including methods of recycling the greywater produced at the farm stand.

Blackwater and greywater are the two components that we will discuss within this report. Blackwater is water that has come into contact with human excrement or toxic chemicals. This waste must be treated to reduce health risks for humans and environmental risks for local ecosystems. Greywater is water that has not been polluted by human waste or toxic chemicals, but potentially contains human biological material or soaps. This water can be recycled and used in a number of ways that may benefit the farm as long as it remains separated from blackwater systems.

In deciding which systems were best suited for this project, we studied the City of Auburn ordinances, Maine state laws, and Lake Auburn Water District requirements. Additionally, we sought out advice from professionals and took into account the needs of the farm in order to develop a comprehensive waste management plan. We have concluded that a single septic system shared between the farm stand and greenhouse is the farm's best option for blackwater treatment. In this report we also outline the options for implementing a greywater recycling system and rainwater harvesting system at the farm stand.

Results and Discussion:

1. Blackwater

For blackwater treatment systems at the greenhouse and farm stand we recommend installing a single septic system to service both locations. This will allow for easy and safe management of waste. Based on soil testing, we have determined where this system will be located on the farm (see map in Appendix A).

1.a Septic Systems

i. Viability of Septic Systems

Septic systems are best suited to meet the needs of the farm. At maximum capacity, the farm estimates that the farm stand will receive 300 visitors per week while the greenhouses will receive 500 visitors per week. Septic systems can easily accommodate this high use because their design is capable of being manipulated to meet capacity needs. In general, the physical size of the septic tank and leach field must be proportional to the size of the flow[1]. Unlike composting toilets, the internal processes of septic systems do not change as they increase in size. This uniformity between system size and function ensures that waste management continues safely at high capacities.

Another benefit of septic systems is that they are easy to maintain. Once installed, the farm should have a licensed professional evaluate the septic system once a year. This specialist will determine whether the tank needs to be pumped and if the leaching field is working properly. Although these yearly tests carry a small cost, they are important because they can prevent environmental damage and mitigate the larger costs associated with system neglect. If designed properly, the septic systems at the farm will only need to be emptied once every 2 to 3 years[2]. This pumping will be completed by a waste management professional, which will limit the hands-on time that farm employees will have to dedicate to system management.

The main drawback of installing a septic system is its cost. Gary Fullerton, the soil specialist from Sebago Technics who has designed a system for the farm, estimates that it will cost between $18,000 to $25,000 to install. It is unlikely that the farm will be able to find a grant for this project because septic tanks do not have an education component; however, we still recommend that the farm install a septic system because we believe that its easy maintenance outweighs its high cost.

ii. Considerations for Design and Installation:

In order to design a septic system for the farm, two major considerations had to be taken into account. The first was the soil quality at leaching sites and the second was the maximum flow of waste that the system will receive on a weekly basis[3].

The total flow that the septic system receives (in gallons per week) was the major factor in determining the system's size. Flow is the total volume of solid waste and water that enters the septic tank. Within the tank, water is separated from solids. The solids settle to the bottom of the tank and must be pumped out by a waste management professional. The water is directed to a leach field where soil filters out bacteria and harmful nutrients. Proper sizing of the leach field is important because if its size does not correspond appropriately with the water use of the farm, the leach field could fail, resulting in environmental damage. In accordance with the Maine Division of Environmental Health recommendations, we determined that the maximum weekly flow at the farm will be 3,904

[1] EPA, "A Homeowner's Guide to Septic Systems" accessed September 29, 2015. Web.http://www3.epa.gov/npdes/pubs/homeowner_guide_long.pdf

[2] EPA, "A Homeowner's Guide to Septic Systems."

[3] EPA, "Onsite Wastewater Treatment Systems Manual" accessed September 20, 2015. Web. http://www2.epa.gov/aboutepa/about-office-water#wastewater

gallons[4] (see Appendix B). This flow calculation was used by Gary Fullerton to determine the size and design of the septic system at the farm.

The physical properties of the soil at the site determine where the leach field can be installed. Maine state laws require that soil must be nine inches deep for conventional leach fields[5]. However, because the farm is located within the Lake Auburn watershed, the ordinances are stricter than the Maine state requirements. The Lake Auburn watershed requires that the soil at the site of leach fields be 3 feet deep[6]. We acquired a map of the soil at the farm, which provided assistance for the subsurface analysis of the farm's soil (see Appendix C).

iii. Soil Testing and Septic Installation

Soil tests were done by a subsurface specialist at the farm on Thursday, November 19th. The soil at our chosen location on the farm met the requirements for the Auburn Water District (see Appendix D). These tests confirmed that the farm will be able to install a septic tank and leach field. Gary Fullerton has created the final design for the system. In this report we have included the HHE-200 septic system application form that Gary completed for the site (see Appendix D). In order to obtain a permit for the system the owner of Whiting Farm must sign the first page of this document and submit it to the City of Auburn.

1.b Composting Toilets

We do not recommend installing composting toilets for the greenhouse and farm stand. Initially we envisioned that composting toilets would fit well with the educational goals of the farm; however, this kind of system will not meet the capacity needs of the greenhouse and farm stand.

i. Viability of Composting Toilets

Initially, composting toilets appeared to be an adequate fit for Whiting Farm due to their strong educational components; these toilets are an example of alternative waste management and sustainable water use. Composting toilets are unique because they are closed loop systems. Instead of treating wastewater before it flows into the watershed, composting toilets take this waste out of the environment, turning it into a reusable form of fertilizer. An additional benefit of composting toilets is that they require limited water usage. Unlike conventional toilets, which use up to 6 gallons per flush, composting toilets often do not require water for flushing and therefore exhibit sustainable water

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[4] Maine Division of Environmental Health, "State of Maine Subsurface Wastewater Disposal Rules", accessed October 13, 2015, http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/documents/SubsurfaceWastewaterDisposalRulesProposal.pdf

[5] Maine Division of Environmental Health, "State of Maine Subsurface Wastewater Disposal Rules."

[6] Municode, "Auburn, ME," accessed September 17, 2015, https://www.municode.com/library/me/auburn/codes/code_of_ordinances?nodeId=PTIICOOR_CH60ZO_ARTXIIENDRE_DIV4LAAUWAOVDI.

management. Learning about these environmental components of composting toilets would increase the educational experience at the farm.

Unfortunately, composting toilets have a number of drawbacks, which ultimately take this option out of the equation for use at the greenhouse and farm stand. The inability of composting toilets to meet the capacity needs of the farm while ensuring efficient maintenance is the limiting factor. The high costs of installing composting toilets also decreases the economic feasibility of this wastewater system.

Capacity is the biggest drawback when installing composting toilets. Typically, prefabricated composting toilets can only support up to 4 full-time users and 6 part-time users per week. Since the farm anticipates many more users in the greenhouses and farm stand, these management system could not support the farm's intended capacity[7] [8] [9]. Large capacity composting toilets can be built (see Appendix E). However, these systems come with maintenance and financial drawbacks that make them unrealistic for use at the farm.

Maintenance is the main problem with large capacity composting toilets. These systems require the regulation of moisture content, temperature, and aeration of the human waste. Maintenance frequency depends on how large the tank is but often is once every two or three months for constant use. If maintenance standards are not met, then the waste could pose serious threats to the watershed and health of users.

Large scale, custom-built systems come with long application process to ensure that they meet appropriate standards for installation[10]. Tight regulations have been put in place by the Lake Auburn Water District to guarantee that composting toilets work efficiently and are environmentally safe[11]. These regulations would require that the farm obtain licenses from the state. The systems, if installed, would also be subject to inspection. Since composting toilets may fail with large inputs of urine, the farm might also have to install a leach field[12].

The final drawback of installing composting toilets at the farmhouse and greenhouse is their cost. Installing a large scale, custom built composting toilet costs between $10,000 to $25,000 (see Appendix E). Realistically the farm would need to install two of these systems; one for the greenhouse and one at the farm stand. It is more likely that the farm could receive grants for the installation of these two systems. However, with

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[7] City Council of Auburn, Maine, "Code of Ordinances City of Auburn, Maine," accessed September 25, 2015. Web. https://www.municode.com/library/me/auburn/codes/code_of_ordinances?nodeId=PTICH_ARTIICICO#!

[8] Department of Health and Human Services, "State of Maine- Subsurface Wastewater Disposal Rules," accessed September 25, 2015, https://www.municode.com/library/me/auburn/codes/code_of_ordinances?nodeId=PTICH_ARTIICICO#!

[9] Chirjiv K. and Defne S. Apul. "Composting toilets as a sustainable alternative to urban sanitation – a review," *Waste Management* Volume 34, Issue 2, 329-343, 2014, accessed September 17, 2015. Web.

[10] Julia Branstrator, "The Barriers to Adopting Composting Toilets into Use in Urban and Suburban Locations in the United States," accessed October 15, 2015. http://docs.lib.purdue.edu/dissertations/AAI1584769/

[11] City Council of Auburn, Maine, "Code of Ordinances City of Auburn, Maine."

[12] Branstrator, "The Barriers to Adopting Composting Toilets."

grants it is unlikely that the cost will be less than the $18,000 to $25,000 that is estimate for the implementation of a single septic system.

ii. Future Expansion Using Composting Toilets

Composting toilets are not a viable option for the greenhouse or farm stand; however, they could replace the current portable toilets in the fields. At these locations, high capacity is not an issue as the farm staff is the only source of waste. Thus, at these locations the benefits of composting toilets outweigh the drawbacks. Installing these composting toilets could also provide an educational component for tours of the farm, highlighting alternatives to traditional blackwater management systems.

We have listed options of several composting toilets (see Appendix E). Out of these options, we recommend the Biolet 65 model. This model has received the Swan Ecolabel, the most prestigious approval in Europe, and is the best closed toilet system on the market. It supports 4 full-time users and 6 part-time users, comes equipped with a thermostat, fan, automatic mixer, and automated liquid controls, and is reviewed as the easiest-to-operate biological toilet. This system costs $2,799, which is relatively high based on the other options listed in Appendix E, but appears to be the most efficient and effective choice.

2. Greywater

In order to conserve well water and exhibit sustainable water use practices, we propose that the farm install a system to reuse the farm stand sink greywater along with a rainwater harvesting system to supplement water used in the greenhouse. Installing these systems would decrease the farm stand's use of potable well water, lessen the water runoff into the watershed, and demonstrate sustainable water usage at the educational greenhouse.

2.a Sink Greywater Reuse

After thorough research on various methods of recycling and reusing greywater on domestic properties, we found that reusing the farm stand sink's greywater to irrigate the greenhouse would be the most reasonable and impactful method of repurposing water. Installing this system will have a low cost and requires low maintenance.

Most modern greywater recycling systems are designed for traditional family homes where sources of greywater would include washtubs, sinks, showers, and laundry facilities[13] [14] [15]. These designs often propose to store, filter, and recycle the greywater from all of these sources. However, the farm stand at Whiting only has one current source of

[13] A. Gross et al, "Recycled vertical flow constructed wetland (RVFCW)—a novel method of recycling greywater for irrigation in small communities and households," Chemosphere 66 (2007): 916-923, accessed September 23, 2015, http://www.ncbi.nlm.nih.gov/pubmed/16844197.

[14] Colin Booth et al, *Water Resources for the Built Environment - Management Issues and Solutions* (Chichester, United Kingdom : John Wiley & Sons Inc., 2014).

[15] "Greywater Action for a Sustainable Water Culture. "Greywater Action", accessed September 17, 2015. Web.

greywater: the water used to wash produce before market. The current method of washing vegetables involves spraying the produce with a hose outside the farm stand and allowing the water to runoff into the road. By installing a sink specifically designed to wash produce, the farm has the ability to recapture this greywater and reuse it to irrigate the greenhouse attached to the farm stand.

Reusing the farm stand sink water to irrigate plants in the farm stand greenhouse is the most realistic system for the farm, as it requires a simple design and low upkeep. Because the farm stand sink will only be used to rinse produce and will therefore not contain soaps and human biological materials, the greywater can be treated similarly to rainwater and be collected and stored without being filtered or treated[16]. The design of the system would require the installation of a vegetable washing station and a 200 gallon storage tank with an attached hose for watering the beds in the greenhouse (Appendix F). As compared to traditional greywater recycling systems which require either biological or chemical filtration, this proposed system is simple and cost efficient.

2.b Rainwater Harvesting

Another sustainable water system involves collecting rainwater to supplement irrigation systems in the greenhouse. This is a simple system that has the potential for decreasing the use of the well water at the farm stand, as well as decreasing stormwater runoff into the watershed[17].

A simple rainwater cistern can collect hundreds of gallons of rainwater during the spring, summer, and fall, which could be used immediately in the greenhouse. Because the roof of the farm stand is metal, the rainwater runoff from the roof is non-toxic, and therefore can be used without being filtered or treated[18]. The ability to use rainwater without treatment allows for rainwater harvesting systems to be simple to build and easy to maintain.

Installing a rainwater harvesting system at the farm stand involves placing a rain barrel outside the stand and connecting a hose to the base of the barrel, which can transport the water to the beds in the greenhouse (see Appendix G). The only complication with the installation of this system is that the farm stand no longer has a gutter system. Installing another gutter is unrealistic, because it will likely be damaged by snow. For this reason, we recommend placing the rainwater cistern under the area of the roof that has the greatest water runoff. Even without gutters to collect all of the rainwater from the roof, we

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[16] American Rainwater Catchment Systems Association. "Rainwater Standards and Installation Standards", accessed November 29, 2015. http://www.harvesth2o.com/adobe_files/ARCSA_Rainwater%20Code.pdf
[17] Santosh R.Ghimire, John M. Johnston, Wesley W. ingwersen, and Troy R. Hawkins, "Life Cycle Assessment of Domestic and Agricultural Rainwater Harvesting Systems," *Environmental Science & Technology* 48, no. 7, 2014. Accessed November 2, 2015, http://pubs.acs.org/doi/abs/10.1021/es500189f.
[18] American Rainwater Catchment Systems Association. "Rainwater Standards and Installation Standards."

estimate that a rainwater harvesting barrel with a funnel could collect up to 1,500 gallons of rainwater annually (see Appendix G).

2.c Greywater Recycling for Toilet Flushing

Ideally, installing a small greywater recycling system to flush the toilet at the farm stand would be an impactful way of repurposing greywater. However, the high costs associated with installing this form of greywater recycling make it not economically viable.

In researching greywater recycling systems we found that toilets have one of the highest impacts on water use in the average home, with newer models using 1.6 gallons per flush and older models using as much as 7 gallons per flush[19]. Therefore, using greywater to fill and flush toilets would be a very effective method of decreasing the amount of potable water used at the farm stand. However, the requirements for such a system are much too complex and costly for the scope of the farm.

Installing a greywater recycling system for toilet flushing requires treatment of the water, which in turn requires a complicated system. In the market there are currently no prefabricated systems that treat water from bathroom sinks and transfer recycled water into the toilet cistern. Unfortunately, purchasing and installing greywater toilets is extremely costly (Appendix H). Instead, we propose that when installing a bathroom at the farm stand, the farm should install a low-flush toilet in order to save well water. Low-flush toilets are an economically viable option for reducing the use of potable water in the flushing of toilets.

Next Steps

Moving forward, we hope Whiting Farm can use this report to implement blackwater and greywater management systems in the locations we have analyzed in this report. Additionally, we believe that the farm can use our work as a guide for future expansion. Currently, soil tests have been completed at the farm. These tests have confirmed that installing a septic system is a viable option. Gary Fullerton of Sebago has completed the design of an appropriate system for the farm (see Appendix D). In order to obtain permits for the installation of this septic system the owner of Whiting Farm must sign the first page of Appendix D and turn this document into the City of Auburn.

The farm has expressed interest in expanding use at the barn and in the fields. Before this occurs waste management systems must be installed at these locations. We believe that installing a composting toilet in the fields, as discussed previously in this report, and installing a septic tank at the barn are the best options moving forward. Installing a septic system at the barn will have to take into consideration the same

[19]EPA, "Indoor Water Use in the United States", accessed November 3, 2015, http://www3.epa.gov/watersense/pubs/indoor.html.

requirements that we have outlined in this report. This project should serve as a guide for the development of this system

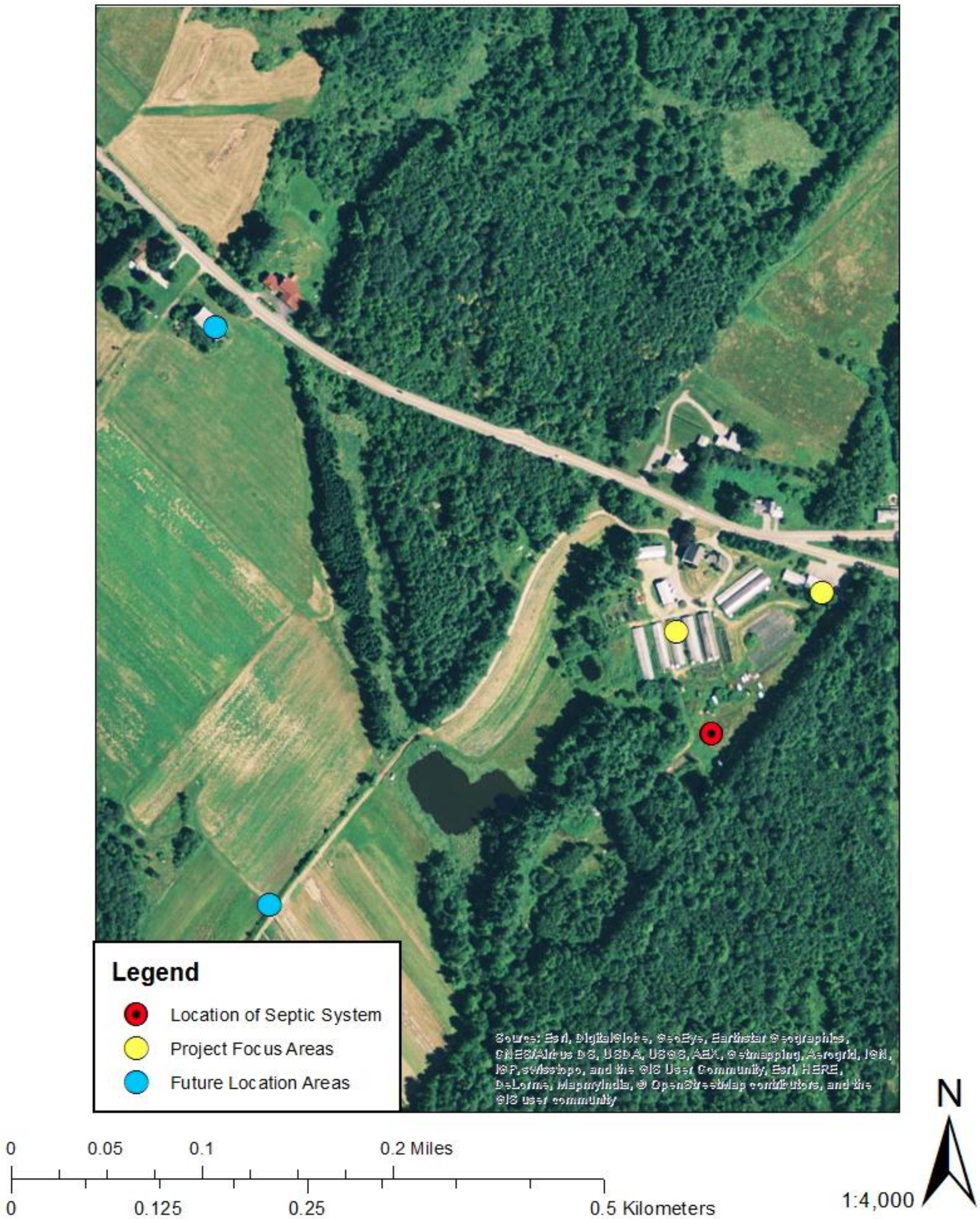
Additionally, rainwater harvesting systems could be implemented at the barn. The large surface area of the barn roof would enable the recapturing of large quantities of rainwater, which could be used to water decorative gardens around this location. Unfortunately, sink re-harvesting is only realistic at the farm stand because of the high quality of greywater produced by the sink. We hope that these recommendation are useful for the farm and that our project helps Whiting reach its developmental goals.

Acknowledgements

First and foremost, we would like to thank our community partner and Whiting Farm manager, Kim Finnerty, for all of her help setting up meetings, answering our questions and being flexible with our possible meeting times. Thank you to John F. Murphy Homes for allowing us to work on the Whiting Farm property. Thank you to Cynthia Klevens, Small Systems Engineer, Treatment and Technical Assistance for the NHDES Drinking Water and Groundwater Bureau, for the initial push and help regarding composting toilets and septic, and for the professional advice. Thank you to Mary Jane Dillingham, Water Quality Manager for the Auburn Water District/Lewiston Water Division, for all of the help regarding city ordinances and for the direction provided throughout the course of the project. Thank you to Mark Stambach, Building/Plumbing Inspector for the City of Auburn for shedding light on the State of Maine's subsurface rules and regulations and for pointing us to potential site evaluators. Many thanks to Gary Fullerton, CSS, LSE, and Director of Natural Resources for Sebago Technics for answering many of our questions, for agreeing to a monetary contract with a group of college students, and for helping us with the testing of the farm soils/design of the septic system. Finally, we would like to thank our ENV 417 professors, Thomas Wenzel and Jane Costlow for providing continued support and direction throughout the duration of the semester.

Appendices:

Appendix A:
Aerial Map of Whiting Farm: Possible Location for Septic System Installation



Appendix B:
Flow Estimations for the Septic System

Flow Calculations

Source of Wastewater	Flow Per User (gallons per day)	Number of Users (per week)	Total Flow Per Week (gallons)
Sink at farm stand	-	-	1,000
Farmstand Toilet	3	300	900
Greenhouse Toilet	3	500	1,500
Employees	12	6	504
Total	**-**	**-**	**3,904 Gallons**

Methodology:

- This calculation is an overestimate of the expected flow. It represents the maximum capacity that the system may experience in a given week. No attempt has been made to determine how many of the users will or will not use the facilities. This has been done because it is better to overestimate flow for environmental reasons. If the flow rate is underestimated, the septic system that is installed will be too small. This could lead to improper filtration and excess leaching of waste materials into the Lake Auburn and Taylor pond watersheds.

Sink Calculation:

- Kim said that their maximum flow capacity per week with the sink would not exceed 1,000 gallons per week.
- Some of this water may be used for flushing the toilet at the farm stand. This will likely reduce the total amount of water going into the septic system. However, for this calculation we assumed this is not the case in an attempt to overestimate the total flow per week.
- Assume for this calculation that that the sink will produce **1,000 gallons per week.**

Farmstand:

- 300 users per week
- The toilet will be a public restroom
- 3 gallons per day (GPD) per user is the estimated flow for a public restroom (Maine Division of Environmental Health).

- Not all 300 users will use the restroom at the farm stand. However, this calculation is an attempt to overestimate flow. For this reason we assume that all 300 users use the restroom.
- 300 users per week x 3 gpd = **900 gallons per week**

Greenhouses:
- 500 users per week
- The toilets will mostly service K-12 students. According to the Maine Division of Environmental Health students at school will use 10 gpd. However, students at the farm likely not spend the whole day at the farm. For this reason we believe that the toilet at the greenhouse will function more like a public restroom. 3 gpd per user is the estimated flow for a public restroom (Maine Division of Environmental Health).
- 500 users per week x 3 gpd = **1,500 gallons per week**

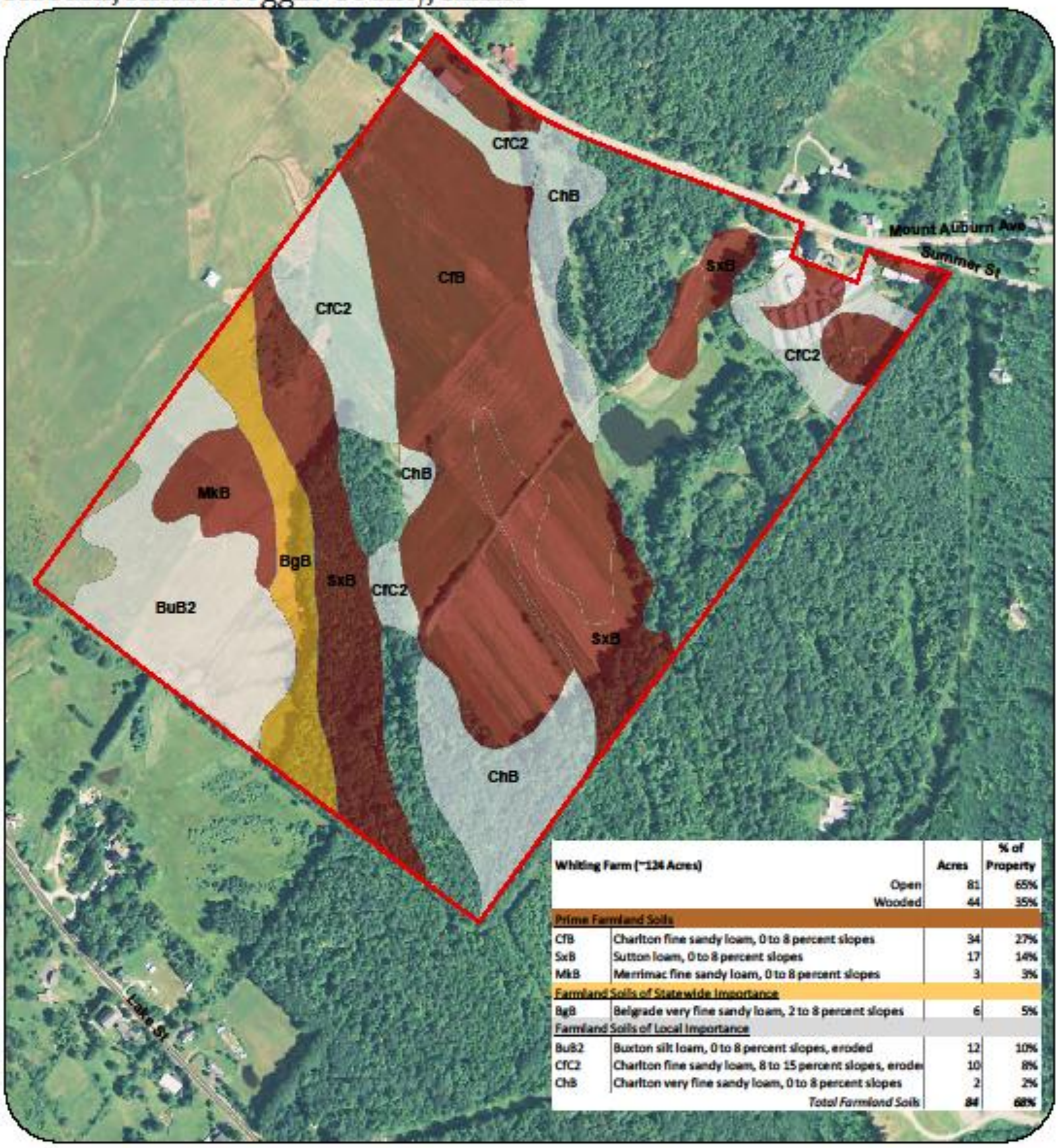
Employees:
- 10 employees
- 12 gpd for employees at place of employment with no showers
- 12 gpd x 6 employees x 7 days per week = **504 gallons per week**

Appendix C:
Aerial Map of Whiting Farm Soil

Whiting Farm (~124 Acres)

Soils Map

Auburn, Androscoggin County, Maine



Whiting Farm (~124 Acres)		Acres	% of Property
	Open	81	65%
	Wooded	44	35%
Prime Farmland Soils			
CfB	Charlton fine sandy loam, 0 to 8 percent slopes	34	27%
SxB	Sutton loam, 0 to 8 percent slopes	17	14%
MkB	Merrimac fine sandy loam, 0 to 8 percent slopes	3	3%
Farmland Soils of Statewide Importance			
BgB	Belgrade very fine sandy loam, 2 to 8 percent slopes	6	5%
Farmland Soils of Local Importance			
BuB2	Buxton silt loam, 0 to 8 percent slopes, eroded	12	10%
CfC2	Charlton fine sandy loam, 8 to 15 percent slopes, erode	10	8%
ChB	Charlton very fine sandy loam, 0 to 8 percent slopes	2	2%
	Total Farmland Soils	**84**	**68%**

Whiting Farm Boundary

Prime farmland soils

Farmland soils of statewide importance

Farmland soils of local importance

MAINE FARMLAND TRUST

Note: Information on this map is provided for purposes of discussion and visualization only; mapped boundaries and acreages are approximate.

N

0 500 1,000 Feet

Created by Pippa Stanley, MFT, 1/9/2015
Base Data Source: Maine Office of GIS, NAIP 2013, NRCS Soils. Boundary Based on Town of Auburn Tax Maps.

Appendix D:
Septic System Design and Permit Application

15480

SUBSURFACE WASTEWATER DISPOSAL SYSTEM APPLICATION

Maine Dept. of Health & Human Services
Division of Environmental Health, 11 SHS
(207) 287-5672 Fax: (207) 287-4172

PROPERTY LOCATION

City, Town, or Plantation	Auburn
Street or Road	876 Summer Street
Subdivision, Lot #	Whiting Farm

>> CAUTION: LPI APPROVAL REQUIRED <<

Town/City ____________ Permit # ________

Date Permit Issued ___/___/___ Fee: $________ Double Fee Charged [ ]

Local Plumbing Inspector Signature ____________ L.P.I. # ________

☐Owner ☐Town ☐State

OWNER/APPLICANT INFORMATION

Name (last, first, MI)	John F. Murphy Homes, Inc. ■ Owner ☐ Applicant
Mailing Address of Owner/Applicant	800 Center Street Auburn, ME 04210
Daytime Tel. #	(207) 777-5129

The Subsurface Wastewater Disposal System shall not be installed until a Permit is issued by the Local Plumbing Inspector. The Permit shall authorize the owner or installer to install the disposal system in accordance with this application and the Maine Subsurface Wastewater Disposal Rules.

Municipal Tax Map # _______ Lot # _______

OWNER OR APPLICANT STATEMENT

I state and acknowledge that the information submitted is correct to the best of my knowledge and understand that any falsification is reason for the Department and/or Local Plumbing Inspector to deny a Permit.

Signature of Owner or Applicant ____________ Date ________

CAUTION: INSPECTION REQUIRED

I have inspected the installation authorized above and found it to be in compliance with the Subsurface Wastewater Disposal Rules Application. ________ (1st) date approved

Local Plumbing Inspector Signature ____________ (2nd) date approved ________

PERMIT INFORMATION

TYPE OF APPLICATION

- ■ 1. First Time System
- ☐ 2. Replacement System
  - Type replaced: ____________
  - Year installed: ____________
- ☐ 3. Expanded System
  - ☐ a. <25% Expansion
  - ☐ b. ≥25% Expansion
- ☐ 4. Experimental System
- ☐ 5. Seasonal Conversion

THIS APPLICATION REQUIRES

- ■ 1. No Rule Variance
- ☐ 2. First Time System Variance
  - ☐ a. Local Plumbing Inspector Approval
  - ☐ b. State & Local Plumbing Inspector Approval
- ☐ 3. Replacement System Variance
  - ☐ a. Local Plumbing Inspector Approval
  - ☐ b. State & Local Plumbing Inspector Approval
- ☐ 4. Minimum Lot Size Variance
- ☐ 5. Seasonal Conversion Permit

DISPOSAL SYSTEM COMPONENTS

- ■ 1. Complete Non-engineered System
- ☐ 2. Primitive System (graywater & alt. toilet)
- ☐ 3. Alternative Toilet, specify: ________
- ☐ 4. Non-engineered Treatment Tank (only)
- ☐ 5. Holding Tank, _______ gallons
- ☐ 6. Non-engineered Disposal Field (only)
- ☐ 7. Separated Laundry System
- ☐ 8. Complete Engineered System (2000 gpd or more)
- ☐ 9. Engineered Treatment Tank (only)
- ☐ 10. Engineered Disposal Field (only)
- ☐ 11. Pre-treatment, specify: ________
- ☐ 12. Miscellaneous Components

SIZE OF PROPERTY

127± ☐ SQ. FT. ■ ACRES

SHORELAND ZONING

☐ Yes ■ No

DISPOSAL SYSTEM TO SERVE

- ☐ 1. Single Family Dwelling Unit, No. of Bedrooms: ____
- ☐ 2. Multiple Family Dwelling, No. of Units: ____
- ■ 3. Other: Farmstand and outdoor classroom (specify)

Current Use ☐ Seasonal ■ Year Round ☐ Undeveloped

TYPE OF WATER SUPPLY

☐ 1. Drilled Well ■ 2. Dug Well ☐ 3. Private ☐ 4. Public ☐ 5. Other

DESIGN DETAILS (SYSTEM LAYOUT SHOWN ON PAGE 3)

TREATMENT TANK

- ■ 1. Concrete
  - ■ a. Regular (2) 1,000 gal.
  - ☐ b. Low Profile
- ☐ 2. Plastic
- ☐ 3. Other: ________

CAPACITY: 2000 GAL.

DISPOSAL FIELD TYPE & SIZE

- ■ 1. Stone Bed ☐ 2. Stone Trench
- ☐ 3. Proprietary Device
  - ☐ a. Cluster array ☐ c. Linear
  - ☐ b. Regular load ☐ d. H-20 load
- ☐ 4. Other: ________

SIZE: 1,500 ■ sq. ft. ☐ lin. ft.

GARBAGE DISPOSAL UNIT

■ 1. No ☐ 2. Yes ☐ 3. Maybe

If Yes or Maybe, specify one below:

- ☐ a. multi-compartment tank
- ☐ b. ___ tanks in series
- ☐ c. increase in tank capacity
- ☐ d. Filter on Tank Outlet

DESIGN FLOW

450 gallons per day

BASED ON:

- ☐ 1. Table 4A (dwelling unit(s))
- ■ 2. Table 4C (other facilities)

SHOW CALCULATIONS for other facilites

10 employees @ 12 gpd = 120 gpd

110 public restroom users @ 3 gpd = 330 gpd

- ☐ 3. Section 4G (meter readings)

ATTACH WATER METER DATA

SOIL DATA & DESIGN CLASS

PROFILE 2 CONDITION C

at Observation Hole # TP-1

Depth >40"

of Most Limiting Soil Factor

DISPOSAL FIELD SIZING

- ☐ 1. Medium---2.6 sq. ft. / gpd
- ■ 2. Medium---Large 3.3 sq. f.t / gpd
- ☐ 3. Large---4.1 sq. ft. / gpd
- ☐ 4. Extra Large---5.0 sq. ft. / gpd

EFFLUENT/EJECTOR PUMP

- ☐ 1. Not Required
- ☐ 2. May Be Required
- ■ 3. Required

Specify only for engineered systems:

DOSE: ________ gallons

LATITUDE AND LONGITUDE

at center of disposal area

Lat. 44 d 07 m 12.4 s

Lon. -70 d 15 m 17.7 s

SITE EVALUATOR STATEMENT

I certify that on 11/19/15 (date) I completed a site evaluation on this property and state that the data reported are accurate and that the proposed system is in compliance with the State of Maine Subsurface Wastewater Disposal Rules (10-144A CMR 241).

Site Evaluator Signature	SE # 355	Date 12-3-15
Site Evaluator Name Printed: Gary M. Fullerton	Telephone Number: (207) 200-2063	E-mail Address: gfullerton@sebagotechnics.com

SEBAGO TECHNICS
WWW.SEBAGOTECHNICS.COM

Note: Changes to or deviations from the design should be confirmed with the Site Evaluator.

Page 1 of 3
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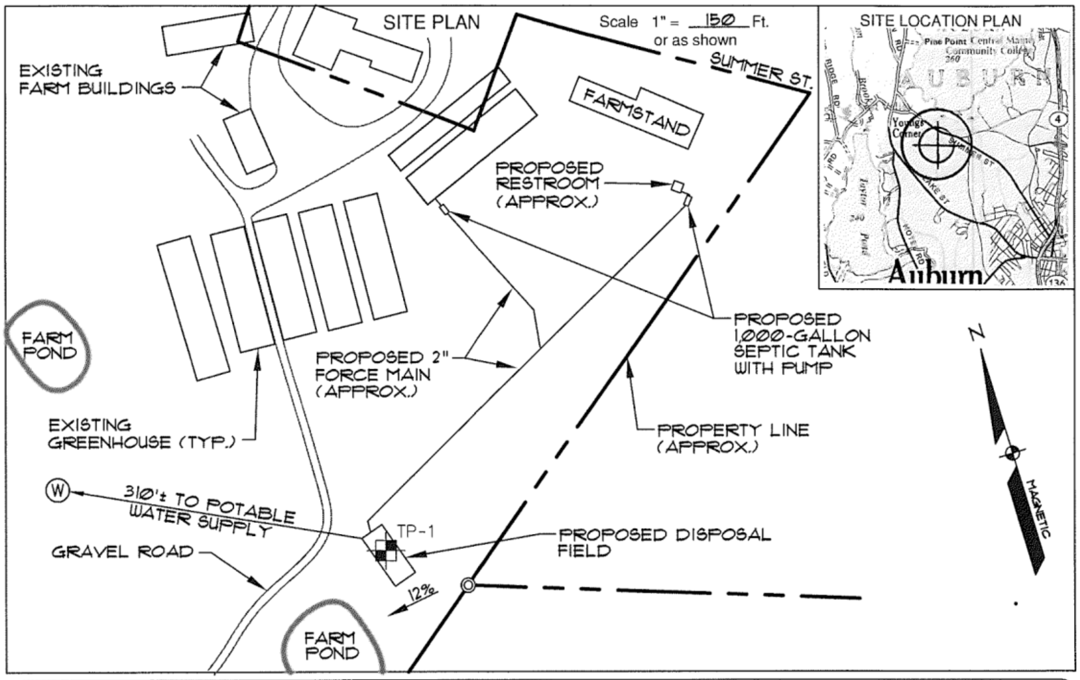
15480

SUBSURFACE WASTEWATER DISPOSAL SYSTEM APPLICATION

Maine Dept. of Health & Human Services
Division of Environmental Health, 11 SHS
(207) 287-5672 Fax: (207) 287-4172

Town, City, Plantation	Street, Road, Subdivision	Owner or Applicant Name
Auburn	876 Summer Street	John F. Murphy Homes, Inc.

SITE PLAN — Scale 1" = 150 Ft. or as shown



SOIL DESCRIPTION AND CLASSIFICATION (Location of Observation Holes Shown Above)

Observation Hole TP-1 ■ Test pit ☐ Boring

1-2 " Depth of Organic Horizon Above Mineral Soil

Depth below mineral soil surface (inches)	Texture	Consistency	Color	Mottling
0–20	FINE SANDY LOAM	FRIABLE	10YR 3/3 BROWN	
20–30	SANDY LOAM		10YR 5/6 YELLOWISH BROWN	NONE OBSERVED
30–40	LOAMY SAND		2.5Y 5/4 LIGHT OLIVE BROWN	
40–50	LIMIT OF EXCAVATION = 40"			

Soil Classification	Slope	Limiting Factor	
2 (Profile) C (Condition)	8-15 %	40 "	☐ Ground Water ☐ Restrictive Layer ☐ Bedrock ■ Pit Depth

Observation Hole ________ ☐ Test pit ☐ Boring

________ " Depth of Organic Horizon Above Mineral Soil

Depth below mineral soil surface (inches)	Texture	Consistency	Color	Mottling
0–50				

Soil Classification	Slope	Limiting Factor	
____ (Profile) ____ (Condition)	____ %	____ "	☐ Ground Water ☐ Restrictive Layer ☐ Bedrock ☐ Pit Depth

Site Evaluator Signature: [signature] | SE # 355 | Date 12-3-15

SEBAGO TECHNICS, INC.

15480

SUBSURFACE WASTEWATER DISPOSAL SYSTEM APPLICATION	Maine Dept. of Health & Human Services Division of Environmental Health, 11 SHS (207) 287-5672 Fax: (207) 287-4172

Town, City ,Plantation	Street, Road, Subdivision	Owner or Applicant Name
Auburn	876 Summer Street	John F. Murphy Homes, Inc.

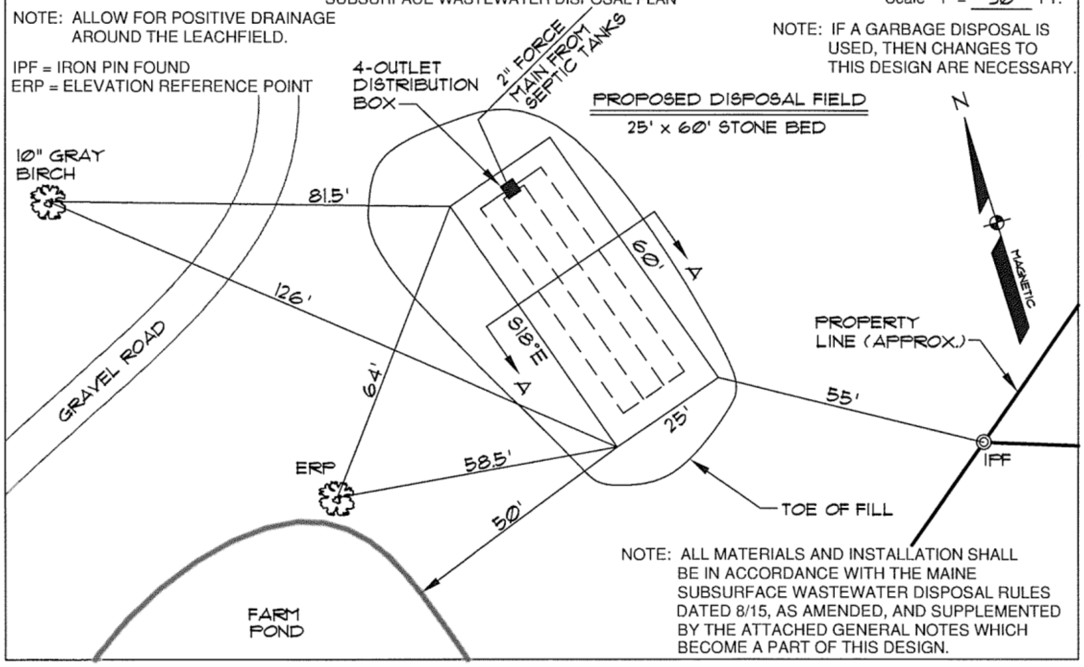
SUBSURFACE WASTEWATER DISPOSAL PLAN

Scale 1" = 30 FT.

NOTE: ALLOW FOR POSITIVE DRAINAGE AROUND THE LEACHFIELD.

IPF = IRON PIN FOUND
ERP = ELEVATION REFERENCE POINT

NOTE: IF A GARBAGE DISPOSAL IS USED, THEN CHANGES TO THIS DESIGN ARE NECESSARY.



NOTE: ALL MATERIALS AND INSTALLATION SHALL BE IN ACCORDANCE WITH THE MAINE SUBSURFACE WASTEWATER DISPOSAL RULES DATED 8/15, AS AMENDED, AND SUPPLEMENTED BY THE ATTACHED GENERAL NOTES WHICH BECOME A PART OF THIS DESIGN.

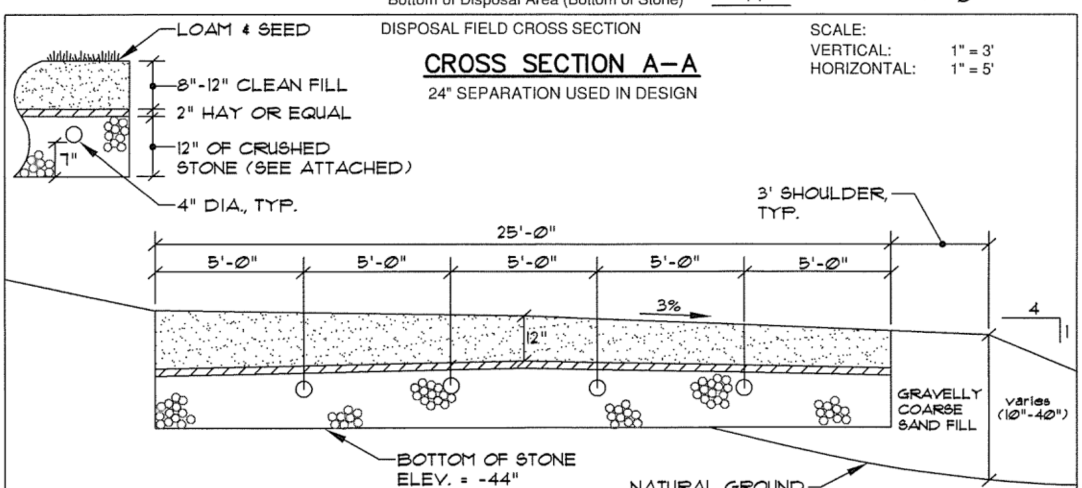
BACKFILL REQUIREMENTS		CONSTRUCTION ELEVATIONS		ELEVATION REFERENCE POINT
Depth of Fill (Upslope)	varies (0"-4")	Finished Grade Elevation	-20"	Location & Description Nail up 57"
Depth of Fill (Downslope)	varies (10"-40")	Top of Distribution Pipe or Proprietary Device	-33"	in a 7" diam. Gray Birch
		Bottom of Disposal Area (Bottom of Stone)	-44"	Reference Elevation 0"

DISPOSAL FIELD CROSS SECTION

CROSS SECTION A–A

24" SEPARATION USED IN DESIGN

SCALE:
VERTICAL: 1" = 3'
HORIZONTAL: 1" = 5'



Site Evaluator Signature	355 SE #	12-3-15 Date	Page 3 of 3 HHE-200 Rev. 02/11

SEBAGO TECHNICS, INC.

Appendix E:
Types of Composting Toilets

Type of Composting Toilets	Pros and Cons/ Other Considerations	Price Per Toilet
Biolet (25)	• first fully automatic composting toilet. • fully automatic mixing system has been added to the quiet fan and thermostatically controlled heaters. • 3 people full-time use and 4 people part-time. • thermostat, fan, automatic mixer, double heaters. • easy to install.	$1,999
Biolet (10 standard)	• almost identical to the Biolet 25 except for it has a manual mixer instead of an automatic one.	$1,899
Biolet (65)	• only biological toilet to carry the Swan ecolabel. • 4 people full-time use and 6 people part-time use. • thermostat, fan, automatic mixer and automated liquid controls. • advertised as the easiest-to-operate system on the market.	$2,799
SunMar (Excel)	• odorless. • non-flush system (self- contained). • has electric and non-electric models. • system stands alone and does not require a separate tank. • could support use by 3 to 6 full time users.	$1,645.00 to $1,845.00
SunMar (Centrex)	• odorless. • flush system (requires purchase of separate toilet - $350). • centralized tank. • requires space for separate tank below the toilet. • requires ventilation and additional organic input.	$1,845.00 to $2,245.00

	• requires ventilation and additional organic input. • can support 4 to 8 full time users.	
SunMar (Centrex AF Dry Systems)	• odorless. • dry toilet (requires special toilet with no flush- $335). • with heavy use may not work due to accumulation of liquid. • uses same central system as the SunMar (Centrex), but uses a dry toilet. • requires ventilation and additional organic input. • can support 4 to 8 full time users based on size chosen.	$1,845.00 to $2,245.00
Clivus Multrum	• company works alongside engineers and architects to design a system specific for desired location. • can also design all grey water systems (accurate usage data, site plan, and percolation tests are all performed). • accommodate between 18,000-65,000 uses per year. • comes with a fan that eliminates odors. • comes with a liquid removal pump. • comes with an automatic moistening system and storage for the liquid end product. • all systems are compatible with both the waterless and the foam-flush toilets. • in general this company designs large scale systems.	Will provide a budget based on the system designed for the farm
Clivus Multrum (M54 Trailhead Series)	• composting toilet system with ADA accessible bathroom structure. • accommodates 22,000 uses per fixture per year. • available as a kit or as a pre-fabricated building. • single or double stall building layouts available. • solar system powers ventilation fan to keep the structure odorless. • replaces portable toilets where	$10,000 to $25,000 for a large commercial toilet structure with installation

	continuous restroom service needed.	
Phoenix (residential toilets R-199, R-200 and R-201)	● requires toiles that deposit waste into separate tank that is below toilet. ● requires separate ventilation systems. ● can support 2 to 4 full time users. ● may require a separate greywater system for urine.	$4,700 to $6,100
CTS (CTS-410 through CTS-1010)	● can support 18 to 120 daily uses depending on the model. ● larger systems cost more. ● large capacity means it needs to be emptied less frequently. ● systems are odorless, waterless and require less maintenance because they are larger. ● single tank can support more than one toilet.	System designed to fit specific location. Cost will depend on the design made for the farm.
Composting Toilets USA (Separett 9200 AC, and 9210 DC)	● urine is drained away (three different methods) and the solid is dehydrated and dried. ● utilizes regular household electricity to run fan. ● two speed 9200 AC fan runs on 18 watts. ● one speed 9210 DC fan uses about 3 watts. Perfect for off-grid situations. ● "slightly louder than a whisper" fans	$1,389 (including shipping)
Composting Toilets USA (Nature's Head)	● capacity of two people over the course of 6 weeks. ● produces organic compost- no raw sewage. ● ideal for cottages, boats, or RV's. ● utilizes urine separation system	$960 (including shipping)

Appendix F:
Greywater Reuse System Design

The system that we are proposing for reusing greywater at the farm stand is comprised of two major components: a vegetable washing station and a holding tank for the greywater. This greywater reuse system works by containing the water used to wash produce in the basin of the vegetable wash station, which is then gravity-fed into the holding tank, which is located in proximity to the sink. A hose attached to the base of the tank enables one to water beds in the greenhouse with water in the holding tank. The farm stand needs a proper washing area for the vegetables regardless, so the holding tank is the only additional aspect that we are proposing that the farm purchases.

The Vegetable Wash Station

We propose that the farm stand build a vegetable washing station, similar to the one pictured below. This station would essentially be a wooden table with a washing basin. The washing basin, or sink, would contain the water used to wash the produce. A wire screen fitted to the size of the sink basin may be helpful for holding the produce while being washed. A spray hose would be connected to this washing station to rinse the produce with clean well water before market. The station will need to be built by constructing a wooden table and purchasing a steel sink to build into this table.


[20]

If this design is too complicated, the farm could instead purchase an industrial sink and link it up to a hose to wash produce in, such as in the photograph below. As in the example below, it may then be necessary to build wooden frames with wire screens to put across the sink basin in order to spray down the vegetables.

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[20] Robert Withberg, "Overbuilding," accessed November 30, 2015, http://www.farmerbobcomics.com/2010/06/overbuilding-2/.

[21]

More information about building a proper wash station for vegetable farms can be found in Attachment A, a guide created by the Cornell Cooperative Extension for Agriculture.

Greywater Holding Tank

According to Kim's estimation that the farm stand uses up to 1000 gallons of water a week to wash vegetables during the peak harvest season, we propose that the farm purchase a 200 gallon holding tank. This size tank would allow for the farm to store up to a day and a half's worth of greywater. The decision on this size tank was made by considering the future water use in the educational greenhouse and the space requirements of the greenhouse. The future daily water use of the greenhouse was estimated by using the irrigation rate of 2 quarts per square foot, a commonplace estimate for greenhouses, and multiplying that by the approximately 400 square feet of available space in the educational greenhouse, resulting in an estimate of up to 200 gallons of water used daily. Thus, keeping in mind the small size of the greenhouse, a 200 gallon holding tank will not take up very much space in the small greenhouse, but has the ability to supply a great amount of water for the greenhouse. However, because the greywater supply may at times be greater than the irrigation demand in the greenhouse, there will need to be a overflow valve to release excess water outside or into the septic system. Such a holding tank can be seen below.

[21] Cindy Connor, "Garden Washing Station," accessed November 30, 2015, https://homeplaceearth.wordpress .com/2012/08/21/garden-washing-station/.

 [22]

Appendix G:
Rainwater Harvesting Design

We propose that the farm install a rainwater harvesting cistern outside of the farm stand. Because the farm stand does not have a gutter system, and installing a new one would be impractical due to the heavy annual snowfall that Auburn receives, the rainwater cistern will need to be placed under the area of the roof that has the greatest waterfall during heavy storms. This can be determined by observing the draining of rainwater off of the roof during a storm. Once this area has been determined, a rainwater harvesting barrel with a funnel can be placed under this area in order to collect the stormwater. RainSaucers is a company that builds funnels specifically for collecting rainwater without gutters or other collection systems. This design is shown below:

 [23]

[22] John E. Carter, " My Rain Barrel Design," accessed November 30th, 2015, http://www.wizardanswers.com /files/rain-barrel.pdf.
[23] RainSaucers, "Products," accessed December 1, 2015, http://www.rainsaucers.com/products.htm.

Lewiston-Auburn annually receives 46 inches of rainfall[24], which suggests that the proposed rainwater harvesting system could collect up to 1,500 gallons of water throughout the spring, summer, and fall months. The RainSaucer technology requires a open top harvesting barrel, such as the 55 gallon barrel shown above. One specific requirement is that the purchased barrel must have a spigot at the base in order to use the collected water. These barrels can be purchased at many online retailers, and can be found for less than $100. In total, we estimate that a rainwater collection system will cost the farm $150.

[24] U.S. Climate Data, "Climate-Lewiston, Maine," accessed November 20, 2015. Web. http://www.usclimatedata.com/climate/lewiston/maine/united-states/usme0213.

Appendix H:
Costs of Greywater Recycling Toilets

Caroma Profile Smart 305 Round Front Plus


[25]

This model of toilet involves using hand sink greywater to flush the toilet. This model of greywater recycling toilet requires the use of the handsink to fill the tank for each flush of the toilet. As you can see from the photograph of this design, the sink is pretty impractical in that it is located directly on top of the toilet water tank. This system would be the least expensive option for the farm in that the system costs $500 and includes both a handsink and a low-flush toilet.

Roca W+W Vitreous China Basin+Toilet


[26]

This toilet design is similar to the Caroma design, with the difference being that the sink orientation is more practical for hand washing. This design of greywater toilet filters

[25] Caroma, "Profile Smart 305 Round Front Plus," accessed November 30th, 2015, http://www.caromausa.com/about_us/company_overview.php.

[26] Roca, "W+W Wall-hung vitreous china WC and basin," accessed November 30th, 2015, http://www.roca.com/catalogue/products/basins/wall-hung-basins/w-w/wall-hung-vitreous-china-wc-basin-893020..1.

and treats the greywater from the sink within the tank before it is used for flushing the toilet. This model is designed in Spain and costs approximately $4,800, without shipping or installation costs.