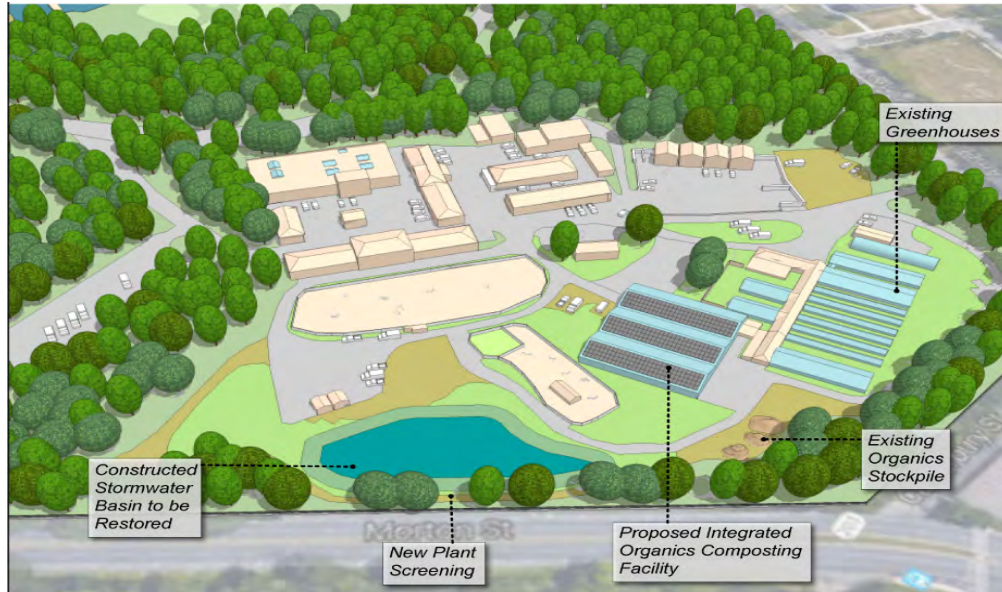


# Renewable BioEnergy Feasibility Study for City of Boston's Franklin Park Maintenance Yard



Report to the Massachusetts Clean Energy Center

**Office of the Environment, Energy and Open Space**

Chief Austin Blackmon

**Boston Parks and Recreation Department**

Commissioner Christopher Cook

City Soil & Greenhouse LLC

AgriLab Technologies Inc.

DeRosa Environmental

KZLA Landscape Architects

July 10, 2017

# Executive Summary

This feasibility study proposes an organics-to-energy facility that would fully enclose and recover heat energy from an Aerated Static Pile composting system at the Franklin Park Maintenance Facility. The integrated system would integrate proven technologies to provide renewable thermal energy to on-site buildings including greenhouses, workshops, and office space. The proposed facility would deliver structural and visual improvements, financial returns, operational efficiencies, and environmental value to the City of Boston. The facility and its end products will help the City and the Commonwealth to meet existing commitments to reduce greenhouse gases and achieve climate change mitigation and adaptation goals. The Boston Parks Department would become more horticulturally self-reliant and build on recent integration with the City's community gardens and urban agriculture. The operational improvements yielded by this proposed facility also address established state, federal, and local environmental quality regulations and directives for stormwater, air pollution, and organic waste diversion. While these benefits have not been monetized in the proforma included in the following feasibility study, they provide compelling incentives, and funding opportunities. The capital cost of the facility is estimated at \$994,000, including contingency, with a Return on Investment (ROI) calculated to be 5.5 years from implementation of operations. Capital cost sharing of up to \$500,000 of the proposed facility is presently available from the Massachusetts Clean Energy Center. Existing grant funding from the Partners for Places Urban Farming Pathways could be applied to the project in 2017. Future grant funding is available from a variety of Commonwealth of Massachusetts programs and agencies, and from philanthropic foundations. Low-cost capital from the Massachusetts Recycling Loan Fund and from private investors is available to implement specific elements of the project, providing that a clear financial structure and effective management can be assured.

## Background

The City of Boston and the Commonwealth of Massachusetts are international leaders in reducing energy consumption, greenhouse gas emissions, developing diversified and renewable energy supplies, and climate-adaptive infrastructure. New England's most populous city has its greatest density of residents, businesses, and institutions that are at risk from the impacts of climate change. Public, private, non-profit and educational stakeholders are planning and have implemented innovative organics-to-energy and stormwater management initiatives in demonstration and full-scale operational settings. This cooperative formula has developed important precedents, completed conclusive feasibility studies, and made tangible improvements to the City's organic waste diversion and environmental management systems.

Boston's private and institutional sectors generate the region's most concentrated source of clean, source separated food residuals; less than 3% of that is presently composted within city limits. Small and moderately scaled composting systems for food residuals that divert a significant tonnage of

food residuals are not presently operational in Boston. The City's Zero Waste Plan, Boston 2030 and the Franklin Park Master Plan embrace new vision, a robust community planning process, and decades of engagement with Boston's dynamic neighborhoods abutting Franklin Park. City departments working in partnership with local businesses, institutions and residents are designing and implementing more environmentally impactful infrastructure and management practices. The site and the proposed facility evaluated in this study capitalize on established partnerships, proven technologies, underutilized urban land and skilled residents of this historically underserved community.

The site is situated in an impaired watershed, within a host community that is engaged, informed and is most directly affected by technology and management practices for organic materials that are generated within Boston's city limits. Boston residents, City of Boston departments, and locally-based small businesses, worker-owned cooperatives, and non-profit groups will benefit from a well designed and professionally managed facility for source-separated organic feedstocks. Franklin Park also serves local, regional and international visitors to Boston. Matching funding from MCEC's Organics-to-Energy facility and development program, and low interest loans from the Recycling Loan Fund and targeted private equity investors, tipping fees for food residuals, and product sales provide the key financial mechanisms to modernize an existing underutilized composting site. Nutrients and moisture contained in locally sourced food residuals will yield higher value products that in turn support the ongoing operation and local workforce development.

Food residuals, and the tipping fees to accept and process them, can anchor the financial viability of an invaluable, strategically located public facility that requires capital and management investment to come into compliance with existing solid waste and stormwater management regulations. The facility would double the capacity of the City of Boston to manage its own organic waste within the City limits, elevate its recycling rate, and reduce Boston Parks and Recreation Department's reliance on commercial soil amendments, fertilizers and water. The highly visible project would demonstrate Boston's leadership in international efforts to address the causes and effects of an increasingly unstable climate.

The City's municipal composting infrastructure diverted more than 10,000 tons of organics from disposal in 2016 via processing at the Boston Composting Facility at the Boston Nature Center, the City's Greenovate/ Project Oscar food scrap collection program, and separation of landscape organics, manure and horticultural crop residue generated within the Boston Parks and Recreation Department.

City Soil & Greenhouse LLC is the contracted operator of the three-acre municipal composting facility on a 5 acre parcel on American Legion Highway. In 2015-2016, City Soil, the Boston Public Works Department and Mass Audubon's Boston Nature Center developed a compost heated greenhouse and aerated static pile composting system. The Mattapan Ecovation Center has employed Agrilab Technologies modular aeration and heat recovery system for capturing biothermal energy from compost exhaust vapor. The system converts it to hydronic heat for stored and circulated water within the educational greenhouse and attached mobile on-site office.

The Ecovation Center began operating in July 2015, and was officially opened in September 2016, with private and public funding from Commonwealth of Massachusetts Department of Agricultural Resources, from City Soil & Greenhouse, Mass Audubon, Agrilab Technologies, and matching contributions from

Equipment Rentals of Dorchester and other team members. City Soil received secured appropriate legal permissions through the Boston Inspectional Services Department, from Boston PWD, Mass Audubon, Boston Parks Commission, and the Conservation Commission and approval from local residents, businesses, and elected officials.

At the facility proposed in this study, the collection and composting of source-separated residential and municipally generated organics would also utilize Aerated Static Pile (ASP) processing using established compost heat recovery (CHR) technology from Agrilab Technologies, Inc. (AGT). The heat recovered will provide hot water, seasonal space heating for buildings and product drying within the Franklin Park Maintenance Area facility. This feasibility study defines the scope of work and project details to enable the use of AGT's unique compost aeration and heat recovery process at the site.

The Boston Parks and Recreation Department's consultants City Soil & Greenhouse (City Soil), and its subcontractor team of AGT, DeRosa Environmental and KZLA have conducted the feasibility study. City Soil and AGT have cooperated on prior biothermal feasibility, design, engineering and operations. AGT provides contracted operating services, consulting, engineering, and other compost technical services in MA, NH, VT, NY, CT and beyond. DeRosa Environmental and KZLA have extensive track records of environmental work in Boston on public land and at facilities hosting compost sites, stormwater management and renewable energy production. KZLA's current role in the Franklin Park Master Planning process, and related work in the Emerald Necklace afford this collaborative process a uniquely embedded advantage in tuning the design and in the implementation of the proposed project. Additional partners may be identified to provide technical input and developing funding sources for future implementation phases.

Applicant Contact: Dennis Roache, Administration and Finance Manager, Boston Parks & Recreation Department (617) 635-7263

Consultants: Bruce Fulford, President, City Soil & Greenhouse, LLC (617) 834-1934, bfulford@citysoil.org and Brian Jerose, President, Agrilab Technologies, Inc. (802) 370-4774, brian@agrilabtech.com.

# Project Concept and Goals

This feasibility report details a proposed facility that embodies the economic and environmental sustainability goals of the City of Boston and the Commonwealth of Massachusetts. The proposed enclosed Bioenergy and Aerated Static Pile Composting project would be located at the Boston Parks and Recreation Department's Franklin Park Maintenance Facility, in southern and eastern Boston. The project scope explores the economic and logistic feasibility and host community compatibility of the project as it relates to site design, site circulation, fiscal and operational benefits, and environmental best management practices.

## GENERAL SITE DESCRIPTION

The Franklin Park Maintenance Facility Yard is adjacent to the intersection of Morton and Canterbury Streets and the American Legion Highway in neighborhoods of Dorchester, Jamaica Plain, Roslindale and Mattapan, Boston, Massachusetts. The facility is primarily accessed via Circuit Drive and is at the south end of Franklin Park, just east of the Shattuck Hospital. It is also accessible through a service gate on American Legion Highway for infrequent bulk deliveries and materials export functions. The site has been an established Boston Parks and Recreation Department (BPRD) facility for more than 120 years. The site proposed for a permanent compost facility includes an unimproved open storage area where leaves, manure and horticultural residue are dumped and turned occasionally. Portions of the proposed enclosed facility connect to existing head-house and foundation of the greenhouse complex. This is located adjacent to the lowest point within Franklin Park sub-basin that feeds into the Canterbury Brook, Stony Brook, and the Charles River Watershed.

The greenhouse complex includes modern, well-maintained and high performing structures and underutilized and idle greenhouse that are unlikely to be reparable. All of the greenhouses are physically connected or immediately adjacent to a common 'head house' that is used by staff for propagation and production of BPRD's flowers, perennials and container plants that are used throughout public open space maintained by the Parks Department.

The site is contained within an approximately 4 acre complex of permanent and temporary buildings, greenhouses, enclosed and open-air materials and equipment storage, a horse stable, paddock, and loafing enclosure, and a stormwater runoff sedimentation basin.

Ground-level hardscape and unpaved working surfaces are used for storage of mechanized equipment and attachments that are actively used, idle, or awaiting repair or disposal. Sand, salt, and stone dust are contained in concrete commodity bays covered by fabric structure. Landscape materials (mulch, palletized and bulk horticultural supplies) and specialty soils, park construction materials, and an assortment of large plant containers are also stored on the site. Steel and aluminum storage containers, landscape equipment trailers, idle office trailers and outdoor exhibits are located by convenience on

portions of the site.

Wood chips, tree trunks and large limbs harvested from Parks property are stored on the site in a dedicated corner adjacent to Morton Street. Tree trucks, chipping equipment, stored under temporary fabric covered enclosures on a paved pad adjacent to the stormwater sedimentation basin. A network of paved access roads provide plowable, all-weather access, and parking for Parks Department vehicles and equipment and for vehicles of personnel and visitors on work-related business.

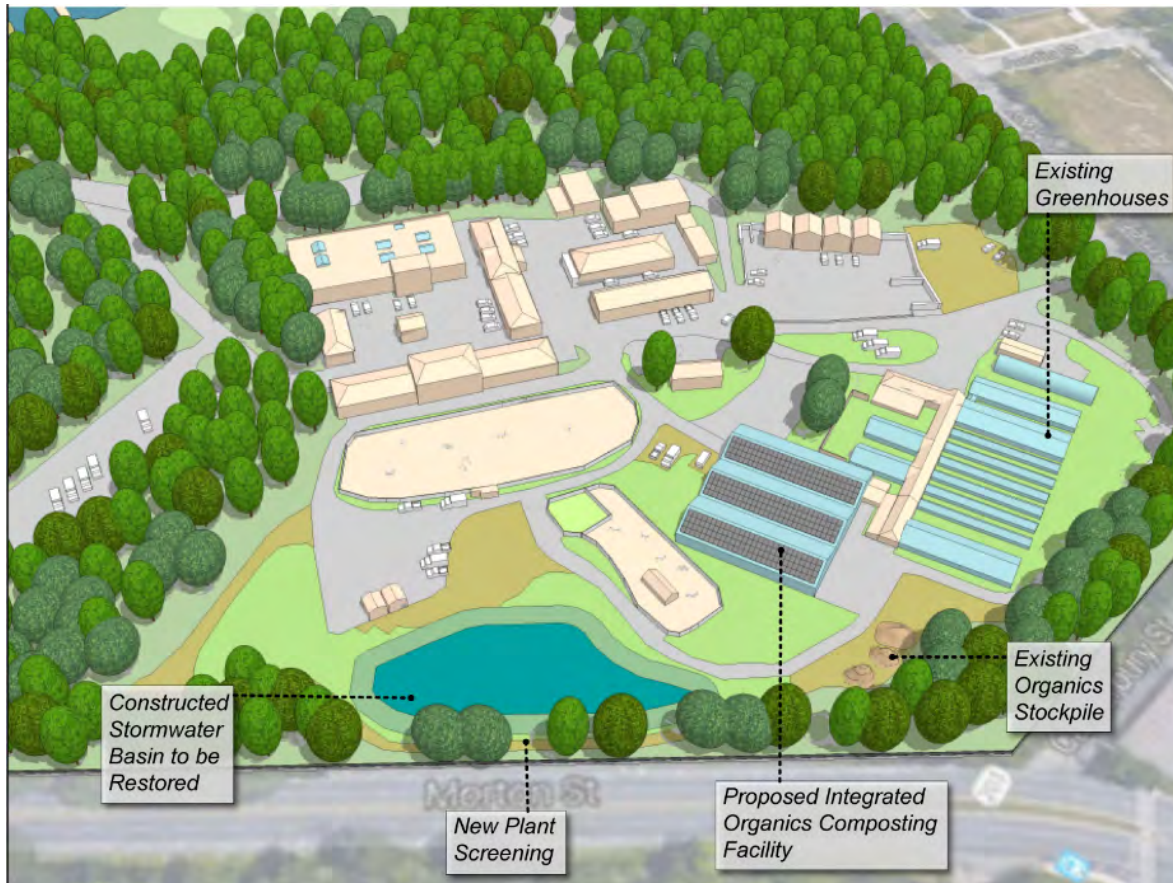


Franklin Park Compost Facility Existing Conditions

The facility includes offices, workshops, 12 greenhouses, horse stables and paddocks, commodity bays for bulk materials, parking, and equipment storage. This property is a well-qualified location due its existing use as a materials handling site for leaves, wood chip, stable manure and bedding, grass

clippings, plant residue from greenhouse and landscape, spent horticultural growing media other organic feedstock material. The greenhouses are adjacent to the leaf and wood biomass stockpiles and will be the primary recipients of energy (heat) generated by the Aerated Static Pile (ASP) process.

A constructed wetland is located on site and was established to capture and treat stormwater runoff from the maintenance yard and stables in 2005. This area will need to be upgraded, invasive common reed (*Phragmites australis*) removed, and a more functional plant community re-established in the bioretention basin to improve nutrient removal and restore designed volume storage.



## Conceptual Site Improvements

The proposed Aerated Static Pile (ASP) compost production area (working floor/concrete slab) space requires a footprint of 120 feet by 120 feet, totaling approximately 14,400 square feet. The recommendation is to erect a pre-engineered free span or post-supported truss building to enclose the working floor, and receiving and materials handling pad. The superstructure would be able to support

other renewable energy infrastructure including approximately 6,000 square feet solar panels and/or vertical axis wind turbines.

The covered receiving and mixing pad is proposed to the west of the working floor. This pad would be a poured concrete slab engineered for truck deliveries of materials in all weather conditions and bucket loader traffic for mixing, blending, and for loading and unloading materials from the working compost aeration floor.

Bioswales are a proven and commonly deployed Best Management Practice (BMP) that utilizes plantings and microbial activity to remediate and polish runoff waters from non-point source pollutants. Typical contaminants treated with bioswales include road water runoff constituents such as automotive fluids, and heavy metal, salt, suspended organics and silt from truck and equipment tires, and the primary nutrient pollutants of phosphorus and nitrogen, in various forms. The proposed bioswale at the Greenhouse site will serve to provide treatment for sources of contaminants associated with the ASP facility as well as runoff from portions of the Franklin Park Maintenance Yard roadways and parking facilities.

## Feedstock Opportunities and Evaluation

Presently, the Boston Parks and Recreation Department (BPRD) receives more than 5000 cubic yards of organic feedstocks annually at the Franklin Park maintenance facility. These materials are generated from on-site sources and its points of generation within the BPRD system leaves and organic waste, horse manure and other compostable landscaping materials. These organic feedstocks are generated from Parks Department operations within the Franklin Park Maintenance Yard and other BPRD points of generation. These materials are well-suited as feedstocks for managed composting. The BPRD organics are informally handled at this location, but are not regularly mixed, turned, or managed to produce quality compost for use in Parks Department landscaping, horticultural, or greenhouse growing activities. The end-products are used in an ad-hoc manner and not part of regular maintenance or programming. These materials would be converted into diverse end products with value as soil amendment, mulch, and components of potting and growing media and stormwater treatment infrastructure. Further, by using negative aeration and specialized heat exchange equipment, thermal energy can be generated and transferred via hot water for on-site uses including greenhouse and building heating, product drying, as well as heated wash water. This opportunity represents both economic savings through reduced fuel consumption, and a decreased carbon footprint of the composting operation and greenhouse heating activities.

Managed composting can be defined as blending feedstocks in specific proportions to target a carbon to nitrogen ratio of approximately 30:1 (dry weight basis), moisture content of 60-63%, and a bulk density of less than 1000 lbs. per cubic yard. These parameters encourage beneficial microorganisms (largely bacteria in early stages and fungi in later stages) to rapidly decompose the original feedstocks. Once



blended, mixtures in the targeted ranges typically generate significant biological respiration (thermophilic stage decomposition) where pile temperatures exceed 130°F and can rise to 160°F. From this point, oxygen levels should stay above 5% within the piles to promote aerobic (oxygen-loving) microorganisms. Using a combination of forced aeration (negative or positive – meaning pulling or pushing air through the windrow) and mechanical mixing and turning, desirable oxygen levels can be maintained. This is important to accomplish rapid decomposition of the materials that produce odors when they decay with insufficient oxygen. Odor management in this increasingly residential neighborhood is an important design criteria and community benefit that the facility would afford. Odors are typically generated from anaerobic (absence of oxygen) conditions within the pile or from accumulated leachate (liquid from piles) near the compost. The proposed integrated organics facility prevents leachate from being generated on the site by enclosing the handling functions for nutrient rich materials. The blended materials undergo accelerated aerobic composting, further mitigating the formation of odor during composting. The third safeguard is a biofilter that treats any remaining odors generated during composting or within the building enclosure. The high heat from the composting process also kills weed seeds and plant diseases, and destroys potential pathogens in manures, food scraps.

Additional feedstocks are available from within BPRD's contracted and internal operations and local public, private and non-profit generators, and add economic value to the project. Wood chips and food residuals, in particular, are locally abundant compost feedstocks that the facility is designed to process. Wood chips provide improved porosity and carbon to help maintain desirable oxygen levels in the windrows during aeration intervals. The additional carbon provides surface area and sites for nitrogen and carbon interaction on a microbial level. Food scraps provide rapidly available carbon, nitrogen, phosphorus and potassium, and important micronutrients to a compost mixture. Their inclusion in a recipe results in more energy production and a higher nutrient concentration in the finished compost product. Since these materials can release odors if left unmixed, best practices include mixing in carbon-rich feedstocks (leaves, wood chips, animal bedding, etc.) on the day of food scrap receipt. These materials are blended at a proportion where they can be a fraction of the overall blend and capped with additional carbon-rich materials. A site-specific recipe has been developed to meet these objectives.

Food scraps also present the opportunity for the City and state to achieve waste reduction and landfill avoidance goals for these materials, technically classified as solid waste. The avoidance of landfilling of food scraps and other biomass saves future landfill capacity, and reduces the amount of methane emissions that result in the anaerobic and largely unmanaged conditions of a landfill. Even landfills with methane gas recovery can capture a small fraction of the generated gas and result in GHG releases that are 22-28 times more concentrated than CO<sub>2</sub>. The proposed Franklin Park integrated organics facility would present an invaluable educational opportunity for city and state staff, city residents, and other stakeholders in demonstrating city/state leadership.

Tip fee revenues for food scraps would be used to offset ongoing handling and composting operation costs. Massachusetts tip fees for food scraps range from \$30/ton outside of Boston to \$50/ton within the

city. The transportation costs for haulers to transport materials from the collection point to disposal point can be a significant. As food scraps may weigh 1500-lbs/cubic yard (cy), or 1.33-cy/ton, a scenario of 195-cy/month is 147-tons/month. At \$50/ton this means \$7361 per month and \$88,361 annually could be generated to support ongoing operations.

Goals for the compost beyond the opportunities listed above include the cost-effective and efficient production of higher value compost than is currently made at the BPRD maintenance facility. The BPRD manages over 2100-acres of greenspace. A conservative estimate of 3000 cy of mulch are used in its landscaping and horticultural applications each year. Initial projections are that this facility could produce 5000-cy/year of higher quality compost, mulch, specialty soils and growing media. At an averaged (below market valuation) purchase price of \$30/cy BPRD could save up to \$150,000 per year, and further justify the capital and operating costs of upgrading composting infrastructure and management practices.

The facility would generate end-products with valuable local and civic end uses. Beyond standard landscaping uses for compost, it has been documented locally and nationally that compost is an excellent medium for stormwater management, runoff control, and sediment/nutrient filtration practices. Compost blankets and amending green space areas with compost have been shown to increase soil organic matter content, increase rainfall infiltration, and thus reduce runoff from storm events. Improved soils reduce phosphorus (P), nitrogen (N), and sediment loss in the immediate area, reduce peak flows through local streams and drainage, and mobilize less pollution in precipitation and snow-melt events. BPRD has the opportunity to develop a professionally designed, engineered, and well managed composting facility that complies with applicable permitting and local programming. The internal value to Boston city government and its residents and Boston Water and Sewer Commission (BWSC) ratepayers include use by BPRD, Boston Public Works, and to fulfill contracts managed by the Boston Planning and Development Authority and Neighborhood Development, and to establish costly stormwater infrastructure improvements to be required by the Boston Water and Sewer Commission.

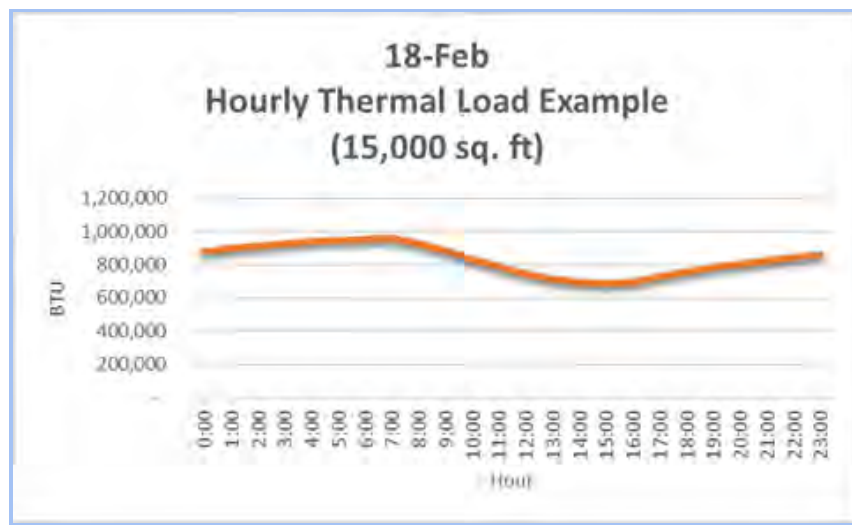
## Existing Heat Load Profiles

Following an on-site meeting with the project partners, Anthony Hennessey, Horticultural Director for Boston Parks and Recreation Department (BPRD), exhibited and described the existing greenhouses and their heating systems. The Franklin Park Maintenance Facility has a total of 60,000-ft<sup>2</sup> greenhouse space available in spring, however only 15,000-ft<sup>2</sup> is fully functional in deep winter conditions. Currently the functional 15,000 ft<sup>2</sup> is kept at 60-64 degrees Fahrenheit for optimum growing conditions and pest attenuation. The additional 45,000-ft<sup>2</sup> difference is underutilized potential growing space; seasonally vulnerable to cold weather plant damage that requires additional seasonal labor to move plants to sheltered, unlit areas

Thermal loads were calculated using 30 year average temperature data for Boston while assuming an air

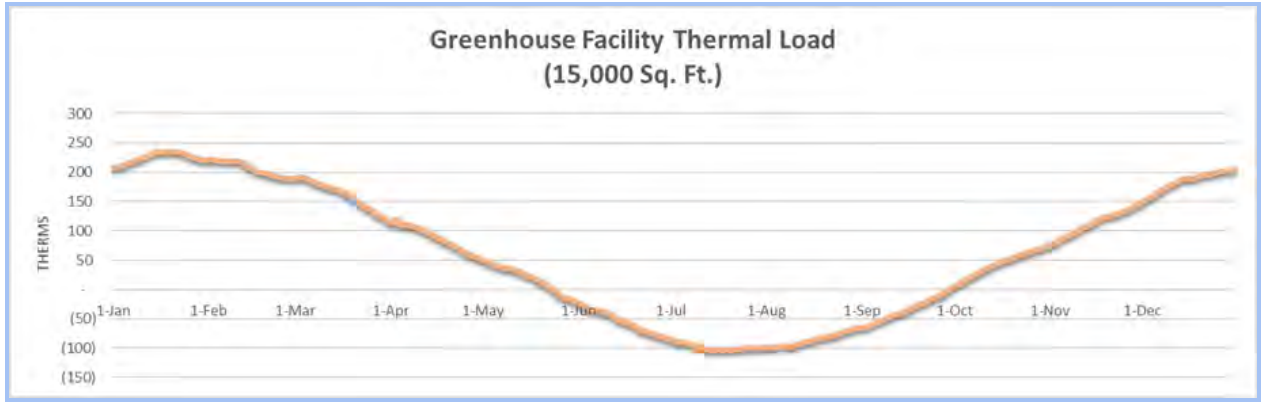
temperature of 60 degrees Fahrenheit will be maintained inside the greenhouse. The usable 15,000 ft<sup>2</sup> space is assumed to have an average R-value of 0.5, given that most of the space contains structurally deficient greenhouses lacking airtight glazing envelopes. The legacy greenhouses are more than 100 years old, have high rates of air infiltration, and high radiant surface to usable space ratios. Extensive and costly repairs would be required to preserve the greenhouses, and would not be an efficient use of space nor would it address current and projected growing needs. Replacement of the compromised structures with more efficient, functional modern growing space is recommended as a top priority to reduce energy consumption. The following charts summarize the thermal energy demand for the existing 15,000 ft<sup>2</sup>.

Hourly thermal demand for BPRD Greenhouse facility in February.



The figure shows the peak thermal load to be in the morning hours before sunrise, and minimum load in the mid-afternoon. To meet the peak thermal load with biothermal energy, hot water storage is planned to be able to provide heating when the need exceeds the instantaneous generation from composting activity. The existing natural gas and heating oil systems will be able to meet heating demands that are beyond the instantaneous and hot water storage capacity.

Estimated Thermal Energy Load for existing BPRD Greenhouse facility

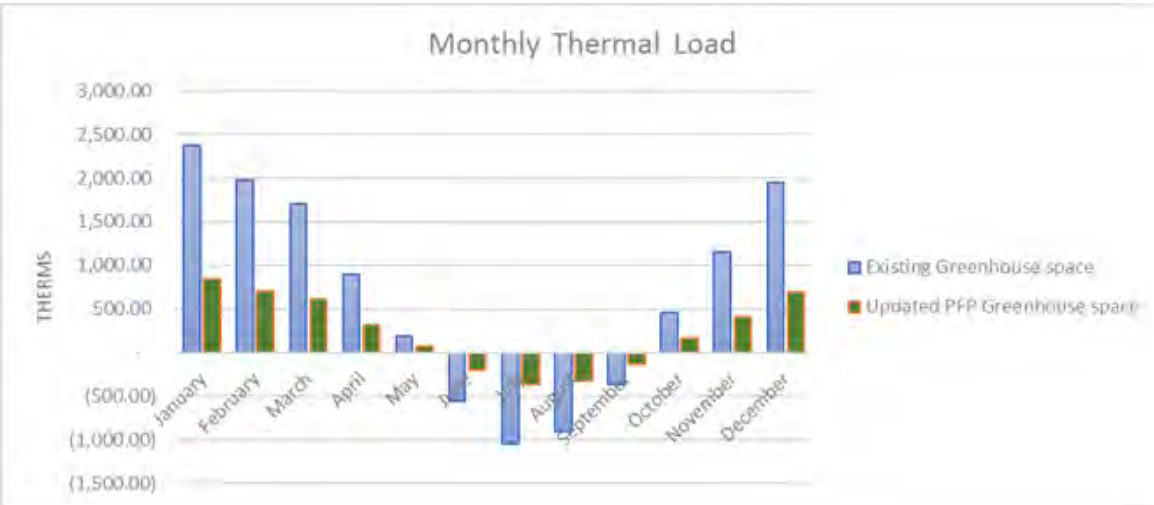


The total thermal energy estimated for a period of one year is 31,339 therms. Using a value of \$0.96/therm the total estimated cost for heating useable greenhouse space is \$30,086 annually.

The heating infrastructure for the greenhouses is varied, and the oldest houses do not utilize the hydronic network. There are significant retrofit or full replacement options that could improve function and efficiency. The presence of lead, asbestos, and possibly other materials with health risks is a significant consideration and adds costs to renovations. However, the removal of hazardous elements would benefit the long-term value of the site and the safety of the city. Separate remediation funding will be explored.

BPRD Director of Horticultural Anthony Hennessey needs additional modernized greenhouse growing capacity to meet seasonal crop production demands of the Franklin Park Maintenance facility. A Partners for Places (PFP) Urban Farming Pathways grant affords Boston with a funding mechanism and labor resources to expand and manage crop production within a compost heated greenhouse. As proposed, budgeted, and funded the greenhouse shell assumes a model energy efficient greenhouse with an R value of 1.4. With a footprint of 30 ft x 96 ft and surface area of 5300 square feet, it is ideally sized to replace two of the smaller legacy greenhouses at BPRD. The following figure shows the difference in thermal load between the proposed hoop style PFP greenhouse and similar square footage of existing greenhouse space.

Difference in thermal load between proposed greenhouse and existing equivalent square footage



We recommend primary application for renewable energy use from composting to be for the largest adjacent thermal load of greenhouse heating. There are several other economic values for using the thermal energy, particularly during the late spring and summer months when greenhouse heating loads are reduced or absent. A drying loop to reduce moisture content in finished compost, hot water washing of trucks and other equipment, and tempered irrigation water for heat-loving plants appear to be the top three summer uses of heat.

The drying loop, consisting of a hydronic loop to a water-to-air heat exchanger, allows heated dry air to be forced up through maturing piles of compost, which accelerates final drying and reduces the weight of the product. This provides the benefits of transportation efficiency, allowing trucks and trailers to be loaded with the maximum volume of compost products without exceeding weight restrictions, as can routinely occur with wet and dense materials. At the point of application/utilization, dry products are able to be spread more evenly and avoid clumping, reducing BPRD labor and enhancing product performance. For on-site storage, dried product is more stable for longer-term placement in commodity bays and greatly reduces risks of odors when compared to stockpiling of immature compost. In the case of outdoor storage of dried compost products, the material has more infiltration and moisture storage capacity, reducing the risk of leachate and associated sediment and nutrient loss.

The significant energy value that could be captured outside of the greenhouse heating season, the environmental impact of air conditioning and its associated financial cost to the City, (capital and operating) warrant further evaluation of Absorption Chiller technology in a final design phase. An absorption chiller affords an energy-efficient mechanism for using biothermal heat from the ASP system for cooling workspace in the BPRD Maintenance facility that is presently provided by electrical grid powered conventional air conditioning equipment. The thermodynamic cycle of an absorption chiller is driven by a heat source delivered to the chiller via steam, hot water, or combustion. Compared to electrically powered refrigeration and air conditioning, an absorption chiller has very low electrical power requirements for both the solution pump and the refrigerant pump. Heat input requirements are

large, and its COP is often 0.5 (single-effect) to 1.0 (double-effect). The technology merits further assessment to determine if additional waste heat sources and cooling loads at BPRD justify inclusion in the facility design and operation. This option has not been included in the capital cost or operating assumptions modelled in this study.

## Detailed Design and Evaluation

The following is a summary of the design and evaluation of the proposed Aerated Static Pile (ASP) compost and heat recovery project at the Boston City Park Greenhouse Facility located at Franklin Park Maintenance Facility.

The present greenhouse heating and baseline energy consumption is the largest energy load that the proposed facility seeks to meet. Two of the newer greenhouses are located at the northern end of the horticultural complex and are oil heated. They consumed 2,372 gallons of #2 heating oil in 2015; they comprise less than 15% of the total square footage of greenhouse space at BPRD. Approximately 85% of the existing greenhouse area is natural gas fueled heat delivered via hydronic bench, radiant finpipe, forced hot air, and fan-assisted radiant air distribution.

Maintenance facility data has been used to inform seasonal demand, total consumption is divided between greenhouses, office and other maintenance buildings, and shop. Individual buildings, including the greenhouse complex are not separately metered, therefore greenhouse heat loads are estimated via pro-rating and via independent calculations.

Using a greenhouse heating cost calculator, the following assumptions were made to produce an initial natural gas consumption estimate for greenhouse heating: The surface area of the natural gas-heated greenhouses is estimated to be 40,000 square feet. The average inside temperature for the multiple greenhouses is estimated to be 60 degrees F (subtropical greenhouses are higher and other greenhouses are not used in all 5 months of the prime heating season). The average low temperature used was 0 degrees F based on USDA Zone 6a for plant hardiness. The typical heat loss value for the glass and polycarbonate walls and roofs is 0.9. The peak heating months (as tracked in past utility records) is 5 months.

The total predicted amount of natural gas consumption in greenhouses is 4,116,706 cubic feet or 41,177 therms. 41,177 therms is estimated as 68.9% of the Franklin Park facility total consumption.

Other factors that would influence this prediction include: 0 degrees F as average low temp is appropriate for Jan-Feb but November, December, and March may not be this low, thus reducing natural gas demand. Peak heating season is shown as November through March, but records indicate moderate natural gas consumption in September, October and April, thus increasing natural gas demand.

The total and individualized use of electrical heating for buildings other than the greenhouse complex are not included in this feasibility study. In some of the greenhouses, HPS and HID greenhouse lighting also supplies heat as a byproduct, which meets some of the total greenhouse complex thermal load. Electric baseboards and other heating systems are used in other buildings at the facility. Boston's EEOS is

in the process of conducting a systematic review of energy use and demand-side management of city owned buildings. Given the financial cost and carbon footprint of electrical production and transport, a more detailed cost/benefit analysis of the compost heat recovery and distribution system that could supply hydronic heat to other buildings will add more detail to this assessment.

The design of the aerated composting facility and heat recovery components was intended to match as closely as possible the coincident energy demands, as well as the current volumes of feedstocks handled on site. The eight-bay, 1600 cubic yard facility with two Hot Box 250R units achieves both of these design goals, while accommodating the new importation of food scraps for composting with these existing materials.

## Covered Bioswale

Reducing the volume and pollution from stormwater runoff from urban and residential surfaces is a primary interest of the City of Boston. Technologies that are able to process and treat contaminants, principally heavy metals and nutrients, from these non-point source inputs are beneficial to the overall well being of the local ecology as well as residents and citizens of the city. Accordingly, this project examined the use of methodologies that would be inexpensive to implement but have high value in the treatment of stormwater runoff at the site.

Bioswales are a well known and often used Best Management Practice (BMP) that utilize plantings and microbial activity as means to mediate and polish runoff waters from nonpoint source pollutant inputs. Typically the contaminants of concern include road water runoff constituents including heavy metals but also include primary nutrients as well such as phosphorus and nitrogen, in their various forms. The proposed bioswale at the Greenhouse site will serve to provide treatment for both sources of contaminants associated with the ASP facility as well as runoff from roadways and parking facilities.

Since the treatment efficiency of bioswales is principally based on plant species assemblage and activity and biological activity associated with bacteria and fungi within the soil microcosm, it makes sense that the most efficient period of treatment is during the growing season and even within the early part of the growing season when plantings are most active in converting nutrients to biomass. In our New England climate most biological activity occurs between April and November, leaving several months where little to no treatment (but for sediment filtering) is occurring within any biological treatment train. We propose to cover the bioswale with an inexpensive greenhouse shell to extend the growing season and extent of biological activity and continue treatment through the non-growing season. Simply by keeping the soils from freezing will extend the functional activity of mycelial mats that would be established within the biotreatment soil matrix.

We propose to construct a simple pole-framed structure attached to the Jersey Barrier superstructure of the bioswale. We proposed a covering the frame with Solexx XP, a high density polyethylene product fabricated with UV inhibitors (Figure 4). The product is used on greenhouses and provides protection

from wind and loss of moisture and still provides 70 to 75% light penetration. With this system growing conditions for soil microbes as well as plants can be maintained through the winter months. Supplemental heat c This will result in extending the treatment period of the bioswale and allow us to examine the seasonal fluctuation in pollutant attenuation efficiency throughout the year.

To assist with the establishment of an extensive mycelial ecology we intend to blend into our biotreatment soil mix which is a biochar based soil amendment seeded with selected beneficial fungi. A proprietary soil amendment formulation of this type increased heavy metal and nutrient removal from road water runoff based on a study in Portland, Oregon.<sup>1</sup> Building on this model we will incorporate a locally-sourced and tested equivalent into our blended soils for the bioswale.

Costs associated with the control of nutrients in stormwater runoff from urban and residential areas were reported for a range of structural and nonstructural best management practices. For example, infiltration basins were found to have a phosphorus removal efficiency of 65% with costs ranging from \$819/m<sup>3</sup> to \$1,768/m<sup>3</sup>, and programs to identify and correct illicit discharges into storm sewer systems had costs (based on 20-year present worth) as low as \$8.82 per pound of nitrogen removed and \$35 per pound of phosphorus removed.

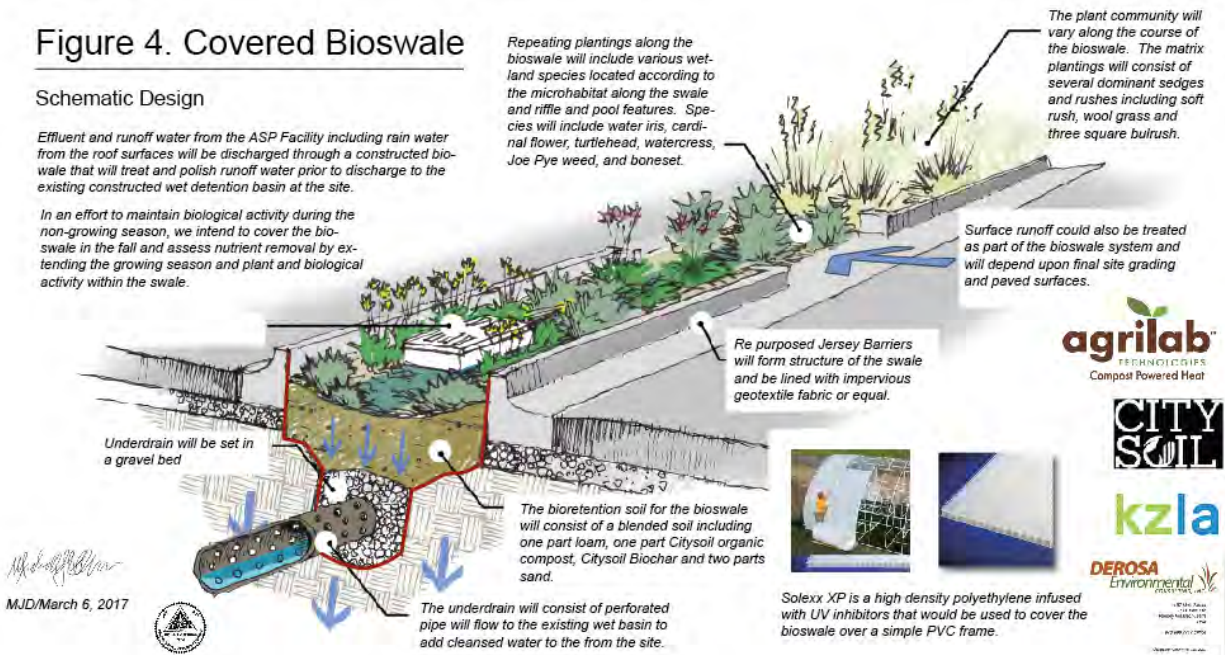
Source: <https://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf>

## Figure 4. Covered Bioswale

### Schematic Design

Effluent and runoff water from the ASP Facility including rain water from the roof surfaces will be discharged through a constructed bioswale that will treat and polish runoff water prior to discharge to the existing constructed wet detention basin at the site.

In an effort to maintain biological activity during the non-growing season, we intend to cover the bioswale in the fall and assess nutrient removal by extending the growing season and plant and biological activity within the swale.



<sup>1</sup> Melville, Alaina. 2016. Assessment of Mycorrhizal Fungi Application to Treat Stormwater in an Urban Bioswale. Master of Science Thesis Research Summary, Geography Department, Portland State University.



# Repair and Replanting of Existing Stormwater Basin

The existing stormwater basin is replete with common reed (*Phragmites australis*) an insidious invasive plants species in our region. The efficiency of the constructed detention basin has been dramatically impaired from its original design both in pollutant and sediment removal but also flood storage volume. We propose to improve the functionality of this basin by removing the *Phragmites* and replacing with native plant species similar to the bioswale plant community assemblage (Figure 4). In this way, the function and value of this basin will be restored and storage volume will be substantially increased.

## Daily, Monthly, and Seasonal Materials Handling

### FEEDSTOCK INTAKE

Materials that exist currently at the site and are proposed for intake as composting feedstocks include leaves (bulk loose, shredded, and in biodegradable paper bags) from Boston Parks, horse manure and bedding, grass clippings, wood chips, food scraps and greenhouse crop residuals and spent growing media. Trucks from BPRD and contractors, ranging from pick-up trucks, BPRD vacuum trucks, compactor packer truckers to 10-wheel dump trucks and hook-lift trucks with roll-off containers dump loads of leaves on a partially improved pad. A small portion of the pad closest to the driveway is asphalt paved but most of the stockpile area is on unimproved soils and is prone to rutting and ponding of runoff. Horse manure with bedding is shuttled on-site to the stockpile area with a payloader using a 3-cubic yard bucket.

Modest changes are proposed to the current method of handling leaves, horse manure and greenhouse residuals. Leaves are delivered to the stockpile area on a nearly daily basis and dumped on the ground. The on-site loader periodically pushes the received materials up into the face of the stockpiles in order to leave open area for additional deliveries.

New material handling practices would be to dump incoming materials on the improved tipping and mixing pad. The loader operator will leave a portion of leaves and bedded manure on the pad as an absorbent base to accept incoming food scraps. Excess leaves, wood chips and other carbon-rich feedstocks can be moved to the edge of the pad or in adjacent carbon-storage and overflow areas, especially during fall leaf collection.

On a daily basis there is a wide range of anticipated volumes from no inputs during some portions of summer, to upwards of several hundred cubic yards during peak leaf collection season. The resulting workload for the loader operator will vary significantly from a few minutes to several hours depending on that daily volume.

On a weekly basis the site operator(s) will have two intensive days of material handling with several

activities. This will be most efficient if the delivery of food scraps from Boston schools, and/or other local sources is scheduled on a single day. A typical schedule could be Tuesday consolidating and removing older batches, and transferring of batches that have met and achieved time and temperature requirements of the Process to Further Reduce Pathogens (PFRP). 400 to 600 cy of material may be handled on this day. This opens up an aeration bay and facilitates mixing and loading of new batches. Blending takes additional time and will require several hours of equipment operator time, depending on the volume handled on that day, but may be 200-250 cy in typical operating conditions.

Material volumes on a weekly basis that would be loaded into aeration bays may be mixed in varying proportions, depending on the materials on-hand, provided basic C:N ratios, moisture content and bulk density targets are met for the blend. A typical batch may consist of:

Leaves: 138 cy

Horse Manure: 17 cy

Wood Chips: 29 cy

Food Scraps: 46 cy

Greenhouse Residuals: 2 cy

On a monthly basis, 3000 cy may be handled between moving incoming materials, loading new batches, transferring and consolidating batches as they decompose, and loading materials for export and use. Monthly, 9 to 10 days of bulk material handling should be anticipated, with lesser time requirements on other days to handle on-going incoming materials - leaves, horse manure, wood chips, greenhouse residuals and grass clippings.

Peak volumes are seasonal and are related to fall leaf collection and to a lesser extent additional leaf clean-up in the spring. Separate from storm events, up to 1500 cy/month of leaves are anticipated in October, November and December. 500 to 750 cy/month could be expected during spring clean-up in March and April. Only a fraction of incoming leaves would be kept on the receiving and mixing pad during these seasonal peaks for mixing into weekly batches, the balance of those materials would be stockpiled on the adjacent storage areas and used in blends during winter and summer periods when no new materials are coming in. Horse manure and bedding would no longer be stockpiled on an unimproved surface, but rather incorporated into weekly batches.

Space efficiency:

The proposed enclosed Aerated Static Pile technology makes more efficient use of space than the turned windrow technology used at the City's Public Works Composting Facility operated by City Soil. Aisles between the open windrows used at the Public Works/Audubon site occupy more than 35% of the footprint of the site. This coupled with the sloped sides of windrows, results in inefficient use of space relative to Aerated Static Pile processing. The proposed BPRD facility composting bays have vertical walls and no aisles separating the batches, and a capacity to manage 2.5 to 3x greater volume to working

surface area than windrow based composting.

Sophisticated control technology:

The speed of volume reduction in the ASP system is also accelerated greatly by more efficient process management and with the addition of nutrients and moisture from manure, food scrap and greenhouse crop residuals. The aerated static pile system utilizes computer-controlled blowers to remove surplus heat and supply oxygen on a continuous cycling basis, and maintains optimized moisture levels in the composting materials, and results in rapid reduction in the weight and volume of the feedstock materials.

Recipe:

The nutrients in manure and food scrap speed the decomposition process and result in a rapid reduction of the weight and volume of the materials that are loaded into the aerated composting bays, and facilitate a more rapid decomposition of the leaves, bedding and wood chip that they are blended with, yielding a much higher throughput rate per square foot of space dedicated to the operation. Food residuals - such as coffee grounds, and spent hops and grains from local breweries, can be selected for specific nutrient concentrations and are good 'starter' organics for small batch composting. Recipes for the composting process may be modified to accommodate more food residuals and other source separated organics as warranted by supply, heat yield benefit in the composting process, or financial performance of the facility, and phased in based on a proven capacity to manage the materials responsibly.

Materials Density:

Food scrap is 2-3x more dense than landscape organics, as it contains more water than leaves and yard debris that are processed at the PWD site by City Soil. Each cubic yard of food scraps weighs more than double what leaves weigh when they are deposited on the site. The tonnage throughput capacity of the site increases as the percentage of food waste increases.

On-site curing or export options:

Materials that are removed from the enclosed facility have undergone accelerated composting, rapid odor removal, and dropped more than 40% of the moisture. They will be reduced in volume by approximately 60%- from their initial loading at this stage. On-site storage of curing materials would incur the least handling cost and environmental impact, and take advantage of biothermal heating to dry product to optimal moisture levels for screening, blending and bagging. Primary composted materials could be immediately exported to another site if required for final curing, and screening. Logically this would be at the Public Works Composting Site, providing sufficient space is allocated with appropriate interdepartmental approvals and coordination. This interdepartmental model with BPRD and Public Works was proposed by City Soil and successfully implemented in April 2016. City Soil removed more than 1000 cubic yards of stockpiled partially composted material from the BPRD site, composted and screened it at the Public Works site. This proved invaluable in meeting the compost needs of more than

100 community gardens throughout Boston.

*Bagged products distributed in the Boston area market would support the operation*



**End use and sales strategy:  
Maximizing value to the City**

Many municipalities and other public sector generators of compost products use public/private partnerships or a contracted sales arrangement to insure that finished products made from organic wastes are used beneficially. City Soil's site operating contract with the City of Boston's Public Works Department shares a cash value credit to the City for a portion of the revenues derived from the sale of the finished products. This arrangement insures that the City and Audubon have an ample supply of the finished compost and mulch for civic uses, and outsources the marketing responsibilities for more than it can use internally, and insures that the

City financially benefits from the marketing of the products manufactured from its organic waste stream. In addition, the host landowner, Mass Audubon's Boston Nature Center and the City-owned George Robert White Environmental Conservation Center receive donations of products and collaborative educational programming services from this public/private/educational partnership.

There are other sales and end use models that increase demand for and revenue from the City's transformed organic wastes and urban forest byproducts. City Soil's expanded marketing and sales

initiatives for its 2017/2018 season are expanding the demand for finished compost-based products within Boston and its suburbs. With effective marketing and sales initiative the marketplace would readily absorb all of the products that could be generated from the BPRD facility.

#### Commercial sales

City Soil's 2017 marketing initiative has branded 'Olmsted Organics™' and Sovereign Soil 'High End Blend™' to expand the opportunity for product lines manufactured from composted BPRD organic materials and other local ingredients from the local organic waste stream. City Soil is developing a line of bagged and containerized premium, competitively priced composts, soils, specialty soilless growing media, mulches and other soil amendments. City Soil's 2017 spring sales and distribution have built demand from private and public sector markets, non profit groups and institutions throughout Boston and in peri-urban markets.

#### Civic projects

Projects on public land are a common-sense high-volume market for some of the soil products generated by the facility. Public funds are used to build and maintain parks, playgrounds, ballfields and other greenspace. 'Green infrastructure' projects include landscape-based climate adaptation and resilience. The materials generated from the Facility used for these projects would insure that the city's own organics materials are funnelled into these projects, effectively closing the loop from public sector (City of Boston) generator to end user. Specifications could be developed to insure the quality of the products, the integrity of the manufacturing process, and distribution into public sector uses is beneficial to Boston residents.

The Boston Parks Department Greenhouses current uses of soil amendments and composted products comprise approximately 500 cubic yards of mulches, compost and specialty growing media annually.

The two Parks Department managed golf courses, cemetery, public gardens, ballfields and parks, and large construction projects managed by the BPWD use thousands of cubic yards of materials every year. For the purposes of this study, the volume has been estimated at 3000 cubic yards annually, which we believe to be a very low projection given the pace and scope of the projects.

Stormwater infrastructure will require engineered soils, compost, mulches and plants, and filtration socks filled with custom-composted organic filtration media blends.

The Public Garden, City Hall Plaza, Franklin Park, Jamaica Pond and Columbia Road are examples of high profile, high value and large volume, municipally contracted uses of the products that would be generated at the facility.

#### Boston Parks and Recreation Department

A cooperative mission-driven marketing and sales arrangement could utilize sales revenues for education and job training, operational costs and additional facility infrastructure investments.

Olmsted Organics™ products are being used in school gardens, urban farms, turf and high performance

landscapes, and in specialty greenhouse and field crop production. Five new pollinator gardens were built on land owned by Boston Department of Neighborhood Development in June with specialty blend custom soils that included BPRD compost. 'Grow with CitySoil' is a partnership between GrowBoston, City Soil that has established two schoolyard raised vegetable gardens in Sudbury, MA with City Soil's HighEnd Blend, with seed funding from Roche Brothers. The collaborative is underway to install these ready-to-grow garden kits in high profile settings throughout Boston in public, private and institutional locations. Olmsted Organics products could be used immediately in City Hall plaza to repair distressed landscape plantings. Expanded marketing opportunities through web-based direct sales and garden centers will leverage the City's commitment to climate solutions, environmental education, and community based, mission driven public/private partnerships.



*Growing with City Soil™*

City Soil's market research for its expanded product line has identified existing commercial sales

opportunities for more than 10,000 cubic yards of bulk and premium bagged value-added products annually. These would be distributed through diversified retail and wholesale markets within and outside of Boston.



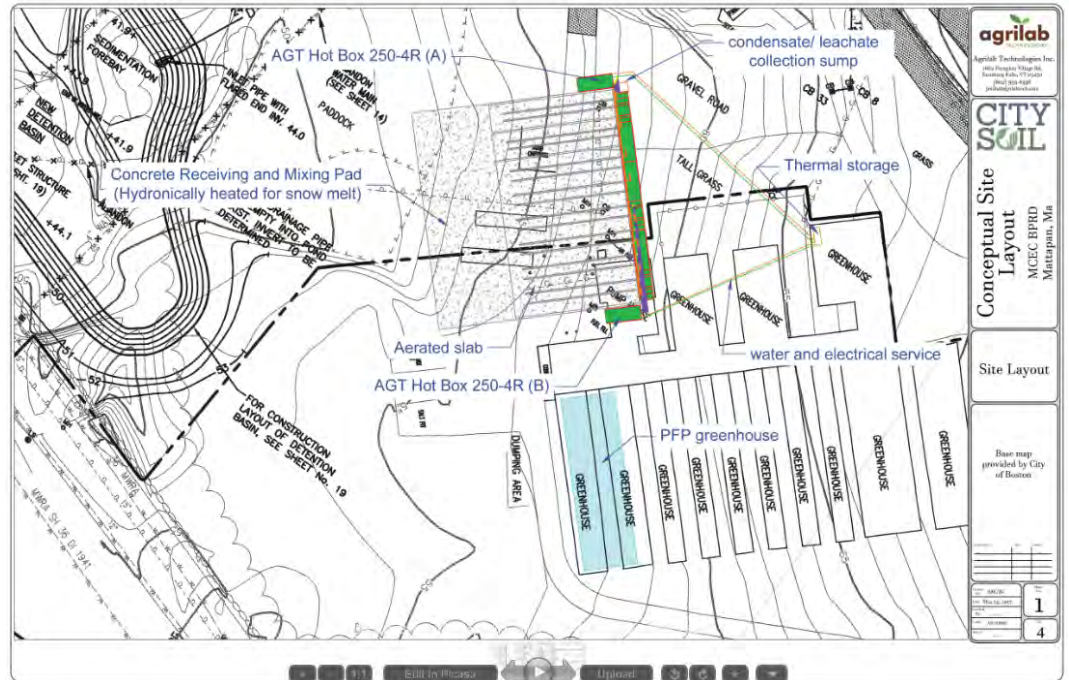
*Loading finished compost for delivery to Haley House farm in Roxbury*

More than 1000 cubic yards of BPRD's stockpiled and partially composted manure and bedding, leaves, grass clippings and greenhouse crop residuals were sampled and lab-tested by City Soil in 2017 to exceed the City's Soil Safety standards. They were excavated and removed by City Soil from the Franklin Park Maintenance Facility in April 2017 to complete processing at the Boston Public Works Composting Facility. These materials were managed in an agreement between Boston Parks and Public Works Departments that was coordinated by City Soil. This interdepartmental public/private partnership supplied high quality, safe screened compost to more than 100 of Boston's community gardens, to more than 10 urban farms, commercial landscapers home gardeners, and to newly developed pollinator gardens developed by Best Bees on land in Dorchester owned by the Boston Department of Neighborhood Development.

# Infrastructure Requirements

The proposed facility will occupy space on the site that is underutilized but presently hosts some materials equipment and storage functions. Construction of the facility will require the following infrastructure commitments to support the development and operation:

- subsoil sampling to determine structural integrity and composition of proposed working surface areas
- grade modification that may include cut and fill
- 3-phase power, 100 amp service, separately metered panel.
- all weather, bituminous or concrete paved and plowable access for deliveries and egress from the facility, sloped and pitched to facilitate runoff drainage to appropriate receiving and treatment infrastructure.
- Dedicated high speed internet line
- Frost protected separate BWSC metered water supply at >30 PSI
- Minor reconfiguration of horse paddock perimeter

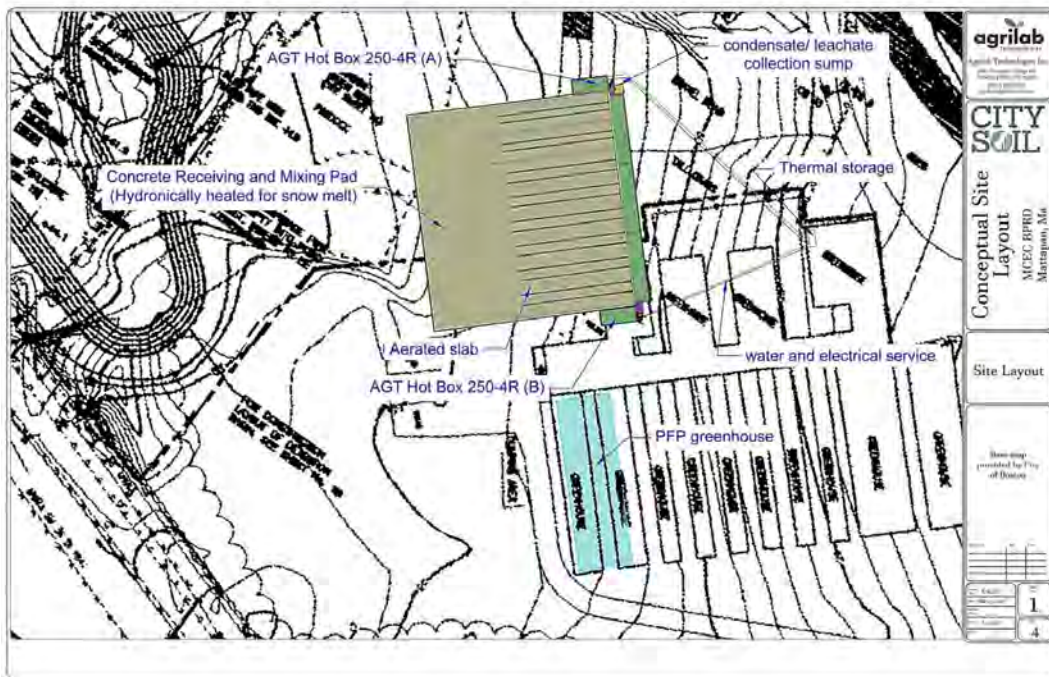




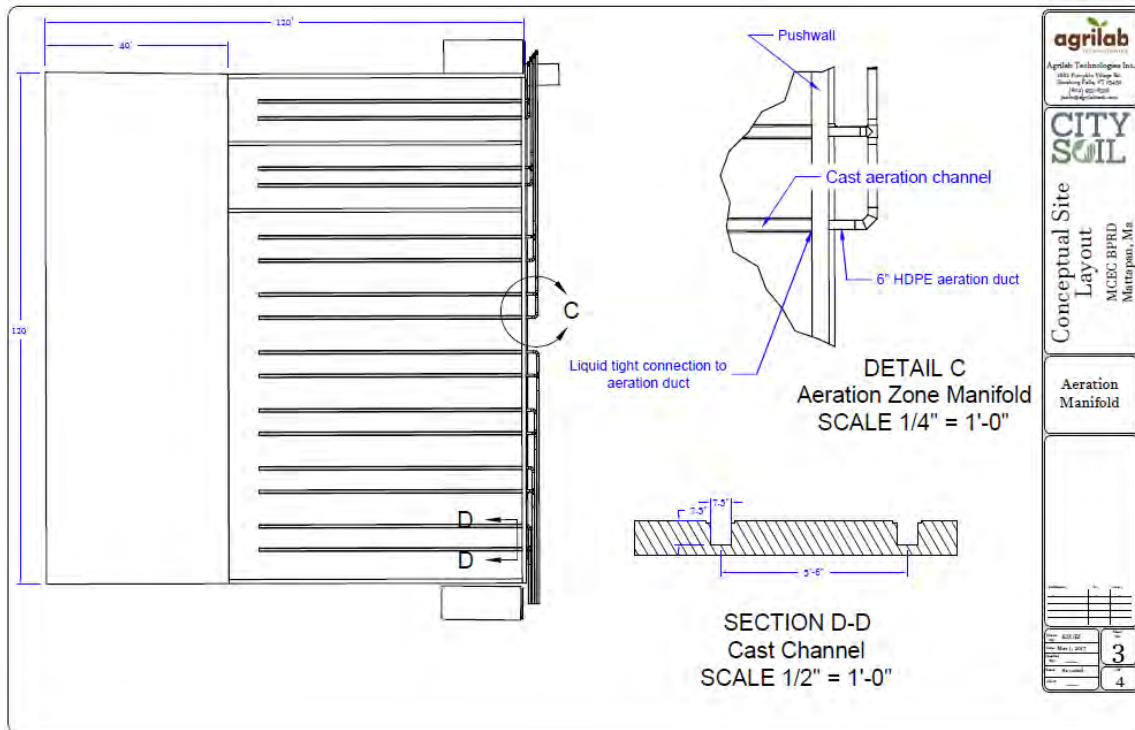
- Reorganization and relocation of some existing parking zones for active fleet vehicles
- Reorganization and relocation informally organized equipment storage
- Allocation of existing BPRD contained storage requirements

Some of the requisite storage for BPRD equipment, supplies and tools may be included in the proposed structure, in enclosed and sealed and accessible containers at or near the perimeter of the building.

### 1. Scaled Engineering Drawings



## Equipment Options and Analysis



There are numerous systems capable of managing compost feedstocks from the sources described earlier. Broadly, more automated space efficient equipment systems such as rotary composting drums are most capital intensive and loader-turned windrows are more labor and space intensive, with lower capital requirements. The intent of this design report focuses on capturing the most cost-effective portion of renewable thermal energy from composting. The recommended system eliminates the turned windrow approach for organics management, and incorporates materials handling equipment and practices that minimize the use of fossil fuels for processing organic wastes generated within the City. The existing method of low-input feedstock stockpiling and partial composting allocates more than one acre of the Franklin Park Maintenance Yard.

The selected composting methodology, and associated equipment options is aerated static pile (ASP) using negative aeration (pulling rather than pushing air through the composting mass). It is projected to

require 25% of the space that a functional turned windrow system would need to process the same volume of material. This is due to both the alley space required for turning equipment in the turned windrow method, as well as the aeration process accelerating the decomposition of feedstocks. The provision of air (oxygen of most importance) optimizes decomposition speed as well as thermal output.

Both rotary drum composting and negative ASP composting can facilitate renewable thermal energy capture, while accelerating the overall decomposition process. Beyond their varied capital requirements, the negative ASP approach is recommended for this site for its flexibility in management, on both short and long-term scales. As proposed an eight-bay composting floor would provide active aeration for approximately 1600 cubic yards (cy) of materials at one time with a typical 8-week residence time. The aerated floor facilitates batch loading of existing materials and new food scrap deliveries on a once per week basis. The layout allows flexibility in the timing of loading, length of active aeration and storage, based on actual material volumes and other BPRD labor needs. Further, it can accommodate surges of material due to normal seasonal variations, as well as from storm events. Importantly, the labor can be concentrated into two days of weekly loader operation, a single day of food scraps receipt and mixing, with partial days required to monitor and maintain the facility for the remainder of the week.

The rotary drum composting alternative is not recommended at this time as beyond its higher capital cost, it would require more daily operating and maintenance labor, and consumes significantly more electrical energy. One or more rotary drums would allow the facility on a compact footprint, to process greater volume and tonnage of food scraps in the future, rapidly treat manures for pathogen kill prior to materials being loaded into the ASP system. This technology should be considered as a complementary component that would substantially increase the throughput of the site. It would increase renewable thermal energy generation, increase tip fee revenue and increase total compost production. This additional process investment would help to achieve other city and state landfill diversion goals, and has been modelled in a prior MCEC Organics -to-Energy feasibility study completed by City Soil, Agrilab Technologies, and KZLA.

As a result of this equipment analysis and assessment of site-specific factors, the specific equipment recommended as preferred options is listed in the Capital Expense budget worksheet. Items beyond the structural enclosure and concrete working floors include the two Hot Box 250R units (containerized aeration, heat recovery, monitoring and control systems), a drying loop to reduce moisture in finished products, a mixing bucket attachment to blend food scraps and other amendments, hot water storage and associated plumbing, electrical and internet connections, containerized biofiltration beds and shipping containers to enclose aeration and drainage ductwork, and provide supplemental tool and material storage.

# Daily, Monthly and Seasonal Material Handling Flow Chart

Typical bulk material handling twice per week (example Tuesday material turning, transfer and consolidation, Wednesday food scrap delivery, mixing and new batch loading):

1. Leaves are stockpiled at southwestern and western edge of composting area.
2. Incoming horse manure, food scraps or other biomass is tipped on receiving area pad and mixed with stock-piled leaves and wood chips.
3. Blended batches (250-cy/week peak operation) loaded into aeration bays.
4. Once loaded, batches are flipped to an adjacent bay after 2 weeks of static aeration.
5. After 8 weeks of typical operation, compost material is reduced in volume approximately 40% and transferred to on-site or off-site location for product curing/maturing.

Figure 5. Materials Handling Flow Diagram

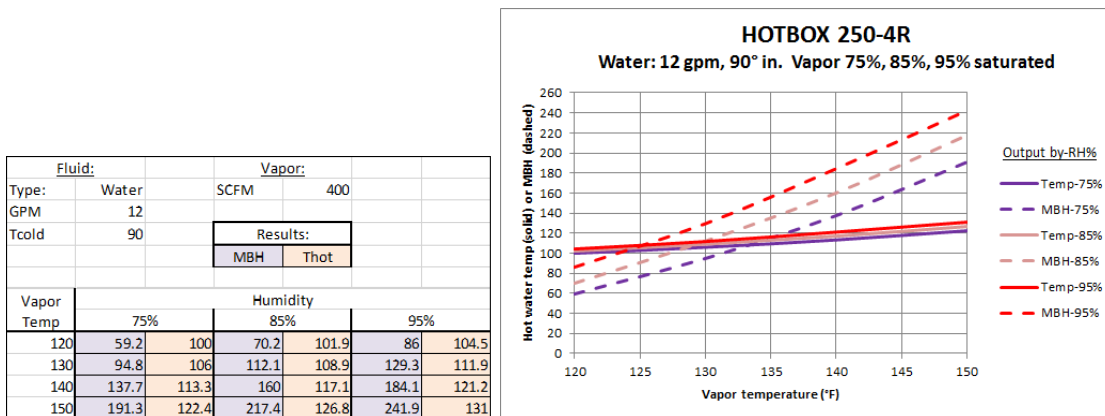


## DAILY, MONTHLY AND SEASONAL THERMAL ENERGY PROJECTIONS

The following charts summarize thermal production for one Agrilab Technologies Hot Box 250-4R. The current conceptual design for this study will include the use of two Hot Box 250-4R units for compost heat recovery. Thermal performance is impacted by the saturation level of the vapor recovered for actively aerated compost, vapor temperature from compost piles, and fluid temperature incoming to the exchanger. In this design a 12,000 gallon thermal storage tank with two separate exchangers are expected to return 90 degree Fahrenheit water back to the compost heat recovery exchangers at 12 gallons per minute.

Peak performance will be maintained using a spray irrigation system to ensure proper compost moisture to achieve 95% vapor saturation. Peak vapor temperatures will also be maintained through frequent feedstock loading to compost ASP as well precise control for oxygen levels. Healthy aerated compost can maintain vapor temperatures of 130-160 degree Fahrenheit given available fresh feedstock.

Figure 6. Hot Box 250-4R Thermal Production at varying vapor temperatures and moisture levels.



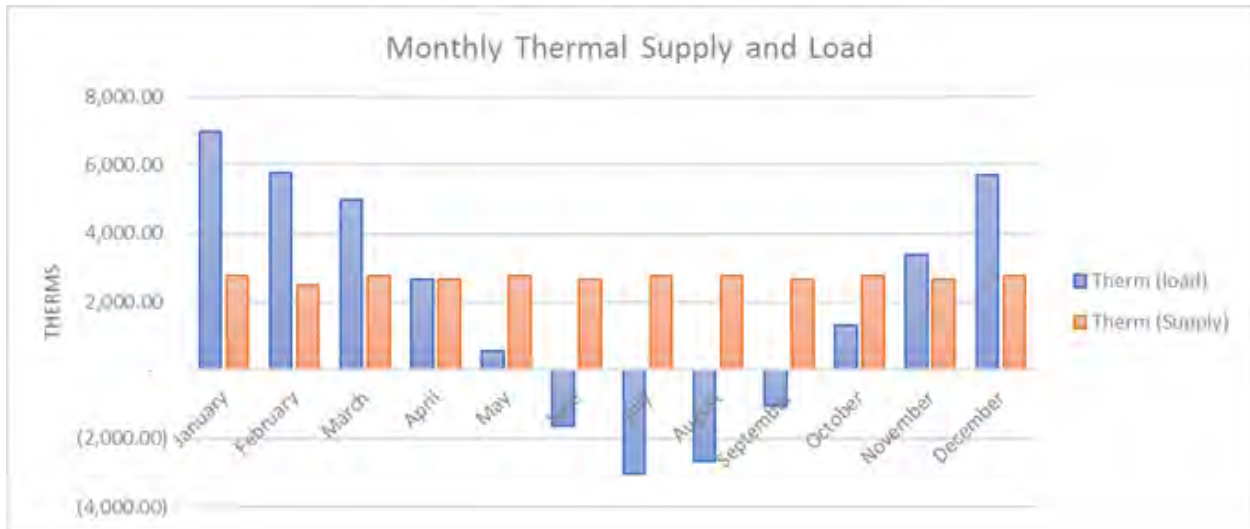
With provisions to maintain optimum moisture levels and feedstock availability throughout the year, an estimated average thermal production for 130-160 degree vapor temperatures at 95% saturation levels was calculated at 185 Mbtu/hr. The total average Btu per hour output estimated for two AGT Hot Box 250-4Rs is 370,000 btus/hr (370 Mbtu/hr) with a maximum output of 480,000 btus/hr (480,000 Mbtu/hr).

Given the average production of 370 Mbtu/hr for the entire compost heat recovery system, we can expect 8880 Mbtu or 88 therms per day. Using average production of 88 therms per day we can expect 2,700 therms per month. Using the same average thermal production, a yearly production of 32,412 therms can be expected, a value of \$31,000 at \$0.96 per therm.

## COINCIDENT HEAT USE OPPORTUNITIES AND VALUES (AVOIDED COSTS)

During the peak heating months of November through April traditional sources of heat may still need to be used but at a fraction of historical usage as illustrated in the figure below.

Figure 7. Monthly thermal supply and greenhouse load depicted throughout the year.



During months where heat is unlikely to be needed (May through September) to maintain greenhouse temperatures there will be an excess of thermal energy estimated at 10,922 therms, a value of \$10,000 annually at \$0.96 per therm .

To utilize thermal energy produced during non-heating months for the greenhouse, we recommend the use of a separate drying core to further dry finished compost, creating a value added product for use throughout the Parks Department. Finished compost can be dried using typically two, but up to four of the proposed eight ASP bays. An equipment and truck washing station can also be proposed to further utilize excess thermal energy during seasonal absence of greenhouse demand.

Hydronic snow melt zones have also been proposed as part of the mixing and receiving pad connected to the ASP. Snow collected from the maintenance yard driveways and parking lots can be collected and dumped onto the receiving pad, where melting can be radically accelerated.

## MAINTENANCE REQUIREMENTS

The Hot Box 250-4R units should be visually checked daily for leaks, excessive vibration and or noise. All fan bearings should be checked and greased on a monthly basis or when excessive bearing noise is heard. Automated valves should also be kept clean and checked for smooth operation. The specialized heat exchangers should be checked on an annual basis for buildup and cleanliness of components. Sensors should also be verified for accuracy on an annual basis. The following table summarizes maintenance costs and associated activities.

Table 1. Annual Maintenance

<b>MCEC BPRD Compost Aeration and Thermal Energy Annual Maintenance</b>			
<b>Maintenance Item</b>	<b>Description</b>	<b>Estimated Use (Hrs/Yr)</b>	<b>Annual Cost (USD)</b>
Loader Maintenance	Grease bearings.	1,000	2,500
	Change oil and filters.		
	Replace worn hoses.		
	Replace belts.		
	Check engine and hydraulic system fluids		
Aeration Blowers	Grease motor and fan shaft bearings.	8,700	2,200
	Check and rinse aeration ductwork/heat exchanger plenum		
Sump Pump	Grease motor bearings	250	1,200
	Change oil.		
	Replace shaft sleeve and seals (run to failure)		
Controls Instrumentation	Replace faulty sensors and modules as needed	8,760	2,500
Composting Bay	Monitor air data for signs of plugging or bypass. Clear aeration piping as needed.	8,760	1,500
Biofilters	Monitor filter for indications of bypass or breakthrough. Repair or replace media stack and distribution piping as needed.	8,760	*6,000
Bio swale	Dead material and sediment buildup removal		1,000
Building and Grounds	General building maintenance, mowing, cleanup, etc.	N/A	2,000
Pest Control	Establish and maintain rodent control program or add to scope of existing BPRD program.	N/A	1,000
Contingency	Budget placeholder for emergency repairs, equipment rental, contract labor, etc.	N/A	10,000
Operating Supplies	Tools, copy/fax machine, paper, personal protective equipment, etc	N/A	2,000
Analytical Testing	In-process and end product testing by approved laboratories. (Pathogens and Contaminants)	N/A	4,000
**Utilities	Includes water, internet and electrical service only.	N/A	3,000
<b>*Includes annualized cost of biofilter media replacement every 2</b>		<b>Estimated Annual Total</b>	
<b>**See energy cost estimate table for gas and electric projections.</b>		<b>\$32,900</b>	

## Permits Required and Other Regulatory Issues

The following are potential permit obligations that may be triggered by the proposed project. Each is discussed separately below subject to pre-application meetings with the appropriate state and local

commissions, departments and agencies.

1. Massachusetts Wetlands Protection Act
  - a. As the constructed detention basin is a designed stormwater detention facility it is not considered a wetland resource area under the MA Wetlands Protection Act at 310 CMR 10.00, et seq.. Accordingly, no filing with the Boston Conservation Commission is required as part of the implementation of this project scope.
2. Building Permit - City of Boston
  - a. The project would require a building permit from the City of Boston. Appropriately engineered plans and specifications will be required that conform with with existing City of Boston Building Department code and permits.
  - b. Site Plan Review - City of Boston
  - c. Site plan review may be required based on pre-application meetings with the City of Boston Planning Board which will be subsequent to the final site design and facility plans.
3. Boston Parks and Recreation - City of Boston
  - a. As the project is located within lands under the management of Boston Parks and Recreation Department, internal review of the final project to address setback to existing and planned roadways, pedestrian and vehicular traffic defined in the Master Plan including access to buildings, parking areas and general site circulation.
4. Boston Parks Commission - City of Boston
  - a. A full set of project plans will be submitted to the Boston Parks Commission for review and comment. Of particular concern will be setbacks and changes to the view corridors, plant and tree selection, along Morton Street and American Legion Parkway.
5. Boston Landmarks Commission - City of Boston
  - a. A pre-application meeting should be conducted with the Boston Landmarks Commission once it is determined if proposed site work or demolition of existing greenhouses/buildings are required as part of the final build out of the site. BLC's purview includes the historic significance of the deteriorated greenhouse structures proposed to be removed. The location of the enclosed ASP composting and AGT heat recovery system as defined in this feasibility analysis is not contingent on removal or renovation of any of the existing the greenhouses. The conceptual footprint of a portion of the facility could encompass the poured concrete foundation of the former central boiler room for the greenhouse complex and repurpose it for stormwater storage.
6. Boston Planning and Development Authority - City of Boston
  - a. Once final site plans and design are prepared, review by the Boston Planning and Development Authority may be needed. A pre-application meeting is recommended to determine the extent of review and interests of the BPDA.
7. Boston Public Health Commission -
  - a. A General Organics Facilities Permit is required for the existing informal composting



operation, and for the ASP composting operation to commence. This is a self-certified form that is prepared by the facility operator, and submitted as an official notification to BPHC. No action on the part of BPHC is required. Time should be budgeted in the development phase to complete the submittal, which is required by MassDEP.

- b. The MassDEP will receive and file the General Permit Application for the composting operation. 30 days from the receipt of the form, assuming that it is completed accurately and requires no amendment or modification, the facility will be legally operational. MassDEP responds to reported problems if they arise, but will not issue a permit.
8. Utilities
    - a. Gas, electric, water and sewer, fiber optic, cable other internet service will need to be installed or extended from existing service points at the Maintenance Yard. Utilities providers including National Grid, Eversource, the Boston Water and Sewer Commission and the Boston Inspectional Services Department would be consulted in advance to assure conformance with applicable codes, and accurate capital costs and timelines are assumed as part of the design and build out of the final proposed plan,
  9. Boston Park Advocates, Franklin Park Coalition, Emerald Necklace Conservancy
    - a. These membership organizations serve as the community voice for Franklin Park and will be generally interesting in the project regarding impacts to the neighborhood from the proposed project. We recommend two community outreach meetings early in the final design process to communicate the project details, answer questions, and incorporate specific interests from the community. More detail is provided in the Community Engagement Plan previously submitted and attached as an Appendix to this report.
  10. Greenbelt
    - a. The American Legion Parkway corridor and Morton Street are part of a greenbelt that carries some 50,000 vehicles daily in and out of Boston. The existing Greenbelt Zoning defines a 100' setback from the curb, and a neighborhood-based and City-driven planning process for modifications to the Greenbelt, and maintenance of the property.
  11. Boston Water and Sewer Commission
    - a. Interest will be centered on the introduction of Green Infrastructure and the proactive implementation of green infrastructure principally to address the USEPA consent decree that compels BWSC, and the City departments, agencies, institutional and private landowners and managers to dramatically reduce the discharge of phosphorus and other pollutants to the Canterbury Brook and Charles River Watershed.

Permits may be needed to be filed with the Boston Parks Commission, and the Boston Conservation Commission for the ASP infrastructure once final plans are made. Continued stockpiling operations at the site require certification through MassDEP and Boston Public Health Commission. The Mass DEP

General Permit Initial Certification – Recycling, Composting or Aerobic/Anaerobic Digestion Operations category would afford the site and its operators the flexibility to accommodate greater volumes and diversity of organic materials on the site. The MA DEP Self-Certification Process requires that the form be completed by the site operator with the approval of the landowner/custodian of record.

## Community Compatibility

The proposed project is consistent with community compatibility by optimizing energy recovery and use of existing resources.

### COMMUNITY MEETING

Extensive outreach had already occurred as a deliverable prior to the MCEC feasibility study performed by CS&G and AGT with Zoo New England. Additional community interaction and stakeholder engagement is ongoing as a function of City Soil's and the team's focused and local involvement in composting, stormwater management, community greenspace management, and multi-party planning initiatives. Outreach with the local community at the Mattapan Ecovation Center (MEC) had introduced the model of integrated bioenergy and composting through a community-build process, and the MEC employs local residents in ongoing operations at the site. Field trips by Boston Public Schools staff and students to the MEC included English High School, Young Achievers, the John D. O'Bryant High School for Math and Science, and Boston Latin Academy. Groups from MIT and Northeastern University have also visited the MEC.

CS&G has met with with Boston Water & Sewer Dept. Chief Engineer John Sullivan, Charles Jewell and Amy Schofield and three meetings with Green Infrastructure program manager for the Canterbury projects Kate Englund to discuss design and implementation of water pollution control measures at the three compost sites and the unbuildable, unmanaged, and the maintained open space in the Canterbury sub-basin and Charles River watershed. These include the development of accessible and effectively messaged interactive landscapes and constructed BMP's that teach, train and employ local youth and adults.

The project could be integrated with initiatives embraced by EOS and BPRD to transform Franklin Park and other and facilities into educational tools that shape the long-term stewardship of the City's natural resources and the sustainability of its constructed environment. CS&G has met with State Representatives Russell Holmes and Liz Malia, State Sen. Sonia Chang-Diaz, Linda Dorcena- Forry. Boston City Councilors Andrea Campbell, Matt O'Malley, and Frank Baker, and Conservation Commission Executive Secretary to discuss the expansion and improvement of composting in the watershed. CS&G had participated in key strategic discussions with the Mayor's Food Policy Council, Trustees of the Reservation, the Boston Public Development Authority and continues to meet frequently with the leadership of the Clark-Cooper Community Gardens other local groups.

The Project Leader has met with representatives from the closest abutting and influential entities regarding and operational improvements to the organic waste management in the Canterbury sub-basin. These include the Boston Parks Commission, Franklin Park Coalition, and the Emerald Necklace Conservancy Olmsted Green/Hearth, and Mass Audubon. BPRD will present the study in draft form to the abutting land users to solicit their feedback. Kyle Zick, principal of KZLA, has been a core participant in the Franklin Park Master Planning process, and has informed the Master Planning team and this feasibility study team of the specific proposed location, form and conceptual design elements included in this report. Feasibility study lead Bruce Fulford chaired the community-based Environment Committee of Mass Audubon's Boston Nature Center for 12 years, and presently serves on Mass Audubon's Statewide Council and its Climate Committee.

## Site Access

Site circulation will need to be modified slightly based on the proposed footprint of the ASP facility as well as adjusted and improved parking facilities within the Boston City Parks Greenhouse site (Figure 3). Deliveries of feedstock for the ASP system will follow existing roadways into the Greenhouse Site and proceed around the existing greenhouses to enter and drop material for handling and processing within the covered ASP facility. Worker and visitor vehicles will occupy new and existing parking facilities in a that follows the existing or moderately modified circulation pattern. The Master Planning Process has proposed new access be developed into the Franklin Park Maintenance Yard for a public entrance off of Morton Street. This development would greatly improve the educational benefit of the facility, and afford visitors a participatory market based means of support the Boston Parks system, the local community, environmental stewardship and address climate change with every purchase of locally manufactured horticultural products. Deliveries of feedstock materials into the site can be coordinated through either entrance and not conflict with traffic flow and public access.



## Construction Budget

A capital expenditure budget was prepared. This budget includes all equipment needed for material handling, aerated static composting, bio thermal energy recovery and energy distribution to existing thermal loads within the greenhouse facility. Equipment prices have been quoted specific to the project, while some labor and structural projections are categorized as estimates based on provided information and may require further refinement during an anticipated public bidding process for construction. A 5% contingency has been applied to the total project cost and is included in this budget.

## Operational Budget Projections

An operating budget has been compiled for the compost aeration and bio-thermal energy recovery system. With programmable operation of the compost aeration system and on-site and remote monitoring of vapor temperatures, flow rates and oxygen levels, and water temperatures and flow rates via the Hot Box 250R units, this facility should only require the presence of one person who is dedicated to material handling and operational oversight. A total of 40 hrs a week is projected where the bulk of the hours will be spent unloading and unloading feedstock on two days of the week. Remaining days of the week will require smaller tasks that most likely will not consume a full day or be more administrative in nature.

Table 2. Operating labor

MCEC BPRD Compost Aeration and Thermal Energy Operating Labor Cost				
Task / Function	Skill Set Required	Labor Rate (\$/Hr)	Allocation (Hrs/Wk)	Weekly Cost
Receive and unload feedstock. Record receipts.	Equipment operation Record-keeping	28	4	
Inspect, cull non-compostables, adjust recipe, load mixer.	Process knowledge Ability to assess recipe requirements.		2	
Unload secondary compost bay and move to final storage bunk, unload primary compost bay, transfer product to Phase 2 processing bay.	Equipment operation		7	
Mix fresh feedstocks and re-load primary compost bay	Equipment operation		7	
Check control system for process excursions or alarm conditions. Ensure that	Basic computer skills, Process knowledge		2	
Conduct physical inspection of facility and log any O&M issues in daily operations log. Respond as needed.	Process knowledge Basic mechanical ability Basic electrical Basic control systems Record-keeping		2.5	
Ship finished product. Record shipments.	Equipment operation		0	
Wash down tipping floor and equipment. Transfer wash liquid and captured leachate to process or sewer	Unskilled		1	
Perform preventive maintenance on equipment.	Equipment operation		2.5	
Grease loader	Basic mechanical skills			
Check loader fluids; change oil and filters per schedule.	Record-keeping			
Grease conveyors.				
Grease blower bearings.				
Grease mixer.				
Check mixer fluids; change oil and filters per schedule.				
Update maintenance log.				
Co-ordinate deliveries and shipments.	Organizational skills		4	
Arrange unscheduled maintenance with contractors.	Communication skills			
Communicate with suppliers, customers, and regulatory bodies.				
Plan and manage periodic maintenance shutdown for biofilter replacement or major equipment repairs.	Planning skills		2	
Labor contingency - may cover seasonal flex	miscellaneous		4	
Prepare and ship product samples for testing.			2	
Receive and file testing reports.				
<b>Totals</b>			<b>40</b>	<b>1120</b>
Notes:				
*Assumes two 11.5-ton food waste deliveries per week.				
**Seasonal variations of increased material volumes for handling will affect total hours to maintain operations.				
The process will run automatically nights and weekends and will be equipped with automatic paging in the event of blower failure.				

# Financials

## BUSINESS PLAN AND FINANCING OPTIONS

The overall business plan encompasses the multiple values of improved resource management and material handling, savings from greenhouse heating displacing reliance on fossil fuel, new revenues from food scrap tipping fees, and internal use or sale of compost and soil amendments generated from the operation. Compost value modeled in the business plan is conservatively priced, and assumes that the end products from the facility (composts, mulches and associated soil products) can be used in landscaping, stormwater management and other green infrastructure applications within BPRD operations, or will be sold in bulk outright to a commercial entity for export from the facility. A combination of the two approaches would provide the most flexibility and opportunity to select the higher savings or revenue options that emerge over time. Parks Department's organic wastes and remaining stockpile of may be composted by City Soil in 2017 to again provide compost to Community Gardens this year, improving upon the spring 2017 arrangement facilitated and funded by the Boston Public Works Department.

CERO, a local cooperatively owned hauling business, can provide up to 100 ton/week of clean food scrap from its local collections; The modelled facility is currently sized for 34 tons per week in this study; CERO and other local haulers can supply locally sourced selected organics from Bostons municipal, commercial and institutional food sectors instead of hauling it to suburban and rural disposal and composting sites and anaerobic digesters. Incorporating tip fees from CERO, Bootstrap Compost, City Compost, and larger hauling firms already contracted by the City of Boston keeps more money in the Boston economy, and avoids greenhouse gas, truck miles, and transportation impacts for export and processing of these resources outside of Boston.

The existing working floor and aeration capacity could reasonably accommodate a doubling of food scrap inputs and further improve the tip fee revenues and end product value and financial performance of the facility. This is not recommended for initial operation but should be considered after labor, operating economics and other city/state goals are reassessed after the initial shakedown period. Photovoltaic solar panels can be added to the roof of installed buildings to generate electricity or revenue during initial construction or future development phases. The proposed facility affords ideal, unobstructed solar orientation and a cost-effective engineered support framework for a photovoltaic array. Preliminary estimates for annual PV power generation on this building exceed 70,000 kWh, sufficient electrical energy to power much of the aeration and pump functions associated with the operation. No capital costs, revenues or avoided costs have been assumed for photovoltaic contribution.

Biogas generation from a modestly scaled Anaerobic Digester (AD) unit could be added to the initial facility or be available in future development phases. Small scale AD systems have high capital costs but



merit consideration as a complementary technology for handling food residuals and high-energy yielding liquid feedstocks, and generate digestate products that can be beneficially used in landscape management and amending dry feedstocks. An AD system could supply gas for greenhouse heating, fueling vehicles, or combined heat and power that produce renewable electricity and heat. These systems tend to be more costs effective at a scale that could be co-located with the composting operation but has not been the focus of this feasibility analysis.

## SENSITIVITY ANALYSIS

The proposed site and the facility designed in this feasibility study have sufficient space and capacity to yield a greater economy of scale and improved IRR. The technology and facility assumptions identified in the CAPEX process significantly greater volumes and different ratios of materials with minimal to moderate additional capital expenditure. Factors that could substantially increase the IRR include additional direct revenues from tip fees, avoided disposal costs, typically based on rate per ton, the quantity and value of marketable end products, and increases in the unit value and total yield of bioenergy-derived heat.

No direct values have been included in this financial model that monetize the substantial and quantifiable environmental benefits to the City of Boston, or the enhancement of the City's international leadership on climate solutions that this facility would provide. Foremost of the fiscal benefits are water quality improvements resulting from reductions in phosphorus pollution of the Canterbury Brook, the Charles River and the Boston Harbor. These will be achieved through the prevention, interception and treatment of stormwater runoff that contains nutrients and sediment. Additional benefits include the capacity of the facility to be a net green energy producer. Solar photovoltaic electricity production from PV's mounted on or integrated into the roof of the southern oriented structure could yield more than 100 KW.

This facility would be a cost- effective green infrastructure investment that yields direct cost savings to the BPRD by capturing and treating phosphorus from the Maintenance Facility and Franklin Park and upslope non-point sources from Canada geese, pets, and other sources. The City and other agencies are already obligated to address costly water quality issues. The operating and facility BMPs impart other benefits. These include greenhouse gas mitigation, water pollution prevention, particularly phosphorus interception and reduced water consumption.

## OVERALL PROJECT CAPITAL COSTS, ANNUAL OPERATING COSTS AND REVENUES, ANNUALIZED ROI

The proforma worksheet includes the inputs of projected capital costs, revenues, savings and operating costs, with assumed rates of increases over the project for appropriate categories. The proforma shows an Internal Rate of Return (IRR) of 13.9%. The Return on Investment (ROI) calculation is 5.5 years.

There are a number of assumptions that were intentionally conservative, from food residuals tonnage (and associated revenues), value of compost produced and perhaps most significantly, using 25% as the cost-sharing percentage that could be obtained for construction and implementation. Positive adjustments in those categories would increase the IRR and shorten the ROI.

Further, no revenue was assumed for Renewable Energy Credits (RECs), carbon credits (from greenhouse gas offsets via Native Energy or other entities), or for phosphorus and other nutrient reduction credits. No cost savings were assumed for secondary benefits for reduced BPRD landscaping costs, water consumption, tree mortality reduction and other aspects related to increased compost use on BPRD managed land.

Other scenarios were modeled to determine the impact of the reliance on tip fees for food residuals and the viability of the project if grant revenues were not paying for approximately half of the capital cost. Modeled scenarios show that the facility would yield attractive returns on investment if it focussed more heavily on value-added product sales. Another economic driver to anchor the the facility would be increasing the City of Boston's internal use of and avoided costs for soil amendments. This scenario is supported by real data and by reasonable assumptions of increased use by the City on its own products to address environmental priorities.

The absence of tip fees for food residuals and MCEC construction grant support could also be offset if City of Boston internal costs for water, and future costs to be incurred by BWSC ratepayers and public land management entities (including City of Boston BPRD) for mitigation of water pollutants were included in the proforma. The true financial benefit to the City for development of this facility would include comprehensive valuation for avoided costs for the products the facility would generate, and for the management of hundreds of thousands of cubic yards of organic that the facility would afford.





City Soil & Greenhouse LLC			MCEC BPRD										
Pro forma operating projections													
No food waste, added Zoo manure, increased retail value for compost													
Printed 8/1/2017													
1	Quantities	Unit	Units	1	2	3	4	5	6	7	8	9	10
2	Feedstocks -	(weekly input)	(Annual inputs)										
3	Food scraps	ton	0	-	-	-	-	-	-	-	-	-	-
4	Leaves	ton	61	3,172	3,172	3,172	3,172	3,172	3,172	3,172	3,172	3,172	3,172
	Wood chips	ton	14	728	728	728	728	728	728	728	728	728	728
5	Manure/bedding	ton	15	780	780	780	780	780	780	780	780	780	780
6	Total		90	4,680	4,680	4,680	4,680	4,680	4,680	4,680	4,680	4,680	4,680
7	Compost product		55%	2,574	2,574	2,574	2,574	2,574	2,574	2,574	2,574	2,574	2,574
8	Screened residuals		1%	47	47	47	47	47	47	47	47	47	47
9	Thermal energy		Therm	32,412	32,412	32,412	32,412	32,412	32,412	32,412	32,412	32,412	32,412
10	RECs												
11	<b>Tip Fees, Prices and Costs</b>												
12	<b>Tip fees</b>												
14	Food scraps	ton	3.0%	\$ 50.00	\$ 51.50	\$ 53.05	\$ 54.64	\$ 56.28	\$ 57.96	\$ 59.70	\$ 61.49	\$ 63.34	\$ 65.24
15	Yard waste		3.0%	\$ 2.00	\$ 2.06	\$ 2.12	\$ 2.19	\$ 2.25	\$ 2.32	\$ 2.39	\$ 2.46	\$ 2.53	\$ 2.61
16	Manure		3.0%	\$ 15.00	\$ 15.45	\$ 15.91	\$ 16.39	\$ 16.88	\$ 17.39	\$ 17.91	\$ 18.45	\$ 19.00	\$ 19.57
17	<b>Prices</b>												
18	Compost	ton (@ 2 cy/ton bulk)	3.0%	\$ 80.00	\$ 82.40	\$ 84.87	\$ 87.42	\$ 90.04	\$ 92.74	\$ 95.52	\$ 98.39	\$ 101.34	\$ 104.38
19	Thermal energy	\$/therm	3.0%	\$ 1.01	\$ 1.04	\$ 1.07	\$ 1.10	\$ 1.14	\$ 1.17	\$ 1.21	\$ 1.24	\$ 1.28	\$ 1.32
20	<b>Costs</b>												
21	Residuals haul+disposal		1.0%	\$ 90.00	\$ 90.90	\$ 91.81	\$ 92.73	\$ 93.65	\$ 94.59	\$ 95.54	\$ 96.49	\$ 97.46	\$ 98.43
22	Manure disposal												
23	<b>Revenues and values</b>												
24	<b>Tip fee revenues</b>												
25	Food scraps			-	-	-	-	-	-	-	-	-	-
26	Yard waste			6,344	6,534	6,730	6,932	7,140	7,354	7,575	7,802	8,036	8,277
27	Manure			11,700	12,051	12,413	12,785	13,168	13,564	13,970	14,390	14,821	15,266
28	Wood chip												
28	Avoided disposal cost and tip fee value	BPRD manure Zoo Manure		11,700	70,902	71,611	72,327	73,050	73,781	74,519	75,264	76,017	76,777
29	<b>Product sales</b>												
30	Compost sales			205,920	212,098	218,461	225,014	231,765	238,718	245,879	253,256	260,853	268,679
	Thermal energy savings			32,736	33,718	34,730	35,772	36,845	37,950	39,089	40,261	41,469	42,713
31	<b>Total</b>												
32				268,400	335,303	343,944	352,830	361,969	371,367	381,032	390,973	401,197	411,712
33	<b>Expenses</b>												
34	<b>Operations</b>												
36	Labor		3.0%	58,240	59,987	61,787	63,640	65,550	67,516	69,542	71,628	73,777	75,990
37	Maintenance		3.0%	32,900	33,887	34,904	35,951	37,029	38,140	39,284	40,463	41,677	42,927
38	Outside services		3.0%	40,000	20,600	21,218	21,855	22,510	23,185	23,881	24,597	25,335	26,095
39	Residue disposal			4,212	4,254	4,297	4,340	4,383	4,427	4,471	4,516	4,561	4,607
40	Overhead		3.0%	-	-	-	-	-	-	-	-	-	-
41	Insurance		3.0%	20,000	20,600	21,218	21,855	22,510	23,185	23,881	24,597	25,335	26,095
42	Property taxes		3.0%	-	-	-	-	-	-	-	-	-	-
43	Site lease payments		3.0%	-	-	-	-	-	-	-	-	-	-
44	Admin and General		3.0%	12,000	12,360	12,731	13,113	13,506	13,911	14,329	14,758	15,201	15,657
45	Total			167,352	151,688	156,154	160,753	165,488	170,365	175,388	180,560	185,886	191,372
46	<b>Operating Gain</b>												
47				101,048	183,615	187,790	192,078	196,480	201,001	205,644	210,413	215,310	220,340
48	Capital cost	(994,770)											
49	Grants, offsets, intangibles	50%		497,385									
50	Cash flow			(497,385)									
51	Cumulative cash flow			(396,337)	(212,722)	(24,932)	167,146	363,626	564,628	770,272	980,685	1,195,995	1,416,335
52	IRR	32.0%											
53	<b>Operating Gain</b>												
54				101,048	183,615	187,790	192,078	196,480	201,001	205,644	210,413	215,310	220,340
55	Debt service			48,994	48,994	48,994	48,994	48,994	48,994	48,994	48,994	48,994	48,994
56	Debt service coverage ratio			2.06	3.75	3.83	3.92	4.01	4.10	4.20	4.29	4.39	4.50
57	<b>Loans</b>												
58				1	2	3	4	5	6	7	8	9	10
59	Opening balance			397,385	364,286	329,864	294,064	256,833	218,112	177,843	135,963	92,407	47,110
60	Principal			(33,099)	(34,423)	(35,799)	(37,231)	(38,721)	(40,269)	(41,880)	(43,555)	(45,298)	(47,110)
61	Closing balance			364,286	329,864	294,064	256,833	218,112	177,843	135,963	92,407	47,110	0
62	Interest			(15,895)	(14,571)	(13,195)	(11,763)	(10,273)	(8,724)	(7,114)	(5,439)	(3,696)	(1,884)
63	Debt service			(48,994)	(48,994)	(48,994)	(48,994)	(48,994)	(48,994)	(48,994)	(48,994)	(48,994)	(48,994)
64	<b>Capital cost (994,770)</b>												
65	Grants, offsets			497,385									
66	Financed cost	100.0%		(497,385)									
67	Equity	20.1%		100,000									
68	Debt	79.9%		(397,385)									
69	<b>Notes:</b>												
70	Assuming food waste is not processed at this facility, the following operational adjustments are reflected in this proforma to replace revenues from tip fees and reduced product volume.												
	1) Zoo manure from Franklin Park is managed in the facility and charged a competitive tip fee												
	2) Cost for residuals disposal (screener tailings) would be reduced if food waste were not included												
	3) The value of the compost is increased and marketed as a value-added product, the average price per unit is reflects the total volume using a blended price as bulk and bagged												
	4) Increase the use of products generated by the facility within the BPRD and City sponsored projects												

## Project Risks

Lead and asbestos in existing greenhouse and associated structures that would be included in the site development process would need abatement prior to or during their removal and replacement; there may be dedicated funds available for this work from City and State sources that would be identified during a more detailed site development planning process that includes this work area.

Setbacks (100' green corridor from Morton St.) are now met by the updated location of the working floor, receiving pad and containerized aeration and heat recovery units. Removal of additional tree canopy within this setback may not be approved without a variance.

When accepting food scraps, if staff was not attentive, there could be odors or vectors during tipping, until they are incorporated into blended batches. To this end, contracted labor is proposed for an initial training and joint operating phase for the first year, and to a smaller degree is budgeted in future years to assist BPRD in facility operation during seasons with peak workloads for staff or to cover during vacations, illness or other temporary displacement of staff. Commitment of parks department staff for dedicated operation, especially if accepting food scraps that require coverage and/or mixing before close of business on day of receipt should be addressed before proceeding. The risk of the facility operations demands competing with other BPRD staff priorities could mean the facility wouldn't operate at optimal performance.

Maintenance:

The facility requires management and maintenance commitments to maintain the bioswale, wetland

and the surrounding landscape along American Legion Parkway and Morton Street. Dead plant material must be removed from the bioswale annually and composted before it begins to decompose to maintain performance efficiency.

Primary consultants CS&G and AGT have conducted numerous similar site and infrastructure feasibility projects that have been developed and successfully operated. This project does not present significant risk as the processes of composting and biothermal heat recovery are well-understood and have been deployed at numerous sites, including the Mattapan Ecovation Center located less than ¼ mile from the City of Boston Franklin Park Maintenance Yard site proposed for the feasibility study. Bruce Fulford developed and managed Greenleaf Composting's open windrow composting operations for manures, landscape organics, and food waste in Franklin Park from 1994 to 1997 that deployed successful odor and vector management within 100' of public areas.

The site converted approximately 30 cubic yards of manure and bedding per week mixed with leaves and source-separated food waste into compost that was used in Franklin Park, sold to landscapers, home gardeners, and launched the compost distribution initiative to Boston's community gardens that continues and this year included BPRD organics from the Franklin Park Maintenance Yard.

This is a feasibility study for improving composting operations at approximately the same or slightly increased throughput but utilizing more sophisticated technology to sharply reduce the footprint of the operation and permit recovery of renewable thermal energy and valuable co-products. The tipping location for food wastes and mixing with manures would be completely enclosed to prevent escape of odors and attract vectors and vermin. The composting process for these materials will be completely contained, and the air drawn through the compost will be used to speed decomposition and will be treated through biofiltration cells before venting to the outdoors. These proven compost Best Management Practices will ensure that odors associated with the composting operation are controlled from the time of delivery through curing stage of composted material.

The materials evaluated in this study are organic feedstocks that are presently composted in Franklin Park blended with clean pre-consumer and post-consumer food scraps. As a precedent, these ingredients have been successfully composted on a commercial scale in two locations less than a quarter mile from the location evaluated in this feasibility study by City Soil, and at Allandale Farm in Brookline. The risk of pathogen survival in livestock manure and bedding, and from pre-consumer and post-consumer food wastes is addressed through industry leading site design, composting technology selection, professional management and operational oversight, operator training and accountability, record-keeping, and regular sampling and testing of feedstocks and end-products.

In 2014, City Soil & Greenhouse and subcontractor Agrilab Technologies completed a Massachusetts Clean Energy Center's Organics-to-Energy feasibility study harnessing biothermal energy and CO<sub>2</sub> from composting of food scrap, manure and landscape organics at Zoo New England's Franklin Park Zoo. The system's footprint, operations, and capital cost analysis was based on a 30 ton per day enclosed rotary drum and ASP composting system with greenhouse production and odor biofiltration systems. Zoo New England's technical team of City Soil & Greenhouse, Agrilab Technologies and KZLA determined that

project was financially and functionally viable, an appropriate scale of a responsible technology. The capital cost for a new rotary drum system and the management responsibilities associated with the facility illustrated the need for a long term management contract, low-interest capital, and sales of high value end-products to support the operation.

It is the project team's assessment that this project has not yet been implemented for several factors that do not negatively reflect upon this current study. Zoo New England had been engaged in major construction projects and prioritized capital raise and implementation for these activities prior to embarking on new efforts. A lead individual or advocate at the Zoo has not been available to coordinate next steps of development.

At the time of the Zoo report's completion, the statewide ban for food waste disposal via landfill and incineration had not yet been implemented, and less impetus at the state and municipal level to compost those valuable residuals locally. Further, the zoo presently largely exports most its biomass feedstocks that are suitable for composting. This is the biggest difference with the proposed site in this study, as between 6,000 and 7,000 cubic yards of materials are already handled at the Franklin Park Maintenance Yard with only a modest increase in total volume proposed, with an approach that reduces energy consumption, space requirements and imparts the complimentary benefits identified in this report.

## Summary

This project is aligned with key city goals, community planning process, and its commitments to build and maintain world class climate-resilient educational greenspace in Boston's community of color. The proposed state-of-the-art integrated organics and bioenergy can be funded, developed and managed at the scale proposed in this study at the Franklin Park Maintenance Facility. A wealth of public and private capital sources tailored to this type of project are available to implement this operational model. Three different scenarios have been modeled that demonstrate that the proposed facility could be financially viable without reliance on tip fees for food residuals or from MCEC grant support. A determination of the appropriate public/private structure for further development of the management and operation of the facility will be instrumental in securing capital and in developing and operating the Facility.

## Recommended Next Steps

The project affords financial, programmatic, and operational benefits that could be quickly implemented. With the completion and internal review of this report, preliminary phased steps can be implemented to secure investment to commence with the development of the Facility. The project team recommends meeting with key stakeholders - including interested investors and funding advisors - to advance the decision-making process regarding the development of this project.



The removal of the remaining organics stockpile from the proposed site, and delivery to the City's Public Works Composting facility could be completed to clear the site in advance of any site preparation. Existing funding secured through the Partners for Places Urban Farming Pathways and managed by the Office of Workforce Development could be utilized to implement some of the key elements that are a sensible first stage while permitting, final design, partnership agreements and procurement of funding and professional services are secured. Application for a \$500,000 MCEC Capital Construction Grant could use Partners for Places as a significant portion of the match requirement. Massachusetts Department of Agriculture and MassDEP both have upcoming and recurring grant opportunities that apply directly to this project. Scoping for final design refinements, timing for cost-share funding opportunities and low-interest financing options can be further explored, and warrant attention before deadlines pass for submission for existing funding sources. The feasibility report as presented above has used conservative estimates, and demonstrates a significant cost savings to the City by recovery and redistribution of bio-thermal heat from operation of the proposed Aerated Static Pile (ASP) composting system coupled with the Agrilab Technologies Hot Box 250R energy recovery process. The return on investment for the installation of the program as currently proposed is estimated to be approximately 5.5 years based on current coincident energy demands and foreseeable weather forecasting for the local area.

More than \$1 million in development and operations funding from non-City of Boston sources have been identified that could be utilized to develop this project. These include CDFI subordinated debt, equity, environmental bonds, and other financial instruments that are designed to spur high impact projects and sustainable infrastructure and business development. The proposed facility and operation can be implemented in a phased approach that could commence as soon as contractual commitments authorizing work are approved.

Implementing the startup of the first phase of the project could be accomplished with Partners for Places funding. Finalizing the design, engineering, construction specifications and design review, and permitting larger facility and permanent enclosed aerated static pile system could be proceeding simultaneously. Securing MCEC construction funding, debt and equity financing will require dedication of City staff time and consultant or co-investor resources to develop proposals and to manage the project. Private capital investment for facilities development, operations, programming, product marketing, sales distribution is available for a public/private cooperative partnership. Additional resources for stormwater infrastructure, renewable energy and workforce development can be secured through a host of targeted proposals, initiatives and partnership pathways. A percentage of net revenues could be returned to the City directly or indirectly for education and environmental management at the facility, within Franklin Park and other public greenspace in the surrounding community and throughout Boston, and in the Boston Public Schools.

# Figures

---

Figure 1: Overview of Existing Site Conditions

Figure 2: Project Elements Plan

Figure 3: Site Circulation Plan

Figure 4: Covered Bioswale

Figure 5: Stormwater Basin Restoration Plan

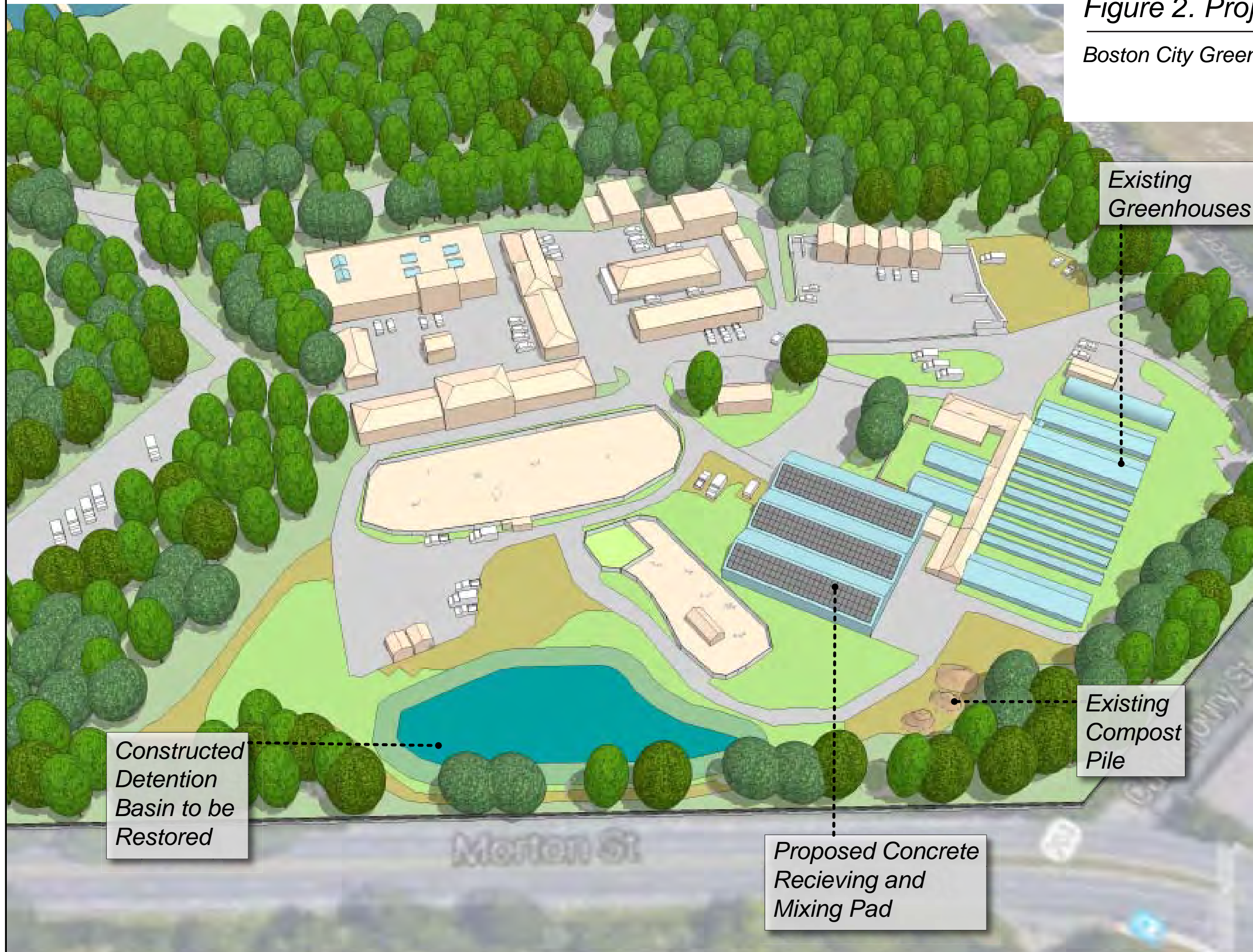
Figure 1. Overview of Existing Site Conditions

Boston City Greenhouses | Mattapan MA



Figure 2. Project Elements Plan

Boston City Greenhouses | Mattapan MA





# Figure 4. Covered Bioswale

## Schematic Design

Effluent and runoff water from the ASP Facility including rain water from the roof surfaces will be discharged through a constructed bioswale that will treat and polish runoff water prior to discharge to the existing constructed wet detention basin at the site.

In an effort to maintain biological activity during the non-growing season, we intend to cover the bioswale in the fall and assess nutrient removal by extending the growing season and plant and biological activity within the swale.

Repeating plantings along the bioswale will include various wetland species located according to the microhabitat along the swale and riffle and pool features. Species will include water iris, cardinal flower, turtlehead, watercress, Joe Pye weed, and boneset.

The plant community will vary along the course of the bioswale. The matrix plantings will consist of several dominant sedges and rushes including soft rush, wool grass and three square bulrush.

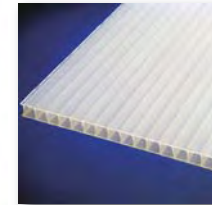
Surface runoff could also be treated as part of the bioswale system and will depend upon final site grading and paved surfaces.

Jersey Barriers will form structure of the swale and be lined with impervious geotextile fabric or equal.

Underdrain will be set in a gravel bed

The bioretention soil for the bioswale will consist of a blended soil including one part loam, one part organic compost and two parts sand.

The underdrain will consist of perforated pipe will flow to the existing wet basin to add cleansed water to the from the site.



187 Main Street  
#10, Box 716  
Framingham, Massachusetts  
01934  
978.948.7717 Office  
derosaeenvironmental.com

*Michael J. Derosa*

MJD/March 6, 2017



## Figure 5. Stormwater Basin Restoration Plan

Boston City Parks Greenhouse Facility | Mattapan MA

**DEROSA**  
Environmental  
CONSULTING, INC.

167 Main Street  
P. O. Box 716  
Rowley Massachusetts  
01969

978.948.7717 Office

derosaenvironmental.com

Michael J. DeRosa  
PWS No. 2250

March 18, 2017



### General Notes:

1. Remove standing plant material by cutting and compost harvested material along with other feedstock to the ASP processing facility. Work will be conducted during the winter months, outside of the growing season to reduce impacts to the wetland resource area.
2. After the initial harvest of *Phragmites* new shoots emerging in the spring/summer will be cut by hand with a weedwhacker every 3 to 4 weeks during the growing season. This removal of the shoots and leaves will repeatedly stress the plant allowing native seed stock to germinate and develop and re-occupy the area.
3. Final treatment by cut stem and/or glove wipe method with "Nature's Avenger" when *Phragmites* shoots are too few to cut.
4. Desirable plantings will be installed as plugs and include highly tolerant species that can take inundation followed by dry periods, including: soft rush, wool grass, path rush, Canada rush, and three-square bullrush.

*Phragmites australis*, a common invasive plant species, has come to occupy the stormwater basin, significantly reducing its design volume capacity and pollutant removal efficiency.

Standing vegetation will be cut and composted on site as part of the initial removal effort. Subsequent cuttings during the growing season will substantially reduce the vigor of the invasive reed and allow native species to recolonize the basin.

# Appendix A

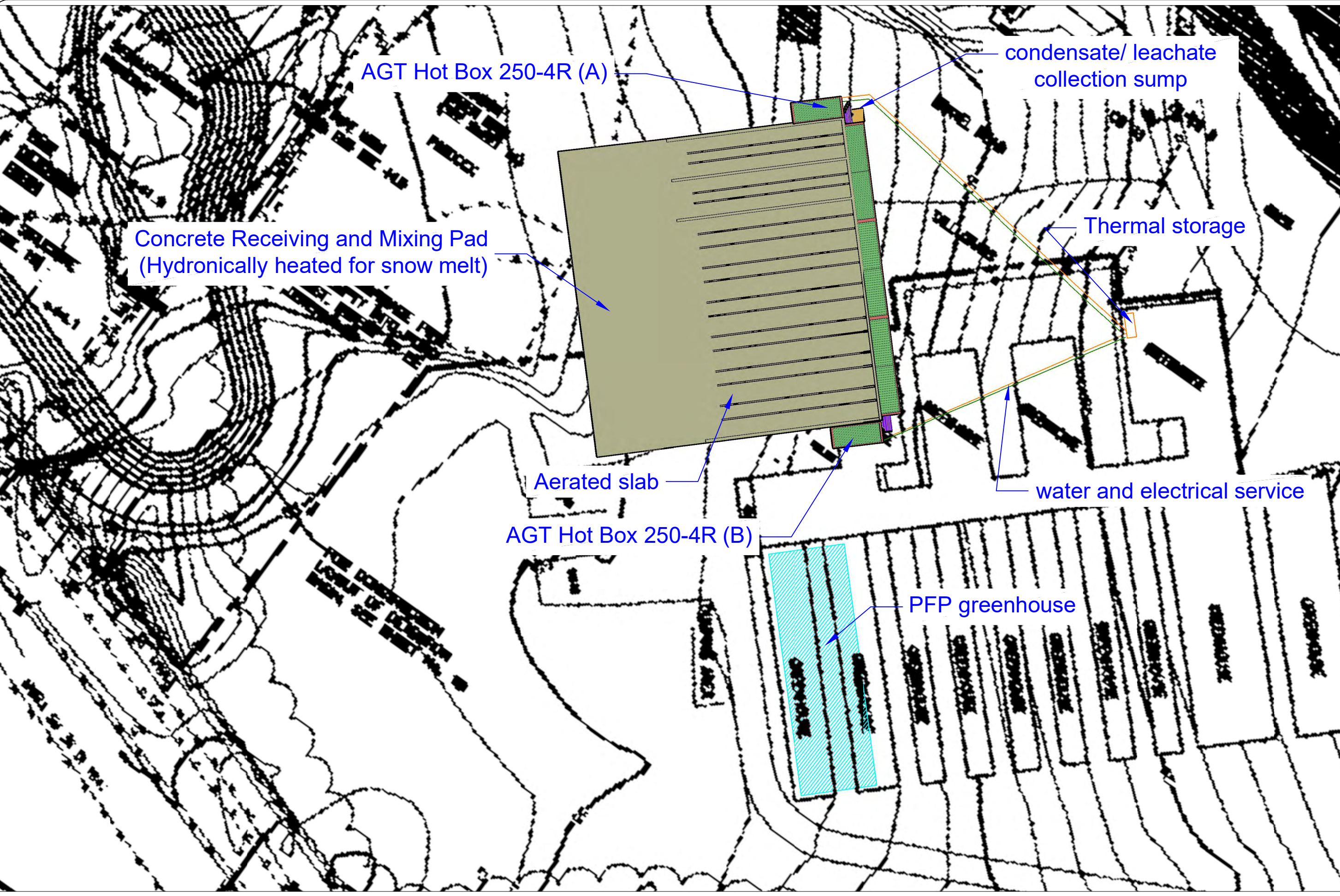
---

Conceptual Site Layout Sheets 1-6



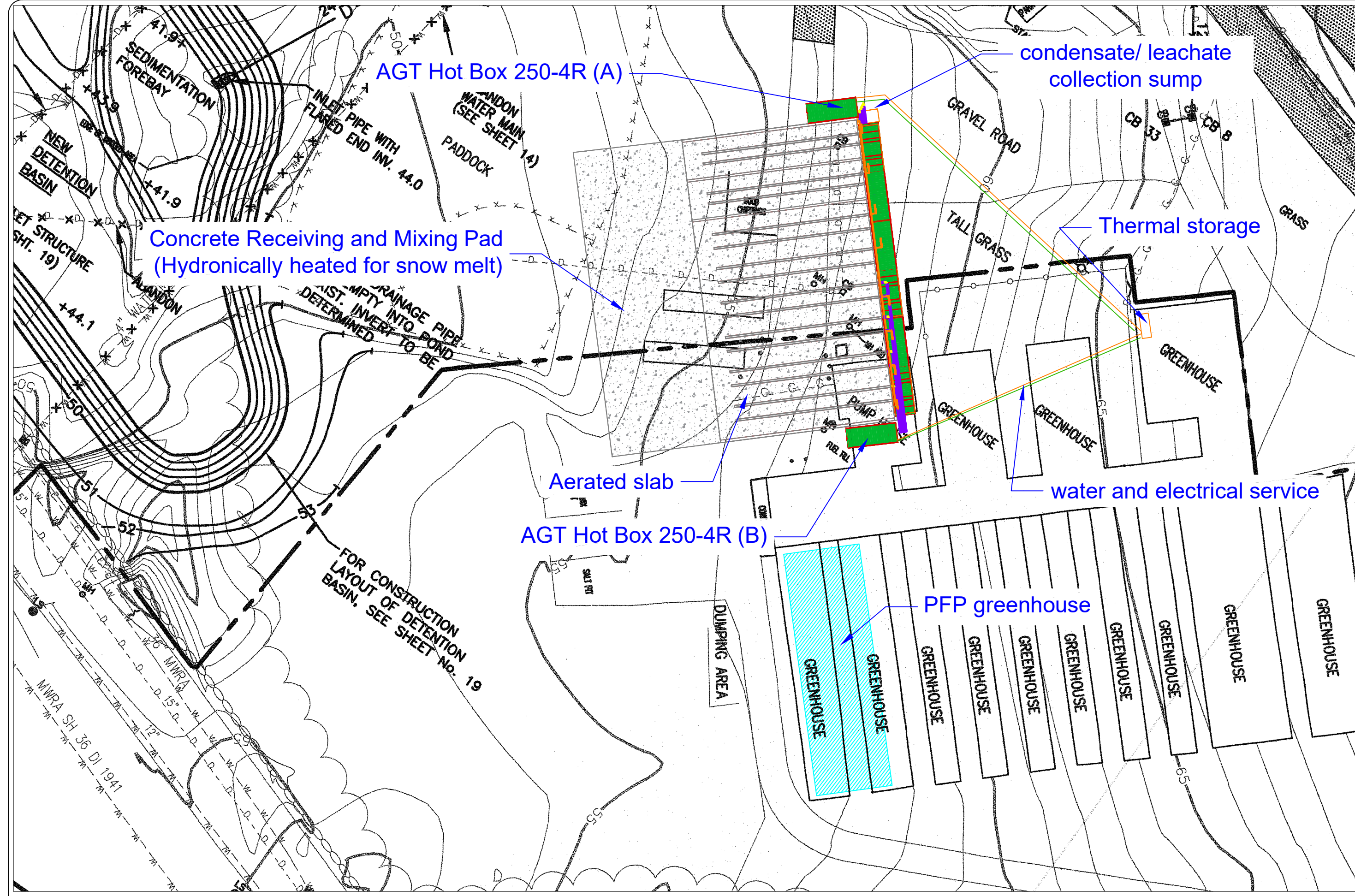
Revisions:	By:	Date:

Drawn By: RJK/BJ	Sheet No: <b>1</b>
Date: Mar 13, 2017	Of: <b>4</b>
Checked By: _____	
Scale: As noted	
Job #: _____	



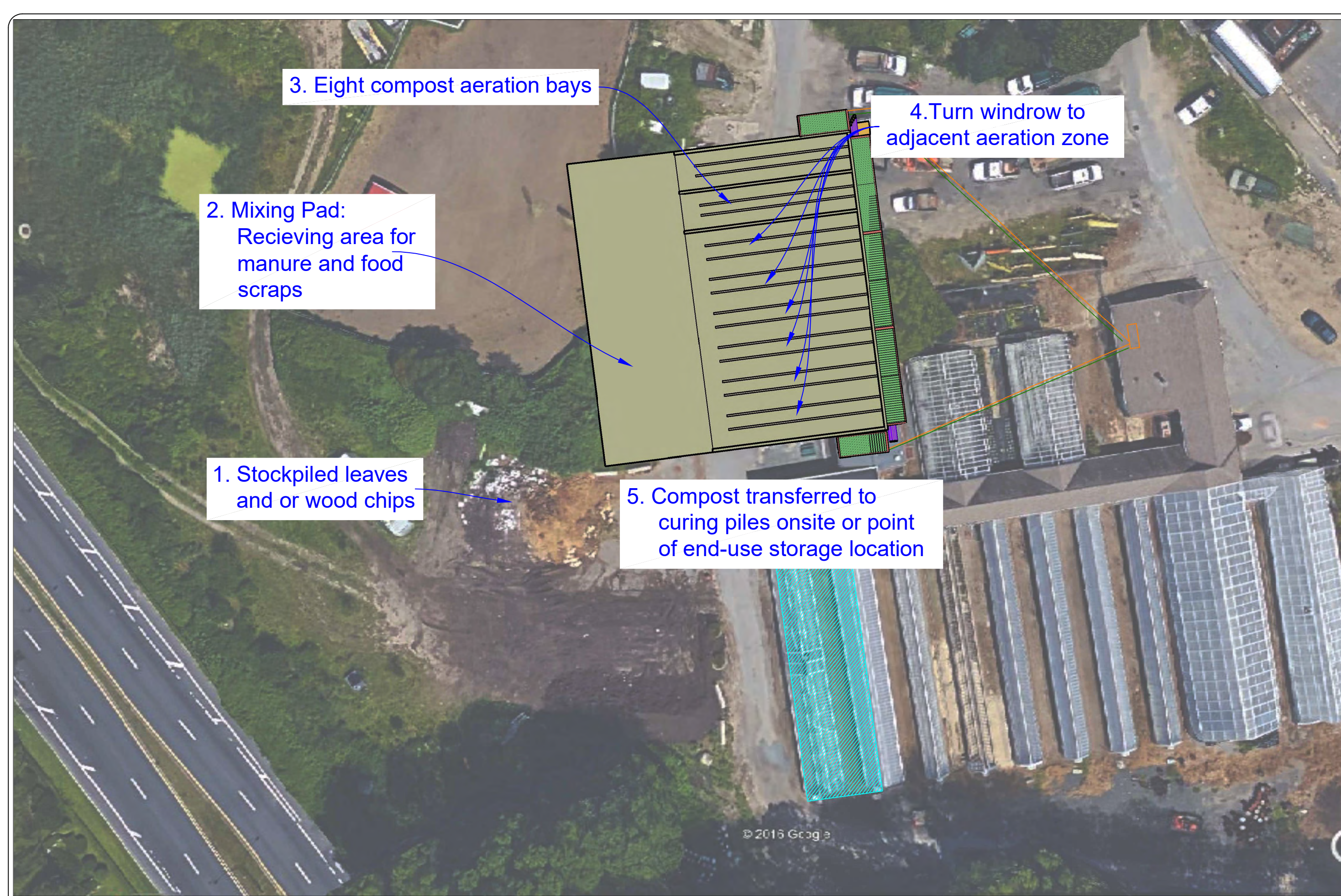
Revisions:	By:	Date:

Drawn By: RJK/BJ	Sheet No: <b>1</b>
Date: Mar 13, 2017	
Checked By:	
Scale: As noted	
Job #:	



Revisions:	By:	Date:

Drawn By: RJK/BJ	Sheet No: <b>1</b>
Date: Mar 13, 2017	
Checked By: _____	
Scale: As noted	
Job #: _____	

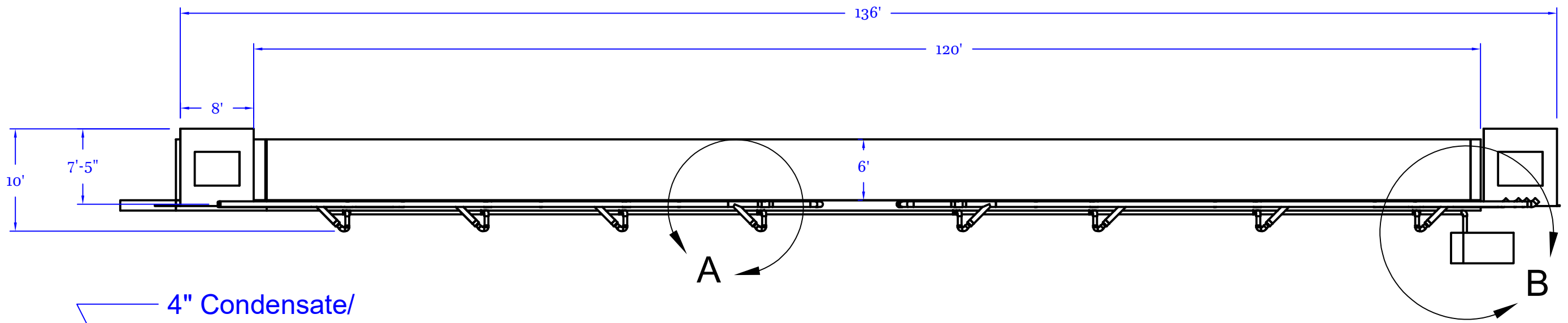
3. Eight compost aeration bays

2. Mixing Pad:  
Receiving area for manure and food scraps

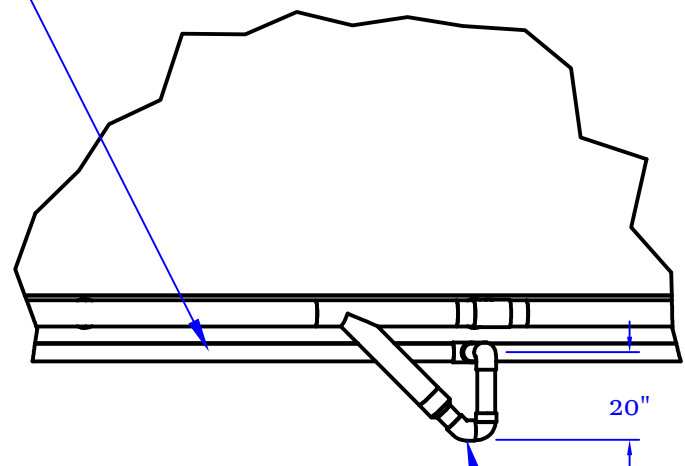
1. Stockpiled leaves and or wood chips

4. Turn windrow to adjacent aeration zone

5. Compost transferred to curing piles onsite or point of end-use storage location



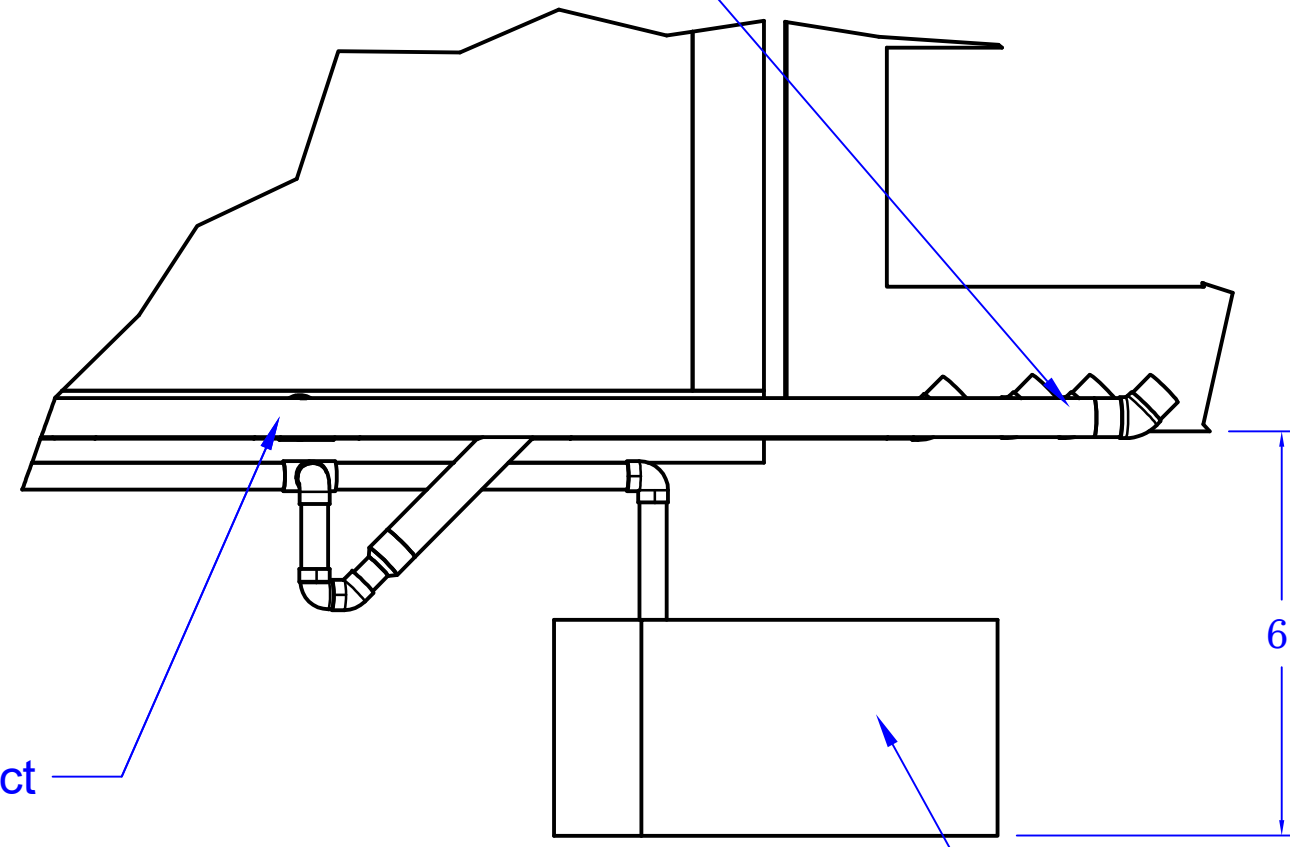
4" Condensate/  
leachate collection line



**DETAIL A**  
(Condensate Trap)  
SCALE 1/4" = 1'-0"

4" PVC traps to allow 10" of  
W.C pressure or vacuum

Aeration zone connection to Hot Box



6" HDPE aeration duct

**DETAIL B**  
(Condensate Tank)  
SCALE 3/8" = 1'-0"

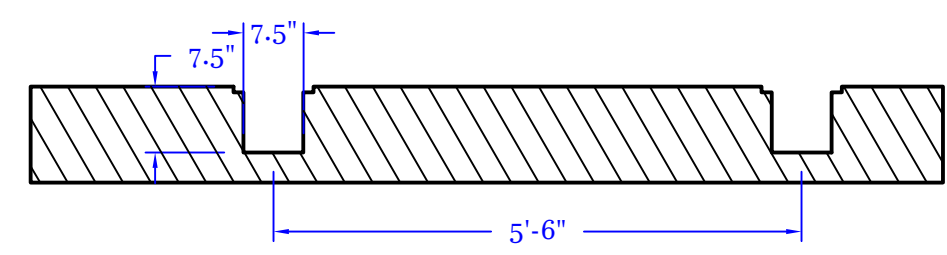
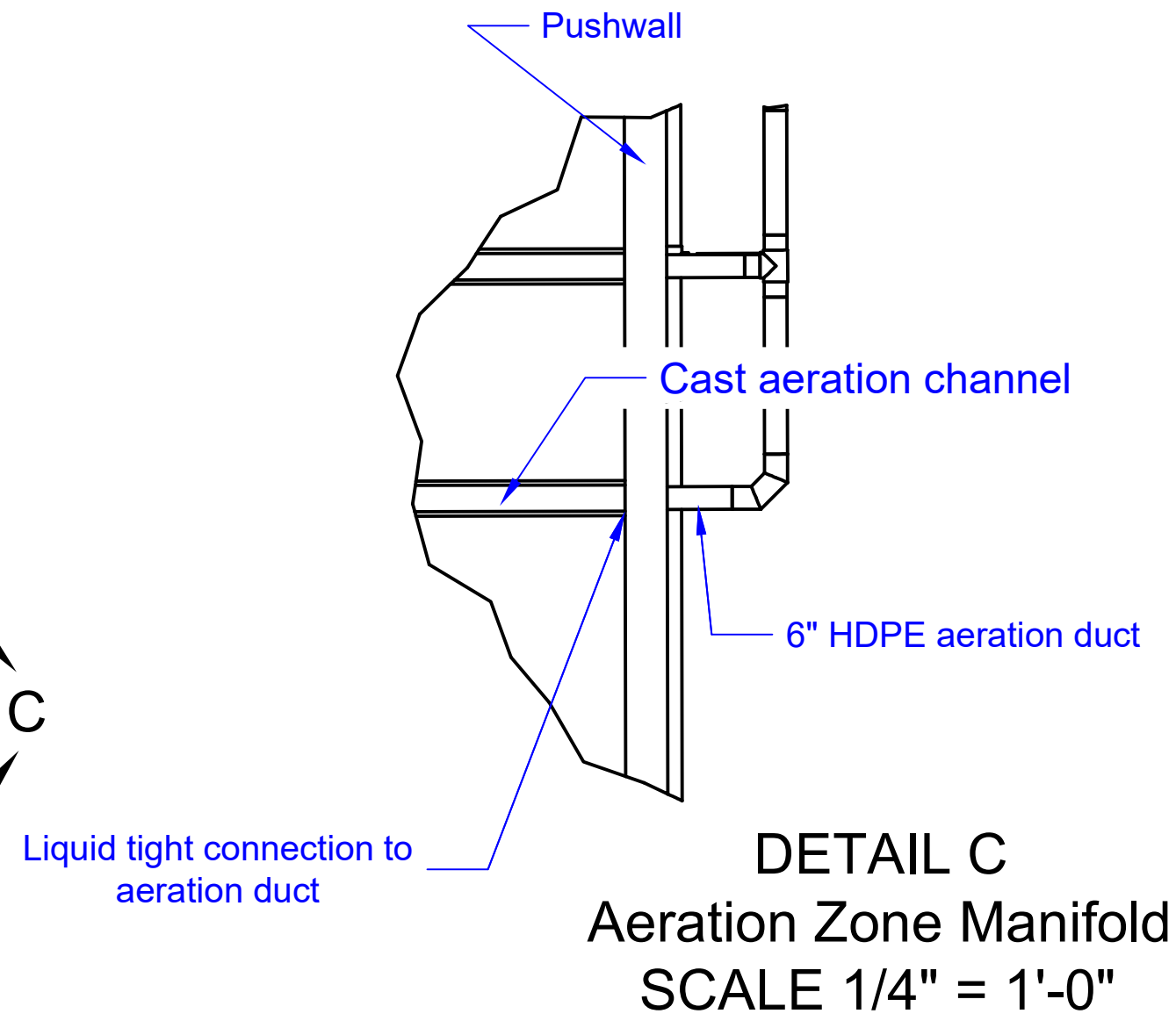
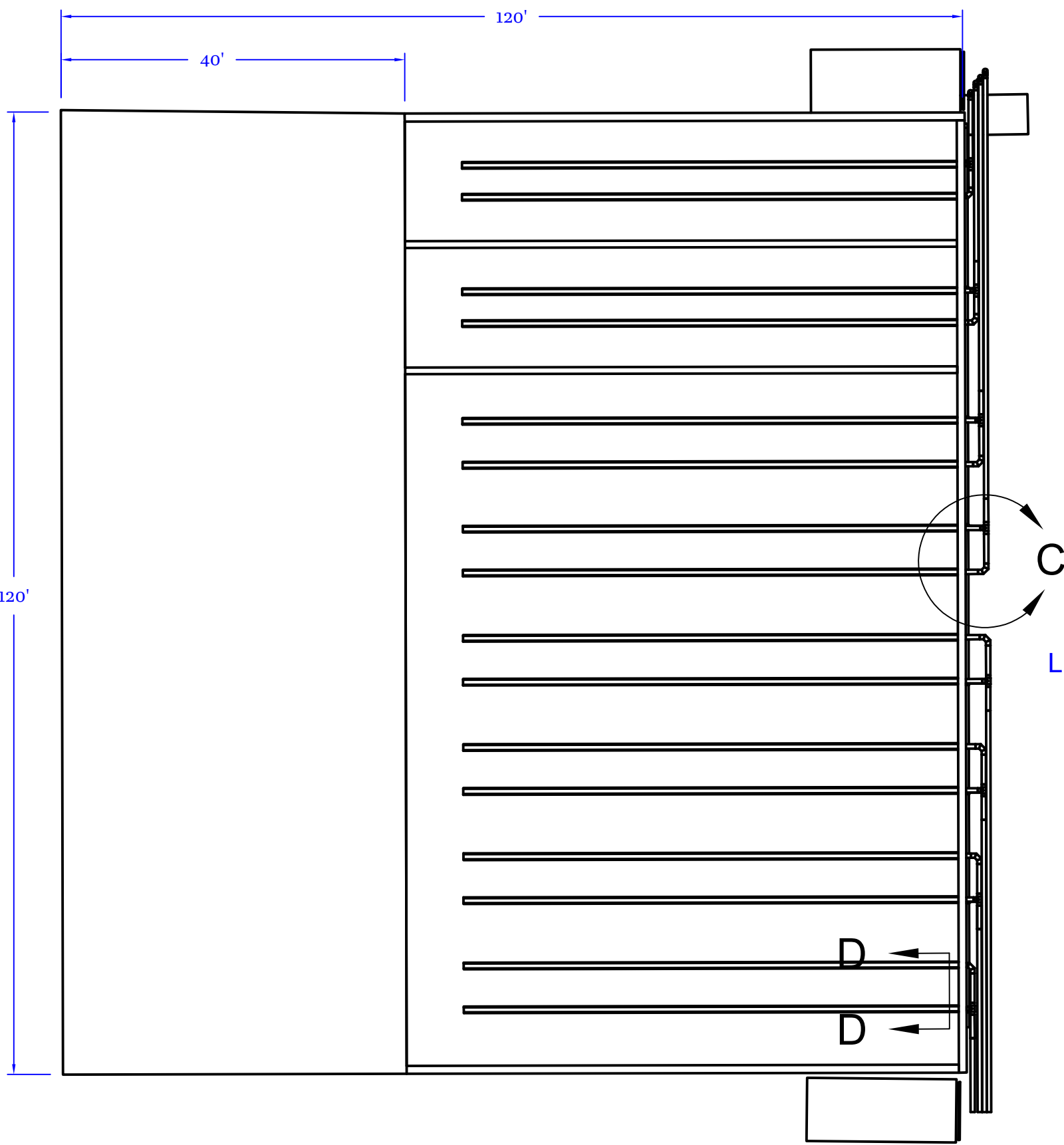
1000 gal.  
Condensate and  
leachate  
collection sump

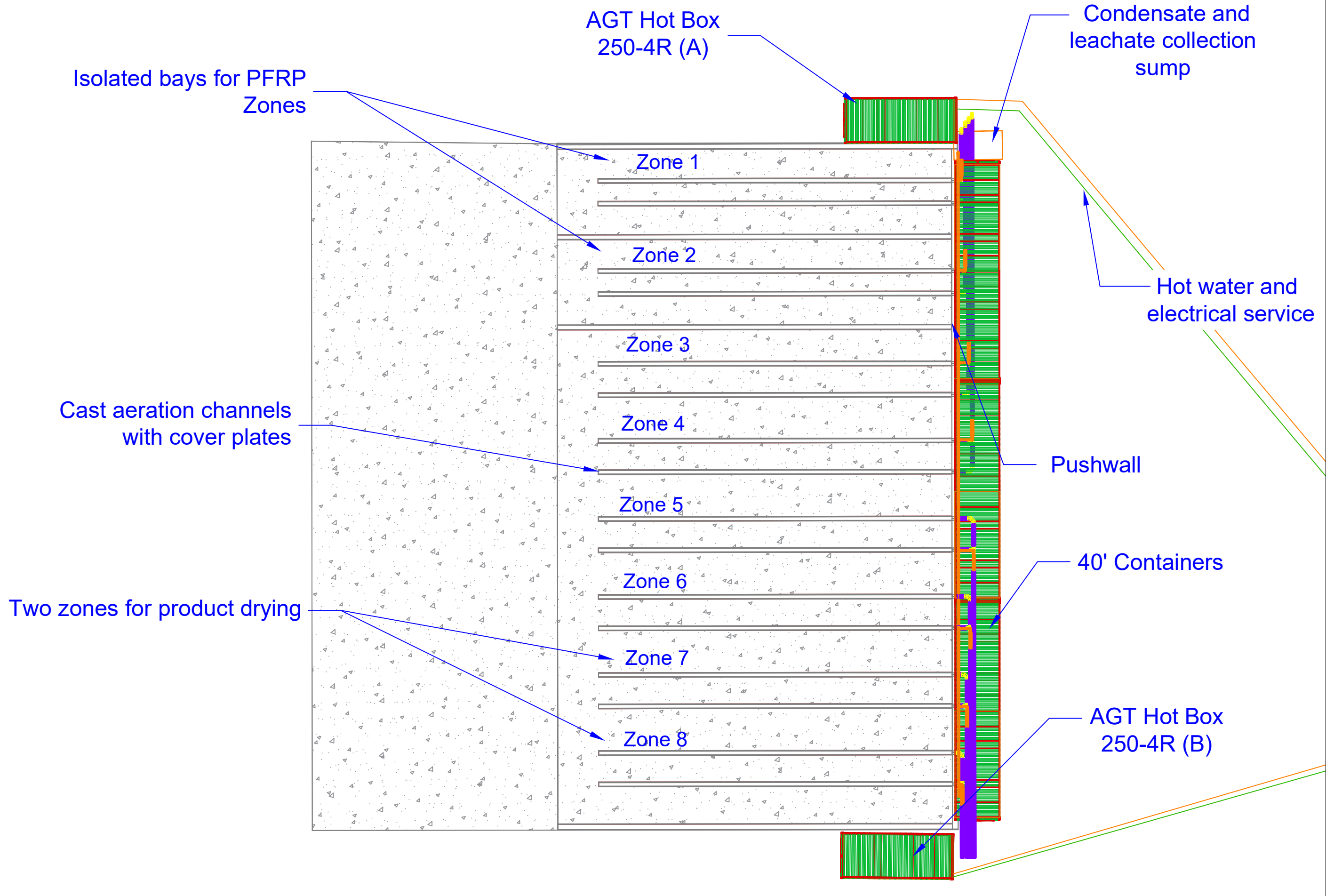
Revisions:	By:	Date:

Drawn By: RJK/BJ	Sheet No: <b>4</b>
Date: Mar 1, 2017	
Checked By:	
Scale: As noted	
Job #:	


Revisions:	By:	Date:

Drawn By: RJK/BJ	Sheet No: <b>3</b>
Date: Mar 1, 2017	
Checked By: <b>3</b>	
Scale: As noted	
Job #: <b>4</b>	





Revisions:	By:	Date:

Drawn By: RJK/BJ	Sheet No: <b>2</b>
Date: Mar 1, 2017	
Checked By: _____	
Scale: As noted	
Job #: _____	

# Appendix B

---

Photo Essay

View of Compost Yard at Franklin Park Facility.

- Bulk Fall Leaves
- Bagged Leaves
- Wood chips
- Horse Manure and Bedding



Improved drainage and working surface, would improve equipment access, reduce runoff, conserve nutrients in finished compost and reduce odors and greenhouse gas (GHG) emissions.

Leaves and other feedstocks collected on BPRD grounds typically have less plastic and other debris than residential curbside collected leaves. However some non-biodegradable or bulky items can enter the feedstock stream and need to be removed in order to achieve a high quality compost end product





Compost windrows in close proximity to greenhouse complex.

The point of thermal energy generation (aerated composting system) near to the point of thermal energy use (greenhouse heating) minimizes plumbing, heating and site integration costs .



Constructed wetland area to west and downslope of composting area.

Clean roof water and upslope drainage water can be directed to vegetated swales at south and north edges of composting area. Runoff from composting area can be directed to constructed wetland, reduce peak flows and improve filtration performance.



View of constructed wetland and horse paddocks/shelter.

Looking west and north past composting area to constructed wetland and fenced horse paddocks



Recommended feedstock receiving and mixing area.

Improved pad to accept incoming loads from parks department and contractors at south end of current composting area



View to north

- Truck and equipment access to composting site
- Driveway separates west end of greenhouse site and composting area (current outdoor pad and proposed covered working area)
- Electrical, plumbing and CAD-5 utilities recommended to run from corner of greenhouse and brick head house under driveway to composting pad
- Driveway can be crowned to pitch drainage to either side of receiving pad and working area
- Separate clean roof water from runoff than may contain sediment and nutrients to maximize effectiveness of constructed wetland and other vegetative filtration on premises



View of the eastern property line looking northerly.



Greenhouse Interior and Hydronic Heating.

- View of one of larger greenhouses using hydronic (hot water) under-bench heating
- Multiple greenhouse sizes and heating hydronic heating systems in use on site to service different growing needs
- Built ranging from 1920's to 2010's



Four pipes under bench

Hydronic heating with fin pipe runs under growing benches

-Separate greenhouse heating set-up



### Subtropical plants greenhouse

Requires highest temperature setting to over-winter plants

- Preheated water using thermal bioenergy from compost may require topping off from boiler operation
- Boiler use reduced but not eliminated for meeting peak thermal demands



### Older hydronic heating

2 pipe heating set-up

- Several older greenhouses under consideration for removal and modern reconstruction
- Historical preservation considerations may result in renovation for some greenhouses versus replacement



Older Greenhouse at Franklin Park Maintenance Facility

- Energy conservation principles were used such as bricks and concrete for radiating heat from a thermal mass and rising convective transfer from hydronic under bench heating
- Plumbing infrastructure aging and in consideration for upgrades



Location for modular compost aeration and heat recovery equipment

View facing southwest

- Area at northwest corner of compost windrows and south end of existing shipping containers is recommended for mechanical components of system
- Aeration fan(s), specialized heat exchangers, water/glycol circulation pump(s), connections for plumbing, electrical and internet, monitoring and control equipment included in standard plug and play package in shipping container
- Existing access roads and driveways suitable to handle truck and heavy equipment traffic
- Heavy-use areas (receiving/mixing pad, aerated working floor recommended with improved impervious surfaces with proper drainage and runoff filtration)



Aerial view of greenhouses.



Aerial view of site looking north.



# Appendix C

---

Professional Qualifications



Bruce Fulford  
City Soil & Greenhouse LLC  
416 American Legion Highway  
Mattapan MA 02126  
617.834.1934 / bfulford@citysoil.org

## **Qualifications**

Bruce Fulford has developed technologies, services, and leading edge programs that unite sustainable agriculture and environmental quality during a career that has spanned more than 35 years. He specializes in composting site development and operations management - including the implementation of safeguards for water, air and soil quality and benefits to host communities. His public sector work includes projects funded by the USDA, US-EPA, Massachusetts Department of Agricultural Resources, The Massachusetts Clean Energy Center, Massachusetts DEP, the City of Boston Public Works Department and the New York Department of Sanitation.

Fulfords' design/build firm specializes in integrated landscapes that feature food crops, native plants and reclaimed soils and stone, mulch and compost from recycled local organic materials, and water conservation and stormwater management systems. He has worked extensively with non-profit groups and community based organizations in agricultural program development and business design, strategic development, fund raising, construction projects, job training and day-to-day operations. He is active locally and nationally in environmental conservation and education, chaired the Environment Committee for Massachusetts Audubon Society's Boston Nature Center from its inception through 2012, has been a Supervisor with the Suffolk County Conservation District, and presently serves on the Mass Audubon Council and its Climate Committee. Mr. Fulford has designed, constructed and managed innovative systems for controlled environment agriculture (greenhouses), composting and organic materials processing operations, and ecological landscapes. He has designed and built 15 greenhouses including commercial scale facilities, bioenergy and solar heated greenhouses, and educational greenhouses at public schools and other institutions. He has performed feasibility studies, market assessments, and economic analyses for numerous commercial scale greenhouse and intensive urban agricultural operations.

Mr. Fulford's has designed and worked collaboratively with most of Boston's stakeholder organizations to implement major elements of Boston's urban food production infrastructure since 1990. These goods and services range from site acquisition, testing and remediation, managing neighborhood engagement, construction permitting, water and sewer interconnection, and design and installation of rainwater harvesting and automated irrigation systems. urban farm design and construction projects include Garrison-Trotter Urban Farm, contracted by The Trust for Public Land, owned by Dudley Neighbors, Inc., and managed by the Urban Farm Institute. Clients include the Food Project in Roxbury, The Dudley Street Neighborhood Initiative, Re-Vision House Urban Farm, City Growers, Higher Ground Farm, Urban Farm Institute, the Boston Natural Areas Network/Trustees, the Conservation Law Foundation, and the Boston Nature Center. Fulford designed and managed construction and startup of compost heated germination beds installed at City Natives greenhouse on DCR land in Mattapan, and rehabilitated the urban orchard at the Boston Nature Center through pruning, and procurement and planting and biological pest management of apple and asian pear trees.

His compost consulting includes site and equipment design and specification, permitting, economic analyses, operations and environmental management plans, and training programs for compost personnel. His work includes developing research and educational programs, developing and reviewing state guidelines and regulations and organic waste management initiatives. He has performed comparative growth trials on a variety of agricultural and municipal composts and amended soils. He has marketed and supplied thousands of cubic yards of locally-produced composts, mulches and amended soils in constructed landscapes for private and public sector clients.

## **Professional Experience**

**1982 - Present**

### **City Soil & Greenhouse LLC Owner/Senior Consultant**

1998 – 2015

Boston based firm specializing in composting technical assistance, urban soil remediation, and intensive growing systems. Clients include non-profit service and research/education organizations, municipalities, commercial landscapers, farmers and developers. Projects include work in Boston, Lowell, and rural Massachusetts, Providence RI, Teton County, Wyoming, San Francisco and San Diego County, CA, New York City, and Vermont. Specializing in troubleshooting and site remediation guidance on distressed compost sites, startup planning and site design for farm and municipal composting sites in Massachusetts as contracted consultant to MA-DEP/US-EPA compost capacity initiative. Provided municipal compost site management guidance for Boston's Boston Public Works and DCR site with USDA and USEPA conservation program funding.

Worked extensively with Boston Schoolyard Initiative on the design, curriculum integration and managed construction of the first series of outdoor classrooms at 6 Boston public schools. Sites featured sustainable materials reuse and recycling, storm water management, native plants, a rooftop greenhouse, and wetland trail using locally harvested lumber. Planted and provided remedial management services at Boston's largest urban orchard – located at the Mass Audubon Boston Nature Center in Mattapan.

Developed on-site vermicomposting systems for food wastes for Seaport Hotel in Boston and at UMass Lowell. Conducted greenhouse and urban agriculture feasibility studies and business plans, performed soil evaluations and supplied specialized blends of compost and soil for intensive agriculture for non-profit urban groups in Boston MA and Providence RI. Provided technical assistance under two USDA-SARE grants for on-farm composting for pollution prevention and improved nutrient management. Contracted work for Lena/New Boston, developer of former Boston State Hospital (with New Ecology, Inc) providing guidance on soil, compost and landscape-based BMPs for storm water management, and urban forest harvest and sawlog management for conversion to high grade lumber and furniture.

Principal researcher and manager of all site work for USEPA/MA-DEP 319 grant demonstrating Best Management Practices for mitigating erosion and water pollution using compost and mulch from recycled organic wastes. Designed and built green roof educational exhibit and community

garden tool shed on historical building at the Boston Nature Center. Co-produced video on project with professional filmmaker.

**City Growers, LLC**

2010-2011

Co-founded Roxbury Massachusetts based company, and was first General Manager. Developed multiple agricultural site plans from 10,000 square foot to 4 acres sites, recruited grower, secured grant funding, performed soil sampling, soil test interpretations, procurement and delivery. Evaluated CSA and direct sales models, provided capital and equipment for startup of operations. Performed analyses for multiple field- and greenhouse crop scenarios, seed to harvest/ processing packing and transportation. Developed detailed job descriptions, season extension facility designs, capital and operational budgets, cropping options and adaptive cost and revenue projection models.

**STS Organics, LLC**

2010

Co-founded Massachusetts based company with partners from Save That Stuff, Inc. of Charlestown to position the company to develop commercial scale anaerobic digestion (AD) and composting operations, integrated with bioenergy recovery, greenhouse facilities and on-site horticultural applications. Focus on facility feasibility analyses in Charlestown, including due diligence and site visits to European AD systems vendors, technologies and economic performance, greenhouse facility and site design, financial modeling, permitting, woody biomass, manure and food sector byproduct feedstock sourcing, negotiations with site owners, abutters to potential sites, technology vendors, and investors.

**BioThermal Associates**

**President, Senior Consultant**

1982 - 1998

Founder and principal consultant, focused on the research, development and implementation of new agricultural and municipal composting strategies for diverse organic wastes, specializing in environmental impact mitigation and season extension strategies. Had extensive experience with the collection, composting and end use of a wide variety of organic materials. Responsible for the design, construction and testing of composting and biofilter systems that utilize compost byproducts in intensive greenhouse systems.

**Greenleaf Composting Co.**

**Co-founder and CEO**

1993-1998

Started Boston's first commercial composting business, locating sites and funding, developing and obtaining permits for operations at Boston's only working farm (Allandale Farm), at the Franklin Park Zoo, and negotiating for Greenleaf's DCR-owned site in Boston. Developed grant proposal, plan and project report on Haymarket food waste collection and composting with EOE funding. Developed company logo and product line, branding and recipes, corporate strategy and marketing plans for compost, soil blends, and mulches; conducted outreach services to Boston's non-profit urban agriculture groups and established educational links with public schools and local universities including Tufts University, Harvard University and UMass Boston.

**Tellus Institute**

**Associate Scientist, Director, Organic Waste Management Team**

1990 - 1991

Focused on the development of moderately scaled enclosed composting systems for source separated organic wastes, including conceptual design and authoring the successful grant proposal that launched the \$5 million Rikers Island NYC food waste composting facility. Work included compost site remediation, economic and environmental analyses of a variety of organic waste collection and composting systems for municipal, and commercial and agricultural clients. Co-authored successful grant proposals for innovative composting projects for source separated organics and manures, developed training programs for compost personnel, and performed site planning and operations management.

#### **Recourse Systems, Inc.**

##### **Senior Consultant, Compost Projects Manager**

1988 - 1989

Provided technical assistance in the development of organics management and implementation plans including the development of source separated organic waste collection, educational programs, site planning and management, equipment design and specification, and economic analyses. Oversaw development of municipal composting sites and operations, trained municipal personnel in composting operations management. Primary author of \$100,000 grant from Massachusetts DEP to the City of Lowell.

#### **New Alchemy Institute**

##### **Research Scientist, Compost Projects Director**

1984 - 1987

Assembled and managed a team of 10 that designed, engineered, collectively constructed, operated and monitored the enclosed 'composting greenhouse', a prototype greenhouse/biofilter developed at the Institute. Developed first Massachusetts composting seminar, a two-day program that was also featured in the Institute's college-accredited program. Composting consultant to the State of Massachusetts Department of Food and Agriculture and the Department of Environmental Protection, developed and gave presentations and oversaw the planning and development of on-farm composting operations, including disposal of aquaculture mortalities. Performed comparative growth trials on a variety of agricultural and municipal composts and produced and marketed compost and organic food crops raised in greenhouse, including tomatoes, cucumbers, melons, herbs and salad greens.

### **Selected Publications, Reports and Work Products**

2010. Wilsen S., B. Fulford, R. Spencer, D. Battelle. Compost-based best management practices: Erosion and Sediment Control Project in Boston. Final Report to Massachusetts Department of Environmental Protection and US EPA Grant 04-17/319. Patriot Resource Conservation and Development District Area Council.

2010. Turano, Paul, B. Fulford. Compost-based erosion and Sediment Control: Best Management Practices. Provided content, editing and text for interviews for 20 minute video produced to inform and educate stakeholders from the developers, engineers, the landscape industry, environmental regulators, and public and private land managers.

2009. Fulford, Bruce. Investing in integrated organics facilities: *BioCycle* Vol. 50, No. 4, Pp. 37-41.

2009. Fulford, B., R. Spencer. Biomass heated greenhouses: Opportunity and feasibility in Western Wyoming. Western Wyoming Cooperative Biomass Initiative; Report to the Western Wyoming Resource Conservation and Development Council, Teton Conservation District and Dubois-Crowheart Conservation District US Forest Service Grant #07-DG-11046000-627.
2007. Fulford, B., R. Spencer, and K. Gekas. Rocky Hill Farm Composting Facility: Short Term Recommendations and Long Term Options to Build Sustainable Capacity for Food and Yard Waste Recycling in Massachusetts: Report on composting and anaerobic digestion strategies for private processor of food wastes to Massachusetts Department. of Environmental Protection by City Soil & Greenhouse Co.
2006. Majercak, John, and B. Fulford, Building Composting Capacity in Massachusetts: Technical evaluation and recommendations for increasing food waste composting at five composting sites in Massachusetts. Final Report prepared by Center for Ecological Technology and City Soil & Greenhouse Co. to the Massachusetts Department of Environmental Protection, supported by EPA funding.
2004. Fulford, Bruce. Yale University Sustainable Food Program's Composting Center: Schematic Design, Operations Plan, and Cost Estimate. Final report, schematic design, and cost estimates for integrated enclosed composting system for food waste, horse manure and yard debris coupled with greenhouse located at proposed urban farm site in New Haven CT.
2002. Curtis, James and B. Fulford, Preliminary report on the status of animal bedding waste composting in Massachusetts. Report to Massachusetts Department of Environmental Protection.
2001. Fulford Bruce, Majercak, J. (Center for Ecological Technology, Northampton, MA) Composting commercial food waste and waxed corrugated cardboard waste on farms in Massachusetts- General guidelines and case studies. Prepared report under RIRC contract for Massachusetts Department of Environmental Protection
2000. Fulford, Bruce Business Plan for a 10,000 square foot greenhouse based in Roxbury MA: Final report to the Food Project, Lincoln, MA. Recommended cropping scenarios, potential product lines, 3 year business pro-forma, including costs of production, processing and wholesale marketing, potential retail scenarios.
2000. Fulford, Bruce, and R. Innes. CleanScape Organics: A business plan for Agricultural Remediation in South Providence, Rhode Island. Prepared for the South Providence Development Corporation with funding from the USEPA's Jobs Through Recycling Program and the Rhode Island Department of Environmental Management.
1998. Fulford, Bruce. Crop Selection for a 10,000 square foot greenhouse in Roxbury, MA: Final report to the Dudley Street Neighborhood Initiative. Report detailing cropping options and cost implications of different cropping, packaging and marketing scenarios for urban greenhouse, leading to greenhouse design specifications.

1998. Buchanan, Marc, B. Fulford, R. Hartner, J. Davis. On-farm composting in the County of Boulder, Colorado. Final Report by Solana Recyclers, Inc. to Boulder County Recycling and Composting Authority. Multi-site scenario and cost analyses for composting: site design, capital and operational costs. Included design of operation on organic farm producing mesclun salad for commercial market. 212 pp.

1992. Fulford, B., B. Nash, D. Beverly Olcott and K. Teichert. "North San Diego County Food Waste Composting Pilot Project Feasibility Study". A feasibility study for the Cities of Encinitas, Del Mar, Vista, San Marcos and Solana Beach on the development of a local commercial organics management program and facility (with Solana Recyclers, Inc., Encinitas, CA).

1992. Fulford, B., W.F. Brinton and R. Degregorio. "The environmental impact of composting grass clippings and other yard wastes." Final report to the Massachusetts Department of Environmental Protection, Division of Solid Waste Management on pesticide residues, nutrient movement through soil profile, and odor management at a yard waste composting site in Yarmouth, Massachusetts.

1992. Fulford, B. and D. Holmes. "Air quality management recommendations for a 75 ton per day enclosed agitated-bay composting facility." Process management recommendations, facility redesign, biofilter design and preliminary economic analysis for private client's 200,000 cubic yard per year composting facility for poultry manure, food waste and yard waste.

1990. Simpson, M., B. Fulford, N. Dickson, P. Ligon and L. Segall, "Source Separation Composting Report." Tellus Institute Report to the New York City Department of Sanitation. Feasibility study on the collection options for composting New York City's commercial, residential and institutional food wastes, yard wastes and other source separated organics.

1988. Fulford, B. "Composting in greenhouses for heat, CO<sub>2</sub> enrichment and nutrient economy," in Global Perspectives on Agroecology and Sustainable Agricultural Systems: The Proceedings of the Sixth International Scientific Conference of the International Federation of Organic Agriculture Movements, Vol. 1, pp 337 -344 ed. P. Allen, D. Van Dusen, U. of California.

1987. Fulford, B. "Co-composting dairy manures with bulking agents from the solid waste stream." Report to the Massachusetts Department of Environmental Quality Engineering, Division of Solid Waste Management and to the Department of Food and Agriculture. Boston, MA. 108 pp, illus.

1986. Fulford, B. "The composting greenhouse: A report and analysis of the first two years of operation." New Alchemy Institute Research Report No. 3., 237 Hatchville Rd., E. Falmouth, MA.

1985. Pscheidl, H., and B. Fulford. "Design and engineering specifications for compost aeration system and biofilter for New Alchemy Institute's compost greenhouse".

### **Selected conference lectures and presentations**

March, 2012 Developing markets for compost in Massachusetts: Presentation at the 10<sup>th</sup> Mass Recycle and Organics conference, Boxboro MA

March, 2012. The good, the Bad and the Ugly: Compost quality for urban agriculture, and the role of centralized and decentralized composting infrastructure. Presentation to Boston Natural Areas Network Gardeners Gathering, Northeastern University

August, 2011. Managing urban agricultural soils, stormwater and organic waste recycling facilities. Presentation to National Association of Conservation District Supervisors, Annual Conference – tour of the Boston Nature Center and the Clark-Cooper Community Gardens.

July, 2009. Biomass energy recovery from organic wastes: fuels for controlled environment agriculture Presentation at BioCycle in the Rockies Conference. Jackson, Wyoming.

April, 2009. Hybrid organics facilities: Integrating organic waste processing, bioenergy recovery, and controlled environment agriculture. Presentation at BioCycle 50<sup>th</sup> Anniversary Conference. San Diego CA

March, 2009. Controlling erosion, sediment and nutrients through compost, mulch and soil based best management practices. Presentation at 9<sup>th</sup> Massachusetts Organics Summit, Devens MA.

May, 2007. Compost based BMP's in construction to control erosion, sediment, N and P pollutants in surface water. Workshop to state and local regulators, environmental planners and engineers. Presentation at Massachusetts Audubon Society Boston Nature Center funded by US-EPA and Massachusetts Department of Environmental Protection 319 Grant program.

December 2006. On-farm composting: methods, technologies and regulations for the Massachusetts farmer Presentation to Massachusetts Farm Bureau Annual Meeting.

October 2004. Recycled organic matter, soil, and stone in Low Impact Design strategies for urban watershed protection 5<sup>th</sup> annual Sustainable Design Symposium, Massachusetts Institute of Technology, Cambridge, Massachusetts.

April, 2004. Making and Caretaking of Urban Soil and greenhouses: presentation and tour leader on field trips, hosted tour at ReVision's Compost greenhouse and at the Food Project Brook Ave./ Cottage Street lot Food Project Conference on Sustainable Agriculture.

April, 2003 Urban soils: A Case study: Presentation at *Growing Possibilities: Agriculture in the City*. Food Project conference, Roxbury Community College Boston MA .

August, 2002 On-Farm Composting – Natural & Organic Farming Association Conference, Belchertown, MA.

August, 2000. “Lessons learned in commercial food waste composting” BioCycle Food Residuals Conference, Burlington Vermont.

May, 1992. "Mitigating environmental impacts at composting sites for source separated organic wastes." BioCycle National Conference, St. Louis, Missouri.

August, 1990. "Yard waste composting - lessons from successful and problematic operations." Discussion of the environmental impact of grass clippings, wood wastes and brush composting facilities and how it affects yard waste siting and facilities operation. 10th National Recycling Congress, San Diego, California

September, 1989. "Composting newsprint and corrugated cardboard with dairy manure. A review of the study sponsored by Massachusetts Department of Environmental Quality Engineering and the Department of Food and Agriculture." BioCycle Northeast Regional Conference, Portland, Maine.

September, 1983. "BioThermal energy: Cogenerants of the composting process and their use in waste recycling and food producing systems." The First International Conference on Composting of Solid Wastes and Slurries, University of Leeds, England.

### **Professional affiliations**

United States Composting Council  
Ecological Landscape Association  
Massachusetts Audubon Society –

Boston Nature Center, Advisory Board Member, Chair of Environment Committee 1996 – 2012

Mass Audubon Council (Appointed 2011)

Mass Audubon Climate Change Committee

Massachusetts Department of Environmental Protection, Solid Waste Advisory Committee (SWAC) Organics Subcommittee (Appointed 1998)

Suffolk County Conservation District Supervisor (2005 - 2006)

### **References:**

Julie Brandlen  
Executive Director  
Boston Nature Center  
50 Walk Hill St.  
Mattapan MA 02126  
(617) 983-8500

Nora Goldstein  
Senior Editor - JG Press  
*BioCycle*  
*Compost Science and Utilization*  
419 State Ave., Emmaus, PA 18049  
(610) 967-4135 x 26



Ed Connelly, Executive Director  
New Ecology, Inc.  
130 Bishop Allen Drive, 5<sup>th</sup> floor  
Cambridge, MA  
(617)354-4099 x 22

John Majercak, Executive Director  
Center for Ecological Technology (CET)  
26 Market Street  
Northampton, MA 01060  
Phone: (413) 586-7350

**David Fulford**  
**City Soil & Greenhouse LLC**

**Industrial process and equipment systems specialist**

David Fulford has more than 35 years industrial experience in the manufacturing, maintenance and operation of high performance mechanical and electrical equipment and facilities. His expertise includes troubleshooting and process optimization, commissioning, construction and startup of facilities demanding precision control of high temperature and pressure, explosive conditions, gaseous and liquid heat exchange, power generation, distribution and energy efficiency, odor and particulate emissions controls and wastewater reclamation. He is an experienced diesel, gas, hydraulic and HVAC systems mechanic and has operated and maintained a wide range of stationary, mobile and marine power equipment. He has redesigned and built numerous electrical and mechanical control systems, distributed controls and stand alone (TLC) controls. He has designed, constructed and maintained stormwater retention and biological filtration systems, subgrade drainage, and groundwater heat pumps.

David worked for Johnson & Johnson, the world's largest manufacturer of pharmaceuticals and medical devices from 1984 to 2009. He began as a precision welder at the Wilmington DE plant, (owned by subsidiary NORAMCO) and rose to a leadership position in redesigning production and operations for two key US facilities and plants in Switzerland, Belgium, and Ireland. These facilities employed approximately 200 and 800 people respectively and manufactured products valued between \$100 Million and \$500 Million annually.

His responsibilities at the Delaware plant included design, construction, installation and testing of new utility and process systems for the production of federally regulated pharmaceuticals valued at more than \$100 Million annually. He directly supervised employees, and performed due diligence and managed subcontractors and suppliers of components and services. He represented the company in meetings with federal regulators from the EPA, OSHA, DEA, and the FDA. As project manager for the Sarbanes-Oxley Act compliance testing at the Delaware and Georgia NORAMCO plants, he developed corporate valuation testing programs, protocols and implementation, and tested reporting systems to trace and accurately report financial data.

Prior to working with J&J, David spent four years working in custom machine shops that specialized in fabricating and repairing composting equipment for mushroom growers in southeastern Pennsylvania. He worked for three years in Wyoming's fossil fuels industries; as an underground mining equipment operator he was employed drilling, blasting, continuous mining and transporting bituminous coal. He also worked as a roughneck and drill hand in the eastern Wyoming oil fields for two years.



## BRIAN JEROSE

Experience continued (WASTE NOT Resource Solutions)

- Project contractor to Friends of Northern Lake Champlain to implement Sediment Abatement Project with partnering farms in Rock River and St. Albans Bay basins and for VT Agency of Agriculture project, conservation practices in ditch networks. Integrating field-based, edge-of-field and edge-of-water practices to meet site needs.
- Instruction/curriculum development for course: Compost Use in Stormwater BMPs and technical coordinator of CAV Compost Filter Sock Demonstration Project. Applying low-impact development practices to manage runoff and reduce sediment.
- Technical contractor to Farmers Watershed Alliance farms on mortality composting sites, compost formulations, O&M plans and water quality protection plans.
- Managed "Northern Forest Compost Collaborative," 8 NY farms sharing equipment, materials, technical assistance and other resources to expand compost production.
- Developer/tech support to on-farm composting site, Toad Hollow Farms in Onondaga County, NY; since 1997 for manure, food scraps, leaf and wood utilization.
- SARE Professional Development VT educator- trained regulators, agency/technical staff, policy makers, farmers and operators on best practices for composting slaughtering residuals and livestock mortalities, and compost use in VT, NY and PA.
- WASTE NOT Resource Solutions has moved most work projects into Agrilab Technologies during 2014 in order to work with larger team

2000-present                      Missisquoi River Basin Association                      East Fairfield, VT  
*Technical Advisor- part-time and Board Member*

Performing planning, selection, supervision and outreach in developing and conducting professional and volunteer conservation/pollution reduction projects in the Missisquoi River watershed. Forming creative partnerships between farmers, agencies and citizens.

Projects range from implementing tree and shrub riparian plantings, willow livestock and tree revetment bioengineering projects, livestock exclusion fencing and stabilized stream crossings, critical area seedings, gully, ditch and tile drain outlet stabilization, and site stewardship. Planning and site work with professional contractors and volunteers.

August 1997-2002                      Environmental Fertilization Corp.                      Parish, NY  
*Research Coordinator*

- Conducted vermicomposting, biofiltration and composting R&D with SUNY ESF, Cornell Coop. Ext., Cayuga Cons. Dist., Fessenden Farms and Mapleton Farms.

1994-1996                      Student Conservation Association                      Charlestown, NH  
*Assistant Event Coordinator, "EarthWork New Hampshire"*

- Development and planning for nation-wide volunteer service event. Coordinated crews, transportation and tools with hosts/agencies at state parks and 15 other sites.

*Corpsmember, AmeriCorps at Monadnock- community and national service program*

- Completed erosion control projects, water quality monitoring, and restored state parks. Implemented pilot composting program, coordinated service days, led recycling education, surveyed/mapped trails and wrote state/local newsletters.

**1662 Pumpkin Village Road, Enosburg Falls, VT 05450**

**Email: [jerose@together.net](mailto:jerose@together.net) Phone (802) 933-8336**

## BRIAN JEROSE

1993-94 Onondaga County Resource Recovery Agency N. Syracuse, NY  
*Recycling Staff*

- Educated county residents on integrated solid waste and household hazardous waste management programs through phone hotline, outreach, events and correspondence.
- Participated in program planning, waste hauler permits, surveys, composting, records management, program newsletter and cataloging of trade publications.

### EDUCATION

1997-2001 SUNY College of Environmental Science and Forestry Syracuse, NY

- MS Environmental and Resource Engineering
- Research Project Assistant, paid research position in composting R&D 1998

1996 Continuing Education Student, Keene State College Keene, NH

- Coursework in Chemistry, Calculus and Biology, Spring semester

1990-1994 Geneseo State University Geneseo, NY

- BA Political Science, minor Environmental Studies- GPA: 3.2/ in major: 3.5
- SUNY Study Abroad Program- Schiller Int'l University, Heidelberg, Germany 1992
- Congressional Intern, U.S. Representative James Walsh, Syracuse, NY 1993
- Dean's List; Pi Sigma Alpha; Student Club offices; Rugby; Directed Studies 1993-94

### PROFESSIONAL AFFILIATIONS/PROFESSIONAL DEVELOPMENT

- Composting Association of Vermont (CAV), Treasurer and Chair, Tech. Adv. Cmte.
- Highfields Center for Composting, Hardwick, VT. Member, Research and Education Advisory Board
- Certified Vermont Compost Site Operator – 2011
- Soil & Water Conservation Society, VT Farm Bureau, NOFA-VT member, The Nature Conservancy, Union of Concerned Scientists
- Phase II Stream Geomorphic Assessment Training, VT DEC, Rochester, VT, 2005

Presenter and/or attendee at numerous conferences, workshops and open houses related to conservation, composting, water quality, sustainability, bioenergy and agriculture.

Most recent: Feb. 2016, Northeast Organic Farming Association of VT – Winter Conference;  
Nov. 2015, Guest Lecturer, Miner Institute, Chazy, NY; Dr. Steve Kramer Agriculture and Environment class; Oct. 2015 BioCycle Renewable Energy From Organics Conference, Danvers, MA; March 2015, Vermont Organic Recycling Summit, Randolph, VT; Jan. 2014, US Composting Council Annual Conference, Oakland, CA; Nov. 2012, NY State Recycling Conference, Cooperstown, NY and VT-USDA staff training, Montpelier, VT;

**1662 Pumpkin Village Road, Enosburg Falls, VT 05450**

**Email: [jerose@together.net](mailto:jerose@together.net) Phone (802) 933-8336**

# Gaelan BROWN

PO Box 639 Waitsfield, VT 05673 | (C) (802) 498-3218 | [gaelanb@gmail.com](mailto:gaelanb@gmail.com)

## Professional Summary

Highly motivated professional experienced in all levels of sales, marketing, product development and business development with B2B and B2C growth companies. Self-directed entrepreneurial executive with proven track record of success managing people, programs, departments, channels, markets and customers.

## Skills Summary

- Sales Strategy, Team Supervision, Account and Pipeline Management
- Marketing Campaign Strategy and Execution
- Outside Sales and Sales Executive
- Languages: Competent in Serbo-Croatian, learning Spanish.
- Proficient in Microsoft Office and Adobe applications, particularly Excel and PPT.
- Experienced with Netsuite, PeopleSoft, SalesForce and other ERP systems including creation of new ERPs, database hygiene and mapping
- Experienced in Cognos reporting tools, Nielsen/Spectra/Claritas, web-based CMS;

## Education

1994-1998 Washington and Lee University, Lexington, VA

- **BA in Mass Communication**, Concentration in Economics
- Full-Scholarship Recipient, Graduated with Honors, 3.0 GPA
- Editor of The Trident Student Newspaper; Member NCAA Basketball team,
- **Certificates: Situational Leadership, Supervisor Success, Don Rheem Presentation Training, MOUSE,**

## Work History

**2013: Author "The Compost Powered Water Heater"** W.W. Norton Publishing

**June 2013-present: Consultant-VP of Sales/Marketing** [www.Agrilabtech.com](http://www.Agrilabtech.com)

- Lead business development, product development, sales and marketing for a startup company that is a global leader compost heat recovery technology.
- Develop short term and long term capital and operating budgets and P&L projections.
- Develop investor materials and raise seed capital.
- Build out commissioned sales-team and lead all PR efforts.
- Built a multi-million dollar project pipeline via direct sales, public presentations and networking.

**1998-2004, 2010-present Freelance Management Consultant**

- Consulting on sales/marketing strategy, strategic planning, project management, product development, consumer research, PR, digital and software-solutions, renewable energy, compost technology and general management with clients such as [www.Agrilabtech.com](http://www.Agrilabtech.com), [www.SeventhGeneration.com](http://www.SeventhGeneration.com), [www.KingArthurFlour.com](http://www.KingArthurFlour.com), [www.Enconhvac.com](http://www.Enconhvac.com), [www.Sourcefuse.com](http://www.Sourcefuse.com), [www.GuidepointGlobal.com](http://www.GuidepointGlobal.com), [www.GaltsGulchChile.com](http://www.GaltsGulchChile.com), [www.TheWaterFinder.com](http://www.TheWaterFinder.com), [www.GMCR.com](http://www.GMCR.com), [www.Evergreen.edu](http://www.Evergreen.edu), [www.UVM.edu](http://www.UVM.edu), [www.highfieldscomposting.org](http://www.highfieldscomposting.org)

**2009-present Founder CompostPower.org**

- Created an open source research network of compost scientists, engineers, agricultural leaders and renewable energy experts that has successfully refined methods to capture energy from specially designed compost systems including several projects integrated with household/greenhouse heating systems across N. and S. America, Europe and Asia; project consultant;

**2009-2014 Instructor, Yestermorrow Design Build Warren VT**

- Teach weekend workshops on compost-heat recovery systems, including project management and hands on training.

**2011-2013 Director of Marketing, 1% for the Planet, Waitsfield VT**

- Manage all communications, advertising, PR, ambassador program, social media, digital engagement, licensed products and events for a global client network of 1500 businesses including Clif Bar, Patagonia, New Belgium Brewing and 3000 environmental non-profits.

**2009-2011 VP Marketing, groSolar White River Jct. VT**

- Lead nationwide marketing for the nation's 5<sup>th</sup> largest solar power installer.
- Residential lead-gen/branding and education-based training events.
- Manage national and regional multi-media advertising including production of TV, radio, print, web and outdoor, generating 20,000+ sales-leads.
- Design and implement referral program, collateral, technology + social media.
- Nationwide Dealer Network; B2B acquisition, support programs.
- Promote Dealer-installer Training programs specific to key technologies.
- Lead all PR efforts achieving hundreds of press-hits nationwide.
- Managed all outsourced design, agency and overflow call-center relationships.

**2006-2009 Senior Marketing Manager, Green Mountain Coffee Waterbury VT**

- Leader of product-development and short-term/long-term demand modeling
- Create/execute marketing budgets ranging from \$1.5MM to \$3MM
- Development of products and programs for three new channels including direct, specialty retail and supermarket that grew from \$10MM to over \$400MM in annual sales.
- Develop/execute strategic growth and nationwide expansion plans.
- Selected by CEO for the "Key Manager" Bonus program 2006-2009.
- Online content and consumer engagement strategy.
- Forecasting, strategic, budget and cap-ex planning, data modeling and analysis.
- Expanded the percentage of Fair Trade and Organic coffee sales in concert with brand marketing campaigns.

**2007-2012 Business/Advertising Manager, Vermont Commons Newspaper**

- Managed the books and all advertising sales and accounts for multi-media news journal in a part time role.

**2004-2006 Sales Representative, VT Pure Springs, Burlington, VT**

- Grew a \$10 million region in a saturated market to \$14 million in annual sales
- Consistently doubled sales quota by generating hundreds of new account contracts while personally generating 90% of sales leads via networking and cold-calling.
- Company-wide Salesman of the Year 2004 and 2005

**2002-2004 Co-founder, Grobar, Inc Jamaica and Serbia**

- Developed business plan, secured development land and investors, and developed site-plan for "Calichi," a proposed RE-powered retreat-center in Jamaica.

- 1998-2001**                    **Co-Founder/VP Sales, Infopia.com**                    Salt Lake City UT
- Internet marketing firm valued at \$20MM within first 18 months.
  - Wrote business plan that raised initial \$4 million in funding.
  - Recruited, hired and developed B2B sales team and lead-gen programs.
  - Developed business/client partnerships with Ubid.com, Overstock.com, Yahoo.com, Value- America.com, AOL and many others.
- 1999-2000**                    **Website Manager/E-Newsletter Publisher**                    Utilityfree.com
- Designed architecture and created all content for Solar PV and Micro-hydro website.
  - Educated audience about energy efficiency measures, appliance-consumption calculators, and PV sizing calculators.
- 1997**                    **Metro Beat Reporter, Roanoke Times**, 100k circ.                    Roanoke VA
- Covered City Hall and Business News; 20+ front-page stories during 3 month internship.
- 1995**                    **Reporter Newport Daily Express**                    Newport VT
- Covered City Hall and Business News
  - Broke story that got AP and international pickups re US Coast Guard polluting international lakes. Senator Leahy used the story to get federal appropriations to stop the practice and clean up both lakes; Leahy as well as Governor Howard Dean personally thanked Gaelan for his efforts.

## Personal Interests

Business innovation, perma-culture, economic and political decentralization, the merger of liberty and sustainability values, regenerative business/agricultural models, renewable energy, conservation;

## Activism and Volunteer Experience

- Co-founder of the Carbon Shredders, a non-profit that educated thousands of people on the economic and ecological impacts of living a "low carbon diet." 2008-2011
- Steering Committee for community wind and solar group net metering projects.
- Energy Committee of the Valley Futures Network: 2006-2010
- Renewable Energy Vermont Conference Panelist: 2009, 2010, 2011, 2012
- Transition Towns organizer, forum Moderator: 2009, 2010
- Columnist as "An Energy Optimist" published in PV Magazine, Inter-PV Magazine, Vermont Commons, Green Energy Times: 2006-2014
- Vermont Commons Editorial Board: 2006-2012

## Event Organizer and Presentation-Panelist Activity

- National Zep Week: organizer/promoter of nationwide solar technology installer-training event, 2011
- Kick Gas Festival and Solar Sweepstakes organizer with groSolar, Carbon Shredders, 2009
- Bonnaroo music festival organizer for Carbon Shredders '07, '08
- Vermont Businesses For Social Responsibility: Conference Presenter on "Green Benefits," 2009
- Renewable Energy Vermont panelist "Internet Marketing Best Practices" fall '09 conference
- Renewable Energy Vermont '10 Expo organizing committee, panelist "Energizing Solar Markets"
- Solar Power International '09, '10 booth/sponsorship including live Zep Solar demonstration



- PV America '09 Panelist "Solar Power Pricing Strategies"
- Green Up Your Bottom Line '09 presenter "The Economics of Solar Power for Business"
- Expo West Natural Products exhibit for Green Mountain Coffee, 2008
- Village Building Convergence Event, Moderator of "Our Energy Options" panel,
- Transition Towns Mad River Valley Kickoff, 2010, organizer and panelist
- Carbon Shredders Rally organizer and speaker, Waitsfield '07, '08
- Organizer for Chelsea Green Publishing's Vermont tour of Mike Ruppert, Collapse
- Organizer for David Cobb's Vermont tour re MoveToAmend.org and Vermont's legislation to overturn corporate personhood.
- Managed presence at hundreds of local/regional trade shows, conferences, home shows, etc
- PorcFest Presenter 2014
- Freedom and Unity Festival Presenter 2013, 2014

### **Biography**

Gaelan has a history of leading sales, marketing, product development and business development with growth companies in several sectors while being active in volunteer and non-profit organizations. He is the founder of CompostPower.org, a non-profit research network that has developed successful compost heat recovery systems with projects across the globe from Siberia to Argentina, while refining parameters for commercialization of the concept. In May of 2014 his first book, "The Compost Powered Water Heater" was published by W.W. Norton, a large US publisher.

Since 2013 he has worked as a consultant as VP of Sales/Marketing for Agrilab Technologies, a global leader in commercial scale compost heat recovery technology, along with other consulting clients on digital projects such as Seventh Generation, King Arthur Flour, Galts Gulch Chile, VertMont Perfumery and SourceFuse.com.

Over the years he has held leadership roles in high growth companies focused on sales/marketing, product development, channel development, sustainability strategy, strategic/tactical planning, PR, and general management.

As Director of Marketing for 1% for the Planet, a global network of more than 5000 corporate/non-profit clients, he managed all B2C and B2C marketing focused on the intersection of business and sustainability. As VP of Marketing for groSolar, the 5<sup>th</sup> largest solar installation company in the US, he managed multi-million dollar national advertising campaigns across all media types along with PR placements that brought in more than 20,000 customer leads. As Senior Marketing Manager for Green Mountain Coffee Roasters he led the development of products and channels that grew from \$10MM to more than \$400MM in annual revenue during his tenure (\$6+ billion in 2014). As a Sales Representative for Vermont Pure Springs he single handedly grew a \$10 million region in a saturated market to a \$14 million region earning the title of company Salesman of the Year two years in a row.

Gaelan graduated with honors with a BA in Mass Communication with a concentration in Economics from Washington and Lee University.

# Michael J. DeRosa

46 North Main Street  
Ipswich, Massachusetts 01938

(978) 356-5408 – office  
(978) 265-9298 – mobile

## Education

---

<b>Boston University</b> MA, Energy and Environmental Studies with Water Resources Concentration (1993)	<b>1987 to 1993</b>
<b>North Carolina State University</b> MS Coursework in Ecology – Department of Entomology	<b>1985 to 1986</b>
<b>Harvard University, School of Public Health</b> Coursework in epidemiology and vector borne disease	<b>1982 to 1985</b>
<b>University of Denver</b> BA, Environmental Science with Ecology Emphasis, Philosophy Minor (1982)	<b>1978 to 1982</b>

## Professional History

---

<b>DeRosa Environmental Consulting, Inc.</b> Principal, LSP, LEED AP BC&D	<b>1994 to Present</b> Ipswich, Massachusetts
--	--

- Founded and incorporated DeRosa Environmental Consulting, Inc., in May 1994.
- Provides environmental consulting services to engineers, architects, government agencies.
- Focus in three areas of inquiry: environmental consulting services, renewable energy & design services.

### Hazardous Waste Consulting Services

- MA Licensed Site Professional (LSP License Number: 3452)
- Fully services MGL Chapter 21E and the Massachusetts Contingency Plan
- Phase 1 & Phase 2 Environmental Site Assessments: ASTM E1527 - 05
- Designs biological treatment systems for hazardous waste disposal sites and provides oversight for the installation, operation, and maintenance of soil and groundwater treatment systems

### Ecological Consulting Services

- Environmental permitting, wetland delineation, presentation of project to review boards
- Designs and constructs wetland replication and landscape restoration projects
- Prepares wildlife impact assessments, vernal pool certifications, and ecological research
- Provides technical review services for permitting agencies during preconstruction review of proposed projects

### Renewable Energy & Design Services

- LEED Accredited Professional BC&D
  - Assists engineers and architects in green building design
  - Assists with siting of large scale wind turbines
  - Design of Low Impact Development and LEED Site Design elements, rain gardens, water quality swales, constructed wetland basins
-

---

## **Professional Memberships/Affiliations**

---

- Affiliate to the Conservation Commission, Town of Ipswich (1995, 1996)
- National Ground Water Association (Active)
- Association of Ground Water Scientists and Engineers (Active)
- Massachusetts Association of Conservation Commissioners (Active)
- Association of Massachusetts Wetlands Scientists (Active)
- Society of Wetland Scientists (Active)

## **Community Service**

---

- **Manager, World Computer Exchange, Solar Technologies Initiative.**
    - Five years of developing Computer Literacy programs at schools in Ejisu, Ghana.
    - Raised money to purchase and ship 100 desktop computers to Model School to populate two (2) computer classrooms.
    - Conduct training in basic computer operation, MS Word, MS Excel.
    - Continuing to develop fundraising and hardware acquisition to implement programs, training, and renewable energy systems.
    - Currently working to secure and ship solar panels to Ejisu Ghana to power the new Community Computer Center and Model School with solar energy.
  - **The Food Project, Boston MA.**
    - Designed containment barrier to isolate residually contaminated soils in greenhouse to allow The Food Project to work with local schools in the propagation of seeds for transplanting to their fields on the North Shore of Boston.
    - Volunteered time to provide permitting services to establish a new 7 acre agricultural field in Ipswich MA which expanded the regional footprint of The Food Project.
  - **The Town of Ipswich, MA**
    - Member of the Clark Pond Study Group to assess the current ecological health of local 20 acre freshwater pond.
    - Conduct a bathymetry study, water quality sampling, and document preparation.
    - Report results to Town in summary presentation and report.
  - **Cuvilly Arts and Earth Center, Ipswich MA**
    - Volunteered time to various projects on campus including permitting of new agricultural barn, permitting of additional out buildings, delineation of wetland resource areas.
    - Assist with the siting of wind turbine to generate electricity for campus and agricultural buildings
  - **Glen Urquhart School, Beverly MA**
    - Co-sponsored grant application with Audubon Society, Glen Urquhart School, and Endicott College to raise loosestrife beetles for release to invaded wetland areas. Successfully raised and released beetles to control purple loosestrife in local wetland areas. Program was funded for 5 consecutive years.
  - **Mentoring to High School and College Students**
    - Provide internship opportunities for high school and college students interested in environmental careers
    - Mentor and provide advice and guidance to students as they develop their course of study and college/university selection
-

---

**Web Engineering Associates, Inc.****1990 to 1994**

Technical Director, Environmental Engineering Division

Norwell, Massachusetts

- Developed quality control systems for field operations and division operations
- Prepared specifications and design plans for soil and groundwater treatment systems including pump and treat, air sparging, vapor extraction, and bioremediation treatment systems
- Responsible for business development and profitability of division
- Lead person for large remedial projects
- Principal corporate liaison with federal, state, and local regulatory agencies

**Dennison Environmental, Inc.****1988 to 1990**

Operations Manager, Environmental Management Division

Woburn, Massachusetts

- Established and managed Environmental Management Services Division
- Full profit and loss responsibility
- Managed technical, marketing, financial, personnel, and accounting aspects of operations
- Managed corporate quality control for data collection, field operations, and report preparation
- Established cooperative teams with specialty consulting firms including bioremediation system design
- Prepared hazardous material site assessments for locations in all New England states

**U. S. Environment Corporation****1988 to 1989**

Project Manager/Environmental Scientist

Hudson, New Hampshire

- Managed hazardous waste site assessments for real estate transfers
- Supervised hazardous materials site remediation projects for on and off site treatment methods
- Prepared reports and was principal liaison with clients and attorneys
- Trained and managed entry level personnel

**Lelito Environmental Consultants, LLC****1987 to 1988**

Population Ecologist &amp; Wetlands Specialist

North Falmouth, Massachusetts

- Assisted in the review of the wildlife habitat regulations under MA Wetlands Protection Act - 310 CMR 10.60
- Delineated wetlands under the MA Wetlands Protection Act and local bylaws
- Designed and constructed vegetated wetland replication projects
- Primary technical writer for wetland resource area reports, wetland replication plans, and, wildlife habitat assessments
- Prepared reports and presented findings at public hearings with regulatory agencies

**North Carolina State University****1985 to 1987**

Research Assistant

Raleigh, North Carolina

- Conducted independent research regarding the role of migratory songbirds in the dissemination of the Lyme disease agent *Borellia burgdorferi* to new disease loci
  - Contributed to the writing of grant proposals to the U.S. Army, National Science Foundation, and World Health Organization
  - Co-authored articles published in reviewed scientific journals
-

---

**Entropy Environmentalists, Inc.****1985 to 1987**

Air Pollution Analyst

Research Triangle Park, North Carolina

- Sampled and analyzed air pollutants from stationary sources including nitrous oxides, sulfates and chlorides by USEPA Methods 1-8
- Performed USEPA quality assurance audits
- Compiled Laboratory Procedures Manual for EPA testing methodologies (92 pages)

**Harvard University, School of Public Health****1983 to 1985**

Senior Research Assistant

Boston, Massachusetts

- Independently researched the ecology/epidemiology of Lyme disease
- Organized and conducted field activities for data collected at study sites
- Collaborated with the Department of Biology at Boston University with similar research projects regarding small mammal ecology
- Applied research findings to the development of disease agent control programs
- Co-authored publications in reviewed scientific journals

**The Trustees of Reservations****1983 to 1985**

Naturalist – Crane Beach Reservation

Ipswich, Massachusetts

- Independently investigated and researched colonial nesting least terns and common terns at the Crane Beach Reservation
- Provided educational signage and literature regarding beach ecology
- Implemented proven management methods to protect colonies from predation and human impact

---

**Training & Educational Speaking**

- *Massachusetts Wetland Compliance (2010)* Halfmoon Seminars LLC., Eau Claire, Wisconsin. Wetland Preservation, Restoration, Creation and Enhancement.
- *Environmental Compliance in Massachusetts*. Webinar for the Property Managers of The Roman Catholic Archdiocese of Boston. (2009, 2010).
- *Invasive Species Control. (2010)*. Informational Seminar for regulatory agencies and public interest. Ipswich Town Hall with Bartlett Tree Company.
- *The Ecology of Invasive Species. (2011)*. North Shore Garden Club. Ipswich MA.
- Assist in science classes at Glen Urquhart School. Lectured on invasive species management, ecology, evolution. Conducted field trips and taught classes in vegetation sampling, identification, and basic population ecology.
- The Boston Architectural College. Assist with studio for The Fruitlands Museum in Harvard MA. Attend classroom lectures and field trips to study site. Discuss invasive plant impacts to landscape and ecological importance of site design considerations.

---

**Certifications and Special Training**

- Licensed Site Professional (LSP), Lic. No. 3452
  - LEED Accredited Professional (10342989)
  - Certified Ecologist, The Ecological Society of America (June 2002 – May 2007)
  - CERCLA 40 Hour Hazardous Materials Safety Training (OSHA 29 CFR 1910.120)
  - Confined Space Entry Training (OSHA 29 CFR 1910.146)
  - Management Training Workshop (Dun and Bradstreet)
  - Hazardous Materials Chemistry Seminar (University of Toledo)
-

---

## Publications and Reports

---

### Wetlands/Hydrology

- Madeja, J. B., M. J. DeRosa, 2010. Massachusetts Wetlands Compliance. Halfmoon Seminars, LLC., 754 Bartlett Avenue, Altoona, WI 54720
- DeRosa, M. J., C. H. Sham, E. Pritham, and E. Ettinger. 1992. Responses to the 1991 proposed revisions to the Federal Method for delineating jurisdictional wetland areas. Center for Energy and Environmental Studies, Boston University. January 1992. (33 pages).
- DeRosa, M. J. 1991. Protecting Wetlands: A case study of vernal pool protection. *Agora*. 5(3):28-29.
- DeRosa, M. J. 1990. Use of Vegetated Wetlands for the attenuation of stormwater runoff pollutants: Plant species communities and their capacity to attenuate pollutants. Center for Energy and Environmental Studies, Boston University. December, 1990. (23 pages).
- DeRosa, M. J. 1990. An Environmental Career. *Agora*. 4(3):24-25.
- DeRosa, M. J. 1989. Use of vegetated wetlands for the attenuation of stormwater runoff pollutants. Center for Energy and Environmental Studies. Boston University. April, 1989. (29 pages).
- DeRosa, M. J., and P. R. Lelito. 1988. Wildlife habitat and the Massachusetts Wetlands Protection Act Regulations. MCLPA Newsletter.

### Ecology and Population Biology

- Adler, G.H., M.L. Wilson, and M.J. DeRosa. 1986. Influence of island area and isolation on population characteristics of (*Peromyscus leucopus*). *Journal of Mammalogy*. 67:406-409.
- Adler, G.H., M.L. Wilson, and M.J. DeRosa. 1987. Effects of adults on survival and recruitment of *Peromyscus leucopus*. *Canadian Journal of Zoology*. 65:2519-2523.
- DeRosa, M.J. 1982. Interspecific competition between red-winged and yellow-headed blackbirds during the breeding season. Senior Thesis, Department of Biology, University of Denver, Colorado.
- DeRosa, M.J. 1983. The 1983 tern progress report: Richard T. Crane, Jr., Memorial Reservation, Ipswich, Massachusetts. The Trustees of Reservations, Milton, Massachusetts.
- DeRosa, M.J. 1984. The 1984 tern progress report: Richard T. Crane, Jr., Memorial Reservation, Ipswich, Massachusetts. The Trustees of Reservations, Milton, Massachusetts.
- DeRosa, M.J. 1985. The 1985 tern progress report: Richard T. Crane, Jr., Memorial Reservation, Ipswich, Massachusetts. The Trustees of Reservations, Milton, Massachusetts.
- DeRosa, M.J. Microhabitat characteristics of least tern (*Sterna albafrons*) nest sites in Ipswich, Massachusetts.
- DeRosa, M. J. 1987. The evolution of interspecific avian brood parasitism in altricial birds. Department of Biology. North Carolina State University, Raleigh, NC
- Monahan, M.W., D.W. Cameron, and M.J. DeRosa. 1987. Male survivorship, female habitat selection, and nest success of red-winged blackbirds on the Lafayette Marsh, Boulder County, Colorado, in 1982: a final report. Denver Wildlife Research Center, Denver, Colorado.
- Wilson, M.L., M.J. DeRosa, J.F. Levine, and A. Spielman. 1985. Transport of deer tick (*Ixodes dammini*, Acari: Ixodidae) by fall migrating birds. In: Population Ecology of the Deer Tick, *Ixodes dammini*, by Mark L. Wilson, A Thesis Submitted to the Faculty of The Harvard School of Public Health. June 1985.
-

---

## Various Topics

- DeRosa, M. J., and Paula A. Cutillo. 1993. Gaian Theory and Ecological Economics: Common ground for a sustainable economy. Center for Energy and Environmental Studies, Boston University. August 1993. (25 pages)
- DeRosa, M. J. 1990. Geochemistry of acid mine drainage and groundwater quality. Center for Energy and Environmental Studies. May 1990. (20 pages).
- DeRosa, M.J., M.E. Jackson, and J.F. Jones. 1986. Laboratory Procedures Manual. Entropy Environmentalists, Inc., Research Triangle Park, Raleigh, North Carolina (92 pages).