Feasibility Study

Anaerobic Digestion and Other Alternatives for Dog Waste Management and Education in Thurston County

Prepared for

Thurston Conservation District
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EXECUTIVE SUMMARY

Dogs generate a large volume of waste in Thurston County. Animal Services estimates that there are 50,000 dogs in Thurston County producing approximately 11 tons of waste per day. While the current pet waste management system protects human health and water quality, it contributes both organic waste and plastic bags to the local landfill.

This feasibility study examines the potential of establishing an anaerobic digester for dog waste at Hawk's Prairie Off-leash Area in Thurston County. The digester would "green" the park by reducing over 15,000 pounds of dog waste and associated plastic bags to the landfill each year and "upcycling" the waste into commodities such as bioenergy and potentially compost. The unit would also serve as a tool for providing education and outreach related to the importance of cleaning up after dogs to protect human health and water quality.

This report reviews four case studies of anaerobic experiments for dog waste in the U.S. and abroad, including advice from project coordinators and lessons learned. It discusses the needs and considerations for establishing a digester at Hawk's Prairie including team selection, monitoring and maintenance requirements, unit selection and outreach.

As anaerobic digestion for dog waste is still in its infancy, one can probably expect to dedicate a fair amount of time to monitoring and troubleshooting the unit within the first year. That said, such a project appears to have strong community and jurisdictional support (with noted concerns) and with a carefully selected project team, a promising chance of being successful. The project is estimated to cost $30,776 during the first year which includes the purchase of the digester, installation, digestible bags, monitoring, analytical testing, interpretive signage, outreach and evaluation. Funding would likely come from a combination of grants, private sponsors, and in-kind contributions. Future sustainability would depend on support from local departments, institutions and/or organizations that would be responsible for ongoing maintenance costs estimated at $3,500 annually.

While a small-scale digestion project at a local dog park would be a useful tool in public education and engagement, other options exist for more comprehensive pet waste management. As jurisdictions continue to work towards meeting local waste reduction plan goals, it may be an optimal time to initiate a discussion about ways to turn this organic waste into a commodity. This report explores large scale solutions to pet waste management including the procurement of large quantities of dog waste, municipal and/or regulated composting, and centralized anaerobic digestion.

Collaboration with others throughout Puget Sound and internationally will advance research and ensure that safe and environmentally beneficial solutions are adopted for this particular waste stream region wide. Installation of an anaerobic digester at a local off-leash area will provide a unique opportunity to educate and engage pet owners, students, and local businesses in pet waste management and pave the way towards the adoption of larger scale sustainable solutions in the future.

INTRODUCTION

Anaerobic digestion (Figure 1) is the process through which organic materials are broken down in the absence of oxygen, producing a gas composed primarily of methane and carbon dioxide. Anaerobic digesters have been around for hundreds of years and have been successfully used in rural areas of India, China, and Africa for household cooking and lighting (Figure 2). More recently, this decentralized source of energy has been gaining momentum in the UK, Germany, and Sweden as a way to "recycle" the waste stream and mitigate climate change. Here in Washington State, anaerobic digestion is used by wastewater treatment plants as a method to reduce pathogens and stabilize biosolids. It is also being used by dairy farms to generate energy, manage manure, reduce odors, and improve soil health.

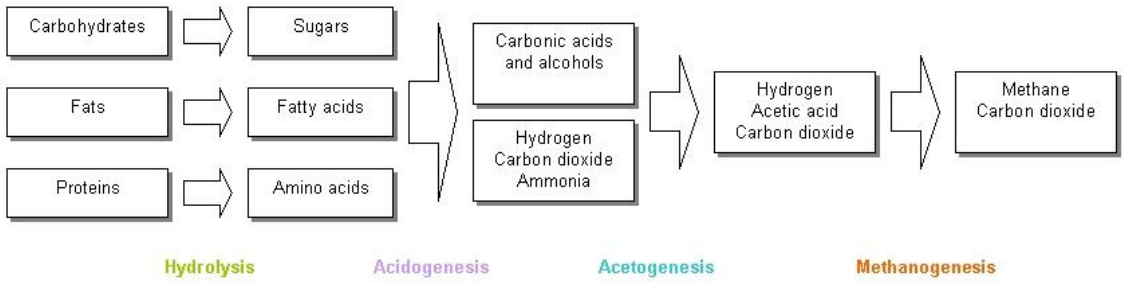

Figure 1. Four stages of anaerobic digestion. Image by Clarke Energy.

In the last few years, groups and individuals have begun applying this technology to other areas of waste management. In 2010 the Cambridge Arts Council and students from the Massachusetts Institute of Technology (MIT) developed an anaerobic digester at an off-leash dog park in Cambridge, Massachusetts. This effort, known as the Park Spark Project, was initiated with the goal of "transforming dog waste into energy to power public art" (www.parksparkproject.com/home.html). Inspired by this idea, similar projects have followed suit, not as an art installation per se, but rather as a way to educate the public about the importance of cleaning up after their pets while using anaerobic digestion to treat dog waste, generate biogas and/or compost, and reduce the amount of plastic bags and organics sent to the landfill. While anaerobic digestion has been around for a long time, using this process to treat dog waste in an urban environment is new and quickly gaining momentum. Efforts are currently underway in Arizona (USA), north Wales (UK), and Melbourne (Australia) and have received notable media coverage.

Figure 2. Digester for treatment of feces and kitchen waste in Trivandrum, India. Photo courtesy of Eawag.

This report examines the feasibility of establishing an anaerobic digester for dog waste at an off-leash park in Thurston County, Washington. The report is divided into four parts. Part 1 (*Case Studies-*

Anaerobic Digestion of Dog Waste) describes previous and ongoing efforts around the world and offers advice and lessons learned. Part 2 (*Needs and Considerations for Anaerobic Digestion of Dog Waste at Hawk's Prairie Off-Leash Area, Thurston County)* describes local considerations (e.g. installation, citing and maintenance requirements, community and jurisdictional support, and long-term sustainability) associated with establishing a digester in Thurston County. Part 3 (*Large Scale Alternatives to Dog Waste Disposal*) explores alternatives to disposing bagged pet waste in the landfill including large scale production of biogas and/or compost. Part 4 (*Recommendations*) offers recommendations on how the County might proceed in developing anaerobic digestion and large-scale pet waste management projects.

PART 1 – CASE STUDIES: ANAEROBIC DIGESTION OF DOG WASTE

To more fully examine the potential for anaerobic digestion of pet waste in Thurston County, the following section of this report details several case studies of anaerobic experiments in the U.S. and abroad, including advice from project coordinators and lessons learned.

The Park Spark Project

Location: Pacific Street Park, Cambridge, Massachusetts, USA
Contact: parksparkproject@gmail.com
Website: http://parksparkproject.com/home.html
Cost: The project was funded by a $4,000 grant from the Council of the Arts at the Massachusetts Institute of Technology (MIT) in addition to graduate student time.

The Park Spark project was initiated at an off-leash dog park in Cambridge, Massachusetts during the summer of 2010. The project was developed in cooperation with the Cambridge Arts Council and students from MIT. The result was an interactive demonstration that allowed the community to generate methane while questioning the current waste disposal system.

Figure 3. Matthew Mazzotta, brainchild of Park Spark, posing in front of the digester.

The Park Spark Project transformed dog waste into energy (methane) through a publicly fed anaerobic digester. The anaerobic digester was placed above-ground and consisted of two connected 500-gallon tanks (Figure 3). Park users used special digestible bags to collect dog waste and deposit it into the digester through a feeding tube (tank on the left). Turning the hand crank allowed individuals to mix the waste and facilitate the production of methane. The community was then able to select a way to use the heat and light of the constantly burning flame (e.g. lamppost, popcorn popper, barista station, etc.) (Figure 4).

Advice and Lessons Learned

The Park Spark web-site offers the following advice for initiating a neighborhood digester project:

Figure 4. Individuals brewing tea from locally collected edible plants using methane from cow manure, Drachten, Netherlands, 2010.

Acquire Funding: Sources of financial support might include art grants, "green" or sustainability project money, inventive grants or funds, or funds offered by local jurisdictions.

Establish Team and Gain Support: A team of 6-10 committed members is recommended to implement the project. The team should consist of a lead scientist (e.g. a partner at a university or local school, individual with expertise in microbiology or digesters), dog owners, city officials, and a community or dog advocacy group. Participating entities might include Parks and Recreation, Public Health, Open Space Committee, Public Health Department, or the Environmental Protection Agency (EPA).

Perform Maintenance and Monitoring: Periodic monitoring will be required to ensure that the digester unit is airtight, and that pH levels and methane content are accurate. Problems due to neglect or poor monitoring should be easy to diagnose and correct. The resulting solid waste (slurry) will need to be removed 1-2 times per year and taken to a wastewater treatment facility. Using the slurry as fertilizer for gardens was not tested, but is recommended as an additional benefit.

Weather: Methane-producing microbes perform optimally around 100 degrees F. Although they still produce methane in colder weather, the production diminishes as temperature drops below a certain point. In Cambridge, MA, the unit functions best from late spring to early fall. Locations that are much warmer will have more efficient results, with a possibility of running year-round.

Current Status

The Park Spark Project was primarily intended as an art installation and was terminated after the first year. While the digester is no longer functioning at the Park, it continues to inspire similar projects worldwide.

E-TURD (Energy Transformation Using Reactive Digestion)

Location: Cosmo Off-Leash Park, Gilbert, Arizona, USA
Contacts:
Dr. Kiril Hristovski, Assistant Professor and *Michael L. Ingram*, Graduate Student - Environmental Technology & Emergency Management, Arizona State University – Polytechnic Campus, Mesa, AZ.
William Loux – Patent Office
Louis Andersen, Environmental Manager - City of Gilbert.
Cost: $25,000 (not including graduate student time)

In May 2012, a team of students from Arizona State University's (ASU) College of Technology & Innovation (CTI) and the Town of Gilbert partnered to install a methane digester for dog waste (E-TURD) at Cosmo Park, an award winning park that draws more than 600,000 visitors annually (200 dogs/day). The dog waste digester allows park visitors to deposit dog waste into the digester, turn a handle to mix the waste, and produce methane that powers a lamppost (Figure 5). Unlike the above-ground digester unit used in the Park Spark Project, this unit was placed underground to mitigate for extreme summer temperatures in excess of 110°F and the potential for unpleasant odors.

The goal of the installation is to encourage residents to clean up dog waste, keep the park clean, and provide educational opportunities for students and the community. Ultimately, it is hoped that the digester will help the city save money by eliminating the cost of collecting and hauling dog waste to the landfill and benefit the environment by reducing atmospheric emissions of methane, a greenhouse gas.

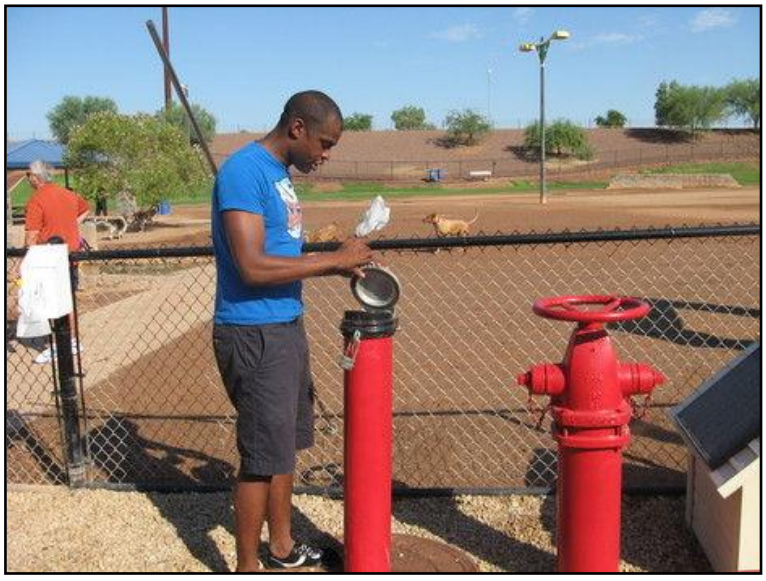

Figure 5. Michael Ingram demonstrating how to use the anaerobic digester at Cosmo Dog Park in Gilbert, AZ.

The project was reviewed and supported by the Town of Gilbert Environmental and Energy Conservation Advisory Board and the Parks, Recreation and Library Services Advisory Board. The City of Gilbert raised $25,000 through sponsor donations to help fund the project. Major sponsors included Republic Waste Services, PetSmart, Salt River Project, Severn Trent, and Carollo Engineering.

Advice and Lessons Learned

Installation: The digester unit was placed underground for optimal digestion during summer months. This design was selected to attenuate daily temperature fluctuations that can be particularly difficult on methanogenic bacteria. Project developers suggest that below-ground installation might work better for the cooler Pacific Northwest climate.

Maintenance Requirements: The digester was inoculated with activation sludge from a wastewater treatment plant at the beginning of the project and then fed a continuous supply of dog waste. Maintenance and minor design adjustments were required to ensure that the unit was functioning properly. Michael Ingram, a graduate student working on the project hypothesizes that a digester unit in the Pacific Northwest would likely function from spring through fall and require end-of-season pumping. The digestate would then need to be pumped and disposed of at a wastewater treatment plant. The main digester compartment would also need to be flushed annually to remove plastic fragments, rocks, and other materials that are inadvertently picked up during the scooping process. ASU researchers eventually intend on experimenting with using the digestate as a component in compost.

Figure 6. Dog waste-only garbage cans were installed throughout Cosmo Park in response to individuals placing dog waste in regular garbage cans instead of the digester.

Biodegradable bags were required for the digester. The selected bags worked well in the unit, but the extreme ambient temperatures were difficult on those in the dispensers.

Outreach: Toward the end of the first year, interviews revealed that despite the media attention that the project received, many park users were not aware of the digester or did not know how to use it. Others simply chose to deposit their pet's waste in the nearest garbage can instead of placing it in the digester.

Once this issue was recognized, "dog waste-only" garbage cans (Figure 6) were placed throughout the park. Park personnel were then able to transfer the dog waste to the digester. Ongoing outreach and evaluation is, therefore, strongly recommended throughout the duration of the project.

Current Status

The E-TURD program is still active and students are making design improvements to increase the unit's efficiency and effectiveness.

Streetkleen Bio-Project
Location: Flintshire, North Wales, UK
Website: http://www.streetkleen.co.uk/
Contacts: *Gary Downie and Dr. John Walsh*, Streetkleen
Cost: £20,000-40,000 ($32,000-64,000 USD)

The Streetkleen Bio-Project will be established in the Welsh capitol city of Cardiff in spring 2013. Streetkleen is a Community Interest Company providing both small and large scale solutions to pet waste disposal while also creating a new source of renewable energy. An anaerobic digester in the shape of a 30-foot steel fabricated Welsh dragon (the national emblem of Wales) will be installed in a newly designated dog area in Victoria Park. This dragon will breathe an ignited burst of biogas that will be created from collected dog waste. The developers hope this public showpiece will provide impetus for discussion on what can be done to manage the chronic problems associated with dog fouling in some UK communities. Creating usable energy from Cardiff's dog waste will enhance the image of the Welsh capital as an environmentally friendly European city that values quality of life and intends to conserve its open spaces for future generations. Streetkleen has received interest from other UK cities such as Edinburgh, Manchester, and London regarding additional Streetkleen Bio-Projects.

Figure 7. Gary Downie watches as a load of chicken manure is brought to a large anaerobic digester at Streetkleen's research and development facility outside Wrexham.

Streetkleen is also working towards implementing a larger scale infrastructure for handling this waste stream. Plans include treating dog waste in a fully operational anaerobic digester (1000 m^3) servicing the largest organic farm in Wales (Figure 7) and treating dog waste using the Streetkleen Micro, a manufactured digester for food and/or bio waste (Refer to Part 3 for details).

Advice and Lessons Learned

Outreach: Project success depends on both community support and outreach and education. For this reason Streetkleen Total Prevention, an accredited education program, was designed with the help of a professional consultant. One goal within this program is to make cleaning up after dogs easy and convenient for dog owners. Wales recently initiated a "Bags-For-Life" program, which charges a fee for single use plastic bags. The unintended consequence of this action was an upsurge in dog fouling rates as dog walkers find themselves without a free supply of plastic bags. In response, Streetkleen has designed Dicky Bags (Figures 8 and 9) and Dog Waste Disposal Receptacles (Figure 10) that work in unison to create a "bag disposal system" for dog walkers. These products also generate revenue to support the infrastructure required to transport and anaerobically digest the waste.

Figure 8. The Dicky Bag is a transportation device for carrying dog waste to a proper disposal receptacle. The bags are airtight, washable and include air freshener and sanitary hand cleaner.

Figure 9. Mandy Davies (Dicky bag inventor), Kevin McCloud (British TV personality) and Gary Downie.

Figure 10. Dog waste disposal receptacles.

Current Status

The Streetkleen Bio-Project will be fully operational by spring 2013 acting as a beacon of what can be achieved by community and Local Authority collaboration.

The Poo Power Project – A New Breed of Superhero

Location: Melbourne, Australia
Website: http://www.poopower.com.au/index.html
Contacts: *Duncan Chew* and *Margaux Hayes*, Poo Power Project
Digester Cost Estimate: $14,000 AUD ($14,805 USD)

The Poo Power Project is an effort to unleash the power in 1,350 tons of dog waste produced each day in Australia (Figure 11). The goal is to "build an anaerobic methane digester to process the dog waste (and other appropriate wastes) to create a biogas that can serve as renewable energy source to super-power dog parks" (http://www.poopower.com.au/index.html). The Poo Power Project will partner with a local biodigester company to produce an appropriate biodigester and conduct environmental testing that will comply with Australian standards for pathogen content. The project team will collaborate with other researchers to test a dog waste/leaf mulch mixture and its effect on efficiency and outputs of the digestion process. This project will also attempt to fill the large research gap that exists around using dog waste digestate as a safe component in compost.

Figure 11. The Poo Power Project gaining community support with the help of a dog mascot.

Advice and Lessons Learned

Political will: The project takes a huge amount of initial commitment, but according to the project team, is well worth the effort. Project feasibility will depend largely on local government support and regulations.

System design: In terms of system design, finding a local engineer that specializes in anaerobic digestion to provide system guidance is recommended. Digester units have progressed since the Park Spark Project, but still prove temperamental in terms of weather, biogas storage, and blockages. Purchasing a commercially available digester may be financially beneficial, but may not be as aesthetically pleasing.

Funding: Funds should come from a variety of sources, but must include the local government since they will be tasked with long term maintenance.

Current Status

The project is in the early developmental stages and funding is pending for the technical portion of the project. After funding is secured, the project will move forward with building and testing the biodigester. Poo Power is also communicating with a group in Toronto, Canada to establish an institution that will allow greater collaboration between groups working on similar projects worldwide.

PART 2 - NEEDS AND CONSIDERATIONS FOR AEROBIC DIGESTION OF DOG WASTE AT HAWK'S PRAIRIE OFF-LEASH AREA, THURSTON COUNTY

Installation of a small anaerobic digester for dog waste at an off-leash park would serve two main functions. First, it would reduce the amount of solid waste and bags deposited in the landfill while providing benefits associated with anaerobic digestion (pathogen and odor removal, energy production, possible nutrient application). Second, the unit would serve as a tool for demonstrating potential alternatives to handing dog waste on a larger scale for future consideration.

This report aims to determine the feasibility of establishing an anaerobic digester for pet waste in Thurston County. Based on research into the process of anaerobic digestion and the case studies presented in Part 1 of this report, several technical, financial, and social issues will need to be considered and/or addressed in order for such a project to move forward.

Team Selection

Project success will likely depend on the amount of support generated from the community and local jurisdictions. Creating a dedicated team to plan, implement, monitor, evaluate and provide outreach will help ensure that project goals are met.

The team should consist of, or receive consultation from, representatives of the following departments and organizations: Thurston County Solid Waste, Thurston County Environmental Health, Washington Department of Ecology, Stream Team, and Sound Hounds. Experts on methane digestion and composting should also be included and might include Washington State University's (WSU) Center for Sustaining Agriculture and Natural Resources, Environmental Engineering and Energy Company, Living Arts Systems, or WSU Extension (Puyallup). WSU has particular expertise in small-scale anaerobic digestion in the Pacific Northwest climate. In addition, the project team should contain several enthusiastic citizens or students (e.g. WSU, The Evergreen State College, University of Washington-Tacoma – Urban Studies Program) with relevant experience. Ken Butti, Environmental Compliance Supervisor at LOTT is an expert in anaerobic digester processes associated with wastewater treatment and willing to answer questions related to this project.

Figure 12. Hawks Prairie Off-Leash Dog Area, Thurston County, WA.

Site Selection

Hawk's Prairie Off-Leash Dog Area, located at the Thurston County Waste and Recovery Center (2418 Hogum Bay Road NE, Lacey, WA 98516) is the most likely candidate for placement of the dog waste digester (Figure 12). Opened in October 2010, this well-attended five-acre dog park is open seven days a week and features water stations, paths and

fencing, sand and gravel for digging, and a separate area for shy and small dogs. The property is owned by Thurston County and managed by the Solid Waste Department (TCSW).

TCSW Director, Scott Schimelfenig, supports the idea of a well-designed, aesthetically pleasing dog waste digester at the park and will assist with installation and relevant permitting requirements. According to Schimelfenig, the park generates 300 pounds of dog waste per week, or 43 pounds per day. It is a well-contained, controlled environment that will be ideal for protecting the digester from vandalism, conducting outreach, and generating a steady stream of dog waste.

Anaerobic Digester Selection and Unit Cost

The Park Spark and E-TURD projects both relied on students from MIT and ASU's Polytechnic College to design their own digester units, which consisted of two 500-gallon steel tanks placed above ground and below ground respectively (Figure 13).

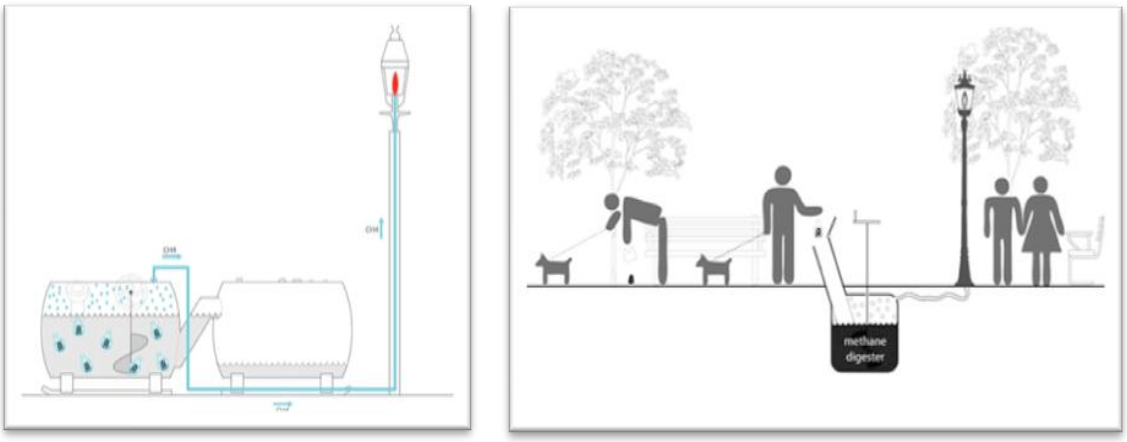

Figure 13. Examples of above ground and below ground placement. http://parksparkproject.com

While the concept is straightforward, actual construction requires specialized expertise (Figure 14). Without the resources of a technical college, purchasing an "off-the-shelf" digester may be more cost effective. The Town of Gilbert, ASU and ASU students equally share intellectual property rights to the methane digester with ASU having first opportunity to file for intellectual property protection and commercialization. This arrangement may create an opportunity for outside parties to purchase a digester unit from one of these entities in the future.

Figure 14. Welding the handle onto the anaerobic digester. http://parksparkproject.com

The cost for assembling this type of model is variable. The Park Spark Project was completed with a $4,000 grant from MIT, whereas, the Cosmo Park digester cost $25,000. The itemized budget for the latter effort includes two 500-gallon steel tanks ($8,000), a gas light post

($1,500), plumbing materials ($2,000), agitation system ($2,000), concrete work ($3,000), two trenchers ($600), miscellaneous parts-bolts, art panels, educational display ($3,500), and management expenses ($4,400). A significant amount of student contribution is not included in either budget.

Living Arts Systems (http://www.livingartsystems.com/), based out of Crestone, Colorado, offers the AART-1, a commercially available, above-ground unit for $15,000 including a fully insulated skid (Figure 15). The unit is a $1m^3$ digester with 1.2 m^3 of hydraulic gas storage—enough to cook three meals for a family of four every day (about 21,000 BTUs per day). The tank volume is 1,200 gallons, with equal parts active digestion space, gasholder volume, and displacement area. The $1m^3$ AART-1 module has a footprint of 8 feet by 12 feet. The unit can accept 7-20 pounds of dog waste daily and can be scaled up to accommodate additional volume if required. It is designed so the public can lift a hatch and make deposits using digestible bags. The unit has 100 gallons of on-board water storage (from rain catchment) for adding to the tank, dog watering, hand washing, or spraying down spills. The unit is completely "off-grid" and should not require any additional features to operate cleanly, safely, and efficiently. Power needed for pumps, automated monitoring, and supplemental tank heating is supplied by solar energy (evacuated tubes). Biogas can also be used to provide additional warmth to the tank during winter months for year round functioning if necessary. The sides of the unit are particularly well suited for art and/or posting of educational displays. The unit would require shipping to Olympia via ground transportation (estimated cost of $1,200) and the use of a fork lift for placement.

Figure 15. AART-1.
http://www.livingartsystems.com/

Researchers from WSU have also invented a small-scale anaerobic digester (working volume less than 50 m^3) to stabilize and convert household manures into biogas for the Pacific Northwest climate where temperatures are below those required for anaerobic digestion for six months a year. A scaled down version may be a consideration. According to the inventors of the system:

> *"The design includes a column fermentation chamber with arc baffle and slope on the bottom and a domed biogas chamber on the top, a hydrolysis chamber in connection with the influent and effluent chambers, and back valves as well as biogas outlet. The construction of the disclosed small digester is suggested to be in greenhouse beneath the frost depth for temperature preservation. An automatic broth recirculation mechanics is realized through the pressure changes with intermittent biogas generation and usage, which not only creates the mixing effect but also bring along continuous inoculation. Stalk materials are separately liquefied in a dedicated hydrolysis chamber to prevent clogging risk. The arc baffle and slope floor are particularly designed to prevent short-circuit and ensure smooth desludge. High specific surface*

inner wall structure is also devised to retain fermentative microbial in the form of biofilm. This advanced small digester design fixes a series of intrinsic problems in terms of heating, mixing, inoculation, clogging, crustation and stalk digestion that have hampered the conventional small digesters application" (Zhi-Wu Wang et al. 2009).

Digester Monitoring and Maintenance

Monitoring

Based on previous and ongoing projects, the digester unit will require initial and ongoing monitoring and maintenance. Initially, the tank must be inoculated with activation sludge (a mixture of fecal matter and water). According to Living Arts Systems, the unit should start generating measurable levels of methane within a week. At this point, a "maintenance ration" of dog waste can be added twice per week for approximately two weeks. Once stabilized, the system will be ready to accept daily inputs of waste at the optimal feeding rate. Until this time, the unit should be monitored daily for pH, temperature and gas pressure. Eventually, monitoring frequency can be reduced and a control system can be used to collect data and relay the information to a computer and/or smart phone.

An expert in anaerobic digestion should be involved in the initial establishment and monitoring of the unit and be available in the event that significant troubleshooting is required. Once functioning properly, monitoring and maintenance responsibilities may be taken over by students at The Evergreen State College, Solid Waste staff, the Parks Department, Sound Hounds, or dedicated volunteer. Pacific Shellfish Institute (PSI) staff received Biomass Energy training including hands-on experience with the AART-1 (*Anaerobic Digestion & Biomass Gasification*) (http://biofuels.greentraining.sfcc.edu/biogas-pyrolysis) at Santa Fe Community College in January 2013 and can provide training and oversight.

Maintenance

All materials that enter the digester will have to be removed eventually. Michael Ingram (E-TURD) estimates that if the unit is used from spring to fall, it will need to be pumped and flushed at the end of the season. The tank will also have to be flushed and cleaned of plastic, rocks, and other small accumulated debris. Other suggestions are to remove the digestate quarterly, or even continuously, depending on input. Nicholas Chambers (Living Arts Systems) proposes that the digester run year-round using a combination of solar energy and biogas. In this case, the digestate can be removed periodically (twice per year) through a 3-inch valve and transferred to a contained static aerobic compost pile mixed with layered straw. The slurry can also be removed by a septic hauling service and taken to a waste water treatment facility.

LOTT generally discourages the acceptance of pet waste at their facility for a number of reasons (see Part 3). However, LOTT has agreed to accept the slurry generated from such a project since it will have undergone some level of treatment via the anaerobic digestion process. The amount of waste is also very small and will not require significant financial resources in terms of treatment or disposal. In addition, the facility's state-of-the art de-nitrification system would provide the highest possible level of treatment for the waste. LOTT charges $27/ton for waste disposal which would be included in the septic hauling fee, estimated to be approximately $300. Other disposal options might include Biorecycling (serving Mason and Lewis County), which accepts septic and other types of organic wastes or Fire Mountain Farms, which accepts various commercial waste streams.

While the Park Spark and E-TURD teams both promote the idea of using the digestate in compost trials, neither has tested this option. In both cases, the digestate was removed and taken to a wastewater treatment facility after obtaining special approval. The Poo Power and StreetKleen Bio-Projects intend to test the digestate for pathogens and explore alternative uses for this nitrogen-rich product.

Digestible Bags

The anaerobic digester will require specific bags that are designed to break down in the absence of oxygen. Most bags that claim to be biodegradable, or oxo-biodegradable, may not function properly in a digester. They contain a chemical additive that causes the bag to break up into smaller fragments, but not entirely decompose. In addition, these bags are designed to degrade in the presence of oxygen, something not found in either a landfill or anaerobic digester.

Custom Bioplastics (Crown Films) offers dog waste bags designed for anaerobic digesters ($0.06/each) and composting ($0.05/each) (for pilot dog waste composting programs at the municipal level) (Figure 16). For comparison, Steam Team currently purchases *standard* plastic dog waste bags for $.03/each. The digester bags from Custom Bioplastics are made of a polymeric resin that is essentially 100% carbon and passes testing for anaerobic digestion and marine degradability. Both bag types pass ASTM D6400 standards (12 Standard Specification for Labeling of Plastics Designed to be Aerobically Composted in Municipal or Industrial Facilities) requiring that biodegradable products completely decompose in a composting setting in a specific time frame, leaving no harmful residues behind. The digester bag would biodegrade to levels acceptable for disposal of digestate at LOTT or for use in compost trials.

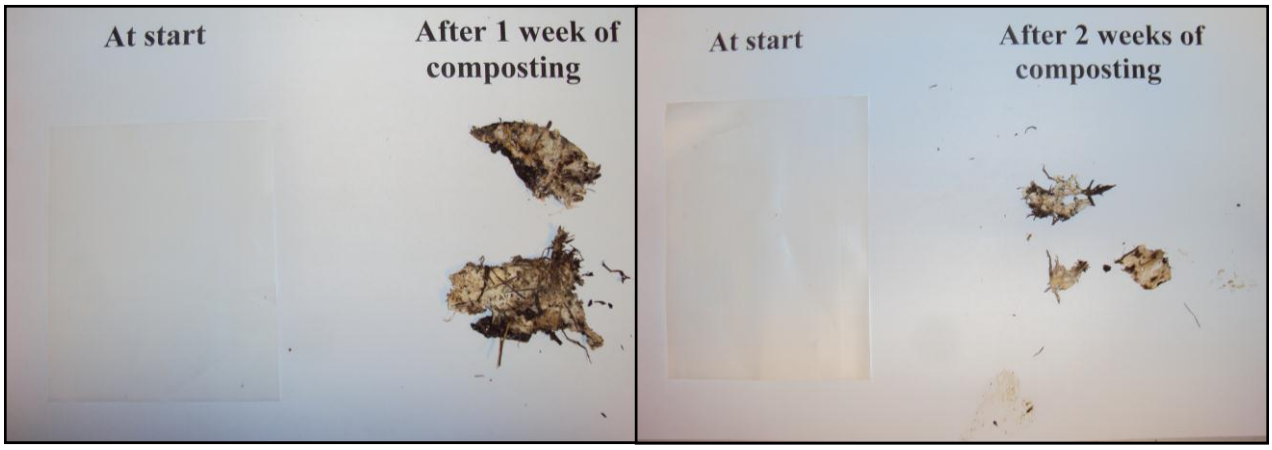

Figure 16. Images of digester bags during compost trials. Bags are both digestible and compostable. Image courtesy of Custom Bioplastics.

Additional bag suppliers noted during this study included Grainger and S & Q Plastics (Ontario, Canada).

Outreach & Evaluation

The digester unit for dog waste would serve as a way to "green" the park by decreasing over 300 lbs of solid waste (and plastic bags) per week to the landfill and generate usable commodities such as biogas and potentially compost. The unit would also serve as a tool for providing education and outreach related

to the importance of cleaning up after pets to protect human health and water quality. Finally, the project would promote research and collaboration surrounding ways to safely and sustainably handle this particular waste stream in the future. Outreach is critical in order to promote these messages and ensure that park users are aware of the system and understand how to use it.

Although the digester at Cosmo Dog Park (E-TURD) received extensive promotion, follow-up interviews revealed that many dog owners were unaware of the digester, did not know how to use it, or simply did not want to carry their dog waste to the digester in lieu of depositing it in nearby garbage cans. This example underscores the importance of conducting outreach and evaluation throughout the duration of the project. Sound Hounds is a South Puget Sound dog park advocacy group whose mission is to work with the local jurisdictions "to provide a variety of successful off-leash areas for South Puget Sound residents and visitors." The group uses volunteers to maintain and monitor dog parks, host work parties, and communicate information. President Lynn Scroggins supports the idea of a digester at Hawk's Prairie and believes her membership will actively participate in planning, monitoring, and helping to ensure that the project's goals are met.

Stream Team and Thurston County Environmental Health have provided pet waste education in the community for decades and should be included in outreach related to this project. Stream Team supports the idea of a digester and would be willing to advertise the project via their Newsletter and electronic postings and help recruit volunteers as needed. Other methods of project promotion include web-based information, articles in The Olympian, Thurston County Solid Waste's publication Talking Trash and; presentations at LOTT's Lecture Series. Journal articles and conference presentations would provide outreach to the scientific community serving to advance the state-of-knowledge surrounding the use of digester units for dog waste, pathogen removal, and digestate application.

This project lends itself to a number of measurable objectives including pounds of waste and bags diverted from the landfill, and amount of biogas and compost produced (if applicable).

PART 3 - LARGE-SCALE ALTERNATIVES TO DOG WASTE DISPOSAL

While a small-scale digestion project at a local dog park could be a useful tool in public education and engagement, other options exist for more comprehensive pet waste management. This report presents both resources and efforts that are taking place both nationally and internationally to manage dog waste on a large-scale. This field is relatively new and peer-reviewed research data for both anaerobic digestion and composting of dog waste is limited. Adopting new practices for managing pet waste will require ingenuity, testing, and strict monitoring to ensure protection of human health.

Current Disposal Practice

Pet waste, both in quantity and composition, has always posed a challenge in terms of waste disposal. Animal Services estimates that there are 50,000 dogs in Thurston County producing approximately 11 tons of waste per day. A 2007 pet census by the American Veterinary Medical Association revealed 72 million dogs live among humans in the U.S. Dog waste contains an array of harmful pathogens, many of which require very high temperatures to treat.

Until recently, local governments across Puget Sound formulated their own approach to manage dog waste, offering a selection of choices for homeowners (flushing, burying, Doggie Dooley-style backyard "composters"). Now, as part of the Washington Waters and Puget Sound Starts Here Campaigns, a one-size-fits-all recommendation of placing all bagged pet waste in the garbage can (not co-mingled with organic waste) has been adopted. This "Scoop it, Bag it, Trash it" recommendation is easy, straightforward, and protects water quality and human health.

Neither the LOTT wastewater treatment facility nor Silver Springs Organics will directly accept dog waste (personal communication, Lisa Dennis Perez and Samantha Fleischner). For LOTT, sanitary waste requires a great deal of water, energy, and money to process. Dogs produce a sizable quantity of fecal matter that would not be taken into consideration by the facility's capacity projections, which are based on people and not pets. In addition, LOTT's waste treatment processes are designed to handle human waste and may not be appropriate for other types of waste that differ in pathogen/microbe content, moisture levels, and overall chemistry. Silver Springs Organics does not, and will not ever, accept dog waste, which would require a Type 4 Feedstock permit, or equivalent.

Composting

According to the Washington State Compost Educators Guide, dog waste is decomposable and will biodegrade like other organic materials when composted or vermin-processed. That said, *it is widely agreed upon that backyard composting is not a safe option for disposal and/or treatment of dog waste*. Backyard composters rarely maintain "hot piles" that reach temperatures high enough and for a long enough duration to kill pathogens. In one trial from Eugene, Oregon, backyard compost containing dog waste that was composted for a year and matured for another year and a half, resulted in decreased, but positive, levels of fecal coliform, Salmonella, and viable Helminth Ova.

Several examples exist, however, of successful dog waste composting trials that involve more intensively monitored and maintained "hot piles."

Fairbanks Soil and Water Conservation District – Composting Dog Waste , U.S. Department of Agriculture, Natural Resources Conservation Service (USDA/NRCS, 2005).

A guidance document produced by the U.S. Department of Agriculture, Natural Resources Conservation Service and the Fairbanks Soil and Water Conservation District provides easy, yet effective, dog waste composting practices that reliably destroy pathogens found in dog feces. The guidelines were developed based on research trails conducted in 1991 with dog kennel operators in Fairbanks, Alaska, to evaluate the possibility of composting dog waste in northern climates. *The document stresses that compost must reach 145 degrees F for several days to destroy pathogens.* It also discusses health risks associated with handling pet waste and recommends not applying dog waste compost to crops intended for human consumption. The document concludes that "composting dog waste is a simple, inexpensive method for disposing dog waste that can enhance the environment and reduce the amount of waste deposited in landfills." The method is intended for managing dog waste for 10-20 dogs housed in one location.

Design, Testing and Implementation of a Large-Scale Urban Dog Waste Composting Program, Concordia University, Montreal, Quebec, Canada (Nemiroff, L. and J. Patterson, 2007).

This study describes an experimental large-scale dog waste composting program that was initiated at the Notre-Dame-de-Grace dog run (estimated 50-75 dogs/day) in Montreal, Quebec. In two months, a total of 470 lbs of dog waste and 72 lbs of sawdust were placed into two research compost bins resulting in 394 lbs of compost. Enthusiasm for the project resulted in the implementation of a full-scale composting program with nine bins filled over a 12-month period. Annually, the program diverts 2,115 lbs of dog waste, 300 lbs of sawdust, and at least 7,000 plastic bags from Montreal's landfill and produces 1,700 lbs of compost.

Figure 17. In-vessel tumbler that will be used for dog waste composting trials in the near future. Photo courtesy of EnviroWagg.

It is notable that temperatures in the bins peaked between 40°C and 55°C (104°F and 131°F) and were not maintained long enough to ensure that pathogens were eliminated. The Ontario Ministry of the Environment requires manure to be composted at 55°C for a minimum of five days to meet standards for unrestricted use of compost. For this reason, the program recommends that compost generated from this project must be used in locations where no children play, or dog park sites, and that rubber gloves be worn when handling dog waste and dog waste compost. No discernible odors were experienced once the dog waste was covered with sawdust and no odors were detected in the spring when the bins thawed.

Dog Waste Composting Facility for Commercially Available Compost, EnviroWagg, LLC, Aurora, Colorado.

EnviroWagg is a company that builds community partnerships in an effort to compost dog waste into "Doggone Good Compost, a safe and nutrient-rich soil amendment that greens up gardens." While the company recognizes the risks of backyard dog waste composting, it maintains that professional, "high volume, high-heat dog waste composting by conscientious, well-informed individuals" is quite possible.

EnviroWagg conducted a dog waste trial at a commercial composting facility in 2008. Large quantities of dog waste from community parks were combined with bark, enzymes, and mychorrizae and commercially composted in a static, aerobic system where the materials were cured, tested, and bagged. Doggone Good Compost is currently sold at local retail centers.

The company is now working with the local jurisdiction and community to procure large quantities of dog waste that will be composted using an in-vessel tumbler system (Figure 17). The company generates revenue to support the program in a variety of ways. They procure dog waste from businesses and animal shelters for a fee comparable to solid waste collectors and solicit sponsorships to cover the cost of services for several dog parks. Additional revenue includes compost sales and advertising by daycare facilities and businesses that want to demonstrate their support for green practices that upcycle waste in a way that benefits the environment. EnviroWagg offers a number of resources relating to the current status of dog waste research and general information on their web-site (http://www.envirowagg.com/index.html).

Pet Waste Composting Facility for Commercially Available Compost, Green Pet Compost Company, Portland, Oregon.

Green Pet Compost Company (GPCC) is a pet waste collection and composting company serving Portland, Oregon and Gig Harbor, Washington, with plans to expand into Tacoma, Seattle, and Bainbridge Island. The company collects over 10 tons of pet waste per week from residential and commercial customers via curbside pick up service and composts the waste together with wood chips, sawdust and grass clippings in an in-vessel composting system located in western Washington. The contained system maintains constant temperatures between 140-145º F for a minimum of 72 hours to ensure that the nitrogen-rich compost is pathogen-free. Green Pet Compost (.5 cu ft bags) is commercially available on-line and will be offered through retailers in the near future. The company distributes compostable bags of various sizes to its clients for $10.95 (100 bags). GPCC has future plans to design and construct an anaerobic digester for pet waste to produce bioenergy and fertilizer and/or compost.

Anaerobic Digestion

As noted earlier, anaerobic digestion is the process through which organic materials are broken down in the absence of oxygen, producing a gas composed primarily of methane and carbon dioxide. This is a well-tested method of recycling various waste streams, however, it has only recently been applied to dog waste management. A recent study conducted by the National Center for Energy Research and

Development at the University of Nigeria (Okoroigwe, E.C. et al. 2010), found that dog waste has a high potential for biogas production, more so if blended with field grass or cow dung. Researchers believe that microbes in dog waste may actually enhance biogas production of field grass by breaking down the molecular structure of the grass allowing for anaerobes to digest it.

Streetkleen, north Wales, UK

Several communities are already working towards establishing a larger scale infrastructure that uses anaerobic technology as a way to treat dog waste. In addition to building a small demonstration digester at a park in Cardiff, north Wales, StreetKleen will also implement a larger scale plan for handling this waste which will involve two possible solutions, or combination of both. First, Streetkleen is investigating the possibility of adding dog waste directly to an already established anaerobic digester facility that handles agricultural waste. The company's research and development facility just outside Wrexham houses a fully operational digester servicing the largest organic farm in Wales. The 1,000m^3 digester currently produces 160 kWh from 24 tons of cow slurry and 6 tons of chicken litter. Streetkleen is working with the Environment Agency to approve dog waste as an acceptable feedstock for large AD facilities. The process takes time as environmental and lab based data are reviewed and evaluated regarding potential risks of spreading the resultant digestate on agricultural land used in food production.

Second, Streetkleen has partnered with a manufacturing company to create the Streetkleen Micro (2 models), a compact, easy to install, fully integrated anaerobic digestion system with the capacity to treat between 0.5 and 2.5 tons (1,100 to 5,500 pounds) of food and bio waste per day and generate between 8kWh and 55kWh electricity using a combined heat and power unit to burn the biogas (Figure 18). The system is built entirely within a 40ft recycled shipping container that can be located next to a school, waste facility, hospital, or similar venue. The system includes pasteurization enabling the residual organic digestate to be sold as fertilizer or mulch. The 0.5 ton and 2.5 ton systems cost $220,000 and $450,000 respectively with an anticipated payback time of 3 to 6 years (depending on feedstock and commodity prices). Given the relatively small, localized tonnages associated with dog waste, the Streetkleen Micro is seen as the best option for treating this waste and providing bio-energy to the region.

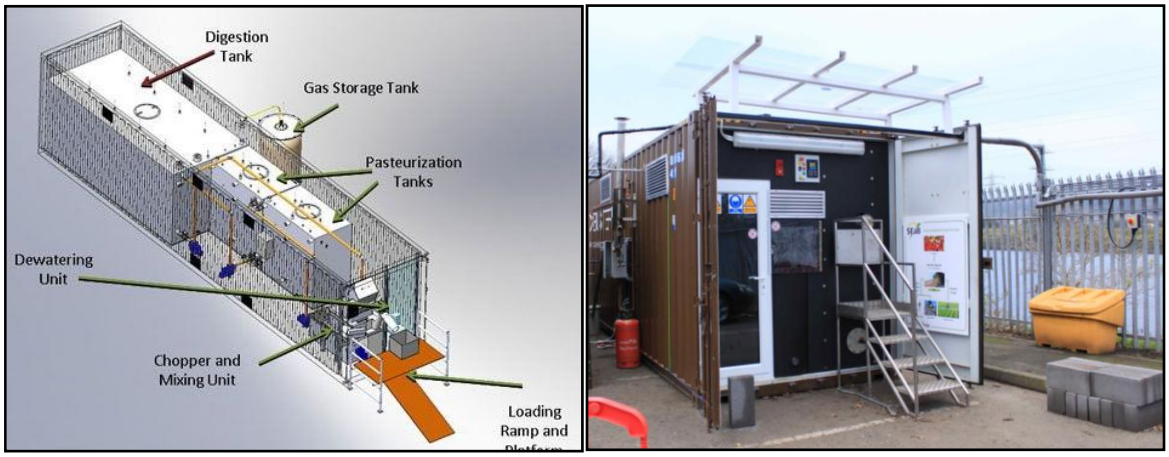

Figure 18. The Streetkleen Micro, an anaerobic system that can treat between 200 and 1000 tons of food and bio waste per year. Photo courtesy of Streetkleen.

Living Arts Systems, Colorado

In the U.S., a Colorado-based company, Living Arts Systems, offers several commercially available anaerobic digesters. The first is an in-ground 10m3 casted-concrete hydraulic-pressure digester. It is a Chinese style fixed dome digester that can accept 200 pounds of feedstock per day. Additional units can be placed in series or parallel to accommodate larger volumes. The cost is $15,000-$25,000 depending on site specifics and options. The second model is based on the first, but with increased gas storage and capability of scrubbing the gas and compressing the methane into cylinders at a rate of two gallons per day gasoline equivalent depending on feedstock. The cost is in the $50,000 range.

Environmental Energy and Engineering Company (E3), Olympia, Washington

Locally, Environmental Energy and Engineering Company (E3), a private engineering and construction management corporation, produces renewable energy from liquid or solid waste, animal manure, yard waste and the food fraction of municipal solid waste. The company has developed a variety of anaerobic digestion technologies that maximize the conversion of solids to biogas and biogas to methane. In 2006, E3 completed the design of a 40 ton per day solid waste anaerobic digestion facility in Mason County.

E3 was approached by a major metropolitan city to design a small anaerobic digester unit for dog waste at a park. After consideration, E3 declined, but gave considerable thought to the idea of a broader, more centralized system. The company maintains that dog waste should be handled in the most economically and environmentally beneficial way. Small anaerobic digester units will keep dog waste off the ground and out of the landfill, but they still require money, energy, and water to function and create a nitrogen-rich slurry that will require treatment at a wastewater treatment facility. Instead, the company has designed what they believe to be the most effective way to generate a usable, profitable product. The idea involves positioning collection stations for dog and other organic wastes throughout town, which utilize a "special technology" to process the waste directly within the collection station itself. The processed waste is now in a form that is extremely easy to transport and efficient to burn for energy. E3 can design the system and claims that it is relatively inexpensive to build.

PART 4 - RECOMMENDATIONS

Installation of an Anaerobic Digester at Hawks Prairie Off-Leash Area

The idea of installing a small anaerobic digester for dog waste in a park setting is still in its infancy. The Park Spark Project was not designed for long-term sustainability. Those that are currently applying this technology to their own parks are challenged with developing a system that is appropriate for their climate and self-sufficient enough to not require significant resources to sustain it. The technology specific to this application, however, is advancing rapidly and new projects are cropping up each year. Therefore, the County can either take a position to "wait and see" how current projects are advancing or choose to participate in moving this work forward.

It is important to recognize that while the installation of a small digester is a positive step towards "greening" the park in terms of reducing waste to the landfill (over 15,000 pounds of dog waste per year and associated plastic bags) and "upcycling" dog waste into usable commodities, there are limitations to what it can accomplish. The methane generated by the digester will likely be used for smaller scale applications (e.g. lamppost, water heating), and the slurry, if not turned into compost, will need to be treated at a wastewater treatment facility. Instead, the digester will likely be a symbolic demonstration of what can be done with this waste stream on a larger scale. In fact, the real power behind the installation of an anaerobic digester unit at a dog park is to 1) provide a new, creative, and interactive opportunity for outreach and education related to the importance of cleaning up after dogs in terms of human health and water quality; and 2) demonstrate potential uses (large scale and regulated) for this organic waste.

If a project in Thurston County moves forward at this time, one can probably expect to dedicate a fair amount of time to designing, monitoring, and optimizing methane production within the first year. The AART-1 (Living Arts Systems), and WSU's small anaerobic digester for the Pacific Northwest climate are both promising options that may, or may not, require significant maintenance requirements. That said, such a project appears to have community and jurisdictional support and with a carefully selected project team for support and maintenance, a promising chance of being successful. The project is estimated to cost $30,776 for the first year (Table 1). Funding would likely come from a combination of grants, private sponsors, and in-kind contributions. Future sustainability would depend on support from local departments and organizations (Solid Waste, Parks Department, Sound Hounds, or others) that would be responsible for ongoing maintenance costs estimated at $3,500 annually (bags, monitoring, pumping). Potential sources of funding for such a project are outlined in Appendix B of this report.

Table 1. Sample budget for anaerobic digester project – Year 1 (May – September)

PERSONNEL	
Installation (2 staff, 4 hrs/each, $50/hr)	$400
Digester monitoring [72 hrs@$42/hr + in-kind (PSI, students)]	$3,024
Outreach [56 hrs@$42/hr + 100 hrs in-kind (PSI + Sound Hounds)]	$2,352
EQUIPMENT AND SUPPLIES	
AART-1 Digester or similar	$15,000
Interpretive signage	$2,500
Bags (150 days, 200 bags/day, $.06/bag)	$1,800
Miscellaneous Equipment	$500

TRANSPORTATION AND OTHER SERVICES	
Shipping – FEDEX Freight (1,400 miles, 1,500 lbs)	$1,200
Pumping	$500
Analytical Testing (slurry, compost)	$1,500
Compost Trial	$2,000
TOTAL	**$30,776**

Large-scale Alternatives to Dog Waste Disposal

While the installation of a pilot anaerobic digestion project in Hawks Prairie off-leash area will provide a valuable opportunity to educate and engage pet owners, other opportunities exist for a more comprehensive management of dog waste. Animal Services estimates that there are 50,000 dogs in Thurston County alone producing approximately 11 tons of waste per day. Counties across Puget Sound have dedicated significant resources to educating the public about proper disposal practices for dog waste in an effort to protect human health and water quality. The Washington Waters and Puget Sound Starts Here campaigns have helped promote the State-wide, regionally accepted motto "Scoop It, Bag It, Trash It." Any future discussions pertaining to dog waste disposal alternatives should remain consistent with this message. Discussions should focus on what to do *after* the waste is properly disposed of (e.g. Scoop It, Bag It, Trash It, Upcycle It), and should guarantee protection of human health above all.

Exploring alternatives to the current dog waste disposal system would support Washington's Beyond Waste Plan, the Thurston County Solid Waste Plan and the City of Olympia's Towards Zero Waste Plan. "Beyond Waste" is the State plan for managing hazardous and solid waste with the goal of "eliminating wastes and toxics whenever we can and using the remaining wastes as resources." Within this program is the Organics Initiative:

> *"The Organics Initiative supports research and development of processes and products to close the loop on organic materials. Keeping organics out of the landfill reduces greenhouse gas emissions by decreasing methane released during its decomposition. Turning organics into compost, bioenergy, biofuels and other products, promotes economic vitality in growing industries, and protects the environment by turning waste into resources. Anaerobic digestion is one of many important systems that will help us meet our closed loop organics recycling goals."*

Many organizations, companies, and agencies in Thurston County support the idea of engaging in a discussion about ways to eliminate dog waste from the solid waste steam. Thurston County Solid Waste welcomes this dialogue, particularly in the wake of recently publishing "Reducing Our Use, Plastic Shopping Bags" study. The department is constantly implementing new and creative ways to reduce the volume of solid waste to the landfill, including the organic fraction, and sees this as a worthwhile pursuit. Stream Team and Sound Hounds have also expressed support. LOTT has offered to assist with technical questions related to the anaerobic digestion process. Animal Services and Lawn Doodles, a professional scooping service in this region, are also very interested in finding alternatives to landfill disposal. Animal Services houses up to 8,000 animals per year and calculates that the dogs alone generate 500 gallons (100 5-gallon buckets worth) of waste annually (substantially more if cat waste/litter are included). Lawn Doodles fills a 1-yard dumpster per week with dog waste. Both pay to have their dog waste hauled to the landfill and are eager to participate in research or pilot programs to put this waste to beneficial use.

Finally, the founders of Streetkleen, the Poo Project, and Envirowagg are extremely supportive and willing to share information freely in an effort to advance research and efforts worldwide.

While many organizations and agencies support this work, others have expressed reasonable concerns. Thurston County Environmental Health (B. Dean, conversation) expressed the following concerns about treating dog waste using anaerobic digestion: high capital investment associated with this technology, pathogen treatment, procurement of significant quantities of feedstock, and the disposal/use of digestate. Concerns related to composting dog waste include pathogen reduction, leachate management, and adherence to regulations regarding pathogen harboring materials.

Washington Department of Ecology (D. M. Maurer, conversation) asserts that landfilling is the best disposal option for dog waste at this time based on current available technology and economics, but does not discount the adoption of new practices in the future. Large scale digestion of dairy waste requires an enormous capital investment that has proven difficult to repay in a timely manner. Their operations require dedicated, skilled technicians to satisfy maintenance and safety requirements. In addition, the units are extremely sensitive to contamination issues and, in most cases, do not include screening mechanisms making it highly unlikely that existing digesters would accept dog waste. Finally, while the digestion process reduces pathogens, it does not reduce the high nitrogen content associated with dog waste making land application risky in terms of water quality for some Puget Sound counties. Ultimately, WDOE warns against creating systems in which the capital investment, coordination, transportation, maintenance, and oversight expenditures exceed, or negate, the sought after environmental benefits.

Future discussions for large-scale pet waste management should include a number of key players including Washington Department of Ecology, Thurston County Solid Waste, Thurston County Environmental Health, Washington State University, Stream Team, LOTT, Sound Hounds, and Animal Services. When developing such a program, the following potential considerations should be discussed:

1) Procure large quantities of dog waste from residential, commercial, and public (dog parks) sources. Collection might be performed by a private company (e.g. LeMay, existing scooping service, etc.) or non-profit organization using revenue generated from residential service fees or the transfer of solid waste disposal costs.

2) Transfer dog waste to a mid-size anaerobic digestion system (similar to the Streetkleen Micro) located near Animal Services, Thurston County transfer station, or other location, to handle dog waste and other organics and generate biogas and fertilizer.

3) Transfer dog waste to an enclosed facility for large-scale, regulated composting while focusing on creative ways to market the product.

4) Facilitate a partnership with Green Pet Composting Company to collect and transfer dog waste to their existing compost (and proposed digestion) facility.

5) Establish a small anaerobic digester for dog waste that will serve to educate the public about the importance of cleaning up after pets while directing attention to larger scale efforts to eliminate this material from the landfill and generate valuable commodities.

CONCLUSION

While the current pet waste management system in Thurston County protects human health and water quality, it results in the distribution of organic waste and plastic bags in the local landfill. As jurisdictions continue to work towards meeting local waste reduction plan goals, it may be time to initiate a discussion about ways to turn this organic waste into a commodity. Collaborating with others throughout Puget Sound and internationally will advance research and ensure that safe and environmentally beneficial solutions are adopted for this particular waste stream region-wide. Installation of an anaerobic digester at a local off-leash area will provide a unique opportunity to educate and engage pet owners, students, and local businesses in pet waste management and pave the way towards adopting sustainable solutions in the future.

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http://www.co.thurston.wa.us/wwm/Publications/Solid%20Waste/Thurson%20SWMP%20072409.pdf

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US EPA AgSTAR Program – http://www.epa.gov/agstar/

WDOE – Organic Waste Recycling Document
http://www.ecy.wa.gov/beyondwaste/pdf/ClarkOrganics.pdf

WDOE – Solid Waste Laws and Regulations
http://www.ecy.wa.gov/programs/swfa/nav/lawsregs.html

WDOE - Anaerobic Digestion
http://www.ecy.wa.gov/programs/swfa/ad/

WDOE – Producing energy and fertilizer from organic municipal solid waste through anaerobic digestion
https://fortress.wa.gov/ecy/publications/publications/0707024.pdf

WDOE – Washington State's Waste Reduction Plan
http://www.ecy.wa.gov/beyondwaste/

Washington State Compost Educator's Guide
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Washington State University's Climate Friendly Farming – Small Scale Biogas Technology:
http://csanr.wsu.edu/pages/Small-Scale_Biogas_Technology

Zhi-Wu Wang et al. (2009). WSU Invention Disclosure – Advanced small-scale anaerobic digester design tailored for household user living in cold climate. Available at:
http://csanr.wsu.edu/publications/patents/Smallscale%20biogas%20invention%20disclosure%204%2009.pdf

APPENDIX A - Contact Information

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Biorecycling Inc., Centralia, WA. Contact: Roger Hickey, 360-455-3386.

City of Gilbert. Contact: Louis Andersen, Environmental Manager, 480-503-6426.

Custom Bioplastics, Burlington, WA. http://www.bio-buddy.com Contact: Dick Mathes-General Manager sales@custombioplastics.com.

Environmental Engineering and Energy Company, Olympia, WA, http://makingenergy.com/index.php Contact: Dennis Burke, 360-923-2000.

EnviroWagg, LLC., Aurora, CO, http://www.envirowagg.com/index.html Contact: Rose, envirowagg@comcast.net.

Fire Mountain Farms, Onalaska, WA. Contact: Bob Thody, 360-266-0695.

Green Pet Compost Company, Portland, OR, http://www.greenpetcompostcompany.com/ Contact: Steve, steve@greenpetcompostcompany.com, 877-379-0005.

Lawn Doodles Poop Scoopers, Shelton, WA. http://www.lawndoodles.com/ Contact: Evie Bradford evie@lawndoodles.com 360-427-1024.

Living Arts Systems, Crestone, Colorado. http://www.livingartsystems.com/ Contact: Nicholas Chambers nick@livingartsystems.com 719-256-5572.

LOTT Clean Water Alliance, Olympia, WA. http://www.lottcleanwater.org/ Contacts: Lisa Dennis Perez, 360-664-2333 and Ken Butti, 360-528-5708.

Patent Office – E-TURD Project. Contact: William Loux, bloux@azte.com.

Poo Power Project, Melbourne, Australia, http://www.poopower.com.au/index.html. Contacts: Duncan Chew, duncan@poopower.com.au, Margaux Hayes, margaux.hayes@gmail.com.

Silver Springs Organics, Rochester, WA. http://www.silverspringsorganics.com/ Contact: Samantha L. Fleischner, 360-446-7645 X102.

Sound Hounds, Olympia, WA. http://www.soundhounds.org/ Contact: Lynn Scroggins - President, info@soundhounds.org, 360 943-2119.

StreetKleen, Flintshire, North Wales, UK. Contacts: Gary Downie, gary@streetkleen.co.uk and Dr. John Walsh, john@streetkleen.co.uk.

Thurston County Animal Services, Olympia, WA. http://www.jointanimalservices.org/index.htm Contact: Susanne Beauregard susanneb@jointanimalservices.org.

Thurston County Environmental Health Division, Thurston County, WA. http://www.co.thurston.wa.us/planning/natural-res/shellfish-pet-waste.htm Contact: Bill Dean, deanbf@co.thurston.wa.us, 360-867-2639.

Thurston County Solid Waste, Thurston County, WA. http://www.co.thurston.wa.us/solidwaste/ Contacts: Scott Schimelfenig, schimes@co.thurston.wa.us; Loni Hanka, hankal@co.thurston.wa.us; Terri Thomas thomaste@co.thurston.wa.us.

Thurston County Stream Team, Thurston County, WA. http://www.streamteam.info/ Contact: Erin Keith, 360-438-2687.

Washington Department of Agriculture, WA. Contact: Chery Sullivan - Technical & Compliance Specialist, csullivan@agr.wa.gov, 360-902-1928.

Washington Department of Ecology, WA. Contacts: Kyle Dorsey, kdor461@ecy.wa.gov, 360-407-6559; Dawn Marie Maurer dmau461@ecy.wa.gov, 425-649-7192; Al Salvi, asal461@ecy.wa.gov, 360-407-6287.

Washington State University, Pullman, WA. Contact: Dr. Craig Frear, Ph.D. cfrear@wsu.edu, 509-335-0194.

Woodland Park Zoo, Seattle, WA. Contact: Dan Corum, Dan.Corum@Zoo.org, 206-548-2633.

APPENDIX B - Potential Funding Sources

1. Bullitt Foundation
http://bullitt.org/urban-ecology

The Bullitt Environmental Fellowship is a two-year, $50,000/year fellowship *for graduate students* interested in pursuing leadership positions within the environmental field. Program priorities include promoting green architecture and ecologically sensitive urban design and encouraging environmentally friendly infrastructure and waste management.

Applications must be submitted by April 1st each year.

2. Giles W. and Elise G. Mead Foundation: Environmental Grants
http://www.gileswmeadfoundation.org/

The Mead Foundation supports organizations dedicated to preserving and improving the environment, the advancement of medical science, and other important social needs.

Awards average $25,000.

3. Paul G Allen Family Foundation – Science & Technology Program
http://www.pgafoundations.com/

This program advances research and technological developments that have the potential to expand knowledge, improve health, and protect the environment. The Foundation supports the development and applications of technology to protect the environment and mitigate climate change. Grant applications are by invitation only. Awards range from $15,000-$100,000.

4. The Russell Family Foundation (TRFF) – Environmental Sustainability Program
http://www.trff.org/home.aspx

The Environmental Sustainability Program is committed to improving the protection and restoration of Puget Sound via three focuses: polluted runoff and green infrastructure, environmental education and the Puyallup watershed. Projects that fall under the Polluted Runoff and Green Infrastructure Program include those that engage the public to understand how their activities affect Puget Sound water quality and to change their behaviors that contribute to polluted runoff. TRFF will consider funding projects that improve citizens understanding of polluted runoff, and model programs that engage citizens in creating more sustainable communities that reduce impacts on Puget Sound.

For funding in 2013, Letters of Inquiry (LOI) are due by October 15, 2012, January 28, 2013, or July 15, 2013. Average grant size is $48,000.

5. USDA-AgSTAR-Funding Programs for Developing Anaerobic Digestion Systems
http://www.epa.gov/agstar/documents/agstar_federal_incentives.pdf

Applicable to large-scale systems but not small digesters.

6. U.S. EPA Environmental Education Grants:
http://www.epa.gov/education/pdf/solNotice2012.htm

The purpose of the Environmental Education (EE) Regional Grant Program is to increase public awareness and knowledge about environmental issues and provide the skills that participants in its funded projects need to make informed environmental decisions and take responsible actions toward the environment. Community Projects should address environmental stewardship in a local formal or informal educational context in rural, suburban and urban settings, and using outdoor, place-based, experiential, service learning and/or community-focused stewardship activities as the primary teaching tool(s). One priority area, Cleaning Up Our Communities, targets projects that provide guidelines for safe and environmentally-friendly practices in waste management and support the redevelopment and reuse of potentially contaminated sites.

Application deadline is December 12, 2012 (may be suitable for next round) Awards are given to one applicant per region and do not exceed $216,000 per project.

7. Washington Department of Ecology – Public Participation Grant
http://www.ecy.wa.gov/services/ee/grants.html

Public Participation Grants (PPG) offer funds to non-profit organizations to educate Washington residents about environmental issues in the state. Funding for Waste Management Projects are available that encourage citizen involvement in eliminating and reducing waste and toxics. PPG funds "encourage the practical and responsible reuse of materials currently going to disposal sites as waste." They cover administrative costs, learning tools, educational outreach and public activities such as meetings and workshops.

The program expects $3 million for the upcoming two-year cycle (up to $120,000 per project). Applications due January 7, 2013.

8. Washington Department of Ecology – Waste 2 Resources Program - Coordinated Prevention Grants (CPG)
http://www.ecy.wa.gov/programs/swfa/grants/cpg.html

The goals of the program are to minimize or eliminate the generation of solid waste and hazardous substances in order to protect, preserve, and enhance the air, land, and water resources of Washington State. The CPG program protects human health and the environment by reducing human exposure to toxins, reducing waste, ensuring proper management of solid and household hazardous waste, and promoting energy and resource conservation. CPG provides funding assistance to local governments for planning and implementing their local solid and hazardous waste management plans.

Due to budget shortfalls, full allocation of funds did not occur. CPG needs the full allocation to start the next regular cycle (2012-13) and offer a competitive offset cycle (2013-14).

9. Washington Foundation for the Environment (WFFE)
http://www.wffe.org/guidelines.html

WFFE focuses primarily on environmental education and favors projects that have a significant positive effect on public awareness of environmental issues, involve imaginative technical approaches that would

make its success instructive, and where the proposed uses of the project site and access to it will result in education about environmental matters.

Grants range in size from $200 to $2,000 and are awarded throughout the year.

10. Wells Fargo Environmental Grant Program:
https://www.wellsfargo.com/about/csr/ea/environmental-giving

Wells Fargo offers grants focused on addressing local environmental priorities in the community and providing support that fosters innovation to help accelerate a "green" economy. The WF Environmental Solutions for Communities Grant Program is funded through a partnership with the National Fish and Wildlife Foundation. Projects focus on sustainable agriculture and forestry, water quality, land conservation and healthy urban eco-systems. Awards range from $50,000-$150,000 per entity and target cities rotate annually.

The funding cycle is April 1, 2013- October 31, 2014.