FOG to Fuel:

Keeping Missouri's Resources from Going Down the Drain

Energize Missouri Renewable Energy Study

FINAL REPORT

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Project Background

The Missouri Department of Natural Resources (DNR) awarded H2O'C Engineering a sub-grant to investigate the fate of Fats, Oils, and Grease in Missouri's two major metropolitan statistical areas (MSAs). The comprehensive feasibility study has concluded as set forth in the initial Application and subsequent Agreement dated August 16, 2010. For this subgrant, the project team of H2O'C Engineering and subcontractor BlackGold Biofuels investigated the two largest and most viable grease sheds in the State: St. Louis and Kansas City. This report includes a comprehensive evaluation of the volume, availability, and quality of sewer FOG in the targeted MSAs, as well as site assessments, economical analyses, a basis of design, and an implementation plan.

Section I. What is FOG?

FOG stands for Fats, Oils and Greases, and in the wastewater industry, FOG is known as the solid gel-like substance that sticks to sewer pipes, clogs mechanical equipment and generally wreaks havoc on infrastructure. From a chemical stand point; FOG is composed of a conglomeration of animal fats and vegetable oils and consists of a varying array of glycerides (triglycerides, diglycerides and monoglycerides) and an acidic compound called free-fatty acids (FFA). By the time that these substances are harvested from sewers, wastewater treatment plants or restaurant grease traps, they have typically gone rancid and have a severe pungent odor.

Figure 1: Pipe clogged with grease

From a nomenclature point of view, FOG that enters drains from restaurants, gets recovered from grease traps, and is cleaned up is called brown grease. Brown grease, when free from contaminants such as food particles, trash and water, can be converted into biodiesel by processes called esterification and transesterification. Since brown grease has high levels of FFA (50-90%), and conventional biodiesel conversion technologies are often limited to low-FFA content fats (<15% FFA), this material has generally been ignored as a feedstock for alternative energy production. New technology in the marketplace is changing that perception of FOG, and one of the purposes of this study is to determine if an opportunity exists within the State of Missouri to utilize such a feedstock for alternative energy production.

For the purposes of this study, only high-FFA brown grease was evaluated; cleaner feedstocks, such as yellow grease, white grease, and other virgin oils that are typically used in biodiesel production were not included in this study due to their commodity pricing and alternative markets. Brown grease, in most cases, is considered a waste product with no valuable use; it is collected, minimally processed, and disposed of in a landfill, through land application, or in an incinerator or digester. In rare cases, high-grade brown grease can be used as a burner fuel.

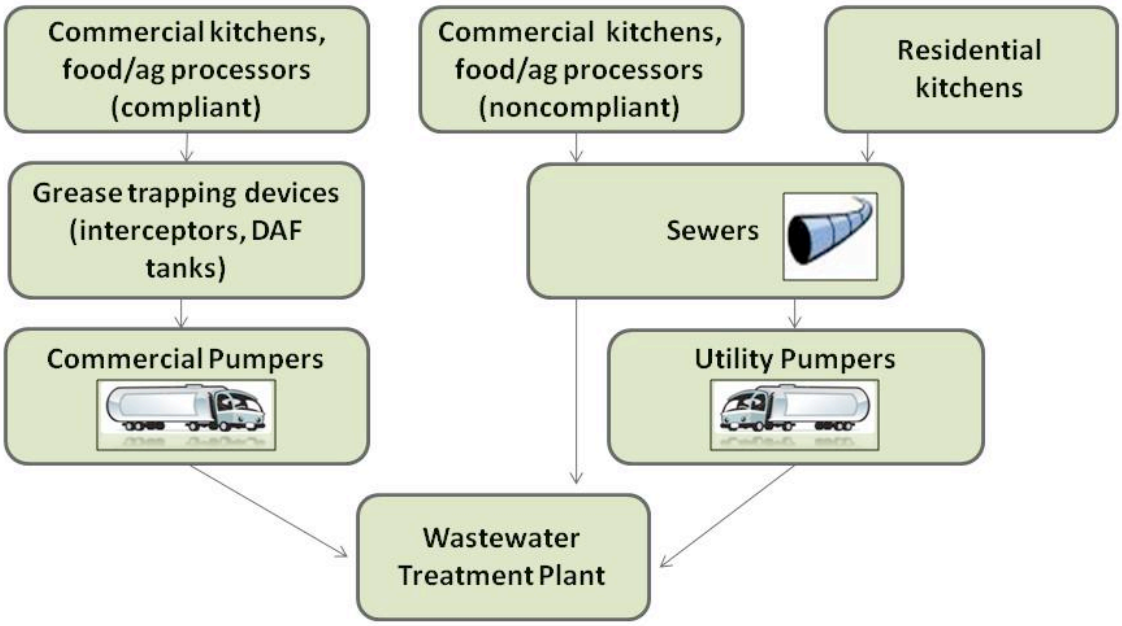
Section II. Common Pathways for FOG Disposal

FOG enter the sewer system through sinks and drains during food preparation and dishwashing in homes, restaurants, and commercial food processing businesses. Some FOG is caught before it enters the sewer system by devices such as grease traps and dissolved air flotation tanks, which commercial kitchens (restaurants and food processors) are required to install. These businesses pay pumpers to regularly remove the grease from these traps and transport it long distances to one of the few wastewater treatment plants that accepts the grease. Pumpers then pay the wastewater treatment plant to dispose of the grease.

Grease from households and non-compliant commercial kitchens flows directly into the sanitary sewer. This grease flows through sewer pipes to the wastewater treatment plant, where it gums up machinery and requires vast sums of energy to break down, reducing operational efficiency and increasing energy costs. Ultimately the grease is skimmed off the top of treatment tanks and segregated for disposal. The figure below illustrates how sewer grease aggregates at wastewater treatment plants.

Grease traps are not 100% effective in capturing grease that goes down restaurant drains and households and other establishments discharge food wastes and grease to the sewer system. Therefore a majority of grease is handled by wastewater treatment utilities, and is the focus of this paper.

Figure 2: Grease Flow Diagram



FOG handling and disposal is a major expense to wastewater utilities, often costing millions of dollars per year in operation and maintenance (O&M) costs and lost infrastructure lifespan. Increasing compliance with FOG codes and reducing FOG-related utility expenses through high-value beneficial reuse presents a major opportunity to improve operational and financial efficiency. Other less utilized pathways include direct land application, composting, dewatering and landfilling, or rendering for brown grease. Brown grease can be employed as an energy

source and is sometimes illegally used in animal feed. Both of these pathways are legislatively frowned upon and will soon no longer be viable pathways as the EPA intensifies regulations and seeks to eliminate sulfur emissions from off-road vehicles utilizing brown grease.

FOG in Wastewater Treatment

Historically, the primary goal of FOG management was to protect sewer infrastructure and treatment plants. To date, FOG management efforts have been both ineffective and costly. Ineffectiveness is evidenced by rampant noncompliance; New York City determined there was a 73% noncompliance rate among its restaurants[1]. Noncompliant discharges result in substantial expenses for utilities; the City of San Francisco estimates its FOG costs on the order of $50 million a year. Of San Francisco's FOG costs, $3.5 million are operations and maintenance related (removing FOG from the sewer lines and addressing FOG related overflows), while upwards of $47 million is lost in infrastructure lifespan[2]. In its Report to Congress, the EPA stated that FOG is the most common cause of reported sewer blockages[3]. Over and above causing blockages and infrastructure deterioration, once at the treatment plant, FOG coats equipment, clogs pipes and pumps, and increases pumping and aeration energy demand, which reduces operational efficiency and treatment effectiveness, while increasing treatment costs.

Depending on a treatment plant's configuration and ease of access, FOG can be injected at any point in the process. The majority of treatment plants that handle grease inject it into the headworks with the hopes that the treatment process will breakdown and consume FOG. In most cases, this technique is unsuccessful for the reasons described below.

Some treatment plants inject FOG at other points in the process (digesters, incinerators, thickening and sludge dewatering). In most cases, FOG ultimately ends up mixed with biosolids and disposed of along with the treatment plant's biosolids despite FOG's high energy value and different physical properties.

Primary Treatment

Primary treatment at a WWTP involves screening and settling wastewater. Primary sedimentation tanks allow settleable solids to accumulate on the bottom, and scum, consisting of FOG and other materials, floats to the surface where it can be skimmed off.

Secondary Treatment

If FOG bypasses primary settling, it enters the secondary treatment process, which is a biological processes. Activated sludge is the most common method of secondary treatment. Air is pumped through the wastewater to promote the growth of microorganisms capable of breaking down the organic matter. Aeration accounts for more than half of the energy used in WWTPs. A typical WWTP that utilizes the activated sludge process would be expected to use on the order of 4,000 kWh of electricity per MG treated.

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[1] EPA, Office of Water, EPA-833-F-07-007, June 2007

[2] Jordan, 2009

[3] EPA, Impacts and Controls of CSOs and SSOs, EPA-833-R04-001, August 2004

Sludge Handling

Historically, treatment plants' efforts to handle FOG have included incinerating sewer grease to offset the energy demand of sludge incinerators and adding sewer grease to anaerobic digesters to increase the production of methane-rich biogas, which can be employed for energy use. Some WWTPs have recycled FOG material back to the land through composting or land applying. Others have dewatered FOG to dry grease for land filling or sale as a fuel.

Anaerobic Digestion

Microbes can digest sludge in oxygen-free environments. The process is time- and space-intensive, requiring 12-30 days and 350,000+ gallon containment tanks to carry out digestion. Additionally, introducing FOG to a digester is a complicated process requiring close maintenance of operational parameters such as temperature, moisture content, and pH. The methane produced by anaerobic digestion must be captured, requiring additional infrastructure, and incomplete deactivation of pathogens in the digestate pose an environmental hazard. Most importantly, FOG to methane conversion yields a significantly lower net energy balance than FOG-to-biodiesel conversion, resulting in a 70% loss of grease energy content.

Filter Press

Filter presses remove the water from sludge, leaving behind the filtered sludge (filter cake) that can be disposed of in many ways. Filter presses require large quantities of inorganic conditioning chemicals and replacement of filter media is both expensive and time consuming.

Following its separation from water, sewer grease and sludge is typically disposed of in one of the follow ways:

Incineration

Sewer grease can be burned in incinerators, reducing the volume of FOG and killing pathogens but emitting greenhouse gases, toxic CO and particulate matter in the process. Though incineration reduces the amount of raw sludge, it presents significant environmental issues relating to both air emissions and solid waste generation. Sewage sludge incinerators (SSI) will be significantly affected by increased costs borne to comply with stricter Clean Air Act (Section 129) and the Clean Water Act (Part 503) standards. As regulations and public attention around emissions increase, incineration is becoming a less and less desirable option.

Landfill

Sewer grease can be buried in landfills, where it anaerobically decomposes. Sequestering grease in landfills requires investment into transportation to the landfill, and increasing scarcity of landfill availability poses a threat to the future of this disposal method. Additionally, the anaerobic decomposition of grease releases methane, which is 23 times more potent a greenhouse gas than carbon dioxide (CO_2).

Land Application

FOG can be mixed with soil and injected into or sprayed over agricultural land. Sewer grease is highly concentrated in urban areas with small areas of open agricultural land, however. The FOG can also leach into and contaminate groundwater; introduce pathogens into the ecosystem; coat plants, kill crops, and clog soil; and release volatile organic compounds and greenhouse gases upon decomposition.

Each of these wastewater treatment and sludge disposal methods presents viable options for water utilities, but their costly maintenance, production of pollutants, and energy inefficiency make alternative solutions more desirable from financial and environmental standpoints. The fact that these disposal options exist and yet FOG continues to be such a major industry issue is proof that they are ineffective solutions to comprehensive FOG management and utilization.

Section III. FOG impacts on Missouri

While theoretical study of the negative impacts of FOG is certainly interesting, the project team sought to evaluate exactly how FOG was impacting the MSA's of St. Louis and Kansas City.

St. Louis

St. Louis MSA is not unlike most wastewater utilities when it comes to its sewer infrastructure. With an aging collection system and cold average annual temperatures, St. Louis is highly susceptible to FOG issues. The EPA is currently in the process of cracking down on sewer overflows, and while St. Louis is not currently under consent decree, the threat of EPA action is looming. Since FOG is the largest cause of sanitary sewer overflows, FOG management through enforcement of grease trap ordinances has been a big push for the EPA and is seen as a promising means to accomplish sewer overflow reductions necessary to comply with the Clean Water Act. In fact, the EPA did a round of workshops in 2008 to educate state utility professionals on the impacts of FOG on infrastructure and means to mitigate the escalation of FOG issues in the state.

On the treatment plant side of wastewater, a novel approach is being pursued in the case of FOG management and handling within the St. Louis MSA. The Metropolitan St. Louis Sewer District (MSD) Bissell Point Wastewater Treatment Facility has a significant hauled waste-receiving program. MSD monitors and tracks hauled waste received at their facility in a detailed database. While collection of this type of data isn't novel per se, it is the analysis of this data that sets MSD apart from most wastewater utilities. Bissell Point engineers compile this data on an annual basis, segregate the hauled waste components (grease, septage and other industrial wastes), and calculate the cost of treating these various wastes. From this analysis, MSD is able to set hauled waste tipping fees that are appropriate for the given contaminant being dropped off.

Like most wastewater utilities that receive grease, MSD injects hauled waste grease into the head works. Since grease has a high energy content, it requires a significant amount of energy to break down. In 2010, treatment of these high-strength wastes accounted for greater than 50% of the total hauled waste cost. Although the hauled waste volume contributed to less than 1% of the total annual Bissell Point flow, its chemical oxygen demand (COD) and total suspended solids (TSS) load on the plant were 7% and 10% respectively.[4]

Kansas City

Since 2002, Kansas City has experienced approximately 1,294 illegal sewer overflows, including at least 138 unpermitted combined sewer overflows, 390 sanitary sewer overflows, and 766 backups in buildings and private properties.[5] On May 18, 2010, The U.S. Department of Justice and the U.S. Environmental Protection Agency lodged a consent decree against the City of Kansas City. As part of the agreement, the City of Kansas City agreed to spend an estimated $2.5 billion over a 25-year period to rebuild its sewer system and to eliminate the

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[4] Metropolitan St. Louis Sewer District Division of Environmental Compliance Hauled Waste Program, Annual Rate Review (January 2011)

[5] http://www.justice.gov/opa/pr/2010/May/10-enrd-584.html

unauthorized overflows of raw sewage into surface waters. Additionally, the consent decree required the city to pay a civil penalty of $600,000 to the United States.

Since no treatment plants in the Missouri section of the Kansas City MSA receive hauled liquid waste, the acute impacts of grease on treatment plant infrastructure are difficult to isolate and quantify. Additionally, the project team was unable to make successful connection into Kansas City's largest wastewater utility in order to identify more detailed information with regards to FOG impacts on treatment processes.

Section IV. FOG Assessment Objectives

Project Task 1 objectives focused on defining the grease sheds of each of the St Louis and Kansas City MSA. This involved locating FOG generators, collectors, and renderers, as well as Wastewater Treatment Facilities (WWTF) handling FOG. Specific project objectives were as follows:

- Determine the volume, availability, and quality of sewer FOG in densely-populated areas of Missouri with an emphasis on Kansas City and St Louis
- Characterize currently collected sewer FOG according to its origin or quality and document whether it could be collected, transported, stored, and processed
- Identify transportation needs and collection costs on a volumetric basis for sewer FOG

Methodology

The first step of the process required identifying the major entities involved in FOG production, handling, and treatment. This included all public and private wastewater utilities operating in the two metropolitan regions (within 30 miles of the city centers); major disposal outlets; major pumpers serving the Greaseshed®; major industrial fixtures in the area, including dairy and food processors, livestock owners, chemical manufacturers, grease renderers, and trade associations for utilities and private industries.

Colloquially referred to as pumpers, the waste haulers targeted in this study operate businesses that engage in the collection of grease trap waste (e.g., from restaurants), waste animal fats (e.g., from butchers), and waste industrial FOG (e.g., from food processors). Pumpers are the intermediates along the disposal chain, between FOG generators and FOG disposal. From local “mom and pops” with a single truck to market giants, such as Darling International, with fleets throughout the world, the pumping industry supports all scales of business operations. Due to the number of pumping entities in today’s market, competition is fierce and often drives a local market’s tipping fees; unfortunately, this severe competition can also lead cash-tight pumpers to illegal methods of waste disposal (e.g., dumping into rivers) in order to keep pace with larger competitors who can offer lower prices.

Data Gathering

Following the compilation of these research efforts into a comprehensive database, letters were dispatched to entities informing them of the nature of the project team’s study (Appendix A, B, C, D) and subsequently surveys were sent as well. These surveys were intended to determine the volume of FOG handled by each of the entities; which WWTPs accept trucked grease; how much scum each WWTP collects and where it is disposed; the source of the FOG and its quality; and the availability of FOG besides brown grease, such as yellow grease.

After a low survey response rate, a call campaign was conducted to facilitate direct contact with the entities and retrieve more data. Difficulty in obtaining more information prompted a physical visit by project team members in order to meet directly with haulers and WWTPs.

From the information collected, the project team developed an algorithm to describe how much grease is currently being processed by WWTPs and how much more may be available. According to the US Department of Energy, on average, a person living in a MSA generated approximately 13 pounds of trap grease annually[6]. Nationally, this equates to 4 billion pounds of trap grease per year; Missouri contributes 78 million pounds to the total[7].

At 7.5 pounds per gallon of raw brown grease and an 80% conversion rate of dry FOG to biodiesel, Missouri's current population could theoretically generate enough grease to produce 8.3 million gallons of biodiesel a year. In today's marketplace, that equates to over $33 million[8] in potential fuel cost savings annually if Missouri were to use the produced fuel in municipal fleets.

[6] Wiltsee, G. 1998. Urban Waste Grease Resource Assessment. National Renewable Energy Laboratory, SR-570-26141.

[7] "Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2009". United States Census Bureau.

[8] Assuming $4.00 / gallon commodity pricing

Section V. Site Assessment

Initial site assessment identified public and private WWTF's in each MSA. The following section lists these WWTF's and provides detailed information for those utilities and locations that are most relevant to this study.

St. Louis

The table below lists the WWTFs located in the St. Louis MSA. The project team reached out to each operating entity to discuss the current study and evaluate as a possible location for the proposed FOG-to-biodiesel site.

Table 1: Contacted WWTFs

MSA	Entity Name	County	Accept Trucked FOG?
St Louis	Spencer Creek WWTP	St Peters	No
St Louis	Bissell Point WWTP /St Louis HWRS		Yes
St Louis	Lemay WWTP	St Louis	No
St Louis	Coldwater Creek WWTP	St Louis	No
St Louis	Missouri River WWTP	St Louis	No
St Louis	Fenton WWTP	St Louis	No
St Louis	Lower Meramec WWTP	St Louis	No

SPENCER CREEK WWTP

The City of St. Peters operates a 6.5 MGD WWTP about 27 miles from St. Louis, serving 18,000 customers. The facility does not accept trucked-in FOG. Its current grease management method entails clarifying float grease, sending it to aerated holding tanks with sludge, and dewatering with a filter belt press. The system uses PVC pipeline, so there is no corrosion seen from FOG, but the 500-1000 gallons of FOG removed per year results in $10,000 costs.

- 30 diesel vehicles, both on and off road
- No alternative fuel program currently

METROPOLITAN ST. LOUIS SEWER DISTRICT (MSD)

We recommend the Metropolitan St. Louis Sewer District (MSD) as the optimal site for a FOG-to-biodiesel installation. The MSD features seven WWTFs. The Bissell Point treatment plant, featuring a 163 MGD system, accepts trucked FOG at $0.08/gallon, charged at the total truck capacity whether or not it is hauling its maximum capacity. Each day, approximately 16,000 gallons of fatty wastewater containing about 8,000 pounds of FOG pass through the WWTP each day, amounting to 4.5 million gallons of

wastewater from grease traps being processed each year. Additionally, the plant receives 400,000-500,000 gallons of food grease per month from haulers and has been increasing at a rate of 50,000 gal/year. This can provide 40,000 of usable brown grease per week after dewatering. Waste grease volume continues to increase approximately 9% annually.

In addition to significant volume of FOG processes by the city, St. Louis also purchases more than 300,000 gallons of fuel per year for its fleet. The City could drastically reduce its fuel purchases by utilizing biodiesel produced from FOG. The City's engineering consultant, Jacobs Engineering has ruled out incineration as a grease disposal pathway due to flaring, making conversion to biodiesel an even more viable option. Furthermore, a FOG-to-biodiesel conversion system will satisfy the MSD's interest in instituting a pilot plant to recycle residential cooking oil modeled after Daphne, AL.

Kansas City

Below is a list of the WWTFs located in the Kansas City MSA. The project team reached out to each entity to discuss the project and evaluate it as a possible location for the proposed site.

Table 2: Contacted WWTFs

MSA	Entity Name	County	Accept Trucked FOG?
Kansas City	Little Blue Valley Sewer District	Jackson	No
Kansas City	Public Works	Jackson	No
Kansas City	City of Independence WWTP	Jackson	No
Kansas City	City of Adrian	Bates	No
Kansas City	City of Alma	Lafayette	No
Kansas City	Misty Springs WWTF	Platte	No
Kansas City	Westside WWTP		No
Kansas City	Todd Creek WWTP		No
Kansas City	Rocky Branch Creek WWTP		No
Kansas City	Northland WWTP		No
Kansas City	Fishing River WWTP		No
Kansas City	Birmingham WWTP		Yes: digested sludge from Blue River for land application
Kansas City	Blue River WWTP		No Response

Little Blue Valley Sewer District

The Little Blue Valley Sewer District is a quasi-public wastewater wholesaler that operates a 52 MGD WWTP outside of Kansas City, in Atherton, approximately 40 miles from the heart of the metropolitan area. While it serves 278 square miles and 300,000 people, the facility does not accept trucked-in FOG. Additionally, the facility's wide pipes

have thus far prevented FOG clogging, and with 10% of the sewer system televised, clogs can easily be identified. On June 6, 2010, they implemented a pilot plant to turn sludge to oils and cellulose and ash (NOWA Technology) in lieu of land filling. The ash is subsequently turned into cement. The district has a $11.5 million budget for operations, rehab, and debt financing, which it uses toward contracting out waste removal by vacuum, sewer pipe jetting, and sucking out scum pits on clarifiers and gravity thickeners that are dewatered and taken to landfills. Sludge is eliminated by incineration.

Little Blue Valley also has a subdistrict, Middle Big Creek, and is pursuing the purchase of 69 acres at a future WWTP site in Pleasant Hill through bonds and a $38 million loan from the state DNR, in addition to the purchase of 5.5 acres adjacent to the Atherton plant.

Due to their inability to accept trucked-in FOG, their lack of FOG-clogged pipes, and their in-place sludge management techniques, we do not recommend the Little Blue Valley Sewer District as an ideal installation site for a FOG-to-biodiesel system.

Jackson County WWTP

The Jackson County WWTP features only one plant serving approximately 60 residents. Its two extended air plants are rated at 22,000 gallons; contain only one lift station, and have only 7,000 feet of pipe. The plant contains very little FOG, if any, and does not accept any trucked-in FOG. The plant digests any sludge it handles. Due to their low FOG volume and inability to accept trucked in FOG, we do not recommend Jackson County as an ideal installation site for a Fog-to-biodiesel system.

North Kansas City WWTP

The North Kansas City WWTP pumps all its waste to the Blue River plant in the KCMO district, so it is not a viable site for a FOG-to-biodiesel system.

City of Independence

The City of Independence operates a 10 MGD WWTF in the Independence suburb of Kansas City, approximately 20 miles from the heart of the metropolitan area. While conveniently located, this facility does not accept trucked-in FOG and they are currently in a “prevention mode,” meaning they do not recognize FOG as a detrimental problem in their sewer system. The only costs Independence accounts for relating to FOG is labor —they employ full time personnel to prevent build-ups. The laborers do not actually remove the FOG from the sewer, rather they use high-pressure water jets to push the FOG material downstream to the WWTF. In an average year, the City on sees about 5 SSO’s due to their water jetting technique. The FOG that is pushed downstream is then

aggregated at the facility and totals about 5,000 tons per year; this number also includes the facility's annual volume of scum, as they do not differentiate the two.

Due to their low FOG volume and inaccessibility to accept trucked in FOG, it is not recommended that the City of Independence as an ideal installation site for a FOG-to-biodiesel system.

St Joseph City

The City of St. Joseph is not located in the Kansas City MSA, but is the closest WWTF in Missouri that receives hauled FOG. The City of St. Joseph is located approximately 50 miles north of Kansas City and operates a 17 MGD treatment works. Additionally, a 2-3 MDG private treatment facility is operated in the City of St. Joseph. The city experiences 10-25 SSOs annual due to FOG, but it is currently implementing ordinances to manage FOG. The city will invest $50,000-$300,000 per year in FOG management practices, including monitoring sewer lines with FOG problems and tracking grease devices. St. Joseph accepts 300,000-400,000 gallons per year of trucked-in grease. One to three trucks dispose on a daily basis with three being the maximum deliveries allowed. The trucked-in grease, which primarily comes from restaurants, is fed into a thermophilic digester and then land applied or land filled along with sludge from the digester. They currently charge $2.50 per load, but will change their cost to $0.02-0.06 per gallon.

While St. Joseph is proactive with FOG management, the municipality and surrounding population does not have the critical mass in order to produce the amount of FOG necessary to support the economics of a FOG-to-biodiesel project.

Site Recommendations

Based on this site evaluation, the primary recommendation for a proposed FOG-to-biodiesel project site is the St. Louis MSD Bissell Plant. This site is ideal because has an existing FOG receiving station, it's located adjacent to downtown St. Louis, and is less than one-quarter mile from a major interstate. This facility also has a devoted team of engineers and operators that oversee the hauled waste receiving facility. Immediately adjacent to this receiving facility is an open plot of land, without future plans for expansion. This site would be more than sufficient to install a FOG-to-biodiesel conversion system, with room for future expansion.

Based on existing research and local outreach, it is not recommended that a FOG-to-biodiesel facility be pursued in the Kansas City MSA. Although sufficient volume to support a facility is present, management prefers to use the energy in FOG to enhance anaerobic digestion or drying of biosolids. Based on the project team's analysis, candidate locations for a Kansas City MSA project could be at the existing Kaw Point FOG receiving facility or in the area south of Kansas City, where there is a critical mass of restaurants. **Section VI. FOG Volume** Analysis

Following identification of existing and potential grease receiving facilities, the project team performed a FOG volume assessment. Below is a detailed summary of the FOG volumes in both of the St. Louis and Kansas City MSAs.

St. Louis

The St. Louis Greaseshed® or metropolitan statistical area includes the Missouri counties of St. Louis, St. Charles, Jefferson, Franklin, Lincoln, Warren and Washington, as well as the Illinois counties of St. Clair, Madison, Macoupin, Clinton, Monroe, Jersey, Bond and Calhoun. The population of this region was determined to be 2.8 million as defined in the 2010 US Census data. 76% of this MSA population is based in the State of Missouri.

Table 3: Estimated Missouri FOG Generation based on MSA Population[9]

MSA	Pounds	Gallons
St Louis	36 million	4.8 million

Like many MSAs, St Louis and Kansas City have a wide array of generators, haulers, and renderers who contribute to Missouri's grease shed. Generators are abundant and represent a variety of feedstock—from butchers to restaurants to dairy farms, and FOG is generated throughout the MSA. There are approximately 1,700 restaurants in St. Louis[10] . This number represents a 13.76% increase since 2009, with 234 new food service establishment (FSE) licenses issued. At the rate the number of restaurants in the city has been increasing, St. Louis will have a substantial volume increase in its Greaseshed® over the next few years. Similarly, the grease hauling industry is highly competitive and oversaturated; this means grease can easily be sourced and there is no large company hauling and processing major streams of brown grease.

The State of Missouri is home to 10,487 food service establishments and approximately 3,900 of these are located within the St Louis MSA. [11] These account for approximately 37% of the State's FSEs. There are approximately 1,700 restaurants in St. Louis city[12], while the northern and southern areas of the MSA have approximately 1,100 restaurants each.[13]

Based on assumptions that an average restaurant has a 1,250 gallon grease interceptor installed within their facility and that it is cleaned out at least every three months, there is the potential for 19.5 million gallons of grease trap waste to be delivered to the Bissell Point WWTP. This amounts to approximately 0.94 million gallons of dry FOG per year (3% of grease trap waste). Bissell Point records[14] state that 6.3 million gallons of grease trap waste was delivered to the facility. Based on our assumptions, it appears that less than one-third of the total grease being generated by the restaurants is actually reaching the WWTP in the form of

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[9] "Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rice: April 1, 2000 to July 1, 2009". United States Census Bureau.

[10] Aaron E. Phillips, Chief Deputy, Office of the License Collector, 2011

[11] National Restaurant Association, based on data from Bureau of Labor Statistics and US Census Bureau, 2009

[12] Aaron E. Phillips, Chief Deputy, Office of the License Collector, 2011

[13] National Restaurant Association, based on data from Bureau of Labor Statistics and US Census Bureau, 2009

[14] Metropolitan St Louis Sewer District Division of Environmental Compliance Hauled Waste Program, Annual Rate Review (January 2011)

hauled waste. The remaining grease reaches the WWTP through the sewer system and may be skimmed off the wastewater during primary treatment.

From discussions with haulers, it was determined that several entities have been transporting FOG out of state to receive better tipping fees or because the out-of-state disposal site was closer. Similarly, several WWTFs indicated they too are sending their biosolids out of state; by offering a regional location for haulers and WWTFs to dispose of their wastes at an affordable rate, Missouri could increase the volume of FOG retained as a Missouri resource.

Generators are the grease producers, such as restaurants and food processors. Haulers are responsible for pumping and clearing clogged grease traps and transporting the recovered waste to disposal or treatment facilities. Renderers convert the grease from unusable waste to useful products. Wastewater treatment facilities process wastewater to remove sewage and other contaminants.

Table 4: FOG Assessment Contacts

Entity	St Louis Contacts
Generators	91
Haulers	42
Renderers	8
WWTFs	16

- Of the haulers who were receptive to participating in the research, they were very enthusiastic to hear about the study and were interested in having a cost-effective, local way to dispose of their collected wastes. It was a common theme among haulers that high disposal fees and limited disposal locations have severely impacted their bottom line. Some haulers indicated they trucked wastes across state lines, commonly to Kansas or Illinois but even up to Ohio, just to dispose of the wastes more cost effectively than in their home state. Similarly, on a few accounts, haulers indicated the high costs of disposal had caused them to temporarily close their business or to discontinue hauling brown grease.
- Very few WWTFs accepted trucked-in FOG.
    - St Louis Municipal Sewer District funnels all FOG to one treatment plant, the only receiving facility in the County
- Smaller-scale facilities are uneducated on FOG management practices
    - Satellite treatment plants within the MSA of smaller cities claimed to not have FOG problems.
    - Some indicated they cleaned their infrastructure, but jetted the lines by pushing the solidified FOG through the system, not removing it; theoretically this FOG should then have resurfaced at the treatment plant facility, but the operator indicated this was not the case.

Kansas City

The Kansas City Greaseshed® or metropolitan statistical area includes the Missouri counties of Jackson, Clay, Cass, Platte, Lafayette, Ray, Clinton, Bates and Caldwell, as well as the Kansas counties of Johnson, Wyandotte, Leavenworth, Miami, Franklin and Linn. The population of this region was determined to be 2.1 million as defined in the 2010 US Census data. 58% of this MSA population is based in the State of Missouri.

Table 5: Estimated Missouri FOG Distribution based on MSA Population[15]

MSA	Pounds	Gallons
Kansas City	27 million	3.6 million

According to the National Restaurant Association, Kansas City has around 1,344 restaurants within the City.[16] If all these restaurants had a proper grease interceptor (2000 gallons) installed, which was cleaned out every 3 months, there could potentially be 10.75 million gallons of grease trap waste (0.32 million gallons of dry FOG) available for collection from restaurants within the Kansas City MSA alone.

These numbers are slightly more conservative compared to the Wiltsee study[17], which uses a weighted average of 9,453 pounds/year/restaurant of trap grease for grease estimation. Using the Wiltsee assumptions and 7.5 pounds per gallon of brown grease, there could potentially be 1.7 million gallons of FOG in trap grease from restaurants within the Kansas City MSA.

Additional study is required to more accurately identify specific grease volumes in the Kansas City MSA. Since the only receiving station and all large grease haulers in the Kansas City MSA are based in the State of Kansas, obtaining detailed information for this study for the State of Missouri has been challenging.

Table 6: FOG Assessment Contacts

Entity	Kansas City Contacts
Generators	57
Haulers	15
Renderers	2

[15] "Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rice: April 1, 2000 to July 1, 2009". United States Census Bureau.

[16] National Restaurant Association, based on data from Bureau of Labor Statistics and US Census Bureau, 2009

[17] Wiltsee, G. 1998. Urban Waste Grease Resource Assessment. National Renewable Energy Laboratory, SR-570-26141.

- Like their counterparts in St. Louis, haulers receptive to participating in the research were enthusiastic about the study and were interested in having a cost-effective, local way to dispose of their collected wastes. They also reported trucking wastes across state lines to dispose of the wastes more cost effectively than in their home state and indicated the high costs of disposal had caused them to temporarily close their business or to discontinue hauling brown grease.
- Very few WWTFs accepted trucked in FOG.
    - No WWTF in Kansas City was identified to accept hauled FOG
        - Some Kansas City WWTFs truck their biosolids to Kaw Point WWTF, which is located out of state, in Kansas
        - City of St. Joseph WWTF is the closest FOG receiving facility to Kansas City in the state of Missouri
- Smaller scale facilities may be unfamiliar with FOG management practices
    - Satellite treatment plants within the MSA of smaller cities claimed to not have FOG problems and indicated that they cleaned their infrastructure and jetted the lines by pushing solid FOG through the system, not removing it.

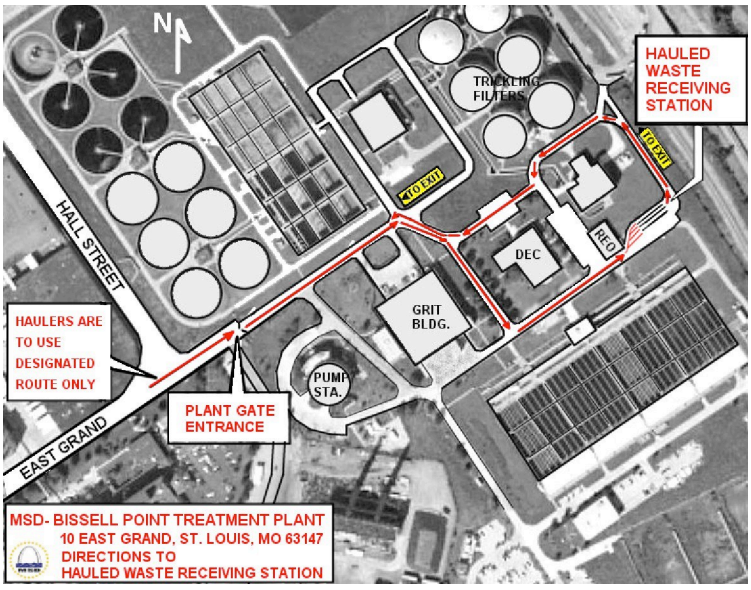
Section VII: Basis of Design

This section will describe the expected engineering requirements for the proposed site identified in the earlier sections of this report.

Proposed Location:

We recommend the Bissell Point WWTP as the optimal site for a FOG-to-biodiesel installation. The Bissell Point plant currently accepts trucked FOG at $0.08/gallon, charged at the total truck capacity whether or not it is hauling its maximum capacity. It is one of the seven WWTFs operated by the Metropolitan St. Louis Sewer District (MSD). MSD maintains 9,649 miles of sewers, making it the fourth largest in the United States.[18] The age of sewers maintained by MSD range in age from less than one year old to 150 years old. In general, combined sewers represent the older portions of the collection system; over 300 miles of combined sewers predate 1890 in their construction. [19] The older a sewer line is, the more susceptible pipes are to corrosion and deterioration. The Bissell Point service area contains 88 square miles of land, representing about 17% of MSD's total service area. [20] The presence of the treatment plant within the St. Louis MSA and existing Hauled Waste program makes it the ideal location for the FOG-to-biodiesel site. An aerial view of the Bissell Point WWTP is shown in Figure 3 and the proposed project site is the empty field adjacent to the existing Hauled Waste Receiving station. This location would allow for shorter transport distance of grease from the point where it is received from the haulers. Adequate space is available and the site is located adjacent to one of the access roads within the plant.

Figure 3: Aerial view of Bissell Point WWTP



[18] MSD website: http://www.stlmsd.com/aboutmsd

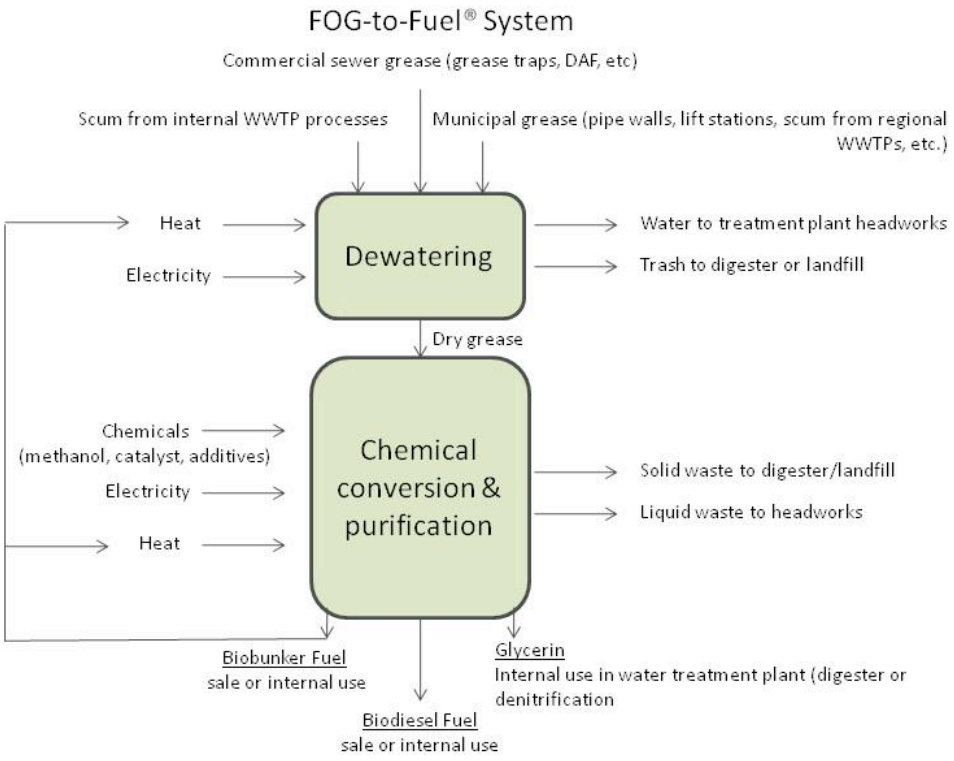
[19] Metropolitan St.Louis Sewer District CSO LTCP Update (August 2009): Page 3-8

[20] Metropolitan St.Louis Sewer District CSO LTCP Update (August 2009): Page 3-8

FOG-to-biodiesel

BlackGold Biofuels' 250k FOG-toFuel® system was utilized for the purposes of this study to represent a viable FOG-to-biodiesel system. Other FOG-to-biodiesel technologies are in development, but there is little evidence they have physically produced any ASTM biodiesel from 100% sewer grease at a large scale. BioFuelBox developed a supercritical process, but they ceased commercial operations in March 2010. The FOG-to-Fuel® system has three main components: dewatering, conversion, and purification. Figure 4 gives the flow diagram of the process and provides for better understanding of the components of the system.

Figure 4: Inputs & Outputs of the FOG-to-Fuel® System



BlackGold's process is protected by patent and trade secret law. Its technology is an automated process that utilizes chemicals already used in many wastewater treatment plants and can be run in a continuous manner, enabling a small footprint relative to typical wastewater treatment infrastructure. The patented FOG-to-Fuel® process includes a single-process chemical conversion of plant- and animal-based fats, oils and greases into fatty-acid-methyl-esters

(biodiesel). The process performs the esterification and transesterification conversion in a single step, regardless of feedstock composition. During the process, the triglycerides, diglycerides, monoglycerides and free fatty acid (FFA) molecules that comprise the FOG are combined with an alcohol (most commonly methanol) and a proprietary catalyst. Since FOG has a high degree of variability with respect to chemical composition (FFA percentage) and can be highly contaminated with food particles, detergents, trash solids, sewage, and other contaminants, the biodiesel made from FOG requires substantial polishing to meet ASTM specifications. BlackGold has a proprietary polishing process that consistently produces biodiesel that meets ASTM specifications.

Utility Requirements

FOG dewatering and biodiesel conversion equipment requires process heat for oil/water separation as well as biodiesel refining. Process heat has been proven to be achieved with thermal heat transfer through various heat transfer mechanisms/fluids such as steam or hot oil. BlackGold can tailor the process heat usage if waste heat sources such as hot water or steam already exist onsite. Many wastewater utilities produce methane-rich biogas in anaerobic digesters. Where biogas is produced, many utilities use this fuel to meet digestion process heat requirements by burning biogas to create hot water or steam. In most cases, the remaining biogas is then flared onsite. If excess hot water or steam is available at Bissell Point, this can be utilized to heat the process and/or keep storage tanks warm. This is an approach that has been proven successful at BlackGold Biofuels' San Francisco installation.

Steam and hot oil can also be heated with electricity, natural gas or biobunker fuel (created in the FOG-to-Fuel® process). Final decision on heating mechanism will be determined in the detailed site engineering phase of implementation, and will ultimately be based on local utility availability and cost. It is anticipated that as a baseline, the FOG-to-Fuel® package will require natural gas service.

Beyond heating requirements, the system has various pieces of mechanical equipment such as pumps, mixers and instrumentation that must operate in an OSHA Class I Div II environment. It is estimated that 1000 Amps (?!?) of 480 Volt service will be needed to meet equipment needs.

Instrumentation can also be operated by compressed air, which can be utilized if available onsite. If not, a small compressor would need to be installed should excess instrument air be required onsite.

Along with fire protection water piping modifications, non-contact process water is used for cooling at various points in the FOG-to-Fuel® process. An estimated 2,000 gallons per day of process water would be required. Reuse water (#2 & #3) produced at Bissell Point will be of sufficient quality for process needs. This water will not come in contact with any chemicals, FOG or biodiesel and requires no treatment following use. Potable water and wastewater service will be required for restrooms, showers and sinks in the proposed Office/Operations Center.

Utility Requirement Overview:

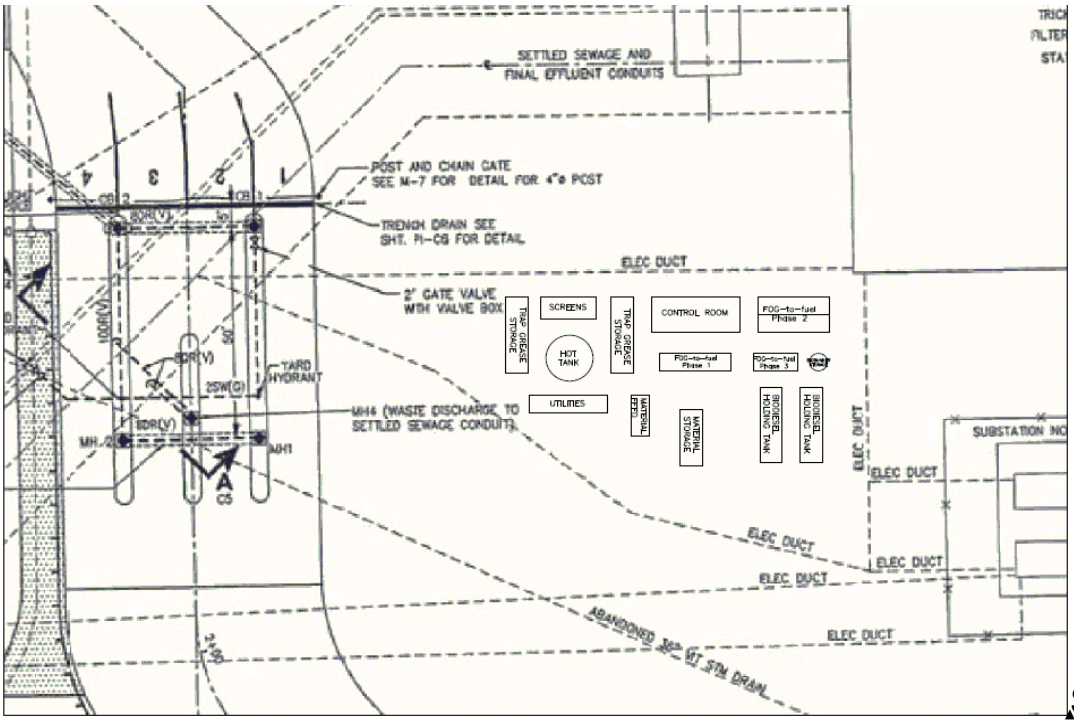
- Natural Gas

- 480V Electric Feed
- Non-potable Water
- Potable Water
- Phone / Cable
- Instrument/Compressed Air (if available)
- Hot Water (if available)
- Steam (if available)

Site Preparation/Construction

The designated site location at the Bissell Point WWTP would require certain updates in order to implement a FOG-to-biodiesel facility. An enclosed office building as well as an additional 2,000 square foot outdoor containment area would be constructed to house all equipment modules, control systems, tanks and peripheral equipment. There are a number of electrical ducts within the field. Care will have to be taken during the design of the installation that structures are not built over them. Further study is required to identify which utilities are accessible from the field. Figure 5 is a layout drawing of such an installation. Note that the enclosure is not shown in this drawing.

Figure 5: Layout drawing of FOG-to-biodiesel installation



Section VIII: Economic Analysis of FOG-to-biodiesel

The purpose of this section is to describe the business case analysis of implementing a FOG-to-biodiesel project in Missouri.

St. Louis

Tangible Benefits

In Section V, the project team determined that the Metropolitan St. Louis Sewer District (MSD) Bissell Point WWTP would be an ideal location for a FOG-to-biodiesel facility. The Bissell Point WWTP has a unique method of calculating the tipping fee associated with the operation of the District's hauled waste program. MSD monitors hauled waste received at their facility and the data is compiled on an annual basis. The proposed tipping fee is calculated based on the estimated cost of the hauled waste program to the treatment plant. Hauled waste is characterized as domestic or industrial depending on the waste source. In 2010, Bissell Point received 18,608,000 gallons of hauled waste; 34% of this waste was from restaurant grease traps and 3% was from industrial grease traps.[21] The hauled waste volume referenced above is based on tank capacities (maximum wastewater volume, in gallons, a tanker can store) while the treatment costs were based on actual hauled waste volumes.

According to MSD's Division of Environmental Compliance Hauled Waste Program - Annual Rate Review (January 2011), 6,282,843 gallons of raw FOG waste was received in 2010. Based on market research, raw FOG waste is 3% dry FOG on average. Therefore it is anticipated that the Bissell Point hauled waste receiving station collects over 188,000 gallons of dry FOG per year. "Dry FOG" is described as containing less than 2% Moisture, Insolubles and Unsaponifiables (MIU). Removal of these contaminants is required as a pre-processing step if said materials are to be used for biodiesel conversion.

For purposes of this economic analysis, the project team utilized the capital and operating costs of the BlackGold Biofuels' 250,000 gallon per year (250k) FOG-to-Fuel® system as the baseline technology, which are.... Since nameplate capacity on the system refers to biodiesel produced, the 250k system requires 312,500 gallons per year of dry FOG; 80% of dry FOG is converted to biodiesel. Since only 188,000 gallons of dry FOG are currently being received at Bissell Point, a 25% supplemental feedstock purchase of yellow grease at market rate ($3.60/gallon) was incorporated into the economic analysis. Assuming that waste grease volume continues to increase at an annual percentage of ~9% (averaged from FY03-FY10); volume of required supplemental feedstock would decrease rapidly over time. Despite this likely scenario, the project team utilized a 25% feedstock purchase through the entirety of the project.

MSD's Bissell Point receiving facility currently receives grease at a tipping fee of $0.08/gal. Using the existing tipping fee scenario, installation of the FOG-to-biodiesel system defined above would have a payback period of three (3) years and a NPV of $7.6 million. When considering operating expense and debt service on the capital expenditure, the system would produce $0.6 million in available profit to MSD. Additionally, the economic returns of the system would increase with a reduction in the dependence on supplemental feedstock.

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[21] Metropolitan St Louis Sewer District Division of Environmental Compliance Hauled Waste Program, Annual Rate Review (January 2011)

Table 7 shows the parameters used in the economic analysis. Biodiesel & RIN prices were obtained from National Biodiesel Board (NBB), while biobunker & natural gas pricing was based on information provided by the U.S. Energy Information Administration (EIA). According to the Jacobsen B100 Index™, biodiesel price was at $5.15/gal on May 26, 2011 and is expected to be price competitive with petrodiesel this summer, as biodiesel (B20) retail pricing has already dipped below the retail selling price of petrodiesel. Grant funding was not considered in this model in order to simulate the worst-case scenario. However, there are various federal as well as state programs in place that could assist in implementing a project of this kind. Water disposal fee was not included in this analysis because the whitewater from the process could be diverted to the headworks.

NOTE: Provide functional spreadsheet with report.

Table 7: Project Survey Parameters

Base Case: co-located at WWTP	Inputs	
Customized supplemental feedstock assumption	25%	
Supplemental feedstock (price/gal)	$3.00	2011-04-05 USDA: yellow grease =$3.60
% grease recovered from raw effluent	3%	
Tipping Fee	$0.080/gal	Market price currently 5-20 cents
Water Disposal Fee	$0.000/gal	
% of Capital Cost financed-Biodiesel	100%	
WACC/ Interest % - Biodiesel Processing Unit	3.0%	
Financing term = project term	20 years	
Grant 1	$0	
Grant 2	$0	
Income Tax rate	0.0%	
Sales Tax rate	0.0%	
Biodiesel wholesale price	$2.18	2011-04-05 NBB = $5.127, Subsidy & RIN price deducted for wholesale cost
Biobunker retail price	$1.89	Residual Fuel Oil 2011-01 US EIA (02-2011 = $2.08, 03-2011 = $2.31)
RINs/gal	1.5	Fixed per US federal regulations
$/Dry RIN	$1.00	2011-06-07 NBB =$1.34
Starting Year (Financial Close)	2011	
# Years Federal biodiesel subsidy	0 years	Currently valid through 2011
Federal biodiesel subsidy	$1.00	
Biobunker federal subsidy	$0.50	
# Years State biodiesel subsidy	0 years	
State biodiesel subsidy	$0.00	
Electricity cost ($/Kwh)	$0.08	
Natural Gas cost ($/MCF)	$5.00	US EIA, 01-2011=$4.08, 02-2011=$4.28, 03-2011=$3.90
Process Building (Price/sq.ft)	$40.00	
Methanol truck/rail price	$1.61	2011-06-07 Methanex = $1.28

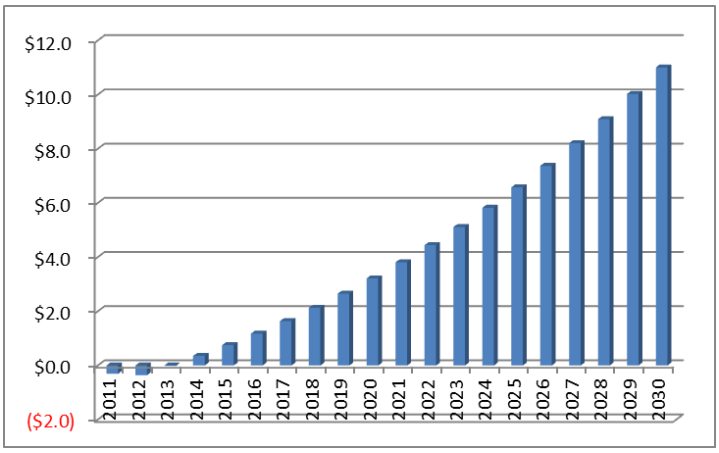
Figure 6 shows anticipated profit recognized from a FOG-to-biodiesel project. With a simple payback period of 3 years, and a healthy biodiesel market, with national B20 gallon prices averaging at $3.36 in early June 2011, cumulative cash flow is very favorable for these projects. Additionally, the RIN market helps boost profitability. Current market conditions indicate tight biodiesel supply in 2011, leading to relatively high RIN prices. The volume requirements mandated by the U.S. EPA under the Renewable Fuel Standard (RFS2)[22] appear to contribute to the relatively high price of RINs. In November 2010, the agency released 2011 volume

[22] Regulation of Fuels and Fuel Additives: 2011 Renewable Fuel Standards, December 9 2010 [EPA–HQ–OAR–2010–0133; FRL–9234–6]

requirements, which consists of nested mandates. According to the release, a minimum of 1.35 billion gallons of advanced biofuel (such as biodiesel, renewable diesel and sugarcane ethanol) must be consumed in the U.S. during 2011.

NOTE: Graph should show annual cash flow (as opposed to cumulative).

Figure 6: Graph of cumulative cash flow



In 2010, MSD estimated that $947,307 was spent treating the entirety of the high strength hauled waste received at Bissell Point. Raw FOG waste from domestic grease traps amounted to 34% of the total hauled waste received in 2010. Using MSD's reported values of Chemical Oxygen Demand ("COD") and Total Suspended Solids ("TSS") in domestic grease trap waste (56,864 mg/L and 29,007mg/L, respectively) and in industrial grease trap waste (82,832 mg/L and 40,851 mg/L, respectively), it was estimated that MSD could save as much as $276,711 per year (29% of the previously calculated treatment plant cost) by diverting grease from the headworks. If these savings were to be incorporated into the economic analysis previously described, the FOG-to-biodiesel system would have a payback period of a little over 2 years.

These savings could be even higher if accounting for the maintenance issues caused by FOG throughout the plant. The methods of analysis in the MSD report put equal weight on the cost of treating COD and TSS. It is the project team's belief that COD has a much greater impact on treatment process costs, and therefore estimated that the costs of treating FOG wastes could be as high as $345,000 per year.

In addition to the significant volume of FOG processed by MSD, St. Louis also purchases more than 300,000 gallons of fuel per year for its fleet. The City could drastically reduce its fuel purchases by utilizing biodiesel produced from FOG.

Since MSD's current tipping fee philosophy is to simply cover the cost of treating FOG, by constructing a FOG-to-biodiesel system, the revenue generated from fuel sales would enable them to eliminate tipping fees for FOG. With a compelling beneficial reuse in the form of biodiesel, MSD can institute comprehensive FOG management programs focused on increasing grease handling compliance and maximizing biodiesel production. With a financial and

environmental incentive for compliance, less grease enters the sewer system and more is directly transported via haulers to the biodiesel plant at the wastewater treatment plant.

Intangible Benefits

Operations & Management Cost Savings

The EPA estimates that 47% of Sanitary Sewer Overflows (SSO's) caused by sewer blockages are related to FOG build-up in the sewer system. Due to the damage to residential homes, neighborhoods, roadways, and streams caused by SSO's, preventing these events is a top priority for MSD. With less grease entering the sewer system, water utilities can significantly reduce emergency maintenance costs associated with SSO's caused by FOG related clogging. Reduction of FOG in the sewer system will also increase the lifespan of pipe infrastructure and reduce annual capital budgets.

Social

The community will also benefit from MSD implementing a FOG-to-biodiesel program. These processing systems will directly and indirectly employ dozens of people throughout the supply chain, from grease collectors to processing unit workers to fuel distributors. Additionally, fuel sales create revenue streams and cost savings for utilities, decreasing the burden on taxpayers and increasing the utility's ability to serve its constituents. Further, by purchasing locally-made fuel instead of exporting Missouri's energy dollars, more wealth will circulate within the regional economy, benefiting Missouri business owners and employees.

Energy Security, Energy Independence

In addition to the economic benefits, internal fuel production safeguards energy supply for critical operations. In times of shortages or supply disruptions, St. Louis will be able to maintain operations by utilizing its own fuel production that functions independently of affected national systems. Moreover, domestic fuel production reduces Missouri's reliance on foreign oil and reduces the money sent overseas. With the FOG-to-biodiesel system, the utility could potentially reduce the purchase of foreign oil by up to 312,000 gallons per year.

Environment

Biodiesel is a nontoxic fuel that dramatically reduces the emission of various tailpipe pollutants compared to petroleum diesel. By producing and using biodiesel, St. Louis would help improve air quality in its community. Biodiesel dramatically reduces greenhouse gas emissions, and biodiesel made from recycled waste material generates even greater reductions. By creating an incentive to reduce the amount of grease in the sewer system, sewer overflows are reduced and less untreated wastewater is introduced into the environment, improving public and environmental health. A FOG-to-biodiesel system provides St. Louis with an easy and cost-effective way to green its operations.

Anticipated Environmental Benefits:

- Reduction in Greenhouse Gas emissions by up to 2,116 tons each year
- Reduce waste to landfill

- Prevent millions of gallons of sewage from overflowing into regional waterways

Kansas City

Based on the findings of Section V, Site Assessment, it was determined that a FOG-to-biodiesel project may not be feasible in the Kansas City, Missouri metro area at this time, and therefore an economic analysis was not performed for Kansas City.

Section IX: Conclusions, Recommendations, and Implementation Plan

FOG can be a major financial and environmental liability for water utilities, placing a burden on wastewater treatment in terms of infrastructure lifespan, operational efficiency, energy demand, environmental management, and labor. The nearly 80 million pounds of trap grease produced yearly in Missouri are responsible for significant operations, maintenance, and infrastructure lifespan expenses. Disposal and treatment of FOG, pipeline blockages and infrastructure deterioration, and Sanitary Sewer Overflows and waterway contamination represent significant financial and environmental burdens. To date, FOG management has been costly and ineffective. Conversion to biodiesel is not only a beneficial reuse of this waste material, but is also strongly compelling from operational, environmental, and financial standpoints: it reduces the volume of FOG present in wastewater streams, improving infrastructure lifespan and WWTP operational efficiency; reduces SSOs and pollution of waterways; produces a nontoxic and low-carbon fuel; and creates a direct revenue stream for the wastewater utility.

Based on the analysis of Greasesheds® and FOG volumes, waste hauling patterns, and WWTP characteristics of the St. Louis and Kansas City MSAs, the project team recommends the installation of a FOG-to-biodiesel system at the Bissell Point WWTP in the Metropolitan St. Louis Sewer District. Bissell Point WTTP is an ideal location for a FOG-to-biodiesel conversion system for several reasons. Most notably, the plant already processes an extraordinary 40,000 pounds of usable brown grease each week derived from both fatty wastewater and hauled-in food grease. The existing Hauled Waste program and FOG receiving station is unique among WWTPs in the MSD and allows additional FOG to be trucked in; the volume of trucked-in food grease has been increasing by approximately 50,000 gallons per year. An existing team of engineers and operators that oversee the hauled waste receiving facility is a crucial benefit for the operation of a FOG-to-biodiesel installation. An empty field adjacent to Hauled Waste receiving station accessible by existing roads serves as an optimal installation site for the FOG-to-Fuel® system with room for future expansion.

Implementation of a FOG-to-biodiesel system at Bissell Point WWTP would require a site inspection with the technical staff onsite to review existing site assets and challenges. Prior to process design, grease samples from the site would have to be analyzed to understand unique characteristics and ensure successful conversion to ASTM biodiesel. Preliminary drawings and project proposals could be developed at this stage with the clients being engaged through project drawing submittals. Once the designs have been approved by the client, process equipment can be prefabricated and tested at a centralized location to ensure quality and efficiency. According to this implementation plan, Bissell Point WWTF could be producing clean-burning biodiesel from its waste streams within 12 months.

A FOG-to-Biodiesel system at the Bissell Point WWTF would be a winning project for every Missourian. From the restaurant small business owners, to the grease haulers, to the utilities themselves, a FOG-to-biodiesel project will positively impact residents of the State. Environmentally, financially, and operationally, FOG-to-biodiesel is a smart, viable project we strongly recommend the MSD considers implementing.

Appendix A: Outreach Letter to Utilities

September 27, 2010

Missouri Company:

The Missouri Department of Natural Resources recently funded several projects to assess the feasibility of utilizing renewable resources to energize Missouri. Our company, H2O'C, an environmental engineering firm based in Boone County, was awarded one of these projects. The purpose of this project is to study the fate of wastewater derived fats, oils, and greases (FOG) in the State of Missouri and the potential of utilizing these materials to produce biodiesel, a renewable, clean-burning diesel fuel. FOG is a costly problem for utilities and by finding a high value beneficial reuse for FOG, this study can help Missouri utilities reduce sewer overflows, decrease sewer maintenance costs, improve FOG management, and in the process, relieve cash-constrained budgets.

As part of this study we are contacting wastewater utilities to learn the volumes of FOG that they collect and / or generate through treatment. These potential FOG materials would include scum, trap grease waste, brown grease, and yellow grease. Furthermore, we are interested in learning what Missouri's utilities currently do with the FOG they receive or treat (ie. digest, incinerate, land apply, etc.). Please look out for a questionnaire that we will be sending shortly.

We selected BlackGold Biofuels, a company that has pioneered technology and equipment to convert wastewater derived FOG into biodiesel, to assist us in this study because of their expertise with wastewater derived FOG materials. BlackGold is currently working with the City of San Francisco's Public Utility Commission to convert their sewer FOG into biodiesel. BlackGold's CEO and COO co-chair the Water Environment Federation's Biofuels Task Force as well, so you may already be familiar with their work.

This study has no connection to regulatory enforcement nor compliance at the utility level. Rather, the purpose of this project is to identify resources for renewable energy and economic development for Missouri communities. In return for your participation in the research, we would be happy to share the final report with you. With your help, we seek to reduce your utilities costs associated with FOG, spur economic development, and reduce America's reliance on foreign oil.

If you have any questions or would like to learn more about the project, please contact:

Brittany Gillow
BlackGold Biofuels
1528 Walnut St., Floor 21
Philadelphia, PA 19102
phone: 215-253-5844 fax: 215-764-5073
email: info@blackgoldbiofuels.com website: www.blackgoldbiofuels.com

Sincerely,

Tom O'Connor

Appendix B: Outreach Letter to Generators

September 27, 2010

Missouri Company:

We recently received your name from AgriNet, the Missouri Association of Meat Processors, or the Missouri National Renderers Association as an ideal company to speak with regarding waste fats, oils, and greases in the State of Missouri. The Missouri Department of Natural Resources recently funded several projects to assess the feasibility of utilizing renewable resources to energize Missouri. Our company, H2O'C, an engineering firm based in Boone County, was awarded one of these projects. The purpose of this project is to study the fate of waste fats, oils, and greases (FOG) in the State of Missouri and the potential of utilizing these materials to produce biodiesel, a renewable, American-made diesel fuel. The goal of this project is to find a high value beneficial use for FOG in order to help the Missouri businesses that process these materials become more profitable.

As part of this study we are contacting FOG processors to learn the volumes of material such as tallow, dairy sludge, vegetable oil, animal by-products, yellow grease, or brown greases that your company generates through operation. Please look out for a questionnaire that we will be sending shortly. We understand that the volume you generate is sensitive business information. We would like to reassure you that the specific information you provide about volume will be held in confidence and used only to calculate the sum total produced in the State. Again, specific companies will not be identified and individual volumes will not be shared - in the report or otherwise.

We have chosen BlackGold Biofuels, a company that has pioneered technology and equipment to convert sewer greases like trap grease into biodiesel, to assist us in this study because of their expertise working with FOG.

Please note that this study has no connection to regulatory enforcement nor compliance in any fashion. Rather, the purpose of this project is to identify resources for renewable energy and economic development for Missouri communities. In return for your participation in the research, we would be happy to share the final report with you. With your help, we seek make Missouri industry more profitable and sustainable spurring economic development, and reducing America's reliance on foreign oil.

If you have any questions or would like to learn more about the project, please contact:

Brittany Gillow
BlackGold Biofuels
1528 Walnut St., Floor 21Philadelphia, PA 19102
phone: 215-253-5844 fax: 215-764-5073
email: info@blackgoldbiofuels.com website: www.blackgoldbiofuels.com

Sincerely,

Tom O'Connor

Appendix C: Outreach Letter to Haulers

September 27, 2010

Missouri Business:

We recently received your name from Dave Flagg of Septic Services, Inc. and Tom Ferrero (NAWT) as an ideal company to speak with regarding trap greases in Missouri. The State has funded a study to identify the volume of FOG (Fats, Oils, and Greases) and the potential to convert this waste to biodiesel, a renewable, American-made diesel fuel. Ideally, finding a high value beneficial reuse for the greases will help Missouri pumpers and other businesses be more profitable.

As part of this study we are contacting pumpers to learn the volume of FOG (like trap grease, material from DAF tanks, etc) that your company collects. We will be sending you a questionnaire shortly. We understand that the volume you collect is sensitive business information, so the specific information you provide about collection volumes will not be identified and shared. Instead, the study will report the sum total collected from all the companies interviewed, together. Again, specific companies will not be identified and individual volumes will not be shared - in the report or otherwise.

We selected BlackGold Biofuels, a company that has pioneered technology and equipment to convert sewer greases like trap grease into biodiesel, to perform the study because of their experience in the industry. They've presented at NAWT and the Pumpershow and have been featured in Pumper Magazine, so you may already be familiar with them.

This study has no connection to regulatory enforcement or compliance at the pumper level. Rather, its an attempt by the state to identify resources for renewable energy and economic development. For your participation in the research, we would be happy to share the final report with you. With your help, we can make the industry more profitable, spur economic development, and reduce our reliance on foreign oil.

If you have any questions or would like to learn more about the project, please contact:

Brittany Gillow
BlackGold Biofuels
1528 Walnut St., Floor 21 Philadelphia, PA 19102
phone: 215-253-5844 fax: 215-764-5073
email: info@blackgoldbiofuels.com website: www.blackgoldbiofuels.com

Sincerely,

Tom O'Connor

Appendix D

BLACKGOLD BIOFUELS

Dear Missouri Business:

You were recently contacted by $H_2O'C$, a Missouri water engineering firm and our project partner, regarding a study about the fate of Fats, Oils, and Grease (FOG) in Missouri. As mentioned in the previous letter, the State's Department of Natural Resources has funded this study to firstly identify the volume of FOG and secondly evaluate the potential to convert this waste into a clean burning, American-made fuel in the form of biodiesel.

Enclosed please find the questionnaire described in the previous letter. You may type or print your answers. If you would prefer to submit your answers online, please visit the secure, encrypted electronic version of the survey at [google forms link insert]. We ask that you please submit your answers only once through either the enclosed questionnaire **or** the online survey.

Please postmark or submit your survey by Friday, October 22, 2010.

- If returning by mail, please submit to:
  - BlackGold Biofuels
  - 1528 Walnut St, Floor 21
  - Philadelphia, PA 19102
- If submitting by fax, please send to: (215) 764-5073
- If replying by email, please send to: missouri@blackgoldbiofuels.com
- If you choose to utilize the online survey, no paper submission is required

Please be as detailed as possible and feel free to provide additional information or explanation. Again, this research is an attempt by the state to identify resources for renewable energy and economic development and WILL NOT be used for any regulatory enforcement or compliance purposes.

For your participation in the research, we would be happy to share the final report with you; please indicate your interest in receiving the report in the final question of the survey.

If you have any questions or concerns, please do not hesitate to contact us:

Brittany Gillow
BlackGold Biofuels
1528 Walnut St, Floor 21
Philadelphia, PA 19102
Phone: 215-253-5844 Fax: 215-7764-5073 Email: Brittany@blackgoldbiofuels.com

Sincerely,

Brittany Gillow

Appendix E: Hauled Waste receipt, Metropolitan St. Louis Sewer District

Metropolitan St. Louis Sewer District

Hauled Waste Receipt (Multiple Domestic Sources) NO. M- 072061

A. Domestic Waste Sources

1. Name: _____ Type of Waste: _____
   Address: _____ Volume of Waste (Gallons): _____
   We certify this waste was loaded onto the transport vehicle identified in Part B on (DATE) _____ at (TIME) _____
   _____ _____ _____
   Signature of Source Owner or Representative | Telephone Number | Signature of Driver

2. Name: _____ Type of Waste: _____
   Address: _____ Volume of Waste (Gallons): _____
   We certify this waste was loaded onto the transport vehicle identified in Part B on (DATE) _____ at (TIME) _____
   _____ _____ _____
   Signature of Source Owner or Representative | Telephone Number | Signature of Driver

3. Name: _____ Type of Waste: _____
   Address: _____ Volume of Waste (Gallons): _____
   We certify this waste was loaded onto the transport vehicle identified in Part B on (DATE) _____ at (TIME) _____
   _____ _____ _____
   Signature of Source Owner or Representative | Telephone Number | Signature of Driver

4. Name: _____ Type of Waste: _____
   Address: _____ Volume of Waste (Gallons): _____
   We certify this waste was loaded onto the transport vehicle identified in Part B on (DATE) _____ at (TIME) _____
   _____ _____ _____
   Signature of Source Owner or Representative | Telephone Number | Signature of Driver

B. Waste Transporter

Company Name: _____ MSD HAULER AUTHORIZATION ID #: _____
MSD VEHICLE ID #: _____ Total Vehicle Tank Capacity: _____ gallons
Driver's Name *(Print)* _____

C. MSD Hauled Waste Receiving Station

Daily Receipt Log Number: _____

TRANSPORTER:
I certify that the waste described in Part A was tendered for delivery on (DATE) _____ at (TIME) _____
Driver's Name *(Print)* _____ Signature _____

RECEIVING STATION ATTENDANT:
The transport vehicle described in Part B entered the receiving station on (DATE) _____ at (TIME) _____ and
the vehicle was **allowed** ☐ to discharge; or the vehicle was **not allowed** ☐ to discharge and exited the facility.

Reason for Rejection: _____
pH: _____ Observations: _____

Attendant's Name *(Print)* _____ Signature _____

Instructions:
This form is to be used only for multiple sources of domestic waste which do not require approval from MSD prior to discharge at the MSD Hauled Waste Receiving Station. Examples of such waste are those from residential septic tanks, restaurant and institutional kitchen grease traps, etc. This form may not be used if the load includes industrial waste from any source. The transport driver must complete Part B prior to loading any waste.

Complete the information in Part A for each source from which waste is loaded onto the vehicle identified in Part B. Record the time and date of loading. The source owner/representative and the driver must both sign. The driver should sign in the presence of the source owner/representative.

Part C is completed by the transporter and the Receiving Station attendant at the time the waste is tendered for discharge. The attendant records the date and time the transport vehicle enters the receiving station and indicates whether the waste is accepted or rejected. If the waste is rejected, the attendant records the reason for rejection. The signed *yellow* copy is retained by the transporter and the *white* copy is retained by the attendant.

HWR-M 5/01

Appendix F: Finding the Fog

Finding the FOG

Tracking Fats, Oils, and Grease at the City of Columbia Regional Wastewater Treatment Facility

H2O'C ENGINEERING

Columbia, Missouri

- population ~100,000
- WWTP treats ~16 MGD
- ~500 food service establishments
- almost all yellow grease from Columbia is trucked out of town
- lower-value trap waste (brown grease) is trucked to WWTP

H2O'C ENGINEERING

Columbia, Missouri

- population ~100,000
- estimate: 13 lbs of trap grease per person per year (Wiltsee, 1998)
- City might produce 1.3 million lbs/year
- …that's 3,600 lbs/day
- …or about 425 gallons/day
- ~ 0.004 gpd/person

H2O'C ENGINEERING

GREASE RECYCLING CONTAiNER

Yellow grease is collected in recycling containers outside food service establishments.

Most of these are emptied by three companies:

- **Kostelac (Belleville, IL)**
- **Ace Grease (Millstadt, IL)**
- **Darling (Quincy, IL)**

Almost all yellow grease from Columbia is trucked to Illinois for rendering.

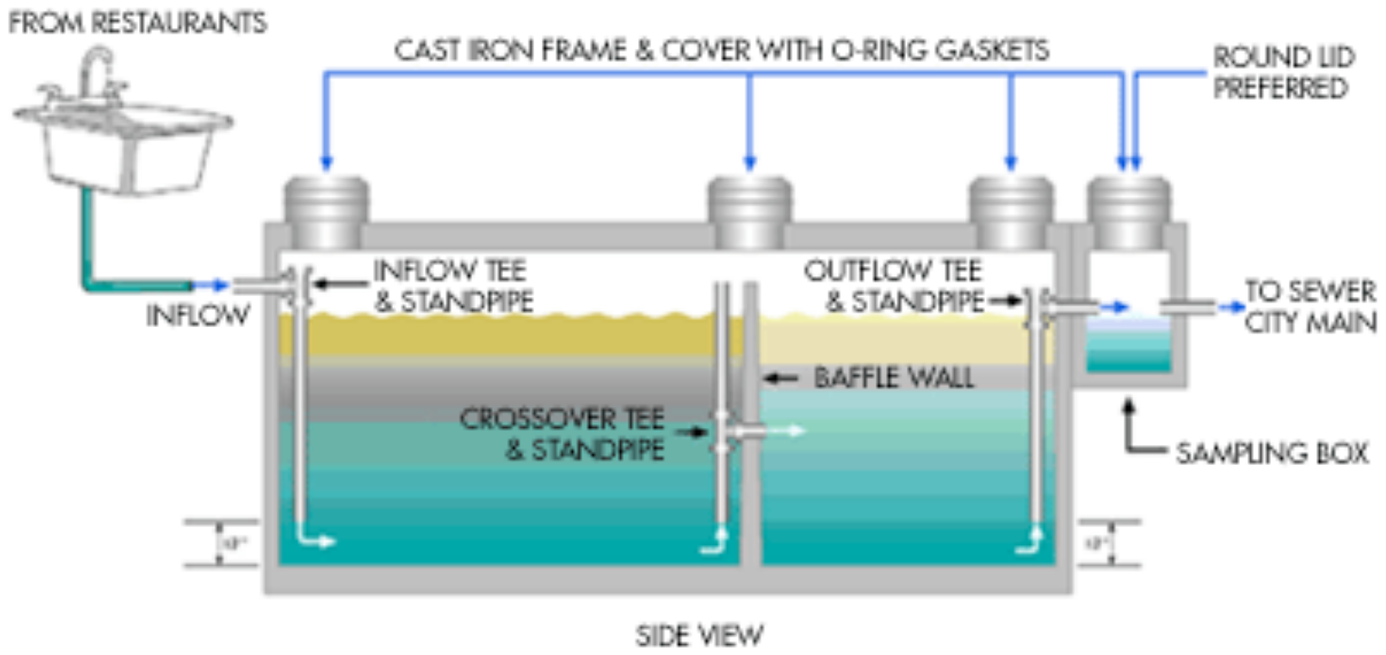
H2O'C ENGINEERING

Small grease traps and larger interceptors collect relatively low-value brown grease.

These are usually emptied by local companies and trucked to the septage acceptance plant at the WWTP.

GREASE TRAP

GREASE INTERCEPTOR
(Drawing not to scale)



H2O'C ENGINEERING

Material Trucked to WWTP

- **WWTP accepts brown grease from haulers**
- **Usually mixed with septic waste from porta-potties or septic systems (uh-oh)**
- **Fee: $7 per truck, plus 3 cents/gallon**
- **Accepted 384,000 gallons last year (3.84 gal/person/yr; 768 gal/establishment/yr)**
- **Material is tested for BOD, TSS, COD, NH_4^+**

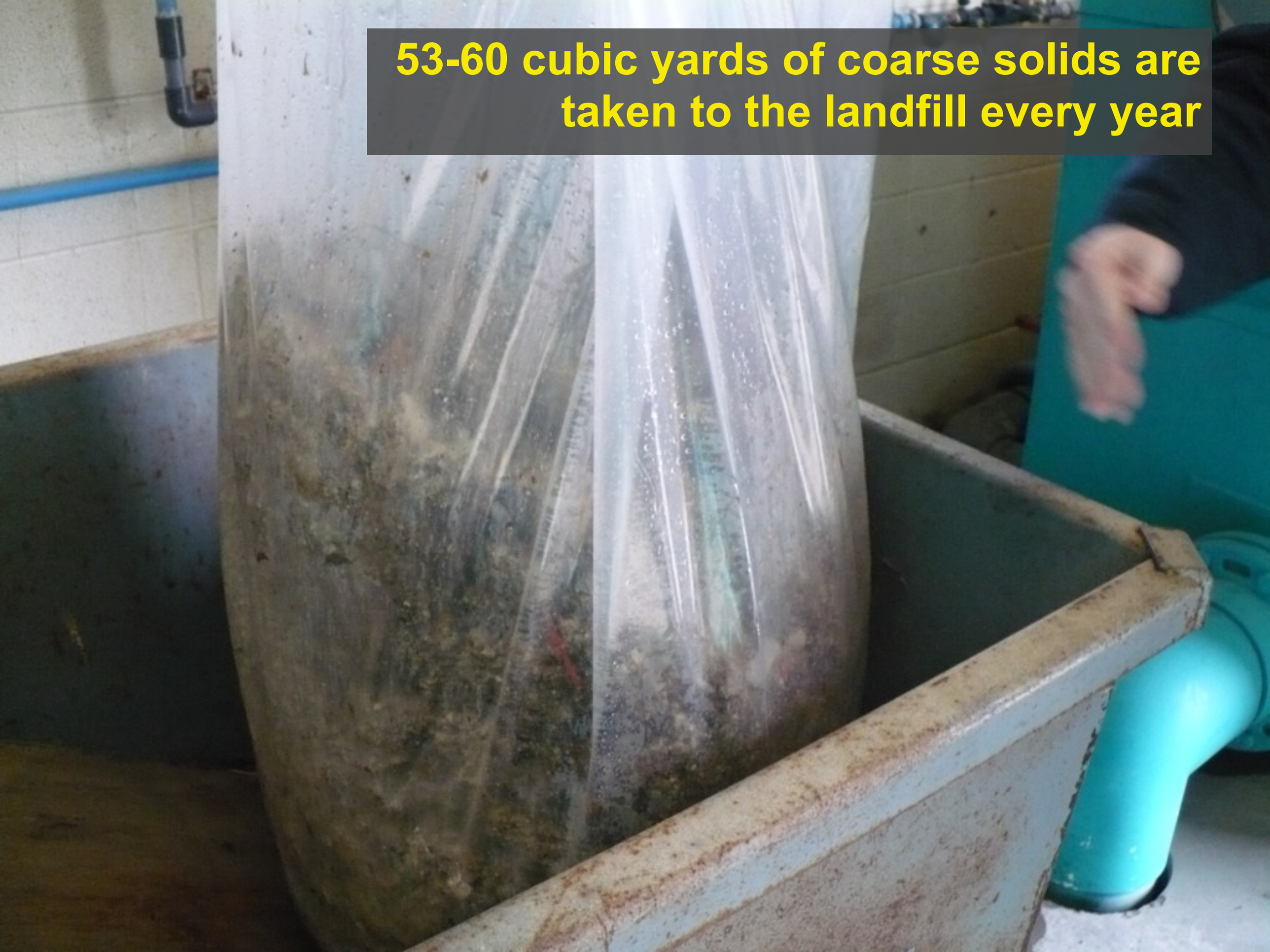
That's 0.01 gal/person/day—
Wiltsee's # estimated we'd have 0.004

H2O'C ENGINEERING

Trucks empty their load at the Septage Acceptance Plant

Auger lifts coarse solids from septage; liquid flows into head of treatment plant


This is where you'd grab the FOG,
perhaps with an oil-water separator


53-60 cubic yards of coarse solids are taken to the landfill every year

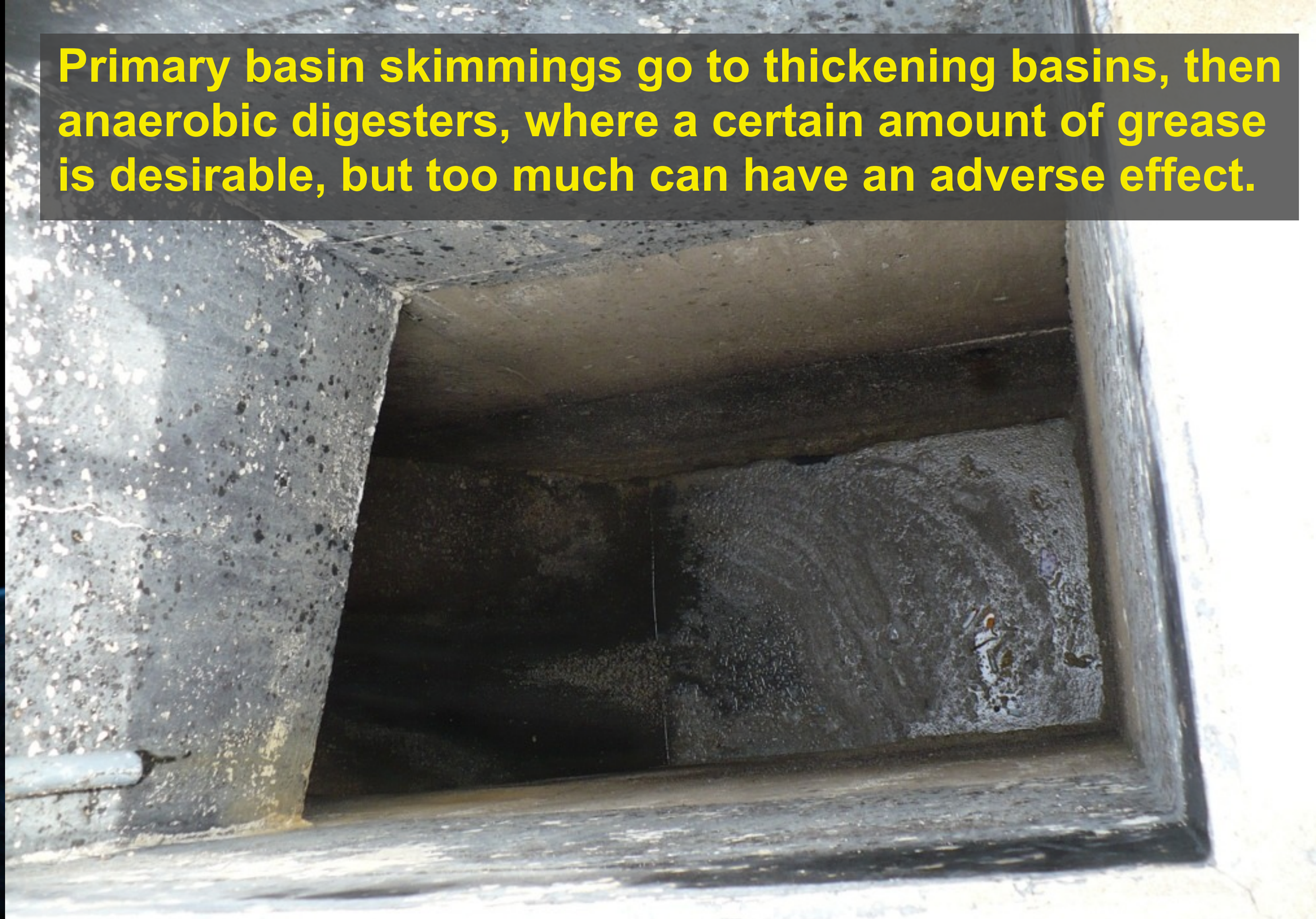

tube lower bushing at bushing
FAIRFIELD
THE FAIRFIELD ENGINEERING COMPANY
MARION, OHIO, U.S.A.
BAR SCREEN
BAR SCREEN EAST #1

Headworks pump station: 60’ deep

Primary settling basin with rotating skimmer

Floating material is collected here...

...and deposited in the primary basin skimmings pit.



Primary basin skimmings go to thickening basins, then anaerobic digesters, where a certain amount of grease is desirable, but too much can have an adverse effect.

FOG-to-Biodiesel

- more complicated than traditional feedstock
- requires pre-treatment (removing Barbie® doll heads, dewatering, acid catalysts)
- estimate capital costs at $2 /MG/yr
- estimate O&M costs at $0.50 /gal
- estimate revenues (or avoided fuel costs) at $4 /gal

cost estimates based on: Jon H. Van Gerpen, 2008. Biodiesel Economics

FOG-to-Biodiesel

- **0.004 to 0.01 gals FOG per person per day**
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