November 1998 • NREL/SR-570-26141

Urban Waste Grease Resource Assessment

G. Wiltsee

Appel Consultants, Inc.
Valencia, California

National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado 80401-3393
A national laboratory of the U.S. Department of Energy
Managed by Midwest Research Institute
for the U.S. Department of Energy
under contract No. DE-AC36-83CH10093

NREL/SR-570-26141

Urban Waste Grease Resource Assessment

G. Wiltsee

Appel Consultants, Inc.
Valencia, California

NREL technical monitor: K.S. Tyson

National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado 80401-3393
A national laboratory of the U.S. Department of Energy
Managed by Midwest Research Institute
for the U.S. Department of Energy
under contract No. DE-AC36-83CH10093

Prepared under Subcontract No. ACG-7-17090-01

November 1998

NOTICE

Available to DOE and DOE contractors from:
Office of Scientific and Technical Information (OSTI)
P.O. Box 62
Oak Ridge, TN 37831
Prices available by calling (423) 576-8401

Available to the public from:
National Technical Information Service (NTIS)
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
(703) 605-6000 or (800) 553-6847
or
DOE Information Bridge
http://www.doe.gov/bridge/home.html

CONTENTS

Section **Page**

TABLES

EXECUTIVE SUMMARY

Overview

This study, which was funded by the US Department of Energy's National Renewable Energy Laboratory (NREL), collected and analyzed data on urban waste grease resources in 30 randomly selected metropolitan areas in the United States. The metropolitan areas ranged in size from Bismarck, North Dakota (83,831) to Washington, DC (3,923,574). Two major categories of urban waste grease were considered in this study:

1) yellow grease feedstock collected from restaurants by rendering companies; and
2) grease trap wastes from restaurants, which can either:
   a. be pumped into tank trucks for disposal (often at wastewater treatment plants) or processing (at rendering plants or other facilities); or
   b. flow through municipal sewage systems into wastewater treatment plants.

Yellow grease feedstock is a valuable commodity, used to manufacture tallow, animal feed supplements, and other products. Grease trap waste and grease entering sewage treatment plants are zero or negative cost feedstocks at their sources, but are contaminated with sewage components. Other than collecting information on tipping fees, this study did not address feedstock preparation and cost issues.

The number of restaurants in most of the 30 metropolitan areas studied is quite consistent, at about 1.4 restaurants per 1,000 people. Cultural and dietary preferences greatly affect the amount of grease used in cooking. The amount of grease discarded from certain fast food restaurants is especially high. Despite significant local variations among neighborhoods' grease outputs, when entire metropolitan areas are considered the quantities of grease are reasonably consistent on a per capita (and a per restaurant) basis.

The amount of yellow grease feedstock collected from restaurants ranged from about 3 to 21 pounds/year/person, or about 2,000 to 13,000 pounds/year/restaurant for the metropolitan areas sampled in this study. Many rendering companies refused to provide data, so factored estimates were used in many of the cities. The combined resource of collected grease trap waste and uncollected grease entering sewage treatment plants ranged from about 2 to 27 pounds/year/person, or about 800 to 17,000 pounds/year/restaurant. Thus, a metropolitan area the size of Washington, DC (which includes suburban Maryland and Northern Virginia) generates about 39,000,000 pounds/year of yellow grease feedstock and about 50,000,000 pounds/year of grease trap waste.

Table 1 summarizes the data collected in this study on a per capita basis, in pounds of grease per year, per person. The table also shows the metropolitan area populations and the number of restaurants per 1,000 people in each area. The numbers in front of the metropolitan areas represent the order in which the areas were visited. City names

followed by dashes indicate that additional cities are included in the official name of the metropolitan area (e.g., Provo-Orem).

Table 1
Urban Waste Grease Resources in 30 Metropolitan Areas
Pounds/Year/Person

No.	Metro Area	State	Population	Rstrnts /1000P	Yellow Grease	Trap Grease	Total Grease
1	Sacramento	CA	1,481,102	1.49	3.04	11.21	14.25
2	Olympia	WA	161,238	1.49	6.70	7.44	14.14
3	Provo-	UT	263,590	1.52	16.62	26.56	43.17
4	Denver-	CO	1,848,319	1.44	9.20	8.60	17.80
5	Lincoln*	NE	213,641	1.64	21.06	12.17	101.10
6	Bismarck	ND	83,831	1.59	5.13	4.77	9.90
7	Bloomington-	IL	129,180	1.55	3.87	17.80	21.68
8	Battle Creek	MI	135,982	1.55	11.03	11.03	22.06
9	Mansfield	OH	126,137	1.93	5.15	1.51	6.66
10	Elmira	NY	95,195	1.47	9.98	15.76	25.74
11	Boston	MA	1,950,855	1.54	5.33	17.22	22.55
12	Harrisburg-	PA	587,986	1.53	10.20	18.37	28.57
13	Altoona	PA	130,542	1.10	9.96	7.66	17.62
14	Hagerstown	MD	121,393	1.40	9.89	8.24	18.12
15	Washington	DC	3,923,574	1.27	9.94	12.74	22.68
16	Richmond-	VA	865,640	1.71	10.05	19.99	30.04
17	Danville	VA	108,711	1.44	10.12	17.48	27.60
18	Fayetteville	NC	274,566	1.40	9.83	7.65	17.48
19	Florence	SC	114,344	1.62	9.62	7.87	17.49
20	Greenville-	SC	640,861	1.59	9.99	7.18	17.16
21	Lexington-	KY	348,428	1.61	10.05	10.33	20.38
22	Memphis	TN	981,747	1.15	9.98	18.84	28.83
23	Decatur	AL	131,556	1.86	9.88	18.24	28.12
24	Macon-	GA	281,103	1.24	9.96	20.99	30.95
25	Lakeland-	FL	405,382	1.10	10.11	11.35	21.46
26	Bradenton	FL	211,707	1.70	9.92	14.17	24.09
27	Baton Rouge	LA	528,264	1.24	10.03	10.98	21.01
28	Shreveport	LA	334,341	1.32	9.87	14.06	23.93
29	Beaumont-	TX	361,226	1.06	9.97	10.80	20.76
30	Bryan-	TX	121,862	1.62	9.85	16.41	26.26
	Weighted average			1.41	8.87	13.37	23.09

*Lincoln total includes 67.87 pounds/year/person of food plant waste grease.

There is not much variability from one urban area to another in the number of restaurants per 1,000 people. The number is between 1 and 2 for all 30 cities, and usually in the middle of this range, with a weighted average of 1.41 restaurants/1,000 people. Regression analysis shows that the best fit line has a coefficient (slope) of 1.36 restaurants/1,000 people, with an r-squared value of 0.985. Based on this finding, we would expect that the number of restaurants and the number of people in a metropolitan

area give about the same ability to predict the quantities of waste grease resources in that area. Regression analysis showed that this is indeed the case, as summarized below:

	Yellow Grease	Trap Grease	Total Grease
vs. Population			
Weighted average, pounds/year/person	8.87	13.37	23.09
Regression coefficient, lb/y/p	8.74	13.11	21.96
R squared	0.901	0.924	0.930
vs. Number of Restaurants			
Weighted average, pounds/year/restaurant	6,268	9,453	16,325
Regression coefficient, lb/y/r	6,256	9,553	15,903
R squared	0.849	0.921	0.908

The population of a metropolitan area, state, or other geographic area is generally easier to obtain than the number of restaurants in that area. Rounding off to reflect a reasonable number of significant digits, the urban waste grease resources of a metropolitan area, region, state, or the US as a whole can be predicted from the following simple equations:

- Yellow grease, pounds/year/person = 9
- Trap grease, pounds/year/person = 13
- Total waste grease, pounds/year/person = 22

Yellow Grease

Rendering companies process grease and fat from restaurant kitchens, and produce tallow (most of which is exported to the Orient) and feed fat for use in animal feed. Prices for yellow grease fluctuate as with all commodities; during the past year they have been in the 10-20¢/pound range. Waste grease from restaurants appears to be growing in economic value and is the focus of intense competition in some cities. Some of the rendering companies are major companies with nationwide or large regional operations. The companies I encountered most often in the 30 metropolitan areas studied were:

- Valley Proteins, Inc. -- in nine metropolitan areas in the eastern US (Harrisburg, Altoona, Hagerstown, Washington, DC, Richmond, Danville, Florence, Greenville, and Lexington);
- Darling International, Inc. -- in eight metropolitan areas throughout the US (Olympia, Lincoln, Battle Creek, Lakeland, Baton Rouge, Shreveport, Beaumont, and Bryan);
- Griffin Industries, Inc. -- in seven metropolitan areas in the south (Memphis, Decatur, Macon, Lakeland, Bradenton, Baton Rouge, and Shreveport);
- Baker Commodities, Inc. -- in three metropolitan areas in the north (Olympia, Bismarck, and Boston);
- National Byproducts Company -- in Denver and Lincoln; and
- CBP Resources Inc. -- in Richmond and Fayetteville.

In addition, I encountered at least 23 other rendering companies in one metropolitan area each. The grease collection business in Provo-Orem, Utah is typical of those in many of

the other metropolitan areas studied. Bonneville Livestock Inc. collects and processes about 55-60% of the restaurant grease in Utah, and also operates in four or five nearby states. Its manager described a competitive business, with John Kuhni & Sons, American Commodities Co., and Renegade Oil Co. all vying for restaurant accounts in the Provo-Orem area. The manager at John Kuhni & Sons stated that Renegade Oil Co. in Salt Lake City is his biggest competitor. In the Provo-Orem area, John Kuhni & Sons picks up, on average, about two barrels every three weeks from about 70-75 restaurants. Assuming an average of 300 pounds of grease per barrel, this is equivalent to about 10,000 pounds/year/restaurant.

National Byproducts, Inc., which recently acquired Colorado Grease Company, appears to have the largest market share of the rendering companies serving the Denver-Boulder area. They pay some restaurants for grease, and do not pay some others (depending on volume and location). National has eight rendering plants in the mid-continent area, and provides bulk containers to its large customers (approximately 5x3x3 feet) which get emptied into the collection trucks, instead of exchanging 55-gallon drums as most of the rendering companies do.

Valley Proteins Inc. was typical of many rendering companies in that my calls were answered by secretaries who took messages, but the managers did not return the calls, even after several call-backs. Some rendering company managers said if I sent them a letter with my questions they would take a look at it, but that chances were good they would not respond with any quantitative information. I did not bother. Others were friendly and gave me qualitative information such as the names of the companies serving the metropolitan area and their approximate market shares, but stayed away from giving out data on quantities of grease collected. A few rendering company managers gave me their "estimates" of quantities of grease collected from restaurants in certain metropolitan areas. It was impossible to verify these estimates.

The amount of yellow grease feedstock recovered per restaurant varies greatly for different types of restaurants. Jack-in-the-Box restaurants generate two or three times as much grease as McDonald's, whereas Denny's restaurants produce about 2/3 as much as McDonald's. A typical small family restaurant generates about 1/3 as much grease per day as a McDonald's.

Trap Grease Collected by Tank Trucks

Most of the cities in the survey have a "grease traps" section in the yellow pages, which typically lists a small number of companies. Usually these companies are septic tank service companies that also provide grease trap service, usually with different trucks (depending on local regulations). If the yellow pages had no listings for grease traps, I was usually able to find several companies listed under septic tank service that also provided grease trap service. In some areas I found that rendering companies also pump out grease traps.

In general, attempts to develop estimates of the total amounts of grease trap wastes collected by tank trucks by asking the service companies themselves for the data were not successful. There were too many non-respondents or respondents who did not keep good records. After the first few metropolitan areas, my interview technique for these companies had evolved to a very short set of questions designed to find out where the grease trap pump trucks discharged the material and what the local regulations concerning such discharges were. If the answer was the local wastewater treatment plant, I would try to get information on quantities from the wastewater treatment plant, and usually met with

success. If the answer was evasive, or honestly indicated that the material was being dumped somewhere, it was necessary to use a factored estimate.

Some cities and counties are grappling with the political issue of how best to handle grease trap wastes. Most wastewater treatment plant managers feel that from a technical point of view it is best to have strong regulations requiring restaurants to have grease traps pumped regularly, and to have the waste discharged at wastewater treatment plants where it can be properly treated and disposed of. However, local politics and lobbying by business owners often create much less effective approaches to the problem. In some areas, there are no legal or permitted approaches to disposing of grease trap wastes, forcing it to be done illegally. Data collection in such areas is essentially impossible.

Regulations in some areas (e.g., California) are moving towards collection and processing of grease trap wastes by rendering companies instead of disposal in wastewater treatment plants. Newer restaurants in some areas of California are required to install interceptors instead of traditional grease traps. An interceptor is a larger device that can be visualized as a wide spot in the line that allows cleaner grease to be recovered.

In some cities, pump trucks drive to designated sites and discharge grease trap wastes to manholes that provide a "straight shot" to the wastewater treatment plant. In effect, restaurant grease is prevented from flowing through the narrow drains and piping at the beginning of the collection system, but is reinjected into the main sewage stream near the treatment plant where the lines are wide and plugging is not a concern. More commonly, trucks are required to discharge grease trap wastes at the wastewater treatment plant, where accurate records can be kept and sources can be monitored. Some plants have pretreatment systems designed specifically for grease trap wastes. One pretreatment manager (in Altoona, Pennsylvania) places bacteria in several manholes to allow the pretreatment process to start before the sewage arrives at the plant.

Some wastewater treatment plants not only accept material pumped from restaurant grease traps; they accept food processing grease wastes as well. In Lincoln, Nebraska, one wastewater treatment plant receives not only all of the grease trap wastes collected in the metropolitan area, but also waste grease from an ADM soybean processing plant and a Cook Foods ham and bacon plant. In Memphis, one wastewater treatment plant receives effluent from a Protein Tech soybean processing plant and a Cargill corn processing plant.

Grease trap wastes in the Provo-Orem area are delivered to a soils regeneration operation in Salt Lake City, where oily wastes and greases are bioremediated using microbes and nutrients. Materials are blended and composted; the product is used as topsoil for the final cover on closed landfill sites. In the Boston area, grease trap pumping companies discharge pump trucks at processing facilities that charge tipping fees such as 11¢/gallon for grease trap waste and 6¢/gallon for septage. One major septic service company treats its own grease trap material, recovering the grease and landfilling the rest. In the Lakeland-Winter Haven and Bradenton, Florida metropolitan areas, several companies recover and process grease trap wastes. Nopec Corporation converts grease into biodiesel fuel, and septic tank service companies separate the waste grease from water, adjust the pH of the grease with lime, and land spread the material in accordance with permits from county and state environmental agencies. The Natural Solution Inc. in Shreveport uses a patented bioremediation process (bacteria) to convert grease to inert solids. Grease trap pump trucks in Bryan-College Station discharge at a wastewater treatment plant, where a private company processes the material with bacteria. The gray water enters the treatment plant and the solids go to a landfill.

In Harrisburg, Pennsylvania, a grease trap pumping company dewaters the material in a plate and frame filter press and hauls the grease cake to the Harrisburg Refuse Incinerator. Grease trap pumping companies in the Port Arthur, Texas area discharge their wastes at the Chemical Waste Management incinerator nearby, which receives hundreds of different types of wastes and chemicals, including PCBs and other hazardous wastes. The Beaumont, Texas wastewater treatment plant currently accepts grease trap discharges, but a plant is under construction by a private company that will convert the grease trap wastes to products. When this plant is operating, the Beaumont wastewater treatment plant will stop accepting grease trap discharges.

Data collected on grease trap wastes are subject to inherent inaccuracies because this material can include a significant amount of water and other materials mixed with the grease. In fact, the usable grease content may be as low as 5-10%. In all cases, the estimates in this report were adjusted to provide a best estimate of the amount of grease contained in the grease trap waste.

Restaurant Grease Flowing Directly to Wastewater Treatment Plants

Grease traps are not 100% effective in capturing grease that goes down restaurant drains, and restaurant owners are not uniformly diligent (depending on local regulations and enforcement) in having grease traps serviced at regular intervals. In addition, households and other establishments discharge food wastes and grease to the sewer system. Motor oils and industrial oils are also included in the "oil and grease" component that makes its way into wastewater treatment plants. Some wastewater treatment plant laboratories report the oil and grease content of their influent wastewater in the units milligrams (mg)/liter; others report in parts per million (ppm). It turns out that these two sets of units are the same, because water weighs 1,000 grams/liter.

Although there is considerable variation, the amount of raw sewage entering wastewater treatment plants in the 30 metropolitan areas averages about 110 gallons per day per person. The range was from 36 gallons/day/person in the Harrisburg-Lebanon-Carlisle, Pennsylvania metropolitan area to 247 gallons/day/person in the Provo-Orem, Utah area. These values are the average flow rates reported by the plant managers; flow rates during rainstorms are much higher.

The concentrations of oil and grease measured in the raw sewage to wastewater treatment plants in the 30 metropolitan areas generally fall in the range of 20 to 50 ppm. The most detailed information I received on this subject was for a group of five plants in the Maryland suburbs of Washington, DC. Although individual (daily) measurements ranged from 1.2 to 206 ppm, the annual average concentrations for all five plants fell in the range of 27 to 38 ppm. It appeared from these data that 35 ppm was a good average value for the oil and grease concentration in the raw sewage in DC and its Maryland suburbs.

A. INTRODUCTION

Objective

The National Renewable Energy Laboratory (NREL) stated the following objective in funding this work: "The objective of this work is to develop a cost effective methodology for estimating urban waste grease quantities and values on a state and regional scale for the United States; and implement it to produce state-level urban waste grease data. If successful, this research will provide a replicable methodology for others to use."

Review of Existing Urban Waste Grease Resource Assessments

There are relatively few published reports that provide data and analyses of urban waste grease resources in the US. In fact, only a small number of published articles provide any information on waste grease resources in the US; those that were found in this literature search are summarized below.

Richard G. Nelson et. al. (Kansas State University), "Potential Feedstock Supply and Costs for Biodiesel Production", in Proceedings of BIOENERGY '94, the Sixth National Bioenergy Conference, Reno/Sparks, Nevada, October 2-6, 1994. The majority of tallow (edible and inedible) in the US is generated by the meat packing, poultry, and edible/inedible rendering industries. Most edible tallow is used as baking and frying fats, margarine and other edible products. Inedible tallow is mainly used as an animal feed supplement (62.4%), with minor uses as fatty acid feedstock (22.4%), soaps and lubricants. Waste grease discarded by food service operations (the resource of interest here) can be processed to produce a mixture of waste oils and fats known as yellow grease. A majority of yellow grease is used as an added fat source for animal feeds (64%), as a feedstock for industrial fatty acids (4%), or as a diluent for higher grade inedible products (7%), with the remainder being exported.

Researchers believe that biodiesel derived from inedible tallow and greases has significant potential in certain locations such as large cities (yellow grease) and possible rural locations that are in close proximity to large cattle slaughtering facilities (inedible tallow). Nelson presents data on national edible tallow production taken from the US Department of Agriculture - Economic Research Service (USDA-ERS) "Oil Crops, Situation and Outlook Report", and data on inedible tallow from the US Department of Commerce, Bureau of the Census M20K Reports. These data are summarized in Table 2.

Thomas B. Reed (Colorado School of Mines), "An Overview of the Current Status of Biodiesel", in Proceedings, First Biomass Conference of the Americas, Burlington, Vermont, August 30-September 2, 1993. Reed mentions that the US Department of Agriculture maintains the Northern Agriculture Energy Center in Peoria, IL to work primarily in the area of oils and fats. He states that waste fat (yellow grease) typically sells for $0.60-$1.00/gallon and estimates that it can be converted to biodiesel for $0.60/gallon.

Frank Pudel and Peter Lengenfeld (OEHMI Forschung und Ingenieurtechnik GmbH, Magdeburg, Germany), "Processing Waste Fats into a Fuel Oil Substitute", in Proceedings, First Biomass Conference of the Americas, Burlington, Vermont, August 30-September 2, 1993. In several branches of industry, especially in the food industry, fats of

biological origin result as wastes that need to be disposed of. The primary sources are: fats that were used for deep-frying, cooking, or baking; fatty wastes such as tank slurries; returned fatty foods; fats from fat traps of sewage treatment plants; and technical oils of biological origin like lubricating, hydraulic, or drill oils.

Table 2
US Production, Consumption, and Potential Biodiesel Supply from Tallow and Waste Greases (1991)

Edible Tallow	
Total production, million pounds/year	1,515
Consumption	1,183
Potential biodiesel from total production, million gallons/year	196
Inedible Tallow and Waste Greases	
Total production, million pounds/year	
Inedible tallow	3,603
Greases	2,167
Consumption	2,993
Potential biodiesel from total production, million gallons/year	747

Jesse Katz, Los Angeles Times, "The Rancid Riches of Texas' New Range War", August 22, 1997. Subheadlines: "Lucrative recycling industry fuels demand for restaurants' used cooking oil. Across this fry cook's nirvana, big entrepreneurs and rogue operators battle over who gets the goo." Waste grease from restaurants is a commodity that is growing in economic value and is the focus of intense competition in some cities.

The rendering industry lives off waste grease, recycling it as an additive in soap, cosmetics, lubricants and livestock feed, among other uses. The largest renderers sign contracts with restaurants, installing grease vats in kitchen alleys and paying a few cents per pound every time they come for a load. That arrangement, however, rarely goes unchallenged. Rogue haulers often snatch the grease before the big companies can get there -- a phenomenon that has led to criminal probes, civil lawsuits and other charges of slippery commerce. A poacher can earn 7 to 14 cents a pound, depending on the demand for rendered grease, which is bought and sold each day on the commodities market.

I interviewed a person from Darling International, a large rendering company based in Dallas, TX that has operations all over the US. They process grease and fat from restaurant kitchens, and produce tallow (95% of which is exported to the Orient) and feed fat for use in animal feed. Prices fluctuate as with all commodities, but recently have been in the 15-20¢/pound range. It is possible that some of these markets and prices may be threatened by concerns over "mad cow disease." If so, it is possible that used cooking oil could become available as a tipping fee waste in some locations. At the present time in most locations, the only waste grease that fits that description is grease trap waste, which is contaminated with other sewage material. Most grease trap waste ends up being treated in municipal wastewater treatment systems.

Categories and Key Variables

The amount of yellow grease feedstock recovered per restaurant varies greatly for different types of restaurants. Jack-in-the-Box restaurants generate two or three times as much

grease as McDonald's, whereas Denny's restaurants produce about 2/3 as much as McDonald's. A typical small family restaurant generates about 1/3 as much grease per day as a McDonald's. Thus, the demographics of the area and types of restaurants serviced by the rendering company reporting the data can greatly affect the estimated total quantities of grease recovered.

Data collected on grease trap wastes are subject to inherent inaccuracies because this material can include a significant amount of water and other materials mixed with the grease. In fact, the usable grease content may be as low as 5-10%. In contrast, the grease/oil quantities reported by the laboratories at some wastewater treatment plants are based on gravimetric analyses of total raw sewage, thus eliminating water and other contaminants or diluents from the estimates. In all cases, a best effort has been made in this report to adjust grease trap resource data to include only the grease, and to exclude water and other materials that may be present. These adjustments necessarily involved assumptions and considerable uncertainty.

Some wastewater treatment plant laboratories report the oil and grease content of their influent wastewater in the units mg/liter; others report in parts per million (ppm). It turns out that these two sets of units are the same, because water weighs 1,000 grams/liter. Therefore, one mg/liter is the same as one gram per million grams, or one ppm.

Some cities and counties are grappling with the political issue of how best to handle grease trap wastes. Most wastewater treatment plant managers feel that from a technical point of view it is best to have strong regulations requiring restaurants to have grease traps pumped regularly, and to have the waste discharged at the wastewater treatment plants where it can be properly treated and disposed of. However, local politics and lobbying by business owners often create much less effective approaches to the problem. In some areas, there are no legal or permitted approaches to disposing of grease trap wastes, forcing it to be done illegally. Data collection in such areas is essentially impossible.

Sample of US Metropolitan Areas

The United States Office of Management and Budget (OMB) defines metropolitan areas according to published standards that are applied to Census Bureau data. The general concept of a metropolitan area is that of a core area containing a large population nucleus, together with adjacent communities having a high degree of economic and social integration with that core. The current (1996) standards provide that each newly qualifying metropolitan area must include at least one city with 50,000 or more inhabitants, or a Census Bureau-defined urbanized area (of at least 50,000 inhabitants) and a total metropolitan population of at least 100,000 (75,000 in New England).

The Census Bureau report "State and Metropolitan Area Data Book 1991" (based on the 1990 census) lists 281 metropolitan areas in the United States (See Appendix A). The total 1990 population of the 281 metropolitan areas in the US was 193,007,670, which is 77.4% of the total July 1, 1990 US population of 249,397,990. A sample of 30 metropolitan areas was selected randomly for this study. The initial sample was reviewed to make sure it reflected a good cross-section of the nation geographically, and that it was representative of the total group of 281 metropolitan areas in terms of size distribution. Three substitutions were made for these reasons, resulting in the sample of 30 metropolitan areas shown in Table 3. Table 4 shows how the sample of 30 compares to the total of 281 metropolitan areas in size distribution.

Table 3
Sample of 30 Metropolitan Areas

No.	Metropolitan Area	State	Population
1	Sacramento	CA	1,481,102
2	Olympia	WA	161,238
3	Provo-Orem	UT	263,590
4	Denver-Boulder	CO	1,848,319
5	Lincoln	NE	213,641
6	Bismarck	ND	83,831
7	Bloomington-Normal	IL	129,180
8	Battle Creek	MI	135,982
9	Mansfield	OH	126,137
10	Elmira	NY	95,195
11	Boston	MA	1,950,855
12	Harrisburg-Lebanon-Carlisle	PA	587,986
13	Altoona	PA	130,542
14	Hagerstown	MD	121,393
15	Washington	DC	3,923,574
16	Richmond-Petersburg	VA	865,640
17	Danville	VA	108,711
18	Fayetteville	NC	274,566
19	Florence	SC	114,344
20	Greenville-Spartanburg	SC	640,861
21	Lexington-Fayette	KY	348,428
22	Memphis	TN	981,747
23	Decatur	AL	131,556
24	Macon-Warner Robins	GA	281,103
25	Lakeland-Winter Haven	FL	405,382
26	Bradenton	FL	211,707
27	Baton Rouge	LA	528,264
28	Shreveport	LA	334,341
29	Beaumont-Port Arthur	TX	361,226
30	Bryan-College Station	TX	121,862

Methodology

I traveled by personal car to all 30 cities in the order shown in Table 3, starting in October 1997 and finishing in March 1998. I spent 2-5 days gathering data in each city, mostly by telephone from motel rooms. (Gathering data on urban wood wastes took most of this time; the time spent on waste grease data collection ranged from about two hours to about eight hours, depending on the size of the metropolitan area.) I was able to make use of local resources such as yellow pages, libraries, Chambers of Commerce, and government agencies. Spending time in each area helped provide an "on-the-ground" perspective to the study, including site visits and meetings with key waste managers, that hopefully created tangible benefits in the quality of the data and interpretation. The methodology used in this study can easily be replicated by myself or others, entirely by telephone and without personal visits. The availability of yellow pages and other resources on the Internet makes the initial step of obtaining names and numbers relatively easy and inexpensive.

Table 4
Size Distributions: Sample of 30 and 281 US Metropolitan Areas

	281 Metro Areas		Sample of 30 Metro Areas	
No. of metro areas with population:				
> 1,000,000	38	14%	4	13%
500,000 - 1,000,000	37	13%	5	17%
200,000 - 500,000	81	29%	9	30%
125,000 - 200,000	68	24%	6	20%
< 125,000	57	20%	6	20%
Total	281	100%	30	100%
Average population	686,860		565,410	

Upon completion of data-gathering for each successive group of five metropolitan areas, I compiled all the data for those five cities into a report and submitted each report to the NREL Technical Monitor, Shaine Tyson. This allowed for feedback and redirection as the study proceeded, and made compilation of the final report and interpretation of the total package of results an easier task.

In each city, I started by making complete lists from the government pages and the yellow pages of every agency and company that appeared to be relevant: wastewater treatment plants, rendering companies, and grease trap pumping companies. I counted the number of restaurants listed in the yellow pages. I had developed a set of survey forms and questions, with different questions for different types of businesses or agencies (see Appendix B). These forms were useful as prompters, but I did not adhere to them strictly. I stated very briefly that I was collecting data on urban waste grease resources for the US Department of Energy, and then asked a simple lead-off question such as "What do you do with the material you pump from restaurant grease traps?" (to a grease trap pumping company manager). In most cases I was able to engage in a friendly conversation while obtaining whatever quantitative information the person could share.

Many waste grease collectors and processors do not keep records; rendering companies guard their data jealously; so it was often necessary to use estimation techniques. These factored estimates are clearly noted in the report on each metropolitan area in Section C. Immediately after each phone call, I performed calculations as necessary and developed my best estimate of each respondent's waste grease collection or processing rate. Later (sometimes two or three weeks later), when I prepared the draft report on each group of five metropolitan areas, I combined all of these estimates with other data I had obtained to produce the waste grease resource estimates for each metropolitan area. In this process, I also took into account the non-respondents. For example, I might have obtained useful information from three grease trap pumping companies out of five in a particular area, but the estimate I generated was for all five companies. When the estimates were completed for all 30 cities, I went back over the entire set, checking carefully for consistency of calculation methods and assumptions. Then I performed some statistical analysis on the complete set of data, as discussed in Section B.

B. OVERVIEW OF URBAN WASTE GREASE DATA

Urban Waste Grease Resources

Tables 5 and 6 summarize the data collected on urban waste grease resources from 30 metropolitan areas in the US during the period from October 1997 to March 1998. Table 5 shows the data for each metropolitan area in pounds/year; Table 6 shows the same data on a per capita basis, in pounds/year/person. The numbers in front of the metropolitan areas represent the order in which the areas were visited, and correspond to the subsection numbers in Section C, the part of the report describing the metropolitan areas' waste grease resources. City names followed by dashes indicate that additional cities are included in the official name of the metropolitan area (e.g., Provo-Orem). As a shortcut in the following discussion, the word "city" is used interchangeably with "metropolitan area", even though this is not strictly correct.

Statistical Analysis of the Data

Appendix C presents a series of seven regression plots and statistical analyses. The first plot, restaurants vs. 1,000 population, confirms the observation that there is not much variability from one urban area to another in the number of restaurants per 1,000 people. Table 6 shows that the number is between 1 and 2 for all 30 cities, and usually in the middle of this range, with a weighted average of 1.41 restaurants/1,000 people. The regression plot shows that the best fit line has a coefficient (slope) of 1.36 restaurants/1,000 people, with an r-squared value of 0.985. Based on this finding, we would expect that the number of restaurants and the number of people in a metropolitan area give about the same ability to predict the quantities of waste grease resources in that area. The other six regression plots show that this is indeed the case, as summarized below:

	Yellow Grease	Trap Grease	Total Grease
vs. Population			
Weighted average, pounds/year/person	8.87	13.37	23.09
Regression coefficient, lb/y/p	8.74	13.11	21.96
R squared	0.901	0.924	0.930
vs. Number of Restaurants			
Weighted average, pounds/year/restaurant	6,268	9,453	16,325
Regression coefficient, lb/y/r	6,256	9,553	15,903
R squared	0.849	0.921	0.908

The population of a metropolitan area, state, or other geographic area is generally easier to obtain than the number of restaurants in that area. Rounding off to reflect a reasonable number of significant digits, the urban waste grease resources of a metropolitan area, region, state, or the US as a whole can be predicted from the following simple equations:

- Yellow grease, pounds/year/person = 9
- Trap grease, pounds/year/person = 13
- Total waste grease, pounds/year/person = 22

Table 5
Urban Waste Grease Resources in 30 Metropolitan Areas
Pounds/Year

No.	Metro Area	State	Population	No. of Rstrnts	Yellow Grease	Trap Grease	Total Grease
1	Sacramento	CA	1,481,102	2,200	4,500,000	16,600,000	21,100,000
2	Olympia	WA	161,238	240	1,080,000	1,200,000	2,280,000
3	Provo-	UT	263,590	400	4,380,000	7,000,000	11,380,000
4	Denver-	CO	1,848,319	2,670	17,000,000	15,900,000	32,900,000
5	Lincoln*	NE	213,641	350	4,500,000	2,600,000	21,600,000
6	Bismarck	ND	83,831	133	430,000	400,000	830,000
7	Bloomington-	IL	129,180	200	500,000	2,300,000	2,800,000
8	Battle Creek	MI	135,982	211	1,500,000	1,500,000	3,000,000
9	Mansfield	OH	126,137	244	650,000	190,000	840,000
10	Elmira	NY	95,195	140	950,000	1,500,000	2,450,000
11	Boston	MA	1,950,855	3,000	10,400,000	33,600,000	44,000,000
12	Harrisburg-	PA	587,986	900	6,000,000	10,800,000	16,800,000
13	Altoona	PA	130,542	143	1,300,000	1,000,000	2,300,000
14	Hagerstown	MD	121,393	170	1,200,000	1,000,000	2,200,000
15	Washington	DC	3,923,574	5,000	39,000,000	50,000,000	89,000,000
16	Richmond-	VA	865,640	1,480	8,700,000	17,300,000	26,000,000
17	Danville	VA	108,711	157	1,100,000	1,900,000	3,000,000
18	Fayetteville	NC	274,566	384	2,700,000	2,100,000	4,800,000
19	Florence	SC	114,344	185	1,100,000	900,000	2,000,000
20	Greenville-	SC	640,861	1,017	6,400,000	4,600,000	11,000,000
21	Lexington-	KY	348,428	562	3,500,000	3,600,000	7,100,000
22	Memphis	TN	981,747	1,128	9,800,000	18,500,000	28,300,000
23	Decatur	AL	131,556	245	1,300,000	2,400,000	3,700,000
24	Macon-	GA	281,103	348	2,800,000	5,900,000	8,700,000
25	Lakeland-	FL	405,382	445	4,100,000	4,600,000	8,700,000
26	Bradenton	FL	211,707	360	2,100,000	3,000,000	5,100,000
27	Baton Rouge	LA	528,264	657	5,300,000	5,800,000	11,100,000
28	Shreveport	LA	334,341	442	3,300,000	4,700,000	8,000,000
29	Beaumont-	TX	361,226	383	3,600,000	3,900,000	7,500,000
30	Bryan-	TX	121,862	198	1,200,000	2,000,000	3,200,000

*Lincoln total includes 14,500,000 pounds/year of food plant waste grease.

Table 6
Urban Waste Grease Resources in 30 Metropolitan Areas
Pounds/Year/Person

No.	Metro Area	State	Population	Rstrnts /1000P	Yellow Grease	Trap Grease	Total Grease
1	Sacramento	CA	1,481,102	1.49	3.04	11.21	14.25
2	Olympia	WA	161,238	1.49	6.70	7.44	14.14
3	Provo-	UT	263,590	1.52	16.62	26.56	43.17
4	Denver-	CO	1,848,319	1.44	9.20	8.60	17.80
5	Lincoln*	NE	213,641	1.64	21.06	12.17	101.10
6	Bismarck	ND	83,831	1.59	5.13	4.77	9.90
7	Bloomington-	IL	129,180	1.55	3.87	17.80	21.68
8	Battle Creek	MI	135,982	1.55	11.03	11.03	22.06
9	Mansfield	OH	126,137	1.93	5.15	1.51	6.66
10	Elmira	NY	95,195	1.47	9.98	15.76	25.74
11	Boston	MA	1,950,855	1.54	5.33	17.22	22.55
12	Harrisburg-	PA	587,986	1.53	10.20	18.37	28.57
13	Altoona	PA	130,542	1.10	9.96	7.66	17.62
14	Hagerstown	MD	121,393	1.40	9.89	8.24	18.12
15	Washington	DC	3,923,574	1.27	9.94	12.74	22.68
16	Richmond-	VA	865,640	1.71	10.05	19.99	30.04
17	Danville	VA	108,711	1.44	10.12	17.48	27.60
18	Fayetteville	NC	274,566	1.40	9.83	7.65	17.48
19	Florence	SC	114,344	1.62	9.62	7.87	17.49
20	Greenville-	SC	640,861	1.59	9.99	7.18	17.16
21	Lexington-	KY	348,428	1.61	10.05	10.33	20.38
22	Memphis	TN	981,747	1.15	9.98	18.84	28.83
23	Decatur	AL	131,556	1.86	9.88	18.24	28.12
24	Macon-	GA	281,103	1.24	9.96	20.99	30.95
25	Lakeland-	FL	405,382	1.10	10.11	11.35	21.46
26	Bradenton	FL	211,707	1.70	9.92	14.17	24.09
27	Baton Rouge	LA	528,264	1.24	10.03	10.98	21.01
28	Shreveport	LA	334,341	1.32	9.87	14.06	23.93
29	Beaumont-	TX	361,226	1.06	9.97	10.80	20.76
30	Bryan-	TX	121,862	1.62	9.85	16.41	26.26
	Weighted average			1.41	8.87	13.37	23.09

*Lincoln total includes 67.87 pounds/year/person of food plant waste grease.

It is important to note that the waste grease resource estimates in many of the metropolitan areas were not based on actual measured data. In the absence of measured data, I used factored estimates, which were based on measured data in other cities combined with the qualitative data and opinions obtained from local experts. As a result, the above predictive equations are really most representative of the small number of cities where measured data were available. If measured data had been obtained from all 30 of the cities, the variability in the data would probably be higher (greater scatter of data points on the regression plots, and smaller r-squared values).

C. METROPOLITAN AREA REPORTS

---

1. Sacramento, California **Population (1990): 1,481,102**

The Sacramento Yellow Pages list two rendering companies, 11 grease trap cleaning companies, and about 2,200 restaurants. Based on the information provided by the rendering companies, I estimate that about 4,500,000 pounds/year of grease are collected from Sacramento area restaurants for processing into yellow grease and subsequent blending into animal feed and other products. This amount of grease corresponds to about 2,000 pounds/year/restaurant, which is significantly lower than in other cities in the sample. This leads me to suspect that the estimate is low.

In Sacramento, as in other large cities, the business of picking up grease from restaurants is very competitive. Sacramento Rendering Company, which I believe has the largest market share in Sacramento, told me that at least four other companies compete with them. They are paying restaurants at least 1¢ per pound of grease. Pilfering of grease containers is a problem from time to time (when commodity grease prices are high). Florin Tallow Company also services Sacramento restaurants and delivers grease to its parent company, the Modesto Tallow Company, which has a rendering plant in Modesto.

California regulations and ballot referenda are moving towards collection and processing of grease trap wastes by rendering companies instead of disposal in wastewater treatment plants. This trend will probably gain momentum nationwide during the next several years. Newer restaurants in some areas of California are required to install interceptors instead of traditional grease traps. An interceptor is a larger device that can be visualized as a wide spot in the line that allows cleaner grease to be recovered.

The Regional Sanitation District wastewater treatment plant (which services the city and county of Sacramento and the city of Folsom) currently receives most of the grease trap wastes in the Sacramento metropolitan area. The pump trucks drive to three different sites and discharge to manholes which provide a "straight shot" to the treatment plant. In effect, restaurant grease is prevented from flowing through the narrow drains and piping at the beginning of the collection system, but is reinjected into the main sewage stream near the treatment plant where the lines are wide and plugging is not a concern. The total amount of grease trap pump truck material received by the Regional Sanitation District in calendar year 1996 was 914,945 gallons, which at 7.3 pounds/gallon is about 6,700,000 pounds/year. Assuming the grease content of this material averages about 10% by weight, the estimated amount of grease collected from Sacramento area grease traps is about 670,000 pounds/year.

The Regional Sanitation District wastewater treatment plant receives an average of 157 million gallons/day of raw sewage. The oil and grease content in the raw sewage averages about 35 parts per million (ppm). This results in an estimate of about 16,600,000 pounds/year of oil and grease entering the wastewater treatment plant. The 670,000 pounds/year of grease recovered from restaurant grease traps and discharged into the designated manholes is included in this number.

In summary, for Sacramento:

Number of restaurants	2,200
Restaurants/1,000 people	1.49

	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	4,500,000	3.0	2,000
Grease trap waste	16,600,000	11.2	7,500
Total grease resource	21,100,000	14.2	9,600

2. Olympia, Washington **Population (1990): 161,238**

The Olympia Yellow Pages list two rendering companies and one grease trap service company. There are approximately 240 restaurants in the Olympia metropolitan area. The general manager at Darling International, the rendering company with the largest market share in the Puget Sound area, suggested I use a factor of 200 pounds of grease per month per restaurant. I suspect this factor to be low based on information from other cities. The manager at Baker Commodities stated that his company had collected about 360,000 pounds/year from about 80 restaurants in Olympia (about 4,500 pounds/year/restaurant). I decided to use this factor for the total estimate, giving 1,080,000 pounds/year.

The grease trap company, which is a subsidiary of Baker Commodities, collects grease trap wastes from only about six restaurants in Olympia. These wastes are delivered to the Baker Commodities rendering plant for processing. Most of the restaurants in the area do not have grease traps. A laboratory employee at the Olympia Wastewater Treatment Plant told me that the plant received (through the sewer system) about 1,200,000 pounds of grease and oil in 1996. This estimate is based on gravimetric analyses performed on monthly grab samples of the raw sewage entering the plant.

In summary, for Olympia:

Number of restaurants	240
Restaurants/1,000 people	1.49

	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	1,080,000	6.7	4,500
Grease trap waste	1,200,000	7.4	5,000
Total grease resource	2,280,000	14.1	9,500

3. Provo-Orem, Utah **Population (1990): 263,590**

The Provo-Orem Yellow Pages list two rendering companies, two grease trap service companies, and about 400 restaurants. Bonneville Livestock Inc. in Lehi collects and processes about 55-60% of the restaurant grease in Utah, and also operates in four or five nearby states. Its manager described a competitive business, with John Kuhni & Sons (the other company listed in the yellow pages), American Commodities Co., and Renegade Oil Co. all vying for restaurant accounts in the Provo-Orem area. The manager at John Kuhni & Sons stated that Renegade Oil Co. in Salt Lake City is his biggest competitor. In the Provo-Orem area, John Kuhni & Sons picks up, on average, about two barrels every three weeks from about 70-75 restaurants. Assuming an average of 300 pounds of grease per barrel, this is equivalent to about 30 pounds/day/restaurant. Using this data point, I estimate that the total amount of yellow grease feedstock generated by the 400 restaurants in the Provo-Orem metropolitan area is about 4,380,000 pounds/year.

Both grease trap service companies provided estimates of their grease trap wastes from the Provo-Orem area, which total about 3,000,000 pounds/year. All grease trap wastes in the Salt Lake City-Provo-Orem area are delivered to ET Technologies, a soils regeneration operation in Salt Lake City. At this facility, oily wastes and greases are bioremediated using microbes and nutrients. Materials are blended and composted; the product is used as topsoil for the final cover on closed landfill sites. The manager of this facility estimated that it receives about 600 tons/month (14,400,000 pounds/year) of raw material from tank trucks that is a mixture of oils and greases, food wastes and other garbage, and water. Assuming that Provo-Orem generates about 20% of this material (based on population), this estimate comes out very close to the 3,000,000 pounds/year estimated by the grease trap service companies. However, both the ET Technologies manager and one of the grease trap service company representatives stated that only about 10% of this mixture is usable oils and greases that could be processed by rendering companies (or by biodiesel plants). On this basis I reduced the estimate of the amount of grease being recovered from Provo-Orem restaurant grease traps to 300,000 pounds/year.

Not all of the restaurants in the Provo-Orem area have grease traps; in addition, there are some industrial (e.g., food processing) facilities that discharge grease and oily wastes to the sewage system. There are three wastewater treatment plants in the Provo-Orem metropolitan area: the Provo Sewage Treatment Plant, the Orem Sewage Treatment Plant, and the Timpanogis Special Service District in American Fork, which serves nine small cities and towns north of Orem.

The Provo plant receives about 45,000,000 gallons/day of total influent. Weekly grab samples of the raw sewage contain an average of about 45 milligrams/liter of grease and oil. This is equivalent to 0.000376 pounds/gallon, and produces an estimate of about 5,480,000 pounds/year of oil and grease entering the Provo sewage treatment plant.

The Orem plant receives about 9,500,000 gallons/day of total influent. Weekly grab samples of the raw sewage contain 13-22 milligrams/liter of grease and oil. Using the midpoint of this range (which is equivalent to 0.000146 pounds/gallon) produces an estimate of about 506,000 pounds/year of oil and grease entering the Orem sewage treatment plant.

The Timpanogis plant receives about 10,500,000 gallons/day of total influent, of which about 7% is from "industrial" sources including restaurants. Weekly grab samples of the raw sewage contain 20-25 milligrams/liter of grease and oil. Using the midpoint of this range (which is equivalent to 0.000188 pounds/gallon) produces an estimate of about 720,000 pounds/year of oil and grease entering the Timpanogis Special Service District sewage treatment plant. The grand total for the three sewage plants in the Provo-Orem metropolitan area is about 6,700,000 pounds/year of grease and oil.

In summary, for Provo-Orem:

Number of restaurants	400		
Restaurants/1,000 people	1.52		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	4,380,000	16.6	11,000
Grease trap waste	7,000,000	26.6	17,500
Total grease resource	11,380,000	43.2	28,500

4. Denver-Boulder, Colorado **Population (1990): 1,848,319**

The Denver-Boulder Yellow Pages list 2,670 restaurants, six rendering companies (one of which now owns one of the others, and another of which processes animal carcasses only), and 13 grease trap service companies. National Byproducts, Inc., which recently acquired Colorado Grease Company, appears to have the largest market share of the rendering companies serving the Denver-Boulder area. They pay some restaurants for grease, and do not pay some others (depending on volume and location). National has eight rendering plants in the mid-continent area, and provides bulk containers to its large customers (approximately 5x3x3 feet) which get emptied into the collection trucks, instead of exchanging 55-gallon drums as most of the rendering companies do. National's manager estimated that the total amount of grease generated by Denver-Boulder restaurants is 300,000-350,000 pounds/week, of which his company picks up about 200,000-250,000 pounds/week. Discussions with the other rendering companies reinforced these estimates. I used the midrange of National By-Products' estimate to arrive at the total estimate of 17,000,000 pounds/year of yellow grease generated by Denver-Boulder restaurants.

Discussions with the Denver-Boulder grease trap service companies did not produce meaningful resource estimates, but did indicate that all of these companies haul the grease trap wastes to the Denver Metropolitan Wastewater Treatment Plant. A laboratory employee at the wastewater treatment plant reported that 3,531,000 gallons of grease trap wastes were delivered to the plant in calendar year 1996 (versus about 3,700,000 gallons in 1995). She stated that the tank truck drivers do not mix grease trap wastes with other wastes (such as septic) and that her number is based on summing the numbers each driver reports when the wastes are discharged at the plant. She also stated that this number includes grease wastes from food processing plants as well as restaurants, but did not know the relative amounts of each. Assuming 7.3 pounds/gallon for the density of this material and assuming that about 10% of the material is grease, the estimated amount of grease containted in grease trap wastes in Denver-Boulder is about 2,580,000 pounds/year.

The Denver Metropolitan Wastewater Treatment Plant receives an average of 150 million gallons/day of raw sewage. The oil and grease content in the raw sewage averages about 35 ppm. This results in an estimate of about 15,900,000 pounds/year of oil and grease entering the wastewater treatment plant. The 2,580,000 pounds/year of grease recovered from restaurant grease traps and discharged at the wastewater treatment plant is included in this number.

In summary, for Denver-Boulder:

Number of restaurants	2,670		
Restaurants/1,000 people	1.44		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	17,000,000	9.2	6,400
Grease trap waste	15,900,000	8.6	6,000
Total grease resource	32,900,000	17.8	12,300

5. Lincoln, Nebraska **Population (1990): 213,641**

The Lincoln Yellow Pages list 350 restaurants, two rendering companies, and one grease trap pumping company. A manager at Darling International, a major rendering company with nationwide operations, provided a fairly complete picture of the restaurant grease recovery business in Lincoln. He estimated that Darling International and General Grease each recover about 40% of the total restaurant grease, and that National Byproducts

recovers the other 20%. He believes the total amount of grease recovered from Lincoln area restaurants is about 4-5 million pounds/year. I used an estimate of 4,500,000 pounds/year.

One of the two wastewater treatment plants in Lincoln, the Theresa Street Treatment Plant, receives all of the grease trap wastes collected in the metropolitan area. This material is fed to anaerobic digesters at the treatment plant. The laboratory manager at the treatment plant provided the following figures for calendar year 1996:

- Restaurant grease traps -- 1,218 tank truck loads totaling 629,925 gallons. Assuming 7.3 pounds/gallon and 10% grease content, this material contains about 460,000 pounds/year of grease.
- ADM soybean processing plant waste grease -- 266 tank truck loads totaling 733,200 gallons, which converts to about 5,400,000 pounds/year (dilution factor unknown).
- Cook Foods plant (ham, bacon) -- 624 tank truck loads totaling 1,243,400 gallons, which converts to about 9,100,000 pounds/year (dilution factor unknown).

The two wastewater treatment plants in Lincoln receive a total of about 20 million gallons/day of raw sewage. The oil and grease content in the raw sewage averages about 35 ppm. This results in an estimate of about 2,100,000 pounds/year of oil and grease entering the wastewater treatment plants. The grease recovered from restaurant grease traps and food processing plants and discharged at the Theresa Street treatment plant is not included in this number.

In summary, for Lincoln:

Number of restaurants	350		
Restaurants/1,000 people	1.64		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	4,500,000	21.1	12,900
Grease trap waste	2,600,000	12.2	7,400
Subtotal	7,100,000	33.2	20,300
Food processing plants	14,500,000		
Total grease resource	21,600,000		

6. Bismarck, North Dakota **Population (1990): 83,831**

The Bismarck-Mandan Yellow Pages list 133 restaurants, four rendering companies, and one grease trap pumping company. One rendering company, located about 60 miles west of Bismarck, estimated that they recover about 260,000 pounds/year of yellow grease feedstock from Bismarck area restaurants, and that they have about a 60% market share. Assuming these estimates are accurate, the total amount of yellow grease feedstock being recovered from Bismarck area restaurants is about 430,000 pounds/year.

The Bismarck wastewater treatment plant reported that it had been many years since an analysis of grease in the raw sewage had been performed. The plant receives about 6.5 million gallons/day of raw sewage. Hydrosieve screens in the pretreatment facility remove the large grease balls (which contain many materials other than restaurant grease); this material is landfilled. Smaller grease particles coagulate on the primary clarifiers and are treated by aeration in the oil/grease pit. The plant manager estimated that perhaps 300 gallons/day enter the pit, of which maybe 75 gallons/day are grease. Adding another 25

gallons/day for grease balls, this results in a very rough estimate of 270,000 pounds/year of grease entering the Bismarck sewage treatment plant.

The Mandan wastewater treatment plant receives about 1.8 million gallons/day of raw sewage. No estimate was available of the quantity of grease entering the plant. Ratioing from the Bismarck plant results in an estimate of about 80,000 pounds/year of grease entering the Mandan sewage treatment plant.

The grease trap pumping companies in the Bismarck area apparently take the material to the landfills. My very rough estimate of the total quantity of grease trap waste disposed of in the Bismarck metropolitan area is 50,000 pounds/year. Adding this to the amounts estimated for the two sewage treatment plants results in a total estimate of 400,000 pounds/year of grease trap waste.

In summary, for Bismarck:

Number of restaurants	133		
Restaurants/1,000 people	1.59		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	430,000	5.1	3,200
Grease trap waste	400,000	4.8	3,000
Total grease resource	830,000	9.9	6,200

7. Bloomington-Normal, Illinois Population (1990): 129,180

The Bloomington-Normal Yellow Pages list 200 restaurants, no rendering companies, and one grease collection service that turned out to be a rendering company in Joliet (about 80 miles northeast of Bloomington). The rendering company estimated that they recover about 500,000 pounds/year of yellow grease feedstock from Bloomington-Normal area restaurants, and that they have close to a 100% market share.

The Bloomington-Normal Water Reclamation District wastewater treatment plant reported that they process about 20 million gallons/day of raw sewage, and that the grease and oil content is well below 100 parts per million. I assumed 35 ppm, which results in an estimate of 2,100,000 pounds/year of grease entering the sewage plant with the raw sewage. In addition, about 150 grease trap pumping trucks per year discharge their contents (assumed to average 1,500 gallons each) to the wastewater treatment plant's anaerobic digesters. At 7.3 pounds/gallon and a 10% grease content, this results in an estimated total of 160,000 pounds/year of grease trap pumping waste. Adding this to the amount estimated for the sewage treatment plant influent results in a total estimate of 2,300,000 pounds/year of grease trap waste.

In summary, for Bloomington-Normal:

Number of restaurants	200		
Restaurants/1,000 people	1.55		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	500,000	3.9	2,500
Grease trap waste	2,300,000	17.8	11,500
Total grease resource	2,800,000	21.7	14,000

8. Battle Creek, Michigan **Population (1990): 135,982**

The Battle Creek Yellow Pages list 211 restaurants, no rendering companies, and 13 septic tank cleaning companies. The municipal wastewater treating plant receives about 12 million gallons of raw sewage per day containing "less than 100 ppm" of grease and oil. Based on data from other cities, I assumed a concentration of 35 ppm, which results in an estimate of about 1,300,000 pounds/year of grease entering the wastewater treatment plant with the raw sewage. The wastewater treatment plant does not allow grease trucks or septic tank trucks to discharge there.

Roto Rooter in Kalamazoo was the only company I found that acknowledged pumping grease traps in the Battle Creek area. They have a processing facility in Kalamazoo, and take the resulting solid waste material to a landfill. My guesstimate of the total amount of grease trap waste pumped from Battle Creek restaurants is about 200,000 pounds/year, bringing the total estimate for grease trap waste plus grease entering the sewage plant to 1,500,000 pounds/year.

I was unable to get any useful information directly from the rendering companies that pick up most of the waste grease from Battle Creek restaurants, which I believe to be Cedar Creek Rendering in Grand Rapids, MI, Krueger Commodities in Hamilton, MI, and Darling International in Detroit. The manager at Darling International told me that the company with the largest market share in Battle Creek is Krueger Commodities (who did not return my calls). The Darling manager gave me data from the Detroit metropolitan area, which translates to 11.1 pounds of yellow grease feedstock per year per person. I used this figure as a basis for estimating the yellow grease resource in Battle Creek: 11.1 pounds/year/person is equivalent to about 1,500,000 pounds/year of yellow grease.

In summary, for Battle Creek:

Number of restaurants	211		
Restaurants/1,000 people	1.55		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	1,500,000	11.0	7,100
Grease trap waste	1,500,000	11.0	7,100
Total grease resource	3,000,000	22.1	14,200

9. Mansfield, Ohio **Population (1990): 126,137**

The Mansfield Yellow Pages list 244 restaurants, no rendering companies, and several septic tank cleaning companies. The municipal wastewater treating plant receives about 10 million gallons of raw sewage per day which contains 4-5 ppm of grease and oil, based on grab samples analyzed twice a week. This results in an estimate of about 150,000 pounds/year of grease entering the wastewater treatment plant with the raw sewage.

From the local McDonald's business office I learned that GA Windsor of Wapakoneta, Ohio (west of Mansfield, near Lima) picks up grease and pumps grease traps in the Mansfield area. A manager at GA Windsor estimated that they have about a 65% market share in Mansfield, and that they recover about 35,000 pounds of yellow grease per month from Mansfield area restaurants. This translates to a total yellow grease estimate for Mansfield of about 650,000 pounds/year.

GA Windsor also pumps grease traps. They refine the material and extract the usable grease from it. Based on the information I obtained from GA Windsor, I estimate that

about 37,000 pounds/year of grease is recovered from grease trap wastes pumped from Mansfield area restaurants. Combining this estimate with the 150,000 pounds/year entering the wastewater treatment plant gives a total estimate of about 190,000 pounds/year for grease trap waste either being recovered or entering the wastewater treatment plant.

In summary, for Mansfield:

Number of restaurants	244		
Restaurants/1,000 people	1.93		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	650,000	5.2	2,700
Grease trap waste	190,000	1.5	800
Total grease resource	840,000	6.7	3,400

10. Elmira, New York **Population (1990): 95,195**

The Elmira Yellow Pages list 140 restaurants, two rendering companies, and one grease trap pumping company. Neither rendering company manager returned my calls. I estimate the yellow grease resource in Elmira to be similar to those in Michigan and Ohio on a per capita basis (11.1 pounds/year/person in Battle Creek and 5.1 pounds/year/person in Mansfield). Assuming a value of 10 pounds/year/person in Elmira gives an estimate of about 950,000 pounds/year.

There are two wastewater treatment plants in the Elmira area. Plant #1 in Horseheads receives about 6 million gallons/day of raw sewage, and the "Southside" plant in Elmira receives about 8 million gallons/day. Neither plant measures the grease content in the raw sewage. "Greaseballs" are removed at the screens and clarifiers, and disposed of at the landfill. Neither wastewater treatment plant allows grease trap pump trucks to discharge their wastes at the treatment plant. Grease trap pumping companies are supposed to dispose of their wastes privately. Because the grease trap company manager did not return my calls, I was unable to find out either how much grease trap waste his company removes from Elmira area restaurants, or where they dispose of it.

My estimate for grease trap wastes for Elmira, like the yellow grease estimate, is based on data from other cities. Assuming the raw sewage to the wastewater treatment plants contains about 35 parts per million grease, then the total amount of grease entering the two wastewater treatment plants in the Elmira area is about 1,500,000 pounds/year. Combining this estimate with an estimate of 30,000 pounds/year removed from restaurant grease traps gives a total estimate of 1,500,000 pounds/year for grease trap waste either being disposed of or entering the wastewater treatment plants.

In summary, for Elmira:

Number of restaurants	140		
Restaurants/1,000 people	1.47		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	950,000	10.0	6,800
Grease trap waste	1,500,000	15.8	10,700
Total grease resource	2,450,000	25.7	17,500

11. Boston, Massachusetts Population (1990): 1,950,855

The Boston Area Yellow Pages list about 2,700 restaurants, three rendering companies, and nine grease trap pumping companies. An official in the Enforcement Division of the Boston Water & Sewer Commission said that they "enforce" grease trap pumping standards on about 1,500-1,600 restaurants, and that there are probably 3,000-4,000 restaurants in the metropolitan area. Typically they require pumping of grease traps about once a week. Grease trap pumping companies are not allowed to discharge to the regional wastewater treatment plants.

Two regional wastewater treatment plants in Boston Harbor handle essentially all of the wastewater from the metropolitan area. One of these plants, Nut Island, is closing, and the entire flow of about 280-300 million gallons/day will soon be going to the Deer Island plant. Based on an average of about 35 parts per million grease in the raw influent to the wastewater treatment plants, about 30,000,000 pounds of grease per year enter the Boston area wastewater treatment plants.

Based on discussions with the rendering companies, the approximate market shares in the Boston area are about 50% for Baker Commodities (who has a rendering plant in North Bellerica, MA); 30% for A. Martucci & Sons (who has a rendering plant in Tewksbury, MA); and 20% for American By-Products. The total amount of yellow grease feedstock recovered from Boston area restaurants is estimated to be about 10,400,000 pounds/year.

Only a couple of the grease trap pumping companies provided useful information. One of them discharges its material at a company named Mass Environmental in Carver, Massachusetts. They pay tipping fees of $0.11/gallon for grease trap waste, and $0.06/gallon for septage. The manager at Mass Environmental did not return my calls. I was told that there are several other facilities in the Boston metropolitan area that process grease trap wastes, but I did not get their names or numbers.

Stewart Septic Service Inc. estimates that it pumps about 20,000 gallons/day from grease traps in the region from Rhode Island to New Hampshire. They treat the material at their own facility in Lawrence, Massachusetts, recovering the grease and landfilling the rest. It seems likely that about 1/3 of this material comes from the Boston metropolitan area, which would be about 18 million pounds/year of grease trap waste. My guess is that Stewart Septic Service probably has at least a 50% market share of the restaurant grease trap pumping business in the Boston metropolitan area. Assuming 50%, this implies that the total amount of grease trap waste pumped in the Boston metropolitan area is about 36 million pounds/year, containing about 10% grease, or about 3,600,000 pounds/year.

In summary, for Boston:

Number of restaurants	3,000		
Restaurants/1,000 people	1.54		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	10,400,000	5.3	3,500
Grease trap waste	33,600,000	17.2	11,200
Total grease resource	44,000,000	22.6	14,700

12. Harrisburg-Lebanon-Carlisle, PA Population (1990): 587,986

The Harrisburg Yellow Pages list about 550 restaurants, two rendering companies (Mopac and Valley Proteins Inc.), and four septic tank pumping companies that mentioned grease

traps in their ads. I suspect the number of restaurants in the Harrisburg-Lebanon-Carlisle metropolitan area is probably closer to 900, or roughly 1.5 restaurants per capita (which is a fairly consistent number in nearly all of the cities I have sampled). I did not actually obtain phone books from Lebanon or Carlisle, and although many restaurants in these cities were listed in the Harrisburg phone book, I suspect many were also not included. I have used an estimate of 900 restaurants in the calculations below.

Neither rendering company manager returned my calls. A manager of a septic tank pumping company told me that Mopac definitely has the largest share of the restaurant grease recovery market in the area. I estimate the yellow grease resource in Harrisburg to be similar to those in Michigan and Ohio on a per capita basis (11.1 pounds/year/person in Battle Creek and 5.1 pounds/year/person in Mansfield). Assuming a value of 10 pounds/year/person in Harrisburg gives an estimate of about 6,000,000 pounds/year.

The one septic tank (grease trap) pumping company manager who was willing to talk to me said his company dewaters the material pumped from restaurant grease traps in a plate and frame filter press and hauls the grease cake to the Harrisburg Refuse Incinerator. They used to discharge their pumping trucks at the wastewater treatment plant, but the plant stopped accepting grease. I did not receive any quantitative estimates, but this manager told me I could get a ballpark estimate by assuming that most restaurants in the area have a 1,000 gallon grease interceptor that is pumped roughly once a month, thus producing about 12,000 gallons per year of sludge that contains roughly 10 weight percent grease. Using those assumptions, I estimate that grease trap pumping companies in the Harrisburg area recover (and then dispose of by incineration) about 9,000,000 pounds/year of grease.

The Harrisburg wastewater treatment plant receives about 20-22 million gallons/day of raw sewage, which contains about 15-40 parts per million grease based on grab sample analyses. Using the middle of both of these ranges, I estimate that about 1,800,000 pounds/year of grease enter the Harrisburg wastewater treatment plant along with the raw sewage.

In summary, for Harrisburg-Lebanon-Carlisle:

Number of restaurants	900		
Restaurants/1,000 people	1.52		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	6,000,000	10.2	6,700
Grease trap waste	10,800,000	18.4	12,000
Total grease resource	16,800,000	28.6	18,700

13. Altoona, Pennsylvania — Population (1990): 130,542

The Altoona Yellow Pages list about 143 restaurants, no rendering companies, and 6 septic tank pumping companies, none of which mentioned grease traps in their ads. The septic tank companies said that they do not pump grease traps.

Altoona has two sewage treatment plants, the East and West plants. I got essentially all the useful information about restaurant grease in the Altoona area from the plants' pretreatment coordinator. The West plant has an average flow of 7.3 million gallons/day, and receives virtually all of the restaurant grease, which is pretreated by placing bacteria in several manholes. (The East plant has an average flow of about 6.2 million gallons/day, mostly from industrial sources such as Conrail and the hospital.) The concentration of grease in the West plant's raw sewage averages about 50 parts per million. From this I estimated

that about 1,000,000 pounds/year of grease from Altoona restaurants enter the sewage treatment plant.

About eight restaurants in Altoona have large (1,000-2,000 gallon) grease interceptors. (The ones mentioned were Olive Garden, Red Lobster, TGI Friday's, Chi Chi's, and McDonald's.) A septic tank cleaning company from Laretto, PA (not listed in the Altoona Yellow Pages) has a contract to haul the contents of these grease traps to the Ebensburg Sewage Treatment Plant. The sludge is dewatered at the treatment plant and landfilled. The amount pumped from these large grease traps averages about 2,000 gallons/month, or about 20,000 pounds/year of grease (assuming about 10% grease in the slurry). The other restaurants, which have smaller grease traps (45-50 gallon), apparently dispose of their contents with the garbage. Based on this information, I believe it is reasonable to assume that almost all of the grease trap waste ends up in the West Sewage Treatment Plant and is included in the 1,000,000 pound/year estimate discussed above.

I learned from the pretreatment manager that Valley Proteins and Inland Products are the rendering companies that pick up yellow grease from restaurants in Altoona. These companies did not give me any useful information. I estimate the yellow grease resource in Altoona to be similar to those in Michigan and Ohio on a per capita basis (11.1 pounds/year/person in Battle Creek and 5.1 pounds/year/person in Mansfield). Assuming a value of 10 pounds/year/person in Altoona gives an estimate of about 1,300,000 pounds/year.

In summary, for Altoona:

Number of restaurants	143		
Restaurants/1,000 people	1.10		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	1,300,000	10.0	9,100
Grease trap waste	1,000,000	7.7	7,000
Total grease resource	2,300,000	17.6	16,100

14. Hagerstown, Maryland **Population (1990): 121,393**

The Hagerstown Yellow Pages list about 170 restaurants, no rendering companies, and 6 septic tank pumping companies, none of which mentioned grease traps in their ads. Most of the septic tank companies said that they do not pump grease traps; the one that acknowledged pumping restaurant grease traps said he takes the material to the Conipagig Wastewater Treatment Plant in Williamsport, which treats rural Washington County's sewage. However, the Conipagig plant manager said they do not accept grease trap waste. He said Washington County does not have a place to legally dispose of grease trap waste, since a law was passed in 1992. He believes the material gets hauled to West Virginia.

The Hagerstown Water Pollution Control Plant has an average flow of about 7 million gallons/day. The plant does not allow grease trap wastes to be discharged there. The concentration of grease in the plant's raw sewage ranges from 40 to 70 parts per million and averages about 50 parts per million. From this I estimated that about 1,000,000 pounds/year of grease from Hagerstown restaurants enter the sewage treatment plant.

I did not get information on rendering companies that service restaurants in Hagerstown. I estimate the yellow grease resource in Hagerstown to be similar to those in Michigan and Ohio on a per capita basis (11.1 pounds/year/person in Battle Creek and 5.1

pounds/year/person in Mansfield). Assuming a value of 10 pounds/year/person in Hagerstown gives an estimate of about 1,200,000 pounds/year.

In summary, for Hagerstown:

Number of restaurants	170		
Restaurants/1,000 people	1.40		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	1,200,000	9.9	7,100
Grease trap waste	1,000,000	8.2	5,900
Total grease resource	2,200,000	18.1	12,900

15. Washington, DC **Population (1990): 3,923,574**

The Northern Virginia Yellow Pages list about 2,000 restaurants in the Washington, DC metropolitan area, one rendering company, and 60 septic tank pumping companies. It is likely that the true number of restaurants in the metropolitan area is 2 or 3 times this number, but I was unable to find a convenient way to confirm this. The 682 restaurants in Arlington (see below) translate to a much higher per capita figure than usual. I will use an estimated figure of 5,000 restaurants in the calculations below for lack of a better one; it is equivalent to about 1.27 restaurants per 1,000 people in the metropolitan area.

The one rendering company listed, Valley Proteins Inc., did not return my phone calls. It is headquartered in Winchester, Virginia, and I learned that it has a rendering plant in the Baltimore area. My guess is that this plant, and possibly another Valley Proteins plant in Virginia, process a large fraction of the restaurant grease from the Washington, DC area, but I was unable to obtain any estimates and had to resort to a factored estimate. Assuming a value of 10 pounds/year/person in the Washington, DC metropolitan area gives an estimate of about 39,000,000 pounds/year.

The five septic tank pumping companies I was able to talk to said they do not pump restaurant grease traps. I learned from wastewater treatment plant pretreatment coordinators that some wastewater treatment plants in the metropolitan area do not allow trucks to discharge grease trap material, while others do. I believe most of this material is accounted for in the treatment plant influent numbers discussed below.

All of the municipal wastewater in the District of Columbia, and nearly all of the municipal wastewater in Montgomery County, is treated at the Blue Plains Wastewater Treatment Plant in Washington, DC. The total flow is about 350 million gallons per day, of which about half comes from DC and half from Montgomery County. There are two small wastewater treatment plants in Montgomery County: the Seneca plant (about 4.7 million gallons/day), and the Damascus plant (about 0.7 million gallons/day). In Prince George's County there are three wastewater treatment plants: Parkway, near Laurel (about 6.1 million gallons/day); Western Branch, in Upper Marlboro (about 17 million gallons/day); and Piscataway (about 22 million gallons/day). A manager at the Washington Suburban Sanitary Commission in Landover, Maryland gave me information on these operations, including the oil and grease concentrations measured in monthly grab samples at all five plants in Maryland. Although individual measurements ranged from 1.2 to 206 mg/liter, the annual average concentrations for all five plants fell in the range of 27 to 38 mg/liter. It appears from these data that 35 mg/liter is a good assumption for the oil and grease concentration in the raw sewage in DC and its Maryland suburbs. The total flow rate is about 400 million gallons/day, which results in an estimate of about 42,000,000

pounds/year of grease entering the wastewater treatment plants in the District of Columbia, Montgomery County, and Prince George's County.

Material pumped from restaurant interceptors (large capacity grease traps) can be discharged at Muddy Branch in upper Montgomery County; it ends up in the Blue Plains treatment plant. Material pumped from smaller grease traps is put in barrels and taken to rendering plants for processing.

The Arlington County wastewater treatment plant averages about 30 million gallons/day of raw sewage from the city of Arlington, parts of Alexandria, Crystal City, parts of Falls Church, and Fairfax City. The pretreatment coordinator said that the number of residents in this area is approximately 170,000; the daytime population is about 250,000; and that there are at least 682 restaurants in the area. (These figures translate to about 4.0 restaurants per 1,000 residents, or about 2.7 restaurants per 1,000 daytime population.)

Detailed studies by the Arlington County wastewater treatment plant pretreatment coordinator in 1991-1993 showed that the weighted average concentration of oil and grease in the effluent from the interceptors of all restaurants sampled was 295 mg/liter (note that in water, which weighs 1,000 grams/liter, mg/liter are equivalent to parts per million or ppm by weight). The effluent from one Chinese restaurant contained less than 1 mg/liter oil and grease. The plant regulates restaurants on an individual basis and limits their effluent to a maximum of 399 mg/liter, based on the mean and standard deviation of sample analyses. I estimate the oil and grease concentration in the Arlington County wastewater treatment plant to be 35 mg/liter, the weighted average for the five plants in the Maryland suburbs. With the estimated total raw sewage flow rate of 30 million gallons/day, this gives an estimate of about 3,200,000 pounds/year of grease entering the Arlington County wastewater treatment plant in the raw sewage.

The Arlington County wastewater treatment plant does not allow grease trap pumping trucks to discharge their wastes at the plant. The pretreatment coordinator said that other wastewater treatment plants in the area may accept this material, and that the Valley Proteins rendering plant in Baltimore does accept it.

The Fairfax County Lower Potomac wastewater treatment plant in Lorton averages about 45 million gallons/day of total raw sewage influent. The plant prohibits restaurants from discharging oil and grease through the sewage system to the plant. All oil and grease delivered to the facility is burned in the furnace along with natural gas (the primary fuel) and landfill gas (this operation is just starting). The wastewater treatment plant does not measure oil and grease in its influent. My estimate is that the concentration is similar to that in other plants in the area, 35 mg/liter. Assuming this results in an estimate of about 4,800,000 pounds/year of grease entering the Fairfax County Lower Potomac wastewater treatment plant in the raw sewage. Adding the two Virginia county estimates to the DC and Maryland county estimates gives a total estimate for the Washington, DC metropolitan area of 50,000,000 pounds/year of grease entering wastewater treatment plants.

In summary, for the Washington, DC metropolitan area:

Number of restaurants	5,000		
Restaurants/1,000 people	1.27		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	39,000,000	9.9	7,800
Grease trap waste	50,000,000	12.7	10,000
Total grease resource	89,000,000	22.7	17,800

16. Richmond-Petersburg, Virginia Population (1990): 865,640

The Richmond and Petersburg Yellow Pages list about 1,480 restaurants, two rendering companies, and 36 septic tank pumping companies. One rendering company, Valley Proteins Inc., did not return my phone calls. It is headquartered in Winchester, Virginia, and has rendering plants in the Baltimore area and somewhere in Virginia. The other rendering company, CBP Resources Inc. (Norfolk Tallow Co. Division), is located in Chesapeake, Virginia. It also has a Yellow Pages ad under the heading Grease Traps. The general manager said if I sent him a letter with my questions he would take a look at it, but that chances were good they would not respond with any quantitative information. These two companies undoubtedly process a large fraction of the restaurant grease from the Richmond-Petersburg area, but I was unable to obtain any estimates and had to resort to a factored estimate. Assuming a value of 10 pounds/year/person gives an estimate of about 8,700,000 pounds/year.

The septic tank pumping companies that I talked to said that they discharge grease trap wastes into the sewage treatment system; exactly where and how they discharge depends on which county or city the waste comes from, but the material ends up in sewage treatment plants. Hanover County has a designated manhole where pump truckers pay $60 per 1,000 gallons to discharge grease trap wastes. Hanover County does not have a wastewater treatment plant; its sewage is pumped into the Henrico County wastewater treatment plant (about 45 million gallons/day average inflow), which, oddly enough, does not allow grease trap wastes to be discharged at the facility. (Actually, the plant normally allows discharge, but has a moratorium. Several of the counties and the City of Richmond are grappling with the political issue of how best to handle grease trap wastes. The wastewater treatment plant managers all seem to feel that from a technical point of view it is best to have strong regulations requiring restaurants to have grease traps pumped regularly, and to have the waste discharged at the wastewater treatment plants where it can be properly treated and disposed of. However, local politics and lobbying by business owners often create much less effective approaches to the problem.)

The City of Richmond wastewater treatment plant (about 44 million gallons/day average inflow) recently started "officially" accepting grease trap wastes (meaning that they were "unofficially" accepted previously). The ballpark estimate of the plant manager was about 200,000 gallons/year of grease trap wastes discharged at the facility (out of a total of about 1,500,000 gallons/year of total hauled waste (the rest being septage). Assuming a density of 7.3 pounds/gallon and a grease content of 10%, I estimate that a total of about 150,000 pounds/year of grease are being discharged at the City of Richmond wastewater treatment plant by grease trap pump trucks. The treatment plant recently invested in an automated system to allow haulers to use magnetic cards, but the system has not been debugged yet. The City of Richmond monitors about 700 restaurants' discharges directly, enforcing a 300 ppm limit on grease, and assesses a 4.5% tax on restaurants' sales. The plant manager did not have direct data on the grease content in the raw sewage entering the plant, but suggested I use a figure of about 50 ppm.

Chesterfield County has two wastewater treatment plants (27 million gallons/day and 12 million gallons/day average inflow). The larger plant accepts grease trap waste. The total amount of grease trap wastes discharged at the plant during the last six months of 1997 was 67,700 gallons. Doubling this and assuming a density of 7.3 pounds/gallon and a grease content of 10%, I estimate that a total of about 100,000 pounds/year of grease are being discharged at the Chesterfield County wastewater treatment plant by grease trap pump trucks. The plant manager has measured the oil and grease content in restaurants' effluents directly, but does not measure the oil and grease content in the raw sewage entering the treatment plants.

In Petersburg, the South Central wastewater treatment plant has an average inflow of about 12 million gallons/day. It does not allow grease trap wastes to be discharged at the facility. The laboratory manager estimated that the oil and grease measurements in grab samples of the raw sewage average about 40 mg/liter.

The table below summarizes the data I obtained on grease trap wastes in the Richmond-Petersburg metropolitan area. To estimate the amount of grease flowing into these treatment plants with the raw sewage (remembering that the Henrico County plant receives grease trap pump truck wastes discharged at the Hanover County designated manhole), I assumed an average concentration of 40 ppm grease in the 140 million gallons/day of raw sewage. This results in an estimate of about 17,000,000 pounds/year of grease trap waste entering the five treatment plants with the raw sewage. Combining this with the estimate of 250,000 pounds/year of grease discharged at two of the plants gives a total estimate for the Richmond-Petersburg metropolitan area of 17,300,000 pounds/year of grease entering wastewater treatment plants.

Wastewater treatment plant	Million gallons/day average inflow	Pounds/year grease discharged by trucks	Pounds/year grease in raw sewage
Henrico County	45	0	5,500,000
City of Richmond	44	150,000	5,300,000
Chesterfield Co. (2)	39	100,000	4,700,000
Petersburg	12	0	1,500,000
Total	140	250,000	17,000,000

In summary, for the Richmond-Petersburg metropolitan area:

Number of restaurants	1,480		
Restaurants/1,000 people	1.71		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	8,700,000	10.1	5,900
Grease trap waste	17,300,000	20.0	11,700
Total grease resource	26,000,000	30.0	17,600

17. Danville, Virginia **Population (1990): 108,711**

The Danville Yellow Pages list about 157 restaurants, no rendering companies, and five septic tank pumping companies. I assume the primary rendering company serving Danville restaurants is Valley Proteins Inc. I was unable to obtain any estimates and had to resort to a factored estimate. Assuming a value of 10 pounds/year/person for yellow grease in the Danville metropolitan area gives an estimate of about 1,100,000 pounds/year.

The septic tank pumping companies that I talked to said that they discharge grease trap wastes at the Danville wastewater treatment plant. The plant has an average raw sewage inflow of about 16 million gallons/day. The pretreatment manager said they do not measure the oil and grease concentrations in the raw sewage, and did not have records of the amount of grease trap waste discharged at the plant. Assuming an average concentration of 40 ppm grease in the 16 million gallons/day of raw sewage results in an estimate of about 1,900,000 pounds/year of grease trap waste entering the treatment plant.

In summary, for Danville:

Number of restaurants	157
Restaurants/1,000 people	1.44

	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	1,100,000	10.1	7,000
Grease trap waste	1,900,000	17.5	12,100
Total grease resource	3,000,000	27.6	19,100

18. Fayetteville, North Carolina **Population (1990): 274,566**

The Fayetteville Yellow Pages list about 384 restaurants, one rendering company, and 19 septic tank pumping companies. The rendering company serving most of the Fayetteville restaurants is Cape Fear Feed Products, a division of CBP Resources Inc. The environmental manager said that they cover a region from Myrtle Beach to about halfway to Charlotte, and that they work with the cities to remove wastes from restaurant grease traps (and thus from sewage treatment plants). He referred me to the general manager for estimates of quantities of grease recovered; the general manager did not return my calls. I had to resort to a factored estimate. Assuming a value of 10 pounds/year/person of yellow grease feedstock in the Fayetteville metropolitan area gives an estimate of about 2,700,000 pounds/year.

There are two sewage treatment plants in the Fayetteville metropolitan area. The Cross Creek plant has an average raw sewage inflow of about 13 million gallons/day, and the Rock Fish plant has an average raw sewage inflow of about 10 million gallons/day. Grease trap wastes are discharged at the plants, but the amounts are relatively small because Cape Fear Feed Products pumps the grease traps of the restaurants that have separate plumbing for grease traps. The pretreatment manager at the Cross Creek plant said they do not measure the oil and grease concentrations in the raw sewage, and she did not have records handy of the amount of grease trap waste discharged at the plant. Based on her comments, I assumed an average concentration of 30 ppm grease in the 23 million gallons/day of raw sewage. This results in an estimate of about 2,100,000 pounds/year of grease trap waste entering the treatment plant.

In summary, for Fayetteville:

Number of restaurants	384
Restaurants/1,000 people	1.40

	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	2,700,000	9.8	7,000
Grease trap waste	2,100,000	7.6	5,500
Total grease resource	4,800,000	17.5	12,500

19. Florence, South Carolina **Population (1990): 114,344**

The Florence Yellow Pages list about 185 restaurants, no rendering companies, and 11 septic tank pumping companies. I was unable to obtain estimates of the amounts of yellow grease feedstock recovered from Florence area restaurants, and used a factored estimate of 10 pounds/year/person, or about 1,100,000 pounds/year. The Florence sewage treatment plant has an average raw sewage inflow of about 8 million gallons/day. Grease trap wastes are discharged at the plant, but the amounts are relatively small. The pretreatment manager said they do not measure the oil and grease concentrations in the raw sewage, and he did

not have records handy of the amount of grease trap waste discharged at the plant. Based on his comments, I assumed an average concentration of 35 ppm grease in the 8 million gallons/day of raw sewage. This results in an estimate of about 900,000 pounds/year of grease trap waste entering the treatment plant.

In summary, for Florence:

Number of restaurants	185		
Restaurants/1,000 people	1.62		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	1,100,000	9.6	5,900
Grease trap waste	900,000	7.9	4,900
Total grease resource	2,000,000	17.5	10,800

20. Greenville-Spartanburg, SC **Population (1990): 640,861**

The Greenville and Spartanburg Yellow Pages list about 1,017 restaurants, one rendering company, and 26 septic tank pumping companies. The rendering company serving most of the Greenville-Spartanburg restaurants is Valley Proteins Inc., of Ward, South Carolina. I spoke to the manager of that rendering plant, and he confirmed that they service most of the restaurants in the area. He referred me to the main office in Winchester, Virginia for estimates of quantities of grease recovered, who did not return my calls. I was unable to obtain any estimates and used a factored estimate of 10 pounds/year/person, or about 6,400,000 pounds/year.

About 65% of the sewage in the Greenville area is treated at the Western Carolina wastewater treatment plant. The remaining 35% of the flow is treated by 20 or 30 much smaller plants around the area. The average flow rate of raw sewage into the Western Carolina plant is about 21 million gallons/day, so I estimate a total flow to all plants of about 32 million gallons/day. Grease trap pump trucks discharged a total of about 469,380 gallons/year of grease trap wastes at the Western Carolina plant in 1997. Assuming 7.3 pounds/gallon and 10% grease content, this is about 340,000 pounds/year of grease. Based on the pretreatment coordinator's comments, I assumed an average concentration of 30 ppm grease in the 32 million gallons/day of raw sewage to all plants. This results in an estimate of about 2,900,000 pounds/year of grease entering the treatment plants with the raw sewage. The total estimated grease trap waste for the Greenville area is 3,200,000 pounds/year.

The Spartanburg wastewater treatment plant has an average flow rate of about 10 million gallons/day. Grease trap pump trucks discharged a total of about 672,000 gallons/year of grease trap wastes at the Spartanburg plant in 1997. Assuming 7.3 pounds/gallon and 10% grease content, this is about 490,000 pounds/year of grease. Based on the pretreatment coordinator's comments, I assumed an average concentration of 30 ppm grease in the 10 million gallons/day of raw sewage to all plants. This results in an estimate of about 900,000 pounds/year of grease entering the treatment plant with the raw sewage. The total estimated grease trap waste for the Spartanburg area is about 1,400,000 pounds/year. The combined total of the estimates for grease trap waste in the Greenville-Spartanburg metropolitan area is about 4,600,000 pounds/year.

In summary, for Greenville-Spartanburg:

Number of restaurants	1,017		
Restaurants/1,000 people	1.59		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	6,400,000	10.0	6,300
Grease trap waste	4,600,000	7.2	4,500
Total grease resource	11,000,000	17.2	10,800

21. Lexington-Fayette, Kentucky **Population (1990): 348,428**

The Lexington-Fayette Yellow Pages list about 562 restaurants, no rendering companies, and 10 septic tank pumping companies. The rendering company serving most of the Lexington-Fayette restaurants is Valley Proteins Inc. I was unable to obtain any estimates and used a factored estimate of 10 pounds/year/person, or about 3,500,000 pounds/year.

The sewage in the Lexington area is treated at the Main and South End wastewater treatment plants; the average flow rates of raw sewage into these plants are about 16 and 17 million gallons/day, respectively, so I estimate a total average flow to both plants of about 33 million gallons/day. Grease trap pump trucks discharged a total of about 156,000 gallons/year of grease trap wastes at the Main plant in 1997. Assuming 7.3 pounds/gallon and 10% grease content, this is about 110,000 pounds/year of grease. Based on the pretreatment coordinator's comments, I assumed an average concentration of 35 ppm grease in the 33 million gallons/day of raw sewage to both plants. This results in an estimate of about 3,500,000 pounds/year of grease trap waste entering the treatment plants. The total estimated grease trap waste for the Lexington-Fayette area is about 3,600,000 pounds/year.

In summary, for Lexington-Fayette:

Number of restaurants	562		
Restaurants/1,000 people	1.61		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	3,500,000	10.0	6,200
Grease trap waste	3,600,000	10.3	6,400
Total grease resource	7,100,000	20.4	12,600

22. Memphis, Tennessee **Population (1990): 981,747**

The Memphis Yellow Pages list about 1,128 restaurants, one rendering company, and nine septic tank pumping companies. The rendering company serving most of the Memphis restaurants is Griffin Industries Inc. I spoke to the manager of that rendering plant, and he confirmed that they service most of the restaurants in the area. He was unwilling to give me any data, however, so I used a factored estimate of 10 pounds/year/person, or about 9,800,000 pounds/year.

The sewage in the Memphis area is treated at the North and TE Maxson (South) wastewater treatment plants; the average flow rates of raw sewage into these plants are about 75 and 90 million gallons/day, respectively, so I estimate a total average flow to both plants of about 165 million gallons/day. Pump trucks discharge grease trap wastes at the North plant; the pretreatment coordinator was unable to provide data on the total amount. In addition, the North plant receives effluent from a Protein Tech soybean processing plant and a Cargill corn processing plant. Based on the pretreatment coordinator's comments, I assumed an average concentration of 35 ppm grease in the 165 million gallons/day of raw sewage to

both plants. This results in an estimate of about 17,500,000 pounds/year of grease trap waste entering the treatment plants with the raw sewage. In addition, I estimate that pump trucks discharge another 1,000,000 pounds/year. The total estimated grease trap waste for the Memphis area, then, is about 18,500,000 pounds/year.

In summary, for Memphis:

Number of restaurants	1,128		
Restaurants/1,000 people	1.15		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	9,800,000	10.0	8,700
Grease trap waste	18,500,000	18.8	16,400
Total grease resource	28,300,000	28.8	25,100

23. Decatur, Alabama **Population (1990): 131,556**

The Decatur Yellow Pages list about 245 restaurants, no rendering companies, and 10 septic tank pumping companies. I did not find out which rendering companies serve the Decatur area restaurants. Assuming a value of 10 pounds/year/person of yellow grease feedstock in the Decatur area gives an estimate of about 1,300,000 pounds/year.

The sewage in the Decatur area is treated at the Decatur Utilities wastewater treatment plant; the average flow rate of raw sewage into this plant is about 20 million gallons/day. Pump trucks are allowed to discharge grease trap wastes at the treatment plant, but the fee was recently raised to $100 per 1,000 gallons of oil and grease, which is discouraging pump truck drivers from discharging grease trap wastes at the plant. About one truck per day has been discharging grease trap wastes at the plant, which I translated to an estimate of about 300,000 pounds/year of grease. Based on the chief operator's comments, I assumed an average concentration of 35 ppm grease in the 20 million gallons/day of raw sewage to the plant. This resulted in an estimate of about 2,100,000 pounds/year of grease trap waste entering the treatment plant with the raw sewage. The total estimated grease trap waste for the Decatur area, then, is about 2,400,000 pounds/year.

In summary, for Decatur:

Number of restaurants	245		
Restaurants/1,000 people	1.86		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	1,300,000	9.9	5,300
Grease trap waste	2,400,000	18.2	9,800
Total grease resource	3,700,000	28.1	15,100

24. Macon-Warner Robins, Georgia **Population (1990): 281,103**

The Macon and Warner Robins Yellow Pages list about 247 and 101 restaurants, respectively, giving an estimated total of 348 restaurants in the Macon-Warner Robins metropolitan area. The Yellow Pages list no rendering companies and six septic tank pumping companies. Two rendering companies serve the Macon-Warner Robins area restaurants: Mercer Grease Company and Griffin Industries. I talked to both companies and they confirmed that they collect restaurant grease in the area, but did not give me estimates of the quantities. Assuming a value of 10 pounds/year/person of yellow grease

feedstock in the Macon-Warner Robins metropolitan area gives an estimate of about 2,800,000 pounds/year.

The sewage in the Macon area is treated at the Poplar Street and Rocky Creek wastewater treatment plants; the average flow rate of raw sewage into each of these plants is about 16 million gallons/day. Pump trucks are allowed to discharge grease trap wastes at the Poplar Street treatment plant. About 2.5 trucks per day discharge grease trap wastes at the plant, which I translated to an estimate of about 900,000 pounds/year of grease. Based on the plant manager's comments, I assumed an average concentration of 35 ppm grease in the 32 million gallons/day of raw sewage to both plants. This resulted in an estimate of about 3,400,000 pounds/year of grease trap waste entering the Macon treatment plants with the raw sewage.

The Warner Robins wastewater treatment plant does not allow discharge of grease trap wastes at the plant. The Roto-Rooter manager told me that if he were to pump grease traps in Warner Robins, he would have to take the material to Atlanta. The implication was that not many Warner Robins restaurants have their grease traps pumped. The average flow rate of raw sewage into the Warner Robins wastewater treatment plant is about 15 million gallons/day. Assuming an average concentration of 35 ppm grease in the raw sewage to this plant, about 1,600,000 pounds/year of grease trap waste enter the Warner Robins treatment plant with the raw sewage. The total estimated grease trap waste for the Macon-Warner Robins area, then, is about 5,900,000 pounds/year.

In summary, for Macon-Warner Robins:

Number of restaurants	348		
Restaurants/1,000 people	1.24		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	2,800,000	10.0	8,000
Grease trap waste	5,900,000	21.0	17,000
Total grease resource	8,700,000	30.9	25,000

25. Lakeland-Winter Haven, Florida Population (1990): 405,382

The Lakeland-Winter Haven Yellow Pages list about 445 restaurants, two rendering companies, and four grease trap pumping companies. Two rendering companies, Darling International and Griffin Industries, serve the Lakeland-Winter Haven area restaurants. I talked to both companies and they confirmed that they collect restaurant grease (both yellow grease feedstock and grease trap waste) in the area, but did not give me estimates of the quantities. Assuming a value of 10 pounds/year/person of yellow grease feedstock in the Lakeland-Winter Haven area gives an estimate of about 4,100,000 pounds/year.

The sewage in the Lakeland-Winter Haven metropolitan area is treated at the Glendale and Northside wastewater treatment plants in Lakeland; the Fairfax, #2, and #3 wastewater treatment plants in Winter Haven; the City of Bartow sewer plant; and the City of Auburndale sewer plant. The average flow rate of raw sewage into all of these plants taken together is about 40 million gallons/day. Pump trucks are not allowed to discharge grease trap wastes at any of these treatment plants. Based on the plant managers' comments, I assumed an average concentration of 35 ppm grease in the 40 million gallons/day of raw sewage to all plants. This resulted in an estimate of about 4,200,000 pounds/year of grease trap waste entering the Lakeland-Winter Haven area treatment plants with the raw sewage.

In addition to the two rendering companies, several other companies in the Lakeland-Winter Haven metropolitan area recover and process grease trap wastes. Nopec Corporation converts grease into biodiesel fuel, but was unwilling to give me any quantitative data on the amounts of grease they recover. Two septic tank service companies that I talked to bring grease trap waste to their own facilities and process it. I believe the processing consists of separation from water, pH adjustment of the grease with lime, and land spreading in accordance with permits from county and state environmental agencies. My guesstimate is that the amount of grease trap wastes recovered and processed is about 10% of the amount that enters the wastewater treatment plants with the raw sewage -- about 400,000 pounds/year. The total estimated grease trap waste for the Lakeland-Winter Haven area, then, is about 4,600,000 pounds/year.

In summary, for Lakeland-Winter Haven:

Number of restaurants	445		
Restaurants/1,000 people	1.10		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	4,100,000	10.1	9,200
Grease trap waste	4,600,000	11.3	10,300
Total grease resource	8,700,000	21.5	19,600

26. Bradenton, Florida **Population (1990): 211,707**

The Bradenton Yellow Pages list about 360 restaurants, one rendering company, and six grease trap pumping companies. Griffin Industries is the rendering company that serves the Bradenton area restaurants. They confirmed that they collect restaurant grease (both yellow grease feedstock and grease trap waste) in the area, but did not give me estimates of the quantities. Assuming a value of 10 pounds/year/person of yellow grease feedstock in the Bradenton metropolitan area gives an estimate of about 2,100,000 pounds/year.

The sewage in the Bradenton metropolitan area is treated at the Southeast and Southwest wastewater treatment plants in Bradenton, and three wastewater treatment plants in Manatee County. The average flow rate of raw sewage into all of these plants taken together is about 25 million gallons/day. Pump trucks are not allowed to discharge grease trap wastes at any of these treatment plants. Based on the plant managers' comments, I assumed an average concentration of 35 ppm grease in the 25 million gallons/day of raw sewage to all plants. This resulted in an estimate of about 2,700,000 pounds/year of grease trap waste entering the Bradenton area treatment plants with the raw sewage.

In addition to the rendering company, several other companies in the Bradenton metropolitan area recover and process grease trap wastes. Two septic tank service companies that I talked to bring grease trap waste to their own facilities and process it. I believe the processing consists of separation from water, pH adjustment of the grease with lime, and land spreading in accordance with permits from county and state environmental agencies. My guesstimate is that the amount of grease trap wastes recovered and processed is about 10% of the amount that enters the wastewater treatment plants with the raw sewage -- about 300,000 pounds/year. The total estimated grease trap waste for the Bradenton area, then, is about 3,000,000 pounds/year.

In summary, for Bradenton:

Number of restaurants	360		
Restaurants/1,000 people	1.70		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	2,100,000	9.9	5,800
Grease trap waste	3,000,000	14.2	8,300
Total grease resource	5,100,000	24.1	14,200

27. Baton Rouge, Louisiana **Population (1990): 528,264**

The Baton Rouge Yellow Pages list about 657 restaurants, three rendering companies, and seven grease trap pumping companies. The rendering companies are Darling International, Griffin Industries, and S Perkins Grease Service. All confirmed that they collect restaurant grease (both yellow grease feedstock and grease trap waste) in the area, but did not give me estimates of the quantities. Assuming a value of 10 pounds/year/person of yellow grease feedstock in the Baton Rouge area gives an estimate of about 5,300,000 pounds/year.

The sewage in the Baton Rouge metropolitan area is treated at the North, Central, and South wastewater treatment plants. The average flow rate of raw sewage into all of these plants taken together is about 50 million gallons/day. Pump trucks are not allowed to discharge grease trap wastes at any of these treatment plants. Based on the plant managers' comments, I assumed an average concentration of 35 ppm grease in the 50 million gallons/day of raw sewage to all plants. This resulted in an estimate of about 5,300,000 pounds/year of grease trap waste entering the treatment plants with the raw sewage.

In addition to the rendering companies, several other companies in the Baton Rouge metropolitan area recover and process grease trap wastes by separation from water, pH adjustment, and land spreading. The City of Baton Rouge Environmental Division supervises the grease trap cleaning process as well as the processing and disposal. My guesstimate is that the amount of grease trap wastes recovered and processed is about 10% of the amount that enters the wastewater treatment plants with the raw sewage -- about 500,000 pounds/year. The total estimated grease trap waste for the Baton Rouge area is about 5,800,000 pounds/year.

In summary, for Baton Rouge:

Number of restaurants	657		
Restaurants/1,000 people	1.24		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	5,300,000	10.0	8,100
Grease trap waste	5,800,000	11.0	8,800
Total grease resource	11,100,000	21.0	16,900

28. Shreveport, Louisiana **Population (1990): 334,341**

The Shreveport Yellow Pages list about 442 restaurants, three rendering companies, and seven grease trap pumping companies. The rendering companies are Darling International, Griffin Industries, and Riegel By-Products Company. All confirmed that they collect restaurant grease (both yellow grease feedstock and grease trap waste) in the area, but did not give me estimates of the quantities. Assuming a value of 10 pounds/year/person of yellow grease feedstock gives an estimate of about 3,300,000 pounds/year.

The sewage in the Shreveport metropolitan area is treated at the Lucas and North Regional wastewater treatment plants. The average flow rates of raw sewage into these plants are about 31 and 5 million gallons/day, respectively, for a total of about 36 million gallons/day. (These figures include significant amounts of infiltration into leaky sewer lines, according to the Lucas plant manager.) Pump trucks are not allowed to discharge grease trap wastes at either of these treatment plants. Based on the plant managers' comments, I assumed an average concentration of 25 ppm grease in the 36 million gallons/day of raw sewage. This resulted in an estimate of about 2,700,000 pounds/year of grease trap waste entering the Shreveport area treatment plants with the raw sewage.

The city employee in charge of grease trap permitting said that when groceries, bakeries, fast food establishments, and restaurants are considered, the total number in the area is between 500 and 700. Three inspectors make the rounds, visiting every establishment once or twice a year. If the grease content in a restaurant's effluent exceeds 100 ppm or if the pH is below 6, the city orders that establishment to clean its grease trap.

In addition to the three rendering companies, two other companies (Bio-Vac Inc. and The Natural Solution Inc.) in the Shreveport metropolitan area recover and process grease trap wastes. The processing consists of separation from water, discharging the gray water to the sewer, neutralizing the pH of the grease with lime and/or treating the grease with bacteria, and taking the solids to the landfill. The Natural Solution Inc. uses a patented bioremediation process (bacteria) to convert the grease to inert solids. The owner of The Natural Solution Inc. estimated that the total amount of grease trap waste being collected and processed in the Shreveport metropolitan area is about 400,000 gallons/month. He said this material is about 90% water, 5% "trash", and 5% grease. This converts to an estimated grease content of about 2,000,000 pounds/year. The total estimated grease trap waste for the Shreveport area, then, is about 4,700,000 pounds/year.

In summary, for Shreveport:

Number of restaurants	442		
Restaurants/1,000 people	1.32		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	3,300,000	9.9	7,500
Grease trap waste	4,700,000	14.1	10,600
Total grease resource	8,000,000	23.9	18,100

29. Beaumont-Port Arthur, Texas Population (1990): 361,226

The Beaumont and Port Arthur Yellow Pages list about 271 and 112 restaurants, no rendering companies, and four grease trap pumping companies. Darling International, based in Houston, is the primary rendering company serving the area restaurants. They confirmed that they collect restaurant grease (both yellow grease feedstock and grease trap waste) in the area, but did not give me estimates of the quantities. Assuming a value of 10 pounds/year/person of yellow grease feedstock in the Beaumont-Port Arthur metropolitan area gives an estimate of about 3,600,000 pounds/year.

The Beaumont wastewater treatment plant currently accepts grease trap discharges, but a plant is under construction by a private company (JTB Recycling Facility, Inc.) that will convert the grease trap wastes to products. When this plant is operating, the Beaumont wastewater treatment plant will stop accepting grease trap discharges. The wastewater treatment plant accepted a total of 867,720 gallons of grease trap truck discharges in 1997, or about 360,000 pounds/year of grease (assuming 5% grease in the pump truck

discharges). The average flow rate of raw sewage into the Beaumont wastewater treatment plant is about 22 million gallons/day.

Port Arthur has four wastewater treatment plants: the Main plant, which receives an average inflow of about 5-6 million gallons/day of raw sewage, and the much smaller Port Acres plant (~0.3 million gallons/day), Sabine plant (~0.15), and Pleasure Island plant (~0.025). The cities of Groves, Nederland, and Port Neches all have their own wastewater treatment plants as well. None of these plants allow grease trap discharges; grease trap pumping companies in the Port Arthur area discharge their wastes at the Chemical Waste Management incinerator nearby, which was unable to give me an estimate of the total quantity of grease trap waste they receive. The incinerator receives hundreds of different types of wastes and chemicals, including PCBs and other hazardous wastes. I assumed the amount of grease trap wastes pumped in the Port Arthur area to be similar to Beaumont on a per-restaurant basis. This produced an estimate of about 140,000 pounds/year, giving a total of about 500,000 pounds/year for the metropolitan area as a whole.

The grand total raw sewage inflow to the seven Port Arthur area wastewater treatment plants is about 10 million gallons/day. Thus, the total average flow rate of raw sewage into the Beaumont-Port Arthur metropolitan area wastewater treatment plants is about 32 million gallons/day. Based on the plant managers' comments, I assumed an average concentration of 35 ppm grease in the raw sewage to all plants. This resulted in an estimate of about 3,400,000 pounds/year of grease trap waste entering the Beaumont-Port Arthur area treatment plants with the raw sewage. The total estimated grease trap waste for the Beaumont-Port Arthur area, then, is about 3,900,000 pounds/year.

In summary, for Beaumont-Port Arthur:

Number of restaurants	383		
Restaurants/1,000 people	1.06		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	3,600,000	10.0	9,400
Grease trap waste	3,900,000	10.8	10,200
Total grease resource	7,500,000	20.8	19,600

30. Bryan-College Station, Texas Population (1990): 121,862

The Bryan-College Station Yellow Pages list about 198 restaurants, no rendering companies, and four grease trap pumping companies. Darling International, based in Houston, is the primary rendering company serving the Bryan-College Station restaurants. They confirmed that they collect restaurant grease (both yellow grease feedstock and grease trap waste) in the area, but did not give me estimates of the quantities. Assuming a value of 10 pounds/year/person of yellow grease feedstock gives an estimate of about 1,200,000 pounds/year.

Bryan has three wastewater treatment plants that receive a total average inflow of about 9 million gallons/day. College Station has one wastewater treatment plant that receives an average of about 6 million gallons/day. Based on the plant managers' comments, I assumed an average concentration of 35 ppm grease in the 15 million gallons/day of raw sewage to all plants. This resulted in an estimate of about 1,600,000 pounds/year of grease trap waste entering the Bryan-College Station area treatment plants with the raw sewage.

The grease trap pump trucks in Bryan-College Station discharge their material at Bryan wastewater treatment plant #3, where a private company, Wastewater Systems, Inc.,

processes the material with bacteria. The gray water enters the treatment plant and the solids go to the landfill. Wastewater Systems, Inc.'s manager estimated that his facility treats an average of about 85,000 gallons/month of grease trap pump truck discharges, which I translated to about 420,000 pounds/year of grease (assuming 5% grease in the pump truck discharges). The total estimated grease trap waste for the Bryan-College Station area, then, is about 2,000,000 pounds/year.

In summary, for Bryan-College Station:

Number of restaurants	198		
Restaurants/1,000 people	1.62		
	Pounds/year	Pounds/year/person	Pounds/year/restaurant
Yellow grease	1,200,000	9.8	6,100
Grease trap waste	2,000,000	16.4	10,100
Total grease resource	3,200,000	26.3	16,200

APPENDIX A -- METROPOLITAN AREAS

Table A1 lists the 281 metropolitan areas in the United States in order of population. Table A2 lists them by state.

Table A1 – 281 Metropolitan Areas in Order of Population

Metropolitan Area	State	1990 Population	Pop. Rank	Coal MW	Coal Rank
New York-Northern New Jersey-Long Island	NY	17,953,372	1	3,219	98
Los Angeles-Anaheim-Riverside	CA	14,531,529	2		254
Chicago-Gary-Lake County	IL	8,065,633	3	11,253	16
San Francisco-Oakland-San Jose	CA	6,253,311	4		272
Philadelphia-Wilmington-Trenton	PA	5,899,345	5	2,141	125
Detroit-Ann Arbor	MI	4,665,236	6	8,817	21
Washington	DC	3,923,574	7	5,810	45
Dallas-Ft. Worth	TX	3,885,415	8		240
Boston-Lawrence-Salem-Lowell-Brockton	MA	3,783,817	9	2,164	123
Houston-Galveston-Brazoria	TX	3,711,043	10	2,697	109
Miami-Fort Lauderdale	FL	3,192,582	11		258
Atlanta	GA	2,833,511	12	12,187	11
Cleveland-Akron-Lorain	OH	2,759,823	13	2,994	103
Seattle-Tacoma	WA	2,559,164	14	1,460	155
San Diego	CA	2,498,016	15		271
Minneapolis-St. Paul	MN	2,464,124	16	4,586	65
St. Louis	MO	2,444,099	17	9,074	19
Baltimore	MD	2,382,172	18	5,700	48
Pittsburgh-Beaver Valley	PA	2,242,798	19	18,838	2
Phoenix	AZ	2,122,101	20	3,232	97
Tampa-St. Petersburg-Clearwater	FL	2,067,959	21	6,245	40
Denver-Boulder	CO	1,848,319	22	1,857	135
Cincinnati-Hamilton	OH	1,744,124	23	13,077	8
Milwaukee-Racine	WI	1,607,183	24	4,103	70
Kansas City	MO	1,566,280	25	5,405	54
Sacramento	CA	1,481,102	26		267
Portland-Vancouver	OR	1,477,895	27		264
Norfolk-Virginia Beach-Newport News	VA	1,396,107	28	3,260	94
Columbus	OH	1,377,419	29	2,728	107
San Antonio	TX	1,302,099	30	2,340	120
Indianapolis	IN	1,249,822	31	5,678	49
New Orleans	LA	1,238,816	32	750	193
Buffalo-Niagara Falls	NY	1,189,288	33	2,496	113
Charlotte-Gastonia-Rock Hill	NC	1,162,093	34	5,062	57
Hartford-New Britain-Middletown-Bristol	CT	1,123,678	35	1,302	163
Orlando	FL	1,072,748	36	1,606	145
Salt Lake City-Ogden	UT	1,072,227	37	69	227
Rochester	NY	1,002,410	38	2,251	121
Nashville	TN	985,026	39	7,898	26
Memphis	TN	981,747	40	990	184
Oklahoma City	OK	958,839	41	1,138	176
Louisville	KY	952,662	42	9,037	20
Dayton-Springfield	OH	951,270	43	5,891	42
Greensboro-Winston-Salem-High Point	NC	942,091	44	8,438	22
Providence-Pawtucket-Woonsocket	RI	916,270	45	1,555	146
Birmingham	AL	907,810	46	6,390	37
Jacksonville	FL	906,727	47	2,913	104

Table A1 – 281 Metropolitan Areas in Order of Population

Metropolitan Area	State	1990 Population	Pop. Rank	Coal MW	Coal Rank
Albany-Schenechtady-Troy	NY	874,304	48	136	221
Richmond-Petersburg	VA	865,640	49	4,116	68
West Palm Beach-Boca Raton-Delray Beach	FL	863,518	50		279
Honolulu	HI	836,231	51		249
New Haven-Waterbury-Meriden	CT	804,219	52	1,166	173
Austin	TX	781,572	53	3,621	82
Las Vegas	NV	741,459	691	637	199
Raleigh-Durham	NC	735,480	55	4,024	74
Scranton--Wilkes-Barre	PA	734,175	56	2,515	112
Worcester-Fitchburg-Leominster	MA	709,705	57	1,075	179
Tulsa	OK	708,954	58	4,810	59
Grand Rapids	MI	688,399	59	2,391	117
Allentown-Bethlehem	PA	686,688	60	3,217	99
Fresno	CA	667,490	61		245
Tucson	AZ	666,880	62	562	207
Syracuse	NY	659,864	63	646	198
Greenville-Spartanburg	SC	640,861	64	3,171	100
Omaha	NE	618,262	65	2,476	115
Toledo	OH	614,128	66	5,725	46
Knoxville	TN	604,816	67	3,488	87
Springfield	MA	602,878	68	136	224
El Paso	TX	591,610	69		241
Harrisburg-Lebanon-Carlisle	PA	587,986	70	3,669	80
Bakersfield	CA	543,477	71		233
Baton Rouge	LA	528,264	72	1,711	137
Little Rock-North Little Rock	AR	513,117	73	1,700	139
Charleston	SC	506,875	74	4,293	66
New Bedford-Fall River-Attleboro	MA	506,325	75	1,225	170
Youngstown-Warren	OH	492,619	76	10,491	17
Wichita	KS	485,270	77		280
Stockton	CA	480,628	78		277
Albuquerque	NM	480,577	79		231
Mobile	AL	476,923	80	4,059	71
Columbia	SC	453,331	81	3,577	85
Johnson City-Kingsport-Bristol	TN	436,047	82	1,927	129
Chattanooga	TN	433,210	83	8,121	24
Lansing-East Lansing	MI	432,674	84	1,428	157
Flint	MI	430,459	85	5,416	53
Lancaster	PA	422,822	86	5,213	56
York	PA	417,848	87	4,637	63
Lakeland-Winter Haven	FL	405,382	88	4,731	61
Saginaw-Bay City-Midland	MI	399,320	89	964	185
Melbourne-Titusville-Palm Bay	FL	398,978	90	929	187
Colorado Springs	CO	397,014	91	2,145	124
Augusta	GA	396,809	92	2,707	108
Jackson	MS	395,396	93		250
Canton	OH	394,106	94	4,729	62

Table A1 – 281 Metropolitan Areas in Order of Population

Metropolitan Area	State	1990 Population	Pop. Rank	Coal MW	Coal Rank
Des Moines	IA	392,928	95	1,019	182
McAllen-Edinburg-Mission	TX	383,545	96		255
Daytona Beach	FL	370,712	97	1,304	162
Modesto	CA	370,522	98		260
Santa Barbara-Santa Maria-Lompoc	CA	369,608	99		273
Madison	WI	367,085	100	1,692	141
Fort Wayne	IN	363,811	101	149	220
Spokane	WA	361,364	102		276
Beaumont-Port Arthur	TX	361,226	103	615	201
Salinas-Seaside-Monterey	CA	355,660	104		269
Davenport-Rock Island-Moline	IA	350,861	105	2,754	106
Portsmouth-Dover-Rochester	NH	350,078	106	609	203
Corpus Christi	TX	349,894	107	600	204
Lexington-Fayette	KY	348,428	108	13,245	7
Pensacola	FL	344,406	109	2,906	105
Peoria	IL	339,172	110	4,270	67
Reading	PA	336,523	111	3,948	76
Manchester-Nashua	NH	336,073	112	939	186
Fort Myers-Cape Coral	FL	335,113	113		243
Shreveport	LA	334,341	114	5,496	51
Atlantic City	NJ	319,416	115	1,759	136
Utica-Rome	NY	316,633	116	75	226
Appleton-Oshkosh-Neenah	WI	315,121	117	1,874	132
Huntington-Ashland	WV	312,529	118	14,482	4
Visalia-Tulare-Porterville	CA	311,921	119		278
Montgomery	AL	292,517	120	2,013	126
Rockford	IL	283,719	121	5,831	44
Eugene-Springfield	OR	282,912	122		242
Macon-Warner Robins	GA	281,103	123	5,491	52
Evansville	IN	278,990	124	11,465	13
Salem	OR	278,024	125		268
Sarasota	FL	277,776	126	3,125	101
Erie	PA	275,572	127	1,236	168
Fayetteville	NC	274,566	128	896	188
Binghamton	NY	264,497	129	634	200
Provo-Orem	UT	263,590	130	1,151	174
Brownsville-Harlingen	TX	260,120	131		237
Poughkeepsie	NY	259,462	132	1,426	158
Killeen-Temple	TX	255,301	133	793	192
New London-Norwich	CT	254,957	134	1,625	143
Reno	NV	254,667	135		266
Fort Pierce	FL	251,071	136		244
Charleston	WV	250,454	137	12,352	10
South Bend-Mishawaka	IN	247,052	138	3,568	86
Portland	ME	243,135	139	150	219
Columbus	GA	243,072	140	3,392	89
Savannah	GA	242,622	141	876	189

Table A1 – 281 Metropolitan Areas in Order of Population

Metropolitan Area	State	1990 Population	Pop. Rank	Coal MW	Coal Rank
Johnstown	PA	241,247	142	11,974	12
Springfield	MO	240,593	143	679	195
Duluth	MN	239,971	144	182	217
Huntsville	AL	238,912	145	3,457	88
Tallahassee	FL	233,598	146	98	225
Anchorage	AK	226,338	147		232
Roanoke	VA	224,477	148	3,642	81
Kalamazoo	MI	223,411	149	1,916	130
Lubbock	TX	222,636	150	1,136	177
Hickory	NC	221,700	151	3,987	75
Lincoln	NE	213,641	152	2,476	114
Bradenton	FL	211,707	153	3,802	79
Lafayette	LA	208,740	154	1,711	138
Boise	ID	205,775	155		236
Gainesville	FL	204,111	156	5,356	55
Biloxi-Gulfport	MS	197,125	157	3,921	77
Ocala	FL	194,833	158	4,927	58
Green Bay	WI	194,594	159	1,243	167
St. Cloud	MN	190,921	160	3,352	91
Bremerton	WA	189,731	161	1,460	153
Springfield	IL	189,550	162	8,258	23
Waco	TX	189,123	163	3,607	83
Yakima	WA	188,823	164	561	209
Amarillo	TX	187,547	165	1,080	178
Fort Collins-Loveland	CO	186,136	166	1,393	159
Houma-Thibodaux	LA	182,842	167	25	229
Chico	CA	182,120	168		239
Merced	CA	178,403	169		257
Fort Smith	AR	175,911	170	3,255	96
Asheville	NC	174,821	171	2,350	119
Champaign-Urbana-Rantoul	IL	173,025	172	5,865	43
Clarksville-Hopkinsville	TN	169,439	173	11,257	15
Cedar Rapids	IA	168,767	174	1,980	128
Lake Charles	LA	168,134	175	615	202
Longview-Marshall	TX	162,431	176	6,683	35
Benton Harbor	MI	161,378	177	1,483	151
Olympia	WA	161,238	178	1,460	154
Topeka	KS	160,976	179	6,467	36
Wheeling	WV	159,301	180	22,587	1
Muskegon	MI	158,983	181	1,861	133
Athens	GA	156,267	182	6,263	39
Elkhart-Goshen	IN	156,198	183	1,547	148
Lima	OH	154,340	184	703	194
Fargo-Moorhead	ND	153,296	185	136	222
Naples	FL	152,099	186		262
Tyler	TX	151,309	187	7,149	30
Tuscaloosa	AL	150,522	188	6,820	34

Table A1 – 281 Metropolitan Areas in Order of Population

Metropolitan Area	State	1990 Population	Pop. Rank	Coal MW	Coal Rank
Richland-Kennewick-Pasco	WA	150,033	189	561	208
Jacksonville	NC	149,838	190	1,074	180
Jackson	MI	149,756	191	6,310	38
Parkersburg-Marietta	WV	149,169	192	14,350	5
Redding	CA	147,036	193		265
Waterloo-Cedar Falls	IA	146,611	194	804	191
Bangor	ME	146,601	195		234
Medford	OR	146,389	196		256
Anderson	SC	145,196	197	1,550	147
Fort Walton Beach	FL	143,776	198	1,475	152
Steubenville-Weirton	OH	142,523	199	18,294	3
Lynchburg	VA	142,199	200	254	214
Monroe	LA	142,191	201		261
Jamestown-Dunkirk	NY	141,895	202	1,623	144
Janesville-Beloit	WI	139,510	203	4,036	72
Pittsfield	MA	139,352	204	136	223
Eau Claire	WI	137,543	205	1,264	166
Burlington	VT	137,079	206		238
Battle Creek	MI	135,982	207	585	206
Las Cruces	NM	135,510	208		252
Joplin	MO	134,910	209	1,295	164
Laredo	TX	133,239	210		251
Greeley	CO	131,821	211	1,893	131
Alexandria	LA	131,556	212	2,244	122
Decatur	AL	131,556	212	7,558	27
Florence	AL	131,327	214	1,350	161
Charlottesville	VA	131,107	215	1,455	156
Dothan	AL	130,964	216	438	212
Terre Haute	IN	130,812	217	9,528	18
Anderson	IN	130,669	218	1,230	169
Lafayette-West Lafayette	IN	130,598	219	5,707	47
Altoona	PA	130,542	220	7,042	32
Bloomington-Normal	IL	129,180	221	5,589	50
Bellingham	WA	127,780	222		235
Panama City	FL	126,994	223	438	213
Mansfield	OH	126,137	224	3,258	95
Sioux Falls	SD	123,809	225	1,686	142
State College	PA	123,786	226	4,607	64
Pueblo	CO	123,051	227	1,203	172
Yuba City	CA	122,643	228		281
Wichita Falls	TX	122,378	229	664	197
Bryan-College Station	TX	121,862	230	4,110	69
Hagerstown	MD	121,393	231	1,212	171
Sharon	PA	121,003	232	2,364	118
Wilmington	NC	120,284	233	1,001	183
Texarkana	TX	120,132	234	3,582	84
Muncie	IN	119,659	235	1,484	150

Table A1 – 281 Metropolitan Areas in Order of Population

Table A1 – 281 Metropolitan Areas in Order of Population

Metropolitan Area	State	1990 Population	Pop. Rank	Coal MW	Coal Rank
Abilene	TX	119,655	236		230
Odessa	TX	118,934	237		263
Williamsport	PA	118,710	238	2,566	111
Glens Falls	NY	118,539	239		246
Decatur	IL	117,206	240	7,076	31
Santa Fe	NM	117,043	241		274
Anniston	AL	116,034	242	12,817	9
Wausau	WI	115,400	243	457	211
Pascagoula	MS	115,243	244	3,921	78
Sioux City	IA	115,018	245	1,860	134
Florence	SC	114,344	246	3,289	93
Billings	MT	113,419	247	191	216
Fayetteville-Springdale	AR	113,409	248	3,343	92
Albany	GA	112,561	249	231	215
Columbia	MO	112,379	250	1,268	165
Lawton	OK	111,486	251	664	196
Bloomington	IN	108,978	252	7,256	29
Danville	VA	108,711	253	4,760	60
Burlington	NC	108,213	254	6,114	41
Midland	TX	106,611	255		259
Rochester	MN	106,470	256	2,431	116
Lewiston-Auburn	ME	105,259	257		253
Sheboygan	WI	103,877	258	3,027	102
Cumberland	MD	101,643	259	7,414	28
Gadsden	AL	99,840	260	11,285	14
San Angelo	TX	98,458	261		270
La Crosse	WI	97,904	262	1,351	160
Kokomo	IN	96,946	263	178	218
Kankakee	IL	96,255	264	8,025	25
Iowa City	IA	96,119	265	2,646	110
Elmira	NY	95,195	266	559	210
Sherman-Denison	TX	95,021	267		275
Owensboro	KY	87,189	268	14,307	6
Dubuque	IA	86,403	269	1,042	181
Pine Bluff	AR	85,487	270	1,700	140
Bismarck	ND	83,831	271	4,034	73
St. Joseph	MO	83,083	272	3,382	90
Lawrence	KS	81,798	273	6,991	33
Rapid City	SD	81,343	274	60	228
Jackson	TN	77,982	275	1,485	149
Great Falls	MT	77,691	276		248
Victoria	TX	74,361	277	600	205
Cheyenne	WY	73,142	278	1,995	127
Grand Forks	ND	70,683	279		247
Casper	WY	61,226	280	817	190
Enid	OK	56,735	281	1,138	175

Table A2 – 281 Metropolitan Areas by State

Metropolitan Area	State	1990 Population	Pop. Rank	State Metro Population
Anchorage	AK	226,338	147	226,338
Birmingham	AL	907,810	46	
Mobile	AL	476,923	80	
Montgomery	AL	292,517	120	
Huntsville	AL	238,912	145	
Tuscaloosa	AL	150,522	188	
Decatur	AL	131,556	212	
Florence	AL	131,327	214	
Dothan	AL	130,964	216	
Anniston	AL	116,034	242	
Gadsden	AL	99,840	260	2,676,405
Little Rock-North Little Rock	AR	513,117	73	
Fort Smith	AR	175,911	170	
Fayetteville-Springdale	AR	113,409	248	
Pine Bluff	AR	85,487	270	887,924
Phoenix	AZ	2,122,101	20	
Tucson	AZ	666,880	62	2,788,981
Los Angeles-Anaheim-Riverside	CA	14,531,529	2	
San Francisco-Oakland-San Jose	CA	6,253,311	4	
San Diego	CA	2,498,016	15	
Sacramento	CA	1,481,102	26	
Fresno	CA	667,490	61	
Bakersfield	CA	543,477	71	
Stockton	CA	480,628	78	
Modesto	CA	370,522	98	
Santa Barbara-Santa Maria-Lompoc	CA	369,608	99	
Salinas-Seaside-Monterey	CA	355,660	104	
Visalia-Tulare-Porterville	CA	311,921	119	
Chico	CA	182,120	168	
Merced	CA	178,403	169	
Redding	CA	147,036	193	
Yuba City	CA	122,643	228	28,493,466
Denver-Boulder	CO	1,848,319	22	
Colorado Springs	CO	397,014	91	
Fort Collins-Loveland	CO	186,136	166	
Greeley	CO	131,821	211	
Pueblo	CO	123,051	227	2,686,341
Hartford-New Britain-Middletown-Bristol	CT	1,123,678	35	
New Haven-Waterbury-Meriden	CT	804,219	52	
New London-Norwich	CT	254,957	134	2,182,854
Washington	DC	3,923,574	7	3,923,574
Miami-Fort Lauderdale	FL	3,192,582	11	
Tampa-St. Petersburg-Clearwater	FL	2,067,959	21	
Orlando	FL	1,072,748	36	
Jacksonville	FL	906,727	47	
West Palm Beach-Boca Raton-Delray Beach	FL	863,518	50	
Lakeland-Winter Haven	FL	405,382	88	
Melbourne-Titusville-Palm Bay	FL	398,978	90	

Table A2 – 281 Metropolitan Areas by State

Metropolitan Area	State	1990 Population	Pop. Rank	State Metro Population
Daytona Beach	FL	370,712	97	
Pensacola	FL	344,406	109	
Fort Myers-Cape Coral	FL	335,113	113	
Sarasota	FL	277,776	126	
Fort Pierce	FL	251,071	136	
Tallahassee	FL	233,598	146	
Bradenton	FL	211,707	153	
Gainesville	FL	204,111	156	
Ocala	FL	194,833	158	
Naples	FL	152,099	186	
Fort Walton Beach	FL	143,776	198	
Panama City	FL	126,994	223	11,754,090
Atlanta	GA	2,833,511	12	
Augusta	GA	396,809	92	
Macon-Warner Robins	GA	281,103	123	
Columbus	GA	243,072	140	
Savannah	GA	242,622	141	
Athens	GA	156,267	182	
Albany	GA	112,561	249	4,265,945
Honolulu	HI	836,231	51	836,231
Des Moines	IA	392,928	95	
Davenport-Rock Island-Moline	IA	350,861	105	
Cedar Rapids	IA	168,767	174	
Waterloo-Cedar Falls	IA	146,611	194	
Sioux City	IA	115,018	245	
Iowa City	IA	96,119	265	
Dubuque	IA	86,403	269	1,356,707
Boise	ID	205,775	155	205,775
Chicago-Gary-Lake County	IL	8,065,633	3	
Peoria	IL	339,172	110	
Rockford	IL	283,719	121	
Springfield	IL	189,550	162	
Champaign-Urbana-Rantoul	IL	173,025	172	
Bloomington-Normal	IL	129,180	221	
Decatur	IL	117,206	240	
Kankakee	IL	96,255	264	9,393,740
Indianapolis	IN	1,249,822	31	
Fort Wayne	IN	363,811	101	
Evansville	IN	278,990	124	
South Bend-Mishawaka	IN	247,052	138	
Elkhart-Goshen	IN	156,198	183	
Terre Haute	IN	130,812	217	
Anderson	IN	130,669	218	
Lafayette-West Lafayette	IN	130,598	219	
Muncie	IN	119,659	235	
Bloomington	IN	108,978	252	
Kokomo	IN	96,946	263	3,013,535
Wichita	KS	485,270	77	

Table A2 – 281 Metropolitan Areas by State

Metropolitan Area	State	1990 Population	Pop. Rank	State Metro Population
Topeka	KS	160,976	179	
Lawrence	KS	81,798	273	728,044
Louisville	KY	952,662	42	
Lexington-Fayette	KY	348,428	108	
Owensboro	KY	87,189	268	1,388,279
New Orleans	LA	1,238,816	32	
Baton Rouge	LA	528,264	72	
Shreveport	LA	334,341	114	
Lafayette	LA	208,740	154	
Houma-Thibodaux	LA	182,842	167	
Lake Charles	LA	168,134	175	
Monroe	LA	142,191	201	
Alexandria	LA	131,556	212	2,934,884
Boston-Lawrence-Salem-Lowell-Brockton	MA	3,783,817	9	
Worcester-Fitchburg-Leominster	MA	709,705	57	
Springfield	MA	602,878	68	
New Bedford-Fall River-Attleboro	MA	506,325	75	
Pittsfield	MA	139,352	204	5,742,077
Baltimore	MD	2,382,172	18	
Hagerstown	MD	121,393	231	
Cumberland	MD	101,643	259	2,605,208
Portland	ME	243,135	139	
Bangor	ME	146,601	195	
Lewiston-Auburn	ME	105,259	257	494,995
Detroit-Ann Arbor	MI	4,665,236	6	
Grand Rapids	MI	688,399	59	
Lansing-East Lansing	MI	432,674	84	
Flint	MI	430,459	85	
Saginaw-Bay City-Midland	MI	399,320	89	
Kalamazoo	MI	223,411	149	
Benton Harbor	MI	161,378	177	
Muskegon	MI	158,983	181	
Jackson	MI	149,756	191	
Battle Creek	MI	135,982	207	7,445,598
Minneapolis-St. Paul	MN	2,464,124	16	
Duluth	MN	239,971	144	
St. Cloud	MN	190,921	160	
Rochester	MN	106,470	256	3,001,486
St. Louis	MO	2,444,099	17	
Kansas City	MO	1,566,280	25	
Springfield	MO	240,593	143	
Joplin	MO	134,910	209	
Columbia	MO	112,379	250	
St. Joseph	MO	83,083	272	4,581,344
Jackson	MS	395,396	93	
Biloxi-Gulfport	MS	197,125	157	
Pascagoula	MS	115,243	244	707,764
Billings	MT	113,419	247	

Table A2 – 281 Metropolitan Areas by State

Metropolitan Area	State	1990 Population	Pop. Rank	State Metro Population
Great Falls	MT	77,691	276	191,110
Charlotte-Gastonia-Rock Hill	NC	1,162,093	34	
Greensboro-Winston-Salem-High Point	NC	942,091	44	
Raleigh-Durham	NC	735,480	55	
Fayetteville	NC	274,566	128	
Hickory	NC	221,700	151	
Asheville	NC	174,821	171	
Jacksonville	NC	149,838	190	
Wilmington	NC	120,284	233	
Burlington	NC	108,213	254	3,889,086
Fargo-Moorhead	ND	153,296	185	
Bismarck	ND	83,831	271	
Grand Forks	ND	70,683	279	307,810
Omaha	NE	618,262	65	
Lincoln	NE	213,641	152	831,903
Portsmouth-Dover-Rochester	NH	350,078	106	
Manchester-Nashua	NH	336,073	112	686,151
Atlantic City	NJ	319,416	115	319,416
Albuquerque	NM	480,577	79	
Las Cruces	NM	135,510	208	
Santa Fe	NM	117,043	241	733,130
Las Vegas	NV	741,459	691	
Reno	NV	254,667	135	996,126
New York-Northern New Jersey-Long Island	NY	17,953,372	1	
Buffalo-Niagara Falls	NY	1,189,288	33	
Rochester	NY	1,002,410	38	
Albany-Schenechtady-Troy	NY	874,304	48	
Syracuse	NY	659,864	63	
Utica-Rome	NY	316,633	116	
Binghamton	NY	264,497	129	
Poughkeepsie	NY	259,462	132	
Jamestown-Dunkirk	NY	141,895	202	
Glens Falls	NY	118,539	239	
Elmira	NY	95,195	266	22,875,459
Cleveland-Akron-Lorain	OH	2,759,823	13	
Cincinnati-Hamilton	OH	1,744,124	23	
Columbus	OH	1,377,419	29	
Dayton-Springfield	OH	951,270	43	
Toledo	OH	614,128	66	
Youngstown-Warren	OH	492,619	76	
Canton	OH	394,106	94	
Lima	OH	154,340	184	
Steubenville-Weirton	OH	142,523	199	
Mansfield	OH	126,137	224	8,756,489
Oklahoma City	OK	958,839	41	
Tulsa	OK	708,954	58	
Lawton	OK	111,486	251	
Enid	OK	56,735	281	1,836,014

Table A2 – 281 Metropolitan Areas by State

Metropolitan Area	State	1990 Population	Pop. Rank	State Metro Population
Portland-Vancouver	OR	1,477,895	27	
Eugene-Springfield	OR	282,912	122	
Salem	OR	278,024	125	
Medford	OR	146,389	196	2,185,220
Philadelphia-Wilmington-Trenton	PA	5,899,345	5	
Pittsburgh-Beaver Valley	PA	2,242,798	19	
Scranton--Wilkes-Barre	PA	734,175	56	
Allentown-Bethlehem	PA	686,688	60	
Harrisburg-Lebanon-Carlisle	PA	587,986	70	
Lancaster	PA	422,822	86	
York	PA	417,848	87	
Reading	PA	336,523	111	
Erie	PA	275,572	127	
Johnstown	PA	241,247	142	
Altoona	PA	130,542	220	
State College	PA	123,786	226	
Sharon	PA	121,003	232	
Williamsport	PA	118,710	238	12,339,045
Providence-Pawtucket-Woonsocket	RI	916,270	45	916,270
Greenville-Spartanburg	SC	640,861	64	
Charleston	SC	506,875	74	
Columbia	SC	453,331	81	
Anderson	SC	145,196	197	
Florence	SC	114,344	246	1,860,607
Sioux Falls	SD	123,809	225	
Rapid City	SD	81,343	274	205,152
Nashville	TN	985,026	39	
Memphis	TN	981,747	40	
Knoxville	TN	604,816	67	
Johnson City-Kingsport-Bristol	TN	436,047	82	
Chattanooga	TN	433,210	83	
Clarksville-Hopkinsville	TN	169,439	173	
Jackson	TN	77,982	275	3,688,267
Dallas-Ft. Worth	TX	3,885,415	8	
Houston-Galveston-Brazoria	TX	3,711,043	10	
San Antonio	TX	1,302,099	30	
Austin	TX	781,572	53	
El Paso	TX	591,610	69	
McAllen-Edinburg-Mission	TX	383,545	96	
Beaumont-Port Arthur	TX	361,226	103	
Corpus Christi	TX	349,894	107	
Brownsville-Harlingen	TX	260,120	131	
Killeen-Temple	TX	255,301	133	
Lubbock	TX	222,636	150	
Waco	TX	189,123	163	
Amarillo	TX	187,547	165	
Longview-Marshall	TX	162,431	176	
Tyler	TX	151,309	187	

Table A2 – 281 Metropolitan Areas by State

Metropolitan Area	State	1990 Population	Pop. Rank	State Metro Population
Laredo	TX	133,239	210	
Wichita Falls	TX	122,378	229	
Bryan-College Station	TX	121,862	230	
Texarkana	TX	120,132	234	
Abilene	TX	119,655	236	
Odessa	TX	118,934	237	
Midland	TX	106,611	255	
San Angelo	TX	98,458	261	
Sherman-Denison	TX	95,021	267	
Victoria	TX	74,361	277	13,905,522
Salt Lake City-Ogden	UT	1,072,227	37	
Provo-Orem	UT	263,590	130	1,335,817
Norfolk-Virginia Beach-Newport News	VA	1,396,107	28	
Richmond-Petersburg	VA	865,640	49	
Roanoke	VA	224,477	148	
Lynchburg	VA	142,199	200	
Charlottesville	VA	131,107	215	
Danville	VA	108,711	253	2,868,241
Burlington	VT	137,079	206	137,079
Seattle-Tacoma	WA	2,559,164	14	
Spokane	WA	361,364	102	
Bremerton	WA	189,731	161	
Yakima	WA	188,823	164	
Olympia	WA	161,238	178	
Richland-Kennewick-Pasco	WA	150,033	189	
Bellingham	WA	127,780	222	3,738,133
Milwaukee-Racine	WI	1,607,183	24	
Madison	WI	367,085	100	
Appleton-Oshkosh-Neenah	WI	315,121	117	
Green Bay	WI	194,594	159	
Janesville-Beloit	WI	139,510	203	
Eau Claire	WI	137,543	205	
Wausau	WI	115,400	243	
Sheboygan	WI	103,877	258	
La Crosse	WI	97,904	262	3,078,217
Huntington-Ashland	WV	312,529	118	
Charleston	WV	250,454	137	
Wheeling	WV	159,301	180	
Parkersburg-Marietta	WV	149,169	192	871,453
Cheyenne	WY	73,142	278	
Casper	WY	61,226	280	134,368

APPENDIX B -- SURVEY FORMS AND QUESTIONS

Survey forms and questions are included in this Appendix for the following categories of respondents:

1. Sewage treatment plants

2. Grease collection/rendering companies

3. Restaurants

Sewage Treatment Plants

Hello (introduction). I'm doing a study of urban waste grease resources for the National Renewable Energy Laboratory. Do you have a few minutes to answer some quick questions?

Company name:
Address:
Contact:
Phone number:

1. What is the average flow rate of raw sewage into your treatment plant?
2. Do you measure the concentration of oil and grease in the raw sewage?
   a. If so, what are the concentrations?
   b. If not, what do you think the concentrations are?
3. Do you allow grease trap pump trucks to discharge at your facility?
   a. If so, how many gallons (or truckloads) per year?
   b. If not, what do the pumping companies do with that material in your area?
4. How is waste grease recovered from your facility and disposed of?
5. What is the quantity of waste grease you recover and dispose of per year?
6. Is the quantity increasing or decreasing? Why?
7. What are the costs of recovery and disposal?
8. Are there any alternative approaches to recovery and disposal?
9. Does waste grease have a market value? What is it?
10. Do you have any suggestions on how I should estimate the total amount of waste grease generated in the _____ metropolitan area?
11. Do you have any suggestions on people I should contact, or approaches I should take?

Grease Collection/Rendering Companies

Hello (introduction). I'm doing a study of urban waste grease resources for the National Renewable Energy Laboratory. Do you have a few minutes to answer some quick questions?

Company name:
Address:
Contact:
Phone number:

1. How do you obtain your waste grease supply?
2. What is the quantity of waste grease you collect or process per year?
3. Is the quantity increasing or decreasing? Why?
4. How much do you pay (or charge) for the waste grease you collect?
5. Do you process the waste grease into saleable products?
   a. If yes, what products do you make from waste grease and sell? Amounts? Prices?
   b. If no, where and how do you dispose of the material? Tipping fees?
6. Who are your biggest competitors? (names, numbers)
7. Who are your biggest customers?
8. Are there any factors that could change the demand for your products? What are they?
9. Do you have any suggestions on how I should estimate the total amount of waste grease generated in the _____ metropolitan area?
10. Do you have any suggestions on people I should contact, or approaches I should take?

Restaurants

Hello (introduction). I'm doing a study of urban waste grease resources for the National Renewable Energy Laboratory. Do you have a few minutes to answer some quick questions?

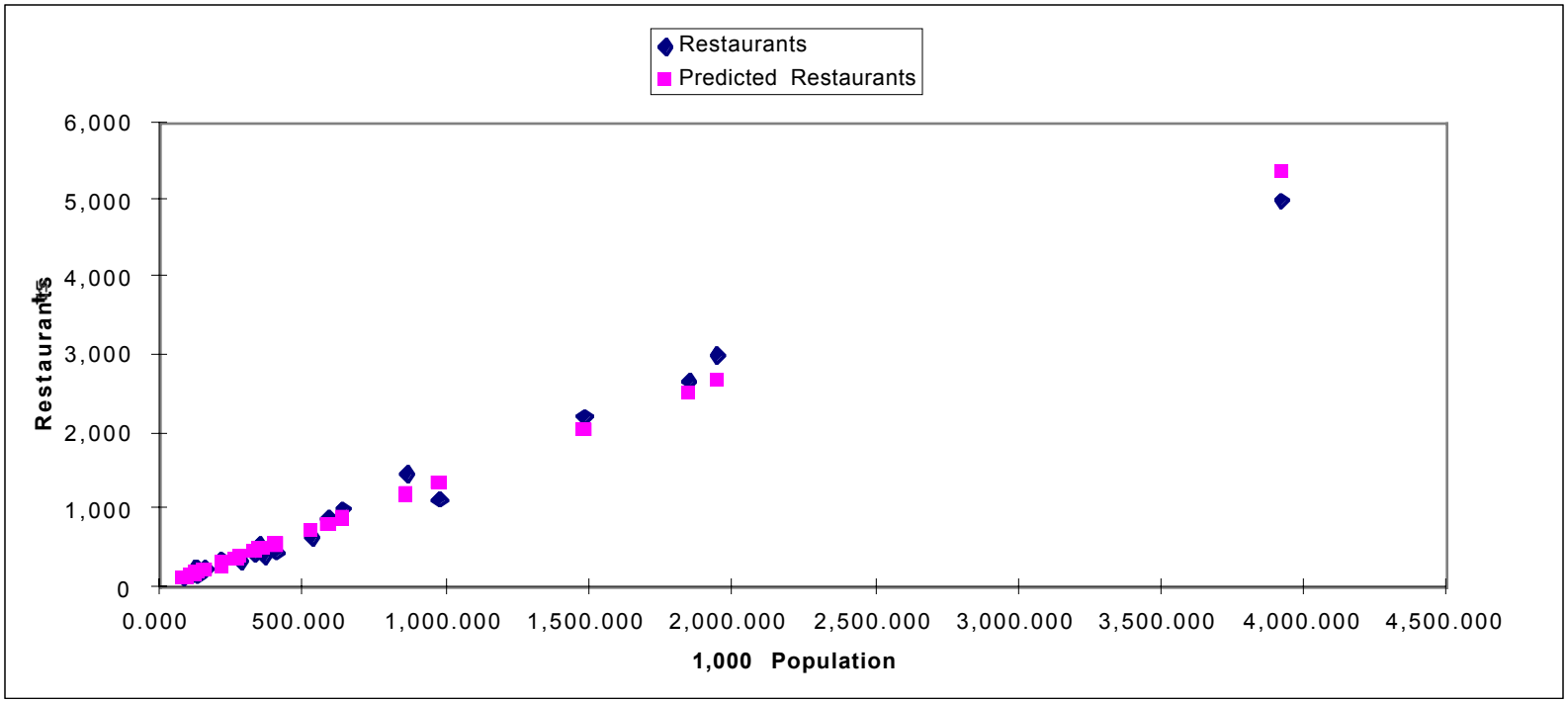
Company name:
Address:
Contact:
Phone number:

1. Do you have an estimate of the quantity of waste grease you generate per year?
2. Is the quantity increasing or decreasing? Why?
3. How do you dispose of it? Who takes it? (names, numbers)
4. How much do you receive for the waste grease? Is the price increasing or decreasing?
5. Are there any factors that could change the demand for your waste grease? What are they?
6. Do you have any suggestions on how I should estimate the total amount of waste grease generated in the _____ metropolitan area?
7. Do you have any suggestions on people I should contact, or approaches I should take?

APPENDIX C -- REGRESSION PLOTS

This Appendix presents a series of seven regression plots and statistical analyses, as discussed in Section B. All of the regression equations were specified to go through the origin, based on the assumption that a city with zero population would have no restaurants and would generate no waste grease.

Number of Restaurants vs. Population: 30 Cities



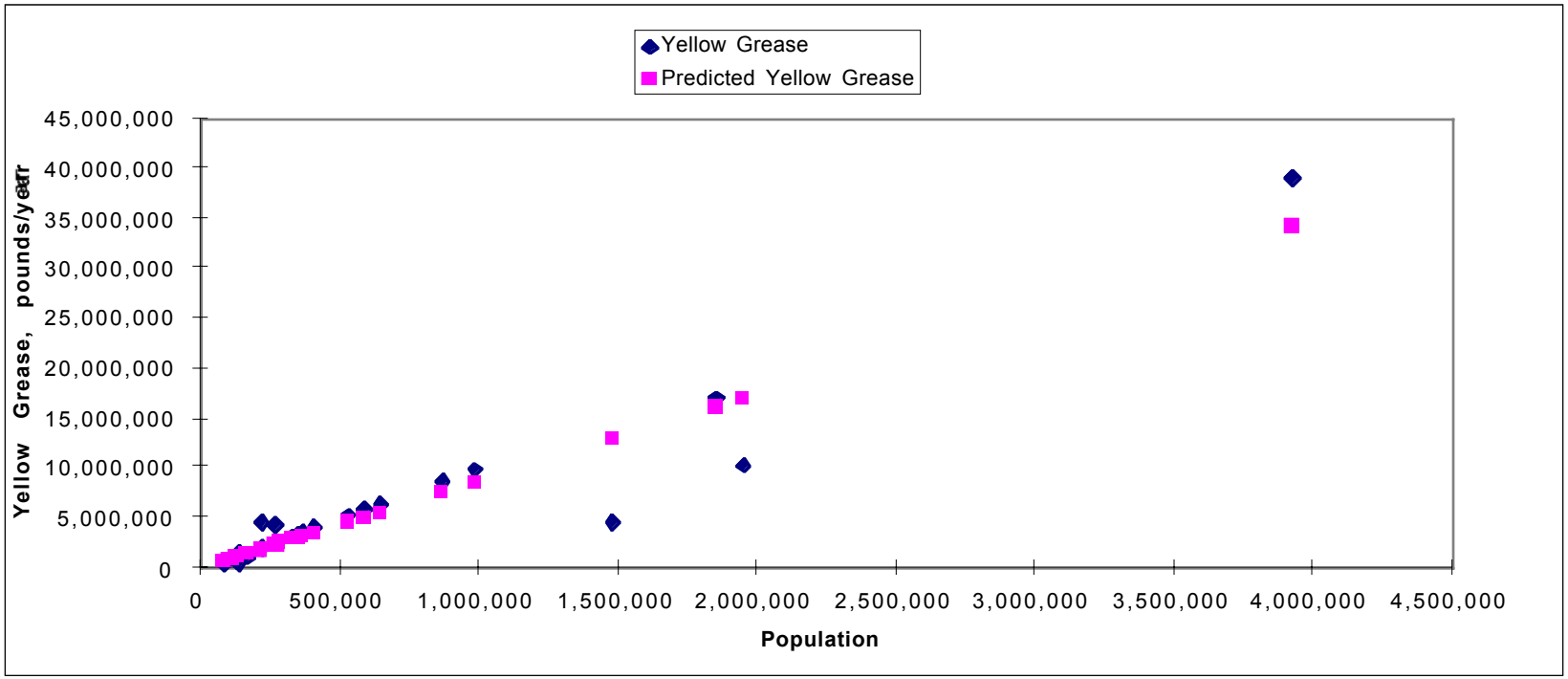
Regression Statistics	
Multiple R	0.99245104
R Square	0.98495907
Adjusted R Square	0.95047631
Standard Error	133.77324
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	33984436.8	33984436.8	1899.07268	2.81247E-27
Residual	29	518963.111	17895.2797		
Total	30	34503399.9			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
1,000 Population	1.36390594	0.02502152	54.5093217	9.0141E-31	1.31273116	1.41508072	1.31273116	1.41508072

Yellow Grease vs. Population: 30 Cities



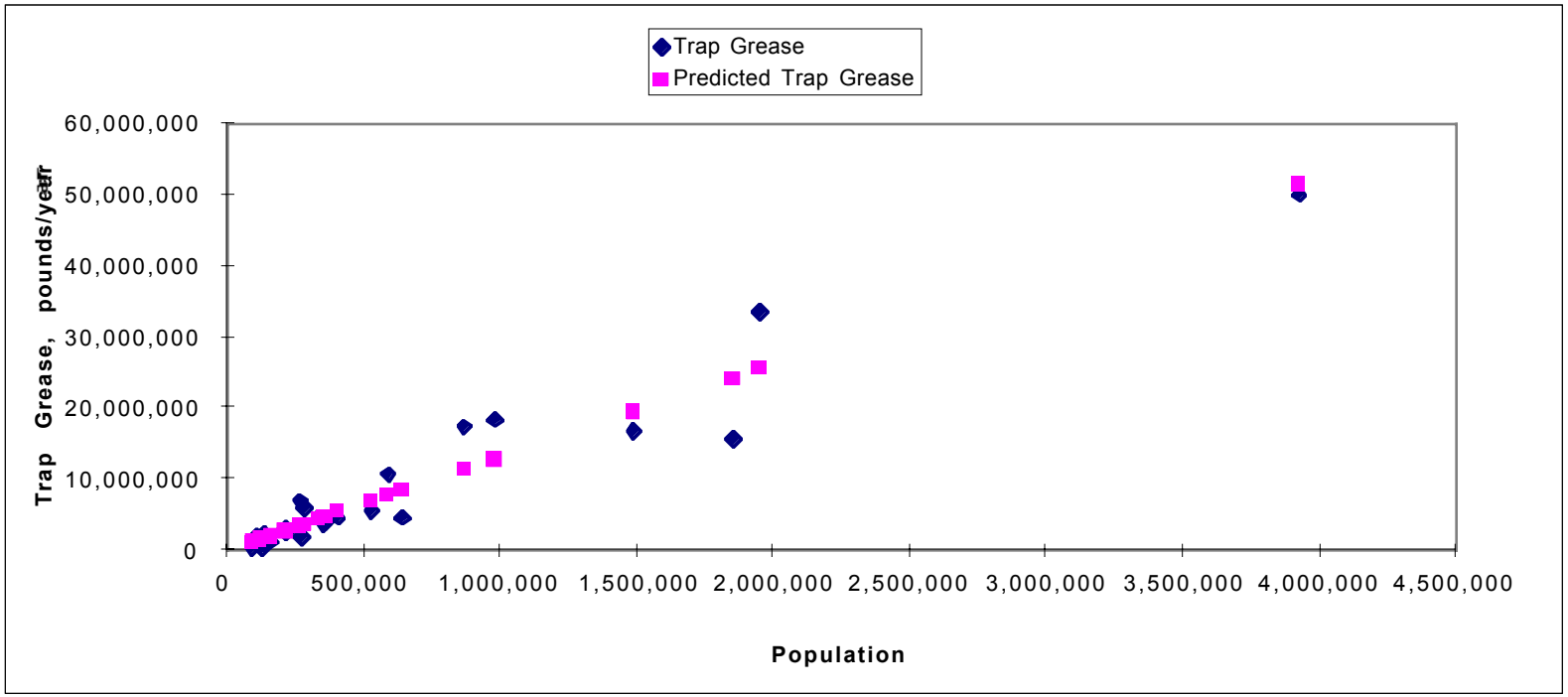
Regression Statistics	
Multiple R	0.94943387
R Square	0.90142467
Adjusted R Square	0.86694191
Standard Error	2322614.29
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.4306E+15	1.4306E+15	265.191252	8.2198E-16
Residual	29	1.5644E+14	5.3945E+12		
Total	30	1.587E+15			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Population	8.74217187	0.43443168	20.1232374	1.3899E-18	7.85365883	9.63068491	7.85365883	9.63068491

Trap Grease vs. Population: 30 Cities



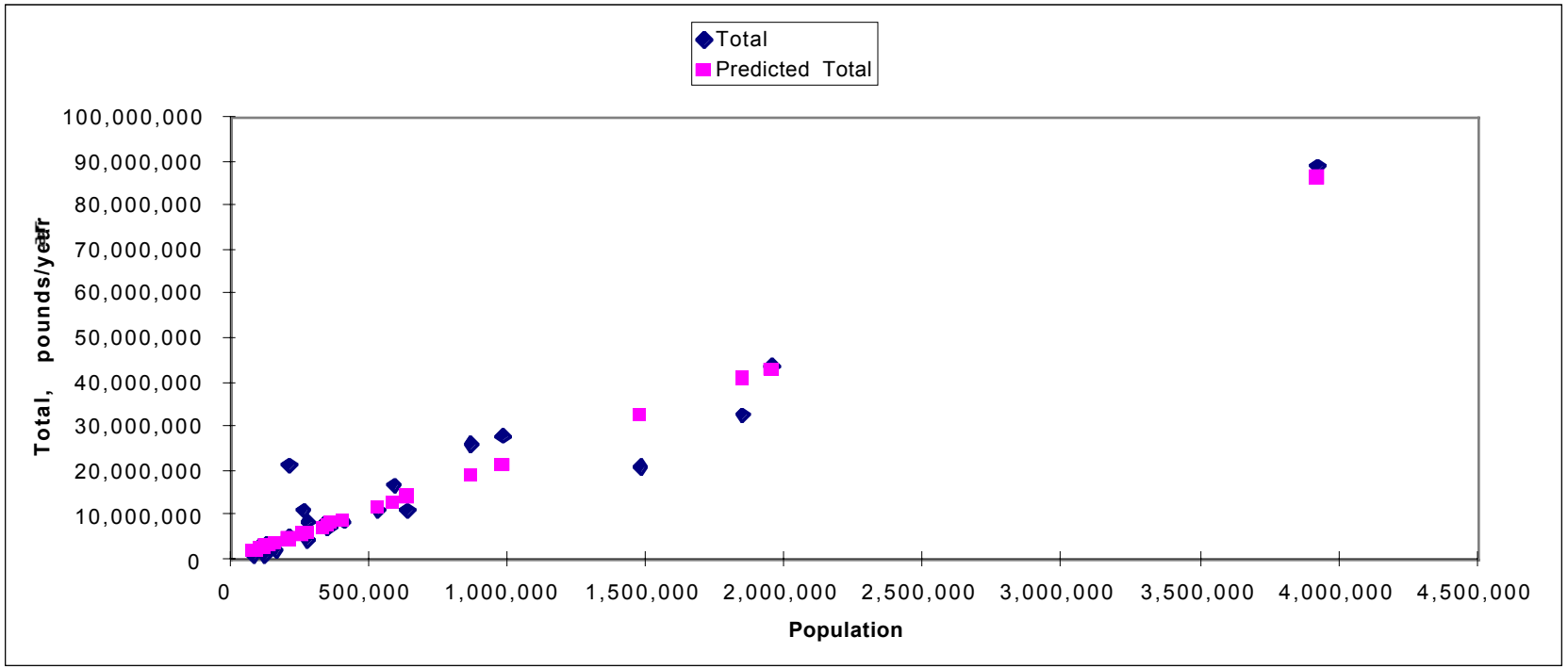
Regression Statistics	
Multiple R	0.96103748
R Square	0.92359303
Adjusted R Square	0.88911027
Standard Error	3018797.17
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3.19458E+15	3.1946E+15	350.546531	2.2728E-17
Residual	29	2.64281E+14	9.1131E+12		
Total	30	3.45886E+15			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Population	13.1051642	0.5646487	23.2094119	2.805E-20	11.95032734	14.2600011	11.9503273	14.2600011

Total Grease vs. Population: 30 Cities



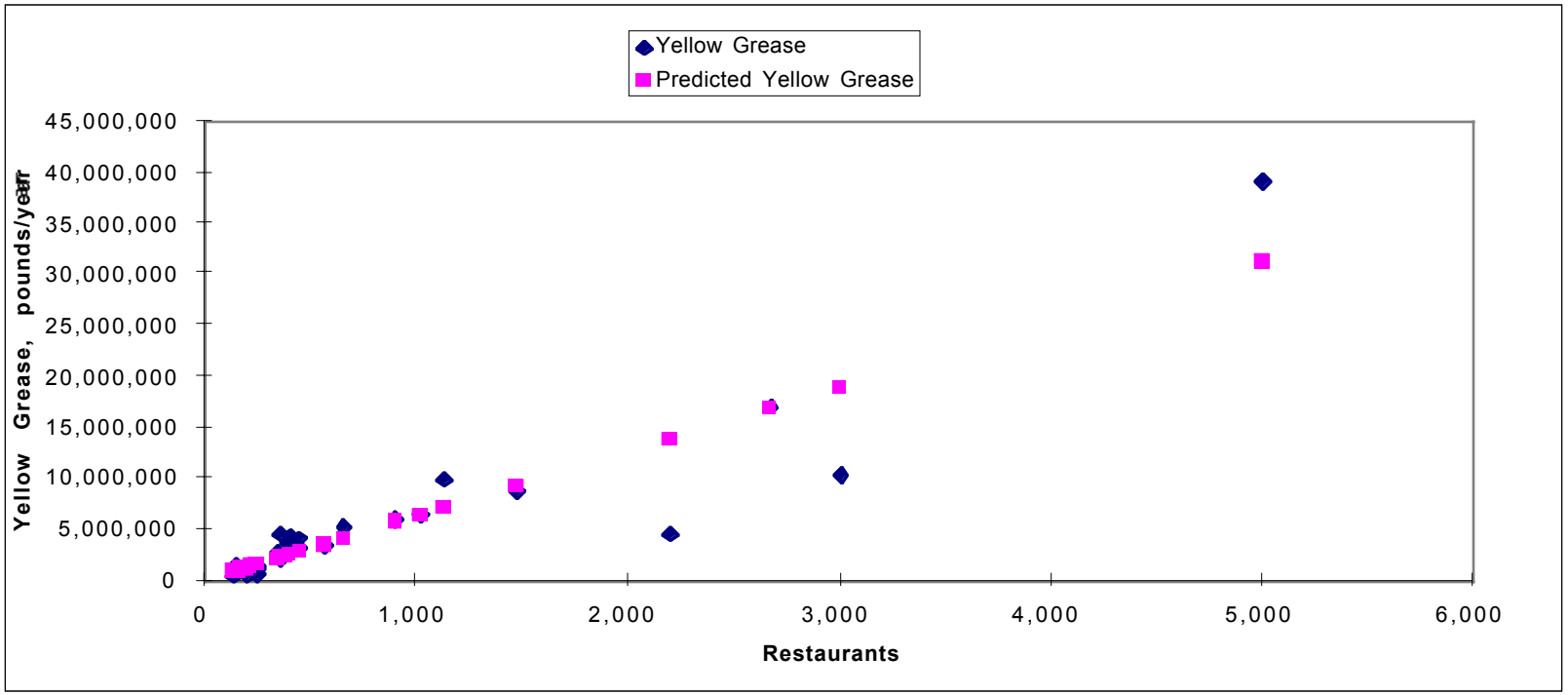
Regression Statistics	
Multiple R	0.96432492
R Square	0.92992255
Adjusted R Square	0.89543979
Standard Error	4745125.09
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	8.6649E+15	8.6649E+15	384.827854	6.7319E-18
Residual	29	6.5297E+14	2.2516E+13		
Total	30	9.3178E+15			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Population	21.9557142	0.88754843	24.7374828	4.8115E-21	20.1404728	23.7709555	20.1404728	23.7709555

Yellow Grease vs. Number of Restaurants: 30 Cities



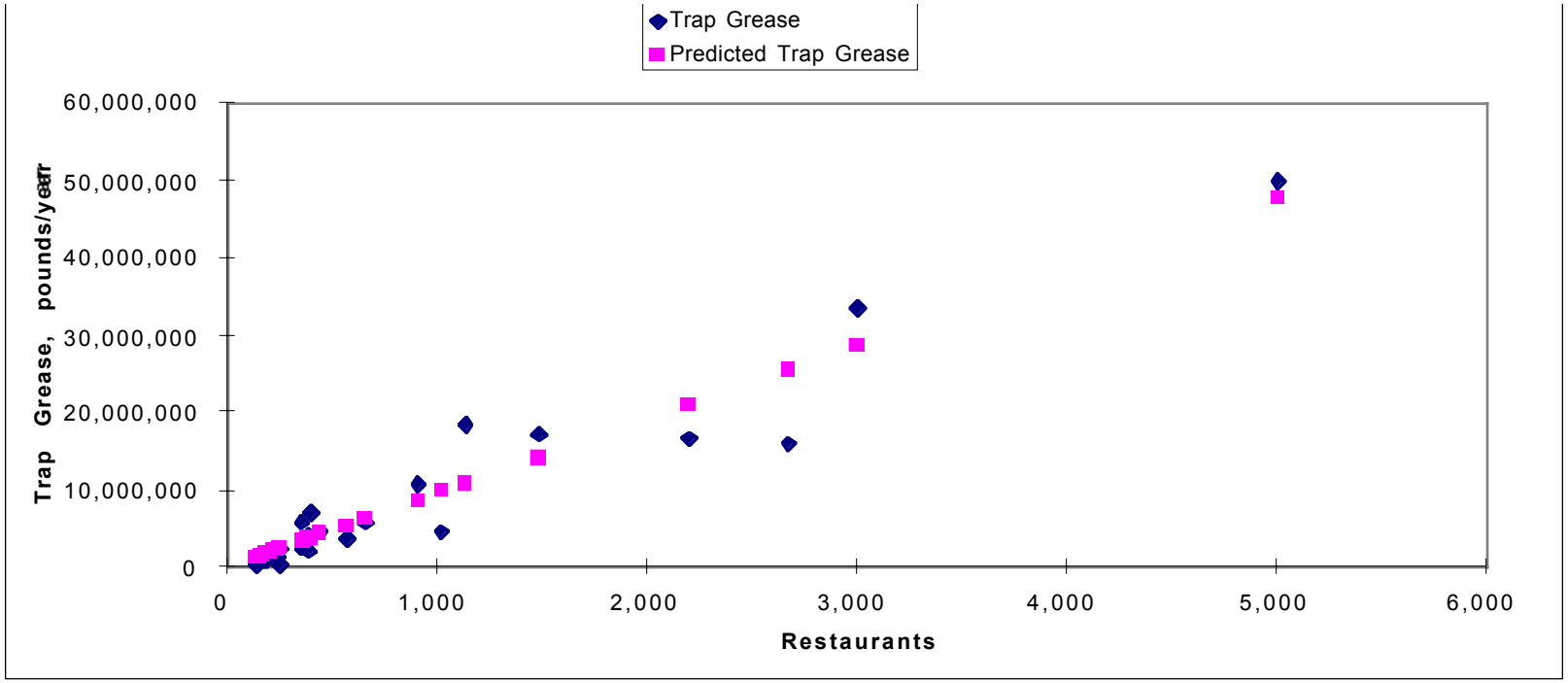
Regression Statistics	
Multiple R	0.92139025
R Square	0.84895999
Adjusted R Square	0.81447723
Standard Error	2875007.46
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.3473E+15	1.3473E+15	163.002104	3.4051E-13
Residual	29	2.397E+14	8.2657E+12		
Total	30	1.587E+15			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Restaurants	6255.86374	392.36462	15.9440057	6.8871E-16	5453.38755	7058.33993	5453.38755	7058.33993

Trap Grease vs. Number of Restaurants: 30 Cities



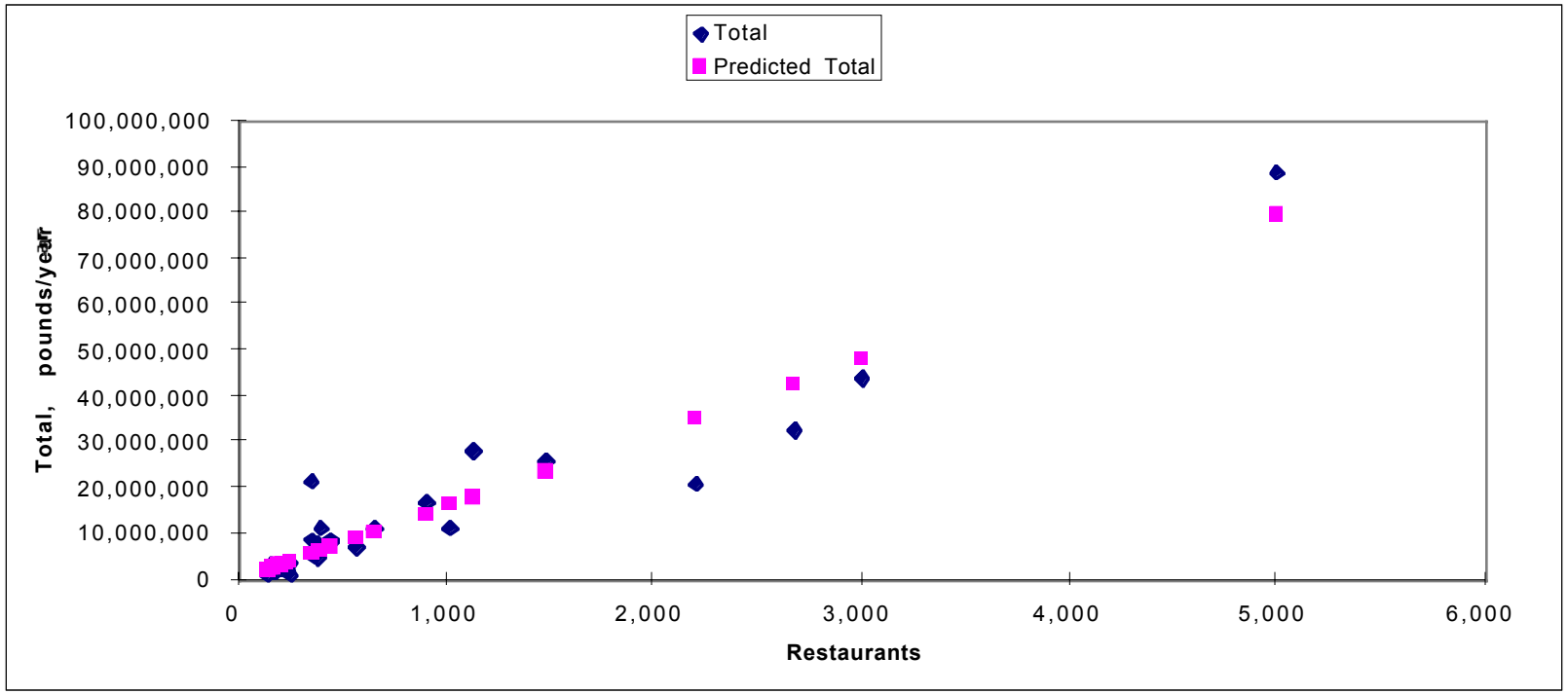
Regression Statistics	
Multiple R	0.95957232
R Square	0.92077903
Adjusted R Square	0.88629627
Standard Error	3073884.39
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3.1848E+15	3.1848E+15	337.064688	3.7814E-17
Residual	29	2.7401E+14	9.4488E+12		
Total	30	3.4589E+15			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Restaurants	9552.5202	419.506209	22.7708673	4.7434E-20	8694.5332	10410.5072	8694.5332	10410.5072

Total Grease vs. Number of Restaurants: 30 Cities



Regression Statistics	
Multiple R	0.95312209
R Square	0.90844172
Adjusted R Square	0.87395897
Standard Error	5423845.72
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	8.4647E+15	8.4647E+15	287.738164	2.9032E-16
Residual	29	8.5312E+14	2.9418E+13		
Total	30	9.3178E+15			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Restaurants	15902.907	740.215527	21.4841575	2.3387E-19	14388.9954	17416.8186	14388.9954	17416.8186

REPORT DOCUMENTATION PAGE

Form Approved
OMB NO. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	November 1998	NREL Subcontract Report

4. TITLE AND SUBTITLE

Urban Waste Grease Resource Assessment

5. FUNDING NUMBERS

Task #: BF996001

6. AUTHOR(S)

G. Wiltsee

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Appel Consultants, Inc.
23905 Plaza Gavilan
Valencia, California

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80401-3393

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

NREL/SR-570-26141

11. SUPPLEMENTARY NOTES

NREL Technical Monitor: K.S. Tyson

12a. DISTRIBUTION/AVAILABILITY STATEMENT

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

12b. DISTRIBUTION CODE

UC-600

13. ABSTRACT *(Maximum 200 words)*

This study collected and analyzed data on urban waste grease resources in 30 randomly selected metropolitan areas in the United States. Two major categories (yellow grease feedstock collected from restaurants by rendering companies; and grease trap wastes from restaurants, which can either be pumped into tank trucks for disposal or flow through municipal sewage systems into wastewater treatment plants) were considered in this study.

14. SUBJECT TERMS

15. NUMBER OF PAGES
70

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT