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Results indicate that the mean percentage of vehicles entering the rest area ranged from 2% at Kentwood (urban) to 20% at Mound (rural). The median value of the water/waste ratio at all sites was found to be close to one, suggesting that daily water use measurements may be used as a surrogate for waste flow measurements. This is significant because water usage is substantially easier to measure than waste generation and could be carried out by LADOTD personnel.

Median waste flows at the sites vary by a factor of 2 to 3 while the less frequent (90 percentile) flows vary by a factor of 3 to 4. In general, the variation in flow rate is larger for larger flows.

Given the technology available, it is relatively easy to collect and analyze large amounts of accurate data that can be used to answer a variety of technical and non-technical questions and to justify changes in operating policy or requests for funding.

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Water Use, Waste Generation, and Traffic Counts at Interstate Rest Areas in Louisiana

by
D.M. Griffin, Jr., Ph.D., P.E.
Xiadong Yan, M.S., C.E.

Department of Civil Engineering
Louisiana Tech University
Ruston, Louisiana 71270

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ABSTRACT

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IMPLEMENTATION STATEMENT

Data collected from this study can be used by the LADOTD and other state and local agencies to estimate the number of vehicles entering an interstate rest area, the fraction of total vehicles entering the rest area, the water use per vehicle, and the waste generated per vehicle. Although this project was initiated in order to obtain accurate estimates of water use and waste generation for design or redesign of water/waste treatment systems, such data can be used to answer both technical and non-technical questions of interest to LADOTD as well as other state agencies such as the Department of Tourism, which is responsible for the operation of visitor centers. For example, data collected may be used to determine whether or not a given rest area or visitor center should be closed. It can also be used to determine if the operating hours of visitor centers are such that a majority of traffic entering is being served. If the rest area or visitor center is contemplating connecting to the water and sewerage system of a nearby municipality, such data will be needed by both LADOTD and the municipality in order to make a rational decision, both technically and economically.

This study demonstrated the wide availability and ease of use of computer-controlled flow measurement and traffic counting devices as well as the relative ease with which large amounts of accurate data can be collected by small numbers of qualified personnel.

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INTRODUCTION

Rest areas have become an indispensable part of our interstate highway system. They provide tired drivers a safe, convenient, and comfortable place to recover after a long-distance drive. They help reduce the hazards posed by driver fatigue and also time and fuel that otherwise would be lost if drivers had to exit from the highway into the traffic and crowded streets of unfamiliar towns. From a public relations/tourism standpoint, rest areas are often the first contact a visitor has with a state and may be a major determinant in their opinion of the state and resulting desire to return.

The earliest highway rest areas appeared around 1938 and were built entirely with state funds. Enthusiastic public acceptance and use of early rest areas encouraged the states to place more emphasis on their rest area programs and to request federal funding. The Federal-Aid Highway Act of 1938 was the first such legislation that allowed the states to use highway funds for safety rest areas and other facilities. Subsequently, the Federal-Aid Highway Act of 1956 and the Highway Beautification Act of 1965 have given authority, funding, and substance to the rest area program.

The Current Situation - Highway Rest Areas

There are approximately 2,019 rest areas in the interstate highway system in the USA *[1]*. Table 1 lists the distribution of rest areas in each state. The state with the largest number of rest areas is Texas with 114, and that with the lowest number is Rhode Island with 1. The average per state is 41 and the median is 36. At the time the list in *[1]* was prepared, Louisiana had 33 rest areas, slightly lower than the average and median of the nation.

Table 1

Rest area distribution in USA *[1]*

No.	State	Number of Rest Areas	No.	State	Number of Rest Areas
1	Alabama	37	26	Nebraska	29
2	Alaska	52	27	Nevada	19
3	Arizona	53	28	New Hampshire	19
4	Arkansas	38	29	New Jersey	34
5	California	89	30	New Mexico	36
6	Colorado	47	31	New York	72
7	Connecticut	7	32	North Carolina	60
8	Delaware	2	33	North Dakota	39
9	Florida	70	34	Ohio	65
10	Georgia	28	35	Oklahoma	27
11	Idaho	31	36	Oregon	68
12	Illinois	57	37	Pennsylvania	66
13	Indiana	48	38	Rhode Island	1
14	Iowa	39	39	South Carolina	32
15	Kansas	82	40	South Dakota	27
16	Kentucky	29	41	Tennessee	32
17	Louisiana	33	42	Texas	114
18	Maine	22	43	Utah	33
19	Maryland	15	44	Vermont	28
20	Massachusetts	29	45	Virginia	39
21	Michigan	83	46	Washington	42
22	Minnesota	54	47	West Virginia	20
23	Mississippi	25	48	Wisconsin	34
24	Missouri	38	49	Wyoming	36
25	Montana	39		Total	2019

Estimates of water usage and wastewater generation are critical in the interstate rest areas. A safe, dependable water supply system and a properly functioning waste treatment system are a must for a modern, successful rest area and their design and operation must meet increasingly stringent state and federal regulations. Connection to a nearby municipal system, if feasible, offers an ideal solution because it relieves the state DOT of the burden of design and operation of these systems, duties their personnel are not usually trained to carry out. Even so, it is still necessary for both the DOT and the municipality to know the volume of water to be supplied and the volume and characteristics of waste to be treated in order to do the necessary economic and design calculations prior to deciding if connection is feasible and cost effective.

However, by their nature, many rest areas are often built in locations substantially removed from population centers. In these cases, municipal water supply and waste treatment systems are not a viable alternative and rest areas usually have to depend on on-site wells and waste treatment systems. To design a wastewater system, one must have reliable information regarding the amount of wastewater generated during a 24-hour period. In the case of a water system peak usage rates are important for sizing well pumps, hydro-pneumatic pressure tanks and distribution lines. Inadequately designed water and wastewater treatment systems can seriously affect the function and aesthetics of a rest area. Perhaps more importantly in the long run is the effect poorly designed facilities have on a visitor's opinion of the state and their desire to return for future visits. This is particularly true in states like Louisiana that depend on tourism for significant revenues.

Review of the Literature

While attempting to get this project funded, the primary investigator was met repeatedly with the response "that's already been done" or "that data is already in the literature." However, repeated literature searches by the primary investigator, graduate students, and others could find no work of this nature carried out since 1974.

The U.S. Army Corps of Engineers Waterways Experiment Station (WES) in Vicksburg, MS, conducted the most recent study of a similar nature for the Federal Highway Administration *[2]*. A WES team visited states in each of the nine (at that time) Federal Highway Administration regions. Based on the total number of systems examined (442) they found the most prevalent type of waste treatment scheme to be septic/drain field systems (180/422) followed by extended aeration package plants (116/422). They concluded that the waste treatment systems for the majority of rest areas equipped with flush toilets had been over-designed and suggested that the assumption of 3.1 persons per automobile and 5 gallons/person used by many states (at the time the report was prepared) is excessive. They presented a procedure for computing rest area waste flow based on 24-hour traffic counts during peak weekend periods. Nine percent of the average daily traffic (ADT) is assumed to stop at the rest area. This figure is then multiplied by 6.7 gal/vehicle, a value obtained for FHWA by researchers at the University of West Virginia *[3]*.

Zaltman et al. *[3]* and Pfeffer *[4]* found that most rest areas are designed based on the projected 20 year average daily traffic count (ADT) and, as a result, waste treatment systems were also designed based on the 20 year ADT, corrected for various factors (% stopping, seasonal corrections, persons per vehicle). Based on numerous assumptions they developed design values for water use from 4.25 to 6.5 gallons/vehicle. Additional computations suggested that waste generation rates range from 90 to 100% of design water use rates.

Zaltman et al. studied rest areas in Florida, Tennessee, New Hampshire, Colorado, and Iowa. They found the most important parameter(s) in predicting water use rates were the average daily traffic (ADT) and the percentage of cars stopping at the rest area. A value of 9% of the ADT was used. It was obtained as a weighted average of actual data obtained from a number of facilities in Florida, Tennessee, New Hampshire, Colorado, and Iowa.

The studies reviewed have the following characteristics:

1. They are at least twenty-five years old. Thus, the results may be no longer be valid

2. They were carried out in states other than Louisiana. There has been no research or investigation of this type done in this state.

3. Given that microprocessor technology was first made available to the general public around 1974, it is apparent that these studies did not make use of this technology. Large quantities of data could not be automatically obtained at pre-programmed intervals, logged for later download by laptop computer, and manipulated using multiple software applications such as Excel, Splus, and Mathcad, as was done in this study.

OBJECTIVE

The primary objective of this research was to develop a framework and procedure utilizing computer enhanced measuring/counting equipment and computer technology for collecting, logging, and downloading the relevant data (traffic counts, water use, waste generated) to develop design guidelines for water use and waste generation at interstate rest areas. Total water used and waste generated over a 24-hour period were to be compiled; in addition water use and waste generation was related to the number of vehicles using the facility, the fraction of vehicles entering the facility from the interstate being served, and the geographic location of the site. The resulting data is presented herein as tables and probability plots for use by LADOTD as well as other state agencies. Probability plots can provide all standard statistical parameters normally desired (mean, median, standard deviation) as well as giving the user an estimate of the probability of occurrence for any values chosen for future use. Such plots are commonly used in hydrology, hydraulics, and environmental engineering. The plots used herein are sometimes referred to as “reference distributions” because they make no assumptions regarding the statistical structure of the data, such as normality or log-normality and thus are theoretically correct, requiring no caveats other than they are based on the data collected.

SCOPE

The research was to be carried out at several visitor centers/rest areas located in Louisiana. The sites were chosen to represent the different geographic regions in the state, urban or very near urban areas (Pearl River), sites located some distance from major populations centers, perhaps in suburban areas (Kentwood, possibly Grand Prairie), and sites in rural areas (Mound). Originally, data was to be collected for a period of 180 days. However, for a variety of reasons, it was possible to obtain data for substantially longer periods at some sites (250 – 300 days). Because of power outages and equipment failure, none of the data sets are continuous over the entire study period. Also, because of an improperly functioning main water meter, the data set at Mound is of limited usefulness.

METHODOLOGY

Research Sites

The research described herein was done simultaneously at three visitor center/rest areas and one rest area in Louisiana: Mound, Kentwood, Pearl River, and Grand Prairie. Figure 1 (page 27) shows their locations.

The rest area/visitor center at Mound is on I-20. Restroom facilities are located on both sides of I-20 approximately one mile west of the “Delta” exit and approximately ten miles west of the Louisiana-Mississippi border. This location is in the Mississippi Delta in north Louisiana, one of most of the most rural regions of the state. At the time of the study the rest area/visitor center received water from the city of Tallulah, LA. Wastewater from facilities on both sides of the interstate flows by gravity to a pump station and treatment facility on the south side of I-20, adjacent to the east bound lane.

The rest area/visitor center at Kentwood is located adjacent to the southbound lane of I-55 on the Louisiana/Mississippi border, about 30 miles north of Hammond, LA. Water used in the rest area/visitor center comes from an on-site well connected to a hydro-pneumatic pressure tank. Wastewater flows to an on-site pump station and is treated on-site using a package plant activated sludge process.

The rest area/visitor center at Pearl River is located adjacent to the northbound lane at the Louisiana-Mississippi border on I-59. It is about three miles north of Slidell, LA and approximately 30 miles north of New Orleans, LA. This is a highly urbanized region of the state. Water used comes from an on-site well connected to a hydro-pneumatic pressure tank. Wastewater flows by gravity to an on-site pump station and is treated on-site using an activated sludge process.

The rest area (not a visitor center) at Grand Prairie is located adjacent to the northbound lane of I-49. However, it serves both north and southbound traffic. It is located about 14 miles north of Opelousas, LA, 34 miles north of Lafayette, LA, and 40 miles south of Alexandria, Louisiana. This region of the state could be classified somewhere between suburban and rural. Potable water comes from an on-site well connected to a hydro- pneumatic pressure tank. Wastewater flows to a pump station and is treated on-site using a septic tank/rock plant filter system.

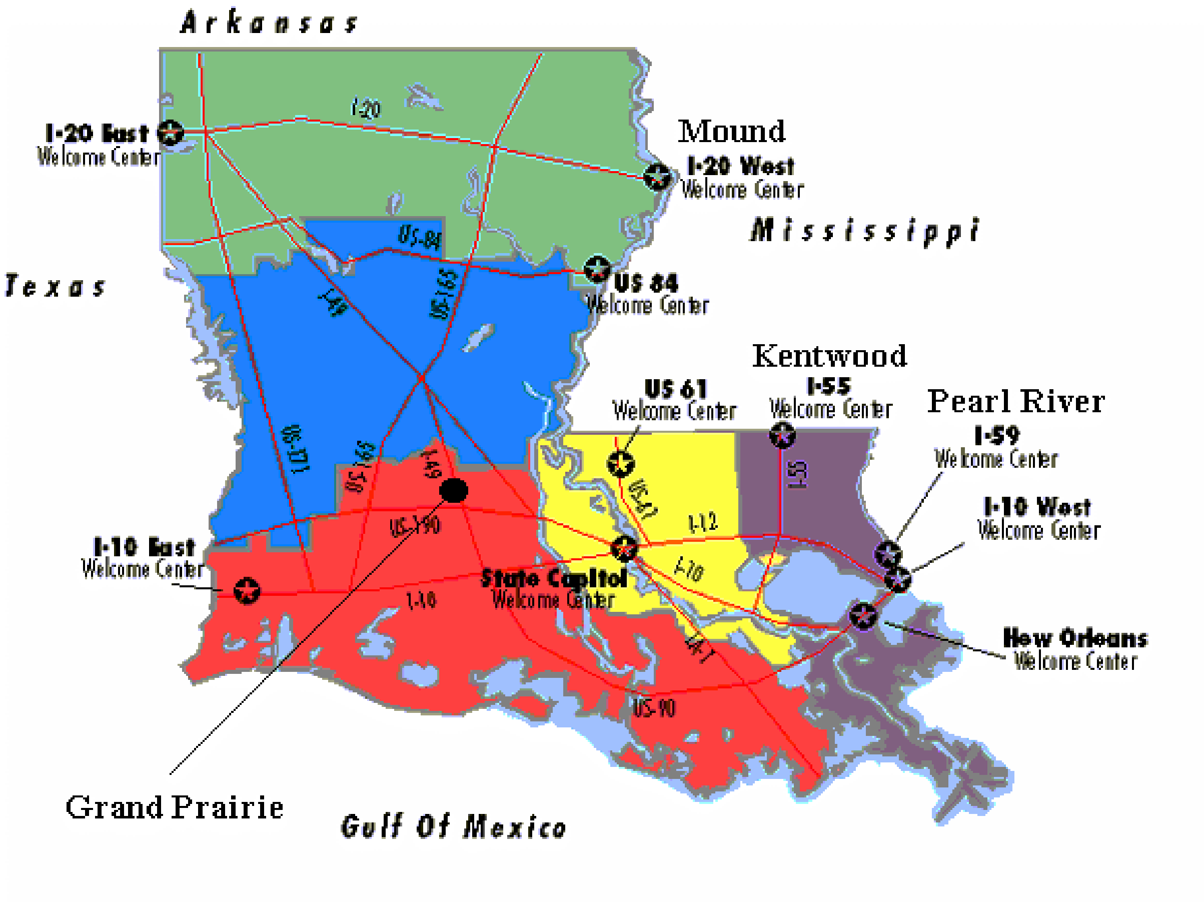

Figure 1
Location map of the research sites

General Description of Data Collection Procedures

Water

In this research, the raw data collected were water flow rates logged at 2 minute intervals, wastewater flow rates logged at 3 minute intervals, traffic entering the rest area, and traffic on the highway served by the rest area. To measure water use, mechanical water meters equipped with transmitters were installed between the well and pressure tank. The flow rate was measured approximately once per second, averaged, and the average value logged by an

American Sigma data logger every two minutes. A two minute logging interval was chosen because the water usage function is not "well behaved" in a mathematical sense. As shown in Figure 2, the flow meter is installed between the well and the pressure tank, rather than

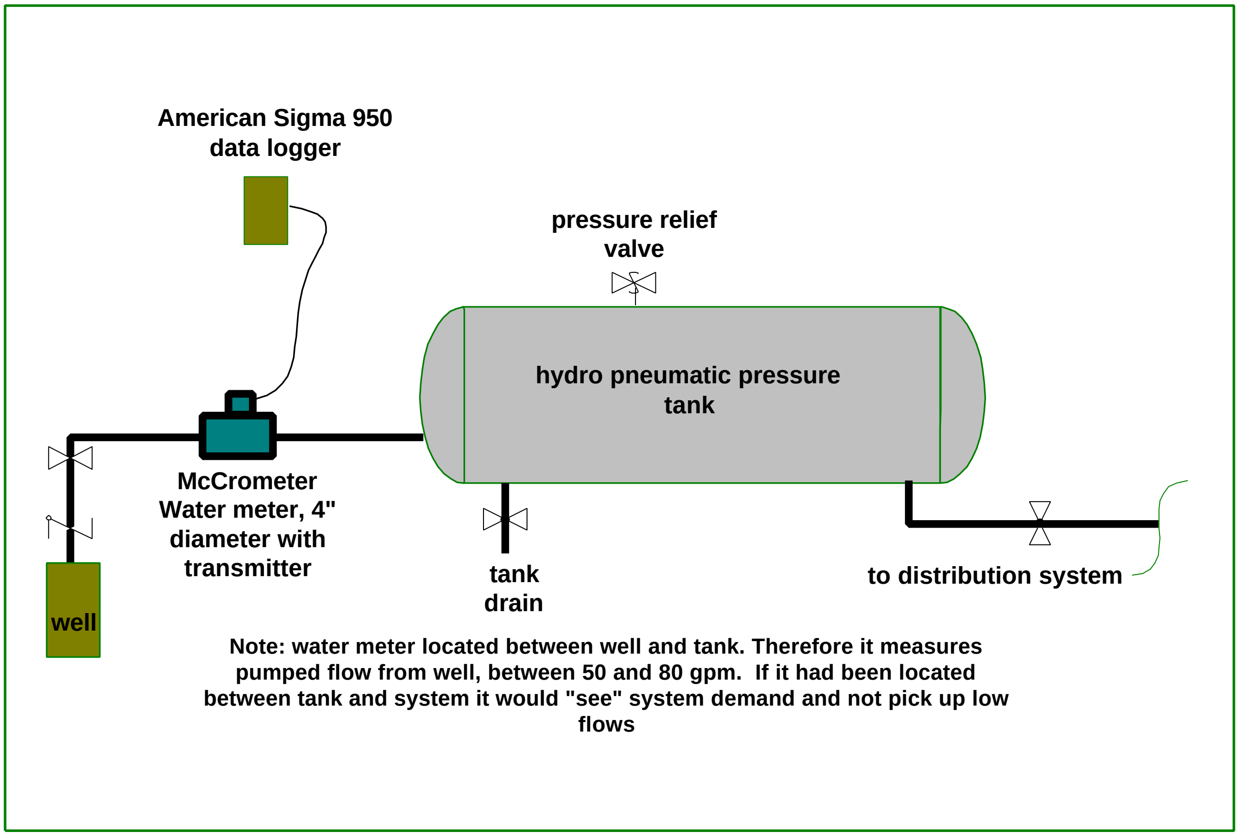

Figure 2

Flow monitoring and data logging setup

the pressure tank and the distribution system. This is because if the meter were installed between the pressure tank and distribution system it would "see" only the system demand which is very low or zero much of the time. Prior experience at Grand Prairie has shown that the meter may well miss the low flows, resulting in significant errors in daily volume. Installing the meter between the well and pressure tank means that the meter will see the well pump discharge when the well is on, which may be five minutes every hour or so. As shown in Figure 3, this produces a plot consisting of many spikes. In order to accurately obtain the total volume under the curve, the points used in the numerical integration procedure must be closely spaced. A comparison of total volumes computed using different time intervals indicated that a two minute logging interval was satisfactory. The logging interval dictates the quantity of data collected, which must be less than the storage capacity of the data logger. Based on a two minute logging interval, data was downloaded at all sites every two-weeks.

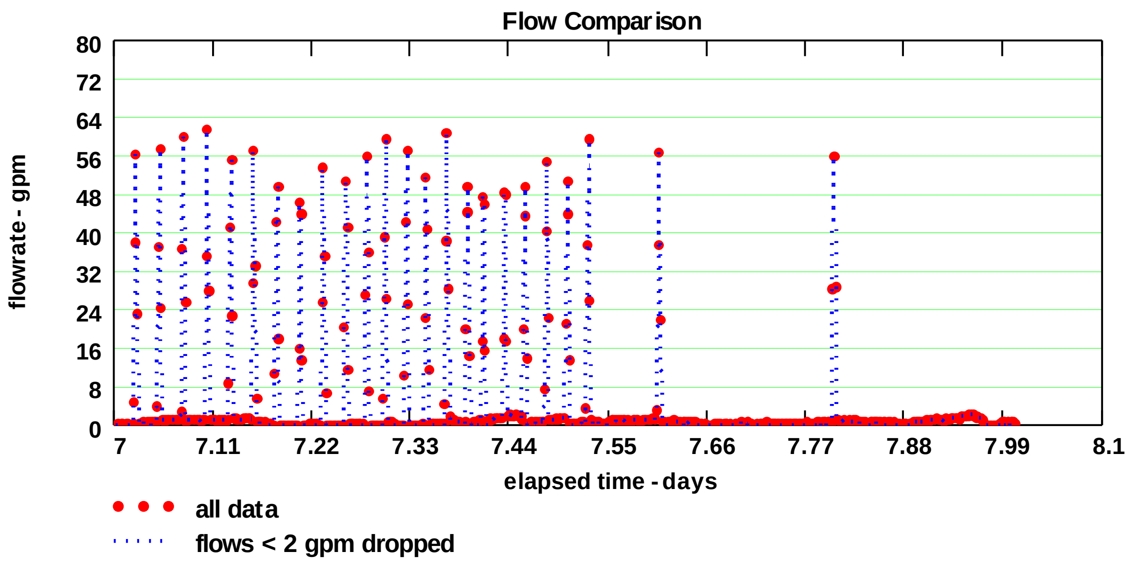

Figure 3

Flow rate from water well serving Kentwood visitors center

As a check on the accuracy of the numerical procedure the volume obtained by integrating the flow rate curve (above) was compared to the difference in sequential water meter readings taken each time the data was downloaded. The ratio was always very close to one at Kentwood. There was a period of time at the Pearl River site when the ratio fell to 0.7 as a result of using a water meter of incorrect size. These data were discarded.

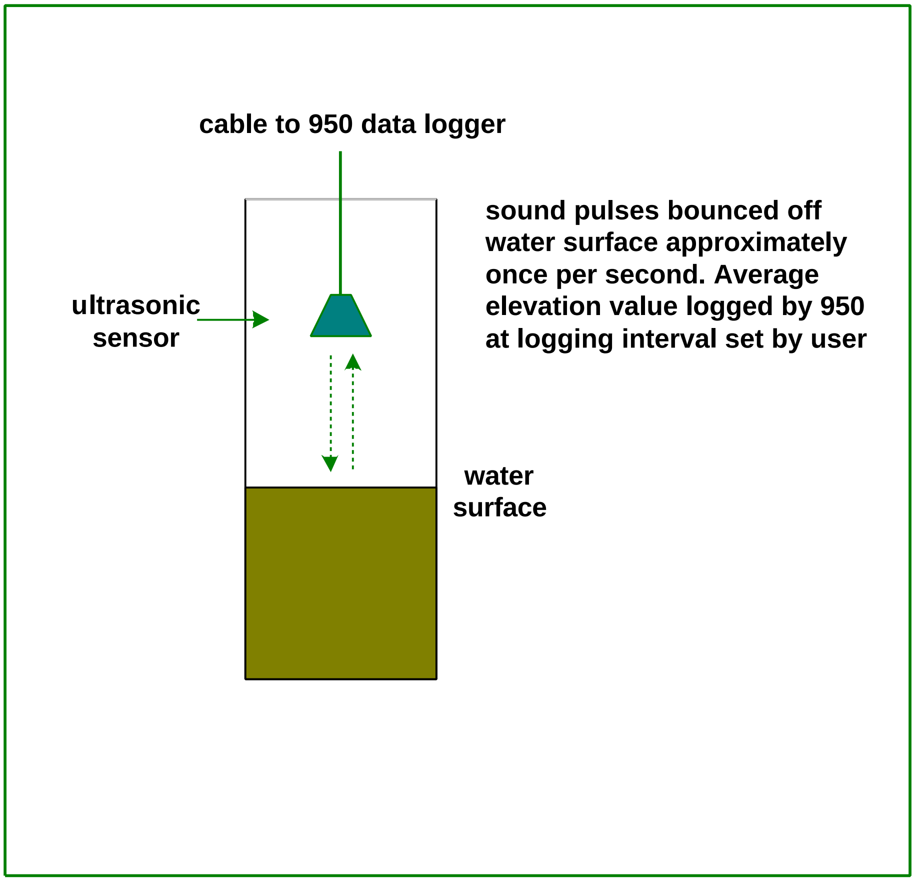

Figure 4

Schematic of ultrasonic sensor in wet well

Wastewater

The method of measuring waste flow used most prevalently in this project is illustrated in Figure 4. At all the sites studied, waste flowed by gravity to a pump station; an ultrasonic sensor was suspended in the wet well over the wastewater surface. The ultrasonic unit could be programmed to sense the liquid elevation and "track" it over time. Knowing the diameter of the wet well, the level data could be converted to daily flow volumes. The resulting output is shown in Figure 5. The wet well fills rather slowly, usually over one to two hours during the day and then is pumped out very rapidly. The vertical difference between pump cut on and cut off at the Kentwood pump station is about 18 inches.

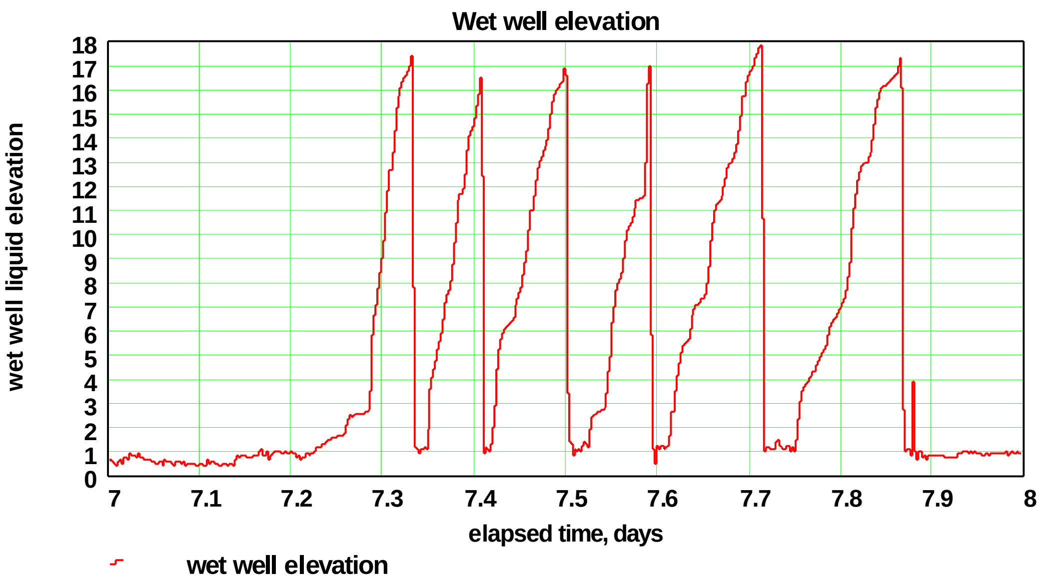

Figure 5

Output from ultrasonic sensor in wet well

Traffic

Traffic was monitored using "side firing radar" installations mounted on light poles near the entrance to or exit from the rest area. These could be aimed to count vehicles in each lane of the interstate as well as the deceleration lane into or the acceleration lane from the rest area. A schematic of the system used at Kentwood is shown in Figure 6. Data downloaded from the system consisted of hourly vehicle counts in each lane. This allowed for computation of the fraction of total vehicles which entered the rest area.

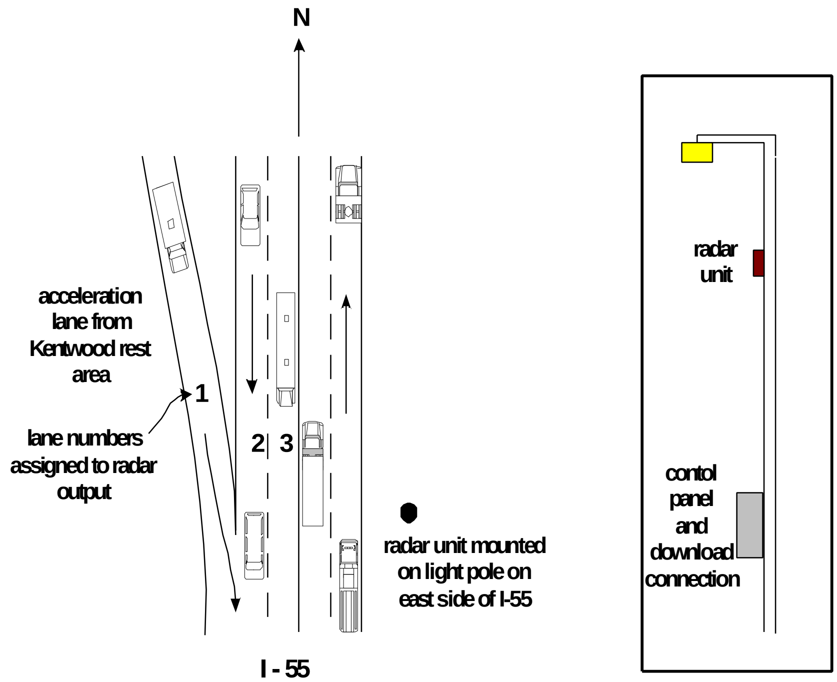

Figure 6

Traffic counting system used at Kentwood visitor center

Although not a part of this project, hourly traffic data of the type collected would be quite valuable in optimizing the hours of operation of the various visitor centers in the state. Table 2 summarizes the equipment and software used at each installation for measuring water usage, waste generation and counting vehicles.

Table 2
Description of water/wastewater flow meters, data loggers and traffic counters

	Mound	**Kentwood**	**Pearl River**	**Grand Prairie**
Water Meter	DCT 6088 transit time meter by Polysonics	McCrometer mechanical water meter with totalizer and internal transmitter	McCrometer mechanical water meter with totalizer and internal transmitter	McCrometer mechanical water meter with totalizer and internal transmitter
Data Logger for water flow meter	Internal to DCT 6088 meter	American Sigma 950 programmable data logger	American Sigma 950 programmable data logger	American Sigma 950 programmable data logger
Software for Downloading Water Data	Dlink version 1.16 from Polysonics	Insight version 4.2 from American Sigma	Insight version 4.2 from American Sigma	Insight version 4.2 from American Sigma
Wastewater measurement meter	Ultrasonic horn suspended in wet well (American Sigma)	Ultrasonic horn suspended in wet well (American Sigma)	Ultrasonic horn suspended in wet well (American Sigma)	(1/1/00~ 8/10/01) Transit time meter by Polysonics (8/10/01 – 3/1/02) ultrasonic horn suspended in wet well (American Sigma)
Software for Downloading Wastewater Data	Insight 4.2, American Sigma	Insight 4.2, American Sigma	Insight 4.2, American Sigma	PolyLink version 2.10, Dlink version 1.1.6, both by Polysonics Insight version 4.2 by American Sigma
Traffic Counter	Peek Traffic	Peek Traffic	Peek Traffic	Peek Traffic
Software for Downloading Traffic Data	TDP 3.20 TDP 3.32	TDP 3.20 TDP 3.32	TDP 3.20 TDP 3.32	TDP 3.20 TDP 3.32

DISCUSSION OF RESULTS

In this section selected results from the sites studied will be presented and discussed. Much of the results will be presented as probability plots or reference distributions. To paraphrase Berthouex and Brown *[5]*: A reference distribution is not based on properties of the data that may not be true. It is based on the data themselves, whatever their properties. If serial correlation or non-normality affects the data, it will be incorporated automatically into the reference distribution.

Traffic Data

Table 3 below is a summary of the mean and median traffic counts obtained at each site.

Table 3

Daily vehicle counts (total and rest area) at each site

	mean	median	observations
Grand Prairie	11619* 853**	11421 810	386 460
Kentwood	7046 620	6814 603	235 235
Pearl River	13588 333	13789 282	273 273
Mound	8534 1410	8686 1387	164 164

* Interstate traffic
**rest area traffic

It should be noted that although Pearl River has the highest mean and median counts on the Interstate (I-59), it has the lowest usage values. This is probably because the majority of the traffic is local in nature, going to the Slidell/New Orleans area to work. Figure 7 is a partial semi-log plot of the average daily traffic count on the south-bound lane of I-55 as well as those vehicles leaving the Kentwood visitor center.

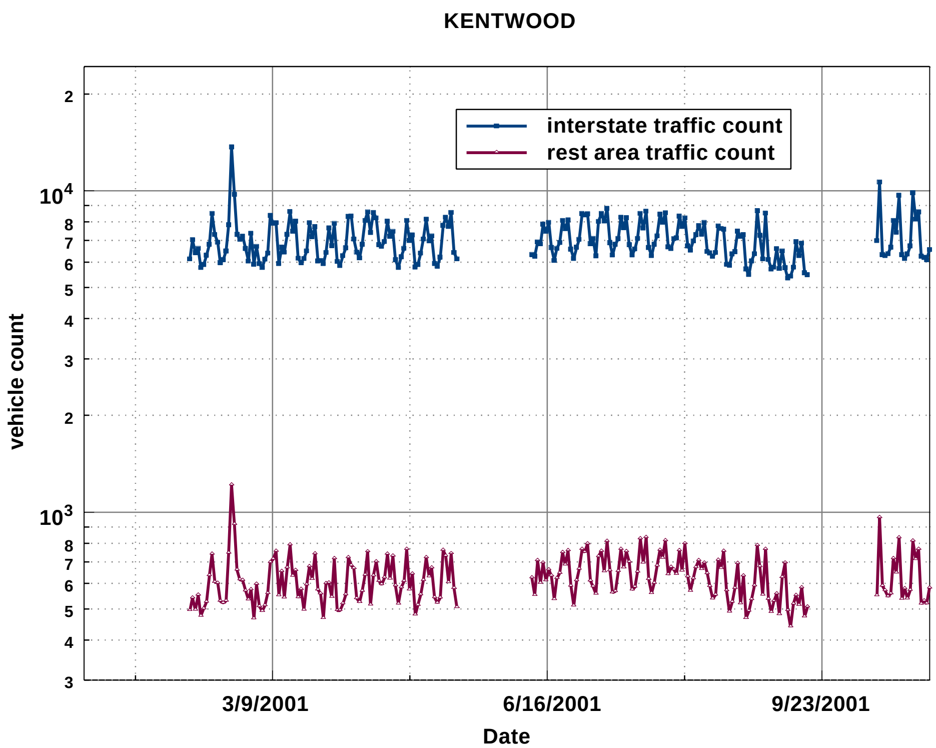

Figure 7

Traffic Counts on I-55 southbound lane and visitor center

Only a portion of the available data was plotted in order to show the seven-day cycle in the data. At Kentwood the highest traffic counts occur during the weekend. Figure 8 shows a similar plot for Pearl River. Interestingly, the Pearl River data show the same seven-day variation; however the highest traffic counts occur during the week while the lowest occurs over the weekend. This reinforces the theory that much of the Pearl River traffic occurring during the week is local in nature, probably Mississippi residents commuting to Slidell or the

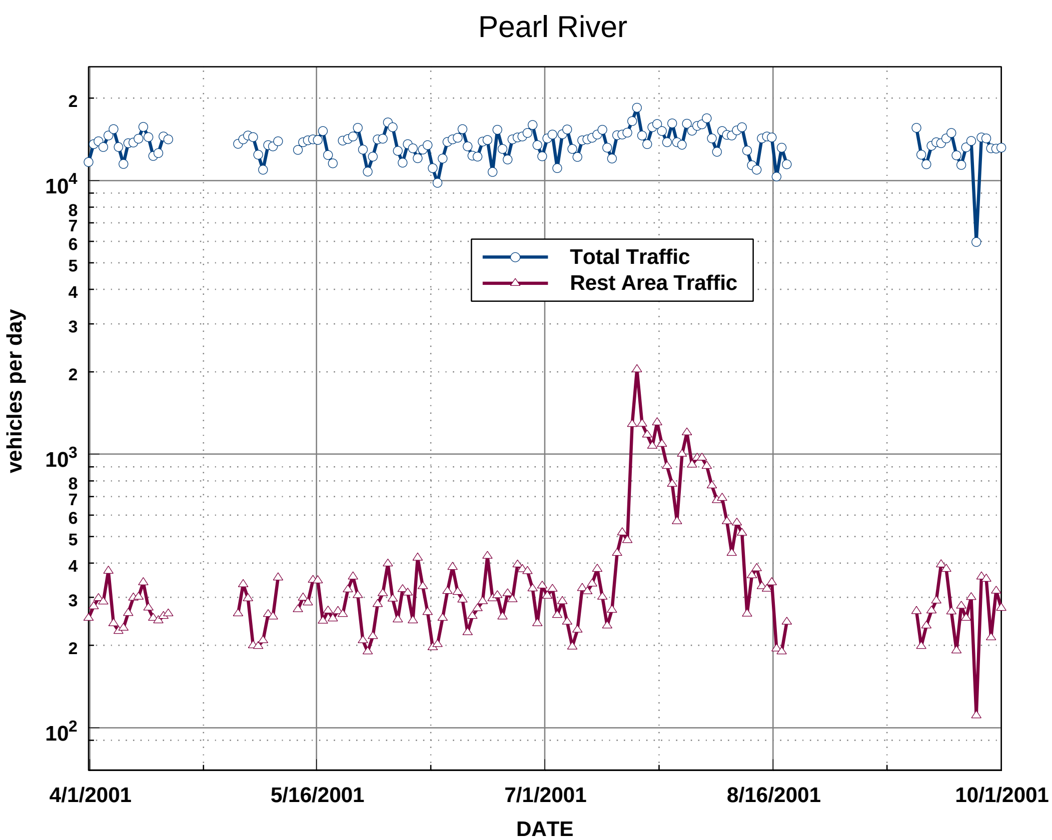

Figure 8

Traffic counts I-59 southbound and Pearl River visitor center

New Orleans area to work while much of the traffic at Kentwood is not local. This is reasonable since Kentwood is not located near a major population center.

Figure 9 shows a similar plot for the Grand Prairie Rest Area. The facility itself exhibits no pronounced cycle, however, the traffic counts on I-49 exhibit a seven day cycle with the highest counts occurring during and just before the weekend and the lowest during the week. The lack of a pronounced cycle is probably due to the fact that a single facility serves both the north and southbound lanes.

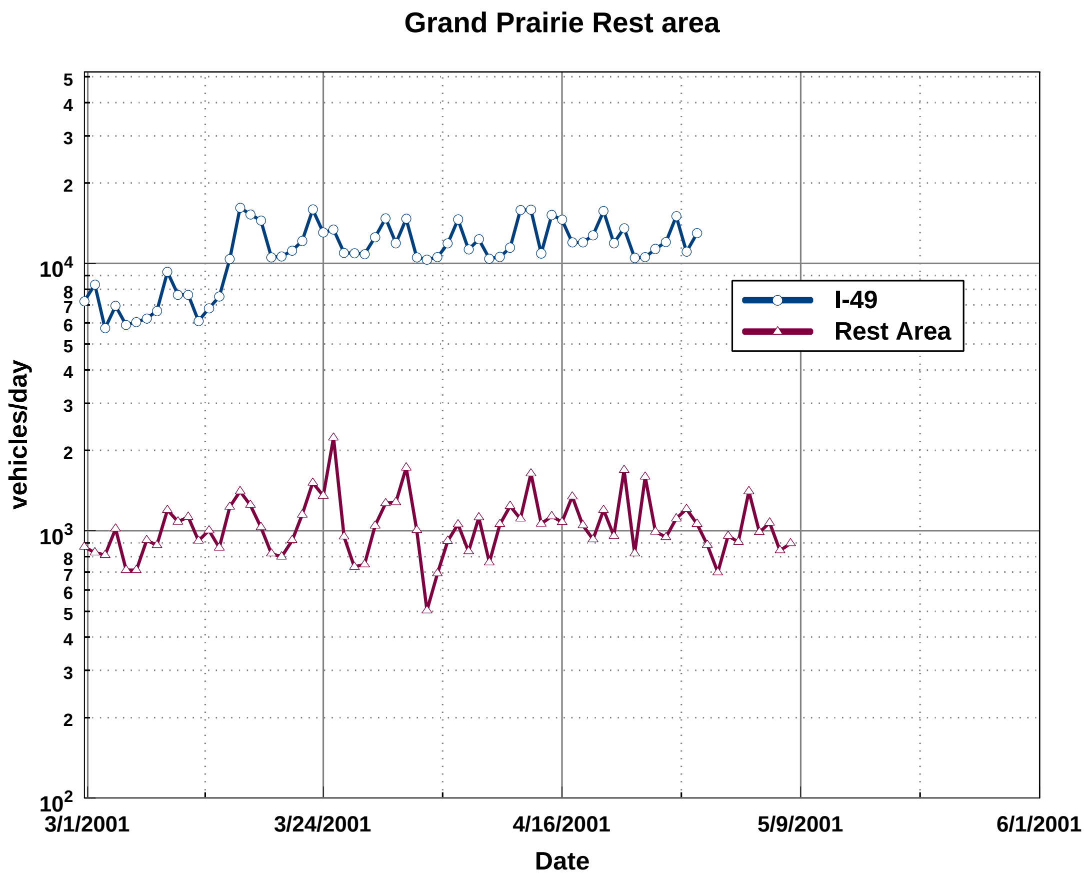

Figure 9

Traffic counts on I-49 and Grand Prairie rest area

Figure 10 shows probability plots for the percentage of vehicles stopping at Pearl River, Kentwood, Grand Prairie, and Mound. From these plots one may conclude that, based on the data collected, 90% of the time the percentage of vehicles stopping at the Kentwood visitor center will be less than 9.55% while at Pearl River this value is 2.57%, at Grand Prairie 12.45%, and at Mound 19.36%. These results conform somewhat to the literature which indicates that rest areas in proximity to population centers have a lower percentage of vehicles stopping than those in rural areas. In general, one must conclude that there is little similarity in daily traffic patterns or the percentage of vehicles stopping at these four sites. Therefore, extrapolation of data from one site to another should be done carefully.

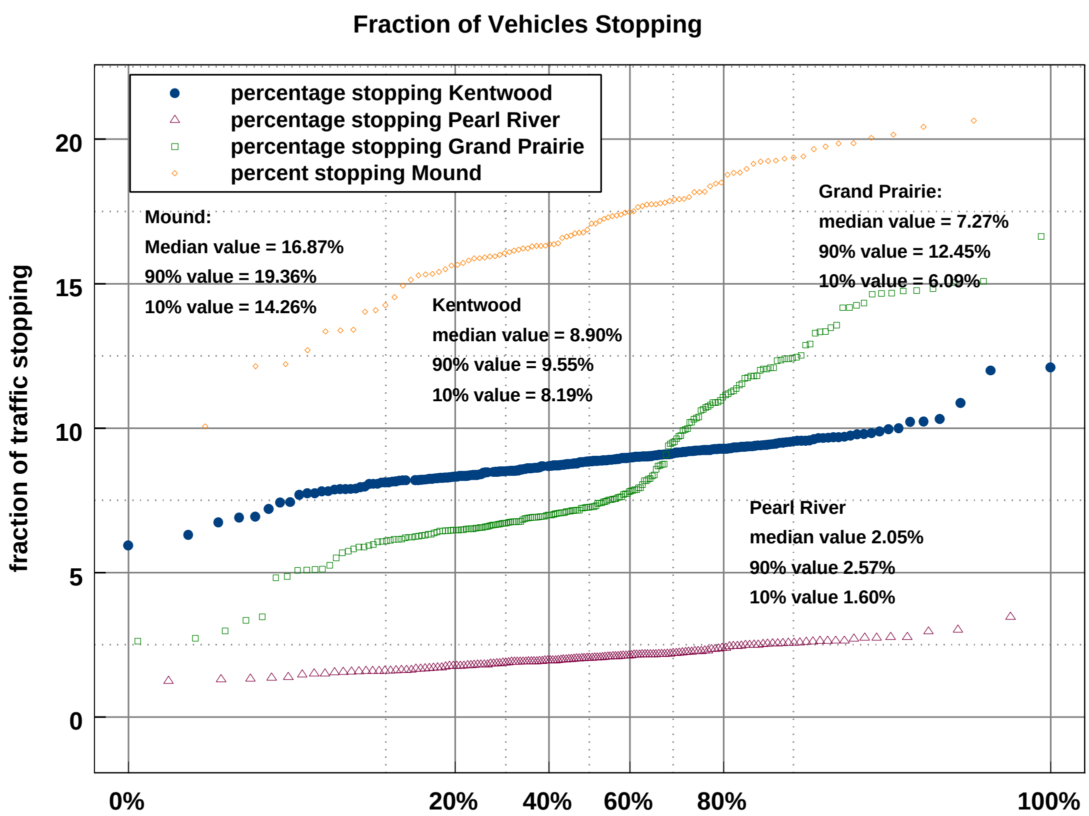

Figure 10

Probability plots of percentage of vehicles stopping

Figure 11 shows probability plots of waste generated per vehicle for Kentwood, Pearl River, and Grand Prairie. A similar plot could not be constructed for Mound because it was not possible to count the vehicles entering both the eastbound and westbound facility. Median

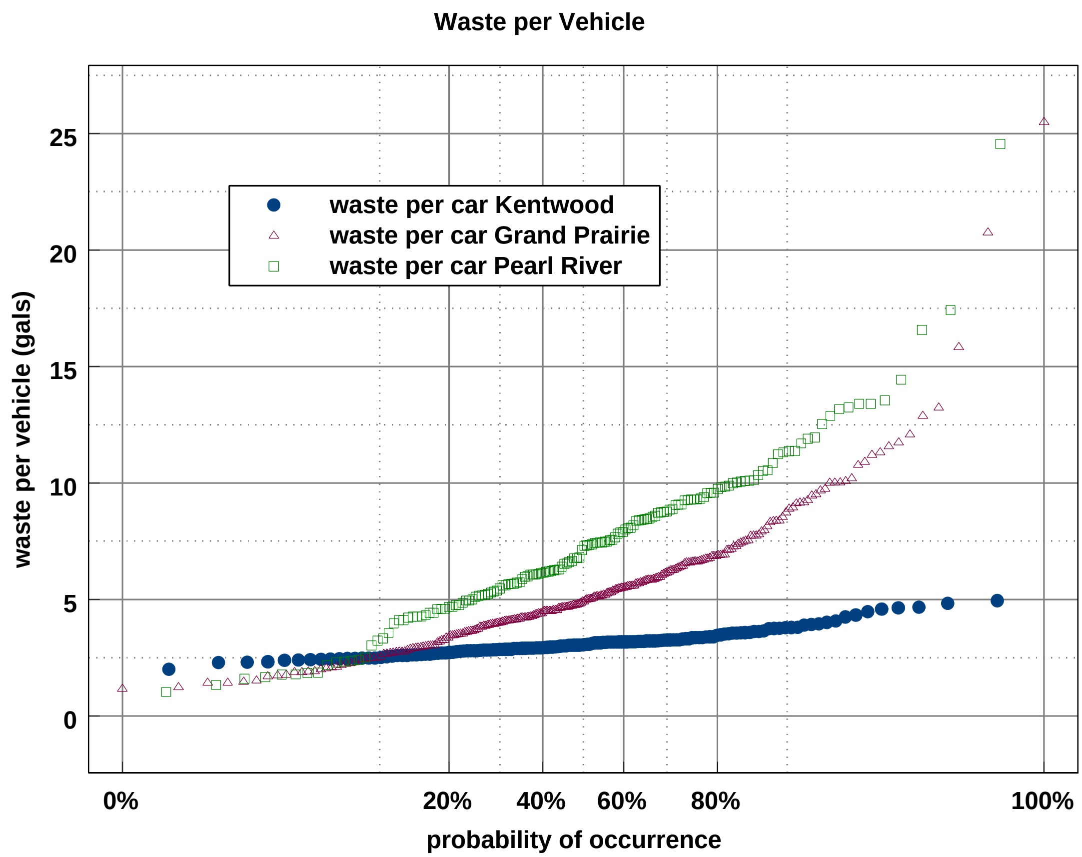

Figure 11

Probability plots – waste per vehicle

values range from 3 gallons/vehicle at Kentwood to 7.3 gallons/vehicle at Pearl River. As shown in the figure, expected flow values for each site diverge as the probability level increases. These results have practical significance for the design of mechanical waste treatment facilities. Most biological processes are designed using average or median flow. However, clarifiers are often designed for less frequent flows since they are physical processes and are sensitive to hydraulic overloads. Based on these results and using the 90% level, the spread in required clarifier size between these facilities is nearly a factor of three: 3.8 gallons/vehicle at Kentwood to 11.3 gallons/vehicle at Pearl River. Once again, extrapolation of data collected at a single rest area facility could lead to serious design flaws. Figure 12 shows probability plots for water use per vehicle at each site. Pearl River exhibits the highest median usage at 9.1 gallons/vehicle while Mound (data questionable) has the lowest at 1.91 gallons/vehicle. The variation in usage between the sites increases with flow rate.

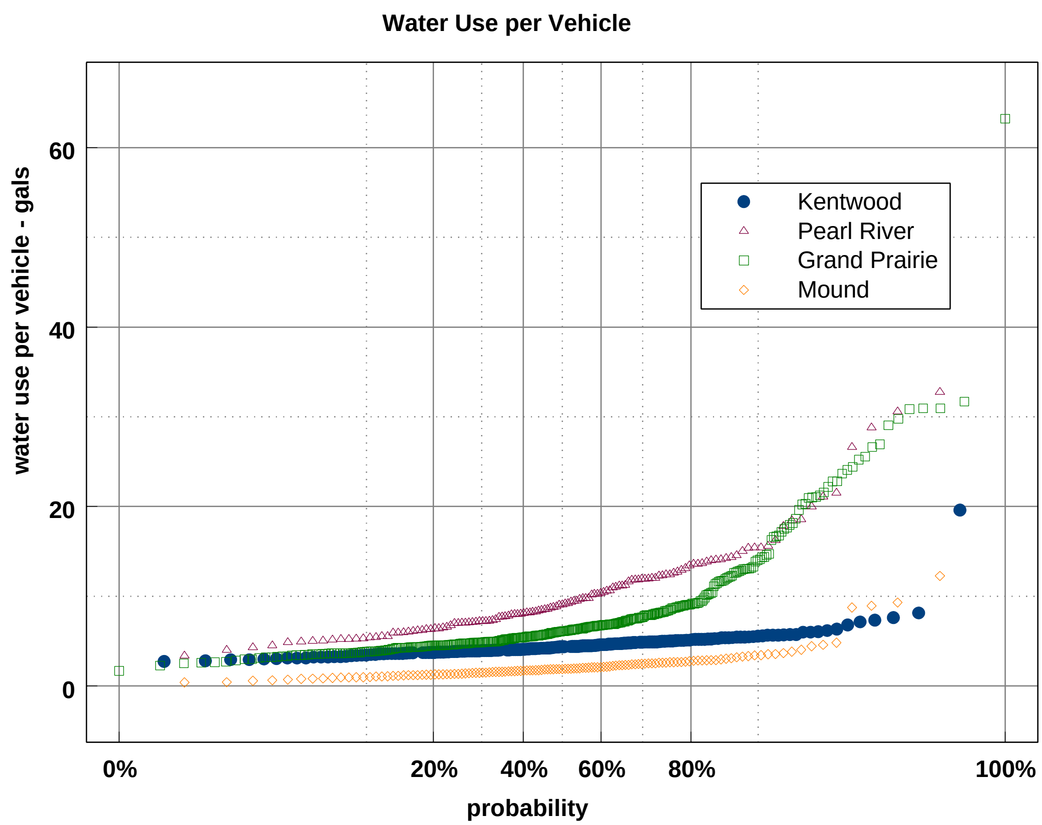

Figure 12

Probability plots – water use per vehicle

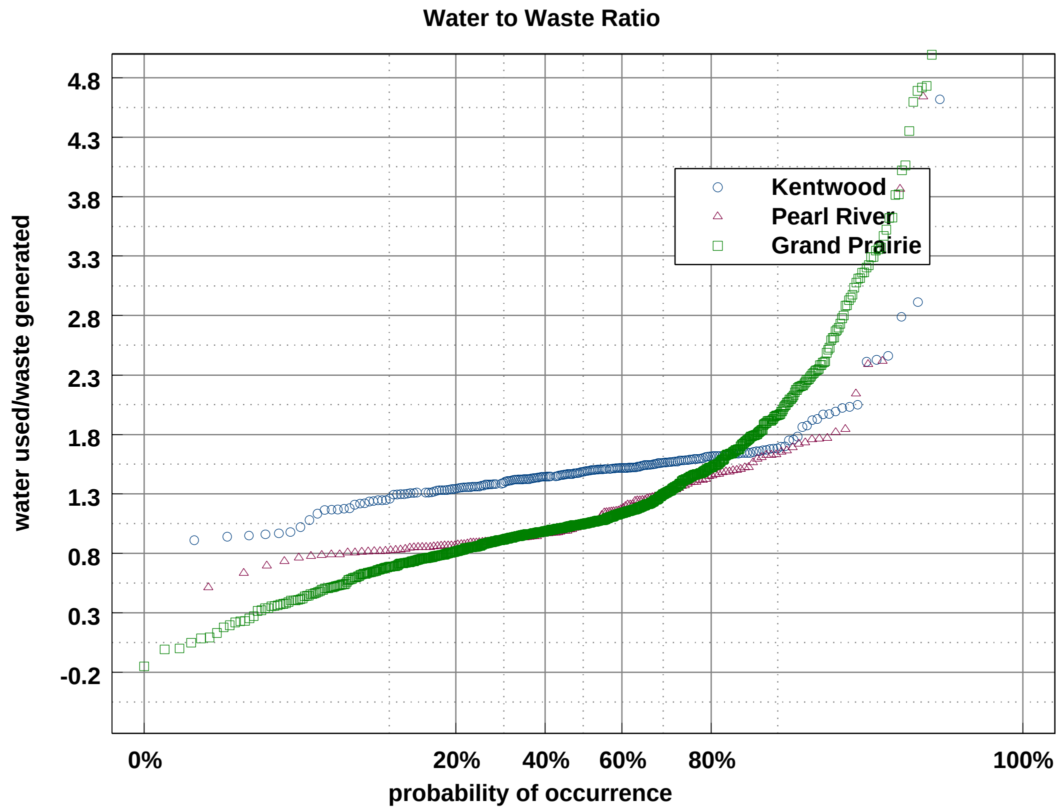

Figure 13

Water to waste ratio

Figure 13 shows that the median daily ratio of water used to waste generated, is very close to one at both Pearl River and Grand Prairie and slightly higher than one at Kentwood. This is quite significant from a practical standpoint because it suggests that water use measurement is a reasonable surrogate for measurement of waste flow. Water measurement is easier and in most cases more accurate than measuring waste flow. Water systems are pressurized (full pipe flow) thus avoiding the difficulties of partially full pipes common in waste collection systems, which are often gravity flow.

Table 4: Results summary

	Kentwood	Pearl River	Grand Prairie	Mound
Stop at Rest Area (%)				
10%	8.2	1.60	4.81	14.00
Mean	8.81	2.06	7.82	20.00
Median	8.90	2.05	7.64	17.00
90%	9.60	2.57	11.07	19.40
Water/Waste				
10%	1.25	.83	0.69	N/A
Mean	1.54	1.28	1.36	N/A
Median	1.50	1.05	1.10	N/A
90%	1.70	1.63	1.99	N/A
Water/Car				
10%	3.43	5.40	3.81	N/A
Mean	4.53	9.30	7.67	N/A
Median	4.36	9.20	6.12	N/A
90%	5.58	15.42	13.85	N/A
Waste/Car				
10%	2.51	3.23	2.49	N/A
Mean	3.12	6.63	5.42	N/A
Median	3.05	7.11	4.92	N/A
90%	3.78	11.32	8.90	N/A

A summary table of the results discussed above is presented above. The data from the Pearl River facility exhibits substantially different characteristics from the other sites and deserves some explanation. First, recall that Pearl River has the highest interstate traffic count but the lowest rest area traffic count of any of the sites. The explanation provided for this is that most of the traffic on I-59 at this location is local and thus would not normally stop at a visitor center. However, the water use per vehicle and waste generated per vehicle at Pearl River are substantially higher than at the other sites. This can be explained by hypothesizing that total water use at **any** visitor center/rest area can be divided into two basic categories: (1) that portion produced by traffic using the facility and (2) that portion required for activities that are essentially independent of incoming traffic such as cleaning and watering grass and flowers. In this study these two categories could not be separately measured. Traffic-independent water uses will affect the per vehicle values at any site, if the facility has a very low traffic count, as at Pearl River, then the traffic independent water uses substantially inflate the per vehicle figures. At the other end of the spectrum, Mound has the highest percentage (and number) of cars stopping and the lowest water use per vehicle. While the per-vehicle values can be large or small, the values obtained can still be used for design since the product of vehicle count times the per vehicle contribution gives the correct daily volume. Any water system must still be designed to supply the water used and any waste treatment system must still treat the waste coming to it, regardless of the activities generating the flows.

With respect to waste treatment using mechanical package plants, these results provide some guidance in terms of the flow rates used for design. The biological portion (aeration basin) of an activated sludge process can usually be designed using the mean or median flow rate. However, clarification is a physical process which is quite sensitive to both high and low hydraulic loadings. These results suggest that the range of daily flows can be substantial. If so, the clarifiers in mechanical plants should be designed for higher, less frequent flows to prevent upsets. It should be noted that waste treatment systems, such as the septic tank-rock filter system used at Grand Prairie are largely immune to the problems.

Finally, the data presented herein illustrate plainly that use of water, wastewater, and traffic data collected at one facility to design systems at another is done with some risk. The facilities studied here, while possessing a few overall similarities, differed greatly in terms of traffic patterns, water use and waste generation rates.

CONCLUSIONS

1. The mean and median water to waste ratio measured at Pearl River, Grand Prairie and Kentwood were all very close to one (Grand Prairie, Pearl River) or slightly greater than one (Kentwood). This suggests that water measurement could be a surrogate for waste measurement. This has practical and beneficial consequences. In the simplest case, daily water use can be obtained from sequential readings of a mechanical water meter at an on-site well or the water line from the supplying municipality. Measuring water flow may be safer (from a disease standpoint) than the risk of contacting wastewater, and meters can be read by LADOTD personnel with little technical expertise (as is done at Grand Prairie).

2. The sites studied exhibited widely varying traffic counts and traffic patterns. These variations appear to be primarily a function of the location of the facility as well as its specific characteristics, i.e. one facility serving both sides of the interstate, as at Grand Prairie. Knowledge of such variations could be useful to LADOTD and other agencies such as the Department of Tourism. Data collected during this study, or similar studies in the future, can be analyzed to provide information regarding optimal (cost effective) times of operation for visitor centers as well as for sizing water supply and waste treatment systems.

3. Median values of water/vehicle and waste/vehicle varied by a factor of 2 to 3, corresponding 90 percentile values varied by a factor of 3 to 4. This suggests that extrapolation of such values between facilities for design purposes is risky.

4. It is quite easy to monitor and download large quantities of accurate data (traffic, waste flow, water) collected at very short time intervals over long time spans. Such data could be useful to LADOTD as well as other state agencies in addressing technical, economic, and political questions.

RECOMMENDATIONS

LADOTD should pursue the possibility of using water measurements at LADOTD visitor centers and rest areas as a surrogate for wastewater measurements meet wastewater discharge permits issued by the Louisiana Department of Environmental Quality Such a request is supported by the fact that the water to waste ratio is close to one at all sites studied.

Other agencies responsible for the operation of visitor centers should consider the use of side firing radar installations to obtain the necessary data for optimizing center operation.

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