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EXECUTIVE SUMMARY
2001 ROADSIDE LITTER CHARACTERIZATION STUDY

Keep Iowa Beautiful (KIB) developed a statewide comprehensive program for litter assessment in 2001. Components of this program included the determination of "benchmark information" including the 2001 Roadside Litter Characterization Study. During the spring of 2001, **BARKER LEMAR ENGINEERING CONSULTANTS (BARKER LEMAR)** was selected to perform the 2001 Roadside Litter Characterization Study at 150 sites and develop an Internet based Geographic Information System (GIS) for KIB. The total budget was $120,700.

BARKER LEMAR'S Internet based GIS website site and related statistical software programming is located at **www.internetgis.org/kib** or via a link at **keepiowabeautiful.com**.

Roadside Site Selection, GIS Development, and Litter Collection Methodology

BARKER LEMAR and KIB stakeholders developed a strategy to stratify and weigh the roadside sites according to the population of urban and rural areas, further dividing urban roadside sites according to average daily vehicle count (traffic volume).

During the fieldwork, staff attempted to collect every piece of visible litter greater than 1/2-inch square including cigarette filters and butts. Sites were generally 200 feet long and did not exceed 40 feet wide.

Data Analysis: Classifying Litter, Identifying Name Brands, and Performing Statistical Analysis

Litter was sorted into several pre-approved classifications with a special emphasis on beverage containers and the deposit designation of the containers. Weight (in grams), area (in square inches), and number of pieces were recorded for each subcategory.

22,585 pieces of litter were collected over a total of 627,998 square feet (or 1 piece of litter every 28 square feet).

Cigar/Cigarette Packaging

Lottery Related

An Example of Litter from a Low Volume Site

An Example of Litter from a High Volume Site

Litter classification included a name brand identification phase, area estimation phase, litter count phase, and litter weight phases for the represented subcategories within each of the 150 roadside sites.

The litter subcategories with the greatest amount of litter were:

- Cigar/Cigarette Filters and Butts - 7,620 pieces
- Candy and Snack Packaging - 1,212 pieces
- Plastic and Paper Cups - 206 and 217 pieces
- Beer and Soda Containers - 174 and 188 pieces

Staff identified every piece of litter by its name brand whenever possible. Leading name brands within key subcategories were:

- Marlboro - Cigar/Cigarette Filters and Butts
- Snickers - Candy & Snack Packaging
- Bud Light - Beer Containers
- Mountain Dew - Soda Containers
- McDonalds - Plastic & Paper Cups

Statistical Analysis of Variables Including Traffic Volume, County Population, Median County Age, Litter Pieces, Litter Area, and Weight.

Another key component of this research was the statistical analysis of the many available variables. The variables selected for this study included: County Population, Median County Age, Litter Pieces, Litter Weight, Litter Area, and Average Annual Daily Traffic Volume (AADTV) data received from the Iowa Department of Transportation.

BARKER LEMAR wrote two statistical analysis packages for KIB that are available over the Internet. The Multiple Regression Analysis Package allows a researcher to select key variables and a range of data within each variable using a "Where Clause" (binocular icon). The Where Clause allows users to select data ranges such as, "equal to", "greater than/less than", and "between". A researcher can then process the available data to return with R^2. R^2 shows a researcher how much of the variability is explained by the variables. An R^2 close to 1.0 suggests that most of the variability of the test was explained by the selected variables.

The Single Regression Analysis Package compares one X variable and one Y variable. This package also allows users to select Subcategories, and a "Where Clause".

The highest simple correlation coefficients were identified for traffic volume and county population. These results are consistent with other linear regression correlation studies researching litter. *An r-value of .20 shows that (80% of the variability is not accounted for via traffic count (r-values closest to 1.0 determine that all variability is accounted for).*

Using the Single Regression package, *r*-values for Cigar/Cigarette Filter and Butts were calculated using various traffic volume ranges. A traffic range between 1000 and 9,071 generated an r-value of .695 (30 graphed points) at a 95% confidence level.

The *r*-values for Candy and Snack Packaging were also calculated using various traffic volume ranges. However, a strong regression correlation was not identified between this litter subcategory and traffic volume.

Beer containers illustrate a weak negative correlation as traffic volume increase from 20,000 to 115,000 vehicles *(r equals* -.262, 23 graphed points). Soda containers illustrate a slightly stronger positive correlation as traffic volume increase from 20,000 *(r equals* -.362, 33 graphed points). A negative, weak correlation was identified for Candy and Snack Packaging as the median age increases *(r equals* -.265, 102 graphed points).

As age increases Beer, Soda and Candy/Snack packaging all show a weak negative simple correlation coefficient *(e.g. r equals* .265 with 102 points for Candy/Snack Packaging). Consequently, age may be having a positive affect on the amount of litter on Iowa's roadways.

Concluding Remarks

BARKER LEMAR staff would like to thank the KIB Review Group that assisted with the development of the 2001 Roadside Litter Characterization Study.

- Keep Iowa Beautiful
- The Iowa Dept. of Natural Resources
- The Iowa Department of Transportation
- Carroll Co. Solid Waste Management Commission
- Iowa Recycling Association
- Story County Engineer's Office
- Iowa League of Cities
- Iowa Beverage Systems, Inc.
- Iowa Wholesale Beer Dist. Assoc.
- Iowa Grocery Industry Assoc.
- Casey's General Stores, Inc.
- Iowa Farm Bureau Federation
- Iowa Assoc. of Co. Conservation Boards

The authors would like to personally thank Field Staff for their enthusiasm and professionalism during the collection and classifying phases. The authors would also like to thank the IT staff that listened to ideas and then transformed those ideas into working databases, reports, Internet compatible programs, statistical programs, and various other technical pieces.

FINAL REPORT
2001 ROADSIDE LITTER CHARACTERIZATION STUDY

I. PURPOSE

Litter continues to be a major issue for both the environmental and business community. The need to better understand and obtain objective information useable by a wide audience is essential; consequently, Keep Iowa Beautiful (KIB) developed a statewide comprehensive program for litter assessment in 2001.

Components of this program included:

- Determining "benchmark information" to evaluate whether KIB has had any impact on litter reduction and beautification improvements. Benchmark data includes the 2001 Roadside Litter Characterization Study.
- Developing a state-of-the-art Internet based Geographic Information System (GIS) that uses the Internet to efficiently communicate the various components of the roadside litter characteristic study.
- Using survey data and roadside litter characteristic data to develop a detailed and effective education and public awareness program(s).

KIB retained **BARKER LEMAR ENGINEERING CONSULTANTS (BARKER LEMAR)** to perform the 2001 Roadside Litter Characterization Study and develop the Internet based GIS. **BARKER LEMAR** and KIB stakeholders met several times during the summer of 2001 to discuss the study's methodology.

II. PLANNING AND RESEARCH

A. Budget

The approved budget for this project included $80,000 for the roadside litter survey and $40,700 for the optional GIS/Internet site, for a total project cost of $120,700. The 2001 Roadside Litter Characteristic Study included five primary components, including:

- Performing a literature review of other roadside litter studies;
- Conducting roadside collection of litter at 150 roadside sites;
- Counting and measuring collected litter in the lab;
- Writing the final report, and;
- Presenting the survey findings.

The GIS/Internet work included development of database programming, construction of customized forms and reports, and development of the primary Iowa map and 99 county maps. **BARKER LEMAR** collected and incorporated the following data into the Internet/GIS site:

- City and county boundaries;
- Road data;
- Roadside litter collection sites;
- Landfills and transfer stations;
- Iowa Department of Transportation (IDOT) road segment data (traffic count and traffic type);
- Roadside litter characterization data including pictures;
- State lands and waterways;
- 2000 US Census Bureau data;
- Schools;
- Solid waste planning areas, and;
- IDNR Field Office zones.

B. Review of Other Litter Studies, Reports, and Related Methodologies

Litter characterization reports reviewed by **BARKER LEMAR** staff for the 2001 Roadside Litter Characterization Study included:

- *Nebraska Litter 1980. A Baseline Survey of Street, Roadside and Recreation Area Litter*.
- *Nebraska Litter 1982. A Baseline Survey for the NE Dept. of Env. Quality*.
- *Nebraska Litter 1985. A Survey of Litter Reduction Trends Since 1980*.
- *Nebraska Litter 1991. A Baseline Survey for the NE Dept. of Env. Quality*.
- *Nebraska Litter 1996.*
- *The Florida Litter Study*: 1994.
- *The Florida Litter Study: 1996*, Report #S97-1.
- *The Florida Litter Study: 1997*, Report #S97-14.
- *The Florida Litter Study. Interim Report.* January 13, 1999.

- *The 1998 Update: Oklahoma Visual Litter Survey and Analysis*.

Staff also reviewed the following reports and summaries from the Institute for Applied Research:

- *Problems with Full Scale Survey*, February 6, 1997.
- *Analysis of Variables Affecting Litter Rates*, Preliminary Draft January 1988.
- *Summary of Litter Research Findings*, S-1 rev 1995.
- *Litter Rate Ranking of States and Provinces Surveyed*, Report S-11.
- *Summary of Visible Litter Composition*, Rev 8/31/99.
- *Using Observations of Persons Littering To Target Advertising, Excerpt S-7.5 From PA99 Final Report.*
- *Summary of Litter Results from Institute Surveys*, Excerpt S-15.1; Rev 1998.
- *Summary of Litter Research Findings,* S-1 Rev 1995.
- *Summary of Visible Litter Compositio*n, Rev 8/31/99.
- *Summary of Problems Encountered in Litter Surveys,* Summary S-13; February 5, 1997. *Litter Control Program Options,* S-4.6, Rev 7/28/98.
- *The Pros and Cons of Various Methods of Litter Measurement*, Report S-9.4, Revised April, 1998.
- A*nalysis of Variables Affecting Litter Rates.* S-8.16, Preliminary Draft Jan. 1988.

C. Developing Litter Collection Criteria

After reviewing previous litter studies, staff provided a summary of possible litter collection criteria to the KIB stakeholders including the pros and cons of each criterion.

During the planning meetings, KIB stakeholders expressed an interest in collecting cigarette litter data. Stakeholders and staff thought cigarette related litter was "under-measured' by previous studies due to the litter size criteria of these studies. A recommendation was made, and accepted, that **BARKER LEMAR** Field Crews collect litter if it was 1/2 square inch or larger. The 1/2 square inch criterion included most cigarette filters, filter material, and butts.

Litter would only be collected if it lied within the boundaries of the delineated roadside site.

D. Developing Preliminary Site Classification Criteria

After reading previous roadside litter studies and discussing the capabilities of the GIS programming, **BARKER LEMAR** developed and presented ideas to the KIB stakeholders for selecting roadside collection locations, including:

- Proximity to schools;
- Stratification of the population into rural and urban sites;
- Proximity to state lands/parks/recreation areas;
- Proximity to stadiums, ballparks, rodeos, and other event venues;
- Proximity to landfills and transfer stations;

- Stratification of road types - paved, not paved, number of lanes, number of commercial, industrial, and recreational access points, etc.;
- State solid waste planning areas;
- Average annual daily traffic count - cars, trucks, semi trucks;
- Speed limit;
- The number of traffic signals and intersections;
- Median width;
- Proximity to exits, rest areas, and adopt-a-highway sites, and;
- Demographic data such as age, income, and education.

III. SITE SELECTION METHODOLOGY

A. Definitions

Random Sampling
Random sampling generates equal probabilities for each unit to be selected.

Stratify
Stratify means to divide or arrange in classes. A separate random sample is selected from each class.

Weigh
To weigh a sample means to give equal weight or consideration to a variable.

B. Site Selection Criteria

Before the KIB site selection meetings, **BARKER LEMAR** attained IDOT road data that, once applied to the preliminary KIB Internet/GIS program, provided the ability of programmers to select roadside sites based on almost one hundred road variables. **BARKER LEMAR** then began to layer the IDOT road data with other data including IDOT center line road data, demographic data from the US Census Bureau, the location of permitted sanitary disposal projects (landfills, transfer stations, etc.), rivers and waterways, railroads, schools, IDNR owned lands, and data describing incorporated places. This preliminary work was provided to assist the stakeholders develop site selection criteria.

During the KIB stakeholder meetings site selection criteria was discussed with **BARKER LEMAR** moderating the discussions. **BARKER LEMAR** staff provided background information from other roadside studies, provided examples of data currently and potentially available, and reviewed possible random selection processes.

KIB stakeholders continually asked two important questions while determining site selection criteria, these were:

- How are the site selection criteria going to influence KIB's ability to change littering behavior through education and marketing efforts?

- How well will the selection process represent the entire state?

KIB stakeholders identified key parameters affecting site selection, they were:

- The entire State must be represented equally;
- The selection of roadside sites must attempt to minimize bias, and;
- The sites should be selected randomly.

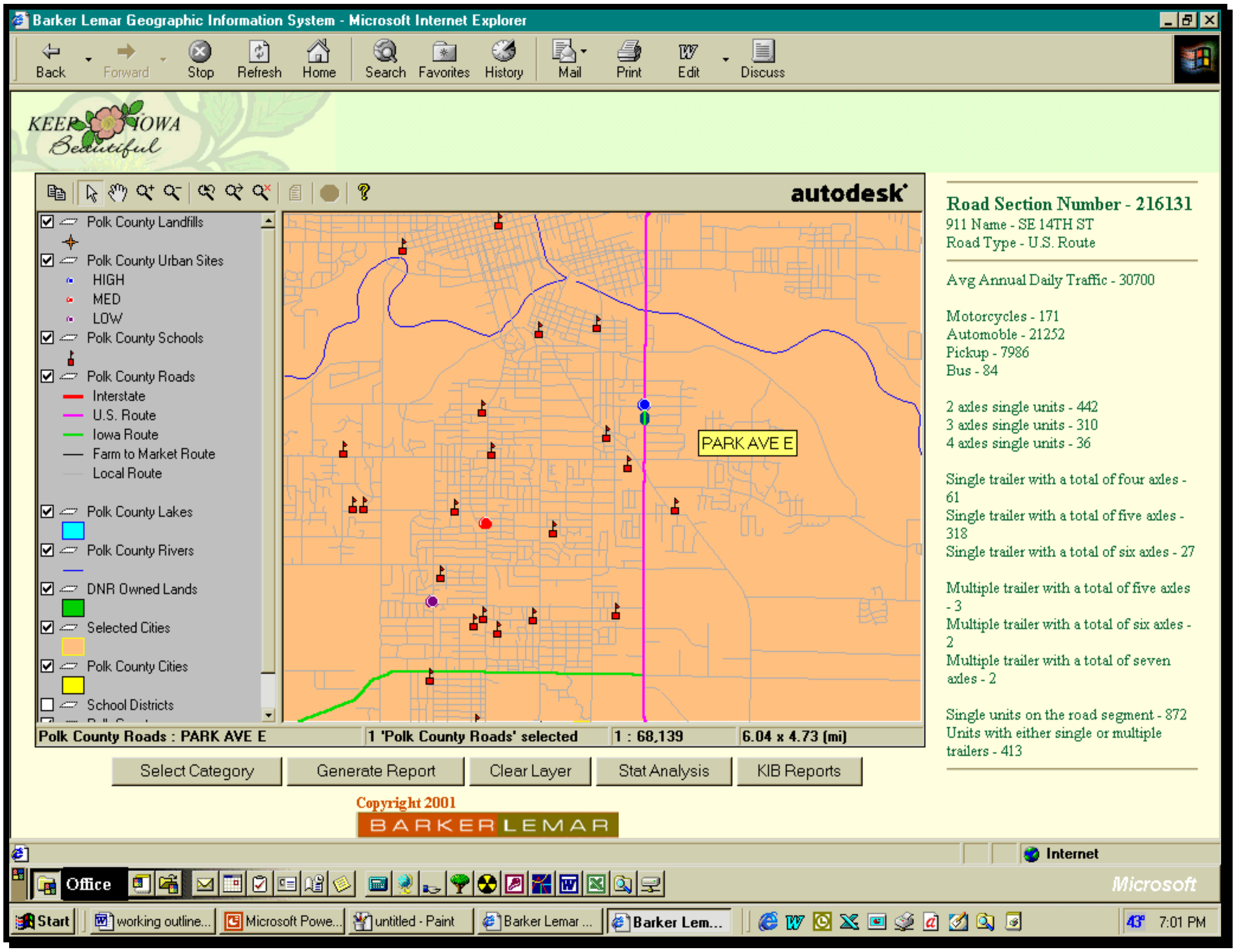
Additional considerations in site selection involved access to data at a state level, preferably access to state level data in an electronic format.

1. Selecting Primary Stratification Systems for the Study

As the site selection discussion progressed, two distinct systems for site selection materialized.

First, the KIB stakeholders asked that the state to be divided into rural and urban areas. The Stakeholders then determined that urban areas should be further divided into categories based on population.

Second, the KIB stakeholders developed another tier of classifying urban sites. This stratification system involved selecting roadside litter collection sites based on IDOT average daily vehicle counts (traffic volume).



Screen shot showing IDOT road segment data and the ability to "mouse-over" and identify geographic features, including roads, railroads, rivers, bodies of water, landfills, schools and universities, and public lands.

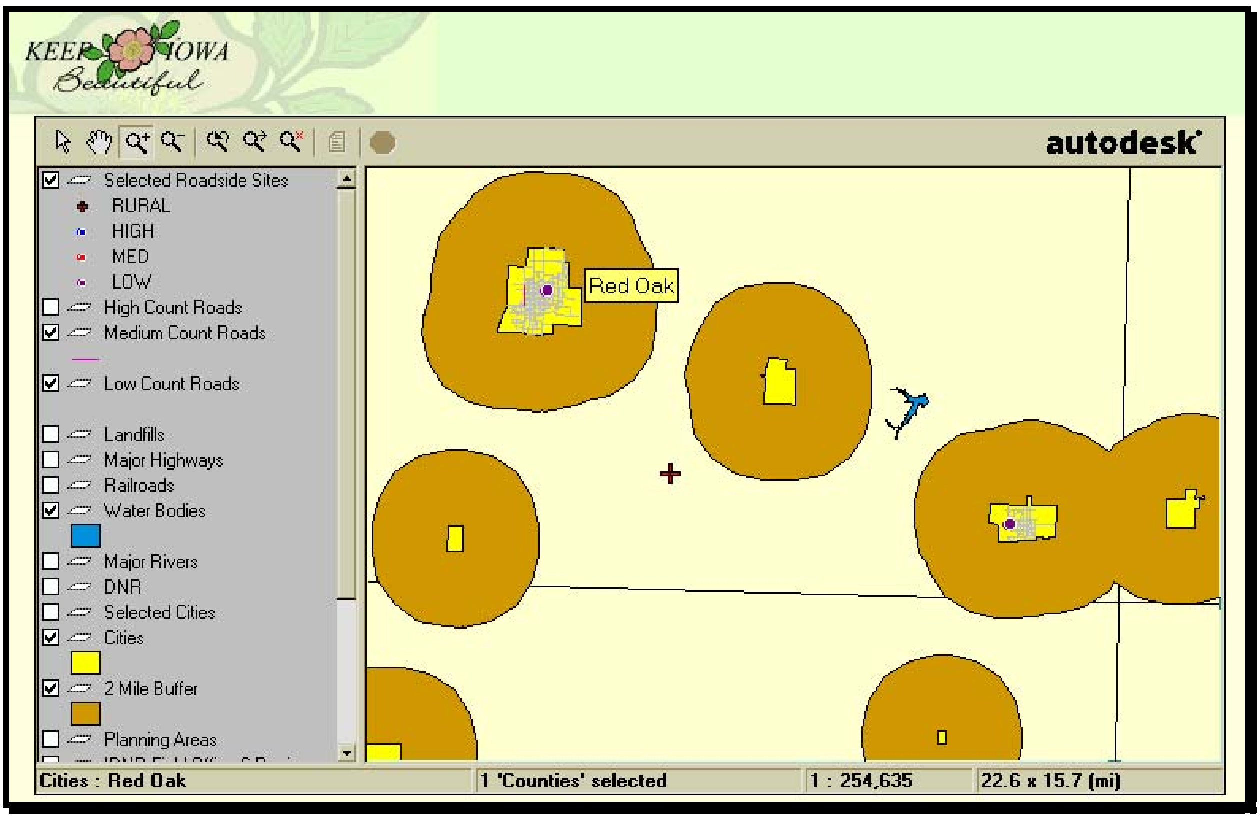
In this example, the average annual daily traffic count is 30,700 vehicles of which 21,252 are automobiles and 7,986 are pick-up trucks.

2. Stratifying and Weighing Rural and Urban Roadside Sites

The State of Iowa has 77% of the population living in incorporated places (urban sites) and 23% of the population living in unincorporated (rural) areas. Therefore, potential urban sites should total 116 (150 multiplied by 77%), and rural sites selected from rural areas should total 35 (150 multiplied by 23%).

Staff defined urban areas for this study as a roadside within the geographic boundary of incorporated places. For this study, rural place was defined as any place 2 miles from the border of any incorporated place. This definition of a rural place attempted to eliminate sites representing high suburban growth into unincorporated areas.

Before staff defined the 2-mile rural definition, a rural definition of 10 miles from any incorporated boundary was attempted. The GIS programming, defining buffers of ten miles around incorporated areas, showed that a 10-mile zone excluded 95% of the State as potential roadside sites. A 2-mile buffer zone was attempted and it afforded significantly more space from which to choose sites and still appeared to minimize sites representing more suburbanized areas.



Screenshot of the 2-mile buffer delineated around incorporated places by the GIS program. The maroon plus sign indicates the location of a rural roadside site.

3. <u>Population</u>

BARKER LEMAR used 2000 US Census Bureau data to stratify urban areas according to population (See Attachment A). The State's cities were ordered in descending order from largest to smallest, and then cities were classified according to IDOT city classification sizes

(**BARKER LEMAR** used IDOT's city classification sizes as identified on IDOT's state highway maps - See Table 1).

Staff divided the total population of the IDOT classification by the total population. The resulting percentage was used to assign a specific number of urban roadside sites to that classification size.

While cities were ordered in descending order, they were assigned a number from 1 to 955. A random number generator chose numbers within the City Classification. For example, the eight largest cities (numbered 1-8) identified as having populations over 50,001 received 39 random numbers (34% of 116 urban sites) numbered from 1-8. See Attachment A.

Table 1

IDOT CITY CLASSIFICATION SIZE	NUMBER OF CITIES IN IDOT CLASSIFICATION	ROADSIDE SITES / CATEGORY (151 TOTAL)	% OF TOTAL URBAN POP.
50,001 plus	8	39	34%
25,001 - 50,000	9	15	13%
10,001 - 25,000	13	11	10%
5,001 - 10,000	39	15	13%
1 - 5,000	886	36	31%
RURAL	NA	35	NA

Because KIB stakeholders required an equal distribution of roadside sites throughout the State and required sites to be selected randomly, some cities receiving a larger number of roadway sites were reduced by one roadside site so that the "extra" roadside site could go to a city with no representation. Table 3 describes the cities donating a site and the cities receiving a site. Cities received a site if they were next in the list, proceeding in descending order, from the providing city. The selection of cities allowed the next stratification criteria to be implemented - traffic volume.

Table 2

DONATING TOWN	SIZE CLASSIFICATION	ORIGINAL NUMBER	RECEIVING TOWN	SIZE CLASSIFICATION	NUMBER RECEIVED
Mason City	25,001-50,000	3	Marshalltown	25,001-50,000	1
Indianola	10,001-25,000	2	Muscatine	10,001-25,000	1
Oskaloosa	10,001-25,000	2	Keokuk	10,001-25,000	1
Coralville	10,001-25,000	2	Ft. Madison	10,001-25,000	1
Knoxville	5,001-10,000	2	Clear Lake	5,001-10,000	1
Washington	5,001-10,000	2	Estherville	5,001-10,000	1
Perry	5,001-10,000	2	Denison	5,001-10,000	1
Villisca	1-5,000	2	Fayette	1-5,000	1

4. Traffic Volume

Year 2000 IDOT traffic volume data was used to develop three traffic volume classifications. Road segments are the geographical boundary for IDOT road volume data. A road segment is an undetermined length of road from one intersection to another intersection. Staff weighed each traffic volume classification by adding the total miles within each classification and dividing it by the total - see Table 3.

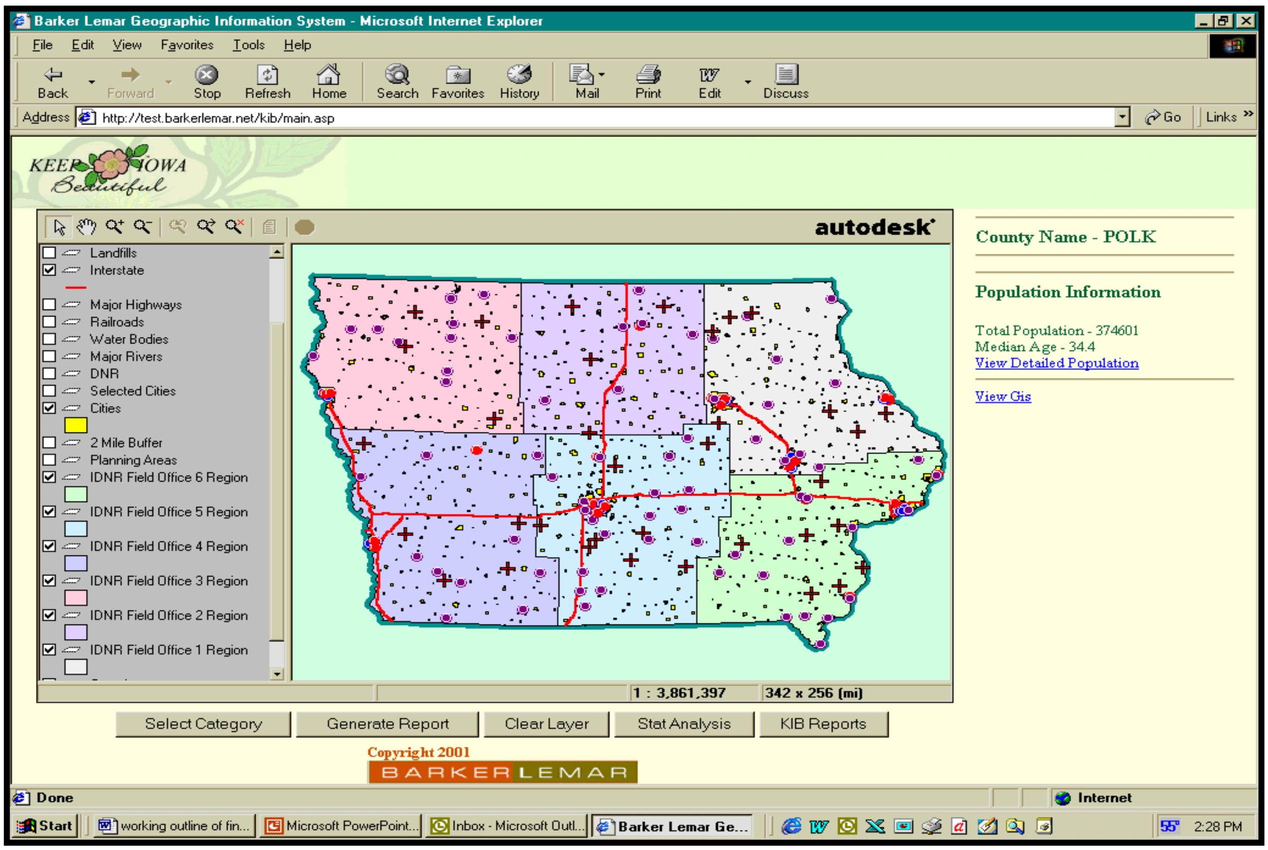
BARKER LEMAR staff used "Natural Breaks" ArcView's default classification method to determine the range for the daily vehicle traffic count classifications. This method identifies breakpoints by looking for groupings and patterns inherent in the data. ArcView uses Jenk's Optimization statistical formula to minimize the variation within each class. The categories for this stratification system are presented in Table 3.

Table 3

CARS PER DAY	KIB CLASSIFICATION	% OF IOWA ROADWAYS	# OF ROADSIDE SITES (116 TOTAL)
1- 9,070	Low Volume	67%	78
9,071 - 31,200	Medium Volume	21%	24
31,201 +	High Volume	12%	14

5. Rural Roadside Sites – Stratified by IDNR Field Office Zones

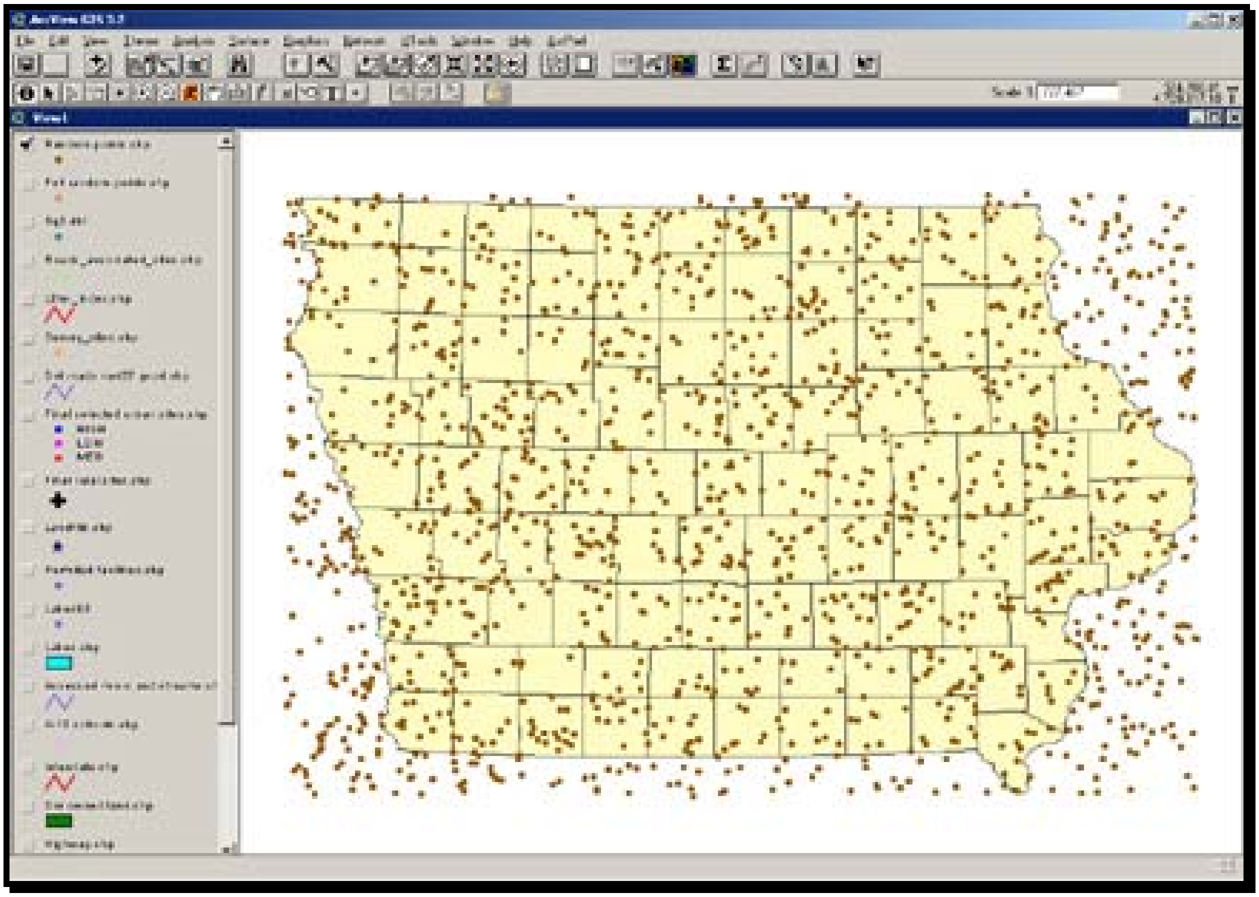
Staff reviewed a GIS map of the selected roadside sites with KIB stakeholders at which time the random selection process was described. This first draft of mapped sites showed a significantly greater number of sites in the northern half of the state (due to the random selection process). In order to distribute the roadside sites equally throughout the State, the KIB stakeholders agreed that the IDNR Field Office Zones should be used to further stratify the rural roadside sites. The goal was to spread the rural sites equally throughout the State and weigh them equally by population.



Screen shot showing IDNR Field Office zones. The Field Office zones use counties for geographic borders. BARKER LEMAR staff identified the population within each Field Office Zone (using county populations) and then associated a number of rural roadside sites according to the percent of total State population in the Zone.

C. Random Point Selection and Geographic Plotting of Roadside Sites

BARKER LEMAR staff designed a random point generator for use with ArcView and the KIB GIS/Internet site to select the actual roadside site location. To select urban sites in the State, staff selected a field encompassing the entire State. A random point generator created 50,000 points based on XY coordinates within the selection field and points were then selected within a 50-foot buffer of a road segment matching the specific traffic volume. Staff eliminated points outside incorporated places, then went to each of the selected cities and looked for a random point. If more than one point existed and only one point was required, then staff chose the first XY coordinate from the table of randomly selected XY coordinates. Tabular views were used to reduce geographical bias while selecting roadside sites.



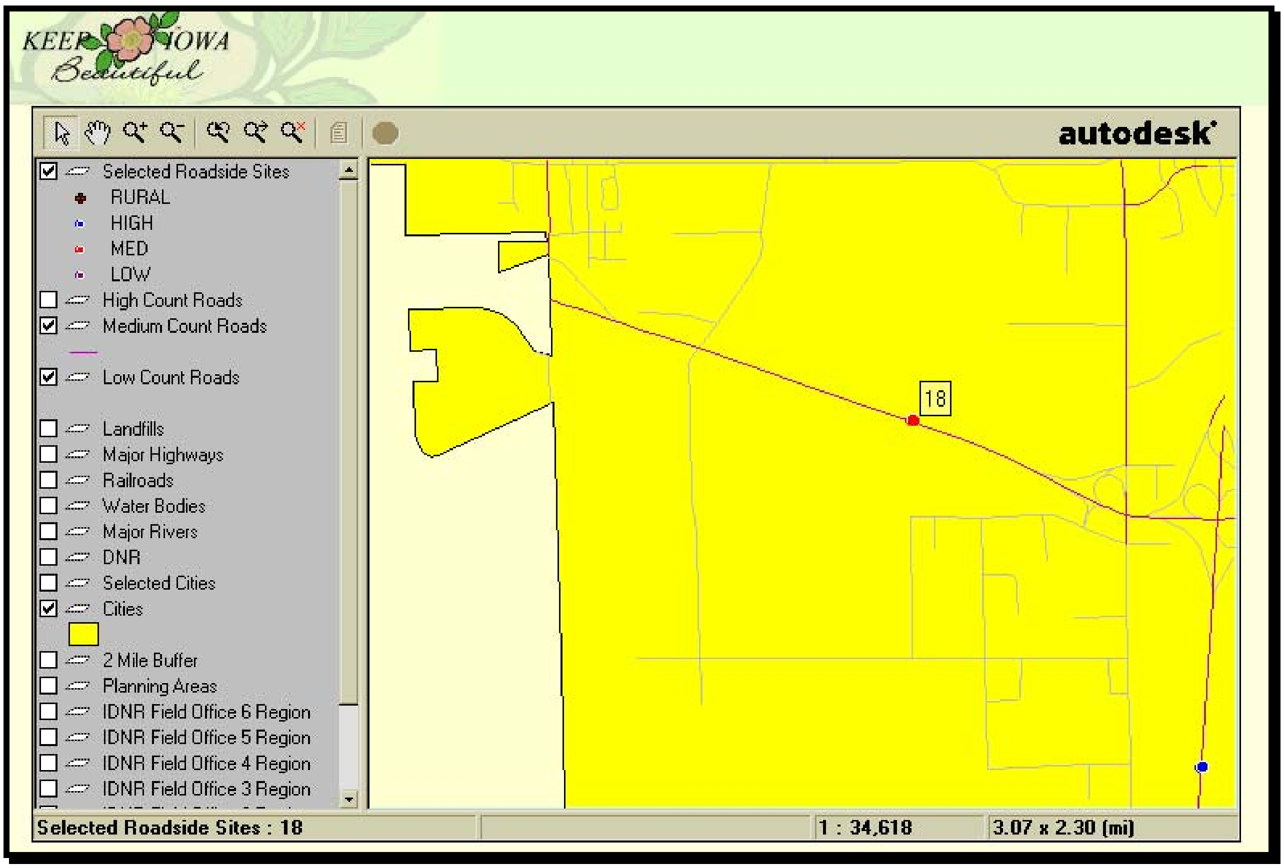
Example of Random Points Generated at a State Level

If a selected city did not receive a point during the first statewide selection process, 100-200 random points were generated within the city using the same traffic volume criteria. During this selection process, points were selected if they intersected a road not if they were within a 50-foot buffer.

To select rural sites around each IDNR Field Office Zone staff selected a field encompassing the entire Zone. The random point generator created 5,000 points based on XY coordinates within the selection field and within 50 feet of a road. Staff eliminated points inside the 2-mile buffer around incorporated places, then chose the required number of sites for that Zone from a table of randomly selected XY coordinates. Staff used Tabular Views to reduce bias in selecting roadside litter collection sites based on geography. Staff selected the required number of sites from the top of the XY coordinate table.

Numbering System of Roadside Sites

Staff assigned a number from 1 to 151 to each roadside site. Urban sites were sorted alphabetically within the three traffic volume classes and then numbered. Rural sites were sorted by X, Y coordinate within each IDNR zone and then numbered.



Screen shot of GIS/Internet site with site 18 (medium traffic volume site) highlighted. Each site is identified by a number from 1-151

The KIB Internet/GIS web site uses the site numbers as the primary identifier.

- High traffic volume sites are numbered 1-14, representing the 14 high traffic volume roads.

- Medium traffic volume sites are numbered 15-38, representing the 24 medium traffic volume roads.
- Low traffic volume sites are numbered 39-116, representing the 77 low traffic volume roads.
- Rural sites are numbered 117-151, representing the 35 rural sites.

IV. LITTER COLLECTION - METHODOLOGY

A. Dates of Sample Collection

BARKER LEMAR trained staff on the methodologies and equipment they would use for the roadside litter study on September 14, 2001. This training also included a review of the KAB Litter Index system (KAB video) and roadside safety.

BARKER LEMAR staff began collecting roadside litter data on Wednesday, September 19, 2001 and completed the last site on November 12, 2001. Snow was not present during any of the litter collection events.

B. Technology - GPS, Handheld Notepad, and Customized Programming

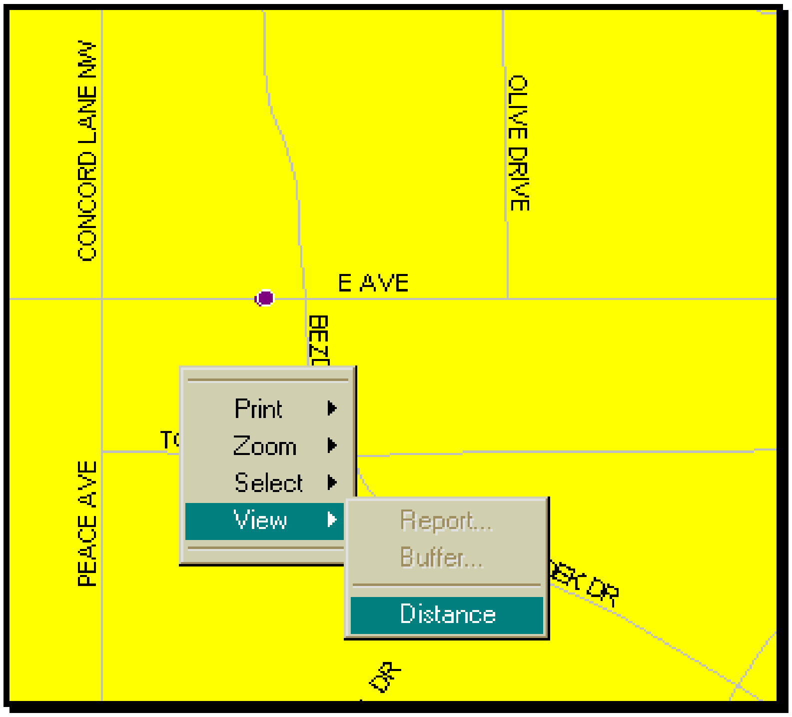
The equipment used in site litter collection was a ruggedized Hitachi ePlate Tablet PC and a Crux II GPS unit. Staff developed a custom program in Embedded Visual Basic to record data and write it to a Pocket Access database to eliminate "in office" data entry.

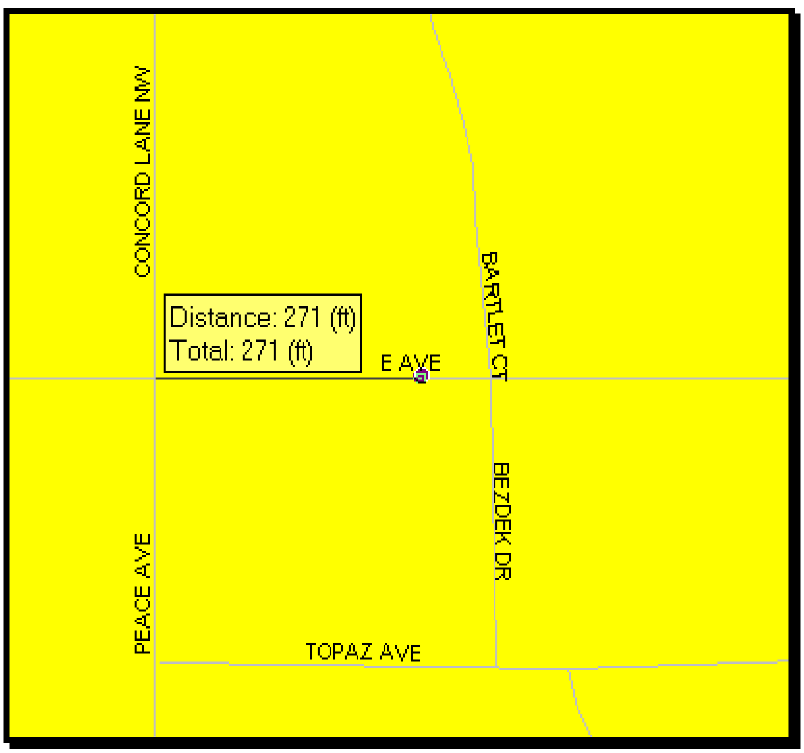
For sorting and cataloging the data, a custom program was written in Visual Basic that was bound to an Access database.

The GIS programming uses MapGuide by Autodesk, version 6.0 as the basic GIS program. Data was collected in Microsoft Access 2000 and uploaded to a Microsoft SQL database. Staff used Seagate Crystal Reports to generate reports from both SQL or Access databases. **BARKER LEMAR** hosts the GIS/Internet site on its servers under a separate agreement with KIB.

C. Locating Sites

As staff scheduled field activities, maps were printed using the Internet/GIS program. Staff was able to locate the position of the litter collection point and then print maps with the site location, road names, intersections, town names, etc. Field technicians used the program to measure the distance, usually from a nearby intersection(s) to the site. Additional maps, printed on a larger scale, provided interstates and major highways instructing staff to the approximate roadside location.





Screen shots illustrating how staff quickly developed maps and an exact distance to begin the fieldwork.

The distance calculated from the GIS program was used in the field to find a starting point for the survey area. Staff noted which direction they traveled as they measured site length.

Barker Lemar instructed field crews to use the exact site randomly selected by the GIS program and not to bias the roadside site by changing roadsides, etc. However, staff was instructed to maintain safety and use common sense regarding site substitutions. For example, one site was not used as the entire street was closed for construction and another site was moved down the road a few hundred feet to avoid menacing dogs.

D. Length and Width of Sites

Field workers used a measuring wheel to measure length and width of the sites. The four corners of the roadside collection site were recorded for some sites with the GPS receiver and Tablet PC. Staff used spray-marking paint to identify the four corners of the site and outline the length and width of the site. Field crews were instructed to make sites 200 feet long if possible. Site width was not pre-determined, rather staff determined width in the field based on the location of barriers and natural breaks. Sites were not to exceed 40 feet in width. Paint markings, field notes, and GIS maps will serve as a backup to the GPS coordinates for additional roadside studies planned for 2002.

E. Size Limitation - 1/2 Square Inch

Staff determined a ½-inch square litter size was appropriate, as field staff could approximate this size quickly in the field (about the size of a thumbnail). Additionally, the 1/2-inch square size included cigarette butts and cigarette filter material.

F. Photographs

Staff was instructed to take photographs at each roadside site. The pictures are available on the GIS/Internet site

High Volume – Commercial Area

High Volume – Interstate

Low Volume – Rural Community

Medium Volume – Residential

G. Observations of Independent Variables

Other roadside litter studies identified other independent variables that may influence the amount of litter at any given site. **BARKER LEMAR** collected several key independent variables while on site. These variables included:

- grass height;
- location of a stop sign or stop light;
- location of a barrier such as a fence, row crop, ditch, building, bushes/weeds, etc.;
- location of convenience store or fast-food type restaurant, and;
- location of nearby school or park.

Visual Count - Walking Speed

Other litter characteristic researchers believe a visual count of litter is directly correlated to the actual amount of litter at a site and that visual litter is a better reflection of how an area is perceived by residents, pedestrians, and motorists.

The visual count was a separate measure of how much litter was located at a site. Before litter was collected, the field staff counted the visual litter at walking speed. **BARKER LEMAR** instructed staff to not stop walking while counting. The counts were revealed after each person had finished counting. Staff recorded the average of the two visual counts (one from each of the field crew staff).

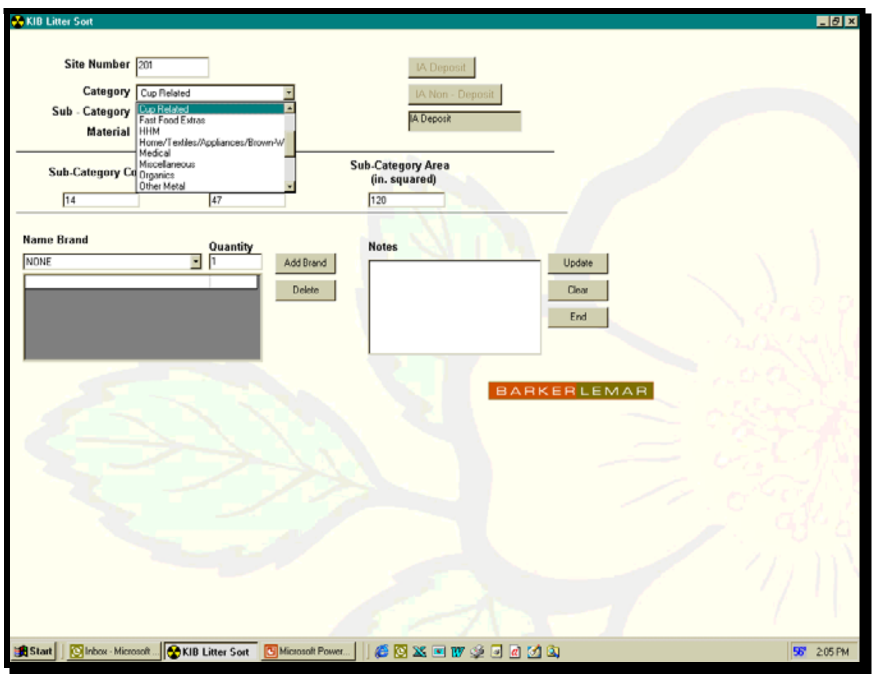
If sidewalks were available, then the visual count took place from the sidewalk. If a sidewalk was not available, then the visual count took place from the edge of roadway.

V. LITTER CLASSIFICATION METHODOLOGY

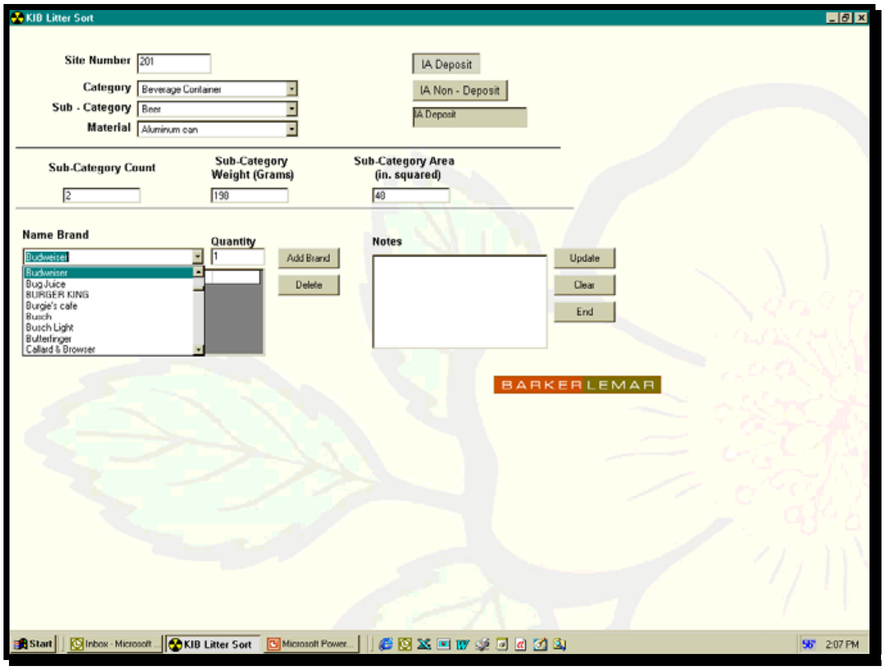
A. Classifying Litter

Sorting and classifying litter samples began on December 3 and concluded on December 19. KIB stakeholders provided input regarding some key litter classification categories, and subcategories. Specifically KIB stakeholders requested that beverage containers be identified by material type and then by their designation as a deposit or no-deposit container. Staff developed other categories from research performed on other statewide litter characterization studies and the experience of the **BARKER LEMAR** staff.

A data entry screen, written in Visual Basic was used to enter and store database information.



Screen shots of BARKER LEMAR'S data entry page for the litter classification and counting phase. Drop-down boxes provided lists of categories (shown), subcategories, and material types.



Drop-down boxes saved previously entered name brands saving data entry time and maintaining consistency.

B. Classification Changes / Notes

Table 4 displays the original categories and subcategories used to classify litter and the changes made to the categories and subcategories.

1. <u>Adding New Categories</u>

"Fast Food Extras - Straw Related Packaging Plastic/Paper", "Fast Food Extras - Fast Food Wrappers/Bags", "Organics - Miscellaneous", and "Beverage Container - Water" were added as subcategories after the first few sorts. Staff thought these subcategories would better represent these unique litter streams. Staff also added the "Miscellaneous" category for materials not identified with any of the other subcategories.

2. <u>Combining Categories for Data Analysis</u>

BARKER LEMAR developed the litter categories by reviewing other roadside litter characteristic studies and listening to the ideas generated by KIB stakeholders. After the data was collected and reviewed, staff combined several subcategories because some of these contained no litter pieces. Additionally, sorting crews had difficulty distinguishing similar sub categories; consequently, the data is better represented if some subcategories and some categories are combined.

Table 4

CATEGORY (ORIGINAL AND/OR NEW)	OLD SUBCATEGORY	NEW SUBCATEGORY
Bags	**Ice**	**Plastic and Paper Bags**
	Paper Retail	
	Paper Small	
	Plastic Retail	
	Plastic Small	
	Sandwich Style Bags	
Construction Debris	**Drywall / Framing / Trim / Paving / Demolition Related**	**Demolition/Construction Related**
	Rocks / Gravel / Minerals	
Cup Related	**Plastic Reusable**	**Plastic Cups**
	Plastic Not Reusable	
Old Category = **Home/Brown Good/White Good/ Textiles**	**Blankets/Towels**	**Miscellaneous**
New Category = **Textiles**	**Textiles**	

Old Category = Medical **Old Category = Biological** **New Category = Biohazardous/Medical**	**Medical Supplies/Veterinarian Supplies**	**Miscellaneous**
	Biohazardous/Human Waste	
Other Metal	**Metal/Aluminum Pieces**	**Metal Pieces**
	Foil/Pie Tins	
Other Plastic	**Foamed "Block and Shape" Pieces**	**Foamed Packaging**
	Foamed "Peanuts"	
Tobacco	**Cigar Filter/Butts**	**Cigar/Cigarette Filter and Butts**
	Cigarette Filter/Butts	

3. <u>Determining Deposit or Non-deposit Designations for Beverage Containers</u>

During the litter classification stage, **BARKER LEMAR** instructed staff to designate a beverage container as "Deposit" only if staff observed deposit language on the container. **BARKER LEMAR** thought this system would be the most objective method for determining the deposit designation. If field staff could not identify any deposit language on the container, they were to classify the beverage container litter as "Non-deposit".

4. <u>Categories Removed - No Litter Recorded</u>

The following litter categories did not record any litter and are consequently not included in any analysis: "Brown Goods", "White Goods", "Cushions", "Tableware", "Blankets/Towels", "Household Hazardous Material" ("HHM"), "Yard Waste", "Dead Animals", "Prepared Foods"', and "Animal Feed".

VI. COUNTING AND MEASURING COLLECTED LITTER

A. Counting Litter

Individual litter pieces ½ square inch or larger were counted and individually recorded. Staff counted separate pieces of litter even if the pieces appeared to match, e.g. a reusable stadium type cup mowed into four pieces was counted as four separate pieces of litter. Field staff determined this system of counting to be the most objective system.

B. Estimating the Area of Each Litter Category and Subcategory

The area of litter was calculated to the nearest half-inch square. Classifying teams used a one-inch square grid to assist estimating area. After being sorted by subcategory, litter was spread into a single layer, without changing the shape of the litter significantly, e.g. unfolding candy wrappers, etc. The pieces were laid onto the grid and, looking down on the grid and counting 1-inch square sections covered by the litter, staff recorded the best estimate of area.

This example of Candy Packaging/Snack Packaging represents approximately 31 square inches. Staff estimated area looking down over litter - the angle of this photograph skews the perspective.

A standard measurement of ½ square inch for cigarette filters/butts was used to speed the classification process.

For pieces of litter too large for the 1 square inch grid system (tire retreads, barrel lids, etc.), staff used a measuring tape to estimate area.

C. Recording the Weight of Each Litter Category and Subcategory

Litter categories were weighed to the nearest tenth of a gram up to materials weighing over 24 pounds (scale capacity). Staff weighed heavier items on a bathroom scale and converted the weight from pounds to grams.

Scale, computer and workplace where each litter sample was characterized. BARKER LEMAR staff worked at the BARKER LEMAR Field Office (The Shop) in Grimes, Iowa.

D. Recording the Name Brands Within Each Litter Category for Each Site

After staff estimated the area for each litter category, individual name brands were identified and recorded. **BARKER LEMAR** instructed staff not to guess at a name brand but to look for clear indications of the name brands on the individual piece of litter.

E. Photographs

Staff took photographs of the litter from each site, the pictures show the litter in various stages of being classified and sorted and were used primarily to resolve any discrepancies in recorded data. Some pictures are representative of specific categories or sub categories. Staff will use these pictures to supplement sorting work and provide training for future studies. Most of the individual roadside sites have a photograph associated with it, except those sites where no litter was collected.

Photographs are available on the KIB Internet/GIS web site.

Photographs were taken of the litter collected from each site. The litter on the board represents litter from site 75.

Plastic containers were used to keep subcategories separate.

Pictures also assisted researchers identify discrepancies in data. If site numbers were entered incorrectly, (e.g. 18 for 118) the pictures, combined with a report of the data, could help identify the correct site.

VII. ANALYZING COUNT, WEIGHT, AREA AND NAME BRANDS OF ROADSIDE LITTER AND REVIEWING THE VISUAL LITTER COUNT DATA

A. Calculating and Comparing the Amount, Area, and Weight of Categories.

NOTE: The following tables are only summaries, complete reports are located in the KIB Internet/GIS program and Attachment C.

1. Traffic Volume and Total Pieces of Litter

Staff compared the amount of litter per square foot sampled and compared these trends to the total pieces trend in which high volume sites had the most number of pieces.

Table 5

TRAFFIC VOLUME	TOTAL PIECES	TOTAL AREA (SQ. FT.)	AVG. SURVEY SIZE/ROAD TYPE	SQ. FT. / PIECE	PIECE/SQ. FT.
High	10,127	81,108	5,793 sq. ft.	8 sq. ft./piece	.1249
Medium	6,317	106,238	4,427 sq. ft.	17 sq. ft./piece	.0595
Low	5,775	265,252	3,445 sq. ft.	46 sq. ft./piece	.0218
Rural	366	175,400	5,011 sq. ft.	476 sq. ft./piece	.0021
TOTAL	22,585	627,998	4,669 sq. ft.	27.8 sq. ft./piece	.0360

NOTE: The amount of litter collected at high volume sites may not be directly related to the average survey size. According to field observations, more litter was observed in the first 15 feet from the roadside edge.

2. Categories Ordered by Weight

The top five categories from heaviest to lightest were Beverage Containers, Tobacco, Construction Debris, Other Metal, and Tires.

Table 6

CATEGORY	WEIGHT (GRAMS)
Beverage Container	28,617.2
Tobacco	26,810.7
Construction Debris	26,520.2
Other Metal	24,678.91
Tires	24,342.0

3. Categories Ordered Descending by Area

The top five categories consuming the greatest area were: Packaging, Tobacco, Bags, Other Paper, and Beverage Containers. Within the "Packaging" category, 92% of the area (96,871.25 square inches) was associated with the sub category "Candy Wrappers/Snacks Packaging (Paper or Plastic)".

Table 7

CATEGORY	AREA (SQUARE INCHES)
Packaging	105,277.1
Tobacco	49,554.5
Bags	16,525.0
Other Paper	12,664.2
Beverage Container	11,988.7

4. **Categories Ordered Descending by Count**

The top five categories totaling the most number of litter pieces were: Tobacco, Other Paper, Packaging, Cup Related, and Beverage Containers.

Table 8

CATEGORY	COUNT
Tobacco	8,590
Other Paper	2,893
Packaging	2,731
Cup Related	1,218
Beverage Container	1,059

B. Calculating and Comparing the Amount, Area, and Weight of Selected Subcategories.

1. **Cigar/Cigarette Filters and Butts**

Table 9

SUBCATEGORY	AMOUNT	AREA (SQUARE INCHES)	WEIGHT (GRAMS)
Cigar/Cigarette Filters and Butts	8,590	40,291.0	2271.96

2. **Candy/Snack Packaging**

Table 10

CATEGORY	AMOUNT	AREA (SQUARE INCHES)	WEIGHT (GRAMS)
Candy/Snack Packaging	2,731	96,871.3	14,274.28

3. **Beverage Containers**

Table 11

CATEGORY	AMOUNT	AREA (SQUARE INCHES)	WEIGHT (GRAMS)
Beer	225	3,511.7	12,124.3
Soda	208	5,311.0	8,323.7
Milk	18	301.5	423.5
Juice	12	184.4	428.4
Vegetable/Health	10	226.5	347.5
Water	3	53.0	492.6
Sports	3	90.5	109.2
Tea	2	40.0	378.7
Broken & Undetermined Glass	426	559.5	3,504.8
Broken & Undetermined Metal	92	843.0	1,016.0
Broken & Undetermined Plastic	59	805.5	973.6

4. **Paper Cups**

Table 12

CATEGORY	AMOUNT	AREA (SQUARE INCHES)	WEIGHT (GRAMS)
Paper Cups	236	3,969.0	2,351.7

5. **Plastic Cups**

Table 13

CATEGORY	AMOUNT	AREA (SQUARE INCHES)	WEIGHT (GRAMS)
Plastic Cups	236	4,037.8	3,397.2

6. **Fast Food Wrappers and Bags**

Table 14

CATEGORY	AMOUNT	AREA (SQUARE INCHES)	WEIGHT (GRAMS)
Fast Food Wrappers & Bags	319	7,752.8	2,673.28

C. Calculating and Comparing Name Brands

1. **Cigar/Cigarette Filters and Butts**

Table 15

NAMEBRAND	COUNT
Marlboro	1,449
GPC	116
Winston	68
Salem	55
Basic	50

Camel	48
Parliament	47
Merit	44
Pall Mall	25
Old Gold Lights	24
Newport	23
Doral	22
Virginia Slims	16

2. Candy/Snack Packaging

Table 16

NAMEBRAND	COUNT
Snickers	59
Tootsie Rolls	37
Brach's Star Brites	18
Reeses	18
Twix	18
Lifesaver Crème Saver	17

Starburst	16
Life Savers	15
Nestle	14
Slim Jim	14
Trident	14
Winterfresh	13
Jolly Rancher	12

3. <u>Beverage Containers</u>

Table 17

NAMEBRAND - BEER	COUNT
Bud Light	43
Busch Light	39
Budweiser	27
Miller Light	14
Busch	11
Ice House	5
Natural Light	5
Coors Light	4

Old Milwaukee	3
Pabst Blue Ribbon Light	3
NAMEBRAND - SODA	**COUNT**
Mountain Dew	59
Pepsi	41
Coke, Coca-Cola Classic	30
Sprite	7
Sunkist	5
Diet Coke	4
Dr. Pepper	4
A&W Cream Soda	2
Diet Pepsi	2
7-UP	1
NAMEBRAND – JUICE, MILK, SPORTS, TEA, VEGETABLE/ HEALTH, WATER	**COUNT**
Sunny Delight Juice	4
Blue Bunny Milk	4
Anderson Erickson Milk	3
Nestle Quik	3

4. **Paper Cups**

Table 18

NAMEBRAND	COUNT
McDonalds	55
Burger King	28
Taco Johns	12
Wendy's	8
Subway	7
Hardee's and KFC (Pepsi)	6

5. **Plastic Cups**

Table 19

NAMEBRAND	COUNT
Burger King	9
McDonalds	5
Steak and Shake	4
Casey's	3
Kum & Go	3

6. Fast Food Wrappers and Bags

Table 20

NAMEBRAND	COUNT
McDonalds	18
Subway	16
Burger King	13
Hardees	7
Taco Bell	7

D. Beverage Container Litter Comparing Deposit and Non-deposit Containers

Deposit designations were only determined if the deposit language could be read on the litter piece. Note: not all litter pieces counted as a beverage container were in one piece when they were collected. Pieces were not associated with a whole bottle to limit bias and guesswork.

1. Total Litter Pieces Identified as Beverage Containers

Table 21

BEVERAGE CONTAINER TYPE	TOTAL COUNT	TOTAL WEIGHT	TOTAL AREA
Beer	104	12,423.3	3,562
Soda	125	8,323.7	5,311
Wine/Liquor	1	195.9	12

2. Total Litter Pieces Identified as Deposit Containers

Table 22

BEVERAGE CONTAINER TYPE	DEPOSIT- COUNT	WEIGHT	AREA
Beer	75	10,152.7	2,488.1
Soda	69	3,925.0	2,045.0
Wine/Liquor	1	195.9	12

3. Total Litter Pieces Identified as Non-deposit Containers

Table 23

BEVERAGE CONTAINER TYPE	NON-DEPOSIT COUNT	WEIGHT	AREA
Beer	29	2,270.6	1,073.0
Soda	56	4,398.7	3,266.0

E. Comparing Litter Piece Count to Traffic Volume Categories

Note: not all litter pieces counted as a beverage container were in one piece when they were collected. Pieces were not associated with a whole bottle to limit bias and guesswork. Low volume roads are 1-9,070 average annual vehicles per day, medium are 9.071-31,200, and high volume roads were greater than 31,201 vehicles.

1. Total Litter Pieces Identified as Beverage Containers and Traffic Volume

Table 24

BEVERAGE CONTAINER TYPE	LOW	MEDIUM	HIGH
Beer	35	67	72
Soda	48	23	117
Broken Glass	150	170	96
Broken Metal	35	16	32
Broken Plastic	6	15	30

2. Total Litter Pieces Identified as Cup Related and Traffic Volume

Table 25

CUP RELATED TYPE	LOW	MEDIUM	HIGH
Paper Cups	58	61	87
Plastic Cups	41	33	143
Plastic Lids	51	56	49
Foam Cups	69	62	243
Straws	46	66	78

3. Total Litter Pieces Identified as Fast Food Extras and Traffic Volume

Table 26

FAST FOOD EXTRAS TYPE	LOW	MEDIUM	HIGH
Condiment Packages	18	45	32

Fast Food Wrappers and Bags	31	17	77
Straw Wrappers (paper and plastic)	18	32	11
Utensils	4	17	8

3. Total Litter Pieces Identified as Other Paper and Traffic Volume

Table 27

OTHER PAPER TYPE LITTER	LOW	MEDIUM	HIGH
Lottery	20	10	19
Small Pieces of Undetermined Source	579	667	1,173
Towel/Napkin	157	118	127

4. Total Litter Pieces Identified as Other Plastic and Traffic Volume

Table 28

OTHER PLASTIC TYPE LITTER	LOW	MEDIUM	HIGH
Bottle Lid/Cap	47	64	45
Small Pieces of Undetermined Source	410	484	1,120
Foamed Plastic	116	158	981

5. Total Litter Pieces Identified as Packaging and Traffic Volume

Table 29

PACKAGING TYPE LITTER	LOW	MEDIUM	HIGH
Candy Wrappers and Snack Packaging	389	392	431

6. Total Litter Pieces Identified as Tobacco Related and Traffic Volume

Table 30

PACKAGING TYPE LITTER	LOW	MEDIUM	HIGH
Cigar/Cigarette Filters and Butts	1,684	2,470	3,466
Dip/Chew/Snuff	1	3	0
Packaging	226	155	233

F. Analyzing the Results of the Visual Litter Survey

(For a description of the visual litter counting technique, please see section IV - Litter Collection Methodology.)

Staff postulated that the higher traffic volume the higher the visual litter.

- The 14 high volume roadside sites averaged 75 pieces of visual litter.
- The 24 medium volume roadside sites averaged 62.6 pieces of visual litter.
- The 77 low volume roadside sites averaged 14.8 pieces of visual litter.
- The 35 rural roadside sites averaged 2 pieces of visual litter.

VIII. USING STATISTICS TO ANALYZE THE IMPACT OF TRAFFIC VOLUME, VEHICLE TYPE, AND THREE DEMOGRAPHIC VARIABLES

(Many of the following definitions/explanations were developed from definitions provided at www.statsoft.com)

Statistical methods provide a summary of conclusions that can be drawn from an experiment but also provide a reliable prediction of information that can be gained from a proposed experiment.

For this report **BARKER LEMAR** analyzed several independent variables, comparing traffic volume, median county age, county population, to the total number of litter pieces, litter weight, and litter area within the litter research subcategories. The searches for statistically significant relationships between independent variables may assist litter researchers predict the location and type of litter on specific roadways in their town or state or assist manages develop education/promotion initiatives.

Statistics are measuring reliability of the sample for the entire population. Reliability says how probable it is that a similar relation would be found if the experiment was replicated with other samples drawn from the same population. Reliability of a relation between variables observed in a sample can be quantitatively estimated and represented using a standard measure called the p-value or statistical significance level

r - simple linear regression coefficient

Lower case *r* is the percent of the variance in the dependent variable explained by the independent variable. This section attempts to determine the following; "Is there a relationship between two variables and does this relationship represent a statistical correlation".

Simple linear regression can be a negative or a positive number from -1.0 to 1.0. An ***r*** closer to 1.0 indicates that we have accounted for the variability with the variable specified in the model and that a positive relationship exists.

Statistical Significance (p-value)

This section describes how and why a Confidence Level is calculated.
The statistical significance of a result is the probability that the observed relationship occurred by pure chance, and that in the population from which the sample was drawn, no such relationship or differences exist.

The statistical significance of a result tells something about the degree to which the result is representative of the population. The higher the p-value, the less we can believe that the observed relation between variables in the sample is a reliable indicator of the relation between the respective variables in the population. For example, a p-value of .05 (a very good regression performance) indicates that there is a 5% probability that the relation between the variables found in the sample occurred by pure chance.

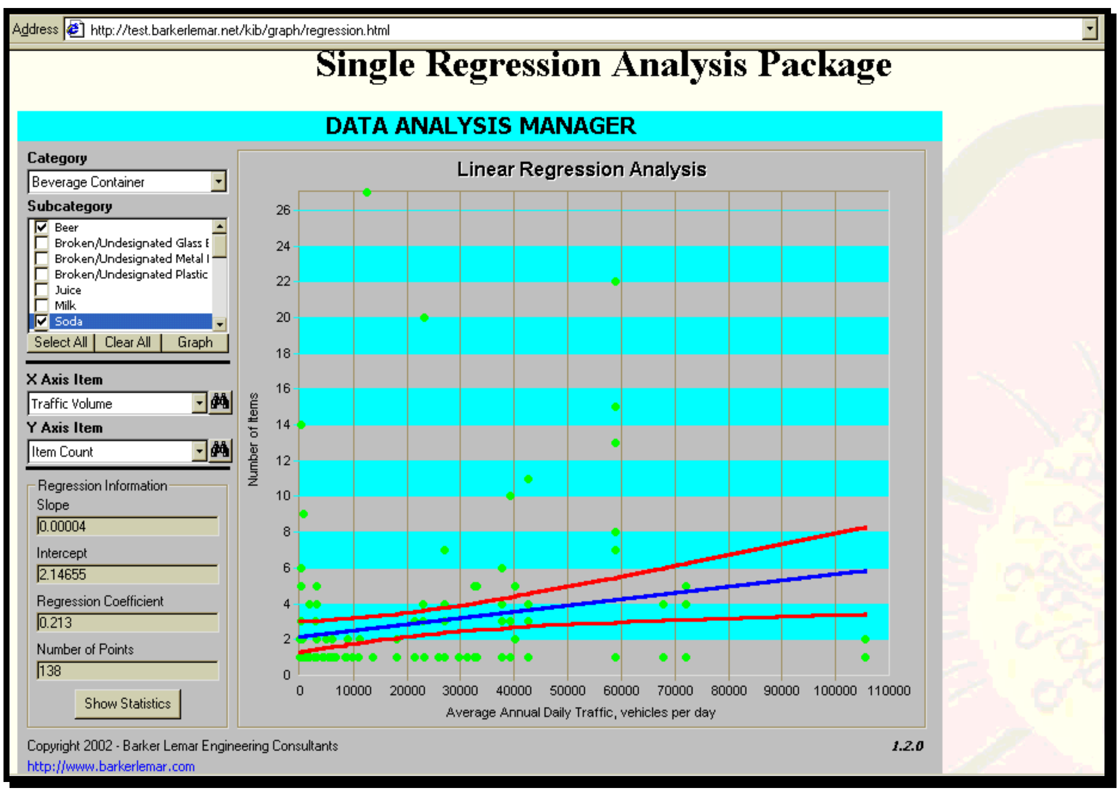
For the statistical analysis performed on litter, a 95% Confidence Interval was used to determine the reliability of the relations between variables (indicating a probability of error of 5% or .05).

The major conceptual limitation of all regression techniques is that they can only ascertain relationships, but not the cause of the relationship. Data from correlational research can only be "interpreted" in causal terms based on developed theories, but correlational data cannot conclusively prove causality.

Barker Lemar has not attempted to remove Outliers (atypical, infrequent observations) from any of the scatter plots.

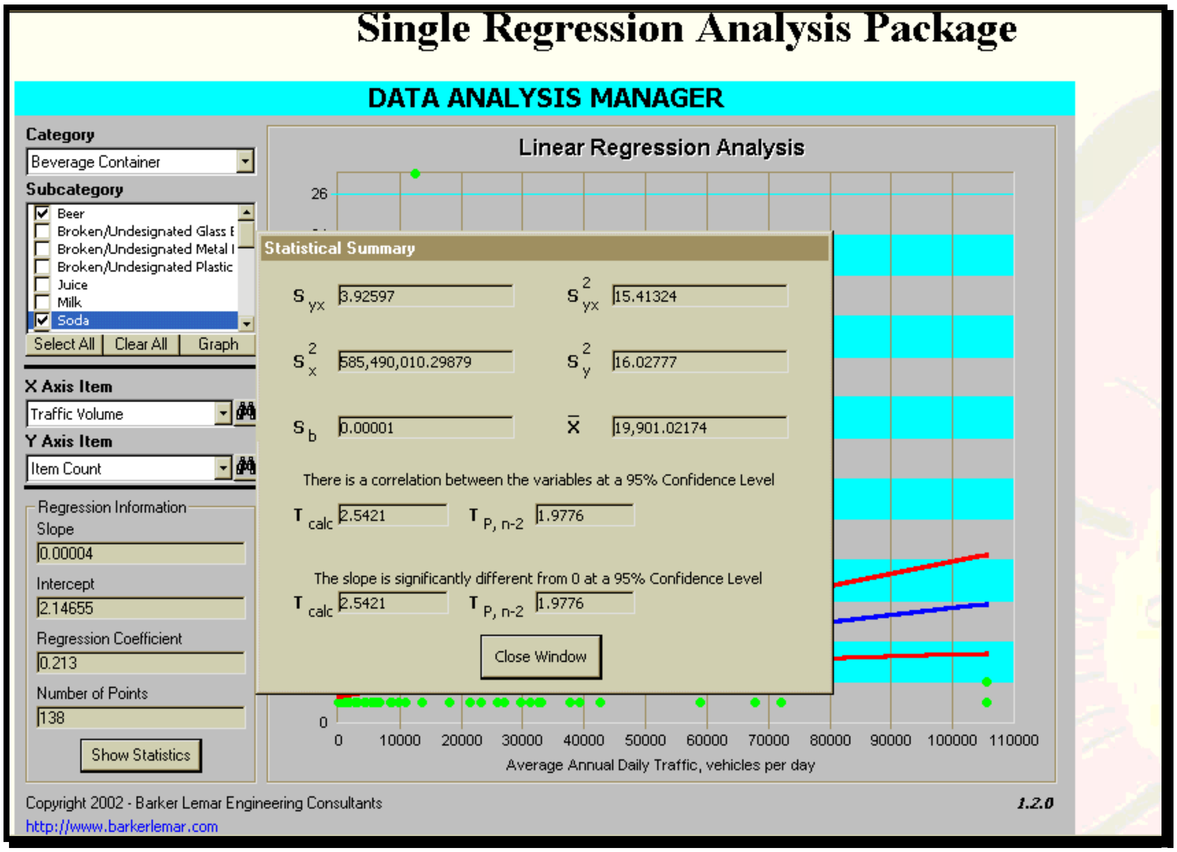
A. User Defined / Web Based Statistical Calculations

Barker Lemar developed an automated regression analysis package for KIB. This package allows users to select one or all categories, one or all subcategories, and ranges within Traffic Volume Data, County Median Age, County Population, Item Count, Item Area, and Weight.



The screen shot provides an example of a scatter plot with regression line, slope, intercept, Regression Coefficient, and number of points. The r or simple linear regression coefficient for this example is .213. The scatterplot visualizes a relation (correlation) between two variables X and Y (e.g., weight of litter and a litter subcategory). Individual data points are represented in two-dimensional space where axes represent the variables (X on the horizontal axis and Y on the vertical axis).

If a 95% Confidence level is not reached, the pop-up box will show the user what confidence interval must be used to reach a 95% Confidence Level.



The screen shot displays the "pop-up box" that appears when the "Show Statistics" box is selected, this information will tell a user if there is a correlation between the variables at a 95% Confidence Level.

B. Linear Regressions - Two Variables

Comparing Traffic Volume to the Amount and Type of Litter

The following data uses Year 2000 IDOT traffic volume data. **BARKER LEMAR** staff used "Natural Breaks", ArcView's default classification method to determine the ranges for Total Litter Pieces. ArcView uses Jenk's Optimization statistical formula.

This section attempts to determine the following; "Is there a statistical correlation between the volume of traffic and the total number of litter pieces, litter area, and litter weight in selected subcategories?

The single regression analysis calculates a regression coefficient using IDOT traffic volume data for road segments with roadside sites containing the selected type of litter.

Litter Pieces (AKA Item Count) was calculated as sites having one or more pieces of litter. For all road types: Traffic Volume set at 1-115,000 vehicles per day.

1. Traffic Volumes and All Litter

There were significant relationships, at the 95% Confidence Level, identified between the variables "Beer Containers" and "Medium Volume Roads" for "Total Litter Pieces" and "Total Litter Weight"

There were significant relationships, at the 95% Confidence Level, identified between the variables "Beer Containers" and "Low Volume Roads" for "Total Litter Pieces" and "Total Litter Weight"

Table 31

ROAD TYPE	CORRELATION, CONFIDENCE LEVEL, AND REGRESSION COEFFICIENT	LITTER VARIABLE
High	There is not a correlation between variables at the 95% Confidence Level.	Total Litter Pieces, Litter Weight, Litter Area
Medium	***There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces.***	***Total Litter Pieces***
	There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces	***Litter Weight***
	There is not a correlation between variables at the 95% Confidence Level.	Litter Area
Low	***There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces.***	***Total Litter Pieces***
	There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces.	***Litter Weight***
	There is not a correlation between variables at the 95% Confidence Level.	Litter Area

2. Traffic Volumes and Candy and Snack Packaging

There were no significant relationships, at the 95% Confidence Level, identified between the variables "Beer Containers" and All Road Volumes (High, Medium, and Low) for "Total Litter Pieces", "Litter Weight', and "Litter Area".

Table 32

ROAD TYPE	CORRELATION, CONFIDENCE LEVEL, AND REGRESSION COEFFICIENT	LITTER VARIABLE
All Road Volumes	***There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces, Weight, and Area. r = .406, .345, and .483***	***Total Litter Pieces, Litter Weight, Litter Area***
High	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 52% Confidence Interval. Negative Slope. ***r =- .213***	Total Litter Pieces
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 48% Confidence Interval. Negative Slope. ***r =- .198***	Litter Weight
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 49% Confidence Interval. Negative Slope. ***r =- .203***	Litter Area
Medium	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 21% Confidence Interval. ***r = .1***	Total Litter Pieces
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 6% Confidence Interval. ***r = .051***	Litter Weight
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 54% Confidence Interval. ***r = .199***	Litter Area
Low	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 78% Confidence Interval. ***r = .234***	Total Litter Pieces

	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 43% Confidence Interval. ***r = -.028***	Litter Weight
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 51% Confidence Interval. ***r = -.031***	Litter Area

3. Traffic Volume and Cigar/Cigarette Filters and Butts

Litter Pieces (AKA Item Count) was calculated as sites having one or more pieces of litter.

For all road types: Traffic Volume was set at 1-115,000 vehicles per day (this setting includes all roadside sites). There was a significant relationships, at the 95% Confidence Level, identified between the variables "Cigar/Cigarette Filters and Butts" and "All Road Volumes" (High, Medium, and Low) for "Total Litter Pieces", "Litter Weight", and "Litter Area".

Table 33

ROAD TYPE	CORRELATION, CONFIDENCE LEVEL, AND REGRESSION COEFFICIENT	LITTER VARIABLE
All Road Volumes	***There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces, Weight, and Area.***	***Total Litter Pieces, Litter Weight, Litter Area***
High	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 23% Confidence Interval. Negative slope.	Total Litter Pieces
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 25% Confidence Interval. Negative slope.	Litter Weight
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 22% Confidence Interval. Negative slope.	Litter Area

Medium	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 51% Confidence Interval.	Total Litter Pieces
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 50% Confidence Interval. Negative slope.	Litter Weight
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 20% Confidence Interval. Negative slope.	Litter Area
Low	***There is a correlation between variables at the 95% Confidence Level.***	***Total Litter Pieces***
	There is a correlation between variables at the 95% Confidence Level.	***Litter Weight***
	There is a correlation between variables at the 95% Confidence Level.	***Litter Area***

4. Traffic Volume and Soda and Beer Containers

Litter Pieces (AKA Item Count) was calculated as sites having one or more pieces of litter.

For all road types: Traffic Volume set at 1-115,000 vehicles per day. There were no significant relationships, at the 95% Confidence Level, identified between the variables "Beer Containers and Soda Containers" and "All Road Volumes" and litter pieces (requires a 84% Confidence Interval) and litter weight. There was a significant relationships, at the 95% Confidence Level, identified between the variables "Beer Containers and Soda Containers" and "All Road Volumes" and Litter Area.

Table 34

ROAD TYPE	CORRELATION, CONFIDENCE LEVEL, AND REGRESSION COEFFICIENT	LITTER VARIABLE
All Road Volumes	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at an 84% Confidence Interval.	Total Litter Pieces
All Road Types	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at an 11% Confidence Interval.	Litter Weight
All Road Types	***There is a correlation between variables at the 95% Confidence Level.***	***Litter Area***
High	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 28% Confidence Interval.	Total Litter Pieces
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 16% Confidence Interval.	Litter Weight
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 2% Confidence Interval.	Litter Area
Medium	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 66% Confidence Interval. Negative slope.	Total Litter Pieces
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 54% Confidence Interval.	Litter Weight
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at an 44% Confidence Interval.	Litter Area
Low	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 74% Confidence Interval. Negative slope.	Total Litter Pieces

	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 54% Confidence Interval. Negative slope.	Litter Weight
	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at an 78% Confidence Interval. Negative slope.	Litter Area

5. Traffic Volume and Plastic Cups

Litter Pieces (AKA Item Count) was calculated as sites having one or more pieces of litter.
For all road types: Traffic Volume set at 1-115,000 vehicles per day. There was a significant relationships, at the 95% Confidence Level, identified between the variables "Plastic Cups" and "All Road Types" (High Volume, Medium Volume, and Low Volume").

Table 35

ROAD TYPE	CORRELATION, CONFIDENCE LEVEL, AND REGRESSION COEFFICIENT	LITTER VARIABLE
All Road Volumes	***There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces***	***Total Litter Pieces***
All Road Types	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 66% Confidence Interval.	Weight
All Road Types	There is not a correlation between variables at the 95% Confidence Level. Significant difference attained at a 90% Confidence Interval.	Area
High	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area
Medium	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area

Low	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area

6. Traffic Volume and Paper Cups

Litter Pieces (AKA Item Count) was calculated as sites having one or more pieces of litter.
For all road types: Traffic Volume set at 1-115,000 vehicles per day. There were no significant relationships, at the 95% Confidence Level, identified between the variables "Paper Cups" and the Traffic Volume categories.

Table 36

ROAD TYPE	CORRELATION, CONFIDENCE LEVEL, AND REGRESSION COEFFICIENT	LITTER VARIABLE
All Road Volumes	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area
High	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area
Medium	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area
Low	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area

7. Traffic Volume and Fast Food Wrappers and Bags

Litter Pieces (AKA Item Count) was calculated as sites having one or more pieces of litter.

For all road types: Traffic Volume set at 1-115,000 vehicles per day. The only significant relationships, at the 95% Confidence Level, identified between the variables "Fast Food Wrappers and Bags" and "Traffic Volume" was identified with "All Road Types" and Litter Area".

Table 37

ROAD TYPE	CORRELATION, CONFIDENCE LEVEL, AND REGRESSION COEFFICIENT	LITTER VARIABLE
All Road Volumes	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, and weight	Total Litter Pieces, and Weight
All Road Types	***There is a correlation between variables at the 95% Confidence Level for Area***	***Area***
High	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area
Medium	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area
Low	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area

C. Linear Regressions - Two Variables

Comparing the Amount and Type of Litter to Specific Demographic Categories (Median Age or County Population)

The following data uses 2000 Census Bureau County Data. **BARKER LEMAR** staff used "Natural Breaks", ArcView's default classification method to determine the ranges for Median Age and Median Population. ArcView uses Jenk's Optimization statistical formula. The three Median Age ranges selected were 27-35, 36-39, and 40-43.

This section attempts to determine the following; "Is there a statistical correlation between the median age of counties and the total number of litter pieces collected (or the total number of litter pieces in selected subcategories)?

The single regression analysis calculates a regression coefficient using county demographic data for the counties with roadside sites containing the selected type of litter. The litter at each site must meet the criteria selected for the number of total litter pieces.

Litter Pieces (AKA Item Count) was calculated as sites having one or more pieces of litter. To query all ages, the median ages was set at 1-45 years old.

1. **Median Ages and All Litter**

Litter Pieces (AKA Item Count) was calculated as sites having one or more pieces of litter.

For all road types: Traffic Volume set at 1-115,000 vehicles per day. There was a significant relationships, at the 95% Confidence Level, identified between the variables "All Litter Categories" and "All Median Age Ranges" for Litter Pieces and Litter Area.

There was a significant relationships, at the 95% Confidence Level, identified between the variables "All Litter Categories" and "Median Ages from 36 through 39" for Litter Pieces and Litter Area.

Table 38

Median Age	CORRELATION, CONFIDENCE LEVEL, AND REGRESSION COEFFICIENT	LITTER VARIABLE
All Age Ranges	***There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces. This is a Negative Slope.***	***Total Litter Pieces, and Litter Area***
All Age Ranges	There is not a correlation between variables at the 95% Confidence Level. For litter weight.	Weight
27-35	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area
36-39	***There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces and Area. This is a Negative Slope.***	***Total Litter Pieces, Area***
36-39	There is not a correlation between variables at the 95% Confidence Level. For total litter weight.	Weight
40-43	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area

2. **Median Ages and Candy and Snack Packaging**

There was a significant relationship, at the 95% Confidence Level, identified between the variables "Candy and Snack Packaging" and "All Median County Ages".

Table 39

Median Age	CORRELATION, CONFIDENCE LEVEL, AND REGRESSION COEFFICIENT	LITTER VARIABLE
All Age Ranges	***There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces. This is a Negative Slope.***	***Total Litter Pieces,***
All Age Ranges	There is not a correlation between variables at the 95% Confidence Level. For weight, or area.	Weight, Area
27-35	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area
36-39	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight or area. Negative slope.	Total Litter Pieces, Weight, Area
40-43	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area

3. Median Ages and Cigar/Cigarette Filters and Butts

Two significant relationships, at the 95% Confidence Level, were identified between the variables "Cigar/Cigarette Filters and Butts" and "Median County Age".

There was a significant relationship, at the 95% Confidence Level, identified between the variables "Cigar/Cigarette Filters and Butts" and "All Median County Ages" for Litter Pieces, Litter Area, and Litter Weight.

There was a significant relationship, at the 95% Confidence Level, identified between the variables "Cigar/Cigarette Filters and Butts" and "Median County Age 26-39" for Litter Pieces.

Table 40

Median Age	CORRELATION, CONFIDENCE LEVEL, AND REGRESSION COEFFICIENT	LITTER VARIABLE
All Age Ranges	***There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces. Negative Slope.***	***Total Litter Pieces, Weight, and Area***
27-35	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area
36-39	***There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces***	***Total Litter Pieces***
36-39	There is not a correlation between variables at the 95% Confidence Level. For weight or area. Negative slope. Significant difference attained for Area at a 91% Confidence Interval.	Weight, Area
40-43	There is not enough data to analyze.	Total Litter Pieces, Weight, Area

4. Median Ages and Beer Containers

There were no significant relationships, at the 95% Confidence Level, identified between the variables "Beer Containers" and "Median County Age".

Table 41

Median Age	CORRELATION, CONFIDENCE LEVEL, AND REGRESSION COEFFICIENT	LITTER VARIABLE
All Age Ranges	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, and Area

27-35	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area
36-39	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area
40-43	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area. Only four points are available.	Total Litter Pieces, Weight, Area

5. Median Ages and Soda Containers

There were no significant relationships, at the 95% Confidence Level, identified between the variables "Soda Containers" and "Median County Age".

Table 42

Median Age	CORRELATION, CONFIDENCE LEVEL, AND REGRESSION COEFFICIENT	LITTER VARIABLE
All Age Ranges	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area
27-35	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Pieces, Weight, Area
36-39	There is not a correlation between variables at the 95% Confidence Level for total litter pieces, weight, or area. Negative slope.	Total Litter Pieces, Weight, Area
40-43	There is not enough data to analyze. Only three points are available.	Total Litter Pieces, Weight, Area

6. Median County Population and All Litter

Three population ranges were selected for Median County Population: 4,482 - 50,149 people, 50,150-191,701 people, and 191,702 - 374,601 people.

There were significant relationships, at the 95% Confidence Level, identified between the variables "All Population Ranges" and "All Litter Categories" for Litter Pieces, Litter Weight, and Litter Area.

There were significant relationships, at the 95% Confidence Level, identified between the variables "Population from 4,482 - 50,149 and "All Litter Categories" for Litter Pieces.

Table 43

County Population	CORRELATION, CONFIDENCE LEVEL, AND REGRESSION COEFFICIENT	LITTER VARIABLE
All Population Ranges	***There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces, Weight, and Area. Flat to slightly negative Slope***	***Total Litter Pieces, Weight, Area***
4,482-50,149	***There is a correlation between variables at the 95% Confidence Level for Total Litter Pieces.***	***Total Litter Pieces***
4,482-50,149	There is not a correlation between variables at the 95% Confidence Level. For total litter pieces, weight, or area.	Total Litter Weight and Area
50,150-191,701	There is not a correlation between variables at the 95% Confidence Level for total litter pieces, weight, or area. Negative slope.	Total Litter Pieces, Weight, Area
191,702-374,601	Error message	Total Litter Pieces, Weight, Area

D. Multi Linear Regressions

Multiple Regressions (Multi-Linear Regressions)

Multiple Regression is a mathematical formula that allows the researcher to ask (and hopefully answer) the general question "what is the best predictor of litter". The general purpose of multiple regression is to learn more about the relationship between several independent and a dependent variables. For example, multiple litter subcategories might be recorded on roadsides with variable traffic volumes, in cities of different population sizes and different median county ages. Once this information has been compiled for various roadside sites it can be calculated which one of these measures (if any) relate to the amount of litter (in a specific subcategory).

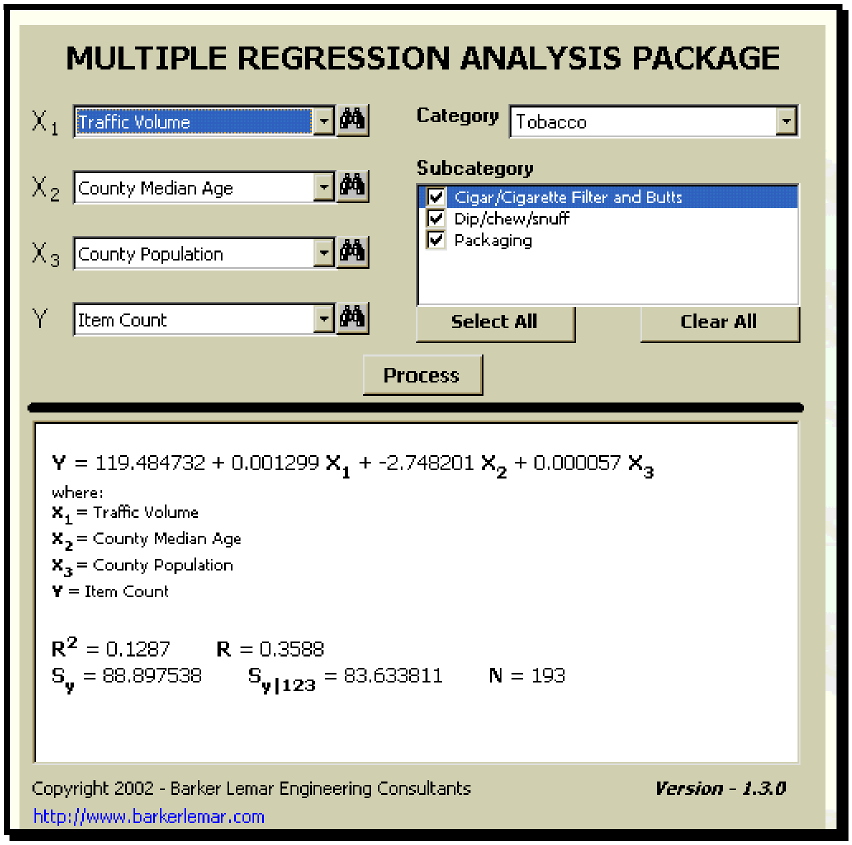
For example, a researcher might learn that the median age of a city is a better predictor of the amount of beverage containers than how many cars drive by each day.

$\mathbf{R^2}$ is the percent of the variance in the dependent explained by the independents. This section attempts to determine the following; "Is there a relationship between several variables and does this relationship represent a statistical correlation".

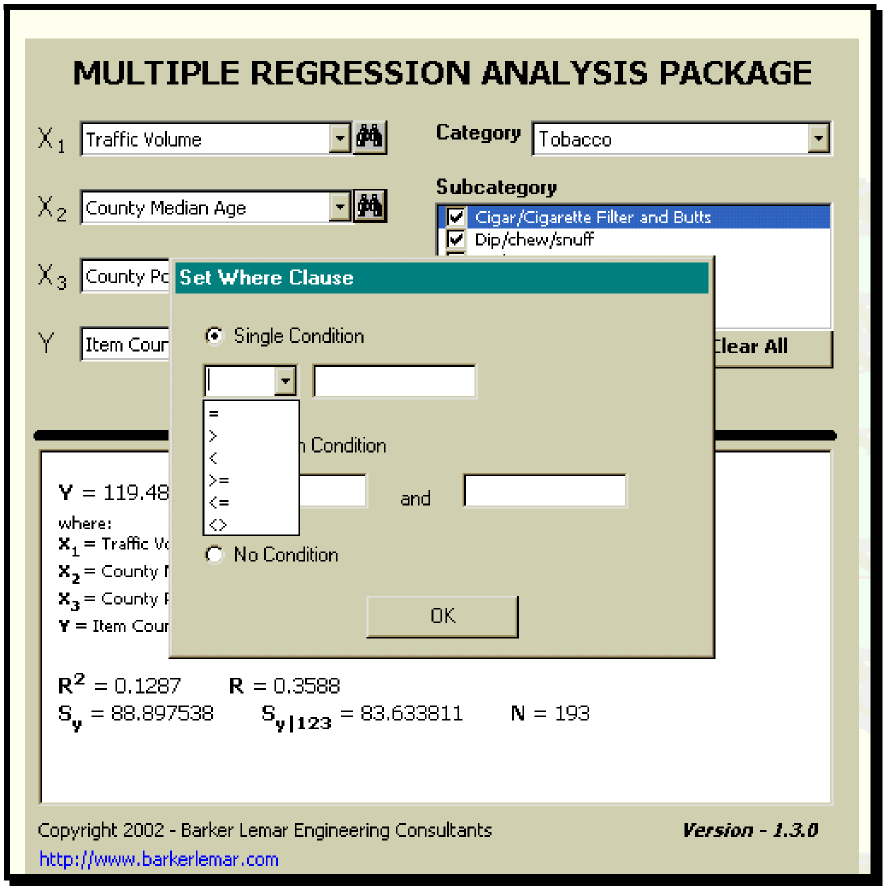
Unlike the single regression performed earlier, multiple regressions use $\mathbf{R^2}$ as the primary indicator - $\mathbf{R^2}$ is the percent of the variance in the dependent variable explained by the independent variables. This value is immediately interpretable in the following manner. If we have an $\mathbf{R^2}$ of 0.62 then we the variables listed have explained 62% of the original variability, and are left with 38% residual variability. An $\mathbf{R^2}$ close to 1.0 indicates that we have accounted for almost all of the variability with the variables specified in the model. **$\mathbf{R^2}$ cannot be interpreted as the percent of cases explained.**

Due to the almost infinite number of possible multiple regressions potentially performed using the KIB Multiple Regression Package, this section will review multiple regressions performed for two litter categories.

The Multiple Regression Package allows researchers to select the category, subcategory, traffic volume, median county age, and median county population for the X-axis. Item count, weight, or area can be selected for the Y-axis. *Note: N represents the number of points used to calculate* $\boldsymbol{R^2}$



Screen shot of KIB's Multiple Regression Analysis Package designed and programmed by BARKER LEMAR. The X and Y variables each have a "Where Clause" allowing a researcher to set the parameters for the data to be reviewed. Clicking on the Binocular Icon accesses the "Where Clause". Single Conditions or Between Conditions can be set for each of the variables.



Screen shot showing how a user may click on the Binocular Icon accesses the "Where Clause". Single Conditions or Between Conditions can be set for each of the variables.

1. Median Ages, Traffic Volume, Population and Selected Litter Subcategories

CIGAR / CIGARETTE FILTER AND BUTTS

In the example below, as traffic volume increases, the amount of original variability between variables (median, age, traffic volume, and number of litter pieces for the subcategory cigar/cigarette filter and butts) decreases ($\mathbf{R^2}$ closer to 1). Consequently this litter data shows a relatively strong relationship ($\mathbf{R^2}$ of 0.61) using the filtering parameters as listed. *Note that N (or the total sample size) is small.*

Table 44

Median Age	COUNTY POPULATION	TRAFFIC VOLUME	LITTER VARIABLE	R^2	N	LITTER VARIABLE
≥ 27	4,482-50,149	≥ 31,201	Total Litter Pieces: ≥ 1	NEDP	NEDP	Tobacco - Cigar/Cigarette Filter and Butts
≥ 27	50,150 - 191,701	≥ 9,071	Total Litter Pieces: ≥ 1	.0338	28	Tobacco - Cigar/Cigarette Filter and Butts
≥ 27	50,150 - 191,701	9,071 - 31,200	Total Litter Pieces: ≥ 1	.2743	16	Tobacco - Cigar/Cigarette Filter and Butts
≥ 27	50,150 - 191,701	≥ 31,201	Total Litter Pieces: ≥ 1	.6112	12	Tobacco - Cigar/Cigarette Filter and Butts
≥ 27	≥ 191,702	≥ 31,201	Total Litter Pieces: ≥ 1	NEDP	NEDP	Tobacco - Cigar/Cigarette Filter and Butts

NEDP = Not Enough Data Points (minimum of 4 required). As County age increases, and traffic volume remains constant not enough data point errors are regularly encountered.

CANDY WRAPPERS AND SNACK PACKAGING

In the example below, as traffic volume and population increases, the amount of original variability between variables (median, age, traffic volume, and number of litter pieces) for the subcategory candy wrappers and snack packaging decreases (**R^2** closer to 1). Consequently this litter data shows a relatively strong relationship (**R^2** of 0.59) for the listed variables. Note that N (or the total sample size) is small. Notice the increased **R^2** value as traffic volume increases and population and age remain constant.

Table 45

Median Age	COUNTY POPULATION	TRAFFIC VOLUME	LITTER VARIABLE	R^2	N	LITTER VARIABLE
≥ 27	4,482-50,149	≥ 31,201	Total Litter Pieces: ≥ 1	NEDP	NEDP	Packaging - Candy and Snack Packaging
≥ 27	50,150 - 191,701	≥ 9,071	Total Litter Pieces: ≥ 1	.0765	28	Packaging - Candy and Snack Packaging
≥ 27	50,150 - 191,701	9,071 - 31,200	Total Litter Pieces: ≥ 1	.0959	17	Packaging - Candy and Snack Packaging
≥ 27	50,150 - 191,701	≥ 31,201	Total Litter Pieces: ≥ 1	.5853	11	Packaging - Candy and Snack Packaging
≥ 27	≥ 191,702	≥ 31,201	Total Litter Pieces: ≥ 1	NEDP	NEDP	Packaging - Candy and Snack Packaging
27 - 39	≥ 50,150	≥ 31,201	Total Litter Pieces: ≥ 1	.641	13	Packaging - Candy and Snack Packaging
27 - 39	50,150 - 191,701	≥ 31,201	Total Litter Pieces: ≥ 1	.5853	11	Packaging - Candy and Snack Packaging

NEDP = Not Enough Data Points (minimum of 4 required).

BEVERAGE CONTAINERS - BEER AND SODA

In the example below, as traffic volume and population increases, the amount of original variability between variables (median, age, traffic volume, and number of litter pieces) for the subcategory beer and soda containers decreases (**R^2** closer to 1). This litter data shows a relationship (**R^2** of 0.41) for the listed variables.

Table 46

Median Age	COUNTY POPULATION	TRAFFIC VOLUME	LITTER VARIABLE	R^2	N	LITTER VARIABLE
≥ 27	4,482-50,149	≤ 31,201	Total Litter Pieces: ≥ 1	.0457	57	Item Count
≥ 27	50,150 - 191,701	≤ 31,201	Total Litter Pieces: ≥ 1	.0441	40	Item Count
≥ 27	4,482-50,149	≥ 31,201	Total Litter Pieces: ≥ 1	NEDP	NEDP	Item Count
≥ 27	50,150 - 191,701	≥ 31,201	Total Litter Pieces: ≥ 1	.0324	34	Item Count
≥ 27	≥ 191,702	≥ 31,201	Total Litter Pieces: ≥ 1	.4121	9	Item Count
≥ 27	≥ 191,702	≥ 9,071	Total Litter Pieces: ≥ 1	.1153	10	Item Count
≥ 27	≥ 50,150	≥ 31,201	Total Litter Pieces: ≥ 1	.2992	43	Item Count
27 - 39	50,150 - 191,701	≥ 31,201	Total Litter Pieces: ≥ 1	.0324	34	Item Count
27 - 39	≥ 191,702	≥ 31,201	Total Litter Pieces: ≥ 1	.4121	9	Item Count
27 - 39	≥ 191,702	≥ 9,071	Total Litter Pieces: ≥ 1	.1153	10	Item Count

NEDP = Not Enough Data Points (minimum of 4 required).
Note that N (or the total sample size) is small.

Notice the increased $\mathbf{R^2}$ value as traffic volume increases and population and age remain steady. Note that N (or the total sample size) is small for these higher R^2 values and may be attained by chance.

E. Summary of Statistically Significant Relationships

Statistics can help identify significant relationships between variables and provide a reliable prediction of information from another experiment. Additionally the significant relationships may assist KIB answer the questions, "Do the statistical correlations provide a framework from which we can develop systems to change littering behavior through education and marketing efforts?"

Cigar/Cigarette Filters and Butts, Candy and Snack Packaging, and Beer and Sods Containers show the same trend - as traffic volume increases the variability between population, age and traffic volume decreases. However 40% to 60% of the variability is still not accounted for. Other demographic or geographic variables are influencing the variability and are not accounted for in these results.

Traffic volume alone (as a single independent variable), run through the Single Regression Package, did not produce a correlation between variables at a 95% confidence Level for high or medium traffic roads. Additional variables are likely influencing the amount of litter.

Using the Multiple Regression Package and simultaneously comparing the effect of county population, county median age and traffic volume, an R^2 near .6 can be calculated. Meaning 60% of the variability can be explained with the selected variables. The .6 is attained by adjusting traffic to high volume, including all county ages, and using medium county populations. For field-tests an R^2 above .6 is thought to be a strong correlation considering all the possible outside influences (variables) not taken into consideration (such as median income, median education, pedestrian traffic, speed of vehicles, etc.).

As age is adjusted in the Multiple Regression Package an R^2 is calculated from .2 to .3. Therefore many other variables are unaccounted for in the correlation between ages, population, traffic count and litter pieces.

If littering behavior is to be changed, a theory could be developed that litter is not necessarily age specific, rather traffic volume specific. Educational information might be concentrated in the areas of heaviest traffic volume within counties of medium to high populations.

VII. RECOMMENDATIONS

A. Recommendations for Future Studies

Fresh Litter Rates are Highly Recommended

Because some of the litter collected was distributed over the sample site over several years, a fresh litter study is recommended to calculate how fast litter is accumulating and to calculate changes in the type of litter.

Follow-up Studies are Not Recommended at Rural Sites or Urban Sites Representing Incorporated Places Less than 5,000 People

Staff defined rural roadside locations as being two miles from any incorporated place. This two-mile buffer resulted in roadside sites that were extremely rural. The amount of litter located at each of these rural sites was minimal compared to urban sites in larger cities. Because traffic volume is affecting litter in Iowa, as determined from multiple regression analysis, further research on litter in rural settings could be terminated without compromising litter reduction campaigns.

As observed by field staff, the amount of litter collected in small communities was less compared to the volume of litter collected from roadside sites in larger urban areas with greater vehicle traffic. Because traffic volume is affecting litter in Iowa, further research on litter in small towns (less than 5,000 people) could be terminated without compromising litter reduction campaigns.

Additional litter characterization studies could reduce the maximum width of roadsides to 25 feet and still collect a representative sample. Staff observed a significant decline in the amount of litter pieces after they traveled 25 feet from the roadway.

B. Recommendations for Educational Initiatives

NOTE: a professional marketing firm should be enlisted to assist KIB with education and promotional campaigns using this roadside data.

A targeted litter reduction education and promotional system should involve the leading sub category data, the leading name brand data, and traffic volume data.

The litter subcategories (categories) at the top of the litter count and litter area lists are:

- Cigar/Cigarette Filters and Butts - 7,620 pieces (Tobacco Related);
- Candy and Snack Packaging - 1,212 pieces (Packaging Related);
- Plastic and Paper Cups - 206 and 217 pieces (Cup related), and;
- Beer and Soda Containers - 174 and 188 pieces (Beverage Containers).

NOTE: Miscellaneous paper (Other Small Pieces of Paper) was identified as having a greater quantity of pieces along the roadside (2,419 pieces); however this material is from many unidentifiable sources.

Leading name brands were:

- Marlboro - Cigar/Cigarette Filters and Butts (Tobacco Related);
- Snickers - Candy and Snack Packaging (Packaging Related);
- Bud Light - Beer Containers (Beverage Containers);
- Mountain Dew - Soda Containers (Beverage Containers), and;
- McDonalds - Plastic and Paper Cups (Cup related).

Education/promotion opportunities related to name brands could be applied with the following techniques:

C. Recommendations for Adapting the Litter Index to Iowa and Rural Iowa

The KAB Litter Index may require adjustments if this tool is applied toward rural areas and incorporated places less than 5,000 people. Staff scored small towns with a score of "1" consistently using the current KAB system. Staff recommends a review of the 1-4 scoring system for small urban areas making the scores more conservative.

BARKER LEMAR experimented with the Internet/GIS/Table PC technology to track and digitally record Litter Index routes and scores. Problems associated with data entry/programming bugs, memory capacity, and battery life were encountered while field testing this application during the first half of the 2001 roadside litter characterization study. However, the technology and the associated programming was de-bugged and was able to capture and download the physical Litter Index routes of Field Staff during the second half of the study. The technology uses and small GPS receiver to capture XY coordinates as the Litter Index route is driven and has fields to record the route Litter Index Score and the route's Litter index notes.

This field test showed how a State might collect electronic Litter Index Data from local affiliates and send information, including routes, over the web to parent organizations.

The collection of Litter Index Scores also provided KIB with suggestions for adjusting the KIB scoring system to accurately reflect Iowa's roadways (See Section VIII. C).

Sites 1, 2, 18, 27, 31, 56, 61, 65, 80, 96, 119, and 143 have Litter Index maps, notes, and scores recorded via handheld Tablet PCs and GPS units.

D. Recommended Studies Correlating Littered Name Brands with Iowa Sales Data

Another interesting might involve collecting sales data and calculate if the total number of name brand litter pieces identified in this litter study correlated with overall sales. If some of the leading littered name brands did not correlate with sales, then what other factors might influence their litter rate. Could it be the targeted demographic of the product, (e.g. are older or younger individuals littering)? Or, in the case of product sold primarily through fast food and/or convenience stores, is the amount of litter of a specific name brand directly related to the proximity of the roadside site to a fast food restaurant or convenience store, or proximity to a stop sign or stop light?

E. Field Observations

The high volume roads that were not interstates were observed by Barker Lemar Field Staff to have a high concentration of litter and cigarette/tobacco products. An example of this type of site would be site 11 along SE 14th Street in Des Moines.

F. Directions to Enter the GIS/Internet Site

BARKER LEMAR developed an Internet based GIS for KIB. The KIB Internet/GIS site is located at **www.internetgis.org/kib/default.asp** or via a link at **keepiowabeautiful.com**.

G. Advantages and Disadvantages of Using Customized Programming to Collect, Store, and Report Data

Staff identified several advantages associated with the development of custom programming including elimination of excessive data entry, and manipulation. Technology also provided a way to record data that would have otherwise been impossible, such as recording coordinates for the survey sites.

The Multi and Single regression Packages provided to KIB online are excellent tools to quickly perform statistics on all the litter categories, all the litter subcategories and other variables including: median county age, median county population, number of litter pieces, litter area, litter weight and traffic volume.

The tablet computers loaded with customized GIS programming created the following advantages over other electronic and hard copy reporting techniques:

- GIS programming combined with the power of the Internet allows managers to store, retrieve, and manipulate data using maps and geographical reference points. GIS provides a visual system (usually a map) showing the location of a key geographic feature (roadside sites) that are associated with other key pieces of information. For example the KIB site has multiple layers showing the geographic relationship of traffic volume and traffic type data, schools, landfills, solid waste planning areas, state lands, and US Census Bureau data to the roadside survey sites. The information linked and associated in the KIB Internet/GIS tool have been identified in other litter characterization studies as potentially impacting the level of litter on roadways.

- The GIS also stores and associates photographs and site specific litter data to each individual roadside site making data retrieval and data comparison only a few mouse clicks away. **BARKER LEMAR** has designed the GIS site to assist users generate linear regression and multiple linear regression models for various independent and dependent variables.

- The Internet/GIS website has linear regression and multi linear regression formulas pre-programmed allowing users to select independent variables for the X and Y axis from a drop-down lists. This unique feature allows users to review a wide variety of user generated statistics. Additionally, as other roadside studies are completed in Iowa, these statistical formulas can be quickly updated as the data is tied held in linked databases.

One of the disadvantages of new technology includes the time required to beta test new programming for field use. By beta testing the software field staff can test the entire system (battery life, memory capacity, data collection and storage systems, etc.) and avoid down time while collecting field data. Proper training of all staff potentially using computers, periphery attachments, and power supplies is necessary to avoid downtime. Field staff should carry paper backups of all electronic forms.

ATTACHMENT A

Stratification of Urban Cities Based on Population

ATTACHMENT B

Standard Reports