SEATTLE/KING COUNTY EMS STUDY

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I. Summary

In early 2007 the Seattle Fire Department initiated a study to see if the demand for public emergency medical services (EMS) could be predicted using demographic information. The Department has a number of compelling reasons to do this (see *Business Drivers for Conducting the Study* below). A study team was formed from the Seattle Fire Department, King County EMS Division, Medic One, and the Seattle Office of Planning & Management. A significant amount of data was collected from the Puget Sound Regional Council, King County Auditor, US Census and Seattle Department of Planning and Development to conduct the analysis.

A survey of related studies was conducted to identify parameters that were most likely to have predictive value (Attachment A). The general theory is that the number of people in a geographic area (density), and socioeconomic differences amongst people within those geographic areas would explain EMS demand.

The University of Alberta was engaged to assist in the analysis, build the model and provide advice to the team. The University has experience in conducting this type of work (but had not conducted a study specific to what this effort involved.)

Key findings:

- A reasonable forecast of EMS demand for the Seattle area (and neighborhoods within Seattle) can be made from certain demographic information. Specifically, population, number of employees, median income and property use. Over 88% of EMS demand can be explained using these variables in the model. Specific findings:
    - Medical emergencies are highly associated with demographic data that changes over time.
    - Population and employee density have the greatest positive impact on EMS demand – i. e., as density increases so will medical emergencies.
    - EMS demand varies by time of day and day-of-week with most demand occurring during the business week and business hours. This should be expected since people/employee density is greatest during those periods and people are more active and likely to experience a medical emergency.
    - Income has a negative impact on EMS demand – i. e., as income increases there is less demand for public emergency medical services.
    - Institutional and industrial properties have a negative impact on EMS demand. These facilities may have on-site medical services and increased emphasis by employers on worker safety and result in fewer medical emergencies or incidents requiring a 9-1-1 call. As an area becomes more

commercialized or institutionalized EMS demand should drop.

- Parks/open space areas (where people density is low) have a negative impact on EMS demand.

- Hospitals, clinics, and adult care facilities (nursing homes, retirement homes, etc.) have a significant positive impact on EMS demand – i. e., increases in the presence of these facilities will increase EMS demand.

- Past studies focused on ambulance demand or work load on emergency departments and not EMS. Most did not collect data over extended periods of time. However, those studies confirmed that the variables used for the modeling work completed in this study have a significant role in explaining changes in EMS demand.

- The quality of the analysis depends on demographic information (1) being available for a sufficient number of years and (2) being accurately collected at the census tract level (or some other standard geographic unit)

- Demographic information that might have been useful for the study was not available over the study period: education, ethnicity, age, etc. However, this limitation did not hinder the creation of a useful model.

- From the analysis of Seattle data there appears to be a reasonably good chance that a similar model can be constructed to forecast EMS demand for King County since the demographic data that the team finally agreed to use for modeling is available on a county-wide basis at the census tract level.

  However, Seattle is a highly urbanized area and King County has large areas that are highly rural. Care should be taken in constructing the model or models for King County. It may be appropriate to use the Seattle model for areas that have similar demographics – e. g., Bellevue/Redmond and places south of Seattle along the I-5 corridor. A different set of variables may produce a more useful for rural areas.

II. BUSINESS DRIVERS FOR CONDUCTING THE STUDY

Emergency medical services consume a significant amount of public resources and it is expected that demand for these resources will grow over time. Forecasting demand will give policy makers better information to make decisions about resource allocation, deployment and location strategies, and alternate intervention methods.

For example, every 6 years the County presents an operating levy to the voters to support regional emergency medical services. A large part of the planning and financial analysis relates to the forecast of Advanced Life Support (ALS) service demand. After a levy is passed, the County and local jurisdictions within the County should have a means of

evaluating how well the levy objectives are meeting ALS demands. Having an EMS demand forecasting tool – an objective of this study - will also help.

III. SEATTLE EMS PROFILE

Emergency medical services are provided by the Seattle Fire Department (SFD). The following resources provide basic life support (BLS) and advanced life support (ALS) to the City and mutual aid areas contiguous to the City:

- 7 Paramedic companies
- 4 Aid companies
- 33 Engine companies
- 11 Ladder truck companies

Paramedic companies are staffed by firefighter/paramedics and the other companies are staffed by firefighter/EMTs.

As of 2010 the Department has 207 on-duty firefighters, 1,030 firefighter/EMTs and 81 firefighter/paramedics.

Seattle is 84 square miles and the SFD service area is approximately 91 square miles (which includes mutual aid territories) with 193 miles of waterfront. The Department responds to approximately 63,000 medical emergencies per year (see Table 1). Transport services are provided by SFD for ALS incidents and a private ambulance company provides transport for BLS incidents. Approximately 8,500 ALS transports are done by SFD each year and 20,000 BLS transports by the ambulance company.

EMS calls by year since 1995 and additional performance information can be found at www.cityofseattle.gov/fire/statistics/stats.htm.

IV. EMS Demand Profile & Trends

This section discusses the use of SFD medical services across the City over time. The data reflects SFD responses (dispatches) to 9-1-1 calls received by the Department so it excludes calls that do not result in a dispatch of SFD resources.

A. Overall

ALS incidents peaked in the 2000-2001 period, dropped from 2002 to 2004 and have grown slowly since then.[1] (See Attachment B - Chart 2) The fluctuation was due to medical dispatching protocol changes implemented in 2002 and 2003. Protocol changes are intended to more accurately identify the correct mix of fire resources (i. e., apparatus and firefighters) to an emergency. Some of the incidents that were characterized as "ALS" in 2001 were dispatched as "BLS" in 2002. The protocol changes made in 2002 and 2003 had this effect – incidents that would have an ALS response prior to 2002 had a BLS response. As indicated in the charts below, BLS incidents increased in the 2002-through-2004 period commensurate with the decline in ALS incidents.

[1] Using a 95% confidence interval Years 2000 and 2001 are outside the interval (on the high side).

Dispatching protocols were also changed in 1996 and resulted in a reduction in ALS dispatches (approximately 500). Although exact data is not available it appears that the protocol change in 1996 resulted in BLS units being dispatched instead of ALS. This, potentially, explains why the ALS count dropped in 1997 and 1998 and the overall EMS and BLS counts continued to increase for those years. Despite the overall drop in ALS in the past seven years the fact that ALS incidents increased 5% since 1994 suggest that ALS incidents will increase city-wide (albeit slowly) regardless of protocol changes.

The EMS, ALS, and BLS charts in Attachment B.1 show incidents for a 15 year period along with trend lines. The R^2 values for the trend lines are over 0.94 for EMS and BLS. So a straight-line projection can forecast EMS and BLS with a high degree of accuracy. This means that any forecasting model based on socioeconomic and demographic data should closely match the trend lines for EMS and BLS.

A good straight-line projection for ALS is not possible because of the protocol changes discussed above. The polynomial regression measures the "fit" of non-linear data. The R^2 value (0.53) for the polynomial is higher than the linear regression (0.43) but is still not a particularly good fit because the cycle of high/lows does not occur in a consistent pattern – again, due to the fact that protocol or policy changes are not consistently applied or predictable.[2]

B. Seasonal & Time-of-Day Characteristics

Monthly: EMS calls are high in July and August and low for November, February and March.[3] The analysis of variance (ANOVA) details in Attachment B.2 show that the differences throughout the year are not great, However, the differences between ***three months*** (February and July; March and July) are statistically significant because the p-value is less than 0.05. The low R^2 value (0.0569) indicates that the overall month-to-month differences are probably better explained by factors not reflected in the ANOVA model (e. g., weather conditions, existence of holidays, major events, etc.)

Weekly: EMS calls are statistically higher on Thursday and Friday than other days of the week. The low R^2 of the ANOVA model (0.0617) suggests that the difference is due to factors not in the model. (See Attachment B.3.)

Further analysis of the effect of holidays, weather and special events may generate different results or explain the variation. For example, in 2007 five (5) of the nine (9) national holidays were on a Monday, and one holiday on Wednesday, Thursday, Friday and Saturday (with most of the public sector taking off on the preceding Friday). The number of people in Seattle, particularly employees, may be significantly lower on holidays and should reflect a drop in calls. Offsetting this would be the ***type*** of holiday that may attract people into the City. The table of 2007 data below illustrates these points:

---

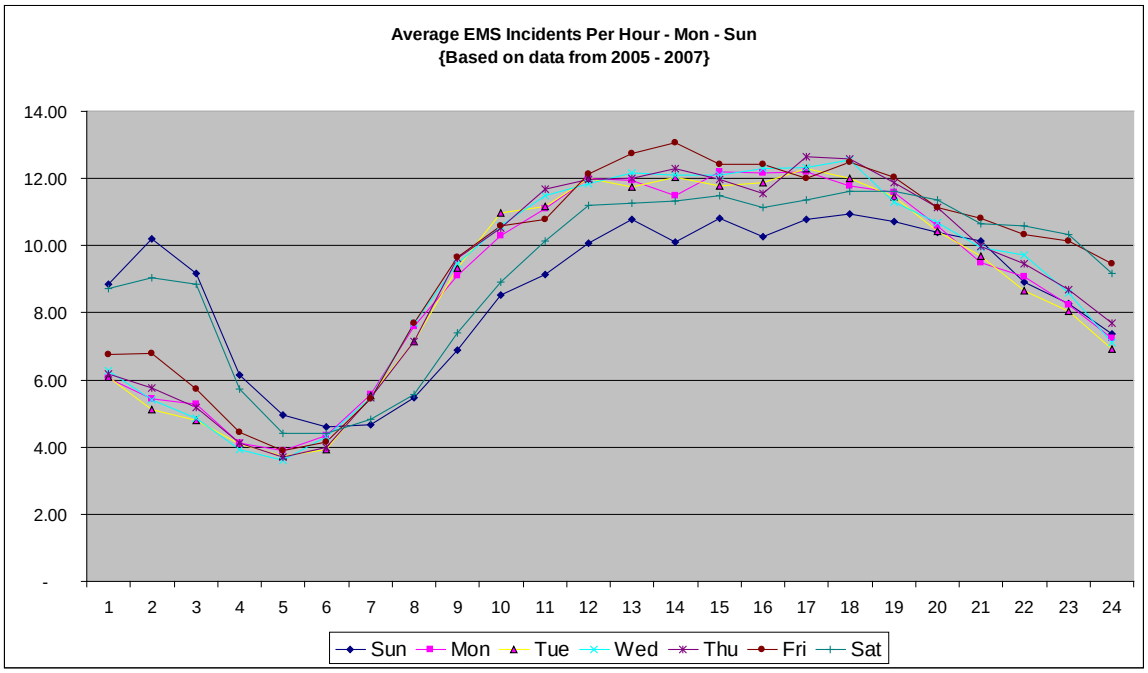
[2] Even transforming the ALS data (using the logarithm of values) does not improve the polynomial fit.

[3] The analysis is based on the average daily number of EMS calls for each month for the years 1994 through 2008. The average daily count was used instead of monthly totals because the days in a month effect the total – i. e., February has fewer days and will always have a lower monthly total.

Holiday	EMS
Monday (Jan 1, MLK, Presidents Day, Lincoln Birthday)	159 avg
Tue (Christmas)	109
Wed (July 4th)	189
Thu(Thanksgiving)	142
Sat (Veterans)	179

The EMS calls for Monday, Tuesday and Thursday are well below the averages shown in the ANOVA model (which are 168, 170 and 180 for those days). The 4th of July is the type of holiday that attracts people into Seattle for fireworks displays and other activities and is the type of holiday that would logically generate more medical emergencies, so it is not surprising that EMS calls on the 4th of July in 2007 were well above the Wednesday average of 171.

Hourly: The chart below is based on the average of EMS incidents per hour for 2005 through 2007[4]. As expected the bulk of incidents occur during business hours – 7am through 6pm.



Also, not surprising is the higher volume of calls on early Saturday and Sunday mornings.

Business Week: Approximately 45% of ***all*** EMS incidents fall into the business week day/time period: Monday-Friday, 7 a. m. to 6 p. m. Of the incidents that occur Monday-Friday approximately 60% fall within the "business work day" period 7 a. m. to 6 p. m.

[4] Prior and subsequent years were evaluated and the patterns remained the same. For this report the data set used only covers a 3 year period.

The Weekly, Hourly and Business Week patterns suggests that the number of employees should have a significant effect on EMS demand and the modeling includes the "business week/hours" analysis as well as demand during all days/hours.

V. REGRESSION MODEL – APPROACH & RESULTS

A. Study Scope

The objective of the study is to determine if there are demographic factors that can explain and predict the demand for emergency medical services. As indicated in the profile of service, most of the SFD resources are used to respond to medical emergencies.

Previous studies identified a number of independent variables associated with EMS demand. (Attachment A). These studies show that demographic factors have value in predicting the demand for emergency medical services. The studies were based primarily on 1970 and 1990 census information and EMS data collected from public and private agencies – i. e., the studies used snapshots of data collected over a short period of time (usually a single year).

The studies do not show the impact on EMS demand from ***changes*** in the independent variables over longer periods of time. The scope of this study starts with the general assumption that if the demographic factors have predictive value from the snapshot analysis then changes in those factors should predict EMS demand consistently over time. The challenge is to collect demographic data in a consistent manner over time.

B. Study Questions

The key hypotheses are:

1. Medical emergencies vary with changes in demographics – specifically population, age of population, number of households, number of employees, income, education, etc.
   - 1.1. Medical emergencies increase or decrease with increases or decreases in population/employee density.
   - 1.2. Medical emergencies vary with changes in one or more non-people density demographic variables: age, number of households, income, education, etc.
2. Medical emergencies vary over time-of-day and day-of-week as a result of changes in the number of residents and employees in geographic areas (density fluctuations)
3. Medical emergencies vary in different geographic areas that reflect the level of activity in those areas. The theory is that people in commercial, residential, recreational geographic areas engage in activity that is more or less prone to medical emergencies.

C. Data Sources

The demographic/socioeconomic data for Seattle was collected for 2000 through 2007; EMS data collected from 2000 through 2008:

Data	Source
EMS incidents	Seattle Fire Department
Population	Puget Sound Regional Council (PSRC)
Employment (number of employees)	PSRC
Land & Building Value	King County Assessor
Property Use	King County Assessor
Land Use	Seattle Department of Planning & Development (DPD)
Housing	PSRC
Building Permits	PSRC
Median Income	Federal Financial Institutions Examination Council (FFIEC)
Crime	Seattle Police Department

D. Time Period of Study

The analysis needed to be based on a consistent time period – i. e., all parameters need to have data available for all years included.[5] EMS and population data is available for 15+ years but employment was only available for 9 years (2000-2008). Therefore the modeling was based on demographic/socioeconomic data from 2000-2007 and EMS data from 2001-2008.

E. Narrowing the Model Parameters

The study needed to identify and avoid situations of co-linearity – i. e. - the analysis needed to exclude parameters that measure the same thing as another parameter (and the "best" parameter that has the strongest logical and statistical value should be used). The variables used in the modeling did not have significant levels of co-linearity[6].

In addition the team wanted a model that could be easily maintained over time. Therefore, the data used in the model needed to be:

a) Readily available and easy to collect
b) Reliable
c) Available in jurisdictions that might use the model – i. e., King County and cities within it.
d) Available on an annual basis (i. e., temporal)
e) Available on a census tract basis
f) Logically related to EMS demand

[5] The only exception to this "rule" was land use. As discussed in Part V.E, land use is very static and does not change much over time.

[6] As shown in the regression models in Attachment D, the Variance Inflation Factor (VIF) for the variables is consistently under 2, indicating only moderate-to-low multi-co linearity.

Finally, the team wanted to use previous studies as a guide in identifying appropriate parameters (since those studies proved the value of certain data in explaining EMS demand)[7].

Using the above criteria the team made the following decisions on what to include/exclude:

Population and **employment**[8] have the greatest predictive value[9] and these are parameters used in all previous studies.

Housing is highly correlated with population and the analysis needed to avoid co-linearity in the model so housing was dropped early on in the study process. However, housing was used in most of the previous studies and provided to have a significant effect on EMS demand. This outcome could not be replicated in the Seattle analysis even when housing density (and variations of this parameter) was used as a replacement for population. Although housing density had a minor impact it did not warrant using it the model as a replacement for population.

Age from the 2000 Census was used in early modeling and was identified as a powerful predictor in previous studies. Plus there is a generally recognized theory that medical emergencies in a population increase with the population age and that should be verified in the course of the analysis. Having only one year of data at the time of this study (i. e., a single point) was recognized as a weakness in using age in the model[10]. Therefore, age (specifically population over the age of 65 years) was dropped.

Since age, race, and education data was not available beyond the 2000 Census data, the analysis needed to incorporate some aspects of socioeconomic condition into the model. Previous studies have proven that these socioeconomic parameters have a significant impact on medical service demands (ambulance calls, emergency room use, etc.) The University suggested that **crime** could be used as a surrogate for these socioeconomic parameters. This was later discussed with Mike Quinn, Seattle Police Department, who suggested that crime NOT be used as a surrogate. Crime is not really predictable and if it is being used to estimate underlying demographics it would be better to identify those underlying variables (that might be highly correlated with crime *and* EMS) instead.

Crime has been excluded from the modeling exercise for this study but may be re-introduced later. The discussion about outlier observations in G.5, below, suggests that crime may have an important role in explaining the outliers if not explaining changes in medical emergency demand in general.

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[7] Siler (1975); Kvalseth (1979); Aldrich (1971). See Attachment A for references and study highlights..
[8] This is the "number of employees" in businesses with more than 25 employees. Information on small businesses that are not covered by industrial insurance in Washington has not been included in the study since it is not readily available.
[9] Contributions to the Coefficient of Determination or R^2 or Adjusted $R^{2.}$
[10] There are ways to project current population age (in/out migration, births, deaths, insurance rolls, school enrollment records, etc.) but getting this information at the census tract level would be extremely difficult.

Income data was obtained from the Federal Financial Institutions Examination Council (FFIEC). The FFIEC derives annual median income data by census tract from Federal HUD estimates of median income. There are three constraints or problems with the data: (1) observation counts – i. e., number of cases – used to determine the median (or mean) is not available, (2) information prior to 2003 is based on 1990 Census Tracts, and (3) the income data only reflects individuals who applied for a homeowner loan or refinanced a homeowner loan. The first two problems make it difficult to roll the income information up into Forecast Analysis Zones (FAZs) and all other data in this study is organized by 2000 Census Tract.

Two steps were taken to transform the median income values:

1. A weighted average of median income values was calculated for each FAZ using total housing units:

   Weighted Average = $\sum$ (Median Inc x Housing) / $\sum$ Housing

   Housing is not a perfect method of weighting the average but does reflect differences across census tracts in households that have or might possibly engage in some mortgage transaction – i. e., a homeowner buying a new home or refinancing or a renter buying a home. [11].

2. 1990 census tracts were matched to FAZs. This required splitting and adding some of the housing data to different tracts so the information was consistent across the years and could be rolled up to the FAZ level.

The third constraint (only homeowner loan data) may not lower the value of the information since the income of people engaged in mortgage transactions can be viewed as an income sample that would be consistently skewed on the high side across the years. Using homeowner income information means that many people in rental or transient living situations are excluded – which may skew the median upwards. This should not be a serious defect in using this in the model.

Land use was identified in previous studies as having some value in predicting emergencies. (See Attachment A) Land use is related to (1) the level of activity in a geographic area – e. g., traffic flow, recreational, foot traffic, etc. (2) socioeconomic status of a population and (3) 'people density' (i. e., the combination of the population and employees). Even though land use data is not available on an "annual" basis it is very slow changing parameter so including it in the model would not present a significant amount of risk even though it is "point" or non-linear data.

[11] Other methods for refining the income data is to calculate a weighted average using the population totals or square footage of land designated single and multi-family for each census tract. These will be evaluated in the update to this study if the observation counts cannot be obtained from FFIEC or HUD.

Property Use – e. g., commercial, housing, etc. - is determined on an annual basis for each parcel in King County by the King County Assessor's Office[12]. The determination is made on every parcel each year (for taxing and other purposes.) This turns out to be a better parameter for measuring the amount of "people/employee activity" in a geographic area than land use and is available on an annual basis.

Attachment D contains modeling results that are better than results using Land Use parameters because of fewer extreme residuals. In compiling data from the Assessor's Office it became clear that there is some inconsistency in the coding and possibly data collection. Property use fluctuated dramatically from year-to-year between census tracts and FAZs. It took a substantial amount of work to compile the data in a consistent format. Before using the Property Use parameters going forward there should be further study of the work done on the data, with participation of the King County Assessor's Office, to ensure that the data is reliable.

Land and building value (or total value of a geographic area) is another measure of the socioeconomic status of the population and may be related to the level of activity in a geographic area. There is no interdependence with land use or other variables[13]. Land and building values are readily available from the County Assessor's Office on an annual basis.

However, through several iterations of the model the R^2 values were inconsistent when land/building value was used – e. g., it had an acceptable p-value when used to predict EMS demand but an unacceptable p-value when used for BLS. Therefore, land/building value is not used in the model results discussed in Part V.G.

Building permits (specifically single family building permits) showed positive predictive value at one point in the analysis. However there does not appear to be any logical relationship between new single family permits and EMS incidents (although there was a coincidental high correlation between the two.) Since building permits did not contribute a significant amount to the model it was excluded from further analysis.

There were several iterations of models that included other census (point) data that contributed to higher adjusted R^2 values. However given the difficulty of measuring this data over time these parameters were excluded from the analysis.

F. Geographic Basis of Analysis

All data was collected at the Census Tract level so there would be a standard means of comparing data on a geographic basis (which would be necessary to test the theory of 'people density' explaining EMS demand).

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[12] Frequently there are multiple property uses on a parcel but the dominant or "highest" use is assigned to the parcel.

[13] Correlations between land use categories (commercial, public institution, single family, etc.) and land/building value across the forecast analysis zones (FAZs) is insignificant. The R^2 was less than 0.3 for each land use category correlated with land/building value.

Census tracts, however, are too granular for analysis because the number of observations for the different parameters is very small. We needed a higher order of aggregation. This is also suggested by previous studies.

The Puget Sound Regional Council (PSRC) uses what is called Forecast Analysis Zones (FAZ) to conduct analysis and prepare long range forecasts. The FAZs have been used for years and are roll-ups of census tracts. Since a lot of the data used in this study came from PSRC and would be a source of data in the future using the FAZ as the focus of analysis would be appropriate. Also, FAZs are highly recognizable neighborhoods so using these as a foundation to display information, findings, etc., would make presentations more understandable and make explanations for outlier results easier to identify.

G. Modeling Results

The initial analytical approach recommended by the University of Alberta was a non-linear step-wise regression analysis (similar to the approach taken in other studies and typical for analysis using non-linear or 'point' data.) Ultimately, a regular multivariate regression model was used once a useful set of independent variables were identified.

Since the objective of the study was to predict future EMS demand – and not just to establish relationships between demand and demographics - the EMS data was "shifted" one year – i. e., 2001 EMS was matched with 2000 demographic data. Since the study has multiple years of data this method of analysis should reflect the predictive value of changes in the independent variables.

After several iterations of analysis and discussions the University of Alberta was asked to produce a set of models just based on a limited set of data: population, employment (number of employees), crime, and land use/value.

The Seattle Police Department and King county demographers recommended against using crime as a surrogate variable for economic conditions. So, focus of the investigation turned to land use and property use as more meaningful surrogates for socioeconomic condition.

As the results in Attachment C indicate the model using land use produced significantly higher adjusted R^2 values than using property use variables: With land use variables EMS adjusted R^2 was 0.897, EMS during business days/hours was 0.895, BLS was 0.891 and ALS was 0.883. However, the number of unusual observations[14] was significantly higher than models using property use variables (Attachment D). This highlights the difficulty of using land use in a temporal model. The land use values (repeated for each year in the data set) do not adequately capture the changes - sometimes dramatic - in demography over time.

This is further supported by the FAZ neighborhoods that appear in the unusual observation or outlier list (e. g., Denny Regrade). These communities underwent some

[14] Standardized residual values were greater than 2.

fairly dramatic changes in housing (population) and employment during the study period and/or have neighborhood characteristics significantly different from other neighborhoods in the city. Even though the R^2 values are lower than a model with land use variables, a model with property use variables is more realistic and will probably be more stable and accurate over time.

Given the above considerations for crime and land use the team agreed to a base the model on **population, employment, median income and property use variables.**

1. EMS Data

The regression model below uses the natural log of EMS data[15] for each FAZ for years 2001 through 2008 as the dependent variable and demographic data for 2000 through 2007 as independent variables:

PopPer10K:	Population per 10,000
EmplPer10K:	Employees per 10,000
MedIncPer10K:	Median Income per $10,000 (weighted average; weighting based on number of households)
PropHOSPITAL:	Proportion of total property use within the FAZ that is Hospital
PropINSTITU_GOV_UTIL:	Proportion of total property use within the FAZ that is Institutional, Government or Utility
PropMEDCARE:	Proportion of total property use within the FAZ that is Nursing, Retirement, Rehabilitation
PropPARK_OPEN:	Proportion of total property use within the FAZ that is Park or Open Space
PropINDUS:	Proportion of total property use within the FAZ that is Industrial

The model yielded an **Adjusted R^2 of 0.882**:

```
LogEMS =     6.76 (Constant)
             + 0.422 PopPer10K
             + 0.183 EmplPer10K
             - 0.00373 MIncPer10K
             + 9.85 PropHOSPITAL
             - 1.04 PropINSTITU_GOV_UTIL
             + 7.61 PropMEDCARE
             - 0.379 PropPARK_OPEN
             - 0.528 PropINDUS
```

Details of the regression analysis for this model are in Attachment D. The plots show that residuals are normally distributed and there are not a lot of extreme data points.[16]

[15] The transformation or smoothing of the EMS data minimizes the fluctuations resulting from the ALS/BLS protocol changes and allowed the use of linear regression. Using non-transformed data would require us of non-linear regression which was beyond the capability of the study team.
[16] There are only 14 out of 231 observations with large residual values.

The caution here is that Median Income data was not derived using a more rigorous statistical method. A better estimate of Median Income may not produce similar results in the model.

3. EMS During Business Days/Hours

As indicated in the EMS Profile section, most medical emergencies occur during the working week and during business hours. Therefore, the model should have a better fit if the forecast is made using only incident data from the business day/time periods. As expected, the model for EMS in the Monday-to-Friday, 7am-to-7pm period is slightly stronger with an adjusted R^2 of 0.889

4. ALS & BLS Data

As expected the modeling results for ALS and BLS produced R^2 values different from the results for EMS: 0.867 for BLS and 0.877 for ALS. See Attachment C.3 and C.4

5. Outlier Observations

The regression analysis in Attachment D shows unusual observations falling in a discrete group of FAZs: Denny Regrade, Ravenna/University District, Magnolia and - to a lesser degree - the Industrial District.

The approach to explaining the outliers focuses on two factors:

a) The differences in population and employment ***density*** – i. e., the number of residents and employees per acre. The analysis looked at linear growth (correlation coefficient) and the rate of growth (slope).

b) **Neighborhood characteristics** that may be implied by the property uses but also include characteristics known about the specific communities but not reflected in the variables used in the modeling.

EMS incidents in the **Denny Regrade** were <u>significantly higher</u> than the model expected. The Denny Regrade had a 50% increase in population during the study period (much higher than most other neighborhoods in the city)[17]. The Regrade also had the second highest density of any FAZ: 126 per acre. Only the Central Business District had higher density (232 per acre). The Denny Regrade has a significant number of taverns and "street people" which contributed to more medical emergency calls than most other neighborhoods. The Regrade also had the second highest amount of crime (behind the Central Business District.)[18] Interestingly, the median income was the third highest in the city (which suggests that residents would use non-emergency medical services more

[17] The sum of population and employees per acre was evaluated. The evaluation is based on the slope of a least squares equation for population + employee per acre for 2000 through 2009. The slope for Denny Regrade was 2.778 and correlation coefficient of 0.75. The next largest slope was 1.36 for the First Hill/Broadway area. The slope for all other FAZs was less than 1. This indicates that the Denny Regrade density growth was abnormally high compared to the rest of the city. Most of it was due to population whereas employment fluctuated up and down.

[18] The Regrade had over 4 times the average number crimes per acre in the 1996-to-2006 period. The city-wide average was 1.7 and the Regrade was 8.1.

than other communities). However, it appears that the income variable (which does not contribute a lot in the model) is more than offset by the other factors: The high growth rate, high density, and neighborhood characteristics that are somewhat unique to this FAZ may explain why the actual observations are higher than expected.

The **Ravenna/University District (RavUD)** had actual EMS incidents significantly lower than the model expect. This FAZ is contiguous to a major university (University of Washington) so the people who live and work in this FAZ include a large number of students and young professionals. Many of the people living or working in this FAZ will have access to the University medical resources (at discounted cost to the student or employee), or are younger, healthier and are not inclined to use public emergency medical services as much as other neighborhoods. Although the density of population and employment is comparable to the average for the city it was slightly declining over the study period (slope of -0.33 and correlation coefficient of -0.57)[19].

The **University of Washington** (UW) FAZ is predominately the university, student housing and faculty facilities. The UW has over 40,000 students and 25,000 employees. The actual EMS incidents are significantly lower than the model expects. The people who live and work in this FAZ will be overwhelmingly students and young professionals with immediate access to UW medical resources. (The UW provides medical services to students and employees at discounted cost.) Therefore, it is unlikely that people in this FAZ will need public emergency medical services as much as other neighborhoods. Density growth was reasonably high (correlation coefficient of 0.85) and the rate of growth was third highest in the city (slope = 0.9). Again, the property use variables attempt to act as a surrogate for socioeconomic conditions but does not adequately reflect the characteristics of the people living and working in this neighborhood that would explain lower EMS demand.

Magnolia had actual EMS events significantly below what the model projects. It is second from the bottom in population-employee density and density has not grown over the study period (flat). Magnolia is in one of the wealthier areas of Seattle where it is expected that residents have greater access to non-emergency medical services[20]. Again, the property use variables are not capturing the extreme differences in the socioeconomic profile of Magnolia.

The **Industrial District** has actual EMS values significantly higher than the model expected for several years after 2004. As implied by the name, the Industrial District has a very high concentration of light industry with little non-business day/hour activity. Population/employment density is well below the city-wide average (18 versus 32 per acre). Traffic and pedestrian related EMS events are likely to be higher during the Monday-Friday, 7am-6pm period versus other neighborhoods and the EMS model for

[19] The city-wide average of population-employee per acre was 32. The number for Ravenna/University District was 35.

[20] Magnolia had the second highest median income over the study period – ranging from $85,00 to $110,000.

business days/hours has even more extreme observations for the Industrial District than the other models (which should be expected given this FAz's demographics).

The industrial district is contiguous to the southern part of the Central Business District (CBD). The CBD has a high concentration of homeless shelters and "street people" that has grown over the years. This may explain the increase in extreme observations for the Industrial District in the later years of the study period.

ATTACHMENT A - UNIVERSITY OF ALBERTA PRIOR STUDY SURVEY

- A total of 7 relevant papers were reviewed;
- Common predictors of demand for EMS services are: housing, income, age, ethnicity, employment
- The selection of papers includes studies in Atlanta, Southwestern Pennsylvania, Los Angeles, Chicago and Dallas;
- The coefficients of determinations (R^2) varied from 0.661 to 0.930 in these studies.

Study Authors	**Dependent Variable**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Aldrich *et al* (1971)	Demand per capita for public ambulance	E	D	I	B	C	A	J	F	H	L	G		
Gibson (1971)	Total ambulance use of patients seen in emergency rooms		C	B		D			A					
Siler (1975)	Demand per 10 residents	A						C		B				
Kvalseth and Deems (1979)	Total EMS demand	G			C	E	B		D		A	F		
Kamenetsky *et al* (1982)	Total EMS demand	A						C		B				
McConnell and Wilson (1998)	Total EMS demand			B	A									
Larkin *et al* (2006)	Total ambulance use of patients seen in emergency rooms			D	C								A	B
TOTAL # of Studies Using Listed Independent Variables		4	2	4	4	3	2	3	3	3	2	2	1	1

Independent Variable Legend:

1) Housing density	2) Recently moved	**3) Ethnicity**
4) Elderly citizens	**5) Low Income**	6) % Male unemployed
7) Total employment	**8) % Children**	**9) % Married whites**
10) Acres/capita	11) % land Commercial use	12) Mental health problems
13) Kind of insurance		

Bolded variables used in 3 or more studies

The letters – A, B, C, etc. – indicate the order of significance of the variable in the models created in the different studies. E. g. Acres/capita was the most significant variable used in the Kyalseth study.

Siler Study _ Los Angeles

The Siler study in Los Angles recognized that the population at risk for medical emergencies varies significantly throughout the day because employee migration in and out of the urban area that is not captured in census surveys. Measuring resident population alone would not be an accurate reflection of EMS demand, nor would the count of employees. So, Siler used a ratio of employees to population to reflect the assumption that in highly residential areas most of the population would leave (with some in-migration of employees) and most of the commercial/industrial areas would get the

influx of employees with a minute change in the resident population. The Siler study used the square of this ratio (and the reciprocal of it) and found that it added significant value to the model.

The study used the employee/population ratios along with housing units per capita, race and martial status. There was no analysis of this data over time. When used in the Seattle model these variables actually lowered the adjusted R^2 value.[21] Even using different combinations of these variables with housing, land use, etc., with the Seattle data produced low R^2 values. This suggests that the strength of the ratio may be coincidental for that one year or unique to the Los Angeles socioeconomic/demographic profile.

Aldrich Study – Los Angeles

This study used numerous variables to forecast EMS calls per capita and other specific medical incident types: auto and other accidents, cardiac, poison, illness, etc. The socioeconomic data was based on the 1960 census and demand data collected over a three year period from 1964 to 1967 (and a sample of that data by census tract was used in the model). The authors of the study recognized the problem with the large gap in time between the data sets and suggested conducting further analysis with the next census.

The Adjusted R^2 from this study was 0.927 using the census data as independent variables and the total number of EMS calls per capita for each census tract.

Several highlights from the analysis:

- Factors indicating lower socioeconomic status have higher EMS demand (income, unemployed, etc.)
- People under 15 years old and over 65 generate more EMS calls with those over 65 generating the most calls
- Whites generate fewer calls than non-whites
- Single white woman generate fewer calls than married whites
- Land use variables indicate that EMS demand rises as acreage per capita increases. So, commercial land had higher demand than residential and the more land devoted to commercial (relative to other uses) the higher the demand. "Commercial areas have considerably more pedestrian and auto traffic with a consequently greater opportunity for injury or illness to occur on public street(sic). Industrial land generates fewer calls than residential. Industrial settings are now relatively safe due to the influence of Workmans' Compensation laws and many industrial firms have set procedures to handle accidents without calling the public (emergency medical) system."[22]

Land use has a significant impact on EMS demand in the Seattle study but, as mentioned in the Silver study discussion, combinations of variables per capita and acres did not produce particularly useful results.

---

[21] Drops from 0.876 to 0862.

[22] Aldrich, A., et al, *An Analysis of the Demand for Emergency Ambulance Service in an Urban Area*. Am. Journal of Public Health page 1165. June 1971

KValseth Study – Atlanta

The analysis was based on one month of EMS call data in 1970 and compared with 1970 census data. The analysis produced an R^2 of 0.90 using 18 exogenous variables in a first-order model, and R^2 of 0.93 using 6 exogenous variables in a second order model.

Analysis highlights:

- Acreage and acreage per capita has the most effect on EMS demand with acres having a negative impact and acres-per-capita having a positive impact. (The authors recognized the multi-co-linearity of using both in the model). In the second order model the
- Percent of land use that was commercial had a negative effect on EMS demand. (Degree of commercialization was used as a secondary determinant in the second order model on family income, acreage and acreage per capita.)
- Family income had a significant negative impact on EMS demand – i. e., the higher the income the lower the demand.
- The interaction between the work force that commutes to work and size of an area's transient population had a substantial positive impact on EMS demand.

Income was used in the Seattle study and had the same negative effect on EMS demand. As mentioned above, land use in the Seattle study had effect on EMS demand similar to the Kvalseth and Aldrich studies.

<u>Select references</u>:

1. Andrews, R. L. Davis, J. Bettman, R. Granit, and K. Siler. *Methodologies for the Evaluation and Improvement of Emergency Medical Systems*. U. S, Department of Transportation, DOT HS-801 648, 1975.

2. Aldrich, A., C. Hisserich, and L. B. Lave. *An Analysis of the Demand for Emergency Ambulance Service in an Urban Area*. Am. Journal of Public Health 61:1158. June 1971

3. Kvalseth T. O., Deems, J. M. *Statistical Models of the Demand for Emergency Medical Services in an Urban Area*. Am. Journal of Public Health 69:250-255. 1979

4. Siler, Kenneth F., *Predicting Demand for Publicly Dispatched Ambulances in a Metropolitan Area*, Health Services Research, Fall 1975

ATTACHMENT B – EMS TRENDS

1. EMS Charts

Chart 1 – EMS Incidents 1994 - 2008

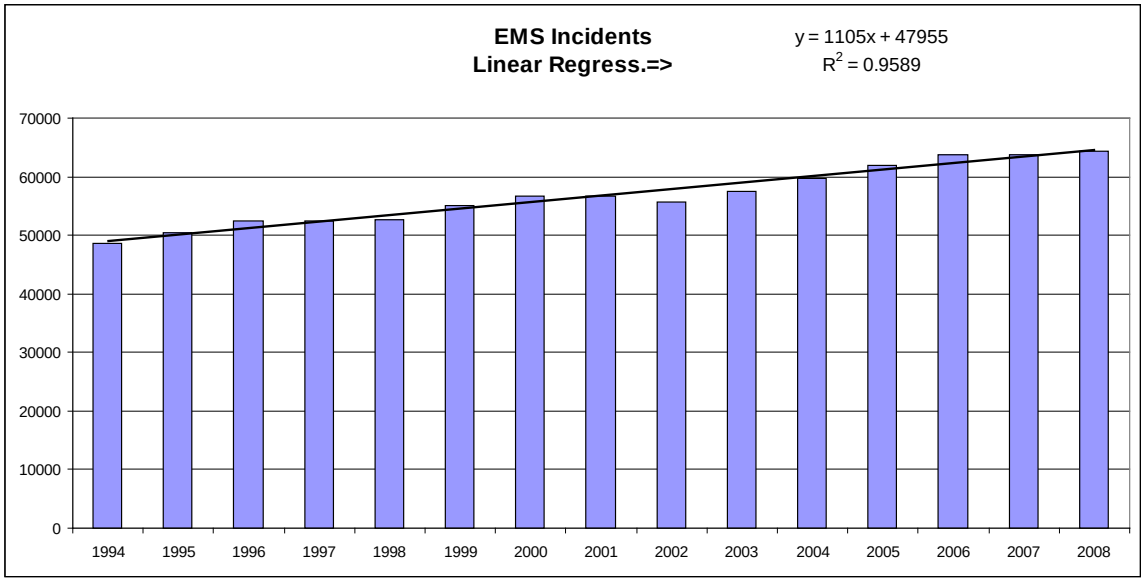


Chart 2 – ALS Incidents 1994 - 2008

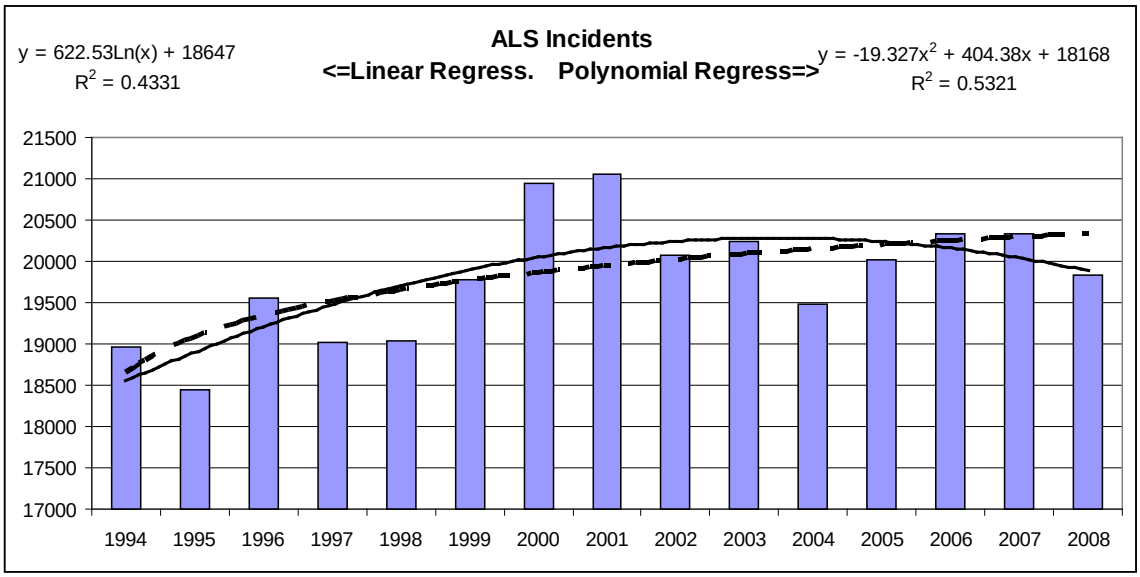
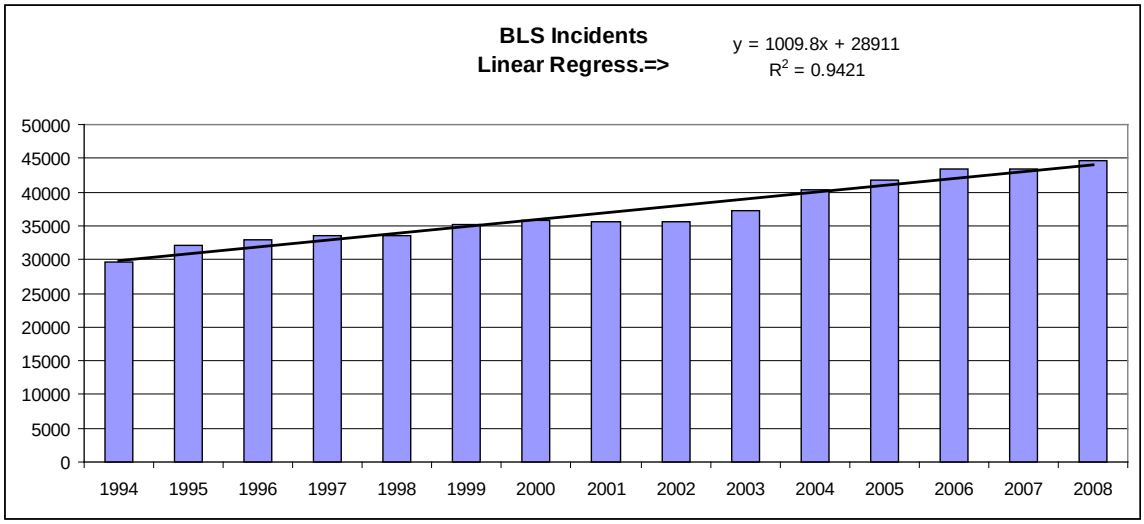


Chart 3 – BLS Incidents 1994 - 2008



2. Analysis Of Variance – EMS Monthly Differences

EMS One-way ANOVA: JAN thru DEC

```
Source   DF     SS   MS     F      P
Factor   11   4500  409  1.98  0.033
Error   168  34676  206
Total   179  39176

S = 14.37   R-Sq = 11.49%   R-Sq(adj) = 5.69%

                    Individual 95% CIs For Mean Based on Pooled StDev
Level   N    Mean  StDev    --+---------+---------+---------+-------
JAN    15  153.06  15.25        (--------*--------)
FEB    15  149.74  15.66    (--------*--------)
MAR    15  150.07  14.24    (---------*--------)
APR    15  153.79  12.42         (--------*--------)
MAY    15  157.79  14.97              (--------*--------)
JUN    15  161.12  14.62                  (--------*---------)
JUL    15  165.54  14.11                        (--------*--------)
AUG    15  162.53  13.98                    (--------*--------)
SEP    15  158.30  14.61               (--------*--------)
OCT    15  153.60  15.22         (--------*--------)
NOV    15  149.94  13.34    (--------*---------)
DEC    15  154.81  13.65          (---------*--------)
                           --+---------+---------+---------+-------
                         144.0     152.0     160.0     168.0
Pooled StDev = 14.37
Tukey 95% Simultaneous Confidence Intervals
All Pairwise Comparisons
Individual confidence level = 99.89%
```

3. Analysis Of Variance – EMS Week-Day Differences

EMS One-way ANOVA: Mon, Tue, Wed, Thu, Fri, Sat, Sun[23]

```
Source    DF      SS    MS      F      P
Factor     6   40516  6753  21.02  0.000
Error   1820  584732   321
Total   1826  625248

S = 17.92   R-Sq = 6.48%   R-Sq(adj) = 6.17%

                    Individual 95% CIs For Mean Based on Pooled StDev
Level    N    Mean  StDev    --+---------+---------+---------+-------
```

[23] Based on the number of incidents for each week day for a 5 year period: 2004-2008.

```
Mon    261  168.16  17.97        (---*----)
Tue    261  170.33  15.04            (----*---)
Wed    261  170.68  17.28             (---*----)
Thu    261  180.35  18.08                                (----*---)
Fri    261  177.03  19.97                           (---*---)
Sat    261  166.38  19.20    (----*---)
Sun    261  168.85  17.52         (----*---)
                            --+---------+---------+---------+-------
                          165.0     170.0     175.0     180.0
Pooled StDev = 17.92
Tukey 95% Simultaneous Confidence Intervals
All Pairwise Comparisons
Individual confidence level = 99.68%
```

ATTACHMENT C – MODEL RESULTS WITH LAND USE

1. EMS: Pop, Empl, Med Income, Maj Institutional Land Use, Commercial Land Use

```
LogEMS = 6.79 + 0.443 PopPer10K + 0.161 EmplPer10K - 0.00760 MIncPer10K
         - 0.890 Prop_MajInst_Land + 1.15 Prop_Comm

Predictor                Coef    SE Coef      T      P    VIF
Constant               6.7922     0.1042  65.16  0.000
PopPer10K             0.44269    0.02158  20.52  0.000  1.976
EmplPer10K            0.16071    0.01095  14.68  0.000  2.613
MIncPer10K         -0.0076024  0.0008844  -8.60  0.000  1.405
Prop_MajInst_Land     -0.8900     0.1024  -8.69  0.000  2.409
Prop_Comm              1.1534     0.1623   7.11  0.000  2.587
```

S = 0.220890 R-Sq = 89.9% R-Sq(adj) = 89.7%

```
Analysis of Variance
Source           DF       SS      MS       F      P
Regression        5   98.247  19.649  402.71  0.000
Residual Error  226   11.027   0.049
Total           231  109.274

Source             DF  Seq SS
PopPer10K           1  37.468
EmplPer10K          1  50.750
MIncPer10K          1   0.256
Prop_MajInst_Land   1   7.308
Prop_Comm           1   2.464

Unusual Observations
Year FAZ      Obs  PopPer10K  LogEMS     Fit  SE Fit  Residual  St Resid
2001 CBD        4       1.03  8.7339  9.0048  0.0766   -0.2708     -1.31 X
2001 DennyR     6       0.62  7.1131  7.0327  0.0687    0.0805      0.38 X
2001 LakeU/SC  15       1.54  8.1441  8.6355  0.0443   -0.4914     -2.27R
2001 RavUD     23       2.55  7.4582  7.9104  0.0306   -0.4522     -2.07R
2001 UW        26       0.51  5.8522  6.3908  0.0620   -0.5386     -2.54RX
2001 WallFre   27       1.65  6.9518  7.4092  0.0321   -0.4574     -2.09R
2002 CBD       33       1.08  8.7187  8.9495  0.0767   -0.2308     -1.11 X
2002 DennyR    35       0.62  7.0867  6.9326  0.0726    0.1541      0.74 X
2002 LakeU/SC  44       1.61  8.1158  8.5890  0.0429   -0.4731     -2.18R
2002 RavUD     52       2.86  7.3721  8.0107  0.0280   -0.6386     -2.91R
2002 WallFre   56       1.67  6.9217  7.3787  0.0285   -0.4570     -2.09R
2003 CBD       62       1.10  8.7608  8.8453  0.0720   -0.0845     -0.40 X
2003 DennyR    64       0.70  7.1293  6.8579  0.0773    0.2714      1.31 X
2003 RavUD     81       2.87  7.3883  7.9506  0.0268   -0.5622     -2.56R
2003 UW        84       0.25  5.8021  6.2745  0.0607   -0.4724     -2.22R
2004 BroadHL   90       2.27  7.7605  7.3152  0.0162    0.4453      2.02R
2004 CBD       91       1.11  8.8121  8.7341  0.0621    0.0780      0.37 X
2004 DennyR    93       0.75  7.2160  7.2554  0.0688   -0.0394     -0.19 X
2005 BroadHL  119       2.27  7.7744  7.3087  0.0162    0.4658      2.11R
2005 DennyR   122       0.78  7.3933  7.2919  0.0673    0.1014      0.48 X
2006 BroadHL  148       2.27  7.7647  7.3014  0.0162    0.4633      2.10R
2006 DennyR   151       0.76  7.3753  7.2558  0.0684    0.1195      0.57 X
2007 BroadHL  177       2.27  7.8352  7.2964  0.0164    0.5388      2.45R
2007 CBD      178       1.10  8.9728  8.5269  0.0529    0.4459      2.08R
2007 DennyR   180       0.82  7.5554  7.2878  0.0673    0.2676      1.27 X
2007 IndusD   186       0.25  7.5746  7.1210  0.0447    0.4536      2.10R
2008 BroadHL  206       2.29  7.8951  7.2893  0.0167    0.6058      2.75R
2008 DennyR   209       0.89  7.5213  7.3222  0.0665    0.1991      0.95 X

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
Durbin-Watson statistic = 1.81919
```

3. BLS: Pop, Empl, Med Inc , Maj Institutional Land Use, Commercial Land Use

```
LogBLS = 6.27 + 0.451 PopPer10K + 0.159 EmplPer10K - 0.00718 MIncPer10K
         - 0.743 Prop_MajInst_Land + 1.44 Prop_Comm

Predictor                Coef    SE Coef      T      P    VIF
Constant               6.2696     0.1085  57.78  0.000
PopPer10K             0.45056    0.02246  20.06  0.000  1.976
EmplPer10K            0.15942    0.01140  13.99  0.000  2.613
MIncPer10K         -0.0071831  0.0009206  -7.80  0.000  1.405
Prop_MajInst_Land     -0.7428     0.1066  -6.97  0.000  2.409
Prop_Comm              1.4376     0.1689   8.51  0.000  2.587
```

S = 0.229932 R-Sq = 89.4% R-Sq(adj) = 89.1%

```
Analysis of Variance
Source           DF       SS      MS       F      P
Regression        5  100.577  20.115  380.48  0.000
Residual Error  226   11.948   0.053
Total           231  112.525

Source             DF  Seq SS
PopPer10K           1  33.883
EmplPer10K          1  56.330
MIncPer10K          1   0.198
Prop_MajInst_Land   1   6.336
Prop_Comm           1   3.829


Unusual Observations
Obs  PopPer10K  LogBLS     Fit  SE Fit  Residual  St Resid
  4       1.03  8.3226  8.6749  0.0798   -0.3523     -1.63 X
  6       0.62  6.7393  6.7312  0.0715    0.0082      0.04 X
 15       1.54  7.7698  8.2932  0.0461   -0.5234     -2.32R
 26       0.51  5.5053  6.0235  0.0645   -0.5182     -2.35RX
 33       1.08  8.3197  8.6235  0.0799   -0.3038     -1.41 X
 35       0.62  6.6821  6.6359  0.0755    0.0462      0.21 X
 44       1.61  7.7519  8.2495  0.0446   -0.4976     -2.21R
 52       2.86  7.0031  7.5802  0.0292   -0.5772     -2.53R
 62       1.10  8.3703  8.5216  0.0749   -0.1513     -0.70 X
 64       0.70  6.7822  6.5661  0.0805    0.2161      1.00 X
 81       2.87  7.0148  7.5221  0.0279   -0.5073     -2.22R
 91       1.11  8.4820  8.4091  0.0646    0.0729      0.33 X
 93       0.75  6.8752  6.9434  0.0716   -0.0682     -0.31 X
119       2.27  7.3369  6.8742  0.0169    0.4627      2.02R
122       0.78  7.1123  6.9802  0.0701    0.1321      0.60 X
128       0.26  7.1732  6.6529  0.0453    0.5203      2.31R
148       2.27  7.3601  6.8671  0.0169    0.4930      2.15R
151       0.76  7.0758  6.9442  0.0712    0.1316      0.60 X
157       0.26  7.1601  6.7012  0.0467    0.4589      2.04R
177       2.27  7.4079  6.8627  0.0170    0.5452      2.38R
180       0.82  7.2428  6.9773  0.0701    0.2655      1.21 X
186       0.25  7.2428  6.6987  0.0465    0.5441      2.42R
206       2.29  7.5060  6.8562  0.0174    0.6498      2.83R
209       0.89  7.2174  7.0128  0.0692    0.2046      0.93 X
215       0.26  7.1785  6.7051  0.0466    0.4734      2.10R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
Durbin-Watson statistic = 1.53921
```

4. ALS: Pop, Empl, Med Inc, Maj Institutional Land Use, Commercial Land Use

```
LogALS = 5.90 + 0.426 PopPer10K + 0.165 EmplPer10K - 0.00831 MIncPer10K
         - 1.20 Prop_MajInst_Land + 0.591 Prop_Comm

Predictor                Coef    SE Coef       T      P    VIF
Constant               5.8963     0.1113   52.98  0.000
```

PopPer10K	0.42600	0.02304	18.49	0.000	1.976
EmplPer10K	0.16479	0.01169	14.09	0.000	2.613
MIncPer10K	-0.0083066	0.0009444	-8.80	0.000	1.405
Prop_MajInst_Land	-1.2008	0.1094	-10.98	0.000	2.409
Prop_Comm	0.5913	0.1733	3.41	0.001	2.587

S = 0.235857 R-Sq = 88.5% R-Sq(adj) = 88.3%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	5	96.928	19.386	348.48	0.000
Residual Error	226	12.572	0.056		
Total	231	109.501			

Source	DF	Seq SS
PopPer10K	1	45.230
EmplPer10K	1	41.016
MIncPer10K	1	0.319
Prop_MajInst_Land	1	9.716
Prop_Comm	1	0.648

Unusual Observations

Obs	PopPer10K	LogALS	Fit	SE Fit	Residual	St Resid
4	1.03	7.6468	7.7466	0.0818	-0.0997	-0.45 X
6	0.62	5.9480	5.7137	0.0734	0.2343	1.05 X
23	2.55	6.2634	6.8454	0.0327	-0.5820	-2.49R
26	0.51	4.6250	5.1732	0.0661	-0.5482	-2.42RX
27	1.65	5.8051	6.3493	0.0343	-0.5442	-2.33R
33	1.08	7.6069	7.6843	0.0819	-0.0774	-0.35 X
35	0.62	5.9865	5.6053	0.0775	0.3811	1.71 X
52	2.86	6.1964	6.9373	0.0299	-0.7408	-3.17R
55	0.33	4.5747	5.0808	0.0656	-0.5060	-2.23R
56	1.67	5.8111	6.3148	0.0304	-0.5037	-2.15R
62	1.10	7.6314	7.5752	0.0768	0.0563	0.25 X
64	0.70	5.9026	5.5218	0.0826	0.3808	1.72 X
81	2.87	6.2226	6.8733	0.0286	-0.6507	-2.78R
84	0.25	4.4886	5.0598	0.0648	-0.5712	-2.52R
85	1.67	5.8051	6.2865	0.0274	-0.4814	-2.05R
91	1.11	7.5427	7.4644	0.0663	0.0783	0.35 X
93	0.75	5.9738	5.9529	0.0734	0.0209	0.09 X
110	2.83	6.1377	6.7087	0.0230	-0.5709	-2.43R
122	0.78	5.9865	5.9891	0.0719	-0.0026	-0.01 X
151	0.76	6.0234	5.9527	0.0730	0.0708	0.32 X
177	2.27	6.7788	6.2299	0.0175	0.5489	2.33R
180	0.82	6.2403	5.9829	0.0719	0.2574	1.15 X
206	2.29	6.7627	6.2213	0.0179	0.5414	2.30R
209	0.89	6.1821	6.0153	0.0710	0.1667	0.74 X
226	2.93	6.2305	6.7310	0.0245	-0.5005	-2.13R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
Durbin-Watson statistic = 2.18825

5. EMS Business Day/Hours

LogEMSBusDyHr = 6.13 + 0.418 PopPer10K + 0.170 EmplPer10K - 0.00577 MIncPer10K
- 0.455 Prop_MajInst_Land + 0.894 Prop_Comm

Predictor	Coef	SE Coef	T	P	VIF
Constant	6.12518	0.09343	65.56	0.000	
PopPer10K	0.41751	0.01934	21.59	0.000	1.976
EmplPer10K	0.170496	0.009815	17.37	0.000	2.613
MIncPer10K	-0.0057676	0.0007927	-7.28	0.000	1.405
Prop_MajInst_Land	-0.45477	0.09183	-4.95	0.000	2.409
Prop_Comm	0.8940	0.1455	6.15	0.000	2.587

S = 0.197990 R-Sq = 89.7% R-Sq(adj) = 89.5%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	5	77.452	15.490	395.16	0.000
Residual Error	226	8.859	0.039		
Total	231	86.311			

Source	DF	Seq SS
PopPer10K	1	24.194
EmplPer10K	1	48.944
MIncPer10K	1	0.435
Prop_MajInst_Land	1	2.398
Prop_Comm	1	1.481

Unusual Observations

Obs	PopPer10K	LogEMSBusDyHr	Fit	SE Fit	Residual	St Resid
4	1.03	8.2751	8.5395	0.0687	-0.2644	-1.42 X
6	0.62	6.6346	6.4763	0.0616	0.1583	0.84 X
15	1.54	7.6280	8.0166	0.0397	-0.3886	-2.00R
23	2.55	6.8341	7.2549	0.0274	-0.4207	-2.15R
26	0.51	6.0186	6.1926	0.0555	-0.1740	-0.92 X
33	1.08	8.2008	8.4969	0.0688	-0.2960	-1.59 X
35	0.62	6.5554	6.3949	0.0650	0.1605	0.86 X
52	2.86	6.8533	7.3558	0.0251	-0.5025	-2.56R
61	2.25	7.1952	6.7878	0.0144	0.4074	2.06R
62	1.10	8.2399	8.3921	0.0645	-0.1522	-0.81 X
64	0.70	6.6464	6.3343	0.0693	0.3121	1.68 X
81	2.87	6.8189	7.3007	0.0240	-0.4818	-2.45R
90	2.27	7.1899	6.7851	0.0145	0.4048	2.05R
91	1.11	8.2703	8.2592	0.0556	0.0111	0.06 X
93	0.75	6.6567	6.6403	0.0616	0.0164	0.09 X
119	2.27	7.2056	6.7796	0.0145	0.4260	2.16R
122	0.78	6.6871	6.6786	0.0603	0.0085	0.05 X
128	0.26	6.9967	6.6013	0.0390	0.3954	2.04R
148	2.27	7.1854	6.7728	0.0145	0.4126	2.09R
151	0.76	6.7441	6.6427	0.0613	0.1013	0.54 X
157	0.26	7.0724	6.6538	0.0402	0.4187	2.16R
177	2.27	7.2584	6.7705	0.0147	0.4879	2.47R
180	0.82	6.9207	6.6770	0.0603	0.2437	1.29 X
186	0.25	7.1333	6.6532	0.0401	0.4801	2.48R
206	2.29	7.2759	6.7649	0.0150	0.5109	2.59R
209	0.89	6.8123	6.7131	0.0596	0.0993	0.53 X
215	0.26	7.0673	6.6618	0.0401	0.4055	2.09R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
Durbin-Watson statistic = 1.98917

ATTACHMENT D – MODEL RESULTS WITH PROPERTY USE

1. EMS: Pop, Empl, Med Inc, Hospital, Institu, MedCare, Park, Indus

```
LogEMS = 6.76 + 0.422 PopPer10K + 0.183 EmplPer10K - 0.00373 MIncPer10K
         + 9.85 PropHOSPITAL - 1.04 PropINSTITU_GOV_UTIL + 7.61 PropMEDCARE
         - 0.379 PropPARK_OPEN - 0.528 PropINDUS
```

Predictor	Coef	SE Coef	T	P	VIF
Constant	6.7596	0.1116	60.56	0.000	
PopPer10K	0.42190	0.02249	18.76	0.000	1.884
EmplPer10K	0.182624	0.008732	20.91	0.000	1.458
MIncPer10K	-0.0037255	0.0009845	-3.78	0.000	1.528
PropHOSPITAL	9.854	1.904	5.18	0.000	1.181
PropINSTITU_GOV_UTIL	-1.04174	0.09563	-10.89	0.000	1.513
PropMEDCARE	7.611	2.085	3.65	0.000	1.309
PropPARK_OPEN	-0.37879	0.08120	-4.66	0.000	1.455
PropINDUS	-0.52779	0.07146	-7.39	0.000	1.849

S = 0.235794 R-Sq = 88.7% R-Sq(adj) = 88.2%

Analysis of Variance

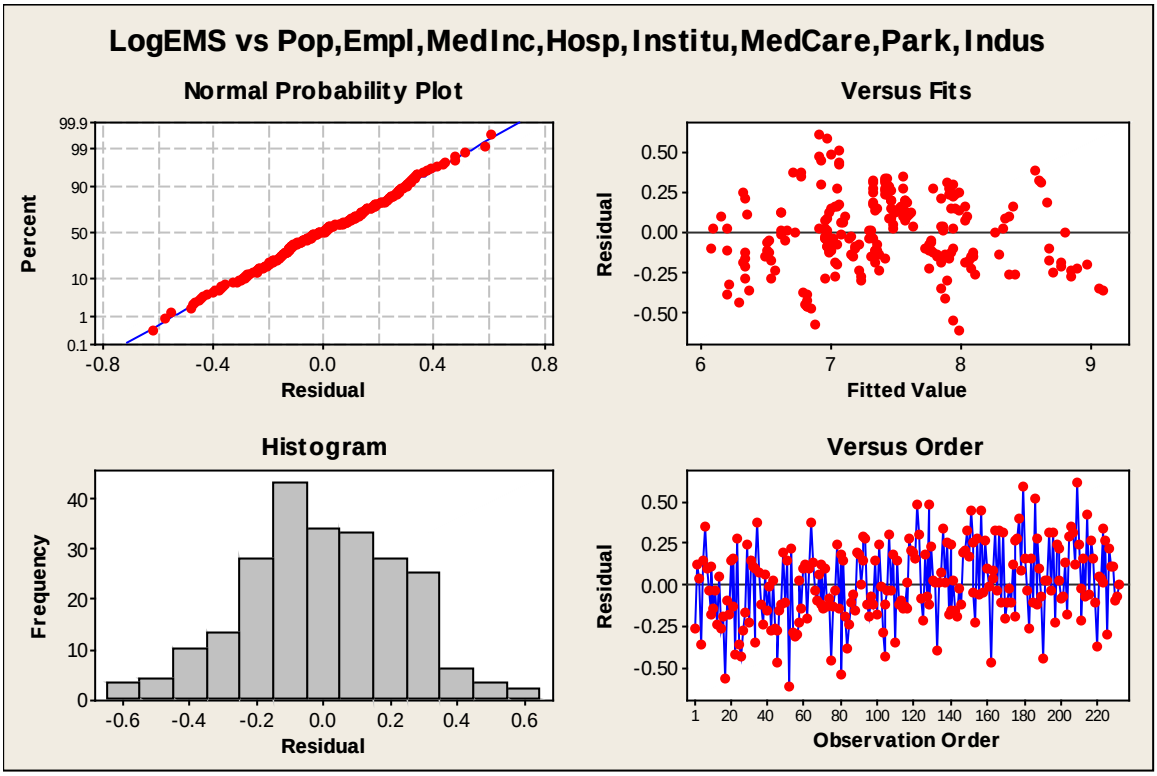
Source	DF	SS	MS	F	P
Regression	8	96.875	12.109	217.80	0.000
Residual Error	223	12.399	0.056		
Total	231	109.274			

Source	DF	Seq SS
PopPer10K	1	37.468
EmplPer10K	1	50.750
MIncPer10K	1	0.256
PropHOSPITAL	1	0.834
PropINSTITU_GOV_UTIL	1	3.306
PropMEDCARE	1	0.764
PropPARK_OPEN	1	0.464
PropINDUS	1	3.033

Unusual Observations

Year	FAZ	Obs	PopPer10K	LogEMS	Fit	SE Fit	Residual	St Resid
2001	Mag	17	1.22	6.2989	6.8767	0.0388	-0.5778	-2.48R
2001	UW	26	0.51	5.8522	6.2937	0.0819	-0.4415	-2.00 X
2002	Mag	46	1.22	6.3630	6.8455	0.0397	-0.4824	-2.08R
2002	RavUD	52	2.86	7.3721	7.9933	0.0426	-0.6212	-2.68R
2002	UW	55	0.33	5.8833	6.2084	0.0818	-0.3251	-1.47 X
2003	Mag	75	1.21	6.3491	6.8147	0.0419	-0.4656	-2.01R
2003	RavUD	81	2.87	7.3883	7.9437	0.0415	-0.5554	-2.39R
2003	UW	84	0.25	5.8021	6.1969	0.0815	-0.3948	-1.78 X
2005	DennyR	122	0.78	7.3933	6.9168	0.0403	0.4765	2.05R
2005	IndusD	128	0.26	7.4916	7.0088	0.0401	0.4829	2.08R
2006	Mag	162	1.21	6.3421	6.8141	0.0421	-0.4720	-2.03R
2007	RavUD	180	0.82	7.5554	6.9700	0.0422	0.5854	2.52R
2007	IndusD	186	0.25	7.5746	7.0609	0.0405	0.5137	2.21R
2008	DennyR	209	0.89	7.5213	6.9105	0.0379	0.6108	2.62R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
Durbin-Watson statistic = 1.87005



2. EMS BusHrs: Pop, Empl, Med Inc, Hospital, Institu, MedCare, Park, Indus

```
LogEMSBusDyHr = 6.14 + 0.381 PopPer10K + 0.193 EmplPer10K - 0.00317 MIncPer10K
                + 8.79 PropHOSPITAL - 0.555 PropINSTITU_GOV_UTIL
                + 5.53 PropMEDCARE - 0.254 PropPARK_OPEN - 0.355 PropINDUS
```

Predictor	Coef	SE Coef	T	P	VIF
Constant	6.14251	0.09619	63.86	0.000	
PopPer10K	0.38113	0.01938	19.66	0.000	1.884
EmplPer10K	0.192647	0.007526	25.60	0.000	1.458
MIncPer10K	-0.0031701	0.0008485	-3.74	0.000	1.528
PropHOSPITAL	8.789	1.641	5.36	0.000	1.181
PropINSTITU_GOV_UTIL	-0.55527	0.08242	-6.74	0.000	1.513
PropMEDCARE	5.531	1.797	3.08	0.002	1.309
PropPARK_OPEN	-0.25358	0.06998	-3.62	0.000	1.455
PropINDUS	-0.35481	0.06159	-5.76	0.000	1.849

S = 0.203220 R-Sq = 89.3% R-Sq(adj) = 88.9%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	8	77.1016	9.6377	233.37	0.000
Residual Error	223	9.2095	0.0413		
Total	231	86.3111			

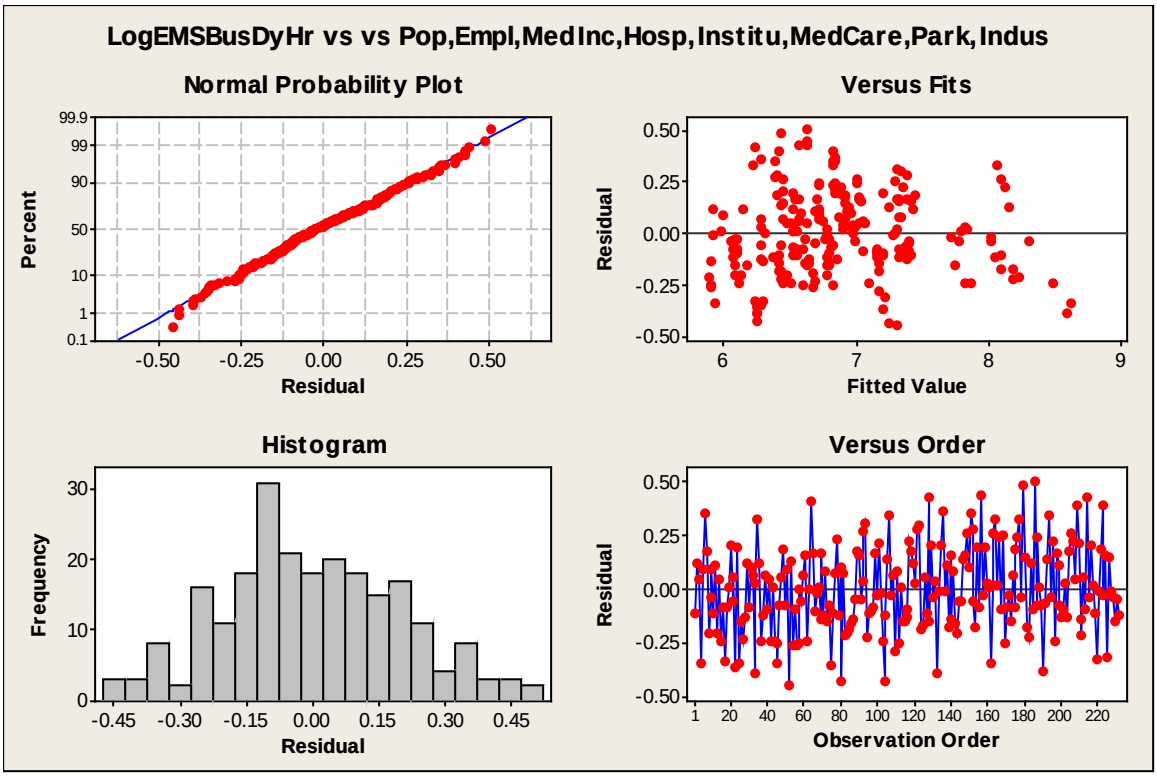
Source	DF	Seq SS
PopPer10K	1	24.1938
EmplPer10K	1	48.9443
MIncPer10K	1	0.4348
PropHOSPITAL	1	0.9179
PropINSTITU_GOV_UTIL	1	0.6314
PropMEDCARE	1	0.4022
PropPARK_OPEN	1	0.2067
PropINDUS	1	1.3704

Unusual Observations

Year	FAZ	Obs	PopPer10K	LogEMSBusDyHr	Fit	SE Fit	Residual	St Resid
2001	UW	26	0.51	6.0186	6.1737	0.0706	-0.1551	-0.81 X
2002	CBD	33	1.08	8.2008	8.5977	0.0673	-0.3968	-2.07R

2002	RavUD	52	2.86	6.8533	7.3057	0.0367	-0.4524	-2.26R
2002	UW	55	0.33	5.9989	6.0961	0.0705	-0.0972	-0.51 X
2003	DennyR	64	0.70	6.6464	6.2319	0.0586	0.4145	2.13R
2003	RavUD	81	2.87	6.8189	7.2558	0.0357	-0.4369	-2.18R
2003	UW	84	0.25	5.8861	6.0903	0.0702	-0.2042	-1.07 X
2004	Mag	104	1.22	5.8141	6.2499	0.0360	-0.4358	-2.18R
2005	IndusD	128	0.26	6.9967	6.5663	0.0346	0.4304	2.15R
2006	IndusD	157	0.26	7.0724	6.6271	0.0349	0.4454	2.22R
2007	DennyR	180	0.82	6.9207	6.4289	0.0364	0.4918	2.46R
2007	IndusD	186	0.25	7.1333	6.6253	0.0349	0.5080	2.54R
2008	IndusD	215	0.26	7.0673	6.6374	0.0349	0.4299	2.15R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
Durbin-Watson statistic = 1.87909



3. BLS: Pop, Empl, Med Inc, Hospital, Institu, MedCare, Park, Indus

```
LogBLS = 6.30 + 0.424 PopPer10K + 0.195 EmplPer10K - 0.00334 MIncPer10K
         + 9.03 PropHOSPITAL - 0.992 PropINSTITU_GOV_UTIL + 4.94 PropMEDCARE
         - 0.407 PropPARK_OPEN - 0.532 PropINDUS
```

Predictor	Coef	SE Coef	T	P	VIF
Constant	6.3024	0.1206	52.25	0.000	
PopPer10K	0.42353	0.02430	17.43	0.000	1.884
EmplPer10K	0.194939	0.009437	20.66	0.000	1.458
MIncPer10K	-0.003335	0.001064	-3.13	0.002	1.528
PropHOSPITAL	9.032	2.057	4.39	0.000	1.181
PropINSTITU_GOV_UTIL	-0.9916	0.1033	-9.59	0.000	1.513
PropMEDCARE	4.942	2.253	2.19	0.029	1.309
PropPARK_OPEN	-0.40723	0.08775	-4.64	0.000	1.455
PropINDUS	-0.53229	0.07723	-6.89	0.000	1.849

S = 0.254828 R-Sq = 87.1% R-Sq(adj) = 86.7%

Analysis of Variance

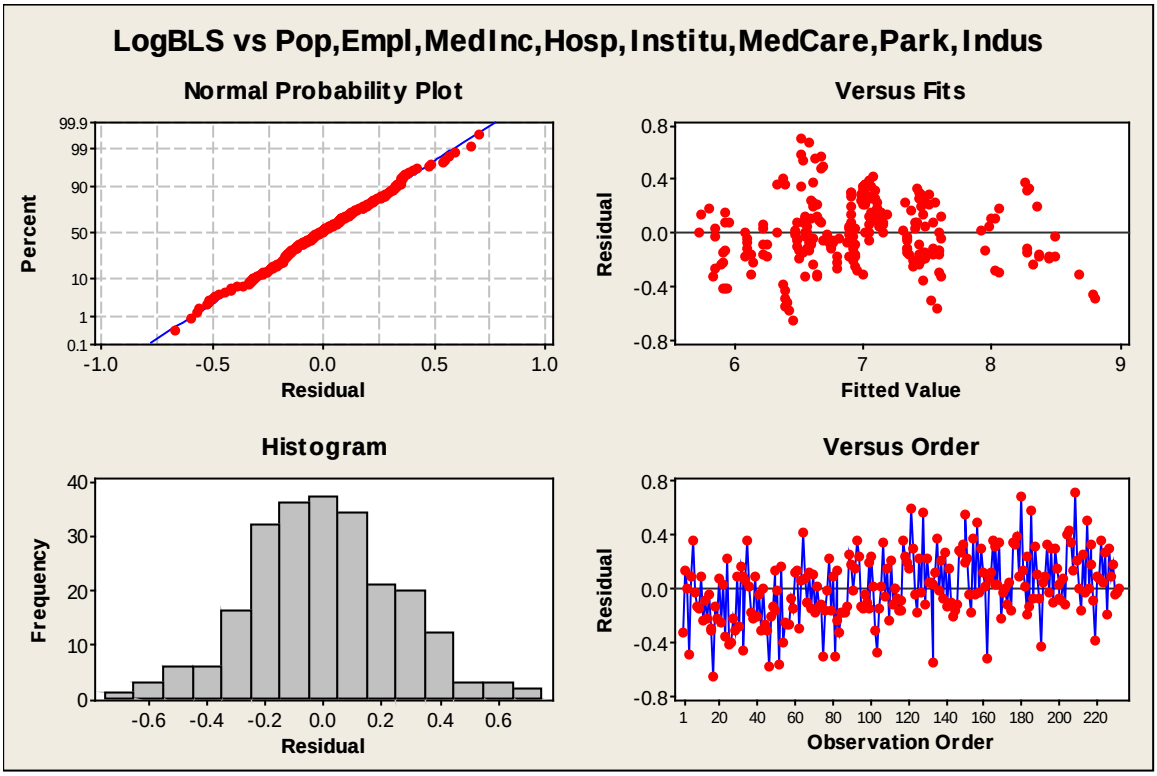
Source	DF	SS	MS	F	P
Regression	8	98.044	12.256	188.73	0.000
Residual Error	223	14.481	0.065		
Total	231	112.525			

Source	DF	Seq SS
PopPer10K	1	33.883
EmplPer10K	1	56.330
MIncPer10K	1	0.198
PropHOSPITAL	1	0.701
PropINSTITU_GOV_UTIL	1	2.935
PropMEDCARE	1	0.330
PropPARK_OPEN	1	0.582
PropINDUS	1	3.084

Unusual Observations

Year	FAZ	Obs	PopPer10K	LogBLS	Fit	SE Fit	Residual	St Resid
2001	CBD	4	1.03	8.3226	8.8163	0.0848	-0.4936	-2.05R
2001	Mag	17	1.22	5.7900	6.4555	0.0420	-0.6656	-2.65R
2001	UW	26	0.51	5.5053	5.9217	0.0885	-0.4164	-1.74 X
2002	Mag	46	1.22	5.8348	6.4276	0.0429	-0.5928	-2.36R
2002	RavUD	52	2.86	7.0031	7.5767	0.0460	-0.5737	-2.29R
2002	UW	55	0.33	5.5683	5.8363	0.0884	-0.2680	-1.12 X
2003	Mag	75	1.21	5.8805	6.3997	0.0453	-0.5192	-2.07R
2003	RavUD	81	2.87	7.0148	7.5261	0.0448	-0.5113	-2.04R
2003	UW	84	0.25	5.4889	5.8271	0.0881	-0.3382	-1.41 X
2005	DennyR	122	0.78	7.1123	6.5187	0.0436	0.5936	2.36R
2005	IndusD	128	0.26	7.1732	6.6172	0.0434	0.5560	2.21R
2005	Mag	133	1.21	5.8406	6.3969	0.0454	-0.5562	-2.22R
2006	DennyR	151	0.76	7.0758	6.5295	0.0468	0.5463	2.18R
2006	Mag	162	1.21	5.8749	6.3994	0.0455	-0.5245	-2.09R
2007	DennyR	180	0.82	7.2428	6.5706	0.0457	0.6722	2.68R
2007	IndusD	186	0.25	7.2428	6.6742	0.0438	0.5686	2.26R
2008	DennyR	209	0.89	7.2174	6.5165	0.0410	0.7010	2.79R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
Durbin-Watson statistic = 1.66363



4. ALS: Pop, Empl, Med Inc, Hospital, Institu, MedCare, Park, Indus

```
LogALS = 5.72 + 0.433 PopPer10K + 0.161 EmplPer10K - 0.00454 MIncPer10K
         + 9.93 PropHOSPITAL - 1.17 PropINSTITU_GOV_UTIL + 10.8 PropMEDCARE
         - 0.277 PropPARK_OPEN - 0.495 PropINDUS

Predictor                  Coef    SE Coef       T      P    VIF
Constant                 5.7193     0.1142   50.06  0.000
PopPer10K               0.43302    0.02302   18.81  0.000  1.884
EmplPer10K             0.160880   0.008938   18.00  0.000  1.458
MIncPer10K            -0.004541   0.001008   -4.51  0.000  1.528
PropHOSPITAL              9.931      1.949    5.10  0.000  1.181
PropINSTITU_GOV_UTIL   -1.17125    0.09789  -11.97  0.000  1.513
PropMEDCARE              10.818      2.134    5.07  0.000  1.309
PropPARK_OPEN          -0.27675    0.08312   -3.33  0.001  1.455
PropINDUS              -0.49511    0.07315   -6.77  0.000  1.849
```

S = 0.241358 R-Sq = 88.1% R-Sq(adj) = 87.7%

```
Analysis of Variance
Source            DF       SS      MS       F      P
Regression         8   96.510  12.064  207.09  0.000
Residual Error   223   12.991   0.058
Total            231  109.501

Source                 DF  Seq SS
PopPer10K               1  45.230
EmplPer10K              1  41.016
MIncPer10K              1   0.319
PropHOSPITAL            1   0.746
PropINSTITU_GOV_UTIL    1   4.858
PropMEDCARE             1   1.509
PropPARK_OPEN           1   0.162
PropINDUS               1   2.669

Unusual Observations
Year FAZ      Obs  PopPer10K  LogALS     Fit  SE Fit  Residual  St Resid
2001 RavUD     23       2.55  6.2634  6.8030  0.0455   -0.5396     -2.28R
2001 UW        26       0.51  4.6250  5.0675  0.0839   -0.4425     -1.96 X
```

```
2001 WindLH    29        1.71  5.6768  5.0895  0.0770    0.5872      2.57R
2002 RavUD     52        2.86  6.1964  6.9145  0.0436   -0.7181     -3.02R
2002 UW        55        0.33  4.5747  4.9796  0.0838   -0.4049     -1.79 X
2003 RavUD     81        2.87  6.2226  6.8664  0.0424   -0.6439     -2.71R
2003 UW        84        0.25  4.4886  4.9627  0.0834   -0.4741     -2.09RX
2004 RavUD    110        2.83  6.1377  6.7623  0.0380   -0.6246     -2.62R
2007 RavUD    197        2.60  6.1377  6.6600  0.0364   -0.5222     -2.19R
2008 RavUD    226        2.93  6.2305  6.7943  0.0387   -0.5639     -2.37R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
Durbin-Watson statistic = 2.18135
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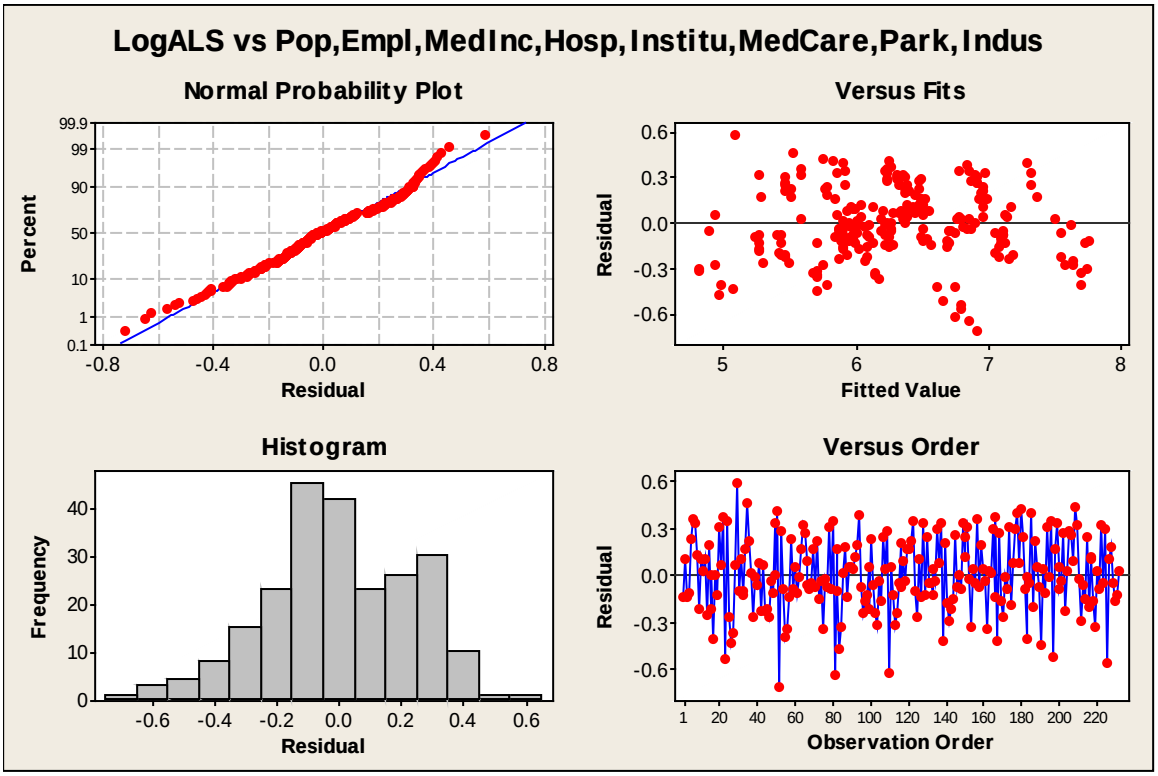

ORDER OF FAZ by Population, Employment, Pop & Employment and (Pop + Empl)/Acre

FAZ	POP	FAZ	EMPLY	FAZ	Pop&Empl	FAZ	Pop&Empl Per Acre
SBeaconH/Colum	37400	CBD	93,763	CBD	105,240	Denny Regrade	49.10
Alki / Admiral	34166	LkUn/SeaCtr	65,230	LkUn/SeaCtr	84,066	First Hill / Broadway	41.39
Greenwood/CrwnH	34015	First Hill / Broadway	44,128	First Hill / Broadway	76,369	Rav/UW	27.21
ECapHill/CentralA	33104	Industrial District	42,197	Industrial District	44,756	CBD	23.42
First Hill / Broadway	32241	LowerDuwam/Boeing	26,551	ECapHill/CentralA	44,192	Queen Anne	18.38
Rav/UW	29330	UW	25,267	SBeaconH/Colum	42,592	Wallingford / Fremont	17.87
Delridge/HighPk	28987	Denny Regrade	16,340	Alki / Admiral	41,976	ECapHill/CentralA	16.32
Lake City	26975	Ballard	14,434	Rav/UW	40,220	LkUn/SeaCtr	14.85
NBeaconH/MtBaker	26169	Northgate	12,819	Ballard	40,015	Ballard	13.17
Ballard	25581	Wallingford / Fremont	11,716	Greenwood/CrwnH	39,154	Green Lake	12.71
Queen Anne	24939	ECapHill/CentralA	11,088	LowerDuwam/Boeing	37,144	Northgate	12.66
Wedgewood/VR	24160	Rav/UW	10,890	NBeaconH/MtBaker	35,882	SBeaconH/Colum	11.61
Bview/Haller	22861	NBeaconH/MtBaker	9,713	Queen Anne	34,519	Alki / Admiral	11.23
Green Lake	20723	Queen Anne	9,580	Delridge/HighPk	34,432	Greenwood/CrwnH	11.20
NCapHill/MadPk	20431	Bview/Haller	8,075	Lake City	32,205	NBeaconH/MtBaker	10.61
Rainier Beach	19918	Wnd/Laurelh	7,898	Bview/Haller	30,936	Lake City	10.33
Wnd/Laurelh	19130	Alki / Admiral	7,810	Northgate	30,679	NCapHill/MadPk	9.93
LkUn/SeaCtr	18836	UpperDuwam/HI	7,214	UW	29,298	Wedgewood/VR	9.70
Northgate	17860	Interbay	6,841	Wallingford / Fremont	28,903	Wnd/Laurelh	9.34
Wallingford / Fremont	17187	NCapHill/MadPk	5,868	Wedgewood/VR	27,986	Delridge/HighPk	8.91
Fauntl/ArborH	16365	Green Lake	5,740	Wnd/Laurelh	27,028	Rainier Beach	8.88
Magnolia	12116	Delridge/HighPk	5,445	Green Lake	26,463	Bview/Haller	8.50
CBD	11477	Lake City	5,230	NCapHill/MadPk	26,299	Fauntl/ArborH	8.39
LowerDuwam/Boeing	10593	SBeaconH/Colum	5,192	Denny Regrade	25,277	Interbay	7.82
Interbay	9475	Greenwood/CrwnH	5,139	Rainier Beach	23,236	UW	6.53
Denny Regrade	8937	Wedgewood/VR	3,826	Fauntl/ArborH	17,504	Magnolia	6.04
UpperDuwam/HI	4819	Rainier Beach	3,318	Interbay	16,316	LowerDuwam/Boeing	3.44
UW	4031	Magnolia	2,016	Magnolia	14,132	UpperDuwam/HI	3.00
Industrial District	2559	Fauntl/ArborH	1,139	UpperDuwam/HI	12,033	Industrial District	1.09

ATTACHMENT E – KING COUNTY PROPERTY USE TABLE

Demand Study Property Use Category	County Property Use	County Property Use Sub-Category
COMMERCIAL	Agriculture	Greenhse/Nrsry/Hort Srvc
	Office	Medical/Dental Office
	Office	Office Building
	Office	Historic Prop(Office)
	Office	Office Park
	Office	Condominium(Office)
	Office	High Tech/High Flex
	Other	Historic Prop(Misc)
	Parking	Parking(Assoc)
	Parking	Parking(Commercial Lot)
	Parking	Parking(Garage)
	Public Facility	Art Gallery/Museum/Soc Srvc
	Public Facility	Auditorium//Assembly Bldg
	Recreation/Entertainment	Historic Prop(Park/Billbrd)
	Recreation/Entertainment	Health Club
	Recreation/Entertainment	Historic Prop(Rec/Entertain)
	Recreation/Entertainment	Sport Facility
	Recreation/Entertainment	Club
	Recreation/Entertainment	Bowling Alley
	Recreation/Entertainment	Movie Theater
	Retail/Service	Mini Lube
	Retail/Service	Restaurant(Fast Food)
	Retail/Service	Restaurant/Lounge
	Retail/Service	Retail Store
	Retail/Service	Retail(Big Box)
	Retail/Service	Retail(Discount)
	Retail/Service	Retail(Line/Strip)
	Retail/Service	Hotel/Motel
	Retail/Service	Resort/Lodge/Retreat
	Retail/Service	Tavern/Lounge
	Retail/Service	Vet/Animal Control Srvc
	Retail/Service	Auto Showroom and Lot
	Retail/Service	Bank
	Retail/Service	Car Wash
	Retail/Service	Conv Store with Gas
	Retail/Service	Service Building
	Retail/Service	Grocery Store
	Retail/Service	Historic Prop(Retail)
	Retail/Service	Shopping Ctr(Regional)

Demand Study Property Use Category	County Property Use	County Property Use Sub-Category
	Retail/Service	Shopping Ctr(Nghbrhood)
	Retail/Service	Shopping Ctr(Maj Retail)
	Retail/Service	Shopping Ctr(Community)
	Retail/Service	Mortuary/Cemetery/Crematory
	Retail/Service	Service Station
	Retail/Service	Conv Store without Gas
	Terminal/Warehouse	Historic Prop(Loft/Warehse)
	Terminal/Warehouse	Mini Warehouse
	Terminal/Warehouse	Warehouse
EASEMENT	Other	Easement
	Utility	Right of Way/Utility, Road
HOSPITAL	Public Facility	Hospital
INDUS	Industrial	Industrial(Lignt)
	Industrial	Industrial(Heavy)
	Industrial	Industrial(Gen Purpose)
	Industrial	Industrial Park
	Recreation/Entertainment	Marina
	Terminal/Warehouse	Terminal(Marine)
	Terminal/Warehouse	Air Terminal and Hangers
	Terminal/Warehouse	Terminal(Rail)
	Terminal/Warehouse	Terminal(Marine/Comm Fish)
	Terminal/Warehouse	Terminal(Auto/Bus/Other)
INSTITU_GOV_UTIL	Church	Church/Welfare/Relig Srvc
	Government Service	Governmental Service
	Government Service	Post Office/Post Service
	School/Daycare	Daycare Center
	School/Daycare	School(Public)
	School/Daycare	School(Private)
	Utility	Utility, Public
	Utility	Utility, Private(Radio/T_V_)
MEDCARE	Other Housing	Nursing Home
	Other Housing	Rehabilitation Center
	Other Housing	Retirement Facility
MULTI_FAM	Mixed Use	Apartment(Mixed Use)
	Mixed Use	Condominium(Mixed Use)
	Multi-Family	Condominium(Residential)
	Multi-Family	4-Plex
	Multi-Family	Apartment
	Multi-Family	Apartment(Co-op)
	Multi-Family	Apartment(Subsidized)

Demand Study Property Use Category	County Property Use	County Property Use Sub-Category
	Multi-Family	Triplex
	Multi-Family	Townhouse Plat
	Multi-Family	Duplex
	Other Housing	Bed & Breakfast
PARK_OPEN	Park/Playground	Park, Public(Zoo/Arbor)
	Park/Playground	Open Space(Curr Use-RCW 84_34)
	Recreation/Entertainment	Golf Course
	Recreation/Entertainment	Park, Private(Amuse Ctr)
	Recreation/Entertainment	Driving Range
RESIDENTIAL	Other Housing	Houseboat
	Other Housing	Historic Prop(Residence)
	Other Housing	Mobile Home Park
RMHOUSE_DORM_GROUPHOME	Other Housing	Group Home
	Other Housing	Residence Hall/Dorm
	Other Housing	Fraternity/Sorority House
	Other Housing	Rooming House
SINGLE_FAM	Single Family	Single Family(Res Use/Zone)
	Single Family	Single Family(C/I Zone)
	Single Family	Single Family(C/I Use)
UNK	UNK	UNK
VACANT	Other	Shell Structure
	Vacant	Vacant(Industrial)
	Vacant	Vacant(Multi-family)
	Vacant	Vacant(Single-family)
	Vacant	Vacant(Commercial)