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Daviess County Hazardous Materials Commodity Flow Study

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Daviess County Hazardous Materials Commodity Flow Study

Final Report
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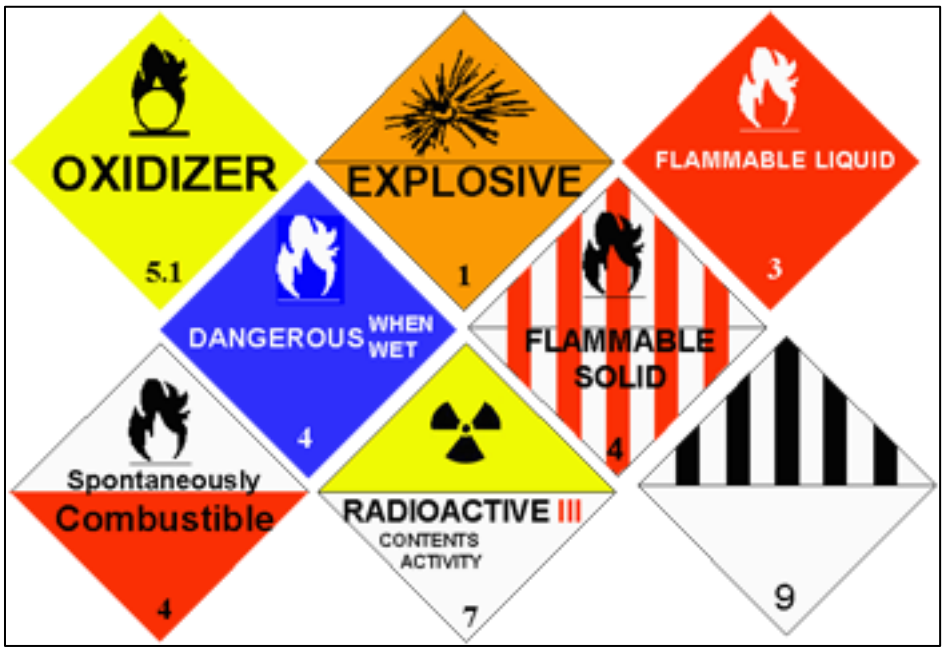

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Prepared by:

Daviess County Hazardous Materials Commodity Flow Study

This project was completed by Western Kentucky University in partnership with

Daviess County, KY Emergency Management Agency

and

Owensboro/Daviess County Local Emergency Planning Committee

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Chapter 1

Introduction

This report presents the results of a Hazardous Materials Commodity Flow Study for Daviess County, KY. Study components were conducted by Western Kentucky University in partnership with Daviess County Emergency Management Agency. The study area was focused in Daviess County and included a railway-monitoring site near Henderson, KY. A map of the Daviess County is shown in Figure 1.1. As part of this study, hazardous materials (hazmats) transported through the study area were monitored via placard surveys at the following sites:

- U.S. Highway 60 (Hwy 60), east and westbound lanes at East Fourth Street & the Hwy 60 Bypass (U.S. 231)
- U.S. Route 231 (Route 231), southbound lanes at East Fourth Street & and U.S. 231 South
- William H. Natcher Parkway (Natcher Pkwy), north and southbound lanes at 4301 Plantation Pointe.
- Audubon Parkway, east and westbound lanes at second overpass west of Owensboro
- CSX Railway (CSX), north and southbound trains monitored from Sunset Park in Henderson, KY while crossing over bridge between Kentucky and Indiana.

The purpose of this report is to present information on patterns of hazardous materials commodity flow along Hwy 60, Hwy 231, Natcher Parkway, Audubon Parkway, and CSX, as observed from May 27, 2013 to August 7, 2013. This report also summarizes incidents involving hazardous materials over the previous 5 years, December 2008 to June 2013, in Daviess County.

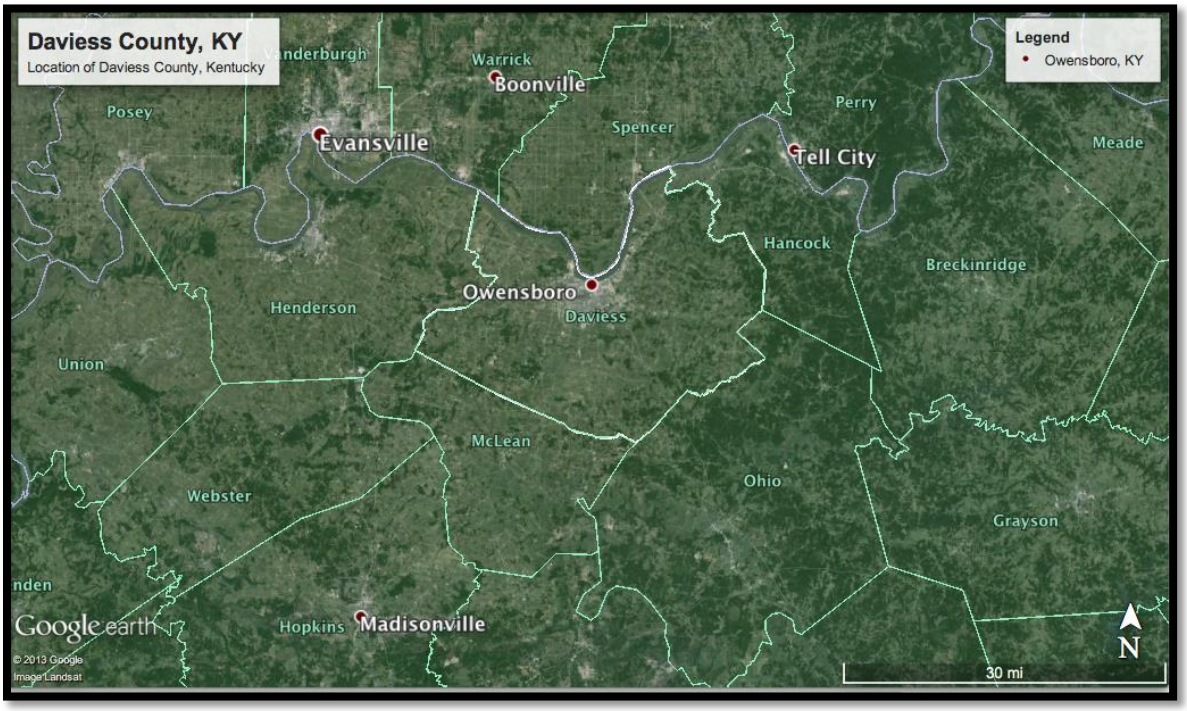

Figure 1.1. Location of Daviess County in Kentucky.

Finally, this report assesses survey information collected from fixed facilities that ship and receive hazardous materials in Daviess County. The results obtained through this study can serve as a source of information to increase hazardous materials incident preparedness of Daviess County and contiguous communities, Daviess County Emergency Management (DCEM), and Daviess County Local Emergency Planning Committee (LEPC). Data collected will aid in the emergency planning and response process for specific hazardous material incidents. This information can be used to forecast the risk of specific events, and to aid in the development of contingency plans for emergency response and preparedness.

i. Background

Commodity flow studies have a primary goal of identifying the transport of specific goods through the transportation system of a specific area (Taylor, 2010). Commodity, as defined by the EPA, is any

physical good moving or any good being transported (U.S. EPA, 2010). In this particular study, hazardous materials are the commodities of interest and are defined in the following ways:

- US Department of Transportation: "Any substance or material in any form or quantity which poses an unreasonable risk to safety and health and to property when transported in commerce," (US DOT, 1991).
- US EPA: "Any material, which when discharged into the environment, may be harmful to the public health or welfare of the United States," (U.S. EPA, 2010).

According to the EPA, a material is considered hazardous if it displays one or more of the following characteristics (U.S. EPA, 2010):

- Ignitability: Can create fires under certain conditions. e.g. fuels which catch fire, and friction-sensitive substances.
- Corrosivity: Is acidic and capable of corroding metal.
- Reactivity: Can create explosions or toxic fumes, gases, or vapors when exposed or mixed with water.
- Toxicity: Is harmful or fatal when ingested, breathed, or absorbed by the skin.

Hazardous material categories include:

- Explosive Substances: will release pressure, gas, and heat when exposed to sudden shock, heat, or high pressure. e.g. Explosives, fuel, ammonium nitrate.
- Flammable and Combustible Substances: either liquid or solid, that can be easily ignited. e.g. petroleum substances.
- Toxic Materials (Poisons): can cause injury or death when they enter the bodies of living organisms; can be classified by chemical nature or toxic action. e.g. heavy metals, cyanides, irritants.
- Oxidizers: supply oxygen to support normally non-flammable materials. e.g. fertilizers (oxides).
- Radioactive Materials: emit harmful rays and particles with their decay. e.g. plutonium, cobalt.

- Etiological Materials: cause disease or infection. e.g. microbes which cause rabies, botulism, tetanus.

ii. Davies County Study Area

The study area was Daviess County, Kentucky as shown in Figure 1.1. Data from a railway placard survey near Henderson, Kentucky was included in the analysis for this report. Sites in Daviess County for placard surveys of hazmat commodity flow are shown in Figure 1.2. These sites were selected in order to monitor major commodity flow routes through the County. Placard surveys were conducted on the roadways described below. Additionally, fixed facilities, located in Daviess County, that receive and ship hazmats were surveyed to assess commodity flow.

U.S. Hwy 60 is a major part of the U.S. Highway System spanning some 2,670 miles as it travels east to west across the country. Hwy 60 begins in Virginia Beach, Virginia and ends at Brenda, Arizona. The speed limit varies across different sections of the highway; however where our monitoring location was located in Daviess County the speed limit is 35 mph.

Another roadway sampled during this study was U.S. Route 231. Route 231 runs north to south for 912 miles. U.S. 231 begins in St. John, Indian and ends in Panama City, Florida. The speed limit on U.S. 231 varies as it passes through different jurisdictions. A placard survey location was established in Daviess County and the speed limit at this site was 55 mph.

A placard survey was completed for the Audubon Parkway approximately five miles west of its eastern terminus near Owensboro, KY. Route 279 crosses the Audubon Parkway at this location. Audubon Parkway is one of nine controlled access freeways in the Kentucky parkway system. The Audubon Parkway is the shortest parkway in the state, at only 23.4 Miles. The Audubon Parkway connects Owensboro, KY at its eastern terminus to Henderson, KY at its western terminus. Audubon Parkway's speed limit is 70 mph along its entire stretch. However, the speed limit was 60 mph during the survey due to road construction.

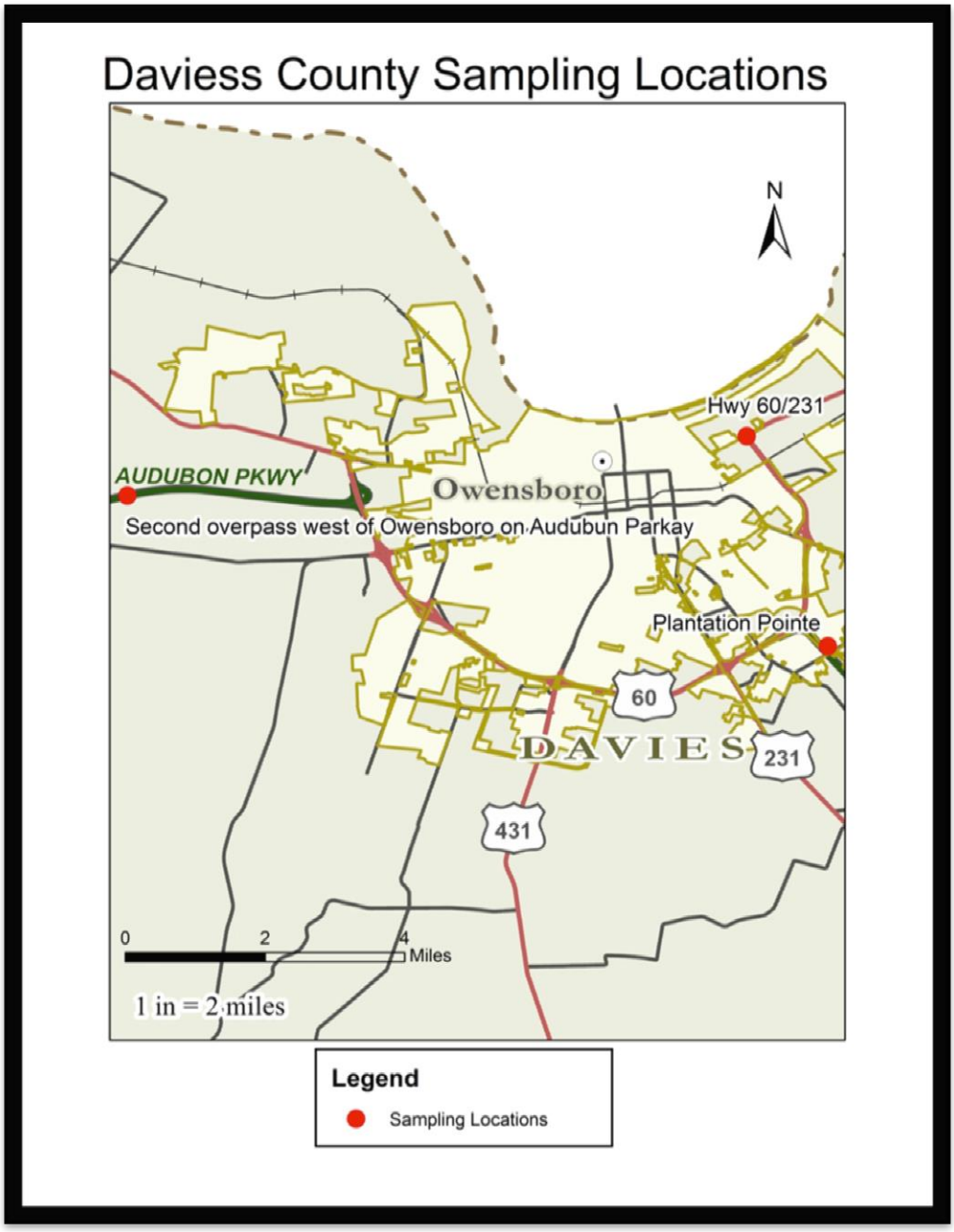

Figure 1.2. Location of placard survey sampling sites in Daviess County, Kentucky.

William H. Natcher Parkway is one of nine controlled access freeways in the Kentucky parkway system. The Natcher parkway spans 70.2 miles from its northern terminus in Owensboro, KY to its southern terminus in Bowling Green, KY. The speed limit is 70 mph across the Parkway with exception to 65 mph once in the Owensboro, KY city limit and near the southern terminus in Warren County, KY. Bowling Green and Owensboro are the third and fourth largest cities in the Commonwealth. Thus, the Natcher Parkway is a vital transportation route.

A CSX rail line crosses the Ohio River between Henderson, KY and Evansville, IN. A railway placard survey for the CSX line was completed from Sunset Park in Henderson, KY. The CSX rail line was once operated by the historic L&N Railroad and was constructed in 1885. In 1937 the line and bridge over the Ohio River were rebuilt to the current configuration. CSX Rail Bridge provides a vital trade route between southern Indiana and northwestern Kentucky.

iii. Data Collection Methods

Data collection methods included placard surveys, at highway sites and a railway site, fixed facility surveys, and analysis of Hazmat incidents. Data collection in Daviess County occurred from June 25, 2013 to July 26, 2013. Methods for each component of the study are described below.

Placard Surveys

The placard surveys for Daviess County were conducted at four locations, East Fourth Street & the Hwy 60 Bypass, Audubon Parkway at the Route 279 overpass and approximately 5 miles west of the eastern terminus, 4301 Plantation Pointe for the Natcher Parkway, and the CSX railway was monitored in Henderson, KY from Sunset Park. These four locations were chosen for their proximity to major transportation routes that traverse through the County. Each survey administered consisted of 40 observation hours. Surveys were carried out during the months of June through August. Hours of observation were selected to note daily and temporal differences in the transportation of hazardous materials. Graduate students of Western Kentucky University, Department of Public Health, Environmental Health Science program, conducted the observation periods. Two observers were located

at each monitoring site in order to avoid bias in data gathering. All lanes of traffic were monitored at each location. Placard observations at the monitoring sites consisted of recording the date, time, placard ID number, any multiple placards, and type of vehicle/ trailer (Appendix 2).

With all necessary safety precautions, a team of two observers monitored each site for a five-day period. A typical monitoring day consisted of an 8-hour observation period. The monitoring periods totaled 160 observation hours. Monitoring dates and times for each site are presented in the list below:

- U.S. Highway 60 (Hwy 60), east and westbound lanes at East Fourth Street & the Hwy 60 Bypass (U.S. 231) June 24-28, 2013. Observation period was from 07:00 to 15:00 each day
- U.S. Route 231 (Route 231), southbound lanes at East Fourth Street & and U.S. 231 South June 24-28, 201 . Observation period was from 07:00 to 15:00 each day
- William H. Natcher Parkway (Natcher Pkwy), north and southbound lanes at 4301 Plantation Pointe July7-12, 2013. Observation period was from 07:00 to 15:00 each day
- Audubon Parkway, east and westbound lanes at second overpass west of Owensboro July 15-19. Observation period was from 07:00 to 15:00 each day
- CSX Railway (CSX), north and southbound trains monitored from Sunset Park in Henderson, KY while crossing over bridge between Kentucky and Indiana.
- June 3-7, 2013. Observation period was from 07:00 to 15:00 each day

Hazmat Incidents Analysis

An analysis of Hazmat incident data for Daviess County was completed in this study. Incident data used for the analysis was collected by DCEM from December, 2008 through June, 2013. These were incidents that occurred in Daviess County involving commercial motor vehicles transporting hazardous materials. This information was used to map the recent history of recorded Hazmat incidents. A methodology for mapping incidents and identifying densities of incidents was applied with the use of ESRI ArcGIS Spatial Analyst software (2011). The methodology consisted of mapping incident data and

using a point density algorithm to show clusters of points using a color intensity method, much like is used in a radar system to indicate the intensity of storms.

Fixed Facility Survey

The fixed facility survey, developed by WKU, consisted of 35 response items (Appendix 1) designed to collect data from Daviess County facilities that ship and receive hazardous materials. General information on the facility, trends in hazardous materials shipped and received, and frequency of specific hazardous materials shipped and received were the topics of interest.

Fixed facility surveys were administered with the assistance of DCEM. Surveys were emailed to fixed facilities throughout the study area and returned to DCEM. Returned surveys were collected and delivered to WKU for data processing. WKU graduate students created an Access database for storage and organization of survey data. Survey data were analyzed with SPSS and Excel to determine Hazmat shipping and receiving trends.

iv. Report Organization

The first chapter of the report provides an introduction to the study, a description of methods, and other pertinent information. In the second chapter, a summary of transportation incident reports is provided. Results from the placard surveys are presented in the third, fourth, fifth, sixth, and seventh chapters of this report. Chapter eight illustrates the results of the fixed facility survey, as well as describing the appropriate responses for incidents involving these materials. Chapter nine includes the summary of results and recommendations. Appendices include a copy of the survey that was sent to fixed facilities, a list of placard IDs observed, and a list of the most common roads used by facilities to reach/leave the study area.

Chapter 2

Analysis of Incident Reports for Daviess County 2008-2012

Analysis of Hazmat incident reports for Daviess County was completed in this study. Incident data used for the analysis were collected by DCEM from December, 2008 to June, 2013. These were incidents that occurred in Daviess County involving commercial motor vehicles transporting hazardous materials. This information was used to map the recent history of recorded Hazmat incidents. A methodology for mapping and identifying densities of incidents was applied with the use of ESRI ArcGIS Spatial Analyst software (2011).

i. Hazmat Incidents from 2008-2013

The methodology consisted of mapping incident data and using a point density algorithm to show clusters of points. Locations of incident clusters was classified using a color intensity method, much like is used in a radar system, to indicate the intensity of storms (Figure 2.1). Point density modeling was accomplished through ESRI ArcGIS ArcMap (2011) by detecting overlapping point areas as clusters. In this method, each incident point was buffered with a circular area that had a diameter of 1.0 mile. A 1.0 mile diameter was chosen due to the spatial scale of incidents. Incidents within a 0.5 mile or less separation at the county scale were detected as a cluster with the selected diameter. It was found through screening, that application of a greater than 1.0 mile buffer width would result in loss of clusters along significant travel corridors. Each incident cluster was color-coded with increasing intensity. For example, an isolated incident point, only one incident, would have a color of green, a cluster of 3 incidents would have a color of yellow, and a cluster of six or more incidents would have a color of red. In this manner, the map indicates areas with multiple overlapping incidents. This methodology can be used to quickly determine hotspots for recurrence of Hazmat incidents.

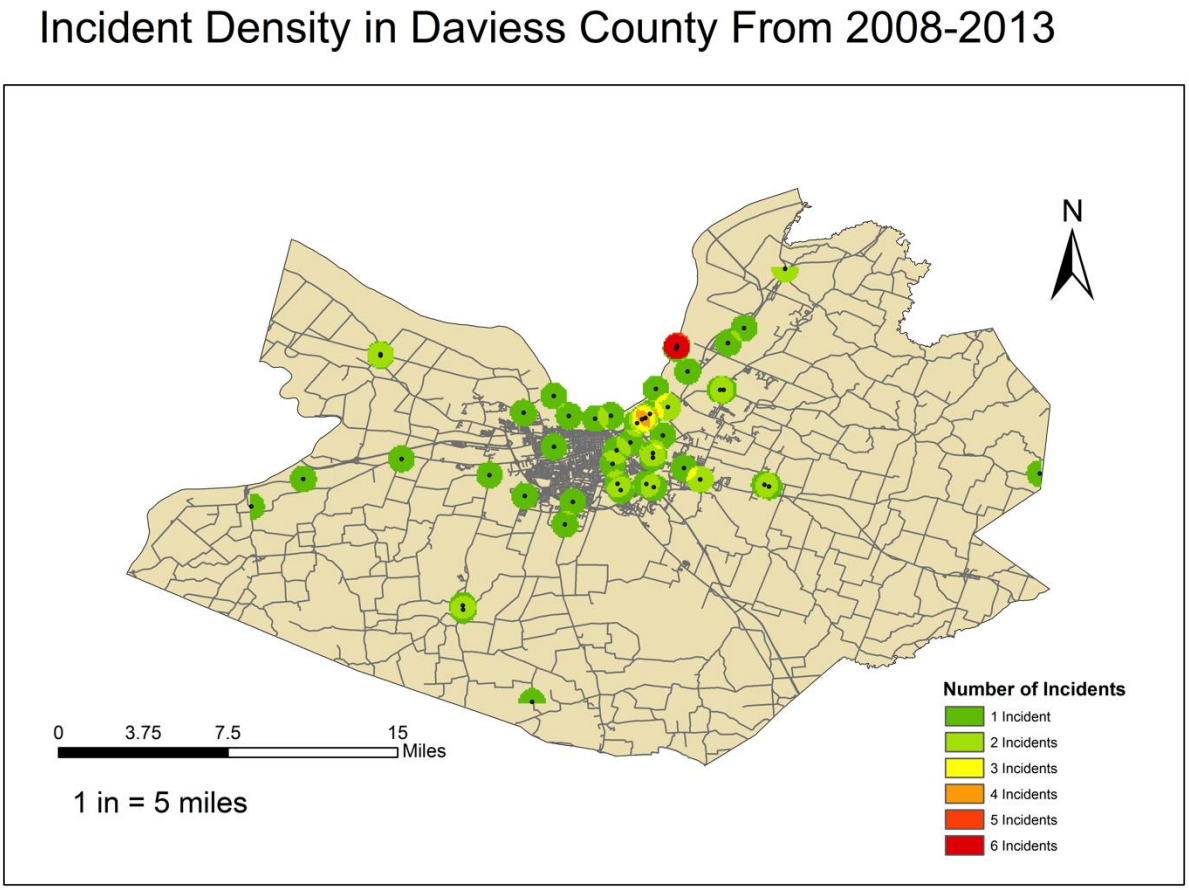

Figure 2.1. Point density map of hazmat incidents in Daviess County, Kentucky.

By viewing the density map, recurrence of incidents was evident in specific locations, along transportation corridors, and in areas of Owensboro, KY. The dataset analyzed indicated that clusters of incidents had occurred along Hwy 60 and Route 231 on the east side of Owensboro, Kentucky. A larger cluster of overlapping incidents occurred throughout the eastern and southeastern areas of Owensboro, and on the Ohio River north of the junctions of Hwy 60/231 with Route 2830 and the junction of Route 2830 with 1831.

ii. Hazmat cases in the Daviess County Area

To further evaluate the density of incidents, the data were tabulated and graphically analyzed. The period of record provided was December, 2008 to June, 2013. Data for the years 2008 and 2013 were not from a complete annual period. Therefore, data for those years is presented for information only and was excluded from calculation of mean and standard deviation values. As presented in Figure 2.2, incidents in Daviess County decreased from 13 events in 2009 and 2010 to an annual low of 9 in 2012 (Figure 2.2). An average of 11.5 incidents per year was calculated from the four complete years of record with a standard deviation of 1.9 incidents per year. Based on the four years of records, the number of incidents per year was somewhat stable. A note to make is that data for 2013 were recorded through June and showed a total of eight incidents.

The type of emergency and hazardous material involved ultimately determines the appropriate emergency response. Five types of incidents were reported between 2008 and 2013 (Figure 2.3). Spills accounted for 53.7% of all incidents reported, followed by vehicle crashes (20.3%), while leaks and underground storage tank failure accounted for 11.1% each, and fires accounted for the remaining 3.7%. Numerous types of materials were identified in the incident reports. As shown in Figure 2.4, the most common material classes identified were fuel products 40.4 % .Oil represented 36.8% of reported incidents, while unspecified material accounted for 7.0%. A combination of other materials accounted for 15.8%.

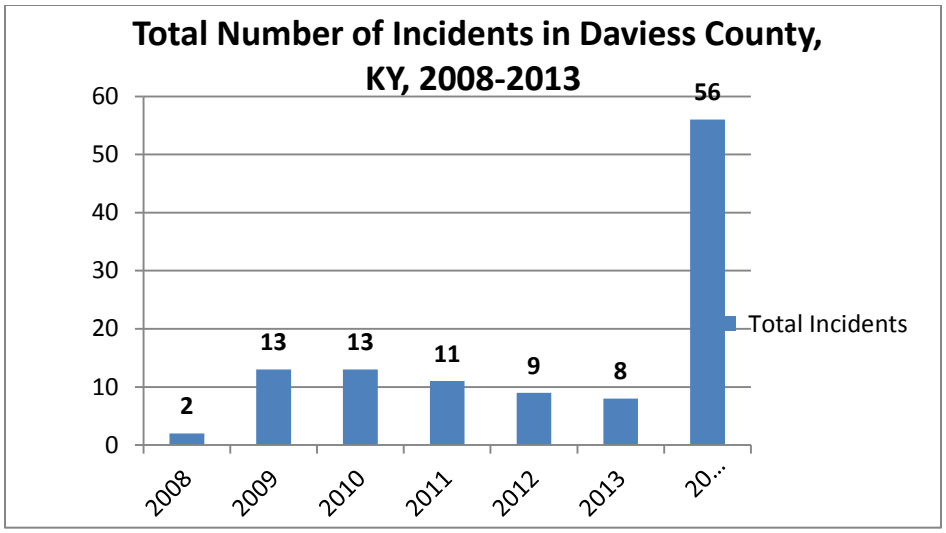

Figure 2.2. Total number of hazmat incidents in Daviess County by year and for all years.

Note: Data for 2008 and 2013 were not for an annual period. Data were collected in 2008 beginning in December, two events occurred in one month, and through June for 2013. These data are presented for information only.

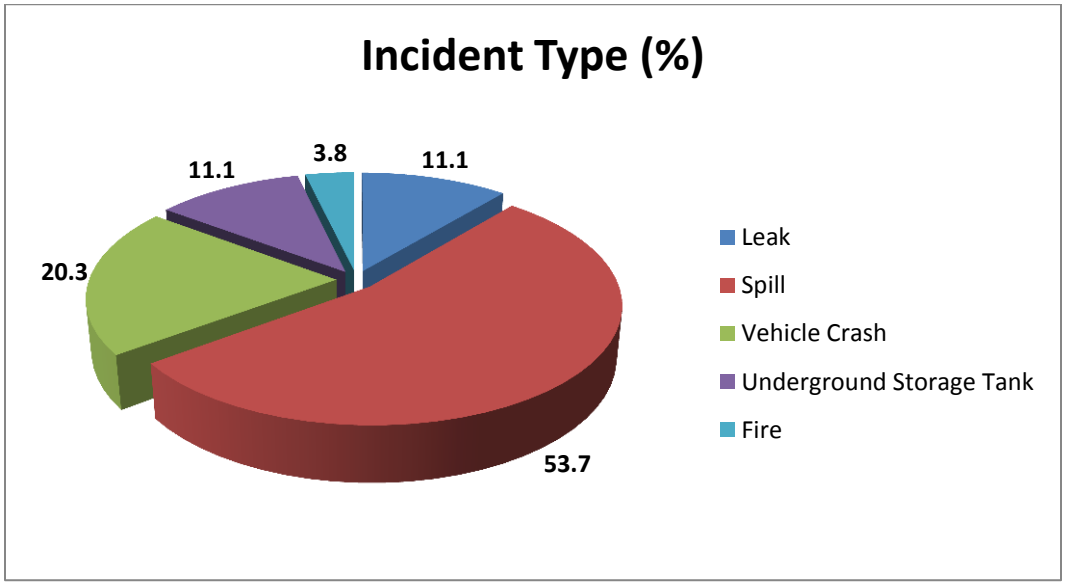

Figure 2.3. Types of incidents occurring from December 2008 through June 2013.

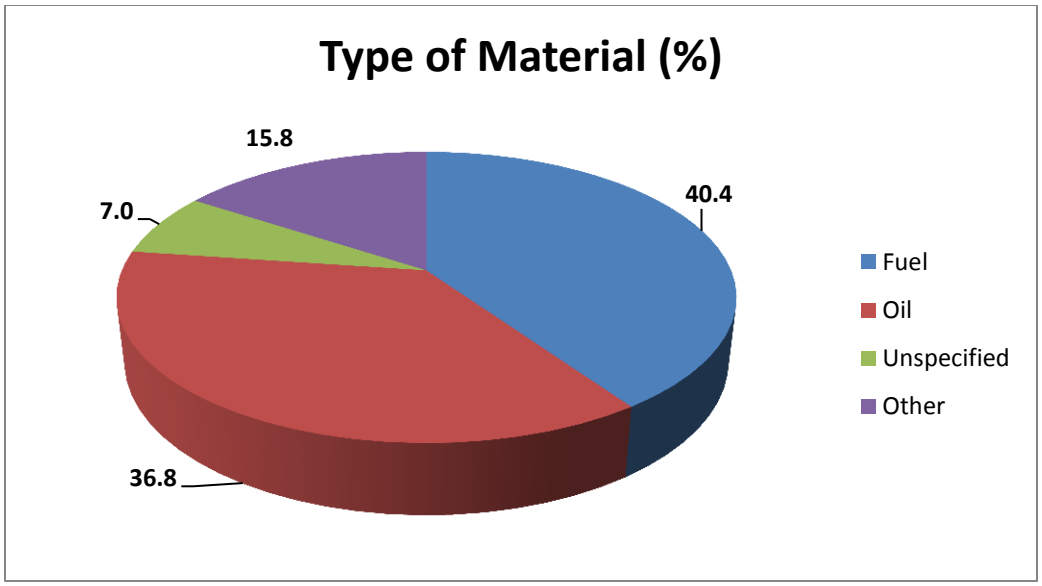

Figure 2.4: Types of hazmats identified in the incidents from December 2008 through June 2013.

Chapter 3

Analysis of the U.S. Hwy 60 Placard Survey

The placard survey for Hwy 60 was conducted at one location, the intersection of East Fourth Street & Hwy 60 Bypass (U.S. 231). The Hwy 60 eastbound and westbound monitoring stations were located at the same location. In total, the survey administered for this location included 40 monitoring hours. This survey was carried out during the month of June 24-28, 2013. Hours of observation were selected to note daily and temporal differences in the transportation of hazardous materials through Daviess County via Hwy 60. Each observation period was conducted in shifts by graduate students of Western Kentucky University, Department of Public Health, Environmental Health Science program. Two observers were located at each monitoring site in order to avoid observational bias. Placard observations consisted of recording the date, time, placard ID number, any other number on the placard, multiple placards, as well as type of vehicle.

i. Aggregate frequency of placarded vehicles on Hwy 60

During the Hwy 60 monitoring period, June 24-28, 2013, the total number of placarded vehicles observed, on both eastbound and westbound lanes, was 455 (Figure 3.1). There were more vehicles transporting hazardous materials on the westbound lane of Hwy 60 (340) compared to the eastbound lane (115), representing a 75% difference between westbound and eastbound lanes. Similarly, the average number of vehicles transporting hazardous materials per hour was greater in the westbound lane (8.0 vehicles/hour) compared to the eastbound lane (3.6 vehicles/hour) (Figure 3.2).

ii. Placarded vehicle frequencies by day of the week

Hazardous material transportation frequency displayed differences throughout the week (Figure 3.3). Total hazardous material transport across Hwy 60 peaked on Tuesday, with an average of 9.0 vehicles per hour westbound and 3.2 vehicles per hour eastbound. This peak is seen in both eastbound and

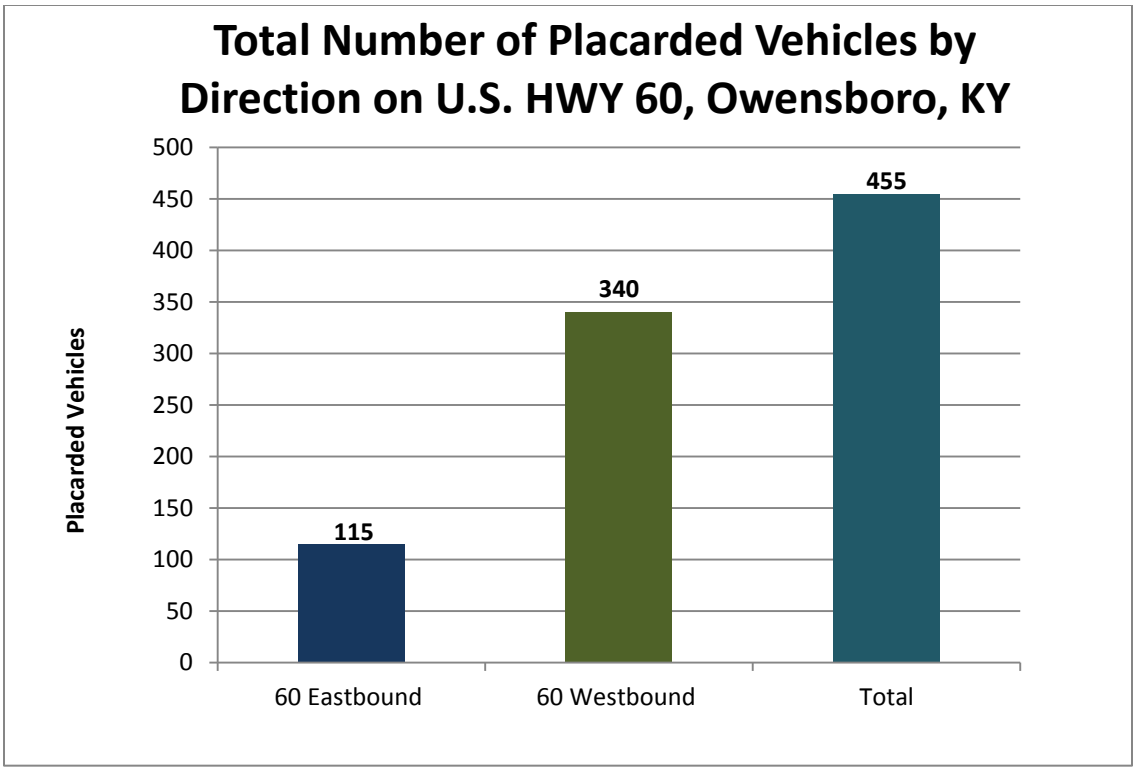

Figure 3.1. Placarded vehicles observed on Hwy 60.

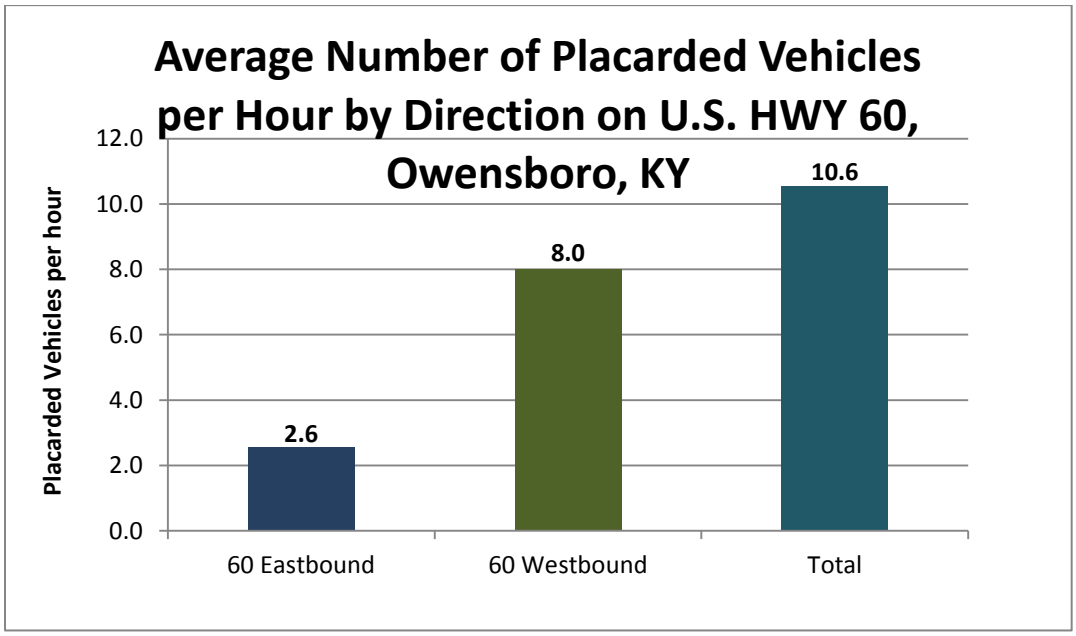

Figure 3.2. Frequency of placarded vehicles *per hour on Hwy 60.*

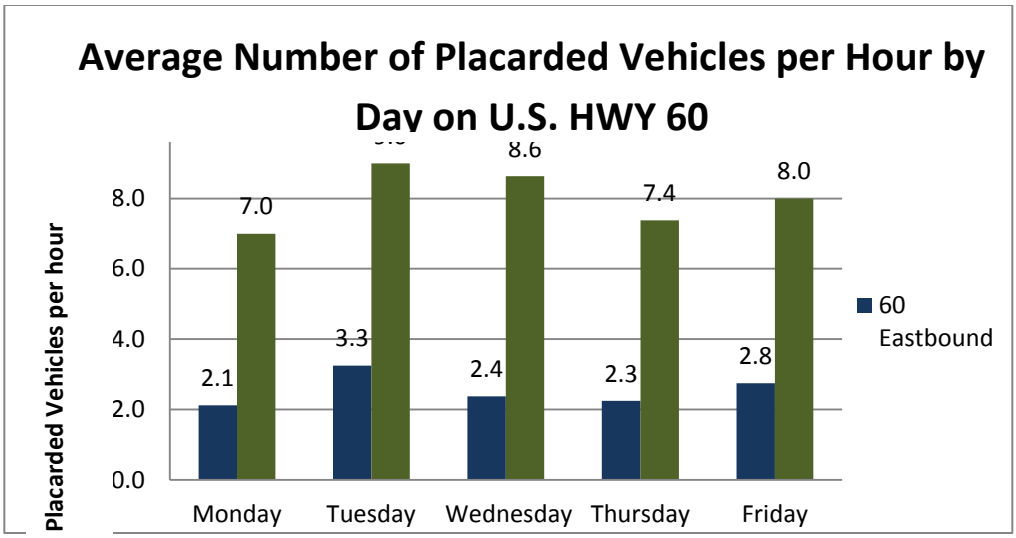

Figure 3.3 Commodity flow rates of placarded vehicles by day of the week on Hwy 60.

westbound lanes of traffic (Figure 3.3). The lowest average rate was seen on Monday, with only 7.0 vehicles per hour westbound and 2.1 vehicles per hour eastbound.

The average number of placarded vehicles observed, on both eastbound and westbound Hwy 60, was determined to be 10.6 per hour (422 placarded vehicles/40 monitoring hours), as shown in Figure 3.3. An average of 8.0 westbound and 2.6 eastbound were observed for the monitoring period.

iii. Placarded vehicle frequency by time of day for Hwy 60

Variations in frequency of hazardous materials transported were determined with reference to the time of day. The time of day is important in order to correlate hazardous materials vehicle movements with the expected times of traffic congestion and availability of emergency responders. By analyzing these variations, risk profiles for hazardous materials transport can be projected by time of day.

In order to analyze the hourly frequency of hazardous materials transport, the monitoring hours at each observation point were divided into three separate periods of four hours. This creates morning, midday, and afternoon scenarios:

Period 1 (Morning): 07:00 to 10:00

Period 2 (Midday): 10:01 to 13:00

Period 3 (Afternoon): 13:01 to 15:00

As shown in Figure 3.4, the maximum frequency of hazardous materials observed was during the midday period for the westbound lane, about 52 placarded vehicles per hour, and in the morning for the eastbound lane, about 20 placarded vehicles per hour for the study period. For both eastbound and westbound lanes, the lowest frequency of placarded truck traffic was seen in the afternoon period, with 7.5 and 29 vehicles per hour, respectively.

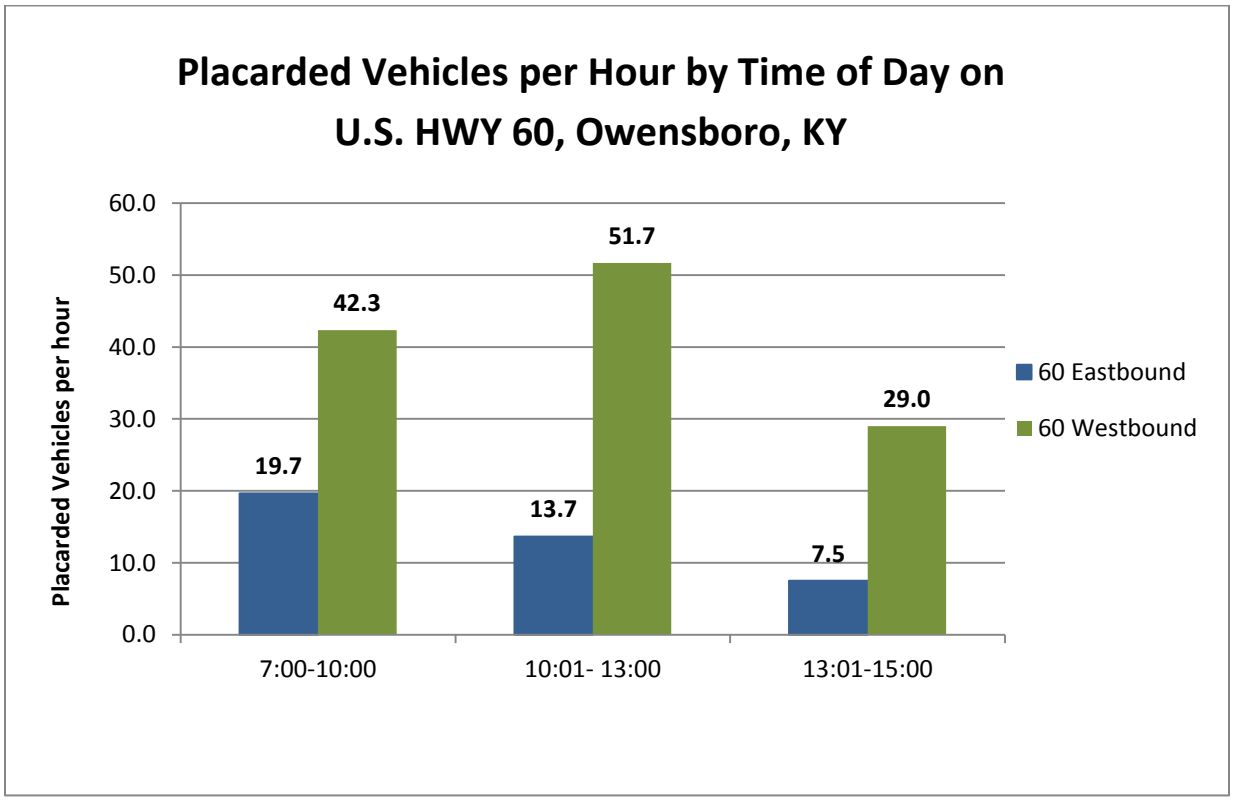

Figure 3.4: Commodity flow rates of placarded vehicles by time of the day on Hwy 60.

iv. Composition of Hazardous Material being transported

The composition (%) of hazardous material transported by vehicles on eastbound Hwy 60 is displayed in Figure 3.5. Gasoline (Placard ID 1203) was the most frequently transported material on eastbound Hwy 60, accounting for 42.6% of the total hazardous material observed. Other commonly observed materials Ethanol (Placard ID 1170) (18.3%), Nonflammable gas (10.4%), Flammable gas

(10.4%) Alcoholic beverages (Placard ID 3065) (4.4%). Appendix 3 shows frequencies of other hazardous materials transported; the "Other" category indicates all other observed materials, which individually account for than 2% of the observations.

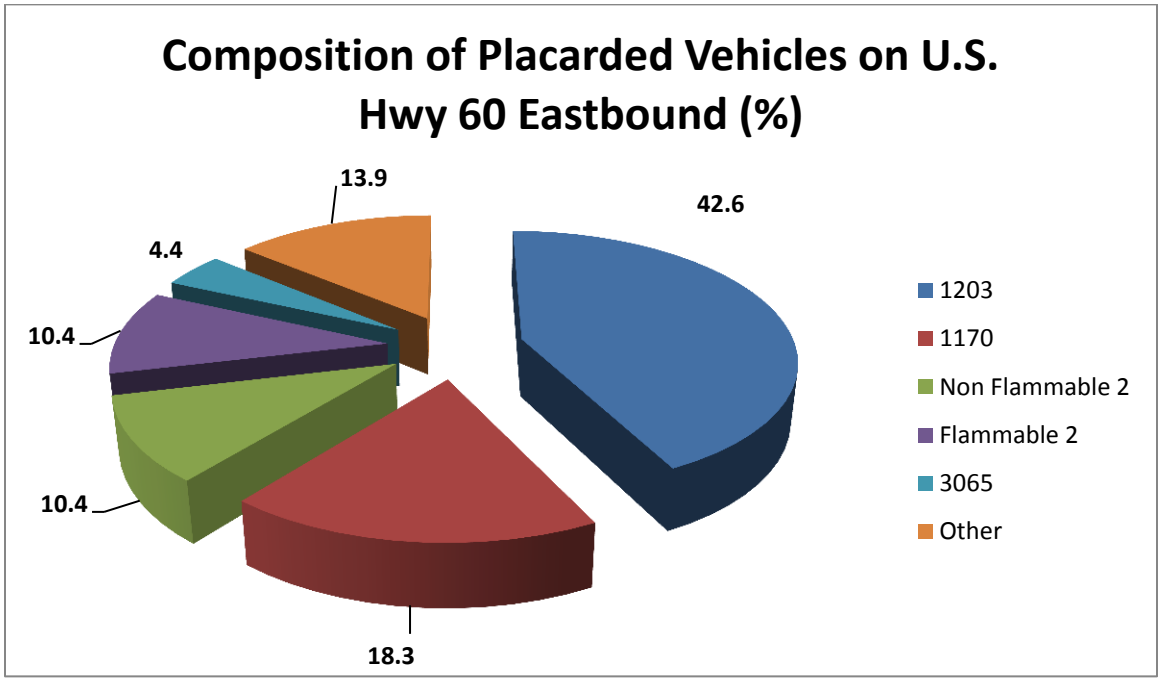

Figure 3.5: Composition of hazardous materials transported on eastbound Hwy 60.

As shown in Figure 3.6, gasoline (Placard ID: 1203) was the most frequently transported hazardous material on westbound Hwy 60, (47.7) of the total hazardous material observed. Other commonly observed materials include Elevated Temperature Liquid (Placard ID 3257) (12.7%), Propane (6.5%), Ammonia Nitrate (Placard ID 2067) (2.7%) and Aluminum by-products (Placard ID 3170) (2.3%). A table presented in Appendix 4 shows frequencies of other materials transported; the "Other" category indicates all other observed materials that individually account for less than 2% of the observations. A complete list of these materials can be found in Appendix 4.

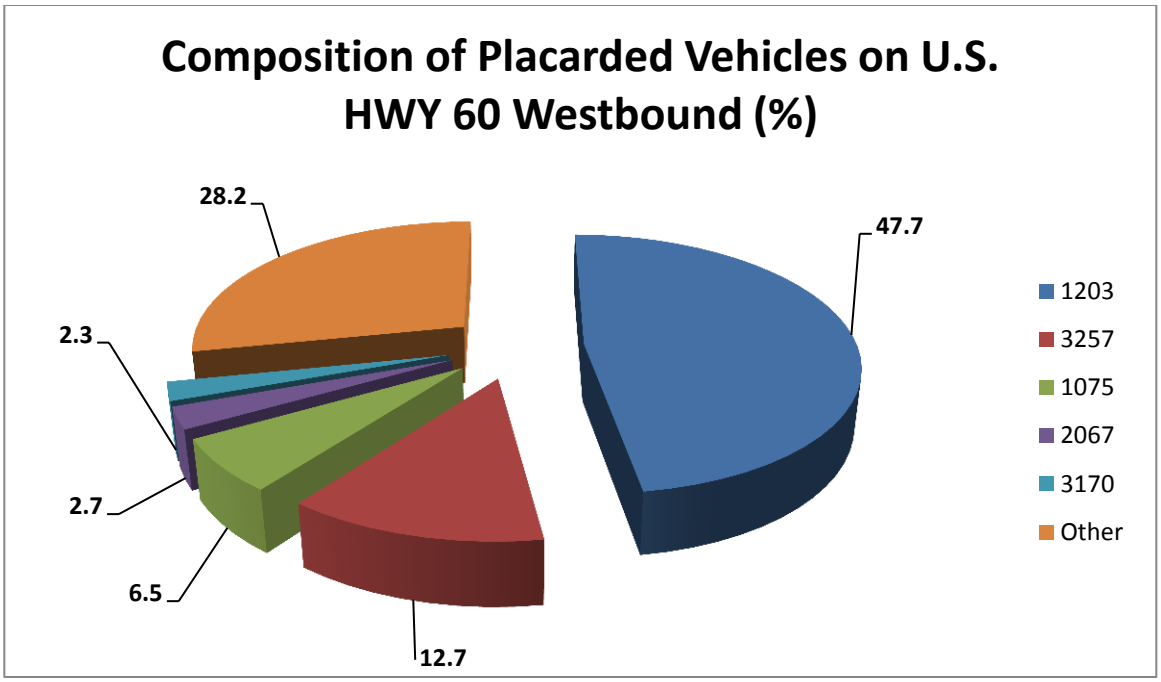

Figure 3.6. Composition of hazardous materials transported on westbound Hwy 60.

Chapter 4

Analysis of the U.S. 231 Placard Survey

The placard survey for U.S. 231, terminus of Wendell Ford Expressway east of Owensboro, was conducted at the intersection of East Fourth Street & Hwy 60 with the U.S. 231/Hwy 60 bypass. Due to construction, only the southbound lane was monitored for U.S. 231, Wendell Ford Expressway. The placard survey conducted at this location included 40 monitoring hours. This survey was carried out June 24-28, 2013. Hours of observation were selected to note daily and temporal differences in the transportation of hazardous materials through Daviess County. Survey details were as described for Hwy 60.

i .Aggregate frequency of placarded vehicles U.S. 231

Observations on U.S. 231, terminus of Wendell Ford Expressway east of Owensboro, were made to determine the frequency of hazardous materials transported for the monitoring period. Total placarded vehicles observed were 213 for the southbound lane. The average number of vehicles observed on the southbound lane per hour was 5.3 vehicles/hour.

ii. Placarded vehicle frequencies by day of the week on U.S. 231

U.S. 231 was observed to study flow patterns of hazardous materials during the week. Hazardous material transport showed differences throughout the week (Figure 4.1). Total hazardous material transport across U.S. 231 peaked on Tuesday and Thursday, with averages of 6.0 and 6.3 vehicles per hour (Figure 4.1). The lowest hazmat commodity flow rate was observed on Monday and Wednesday with an average of 4.8 vehicles per hour.

iii. Placarded vehicle frequencies by time of the day on U.S 231

In order to analyze the hourly frequency of hazardous material transport, the monitoring hours at each observation point were divided into three separate periods of four hours. This creates the following three time periods:

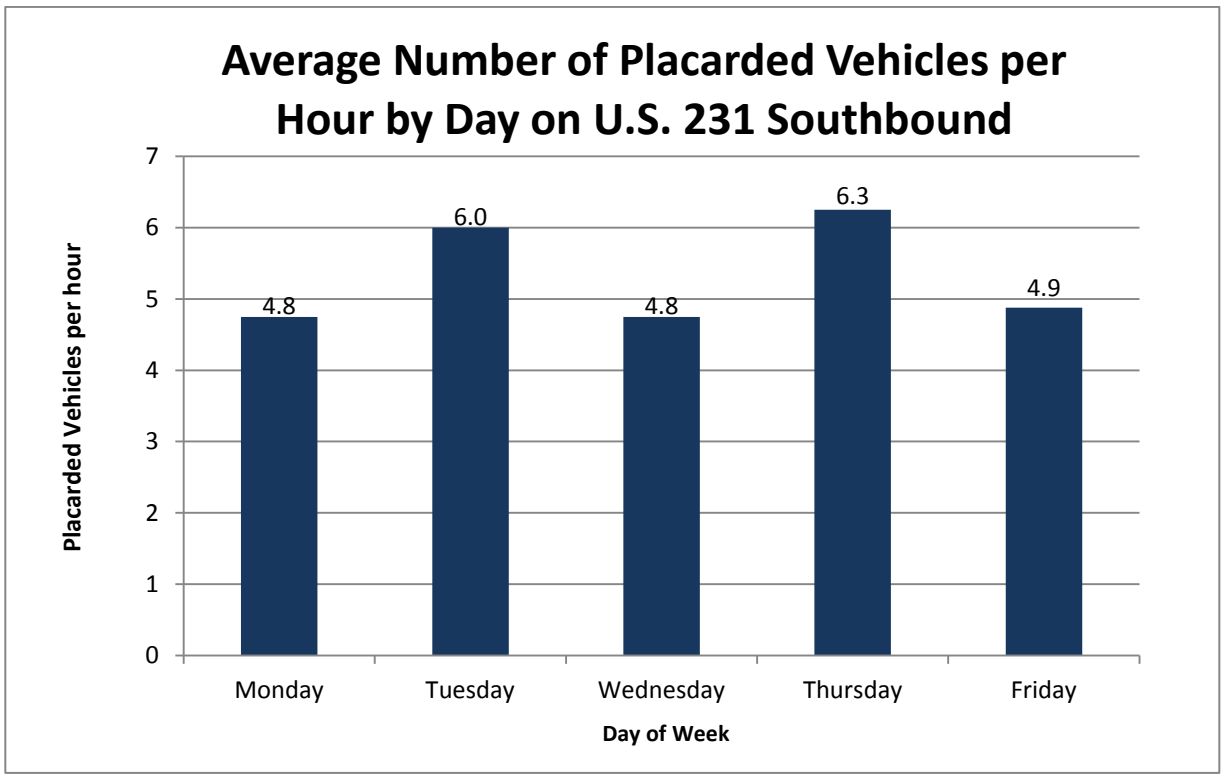

Figure. 4.1. Commodity flow rates of placarded vehicles by day of the week on southbound U.S. 231.

Period 1 (Morning): 7:00 to 10:00

Period 2 (Midday): 10:01to 13:00

Period 3 (Afternoon): 13:01 pm to 15:00

As shown in Figure 4.2, the maximum frequency of placarded vehicles per hour, 30.3, was observed during the midday period for the southbound lane. A similar load was witnessed during the morning, 29 placarded vehicles per hour. The lowest frequency of placarded vehicles was seen in the afternoon period, with 17.5 vehicles per hour.

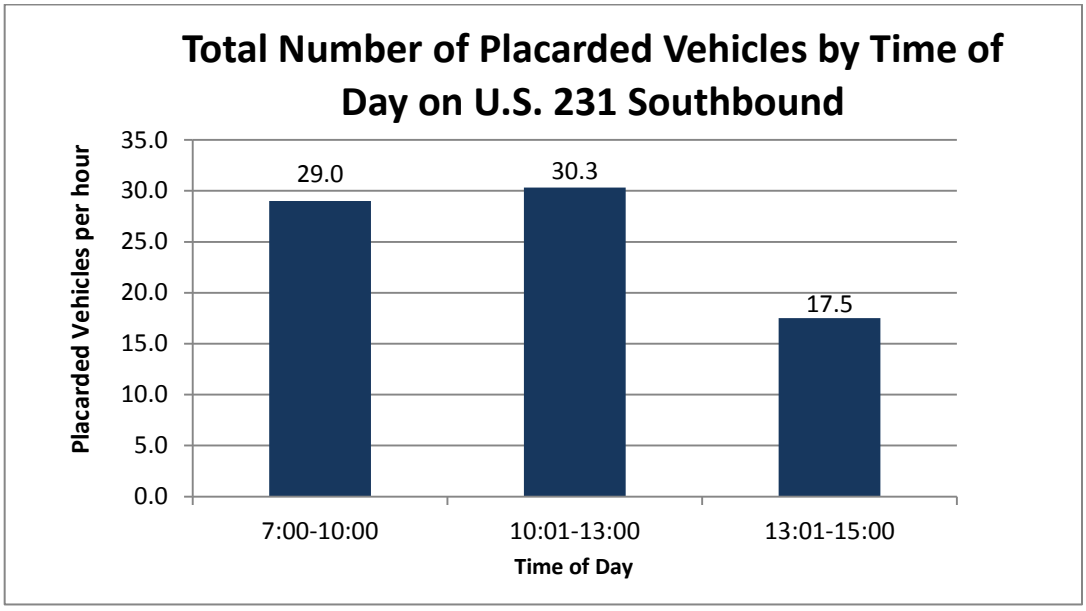

Figure 4.2. Commodity flow rates of placarded vehicles by time of the day on southbound U.S. 231.

iv. Composition of Hazardous Materials transported on U.S. 231

Analysis of the placard data was used to assess the materials being transported southbound. As shown in Figure 4.3, Gasoline, Placard ID 1203, was the most frequently transported material on U.S. 231, accounting for 45.9% of the total hazardous materials observed during the observation period. Other commonly observed materials Elevated Temperature Liquid, Placard ID 3257 (14.0%), Corrosive Liquid, Placard ID 1760 (6.1%), Propane, Placard ID 1075 (4.7%), Ethanol, Placard ID 1170 (3.1%). Frequencies of other materials transported; the "Other" category indicates all other observed materials that individually account for less than 2% of the observations and cumulatively accounted for 26.2%. A list of these materials can be found in Appendix 5.

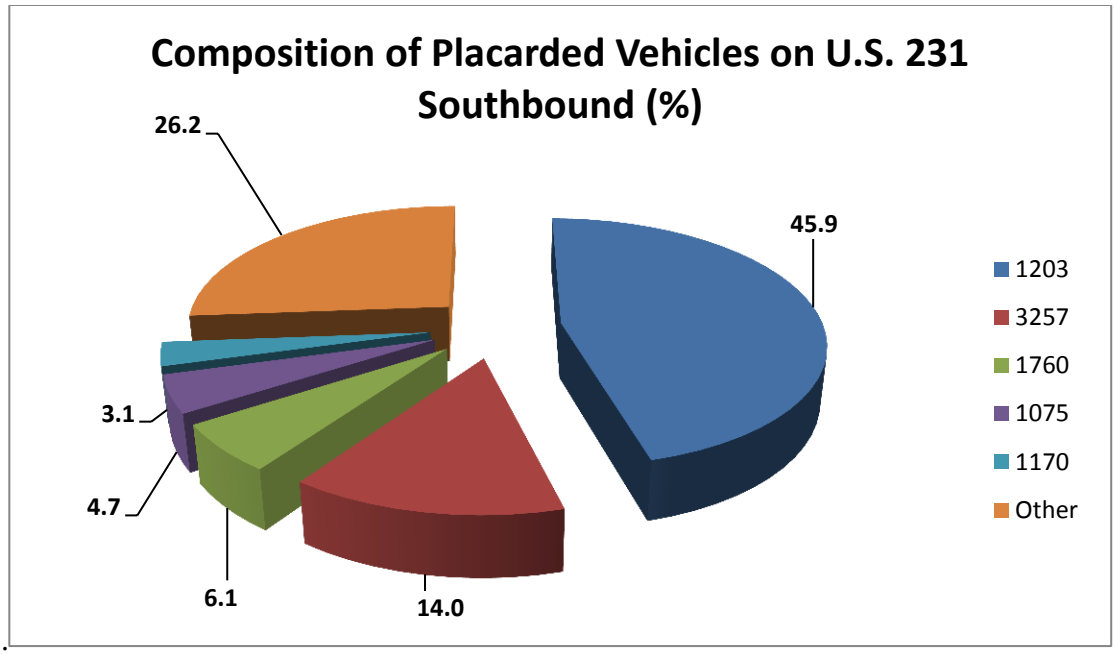

Figure 4.3. Composition of hazardous materials observed on southbound U.S. 231.

Chapter 5

Audubon Parkway

A Placard survey was conducted on the Audubon Parkway to study the frequency of hazardous material transport for the monitoring period July 15-19, 2013. Methods for the placard survey were the same as previously described for Hwy 60. The monitoring site was established on the Audubon Parkway approximately five miles west of its eastern terminus near Owensboro, KY. Route 279 crosses the Audubon Parkway at this location. Observations were made over the five-day period with 40 hours of monitoring.

i .Aggregate frequency of placarded vehicles Audubon Parkway

A total of 212 placarded vehicles were observed during the Audubon Parkway monitoring period (Figure 5.1). The average commodity flow rate observed on both east and westbound per hour was 5.3 placarded vehicles per hour (Figure 5.2). Higher number of placarded vehicles was observed transporting hazardous materials on westbound Audubon Parkway, 119, than eastbound, 93, representing a 21.9% difference between the lanes. Similarly, the rate of placarded vehicle transport was greater westbound, 3.0 placarded vehicles per hour, compared to eastbound, 2.3 placarded vehicles per hour.

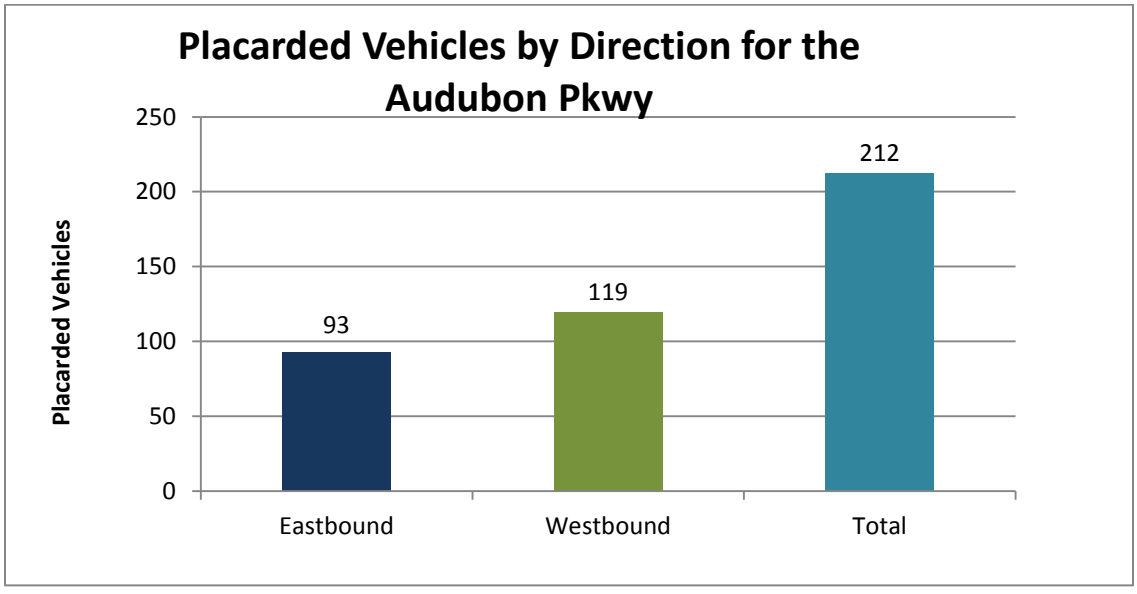

Figure 5.1. Placarded vehicles observed on the Audubon Parkway.

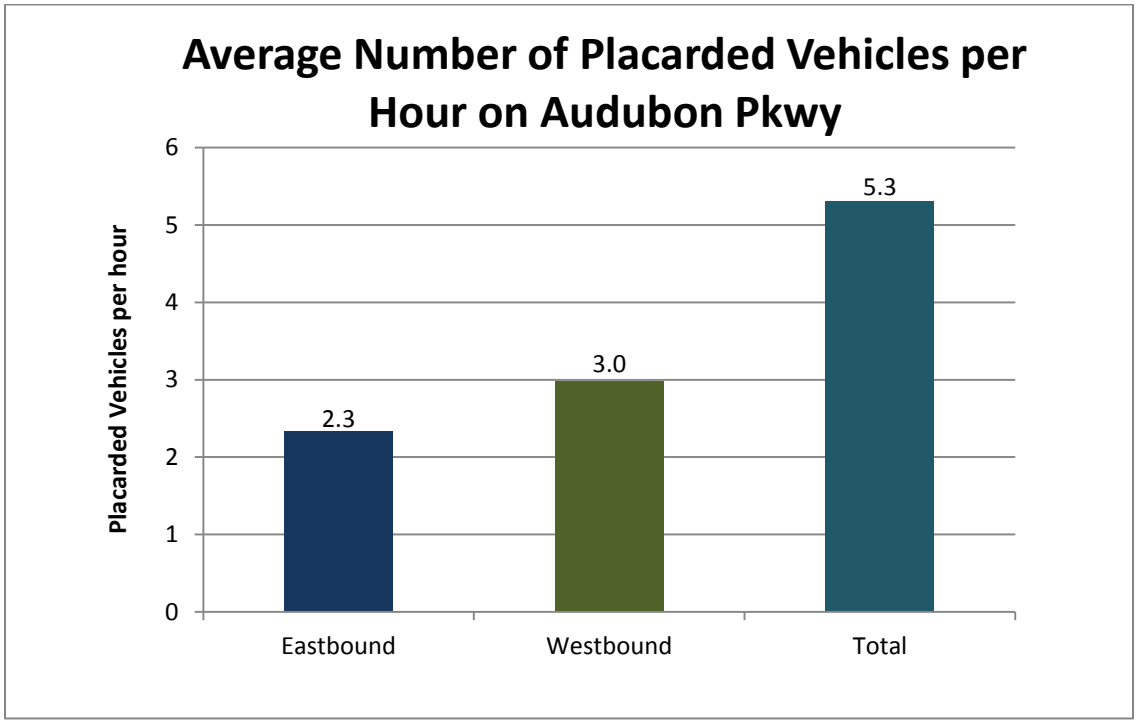

Figure 5.2. Frequency of placarded vehicles *per hour on Audubon Parkway*

ii. Placarded vehicle flow rate by day of the week on Audubon Parkway

The observation hours for the Audubon Parkway were scheduled to observe differences in the flow rate of hazardous materials during the week. Hazardous materials transported at the Audubon Parkway showed a peak flow rate (3.5 placarded vehicles per hour), on Wednesday for the westbound lane (Figure 5.3). A peak commodity flow rate occurred for the eastbound lane on Tuesday with 2.8 vehicles. Minimum commodity flow rates were witnessed on Friday for the eastbound lane, 1.8 placarded vehicles per hour, and on Monday for the westbound lane, with 2.6 placarded vehicles per hour.

iii. Placarded vehicle frequency by time of the day on Audubon Parkway

To evaluate the hourly variation of hazardous material commodity flow, data collected was divided into monitoring periods. This analysis provides a picture of the heaviest loads of commodities. In

this manner, time periods with heaviest loads of commodities were determined. Time periods were assigned as follows:

Period 1 (Morning): 7:00 to 10:00

Period 2 (Midday): 10:01 to 13:00

Period 3 (Afternoon): 13:01 to 15:00

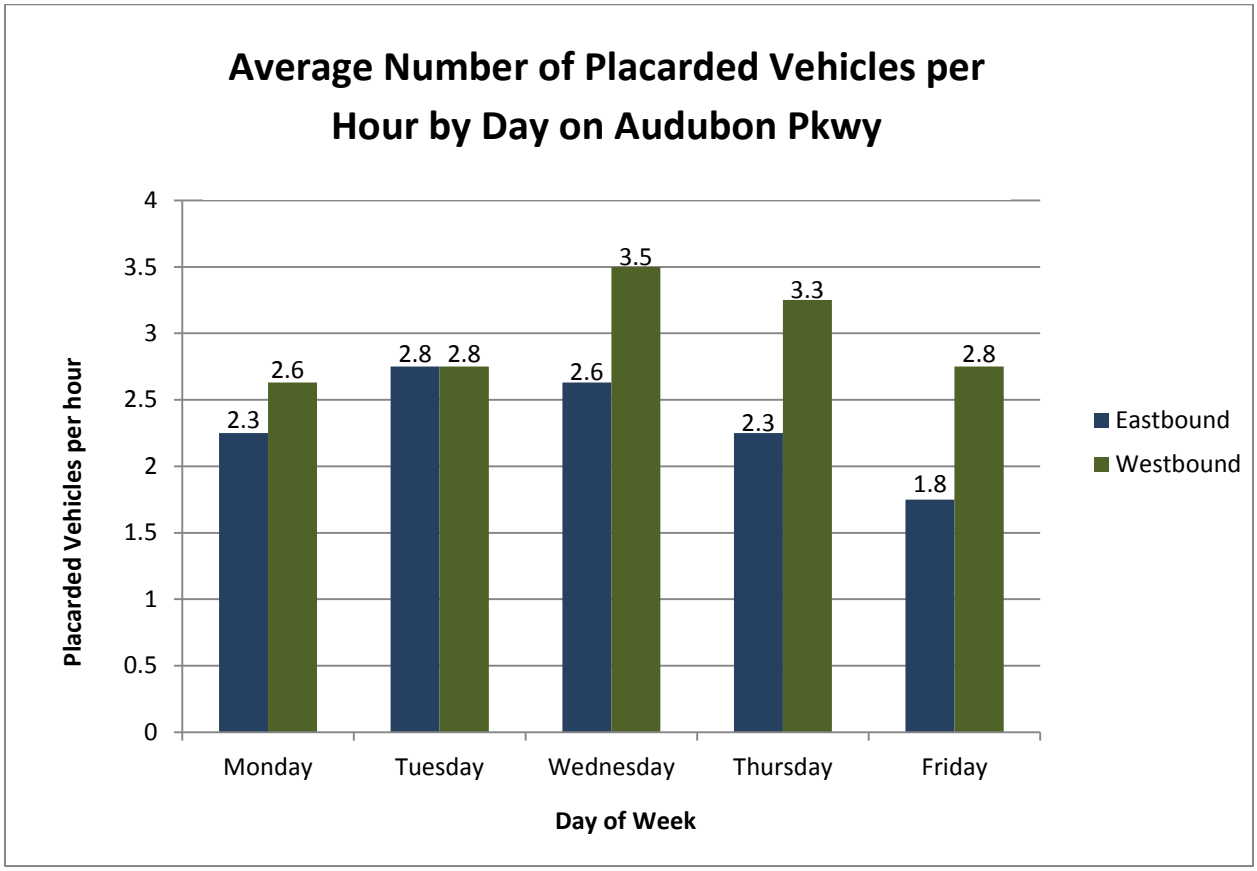

Figure 5.3. Commodity flow rates of placarded vehicles by day of the week on Audubon Parkway.

As shown in Figure 5.4, the maximum rate of hazardous materials was observed during the morning period for eastbound and westbound lanes, 15.0 and 18.0 vehicles per hour, respectively. Minimum hazardous materials loads were identified in the afternoon period for east and westbound, with 6.5 and 11.0 placarded vehicles per hour, respectively. Rates of 11.7 and 14.3 placarded vehicles per hour were observed midday. The variation in loads from morning to midday to afternoon shows a negative trend or decreasing trend over time.

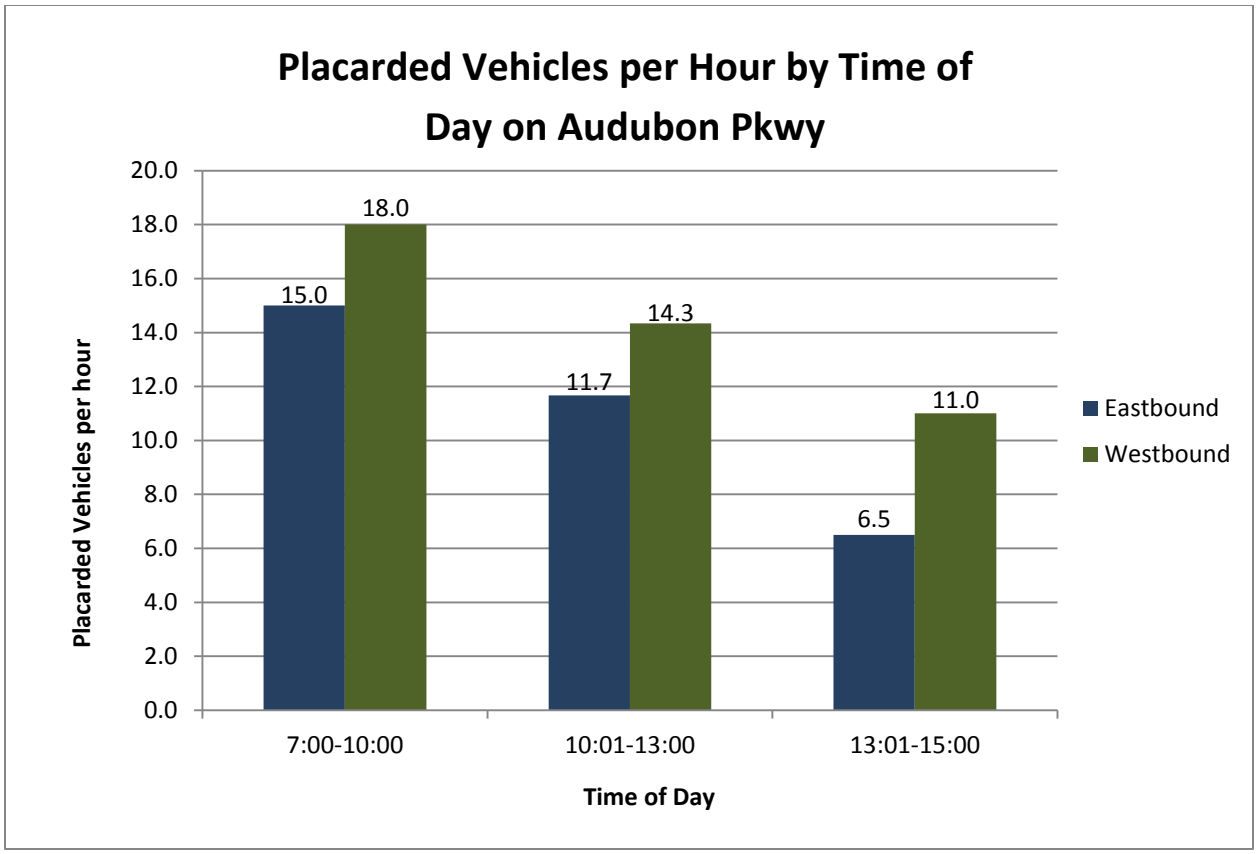

Figure 5.4. Commodity flow rates of placarded vehicles by time of the day on Audubon Parkway.

iv. Composition of Hazardous Material being transported on Audubon Parkway

Analysis of placard data was used to assess the materials being transported both eastbound and westbound on the Audubon Parkway. As shown in Figure 5.5, Gasoline, Placard ID 1203, was the most frequently transported material on eastbound Audubon Parkway, with 16.7% of the total hazardous materials observed. Other frequently observed materials included Propane, Placard ID 1075, 12.3%, Flammable Liquids, 7.9%, Petroleum Crude Oil, Placard ID 1267, 7.9%, and Corrosive Liquids, 6.1%. The "Other" category indicates all other observed materials, which individually account for less than 5.3% of the observations. A list of these materials can be seen in Appendix 6.

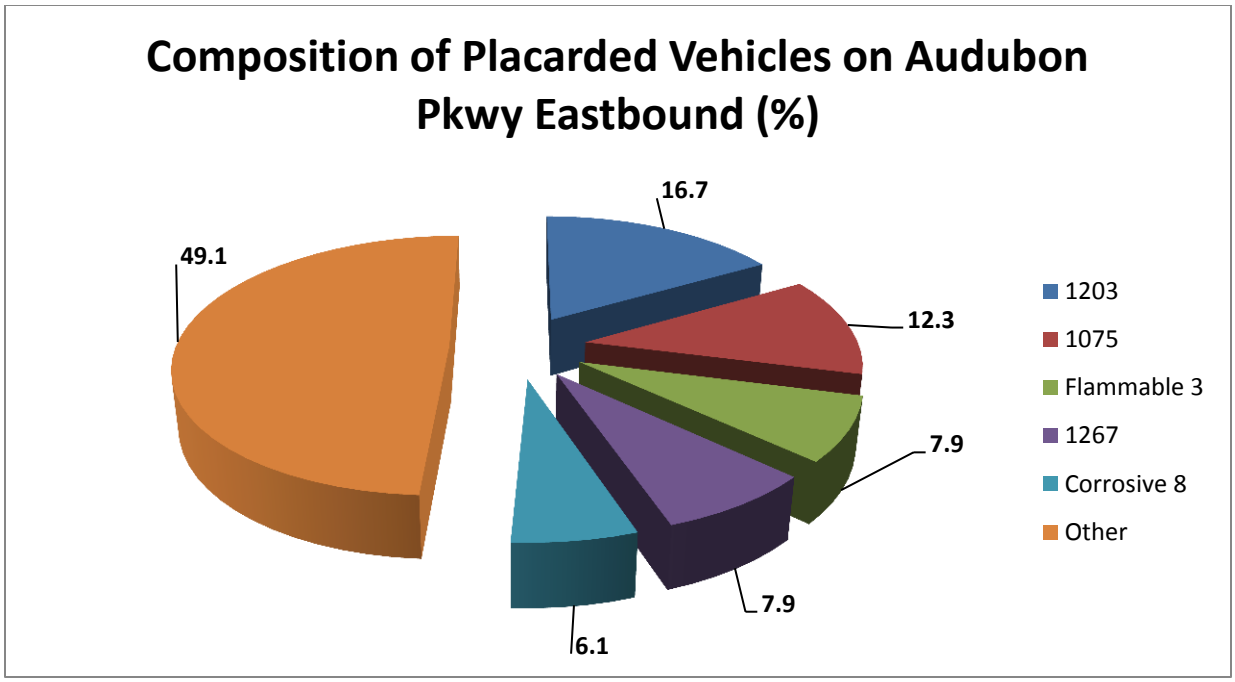

Figure 5.5. Composition of hazardous material observed on eastbound Audubon Parkway.

Composition of the hazardous materials observed for westbound Audubon Parkway is shown in Figure 5.6. Gasoline, Placard ID 1203, was the most frequently detected material during the placard survey on westbound Audubon Parkway, accounting for 18.1% of the total hazardous materials observed. Other commonly observed materials include Combustible liquid, Placard ID 1993, 12.5%, Ammonium Nitrate, Placard ID 2067, 11.1%, Propane, Placard ID 1075, 4.9%, Sodium Hydroxide, Placard ID 1824 4.9%. The "Other" indicates all other observed materials, which individually accounted for less than 4.2% of the total observations. A table with the hazardous materials observed and frequency of occurrence is presented in Appendix 7.

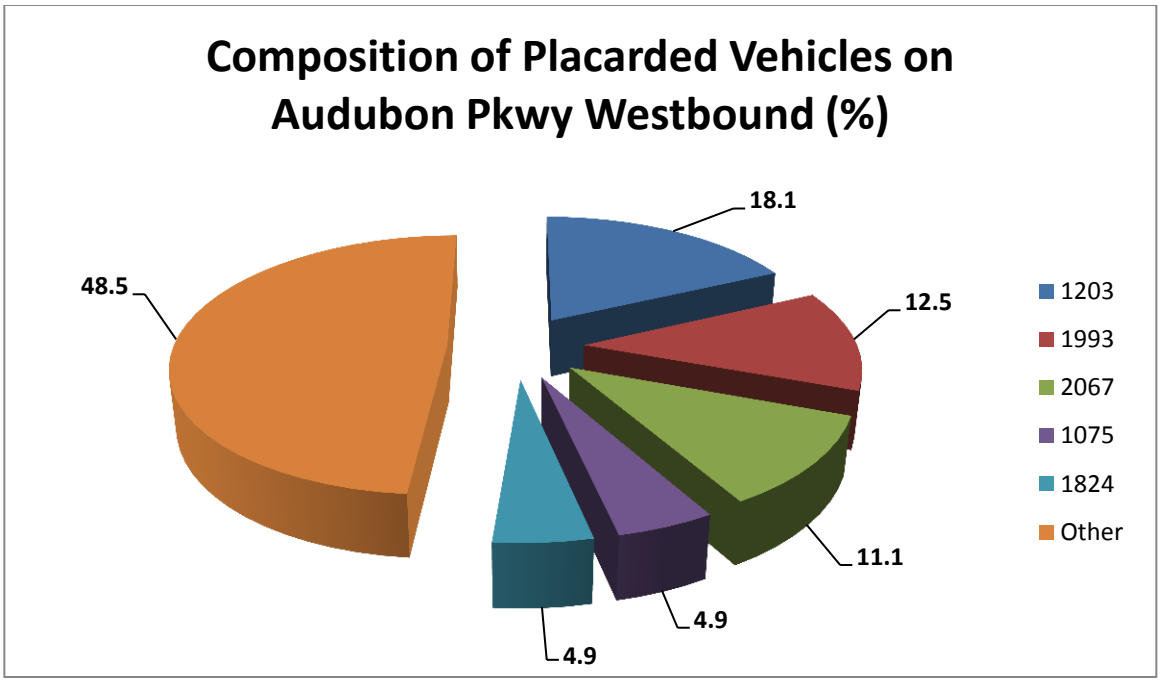

Figure 5.6. Composition of hazardous material observed on westbound Audubon Parkway.

Chapter 6

William H. Natcher Parkway

Observations on William H. Natcher Parkway were made to study the frequency of hazardous materials transported for the monitoring period July 8-12, 2013. Methods for the placard survey were the same as previously described for Hwy 60. A monitoring site was established in a cul-de-sac, 4301 Plantation Pointe, which overlooked both the north and southbound lanes of the Parkway near the northern terminus in Owensboro, Kentucky. Observations were made over the five-day period with 40 hours of monitoring.

i. Aggregate frequency of placarded vehicles on Natcher Parkway

A total of 254 placarded vehicles were observed for the Natcher Parkway (Figure 6.1). The average number of placarded vehicles observed for both directions of flow was determined to be 6.4 vehicles per hour (Figure 6.2). There were a greater number of vehicles transporting hazardous materials on southbound Natcher Parkway, 137 vehicles, than northbound, 117 vehicles, representing a 14.6% difference. The average number of placarded vehicles transporting hazardous materials per hour was greater southbound, 3.4 vehicles/hour, compared to northbound, 2.9 vehicles/hour.

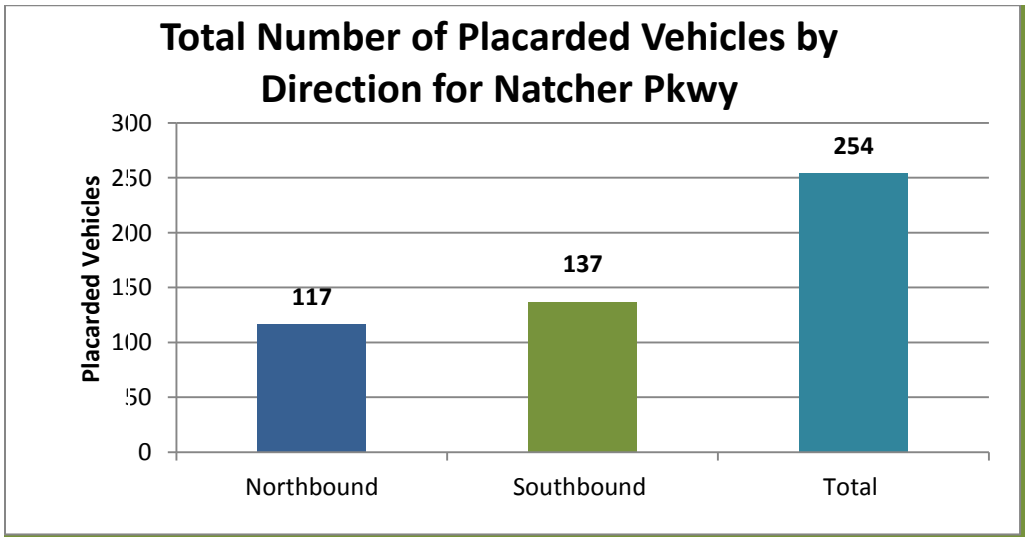

Figure 6.1. Placarded vehicles observed on the William H. Natcher Parkway.

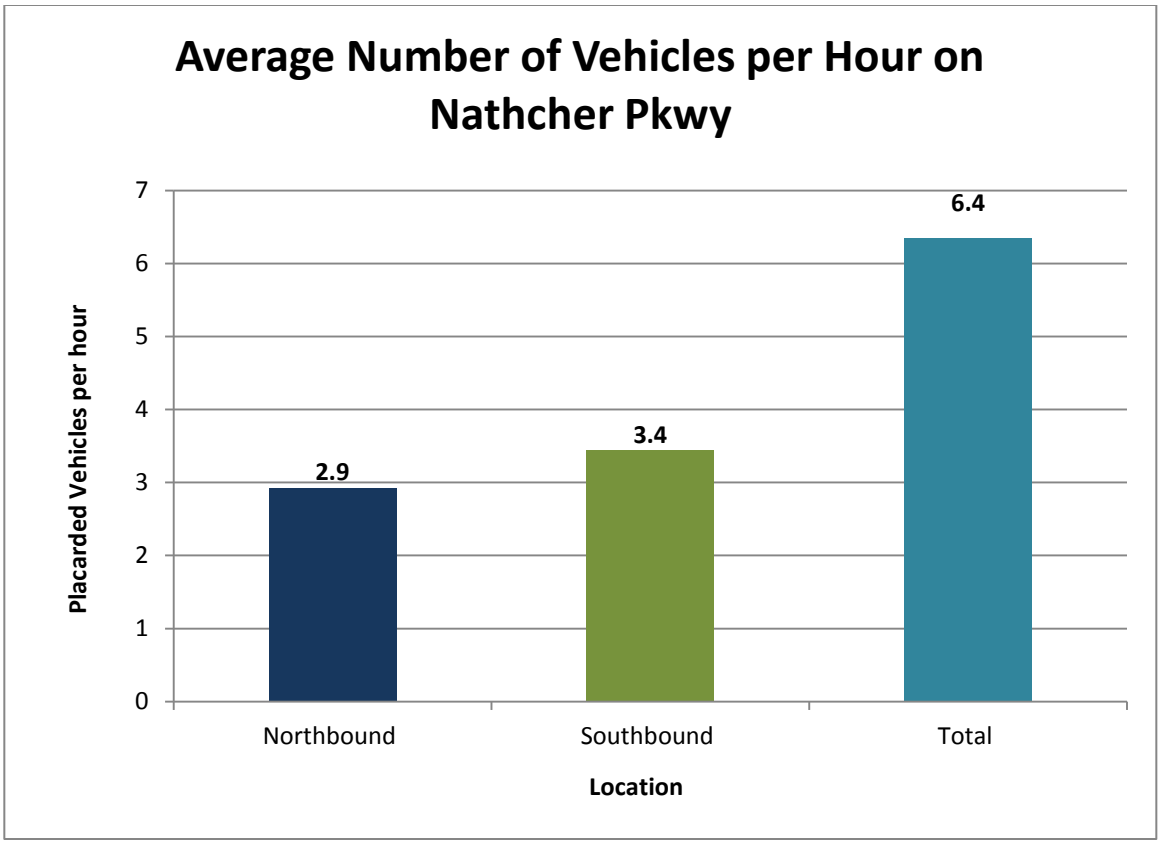

Figure 6.2. Frequency of placarded vehicles *per hour on William H. Natcher Parkway.*

ii. Placarded vehicle flow rates by day of the week on Natcher Parkway

The observation hours for the Natcher Parkway monitoring site were scheduled to study differences in the average flow rates of hazardous materials during the week. Hazardous materials transported along Natcher Parkway peaked on Tuesday southbound with an average of 3.9 vehicles per hour and peaked on Friday northbound, with an average of 3.5 vehicles per hour (Figure 6.3). The lowest average rates occurred on Tuesday northbound, 2.4 vehicles per hour, and Thursday southbound, at 2.8 vehicles per hour. Opposite patterns of flow rate occurred for each direction on the Natcher Parkway. Commodity flow increased through the week northbound and decreased southbound through Thursday, with an increase of placarded vehicles on Friday.

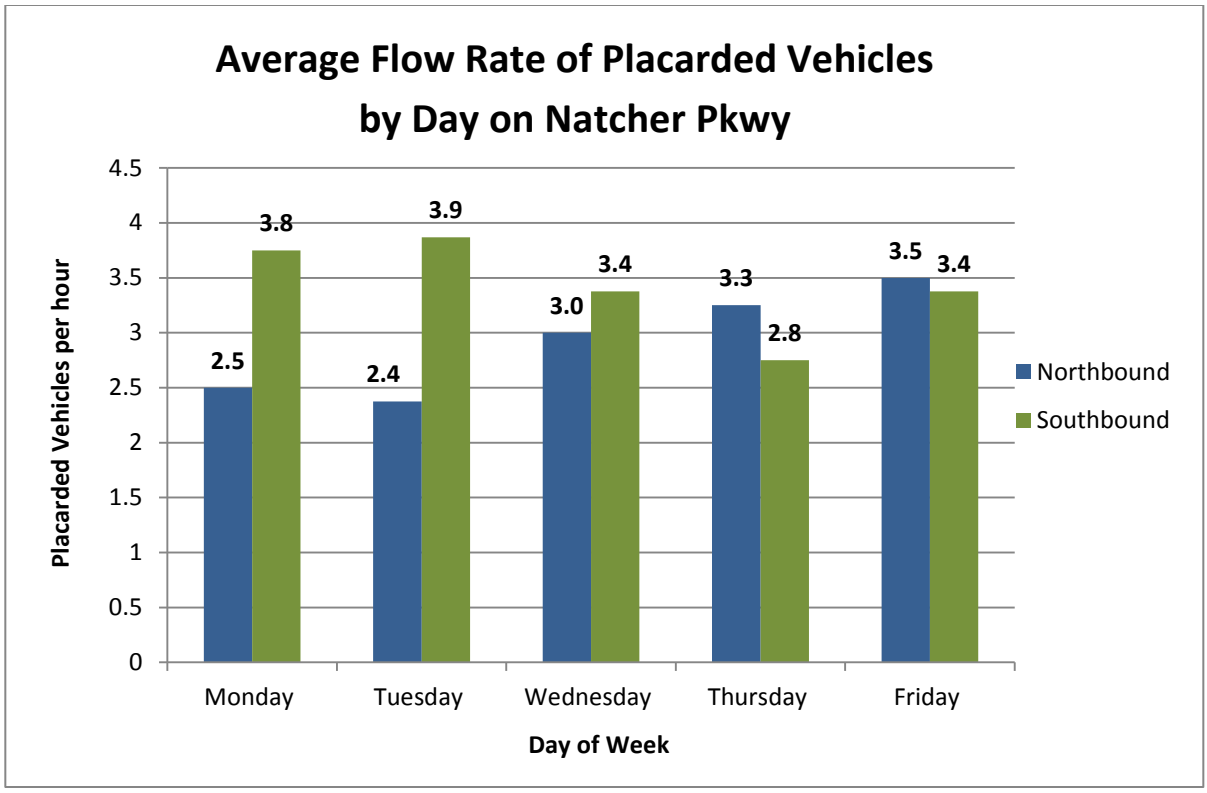

Figure 6.3. Commodity flow rates of placarded vehicles by day of the week on William H. Natcher Parkway.

iii. Placarded vehicle flow rate by time of the day on Natcher Parkway

In order to analyze the hourly frequency of hazardous materials transported, the monitoring hours at each observation point were divided into periods of the day. This created the following three time periods:

Period 1 (Morning): 7:00 to 10:00

Period 2 (Midday): 10:01 to 13:00

Period 3 (Afternoon): 13:01 to 15:00

As displayed in Figure 6.4, the maximum rates of hazardous materials were observed during the morning period for the southbound and northbound lanes, 17.0 and 20.3 vehicles per hour, respectively. The least rates of hazardous materials commodity flow was found to occur in the afternoon period, with 11.5 and 13.0 vehicles per hour, for north and southbound lanes, respectively. These data indicate that hazmat commodity flow decreases throughout the day.

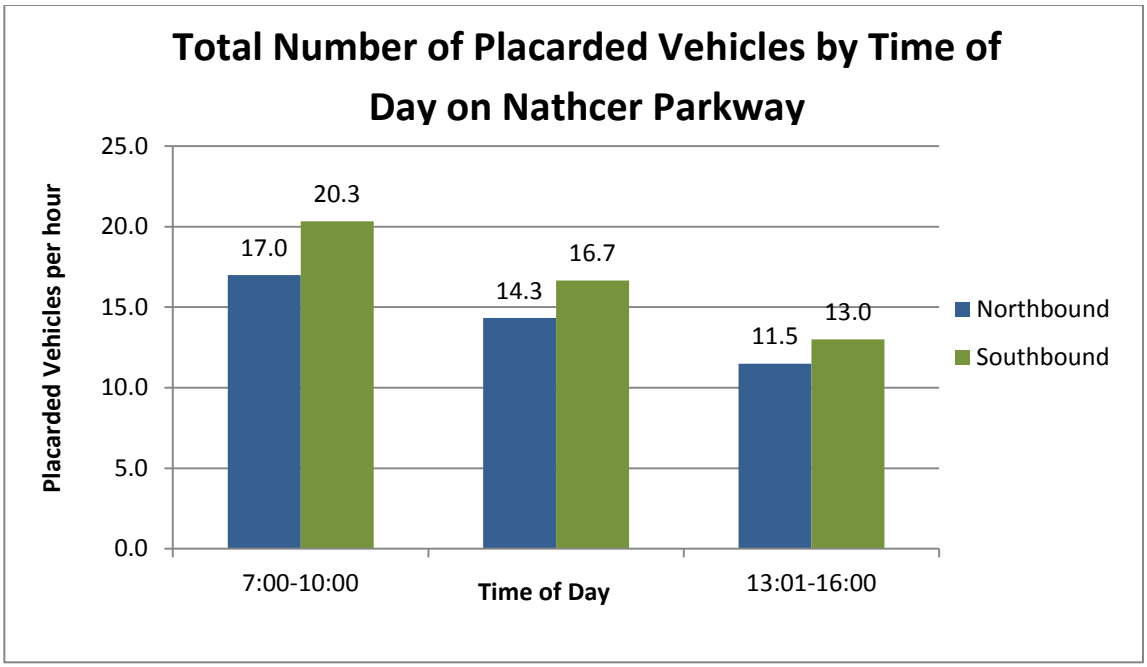

Figure 6.4. Commodity flow rates of placarded vehicles by time of the day on the William H. Natcher Parkway.

iv. Composition of Hazardous Material being transported on Natcher Parkway

Analysis of placard data was used to assess the composition of materials transported on both northbound and southbound Natcher Parkway. Elevated temperature liquid, Placard ID 3257, was the most frequently transported material northbound at 36.3% of the total hazardous materials observed (Figure 6.5). Commonly observed materials included Gasoline, Placard ID 1203, 25%, Propane, Placard ID 1075, 5.6%, and Ethanol, Placard ID 1170, 4.0%. The "Other" category indicates all other observed materials, which individually accounted for less than 3.3% of the total observations. A data table can be found in Appendix 8.

As shown in Figure 6.6, Elevated temperature liquids, Placard ID 3257, was also the most frequently transported material on southbound Natcher Parkway, accounting for 33.1% of the total hazardous materials flow. Other commonly observed materials included Gasoline, Placard ID 1203, 21.8%, Propane, Placard ID 1075, 9.2%, and Ethanol, placard ID 1170, 6.3%. The "Other" category indicates all other observed materials, which individually accounted for less than 3% of the observations and can be found in Appendix 9.

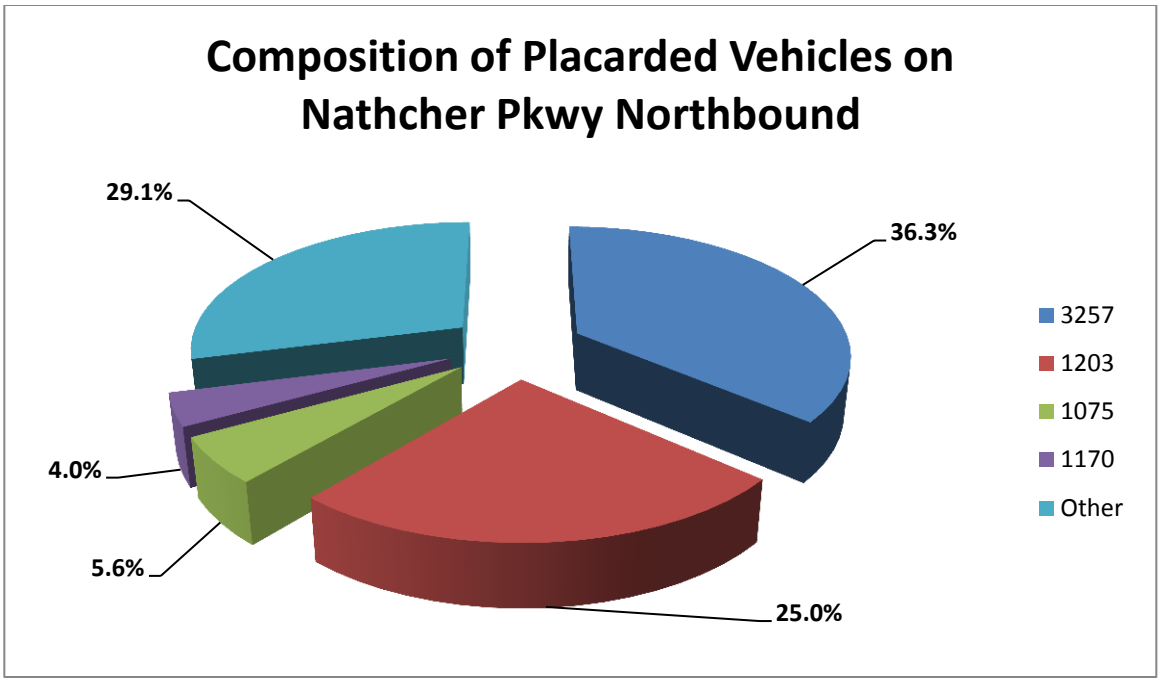

Figure 6.5. Composition of hazardous materials observed on northbound Natcher Parkway.

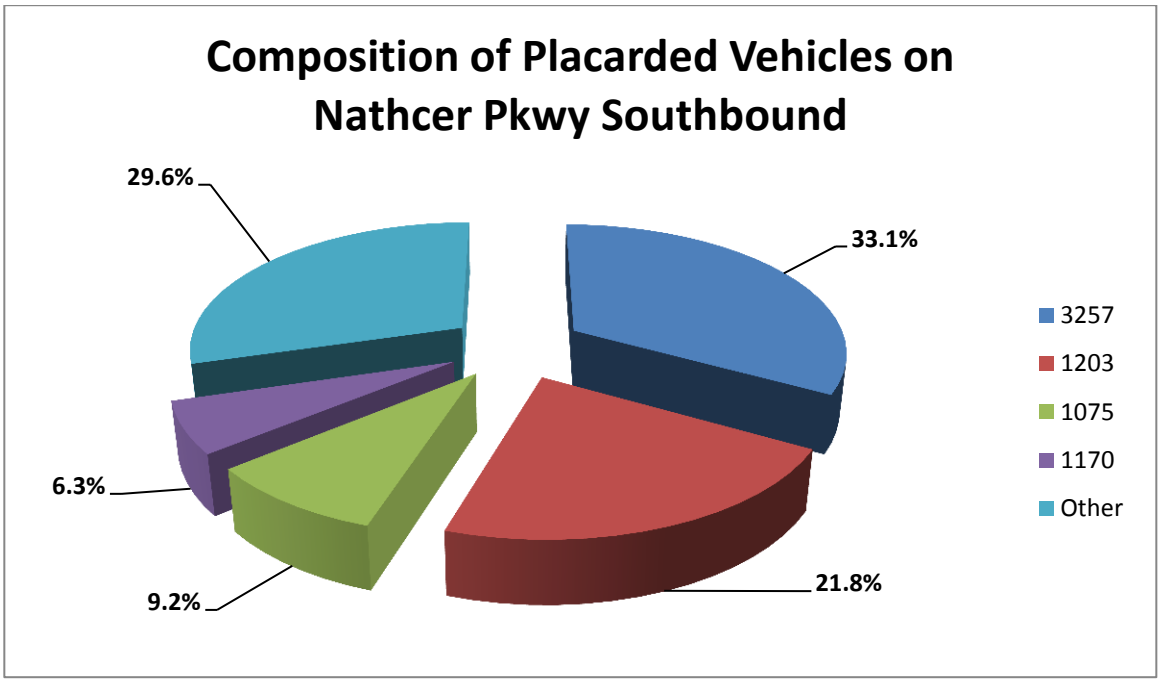

Figure 6.6. Composition of hazardous materials observed on southbound Natcher Parkway.

Chapter 7

CSX Railroad Bridge

A placard survey was conducted for the CSX Railway crossing the bridge between Evansville, IN and Henderson, KY. Monitoring was completed for the period June 3-7, 2013 from Sunset Park in Henderson, KY. A total of 40 observation hours were completed. This placard survey was part of a study for Henderson County Emergency Management (HCEM) and Henderson County Local Emergency Planning Committee. An agreement was made between DCEM and HCEM to share pertinent placard survey data. Data for the CSX Railway placard survey were provided by WKU at the request of DCEM with HCEM approval.

i. Commodity Flow of Placarded Railcars on the CSX Railway

Total placarded railcars observed during the survey were 221, on both north and southbound lines (Figure 7.1). The average number of placarded railcars observed on both north and southbound lines was 5.5 per hour (Figure 7.2). Overall, there were a greater number of railcars transporting hazardous materials on the southbound line of the CSX Railroad, 185 railcars, as compared to northbound, 36 railcars. Similarly, the average number of placarded railcars per hour was much greater southbound, 4.62 railcars per hour, as compared to northbound, 0.9 railcars per hour. Thus, almost five times as many placarded railcars were observed entering Kentucky as compared to leaving the State.

ii. Flow rate of placarded CSX railcars by day of week

Hazardous materials transported showed differences throughout the week (Figure 7.3). A maximum flow rate of 18.1 railcars per hour occurred on Wednesday for the southbound direction. Hazmat flow rate was highly variable; with no placarded railcars observed Tuesday and Thursday northbound, and only minimal flow southbound on Monday, Tuesday, and Thursday (Figure 7.3). Data for the CSX railway indicate that heavy loads occur on specific days, thus these days have a disproportionate risk of exposure. It should be noted that railroad transport of hazardous materials was

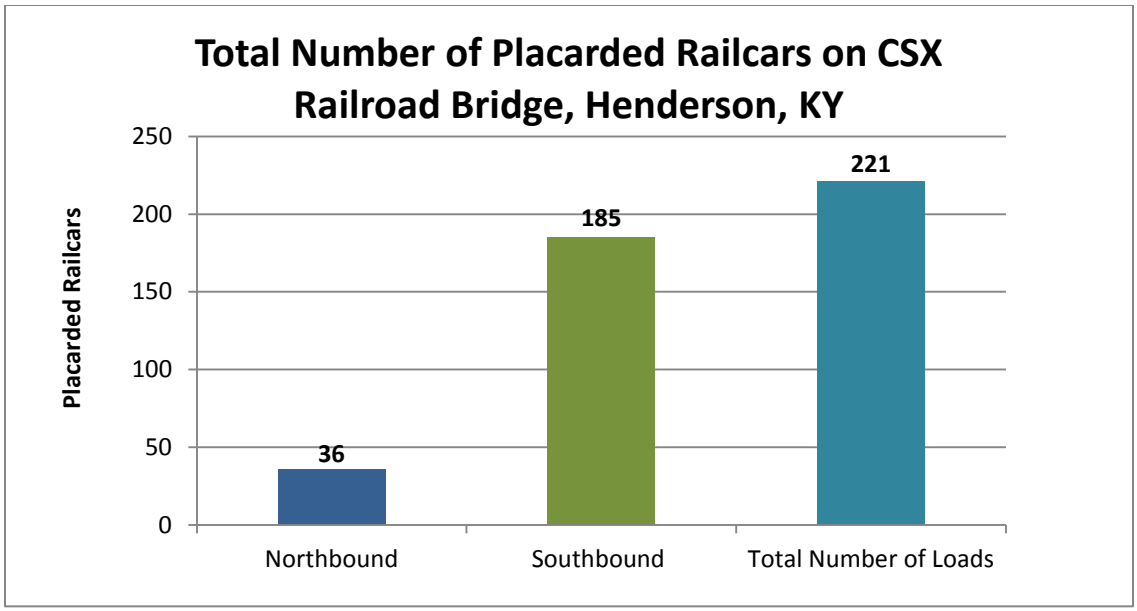

Figure 7.1. Placarded railcars observed on CSX Railroad Bridge

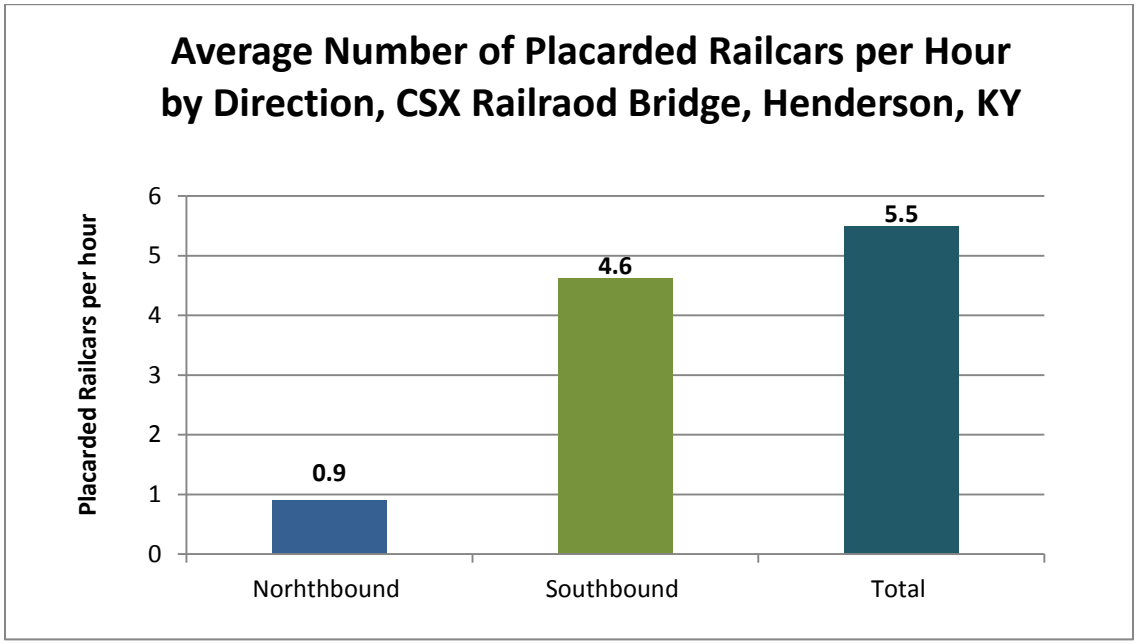

Figure 7.2. Frequency of placarded railcars *per hour on CSX Railroad Bridge.*

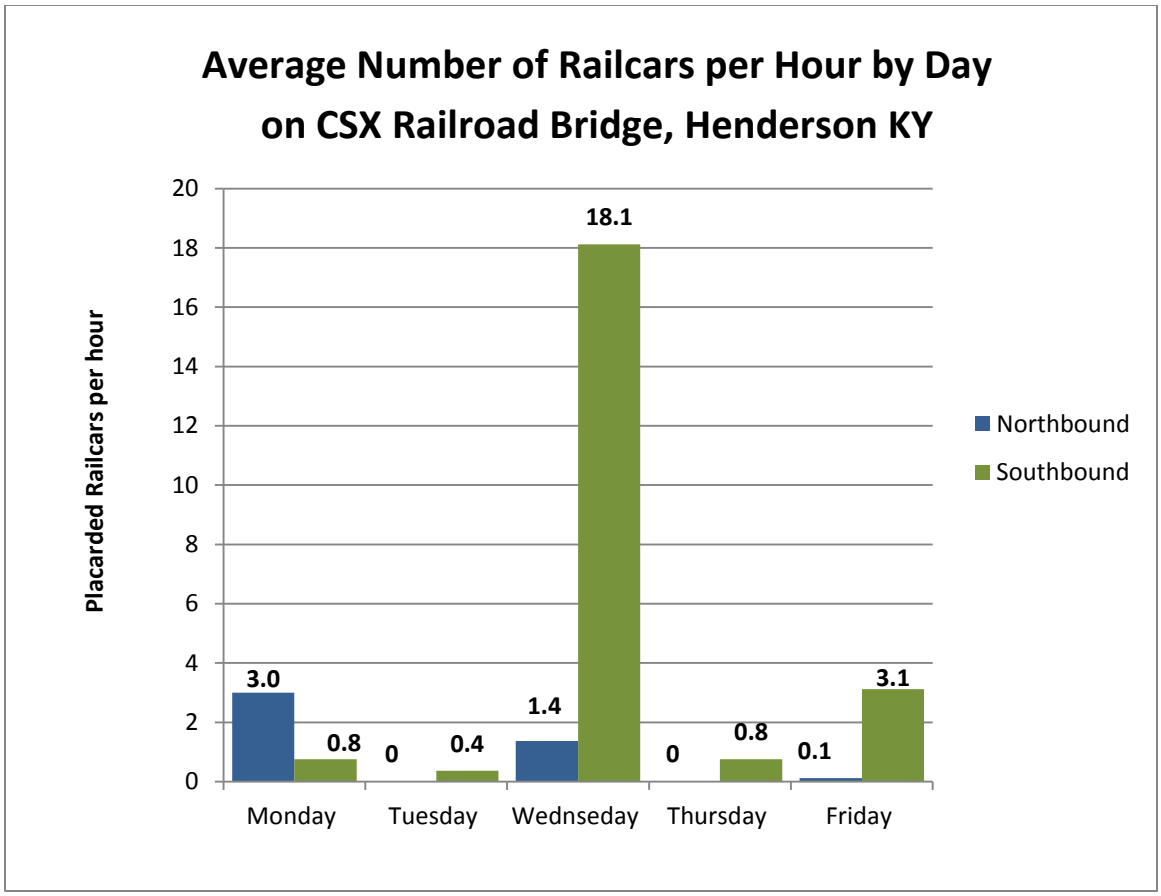

Figure 7.3. Commodity flow rates of placarded railcars by day of the week on CSX Railroad Bridge.

sporadic and not as predictable as highway traffic. Railroad transport may be impacted by maintenance on rail lines, as was observed during the study, and shipping/receiving schedules.

iii. Placarded railcar frequency by time of day on CSX Railway

In order to analyze the hourly frequency of hazardous material transport, the monitoring hours at each observation point were divided into three separate periods. This created the following three time periods:

Period 1 (Morning): 7:00 to 10:00

Period 2 (Midday): 10:01to 13:00

Period 3 (Afternoon): 13:01 pm to 16:00

As shown in Figure 7.4, the maximum rate of placarded railcars per hour was observed during the afternoon period southbound with 53 railcars/hour. For both north and southbound lines, the least rates of placarded railcars were seen in the afternoon and midday, with 3.0 and 8.3 railcars per hour, respectively. Morning and afternoon periods showed the heaviest loads of hazmats being transported into Kentucky. However, with the sporadic nature observed for these data, additional placard surveys of the CSX railroad should be conducted over an extended period of time.

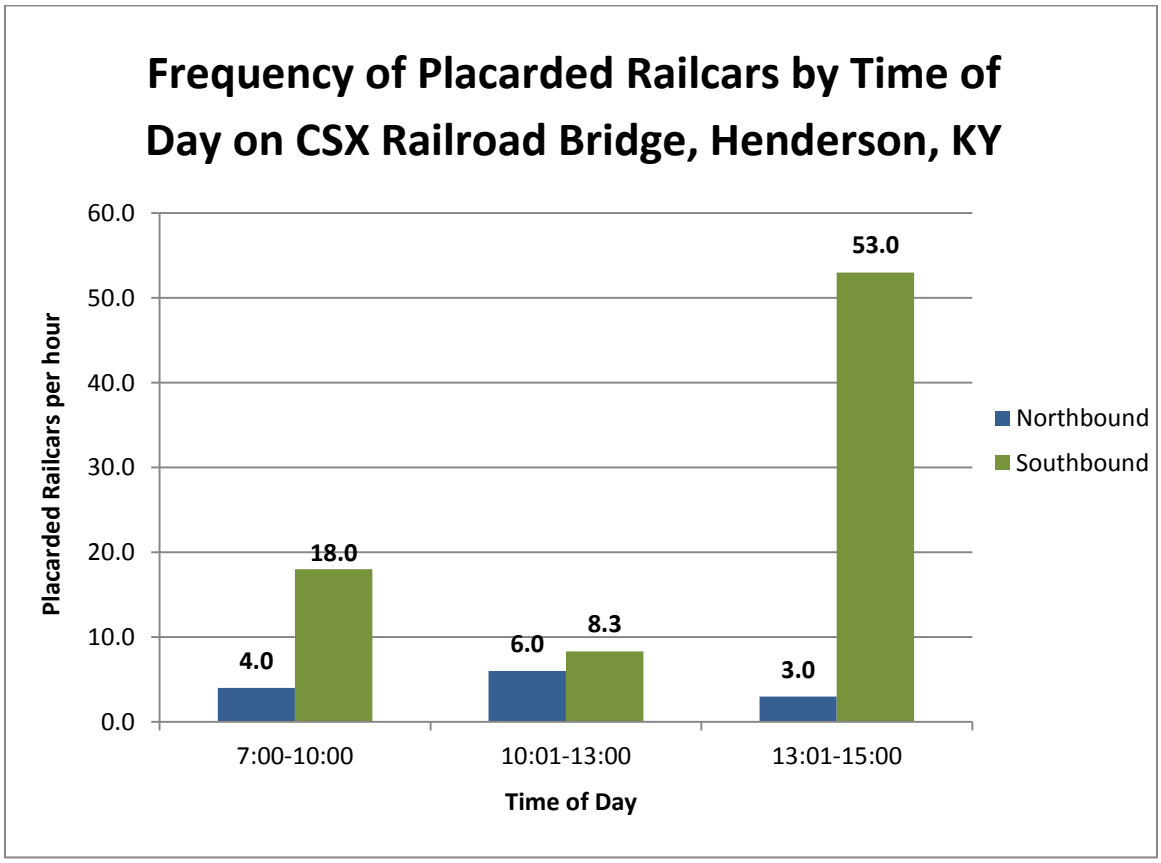

Figure 7.4. Commodity flow rates of placarded railcars by time of the day on CSX Railroad Bridge.

iv. Composition of Hazardous Material transported on CSX Railroad Bridge

Analysis of the placard data was used to assess the composition (%) of materials being transported on both northbound and southbound lines of the CSX Railroad. As shown in Figure 7.5, Chlorine, Placard ID 1017, was the most frequently transported material on the northbound line,

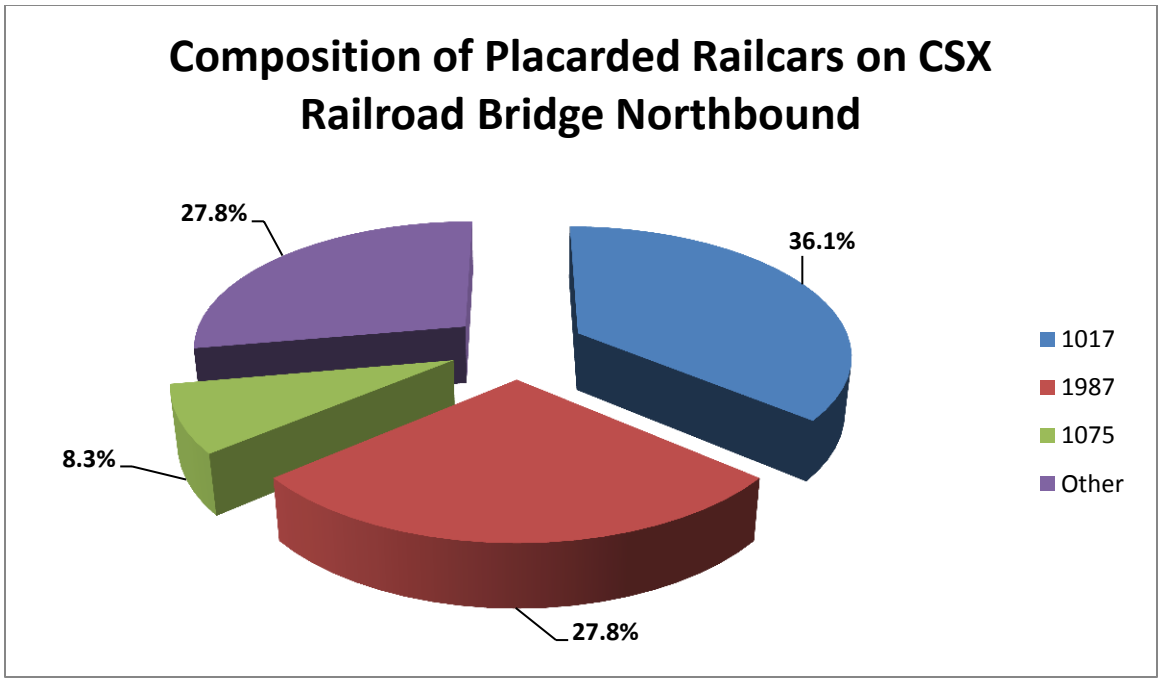

Figure 7.5. Composition of hazardous material observed on northbound CSX Railroad Bridge.

accounting for 36.1% of the total hazardous materials observed during the observation period. Other commonly observed materials included Alcohol, Placard ID 1987, 27.8%, and Propane, Placard ID 1075, 8.3%. All other observed hazardous materials were put in the "Other" category, which accounts for 27.8% of the total observed placarded railcars for the northbound line. The "Other" category indicates all other observed materials, which individually account for less than 6% of the observations. A table of data can be found in Appendix 10.

Unlike the northbound line of the CSX Railroad, Alcohol (Placard ID 1987) was the most frequently transported material on the southbound line, accounting for 58.2% of the total hazardous materials observed (Figure 7.6). Other frequently observed materials included Sulfuric Acid, Placard ID 1830, 5.8%, Chlorine, Placard ID 1017, 4.8 %, Phosphoric Acid, Placard ID 1805, 3.2%, and Carbon Dioxide refrigerated liquid, Placard ID 2187, accounting for 3.2%. The "Other" category indicates all other observed materials which accounted for 24.8% of all observed placarded railcars on the southbound

line. The “Other” category indicates all other observed materials, which individually accounted for less than 2.6% of the observations and a table can be found in Appendix 11.

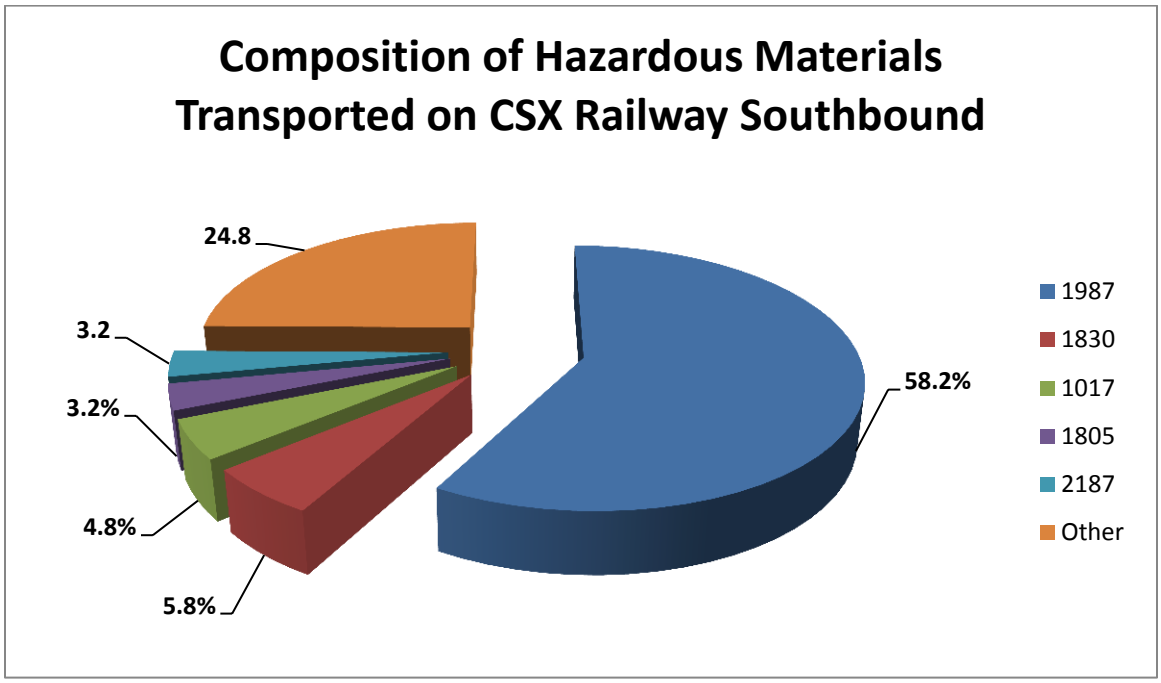

Figure 7.6. Composition of hazardous materials observed on southbound CSX Railroad.

Chapter 8

Fixed Facilities Hazardous Commodity Transport Survey

A fixed facilities hazardous materials transport survey was administered through DCEM. Survey data was collected from 14 fixed facilities within the Daviess county study area. The Kentucky Emergency Response Commission monitors these facilities as they may store large amounts of hazardous materials. In some instances, hazardous materials could exceed the threshold planning capacity of the EPA's "Extremely Hazardous Materials". Emergency planning for future hazardous materials incidents should be based upon knowledge of fixed facilities use of trucking, both timing and routes, along with the types and quantities of hazmat shipped and / received. Other modes of transportation such as rail and barge should be included if used by the fixed facilities.

In order to investigate the travel of hazardous materials to and from fixed facilities, the survey consisted of a voluntary questionnaire. Surveys were mailed to environmental health and safety managers in May 2013. The questionnaire was designed to document the origins and destinations of hazardous material commodities interacting with fixed facilities, within the study corridor. Surveys were returned to Daviess County Emergency Management. The results were assessed to portray the types of hazardous material transport within the study area.

Information requested in the questionnaire included:

- Frequency of Hazmat Shipments
- Routine of Hazmat shipments
- Total quantities of hazardous materials
- Origins/Destinations of shipments
- Timing of Hazmat shipments
- Composition of Hazmat shipments
- Recent Trends

i. Fixed facilities and hazardous materials

A total of 14 industrial facilities responded to the survey. Most of the responding industries ship and receive hazardous materials. It is essential to know the type of hazardous materials transported, as well as their regular periods of shipment. Survey results evaluate the most common substances transported, their origins and destinations, as well as trend of transportation over the last five years, i.e. 2008-2012. Daviess County Emergency Management can utilize the fixed facility survey results, in conjunction with the commodity flow survey, to assess preparedness for hazardous material incidents within the study region. An important aspect of this survey was to determine if facilities transport hazardous materials on legal holidays. Facilities, which indicated that they do not carry hazardous materials, were discarded from the results.

ii. Fixed Facility Locations

Survey questions, regarding the location of facilities based on city, state and county, were provided to local industries. This data was used to assess hazardous material commodity imports and exports in the Daviess county study area. All 14 facilities that responded to the survey were based in Kentucky, with some having corporate offices in other states.

Questions in the survey addressed the most common mode of transportation of hazardous material to and from the facilities. All 14 facilities reported using trucks as a major source of hazardous material transport, and some of the facilities reported using railroad and/or other means of transportation. The survey included questions requiring the facilities to give information about the number of placarded trucks that leave or arrive at their facilities. Routes of hazardous material transport were requested in the questionnaire. Location, by zip code, of the 14 facilities is shown in Figure 8.1. Approximately, 50% of all facilities were located within the 42301 zip code, 21.4% in both the 42302 and 42303 zip codes, and 7.1% were located in 42304 zip code.

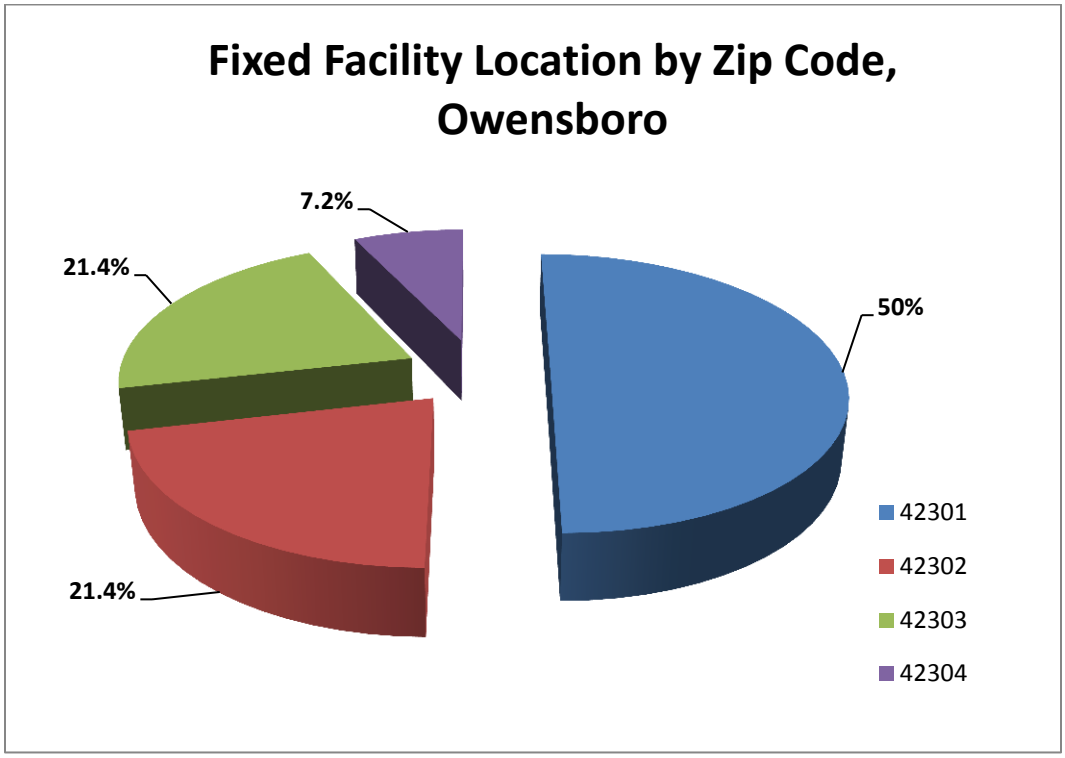

Figure 8.1. Locations of fixed facilities by zip code.

iii. Time pattern for receiving hazardous materials shipments

One of the questions in the survey asked the facilities to give information regarding the number of shipments that arrived and departed from their facilities. When we compare the materials received over the past five years, we observe that the bulk of receiving is during the week or Monday through Friday, with 10 facilities also receiving shipments on Sunday as well (Figure 8.2).

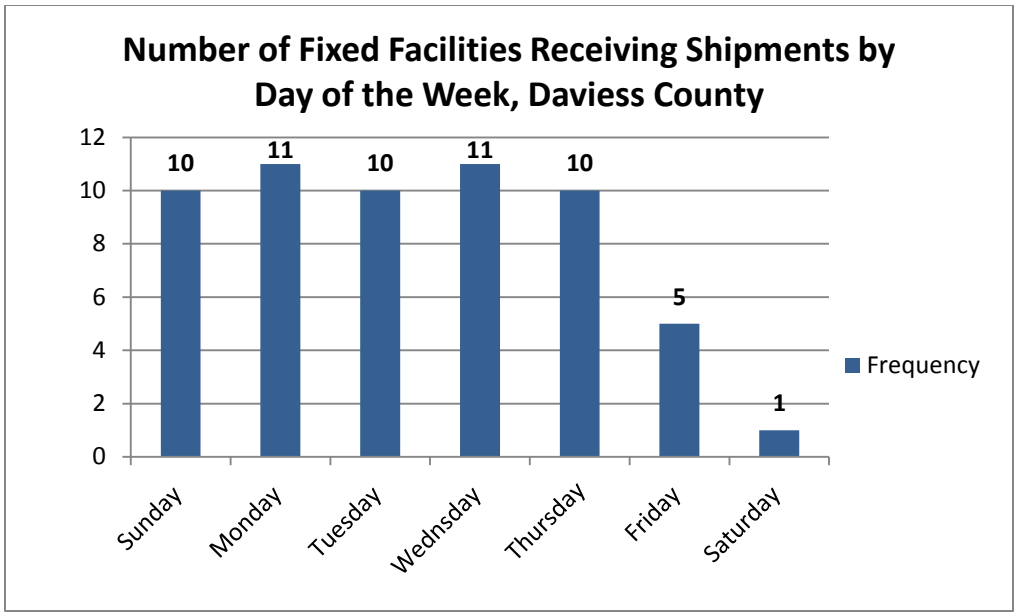

Figure 8.2. Fixed facilities receiving hazardous materials by day of the week.

Fixed facilities were also asked to give information on the most common shipment periods. Results are shown in Figure 8.3. Information submitted indicated that 8 facilities had no routine time of shipment. The most common time of day for shipments of hazardous materials was during normal working hours, between 06:00 – 16:00.

The facilities were asked if they received or shipped hazardous materials on legal holidays. Six facilities, which make up 43% of all responding facilities, ship or receive hazardous materials on legal holidays (Figure 8.4). This may be a contingency to plan for, as altered traffic patterns during holidays may change the operation parameters of hazmat transport, thus increasing the chances for incidents.

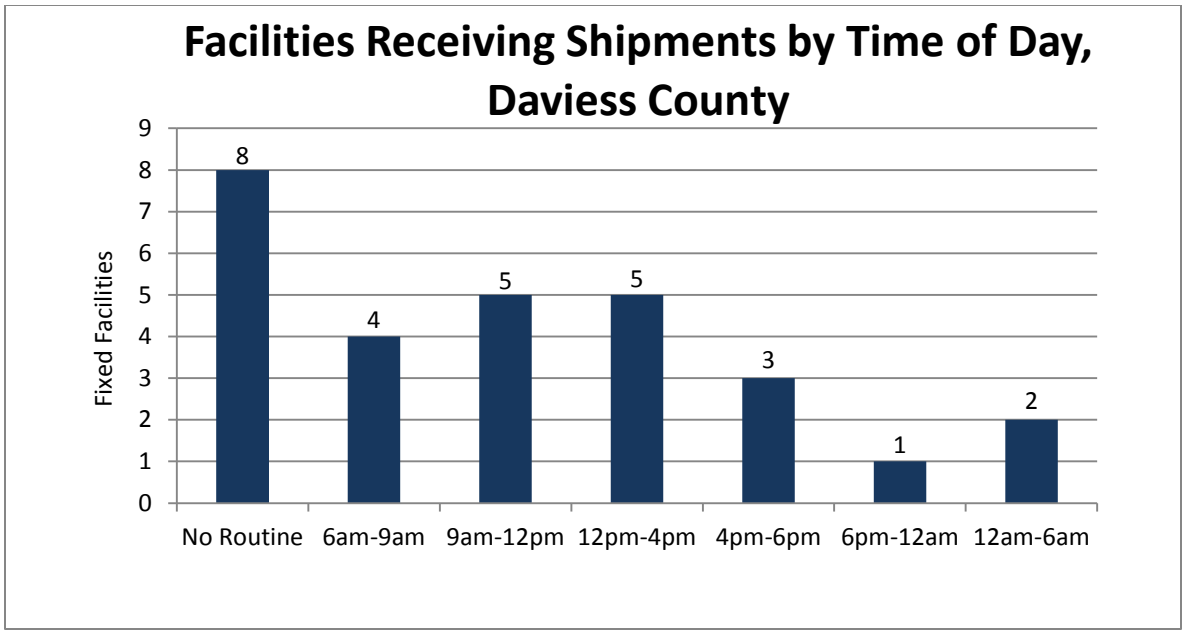

Figure 8.3. Fixed facilities receiving shipments of hazardous materials by time of the day.

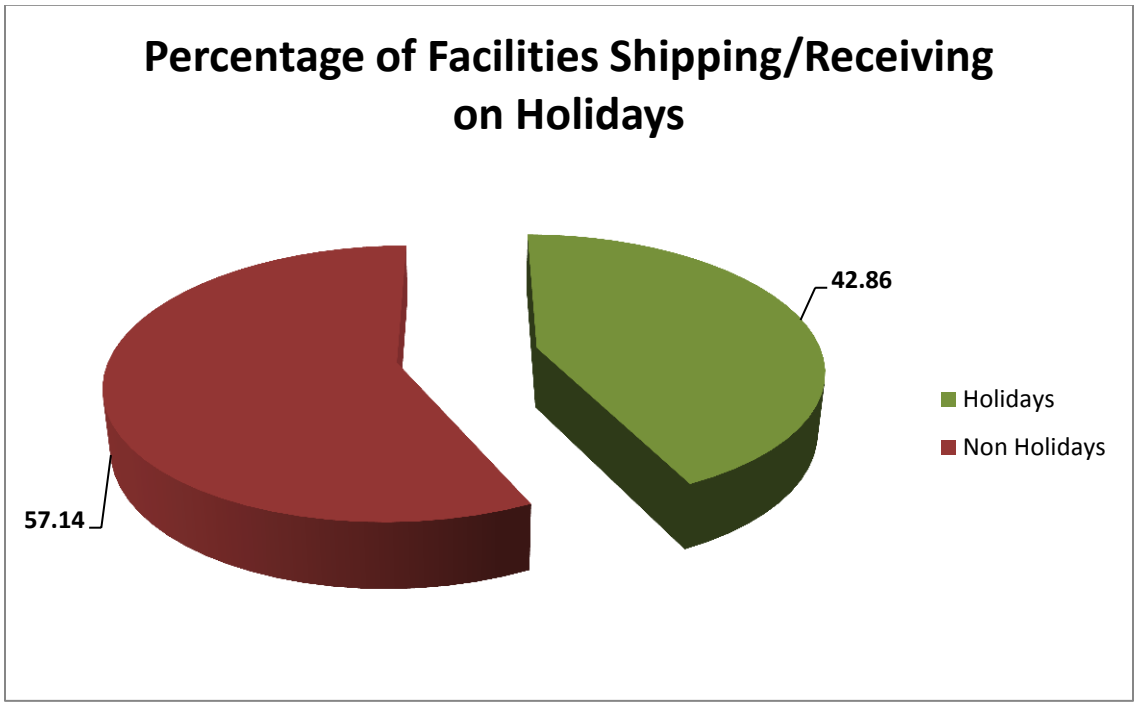

Figure 8.4. Fixed facilities shipping and receiving hazardous materials on holidays.

iv. Time pattern for shipments from facilities

Facilities were asked to report on time patterns for shipping hazardous materials. Six facilities reported Saturday and one facility reported Sunday as routine shipment day. The typical shipment pattern reported (Figure 8.5) by day was during the workweek, Monday through Friday. Time of day patterns for hazardous material shipments showed a trend towards standard work hours, between 06:00 and 16:00 (Figure 8.6). Eight facilities reported there was no routine time of day for shipments.

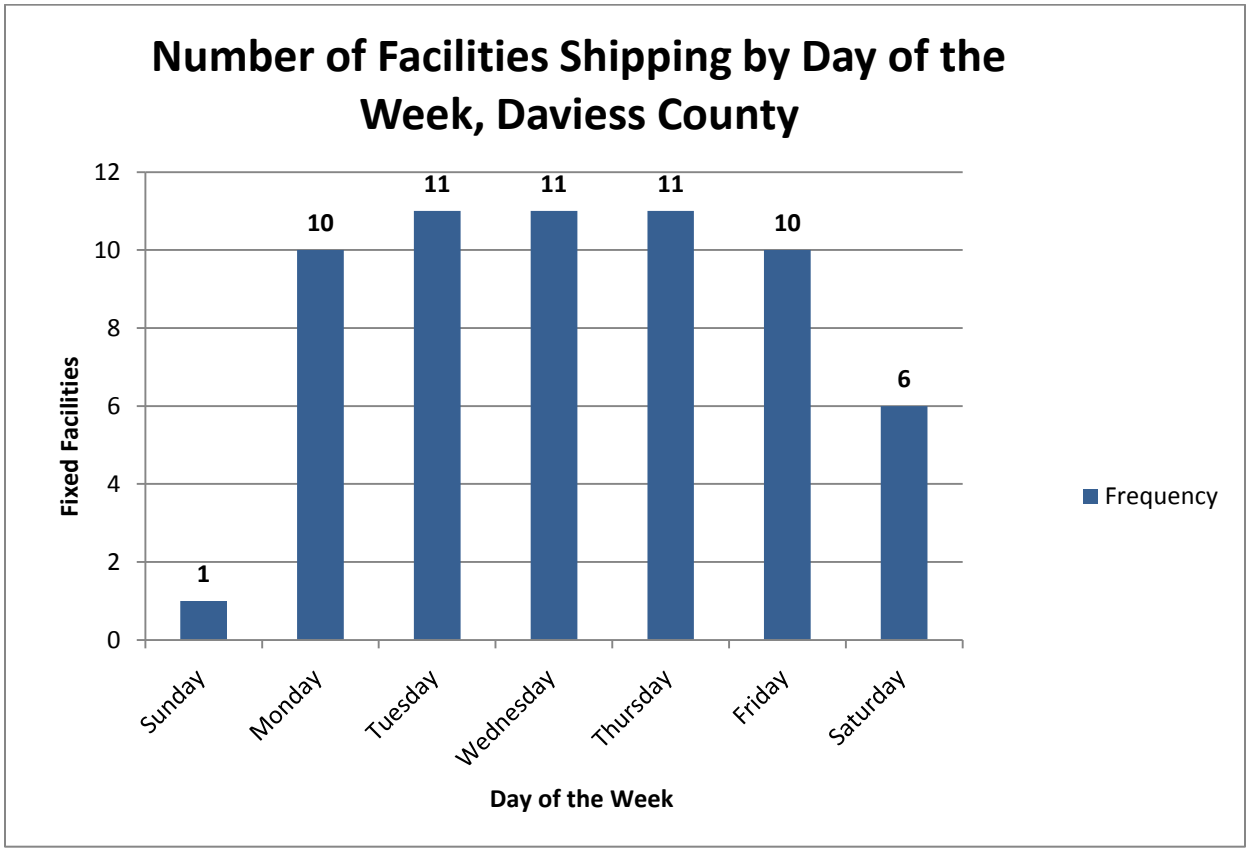

Figure 8.5. Fixed facilities shipping hazardous materials by day of week.

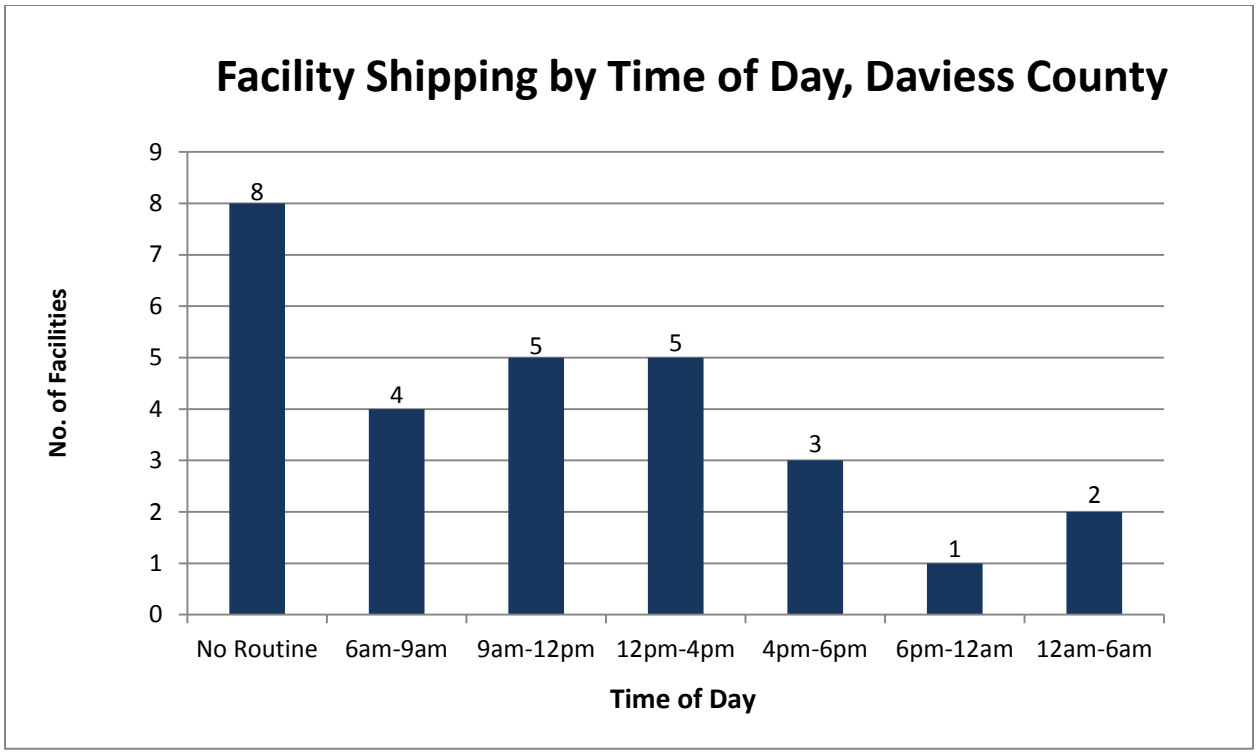

Figure 8.6. Fixed facilities shipping hazardous materials by time of the day.

v. Analysis of hazardous materials

Survey questions were designed to elicit information about the five most frequently shipped hazardous materials from each facility. Respondents listed a total of 46 hazardous materials that were transported during the 5-year period, 2008 through 2013. Survey questions addressed the most common cities and states the materials are transported to, including seasonal transportation. Out of the 46 hazardous materials listed, Pyrethroid Pesticide, Gasoline, Sulfuric Acid, Flammable Liquid/Diesel Fuel, and Tetrachloroethylene formed approximately 34.7% of the hazardous material composition (Figure 8.7) With the other category accounted for 65.3%. Appendix 12 shows frequencies of other materials transported; the "Other" category indicates all other observed materials, which individually account for less than 2.6% of the observations.

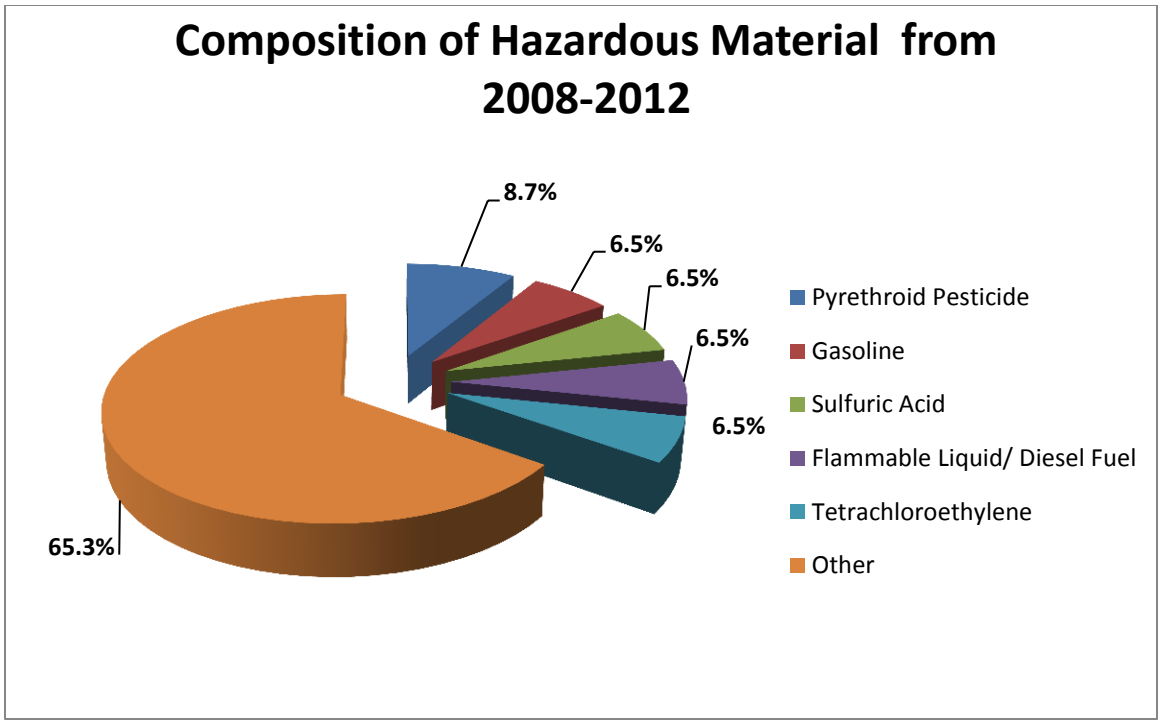

Figure 8.7. Composition of hazardous materials shipped and received by fixed facilities.

Seasonal transport was another series of questions in the survey, including the season during which hazardous material is most frequently transported. Facilities provided the most common seasons of the year during which they transport hazardous materials (Figure 8.8) For the facilities that responded, 34 chemicals were reported to be variable in transport throughout the year. The supply period is based upon demand for their produced materials. The amount of materials transported was lowest between July and September while October through June is stable to increasing.

Survey results also included information as to the origin and destination of hazardous materials, to and from the responding facilities. States that hazardous materials were both imported from and exported to included Indiana, Kentucky, and Illinois (Figure 8.9). Hazardous materials were imported by reporting facilities from as far away as Alabama. Only five states were reported as the origins of hazardous materials coming into the study area (Figure 8.10). More facilities receive shipments from the states of Kentucky, and Indiana, than all others

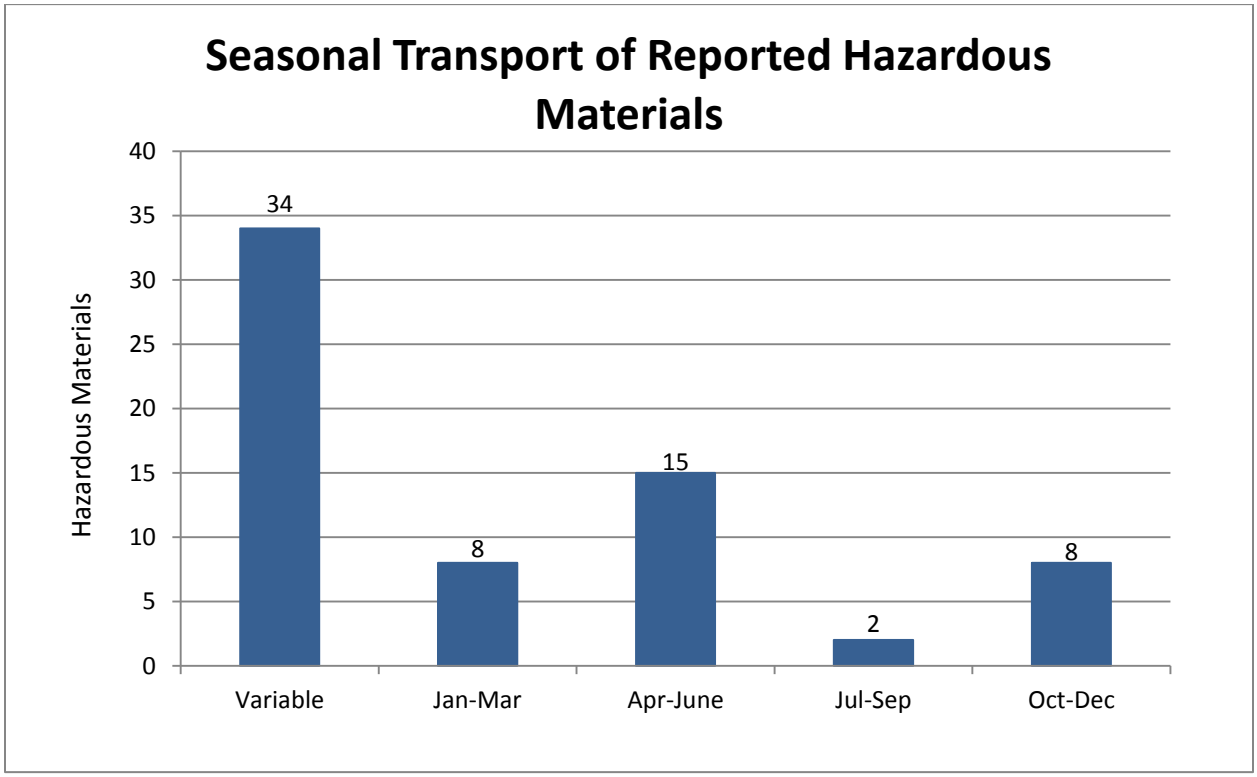

Figure 8.8. Seasonal shipment of hazardous materials by fixed facilities.

Destination states were indicated in the survey by the reporting facilities. Figure 8.10 shows the states that were indicated to send shipments of hazardous materials to the Daviess County study area. Survey responses indicated that Kentucky, and Indiana were reported as the most frequent ship from states by facilities in the study area. Likewise, these states were the highest frequency for receiving shipments from facilities in the study area (Figure 8.11).

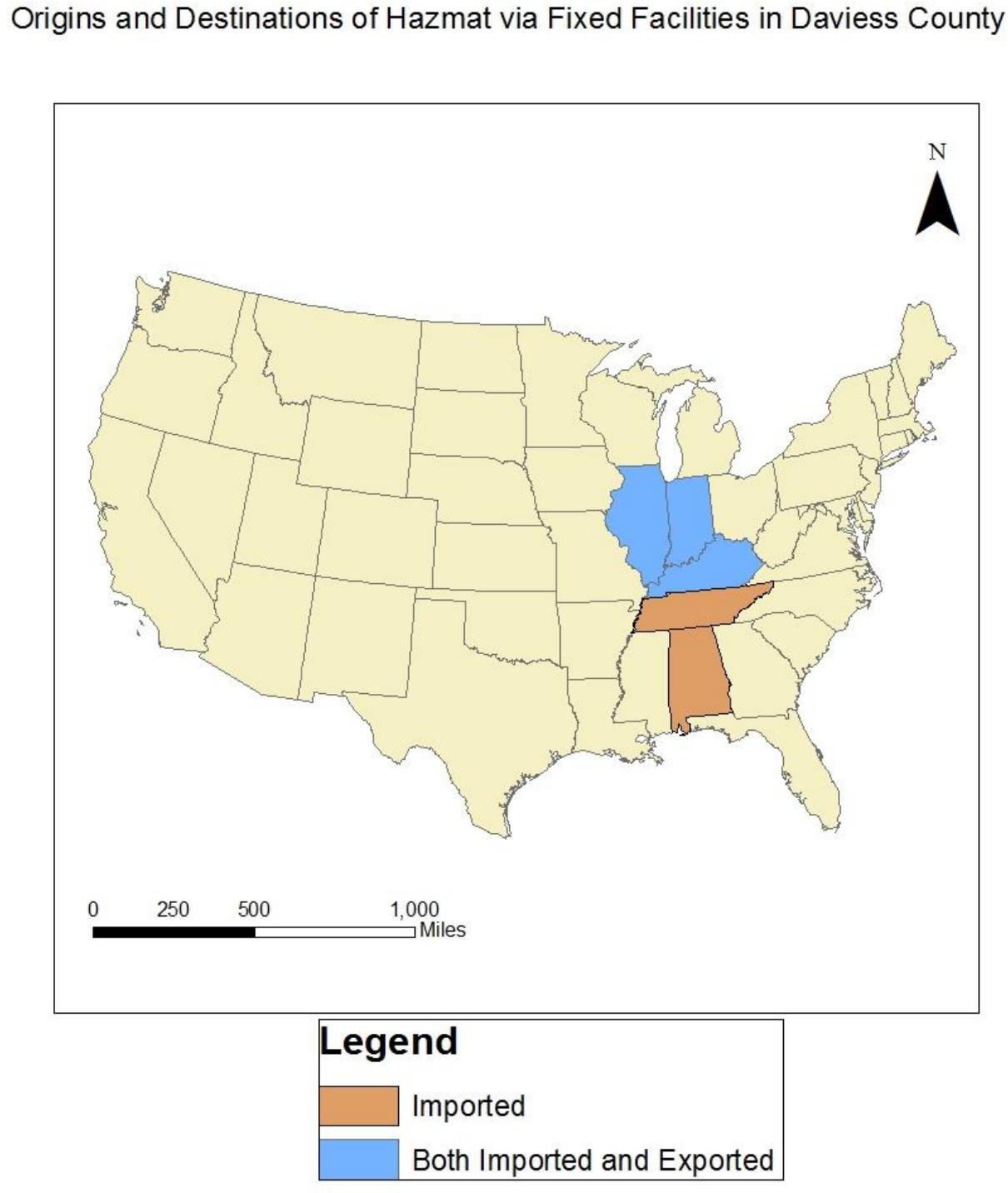

Figure 8.9. Origins and destinations of hazardous materials via fixed facilities in Daviess County.

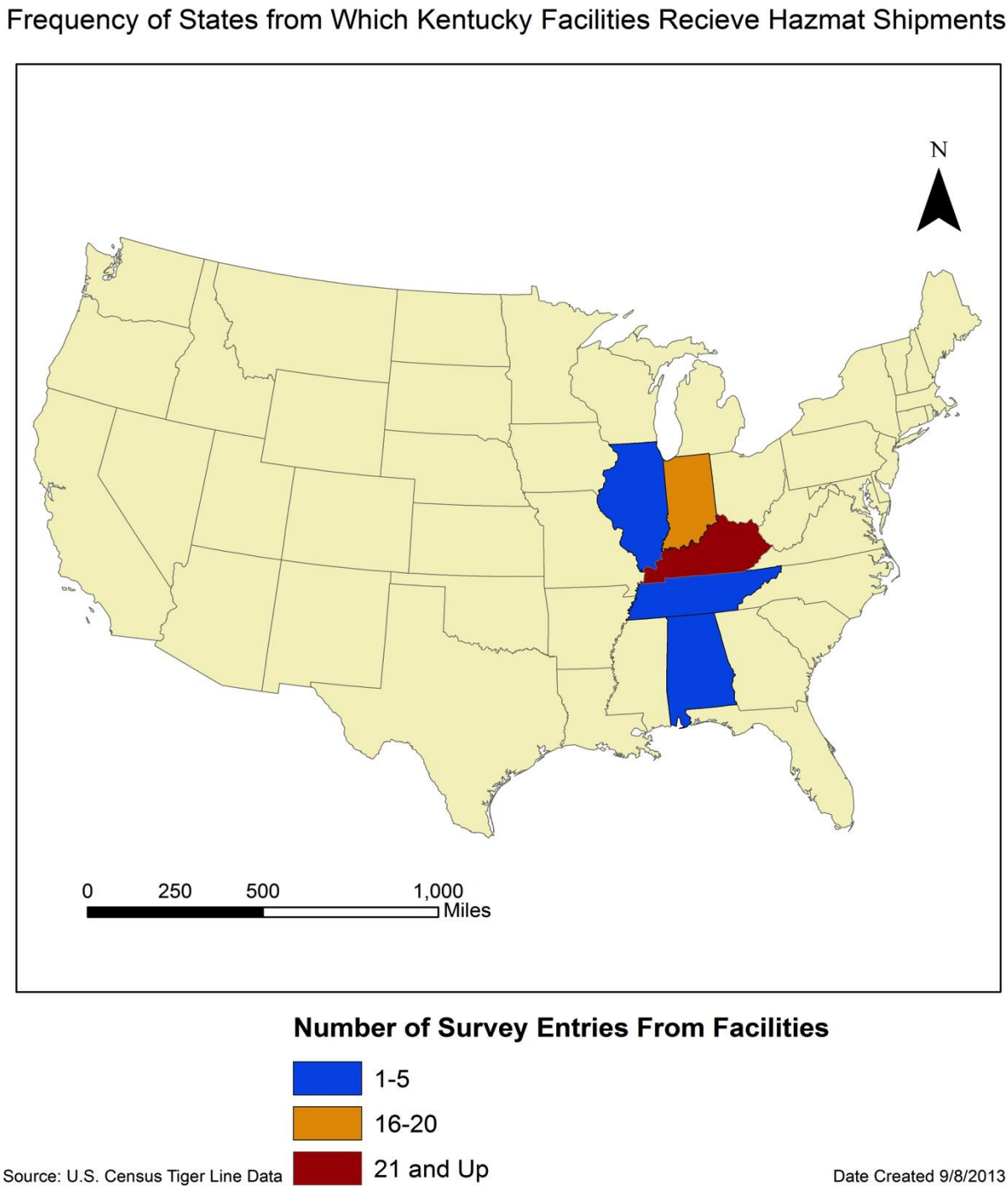

Figure 8.10. Frequency of states that ship to fixed facilities in Daviess County.

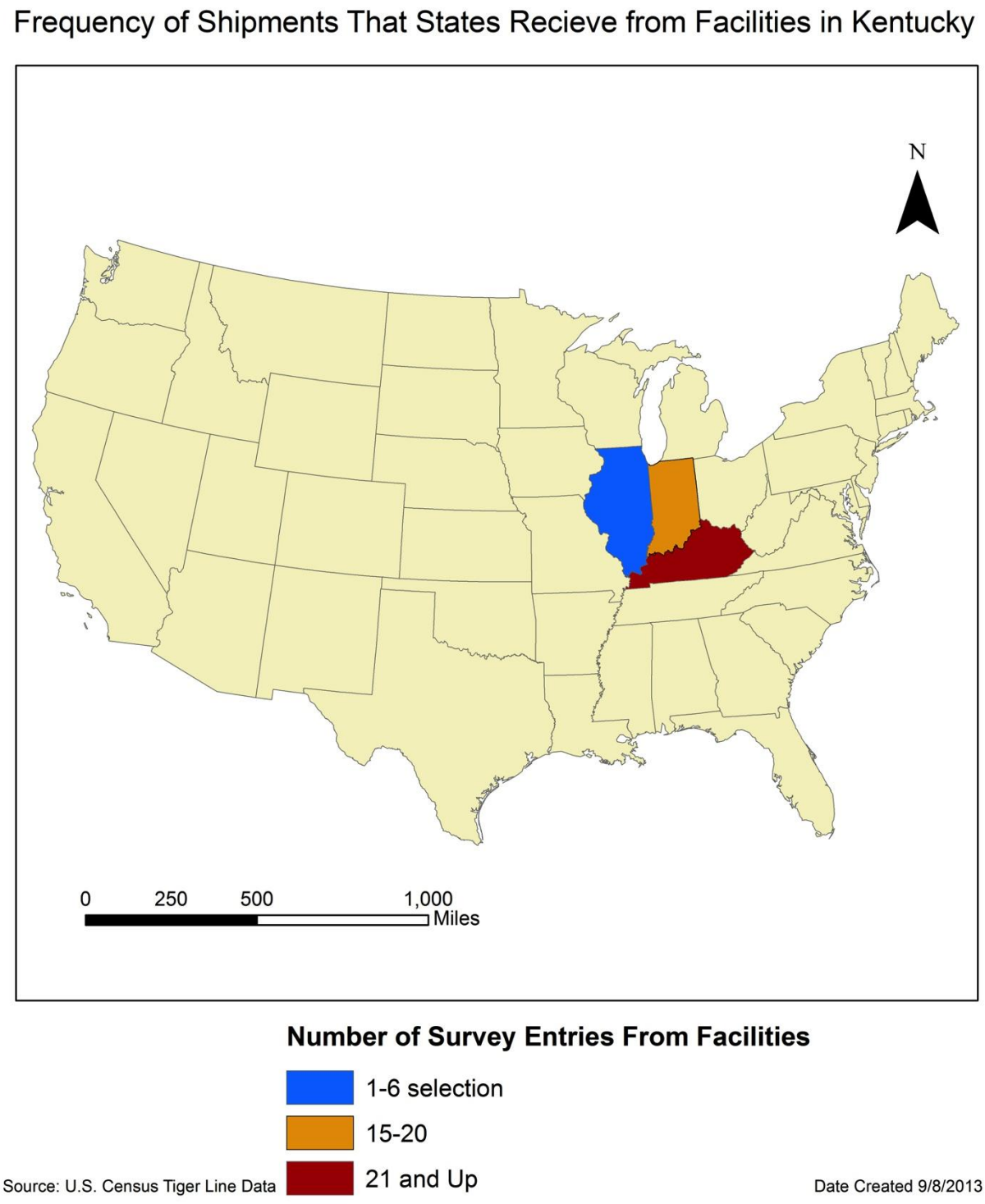

Figure 8.11. Frequency of states that receive shipments from fixed facilities in Daviess County.

Chapter 9

Summary and Recommendations

Hazardous materials are an important part of contemporary American society. As with other commodities, hazardous materials are produced, transported, stored, used and discarded. Hazardous materials that are released due to highway, railway, and other incidents pose a threat to environment and human health. Incidents with hazardous materials can take place at any time, from their production to their disposition. This study clarifies the quantities and types of hazardous materials that are transported on Hwy 60, U.S. 231, Audubon Parkway, William H Natcher Parkway, and CSX Railroad Bridge in Daviess County Kentucky. Likewise, information is provided on the timing of transport, which is critical for emergency preparedness.

It is essential to prepare communities, both large and small, for the potential of hazardous material incidents. Hence, it is important to initiate construction of a knowledge base that concerns types of hazardous materials being transported to, from, and through a respective jurisdiction. In addition to their relative commodity flow rate, knowledge of the timings and routes of hazardous materials increase emergency response preparedness. Emergency response planning should be predicated on an adequate portrayal of these elements of hazardous materials movements. The adequacy of emergency response organizational schemes, contingency plans, equipment inventories and purchases, and personal training must be assessed in the light of this type of information.

This report creates an accurate starting point, and begins the development of the necessary knowledge for the commodity flow of hazardous materials through the study corridor in Daviess County. Communicating this information to emergency responders will generate an initial line of incident response before such an event occurs. Coordination of emergency response will be critical to adequately protect human health and environment from the potential impacts of the hazardous materials documented.

It is hopeful that results and recommendations of this report will be a useful guide in preparing emergency responders and increasing emergency preparedness.

This study provides focus on highway transportation. The empirical results that are summarized below are based on the following:

- A Five-year hazardous material incident history from December 2008 – August 2012, which was reported by Daviess County Emergency Management Agency to WKU.

- A fixed facility survey sent out to facilities that ship and receive large quantities of hazmats in the Daviess County area.

- Commodity flow data collected by placard surveys on Hwy 60, U.S. 231, Audubon Parkway, William H Natcher Parkway, and CSX Railroad Bridge. Monitoring was conducted by Western Kentucky University students from the Department of Public Health, Environmental Health Science program. Student work was supervised by Dr. Vijay Golla and Dr. Ritchie Taylor of Western Kentucky University and by Mr. Richard Payne with Daviess County Emergency Management.

The following section summarizes the results obtained in chapters 2, 3, 4, 5, 6 and 7, and gives recommendations which can be used as a guidance tool for emergency preparedness related to hazardous materials incidents:

Result 1:

During the period of December 2008 – August 2012 a total of 56 incidents involving hazardous materials were reported to the Daviess County Emergency Management.

Recommendation 1.1:

The emergency response committee should index general economic activity as a predictor of commodity transport. Data shows that transport volume corresponds to the number of incidents. Periods of recovery after a sustained economic lull may be particularly dangerous periods in the study corridor.

Recommendation 1.2:

Daviess County Emergency Management should inform local emergency responders as to the most detected placard ID numbers in surveys, incidents, and from other data sources. This would ensure that responders are prepared for hazardous materials incidents that are likely to occur. Also, emergency management planning should take all hazardous materials observed into account.

Recommendation 1.3:

A more detailed hot spot analysis should be completed with a risk assessment to enhance emergency preparedness in the City of Owensboro, as most incidents are concentrated in and around the city. These are sites and areas where incidents have occurred since 2008, and, in all likelihood, will continue to witness hazmat incidents. Preparedness should include contingency plans for the protection of human health and the environment, in light of the hazmats that have been detected in this study.

Result 2:

Majority of incidents include spills and vehicular accidents along the study corridor

Recommendation 2:

It is important to update the drivers about the current rules and regulations and safety norms. Strict rules should be implemented for speed control in this corridor. Logbooks should be thoroughly checked to make sure the drivers do not overwork, and speed limits for trucks should be restricted to 60 mph or less. Within the city limits of Owensboro, KY and other congested areas in Daviess County, the speed of trucks should be strictly enforced and limited to a maximum 30 mph or less. Trucks overtaking other vehicles on highways should be fined. A system of automated signage, especially in the incident hotspots may improve safety.

Result 3:

Commodity flow rates of hazardous materials were greatest during mid-week and during normal work hours.

Recommendation 3:

It is extremely important for emergency responders to be familiar with the peak days and times with reference to the transportation of hazardous materials. This will ensure better alertness and preparedness in case an incident occurs during these time periods. Extra emergency responders should be on call during the aforementioned peak timing in order to ensure efficient response. One potential problem in areas with volunteer emergency responders is that these responders are usually working other jobs during these peak times for hazardous materials transport. A system needs to be devised to improve incident response in these areas.

Result 4:

The most common type of hazardous materials that were transported across the study corridor varied by Roadway. On Hwy 60, ID 1203, is most commonly transported ID 3257, is the most commonly transported on the Natcher parkway. The Railroad Bridge varied greatly in both directions on which hazardous materials were most commonly detected. Also A review of the list of the "other category" in the appendices of this report is needed.

Recommendation 4:

Responders should review the most common types of hazardous materials observed in transport via each study corridor and develop emergency response plans for the related materials. It is extremely important to train emergency responders with reference to these materials. Annual training should be established for incidents involving ID 1203, 3257, 1993 and 1075. Additionally, contingency plans and training exercises should be developed in the areas with the greatest densities of incidents in case an evacuation or extensive response is needed.

Result 5:

From chapter 8, Fixed Facilities Survey, it is clear that the greatest numbers of facilities are located in the Daviess county area.

Recommendation 5:

It is very important for local responders in the Daviess County area to be trained to deal with a range of hazardous materials incidents. Proper training equipment and PPE should be kept in place. Each responder should review the hazardous materials that have been observed in this report and be trained and prepared to respond to each one. Additionally, scenarios with multiple hazmats should be practiced.

Result 6:

Transportation of the majority of hazardous materials was observed to take place during weekdays, and between working hours of 6 am-4 pm. This corresponds to the morning and afternoon rush hours of public traffic. Additionally, this corresponds to school bus hours.

Recommendation 6:

Facilities should be requested to change their hours of shipments to mid-day, early morning or early afternoon. This will limit the risk to the public during traffic rush hour.

Result 7:

Monitoring was constrained to daylight hours due to budget and time restrictions for the project. Additionally, rail and barge commodity loads of hazardous material were not included for the aforementioned reasons.

Recommendation 7:

A placard survey should be completed in Daviess County that includes monitoring during the late afternoon, 18:00-22:00, through the night, 22:00-02:00, and into the early morning hours, 02:00-06:00. Currently, the rate of commodity flow is unknown for these time periods in the study area. A daylight rail and barge commodity flow pilot study should be completed to begin to assess the load of hazardous materials transported by these modes of transport.

Chapter 10

References

ESRI 2011. ArcGIS Desktop: Release 10.0. Redlands, CA: Environmental Systems Research Institute.

Golla, V., Taylor, R. (2011). Madison County, Kentucky, Hazardous Materials Commodity Flow Analysis, Final Report, August 2011. *Public Health Faculty Publications.* Paper 2. http://digitalcommons.wku.edu/public_hlth_fac_pub/2.

Taylor, R., Golla, V., Nair, R., Advani, S., & Brown, J. (2010). Warren County, Kentucky Hazardous Materials Commodity Flow Analysis, Final Report, August 12, 2010. *Public Health Faculty Publications.* Paper 1. http://digitalcommons.wku.edu/public_hlth_fac_pub/1/.

Taylor, R., Golla, V., Eagleson, J., Givan, E., & Koerber, L. (2013). Henderson County, Kentucky Hazardous Materials Commodity Flow Study, Final Report, September 2013. Western Kentucky University. *Public Health Faculty Publications*.

U.S. Department of Transportation. (2010). *U.S Department of Transportation Federal Motor Carrier Safety Administration*. Retrieved August 26, 2012, from DOT: http://www.fmcsa.dot.gov/safety-security/hazmat/hm-theme.htm.

U.S. Environmental Protection Agency. (2010, March 10). *Wastes-Hazardous Wastes*. Retrieved August 26, 2012, from U.S.Environmental Protection Agency: http://www.epa.gov/osw/hazard/.