Alternative Hazardous Material Routes for Victoria County that Minimize Risk to Population
The University of Texas at Austin

CRP 386 – Fall 2007

Shawn M. Strange
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EXECUTIVE SUMMARY:

This project focuses on Hazardous Material (HazMat) transportation routes through Victoria County/Victoria City in the State of Texas. The focus of the study is the current transit route. It analyzes the impact zone should an accident or incident occur in the central region of the city as well as defines the current at risk population. The study utilizes Census 2000 data as well as recent accident and traffic volume data that were gathered by the firm, *Alliance Transportation Group, Inc.* The study focuses on the Highways in the center of the city, as this is the location with high accident levels and sensitive locations. Victoria County is cut by several major roadways with heavy truck flows that converge at this central point in Victoria City. This particular area has 1) a high number of schools, 2) a high number of car accidents that involved more than 3 automobiles, 3) land-use that is mostly commercial and residential, and 4) is located within close proximity to Hospitals and the city’s HazMat Emergency Response team. The city ordained the current HazMat route in 1982. Since that time a transit loop has been built in the north-western region of the city. Projections were made for this route and it is apparent that this new loop would be the most suitable for future HazMat routing. The proposed route will avoid high density areas, schools, and will be accessible by emergency response teams.

INTRODUCTION:

Growing consumer and industrial demand for products that are, or based on, flammable, poisonous, explosive, corrosive, or otherwise potentially harmful materials, has resulted in greater movement of these commodities on these national highways (Harwood, 1993). HazMat trucks provide the easiest mobility for these materials. While rail is efficient in transporting HazMat, it does not provide the material to all locations that demand it. The use of trucks on public roads therefore puts local populations at risk should an accident or incident occur. This increased congestion in urban areas raises the potential for accidents. There are heightened concerns about the human and environmental consequences associated with the unintentional release of these materials. These issues are of particular concern to a crossroads community such as the City of Victoria and Victoria County. Currently, vehicles and large trucks carrying HazMat are allowed to travel through the City of Victoria along state facilities that bisect the city. These major roadways are US 87, US 77, and US 59. This project looks at the 892 square miles of Victoria County which is composed of approximately 84,000 residents. I focus mostly on Victoria City which is comprised of 60,000+ residents.

This study looks specifically at Non-radioactive Hazardous Materials (NRHM). The routes are typically developed by local jurisdictions, (such as a city or county) and must follow guideline established by federal regulations (TxDOT, 2007). These federal
regulations are administered by the Federal Motor Carrier Safety Administration in the US Department of Transportation. The Texas Department of Transportation is primarily responsible for reviewing and approving NRHM routes. TxDOT is not involved with issuing permits for the actually movement of HazMats. In order to get permits approved the Commercial Vehicle Enforcement Service of the Texas Department of Public Safety must be contacted. TxDOT is the primary contact for the development of these routes. It is primarily the region’s Metropolitan Planning Organization that develops the plans for such routing, and Alliance Transportation Group, Inc is a transportation analysis firm that conducts this data analysis with the city.

The City of Victoria was first designated as the Fiscal Agent for the Victoria Metropolitan Planning Organization (MPO) in February 1982. The original decision making body was called the Victoria Urban Transportation Planning Committee (VUTCP) (Miller, 2005). The MPO is:

".....Cooperatively responsible for the performance of the planning process including transportation systems plans developed as a part of the planning process; ensure proper coordination of transportation modes and between subareas; cooperatively establish transportation needs; and propose projects from all transportation modes for recommendation to those governmental units responsible for program development and project implementation."

[State Department of Highways and Public Transportation Minute Order No. 76787, dated 20 February 1980]

Any incident causing fatalities on a scale which threaten or cause an overload of the emergency medical services (EMS) or associated systems, constitutes a major incident (MI). These emergency services have a statutory duty to develop a comprehensive Major Incident Plan (MIP). These plans include management provisions for HazMat incidents and for the safety and protection of both casualties and emergency response personnel (Moles, 2000). The City of Victoria’s primary HazMat emergency response team is located in the downtown area with easy access to all major arterials. This team has gone through the proper training in case an accident or incidents occur. Members of the Fire Department attend a 40 hour HazMat Technician course. The Operations section of the Victoria City Fire Department includes 101 uniformed men and woman. The city is equipped with essential equipment as well as a HazMat truck with trailer. The city is also served by four hospitals with two located in close proximity to the HazMat response team (City of Victoria, 2007).

Victoria’s location along these major arterials makes the population vulnerable should an incident occur. However, the city is currently working on developing a new route for HazMat. The recent development of a Highway Loop may prove sufficient in reducing risk to the population, as my study will show. The cities current ordinance can now be considered outdated (Figure 1). As stated in their 2005 Victoria County Urban Transportation Study:

“The City of Victoria currently has an ordinance in place that specifies Hazardous
Cargo Routes in and around the City. However, the City, County, Emergency Management Coordinator and the Local Emergency Planning Committee (LEPC) are working towards revising and redesignating the Hazardous Cargo Routes in and around Victoria. It is the intent of these agencies to designate US 77, LP 463 and US 59 as the specific HC Routes for Victoria.”

[Victoria County Urban Transportation Study, 2005, p.45]

**Figure 1: Victoria City HazMat Route 1982**


**PROBLEM STATEMENT:**

As stated above, the population centrality in the city along with the convergence of highway systems in the center of the city, it is important to look at other sensitive factors that might be at risk should an accident occur. For my study I am utilizing a 0.5 mile impact area provided by the US Department of Transportation Emergence Response Guidebook (US DOT 1993). The primary sensitive sites that I am looking at are schools
and land use types. When these two factors are tied in with the population per acre in the central area (Figure 2), it is seen as a highly vulnerable section of the route. There are also many accidents in this area (as you will see with my accident volume map later in this report), that create higher risk for the population. The goal of this study is to identify routes for hazardous materials transportation through Victoria County that minimizes risk to residents.

The original HazMat Ordinance was created in 1982. Since that time construction has been completed along the western part of the city of Loop 463. Using projection data, I interpolated the 2007 volume of this route will propose it as a reasonable alternative. This route has low risk as the projected volume is low, there are less sensitive sites, and population density is low.

Figure 2: Victoria City Density

![Figure 2: Victoria City Density](image-url)
METHODOLGY:

Determine what data is currently available and from which source:

Once the project was proposed it was necessary to determine which information was available for the research.

DEMOGRAPHIC DATA: This was done by looking at the 2000 Census data for the County of Victoria. The census data provided sufficient information with regards to demographics at the block level within the city and the county. I used this data to calculate persons per acre in the region.

HAZMAT DATA: It was important to look at what the current HazMat route was for the region. This was found on the TxDOT website as they have documentation of each county’s ordinance for HazMat routing. As stated above, I reference the USDOTs Emergence Response Guidebook in determining the appropriate impact buffer zone.

TRAFFIC VOLUME DATA: The volume data was gathered from a volume study of Victoria and the surrounding region that was conducted in 1996 by Alliance Transportation Group, Inc. The study gave a projection of volume for 2030. However, there was a lack of data for the new Loop 463. It was necessary to interpolate the data in order to get a projection of traffic volume for all routes in 2007. I then looked at the road types and class. In comparing the types and class of roads that were present in the first study I was able to project the volume along this new Loop 463.

ACCIDENT DATA: Alliance also conducted an accident volume study of the region in 2003. This data was very detailed and it was important to narrow the study area to the central part of the city, as this is the location where the major arterials converge. I looked at locations that involved 3 or more cars in one accident. The number of cars involved in accidents is a good indicator of poor intersection design and this is important when considering the potential for a truck accident along these routes.

CITY SENSITIVE AND RESPONSE SITES: Locations of emergency response services as well as sensitive sites were important for this study. I contacted the City of Victoria in order to obtain shapefiles that showed these sensitive locations and emergency response services. Once these were provided I was able to apply them to my study area. Other data provided by the city was: City Shape File, Road System Line File, and County Boundary Shape File.

LAND USE: The city also provided me with a land use map that I was able to apply to my specific study area. This allowed me to look at residential and commercial areas. The
original purpose was to differential between night and day populations in the area; however once looking over the land use map, it was evident that there was a rather even distribution between residential and commercial uses. This meant that the population density in the area does not fluctuate sufficiently to conduct a night and day study.

Compiling data for analysis:

CONSTRUCTION OF HAZMAT ROUTE: Using the city ordinance code I was able to construct the HazMat route. This was a key file in my study and was used throughout.

APPLYING VARIOUS DATA TO LOOK AT IMPACT ZONE:

1) A 0.5 buffer zone was set along the current route.

2) I applied the population distribution map by census block. I then converted the persons per census block to persons per acre. This allowed me to see the approximate persons per acre in the region, and it proved extremely helpful in looking at the at risk population. The center of the city became the focus of the study due to the following factors.

   a. The convergence of the route in this area.

   b. The relative high density of the location.

3) I then added the school locations to my study area. This called my attention to the central area again as there were 10 schools within the 0.5 mile impact area.

4) I added the land use map to my analysis to see if commercial or residential uses were more concentrated in the center of the city. Being that they were both very prominent in this area, I was able to continue with my analysis that the center of the city does not have a population that fluctuates extremely.

5) The location of Hospitals and Fire Stations were added to the maps to look at emergency response capabilities. The city has 4 fire stations located along the main arterials of the city, which also happen to be the HazMat route.

6) Once adding the accident study to the area, it was evident that my study area had a large number of accidents involving more that 2 automobiles. As stated above, this is an indicator of poor intersection design, and importance when determining the likelihood of an accident.

7) Traffic volume in the region was interpolated for all major routes. At this point I looked at the new Loop 463. Being that this route was not in existence when the study was first conducted, I looked at roads of the same type and
class and averaged out the numbers for a 2007 projection. This Loop proved importance in looking at alternative routes for the region, as it circumvents the sensitive locations of schools and areas of high population density.

**FINDINGS:**

The following maps represent my findings. They start with the general HazMat route and end with the proposal of a new route that circumvents the city:

**Map 1: Current Hazardous Material Routing**

**VICTORIA CITY, TEXAS**
Current Hazardous Material Routing (Ordinance Code 82-15, October 7, 1982)

**Explanation:** This map shows the current HazMat routing for the city of Victoria, ordained in 1982.
Map 2: Population Along HazMat Route

Explanation: This map shows the population per acre along the Route.
Map 3: School Proximity and Response

**Explanation**: This Map shows the proximity of schools along the Route. There are 10 schools within the 0.5 mile impact area.
Map 4: Land Use and Emergency Response

**VICTORIA CITY, TEXAS**
Land Use and Emergency Response

**Explanation**: This map shows the rather even distribution of commercial and residential uses. It also shows the other locations of emergency response services.
Map 5: 2003 Accident Data

Explanation: This map shows the concentration of accidents in the center of the city where the HazMat Route converges. It highlights the locations that had 3 or more cars involved in an accident, which is a signifier of a vulnerable site for accident occurrence.
Map 6: 2007 Traffic Volume Projections

**Explanation:** This map shows the projection of traffic volume for all major routes in the city. Upon analysis the new loop appears to have lighter volume than the routes that converge in the center of the city.

Map 7: Proposed Alternative for HazMat Routing
**Explanation:** This map shows the proposed alternative with sensitive sites presented as well as persons per acre. It proves to provide the least risk to the population as it circumvents the central part of the city.

**ANALYSIS:**
The above maps provide an analysis of current HazMat route that converges in the center of the city. It is this central region that proves most vulnerable to risk as it is a location with a high number of accidents. When comparing it along-side the 2007 volume projection map, I also find that the central region experiences a high volume of traffic which also leads to an increase in accidents. The location of 10 schools in the 0.5 mile impact area also illuminates the fact that the current route provides much risk to a large population in the area. The analysis of land use shows that the study area is one with a steady population throughout the day. The center of the city is comprised of approximately 20 persons per acre. This is a large density compared to the outer region which has approximately 1-3 persons per acre. The new Loop 463 does not display a high volume for the 2007 year. While this of course increases with time, it still avoids sensitive sites and areas with high density. One thing that was noted in my analysis is that the locations of emergency response services are a further distance from the Loop alternative. However, should an incident occur, the at-risk population will be minimal in the outer regions. Loop 463 is tied to these major arterials and the response capability will not be hindered much. Therefore, my original hypothesis was supported by these findings.

Many caveats present themselves with this study. The primary issue is that there is a system in place when conducting a study of this sort. The federal government regulates this process very strictly by way of State Departments of Transportation. Had this been conducted under federal regulations, the process would have taken years. My volume and accident data was based on prior studies, and it would have helped analysis if a more recent study had been conducted. This is particularly true with the projections made for the Loop 463. This loop was not in existence during the time of the studies. This means that many other factors may have changed since then. Populations may have grown along the route or schools may have been established.

While my conclusion is supported by the analysis, it will be important to continue research of the area. Alliance Transportation will be working with the Victoria MPO to gather further data. They will then be following the guidelines that are in place by the federal government. I did not go into these guidelines as they are extensive and limiting in the short analysis that I have conducted. As stated above, the city hopes to propose a new HazMat route for Victoria, and it will be interesting to see what policy will come out of their analysis.
REFERENCES:


Texas Department of Transportation:
<<http://www.dot.state.tx.us/services/traffic_operations/non_radioactive_routing.htm>>

U.S. DOT 1993 Emergency Response Guidebook (RSPA P 5800.6)

Victoria City Fire Department, (2007) <<http://www.victoriatx.org/fire/operations.htm>>
APPENDIX
Map 1: Current Hazardous Material Routing

The steps taken for the creation of this map follow:

1) The first step for the project was to find the current HazMat routing system for Victoria County. The first issue that came up in the search for a route is that Counties do not have legal capability to make routing policy. Routing tends to be limited to State Highways in counties and it is at the city level that ordinances can be passed to regulate routing. In looking at the TxDOT HazMat routing website:

http://www.dot.state.tx.us/services/traffic_operations/non_radioactive_routing.htm

I came across the following ordinance codes:

<table>
<thead>
<tr>
<th>City</th>
<th>County</th>
<th>Route Description</th>
<th># of ord or code</th>
<th>Date of ord or code</th>
<th>Prohibited</th>
<th>Through Routing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Victoria</td>
<td>Victoria</td>
<td>SH 146 (Victoria), from North City Limits to South City Limits</td>
<td>22-6</td>
<td>12/1/92</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Victoria</td>
<td>Victoria</td>
<td>SH 59 (Victoria), from US 17 (northwest) to John Stokoe Rd</td>
<td>52-15</td>
<td>10/7/92</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Victoria</td>
<td>Victoria</td>
<td>John Stokoe Rd (Victoria), from US 59 to SH 59</td>
<td>52-15</td>
<td>10/7/92</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Victoria</td>
<td>Victoria</td>
<td>US 483 (Victoria), from US 41 to US 27</td>
<td>52-15</td>
<td>10/7/92</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Victoria</td>
<td>Victoria</td>
<td>SH 105 (Victoria), from SH 59 to S City Limits</td>
<td>52-15</td>
<td>10/7/92</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Victoria</td>
<td>Victoria</td>
<td>US 59 (Victoria), from US 41 to Yoe City Limits</td>
<td>52-15</td>
<td>10/7/92</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Victoria</td>
<td>Victoria</td>
<td>US 77 (Victoria), from W City Limits to N City Limits</td>
<td>52-15</td>
<td>10/7/92</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Victoria</td>
<td>Victoria</td>
<td>US 97 (Victoria), from S City Limits to NW City Limits</td>
<td>52-15</td>
<td>10/7/92</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

(Figure 1 (Page 4) in the beginning of my report shows this ordinance code in map form.)

2) I then gathered the appropriate shapefiles for my analysis from: www.geographynetwork.com.

   - Roads, Census Blocks, Victoria County Boundary

3) I defined these shapefiles as: US_NAD_North_America_Datum_1983

4) Then I projected them under the appropriate coordinate system for this region: NAD_1983_StatePlane_Texas_South_Central_FIPS_4204_Feet

   (All shape files were defined and projected the same way)

5) I created a new map in ArcGIS and added all these files. I defined the major roads in the region. I looked for a specific road type that differentiated the Highways from local roads as going by name was not sufficient. The unifying factor for this type of road was: CFCC = A21. I looked at the Tiger Line Files: Technical Documentation
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(http://www.census.gov/geo/www/tiger/tiger2006se/TGR06SE.pdf), and found
that this coding signified: “Primary road without limited access, US highways,
unseparated”. This was the proper coding for this type of road.

6) I selected all roads of this type using the select by attribute tool.

7) I created a new layer from my selection and made it the only selectable layer.

8) Using the ordinance code from above, as well as using the provided map as a
guide, I selected only the streets that were part of the ordinance. I created a new
layer from this and made this layer my HazMat Route layer.

8) I then formatted the map appropriately by 1) including a Texas State inset map,
2) creating a data frame that showed the county and the major highways in the
region, 3) defined the roads, city limits, and HazMat route in a separate data
frame, 4) and added the appropriate factors such as scale, north arrow and
sources.

Map 2: Population Along HazMat Route

1) Using Census Data at the Block Level obtained from geographynetwork.com I
joined the Census Block Shapefile with the SF1 Long Form survey. The
joining field in this process was STFID.

2) In the newly created table I created a new field that was assigned as “Acre”.
This was done by using the Field Calculator option on the dataset. This gave
me the approximate area of each block.

3) I then normalized the Category option of the properties for that specific data
frame as: POP2000 by the new Area field. The result gave me the persons per
acre in the region.

4) This Persons per Region shape was clipped by the City Limits shapefile.

5) I then created a buffer along the HazMat Route using the Proximity/Analysis
option in ArcToolbox.

a. I determined the impact area by referencing the USDot Emergency
response Guidebook (RSPA P 5800.6). The most conservative value
for impact area is 5 miles. As this would have covered the entire city,
and the materials that call for this impact zone are poisonous gases
(which were not in this study), I used a 0.5 mile impact zone which is
sufficient for all other materials.
6) This was placed on top of the Population per Acre layer to show the population that would be at risk should an accident occur.

**Map 3: School Proximity and Response**

1) Using the previously created city data frame that had the HazMat route and buffer I then added the school shapefiles, the fire stations, and hospitals.

2) I then looked at the location that had the highest concentration of schools and created an inset map for that particular area in the center of the city.

3) I zoomed in on this section in the new data frame and displayed school name and emergency response services that were provided by the city.

**Map 4: Land Use and Emergency Response**

1) Using the same format at the last map, I added the Land Use shape file that was provided by the City of Victoria and coded each land-use parcel appropriately.

**Map 5: 2003 Accident Data**

1) The accident data map was one that required more work. I used the same format at the previous 2 maps had to work on the Accident data before it could function correctly. The original data set that had been created by Alliance Transportation Group was created using the GIS Software Maptitude. It was necessary to:

   a. Convert the point files and data table to TransCAD

   b. Create a new linkage between the Shape File and data set in TransCAD

   c. Then convert this file to an ESRI shapefile.

   d. I then had to project and define this data as stated in map 1.

2) I then used the data to classify accidents that involved:

   a. 1-2 cars

   b. 3-6 cars

3) This was then put into my map. This showed me the locations of high accident probability.
Map 6: 2007 Traffic Volume Projections

1) I created a new layout for this map because the study area went out the region that the new Loop 463 was located.

2) The Volume data that was provided by Alliance Transportation was in TransCAD and had to be converted to an ESRI shape.

3) The data was based on a 1996 study of traffic volume. The projection in this data was to 2030.

4) I interpolated the data to find a projection for 2007.

5) In order to find the 2007 projection for this new loop, that had not been accounted for in the original data, I had to find an average of volume for roads of this functional type and class. I found the unique factor to be Functional Class = 2 and AType = 4. I then selected by attribute all road segments of this class, exported them to an excel spreadsheet, and found an average for these road types.

6) I added the average to the missing data in the 2007 projection of volume.

7) This map was then formatted to show the projected volume in 2007 of all major roads, including that of Loop 463.

Map 7: Proposed Alternative for HazMat Routing

1) Using the Add to Current Selection tool, I selected this new route as the viable alternative.

2) Made a new layer

3) Then highlighted it as such.

4) I added the sensitive sites that are mentioned above

5) I added the emergency services

6) And then included population density per acre to show the viability of this route as one that would have minimal impact on population and sensitive sites.