Characterization of Cross-Border Heavy-Duty Drayage Activity in the Laredo-Nuevo Laredo Airshed

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ABSTRACT
The research presented in this paper characterizes the activities and emissions of drayage truck activities in the Laredo-Nuevo Laredo region. Drayage vehicle activity is a significant component of total on-road vehicle activity and mobile source emissions in the Laredo-Nuevo Laredo airshed. Currently the air quality impacts of drayage trucks are only partially captured in regional emissions inventories through vehicle activity estimates based on regional travel demand models. In this study, global positioning system (GPS) units were fitted to a sample of 20 drayage trucks operating in the Laredo-Nuevo Laredo area. The resulting GPS data were analyzed in GIS to generate trip by trip information on truck activity, with each trip defined by an origin and destination. The trip data were used to determine the most visited trucking facilities, to develop maps illustrating the key freight corridors in the region, and extract other relevant information such as trip lengths and speed distributions and resulted emissions. The results show that the Colombia bridge crossing is the most utilized port of entry in the region, and is associated with relatively high emissions caused by high truck volumes and slow speeds. Additionally, the specific geography of the Colombia Bridge port of entry, and truck facilities on the US side of the border results in high truck volumes, low truck speeds, and therefore high emissions adjacent to some urban areas of Laredo.
INTRODUCTION

Drayage vehicle activity is a significant component of total on-road vehicle activity and mobile source emissions in the US-Mexico border region, specifically the Laredo-Nuevo Laredo airshed. Laredo is the largest port of entry along the US-Mexico border with more than 2 million of reported trucks crossing into the US in 2015. Currently the impacts of drayage trucks are only partially captured through vehicle activity estimates based on regional travel demand models (TDMs) and traffic counts. Vehicle activity estimates from TDMs are indirect and not detailed enough to provide a full picture of the drayage activity in the area. The goal of the study presented in this paper was to provide a detailed characterization of the drayage activity in the Laredo-Nuevo Laredo region using data collected directly from a sample of trucks in the region. These data are important for transportation and air quality planners and policy makers to develop strategies and policies to address the air quality and transportation needs at a bi-national, regional level.

The data, methodologies, and information generated from the project provide information and inputs for characterizing local drayage activities and assessing their air quality implications including in regional emissions inventories and local/project-level evaluations. The information and methodologies can also be used to better characterize drayage activity at other border locations along the US-Mexico border; specifically the speed profiles generated will enable responsible agencies to develop more accurate Motor Vehicle Emissions Simulator (MOVES) drive schedules for border-crossing drayage trucks. Besides helping to evaluate air quality impacts, the results of this study will also enable local stakeholders to monitor the existing state of the drayage activity in the region and identify opportunities to improve the efficiency and impacts of this activity at a regional level.

STATE-OF-THE-PRACTICE

Due to restrictions on Mexican trucks conducting long-haul operations in the United States, freight crossing the border is transported by a drayage system. The border drayage trucks that transport goods between the two countries have unique fleet and operational characteristics. In freight transportation, the term drayage refers to a segment of the supply chain where a good is transported from one site to another, but not the entire distance of its trip. Drayage often involves the transport of cargo to or from a seaport, border POE, inland port, or intermodal freight facility, to another destination and is typically characterized by short trips. For cities that are freight trade centers, drayage activity can be a significant component of freight transportation.

The North American Free Trade Agreement (NAFTA) significantly increased US-Mexico trade and resulted in increased drayage activity along the border. Because of long-haul trucking restrictions between Mexico and the United States and other factors such as language barriers and insurance requirements, most Mexican trucks do not operating in the United States beyond a certain distance from the border (i.e. the commercial zone). Instead, freight is transported across the border in drayage trucks to warehouses located within the commercial zone on the US side of the border. US domiciled long-haul trucks are then responsible for transporting the freight to final destinations within the United States. Table 1 lists the busiest land POEs on the US-Mexico border by the number of truck crossings in 2013. As shown in Table 1, Laredo has more than twice as many truck crossings as the second busiest POE in Otay Mesa, California.
Table 1: Southern Border POEs by Number of Truck Crossings 2013 (Error! Bookmark not defined.).

<table>
<thead>
<tr>
<th>POE Name</th>
<th>Truck Crossings into United States</th>
<th>% of Total Mexico Border</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laredo, TX</td>
<td>1,846,282</td>
<td>35.5%</td>
</tr>
<tr>
<td>Otay Mesa, CA</td>
<td>769,886</td>
<td>14.8%</td>
</tr>
<tr>
<td>El Paso, TX</td>
<td>738,914</td>
<td>14.2%</td>
</tr>
<tr>
<td>Hidalgo, TX</td>
<td>510,706</td>
<td>9.8%</td>
</tr>
<tr>
<td>Calexico East, CA</td>
<td>325,690</td>
<td>6.3%</td>
</tr>
<tr>
<td>Nogales, AZ</td>
<td>311,669</td>
<td>6.0%</td>
</tr>
</tbody>
</table>

Border drayage vehicles operate in commercial zones varying in distance from 3–25 miles from the border. These drayage trucks pick up trailers on the Mexican side of the border and deliver them to broker facilities or warehouses in the US commercial zone. Trailers are then transferred to a US carrier that delivers the goods to their final destination (1). Due to long and unpredictable wait times at the border, drayage vehicles spend much time idling. It is common for drayage trucks to be older than typical long haulers because they are not required to be as efficient and reliable as trucks hauling goods for long distances from their base.

Figure 1 shows a basic overview of the border crossing process involving the drayage operation. The process starts when a Mexican domiciled long-haul truck drops its cargo at a warehouse or yard in the commercial zone on the Mexican side of the border. The office manager calls a customs broker, who fills out the documents necessary to inform both Mexico and the United States of the origin and destination of the goods. Once the paperwork is complete and the trailer is ready to cross, a drayage truck and second driver pick up the cargo. At Mexican customs, called Aduanas, documents are verified and cargo is inspected. Some cargo goes through a secondary inspection before crossing the border. On the US side of the border crossing compound, the US Customs and Border Protection agents conduct a primary inspection of documents. Secondary inspections can be done by a Vehicle and Cargo Inspection System or x-ray machine. Safety inspections are carried by other inspectors such as the Federal Motor Carrier Safety Administration or the state agency responsible for road safety where inspections are focused on road-safety requirements (2).

After completing all inspections and exiting the compound, the second driver drops off the cargo at a warehouse or yard in the commercial zone in the United States where a US long-haul vehicle and a third driver pick up the cargo. At this point the drayage vehicle and second driver will return to Mexico, either with new cargo or empty.
**Figure 1: Cross-Border Drayage Process.**

**Characteristics of the Drayage Fleet**

The emissions of commercial vehicles such as drayage trucks are strongly dependent on characteristics such as model, maintenance history, and especially age. In 2013, TTI researchers collected a sample of over 3,000 vehicles at the Bridge of the Americas (BOTA) and the Ysleta-Zaragoza Bridge in El Paso, Texas, to develop an emissions estimation tool for border crossings (3). The sample represented freight trucks that crossed the border and can be assumed to comprise mostly drayage vehicles. Almost every truck sampled crossing the border was registered in Mexico, with only 5 trucks domiciled in the United States. Figure 2 summarizes the age distribution from this study along with the age distribution of short and long-haul heavy duty vehicles registered in El Paso obtained from the vehicle registration dataset for 2011. The 2013 TTI study has shown that almost all drayage vehicles are registered in Mexico, therefore it is highly unlikely that the US-registered trucks are drayage vehicles.

Figure 2 shows that the most common age for drayage vehicles is between 15–19 years (37.5 percent), whereas the most common age for US short haul vehicles is newer, between 10–14 years (29.6 percent). US long-haul vehicles are even newer, with the most common age between 5–9 years (25.98 percent), and only a slightly smaller proportion of vehicles less than 5 years old (22.28 percent).
Cross-Border Drayage Truck Activity And Emissions

In 2005, Zietsman et al. looked at the border crossing travel profile (Error! Bookmark not defined.). Using GPS data, the authors separated the crossing process into three sections: the entrance of Mexican Customs to the US customs primary inspection booth; the distance traveled within the US federal compound; and the distance traveled through the state safety inspection facility. The results showed that vehicles were either idling or creep idling for 63 percent of the time they spent during the crossing process.\(^1\)

Farzaneh et al. developed an emissions estimation tool for the El Paso-Ciudad Juárez border (3). A total of 10 drayage trucks were equipped with global positioning system (GPS) units for two weeks to collect data to develop operating mode distributions. These vehicles engaged in border crossing activities at different times of the day, different days of the week, and different directions of entry. The operating mode distributions of each border crossing trip were developed as the inputs for emissions estimation using EPA’s MOVES model.

Zietsman et al. developed a border crossing emissions profile of trucks at the El Paso-Ciudad Juárez border (Error! Bookmark not defined.). In this study a total of nine trucks, 1985 to 1998 model years, were tested. Results showed that trucks with the highest mileage had the highest hydrocarbon (HC) emissions rate, but that there were no clear patterns for HC emissions across modes of idling. There was also no clear correlation between the age of trucks and oxides of nitrogen (NO\(_x\)), carbon monoxide (CO), and particulate matter (PM) emissions. No clear correlation existed between miles accumulated and NO\(_x\). CO, and PM emissions tended to increase with higher engine loads.

Cambridge Systematics, Inc. estimated emissions rates for a variety of traffic conditions based on data obtained from the BOTA and Ysleta-Zaragoza border crossings in El Paso (4). This study was intended to develop an approach for estimating emissions rates for US-Mexico border

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\(^1\) In this study, idling was defined as being at a complete stop and creep idling was defined as traveling less than 5 mph and with acceleration or deceleration less than 0.5 mph/sec.
crossings. Different congestion conditions were simulated by developing MOVES operating mode profiles and classifying travel as almost complete idling (less than 1 mph), creeping (less than 5 mph), and uncongested operation (around 25 to 35 mph). Various traffic scenarios were tested as case studies for measuring emissions. These included free flow at the border with no delay, no action being taken, shifting private vehicles to faster Secure Electronic Network for Travelers Rapid Inspection (SENTRI) lanes, and combining US and Mexican cargo inspections.

The NAFTA/Mexican Truck Emissions Overview looked at Mexican truck emissions profiles and estimated emissions and air quality impacts of increased Mexican vehicle travel into the United States, specifically California. It was found that 66 percent of the Mexican trucks were from 1993 or before, which means that these vehicles do not use the computer controls to reduce emissions that later models have. A total of 25 percent of the observed Mexican truck fleet was from prior to 1980, and on average emit high levels of NOx and PM emissions. This study also pointed out that Mexico did not follow US standards that require a 50 percent reduction in NOx for model years 2004 to 2007 and a 90 percent reduction for model year 2007. The requirement to use ultra-low sulfur diesel fuel was also not required in Mexico. The most recent diesel engine emissions standards applied in Mexico at the time were the EPA standards for the 1993–2003 model years.

Drayage Activity in Laredo-Nuevo Laredo
Harrison et al. identified the range of drayage truck movement and the types of drayage truck movements in the Laredo border area through a literature review and interviews. The boundaries of the Laredo commercial zone extended 18 kilometers into Mexico from the border and were within 8 miles of the Laredo city limits on the Texas side of the border. Drayage companies, which are almost all based in Mexico, move trailers across the Texas-Mexico border as well as transport both truckload movement and less than truckload deliveries between locations in Laredo. The authors used truck crossing data, studied maps, and conducted interviews to collect detailed information about major industrial areas near the Laredo crossing. Based on information from the Laredo Bridge Authority, the authors estimated that 77 percent of trucks use the World Trade Bridge and the remaining 23 percent use the Colombia Solidarity Bridge. This is likely because the World Trade Bridge is closer to industrial areas than the Colombia Solidarity Bridge.

A TTI study provides detailed descriptions of the two international bridges (World Trade Bridge and Laredo-Columbia Solidarity Bridge) in Laredo that allow commercial traffic. Although the study does not specifically focus on drayage or emissions, location information is presented as well as information regarding access and connections to major roadways to in both Texas and Mexico. Operational characteristics for both bridges including hours of operation, truck crossing volumes, and the process for crossing the border are included.

Zietsman et al. focused on the use of alternative fuels in heavy-duty diesel trucks as a means of reducing emissions. The authors used GPS data to develop

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2 The SENTRI program is a trusted traveler program that allows private vehicles to use separate lanes at POEs for expedited processing. For more information see: http://www.cbp.gov/travel/trusted-traveler-programs/sentri.
3 The website www.forwarders.com/StateDirectory/TX.html provides a list of freight forwarding companies found in Laredo.
drayage drive cycles that capture the driving patterns (acceleration, deceleration, speed, etc.) of
drayage trucks from Mexico at the Laredo border. Second-by-second speed (mph) and location
(coordinate) data were collected and analyzed to develop a representative drayage cycle to
address critical driving components of drayage trips. Three movement phases are indicated from
drive cycles, including border to company, company to company, and border crossing. Emission
testing using PEMS units for various pollutants was conducted. The results were mixed
regarding the relationship of fuel type to emissions across drive cycle and vehicle age.

TTI conducted a case study to analyze the air quality impact of truck and rail freight movement
along the corridor from Mexico City to Montreal. As part of this study, data for trucks crossing the border into the United States were obtained from the US
Bureau of Transportation Statistics (BTS). Because 2008 was the last full year of data available
at the time, the study authors assumed that 2010 truck volumes would recover to 2007 levels;
therefore, 2007 border crossing truck volumes were used to estimate 2035 truck volumes. The
report includes BTS’s most recent full-year traffic data for POE at Laredo for analysis years
from 1995 to 2014.

The Laredo-Coahuila/Nuevo León/Tamaulipas Border Master Plan is a part of the Border Master
Plans along the US-Mexico border that also include the El Paso and Lower Rio Grande Valley
regions. The focus of the reports is on long range plans to inventory and prioritize
transportation and POE infrastructure as a means of facilitating trade. The Border Master Plans
were created through detailed research on infrastructure projects and many in-depth interviews
and meetings with stakeholders. The reports include comprehensive descriptions of the
infrastructure in the region, on both the US and Mexican side of the border. The authors
predicted that population in the Laredo/Nuevo León/Tamaulipas region would increase
20 percent in the following 20 years and that employment in the same region would increase by
38 percent in the same time period. They also predicted that congestion at the border and
approaching roadways would increase.

STUDY APPROACH AND RESULTS

A series of field data collections and an activity and emissions estimation approach in a GIS
environment were developed and executed to characterize the regional cross-border trucks
activity and tailpipe emissions from a sample of drayage trucks. The field data collections
included an activity data collection using GPS loggers. The first step in the data collection
process was to locate participants willing to participate in the study. The TTI research team was
able to locate two fleets in Laredo who were willing to participate in the study.

Researchers traveled to Laredo in June 2015 to perform the following tasks:

- Obtain consent from signatures from each participant.
- Install three GPS data loggers in each participating vehicle. Typically, the devices were
  set in the driver-side storage compartment to ensure that the vibration detector starts
  recording whenever the vehicle door is opened, usually at the beginning of a trip. If the
  vehicle did not have a driver-side storage compartment, the loggers were placed in the
  vehicle’s glove box or another secure location inside the cabin.
- Details about the participant and vehicle were logged.
The GPS battery capacity and memory size are the main factors influencing the number of days they can be used to collect data. Based on previous research projects, the research team has determined that the data loggers can be used to collect a week of truck activity data. One week after the GPS loggers were installed in participating vehicles, TTI researchers returned to Laredo to retrieve the devices. Data from each GPS unit were downloaded into an electronic spreadsheet and saved onto a central server and given a unique identifier. Under IRB guidance, this unique identifier cannot be traced back to the participating driver or vehicle. After completing the data transfer to the server, the data points from each of the three devices installed on each truck were merged into a single file labeled with unit number, date of initial activation, and type of vehicle observed. Only researchers assigned to the project were provided access to the secure files on the server, and data encryption was used to protect all data files.

Data Analysis

The goal of the data analysis was to translate the second-by-second coordinate and speed data from the GPS units into more easily interpretable information that describes the activity of drayage trucks in the region. The specific informational products produced by the data analysis are:

1. Tables and graphs summarizing the length, speed, duration, and emissions associated with each trip undertaken by each truck during the study period.
2. Maps that illustrate the activity and emissions of trucks along the major freight corridors in the region.

Summarizing Truck Activities

TTI researchers imported the individual GPS points from each data logger into ESRI ArcMap GIS software. The points were plotted using their unique ID and date to separate the points into more manageable activity segments. Then, unique trips for each truck and each day were identified using plots of the GPS data overlaid onto a map of the region. Trips were defined as periods of activity that had continuous truck activity and that had a distinct origin and destination. Each truck trip was given a unique ID and the data points converted to a single polyline shapefile containing the detailed path of each truck trip during the study. The locations of origins and destinations were also tagged with unique identifications, and stored in a data table. Each truck trip was then further split into line segments representing portions of the trip occurring in the United States and Mexico. Finally, the length and average speed of the total US and Mexican portions of each trip were calculated using ArcMap’s Calculate Geometry tool. Data for each unique truck trip (including US and Mexican portions of the trip) and Origin and destination locations were then exported to a spreadsheet to calculate summary statistics and for to create graphs for visualization.

The trip by trip data were also used to create maps illustrating the movement of trucks along freight corridors in the region. The average speed and volume of trucks operating on each link during each hour of the day (i.e., 12:00 a.m. to 1:00 a.m., 1:00 a.m. to 2:00 a.m., 2:00 a.m. to 3:00 a.m.) were derived from this process. This process was repeated for different temporal periods within the 6-day study period. The temporal aggregations were: weekdays only (4 days), weekends only (2 days), weekday mornings, and weekday afternoons. ArcMap was used to create maps that plot the width of the corridor segments as a function of the number of discrete truck trips that occurred on that corridor segment (corridor activity maps). These maps were also
used to simultaneously display the average speed and estimated NO\textsubscript{x} and PM associated with the truck activity on each corridor link. NO\textsubscript{x} and PM emissions were estimated using the methodology outlined next.

**Emission Estimation**

The analyses described above provide summarized truck activity data in two distinct formats:

1. Trip by trip summaries of routes traveled during the study, including sections of each trip that occurs in the United States versus Mexico. These trip by trip summaries include average speed and the date and times of the trips.
2. Link by link summaries of truck activity along the freight corridors identified during the study.

These truck activity data were used to estimate emissions associated with each trip and with each link of the freight corridor. Emissions were estimated using EPA’s MOVES. MOVES 2014 was used to create a database of NO\textsubscript{x} and PM emission rates specific to diesel short-haul combination truck types operating in the Laredo. These inputs were obtained for Laredo from the Texas Statewide Emission Inventory. Emission rates were calculated for a rural arterial highway using worst case environmental conditions for the two pollutants. In the case of NO\textsubscript{x}, worst case emission rates occur under summer temperature and humidity conditions (89.5°F and 50.9 percent relative humidity). For PM, the worst case emissions occur during winter temperature and humidity conditions (59.3°F and 59.6 percent relative humidity). These MOVES emission rates, expressed in grams per mile per vehicle (g/mi) were generated for 16 speed bins from <2.5 mph, 5 mph, 10 mph, and every 5 mph to 75 mph. Emissions were estimated for both trip by trip and link by link.

**Results**

Table 2 shows a summary of activities during the study period, aggregated by trip origin (United States or Mexico) and by the time of day (mornings or afternoon). In total, 189 distinct trips were made during the 6-day study period. A similar number of trips were made from US and Mexican destinations, but the data suggest that trips from Mexican destinations were more common during the morning hours, while trips originating from the United States tended to occur in the afternoon. This is probably explained by the fact that drayage trucks are predominately Mexican domiciled and permanently reside at warehouses or residences on the Mexican side of the border.

<table>
<thead>
<tr>
<th></th>
<th>AM</th>
<th>PM</th>
<th>Entire Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>USA</td>
<td>Mexico</td>
<td>USA</td>
</tr>
<tr>
<td>Number of trips by origin</td>
<td>22</td>
<td>54</td>
<td>71</td>
</tr>
<tr>
<td>Number of portions of trips occurring in each country</td>
<td>44</td>
<td>65</td>
<td>88</td>
</tr>
<tr>
<td>Total driven miles in each country</td>
<td>417</td>
<td>898</td>
<td>585</td>
</tr>
</tbody>
</table>
Table 2 also shows the average distance per vehicle, average speed, and emissions generated during travel within Mexican versus the United States. Error! Reference source not found. shows a histogram of the distances traveled during each trip recorded during the study. The average daily distance per vehicle traveled in Mexico is 1.8 times that of the distance traveled in the United States (14.1 miles compared to 7.6 miles equating to 1.8 times the average travel distance). As a result more NO\textsubscript{x} and PM emissions are generated in Mexico compared to the United States. However, because trucks generally traveled at a higher speed in Mexico than in the United States, (17.4 mph compared to 12.87 mph, respectively), Mexican NO\textsubscript{x} emissions are only 1.65 greater than those generated in the United States, while Mexican PM emissions are only 1.13 times those of emissions generated in the United States.
**Figure 3:** Distribution of Trip Lengths for A) Cross-Border and B) Non-Cross-Border Trips.
The researchers also calculated summary statistics for cross-border and non-cross-border trips undertaken during the study. In total 77 (41 percent) of the 184 total trips were cross-border trips (three cross-border trips involved a circular trip across the border). Over the duration of the study, there were 112 non-cross-border trips (59 percent of the total). However, 71 percent of the total miles driven during the study were during cross-border trips compared to only 29 percent of the total miles driven during non-cross-border trips, reflecting the generally smaller average trip length of non-cross-border trips (Figure 3). In total, cross-border trips generated approximately 70 percent of total NOx and PM emissions. Southbound cross-border trips tended to occur at higher average speeds in both United States and Mexico than northbound trips possibly because southbound trips occurred more frequently in the afternoon, possibly coinciding with lighter traffic (both at the border and on the broader network). Trucks traveled at approximately half the speed during non-cross-border trips than during cross-border trips.

Northbound cross-border trips (i.e., trips originating from Mexico) were more frequently undertaken in the mornings (65 out of 109 morning trips) while southbound trips were more frequently undertaken during the afternoon (88 out 157 afternoon trips). A similar trend occurs for non-cross-border trips. The majority of morning trips occur from Mexico, while most afternoon non-cross-border trips occur from the United States. An approximately equal number of north- and southbound cross-border trips occurred through the study. This reflects the intrinsic, reciprocal nature of drayage activities (i.e., trucks crossing the border one way will return across the border in a relatively short period of time [within a single day]). However, the high proportion of non-cross-border trips observed during this study suggest that for every cross-border trip, between one and two shorter, non-cross-border trips are undertaken in preparation for the cross-border trip. It is likely that delays at the border represent a significant portion of the time taken to complete a cross-border trip. Therefore, it is possible that the frequency of non-cross-border trips is caused by trucks consolidating goods from a number of locations on one side of the border before they are delivered to one, or a number of facilities across the border.

The differences in miles traveled, speed, and emissions on each side of the border can be largely explained by differences in the location of facilities in the United States versus Mexico (Figure 4). Here, two factors are important. First, the average distance between facilities most likely has a large impact on the distances traveled in the United States and Mexico for all trips (cross-border and non-cross-border). In general, Mexican facilities tend to be more widely distributed than US facilities. Second, the distance traveled during cross-border trucks specifically is also likely related to the distance between border crossings and each facility. Again, Figure 4 illustrates that the most frequently visited US facilities tend to be located much closer to the principal border crossing (World Trade Bridge) compared to facilities in Mexico.

The complex relationship among travel distance, travel speeds, and emissions highlights the importance of developing a thorough understanding of the truck activity on the network. Researchers developed maps illustrating the volume, speed, and emissions (NOx and PM) of trucks using the network according to different aggregations of trip type and time period. In all cases, the width of the bands represents truck volume and the color of the lines represent either speed, or the emissions per mile calculated using truck volumes and average speeds. In the first set of figures representing activities across the entire study period (Figure 5 and Figure 6), maps showing all data (i.e., volume, speed, and PM) are provided to illustrate the connections between them.
Figure 4: Location of Facilities Visited by Trucks during the Study and the Number of Visits Made to Each Facility.

Figure 5 provides a comprehensive map of truck volume and speed during the entire study period, with the width of the bands representing truck volume and the color of the lines representing the speed of the trucks. For the same time period, Figure 6 shows the PM emissions associated with the speed illustrated in Figure 5. The maps illustrate that the most important crossing location throughout the study was the World Trade Bridge, and as might be expected, there is an approximately mile stretch of network on either side of the crossing associated with high truck volumes, low speeds, and therefore high and concentrated emissions (both NOx and PM). Figure 5 and Figure 6 also illustrate the generally longer travel distances and higher travel speeds in Mexico compared to the United States.
Figure 5: Corridor Activity Map Showing the Truck Activity (Number of Truck Trips) along Different Sections of the Corridor for the Entire Study Period and the Average Speed of Trucks along the Freight Corridors.
Figure 6: Corridor Activity Map Showing the Truck Activity (Number of Truck Trips) along Different Sections of the Corridor for the Entire Study Period and the PM Emissions Associated with This Truck Activity.
Of particular interest is the close proximity of the World Trade Bridge crossing to an urbanized areas of Laredo and to a number of facilities in this area. Emissions close to the US border tend to be highly concentrated because of relatively slow speeds associated with the border crossing and the urban roads close to the border. The most heavily visited US facility also occurs in a relatively urbanized area close to the border. In contrast, the most heavily urbanized areas of Nuevo Laredo are located farther away from the border crossing, and in general (except for the congested urbanized areas) average speeds on the Mexican network tend to be higher.

Another significant feature of Figure 5 is the relatively low volumes of trucks using the Colombia Solidarity Bridge to the north of Laredo relative to the World Trade Bridge POE. Except for the need to service facilities to the north of the region, the figures suggest that there is little advantage for trucks to make border crossings at this POE. As Figure 4 illustrates, the extra travel distance required to reach most of the facilities via the Colombia Solidarity Bridge is approximately 35 miles, which at the average speeds recorded through the study, is likely to equate to a detour of approximately 1 to 2 hours.

CONCLUSIONS

The goal of this study was to characterize the activities and emissions of drayage truck activities in the Laredo-Nuevo Laredo airshed. This research is part of a larger goal of improving cross-border freight transportation in the Laredo region. Additionally, there is increasing societal awareness of the impact of air quality on human health. Laredo POE is the busiest POE for trucks in the United States. In line with increased trade between United States and Mexico, it is also one of the fastest growing. Although the Laredo airshed currently attains the air quality standards set by EPA, there is considerable motivation to ensure that economic development in the region is planned such that, over the long term, the region maintains or improves current air quality conditions.

This study has resulted in the development of data collection methods and analyses to effectively communicate drayage activities and their air quality impacts to a broad range of border transportation stakeholders. The identification and communication of current drayage activities is an important first step in developing an informed plan to improve the efficiency of cross-border trade in the region. Some of the most important findings from the study and their implications to air quality and cross-border freight in the region are:

- Morning drayage activities generally occur on the Mexican side of the border. Presumably this is because most drayage trucks and drivers are Mexican domiciled. Similarly, afternoon activities tend to involve return trips from the United States to Mexico. The requirement for reciprocal trips (preferably fully loaded) is probably an important factor that drives the timing of trips.

- According to the trucks sampled in this study, most drayage activities occur during weekdays. Weekend activities are considerably more limited. To develop a full and consistent picture of drayage activities, it is important to understand current drayage activities, but also to identify why these activities occur when they do.
• For every cross-border trip observed through the study, between one and two non-cross-border trips took place. Although non-cross-border trips tended to be of shorter duration, they are an important component of the whole drayage industry. As such, it is important to understand why these trips take place. For example, non-cross-border trips may occur as drivers commute to work in their trucks, or may be undertaken to consolidate loads to ensure fully loaded trucks are taken across the border.

• Most border crossings from trucks sampled during this study took place at the World Trade Bridge. Although there are a number of facilities located north of Laredo and Nuevo Laredo, and therefore close to the Colombia Solidarity Bridge, relatively few crossings take place at this POE. Based on the current data, it appears that in most cases, detours through this POE are not beneficial. However, it is possible that under some circumstances this crossing could be advantageous (e.g., heavy traffic near the urban areas of Laredo-Nuevo Laredo, increased border wait times at the World Trade Bridge crossing, or during periods of construction).

• The World Trade Bridge crossing is associated with high concentrations of NO\textsubscript{x} and PM pollutants associated with slow moving trucks. The proximity of this crossing to the city of Laredo is particularly relevant for PM pollutants that have been shown to cause localized health problems.

• The spatial distribution of facilities serviced by the drayage trucks is different on each side of the border. Note the close proximity of US facilities to the World Trade Bridge POE and to urban Laredo. The slow speeds associated with border crossing, in combination with lower speeds near within urban areas, lead to high emission concentrations in this area.

The results of this study provide insights into current drayage activities in the Laredo-Nuevo Laredo airshed. They also provide information that can be used toward a long-term goal of identifying planning and policy strategies capable of improving border freight transportation efficiency. Based on the findings presented in this study, researchers suggest a number of ways in which the methods presented could be expanded and improved.

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1 REFERENCES


