EXECUTIVE SUMMARY

TIRE FLOW STUDY IN THE TEXAS–MEXICO BORDER REGION

Produced for

United States Environmental Protection Agency, Region 6
&
North American Development Bank

By

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Disclaimer

Integrated Environmental Management Services, S. A. de C.V. (IEMS) was retained by the North American Development Bank (NADB) to conduct the project titled “Tire Flow Study in the Texas-Mexico Border Region” with the financial support of the United States Environmental Protection Agency, Region 6 (EPA).

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Table of Contents

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Attachments Index

Introduction

Throughout the Texas–Mexico Border Region, a significant number of scrap tire piles exist containing millions of scrap tires. Scrap tire piles pose significant environmental and health risks. For instance, if tire piles catch fire, they can burn for weeks, even months, causing serious air quality problems from dense smoke and noxious fumes. Also, when this occurs, large amounts of liquid waste are generated, which can contaminate the soil, as well as ground and surface waters. Further, these sites are ideal breeding grounds for mosquitoes, rodents, and other vectors of disease; and increase risks of malaria, dengue fever, West Nile Virus, and encephalitis. The health risks are especially of concern because of the proximity of tire piles to communities.

To address this problem, the U.S. and Mexico officials have collaborated through programs such as the Border 2012 Environmental Program, adopted in 2007. This bi-national program aims to protect public health and the environment in the U.S.–Mexico border region within 100-kilometer on each side of the international border. One of the program's key goals is for the two countries to reduce land contamination along their shared border, including tire piles. The Border 2012 program has helped communities on both sides of the U.S.-Mexico border analyze environmental problems, such as waste tires, and evaluate potential solutions.

The primary purpose of this study was to conduct a used and waste tire flow study in the Texas-Mexico Border Region. The study assessed in a comprehensive manner the current situation of scrap tires in the Texas-Mexico Border Region and suggests actions to address and attenuate the problem. The NADB hired Integrated Environmental Management Services S.A. de C.V. (IEMS) to perform the tasks outlined below to provide the NADB and the EPA with the information necessary to better understand the nature and logistics of how and where used and waste tires are being transported and stored along the Texas-Mexico Border Region.

IEMS developed a methodology to obtain and report information on the number of used and waste tires that have been transported between Texas and Mexico from 2005 to date. Data was also collected about locations of existing tire piles and estimates of the number of the tires that are being sold, reused, and disposed of in the Texas-Mexico Border Region.

Another component of this study addresses the economic and environmental aspects of tire flow into the Texas-Mexico Border Region. The economic considerations include the costs to transport the tires, revenue from the sale of the tires, costs of disposal of the tires, costs to remediate disposal sites, and the costs resulting from possible waste tire pile fires.

An evaluation of the existing regulatory structure used by Texas and Mexico to manage used tires along the Texas-Mexico Border Region was necessary to understand the current waste tire management systems.

This included investigating and providing an evaluation of current waste tire policies, laws, regulations and procedures along the Texas-Mexico Border Region and making suggestions, if appropriate, for considerations by policy makers.

This Executive Summary includes key information of the study. A full description of the information here described can be found in the study Full report and its attachments, including copies of relevant documents, description of estimations made, and reference data, figures, and images.

Section 1.
Scope of Work

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1 Scope of Work

The Texas-Mexico border comprises 1,241 miles along the Rio Grande River and 31 established crossings; 26 of them for vehicles and 5 rail lines. According to the August 1983 La Paz Agreement on Cooperation for the Protection and Improvement of the Environment in the Border Area, the "border area" was defined as a "the area situated 100 kilometers (62.5 miles) on either side of the inland and maritime boundaries between the Parties".

For this study, IEMS has chosen a different definition of the border area based on political/administrative divisions (counties on the US side and municipalities on the Mexican one) rather than distance, to facilitate a clear boundary and avoid jurisdiction issues between counties or municipalities. Only those counties and municipalities that make-up the border were chosen as a study area. There are a total of nineteen (19) counties and twenty-two (22) municipalities that form the Texas-Mexico border.

This study chose to focus on urban areas because one of the magnets for used and waste tire flow are population centers due to their potential large consumption markets, and because the impacts of the tires may be more severe around larger population centers.

Using the definition of urban area both for the U.S. and Mexico, a total of fifty two (52) urban areas were located in the bordering counties/municipalities. Of these, thirty (30) are located around the 26 international crossings, and thus, these were selected for the study.

In summary a total of thirty (30) urban areas were chosen, 13 on the U.S. side and 17 on Mexico. The cities chosen depicted in **Figure 1.1**.

1.1 Methodology

IEMS' methods are divided as follows: 1) desktop work and 2) field work. Both methods are aimed at acquiring both quantitative and qualitative information; however, desktop work also includes the analysis of information as required by NADB's terms of reference (TOR).

Data to be collected includes quantitative and qualitative information; some of which was estimated based on observations and interviews. There is a clear distinction on the type of data used so any user can support his assumptions and projections stated in this project.

Figure 1.1.
Cities Identified in the Texas-Mexico Tire Flow Study

Texas

1. El Paso
2. Fabens
3. Presidio
4. Del Rio
5. Eagle Pass
6. Laredo
7. Roma
8. Rio Grande City
9. La Joya
10. McAllen
11. Pharr
12. Progreso
13. Brownsville

Mexican States Bordering Texas:

Chihuahua

14. Cd. Juarez
15. Guadalupe
16. Ojinaga

Coahuila

17. Cd. Acuña
18. Piedras Negras
19. Nava
20. Venustiano Carranza

Nuevo Leon

21. Anahuac

Tamaulipas

22. Nuevo Laredo
23. Nueva Cd. Guerrero
24. Cd. Miguel Aleman
25. Cd. Camargo
26. Cd. Gustavo Diaz Ordaz
27. Reynosa
28. Cd. Rio Bravo
29. Nuevo Progreso
30. Matamoros

1.2 Desktop Activities

IEMS envisioned that the use of both desktop-based research and field data would result in a well-rounded study that offers its users a solid platform that reflects the day to day reality of the tire issues along the Texas-Mexico border region.

Desktop-based research consists of the review of available literature sources, electronic correspondence and/or teleconferencing with key stakeholders and design of field-research methodology and procedures.

This was done primarily through telephone calls with Mexican municipal authorities, data base preparation and analysis, consulting written material found in U.S. and Mexican governmental information sources, recognized industry associations, public Geographical Information Systems (GIS), news sources, and related studies in similar regions, among others.

1.2.1 General Information Sources

The general information search dealt with the border region and social, economical and environmental characteristics including information about new, used and waste tires and their uses. This information was obtained from U.S. and Mexican governmental sources, industrial associations from both countries and complemented by news articles, academic thesis, and information obtained from telephonic interviews with tire related stakeholders.

1.2.1.1 Historical Research

Historical research focused on tracing the flow of waste tires across the Texas-Mexico border and with other parts of the world. Sources for this information include telephone interviews, documents by industrial associations and previous related studies of the Texas-Mexico border and of regions similar to the study area.

The U.S.-Mexico border area has been in the past the focus of several environmental studies on the tire movement along and across the border.
These studies were given a careful consideration to generate a standardized and defensible method for estimating the waste and used tire generation and demand in order to perform the tasks presented above.

Consulted previous tire flow studies and publications about the Texas-Mexico border include those of Border 2012, and other conducted researches. Consultation of previous tire flow related studies and publications about regions similar to the Texas-Mexico border area covered:

- ✓ California-Mexico border.
- ✓ California.
- ✓ New Mexico.
- ✓ Mexico Federal District.

- ✓ Puerto Rico.
- ✓ Continental United States of America.
- ✓ The Americas

1.2.1.2 Survey Design and Analysis

Survey design and analysis were done to gather quantitative and semi-quantitative information regarding used and waste tire management and cross-border flow, as well as its trends/behaviors. Surveys were designed for the following:

Key stakeholders in Texas

- ✓ Texas Commission on Environmental Quality
- ✓ Texas State Health Department
- ✓ Councils of governments.
- ✓ City waste management authorities
- ✓ City vector control authorities
- ✓ City code enforcement authorities
- ✓ Fire department
- ✓ New tire dealers
- ✓ Used tire dealers
- ✓ Tire haulers
- ✓ Collection stations
- ✓ Storage facilities
- ✓ Landfill managers
- ✓ Industry associations
- ✓ Processing and recycling facilities.

Key stakeholders in Mexico

- ✓ Ministry of Economy (*Secretaria de Economia or SE*)
- ✓ Federal Institute of Access to Information (*Instituto Federal de Acceso a la Informacion* or IFAI)
- ✓ Tax Administration Service (*Servicio de Administración Tributaria* or SAT)
- ✓ State of Nuevo Leon Environmental Ministry
- ✓ Customs administrators
- ✓ Municipal waste management authorities
- ✓ Municipal civil guard authorities
- ✓ Landfill managers
- ✓ Processing and recycling facilities
- ✓ Industry associations
- ✓ Non-Government Organizations.

These questionnaires were sent via email to all Mexican authorities and stakeholders in the contact directory and were applied individually during U.S. fieldwork.

1.2.1.3 Interview Planning

The content and style of the interviews (semi-structured) was developed by the team leader with the objective to gather all the information required by the designed surveys and record details that arise during a conversation style approach.

This style was useful during face to face interviews, especially with public officials. Nevertheless, a structured question-answer approach was implemented when time-availability was an issue for the interviewee which was generally the case for business owners and managers as well as for officials interviewed via telephone.

1.3 Fieldwork Activities

Field-based research consisted of site visits to the thirteen (13) selected Texas cities plus Austin and Houston as well as a visit to Mexico Federal District for interviews with industrial association representatives. The information obtained was both quantitative and qualitative and even though the location of tire piles was requested, the research focused more on obtaining an estimation of the tire flow from Texas to Mexico as well as the state of the market in the study area. Also during one day face to face quotations were obtained from used tire dealers in the cities of Ciudad Juarez, Reynosa and Matamoros.

1.3.1 Road Reconnaissance

Road reconnaissance trips to the thirteen border cities along the international crossings with population greater than 2,500 were performed on the Texas side of the border.

The visits purpose was to identify the location of waste tire piles, reach relevant stakeholders, and assess the relationships and activities these stakeholders have with waste tires. The trips were of limited utility in identifying larger tire piles as required by the TOR, since most of these are located outside the cities in county back-roads and information on known locations was restricted due to administrative and legal procedures against dumpsite owners. However the remaining goals were fulfilled with these visits. Due to security reasons no fieldwork was performed on the Mexican side of the border.

1.3.2 Interviews with Key Stakeholders

On the Texas side of the border 122 (one hundred and twenty two) face to face interviews were performed to gather the necessary data required to perform the tasks described above as well as to obtain quantitative and semi-quantitative information and trends/behaviors regarding used and waste tire management and cross-border flow. Emphasis was set for medium and small used tire dealers which represent more than 40% of the interviews.

The largest new and used tire dealers in each of the cities were sought to obtain estimated numbers from the bigger sellers and decrease the uncertainty gap of not interviewing a 100% of the dealers. All the U.S. cities identified in this study had at least one used tire dealer and was interviewed.

Face to face interviews in Mexico were conducted to:

- ✓ Waste management authorities of Ciudad Juarez and Matamoros
- ✓ Landfill representative of Ciudad Juarez
- ✓ ANDELLAC and CNIH representatives.

During one day face to face used tire price requests were performed in the Mexican cities of Juarez, Reynosa and Matamoros, yet for security reasons other cities and further field data in the Mexican side of the Texas-Mexico border was not requested.

1.4 Safety

The safety of all the personnel involved with the project was of outmost importance, especially those conducting field work activities. Following recommendations by the U.S. Department of State, minimum fieldwork was conducted on the Mexican side of the border.

Most interviews were sent via e-mail with a formal letter explaining the purpose of the project and the organizations involved. This because releasing any type of information represents a potential security threat to the Mexican officials.

Private landfill managers requested an additional letter from the NADB project's commissioner assuring that IEMS was hired to gather and perform the present study. It was provided to IEMS from NADB representatives on September 15, 2011 in both English and Spanish.

1.5 Key Stakeholders

In order to assess the actual inflow of used and waste tires into Mexico from Texas a variety of stakeholders was interviewed as detailed in Section 1.2.3.

Authorities and industry associations provided general estimations on the flow of these tires into Mexico. Tire dealers and haulers provided other details on the overall tire flow from Texas to Mexico.

All the stakeholders interviewed were asked to sign a permission letter to be quoted on this project; these letters are kept by IEMS as hard-copy and are available upon request.

Other stakeholders that have been identified are junkyard owners, community environmental leaders, and used tire customers.

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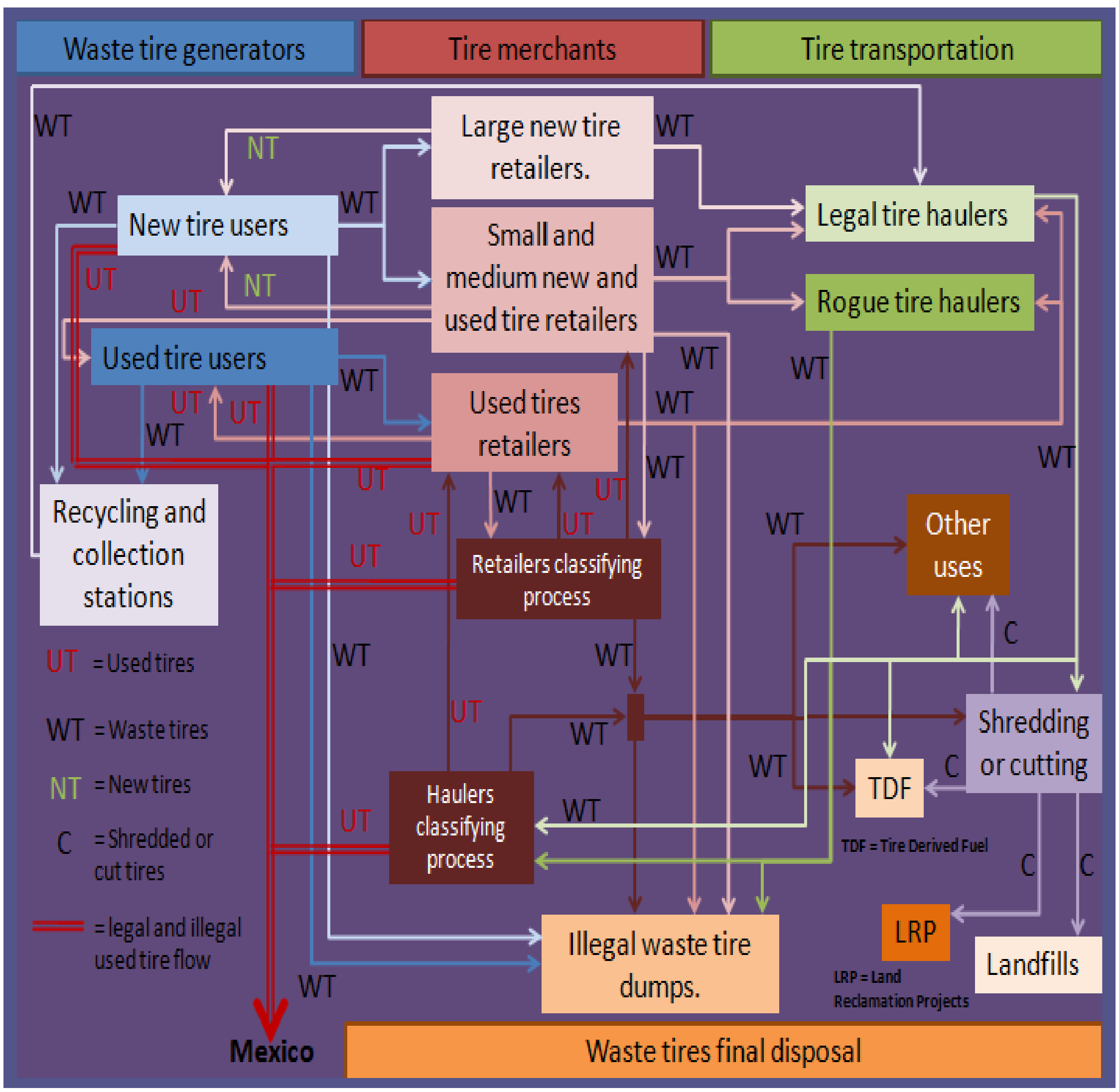
Section 2. Tire Flow Estimation

2 Tire Flow Estimation

The movement of tires is presented using a simple diagram depicted on **Figure 2.1.**, displaying the origin and destiny of tires used in Texas.

Between 2005 and 2011 the tire flow in the U.S.-Mexico border area, or part of it, had already been mapped in two previous studies. Both studies display very similar flows to that presented by IEMS with the exception of the addition of the classification between waste tires and used tires. This classifying process happens inside the tire merchant and tire transportation facilities (i.e., waste tire generators and transporters).

Figure 2.1.
Tire flow in the State of Texas



2.1 Methodology to Estimate Tire Flows

There are primarily three distinct tire flows/movements:

1. Texas-Mexico.
2. U.S. -Texas international border.
3. Third country-Texas international border.

The first flow requires different levels of detailing:

a. Legal vs. illegal flow
b. Reuse vs. recycling vs. processing
c. Proper disposal vs. illegal disposal

2.1.1 Texas-Mexico

2.1.1.1 Legal Used Tire Flow

Formula 1.

Annual legal used tire flow = Used tires to be commercialized flow + Used tires in annual legal car imports flow + Commercial used tires import from Texas for re-treading

Used Tires to be Commercialized

The Ministry of Economy (*Secretaria de Economia* or SE) is in charge of issuing importation permits for three regions in the U.S. – Mexico border. These permits are granted annually according to a global used tire import quota to people or companies dedicated to commercialization of used tires in these areas. The regions where used tire importation has been authorized and controlled by the SE are:

1. The State of Baja California;
2. The State of Sonora State; and,
3. Ciudad Juarez, Chihuahua.

Every year the number of authorized used tires for import or used tire import quota is established by the SE and divided between each of the three regions. For the purpose of this study the number of used tires legally imported was based on the quota established at the ports of entry in the region of Ciudad Juarez, Chihuahua, Mexico.

This is defined as Ciudad Juarez annual used tire import quota. Note that there is no legal import quota assigned to the rest of the Texas-Mexico border.

Formula 2.

Used tires to be commercialized flow = Ciudad Juarez annual used tire import quota.

Used Tire Flow for Legal Annual Car Imports

Formula 3.

Used tires in annual legal car imports flow = Annual legal car imports flow X Average number of tires per car

Commercial Used Tires Import for Retreading

There are a different set of authorizations issued by the SE for the importation of commercial tires for the sole purpose of retreading in a Mexican facility. Only registered tire renovation facilities are assigned a used tires import quota for renovating purposes. Retreading passenger tires although possible is not economically viable (ANDELLAC, 2011). Without this tire renovating industry the commercial carriers in Mexico would go bankrupt given the cost of new tires. (CNIH, Rubber Industry National Chamber , 2011).

Used tires for retreading can be imported into Mexico through any legal port of entry following the used tire legal import requirements for retreading purposes.

For this purpose the following formula will be applied:

Formula 4.

Commercial used tires import for retreading purposes entering from Texas = Used tires imported under legal import requirements for retreading purposes through any legal Texas-Mexico point of entry.

According to what was reported previously used tires to be commercialized may only be imported from the United States through the Ciudad Juarez, a portion of Sonora and Baja California border.

Because of this, all used tires legally imported through any point of entry in the Texas-Mexico border, excepting Ciudad Juarez, will be assumed to be destined to retreading purposes. Except for the year 2005 when importing used tires for commercialization was not allowed, this year all used tires imported through the Texas-Mexico border are assumed to be for retreading purposes.

2.1.1.2 Illegal Used Tire Flow

The illegal flow of used and waste tires from Texas is a much more complex issue to estimate. This flow consists of very different streams and each must be estimated separately to determine the overall illegal flow.

This study is based on information obtained from interviews on both sides of the border, data from the Tax Administration System (SAT), National Institute of Geography and Statistics (INEGI), Non Government Organizations, environmental studies and Mexican states public information, among others.

Information obtained from interviews includes tire-flow estimations from Mexican industry representatives and final destinations.

It has been assumed that commercialization for profit is the driving force for the flow of tires. Therefore to estimate the tire flow from Texas into the Texas-Mexico border area it was assumed that:

Formula 5.

$$\text{Used tire flow} = \text{Legal used tire flow} + \text{Illegal used tire flow}$$

Formula 6.

Used tire flow is greater than or equal to the theoretical Mexico border area used tire demand.

Formula 7.

$$\text{Theoretical Mexico border area used tire demand} = \frac{\left(\text{Theoretical Mexico border area tire demand} - \text{Estimate of new tires sold in Mexico border area}\right)}{\text{Percentage of useful life remaining on a Type 3 used tire}}$$

Used tires are classified as follows:

- **Special.** Semi new;
- **Type 1.** Not toasted or cracked, evenly worn and have 60% of tread remaining;
- **Type 2.** One side is more worn than the other, have 20 to 40% of remaining tread;
- **Type 3.** May be toasted or cracked, have less than 20% of remaining tread;

Formula 8.

$$\text{Estimate of new tires sold in Mexico border area} = \text{New tires sold per vehicle in the state} \times \text{Vehicles in each municipality}$$

Formula 9.

$$\text{New tires sold per vehicle in the state} = \frac{\text{New tires sold in the state}}{\text{Vehicles in the state}}$$

Formula 10 a.

$$\text{Theoretical Mexico border area tire demand} = \frac{\text{Vehicles in each municipality} \times \text{Tires per car} \times \text{Average annual mileage per tire}}{\text{Average endurance of a new tire sold in Mexico}}$$

or

Formula 10 b.

$$\text{Theoretical Mexico border area tire demand} = \frac{\text{Vehicles in each municipality} \times \text{Tires per car}}{\text{5 years}}$$

The reason two different formulas may be applied to estimate the theoretical Mexico border area tire demand is that tires may degrade more over time from elements exposure than from tread wear due to friction with the road surface. Basing tire demand only on degradation due to exposure to the ambient elements does not consider tires may be discarded earlier than when they are 5 years old, but neither after this time, yet it provides an estimated number with which stakeholders may work and compare with other estimations.

Formula 11

$$\text{Illegal used tire flow} \geq \text{Theoretical Mexico border area used tire demand} - \text{Legal used tire flow}$$

Formula 12.

$$\text{Vehicles in each municipality} = \text{Registered vehicles} + \text{Unregistered vehicles}$$

To estimate the number of illegal and American vehicles in the Mexican border area two different formulas were applied.

Formula 13.

Unregistered vehicles = Illegal vehicles + American vehicles

Each car imported into Mexico through any point of entry in the Texas-Mexico border has at least 4 tires that presumably will eventually be disposed on the Mexican side of the border. For this reason every imported car through the bridges in Chihuahua, Coahuila, Nuevo Leon and Tamaulipas will be considered as four tires.

Based on information from interviews with Mexican industrial associations most tires do not remain within the border area. The largest markets are the bigger cities such as Mexico City, Guadalajara, Monterrey, Puebla among others. One of the industrial associations interviewed estimated that at least 50% of tires that flow from the US into Mexico leave the border region to be sold further inland.

2.1.1.3 Reuse, Recycling, Raw Material and Energy

After their initial intended use, tires can have a variety of destinations: reused in vehicles, recycled into alternative uses, processed for use as raw material for other products, burned to extract energy or disposed on the land.

Literature has some estimation on the proportion of tires that follow these different paths, and calculations were made using field data.

For the U.S. data are more centrally controlled by the Texas Commission on Environmental Quality (TCEQ) and those numbers were taken. For Mexico, some municipalities had information on the amount of tires diverted to landfills and cement companies supplied data for the energy stream.

The proportion of tires destined for recycling was estimated based on interviews and news sources; the reused fraction for Mexico is reported by industrial associations to be minimal. Finally the reused fraction in the Texas side of the border was requested through interviews with the tire recyclers and processors in the state.

2.1.1.4 Proper and Illegal Disposal

Proper disposal in the U.S. side of the border is well documented by the TCEQ although in the City of Presidio there is no option for proper disposal of tires.

Illegal disposal was documented during interviews to local code enforcement authorities and through the interviews with used and new tire dealers.

Data on proper/legal disposal in Mexico were obtained from the local environmental authorities of each municipality. Although not all Mexican municipalities possess adequate disposal facilities and management procedures, their storage sites for waste tires for the purposes of this study will be considered the proper disposal option for those specific regions.

Attachments 1 and **2** display the proper disposal facilities, the approximate number of waste tires accumulated, location and management procedures in each of the Mexican municipalities.

2.1.2 Tires from Other U.S. States

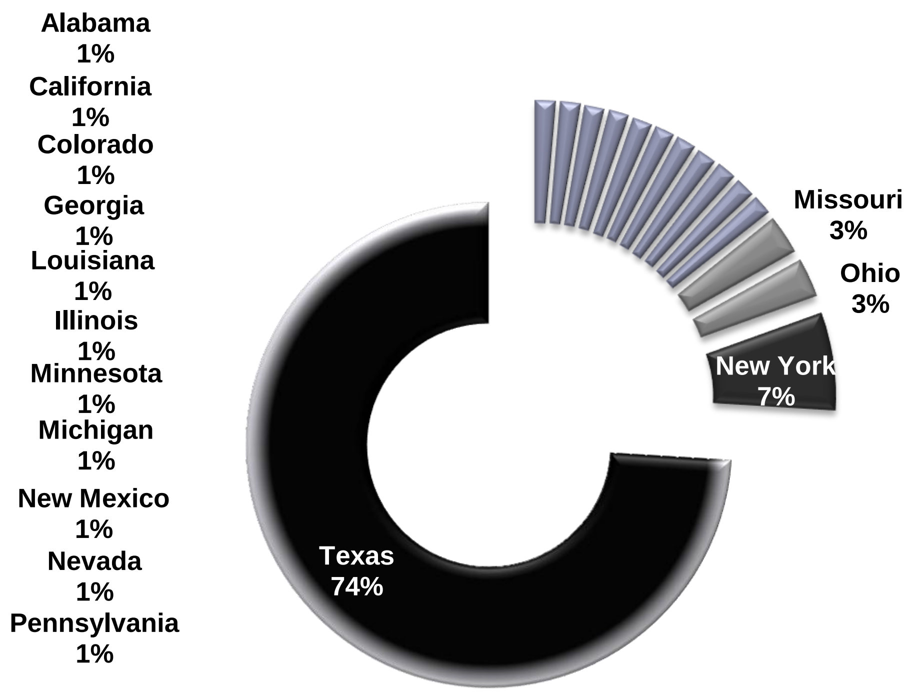
The origin of used tires in Texas was obtained through interviews with local used tire dealers. There are no tire manufacturing facilities within Texas (interview e-mail with RMA) so all new tires sold or entering the study's scope area is assumed to originate from one of the other 49 states, Canada, or another foreign country.

The origin of used tires that are being transported through Texas from other states, which are considered to have the greatest environmental or economic effect on the Texas-Mexico border based on information obtained through fieldwork on the Texan side of the border are:

- Alabama
- California
- Denver, Colorado
- Atlanta, Georgia
- Illinois
- Louisiana
- Michigan
- Minnesota
- Missouri
- Las Vegas, Nevada
- Las Cruces, New Mexico
- New York
- Cincinnati and Fostoria, Ohio
- Pennsylvania

Figure 2.2 represents the states from which used tire dealers obtain their used tires for commercialization on the U.S. side of the Texas-Mexico border area. It is assumed that 74% of the used tire dealers on said area acquire their used tires on Texan cities.

Figure 2.2.
Used Tires Origin Presented by Used Tire Dealer Interviews



A used tire dealer that obtains used tires from Texas may also acquire used tires from other states. The number of used tires brought to Texas from other parts of the U.S. is yet to be assessed.

No data regarding the number of used tires arriving to the Texas-Mexico border region from other American states was obtained during fieldwork or desktop interviews and activities reason for which it was not possible for IEMS to estimate the number of tires that are being transported through Texas from other states, which may have either an environmental or economic effect on the Texas-Mexico Border.

2.1.3 Third Country-Texas-Texas Border

Information on out-of-U.S. origins of used tires was obtained during the Texas interviews. The only third country mentioned, by only 1 of the interviewees, was Canada.

No data regarding the number of used tires arriving to the Texas-Mexico border region from other countries was obtained during fieldwork or desktop interviews and activities. Because of this, it was not possible for IEMS to estimate the number of tires that are being transported to the Texas-Mexico Border Region from countries outside the United States.

2.2 Estimations and Results

The following includes the results of the use of information obtained from different stakeholders across Texas and Mexico and the application of the previously described formulas and criteria.

2.2.1 Legal Used Tires Flow

2.2.1.1 Ciudad Juarez Annual Used Tire Import Quota

The following table was created by applying **Formula 2**, employing data obtained from the Economy Ministry through IFAI.

Table 2.1 Ciudad Juarez, Chihuahua Annual Used Tire Import Quota	
Year	**Used tires legally imported per year**
2005	0
2006	340,000
2007	340,000
2008	340,000
2009	340,000
2010	191,100
2011	198,400
Total	**1,749,500**

2.2.1.2 Used Tires in Annual Legal Car Imports Flow

Table 2.2 presents the results from applying **Formula 3** employing data obtained from the Tax Administration System (SAT) commercial imports balance report.

2.2.1.3 Commercial Used Tire Import for Retreading

Table 2.3 presents the results from applying **Formula 4** employing data obtained from the Tributary Administration System (SAT) commercial imports balance report.

Table 2.2. Used Tires Flow for Annual Legal Car Imports							
Imported vehicles each year per scope state (Vehicles)					Annual legal car imports flow (cars)	Average number of tires per car (used tires/car)	Used tires in car imports flow (used tires)
Year	Chihuahua	Coahuila	Nuevo Leon	Tamaulipas			
2005	58,482	16,074	26,183	144,701	245,440	4	**981,760**
2006	202,076	46,702	101,275	521,855	871,908	4	**3,487,632**
2007	132,624	28,375	14,351	628,889	804,239	4	**3,216,956**
2008	73,993	15,254	532	422,761	512,540	4	**2,050,160**
2009	42,805	10,338	1,346	163,496	217,985	4	**871,940**
2010	91,073	10,665	1,976	205,615	309,329	4	**1,237,316**
2011*	68,543	8,965	9,960	151,056	238,524	4	**1,602,692**
Total	***669,596***	***136,373***	***155,623***	***2,238,373***	***3,199,965***	***4***	***13,448,456***

*Information obtained until August 2011. Used tires in car imports flow data for year 2011 was linearly extrapolated from imports on years 2009 and 2010.

Table 2.3. Import for retreading flow entering from Texas	
Year	**Used tires import for retreading**
2005[1]	168,457
2006	219,399
2007	274,036
2008	276,619
2009	299,073
2010[2]	343,052
2011[2]	374,898
Total[2]	**1,955,534**

[1]Estimated by adding all used tire legal imports through the Texas-Mexico border including the Ciudad Juarez border since no legal import quota existed in 2005 for this area.

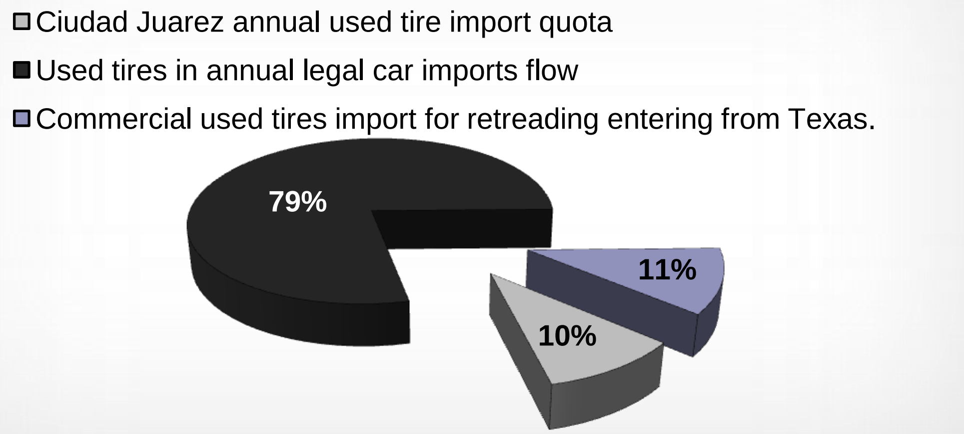
[2]From June 2010 to December 2011 import data was obtained through a linear extrapolation with a R^2 of 0.901

From the information presented on **Tables 2.1** thru **2.3**, the legal flow of used tires from 2005 to 2011 is estimated on:

<u>17,153,490 tires units</u>

Figure 2.3 depicts the distribution of this flow. Used tires mounted on imported vehicles represent almost 80% of the legal used tires import flow.

Figure 2.3
Legal used tire import flows through the Texas-Mexico border



2.2.2 Illegal Used Tire Flow

The results of applying the formulas to estimate the illegal flow of used tires resulted on a negative value. This value should not be interpreted as a negative flow of used tires back into Texas; it should be interpreted as a sign that the current used tire imports could theoretically supply the Mexican scope border region used tire demand.

Actually the legal used tire flow could theoretically supply more than two times the estimated used tire demand of the Texas-Mexico border region as the table above displays.

Assessing the reason for this surplus in used tire offer crossing the Texas-Mexico border is not part of this study scope and will not be further addressed. Yet it is important to note that the National Rubber Industry Chamber (Camara Nacional de la Industria Hulera or CNIH) associates have detected used tire shipments in large Mexican cities further south of the border such as Guadalajara and the Federal District.

Based on the fact that both fieldwork and desktop interviews with key stakeholders report the existence of an illegal flow of used tires from Texas into Mexico it would be safe to imply that a demand larger than the one of the border area is being supplied by both legal and illegal used tire flows.

As a general conclusion the results obtained from estimating the illegal used tire flow from Texas into Mexico based only on the Mexican border region demand greatly underestimates the actual illegal used tire flow.

2.2.3 Theoretical Mexico Border Area Used Tire Demand

From the application of **Formula 7**, the theoretical Mexico Border Area used tired demand resulted in the information presented in **Table 2.4.**

Table 2.4.
Theoretical Mexico border area used tire demand

Year	Theoretical Mexico border area used tire demand (used tires)
2005	913,904
2006	1,431,049
2007	847,033
2008	997,133
2009	1,227,711
2010	1,396,641
2011	1,576,431
TOTAL	**8,389,903**

Additional results and estimations made during the study are presented in the study Full Report.

2.2.4 Reuse, Recycling & Processing

No relevant information regarding tires sold for reuse, recycling or for other tire derived products in the Texas-Mexico border region was reported or provided by any interviewed stakeholder. For this reason no estimations regarding this subject were made in this report.

2.2.5 Proper Disposal vs. Illegal Disposal

2.2.5.1 Proper Disposal

Attachments 1 and **2** display the proper disposal facilities, the approximate number of waste tires accumulated, location and management procedures in each of the Mexican scope municipalities.

2.2.5.2 Illegally Disposed

No conclusive data regarding illegal waste tire disposal was obtained from the interviewed Mexican stakeholders. **Attachment 3** presents a map with potential illegal tire disposal locations on the Mexican side of the Texas-Mexico border region.

Section 3. Waste Tires Ultimate Disposal Locations

3 Waste Tires Ultimate Disposal Locations

IEMS created a geo-referenced directory and display map of known ultimate disposal locations of waste tires that are being transported from Texas into Mexico. Their operation, who is responsible for them, their management procedures, number of waste tires accumulated and display maps.

Also IEMS presents the Mexican cities of the Region geo referenced list of possible waste tire generators, possible illegal tire piles and a display map for each city.

3.1 Disposal Locations

IEMS envisioned that the use of both desktop-based research and field data would result in a well-rounded study that offers its users a solid platform that reflects the day to day reality of the tire issues along the Texas-Mexico border region.

Desktop-based research consisted on the review of available literature sources, online regional periodic publications, electronic correspondence and/or teleconferencing with key stakeholders.

This was done primarily through telephone calls with Mexican municipal authorities and key stakeholders, data base preparation and analysis, consulting written material found in U.S. and Mexican governmental information sources, recognized industry associations, public Geographical Information Systems, news sources, and related studies in the region, among others.

Location of waste tire dumps sites was assessed through directions obtained from stakeholders interviewed, the border tire network tire pile database and online periodic news sources that described the location settings and/or surroundings.

The areas geographical coordinates were obtained using public Geographical Information Systems (GIS), primarily the Google™ Earth software, by visually searching the sites following the directions given by the sources mentioned on the paragraph above.

No fieldwork was performed on the Mexican side of the Region due to security reasons. No confirmation visits, using Geographical Positioning Systems (GPS) devices or what was observed through GIS were performed in order to verify the accuracy of the data obtained from the sources. Nevertheless only sites that were visually consistent to what was described by the Mexican stakeholders were selected as dump sites.

Instead a visual search of junkyards and used vehicle lots in the Mexican cities using public GIS was performed in order to assess the possible location of waste tire generators and potential tire pile sites; this methodology is further explained in this document.

IEMS employed desktop-based research which consisted on the review of available literature sources, online regional periodic publications and electronic correspondence and/or teleconferencing with key stakeholders. The location of waste tires piles along the Texas-Mexico region had been the focus of the following publications:

- Border 2012: U.S.-Mexico Border Scrap Tire Inventory Summary Report. (United States Environmental Protection Agency (EPA), 2007)
- Border Tire Network, Tire Pile Information (Border 2012, 2011)

The tire pile sites reported in above mentioned documents were used as a base for which the report objectives were constructed.

IEMS also performed a visual search of junkyards of all sizes and used car lots on the Mexican cities of the Region to assess the potential final destination of the used and waste tires mounted on imported vehicles from Texas into Mexico.

From all the information gathered, display maps with the identified locations of possible junkyards, possible illegal tire piles, and the piles, were prepared and are presented for each of the Mexican cities under the scope of the study in **Attachment 4**.

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Section 4. Environmental and Economic Impacts of the Waste Tire Flow from Texas into Mexico

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4 Environmental and Economic Impacts of the Waste Tire Flow from Texas into Mexico

For the estimation of environmental an economic impacts related to the scope of work, several considerations and assumption were made. These considerations are described in full in Chapter 4 of the study Full report.

4.1 Revenue from the Sale of Used Tires to Mexico

IEMS estimated a revenue range, rather than a single number, of what the revenues may have been in any determined period of time between January 2005 and April 2012. As presented on **Figure 4.1.**

Figure 4.1
Lowest (blue) and Highest (red) estimated revenue per tire

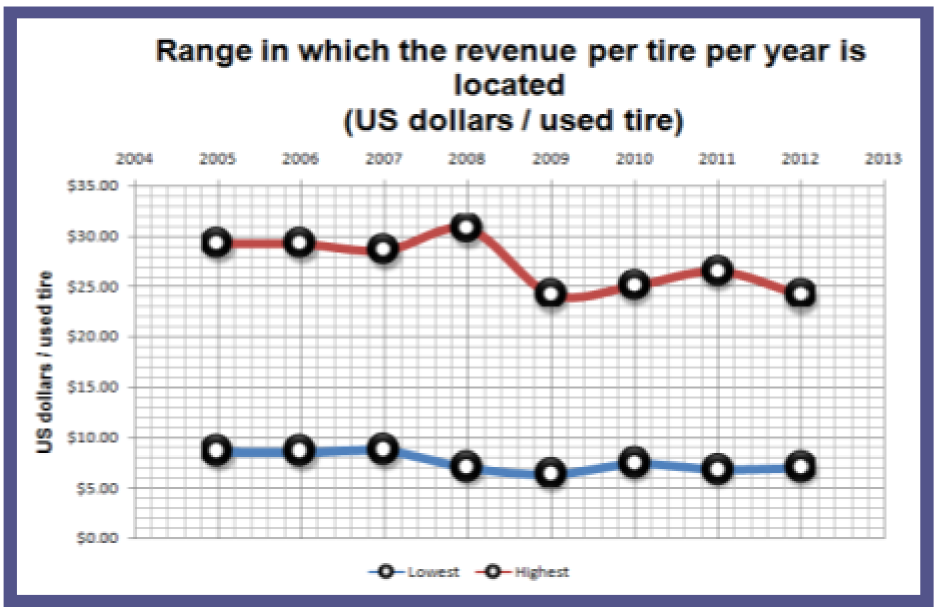

Table 4.1. Highest revenue per tire per year (US dollars / used tire)					
Rim size	**R 13**	**R 14**	**R 15**	**R 16**	**Highest net revenue (US dollars / used tire)**
Remaining tread / year	**20%-40%**	**20%-40%**	**20%-40%**	**20%-40%**	
2005	$2.95	$10.86	$12.15	$3.25	$29.21
2006	$2.95	$10.84	$12.12	$3.24	$29.15
2007	$2.88	$10.60	$11.86	$3.17	$28.52

Table 4.1. Highest revenue per tire per year (US dollars / used tire)					
Rim size	**R 13**	**R 14**	**R 15**	**R 16**	**Highest net revenue (US dollars / used tire)**
Remaining tread / year	**20%-40%**	**20%-40%**	**20%-40%**	**20%-40%**	
2008	$3.10	$11.40	$12.75	$3.41	$30.66
2009	$2.44	$8.98	$10.04	$2.69	$24.14
2010	$2.53	$9.30	$10.40	$2.78	$25.01
2011	$2.67	$9.83	$10.99	$2.94	$26.44
2012	$2.43	$8.95	$10.01	$2.68	$24.08

Table 4.2. Lowest revenue per tire per year (US dollars / used tire)					
Rim size	**R 13**	**R 14**	**R 15**	**R 16**	**Lowest revenue (US dollars / used tire)**
Remaining tread / year	**0-20%**	**0-20%**	**0-20%**	**0-20%**	
2005	$0.86	$3.13	$3.58	$0.98	$8.55
2006	$0.86	$3.11	$3.56	$0.97	$8.49
2007	$0.87	$3.17	$3.62	$0.99	$8.66
2008	$0.71	$2.57	$2.93	$0.80	$7.01
2009	$0.64	$2.33	$2.66	$0.72	$6.35
2010	$0.75	$2.71	$3.10	$0.84	$7.40
2011	$0.69	$2.51	$2.87	$0.78	$6.85
2012	$0.71	$2.56	$2.93	$0.80	$7.00

Table 4.3. Mexican's specific rim size preference when buying used tires (percentage)				
Rim size / municipality	**Rim 13**	**Rim 14**	**Rim 15**	**Rim 16**
Juarez	17%	44%	33%	6%
Reynosa	10%	30%	40%	20%
Matamoros	8%	42%	42%	8%
Geometric mean	**11%**	**38%**	**38%**	**10%**
			error	**3%**

Table 4.4. Highest mean revenue per rim size of used tire in the 2005-2012 period in representative Mexican scope cities (US dollars / used tire)				
Rim size	**R 13**	**R 14**	**R 15**	**R 16**
Remaining tread / year	**20%-40%**	**20%-40%**	**20%-40%**	**20%-40%**
2005	$26.45	$28.47	$31.84	$33.34
2006	$26.40	$28.41	$31.77	$33.28
2007	$25.82	$27.79	$31.08	$32.55
2008	$27.76	$29.88	$33.41	$35.00
2009	$21.86	$23.53	$26.31	$27.55
2010	$22.65	$24.38	$27.26	$28.55
2011	$23.94	$25.77	$28.81	$30.18
2012	$21.80	$23.46	$26.24	$27.48

Table 4.5. Lowest mean revenue per rim size of used tire in the 2005-2012 period in representative Mexican scope cities (US dollars / used tire)				
Rim size	**R 13**	**R 14**	**R 15**	**R 16**
Remaining tread / year	**0-20%**	**0-20%**	**0-20%**	**0-20%**
2005	$7.74	$8.21	$9.38	$10.01
2006	$ 7.68	$ 8.16	$ 9.32	$ 9.94
2007	$ 7.83	$ 8.31	$ 9.50	$ 10.13
2008	$ 6.34	$ 6.73	$ 7.69	$ 8.20
2009	$ 5.74	$ 6.09	$ 6.96	$ 7.43
2010	$ 6.69	$ 7.10	$ 8.12	$ 8.66
2011	$ 6.19	$ 6.57	$ 7.51	$ 8.02
2012	$ 6.33	$ 6.72	$ 7.68	$ 8.19

Table 4.6. Minimum mean revenue per tire in a specific Mexican city (Mexican pesos / used tire)					
Rim size	**R 13**	**R 14**	**R 15**	**R 16**	**R 17**
Remaining tread /municipality	**0-20%**	**0-20%**	**0-20%**	**0-20%**	**0-20%**
Juarez	$123	$130	$141	$196	$205
Reynosa	$77	$77	$85	$85	$98
Matamoros	$72	$82	$102	$89	$92
Lowest mean revenue per tire in Mexican scope cities i (Mexican pesos / used tire)	**$88**	**$94**	**$107**	**$114**	**$123**

Table 4.7. Highest mean revenue per tire in Mexican scope cities (Mexican pesos / used tire)					
Rim size		Rim 13	Rim 14	Rim 15	Rim 16
No.	Remaining tread / Municipality	20%-40%	20%-40%	20%-40%	20%-40%
1	Juarez	$355	$346	$382	$452
2	Reynosa	$248	$265	$279	$297
3	Matamoros	$237	$284	$342	$312
Highest mean revenue per tire in Mexican scope cities (Mexican pesos /used tire)		**$275.33**	**$296.36**	**$331.40**	**$347.10**

Table 4.8. Mean retail price in Mexican representative scope (Mexican pesos / used tire)											
Rim size		R 13		R 14		R 15		R 16		R 17	
No.	Remaining tread /Municipality	0-20%	20%-40%	0-20%	20%-40%	0-20%	20%-40%	0-20%	20%-40%	0-20%	20%-40%
1	**Juarez**	$203	$355	$215	$346	$233	$382	$325	$452	$339	$466
2	**Reynosa**	$111	$248	$111	$265	$122	$279	$122	$297	$141	$339
3	**Matamoros**	$96	$237	$108	$284	$135	$342	$118	$312	$122	$331
Mean retail price in Mexican representative scope [i] (Mexican pesos / used tire)		**$129**	**$275**	**$137**	**$296**	**$157**	**$331**	**$167**	**$347**	**$180**	**$374**

4.2 Disposal Cost per Tire in Texas and Mexico Border Region

Contrary to the Mexican side of the border in Texas private disposal companies as well as local authorities are the ones in charge of the collection and disposal of waste tires. The price charged to a waste tire generator depends on confidential agreements between each waste tire management company and each generator. Prices charged by public landfills and collection centers are fixed. Large new tire retailers have corporate agreements with a single authorized hauler which provides the waste tire collection service in all of their stores and information regarding the cost per tire is kept confidential by both parties.

Although private companies are seldom involved, in the Mexican side of the border Municipal authorities are the ones in charge of the waste tire storage and disposal sites, specifically the Ecology and/or municipal services departments. Only Ciudad Juarez declares a disposal cost for waste tires.

4.3 Potential Cost to Clean up Significant Tire Piles in the Texas-Mexico Border Region

Activities such as fire prevention, fumigation and volume diminishing should be addressed by each stakeholder depending on his own criteria.

The transportation costs to the closest appropriate disposal sites are presented on **Table 4.9** based on quotations obtained from trucking companies:

Table 4.9
Estimated transportation costs to closest appropriate disposal sites

Id #	Destination[1]		Accumulated waste tires (tires)	Equip.	State of tire	Estimated number of travels	Cost per travel	Total Transportation Cost (USD)
	Disposal Site	City						
1	CEMEX Plant	Monterrey, NL.	2,500,000	Truck	Whole	1667	$ 829.07	$ 1,382,067.86
				Train	Whole	1008	$1,480.00	$ 1,491,840.00
				Truck	Cut/Shred	1042	$ 829.07	$ 863,896.05
				Train	Shred	323	$1,480.00	$ 478,040.00
35	GCC Plant	Samalayuca Chih	2,500,000	Truck	Whole	---	---	$ 0.00
				Train	Whole	---	---	$ 0.00
				Truck	Cut/Shred	---	---	$ 0.00
				Train	Shred	---	---	$ 0.00
3	CEMEX Plant	Monterrey, NL.	550,000	Truck	Whole	367	$ 350.00	$ 128,450.00
				Train	Whole	222	$1,272.92	$ 282,587.50
				Truck	Cut/Shred	230	$ 350.00	$ 80,500.00
				Train	Shred	71	$1,272.92	$ 90,377.08
36	CEMEX Plant	Monterrey, NL.	400,000	Truck	Whole	267	$ 829.07	$ 221,363.00
				Train	Whole	162	$1,480.00	$ 239,760.00
				Truck	Cut/Shred	167	$ 829.07	$ 138,455.51
				Train	Shred	52	$1,480.00	$ 76,960.00
31	Landfill[2]	Acuña, Coah.	200,000	Truck	Whole	---	---	$ 0.00
				Train	Whole	---	---	$ 0.00
				Truck	Cut/Shred	---	---	$ 0.00
				Train	Shred	---	---	$ 0.00
32	Landfill[2]	Piedras Negras, Coah	115,500	Truck	Whole	---	---	$ 0.00
				Train	Whole	---	---	$ 0.00
				Truck	Cut/Shred	---	---	$ 0.00
				Train	Shred	---	---	$ 0.00
8	CEMEX Plant	Monterrey, NL.	100,000	Truck	Whole	67	$ 350.00	$ 23,450.00
				Train	Whole	41	$1,272.92	$ 52,189.58
				Truck	Cut/Shred	42	$ 350.00	$ 14,700.00
				Train	Shred	13	$1,272.92	$ 16,547.92

Table 4.9 Estimated transportation costs to closest appropriate disposal sites								
Id #	Destination[1] Disposal Site	Destination[1] City	Accumulated waste tires (tires)	Equip.	State of tire	Estimated number of travels	Cost per travel	Total Transportation Cost (USD)
4	CEMEX Plant	Monterrey, NL.	50,000	Truck	Whole	34	$ 350.00	$ 11,900.00
				Train	Whole	21	$1,272.92	$ 26,731.25
				Truck	Cut/Shred	21	$ 350.00	$ 7,350.00
				Train	Shred	7	$1,272.92	$ 8,910.42
34	APASCO Plant	Ramos Arizpe, Coah.	50,000	Truck	Whole	34	$1,959.63	$ 66,627.47
				Train	Whole	---	---	---
				Truck	Cut/Shred	21	$1,959.63	$ 41,152.26
				Train	Shred	---	---	---
2	CEMEX Plant	Monterrey, NL.	32,000	Truck	Whole	22	---	---
				Train	Whole	13	$1,329.33	$ 17,281.23
				Truck	Cut/Shred	---	---	---
				Train	Shred	5	$1,329.33	$ 6,646.63
15	CEMEX Plant	Monterrey, NL.	13,000	Truck	Whole	9	---	---
				Train	Whole	6	$1,160.13	$ 6,960.80
				Truck	Cut/Shred	---	---	---
				Train	Shred	2	$1,160.13	$ 2,320.27
12	CEMEX Plant	Monterrey, NL.	3,000	Truck	Whole	2	---	---
				Train	Whole	2	$1,115.02	$ 2,230.03
				Truck	Cut/Shred	2	---	---
				Train	Shred	1	$1,115.02	$ 1,115.02
7	CEMEX Plant	Monterrey, NL.	1,000	Truck	Whole	1	$ 350.00	$ 350.00
				Train	Whole	1	$1,272.92	$ 1,272.92
				Truck	Cut/Shred	1	$ 350.00	$ 350.00
				Train	Shred	1	$1,272.92	$ 1,272.92
33	APASCO Plant	Ramos Arizpe, Coah.	1,000	Truck	Whole	1	$ 565.28	$ 565.28
				Train	Whole	1	$6,757.26	$ 6,757.26
				Truck	Cut/Shred	1	$ 565.28	$ 565.28
				Train	Shred	1	$6,757.26	$ 6,757.26
11	CEMEX Plant	Monterrey, NL.	800	Truck	Whole	1	---	---
				Train	Whole	1	$1,115.02	$ 1,115.02
				Truck	Cut/Shred	1	---	---
				Train	Shred	1	$1,115.02	$ 1,115.02

* Means data was not confirmed with a key stakeholder, it is presented as it was obtained from previous tire pile inventories.

Tire sites 16 to 30 are not located within the study's selected search area but are located within 100km from the Texas-Mexico border.

The information presented on this Table was obtained through remote interviews with the key stakeholders.

Nuevo Laredo tire pile was cleaned up during the writeup of this Report according to the remote interview applied to the municipal Environment and Climate Change Coordinator on April 20, 2012.

Prices in red are subject to KCSM FSC

Prices in blue are subject to negotiations with Ferromex

Prices don't include VAT.

[1] Disposal sites selected according to cheaper transportation cost.

[2] Transportation costs for Acuña, Juarez and Piedras Negras are not considered due to landfill being in the same city.

4.4 Current Potential Cost to Extinguish Fires and Remediate Environmental, Public Health, and Economic Impacts Should Any of the Major Tire Piles in the Region Set Ablaze

4.4.1 Cost to Extinguish Fires in the Texas-Mexico Border Area

The **Table 4.10.** represents an abstract of the responses given for Mexican civil guard; the personnel cost was obtained considering Mexican minimum wage as $4.77 (US dollars) for 8 hours, the salary per hour is about $0.59 USD.

Table 4.10.
Summary of Resources to extinguish fires given by Mexican civil guard

City	State	Number of tire fires attended since 2005	Resources to extinguish fires			
			Time	Personnel	Personnel Cost (USD)[+]	Extinguishing agents
Ojinaga	Chihuahua	----	1.5 to 2 h	----	----	Water / Foam
Nava	Coahuila	90	1 to 3 h	5	$ 3 - 9	Water / Foam
Acuña	Coahuila	210	20 min to 1 h	----	----	Water / Foam
Piedras Negras	Coahuila	----	1 to 2 h	3	$ 1.8 - 3.6	Water / Foam
Anahuac	Nuevo Leon	Rarely	0.5 to 1 h	3	$ 1 - 1.8	Water / Foam
Nuevo Laredo	Tamaulipas	Rarely	----	----	----	Water / Foam
Guerrero	Tamaulipas	72	12 to 24 h	6	$ 43 - 85.8	Water / Foam
Gustavo Diaz Ordaz	Tamaulipas	300	----	6	----	Water / Foam
Río Bravo	Tamaulipas	Frequently	20 to 30 min	3	$1	Water / Foam

[+] Personnel cost was estimated as follow: $\text{Number of personnel} \times \text{salary per hour} \times \text{Time}$

According to interviewees, the estimate personnel cost is considered $35 USD per hour per person and $75 USD per hour to estimate de extinguishing agents cost; although a global cost was given.

Table 4.11.
Summary of Resources to extinguish fires given by Texas firefighting agency

City	Number of tire fires attended since 2005	Resources to extinguish fires				
		Time	**Number of Personnel**	**Personnel Cost (USD)**	**Extinguishing agents**	**Extinguishing agents cost (USD)**
Brownsville	6	6 to 8 h	18	$4000 to $5000	4 Engines and 3000 gall of water	$450 to 600
Laredo	30	45 min to 1 h	4	$90 to 140 +	Water / Foam	$50 to 75 *
Mc Allen	18	----	---	----	Water / Foam	$2,500 to 6,000
Rio Grande	72	----	15	----	90 gall of foam and 700 gall of water	$10,000 to 12,000
Del Rio	One in the landfill	----	----	----	Water / Foam	$6,000 to 7,000
Eagle Pass	120	20 min to 2 h	6	$70 to 420 +	15 gall of foam and 2 engines	$25 to 150 *

+ *Personnel cost was estimated as follow:* $Number\ of\ personnel \times salary\ per\ hour \times Time$
* *Extinguishing agents cost was estimated as follow:* $Cost\ for\ extinguishing\ agents\ per\ hour \times Time$

4.4.2 Public Health Impacts Remediation Costs

4.4.2.1 Pyrolytic Oil and Ash

In order to identify the best remediation techniques and their estimated costs IEMS consulted the US Federal Remediation Technologies Roundtable (FRTR) Table 3-2 Remediation Technologies Screening Matrix and Reference Guide and selected the following remediation options:

In Situ Biological Treatment: Phytoremediation

"Phytoremediation is a process that uses plants to remove, transfer, stabilize, and destroy contaminants in soil and sediment. Contaminants may be either organic or inorganic." (FRTR)

Table 4.12.
FRTR reported remediation costs estimates for Phytoremediation (US dollars)

RACER PARAMETERS	Small site		Large site	
	Easy	**Difficult**	**Easy**	**Difficult**
Cost per cubic foot	$18	$66	$4	$14
Cost per cubic meter	$626	$2,322	$147	$483

RACER means Remedial Action Cost Engineering Requirements

Ex situ Physical/Chemical Treatment (assuming excavation): Chemical Oxidation

"Reduction/oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide." (FRTR)

"Estimated costs range from $190 to $660 per cubic meter ($150 to $500 per cubic yard)." (FRTR)

Excavation, Retrieval & Offsite disposal

"Contaminated material is removed and transported to permitted off-site treatment and disposal facilities. Pretreatment may be required." (FRTR)

Cost estimates for excavation and disposal range from $300 to $510 per metric ton ($270 to $460 per ton) depending on the nature of hazardous materials and methods of excavation. These estimates include excavation/removal, transportation, and disposal at a permitted facility. Additional cost of treatment at disposal facility may also be required. (FRTR)

4.5 History of Known Environmental Health Hazards Associated with past or Current Waste Tire Piles Located in Regions with Ecosystems Similar to the Texas-Mexico Border Region

Over the past decade American used vehicles imports, explosive population growth and a steady demand for used American tires in Mexico have contributed to the proliferation of scrap tires on the Texas–Mexico border.

Most of the major border cities host piles containing from tens of thousands to millions of tires, and a few of the largest cities are home to piles ten times as large. Tire piles, legal or illegal, pose at least two health threats: pests and fire.

Tire piles easily accumulate rain and organic matter transported by wind and, therefore, become ideal incubators for mosquito larvae. As leaf litter decays, the microorganisms that grow on it serve as food for the mosquito larvae. Furthermore, tires absorb heat, which helps accelerate the larval growth.

Tire piles have also been identified as breeding ground for vermin (rodents and other pests) due to the combined presence of water, heat, and shade. (Secretaría de Medio Ambiente, 2002).

Mosquito-borne diseases include Dengue, encephalitis, malaria, and yellow fever. (Moore & Mitchell, 1997). Globally, Dengue is currently the most important of all vector-borne viral diseases in terms of human morbidity and mortality, with Aedes aegypti and Aedes albopictus, the mosquito vector for the Dengue viruses, found in more than 100 tropical countries (Cortez Florez, 2001). In areas where Ae. aegypti is abundant, this species might be expected to play a far more important role in Dengue transmission than Ae. albopictus (Moore & Mitchell, 1997).

Dengue can produce a spectrum of clinical illness, ranging from a nonspecific viral syndrome to severe and fatal hemorrhagic disease. Although Dengue fever is not usually fatal, Dengue hemorrhagic fever (DHF) and Dengue shock syndrome can be. On average, 5% of hospitalized cases result in death. The majority of fatalities occur among children younger than 15 years (Lloyd, 2003).

In 2002, the Department of Health Services' Vector-Borne Disease Section identified five discarded truck tires, one of which yielded seven Aedes albopictus larvae after being tested. The Aedes albopictus, was initially detected in 2001 in Los Angeles and Long Beach, according to a 2003 Department of Health Services report. The most immediate concern in California, however, is the potential role of waste tires in the spread of the West Nile Virus. According to the Department of Health Services, this mosquito-borne disease reached the United States in 1999 and has since spread to 48 states.

In 2004, it had been detected in 56 of California's 58 counties with nearly 600 identified cases of persons afflicted by the disease. In 2008, 35 cases of West Nile Virus were reported for San Diego County alone. Fortunately, the arid conditions of California lower the risk of adequate mosquito habitat in tire piles in the region.

However, a year with more precipitation or development of tire piles in locations where they would trap water from stormwater runoff would be a matter of concern (Reyes Tomassini, 2009).

Tire piles are typically high-priority targets of efforts to prevent or slow outbreaks of mosquito-borne diseases. Unfortunately, treating them with insecticides is problematic. It is difficult to penetrate tire piles to the depths where mosquitoes breed.

Also, mosquitoes are developing resistance to many widely used insecticides. Finally, insecticides used to suppress adult mosquitoes are environmentally hazardous, and those used to suppress larvae are costly. Thus, mitigating mosquito-borne diseases may require completely removing tire piles (Blackman & Palma, 2002).

Tire piles also pose a major environmental threat given their risk of burning. Tire piles burn intensely due to their high per-pound heat output.

For example, the energy content of tires is 14,000–15,000 British thermal units (BTUs) per pound, as compared to 8,000–12,000 per pound of coal (California Integrated Waste Managment Board, 2009).

The environmental impact of tire fires ranges from moderate to severe effects on air, water, and soil pollution. Tires do not combust completely and, as a result, produce both conventional air pollutants and hazardous air pollutants; along with solid and liquid waste.

Tire fire smoke contains irritating chemicals, particulate matter, and carcinogens. A 1997 USEPA report indicated that tire fire emissions are significantly more toxic than emissions from coal-fired utilities with pollution controls.

Identified health effects from exposure to such compounds include irritation of mucous membranes (eye, nose, and throat), exacerbation of asthma symptoms and respiratory conditions, and potential exacerbation of preexisting heart disease (California Integrated Waste Managment Board, 2009).

Tire fires also cause water and land contamination. A standard automobile tire generates about two gallons of oil when burning and liquefying.

The burning of large tire piles, then, could potentially result in the leaching of large amounts of toxic oil into the soil and possibly into the aquifers.

If soil becomes contaminated with oil, its microbiological quality is reduced and plant growth is depressed, diminishing the health and productive capacity of the land.

Remediation is generally difficult, and the sites of many tire fires have been designated as hazardous waste cleanup sites (Blackman & Palma, 2002).

An example of the potential extent of a tire fire is the one which engulfed the S.F. Royster Tire Disposal Facility in Tracy, California, in San Joaquin County. The facility stored an estimated 7 million tires that burned for more than two years.

Local, state, and federal authorities worked together to conduct emergency response activities. They determined that the best course of action was to let the fire burn itself out.

The decision was based primarily on concerns that water hosing the fire might produce excessive amounts of hazardous wastewater. In December 2001, state and local agencies completely extinguished the fire and remediation efforts followed.

The Board estimated that the fire contaminated an area of some 564,000 ft2, or 13 acres (California Integrated Waste Managment Board, 2009).

To address the long-term economic impacts of a tire fire, the highly toxic emissions of the smoke plume must be considered significant ozone pollution contributors in the wider air basin.

Ground-level ozone, or “bad” ozone, is formed when volatile organic compounds—such as benzene and butadiene, which are components of tire fire smoke—react with sunlight and nitrogen oxide in the earth’s lower atmosphere. High ozone concentrations reduce crop yield and result in losses to consumer and producer welfare (California Integrated Waste Managment Board, 2009).

In summary, known environmental health hazards associated with past or current waste tire piles located in regions with ecosystems similar to the Texas-Mexico Border Region are the following:

- Mosquito transmitted diseases such as Dengue fever and West Nile Virus.
- Carcinogenic compound emissions when tires are burned.
- Increase in ground level ozone when tires are burned.
- Soil and water contamination with toxic oil which leaches when tires are burned.

Identified health effects from exposure to emissions from tire fires include irritation of mucous membranes (eye, nose, and throat), exacerbation of asthma symptoms and respiratory conditions, and potential exacerbation of preexisting heart disease.

4.6 Potential Cost to Remediate the Environmental Health Threats Associated with Disease Carrying Vectors Located in Tire Piles Along the Texas-Mexico Border Region

To obtain information related to health threats remediation costs associated with Dengue and West Nile Virus, the following key stakeholders in the Mexico were consulted:

- Tamaulipas Health Secretariat
- Nuevo Leon Health Secretariat
- Coahuila Health Secretariat
- Chihuahua Health Secretariat

These key departments were asked to deliver information regarding Dengue and West Nile Virus recorded cases from 2005 to this day within the study’s scope regions, and the treatment costs for said diseases.

4.6.1 Dengue

State of Tamaulipas

Mr. Juan Francisco Castañon Barron, Chief of the Vector State Department of Tamaulipas Health Secretariat delivered data from all municipalities in the State of Tamaulipas regarding Dengue Fever and Dengue Hemorrhagic Fever from 2005 to half 2011, which was the most recent available data. No West Nile Virus data was provided. The following tables contain detected dengue fever and dengue hemorrhagic fever cases in study's scope regions in the State of Tamaulipas.

Table 4.13.
Detected dengue fever and dengue hemorrhagic fever cases in study's scope regions in the State of Tamaulipas. (2005-2007)

Municipality	2005			2006			2007		
	DF	DHF	TOTAL	DF	DHF	TOTAL	DF	DHF	TOTAL
Camargo	0	1	1	0	0	0	9	3	12
Diaz Ordaz	0	0	0	0	0	0	1	4	5
Matamoros	1160	438	1598	14	10	24	46	21	67
Miguel Aleman	0	1	1	0	0	0	8	2	10
Nuevo Laredo	1	2	3	1	0	1	360	142	502
Reynosa	143	62	205	27	9	36	448	198	646
Rio Bravo	2	3	5	1	3	4	9	2	11
Guerrero	0	0	0	0	0	0	0	0	0
Total	**5069**	**1832**	**6901**	**151**	**46**	**197**	**1406**	**516**	**1922**

Table 4.14.
Detected dengue fever and dengue hemorrhagic fever cases in study's scope regions in the State of Tamaulipas. (2008-2011)

Municipality	2008			2009			2010			2011		
	DF	DHF	TOTAL	DF	DHF	TOTAL	DF	DHF	TOTAL	DF	DHF	TOTAL
Camargo	0	0	0	0	0	0	0	0	0	0	0	0
Diaz Ordaz	0	0	0	0	0	0	0	1	1	0	0	0
Matamoros	257	231	488	46	29	75	23	3	26	2	0	2
Miguel Aleman	0	0	0	0	0	0	0	0	0	0	0	0
Nuevo Laredo	4	3	7	9	0	9	2	1	3	0	0	0
Reynosa	284	105	389	81	35	116	29	14	43	15	0	15
Rio Bravo	4	2	6	5	1	6	107	99	206	0	1	1
Guerrero	0	0	0	0	0	0	0	0	0	0	0	0
Total	**1014**	**522**	**1536**	**696**	**215**	**911**	**409**	**168**	**577**	**78**	**15**	**93**

DF = Dengue Fever Cases
DHF = Hemorrhagic Fever Cases

Mr. Juan Francisco Castañon Barron also provided information on length of hospitalization times and its corresponding costs. On average it is known that Dengue Hemorrhagic Fever patients need between 4-7 days to recover from illness which translates into $5,000 - $8,000 pesos for hospitalization costs.

There are no specific antiviral medicines for dengue, doctors prescribe medicine to counteract disease symptoms such as painkillers and antipyretics, Parecetamol is highly recommended as it fulfills both functions, as well as electrolyte drinks.

For cost estimation, treatment cost (TrC) of $130 pesos and hospitalization cost (HC) of $5,000 pesos will be used per patient. Costs can be higher according to patient critical condition.

The following tables contain detected dengue fever and dengue hemorrhagic fever costs in study's scope regions in the State of Tamaulipas.

Table 4.15.
Dengue fever and dengue hemorrhagic fever costs in study's scope regions in the State of Tamaulipas (2005-2006)

Municipality	2005			2006		
	TrC	HC	TC	TrC	HC	TC
Camargo	$130	$5,000	$5,130	$0	$0	$0
Diaz Ordaz	$0	$0	$0	$0	$0	$0
Matamoros	$207,740	$2,190,000	$2,397,740	$3,120	$50,000	$53,120
Miguel Aleman	$130	$5,000	$5,130	$0	$0	$0
Nuevo Laredo	$390	$10,000	$10,390	$130	$0	$130
Reynosa	$26,650	$310,000	$336,650	$4,680	$45,000	$49,680
Río Bravo	$650	$15,000	$15,650	$520	$15,000	$15,520
Guerrero	$0	$0	$0	$0	$0	$0
Total	**$235,690**	**$2,535,000**	**$2,770,690**	**$8,450**	**$110,000**	**$118,450**

Table 4.16.
Dengue fever and dengue hemorrhagic fever costs in study's scope regions in the State of Tamaulipas (2007-2008)

Municipality	2007			2008		
	TrC	HC	TC	TrC	HC	TC
Camargo	$1,560	$15,000	$16,560	$0	$0	$0
Diaz Ordaz	$650	$20,000	$20,650	$0	$0	$0
Matamoros	$8,710	$105,000	$113,710	$63,440	$1,155,000	$1,218,440
Miguel Aleman	$1,300	$10,000	$11,300	$0	$0	$0
Nuevo Laredo	$65,260	$710,000	$775,260	$910	$15,000	$15,910
Reynosa	$83,980	$990,000	$1,073,980	$50,570	$525,000	$575,570
Río Bravo	$1,430	$10,000	$11,430	$780	$10,000	$10,780
Guerrero	$0	$0	$0	$0	$0	$0
Total	**$162,890**	**$1,860,000**	**$2,022,890**	**$115,700**	**$1,705,000**	**$1,820,700**

Table 4.17. Dengue fever and dengue hemorrhagic fever costs in study's scope regions in the State of Tamaulipas (2009-2011)									
Municipality	**2009**			**2010**			**2011**		
	TrC	**HC**	**TC**	**TrC**	**HC**	**TC**	**TrC**	**HC**	**TC**
Carmargo	$0	$0	$0	$0	$0	$0	$0	$0	$0
Diaz Ordaz	$0	$0	$0	$130	$5,000	$5,130	$0	$0	$0
Matamoros	$9,750	$145,000	$154,750	$3,380	$15,000	$18,380	$260	$0	$260
Miguel Aleman	$0	$0	$0	$0	$0	$0	$0	$0	$0
Nuevo Laredo	$1,170	$0	$1,170	$390	$5,000	$5,390	$0	$0	$0
Reynosa	$15,080	$175,000	$190,080	$5,590	$70,000	$75,590	$1,950	$0	$1,950
Río Bravo	$780	$5,000	$5,780	$26,780	$495,000	$521,780	$130	$5,000	$5,130
Guerrero	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	**$26,780**	**$325,000**	**$351,780**	**$36,270**	**$590,000**	**$626,270**	**$2,340**	**$5,000**	**$7,340**

Notes:
TrC = Treatment Cost ($130 pesos per patient)
HC = Hospitalization Cost ($5,000 per patient)
TC = Total Cost
Costs can be higher according to patient critical condition.

No written or specific data was provided during the preparation of this report for the States of Nuevo Leon, Coahuila or Chihuahua.

4.6.2 West Nile Virus

The results of the estimations of the number of WNV cases in Mexican border municipalities are presented only for border counties which presented at least one WNV case from 2005 to 2011.

Table 4.18.
Estimated West Nile Virus cases in Matamoros

Year	**Mexican Border Municipality of Matamoros**		**US Border Cameron County**		
	Population (Inhabitants)	**Estimated WNV Ocurrence**	**Population (Inhabitants)**	**WNV Cases**	**WNV / Inhabitant**
2005	462157	0	370735	0	0
2006	467564	4	376882	3	7.96E-06
2007	472971	5	382703	4	1.05E-05
2008	478379	0	389164	0	0
2010	489193	0	406220	0	0
Total WNV Ocurrence		**9**		**7**	

Table 4.19.
Estimated West Nile Virus cases in Rio Bravo

Year	Mexican Border Municipality of Rio Bravo		US Border Hidalgo County		
	Population (Inhabitants)	Estimated WNV Ocurrence	Population (Inhabitants)	WNV Cases	WNV / Inhabitant
2005	106842	0	665475	0	0
2006	109125	1	683719	2	2.93E-06
2007	111409	1	701862	3	4.27E-06
2008	113692	0	721275	0	0
2010	118259	0	774769	0	0
Total WNV Ocurrence		**2**		**5**	

Table 4.20.
Estimated West Nile Virus cases in Reynosa

Year	Mexican Border Municipality of Reynosa		US Border Hidalgo County		
	Population (Inhabitants)	Estimated WNV Ocurrence	Population (Inhabitants)	WNV Cases	WNV / Inhabitant
2005	526888	0	665475	0	0
2006	543289	2	683719	2	2.93E-06
2007	559689	3	701862	3	4.27E-06
2008	576090	0	721275	0	0
2010	608891	0	774769	0	0
Total WNV Ocurrence		**5**		**5**	

Table 4.21.
Estimated West Nile Virus cases in Gustavo Diaz Ordaz

Year	Mexican Border Municipality of Gustavo Diaz Ordaz		US Border Hidalgo County		
	Population (Inhabitants)	Estimated WNV Ocurrence	Population (Inhabitants)	WNV Cases	WNV / Inhabitant
2005	15028	0	665475	0	0
2006	15177	1	683719	2	2.93E-06
2007	15327	1	701862	3	4.27E-06
2008	15476	0	721275	0	0
2010	15775	0	774769	0	0
Total WNV Ocurrence		**2**		**5**	

Table 4.22.
Estimated West Nile Virus cases in Miguel Aleman

Year	Mexican Border Municipality of Miguel Aleman		US Border Webb County		
	Population (Inhabitants)	Estimated WNV Ocurrence	Population (Inhabitants)	WNV Cases	WNV / Inhabitant
2005	24020	0	220968	0	0
2006	24619	0	225985	0	0.00E+00
2007	25218	1	230848	1	4.33E-06
2008	25817	1	235937	1	4.23842E-06
2010	27015	1	250304	1	3.99514E-06
Total WNV Ocurrence		**3**		**3**	

Table 4.23.
Estimated West Nile Virus cases in Nuevo Laredo

Year	Mexican Border Municipality of Nuevo Laredo		US Border Webb County		
	Population (Inhabitants)	Estimated WNV Ocurrence	Population (Inhabitants)	WNV Cases	WNV / Inhabitant
2005	355827	0	220968	0	0
2006	361468	0	225985	0	0.00E+00
2007	367109	2	230848	1	4.33E-06
2008	372751	2	235937	1	4.23842E-06
2010	384033	2	250304	1	3.99514E-06
Total WNV Ocurrence		**6**		**3**	

Table 4.24.
Estimated West Nile Virus cases in Juarez

Year	Mexican Border Municipality of Juarez		US Border El Paso County		
	Population (Inhabitants)	Estimated WNV Ocurrence	Population (Inhabitants)	WNV Cases	WNV / Inhabitant
2005	1313338	21	708683	11	1.55217E-05
2006	1317097	28	720756	15	2.08E-05
2007	1320855	68	727828	37	5.08E-05
2008	1324614	0	738416	0	0
2010	1332131	0	800647	0	0
Total WNV Ocurrence		**117**		**63**	

Although symptoms and general treatments for WNV are publicly available all cases require different levels of medical care and costs can be very high depending on complications. Also WNV time of recovery varies greatly on a case by case basis.

For the reasons above stated; standard treatment costs and time for recovery of WNV cases are not available on public literature and are were not provided by health stakeholders on neither side of the border.

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Section 5. Comparison between Texan and Mexican Tire Tracking Systems

5 Comparison Between Texan And Mexican Tire Tracking Systems

To obtain the information required, IEMS performed the following activities:

- ✓ Face to face interviews with industry key stakeholders.
- ✓ Face to face interviews with Texas local environmental authorities in the scope's selected fieldwork cities
- ✓ Remote interviews with the Mexican municipal´s environmental authorities.
- ✓ Consulted previous studies focused on tracing the flow of waste tires across the Texas-Mexico Border and similar regions in both countries and the regulatory framework described by them.
- ✓ Reviewed the existing regulatory structure used by Texas and Mexico to manage used tires along the Texas-Mexico Border Region.

The last one includes an investigation of current waste tire policies, laws, regulations and procedures along the Texas-Mexico Border Region in international, federal, state and local levels applying to it described in detail on the Chapter 6 of the Full Report.

5.1 Tracking Systems

In this section the tracking systems employed in Texas and Mexico are examined and later on compared.

In the study area, tires sold, imported and exported can be classified as:

- New
- Used

Although waste tires are likely to be sold, imported or exported if mixed with used tires, special handling waste tracking systems for them are later on presented in detail on the Chapter 6 of the Full Report.

5.1.1 Texas Tracking Systems

5.1.1.1 New Tires Sales Tracking Systems

Tire sale tracking systems are regulated at federal level by the National Traffic and Motor Vehicle Safety Act section 30117

5.1.1.2 Used Tires Sales Tracking Systems

No used tire tacking systems were reported to be used by the used tire dealers interviewed during fieldwork activities in the Texas scope cities.

5.1.1.3 New and Used Tires Import and Export Tracking Systems

"The Harmonized Commodity Description and Coding System", generally referred to as "Harmonized System" or simply "HS", is a multipurpose international product nomenclature developed by the World Customs Organization (WCO). It comprises about 5,000 commodity groups; each identified by a six digit code, arranged in a legal and logical structure and is supported by well-defined rules to achieve uniform classification. The system is used by more than 200 countries and economies as a basis for their Customs tariffs and for the collection of international trade statistics. Over 98 % of the merchandise in international trade is classified in terms of the HS.

The HS contributes to the harmonization of Customs and trade procedures, and the non-documentary trade data interchange in connection with such procedures, thus reducing the costs related to international trade. It is also extensively used by governments, international organizations and the private sector for many other purposes such as internal taxes, trade policies, monitoring of controlled goods, rules of origin, freight tariffs, transport statistics, price monitoring, quota controls, compilation of national accounts, and economic research and analysis. The HS is thus a universal economic language and code for goods, and an indispensable tool for international trade." (World Customs Organization (WCO))

New and used tires are classified in chapter 40, "Rubber and articles thereof", and their tariff schedules or codes start with the four numbers, or heading:

New tires → 4011 (United States International Trade Commission, 2012)
Used tires →4012 (United States International Trade Commission, 2012)

5.1.2 Mexico's Tire Tracking Systems

5.1.2.1 Sales Tracking Systems

No new or used tires tracking systems are applied neither by the industry nor any level of government.

5.1.2.2 New and Used Tires Import and Export Tracking Systems

The same Harmonized system described developed by the World Customs Organization is applied by Mexico's federal government Tributary Administration System (*Sistema de Administracion Tributaria*, SAT) to track the import and export of used and new tires.

An additional used tire tracking system is employed by the Secretary of Economy to ensure the proper disposal of used tires legally imported through the El Paso-Ciudad Juarez border.

The Secretary of Economy (*Secretaria de Economia* or SE) is in charge of issuing importation permits for three regions in the U.S. – Mexico border.

These permits are granted annually according to a global used tire import quota to people or companies dedicated to commercialization of used tires in these areas. The *used tire import quota* also determined by the SE is based on:

a) The volume of used tires imported the previous year and
b) Compliance with final disposal legislation.

The regions were used tire importation has been authorized and controlled by the SE are:

1. The state of Baja California.
2. Sonora State.
3. Ciudad Juarez, Chihuahua.

Every year the number of authorized used tires for import or used tire import quota is established by the SE and divided between each of the three regions. For the purpose of this study the number of used tires legally imported was based on the quota established at the ports of entry in the region of Ciudad Juarez, Chihuahua, Mexico. This is defined as *Ciudad Juarez annual used tire import quota*.

5.1.2.3 Used Tire Legal Import Requirements for Commercialization Purposes

According to the Colombia international bridge customs administrator A. Diaz (personal communication, June, 28, 2011) there are several conditions that must be met to legally introduce used tires into Mexico. The legal import requirements are:

I. The used tire importer must be registered, as such, in the used tires importers record kept by the Central Administration of Accounting and Explanation (*Administracion Central de Contabilidad y Glosa* or ACCG) of the SAT.

II. Retain a share of the authorized used tire import quota set by the Mexican Secretary of Economy (*Secretaria de Economia* or SE) for the year during which the import is performed. The used tire import quota is the maximum number of used tires that can enter through a portion of the U.S.-Mexico border in a particular year. It is specific for the type or origin of the used tires and is valid only for a particular year.

III. Legal submission of an import petition to the customs authority of the point of entry through which the tires will enter Mexico. This has to be made by a customs agent and comply with the requirements set in the Annex 22 of the General Character Rules Regarding Exterior Commerce (*Anexo 22 de las reglas de caracter general en materia de comercio exterior*).

Note: in order for the customs agent to submit an import petition other legal requirements must be met.

IV. Pay the import tariff (schedule) for each used tire entering Mexico. This varies depending on the year and it is defined in the Import and Export General Tax Law (*Ley de los impuestos generales de importación y de exportacion)* valid during importation.

Each item legally crossing the Mexican border has a numeric code or tariff item(schedule) assigned to it depending on how it is classified by the Import and Export General Tax Law (*Ley de los Impuestos Generales de Importacion y Exportacion* or LIGIE).

5.1.2.4 Commercial Used Tires Import for Retreading

There are a different set of authorizations issued by the SE for the importation of commercial tires for the sole purpose of retreading in a Mexican facility. Only registered tire renovation facilities are assigned a *used tires import quota for renovating purposes.* Retreading passenger tires although possible is not economically viable. Without this tire renovating industry the commercial carriers in Mexico would go bankrupt given the cost of new tires.

Used tires for retreading can be imported into Mexico through any legal port of entry following the <u>used tire legal import requirements for retreading purposes.</u>

5.1.2.5 Used Tire Legal Import Requirements for Retreading

In addition to the four legal import requirements described, the import of used commercial tires for retreading is exclusive for natural and legal persons/entities dedicated to tire retreading.

The authorizations are annual, unchangeable, and defined according to formulas.

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Section 6. Waste Tire Management Regulatory Framework

6 Waste Tire Management Regulatory Framework

IEMS conducted a thorough review of U.S. and Mexican legislations, regulations and standards, at all Federal, State, and Local levels, in order to identify all applicable to waste tire management. The review included International treaties. In addition, the enforcement agencies related to the identified applicable requirements were also identified and listed.

The following list summarizes the laws and regulations related to the management and disposal of tires in both countries. A full list of applicable articles is included in Chapter 6 of the study Full report.

6.1 International Treaties

- ✓ NAFTA
- ✓ North American Agreement on Environmental Cooperation
- ✓ Agreement on Cooperation for the Protection and Improvement of the Environment in the Border Area
- ✓ Basel Convention about Control of Transboundary Movements of Hazardous Wastes and their Disposal
- ✓ Customs Convention for the Temporary Importation of Private Road Vehicles.
- ✓ Convention on Combating Bribery of Foreign Public Officials in International Business Transactions
- ✓ World Health Regulations
- ✓ Guidance Manual for the Control of Transboundary Movements of Recoverable Wastes
- ✓ United Nations Convention on the Law of the Sea

6.2 American Regulatory Framework

- ✓ Federal Law
  - o US Disposal of Solid Waste Code – Section 6002 - 101
- ✓ State of Texas
  - o Texas Health and Safety Code 361.112 - Storage, Transportation, and Disposal of Used or Scrap Tires
- ✓ Local Law
  - o City of El Paso
    - ▪ Chapter 9.04 - Solid Waste Management
  - o City of Del Rio
    - ▪ CHAPTER 24 - Solid Waste
  - o City of Eagle Pass
    - ▪ CHAPTER 14 - Municipal Solid Waste [26]
  - o City of Laredo
    - ▪ ARTICLE IV. - Tire Business Registration Program
    - ▪ ARTICLE V. - Dengue Fever Prevention [45]

  - City of McAllen
    - CHAPTER 90 - Solid Waste
  - City of Pharr
    - ORDINANCE NO. O-2010-33
  - City of Brownsville
    - CHAPTER 82 - Solid Waste

6.3 Mexican Regulatory Framework

- ✓ Federal laws
  - General Law for the Prevention and Integrated Management of Wastes
- ✓ State and local laws
  - Chihuahua
    - Law of Ecological Equilibrium and Environmental Protection of the State of Chihuahua
    - Municipal Regulation of Ecology and Environmental Protection of the Municipality of Juarez, Chih.
    - Regulation of the public cleaning service for the municipality of Ojinaga
  - Coahuila
    - Law of Ecological Equilibrium and Environmental Protection of the State of Coahuila
    - Law for the Prevention and Integrated Management of Wastes of the State of Coahuila
    - Regulation of the Ecological Balance and Environmental Protection Law of the State of Coahuila de Zaragoza on matter of Environmental Impact
    - Regulation of the Ecological Balance and Environmental Protection Law of the State of Coahuila de Zaragoza on matter of Contaminants Emissions and Transfer Registry
    - Regulation of Ecology of the Municipality of City of Acuña, Coahuila.
    - Regulation of Ecology and Environmental Protection of the Municipality of Piedras Negras, Coahuila.
  - Nuevo Leon
    - Environmental Law of the State of Nuevo Leon
    - Law of the Environment and Natural Resources Protection Agency
    - Regulation of the Environmental Law of the State of Nuevo Leon
    - Civil Guard Rulebook of Anahuac, Nuevo Leon
  - Tamaulipas
    - Environmental Protection Law for the sustainable development of the State of Tamaulipas.
    - Law of Ecological Equilibrium and Environmental Protection of the State of Tamaulipas
    - Code for Sustainable Development of the State of Tamaulipas

- Regulations for the Ecological Equilibrium and Environmental Protection in the Municipality of Nuevo Laredo, Tamaulipas
- Regulation for the Ecological Equilibrium and Environmental Protection in the Municipality of Reynosa, Tamaulipas
- Regulation for the Ecological Equilibrium and Environmental Protection in the Municipality of Rio Bravo, Tamaulipas
- Regulation for the Equilibrium and Environmental Protection in the Municipality of Matamoros, Tamaulipas

6.4 Enforcement Agencies

Two different levels of authority are involved in the main enforcement of applicable requirements for the management of scrap tires in the U.S. territory:

- ✓ The Federal authority is the Environmental Protection Agency.
- ✓ Environmental Authority at State level in Texas is the Texas Commission on Environmental Quality.

Three different levels of authority are involved in the main enforcement of applicable requirements for the management of scrap tires in the Mexican territory:

- ✓ The Federal authority is the Mexican Secretary for the Environmental and Natural Resources (*Secretaria del Medio Ambiente y Recursos Naturales*, SEMARNAT). The prosecutor agency at the service of SEMARNAT for the supervision of the applicably of federal regulations is the PROFEPA (*Procuraduria Federal de Proteccion al Ambiente*).

- ✓ Four Mexican States are involved in the Texas-Mexico border area as previously identified. Each State with an environmental office, identified as follows:
  - State of Coahuila Environmental Office (*Secretaria del Medio Ambiente de Coahuila*, SEMAC).
  - State of Chihuahua Urban Development and Ecology Office (*Secretaria de Desarrollo Urbano y Ecologia*, SEDUE).
  - State of Nuevo Leon Environment Protection and Natural Resources Agency (*Subsecretaria de Proteccion al Medio Ambiente y Recursos Naturales*, SPMARN).
  - State of Tamaulipas Urban Development and Environment Office (*Secretaria de Desarrollo Urbano y Medio Ambiente*, SEDUMA).

- ✓ Municipal Ecology and public Works departments are in charge of tire management enforcement in a municipal level when waste tires are generated as municipal solid waste.

Section 7. Recommendations regarding changes to the current Texas and Mexico Waste Tire Policies, Laws, Regulations and Procedures

7 Recommendations Regarding Changes to the Current Texas and Mexico Waste Tire Policies, Laws, Regulations and Procedures

7.1 Recommendations

Table 7.1 shows the Recommendations regarding changes to the current Texas and Mexico waste tire policies, laws, regulations and procedures in order to improve waste tire management in the Texas-Mexico Border Region.

Table 7.1.
Recommended changes to the current Texas and Mexico waste tire policies, laws, regulations and procedures

No.	Impact	Cause(s)	Recommendations for each impact
1	Tire fires	➢ Trash fires ➢ Tire burning for metal extraction ➢ Grass fires	✓ CPR dead tires campaign ✓ Tire fire prevention measures ✓ Tire ordinance-passing-training-enforcement
2	Mosquitoes	➢ Water accumulation inside whole tires	✓ CPR dead tires campaign ✓ Tire ordinance-passing-training-enforcement
3	Blocked water ways	➢ Illegal dumping of whole tires	✓ CPR dead tires campaign ✓ Tire ordinance-passing-training-enforcement ✓ Make access difficult to sensitive spots
4	Bad image, Hives, Vermin and poisonous animals	➢ Whole tire dumping or improper storage	✓ CPR dead tires campaign ✓ Tire ordinance-passing-training-enforcement
5	Used tires lack of tracking	➢ No manifest given when reinserted into the market	✓ Include the number of resold used tires in their annual report to the TCEQ scrap tire program.
7	Tire piles	➢ High disposal costs. ➢ No available recycling markets.	✓ CPR dead tires campaign ✓ Market recommendations of Section 8.

7.2 CPR Dead Tires Campaign

CPR stands for Cut-Pack-Recycle which are basic steps IEMS identified in order to facilitate waste tire handling.

Dead tires is the name given by Texas used tire dealers to tires that are no longer reusable.

7.2.1 Cut

Cutting refers to the act of removing the sidewalls of a waste tire.

It can be accomplished manually using a linoleum knife or cutter or by means of a machine, necessary especially for cutting commercial truck tires.

Cutting a tire provides the following benefits:

- Retained water inside waste tires is easier to remove.
- Disposal fee reduction (In Texas up to 80% and average savings of 55%, refer to **Figure 7.1**).
- Volume reduction ranging from 70% to 79% depending on the tire size demanding less storage area and diminishing transportation costs (see **Figure 7.2**).
- Increase recycling and marketing options (refer to Section 8).

Figure 7.1.
Comparison of the disposal fees for whole and cut tires in several Texas border cities (US dollars / tire)

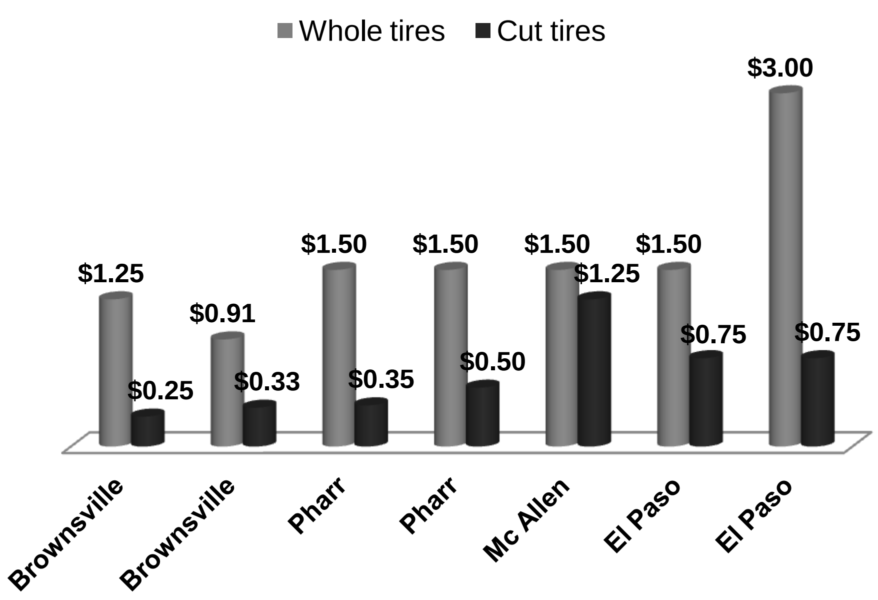
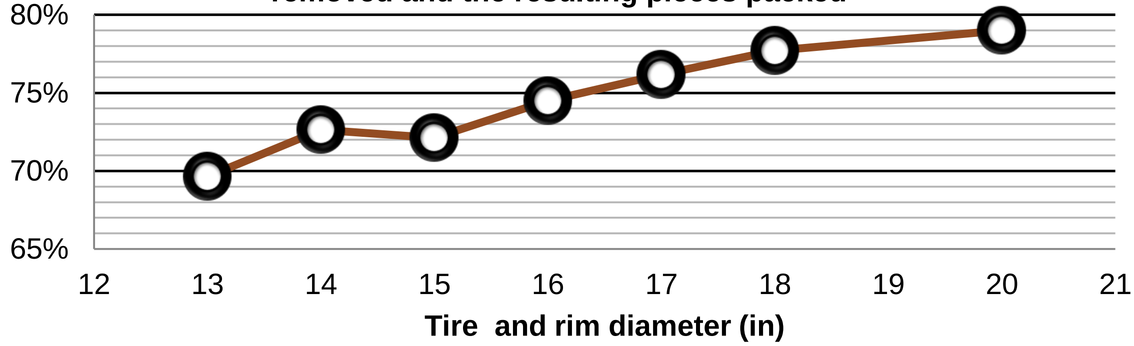


Figure 7.2.
Approximated waste tires volume reduction when sidewalls are removed and the resulting pieces packed



7.2.2 Pack

Packing refers to the act of storing in an ordered fashion the cutting resulting pieces to take advantage of their reduced volume.

It is easy to notice the volume reduction advantages obtained when tire sidewalls are removed as well as several packing alternatives.

Packing the resulting cut tire pieces provides the following benefits:

- Diminish the storage area required.
- Increase storage order.
- Diminish transporting cost per tire.
- Facilitate the loading and unloading into transport vehicles. (Either by hand or stacking on standard pallets).

7.2.3 Recycle

Waste tires tread and sidewalls can have different alternative uses than whole tires depending on whether they belonged to passenger of commercial truck tires. Recycling involves classifying activities based on whether they came from commercial or passenger tires, tread quality and dimensions. The following tread quality classification is suggested:

Type A

No visible wiring is observed, when sliding a plastic bag across the surface (in any direction) it isn't cut or damaged meaning a person can handle the tread without using gloves without hurting his skin.

Image 7.1.
Example of a Type A waste tire tread.

Type B

Tread presents visible wiring and/or when sliding a plastic bag across the surface (in any direction) it is cut or damaged meaning a person cannot handle the tread without using gloves.

Image 7.2.
Examples of type B tire treads.

Dimensions and tire of origin classification is only relevant on specific recycling options. Tire part properties as well as market and recycling options are enumerated and detailed on the market recommendations of Section 8.

7.3 Tire Fire Prevention Measures

The following fire prevention measures should be implemented in every tire storage site, plus the local, state and federal fire prevention requirements.

- Waste tires should be separated from vegetation or any other flammable material by at least 40 feet. (12.2 meters).
- Every tire storage site should be fenced or surrounded by walls at least 2m tall, barb wired on the top, and have access doors with control such as locks. This with the objective to prevent the entrance of arsonists.

7.4 Tire Ordinance

The tire ordinance recommended is based on the regulations already in place in the cities of Laredo and Pharr, Texas. These ordinances both share the sections marked on blue on the following table:

Table 7.2.
Comparison of tire ordinances sections

Laredo	Pharr
	Purpose and intent
Definitions	Definitions
	Residential property
Tire business registration program	Tire business permits
Tire business and mobile repair road service units application	
Terms of registration	
Denial of permit or renewal; suspension or revocation of permit	Denial of permit or renewal; suspension or revocation of permit
Fees	
	Tire hauler permit
	Destruction of tires
	Storage of tires
Disposal of tires	Disposal of tires
	Disposal records/Transmittal Manifest
	Administration/Enforcement
Penalty for violations	Violations and penalties
Injunctive relief	Injunctive relief
Severability	

Tire ordinances common sections are:

1. Definitions.
2. Denial of permit or renewal; suspension or revocation of permit.
3. Disposal of tires.
4. Penalties.
5. Injunctive relief.

In summary the Pharr ordinance presents a more specific approach, especially on violations and penalties, and covers more tire related issues than the Laredo ordinance.

Both cities report significant waste tire management improvement when applying their own tire ordinances. IEMS recommends that each city, county or municipality in the Texas-Mexico border facing tire related issues to pass an ordinance which as a minimum contains the enumerated sections.

This suggestion should be considered, taking into account that always the opinion of a professional legal ordinance advisor should be obtained when an ordinance is to be written and passed. This recommendation doesn't replace the need of legal professional counseling when writing an ordinance or any other legal document.

Naturally it would also be desirable to consider including all of the recommendations presented in this report in the tire ordinances. These recommendations should be carefully reviewed by a professional experienced in law making of each country and consulted with all involved entities, public or private, before passed.

7.4.1 Passing

The city of Laredo set the example on the Texas-Mexico border area by passing a tire ordinance; afterwards it was followed by the city of Pharr. Other cities such as El Paso are in process of passing one. The stakeholders interviewed in said cities highlighted the benefits of possessing a specific legal framework for waste tire management in their areas because it facilitates antidumping enforcement and prevention.

7.4.2 Training

The person in charge of setting up, direction and enforcement of the tire ordinance should perform the following activities:

1. The regulated entities have to be notified and trained on the purposes, scope and application of the tire ordinance. To effectively perform this, the following activities are suggested:

- Summon a meeting with the waste tire generators, haulers and processors of the area. Present the tire ordinance and provide a copy of it. Finally request them to sign a confirmation of notification and training by means of a list of assistance. (The presence and coverage of the event by the local media is desirable).

- Perform a visit to each tire generator, signal it location by means of a GPS, provide a copy of the ordinance and have them sign of reception and give them a period of time to comply. (six months).

2. Enforcement agents training. Passing an ordinance is not effective if the following agencies do not know its purpose and scope. The following agencies and agents should be educated on the tire ordinance purpose, scope and application:

    - Enforcing agency personnel.
    - Special commission personnel.
    - Code enforcement agents.
    - Fire department.
    - Police department.
    - Vector control and health departments.

3. Also after the enforcing personnel has been trained in the purposes, scope and application of the tire ordinance, the training on these subjects of the Municipal judges is key

The success or failure of a tire ordinance relies on the consequences faced by violators. The municipal court will have the final word on whether a civil penalty should be applied or not as well as its severity.

An untrained or unwilling to punish judge may let go violators without any punishment discouraging and disempowering enforcement agencies and officers and sending the wrong message to the regulated entities which may think complying is not necessary.

7.4.3 Enforcement

Immediately after the time given to the regulated entities to comply with the new legislation has passed, tire ordinance enforcement agents should visit all notified regulated entities and inspect their compliance if any violation is identified the corresponding fine or consequence should be applied with zero tolerance.

Periodic visits should be performed, at least annually to ensure a continued compliance and application of the tire ordinance.

New regulated entities identified should be trained and afterwards also be visited.

7.5 Make Access Difficult to Sensitive Dumping Spots

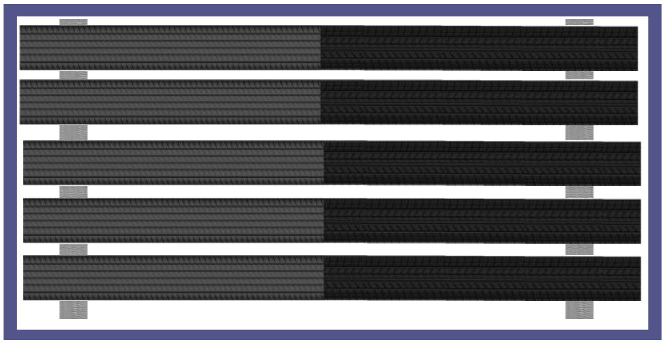
Although tire dumping always generates negative impacts, these are exacerbated when it occurs on waterways causing their course reduction or blocking.

In most cases illegal dumping takes very little effort. It can take more effort to dispose of waste legally tan to dump it illegally.   areas continue to experience illegal dumping problems after being cleaned up.

Effective structural solutions will increase the effort and risk of being caught thereby deterring offenders. Structural solutions can reduce accessibility to popular sites for illegal dumping. A clean up plus:

- Introducing signs;
- Lighting;
- Barriers;
- Landscaping; and,
- Increasing the visibility;

Image 7.3.
Diagram of a tire tread fence



Further information is available on Section 8 Markets Report.

Attachment 5 of this report presents an extract of Chapter 4 (Illegal dumping prevention techniques) of the following document:

✓ Crackdown on Illegal Dumping - Handbook for Local Government (Department of Environment and Climate Change (DECC) New South Wales Government, 2008)

This document presents experience and suggestions on access control techniques and their efficiency in preventing dumping.

7.6 TCEQ Scrap Tire Program Modification

Transporters, scrap tire facilities, and storage sites must file annual reports to the Texas Commission on Environmental Quality (TCEQ). Current Scrap tire annual reports do not include reselling used tires as an option, meaning that waste tires which are reported to be disposed of could actually be reinserted into the market.

By counting the number of waste tires reused a more realistic number of properly processed tires will be at hand. As well as facilitating the tracking of used tires and their actual generation within Texas. No modification to the report format is required.

Section 8. Recommendations Regarding Potential Markets for Tire-Derived Products in Mexico

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8 Recommendations Regarding Potential Markets for Tire Derived Products in Mexico

Each stakeholder should decide what market is more attractive to him based on his own considerations. Nevertheless IEMS recommendations are based on the following criteria:

- Markets which require the minor equipment investment and provide the higher income per tire (high market price) were selected as the most recommendable markets.

- Estimated incomes per tire which are minor than the income theoretically obtained from the burning of tires for metal extraction were not considered recommendable.

- By doing this discrimination the market thrives to burn waste tires for metal extraction would theoretically be discouraged because a higher income could be obtained through alternative recommended markets.

- Alternatives which imply higher green house gas emissions per tire processed are considered less recommendable.

8.1 Social Considerations

Only Mexican legal framework was considered. To identify legal restrictions and regulations, concerning the markets identified a search was performed on Mexican Official Standards (*Normas Oficiales Mexicanas*, NOMs), International treaties signed by Mexico, federal, state and local Mexican laws.

All recycling markets identified as long as they promote energy and raw materials savings without affecting health, ecosystems or their elements, are allowed. It would be recommendable for each project to perform a SIA prior to make any decision regarding a processing project.

By identifying impacts in advance:

- Better decisions can be made about which interventions should proceed and how they should proceed; and
- Mitigation measures can be implemented to minimize the harm and maximize the benefits from a specific planned intervention or related activity.
- In order to aid stakeholders to assess social impacts the SIA is described according to the international principles of the social impact assessment emitted by the International Association for Impact Assessment.

IEMS will present the bases of a social impact assessment and useful data in order for each stakeholder to perform its own local social impact assessment on the area to be impacted by their planned projects.

8.2 Economic Impact Considerations

To make evident the difference in amount of economic investment required by each raw material state, the necessary investments on equipment to process waste tires was obtained from previous studies and quotations from manufacturers.

The equipment necessary was determined according to market tire derived raw materials specifications such as:

- Tire part
- Type of tire where the raw material originated
- Particle size
- Metal content
- Fiber content.

This estimation considers the required machinery to modify waste tires in order to obtain the raw materials as the market demands them. It does not include secondary equipment, land, vehicles or facilities.

8.3 Environmental Impact Considerations

Since all alternatives identified are actually recycling activities, all alternatives provide the positive environmental impacts and benefits of:

- Waste reduction.
- Tire pile mitigation which means a reduction in soil pollution.
- Prevent atmospheric and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Diminish the environmental impacts of virgin materials extraction and transportation.
- Savings in landfill space.

Yet health and environment issues have been presented though time regarding tire derived products.

IEMS performed a search of serious publications and studies and selected the one that was considered to be performed in the most scientific rigor in order to assess if health and environmental risks may present in any of the identified markets.

Based on electrical energy consumption and processing speed a comparison of estimated green house gas emissions per passenger tire equivalent processed was performed to identify the less pollutant alternatives.

Emission per kilowatt-hour were the ones reported for the Mexican Federal Commission of Electricity (Comision Federal de Electricidad, CFE) estimated by the Technicians and Professionals in Energetic Application Association (Asociacion de Tecnicos y Profesionistas de Aplicacion Energetica, ATPAE), which is of 0.6539 Kilograms of equivalent CO_2 per kilowatt-hour.

8.4 Markets Identified

Markets are any tire derived application where waste tires can be put to a new use, different than their original and the end user or processor economically compensates their tire derived raw materials supplier. The identified markets on the Texas-Mexico border area are the following:

1. Passenger tire sidewalls (bulk).
2. De-beaded passenger sidewalls (bulk).
3. Passenger tire sidewalls' bead wire (bulk).
4. Tire treads (bulk).
5. Tire derived geo cells (TDGC).
6. Steel belted rubber for rammed-earth encased walls.
7. Landscaping edging.
8. Tire fences.
9. Tire derived aggregates (TDA) (bulk).
10. Ground rubber for rubberized asphalt (RA) (bulk).
11. Ground rubber for athletic and recreational surfaces (bulk).
12. Rubber mulch (bulk).
13. Ground rubber for molded and extruded products (bulk).

During this search a pattern was identified and products could be catalogued by the state of the raw material needed by them, it could be:

- Shredded or ground rubber.
- A specific part of a whole tire (i.e. tread, sidewalls, tread with one sidewall, etc).

8.4.1 Passenger Tire Sidewalls

Bulk passenger tire sidewalls can be considered a source for rubber, metal, synthetic fibers and thermal energy.

Passenger tire sidewalls are also employed in the creation of diverse handcrafts and pet biting toys.

Sidewalls from passenger tires can be easily obtained by cutting through the tires shoulder using a knife. Also sidewall removing machines of different models and brands are available in the market.

Truck tire sidewalls can only be removed employing a truck tire sidewalls remover.

Benefits from recycling tire sidewalls:

- Sidewalls are easily removed.
- Sidewalls can be available with no investment costs through a dead tire Cut-Pack-Recycle (CPR) campaign
- Waste reduction.
- Tire pile mitigation which means a reduction in soil and water pollution.
- Prevent tire piles burns.
- Savings in disposal fees.
- Savings in landfill space.

Image 8.1.
Passenger tire sidewalls, slit at the shoulder of the tire, ready to be transported at a processors site in El Paso, Texas, USA

Issues related to recycling tire sidewalls:

- Need of a shredding machine capable of shredding rubber with metal content.
- Rubber obtained contains metal traces even if magnetic separation is applied.
- Demand may not be locally available.

Note: Open air burning of tires or of any of their pieces is illegal in all states of the Mexican side of the border.

Image 8.2.
Rubber garden jars made out of tire treads and sidewalls

8.4.2 De-beaded Passenger Tire Sidewalls

Bulk de-beaded passenger tire sidewalls can be considered a source of rubber, metal, synthetic fibers and thermal energy. Passenger tire sidewalls are also employed in the creation of diverse handcrafts and pet biting toys.

Sidewalls from passenger tires can be easily obtained by cutting through the tires shoulder using a knife. Also sidewall removing machines of different brands and models are available in the market. Truck tire sidewalls can only be removed from a tire employing a truck tire sidewall removing machine.

The benefits identified are:

- Sidewalls are easily removed from a tires body using a linoleum knife or a sidewall removing machine.
- De-beaded passenger tire sidewalls are a source or non metallic content rubber which has a higher market value.

- Bead wire removed can be sold as scrap steel.
- Less powerful shredding equipment is necessary since rubber and fiber are the only constituents of passenger tire sidewalls.
- Tire sidewalls can be available with no investment costs through a dead tire Cut-Pack-Recycle (CPR) campaign implemented in coordination with waste tires generators.
- Waste reduction. Reuse of a raw material that was considered a waste.
- Tire pile mitigation which means a reduction in soil and water pollution.
- Prevent atmospheric, soil and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Diminish the environmental impacts of virgin materials extraction and transportation.
- Savings in landfill space.

Issues related to recycling tire sidewalls are:

- Demand may not be locally available

8.4.3 Passenger Tire Sidewalls' Bead Wire

The bead is a rubber-coated steel cable whose function is to ensure that the tire remains attached to the wheel rim. Bead wire removed from passenger, light truck and heavy truck tires is a source of metal.

De-beading machines are commonly employed for this purpose. No manual techniques were identified in this study's desktop and fieldwork activities.

Benefits from recycling tire sidewalls:

- Attractive purchase prices from diverse buyers are available in most large cities Mexico.
- Waste reduction.
- Tire pile mitigation.
- Prevent atmospheric, soil and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Diminish the environmental impacts of virgin materials extraction and transportation.
- Savings in landfill space.

The following related to recycling tire sidewalls' bead wire issues were detected:

- Specialized equipment is required to remove the sidewall's bead wire.

- If the rubber was set on fire to obtain the steel bead wire a large amount of carcinogenic and toxic gases and liquids are released, additionally it is one of the main causes of tire pile fires in the Mexican side of the scope border area.

8.4.4 Tire Treads

Bulk tire treads can be considered a source of tire derived geo cells, molds for rammed earth tire walls, landscape edging, fencing components, rubber, metal, synthetic fibers, thermal energy,

Benefits from recycling tire sidewalls:

- High value products such as TDGC, landscape edging, and fence railings can be locally obtained at very low costs.
- The use of treads as rammed earth walls molds presents an opportunity for low income families without access to commercial building materials or for enthusiasts of eco-friendly buildings.
- Passenger tire treads may be easily obtained using a knife to slit through a passenger tire shoulders.
- Transportation of tire treads is cheaper than transportation of whole tires due to extreme volume reductions.
- Tire cylinders, with sidewalls removed, can be available with no investment costs through a dead tire Cut-Pack-Recycle (CPR) campaign implemented in coordination with waste tires generators.
- Waste reduction.
- Tire pile mitigation which means a reduction in soil and water pollution.
- Prevent atmospheric, soil and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Diminish the environmental impacts of virgin materials extraction and transportation.
- Savings in landfill space.

Issues related to recycling tire treads:

- If the rubber was set on fire to obtain the steel belts a large amount of carcinogenic and toxic gases and liquids are released, additionally burning of tires to extract the metal in the is one of the main causes of tire pile fires in the Mexican side of the border area.
- Rubber obtained would present metal traces lowering its market value and increasing rubber production costs if metal is removed.
- Some markets may not be locally available.

8.4.5 Tire Derived Geo Cells (TDGC)

Geo cells are widely recognized in the construction industry as a permanent soil stabilization best management practice (BMP) used for a variety of applications including: Roadway load support and stabilization, erosion control, soil stabilization on steep slopes, revetments and flexible channel lining systems, earth retention structures.

By removing one or both sidewalls of a tire, slit at the shoulder, the remaining tread cylinder can be used as a geo cell, herein the name tire derived geo cell or tire derived geo cylinder (TDGC).

Benefits from recycling TDGC applications:

- Use of TDGC as road base strengthening in Mexican scope municipalities could completely remediate all identified tire piles.
- Local materials and soils may be used as TDGC fill material eliminating the need of transport and mining of aggregates from distant locations thus eliminating the transport and mining environmental and economic impacts.
- Reduced cost of materials and construction since both scrap tires and backfill soils can be recycled local materials.
- The construction of the system is relatively simple. It doesn't require skilled workers or heavy machinery.
- A problem causing waste is converted into a high value engineering input which improves the quality of life and safety of its users.
- Large number of applications in civil engineering projects.
- Green Building certification.
- Facilities earn more points for the US Green Building Council's LEED® certification program or for any other green building certification standard.
- Tire cylinders, with sidewalls removed, can be available with no investment costs through a dead tire Cut-Pack-Recycle (CPR) campaign implemented in coordination with waste tires generators.
- Waste reduction.
- Tire pile mitigation which means a reduction in soil and water pollution.
- Prevent atmospheric, soil and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Savings in landfill space.

The following related to TDGC issues were detected:

- Some tire derived geo cell technology applications are patented in the United States, such as the Mechanical concrete® application.
- Zinc Leaching.

8.4.5.1 TDGC Mechanical Concrete®

Mechanical Concrete® is built with cylindrical tension bands created from used auto tires from which both sidewalls have been removed. When appropriately sized stone aggregate is poured into the cylinders, the stones tightly lock together and behave as a solid, immovable mass: Mechanical Concrete®. This construction method uses less stone, requires no compaction or curing, and is instantly ready to support construction loads.

It is a way of binding crushed stone aggregates together into a load bearing cellular building unit. The Mechanical Concrete® unit can support compressive loads and resist lateral soil pressure. It is basically a compressive material. The TDGC performs functions similar to the cement / water mixture, the rebar and the formwork in hydraulic cement concrete. It actually improves the load bearing capacity of the aggregate material be it sand, stone or sandy clay.

Image 8.3.
Mechanical cement® and mechanical concrete® images

Tire derived geo cylinder (TDGC) also named Mechanical Cement®

Tire derived geo cylinder (TDGC) filled with aggregates also named Mechanical Concrete®

Mechanical Concrete® geo-cylinder confinement system has many economical and beneficial uses reported by its patent holder. Rural and heavy duty road base, gas well pad, mechanically stabilized earth retaining wall systems (MSE) and bearing wall applications have been currently implemented.

Image 8.4.
TRIAD Consulting Engineers Parking Lot, Morgantown, WV USA (REAGCO, 2011)

Potential applications of mechanical concrete TDGC are:

Load Support for

- Paved and Unpaved road sub-base, base, and shoulders
- Unpaved and Paved Low Volume Road intersection interfaces
- Industrial and mining roadways
- Rail road ballast bed stabilization, repair and reconstruction
- Conveyor foundations
- Bridge piers
- Underwater foundations

Earth Retaining Walls and Free Standing Load Bearing Walls

- MSE & Gravity Retaining Walls
- Industrial and commercial building and other load bearing walls and foundations
- Mining protective walls and sound wall structures
- Dams, ponds, levees, embankment construction
- Industrial Security walls and sound walls

Channel and Slope Protection

- Drainage control structures
- Bridge pier scour protection
- Erosion control structures to reduce and absorb water runoff velocity energy
- Storm water retention
- Channel, Slope and Embankment stabilization and Restoration

Other Uses

- Helipads
- Oil and Natural Gas Drill Pads
- Airfield Construction
- Overflow parking site stabilization
- Emergency Vehicle Road Entrances
- Energy Absorbing Highway and Transportation Crash Barriers
- Natural stone golf cart paths, cycle and walking paths and trails that support natural drainage patterns
- Permeable structures for highway, railway and trail slippage repair and reconstruction
- Military force protection.

Benefits on the implementation of MC technology on road bases:

- Road bases load tested to greater than HS 20 wheel loads.
- Using a tire tread cylinder, i.e. any standard automotive tire with both sidewalls removed, in a construction application; i.e. where the supported vertical loads are in the range of 100psi, 7 TSF; provides a rugged, very conservative materials engineering approach.
- Tire-derived-geo-cylinders economically create a virtually indestructible base so it basically eliminates most road maintenance problems.
- It can be used effectively and economically in nearly all construction, on-road or off-road applications for a maximum wheel loading of 50,000lbs.
- It more than triples the usual maximum load carrying capacity of sandy, granular, and graded stone materials.
- Less general labor and less skilled labor is required.
- It consumes less energy in its construction process since it can use smaller equipment.
- It requires no compaction, vibration, forms or rebar.
- It reuses a ready-made cylinder that is a low cost, combination stay-in-place form and reinforcing element.
- It uses the compressive load bearing capacity of low-cost stone aggregates or other recycled or earthen aggregate materials.
- It is simple to understand and use so it improves construction worker productivity.
- Speeds-up and facilitates the construction process.
- Common infrastructure problems such as potholes and ruts are virtually eliminated.
- When compared to the cost of retaining walls, bearing walls and foundations, roads and site stabilization made of conventional concrete or compacted stone; Mechanical Concrete® can deliver a minimum 25% savings. In many cases this savings can be as high as 50%. In road construction the savings can be 25 to 30% or more depending on the aggregate used.

The following related to Mechanical concrete® issues were detected:

- Tire derived geo cylinder technology is patented in the United States (U.S. Patent 7,470,092 B2).
- It should be implemented using accepted civil engineering design techniques, processes and traditional construction techniques.

8.4.6 Steel Belted Rubber for Rammed Earth Tire Walls

In order to build a rammed earth structure, temporary forms are needed in which the soil may be compressed. Generally, rammed earth walls are simple to construct, requiring only a form to mold the dirt in and the soil itself. Tires perform the function of a mold that can withstand the pressure generated by fill dirt being hit by a sledgehammer in order to compress it.

The most common method of building rammed earth tire walls is to place a used tire on the ground, fill the tire with dirt and compress the dirt with a hammer. Cardboard is often placed in the bottom of a tire before the dirt is placed in it to prevent the soil from falling out as it is compacted. This process is repeated until the tire is completely filled with compacted soil.

An individual tire is placed on the running axis of the wall; it is filled and compacted in that position. Other tires are then placed and filled next to the first tire. Once one row of tires is complete, another row is placed on top of the first row, but staggered in alternate lay from the first row, like bricks. In order for this to happen, half tires must be used.

Benefits of structures built using rammed earth tire walls:

- Incombustible, thermally massive and nearly soundproof
- Strong and durable.
- Facilities earn more points for the US Green Building Council's LEED® certification program or for any other green building certification standard.
- Tire cylinders, with sidewalls removed, can be available with no investment costs through a dead tire Cut-Pack-Recycle (CPR) campaign implemented in coordination with waste tires generators.
- Waste reduction.
- Tire pile mitigation which means a reduction in soil and water pollution.
- Prevent atmospheric, soil and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Diminish the environmental impacts of virgin materials extraction and transportation.
- Savings in landfill space.

Issues of structures built using rammed earth tire walls:

- Ramming earth is labor intensive.
- As with any construction a proper technique is imperative for security's sake.
- Thick walls diminish internal living spaces on buildings with small lots.

8.4.7 Tree and Landscaping Tire Tread Edging

Landscaping using tire derived products is a proven and current use of waste tires, mostly in the form of tire derived rubber mulch. Garden edging is a new application developed by IEMS' team. No knowledge of its application in the Texas-Mexico border or elsewhere was found. Nevertheless it is presented as a potentially large market once its viability is confirmed through testing and pilot applications, which are strongly suggested but not part of this study's scope.

Landscape edging provides the following benefits:

- Edging permanently defines the landscape bed, so that continual reshaping of the bed is virtually eliminated.
- Significant savings in maintenance expenses will be achieved as landscape edging eliminates the continual spading of the bed edge by hand or using power edgers.
- Edging assures crisp, clean lines will be maintained throughout the landscape bed, ensuring the original design intent is maintained.
- Edging blends architectural details with the landscape beds, building a properly designed and balanced landscape.
- Landscape is truly defined by proper separation of lawn, flowerbeds and aggregates and edging will achieve those goals.
- When various aggregates are used in a contained area, edging is the only way to assure a permanent separation.
- Properly installed, quality landscape bed edging gives clarity and significantly increases the level of visual aesthetics and adds value to the business or residence.

Landscaping edging using cut tire treads provides the following additional benefits:

- Long lasting product materials, virtually indestructible.
- Use of low carbon footprint product since required energy input to produce it is minimum compared to extruded and molded ground rubber products.
- With a relatively low investment an almost ubiquitous residue becomes a highly valued product.
- Because of its relatively low required investment it can represent a viable market solution to the waste tire problems occurring on the Texas-Mexico border, especially on the Mexican side where municipal solid waste management budgets are significantly lower.
- Municipalities, cities and counties can improve the public landscaping on parks and public areas with a minimum investment, avoiding tire disposal costs which burden them nowadays.
- Tire tread cylinders, with sidewalls removed, can be available with no investment costs through a Cut-Pack-Recycle (CPR) campaign implemented in coordination with waste tires generators.

- Using 100 percent acrylic exterior house paint the edging can be colored as desired.
- Facilities earn more points for the US Green Building Council's LEED® certification program or for any other green building certification standard.
- Waste reduction.
- Tire pile mitigation which means a reduction in soil and water pollution.
- Prevent atmospheric, soil and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Diminish the environmental impacts of virgin materials extraction and transportation.
- Savings in landfill space.

Issues from tree and landscape edging using cut tires:

- Accidentally exposed wires could harm people or animals.
- Possible human health hazards.

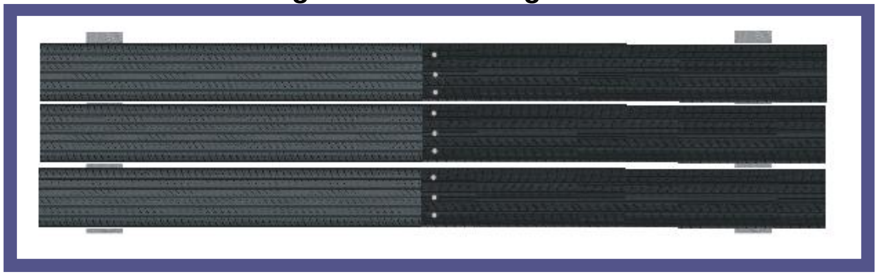
No adverse human health or ecological health effects are likely to result from these beneficial reuses of tire materials.

Since recycled tire rubber has been deemed non dangerous for human health or the environment in playgrounds, which are located in parks and gardens, it is IEMS's opinion that cut tire treads (with a protection installed on each extreme to prevent wires to be exposed) will be as safe for humans and the environment as both applications evaluated by ChemRisk.

8.4.8 Tire Tread Fences

The creation of fences using cut tire treads is an innovative solution developed by IEMS' team. No knowledge of its application in the Texas-Mexico border or elsewhere was found. Nevertheless it is presented as a potentially large market once its viability is confirmed through testing and pilot applications, which are strongly suggested but not part of this study's scope.

Image 8.5.
Diagram of tread hog fence



Benefits expected from cut tire tread fencing:

- Cut tire tread fences may lower labor and inputs costs making them more affordable than treated wood applications with similar performance except on strength.
- For intruder control, cut tread fences would have the added value of being more resilient to vandalism or entrance attempts by cutting them than other kinds of fences, such as chain link which can be easily cut with manual tools.
- Tread fences wouldn't be see through, providing more privacy to the protected area.
- Long lasting product materials.
- Use of a recycled product which avoids the use of virgin materials such as wood.
- Municipalities, cities and counties can fence municipal properties using waste tires with a minimum investment.
- The tire dump sites may be fenced using this technology to avoid arson.
- Tire cylinders, with sidewalls removed, can be available with no investment costs through a dead tire Cut-Pack-Recycle (CPR) campaign implemented in coordination with waste tires generators.
- Using 100 percent acrylic exterior house paint the fence can be colored as desired.
- They require low energy input.
- Facilities earn more points for the US Green Building Council's LEED® certification program or for any other green building certification standard.
- Waste reduction.
- Tire pile mitigation which means a reduction in soil and water pollution.
- Prevent atmospheric, soil and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Diminish the environmental impacts of virgin materials extraction and transportation.
- Savings in landfill space.

8.4.9 Tire Derived Aggregate (TDA)

Tire derived aggregate (TDA) is an engineered product made by cutting scrap tires into 25- to 300-millimeter (mm) pieces. Depending on particle sizes TDA is classified on types A and B (Gray, 2010).

8.4.9.1 Type A TDA

Type A TDA is appropriate for a range of drainage applications in layers up to 1 m (3.3 feet) thick.

Potential drainage applications include (Gray, 2010):

- Drainage layers within landfill leachate collection and removal systems.
- Permeable aggregate for landfill gas collection layers and trenches.
- Free draining aggregate for edge drains for roadways.
- Permeable backfill for exterior walls below the ground surface.
- Septic system drains fields.
- Landfill gas collection systems.

8.4.9.2 Type B TDA

Type B TDA is used for lightweight fill applications in layers up to 3 m (10 feet) thick.

Fill applications include:

- Lightweight fill for highway embankments.
- TDA and TDA soil mixtures have been used as a replacement for conventional soil in embankment construction.
- Compressible layers behind integral abutment and rigid frame bridges.
- Backfill for retaining walls, bridge abutments, and sheet-pile walls.
- Limit the depth of frost penetration and to provide drainage during the spring thaw.
- Use as drainage layers in landfills, septic system drain fields, and highway edge drains.
- A TDA layer beneath the stone ballast of rail lines reduces off-site vibrations.

Benefits from using TDA in specific engineering applications:

- TDA provides many solutions to geotechnical challenges since it is lightweight: 50 pounds per cubic foot.
- Produces low lateral pressures on walls (as little as one-half that of soil).
- Is a good thermal insulator (eight times better than soil).
- Has high permeability (more than 1 centimeters per second [cm/s] dependent on TDA size).
- Has good shear strength
- Absorbs vibrations.
- Moreover, each cubic meter of TDA fill contains the equivalent of 100 passenger car tires.
- Is used to improve the stability of embankments constructed on weak marine clay.
- Cost reduction
- Small scale applications can be implemented by municipal officials such as public works directors.
- Waste reduction.

- Tire pile mitigation which means a reduction in soil and water pollution.
- Prevent atmospheric, soil and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Diminish the environmental impacts of virgin materials extraction and transportation.
- Savings in landfill space.
- Green Building certification. Facilities earn more points for the US Green Building Council's LEED® certification program or for any other green building certification standard.

Issues arising from using TDA in specific engineering applications:

- The economics of using TDA for civil engineering applications depend on the local costs to produce TDA and the local costs for competing alternative construction materials. TDA is not a generally cost-effective substitute for conventional earth fill.
- Zinc leaching
- Sophistication

8.4.10 Ground Rubber for Rubberized Asphalt (RA)

Rubber modified asphalt is the product of mixing crumb rubber from scrap tires or other sources with asphalt. It is used as Asphalt pavement for roads.

Benefits obtained from paving using rubberized asphalt (RA)

- Performance. Roads last longer than traditional asphalt, sometimes dramatically longer, but this performance has not been universal.
- Cost. Use of thinner rubber modified asphalt lifts (layers) can turn cost into an advantage where applicable and accepted.
- Noise reduction and increased safety are accomplished through use of open-graded friction course (OGFC) pavement using large, uniformly graded aggregate. Improves the flexibility and tensile strength of the asphalt mix reducing the appearance of cracks due to fatigue or temperature changes.
- Waste reduction.
- Tire pile mitigation which means a reduction in soil and water pollution.
- Prevent atmospheric, soil and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Diminish the environmental impacts of virgin materials extraction and transportation.
- Savings in landfill space.
- Facilities earn more points for the US Green Building Council's LEED® certification program or for any other green building certification standard.

Issues arising from paving using rubberized asphalt (RA):

- Poor performance has been attributed to improper installation, weather conditions, bed preparation, and aggregate grading.
- Florida found that rubber modified asphalt performed well, but that polymers out-performed terminal-blended rubber modified asphalt for some high-traffic applications.
- The installed cost of an equivalent thickness of rubber modified asphalt is generally 10 to 100 percent higher than unmodified asphalt, as previously discussed.

8.4.11 Ground Rubber for Athletic and Recreational Surfaces

The current generation of artificial sports turf uses 7.6-cm (3-inch)-long strands of green polyethylene embedded in a porous backing to form a carpet like structural framework for the turf system.

The polyethylene grass-like blades add containment to the ground rubber, and the rubber provides cushioning while the combined synthetic turf system bears the physical forces of athletic activity (Gray, 2010).

Synthetic sports turf is mostly used in football stadiums but now this can be used on a wide range of sports fields at all levels of play, like American football, field hockey, baseball, etc.

Benefits obtained from using ground rubber for athletic and recreational surfaces:

- Health. Studies indicate that the severity of injuries is worse on natural grass turf. There are more head, neural, and ligament injuries on natural grass, while there are more epidural, muscle trauma, and temperature related injuries on synthetic turf.
- Economics. Synthetic turf's higher initial cost is offset by reduced maintenance associated with water, fertilizer, pesticides, cutting, turf replacement, and manpower.
- Synthetic turf drains rapidly, allowing use quickly after heavy downpours. In addition, synthetic grass turf can reportedly tolerate up to 3,000 hours of use per year, about four times more use than natural grass turf.
- Tire pile abatement
- Waste reduction.
- Tire pile mitigation which means a reduction in soil and water pollution.
- Prevent atmospheric, soil and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Diminish the environmental impacts of virgin materials extraction and transportation.

- Savings in landfill space.
- Facilities earn more points for the US Green Building Council's LEED® certification program or for any other green building certification standard.

Issues from using ground rubber for athletic and recreational surfaces:

- Elevated Turf Temperature
- The pieces of black rubber and colored synthetic turf blades absorb light energy and become warmer than ambient temperatures.
- Zinc Leaching

8.4.11.1 Playground Safety Surfaces

In order to avoid injuries derived from falls from playground equipment the areas under and surrounding them are covered with surfaces with high shock absorbing properties.

Benefits obtained from applying rubber for playground safety surfaces:

- Higher fall protection.
- Durability. Rubber is flexible, resilient, and durable, properties that make it a good outdoor cushioning material.
- Accessibility of equipment by children in wheelchairs or on crutches can be an important consideration.
- Waste reduction.
- Tire pile mitigation which means a reduction in soil and water pollution.
- Prevent atmospheric, soil and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Diminish the environmental impacts of virgin materials extraction and transportation.
- Savings in landfill space.
- Facilities earn more points for the US Green Building Council's LEED® certification program or for any other green building certification standard.

Issues from applying rubber for playground safety surfaces:

- Flammability.
- Latex Sensitivity.
- Toxicity and environmental questions associated with ground rubber have been raised for playground applications as well as for synthetic turf.
- Zinc Leaching.

8.4.12 Rubber Mulch

Mulch is any material applied to the garden in order to retain soil humidity and suppress weeds. It also has esthetical purposes. It can be made of leaves, gravel, wood chips and rubber, among other many materials, which normally are locally available.

Benefits of rubber mulch:

- Control weeds
- Resist mold.
- Retain moisture.
- Requires infrequent addition.
- Does not harbor insects or attract neighborhood animals.
- Waste reduction.
- Tire pile mitigation which means a reduction in soil and water pollution.
- Prevent atmospheric, soil and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Diminish the environmental impacts of virgin materials extraction and transportation.
- Savings in landfill space.
- Facilities earn more points for the US Green Building Council's LEED® certification program or for any other green building certification standard.

Issues that arise from using rubber mulch:

- Flammability
- Temperature. Black ground rubber pieces absorb light and can heat up.
- Zinc Leaching

8.4.13 Ground Rubber for Molded and Extruded Products

Molded products are created when heated rubber is pressed into a mold or through a die cast to shape it into a new product. Extrusion normally involves using a screw system to mix, heat, and force a raw material through a die to produce a continuous shape.

This market is very versatile and can create a wide variety of products.
Molded crumb rubber for example can be transformed into items such as pavers, tiles, splash guards, tree rings, curbing, mats, wheels for trash cans, traffic cones, vehicle bumpers, wheels, mud flaps, etc.

Long items such as: hoses, weather stripping, tubes, molding, belting, pet toys, car bumpers, gaskets, garden hoses, complex components for medical and electrical equipment, synthetic woods, shingles and other structural materials are made by extrusion processes.

Benefits from creating molded and extruded products from ground rubber

- Low-Cost Raw Material.
- Ground rubber can be a low-cost raw material with many of the intrinsic performance properties of rubber.
- This market is very versatile and can create a wide variety of products.
- Waste reduction.
- Tire pile mitigation which means a reduction in soil and water pollution.
- Prevent atmospheric, soil and potentially water contamination by eliminating tire piles which could burn.
- Savings in disposal fees.
- Diminish the environmental impacts of virgin materials extraction and transportation.
- Savings in landfill space.
- Facilities earn more points for the US Green Building Council's LEED® certification program or for any other green building certification standard.

Issues involved in creating molded and extruded products from ground rubber:

- Displacement Challenges. Making any new product can involve substantial investment in processing technology, equipment, optimization, product testing, distribution, and marketing.
- Any residual wire or fiber can accelerate wear, or damage extrusion heads and equipment.
- This technology can be labor intensive in its basic form.
- Mixtures. Rubber generally functions as filler in mixtures with plastics. Thermoset rubber and thermoplastics do not naturally bond, resulting in significant changes in the performance characteristics of plastics when rubber is added.

New tires can contain from 5% to 10% of recycled rubber, if more than that is added the tire will fail (Information provided by Francisco Martha Hernandez, general director of the Mexican rubber industry national chamber. Tire rubber dust can be de-vulcanized at very high costs; it would be over than 3 times more expensive than virgin materials.

Ground rubber for extruded products could also be presented as a separate market since additional equipment is necessary in order to achieve the fine mesh size required by these applications (30 to 200 mesh).

8.5 Market Recommendations of Tire Derived Products in Mexico

Each stakeholder should select the market that better suits him/her needs, the purpose of this section is to present the evaluation results in order to aid in the market selection process.

8.5.1 Tire Derived Products Market Prices

The following references to Attachments included in the study Full report, present information on market prices for the identified tire derived products:

- **Attachment 27.** Estimated and consulted market prices of tire derived products currently supplying the identified markets.
- **Attachment 28.** Daily prices of tire derived products and parts during May 2012.
- **Attachment 29.** Potential revenue per passenger tire equivalent (PTE) for each market and formulas applied to obtain each.
- **Attachment 32.** Scrap tire wire purchase prices in the Mexican side of the Texas-Mexico border region.

8.5.2 Required Investments on Equipment

The following references to Attachments included in the study Full report, present information on equipment necessary to produce each of the identified tire derived products. It is relevant to note that the amounts presented are for equipment only, not including required land, facilities, secondary equipment, production costs, etc:

- **Attachment 30.** Matrix of required equipment per type of product.
- **Attachment 31.** Equipment quotations and pricing sources.

Of the identified existing and potential markets the most expensive to access, based only on required investment on equipment, are the following:

- Type B tire derived aggregate (TDA) (bulk).
- Type A tire derived aggregate (TDA) (bulk).
- Ground rubber for Rubberized Asphalt (RA) (bulk).
- Ground rubber for Athletic and recreational surfaces (bulk).
- Rubber mulch (bulk).
- Ground rubber for molded and extruded products (bulk).
- Ground rubber for extruded products (bulk).

Of the identified existing and potential markets the most accessible ones, based only on required investment on equipment, are the following:

- Passenger tire sidewalls (bulk).
- Tire-derived-geo-cylinders, (TDGC).
- Steel belted rubber for rammed-earth encased walls.
- Tire treads (bulk).
- Passenger tire de-beaded passenger sidewalls (bulk).
- Passenger tire sidewalls' bead wire (bulk).
- Cut tire tread tree and landscape edging
- Cut tire tread fencing.

8.5.3 Recommendations

A) ***The income per tire of any promoted market should be higher than the amount paid for the steel present in the tire to discourage tire open burning for metal extraction.*** One of the main causes of tire fires is tire burning for metal extraction. This is caused by the need to obtain resources through the sale of the steel wire embedded inside tires.

For example: scrap tire wire is bought in Reynosa, Tamaulipas, Mexico at an estimated mean of $2.92 Mexican pesos per kg ($0.096 USD per pound). So the potential income per passenger tire by burning it for metal extraction is $4.38 Mexican pesos per passenger tire ($0.316 USD per passenger tire) in Reynosa.

B) ***Zinc leaching should be considered an Environmental Issue of Concern (EIC) on some tire derived products.*** Since the following tire derived applications will be in direct contact with rain water and soil, it was considered relevant to consider this EIC also for them: TDGC, Landscape edging, TDA, RA, Ground rubber for athletic and recreational surfaces and Rubber mulch

C) To implement CPR dead tires campaigns, or similar, in the Texas-Mexico scope areas

Image 8.6.
English version example of a CPR dead tires campaign

Image 8.7.
Spanish version of example of a CPR dead tires campaign

A CPR dead tires campaign promotes waste tire generators to:

i. Slit passenger waste tires on the shoulder to remove both sidewalls "Cut".
ii. Order and pack the resulting tread cylinders and sidewalls in a way the volume they occupy is minimum "Pack".
iii. Recycle them or send the packed tire pieces to a recycling facility "Recycle".

By implementing a CPR dead tires campaign the following benefits could be obtained:

- Eliminate mosquito breeding areas.
- Health benefits. By eliminating mosquitoes breeding sites, their related diseases such as Dengue Fever and West Nile Virus are also fought.
- Storage space required by waste tires is greatly reduced.
- Transportation costs are reduced.
- Disposal fees are reduced.
- Promoting a Cut-Pack-recycle (CPR) campaign among waste tire generators would make tire derived cylinders (treads) and slit sidewalls available to recyclers, authorities and processors without the need of investing resources such as time, labor and money in sidewall removing activities.

Also by implementing a CPR dead tires campaign recyclers, authorities and processors would have direct and cheap access to:

- Tire derived geo cells for civil engineering projects.
- Steel belted rubber for rammed earth tire walls.
- Slit sidewalls ready for de-beading.
- Packaged tire treads ready for transportation to processing or disposal sites at lower costs than when transporting whole waste tires.

Image 8.8.
Used tire dealership worker manually cutting passenger tires' sidewalls using a cutter knife in Brownsville, Texas

8.6 Markets Evaluation

8.6.1 Legal Evaluation

While none of the proposed market alternatives is illegal in Mexico, some alternatives are more heavily regulated and or restricted than others.

A general prohibition throughout the Mexican side of the border is the burning of tires in open air.

Only the rubberized asphalt application is specifically regulated in Mexican legal framework. These regulations are focused on ensuring the quality control of the modified asphalt created in part of tire ground rubber.

It should be noted that even if no specific regulations were found, it doesn't mean general regulations and laws don't apply. The purpose of this search was to identify regulations that applied specifically to tire derived products, apart from the general regulations which apply to a traditional application.

8.6.2 Economic Evaluation

8.6.2.1 Market Prices per Tire

Prices currently paid for each tire derived product identified are described in study Full report. Since some of these products are not yet available on the market, the prices presented for these are the ones paid for similar products with which they would compete.

Figure 8.1 displays the potential income per Passenger Tire Equivalent (PTE) received when supplying each of the identified markets.

It is relevant to note that the following are considered to use de-beaded tire sidewalls as rubber source:

- Ground rubber for athletic and recreational surfaces.
- Molded and extruded products.

Meaning that an alternative income for the tire treads sale can be obtained depending on the market supplied with them. Violet bars represent consulted current prices of the tire derived products on existing markets. Gray bars represent estimated prices based on what similar products are currently worth in the market.

8.6.2.2 Required Equipment Investment per Market

In order to supply any of the identified markets, waste tires require modifications in order to comply with the demand specific needs. The equipment necessary to perform said modifications greatly varies in size, complexity, required energy input, required investment, labor needs, etc.

The estimated economic investment on equipment to modify waste tires according to current and potential markets demands is presented on **Figure 8.2.**

This figure displays the required investment on equipment, not including the required facilities, labor, energy inputs, secondary equipment, etc.

Rubber for extruded products is presented on a separate column in **Figure 8.2.** because mesh size required can be as low as 200 mesh, to obtain this mesh size it is required additional equipment which would further elevate the investment required. Since no quotations were obtained for this specific equipment it is only noted that the market which requires the largest investment on equipment is the ground rubber for extruded products.

The section below evaluates in more depth which markets require large investments on equipment to process tires.

8.6.2.3 Most Expensive Markets to Enter Based on Equipment Required Investment

Based on the information presented on **Figure 8.2.** it is visible that some markets require larger initial investments on processing equipment than others.

Of the identified existing and potential markets the most expensive to access, based only on required investment on equipment, are the following:

- Type B tire derived aggregate (TDA) (bulk)
- Type A tire derived aggregate (TDA) (bulk)
- Ground rubber for Rubberized Asphalt (RA) (bulk)
- Ground rubber for Athletic and recreational surfaces (bulk).
- Rubber mulch (bulk).
- Ground rubber for molded and extruded products (bulk).

8.6.2.4 Most Accessible Markets Based on Equipment Required Investment

Of the identified existing and potential markets, the most accessible ones based only on required investment on equipment are the following:

- Passenger tire sidewalls (bulk).
- Tire-derived-geo-cylinders, (TDGC).
- Steel belted rubber for rammed-earth encased walls.
- Tire treads (bulk).
- De-beaded passenger sidewalls (bulk).
- Passenger tire sidewalls' bead wire (bulk).
- Tire tread tree and landscape edging
- Tire tread fencing.

It is evident that some markets require the same equipment to produce tire derived products. For example to sell passenger tire sidewalls, treads, TDGC and steel belted rubber for rammed earth tire walls the investment is the same. The same happens with the equipment required to produce de-beaded sidewalls and bead wire, and yet again on the fencing and edging markets.

More accessible equipment investment range from $3,900 USD ($54,011 Mexican pesos) in order to manufacture:

- Passenger tire sidewalls in bulk.
- Tire-derived-geo-cylinders, (TDGC).
- Steel belted rubber for rammed-earth encased walls.
- Tire treads (bulk).

These markets require only removing the sidewalls of waste tires. Equipment investment to remove passenger tire sidewalls can be lowered to $15.2 USD ($210.5 Mexican pesos) for the purchase of a professional linoleum knife or even lower. Making the markets that only require removing one or both passenger tire sidewalls the most accessible based on required investment on equipment.

To a required equipment investment of $10,950 USD ($151,646.55 Mexican pesos) in order to manufacture cut tire tread for fencing.

8.6.3 Environmental Evaluation

Performing environmental impact assessments on each application for each location in the Mexican scope area is not possible since many variables would be unknown. Such as: water bodies, biodiversity in the area, type of soil and its characteristics, climate, processes, etc.

Yet during fieldwork and deskwork activities IEMS identified environmental issues of concern which are presented as follows:

8.6.3.1 Environmental Issues of Concern (EIC)

Zinc Leaching

Tire rubber contains about 1.5 percent zinc as a vulcanization accelerator within the rubber polymer matrix. Water can gradually leach small amounts of zinc from the chip into the underlying soil. Traces of zinc serve as a micronutrient for many species, but excessive quantities can have a negative impact on some plants and grasses.

Leaching is slow and controlled with water flowing through chips on the surface of beds, but it could be accelerated by continuous submersion in water or soil (Gray, 2010).

The following information was obtained from the document "Kanematsua, Masakazu et al. (2010) *Characterization and potential environmental risks of leachate from shredded rubber mulches"*. Davis: National Institutes of Health, and is presented textually to illustrate why Zinc leaching is an environmental issue of concern on some of the identified markets.

> *"In order to determine whether shredded rubber mulches (RM) posed water quality risks when used in stormwater best management practices (BMPs) such as bioretention basins, batch leaching tests were conducted to identify and quantify constituents in leachates from RM such as metal ions*
>
> *"The results indicate that aqueous extracts of RM contain high concentrations of zinc (Zn) compared with wood mulches (WM), and its concentration increased at lower pH and higher temperature.*
>
> *Leaching of Zn from RM appears to be a potentially larger water quality issue for RM" (Kanematsua, 2010)".*

Analysis of EIC

Some zinc concentrations on rubber mulch leachate are higher than 20 mg/L, which is the maximum permissible monthly average limit established by Mexican Official Standard NOM-001-SEMARNAT-1996 for zinc concentrations in water discharges on national water bodies or soil. Although this regulation does not directly apply to mulch leachate it provides a reference value of how relevant these concentrations are.

In mediums with pH of 5 all rubber mulch leachates at any temperature, ranging from 10°C to 40°C, surpassed zinc concentrations of 10mg/L, which is the maximum daily authorized average concentration of zinc in waste water discharges according to the mentioned standard.

Although the study of the NHS encompasses rubber mulch on a very conservative approach, since the following tire derived applications will be in direct contact with rain water and soil, it was considered relevant to consider this EIC also for them.

Tire applications where relevant Zinc leaching may occur:

- Tire derived geo cells (TDGC).
- Landscaping edging.
- Tire derived aggregates (TDA) (bulk).
- Ground rubber for rubberized asphalt (RA) (bulk).
- Ground rubber for athletic and recreational surfaces (bulk).
- Rubber mulch (bulk).

IEMS strongly suggests that the Environmental Impact Assessment (EIA) performed for the application of any of the markets mentioned above should consider the impact caused by zinc leaching from tire rubber when in contact with water. And propose mitigation alternatives to prevent contamination of soil and ground or surface water bodies.

Figure 8.1.
Potential income per passenger tire equivalent on each market

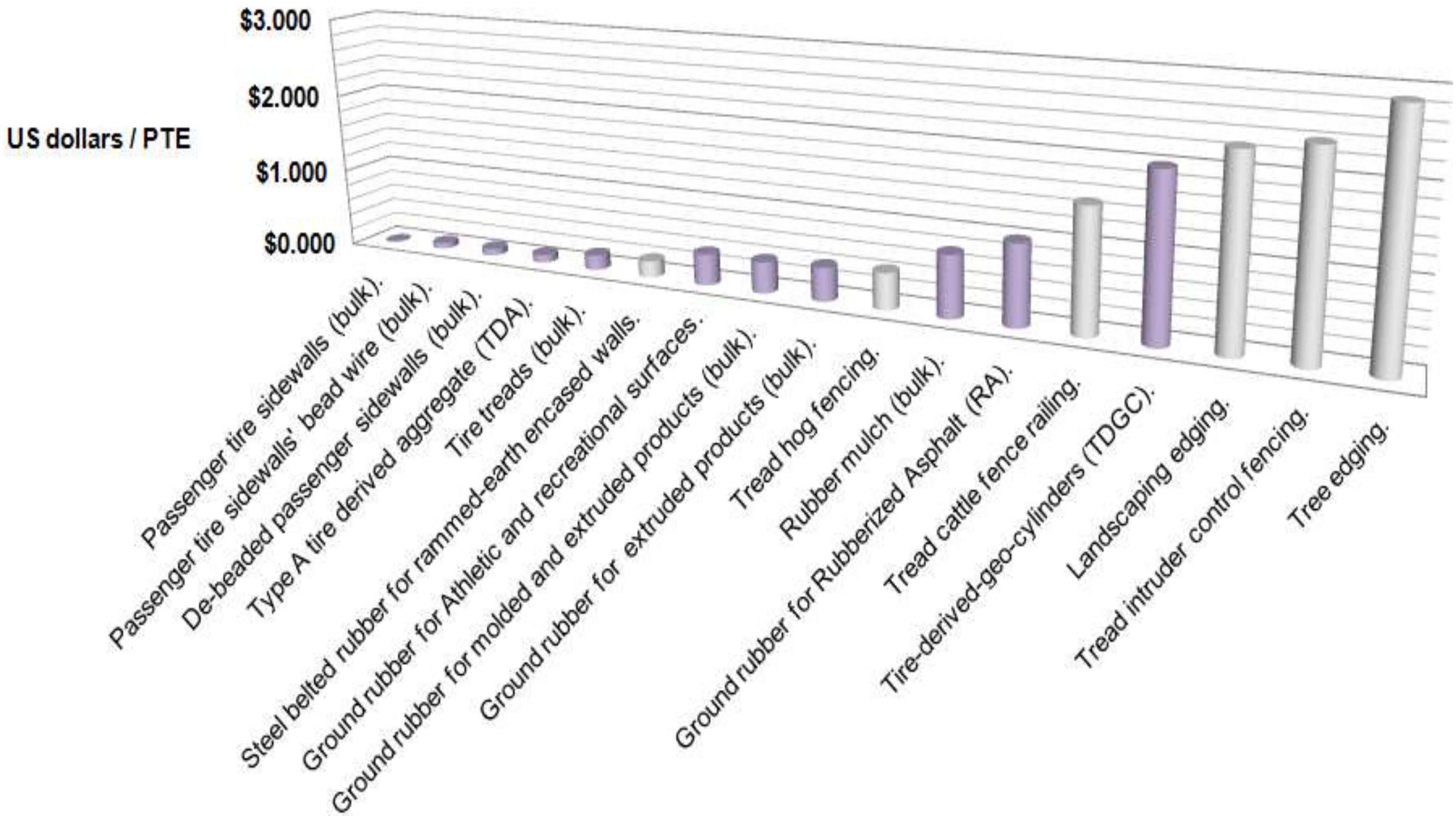
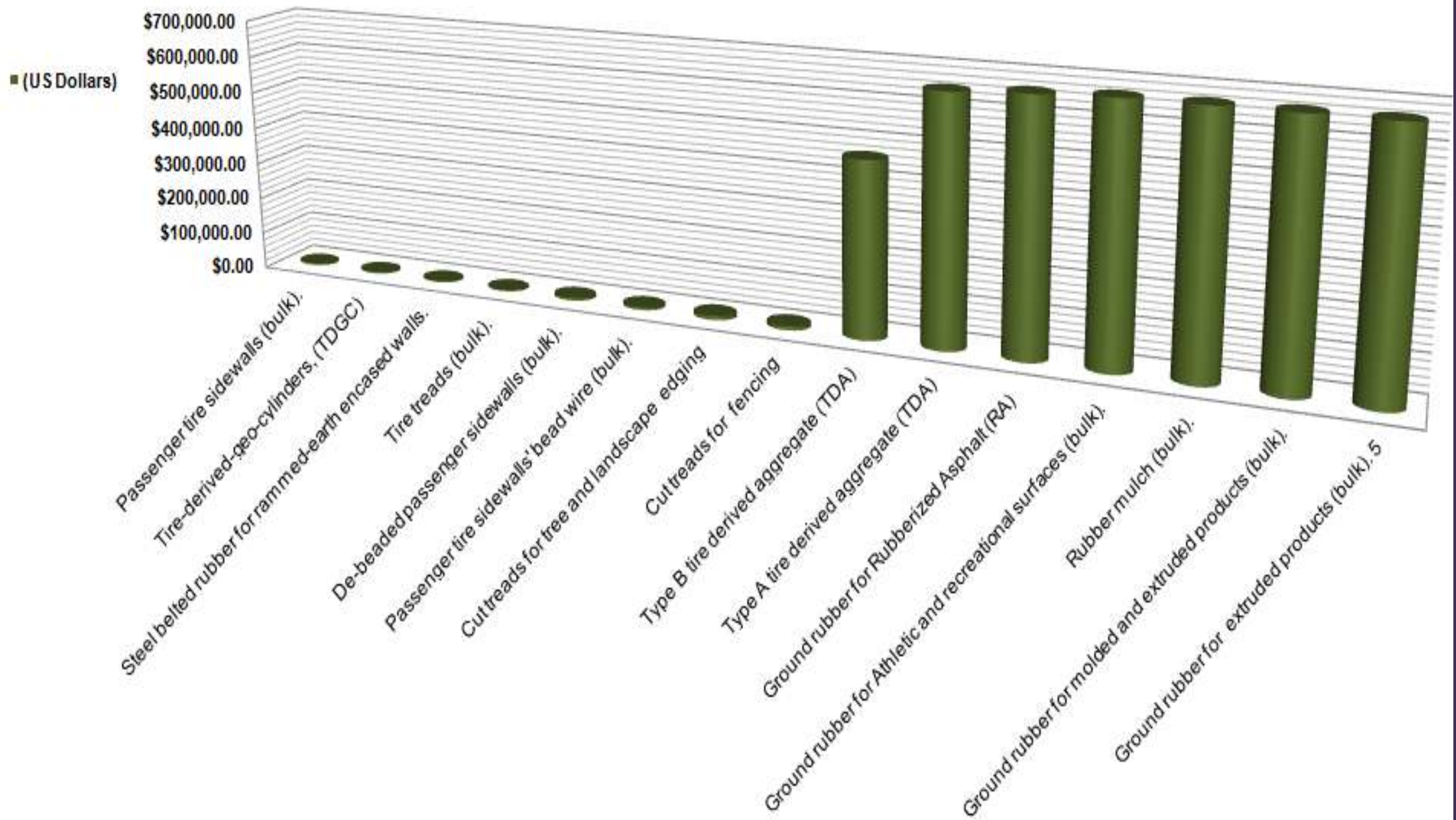


Figure 8.2.
Required Investment on processing equipment to produce each tire derived product (US dollars)



Section 9.
Waste Tires Appropriate Disposal Alternatives

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9 Waste Tires Appropriate Disposal Alternatives

9.1 Methodology

The following methodology was followed for the determination of appropriate disposal alternatives.

9.1.1 Identification

Appropriate disposal alternatives in this study are the ones which, as a base, comply with the legal regulations that apply where the disposal site is located. Waste tire disposal stakeholders in both sides of the border were interviewed to gather the required information for this section.

A brief description based on previous publications, studies, regulations, laws and government agencies data bases, publications, fieldwork and deskwork data, associations, etc., are presented to educate the reader.

9.1.2 Recommendation

Based on the evaluation results specific recommendations regarding appropriate tire disposal management are presented.

9.1.3 Evaluation

Texas' border region tire disposal alternatives evaluated:

- ➢ Land reclamation projects using tires (LRPUT).
- ➢ Landfills.

Mexico's border area evaluated alternatives:

- ➢ Landfills
- ➢ Tire derived fuel in cement kilns (TDF)

Each local stakeholder should base local disposal guidelines on:

✓ Social evaluation:

- people's way of life;
- their culture;
- their community;
- their political systems;
- their environment;
- their health and wellbeing;
- their personal and property rights;
- their fears and aspirations;

- ✓ Environmental impacts on:
  - Inert physical media;
  - Living physical media;

- ✓ Economic evaluation:
  - Transportation costs;
  - Disposal fees.

9.2 Identified Disposal Alternatives

Appropriate tire disposal alternatives identified in the Texas-Mexico border region and the ones developed by IEMS are the following:

1. Landfill, shred or cut waste tires;
2. Burial of whole, shred or cut waste tires in land reclamation projects using tires (LRPUT);
3. Burning, shred, cut or whole, waste tires as tire derived fuel in cement kilns (TDF);
4. Reclamation of depleted open pit coal mines.

Options 1 and 2 are applied in the U.S. side of the border while only 1 and 3 are applied in the Mexican side of the border. Option 4 was developed by IEMS' team of engineers and is not yet applied in any side of the border.

9.3 Landfill Shred or Cut Waste Tires

Landfills are engineered areas where waste is placed into the land. Landfills usually have liner systems and other safeguards to prevent polluting the groundwater.

Modern landfills are well-engineered facilities that are located, designed, operated, and monitored to ensure compliance with federal regulations. Solid waste landfills must be designed to protect the environment from contaminants which may be present in the solid waste stream.

Only split, quartered, or shredded tires may be disposed of in a landfill. Storage or processing activities must be specified in a landfill's permit and scrap management registration is required.

According to Mexican remote interviews private landfills in Mexico also receive waste tires. These are previously shredded in order to prevent them from floating into the surface.

Landfills in the Texas side of the border area are classified, according to the type of waste they may receive, as following:

- ✓ Type I landfills are authorized to accept municipal solid wastes.

✓ Type IV landfills are normally more limited in that they may only accept brush, construction and demolition debris, and other waste that will not putrefy.

An additional designation "AE" in the landfill type indicates an "arid exempt" facility. AE landfills normally are limited in the amount of waste they are authorized to accept.

Image 9.1.
Hogzilla® shredder

Waste tires are considered by Mexican legislation as a special handling waste. The federal standard NOM-083-SEMARNAT-2003 dictates the environmental protection specifications for the selection, design, construction, operation, monitoring, closure and complementary works of an urban solid waste and special handling waste disposal sites.

This standard classifies final disposal sites (landfills) based on the amount of daily waste entering to them, in metric tons, as the following table displays.

Table 9.1.
Final disposal sites categories

Type	Tons received Per Day (Tons / Day)
A	More than 100
B	From 50 to100
C	From 10 to less than 50
D	Less than10

9.3.1 Disposal of Cut or Shred Tires in Landfills

Tires present unique and challenging disposal problems because of their size, shape, and physical and chemical properties. Landfill of whole tires consumes a large volume of landfill space because the tires are relatively incompressible and 75 percent of the space a tire occupies is empty. In addition, they tend to trap gases and rise to the top of landfills after being buried. As a result, laws in both Mexico and the United States prohibit landfill tires along with other types of waste.

In the US, the tire management laws in most states do not ban disposal outright. In all, 38 states have bans, however, of those states with tire bans, some states allow disposal if the tires have been shredded, chipped, or halved. To keep track of who is collecting and transporting tires some states also have put permitting or registration requirements into legislation. Along the Mexican boundary, solid waste disposal sites began accepting waste tires that had the sidewalls removed. There, the tires are buried in the landfill. Waste tires that have been shredded or cut into three pieces also are allowed to dispose in the landfills.

Private landfills in the Mexican side of the border, such as the Piedras Negras PASA facility, posses an exclusive cell for shredded of cut waste tire final disposal. In theory all sanitary landfills which comply with federal legislation in Mexico are able to receive cut or shred waste tires.

Cutting Process Description

Cutting the sidewalls out of waste passenger tires, and also making at least one cut across the tread for larger tires are the ways in which a tire must be processed prior to disposal at a landfill since these methods of processing reduce the volume of the tire by at least 50% and prevent the tire from retaining water.

9.4 Land Reclamation Projects Using Tires (LRPUT)

LRPUTs are projects to fill, rehabilitate, improve, or restore already excavated, deteriorated, or disturbed land, using no more than 50 percent by volume of tire pieces along with inert fill materials, to restore the land to its approximate natural grade and to prepare or reclaim the land for reuse. In Texas all tires used to fill land must be split, quartered, or shredded. Whole tires cannot be placed belowground. Completed projects must be covered with 18 inches (0.46 meters) of clean soil.

In the state of New Mexico, USA, land reclamation projects are not required to cut or shred waste tires in order to bury them as it is stated in the New Mexico Administrative Code (NMAC) 20.9.20 and specifically in 20.9.20.43.

Mexican legislation does not contemplate the use of special handling wastes such as tires as filling material in abandoned open pit mines. The only allowed disposal alternative are sites which comply with standard NOM-083-SEMARNAT-2003.

Image 9.2.
LRPUT in El Paso, Texas

9.5 Tire Derived Fuel (TDF) in Cement Kilns

Calcinations of raw materials to manufacture clinker (a fundamental element in the production of cement) which takes place inside of kilns, is the core of the process within the cement plants; which requires a large amount of energy, supplied by fuel, which is injected into the kilns, and represents the bigger cost in the manufacture of cement. High temperatures in kilns and long residence times inherent to the cement manufacturing process, represent an high potential for the destruction of organic compounds, which enables the use of a wide variety of fuels, by-products of other industrial processes or derived from wastes, both solid (waste tires, wood, paper, cardboard, plastic, urban and industrial sludge, etc.) and liquids (solvents, used oils, distillation waste, etc.). For this, cement plants meet the necessary conditions to carry out a clean burning of tires and taking advantage of its high caloric content instead of petroleum or coal.

No cement kilns are installed in the Texas side of the scope border area, only one kiln is located in the Mexican side of said border in the city of Ciudad Juarez, Chihuahua, which has no facilities for the use of tires as TDF.

The General Law for the Prevention and Integral Management of Waste *(Ley General para la Prevencion y Gestion Integral de Residuos, LGPGIR)* promotes waste valorization, which encompasses the principle and group of associated actions whose objective is the recovery of the remaining value or caloric power of the materials which make up wastes, through their incorporation in productive processes, under shared responsibility criteria, integral management and environmental, technologic and economic efficiency.

9.6 Reclamation of Depleted Open Pit Coal Mines

Open pit mining is an industrial activity of high environmental, social and cultural impact. It is an inherently unsustainable industrial activity.

Technical innovations that have experienced mining from the second half of this century have radically changed the activity, so that it has gone from the exploitation of underground mines of high quality to exploitation in open pit mines of lower quality minerals in larger deposit areas.

Open pit mining removes the surface layer or overload the soil to make accessible the extensive deposits and low quality ores. It is profitable because it is less expensive than an underground mine (AECO-AT, 2001).

Coal, like all other sources of energy, has a number of environmental impacts, from both coal mining and coal use. According to World Coal Association, coal mining raises a number of environmental challenges, including soil erosion, dust, noise and water pollution, and impacts on local biodiversity.

Image 9.3.
Active open pit coal mine in Coahuila, Mexico

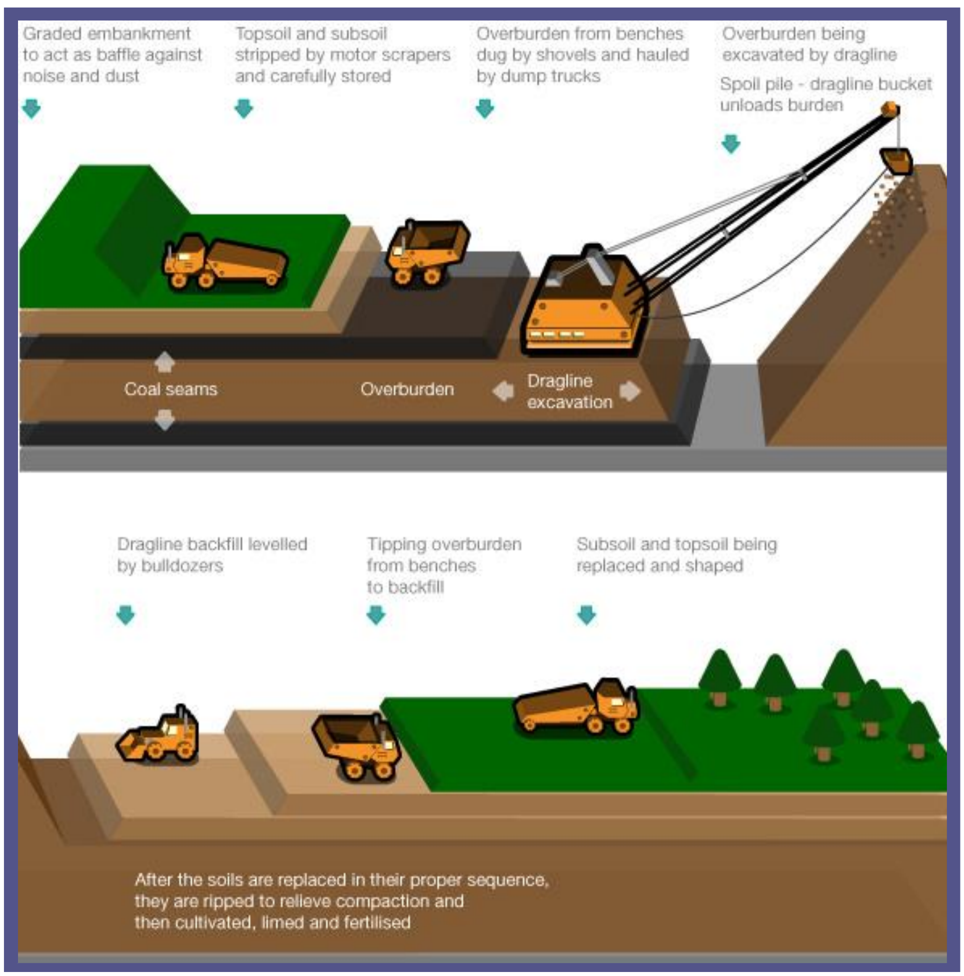
Image 9.4.
Unrehabilitated inactive coal mine in Coahuila, Mexico.

9.6.1 IEMS's Land Reclamation Proposal in Open Pit Mines

In Land Reclamation Projects Using Tires (LRPUT), tires are used as a fill material on land that has been mined or subjected to significant erosion and is in the process of being restored (reclaimed). Tires are used to level out the contour of the land before the land is covered with soil and reseeded. In 2007, about 70.8 thousand tons of scrap tires were used in reclamation projects in the United States. Reclamation projects were reported in four states: Arkansas, Nebraska, New Mexico and Texas, being the later one that has the more relative usage of scrap tires in land reclamation projects (87.8 %).

Land reclamation is commonly used in the United States; the second largest use category for scrap tires in Texas is Land Reclamation Projects Using Tires (LRPUT). Shredded scrap tires have routinely been used as fill material in civil engineering and reclamation projects for a number of years.

Figure 9.1.
Diagram of surface coal mining operations (top) & mine rehabilitation activities (bottom)

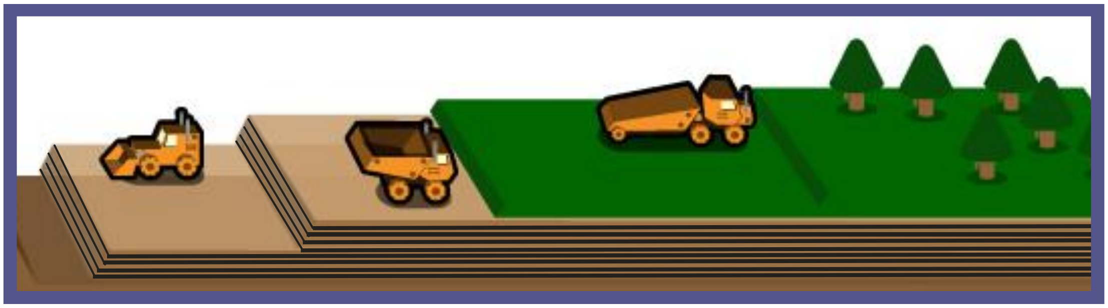


As a reference: in areas that have been strip mined or mined for sand and gravel, a 50:50 mixture of tire pieces and soil is usually used as fill material to reclaim the mined area.

The mine reclamation process proposed by IEMS consist in the use of a cut tires layer less than 1 meter thick followed by a soil layer with 1 meter thick and then repeated. Since the mineral coal extracted in Coahuila has 69-86% of carbon, it is feasible to refill open pit mines with waste tires, whose composition has 85% of total carbon approximately, practically replacing the coal extracted with a similar carbon source.

Since carbon mines are to be reclaimed at the end of their life, the reclamation equipment and machinery could very well be used for the burial of already cut or shredded tires. This assuming tires disposed by generators are cut or shredded before being sent for disposal. **Figure 9.2.** displays a diagram of the proposed reclamation technique using tires.

Figure 9.2.
Coal mine rehabilitation diagram including intermediate cut-tires layers



To determinate layers thickness, IEMS proposes to apply the *Design Guidelines to Minimize Internal Heating of Tire Shred Fills* published by the EPA on the Scrap Tires: Handbook on Recycling Applications and Management for U.S. and Mexico (EPA, 2010). According to this report, although there have been no projects with tire layers less than 4 meters (13.1 feet) that have experienced a catastrophic heating reaction, to be conservative, tire layers greater than 3 meters (9.8 feet) thick are not recommended. Additionally no design features are required to minimize heating of tires layer less than 1 meter thick.

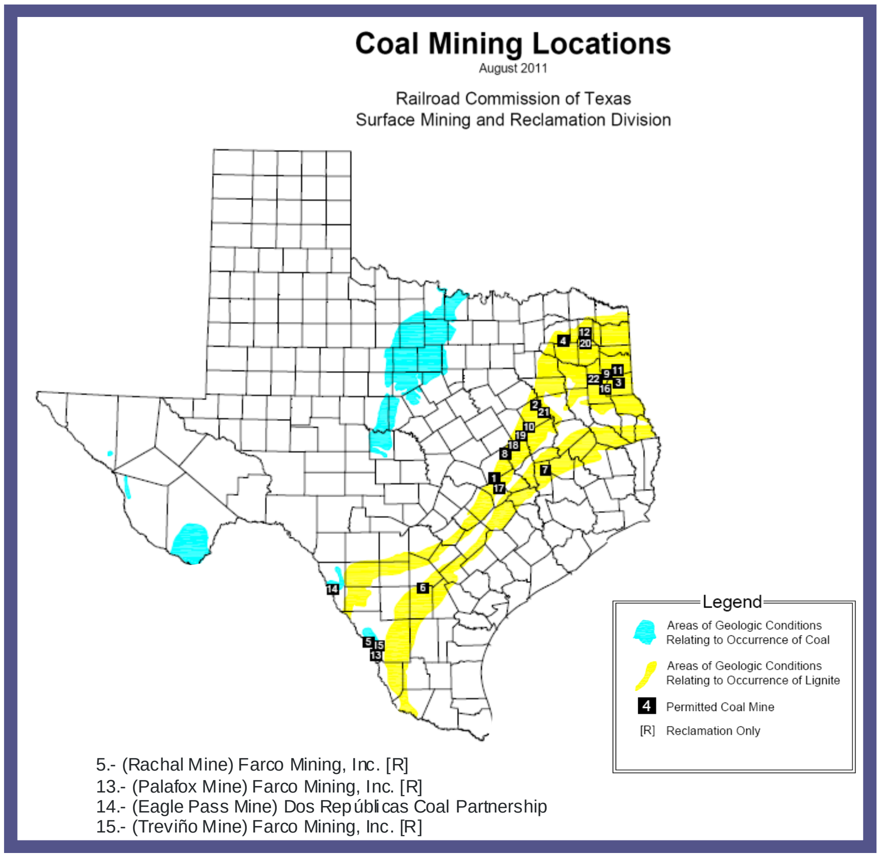
It also recommends that tires are contaminant-free such as oil, grease, gasoline, diesel fuel, etc., that could create a fire hazard or leachate. In any case the cut tires shall not contain the remains of tires that have been subjected to a fire because the heat of a fire may liberate liquid petroleum products from the tire that could create a fire hazard or leachate when the tires are placed in a fill.

For every cubic meter of volume to be reclaimed 28 passenger tires could be disposed. Considering millions of cubic meters of coal are extracted from the mines, a large disposal volume potential is available.

9.6.1.1 Coal Mining in the Texas Border with Mexico

Currently four coal mines are located in the Texas side of the scope area. Three of them, located in Webb County, were still in reclamation process on August 2011 which presents a waste tire disposal opportunity for Texas border cities nearby. **Figure 9.3.** displays the coal mining locations in Texas.

Figure 9.3.
Permitted coal mines in Texas



The currently active Eagle Pass mine could be an appropriate tire disposal site once it begins reclamation works for Del Rio and Eagle Pass cities which currently only posses a type 1 landfill for local waste tire disposal.

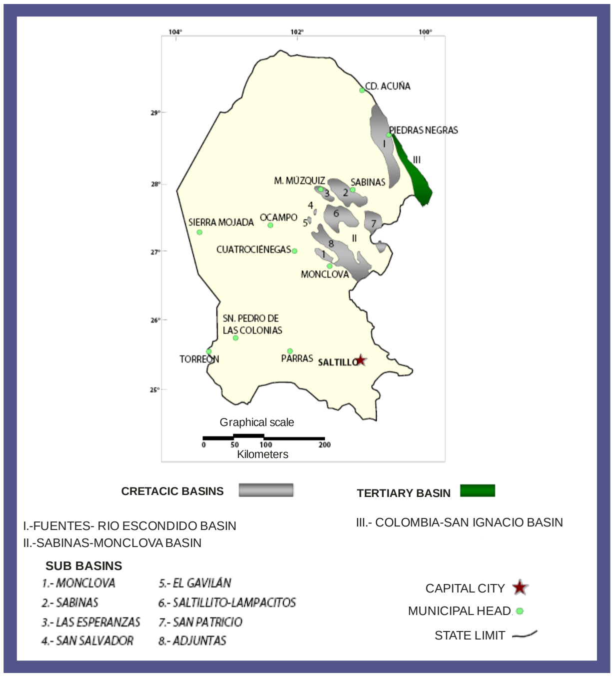
9.6.1.2 Coal Mining in the State of Coahuila, Mexico

The coal mining industry and the variability of its activity have played a decisive role in the structuring and regional evolution of the central-eastern and northeastern areas of Coahuila state. The dependence of this region on mining exploitation in the absence of other economic activities that constitute real development alternatives, have made this region become vulnerable because of its geographical impact due to overexploitation of coal in open pit mines.

In 2010 State of Coahuila participated with 5.86% mining national production, occupying the first place in coal, iron and magnesium sulfate production. Coahuila is the Mexican state with more production of coal.

Mining in Coahuila started in 1828 by extracting coal in mines. The overexploitation of coal deposits in Coahuila began in the Sabinas basin to serve the steel industry of Piedras Negras, Monclova and Monterrey. Coal exploitation was subsequently extended to Fuentes-Río Escondido Basin as a result of the need to supply fuel to Río Escondido and Carbon II power plants.

Figure 9.4.
State of Coahuila, Mexico coal basins



The coal extracted from Coahuila open pit mines is Bituminous and has a total carbon concentration range of 69-86% as well as high sulfur and ashes content, so according to international standards, it is considered of poor quality, due to having a high polluting potential, before and after being extracted, as well as during its use.

As it was previously mentioned on the LRPUT description current Mexican legislation doesn't allow the final disposal of special handling wastes on sites unless they comply with the standard NOM-083-SEMARNAT-2003.

9.7 Recommendations

The Texas-Mexico border region being of great extent does not present a unique disposal alternative for all of its population. Each city should evaluate independently which alternative fits its economic and social needs based on the presented cost estimations and environmental impacts. Nevertheless all alternatives recommended theoretically comply with their local, state and federal regulations and are authorized by their corresponding environmental authorities.

By identifying social, environmental and economic impacts in advanced a stakeholder:

1. Can make better decisions about which appropriate tire disposal alternatives to select, how to proceed; and,

2. Select what mitigation measures can be implemented to minimize the harm and maximize the social, environmental and economic benefits.

In IEMS' opinion each individual community should perform the following based on what it's presented in this document and other sources they consider appropriate:

- Decisions need to be deduced from principles, and principles need to be derived from core values. Only by first establishing the core values of the community of practice, then deriving the principles, and only then developing guidelines, can truly appropriate guidelines emerge.

- Guidelines and principles must be developed in participatory processes, include the people to whom the guidelines are directed. These are the people who ultimately need to develop 'ownership' of the guidelines if they are to be adopted and be utilized. (Vanclay, SIA principles, 2003)

9.7.1 Appropriate Tire Disposal Alternatives

Texas international border area appropriate tire disposal alternatives currently available:

A. Land Reclamation Projects Using Tires (LRPUT);

B. Type 1 Sanitary Landfills.

LRPUT being an option which does not occupy landfill space and its used in a re-habilitation process its more socially and environmentally desirable tire disposal alternative than landfills. Although both are considered appropriate by this study.

TCEQ authorized tire transporters and processors which finally dispose of waste tires in these alternatives or other TCEQ authorized alternatives located further north should also be considered appropriate. This study focus was specifically on final disposal alternatives, not including intermediaries.

Mexican side of the Texas-Mexico border:

A. Tire Derived Fuel in Cement Kilns;

B. Sanitary Landfills complying with standard NOM-089-SEMARNAT-2003.

The following attachments present information regarding LRPUTs and Type 1 landfills:

- **Attachment 6.** Display map of appropriate tire disposal alternatives identified in the Texas side of the Texas-Mexico border area.
- **Attachment 7.** Display map of appropriate tire disposal alternatives identified in the Mexican side of the Texas-Mexico border area.

Additional information including:

- ✓ List of appropriate tire disposal alternatives identified in the Texas side of the Texas-Mexico border area and disposal fees charged at the time this study was written.
- ✓ Environmental evaluation regarding the disposal of tires in land reclamation projects.
- ✓ Environmental evaluation regarding tire disposal in a sanitary landfill.
- ✓ Approximate driving distances from Texas scope cities to appropriate tire disposal sites in the Texas side of the Texas-Mexico border area.
- ✓ List of appropriate sites in the Texas side of the Texas-Mexico border area and disposal fees charged at the time this study was written.
- ✓ Environmental performance report of using tires as fuel in cement kilns both in Mexico and the U.S.A.
- ✓ Approximate driving distances from Mexican scope cities to appropriate tire disposal sites in the Mexican side of the Texas-Mexico border area.
- ✓ Transportations costs to cement kilns available to the Mexican side of the Texas-Mexico border area (per city per whole, cut or shredded tire).

Is presented within study Full report attachments for further reference.

9.7.2 Tire Management Recommendations

Waste tires should be cut or shred by generators prior to their transportation. From these actions, transportation and disposal benefits can be obtained.

Table 9.2. presents estimated savings obtained when transporting cut tires instead of whole tires.

Table 9.2. Estimated savings when transporting cut tires instead of whole			
Vehicle	**Cost/tire/mile**		**Savings***
	whole	**cut**	
Pickup truck	$0.017	$0.010	**41%**
Pickup with trailer	$0.004	$0.003	**29%**
Box truck	$0.003	$0.002	**27%**
Tractor with 48 foot trailer	$0.002	$0.001	**38%**

*Increasing the gross weight at which a vehicle operates will increase its fuel consumption (Coyle, 2007) this increase is not considered when estimating the savings.

As **Table 9.2.** displays important savings may be obtained when transporting cut tires instead of whole tires. These savings will be more relevant as the hauling distance increases. This savings are obtained because of the increase in the number of tires that can be transported. As an example a 48 foot trailer may transport approximately 60% more tires if the tires are cut.

Additionally, tire disposal fees are **75%** minor when disposing of cut or shred waste tires in appropriate disposal sites compared to whole tire disposal fees on the same sites. This occurs because sites no longer need to further process waste tires in order to landfill or bury them.

9.8 Alternatives Economic Evaluation

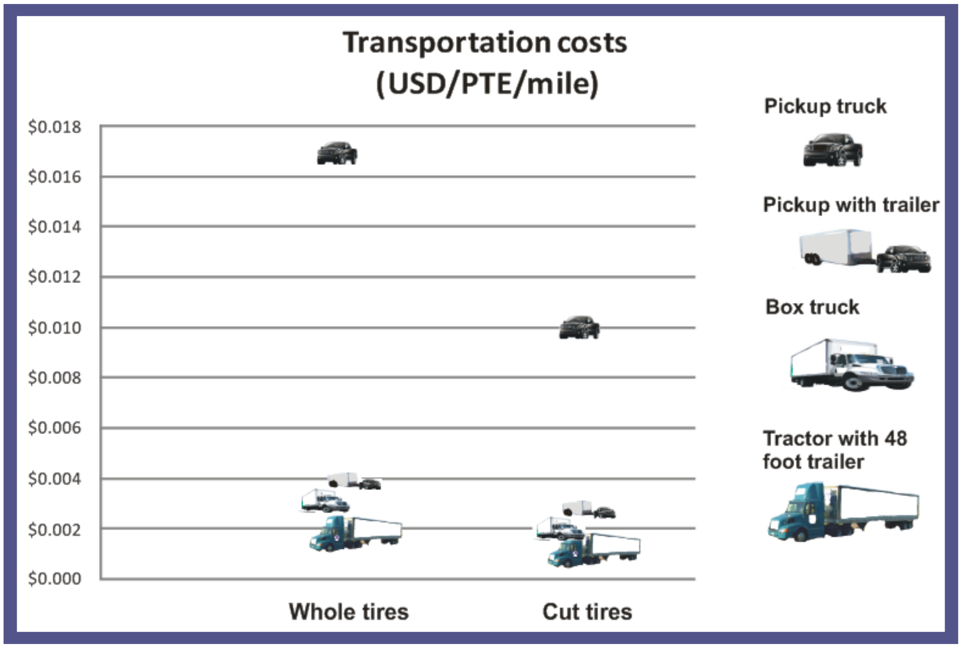
As previously mentioned, two main variables affect the disposal cost:

1. Transportation costs
2. Disposal fees

9.8.1 Common Transportation Options

The purpose of evaluating the different transporting options in this section is to aid the reader in choosing the one which better suits his/her needs. **Figure 9.5.** presents the cost per tire (whole and cut) per mile employing each type of equipment considered for Texas.

Figure 9.5.
Estimated transportation cost per tire per mile



Based on the results presented on **Figure 9.5.** it is visible that tractors with trailers are the most cost efficient way to transport cut and whole tires, especially on large distances. Pickup trucks are the most inefficient in the same way.

As previously mentioned in **Table 9.2.**, important savings may be obtained when transporting cut tires instead of whole tires. These savings will be more relevant as the hauling distance increases. This savings are obtained because of the increase in the number of tires that can be transported. This increase in the number of tires that can be transported per trip is summarized in **Table 9.3**.

Table 9.3.
Estimated increase in tires per load capacity when transporting cut tires instead of whole.

Vehicle	PTE / load		Load capacity estimated increase
	whole	cut	
Pickup truck	50	85	70%
Pickup with trailer	250	350	40%
Box truck	400	550	38%
Tractor with 48 foot trailer	1400	2250	61%

It is worth mentioning that cost efficiency when transporting shredded tires on the mentioned vehicles and equipment would not further increase since their maximum payload capacity is already reached when transporting cut tires.

9.9 Disposal Fees per Tire

Disposal costs per tire are presented separately for the Texas and Mexican sides of the border.

9.9.1 Texas Side of the Border

A full list of costs for appropriate tire disposal alternatives identified in the Texas side of the Texas-Mexico border area and disposal fees charged at the time this study was written is presented on **Attachment 44** of the study Full report.

Since the tire disposal in reclamation of depleted open pit coal mines sites alternative is not currently being applied there is no available data regarding disposal fees that could be charged by the site owner. It could be presumed that fees would be similar to the ones charged on LRPUT currently working on the border area.

9.9.2 Mexico's Side of the Border

A full list of costs for appropriate tire disposal alternatives identified in the Mexican side of the Texas-Mexico border area and disposal fees charged at the time this study was written is presented on **Attachment 49** of the study Full report.

ATTACHMENT 1
Ultimate disposal locations of waste tires that are being transported from Texas into Mexico

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Table 1.
Ultimate disposal locations of waste tires that are being transported from Texas into Mexico on the Texas-Mexico border area

General Data			Accumulated waste tires (tires)	Directions to the site	site's coordinates (UTM, Datum WGS84)			Elevation	
Id #	Municipality	State			Zone	X	Y	(FASL)	(MASL)
1	Matamoros	Tamaulipas	**2,250,000**	"Ejido of Guadalupe". Road to Reynosa Km 11.5 (7.15 miles)	14	642436	2866898	33	10
2	Rio Bravo	Tamaulipas	**32,000**	Taking federal highway 2 (Reynosa-Matamoros) turn right 4.17 km (2.59 miles) after "Camioneta Tahoe" road. Cross a ditch and continue 3.45km (2.14 miles), turn right and continue 400m (0.25 miles)	14	598665	2868165	89	27
3	Reynosa	Tamaulipas	**200,000**	Open air dump "Las Anacuas". Taking the Reynosa-San Fernando road, turn right on "Beatriz Velazco" (or "Puerto Escondido"), then turn left on "Prolongacion Boulevard Loma Bonita", continue 1.42Km (0.89 miles), the road will turn right, continue 1.17Km (0.72 miles) and the disposal site is located on the right side of the road.	14	568689	2876212	194	59
4	Reynosa*	Tamaulipas*	**50,000***	Open air dump "Las Calabazas"*	14*	Unknown*	Unknown*	Unknown*	Unknown*
5	Reynosa*	Tamaulipas*	**50,000***	Open air dump "Corrales"* UTM coordinates point an approximate location.	14*	575974.53*	2882372.51*	0*	0*

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Table 1.
Ultimate disposal locations of waste tires that are being transported from Texas into Mexico on the Texas-Mexico border area

General Data			Accumulated waste tires (tires)	Directions to the site	site's coordinates (UTM, Datum WGS84)			Elevation	
Id #	Municipality	State			Zone	X	Y	(FASL)	(MASL)
6	Reynosa*	Tamaulipas*	**50,000***	Open air dump "Cumbres"*	14*	Unknown*	Unknown*	Unknown*	Unknown*
7	Reynosa*	Tamaulipas*	**50,000***	"Las Colmenas" Landfill*	14*	Unknown*	Unknown*	Unknown*	Unknown*
8	Reynosa*	Tamaulipas*	**50,000***	"Alto Bonito" Landfill*	14*	Unknown*	Unknown*	Unknown*	Unknown*
9	Reynosa	Tamaulipas	**200**	Km 187.5 (116.5 miles) Monterrey-Reynosa road. UTM coordinates point an approximate location.	14	558979	2880564	263	80
10	Gustavo Dias Ordaz	Tamaulipas	**Unknown**	4Km (2.48 miles) taking the road to Monterrey from Gustavo Diaz Ordaz city.	14	541240	2897625	125	38
11	Camargo	Tamaulipas	**800**	"Las Flores" colony municipal yards. Entering Camargo city from Reynosa turn right on "Acceso No. 4" Drive 750 meters (0.465 miles) then turn left. Continue one block to arrive to the municipal grounds. UTM coordinates point an approximate location.	14	518635	2910553	164	50
12	Miguel Aleman	Tamaulipas	**3,000**	Located on the "5 de Junio" overpass in "Rodriguez" colony. UTM coordinates point an approximate location.	14	496410	2920211	0	0

Table 1.
Ultimate disposal locations of waste tires that are being transported from Texas into Mexico on the Texas-Mexico border area

General Data			Accumulated waste tires (tires)	Directions to the site	site's coordinates (UTM, Datum WGS84)			Elevation	
Id #	Municipality	State			Zone	X	Y	(FASL)	(MASL)
13	Guerrero	Tamaulipas	**200**	"General Lazaro Cardenaz" street corner with "Adrian Gonzalez Gonzalez". Take "Avenida Hermanos Gutierrez de Lara" towards the city center, turn left on "sexta", and continue 3 blocks west. Behind the city's cemetery.	14	475931	2938002	325	99
14	Nuevo Laredo	Tamaulipas	**Unknown, site was remediated on year 2012**	Integral center for the handling of waste tires. Located on Km 18 (11.2 miles) of national highway Mexico 85. Take Nuevo Laredo-Sabinas Hidalgo road (Mexico 85) continue 11.88km (7.38 miles) starting from the corner with "Luis Donaldo Colosio" boulevard, then turn left and continue 1.5 km (0.96 miles) towards east.	14	443827	3022773	446	136
15	Anahuac	Nuevo Leon	**13,000**	6.5 Km (4 miles) from the city center on the Anahuac-Nuevo Laredo road, on the left side.	14	392412.45	3016770	686	209
16	Cerralvo*	Nuevo Leon*	**200***	Not available*	14*	445886*	2888049*	Unknown*	Unknown*
17	Cerralvo*	Nuevo Leon*	**Unknown***	Not available*	14*	442743*	2888198*	Unknown*	Unknown*

Table 1. Ultimate disposal locations of waste tires that are being transported from Texas into Mexico on the Texas-Mexico border area										
General Data			Accumulated waste tires (tires)	Directions to the site	site's coordinates (UTM, Datum WGS84)			Elevation	
Id #	Municipality	State			Zone	X	Y	(FASL)	(MASL)
18	Cerralvo*	Nuevo Leon*	**Unknown***	Not available*	14*	442709*	2888207*	Unknown*	Unknown*
19	Cerralvo*	Nuevo Leon*	**1,500***	Not available*	14*	442706*	2888060*	Unknown*	Unknown*
20	Sabinas Hidalgo*	Nuevo Leon*	**8,000***	Not available*	14*	384468*	2926343*	Unknown*	Unknown*
21	Los Aldamas*	Nuevo Leon*	**230***	Not available*	14*	480135*	2881301*	Unknown*	Unknown*
22	Los Aldamas*	Nuevo Leon*	**Unknown***	Not available*	14*	480115*	2881384*	Unknown*	Unknown*
23	Los Aldamas*	Nuevo Leon*	**Unknown***	Not available*	14*	480099*	2881301*	Unknown*	Unknown*
24	General Bravo*	Nuevo Leon*	**450***	Not available*	14*	481032*	2846332*	Unknown*	Unknown*
25	General Bravo*	Nuevo Leon*	**Unknown***	Not available*	14*	480653*	2846462*	Unknown*	Unknown*
26	General Bravo*	Nuevo Leon*	**Unknown***	Not available*	14*	481099*	2846526*	Unknown*	Unknown*
27	General Bravo*	Nuevo Leon*	**Unknown***	Not available*	14*	480626*	2846671*	Unknown*	Unknown*
28	Vallecillo*	Nuevo Leon*	**65***	Not available*	14*	402210*	2948724*	Unknown*	Unknown*
29	Vallecillo*	Nuevo Leon*	**Unknown***	Not available*	14*	402182*	2948764*	Unknown*	Unknown*

Table 1. Ultimate disposal locations of waste tires that are being transported from Texas into Mexico on the Texas-Mexico border area									
General Data			Accumulated waste tires (tires)	Directions to the site	site's coordinates (UTM, Datum WGS84)			Elevation	
Id #	Municipality	State			Zone	X	Y	(FASL)	(MASL)
30	Vallecillo*	Nuevo Leon*	**Unknown***	Not available*	14*	402393*	2948827*	Unknown*	Unknown*
31	Acuña	Coahuila	**200,000**	Acuña-Santa Eulalia road 7.18km (4.46miles) from the "Emilio Mendoza Cisneros" overpass.	14	299864	3245347	1085	330
32	Piedras Negras	Coahuila	**115,500**	Taking the Piedras Negras-Acuña road (Federal 2), turn right 7.5km (4.64miles) after the "Manuel Perez Trevino" overpass and drive north 800m (0.5miles).	14	345497	3182226	833	254
33	Nava	Coahuila	**1,000**	Progreso street, 2km (1.24 miles) west of downtown Nava.	14	328493	3143850	1049	321
34	Ojinaga	Chihuahua	**50,000**	Taking the Chihuahua freeway turn right 8.4km (5.23 miles) after crossing the overpass with the road to Camargo (Avenida de la Juventud). The site is located 100meters (328 feet) from the freeway.	13	548717	3269389	2684	818

Table 1.
Ultimate disposal locations of waste tires that are being transported from Texas into Mexico on the Texas-Mexico border area

General Data			Accumulated waste tires (tires)	Directions to the site	site's coordinates (UTM, Datum WGS84)			Elevation	
Id #	Municipality	State			Zone	X	Y	(FASL)	(MASL)
35	Juarez	Chihuahua	**2,500,000**	Located at km 27.5 (17 miles) of the Panamerican freeway (Mexico 45). Taking Mexico 45 towards the south turn right 6Km (3.72 miles) after crossing Federal 2 freeway, finally continue 1.5 km (0.93 miles) towards the west.	13	358959	3492229	4065	1239
36	Matamoros	Tamaulipas	**400,000**	Federal Freeway number 101, Km. 21 (75.2 miles) without number, turn right and follow the road 1.54Km (0.96 miles)	14	641485	2843741	23	7

*** Means data was not confirmed with a key stakeholder, it is presented as it was obtained from previous tire pile inventories mentioned on Chapter 3 and public Geographical Information Systems.**

Tire sites 16 to 30 are not located within the study's selected search area but are located within 100km from the Texas-Mexico border.

MASL = meters above sea level. | **FASL = feet above sea level**

ATTACHMENT 2
Operation and management procedures of each waste tires accumulation site of the Mexican side of the Texas-Mexico border area

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Table 1.
Operation and management procedures of each waste tires accumulation site of the Mexican side of the Texas-Mexico border area

General Data			Number of waste tires accumulated	Operation and management procedures				
Id #	Municipality	State		Responsible of the site's management	Type of site	Waste tires inflow source	Waste tires outflow destiny	Status
1	Matamoros	Tamaulipas	**2,250,000**	Municipal government	Municipal Waste Tires Collection Center	All waste tires collected in the cleaning of drainage ditches, junk collection programs, incidentally collected by garbage trucks, disposed by factories, among other sources used to be taken to this collection and storage center by the municipal authorities. Site is currently not receiving waste tires, they are being sent to the landfill waste tire storage center.	Tires are sent to a cement kiln to be used as Tire Derived Fuel (TDF) in the city of Monterrey, state of Nuevo Leon, Mexico. 32,000 waste tires were sent on the year 2011.	Active
2	Rio Bravo	Tamaulipas	**32,000**	Municipal government	Municipal Landfill and waste tires storage center	Waste tires are collected by the municipal government employees from people's homes and taken to the storage center.	Non	Active
3	Reynosa	Tamaulipas	**200,000**	Municipal government	City open-air dump.	Municipal employees collect the waste tires throughout the city and leave them in the open air dump.	On 2010 nearly 800,000 waste tires were burned in a fire.	Active

Table 1. Operation and management procedures of each waste tires accumulation site of the Mexican side of the Texas-Mexico border area									
General Data			Number of waste tires accumulated	Operation and management procedures					
Id #	Municipality	State		Responsible of the site's management	Type of site	Waste tires inflow source	Waste tires outflow destiny	Status
4	Reynosa *	Tamaulipas*	50,000*	Unknown*	Open air dump "Las Calabazas"*	Unknown*	Unknown*	Active*
5	Reynosa *	Tamaulipas*	50,000*	Unknown*	Open air dump "Corrales"*	Unknown*	Unknown*	Active*
6	Reynosa *	Tamaulipas*	50,000*	Unknown*	Open air dump "Cumbres"*	Unknown*	Unknown*	Active*
7	Reynosa *	Tamaulipas*	50,000*	Unknown*	"Las Colmenas" Landfill*	Unknown*	Unknown*	Active*
8	Reynosa *	Tamaulipas*	50,000*	Unknown*	"Alto Bonito" Landfill*	Unknown*	Unknown*	Active*
9	Reynosa	Tamaulipas	200	Private company: RECO de Reynosa S.A. de C.V.	Private landfill.	Waste tires generated by their own vehicles or accidentally introduced into garbage collecting trucks.	Waste tires are used within the landfill to delineate roads, to create planters and when 100 waste tires are accumulated they are used as daily cell base.	Inactive
10	Gustavo Dias Ordaz	Tamaulipas	Unknown	Municipal government	Open air dump.	Waste tires are taken and dumped into the municipal open air dump.	Waste tires are burned as they arrive to the municipal open air dump.	Active

Table 1.
Operation and management procedures of each waste tires accumulation site of the Mexican side of the Texas-Mexico border area

General Data			Number of waste tires accumulated	Operation and management procedures				
Id #	Municipality	State		Responsible of the site's management	Type of site	Waste tires inflow source	Waste tires outflow destiny	Status
11	Camargo	Tamaulipas	**800**	Municipal government	Municipal Waste Tires Collection Center	Tires are collected and stored were the municipal junk yard was located waiting to be processed.	Non	Active
12	Miguel Aleman	Tamaulipas	**3,000**	Municipal government	Provisional Municipal Waste Tires Collection Center	Tires are collected and stored on the municipal fair grounds.	During a period of time waste tires were sent to Nuevo Laredo for their handling. Actually they are stored waiting for disposal due to a lack of budget.	Active
13	Guerrero	Tamaulipas	**200**	Municipal government	Municipal open-air dump	Tires are collected and sent to the open air municipal dump.	The Mexican armed forces use them as barricades. Also 400 waste tires were lost during a fire.	Active
14	Nuevo Laredo	Tamaulipas	**Unknown, during year 2012 site was remediated**	Municipal government	Storage center	Waste tires are collected on 5 mobile collection centers by the environmental municipal authority, taken to the storage center where they are counted.	Waste tires are shredded and sent to the city of Ramos Arizpe in the state of Coahuila, Mexico to be used as Tire Derived Fuel (TDF) in a cement kiln. 300,000 waste tires were burned during a fire in August 2011.	Active

Table 1. Operation and management procedures of each waste tires accumulation site of the Mexican side of the Texas-Mexico border area								
General Data			Number of waste tires accumulated	Operation and management procedures				
Id #	Municipality	State		Responsible of the site's management	Type of site	Waste tires inflow source	Waste tires outflow destiny	Status
15	Anahuac	Nuevo Leon	**13,000**	Municipal government	Municipal Landfill	Tires are collected by the municipal authorities from tire repair shop and stored in a storage center adjacent to the city landfill. Also the inhabitants dispose of their waste tires on said location.	Waste tires are sent to the city of Monterrey in the state of Nuevo Leon, Mexico were they are shredded and used as Tire Derived Fuel (TDF) in cement Kilns or sent to a state managed landfill.	Active
16	Cerralvo*	Nuevo Leon*	**200***	Not available*	Unknown*	Unknown*	Unknown*	Inactive*
17	Cerralvo*	Nuevo Leon*	**Unknown***	Not available*	Unknown*	Unknown*	Unknown*	Unknown*
18	Cerralvo*	Nuevo Leon*	**Unknown***	Not available*	Unknown*	Unknown*	Unknown*	Unknown*
19	Cerralvo*	Nuevo Leon*	**1,500***	Not available*	Unknown*	Unknown*	Unknown*	Inactive*
20	Sabinas Hidalgo*	Nuevo Leon*	**8,000***	Not available*	Unknown*	Unknown*	Unknown*	Active*
21	Los Aldamas*	Nuevo Leon*	**230***	Not available*	Unknown*	Unknown*	Unknown*	Inactive*
22	Los Aldamas*	Nuevo Leon*	**Unknown***	Not available*	Unknown*	Unknown*	Unknown*	Unknown*
23	Los Aldamas*	Nuevo Leon*	**Unknown***	Not available*	Unknown*	Unknown*	Unknown*	Unknown*

Table 1. Operation and management procedures of each waste tires accumulation site of the Mexican side of the Texas-Mexico border area									
General Data				Operation and management procedures					
Id #	Municipality	State	Number of waste tires accumulated	Responsible of the site's management	Type of site	Waste tires inflow source	Waste tires outflow destiny	Status
24	Gral. Bravo*	Nuevo Leon*	**450***	Not available*	Unknown*	Unknown*	Unknown*	Active*
25	Gral. Bravo*	Nuevo Leon*	**Unknown***	Not available*	Unknown*	Unknown*	Unknown*	Unknown*
26	Gral. Bravo*	Nuevo Leon*	**Unknown***	Not available*	Unknown*	Unknown*	Unknown*	Unknown*
27	Gral. Bravo*	Nuevo Leon*	**Unknown***	Not available*	Unknown*	Unknown*	Unknown*	Unknown*
28	Vallecillo*	Nuevo Leon*	**65***	Not available*	Unknown*	Unknown*	Unknown*	Inactive*
29	Vallecillo*	Nuevo Leon*	**Unknown***	Not available*	Unknown*	Unknown*	Unknown*	Unknown*
30	Vallecillo*	Nuevo Leon*	**Unknown***	Not available*	Unknown*	Unknown*	Unknown*	Unknown*
31	Acuña	Coahuila	**200,000**	Municipal government	Municipal Landfill	Waste tires are taken to collection centers by tire repair shops personnel and by regular people motivated by different education campaigns. Then taken to a storage center by the Ecology municipal authorities.	Non	Active

Table 1. Operation and management procedures of each waste tires accumulation site of the Mexican side of the Texas-Mexico border area								
General Data			Number of waste tires accumulated	Operation and management procedures				
Id #	Municipality	State		Responsible of the site's management	Type of site	Waste tires inflow source	Waste tires outflow destiny	Status
32	Piedras Negras	Coahuila	**115,500**	Promotora Ambiental S.A. De C.V.	Private landfill.	The municipal Ecology and Urban Image department picks up the tires throughout the city and takes them to the private company landfill.	Tires are shredded and buried in an exclusive cell. Also waste tires were transported, by train, to the city of Torreon, state of Coahuila, Mexico for their handling.	Active
33	Nava	Coahuila	**1,000**	Municipal government	Storage center	Tires are collected from tire repair shops by municipal workers and accumulated in a storage center adjacent to the municipal landfill waiting for an adequate disposal. Inhabitants also take there their waste tires.	Non	Active
34	Ojinaga	Chihuahua	**50,000**	Municipal government	Storage center	Tires are collected from tire repair shops by municipal public services workers and accumulated in a storage center adjacent to the municipal landfill waiting for an adequate disposal.	Non	Active

Table 1. Operation and management procedures of each waste tires accumulation site of the Mexican side of the Texas-Mexico border area									
General Data			Number of waste tires accumulated	Operation and management procedures					
Id #	Municipality	State		Responsible of the site's management	Type of site	Waste tires inflow source	Waste tires outflow destiny	Status
35	Juarez	Chihuahua	2,500,000	Municipal government	Storage center	Tires are accumulated in a storage center adjacent to the municipal landfill.	Tires are sent to a cement kiln to be used as Tire Derived Fuel (TDF).	Active
36	Matamoros	Tamaulipas	400,000	Municipal government	Municipal landfill waste tire storage center	Waste tires collected in the cleaning of drainage ditches, junk collection programs, incidentally collected by garbage trucks, disposed by factories, among other sources are taken to the collection and storage center by the municipal authorities.	Tires are cut in four pieces by a machine. Then the pieces are accumulated.	Active

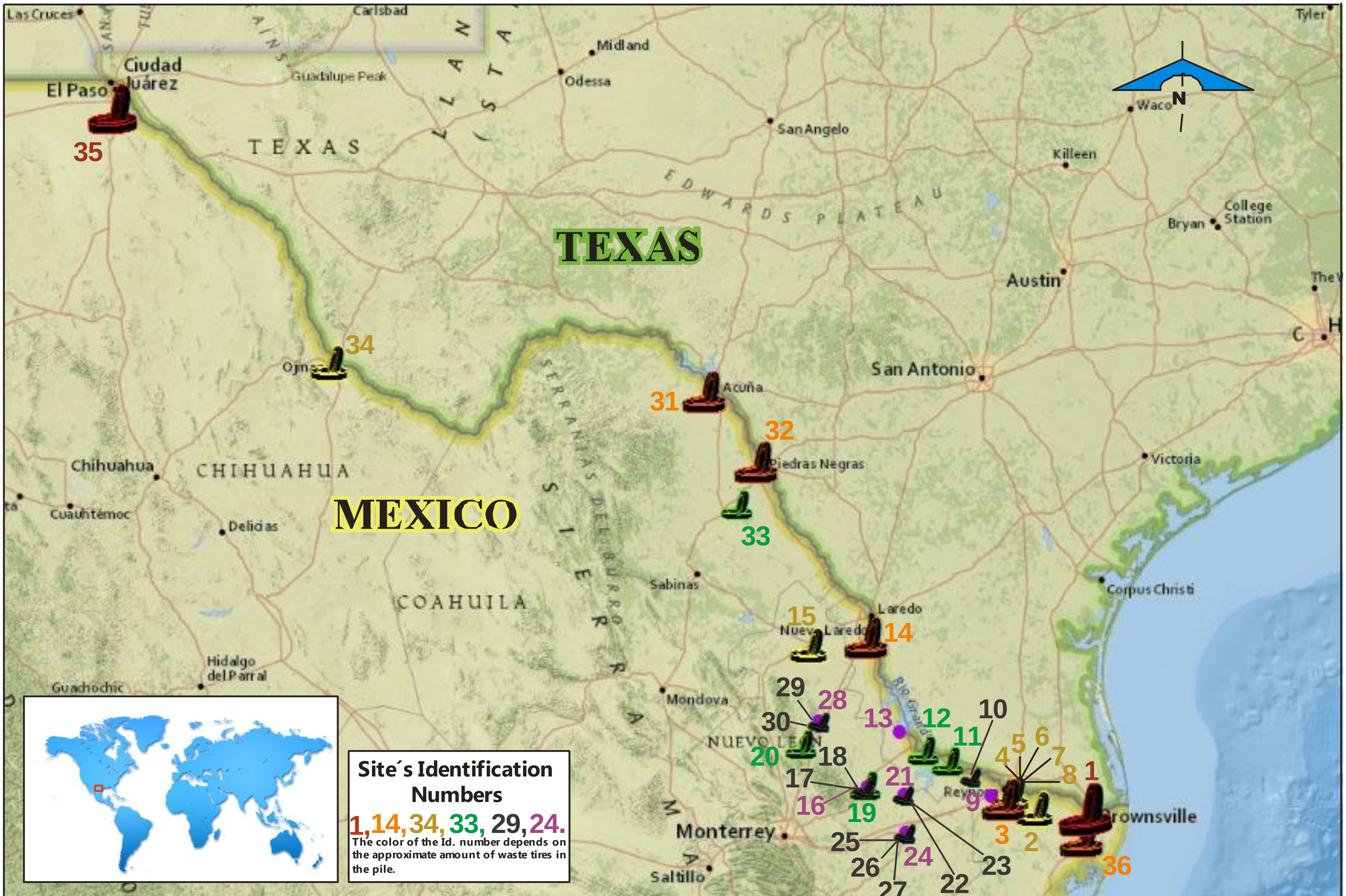
*** Means data was not confirmed with a key stakeholder, it is presented as it was obtained from previous tire pile inventories mentioned on section 2.0.1 of the Chapter 3.**

Tire sites 16 to 30 are not located within the study's selected search area but are located within 100km from the Texas-Mexico border.

The information presented on this attachment was obtained through remote interviews with the key stakeholders mentioned on Attachment 1.

ATTACHMENT 3
Ultimate disposal locations map of waste tires being transported from Texas into Mexico

Printed on 100% recycled fiber paper using solid ink



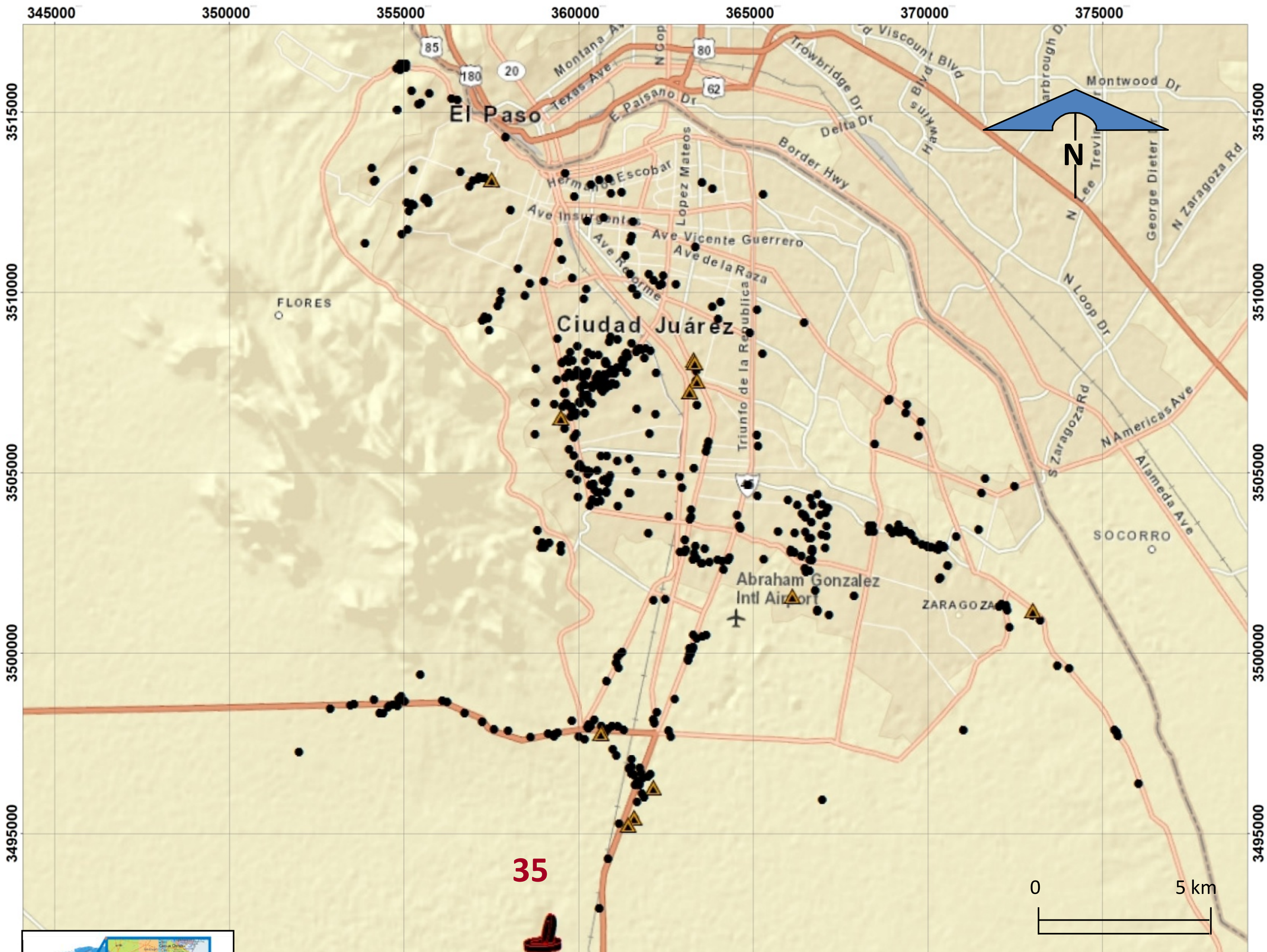
Approximate amount of waste tires per pile:

- >1’000,000
- 100,000 - 1´000,000
- 10,000 - 99,999
- 500 - 9,999
- Quantity unknown
- <500 Non significant

I E M S	TITLE. Ultimate disposal locations	PROJECT. 432.01	DATE. 1 / 02 / 2012	SCALE. 1:5'900,000
				CHECK. MK
	CLIENT. N A D B	LOCATION. Texas-Mexico Border Region	DRAWN BY. Esteban Ibarra	AUTH. RV

ATTACHMENT 4
Waste tire sites display map per Mexican city

Printed on 100% recycled fiber paper using solid ink



Site´s Identification Numbers

1, 14, 34, 33, 29, 24.

The color of the Id. number depends on the approximate amount of waste tires in the pile.

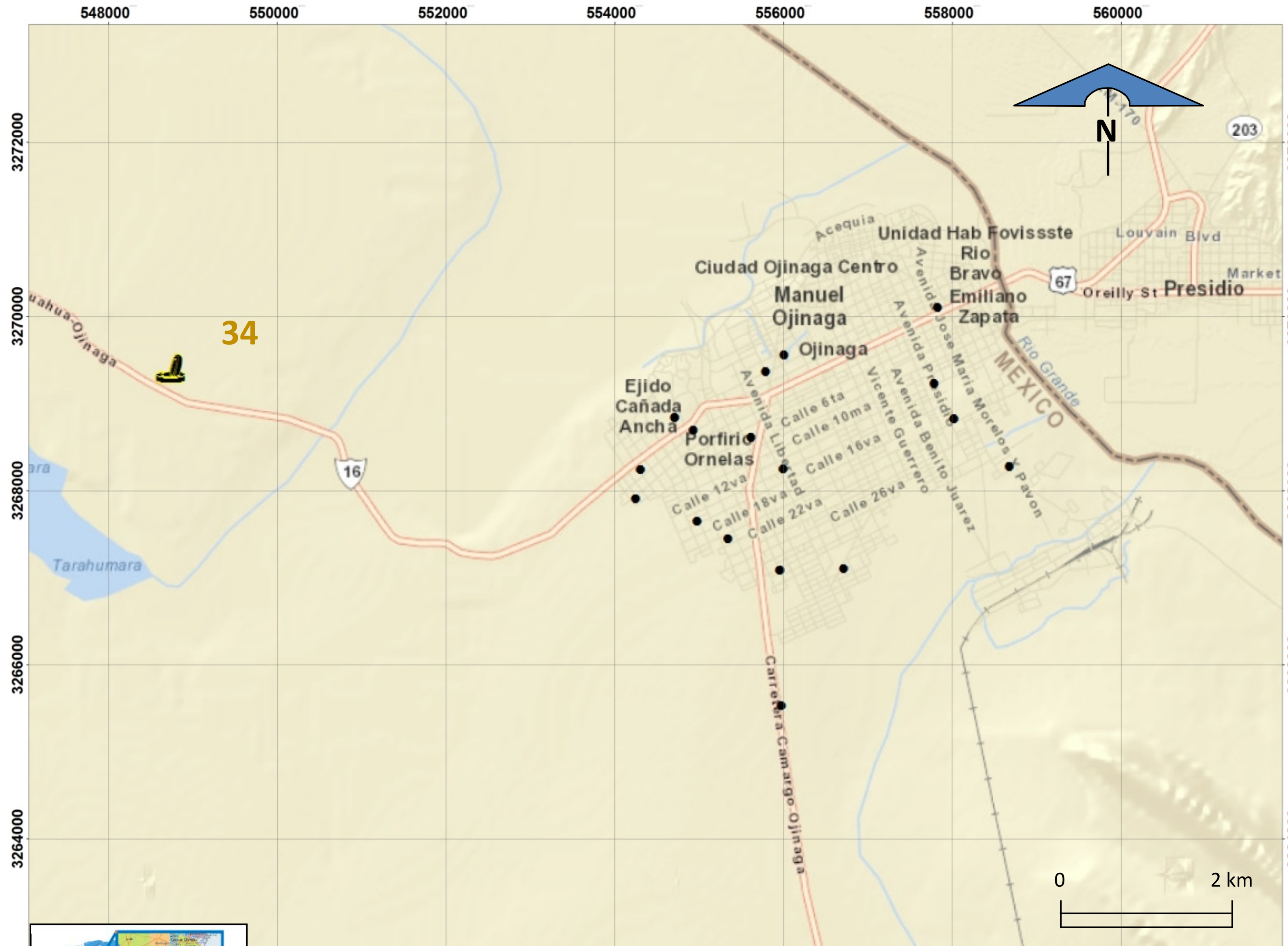
Legend	
International border line.	watercourse. (presence of water not implied)
Principal road.	Non perennial stream.
Secondary road.	Airport.
Minor road.	Municipal borderline.
Town.	Urban area.
Perennial lake.	Possible illegal tire pile.
Rail.	Possible Junkyard.

Approximate amount of waste tires per pile:

- >1'000,000
- 100,000 - 1´000,000
- 10,000 - 99,999
- 500 - 9,999
- Quantity unknown
- <500 Non significant

I E M S

TITLE	PROJECT	DATE	SCALE.	
Ciudad Juarez sites display map.	432.01	23/08/2012	Graphic	
CUENT.	LOCATION.	DRAWN BY.	CHECK.	EI
N A D B	Ciudad Juarez Chihuahua, Mexico.	Marcel Lopez	APRP	RV



Site´s Identification Numbers

1, 14, 34, 33, 29, 24.

The color of the Id. number depends on the approximate amount of waste tires in the pile.

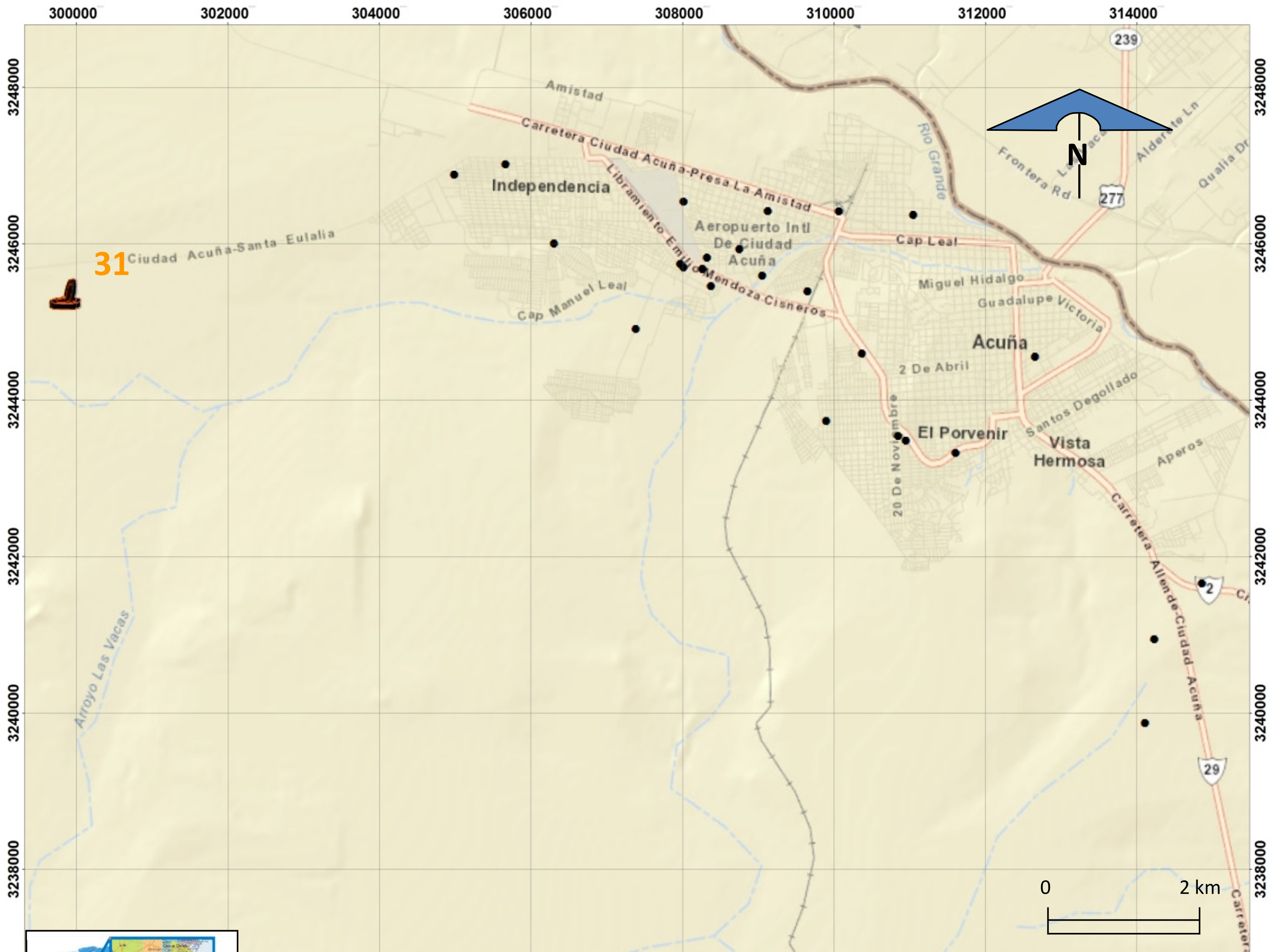
- International border line.
- Principal road.
- Secondary road.
- Minor road.
- Town.
- Perennial lake.
- Rail.
- watercourse. (presence of water not implied)
- Non perennial stream.
- Airport.
- Urban area.
- Possible Junkyard.
- Municipal borderline.
- Possible illegal tire pile.

Approximate amount of waste tires per pile:

- >1'000,000
- 100,000 - 1´000,000
- 10,000 - 99,999
- 500 - 9,999
- Quantity unknown
- <500 Non significant

I E M S

TITLE	PROJECT	DATE	SCALE.
Ojinaga sites display map.	432.01	23/08/2012	Graphic
CUENT. NADB	LOCATION. Ojinaga Chihuahua, Mexico.	DRAWN BY. Marcel Lopez	CHECK. EI / APRP RV



Site´s Identification Numbers

1, 14, 34, 33, 29, 24.

The color of the Id. number depends on the approximate amount of waste tires in the pile.

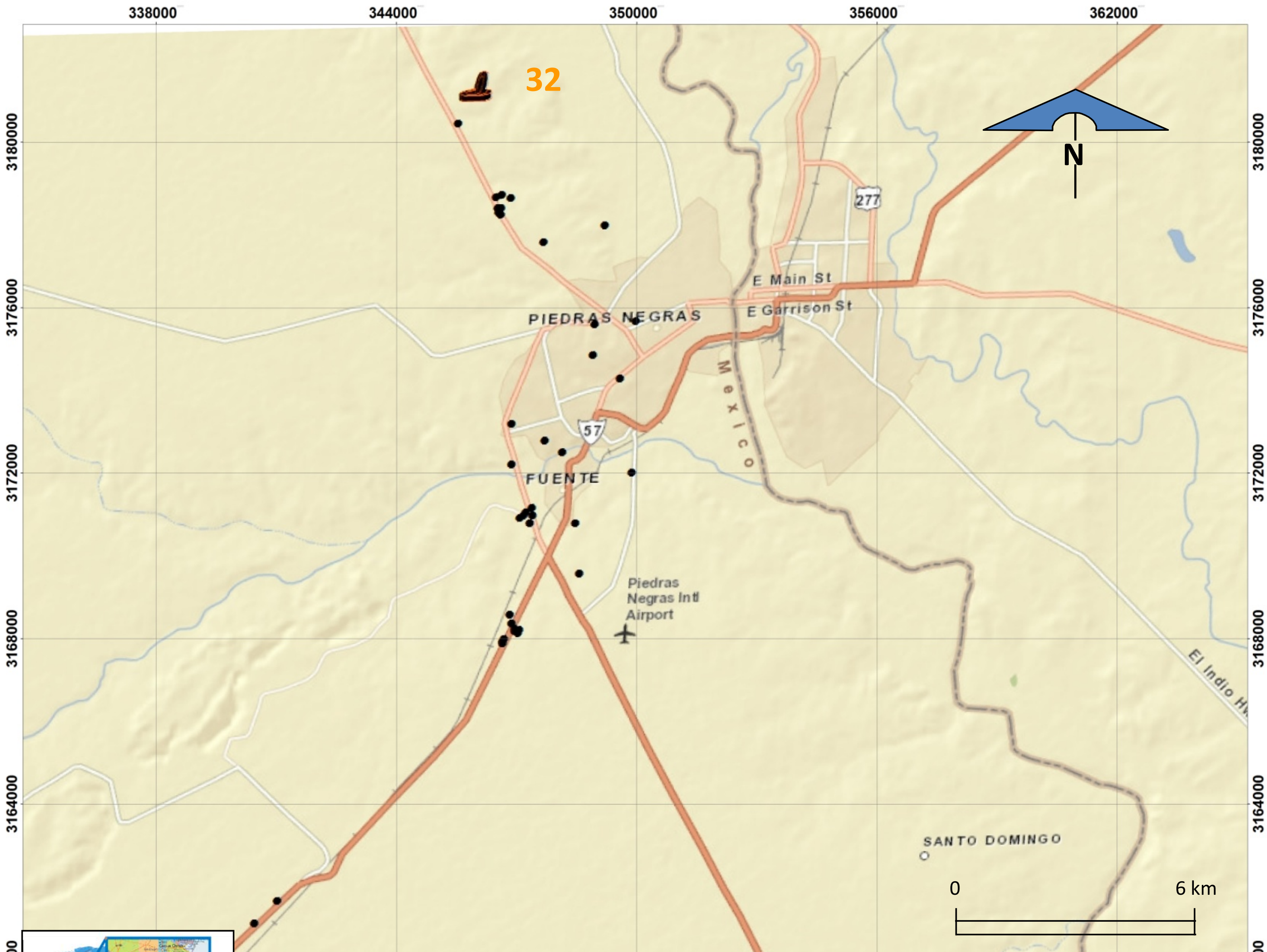
International border line.
Principal road.
Secondary road.
Minor road.
Town.
Perennial lake.
Rail.
watercourse. (presence of water not implied)
Non perennial stream.
Airport.
Urban area.
Possible Junkyard.
Municipal borderline.
Possible illegal tire pile.

Approximate amount of waste tires per pile:

>1'000,000
100,000 - 1´000,000
10,000 - 99,999
500 - 9,999
Quantity unknown
<500 Non significant

I E M S

TITLE	PROJECT	DATE	SCALE.
Acuña sites display map.	432.01	23/08/2012	Graphic
CUENT. NADB	LOCATION. Acuña Coahuila, Mexico.	DRAWN BY. Marcel Lopez	CHECK. EI / APRP RV



Site´s Identification Numbers

1, 14, 34, 33, 29, 24.

The color of the Id. number depends on the approximate amount of waste tires in the pile.

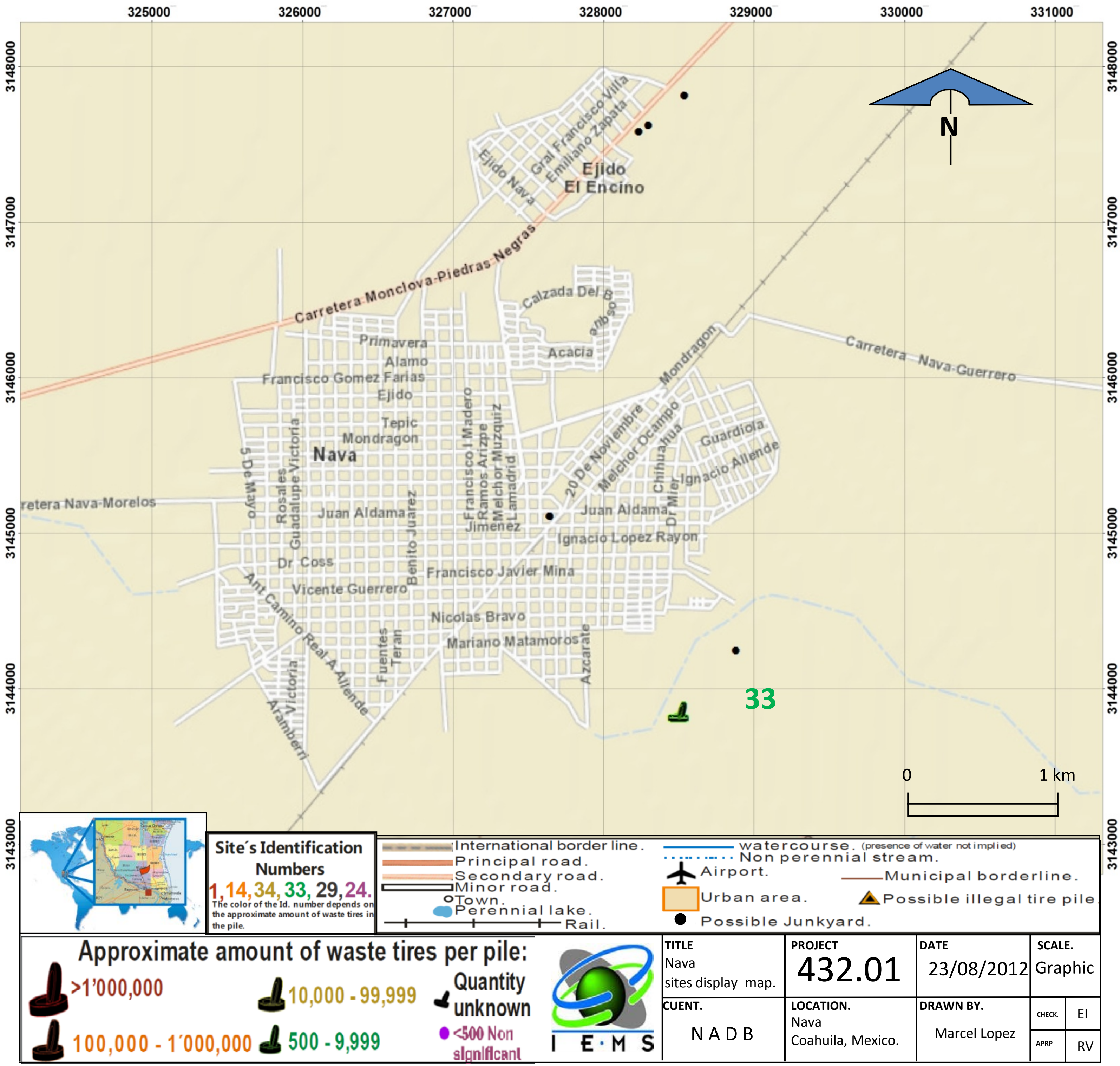
International border line.
Principal road.
Secondary road.
Minor road.
Town.
Perennial lake.
Rail.
watercourse. (presence of water not implied)
Non perennial stream.
Airport.
Urban area.
Possible Junkyard.
Municipal borderline.
Possible illegal tire pile.

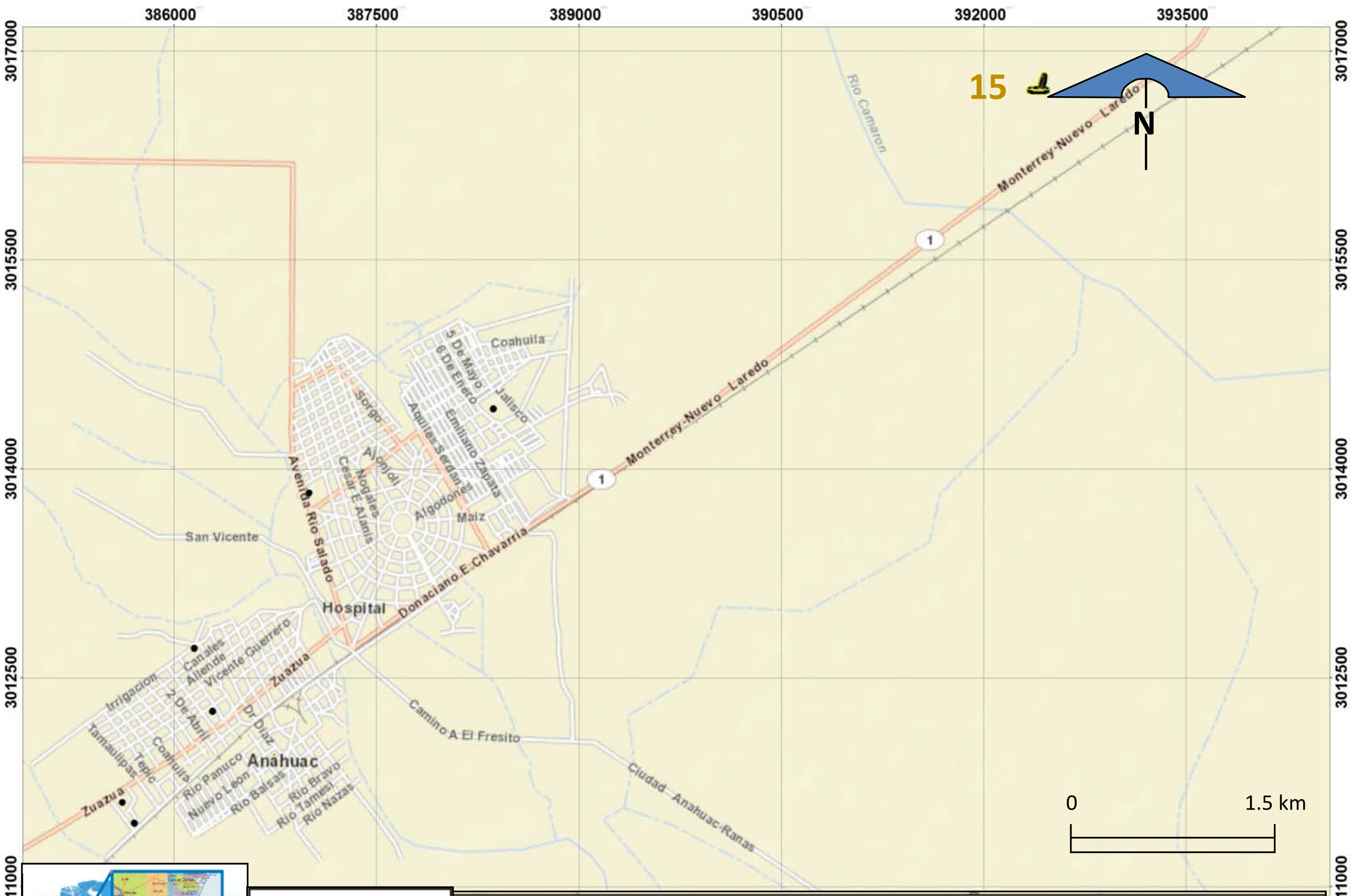
Approximate amount of waste tires per pile:

>1'000,000
100,000 - 1´000,000
10,000 - 99,999
500 - 9,999
Quantity unknown
<500 Non significant

I E M S

TITLE Piedras Negras sites display map.	PROJECT 432.01	DATE 23/08/2012	SCALE. Graphic
CUENT. N A D B	LOCATION. Piedras Negras Coahuila, Mexico.	DRAWN BY. Marcel Lopez	CHECK. EI APRP RV


325000
326000
327000
328000
329000
330000
331000
3148000
3147000
3146000
3145000
3144000
3143000
N
Ejido El Encino
Gral Francisco Villa
Emiliano Zapata
Ejido Nava
Carretera Monclova-Piedras Negras
Calzada Del B
Acacia
Primavera
Alamo
Francisco Gomez Farias
Ejido
Tepic
Mondragon
Nava
Carretera Nava-Guerrero
retera Nava-Morelos
5 De Mayo
Rosales
Guadalupe Victoria
Juan Aldama
Benito Juarez
Francisco I Madero
Ramos Arizpe
Melchor Muzquiz
Lamadrid
Jimenez
20 De Noviembre
Melchor Ocampo
Chihuahua
Dr Mier
Guardiola
Ignacio Allende
Ignacio Lopez Rayon
Dr Coss
Vicente Guerrero
Francisco Javier Mina
Nicolas Bravo
Mariano Matamoros
Azcarate
Ant Camino Real A Allende
Fuentes
Teran
Victoria
Aramberri
33
0
1 km
Site´s Identification Numbers
1, 14, 34, 33, 29, 24.
The color of the Id. number depends on the approximate amount of waste tires in the pile.
International border line.
Principal road.
Secondary road.
Minor road.
Town.
Perennial lake.
Rail.
watercourse. (presence of water not implied)
Non perennial stream.
Airport.
Municipal borderline.
Urban area.
Possible illegal tire pile.
Possible Junkyard.
Approximate amount of waste tires per pile:
>1'000,000
10,000 - 99,999
Quantity unknown
100,000 - 1´000,000
500 - 9,999
<500 Non significant
I E M S
TITLE
Nava sites display map.
PROJECT
432.01
DATE
23/08/2012
SCALE.
Graphic
CUENT.
N A D B
LOCATION.
Nava
Coahuila, Mexico.
DRAWN BY.
Marcel Lopez
CHECK.
EI
APRP
RV



Site´s Identification Numbers

1, 14, 34, 33, 29, 24.

The color of the Id. number depends on the approximate amount of waste tires in the pile.

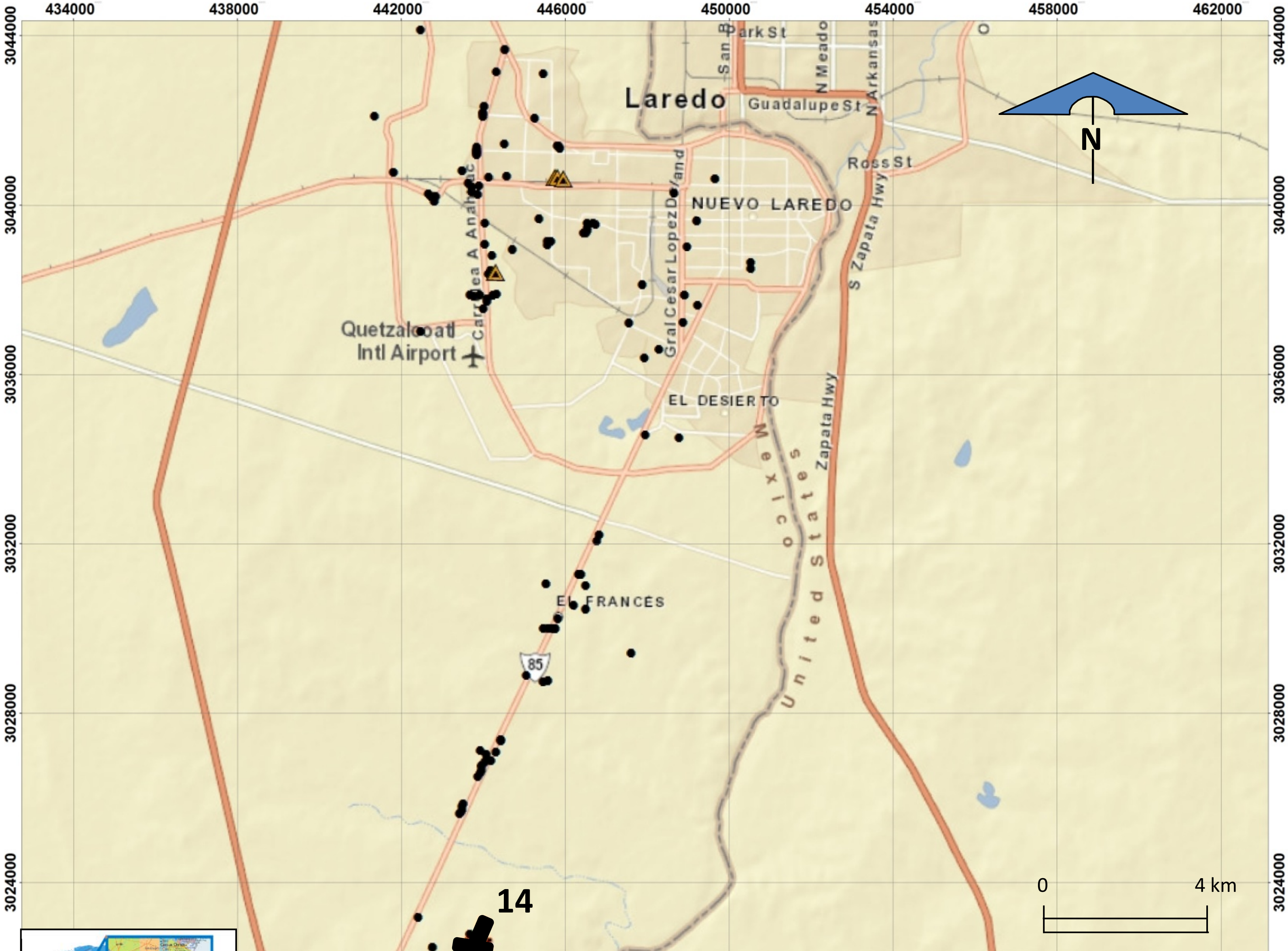
- International border line.
- Principal road.
- Secondary road.
- Minor road.
- Town.
- Perennial lake.
- Rail.
- watercourse. (presence of water not implied)
- Non perennial stream.
- Airport.
- Municipal borderline.
- Urban area.
- Possible illegal tire pile
- Possible Junkyard.

Approximate amount of waste tires per pile:

- >1'000,000
- 100,000 - 1´000,000
- 10,000 - 99,999
- 500 - 9,999
- Quantity unknown
- <500 Non significant

I E M S

TITLE	PROJECT	DATE	SCALE.	
Anahuac sites display map.	432.01	23/08/2012	Graphic	
CUENT.	LOCATION.	DRAWN BY.	CHECK.	EI
N A D B	Anahuac Nuevo Leon, Mexico.	Marcel Lopez	APRP	RV



Site´s Identification Numbers

1, 14, 34, 33, 29, 24.

The color of the Id. number depends on the approximate amount of waste tires in the pile.

- International border line.
- Principal road.
- Secondary road.
- Minor road.
- Town.
- Perennial lake.
- Rail.
- watercourse. (presence of water not implied)
- Non perennial stream.
- Airport.
- Urban area.
- Possible Junkyard.
- Municipal borderline.
- Possible illegal tire pile.

Approximate amount of waste tires per pile:

- >1'000,000
- 100,000 - 1´000,000
- 10,000 - 99,999
- 500 - 9,999
- Quantity unknown
- <500 Non significant

I E M S

TITLE	PROJECT	DATE	SCALE.	
Nuevo Laredo sites display map.	432.01	23/08/2012	Graphic	
CUENT.	LOCATION.	DRAWN BY.	CHECK.	EI
N A D B	Nuevo Laredo Tamaulipas, Mexico.	Marcel Lopez	APRP	RV

Site´s Identification Numbers

1, 14, 34, 33, 29, 24.

The color of the Id. number depends on the approximate amount of waste tires in the pile.

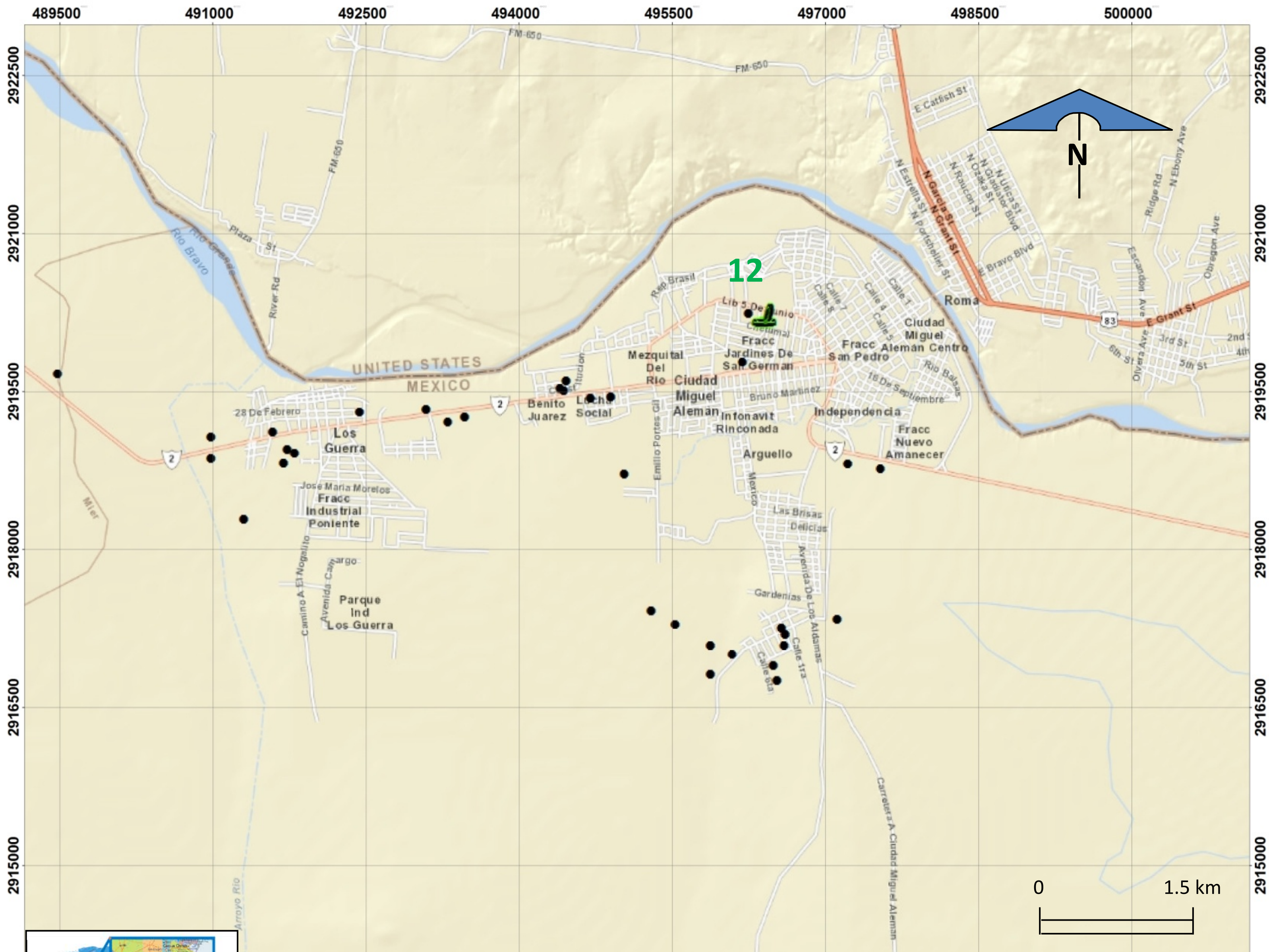
International border line.
Principal road.
Secondary road.
Minor road.
Town.
Perennial lake.
Rail.
watercourse. (presence of water not implied)
Non perennial stream.
Airport.
Municipal borderline.
Urban area.
Possible illegal tire pile.
Possible Junkyard.

Approximate amount of waste tires per pile:

>1'000,000
10,000 - 99,999
Quantity unknown
100,000 - 1´000,000
500 - 9,999
<500 Non significant

I E M S

TITLE	PROJECT	DATE	SCALE.	
Nueva Cd. Guerrero sites display map.	432.01	23/08/2012	Graphic	
CLIENT: N A D B	LOCATION. Nueva Cd. Guerrero Tamaulipas, Mexico.	DRAWN BY. Marcel Lopez	CHECK.	EI
			APRP	RV



Site´s Identification Numbers

1, 14, 34, 33, 29, 24.

The color of the Id. number depends on the approximate amount of waste tires in the pile.

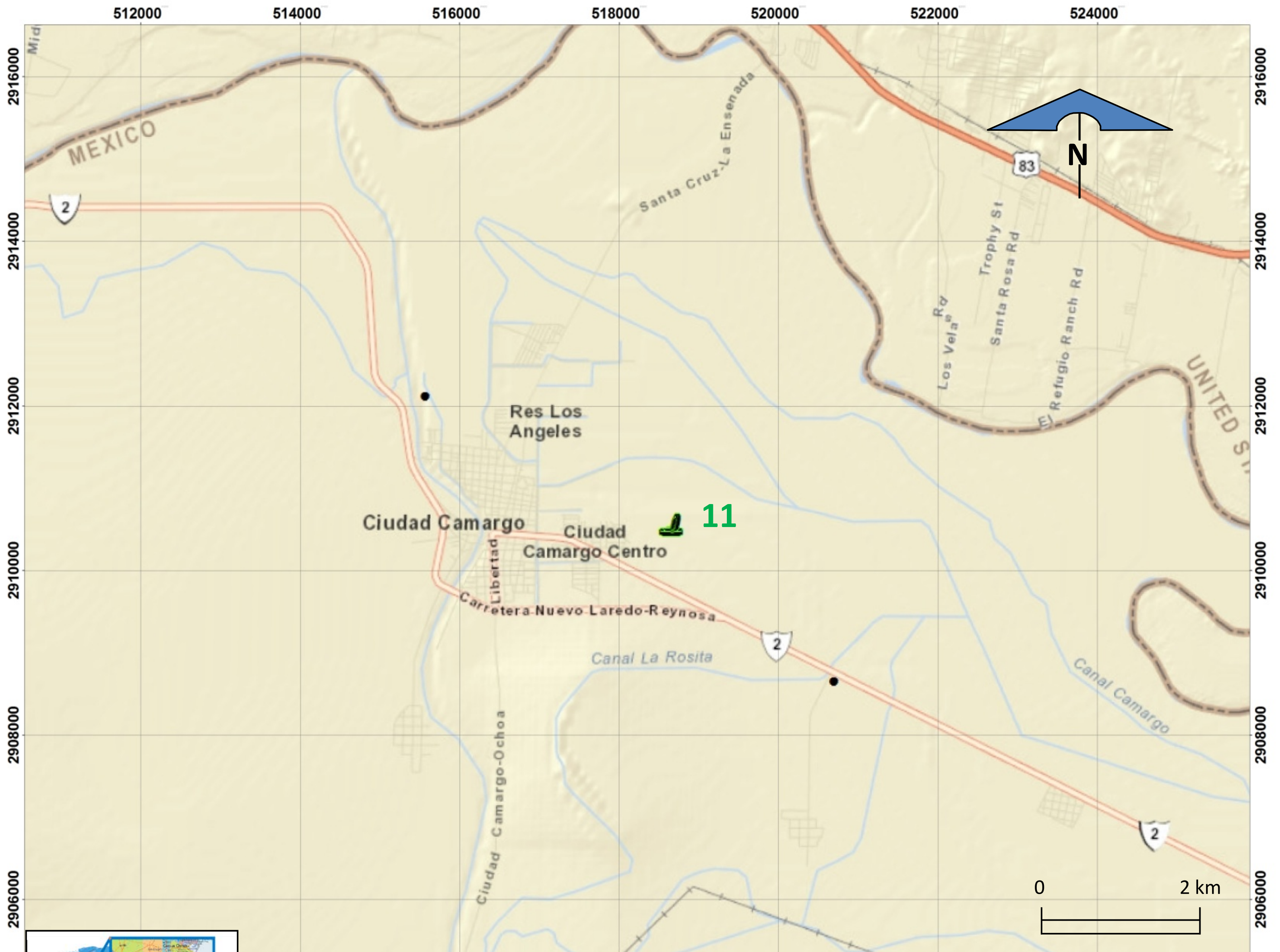
International border line.
Principal road.
Secondary road.
Minor road.
Town.
Perennial lake.
Rail.
watercourse. (presence of water not implied)
Non perennial stream.
Airport.
Urban area.
Possible Junkyard.
Municipal borderline.
Possible illegal tire pile.

Approximate amount of waste tires per pile:

>1’000,000
100,000 - 1´000,000
10,000 - 99,999
500 - 9,999
Quantity unknown
<500 Non significant

I E M S

TITLE	PROJECT	DATE	SCALE.	
Miguel Aleman sites display map.	432.01	23/08/2012	Graphic	
CUENT.	LOCATION.	DRAWN BY.	CHECK.	EI
N A D B	Miguel Aleman Tamaulipas, Mexico.	Marcel Lopez	APRP	RV



Site´s Identification Numbers

1, 14, 34, 33, 29, 24.

The color of the Id. number depends on the approximate amount of waste tires in the pile.

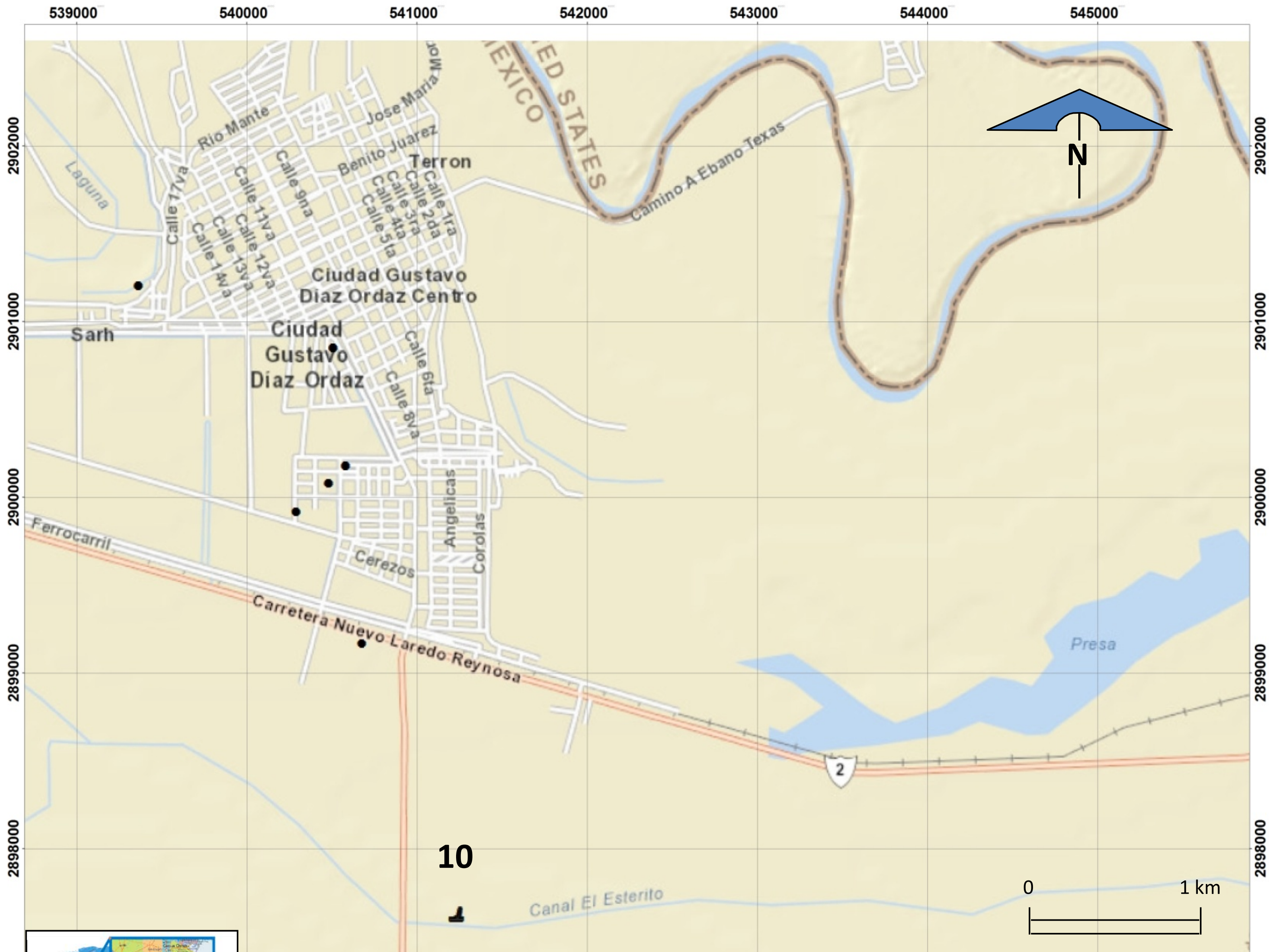
International border line.
Principal road.
Secondary road.
Minor road.
Town.
Perennial lake.
Rail.
watercourse. (presence of water not implied)
Non perennial stream.
Airport.
Urban area.
Possible Junkyard.
Municipal borderline.
Possible illegal tire pile.

Approximate amount of waste tires per pile:

>1'000,000
100,000 - 1´000,000
10,000 - 99,999
500 - 9,999
Quantity unknown
<500 Non significant

I E M S

TITLE	PROJECT	DATE	SCALE.	
Camargo sites display map.	432.01	23/08/2012	Graphic	
CUENT.	LOCATION.	DRAWN BY.	CHECK.	EI
N A D B	Camargo Tamaulipas, Mexico.	Marcel Lopez	APRP	RV



Site´s Identification Numbers

1, 14, 34, 33, 29, 24.

The color of the Id. number depends on the approximate amount of waste tires in the pile.

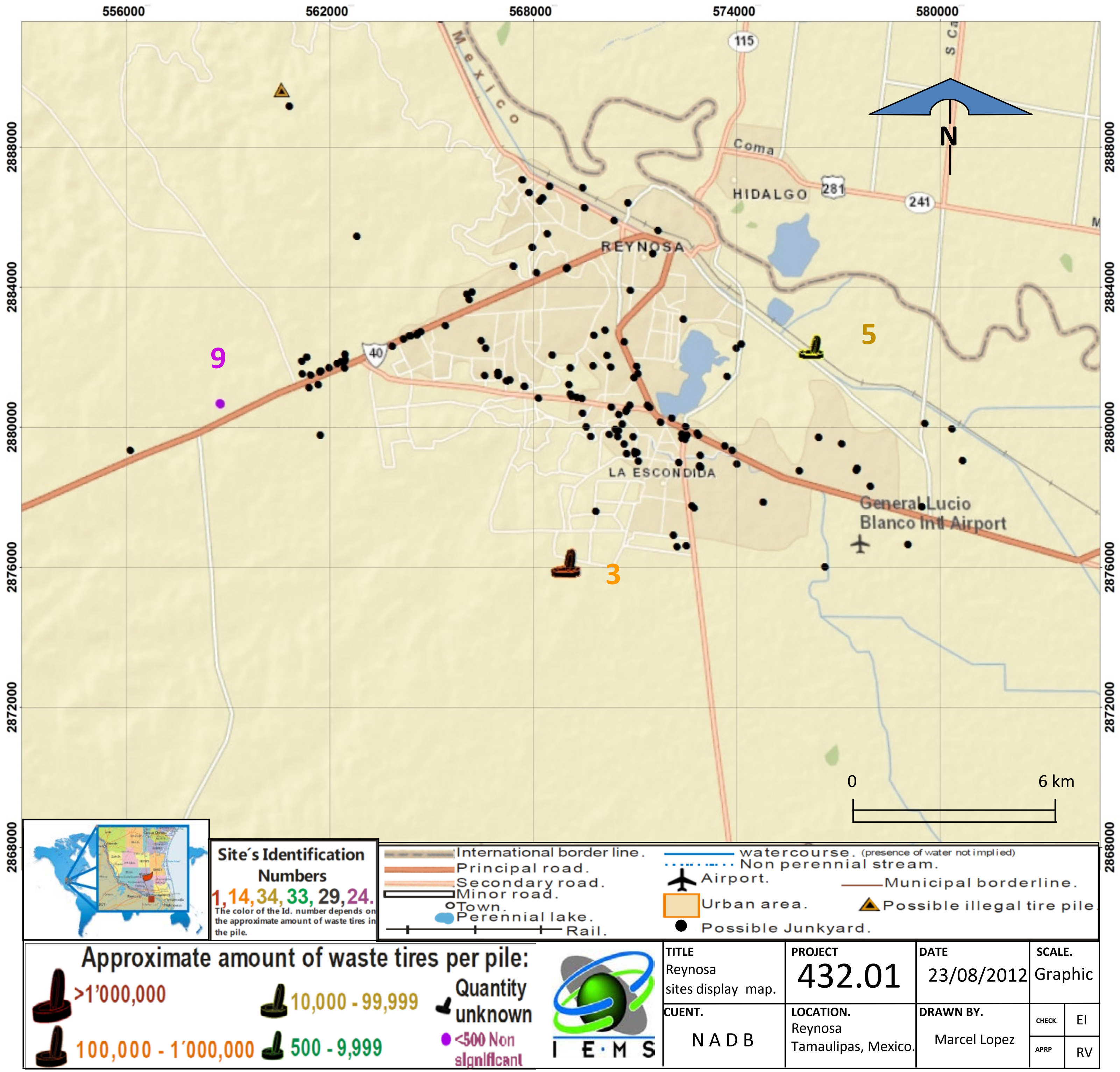
International border line.
Principal road.
Secondary road.
Minor road.
Town.
Perennial lake.
Rail.
watercourse. (presence of water not implied)
Non perennial stream.
Airport.
Municipal borderline.
Urban area.
Possible illegal tire pile.
Possible Junkyard.

Approximate amount of waste tires per pile:

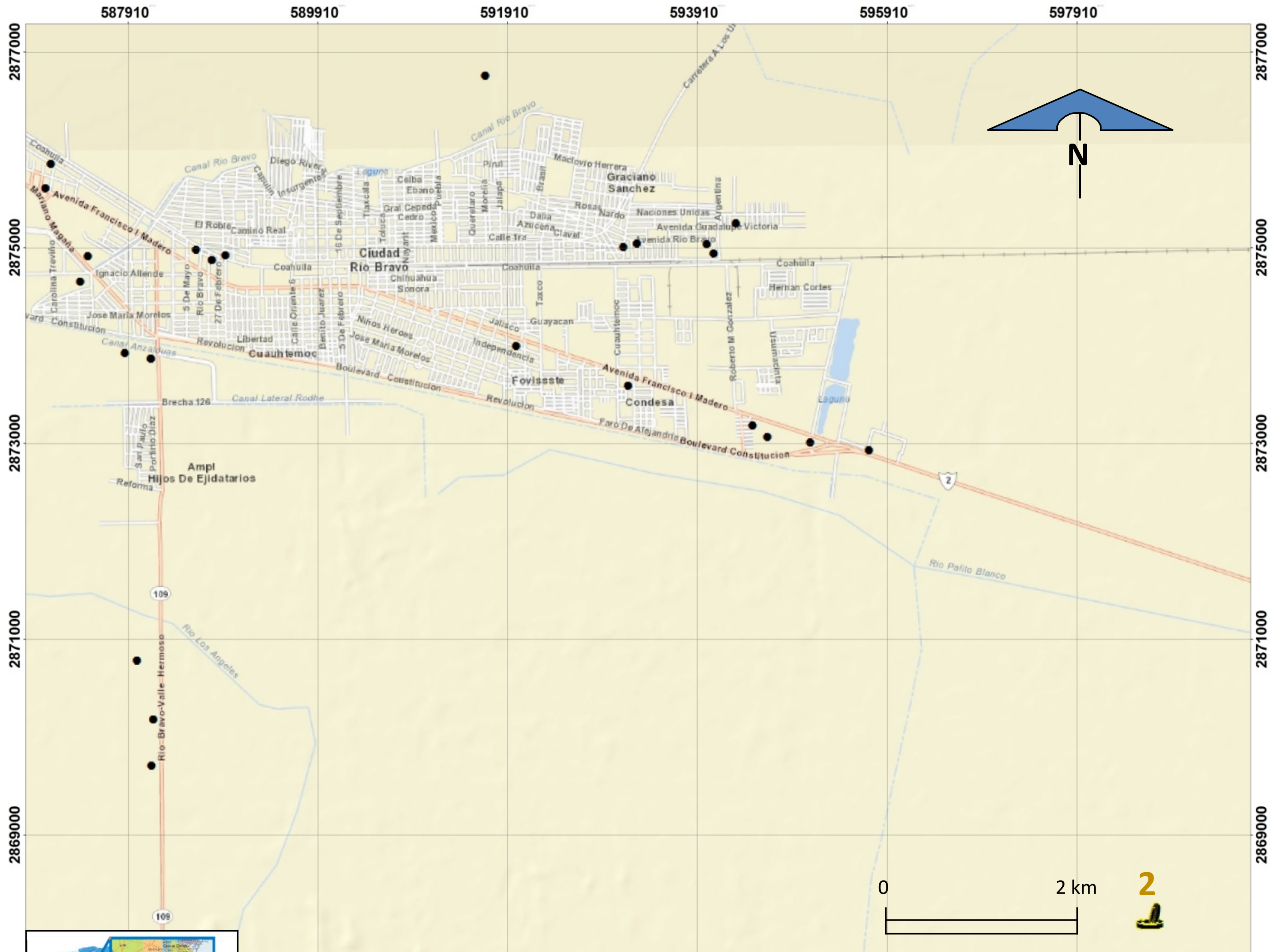
>1'000,000
100,000 - 1´000,000
10,000 - 99,999
500 - 9,999
Quantity unknown
<500 Non significant

I E M S

TITLE	PROJECT	DATE	SCALE.	
Gustavo Diaz Ordaz sites display map.	432.01	23/08/2012	Graphic	
CUENT.	LOCATION.	DRAWN BY.	CHECK.	EI
N A D B	Gustavo Diaz Ordaz Tamaulipas, Mexico.	Marcel Lopez	APRP	RV



556000
562000
568000
574000
580000
2888000
2884000
2880000
2876000
2872000
2868000
115
Mexico
Coma
HIDALGO
281
241
N
REYNOSA
40
LA ESCONDIDA
General Lucio Blanco Intl Airport
9
5
3
0
6 km
Site´s Identification Numbers
1, 14, 34, 33, 29, 24.
The color of the Id. number depends on the approximate amount of waste tires in the pile.
International border line.
Principal road.
Secondary road.
Minor road.
Town.
Perennial lake.
Rail.
watercourse. (presence of water not implied)
Non perennial stream.
Airport.
Municipal borderline.
Urban area.
Possible illegal tire pile.
Possible Junkyard.
Approximate amount of waste tires per pile:
>1'000,000
10,000 - 99,999
Quantity unknown
100,000 - 1'000,000
500 - 9,999
<500 Non significant
I E M S
TITLE
Reynosa sites display map.
PROJECT
432.01
DATE
23/08/2012
SCALE.
Graphic
CUENT.
N A D B
LOCATION.
Reynosa Tamaulipas, Mexico.
DRAWN BY.
Marcel Lopez
CHECK.
EI
APRP
RV



Site´s Identification Numbers

1, 14, 34, 33, 29, 24.

The color of the Id. number depends on the approximate amount of waste tires in the pile.

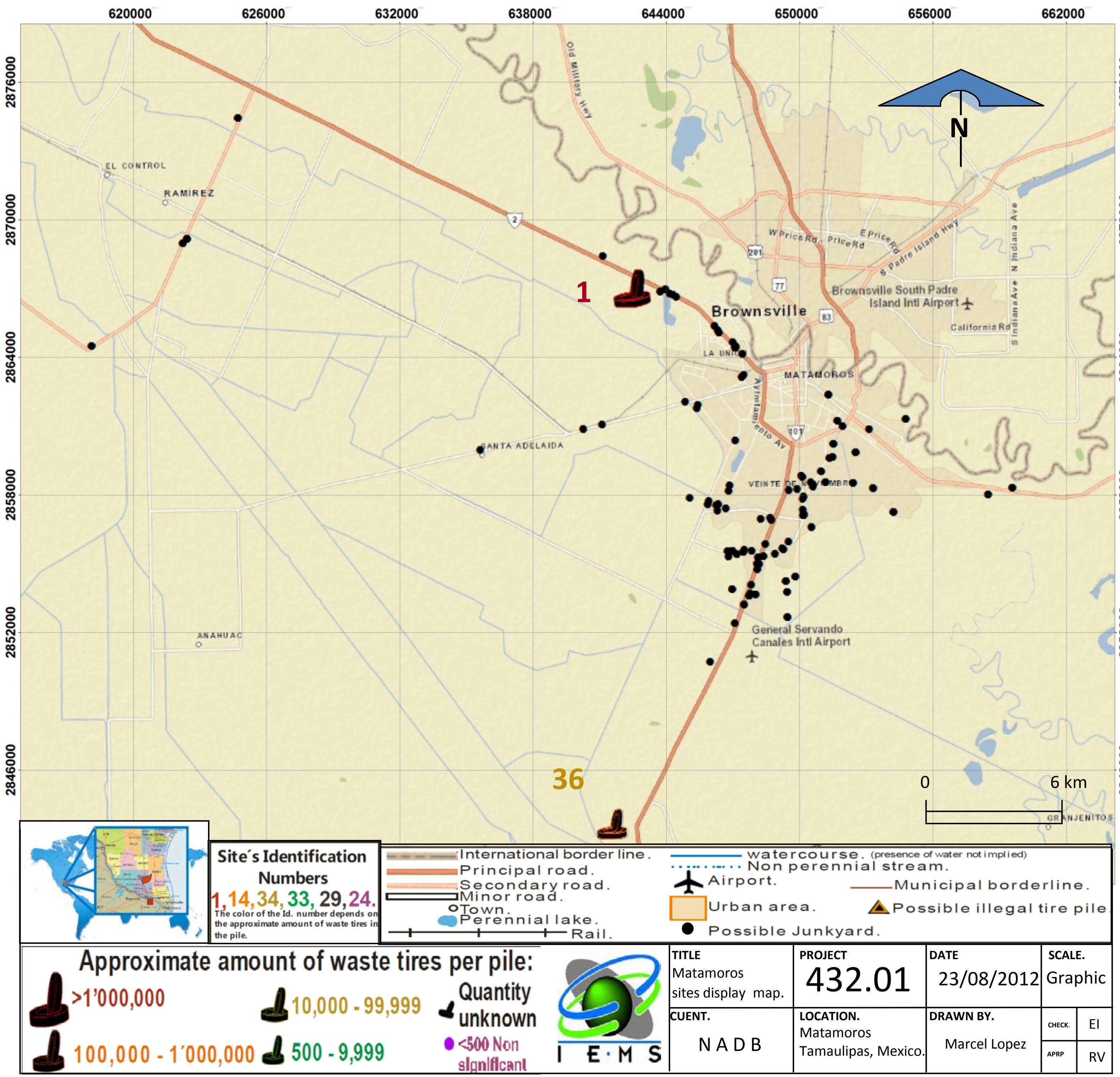
- International border line.
- Principal road.
- Secondary road.
- Minor road.
- Town.
- Perennial lake.
- Rail.
- watercourse. (presence of water not implied)
- Non perennial stream.
- Airport.
- Urban area.
- Possible Junkyard.
- Municipal borderline.
- Possible illegal tire pile.

Approximate amount of waste tires per pile:

- >1'000,000
- 100,000 - 1´000,000
- 10,000 - 99,999
- 500 - 9,999
- Quantity unknown
- <500 Non significant

I E M S

TITLE	PROJECT	DATE	SCALE.	
Rio Bravo sites display map.	432.01	23/08/2012	Graphic	
CUENT.	LOCATION.	DRAWN BY.	CHECK.	EI
N A D B	Rio Bravo Tamaulipas, Mexico.	Marcel Lopez	APRP	RV


620000
626000
632000
638000
644000
650000
656000
662000
2876000
2870000
2864000
2858000
2852000
2846000
N
Old Military Hwy
EL CONTROL
RAMIREZ
Brownsville
W Price Rd
Price Rd
E Price Rd
S Padre Island Hwy
N Indiana Ave
S Indiana Ave
Brownsville South Padre Island Intl Airport
California Rd
LA UNI
MATAMOROS
Ayuntamiento Av
SANTA ADELAIDA
VEINTE DE NOVIEMBRE
General Servando Canales Intl Airport
ANAHUAC
GRANJENITOS
1
36
0
6 km
Site´s Identification Numbers
1, 14, 34, 33, 29, 24.
The color of the Id. number depends on the approximate amount of waste tires in the pile.
International border line.
Principal road.
Secondary road.
Minor road.
Town.
Perennial lake.
Rail.
watercourse. (presence of water not implied)
Non perennial stream.
Airport.
Urban area.
Possible Junkyard.
Municipal borderline.
Possible illegal tire pile.
Approximate amount of waste tires per pile:
>1'000,000
100,000 - 1´000,000
10,000 - 99,999
500 - 9,999
Quantity unknown
<500 Non significant
I E M S
TITLE
Matamoros sites display map.
PROJECT
432.01
DATE
23/08/2012
SCALE.
Graphic
CUENT.
N A D B
LOCATION.
Matamoros Tamaulipas, Mexico.
DRAWN BY.
Marcel Lopez
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ATTACHMENT 5
Crackdown on Illegal Dumping - Handbook for Local Government

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4.0 ILLEGAL DUMPING PREVENTION TECHNIQUES

When researchers at University College London studied the opportunities that give rise to illegal dumping they found that conventional enforcement tactics can sometimes reduce the activity quickly but the effects soon fade without additional preventive measures. Whereas well-designed and well-focused illegal dumping prevention programs can have a substantial and long-term impact on illegal dumping.[12]

Which techniques councils choose to adopt will depend on the analysis of existing data and information. Importantly, the decision must focus on the mechanism most suited to the problem, for example, increase the effort or reduce the rewards, before going on to select the particular technique that's most likely to trigger it. Too often practitioners jump to the technique before thinking through how it is supposed to work and whether this is likely in the circumstances of the particular problem.

You will then need to monitor how it is done and the outcome to identify the need for any further intervention. This may involve refining the initial response, or if necessary trying something completely different. It may also be necessary to keep an eye on newly emerging problems so that they can be dealt with as quickly as possible. Where appropriate, a combination of mechanisms, if used strategically, can often be more effective.[12]

Figure 17 summarises the techniques you can use to tackle illegal dumping.

4.1 Increase the effort: make access difficult

In most cases illegal dumping takes very little effort. It can take more effort to dispose of waste legally than to dump it illegally. Councils can change the balance to make it easier to comply with the law and make it harder to not do so. Many areas continue to experience illegal dumping problems after being cleaned up. Effective structural solutions will increase the effort and risk of being caught thereby deterring offenders. Structural solutions can reduce accessibility to popular sites for illegal dumping.[12] A clean up plus introducing signs, lighting, barriers, landscaping or increasing the visibility of a site can contribute to reducing or eliminating continued dumping.

Structural approaches

Councils across NSW have used the following structural approaches, usually combined with a mix of education and regulation.

Lighting

When lighting is used in other crime prevention strategies it can be an effective deterrent in poorly lit or remote areas. This may be useful where dumping occurs under the cover of darkness. Additional lighting increases the visibility of the offender and increases the risk of being caught. The impact of sensor lights has yet to be evaluated.

Solar lights in hotspots

City of Canada Bay Council installed solar lights and signs in a dumping hot spot.

Outcome

The enhanced lighting has deterred dumping in the area and resulted in fewer complaints to the council. Anecdotal opinion is that other known dumping areas near this hot spot are also experiencing less illegal dumping.

Figure 17: The five main illegal dumping prevention mechanisms

1. Increase the effort: make access difficult (see Section 4.1)

- Make access difficult to hot spots using **structural approaches**, such as:
  - lighting
  - landscaping, revegetation or beautification
  - barriers, such as fences and locked gates, concrete blocks, logs and boulders and earth mounds.

2. Increase the risk of getting caught (see Section 4.2)

- Strengthen **surveillance**:
  - use surveillance cameras and signs to indicate the area is being watched
  - increase patrols in hot spots
  - assist community surveillance and reporting of suspect activities
  - use aerial surveillance in rural and remote areas.
- Carry out periodic, high-profile **compliance campaigns**.
- Use **partnerships** with other councils, agencies and stakeholders.
- **Publicise successes** as widely as possible.

3. Reduce the rewards: deny financial benefits (see Section 4.3)

- Provide and/or promote **free or subsidised waste services**.
- Issue **fines** to offenders.
- **Require offenders to clean up**.

4. Reduce provocations: don't give them a reason to dump (see Section 4.4)

- Provide **efficient and well communicated waste services**.
- Ensure **reasonable waste service costs** where possible.
- Foster **community pride** by enhancing the area's aesthetic appeal.
- **Keep areas free of illegally dumped material**.

5. Remove excuses: educate and inform the community (see Section 4.5)

- **Publicise waste services**.
- Carry out **education programs** outlining responsibilities.
- **Keep areas free of illegally dumped material**.
- Install **signs** at hot spots with illegal dumping prevention messages.

It is crucial to alter the perceived as well as the actual degree of effort, risk and reward involved.[12]

Landscaping, revegetation and beautification

Landscaping and revegetating a site can indicate it is valued, monitored and used. Simple landscape activities, such as grass cutting and weed removal, can be enough in some areas to suggest that a site is cared for and maintained, which will deter some of the nuisance dumping offenders.

Beautification, such as benches, pathways, picnic tables, murals or flowerbeds, can change a community's perception of a site. Many communities will get involved in and take part in projects that build community pride and can lead to changed perceptions and increased community surveillance, which all contribute to increasing the risk for people illegally dumping.

Barriers

Physical barricades that restrict access are very effective for reducing dumping in areas with a single point of entry, such as lanes, fire trails and private roads. Fences, posts, earth mounds, bollards and rocks have all been used to prevent vehicle access. Each site is unique and therefore deterrents need to be carefully managed and planned. On some sites a single barrier blocking access is all that is required. In some cases offenders may be able to continue to dump over a barrier, but this increases the risk of being caught and may deter the majority of offenders.

Councils used funding from the 2002-2004 Illegal Dumping Clean-up and Deterrence Grants to build a range of physical barriers with varying success. They reported that some sites were difficult to enclose.

Beautification: Woollahra Municipal Council's 'Liveable Lanes' project

Woollahra Municipal Council's 'Liveable Lanes' project was designed to change its community's perception of back lanes as a dumping ground. The council was committed to beautify and improve the look and feel of the area to increase community pride and, therefore, reduce the incidence of illegal dumping. It used a 2002-2004 Illegal Dumping Clean-up and Deterrence grant to clean up dumping hot spots, landscape them and carry out an education campaign to deter future dumping. Minor capital works in the area complemented the educational component.

The council developed its project in an attempt to keep sites clean long after the campaign had finished. A second part of the project focused on a reserve that experienced persistent dumping. It used landscaping works, including new plants for garden beds, to improve the aesthetics of the area and detract dumpers. The new plants were selected to make it difficult to hide bags and other dumped rubbish, as was previously the case. Plants were widely dispersed so that the garden is more open to deter other anti-social behaviours. The council also built a retaining wall to stop bins being dragged through, presented and stored in the garden area.

Woollahra Municipal Council attributes the success of its project to a multidisciplinary team of council staff, including team members from communications, waste section, compliance, outdoor works and management, who collaborated and brought together areas of the project according to their expertise. A broader, more strategic prevention program can bring in representation from much wider sections of council asking for comments on program design, use and evaluation. The project is also a good example of community participation where the council values the community as a partner.

Outcome

The enhancement of the Oswald Street Reserve has provided the most positive results in improved environment. Dumps in this area have decreased and been maintained over a five-month period.

4

Fences and locked gates

Many councils used illegal dumping clean up and deterrence grants of 2002-2004 to install fences and locked gates.

Some councils indicated that new gates and locks were vandalised almost immediately after installation. Locks were tampered with or gates and fences broken down. For some dumpers, locked gates "just seem to be an invitation to become a vandal as well". Often there was no real alternative to fences and gates and so many councils need to consider vandalism in project planning as either programmed maintenance scheduled for a period of time or as the additional cost of vandal-resistant materials.

At a number of sites vandal-resistant locks, locking bollards and almost indestructible fence materials have been carefully selected.

Concrete blocks

A number of councils reported using concrete blocks to barricade entry to a site. This was described as a 'relatively cheap, inexpensive and effective option'. For many residents though the blocks are unsightly, do not fit in with the natural environment and may incur complaints to council. Some sites had experienced graffiti soon after installing the blocks.

Indestructable fencing materials

Tharawal Local Aboriginal Land Council (LALC) and DECC Parks and Wildlife Division used almost indestructible fence materials at a remote site in Wedderburn to prevent 4WD and commercial vehicles dumping materials. The adjoining landholder (industry) donated railway track and steel rope, which was used to erect a 500-metre fence line.

Outcome

The fence has remained intact and unauthorised vehicles have been kept out.

Fences to protect rural hotspots

Maitland City Council selected a rural style fence to restrict vehicle access at some rural sites.

Outcome

It helped reduce illegal dumping on the sites and restricted access to a small stockpile area for local road reconstruction works. Four of the five fenced sites continued to show little signs of illegal dumping activity 12 months after the project.

ATTACHMENT 6
Display map of appropriate tire disposal alternatives identified in Texas

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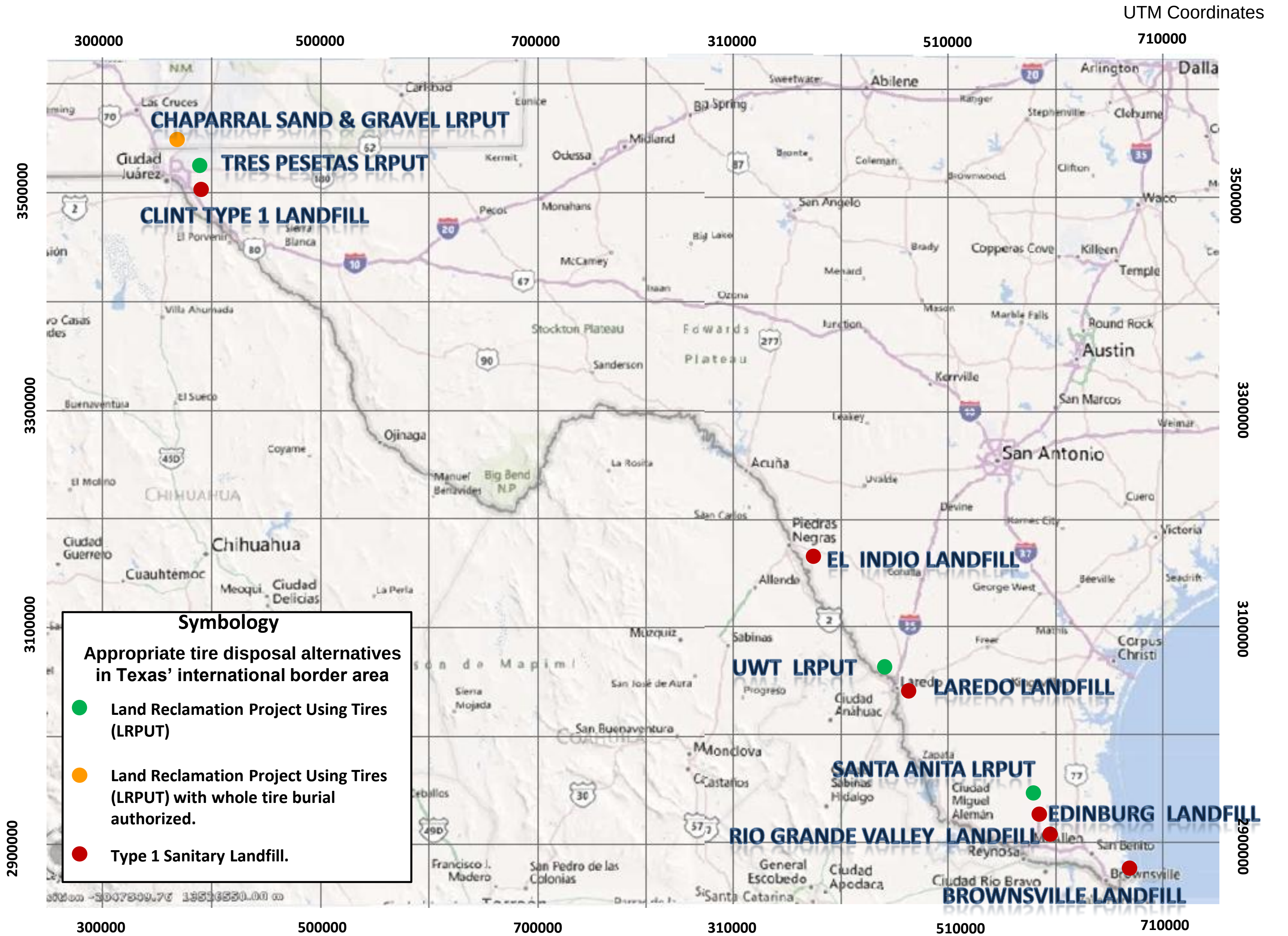

Note: Sites colored according to social and/or environmental performance, being green the most recommended, and red the least recommended alternative .Although all are considered appropriate tire disposal alternatives by this study.

ATTACHMENT 7
Display map of appropriate tire disposal alternatives identified in the Mexican side of the Texas-Mexico Border Area

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110°0'0"W
105°0'0"W
100°0'0"W
32°0'0"N
30°0'0"N
28°0'0"N
26°0'0"N
24°0'0"N
Mesa
Alamogordo
Las Cruces
Carlsbad
Tucson
El Paso
Odessa
Abilene
Fort Worth
Dallas
Garland
TEXAS
Douglas
San Angelo
Waco
GCC PLANTA SAMALAYUCA
Austin
SONORA
Houston
San Antonio
Del Rio
Hermosillo
ACUÑA MUNICIPAL LANDFILL
Victoria
Chihuahua
PIEDRAS NEGRAS PRIVATE LANDFILL
GCC PLANTA CHIHUAHUA
CHIHUAHUA
COAHUILA
Corpus Christi
Laredo
McAllen
CEMEX PLANTA HIDALGO
Brownsville
Monterrey
SINALOA
APASCO- PLANTA RAMOS ARIZPE
APASCO
CEMEX PLANTA MONTERREY
NUEVO LEÓN
Saltillo
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