TABLE OF CONTENTS

I. Introduction .......................................................................................................................... 1

II. Acoustic Analysis ................................................................................................................ 3-6
   1. Methodology
   2. Site Selection
   3. Data Recording Equipment
   4. Procedures
   5. Data Reduction

III. Results and Discussion ....................................................................................................... 6-10
   1. Sound Levels
   2. Relationships between noise level and perceived annoyance
   3. Measured Noise Levels
   4. Noise Level Contours
   5. Conclusion

IV. Appendix ............................................................................................................................ 11-24
   Figure 3. Noise Impact Level Contours (Union Pacific Railroad)
   Figure 4. Noise Impact Level Contours (Texas Mexican Railway)
   Figure 5. Site - 1
   Figure 6. Site - 2
   Figure 7. Site - 3
   Figure 8. Site - 4
   Figure 9. Site - 5
   Figure 10. Site - 6
   Figure 11. Site - 7
   Figure 12. Site - 8
   Figure 13. Site - 9

V. References ........................................................................................................................... 22
List of Tables

Table 1.  Community Noise Impact .................................................................................................................9

List of Figures

Figure 1. Study Area ..................................................................................................................................................2
Figure 2. Noise Impact Criteria ..............................................................................................................................7
1. **INTRODUCTION**

   This noise study is an effort to define existing noise and train noise sound levels at several at-grade railroad crossings in Laredo, Texas. The study area consists of selected at-grade rail crossings inside a 400 foot buffer zone around both the Texas-Mexican Railway (east/west) and the Union Pacific Railroad lines, as shown in Figure 1. Noise monitors were set-up at a variety of distances, ranging from 50 to 400 feet within the study buffer and up to 650 feet beyond the buffer zone in some instances. Certain rail crossings of major interest were specifically monitored to insure a thorough representation of sound levels when a train horn is sounded at a nearby railroad crossing. A total of twelve (12) railroad sites (9 crossings total) were studied, including four (4) sites along the Union Pacific Railroad line and the remaining eight (8) sites along the Texas-Mexican Railway line. Additional noise readings around Mier, Garfield, and Corpus Christi Streets where taken outside the 400 foot study buffer in order to evaluate noise levels as the railroad track curves away from a straight line. These measurements were taken to determine what kind of impact, if any, train horns have at further distances within residential areas. Though the Texas-Mexican line contained more studied rail crossings, this was due primarily to the large concentration of residential dwellings along this rail line as compared to the Union Pacific line, which traverses more commercial properties.

   For motorist and pedestrian safety, a locomotive engineer regularly sounds a train-mounted horn as the train approaches any at-grade railroad crossing. The horn is sounded usually within 500 feet of the crossing since train speeds are generally in the 5-15 mile per hour range within the study area. This warning also exposes residents and businesses located along or near the railroad tracks and adjacent to all of the crossing locations to the noise. Since this warning is intended for vehicles and pedestrian traffic using the crossings, these residents and businesses perceive the resulting noise as highly annoying.
FIGURE 1. Study Area
Federal regulations (CFR 229.129, 1992) require that all train horns be at least 96 dBA 100 feet in front of the train in its direction of travel. For the noise or loudness to be detected, the horn intensity must exceed any background noise level. A 10 dBA increase above background noise levels is considered sufficient to be noticeable. For any resident living 100 feet from the rail grade crossing, the signal may range from 46-66 dBA above existing background levels outside the house.

Speech interference may occur at noise levels above 70 dBA. The horn also interferes with activities that require concentration, such as reading or studying. This noise also interferes with sleeping and sleeping patterns.

Along the study area, the structure of the individual house or building affected by the train noise is directly related to reducing some of the noise levels in the building. The noise loses strength (attenuates) as it passes through walls and windows. This is very evident along the Texas-Mexican line, as residential dwellings are densely populated all along this track. Due to Laredo’s warm climate, windows and doors are more likely to be left open to ventilate, exposing occupants to higher train horn noise levels. Also, studies have shown that sounds are more annoying when they cannot be controlled by the individual(s) affected, such as train horns or gate crossing signals.

II. ACOUSTIC ANALYSIS

1. Methodology

The Laredo Rail Noise Study analysis involved taking noise readings for both existing (ambient) noise levels without trains and noise levels with trains at select locations throughout the study area. This information was evaluated and tabulated using formulas for $L_{\text{day-night}}$, $L_{\text{day}}$ and $L_{\text{night}}$ readings. For clarity of this report, the following definitions apply:
### Decibel (dB)

- Is the general strength of noise.

### A-Weighted Sound Level (dBA)

- Is a receiver’s noise at any given moment. It describes a receiver’s noise at any moment in time. The letter “A” indicates that sound has been filtered to reduce the strength of very low and very high-frequency sounds, as much as the human ear does.

### Maximum Level ($L_{max}$)

- Occurs during a single noise event.

### Sound Exposure Level (SEL)

- Is the receiver’s cumulative noise exposure from a single noise event.

### Hourly Equivalent Sound Level ($L_{eq}$)

- Is the receiver’s cumulative noise exposure from all events over a one-hour period.

### Day Sound Level ($L_{day}$)

- Is the cumulative noise exposure from all events (noise) between the hours of 7 a.m. and 10 p.m.

### Night Sound level ($L_{night}$)

- Is the cumulative noise exposure from all events (noise) over between 10 p.m. and 7 a.m.

### Day-Night Sound Level ($L_{dn}$)

- Describes a receiver’s cumulative noise exposure from all events (noise) over 24 hours, with events between 10 p.m. and 7 a.m. increased by 10 dB to account for greater nighttime sensitivity to noise.

---

2. **Site Selection**

   As mentioned earlier, a total of twelve (12) railroad sites (9 crossings total) were studied. These sites and crossings, along with individual noise monitor locations, are all shown within the study area as located within *Figures 5 through 13* in the Appendix. Specific site locations were selected mostly because of their proximity to residential or commercial neighborhoods, as well as other areas of interest requested by the city of Laredo. Commercial establishments were considered less vulnerable to train noise and/or any related impacts, since these locations would likely be vacated at night. Land use within the study area varies from residential, commercial, industrial, and mixtures of these types.

3. **Data Recording Equipment**

   Equipment used in this noise study included one (1) Metrosonics dB-308 noise meter, one (1) Metrosonics dB-3080 noise meter, and one (1) Metrosonics dB-3100 noise meter.
meter. Each instrument is capable of recording the maximum A-weighted sound levels of individual noise events. In addition, these instruments measure the average sound levels \( L_{eq} \), minimum sound levels \( L_{min} \) and sound exposure levels (SEL). All instruments were calibrated in accordance with the manufacturer’s instructions.

Air temperature, wind speed, wind direction and relative humidity levels were evaluated by local Laredo News Channels at various times throughout the day/night. Train-related data was obtained from Texas-Mexican Railway or Union Pacific Railroad, but some individual assessments were made in the field, such as individual train speeds which repeatedly varied.

4. Procedures

Field personnel included a two (2) person team. The majority of the field work was between 6:00 am and 9:00 pm. All readings took place the week of May 17 to May 21, 2005. Noise readings were most frequently taken at locations 50, 100, and 200 feet from the railroad tracks. Some sites did not allow this to occur due to the area or the layout. In some instances, readings were also taken at 300- and 400-foot distances. Noise measurements, taken outside the 400-foot buffer, were also recorded at the request of the City of Laredo, to determine dBA levels around track curvatures. Ambient (existing) noise levels were also taken at these same locations. Time intervals varied from 5-10 minutes to 30-40 minutes. By varying intervals, we were able to achieve a more comprehensive recording of real time noise conditions, while allowing us to get a fair assessment of the existing conditions within the project area.

Noise meters were hand-held with microphones attached to their respective noise monitor at a distance of approximately four (4) feet above the ground.

5. Data Reduction

At the end of each noise reading, all of the data from the noise meters were recorded from printed hardcopy noise tables. This information was also transferred to computer using Excel® spreadsheets and is shown in Table 1.

Specific formulae used in the noise analysis are noted as follows:
Let $L_{dn} = SEL + 10 \log (number \ of \ trains/day + 10 \ (number \ of \ trains/night)) - 49.4$

Let $L_{day} = SEL + 10 \log (number \ of \ trains/day) - 47.3$

Let $L_{night} = SEL + 10 \log (10 \ (number \ of \ trains/night)) - 45.1$

SEL is the average SEL for the given location. Within a 24-hour period, the total number of trains varied from around seven (7) on the Texas-Mexican line, to around fifteen (15) on the Union Pacific line. The daytime train average is calculated by using a factor of 15/24 times the total number of trains. The nighttime train average is calculated by using a remaining factor of 9/24 times the total number of trains.

III. RESULTS AND DISCUSSION

1. Sound Levels

$L_{max}$ is the sound measure selected to describe the maximum sound levels produced by the train horn. $L_{dn}$ is the sound measure used to describe the community noise impact of the train horn. $L_{dn}$ is commonly used because it accounts for people’s increased sensitivity to noise at night by imposing a 10 dB penalty on all nighttime sounds.

2. Relationships between noise level and perceived annoyance:

Several agencies, including the Federal Transit Authority (FTA) and Environmental Protection Agency (EPA), have defined 65 dBA as the noise level at which the community annoyance is considered a problem requiring action. Three (3) levels of impact are defined — (1) No Impact; (2) Impact; and (3) Severe Impact – and are shown in Figure 2.
FIGURE 2. Noise Impact Criteria

Source: Transit Noise and Vibration Impact Assessment, prepared by Harris, Miller, Miller and Hanson, Inc.

Agencies have determined that a 5 dBA increase over ambient (background) noise levels for Ldn or Leq is the minimum requirement for a change in community reaction. Specifically, the impact areas are described below:

1. The **No Impact** area is defined as the threshold at which the percentage of people highly annoyed by the noise is not measurable.
(2) The **Impact** area is defined as the threshold at which the percentage of people highly annoyed by the noise starts to become measurable.

(3) The **Severe Impact** area is defined as the threshold at which the percentage of people highly annoyed becomes significant. The increase in noise levels is likely to produce strong, adverse reactions from the community.

Category 1, 2 and 3 land uses are defined as follows:

**Category 1** – Outdoor $L_{eq}$: Tracts of land where quiet is an essential element in their intended purpose. This would include lands set aside for serenity and quiet, along with National Historic Landmarks with significant outdoor use.

**Category 2** – Outdoor $L_{dn}$: This includes residences and buildings where people normally sleep, such as homes, hospitals and hotels, where a nighttime sensitivity to noise is assumed to be of utmost importance.

**Category 3** – Outdoor $L_{eq}$: This category includes institutional land uses with primarily daytime and evening use, such as schools, libraries and churches. Land use for Category 3 is less sensitive to noise that Category 1.

3. **Measured Noise Levels:**

Noise levels from both existing and train noise conditions are shown in Table 1. These levels compare existing noise with train noise for each site that was analyzed. All recorded noise sites were identified as **Category 2** land use. As shown in the table, Chicago Street had the highest average noise level for $L_{eq}$, $L_{dn}$, $L_{day}$ and $L_{night}$. Conversely, Loring Avenue had the lowest average noise readings for $L_{eq}$, $L_{dn}$, $L_{day}$ and $L_{night}$. Springfield Avenue and Maryland Avenue actually had lower noise levels compared to Loring Avenue, but measurements were taken in an area east of the Texas-Mexican rail line rather than at a crossing. While measurements at Springfield and Maryland do not correspond to a particular crossing, they yielded valuable distance noise measurements nevertheless. The highest average $L_{max}$ was located at Chicago Street (96.6) and the lowest average $L_{max}$ was at Madison Street (78.7). The average $L_{max}$ for Springfield Avenue was actually lower. However, as noted above, the measurement there was not an equivalent measurement: the measurement was not at a crossing, but at a location east of the rail line.
TABLE 1.

### TABLE 1. COMMUNITY NOISE IMPACT

<table>
<thead>
<tr>
<th>Site Location</th>
<th>Street Crossing</th>
<th>Ambient Leq</th>
<th>Ambient Ldn</th>
<th>Leq</th>
<th>Ldn</th>
<th>Type of Impact</th>
<th>Lday</th>
<th>Type of Impact</th>
<th>Lnight</th>
<th>Type of Impact</th>
<th>Lmax</th>
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</thead>
<tbody>
<tr>
<td>#1</td>
<td>Chicago Street</td>
<td>58.5</td>
<td>54.9</td>
<td>71.9</td>
<td>70.9</td>
<td>Severe</td>
<td>65.3</td>
<td>Severe</td>
<td>72.3</td>
<td>Severe</td>
<td>96.6</td>
</tr>
<tr>
<td>2</td>
<td>Baltimore Street</td>
<td>64.4</td>
<td>66.1</td>
<td>71.4</td>
<td>64.5</td>
<td>Impact</td>
<td>58.8</td>
<td>No Impact</td>
<td>85.8</td>
<td>Impact</td>
<td>94.2</td>
</tr>
<tr>
<td>3</td>
<td>Buena Vista Avenue</td>
<td>60.7</td>
<td>53.7</td>
<td>66.6</td>
<td>58.9</td>
<td>Impact</td>
<td>53.8</td>
<td>No Impact</td>
<td>62.3</td>
<td>Severe</td>
<td>91.6</td>
</tr>
<tr>
<td>4</td>
<td>Monterey Avenue</td>
<td>61.6</td>
<td>57.3</td>
<td>62.7</td>
<td>58.5</td>
<td>Impact</td>
<td>53.4</td>
<td>No Impact</td>
<td>61.9</td>
<td>Impact</td>
<td>84.6</td>
</tr>
<tr>
<td>5</td>
<td>*Springfield Avenue</td>
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<td>51.5</td>
<td>52.0</td>
<td>50.8</td>
<td>No Impact</td>
<td>45.7</td>
<td>No Impact</td>
<td>54.2</td>
<td>Impact</td>
<td>75.7</td>
</tr>
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<td>Sanders Avenue</td>
<td>61.6</td>
<td>55.7</td>
<td>64.4</td>
<td>61.5</td>
<td>Impact</td>
<td>56.4</td>
<td>Impact</td>
<td>64.9</td>
<td>Severe</td>
<td>90.3</td>
</tr>
<tr>
<td>7</td>
<td>*Maryland Avenue</td>
<td>60.5</td>
<td>56.7</td>
<td>60.2</td>
<td>55.8</td>
<td>No Impact</td>
<td>50.7</td>
<td>No Impact</td>
<td>59.2</td>
<td>Impact</td>
<td>80.4</td>
</tr>
<tr>
<td>8</td>
<td>Loring Avenue</td>
<td>54.5</td>
<td>48.1</td>
<td>59.0</td>
<td>54.9</td>
<td>Impact</td>
<td>49.8</td>
<td>No Impact</td>
<td>58.3</td>
<td>Impact</td>
<td>87.9</td>
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<tr>
<td>9</td>
<td>Zaragoza Street</td>
<td>57.8</td>
<td>57.8</td>
<td>69.3</td>
<td>62.1</td>
<td>Impact</td>
<td>57.0</td>
<td>Impact</td>
<td>65.5</td>
<td>Severe</td>
<td>93.8</td>
</tr>
<tr>
<td>10</td>
<td>Madison Street</td>
<td>59.1</td>
<td>55.2</td>
<td>61.5</td>
<td>65.1</td>
<td>Severe</td>
<td>57.9</td>
<td>Impact</td>
<td>66.4</td>
<td>Severe</td>
<td>78.7</td>
</tr>
<tr>
<td>11</td>
<td>River/Drainage Area Between San Francisco / Monterrey Avenues</td>
<td>57.5</td>
<td>53.3</td>
<td>60.2</td>
<td>55.3</td>
<td>Impact</td>
<td>50.2</td>
<td>No Impact</td>
<td>58.7</td>
<td>Impact</td>
<td>82.8</td>
</tr>
<tr>
<td>12</td>
<td>Main Avenue</td>
<td>62.6</td>
<td>56.7</td>
<td>69.3</td>
<td>64.6</td>
<td>Severe</td>
<td>59.5</td>
<td>Impact</td>
<td>67.9</td>
<td>Severe</td>
<td>93.8</td>
</tr>
</tbody>
</table>

* Sound measurement taken east of the railroad track.

Notes: Leq and Lmax values are measured averages for each site location.  
$Ldn = SEL + 10 \log (\# \text{Trains/day} + 10(\# \text{Trains/night})) - 49.4$

$Lday = SEL + 10 \log (\# \text{Trains/day}) - 47.3$

$Lnight = SEL + 10 \log (10(\# \text{Trains/night}) - 45.1$

Land uses were assumed to be Category 2.

The Texas-Mexican Railway line is located within a highly residential layout, running west to the Union Pacific Railroad line. Some commercial buildings are also located there. Existing traffic noise, combined with other existent ambient noise levels, tended to minimize annoyance from train horns, especially during daytime hours. The Union Pacific Railroad, heading north from Zaragoza Street, continuing to the uppermost...
portion of the study area, is associated with more industrial and commercialized areas than the Texas-Mexican Rail line. It was observed that much refueling took place along this line at various times during the day. This only increased ambient noise levels, as the train engines were not shut off and ran throughout the refueling process.

4. **Noise Level Contours**:

Average impact noise level contours are shown within Figures 3 and 4. Noise contours were developed from noise (train horn) impact field data taken from the Texas-Mexican and Union Pacific rail lines. The calculated averaged impacts, where shown as individual color shades ranging from 55 dBA along the outer border, up to 75 dBA found along the actual rail lines. Contour mapping should be considered as a “general” assessment of real world average conditions along both rail lines and should be used primarily as a reference regarding noise variables in Laredo.

5. **Conclusion**:

Of the sites analyzed for this study (See Table 1.), only three (3) sites Chicago Street, Madison Street, and Main Avenue, have a “severe impact” for $L_{dn}$ upon existing noise levels during times of train crossings when the train horn is sounded. This report emphasizes $L_{dn}$ impacts because this measurement covers noise over a 24-hour period. Of the remaining nine (9) sites, seven (7) sites achieved an “impact” classification including Baltimore Street, Buena Vista Avenue, Monterrey Avenue, Sanders Avenue, Loring Avenue, Zaragoza Street, and the River/Drainage Area between San Francisco Avenue and Monterrey Avenue. The remaining two (2) sites, Springfield Avenue and Maryland Avenue, have been classified as “non-impact” sites. These classifications where based solely upon the noise levels taken in the field at various locations. It should be noted that train horns are sounded at varying intervals and lengths of sound depending on the train operator, thus yielding varying noise parameters at any given moment.
IV. APPENDIX

FIGURE 3.
FIGURE 4.
FIGURE 7.
FIGURE 11.
FIGURE 12.
FIGURE 13.
V. REFERENCES


3. *METROSONICS db-308 NOISE MONITOR* 1060 Corporate Center Drive, Oconomowoc, WI 53066, 2002.
