High-Speed Rail Potential in South Texas

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1. Executive Summary

This report comprehensively analyzes the high-speed rail potential between the Rio Grande Valley and the Laredo Metro Area in South Texas. Leveraging geospatial analysis with QGIS and the Gravity Model for transportation planning, our findings indicate a significant potential for passenger traffic between these two burgeoning regions. The Rio Grande Valley, with a 2020 population of 948,877, and the Laredo Metro Area, with 262,646 residents, represent a substantial demographic base for a high-speed rail corridor. Based on 146 miles between the approximate midpoints of these areas, our calculations suggest an annual passenger volume of approximately 2.92 million. Furthermore, projecting a conservative 30% capture rate for high-speed rail translates to over 876,000 potential annual high-speed rail passengers. These figures underscore the economic viability and strategic importance of investing in advanced transportation infrastructure to foster regional connectivity and sustainable growth in South Texas.

2. Introduction

The landscape of transportation infrastructure is continually evolving, driven by the imperatives of economic development, environmental sustainability, and enhanced regional connectivity. In South Texas, a region characterized by dynamic population growth and increasing economic interdependence, high-speed rail has emerged as a compelling solution to address existing transportation challenges and unlock new opportunities. This report, prepared by the Cambrian Business Analytics Group, delves into the feasibility and potential ridership of a high-speed rail link connecting the vibrant Rio Grande Valley with the strategically important Laredo Metro Area.

The primary objective of this study is to provide a data-driven assessment of the potential for a high-speed rail corridor, focusing on demographic patterns, geographical considerations, and established transportation modelling techniques. The Rio Grande Valley, encompassing major cities such as McAllen, Brownsville, and Edinburg, is a significant economic and cultural hub, while Laredo is a critical international trade gateway. The current transportation network, predominantly reliant on roadways, faces increasing congestion and travel times, highlighting the need for innovative alternatives.

Our analysis employs a multi-faceted approach, integrating advanced geospatial techniques using QGIS to delineate the study areas and calculate critical geographical parameters precisely. This is complemented by applying the Gravity Model, a widely recognized tool in transportation planning, to estimate potential passenger flows based on population masses and inter-urban distances. The scope of this report is specifically confined to the Rio Grande Valley and Laredo Metro Area, with a detailed examination of their respective populations and the distance separating them. By providing a robust quantitative foundation, this report aims to inform stakeholders and decision-makers regarding the strategic potential of high-speed rail in fostering a more integrated, efficient, and prosperous South Texas.

3. Methodology

A systematic methodology was adopted to integrate diverse data sources with advanced geospatial and transportation modelling techniques to ensure a rigorous and comprehensive analysis of the high-speed rail potential between the Rio Grande Valley and the Laredo Metro Area. This section details the specific steps and tools employed in this research.

3.1 Data Sources

This study's foundation rests upon various credible and up-to-date data sources. The primary demographic inputs were derived from the provided “Rio Grande Valley Population Sheet” and “Laredo Metro Area Population” data, which detailed the 2020 population figures for individual cities within each respective metro area. For granular population data at the city level, the U.S. Census Bureau’s QuickFacts website (census.gov) was a reliable source for demographic statistics [1].

Geospatial data was critical for accurately defining the study areas and calculating distances. The Texas Census Tract shapefile (2022), obtained from catalog.data.gov [2], provided the foundational geographical boundaries for the state and its subdivisions. Screenshots from data.census.gov [3] were employed to refine city-specific boundaries, particularly for Rio Grande City, Brownsville, and Laredo. Furthermore, an updated Texas City Boundaries shapefile (June 12, 2025) from gis-txdot.opendata.arcgis.com [4] was instrumental in identifying and extracting cities within the defined buffer zones.

3.2 Geospatial Analysis (QGIS)

Geospatial analysis was performed using **QGIS Desktop 3.42.3**, a powerful open-source Geographic Information System. The steps undertaken are detailed as follows:

1. **Base Map Integration**: A QGIS Standard base map layer was inserted to provide a geographical context for the analysis.
2. **Texas Boundary Delineation**: The Texas Census Tract shapefile (2022) was used to identify and visualize the Texas state boundaries and its internal subdivisions. This provided a foundational layer for subsequent spatial operations.

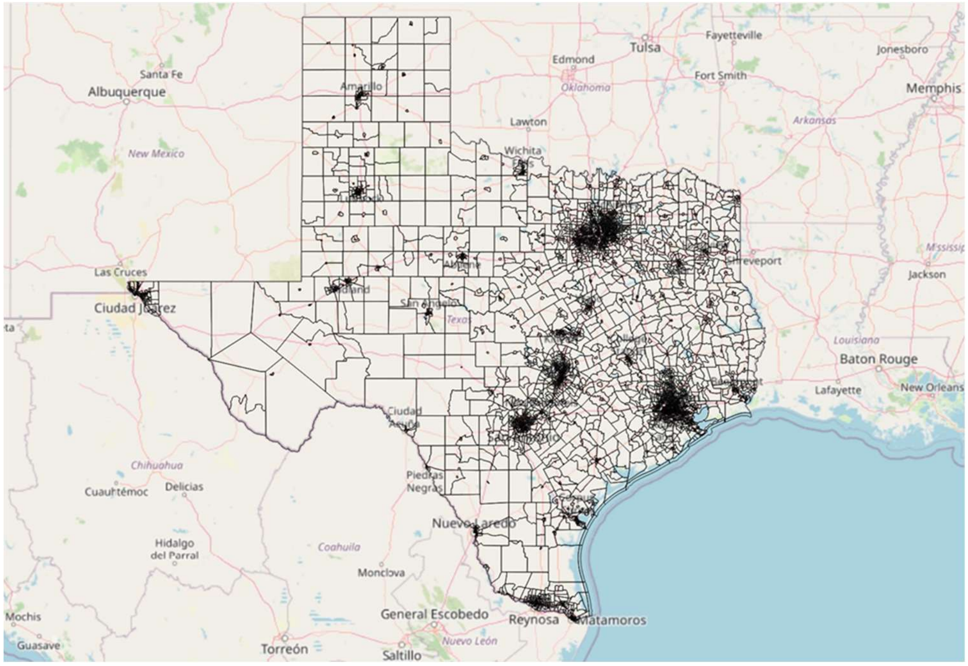

Figure 1: 2022 Texas Census Tract Shapefile layer over the base map layer

3. **City Boundary Georeferencing**: Screenshots of city boundaries from data.census.gov for Rio Grande City, Brownsville, and Laredo were georeferenced within the QGIS environment using the Georeferencer tool. This process aligned the image data with real-world coordinates, enabling accurate spatial analysis.

Figure 2: Screenshot of Rio Grande City Boundary

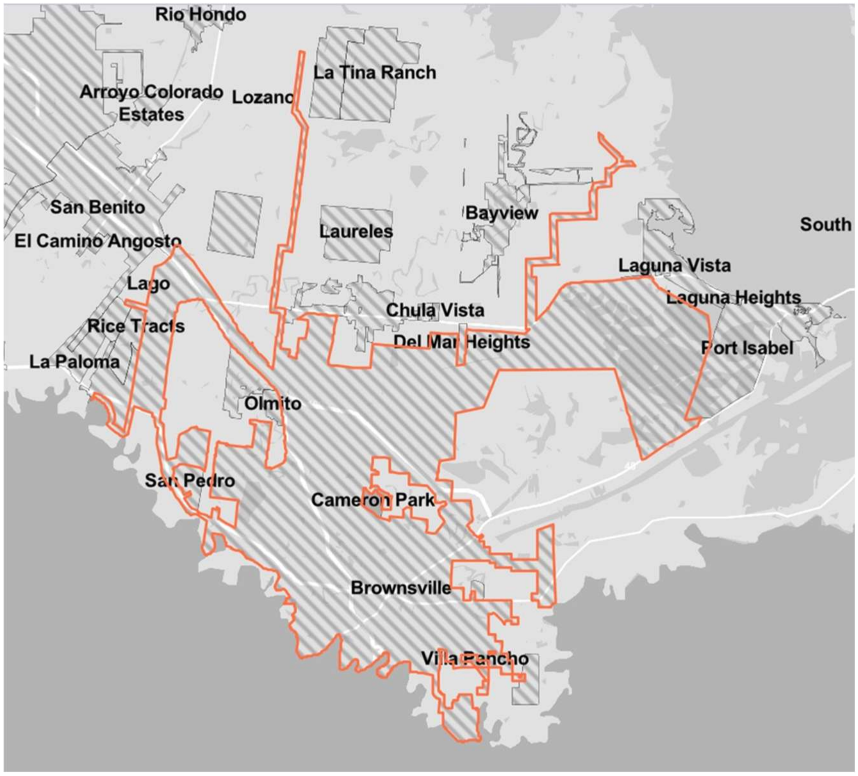

Figure 3: Screenshot of Brownsville City Boundary

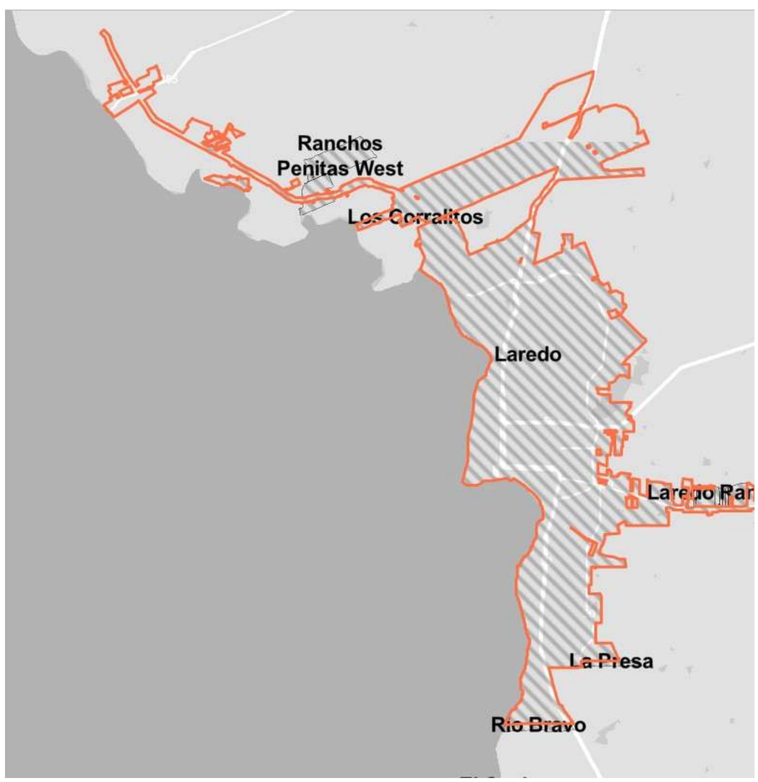

Figure 4: Screenshot of Laredo City Boundary

4. **Polygon Feature Creation**: Following georeferencing, three distinct polygon layers were created by manually drawing the boundary shapes for each city: Rio Grande City, Brownsville, and Laredo. These polygons represented the precise geographical extent of each urban area.

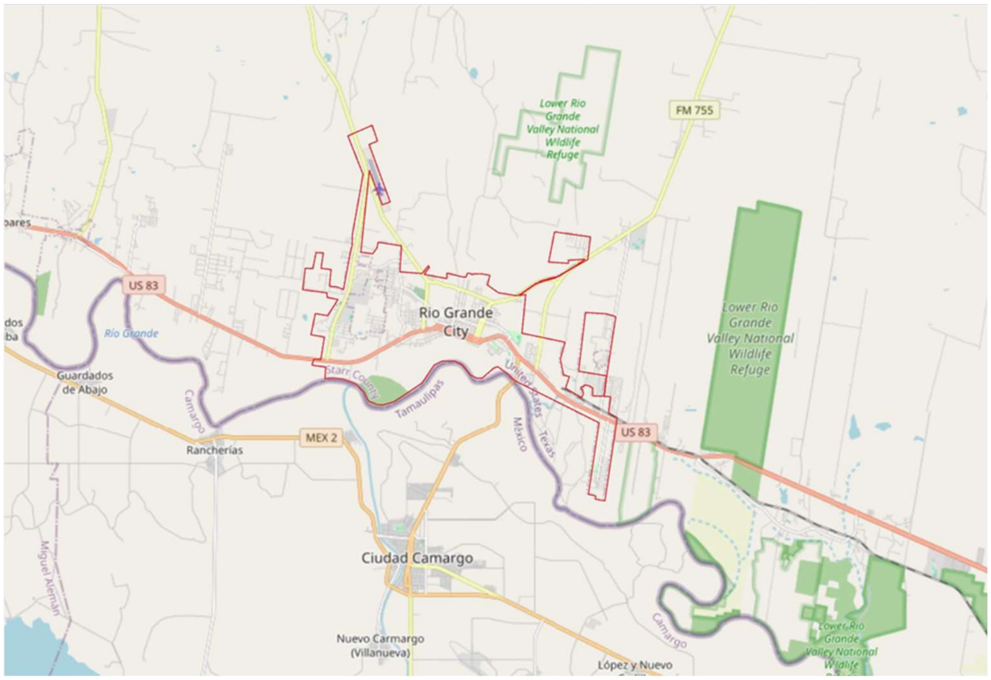

Figure 5: Rio Grande City Boundary Polygon

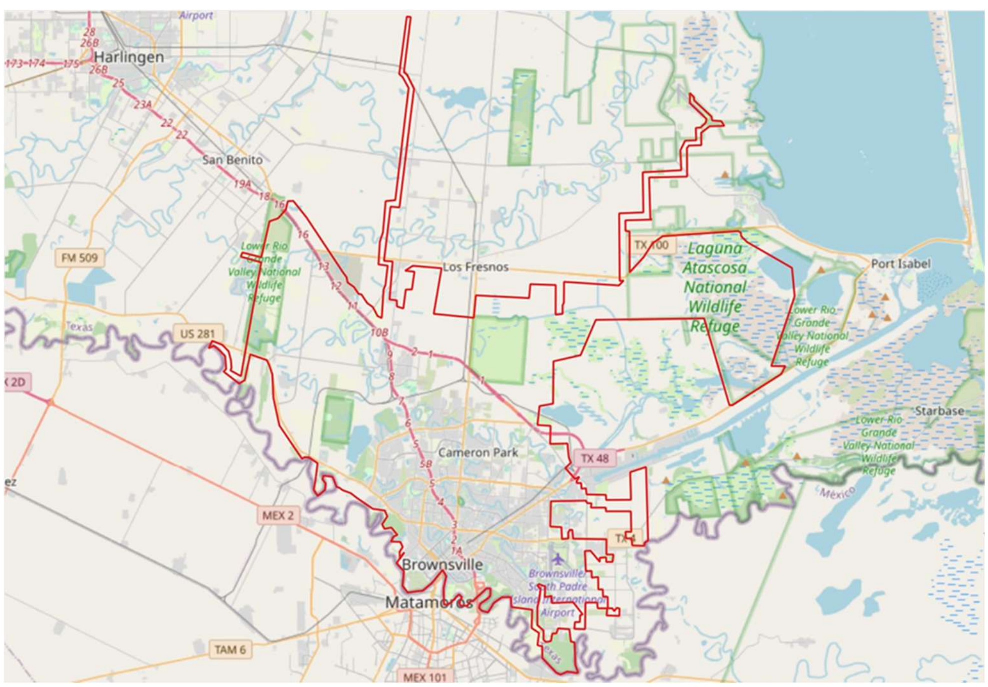

Figure 6: Brownsville City Boundary Polygon

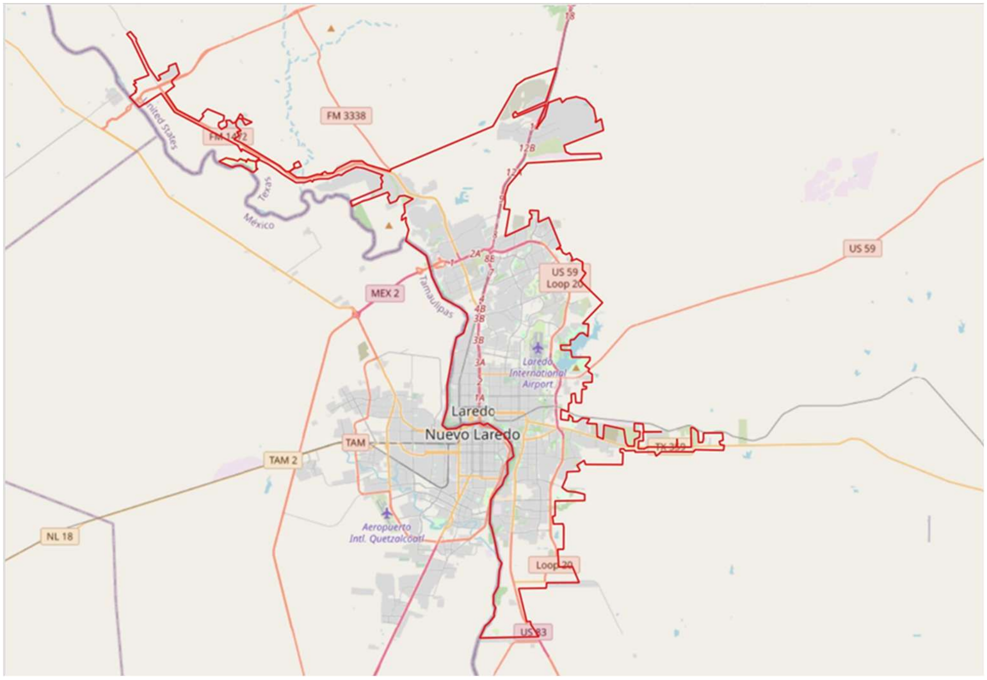

Figure 7: Laredo City Boundary Polygon

5. **Metro Area Merging**: The Rio Grande City Polygon Boundary Layer was merged with the Brownsville Boundary Polygon Layer. This step was crucial as these two cities were considered part of a single, contiguous metro area for this study, allowing for unified buffer zone creation and analysis.
6. **Coordinate System Projection**: To ensure spatial accuracy and consistency, especially for distance calculations and overlay analysis, all layers were projected to **'EPSG:32141 - NAD83 / Texas South'**. This specific projected coordinate system is optimized for the southern region of Texas, minimizing distortions inherent in other projections.
7. **Buffer Zone Generation**: A 50-mile buffer was created around the merged Rio Grande Valley metro area (Rio Grande City and Brownsville) and the Laredo city layer. These buffer zones represent the potential influence areas for a high-speed rail station, capturing a reasonable catchment area for passenger origins and destinations.

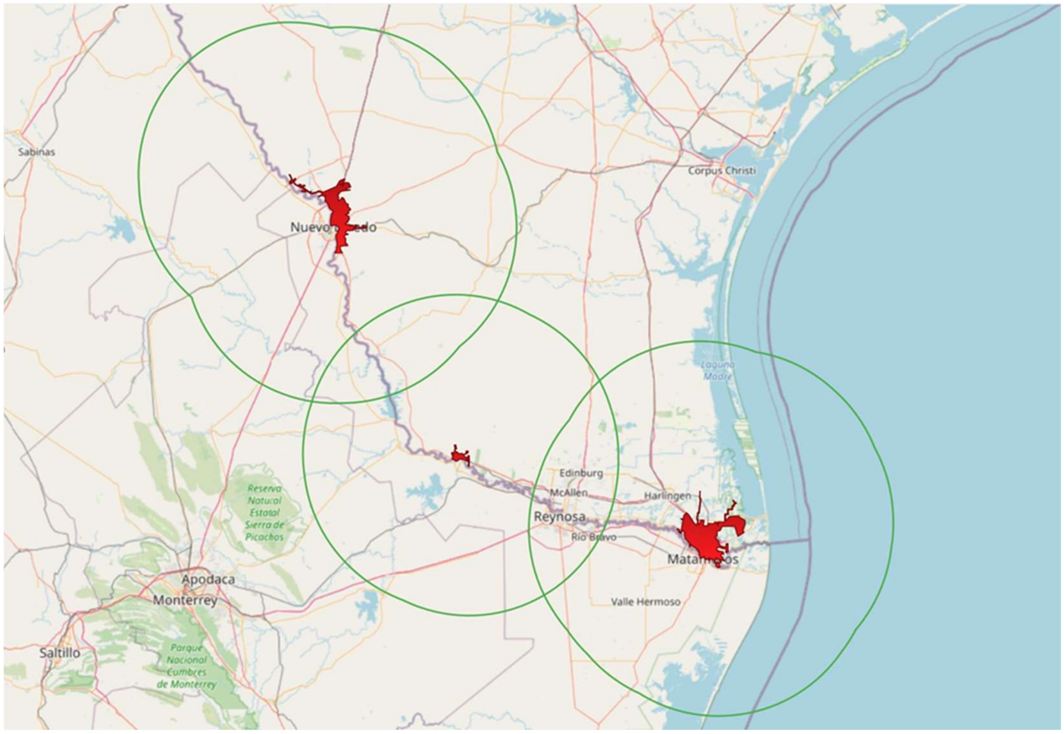

Figure 8: 50-mile buffer for each of the cities (Rio Grande, Brownsville, and Laredo)

8. **Clipping Polygon Features**: Separate shapefile layers were created to draw specific polygon features intended for clipping. These polygons were strategically drawn to encompass the areas within the 50-mile buffers, extending straight from Rio Grande City to Brownsville and focusing on the north, east, and west of Laredo City. During this step, a critical consideration was ensuring that these polygons did not extend into or touch the Mexican border, focusing solely on the U.S. side of the border.

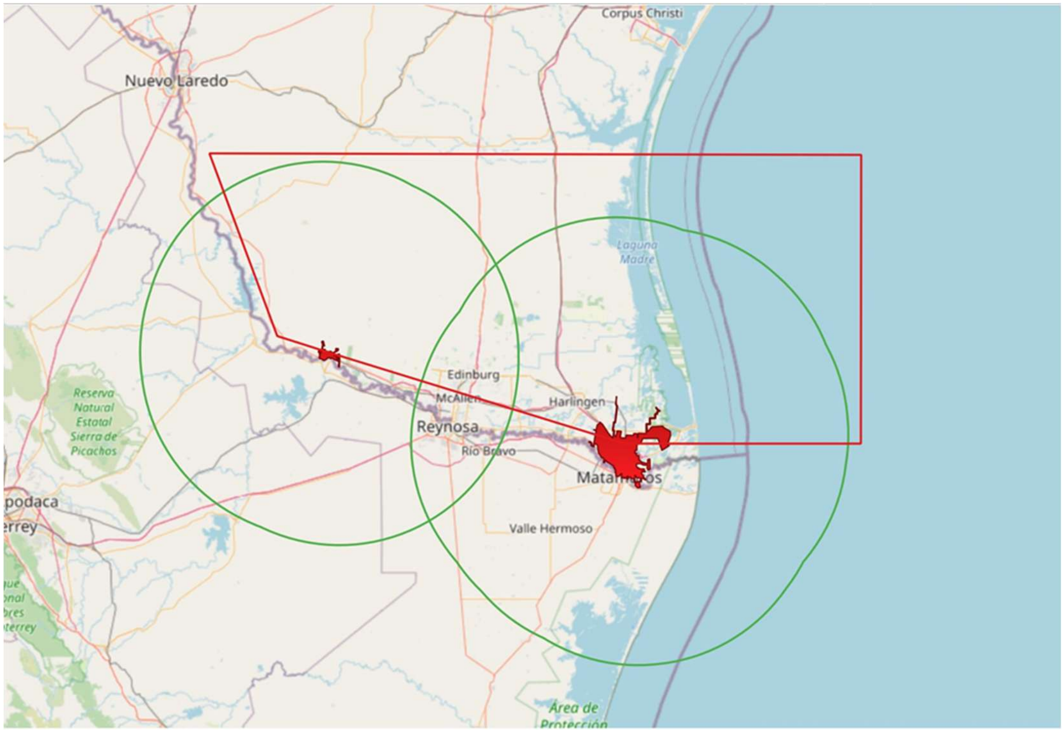

Figure 9: Polygon feature to clip towards the north of the Rio Grande and the Brownsville area

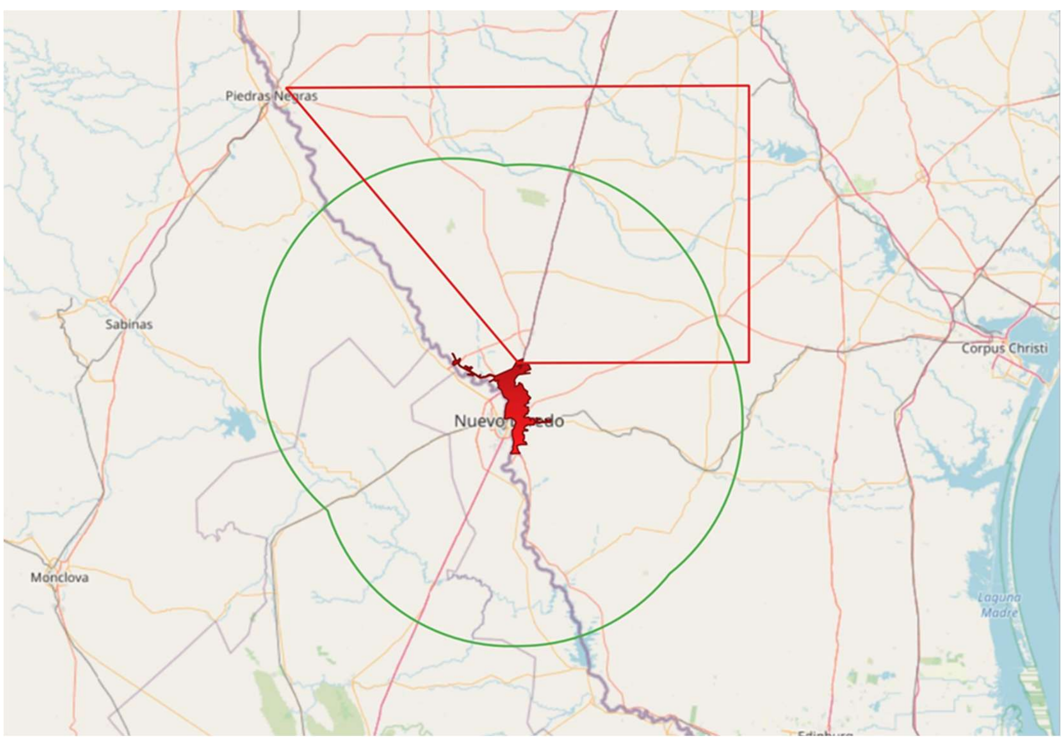

Figure 10: Polygon feature to clip towards the north, east, and western areas of Laredo city

9. **Spatial Clipping**: The Clip feature in QGIS was utilized to extract only the portions of the newly created polygon layers that fell within the previously generated 50-mile buffer zones. This refined the study area only to include relevant regions for population analysis.

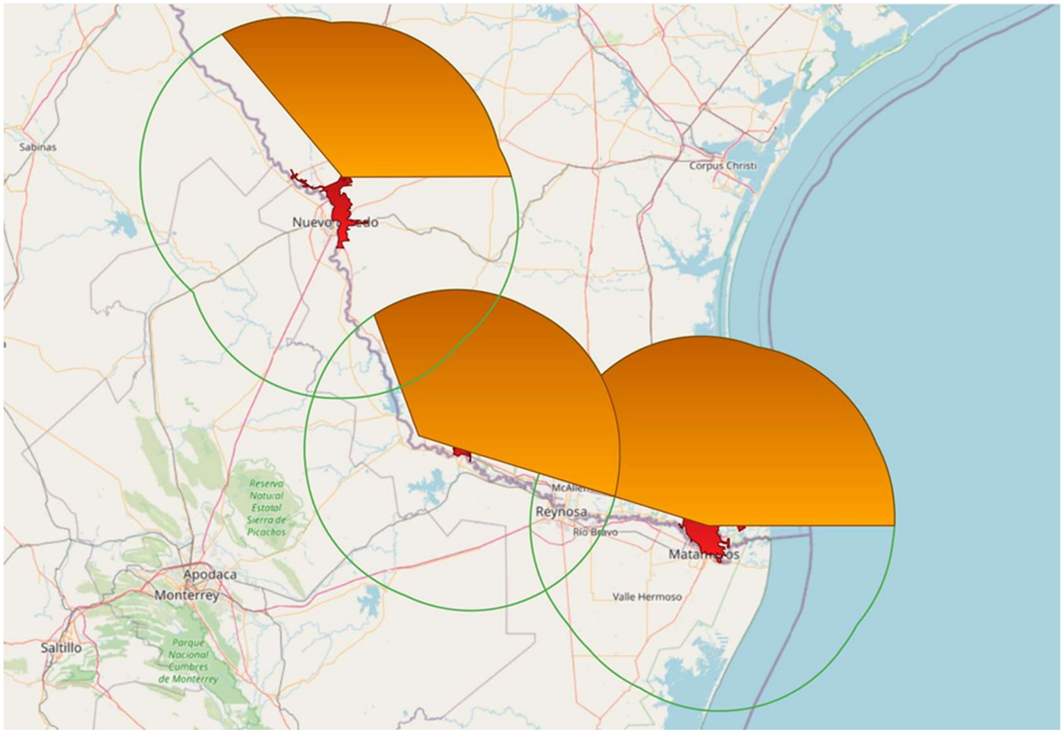

Figure 11: Clipped buffer zones towards the northern side of Rio Grande & Brownsville area, as well as towards the north, east, and west of Laredo city

10. **City Identification and Extraction**: The updated Texas City Boundaries shapefile (June 12, 2025) was then used to identify cities that overlapped or were contained within the clipped areas. The "Select by Location" feature was employed to select these cities for both metro areas. Subsequently, the "Join Attribute by Location" feature was used to extract these selected cities into two new, separate shapefile layers, one for each metro area.

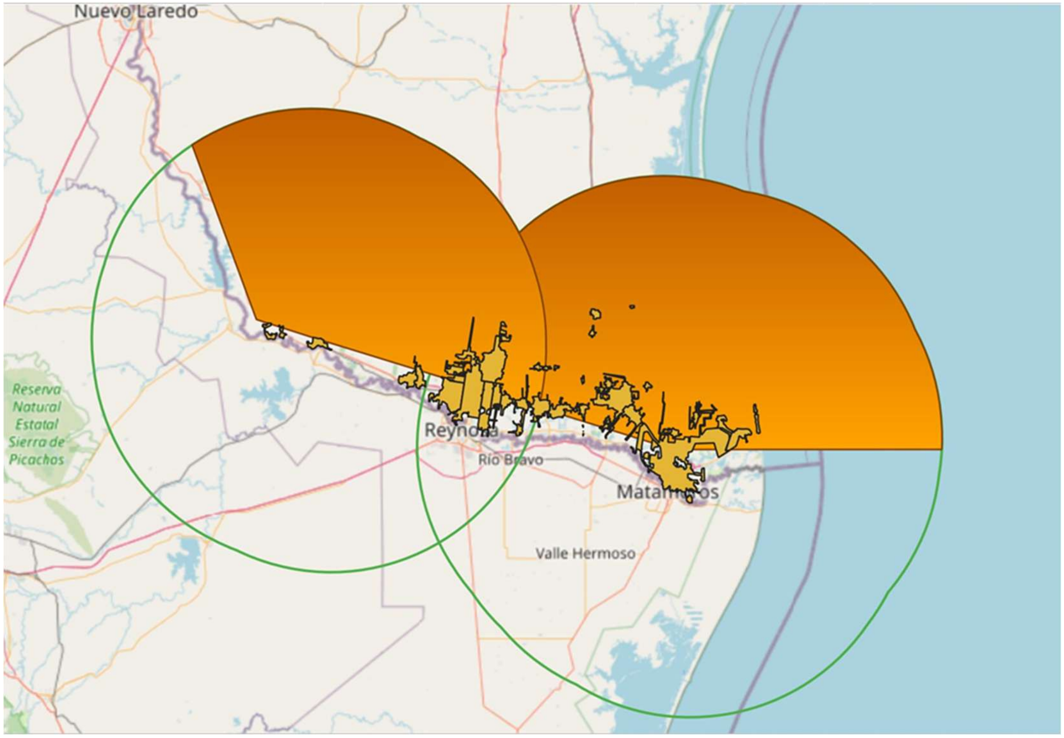

Figure 12: City boundaries of the cities identified for the Rio Grande and Brownsville metro area

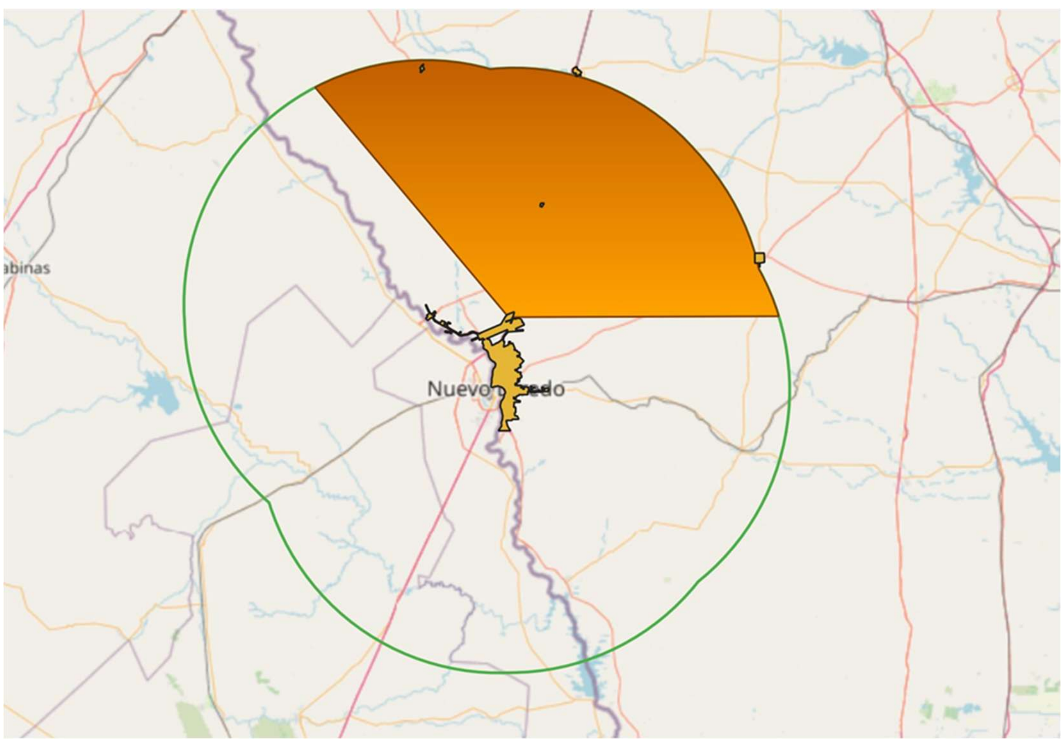

Figure 13: City boundaries of the cities identified for the Laredo metro area

11. **City Name Extraction**: The names of the identified cities for both metro areas were extracted from the attribute tables of the newly created shapefile layers and compiled into an Excel file for further demographic analysis.

3.3 Gravity Model Application

The Gravity Model, a fundamental tool in transportation planning and economic geography, was applied to estimate the potential annual passenger traffic between the Rio Grande Valley and the Laredo Metro Area. This model, analogous to Newton’s law of universal gravitation, posits that the interaction (e.g., passenger flow) between two locations is directly proportional to their respective “masses” (populations) and inversely proportional to the square of the distance separating them. The model’s application in this study is detailed below:

Defined Variables:

- **P1**: Total Population of the Rio Grande Valley Metro Area (948,877 in 2020).
- **P2**: Total Population of the Laredo Metro Area (262,646 in 2020).
- **D**: Distance between the approximate midpoint of the South Texas cities (McAllen) and Laredo, measured at 146 miles.

Formula and Calculation Steps:

1. **Numerator (P1 * P2)**: This component represents the product of the populations of the two metro areas, signifying their combined attractive force for interaction. For this study, the numerator was calculated as: 948,877 (P1) * 262,646 (P2) = 249,218,748,542
2. **Denominator ((D * 2)^2)**: This component accounts for the distance impedance. The distance (D) is multiplied by 2 and then squared, reflecting the non-linear impact of distance on travel propensity. The denominator was calculated as: (146 miles * 2)^2 = (292)^2 = 85,264
3. **Annual Passengers (Total)**: The total annual passengers travelling on all modes of transportation between the two metro areas were estimated by dividing the Numerator by the Denominator. This figure represents the raw potential for interaction based on the gravitational pull between the two population centers: 249,218,748,542 / 85,264 = 2,922,907 annual passengers
4. **Potential High-Speed Rail Passengers (30% of total)**: A conservative capture rate of 30% of the total annual passengers was applied to estimate the potential ridership for a high-speed rail system. This percentage accounts for various factors such as mode shift from existing transportation options, competitive pricing, and service quality: 2,922,907 * 0.30 = 876,872 potential annual high-speed rail passengers

This systematic application of the Gravity Model provides a robust quantitative estimate of the potential demand for a high-speed rail connection, forming a critical basis for further feasibility studies and investment decisions.

4. Findings

This section presents the key quantitative findings derived from the geospatial analysis and the application of the Gravity Model. These findings form the empirical basis for assessing the potential of a high-speed rail link between the Rio Grande Valley and the Laredo Metro Area.

4.1 Population Data

The demographic foundation of this study is rooted in the 2020 population figures for the cities within the Rio Grande Valley and the Laredo Metro Area. The aggregated populations are as follows:

- **Rio Grande Valley Metro Area (P1)**: 948,877
- **Laredo Metro Area (P2)**: 262,646

Detailed city-wise population breakdowns for both metro areas are provided in the Appendix, as extracted from the source datasets. These figures highlight the significant population concentrations in both regions, crucial drivers for inter-city travel demand.

4.2 Geographical Data

The critical geographical parameter for the Gravity Model is the distance between the two metro areas. For this analysis, the approximate midpoint of the South Texas cities (represented by McAllen, Texas) was used as a reference point for the Rio Grande Valley. The measured distance to Laredo, Texas, is:

- **Distance (D) Between These Two Areas**: 146 Miles

This distance is a key input in calculating the impedance factor within the Gravity Model.

4.3 Gravity Model Results

The application of the Gravity Model yielded the following results, which quantify the potential passenger interactions between the Rio Grande Valley and the Laredo Metro Area:

Finding	Values
Rio Grande Valley Metro Area Population (P1)	948,877
Laredo Metro Area Population (P2)	262,646
Distance (D) Between These Two Areas	146 (Miles)
Numerator (P1 * P2)	249,218,748,542
Denominator ((D * 2)^2)	85,264
Annual Passengers (Total)	2,922,907
Potential High-Speed Rail Passengers (30% of total)	876,872

These findings indicate a substantial potential for annual passenger movements between the two metro areas. The calculated total annual passengers of approximately 2.92 million suggest a robust underlying demand for inter-regional travel. Furthermore, the projection of 876,872 potential high-speed rail passengers per year, based on a 30% capture rate, demonstrates a significant market for a dedicated high-speed rail service. These figures provide a strong preliminary indication of economic viability and potential ridership for such a transportation initiative.

5. Discussion

The findings from this research provide compelling insights into the potential for a high-speed rail connection between the Rio Grande Valley and the Laredo Metro Area. The calculated annual passenger volume, particularly the projected high-speed rail ridership, warrants a detailed discussion of its implications, the factors influencing its realization, and the inherent limitations of the current analysis.

5.1 Implications of Annual Passenger Numbers

The estimated 2.92 million annual passengers between the Rio Grande Valley and the Laredo Metro Area signifies a substantial existing demand for inter-regional travel. This figure, derived from the Gravity Model, reflects the natural interaction and connectivity between two significant population centers in South Texas. The projection of 876,872 potential annual high-speed rail passengers is particularly noteworthy. This volume suggests that a high-speed rail system could attract a considerable portion of existing travellers and stimulate new travel demand due to increased convenience, reduced travel times, and enhanced comfort compared to current modes of transportation, primarily private vehicles and buses.

Such a significant ridership base is a crucial indicator of economic viability for large-scale infrastructure projects like high-speed rail. The project could generate sufficient revenue to cover operational costs and contribute to capital recovery over time. Moreover, this consistent flow of passengers would facilitate business and leisure travel and strengthen social and cultural ties between the two regions, fostering a more integrated South Texas.

5.2 Potential Impact on Regional Connectivity and Economic Growth

A high-speed rail link would profoundly impact regional connectivity. Currently, travel between the Rio Grande Valley and Laredo is predominantly by road, subject to traffic congestion, fluctuating fuel prices, and extended travel times. High-speed rail would offer a reliable, time-efficient, and potentially more environmentally friendly alternative. Reduced travel times would make daily commutes or frequent business trips more feasible, effectively shrinking the perceived distance between the two metro areas.

Economically, the benefits could be multi-faceted. Improved connectivity could stimulate trade and commerce, particularly given Laredo’s role as a major inland port and the Rio Grande Valley’s growing industrial and agricultural sectors. Businesses in both regions could expand their market reach, access a broader talent pool, and foster greater collaboration. The construction phase of a high-speed rail project would also generate significant employment opportunities, while its operation would create permanent jobs in various sectors, including transportation, maintenance, and hospitality. Furthermore, enhanced accessibility could attract new investments and businesses to both metro areas, increasing property values and a more robust regional economy.

5.3 Factors Influencing Actual Ridership

While the Gravity Model provides a strong theoretical estimate, actual high-speed rail ridership would be influenced by several practical factors:

- **Cost of Travel**: The pricing strategy for high-speed rail tickets relative to existing modes (e.g., car travel, bus fares, and potential air travel) will significantly impact ridership. Competitive and attractive pricing is essential for encouraging mode shifts.
- **Travel Time and Frequency**: The actual end-to-end travel time, including station access and egress, and the frequency of service, will be critical. A truly high-speed and frequent service will appeal more than slower, less reliable alternatives.
- **Existing Transportation Infrastructure**: The quality and capacity of existing roads and bus services will play a role. If current alternatives are highly efficient and cost-effective, the incentive to switch to high-speed rail might be reduced.
- **Station Location and Accessibility**: The strategic placement of high-speed rail stations within or near major population centers, coupled with efficient last-mile connectivity (e.g., public transit, ridesharing, parking), will be paramount to maximizing ridership.
- **Service Quality and Amenities**: Comfort, onboard amenities (Wi-Fi, dining), safety, and overall passenger experience will influence traveller preferences.
- **Economic Conditions**: Broader economic trends, including disposable income and business travel patterns, will also affect ridership volumes.

5.4 Limitations of the Gravity Model and Study

It is essential to acknowledge the inherent limitations of the Gravity Model and the scope of this study:

- **Simplification of Reality**: By its nature, the Gravity Model simplifies complex human travel behaviour. It primarily considers population and distance, without explicitly accounting for other critical factors such as socio-economic characteristics of the population, specific trip purposes, land use patterns, or the quality and cost of competing transportation modes.
- **Assumption**: The model assumes that interaction is proportional to population size and inversely proportional to distance squared. While generally robust, real-world travel patterns can be influenced by factors not captured by these basic parameters.
- **Data Granularity**: While city-level population data was used, a more detailed analysis might benefit from finer-grained demographic data (e.g., at the census tract or block group level) to better understand localized travel demand.
- **Capture Rate Assumption**: The 30% capture rate for high-speed rail is an assumption based on industry benchmarks and similar projects. The capture rate could vary significantly depending on the proposed high-speed rail system's specific design, operational characteristics, and market conditions.

- **Absence of Cost-Benefit Analysis**: This study focuses solely on ridership potential and does not include a comprehensive cost-benefit analysis, which would be essential for a complete feasibility assessment. Factors such as construction costs, operational expenses, and environmental impacts are beyond the scope of this report.
- **Static Data**: The analysis uses 2020 population data. Meanwhile, recent demographic shifts and future growth projections could alter the long-term ridership potential. A dynamic model incorporating population forecasts would provide a more forward-looking perspective.

Despite these limitations, the Gravity Model provides a valuable initial estimate of potential demand, serving as a strong foundation for more detailed and comprehensive feasibility studies.

6. Conclusion and Recommendations

This research, conducted by the Cambrian Business Analytics Group, has thoroughly examined the potential for a high-speed rail connection between the Rio Grande Valley and the Laredo Metro Area. Our analysis, integrating geospatial techniques with the Gravity Model, reveals a significant and compelling case for such an infrastructure investment. With an estimated 2.92 million total annual passengers and a projected 876,872 potential annual high-speed rail riders, the demand for enhanced inter-regional transportation is apparent and substantial.

The strategic importance of this corridor cannot be overstated. A high-speed rail link would alleviate current transportation burdens and catalyze economic growth, fostering greater connectivity, trade, and social cohesion across South Texas. The demographic strength of both metro areas provides a robust foundation for sustainable ridership, indicating a strong return on investment in terms of regional development and improved quality of life.

Based on these conclusions, we offer the following recommendations:

1. **Proceed with a Detailed Feasibility Study**: Given the promising ridership projections, the next critical step is commissioning a comprehensive feasibility study. This study should delve into engineering considerations, detailed cost estimations (construction, operation, maintenance), environmental impact assessments, and a thorough financial analysis, including potential funding mechanisms and economic impact modelling.
2. **Conduct a Market Demand and Mode Shift Analysis**: While the Gravity Model provides a macro-level estimate, a more granular market demand study is recommended. This should involve surveys, focus groups, and advanced econometric modelling to understand traveller preferences, willingness to pay, and the precise potential for mode shift from existing transportation options.
3. **Evaluate Optimal Corridor Alignment and Station Locations**: Further geospatial analysis, incorporating detailed land use, environmental sensitivities, and community impact assessments, must identify the most optimal high-speed rail corridor alignment and strategically placed station locations that maximize accessibility and ridership.
4. **Explore Public-Private Partnerships and Funding Models**: Given the scale of such a project, exploring innovative funding models, including public-private partnerships, federal grants, and state-level initiatives, will be crucial for successful implementation.

5. **Engage Stakeholders and Communities**: Continuous engagement with local communities, businesses, and governmental bodies in the Rio Grande Valley and Laredo Metro Area is essential. This will ensure the project aligns with regional development goals and addresses local needs and concerns.

In conclusion, the potential for high-speed rail in South Texas is not merely a vision but a tangible opportunity supported by robust demographic and analytical evidence. Pursuing this initiative with diligent planning and strategic investment promises to transform regional mobility and unlock unprecedented economic potential for future generations.

7. References

[1] U.S. Census Bureau. QuickFacts. Available at: https://www.census.gov/programs-surveys/sis/resources/data-tools/quickfacts.html

[2] U.S. Census Bureau. TIGER/Line Shapefile, 2022, State, Texas, TX, Census Tract. Available at: https://catalog.data.gov/dataset/tiger-line-shapefile-2022-state-texas-tx-census-tract

[3] U.S. Census Bureau. data.census.gov. Available at: https://data.census.gov/map/160XX00US4810768,4841464,4862168/ACSST1Y2023/S0101?layer=VT_2023_160_00_PY_D1&loc=26.1082,-98.2890,z8.4058

[4] Texas Department of Transportation. City Boundaries. Available at: https://gis-txdot.opendata.arcgis.com/datasets/TXDOT::city-boundaries/explore?location=30.679303%2C-100.168292%2C6.07

8. Appendices

8.1 Rio Grande Valley Metro Area Population (2020)

City Name	Population (2020)
La Feria	6817
Edinburg	100243
Lyford	2243
Indian Lake	839
Rio Hondo	2021
La Villa	2804
Donna	16797
Los Fresnos	8114
Alamo	19493
Palm Valley	1413
Raymondville	10236
San Perlita	538
Laguna Vista	3520
Mercedes	16258
South Padre Island	2066
Brownsville	186738
Edcouch	2732
Harlingen	71823
Palmhurst	2601
Rancho Viejo	2838
Bayview	475
Port Isabel	5028
Combes	2999
Santa Rosa	2450
Weslaco	40160
Mission	85778
San Juan	35294
McAllen	142210
Alton	18198
Elsa	5668
Primera	5257
San Benito	24861
Pharr	79715
Rangerville	255
La Joya	4457
Penitas	6460
Rio Grande City	15317
Roma	11561
Escobares	2588
Total Population	948877

8.2 Laredo Metro Area Population (2020)

City Name	Population (2020)
Freer	2461
Encinal	540
Cotulla	3718
Laredo	255205
Asherton	722
Total Population	262646