Rio Grande Valley
Metropolitan Planning Organization

CONGESTION AND DELAY STUDY
Spring 2022

Prepared for:

Rio Grande Valley
Metropolitan Planning Organization
617 W. University Drive
Edinburg, TX. 78539

Prepared by:

CoPLAN

280 Shelby Lane
Ladonia, Texas 75449

November 25, 2022

EXECUTIVE SUMMARY

The Rio Grande Valley Metropolitan Planning Organization (MPO) has an established congestion management process (CMP) to monitor the transportation network. The goal of the monitoring system is to ensure optimal performance of the transportation system by identifying congested areas and related transportation deficiencies.

Traffic studies are conducted each year, rotating among the seasons. In 2022, the Spring season was studied. Past CMP studies include Spring 2001, Fall 2002, Summer 2003, Spring 2004, Winter 2005, Fall 2006, Spring 2007, Winter 2008/2009, Summer 2009, Fall 2010, Spring 2013, Winter 2015, and Winter 2019.

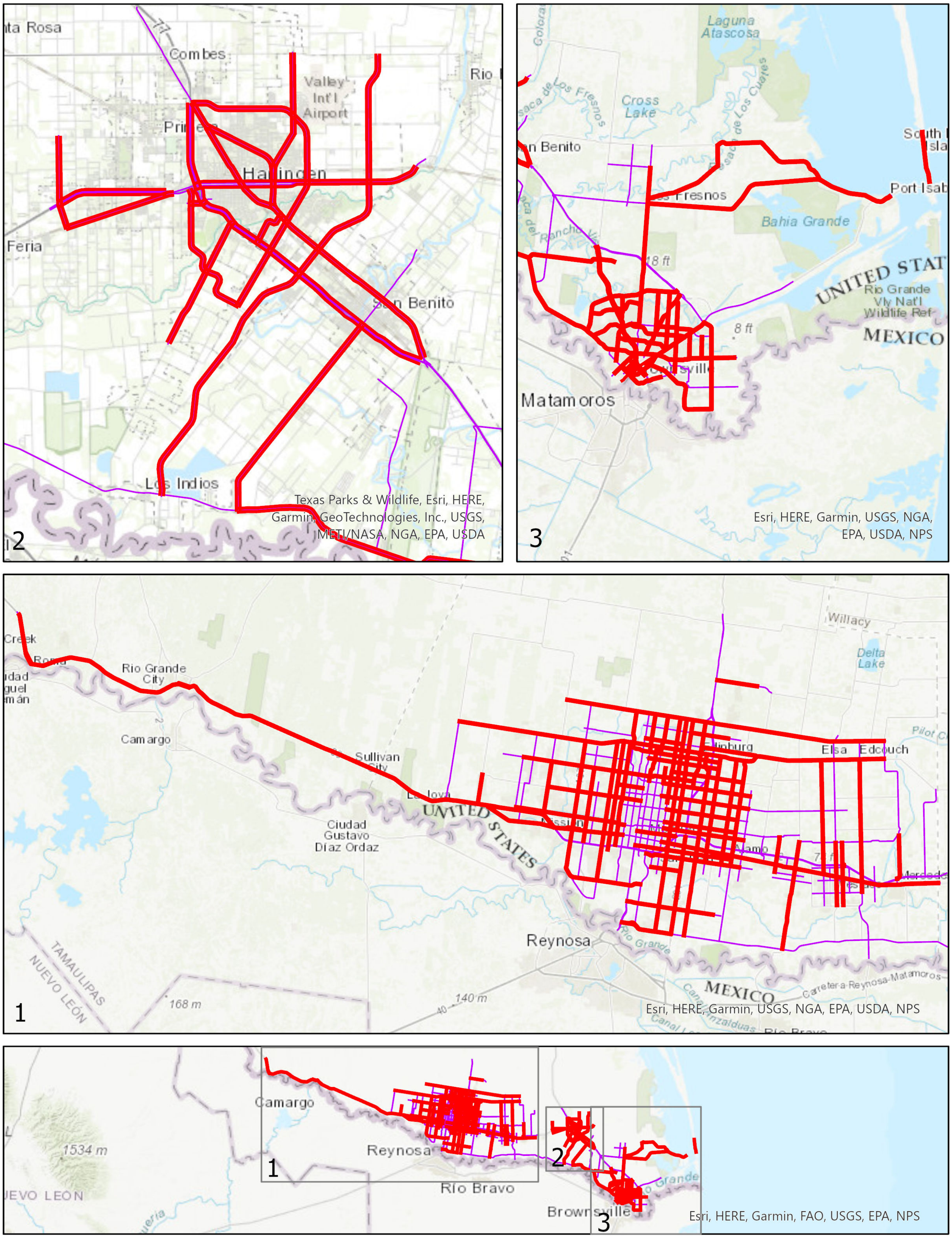
The purpose of this years' study and routes shown in **Figure E-1**, which covered 1,415 directional miles within the region, was to identify problem areas using travel time studies and to prepare recommendations to improve the traffic flow on the transportation system as a whole and on specific corridors. The results of this study can be used as factors in prioritizing needed improvements.

The FHWA requires MPOs over 200,000 to have a CMP to monitor, manage, and mitigate congestion as defined locally. Historically, the MPO has used Congestion Index (CI) as the primary performance measure to identify areas of congestion and delay. This performance measure is based on average travel speed as determined through floating car travel time runs compared to that of the posted speed (judged to be the free flow or unconstrained travel speed). The resulting performance measure is calculated for each segment between intersections (signalized, stop signs, and major uncontrolled intersections in rural areas). In addition to the intersection segment, the same performance measure is calculated for 0.1-mile segments to have a common unit length for baseline comparisons.

By using Global Positioning Systems (GPS) in the travel time runs, congestion and delay are pinpointed as shown in **Figure E-2**. The GPS collects position and speed data every one second which highlights areas of delay. This data, coupled with other integrated data resources, provide the needed reference material to prepare recommendations that are focused on the true cause of the congestion and delay.

Over the years, the majority of the recommended mitigation for the "congested" arterial segments was to optimize and coordinate the arterial signal system to provide more consistent travel speeds along major corridors and avoid frequent stopping at most signals. These conditions are being highlighted in this update cycle to differentiate between "congestion" and "delay". The congestion index threshold used to date to define congestion has been < 0.75 or an average speed within a segment of less than 75% of posted speed. This average could be a result when traffic volumes approach capacity of a link and create enough friction such that drivers are forced to drive slower and are unable to reach the posted speed limit. The other, more common, situation that results in a < 0.75 CI is travel unconstrained for most of the link at or above posted speed, but the driver is forced to stop at the downstream intersection long enough to bring the average speed from center of upstream intersection until passing through the downstream intersection down to a point that results in a longer travel time to traverse the segment and thus a lower average speed. This second condition will be referred to as "delay" instead of "congestion"… a small but very important distinction. To mitigate "delay", it will more commonly be a local intersection or corridor signal system operational issue, thus much lower capital cost vs. "congestion" that may more typically be a capacity issue with a large required investment.

Another signal system component that contributes greatly to unnecessary delay is the condition of the vehicle detection equipment. Past assessments around the region have shown percentages as high as 65% of the areas intersections had inoperable detection.



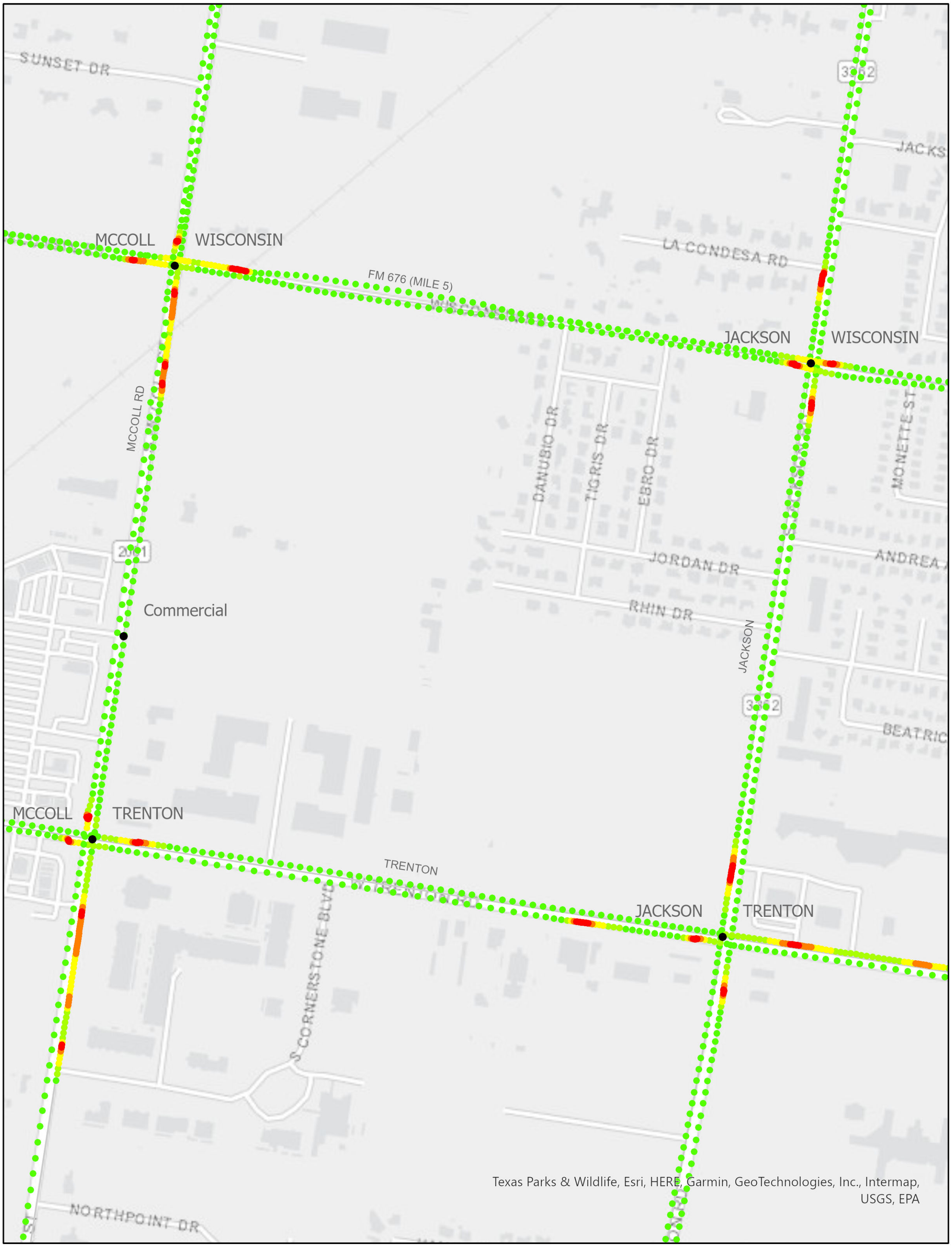
Texas Parks & Wildlife, Esri, HERE, Garmin, GeoTechnologies, Inc., USGS, METI/NASA, NGA, EPA, USDA

Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

Esri, HERE, Garmin, FAO, USGS, EPA, NPS

Figure E-1- Spring 2022 CMP Routes



Texas Parks & Wildlife, Esri, HERE, Garmin, GeoTechnologies, Inc., Intermap, USGS, EPA

Figure E-2 – Example Raw 1-Second Travel Time Data

KEY FINDINGS

As shown in **Table E-1** and **Figure E-3**, of the 1415.8 directional miles of roadways studied in Spring 2022, during the PM Peak Period, 214.0 miles were free-flow, 587.7 miles were stable, and 614.1 miles were congested. Therefore, for the Spring 2022 season, 56.6% of the roadways operated within an acceptable range during the PM Peak Period (compared to 49-68% for previous studies between 2001-2019). The percent congested can vary dramatically each year depending on season and roadways included.

Table E-1 - Summary of Study Roadways in Terms of CI on Intersection Segments Congestion < 0.75

Season	Measure	Roadway Condition			Total
		Free Flow	Stable	Congested < 0.75	
Spring 2022	Number of Miles	214.0	587.7	614.1	1415.8
	Percentage of Miles	15.1%	41.5%	43.4%	100%

For those segments found to be “congested”, many are thought to be secondary approaches as compared to what many feel are the busiest or most congested intersections. To address this issue, a new performance measure was first introduced with the Spring 2013 update and is once again included this year. It is referred to as volume weighted delay. This performance measure will be used to highlight those areas where the combination of delay and higher volumes lead to congestion and delay. The resulting value highlights the total exposure or relative number of vehicles that encounter the measured delay from the travel time runs. The volumes used are gathered from the current MPO maintained travel demand model. The average daily volumes are conflated to the intersection segments in GIS where a weighted average volume is determined based on the lengths of each model link. One element to note in using the model volumes is the distinction that the volumes represent daily (24 hour) volumes combined for both directions, while the delays calculated are directional for a specific time period (AM or PM peak period). Therefore, the performance measure is solely a relative measure of the magnitude of delay for a peak period which highlights the expected daily volumes along the link in question. The average volumes for 2-way segments used in the calculation were divided in half to represent the relative volumes on the directional link in order to be able to compare to other segments that include 1-way volumes in the model such as frontage roads, mainlanes, or 1-way streets.

As expected, the results shown in **Figure E-4** with this performance measure vary substantially from those using only Congestion Index. Congestion Index has been used exclusively for over 20 years by the MPO to rank deficient segments on the network. Over the years, it was seen that many of the higher ranked “congested” segments were secondary approaches or intersections that had high delays but lower volumes. By applying volume to the delay results, we can now represent the relative number of seconds of total delay given the number of vehicles experiencing the measured delay. For those approaches with high delays but relatively low volumes, they will fall down the list vs. those with less delay but very high volumes. Thus, the list will represent those approaches where the most vehicles could benefit from some form of improvement.

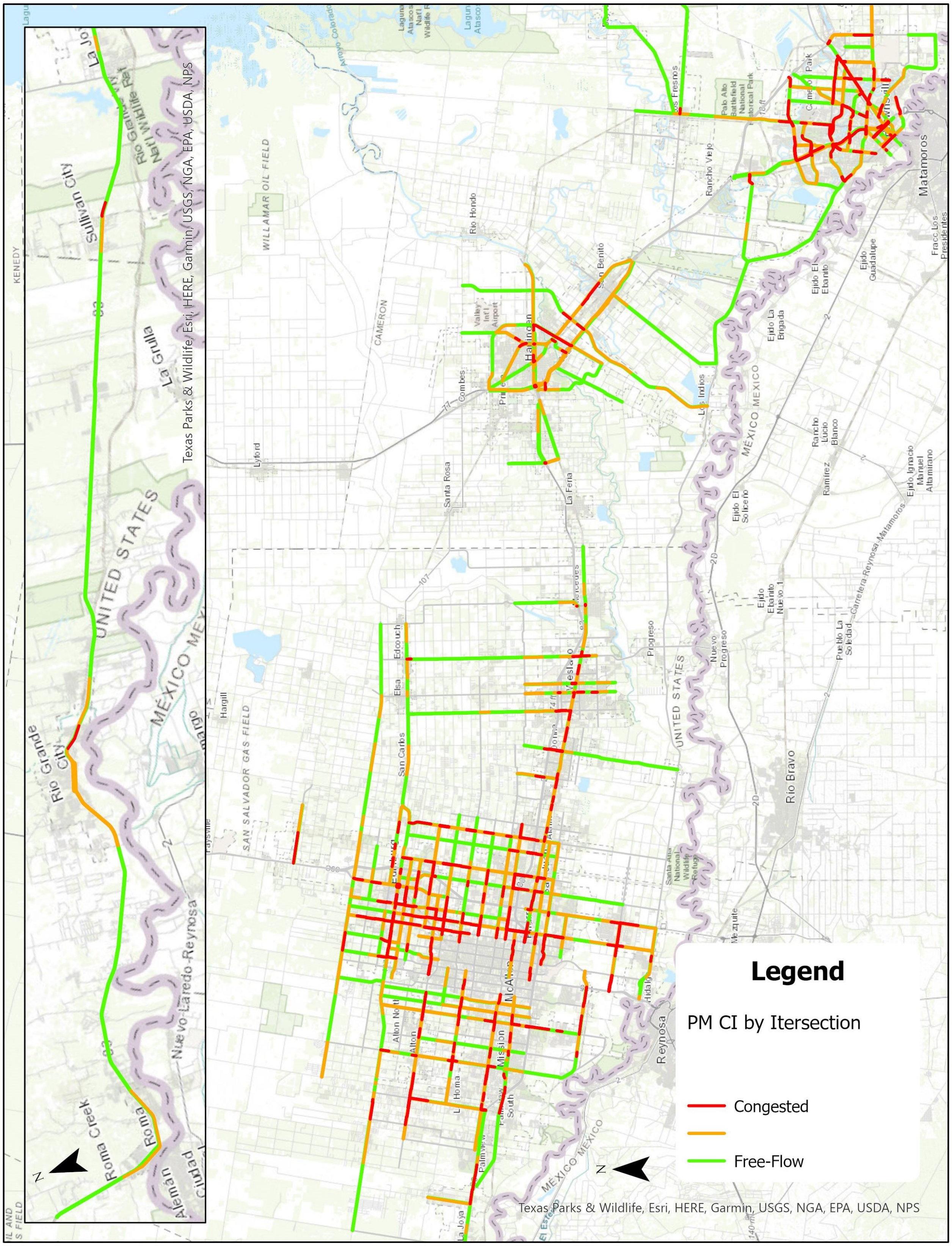
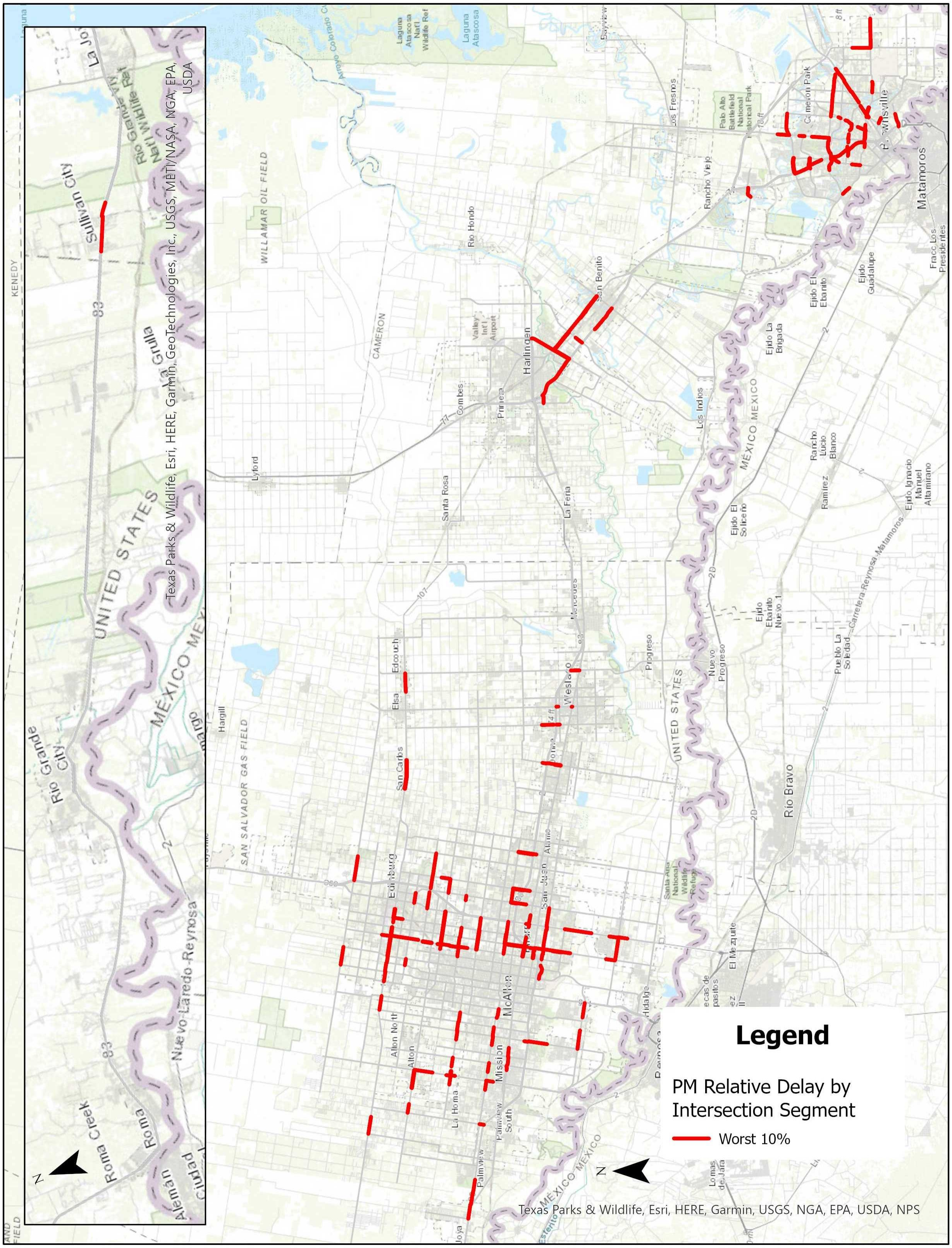


Figure E-3 – Spring 2022 Congestion Index (Intersection Segments)



Texas Parks & Wildlife, Esri, HERE, Garmin, GeoTechnologies, Inc., USGS, METI/NASA, NGA, EPA, USDA

Texas Parks & Wildlife, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

Figure E-4 – Spring 2022 Volume Delay (Intersection Segments)

ONE-TENTH OF A MILE (0.1-mile) SEGMENTS

To address common questions related to congestion and its relation to segment length, a criterion was added in the 2009 season and is included once again this year. The intersection segments that include a signal, stop sign, or major cross street on each end were further broken down into relatively common lengths. These lengths vary slightly depending on the intersection segment length, but the lengths closely match approximately 0.1 mile (approximately 500 feet). This allows close comparison of each segment and further allows assessment of the root cause and location of congestion / delay. The vast majority of the congested 0.1-mile segments fall at the intersection with a signal or stop sign. The overall length of congestion also is greatly reduced given the fact that most congestion is limited to the controlled intersection segment and not those mid-block. **Table E-2**, and illustrated in **Figure E-5**, show the number of congested, stable and free-flow miles on 0.1-mile segments. Comparing this to **Table E-1**, we can see that the number of congested miles is far less based on 0.1-mile segments which can be interpreted to mean congestion does not occur on entire segments and mostly occurs on a shorter portion of the segments between intersections. This helps further narrow down the location and contributing factors of congestion in the region.

Table E-2 - Summary of Study Roadways in Terms of CI on 0.1-mile Segments Congestion < 0.75

Season	Measure	Roadway Condition			Total
		Free Flow	Stable	Congested < 0.75	
Spring 2022	Number of Miles	458.7	793.5	163.6	1,415.8
	Percentage of Miles	35.9%	53.8%	10.3%	100%

In the Spring 2022 Study, a total of 1,661 0.1-mile segments were congested. Of these, 980 segments (about 59%) had a Signal at the downstream end. When comparing the 0.1 results to those of the intersection segments, it becomes clear that a large percentage of the measured delay occurs within 500' of a traffic signal and a large percentage of the signals could benefit from an operational assessment and update. The results indicate that 163.6 miles of 0.1 segments contribute to bring 614.1 miles of intersection segments into the “congested” category of CI. This means that there is sufficient delay in those short segments to bring the average speed for the longer segment low enough to fall below the 0.75 CI threshold.

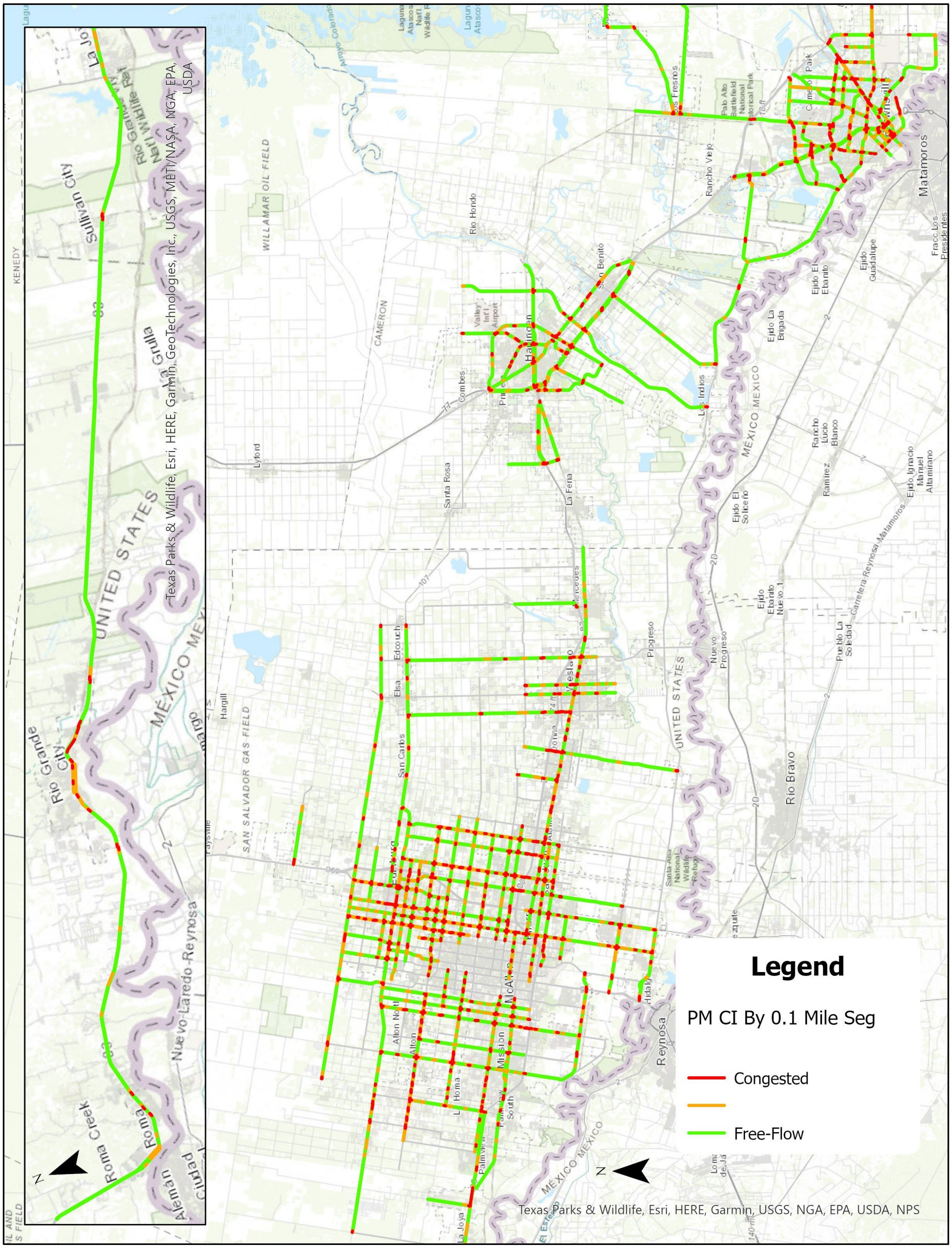


Figure E-5 – Summaries at 0.1-mile segment level for Spring 2022

CONCLUSIONS

A large percentage (43.4%) of roadway intersection segments studied in Spring 2022 were operating under congested conditions. On many of the segments with CI in the congested range, the congestion occurred only near a stop sign or traffic signal and had acceptable conditions through the remainder of the segment.

The results of this report when compared to previous study year roadways indicate higher levels of congestion, particularly when compared to respective seasons. Possible reasons for this include continued population growth and issues with signal timing and coordination. For those corridors that have been part of past signal timing improvements, the typical life before needing updates is 3 years, depending on volume changes and growth. In some cases, construction is completed, but signal optimization is still needed to maximize the efficiency of the new improvements. It is also clear when driving the corridors, a large percentage of the intersections are in need of detection maintenance. This is an area where cities must increase budgets in the respective departments that are responsible to maintaining the traffic signal equipment.

RECOMMENDATIONS

Recommendations were developed for each section of congested roadway. Improvements include traffic signal timing optimization, access management, roadway widening, and adding traffic signals (when warranted) in place of existing stop signs.

The majority of the segments found to be congested would improve by optimizing and coordinating the signals along the corridors. In general, much of the study network would recognize substantially improved operations before warranting larger capital expenditures. Of the roadway segments that were congested, 59% would improve to acceptable levels with optimized and coordinated signal timing. Those signals identified as Priority 1 that would address a large percentage of the “congestion” and “delay” within the region are shown in **Figures E-6, E-7 and E-8**. The signals shown, are primarily those that are maintained by cities with population greater than 50,000. This threshold is the point where TxDOT turns over maintenance of on-system signals to the respective city. The figures also include those that are still maintained by TxDOT primarily the diamond intersections along the freeways. These signals are coupled with those that were recently optimized and coordinated through a City of McAllen funded effort. Leveraging that recent effort by continuing the coordination across city limit lines would allow the region to benefit from the combined effort.

Signal timing continues to be an area that deserves attention within the region to allow maximum efficiency of the existing system before costly widening to add capacity. Signal timing optimization and coordination facilitate smoother operations, less stops, less delay, improved fuel economy, lower vehicle emissions, and less headaches for drivers. The cost / benefit of signal timing projects far exceeds projects 100 times as expensive and can be accomplished in far less time and much less impact to drivers and property owners to endure roadway construction.

Signal timing improvements are a relatively inexpensive way to make significant improvements on a transportation network. Improved signal timing can decrease delay by appropriately allocating green time among competing phases. This allows more traffic to pass through the signal with less delay. By adjusting cycle lengths and offsets, drivers can travel longer distances along a corridor before having to stop for a red light. This decreases travel time and improves air quality. Both signal timing optimization and traffic signal progression are low-cost improvements to make the best use of existing capacity and optimize allocation of funding. The cost for a signal timing improvement project varies depending on the number of traffic signals, the controller capabilities, vehicle detection condition, the location of the traffic signals and adjacent signals, the number of timing plans required, and implementation and fine-tuning needs. The results will be very evident as has been demonstrated previously with localized projects. A regional perspective would produce consistent travel time runs even when crossing from one city / agency to another.

Also, research has shown that coordinated signal timing will not only reduce delay and gas consumption but will also improve safety by reducing stop and go traffic. This will in turn reduce rear end crashes.

The U.S. Department of Transportation's Federal Highway Administration (FHWA) has produced a video showing that retiming traffic signals is one of the more cost-effective techniques available to state and local agencies in their efforts to manage congestion and growing travel demand. The video, "It's About Time, Traffic Signal Management: Cost-Effective Street Capacity and Safety," demonstrates how signal timing on roads can improve air quality while reducing fuel consumption, decreasing traffic congestion, and saving time for commercial and emergency vehicles. Two-thirds of all highway miles in the United States are roads with traffic signals. According to the Institute of Transportation Engineers, the United States has about 300,000 traffic signals. The performance of about 75 percent of them could be improved easily and inexpensively by updating equipment or by simply adjusting the timing.

The Federal Highway Administration defines access management as “the process that provides access to land development while simultaneously preserving the flow of traffic on the surrounding system in terms of safety, capacity, and speed.”

The MPO has recognized the need for access management on their transportation system since the late 1990’s. In September 2003 the Texas Department of Transportation (TxDOT), Transportation Commission, adopted new rules on access management. These rules directed TxDOT to apply access management on all state-owned roadways. Consequently, the MPO developed their first regional Access Management Plan in April 2005. It establishes mechanisms that can be used to apply access management to local transportation plans, projects and procedures.

Access management is accomplished in a variety of ways such as managing the design of access points, the location of access points, the number of access points allowed within a given distance (access density), and the roadway median treatment. Generally, the number of access points is minimized and regularly spaced from each other so that conflict points are separated. On these congested segments, drivers turning into multiple driveways in close proximity interrupted through traffic as they slowed to make their turn. Combining driveways, installing medians, and providing right-turn or left-turn lanes can move the slow-moving traffic out of the way of through traffic, reducing delay and potential for rear-end collisions.

Access management can provide a number of benefits to the public agency and to the traveling public. Capacity is preserved and safety (motorized and non-motorized) is improved by minimizing conflict points and minimizing speed differentials between through traffic and slow-moving turning traffic. Safety for turning movements is also improved by providing adequate turning (auxiliary) lanes or by prohibiting turns in key locations using a raised median. In addition to safety and efficiency improvements, access management also provides environmental and financial benefits with reduced vehicle emissions and improved fuel economy by maintaining the flow of traffic.

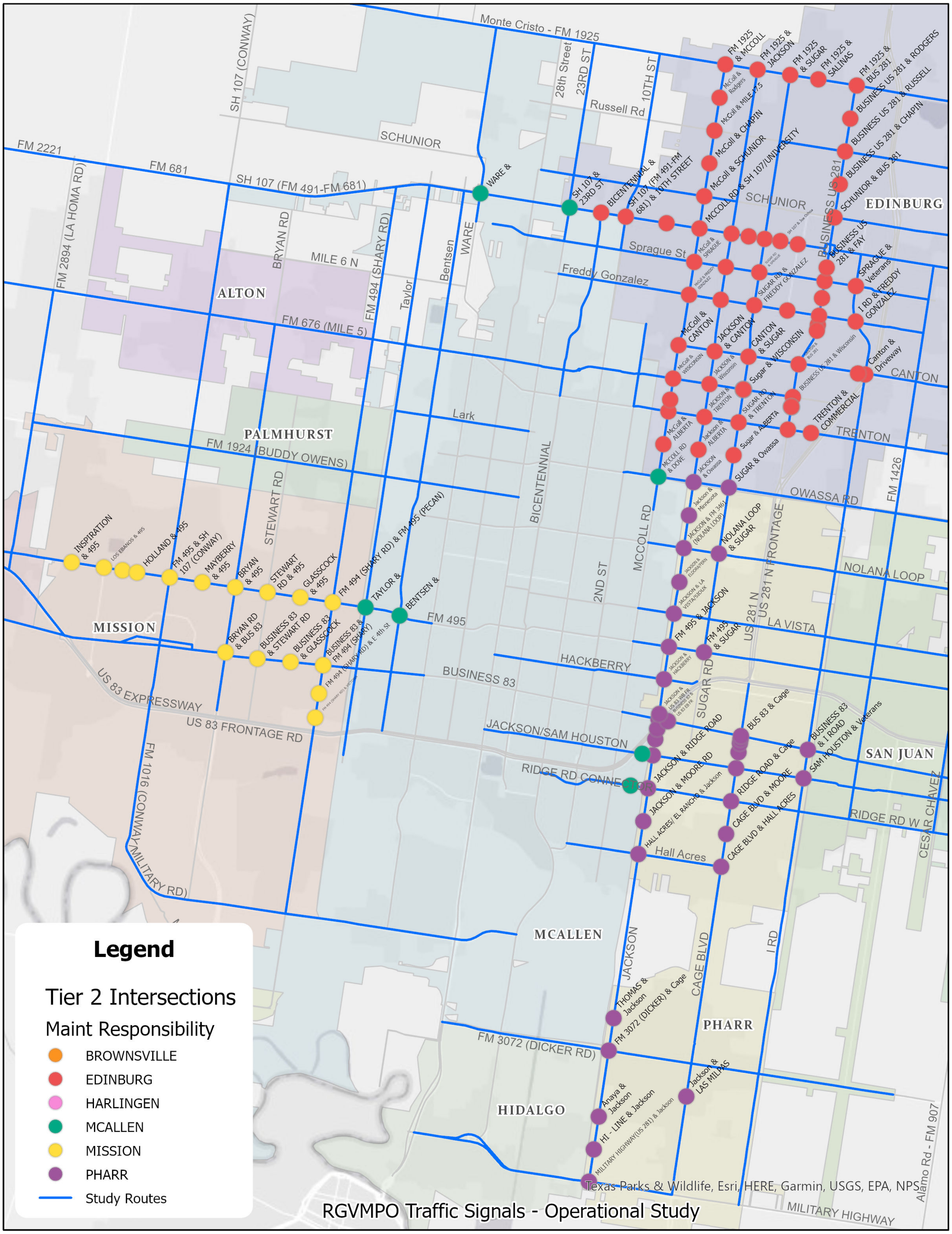


Figure E-6 – Hidalgo County Priority 1 Signals

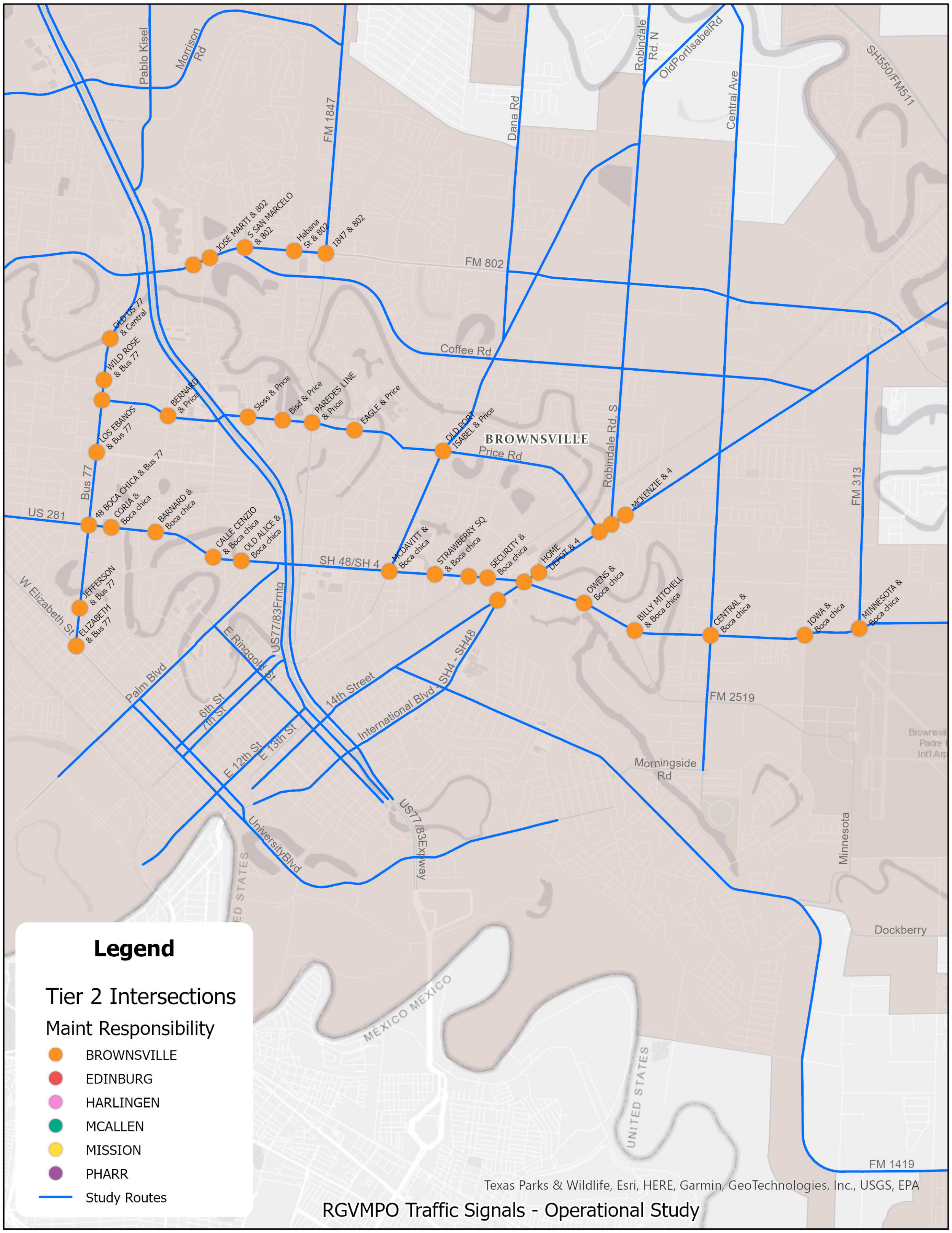


Figure E-7 – Brownsville Priority 1 Signals

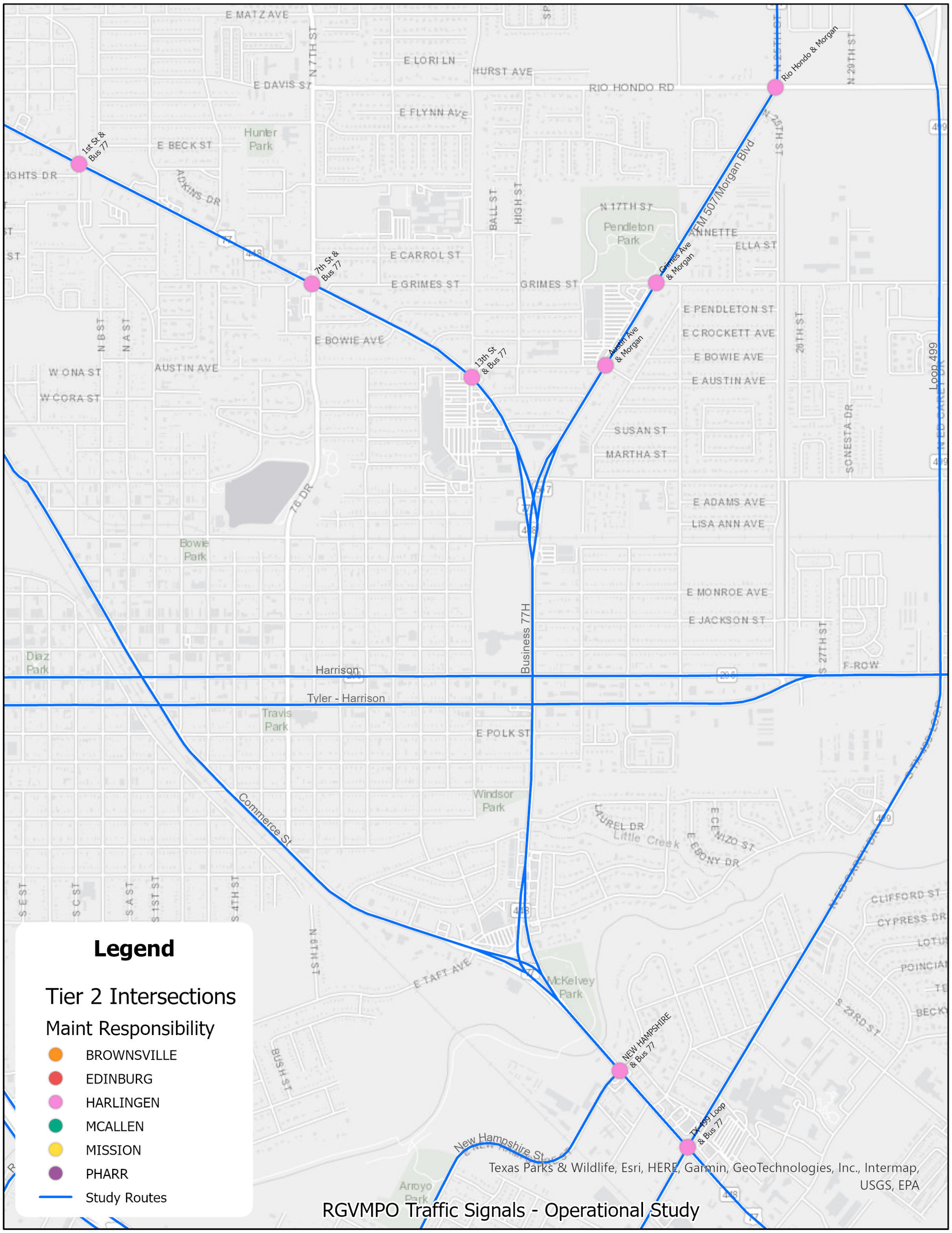


Figure E-8 – Harlingen Priority 1 Signals

On new roadways, or on undeveloped corridors, access management can be used to minimize operational traffic problems, due to unmanaged development, before they occur. In these cases, it is inexpensive and fairly easy to accomplish. The traveling public benefits from a safe and efficient corridor. Property owners benefit from safe access. The agency benefits from a low-cost management plan from the onset rather than costly highway improvement projects once problems occur. Once corridors are developed, it is more difficult, expensive, and time consuming to retrofit managed access. Whenever possible, access management should be given high priority on undeveloped corridors.

Access management can be very challenging on existing ‘built-up’ urban roadways. Common issues include limited right-of-way and opposition by landowners. Still, retrofitting a corridor with access management can provide benefits. Possible retrofitting improvements include: consolidating and closing driveways, constructing raised medians, constructing auxiliary lanes, providing regularly spaced traffic signals to encourage use of a major cross-street or driveway, and providing alternative routes such as internal access roads.

Roadway widening is necessary where traffic signal timing and access management are unable to provide enough capacity for heavy traffic volumes. Some segments may improve in the short term with optimized signal timing but may ultimately warrant additional capacity through widening. Widening could include adding a through lane for a long section of road or providing turn lanes at intersections.

Adding signals may be an improvement at four-way stop intersections or intersections with heavy major street and cross street traffic. This reduces delay for previously stop-controlled movements but may increase delay for movements that were not controlled. As traffic volumes increase, traffic signals or other types of intersection design such as roundabouts or continuous flow intersections should be considered to efficiently move traffic.

As transportation funding continues to be limited, operations are being highlighted by many MPOs across the country. It has been clearly proven locally and nationally that operational improvements provide the highest benefit/cost ratio and on a regional scale as compared to local capacity projects that benefit a smaller portion of the region.

1.0 INTRODUCTION

1.1 History of the Congestion Management

The Rio Grande Valley Metropolitan Planning Organization (RGVMPO) has an established congestion management process (CMP) to monitor the transportation network in Hidalgo and Cameron Counties. The goal of the monitoring system is to ensure optimal performance of the transportation system by identifying congested areas and related transportation deficiencies.

Traffic studies are conducted each year, rotating among the seasons. In the 2022 update, the Spring season was studied in Hidalgo and Cameron Counties. Past CMP studies in Hidalgo County include Spring 2001, Fall 2002, Summer 2003, Spring 2004, Winter 2005, Fall 2006, Spring 2007, Winter 2008/2009, Summer 2009, Fall 2010, Spring 2013, Winter 2015, and the first regional RGVMPO update for the Winter 2019 / 2020. Past CMP studies were performed in the Brownsville region in 2011 and 2019. The 2022 study is the was the second update performed following the merger of the Hidalgo County, Harlingen, and Brownsville MPOs.

1.2 Study Background

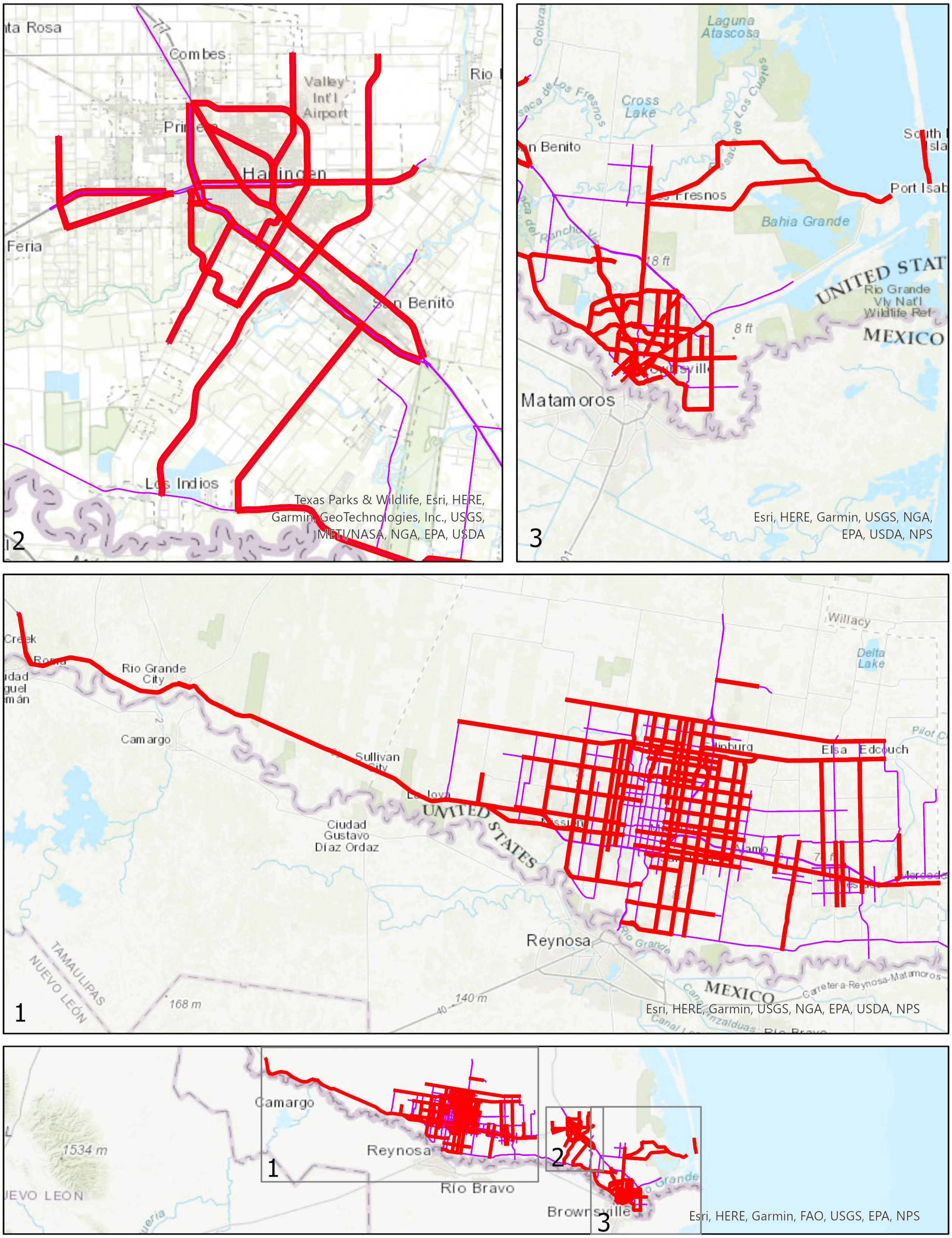
Immediately after notice to proceed, CoPLAN met with the CMP sub-committee to identify 1,415 centerline miles to be part of the study. The majority of the study network includes arterials and thus many traffic signals. It has been observed over the years, that the vast majority of the signalized corridors do not include coordinated signal timing. Therefore, there is a large amount of delay that is not due to capacity issues, but more operational in nature and considered more delay than congestion. The fieldwork portion of the study started in March 2022 and focused on performing the travel time studies on the study corridors.

The 2022 study network included roadways in Hidalgo and Cameron Counties and the following cities: Alamo, Alton, Brownsville, Donna, Edinburg, Harlingen, Hidalgo, La Joya, McAllen, Mercedes, Mission, Palmhurst, Palmview, Peritas, Pharr, Rio Grande City, San Juan, San Benito, South Padre Island, Sullivan City, and Weslaco. **Figure 1** shows the study area and roadways.

All of the roadways studied are evaluated during the AM and PM peak periods, between the hours of 7:00 AM-9:00 AM and 4:00 PM-6:00 PM, respectively.

1.3 Study Purpose

The purpose of this study was to identify problem areas using travel time studies and to prepare recommendations to improve the traffic flow on the transportation system as a whole and on specific corridors. The results of this study are used as factors in prioritizing needed improvements.



Texas Parks & Wildlife, Esri, HERE, Garmin, GeoTechnologies, Inc., USGS, METI/NASA, NGA, EPA, USDA

Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

Esri, HERE, Garmin, FAO, USGS, EPA, NPS

Figure 1- Spring 2022 CMP Routes

2.0 TRAFFIC FLOW THEORY

2.1 Traffic Flow

The Highway Capacity Manual defines capacity as “…the maximum hourly rate at which persons or vehicles reasonably can be expected to traverse a point or a uniform section of a lane or roadway during a given time period under prevailing roadway, traffic, and control conditions.”

The capacity of a roadway, and its operational characteristics, is a function of a number of elements including: the number of lanes and lane widths, shoulder widths, roadway alignment, access, traffic signals, grades, and vehicle mix. Generally, roadways with wider travel lanes, fewer traffic control devices, straight alignments, etc. result in lower delays.

2.2 Level of Service

The Highway Capacity Manual defines level of service as “…a quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience.

“Six LOS are defined for each type of facility that has analysis procedures available. Letters designate each level, from A to F, with LOS A representing the best operating conditions and LOS F the worst. Each level of service represents a range of operating conditions and the driver’s perception of those conditions.”

The FHWA requires MPOs over 200,000 to have a Congestion Management Process (CMP) to monitor, manage, and mitigate congestion as defined locally. Historically, the RGVMPO has used Congestion Index (CI) as the primary performance measure to identify areas of congestion and delay. This performance measure is based on average travel speed as determine through floating car travel time runs compared to that of the posted speed (judged to be the free flow or unconstrained travel speed). The resulting performance measure is calculated for each intersection segment between intersections (signalized, stop signs, major uncontrolled intersections in rural areas, and cross streets along freeways). In addition to the intersection segment, the same performance measure is calculated for 0.1-mile segments in order to have a common unit length for baseline comparisons. CI is a ratio of operating speed to posted speed limit. Congestion Index is explained in detail in Section 4.1. This method allows easy comparison of the efficiency of roadway segments.

3.0 METHODOLOGY

3.1 Roadway Mapping

3.1.1 Global Positioning System (GPS)

Before starting the travel time runs, all surveyed roadways were mapped using Global Positioning System (GPS) technology. This year's roadways were field verified and any changes since the last study, including new signals, changes in speed limit, infrastructure improvements, etc. were identified.

GPS is a satellite-based positional system operated by the United States Department of Defense. These receivers were used in combination with the controlling software while driving each roadway to inventory all elements related to speed.

3.1.2 Mapping Runs

The roadway mapping was done in-vehicle using the GPS equipment and custom software. Mapping was done in one direction for each roadway segment during off-peak periods.

Traffic elements were recorded including speed limits and number of lanes. Other elements that were observed or were coded in GIS using data provided by the RGVMPO. This information would be later used to determine the segment lengths and calculated travel times, and to provide better insight into the resulting travel time runs and improvement recommendations.

3.2 Travel Time Runs

Travel time runs were conducted using the floating car method. In the floating car method, the driver of the test vehicle "floats" with the traffic by attempting to safely pass as many vehicles as pass the test vehicle, thus representing the average vehicles.

Travel time runs were conducted during the morning and afternoon peak periods on all roadway segments. Three runs were planned in each direction during each peak period. The data is saved through a customized travel speed program. The driver of the test vehicle drove the speed limit if no other cars were present and at the school zone speed limit if a school zone speed limit was in effect at the time of the travel time run.

4.0 ANALYSIS

4.1 Congestion Index

Historically since 2000, the RGVMPO has applied a measurement of congestion referred as the Congestion Index (CI). CI is the ratio of the actual average speed to the weighted average posted speed limit.

CI = Actual Average Speed / Weighted Average Posted Speed Limit

CI = Congestion Index
Actual Average Speed = Average speed of all runs on a segment
Weighted Average Posted Speed Limit = Average of all posted speed limits on the segment weighted by length

Historically, according to the RGVMPO criteria, a CI less than 0.75, indicates a congested section. For example, this would be traveling less than 30 mph when the posted speed limit is 40 mph. A CI of 0.75 to 0.99, or approximately 30 mph to 39 mph, indicates a section of stable flow. And a CI greater than 0.99, or 40 mph or higher, indicates free flow conditions. **Table 1** defines the congestion index criteria.

The travel speeds on congested segments are slower than drivers typically want to drive, and there may be less opportunity for lane changing and maneuvering. Stable sections are accommodating volumes less than capacity. Travel speeds are somewhat slower than the speed limit, but generally acceptable to drivers. Lane changing and maneuvering is less difficult than in congested segments. Free-flow sections are operating well below capacity. Travel speeds equal or exceed the speed limit and traffic can maneuver without interference.

Table 1 - Congestion Index Criteria

Congestion Index (CI)		
Congestion	Stable Flow	Free Flow
< 0.75	0.75 to 0.99	> 0.99

Over the years, the majority of the recommended mitigation for the “congested” segments was to optimize and coordinate the arterial signal system to provide more consistent travel speeds along major corridors and avoid frequent stopping at most signals. These conditions are being highlighted this update cycle in order to differentiate between “congestion” and “delay”. The congestion index threshold used to date to define congestion has been < 0.75 or an average speed within a segment of less than 75% of posted speed. This average could be a result when traffic volumes approach capacity of a link and create enough friction such that drivers are forced to drive slower and are unable to reach the posted speed limit. The other, more common, situation that results in a < 0.75 CI is travel unconstrained for most of the link at or above posted speed, but the driver is forced to stop at the downstream intersection long enough to bring the average speed from center of upstream intersection until passing through the downstream intersection down to a point that results in a longer travel time to traverse the segment and thus a lower average speed. As first introduced in 2015, this second condition will be referred to as “delay” instead of “congestion”… a small but very important distinction. In order to mitigate “delay”, it will more commonly be a local intersection or corridor signal system operational issue, thus much lower capital cost vs. “congestion” that may more typically be a capacity issue with a large required investment.

Within those with lowest CI, many are thought to be secondary approaches as compared to what many feel are the busiest or most congested intersections. In the update in 2013, a new performance measure was included in the Congestion and Delay Study and referred to as volume weighted delay. This performance measure highlighted those areas where the combination of delay and higher volumes lead to congestion and delay. The resulting value highlighted the total exposure or relative number of vehicles that encounter the measured delay from the travel time runs. The volumes used were gathered from the validated travel demand model. The average daily volumes were conflated to the intersection segments in GIS where a weighted average volume was determined based on the lengths of each model link. One element to note in using the model volumes is the distinction that the volumes represent daily (24 hour) volumes combined for both directions, while the delays calculated are directional for a specific time period (AM or PM peak period). Therefore, the performance measure is solely a relative measure of the magnitude of delay for a peak period which highlights the expected daily volumes along the link in question. The average volumes for 2-way segments used in the calculation were divided in half to represent the relative volumes on the directional link in order to be able to compare to other segments that include 1-way volumes in the model such as frontage roads, mainlanes, or 1-way streets.

4.2 Roadway Segment Definition

Since the Spring 2001 study, roadway segment endpoints are defined at each traffic signal or stop sign. This allowed the segments to be evaluated on a detailed level and then combine, as appropriate, to make corridor recommendations. For the Spring 2022 season, approximately 708 centerline miles of roadways, including 215 different roads, were further divided into 3689 directional links for detailed evaluation. These segments either had a traffic signal, stop sign, or a major cross street in rural areas with limited controlled intersections, as the end points.

The methodology developed and applied specifically for this project resulted in a calculated congestion index for each 1-second GPS data point. The actual speed between successive points provides detailed results that can highlight the problem areas. A detailed intersection segment level CI was used to develop the appropriate recommendations for the congested segments. In addition to the intersection segment CI analysis, one-tenth of mile segmentation was recently introduced to better highlight local areas of delay. The approach is described in **Section 5.2**.

4.3 Data Reduction

The method of recording roadway information and travel times using GPS results in massive amounts of data that required manipulation into a useable format. Each roadway was defined as a “route” in both directions and beginning and ending points were determined in order to calculate travel time for the segment. The GIS coordinate system provided by the RGVMPO was modified to match the NAD 83 (feet) coordinate system used in the data collection. All information was organized so that data could be sorted by jurisdiction.

4.4 Presentation

The travel time information and associated CI’s were formatted into tables, graphs, and in ArcGIS. ArcGIS is a GIS software that allows the reader a quick, easy-to-understand graphical reference. For example, ArcGIS can be used to find out the number of congested segments in the City of McAllen.

The 1-second data points are color coded according to the criteria for free-flow, stable, and congested conditions. These 1-second points can be used to determine at what point along a segment a traveler experiences delays or congestion.

The data in the figures and tables in this report combines information for AM and PM travel time runs. When congestion occurs during only one time period, the user can study the detailed information to determine the cause of the delay. Thus, improvements can be better focused to ensure the most appropriate use of funds.

ArcGIS can be used to view the information provided in this study for reference and for future projects. Information such as speed limits along specific roadways, location and number of traffic signals, the location and number of stop signs, and the location and length of school zones can be summarized and viewed. The information can be summarized for the entire region or broken down and summarized by city and can be used to identify future improvements.

5.0 EVALUATION

5.1 Congestion Index

As shown in **Table 2** and **Figure 3**, of the 1415.8 directional miles of roadways studied in Spring 2022, during the PM Peak Period, 214.0 miles were free-flow, 587.7 miles were stable, and 614.1 miles were congested. Therefore, for the Spring 2022 season, 56.6% of the roadways operated within an acceptable range during the PM Peak Period (compared to 49-68% for previous studies between 2001-2019). The percent congested can vary dramatically each year depending on season and roadways included.

Table 2 - Summary of Study Roadways in Terms of CI for PM Peak Congested < 0.75

Season	Measure	Roadway Condition			Total
		Free Flow	Stable	Congested < 0.75	
Spring 2022	Number of Miles	214.0	587.7	614.1	1415.8
	Percentage of Miles	15.1%	41.5%	54%	100%

In many cases, congestion indices fell below 0.75 due to stop signs or traffic signals, and many of the recommendations call for signal timing improvements. These situations can be clearly seen in ArcGIS. The 1-second speed points are green (free-flow) along the length of a segment and then several red 1-second speed points (congested) occur while stopped at a stop sign or traffic signal. An example is provided in **Figure 2**. Traffic may be traveling at good speeds until they hit a red light. Less than optimal timing or signal progression may be the cause of delay in these areas. **Figure 3** shows the Congestion Index values for all the intersection segments studied in Spring 2022.

5.2 One-tenth of a mile (0.1 mile) Segments

To address common questions related to congestion and its relation to segment length, a criterion was added in the 2009 season and is included once again this year. The intersection segments that include a signal, stop sign, or major cross street on each end were further broken down into relatively common lengths. These lengths vary slightly depending on the intersection segment length, but the lengths closely match approximately 0.1 mile (approximately 500 feet). This allows close comparison of each segment and further allows assessment of the root cause and location of congestion / delay. The vast majority of the congested 0.1-mile segments fall at the intersection with a signal or stop sign. The overall length of congestion also is greatly reduced given the fact that most congestion is limited to the controlled intersection segment and not those mid-block. **Table 3**, and illustrated in **Figure 4**, show the number of congested, stable and free-flow miles on 0.1-mile segments. Comparing this to **Table 2**, we can see that the number of congested miles is far less based on 0.1-mile segments which can be interpreted to mean congestion does not occur on entire segments and mostly occurs on a shorter portion of the segments between intersections. This helps further narrow down the location and contributing factors of congestion in the region.

Table 3 - PM Period CI on 0.1-mile Segments Congestion < 0.75

Season	Measure	Roadway Condition			Total
		Free Flow	Stable	Congested < 0.60	
Spring 2022	Number of Miles	458.7	793.5	163.6	1415.8
	Percentage of Miles	35.9%	53.8%	14%	100%

In the Spring 2022 Study, a total of 1,661 0.1-mile segments were congested. Of these, 980 segments (about 59%) had a Signal at the downstream end. When comparing the 0.1 results to those of the intersection segments, it becomes clear that a large percentage of the measured delay occurs within 500’ of a traffic signal and a large percentage of the signals could benefit from an operational assessment and update. The results indicate that 163.6 miles of 0.1 segments contribute to bring 614.1 miles of intersection segments into the “congested” category of CI. This means that there is sufficient delay in those short segments to bring the average speed for the longer segment low enough to fall below the 0.75 CI threshold.

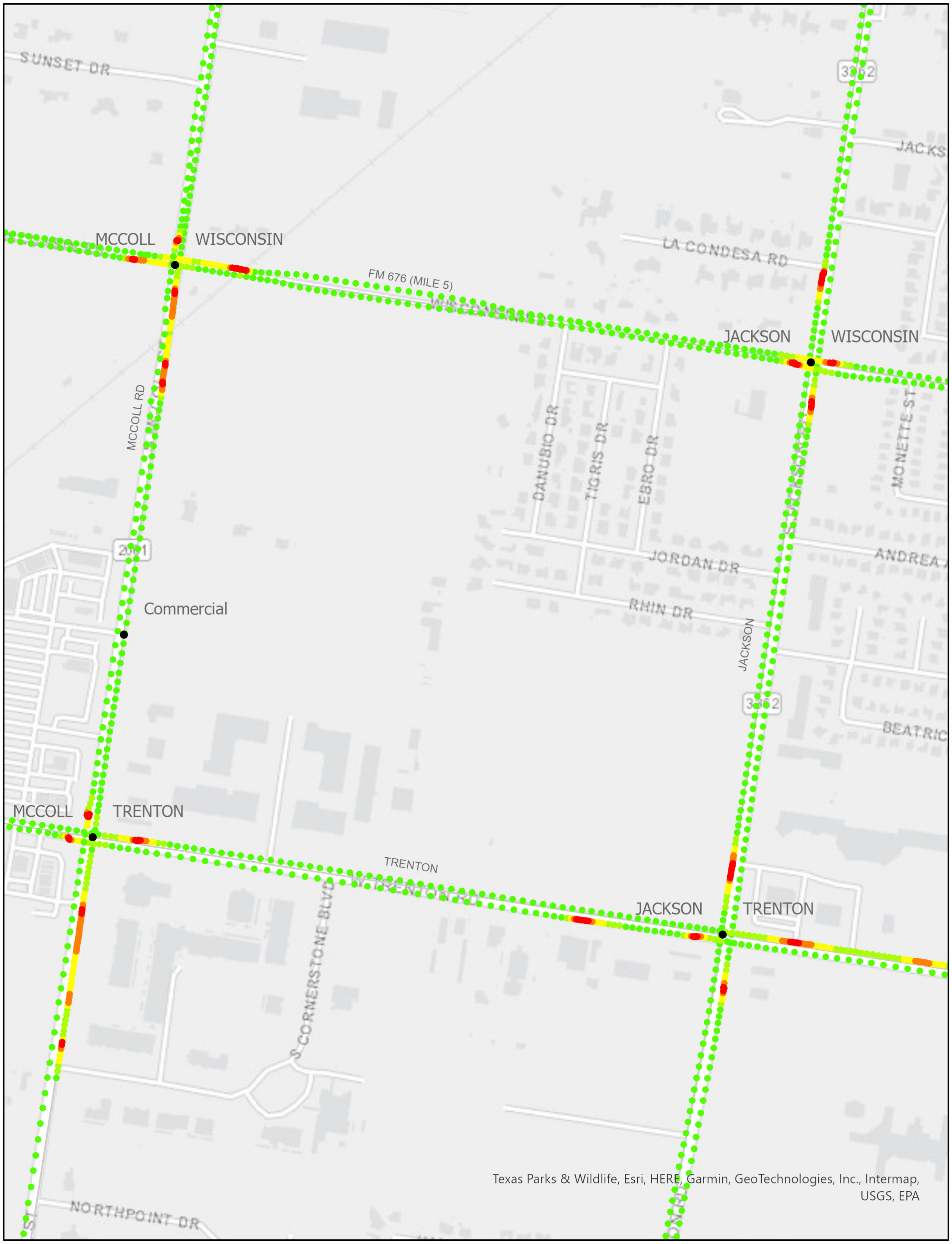
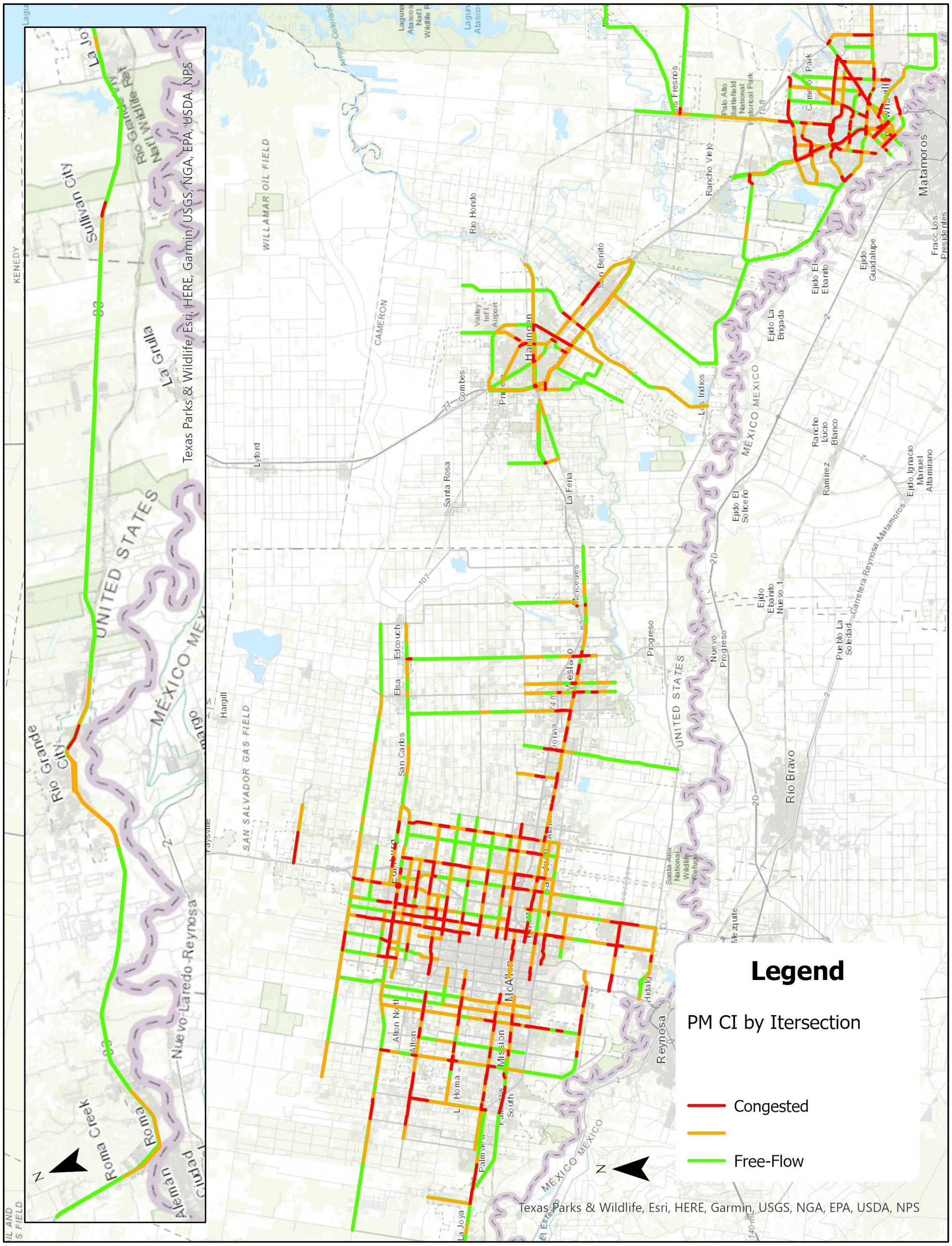


Figure 2 – Example 1-Second Speed on Congested Segment Near Signal



Texas Parks & Wildlife, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

Texas Parks & Wildlife, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

Figure 3 – Spring 2022 Congestion Index

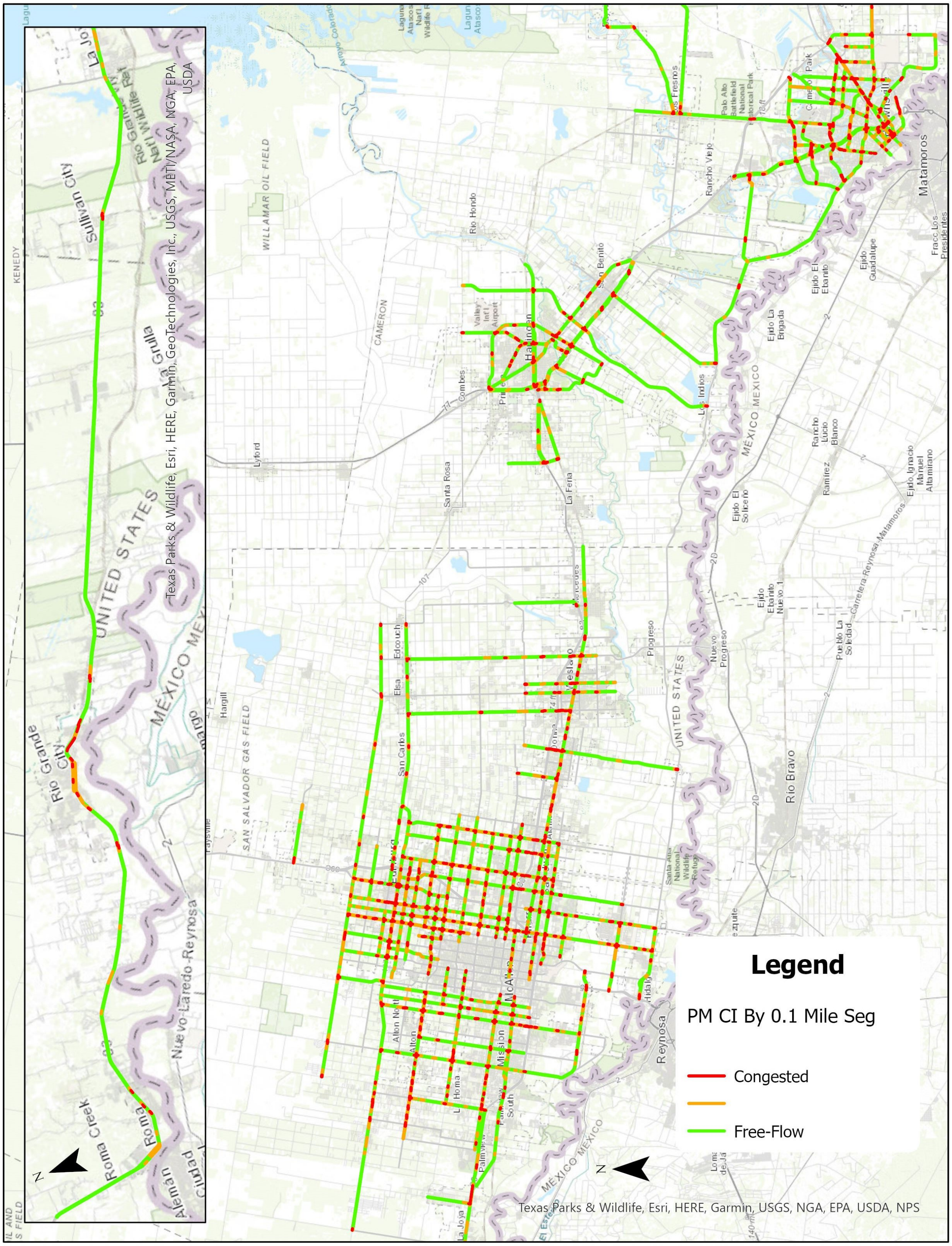
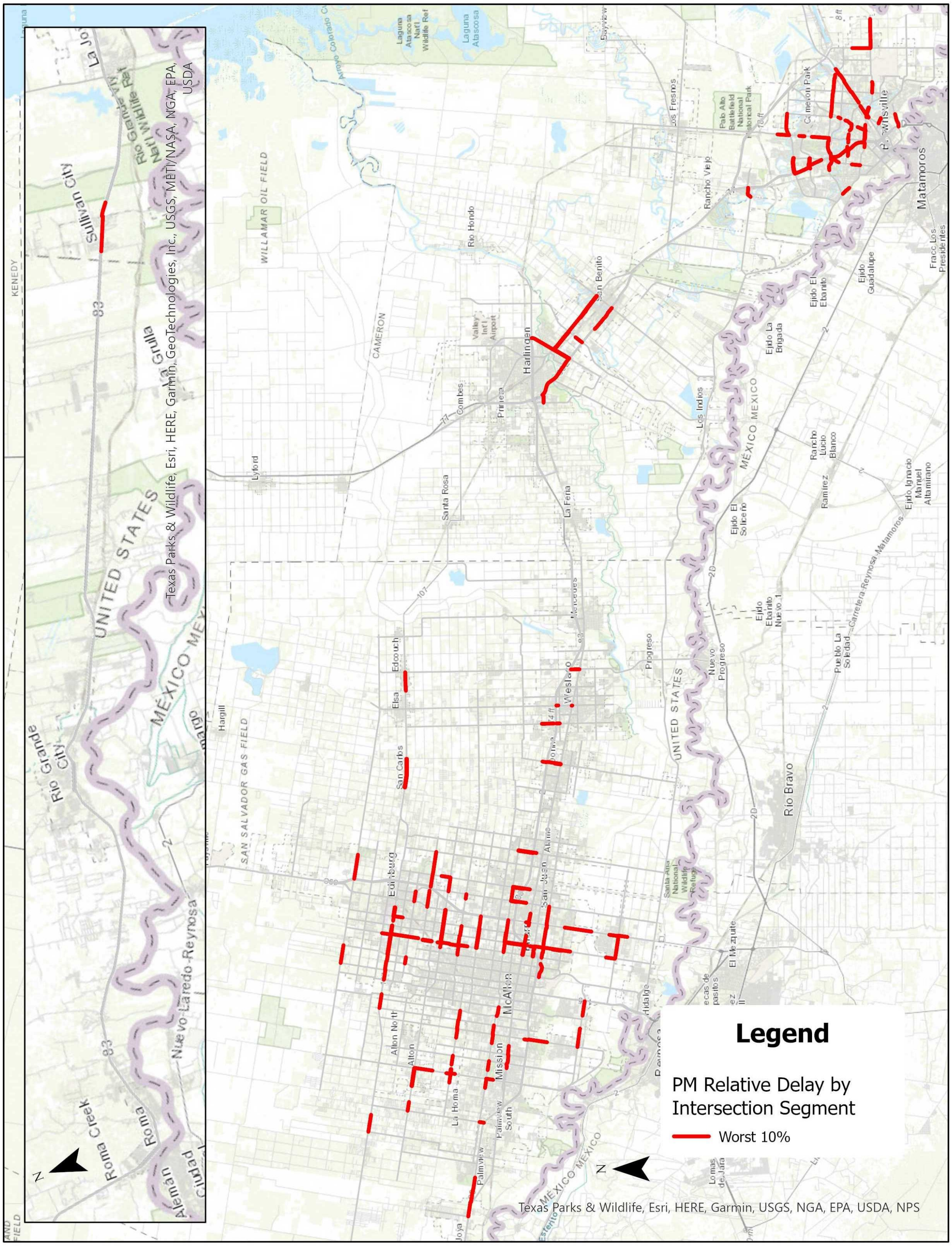


Figure 4 – Summaries at 0.1-mile segment level for Spring 2022

Of those with the lowest CI, many are thought to be secondary approaches as compared to what many feel are the busiest or most congested intersections. In order to address this issue, an additional performance measure was introduced a few years ago.

Beginning with the Spring 2013 update, a new performance measure was included and once again part of the Spring 2022 Congestion and Delay Study. It is referred to as volume weighted delay. This performance measure will be used to highlight those areas where the combination of delay and higher volumes lead to congestion and delay. The resulting value highlights the total exposure or relative number of vehicles that encounter the measured delay from the travel time runs. The volumes used are gathered from the current RGVMPO validated travel demand model. The average volumes for 2-way segments used in the calculation were divided in half to represent the relative volumes on the directional link to compare to other segments that include 1-way volumes in the model such as frontage roads, mainlanes, or 1-way streets.

As expected, the results found with this new performance measure vary substantially from those using only Congestion Index. Congestion Index was used exclusively up until 2013 by the RGVMPO to rank deficient segments on the network. By applying volume to the delay results, we can now represent the relative number of seconds of total delay given the number of vehicles experiencing the measured delay. For those approaches with high delays but relatively low volumes, they will fall down the list vs. those with less delay but very high number volumes. Thus, as shown in **Figure 5**, the worst 10% volume weighted delay primarily includes those that represent those approaches where the most vehicles could benefit from some form of improvement.



Texas Parks & Wildlife, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

Texas Parks & Wildlife, Esri, HERE, Garmin, GeoTechnologies, Inc., USGS, METI/NASA, NGA, EPA, USDA

Figure 5 – Volume Weighted Delay for Spring 2022

6.0 RECOMMENDATIONS

Recommendations for the congested roadways typically included traffic signal timing optimization, access management, roadway widening, and adding traffic signals (when warranted) in place of existing stop signs.

The majority of the segments found to be congested would improve by optimizing and coordinating the signals along the corridors. In general, the majority of the study network would recognize improved operations before warranting larger capital expenditures. Of the roadway segments that were congested, a large majority would improve to acceptable levels with optimized and coordinated signal timing. In previous studies, signal timing was found to be an area that deserved attention within the region to allow maximum efficiency of the existing system before costly widening to add capacity. The results will be very evident as has been demonstrated previously with local municipal projects. A regional perspective will produce consistent travel time runs even when crossing from one city / agency to another.

Operational studies in past years and those by local cities clearly demonstrate the opportunities for improvement with minimum cost and interruption of traffic. Signal timing optimization and coordination facilitate smoother operations, less stops, less delay, lower vehicle emissions, and less headaches for drivers. The cost / benefit of signal timing projects far exceeds projects 100 times as expensive and can be accomplished in far less time and much less impact to drivers and property owners to endure roadway construction.

As transportation funding continues to be limited, operations are being highlighted by many MPOs across the country. It has been clearly proven locally and nationally that operational improvements provide the highest benefit/cost ratio and on a regional scale as compared to local capacity projects that benefit a smaller portion of the county.

Together with the TAC, 172 intersections were chosen as shown in **Figures 6, 7, and 8**, for the 2022 CMP Tier 2 and are part of regional significant corridors that complement previous work performed with the 2016 and 2019 CMP Tier II. It is expected that the operational results will highlight the benefits of traffic signal timing improvements and will be documented in the Tier 2 report.

In review of the results of the 2016 and 2019 CMP Tier II, 250 priority 1 locations were identified. In those years, the study also included a “Self-Assessment” with each respective City responsible for signal maintenance. CoPLAN, along with a City representative, visited each intersection and performed a 97-point assessment of the signal equipment contents, working condition, capabilities, and limitations. The number 1 issue identified through the assessment was the determination that the majority of the intersections had limited vehicle detection. The percentages within each city ranged from 29% – 73%. Clearly, these findings are the primary factor contributing to the unnecessary intersection delay caused by poor performing traffic signals. When detection fails, as a safety measure, the respective approach will put in a continuous “call” even though at times there are no vehicles. This leads to times when the minor side streets are given an extended green signal while the major arterial and high-volume approaches are forced to stop and be delayed while no vehicles are pass through the intersection.

In order to optimize the operations of the corridors and get the most value out of the coordinated signal timing, the intersection detection needs to be addressed by the cities responsible for the signals.

Ideally, we would hope to see number closer to 10% of the intersection needing maintenance.

In addition to highlighting the need to repair detection at a large percentage of intersection, the assessment also documented the need to replace a large number of aging signal controllers and cabinets. The age of many of the signal hardware are causing equipment failures and are beginning to act as roadblocks to addressing national requirements for standardization.
What that means is that all TS 1 cabinets need to be replaced to meet national requirements. This relates to not only dependability needs within the City for maintenance but for the required implementation of “flashing yellow” left turns and “countdown” pedestrian heads. Many of the regions’ cabinets do not have the capacity to incorporate these left turn treatments. To be in compliance, this is an initiative each City needs to dedicate funds to address over the next few years.

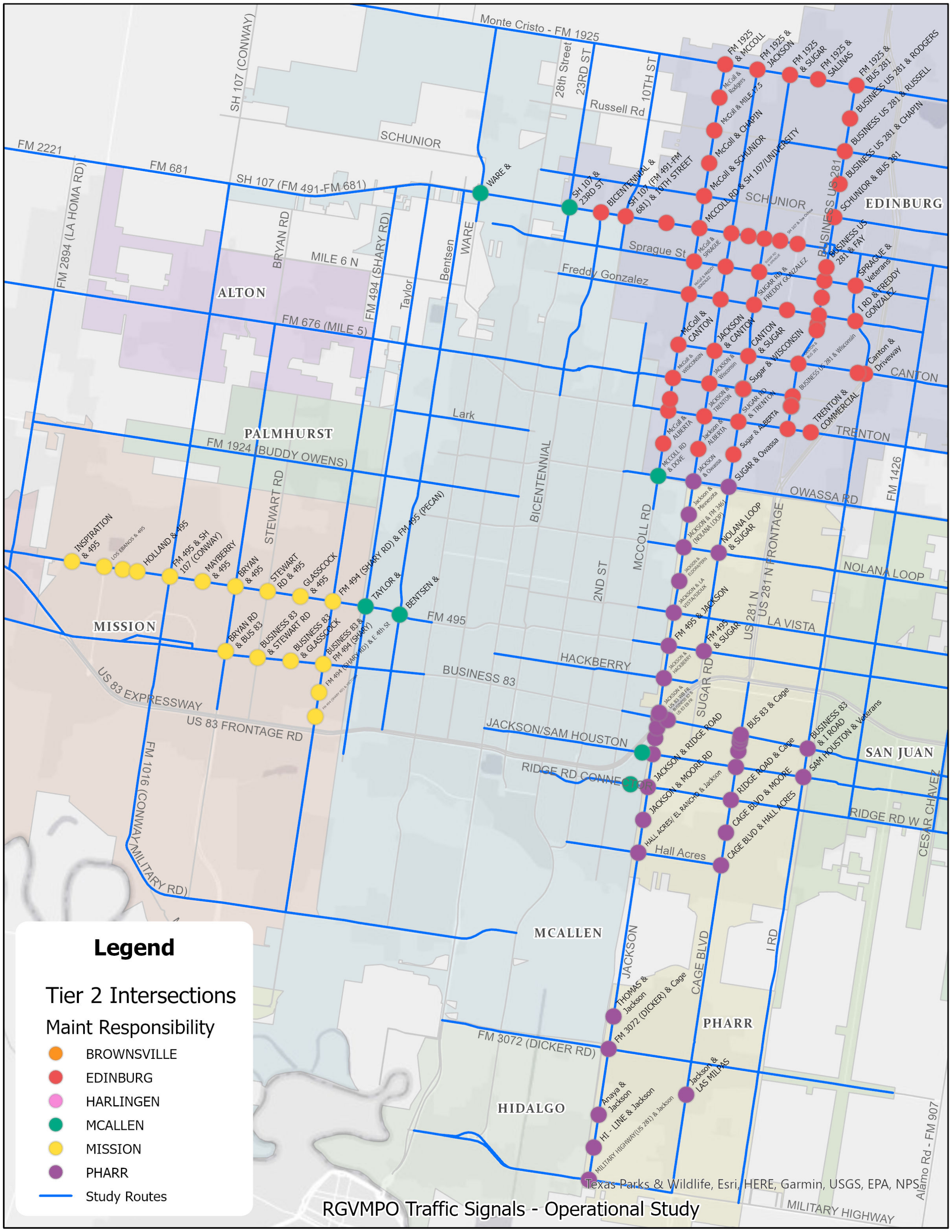
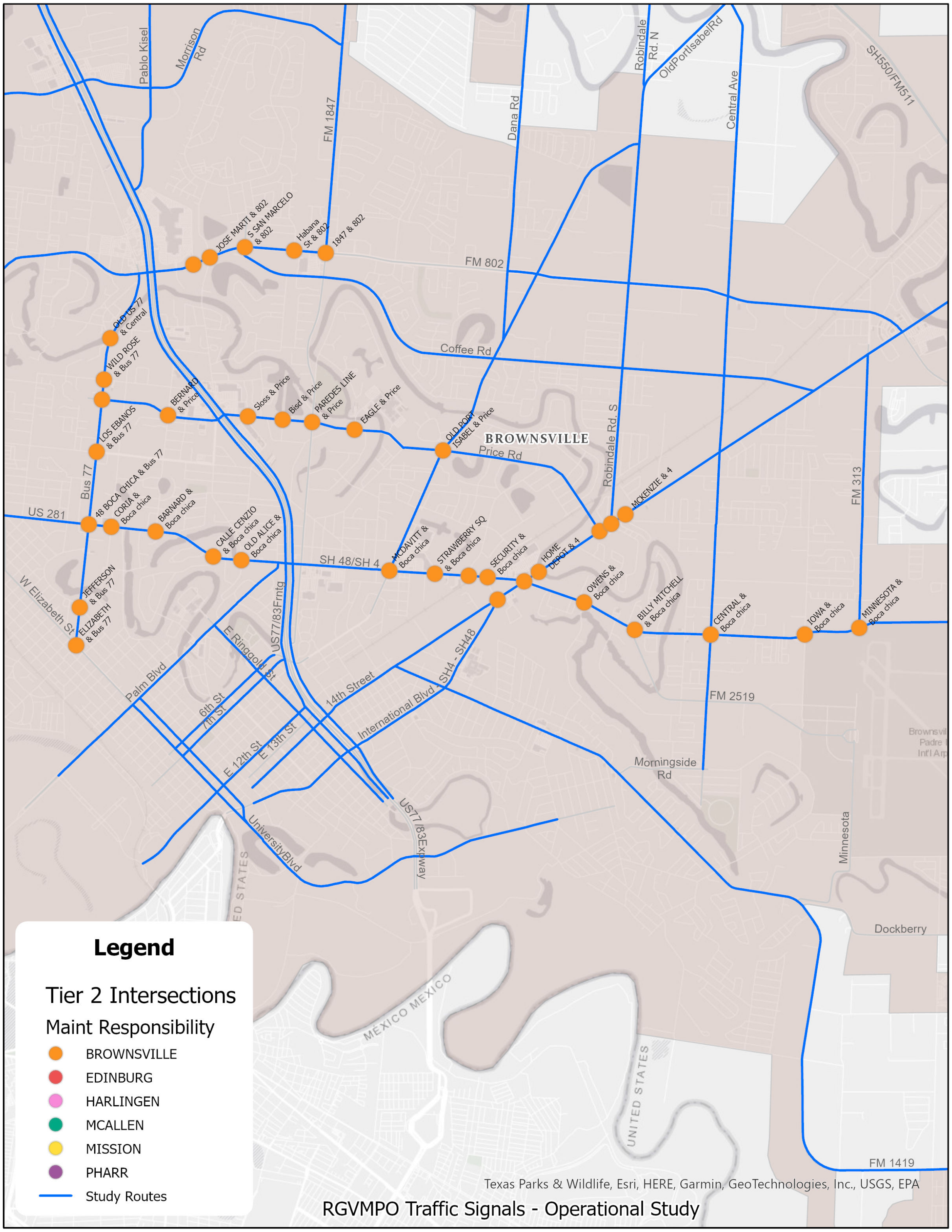
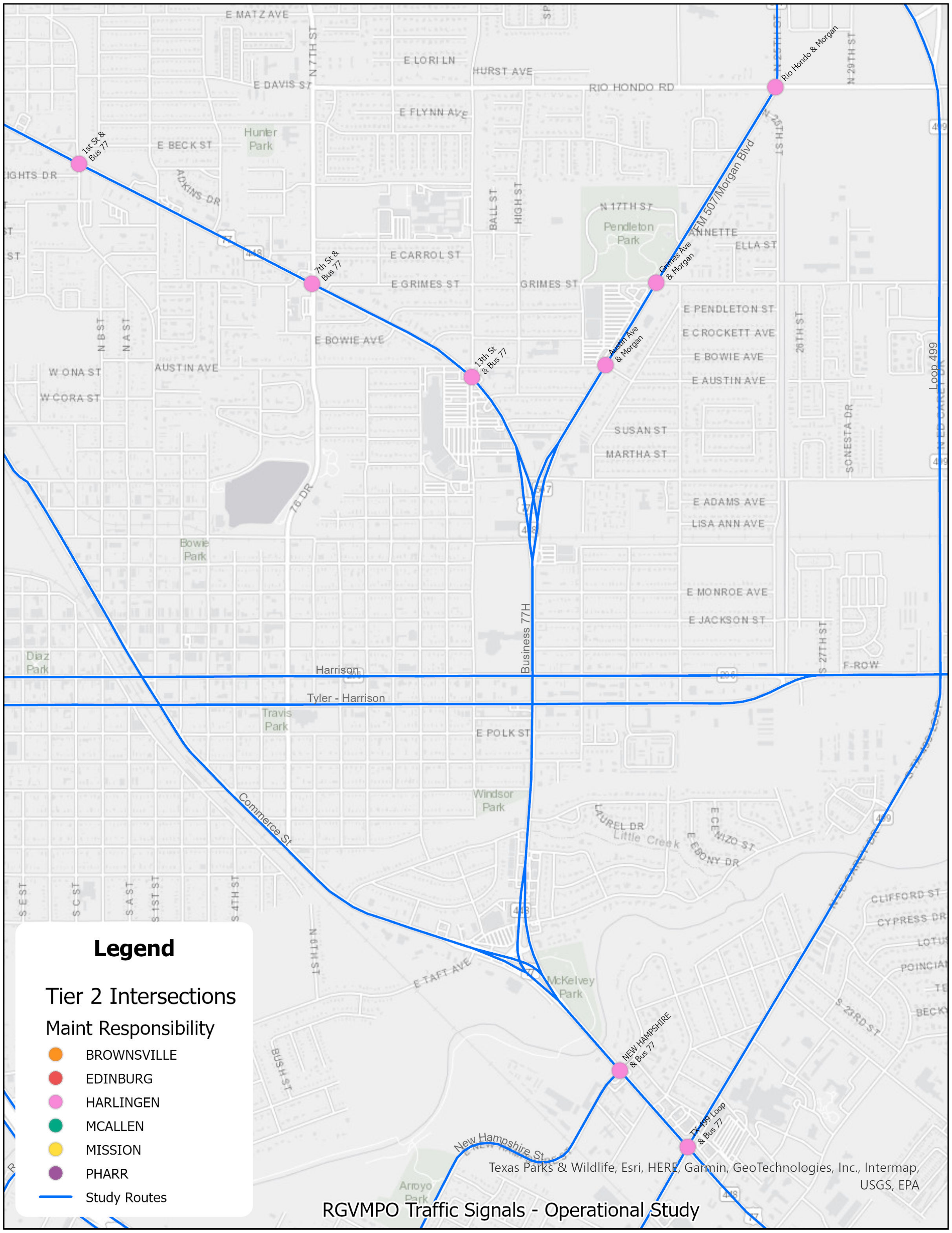


Figure 6 – Hidalgo County Priority 1 Signals



Texas Parks & Wildlife, Esri, HERE, Garmin, GeoTechnologies, Inc., USGS, EPA

Figure 7 – Brownsville Priority 1 Signals



Texas Parks & Wildlife, Esri, HERE, Garmin, GeoTechnologies, Inc., Intermap, USGS, EPA

RGVMPO Traffic Signals - Operational Study

Figure 8 – Harlingen Priority 1 Signals

7.0 CONCLUSIONS

A large percentage (43.4%) of roadway intersection segments studied in Spring 2022 were operating under congested conditions. On many of the segments with CI in the congested range, the congestion occurred only near a stop sign or traffic signal and had acceptable conditions through the remainder of the segment.

The results of this report when compared to previous study year roadways indicate higher levels of congestion, particularly when compared to respective seasons. Possible reasons for this include continued population growth and issues with signal timing and coordination. For those corridors that have been part of past signal timing improvements, the typical life before needing updates is 3 years, depending on volume changes and growth. In some cases, construction is completed, but signal optimization is still needed to maximize the efficiency of the new improvements. It is also clear when driving the corridors, a large percentage of the intersections need detection maintenance. This is an area where cities must increase budgets in the respective departments that are responsible to maintaining the traffic signal equipment.