CORPUS CHRISTI MPO
METROPOLITAN PLANNING ORGANIZATION

TECHNICAL ADVISORY COMMITTEE (TAC) REGULAR MEETING AGENDA

THURSDAY, October 19, 2023 - 9:00 A.M.

Location: Corpus Christi Regional Transportation Authority (CCRTA) Building
602 N. Staples Street, Room 210, Corpus Christi, TX 78401

1. **CALL TO ORDER, ROLL CALL, AND QUORUM DETERMINATION**

2. **PUBLIC COMMENTS FOR ITEMS NOT ON THE AGENDA:**

   Opportunity for public suggestions and comments for any items not on the Agenda and within the TAC's jurisdiction (except in matters related to pending litigation). Proceedings are recorded. To make a public suggestion or comment at the meeting, please fill out the printed comment card available at the meeting and submit it to Corpus Christi MPO staff 10 minutes before the meeting starts. We ask that remarks be limited to three minutes, that you identify yourself, and give your address. Those persons addressing the TAC through a translator are given twice the amount of time, or six (6) minutes to provide their comments. All Public Comments submitted shall be placed into the record of the meeting.

3. **APPROVAL OF THE TAC SEPTEMBER 21, 2023 REGULAR MEETING MINUTES** ✉

4. **DISCUSSION AND POSSIBLE ACTION ITEMS**

   A. **Congestion Management Process and Functional Classification Working Group Formation** ✉
      Proposed Action: Review, Discuss, Receive Public Comments and Possible Action

5. **WORKSHOP/INFORMATION ITEMS**

   A. **Small Area Forecast Task Force October 18th Meeting Recap** ✉
   B. **DRAFT MPO-wide Safety Network Screening Report, including Projects** ✉
   C. **DRAFT Resiliency Plan Technical Memo 2** ✉
   D. **Community Impact Model Development and Implementation Preview** ✉
   E. **TxDOT FM 624/Northwest Boulevard Project Update**
      https://www.txdot.gov/projects/hearings-meetings/corpus-christi/fm624-110223.html

6. **TAC MEMBER STATEMENTS ON LOCAL AGENCY ACTIVITIES OR ITEMS OF INTEREST**

7. **UPCOMING MEETINGS/EVENTS**

A.	**Small Area Forecast Task Force:**	**Meeting**	**October 18, 2023**
B.	**Transportation Policy Committee:**	**Regular Meeting**	**November 2, 2023**
C.	**Regional Traffic Safety Task Force:**	**Meeting**	**November 8, 2023**
D.	**Technical Advisory Committee:**	**Regular Meeting**	**November 16, 2023**

8. **ADJOURN**

✉ - Indicates attachment(s) for the agenda item. 🔗 - Indicates a weblink for agenda item

Public suggestions and comments may be provided before the meeting by emailing ccmpo@cctxmpo.us, by regular mail, or by hand-delivery to the Corpus Christi MPO Office at 602 N. Staples St., Suite 300, Corpus Christi, TX 78401. Please limit written comments to 1,000 characters. Written comments should be provided at least 1 hour before the start of the TAC meeting.

All Corpus Christi MPO Committee meetings are public meetings and open to the public subject to the access policies of the building owner where the meeting is being held. Any persons with disabilities who plan to attend this meeting and who may need auxiliary aids or services are requested to contact the Corpus Christi MPO at (361) 884-0687 at least 48 hours in advance so that appropriate arrangements can be made.

MEETING LOCATION MAP

CORPUS CHRISTI METROPOLITAN PLANNING ORGANIZATION (CORPUS CHRISTI MPO)
TECHNICAL ADVISORY COMMITTEE (TAC) MEETING MINUTES
Thursday, September 21, 2023

1. **Call to Order, Roll Call, and Quorum Determination**

Chairperson Brian DeLatte called the meeting to order.

TAC Members Present:

Chairperson Brian DeLatte, P.E., City of Portland
Juan Pimentel, P.E., Nueces County
Tom Yardley, Commissioner, San Patricio County
Jeff Pollack, AICP, Port of Corpus Christi Authority
Dan McGinn, AICP, City of Corpus Christi
Paula Sales-Evans, P.E., TxDOT – Corpus Christi District (CRP)

MPO Staff Present: Robert MacDonald, P.E., Craig Casper, AICP, Daniel Carrizales, Victor Mendieta, and Karla Carvajal

2. **Public Comments for Items not on the Agenda**

None were made or offered.

3. **Approval of the August 17, 2023, TAC Regular Meeting Minutes**

Mr. McGinn made a motion to approve the August 17, 2023, TAC Regular Meeting Minutes.
Mr. Pollack seconded; the motion passed unanimously.

4. **Discussion and Possible Action Items**

A. FY 2023-2026 Transportation Improvement Program (TIP) Amendment 1

Amendment 1 to the FY 2023-2026 TIP was proposed by Mr. MacDonald to the Technical Advisory Committee for review, discussion, and possible action. Public Notice #23-3 related to the DRAFT FY 2023-2026 TIP Amendment 1 is provided as Attachment 1. This item is a companion agenda item to the FY 2023 and FY 2024 Unified Planning Work Program (UPWP) Amendment 1.

In ongoing discussions about planning tools and processes necessary for a performance-based system, the Corpus Christi MPO was approved for an initial $2,000,000 in federal funding from the Coronavirus Response and Relief Supplemental Appropriations Act (CRRSAA). These funds are intended to fully fund planning projects, data acquisition, and tools either required by regulation, suggested in guidance, or were asked for during the 2045 MTP After-Action Report. These specific CRRSAA funds do not require a local match because they are COVID-related relief funds designated to the Corpus Christi MPO. The specific deliverables are identified in the executed TxDOT NCAFA (Non-Construction Advanced Funding Agreement) for the initial $2,000,000.

The NCAFA was provided as Attachment 4 through a weblink. The revised NCAFA is in review by TxDOT to add the additional $1,179,828 for the enhanced scopes of services and data collection activities in the original NCAFA. The new total of CRRSAA funds is $3,179,828. Most of the changes are to add public outreach activities to the Tasks in the NCAFA and increase some data collection activities. For this FY 2023-2026 TIP Amendment, the key action is to show the total funds for the TIP Project as well as document the expenditure in the DRAFT FY 2023 and FY 2024 UPWP. The Amended NCAFA will proceed on a parallel approval process. The total CRRSAA funds of $3,179,828 have been obligated through TxDOT and FHWA.

Recommendation:

The Corpus Christi MPO staff recommends that the TAC review, comment and receive public comments on the DRAFT FY 2023-2026 TIP with Amendment 1, then recommend approval by the TPC at their October 12, 2023 Regular Meeting.

Return to Agenda

Motion:

Mr. Pollack made a motion for TPC to approve the FY 2023-2026 TIP with Amendment 1.
Mr. Yardley seconded; the motion passed unanimously.

B. FY 2023 and FY 2024 Unified Planning Work Program (UPWP) Amendment 1

The Corpus Christi MPO staff requested that the TAC review, discuss, and receive public comment on the DRAFT Amendment 1 to the FY 2023 and FY 2024 Unified Planning Work Program (UPWP). This Amendment increases the 100% federal funds as part of the Coronavirus Response and Relief Supplemental Appropriations Act (CRRSAA) to $3,179,828 for the MPO Planning Tools and Studies project. There have been no public comments received to date. This item is a companion document to Item 4A, the FY 2023-2026 Transportation Improvement Program (TIP) Amendment 1.

Recommendation:

The Corpus Christi MPO staff recommends that the TAC review, discuss, and receive public comments on Amendment 1 to the FY 2023 and FY 2024 Unified Planning Work Program, then recommend that the TPC approve the document at their October 12, 2023 Regular Meeting.

Motion:

Ms. Sales-Evans made a motion for TAC to approve the DRAFT FY 2023 and FY 2024 UPWP with Amendment 1.

Mr. Pollack seconded; the motion passed unanimously.

C. 2020 Corpus Christi MPO Adjusted Urban Area Boundary

The Corpus Christi MPO staff alerted TAC that the Corpus Christi MPO Transportation Policy Committee (TPC) needs to act on this item during their October meeting in order to meet the current TxDOT and FHWA schedules. The proposed changes to the DRAFT Adjusted Urban Area will follow the 9 factors listed in FHWA's Highway Functional Classification Criteria and Procedures, Section 6. Urban Boundaries with a focus on 4 key criteria. The Corpus Christi MPO team met with FHWA, TxDOT HQ, and TxDOT District staff on September 11th to discuss considerations and methodologies for establishing adjusted boundaries.

Discussion:

Mr. Pollack inquired about the whether the area north of the industrial canal will be included. Mr. Casper confirmed that the industrial property north of the canal will be included in the urban area.

Ms. Sales-Evans asked if the adjusted boundary would be including all the SH 35, SH 361, and Spur 202 interchange. Mr. Casper confirmed.

Ms. Sales-Evans commented that it does not make sense to exclude the SH 361 interchange. Mr. Casper responded that the discussions for this area were that there is active industrial and the other part is agriculturally undeveloped.

Mr. Pollack asked if MPO staff can speak as to why go through this exercise of adjusting the boundary and how often it happens. Mr. Casper confirmed that updating the urban area occurs every 10 years.

Mr. Pollack commented that if this is the last attempt to update the boundary for 10 years, then the fact that there's agriculture on the other side of SH 361 today may not be as relevant as what is expected to be there in 10 years. Mr. Casper responded that the guidance states that updating the boundary is based on what is currently existing.

Mr. Pollack requested to know what the implications of being in or out of the urban area boundary. Mr. Casper stated it is the eligibility of funding. The MPO can distribute urban funds which go into the urban area. Outside of the urban area is by definition rural and so rural funds are not the purview to

the MPO. Mr. MacDonald commented that funding outside of the urbanized area would go through TxDOT.

Mr. Pollack inquired if there is an increase in funds if the urbanized area becomes larger. Mr. Casper responded that the funds stay the same. He further elaborated that some of the categories of funding are based on mileage; so as the urban area expands and the mileage goes up, so then does the share of funding become bigger based on the change in mileage.

Ms. Sales-Evans commented about taking a closer look at the SH 44 interchange when developing the boundary.

Ms. Sales-Evans inquired that because the adjusted urban area does not include the power plant area that means anything associated with a new location for Regional Parkway is not going to be available for MPO funds. Mr. Casper confirmed that unless it connects to Yorktown Boulevard, it would be outside of the MPO.

Mr. Pollack asked about the logic to not extend the boundary further east towards Ingleside from Gregory. Mr. Casper informed Mr. Pollack that the boundary was extended to be flush with the adjusted Aransas Pass-Port Aransas-Ingleside urban area as shown on the next slide in the presentation.

Ms. Sales-Evans asked what the downside is for not including all of the area north of SH 44 up to the adjusted urban area and continuing west toward Robstown. Mr. Casper stated that FHWA staff did not want to include very large areas into the adjusted urban area. Guidance dictates corrections are supposed to be small to smooth out the boundary.

Mr. DeLatte inquired about the frequency of this boundary being updated and the process to do so. Mr. DeLatte's concern was towards upcoming projects that may not fall within the urban area. Mr. Casper responded that there is a process that goes through TxDOT and FHWA, similar to the process for adjusting functional classification of roadways. Mr. Casper noted that the MPO boundary will be adjusted once the urban area is adjusted and that even though a project may not fall within the urban area, it may still fall within the MPO boundary which qualifies for urban funding.

Recommendation:

The Corpus Christi MPO staff recommends the TAC consider the MPO staff proposed adjustments to the Urban Area Boundary following the presentation of the information related to the 9 factors listed in FHWA's Highway Functional Classification Criteria and Procedures, Section 6. Urban Boundaries with a focus on 4 key criteria. After the discussions, the TAC is asked to make a recommendation for approval to the TPC.

Motion:

Ms. Sales-Evans made a motion for TAC to approve the MPO recommended 2020 Census Corpus Christi Adjusted Urban Area Boundary.

Mr. McGinn seconded; the motion passed unanimously.

5. Information Items

A. Corpus Christi MPO Regional Household Travel Survey

TxDOT and the Corpus Christi MPO are conducting a Household Travel Survey in the two-county region. A consultant team is leading the effort under contract with TxDOT. The Household Travel Survey provides essential information on behavior characteristics that are used to develop travel demand models and in the overall transportation planning process. Those members of the public agreeing to participate are assigned a one-day travel period and asked to track all trips for each member of the household during that period. Participants use a smartphone app, website or other methods to record where, when, how, and why they travel. The information is anonymized and used to calibrate the regional travel demand model. Results from the survey are expected to be

available in the next MTP planning cycle for the 2055 MTP. The surveys gather information to provide an in-depth understanding of travel behavior in the region, including for individuals within households and regional establishments, their travel activities, demographics and other factors that affect travel and that these feed into the travel demand model so that it can identify transportation needs within the region.

B. Regional Traffic Safety Task Force Recap from September 13, 2023

MPO Staff updated TAC on topics discussed during the previous Regional Traffic Safety Task Force meeting.

Discussion:

Ms. Sales-Evans commented that there were some concerns about the advanced notification for the Task Force meetings and express that getting these meetings on people's calendar earlier is for the better to eliminate last minute rushed information or confusion.

Mr. MacDonald responded that the MPO staff will provide at least a week of lead time prior to the meeting dates.

C. Corpus Christi MPO Small Area Forecast Growth Areas/Approved Developments

The Corpus Christi MPO staff requested information on the location of subdivisions in the region that are currently in active development. Developments that have full utilities available and are actively selling houses at this time. This information is important as it shows areas that will develop more immediately.

Discussion:

Ms. Sales-Evans inquired how far out does the city wind up with the plats that are outside the city limits?

Mr. McGinn responded with the request that for specific areas/zones to be looked at, to send a request by email to him for more detailed information.

D. Corpus Christi MPO Regional Resiliency Plan Phase 1

The Corpus Christi MPO staff provided an update on the DRAFT Critical Infrastructure Assets and DRAFT Hazards Identification information which comprise Phase 1A of the Regional Resiliency Plan. These data were developed through literature search and reviewing partner agency data sources. A discussion of these items will be conducted. Phase 1 is identifying what the critical infrastructure is and what the threats are. Phase 2 will be identifying the ramifications and prioritization of ramifications of disasters and what the potential costs of that disaster are versus the costs to harden the infrastructure for prevention. MPO staff has a draft report on the infrastructure.

Discussion:

Mr. Pollack asked if MPO staff is looking for feedback from TAC before the finalized report. Mr. Casper confirmed yes.

Mr. Pollack encouraged MPO staff to reach out to modelers, particularly those at the Harte Institute. Mr. Casper noted that the MPO staff are participating in the Harte Institute Study and indicated that the MPO will have better data than any MPO in the country.

E. Corpus Christi MPO Functional Classification of Roads

The Corpus Christi MPO staff updated TAC that they are working with a consultant to update the federal functional classification of roads. FHWA's document Highway Functional Classification: Concepts, Criteria and Procedures, 2013 Edition, describes the procedures and processes for assigning functional classifications to roadways and adjusting urban area boundaries. The Federal-aid system has matured significantly. A significant proportion of new functional classification

designations occur from improvements and modifications to existing roads and corridors, rather than from designations on new roadways and corridors.

Discussion:

Ms. Sales-Evans commented that there a number of roadways that are identified as part of the National Highway System and proceeded to inquire about where in the process is the MPO at to start looking at the functional classification review. Ms. Sales-Evans further asked that when reviewing corridors whether it still makes sense for them to be managed by the National Highway System versus other.

Mr. Casper responded that the National Highway System should be the first three functional classifications: interstates, freeways, and other principal arterials. Mr. Casper further elaborated that if a corridor is not one of those classifications, the corridor will not be a National Highway System route.

Mr. MacDonald noted that the TxDOT Standard Operation Procedure (SOP) for functionally classifying roads was given to TAC members. The SOP acts as background information for TAC members so when MPO staff has a consultant lead TAC members through the process, there will be no surprises and all criteria will be met.

6. Regional Grant Coordination Topic

A. Corpus Christi MPO Regional Coordination Group for Federal Transportation Grants Update
The Corpus Christi MPO staff presented information to serve as the focus for the Regional Coordination Group, which is the monthly TAC meeting. Corpus Christi MPO staff invited other local agency staff to provide information on transportation projects and program grant submittal proposals. They encouraged all those to attend the TAC meeting to provide their input on the specific federal transportation grants being proposed and identified for future submittals over the remaining four years of these transportation grants. The Corpus Christi MPO staff will inform the TAC of available grant opportunities whenever these become available and ask for their comments and directions as part of the regional coordination efforts.

7. TAC Member Statements on Local Agency Activities or Items of Interest

None were offered.

8. Upcoming Meetings/Events

A.	**Transportation Policy Committee:**	**Regular Meeting**	**October 12, 2023**
B.	**Technical Advisory Committee:**	**Regular Meeting**	**October 19, 2023**
C.	**Small Area Forecast Task Force:**	**Meeting**	**October 19, 2023**
D.	**Regional Traffic Safety Task Force:**	**Meeting**	**November TBD, 2023**

9. Adjourn

The meeting was adjourned at 10:25 a.m.

CORPUS CHRISTI MPO
METROPOLITAN PLANNING ORGANIZATION

Date:	October 12, 2023
To:	Technical Advisory Committee (TAC)
From:	Craig Casper, Senior Transportation Planner
Through:	Robert MacDonald, Transportation Planning Director
Subject:	Item 4A: Congestion Management Process and Functional Classification Working Group Formation
Action:	Review, Discuss, and Possible Action

Summary

As discussed previously, the Corpus Christi MPO staff is seeking participants to update the Congestion Management Process (CMP) objectives (*Attachment 1*) and use TxDOT's Functional Classification SOP (*Attachment 2*) to assist with verifying and updating the Federal Functional Classification of roadways within the Corpus Christi MPO region.

Congestion Management Process documents are required in metropolitan areas with more than 200,000 people (known as Transportation Management Areas (TMAs)) The CMP is intended to maximize benefits from capital investments in transportation and should be updated no less frequently than the metropolitan transportation plan updates. Although collecting and re-evaluating the data to produce the annual reports is not a simple task, it is necessary to complete the monitoring requirement of the CMP.

Federal Functional Classification changes are triggered when:

1. New roadways are built or extended
2. Existing roadways are realigned or reconstructed (includes added capacity projects)
3. Traffic patterns or volumes change
4. Land use patterns change
5. The Decennial Census is released

Background

The Federal Highway Administration (FHWA) defines a CMP as: "a systematic and regionally accepted approach for managing congestion that provides accurate, up-to-date information on transportation system performance and assesses alternative strategies for congestion management that meets state and local needs." A principal function of the CMP is guiding the selection of which projects to fund in the TIP. As federally required, any project proposed for federal funding in the TIP that adds general-purpose lanes must demonstrate demand and operational management strategies (such as access management or signal interconnection) are insufficient to satisfy the need for additional capacity. If a roadway expansion project is deemed necessary, the CMP must identify all the other regional demand and operational management strategies that will maintain the functional integrity and safety of the corridor into the future.

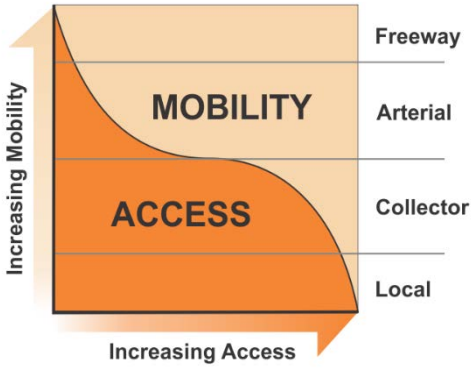
The CMP uses an 8-step process to identify key routes, determine what is acceptable and unacceptable congestion, uses performance measures to prioritize congestion hotspots along the identified corridors,

develops a set of possible policies or projects to improve travel within each identified corridor, and evaluates the set of interventions to determine the most efficient and effective investments to meet the adopted regional goals. Federal guidance requires that policies or projects that reduce congestion without building new or wider roads are used before the decision is made to build a new or wider road. This promotes efficient use of existing transportation infrastructure and allows limited funding to benefit a wider area.

MPOs request functional classifications according to how the roadway is functioning in the current year only. *The existing federal functional classifications are shown in Attachment 4*. With regard to future routes, roads can be reclassified if they are included in the approved Transportation Improvement Program (TIP), are forecast to meet the FHWA criteria for proposed federal functional classification, and will be under construction within 4 years. Roadways serve two primary travel needs: access to/egress from specific locations and travel mobility. While these two functions lie at opposite ends of the continuum of roadway function, most roads provide some combination of each. Currently, Federal and State funding programs assign a substantial share of capital and operating resources to the Principal Arterial system (FC 1, 2, and 3), in comparison to lower functional classifications. These federal functional classifications (FC 1, 2, 3) also comprise the National Highway System, which is eligible for federal funds in the National Highway Performance Program (NHPP), Category 2 in Texas. As a result, expectations for condition and performance of the NHS is higher than for the other functional classifications.

The following is taken from the adopted Corpus Christi MPO Public Participation Program:

Federal Functional Classification of Roads –
Following the 2020 Census, State DOTs and MPOs are required to review the Federal Functional Classification of the roadway system and make any necessary changes due to urban boundary changes, addition of new roadways or changes in the function of the roadways. The Federal Functional Classification process is a hierarchal system of classification that helps to ensure a comprehensive roadway system that provides logical connectivity and continuity across the entire network. The federal functional classification process (*described in Attachment 2*) groups roadways into classes (freeways, arterials, collectors, locals), based on the role they play in the overall roadway system. Roadway classes are determined based on the following factors:



- Connectivity
- Function
- Land use
- Trip length
- Spacing
- Service to Urban Activity Centers
- Traffic Volume
- VMT (vehicle miles of travel)
- Mileage ratio of each class

The process of classification determines which roads are eligible for federal funding such as the Federal Highway Administration's (FHWA's) emergency relief program. Also, performance goals are primarily directed at the National Highway System, so classification onto this system is needed to score well in achieving performance goals. Changes to a roadway's federal functional class can be submitted to the Federal Highway Administration (FHWA) for approval at any time. However, it is essential to provide required data that establish a roadway's eligibility for proposed reclassification. The Corpus Christi MPO will create a Functional Class Working Group made up of City, County, and TxDOT staff to review the data and propose updates to the Regional Roadway Functional Classification System.

The upcoming Green Book version 8 includes new guidance on planning and development improvements to urban thoroughfares; describes the relationship, compatibility and tradeoffs that may be appropriate when balancing the needs of different types of users, adjoining land use contexts, along with environmental and community interests.

Recommendation

The Corpus Christi MPO staff recommends that TAC be the core members for a Congestion Management Process and Functional Classification Working Group to provide key input into reviewing and updating the Congestion Management Process and the Federal Functional Classification of the regional road system. TAC members are requested to invite or name other members of the Working Group from their local agencies.

Proposed Motion

Move to approve the creation of the Congestion Management Process and Functional Classification Working Group with the core members being the current TAC membership.

Attachments:

1. Existing CMP Objectives
2. TxDOT Functional Classification Change SOP
3. FHWA High Functional Classification Criteria (2013)
4. Existing Functional Classification Map

REGIONAL PERFORMANCE MEASURES AND TARGETS

At the core of the CMP are its performance measures; measurable metrics used to evaluate the effectiveness of specific functions of the regional transportation system. Performance measures must be:

- Quantifiable – Comparable to some standard of acceptability over time
- Easily understood – Explicable in simplified terms to both technical and nontechnical people
- Practical – Developed in a cost-effective manner, relying as much as possible on existing, readily-available data sources.

Performance measures are used at two levels of analysis:

- **Regional scale** performance measures are used to evaluate the functionality of the regional metropolitan transportation system and to assess progress towards regional goals and objectives. Data for individual regional measures (or for multiple measures in a composite index) can be compared to state or national benchmarks and to region-specific performance targets to track progress over time.
- **Corridor scale** performance measures are used to evaluate effectiveness and rank the projected return on investment (toward regional goals) among individual projects for the Corpus Christi MPO's 25-year MTP and 4-year TIP.

The Corpus Christi MPO performance measures were distilled from required state and federal measures, as listed in the Decision Lens tool provided by TxDOT. Targets are statewide targets that the Corpus Christi MPO supported. If there were no applicable state performance measures, then other national information was used. The following goals have a direct impact on managing congestion.

1) Significantly Reduce Traffic Fatalities and Serious Injuries:

Safety is the highest priority in the region and crashes are the single largest cause of non-recurring congestion in the Corpus Christi MPO region. Safety goals call for reducing both the number and rate of fatalities and serious injury crashes. In order to reduce non-recurring congestion, it is also necessary to reduce the number of Property Damage Only (PDO) crashes and the amount of time these crashes individually impact travel on the roads. Incident management is an essential component of congestion management. The general perception is that crash frequency increases with increasing congestion levels while injury severity decreases due to slower speeds. Generally, the most intense congestion occurs when crashes happen in locations that are congested on a recurring basis, (i.e. without a crash).

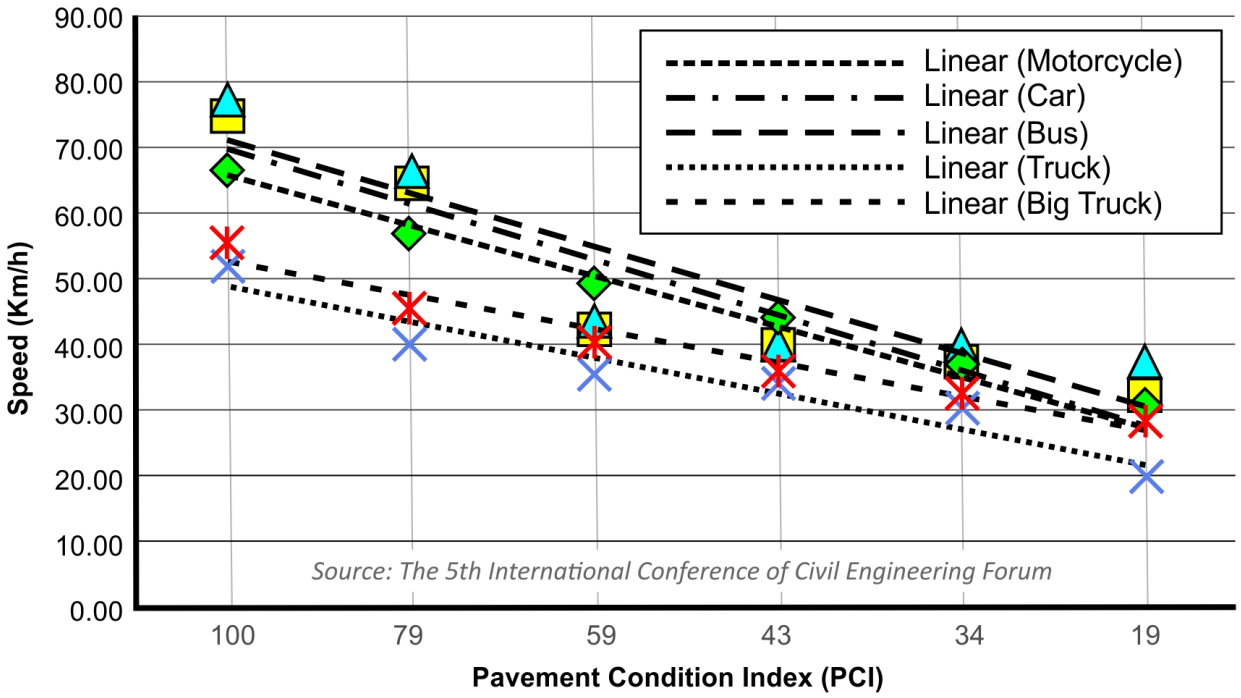
Detailed analyses of all crashes within Regionally Significant Corridors (RSC), at the spot level, are recommended using rigorous software such as Vision Zero Suite©. This tool will identify cost-effective safety projects that could be implemented in high crash locations or where there are already maintenance or construction activities schedule, thereby reducing mobilization costs.

2) Manage regional transportation assets into a state of good repair:

Transportation assets impact congestion in two distinct ways. The first, roads in poor condition generally lead to slower traffic as drivers seek to avoid potholes and other roadway impediments. A corollary to this is that the capacity of road decreases when road roughness increases. *"Significant congestion and delays can be*

attributed to vehicles slowing down to avoid potholes or rough pavement. An increasing frequency of crashes also can be caused by unexpected changes in surface conditions because of reduction of road friction which affects the stopping ability and maneuverability of vehicles."

Exhibit 2-1. Chart of The Effects of Pavement Condition on Vehicle Speeds and Motor Vehicle Emissions



Source: The 5th International Conference of Civil Engineering Forum

Secondly, scheduled and unscheduled maintenance of roads and utility infrastructure under or near roads is the second leading cause of non-recurring congestion, after crashes, in the Corpus Christi MPO area. It is also a possible reason that travel on arterials in the Corpus Christi MPO area is more congested than similar travel in other small MPO areas in the country. The condition of the roads in the Corpus Christi MPO area may be lower than those other MPOs.

Some type of bridge and pavement management system, potentially FHWA's free tool the Highway Economic Requirements System – State (HERS-ST), is recommended to identify the approximate cost-schedule for roadway and bridge maintenance needs throughout the region so that projects may be coordinated with other transportation construction activities and utility infrastructure work. HERS-ST can determine the most economically desirable combination of maintenance projects for specified funding levels and it can also determine the minimum maintenance funding levels needed in order to reach specified performance targets.

3) Reduce congestion on Regionally Significant Corridors.

In the Corpus Christi MPO traffic congestion and travel time reliability metrics are, at a system-wide level, trending in a negative direction. Section 3 of this report, Defining the CMP Network, defines the Regionally Significant Corridors (RSCs) and Section 4, Defining Congestion, defines congestion for both road segments and intersections. Two key metrics that are monitored are delay per capita and the duration of the congested period. Section 5, System Performance Monitoring and Data Collection describes the data monitoring that occurs.

Performance for the Performance Measure Final Rule 3 (PM3) measures is assessed and reported over a four-year performance period. For the PM3 measures, the first performance period began on January 1, 2018 and will end on December 31, 2021. TxDOT reported baseline PM3 performance and targets to FHWA and will report updated performance information at the midpoint and end of the performance period. The second four-year performance period will cover January 1, 2022, to December 31, 2025, with additional performance periods following every four years. The PM3 rule requires state DOTs and MPOs to establish two-year and/or four-year performance targets for each PM3 measure. For all targets, the current two-year and four-year targets represent expected performance at the end of calendar years 2019 and 2021, respectively. TxDOT established targets as follows:

- Percent of person-miles on the Interstate system that are reliable – two-year and four-year targets
- Percent of person-miles on the non-Interstate NHS that are reliable – four-year targets
- Truck Travel Time Reliability – two-year and four-year targets

Exhibit 2-2. Table of Targets for PM 3 Measures

Measure	Region	2014	2015	2016	2017	2020*	2022*	2045
Level of Travel Time Reliability on Interstates (LOTTR-I)**	**Corpus Christi MPO**	**100%**	**100%**	**98%**	**100%**	**92%**	**84%**	**95%**
	Texas	79%	78%	79%	80%	67%	62%	N/A
Level of Travel Time Reliability on Non-Interstate National Highway System (LOTTR-NI)**	**Corpus Christi MPO**	**96%**	**95%**	**94%**	**97%**	**95%**	**93%**	**85%**
	Texas	60%	60%	59%	80%	71%	62%	N/A
Level of Truck Travel Time Reliability on the National Highway System (LOTTTR)***	**Corpus Christi MPO**	**1.16**	**1.22**	**1.22**	**1.15**	**1.19**	**1.21**	**1.35**
	Texas	2.1	2.01	2.24	1.39	1.45	1.5	N/A

**2020 and 2022 values are forecast by TxDOT*
***Higher is better*
****Lower is better*

Another adopted National Goal is to "…achieve a significant reduction in congestion on the National Highway System." There are two primary performance measures for this goal.

- Annual hours of peak-hour excessive delay per capita
- Percent of non-single-occupant vehicle travel

4) Efficiently operate, and invest in, the surface transportation system.

The transportation system underlies all economic activity, allowing consumers, workers, and firms to coordinate to mutual advantage. Getting infrastructure decisions right is a core part of economic policy. Efficient transportation systems are those that enable people to access destinations while reducing vehicle miles traveled, overall transportation costs, reducing traffic congestion, enabling the use of more efficient vehicles, decreasing vehicle emissions, reducing vehicle wear and tear, and saving time for drivers. The Corpus Christi MPO will examine the RSCs and obtain the percent of person-miles traveled on the Interstates that are reliable and the percent of person-miles traveled on the non-Interstate National Highway System (NHS) that are reliable. Also important in evaluating changes in efficiency are the vehicle miles of travel per capita and the miles of roads per capita.

The lifespan of infrastructure projects, and the benefits they provide can extend across generations, making the costs to operate and maintain the infrastructure at least as important as the initial cost to build the

project. The consideration of all three; the costs to build, operate and maintain a project is known as life-cycle cost. Efficient selection of infrastructure projects is crucial in a resource constrained world and the use of life-cycle benefit analyses can provide critical information on efficiency of investments. Investment in technology and other non-infrastructure improvements may improve regional travel more efficiently than infrastructure improvements.

In order to verify efficient and effective investments are made, a life-cycle benefit-cost analysis should be reported individually on all major infrastructure investments and upon several scenarios of portfolios of projects prior to final selection for inclusion into the TIP and MTP. These analyses will report both the Benefit/Cost Ratio (BCR), Internal Rate of Return (IRR) and the Net Present Value (NPV) of investments. The NPV indicates the quantity by which a project's total measurable benefits exceed its total measurable costs.

5) Improve regional freight transportation facility performance.

The efficient movement of goods greatly influences the economic competitiveness of a region. This is especially true in the Corpus Christi MPO region where the regional economy is centered on transportation, distribution, and logistics. Growing international trade markets, expanding trade through the Panama Canal and diversifying and growing employment are directly impacting travel within the region. The Texas Priority Freight Network (TPFN) identifies key freight movement corridors and gateways. Establishing this integrated and multimodal freight transportation system is a critical to facilitating efficient freight mobility in Texas. The TPFN is a statewide network of high priority highway, rail, and waterway transportation corridors connecting the Port of Corpus Christi (POCCA) to inland ports such as Laredo and San Antonio. Texas' ability to maintain its position as a leader in the global economy depends on the strength of its multimodal freight transportation system. The Corpus Christi MPO will evaluate the RSCs to determine the percent of lane miles on the interstate and non-interstate NHS for the Truck Travel Time Reliability index, with critical freight corridors highlighted. The team will also compile the annual congestion costs for trucks, and delay on the critical freight corridors.

To help coordinate regional investments, the Corpus Christi MPO should collaborate with the POCCA using a rigorous tool, such as TREDPLAN-Ports to evaluate vulnerability risks and opportunities impacting the region and the port, especially as industries and markets change over time. The tool can compare the POCCA to competitors and peers to identify the market position in contested markets, assess how the region's freight markets may change in the future relative to those of competitors and peers, and finally assess the region's relative reliance on various domestic and international trading partners.

6) Use transportation investments to improve the regional economy.

Infrastructure investment is closely linked to economic output. In the short term it stimulates demand, creating employment in construction and related industries, and in the long term it boosts supply, enhancing an economy's productive capacity. For example, a new road may facilitate more trade, and it would likely support even more jobs long after the project's completion. This is known as the "multiplier effect," whereby each dollar spent on infrastructure may translate into greater than $1 worth of gains for the region. A similar example is the widening and deepening of the shipping channel to the POCC. This $100 million investment will provide economic benefits for decades.

Econometric analyses, using a rigorous tool such as the Transportation Economic Development Impact System (TREDIS©), should be done individually on all major infrastructure investments and upon scenarios of portfolios of projects prior to final selection for inclusion into the TIP and MTP. This tool will assess the economic benefits and impacts to the region on jobs, household income, business output and gross regional product associated with the different investments. It will also show the public return on investment (ROI) for transportation dollars from all sources, local, state, and federal spent on transportation in the region and quantify the Corpus Christi MPO's economic dependence on different passenger and freight modes of transportation.

7) Protect and enhance communities, the natural environment, and historic and cultural resources.

Transportation decision-making is primarily a process of making trade-offs between different policies and projects that change the regional community's ability to travel to jobs, schools, hospitals, shopping, and entertainment. These changes may reduce congestion by making some trips by motor vehicle unnecessary. Some projects make access faster, some projects make access more difficult, depending on how people travel. This concept, called accessibility, is central to all purposeful travel. Connectivity within a street or transit network as well as between networks, such as walking or cycling to public transit stations, is a critical component of accessibility. For example, wider roads designed to maximize automobile traffic speeds tend to create barriers to walking and bicycling, reducing non-auto access. Similarly, more dense land uses can reduce automobile travel speeds or parking supply, but improve walking, bicycling and public transit accessibility. The Corpus Christi MPO will evaluate each RSC to quantify existing accessibility conditions and identify how transportation and land-use changes may improve or degrade accessibility. The Corpus Christi MPO recommends use of a multi-modal level-of-service indicator and models to measure the travel distances, travel time and travel costs required by various types of transport system users to access various types of services and activities along the corridors. Good measures of increased accessibility, and therefore travel efficiency, are decreased miles traveled per capita and decreased lane miles of roads per capita.

8) Provide an equitable transportation system for all, regardless of age, ability, race, ethnicity, or income.

The Corpus Christi MPO staff will evaluate the project portfolios for both the MTP and the TIP for conformity to the USDOT Title VI and Environmental Justice requirements. An analysis of the distributive effects of investments and policies, possibly aided by the Environmental Protection Agency's free tool EJSCREEN, will assist with determining who receives transportation user benefits, who pays the costs of projects, and who bears the brunt of negative impacts. A Distributive Equity analysis measures the fairness of the allocation of costs, benefits, and other consequences. The purposes of these analytics are determining if there is a "mismatch" between who benefits, who pays, and who must tolerate the worst effects, making sure that protected populations receive benefits that are as timely and of the same magnitude the general population. Exhibits 2-3 through 2-6 show Minority populations and Low income in the Corpus Christi MPO region, along with proximity to traffic noise and exposure to ground level ozone.

CORPUS CHRISTI MPO SMALL AREA FORECAST TASK FORCE REGULAR MEETING

When: Wednesday, October 18, 2023 at 3:00 p.m.

Location: Corpus Christi Regional Transportation Authority (CCRTA) Building
602 N. Staples Street, *Room 324*, Corpus Christi, TX 78401

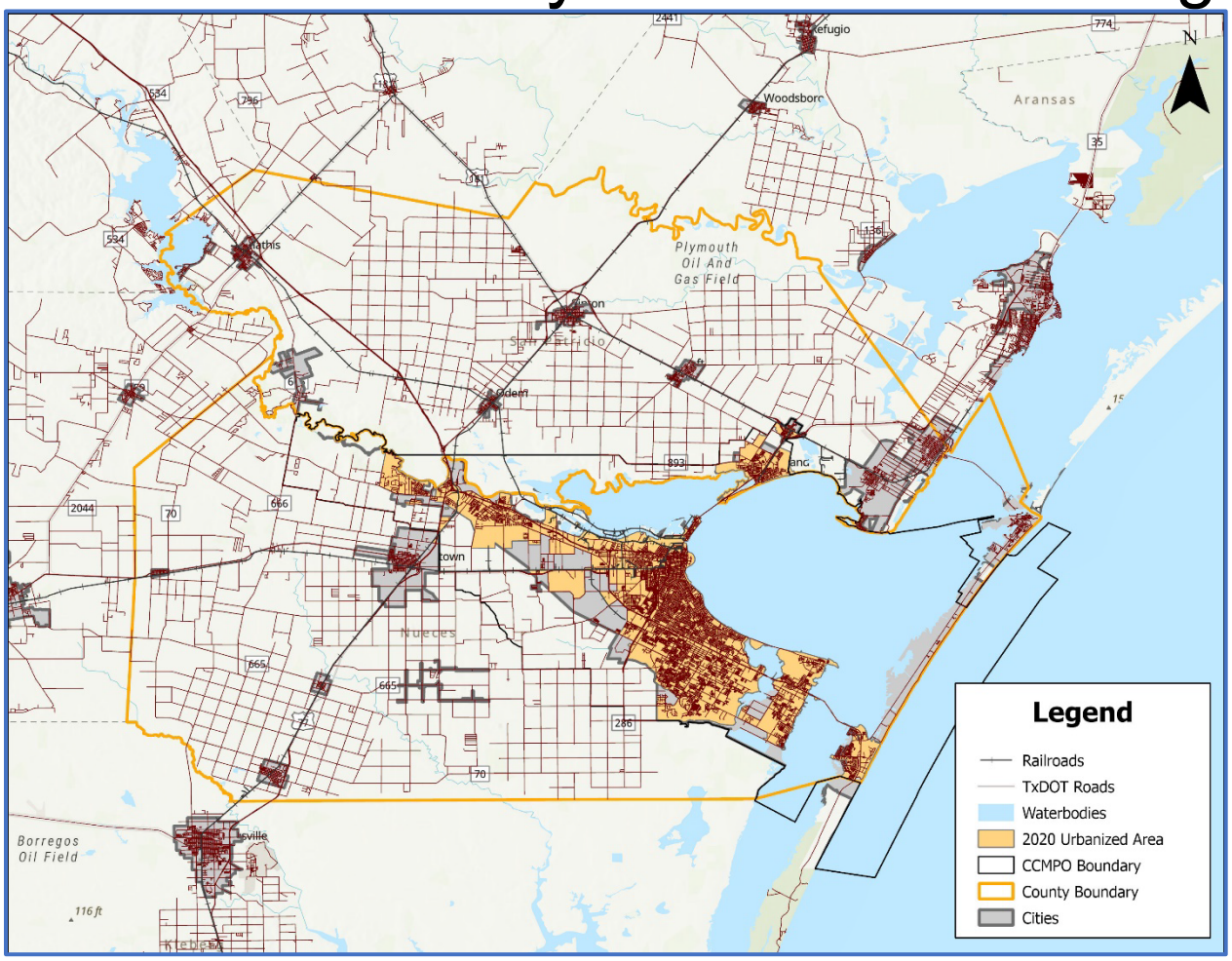
1. **WELCOME AND INTRODUCTIONS**
2. **UPDATE ON TPC ACTIONS ON REGIONAL CONTROL TOTALS FOR 2050 POPULATION AND EMPLOYMENT** ✉
3. **CONSULTANT TEAM PRESENTATION**
   - A. **Introduction to land use forecasting and how it supports transportation planning**
   - B. **Overview of UrbanSim and how it works, including some types of questions it can help answer**
   - C. **Summary of the current status of the UrbanSim development for the Corpus Christi MPO**
   - D. **Introduction to the UrbanSim Scenario Modeler Platform**
   - E. **Next Steps**
4. **OPEN DISCUSSION AND COMMENTS**
5. **NEXT MEETING:**
   - A. **December TBD, 2023 Regular SAF Task Force Meeting**
   - B. **Future Agenda Topics: Special Generators of Traffic Major, Land Uses (NAS/CCAD, Industry, Housing Developments, City's Area Development Plans (ADPs)**
6. **ADJOURN**

✉ Indicates attachment(s) for the agenda item.

Return to Agenda

CORPUS CHRISTI MPO
METROPOLITAN PLANNING ORGANIZATION

MPO-wide Safety Network Screening



October 2023

DiExSys
Road Safety Analytics

DRAFT

Agenda Item 5B

Return to Agenda

EXECUTIVE SUMMARY

Network Screening for opportunities to improve safety in the Corpus Christi MPO has been conducted in the framework of the Safety Analysis component of a Safe Streets and Roads for All (SS4A) Action Plan. Its focus is to assist the MPO staff with data driven decision support analysis for planning and prioritization of safety improvement projects on Corpus Christi MPO's public roads. It accomplishes this by identifying opportunities for cost-effective road safety improvements. Its emphasis is on injury and fatal crashes at intersections and on segments within the MPO boundary, which are susceptible to cost-effective countermeasures.

The guiding principle behind an effective road safety program is that the resources should go to where they achieve the greatest safety effect. The cost-effectiveness is measured by the Benefit-Cost (B/C) ratio which represents the ratio of the benefits derived from crash reduction expressed in dollars to the cost of construction and maintenance over the life cycle of the project. The primary goal for the program/project selection criteria is to select projects in such a way that, following implementation, they will maximize crash reduction in the Corpus Christi MPO area within constraints of the available budgets.

The outcomes of this project will support and extend the goals of the *Vision Zero Texas* policy within the framework of the US Department of Transportation (DOT) SS4A grant program. The goal of the latter is to channel federal funds towards infrastructure, behavioral or operational activities which support the development of a comprehensive safety action plan to address roadway safety issues. One of the key components of a safety action plan is safety analysis which examines conditions and patterns of severe crashes across a jurisdiction. This report meets those objectives by providing a safety network screening across the Corpus Christi MPO area. This report identifies risks across the network and offers low-cost safety treatment options which support the *Vision Zero Texas* policy of movement towards zero deaths on Texas' roads through comprehensive safety measures and policies.

The screening study uses the Countermeasure with Promise (CWIP) approach to identify locations with potential for crash reduction. CWIP approach begins by choosing an effective countermeasure first and then looks for sites where it can be applied cost-effectively. The study focuses on the following emphasis areas from the Texas Strategic Highway Safety Plan:

- Speed Related Crashes
- Intersection Safety
- Vulnerable Users: Pedestrians
- Vulnerable Users: Bicyclists

Problems susceptible to correction which were identified as part of screening were:

- Approach turn (left turn opposite) crashes at intersections

- Broadside crashes at intersections
- Pedestrian and bicycle crashes at intersections and mid-block
- High-severity, high-speed rear-end collisions.

In our approach to identifying strategic emphasis areas and developing safety countermeasure strategies, we relate crash types that resulted in injuries and fatalities in the Corpus Christi MPO area to proven solutions with known and reliable crash reduction factors (CRFs). This included FHWA Proven Safety Countermeasures and the Crash Modification Factors (CMF) Clearinghouse CRFs. The former is a list of strongly encouraged countermeasures for implementation by transportation agencies to accelerate the achievement of Local, State, and National safety goals.

To better understand opportunities for effective safety improvements we examine injury and fatal crashes at intersections separately from those on segments. Distribution of injury and fatal crashes by type at intersections and segments in the area inform identification of emphasis areas and development of countermeasure strategies. The Safe System Approach recognizes that humans will inevitably make mistakes and we used safe speeds and safe road elements to inform project selection.

Network screening analysis and diagnostic examination have initially identified 20 potential safety projects/locations. Each location was analyzed to assess the nature and magnitude of the safety problem using Texas-specific predictive and diagnostic tools, followed by the development of countermeasures and benefit/cost analysis of proposed improvements encoded in the Vision Zero Suite software. These projects were initially rank ordered by their benefit/cost ratio to be later informed by additional criteria such as equity and public preference. *The ranked ordered list of proposed projects, established on the bases of composite criteria (Benefit/Cost, Equity and Public Preference) will be included in the final version of the SS4A Action Plan.* In the course of performing the analysis, in several instances we discovered that a countermeasure we would have proposed had already been implemented or was in the process of being implemented. In these instances, additional recommendations are included.

We have formulated data-driven recommendations based on our analysis and experience. Every recommendation comes with its Benefit/Cost (B/C) ratio quantifying the expected cost effectiveness of a proposed improvement at a specific location. These recommendations are intended to support decision making by the Corpus Christi MPO and its member governments' staff, who are much more familiar with the specific locations and environmental and political circumstances surrounding potential impacts to the site during and after construction. Therefore, the final decisions about how to best prioritize expenditure of limited funds to improve roadway safety in the Corpus Christi MPO area is up to local officials.

An interactive GIS map with locations and proposed scope of all projects has also been published and will be made available.

Major Street	Minor Street	Improvement
Cimarron Blvd	Saratoga Blvd	Operational Signal Timing and Phasing
Weber Rd	Holly Rd	Operational Signal Timing and Phasing
Weber Rd	Yorktown Blvd	Operational Signal Modification, Timing and Phasing, Lighting, Centerline Runble Strips
Callicoatte Rd	Leopard St	Operational Signal Modification, Timing and Phasing
Staples St	Yorktown Blvd	Operational Signal Modification, Timing and Phasing, Backplates, Coordination, Lighting
Staples St	McArdle Rd	Operational Signing and Striping
Staples St	Curtis Clark Dr	Operational Movement Restrictions
McKinzie Rd	Up River Rd	Operational, Signalize Intersection or Restrict Movements
Kostoryz Rd	Hwy 358 (S Padre Isl Dr) Eastbound Frontage Rd	Operational, Signal Modification, Timing and Phasing, Striping
Rodd Field Rd	Hwy 358 (S Padre Isl Dr) Eastbound Frontage Rd	Operational, Signal Modification, Timing and Phasing, Striping
Staples St	Hwy 358 (S Padre Isl Dr) Eastbound Frontage Rd	Operational, Signal Timing, Signing and Striping
Waldron Rd	Knickerbocker St	Vulnerable-Users Focused Signal Timing and Lighting
Leopard St	Staples St	Vulnerable-Users Focused Signal Modification, Timing and Phaisng,
Systemic		Deploy Mid-Block Cross Walks with Beacons Where Indicated by Crash History
Systemic		Deploy Bicycle Related Improvements on Segments Where Indicated by Crash History
Staples St	Saratoga to McArdle	Operational - Access Control
Hwy 358 (S Padre Isl Dr)	MP 4.5 - 11.0	Variable Speed Limit System
Ayers St	Hwy 358 (S Padre Isl Dr) Eastbound Frontage Rd	Operational, Signal Modification, Timing and Phasing, Striping
Baldwin Blvd	Greenwood Dr	Operational Signal Timing
Everhart Rd	Holly Rd	Operational, Signal Timing and Phasing

Preliminary Unranked Project Location List (20 Locations)

STATEMENT OF PHILOSOPHY

The efficient and responsible investment of resources in addressing safety problems is a difficult task. Since crashes occur on all roadways in use, it is inappropriate to say of any roadway that it is safe. However, it is correct to say that roadways can be built to be safer or less safe. Road safety is a matter of degree. When making decisions effecting road safety it is critical to understand that expenditure of limited available funds on improvements in places where it prevents few injuries and saves few lives can mean that injuries will occur and lives will be lost by not spending them in places where more crashes could have been prevented[1]. It is the objective of Corpus Christi MPO to maximize crash reduction within the limitations of available budgets by making road safety improvements at locations where it does the most good or prevents the most crashes.

INTRODUCTION

The focus of the Safety Analysis component is to provide data-driven assistance to the MPO with planning and prioritization of safety improvement projects on roadways. It accomplishes this by identifying opportunities for cost-effective road safety improvements. Its emphasis is primarily, but not exclusively, on intersections with some consideration of segments because, in the urban environment such as most of the Corpus Christi MPO, most of the opportunities to improve safety cost-effectively are found at intersections.

The guiding principle behind an effective highway safety program is that the resources should go to where they achieve the greatest safety effect. The cost-effectiveness is measured by the Benefit-Cost (B/C) ratio which represents the ratio of the benefits derived from crash reduction expressed in dollars to the cost of construction and maintenance over the life cycle of the project. The primary goal for the program/project selection criteria is to select projects in such a way that following construction they will maximize crash reduction in the Corpus Christi MPO within constraints of the available budgets. The study was conducted using six years of crash data from 1/1/2016 to 12/31/2021 focused on Nueces and San Patricio counties only.

Corpus Christi is the sixth largest port in the nation and the eighth most-populous city in Texas[2]. The 2022 population was 317,773, increasing by a little over 4% from 2010[3].

Over the 6-year study period, there were 64,292 crashes recorded in Nueces and San Patricio counties. **Figure 1** shows that 74.61% of those crashes resulted in property

1 Hauer, E., (1999) Safety Review of Highway 407: Confronting Two Myths. TRB
[2] https://www.texas-demographics.com/cities_by_population
[3] https://datacommons.org/place/geoId/4817000?category=Demographics#Population

damage only (PDO), 25.90% were injury (INJ) with 24,431 people injured, and 0.49% were fatal (FAT), with 350 people killed.

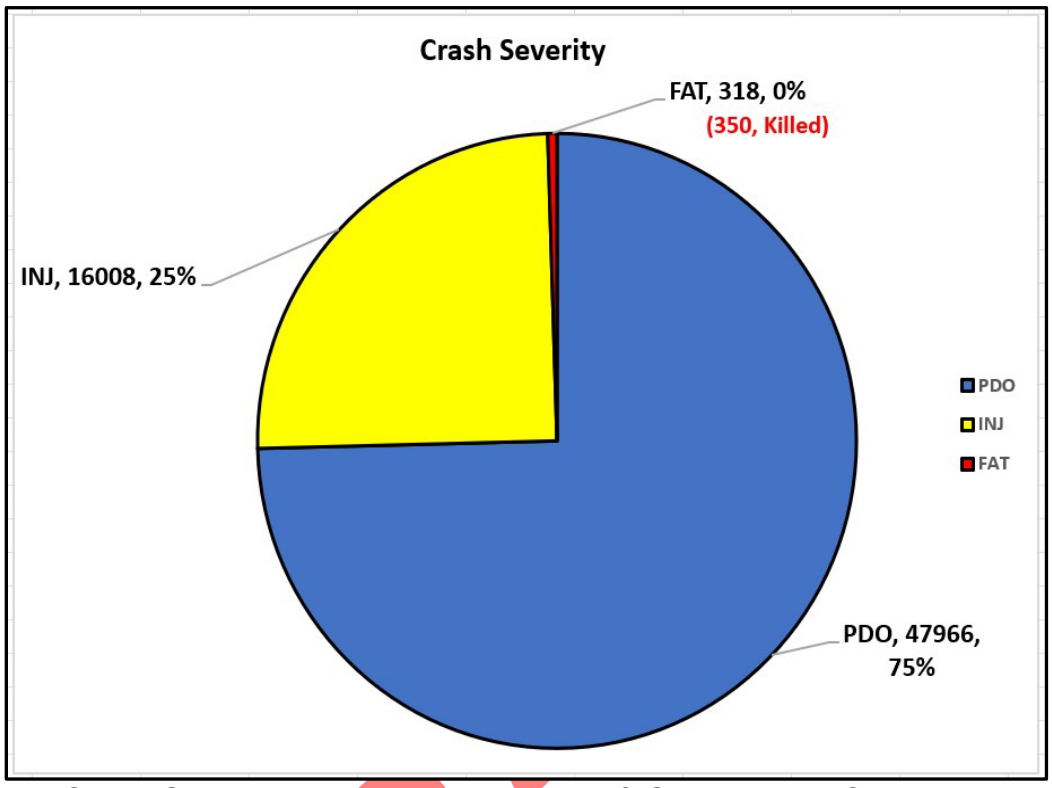


Figure 1: Crash Severity Distribution, Nueces & San Patricio Co., 1/1/16-12/31/21

Figure 2 shows the distribution of all 64,292 crashes by type.

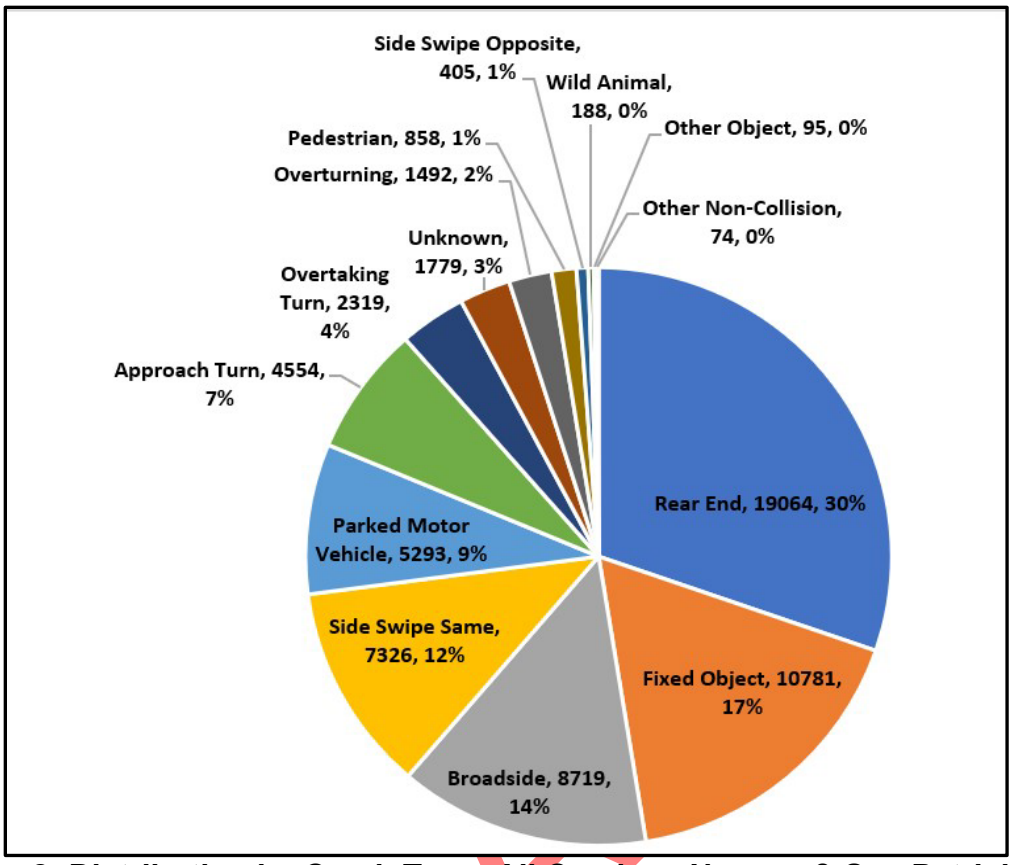


Figure 2: Distribution by Crash Type, All Crashes, Nueces & San Patricio Co.

The study focused on the following infrastructure related emphasis areas from the Texas Strategic Highway Safety Plan:

- Speed Related Crashes
- Intersection Safety
- VulnerableUsers: Pedestrians
- Vulnerable Users: Bicyclists

An overview of all injury and fatal crashes, which are our primary focus for screening, by location type shows that in general there is an even split between the proportion of crashes occurring on segments (non-intersection) and those occurring at intersections, or which are intersection related. **Figure 3** shows that approximately 45% of all injury and fatal crashes were on segments, while approximately 46% were at intersections or intersection related.

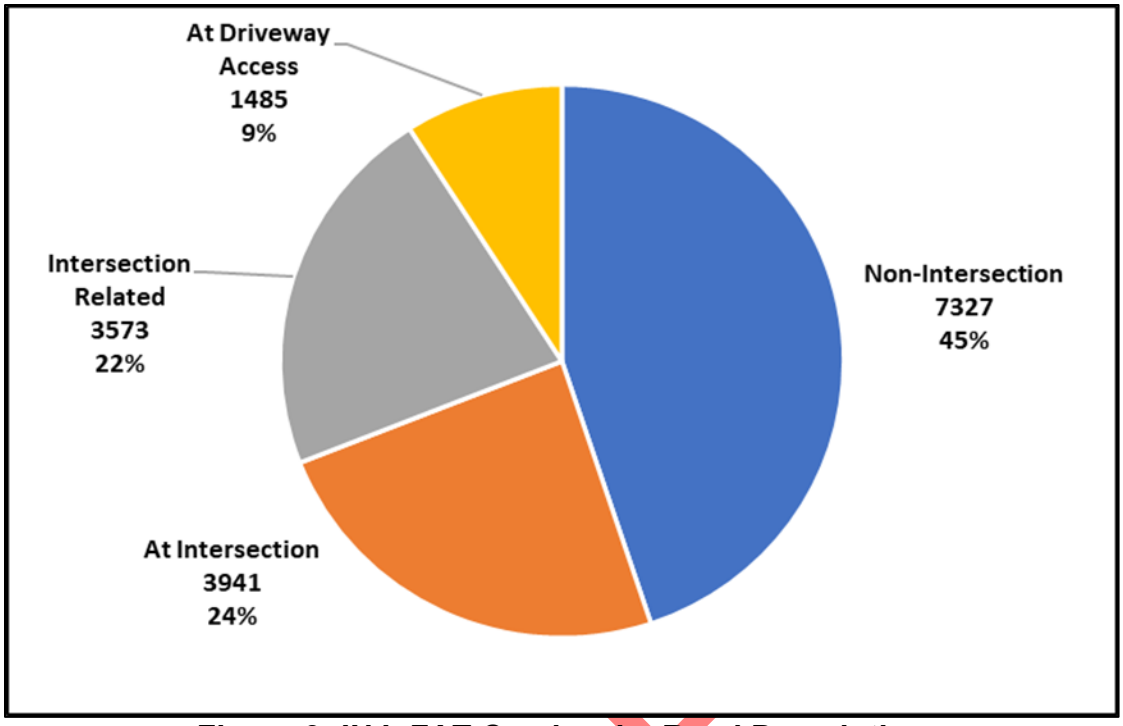


Figure 3: INJ+FAT Crashes by Road Description

Looking only at injury and fatal level crashes, the breakdown of crashes by crash type shows that Rear-End, Fixed Object, Broadside and Approach Turn crashes were the most common crash types (**Figure 4**).

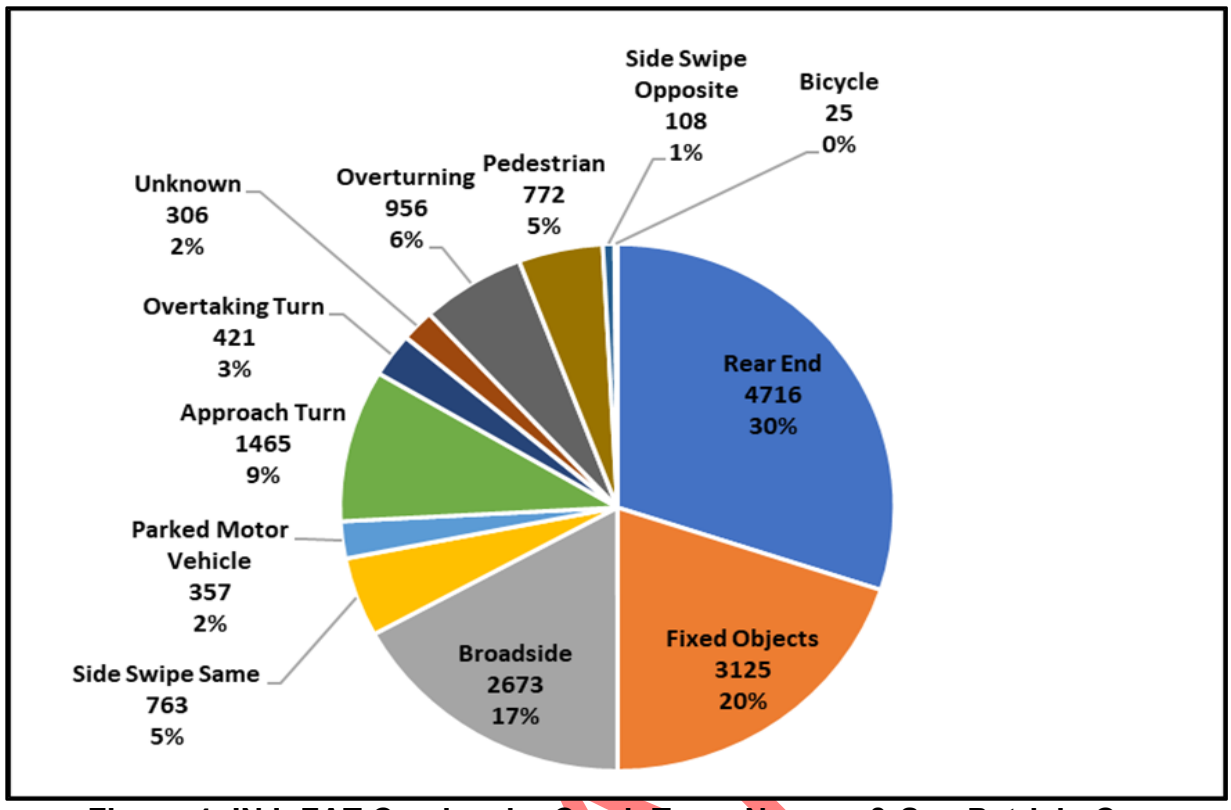


Figure 4: INJ+FAT Crashes by Crash Type, Nueces & San Patricio Co.

Injury and fatal crashes at or related to intersections as distributed by crash type are shown in **Figure 5**. It shows that Rear End, Broadside and Approach Turn crashes were the most common severe crash types at intersections.

Together Broadside and Approach Turns account for around 42% of severe crashes at intersections. These crash patterns have been given particular emphasis with regard to network wide screening of intersections, with locations which exhibit patterns of either crash type susceptible to cost-effective crash mitigation measures prioritized.

Rear end crashes at and approaching intersections can be somewhat intractable and are harder to correct in a cost-effective manner, but Broadside and Approach Turn crashes especially are susceptible to correction through highly cost-effective countermeasures.

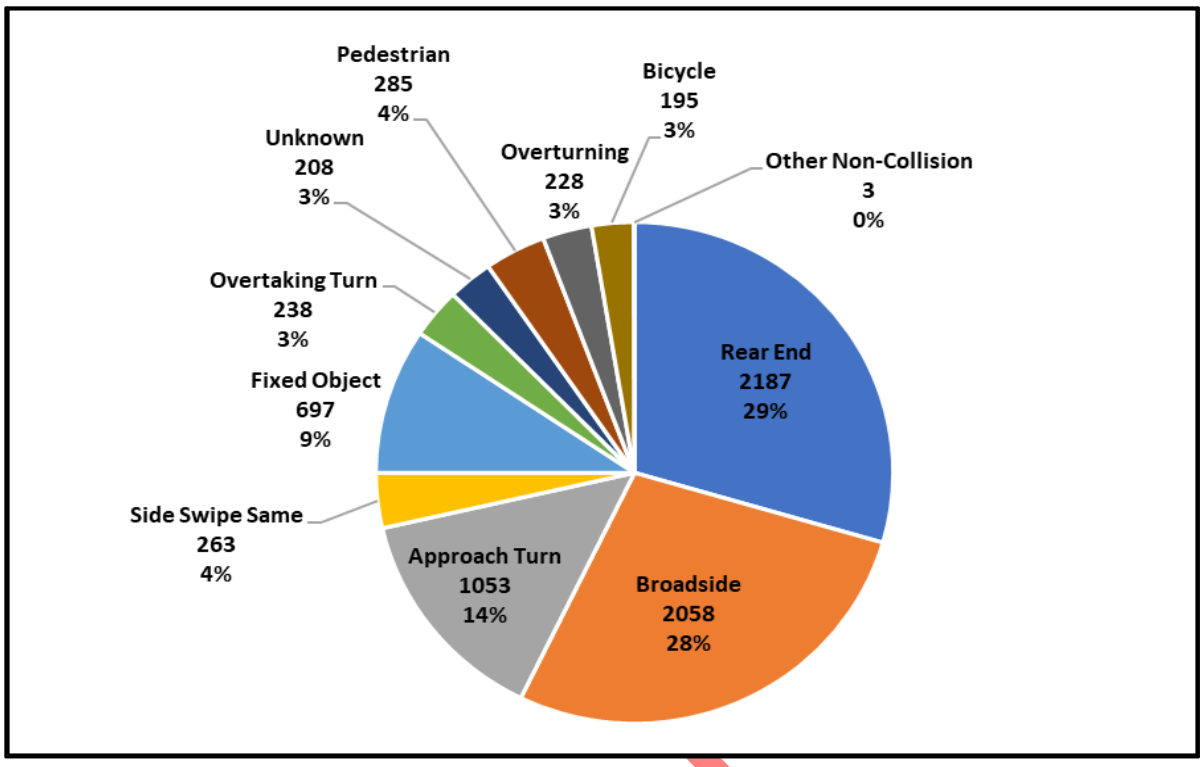


Figure 5: INJ+FAT Crashes by Type at Intersections

Comparatively, injury and fatal crashes recorded on segments, as distributed by crash type are shown in **Figure 6**. It shows that the most prominent severe crash types on segments are Rear-End and Fixed Object.

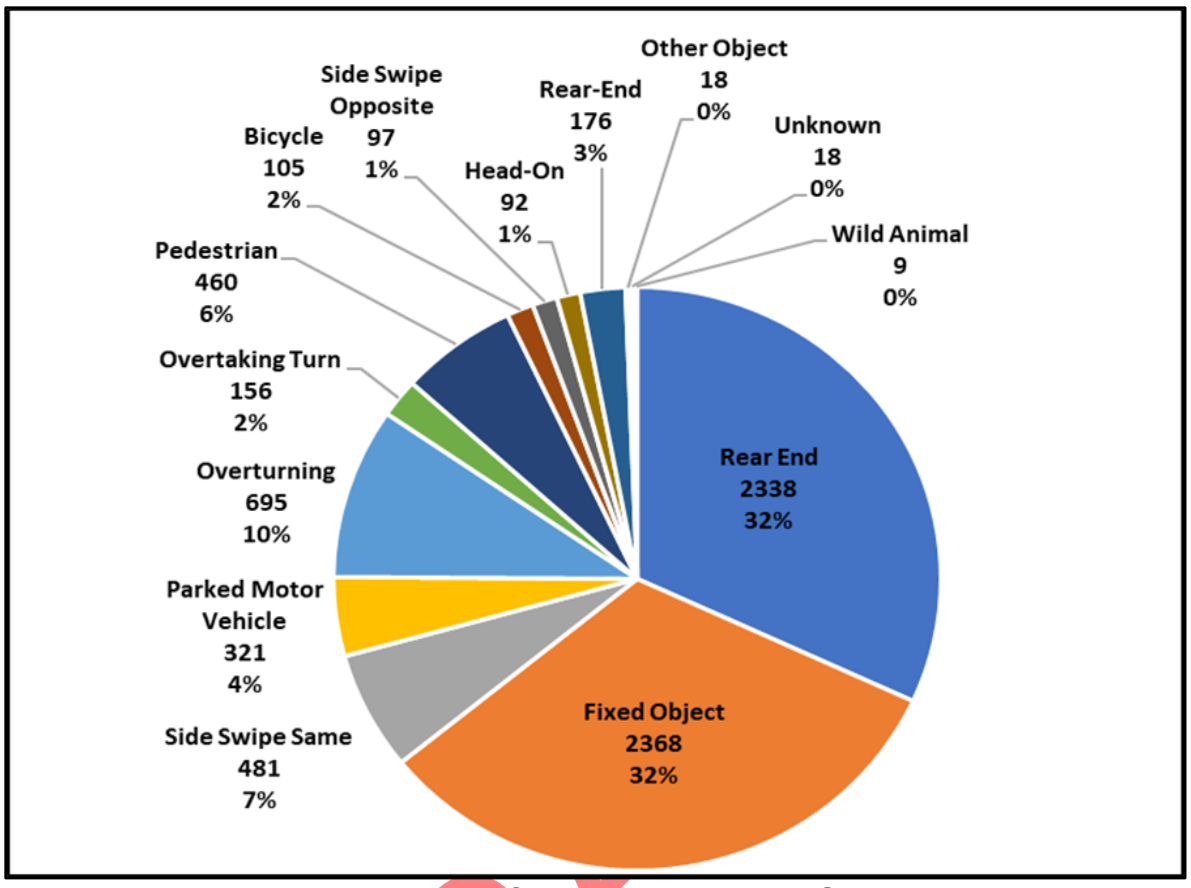


Figure 6: INJ+FAT Crashes by Type on Segments

In our experience, rear-end, sideswipe-same-direction and fixed-object collisions on freeways can be related to high-speed, high-density conditions characterized by evasive maneuvers. As will be seen in the case of SH-358 (South Padre Island Drive), real-time speed management can be an effective countermeasure to these crash patterns.

Although fatal crashes made up less than 1% of all crashes recorded over the study period across both counties, as the most severe crash type they always deserve closer examination. **Figure 7** shows the distribution of fatal crashes by crash type. It demonstrates that the most common fatal crash type was Fixed Object, which is not unexpected as run-off-the-road crashes tend to have severe outcomes. However, notably Pedestrian crashes account for 26% of all fatal crashes. When bicycles are also considered, the proportion of fatal crashes involving vulnerable road users increases to about 30%.

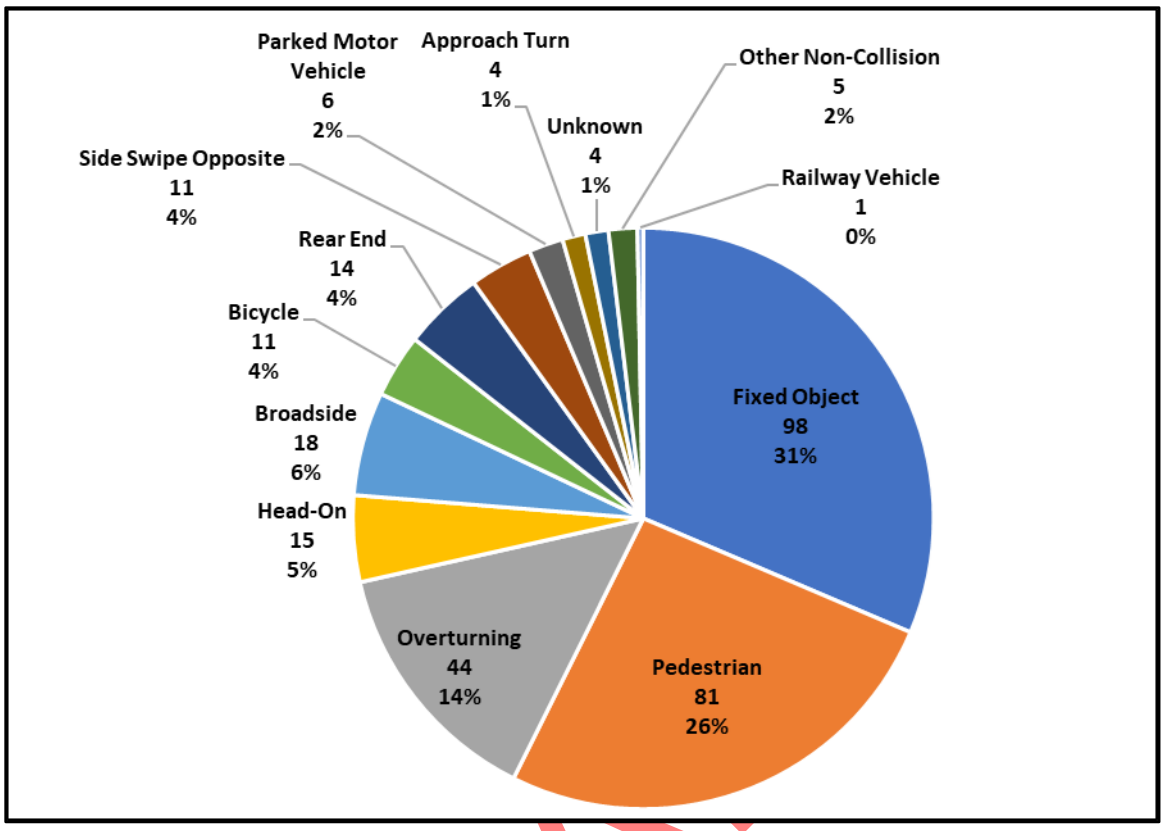


Figure 7: All Fatal Crashes by Crash Type, Nueces & San Patricio Co.

When the road description for fatal pedestrian crashes is examined, it becomes clear that most (72%) occurred on segments i.e. non-intersection (**Figure 8**). Excluding interstates, this points to pedestrian fatalities due to random or mid-block crossings. A map of where pedestrian fatalities on segments have occurred (**Figure 9**) indicates that the problem is not concentrated but rather appears to be systemic, requiring a systemic approach to mitigation. Opportunities to reduce pedestrian (and bicyclist) injuries and fatalities are covered in more detail in the Vulnerable Road Users section of this report.

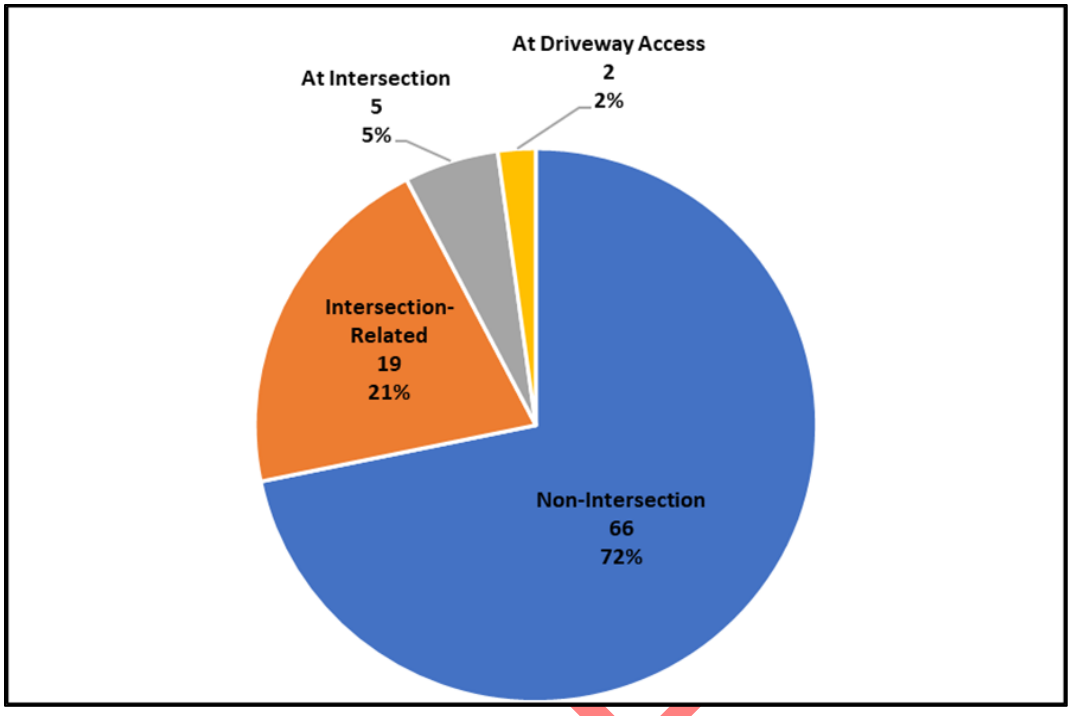


Figure 8: Vulnerable Road User Fatal Crashes by Road Description

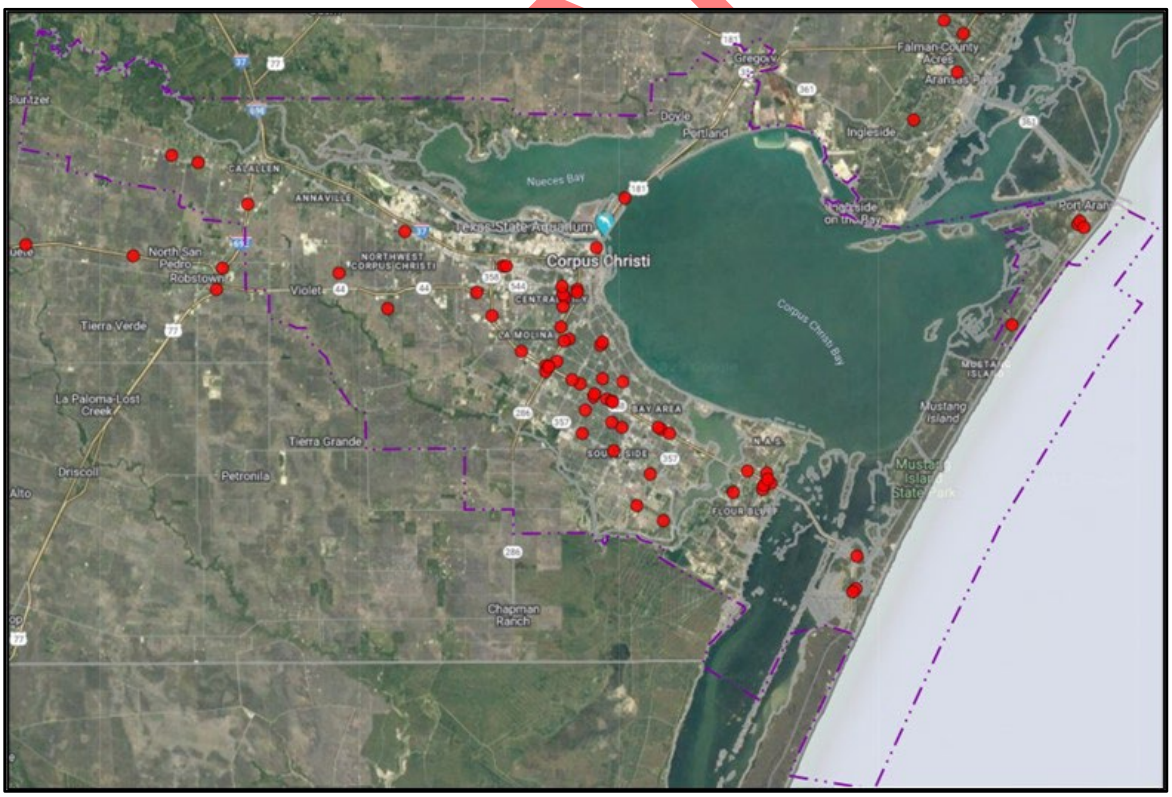


Figure 9: Pedestrian Fatalities on Segments within MPO, 1/1/16-12/31/21

When injury level crashes are included in the dataset for vulnerable road user crashes (pedestrian and bicycle) and road description is re-examined, **Figure 10** shows that while most crashes still appear to have occurred on segments (51%), the degree of bias is not as acute, with 43% occurring at or related to intersections.

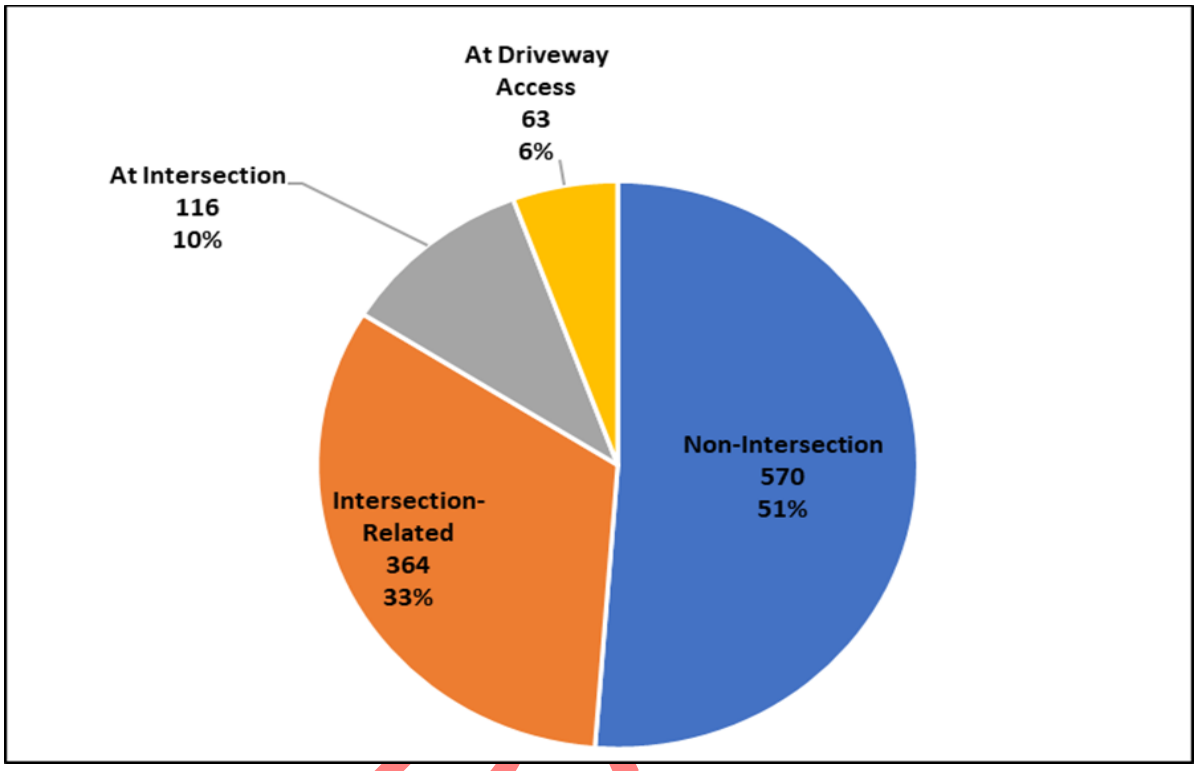


Figure 10: Vulnerable Road Users INJ+FAT Crashes by Road Description

OVERALL SCREENING APPROACH

As outlined previously, our screening process is focused on treating the most serious crash types (injury and fatal level crashes), with cost-effective countermeasures which provide the maximum benefit-cost return in order to ensure money is spent where it has the greatest benefit to safety. As such, our screening was primarily conducted through the lens of injury and fatal crash history, patterns and trends.

The term Countermeasures with Promise (CWIP) was introduced by Dr. Ezra Hauer (the founder of the modern science of road safety) in his published research[4] and working papers[5]. The Countermeasure with Promise (CWIP) approach begins by choosing an effective countermeasure first and then looks for sites where it can be applied cost-effectively. For example, we may screen the entire network for high severity broadside

4 Hauer, E., Kononov, J., Allery, B., and Griffith, M. Screening the Road Network for Sites with Promise. In Transportation Research Record 1784, TRB, National Research Council, Washington, D.C., 2002 pp 27-42.

5 Hauer, E., Countermeasures with promise (CWIP)-Left-turn protection. Colorado Department of Transportation, Report No. CDOT-2006-19, June 2006.

crashes at intersections, with a goal of making minor signal modifications, minor geometric modifications or signal timing changes. Alternatively, we may look for locations with Approach Turn collisions where minor signal modifications could support revised left turn phasing.

HOW TO MEASURE SAFETY

In order quantitatively assess and qualitatively describe the magnitude of the safety problem at selected sites in Corpus Christi we made use of the Texas-specific Safety Performance Functions (SPF) recently developed by the Texas Transportation Institute (TTI)[6], representing intersections and segments. The SPF reflects the relationship between traffic exposure measured in Annualized Average Daily Traffic (AADT), and crash count for a unit of road section, measured in crashes per mile per year for segments, and crashes per year for intersections.

The SPF models provide an estimate of the normal or expected crash frequency and severity for a range of AADT among similar facilities. Two kinds of Safety Performance Functions were developed. The first one addresses the total number of crashes and the second one looks only at crashes involving an injury or fatality. Together they allow us to assess the magnitude of the safety problem from the frequency and severity standpoints. **Figure 11** provides a conceptual illustration of the frequency and severity SPFs representing an intersection. The cross-section taken at a side road AADT can be depicted by two dimensional graphs.

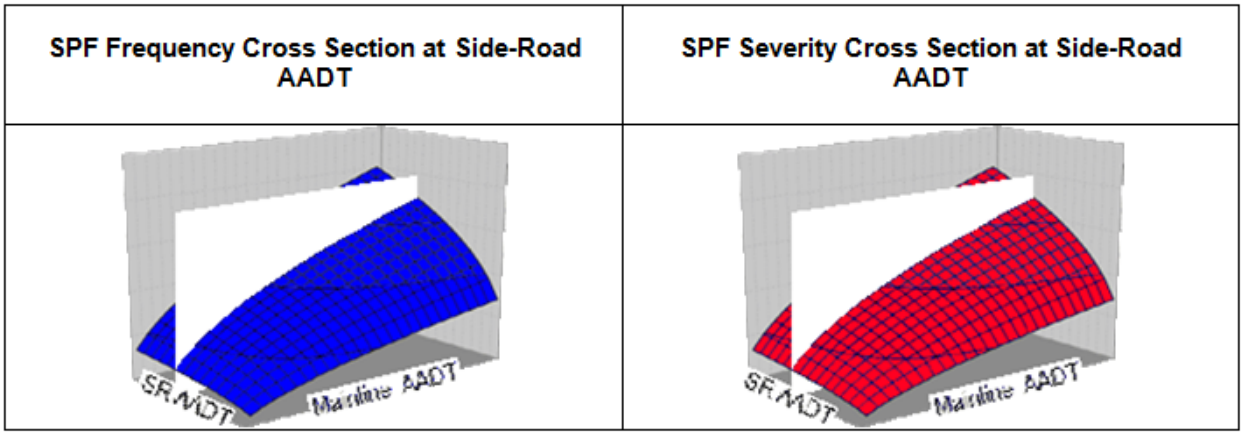


Figure 11: Intersection SPF Frequency and Severity Response Surfaces

LEVEL OF SERVICE OF SAFETY

Development of the SPF lends itself well to the conceptual formulation of the Level of Service of Safety (LOSS). The concept of level of service uses quantitative measures and qualitative description that characterize safety of a roadway segment or an intersection in reference to its expected frequency and severity. The mean predicted by the SPF represents a normal or expected number of crashes at a specific level of AADT, and the

[6] 0-7083: Calibrating the Highway Safety Manual Predictive Methods for Texas Highways, TTI 8/31/2022

degree of deviation from the norm is stratified to represent specific levels of safety.

LOSS I - Indicates low potential for crash reduction
LOSS II - Indicates low to moderate potential for crash reduction
LOSS III - Indicates moderate to high potential for crash reduction
LOSS IV - Indicates high potential for crash reduction

LOSS boundaries are calibrated by computing the 20th and the 80th percentiles using the Gamma Distribution Probability Density Function[7]. Gradual change in the degree of deviation of the LOSS boundary line from the fitted model mean reflects the observed increase of variability in crashes/mile as AADT increases. LOSS analysis reflects how the roadway segment is performing in regard to its expected crash frequency and severity at a specific level of AADT. If the safety problem is present, LOSS will only describe its magnitude from the frequency and severity standpoint. The nature of the problem is determined through diagnostic analysis using direct diagnostics and pattern recognition techniques. **Figure 12** and **Figure 13** depict Frequency and Severity SPFs with LOSS boundaries for a 4-Lane, 4-Leg, divided, signalized intersection in Corpus Christi exhibiting high potential for crash reduction from both the frequency and severity standpoints (LOSS-IV).

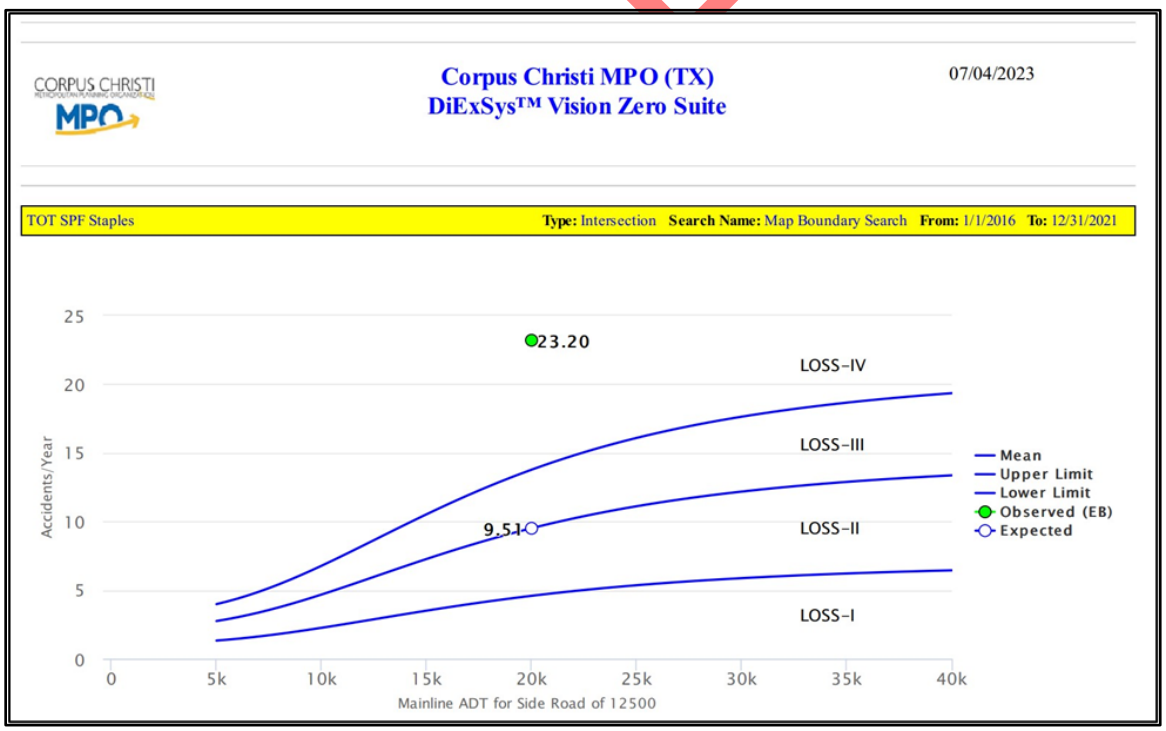


Figure 12: Crash Frequency Intersection SPF with LOSS Boundaries (Location exhibiting LOSS-IV)

7 Kononov, J., Durso, K, Lyon, C and Allery, B. Level of Service of Safety Revisited. , in *Transportation Research Record No 2514,* TRB, National Research Council, Washington, DC 2015, pp 10-21

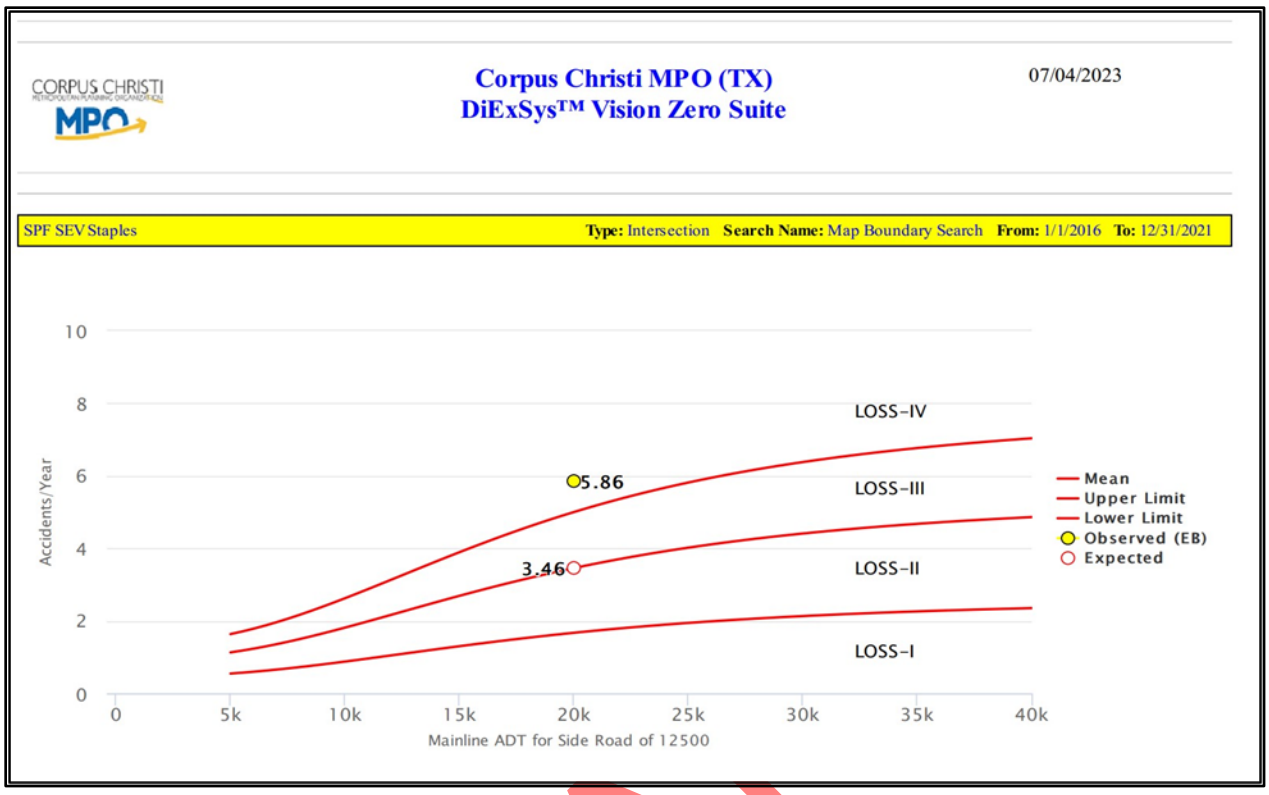


Figure 13: Crash Severity Intersection SPF with LOSS Boundaries (Location exhibiting LOSS-IV)

CORRECTING FOR REGRESSION TO THE MEAN (RTM) BIAS

In road safety, the average of several years of crash history of a highway segment or of an intersection provides us with an estimate of what is likely to be observed in the future. The precision of this estimate, however, can be improved upon by correcting it for the Regression to the Mean (RTM) bias. RTM phenomenon reflects the tendency for random events, such as vehicle crashes to move toward the average over time. For instance, if a segment or an intersection exhibits unusually high or unusually low crash frequency in a particular year, because of RTM we need to be aware that over the long run its true average is closer to the mean representing safety performance of similar facilities. The existence of the RTM bias has been long recognized and is now effectively addressed by using the Empirical Bayes (EB) method[8]. The use of EB method is particularly appropriate when it takes a long time for a few crashes to occur, as is often the case on rural roads.

The Empirical Bayes (EB) method for the estimation of safety increases the precision of estimation and corrects for the regression to the mean bias. It is based on combining the information contained in crash history with the information contained in knowing the safety of similar entities. The information about safety of similar entities is brought into the EB

8 Hauer et al. Estimating Safety by the Empirical Bayes Method. In *Transportation Research Record 1174,* TRB, National Research Council, Washington, D.C., 2002, pp 126-131.

procedure by the Safety Performance Function (SPF) through use of expected mean value and over-dispersion parameter associated with specific SPF. EB corrected values of frequency and severity of crashes were used in the SPF analysis to assess the magnitude of the safety problem. Correcting for the RTM bias is presently a required step in crash analysis by the Federal Highway Administration (FHWA) and American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual (HSM)[9].

DIAGNOSTIC EXAMINATION

Detection of a crash pattern suggests the presence of an element, or elements, in the roadway environment, which triggered a deviation from a random statistical process in the direction of reduced safety. Identification of such an element provides a critical clue to crash causality. Existence of crash patterns susceptible to correction may, or may not, be accompanied by the overrepresentation in crash frequency reflected by the SPFs. In fact, it can be said that the detection of crash patterns provides a more direct link to the development of the countermeasure strategy than a mere increase in crash frequency or severity. While LOSS provides a means of assessing the magnitude of the safety problem, diagnostic examination aids in assessing its nature. During in-depth safety studies of Texas segments and intersections, a comprehensive methodology was developed to conduct diagnostic analysis of safety problems for different classes of roads and intersections in various Texas environments.

A limited extract from a table with diagnostic norms for an example Texas 4-lane, 4-leg urban, signalized, divided intersection with AADT under 30,000 is provided in **Table 1**. If crash patterns are present, they may be detected by comparing observed crash history characteristics with a set of norms using statistical tests for cumulative binomial probability. For example, if 143 total crashes are observed at this 4-leg, 4-lane, divided, signalized urban intersection with AADT on the major street about 20,000, and 43 (30.07%) of them are approach turn, when 20.93% is the expected norm, we would consider this to be an approach turn crash pattern. The computation using cumulative binomial probability is provided below:

$$P(X \leq x) = B(x, n, p) = \sum_{i=0}^{x} \frac{n!}{(n-i)!i!} p^i (1-p)^{n-i}$$

$$P(X \leq 43, n = 143, p = 20.93\%) \approx 99.63\%$$

Where:

n – Total number of crashes (143)

x – Number of observed approach turn crashes (43)

9 American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual (HSM), Washington DC, 2010

p – Expected % approach turn crashes based on statewide statistics (20.93%) from **Table 1**.

P – Cumulative probability of observing x, here 43, approach turn crashes or fewer

Cumulative probability of observing 43 or fewer approach turn crashes, out of 143 total, is about 99.63%, which suggests that approach turns are significantly over-represented, and that this location will need to be examined further for a possible explanation. An approach turn pattern at a signal can often be addressed by improved signal control and or timing. **Table 1** shows an excerpt from a Direct Diagnostic Analysis example location showing Approach Turn as an identified pattern under the same facility type conditions.

Corpus Christi MPO (TX)
DiExSys™ Vision Zero Suite
Diagnostics Report

06/21/2023

FM2444_Staples St — **Cutoff:** 5 Acc's @ 95

Category/Trait	Statewide Average %	This Location # Crashes	This Location %	Probability %
Crash Location				
On Road	59.66%	138	96.5%	100%
Crash Type				
Rear End	37.58%	64	44.76%	96.73%
Approach Turn	20.93%	43	30.07%	99.63%
Lighting Conditions				
Dark - Lighted	23.34%	43	30.07%	97.48%

Table 1: Extract from Direct Diagnostics Report Example for a Texas Urban, 4-Lane, Divided, Signalized, 4-Leg Intersection for AADTs < 30,000

BENEFIT/COST ANALYSIS

Once a specific problem has been identified, an appropriate countermeasure to address it (or sometimes more than one possible countermeasure) is identified. The expected benefit is established by determining how many property damage only (PDO) collisions, injured people at each injury level and fatalities are expected to be prevented over the service life of the countermeasure. Crash reduction factors are determined by consulting the Federal Highway Administration Crash Modification Factors Clearinghouse at http://www.cmfclearinghouse.org/ or the Highway Safety Manual. If no factors exist for a proposed countermeasure in those sources, then professional judgement is employed and a conservative (minimum expected improvement) value, or a range of values are used to determine the expected benefit. The dollar value of the expected benefit is calculated by multiplying the number of PDO crashes, injury crashes of each severity

level, and fatal crashes to be prevented by the standard cost to society of a crash. The crash costs employed in Texas currently are outlined in **Table 2** below.

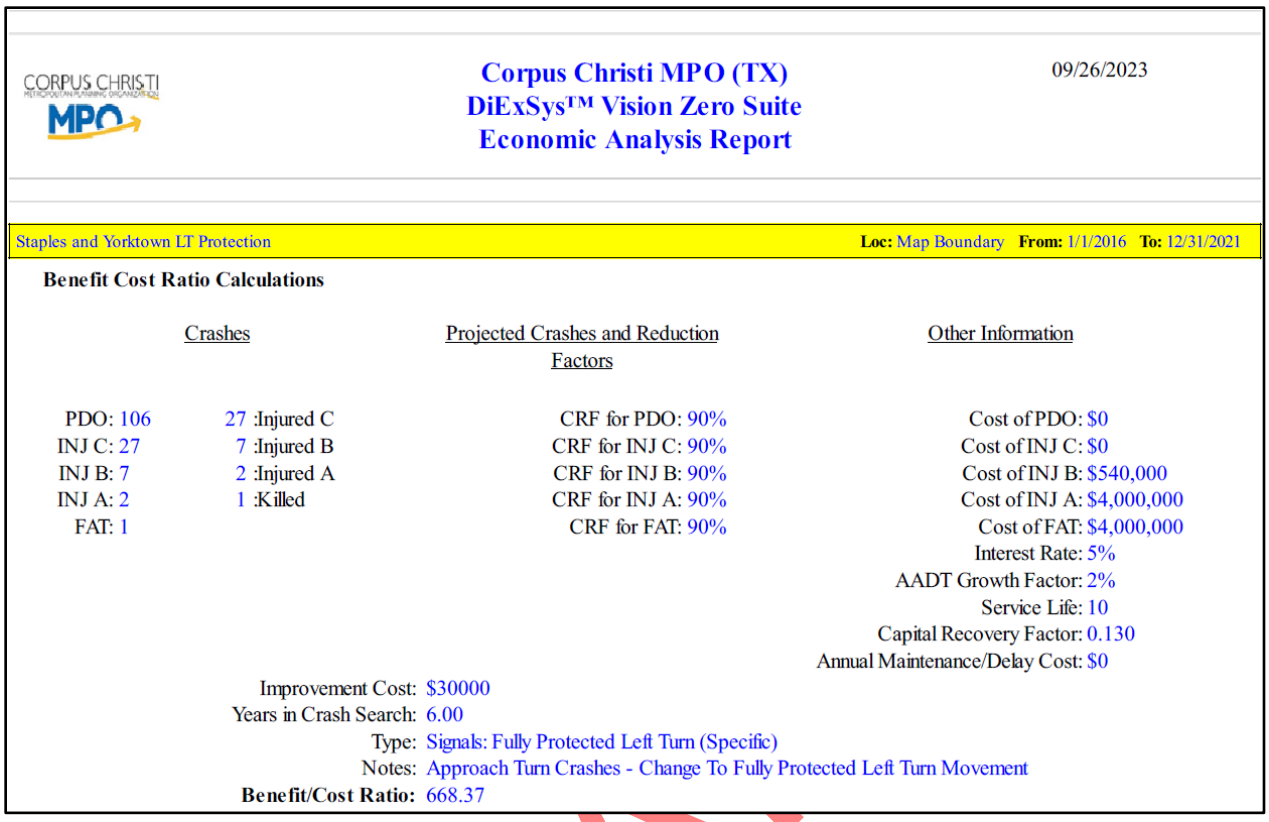
Crash Level	Cost per Crash
PDO	$0
C - injury	$0
B - injury	$540,000
A - injury	$4,000,000
K - fatal	$4,000,000

Table 2: 2022 Texas Crash Costs by Degree of Severity[10]

The benefit amount is adjusted for the time -value of money (future savings are worth less than present savings). Cost is a planning level estimated cost of implementing a countermeasure, adjusted for any reoccurring maintenance or ongoing delay costs (which are also adjusted for time-value of money). The net benefit is divided by the net cost to find the Benefit/Cost, which is used for preliminary ranking (or, if B/C is less than 1.00, for excluding a countermeasure from that ranking). If there is considerable uncertainty about how much a countermeasure would cost to implement, the break-even cost might be calculated instead, showing the maximum amount that could be spent to implement a countermeasure while still expecting to achieve a B/C of 1.00.

For example, modifying the signals at S. Staples Street (FM2444) and Yorktown Boulevard to provide fully protected left turns on all approaches, and adding backplates to northbound and southbound signals, to address an identified pattern of Approach Turn crashes is expected to cost $30,000. The expected service life of this mid-life upgrade to an existing signal is estimated to be 10 years, and it is expected to reduce Approach Turn crashes by 90%. The expected B/C is 668.37, as shown in **Table 3**.

[10] Texas Department of Transportation *2022 SII Calculator*, https://www.txdot.gov/about/programs/highway-safety-engineering.html, accessed 9/26/2023



Corpus Christi MPO (TX)
DiExSys™ Vision Zero Suite
Economic Analysis Report

09/26/2023

Staples and Yorktown LT Protection — **Loc:** Map Boundary **From:** 1/1/2016 **To:** 12/31/2021

Benefit Cost Ratio Calculations

Crashes		Projected Crashes and Reduction Factors	Other Information
PDO: 106	27 :Injured C	CRF for PDO: 90%	Cost of PDO: $0
INJ C: 27	7 :Injured B	CRF for INJ C: 90%	Cost of INJ C: $0
INJ B: 7	2 :Injured A	CRF for INJ B: 90%	Cost of INJ B: $540,000
INJ A: 2	1 :Killed	CRF for INJ A: 90%	Cost of INJ A: $4,000,000
FAT: 1		CRF for FAT: 90%	Cost of FAT: $4,000,000
			Interest Rate: 5%
			AADT Growth Factor: 2%
			Service Life: 10
			Capital Recovery Factor: 0.130
			Annual Maintenance/Delay Cost: $0

Improvement Cost: $30000
Years in Crash Search: 6.00
Type: Signals: Fully Protected Left Turn (Specific)
Notes: Approach Turn Crashes - Change To Fully Protected Left Turn Movement
Benefit/Cost Ratio: 668.37

Table 3: B/C Analysis for Signal Modifications Including Fully Protected Left Turns, S. Staples St. (FM2444) & Yorktown Blvd.

Once a location is selected using the CWIP Approach, described earlier in the General Screening Approach section of this report, it will be examined using analytical tools described above.

- Texas SPF – to assess the magnitude of the safety problem.
- Diagnostic Norms – to understand the problem's nature.
- B/C Analysis to evaluate the expected cost-effectiveness of selected countermeasures.

A BEFORE AND AFTER EXAMPLE USING THESE TOOLS

To demonstrate the effectiveness of this approach and the benefits of using predictive and diagnostic tools we included an observational before and after study of a recent safety improvement project effectively implemented by TxDOT and the City of Corpus Christi in the Corpus Christi MPO area. The intersection of Kostoryz Road and Saratoga Boulevard is a 3-leg, urban, signalized intersection, **Figure 14**.

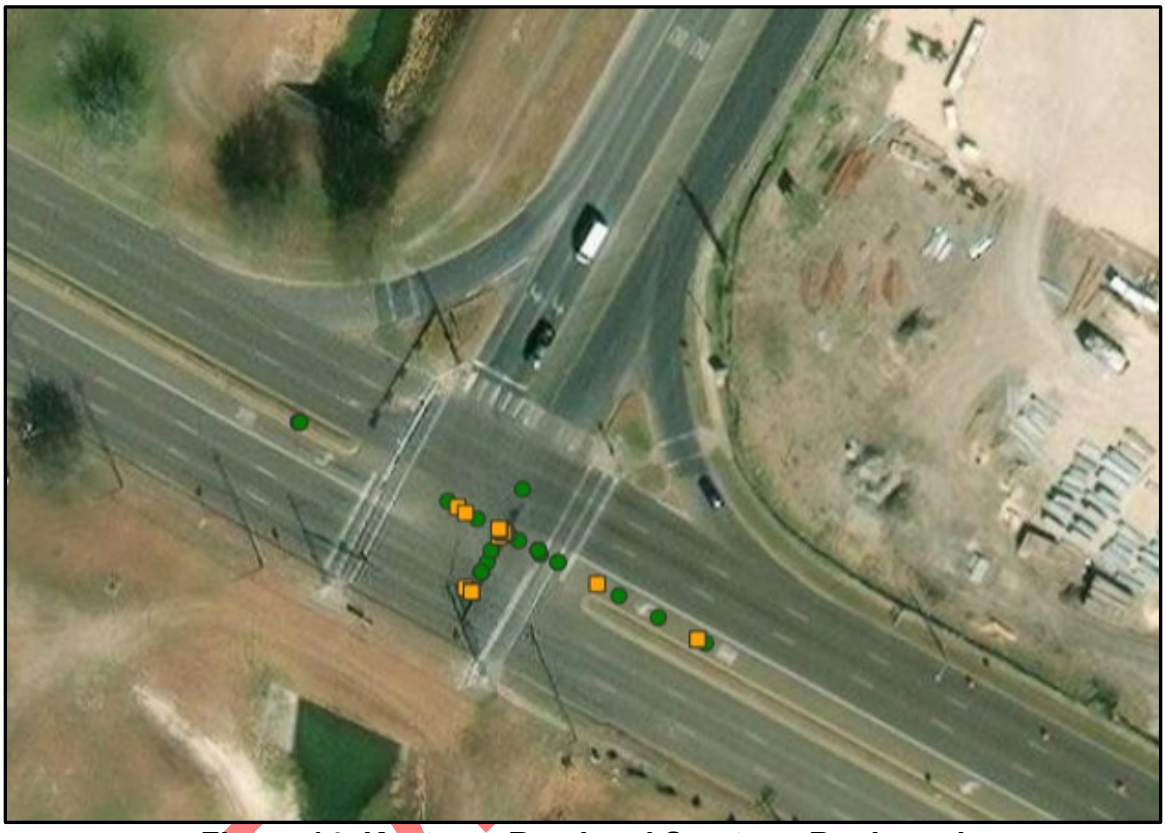


Figure 14: Kostoryz Road and Saratoga Boulevard

Prior to the implementation of a recent safety improvement project, it operated with a permitted-protected left turn phasing for left turns from Saratoga (SH-357), **Figure 15.** Its safety performance was in the LOSS-IV category from the frequency and severity standpoints reflecting high potential for crash reduction.

Figure 15: Saratoga at Kostoryz Looking East (Before Period)

Prior to improvements it exhibited a strong pattern of approach turn (left turn opposite) crashes, **Table 4**.

CATEGORY	TRAIT	STATEWIDE AVERAGE % OF CRASHES	THIS LOCATION # OF CRASHES	THIS LOCATION % OF CRASHES	CUMULATIVE PROBABILITY	IS PATTERN
Crash Location	Off Road	3.34%	6	8.22%	98.89%	True
Crash Location	Off Road Left	1.27%	5	6.85%	99.97%	True
Crash Severity	Injury (INJ)	23.96%	33	45.21%	100%	True
Crash Type	Sideswipe	10.6%	14	19.18%	99.11%	True
Crash Type	Approach Turn	13.94%	27	36.99%	100%	True

Table 4: List of Patterns, Kostoryz and Saratoga (Before Period)

Following the conversion to a fully protected left turn phasing (**Figure 16**) and installing backplates, the safety performance of this intersection has improved significantly (**Figure 17** and **Figure 18**). After correction for the regression to the mean, 65% reduction in frequency and 72% reduction in severity were observed.

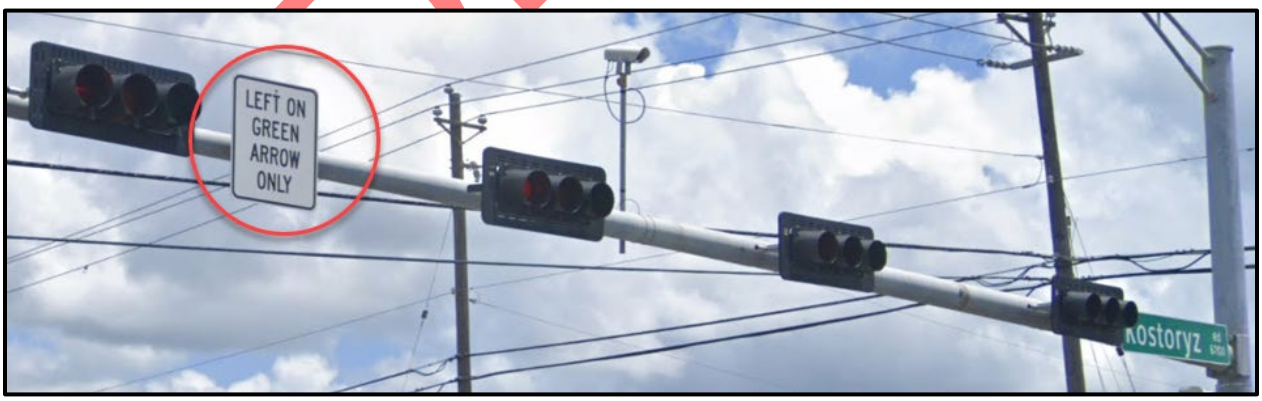


Figure 16: Saratoga at Kostoryz Looking East (After Period)

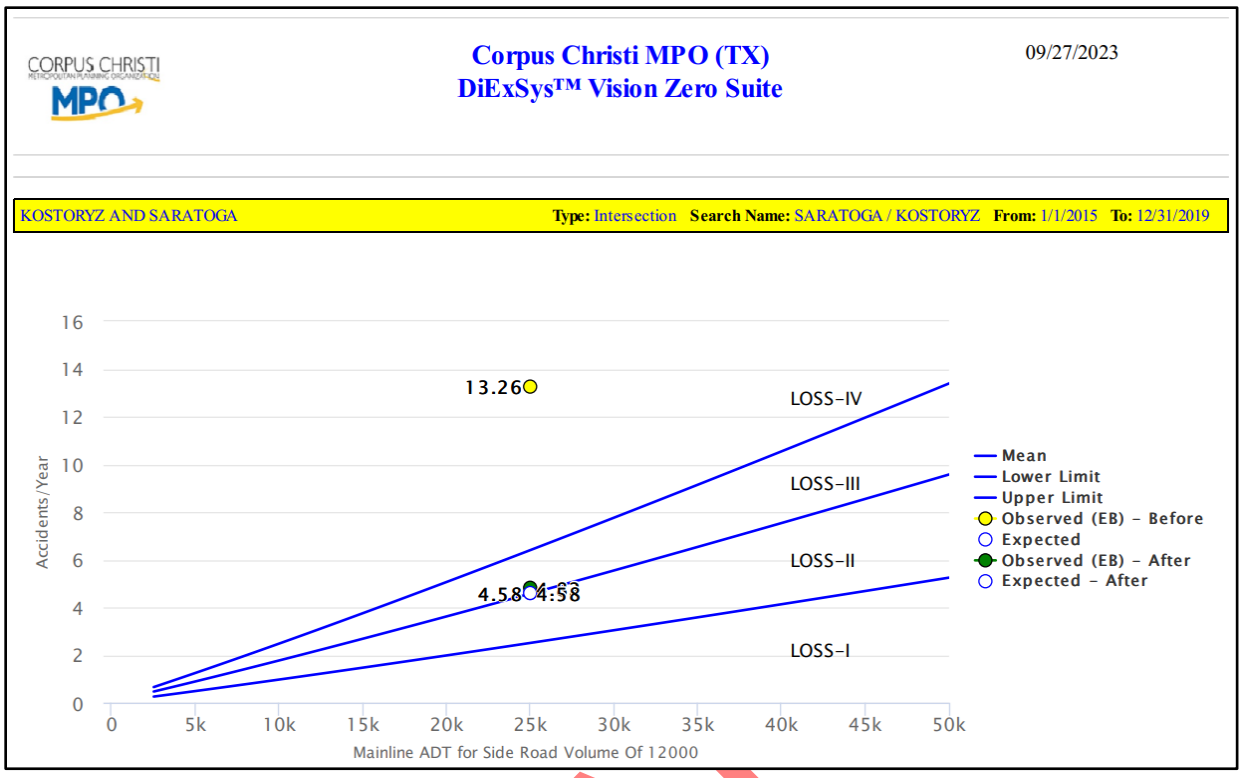


Figure 17: Before and After Total Crash Frequency

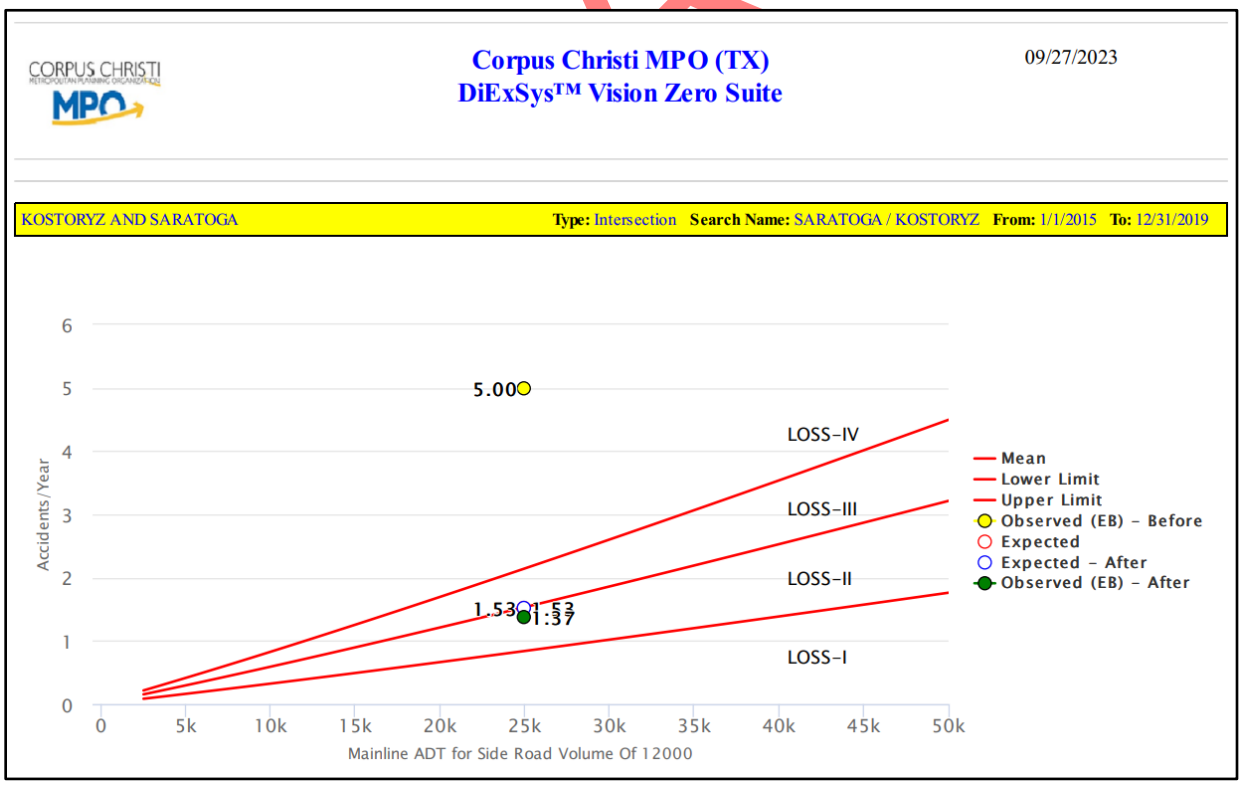


Figure 18: Before and After Crash Severity

NON-INTERSECTION (SEGMENT) CRASHES

As previously outlined, rear-end collisions at intersections tend to be intractable, while they are more susceptible to cost-effective countermeasures on segments. From a geographical point of view, **Figure 19** following, shows where all recorded injury (yellow dots) and fatal (red dots) level rear-end collisions on segments have occurred in Nueces and San Patricio counties. Upon first glance, it can appear that rear-end collisions are widespread. However, when we look within the MPO boundary more closely, we can observe that Hwy 358 (SPID) corridor exhibits a pronounced pattern of injury rear-end collisions that are densely and continuously recorded (**Figure 20**, and **Figure 21**).

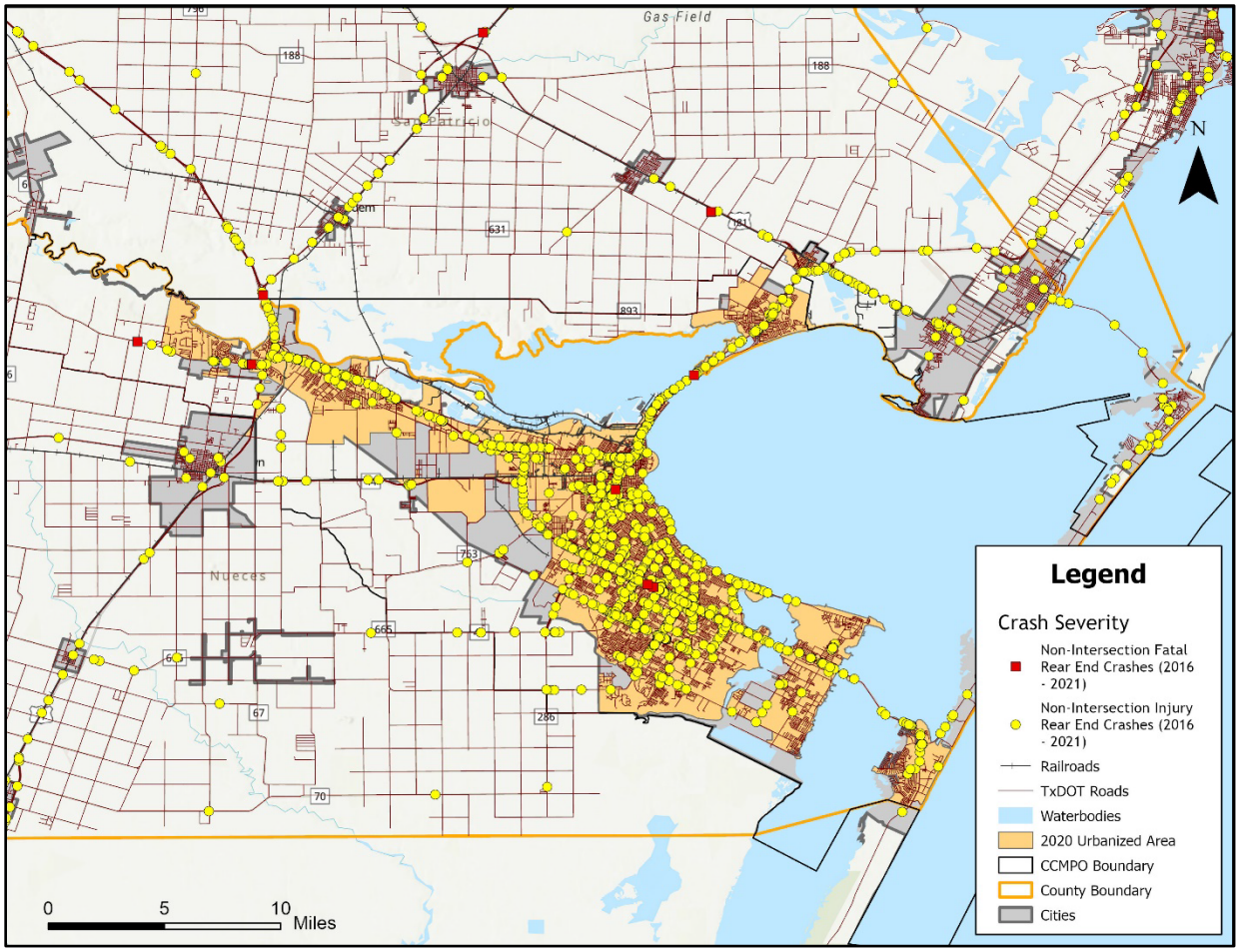


Figure 19: INJ+FAT Rear-End Crashes (Segments) in Nueces & San Patricio Co., 1/1/16-12/31/21

Figure 20: INJ+FAT Rear-End Crashes (Segments), within CCMPO, 1/1/16-12/31/21

Figure 21: INJ+FAT Rear-End Crashes, SH-358, 1/1/16-12/31/21

Rear-end collisions occurring on urban freeway segments such as SH-358 can be due to high-speed, high-density operations and are susceptible to cost-effective crash reduction through the implementation of real-time variable speed limits. As the detailed analysis which follows later in this report for SH-358 shows, a pattern of rear-end collisions was identified as well as a Level of Service of Safety IV, suggesting high potential for crash reduction on the segment. As such, this location was selected as a priority for addressing speed-related rear-end collisions occurring on segments within the study area.

INTERSECTION & INTERSECTION RELATED CRASHES

As discussed above, at-intersection and intersection-related severe crashes comprise a significant proportion of all of the severe crashes recorded within the study area over the 6-year study period. As **Figure 5** shows, the most common injury and fatal crash type at intersections was rear-end collisions. However, rear-end collisions in urban areas such as this tend to be somewhat intractable and not susceptible to cost-effective crash reduction countermeasures. **Figure 5** also shows that broadside and approach turn crashes were the next most common injury and fatal crash types recorded at intersections. Broadside and approach turn crashes tend to result in more severe crashes at intersections and are more susceptible to cost-effective crash reduction countermeasures, such as signal re-timing and signal control modifications. As such, the primary focus of network screening has been on identification of intersections within the study area that displayed patterns of broadside and approach turn crashes. Locations were initially selected based on the degree of severity of crash history at these locations, i.e., locations displaying broadside patterns were ranked according to the number of injury and fatal crashes exhibited over the study period, as were locations displaying approach turn patterns.

In general, top-ranking locations according to severity of crash history were selected for detailed analysis and countermeasure selection. The selected locations for broadside and approach turn crashes, along with crash history numbers are shown in **Table 5**. These locations were determined from larger lists, which were rank ordered based on descending number of severe crashes; however, locations were not selected in exact order in all cases. In some cases, regarding approach turn and vulnerable road user crash types, available street imagery sometimes showed that recent improvements have been made to signals. For example, as discussed earlier, in the case of approach turn crashes, the intersection of Kostoryz Road and SH-357/Saratoga Boulevard is listed as the 7th most severe location for approach turn crashes; however, recent changes have been made which converted signals to provide fully protected left turn movements, to very good effect, removing that particular intersection from further consideration within this effort.

Figure 22 shows the intersections which were selected based on severe broadside crashes and **Figure 23** shows the intersections which were selected based on severe approach turn crashes.

Broadsides					
Location 1	Location 2	Total Crashes	PDO	INJ	FAT
Curtis Clark Dr.	S. Staples Street	38	19	18	1
SH-358 Right Frontage Rd. / S. Padre Island Dr.	S. Staples Street	38	22	15	1
SH-357/Rodd Field Rd.	SH-358 Right Frontage Rd. / S. Padre Island Dr.	28	13	15	0
Kostoryz Rd.	SH-358 Right Frontage Rd. / S. Padre Island Dr.	33	20	13	0
FM-3386/Mc Kinzie Rd.	Up River Rd.	34	22	12	0
BS0286A/Ayers St.	SH-358 Right Frontage Rd. / S. Padre Island Dr.	21	10	11	0
Baldwin Blvd.	Greenwood Dr.	18	7	11	0
Approach Turns					
Location 1	Location 2	Total Crashes	PDO	INJ	FAT
Cimarron Boulevard	SH-357/Saratoga Boulevard	56	34	22	0
FM-43/Weber Rd.	Holly Rd.	32	15	17	0
FM-2444/ S. Staples Street	Yorktown Boulevard	43	27	16	0
Mc Ardle Rd.	S. Staples Street	27	13	14	0
FM-1694/Callicoatte Rd.	SS-407/Leopard Street	28	18	10	0
FM-43/Weber Rd.	Yorktown Boulevard	14	6	8	0

Table 5: Selected Intersections with Broadside/Approach Turn Crashes, by Severity

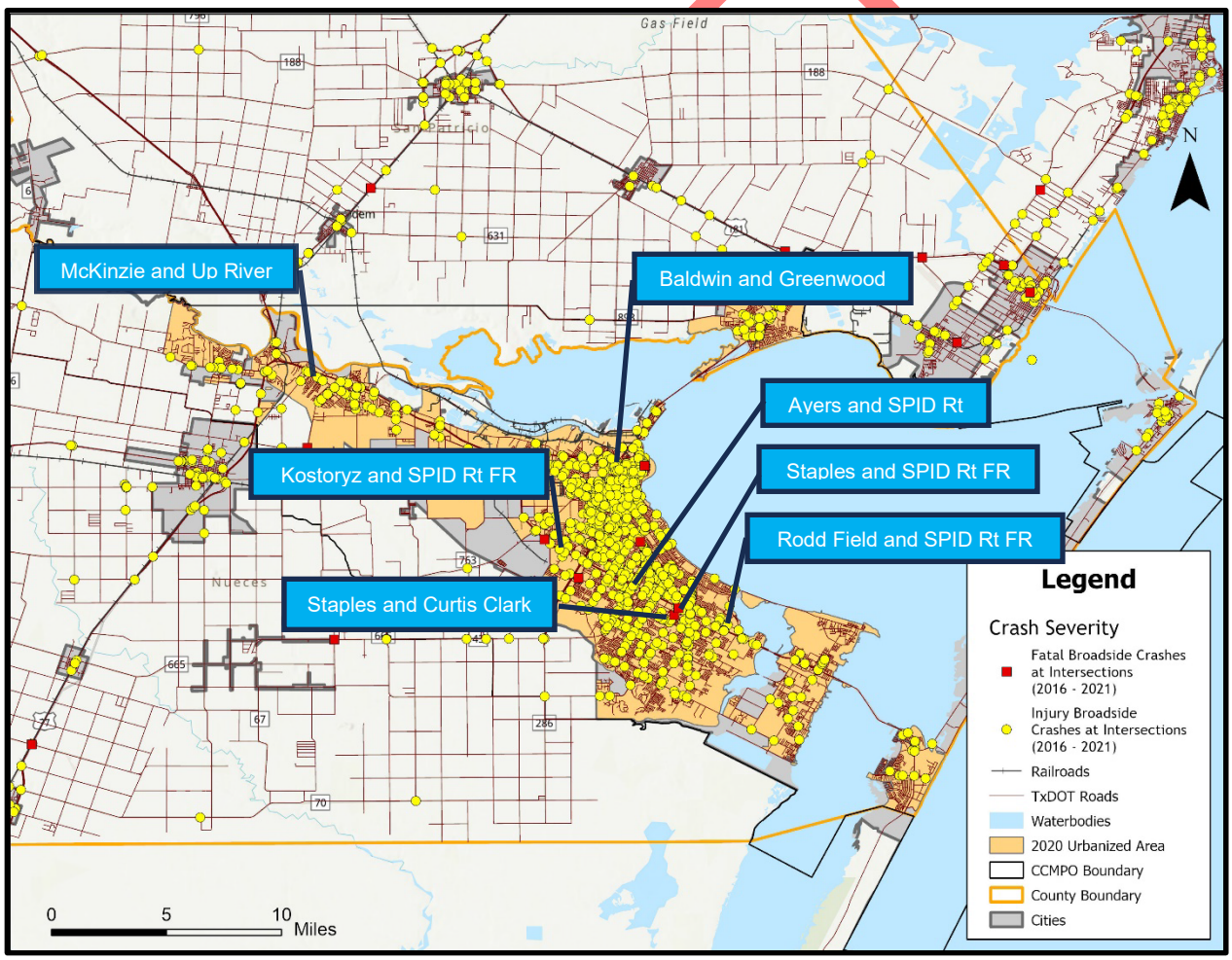


Figure 22: Intersections with Severe Broadside Crashes Selected for Analysis

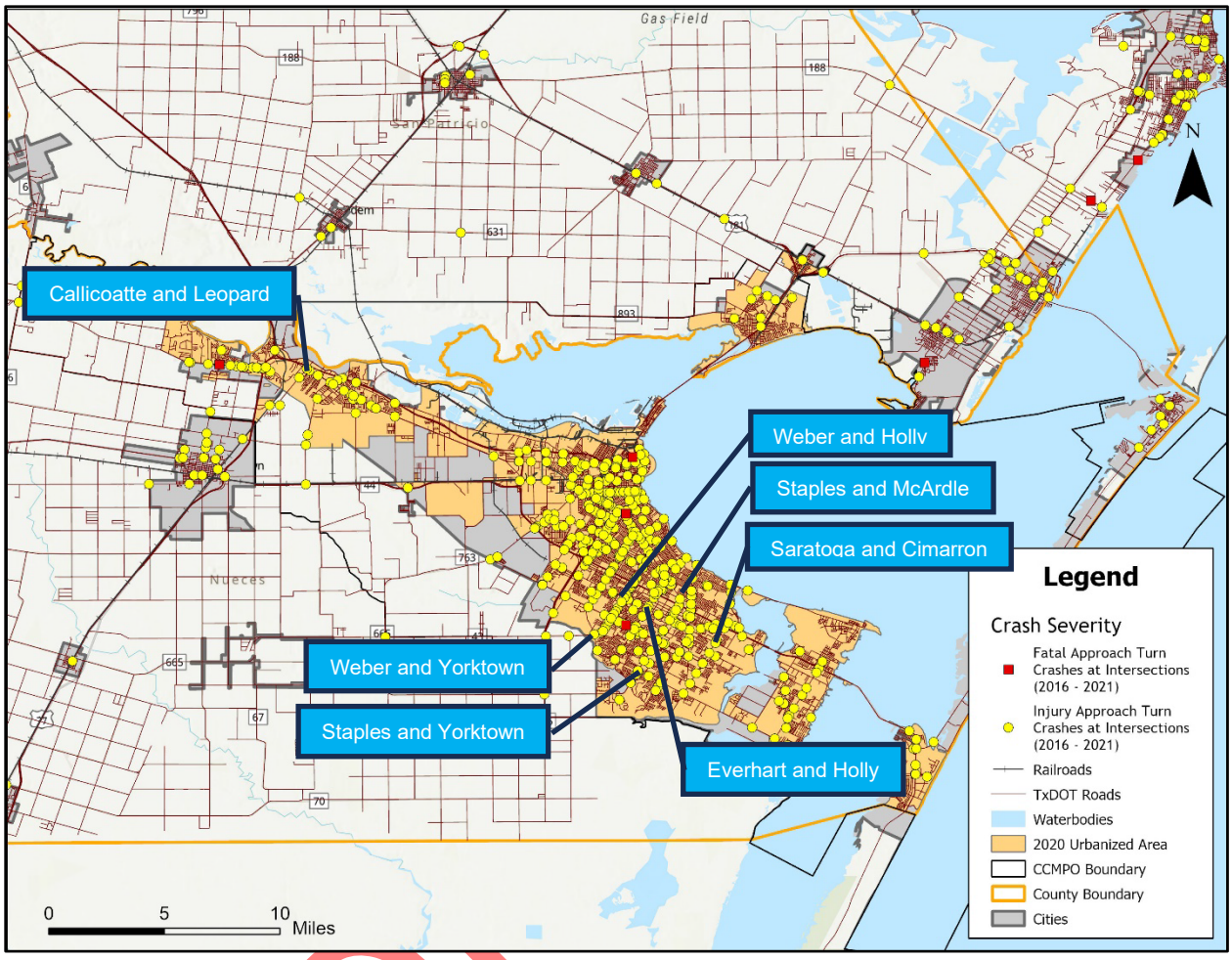


Figure 23: Intersections with Severe Approach Turn Crashes Selected for Analysis

Detailed analysis of each of the 7 locations identified for broadside crashes and the 6 locations identified for approach turn crashes will be included in the Project Profiles section of this report.

*Note: When we identify a pattern of **Broadside** crashes in particular at a signal, we always recommend a comprehensive review of yellow (Change) and all-red (Clearance) duration. We also, in most cases, performed preliminary analysis of the existing yellow change and all-red intervals based on rough measurements from aerial photography, and estimate values that should conform to NCHRP Report 731[11] recommendations. However, this is a preliminary analysis. We did not have access to signal timing plans, did not conduct a*

[11] National Academies of Sciences, Engineering, and Medicine. 2012. Guidelines for Timing Yellow and All-Red Intervals at Signalized Intersections. Washington, DC: The National Academies Press. https://doi.org/10.17226/22700.

physical survey of the geometry of the intersections, and did not collect video from every approach or under differing traffic conditions. Corpus Christi MPO or member governments' staff should independently measure existing durations and calculate the required yellow change and all-red intervals.

VULNERABLE ROAD USER CRASHES

The screening process continued with a more detailed analysis of the information regarding fatal and injury vulnerable road user crashes at the preliminary stages. **Figure 24** shows the locations of all non-intersection injury (yellow dots) and fatal (red dots) pedestrian and bicycle collisions. The two subgroups of vulnerable users are considered separately.

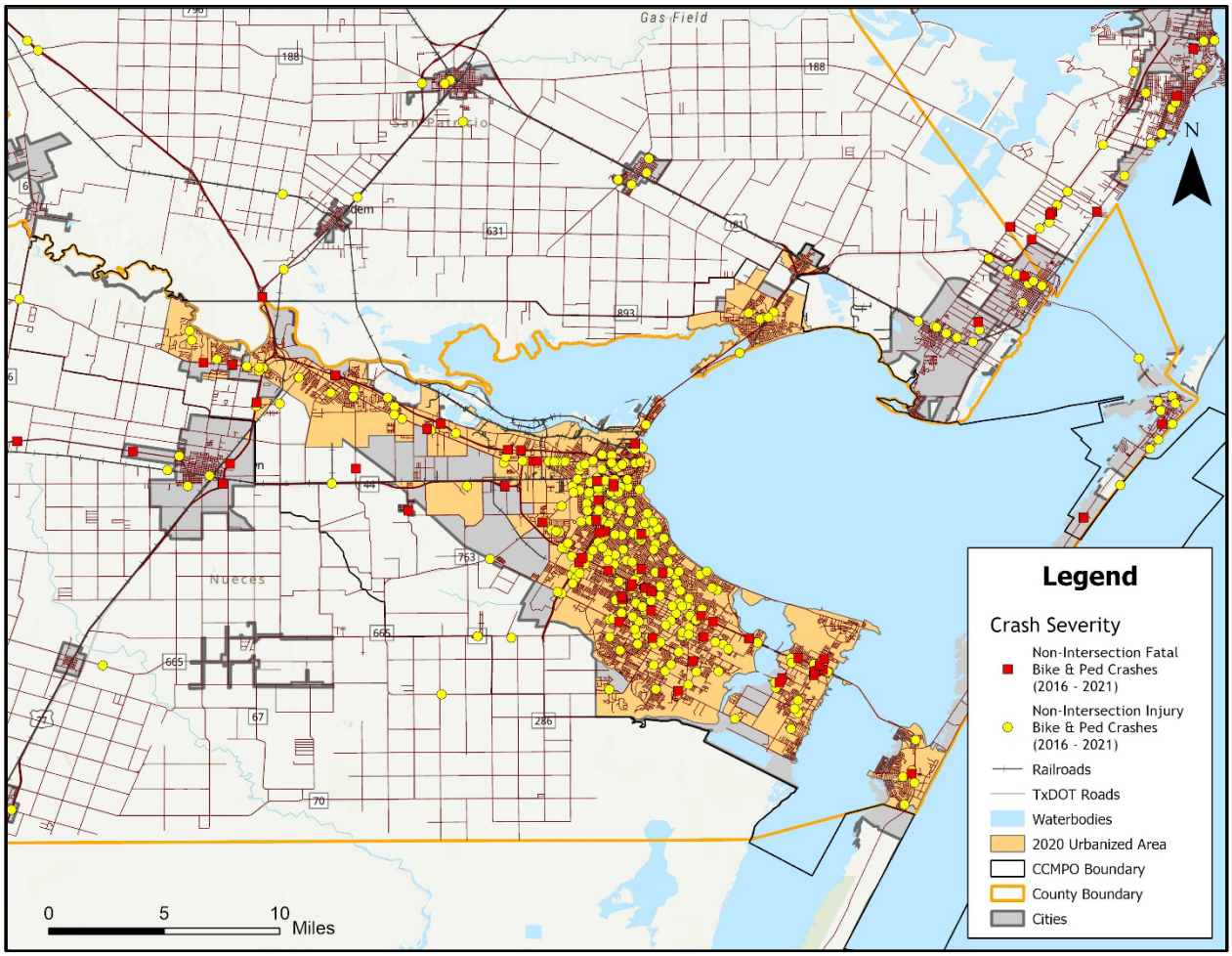


Figure 24: Injury and Fatal Pedestrian and Bicycle Crashes on Segment, 2016-2021

PEDESTRIAN CRASHES ON SEGMENTS

As seen in **Figure 7** when only fatal crashes are considered over the study period, Pedestrian crashes are the second most common crash type representing a substantial

26% of fatal crashes. Pedestrian crashes are typically more common at intersections; however, in this instance, **Figure 8** indicates that most crashes involving pedestrians within the study area occurred at non-intersections i.e. segments. This pattern is suggestive of crashes involving pedestrians crossing at mid-block locations. **Figure 9** shows a map which includes locations of where fatal pedestrian crashes on segments were recorded. The information suggests that the pattern of fatal pedestrian mid-block crossings is systemic across the study area rather than displaying a concentrated pattern. As such, a systemic countermeasure, such as deployment of Rectangular Rapid Flashing Beacons (RRFBs), which is an FHWA Proven Safety Countermeasure, on appropriate mid-block locations might be a suitable countermeasure.

Figure 25, **Figure 26,** and **Figure 27** show locations where pedestrian fatal mid-block crashes may be recurrent. On facilities such as SH-358 and SH-286 these fatalities are more intractable. However, locations such as Weber Road, Waldron Road and Port Avenue, might be more susceptible locations for application of low-cost systemic countermeasures such as RRFBs to be applied.

Figure 25: Mid-Block PED FAT Crashes, SH-358 & Weber Rd.

Figure 26: Mid-Block PED FAT Crashes, Waldron Rd.

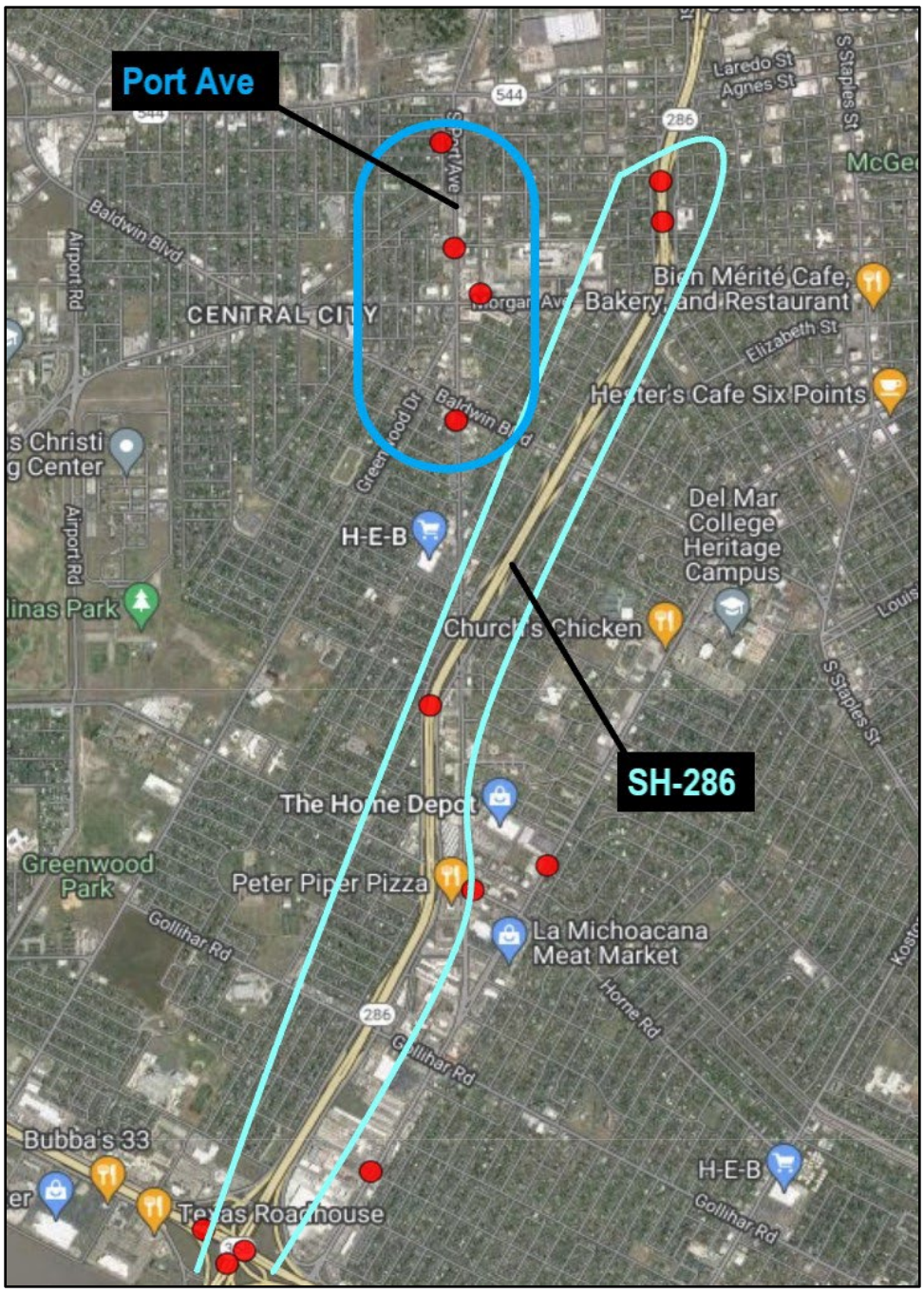


Figure 27: Mid-Block PED FAT Crashes, SH-286 & Port Ave.

BICYCLE-INVOLVED CRASHES ON SEGMENTS

Figure 28 is a map which shows the locations where fatal (red dots) and injury (yellow dots) bicycle-involved crashes on segments were recorded. When a closer examination of the information was made, there were two segments which displayed a history of 5 severe bicycle-involved crashes over the 6-year study period:

- Holly Road between Carroll Lane and Ennis Joslin Road (**Figure 29**)
- Santa Fe Street between Oleander Avenue and Santa Monica Place (**Figure 30**)

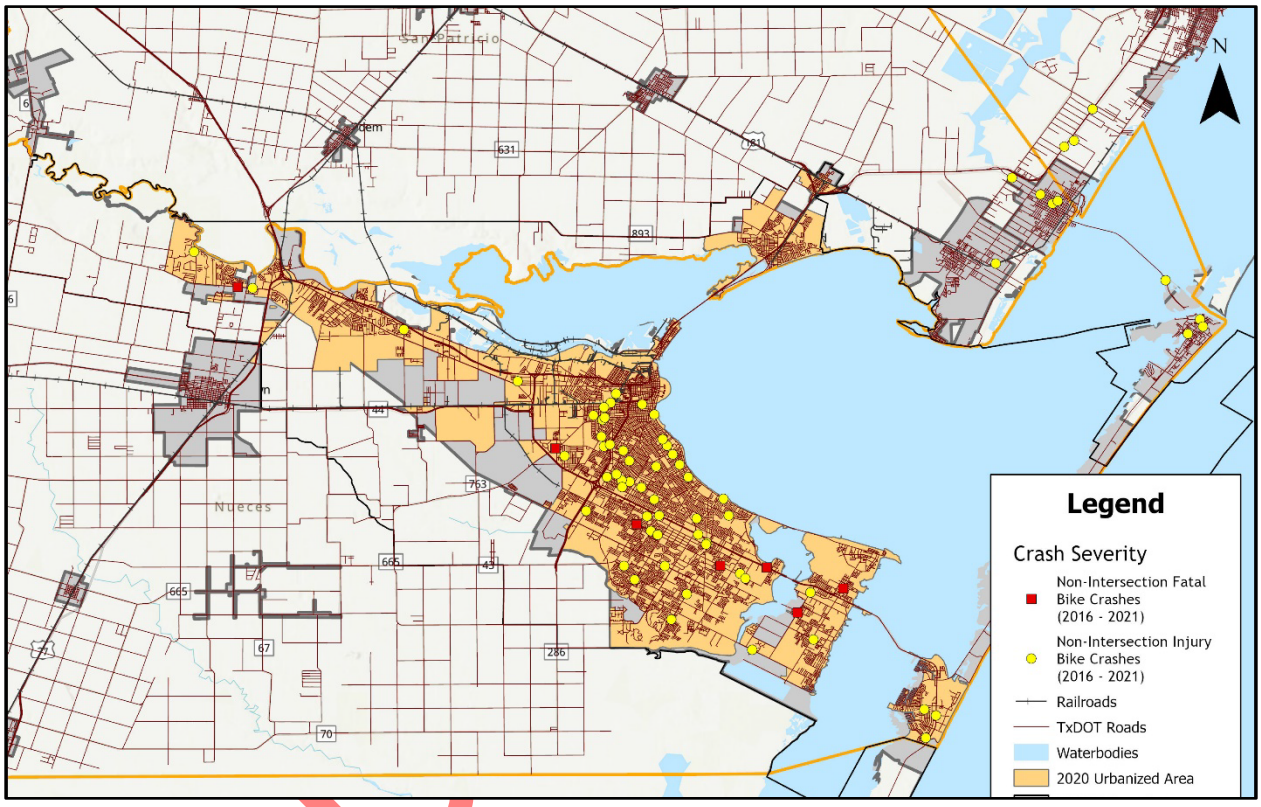


Figure 28: Injury and Fatal Bicycle Crashes on Segments, 2016-2021

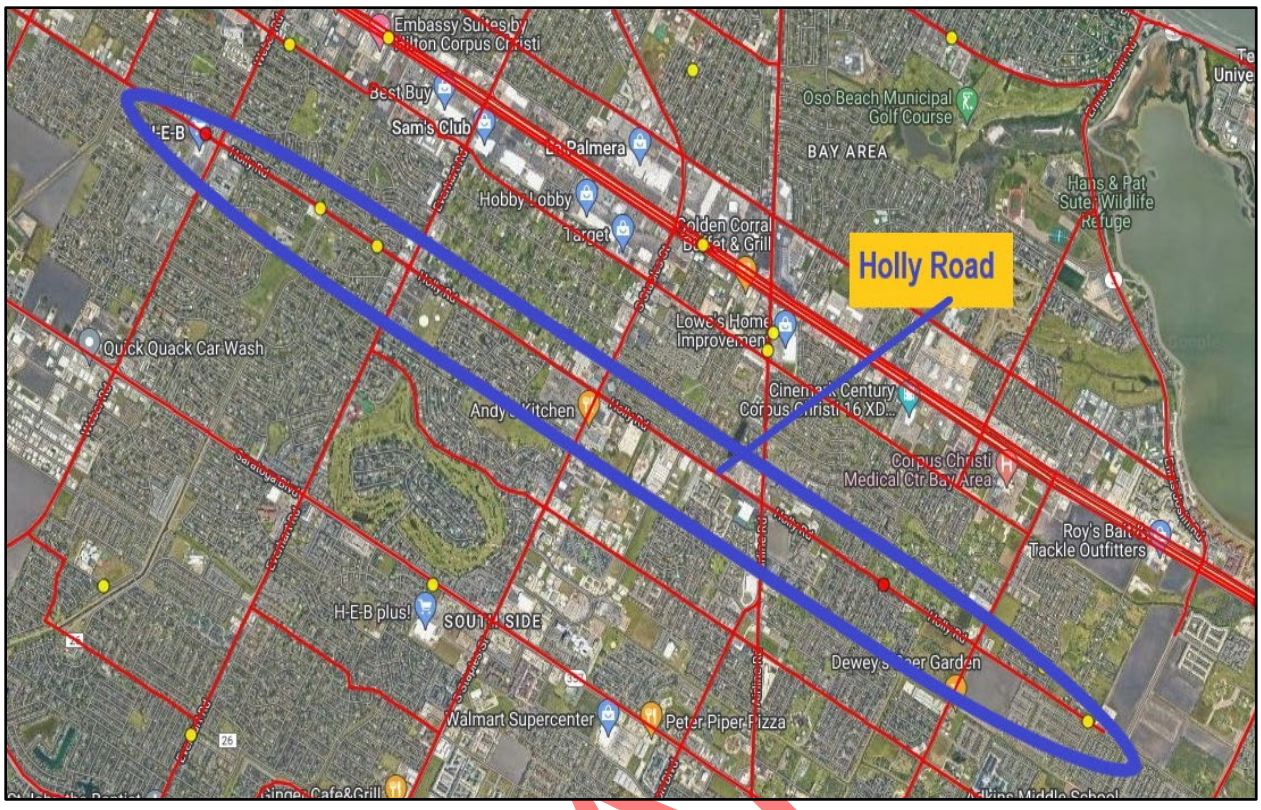


Figure 29: Holly Road, Severe Mid-Block Bicycle Crashes, 2016-2021

Figure 30: Santa Fe Street, Severe Mid-Block Bicycle Crashes, 2016-2021

The sections of Holly Road and Santa Fe Street highlighted above demonstrate instances of non-intersection severe bicycle-involved crashes which may be susceptible to low-cost countermeasures. A detailed analysis of each of these locations will follow as part of the Project Profiles section of this report.

VULNERABLE ROAD USER CRASHES AT INTERSECTIONS

In general, vulnerable road user crashes (pedestrian and bicycle) tend to be more susceptible to treatment with low-cost safety countermeasures at intersection locations. As such, an analysis of severe crashes involving vulnerable road users at intersections was made. The screening process followed the same approach as that for broadside and approach turn crashes: locations were selected from a list of intersections where pedestrian and bicycle-involved crashes had occurred which were ranked according to the number of injury and fatal crashes which were recorded. As was the case with locations for approach turn crashes, in some instances modifications had already been made recently to signals and pedestrian controls at the intersection, in which case another location further down the list was selected to maximize benefit-cost return. The two locations which were selected from the larger list for detailed analysis were as seen in **Table 6**.

Pedestrian & Bicycle Severe Intersection Crashes					
Location 1	Location 2	Total Crashes	PDO	INJ	FAT
Knickerbocker Street	Waldron Road	31	16	14	1
SS0407/Leopard Street	Staples Street	23	13	10	0

Table 6: Intersection Locations selected for PED/BIKE Crash Analysis

A detailed analysis of the intersections which were selected based on pedestrian/bicycle crash history will follow in the Project Profiles section of this report.

A RURAL EXAMPLE

Prior to being informed of the scope of the project being restricted to the MPO boundary within Nueces and San Patricio counties, we had performed an analysis of a rural intersection which shows potential for cost effective crash reduction using proven safety countermeasures. As this work has already been completed it is included as part of our 20 short-listed locations and can be beneficial as serving as an example to interested stakeholders outside of the MPO, such as rural local authorities, town and councils, as an indicator to the potential benefit-cost return, crash reduction and improved safety by targeted application of proven safety countermeasures based on informed data analytics.

The location in question is the intersection of US-BUS-77 and FM-70. The intersection is a 4-leg 4-lane undivided unsignalized intersection. This intersection has an Annual Daily Traffic (ADT) count from 2018 of 3,226 on US-BUS 77 and 980 on FM-70. Streetview imagery indicates that the intersection is currently one-way stop controlled, with STOP control on FM-70 for eastbound and westbound vehicles. There are also overhead flashing safety beacons present facing all directions at the intersection. It appears that recently “CROSS TRAFFIC DOES NOT STOP” warning plaques were installed on the minor approaches.

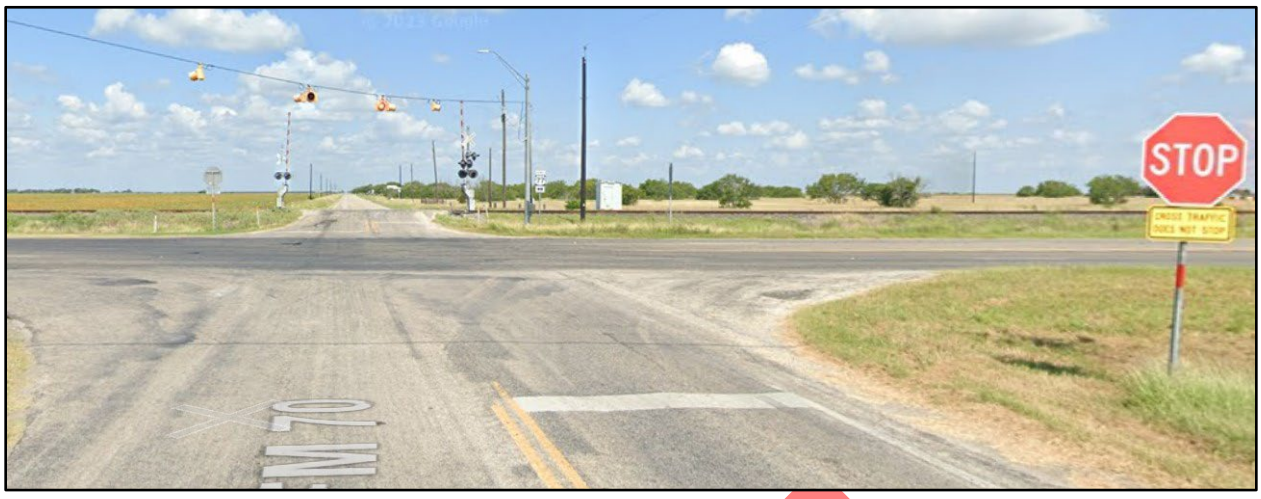


Figure 31: US-BUS-77 & FM-70 (facing West), May 2023

For the study period of 01/01/2016 to 12/31/2021 there were 22 crashes recorded at the intersection, including 8 PDO, 14 Injury (with 20 people injured) and no Fatal crashes. The crash distribution is shown in **Figure 32**.

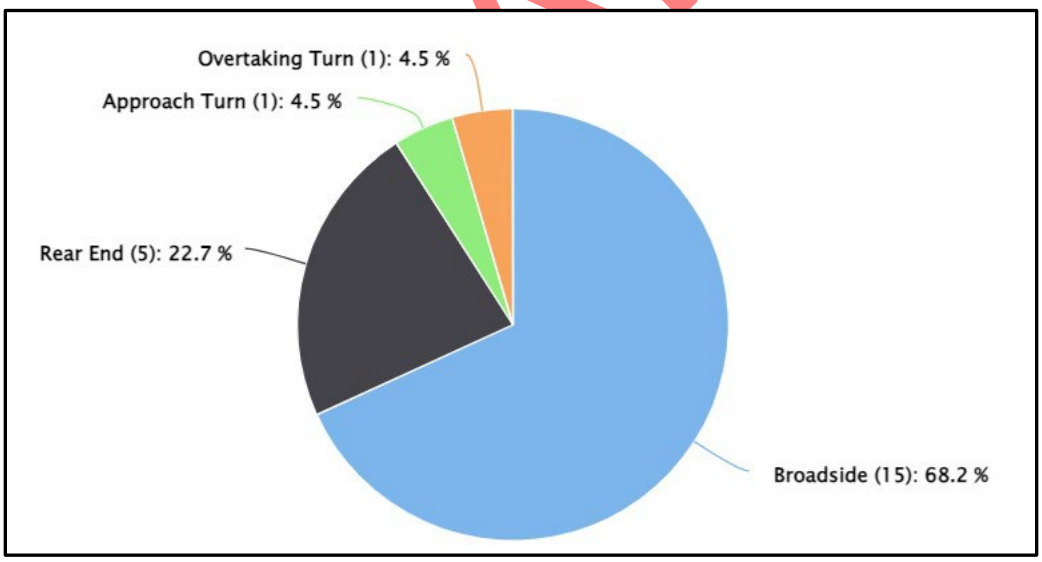


Figure 32: Crash Distribution by Type, US-BUS 77 & FM-70

Injury crashes accounted for 63.6% of all crashes during the study period. Furthermore, Broadside crashes make up over 71% of all Injury level crashes and 80% of all injuries. Broadside crashes are contributing significantly to both the total crash numbers and the crash severity at this intersection. Crash data shows that predominantly, the problem lies with eastbound and westbound at-fault vehicles failing to yield right of way to through traffic on mainline US-BUS 77.

Safety Performance analysis (SPF) shows that the intersection performs at Level of Service of Safety (LOSS) IV for both total crash frequency and crash severity (**Figure 33** and **Figure 34**), indicating high potential for crash reduction at this location.

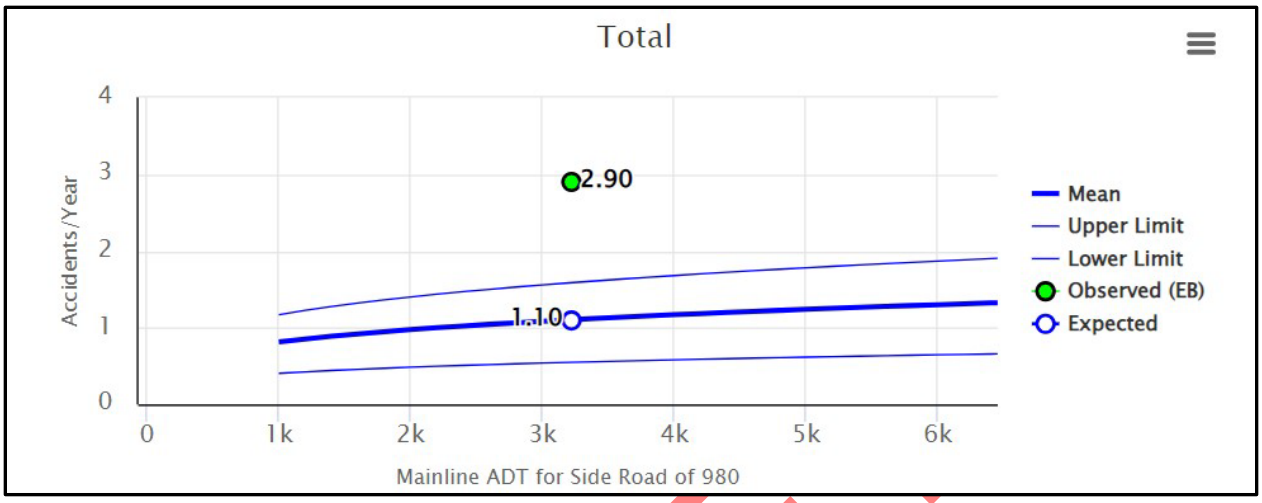


Figure 33: SPF Total Crash Frequency, US-BUS 77 & FM-70

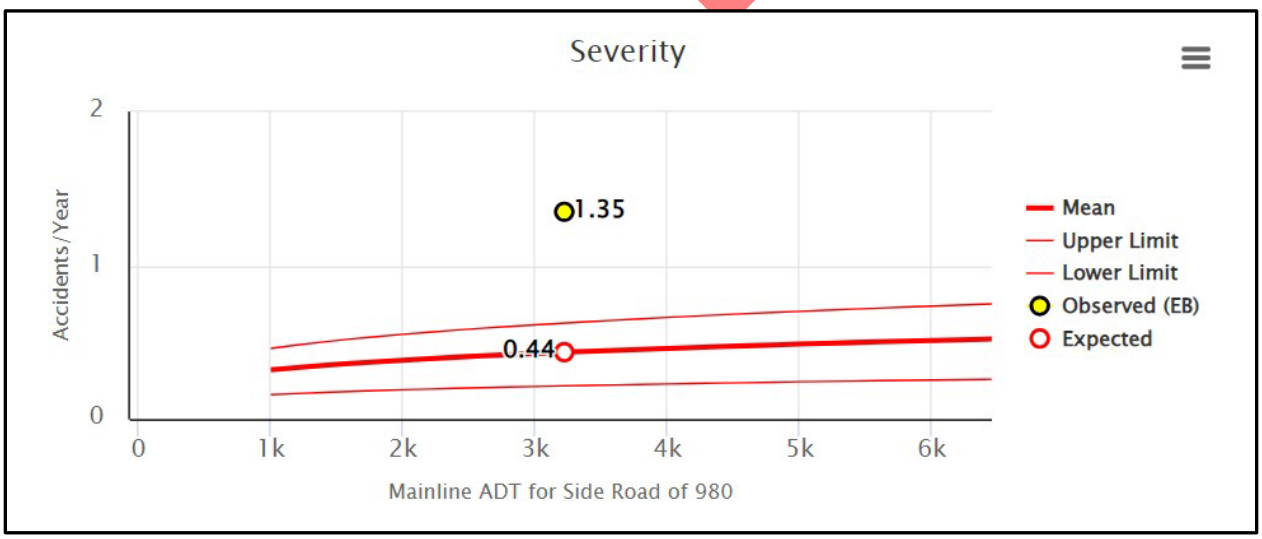


Figure 34: SPF Injury+Fatal Crashes, US-BUS 77 & FM-70

Streetview imagery indicates there are intersection warning signs present northbound and southbound on US-BUS 77, as well as STOP AHEAD warning signs on FM-70 and a grade crossing warning sign on eastbound FM-70. Sight distance does not appear to be an issue at this intersection. Also, as outlined above, recent measures have been implemented to improve safety by way of supplementary warning plaques on STOP signs.

To effectively address the strong pattern of broadside crashes at the intersection, (and indeed the high severity of those crashes), while at the same time recognizing the

difference between mainline and minor road AADT, implementation of an Intersection Conflict Warning System (ICWS) should be considered. This would involve the installation of vehicle detection devices on the major and/or minor approaches with accompanying activated warning signs to alert motorists of the presence of conflicting vehicles on the adjacent approach. The system could be powered by solar panels, or the system could be connected to the existing power supply in the area. **Figure 35** shows "TRAFFIC APPROACHING WHEN FLASHING" warning display used by the Minnesota Department of Transportation, and **Figure 36** shows a typical ICWS layout with detection and warning on the side-road and the main line.

Figure 35: ICWS used by Minnesota DOT

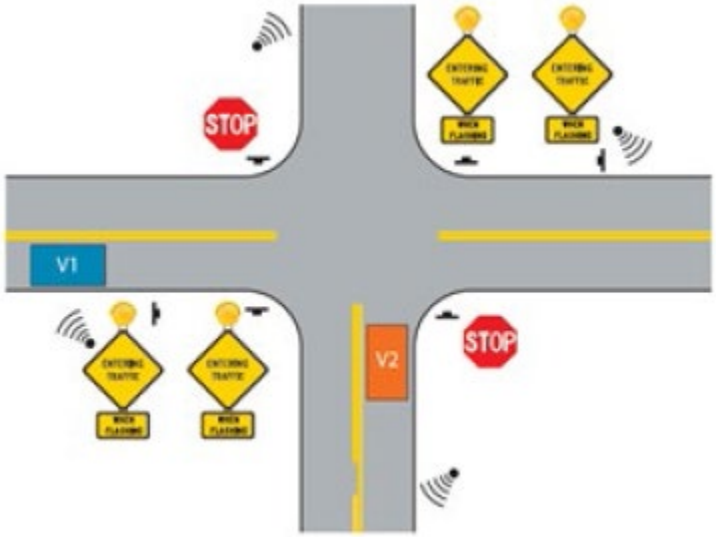


Figure 36: ICWS (FHWA Low-Cost ITS Applications)[12]

[12] FHWA Local and Rural Road Safety Briefing Sheets

An alternative solution would be to implement all-way STOP control at this intersection, with a road-diet or left turn channelization on US-BUS 77 to accommodate the measure. This alternative would require re-striping, as well as the erection of oversized 48-inch gated STOP signs in both directions on US-BUS 77 and gated STOP AHEAD warning signs on US-BUS 77 in advance of the intersection. As per Simpson and Hummer[13], and contrary to prevailing belief, "There is no evidence to suggest that approach volumes have to be nearly equal for the countermeasure (conversion to all-way stop control) to be effective.".

Benefit-Cost Analysis

A preliminary benefit-cost analysis was performed for implementation of an ICWS at the intersection using Vision Zero Suite software. The cost of the system at an intersection with 4 lanes on the major road was estimated to be approximately $100,000 in 2023, including installation[14]. The estimated annual maintenance cost is $4,500. The system has an estimated service life of 10 years. The Benefit-Cost-Ratio (BCR) is expected to be **11.78**. The results show that the measure is expected to be very cost-effective.

CORPUS CHRISTI MPO

Corpus Christi MPO (TX)
DiExSys™ Vision Zero Suite
Economic Analysis Report

09/26/2023

ICWS Bus 77 and FM 70 — **Loc:** Map Boundary **From:** 1/1/2016 **To:** 12/31/2021

Benefit Cost Ratio Calculations

Crashes		Projected Crashes and Reduction Factors	Other Information
PDO: 8	14 :Injured C	CRF for PDO: 17%	Cost of PDO: $0
INJ C: 10	5 :Injured B	CRF for INJ C: 20%	Cost of INJ C: $0
INJ B: 3	1 :Injured A	CRF for INJ B: 20%	Cost of INJ B: $540,000
INJ A: 1	0 :Killed	CRF for INJ A: 20%	Cost of INJ A: $4,000,000
FAT: 0		CRF for FAT: 20%	Cost of FAT: $4,000,000
			Interest Rate: 5%
			AADT Growth Factor: 2%
			Service Life: 10
			Capital Recovery Factor: 0.130
			Annual Maintenance/Delay Cost: $4500

Improvement Cost: $100000
Years in Crash Search: 6.00
Type: Intersection: Intersection Conflict Warning System (4-lane @ 2-lane, 2 way stop controlled)
Notes: Intersection Related Crashes
Benefit/Cost Ratio: 11.78

Table 7: BCA for ICWS at US-BUS 77 & FM-70

A preliminary benefit-cost analysis was performed for implementation of all-way STOP control at the intersection using Vision Zero Suite software. The cost of the measure was estimated to be approximately $31,500. The estimated annual maintenance cost is

[13] Simpson, C.L. and Hummer, J.E., *Evaluation of the Conversion from Two-Way Stop Sign Control at 53 Location in North Carolina,* Journal of Transportation Safety and Security, Vol 2, No 3 (2010) pp 239-260
[14] https://www.itskrs.its.dot.gov/its/benecost.nsf/ID/8bf13d916a5a205d8525822500536cae

$1,000. The system has an estimated service life of 20 years. The Benefit-Cost-Ratio (BCR) is expected to be **228.21**. The results show that the measure is expected to be extremely cost-effective.

Corpus Christi MPO (TX)
DiExSys™ Vision Zero Suite
Economic Analysis Report

09/26/2023

All Way Stop Bus 77 and FM 70 — **Loc:** Map Boundary **From:** 1/1/2016 **To:** 12/31/2021

Benefit Cost Ratio Calculations

Crashes		Projected Crashes and Reduction Factors	Other Information
PDO: 8	14 :Injured C	CRF for PDO: 70%	Cost of PDO: $0
INJ C: 10	5 :Injured B	CRF for INJ C: 70%	Cost of INJ C: $0
INJ B: 3	1 :Injured A	CRF for INJ B: 70%	Cost of INJ B: $540,000
INJ A: 1	0 :Killed	CRF for INJ A: 70%	Cost of INJ A: $4,000,000
FAT: 0		CRF for FAT: 70%	Cost of FAT: $4,000,000
			Interest Rate: 5%
			AADT Growth Factor: 2%
			Service Life: 20
			Capital Recovery Factor: 0.080
			Annual Maintenance/Delay Cost: $1000

Improvement Cost: $31500
Years in Crash Search: 6.00
Type: Intersection: Conversion to All-Way Stop
Notes: Intersection Related Crashes
Benefit/Cost Ratio: 228.21

Table 8:BCA for All-Way Stop at US-BUS 77 & FM-70

Technical Memo 2: Hazard Definition

Corpus Christi MPO Regional Resiliency Improvement Plan Phase 1

Project Context

The Corpus Christi Metropolitan Planning Organization (MPO) and its region face a unique combination of natural hazards including a dry, non-freeze southern Texas climate and its location in 'hurricane alley' along the Gulf Coast. The ability to continue and or quickly restore transportation operations in the face of such hazards can save lives and protect critical and costly infrastructure investments and is therefore of central concern to the Corpus Christi Metropolitan MPO. As evidenced by recent experiences with Hurricane Harvey - which destroyed or severely damaged 80 percent of homes and buildings in Rockport, Fulton, Bayside, Aransas Pass, and Port Aransas [Texas A&M Corpus Christi, 2018] – there is a critical need for more resilient infrastructure in the region.

To proactively make the system more resilient and mitigate potential consequences of known environmental risks and hazards, the Corpus Christi MPO has contracted with the High Street Consulting Group to make progress toward developing a regional Resiliency Improvement Plan by completing a Phase 1 analysis. Phase 1 will identify and prioritize an initial set of assets based on existing data related to their vulnerability to hazards and criticality. This in turn will help position Corpus Christi MPO to tactically pursue federal PROTECT grants that can help fund identified improvements to its vulnerable assets. The PROTECT Formula and Discretionary Grant Programs (1) provides formula funding to states for resilience improvements, (2) distributes competitive planning grants to enable communities to assess vulnerabilities to current and future weather events, natural disasters and changing conditions, and plan transportation improvements and emergency response strategies to address those vulnerabilities, and (3) distributes competitive resilience improvement grants to protect surface transportation assets, coastal infrastructure, natural infrastructure, and communities.

Task Overview

This technical memo (TM2) builds on the previous Technical Memo 1: Network Definition (TM1), which analyzed existing regional resiliency work to identify assets generally considered in resiliency analyses. TM2 incorporates new discussions of relevant natural hazards which have been included in similar resiliency planning efforts through a **Resource Review**

, Hazard Summary

All 11 sources considered in the literature review discussed relevant hazards. Figure 4 provides the literature review hazard reference counts. Flood was referenced the most frequently, with each source mentioning it as a hazard (this includes sources that mention storm surge or specific types of floods, like riverine). Heat Waves and Wildfires are mentioned in half the resources with the other hazards being mentioned in fewer than half. Dam/Levee Failure, Lightning, and Expansive Soils were each mentioned once. Tables 3 and 4 display the hazard references for each individual source.

Data Assessment, and preliminary set of **Implementation Recommendations**. **Appendix II: Additional Resources** summarizes other topical but not directly relevant resources (which may be used in future stages of the analysis).

Return to Agenda

Asset Definitions

The definitions of the assets identified in this resource review and therefore included in the technical memorandum are listed below:[2]

Roadways: physical infrastructure designed and built to accommodate passenger and freight vehicular, bicycle, and pedestrian traffic. Roadway assets review covers roads on and off system as well as evacuation routes.

Railways: networks of tracks and associated structures that enable the movement of trains, which can carry passengers, freight, or both.

Airports: aviation facilities designed to accommodate the arrival, departure, and maintenance of aircraft. The review encompasses various types of aviation facilities including public airports, private airports, and heliports.

Bridges: structures built to span physical obstacles, such as rivers, valleys, or roads, providing a passage for vehicles, pedestrians, and sometimes railways. Bridges included in this document research include bridges that are part of the National Bridge Inventory (NBI), which have spans over 20 ft, and non-NBI bridges.

Seaports: areas along coastlines or navigable waterways where ships can dock to load and unload cargo and passengers. Seaports review covers maritime facilities, waterways, and ports facilities including both shallow and deep draft ports.

Large and Small Culverts: tunnels or pipes that allow water to flow under roads, railways, or other structures. The literature review sections below do not consistently distinguish culverts based on their sizes, so they are referred to as merely culverts. However, the data assessment sections report data availability for the two culvert categories, large and small, which have span greater than and less than or equal to 20 feet, respectively.

Oil and Gas Pipelines: systems for transporting petroleum products, natural gas, and other fluids. Oil and gas pipelines review includes pipelines carrying various commodities such as crude oil, anhydrous ammonia, natural gas, and refined liquid products.

Transit Facilities: stations and routes of the public transportation system that are used to move people from one place to another. Transit facilities cover various modes such as buses, subways, trams, and light rail.

Low Water Crossings: low-elevation roadways traversing over a body of water that stays dry above the water when the flow is low and are designed to be submerged under high-flow conditions, such as floods.

[2] Asset type nomenclature varies among plans and resources; the High Street Team grouped similar or analogous asset names together as illustrated in **Appendix I: Asset Type Crosswalk**.

Ferry Facilities: stations where ferries, which are vessels that transport passengers and vehicles across bodies of water, dock and embark/disembark passengers and vehicles. The ferry facilities review includes terminals and routes.

ITS/Ancillary Assets: Intelligent Transportation Systems (ITS) and ancillary assets refer to technologies and equipment used to improve transportation safety, efficiency, and coordination. This includes traffic signals, cameras, electronic signs, sensors, communication systems, and data management tools.

Hazard Definitions

The following relevant hazards and definitions were identified through the literature review:

Coastal Erosion: the loss of land, marshes, wetlands, beaches, or other coastal features within the coastal zone because of the actions of wind, waves, tides, storm surges, subsidence, or other forces**.**

Dam and Levee Failure: A dam is a barrier that is constructed to hold back water. A dam failure is a systematic failure of a dam structure resulting in the uncontrolled release of water, often resulting in floods that could exceed the 100-year floodplain boundaries. A levee is an embankment built to prevent overflow from a body of water. A levee failure is when a levee embankment fails, or is intentionally breached, causing the previously contained water to flood the land behind the levee.

Drought: a natural reduction in the amount of precipitation expected over an extended period of time, usually a season or more in length.

Expansive Soil: soils and soft rock that tend to swell or shrink due to changes in moisture content.

Extreme Heat/Heat Wave: a combination of very high temperatures and, usually, exceptionally humid conditions. When persisting over a period of time (generally more than two days), it is called a heat wave.

Flooding: the accumulation of water within a water body and the overflow of excess water into adjacent floodplain lands. Types of floods include:

> **Coastal Flooding/Storm Surge**: areas at risk of flooding when sea water surges inland from tropical storm events/an abnormal rise of water generated by a storm over and above the predicted astronomical tide.
>
> **Riverine Flooding:** areas at risk of flooding when rivers and creeks come out of their banks.

Land subsidence/Landslides: the loss of surface elevation due to the removal of subsurface support. It can range from broad, regional lowering of the land surface to localized, full-blown collapses. Land subsidence occurs in different areas for different reasons. A sinkhole is a category of subsidence.

Lightning: a massive electrostatic discharge between electrically charged regions within clouds, or between a cloud and the Earth's surface.

Sea Level Rise: an increase in the level of the world's oceans.

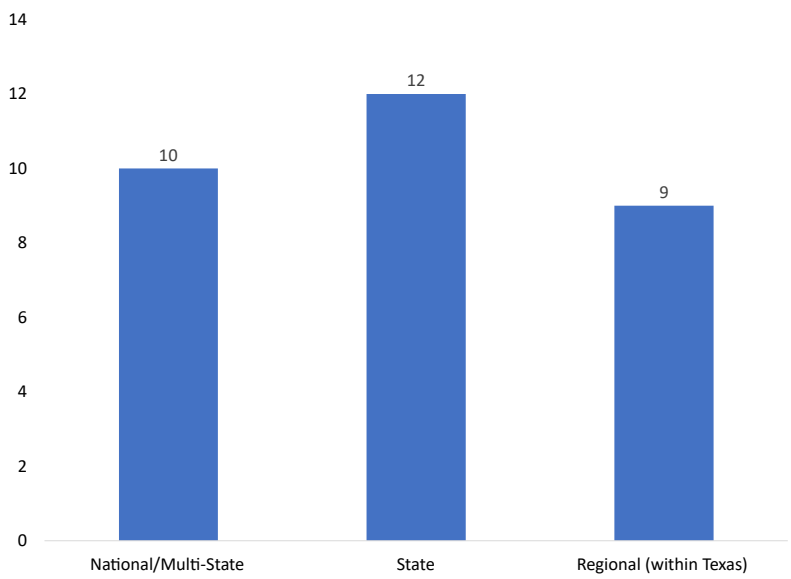
Strong Wind: a storm with high winds or violent gusts with little or no rain. The windstorm hazard excludes extreme wind events that occur with other wind-related natural hazards such as hurricanes, tropical storms, and tornados.

Wildfire: a sweeping and destructive conflagration and can be further categorized as wildland, interface, or intermix fires. Wildland fires are fueled almost exclusively by natural vegetation wildland/urban interface (WUI) fires include both vegetation and the built environment. The wildfire disaster cycle begins when homes are built adjacent to wildland areas.

Resource Review

Resiliency is an emerging and important topic that has garnered increased attention and has new funding programs associated with it (such as PROTECT); as a result, agencies from federal to regional and local have developed resiliency plans, studies, and programs, as well as provide databases and GIS files ("resources"). Therefore, to understand which transportation assets and hazards Corpus Christi MPO should consider including in its inaugural Resiliency Improvement Plan, the project team documented which asset types have been considered most frequently and has available data. High Street team reviewed a total of 31 resources covering a range of geographies, as illustrated Figure 1.

Figure 5: Resources by Geographical Coverage



Literature Review

The literature review identifies which assets and hazards are considered in relevant plans, programs, and studies. There is sometimes overlap and agreement among resources, and they can often differ in their scope, methodology, terminology, and focus. The literature review covers the following:

- **resiliency plans and programs in Texas** such as the Regional Resilience Partnership for Coastal Bend regional counties, Texas Department of Transportation (TxDOT) Statewide Resiliency Plan, vulnerability assessment reports for the Austin and Dallas metropolitan areas; and
- **emergency plans** from Corpus Christi, Nueces County, and other research entities and government agencies.

The following section details the resources considered and summarizes the assets referenced. It also provides a foundation for further work on identifying hazard types and criticality criteria.

Resiliency Plans and Programs in Texas

TxDOT Statewide Resiliency Plan (SRP)

The Texas Statewide Resiliency Plan began in December 2022 and is slated to finish in the Summer of 2024. This ongoing effort aims to proactively manage and assess future transportation system disruptions due to extreme weather events. This includes identifying critical infrastructure and hazards, evaluating the vulnerability of these infrastructure assets to the hazards, and accordingly developing strategies to improve resilience. The SRP includes a balance of a science-based approach and stakeholder and public involvement. The SRP will satisfy Texas' Infrastructure Investment and Jobs Act PROTECT requirements and serve as a resource for state and local agencies to pursue further funding. The TxDOT SRP website lists the types of assets and hazards that will be analyzed in the plan.

Texas SRP

Assets	Hazards
❖ Roadways	❖ Flooding
❖ Railways	❖ Wildfire
❖ Airports	❖ Heat Wave
❖ Bridges	❖ Drought
❖ Seaports	
❖ Oil & Gas Pipelines	
❖ Culverts	
❖ ITS/Ancillary Assets	

TxDOT Statewide Freight Resiliency Plan, Stage 1: Prepare the Freight System

TxDOT developed the Statewide Freight Resiliency Plan to prepare, detect, respond to, and recover from events, which include natural disasters, terrorist incidents, or infrastructure failure. Specifically, the purpose of this study is to "assess the resilience of the strategic freight system in Texas when an event of extended duration limits freight mobility, resulting in prioritized infrastructure enhancements to keep freight moving." Stage 1 of the Plan, released in 2011, focuses on understanding the existing system's preparedness. The report identifies relevant freight infrastructure and hazards before analyzing resiliency. Stage 2, also released in 2011, primarily focuses on the freight communication network. The Statewide Freight Resiliency Plan analyzes the assets relevant to Texas' Freight System, which are included in the call-out box. Additionally, the Plan provides a matrix of hazards considered.

Statewide Freight Resiliency Plan

Assets	Hazards
❖ Roadways	❖ Flooding
❖ Railways	❖ Wildfire
❖ Airports	❖ Strong Wind
❖ Seaports	❖ Land Subsidence/ Landslides
❖ Oil and Gas Pipelines	

Central Texas Extreme Weather and Climate Change Vulnerability Assessment of Regional Transportation Infrastructure

This 2015 report was part of a series of Federal Highway Administration (FHWA) grant pilot studies meant to establish best practices for assessing transportation infrastructure vulnerability to climate change and extreme weather, as well as determine strategies for improving resiliency. Specifically, the Capital Area Metropolitan Planning Organization (CAMPO) and the City of Austin Office of Sustainability assess the potential vulnerability of a limited number of critical transportation assets in the CAMPO region to the effects of extreme weather and climate. The report

Central Texas Extreme Weather and Climate Report

Assets	Hazards
❖ Roadways	❖ Flooding
❖ Railways	❖ Wildfire
❖ Airports	❖ Strong Wind
❖ Bridges	❖ Land Subsidence/ Landslides
❖ Transit Facilities	

discusses the transportation data considered before assessing criticality, sensitivity, and vulnerability to natural hazards.

Climate Change/Extreme Weather Vulnerability and Risk Assessment for Transportation Infrastructure in Dallas and Tarrant Counties

The University of Texas Arlington created this report in 2015 for the North Central Texas Council of Government, a voluntary assortment of local governments and districts, and the MPO for the Dallas-Fort Worth metropolitan regions. The main objectives of this study are to assess how extreme weather events could affect the transportation infrastructure of North Central Texas, focusing on Dallas and Tarrant counties. It enables transportation planners to adapt and prepare future transportation infrastructure for extreme weather events. The assessment discusses the transportation infrastructure and hazards considered before assessing vulnerability. The assets and hazards considered are in the Climate Change/Extreme Weather Risk Assessment call-out box.

Climate Change/Extreme Weather Risk Assessment	
Assets	Hazards
❖ Roadways ❖ Railways ❖ Airports ❖ Bridges	❖ Flooding ❖ Wildfire ❖ Heat Wave

Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phases 1 and 2 (Gulf Coast Study)

The Gulf Coast Study was produced by the U.S. Climate Change Science Program with funds from the U.S. Department of Transportation (DOT) in partnership with the U.S. Geological Survey. The Study Phases consider how changes in weather could affect the transportation infrastructure of the U.S. Gulf Coast between Galveston, Texas and Mobile, Alabama. The Phases aim to evaluate how changes in climate could impact design, construction, safety, operations, and maintenance of transportation infrastructure. Moreover, they focus on the decisions policy makers and managers can consider which increase safety and resiliency in the transportation system. Phase 1 (2008) takes a regional case study approach, while Phase 2 (2013) takes a more focused approach by analyzing specific infrastructure components and adaptation strategies. After elaborating on the importance of and risks to the Gulf Coast, the Phases analyze the potential climate impacts on different transportation modes, with Phase 1 analyzing the entire Gulf Coast and Phase 2 focusing on examples in Mobile, AL.

Gulf Coast Study	
Assets	Hazards
❖ Roadways ❖ Railroads ❖ Roadways ❖ Airports ❖ Seaports	❖ Flooding ❖ Heat Wave ❖ Sea Level Rise

Texas Coastal Resiliency Study (TCRS)

This report was created in 2016 for the Texas General Land Office to identify the critical coastal infrastructure assets that are most vulnerable to storms similar to Hurricanes Dolly and Ike. The report identified and ranked priority existing and future projects that could protect vulnerable assets. Through three phases, the report recommends the projects that

TCRS	
Assets	Hazards
❖ Roadways ❖ Railways ❖ Airports ❖ Bridges ❖ Seaports ❖ Transit Facilities ❖ Oil & Gas Pipelines ❖ Low Water Crossings ❖ Ferry Facilities	❖ Flooding ❖ Coastal Erosion ❖ Strong Wind

would have the greatest impact on recovery and resiliency. The TCRS identifies the critical infrastructure considered, specifies the transportation assets, and then performs the risk analysis for identified hazards.

Texas Coastal Resiliency Master Plan (TCRMP)

The Texas Coastal Resiliency Master Plan (TCRMP), created by the Texas General Land Office (GLO), is a multi-part statewide plan to analyze and protect the natural environment and infrastructure along the Texas coast. The TCRMP outlines projects across four Gulf regions compiled by coastal and environmental experts that will help enhance resiliency along the state's coast. The most recent installment, TCRMP 2023, is an update to the 2019 report. Analysts were asked to assess the impact of eight vulnerabilities in 48 coastal subregions identified in the 2023 TCRMP through a Qualtrics Survey. The projects are ranked by economic and ecological measures to help communities determine which to implement. The report is accompanied by data and mapping resources, which are discussed in depth in the Data Assessment section. The TCRMP 2023 covers five hazards, which are most relevant to the coastal regions of Texas, and it distinguishes between riverine and coastal flooding.

TCRMP

Assets	Hazards
❖ Roadways	❖ Flooding
❖ Railways	❖ Sea Level Rise
❖ Airports	❖ Coastal Erosion
❖ Bridges	❖ Land Subsidence/ Landslides
❖ Maritime	
❖ Seaports	
❖ Transit Facilities	

Coastal Texas Protection and Restoration Feasibility Study Final Report (Coastal Texas Study)

The Coastal Texas Study was a collaboration between the US Army Corps of Engineers and the Texas General Land Office completed in 2021. In recognition of the economic and ecological importance of Texas, the authors created the report to identify feasible projects that can address natural hazard risks to the economy and public health, as well as restore ecosystems and improve coastal resiliency. The report focuses on mechanisms for mitigating the impact of storm surges and protecting communities. It does not discuss specific transportation assets.

Coastal Texas Study

Hazards
- ❖ Flooding
- ❖ Sea Level Rise
- ❖ Coastal Erosion

Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036, 2021 Update (Extreme Weather Assessment)

The Extreme Weather Assessment was an update to a report created by the Texas A&M University, Office of the Texas State Climatologist. The report was sponsored by Texas 2036, a nonpartisan think tank. The report reviews historic trends in temperature, precipitation, and extreme weather in Texas to forecast trends out to 2036. The report acknowledges variation in the actual climate, but this provides scenarios that Texas can use to inform decision making. The report covers the entire state and hazards including coastal erosion, drought, flooding, wildfires, and a variety of storm types. The data employed in the report is not readily available but can provide methods for evaluating resiliency.

Extreme Weather Assessment

Hazards
- ❖ Flooding
- ❖ Heat Wave
- ❖ Wildfire
- ❖ Coastal erosion
- ❖ Strong Wind
- ❖ Drought
- ❖ Lightning

Local Hazard Resources and Emergency Plans

Corpus Christi MPO identified a few regionally specific resources which provide important information for a local understanding of assets, hazards, and critical infrastructure. This subsection provides a summary of these resources.

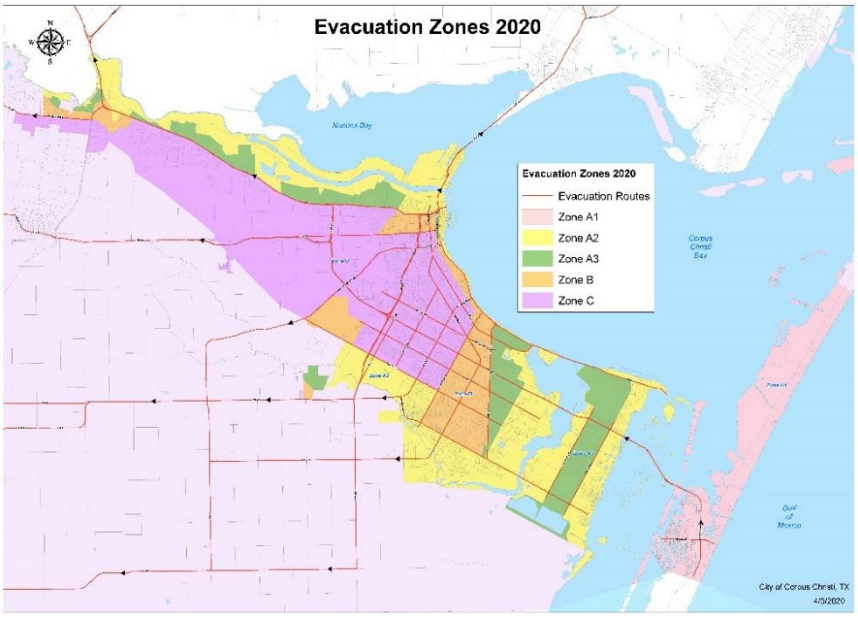
HMAP	
Assets ❖ Roadways ❖ Railways	Hazards ❖ Flooding ❖ Wildfire ❖ Heat Wave ❖ Coastal Erosion ❖ Drought ❖ Land Subsidence/ Landslides ❖ Strong Wind ❖ Expansive Soil ❖ Lightning ❖ Dam/Levee Failure

Nueces County Hazard Mitigation Action Plan (HMAP) Draft

The 2023 HMAP Draft is a 5-year update of the 2017 HMAP sponsored by the Coastal Bend Council of Governments. The goal of the Nueces County HMAP is to eliminate losses due to natural disasters and improve community resilience. The plan employs data analysis, stakeholder meetings, and public engagement to understand the assets and risks for the county and individual cities and districts. It provides valuable insights into the region's hazards and the public's perception towards their seriousness. For each identified hazard, the plan mentions the assets that could be harmed in the included parts of the county.

City of Corpus Christi Emergency Operations Center

Figure 6: City of Corpus Christi Evacuation Map



The City of Corpus Christi's website contains valuable information on emergency response, including resources for residents and information about the Emergency Operations Center (EOC). One such resource provided is an evacuation map with labeled routes (Figure 2). The city is separated into zones and the routes indicate which direction residents should evacuate. Operating as an evacuation route is an important criticality criterion for roadways. The EOC is assembled during an emergency to coordinate the efforts between local, regional, state, and national departments and agencies. Day-to-day EOC activities include receiving and communicating warnings and information, developing policies, and preparing for emergencies. During emergencies, the EOC leads the operations, analyzes information to recommend countermeasures, and communicates with residents, officials, and neighboring jurisdictions. The EOC operates in tandem with the City's Office of Emergency Management (OEM). Both the EOC and OEM contain experts on the City's assets, hazards, and critical infrastructure.

Corpus Christi Regional Transit Authority (CCRTA) Emergency Preparedness Policy

The CCRTA Emergency Preparedness Policy, updated 2023, outlines CCRTA employee responsibilities. During an emergency, CCRTA provides evacuation services for multiple cities and unincorporated areas in Nueces County. CCRTA receives instructions on evacuation procedures from the Nueces County Emergency Management Offices (EMO) when an emergency arises. CCRTA performs evacuation services while safety permits.

Nueces Regional Flood Plan

Nueces Regional Flood Plan	
Assets ❖ Roadways ❖ Airports ❖ Bridges ❖ Culverts ❖ Low Water Crossings	Hazards ❖ Flooding ❖ Heat Wave ❖ Sea Level Rise

The Nueces Regional Flood Plan is updated by the Nueces Regional Flood Planning Group, one of 15 regions overseen by the Texas Water Development Board. The Nueces Regional Flood Plan focuses on determining hazards, exposure, and vulnerability to evaluate the current and future flood risk. This includes evaluating the region's susceptibility to flooding, determining what and who will be impacted, and identifying the most vulnerable communities and critical facilities. This Plan provides in-depth information pertaining specifically to flood risks and policy recommendations for mitigation. As part of the vulnerability analyses, it identifies roadways and roadway crossings (bridges, culverts, low water crossings), as well as hazards to the region.

Summary of Findings

Asset Summary

Nine of the 10 sources in the literature review elaborated on asset types. **Error! Reference source not found.** provides the reference counts for each asset type; roadways, airports, and railways were mentioned most frequently. Table 1 and Table 2 provide the breakdown for which sources referenced which assets. For instance, the Texas Statewide Resilience Plan mentions eight of the 11 asset types.

Figure 7: Count of Asset Types References in the Literature Review

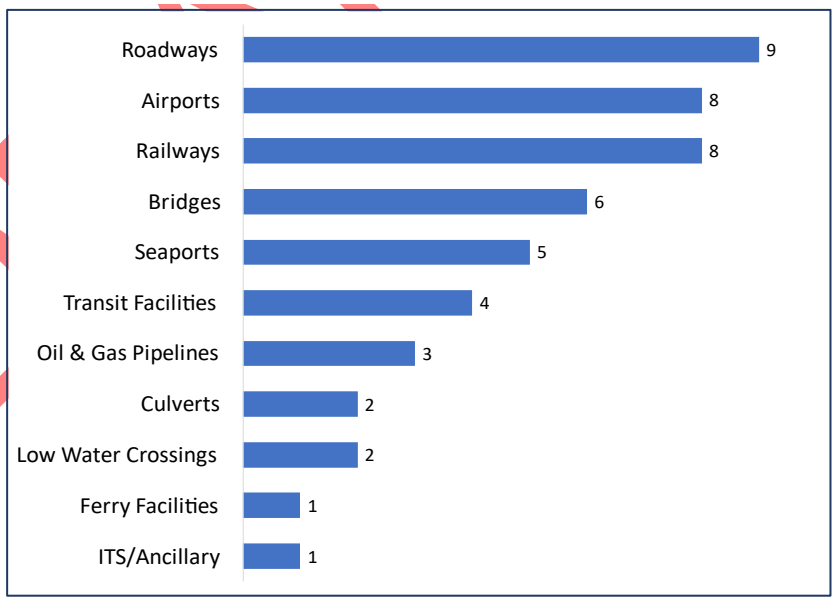


Table 5: Asset Type Literature Review Reference Summary Table

Asset Type	Roadways	Railways	Airports	Bridges	Seaports
Total	**9**	**8**	**8**	**6**	**5**
Texas SRP	x	x	x	x	x
Statewide Freight Resiliency Plan	x	x	x		x
Central Texas Extreme Weather and Climate Report	x	x	x	x	
Climate Change/Extreme Weather Risk Assessment	x	x	x	x	
Gulf Coast Study	x	x	x	x	x
TCRS	x	x	x		x
TCRMP	x	x	x	x	x
HMAP	x	x			
Nueces Regional Flood Plan	x		x	x	

Table 6: Asset Type Literature Review Reference Summary Table (Continued)

Asset Type	Transit Facilities	Oil & Gas Pipelines	Culverts	Low Water Crossings	Ferry Facilities	ITS/Ancillary Assets
Total	**4**	**3**	**2**	**2**	**1**	**1**
Texas SRP		x	x			x
Statewide Freight Resiliency Plan		x				
Central Texas Extreme Weather and Climate Report	x					
Climate Change/Extreme Weather Risk Assessment						
Gulf Coast Study	x					
TCRS	x	x		x	x	
TCRMP	x					
HMAP						
Nueces Regional Flood Plan			x	x		

Hazard Summary

All 11 sources considered in the literature review discussed relevant hazards. Figure 4 provides the literature review hazard reference counts. Flood was referenced the most frequently, with each source mentioning it as a hazard (this includes sources that mention storm surge or specific types of floods, like riverine). Heat Waves and Wildfires are mentioned in half the resources with the other hazards being mentioned in fewer than half. Dam/Levee Failure, Lightning, and Expansive Soils were each mentioned once. Tables 3 and 4 display the hazard references for each individual source.

Figure 8: Count of Hazard Types References in the Literature Review

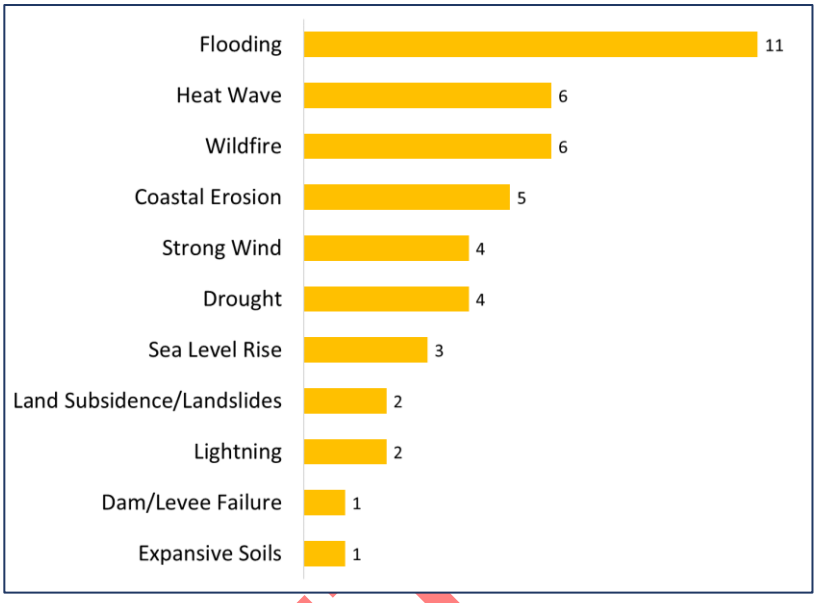


Table 3: Hazard Type Literature Review Reference Summary Table

Asset Type	Flooding	Heat Wave	Wildfire	Coastal Erosion	Strong Wind
Total	**11**	**6**	**6**	**5**	**4**
Texas SRP	X	X	X		
Statewide Freight Resiliency Plan	X		X		X
Central Texas Extreme Weather and Climate Report	X	X	X		
Climate Change/Extreme Weather Risk Assessment	X	X	X		
Gulf Coast Study	X	X			
TCRS	X			X	X
TCRMP	X			X	
Coastal Texas Study	X			X	
Extreme Weather Assessment	X	X	X	X	X
HMAP	X	X	X	X	X
Nueces Regional Flood Plan	X				

Table 4: Hazard Type Literature Review Reference Summary Table (Continued)

Asset Type	Drought	Sea Level Rise	Land Subsidence /Landslides	Lightning	Dam/Levee Failure	Expansive Soils
Total	**4**	**3**	**2**	**2**	**1**	**1**
Texas SRP	X					
Statewide Freight Resiliency Plan			X			
Central Texas Extreme Weather and Climate Report	X					
Climate Change/Extreme Weather Risk Assessment						
Gulf Coast Study		X				
TCRS						
TCRMP		X				
Coastal Texas Study		X				
Extreme Weather Assessment	X			X		
HMAP	X		X	X	X	X
Nueces Regional Flood Plan						

Data Assessment

To understand what data is currently available to locate and potentially assess the criticality of the various asset types and hazards in Corpus Christi MPO, the project team reviewed relevant Esri maps, dashboards, and data hubs. These data sources fall into three groups:

- National-level data sources
  - Homeland Infrastructure Foundation-Level Data (HIFLD)
  - United States Army Corps of Engineers (USACE) National Inventory of Dams (NID)
  - United States Department of Agriculture (USDA) Web Soil Survey (WSS)
- Statewide data sources
  - TxDOT Open Data Portal
  - TxDOT Planning Map
  - Texas Railroad Commission Data
  - Texas Water Development Board
- Regional data sources for Corpus Christi MPO and Nueces County:
  - GeoRED Hazard Impact and Planning Tool
  - The Coastal Bend Hurricane Evacuation Study Planning Atlas

The project team reviewed each data source to assess the availability of location and criticality information including ridership, demand, and condition. The review covered the 11 asset types: roadways, railways, airports, bridges, seaports, oil and gas pipelines, transit facilities, culverts, ferry facilities, ITS/ ancillary assets, and low water crossings.

The team also considered whether spatial data was available for each hazard type identified through the literature review. The following subsections provide full details of the information each data source covered for each asset and hazard type.

Homeland Infrastructure Foundation-Level Data (HIFLD)

Homeland Infrastructure Foundation-Level Data (HIFLD) is a program within the United States Department of Homeland Security (DHS) that focuses on collecting, maintaining, and providing geospatial data related to critical infrastructure and key resources across the United States. The goal of HIFLD is to enhance the nation's understanding of its infrastructure and to support decision-making processes for emergency management, disaster response, and national security. HIFLD collects data from various federal, state, local, tribal, and private sector sources, and compiles this information into a comprehensive geospatial database. This database includes data about infrastructure such as transportation systems, energy facilities, communication networks, water resources, healthcare facilities, and more.

HIFLD	
Assets ❖ Roadways ❖ Railroads ❖ Airports ❖ Oil and Gas Pipelines ❖ Transit Facilities ❖ Railroads	Hazards ❖ Flooding ❖ Wildfire

HIFLD covers six main asset types: roadways, railroads, airports, ferry facilities, transit facilities, and oil and gas pipelines. For roadways, HIFLD provides information about the locations of primary, secondary, and local roads. HIFLD includes the Federal Aviation Administration's aviation facilities dataset, providing precise airport locations. Railroads are also covered, offering insights into their locations. Ferry facilities are comprehensively detailed, revealing essential information such as ferry route locations, lengths, trip durations, passenger numbers, vessel types, and trip types. In terms of transit, HIFLD supplies data on national transit routes and stops. Additionally, the program extends its coverage to oil and gas pipelines, disclosing the locations of major natural gas transmission pipelines, including both interstate and gathering pipelines, as sourced from the U.S. Energy Information Administration.

National Inventory of Dams (NID)

The National Inventory of Dams is a database provided by the U.S. Army Corps of Engineers. The focus of the NID is to provide dam location, type, size, purpose, uses and benefits, date of last inspection, other structural and geographical information. The NID also models dam flood inundation to demonstrate what could occur during a dam-related flood. The NID also provides data from the HIFLD for various public works and critical infrastructure, including nuclear power stations, fire stations, and railway lines.

NID
Hazards ❖ Dam and Levee Failure

Web Soil Survey (WSS)

The Web Soil Survey is a product provided by the US Department of Agriculture Natural Resources Conservation Service. The WSS provides soil information and data collected through the Cooperative Sil Survey. The soil data was collected to provide information for agriculture purposes but can also be used to assess susceptibility to erosion, land subsidence, and expansive soils.

WSS
Hazards ❖ Coastal Erosion ❖ Land Subsidence /Landslides ❖ Expansive Soils

TxDOT Open Data Portal

The TxDOT Open Data Portal is TxDOT's platform for exploring and downloading GIS datasets. It serves as the primary location for state transportation inventory data. It has a wide variety of datasets that are referenced and used in other tools and dashboards. This data source is unique because it includes both on-system and off-system roadway inventory. It also has the location and type of seaports and railroads, including their classification such as business lead, industrial lead, main line, side-track, and spur line. Furthermore, the TxDOT Open Data Portal provides access to the statewide oil and gas pipelines data provided by the Texas Railroad Commission.

TxDOT Open Data Portal

Assets
- Roadways
- Railroads
- Airports
- Bridges
- Seaports
- Oil and Gas Pipelines
- Large Culverts

TxDOT Statewide Planning Map

The TxDOT Statewide Planning Map is an Esri application designed to present a variety of TxDOT transportation geospatial data to facilitate planning operations within the organization. The mapping tool includes the geographic positions and types of seaports and railroads assets. Additionally, the map offers comprehensive details regarding bridges as reported to the National Bridge Inventory (NBI), such as their locations, condition ratings, ages, deck geometries, waterway sufficiency ratings, and lengths.

TxDOT Planning Map

- Roadways
- Bridges
- Railroads
- Seaports

The map also includes a wealth of data about roadway assets including locations, Average Annual Daily Traffic (AADT), Vehicle Miles Traveled (VMT), percentage of truck traffic, geometric characteristics, anticipated future traffic and truck percentages, presence within the Strategic Highway Network, locations of evacuation routes, the top 100 congested roads, as well as both State and National freight networks including critical urban and rural freight corridors.

Texas Railroad Commission

The Railroad Commission (RRC) of Texas is the state agency that regulates the oil and gas industry, gas utilities, pipeline safety, safety in the liquefied petroleum gas industry, and surface coal and uranium mining. RRC publishes Esri maps that have information about oil and gas pipelines (also included in the TxDOT Open Data Portal described above) and wells. Pipelines data include location, diameter, commodity types, and status (active or abandoned). The TRC does not address hazards.

Texas Railroad Commission

Assets
- Oil and Gas Pipelines

Texas Water Development Board (TWDB)

The Texas Water Development Board (TWDB) is a state agency in Texas responsible for collecting and disseminating water-related data; assisting with regional water supply and flood planning that contributes to preparing the state water plan and state flood plan; and administering cost-effective financial programs for constructing water supply, wastewater treatment, flood control, and agricultural water

TWDB

Assets	Hazards
❖ Low Water Crossing	❖ Flooding ❖ Dam & Levee Failure

conservation projects. The TWDB has an open data hub that has data covering the state's hydrological assets and only one transportation asset, which is the low water crossing. TWDB open data hub has the location of the low water crossing assets without information about their criticality. TWDB open data hub also includes data related to flooding and dam or levee failure.

GeoRED - Hazard Impact and Planning Tool

GeoRED	
Assets ❖ Roadways ❖ Railroads ❖ Airports ❖ Oil and Gas Pipelines ❖ Railroads ❖ Ferry Facilities	Hazards ❖ Flooding ❖ Sea Level Rise

The Regional Resilience Partnership (RRP) developed a GIS platform called the Geospatial Resilient Economic Development (GeoRED), which is a tool for building resilience to disaster and economic risks. The GeoRED online platform has multiple tools for local officials and experts to analyze and share data with other interested stakeholders. One of these tools is the Hazard Impact and Planning Tool, which is an Esri tool that contains data layers focused on hazard planning and response, such as critical infrastructure and facilities, storm surge, and FEMA's National Flood Hazard Layer (NFHL) 1% and 0.2% flood zones. This tool includes the locations of roadways, evacuation routes, airports, railroads, ferry facilities, and transit facilities. It also has spatial files for subsets of these assets that are in FEMA 1% and 0.2% annual flood risk. For oil and gas pipelines, this tool has data showing pipelines locations, diameters, commodity types, and activity status.

The Coastal Bend Hurricane Evacuation Study Planning Atlas

Hurricane Planning Atlas	
Assets ❖ Roadways ❖ Railroads ❖ Airports	Hazards ❖ Flooding ❖ Sea Level Rise

The Coastal Bend Hurricane Evacuation Study Planning Atlas is an Esri map that has multiple data layers for the coastal bend region and is published as part of the Coastal Bend Hurricane Evacuation Study. These data layers cover:

- Administrative unit layers, including counties, places, school districts, coastal management zones, and coastal zones.
- Physical risks layers covering:
    - Historic wind and storm tracks.
    - Three sea level rise scenarios.
    - Storm surge models for tropical storms, and storm categories 1 through 5.
- Built environment and critical facilities:
    - Population.
    - Critical facilities including police stations; fire stations, local EOC, EMS, Urgent care, nursing homes, and hospitals.
    - Built environment including hotels, schools, mobile home units, buildings, and infrastructure.
- Social risk layers:
    - Social vulnerability index.
    - Childcare need.
    - Eldercare need.
    - Transportation need.

  - Shelter need.
  - Housing types.
  - Poverty status.
  - Limited English proficiency.
  - Unemployment.
  - Civic capacity.
  - Low to moderate income.
  - Education level.
- Evacuation zones and routes layers.

The Coastal Bend Hurricane Evacuation Study Planning Atlas provides data layers encompassing three primary transportation asset types: roadways, airports, and railroads. Within each of these asset types, users can access two key pieces of information: their respective locations and types. The roadway category includes various types such as major highways, US and state highways, farm roads, and city/county roads. Notably, the Atlas includes layers dedicated to evacuation routes, each representing distinct route types, including major evacuation routes, potential contraflow routes, and evacuation lanes. Moreover, the Atlas features surge-affected routes categorized by storm category.

Texas Geographical Information Office (TxGIO, previously TNRIS)

TxGIO	
Assets ❖ Low Water Crossing	Hazards ❖ Flooding

The Texas Geographic Information Office, previously the Texas Natural Resources Information System, is a division of the Texas Water Development Board. It is a geographical information systems resource. It contains maps and data captured by LIDAR, sensors, and imagery. Some data is region specific while others span the entire state. While TxGIO has extensive data for hazards including increased temperature and extreme heat, wind, wildfires, winter storms, and more, only data related for floods and storm surges covering Corpus Christi has been identified by the project team. Regarding assets, only Low Water Crossing data is available.

Climate Toolbox

Climate Toolbox
Hazards ❖ Wildfire ❖ Heat Wave ❖ Drought ❖ Strong Wind

A University of California Merced project, the Climate Toolbox is a collection of web tools that visualize past and forecasted climate and hydrology for the contiguous US. The applications cover agriculture, climate, fire, and water. One such tool is the Climate Mapper which maps real-time conditions, current forecasts, and future projections of climate information across the United States to assist with decisions related to agriculture, climate, fire conditions, and water. The data employed in the maps is also available for download. Partners for this project include the Climate Impacts Research Consortium, Regional Integrated Sciences and Assessments, the US Department of Agriculture's Northwest Climate Hub, and other regional and national organizations and agencies.

Texas Coastal Resiliency Master Plan (TCRMP) and the Gulf of Mexico Research Initiative Information and Data Cooperative (GRIIDC)

Both the TCRMP 2019 and 2023 installments provide data employed in the written reports. TCRMP 2019 provides an ESRI power map for Region 3, which covers Corpus Christi. The map includes data recording the potential impact of flooding from storm surges.

TCRMP/GRIIDC
Assets ❖ Flooding ❖ Wildfire ❖ Heat Wave ❖ Drought

The data employed in the TCRMP 2023 is published on the GRIIDC. The Gulf of Mexico Research (GoMRI) Initiative is an independent research program funded by BP following the Deepwater Horizon spill to study the impacts of oil spills in the Gulf of Mexico. The GRIIDC is the data center that aims to provide data and information to promote and support research and awareness about the Gulf of Mexico ecosystem. The GRIIDC hosts data and reports from researchers studying the Gulf of Mexico. The GRIIDC satisfies the GoMRI requirement to ensure that relevant data from research is publicly available. The GRIIDC encourages researchers to use available data and share their own data to promote regional research.

Data Assessment Summary

Asset Summary

Figure 9 summarizes the findings of the data assessment. Table 7 details the asset data available for each source. For location data availability, roadway and railroads assets are at the top of the list followed by airports and pipelines. On the other hand, no location data were found for small culverts and ITS/ ancillary assets.

If a data source reports asset condition and/or traffic levels/ridership, it is considered to have criticality data for that asset. Furthermore, data sources with evacuation routes information are considered to have criticality data for roadway assets only. With this initial definition of criticality, roadway assets are covered by the largest number of data sources as expected. Bridges come next in order as they are covered by two data sources. On the contrary, none of the data sources have criticality data for seaports, small culverts, airports, railroads, transit facilities, and ITS/ ancillary assets. It is also important to highlight that vulnerability to FEMA 1% and 0.2% annual flood risk is available for roadways, airports, railroads, ferry facilities, and transit facilities, which fit into the hazards data that will be investigated in later tasks.

Regarding low water crossings, TWDB includes point data for low water crossings. The point data can be joined to roadway data from the TxDOT Open Data Portal to determine the criticality of the low water crossing.

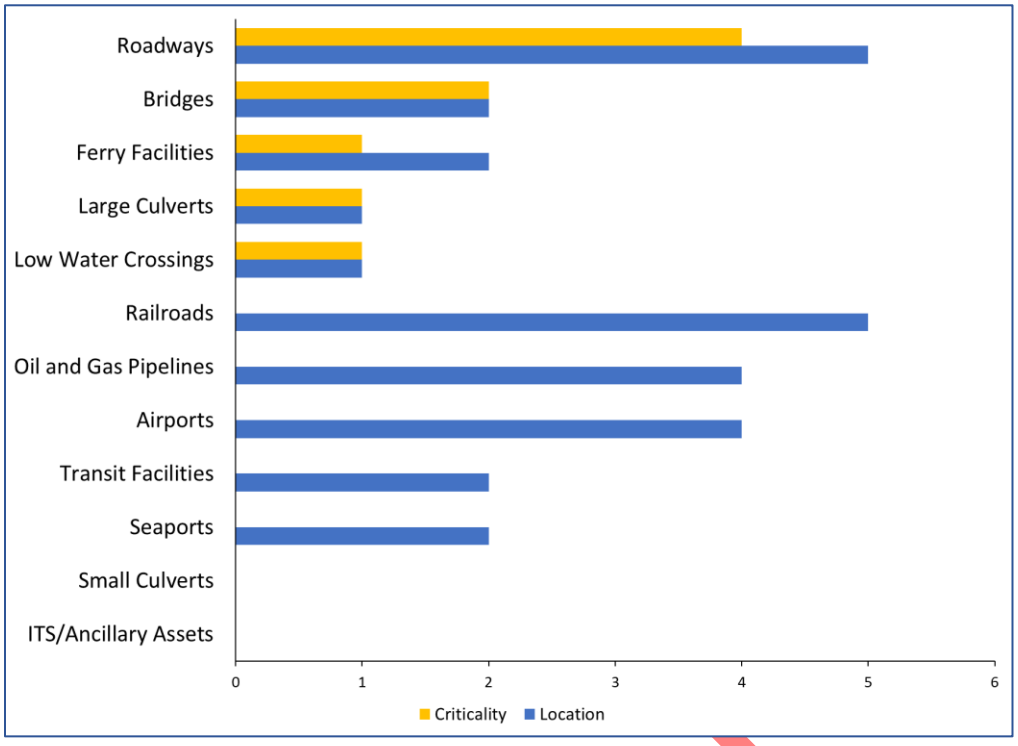
Table 7: Asset Data Assessment Reference Summary Table

Assets	HIFLD	TxDOT Open Data Portal	TxDOT Planning Map	Texas Railroad Commission	GeoRED	Hurricane Planning Atlas	TWDB
Roadways	📍	📍 !	📍 !		📍 !	📍 !	
Railroads	📍	📍	📍		📍	📍	
Airports	📍	📍			📍	📍	
Bridges		📍 !	📍 !				
Seaports		📍	📍				
Oil and Gas Pipelines	📍	📍		📍	📍		
Transit Facilities	📍				📍		
Large Culverts		📍 !					
Small Culverts							
Low Water Crossings		!					📍
Ferry Facilities	📍 !				📍		
ITS/Ancillary Assets							

📍 Asset Locations Available

! Some Criticality Information Available

Figure 9: Location and Criticality Data Availability by Asset Types



Hazard Summary

Table 6 summarizes the hazard data through Technical Memo 2. Notably, each hazard type has at least one data source. Some data hubs reference data from the same resources, for example flood data from FEMA. In a later stage of this project, the asset inventory will be assessed for susceptibility to hazards.

Table 8: Hazard Type Literature Review Reference Summary Table

	RAPT	HIFLD	TWDB	GeoRED	Hurricane Planning Atlas	TxGIO	Climate Toolbox	TCRMP/ GRIIDC	Web Soil Survey	NID
Flooding	✓	✓	✓	✓	✓	✓		✓		
Wildfire	✓	✓					✓			
Heat Wave	✓						✓			
Sea Level Rise	✓			✓				✓		
Coastal Erosion									✓	
Drought	✓						✓			
Land Subsidence /Landslides									✓	
Strong Wind	✓						✓			
Expansive Soils									✓	
Lightning			✓							
Dam and Levee Failure			✓							✓

Implementation Recommendations

Asset Recommendations

Based on the literature review and data assessment, the project team developed recommendations for which assets should continue to be considered in subsequent steps of the Phase 1 Corpus Christi MPO regional resiliency improvement plan. Recommendations are based on whether each asset type i) is included in existing resiliency plans; ii) has location data readily available; and iii) has at least some criticality data readily available (Table 7). Future research and analysis will identify what criteria or data should be used to assess assets' criticality. The list of assets may be narrowed further if data limitations are identified.

The project team recommends focusing on the following assets for the subsequent stages of this Phase 1 analysis:

Roadways are referenced by each of the eight resources which included assets in the literature review and have numerous data sources for both location and potential criticality criteria, which indicates that they are an important and relevant asset and data is likely to be available to execute the initial prioritization. Moreover, roadways connect to most other transportation assets and serve multiple

modes of travel including passenger and freight vehicles, emergency response vehicles, pedestrians, transit, and bicyclists.

Bridges are explicitly referenced in five of eight resources considered in the literature review; in addition, some sources included bridges as part of their definition of "roadway". Bridge location and criticality data are available through multiple TxDOT sources. Similar to roadways, the region's bridges serve multiple modes of travel.

Large culverts were referenced in the literature review and location and potential criticality data related to large culverts is readily available. In some instances, from the literature review, large culverts are classified as bridges or as part of roadways.

Table 9: Recommendation Summary Table

Asset Class	Recommended	Literature Review	Location	Criticality
Roadways	✓	✓	✓	✓
Bridges	✓	✓	✓	✓
Large Culverts	✓	✓	✓	✓
Ferry Facilities	✓	✓	✓	✓
Low Water Crossings	✓	✓	✓	✓
Railways		✓	✓	
Airports		✓	✓	
Seaports		✓	✓	
Oil & Gas Pipelines		✓	✓	
Transit Facilities		✓	✓	
Small Culverts		✓		
ITS/Ancillary Assets		✓		

Ferry Facilities are relatively unique; while slightly outside of the Corpus Christi MPO boundaries, the Port Aransas ferry is one of only two ferry systems in Texas and provides connection to locations within the MPO boundaries. Ferry facilities were mentioned in the literature review and there are both location and criticality data available, so if desired, ferry facilities could be included in future analysis stages.

Low Water Crossings are not mentioned often, only two times in the literature review. Yet, there is location data available, and since they are sections of roadway, the criticality roadway can be employed to determine the criticality of the low water crossing.

Hazard Recommendations

Considering the hazards mentioned in the literature review and with data available per the data assessment, each hazard could be eligible for analysis. Indeed, employing reference and data availability criteria for inclusion would not remove any hazards from the analysis. Therefore, the High Street team recommends that all hazards be considered going into the next phase of the project. Subsequently, the project team will identify the most relevant hazards based on the number of impact assets and the potential impact severity on the transportation assets identified in TM1 and above.

Appendix I: Asset Type Crosswalk

The literature review and data assessment produced a list of 29 distinct asset names, many of which were analogous or overlapping. For the purposes of this memorandum, High Street Team distilled the 29 asset names into a set of 11 as shown in **Error! Reference source not found.**.

Table A1: Asset Types and Assets Mentioned in Resources Crosswalk

Asset Types	Assets Mentioned in Resources
Airports	Airports Aviation
Bridges	Bridges Bridges and Culverts
Culverts, Large & Small	Bridges and Culverts Culverts
Ferry Facilities	Ferries Ferry Facilities
ITS/Ancillary	Intelligent Transportation Networks
Low Water Crossings	Low Water Crossings
Oil & Gas Pipelines	Oil and Gas Pipelines Pipelines
Railways	Rail Rail Transportation Railroad Lines Railroads Railway Facilities Railways
Roadways	Roads Roadways Evacuation Routes Streets
Seaport	Maritime Maritime Ports Ports Waterways Seaports
Transit Facilities	Transit Facilities Public Transportation

Appendix II: Additional Resources

The following resources and data sources did not discuss specific assets but may provide valuable hazard and criticality criteria that will be important for later analyses, technical memos, and reports.

FEMA Resilience Analysis and Planning Tool (RAPT)

RAPT is a free, publicly available geographic information systems (GIS) tool developed by Federal Emergency Management Agency (FEMA) to help emergency managers and community partners of all GIS skill levels visualize and assess potential challenges to community resilience. RAPT has over 100 data layers covering buildings and hazards. RAPT is designed to help decision-makers understand the population and infrastructure at risk for forecasted extreme weather, identify at-risk infrastructure assets, prioritize areas for evacuation, with estimates of nursing home and hospital beds.

Establish TxDOT Transportation Resilience Planning Scorecard and Best Practices: Technical Report

This report was developed by the Texas A&M Institute and sponsored by FHWA and TxDOT. It contains an analysis on policies TxDOT can implement to improve resilience and mitigate the impact of natural hazards. The report performs literature review then implements analytical methods on the Texas road network's vulnerability and resilience. Moreover, it aims to provide a scorecard of best practices that Texas can use to evaluate and improve transportation resiliency. The report outlines an in-depth methodology for determining criticality for roadways.

NCHRP Research Report 1014: Developing a Highway Framework to Conduct an All-Hazards Risk and Resilience Analysis

This report, completed in 2023, was conducted by the Transportation Research Board as part of the National Cooperative Highway Research Program (NCHRP). This report presents a framework for performing quantitative risk and resilience evaluations that satisfy recent federal requirements. It includes economic analyses, project prioritization, performance management, and risk and resilience evaluation. Specifically, the study focuses on protecting and reinforcing the highway system.

Vulnerability Assessment Scoring Tool (VAST)

VAST is a tool created by the USDOT to aid transportation organizations such as DOTs and MPOs in evaluating the vulnerability of their assets. VAST uses asset characteristics as indicators of exposure, sensitivity, and adaptive capacity which are used to calculate assets vulnerability scores. VAST covers various asset types like rail, seaports, airports, pipelines, bridges, and roads, along with climate stressors such as temperature changes, floods, sea level rise, storms, wind, drought, wildfires, freeze/thaw and permafrost thaw. VAST, operating in Microsoft Excel, helps users document asset vulnerability by determining the scope of the vulnerability assessment, selecting appropriate indicators, collecting data about those indicators, and devising an approach to convert raw data about indicators into scores. This process facilitates ranking assets by vulnerability and improving transportation planning and adaptation strategies.

CORPUS CHRISTI MPO

METROPOLITAN PLANNING ORGANIZATION

HIGH STREET

602 N. Staples St., Suite 300
Corpus Christi, TX 78401

Telephone: 361.884.0687
Email: ccmpo@cctxmpo.us
www.corpuschristi-mpo.org

October 12, 2023

Work Authorization 2023.6

Community Impact Model Development and Implementation

Notice to Proceed: October 13, 2023

Description of Services: This task order will add community impact criteria to the project scoring tool and ensuring the project collection tool captures sufficient information to determine societal impacts. This task order will also ensure the development of enhanced methods specially for assessing the societal impacts of planned TIP projects, with a focus on Environmental Justice and Equity requirements.

Deliverables: Consultant will provide professional services and deliver:

- Project initiation and coordination teleconference
- Monthly progress reports and invoices specific to this Work Authorization
- Assessment of available on-line equity tools to aid identification of disadvantaged communities
- Report identifying quality-of-life impacts using a variety of tools and indices
- Technical Memo documenting the benefit and disbenefit metrics to measure impacts
- a project scoring dashboard that reflects project scores across all of the community impact criteria
- Spatial data set conflated with Corpus Christi's Inventory for identified communities and impact types
- Presentation materials for the Corpus Christi MPO TPC and TAC

The attached Work Authorization 2023.6 ends on September 30, 2024 unless extended in writing. The work shall not exceed $94,300 unless preapproved in writing.

Respectfully,

Robert MacDonald, MPA, P.E.
Transportation Planning Director

Community Impact Model Development
and Implementation
Work Authorization 2023.06

General Planning Consultant Task Order Proposal

Overview

Transportation impacts pervade our everyday lives. Having access to safe, congestion-free travel options empowers our shared economy and can have an often overlooked yet profound effect on the quality of life of residents in our communities. To capture the comprehensive effects of transportation investments and ensure an equitable distribution of benefits and any unintentional burdens requires an assortment of analytical tools and techniques. There are a number of industry tools available, each with its own unique set of corresponding input requirements, though some impacts are less frequently evaluated than others. This scope is intended to explore community impact tools available and come up with a unifying framework for integrating such pieces into the overall project evaluation framework at the Census Tract and Block Group levels.

Consistent with Corpus Christi Metropolitan Planning Organization's (Corpus Christi MPO) values for increased transparency and improved stewardship, Corpus Christi MPO is developing project prioritization processes using a repeatable, data-informed performance framework. A separate task order focuses on implementing:

- a project collection tool that stores standardized information about candidate projects for TxDOT UTP Funding Categories 2, 4, 7, 9, and 10CR.
- a project scoring tool that prioritizes candidate projects based on a composite rating across criteria in alignment with Corpus Christi MPO's goals.

This task order will tie into the aforementioned task order adding community impact criteria to the project scoring tool and ensuring the project collection tool captures sufficient information to determine societal impacts. This task order will also ensure the development of enhanced methods specially for assessing the societal impacts of planned TIP projects.

Corpus Christi MPO responsibilities for this task order include:

- Review and respond in a timely manner
- Provide outputs for up to 3 travel demand model runs
- Provide data and information related to other plans that the Corpus Christi MPO is seeking consistency with

Task 1) Project Management

A Technical Advisory Committee comprised of Corpus Christi MPO members will meet once per month with the High Street team throughout the project agreement, with more frequent communications determined as merited. The Consultant/MPO Team will be relied upon to validate technical assumptions and guide inter-organizational and member agency coordination.

Deliverables:

- Monthly meeting agendas and notes

Task 2) Community Impact Data Assessment

A plethora of agencies have sought to define at-risk populations and quantify quality-of-life impacts using a variety of tools and indices. This task is designed to synthesize those efforts

and assess their viability to enhance Corpus Christi MPO's project prioritization process. To do so the High Street team will review the following sources for metrics, methods, and visualizations pertaining to:

- GeoRED Hazard Impact Planning Tool
- NEPAssist
- Justice 40 Initiative Covered Programs List
- US DOT's Equitable Transportation Community Explorer (ETCE)
- Executive Office of the President: Council on Environmental Quality's Climate and Economic Justice Screening Tool
- EPA's Environmental Justice Screening and Mapping Tool (EJScreen)
- FHWA's Screening Tool for Equity Analysis of Projects (STEAP)
- Volpe Center Transportation for Social Equity (TransportSE)
- TxDOT's Community Impacts Data Tool
- USDOT's Area of Persistent Poverty (AoPP) & Historically Disadvantaged Communities (HDC)
- FEMA's National Risk Index (NRI)
- US Climate Resilience Toolkit Climate Mapping for Resilience and Adaptation (CMRA) Assessment Tool
- US Census Community Resilience Estimates for Equity and Disasters
- BTS Transportation Noise Model (TNM)
- CNT H+T Affordability Index
- CDC Agency for Toxic Substances and Disease Registry (ATSDR) Environmental Justice Index (EJI) Explorer and Social Vulnerability Index (SVI)
- FEMA's Resilience Analysis and Planning Tool (RAPT)
- FTA's Title VI Guidance
- CarbonBrief 'Shared Socioeconomic Pathways'
- Sopact Social Impact Assessment
- Planetizen Equity Plus: Toward More Integrated Solutions
- TransitCenter Equity Dashboard
- FHWA Alternative Fuel Corridors (Liquefied Natural Gas)
- American Enterprise Institute (AEI) Housing Center's The Housing and Economic Analysis Toolkit (HEAT)
- FHWA's Environmental Justice Analysis in Transportation Planning and Programming: State of the Practice
- Texas Broadband Development Map

Particular attention will be paid to capturing both benefits and disbenefits, as well as any inherent tradeoffs discovered between metrics (e.g., reduced congestion can result in higher emissions). Findings for each source will be documented in a presentation, along with holistic recommendations for how to incorporate the most pertinent findings into Corpus Christi MPO's project evaluations.

Deliverables:

- Draft: Recommendations from tool review
- Final: Recommendations from tool review

Task 3) Identify & Evaluate Community Impact Prioritization Criteria

Building from the synthesis review, the High Street team will work with Corpus Christi MPO to identify scoring criteria that can be pulled from the reviewed tools. A test set of projects will then be analyzed using the corresponding methods. Resulting scores will be validated for

reasonableness based on Corpus Christi MPO staff expertise. As merited, revisions will be adapted for the Corpus Christi MPO region to more adequately reflect more likely community impacts.

Deliverables:

- Draft: Community impact rating methodologies presentation
- Final: Community impact rating methodologies presentation
- Community impact ratings for a test project set

Task 4) Update Project Scoring and Collection Tools to Incorporate Societal Impact Criteria

High Street will develop a project scoring dashboard that reflects project scores across all of the community impact criteria. A complete project scoring tool reflective of all of the MPO's performance improvement areas (ie, safety, mobility, asset condition, etc) is being developed under a separate task order, and this dashboard will be integrated into the future project scoring tool at a later time. API calls will be used when possible. In addition, High Street will protoype a project collection form that allows projects to be collected from project sponsors and scored on community impact criteria.

Deliverables:

- Draft: Updated Project Scoring and Collection Tools
- Final: Updated Project Scoring and Collection Tools

Budget

Task	Budget
Task 1 Project Management	$8,828
Task 2 Community Impact Data Assessment	$27,713
Task 3 Criteria Development and Testing	$29,483
Task 4 Update Project Scoring and Collection Tools to Incorporate Community Impact Criteria	$28,276
Total	**$94,300**

Project Timeline