U.S. Department
of Transportation
**Federal Highway
Administration**

MIRE and MIRE FDE

Technical Assistance: Final Report

FOREWORD

The Federal Highway Administration (FHWA) developed the Model Inventory of Roadway Elements Fundamental Data Elements (MIRE FDE) Technical Assistance Program to provide technical assistance, support, and resources to FHWA, State Departments of Transportation (DOTs), Tribal, and local agencies for improving their MIRE and MIRE FDE collection and maintenance. The program has also served as a platform for developing a MIRE FDE alignment database. This database combines data from an updated MIRE FDE mapping (as part of this project) and Highway Safety Improvement Program (HSIP) State self-report information and integrates that data for display using a data visualization dashboard. The final component of this project included hosting two, virtual peer exchanges focused on sharing ideas for collecting, managing, and using the MIRE FDE. This report summarizes each of these tasks and makes general conclusions based on their outcomes.

Notice

This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The U.S. Government assumes no liability for the use of the information contained in this document.

The U.S. Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear in this report only because they are considered essential to the objective of the document.

Quality Assurance Statement

The Federal Highway Administration (FHWA) provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

Non-Binding Content

The contents of this document do not have the force and effect of law and are not meant to bind the public in any way. This document is intended only to provide information regarding existing requirements under the law or agency policies.

TECHNICAL DOCUMENTATION PAGE

1. Report No. FHWA-SA-22-026	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle MIRE and MIRE FDE Technical Assistance: Final Report		5. Report Date April 2022	
		6. Performing Organization Code	
7.Author(s) Scott Himes, Robert Scopatz, Yuying Zhou, Joshua DeFisher, Kathleen Haney, Chelsea Palmateer, Kara Peach, and Deep Shah		8. Performing Organization Report No.	
9. Performing Organization Name and Address ICF Incorporated, L.L.C. 9300 Lee Highway Fairfax, VA 22031 VHB 940 Main Campus Drive, Suite 500 Raleigh, NC 27606		10. Work Unit No. 11. Contract or Grant No. DTFH6116D00052L	
12. Sponsoring Agency Name and Address Federal Highway Administration Office of Safety 1200 New Jersey Ave., SE Washington, DC 20590		13. Type of Report and Period Final Report, September 2020 – April 2022	
		14. Sponsoring Agency Code FHWA	
15. Supplementary Notes The contract manager for this report was Robert Pollack, FHWA. Sarah Weissman Pascual provided support for technical content. The contract was led by ICF and this task order was led by VHB.			
16. Abstract The FHWA developed the Model Inventory of Roadway Elements Fundamental Data Elements (MIRE FDE) Technical Assistance Program to provide technical assistance, support, and resources to FHWA, State Departments of Transportation (DOTs), Tribal, and local agencies for improving their MIRE and MIRE FDE collection and maintenance. Additionally, the program served as a platform for developing a MIRE FDE alignment database. This database combines data from an updated MIRE FDE mapping (as part of this project) and Highway Safety Improvement Program (HSIP) State self-report information and integrates that data for display using a data visualization dashboard. The final component of this project included hosting two virtual peer exchanges focused on sharing ideas for collecting, managing, and using the MIRE FDE. This report documents each of these tasks and provides general conclusions based on their outcomes.			
17. Key Words: MIRE, FDE, safety data, technical assistance, peer exchange	18. Distribution Statement No restrictions.		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 34	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed pages authorized

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

TABLE OF CONTENTS

List of Tables

List of Figures

ACRONYMS

AADT	Annual average daily traffic
AEGIST	Applications of Enterprise GIS in Transportation
DOT	Department of Transportation
FAST	Fixing America's Surface Transportation
FDE	fundamental data element
FHWA	Federal Highway Administration
GIS	Geographic Information System
HPMS	Highway Performance Monitoring System
HSIP	Highway Safety Improvement Program
LRS	Linear Referencing System
MAP-21	Moving Ahead for Progress in the 21st Century
MIRE	Model Inventory of Roadway Elements
NG911	Next-Generation 911
NHTSA	National Highway Traffic Safety Administration's
RHUG	Esri Roads & Highways User Group
SHSP	Strategic Highway Safety Plan
TRIPRS	Traffic Records Improvement Program Reporting System
QA/QC	Quality Assurance/Quality Control

EXECUTIVE SUMMARY

The Federal Highway Administration (FHWA) developed the Model Inventory of Roadway Elements Fundamental Data Elements (MIRE FDE) Technical Assistance Program to provide technical assistance, support, and resources to FHWA, State Departments of Transportation (DOTs), Tribal, and local agencies for improving their MIRE and MIRE FDE collection and maintenance. To date, this program focused on providing support to FHWA for outreach to State agencies to update mapping efforts on State capabilities for capturing MIRE FDEs. The original MIRE FDE mapping effort was completed in 2020 and focused on reviewing documentation obtained from previous efforts (i.e., FHWA Roadway Safety Data Capability Assessment and NHTSA Traffic Records Assessment) and any other documentation within the Traffic Records Improvement Program Reporting System (TRIPRS) Document Library. The updated mapping effort included identifying the most recent documentation for MIRE FDE mapping, the changes to the mapping results reflect updated documentation. The results of the updated mappings indicate a shift toward higher overall mapping scores. The number of agencies with an overall mapping score greater than 85 percent increased from 6 to 13. The number of agencies with an overall mapping score between 70 and 85 percent increased from 12 to 28. As part of the technical assistance program, the project team developed an integrated database of revised mapping results and Highway Safety Improvement Program (HSIP) State self-reports. The project team developed a dashboard visualization for the integrated dataset. This dashboard allows FHWA to work with States to indicate areas of improvement for MIRE FDE alignment, as well as discrepancies between the two databases.

As part of this project, FHWA also conducted two virtual peer exchanges with States, the District of Columbia, and Puerto Rico to identify and discuss common challenges to MIRE FDE collection, management, and use, as well as how agencies have overcome those challenges. The peer exchanges included FHWA presentations on available data sources from Federal and Tribal agencies and breakout sessions to discuss collection and integration of local road data and a general session on agency challenges. Key takeaways from the peer exchanges include States' interest in unified linear referencing for State and local roadways, a need for examples of successful completion of MIRE FDE collection efforts, recommended data refresh cycles, funding sources, and opportunities to optimize Federal data requests.

CHAPTER 1—INTRODUCTION

The Moving Ahead for Progress in the 21st Century (MAP-21) Transportation Reauthorization Act and its successor reauthorization, Fixing America's Surface Transportation (FAST) Act, underscore the need for data-driven safety decision making for States' Highway Safety Improvement Programs (HSIPs) and Strategic Highway Safety Plans (SHSP). High-quality, integrated data is the foundation of data-driven safety programs. The authorizing legislation also recognized the need for States to have safety data systems that support the data-driven safety approaches applied to all public roads.

The Federal Highway Administration (FHWA) developed the Model Inventory of Roadway Elements (MIRE), consisting of 205 recommended roadway and traffic inventory elements that support using advanced analytic methods and tools for safety determination. MAP-21 and the FAST Act require States to collect a subset of Fundamental Data Elements (MIRE FDE) [23 U.S.C. 148(f)(2)]. The MIRE FDEs are required for all public roadways (regardless of ownership) and are categorized by roadway functional classification and surface type. States were required to develop a data collection plan with specific quantifiable and measurable efforts for the collection of MIRE FDEs into their State Traffic Records Strategic Plan update by July 1, 2017. Further, States are required to have access to the FDEs on all public roads by September 30, 2026.

The FHWA Office of Safety provides support for collecting, managing, and integrating datasets through the Roadway Safety Data Program and provides support for HSIP analytical methods. While State and local agencies are making significant improvements to their data and analysis capabilities, there is a need for additional support. Many States report that they are struggling to meet the MIRE FDE requirements. One of the largest challenges is local road data, particularly with collecting and integrating local road data with State databases.

1.1 MIRE FDE TECHNICAL ASSISTANCE OVERVIEW

The FHWA developed the MIRE FDE Technical Assistance Program to provide technical assistance, support, and resources to FHWA, State Departments of Transportation (DOTs), Tribal and local agencies for improving their MIRE and MIRE FDE collection and maintenance. Additionally, the program served as a platform for developing a MIRE FDE alignment database. This database combines data from an updated MIRE FDE mapping (as part of this project) and HSIP State self-report information and integrates that data for display using a data visualization dashboard. The final component of this project included hosting two virtual peer exchanges focused on sharing ideas for collecting, managing, and using the MIRE FDE.

1.2 PURPOSE AND ORGANIZATION OF REPORT

The purpose of this report is to document the MIRE mapping effort completed under the technical assistance task of this research, document the development of the alignment database visualization, and report on the results of two virtual MIRE FDE peer exchanges. This report documents the lessons learned to inform future improvements and issues regarding MIRE FDE collection, management, and use. To facilitate this, this report is organized into the following chapters:

1. **Introduction.** This chapter provides an overview of the MIRE FDE technical assistance program and introduces the purpose of this report.
2. **MIRE FDE Technical Assistance and Outreach.** This chapter provides an overview of the technical assistance effort provided for FHWA by reaching out to all 50 States plus the District of Columbia and Puerto Rico to confirm State roadway data documentation and MIRE FDE mapping results.
3. **MIRE FDE Alignment Database and Visualization.** This chapter introduces the development of an integrated database for MIRE FDE mapping results and State self-report data included in annual HSIP submission. This chapter further includes an overview of the project team's development of a data visualization tool for the integrated dataset.
4. **MIRE FDE Virtual Peer Exchanges.** This chapter provides an overview of two MIRE FDE peer exchanges hosted by FHWA, including development of registration questions on MIRE FDE challenges, development of peer exchange agenda, and peer exchange lessons learned. The combined summary report provides the results of the peer exchange and lessons learned.
5. **Conclusions.** This chapter provides a brief overview of the lessons learned for improving future MIRE FDE collection, management, and usage.

CHAPTER 2—MIRE FDE TECHNICAL ASSISTANCE AND OUTREACH

The original objective of this task was to provide a MIRE and MIRE FDE technical assistance program to State DOTs and local agencies regarding MIRE and MIRE FDE questions or challenges concerning data collection, processing, maintenance, integration, and governance. However, the focus of the technical assistance effort needed was directed toward supporting the FHWA Office of Safety with conducting outreach with individual States (including the District of Columbia and Puerto Rico) to review, revise and complete a current status (i.e., baseline) for the MIRE FDE mapping effort using the National Highway Traffic Safety Administration's (NHTSA's) Traffic Records Improvement Program Reporting System (TRIPRS). The following sections characterize the project team's effort, MIRE FDE mapping results, and project team observations.

2.1 TASK OVERVIEW

The objective of this task was to support the FHWA Office of Safety with technical assistance and outreach to States to support their collection of the MIRE FDE by September 30, 2026. The project team provided technical assistance to FHWA through participation in verifying State roadway data documentation, updating MIRE FDE mappings, and attending MIRE FDE virtual meetings. The FHWA benefited from the technical assistance and outreach by increasing their knowledge of States' progress toward the MIRE FDE goal. Individual States gained an understanding of what the FHWA was trying to accomplish through the MIRE FDE mapping effort and how it related to and differed from the States' annual self-report during HSIP report submission. The technical assistance and outreach effort established a baseline measurement of each State's alignment of their roadway database to the MIRE FDE. FHWA will be able to use the results of the project to provide targeted training or other technical assistance to help States meet the MIRE FDE requirement. From this, FHWA can ascertain data elements States are struggling with capturing and look for commonalities for future technical assistance and other outreach efforts.

Prior to the outreach effort conducted as part of this technical assistance effort, the project team completed an initial mapping of MIRE FDEs purely based on State roadway documentation. The project team used documentation obtained from previous efforts (i.e., FHWA Roadway Safety Data Capability Assessment and NHTSA Traffic Records Assessment) and any other documentation within the TRIPRS Document Library. For States whose documentation was not made available to the project team, FHWA provided documentation to the project team after reaching out to State representatives and FHWA division offices. Due to the short turnaround time, not every agency provided documentation prior to completion of the mapping effort and therefore, the project team used the documentation from previous

efforts. Analysts reviewed the States' documentation and used Boolean logic to determine if the State data aligned with the MIRE FDEs—in meaning, manner of collection and number of instances. The project team assessed alignment between the State dataset and the MIRE FDE at the attribute level. Element mapping scores are a percentage of the attributes mapped. Figure 1 includes a graphical representation of the overall MIRE FDE mapping scores based on the original assessment. This project's subsequent effort updated the numbers based on feedback from States (and the District of Columbia and Puerto Rico). The revised results are presented in Section 2.3.

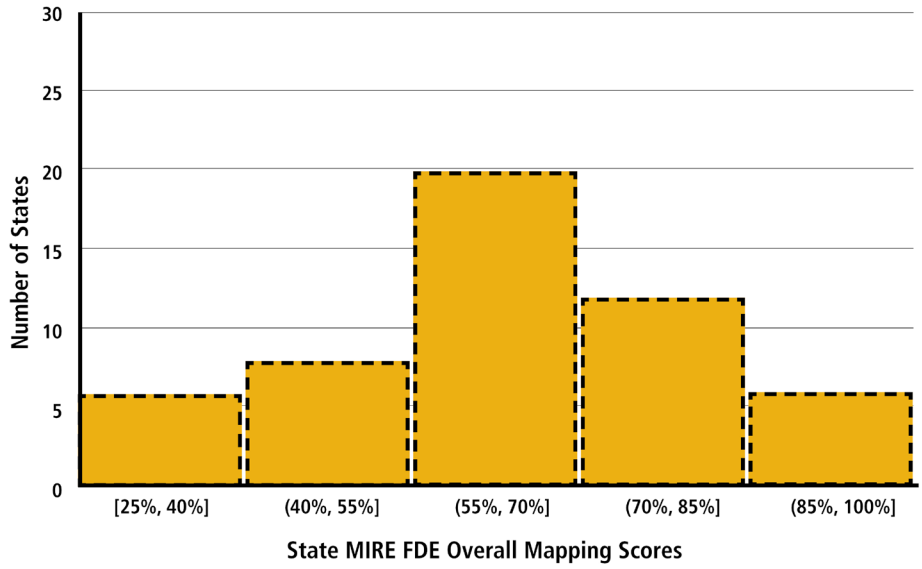

Figure 1. Chart. MIRE FDE mapping scores for all MIRE FDE based on original mapping effort.

Source: FHWA

2.2 PROCESS

The project team established a Microsoft Teams site supporting collaboration and access to documentation for project team members and the FHWA Office of Safety. The Teams site included a mapping tracking spreadsheet, a final summary of mappings, and a final report's folder that included the final MIRE FDE mapping report as well as documentation for each State.

The project team created a logistical mapping tracking spreadsheet to monitor the status of the technical assistance process for each State. The mapping tracking spreadsheet included the following data elements:

- State (includes all 50 States plus the District of Columbia and Puerto Rico).
- Date Division Office was emailed [date].
- Date of outreach meeting [date].
- Documentation confirmed? [Yes, Updates Needed].

- Documentation updates [N/A, Requested, Received, Uploaded to TRIPRS].
- Report Out Led by [name].
- Quality Assurance/Quality Control (QA/QC) by [name].
- QA/QC Date [date].
- Mapping Closed [Yes, No, In Process].
- Final Report Provided to FHWA [Yes, No].
- State summary completed [Yes, No].
- Notes (weekly notes for each State).

FHWA and the project team established a process to update and finalize the MIRE FDE mapping for each State. The process included the following steps:

1. Verify that the State documents used in the MIRE FDE mapping are the most recent before the webinar call and if not, coordinate with the State to obtain the proper documentation.
2. Attend the MIRE FDE mapping virtual meeting with FHWA and the State. FHWA will notify the project team of the date and time for the webinar call. Before each meeting, the project team prepared specific questions that must be answered to finalize the mapping. The project team presented these questions to which the State provided clarification during the call.
3. Upload the State roadway documentation in the TRIPRS document library when updated versions are obtained. To discern new versions of documentation, the project team used the tag "2019 MIRE FDE Mapping" for documentation used in the original mappings and the tag "2021 MIRE FDE Mapping Update" for new versions of documentation. The project team uploaded the State documentation to the appropriate State folder in Microsoft Teams.
4. Update the State structure and mappings to reflect the latest documentation and information from the State participants received during the virtual meeting.
5. Assign QA/QC staff to review updated mappings when they are completed. The QA/QC staff resolved any questions or issues with the mapping staff to create a final MIRE FDE mapping report for each State.
6. Update the mapping tracking sheet and export the final MIRE FDE mapping report to the Microsoft Teams site.
7. Create a mapping summary document for each State detailing the documentation used and any special circumstances or challenges that the project team considered to be important.

8. Notify FHWA when a State mapping was ready to be closed out. FHWA closed out each State MIRE FDE mapping in the TRIPRS mapping module.

2.3 RESULTS

The project team started conducting report out webinars with States in December 2020 and completed all webinars in June 2021, as shown in table 1. The majority of webinars were scheduled in April and May. The project team received updated mapping documentation from 44 States, prompting updates to the State data structures and MIRE FDE mappings. Nearly 20 percent of States required a complete rebuild of the State data structure because the documentation used during the previous MIRE FDE mapping did not accurately reflect their current roadway data capabilities.

Table 1. MIRE FDE Mapping Report Out Webinar Progress.

Month and Year MIRE FDE Mapping Report Out Webinar was Conducted	Number of States
December, 2020	2
January, 2021	1
February, 2021	2
March, 2021	2
April, 2021	9
May, 2021	31
June, 2021	4

Figure 2 illustrates total mapping scores for all 50 States plus the District of Columbia and Puerto Rico for the 2020 MIRE FDE mapping effort and 2021 baseline mapping effort. For the baseline mapping effort, most of the States (39) had mapping scores greater than 70 percent, of which, 13 States had mapping scores greater than 85 percent. The most incomplete scores decreased from 6 agencies having a score below 40 percent to only 2 agencies have a score below 55 percent. This indicates that most States had a roadway dataset that more closely aligned with most of the MIRE FDE.

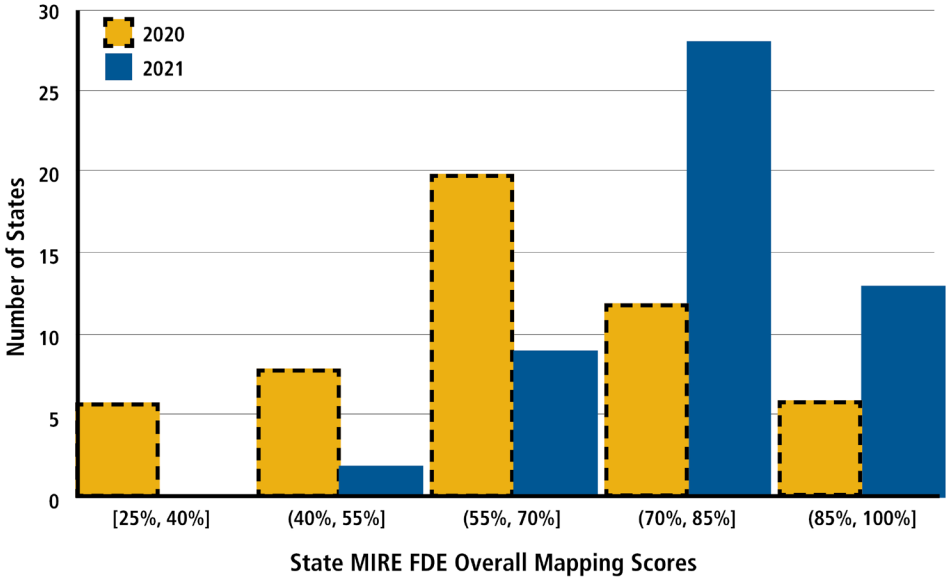

Figure 2. Chart. MIRE FDE mapping scores for all MIRE FDE for original baseline mapping efforts.

Source: FHWA

Most States' datasets aligned with the MIRE FDE roadway segment elements. Figure 3 illustrates that 47 States had mapping scores for roadway segment elements greater than 79 percent. Of those, 27 States had mapping scores greater than 88 percent.

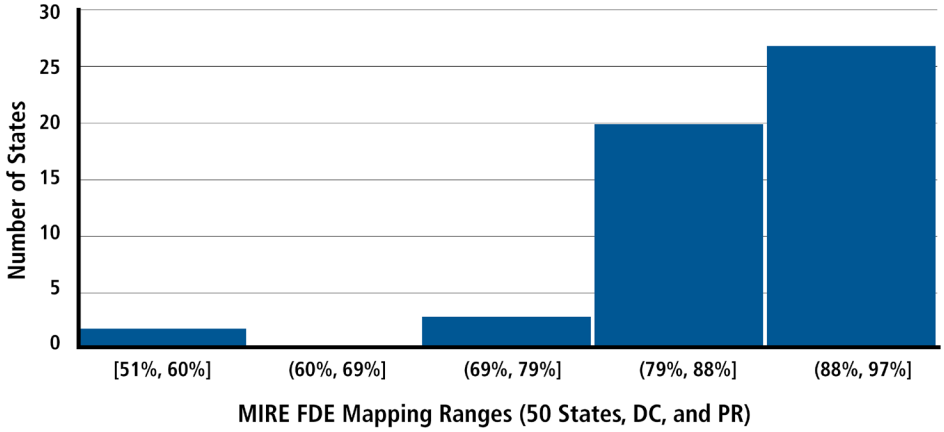

Figure 3. Chart. MIRE FDE mapping scores for roadway segment MIRE FDE.

Source: FHWA

Figure 4 illustrates that 21 States had mapping scores for at-grade intersections greater than 80 percent. There were 9 States that did not collect intersection MIRE FDE or only had a small portion of intersection-related MIRE FDE and their associated attributes (i.e., less than 20 percent).

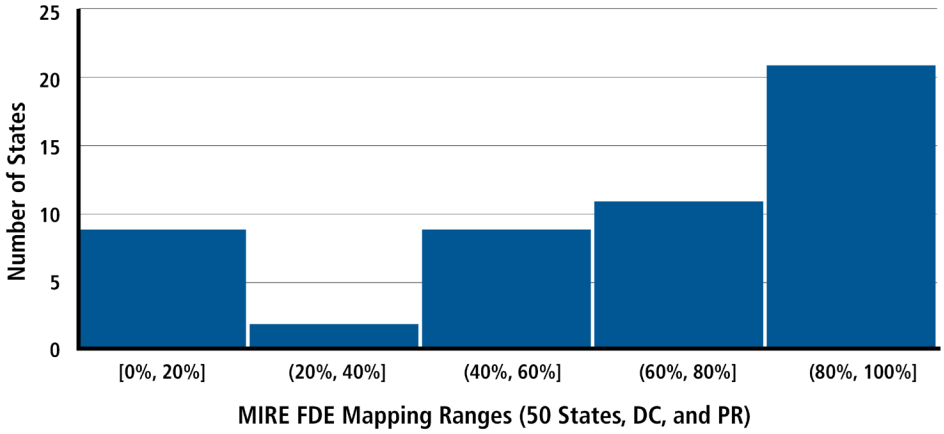

Figure 4. Chart. MIRE FDE mapping scores for at-grade intersection/junction MIRE FDE.

Source: FHWA

Figure 5 illustrates that most States (36) collected intersection leg-related MIRE FDE (greater than 80 percent). Eight States did not collect the intersection leg MIRE FDE data.

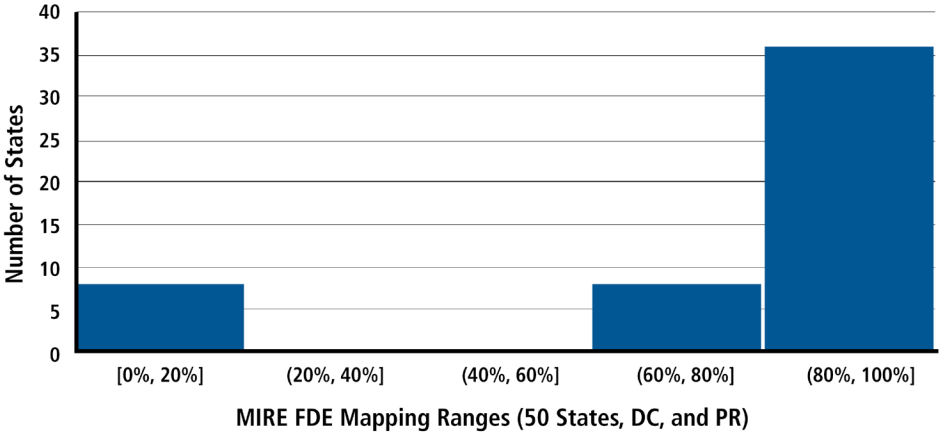

Figure 5. Chart. MIRE FDE mapping scores for intersection leg MIRE FDE.

Source: FHWA

Figure 6 illustrates that half of the States (26 States) had mapping scores ranging from 75 percent to 87 percent for interchange ramp MIRE FDE. Six States adopted nearly all (greater than 87 percent) of the MIRE FDE for interchange ramps. Three States only adopted a small portion of interchange ramp MIRE FDE (mapping score less than 49 percent).

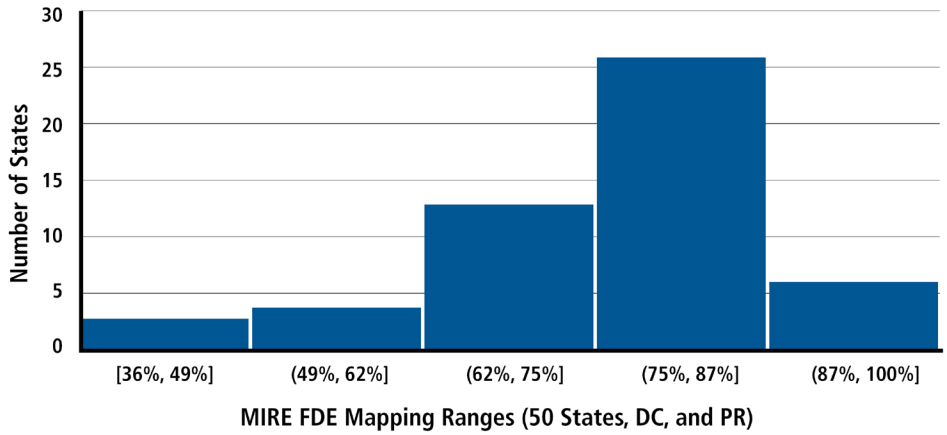

Figure 6. Chart. MIRE FDE mapping scores for interchange ramp MIRE FDE.

Source: FHWA

Since the project team conducted the MIRE FDE baseline mapping effort at the attribute level, FHWA was able to assess State-level average mapping scores for each element. The average mapping score is assessed as the number of attributes mapped divided by the total number of attributes for the given States. Table 2 provides a list of MIRE FDEs States struggle with the most, based on having the lowest average mapping scores across all 52 States. MIRE FDEs such as 116. Intersection/Junction Geometry, 121. Intersection/Junction Traffic Control, 172. Interchange Type, 185. Roadway Type at Beginning Ramp Terminal, 189. Roadway Type at Ending Ramp Terminal Control have very low mapping scores (i.e., less than 50 percent) because many States have limited resources, including staff and technologies, to collect and maintain this information. Some States do not have an intersection or interchange inventory to store these MIRE FDEs and their values.

Table 2. MIRE FDE States need extra assistance.

MIRE FDE	Average Mapping Scores (Percent)
4. Type of Governmental Ownership	59
24. Surface Type	53
55. Median Type	38
110. Unique Junction Identifier	73
112. Location Identifier for Road 1 Crossing Point	73
113. Location Identifier for Road 2 Crossing Point	81
116. Intersection/Junction Geometry	50
121. Intersection/Junction Traffic Control	34
129. Unique Approach Identifier	69
168. Unique Interchange Identifier	71
172. Interchange Type	32
185. Roadway Type at Beginning Ramp Terminal	43
189. Roadway Type at Ending Ramp Terminal Control	42

2.4 OBSERVATIONS

The project team made the following observations during the MIRE FDE mapping technical assistance task:

- Many States are transitioning to Esri Roads and Highways—a fact that was further documented in the peer exchanges and may simplify later attempts at outreach and technical assistance.
- Some States do not have a comprehensive roadway database. State roadway data elements are stored in multiple, sometimes siloed, databases. States may store some of the MIRE FDE in the roadway database, but other FDEs might be found in databases focused on assets, pavement management, or other DOT business needs.
- Many States lack a complete roadway data dictionary. A roadway data dictionary should document roadway data elements maintained in the database, the associated data element attributes and their definitions, and the source of each (i.e., is the element collected, derived, or estimated).

- Some States that do not have a roadway data dictionary but use the Highway Performance Monitoring System (HPMS) Field Manual as their roadway data dictionary. The project team noted that these States did not adopt the entire list of HPMS attributes. It was difficult for the project team to determine which elements and attribute values the State collected due to the lack of complete, State-specific documentation.
- Common struggles faced by States in meeting the MIRE FDE requirement include:
    - Local roadway data collection barriers.
    - Lack of staffing at State and local agencies.
    - Communication difficulties among traffic safety engineers, roadway data collection staff, and other business units.
    - Data collection and storage methods for intersection and interchange data elements.

2.5 FUTURE CONSIDERATIONS

States are required to self-report MIRE FDE compliance in their HSIP annual report. States self-assess their status (percent complete) of MIRE FDE collection efforts at the element level for all three roadway categories: non-local paved roads, local paved roads, and unpaved roads. The State self-assessment displays the completeness of each State's MIRE FDE data collection. The FHWA-led MIRE FDE mapping report independently assessed each State's capability to collect the MIRE FDE and their attributes. FHWA may be able to use the self-reporting and MIRE FDE mapping to assist States' understanding of their status in achieving compliance with the MIRE FDE requirement. Both sources provide FHWA and the States a picture of that status (i.e., what attribute values under each MIRE FDE are collected and their associated percentage of completeness). Any variance between the two views could signal the States and FHWA that a need exists for further review. Agreement showing low levels of attainment may signal a need for more assistance.

CHAPTER 3—MIRE FDE ALIGNMENT DATABASE AND VISUALIZATION

This chapter presents information on the processes used to create data visualizations depicting the alignment of State's roadway inventory databases to the MIRE FDE.

3.1 TASK OVERVIEW

The objective of this task was to provide FHWA with a MIRE FDE alignment database and data visualization dashboards (along with associated documentation). The project team used the following steps to develop a database and create data visualizations:

- **Database Components.** The first step included identifying the input data for integration into the visualization tool, specifying the data sources, and defining potential data update cycles.
- **Platform Identification.** The second step included identifying the appropriate platform to store and integrate datasets and the tools with which to perform data visualization.
- **Data Integration and Dashboard Development.** The final step included integrating the datasets into the dashboard software and developing the visualizations.

The following sections provide further details on each of these steps.

3.2 DATABASE COMPONENTS

FHWA identified two databases for inclusion in the alignment database and associated visualization tool. The first source is the MIRE FDE mapping database housed in NHTSA's TRIPRS database. The second source is the MIRE FDE self-report database provided by State agencies during their annual HSIP report submission.

As noted in the previous chapter, the MIRE FDE mapping database consists of a one-to-one mapping between State roadway documentation and MIRE FDE elements. This comparison provides an understanding of the MIRE FDE elements States can collect based on their known roadway inventory data. The database covers the percentage of attributes collected under each element but does not provide an indication of how complete the data collection is. This snapshot serves as an assessment of the State's capability to collect the MIRE FDE data attributes. It does not measure data quality, only if the State database is structurally able to store the data as defined in the MIRE FDE.

The MIRE FDE annual self-report provides a snapshot of the State's progress toward collecting the required data elements. As part of the annual HSIP report submission, States are asked to provide the current status (percent complete) of MIRE FDE elements collection. Although

there may be some confusion on what is to be reported (percentage of elements present in their database *or* percent of roadways for which they have data), the template provided to the States does clarify that the requested information relates to the percentage of the roadway network for which the FDE is collected. Because some States expressed confusion about this point in discussions, some caution should be exercised when comparing the self-report numbers to the MIRE FDE mapping percent completion. States are free to interpret the self-reported percent complete either way.

3.3 PLATFORM IDENTIFICATION

The project team worked with FHWA to identify the most appropriate platform to develop and warehouse the alignment database and visualization for the two data sources. The platform had to be able to work with integrated data, allow for annual updates for MIRE FDE self-report data as well as allow for periodic updates of the MIRE FDE mapping data as the findings of the mapping effort are updated. Additionally, FHWA must have easy access (and associated licensing) for the visualization tool to be able to maintain and update the information as well as to share the visualization with States on an as-needed basis.

For these reasons, the project team selected Microsoft Power BI, a visualization tool for which the data could be easily read-in and integrated into the tool itself (rather than developing a separate alignment database which could then be read by the tool).

3.4 DATA INTEGRATION AND DASHBOARD DEVELOPMENT

The objective of this task was to prepare the two data sources for integration into Power BI. The project team cleaned both data sources to allow for import and linkage in the visualization tool. FHWA can replicate this process (as described in Section 3.5) for future updates to the MIRE FDE mapping database and the MIRE FDE self-report database. The Power BI dashboard and data visualizations can be refreshed when updates are made to the source data.

The Power BI dashboard contains three reports: one with visualizations from the MIRE FDE mapping database, one with visualizations from the MIRE FDE self-report database, and one with visualizations from the integrated database. The default view for each report displays the national average alignment scores. Users can drill down to analyze alignment scores by selecting a specific State or MIRE FDE element. The comparison report enables users to see how closely a State's self-reported score aligns with the State's score from the MIRE FDE mapping database. This comparison can help identify States with a large variance between the two data sources, which may indicate an opportunity for outreach and support to meet the MIRE FDE requirements.

The project team provided the final Power BI dashboard and data visualizations separately from this report for FHWA's use in analyzing the results of the MIRE FDE baseline mapping effort and HSIP self-reporting. FHWA can update the dashboard database as noted in Section 3.5 and

use in future discussions with States as needed.

3.5 DATA CLEANING AND UPDATING THE ALIGNMENT DATABASE

To accurately import the two source data sets to Power BI, a few data cleaning steps are required. This section explains the steps to this manual process.

3.5.1 MIRE MAPPING DATABASE

This report exports out of TRIPRS as a .csv file.

1. Open in Excel, save it as a .xlsx names "MIRE FDE Alignment Database.xlsx"
2. Three columns must be added. If the export from TRIPRS doesn't change, the three columns can be copied from the Data Cleaning workbook and pasted into the update.
    a. Functional class – roadway segment, intersection, or interchange/ramp
    b. Type – this associates a type to each row: category, element, functional class, or attribute
    c. Link to Self-Report – this creates a link between to two databases to allow integration
3. Select the entire data range, copy the cells, and transpose the data on a new sheet by using the transpose special paste option in Excel
4. Rename this sheet to "MIRE Mapping"

3.5.2 STATE SELF-REPORT DATABASE

After this spreadsheet is updated, copy the sheet containing the new year of data into the MIRE FDE Alignment Database workbook. For Power BI to read in the data, some header rows must be deleted.

1. Replace Row 1 (top header) with Row 1 from the Data Cleaning spreadsheet. This combines all the text from Rows 1 and 2 in the original spreadsheet to create the headers in Power BI.
2. Replace Column A (State) with Column A in the Data Cleaning spreadsheet to change State names to abbreviations. Note: For Puerto Rico to be properly displayed on the map visualizations, the Territory's name must be spelled out.
3. Rename this sheet to "Self-Report".

3.5.3 REFRESHING THE DATA IN POWER BI

To load the new MIRE FDE Alignment Database, open the MIRE FDE Alignment Power BI file. In the Home tab, select Transform Data and a new Power Query Editor window will open. Click on Data Source Settings, and in the new window click Change Source. Navigate to the location of the updated MIRE FDE Alignment Database and click OK. Close the Data Source Settings window. Power BI will run the Applied Steps and read in the updated data. Close the Power Query Editor window and select 'Yes' when asked to apply the changes now. The data visualizations will automatically update with the new data.

CHAPTER 4—MIRE FDE PEER EXCHANGES

The FHWA set the context for the MIRE FDE Peer Exchanges as part of a larger effort promoting adoption of MIRE FDE elements. Rather than using the sessions to assess State compliance with MIRE FDE, FHWA focused the peer exchanges on sharing ideas for collecting, managing, and using the MIRE FDE elements.

The objective of this task was to plan, develop, and host peer exchanges on MIRE FDE-related issues. This was originally scoped to be an in-person peer exchange, or a short series of virtual peer exchanges. FHWA opted to have the project team facilitate this as two virtual peer-exchanges, with topics selected based on feedback received during the meetings within individual States for MIRE FDE mapping presented in Chapter 2. Figure 7 provides an overview of States participating in the virtual peer exchanges held on August 25, and September 1, 2021.

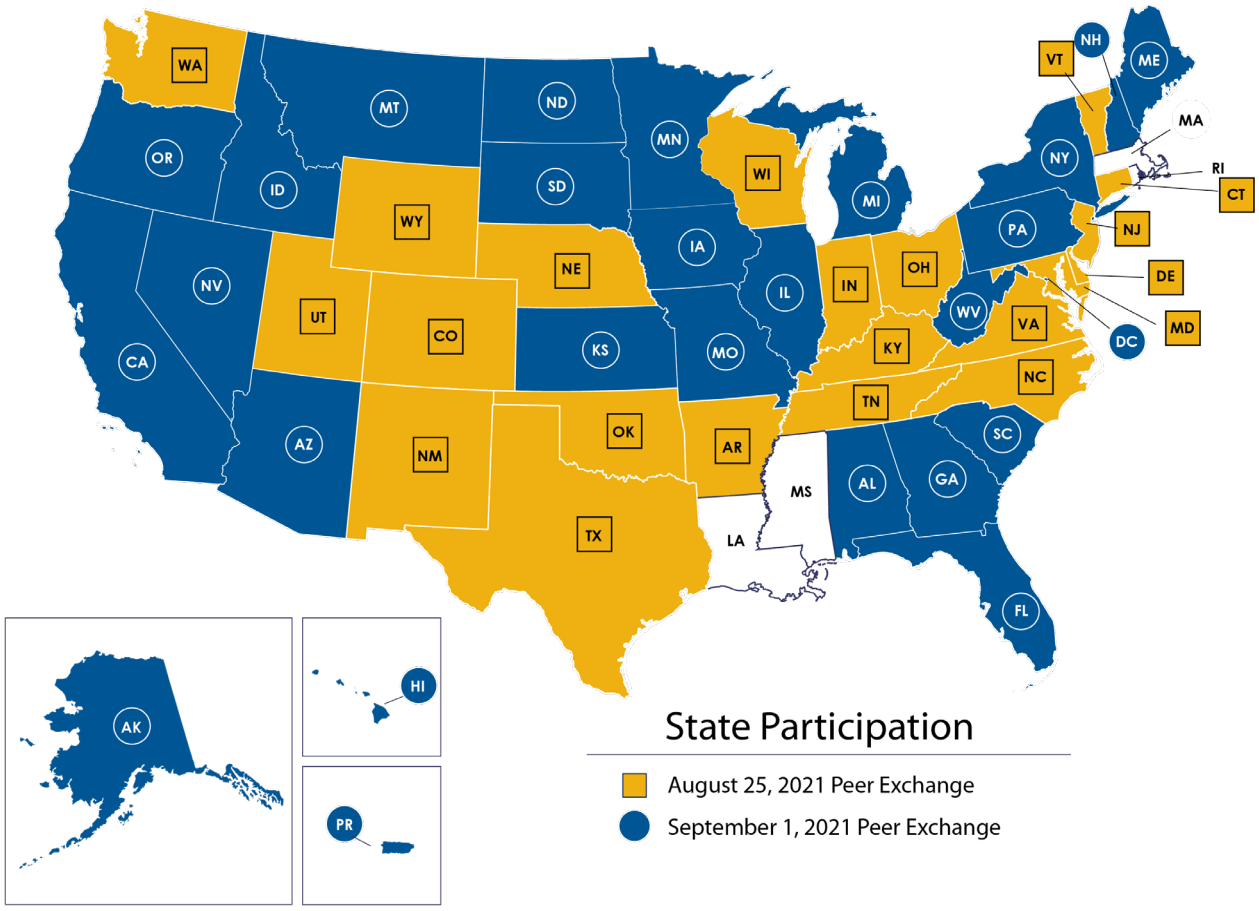

Figure 7. Graphic. Overview of State participation by virtual peer exchange date.

Source: FHWA

4.1 PRE-MEETING PREPARATION

FHWA invited agencies to participate in one of two of peer exchanges, providing an opportunity for States to discuss their MIRE FDE-related successes and challenges, ask questions, and identify next steps for their State. Participating agencies were invited to include up to three participants in addition to the State FHWA Division Safety Engineer representative. A pre-meeting invitation form asked the State representatives to answer the following questions:

1. What areas does your State feel most comfortable with regarding MIRE FDE?
2. What challenges does your State experience with collecting or reporting MIRE FDE?
3. What are your State's main areas of need related to MIRE FDE? Please rank the following in order of priority.
    a. Assessment criteria.
    b. Conflict between State attributes and MIRE FDE attributes.
    c. Data collection methods.
    d. Data governance/documentation.
    e. Data integration.
    f. Discrepancies between MIRE FDE and HPMS elements.
    g. Interpreting/understanding MIRE FDEs.
    h. Inventories (e.g., interchange, intersection).
    i. Level of effort/cost to collect elements.
    j. Local roads (e.g., obtaining local data for the MIRE FDEs, AADT).
    k. Spatial data.

Participants were asked to select their first or second choice (or unavailable) between the August 25 and September 1 dates. Twenty-one States selected August 25th as their first-choice date and twenty-one also selected September 1st as their first choice. It should be noted that not every State responded.

Registrants from most States indicated an area of most comfort regarding MIRE FDE, including the following:

- Data on State maintained roadways (11 responses).
- Data already collected by agency (10 responses).
- Roadway segments (8 responses).
- Meeting requirements by the 2026 deadline (5 responses).

- Intersections (4 responses).

Registrants also provided details on areas of challenge regarding MIRE FDE, which included the following:

- Collecting data (including AADT) on local/tribal roads (16 responses).
- Collecting intersection data (11 responses).
- Sufficient resources to collect Statewide data (7 responses).

Figure 8 provides the aggregated State agency responses for areas of need related to MIRE FDE. A value of 10 indicates the most need and a value of 0 indicates the least. The results indicated that local roads (e.g., obtaining local data for the MIRE FDEs, annual average daily traffic) and level of effort/cost to collect elements were the top two areas of need. This is consistent with the open-ended question responses on areas of challenge provided by registrants. The areas of least need included spatial data and interpreting/understanding MIRE FDEs.

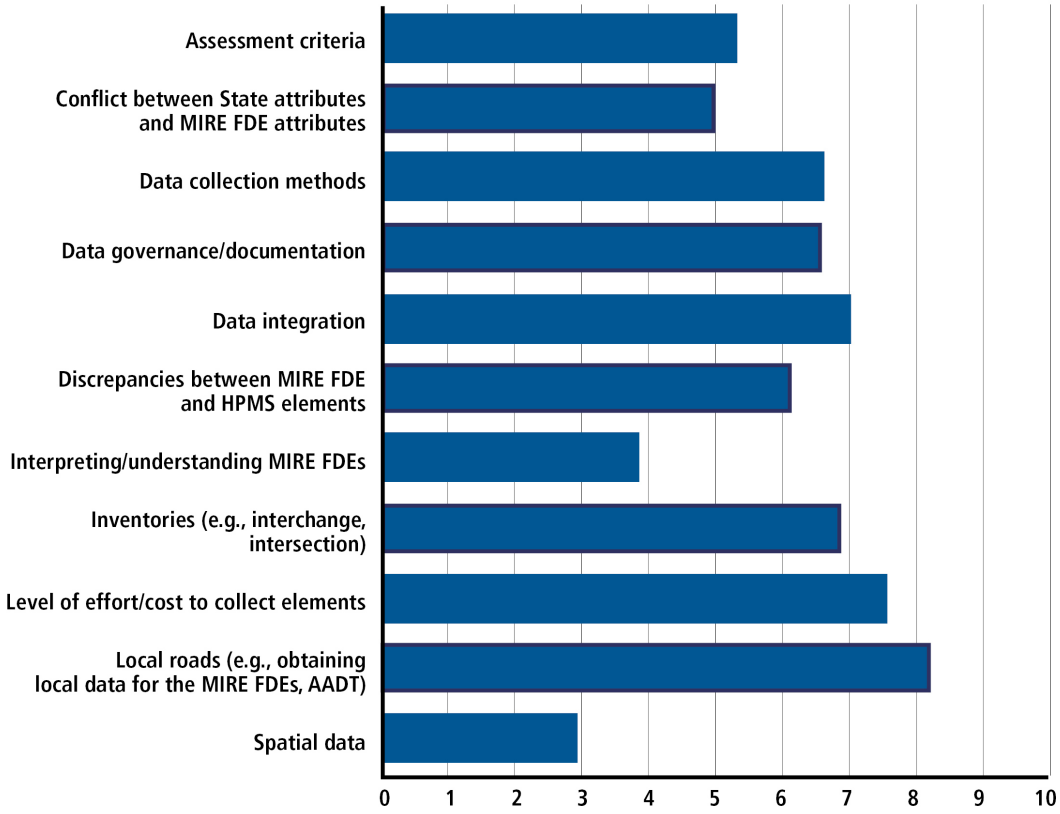

Figure 8. Graph. State responses on MIRE FDE areas of need.

Source: FHWA

4.2 CONDUCTING THE PEER EXCHANGES

FHWA and the project team used the results of these questions to design the content for the peer exchanges. The agendas for both peer exchanges included the following (the exact sequence of items varied between the two dates):

1. Introductions.
2. FHWA MIRE FDE Outreach Efforts and Overview (FHWA Presentation).
3. Federal Agency Panel (FHWA Presentation).
4. Breakout Session 1: Local Data Integration and Collaboration (all).
5. HPMS 9.0 (FHWA Presentation).
6. Breakout Session 2: Current and Future State Challenges and Successes (all).
7. Next Steps and Closing Remarks.

Upon completing registration, participants were asked to identify if their primary function as a data collector, manager, or user. The original intent was to use this information to assign participants with similar functions into breakout groups. However, since there were many more data managers than collectors or users, the meeting facilitators decided to balance the breakout groups to have roughly equal numbers in each virtual room. A fourth break-out group consisted of FHWA Division representatives. Table 3 provides an overview of the initial participant selections for primary function along with the final number of participants assigned to breakout sessions by interest area by peer exchange.

Table 3. Initial and balanced breakout group participants by peer exchange.

Interest Area	August 25		September 1	
	Initial	Balanced	Initial	Balanced
Data Collector	3	14	7	19
Manager	34	20	44	27
User	12	15	14	19
FHWA	13	13	23	23

For each breakout session, room facilitators worked from a set of discussion question prompts and suggested report-out topics. The report-outs were handled by a designated recorder selected at the beginning of the breakout session. The breakout groups were free to discuss the topics in any order and use the breakout time as they wished. As a result, not all of the question prompts were addressed and, by design, the facilitators did not force the groups to

work through the list of prompts. This allowed the States to discuss the issues that were most important to the participants. Appendix A presents the full list of question prompts.

4.3 PEER EXCHANGE RESULTS

The following summarizes the key findings of the two peer exchanges. This summary focuses on the themes arising from the peer exchanges and the actions that FHWA could take to address needs expressed by the States in relation to each of the themes. Appendix A provides more details on the content and discussion during the peer exchanges. The Appendix A report can serve as a resource for specific topics related to Federal land management, Tribal data, HPMS updates, and comparisons of strategies that States have explored as they pursue the goal of compliance with the MIRE FDE requirement. Appendix A presents detailed reports of the presentations, question and answer, discussions, and breakout sessions.

The peer exchange support team identified the following themes based on the discussions in the breakout rooms and the main meeting. The team developed the list of possible future actions based on requests for assistance or information discussed during the peer exchanges and actions that FHWA has pursued in the past that could address the needs expressed during the peer exchanges.

4.3.1 ACHIEVING A SINGLE LINEAR REFERENCING SYSTEM (LRS)

Some States are struggling to create an LRS that combines State and local roads in a single LRS. The main problem appears to be incompatible linear referencing methods (milepoint on State routes; name-based on local routes). Many States have solved this problem already and have settled on a combined LRS that incorporates both types of referencing method, often by using next-generation 911 (NG911) addressing as the first-pass source of street names, or by relying on local agencies as the authoritative source for names. States with a solution in place reported having implemented an all-roads LRS in their GIS. The advantage of this for safety analysis is that it provides a reliable means of integrating roadway, traffic volume, and crash data based on a single set of spatial coordinates. States have flexibility on how to achieve a unified LRS.

Possible Future Actions

- **Peer-to-peer sharing.** FHWA can help States identify successful implementations of a unified LRS that include similar tools and methods, and then arrange consultations and demonstrations so that a State can seek answers before committing to a specific solution. Depending on the number of States needing similar technical assistance, FHWA could help to expand this effort to become a peer network or create a peer exchange among multiple States.
- **Interface with Applications of Enterprise GIS in Transportation (AEGIST).** The AEGIST Pooled Fund Study has attracted engagement or full participation

nationally from over 20 States. AEGIST is now in the implementation phase. It includes activities that could help States (even non-participating States) develop unified LRS solutions that would provide a general solution beyond safety data management and the MIRE FDE. AEGIST workshops and meetings could include a discussion of the unified LRS and its relevance to the MIRE FDE and the 2026 deadline.

- **Interface with Esri Roads & Highways User Group (RHUG).** FHWA does not typically meet with vendors; however, since Esri Roads & Highways has captured such a large market share the RHUG might present an opportunity for sharing successful implementations among the community of Esri users. This would not be an endorsement of any vendor's product. The RHUG is a group for and about users so FHWA could approach them as a way to seek examples of fully implemented MIRE FDE spatial databases that could be shared with the user community. Relevant examples might include specifics on how different States have represented intersections, how segments and intersections interact, and how to determine when to use point and linear events within Esri Roads & Highways.

4.3.2 DATA REPORTING AND REFRESH CYCLES

The MIRE FDE contains a mix of data elements that remain static for relatively long periods and those that may change annually. Some data elements—like traffic volumes on local roads—are subject to change but traditionally are not collected on a regular schedule. In some States, they may not have been collected in decades—estimated data updated using growth factors are not uncommon. States inquired how often the MIRE FDE might need to be reported (if ever, outside of HPMS sample segments) and how often the individual data elements would need to be refreshed.

Possible Future Actions

- **Non-scored criteria for MIRE FDE compliance.** FHWA Office of Safety is developing criteria to assess compliance with the 2026 MIRE FDE requirements. As a companion effort, FHWA could also develop a set of separate suggestions for implementation. These could be viewed as a set of suggested practices for each of the data elements for maintenance and reporting. One suggestion would be to note the subset of data elements that will be reportable under HPMS 9.0 and suggest that States create the ability to perform quality assurance and automate reporting of those elements, with the understanding that the entire MIRE FDE will become reportable via HPMS by 2026. In other words, States may want to develop their QA/QC and reporting methodologies now and work toward the capability that will be needed by 2026. Another non-scored criterion could include a recommended refresh cycle for each of the MIRE FDE. In this case, FHWA may want to consult with practitioners to develop a recommended cycle based on State practices. A panel of State data managers

could advise FHWA on the desired update frequency and FHWA could publish the suggested update frequency without making it a part of the requirement.

4.3.4 DATA COLLECTION METHODS

States that have not yet completed their (mostly local roadway) data collection need information on the various methods that successful States have used. The major components for States to consider include:

- Complete the intersection and interchange inventory.
- Determine which data elements can be collected from existing sources (e.g., video logs, aerials).
- Investigate non-traditional sources (e.g., third-party sources of traffic volume data).
- Explore potential methods of coordinating with local agencies.
- Weigh costs and QA/QC considerations for each method.

Possible Future Actions

- **Research and summary report.** FHWA could prepare a research document summarizing the ways that States have successfully collected each of the MIRE FDE and related spatial components (e.g., intersection inventory or LRS locations). The document could describe the data collection methods for each element, the cost components (if not actual costs), QA/QC considerations, and list the requirements for agency involvement (State, regional, local, etc.). This summary document could serve as a resource for States that are trying to determine the most cost-effective way for them to collect each of the MIRE FDE. If possible, the document could also address possible links to other data collection efforts. For example, if a State is paying for MIRE FDE collection using instrumented vehicles, they could collect asset data at the same time for a slightly higher cost.
- **Data sharing.** FHWA could help States connect, possibly via the Division Offices, to share example datasets to show what the initial and final (corrected/validated) datasets look like based on a successful MIRE FDE data collection effort. This would help States that are considering a particular type of data collection effort to understand what level of QA/QC to expect so that they can budget adequately.

4.3.5 FUNDING

States shared ideas on funding MIRE FDE data collection and management efforts. States are aware that they can use State Planning and Research and HSIP funds for MIRE FDE data collection. States do not often explore other funding sources. For example, State DOTs infrequently apply for the NHTSA Traffic Records Improvement grant funds (Section 405c) and

this only occur when they are actively involved in their State Traffic Records Coordinating Committee (TRCC), the group responsible for promoting a plan to spend the funds.

Possible Future Actions

- **NHTSA Regional Office coordination.** The FHWA Division Office staff could work with NHTSA Regional staff to identify opportunities to help States improve spatial and roadway inventory data collection and management. These efforts could include more frequent attendance at State TRCC meetings, promoting the utility of LRS improvements for data integration of all safety data, and exploring the potential for using unspent 405c grant money for MIRE FDE collection.
- **Data improvement funding sources information.** FHWA can circulate information on data improvement grants. This information already exists in prior documents. Some State and Division Office personnel may not be aware of the options available to pay for data improvement. The Office of Safety can package the information and share it with Divisions and States as part of future MIRE FDE communications.

4.3.6 DATA NORMALIZING

FHWA, in general, requests a broad set of data elements from States, including data elements some States historically have never collected or used. Peer exchange participants voiced concerns with identifying an owner or champion for each data element and meeting the 2026 requirement to show that the MIRE FDE are being used in safety analysis. States welcomed the announcement that HPMS would adopt the MIRE FDE data definitions by 2026 so that the reporting to HPMS would match State MIRE FDE collection requirements. However, States also expressed concern that money spent collecting MIRE FDE would take away from other efforts and that they might not use all of the MIRE FDE in their safety work. The larger theme arising from these discussions was the hope that FHWA would work toward a normalized data request so that States are asked to provide one set of data covering all of FHWA's needs.

Possible Future Actions

- **Data Request Review.** FHWA could review the data requests and requirements to State DOTs and look for opportunities to settle on fewer data elements and common data element definitions. This is already happening (i.e., HPMS 9.0 and MIRE FDE). An optimal solution would continue the review and consult with State DOTs on costs and utility of the data.

4.4 CONCLUSIONS AND POTENTIAL NEXT STEPS

This chapter summarizes two MIRE FDE peer exchanges. The purpose of the report is to highlight themes that arose during the two sessions, especially during the breakout discussions,

and provide ideas for possible future actions that would address those themes. The preceding section of the report discussed five themes:

- Achieving a single LRS.
- Data reporting and refresh cycles.
- Data collection methods.
- Funding.
- Data normalizing.

Under each theme, the possible future actions describe things that the Agency could do that would specifically address that theme. For most, the action is something that the FHWA Office of Safety could take on alone or in coordination with the FHWA Division Offices. FHWA can consider the lists in addition to the typical list of outreach and technical support activities conducted by the Office of Safety. The Office of Safety has already committed to creating a set of criteria to assess States' compliance with the MIRE FDE requirement. It will communicate those criteria to States in the coming years so that States will know how to quantify success. The Office of Safety has several tools available to help States that may also be considered as part of the package of assistance as States work to collect the MIRE FDE, including:

- Peer exchanges.
- Training.
- Case studies.
- Marketing, communications, outreach, and presentations.
- Research.
- Technical support.
- Guidance documents.
- Legislation and regulations.

The Office of Safety, and FHWA more broadly, can use these tools as outreach to States on a variety of topics, including the MIRE FDE requirement. The themes presented in this report are no exception. The additional, specific actions listed in this report are actions suggested during the peer exchanges that States either requested directly or that the project support team selected as likely to meet the needs expressed.

CHAPTER 5—CONCLUSIONS

This chapter is intended as a final overview and conclusion to the project to provide MIRE FDE mappings, technical assistance, data visualizations, and peer exchanges. The goal was to give FHWA and States shared information on progress to date on achieving the required data. This, in turn, would let the partners in FHWA Office of Safety and other headquarters offices, the Division Offices, State DOTs, and regional and local agencies know how much work is left to be done, what barriers are left to overcome, and which States are likely to serve as models for successful completion going forward.

The improvement in MIRE FDE mapping scores between the 2020 baseline to the 2021 update is remarkable. In 2020, 6 States mapped to less than 40 percent of the MIRE FDE and 14 States mapped to less than 55 percent of the MIRE FDE. By 2021, no States mapped to less than 40 percent of the MIRE FDE and only 2 States mapped to less than 55 percent. To date, no State has complete MIRE FDE data. States are looking for examples of successful partnerships with local or regional agencies as sources of data. Or, conversely, models of State-led data collection at a reasonable cost. States are also looking for ways to fund the effort and for ideas on how to sustain the effort through whatever update cycles seem reasonable for the long term.

The States are mindful of the resource constraints they and their local agency partners face, and the concerns professionals have over collecting data before they understand its utility for improving safety.

FHWA has tools it can use to explain and promote data collection, assist States with systems needed to ingest the data, and demonstrate effective ways to integrate the data into safety management processes and analyses. All but two States participated in the peer exchanges—one of those was registered but was unavailable due to an emergency weather event. That level of participation indicates the interest States have in succeeding. Meanwhile, HPMS will continue to add the MIRE FDE data element definitions so that, eventually, all will be part of HPMS. The peer exchanges introduced States to data sources from federal land management agencies and Tribal data sources that can help supplement State DOT sources. The needs expressed in the peer exchanges are not fully met yet, but FHWA can help with technical assistance, training, research, and additional opportunities for States to share expertise and successful implementations.

U.S. Department
of Transportation
**Federal Highway
Administration**

Office of Safety

FHWA-SA-22-026

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE