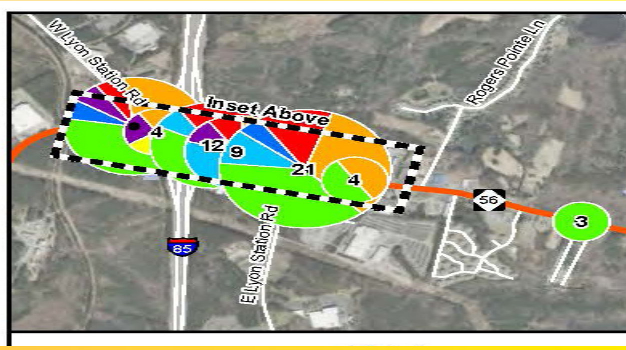
MIRE Fundamental Data Elements Cost Benefit Estimation



FHWA Safety Program

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Federal Highway Administration

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Quality Assurance Statement

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Quality data are the foundation for making important decisions regarding the design, operation, and safety of roadways. Using roadway and traffic data together with crash data can help agencies make decisions that are fiscally responsible and improve the safety of the roadways for all users. The Federal Highway Administration (FHWA) Office of Safety has established a fundamental set of roadway and traffic data elements that States should collect to support the activities conducted under their Highway Safety Improvement Programs. These data are a subset of the Model Inventory of Roadway Elements (MIRE), and are known as the MIRE Fundamental Data Elements (MIRE FDE). The objective of this effort is to conduct an economic analysis of the cost to States and their partners in developing a Statewide linear referencing system and collecting the MIRE FDE on all public roadways. This effort also estimated the reduction in fatalities and injuries needed to exceed a 1:1 ratio, and a 10:1 ratio of benefits to costs. This report provides the results of this effort.</td></tr>
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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)

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ACRONYMS

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
FARS	Fatality Analysis Reporting System
FDE	Fundamental Data Elements
FHWA	Federal Highway Administration
GES	General Estimate System
GIS	Geographic Information System
IHSDM	Interactive Highway Safety Design Model
HPMS	Highway Performance Monitoring System
HSIP	Highway Safety Improvement Program
HSM	Highway Safety Manual
LiDAR	Light Detection and Ranging
LRS	Linear Referencing System
MAIS	Maximum Abbreviated Injury Scale
MAP-21	Moving Ahead for Progress in the 21st Century
MIRE	Model Inventory of Roadway Elements
MIRE FDE	Model Inventory of Roadway Elements Fundamental Data Elements
MIS	Management Information System
MPO	Metropolitan Planning Organization
NHDOT	New Hampshire Department of Transportation
NHS	National Highway System
SHSP	Strategic Highway Safety Plan
UDOT	Utah Department of Transportation
VSL	Value of Statistical Life
WSDOT	Washington State Department of Transportation

INTRODUCTION

Background

Recognizing that quality data are the foundation for making important decisions regarding the design, operation, and safety of roadways, the Federal Highway Administration (FHWA) developed guidance for States on implementing their Highway Safety Improvement Programs (HSIPs). By incorporating roadway and traffic data into safety analysis procedures, States can better identify safety problems and prescribe solutions to support and implement their Strategic Highway Safety Plans (SHSPs). Furthermore, new safety analysis tools and methods have been developed, such as the Highway Safety Manual (HSM) and related software, AASHTOWare's Safety Analyst™, and FHWA's Interactive Highway Safety Design Model (IHSDM). All these tools and methods need quality roadway, traffic, and crash data to achieve the most accurate results. Using roadway and traffic data together with crash data will help agencies make decisions that are fiscally responsible and improve the safety of the roadways for all users.

One study on the effectiveness of the HSIP found that the magnitude of States' fatal crash reduction was highly associated with the years of available crash data, prioritizing method, and use of roadway inventory data. States that used detailed roadway inventory data combined with the empirical Bayes method in network screening and prioritization for consideration in the HSIP had the greatest reductions.

FHWA's Model Inventory of Roadway Elements (MIRE) Version 1.0 provides a recommended listing of 202 roadway inventory and traffic elements critical to safety management.[1] While all of the MIRE elements are important, it may not be feasible for States to collect and integrate all of the elements into their HSIP at the same time. In 2011, FHWA identified a subset of these elements that are critical for safety analysis. These elements, known at the time as the Fundamental Data Elements (FDE), are identified and described in the *Background Report: Guidance for Roadway Safety Data to Support the Highway Safety Improvement Program* and the *Guidance Memorandum on Fundamental Roadway and Traffic Data Elements to Improve the Highway Safety Improvement Program.*[3,4] This set is subsequently referred to as the 2011 FDE.

In 2011, FHWA published the *Market Analysis of Collecting Fundamental Roadway Data Elements to Support the Highway Safety Improvement Program.*[2] The report explored the costs of collecting the 2011 FDE. The analysis developed cost estimates for collecting these data in small, medium, and large States. Cost effectiveness analysis was used to determine the number of fatalities and injuries that would need to be reduced to justify the costs of the data collection. The report represented the best available information on the cost of collecting these data elements at the time it was developed.

MIRE FUNDAMENTAL DATA ELEMENTS COST-BENEFIT ESTIMATION

In July of 2012, Moving Ahead for Progress in the 21st Century (MAP-21) was passed. This transportation funding legislation required the Secretary to establish a subset of MIRE elements that are useful for roadway inventory data. The *MAP-21 Guidance on State Safety Data Systems* provides information on the set of roadway and traffic data elements that fundamentally support a State's HSIP, and therefore, should be collected on all public roads.(5) This guidance supersedes the *Guidance Memorandum on Fundamental Roadway and Traffic Data Elements to Improve the Highway Safety Improvement Program* and the 2011 FDE.(3) This set of elements—herein referred to as the MIRE Fundamental Data Elements (MIRE FDE)—included segment, intersection, and ramp data elements which were determined to be the basic set of data elements that an agency would need to conduct enhanced safety analyses to support a State's HSIP. The MIRE FDE were based on the elements needed to apply the HSM roadway safety management (Part B) procedures using network screening and analytical tools, are a subset of MIRE, and are equivalent to some Highway Performance Monitoring System (HPMS) full extent elements that States submit for Federal-aid highways. The MIRE FDE were divided into a full set of MIRE FDEs and a reduced set of MIRE FDEs for roads with an annual average daily traffic (AADT) less than 400 vehicles per day.

In addition to collecting the MIRE FDE, States should also have a linear referencing system (LRS) for all public roads. The FHWA Office of Highway Policy Information and Office of Planning, Environment, and Realty issued the *Memorandum on Geospatial Network for All Public Roads* on August 7, 2012, which identified an HPMS requirement for States to update their LRS to include all public roadways within the State by June 15, 2014.(6) This LRS will enable States to locate high crash locations on all public roads in the State. As States expand their inventories, additional data, such as roadway and traffic data, should be linkable by LRS geolocation.

In March of 2013, a cost benefit estimation report called *MIRE Fundamental Data Elements Cost-Benefit Estimation* documented an economic analysis of the cost to States in collecting these data (LRS and FDE), the reduction in fatalities, and the number of injuries that would push the benefits to cost ratio beyond 1:1 and a 2:1.(16) The report served as the Regulatory Impact Analysis for the MIRE FDE portion of the 2013 Notice of Proposed Rulemaking (NPRM) on the HSIP (Docket No. FHWA-2013-0019).

Review of NPRM Comments

Numerous agencies commented on the NPRM. Specifically, American Association of State Highway and Transportation Officials (AASHTO) and many State Departments of Transportation (DOTs) provided comments on the NPRM that relate directly to the 2013 MIRE FDE economic analysis. The following key themes were identified after careful review of all comments:

- Twenty-four States said the costs were underestimated (15 provided alternative cost estimates).
- Fourteen States expressed interest in flexibility to estimate AADT on low-volume roads.
- Eleven States mentioned that FHWA should limit which local, rural, or low-volume roads need to have data collection.
- Eighteen States noted that a five-year implementation timeframe is too low: ten States recommend a ten-year timeframe and several simply desired more than five years.
- Ten States requested that unpaved/gravel roads be excluded.
- Eight States expressed that the Federal government should collect data for roads on Federal lands directly from the managing Federal agency.
- Five States and AASHTO commented that too much data is being requested on intersections.

Revisions to MIRE FDE

Based on the NPRM comments, FHWA revised the MIRE FDE and created three categories of MIRE FDEs. The categories were established based on the functional classification and surface type, rather than AADT. Tables 1, 2, and 3 summarize the MIRE FDE in the HSIP Final Rule. Table 1 includes non-local (based on functional classification) paved roadways. Non-local functional classifications include the following categories:

- Interstate.
- Other Freeways and Expressways.
- Other Principal Arterial.
- Minor Arterial.
- Major Collector.
- Minor Collector.

Table 1 is divided into three tables. Table 1a provides the description of the MIRE FDE to be collected for roadway segments, Table 1b provides the description of the MIRE FDE to be collected for intersections and Table 1c provides the description of the MIRE FDE to be collected for interchange/ramps.

Table 2 includes the MIRE FDE for local (based on functional classification) paved roadways. Table 3 includes the MIRE FDE for all unpaved roadways.

Table 1a. MIRE Fundamental Data Elements for Non-Local Roadway Segments (based on functional classification) Paved Roads.

FDE (MIRE Number)^	Definition
Roadway Segment	
Segment Identifier (12)	Unique segment identifier.
Route Number (8)[0]	Signed numeric value for the roadway segment.
Route/Street Name (9)[0]	The route or street name, where different from route number.
Federal-aid/ Route Type (21)*	Federal-aid/National Highway System (NHS) route type.
Rural/Urban Designation (20)*	The rural or urban designation based on Census urban boundary and population.
Surface Type (23)	The surface type of the segment.
Begin Point Segment Descriptor (10)	The location of the starting point of the roadway segment.
End Point Segment Descriptor (11)	The location of the ending point of the roadway segment.
Segment Length (13)	The length of the segment.
Direction of Inventory (18)	Direction of inventory if divided roads are inventoried in each direction.
Functional Class (19)*	The functional class of the segment.
Median Type (54)	The type of median present on the segment.
Access Control (22)†	The degree of access control.
One/Two-Way Operations (91)*	Indication of whether the segment operates as a one- or two-way roadway.
Number of Through Lanes (31)*	The total number of through lanes on the segment. This excludes turn lanes and auxiliary lanes.
Average Annual Daily Traffic (AADT) (79)*	The average number of vehicles passing through a segment from both directions of the mainline route for all days of a specified year.
AADT Year (80)	Year of AADT.
Type of Government Ownership (4)*	Type of governmental ownership.

^ Model Inventory of Roadway Elements – MIRE Version 1.0 *(1)*.

* HPMS full extent elements required on all Federal-aid highways and ramps located within grade-separated interchanges, i.e., NHS and all functional systems excluding rural minor collectors and locals.

[0] HPMS element required on all NHS, Interstate, Freeway & Expressways, and Principal Arterials, and Minor Arterials.

† HPMS element required on all NHS, Interstate, Freeway & Expressways, and Principal Arterials

Table 1b. MIRE Fundamental Data Elements for Non-Local Intersections (based on functional classification) Paved Roads.

FDE (MIRE Number)^	Definition
Intersection	
Unique Junction Identifier (120)	A unique junction identifier.
Location Identifier for Road 1 Crossing Point (122)	Location of the center of the junction on the first intersecting route (e.g. route-milepost).
Location Identifier for Road 2 Crossing Point (123)	Location of the center of the junction on the second intersecting route (e.g. route-milepost). Not applicable if intersecting route is not an inventoried road (i.e., a railroad or bicycle path).
Intersection/Junction Geometry (126)	The type of geometric configuration that best describes the intersection/junction.
Intersection/Junction Traffic Control (131)	Traffic control present at intersection/junction.
AADT (79) [for Each Intersecting Road]	The AADT on the approach leg of the intersection/junction.
AADT Year (80) [for Each Intersecting Road]	The year of the AADT on the approach leg of the intersection/junction.
Unique Approach Identifier (139)	A unique identifier for each approach of an intersection.

^ Model Inventory of Roadway Elements – MIRE Version 1.0 *(1)*.

* HPMS full extent elements required on all Federal-aid highways and ramps located within grade-separated interchanges, i.e., NHS and all functional systems excluding rural minor collectors and locals.

[0] HPMS element required on all NHS, Interstate, Freeway & Expressways, and Principal Arterials, and Minor Arterials.

† HPMS element required on all NHS, Interstate, Freeway & Expressways, and Principal Arterials

Table 1c. MIRE Fundamental Data Elements for Non-Local Interchange and Ramps (based on functional classification) Paved Roads.

FDE (MIRE Number)^	Definition
Interchange/Ramp	
Unique Interchange Identifier (178)	A unique identifier for each interchange.
Location Identifier for Roadway at Beginning Ramp Terminal (197)	Location on the roadway at the beginning ramp terminal (e.g., route-milepost for that roadway) if the ramp connects with a roadway at that point.
Location Identifier for Roadway at Ending Ramp Terminal (201)	Location on the roadway at the ending ramp terminal (e.g. route-milepost for that roadway) if the ramp connects with a roadway at that point.
Ramp Length (187)	Length of ramp.
Roadway Type at Beginning Ramp Terminal (195)	A ramp is described by a beginning and ending ramp terminal in the direction of ramp traffic flow or the direction of inventory. This element describes the type of roadway intersecting with the ramp at the beginning terminal.
Roadway Type at Ending Ramp Terminal (199)	A ramp is described by a beginning and ending ramp terminal in the direction of inventory. This element describes the type of roadway intersecting with the ramp at the ending terminal.
Interchange Type (182)	Type of interchange.
Ramp AADT (191)*	AADT on ramp.
Year of Ramp AADT (192)	Year of AADT on ramp.
Functional Class (19)*	The functional class of the segment.
Type of Government Ownership (4)*	Type of governmental ownership.

^ Model Inventory of Roadway Elements – MIRE Version 1.0 *(1)*.

* HPMS full extent elements required on all Federal-aid highways and ramps located within grade-separated interchanges, i.e., NHS and all functional systems excluding rural minor collectors and locals.

[0] HPMS element required on all NHS, Interstate, Freeway & Expressways, and Principal Arterials, and Minor Arterials.

† HPMS element required on all NHS, Interstate, Freeway & Expressways, and Principal Arterials

Table 2. MIRE Fundamental Data Elements for Local (based on functional classification) Paved Roads.

FDE (MIRE Number)^	Definition
Roadway Segment	
Segment Identifier (12)	Unique segment identifier.
Functional Class (19)*	The functional class of the segment.
Surface Type (23)	The surface type of the segment.
Type of Government Ownership (4)*	Type of governmental ownership.
Number of Through Lanes (31)*	The total number of through lanes on the segment. This excludes turn lanes and auxiliary lanes.
Average Annual Daily Traffic (AADT) (79)*	The average number of vehicles passing through a segment from both directions of the mainline route for all days of a specified year.
Begin Point Segment Descriptor (10)	The location of the starting point of the roadway segment.
End Point Segment Descriptor (11)	The location of the ending point of the roadway segment.
Rural/Urban Designation (20)*	The rural or urban designation based on Census urban boundary and population.

^ Model Inventory of Roadway Elements – MIRE Version 1.0 *(1)*.

* HPMS full extent elements required on all Federal-aid highways and ramps located within grade-separated interchanges, i.e., NHS and all functional systems excluding rural minor collectors and local roads.

Table 3. MIRE Fundamental Data Elements for Unpaved Roads

FDE (MIRE Number)^	Definition
Roadway Segment	
Segment Identifier (12)	Unique segment identifier.
Functional Class (19)*	The functional class of the segment.
Type of Government Ownership (4)*	Type of governmental ownership.
Begin Point Segment Descriptor (10)	The location of the starting point of the roadway segment.
End Point Segment Descriptor (11)	The location of the ending point of the roadway segment.

^ Model Inventory of Roadway Elements – MIRE Version 1.0 *(1)*.

* HPMS full extent elements required on all Federal-aid highways and ramps located within grade-separated interchanges, i.e., NHS and all functional systems excluding rural minor collectors and local roads.

Objective and Scope

The objective of this effort is to estimate the potential costs for States and their partners to develop a Statewide LRS and collect the revised MIRE FDE on all public roadways. The expected benefit is that collecting additional roadway and traffic data and integrating those data into the safety analysis process will improve an agency's ability to locate problem areas and apply appropriate countermeasures—hence, improving safety. This analysis builds on the 2013 report, MIRE Fundamental Data Elements Cost-Benefit Estimation by updating the values needed to determine the costs and benefits of collecting the MIRE FDE (slightly revised from the NPRM), revising the methodology used previously to incorporate more recent data and systems, and adjusting the results accordingly to reflect these changes. (16)

REVIEW OF RECENT DATA COLLECTION EFFORTS

The market analysis report for the 2011 FDE relied solely on vendor information to determine data collection costs.(2) Since that time, a number of studies have been conducted that evaluate data collection methods in an effort to obtain quality data that are the foundation for making important decisions regarding the design, operation, and safety of roadways. These efforts included the MIRE Management Information System (MIRE MIS) Lead Agency Program intersection inventory collection in New Hampshire and Washington State—a task of the MIRE MIS project—and the deployment of light detection and ranging (LiDAR) technology in Utah.(7,8)

A review of these efforts was included in the 2013 analysis report upon which this report is based.(16) The following section updates that review with additional information.

MIRE MIS Project and the Intersection Inventory Collection

The objective of the MIRE MIS project was to test the feasibility of converting the MIRE listing into an MIS. This was done through the exploration, development, and documentation of mechanisms for data collection; processes for data handling and storage; details of data file structure; methods to assure the integration of MIRE data with crash data and other data types; and performance metrics to assess and assure MIRE data quality and MIS performance.

The exploration of the mechanism for collecting MIRE data was done through three major tasks including: a pilot data collection effort where MIRE data were collected in two States (the MIRE MIS Lead Agency Program intersection inventory collection in New Hampshire and Washington State); a white paper that explores the use of collective information for transportation safety data; and development of a MIRE data collection guidebook. The Lead Agency Program in New Hampshire and Washington State are particularly relevant to this task.

The primary objective of the Lead Agency Program was to assist volunteer transportation agencies to collect, store, and maintain MIRE data and to incorporate those data into their safety programs. Using an application process, FHWA selected the New Hampshire Department of Transportation (NHDOT) and the Washington State Department of Transportation (WSDOT) as Lead Agencies to participate in the MIRE MIS effort. The second objective of the Lead Agency Program was to determine the level of effort and resources necessary to achieve these goals.

Both NHDOT and WSDOT requested an intersection inventory for use in AASHTOWare Safety Analyst™, but with slightly different variables. Having both agencies select similar elements provided the project team an opportunity to compare different data collection methodologies. The project team developed two different methods to collect these data elements: one set of simplified tools based on a geographic information system (GIS) platform (for NHDOT), and a more complex automated extraction tool based on proprietary software (for WSDOT). The data collection for both States was done in-office using information from available sources such as aerials, Google Street View, and video logs to populate the data elements.

The rate of data collection for New Hampshire was approximately nine minutes per intersection compared to three minutes per intersection for Washington State. The rate of collection without speed limits is estimated to be approximately two minutes per intersection. Therefore, the New Hampshire collection rate was higher due to the additional time it took to collect speed limits on each approach to the intersection.

LiDAR Collection in Utah

The Utah Department of Transportation (UDOT) is employing the LiDAR technology as a groundbreaking data collection project. UDOT has recently entered into a contract to gather, identify, and process a wide variety of roadway assets along its entire 6,000-plus center lane miles of State route and interstates.(9) One of the key goals of the project is to "deploy state of the art collection methods to improve and develop rigorous safety, maintenance, and preservation programs."

The first phase of the project—data collection— is complete. Initial data collection was conducted in 2012, with plans for an update in 2014. The second phase— post processing and data delivery—is currently underway.

The data collected include roadway distress data, pavement surfaces, lane miles, signs, right-of-way images, vertical clearances, and more. Each of these categories is further subdivided to provide additional detail. Costs associated with data collection of roadway conditions was approximately $26 per mile, $30 per mile with geolocating roadways, and $95 per mile with roadway asset data collection.(8)

Other Vendors

Many agencies use other non-LiDAR data collection vendors to collect data including traffic volumes. The market analysis report for the 2011 FDE summarized cost data provided by 12 data collection vendors from around the country.(2) Costs were obtained from the vendors on a per-mile basis along segments, and a per-location basis for intersections and ramps. For the 2014 analysis, the cost for developing an LRS is estimated per mile divided into five categories based on the number of miles of LRS data to be collected. The cost per mile incorporates some economies of scale. That is, the cost per mile decreases as the total mileage requiring field collection increases. For traffic counts on segments, an estimate of one count per mile is used to generate a per mile cost. These costs, presented in Table 4, included data collection and formatting for integration into a State's existing system.

Table 4. Sliding Scale Cost for LRS Data Collection.

Cost to Collect ($/mile)	Description
$30.00	$30 per mile cost based on 2012 Utah LiDAR project for State where total mileage for LRS is >10,001 miles.
$45.00	For State where total mileage for LRS is 5,001-10,000 miles.
$55.00	For State where total mileage for LRS is 3,001 -5,001 miles.
$70.00	For State where total mileage for LRS is 1,001-3,000 miles.
$90.00	For State where total mileage for LRS is < 1,000 miles.

The majority of vendors estimated that digital data collection vans would be used to collect the roadway inventory data. Vendors estimated traffic count data costs based on 48-hour classification counts for segment and ramp traffic data and peak hour manual counts for intersections.

MIRE FUNDAMENTAL DATA ELEMENTS COST-BENEFIT ESTIMATION METHODOLOGY

Overview and Relation to 2011 and 2013 Analyses

The market analysis report for the 2011 FDE included an extensive literature review that revealed no established methodologies to estimate the benefit of collecting roadway data elements for safety.[(2)] Additionally, no State was determined to already collect the exact list of MIRE FDE on all public roadways within the State. Therefore, a cost effectiveness analysis was conducted based on estimated costs of collecting data for a small, medium, and large State.

As with the previous analysis, a cost effectiveness analysis approach was used for the 2013 analysis.[(16)] However, the general approach was modified to estimate the cost for each State based on the best available estimates for the number of lane miles, intersections, and ramps. The analysis used costs for data collection from the several sources including the MIRE MIS intersection inventory, Utah's LiDAR experience, and vendors' estimates. These sources represented potential methodologies for data collection and were selected for the analysis based on the availability of cost information.

The analysis also considered the extent of data collection already being conducted by the States, and developed a national cost estimate. The cost estimations used in that analysis reflected the additional costs that States would incur based on what was not already being collected through HPMS and through other efforts. During 2011-2012, FHWA conducted a State Data Capabilities Assessment for each State on the collection, management, and use of roadway safety data.[(10)] States provided information about their practices on State and Non-State roads, with most responses for Non-State roads limited to Federal-aid roads. The analysis used the results of this assessment to determine the cost to collect the additional MIRE FDEs for each State and the District of Columbia.

The cost estimation also included the cost to extend existing LRS to all public roads, consistent with the HPMS requirements that States submit their LRS covering all public roadways for their HPMS submittal of 2013 data due June 15, 2014.[(6)]

The 2014 economic analysis employs a cost effectiveness methodology with a similar structure as the 2013 analysis. This analysis included the HSIP Final Rule FDEs as presented in Tables 1a, 1b, 1c, 2, and 3. Updated values were used for several elements such as number of intersections, extent of data already collected by the State, extent of LRS by State, and revised cost estimates. In addition, the 2014 analysis considers miscellaneous costs including the cost associated with developing an implementation plan, local partner liaisons, formatting and analyzing enhanced data, and desktop and web application.

The current analysis continues to acknowledge that some MIRE FDE are already collected for HPMS. Specifically, 13 of the 37 MIRE FDE for non-local paved roadways are also already collected for the HPMS and therefore, the costs to collect them are not included in the analysis. Tables 1a, 1b, 1c, 2 and 3 indicate which of the 37 MIRE FDEs are HPMS elements.

The following sections explain the numerous sources of data used for this analysis and considerations for each.

Roadway Classification

In order to calculate the amount of roadways requiring data collection, each State's roadways segments were divided into various categories based on functional classification (non-local and local), ownership (state and non-state), and surface type (paved and unpaved) in order to apply the associated costs. To calculate the data collection costs for each State, the roadway mileage are determined for:

- State roadways – Roadways that are maintained by the State, including both nationally-numbered highways and un-numbered State highways, arterials and collectors.
- Federal-aid Non-State roadways - Roadways that are not maintained by the State and eligible for Federal-aid funding, this includes arterials and collectors.
- Non-Federal-aid Non-State roadways - Roadways that are not maintained by the State and not eligible for Federal–aid funding, this includes arterials and collectors.
- Local non-State roadways - Local roadways (based on functional classification) that are not maintained by the State.
- Local State roadways - Local roadways (based on functional classification) that are maintained by the State.
- State unpaved roads – State-maintained unpaved roads.
- All other unpaved roads.

Intersections were calculated only for those locations where a non-local paved road intersects with non-local paved road (non-local/non-local) or a non-local paved road intersects with a local roadway (non-local/ local). All ramps to access controlled roadways including interstates, expressways, and other freeways were included in the ramps.

Roadway Segments

The analysis used 2012 mileage data from the FHWA Office of Highway Policy Information *Highway Statistics* series to determine the ownership of the roadways for each State, and the urban and rural mileage.(11) The analysis also used FHWA Office of Highway Policy Information

Highway Statistics series to determine the miles by surface type for each State and Federal-aid mileage for each State by ownership.[12, 13]

Intersections

The number of intersections was known for four States. Estimates were made for the remaining 46 States, using the U.S. Census 2014 TIGER/line Roads National Geodatabase to estimate the total roadway miles and the total number of intersections in each State. This estimate is based on the miles of GIS links (roads) and the nodes (intersections) between those links in the public roads layer for a State. This is a simple estimate but it provides an estimate of the relative number of intersections per mile. The total miles of links in each State was compared to the total road miles reported in the HPMS system, which is considered more accurate. The proportion of the GIS estimate of miles to the HPMS reported miles was calculated. If the proportion was over 1.0, the GIS system overestimated the number of miles and therefore also overestimated the number of intersections. If the proportion was under 1.0, it underestimated. This proportion was applied to the number of intersections estimated from the GIS system to correct this over- or underestimation. For example, from the GIS system, State A has 250,000 miles of roads and 140,000 intersections. In the HPMS data, the State is reported to have 280,000 miles of roads. The GIS system underestimated the miles of roads by just over 10 percent. The proportion of the miles from the HPMS system and the miles from the GIS system is 1.12 (280,000/250,000). The proportion is multiplied by the number of intersections from the GIS system (140,000 X 1.12) and the revised estimate is 157,000. This estimate is used in the analysis.

Ramps

The number of ramps is known for six States. Total number of ramps was estimated for the remaining 44 States, using the U.S. Census 2014 TIGER/line Roads National Geodatabase to estimate the number of interchanges in each State. This number is fairly reliable for each State as interchanges are major features in the GIS system. However, the number of individual ramps was needed, not interchanges. Therefore, the number of ramps was estimated from the number of interchanges.

A proportion of the number of interchanges to ramps was calculated for the six States where the number of ramps is known. This ratio of ramps to interchanges was approximately 2.8 for 5 of the 6 States and is therefore a consistent relationship between ramps and interchanges. This ratio was applied to the number of interchanges in each State to estimate the number of ramps. For example, from the GIS system, State A has 200 interchanges. The number of ramps in State A was estimated as 560 ramps (2.8 X 200).

Data Collection Costs

The costs for each State to collect the additional MIRE FDE are aggregated into eight categories:

1. Costs to develop a common LRS.
2. Costs to collect the MIRE FDE elements for roadway segments.
3. Costs to collect the MIRE FDE elements for intersections.
4. Costs to collect the MIRE FDE elements for ramps.
5. Cost to collect volume data.
6. Cost to manage and administer data collection efforts.
7. Cost to maintain the data annually.
8. Miscellaneous costs including one-time cost of developing an implementation plan; and all annual ongoing costs of local agency partner liaison, formatting and analyzing enhanced data and desktop and web application.

Each of the eight categories are described in the following sections. Additionally, tables in Appendix A1 a provides a detailed listing of the specific cost inputs and the source of the inputs for each of the categories.

Linear Referencing System

An LRS is required for all public roadways as part of the States' HPMS submittal of 2013 data, which was due June 15, 2014. Currently, the completeness of the roadway network for each State varies. Only the costs of adding roadways not currently in the network are considered in this analysis. The analysis assumed that all Federal-aid roadways have already been incorporated into the system, and consequently no additional cost will be incurred. For the non-Federal-aid roadways, the percentage of missing roads was based on an assessment of the mileage reported to HPMS by June 2014. This information is supplemented with information from the State Data Capabilities Assessment.[10] The cost per mile to include these additional roads was assumed to be on a sliding scale, as presented in Table 4, based on the total number of mileage to be collected by each State. This cost is based on the Utah LiDAR program and the market analysis report for the 2011 FDE.[8,2] The estimated cost per State to complete an LRS is provided in Appendix A2. A five percent cost was added to LRS data collection costs for Quality Assurance/Quality Control (QA/QC).

Roadway Segments

The MIRE FDE includes 18 roadway segment elements for non-local paved roads, two of which involve collecting volumes (AADT and AADT year). There are nine MIRE FDE roadway segment elements for local paved roads; including one AADT and five MIRE FDE roadway segment elements for unpaved roads.

Non-Local Paved Roadways

As part of HPMS reporting requirements for Federal-aid roadways, States already collect many of the MIRE FDE for State-maintained roadways. The additional non-HPMS elements include *surface type*, *direction of inventory, median type, begin point segment descriptor, end point segment descriptor, segment length,* and *AADT year*. Several elements are only reported to HPMS for some functional classes. For example, a*ccess control* is collected on NHS roadways, interstates, freeways and expressways, and principal arterials but not for minor arterials and minor or major collectors.

Field data collection is needed for *surface type* and *median type.* Based on the Utah LiDAR project and the market analysis report for the 2011 FDE , the field cost to collect these elements will vary based on the total mileage of field data collection required for all roads in the State.[2, 8] Additionally, a base mobilization fee of $265,000 will be incurred to mobilize the data collection equipment in each State. Table 5 shows the breakdown of data collection cost per mile based on total miles.

Table 5. Sliding Scale Cost for Data Collection on Non-local paved roads – Surface Type and Median.

Cost to Collect ($/mile)	Description
$ 30.00	$30 per mile cost based on 2012 Utah LiDAR project for State where total mileage for data collection is >10,001 miles.
$ 45.00	For State where total mileage for data collection is 5,001-10,000 miles.
$ 55.00	For State where total mileage for data collection is 3,001 - 5,001 miles.
$ 70.00	For State where total mileage for data collection is 1,001-3,000 miles.
$ 90.00	For State where total mileage for data collection is < 1,000 miles.

Access control can be collected in the office utilizing aerial images or as-built plans. The costs associated with this effort were estimated to be $3.10 per mile (10 miles per hour at $31 per hour). This also includes the cost to collect the remaining segment identifiers. The analysis considers identifiers to be basic location and administrative elements (e.g., *segment identifier, direction of inventory*). This analysis also assumed that a State may have FDE data for some roadways in an existing roadway inventory system that requires effort to extract the data. A flat cost of $40,000 per State was included for converting the roadway inventory data from an existing system to the all-public roads LRS, assuming the LRS is GIS-based or similar and conversion of the data would be required.

Local Paved Roadways

In order to calculate the amount of local paved roadways requiring data collection based on the State Data Capabilities Assessment, local paved roads were subdivided into State and non-State-maintained roads by Federal-aid and non-Federal aid. As mentioned above, some States already collect many of the MIRE FDE for State-maintained Federal aid roadways. Some States collect at least a subset of the MIRE FDE on non-Federal-aid roadways, based on the State Data Capabilities Assessment.[10] To account for the additional costs to collect the MIRE FDE, only those elements not currently collected by the States were considered. This was done separately for each State based on their self-reported extent of collection from the State Data Capabilities Assessment. Where a partial number of elements were collected, the cost associated with the missing elements was derived by reducing the overall cost proportionally (missing elements/total elements).

Field data collection is needed for *surface type*. Based on the Utah LiDAR project and the market analysis report for the 2011 FDE, the field cost to collect these elements will vary based on the total mileage of field data collection required for all roads in the State.[2, 8]

Table 6 shows the breakdown of data collection cost per mile based on total miles.

Table 6. Sliding Scale Cost for Data Collection on local paved roads – Surface Type Only.

Cost to Collect ($/mile)	Description
$ 27.00	$26 per mile cost based on 2012 Utah LiDAR project for State where total mileage for data collection is >10,001 miles.
$ 41.00	For State where total mileage for data collection is 5,001-10000 miles.
$ 50.00	For State where total mileage for data collection is 3,001 -5,001 miles.
$ 63.00	For State where total mileage for data collection is 1,001-3,000 miles.
$ 81.00	For State where total mileage for data collection is < 1,000 miles.

The costs associated with in office effort are estimated to be $3.1 per mile (10 miles per hour at $31 per hour). This also includes the cost to collect the remaining identifiers. The analysis considers identifiers to be basic location and administrative elements (e.g., *segment identifier, direction of inventory*).

Unpaved Roadways

For unpaved roads, the MIRE FDE roadway segment element for functional classification can be collected in the office using aerial images or as-built plans. The office data collection for this category varies by rural and urban roadways. The collection costs for urban roadways was estimated to be $2.40 per mile (25 miles per hour at $60 per hour) and $0.75 per mile for rural roadways (80 miles per hour at $60 per hour). Urban roadways were estimated to cost more due to the number of links in GIS for urban areas compared to rural areas (e.g., longer segments in rural areas mean less links than in urban areas).

A five percent cost was added to segment data collection costs for QA/QC which is applied to the total cost of segment data collection for all road classes. Appendix A3 provides the cost breakdown for roadway segment data collection on State and non-State maintained non-local paved, local paved, and unpaved roads for each State.

Intersections

The MIRE FDE includes eight intersection elements for non-local paved roadways, two of which involve traffic volumes (AADT and AADT year).

The MIRE FDE for intersections can be divided into the following categories:

- MIRE FDE Identifiers – unique junction identifier, location identifier for road one crossing point, location identifier for road two crossing point, and unique approach identifier.
- MIR FDE Roadway Characteristics – intersection/junction geometry and intersection/junction traffic control. Volume data (the costs of this item are described in a subsequent section).

States will most efficiently achieve the collection of MIRE FDE identifiers by running a model which imports the intersections' attributes from existing roadway information. The presence of an LRS is a pre-requisite for running the model. While many States already have this system in place, it was assumed that all States will have it by the time they are ready to collect the intersection elements. Based on the MIRE MIS intersection inventory conducted for New Hampshire, the estimated cost to run this model is a flat fee of $12,480 (120 hours at $104/hour).(7) Since this is not a per element cost, the flat cost was applied to States that are missing any of the intersection identifiers on non-local paved roads.

Based on the findings of the MIRE MIS intersection inventory effort, the estimated costs to collect the intersection features were $1.023 per intersection (2 minutes per intersection at $31 per hour). Similar to the roadway segments, some States already collect MIRE FDE for intersections. In States where data were already available for some elements, the cost associated with the missing elements was derived by reducing the overall cost proportionally (number of elements that require data collection/total elements).

A five percent cost was added to intersection data collection for QA/QC which was applied to the total cost of intersection data collection. The cost per state of intersection data collection is provided in Appendix A4.

Ramps

The MIRE FDE includes 11 ramp elements, including two volume-related elements and two elements already collected under HPMS. Similar to intersections, States will most efficiently collect these elements by running a model to import the ramps' identifiers from existing roadway data. The MIRE FDE identifiers for ramps are *unique interchange identifier*, *location identifier for roadway at beginning ramp terminal*, *year of ramp AADT,* and *location identifier for roadway at ending ramp terminal*. The estimated cost to run the model is $8,320 (80 hours at $104/hour) and can only be run once an LRS is in place. Since this is not a per element cost, the flat cost was applied to States that are missing any of the ramp identifiers on State or non-State roads.

The remaining four roadway characteristics—*ramp length*, *roadway type at beginning* and *ending ramp termini*, and *interchange* type—can be collected in the office through aerials and as-built plans. The estimated cost to collect this information is $4.03 per ramp (eight minutes per ramp at $31 per hour). Similar to the intersections, some States already collect MIRE FDE for ramps. In States where data are already available for some elements, the cost associated with the missing elements was derived by reducing the overall cost proportionally (number of elements that require data collection/total elements).

A five percent cost was added to ramp data collection for QA/QC which is applied to the total cost of ramp data collection. Appendix A5 provides the cost breakdown for ramp data collection for each State.

Volume Data

The MIRE FDE includes volume data in the form of AADT and the year of the AADT collection for segments. For non-local paved roadways only, the MIRE FDE includes volume data for ramps and for all intersecting roadways at intersections. Volumes are already collected under HPMS for Federal-aid roadway segments and ramps. The method used to estimate the volume costs is explained in the following sections.

Roadway Segments

As previously mentioned, HPMS requires AADT reporting on all Federal-aid State roadways. Thus, no additional volume collection costs are associated with these roads.

As part of the 2013 analysis, several States were contacted to determine State practices for volume data collection for non-Federal-aid roads.(16) Colorado, Missouri, and Ohio reported that they collect volume data on all State roads, including non-Federal-aid locations. Based on these responses, the analysis assumed volume data are collected on 99 percent of non-Federal-aid State-maintained roadways. The remaining one percent of non-Federal-aid State-maintained roadways will require volume data collection to account for States that may not have fully complete volume data.

The three responding States also indicated they have volumes for approximately five percent of all non-Federal-aid, non-State roads. The analysis assumed that traffic volumes will be estimated for 90 percent of the non-State paved roads, and collected on the remaining 5 percent of the roadways.

The estimated cost to collect the volume data is based on vendors' cost estimates collected in the previous *Market Analysis* report at $480 per count (and updated to present value).(2) The analysis assumed one count per mile for urban roads, and one count per five miles for rural roads given that these roads tend to have similar volumes for longer stretches due to fewer cross roads. This resulted in a $480 per mile cost for urban roads and $96 per mile for rural roads.

The analysis assumed States will use existing volume and roadway data to estimate volumes on the roads where counts are not conducted. This can be done using geospatial analysis that assigns volumes based on roadway and location characteristics. Similar to the model run for segment and intersection identifiers, the analysis assumed a flat cost of $16,640 (160 hours at $104/hour) for estimation of volumes. In addition to this, there is a one-time cost of $166,000 to develop the model.(17)

Intersections

The MIRE FDE includes volumes for intersections of non-local paved roadways for both intersecting roadways. This analysis assumed that separate intersection volumes will not be counted. Instead, volumes will be assigned to the intersection based on the AADT of the intersecting roads. Based on the MIRE MIS intersection inventory effort, the cost to assign the volumes to an intersection was approximately $0.52 per intersection (100 hours per 10,000 intersections at $52 per hour).(7)

Ramps

HPMS reporting includes volume data for ramps; therefore, no additional cost is incurred to collect these data for ramps.

QA/QC Costs

A five percent cost was added to volume data collection for QA/QC which is applied to the total cost of volume data collection for all road classes. Appendix A6 provides the cost breakdown for volume data collection for each State.

Data Maintenance

In addition to the costs of initial data collection, the costs to maintain the data were also calculated (e.g., the costs to update the data as conditions change). For roadway segment data, the analysis assumed that two percent of the roadway mileage will be updated annually. The analysis approximated that updating the segment data will cost $6.20 per mile (five miles per hour at $31/hour). The cost of updating the segment data is more than the initial cost of collecting segment data since these updates will most likely not be done by updating individual segments based on updates from construction/design plans, aerials, and other technological advances, rather than re-collecting the data on a large-scale. More time will be needed to update segments individually (e.g., higher unit price for collection) than the large scale initial collection effort.

For intersections, the analysis assumed two percent of intersections will be updated annually. Similar to segments, these will be based on updates from construction/design plans and aerials. The analysis estimated that updating the intersection data will cost $2.68 per intersection (five minutes per intersection at $31/hour). Similar to segments, this assumed that more time will be needed for each intersection that is updated.

The analysis assumed two percent of ramps will be updated annually. The cost for updating ramps is $5.28 per ramp (10 minutes per ramp at $31/hour). As with segments and intersections, the analysis assumed more time is need per ramp for the data updates.

For updating volumes, the analysis assumed volumes on non-Federal-aid State roads will be updated on a three-year cycle (i.e., 33 percent of volumes updated annually). The volumes on non-Federal-aid non-State roads will be updated on a six-year cycle. This is only for those roads that have existing counts (five percent of total) and roads with new counts from the data collection (five percent of total). This equates to approximately two percent of the non-Federal-aid non-State roads annually. The same rate of collection and cost per count used for the data collection is applied for the updates, for both urban and rural roads.

These data collection cycles and maintenance assumptions were based on standard practices obtained through discussions with several States.

A five percent cost was added to maintenance cost for QA/QC which is applied to the total cost of maintenance.

Appendix A7 summarizes the maintenance costs for each State.

Management and Administration of Data Collection Efforts

The efforts to collect the roadway segment, intersection, and ramp data will require additional costs for management and administration, particularly if the data are collected by vendors or contractors. The analysis included management and administration costs equal to five percent of the total data collection costs, up to $260,000 maximum for each State. Appendix A8 provides the cost breakdown for volume data collection for each State.

Miscellaneous Costs

In addition to the costs of initial data collection and the costs to maintain the data, there are also one-time and annual ongoing costs associated with data collection.

Implementation Plan

Each State is required to prepare a MIRE FDE data collection implementation plan before any data collection effort. The cost for this effort was estimated to be a one-time cost of $100,000 based on project experiences developing plans for similar efforts.

Local Agency Partner Liaison Costs

This study assumed that States will liaise with local municipalities and MPOs for updating the database and importing data collected by these agencies to the State maintained LRS, rather than duplicating the data collection effort. The analysis estimated local partner coordination costs equal to $2.80 per mile for the total road miles in the State, with a minimum of $235,000 for each State based on recommendation by the State of Washington in the NPRM comments.

Formatting and Analyzing Enhanced Data Costs

The annual, ongoing cost of using this enhanced data for each State was also included in this analysis. This cost was estimated to be $125,000 per year for each State based on the comments received on NPRM, approximately equal to one full-time staff member per year. In the initial years, the cost would relate primarily to formatting the data. In subsequent years, the cost would relate to analyzing the enhanced data.

Desktop and Web Application Costs

The annual, ongoing cost of converting and uploading the LRS data on the web for each State was also included in this analysis. This cost is estimated to be $78,000 per year for first two year for each State based on the comments received on NPRM. After the first two year, the annual maintenance cost is estimated to be $15,500 per year. In the initial years, the cost would relate primarily to developing the web application and formatting the data. In subsequent years, the cost would relate to maintaining the website and updating the data.

Appendix A9 summarizes the miscellaneous costs for each State.

Disaggregated Annual Costs

The annual base cost for segments, intersections, and ramps was disaggregated for each State. The analysis assumed that all States will have an LRS by June 30, 2016, as this is the end date for LRS development. The analysis assumed a data collection start date of June 30, 2016, assigning the data to the new LRS. The analysis assumed the MIRE FDE data collection including the implementation plan will be completed by June 30, 2026, for a total time period of 11 years starting on June 30, 2015. The costs are disaggregated annually at an equal rate for the duration of the data collection period, which does not include the first year during which the implementation plan will be prepared.

Data collection and maintenance costs were assessed over the entire analysis period—2015 to 2035. This timeframe allowed for the total eleven year data collection period and an additional ten years of implementation. Three discount rates of undiscounted, 3.0 percent, and 7.0 percent are used to calculate the present value of the collection and maintenance costs for each year in 2014 dollars, representing several inflation scenarios as required by OMB Circular A-4. The present value cost for each year was summed to determine the net present value cost for the total analysis period, including maintenance of the data. Appendix A10 summarizes the net present value costs for each State.

Benefits

The cost-effectiveness analyses is calculated by estimating the reduction in fatalities and all injuries needed to exceed a 1:1 ratio, and a 10:1 ratio of benefits to costs. The 1:1 ratio is necessary for a breakeven analysis, while the 10:1 ratio is more consistent with benefits achieved by highway safety improvement projects. That is, the assumed benefit of collecting the MIRE FDE is a reduction in a cross section of crashes which include some property damage only crashes, some injury crashes, and some fatal crashes.. The 2014 comprehensive cost of a fatality is $9,300,000 and $109,800 for an injury, based on the value of a statistical life.(14) The injury cost reflects the average injury costs based on the national distribution of injuries in the General Estimate System (GES) using a Maximum Abbreviated Injury Scale (MAIS). MAIS injuries are on a scale of zero to five, with five representing the most severe non-fatal injury in the crash. Table 7 shows the detailed calculation of how the average cost of injury in a crash was calculated based on the fraction (proportion) of the Value of Statistical Life (VSL).

Table 7. Cost of Injury Calculation

AIS Level	Severity	2007 2011 Average Injury Distribution excluding Fatalities[2,3]		Fraction of VSL	Cost	Cost of Injury[1]
AIS 1	Minor	$ 2,411,169	88.4%	0.003	$27,900	$ 24,653
AIS 2	Moderate	$ 229,954	8.4%	0.047	$437,100	$36,836
AIS 3	Serious	$ 67,590	2.5%	0.105	$976,500	$24,188
AIS 4	Severe	$ 14,573	0.5%	0.266	$ 2,473,800	$ 13,212
AIS 5	Critical	$ 5,398	0.2%	0.593	$5,514,900	$10,910
Total Cost of Injury for any Severity						$109,800

Notes:

1. Injury cost calculated using distribution of AIS Levels 1-5.
2."Benefit-Cost Analysis for Transportation Infrastructure: A Practitioners Workshop," Darren Timothy, FHWA, http://tti.tamu.edu/conferences/benefit_cost10/program/presentations/timothy.pdf
3. National Automotive Sampling System (NASS), General Estimates System (GES)

The average cost of a fatality and injury was calculated for the analysis period. This calculation accounts for the portion of the fatality and injury costs during the data collection period.

The analysis used a six-year average of fatalities in each State, as reported in the Fatality Analysis Reporting System (FARS) from 2007 to 2012.(15) The six-year ratio of the number of fatalities to injuries is the national average ratio of fatalities to injuries. During this six-year period, there were an average of 35,157 total fatalities per year and 2,312,000 total injuries per year, equating to a fatality to injury ratio of approximately 1:66. Using that ratio, the number of fatalities and injuries needed to exceed a 1:1 ratio, and a 10:1 of benefits to costs is developed for each State. Table 8 shows the growth of cost of fatality and injury over the analysis period using an inflation rate of 1.18 percent.

The future cost of a fatality and injury was forecasted out for each year of the analysis period, and then represented in 2014 dollar values using the three discount rates. The benefits calculation assumed a yearly accumulation of benefits beginning after the June 30, 2016 data collection start date. The analysis assumed a portion of benefits will be accumulated while data are collected, with the full realization of benefits after data collection is complete. The benefits are spread over a 10-year data collection period at equal increments.

Table 9 shows the rate of accumulation of the benefits.

Table 8. Present Value Cost of Fatalities and Injuries (2014 Dollars).

PRESENT VALUE COST OF FATALITIES AND INJURIES (2014 DOLLARS)																					
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Fatality	$9,300,000	$8,794,150	$8,315,814	$7,863,495	$7,435,780	$7,031,329	$6,648,878	$6,287,228	$5,945,250	$5,621,873	$5,316,085	$5,026,930	$4,753,502	$4,494,947	$4,250,456	$4,019,263	$3,800,645	$3,593,918	$3,398,436	$3,213,587	$3,038,791
Injury[4]	$ 109,800	$ 103,827	$ 98,180	$ 92,840	$ 87,790	$ 83,015	$ 78,499	$ 74,230	$ 70,192	$ 66,374	$ 62,764	$ 59,350	$ 56,122	$ 53,069	$ 50,183	$ 47,453	$ 44,872	$ 42,431	$ 40,123	$ 37,941	$ 35,877

Notes:

4. Injury cost calculated using distribution of injury crashes for MAIS Levels 1-5.

Table 9. Accumulation of Benefits.

Year End	Value of Data in Decision Making	Comment
6/30/2017	0%	No value in first full year of collection as data are not readily available for analysis
6/30/2018	10%	LRS is available for use and increases ability for analysis
6/30/2019	20%	LRS is available for use and increases ability for analysis
6/30/2020	30%	LRS is available for use and increases ability for analysis
6/30/2021	40%	LRS and high priority data are available
6/30/2022	50%	LRS and high priority data are available
6/30/2023	60%	LRS and high priority data are available
6/30/2024	70%	LRS and high priority data are available
6/30/2025	80%	Rate of increase in value flattens
6/30/2026	90%	Rate of increase in value flattens
6/30/2027	100%	Rate of increase in value flattens
6/30/2028	100%	Rate of increase in value flattens
6/30/2029	100%	Full value of data realized
6/30/2030	100%	Value of investment continues.
6/30/2031	100%	Value of investment continues.
6/30/2032	100%	Value of investment continues.
6/30/2033	100%	Value of investment continues.
6/30/2034	100%	Value of investment continues.
6/30/2035	100%	Value of investment continues.

MIRE FUNDAMENTAL DATA ELEMENTS COST-BENEFIT ESTIMATION RESULTS

Costs of Data Collection and Maintenance

The costs for each State to collect the additional MIRE FDE are compiled into eight categories:

1. Costs to develop a common LRS.
2. Costs to collect the MIRE FDE elements for roadway segments.
3. Costs to collect the MIRE FDE elements for intersections.
4. Costs to collect the MIRE FDE elements for ramps.
5. Cost to collect volume data.
6. Cost to manage and administer data collection efforts.
7. Cost to maintain the data annually.
8. Miscellaneous costs —including the one-time cost of developing an implementation plan and cost of data collection mobilization and annual ongoing costs of local agency partner liaison, formatting and analyzing enhanced data and desktop and web application.

Table 10 lists the net present value undiscounted, 3.0 percent and 7.0 percent discount rate costs to complete the data collection and maintain the data for the entire 20-year period.

Table 11 lists the annualized undiscounted, 3.0 percent and 7.0 percent discount rate costs to complete the data collection and maintain the data for the entire 20-year period.

Table 10. Net Present Costs of MIRE FDE Data Collection and Maintenance Costs for the 2015-2035 Analysis Period (2014 Dollars) Discounted Seven Percent.

Cost Components	US Average per State			US Total		
	Undiscounted (0.0%)	3.0 % discount	7.0 % discount	Undiscounted (0.0%)	3.0 % discount	7.0 % discount
LRS	$666,865	$657,153	$645,051	$34,010,102	$33,514,809	$32,897,622
Segments	$1,350,574	$1,135,290	$917,558	$68,879,288	$57,899,768	$46,795,474
Intersections	$42,378	$35,622	$28,791	$2,161,256	$1,816,747	$1,468,323
Ramps	$20,745	$17,438	$14,094	$1,057,984	$889,339	$718,777
Volumes	$809,748	$699,169	$585,726	$41,297,152	$35,657,606	$29,872,025
Management & Administration	$125,700	$105,663	$85,398	$6,410,685	$5,388,807	$4,355,316
Maintenance	$1,287,916	$888,614	$566,820	$65,683,740	$45,319,305	$28,907,829
Miscellaneous	$8,619,325	$6,422,002	$4,582,879	$439,585,598	$327,522,078	$233,726,851
Total	$12,923,251	$9,960,950	$7,426,318	$659,085,805	$508,008,459	$378,742,217

Table 11. Annualized Costs of MIRE FDE Data Collection and Maintenance Costs for the 2015-2035 Analysis Period (2014 Dollars) Discounted Seven Percent.

Cost Components	US Average per State			US Total		
	Undiscounted (0.0 %)	3.0 % discount	7.0 % discount	Undiscounted (0.0%)	3.0 % discount	7.0 % discount
LRS	$33,343	$44,170	$60,886	$1,700,505	$2,252,664	$3,105,207
Segments	$67,529	$76,307	$86,608	$3,443,964	$3,891,675	$4,417,025
Intersections	$2,119	$2,394	$2,718	$108,063	$122,111	$138,595
Ramps	$1,037	$1,172	$1,330	$52,899	$59,776	$67,845
Volumes	$40,487	$46,994	$55,287	$2,064,858	$2,396,690	$2,819,620
Management & Administration	$6,285	$7,102	$8,061	$320,534	$362,203	$411,098
Maintenance	$64,396	$59,727	$53,502	$3,284,187	$3,046,092	$2,728,610
Miscellaneous	$430,966	$431,648	$432,578	$21,979,280	$22,014,069	$22,061,477
Total	$646,163	$669,515	$700,970	$32,954,290	$34,145,281	$35,749,478

Benefit-Cost Analysis

The estimated benefits needed for the entire analysis period and the benefits needed per year after the benefits are realized are summarized in Table 12 and Table 13, respectively, for the three discount rates. Fatalities and injuries are rounded to the nearest whole number. In order to achieve a greater than 1:1 benefit to cost ratio, the national fatality and injury average would need to experience a reduction of 76 and 5,020, respectively, over the course of the analysis period at a 7 percent discount rate. As the benefit to cost ratio increases, as does the needed reduction in fatalities and injuries. A 10:1 benefit cost ratio would be achieved through a decrease in the national average of fatalities by 760 and 50,201 injuries. Both, the number of fatalities and injuries will need to be reduced in order to achieve the desired benefit to cost ratio.

As demonstrated in Table 13, a 1:1 benefit to cost ratio would be achieved through reducing the national average (per year) of fatalities by 4 and injuries by 264 (both rounded to the nearest whole number). A 10:1 benefit to cost ratio would reflect a reduction of 40 fatalities and 2,642 injuries.

Between 2007 and 2012 an average of 35,157 people died in motor vehicle traffic crashes in the United States, and an estimated 2.23 million people were injured. [18,19] The decrease in fatalities needed to achieve a 1:1 cost-benefit ratio represent a 0.8 percent reduction of annual fatalities using the average of 2007-2012 statistics. The experiences to date in States that are already collecting and using roadway data comparable to the MIRE FDE suggests there is a very high likelihood that the benefits of collecting and using the MIRE FDE will outweigh the costs. The MIRE FDE in combination with crash data will support more cost-effective safety investment decisions and ultimately yield greater reductions in fatalities and serious injuries per dollar invested.

One study on the effectiveness of the HSIP found: The magnitude of States' fatal crash reduction was highly associated with the years of available crash data, prioritizing method, and use of roadway inventory data.[20] Moreover, States that prioritized hazardous sites by using more detailed roadway inventory data and the empirical Bayes method had the greatest reductions; all of those States relied heavily on the quality of crash data system."

For example, this study cites Colorado's safety improvements, noting "Deployment of advanced methods on all projects and acquisition of high-quality data may explain why Colorado outperformed the rest of the country in reduction of fatal crashes."[20] Illinois was also high on this study's list of States with the highest percentage reduction in fatalities. In a case study of Illinois' use of AASHTO Highway Safety Manual methods, an Illinois DOT official noted that use of these methods "requires additional roadway data, but has improved the sophistication of safety analyses in Illinois resulting in better decisions to allocate limited safety resources."[21] Another case study of Ohio's adoption of a tool to apply the roadway safety management methods described in the AASHTO Highway Safety Manual concluded, "In Ohio, one of the benefits of applying various HSM screening methods was identifying ways to overcome some of the limitations of existing practices. For example, the previous mainframe methodology typically over-emphasized urban "sites of promise" – locations identified for further investigation and potential countermeasure implementation. These locations were usually in the largest urban areas, often with a high frequency of crashes that were low in severity. Now, several screening methods can be used in the network screening process resulting in greater identification of rural corridors and projects. This identification enables Ohio's safety program to address more factors contributing to fatal and injury crashes across the State, instead of being limited to high-crash locations in urban areas, where crashes often result in minor or no injuries."[22] Another document quantified these benefits, indicating that the number of fatalities per identified mile is 67 percent higher, the number of serious injuries per mile is 151 percent higher, and the number of total crashes is 105 percent higher with these new methods than with their former methods.[23] In summary, all three States experienced benefits to the effectiveness of safety investment decision-making through the use of methods that included roadway data akin to the MIRE FDE and crash data in their highway safety analyses.

Table 12. Estimated Benefits Needed to Achieve Benefit-Cost Ratios of 1:1, and 10:1 for the 2015-2035 Analysis Period.

Benefits	Number of Lives Saved/Injuries Avoided Nationally for the 2015 2035 Analysis Period		
	Undiscounted (0.0%)	3.00%	7.00%
Benefit/Cost Ratio of 1:1			
# of lives saved (fatalities)	55	63	76
# of injuries avoided	3,635	4,156	5,020
Benefit/Cost Ratio of 10:1			
# of lives saved (fatalities)	553	632	763
# of injuries avoided	36,351	41,563	50,201

Table 13. Estimated per year Benefits Needed to Achieve Benefit-Cost Ratios of 1:1, and 10:1 for the 2015-2035 Analysis Period.

Benefits	Number of Lives Saved/Injuries Avoided Nationally per year for the 2015 2035 Analysis Period		
	Undiscounted (0.0%)	3.00%	7.00%
Benefit/Cost Ratio of 1:1			
# of lives saved (fatalities)	3	3	4
# of injuries avoided	191	219	264
Benefit/Cost Ratio of 10:1			
# of lives saved (fatalities)	29	33	40
# of injuries avoided	1,913	2,188	2,642

SUMMARY

The purpose of this effort was to update the economic analysis of the development of a statewide common LRS and the collection of the MIRE FDE on all public roads. Collecting additional roadway and traffic data, and integrating those data into the safety analysis process, will improve an agency's ability to make more informed decisions, better target safety investments, and reduce fatalities and serious injuries.

The approach used to conduct the economic analysis was a hybrid of a benefit-cost analysis and a cost effectiveness analysis. The costs for data collection were provided from several sources including the MIRE MIS Lead Agency Program intersection inventory effort, Utah's LiDAR experience, and vendors' estimates. For benefits, an estimate of how many fatalities and injuries would need to be reduced in order exceed the costs (for a 1:1, and 10:1 ratio) were developed. That is, this analysis identified the benefit required to obtain cost effectiveness.

The analysis calculated the costs for each State to collect the MIRE FDE that they do not already collect for HPMS, or for other purposes, as reported in the State Data Capabilities Assessment. [10] The costs were broken down for the development of an LRS, collection of segment, intersection, ramp, and volume data, management and administration of data, annual maintenance of data, and other miscellaneous costs.

The analysis period, including the time for developing an implementation plan and data collection, is from 2015 to 2035. Benefits do not start to accumulate until after the LRS data are available for use, which is assumed to be June 30, 2017. After that date, a portion of the benefits accumulate while the FDE data are collected, with the full realization of benefits after data collection is complete in 2026. Benefits continue to accumulate for a nine-year period after 2026 to 2035 to fully realize the benefits.

The estimated reduction in fatalities and injuries was determined based on the costs. The national average for the total cost of data collection and maintenance over the entire analysis period of 20 years is $7.43 million per State (in 2014 U.S. dollars). Based on the accumulation of benefits from Table 9, the benefit period is 19 years because the LRS data will not be readily available for analysis till June 30, 2016. The period of analysis is 20 years with no benefit in the first year as the data collected in the year 2016 will not be readily available for analysis. Nationally, a reduction of 4 fatalities and 251 injuries per year over a period of 20 years from 2016 to 2035 is required to achieve a greater than 1:1 benefit to cost ratio discounted at 7 percent. This translates to a reduction in the total national fatality (35,157) and injury (2,231,200) average by 0.2 percent per year.

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Appendix A1 a. Cost Inputs and Source - LRS.

OWNERSHIP	VARIABLE	RATE	UNIT	COMMENT
All	Cost to collect	$30.00	per mile	$30 per mile cost based on 2012 Utah LiDAR project for State where total mileage for LRS is >1,0001 miles. Reinforced by previous market analysis has been updated to 2014 value using the Consumer Price Index (CPI) Inflation Calculator
All	Cost to collect	$45.00	per mile	For State where total mileage for LRS is 5,001-10,000 miles. Cost based on a sliding scale reinforced by previous market analysis has been updated to 2014 value using the CPI Inflation Calculator.
All	Cost to collect	$55.00	per mile	For State where total mileage for LRS is 3,001 -5,001 miles. Cost based on a sliding scale reinforced by previous market analysis has been updated to 2014 value using the CPI Inflation Calculator.
All	Cost to collect	$70.00	per mile	For State where total mileage for LRS is 1,001-3,000 miles. Cost based on a sliding scale reinforced by previous market analysis has been updated to 2014 value using the CPI Inflation Calculator.
All	Cost to collect	$90.00	per mile	For State where total mileage for LRS is < 1,000 miles. Cost based on a sliding scale reinforced by previous market analysis has been updated to 2014 value using the CPI Inflation Calculator.
QA/QC	Cost for QA/QC	5%	percent	Based on Utah LiDar and professional experience - refer to the bottom of the sheet for the calculations and source.

Appendix A1 b. Cost Inputs and Source - Segments.

OWNERSHIP	VARIABLE	RATE	UNIT	COMMENT
All	Field collection, LiDAR mobilization	$265,000.0	base cost	Cost based on 2012 Utah LiDAR base mobilization cost has been updated to 2014 value using the CPI Inflation Calculator.
Non-Local Paved Roads	Field collection, LiDAR cost	$30.00	per mile	Cost based on 2012 Utah LiDAR. Surface type ($26/mi), median type ($4/mi). Updated to 2014 value using the CPI Inflation Calculator
Non-Local Paved Roads	Cost to collect	$45.00	per mile	For State where total mileage for data collection is 5,001-10,000 miles. Cost based on a sliding scale reinforced by previous market analysis has been updated to 2014 value using the CPI Inflation Calculator.
Non-Local Paved Roads	Cost to collect	$55.00	per mile	For State where total mileage for data collection is 3,001 -5001 miles. Cost based on a sliding scale reinforced by previous market analysis has been updated to 2014 value using the CPI Inflation Calculator.
Non-Local Paved Roads	Cost to collect	$70.00	per mile	For State where total mileage for data collection is 1,001-3,000 miles. Cost based on a sliding scale reinforced by previous market analysis has been updated to 2014 value using the CPI Inflation Calculator.
Non-Local Paved Roads	Cost to collect	$90.00	per mile	For State where total mileage for data collection is < 1,000 miles. Cost based on a sliding scale reinforced by previous market analysis has been updated to 2014 value using the CPI Inflation Calculator.
Non-Local Paved Roads	In office, rate of collection	10	miles per hour	Access control and number of through lanes can be collected from aerials, plus any additional identifiers (minimal).
Non-Local Paved Roads	In office, cost	$31.00	per hour	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Non-Local Paved Roads	In office, rate of conversion	40,000.00	maximum	Flat rate of conversion of roadway inventory data to LRS database for links with missing data. This cost is based on an assumption that 2% of the links will have to be manually checked and entered.
Local Paved Roads	Field collection, LiDAR cost for elements	$27.00	per mile	Based on Utah LiDAR costs. Surface type ($26/mi). Updated to 2014 value using the CPI Inflation Calculator.
Local Paved Roads	Field collection, LiDAR cost for elements	$41.00	per mile	For State where total mileage for data collection is 5001-10,000 miles. Cost based on a sliding scale reinforced by previous market analysis has been updated to 2014 value using the CPI Inflation Calculator.
Local Paved Roads	Field collection, LiDAR cost for elements	$50.00	per mile	For State where total mileage for data collection is 3001 -5001 miles. Cost based on a sliding scale reinforced by previous market analysis has been updated to 2014 value using the CPI Inflation Calculator.
Local Paved Roads	Field collection, LiDAR cost for elements	$63.00	per mile	For State where total mileage for data collection is 1001-3,000 miles. Cost based on a sliding scale reinforced by previous market analysis has been updated to 2014 value using the CPI Inflation Calculator.
Local Paved Roads	Field collection, LiDAR cost for elements	$81.00	per mile	For State where total mileage for data collection is < 1000 miles. Cost based on a sliding scale reinforced by previous market analysis has been updated to 2014 value using the CPI Inflation Calculator.
Local Paved Roads	Field collection, LiDAR cost for elements	$81.00	per mile	For State where total mileage for data collection is < 1000 miles. Cost based on a sliding scale reinforced by previous market analysis has been updated to 2014 value using the CPI Inflation Calculator.
Local Paved Roads	In office, rate of collection	10	miles per hour	Number of through lanes can be collected from aerials, plus any additional identifiers (minimal).
Local Paved Roads	In office, cost	$27.00	per hour	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Unpaved Roads - Urban	In office, rate of collection	25.00	miles per hour	Functional Class and Ownership, plus any additional identifiers (minimal). Cost estimate is based on professional experience during working on the Functional Classification system for VDOT.
Unpaved Roads - Urban	In office, cost	$60.00	per hour	GIS Technician.
Unpaved Roads - Rural	In office, rate of collection	80.00	miles per hour	Functional Class and Ownership, plus any additional identifiers (minimal). Cost estimate is based on professional experience during working on the Functional Classification system for VDOT.
Unpaved Roads - Rural	In office, cost	$60.00	per hour	GIS Technician.
QA/QC		5%	percent	Based on Utah LiDar and professional experience - refer to the bottom of the sheet for the calculations and source.

Appendix A1 c. Cost Inputs and Source - Intersections.

OWNERSHIP	VARIABLE	RATE	UNIT	COMMENT
All	Number of intersections, all roads			Based on ratio between TIGER and HPMS mileage applied to number of intersections from TIGER Line mileage. Refer to *Intersection Data* tab for calculations.
Non-Local/Non-Local and Non-Local/Local	Portion of intersections that fall in this category	22%	percent	Extrapolation based on data obtained from States. See *StateData_Int* tab.
All	Identification of intersections and identifiers, rate	120	hours	This is a model that is run; setup time is the same regardless of the size of the State. Requires LRS to be in place; this portion occurs after 2016 for most States.
All	Identification of intersections and identifiers, cost	$104.00	per hour	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Non-Local/Non-Local and Non-Local/Local	In office, rate of collection	0.033	hours per intersection	Rate equivalent to 2 minutes per intersection. Geometry and traffic control can be collected from aerials.
Non-Local/Non-Local and Non-Local/Local	In office, cost	$31.00	per hour	Base on NH intersection inventory costs and updated to 2014 value using the CPI Inflation Calculator.
QA/QC		5%	percent	Based on Utah LiDar and professional experience - refer to the bottom of the sheet for the calculations and source.

Appendix A1 d. Cost Inputs and Source - Ramps.

OWNERSHIP	VARIABLE	RATE	UNIT	COMMENT
All	Number of ramps			Based on average interchange to ramp ratio between States that provided ramp data and applied to total interchanges from TIGER. Refer to Ramp Data tab for calculations.
All	Identification of ramps and identifiers, rate	80	hours	This is a model that is run; setup time is the same regardless of the size of the State. Requires LRS to be in place; this portion occurs after 2014 for most States.
All	Identification of ramps and identifiers, cost	$104.00	per hour	
All	In office, rate of collection	0.13	hours per ramp	Rate equivalent to eight minutes per ramp.
All	In office, cost	$31.00	per hour	
QA/QC		5%	percent	Based on Utah LiDar and professional experience - refer to the bottom of the sheet for the calculations and source.

Appendix A1 e. Cost Inputs and Source - Volume.

OWNERSHIP	VARIABLE	RATE	UNIT	COMMENT
Non-Local Paved Roads	Percent of roads with volume	95%	percent	Only for Non-State roads, state roads are all HPMS elements and therefore 100% of the roads have AADT
Non-Local Paved Roads	Percent of roads to collect volume	5%	percent	
Non-Local Paved Roads	ADT on segment, urban, rate of collection	1	count per mile	
Non-Local Paved Roads	ADT on segment, urban, cost	$480.00	per count	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Non-Local Paved Roads	ADT on segment, rural, rate of collection	0.2	count per mile	Rate is equivalent to one count every five miles.
Non-Local Paved Roads	ADT on segment, rural, cost	$480.00	per count	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Local Paved Roads	Percent of roads with volume	5%	percent	
Local Paved Roads	Percent of roads to estimate volume	90%	percent	
Local Paved Roads	Model Development Cost	$166,000.0	per State	One time flat cost to develop the regression model for estimating counts based on five percent actual count to get the 90-10 Confidence Interval. Based on Michigan's 2009 report for estimating traffic on local roads
Local Paved Roads	Estimation of volumes, rate	160.00	hours	Assume estimations are based on exiting roadway information (e.g., functional class, area type) and existing volumes.
Local Paved Roads	Estimation of volumes, cost	$104.00	per hour	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Local Paved Roads	Percent of roads to collect volume	5%	percent	
Local Paved Roads	ADT on segment, urban, rate of collection	1	count per mile	
Local Paved Roads	ADT on segment, urban, cost	$480.00	per count	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Local Paved Roads	ADT on segment, rural, rate of collection	0.2	count per mile	Rate is equivalent to one count every five miles.
Local Paved Roads	ADT on segment, rural, cost	$480.00	per count	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Non-Local/Non-Local and Non-Local/Local Intersection	Assignment of volumes, rate	$0.01	hours per intersection	Rate is equivalent to 100 hours per 10,000 intersections. This is based on the NH intersection inventory effort and updated to 2014 using the CPI.
Non-Local/Non-Local and Non-Local/Local Intersection	Assignment of volumes, cost	$52.00	per hour	
QA/QC		5%	percent	Based on Utah LiDar and professional experience - refer to the bottom of the sheet for the calculations and source.

Appendix A1 f. Cost Inputs and Source - Inventory Maintenance Costs.

OWNERSHIP	VARIABLE	RATE	UNIT	COMMENT
Segment - Non-Local Paved Roads	Roadways updated annually	2%	percent	Update annually. Based on inputs FHWA and knowledge of State practices.
Segment - Non-Local Paved Roads	In office, rate of collection	5	miles per hour	
Segment - Non-Local Paved Roads	In office, cost	$31.00	per hour	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Local Paved Roads	Roadways updated annually	1%	percent	Update annually. Based on inputs FHWA and knowledge of State practices.
Local Paved Roads	In office, rate of collection	5	miles per hour	
Local Paved Roads	In office, cost	$31.00	per hour	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Intersections - S/S and S/L	Intersections updated annually	2%	percent	Update annually. Based on inputs FHWA and knowledge of State practices.
Intersections - S/S and S/L	In office, rate of collection	0.08	hours per intersection	Rate equivalent to five minutes per intersection. Assume more individual attention needed for each intersection.
Intersections - S/S and S/L	In office, cost	$31.00	per hour	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator
Ramps	Ramps updated annually	2%	percent	Update annually. Based on inputs FHWA and knowledge of State practices.
Ramps	In office, rate of collection	0.17	hours per ramp	Rate equivalent to ten minutes per ramp. Assume more individual attention needed for each ramp.
Ramps	In office, cost	$31.00	per hour	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Volume - Non-Local Paved Roads	Volumes updated annually, urban	33%	percent	Update on a three-year cycle.
Volume - Non-Local Paved Roads	ADT on segment, urban, rate of collection	1	count per mile	
Volume - Non-Local Paved Roads	ADT on segment, urban, cost	$480.00	per count	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Volume - Non-Local Paved Roads	Volumes updated annually, rural	33%	percent	Update on a three-year cycle.
Volume - Non-Local Paved Roads	ADT on segment, rural, rate of collection	0.2	count per mile	Rate is equivalent to one count every five miles.
Volume - Non-Local Paved Roads	ADT on segment, rural, cost	$ 480.00	per count	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Volume - Local Paved Roads	Volumes updated annually	1.7%	percent	Update only the roads with volumes on a six-year cycle.
Volume - Local Paved Roads	ADT on segment, urban, rate of collection	1	count per mile	
Volume - Local Paved Roads	ADT on segment, urban, cost	$480.00	per count	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
Volume - Local Paved Roads	Volumes updated annually	0%	percent	
Volume - Local Paved Roads	ADT on segment, rural, rate of collection	0.2	count per mile	Rate is equivalent to 1 count every 5 miles.
Volume - Local Paved Roads	ADT on segment, rural, cost	$480.00	per count	Rate is based on 2013 analysis and has been updated to 2014 value using the CPI Inflation Calculator.
QA/QC		5%	percent	Based on Utah LiDar and professional experience - refer to the bottom of the sheet for the calculations and source.

Appendix A1 g. Cost Inputs and Source - Miscellaneous Inputs.

OWNERSHIP	VARIABLE	RATE	UNIT	COMMENT
All	Implementation Plan	$100,000.0	per State	One time cost for developing a data collection implementation plan.
All	Local Partner Liaison	$2.80	per mile	Annual Ongoing cost of liaison with local partners for data update and maintenance based on Washington $235,000. Will set a floor of 235,000 for States with mileage less than WA but calculate as per mile for other States.
All	Local Partner Liaison	$235,000.0	minimum	Annual Ongoing cost of liaison with local partners for data update and maintenance based on Washington $235,000. Will set a floor of 235,000 for States with mileage less than WA but calculate as per mile for other States.
All	Formatting and Analyzing Enhance Data	$125,000.0	per State	Annual cost based on States comments on NPRM.
All	Discount Rate	7.00%	percent	Per FHWA direction.
All	Inflation Rate	0.00%	percent	
All	Value of a Statistical Life (VSL)	$9,300,000.00	per fatality	Source: Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses - 2014 Update (http://www.dot.gov/sites/dot.gov/files/docs/VSL_Guidance_2014.pdf). Also notes it should grow by 1.18 per year before discounting to PV.
All	Inflation Rate	1.18%	percent	Inflation Rate for VSL.
All	Annualization Factor	0.094390	per dollar	The factor to annualize the total present value cost at the specified discount rate.
All	Data collection M&A, percent of costs	5%	percent	Management and administration costs for data collection.
All	Data collection M&A, maximum	$260,000.0	maximum	
All	Desktop and Web Application	$78,000.00	maximum	Uploading the data to cloud and annual maintenance cost for first two years. Based on 2012 Utah LiDar and updated to 2014 using CPI.
All	Desktop and Web Application	$15,500.00	maximum	Uploading the data to cloud and annual maintenance cost starting in third year and beyond. Based on 2012 Utah LiDar and updated to 2014 using CPI.

Appendix A2. Cost of Completing a Linear Referencing System by State.

State	State[5]	Local[6]	Total	QA/QC	Grand Total
Alabama	-	-	-	-	-
Alaska	$ 43,742	$ 305,425	$ 349,168	$ 17,458	$ 366,626
Arizona	$ 23,542	$ 1,536,427	$ 1,559,969	$ 77,998	$ 1,637,968
Arkansas	-	$ 2,332,500	$ 2,332,500	$ 116,625	$ 2,449,125
California	-	-	-	-	-
Colorado	$ 4,194	$ 2,127,096	$ 2,131,291	$ 106,565	$ 2,237,855
Connecticut	$ 1,392	$ 456,819	$ 458,211	$ 22,911	$ 481,122
Delaware	-	-	-	-	-
Dist. of Columbia	$ 38,428	$ 11,434	$ 49,862	$ 2,493	$ 52,355
Florida	$ 275	$ 2,864,959	$ 2,865,234	$ 143,262	$ 3,008,496
Georgia	-	-	-	-	-
Hawaii	-	-	-	-	-
Idaho	--	$ 1,114,304	$ 1,114,304	$ 55,715	$ 1,170,019
Illinois	-	-	-	-	-
Indiana	-	-	-	-	-
Iowa	-	-	-	-	-
Kansas	$ 446	$ 3,169,674	$ 3,170,120	$ 158,506	$ 3,328,626
Kentucky	-	-	-	-	-
Louisiana	-	-	-	-	-
Maine	-	-	-	-	-
Maryland	-	-	-	-	-
Massachusetts	-	-	-	-	-
Michigan	-	-	-	-	-
Minnesota	-	-	-	-	-
Mississippi	-	-	-	-	-
Missouri	-	-	-	-	-
Montana	-	$ 1,785,209	$ 1,785,209	$ 89,260	$ 1,874,469
Nebraska	$ 200	$ 2,195,365	$ 2,195,565	$ 109,778	$ 2,305,343
Nevada	$ 15,226	$ 928,436	$ 943,662	$ 47,183	$ 990,845
New Hampshire	-	-	-	-	-
New Jersey	-	-	-	-	-
New Mexico	$ 82,939	$ 1,622,239	$ 1,705,178	$ 85,259	$ 1,790,437
New York	-	$ 2,599,472	$ 2,599,472	$ 129,974	$ 2,729,445
North Carolina	$ 475,997	$ 765,390	$ 1,241,387	$ 62,069	$ 1,303,457
North Dakota	-	-	-	-	-
Ohio	-	-	-	-	-
Oklahoma	-	-	-	-	-
Oregon	$ 5,939	$ 1,227,804	$ 1,233,743	$ 61,687	$ 1,295,431
Pennsylvania	-	$ 2,284,104	$ 2,284,104	$ 114,205	$ 2,398,309
Rhode Island	-	-	-	-	-
South Carolina	-	$ 731,663	$ 731,663	$ 36,583	$ 768,247
South Dakota	-	-	-	-	-
Tennessee	-	-	-	-	-
Texas	-	-	-	-	-
Utah	$ 1,812	$ 1,104,657	$ 1,106,468	$ 55,323	$ 1,161,792
Vermont	-	-	-	-	-
Virginia	-	-	-	-	-
Washington	-	$ 1,917,007	$ 1,917,007	$ 95,850	$ 2,012,857
West Virginia	-	-	-	-	-
Wisconsin	-	-	-	-	-
Wyoming	$ 16,057	$ 600,398	$ 616,455	$ 30,823	$ 647,278
US Total	$ 710,190	$ 31,680,383	$ 32,390,573	$ 1,619,529	$ 34,010,102
US Average	$ 13,925	$ 621,184	$ 635,109	$ 31,755	$ 666,865

Notes:

5. Assume that the State roads that do not have an LRS are Non-Federal-aid, State roadways.

6. Assume that the local roads that do not have an LRS are Non-Federal-aid, non-State roadways.

Appendix A3. Cost of Roadway Segment Data Collection by State (in Dollars).

State	Group 1 (Non-local, paved)						Group 2 (Local, paved)				Group 3 (Unpaved)				Roadway Inventory Conversion to LRS (office)	Total	QA/QC	Grand Total
	State Roadways		Non-State				State maintained Local		Non-State maintained Local		State Roads (office)		All others (office)					
			Federal-Aid		Non-Federal-Aid													
	Field	Office	Field	Office	Field	Office	Field	Office	Field	Office	Urban	Rural	Urban	Rural				
Alabama	-	$ 33,260	$ 21,399	$ 11,056	$ 536,755	$ 55,465	-	$ 2	$ 1,251,596	$ 125,160	$ 0	$ 123	$ 1,807	$ 16,763	$ 40,000	$ 2,093,386	$ 104,669	$ 2,198,055
Alaska	-	-	$ 2,565	$ 114	$ 51,176	$ 2,266	-	-	$ 130,316	$ 5,585	$ 29	$ 1,456	$ 914	$ 5,605	$ 40,000	$ 240,027	$ 12,001	$ 252,029
Arizona	-	-	$ 32,628	$ 3,372	$ 229,029	$ 23,666	-	-	$ 735,838	$ 73,584	$ 32	$ 407	$ 2,542	$ 16,107	$ 40,000	$ 1,157,205	$ 57,860	$ 1,215,065
Arkansas	-	$ 40,875	$ 4,501	$ 465	$ 292,733	$ 30,249	-	$ 197	$ 493,543	$ 49,354	$ 55	$ 2,336	$ 2,868	$ 40,309	$ 40,000	$ 997,486	$ 49,874	$ 1,047,360
California	-	$ 45,342	$ 367,579	$ 37,983	$ 1,069,018	$ 110,465	-	$ 1	$ 2,695,588	$ 269,559	$ 5	$ 373	$ 4,537	$ 8,069	$ 40,000	$ 4,648,519	$ 232,426	$ 4,880,945
Colorado	-	-	$ 8,145	$ 842	$ 337,396	$ 34,864	-	-	$ 502,624	$ 50,262	$ 28	$ 2,030	$ 2,807	$ 35,304	$ 40,000	$ 1,014,302	$ 50,715	$ 1,065,017
Connecticut	-	-	$ 2,404	$ 1,242	$ 73,704	$ 7,616	-	-	$ 381,738	$ 38,174	$ 0	$ 6	$ 213	$ 470	$ 40,000	$ 545,567	$ 27,278	$ 572,845
Delaware	-	-	$ 2	$ 0	$ 965	$ 33	-	-	$ 79,264	$ 2,642	$ 8	$ 43	$ 4	$ 5	$ 40,000	$ 122,967	$ 6,148	$ 129,115
Dist. of Columbia	-	-	$ 550	$ 19	$ 1,958	$ 67	-	-	$ 7,910	$ 264	$ 35	-	$ 4	-	$ 40,000	$ 50,807	$ 2,540	$ 53,347
Florida	-	-	$ 68,062	$ 5,626	$ 456,092	$ 47,130	-	-	$ 2,003,330	$ 200,333	$ 27	$ 33	$ 3,180	$ 12,567	$ 40,000	$ 2,836,379	$ 141,819	$ 2,978,198
Georgia	-	-	$ 73,338	$ 7,578	$ 523,682	$ 54,114	-	-	$ 1,554,105	$ 155,411	$ 21	$ 546	$ 4,031	$ 21,353	$ 40,000	$ 2,434,180	$ 121,709	$ 2,555,889
Hawaii	-	-	$ 1,486	$ 84	$ 33,367	$ 1,881	-	-	$ 127,658	$ 6,894	$ 0	$ 0	$ 24	$ 122	$ 40,000	$ 211,515	$ 10,576	$ 222,091
Idaho	-	$ 11,901	$ 28,692	$ 741	$ 209,377	$ 18,931	-	-	$ 353,405	$ 30,923	$ 9	$ 857	$ 299	$ 16,588	$ 40,000	$ 711,724	$ 35,586	$ 747,310
Illinois	-	-	$ 17,711	$ 1,830	$ 473,163	$ 48,893	-	-	$ 676,284	$ 67,628	$1,205	$ 2,401	$ 32,132	$ 53,389	$ 40,000	$ 1,414,638	$ 70,732	$ 1,485,370
Indiana	-	$ 34,091	$ 18,612	$ 1,923	$ 549,578	$ 56,790	-	$ 25	$ 1,751,156	$ 175,116	-	$ 0	-	$ 2	$ 40,000	$ 2,627,293	$ 131,365	$ 2,758,658
Iowa	-	-	$ 22,111	$ 2,285	$ 570,257	$ 58,927	-	-	$ 357,557	$ 35,756	$ 22	$ 2,058	$ 1,723	$ 51,669	$ 40,000	$ 1,142,364	$ 57,118	$ 1,199,483
Kansas	-	-	$ 22,246	$ 11,494	$ 476,921	$ 49,282	-	-	$ 400,932	$ 40,093	$ 155	$ 3,296	$ 1,560	$ 71,395	$ 40,000	$ 1,117,374	$ 55,869	$ 1,173,243
Kentucky	-	-	$ 99	$ 10	$ 27,622	$ 2,854	-	-	$ 1,125,211	$ 112,521	$ 3	$ 821	$ 290	$ 6,723	$ 40,000	$ 1,316,153	$ 65,808	$ 1,381,961
Louisiana	-	-	$ 736	$ 380	$ 69,448	$ 7,176	-	-	$ 760,763	$ 76,076	$ 58	$ 809	$ 2,045	$ 9,900	$ 40,000	$ 967,393	$ 48,370	$ 1,015,763
Maine	-	$ 25,885	$ 5	$ 1	$ 3,317	$ 343	-	$ 14	$ 268,977	$ 26,898	-	$ 15	$ 259	$ 3,236	$ 40,000	$ 368,950	$ 18,448	$ 387,398
Maryland	-	-	$ 3,566	$ 1,843	$ 126,043	$ 13,024	-	-	$ 580,199	$ 58,020	$ 3	$ 24	$ 424	$ 567	$ 40,000	$ 823,713	$ 41,186	$ 864,899
Massachusetts	-	-	$ 13,347	$ 1,379	$ 200,490	$ 20,717	-	-	$ 554,814	$ 55,481	$ 9	$ 13	$ 4,632	$ 1,443	$ 40,000	$ 892,327	$ 44,616	$ 936,943
Michigan	$ 268,242	$ 27,718	$ 206,699	$ 21,359	$ 660,030	$ 68,203	$ 116	$ 12	$ 755,769	$ 75,577	$ 102	$ 498	$ 27,360	$ 33,087	$ 40,000	$ 2,184,772	$ 109,239	$ 2,294,011
Minnesota	-	$ 32,394	$ 146,932	$ 15,183	$ 734,837	$ 75,933	-	$ 10	$ 657,441	$ 65,744	$ 57	$ 1,017	$ 4,348	$ 53,584	$ 40,000	$ 1,827,480	$ 91,374	$ 1,918,854
Mississippi	-	-	$ 12,977	$ 1,341	$ 317,039	$ 32,761	-	-	$ 860,504	$ 86,050	$ 40	$ 298	$ 1,181	$ 14,401	$ 40,000	$ 1,366,593	$ 68,330	$ 1,434,922
Missouri	-	-	$ 4,233	$ 547	$ 123,711	$ 12,783	-	-	$ 1,010,831	$ 101,083	$ 34	$ 531	$ 863	$ 41,997	$ 40,000	$ 1,336,612	$ 66,831	$ 1,403,443
Montana	-	-	$ 3,239	$ 1,674	$ 219,185	$ 22,649	-	-	$ 175,498	$ 17,550	$ 11	$ 3,612	$ 783	$ 36,924	$ 40,000	$ 521,125	$ 26,056	$ 547,181
Nebraska	-	$ 17,157	$ 8,473	$ 4,378	$ 290,565	$ 30,025	-	$ 1	$ 230,495	$ 23,049	$ 30	$ 3,301	$ 949	$ 47,864	$ 40,000	$ 696,287	$ 34,814	$ 731,101
Nevada	$ 113,259	-	$ 1,625	$ 168	$ 108,261	$ 11,187	$ 1,855	-	$ 234,790	$ 23,479	$ 7	$ 1,087	$ 2,240	$ 14,821	$ 40,000	$ 552,779	$ 27,639	$ 580,418
New Hampshire	-	-	$ 571	$ 39	$ 44,117	$ 3,039	-	-	$ 326,263	$ 21,486	$ 3	$ 109	$ 244	$ 2,308	$ 40,000	$ 438,178	$ 21,909	$ 460,087
New Jersey	-	$ 7,199	$ 62,410	$ 6,449	$ 205,643	$ 21,250	-	$ 10	$ 750,539	$ 75,054	$ 0	$ 0	$ 29	$ 151	$ 40,000	$ 1,168,733	$ 58,437	$ 1,227,170
New Mexico	-	$ 33,851	$ 3,711	$ 384	$ 84,587	$ 8,741	-	$ 205	$ 442,948	$ 44,295	$ 13	$ 702	$ 3,329	$ 26,784	$ 40,000	$ 689,548	$ 34,477	$ 724,026
New York	-	$ 46,360	$ 17,342	$ 8,960	$ 576,584	$ 59,580	-	$ 172	$ 1,784,854	$ 178,485	$ 2	$ 8	$ 1,736	$ 8,056	$ 40,000	$ 2,722,138	$ 136,107	$ 2,858,245
North Carolina	-	$ 84,919	$ 1,665	$ 172	$ 34,901	$ 3,606	-	$ 125,506	$ 656,236	$ 65,624	$ 514	$ 3,931	$ 1,067	$ 571	$ 40,000	$ 1,018,713	$ 50,936	$ 1,069,649
North Dakota	$ 165,376	$ 17,089	$ 35,014	$ 3,618	$ 216,353	$ 22,356	$ 100	$ 10	$ 83,506	$ 8,351	$ 43	$ 1,382	$ 516	$ 50,840	$ 40,000	$ 644,555	$ 32,228	$ 676,782
Ohio	-	-	$ 10,400	$ 4,299	$ 440,344	$ 45,502	-	-	$ 1,964,050	$ 196,405	$ 0	$ 65	$ 3,422	$ 10,099	$ 40,000	$ 2,714,586	$ 135,729	$ 2,850,315
Oklahoma	-	$ 33,274	$ 114,500	$ 11,832	$ 478,807	$ 49,477	-	-	$ 735,973	$ 73,597	$ 16	$ 1,145	$ 1,544	$ 39,657	$ 40,000	$ 1,579,822	$ 78,991	$ 1,658,813
Oregon	-	-	$ 19,008	$ 1,964	$ 364,440	$ 37,659	-	-	$ 407,682	$ 40,768	$ 4	$ 969	$ 1,677	$ 15,364	$ 40,000	$ 929,536	$ 46,477	$ 976,012
Pennsylvania	-	-	$ 5,972	$ 617	$ 116,064	$ 11,993	-	-	$ 2,048,378	$ 204,838	$ 12	$ 25	$ 4	$ 89	$ 40,000	$ 2,427,993	$ 121,400	$ 2,549,392

MIRE FUNDAMENTAL DATA ELEMENTS COST-BENEFIT ESTIMATION

State	Group 1 (Non-local, paved)						Group 2 (Local, paved)				Group 3 (Unpaved)				Roadway Inventory Conversion to LRS (office)	Total	QA/QC	Grand Total
	State Roadways		Non-State				State maintained Local		Non-State maintained Local		State Roads (office)		All others (office)					
			Federal-Aid		Non-Federal-Aid													
	Field	Office	Field	Office	Field	Office	Field	Office	Field	Office	Urban	Rural	Urban	Rural				
Rhode Island	$ 33,699	$ 3,316	$ 3,787	$ 326	$ 31,146	$ 2,146	$ 794	$ 75	$ 184,807	$ 12,170	$ 0	$ 1	$ 96	$ 27	$ 40,000	$ 312,390	$ 15,620	$ 328,010
South Carolina	-	-	$ 355	$ 37	$ 18,760	$ 1,938	-	-	$ 395,010	$ 39,501	$1,569	$ 4,575	$ 1,282	$ 6,787	$ 40,000	$ 509,814	$ 25,491	$ 535,304
South Dakota	-	$ 14,811	$ 10,884	$ 1,125	$ 283,760	$ 29,322	-	$ 1	$ 125,699	$ 12,570	$ 13	$ 2,267	$ 569	$ 43,924	$ 40,000	$ 564,943	$ 28,247	$ 593,190
Tennessee	-	$ 42,723	$ 21,100	$ 2,180	$ 410,872	$ 42,457	-	-	$ 1,635,172	$ 163,517	-	$ 78	$ 156	$ 4,959	$ 40,000	$ 2,363,214	$ 118,161	$ 2,481,375
Texas	-	-	$ 49,328	$ 5,097	$ 606,369	$ 62,658	-	-	$ 3,128,303	$ 312,830	$ 367	$ 1,349	$ 15,367	$ 66,614	$ 40,000	$ 4,288,283	$ 214,414	$ 4,502,697
Utah	-	-	$ 12,706	$ 1,313	$ 146,101	$ 15,097	-	-	$ 384,904	$ 38,490	$ 21	$ 1,094	$ 1,431	$ 14,909	$ 40,000	$ 656,067	$ 32,803	$ 688,870
Vermont	$ 107,431	$ 7,401	$ 9,427	$ 649	$ 78,881	$ 5,434	-	-	$ 115,771	$ 7,624	-	$ 173	$ 363	$ 5,051	$ 40,000	$ 378,205	$ 18,910	$ 397,115
Virginia	-	-	$ 26,242	$ 2,712	$ 87,570	$ 9,049	-	-	$ 316,779	$ 31,678	$ 257	$ 6,243	$ 360	$ 464	$ 40,000	$ 521,354	$ 26,068	$ 547,422
Washington	-	-	$ 92,899	$ 9,600	$ 459,336	$ 47,465	-	-	$ 768,800	$ 76,880	$ 1	$ 303	$ 1,258	$ 22,063	$ 40,000	$ 1,518,604	$ 75,930	$ 1,594,534
West Virginia	$ 366,915	$ 37,915	$ 951	$ 98	$ 9,865	$ 1,019	$333,473	$ 33,347	$ 79,970	$ 7,997	$ 103	$ 7,450	$ 127	$ 563	$ 40,000	$ 919,794	$ 45,990	$ 965,783
Wisconsin	-	-	$ 23,948	$ 2,475	$ 626,395	$ 64,727	-	-	$ 1,640,505	$ 164,051	-	$ 135	$ 595	$ 13,087	$ 40,000	$ 2,575,918	$ 128,796	$ 2,704,714
Wyoming	-	-	$ 3,382	$ 932	$ 217,357	$ 14,973	-	-	$ 138,894	$ 9,147	$ 8	$ 1,997	$ 868	$ 9,461	$ 40,000	$ 437,019	$ 21,851	$ 458,870
US Total	$1,054,921	$597,484	$1,619,566	$199,793	$14,303,968	$1,457,786	$336,339	$159,586	$38,833,180	$3,833,623	$4,934	$61,993	$140,057	$956,094	$2,040,000	$65,599,322	$3,279,966	$68,879,288
US Average	$ 20,685	$ 11,715	$ 31,756	$ 3,918	$ 280,470	$ 28,584	$ 6,595	$ 3,129	$ 761,435	$ 75,169	$ 97	$ 1,216	$ 2,746	$ 18,747	$ 40,000	$ 1,286,261	$ 64,313	$ 1,350,574

Appendix A4. Cost of Intersection Data Collection by State.

State	Identify Intersections and Identifiers[7]	Data Collection Non Local/Non Local and Non Local/Local	Total	QA/QC	Grand Total
Alabama	$12,480	$50,445	$62,925	$3,146	$66,072
Alaska	$12,480	$6,523	$19,003	$950	$19,953
Arizona	$12,480	$38,362	$50,842	$2,542	$53,384
Arkansas	$12,480	$40,525	$53,005	$2,650	$55,655
California	$12,480	$-	$12,480	$624	$13,104
Colorado	$12,480	$-	$12,480	$624	$13,104
Connecticut	$12,480	$15,999	$28,479	$1,424	$29,903
Delaware	$12,480	$-	$12,480	$624	$13,104
Dist. of Columbia	$12,480	$2,185	$14,665	$733	$15,398
Florida	$12,480	$102,223	$114,703	$5,735	$120,438
Georgia	$12,480	$-	$12,480	$624	$13,104
Hawaii	$12,480	$2,998	$15,478	$774	$16,252
Idaho	$12,480	$13,913	$26,393	$1,320	$27,713
Illinois	$12,480	$82,149	$94,629	$4,731	$99,360
Indiana	$12,480	$43,912	$56,392	$2,820	$59,212
Iowa	$12,480	$37,290	$49,770	$2,488	$52,258
Kansas	$12,480	$-	$12,480	$624	$13,104
Kentucky	$12,480	$36,049	$48,529	$2,426	$50,955
Louisiana	$12,480	$32,592	$45,072	$2,254	$47,325
Maine	$12,480	$9,665	$22,145	$1,107	$23,252
Maryland	$-	$24,975	$24,975	$1,249	$26,224
Massachusetts	$12,480	$33,986	$46,466	$2,323	$48,790
Michigan	$12,480	$63,184	$75,664	$3,783	$79,447
Minnesota	$12,480	$-	$12,480	$624	$13,104
Mississippi	$12,480	$27,462	$39,942	$1,997	$41,939
Missouri	$-	$60,766	$60,766	$3,038	$63,805
Montana	$12,480	$15,000	$27,480	$1,374	$28,854
Nebraska	$12,480	$26,536	$39,016	$1,951	$40,967
Nevada	$12,480	$20,649	$33,129	$1,656	$34,785
New Hampshire	$-	$-	$-	$-	$-
New Jersey	$12,480	$-	$12,480	$624	$13,104
New Mexico	$12,480	$21,599	$34,079	$1,704	$35,783
New York	$12,480	$72,081	$84,561	$4,228	$88,789
North Carolina	$12,480	$64,769	$77,249	$3,862	$81,112
North Dakota	$12,480	$14,535	$27,015	$1,351	$28,366
Ohio	$12,480	$61,429	$73,909	$3,695	$77,605
Oklahoma	$12,480	$39,959	$52,439	$2,622	$55,061
Oregon	$12,480	$-	$12,480	$624	$13,104
Pennsylvania	$12,480	$80,195	$92,675	$4,634	$97,309
Rhode Island	$12,480	$7,344	$19,824	$991	$20,816
South Carolina	$12,480	$39,821	$52,301	$2,615	$54,916
South Dakota	$12,480	$-	$12,480	$624	$13,104
Tennessee	$12,480	$50,276	$62,756	$3,138	$65,894
Texas	$12,480	$163,765	$176,245	$8,812	$185,057
Utah	$12,480	$19,302	$31,782	$1,589	$33,371
Vermont	$-	$-	$-	$-	$-
Virginia	$12,480	$41,464	$53,944	$2,697	$56,641
Washington	$12,480	$-	$12,480	$624	$13,104
West Virginia	$12,480	$14,905	$27,385	$1,369	$28,754
Wisconsin	$-	$-	$-	$-	$-
Wyoming	$12,480	$5,426	$17,906	$895	$18,801
US Total	$574,080	$1,484,259	$2,058,339	$102,917	$2,161,256
US Average	$11,256	$29,103	$40,360	$2,018	$42,378

Notes:

7. If State is missing any of the intersection identifiers (State or local), apply base cost to run model.

Appendix A5. Cost of Ramp Data Collection by State.

State	Identify Ramps and Identifiers[8]	Data Collection	Total	QA/QC	Grand Total
Alabama	$ 8,320	$ 15,593	$ 23,913	$ 1,196	$ 25,109
Alaska	$ 8,320	$ 832	$ 9,152	$ 458	$ 9,610
Arizona	$ 8,320	$ 9,028	$ 17,348	$ 867	$ 18,215
Arkansas	$ 8,320	$ 10,498	$ 18,818	$ 941	$ 19,759
California	$ 8,320	$ 54,258	$ 62,578	$ 3,129	$ 65,706
Colorado	-	-	-	-	-
Connecticut	$ 8,320	$ 7,067	$ 15,387	$ 769	$ 16,157
Delaware	-	$ 1,653	$ 1,653	$ 83	$ 1,735
Dist. of Columbia	$ 8,320	$ 1,277	$ 9,597	$ 480	$ 10,076
Florida	$ 8,320	$ 19,514	$ 27,834	$ 1,392	$ 29,226
Georgia	$ 8,320	$ 17,770	$ 26,090	$ 1,305	$ 27,395
Hawaii	$ 8,320	$ 1,128	$ 9,448	$ 472	$ 9,921
Idaho	$ 8,320	$ 3,682	$ 12,002	$ 600	$ 12,602
Illinois	$ 8,320	$ 17,896	$ 26,216	$ 1,311	$ 27,527
Indiana	$ 8,320	$ 8,604	$ 16,924	$ 846	$ 17,770
Iowa	$ 8,320	$ 10,373	$ 18,693	$ 935	$ 19,627
Kansas	$ 8,320	$ 11,980	$ 20,300	$ 1,015	$ 21,315
Kentucky	$ 8,320	$ 10,498	$ 18,818	$ 941	$ 19,759
Louisiana	$ 8,320	$ 10,202	$ 18,522	$ 926	$ 19,448
Maine	$ 8,320	$ 2,952	$ 11,272	$ 564	$ 11,836
Maryland	-	$ 16,836	$ 16,836	$ 842	$ 17,678
Massachusetts	$ 8,320	$ 13,918	$ 22,238	$ 1,112	$ 23,350
Michigan	$ 8,320	$ 18,318	$ 26,638	$ 1,332	$ 27,969
Minnesota	$ 8,320	$ 12,128	$ 20,448	$ 1,022	$ 21,471
Mississippi	$ 8,320	$ 18,865	$ 27,185	$ 1,359	$ 28,544
Missouri	-	-	-	-	-
Montana	$ 8,320	$ 3,887	$ 12,207	$ 610	$ 12,817
Nebraska	-	-	-	-	-
Nevada	$ 8,320	$ 9,814	$ 18,134	$ 907	$ 19,041
New Hampshire	$ 8,320	$ 4,673	$ 12,993	$ 650	$ 13,643
New Jersey	$ 8,320	$ 20,130	$ 28,450	$ 1,422	$ 29,872
New Mexico	$ 8,320	$ 6,873	$ 15,193	$ 760	$ 15,953
New York	-	$ 33,295	$ 33,295	$ 1,665	$ 34,960
North Carolina	$ 8,320	$ 18,625	$ 26,945	$ 1,347	$ 28,293
North Dakota	$ 8,320	$ 2,644	$ 10,964	$ 548	$ 11,513
Ohio	$ 8,320	$ 35,150	$ 43,470	$ 2,173	$ 45,643
Oklahoma	$ 8,320	$ 13,077	$ 21,397	$ 1,070	$ 22,467
Oregon	$ 8,320	$ 6,999	$ 15,319	$ 766	$ 16,085
Pennsylvania	$ 8,320	$ 21,521	$ 29,841	$ 1,492	$ 31,333
Rhode Island	$ 8,320	$ 4,012	$ 12,332	$ 617	$ 12,949
South Carolina	$ 8,320	$ 8,914	$ 17,234	$ 862	$ 18,095
South Dakota	$ 8,320	$ 5,357	$ 13,677	$ 684	$ 14,361
Tennessee	$ 8,320	$ 17,417	$ 25,737	$ 1,287	$ 27,024
Texas	$ 8,320	$ 88,944	$ 97,264	$ 4,863	$ 102,127
Utah	$ 8,320	$ 5,848	$ 14,168	$ 708	$ 14,876
Vermont	-	$ 2,508	$ 2,508	$ 125	$ 2,633
Virginia	$ 8,320	$ 17,121	$ 25,441	$ 1,272	$ 26,713
Washington	-	$ 9,882	$ 9,882	$ 494	$ 10,376
West Virginia	$ 8,320	$ 3,853	$ 12,173	$ 609	$ 12,781
Wisconsin	$ 8,320	$ 10,863	$ 19,183	$ 959	$ 20,142
Wyoming	$ 8,320	$ 3,568	$ 11,888	$ 594	$ 12,482
US Total	$ 357,760	$ 649,844	$ 1,007,604	$ 50,380	$ 1,057,984
US Average	$ 7,015	$ 12,742	$ 19,757	$ 988	$ 20,745

Notes:

8. If State is missing <u>any</u> of the ramp business elements (State), apply base cost to run model. Assume no ramps on local, non-Federal-aid roads.
General Note: Cost for collecting Ramp AADT (191) and Year of Ramp AADT (192) is included in Segment cost

Appendix A6. Cost of Volume Data Collection by State (in Dollars).

State	Group 1 (Non Local Paved Roads)								Group 2 (Local Paved)					Segment Total	Non Local/Non Local and Non Local/Local Intersections	Total	QA/QC	Grand Total
	Non State Roads Federal Aid				Non State Roads Non Federal Aid				Non State Non Federal Aid									
	Rural (Miles)	Rural (Cost)	Urban (Miles)	Urban (Cost)	Rural (Miles)	Rural (Cost)	Urban (Miles)	Urban (Cost)	Rural (Miles)	Rural (Cost)	Urban (Miles)	Urban (Cost)	Estimation (Cost)					
Alabama	141.1	13,546	37.2	17,868	707.8	67,953	186.7	17,927.5	1,427.5	137,040	890.3	427,345	16,640.0	698,320	25,642	723,961	36,198	760,160
Alaska	24.9	2,393	13.5	6,463	23.7	2,278	12.8	1,230.9	44.6	4,286	63.6	30,518	16,640.0	63,809	3,316	67,125	3,356	70,481
Arizona	42.9	4,121	221.5	106,313	187.8	18,033	193.9	18,611.3	497.1	47,717	879.5	422,163	16,640.0	633,599	19,500	653,098	32,655	685,753
Arkansas	82.8	7,946	111.5	53,534	384.3	36,895	103.6	9,942.4	502.6	48,254	415.0	199,185	16,640.0	372,397	20,599	392,996	19,650	412,646
California	1,010.6	97,021	1,383.7	664,172	752.0	72,196	1,029.7	98,846.4	1,956.0	187,781	3,035.8	1,457,185	16,640.0	2,593,842	62,752	2,656,593	132,830	2,789,423
Colorado	88.0	8,448	190.2	91,289	392.6	37,692	169.7	16,291.5	268.4	25,762	662.5	318,024	16,640.0	514,146	18,244	532,390	26,620	559,010
Connecticut	26.2	2,511	116.7	56,024	22.5	2,159	100.3	9,633.6	190.0	18,237	518.1	248,682	16,640.0	353,886	8,132	362,018	18,101	380,119
Delaware	0.0	1	0.5	244	0.0	3	0.5	48.3	117.0	11,233	110.4	52,986	16,640.0	81,156	2,699	83,855	4,193	88,047
Dist. of Columbia	0.0	-	1.4	669	0.0	-	1.1	104.4	0.0	-	51.5	24,743	16,640.0	42,156	1,110	43,267	2,163	45,430
Florida	298.6	28,667	500.3	240,156	324.8	31,181	435.4	41,794.2	507.4	48,715	3,202.9	1,537,379	16,640.0	1,944,531	51,961	1,996,492	99,825	2,096,316
Georgia	706.5	67,826	288.5	138,486	619.7	59,494	253.1	24,294.8	1,422.9	136,594	1,455.3	698,563	16,640.0	1,141,898	33,964	1,175,862	58,793	1,234,655
Hawaii	2.7	258	23.7	11,361	11.0	1,054	19.4	1,858.4	52.0	4,989	76.6	36,747	16,640.0	72,907	1,524	74,431	3,722	78,152
Idaho	66.5	6,385	76.2	36,578	283.9	27,255	65.1	6,245.7	477.6	45,849	176.9	84,892	16,640.0	223,843	7,072	230,916	11,546	242,462
Illinois	108.3	10,394	394.9	189,533	456.0	43,775	332.6	31,930.6	278.0	26,693	982.7	471,717	16,640.0	790,683	41,757	832,440	41,622	874,062
Indiana	147.6	14,170	333.0	159,852	631.2	60,592	284.8	27,340.8	2,299.5	220,756	943.8	453,025	16,640.0	952,376	22,321	974,697	48,735	1,023,432
Iowa	200.6	19,253	131.9	63,326	839.9	80,633	110.5	10,608.5	306.2	29,395	356.0	170,858	16,640.0	390,713	18,955	409,668	20,483	430,151
Kansas	165.9	15,923	150.9	72,436	672.5	64,560	122.4	11,747.4	309.3	29,693	433.2	207,929	16,640.0	418,928	20,647	439,575	21,979	461,554
Kentucky	0.9	85	42.4	20,373	4.3	416	41.7	4,003.2	1,815.6	174,296	466.9	224,126	16,640.0	439,939	18,324	458,263	22,913	481,176
Louisiana	11.7	1,120	110.2	52,901	11.1	1,064	104.7	10,048.1	938.7	90,119	545.3	261,755	16,640.0	433,648	16,567	450,215	22,511	472,725
Maine	0.8	82	1.3	636	4.2	405	1.3	126.2	403.1	38,702	95.2	45,710	16,640.0	102,300	4,913	107,212	5,361	112,573
Maryland	93.4	8,970	146.4	70,252	81.9	7,858	128.2	12,309.0	443.0	42,526	645.7	309,945	16,640.0	468,499	12,695	481,194	24,060	505,254
Massachusetts	14.1	1,353	374.9	179,967	52.9	5,074	281.3	27,004.5	113.7	10,911	916.1	439,733	16,640.0	680,682	17,276	697,958	34,898	732,856
Michigan	1,003.4	96,329	441.1	211,739	764.1	73,356	335.9	32,248.7	738.9	70,935	660.9	317,223	16,640.0	818,471	32,117	850,588	42,529	893,117
Minnesota	1,240.0	119,042	229.6	110,205	1,033.4	99,206	191.3	18,368.2	559.5	53,708	658.2	315,943	16,640.0	733,111	24,811	757,922	37,896	795,818
Mississippi	103.8	9,969	117.3	56,309	431.0	41,378	97.4	9,348.5	1,264.5	121,391	335.3	160,928	16,640.0	415,964	13,959	429,923	21,496	451,419
Missouri	23.8	2,280	185.3	88,951	28.5	2,733	177.7	17,060.5	1,033.3	99,197	865.2	415,291	16,640.0	642,152	30,888	673,040	33,652	706,692
Montana	366.9	35,219	25.4	12,210	341.6	32,795	23.7	2,274.0	226.8	21,773	101.7	48,793	16,640.0	169,705	7,624	177,330	8,866	186,196
Nebraska	485.8	46,641	69.0	33,143	424.0	40,705	60.3	5,785.0	210.1	20,169	216.8	104,043	16,640.0	267,127	13,489	280,615	14,031	294,646
Nevada	21.2	2,033	88.1	42,276	98.5	9,457	81.9	7,864.9	192.6	18,485	245.7	117,924	16,640.0	214,680	10,496	225,176	11,259	236,434
New Hampshire	3.5	339	34.5	16,569	16.6	1,593	32.4	3,112.4	243.7	23,396	167.5	80,392	16,640.0	142,043	4,696	146,739	7,337	154,076
New Jersey	51.5	4,944	382.4	183,544	49.4	4,741	293.4	28,161.9	202.5	19,440	1,187.6	570,032	16,640.0	827,503	20,513	848,016	42,401	890,417
New Mexico	43.8	4,207	103.3	49,602	42.0	4,031	99.0	9,503.4	647.1	62,117	177.0	84,966	16,640.0	231,066	10,979	242,045	12,102	254,147
New York	115.8	11,113	526.7	252,811	503.1	48,301	457.8	43,952.5	1,697.9	163,001	1,610.5	773,058	16,640.0	1,308,876	36,640	1,345,516	67,276	1,412,792

State	Group 1 (Non Local Paved Roads)								Group 2 (Local Paved)					Segment Total	Non Local/Non Local and Non Local/Local Intersections	Total	QA/QC	Grand Total
	Non State Roads Federal Aid				Non State Roads Non Federal Aid				Non State Non Federal Aid									
	Rural (Miles)	Rural (Cost)	Urban (Miles)	Urban (Cost)	Rural (Miles)	Rural (Cost)	Urban (Miles)	Urban (Cost)	Rural (Miles)	Rural (Cost)	Urban (Miles)	Urban (Cost)	Estimation (Cost)					
North Carolina	17.9	1,719	43.0	20,660	17.1	1,640	41.1	3,943.9	2,144.7	205,887	1,394.8	669,495	16,640.0	919,985	32,923	952,908	47,645	1,000,553
North Dakota	389.0	37,341	30.0	14,387	334.8	32,140	25.8	2,476.5	109.6	10,522	45.2	21,709	16,640.0	135,215	7,388	142,603	7,130	149,733
Ohio	361.9	34,746	368.2	176,715	404.6	38,845	329.3	31,610.2	2,074.0	199,105	1,563.3	750,374	16,640.0	1,248,035	31,225	1,279,260	63,963	1,343,223
Oklahoma	814.2	78,159	174.7	83,850	657.0	63,076	141.0	13,533.5	821.4	78,859	541.5	259,904	16,640.0	594,021	20,312	614,333	30,717	645,049
Oregon	121.4	11,656	158.7	76,172	481.5	46,227	125.9	12,083.3	349.8	33,581	407.3	195,515	16,640.0	391,875	10,310	402,184	20,109	422,294
Pennsylvania	33.6	3,227	169.8	81,496	32.0	3,069	161.5	15,501.6	2,569.2	246,648	1,642.7	788,512	16,640.0	1,155,092	40,764	1,195,856	59,793	1,255,649
Rhode Island	4.9	467	35.0	16,799	4.2	406	30.4	2,916.5	39.1	3,752	187.7	90,086	16,640.0	131,066	3,733	134,799	6,740	141,539
South Carolina	17.3	1,664	14.5	6,972	17.0	1,633	14.3	1,368.6	851.2	81,712	490.0	235,202	16,640.0	345,191	20,241	365,432	18,272	383,704
South Dakota	105.9	10,162	34.3	16,483	444.1	42,636	28.8	2,766.1	136.6	13,118	96.1	46,146	16,640.0	147,951	8,110	156,061	7,803	163,864
Tennessee	522.2	50,136	197.7	94,900	496.7	47,687	188.1	18,053.0	2,103.4	201,925	924.7	443,860	16,640.0	873,201	25,556	898,756	44,938	943,694
Texas	307.7	29,543	785.1	376,841	284.6	27,321	726.0	69,698.3	2,641.8	253,608	3,171.4	1,522,264	16,640.0	2,295,916	83,243	2,379,159	118,958	2,498,117
Utah	197.4	18,953	67.2	32,279	181.6	17,437	61.9	5,939.2	327.3	31,425	386.4	185,450	16,640.0	308,124	9,811	317,935	15,897	333,832
Vermont	16.1	1,545	17.6	8,461	71.9	6,902	15.7	1,511.5	101.8	9,773	39.4	18,901	16,640.0	63,735	2,816	66,551	3,328	69,879
Virginia	23.8	2,288	165.9	79,612	18.3	1,760	127.6	12,251.0	1,202.7	115,462	862.1	413,815	16,640.0	641,827	21,077	662,904	33,145	696,049
Washington	125.6	12,056	292.5	140,389	522.3	50,139	243.3	23,354.4	621.5	59,660	802.2	385,076	16,640.0	687,315	22,276	709,591	35,480	745,070
West Virginia	2.6	251	15.4	7,400	2.4	229	14.1	1,349.8	592.8	56,906	172.9	82,975	16,640.0	165,750	7,576	173,326	8,666	181,992
Wisconsin	192.7	18,497	280.2	134,484	808.8	77,643	235.2	22,580.4	2,285.3	219,392	752.9	361,396	16,640.0	850,633	24,833	875,466	43,773	919,239
Wyoming	182.5	17,518	32.2	15,454	211.6	20,317	29.9	2,867.8	101.5	9,749	71.2	34,199	16,640.0	116,745	2,758	119,503	5,975	125,478
US Total	10,130	972,515	9,736	4,673,144	15,187	1,457,971	8,369	803,433	40,461	3,884,244	36,701	17,616,683	16,640	29,424,630	1,011,134	31,267,764	1,563,388	32,831,152
US Average	199	19,069	191	91,630	298	28,588	164	15,754	793	76,162	720	345,425	16,640	593,267	19,826	613,093	30,655	643,748

Notes:

Fixed one time model development cost is applied to all States to estimate AADT on local roads

Cost of collection on State roads is not included in this analysis as AADT is a full extent element and is already collected for all States roads.

Appendix A7. Cost of Data Maintenance by State.

State	Segments (Non Local and Local)	Segments (Non Local and Local)	Non Local/Non Local and Non Local/Local Intersections	Ramps	Volumes	Total	QA/QC	Grand Total
Alabama	$3,991	$2,874	$2,446	$408	$100,272	$109,991	$5,500	$115,491
Alaska	$537	$134	$316	$22	$12,180	$13,189	$659	$13,849
Arizona	$1,815	$1,707	$1,860	$236	$63,395	$69,013	$3,451	$72,464
Arkansas	$2,938	$1,138	$1,965	$275	$65,694	$72,009	$3,600	$75,609
California	$7,752	$6,190	$5,986	$1,419	$326,675	$348,021	$17,401	$365,422
Colorado	$2,349	$1,154	$1,740	$263	$68,224	$73,731	$3,687	$77,418
Connecticut	$812	$878	$776	$185	$44,701	$47,351	$2,368	$49,718
Delaware	$218	$282	$257	$43	$8,809	$9,610	$480	$10,090
Dist. of Columbia	$56	$64	$106	$33	$4,023	$4,283	$214	$4,497
Florida	$3,656	$4,601	$4,956	$510	$174,864	$188,588	$9,429	$198,017
Georgia	$4,597	$3,569	$3,240	$465	$131,936	$143,806	$7,190	$150,996
Hawaii	$207	$159	$145	$30	$8,488	$9,029	$451	$9,481
Idaho	$1,490	$812	$675	$96	$32,425	$35,497	$1,775	$37,272
Illinois	$3,825	$1,563	$3,983	$468	$135,120	$144,959	$7,248	$152,207
Indiana	$4,020	$4,022	$2,129	$225	$115,889	$126,285	$6,314	$132,599
Iowa	$3,575	$821	$1,808	$271	$71,248	$77,723	$3,886	$81,609
Kansas	$3,157	$921	$1,969	$313	$67,073	$73,433	$3,672	$77,105
Kentucky	$2,913	$2,830	$1,748	$275	$61,037	$68,802	$3,440	$72,242
Louisiana	$2,045	$1,840	$1,580	$267	$63,431	$69,163	$3,458	$72,621
Maine	$1,049	$618	$469	$77	$20,487	$22,700	$1,135	$23,835
Maryland	$1,194	$1,350	$1,211	$440	$51,451	$55,646	$2,782	$58,429
Massachusetts	$1,471	$1,277	$1,648	$364	$89,046	$93,805	$4,690	$98,495
Michigan	$4,691	$1,736	$3,063	$479	$137,436	$147,406	$7,370	$154,776
Minnesota	$4,940	$1,510	$2,367	$317	$105,875	$115,009	$5,750	$120,760
Mississippi	$2,862	$1,984	$1,331	$493	$61,894	$68,565	$3,428	$71,993
Missouri	$4,579	$2,354	$2,946	$388	$105,950	$116,217	$5,811	$122,028
Montana	$1,731	$407	$727	$102	$28,128	$31,095	$1,555	$32,650
Nebraska	$2,062	$529	$1,287	$123	$39,359	$43,360	$2,168	$45,528
Nevada	$949	$543	$1,001	$257	$29,359	$32,109	$1,605	$33,715
New Hampshire	$565	$510	$448	$122	$16,677	$18,322	$916	$19,238
New Jersey	$1,396	$1,724	$1,957	$526	$88,502	$94,105	$4,705	$98,810
New Mexico	$1,719	$1,022	$1,047	$180	$42,144	$46,112	$2,306	$48,418
New York	$4,596	$4,102	$3,495	$871	$170,522	$183,586	$9,179	$192,765
North Carolina	$3,548	$4,389	$3,140	$487	$113,665	$125,230	$6,261	$131,491
North Dakota	$1,723	$192	$705	$69	$27,343	$30,031	$1,502	$31,533
Ohio	$4,409	$4,510	$2,978	$919	$147,399	$160,216	$8,011	$168,226
Oklahoma	$3,783	$1,690	$1,937	$342	$82,316	$90,068	$4,503	$94,572
Oregon	$2,684	$939	$983	$183	$63,109	$67,898	$3,395	$71,293

State	Segments (Non Local and Local)	Segments (Non Local and Local)	Non Local/Non Local and Non Local/Local Intersections	Ramps	Volumes	Total	QA/QC	Grand Total
Pennsylvania	$4,396	$5,223	$3,888	$563	$154,413	$168,483	$8,424	$176,907
Rhode Island	$232	$281	$356	$105	$13,756	$14,730	$737	$15,467
South Carolina	$2,862	$1,663	$1,931	$233	$74,650	$81,339	$4,067	$85,406
South Dakota	$1,990	$289	$774	$140	$31,969	$35,162	$1,758	$36,920
Tennessee	$3,494	$3,755	$2,438	$456	$96,248	$106,390	$5,320	$111,710
Texas	$12,372	$7,208	$7,940	$2,326	$369,517	$399,363	$19,968	$419,331
Utah	$1,200	$885	$936	$153	$33,905	$37,078	$1,854	$38,932
Vermont	$539	$175	$269	$66	$10,576	$11,625	$581	$12,206
Virginia	$2,988	$2,560	$2,010	$448	$89,005	$97,012	$4,851	$101,862
Washington	$3,107	$1,765	$2,125	$258	$91,683	$98,938	$4,947	$103,885
West Virginia	$1,561	$949	$723	$101	$34,031	$37,365	$1,868	$39,233
Wisconsin	$4,520	$3,767	$2,369	$284	$112,448	$123,388	$6,169	$129,558
Wyoming	$1,155	$214	$263	$93	$22,132	$23,858	$1,193	$25,051
US Total	$140,321	$95,681	$96,447	$17,770	$4,110,477	$4,460,695	$223,035	$4,683,730
US Average	$2,751	$1,876	$1,891	$348	$80,598	$87,465	$4,373	$91,838

Appendix A8. Data Collection Management and Administration Costs.

STATE	M&A
Alabama	$152,470
Alaska	$35,935
Arizona	$180,519
Arkansas	$199,227
California	$260,000
Colorado	$193,749
Connecticut	$74,007
Delaware	$11,600
Dist. of Columbia	$8,830
Florida	$260,000
Georgia	$191,552
Hawaii	$16,321
Idaho	$110,005
Illinois	$124,316
Indiana	$192,954
Iowa	$85,076
Kansas	$249,892
Kentucky	$96,693
Louisiana	$77,763
Maine	$26,753
Maryland	$70,703
Massachusetts	$87,097
Michigan	$164,727
Minnesota	$137,462
Mississippi	$97,841
Missouri	$108,697
Montana	$132,476
Nebraska	$168,603
Nevada	$93,076
New Hampshire	$31,390
New Jersey	$108,028
New Mexico	$141,017
New York	$260,000
North Carolina	$174,153
North Dakota	$43,320
Ohio	$215,839
Oklahoma	$119,070
Oregon	$136,146
Pennsylvania	$260,000
Rhode Island	$25,166
South Carolina	$88,013
South Dakota	$39,226
Tennessee	$175,899
Texas	$260,000
Utah	$111,637
Vermont	$23,481
Virginia	$66,341
Washington	$218,797
West Virginia	$59,466
Wisconsin	$182,205
Wyoming	$63,145
US Total	$6,410,685
US Average	$125,700

Notes:

Assume M&A costs are 5% of data collection costs, up to $260K.

Appendix A9. Miscellaneous One Time and Annual Costs.

STATE	One time Cost		Annual Ongoing Costs			
	Implementation Plan (One time cost)	Segments Field collection, LiDAR mobilization	Local Partner Liaison	Formatting & Analyzing Enhance Data	Desktop and web application (first two years)	Desktop and web application (annually starting year 3)
Alabama	$100,000	$265,000	$285,072	$125,000	$78,000	$15,500
Alaska	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Arizona	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Arkansas	$100,000	$265,000	$280,344	$125,000	$78,000	$15,500
California	$100,000	$265,000	$491,397	$125,000	$78,000	$15,500
Colorado	$100,000	$265,000	$247,868	$125,000	$78,000	$15,500
Connecticut	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Delaware	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Dist. of Columbia	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Florida	$100,000	$265,000	$341,121	$125,000	$78,000	$15,500
Georgia	$100,000	$265,000	$351,464	$125,000	$78,000	$15,500
Hawaii	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Idaho	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Illinois	$100,000	$265,000	$404,145	$125,000	$78,000	$15,500
Indiana	$100,000	$265,000	$272,407	$125,000	$78,000	$15,500
Iowa	$100,000	$265,000	$320,426	$125,000	$78,000	$15,500
Kansas	$100,000	$265,000	$393,718	$125,000	$78,000	$15,500
Kentucky	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Louisiana	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Maine	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Maryland	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Massachusetts	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Michigan	$100,000	$265,000	$341,743	$125,000	$78,000	$15,500
Minnesota	$100,000	$265,000	$388,731	$125,000	$78,000	$15,500
Mississippi	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Missouri	$100,000	$265,000	$369,540	$125,000	$78,000	$15,500
Montana	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Nebraska	$100,000	$265,000	$262,632	$125,000	$78,000	$15,500
Nevada	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
New Hampshire	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
New Jersey	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
New Mexico	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
New York	$100,000	$265,000	$321,185	$125,000	$78,000	$15,500
North Carolina	$100,000	$265,000	$296,977	$125,000	$78,000	$15,500
North Dakota	$100,000	$265,000	$243,183	$125,000	$78,000	$15,500
Ohio	$100,000	$265,000	$345,187	$125,000	$78,000	$15,500
Oklahoma	$100,000	$265,000	$315,898	$125,000	$78,000	$15,500
Oregon	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Pennsylvania	$100,000	$265,000	$335,569	$125,000	$78,000	$15,500
Rhode Island	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
South Carolina	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
South Dakota	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Tennessee	$100,000	$265,000	$267,464	$125,000	$78,000	$15,500
Texas	$100,000	$265,000	$876,988	$125,000	$78,000	$15,500
Utah	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Vermont	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Virginia	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Washington	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
West Virginia	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
Wisconsin	$100,000	$265,000	$322,265	$125,000	$78,000	$15,500
Wyoming	$100,000	$265,000	$235,000	$125,000	$78,000	$15,500
US Total	$5,100,000	$13,515,000	$14,655,321	$6,375,000	$3,978,000	$790,500
US Average	$100,000	$265,000	$287,359	$125,000	$78,000	$15,500

Appendix A10. Net Present Value of Total Data Collection and Maintenance Costs by State for undiscounted, 3.0% and 7.0% discount rates, 2015 - 2036 (2014 Dollars).

State	Net Present Value of Total Data Collection and Maintenance Costs, 2015 2036 (2014 Dollars)		
	Undiscounted	3.0%	7.0%
Alabama	$13,563,345	$10,357,181	$7,597,256
Alaska	$8,739,344	$6,673,341	$4,929,206
Arizona	$12,597,626	$9,976,921	$7,719,798
Arkansas	$13,896,146	$11,085,671	$8,677,657
California	$25,795,818	$19,685,784	$14,398,816
Colorado	$13,189,417	$10,524,232	$8,236,134
Connecticut	$10,041,894	$7,709,071	$5,726,737
Delaware	$8,175,605	$6,154,301	$4,453,268
Dist. of Columbia	$8,038,999	$6,058,869	$4,394,303
Florida	$21,076,418	$16,818,338	$13,108,662
Georgia	$16,143,460	$12,313,930	$9,015,302
Hawaii	$8,266,190	$6,231,734	$4,516,856
Idaho	$10,623,310	$8,323,880	$6,361,844
Illinois	$15,749,401	$11,871,355	$8,572,372
Indiana	$14,412,812	$11,061,248	$8,158,105
Iowa	$12,344,667	$9,331,338	$6,768,136
Kansas	$17,135,187	$13,698,539	$10,758,068
Kentucky	$10,834,158	$8,257,779	$6,050,890
Louisiana	$10,441,950	$7,927,290	$5,783,159
Maine	$8,686,569	$6,554,781	$4,754,287
Maryland	$10,094,650	$7,665,332	$5,594,833
Massachusetts	$11,000,814	$8,342,411	$6,076,019
Michigan	$15,448,429	$11,741,777	$8,562,011
Minnesota	$15,291,603	$11,584,789	$8,416,953
Mississippi	$10,854,779	$8,275,641	$6,065,737
Missouri	$14,340,687	$10,822,397	$7,829,009
Montana	$11,030,367	$8,777,847	$6,856,718
Nebraska	$12,494,655	$9,986,872	$7,842,594
Nevada	$10,217,908	$7,964,663	$6,046,772
New Hampshire	$8,719,486	$6,592,161	$4,792,076
New Jersey	$11,444,782	$8,714,945	$6,376,588
New Mexico	$11,430,867	$9,069,026	$7,051,706
New York	$19,515,544	$15,518,110	$12,050,280
North Carolina	$14,469,277	$11,249,115	$8,495,636
North Dakota	$9,297,898	$7,035,506	$5,117,199
Ohio	$16,775,853	$12,822,081	$9,407,517
Oklahoma	$13,154,277	$9,993,861	$7,289,387
Oregon	$11,649,365	$9,132,676	$6,980,877
Pennsylvania	$18,774,209	$14,850,785	$11,457,775
Rhode Island	$8,535,881	$6,445,790	$4,679,993
South Carolina	$10,836,500	$8,343,212	$6,229,491
South Dakota	$9,132,006	$6,901,572	$5,013,002

State	Net Present Value of Total Data Collection and Maintenance Costs, 2015 2036 (2014 Dollars)		
	Undiscounted	3.0%	7.0%
Tennessee	$13,667,792	$10,489,322	$7,738,109
Texas	$33,416,886	$25,182,002	$18,142,817
Utah	$10,680,854	$8,367,553	$6,392,999
Vermont	$8,454,784	$6,384,508	$4,635,838
Virginia	$10,612,164	$8,008,600	$5,800,678
Washington	$13,842,107	$11,010,950	$8,567,774
West Virginia	$9,589,479	$7,281,236	$5,316,039
Wisconsin	$15,091,720	$11,535,418	$8,467,572
Wyoming	$9,467,867	$7,302,720	$5,467,363
US Total	$659,085,806	$508,008,461	$378,742,218
US Average	$12,923,251	$9,960,950	$7,426,318

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