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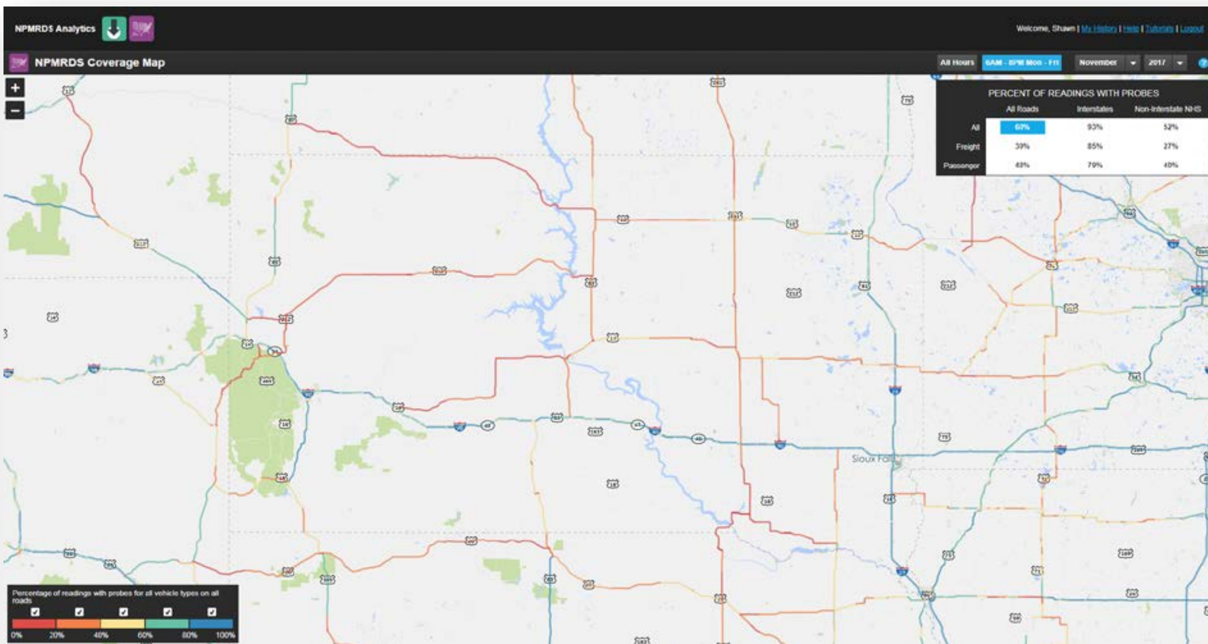

Validating the National Performance Management Research Data Set (NPMRDS) for South Dakota

Study SD2013-08
Final Report

Prepared by
Texas A&M Transportation Institute
Texas A&M University

March 2018

DISCLAIMER

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16. Abstract

The Texas A&M Transportation Institute (TTI) evaluated the accuracy, temporal completeness, and geographic coverage of NPMRDS in South Dakota to determine whether the South Dakota Department of Transportation (SDDOT) should use the National Performance Measure Research Data Set (NPMRDS) for the federal performance management measure regulations as well as other internal applications. TTI found that speed errors were significantly higher on lower-volume arterial roads than on higher-volume Interstate highways. Also, the NPMRDS free-flow speeds are biased low in all cases (e.g., NPMRDS free-flow speeds are 7 to 9 miles per hour (mph) slower than SDDOT-reported free-flow speeds). For all-vehicle travel times, Interstate roads are typically 90% complete during daytime hours (defined as 6 am to 8 pm), and non-Interstate National Highway System (NHS) roads are typically 35% complete during daytime hours. For truck-only travel times, Interstate NHS roads are typically 80% complete during daytime hours, and non-Interstate NHS roads are typically less than 20% complete during daytime hours. The geographic coverage of NPMRDS in South Dakota matched the NHS network within 1% of expected total statewide mileage.

Based on these findings, TTI recommends that SDDOT use NPMRDS to meet the Federal Highway Administration (FHWA) requirements, but should set conservative targets that acknowledge the limitations of NPMRDS on low-volume non-Interstate NHS roads. On Interstate highways and higher-volume roads (i.e., greater than 5,000 Average Annual Daily Traffic (AADT)), SDDOT can use NPMRDS for several internal uses. Caution should be used with NPMRDS free-flow speeds, as these free-flow speeds tend to be at least 5 mph slower than speeds measured at SDDOT monitoring sites. On non-Interstate NHS roads and low-volume roads (i.e., less than 5,000 AADT), SDDOT should use caution when considering NPMRDS data, and may consider internal uses on a case-by-case basis. When possible, NPMRDS data on low-volume roads should be aggregated over multiple days, weeks, or months to increase the sample size and the consistency of the speed data.

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Acronym	Definition
AADT	Annual Average Daily Traffic
AASE	Average Absolute Speed Error
AVC	Automatic Vehicle Classification
BTH	Bluetooth Readers
BTM	Bluetooth Traffic Monitoring
DOT	Department Of Transportation
FHWA	Federal Highway Administration
GIS	Geographic Information System
GLRTOC	Great Lakes Regional Transportation Coalition
GPS	Global Positioning System
HPMS	Highway Performance Monitoring System
LPR	License Plate Readers
MassDOT	Massachusetts DOT
mph	Miles Per Hour
MPO	Metropolitan Planning Organization
NHS	National Highway System
NPMRDS	National Performance Management Research Data Set
POE	Port of Entry
SEM	Standard Error of the Mean
SDDOT	South Dakota Department Of Transportation
TMC	Traffic Message Channel
TTI	Texas A&M Transportation Institute
VOL	Volume
WIM	Weigh-in-Motion

1.0 EXECUTIVE SUMMARY

1.1 Problem Description

The South Dakota Department of Transportation (SDDOT) was concerned about the required use of the National Performance Management Research Data Set (NPMRDS) in federal performance management measure regulations. The NPMRDS-based travel times are gathered from Global Positioning System (GPS) enabled mobile devices (e.g., smart phones, personal navigation devices, truck fleet tracking and telematics systems, etc.) in the traffic stream, and several limitations of NPMRDS had been reported in other studies. Inaccurate measurement of SDDOT’s roadway performance could affect funding, investment decisions, and management strategies. Therefore, SDDOT needs to understand better the quality of NPMRDS travel time data within South Dakota.

1.2 Research Objectives

The SDDOT contracted with the Texas A&M Transportation Institute (TTI) to conduct several analyses of the NPMRDS. In particular, TTI assessed the accuracy, temporal completeness, and geographic coverage of NPMRDS in South Dakota to determine whether SDDOT should use NPMRDS for the federal performance management measure regulations as well as other internal SDDOT applications (such as project planning, project design, and operational evaluations). Specific research objectives were:

1) Determine how representative passenger vehicle and truck travel times in NPMRDS are of actual travel times in South Dakota.
2) Recommend whether the NPMRDS is a reasonable solution for South Dakota to use for reporting performance requirements found in *National Performance Measures: Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program*.
3) Evaluate the suitability of NPMRDS for other potential uses by SDDOT.

1.3 Research Findings

The research findings are summarized in Chapter 5.0, with respect to the accuracy, temporal completeness (i.e., percentage of time periods where a travel time observation was available), and geographic coverage of NPMRDS in South Dakota. It should be noted that these findings are based on the analysis of NPMRDS travel time data from February through June 2017.

1.3.1 Accuracy of NPMRDS

The research team analyzed the accuracy of NPMRDS by comparing it to data gathered at 31 SDDOT permanent traffic monitoring sites. Given project resources, these SDDOT sites were considered the best available benchmarks to compare the NPMRDS data. Several error measures were calculated for four different speed categories:

- 0 to 30 mph
- 30 to 45 mph
- 45 to 60 mph
- Greater than 60 mph

The maximum acceptable error limits will vary depending upon how the NPMRDS speed data is to be used. The I-95 Corridor Coalition (a partnership of transportation agencies, toll authorities, public safety, and related organizations, from the State of Maine to the State of Florida that buy commercially available GPS probe data) sets the following contract requirements when evaluating speeds for real-time traveler information:

- Average absolute speed error less than 10 mph.
- Speed error bias less than 5 mph.

Therefore, those error values that fall outside this limit are highlighted yellow in the following tables.

Speed errors were significantly higher on lower-volume arterial roads than on higher-volume Interstate highways and other freeways/expressways. Tables 1 through 5 indicate that the highest error values are on principal arterials on which the Annual Average Daily Traffic (AADT) is less than 5,000 vehicles per day. High error values are also in the lowest speed category of 0 to 30 mph. However, there were so few comparisons in this category (less than 0.02%) that the calculated error may not be reliable. In other words, very slow speeds occurred so infrequently that it is statistically challenging to quantify reliably the NPMRDS speed error in these slow speed categories.

Also, even for Interstate highways (Table 1) or high-volume sites (Table 4 and Table 5), the NPMRDS free-flow speeds are biased low in all cases (e.g., NPMRDS free-flow speeds are 7 to 9 mph slower than SDDOT-reported free-flow speeds). The slower free-flow speeds in NPMRDS could be caused by one or more of the following reasons:

1) disproportionate truck GPS samples in NPMRDS
2) different speed measurement approaches used by NPMRDS and SDDOT
3) NPMRDS free-flow speeds were affected by delays at several truck weigh stations and the SDDOT speeds were not (due to different measurement approach).

Table 1: NPMRDS Speed Error for All-Vehicle Traffic Speeds, 14 INTERSTATE/FREEWAY/EXPRESSWAY SITES

Benchmark Speed Category	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data (% of total)
0 to 30 mph	18	118%	+18	4 (0.01%)
30 to 45 mph	8	19%	+5	72 (0.09%)
45 to 60 mph	5	9%	+2	2,252 (3%)
> 60 mph	8	11%	-7	77,300 (97%)

Table 2: NPMRDS Speed Error for All-Vehicle Traffic Speeds, 17 PRINCIPAL ARTERIAL SITES

Benchmark Speed Category	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data (% of total)
0 to 30 mph	25	107%	+23	11 (0.02%)
30 to 45 mph	18	43%	+14	1,628 (2%)
45 to 60 mph	12	24%	+6	4,691 (7%)
> 60 mph	9	13%	-8	60,840 (91%)

Table 3: NPMRDS Speed Error for All-Vehicle Traffic Speeds, ONLY SITES LESS THAN 5,000 AADT

Benchmark Speed Category	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data (% of total)
0 to 30 mph	21	88%	+19	14 (0.02%)
30 to 45 mph	18	43%	+14	1,637 (2%)
45 to 60 mph	11	23%	+6	4,947 (8%)
> 60 mph	8	11%	-7	57,267 (90%)

Table 4: NPMRDS Speed Error for All-Vehicle Traffic Speeds, ONLY SITES BETWEEN 5,000-10,000 AADT

Benchmark Speed Category	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data (% of total)
0 to 30 mph	---	---	---	0 (0%)
30 to 45 mph	9	22%	0	15 (0.04%)
45 to 60 mph	9	15%	-5	199 (1%)
> 60 mph	8	12%	-8	36,678 (99%)

Table 5: NPMRDS Speed Error for All-Vehicle Traffic Speeds, ONLY SITES GREATER THAN 10,000 AADT

Benchmark Speed Category	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data (% of total)
0 to 30 mph	58	415%	+58	1 (0.00%)
30 to 45 mph	6	14%	+3	48 (0.1%)
45 to 60 mph	5	8%	+1	1,797 (4%)
> 60 mph	9	12%	-9	44,195 (96%)

1.3.2 Temporal Completeness of NPMRDS

TTI analyzed the completeness (i.e., percentage of time periods where a travel time observation was available) of valid 15-minute travel time data for the period of February to June 2017. Figure 2 shows that, for the all-vehicle travel times, Interstate NHS roads are typically 90% complete during daytime hours (defined as 6 am to 8 pm), and non-Interstate National Highway System (NHS) roads are typically 35% complete during daytime hours. For truck-only travel times, Interstate NHS roads are typically 80% complete during daytime hours, and non-Interstate NHS roads are typically less than 20% complete during daytime hours.

Figure 2 shows a map of overall (i.e., 24 hours per day) data completeness for all-vehicle travel time data for all NPMRDS road segments in South Dakota for the five-month analysis period (Feb-Jun 2017). Figure 2 reinforces the finding that Interstate highways and other higher-volume roads typically have higher levels of completeness, whereas some lower volume roads have average overall completeness values less than 5%.

Even though some of these completeness values may seem low (e.g., non-Interstate NHS roads), it is important to remember that these values are measuring total completeness every 15 minutes for every day in the five-month period. When measured this way, the completeness of traditional travel time collection methods (such as floating car) would likely fall below 1%, since traditional collection methods only collect travel times for a few time periods on a few different days.

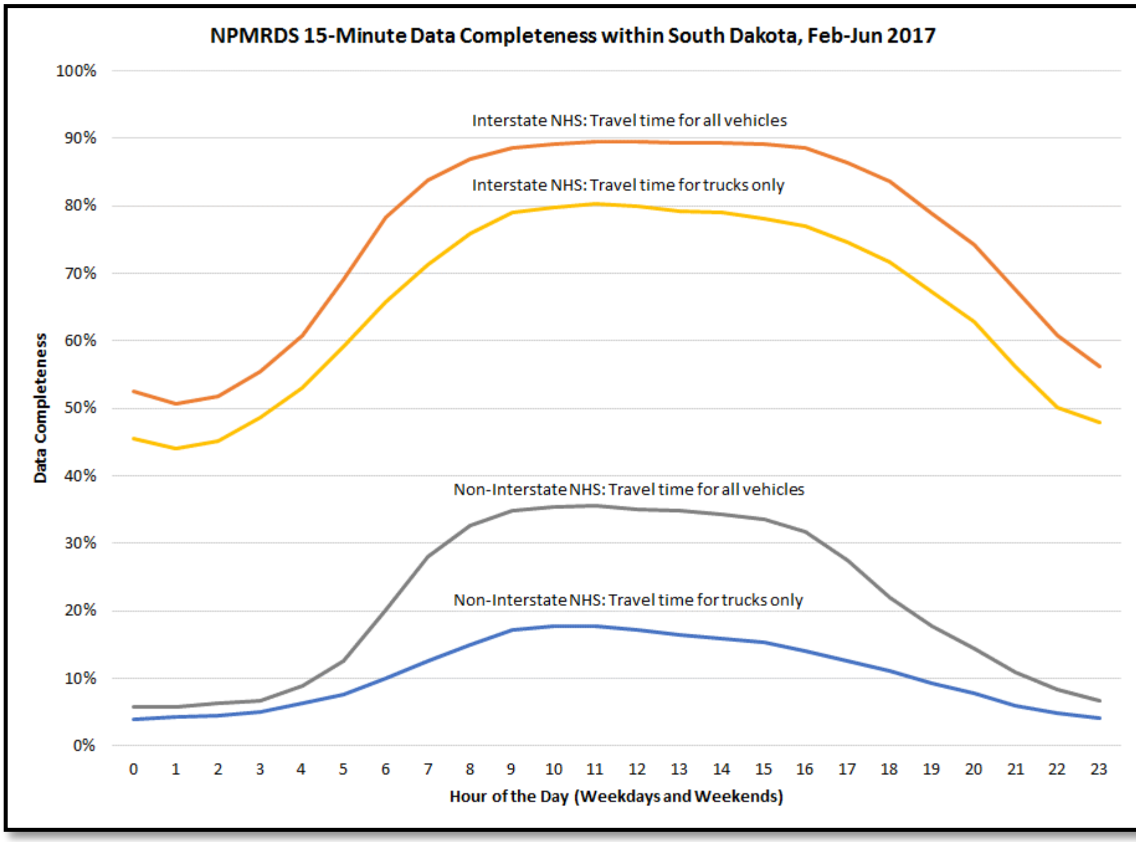

Figure 1: NPMRDS Data Completeness by Time of Day within South Dakota

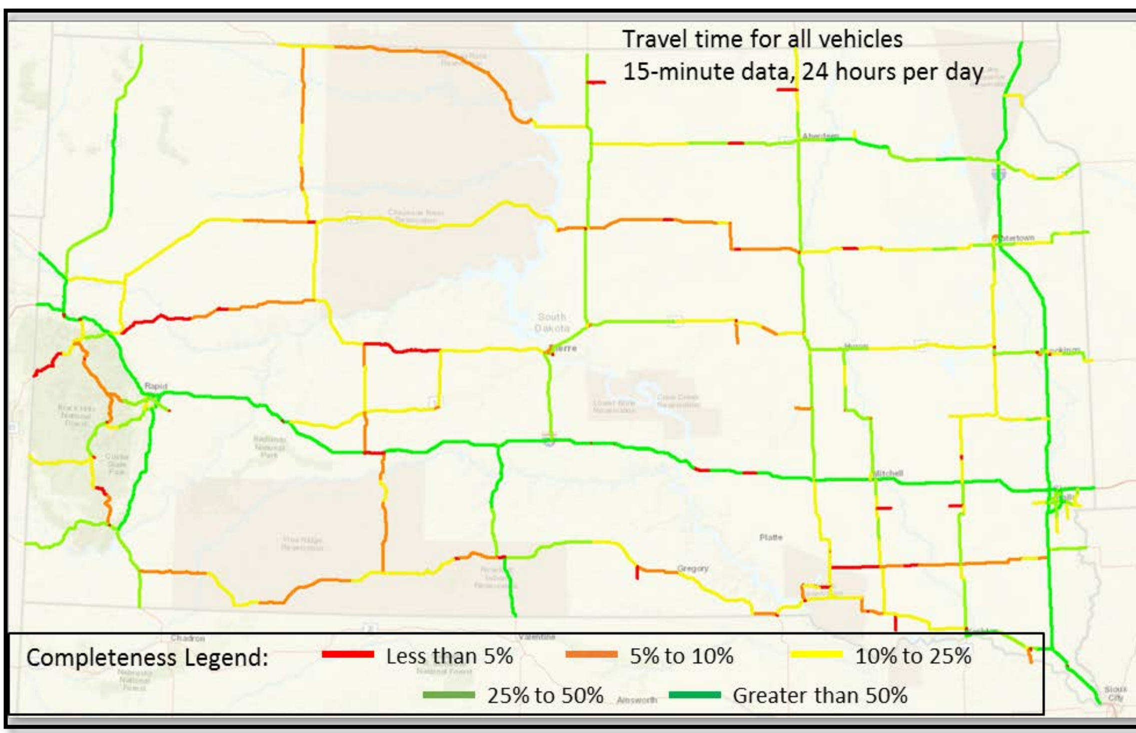

Figure 2: NPMRDS Completeness for Road Segments, All-Vehicle Travel Time, All 24 hours

1.3.3 Geographic Coverage of NPMRDS

The road segments included in NPMRDS are intended to represent the entirety of the National Highway System (NHS) network. In particular, the NPMRDS data analyzed in this project (February through June 2017) represented the NHS designation as reported by each state DOT in their 2015 Highway Performance Monitoring System (HPMS) submittal to the Federal Highway Administration (FHWA). For South Dakota, the FHWA HPMS database indicated a total of 3,723 centerline-miles (7,446 directional-miles) with 2015 NHS designation. This 2015 NHS mileage total of 7,446 directional-miles was considered the benchmark when comparing to the geographic coverage within NPMRDS.

The research team used a Geographic Information System (GIS) to visually assess the geographic coverage of NPMRDS in South Dakota. Currently, NPMRDS includes 1,965 unique directional segments with a combined length of 7,529 directional-miles, only 83 directional-miles greater than the 2015 NHS mileage designated in HPMS. This minor difference in geographic coverage is about 1% of South Dakota's total NHS network. More detailed comparison indicated that NPMRDS includes about 140 extra directional-miles of road segments that are not on the 2015 NHS network. Conversely, NPMRDS is missing about 47 directional-miles of road segments that are on the 2015 NHS network.

1.4 Recommendations

Based on the research findings, TTI offers the following recommendations on the use of NPMRDS.

1.4.1 Use of NPMRDS for National Performance Management Measures

With respect to the use of NPMRDS for meeting FHWA's performance management requirements for system performance and freight movement, SDDOT should use NPMRDS to meet the FHWA requirements, but should set conservative targets that acknowledge the limitations of NPMRDS on low-volume non-Interstate NHS roads. The FHWA requirements allow SDDOT to use an "equivalent data set." However, equivalent data sets from other commercial data providers (such as HERE or TomTom) will likely have the same limitations on low-volume roads as the current NPMRDS provided by INRIX.

1.4.2 Use of NPMRDS for other SDDOT Applications

On Interstate highways and higher-volume roads (i.e., greater than 5,000 AADT), SDDOT can use NPMRDS for most of the applications outlined below. The NPMRDS data on these roads has high levels of completeness and typically falls within acceptable accuracy levels. Caution should be used with NPMRDS free-flow speeds, as these free-flow speeds tend to be at least 5 mph slower than speeds measured at SDDOT monitoring sites.

On non-Interstate NHS roads and low-volume roads (i.e., less than 5,000 AADT), SDDOT should use caution when considering NPMRDS data, and may consider the outlined data uses below on a case-by-case basis. The NPMRDS may be suitable for some low-volume road segments within South Dakota; however, SDDOT staff should visually assess the completeness, consistency, and credibility before using NPMRDS data on low-volume roads. When possible, NPMRDS data on low-volume roads should be aggregated over multiple days, weeks, or months to increase the sample size and the consistency of the speed data. Aggregation will increase the completeness, but will also limit SDDOT's ability to calculate or report speeds on specific days.

With the limitations of NPMRDS on low-volume roads in mind, the following uses of NPMRDS by SDDOT are most likely and feasible at this time:

- replace or supplement traditional methods of travel time data collection

- calibrate/validate travel demand forecast models using speed data
- estimate free-flow speeds for preliminary highway design
- analyze historical speed patterns to set or adjust variable speed limits or speed advisories
- determine compliance with speed limits or advisory speeds near or in work zones
- determine prevailing speeds for setting speed limits
- estimate delay (and delay cost) in work zones, as well conducting before-and-after studies
- estimate traffic flow recovery time after major winter weather events

With the limitations of NPMRDS on low-volume roads in mind, the following uses of NPMRDS are possible, but may be limited to certain cases, or may need to be assessed on a case-by-case basis:

- analyze freight movement and delays during peak harvest
- analyze winter weather driving speeds to develop alternate signal timing plans
- analyze impacts of tourism and special events on travel speeds (e.g., Sturgis and the Black Hills)
- assess need for passing lanes by analyzing speed differentials between truck and car speeds

The following uses of NPMRDS are not feasible or likely at this time:

- estimate vehicle counts/flows (and possibly vehicle classification) from GPS sample sizes
- estimate times of peak flow for design hour determination

2.0 PROBLEM DESCRIPTION

In a Final Rule on National Performance Management Measures published in January 2017[1], the FHWA requires that state Departments of Transportation (DOTs) use a national travel time data set (NPMRDS) currently provided by INRIX to calculate and report specific performance measures for system performance, freight movement, and congestion mitigation and air quality. The NPMRDS-based travel times are gathered from GPS enabled mobile devices (e.g., smart phones, personal navigation devices, truck fleet tracking and telematics systems, etc.) in the traffic stream.

Several different analyses have identified the limitations of the NPMRDS travel time data:

- high levels of missing data on lower-volume roadways and time periods
- suspect data and outliers
- inclusion of non-NHS routes (NPMRDS was intended for NHS routes only)
- lack of integration with state DOT linear roadway referencing
- proprietary segment definitions, including segments that are extremely short (less than 01 mile)

Because of these reported limitations, SDDOT was concerned that the FHWA Final Rule on National Performance Management Measures requires them to use travel time data of questionable or unknown quality to measure their roadway performance. Inaccurate measurement of SDDOT's roadway performance could affect funding, investment decisions, and management strategies. Therefore, SDDOT needs to better understand the quality of the existing NPMRDS travel time data within South Dakota. If the existing NPMRDS is not of sufficient quality, SDDOT needs to identify a better alternative (i.e., an "equivalent data set" as defined in the FHWA Final Rule).

[1] See https://www.federalregister.gov/documents/2017/01/18/2017-00681/national-performance-management-measures-assessing-performance-of-the-national-highway-system.

3.0 RESEARCH OBJECTIVES

In December 2016, the SDDOT contracted with TTI to conduct several analyses of the NPMRDS. The research project had three overall objectives, which are described in the following sections.

3.1 Assess NPMRDS Quality

Determine how representative passenger vehicle and truck travel times in NPMRDS are of actual travel times in South Dakota.

The first objective was to determine how representative (i.e., accurate) passenger vehicle and truck travel times in NPMRDS are of actual travel times in South Dakota. To meet this first objective, TTI conducted an accuracy evaluation at specific locations in South Dakota by comparing the NPMRDS *travel* times/speeds to trusted sources of speed data (e.g., SDDOT-installed traffic monitoring sensors).

3.2 Evaluate Suitability for Federal Performance Measures

Recommend whether the NPMRDS is a reasonable solution for South Dakota to use for reporting performance requirements found in National Performance Measures: Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program.

The second objective was to assess and recommend whether the NPMRDS is a reasonable solution for SDDOT to use for reporting performance requirements found in FHWA's Final Rule for National Performance Management Measures. To meet this second objective, TTI combined the accuracy results from Objective 1 with two other analysis results to determine if NPMRDS is a reasonable solution for federally mandated system performance measures:

Analysis of *the* temporal completeness of NPMRDS in South Dakota.

1. Analysis of the geographic coverage of NPMRDS in South Dakota.

3.3 Evaluate Suitability for Other Uses

Evaluate the suitability of NPMRDS for other potential uses by SDDOT.

The third objective was to evaluate the suitability of NPMRDS for other potential uses by SDDOT. To meet Objective 3, TTI conducted interviews with SDDOT staff about other possible uses of travel time data (e.g., work zone or special event (such as Sturgis) monitoring, calibrating travel demand models, input to safety models, etc.). TTI researchers also used the analysis results from Objectives 1 and 2 (above) to make recommendations about other possible uses within SDDOT.

4.0 TASK DESCRIPTIONS

This research project defined 12 tasks that were intended to accomplish the three objectives described in the previous chapter. This chapter describes the work that TTI conducted within each of these 12 tasks.

4.1 Project Scope Review

Meet with the technical panel to review project scope and work plan.

In Task 1, TTI attended a face-to-face meeting with the project's technical panel on December 16, 2016 to review the project scope and work plan. TTI's past experience has been that face-to-face meetings are very beneficial for project kickoff meetings, to help establish a working relationship between the research team and the study sponsor.

4.2 Literature Review

Review literature pertaining to use and verification of NPMRDS data by state DOTs or other agencies.

In Task 2, TTI reviewed and synthesized the literature with regard to use and validation of NPMRDS by others. From the literature review, TTI researchers identified best practices and lessons learned and how these could be applied in South Dakota.

4.3 Interview SDDOT Staff

Interview SDDOT personnel about potential uses for NPMRDS data.

In Task 3, TTI researchers conducted phone-based technical interviews with SDDOT personnel about various potential uses of the travel times within NPMRDS. The interviews were conducted with SDDOT staff as identified by the project's technical panel. The interviews included a wide cross-section of SDDOT staff from different divisions and regions.

4.4 Evaluate Other Possible Uses of NPMRDS

Evaluate pros and cons of other potential uses of NPMRDS identified in Tasks 2 and 3.

In Task 4, TTI evaluated the pros and cons of these other possible uses of NPMRDS travel time data as identified in Tasks 2 and 3. For example, one of the pros is that NPMRDS is a free data set for which FHWA has already paid the data licensing costs. One of the cons is that the NPRMDS only covers NHS roadways and may not include other state highways of interest to SDDOT. There are numerous other advantages and disadvantages to consider when discussing possible uses of NPMRDS.

4.5 Analyze NPMRDS Coverage and Completeness

Review the NPMRDS data set to characterize temporal and geographical coverage on South Dakota's NHS.

In Task 5, TTI analyzed the NPMRDS to quantify the temporal and geographic roadway coverage and data completeness in South Dakota. The roadway coverage analysis compared the miles of roadway coverage in NPMRDS to the reported NHS mileage and the total statewide "on-system" highway mileage within South Dakota. The geographic coverage analysis also indicated what specific NHS routes (highway number and mileage) are included in NPMRDS, what NHS routes are missing from NPMRDS, and what non-NHS routes are included in NPRMDS.

The data completeness analysis compared the available travel time data within NPMRDS to the maximum possible data records (i.e., a travel time value for every road segment every 5 minutes for every day of the year). This analysis is critically important to quantify these two baseline data quality indicators (e.g., coverage and completeness) of NPMRDS within South Dakota. Looking ahead, Task 8 established the third data quality indicator and perhaps the most important: accuracy of NPMRDS travel time data.

4.6 Propose Experimental Plan

Propose an experimental plan – including segment locations, data collection methodology and duration, and analysis methods – for performing a statewide comparison of NPMRDS travel time data to SDDOT-gathered volume, classification, and speed data.

In Task 6, TTI developed an experimental plan to compare NPMRDS travel time data to SDDOT-gathered data. The SDDOT's traffic monitoring program has decades of experience gathering traffic data, and their traffic monitoring sites will provide a reliable, accurate benchmark against which to compare the NPMRDS data.

The experimental plan accounted for speed measurement differences between NPMRDS and the SDDOT traffic monitoring sites. The travel times in NPMRDS are link-based (space mean speed) and calculated from GPS probe vehicles that are traveling along a road segment. The speeds measured at SDDOT traffic monitoring sites are point-based and measure the speed of every vehicle at a specific location (time mean speed, not across the entire road segment). To account for these differences, the NPMRDS travel times must be converted to link speeds (by dividing the segment length, in miles, by the corresponding travel time, in hours) before being compared to SDDOT speed data. Also, the NPMRDS links selected for the comparison should be relatively short, since a longer segment could have within-segment speed differences that will lessen the comparability with a fixed-location speed monitoring site.

The experimental plan accounted for the fact that some roadway coverage included in NPMRDS is non-NHS routes. Specifically, no NPMRDS locations deemed to be on non-NHS routes were included in this comparative analysis of data accuracy.

The experimental plan also defined several other parameters necessary for a fair and accurate comparison:

- number and location of comparison sites
- duration of comparisons
- time interval/granularity used for comparisons
- accuracy measures and their respective calculation procedures
- speed categories to be used for summarizing accuracy measures

4.7 Submit Technical Memo and Meet with Panel

Submit a technical memorandum and meet with the technical panel to present results from Tasks 2-6 and obtain approval for the experimental plan.

In Task 7, TTI prepared and submitted to SDDOT a technical memorandum that documents Tasks 2 through 6. TTI also met (virtually, using a web meeting tool and teleconference) with the project's technical panel to present and discuss project results to date.

4.8 Analyze NPMRDS Accuracy

Compare NPMRDS passenger and truck travel time data to travel time estimates derived from SDDOT-gathered volume, classification, and speed data.

In Task 8, TTI performed the accuracy comparison as outlined in the experimental plan developed in Task 6 and refined in Task 7. The experimental plan developed in Task 7 defined the specific details for several of the evaluation parameters.

4.9 Develop Recommendations for Uses of NPMRDS

Recommend whether NPMRDS is accurate, complete, and representative enough to meet the national performance reporting requirements and other potential uses by SDDOT.

In Task 9, TTI developed conclusions and recommendations about the use of NPMRDS for federally-mandated system performance measures and other potential uses within SDDOT. The conclusions and recommendations were based on several factors:

- analysis of geographic coverage (Task 5)
- analysis of data completeness (Task 5)
- analysis of data accuracy (Task 8)
- other considerations (Tasks 3 and 4)

4.10 Submit Technical Memo and Meet with Panel

Submit a technical memorandum and meet with the technical panel to present the results of Tasks 8 and 9.

In Task 10, TTI prepared and submitted to SDDOT a technical memorandum that documents Tasks 8 and 9. TTI also met virtually with the project's technical panel to present and discuss project results to date.

4.11 Prepare Final Report

Prepare a final report and executive summary of the research methodology, findings, conclusions, and recommendations. In accordance with *Guidelines for Performing Research for the South Dakota Department of Transportation*, prepare a final report and executive summary of the research methodology, findings, conclusions, and recommendations.

In Task 11, TTI prepared a final report (with executive summary) that documents the research methods, findings, conclusions and recommendations. This final project report includes the documentation and material that was previously prepared and approved in Tasks 7 and 10.

4.12 Make Executive Presentation

Make an executive presentation to the SDDOT Research Review Board at the conclusion of the project.

In Task 12, TTI made an executive presentation to the SDDOT Research Review Board. This presentation focused on overall results and recommendations from the project, and was oriented to mid-level technical managers and non-technical executives. TTI researchers focused on "bottom line" results and implications for SDDOT.

5.0 FINDINGS AND CONCLUSIONS

This chapter of the report discusses the findings and conclusions and is organized around the three study objectives:

1. Determine how representative passenger vehicle and truck travel times in NPMRDS are of actual travel times in South Dakota.
2. Recommend whether the NPMRDS is a reasonable solution for South Dakota to use for reporting performance requirements found in *National Performance Measures: Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program.*
3. Evaluate the suitability of NPMRDS for other potential uses by SDDOT.

5.1 Determine the Accuracy of NPMRDS Travel Times in South Dakota

The first objective was to evaluate the accuracy of NPMRDS speed data by comparing it to speed data gathered at available SDDOT traffic monitoring sites. Given project resources, these SDDOT sites were considered the best available benchmark against which to compare the NPMRDS data.

5.1.1 Accuracy Evaluation Methods

The elements of the accuracy comparison were as follows:

- **Benchmark locations.** Table 6 and Figure 3 present the 31 SDDOT sites that TTI used to evaluate the accuracy of NPMRDS by comparing to Traffic Message Channel (TMC) segments in NPMRDS. These sites represent all possible SDDOT permanent monitoring sites that were available for comparison. It should be noted that Sites 154 and 186 were within a construction zone in 2017 and valid speed data was not available.
- **Duration of comparisons**. TTI used the five months of NPMRDS data available (February through June 2017) at the time of the analysis. SDDOT staff provided the corresponding benchmark speed data from the 31 SDDOT traffic monitoring sites.
- **Time interval used for comparisons**. TTI used 1-hour intervals to compare the NPMRDS speed data to the SDDOT speed data. The NPMRDS speed data is provided in 5-minute and 15-minute intervals, but the SDDOT speed data could only be obtained in 1-hour intervals, thus being the limiting factor.
- **Accuracy measures and their respective calculation procedures**. TTI calculated these accuracy measures in the speed comparison:
    - Average absolute speed error (in mph)
    - Average absolute speed error (in %)
    - Speed error bias (in mph)
- **Speed categories to be used for summarizing accuracy measures**. TTI used these speed categories for the calculation of summary accuracy statistics:
    - 0 to 30 mph
    - 30 to 45 mph
    - 45 to 60 mph
    - Greater than 60 mph

Table 6: SDDOT Traffic Monitoring Sites for NPMRDS Accuracy Evaluation

SDDOT Site Identifier	Highway	Site Type	TMC Segment Direction 1 Segment Identifier	TMC Segment Direction 1 Length (mi)	TMC Segment Direction 2 Segment Identifier	TMC Segment Direction 2 Length (mi)	Functional Class	2016 AADT
102	SD79	AVC	118-19358 (SB)	8.27	118+19359 (NB)	8.36	Rural: Other Principal Arterial	1,900
103	SD50	AVC	118-10252 (WB)	8.32	118+10251 (EB)	8.30	Rural: Other Freeways and Expressways	4,938
104	SD73	AVC	118-13739 (SB)	8.36	118+13740 (NB)	8.36	Rural: Other Principal Arterial	843
105	US18	AVC	118-09222 (WB)	9.00	118+06817 (EB)	9.00	Rural: Other Principal Arterial	372
106	US14	AVC	118-08634 (WB)	25.61	118+08994 (EB)	25.61	Rural: Other Principal Arterial	786
108	US81	AVC	118-06485 (SB)	11.00	118+09384 (NB)	11.00	Rural: Other Principal Arterial	1,828
110	US85	AVC	118-10298 (SB)	37.30	118+10299 (NB)	37.30	Rural: Other Principal Arterial	1,139
157	US14	AVC	118-08638 (WB)	14.14	118+08639 (EB)	14.14	Rural: Other Principal Arterial	3,019
159	US281	AVC	118-06378 (SB)	8.50	118+10116 (NB)	8.50	Rural: Other Principal Arterial	2,322
160	US12	AVC	118-09696 (EB)	3.55	118+09697 (WB)	3.55	Rural: Other Principal Arterial	2,071
165	SD 37	AVC	118-13683 (SB)	7.75	118+06873 (NB)	7.75	Rural: Other Freeways and Expressways	2,680
166	I 90	AVC	118-06010 (WB)	4.59	118+06011 (EB)	4.41	Rural: Interstate	7,120
178	US85	AVC	118-08402 (SB)	30.82	118+10298 (NB)	30.82	Rural: Other Principal Arterial	1,660
181	I 90	AVC	118N05992 (SB)	0.54	118P05992 (NB)	0.50	Rural: Interstate	6,270
182	I 29	AVC	118-06169 (SB)	8.25	118+06170 (NB)	8.04	Rural: Interstate	11,930
183	US16	VOL	118-17927 (WB)	9.30	118+17928 (EB)	9.30	Rural: Other Principal Arterial	1,368
193	I 90	AVC	118-05960 (WB)	3.14	118+05961 (EB)	3.14	Urban: Interstate	14,610
195	I 29	AVC	118-06206 (SB)	4.44	118+06207 (NB)	4.45	Rural: Interstate	7,370
611	I 90	VOL	118-05975 (WB)	0.40	118+05976 (EB)	0.08	Urban: Interstate	37,060
801	SD 37	WIM	118-13677 (SB)	6.98	118+13790 (NB)	6.98	Rural: Other Principal Arterial	3,060
802	US18	WIM	118-09212 (WB)	33.72	118+09213 (EB)	33.72	Rural: Other Principal Arterial	1,395
804	US83	WIM	118-10359 (SB)	11.97	118+10609 (NB)	12.00	Rural: Other Principal Arterial	1,423
805	I 90	WIM	118-06007 (WB)	4.13	118+06008 (EB)	4.16	Rural: Interstate	6,230
807	I 90	WIM	118-06030 (WB)	8.02	118+06031 (EB)	8.06	Rural: Interstate	11,820
809	I 29	WIM	118-06167 (EB)	5.88	118+06168 (WB)	5.92	Rural: Interstate	13,630
811	US85	WIM	118-08400 (SB)	8.80	118+08401 (NB)	8.80	Rural: Other Principal Arterial	8,404
812	SD 79	WIM	118-10612 (SB)	13.84	118+10613 (NB)	13.80	Rural: Other Freeways and Expressways	10,122
901	I 90	WIM	118-05967 (NB)	2.70	118+05968 (SB)	2.63	Rural: Interstate	18,520
903	US12	WIM	118-09685 (EB)	10.95	118+09686 (WB)	10.95	Rural: Other Principal Arterial	6,794
909	US14	WIM	118-09002 (WB)	6.95	118+09003 (EB)	6.95	Rural: Other Principal Arterial	1,614
910	I 29	WIM	118-06213 (SB)	9.49	118+06214 (WB)	9.44	Rural: Interstate	4,960

Legend: AVC=Automatic Vehicle Classification, VOL=Volume, WIM=Weigh-in-Motion

Note: At VOL and AVC sites, only all-traffic speeds were evaluated. At WIM sites, all three types of NPMRDS speeds were evaluated: all-traffic, passenger car only, and truck only.

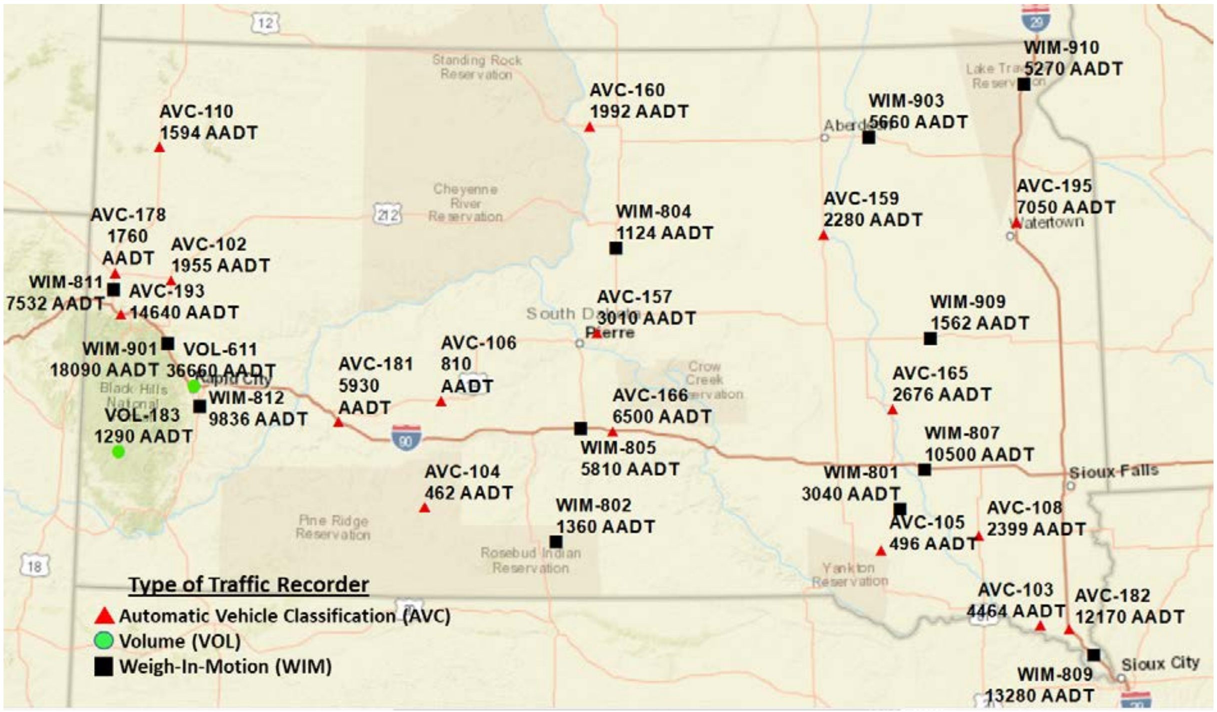

Figure 3: Map of SDDOT Traffic Monitoring Sites (with AADT) for NPMRDS Accuracy Evaluation

5.1.2 Findings from NPMRDS Accuracy Evaluation

The NPMRDS speed error combined across 31 SDDOT monitoring sites are shown in Tables 7 through 9. The NPMRDS provides three different speed values, and each set of speed values was evaluated with corresponding SDDOT benchmark speed data:

- all-vehicle traffic speeds (passenger cars and trucks combined): Table 7
- truck-only speeds: Table 8
- passenger car speeds: Table 9

The maximum acceptable error limits will vary depending upon how the NPMRDS speed data is to be used. TTI chose the same acceptable error limits that I-95 Corridor Coalition sets in their contract requirements when evaluating speeds for real-time traveler information:

- average absolute speed error less than or equal to 10 mph
  - o where average absolute speed error = $\frac{1}{n}\sum_{i=1}^{n} |NPMRDS\ Speed_i - SDDOT\ Speed_i|$
- speed error bias less than or equal to 5 mph
  - o where speed error bias = $\frac{1}{n}\sum_{i=1}^{n} NPMRDS\ Speed_i - SDDOT\ Speed_i$

Therefore, those error values that fall outside this limit are highlighted yellow in the following tables.

Table 7: NPMRDS Speed Error for All-Vehicle Traffic Speeds, All 31 SDDOT Sites

Benchmark Speed Category	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data (% of total)
0 to 30 mph	23	110%	+22	15 (0.01%)
30 to 45 mph	18	42%	+14	1,700 (1%)
45 to 60 mph	10	19%	+5	6,943 (5%)
> 60 mph	8	12%	-8	138,140 (94%)

Table 8: NPMRDS Speed Error for Truck-Only Speeds, 12 SDDOT WIM Sites

Benchmark Speed Category	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data (% of total)
0 to 30 mph	31	159%	+30	3 (0.01%)
30 to 45 mph	10	25%	0	38 (0.07%)
45 to 60 mph	8	14%	-3	578 (1%)
> 60 mph	8	11%	-7	56,898 (99%)

Table 9: NPMRDS Speed Error for Passenger Car Speeds, 12 SDDOT WIM Sites

Benchmark Speed Category	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data (% of total)
0 to 30 mph	60	434%	+60	1 (0.00%)
30 to 45 mph	14	36%	+4	27 (0.06%)
45 to 60 mph	12	22%	-6	420 (1%)
> 60 mph	10	14%	-10	47,995 (99%)

Speed errors were significantly higher on lower-volume arterial roads than on higher-volume Interstate highways and other freeways/expressways. Therefore, the results from Table 7 were subdivided based on functional classification as well as volume range:

- Table 10: Interstates, Other Freeways and Expressways
- Table 11: Other Principal Arterials
- Table 12: Less than 5,000 AADT (all functional classes)
- Table 13: 5,000 to 10,000 AADT (all functional classes)
- Table 14: Greater than 10,000 AADT (all functional classes)

Tables 10 through 14 indicate that the highest error values are on principal arterials on which the AADT is less than 5,000 vehicles per day. High error values are also in the lowest speed category of 0 to 30 mph. However, there were so few comparisons in this category (less than 0.02%) that the calculated error may not be reliable. In other words, very slow speeds occurred so infrequently that it is statistically challenging to quantify reliably the NPMRDS speed error.

Table 10: NPMRDS Speed Error for All-Vehicle Traffic Speeds, 14 INTERSTATE/FREEWAY/EXPRESSWAY SITES

Benchmark Speed Category	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data (% of total)
0 to 30 mph	18	118%	+18	4 (0.01%)
30 to 45 mph	8	19%	+5	72 (0.09%)
45 to 60 mph	5	9%	+2	2,252 (3%)
> 60 mph	8	11%	-7	77,300 (97%)

Table 11: NPMRDS Speed Error for All-Vehicle Traffic Speeds, 17 PRINCIPAL ARTERIAL SITES

Benchmark Speed Category	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data (% of total)
0 to 30 mph	25	107%	+23	11 (0.02%)
30 to 45 mph	18	43%	+14	1,628 (2%)
45 to 60 mph	12	24%	+6	4,691 (7%)
> 60 mph	9	13%	-8	60,840 (91%)

Table 12: NPMRDS Speed Error for All-Vehicle Traffic Speeds, ONLY SITES LESS THAN 5,000 AADT

Benchmark Speed Category	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data (% of total)
0 to 30 mph	21	88%	+19	14 (0.02%)
30 to 45 mph	18	43%	+14	1,637 (2%)
45 to 60 mph	11	23%	+6	4,947 (8%)
> 60 mph	8	11%	-7	57,267 (90%)

Table 13: NPMRDS Speed Error for All-Vehicle Traffic Speeds, ONLY SITES BETWEEN 5,000-10,000 AADT

Benchmark Speed Category	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data (% of total)
0 to 30 mph	---	---	---	0 (0%)
30 to 45 mph	9	22%	0	15 (0.04%)
45 to 60 mph	9	15%	-5	199 (1%)
> 60 mph	8	12%	-8	36,678 (99%)

Table 14: NPMRDS Speed Error for All-Vehicle Traffic Speeds, ONLY SITES GREATER THAN 10,000 AADT

Benchmark Speed Category	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data (% of total)
0 to 30 mph	58	415%	+58	1 (0.00%)
30 to 45 mph	6	14%	+3	48 (0.1%)
45 to 60 mph	5	8%	+1	1,797 (4%)
> 60 mph	9	12%	-9	44,195 (96%)

Appendix A contains an additional 12 tables that summarize the error statistics on a site-by-site basis for each of the three speed values:

- All-traffic speeds
- Truck-only speeds
- Passenger car-only speeds

Tables 7 through 14 summarize aggregate-level error values that were calculated from hundreds of thousands of speed comparisons during a five-month period. As such, it can be difficult to visualize the actual speed values from NPMRDS and SDDOT that are being compared. Several charts are included here to illustrate the actual speed values that were compared for specific days. In particular, TTI identified several examples of Interstate traffic slowdowns to illustrate the capability of NPMRDS to capture these infrequent slowdowns, even in rural areas.

Figure 4 illustrates a slowdown that occurred on I-90 east of Spearfish (Site #193) in the overnight hours of April 9-10. It was determined that a snow storm was causing this slowdown, and similar snow-related slowdowns were captured at several other locations across the state. Figure 5 shows the slowdown as recorded on I-90 east of Wall (Site #181). Finally, Figure 6 shows the same event causing a slowdown on I-90 east of Mitchell (Site #807) in eastern South Dakota. The slowdown in eastern South Dakota occurs mid-day on April 10, which is about 12 hours later than the slowdowns recorded in western South Dakota.

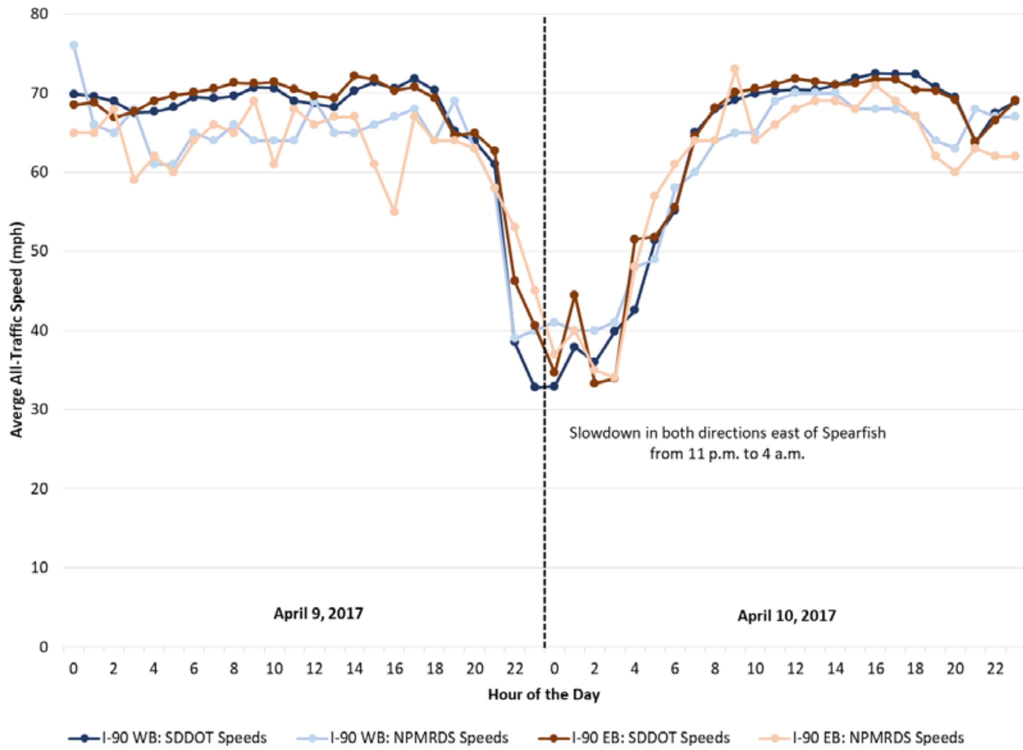

Figure 4: Comparison of All-Vehicle Traffic Speeds near SDDOT #193, April 9-10 2017

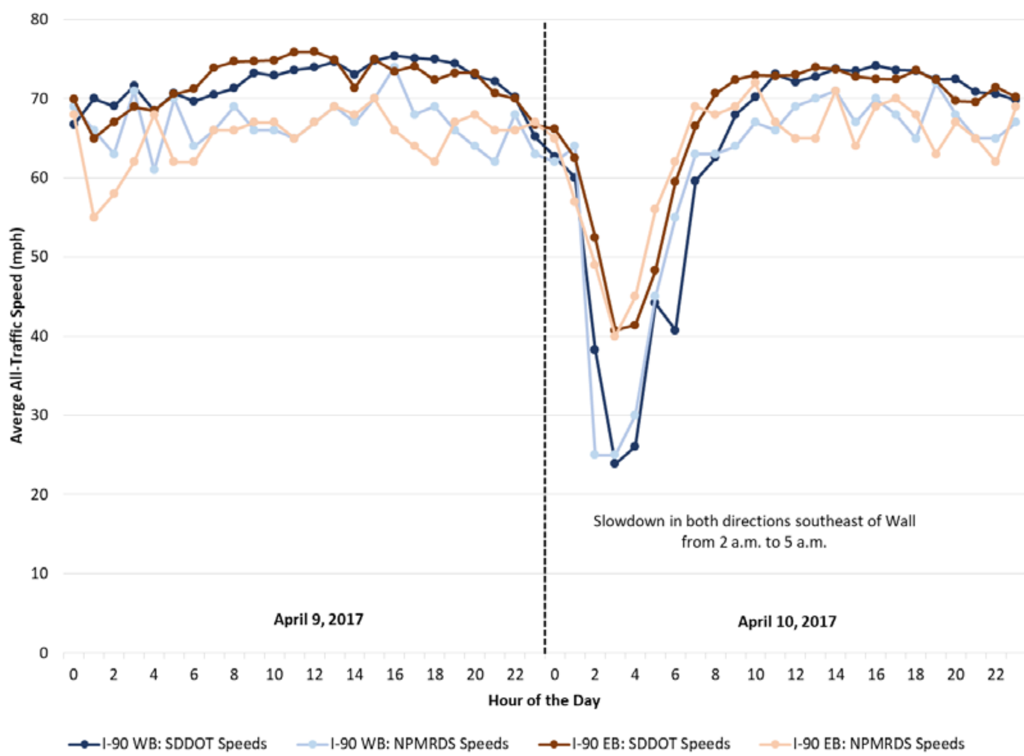

Figure 5: Comparison of All-Vehicle Traffic Speeds near SDDOT #181, April 9-10 2017

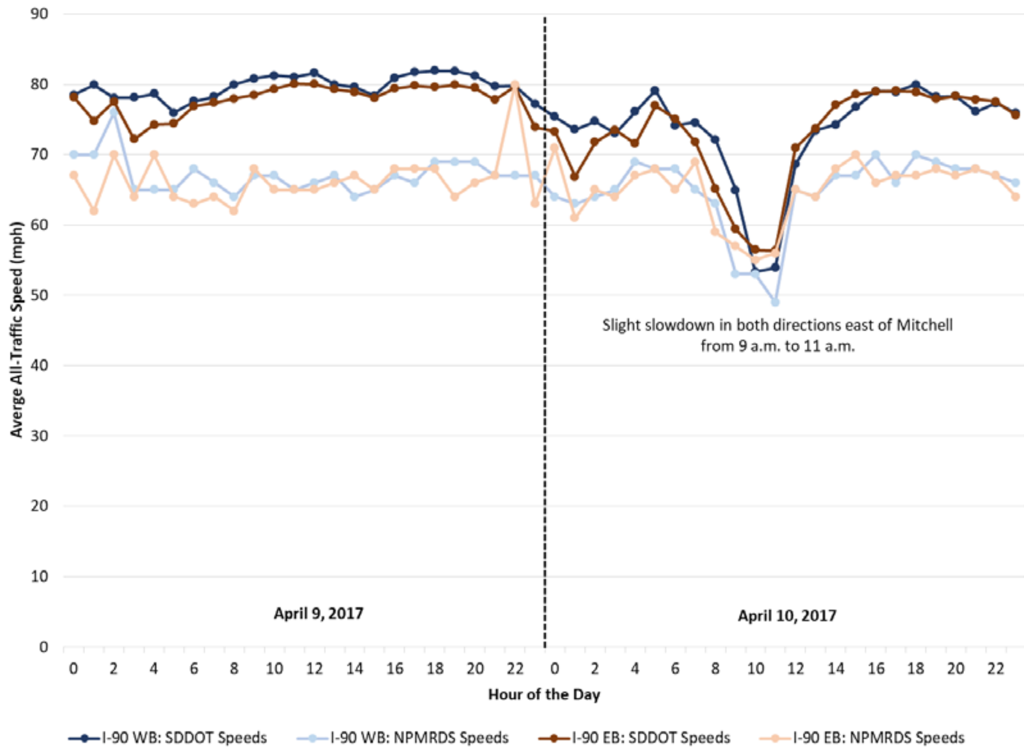

Figure 6: Comparison of All-Vehicle Traffic Speeds near SDDOT #807, April 9-10 2017

Note that, even for Interstate highways (Table 10) or high-volume sites (Tables 13 and 14), the NPMRDS free-flow speeds are biased low in all cases (e.g., NPMRDS free-flow speeds are 7 to 9 mph slower than SDDOT-reported free-flow speeds). In reviewing detailed results, it appears the slower free-flow speeds in NPMRDS could be caused by one or more of the following reasons:

- **Disproportionate truck GPS samples**: INRIX (NPMRDS data provider) gathers GPS data from both commercial truck fleets and passenger cars on a nationwide basis. On rural highways in South Dakota, the ratio of truck GPS samples to car GPS samples may be much higher, which could cause slower truck speeds to have a disproportionate impact when calculating overall traffic speeds. The lower bias values in Table 8 for truck speeds supports this possible reason. That is, Table 8 indicates that NPMRDS truck speeds have much less bias than NPMRDS car speeds (Table 9).
- **Speeds are measured in different ways**: NPMRDS speeds are gathered from GPS devices that report along the entire length of each defined road segment, and represent an average segment speed (comparable to a travel time). In this evaluation, the NPMRDS segments ranged from about a half-mile to over 37 miles long. Conversely, SDDOT speeds are gathered at a single point along a road segment, and represent an average spot speed. This difference in speed measurement could be contributing to the bias, as traffic flow theory indicates that average segment speeds are usually less than average spot speeds. Given project resources, the SDDOT sites were the only available data source that could be in these comparisons, so this difference in speed measurement methods could not be avoided.

- **NPMRDS segment speeds affected at several locations**: It appears that NPMRDS segment speeds are being affected near the Weigh-in-Motion (WIM) Ports of Entry (i.e., weigh stations), whereas the SDDOT spot speeds are not being affected. Because NPMRDS speeds are segment-based, these speeds capture delay experienced at the SDDOT weigh stations, as well as deceleration into and slow acceleration out of these stations. Figure 7illustrates how only the eastbound direction of I-90 at WIM-POE #901 is affected in the NPMRDS speeds, but not in the SDDOT speeds (which are measured at a point and not affected by the weigh station).

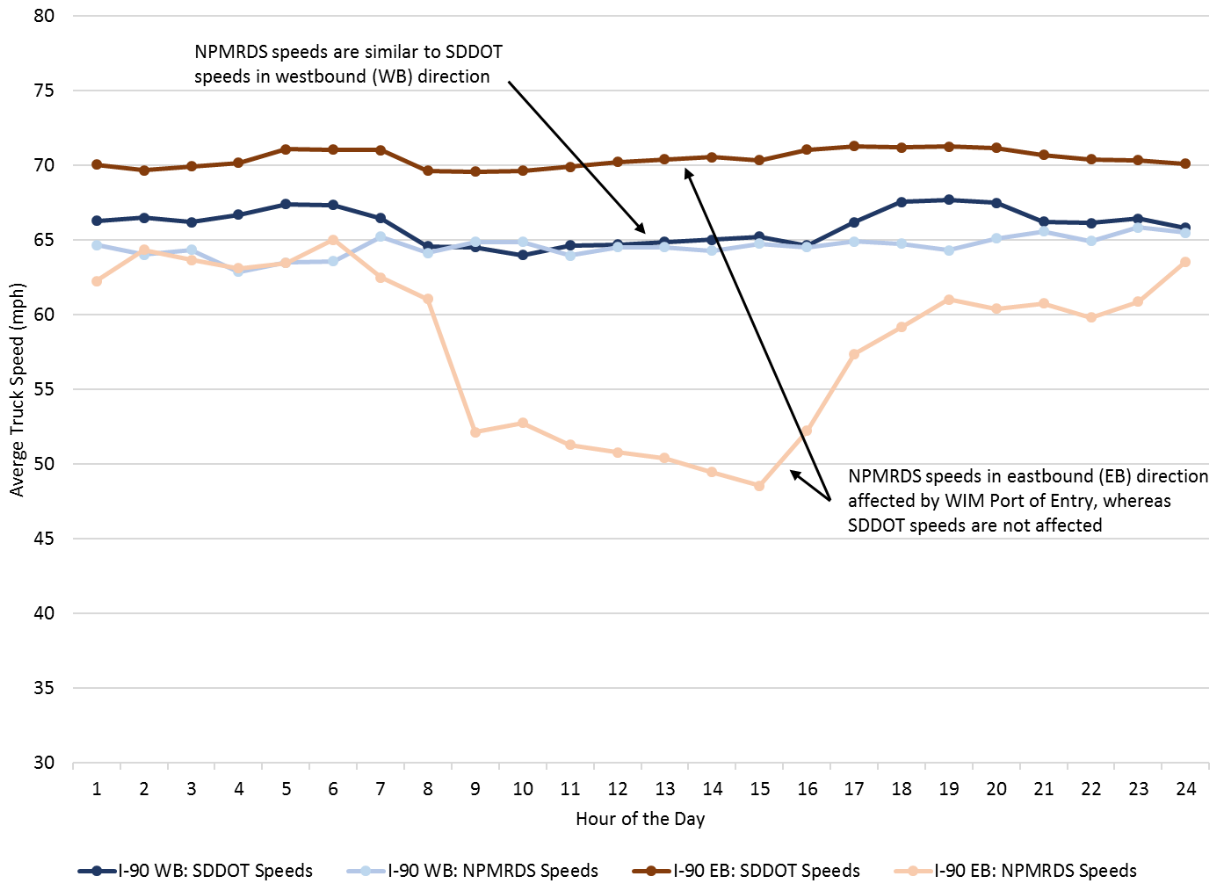

Figure 7: Comparison of Truck-Only Traffic Speeds near SDDOT #901, June 2017

5.2 Determine Whether SDDOT Should Use NPMRDS for National Performance Management Measures

To meet this objective, TTI researchers analyzed the temporal completeness and geographic coverage of NPMRDS data from February through June 2017. FHWA awarded a new data provider contract (i.e., INRIX) in April 2017, and the February through June 2017 period represented the initial launch release of NPMRDS data from this new data provider contract. These five months of NPMRDS data are considered adequate to assess completeness and coverage of the new NPMRDS contract. The following sections document the findings of TTI's analysis of NPMRDS temporal completeness and geographic coverage.

5.2.1 Analyze Temporal Completeness of NPMRDS in South Dakota

This section describes the temporal completeness for all road segments that are currently included in NPMRDS. As of July 2017, there are 1,965 unique directional NPMRDS segments for South Dakota. For each NPMRDS segment, there are a maximum of 288 5-minute values (or 96 15-minute values) in each day. TTI's completeness analysis counted the number of available travel time values for each of the 1,965 NPMRDS segments for each day during the period of February to June 2017. NPMRDS data completeness subtotals were also calculated for several different categories (i.e., road functional classes, time of day, urban versus rural, etc.). The NPMRDS site (https://npmrds.ritis.org) does provide a coverage and completeness map (Figure 8) for each month. However, the NPMRDS map only displays a single month at once, so TTI independently calculated completeness for all five months combined.

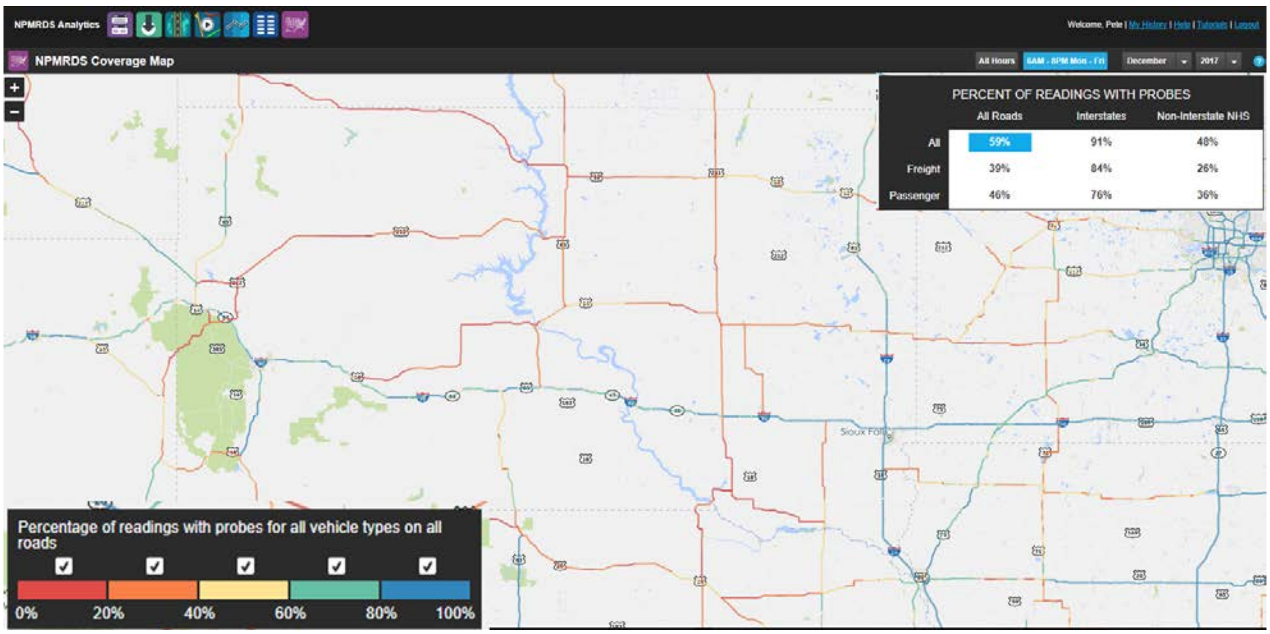

Figure 8: NPMRDS Coverage/Completeness Map (https://npmrds.ritis.org/analytics/coverage-map/)

Figure 9 shows data completeness by time of day for all NPMRDS segments in South Dakota. TTI chose to use 15-minute time intervals for all seven days of the week to calculate completeness, since that day of the week and time interval is specified in the FHWA Final Rule on System Performance Measures. Also, 15-minute time intervals are likely to be used in most SDDOT data applications.

Figure 9 shows that, for the all-vehicle travel times, Interstate NHS roads are typically 90% complete during daytime hours, and non-Interstate NHS roads are typically 35% complete during daytime hours. For travel times of trucks only, Interstate NHS roads are typically 80% complete during daytime hours, and non-Interstate NHS roads are typically less than 20% complete during daytime hours.

Even though some of these completeness values may seem low (e.g., non-Interstate NHS roads), it is important to remember that these are measuring total completeness every 15 minutes for every day in the five-month period. When measured this way, the completeness of traditional travel time collection methods (such as floating car) would likely fall below 1%, since traditional collection methods only collect travel times for a few time periods on a few different days.

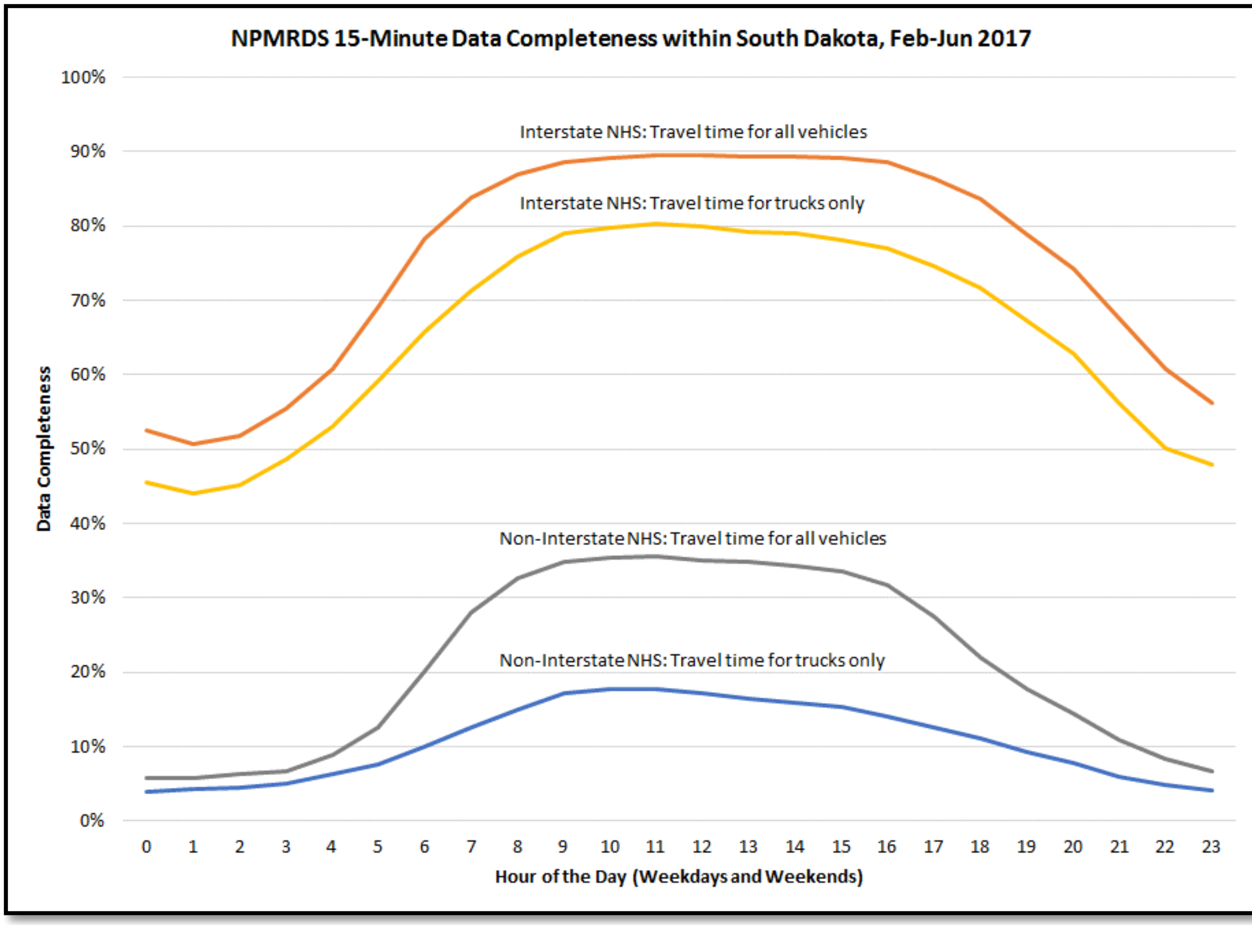

Figure 9: NPMRDS Data Completeness by Time of Day within South Dakota

Figure 10 and Figure 11 show average data completeness across all 24 hours, as well as for daytime hours (i.e., 6 am to 8 pm). Interstate highways have very high levels of completeness, ranging from 65% to 86% depending upon the travel time type and hours of the day. Non-Interstate NHS highways have much lower completeness, ranging from 10% to 30%.

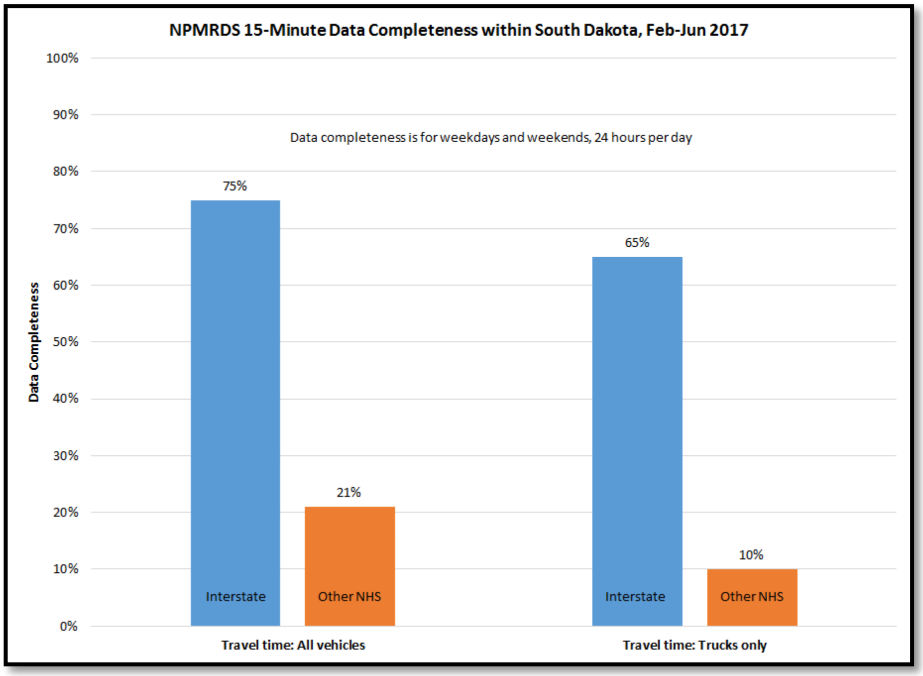

Figure 10: NPMRDS Data Completeness by Road Type within South Dakota, All 24 Hours

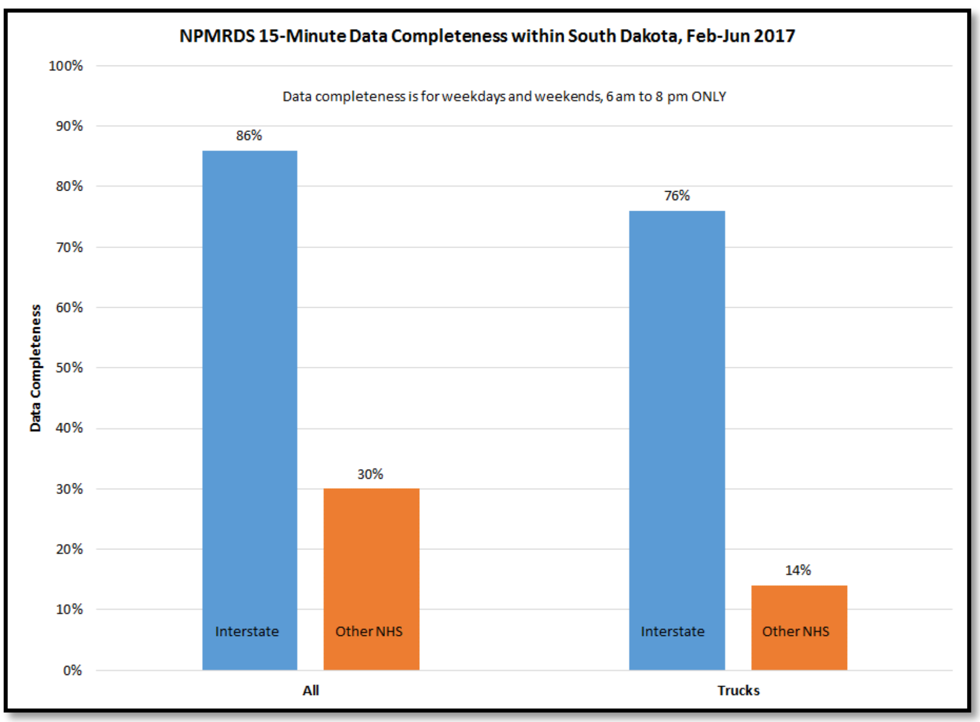

Figure 11: NPMRDS Data Completeness by Road Type within South Dakota, 6 am to 8 pm Only

Figure 12 shows data completeness summarized for three different areas: 1) Sioux Falls; 2) Rapid City; and 3) remaining rural areas in South Dakota. Similar to the previous figures, Figure 12 indicates that, for Interstate NHS highways during daytime hours, the all-vehicle travel time data is about 85% complete, while the truck-only travel time is about 65% complete (except for rural areas at 80%). For non-Interstate NHS highways during daytime hours, the all-vehicle travel time data is about 50% complete (except for rural areas at 26%), while the truck-only travel time is about 15% complete.

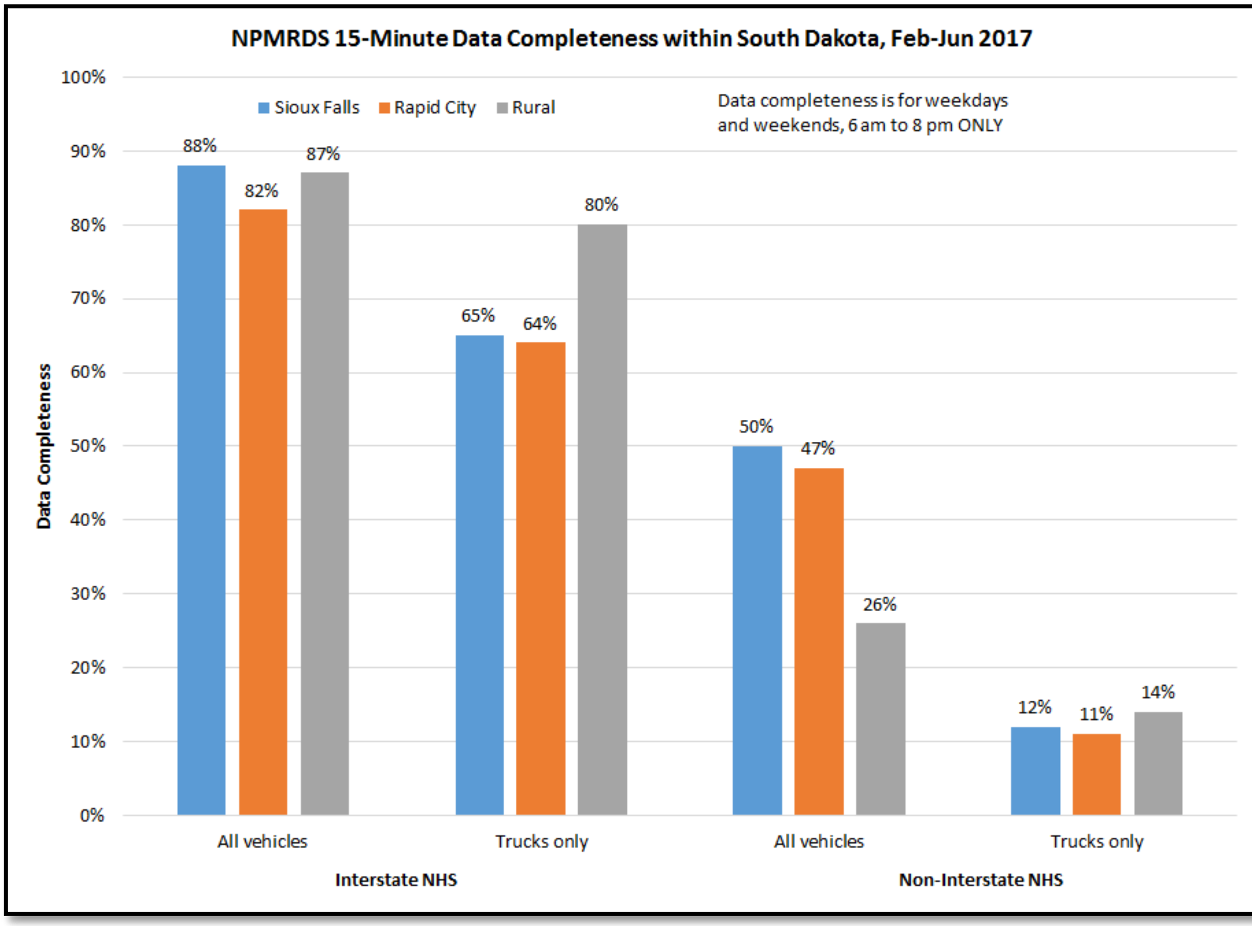

Figure 12: NPMRDS Data Completeness by Area Type within South Dakota, 6 am to 8 pm Only

TTI informally compared the data completeness of the current data provider to that of the previous data provider (i.e., Feb-Jun 2017 compared to Jan-Dec 2015). In most cases, the data completeness improved about 10% to 15%. However, in some cases (such as the truck-only travel times on non-Interstate NHS highways), the data completeness is unchanged between the two different data providers.

Figure 13 and Figure 14 show all-vehicle travel time data completeness maps for all NPMRDS road segments in South Dakota, wherein data completeness has been averaged over the five-month period (Feb-Jun 2017). Figure 13 shows data completeness for all 24 hours of the day, whereas Figure 14 is for daytime hours (6 am to 8 pm) only. Note that several parameters in Figures 13 and 14 are different than what is shown in the online NPMRDS maps (https://npmrds.ritis.org/analytics/coverage-map/).

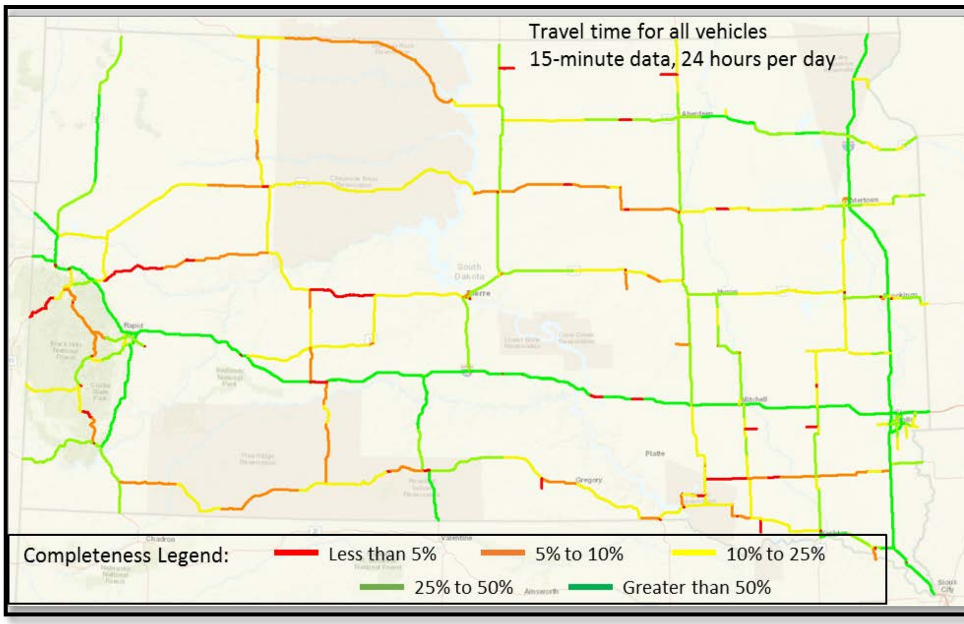

Figure 13: NPMRDS Completeness for Road Segments, All-Vehicle Travel Time, All 24 hours

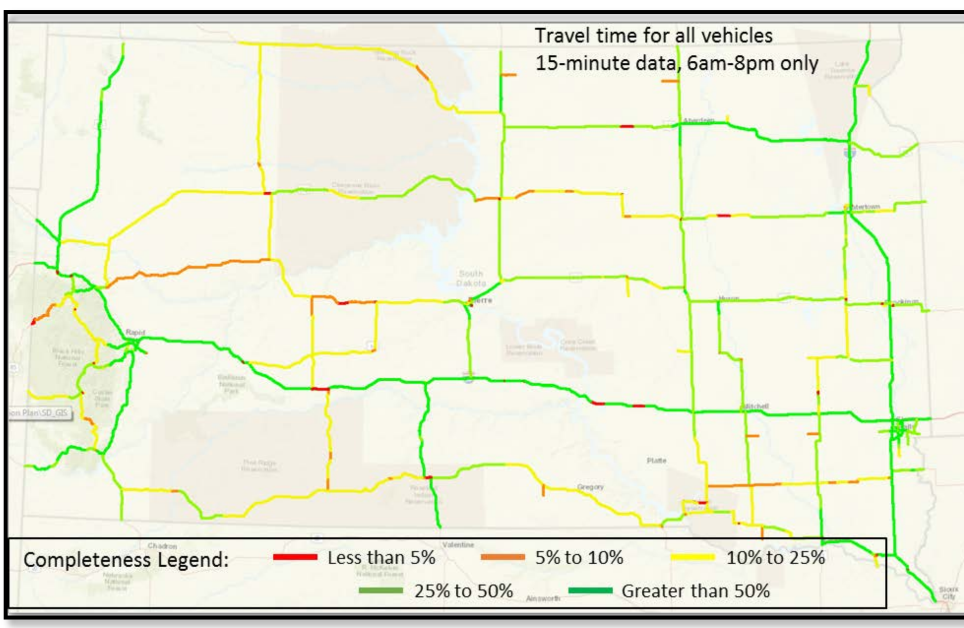

Figure 14: NPMRDS Completeness for Road Segments, All-Vehicle Travel Time, 6 am to 8 pm Only

Figures 15 and 16 show truck-only travel time data completeness maps for all NPMRDS road segments in South Dakota, wherein data completeness has been averaged over the five-month period (Feb-Jun 2017). Figure 15 shows data completeness for all 24 hours of the day, whereas Figure 16 is for daytime hours (6 am to 8 pm) only. Note that several parameters in Figures 15 and 16 are different than what is shown in the online NPMRDS maps (https://npmrds.ritis.org/analytics/coverage-map/).

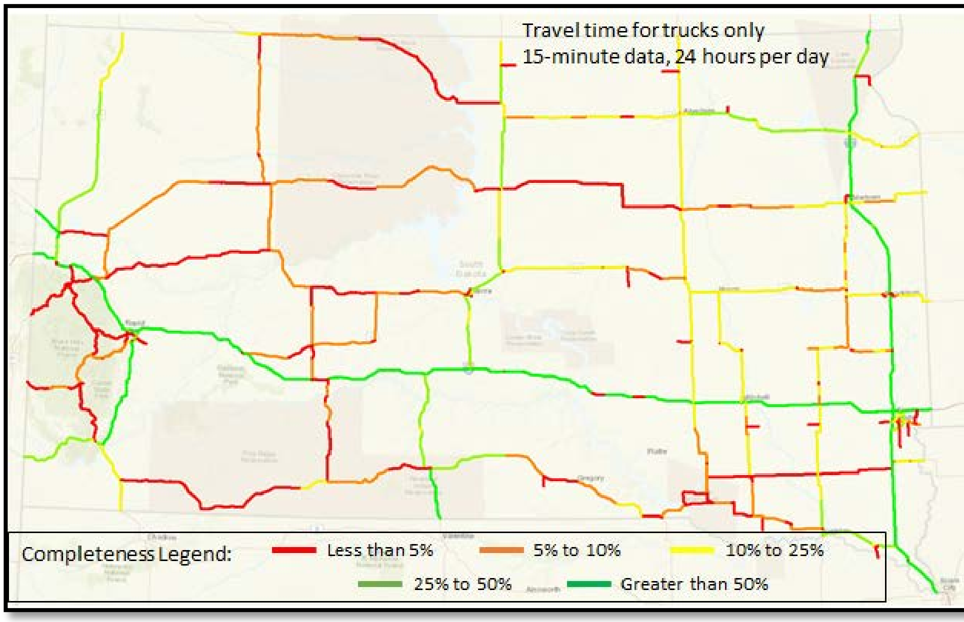

Figure 15: NPMRDS Completeness for Road Segments, Truck-Only Travel Time, All 24 hours

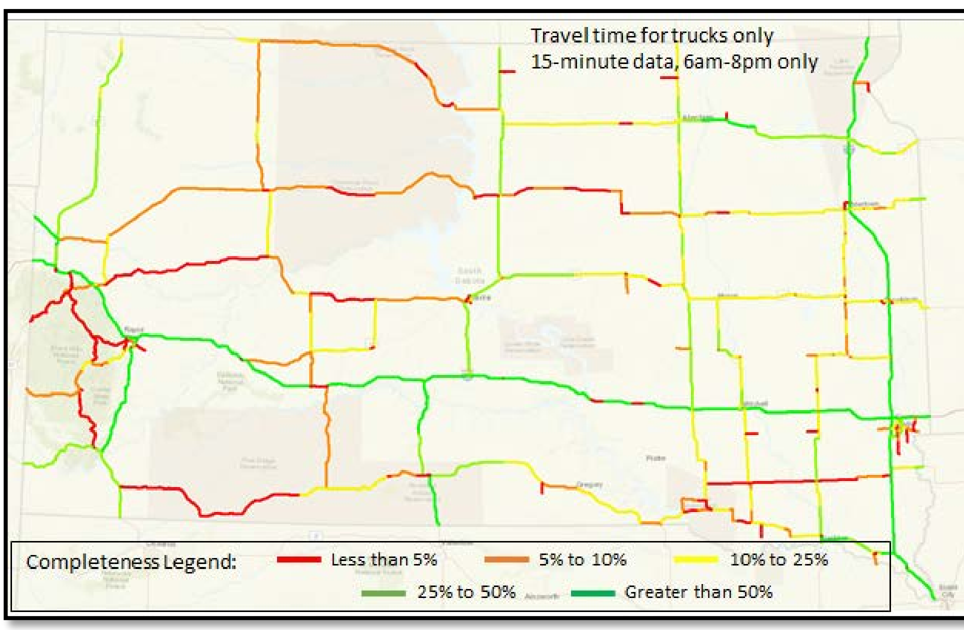

Figure 16: NPMRDS Completeness for Road Segments, Truck-Only Travel Time, 6 am to 8 pm Only

5.2.2 Analyze Geographic Coverage of NPMRDS in South Dakota

This section describes the geographic coverage of road segments that are currently included in NPMRDS. These NPMRDS segments are intended to represent the entirety of the NHS network in South Dakota as indicated in the most recently available Highway Performance Monitoring System (HPMS) data. The FHWA provided the NPMRDS project team with a GIS shapefile that identified the entire 2015 (most recently available at that time) NHS network in the United States, and this GIS shapefile was developed from the HPMS submittals by each state DOT. Therefore, this FHWA-provided HPMS-based shapefile was considered to be the authoritative reference for NHS designation. For South Dakota, the FHWA HPMS shapefile indicated a total of 3,723 centerline-miles (7,446 directional-miles) with 2015 NHS designation. This 2015 NHS mileage total of 7,446 directional-miles was considered the benchmark when comparing to the coverage within NPMRDS.

As of July 2017, there are 1,965 unique directional NPMRDS segments for South Dakota. In many cases, the underlying TMC segment endpoints used in NPMRDS do not match the HPMS segment endpoints. Therefore, in some cases, only a portion of a TMC segment in NPMRDS could have NHS designation. However, all NPMRDS travel times are referenced to the full length of TMC segments, and not partial TMC segments. This point is important for an accurate accounting of NHS mileage within NPMRDS.

When considering the full length of each TMC segment, the 1,965 unique directional segments in NPMRDS account for 7,726 directional-miles. However, if one counts only the portion of a TMC segment that is designated as NHS (i.e., a more accurate accounting), the 1,965 unique directional segments in NPMRDS account for 7,529 directional-miles, only 83 directional-miles greater than the 2015 NHS. It is important to note the relatively small magnitude of this difference. That is, the 83 directional-miles is about 1% of South Dakota's overall NHS network.

Figure 17 shows a map-based comparison of NPMRDS segments and FHWA NHS segments, with areas of discrepancy noted with a numbered symbol. These numbered discrepancies are listed and described in Tables 15 and 16.

Table 15 lists those location discrepancies where NHS segments were not included in NPMRDS.

Table 16 lists those location discrepancies where extra non-NHS segments were included in NPMRDS.

If one adds the missing 47 directional-miles in Table 7 and subtracts the extra 140 directional-miles from the 7,529 directional-miles in NPMRDS, the result is 7,436 directional-miles, which is 10 directional-miles short of the 2015 reported NHS. The TTI research team was not able to reconcile this discrepancy of 10 directional-miles.

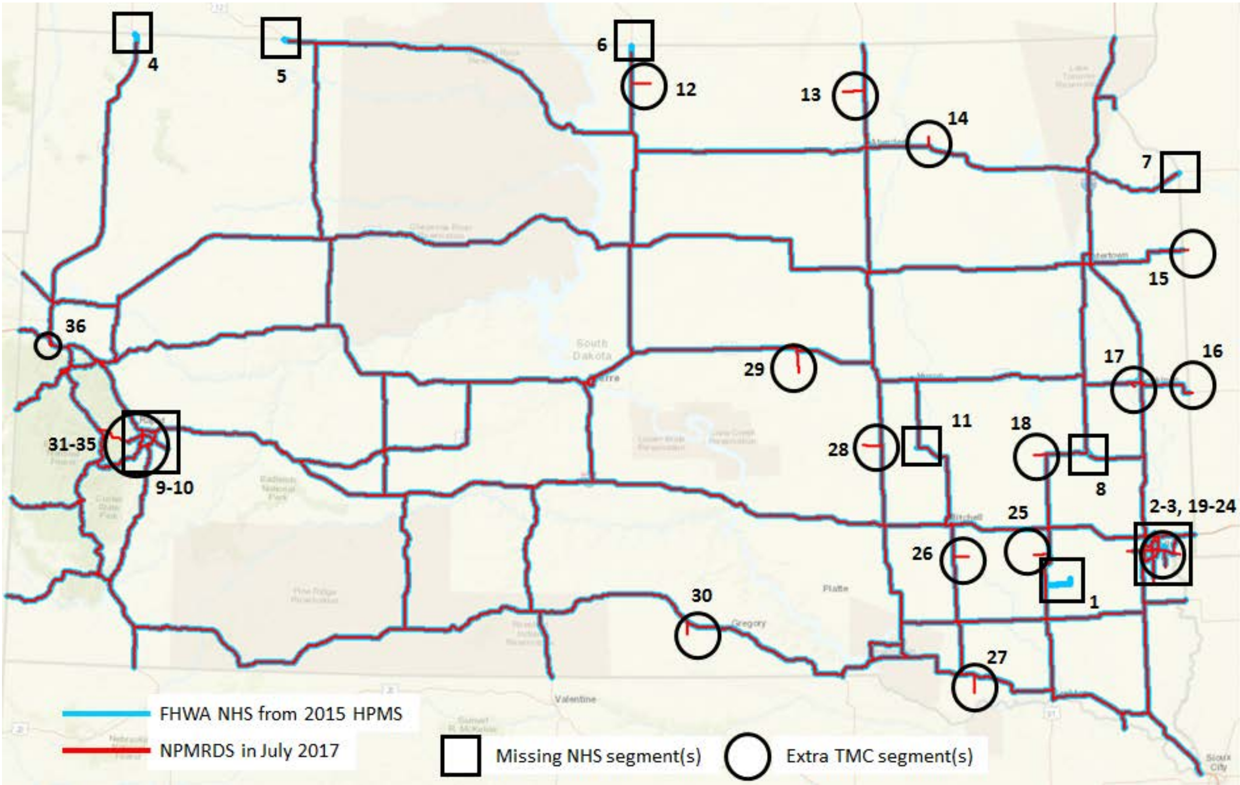

Figure 17: Comparison of Road Segments in NPMRDS (July 2017) and FHWA NHS (from 2015 HPMS)

Table 15: NHS Segments Not Currently Included in NPMRDS (as of July 2017) for South Dakota

Map #	Road and Location	Description	Approx. Length (dir-mi)
1	SD44 west of Marion	No TMC segments exist for these NHS segments	19
2	SD115 in North Sioux Falls	No TMC segments exist for these NHS segments	2
3	SD11/478th Ave in East Sioux Falls	No TMC segments exist for these NHS segments	2
4	US85 at SD/ND state border	TMC segment labeled as ND segment, missed in state-based conflation for SD	6
5	US12 at SD/ND state border	TMC segment labeled as ND segment, missed in state-based conflation for SD	3
6	US83 at SD/ND state border	TMC segment labeled as ND segment, missed in state-based conflation for SD	4
7	US12 at SD/MN state border	TMC segment labeled as MN segment, missed in state-based conflation for SD	2
8	SD34 in Madison	TMC segment(s) missed in auto-conflation	4
9	SD44 (Omaha St) in Rapid City	TMC segment(s) missed in auto-conflation	3
10	SD44 at Rapid City Airport	TMC segment(s) missed in auto-conflation	1
11	SD34 east of Woonsocket	TMC segment(s) missed in auto-conflation	1
		Total NHS Mileage Not Currently Included in NPMRDS	47

Table 16: Non-NHS Segments Currently Included in NPMRDS (as of July 2017) for South Dakota

Map #	Road and Location	Description	Approx. Length (dir-mi)
12	SD10 north of Mound City	Extra TMC segments: 118+13062, 118-13061	12.0
13	SD10 south of Frederick	Extra TMC segments: 118+13071, 118-13070	14.0
14	SD37 north of Groton	Extra TMC segments: 118+13699, 118-13698	6.0
15	US212 at SD/MN border	Partial TMC segment extending across state line	(3.6)
16	US14 at SD/MN border	Partial TMC segment extending across state line	(1.4)
17	US14 (6th St) at Brookings	Extra TMC segment: 118-06633	2.0
18	SD34 west of Winfred	Extra TMC segments: 118+12244, 118-06776	8.0
19	SD42 in E Sioux Falls	Extra TMC segments: 118+13615, 118-13614	4.0
20	SD11 in E Sioux Falls	Extra TMC segments: 118+19964, 118-19963	4.9
21	SD11 in SE Sioux Falls	Partial TMC segment extending beyond NHS segment	(2.0)
22	SD115 in S Sioux Falls	Partial TMC segment extending beyond NHS segment	(4.0)
23	SD42 in W Sioux Falls	Partial TMC segment extending beyond NHS segment	(4.0)
24	Benson Rd in N Sioux Falls	Extra TMC segments: 118+19962, 118-19961	1.6
25	SD42 east of Bridgewater	Extra TMC segments: 118+13636, 118-13635	10.2
26	SD42 at Ethan	Extra TMC segments: 118+13640, 118-13639	10.0
27	SD37 south of Tyndall	Extra TMC segments: 118+06868, 118-06867	11.6
28	SD34 west of Lane	Extra TMC segments: 118+12253, 118-06773	11.8
29	SD45 at Miller	Extra TMC segments: 118+06946, 118-13727	14.5
30	US183 at Colome	Extra TMC segments: 118+08465, 118-11264	8.6
31	SD44 west of Rapid City	Extra TMC segments: 118+19909, 118-19908	15.2
32	SD44 west of Rapid City	Partial TMC segment extending beyond NHS segment	(9.0)
33	Main St in Rapid City	Extra TMC segment: 118+08469	0.8
34	St. Joseph St in Rapid City	Extra TMC segment: 118-08469	0.2
35	West Blvd in Rapid City	Partial TMC segment extending beyond NHS segment	(0.4)
36	Main St in Spearfish	Extra TMC segments: 118+10641, 118-19900	5.0
		Total Non-NHS Mileage Currently Included in NPMRDS (not including partial TMC segments extending beyond NHS)	140.4

5.3 Evaluate the Suitability of NPMRDS for other SDDOT Uses

To evaluate the suitability of NPMRDS for other SDDOT uses, the researchers conducted a literature review of existing NPMRDS uses, and then interviewed numerous SDDOT staff about their desired needs for travel time data. The following sections describe the findings in more detail.

5.3.1 Literature Review

The literature review focuses on rural applications of NPMRDS (see Table 17 for summary), as these rural applications are likely to be most relevant to SDDOT. A brief summary of other urban congestion applications of NPMRDS are included in the second half of this review as background information.

NPMRDS Quarterly Validation Reports (Liao 2016) have a mix of urban, suburban, and rural locations where speed data is compared with state DOT-maintained WIM, microwave, or Bluetooth devices. Some of the rural sites used in the validation have an AADT as low as 8,000 vehicles per day. Each location is analyzed during the morning peak period, evening peak period, and off-peak period to quantify accuracy during varying levels of congestion and volume. Average Absolute Speed Error (AASE) and Standard Error of the Mean (SEM) are used to compare the reference data with the probe data set. Speed accuracy and error in four speed ranges (10–30 mph, 30–45 mph, 45–60 mph, and ≥60 mph) in each time period are calculated.

Table 17: Summary Table of NPMRDS/Probe Data Applications Relevant to SDDOT

Rural area/state	Use(s)	Agency/Location	Lessons Learned
Rural areas of Oregon, Florida, Washington, Virginia, and New York (sites with AADT as low as 8,000)	Validation	FHWA NPMRDS Validation Report	NPMRDS found to be accurate at rural locations with AADT as low as 8,000. However, SDDOT has many roads with AADT less than 8,000.
Arterial road in Philadelphia suburb with relatively low AADT ~10,000	Validation on Arterials	I-95 Corridor Vehicle Probe Project	GPS probe data can be useful on some arterials.
Includes rural Interstates in Iowa, Minnesota, and Kansas	Corridor Freight Mobility Performance	Great Lakes Regional Transportation Operations Coalition – Mid-America Freight Coalition	Example of what is deemed useful by other states.
North Dakota Minnesota (pilot)	Winter Performance Management Speed Recovery (NPMRDS potentially) Normal Condition regain time	North / West Passage	Studies still in progress or awaiting report on using Speed Recovery as a performance measure.
Maryland	Speed Recovery and GPS Confidence Threshold (NOT just NPMRDS but probe data)	Center for Advanced Transportation Technology (University of Maryland) and Maryland State Highway Authority	Probe data can be used for analysis on traffic flow recovery.
All Interstate currently available and all NHS nationwide in development.	Evaluations for project, weather, and travel events.	Great Lakes Regional Transportation Operations Coalition	Visual application of NPMRDS data in an easy to use map format.

The I-95 Corridor Coalition Vehicle Probe Project evaluated "HERE" data on three arterial roads in Pennsylvania during April and May 2016; one of which had an AADT of 10,000, the other was over 20,000. The report (Hamedi et al. 2016) combined the results with the other two sites that were used and presented results that fell within the established limits. The I-95 Corridor Coalition Vehicle Probe Project has also previously investigated probe data for arterials in a separate report published in July 2015 (Young et al. 2015). The study compared probe data (not just "HERE) with Bluetooth Monitoring (BTM) equipment at selected sites and used four different methods to compare probe and BTM data. Figure 18 shows a summary of the arterial probe data usability findings.

✓ RECOMMENDED	SHOULD BE TESTED	✖ NOT RECOMMENDED
● <= 1 signal per mile	● 1 to 2 signals per mile	● >= 2 signals per mile
● AADT > 40,000 vpd (2-way)	● AADT 20K to 40K vpd (2-way)	● AADT < 20K (2-way) - low volume
● Limited curb cuts	● Moderate number of curb cuts	● Substantial number of curb cuts
Principal Arterials	Minor Arterials	Major Collectors
Likely to be accurate…	Possibly accurate, test …	Unlikely to be accurate…

Figure 18: Arterial Probe Data Usability (from I-95 Coalition Arterial Validation Report)

The Great Lakes Regional Transportation Coalition (GLRTOC) has produced corridor performance measures on interstates in the Mid-America region using NPMRDS (Rafferty 2015). The aim is to improve transportation operations at the megaregion scale and identify places where improvements to delay and reliability can be made. In addition to mapping performance measures, GLRTOC also creates heat maps that visually show performance along interstate corridors over time.

Winter performance management using NPMRDS speed data was discussed in a North / West Passage presentation in October 2016 (Ernest 2016). The report does not include any specific results, only that North Dakota has looked at speed from continuous count and WIM sites in a pilot completed in 2015–2016 and planned to explore how they could use NPMRDS on a statewide basis. Additional information was also found in a project report from North / West Passage in a summary report on Winter Performance Management Practices (North / West Passage 2016). A second application of probe data in winter weather road restoration (in this case INRIX) was studied in Maryland (Sharifi 2015). Using the speed data and a confidence indicator (a metric in INRIX's data that indicates whether the data are actual or historical), researchers determined in case studies after a weather event how long the restoration process took.

Third party validation of the NPMRDS data (Liao, 2016) has been a part of the information package available to state DOTs and Metropolitan Planning Organizations (MPOs) since the data sets have been released and have consistently been found to be acceptable by FHWA. As an example, Figure 19 shows a portion of one of the validation reports.

Minnesota WIM 40 (Site #13)

WIM40_TMC118P04408

The reference data at this location is collected from WIM sensors. This site is located on US-52 about 6 miles S of St. Paul, MN. Table 14 summarizes the data quality measures obtained as a result of comparison between probe vehicle and WIM speeds. AASE below 10 MPH meet target specifications. As shown, the AASE and SEM for freight, passenger vehicle, and all vehicle groups in AM/PM peak and off-peak periods are within specification for all speed bins.

Table 14(a) Data Quality Measures for a Roadway Segment in Minnesota (All Vehicles)

All Vehicles	AM Peak			Mid-Day			PM Peak		
Speed Bins	AASE	SEM	Size	AASE	SEM	Size	AASE	SEM	Size
0 - 30 mph									
30 - 45 mph									
45 - 60 mph	6.71	1.42	453	7.05	2.00	1,272	4.64	1.15	122
> 60 mph	5.71	1.17	355	4.63	0.93	676	2.42	1.07	612
All Speed	6.26	1.31	808	6.19	1.62	1,948	2.79	1.09	734

Figure 19: Excerpt from NPMRDS Quarterly Validation Report for October 2016

Another investigation into the validity of HERE data (producers of NPMRDS) is done by the I-95 Corridor Coalition Vehicle Probe Project (Hamadi et al. 2016). Comparable to the NPMRDS validation reports, the I-95 Corridor Coalition produces validation reports every few months using BTM technology. These reports are similar in format and thresholds, using the AASE and SEM while also including a speed error bias. Figure 20 is taken from the executive summary of the October 2016 I-95 Corridor Coalition Validation Report for HERE data and shows that all specifications are within accepted limits.

ES Table 1 – New Hampshire Evaluation Summary for Freeway						
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Number of 5 Minute Samples	Hours of Data Collection
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	2.8	4.5	1.7	2.2	544	45
30-45 MPH	3	5.2	0	0.5	593	49
45-60 MPH	1.1	3.5	-0.2	0.4	3218	268
>60 MPH	1.7	4.4	-1.6	-3.7	25456	2121
All Speeds	1.7	4.4	-1.4	-3.1	29811	2484

Based upon data collected between July 8 and July 22, 2016 across 33 miles of roadway.

Figure 20: Excerpt from the I-95 Corridor Coalition Validation Report

Researchers at the University of Washington (Sankarakumaraswamy 2016) presented an Analysis of NPMRDS Data for Estimating Freight Transportation Performance Measures, wherein there was a comparison of the NPMRDS travel time with both License Plate Readers (LPR) on a minor arterial and BTH on a major arterial that showed the NPMRDS provided useful data on the arterials. Figure 21 and Figure 22 show the travel times compared between NPMRDS and the LPR (Figure 21), and then NPMRDS graphed with the BTH (Figure 22).

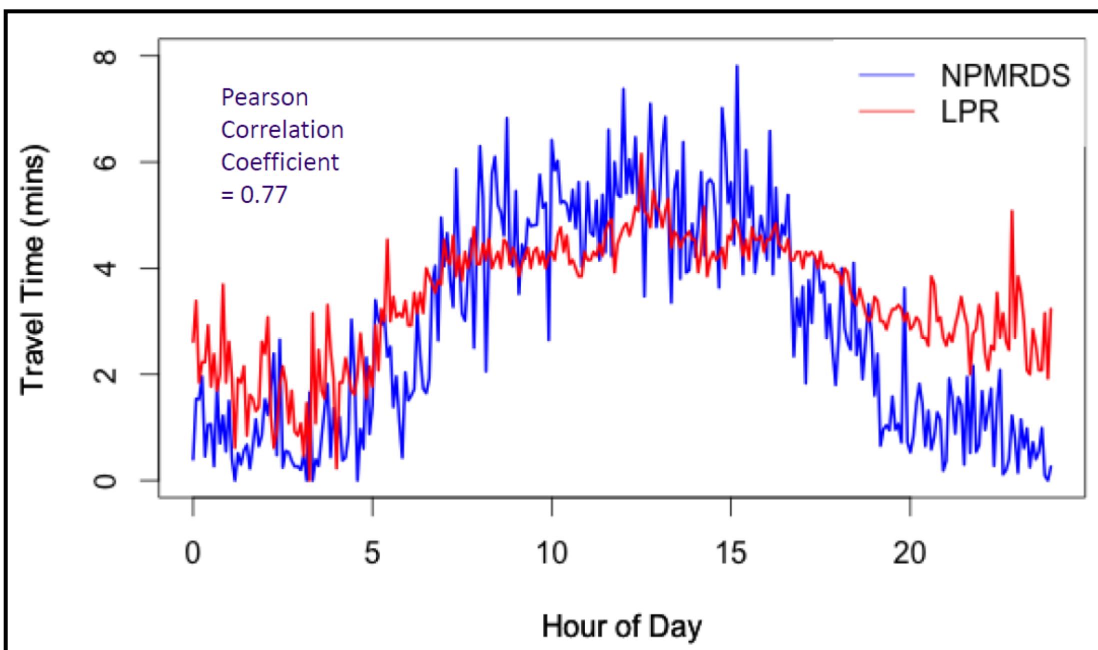

Figure 21: NPMRDS and License Plate Reader Travel Time Comparisons

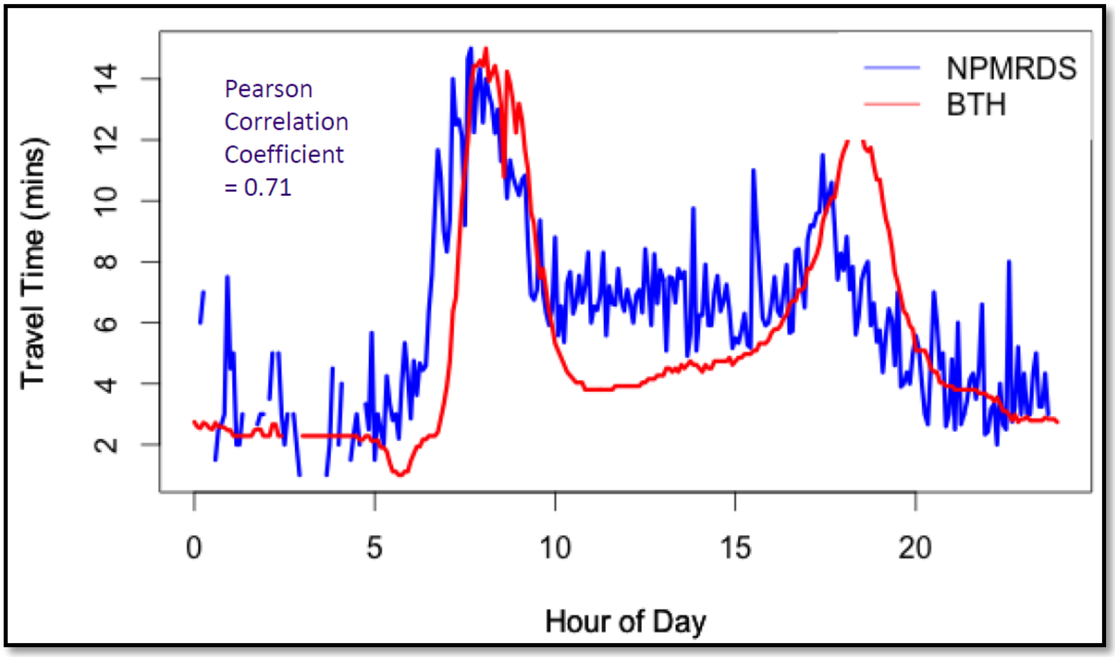

Figure 22: NPMRDS and Bluetooth Reader Travel Time Comparisons

The Boston MPO (Hicks 2015) researched the merits of using NPMRDS or the Massachusetts DOT (MassDOT) roadway-monitoring data set BTR as a cost effective alternative to a purchased INRIX travel time data set in freight planning and for use in the Boston MPO Congestion Management Process. A part of this report compares travel times between the three data sets along a section of I-93 during the AM peak period. Findings showed that NPMRDS travel times were typically higher than INRIX and the MassDOT data:

Northbound

- According to the INRIX database, travel time fluctuated between 7 and 11 minutes.
- According to the NPMRDS database, travel time fluctuated between 7 and 13 minutes.
- According to the MassDOT database, travel time fluctuated between 5.5 and 11 minutes.

Southbound (Peak Direction)

- According to the INRIX database, travel time fluctuated between 10.5 and 19.5 minutes.
- According to the NPMRDS database, travel time fluctuated between 16 and 25.5.
- According to the MassDOT database, travel time fluctuated between 16 and 25 minutes.

Conclusions go on to discuss how INRIX data include estimates while NPMRDS include only observed data. A discussion of removing outliers is addressed; however data are not presented on the results for this section of road. The final recommendations and conclusion were to continue using INRIX data if possible.

An additional study (Habermichael et al. 2015) investigated travel times and performance measures in the Hampton Roads area of Virginia using different data sets, specifically HERE, INRIX, and ATRI. A few of the major findings included:

1. Both HERE and INRIX data capture the major trends in performance measures both temporally and spatially. There are no systematic differences in the spatial and temporal locations of congestion zones in the two data sources along the two corridors, I-64 and I-664.

2. Typically, freight speeds are lower than general traffic speeds at all locations (by about 3 mph in HERE data). Also, the magnitude of difference between freight and general traffic speeds is higher in INRIX data compared to HERE data. Specifically, speed differences computed with respect to general traffic speeds from INRIX data were nearly twice the speed differences computed with respect to HERE data. This suggests that INRIX general traffic speed estimates are higher than the corresponding estimates from HERE data.

The literature review also identified several urban performance monitoring applications of NPMRDS. These applications may be less relevant to SDDOT, but are listed here for completeness.

- Maricopa Association of Governments uses NPMRDS data as an add-in data set for planning and programming at the MPO level (Maricopa Association of Governments, 2014).
- Florida DOT Transtat Office compiled a summary report on multimodal freight data sources including NPMRDS and ratings in areas of coverage, accuracy, access, and usability (Florida DOT, 2016).
- Hawaii DOT Highways Division Planning Branch created travel speed animations using NPMRDS data to show roadway speeds and traffic movement on Oahu (Hawaii DOT, 2015).
- Nashua Regional Planning Commission, New Hampshire, is planning on using NPMRDS data for performance measures to identify the location and severity of congestion and evaluate the transportation system operating conditions (Nashua Regional Planning Commission, 2016).
- Tennessee DOT Long Range Planning Division is investigating using NPMRDS for model inputs, performance management, and project evaluation (Tennessee DOT, 2015).
- Chicago Metropolitan Agency for Planning uses NPMRDS for performance-based programming and creating maps of performance measures (Chicago Metropolitan Agency for Planning, 2016).

Based on the literature review, TTI researchers identified these key findings:

- **There have been several rural applications of NPMRDS data**. The literature review identified the two most common rural applications as winter weather performance management (e.g. time to recovery after a major winter weather event) and freight performance monitoring on rural highway corridors. Overall, however, the most common applications of NPMRDS have been for urban congestion monitoring in major cities.
- **NPMRDS has been evaluated against several other speed/travel time data sets and found to be generally representative of traffic conditions**. Quarterly validation reports of NPMRDS have been provided by the University of Minnesota as part of the NPMRDS data downloads; however, no validation sites were located in South Dakota. Several other agencies have evaluated NPMRDS against similar benchmark data sets and found the results to be acceptable. Further, these other validations typically describe NPMRDS as a data set that could be useful or should be investigated further in congestion management, performance measures, and project evaluations.

5.3.2 SDDOT Staff Interviews

In late February and early March 2017, TTI researchers conducted six separate interviews of SDDOT, FHWA, and MPO staff about current and potential uses of NPMRDS travel time data:

1. SDDOT Project Development: February 23

2. SDDOT P/E Administration, Road Design: February 27
3. SDDOT Transportation Inventory Management, Secretary of Transportation's office (Federal Liaison), Local Technical Assistance Program, and Operations Support: March 3
4. FHWA, SDDOT Region Offices (Aberdeen, Mitchell, Pierre, Rapid City): March 6
5. Rapid City MPO, Sioux Falls MPO: March 9
6. SDDOT Research: March 14

Existing Uses of NPMRDS Data

The interviews identified three separate cases in which NPMRDS data had already been used by SDDOT staff, who gave the following feedback on their applications:

1. **Identify freight bottlenecks**: SDDOT staff used a free online analysis and visualization tool developed by the University of Maryland. The online tool used NPMRDS data and color-coded road segments to indicate locations of slow-moving freight traffic (i.e., freight bottlenecks). The SDDOT staff indicated that most of the bottlenecks indicated in the online tool were not really bottlenecks for freight. In some cases, the segments in the online tool were too long. On highways passing through towns, the normal slowdowns in town were grouped together with normal free-flow speeds outside of town and then inaccurately characterized as bottlenecks. Also, normal operating speed reductions on low-speed ramps were incorrectly shown as freight bottlenecks in the online tool.
2. **Analyze speeds and travel times for major investment study.** SDDOT staff used NPMRDS data for a planning study on Highway 229 in Sioux Falls, South Dakota. SDDOT staff did not have easy-to-use analytic tools and had to download a large multi-state region of data, then had to filter the data to South Dakota, and then select the routes of interest. Even after filtering NPMRDS data to a usable size, the NPMRDS speeds did not show any serious corridor level congestion, so the data results were only used as background material in the Highway 229 planning study.
3. **Analyze before-and-after impacts of adaptive traffic signal control.** The Sioux Falls MPO staff used NPMRDS data for a before-and-after study of adaptive signal traffic travel times along Minnesota Avenue in Sioux Falls. To date, the MPO staff have only conducted the "before" portion of the before-and-after study. The MPO staff indicated that there was adequate travel time data between 6 am and 10 pm for the "before" portion of their study. Previously, they have used Bluetooth re-identification and floating car methods for this, and they still use these traditional travel time data collection methods on non-NHS corridors.

Possible Uses of NPMRDS Data

The interviews also identified numerous other possible uses of NPMRDS data. These possible uses are discussed and evaluated in the following paragraphs.

Multiple Offices

1. **Replace or supplement traditional methods of travel time data collection.** Manual methods of gathering travel time data involve driving one or more cars at the normal pace of traffic while collecting speeds and travel times (referred to as floating car method). Other methods involve license plate matching or Bluetooth device matching. NPMRDS data from GPS devices may have fewer travel time data samples on any given day, but has the benefit of being collected continuously throughout the entire year. Also, the NPMRDS data has already been

collected and is made freely available to state DOTs. **Therefore, in most cases (but not necessarily all cases), the NPMRDS data would be better than other more labor-intensive methods of collecting travel time data, especially if it is desired to have data throughout the entire year.**

2. **Estimate vehicle counts/flows (and possibly vehicle classification) from GPS sample sizes**. Actual GPS sample sizes are not currently provided in the NPMRDS. Instead, a sample size range indicator is provided in NPMRDS as follows: A= 1 to 4 reporting vehicles; B=5 to 9 reporting vehicles; and, C=10 or more reporting vehicles. Even if actual GPS sample sizes were provided, these sample sizes are quite small on most South Dakota highways, and would have to be significantly expanded using statistical algorithms in an attempt to estimate total traffic volumes. Several GPS data providers are currently working on such sample expansion algorithms, but do not currently offer a commercially available traffic count data product. **Therefore, vehicle traffic counts and classification are not currently possible using NPMRDS, but traffic count estimates could be made available by GPS data providers in the coming years.**

Planning & Project Development

1. **Analyze freight movement and delays during peak harvest.** The NPMRDS data includes truck-only speeds (when available). However, the completeness for the truck-only data is low, especially on lower functional class roads. The NPMRDS data does not include any truck-specific movements (like origin, destination, or trip path). **Therefore, the analysis of freight speeds and delay during peak harvest times is possible, but the completeness of the data could be too low in certain cases (determined on a case-by-case basis). The analysis of freight movement patterns is not possible using NPMRDS data, but could be possible using other GPS data sets.**
2. **Calibrate/validate travel demand forecast models using speed data.** NPMRDS data can be used to calibrate and validate travel demand forecasting models, especially when the NPMRDS speeds are averaged over multiple months or even an entire year. In most cases in South Dakota, the NPMRDS speeds will represent free-flow traffic due to lack of traffic congestion. However, even free-flow speeds are useful for model calibration. **Therefore, NPMRDS speed data could be used in South Dakota to calibrate/validate travel demand forecasting models.**

Design

1. **Estimate free-flow speeds for preliminary highway design**. In most cases in South Dakota, the NPMRDS speeds will represent free-flow traffic due to lack of traffic congestion. Also, the NPMRDS speed data can be averaged over multiple months or even an entire year to get more representative and accurate free-flow speeds. **Therefore, NPMRDS data could be used in South Dakota to estimate free-flow traffic speeds for preliminary highway design.**
2. **Estimate times of peak flow for design hour determination.** It is possible to use GPS samples sizes to estimate times of peak flow. However, actual GPS sample sizes are not currently provided in the NPMRDS. Instead, a sample size range indicator is provided in NPMRDS as follows: A= 1 to 4 reporting vehicles; B=5 to 9 reporting vehicles; and, C=10 or more reporting vehicles. This sample size range indicator probably does not have the resolution to determine times of peak flow, especially on those highways with consistently low sample sizes. **Therefore, it is unlikely that NPMRDS data could be used to estimate times of peak vehicle flow for design hour determination.**

Operations

1. **Analyze winter weather driving speeds to develop alternate signal timing plans.** The Sioux Falls MPO has already used NPMRDS speed data to analyze before-and-after impacts of signal timing, and indicated that NPMRDS included adequate speed data during daytime hours. However, the GPS sample sizes could be low on smaller city streets, especially during snowfall. **Therefore, it is likely that NPMRDS speed data could be used to develop alternate signal timing plans on major arterial streets. The feasibility of using NPMRDS speed data on minor arterial and collector streets would have to be determined on a case-by-case basis.**
2. **Analyze historical speed patterns to set or adjust variable speed limits or speed advisories.** This use could also extend to analyzing speed differentials between trucks and cars. The NPMRDS speed data can be averaged over multiple months or even an entire year to get more representative and accurate free-flow speeds. Also, the NPMRDS data does include car-only and truck only-speeds. **Therefore, NPMRDS data could be used on major highways in South Dakota to set or adjust speed limits or speed advisories. The NPMRDS data could also be used to quantify speed differentials between trucks and cars.**
3. **Determine compliance with speed limits or advisory speeds near or in work zones.** This use could also include analyzing speed differentials between trucks and cars in work zones. The NPMRDS speed data can be averaged over multiple months or even an entire year to get more representative and accurate free-flow speeds. Also, the NPMRDS data does include car-only and truck only-speeds. **Therefore, NPMRDS data could be used in or near major highway work zones in South Dakota to determine compliance with speed limits or speed advisories. The NPMRDS data could also be used to quantify speed differentials between trucks and cars in or near major highway work zones.**
4. **Determine prevailing speeds for setting speed limits.** In most cases in South Dakota, the NPMRDS speeds will represent free-flow traffic due to lack of traffic congestion. Also, the NPMRDS speed data can be averaged over multiple months or even an entire year to get more representative and accurate free-flow speeds. In most cases, NPMRDS data will contain substantially more speed samples than are typically collected in a speed limit study. **Therefore, NPMRDS speed data could be used in South Dakota to determine prevailing free-flow speeds for setting speed limits.**
5. **Estimate delay (and associated cost) in work zones, as well conducting before-and-after studies.** The Sioux Falls MPO has already used NPMRDS speed data to analyze before-and-after impacts of signal timing on arterial streets, and indicated that NPMRDS included adequate speed data during daytime hours. The NPMRDS speed data can be averaged over multiple months or even an entire year to get more representative and accurate speeds for delay estimates and before-and-after studies. **Therefore, NPMRDS speed data could be used in major highway work zones in South Dakota to estimate delay in work zones, as well as to conduct before-and-after speed studies.** Delay in work zones can be calculated by comparing the actual speeds reported in NPMRDS to either prevailing free-flow speeds (which can be estimated from NPMRDS during light traffic conditions) or posted speed limits.
6. **Analyze impacts of tourism and special events on travel speeds (primarily associated with Sturgis and the Black Hills).** The feasibility of this use of NPMRDS data depends upon whether there are adequate GPS samples on roads in this area during this specific time frame. The completeness of NPMRDS data can be low on some rural highways with lower volumes. However, the peak event traffic during this time frame may increase the GPS samples to be

much higher than other times of the year. **Therefore, further analysis is needed to determine the feasibility of using NPMRDS speed data to analyze the impacts of special events and tourism in western South Dakota.**

7. **Estimate traffic flow recovery time after major winter weather events.** The NPMRDS data includes large GPS samples on Interstate and other major highways in South Dakota. It is likely that the sample sizes are adequate to assess traffic flow recovery time. **Therefore, NPMRDS data could be used on major highways in South Dakota to assess traffic flow recovery time during major winter weather events.**
8. **Assess need for passing lanes by analyzing speed differentials between truck and car speeds.** The NPMRDS data does include car-only and truck only-speeds, which permits the calculation of speed differentials between cars and trucks. Also, the NPMRDS speed data can be averaged over multiple months or even an entire year to get more representative and accurate speeds. However, if the road segments defined in NPMRDS are too long (i.e., much longer than the actual upgrade), the measured speed differential may not accurately reflect traffic conditions on the upgrade itself. **Therefore, if segment length definitions are not too long, NPMRDS data could be used on major highways in South Dakota to analyze speed differentials between cars and trucks.**

Summary of Potential Uses of NPMRDS Data by SDDOT

Based on the qualitative evaluation in the previous sections, the following uses of NPMRDS by SDDOT are most likely and feasible at this time:

- replace or supplement traditional methods of travel time data collection
- calibrate/validate travel demand forecast models using speed data
- estimate free-flow speeds for preliminary highway design
- analyze historical speed patterns to set or adjust variable speed limits or speed advisories
- determine compliance with speed limits or advisory speeds near or in work zones
- determine prevailing speeds for setting speed limits
- estimate delay (and associated cost) in work zones, as well conducting before-and-after studies
- estimate traffic flow recovery time after major winter weather events

The following uses of NPMRDS by SDDOT are possible, but may be limited to certain cases, or may need additional assessment on a case-by-case basis:

- analyze freight movement and delays during peak harvest
- analyze winter weather driving speeds to develop alternate signal timing plans
- analyze impacts of tourism and special events on travel speeds (such as Sturgis and the Black Hills)
- assess need for passing lanes by analyzing speed differentials between truck and car speeds

The following uses of NPMRDS are not feasible or likely at this time:

- estimate vehicle counts/flows (and possibly vehicle classification) from GPS sample sizes
- estimate times of peak flow for design hour determination

6.0 RECOMMENDATIONS

Based on the findings discussed in the previous chapter, TTI offers these overall recommendations on NPMRDS use.

6.1 Use of NPMRDS for National Performance Management Measures

SDDOT should use NPMRDS to meet FHWA performance management measure requirements, but should set conservative targets that acknowledge the limitations of NPMRDS on low-volume non-Interstate NHS roads.

With respect to the use of NPMRDS for meeting FHWA's performance management measure requirements, SDDOT should use NPMRDS to meet FHWA PM3 requirements, but should set conservative targets that acknowledge the limitations of NPMRDS on low-volume non-Interstate NHS roads. The FHWA requirements do allow SDDOT to use an "equivalent data set." However, equivalent data sets from other commercial data providers (such as HERE or TomTom) will likely have the same limitations on low-volume roads as the current NPMRDS provided by INRIX.

6.2 Use of NPMRDS for Other SDDOT Applications

On Interstate highways and higher-volume roads (i.e., greater than 5,000 AADT), SDDOT can use NPMRDS for most of the applications outlined below. On non-Interstate NHS roadways and low-volume roads (i.e., less than 5,000 AADT), SDDOT should use caution when considering NPMRDS data, and may consider the outlined data uses below on a case-by-case basis

The NPMRDS data on Interstate highways and higher-volume roads has high levels of completeness and typically falls within acceptable accuracy levels. Caution should be used with NPMRDS free-flow speeds, as these free-flow speeds tend to be at least 5 mph slower than speeds measured at SDDOT monitoring sites.

On non-Interstate NHS roadways and low-volume roads, SDDOT should use caution when considering NPMRDS data, and may consider the outlined data uses below on a case-by-case basis. The NPMRDS may be suitable for some low-volume road segments within South Dakota; however, SDDOT staff should visually assess the completeness, consistency, and credibility before using NPMRDS data on low-volume roads. When possible, NPMRDS data on low-volume roads should be aggregated over multiple days, weeks, or months to increase the sample size and the consistency of the speed data.

With the limitations of NPMRDS on low-volume roads in mind, the following uses of NPMRDS by SDDOT are most likely and feasible at this time:

- replace or supplement traditional methods of travel time data collection
- calibrate/validate travel demand forecast models using speed data
- estimate free-flow speeds for preliminary highway design
- analyze historical speed patterns to set or adjust variable speed limits or speed advisories
- determine compliance with speed limits or advisory speeds near or in work zones
- determine prevailing speeds for setting speed limits
- estimate delay (and associated cost) in work zones, as well conducting before-and-after studies
- estimate traffic flow recovery time after major winter weather events

With the limitations of NPMRDS on low-volume roads in mind, the following uses of NPMRDS by SDDOT are possible, but may be limited to certain cases, or may need to be assessed on a case-by-case basis:

- analyze freight movement and delays during peak harvest
- analyze winter weather driving speeds to develop alternate signal timing plans
- analyze impacts of tourism and special events on travel speeds (e.g., Sturgis and the Black Hills)
- assess need for passing lanes by analyzing speed differentials between truck and car speeds

The following uses of NPMRDS are not feasible or likely at this time:

- estimate vehicle counts/flows (and possibly vehicle classification) from GPS sample sizes
- estimate times of peak flow for design hour determination

7.0 RESEARCH BENEFITS

SDDOT can benefit from this research on NPMRDS in two ways:

1. **More Informed Decisions:** SDDOT staff can make more informed decisions using detailed information from NPMRDS, resulting in better decisions that lead to favorable outcomes in a variety of transportation applications (such as project planning, project design, and operational evaluations). The NPMRDS travel times provide detailed information and insight for Interstate highways and other higher-volume roads, and can be used to develop and refine various traffic operations and maintenance strategies that could save SDDOT money. The value of more informed decisions using NPMRDS is difficult to quantify at this time.

2. **Cost Savings of Data Collection:** SDDOT staff can save money by using the freely-available NPMRDS, instead of collecting their own data or paying consultants to gather speed and travel time data. The FHWA provides the NPMRDS travel times to state DOTs and MPOs free of charge for their planning and performance measurement purposes. By using NPMRDS travel times, SDDOT and its partner MPOs do not have to collect similar travel time data on the Interstate highways and other higher-volume roads. This cost savings could amount to more than $500,000 of savings in data collection costs when considered across the entire state of South Dakota (i.e., the approximate cost of gathering equivalent travel time data for all major highways statewide).

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Appendix A: Detailed Results of NPMRDS Accuracy Evaluation

Table 18: Speed Category: 0 to 30 mph, All-Vehicle Speed

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	**Hours of Benchmark Data**
ATR_103_EB: SD50, E of Jct US81-SD50	Rural: Other Freeways and Expressways	4938	8.3	7	23.2%	7	2
ATR_103_WB: SD50, E of Jct US81-SD50	Rural: Other Freeways and Expressways	4938	8.3	2	9.0%	2	1
ATR_178_NB: US85 N of N Jct US85-US212	Rural: Other Principal Arterial	1660	30.82	41	159.7%	41	1
ATR_178_SB: US85, N of N Jct US85-US212	Rural: Other Principal Arterial	1660	30.82	24	106.9%	23	5
ATR_183_EB: US16, E of Jct US16-WY State Line	Rural: Other Principal Arterial	1368	9.3	10	42.6%	3	2
WIM_802_EB: US18, East of Mission	Rural: Other Principal Arterial	1395	33.72	22	93.9%	22	2
WIM_804_SB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	47	206.7%	47	1
WIM_901_NB: I 90, West of Tilford	Rural: Interstate	18520	2.63	58	415.1%	58	1
Overall Speed Category Average				23	109.6%	22	15

Table 19 Speed Category: 0 to 30 mph, All-Vehicle Speed

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
ATR_102_NB: SD79, S of Jct US212-SD79	Rural: Other Principal Arterial	1900	8.36	6	12.8%	5	3
ATR_102_SB: SD79, S of Jct US212-SD79	Rural: Other Principal Arterial	1900	8.36	19	48.3%	19	3
ATR_103_EB: SD50, E of Jct US81-SD50	Rural: Other Freeways and Expressways	4938	8.3	12	34.6%	12	7
ATR_103_WB: SD50, E of Jct US81-SD50	Rural: Other Freeways and Expressways	4938	8.3	14	35.7%	14	3
ATR_104_SB: SD73, S of Jct I90-SD73	Rural: Other Principal Arterial	843	8.36	16	35.4%	16	4
ATR_105_EB: US18, W of Jct US18-SD37	Rural: Other Principal Arterial	372	9	4	9.3%	-4	1
ATR_106_EB: US14, E of Jct US14-SD73	Rural: Other Principal Arterial	786	25.61	7	20.1%	7	1
ATR_106_WB: US14, E of Jct US14-SD73	Rural: Other Principal Arterial	786	25.61	11	27.0%	4	4
ATR_108_NB: US81, S of Jct I90-US81	Rural: Other Principal Arterial	1828	11	5	13.2%	0	7
ATR_108_SB: US81, S of Jct I90-US81	Rural: Other Principal Arterial	1828	11	13	30.4%	-7	2
ATR_159_NB: US281, North of US212	Rural: Other Principal Arterial	2322	8.5	8	19.7%	-8	1
ATR_160_EB: US12, W of W Jct of US12-US83	Rural: Other Principal Arterial	2071	3.55	14	31.8%	14	1
ATR_160_WB: US12, W of Jct of US12-US83	Rural: Other Principal Arterial	2071	3.55	19	48.1%	19	1
ATR_178_NB: US85, N of N Jct US85-US212	Rural: Other Principal Arterial	1660	30.82	19	44.4%	14	294
ATR_178_SB: US85, N of N Jct US85-US212	Rural: Other Principal Arterial	1660	30.82	18	43.3%	15	1265
ATR_181_EB: I90, SE of Jct I90-US14	Rural: Interstate	6270	0.5	2	5.3%	1	2
ATR_181_WB: I90, SE of Jct I90-US14	Rural: Interstate	6270	0.5	8	20.5%	1	4
ATR_182_NB: I29, S of Jct I29-SD50	Rural: Interstate	11930	8.04	4	10.1%	2	14
ATR_182_SB: I29, S of Jct I29-SD50	Rural: Interstate	11930	8.04	5	12.9%	5	14
ATR_183_EB: US16, E of Jct US16-WY State Line	Rural: Other Principal Arterial	1368	9.3	13	30.0%	-6	8
ATR_183_WB: US16, E of Jct US16-WY State Line	Rural: Other Principal Arterial	1368	9.3	9	20.5%	-9	1
ATR_193_WB: I90, W of Jct I90-US85 S	Urban: Interstate	14610	3.14	7	18.1%	-1	5
ATR_195_SB: I29, N of Jct I29-US212	Rural: Interstate	7370	4.45	2	4.0%	2	1
WIM_801_NB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	6.98	6	14.7%	6	2
WIM_801_SB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	6.98	9	20.0%	9	1
WIM_802_EB: US18, East of Mission	Rural: Other Principal Arterial	1395	33.72	15	35.0%	-11	12
WIM_802_WB: US18, East of Mission	Rural: Other Principal Arterial	1395	33.72	10	25.0%	1	11
WIM_804_NB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	12	30.7%	12	1

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
WIM_804_SB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	22	55.8%	22	2
WIM_805_EB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4.16	22	48.9%	22	1
WIM_809_EB: I29, South of Elk Point	Rural: Interstate	13630	5.92	5	12.6%	3	3
WIM_809_WB: I29, South of Elk Point	Rural: Interstate	13630	5.92	4	10.4%	2	4
WIM_811_SB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	8.8	11	26.8%	-5	7
WIM_901_NB: I 90, West of Tilford	Rural: Interstate	18520	2.63	11	30.2%	10	6
WIM_901_SB: I 90, West of Tilford	Rural: Interstate	18520	2.63	4	9.7%	0	2
WIM_909_EB: US14, West of Manchester	Rural: Other Principal Arterial	1614	6.95	18	40.2%	-18	1
WIM_909_WB: US14, West of Manchester	Rural: Other Principal Arterial	1614	6.95	3	7.5%	3	1
Overall Speed Category Average				18	41.8%	14	1700

Table 20 Speed Category: 45 to 60 mph, All-Vehicle Speed

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
ATR_102_NB: SD79, S of Jct US212-SD79	Rural: Other Principal Arterial	1900	8.36	6	9.9%	4	352
ATR_102_SB: SD79, S of Jct US212-SD79	Rural: Other Principal Arterial	1900	8.36	5	9.6%	5	64
ATR_103_EB: SD50, E of Jct US81-SD50	Rural: Other Freeways and Expressways	4938	8.3	5	8.7%	3	14
ATR_103_WB: SD50, E of Jct US81-SD50	Rural: Other Freeways and Expressways	4938	8.3	8	14.2%	-1	17
ATR_104_NB: SD73, S of Jct I90-SD73	Rural: Other Principal Arterial	843	8.36	6	10.6%	5	124
ATR_104_SB: SD73, S of Jct I90-SD73	Rural: Other Principal Arterial	843	8.36	6	11.0%	3	54
ATR_105_EB: US18, W of Jct US18-SD37	Rural: Other Principal Arterial	372	9	7	11.6%	-1	55
ATR_105_WB: US18, W of Jct US18-SD37	Rural: Other Principal Arterial	372	9	10	17.7%	-2	9
ATR_106_EB: US14, E of Jct US14-SD73	Rural: Other Principal Arterial	786	25.61	5	9.0%	0	33
ATR_106_WB: US14, E of Jct US14-SD73	Rural: Other Principal Arterial	786	25.61	5	9.9%	-3	13
ATR_108_NB: US81, S of Jct I90-US81	Rural: Other Principal Arterial	1828	11	5	9.4%	-3	84
ATR_108_SB: US81, S of Jct I90-US81	Rural: Other Principal Arterial	1828	11	9	15.1%	-5	27
ATR_110_NB: US85, S of Jct US85-SD20	Rural: Other Principal Arterial	1139	37.3	11	19.8%	0	9
ATR_110_SB: US85, S of Jct US85-SD20	Rural: Other Principal Arterial	1139	37.3	9	15.7%	-4	5
ATR_157_EB: US14, E of E Jct of US14-83	Rural: Other Principal Arterial	3019	14.14	5	9.2%	-3	98
ATR_157_WB: US14, E of E Jct of US14-83	Rural: Other Principal Arterial	3019	14.14	6	11.1%	-5	25
ATR_159_NB: US281, North of US212	Rural: Other Principal Arterial	2322	8.5	6	10.6%	-2	67
ATR_159_SB: US281, North of US212	Rural: Other Principal Arterial	2322	8.5	7	12.3%	-3	20
ATR_160_EB: US12, W of W Jct of US12-US83	Rural: Other Principal Arterial	2071	3.55	5	9.2%	5	386
ATR_160_WB: US12, W of Jct of US12-US83	Rural: Other Principal Arterial	2071	3.55	5	9.4%	0	59
ATR_165_NB: SD37, S of E Jct SD37-SD34	Rural: Other Freeways and Expressways	2680	7.75	7	12.4%	-2	6
ATR_165_SB: SD37, S of E Jct SD37-SD34	Rural: Other Freeways and Expressways	2680	7.75	7	12.6%	5	17
ATR_166_EB: I90, W of Jct I90 US183	Rural: Interstate	7120	4.41	5	8.7%	5	2
ATR_166_WB: I90, W of Jct I90 US183	Rural: Interstate	7120	4.41	7	12.2%	-4	2
ATR_178_NB: US85, N of N Jct US85-US212	Rural: Other Principal Arterial	1660	30.82	14	28.4%	10	1980
ATR_178_SB: US85, N of N Jct US85-US212	Rural: Other Principal Arterial	1660	30.82	16	33.9%	12	917
ATR_181_EB: I90, SE of Jct I90-US14	Rural: Interstate	6270	0.5	4	6.5%	0	14
ATR_181_WB: I90, SE of Jct I90-US14	Rural: Interstate	6270	0.5	5	9.2%	0	40

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
ATR_182_NB: I29, S of Jct I29-SD50	Rural: Interstate	11930	8.04	4	7.7%	-1	20
ATR_182_SB: I29, S of Jct I29-SD50	Rural: Interstate	11930	8.04	4	7.6%	0	19
ATR_183_EB: US16, E of Jct US16-WY State Line	Rural: Other Principal Arterial	1368	9.3	12	21.6%	-11	47
ATR_183_WB: US16, E of Jct US16-WY State Line	Rural: Other Principal Arterial	1368	9.3	13	22.6%	-11	33
ATR_193_EB: I90, W of Jct I90-US85 S	Urban: Interstate	14610	3.14	4	7.6%	1	56
ATR_193_WB: I90, W of Jct I90-US85 S	Urban: Interstate	14610	3.14	4	7.5%	3	1026
ATR_195_NB: I29, N of Jct I29-US212	Rural: Interstate	7370	4.45	5	9.2%	2	4
ATR_195_SB: I29, N of Jct I29-US212	Rural: Interstate	7370	4.45	5	9.4%	1	3
ATR_611_EB: I90, E of Jct I 90-190	Urban: Interstate	37060	0.08	9	15.0%	-4	158
ATR_611_WB: I90, E of Jct I 90-190	Urban: Interstate	37060	0.08	4	6.3%	-2	320
WIM_801_NB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	6.98	11	20.7%	-6	10
WIM_801_SB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	6.98	8	14.0%	-8	7
WIM_802_EB: US18, East of Mission	Rural: Other Principal Arterial	1395	33.72	13	22.7%	-8	120
WIM_802_WB: US18, East of Mission	Rural: Other Principal Arterial	1395	33.72	12	21.0%	-7	120
WIM_804_NB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	5	9.7%	3	58
WIM_804_SB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	5	10.0%	5	53
WIM_805_EB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4.16	12	22.2%	12	8
WIM_805_WB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4.16	13	26.7%	13	3
WIM_807_EB: I 90, East of Mitchell	Rural: Interstate	11820	8.06	3	5.3%	0	7
WIM_807_WB: I 90, East of Mitchell	Rural: Interstate	11820	8.06	3	4.5%	-1	8
WIM_809_EB: I29, South of Elk Point	Rural: Interstate	13630	5.92	3	6.6%	-1	9
WIM_809_WB: I29, South of Elk Point	Rural: Interstate	13630	5.92	5	9.6%	-4	6
WIM_811_NB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	8.8	11	19.6%	-11	35
WIM_811_SB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	8.8	11	19.1%	-10	64
WIM_812_NB: SD79, South of Rapid City	Rural: Other Freeways and Expressways	10122	13.8	6	10.7%	-4	42
WIM_812_SB: SD79, South of Rapid City	Rural: Other Freeways and Expressways	10122	13.8	6	11.1%	-5	44
WIM_901_NB: I 90, West of Tilford	Rural: Interstate	18520	2.63	7	13.1%	1	59
WIM_901_SB: I 90, West of Tilford	Rural: Interstate	18520	2.63	9	16.9%	-7	23
WIM_903_EB: US12, West of Groton	Rural: Other Principal Arterial	6794	10.95	6	11.1%	-5	10

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
WIM_903_WB: US12, West of Groton	Rural: Other Principal Arterial	6794	10.95	8	15.1%	-7	14
WIM_909_EB: US14, West of Manchester	Rural: Other Principal Arterial	1614	6.95	9	15.8%	-3	26
WIM_909_WB: US14, West of Manchester	Rural: Other Principal Arterial	1614	6.95	5	9.3%	-3	20
WIM_910_NB: I 29, North of Sisseton	Rural: Interstate	4960	9.44	6	10.4%	-2	8
WIM_910_SB: I 29, North of Sisseton	Rural: Interstate	4960	9.44	6	10.3%	-1	10
Overall Speed Category Average				10	18.8%	5	6943

Table 21: Speed Category: > 60 mph, All-Vehicle Speed

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
ATR_102_NB: SD79, S of Jct US212-SD79	Rural: Other Principal Arterial	1900	8.36	4	7.2%	4	955
ATR_102_SB: SD79, S of Jct US212-SD79	Rural: Other Principal Arterial	1900	8.36	3	4.9%	0	1208
ATR_103_EB: SD50, E of Jct US81-SD50	Rural: Other Freeways and Expressways	4938	8.3	3	4.6%	-2	2720
ATR_103_WB: SD50, E of Jct US81-SD50	Rural: Other Freeways and Expressways	4938	8.3	3	4.6%	-2	2564
ATR_104_NB: SD73, S of Jct I90-SD73	Rural: Other Principal Arterial	843	8.36	4	6.3%	0	560
ATR_104_SB: SD73, S of Jct I90-SD73	Rural: Other Principal Arterial	843	8.36	4	6.4%	-2	603
ATR_105_EB: US18, W of Jct US18-SD37	Rural: Other Principal Arterial	372	9	6	9.6%	-3	340
ATR_105_WB: US18, W of Jct US18-SD37	Rural: Other Principal Arterial	372	9	7	10.5%	-6	371
ATR_106_EB: US14, E of Jct US14-SD73	Rural: Other Principal Arterial	786	25.61	6	9.0%	-4	883
ATR_106_WB: US14, E of Jct US14-SD73	Rural: Other Principal Arterial	786	25.61	10	14.2%	-9	920
ATR_108_NB: US81, S of Jct I90-US81	Rural: Other Principal Arterial	1828	11	6	9.0%	-5	2382
ATR_108_SB: US81, S of Jct I90-US81	Rural: Other Principal Arterial	1828	11	10	15.0%	-10	2266
ATR_110_NB: US85, S of Jct US85-SD20	Rural: Other Principal Arterial	1139	37.3	6	8.6%	-6	2446
ATR_110_SB: US85, S of Jct US85-SD20	Rural: Other Principal Arterial	1139	37.3	9	11.7%	-9	2415
ATR_157_EB: US14, E of E Jct of US14-83	Rural: Other Principal Arterial	3019	14.14	8	11.9%	-7	2447
ATR_157_WB: US14, E of E Jct of US14-83	Rural: Other Principal Arterial	3019	14.14	9	13.6%	-9	2414
ATR_159_NB: US281, North of US212	Rural: Other Principal Arterial	2322	8.5	6	9.5%	-5	2153
ATR_159_SB: US281, North of US212	Rural: Other Principal Arterial	2322	8.5	10	15.5%	-10	2084
ATR_160_EB: US12, W of W Jct of US12-US83	Rural: Other Principal Arterial	2071	3.55	4	7.0%	3	460
ATR_160_WB: US12, W of W Jct of US12-US83	Rural: Other Principal Arterial	2071	3.55	4	6.2%	-1	806
ATR_165_NB: SD37, S of E Jct SD37-SD34	Rural: Other Freeways and Expressways	2680	7.75	4	5.8%	-2	1999
ATR_165_SB: SD37, S of E Jct SD37-SD34	Rural: Other Freeways and Expressways	2680	7.75	3	4.7%	-1	1906
ATR_166_EB: I90, W of Jct I90 US183	Rural: Interstate	7120	4.41	6	8.0%	-6	3150
ATR_166_WB: I90, W of Jct I90 US183	Rural: Interstate	7120	4.41	7	10.2%	-7	3169
ATR_178_NB: US85, N of N Jct US85-US212	Rural: Other Principal Arterial	1660	30.82	5	7.2%	5	1
ATR_178_SB: US85, N of N Jct US85-US212	Rural: Other Principal Arterial	1660	30.82	5	7.9%	-1	2
ATR_181_EB: I90, SE of Jct I90-US14	Rural: Interstate	6270	0.5	6	7.7%	-5	3172
ATR_181_WB: I90, SE of Jct I90-US14	Rural: Interstate	6270	0.5	5	7.5%	-5	3181

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
ATR_182_NB: I29, S of Jct I29-SD50	Rural: Interstate	11930	8.04	6	8.7%	-6	3311
ATR_182_SB: I29, S of Jct I29-SD50	Rural: Interstate	11930	8.04	6	7.6%	-5	3310
ATR_183_EB: US16, E of Jct US16-WY State Line	Rural: Other Principal Arterial	1368	9.3	18	28.2%	-18	930
ATR_183_WB: US16, E of Jct US16-WY State Line	Rural: Other Principal Arterial	1368	9.3	17	26.3%	-17	919
ATR_193_EB: I90, W of Jct I90-US85 S	Urban: Interstate	14610	3.14	4	6.0%	-4	3338
ATR_193_WB: I90, W of Jct I90-US85 S	Urban: Interstate	14610	3.14	4	6.2%	-1	2416
ATR_195_NB: I29, N of Jct I29-US212	Rural: Interstate	7370	4.45	5	7.5%	-5	3140
ATR_195_SB: I29, N of Jct I29-US212	Rural: Interstate	7370	4.45	5	7.5%	-5	3095
ATR_611_EB: I90, E of Jct I 90-190	Urban: Interstate	37060	0.08	10	16.2%	-9	2568
ATR_611_WB: I90, E of Jct I 90-190	Urban: Interstate	37060	0.08	5	7.5%	-4	3182
WIM_801_NB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	6.98	13	19.0%	-13	1868
WIM_801_SB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	6.98	12	18.3%	-12	1786
WIM_802_EB: US18, East of Mission	Rural: Other Principal Arterial	1395	33.72	14	20.8%	-13	2080
WIM_802_WB: US18, East of Mission	Rural: Other Principal Arterial	1395	33.72	14	20.5%	-13	1908
WIM_804_NB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	4	6.4%	-4	2011
WIM_804_SB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	5	6.7%	-4	2004
WIM_805_EB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4.16	8	10.9%	-8	3533
WIM_805_WB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4.16	13	16.3%	-13	3542
WIM_807_EB: I 90, East of Mitchell	Rural: Interstate	11820	8.06	11	14.2%	-11	3253
WIM_807_WB: I 90, East of Mitchell	Rural: Interstate	11820	8.06	12	14.8%	-12	3269
WIM_809_EB: I29, South of Elk Point	Rural: Interstate	13630	5.92	10	13.4%	-10	3442
WIM_809_WB: I29, South of Elk Point	Rural: Interstate	13630	5.92	15	18.8%	-15	3445
WIM_811_NB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	8.8	13	19.8%	-13	2736
WIM_811_SB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	8.8	14	21.4%	-14	2717
WIM_812_NB: SD79, South of Rapid City	Rural: Other Freeways and Expressways	10122	13.8	8	12.4%	-8	3261
WIM_812_SB: SD79, South of Rapid City	Rural: Other Freeways and Expressways	10122	13.8	9	13.1%	-9	3142
WIM_901_NB: I 90, West of Tilford	Rural: Interstate	18520	2.63	8	10.3%	-7	3121
WIM_901_SB: I 90, West of Tilford	Rural: Interstate	18520	2.63	16	20.8%	-16	3137
WIM_903_EB: US12, West of Groton	Rural: Other Principal Arterial	6794	10.95	9	12.6%	-9	2515

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
WIM_903_WB: US12, West of Groton	Rural: Other Principal Arterial	6794	10.95	9	13.1%	-9	2728
WIM_909_EB: US14, West of Manchester	Rural: Other Principal Arterial	1614	6.95	5	8.0%	-5	1356
WIM_909_WB: US14, West of Manchester	Rural: Other Principal Arterial	1614	6.95	6	8.5%	-5	1421
WIM_910_NB: I 29, North of Sisseton	Rural: Interstate	4960	9.44	8	10.4%	-8	3051
WIM_910_SB: I 29, North of Sisseton	Rural: Interstate	4960	9.44	12	15.4%	-11	3028
ATR_103_EB: SD50, E of Jct US81-SD50	Rural: Other Freeways and Expressways	4938	8.3	7	23.2%	7	138140
Overall Speed Category Average				8	12%	-8	955

Table 22: Speed Category: 0 to 30 mph, Trucks Only

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
WIM_802_EB: US18, East of Mission	Rural: Other Principal Arterial	1395	34	2.5	6.7%	-3	1
WIM_804_SB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	46.5	206.7%	47	1
WIM_901_NB: I 90, West of Tilford	Rural: Interstate	18520	3	44.9828	264.3%	45	1
Overall Speed Category Average				31	159.2%	30	3

Table 23: Speed Category: 30 to 45 mph, Trucks Only

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
WIM_801_SB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	7	9	20.0%	9	1
WIM_802_EB: US18, East of Mission	Rural: Other Principal Arterial	1395	34	12	25.4%	-7	8
WIM_802_WB: US18, East of Mission	Rural: Other Principal Arterial	1395	34	7	14.8%	-3	6
WIM_804_NB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	12	30.7%	12	1
WIM_804_SB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	22	55.8%	22	2
WIM_809_EB: I29, South of Elk Point	Rural: Interstate	13630	6	7	16.5%	3	3
WIM_809_WB: I29, South of Elk Point	Rural: Interstate	13630	6	5	12.2%	-1	4
WIM_811_SB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	9	8	18.2%	-5	4
WIM_901_NB: I 90, West of Tilford	Rural: Interstate	18520	3	15	43.1%	12	5
WIM_901_SB: I 90, West of Tilford	Rural: Interstate	18520	3	12	25.0%	-12	2
WIM_909_EB: US14, West of Manchester	Rural: Other Principal Arterial	1614	7	9	25.7%	-9	1
WIM_909_WB: US14, West of Manchester	Rural: Other Principal Arterial	1614	7	6	14.7%	6	1
Overall Speed Category Average				10	24.5%	0	38

Table 24: Speed Category: 45 to 60 mph, Trucks Only

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
WIM_801_NB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	7	12	21.6%	-9	7
WIM_801_SB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	7	10	18.0%	-10	2
WIM_802_EB: US18, East of Mission	Rural: Other Principal Arterial	1395	34	9	15.8%	-6	71
WIM_802_WB: US18, East of Mission	Rural: Other Principal Arterial	1395	34	9	18.6%	-2	70
WIM_804_NB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	6	10.0%	3	50
WIM_804_SB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	5	9.7%	4	47
WIM_805_EB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4	10	19.8%	10	7
WIM_805_WB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4	12	24.0%	12	3
WIM_807_EB: I 90, East of Mitchell	Rural: Interstate	11820	8	2	3.1%	-1	6
WIM_807_WB: I 90, East of Mitchell	Rural: Interstate	11820	8	3	5.9%	-2	7
WIM_809_EB: I29, South of Elk Point	Rural: Interstate	13630	6	4	7.6%	-1	9
WIM_809_WB: I29, South of Elk Point	Rural: Interstate	13630	6	5	9.2%	-3	6
WIM_811_NB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	9	12	20.5%	-11	25
WIM_811_SB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	9	10	19.0%	-9	47
WIM_812_NB: SD79, South of Rapid City	Rural: Other Freeways and Expressways	10122	14	7	11.7%	-4	39
WIM_812_SB: SD79, South of Rapid City	Rural: Other Freeways and Expressways	10122	14	5	9.3%	-4	39
WIM_901_NB: I 90, West of Tilford	Rural: Interstate	18520	3	8	14.4%	2	58
WIM_901_SB: I 90, West of Tilford	Rural: Interstate	18520	3	11	20.1%	-9	20
WIM_903_EB: US12, West of Groton	Rural: Other Principal Arterial	6794	11	7	12.5%	-6	9
WIM_903_WB: US12, West of Groton	Rural: Other Principal Arterial	6794	11	8	15.6%	-5	12
WIM_909_EB: US14, West of Manchester	Rural: Other Principal Arterial	1614	7	9	16.8%	-4	18
WIM_909_WB: US14, West of Manchester	Rural: Other Principal Arterial	1614	7	6	11.0%	-1	10
WIM_910_NB: I 29, North of Sisseton	Rural: Interstate	4960	9	8	14.8%	-2	8
WIM_910_SB: I 29, North of Sisseton	Rural: Interstate	4960	9	4	6.9%	1	8
Overall Speed Category Average				8	14.4%	-3	578

Table 25: Speed Category >60 mph, Trucks Only

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
WIM_801_NB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	7	13	18.6%	-12	1086
WIM_801_SB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	7	12	17.8%	-11	954
WIM_802_EB: US18, East of Mission	Rural: Other Principal Arterial	1395	34	10	14.8%	-9	1492
WIM_802_WB: US18, East of Mission	Rural: Other Principal Arterial	1395	34	10	15.3%	-9	1318
WIM_804_NB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	4	6.3%	-4	1733
WIM_804_SB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	4	6.5%	-4	1673
WIM_805_EB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4	4	5.5%	-3	3511
WIM_805_WB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4	8	10.7%	-8	3532
WIM_807_EB: I 90, East of Mitchell	Rural: Interstate	11820	8	7	10.2%	-7	3234
WIM_807_WB: I 90, East of Mitchell	Rural: Interstate	11820	8	8	11.1%	-8	3263
WIM_809_EB: I29, South of Elk Point	Rural: Interstate	13630	6	4	6.0%	-4	3435
WIM_809_WB: I29, South of Elk Point	Rural: Interstate	13630	6	9	12.6%	-9	3441
WIM_811_NB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	9	14	20.9%	-14	2227
WIM_811_SB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	9	15	23.3%	-15	2278
WIM_812_NB: SD79, South of Rapid City	Rural: Other Freeways and Expressways	10122	14	7	10.4%	-7	3032
WIM_812_SB: SD79, South of Rapid City	Rural: Other Freeways and Expressways	10122	14	9	12.9%	-8	2908
WIM_901_NB: I 90, West of Tilford	Rural: Interstate	18520	3	4	5.9%	-3	3072
WIM_901_SB: I 90, West of Tilford	Rural: Interstate	18520	3	14	19.6%	-14	3084
WIM_903_EB: US12, West of Groton	Rural: Other Principal Arterial	6794	11	8	11.5%	-7	2113
WIM_903_WB: US12, West of Groton	Rural: Other Principal Arterial	6794	11	8	11.1%	-7	2353
WIM_909_EB: US14, West of Manchester	Rural: Other Principal Arterial	1614	7	5	7.7%	-4	893
WIM_909_WB: US14, West of Manchester	Rural: Other Principal Arterial	1614	7	5	8.1%	-5	902
WIM_910_NB: I 29, North of Sisseton	Rural: Interstate	4960	9	4	5.2%	-3	2742
WIM_910_SB: I 29, North of Sisseton	Rural: Interstate	4960	9	5	7.1%	-3	2622
Overall Speed Category Average				8	11.2%	-7	56898

Table 26: Speed Category: 0 to 30 mph, Cars Only

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
WIM_901_NB: I 90, West of Tilford	Rural: Interstate	18520	2.63	60	433.70%	60	1
Overall Speed Category Average				60	433.7%	60	1

Table 27: Speed Category: 30 to 45 mph, Cars Only

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
WIM_801_NB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	6.98	7	16.6%	7	2
WIM_802_EB: US18, East of Mission	Rural: Other Principal Arterial	1395	33.72	22	51.1%	-16	6
WIM_802_WB: US18, East of Mission	Rural: Other Principal Arterial	1395	33.72	11	28.6%	4	6
WIM_805_EB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4.16	29	64.4%	29	1
WIM_809_EB: I29, South of Elk Point	Rural: Interstate	13630	5.92	2	5.6%	2	1
WIM_809_WB: I29, South of Elk Point	Rural: Interstate	13630	5.92	13	32.0%	13	3
WIM_811_SB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	8.8	3	8.1%	-1	2
WIM_901_NB: I 90, West of Tilford	Rural: Interstate	18520	2.63	14	35.1%	12	5
WIM_901_SB: I 90, West of Tilford	Rural: Interstate	18520	2.63	32	90.3%	32	1
Overall Speed Category Average				14	35.5%	4	27

Table 28: Speed Category: 45 to 60 mph, Cars Only

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
WIM_801_NB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	6.98	8	13.8%	-8	7
WIM_801_SB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	6.98	8	14.7%	-8	6
WIM_802_EB: US18, East of Mission	Rural: Other Principal Arterial	1395	33.72	19	35.8%	-12	70
WIM_802_WB: US18, East of Mission	Rural: Other Principal Arterial	1395	33.72	18	32.5%	-13	64
WIM_804_NB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	8	17.2%	4	4
WIM_804_SB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	12	20.3%	12	2
WIM_805_EB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4.16	16	30.9%	16	7
WIM_805_WB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4.16	17	32.6%	17	3
WIM_807_EB: I 90, East of Mitchell	Rural: Interstate	11820	8.06	3	5.9%	2	5
WIM_807_WB: I 90, East of Mitchell	Rural: Interstate	11820	8.06	4	6.7%	0	7
WIM_809_EB: I29, South of Elk Point	Rural: Interstate	13630	5.92	5	9.6%	2	7
WIM_809_WB: I29, South of Elk Point	Rural: Interstate	13630	5.92	8	15.9%	-4	5
WIM_811_NB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	8.8	10	18.0%	-8	24
WIM_811_SB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	8.8	10	17.5%	-9	46
WIM_812_NB: SD79, South of Rapid City	Rural: Other Freeways and Expressways	10122	13.8	8	14.2%	-7	24
WIM_812_SB: SD79, South of Rapid City	Rural: Other Freeways and Expressways	10122	13.8	7	13.2%	-7	25
WIM_901_NB: I 90, West of Tilford	Rural: Interstate	18520	2.63	9	16.0%	4	50
WIM_901_SB: I 90, West of Tilford	Rural: Interstate	18520	2.63	10	17.4%	-7	14
WIM_903_EB: US12, West of Groton	Rural: Other Principal Arterial	6794	10.95	5	9.3%	-5	6
WIM_903_WB: US12, West of Groton	Rural: Other Principal Arterial	6794	10.95	8	15.0%	-7	8
WIM_909_EB: US14, West of Manchester	Rural: Other Principal Arterial	1614	6.95	9	16.1%	-4	14
WIM_909_WB: US14, West of Manchester	Rural: Other Principal Arterial	1614	6.95	7	11.2%	-5	12
WIM_910_NB: I 29, North of Sisseton	Rural: Interstate	4960	9.44	8	14.3%	-2	6
WIM_910_SB: I 29, North of Sisseton	Rural: Interstate	4960	9.44	8	12.7%	-2	4
Overall Speed Category Average				12	21.5%	-6	420

Table 29: Speed Category: > 60 mph, Cars Only

SDDOT Site ID and Road Segment	Functional Class	AADT	TMC Length	Average Absolute Speed Error (mph)	Average Absolute Speed Error (%)	Speed Error Bias (mph)	Hours of Benchmark Data
WIM_801_NB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	6.98	13	19.0%	-13	1352
WIM_801_SB: SD37, North of Parkston	Rural: Other Principal Arterial	3060	6.98	12	17.8%	-12	1411
WIM_802_EB: US18, East of Mission	Rural: Other Principal Arterial	1395	33.72	21	30.9%	-19	1143
WIM_802_WB: US18, East of Mission	Rural: Other Principal Arterial	1395	33.72	20	29.8%	-18	1082
WIM_804_NB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	4	6.4%	-4	429
WIM_804_SB: US83, North of Agar	Rural: Other Principal Arterial	1423	12	4	6.4%	-3	489
WIM_805_EB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4.16	7	9.0%	-6	2679
WIM_805_WB: I 90, West of Jct US83 Vivian	Rural: Interstate	6230	4.16	12	14.4%	-12	2735
WIM_807_EB: I 90, East of Mitchell	Rural: Interstate	11820	8.06	8	10.4%	-8	2742
WIM_807_WB: I 90, East of Mitchell	Rural: Interstate	11820	8.06	9	11.1%	-9	2785
WIM_809_EB: I29, South of Elk Point	Rural: Interstate	13630	5.92	8	9.9%	-8	3035
WIM_809_WB: I29, South of Elk Point	Rural: Interstate	13630	5.92	12	14.8%	-12	3187
WIM_811_NB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	8.8	12	17.6%	-12	2072
WIM_811_SB: US85, South of Belle Fourche	Rural: Other Principal Arterial	8404	8.8	12	18.1%	-12	2055
WIM_812_NB: SD79, South of Rapid City	Rural: Other Freeways and Expressways	10122	13.8	9	12.9%	-9	2469
WIM_812_SB: SD79, South of Rapid City	Rural: Other Freeways and Expressways	10122	13.8	9	12.7%	-8	2408
WIM_901_NB: I 90, West of Tilford	Rural: Interstate	18520	2.63	6	7.5%	-4	2633
WIM_901_SB: I 90, West of Tilford	Rural: Interstate	18520	2.63	12	15.3%	-11	2604
WIM_903_EB: US12, West of Groton	Rural: Other Principal Arterial	6794	10.95	9	12.1%	-9	1928
WIM_903_WB: US12, West of Groton	Rural: Other Principal Arterial	6794	10.95	9	12.3%	-9	2017
WIM_909_EB: US14, West of Manchester	Rural: Other Principal Arterial	1614	6.95	5	7.8%	-5	851
WIM_909_WB: US14, West of Manchester	Rural: Other Principal Arterial	1614	6.95	6	8.6%	-5	953
WIM_910_NB: I 29, North of Sisseton	Rural: Interstate	4960	9.44	8	10.5%	-8	2413
WIM_910_SB: I 29, North of Sisseton	Rural: Interstate	4960	9.44	13	15.9%	-12	2523
Overall Speed Category Average				10	13.5%	-10	47995