Nevada Department of Transportation

Report No. 732-19-803

# Evaluation of the Nevada DOT Rest Area System: Recommendations to Reduce Gaps in Traveler Services

June 2022

# Disclaimer

**TECHNICAL REPORT DOCUMENTATION PAGE**

<table>
<tr><td>1. Report No.<br>732-19-803</td><td>2. Government Accession No.</td><td colspan="2">3. Recipient's Catalog No.</td></tr>
<tr><td colspan="2" rowspan="2">4. Title and Subtitle<br>Evaluation of the Nevada DOT Rest Area System: Recommendations to Reduce Gaps in Traveler Services</td><td colspan="2">5. Report Date<br>June 2022</td></tr>
<tr><td colspan="2">6. Performing Organization Code</td></tr>
<tr><td colspan="2">7. Author(s)<br>Timothy J. Gates, Jonathan J. Kay, and Peter T. Savolainen</td><td colspan="2">8. Performing Organization Report No.</td></tr>
<tr><td colspan="2" rowspan="2">9. Performing Organization Name and Address<br>Michigan State University<br>Department of Civil and Environmental Engineering<br>428 South Shaw Lane<br>East Lansing, MI 48824</td><td colspan="2">10. Work Unit No.</td></tr>
<tr><td colspan="2">11. Contract or Grant No.<br>732-19-803</td></tr>
<tr><td colspan="2" rowspan="2">12. Sponsoring Agency Name and Address<br>Nevada Department of Transportation<br>1263 South Stewart Street<br>Carson City, NV 89712</td><td colspan="2">13. Type of Report and Period Covered<br>Final Report<br>November 2019 to July 2022</td></tr>
<tr><td colspan="2">14. Sponsoring Agency Code</td></tr>
<tr><td colspan="4">15. Supplementary Notes</td></tr>
<tr><td colspan="4">16. Abstract<br>Research was conducted to inform decisions related to the system of public rest area facilities owned by the Nevada Department of Transportation (NDOT). The initial steps of the research included collection of data related to the NDOT highway network (including road segment information, traffic volumes, and crashes), NDOT rest areas (including rest areas, basic rest stops, and welcome centers), and private facilities with comparable traveler services (e.g., bathrooms). These data were then analyzed to identify areas of unmet needs (i.e., service gaps) along the NDOT highway network that may be addressed by the inclusion of a new rest area facility or improvement to an existing facility. Additionally, the research also analyzed the safety performance impacts of roadside rest areas on the NDOT highway network. Based on these analyses, recommendations were made regarding: 1.) existing rest area facilities that should continue to be maintained at current levels, 2.) existing facilities that should be improved or relocated to fill gaps in traveler services and reduce crashes, and 3.) areas along the NDOT highway network where potential new facilities may be considered to fill gaps in traveler services and reduce crashes. The recommendations were based on meeting the needs of travelers on the NDOT highway network, with consideration given to the availability of both NDOT rest areas and comparable private facilities. To help prioritize the recommendations, benefit/cost ratios were computed to determine the economic viability for each proposed facility improvement by weighing the benefits to Nevada highway users against agency costs for each facility. A final list of recommended facility improvements was developed considering only those options that resulted in a benefit/cost ratio greater than 1.0.</td></tr>
<tr><td colspan="2">17. Key Words<br>rest areas, welcome centers, traveler services, truck parking, driver fatigue, highway safety</td><td colspan="2">18. Distribution Statement<br>No restrictions. This document is available through the:<br>National Technical Information Services<br>Springfield, VA 22161</td></tr>
<tr><td>19. Security Classif (of this report)<br>Unclassified</td><td>20. Security Classif (of this page)<br>Unclassified</td><td>21. No. of Pages<br>143</td><td>22. Price<br>n/a</td></tr>
</table>

**Form DOT F 1700.7 (8-72)** Reproduction of completed page authorized NDOT Rev 04/2022

# Evaluation of the Nevada DOT Rest Area System: Recommendations to Reduce Gaps in Traveler Services


## Authors

Timothy Gates, Jonathan Kay, and Peter Savolainen



## Sponsoring Organization

Nevada Department of Transportation



## Performing Organization

Michigan State University
Department of Civil and Environmental Engineering
428 South Shaw Lane
East Lansing, MI 48824


## June 2022

# TABLE OF CONTENTS


**EXECUTIVE SUMMARY** **iv**

**1.0 INTRODUCTION AND BACKGROUND** **1**

1.1 Study Objectives 1

**2.0 LITERATURE REVIEW** **3**

2.1 Summary of Literature Review Findings 4

2.2 Overview of Highway Rest Areas 5

2.3 Current Practices in Highway Rest Area Planning in the United States 13

**3.0 DATA COLLECTION** **18**

3.1 NDOT Rest Area Data 18

3.2 Roadway Inventory Data 21

3.3 Private Comparable Facility Data 34

3.4 Traffic Crash Data 37

3.5 Distance to Nearest NDOT Rest Area or Private Comparable Facility 40

**4.0 IDENTIFICATION OF AREAS WITH UNMET NEEDS** **43**

4.1 Identification Areas with Existing Concentrations of Traveler Services 43

4.2 Estimation of Fatigue-Related Target Crash Risk along Study Routes 46

4.3 Identification Areas with Unmet Needs 54

**5.0 DEVELOPMENT OF RECOMMENDATIONS FOR NDOT'S REST AREA SYSTEM** **55**

5.1 Level of Importance Assessment for Existing Facilities 56

5.2 Existing Facilities to Maintain or Consider Potential Modifications 57

5.3 Potential Modifications to NDOT's Rest Area System for Further Economic Analysis 58

5.4 Economic Analysis of Potential Modifications 65

**6.0 CONCLUSIONS AND RECOMMENDATIONS** **71**

6.1 Recommended Modifications to NDOT's Rest Area System 71

**REFERENCES** **74**

**APPENDICES** **82**

Appendix A: Heat Maps of Road User Services 83

Appendix B: Maps of Areas with Unmet Needs 91

Appendix C: Summary of Assessment and Recommendations for Existing Rest Areas 102

Appendix D: Summary Sheets for Nevada DOT Rest Areas 115

# LIST OF TABLES

Table 1. Summary of Federal Hours-of-Service Regulations 9
Table 2. Summary of Prior Evaluations of Safety Performance Impacts of Rest Areas 12
Table 3. Summary of Recent Modifications to Public Rest Area System 13
Table 4. Nevada DOT Rest Area System by Facility Type 18
Table 5. Nevada DOT Rest Area Characteristics 21
Table 6. Study Roadway Miles by Route Type and Roadway Context 27
Table 7. Mean Study Segment AADT by Route Type and Roadway Context 30
Table 8. Mean Study Segment Truck AADT by Route Type and Roadway Context 30
Table 9. Summary of Adjacent Route Daily Traffic Volume and Percent Trucks 30
Table 10. Summary of Rest Area Entering Volume Data (Limited Sample of Nine Facilities) 31
Table 11. Percent of Study Segment Length with Horizontal Curves Present 34
Table 12. Percent of Study Segment Length with Deficient Horizontal Curves Present 34
Table 13. Road User Services Provided by NDOT Rest Areas and Comparable Private Facilities 35
Table 14. Traffic Crashes Occurring along Study Roadway Segments (2015-2017) 37
Table 15. Average Target Crashes per Mile by Route Type and Roadway Context 39
Table 16. Average Target Crash Rate per 1M VMT by Route Type and Roadway Context 39
Table 17. Average Distance to Nearest Facility with Public Parking from Study Segments 42
Table 18. Average Distance to Nearest Facility with Public Bathroom from Study Segments 42
Table 19. Negative Binomial Model Results for Annual Target Crashes 48
Table 20. List of Areas with Unmet Traveler Service Needs 54
Table 21. Level of Importance Assessment 56
Table 22. Nevada DOT Rest Area Facilities by Current Level of Importance 57
Table 23. Criteria to Consider Potential Modifications for Existing Rest Areas 57
Table 24. Existing Facilities to Maintain or Consider Potential Modifications 58
Table 25. Potential Modifications to Consider for Further Economic Analysis 60
Table 26. Comprehensive Costs of Weighted Average Fatigue-Related Target Crashes 66
Table 27. Estimated Rest Area Turn-In Rate and Value of Services by Facility Type 67
Table 28. Summary of Construction and Maintenance Costs for NDOT Roadside Rest Areas 68
Table 29. Annualized Construction and Maintenance Costs for NDOT Roadside Rest Areas 69
Table 30. Benefit-Cost Analysis of Proposed Rest Area Facility Modifications 69

# LIST OF FIGURES


| | |
|---|---|
| Figure 1. Flowchart of Study Process | 3 |
| Figure 2. Estimated Crash Cost Savings for Rest Area | 13 |
| Figure 3. Location of NDOT's 33 Rest Areas | 20 |
| Figure 4. Map of Study Roadways in Nevada by Route Type | 23 |
| Figure 5. Distribution of Study Segments by Length | 24 |
| Figure 6. Example of Roadway Context Classification Process | 26 |
| Figure 7. Study Segments by Annual Average Daily Traffic Volume | 29 |
| Figure 8. Example of Horizonal Curve Data Collection Process | 33 |
| Figure 9. Map of Study Roadways, Rest Area Facilities, and Comparable Private Facilities | 36 |
| Figure 10. Example of Traffic Crash Data Collection Process | 38 |
| Figure 11. Distribution of Distance from Each Segment to Nearest Rest Area Facility | 40 |
| Figure 12. Example of Approximate Distance to Nearest Rest Area from Study Segments | 41 |
| Figure 13. Flowchart of Process to Identify Areas with Unmet Traveler Service Needs | 43 |
| Figure 14. Heat Map of Existing Concentration of Traveler Services | 45 |
| Figure 15. Process to Calculate Expected Target Crashes | 46 |
| Figure 16. Annual Average Target Crashes per Mile vs. AADT – Freeway Segments | 49 |
| Figure 17. Annual Average Target Crashes per Mile vs. AADT – Rural Non-Freeway Segments | 50 |
| Figure 18. Percent Increase in Target Crash Frequency by Distance from Rest Area | 51 |
| Figure 19. Percent Decrease in Target Crash Frequency by Distance from New/Upgraded Rest Area | 51 |
| Figure 20. Distribution of Freeway Segments – Expected Target Crashes per Mile | 52 |
| Figure 21. Distribution of Non-Freeway Segments – Expected Target Crashes per Mile | 52 |
| Figure 22. Expected Target Crashes per Mile and Concentration of Existing Service | 53 |
| Figure 23. Flow Chart of Recommendation Development Process | 56 |
| Figure 24. Example of Safety Performance Impact with Improvement for Bean Flat Rest Stop | 59 |
| Figure 25. Map of Potential Modifications to Consider for Further Economic Analysis | 64 |
| Figure 26. Map of Recommended Modifications to NDOT Rest Area System | 73 |

# EXECUTIVE SUMMARY

Public rest areas in Nevada serve a variety of needs for all travelers, including vacation/recreational travelers, commercial vehicle drivers, commuters, motorcyclists, and others. A majority of travelers stopping at rest areas desire a restroom break or simply a stretch or short break. Other patrons utilize rest areas for picnicking, relief for children or pets, vehicle maintenance, to change drivers, obtain travel information, or to even sleep. Rest areas provide the distinct advantage of quick access and facilities that are open 24 hours per day.

**Problem, Objectives, and Tasks**

Given the rapid development of private comparable facilities in the years since Nevada's rest areas were first opened, as well as the fact that many rest areas are near the end of their service lives, research was conducted to inform both short- and long-term decision-making by NDOT as it relates to its rest area program. The objectives of this research were as follows:

- Conduct a comprehensive literature review to establish the state-of-the-art and the state-of-the practice related to highway rest areas.
- Collect data specific to existing NDOT's rest area system, the highway network supported by the rest area system, the type and location of private comparable facilities, as well as historical traffic crash data.
- Review and analyze these data resources in order to identify areas with currently unmet traveler service needs which can be addressed by the presence of roadside rest areas.
- Benchmark the existing safety performance of Nevada's highway network supported by the rest area system and the quantify the safety performance impact of providing roadside rest areas along highways in Nevada.
- Review NDOT's current rest area system to identify which facilities should be maintained, which facilities could be relocated or improved to reduce gaps in traveler services and improve safety performance, as well as locations to consider for potential new facilities.
- Develop a final list of data-driven recommendations for NDOT to consider which are prioritized based on an economic analysis of the potential rest area system modifications.
- Provide NDOT with a series of decision-support tools based on the outcomes of this evaluation which can be used to support future decision-making, including maps and spatial datasets developed as a part of the study.

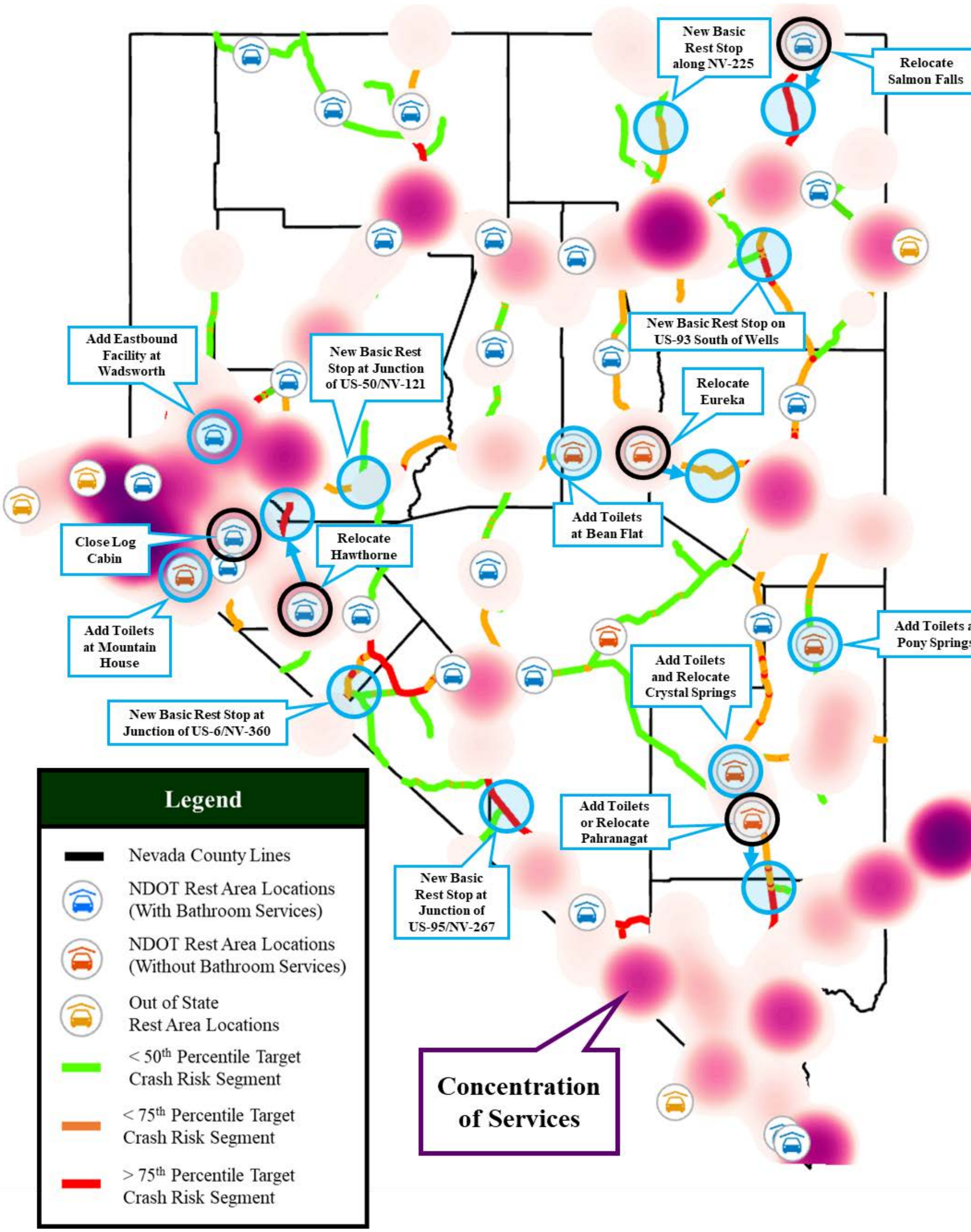
In developing the recommendations, consideration was given to the needs of Nevada highway users, along with agency costs. Specific facility recommendations, including modifications to existing rest areas and construction of new facilities, were based on identification of areas of unmet needs (i.e., service gaps) for travelers on the NDOT highway network, with consideration given to the availability of both NDOT rest areas and private comparable facilities.

To help prioritize the recommended facility modifications, benefit/cost ratios were computed to determine the economic viability for each proposed rest area modification. Benefit/cost ratios are useful in prioritization as they help distinguish between economically favorable and unfavorable alternatives. The benefits were estimated for each modified facility as the incremental changes from the prior condition, considering safety benefits (e.g., expected crash reduction and injury prevention) along with comfort and convenience benefits for travelers (e.g., value of services). These benefits were then compared to the agency costs, which included the construction costs for the proposed new or modified facility, annualized over a 40-year service life, in addition to the change in annual maintenance costs for the proposed facility.

**Recommended Modifications to NDOT's Rest Area System**

Using the benefit/cost ratios, a final list of recommendations was developed to assist NDOT with prioritization of proposed modifications to its rest area network. These recommendations are provided in the following list and corresponding map. Where applicable, the recommendations are listed in order of highest to lowest B/C ratio within the category. Only those proposed modifications with B/C ratios greater than 1.0 for a 3 percent discount rate are included in the recommendations that follow. All other facilities in the NDOT rest area network that are not noted below should continue to be maintained at current levels and replaced with a similar facility at the end-of-service-life. Please refer to Appendix C of the final report for a complete description of the recommendations for each facility within the NDOT rest area network.

- Add vault toilets to the following basic rest stops:
  - Mountain House
  - Pahranagat
  - Crystal Springs
  - Bean Flat
  - Pony Springs
- Relocate the following facilities to fill gaps in services or eliminate safety hazards:
  - Relocate Pahranagat Rest Stop further south along US-93, near Clark Co. line
  - Relocate Crystal Spring Rest Stop away from the curve to eliminate safety hazard
  - Relocate Salmon Falls Rest Stop further south along US-93, near M.M. 108
  - Relocate Hawthorne Rest Area further northwest along US-95, near M.M. 3
  - Relocate Eureka Rest Stop further southeast along US-50, near M.M.31
- Construct the following new facilities to fill gaps in services:
  - Construct new EB rest area near the existing Wadsworth WB Rest Area
  - Construct new basic rest stop along US-95 near junct. of NV-267 (Nye Co.)
  - Construct new basic rest stop along US-93 near junct. of NV-229 (south of Wells)
  - Construct new basic rest stop along US-6 near junct. of NV-360 (Mineral Co.)
  - Construct new basic rest stop along US-50 near junct. of NV-121 (Churchill Co.)
  - Construct new basic rest stop along NV-225, near M.M. 75
- Consider closure of the Log Cabin Rest Area due to end-of-service life, lack of truck parking, and an abundance of comparable traveler services available within close proximity.




**Map of Recommended Modifications to NDOT Rest Area System**

# 1.0 INTRODUCTION AND BACKGROUND

The Nevada Department of Transportation (NDOT) operates and maintains a total of 33 rest areas, which serve a variety of functions for both the traveling public and drivers of commercial motor vehicles. The public tends to use these rest areas when drivers are fatigued, experience problems with their vehicles, or when an occupant needs to use the bathroom. Many of these stops are unplanned, in contrast to commercial vehicle drivers who typically follow a precise, pre-planned route that may include stops at rest areas to meet federal regulation on driving time limits. Ultimately, the decision to use a rest area is dictated by a number of factors, including the availability of comparable facilities along the travel route, such as truck stops/gas stations, fast-food restaurants, and motels. These private facilities provide users with additional services such as gasoline, showers, lodging, and dining options as opposed to publicly maintained rest areas, which generally include only minimal services such as parking, restrooms, and vending machines.

NDOT currently spends approximately $77,000 to $124,000 per rest area per year in time, materials, and contract maintenance. Additionally, the average age of these facilities is 32 years, which significantly exceeds the typical building design life and has resulted in partial or full closures due to various failures. As such, approximately half of these facilities are currently candidates for replacement. Depending upon the type of facility (i.e., basic rest stop, full rest area, or welcome center), the cost of replacement generally ranges from $1.5M to $9.9M per location. Furthermore, many of these rest areas are insufficient in terms of their ability to accommodate commercial vehicle parking and persons with disabilities. There are also both gaps and redundancies in the system when considering the spatial distribution of rest areas and alternate private facilities.

## 1.1 Study Objectives

Given the rapid development of private comparable facilities since Nevada's rest areas were first opened, as well as the fact that many rest areas are near the end of their service lives, a critical evaluation was conducted to inform both short- and long-term decision-making by NDOT as it relates to its rest area program. This study provides a series of data-driven recommendations and decision-support tools to provide important guidance as to NDOT's role in managing rest areas in consideration of the needs of Nevada highway users. The objectives of this research included the following:

- Conduct a comprehensive literature review to establish the state-of-the-art and the state-of-the practice related to highway rest areas.
- Collect data specific to existing NDOT's rest area system, the highway network supported by the rest area system, the type and location of private comparable facilities, as well as historical traffic crash data.
- Review and analyze these data resources in order to identify areas with currently unmet traveler service needs which can be addressed by the presence of roadside rest areas.
- Benchmark the existing safety performance of Nevada's highway network supported by the rest area system and the quantify the safety performance impact of providing roadside rest areas along highways in Nevada.

- Review NDOT's current rest area system to identify which facilities should be maintained, which facilities could be relocated or improved to reduce gaps in traveler services and improve safety performance, as well as locations to consider for potential new facilities.
- Develop a final list of data-driven recommendations for NDOT to consider which are prioritized based on an economic analysis of the potential rest area system modifications.
- Provide NDOT with a series of decision-support tools based on the outcomes of this evaluation which can be used to support future decision-making, including maps and spatial datasets developed as a part of the study.

The structure of this report is provided in **Figure 1**, which outlines the major tasks conducted to accomplish the above study objectives in addition to the associated outcomes.

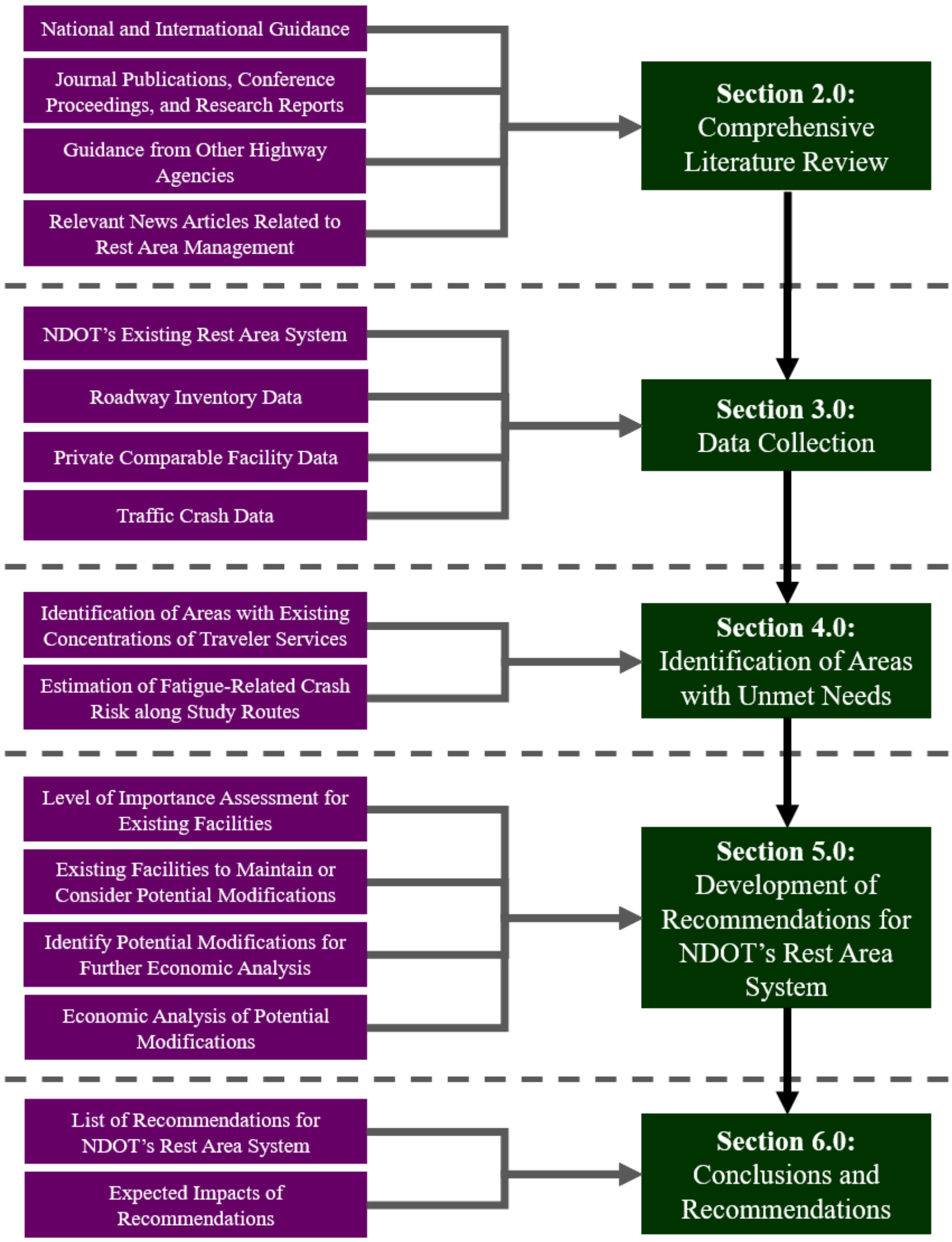



**Figure 1. Flowchart of Study Process**

# 2.0 LITERATURE REVIEW

In order to first establish the state-of-the-art and the state-of-the practice related to highway rest areas, a comprehensive literature review was conducted. Relevant peer reviewed journal articles, conference proceedings, published project reports, news articles and other guidance related to project tasks were identified. Each document was subsequently summarized, evaluated, and critically reviewed with a specific focus on the following topics:

- Appropriate methods for surveying travelers and truckers to determine the desired amenities and services at rest areas

- Identifying areas of unmet need for travel and trucker services – including the consideration of commercial service facilities
- Identifying candidate locations for new rest areas, facilities for upgrades or downgrades as well as facilities for permanent closure
- Determining the appropriate level of amenities and services provided at each rest area location
- Fatigue-related traffic crash prevention
- State and federal rest area guidelines and policies

## 2.1 Summary of Literature Review Findings

While the sections that follow included a detailed discussion of the state-of-the-art and the state-of-the practice specific to highway rest areas, key findings include:

- State agencies maintain rest area program plans, design guides and other standards typically based upon American Association of State Highway and Transportation Officials' (AASHTO) *Guide for Development of Rest Areas on Major Arterials and Freeways (Third Edition)* [*1*].
    - However, this guidance was published in 2001 and there has been a considerable amount of research specific to highway rest areas conducted since its publication.
- While alternative commercial service facilities represent an important component of the transportation system, publicly-owned rest areas offer several unique intrinsic features for road users that are not always present at alternative facilities.
- There has been a variety of studies conducted to quantify rest area usage and demand, both at the national level (including NCHRP Report 324 *Evaluation of Safety Roadside Rest Areas* [*2*]) and at the state level (including work conducted in Maryland, Michigan, Montana New England, and Vermont)
- Highway rest areas are a particularly important component of the transportation system for commercial vehicle operators as they offer an opportunity for drivers to rest in compliance with federal hours-of-service regulations.
    - However, the availability of truck parking adjacent to the interstate system has increasingly become an issue for state highway agencies throughout the United States as trucks parking in the shoulder or ramps can result in accelerated pavement deterioration as well as various safety and security concerns.
    - Studies of truck parking demand have been conducted at both the national and state level to investigate these concerns and identify potential solutions, including the Federal Highway Administration's (FHWA) 2015 Jason's Law survey [*3*].
- Rest areas also serve an important function related to the support of travel and tourism, providing a point of contact with the public for marketing and advertising. This concept is especially relevant for rest areas which function as welcome centers along state borders. There have been several prior studies which attempted to quantify these impacts in order to further define the benefits associated with highway rest areas.
- Prior research has also sought to quantify the safety benefits associated with rest areas, including work conducted in California, Michigan, Minnesota and Texas. These studies have generally shown that rest areas can help to reduce fatigue-related traffic crashes involving both passenger cars and trucks along highways adjacent to these facilities.
- State agencies have been modifying their rest area networks in order to optimize available public funding. These modifications range from the implementation of new

facilities, increasing or decreasing the services offered at a specific facility, to closing existing facilities. Several states have also privatized specific rest areas in order generate revenue where such arrangements align with federal regulations

## 2.2 Overview of Highway Rest Areas

Rest areas serve a variety of key functions within the highway network, providing drivers of both passenger vehicles and commercial vehicles with an opportunity to use the rest room, eat, sleep, take a short break and walk around, use a cellular phone, take a break for children, relieve pets, change drivers, among many others potential functions [*4, 5*]. Highway rest areas are used by a broad range of travelers, including vacationing or recreational travelers, operators of commercial vehicles, motorcyclists, and bus riders [*5*]. While many rest area stops are unplanned, commercial vehicle operators often use the associated truck parking given the federal regulations on driving time limits – particularly long-haul trucks who may use the sleeping cabin included in most large rigs [*5*]. The AASHTO *Guide for Development of Rest Areas on Major Arterials and Freeways (Third Edition)* published in 2001 "provides an overview of components necessary to establish and maintain a successful statewide rest-area program and describes the range of services to be provided" [*1*]. However, there has been a considerable amount of research and other work conducted since its publication. The following sections provide a topical discussion of highway rest areas based upon a review of the existing literature, particularly work performed since the publication of AASHTO's guide.

### *2.2.1 Types of Rest Area Facilities*

The Code of Federal Regulations (23 CFR 752) defines rest areas as a "roadside facility safely removed from the traveled way with parking and such facilities for the motorist deemed necessary for his rest, relaxation, comfort and information needs." [*6*]. The regulations also state that "All facilities within the rest area are to provide full consideration and accommodation for the handicapped." [*6*]. 23 CFR 752.7 further allows states to "establish at existing or new safety rest areas information centers for the purpose of providing specific information to the motorist as to services, as to places of interest within the State and such other information as the State may consider desirable." [*6*].

While the classification, terminology and types of facilities vary from state to state, highway rest area designs generally range from welcome centers which offer a full complement of services in addition to staffed traveler information counters to basic waysides or scenic overlooks which include only parking with limited or no restroom facilities [*7, 8*]. However, the fundamental facility type which represents a typical roadside rest area includes paved parking for both passenger cars and commercial vehicles, restroom facilities, drinking water, picnic areas or space to walk around and other basic services. State agencies also maintain rest area program plans, design guides or other standards, often based upon AASHTO's design guidance, in order to administer their respective highway rest area systems [*8*]. It should also be noted that the Federal Highway Administration (FHWA) published guidance in 2014 to encourage sustainability in rest area design and operations [*9*].

### *2.2.2 Alternative Private Commercial Facilities*

An important consideration specific to the design and planning of highway rest areas is the presence and services offered by alternative commercial service facilities – such as truck stops, gas stations, and fast-food restaurants. These facilities generally provide basic services that are similar to highway rest areas, in addition to other services which are not provided at public rest areas (such as fuel and prepared meals). It is important to note that while such alternative commercial service facilities represent an important component of the transportation system, public rest areas offer several unique intrinsic features for road users that are not always present at alternative facilities, including [*5*]:

- Direct access from limited-access freeway systems
- A natural environment with room to walk which is safe for children to maneuver
- Accommodation for pets
- Accommodation for road users with special needs; and
- Parking for commercial vehicles, buses and recreational vehicles (RV)s.

### *2.2.3 Demand and Usage Characteristics*

An important concept related to the planning and design of highway rest areas is the level of demand and usage expected to be serviced by each rest area and the system as a whole. NCHRP Report 324 *Evaluation of Safety Roadside Rest Areas*, conducted in the late 1980's, performed a comprehensive rest area evaluation, including a survey of road users and an analysis of demand, which provided several key findings [*2*]:

- More than 95 percent of all drivers had previously used a highway rest area
- 60 percent preferred rest areas over similar facilities if the stop did not require gas or food
- Rest areas were used more often by older drivers or drivers on longer trips
- Usage rates varied between 1 percent of 50 percent of total traffic on the adjacent roadway with an average of 10 percent
- Usage rates tended to be higher for trucks and recreational vehicles
- Benefit-cost ratios of highway rest areas based upon the value of user convenience, reductions in excess travel, and reductions in shoulder crashes ranged from 3.2 to 7.4

Since the publication of NCHRP Report 324, there has been a variety of additional work conducted to assess highway rest area demand and usage characteristics. A 2002 study conducted surveys at 11 rest areas in the New England area showed that respondents viewed highway rest areas as a necessity and primary reasons for stopping included using restroom facilities, information related to road condition and tourism [*10*]. Motorists also identified concerns related to both safety and cleanliness. Research which investigated rest area demand conducted in 1991 at three Vermont rest areas demonstrated that the highest levels of use occur on holiday weekends during summary and fall with peak periods between 12:00 PM and 8:00 PM on Fridays and between 10:00 AM and 12:00 PM on Saturdays [*11*].

It is important to note that much of the prior work specific to evaluating highway rest area usage, demand and level of service characteristics are based upon surveys of users. Such reliance on impressions of travelers via survey data may not adequately measure the level of performance [*12*]. Research conducted in Maryland to assess highway rest area performance among users evaluated the use of a comprehensive customer-evaluation card [*12*]. However, the authors noted that additional measures – such as integrating routine inspections with such survey data – should be evaluated in future work.

Two studies related to rest area usage have also been conducted in Montana. A survey of Montana road users was performed to identify needs and expectations for highway rest areas at 16 locations in 1998 [*13*]. While road users suggested that their overall level of satisfaction was favorable, long-distance travelers provided lower scores. Rest area users reported a willingness to pay between $0.25-$1.00 in fees for the services provided. Respondents indicated that there were an insufficient number of rest areas in the system and further that spacing should be between 40 to 100 miles apart. Similar to other studies, using the restroom was the primary reason for stopping at the rest area – with stretching, walking and obtaining water as other reasons for stopping. An additional study was conducted in Montana in 2010 which evaluated usage at 44 highway rest areas [*4*]. Commercial vehicles were shown to have the greatest mean dwell times, followed by RVs and passenger cars. Dwell times were significantly higher at night due to operators of commercial vehicles using the rest area to sleep. The authors recommended a baseline peak traffic usage of 16 percent for interstates and 25 percent for arterial highways for design and planning purposes.

Research conducted in Michigan in 2012 included a survey of road users at 12 rest areas, 3 welcome centers and 2 privately owned truck stops in order to assess usage and road user characteristics (such as vehicle type, trip purpose, age, frequency of use, facility type, trip length [*5, 14*]. The inclusion of both public rest areas and privately owned-truck stops allowed for an important comparison between the perceptions of the two user groups specific to these facility types. The most common reasons for stopping at highway rest areas were using the restroom (95 percent) and walking or taking a break from driving (55 percent). Road users cited the quick direct access from the highway as the primary reason for selecting a public rest area of over an alternative commercial facility. Respondents also reported the median value of services provided during their stop of $1.68 at highway rest areas and $2.21 for welcome centers. Truck stop survey respondents noted that public rest areas were preferred over these private facilities when stopping to use the restroom, taking break from driving or for children, and relieving pets.

Additional work conducted in Michigan in 2014 evaluated demand levels at 47 highway rest areas by analyzing both entering traffic volumes and turn-in rates compared to mainline traffic volumes [*15*]. Several additional features specific to each rest area were also collected, including the size and age of the facility, characteristics of the adjacent highway (such as functional class and number of lanes), as well as the number of parking spaces for passenger cars and trucks. Counts of nearby adjacent alternative service facilities in addition to the number of exits within 20 miles upstream or downstream of each rest area were also collected. The average turn-in rate (or the proportion of mainline traffic entering the rest area) was approximately 5.1 for passenger cars and 11.4 percent for trucks among the rest area facilities included in the sample. Key findings from the evaluation included:

- Both rest area entering volumes and turn-in rates increased as mainline traffic volumes increased, a finding that was consistent for both passenger cars and trucks.
- Both passenger car rest area entering volumes and turn-in rates were higher during the weekend and daylight hours.
- Both commercial vehicle rest area entering volumes and turn-in rates were lower during the weekend and nighttime hours.
- The distance to the nearest upstream rest area or alternative service facility was associated with an increase in both entering volumes and turn-in rates for both passenger

cars and trucks, an effect that was more pronounced for rest areas than alternative service facilities.

### *2.2.4 Relationship with Commercial Vehicles*

Highway rest areas are a particularly important component of the transportation system for commercial vehicle operators as they offer an opportunity for drivers to rest in compliance with federal hours-of-service regulations. The Code of Federal Regulations, Title 49, Part 395 establishes limits for the length of time commercial vehicle operators may drive within a day as well as over a period of days [*16*]. While the limits have slight differences depending on whether the vehicle is transporting property or passengers, off-duty time is required after driving for a specified period of time. Therefore, drivers of commercial motor vehicles often use rest areas to sleep and satisfy these federal requirements – especially at night. These hours-of-service regulations are an important safety consideration as prior work has demonstrated an association between truck driver fatigue and crash risk [*17*], with truck driver fatigue being a factor in 30 percent of all single-vehicle truck collisions and 14 percent of at-fault multiple-vehicle truck collisions [*18*]. Additional work has also shown that appropriate rest reduces the risk of these collisions [*19*]. **Table 1** summarizes the federal hours of service regulations. It should be noted that minor changes were made to the hours-of-service requirements in September of 2019 [*20*].

These federal hours-of-service requirements have contributed to the demand for truck parking at both highway rest areas and alternative facilities. The availability of truck parking adjacent to the interstate system has increasingly become a concern for state highway agencies throughout the United States. A survey of state DOTs conducted in the mid-1990's showed that demand for truck parking at nearly 80 percent of highway rest areas exceeded capacity and were either full or overflowing onto ramps during nighttime hours [*22, 23*]. A survey of truck parking use in Tennessee demonstrated that parking demands were highest Monday through Thursday nights [*24*]. Trucks parking in the shoulder or ramps can result in accelerated deterioration of the pavement and several potential safety hazards [*25*]. An evaluation conducted in 2019 in Tennessee indicated an association between a shortage of commercial vehicle parking and truck-related traffic crashes on freeway ramps [*26*]. Additionally, research has demonstrated that carriers in the United States lose billions annually in both lost time and fuel while drivers search for parking [*27, 28*].

**Table 1. Summary of Federal Hours-of-Service Regulations [*21*]**

| Limit | | Details |
|---|---|---|
| **Property-Carrying Drivers** | 11-Hour Limit | May drive a maximum of 11 hours after 10 consecutive hours off duty. |
| | 14-Hour Limit | May not drive beyond the 14th consecutive hour after coming on duty, following 10 consecutive hours off duty. Off-duty time does not extend the 14-hour period. |
| | Rest Breaks | May drive only if 8 hours or less have passed since end of driver's last off-duty or sleeper berth period of at least 30 minutes. |
| | 60/70-Hour On-Duty Limit | May not drive after 60/70 hours on duty in 7/8 consecutive days. A driver may restart a 7/8 consecutive day period after taking 34 or more consecutive hours off duty. |
| | Sleeper Berth Provision | Drivers using the sleeper berth provision must take at least 8 consecutive hours in the sleeper berth, plus a separate 2 consecutive hours either in the sleeper berth, off duty, or any combination of the two. |
| **Passenger-Carrying Drivers** | 10-Hour Limit | May drive a maximum of 10 hours after 8 consecutive hours off duty. |
| | 15-Hour Limit | May not drive after having been on duty for 15 hours, following 8 consecutive hours off duty. Off-duty time is not included in the 15-hour period. |
| | 60/70-Hour On-Duty Limit | May not drive after 60/70 hours on duty in 7/8 consecutive days. |
| | Sleeper Berth Provision | Drivers using a sleeper berth must take at least 8 hours in the sleeper berth and may split the sleeper berth time into two periods provided neither is less than 2 hours. |

One strategy that is often used to induce truck parking space turnover at highway rest areas is imposing overnight truck parking time limits. Despite this strategy being commonly employed across the United States, these limits are typically not strongly enforced. A 1999 forum sponsored by the FHWA showed mixed opinions with respect to these time limits, with some participants in favor of eliminating time limits and others supporting increased enforcement of existing limits [*29*]. It is also important to note that a survey of commercial vehicle drivers demonstrated a slight preference for highway rest areas over privately-owned truck stops of less than two hours [*22, 23*]. However, drivers preferred truck stops for long-term parking with only 15 percent of drivers preferring to sleep at highway rest areas due to safety and security concerns [*22, 23*].

A comprehensive study of the adequacy of truck parking supply and demand was conducted for FHWA in 2002, including a survey of commercial vehicle drivers as well as supply and demand estimates along the National Highway System [*30*]. The survey demonstrated that only a limited number of drivers felt they could almost always find available parking at both highway rest areas (11 percent) and privately-owned truck stops (34 percent). Consistent with other work on this topic, drivers preferred highway rest areas for shorter stops and alternative facilities for long-term stops. One of the most critical findings from this evaluation included the fact that truck parking supply at highway rest areas was inadequate, while parking supply at alternative service facilities was adequate.

Virginia DOT's rest area policy study conducted in 2011 included a survey of commercial vehicle parking policies in the United States [*31*]. The study showed that nearly 80 percent of responding state agencies noted that overnight truck parking is not allowed at highway rest areas, although two of these states allowed for overnight parking with a limited duration. While none of the responding states charged a fee for overnight parking at rest areas, approximately 40 percent of truck drivers surveyed as a part of the study indicated they would support usage fees and several states had investigated user fees conceptually. Additional studies have recently been completed in Florida [*32*], Minnesota [*33*], Oregon [*34*], the province of Ontario [*35*], and the pacific northwest region [*36*] specific to truck parking trends, demand and availability. Agencies have also experimented with several intelligent transportation systems solutions for addressing truck parking availability and demand, such as the detection systems evaluated in Florida [*37*], Minnesota [*38*] and Wisconsin [*39*].

The most comprehensive evaluation of the current truck parking shortage concerns in the United States was completed by the FHWA in 2015 to meet the requirements of a component of the Moving Ahead for Progress in the 21st Century Act (MAP-21) known as "Jason's Law" after Jason Rivenburg, a truck driver who was murdered while sleeping at an abandoned gas station due to a lack of available parking [*3*]. Jason's Law required the United States Department of Transportation (USDOT) to conduct an assessment which evaluated the capability of states to provide adequate parking, assess the volume of commercial vehicle traffic in each state and develop a system of metrics to measure the adequacy of truck parking availability across the country. Key findings from the survey included:

- Most states reported concerns related to truck parking shortages, particularly those states which were more urban in nature.
- Parking shortages were more prevalent with respect to public parking facilities as opposed to private facilities.
- More than half of states reported concerns related to unofficial or illegal parking on freeway interchange ramps or shoulders.
- Approximately 75 percent of truck drivers and 66 percent of logistics personnel reported regular issues finding safe parking locations when rest was needed.

Additional research related to truck parking supply and demand has included microscopic simulation of truck parking demand in New York [*40*], the use of GPS data to determine parking availability [*41*], and the development of prediction algorithms for drivers to better plan trips [*42*].

### *2.2.5 Tourism Support*

Highway rest areas also serve an important function related to the support of travel and tourism, providing a point of contact with the public for marketing and advertising. This concept is especially relevant for rest areas which function as welcome centers along state borders. Prior studies have attempted to quantify these impacts in order to further define the benefits associated with highway rest areas.

A 2010 study conducted in Texas included the development of a benefit-cost model based upon a public opinion survey performed at both highway rest areas and traveler information centers (which is similar to welcome centers in Nevada) [*43*]. Findings from the survey demonstrated that 29.3 percent of visitors extended their stay in Texas by 2.5 days on average due to information they obtained at travel centers. This was associated with an average additional daily expenditure of $58.39 per visitor, resulting in an estimated $1.3M to $2.0M in annual economic development and tourism benefits specific to each traveler information center. Other benefits noted by study related to highway rest areas and traveler information centers included an increase in comfort and convenience, a decrease in excess travel and diversion, as well as an increase in economic development and tourism.

Michigan State University performed a survey in 2010 of welcome center users at 14 locations in order to assess the effectiveness and satisfaction with traveler services [*44*]. The surveys included respondents from 44 states, as well as Canada and other countries. Respondents spent an average of 4.5 nights in Michigan with an average party size of 2.22 persons per party. While 87 percent of respondents noted that they stopped to use the rest room, approximately 71 percent stopped at the welcome center in order to obtain travel information. The study estimated that approximately 725,000 parties annually used traveler information provided at Michigan's welcome centers with an average cost per party served of $3.73. Approximately 15.7 percent of welcome center users noted that they increased spending based upon travel information they received with an increase of $135 per party.

### *2.2.6 Impacts of Highway Rest Areas on Safety Performance*

While highway rest areas serve a variety of important roles in the transportation system, one of the most important benefits is reducing driver fatigue and therefore potentially mitigating the risk for related traffic crashes. According to NHTSA, approximately 91,000 traffic crashes occurred in 2017 which involved drowsy driving across the United States, resulting in 795 fatalities [*45*]. The State of Nevada has previously recognized this concern as a part of its *2016-2020 Strategic Highway Safety Plan*, where distracted or fatigued drivers represented approximately 5.5 percent of fatalities which occurred in the state from 2009 to 2013 [*46*]. However, these figures are likely to underrepresent the true degree of this problem as such crashes are often not easily distinguishable through police crash reports.

Highway rest areas offer a means of addressing these driver fatigue concerns, as the most effective countermeasure towards addressing driver sleepiness is to stop driving and take a short nap or consume caffeine [*47*]. Prior research has investigated the impacts of public highway rest areas on safety performance of the adjacent highway system in several states. **Table 2** summarizes by state the previous evaluations which have investigated the safety performance impacts of the presence of highway rest areas in the transportation system.

**Table 2. Summary of Prior Evaluations of Safety Performance Impacts of Rest Areas**

| State | Summary of Research |
|---|---|
| California | In 2009, the University of California – Berkeley performed a spatial analysis of fatigue-related crashes to investigate the relationship with rest area spacing [*48*]. The frequency of fatigue-related crashes was shown to increase when the distance from the nearest highway rest area exceeded 30 miles. The study suggested a benefit-cost ratio of 1.61 associated with providing adequate truck parking at highway rest areas. |
| Michigan | A 1999 study conducted by Michigan State University investigated the relationship between rest area spacing and single-vehicle truck crash rate [*49*]. Key findings included that the majority of single-vehicle truck collisions occurred between midnight and 8:00 AM, as well as the fact that there was a positive relationship between rest area spacing and fatigue related single-vehicle truck crashes.<br>Additional work conducted in 2013 evaluated the effects of highway rest areas on fatigue-related crashes [50]. Historical fatigue-related crash data within 20 miles in each direction of 28 rest areas in Michigan were collected and aggregated into one-mile road segments. The study demonstrated that road segments in closer proximity to highway rest areas tended to observe lower frequencies of fatigue-related traffic crashes. This finding suggests that highway rest areas can provide a safety benefit, as shown in **Figure 2**. |
| Minnesot a | A 2007 study conducted in Minnesota demonstrated that single-vehicle truck crash densities increased at distances greater than 30 miles from a highway rest area [*51*]. The study also showed an increase in single-vehicle crash densities at night related to increased truck parking demand and potential capacity concerns. |
| Texas | Researchers in Texas also evaluated the safety benefits of rest areas as a part of a larger study to develop a benefit-cost ratio analysis methodology [*43*]. A simple before-and-after analysis of casualty rates was conducted for highways where rest areas were constructed during the study period. While safety benefits were observed, the authors noted that the results should be interpreted with caution due to several factors which may have changed during the study period which were not captured in the analysis.<br>Additional research conducted in Texas evaluated crash frequencies downstream of seven traveler information centers, including an analysis of a subgroup of crashes which could be associated with the function of these facilities [*52*]. The authors did not find a significant difference between these crash frequencies on the side of the roadway which included the facilities and the adjacent side of the roadway. However, the authors do note that a variety of factors (such as adjacent alternative facilities, traffic volume differences in each direction, among others) were not accounted for and could occlude the impact of the traveler information centers. |

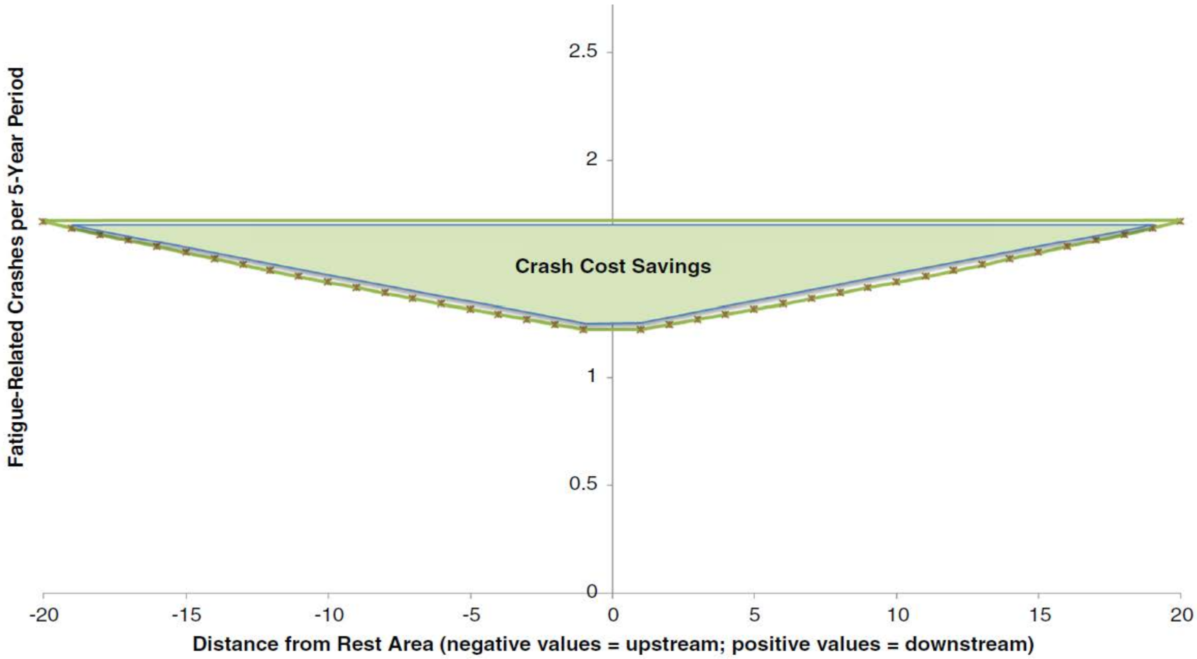



**Figure 2. Estimated Crash Cost Savings for Rest Area Facilities with AADT of 15,000 Vehicles per Day [ *50*]**

## 2.3 Current Practices in Highway Rest Area Planning in the United States

While highway rest areas have been shown in the existing literature to serve a variety of key functions for road users, several state agencies have been modifying their rest area networks in order to optimize available public funding. These modifications range from the implementation of new facilities, increasing or decreasing the services offered at a specific facility, to closing existing facilities. Several states have also privatized specific rest areas in order generate revenue where such arrangements are in agreement with federal regulations. **Table 3** summarizes the recent modifications other states have made to their public highway rest area systems.

**Table 3. Summary of Recent Modifications to Public Rest Area System**

| State | Summary |
|---|---|
| **Arizona** | Arizona proposed closing 13 of its 18 rest areas in 2009 due to budgetary limitations which was subsequently met with considerable pushback from the public [*53*]. The state ultimately was able to reopen at least five of the closed rest areas as budgets stabilized [*54*]. Arizona has also previously passed a bill to allow for agreements with counties, cities, towns, and private entities to maintain and improve rest areas [*31*]. The Arizona DOT also entered into a public-private partnership to operate and maintain the state's rest areas in 2013 [*55*]. |
| **Arkansas** | While the state had previously closed rest area facilities [*5*], Arkansas recently upgraded two rest areas in 2016 to tourist information centers, which included new informational kiosks and upgrades to restroom facilities [*56*]. |
| **California** | California closed at least seven rest areas in 2010 due to maintenance costs associated with weekly water testing [*57*]. The state has also previously developed private facilities into "Traveler Service Rest Areas" as a part of |

| State | Summary |
|---|---|
| | the Interstate Oasis program [*31, 58*]. Prior studies in California have also evaluated various commercial and public-private partnership options, including the implementation of traveler information kiosks which would be paid for by private advertising [*59-61*]. |
| **Colorado** | Colorado has previously closed in 2009 and 2012 in order to reduce costs [*62*]. The state has also conducted research to investigate alternatives to public funding of rest areas, including the sales of lottery tickets or other items, commercializing rest areas outside of the right-of-way or advocating for changes in federal law [*63*]. |
| **Connecticut** | The state has recently reopened a portion of their rest areas 24 hours a day which had only been available during daytime hours since 2016 [*64*]. Connecticut also has a robust service plaza system which incorporates a private partnership and generates revenue for the state [*65*]. |
| **Delaware** | Delaware constructed a new 42,000 square foot welcome center in 2010 as a part of a deal with a private company to manage the facility [*65*]. The state receives a percentage of revenues and did not contribute to the $35 million construction cost. |
| **Florida** | Florida has closed rest areas over the last decade in order to save costs [*66*]. The state had also previously considered a pilot of commercialized state-owned rest areas off the interstate right-of-way [*31*]. |
| **Georgia** | Georgia closed two rest areas in 2008 in order to save costs [*65*]. |
| **Idaho** | The state entered into a public-private partnership with to move a particular rest area's services to a truck stop in order to save $13.7M in construction costs [*67*]. Idaho also entered into agreements to designate business facilities as an Interstate Oasis in 2018 in order to offset the permanent closure of a facility [*68*]. |
| **Illinois** | The state conducted a study of its rest area program in 2017, including conducting a survey of residents [*69*]. The Illinois Tollway has also designated facilities several facilities as an Interstate Oasis using signs with logos [*70*]. |
| **Indiana** | Indiana recently closed two underused rest areas in 2019 [*71*]. |
| **Iowa** | Iowa is implementing a plan to gradually close 11 interstate rest areas [*72*] after conducting a study to evaluate the rest area system in 2018 [*73*]. The state has previously implemented a commercial store via public-private partnership at an interchange [*31*]. |
| **Louisiana** | The state closed 24 of its 34 rest areas in 2008 [*74*], however, rest areas and welcome centers have been added in recent years [*75*]. |
| **Maine** | Maine closed two rest areas and privatized five additional rest areas in order to save costs [*76*]. |
| **Maryland** | Maryland renovated rest areas as a part of an agreement to privatize the sites in 2012 [*77*]. |

| State | Summary |
|---|---|
| **Michigan** | Michigan has closed several rest areas in the last decade in order to reduce costs [*78*]. The state has also previously sponsored research in 2012 to evaluate the appropriate level of service of the state's rest areas [*5*]. |
| **Minnesota** | Minnesota has previously implemented a rest area partnership and sponsorship program [*79*]. |
| **Mississippi** | The state shut down two rest areas which had limited amenities in 2012 which were unpopular with residents [*80*]. |
| **Missouri** | Missouri converted two rest areas to truck parking only with limited restroom facilities in 2013 [*81*]. |
| **Montana** | The state developed a rest area plan in 2014 which set the priorities for rest area needs as well as identified future maintenance and improvement projects [*82*]. |
| **New Hampshire** | The state has recently converted two existing rest areas to welcome centers as a part of a public-private partnership which generates revenue for the state [*83*]. |
| **New Jersey** | New Jersey has recently invested in renovating three rest areas in 2019 [*84*]. The state had also previously considered retailing naming rights to turnpike rest areas and including private/public restaurants [*31*]. |
| **New Mexico** | New Mexico previously considered closing approximately half of the state's rest spots in 2010 in order to save maintenance costs [*65*]. New Mexico's secretary of transportation requested $30 million in the next budget to upgrade the state's rest area facilities [*85*]. |
| **New York** | The state closed six rest areas along interstates in 2010 due to budget cuts [*86*]. The Office of the New York State Comptroller conducted a study of the rest area program in 2019 which provided a series of recommendations to further control costs, ensure compliance with AASHTO standards and improve the state's rest area program as a whole [*87*]. |
| **North Carolina** | North Carolina converted two rest areas into a single improved facility in 2017 – built in the median of Interstate 77 [*88*]. The state had previously piloted programs for subcontracting visitor centers to private and non-profit entities [*31*]. |
| **North Dakota** | The stated closed five rest areas in 2016 due to budget limitations [*89*]. |
| **Ohio** | Ohio, which had been closing rest areas in recent years [*66*], has undergone a shift under the new administration which has focused on upgrading the state's rest area system [*90*]. The state had also previously sold interior advertising at highway rest areas and considered constructing rest areas outside of the right-of-way [*31*]. |
| **Oklahoma** | The state considered closing at least six rest areas which had exceeded their intended service life in 2013 [*91*]. |
| **Pennsylvania** | Pennsylvania recently announced that two adjacent rest areas will be closed for 18 months as a part of a significant truck parking expansion [*92*]. |
| **South Carolina** | South Carolina closed four rest areas in order to due to budget concerns in 2010 [*93*]. The state has also previously subcontracted welcome centers to non-profit concessionaries [*31*]. |

| State | Summary |
| --- | --- |
| **South Dakota** | The state closed four rest areas in 2017 but added two new welcome centers and is expanding two others in order to focus on tourism [*66*]. |
| **Texas** | Texas has both added [*94*] and removed [*95*] rest areas from the system in recent years based upon anticipated needs and existing usage. Texas has also previously developed a benefit-cost analysis methodology to assist agencies in quantifying the benefits of highway rest areas [*43*]. |
| **Utah** | Utah has used public-private partnerships to maintain highway rest areas as well as integrating a system similar to the Interstate Oasis program [*31*]. |
| **Vermont** | Vermont closed four rest areas in order to save costs in 2008 [*65, 96*]. |
| **Virginia** | Virginia closed 19 rest areas in 2009 in order to address budget limitations, however, these rest areas were subsequently reopened by the following administration in 2010 [*97*]. More recently, Virginia has invested in rebuilding three rest areas in 2016 [*98*]. The Virginia Department of Transportation has also previously explored a variety of options for non-public funding of highway rest areas [*31, 99-102*]. |
| **Wisconsin** | Wisconsin has closed several rest areas in recent years in order to save costs [*103*]. The state also conducted an evaluation of its highway rest area program in 2016 [*104*]. |
| **Wyoming** | The state was able to add wireless internet services at rest area locations in 2017 through a partnership with a telecommunications company [*105*]. |

### *2.3.1 Non-Public Funding Strategies and Public-Private Partnerships*

As observed in **Table 3**, state agencies have investigated or implemented a range of commercialization or privatization options to offset the costs associated with the construction, maintenance and operations of rest area facilities. However, it is important to note that federal law prohibits using the Interstate right-of-way for commercial purposes for highways that went into operation after the 1956 *Interstate Highway Act*, which includes the privatizing or commercializing highway rest areas [*106*]. In light of this prohibition, many states have lobbied for permission or changes to this legislation which would allow for potential options for commercialization [59, 99, 107].

Despite the potential benefits to state budgets, there is not a strong consensus related to the commercialization of public highway rest areas. Prior polls conducted on the commercialization of rest areas have demonstrated either mixed or unfavorable support from state agencies, road users, and industry groups [*31, 79, 109*]. Industry groups, such as the National Association of Truck Stop Operators (NATSO), Petroleum Marketers Association of America (PMAA), and the National Federation of the Blind (NFB) have historically been against commercialization. NATSO, in conjunction with a coalition of 15 industry trade associations, lobbied lawmakers in the House Committee on Transportation and Infrastructure to maintain the prohibitions on commercializing rest areas as it was considering significant infrastructure legislation in May of 2019 [*110*].

The use of public-private partnerships has been employed to circumvent the prohibition on commercialization, as seen in **Table 3**. This often includes entering into an agreement with a private company to manage the facilities with state agencies receiving a specified proportion of revenues. In many instances, these agreements have also included reconstruction or improvements to facilities. These partnerships with private industry have also been used to expand the services available at highway rest areas – such as providing wireless internet or restaurant options. Respondents to a 1992 Texas survey of highway rest area users suggested the desire additional commercial services at public rest areas [*108*].

It should be noted that FHWA published a memorandum in 2011 which provided an interpretation related to the placement of sponsorship signs acknowledging the sponsorship of a rest area [*111*]. The memo allows for placement of signs along the mainline of the adjacent roadway, limited to one sign upstream of the rest area facility. The "Interstate Oasis" program, a provision of the 2005 SAFTEA-LU legislation which allows for highway signs to designate alternative commercial service facilities outside of the right of way, has also been used by several states [*58. 112*].

# 3.0 DATA COLLECTION

A broad range of engineering data were collected to conduct the evaluation, including data specific to NDOT's rest area system, roadway inventory and characteristic data, traffic crash data, as well as the location and type of private comparable facilities. This section provides details of the data collection process in addition to a summary of the final datasets used to conduct the evaluation.

## 3.1 NDOT Rest Area Data

Initially, data were collected for each of the 33 NDOT rest areas, including information obtained from the NDOT team as well as Google satellite and street view imagery where available. Each rest area was categorized based upon the facilities present at each location. Locations which included structures with running water were categorized as "*full rest areas*" while locations with only parking and/or basic bathrooms (e.g., vault toilet) without running water were categorized as "*basic rest stops*". The Southern Nevada Welcome Center was categorized separately as a welcome center given the range of services available at that location and the Laughlin Brake Check was also distinguished given the specific safety function of brake check facilities. It should be noted that this structure is consistent with NDOT's current model for developing rest area facilities. A summary of NDOT's existing 33 rest areas by type is provided in **Table 4**.

**Table 4. Nevada DOT Rest Area System by Facility Type (N=33)**

| Type | Facilities |
|---|---|
| **Welcome Center (1)** | Southern Nevada Welcome Center |
| **Full Rest Area (12)** | Amargosa, Beowave (Eastbound and Westbound), Cosgrave, Hawthorne, Log Cabin, Luning, Millers, Sunnyside, Trinity, Valmy, Wadsworth Westbound |
| **Basic Rest Stop (19)** | Bean Flat, Big Smoky, Blue Jay, Crystal Springs, Eureka, Garden Valley, Leonard Creek, Mountain House, Mt. Rose, Orovada, Pahranagat, Pequop, Pony Springs, Salmon Falls, Saulsbury Wash, Schellbourne, Thousand Springs, Valley of the Moon, Wilson Canyon |
| **Brake Check (1)** | Laughlin |

The department currently maintains one welcome center near the California state border along US-95, 12 full rest areas, 19 basic rest stops, as well as the Laughlin Brake Check facility. The basic characteristics of each facility were identified and are summarized in **Table 5**. Seven facilities are located along an interstate freeway (all of which are located adjacent to I-80 in northern Nevada), 15 are located along non-freeway US routes, and 11 are located along Nevada state highways. Passenger vehicle parking spaces range from five to 77 and truck parking spaces range from zero to 30. Seven of the 33 facilities currently do not provide bathroom services and limited basic snacks or drinks are available at six locations. Some level of traveler information is provided at eight facilities. A map of all 33 NDOT rest areas is provided in **Figure 3**, including the facilities which currently provide bathroom services.

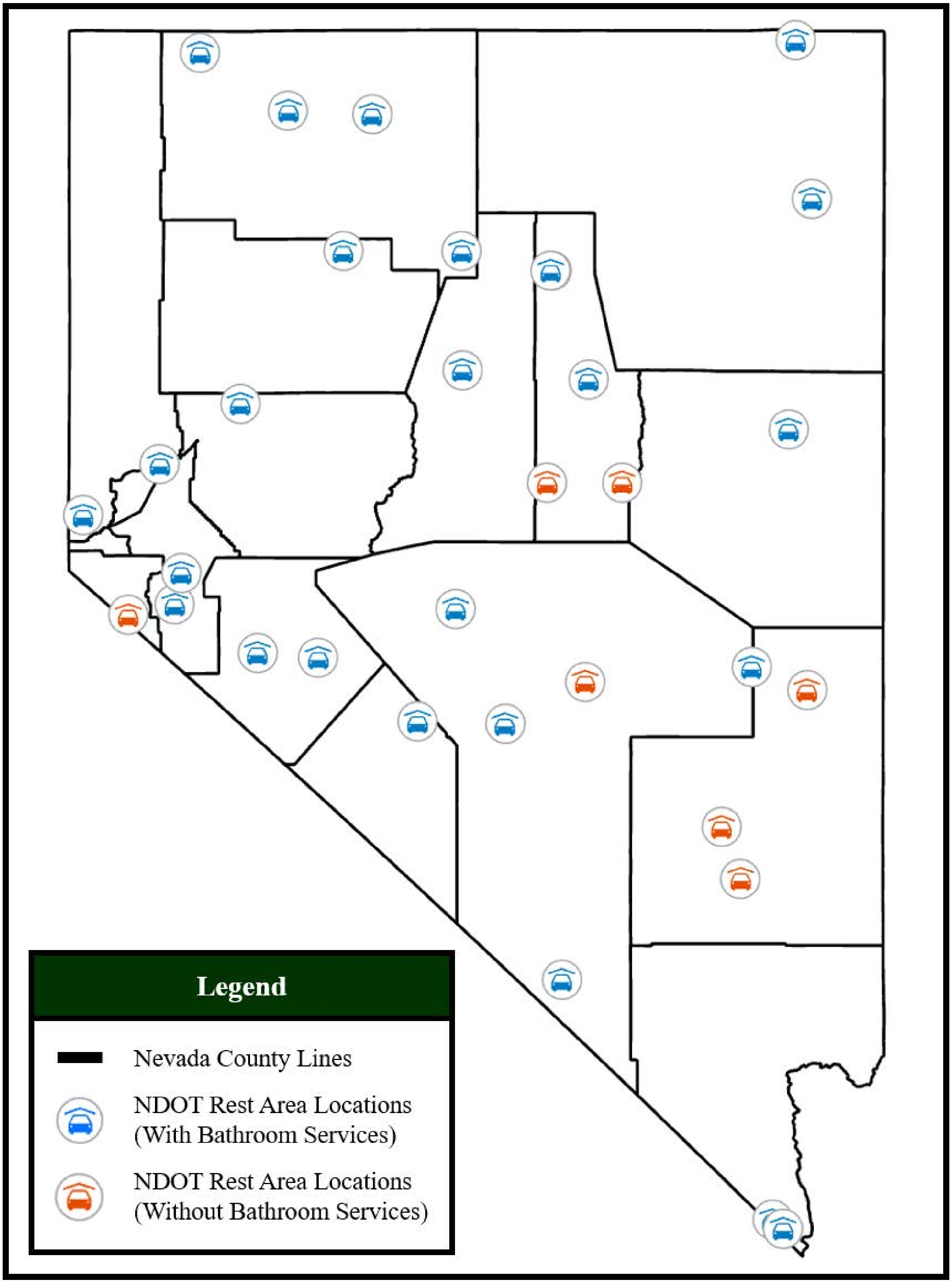



**Figure 3. Location of NDOT's 33 Rest Areas**

**Table 5. Nevada DOT Rest Area Characteristics (N=33)**

| Rest Area Characteristic | | Number of Rest Areas |
|---|---|---|
| Adjacent Route Type | Interstate Freeway | 7 |
| | US Route | 15 |
| | Nevada State Route | 11 |
| Passenger Vehicle Parking Spaces | 5 to 10 | 7 |
| | 11 to 20 | 9 |
| | 21 to 30 | 11 |
| | 31 or More | 6 |
| Truck Parking Spaces | None | 6 |
| | 1 to 5 | 10 |
| | 6 to 20 | 13 |
| | 21 or More | 4 |
| Bathroom Service | None | 7 |
| | Present | 26 |
| Snacks and Drinks Available | None | 27 |
| | Present | 6 |
| Traveler Information Available | None | 25 |
| | Present | 8 |

### 3.2 Roadway Inventory Data

A customized roadway inventory database was then developed based on the Federal Highway Administration's (FHWA) *Highway Performance Monitoring System* (HPMS) [*113*] and NDOT's available geospatial data [*114*]. Routes located within urban areas (greater than 50,000 population) were assumed to include a concentration of adjacent private comparable facilities and were removed from the analysis. Routes in either rural areas (less than 5,000 population) or small urban areas (5,000 to 50,000 population) were maintained for further evaluation. Additionally, selected routes of less than five miles within small urban areas were removed which served as spurs or connections within the specific urban area. These routes were located within areas where there was an existing concentration of private comparable facilities and serves a higher proportion of traffic which primarily is not traveling over an extended distance. A map of these study roadway facilities by route type (interstate, US route, or Nevada state highway) is provided in **Figure 4**. It should be noted that all 33 NDOT rest areas were located along the selected study routes.

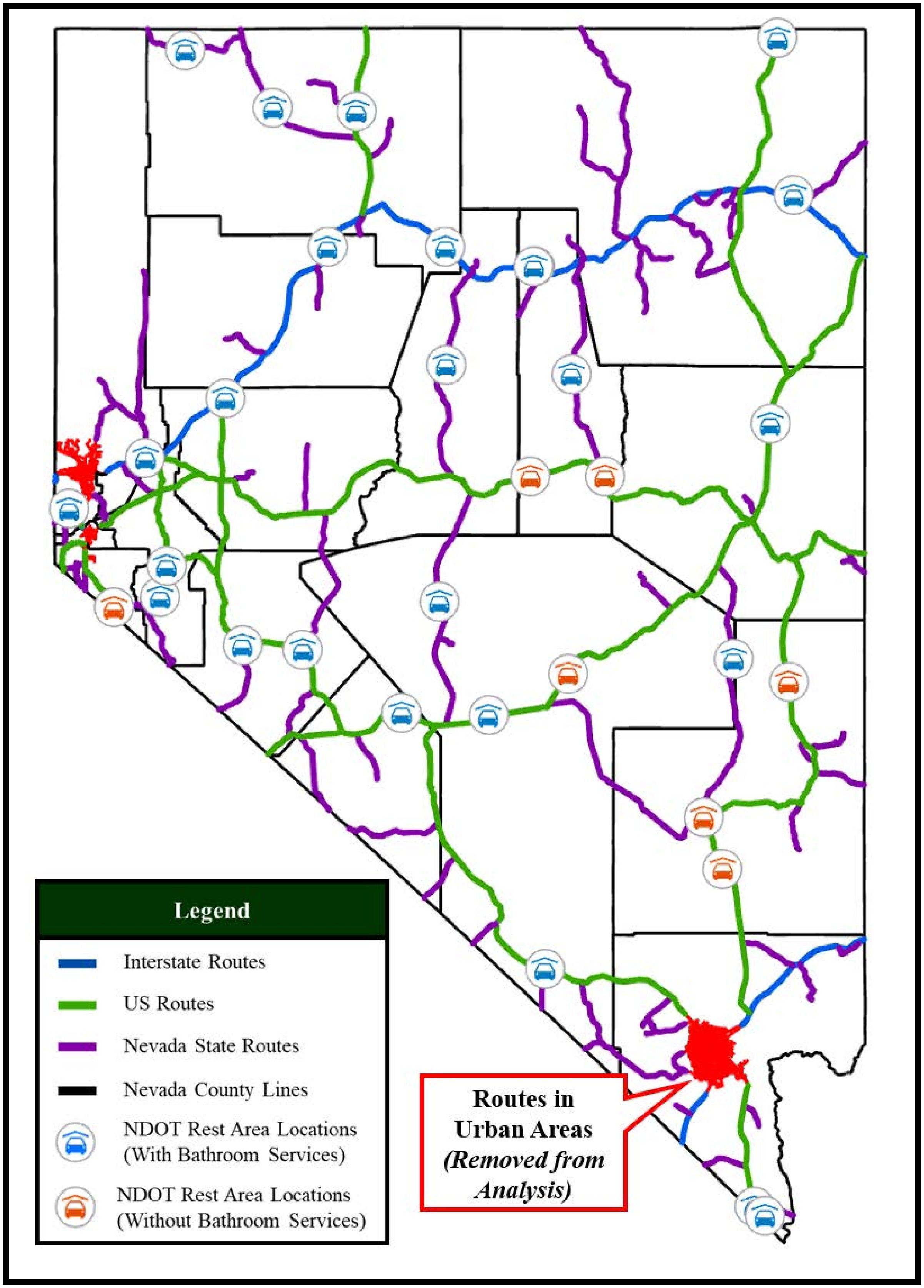



**Figure 4. Map of Study Roadways in Nevada by Route Type**

After the identification of the study routes, these data were segmented in a manner that would best facilitate subsequent analytical activities. This included disaggregating the roadway inventory data into distinct roadway segments which were as close to one-mile in length as possible while maintaining a series of additional criteria:

- The basic geometric characteristics (such as the number of lanes and median type) were homogenous.
- Segments were split at major intersections (minor intersections and driveways did not result in the segment being split).
- A minimum segment length of 0.10 miles.

The distribution by length of the 5,090 study roadway segments developed via this process is shown in **Figure 5**. The majority of study segments (approximately 70 percent) range from 0.95 to 1.05 miles in length. However, it should be noted that the enforcement of the above criteria as well as the fact that routes have non-integer length in miles results in segments which range in length from 0.10 miles to 1.11 miles.

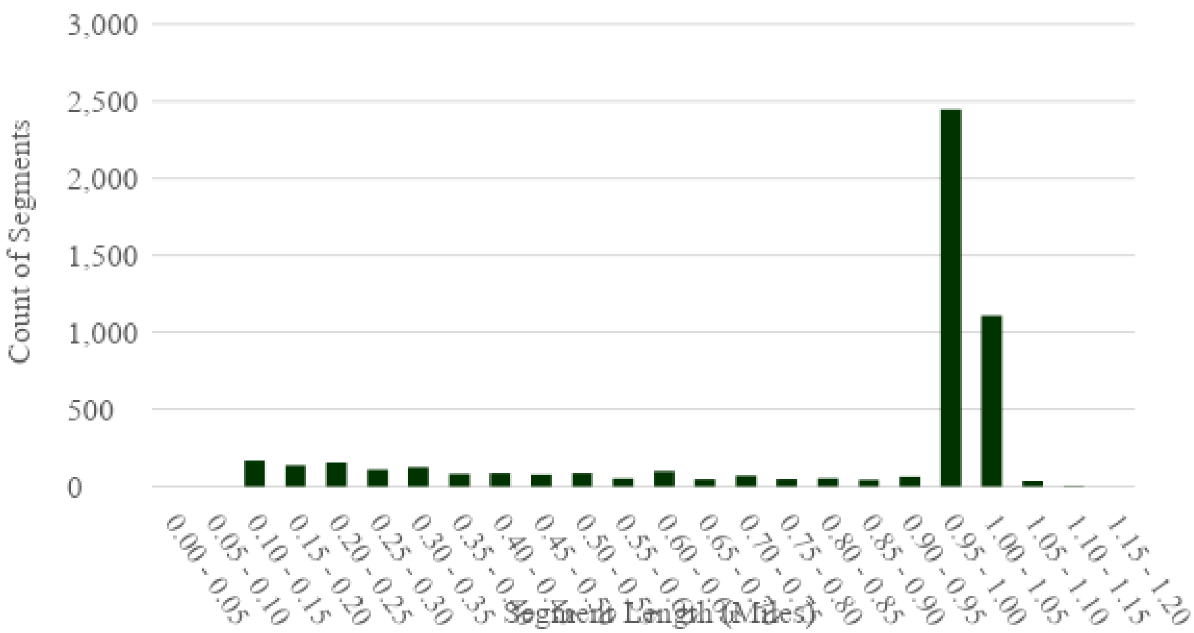



**Figure 5. Distribution of Study Segments by Length**

Each study segment was subsequently reviewed with satellite and street view imagery to determine the roadway context consistent with National Cooperative Highway Research Program Report 855: *An Expanded Functional Classification System for Highways and Streets* [*115*]. Within the context of this study, roadway segments were coded as either suburban, rural town, or rural in nature as shown in **Figure 6**. This roadway context assessment helps to characterize basic characteristics of each study segment (such as access point density or adjacent developments) which were not independently collected as a part of this evaluation. Ultimately, the roadway context data will serve to inform the safety performance analysis outlined in **Section 4.2**

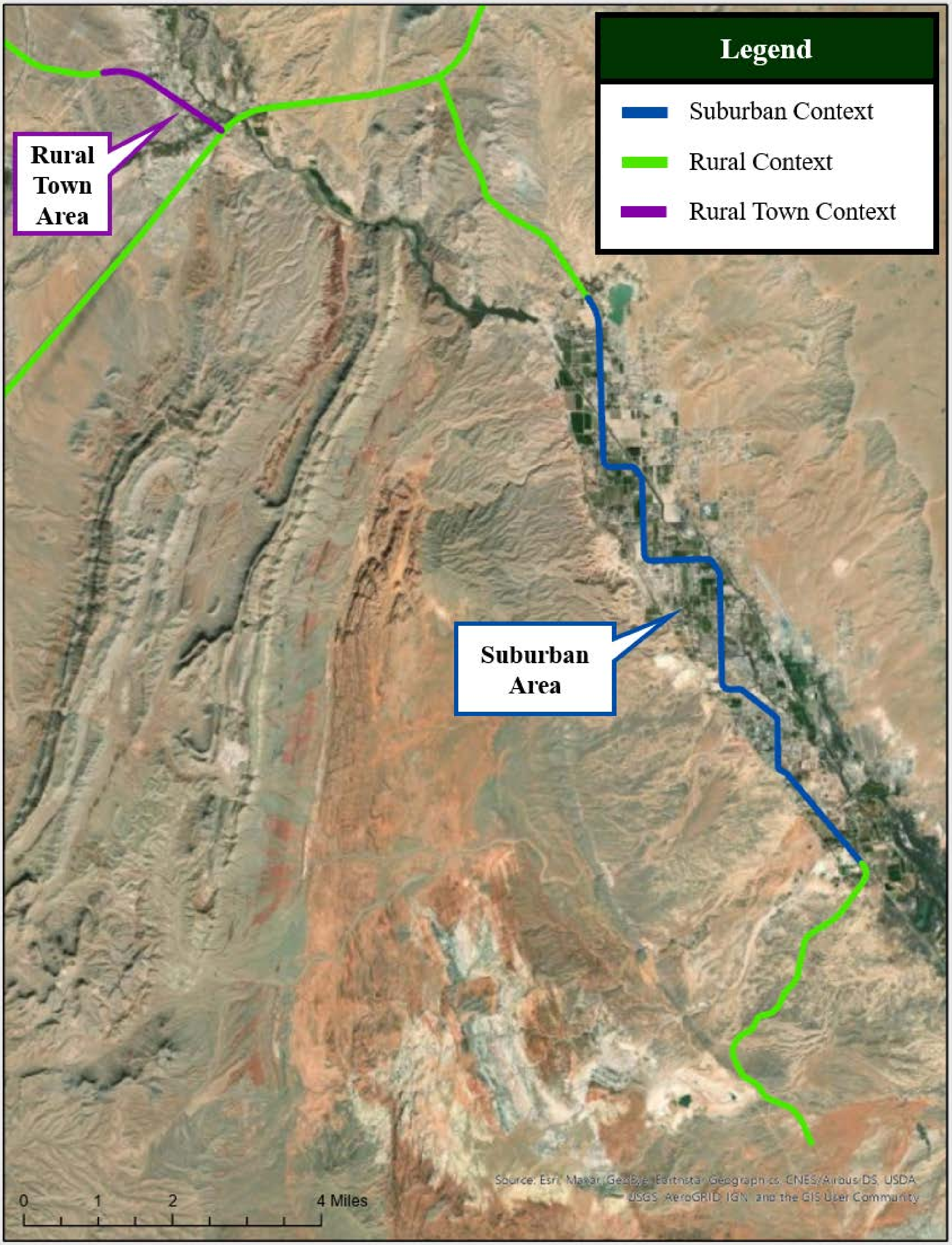



**Figure 6. Example of Roadway Context Classification Process**

Basic geometric characteristics of each roadway segment were obtained from roadway inventory data and confirmed via satellite and street view imagery, including the number of lanes and median type. The functional classification of each segment was also obtained from roadway inventory data. The 5,090 study roadway segments comprised a total of 4,23.4 miles for further evaluation, summarized by route type and roadway context in **Table 6**. It should be noted that for the purposes of this evaluation, divided highways (including both freeways and non-freeways) were analyzed as two-way facilities (i.e., each one-mile segment includes both directions of travel).

**Table 6. Study Roadway Miles by Route Type and Roadway Context**

| Number of Miles | | Roadway Context | | | |
|---|---|---|---|---|---|
| Route Type | | Rural | Rural Town | Suburba n | All |
| Interstate Routes | Six-Lane Freeway | 22.8 | 0.0 | 0.0 | **22.8** |
| | Four-Lane Freeway | 408.8 | 0.0 | 54.5 | **463.3** |
| US Routes | Four-Lane Divided Arterial | 119.9 | 2.8 | 6.1 | **128.8** |
| | Four-Lane Undivided Arterial | 31.7 | 7.9 | 27.6 | **67.3** |
| | Two-Lane Arterial | 1,521.8 | 19.3 | 11.3 | **1,552.3** |
| Nevada State Routes | Four-Lane Divided Arterial | 47.4 | 0.0 | 5.6 | **53.0** |
| | Four-Lane Undivided Arterial | 12.4 | 6.5 | 5.8 | **24.8** |
| | Four-Lane Undivided Collector | 0.0 | 0.5 | 0.5 | **1.0** |
| | Two-Lane Arterial | 432.4 | 23.7 | 25.2 | **481.3** |
| | Two-Lane Collector | 1,385.4 | 40.9 | 13.6 | **1,439.9** |
| **All Route Types** | | **3,982.6** | **101.6** | **150.3** | **4,234.4** |

The overwhelming majority of study roadway miles (or approximately 94 percent) are located within rural areas. Further, approximately 84 percent of the almost 4,000 miles of rural study segments are comprised of undivided two-lane two-way highways. This is important to recognize as it characterizes the general nature of Nevada's transportation network, where NDOT's rest area system plays an important role by providing traveler services to road users in remote undeveloped areas along primarily high-speed two-lane two-way highways.

### *3.2.1 Traffic Volume Data*

Traffic volume data were assigned to each study segment from NDOT's *TRINA* system [*116*], including both annual average daily traffic volume (AADT) as well as truck AADTs. A map of study segments by AADT is provided in **Figure 7**. The mean AADT and truck AADT of study segments by route type and roadway context are summarized in **Tables 7 and 8.** The largest traffic volumes are observed along the I-15 corridor near Las Vegas, where the six-lane freeway facility serves more than 60,000 vehicles per day. The lowest volumes are observed along rural two-lane collectors, which serve an average of approximately 576 vehicles per day. Truck AADTs range from only a limited number of trucks per day (near zero) up to 11,900 trucks per day along a portion of I-80. These traffic volume data also characterize the types of highway facilities which NDOT's rest area system helps to support, ranging from very low volume two-lane rural collectors up to interstate freeways which serve a relatively high volume of passenger cars and trucks. This range in the number of road users each facility supports drives NDOT's current model tiered model (e.g., full rest area vs. basic rest stop) for rest area development. The implementation of basic rest stops (as opposed to a full rest area) along low volume rural routes allows for the department to control costs while providing a higher number of facilities (and therefore more spatial coverage in traveler services in remote areas).

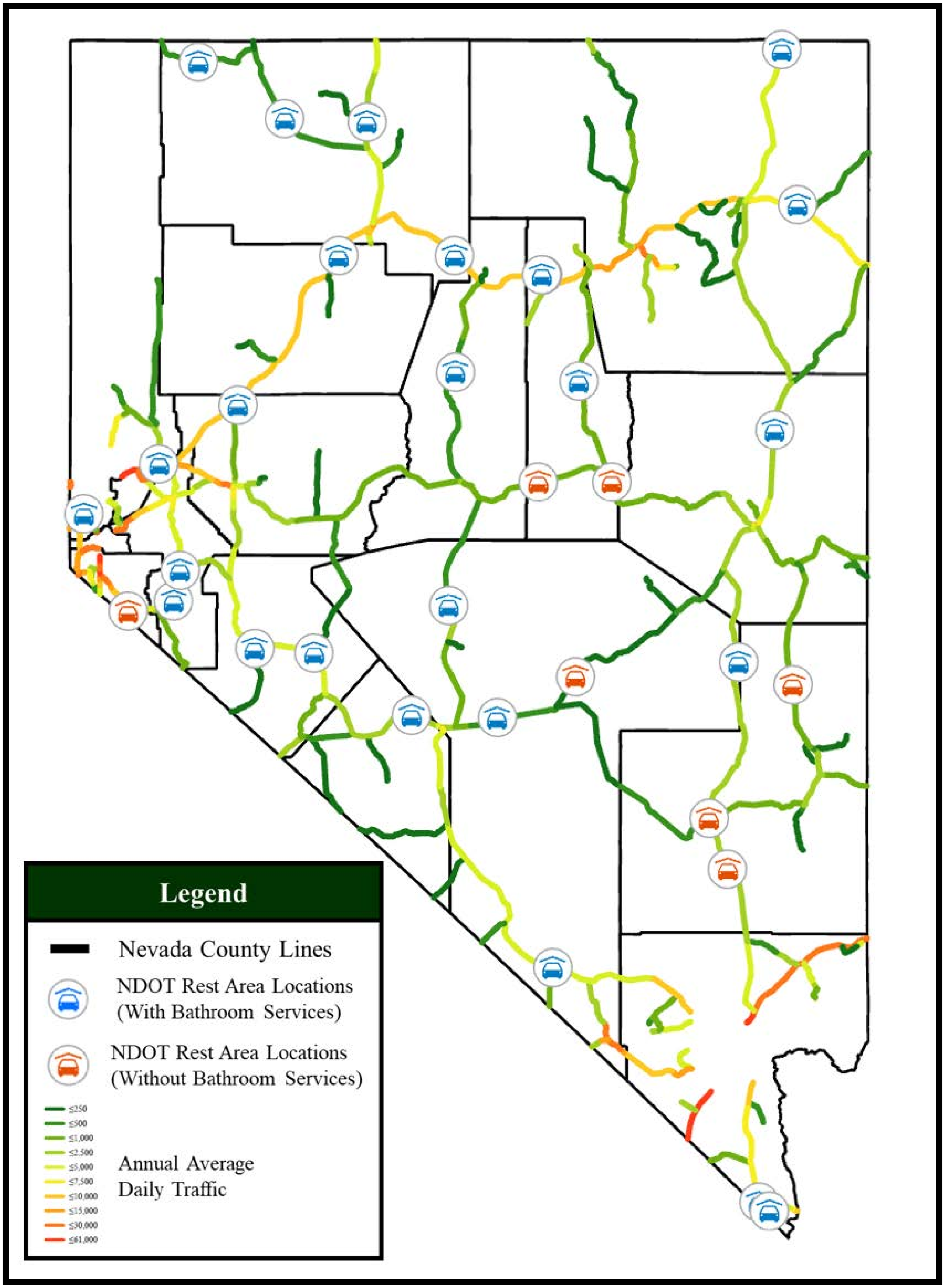



**Figure 7. Study Segments by Annual Average Daily Traffic Volume**

**Table 7. Mean Study Segment AADT by Route Type and Roadway Context**

| Mean AADT (*Vehicles per Day*) | | Roadway Context | | |
|---|---|---|---|---|
| Route Type | | Rural | Rural Town | Suburban |
| **Interstate Routes** | Six-Lane Freeway | 60,360 | na | na |
| | Four-Lane Freeway | 12,850 | na | 16,083 |
| **US Routes** | Four-Lane Divided Arterial | 9,518 | 5,800 | 19,200 |
| | Four-Lane Undivided Arterial | 9,733 | 3,971 | 16,790 |
| | Two-Lane Arterial | 1,916 | 2,898 | 6,597 |
| **Nevada State Routes** | Four-Lane Divided Arterial | 7,383 | na | 19,200 |
| | Four-Lane Undivided Arterial | 9,987 | 10,060 | 23,283 |
| | Four-Lane Undivided Collector | na | 1,750 | 3,125 |
| | Two-Lane Arterial | 2,207 | 3,178 | 14,830 |
| | Two-Lane Collector | 576 | 1,794 | 3,486 |

***Note: na = not applicable***

**Table 8. Mean Study Segment Truck AADT by Route Type and Roadway Context**

| Mean Truck AADT (*Trucks per Day*) | | Roadway Context | | |
|---|---|---|---|---|
| Route Type | | Rural | Rural Town | Suburban |
| **Interstate Routes** | Six-Lane Freeway | 8,324 | na | na |
| | Four-Lane Freeway | 3,085 | na | 3,552 |
| **US Routes** | Four-Lane Divided Arterial | 1,216 | 730 | 1,783 |
| | Four-Lane Undivided Arterial | 1,199 | 520 | 1,831 |
| | Two-Lane Arterial | 316 | 422 | 817 |
| **Nevada State Routes** | Four-Lane Divided Arterial | 714 | na | 1,783 |
| | Four-Lane Undivided Arterial | 1,512 | 1,468 | 733 |
| | Four-Lane Undivided Collector | na | ~ 0 | 388 |
| | Two-Lane Arterial | 215 | 268 | 571 |
| | Two-Lane Collector | 44 | 137 | 435 |

***Note: na = not applicable***

### *3.2.2 Traffic Volumes along Routes Adjacent to Rest Area Facilities*

Consistent with the range of traffic volumes along all study routes summarized in **Section 3.2.1**, the study segments immediately adjacent to NDOT rest area facilities also serve a broad range of traffic volumes (summarized in **Table 9**). The lowest volumes are observed adjacent to the Blue Jay Rest Stop along US-6 (250 vehicles per day) and the largest volumes are observed adjacent to the Wadsworth Westbound Rest Area along I-80 (26,700 vehicles per day). Adjacent route peak hour volumes ranged between 36 vehicles per hour to 2,588 vehicles per hour, with an AM average of 418.7 vehicles per hour and a PM average of 514.1 vehicles per hour. The percentage of trucks served by the adjacent routes ranged from only limited trucks traffic to nearly 30 percent trucks.

**Table 9. Summary of Adjacent Route Daily Traffic Volume and Percent Trucks**

| | Daily Traffic Volume (*Vehicles per Day*) | | | Percent Trucks (%) | | |
|---|---|---|---|---|---|---|
| Rest Area Type | Min | Mean | Max | Min | Mean | Max |
| **Basic Rest Stop** | 250 | 2,117 | 7,300 | ~0.0% | 9.5% | 29.4% |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Full Rest Area** | 1,600 | 7,708 | 26,700 | 11.5% | 21.4% | 29.5% |
| **Welcome Center** | 7,500 | | | 12.4% | | |

### *3.2.3 Rest Area Entering Volume Data*

NDOT also provided rest area entering volume data for a limited sample of nine facilities. It should be noted that this included the Southern Nevada Welcome Center as well as a sample of full rest area facilities and did not include any basic rest stops. These data are summarized in **Table 10**.

**Table 10. Summary of Rest Area Entering Volume Data (Limited Sample of Nine Facilities)**

| Facility (Type) | Average Hourly Entering Volume *(Veh. per Hour)* | Average Peak Hour Entering Volume *(Veh. per Hour)* | Peak Hour Period *(Time)* | Average Daily Entering Volume *(Veh. per Day)* | Average Daily Turn-In Rate *(Perc. of Mainline)* |
|---|---|---|---|---|---|
| **Wadsworth Westbound** | 11.68 | 22.63 | 12:00 PM | 280.39 | 2.1% |
| **Cosgrave** | 10.85 | 23.95 | 11:00 AM | 260.38 | 2.8% |
| **Valmy** | 9.66 | 20.99 | 11:00 AM | 231.89 | 2.8% |
| **Beowave WB** | 11.32 | 22.64 | 11:00 AM | 271.77 | 3.4% |
| **Beowave EB** | 12.24 | 23.81 | 1:00 PM | 293.72 | 3.6% |
| **Southern Nevada Welcome Center** | 14.65 | 37.56 | 11:00 AM | 351.71 | 4.7% |
| **Millers** | 5.89 | 15.89 | 12:00 PM | 141.34 | 5.9% |
| **Amargosa** | 6.92 | 15.63 | 1:00 PM | 166.13 | 5.4% |
| **Luning** | 6.77 | 12.95 | 1:00 PM | 164.46 | 5.0% |

Average hourly entering volumes ranged between 5.89 vehicles per hour at Millers Rest Area up to 14.65 at the Southern Nevada Welcome Center. Peak hour volumes ranged between 12.95 at the Luning Rest Area up to 37.56 at the Southern Nevada Welcome Center. The peak periods were between 11:00 AM and 2:00 PM at all nine rest areas. Average daily entering volumes ranged between 141.34 vehicles per day at Millers Rest Area up to 351.71 vehicles per day at the Southern Nevada Welcome Center. The average daily turn-in rate (or the percentage of adjacent mainline traffic) ranged between 2.1 percent at Wadsworth Westbound (which serves the highest adjacent route volume) to 5.9 percent at Millers Rest Area. These data will be utilized as a part of the economic analysis presented in **Section 5.4**.

### *3.2.4 Horizontal Curve Data*

The presence of horizontal curves along study road segments was expected to impact the potential risk for fatigue-related traffic crashes to occur. Further, the presence of deficient horizontal curves (or those with radii which are less than the minimum design radii prescribed by the AASHTO *Green Book* [*117*]) along study roadway segments was expected to potentially result an even greater risk for fatigue-related traffic crashes. Therefore, it was necessary to collect a series of data to identify not only the location and radii of horizontal curves along study segments, but also whether or not the curve was deficient per AASHTO standards [*117*] for an assumed rate of superelevation and design speed.

Initially, posted speed limit data were collected via the FHWA's HPMS data and were manually reviewed via either Google Street view imagery [*118*] where available or NDOT's *Speed Limit Map* [*119*]. Horizontal curve data for the study segments were estimated via the Road Curvature Analysis Tool (ROCA) in ArcGIS. The ROCA tool was developed by Czech researchers [*120*] to identify tangent vs. curved roadway segments as well as an estimate of the horizonal curve radius. The tool was used to identify horizontal curves along study road segments which were less than 2,500 feet in radius. The 2,500-foot threshold was selected from the AASHTO *Green Book* [*117*] based on the minimum radii for a horizontal curve along a roadway with a design speed of 75 miles per hour (the greatest posted speed limit along study routes during the analysis period – it is recognized that I-80 has been increased to 80 miles per hour in recent years) assuming a maximum superelevation rate of 6 percent (identified from guidance in Nevada DOT's *Road Design Guide* [*121*]). An example of the curve identification process is shown in **Figure 8**.

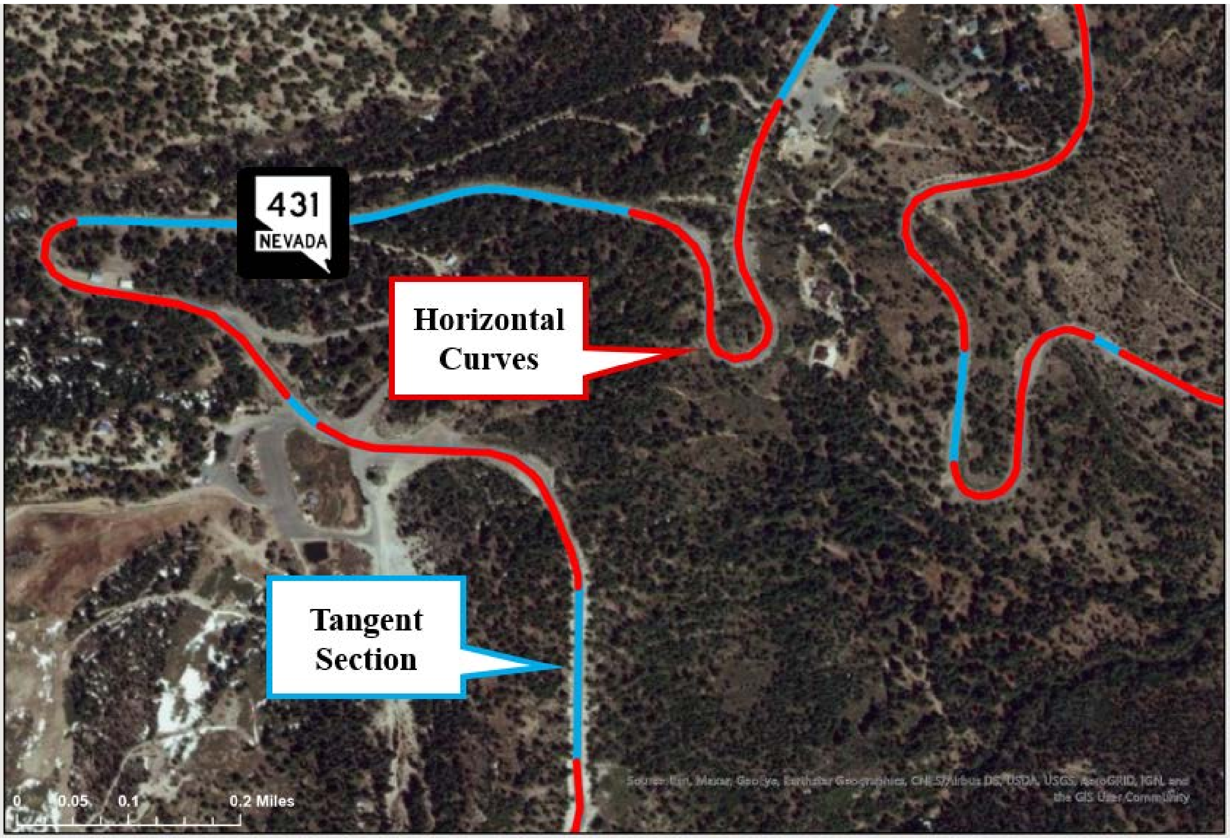



**Figure 8. Example of Horizonal Curve Data Collection Process**

A subset of deficient curves was identified from these data by comparing the posted speed limit along each segment with Table 3-9 from the *Green Book* [*117*] to estimate a deficient curve radius threshold. Ultimately, these data were merged with the study segments to estimate the percent of each segment by length which has horizontal curvature. **Table 11** summarizes these data for all curves (less than 2,500 feet) and **Table 12** for deficient curves (a subset which were less than the threshold value determined based upon the posted speed limit). Intuitively, horizontal curves tended to be present more often along state routes and least along interstate freeway routes. These data will ultimately be used to inform the safety performance analysis outlined in **Section 4.2**

**Table 11. Percent of Study Segment Length with Horizontal Curves Present**

| Percent Length with Horizonta Curvature (< 2,500' Radius) | | Roadway Context | | |
|---|---|---|---|---|
| Route Type | | Rural | Rural Town | Suburban |
| Interstate | Six-Lane Freeway | 0.0% | na | na |
| | Four-Lane Freeway | 1.1% | na | 0.8% |
| US Route | Four-Lane Divided Arterial | 4.6% | 4.1% | 2.4% |
| | Four-Lane Undivided Arterial | 17.0% | 8.9% | 2.7% |
| | Two-Lane Arterial | 2.7% | 12.5% | 7.4% |
| Nevada State Route | Four-Lane Divided Arterial | 5.2% | na | 36.8% |
| | Four-Lane Undivided Arterial | 16.7% | 1.9% | 11.7% |
| | Four-Lane Undivided Collector | na | 0.0% | 0.0% |
| | Two-Lane Arterial | 10.4% | 8.0% | 9.8% |
| | Two-Lane Collector | 7.3% | 10.7% | 17.7% |

***Note: na = not applicable***

**Table 12. Percent of Study Segment Length with Deficient Horizontal Curves Present**

| Percent Length with Deficient Horizontal Curves | | Roadway Context | | |
|---|---|---|---|---|
| Route Type | | Rural | Rural Town | Suburban |
| Interstate | Six-Lane Freeway | 0.0% | na | na |
| | Four-Lane Freeway | 1.0% | na | 0.1% |
| US Route | Four-Lane Divided Arterial | 1.8% | 0.0% | 0.7% |
| | Four-Lane Undivided Arterial | 3.3% | 0.0% | 0.0% |
| | Two-Lane Arterial | 2.0% | 2.0% | 0.0% |
| Nevada State Route | Four-Lane Divided Arterial | 0.3% | na | 0.0% |
| | Four-Lane Undivided Arterial | 15.1% | 0.0% | 0.0% |
| | Four-Lane Undivided Collector | na | 0.0% | 0.0% |
| | Two-Lane Arterial | 5.1% | 1.1% | 0.2% |
| | Two-Lane Collector | 2.9% | 0.7% | 2.6% |

***Note: na = not applicable***

### 3.3 Private Comparable Facility Data

Given the objective to provide recommendations for the location of NDOT rest area facilities, a core component of this evaluation was to identify the presence and type of private comparable facilities along study routes. These private facilities help to provide spatial coverage of core traveler services in conjunction with NDOT's rest area system. For the purposes of this evaluation, a series of potential traveler services were assumed to be provided based upon the type of private comparable facility (i.e., truck stop, fast food restaurant, hotel, etc.). These services include passenger car parking, truck parking, space to walk, picnic areas or scenic views, bathroom, prepared meals, snacks/drinks, fuel, overnight stays, and traveler information. It is important to recognize that many of these services (such as prepared meals or fuel) are not provided by NDOT rest areas and data specific to these services are used to provide context as to the various traveler services which are spatially available along Nevada's highway network.

Private comparable facilities which were located within one-mile of interchanges (for freeways) or a one-mile buffer around the road segment (for non-freeways) were identified, including the name, type, and assumed road user services offered by each facility. It should be noted that comparable facilities located in adjacent states near the border of study routes (including 50 miles for freeways and 10 miles for non-freeways) were also collected. This included four out-of-state rest areas. Finally, the number of truck parking spaces was also estimated via satellite and street view imagery. **Table 13** summarizes the number of NDOT rest area facilities and private comparable facilities which provide each traveler service. A map of all rest area facilities (including out-of-state rest areas) and all comparable facilities is shown in **Figure 9**.

**Table 13. Road User Services Provided by NDOT Rest Areas and Comparable Private Facilities**

| Road User Service | Description of Traveler Service | NDOT Rest Areas | Comparable Facilities* |
|---|---|---|---|
| Passenger Car Parking | Space provided for passenger cars to park (all rest area and comparable facility locations) | 33 | 2,313 |
| Truck Parking | Space provided for trucks to park | 27 | 88 |
| Space to Walk or Take a Break | Green space provided to get out of the vehicle, walk, relive pets, etc. | 32 | 147 |
| Picnic Areas or Scenic Views | Picnic area or scenic view is included within the facility | 32 | 135 |
| Bathrooms | Bathroom structure is included within the facility (both vault and flushing toilets) | 26 | 2,082 |
| Prepared Meals | Prepared meals are available on site (fast food, restaurant, etc.) | 0 | 1,093 |
| Snacks or Drinks | Snacks and drinks (such as chips, soda, water, etc.) are available on site | 6 | 2,060 |
| Fuel | Fuel is available on site (typically gas stations) | 0 | 297 |
| Overnight Stays | The public can stay overnight on site – does not including truck parking | 0 | 554 |
| Traveler Information | Traveler information is available on site (in-person, maps, etc.) | 8 | 13 |

***Includes out-of-state rest areas***

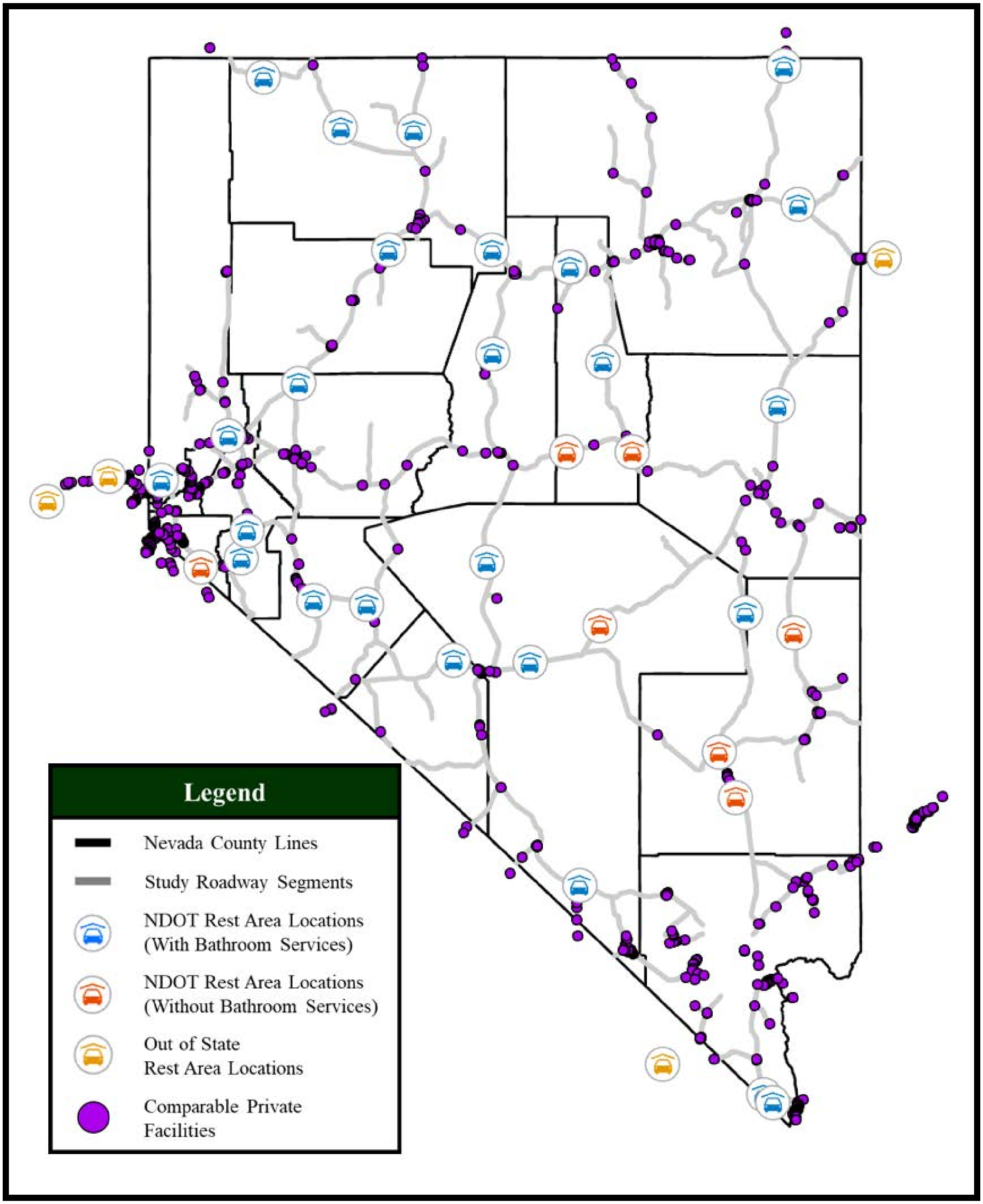



**Figure 9. Map of Study Roadways, Rest Area Facilities, and Comparable Private Facilities**

### 3.4 Traffic Crash Data

Traffic crash data for the study roadway segments were collected from data maintained by the Nevada DOT for the three-year period between 2015 and 2017 [*122*]. These data were associated with study roadway segments in ArcGIS via a spatial join as well as manual review in order to ensure the crash records and study roadway segments were correctly linked. This process resulted in the selection of 11,486 crash records for further analysis out of the 146,751 crashes which occurred statewide during this period.

A subset of these crashes was selected to identify potential fatigue-related "target" crashes based upon criteria developed within prior rest area safety performance research conducted in Michigan [*50*]. While the fields available within Nevada DOT crash data varies from Michigan data, similar criteria were utilized:

- Traffic crashes where one of the involved drivers was noted by the responding officer to have been fatigued or fell asleep but had not been under the influence of alcohol and/or drugs or fallen ill (777 crash records) OR
- Single-vehicle traffic crashes occurring at night (between 10:00 PM and 6:00 AM) which did not involve the driver turning at an intersection and the driver had not been under the influence of alcohol and/or drugs or fallen ill (1,554) OR
- Traffic crashes occurring at night (between 10:00 PM and 6:00 AM) where one of the first events for an involved vehicle included running off the road or striking a fixed object (1,100 crash records)

After this screening was conducted, all crashes which were coded as involving an animal were removed from the analysis. It should be noted that there was some overlap between the above criteria and ultimately a total of 1,773 potentially fatigue-related crashes were identified. This subset of fatigue-related "target" crashes has been shown in prior work [*50*] to be impacted by the presence of a roadside rest area. A summary of the traffic crash data occurring along study segments is provided in **Table 14**, including the number of fatal, fatal and injury (FI) and property damage only (PDO) crashes. An example of the data collection process is shown in **Figure 10**.

**Table 14. Traffic Crashes Occurring along Study Roadway Segments (2015-2017)**

| Route Type | All Crashes | | | | Target Crashes | | | |
|---|---|---|---|---|---|---|---|---|
| | Fatal | FI | PDO | Total | Fatal | FI | PDO | Total |
| Interstate | 62 | 1,071 | 2,450 | 3,521 | 18 | 309 | 440 | 749 |
| US Route | 93 | 1,359 | 2,890 | 4,249 | 21 | 243 | 319 | 562 |
| State Route | 69 | 1,315 | 2,401 | 3,716 | 17 | 208 | 254 | 462 |
| **All Routes** | **224** | **3,745** | **7,741** | **11,486** | **56** | **760** | **1,013** | **1,773** |

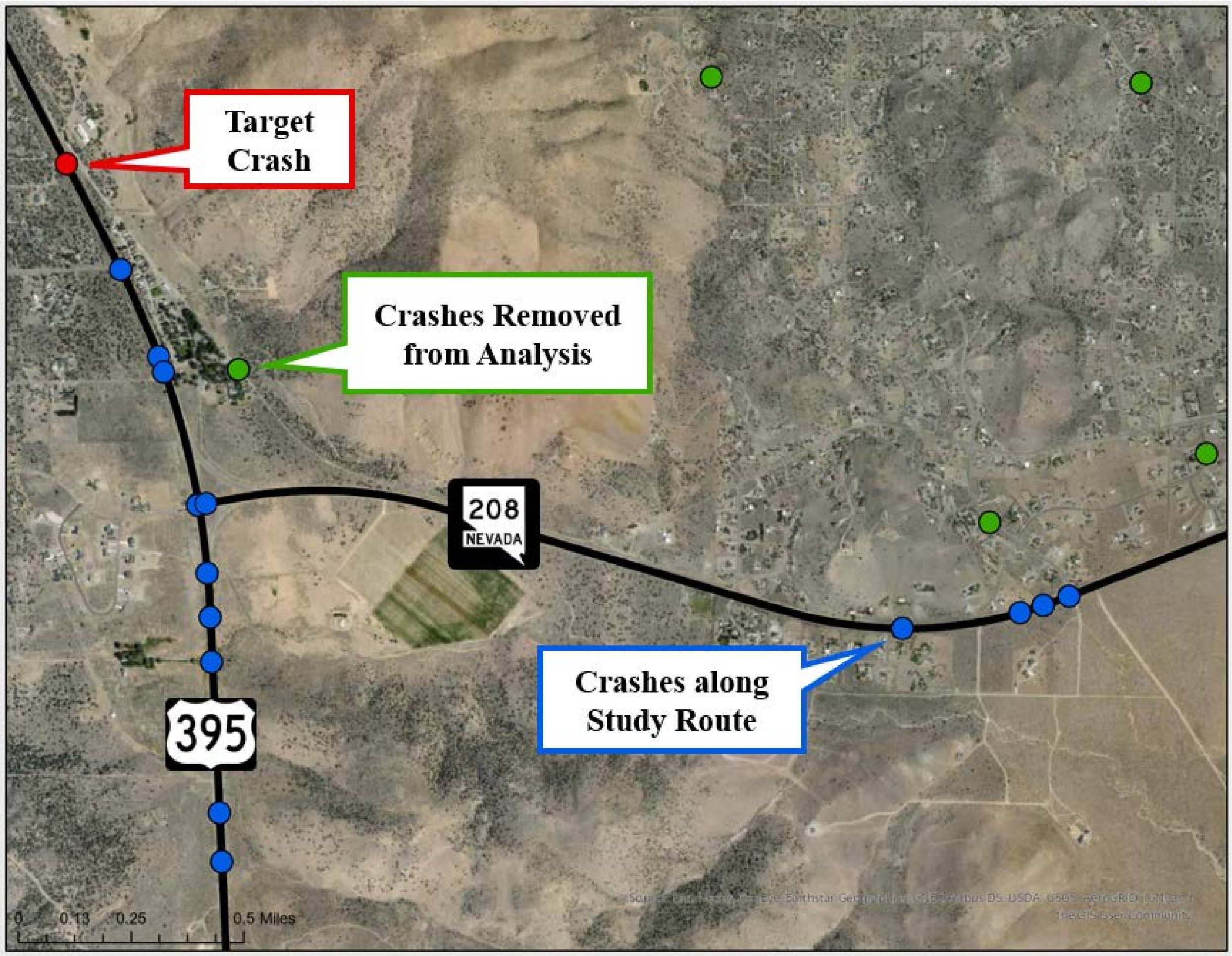


**Figure 10. Example of Traffic Crash Data Collection Process**

It is important to recognize that the subset of fatigue-related target crashes tend to be more severe in nature than all crashes occurring along the study routes. While the 1,773 target crashes represented approximately 15 percent of all crashes occurring along the study road segments, these crashes represented more than 25 percent of fatal crashes and more than 20 percent of fatal and injury crashes. Approximately 2.0 percent of all crashes occurring along study routes resulted in at least one fatality, while 3.2 percent of fatigue-related crashes resulted in at least one fatality. This suggests that investments which can help to reduce the risk for such fatigue-related traffic crashes to occur along Nevada's roadways specifically targets a subgroup of crashes which is overrepresented with respect to severe crash outcomes. This is consistent with the safe system approach adopted by the United States Department of Transportation (USDOT) within the *National Roadway Safety Strategy* [*123*] which prioritizes treatments which eliminate crashes resulting in fatalities and serious injuries. This highlights the importance of NDOT's rest area program which helps to provide critical spatial coverage of traveler services.

The average number of target crashes per mile occurring along study roadway segments in shown in **Table 15** by route type and roadway context. Additionally, the average crash rate per one million vehicle miles traveled is shown in **Table 16** by route type and roadway context.

**Table 15. Average Target Crashes per Mile by Route Type and Roadway Context**

| Average Target Crashes per Mile | | Roadway Context | | |
|---|---|---|---|---|
| Route Type | | Rural | Rural Town | Suburban |
| Interstate | Six-Lane Freeway | 1.07 | na | na |
| | Four-Lane Freeway | 0.48 | na | 0.50 |
| US Route | Four-Lane Divided Arterial | 0.37 | 0.12 | 0.66 |
| | Four-Lane Undivided Arterial | 0.42 | 0.13 | 0.52 |
| | Two-Lane Arterial | 0.07 | 0.19 | 0.41 |
| Nevada State Route | Four-Lane Divided Arterial | 0.36 | na | 0.48 |
| | Four-Lane Undivided Arterial | 0.35 | 0.31 | 0.51 |
| | Four-Lane Undivided Collector | na | 0.00 | 0.00 |
| | Two-Lane Arterial | 0.13 | 0.15 | 0.38 |
| | Two-Lane Collector | 0.03 | 0.15 | 0.07 |

***Note: na = not applicable***

**Table 16. Average Target Crash Rate per 1M Vehicle Miles Traveled by Route Type and Roadway Context**

| Average Target Crash Rate per 1M VMT | | Roadway Context | | |
|---|---|---|---|---|
| Route Type | | Rural | Rural Town | Suburban |
| Interstate | Six-Lane Freeway | 4.8 | na | na |
| | Four-Lane Freeway | 10.4 | na | 8.8 |
| US Route | Four-Lane Divided Arterial | 10.7 | 5.8 | 12.0 |
| | Four-Lane Undivided Arterial | 11.5 | 9.1 | 8.5 |
| | Two-Lane Arterial | 10.0 | 17.8 | 17.2 |
| Nevada State Route | Four-Lane Divided Arterial | 13.3 | na | 6.8 |
| | Four-Lane Undivided Arterial | 9.7 | 7.8 | 6.1 |
| | Four-Lane Undivided Collector | na | 0.0 | 0.0 |
| | Two-Lane Arterial | 17.4 | 10.4 | 7.1 |
| | Two-Lane Collector | 16.6 | 22.3 | 7.2 |

***Note: na = not applicable***

While the number of target crashes per mile tend to be higher along freeway or multilane non-freeway facilities, these facilities also tended to have the smallest crash rates once traffic volumes were considered. Study segments that were either rural in nature or two-lane two-way tended to experience the highest crash rates among study segments. These aggregated average values provide insight into the risks for fatigue-related traffic crashes along Nevada's non-urban roadway network. However, it is important to recognize that the use of such traditional analysis methods alone have several limitations as identified in prior work [*124*]. This is specifically important given that many of the rural two-lane two-way routes in Nevada serve very low traffic volumes, which can result in the calculation of relatively large crash rates despite only a limited number of target crashes occurring along study segments. Therefore, modern analytical methods to evaluate fatigue-related crash risk along study routes consistent with the AASHTO *Highway Safety Manual* (HSM) [*124*] were employed and outlined in **Section 4.2**.

## 3.5 Distance to Nearest NDOT Rest Area or Private Comparable Facilities

A critical concept for both the data-driven safety performance evaluation (**Section 4.2**) as well as the identification of areas with unmet needs (**Section 4.3**) is the proximity to either a roadside rest area or a private comparable facility at regular intervals along study routes. As discussed in **Section 3.2**, the process to disaggregate the roadway inventory data into 5,090 distinct roadway segments as close to one-mile in length as possible resulted in a dataset which is well-suited to this type of analysis. In order to quantify proximity to facilities which provide traveler services, the distance from the center of each study segment to the nearest rest area facility and private comparable facility was calculated using the *Network Analyst Toolbox* in ArcGIS.

### *3.5.1 Distance to Nearest Rest Area Facilities*

Consistent with prior research [*50*], rest areas were assumed to impact safety performance for a distance of 20-miles. Therefore, the distance to a rest area facility was limited to a maximum of 20 miles (or segments which had a distance to a rest area greater than 20 miles were coded as 20.0 in the dataset). Two iterations of this process were completed – first for all 33 NDOT rest areas and again with only the 26 rest areas which provide bathroom services. **Figure 11** shows the distribution of distance to any rest area and the distance to a rest area with bathroom services for the 5,090 study roadway segments. A map of the rest area spatial analysis process is shown in **Figure 12**. As can be observed from **Figure 11**, the vast majority of study segments are located 20 miles or more from a roadside rest area. This is largely driven by the fact that NDOT maintains 33 facilities to cover more than 4,000 miles of non-urban highway network across the state.

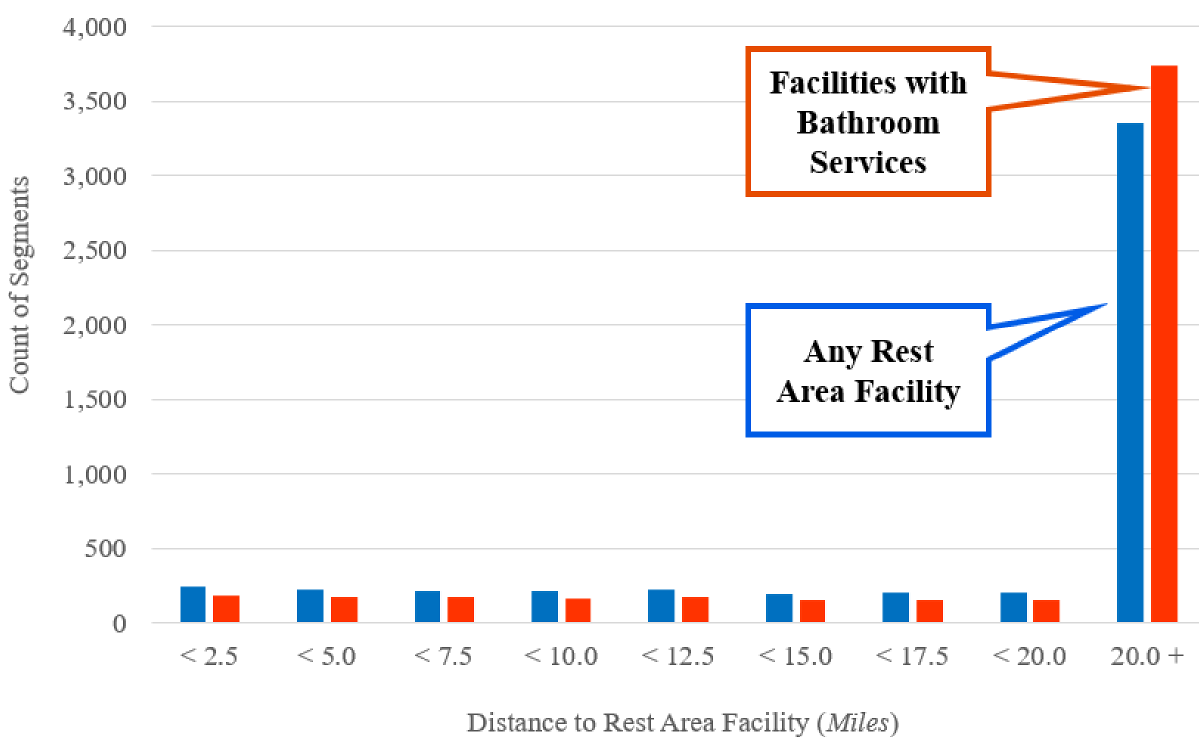



**Figure 11. Distribution of Distance from Each Segment to Nearest Rest Area Facility**

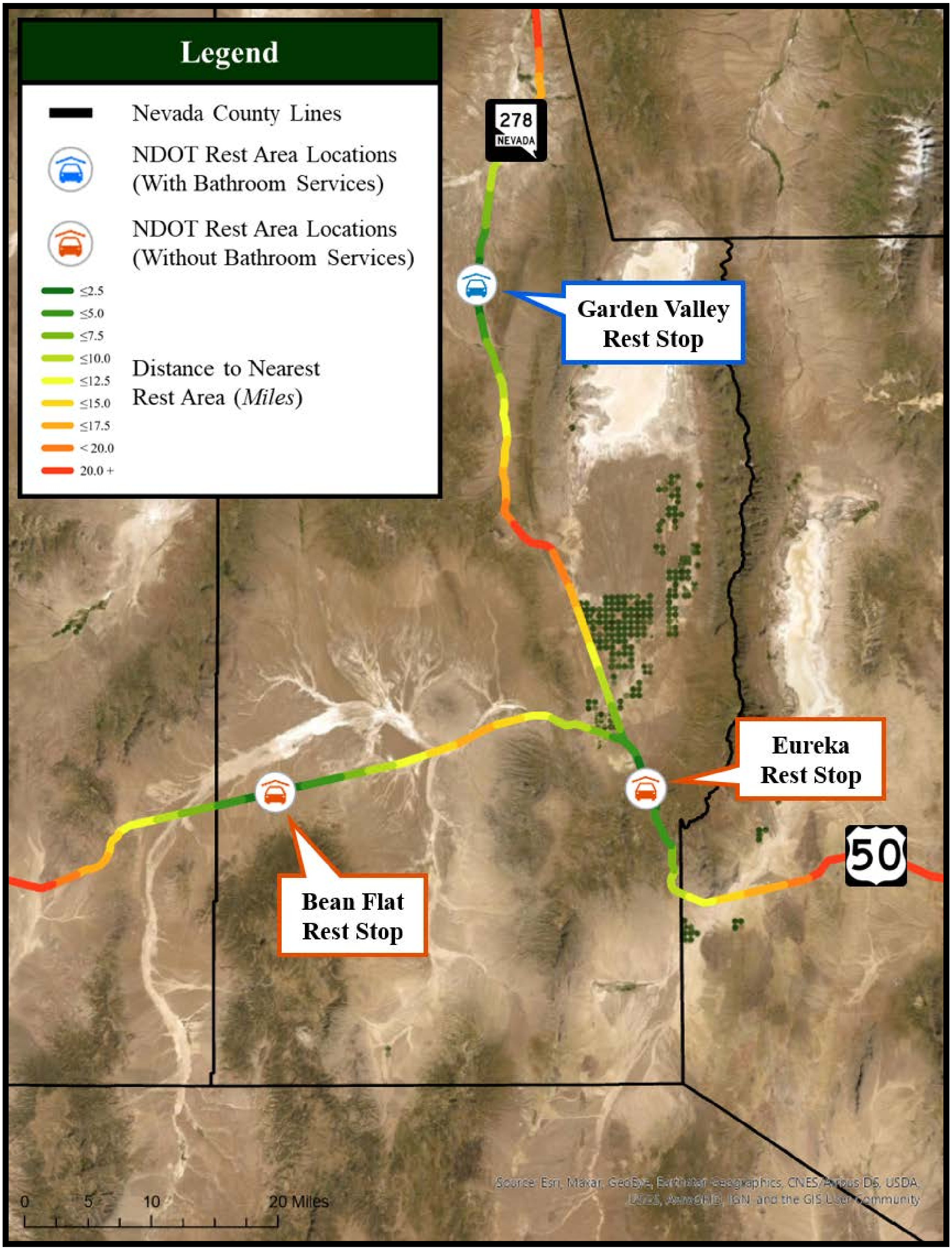



**Figure 12. Example of Approximate Distance to Nearest Rest Area from Study Segments**

### *3.5.2 Distance to Any Traveler Service Facility*

A similar analysis was also completed to estimate (1) the distance to any facility (rest area or private) which at least provides public parking, and (2) the distance to any facility (rest area or private) which at least provides bathroom services. However, unlike the rest area proximity analysis, this distance was not limited to 20-miles. This analysis allows for an estimation of the approximate distance to the nearest traveler service facility at any point along the study highway network. The average distance to the nearest facility with public parking by route type and roadway context is summarized in **Table 17**. The average distance to the nearest facility with public bathrooms by route type and roadway context is summarized in **Table 18**.

**Table 17. Average Distance to Nearest Facility with Public Parking from Study Segments**

| **Average Distance to Nearest Parking (*Miles*)** | | **Roadway Context** | | |
|---|---|---|---|---|
| **Route Type** | | **Rural** | **Rural Town** | **Suburban** |
| **Interstate** | Six-Lane Freeway | 3.8 | na | na |
| | Four-Lane Freeway | 5.2 | na | 1.0 |
| **US Route** | Four-Lane Divided Arterial | 6.5 | 2.8 | 1.8 |
| | Four-Lane Undivided Arterial | 1.7 | 0.9 | 0.4 |
| | Two-Lane Arterial | 8.3 | 0.3 | 0.3 |
| **Nevada State Route** | Four-Lane Divided Arterial | 6.3 | na | 1.8 |
| | Four-Lane Undivided Arterial | 2.9 | 0.9 | 0.1 |
| | Four-Lane Undivided Collector | na | 0.0 | 0.0 |
| | Two-Lane Arterial | 8.1 | 0.5 | 0.8 |
| | Two-Lane Collector | 10.1 | 2.4 | 1.4 |

**Table 18. Average Distance to Nearest Facility with Public Bathroom from Study Segments**

| **Average Distance to Nearest Bathroom (*Miles*)** | | **Roadway Context** | | |
|---|---|---|---|---|
| **Route Type** | | **Rural** | **Rural Town** | **Suburban** |
| **Interstate** | Six-Lane Freeway | 3.8 | na | na |
| | Four-Lane Freeway | 6.3 | na | 1.0 |
| **US Route** | Four-Lane Divided Arterial | 7.5 | 2.8 | 1.8 |
| | Four-Lane Undivided Arterial | 2.1 | 0.9 | 0.4 |
| | Two-Lane Arterial | 14.6 | 0.5 | 0.3 |
| **Nevada State Route** | Four-Lane Divided Arterial | 7.5 | na | 1.8 |
| | Four-Lane Undivided Arterial | 3.0 | 0.9 | 0.1 |
| | Four-Lane Undivided Collector | na | 0.0 | 0.0 |
| | Two-Lane Arterial | 9.3 | 1.0 | 0.9 |
| | Two-Lane Collector | 11.9 | 2.7 | 1.4 |

Intuitively, rural highway segments tend to have the largest distances to the nearest facility with traveler services – particularly two-lane two-way roadways. Consistent with the nature of rural town and suburban areas, roadway segments located within those contextual areas tended to have relatively small distances to the nearest facility. The maximum distance to any facility with public parking was approximately 54.6 miles, and the maximum distance to any facility with bathroom service was approximately 63.7 miles. It is important to recognize that these values do not represent the total "gap" in services which extend in either travel direction.

# 4.0 IDENTIFICATION OF AREAS WITH UNMET NEEDS

Given the data resources outlined in **Section 3.0**, areas with unmet traveler service needs along Nevada's non-urban highway network were identified. These areas were used to inform the recommendations for NDOT's rest area system, as potential modifications to the system should attempt to address existing gaps in traveler services. The process to identify the list of areas with unmet traveler service needs is shown in **Figure 13**. The number of daily road users (obtained from the traffic volume data outlined in **Section 3.2.1**), the availability of existing traveler services (**Section 4.1**), as well as the current safety risk for fatigue-related traffic crashes (**Section 4.2**) were reviewed to identify areas which could benefit most from the presence of new or upgraded roadside rest areas. A final list of areas with unmet traveler service needs is provided in **Section 4.3**.

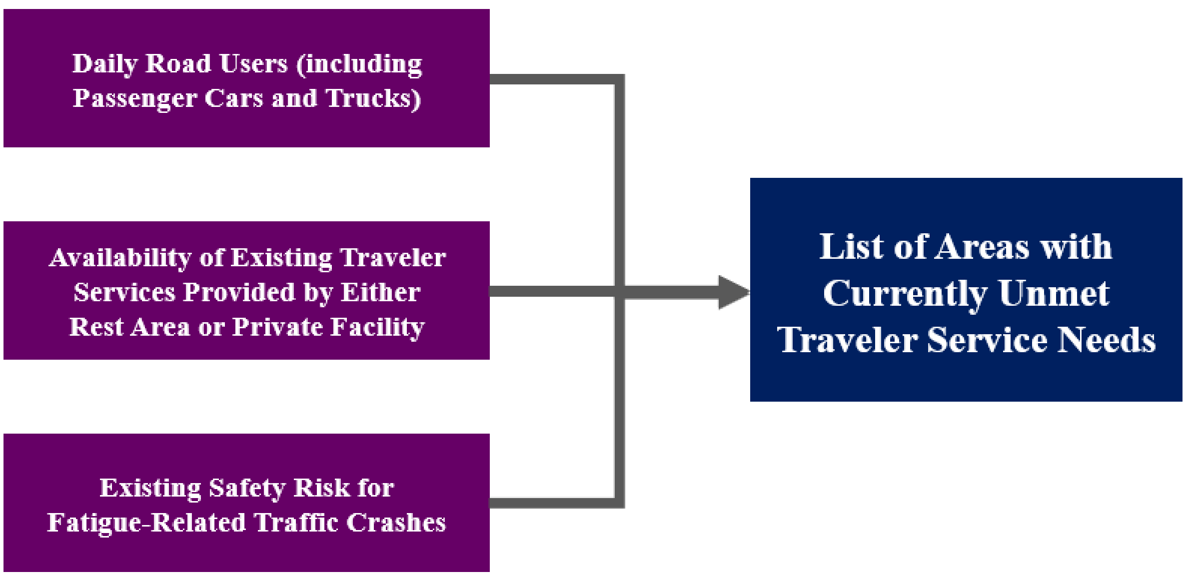



**Figure 13. Flowchart of Process to Identify Areas with Unmet Traveler Service Needs**

## 4.1 Identification Areas with Existing Concentrations of Traveler Services

A series of heat maps specific to concentrations of selected road user services (consistent with **Table 13**) were developed using the kernel density tool in ArcGIS. While the map for any service is provided in **Figure 14**, a copy of each map is included in **Appendices A-1 through A-6**. A search radius of approximately 20 miles was specified to calculate the density of each road user service. The heat maps are scaled such that lightly shaded purple areas represent a relatively low concentration of an existing service, darkly shaded areas represent a relatively high concentration of an existing service, and no color represents little to no concentration of an existing service. NDOT's rest area system is shown (including which facilities provide bathroom services) in addition to the four out-of-state rest areas located near the state border. Comparable facilities are shown via purple circles with a black border. The study highway network is shown in grey.

Each of these maps were reviewed to identify gaps in existing traveler services along study routes. The inspection of **Figure 14** demonstrates that a considerable portion of Nevada's rural transportation network is located outside of areas where there is an existing concentration of traveler services. However, **Figure 14** also demonstrates the potential value of NDOT's rest area system – many facilities are located along corridors which are outside an area with a concentration of traveler services. This underscores the important role NDOT rest areas play in supplementing private comparable facilities by providing spatial coverage of traveler services along routes in remote rural areas.

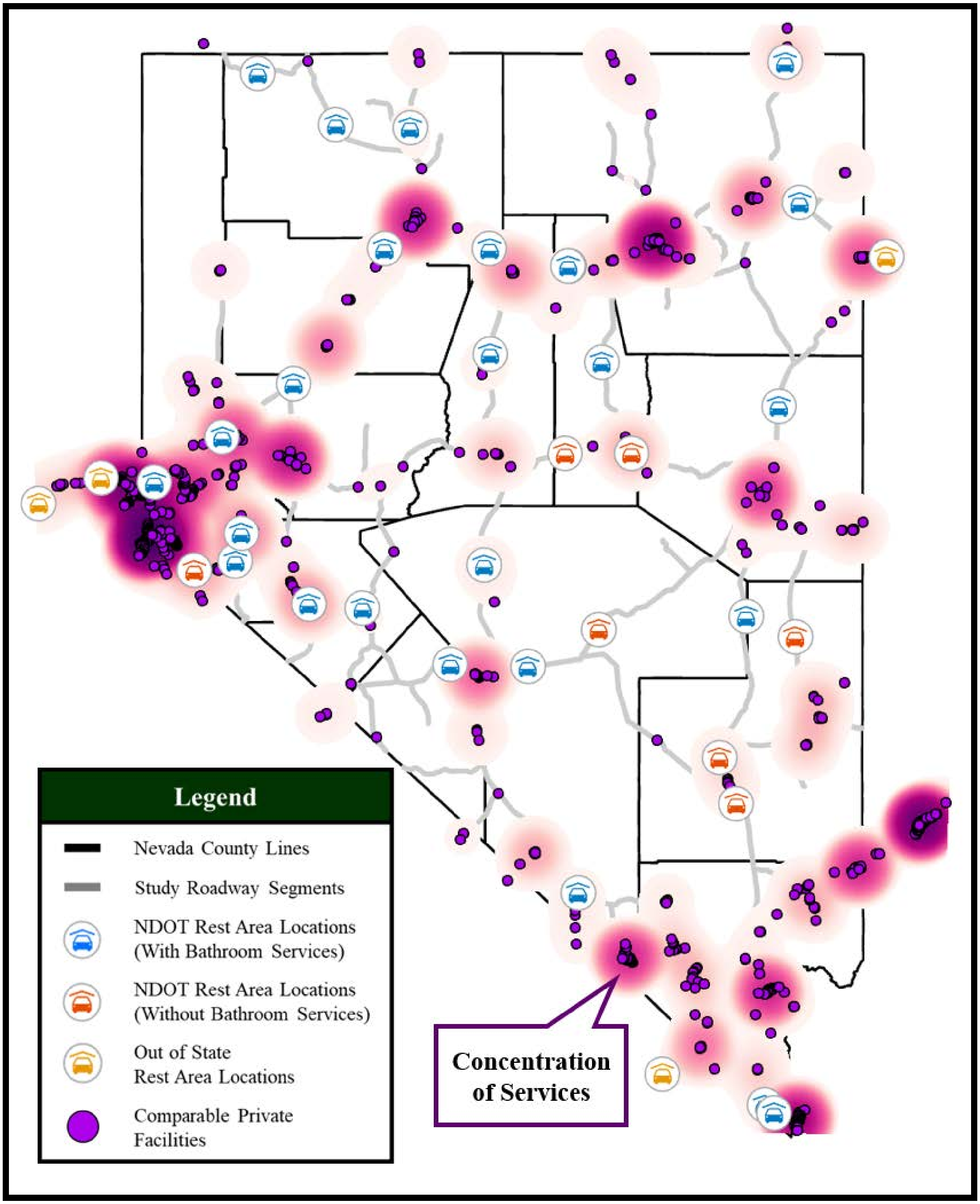



**Figure 14. Heat Map of Existing Concentration of Traveler Services**

## 4.2 Estimation of Fatigue-Related Target Crash Risk along Study Routes

A safety performance analysis of the study highway network was conducted using the data outlined in **Section 3.0**. These findings were used not only to inform the identification of areas with unmet traveler service needs, but also to determine the impact NDOT rest areas have on fatigue-related traffic crash frequency (used as a part of the economic analysis presented in **Section 5.4**).

### *4.2.1 Analysis Methods*

The empirical Bayes (EB) method outlined in the AASHTO HSM [*124*] was employed to estimate the long-term average safety performance expected along each study segment. This process is outlined in **Figure 15.**

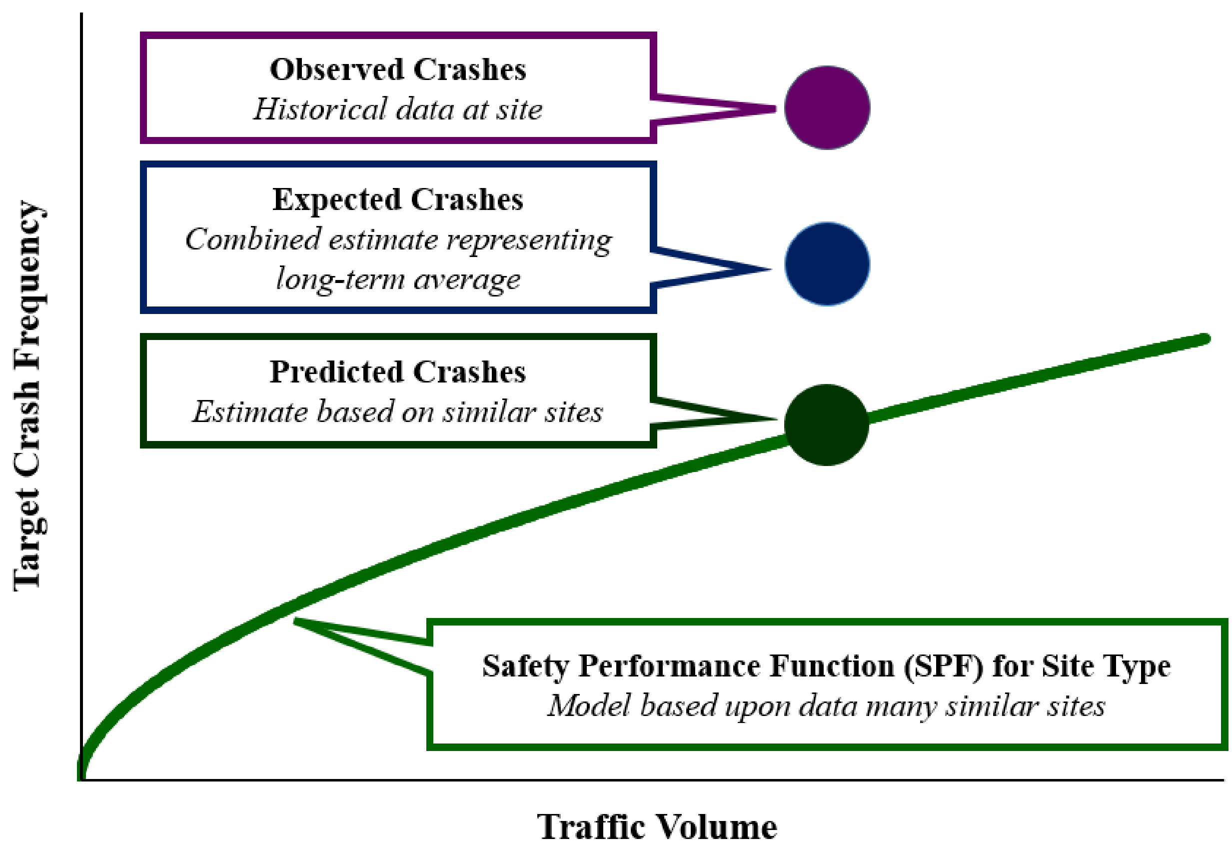



**Figure 15. Process to Calculate Expected Target Crashes**

In the EB method, the observed frequency of target crashes observed along a study road segment is combined with a predicted estimate based upon data from similar sites. This predicted estimate is based on a safety performance function (SPF), or a model which relates the annual number of fatigue-related target crashes along a given road segment to a series of traffic and geometric characteristics. This results in the development of a combined expected crash frequency which represents an estimation of the long-term average for the road segment (as opposed to simply using the three-year sample size of observed data alone).

This concept is particularly critical for this evaluation given the rare and random nature of fatigue-related target crashes along Nevada's highway network. As observed in **Table 15**, the rural highway network tends to experience a relatively small number of fatigue-related target crashes per mile. Further, approximately 85 percent of rural non-freeway segments did not even experience a target crash during the three-year study period. However, these rural corridors also tended to have the largest traffic crash rates per one-million vehicle miles traveled (as shown in **Table 16**). This emphasizes the fact that low volume rural study segments may not have experienced a pattern of fatigue-related traffic crashes during the relatively short three-year study period but still pose risks for such crashes to occur in the future. Therefore, this evaluation employs a risk-based analysis approach based on the expected crash frequency shown in **Figure 15**.

### *4.2.2 Safety Performance Functions*

Negative binomial regression models were estimated to develop (SPFs) that relate the annual number of target crashes along a given road segment to a series of site traffic and geometric characteristics, or the predicted value in **Figure 15**. The negative binomial was employed which is a generalized form of the Poisson model. In the Poisson regression model, the probability of segment *i* experiencing $y_i$ target crashes during a specific period (generally one year) is given by:

$$P(y_i) = \frac{EXP(-\lambda_i)\lambda_i^{y_i}}{y_i!} \quad (1)$$

where $P(y_i)$ is probability of segment *i* experiencing $y_i$ crashes during the period and $\lambda_i$ is equal to the segment's expected number of target crashes, $E[y_i]$. Poisson regression models are estimated by specifying this Poisson parameter $\lambda_i$ as a function of explanatory variables. The most common functional form of this equation is $\lambda_i$ = EXP($\beta X_i$), where $X_i$ is a vector of explanatory variables (e.g., AADT, entering volumes, etc.) and $\beta$ is a vector of estimable parameters. The negative binomial model is derived by rewriting the Poisson parameter for each segment *i* as $\lambda_i$ = EXP($\beta X_i + \varepsilon_i$), where EXP($\varepsilon_i$) is a gamma-distributed error term with mean 1 and variance $\alpha$. The addition of this term allows the variance to differ from the mean as $VAR[y_i] = E[y_i] + \alpha E[y_i]^2$. The $\alpha$ term is also known as the over-dispersion parameter, which is reflective of the additional variation in target crash counts beyond the Poisson model (where $\alpha$ is assumed to equal zero, i.e., the mean and variance are assumed to be equal.

Three distinct models were developed for the purposes of this evaluation (one for freeways and two for non-freeways), summarized in **Table 19**. A variety of modeling approaches were considered using the datasets collected for the evaluation summarized in **Section 3.0**. After an iterative process, it was determined that both daily traffic volume and the proportion of the length of each segment which has deficient horizontal curvature present had consistent impacts on fatigue-related target crash frequency. These factors were included in all three models shown in **Table 19**. The natural logarithm of segment length was also included as an offset.

An iterative process was also used to evaluate the potential safety impacts of the distance to traveler service data outlined in **Section 3.5**. Ultimately, the distance to a rest area facility (with a maximum of 20 miles) was identified as having a consistent impact on fatigue-related traffic crashes. This approach was also consistent with prior research [*50*]. While the 486.2-mile sample of freeway facilities was too limited to identify a relationship between rest area presence, two distinct relationships (one for any rest area and one for rest areas with bathroom services) were observed for the 3,511.0-miles of rural non-freeway facilities (excluding rural town and suburban segments).

**Table 19. Negative Binomial Model Results for Annual Target Crashes**

| Route Type | Parameter | Estimate | Standard Error | Significance |
|---|---|---|---|---|
| **All Freeway Segments (486.2 Miles)** | Intercept | -7.613 | 0.512 | < 0.000 |
| | Daily Traffic Volume (*ln Vehicles per Day*) | 0.725 | 0.053 | < 0.000 |
| | Percent of Segment with Deficient Horizontal Curves (*%*) | 0.016 | 0.006 | 0.002 |
| | Overdispersion Parameter | 0.257 | - | - |
| **Rural Non-Freeway Segments (3,511.0 Miles)** | Intercept | -9.082 | 0.268 | < 0.000 |
| | Daily Traffic Volume (*ln Vehicles per Day*) | 0.830 | 0.032 | < 0.000 |
| | Percent of Segment with Deficient Horizontal Curves (*%*) | 0.022 | 0.002 | < 0.000 |
| | Distance to Any Rest Area within 20 Miles (*Miles*) | **0.015** | 0.004 | < 0.000 |
| | Overdispersion Parameter | 0.781 | - | - |
| **Rural Non-Freeway Segments (3,511.0 Miles)** | Intercept | -9.019 | 0.272 | < 0.000 |
| | Daily Traffic Volume (*ln Vehicles per Day*) | 0.831 | 0.032 | < 0.000 |
| | Percent of Segment with Deficient Horizontal Curves (*%*) | 0.022 | 0.002 | < 0.000 |
| | Distance to Rest Area with Bathroom Service within 20 Miles (*Miles*) | **0.011** | 0.004 | < 0.000 |
| | Overdispersion Parameter | 0.797 | - | - |

It is important to recognize that daily traffic volumes served by each study segment consistently has the largest impact on target crash frequency for both freeways and rural non-freeways. Additionally, study segments with a greater proportion of length which had deficient horizontal curvature present tended to experience more target crashes. The magnitude of this effect was slightly stronger for the rural non-freeway facilities compared to the freeway facilities. As the distance to any rest area facility within 20 miles and the distance to a rest area with bathroom services within 20 miles increased, fatigue-related target crashes also tended to increase along rural non-freeways. This finding is in general agreement with prior research [*50*] conducted to evaluate to the safety performance impact of rest areas. While the effect for the distance to any rest area facility was slightly larger than the distance to a facility with bathroom services, the fact that there was still an increase target crash frequency along segments which potentially had a nearby rest area but no bathroom service available suggests the rest areas with bathroom services offer additional safety benefits beyond the mere presence of basic rest stop with only parking services.

The parameter estimates for rural non-freeways presented in **Table 19** were ultimately used to estimate the impact the presence of NDOT rest areas have on fatigue-related traffic crash risk. Given the limited sample size of freeways in the study limited the ability to identify a relationship between fatigue-related traffic crashes and rest area presence, a parameter estimate of 0.018 was adopted for freeways from prior research [*50*]. It should be noted that this parameter estimate was based upon facilities which serve one direction of traffic, however, all of NDOT's freeway facilities outside of the Wadsworth Rest Area provide services for both directions (and therefore this effect was assumed for both directions outside of Wadsworth). **Figure 16** (freeway) and **Figure 17** (non-freeway) illustrate the number of target crashes per mile observed along study segments as well as the SPFs (assuming no deficient horizontal curves) presented in **Table 19**.

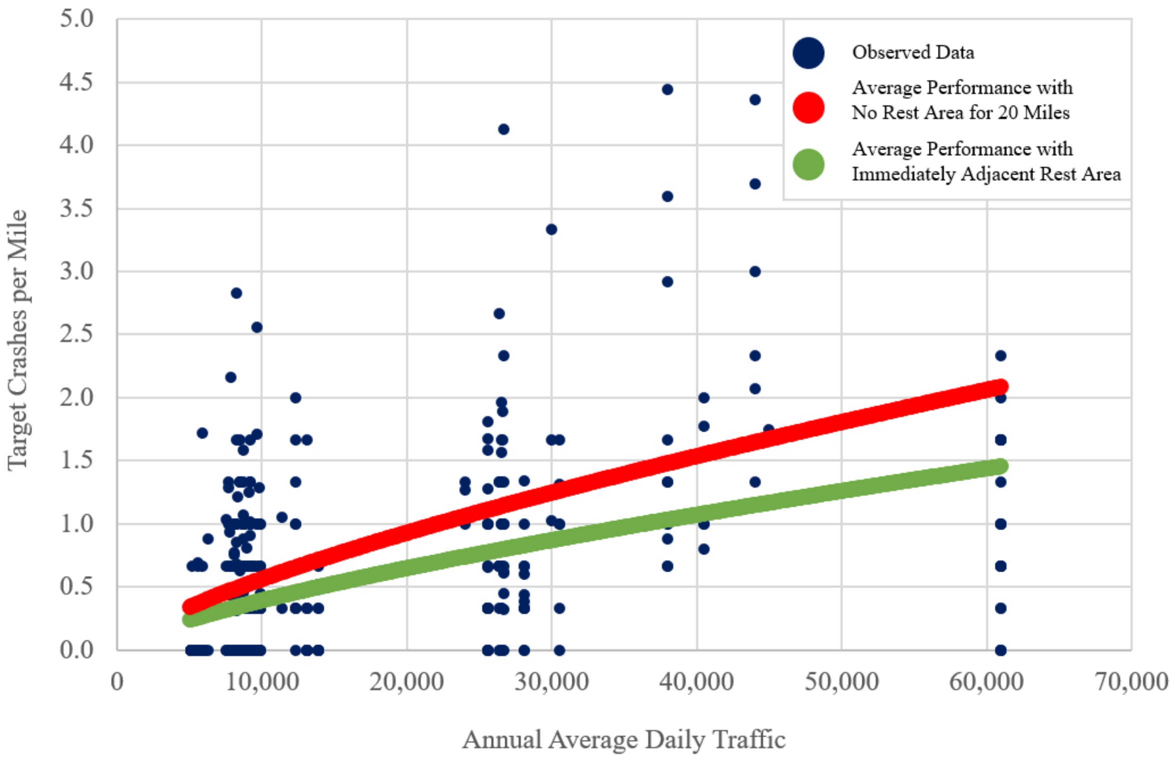



**Figure 16. Annual Average Target Crashes per Mile vs. AADT – Freeway Segments**

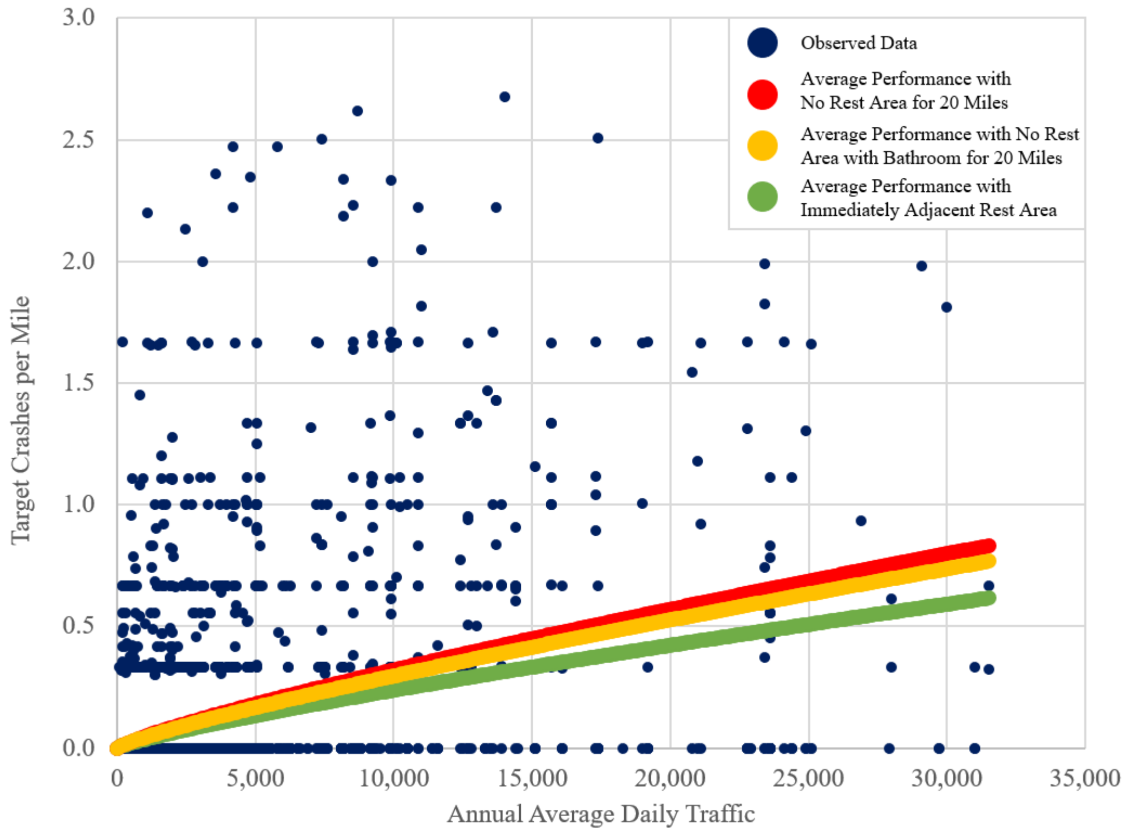



**Figure 17. Annual Average Target Crashes per Mile vs. AADT – Rural Non-Freeway Segments**

### *4.2.3 Impact of Adding or Improving a Rest Area Facility in Nevada*

The findings presented in **Section 4.2.2** were used to estimate the percent increase in target crashes expected along segments by the distance from a rest area facility, shown in **Figure 18**. These values were used to estimate the expected number of annual fatigue-related target crashes along study segments given the current location and services provided by the existing rest area system.

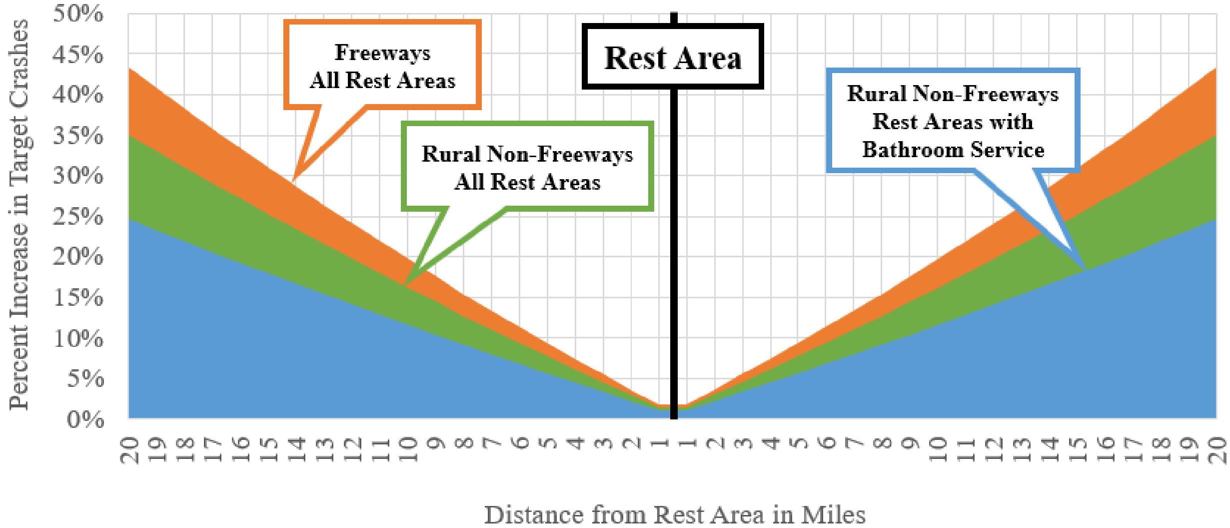



**Figure 18. Percent Increase in Target Crash Frequency by Distance from Rest Area**

The percent increase in target crashes presented in **Figure 18** can also be inverted to estimate the percent reduction in target crashes if a new facility is implemented or a facility is upgraded to include bathroom services (**Figure 19)**. The values presented in **Figures 18 and 19** were used to model the safety performance impacts of potential rest area modifications outlined in **Section 5.3**.

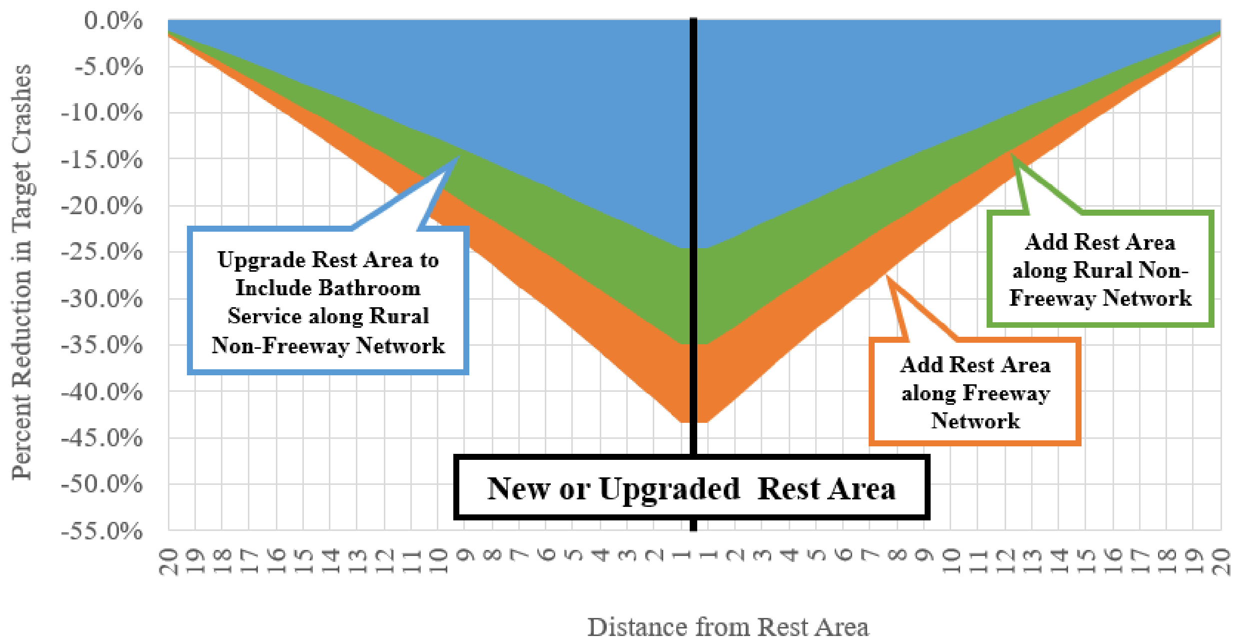



**Figure 19. Percent Decrease in Target Crash Frequency by Distance from New or Upgraded Rest Area**

#### *4.2.4 Annual Expected Fatigue-Related Target Crashes given Current Rest Area System*

The number of annual expected fatigue-related target crashes were estimated for the study routes based on the methods outlined in **Section 4.2.1** and the SPFs presented in **Section 4.2.2**. The distribution of expected target crashes per mile is shown in **Figure 20** (freeways) and **Figure 21** (non-freeways). A map of the current safety performance expected along study routes is shown in **Figure 22** in addition to the heat map of traveler services described in **Section 4.1**. Subsequent maps which include these safety data will show segments which are below the 50th percentile in green, segments which are below the 75th percentile in orange, and greater than the 75th percentile area in red. These values serve as a general visual guide for the relative risk present along specific segments. While safety performance benefits (or a reduction in expected target crashes) can potentially be obtained along all segments, the orange and red segments represent facilities which can offer larger reductions if adjacent rest area facilities can be added or improved.

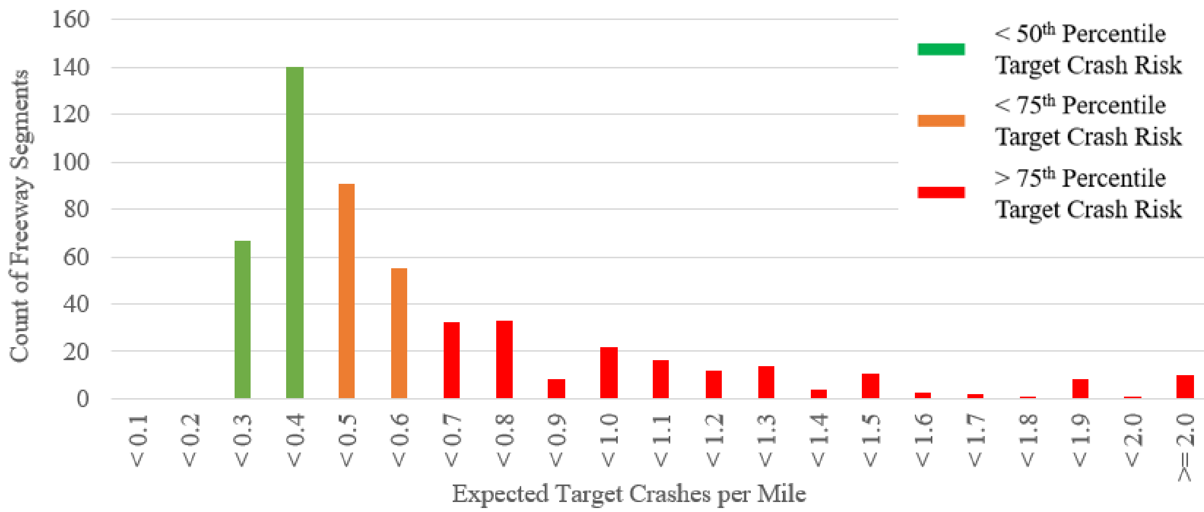



**Figure 20. Distribution of Freeway Segments – Expected Target Crashes per Mile**

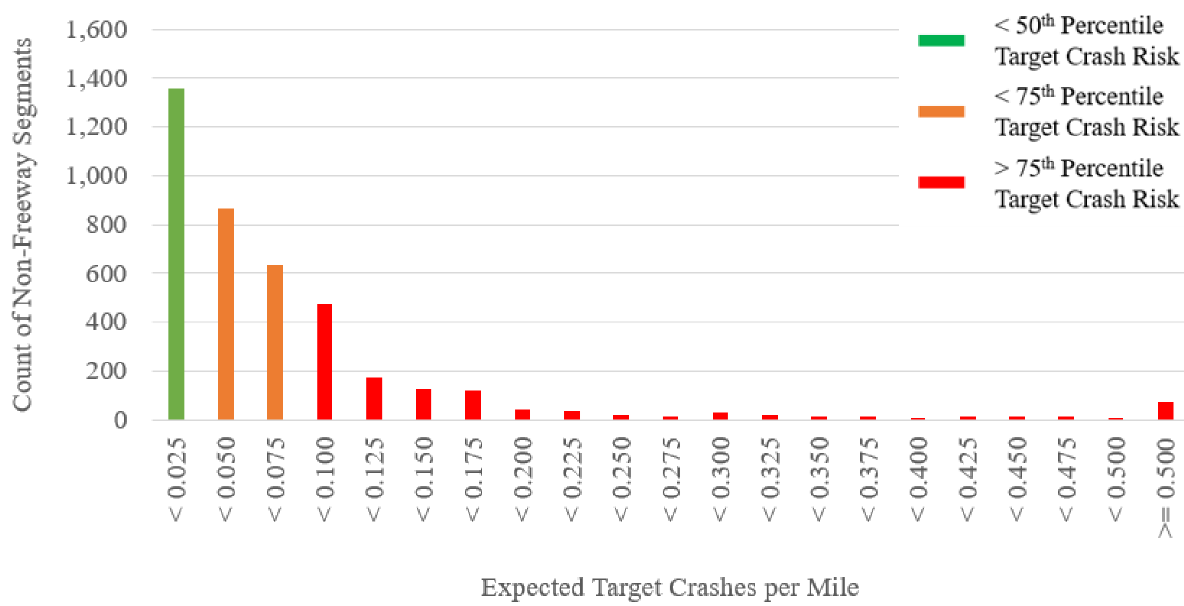



**Figure 21. Distribution of Non-Freeway Segments – Expected Target Crashes per Mile**

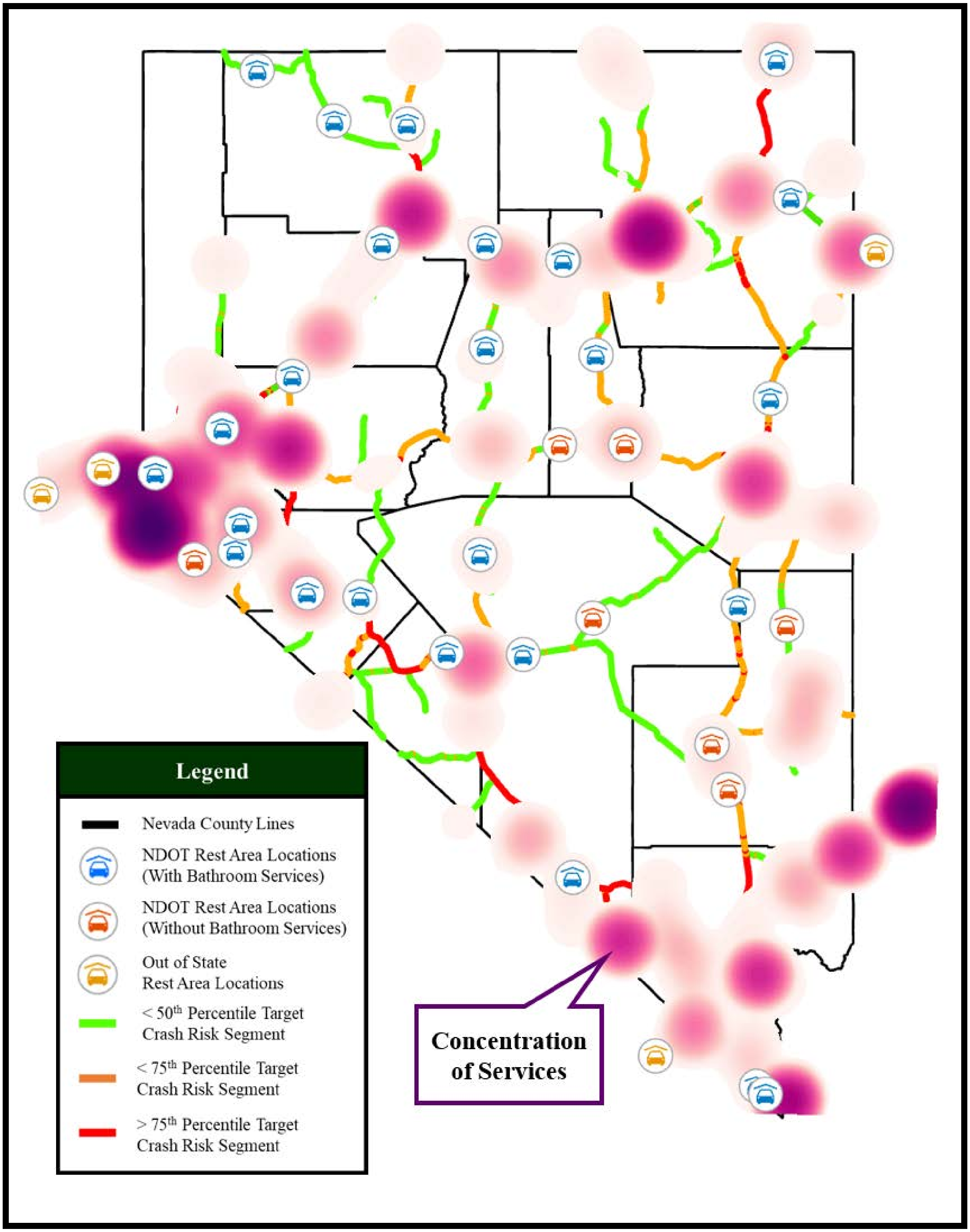



**Figure 22. Expected Target Crashes per Mile and Concentration of Existing Service**

### 4.3 Identification Areas with Unmet Needs

The tools developed in **Section 4.1** and **Section 4.2** were used to identify ten areas with currently unmet traveler service needs. The maximum traffic volume, the largest gap in traveler services, and the risk for fatigue-related crashes (or the total of annual expected target crashes along routes in the area) are summarized for each area in **Table 20**. While these represent the top ten areas in the state with currently unmet traveler service needs, it is important to note that they are currently not prioritized. Instead, recommendations to improve NDOT's rest area system should consider this list and help to improve the coverage of traveler services in each of these areas. A map with additional detail of each area with unmet needs is provided in **Appendices B-1 through B-10**.

**Table 20. List of Areas with Unmet Traveler Service Needs**

| Area (*Appendix Number*) | Max. Traffic Volume (*Vehicles per Day*) | | Largest Gap in Traveler Services (*Miles*) | | | Risk for Fatigue-Related Crashes (*Annual Expected Target Crashes*) |
|---|---|---|---|---|---|---|
| | AADT | Truck AADT | Any | Bathrooms | Truck Parking | |
| US-93, US-93 Alternate, and NV-229 North of Ely (***B-1***) | 1,900 | 254 | 70 | 125 | 140 | 7.456 |
| US-93 North of Wells (***B-2***) | 2,800 | 1,030 | 55 | 65 | 65 | 3.344 |
| US-6, US-95, NV-264, NV-265, and NV-360 West of Tonopah (***B-3***) | 3,300 | 442 | 55 | 65 | 65 | 6.487 |
| US-95, NV-266, and NV-267 South of Goldfield (***B-4***) | 2,900 | 538 | 50 | 90 | 90 | 4.247 |
| US-93 North of Pioche (***B-5***) | 530 | 66 | 50 | 105 | 75 | 1.325 |
| US-6, NV-375, and NV-379 East of Tonopah (***B-6***) | 410 | 34 | 95 | 140 | 100 | 3.357 |
| US-50, NV-121, and NV-361 East of Fallon (***B-7***) | 1,300 | 178 | 30 | 50 | 105 | 2.422 |
| NV-447 North of Nixon (***B-8***) | 280 | 38 | 50 | 60 | 75 | 0.492 |
| US-50 East of Eureka (***B-9***) | 680 | 92 | 55 | 75 | 75 | 1.213 |

| | | | | | | |
|---|---|---|---|---|---|---|
| NV-225 and NV-226 North of Elko (***B-10***) | 980 | 74 | 35 | 35 | 100 | 1.723 |

# 5.0 DEVELOPMENT OF RECOMMENDATIONS FOR NDOT'S REST AREA SYSTEM

A series of recommendations were developed for NDOT to consider towards the improvement of the rest area program. The process to develop these recommendations is outlined in **Figure 23**. First, a review of the 33 existing NDOT rest area facilities was conducted, including each facility's current level of importance to the system. A list of existing facilities which should continue to be maintained by the department was developed, in addition to a list of existing facilities which the department should consider either relocating or improving. Next, a review of the remaining areas with unmet traveler service needs which would not be addressed by these modifications was conducted to develop a list of potential new facilities the department should consider. Finally, an economic analysis was conducted of the potential modifications (the relocated, improved, or new facilities) to prioritize a series of final recommendations for the department to consider.

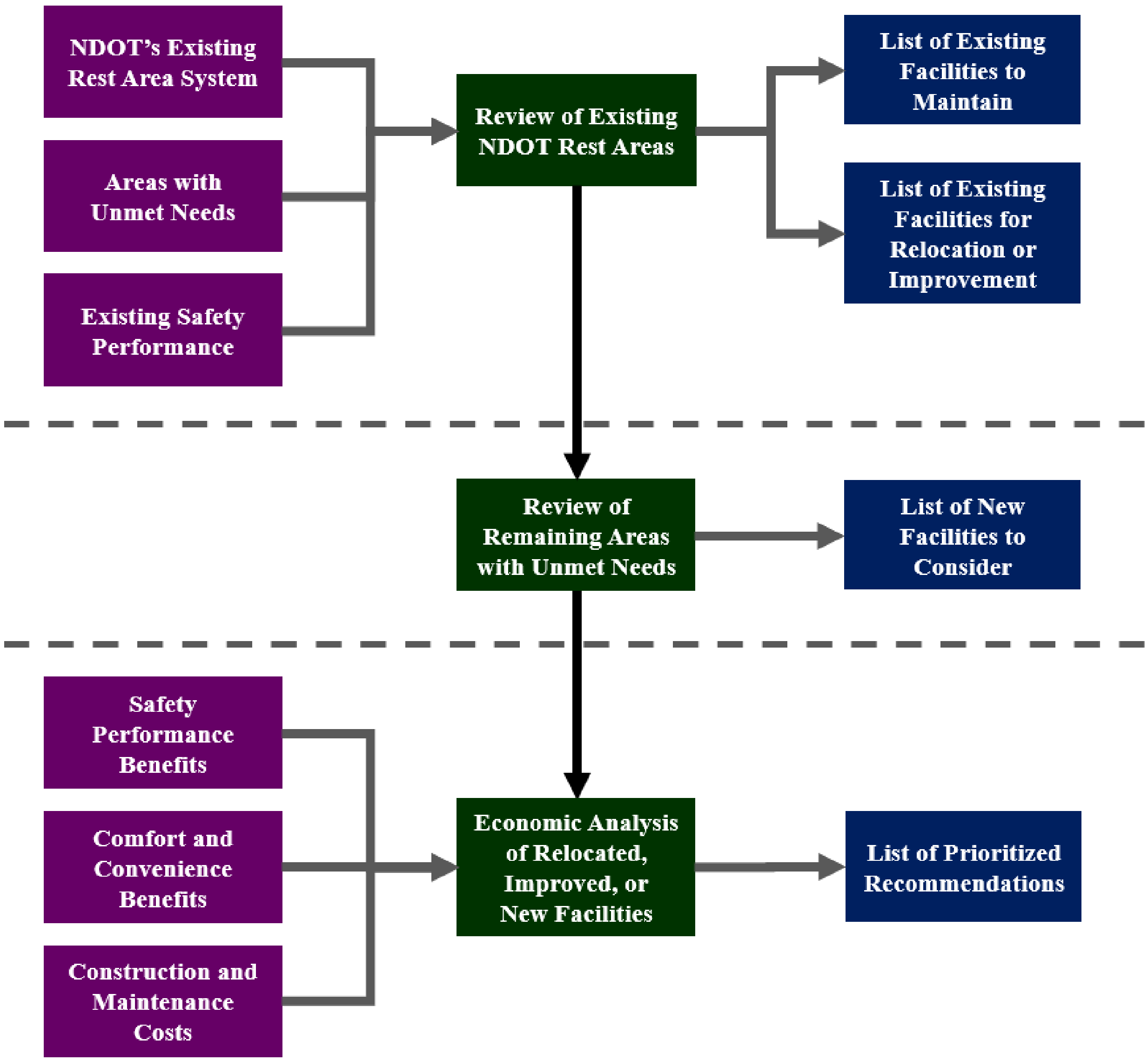



**Figure 23. Flow Chart of Recommendation Development Process**

## 5.1 Level of Importance Assessment for Existing Facilities

Each of the 33 existing rest area facilities was assessed to determine the current level of importance to the system (either high, moderate, or low) according to the criteria shown in **Table 21**. While full details of this assessment for each facility can be found in **Appendix C**, the results are summarized in **Table 22**. Additionally, a summary sheet which includes street view imagery, a map of the surrounding area, and entering traffic volume data (where available) for each facility is provided in **Appendices D-1 through D-32**.

**Table 21. Level of Importance Assessment**

| Level of Importance | Description |
|---|---|

| | |
|---|---|
| **High** | Facilities which help to address a considerable gap in services and/or serves a relatively large volume of road users. |
| **Moderate** | Facilities which help to address relatively smaller gaps in services and/or smaller volumes of road users than the high-level of importance facilities but remain an important component of the system. |
| **Low** | Facilities which provide comparatively low value to the system due to the proximity of private comparable service facilities, small volumes of road users, or missing key services such as bathroom facilities or truck parking. |

**Table 22. Nevada DOT Rest Area Facilities by Current Level of Importance**

| Level of Importance Assessment | Facilities |
|---|---|
| **High (17)** | Beowave (Eastbound and Westbound), Big Smoky, Cosgrave, Garden Valley, Laughlin Brake Check, Luning, Millers, Mt. Rose, Orovada, Pequop, Schellbourne, Southern Nevada Visitor Center, Sunnyside, Trinity, Valmy, Wadsworth |
| **Moderate (7)** | Amargosa, Hawthorne, Leonard Creek, Saulsbury Wash, Thousand Springs, Valley of the Moon, Wilson Canyon |
| **Low (9)** | Bean Flat, Blue Jay, Crystal Springs, Eureka, Log Cabin, Mountain House, Pahranagat, Pony Springs, Salmon Falls |

A total of 17 facilities currently provide a high level of value to NDOT's rest area network, serving as a critical component of the transportation system by providing service to road users along Nevada's non-urban roadway network. An additional seven facilities have a moderate level of value to NDOT's rest area network, supplementing the availability of important traveler services along lower volume routes. Finally, nine facilities have a relatively low level of value to Nevada's highway system. This includes facilities that could either be improved or relocated to better serve the needs of the state's road users.

### 5.2 Existing Facilities to Maintain or Consider Potential Modifications

After the level of importance assessment, each existing facility was reviewed to determine if it should be maintained, or potential modifications should be considered according to criteria presented in **Table 23**. While full details for each rest area can be found in **Appendix C**, this assessment is summarized in **Table 24**.

**Table 23. Criteria to Consider Potential Modifications for Existing Rest Areas**

| Assessment | Description |
|---|---|

| | |
|---|---|
| **Continue To Maintain** | Facilities which have a moderate or high value to the system and are within the intended service life. |
| **Consider Relocation** | Facilities which could have a larger impact on the system by being relocated to a more optimal point along the roadway network. |
| **Consider Improvements** | Facilities which do not currently provide specific services which are lacking along the adjacent corridor. |

**Table 24. Existing Facilities to Maintain or Consider Potential Modifications**

| Assessment | Facilities |
|---|---|
| **Continue To Maintain (22)** | Amargosa, Beowave (Eastbound and Westbound), Big Smoky, Cosgrave, Garden Valley, Laughlin Brake Check, Leonard Creek, Luning, Millers, Mt. Rose, Orovada, Pequop, Saulsbury Wash, Schellbourne, Southern Nevada Visitor Center, Sunnyside, Thousand Springs, Trinity, Valley of the Moon, Valmy, Wilson Canyon |
| **Consider Relocation (1)** | Salmon Falls |
| **Consider Improvements (3)** | Bean Flat, Pony Springs, Wadsworth |
| **Consider Relocation or Improvements (7)** | Blue Jay, Crystal Springs, Eureka, Hawthorne, Log Cabin, Mountain House, Pahranagat |

A total of 22 existing facilities represent a moderate or high value to the system should continue to be maintained by the department. The remaining 11 existing facilities should be considered either for relocation or improvements. These potential modifications, detailed in **Appendix C**, will undergo further economic analysis to prioritize their value to Nevada's road users.

### 5.3 Potential Modifications to NDOT's Rest Area System for Further Economic Analysis

A comprehensive list of potential modifications to NDOT's rest area system was developed for further economic analysis. This included the potential modifications to the 11 existing facilities outlined in **Section 5.2** in addition to a list of potential new facilities to consider. These proposed new facilities are intended to reduce gaps in the system by providing coverage of traveler services along the areas of unmet needs which were not directly addressed by the potential modifications to existing facilities.

Additionally, the expected safety performance impact of implementing a new or upgraded rest area was modeled based on **Figures 18 and 19** presented in **Section 4.2.3**. An example of this analysis for the proposed improvement to provide bathroom services at Bean Flat Rest Stop is shown in **Figure 24**. The annual expected crash frequency along the 40-mile corridor of US-50 adjacent to Bean Flat Rest Stop without improvement is shown in purple (a total of 1.118 crashes). The annual expected crash frequency along the corridor with the bathroom improvement in shown in blue (a total of 0.989 crashes). The difference in annual expected target crash frequency between these conditions (0.129 crashes) represents the potential annual safety performance improvement. In other words, the bathroom improvement Bean Flat Rest Stop is expected to result in an annual reduction of 0.129 fatigue-related target crashes along the corridor.

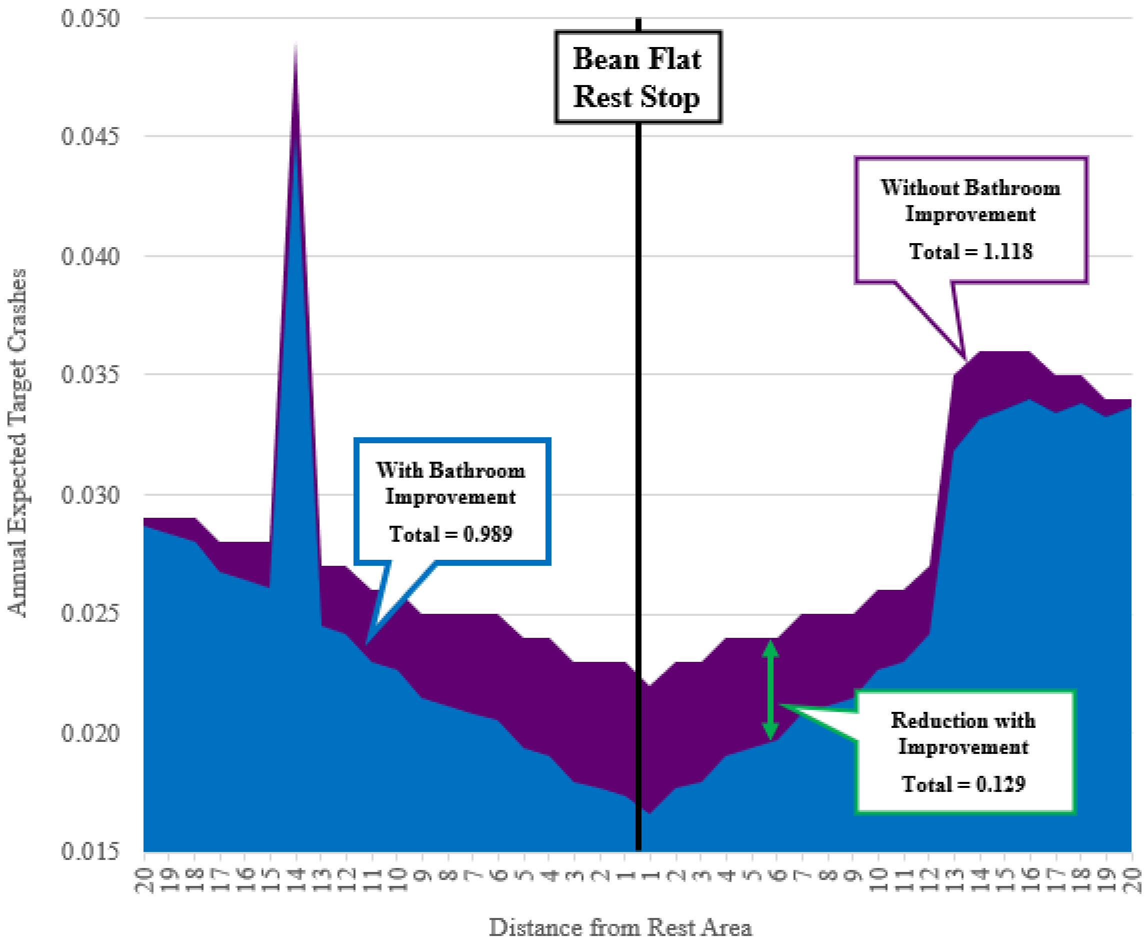



**Figure 24. Example of Safety Performance Impact with Improvement for Bean Flat Rest Stop**

A total of 18 potential modifications were identified for further economic analysis, summarized in **Table 25**. Each of the 18 potential modifications was modeled based upon the process described above to estimate the potential impact on annual expected fatigue-related traffic crashes. The results of this analysis are summarized in bold for each modification. While these annual expected crash reductions will be used as a part of the economic analysis presented in **Section 5.4**, they also help to provide context as to magnitude of the estimated safety performance impact on the system for each potential modification. Finally, the location of new or relocated facilities is also specified within **Table 25**. A map of all potential modifications is presented in **Figure 25**.

**Table 25. Potential Facility Modifications to Consider**

| Modification | Description |
|---|---|
| **Improve Bean Flat Rest Stop to Provide Bathroom Services** | While the rest stop is centrally located within a corridor between Austin and Eureka where there is an existing gap in services, it does not include bathroom services and therefore currently provides only a low level of value to the system. The department should consider improvements to Bean Flat Rest Stop to incorporate bathroom services to close the large gap present in this area. **This improvement is expected to reduce fatigue-related target crashes by approximately 0.129 per year.** |
| **Improve Blue Jay Rest Stop to Provide Bathroom Services** | While the rest stop is located along a corridor which has an existing gap in bathroom services of approximately 140 miles, the facility provides only a relatively low level of value to NDOT's system given the lack of bathroom services. The department should consider improvements which include bathroom services. **This improvement is expected to reduce fatigue-related target crashes by 0.072 per year.** |
| **Add New Facility at Junction of US-6/NV-379 (or Relocate Blue Jay Rest Stop)** | Alternatively, moving the Blue Jay Rest Stop (or a new facility) northeast to the junction of US-6 and NV-379 could help to reduce the overall gaps in traveler services. This modification can be considered either as a stand-alone option (relocate Blue Jay) or in tandem with upgrades to Blue Jay (as a new facility) if sufficient budget were available. **This improvement is expected to reduce fatigue-related target crashes by approximately 0.147 per year if implemented as a new facility. The relocation of the facility is expected to result in more modest safety improvement (approximately 0.118 target crashes per year) due to the negative impact of removing the current location from the system.** |
| **Improve Crystal Springs Rest Stop to Provide Bathroom Services** | While the convergence of the three routes allows for Crystal Springs Rest Stop to provide services for a considerable portion of Nevada's rural highway network, the lack of bathroom services results in the facility providing a relatively low level of value to the system. The department should consider improving the facility to include bathroom services and move the rest stop away from the horizonal curve in a similar location near the junction. **This improvement is expected to reduce fatigue-related target crashes by approximately 0.429 per year. Note that this scenario has been modeled in conjunction with moving Pahranagat Rest Stop south along US-93.** |
| **Relocate Eureka Rest Stop to the Southeast along US-50 (Near Mile Marker 31)** | Eureka Rest Stop currently provides a relatively low level of value to the NDOT system. While upgrading the facility to include bathroom services would represent an improvement over the existing condition, the department should consider constructing an improved rest stop with bathroom services to the southeast along US-50 (near Mile Maker 31) to provide better coverage of an area with a gap in services (**See Appendix B-9**). **The relocation of the facility is expected to result in a reduction of approximately 0.195 fatigue-related target crashes per year while expanding the coverage of traveler services. This positive safety performance impact of the new facility is somewhat offset by the negative impact of removing the current location from the system.** |

| Modification | Description |
|---|---|
| **Relocate Hawthorne Rest Area to the Northwest along US-95 (Near Mile Marker 3 in Churchill County)** | The rest area does provide a moderate value to the NDOT system given it provides coverage along both US-95 and NV-359 as well as the basic traveler information for road users entering the state via NV-359. However, given the proximity of private comparable facilities located in Hawthorne as well as the age of the facility (constructed in 1968), the rest area could be considered for either relocation or improvements by the department. This could include relocating the facility to the northwest along US-95 (near Mile Marker 3 in Churchill County) outside of the developed area to help to address a gap in bathroom facilities between Hawthorne and Fallon. **This improvement is expected to provide a modest reduction of fatigue-related target crashes (approximately 0.154 crashes per year) while expanding the coverage of traveler services. This safety impact is more modest due to the negative impact of removing the current location from the system. It should be noted that the rest area could be constructed as a basic rest stop to control costs.** |
| **Use Resources from Maintaining Log Cabin Rest Area for Other Facilities or Improve with Truck Parking** | Given that there is a concentration of other services available in close proximity to Log Cabin Rest Area, the facility provides comparatively low value to the NDOT system. Additionally, the rest area provides only limited opportunity for a truck to park and there is a gap in truck parking availability in the area around Yerington**.** As the facility was constructed in 1967 is likely nearing the end of its service life, consider either relocating the rest area to cover gaps in service elsewhere in the state or reconstructing Log Cabin to include truck parking facilities. **Given that much of the surrounding highway system is in an area that is developed, and further a concentration of traveler services provided by private comparable facilities is available, the negative safety performance impact due to removing the facility from the system is expected to be minimal.** |
| **Use Resources from Maintaining Mountain House Rest Stop for Other Facilities or Improve to Provide Bathroom Services** | Given that Mountain House Rest Stop is located in an area where there is a concentration of traveler services provided by private comparable facilities and does not provide bathroom services, the facility provides a relatively low level of value to the system. The department should consider either relocating the rest stop to cover gaps in service elsewhere in the state (which would result in additional spatial coverage of traveler services) or reconstructing Mountain House to include bathroom services (which would increase the value of the facility along this relatively high-volume corridor). **While closing Mountain House and adding a new facility elsewhere in the system can offer additional spatial coverage and safety performance benefits elsewhere in the system, it is recognized that removing Mountain House is expected to result in an increase of 0.308 fatigue-related target crashes per year along US-395 and NV-208. Alternatively, upgrading the facility to provide bathroom services is expected to reduce fatigue-related target crashes by approximately 0.760 per year.** |

| Modification | Description |
|---|---|
| **Improve Pahranagat Rest Stop to Provide Bathroom Services or Relocate Farther South along US-93 (Near Clark County Line)** | Pahranagat Rest Stop currently provides a relatively low level of value to the system given the proximity to Alamo and the lack of permanent bathroom services. The department should consider potential improvements to Pahranagat Rest Stop, including permanent bathroom structures. It should be noted that recent street view imagery from 2021 suggests a portable toilet has been placed at this location. Additionally, the department could also consider relocating the rest stop farther south along US-93 (near the Clark County Line) to increase the spatial coverage of traveler services given that private comparable facilities are available nearby in Alamo. This would also include coverage along NV-168. **Adding permanent bathroom services is expected to reduce fatigue-related target crashes by approximately 0.382 per year. Relocating the facility farther south is expected to reduce fatigue-related target crashes by 0.587 per year while also providing additional spatial coverage in traveler services along US-93 and NV-168.** |
| **Improve Pony Springs Rest Stop to Provide Bathroom Services** | Pony Springs Rest Stop currently provides only a relatively low level of value to the system given the lack of bathroom services. The department should consider potential improvements to Pony Springs Rest Stop, including bathroom services. **This improvement is expected to reduce fatigue-related target crashes by approximately 0.115 per year.**<br><br>Additionally, the department could also consider relocating the rest stop farther north along US-93 (closer to the Lincoln County Line) to better cover the gap in services (**See Appendix B-5**). This modification is expected to have only a minor impact on safety performance and is only intended to identify the location which would minimize the gap in services. |
| **Relocate Salmon Falls Rest Stop Farther South along US-93 (Near Mile Marker 108)** | Salmon Falls Rest Stop currently provides only a relatively low level of value to the system due to the nearby private comparable facilities in Jackpot. The department should consider relocation of this rest stop farther south (near Mile Marker 108) to address an area of unmet needs (**See Appendix B-2**). **Relocating the facility father south is expected to reduce fatigue-related target crashes by approximately 0.322 per year.** |
| **Construct an Eastbound Facility near the Existing Wadsworth Westbound Rest Area** | The westbound rest area currently provides a high level of value to the system given the relatively high volume of road users present along the corridor as well as the potential gap in services without the facility. The department could also consider constructing an eastbound rest area in an adjacent area as there is currently only a weigh station directly across from the existing westbound access only facility. **While this facility is located within a concentration of existing traveler services, providing a roadside facility for eastbound road users is expected to reduce fatigue-related target crashes by 3.502 per year along I-80.** |
| **New Basic Rest Stop along US-93 South of Wells (Near Junction with NV-229)** | Despite the presence of Schellbourne Rest Stop, there remains an extended gap in services along US-93 and NV-229 South of Wells (**See Appendix B-1**). A new basic rest stop facility near the junction of US-93 and NV-229 could work in tandem with Schellbourne to provide coverage of traveler services along the corridor. **This new facility is expected to reduce fatigue-related traffic crashes by approximately 0.540 per year along US-93 and NV-229.** |

| Modification | Description |
|---|---|
| **New Basic Rest Stop along US-6 in Mineral County (Near Junction of NV-360)** | While Luning and Millers Rest Areas provide coverage for a gap in traveler services located west of Tonopah (**See Appendix B-3**), there remains extended gaps along US-6, US-95, NV-264, NV-265, and NV-360. A new basic rest stop facility near the junction of US-6 and NV-360 would offer additional coverage along US-6, NV-264, and NV-360. **This new facility is expected to reduce fatigue-related traffic crashes by approximately 0.419 per year along US-6, NV-264, and NV-360.** |
| **New Basic Rest Stop along US-95 in Nye County (Near the Junction of NV-267)** | The gap in services between Goldfield and Beatty (**See Appendix B-4**) could be reduced by a new basic rest stop facility located at junction of US-95 and NV-267. It should be noted that roadside parking services are currently provided at this location. **This new facility is expected to reduce fatigue-related traffic crashes by approximately 0.839 per year along US-95, NV-266, and NV-267.** |
| **New Basic Rest Stop along US-50 in Churchill County (Near the Junction of NV-121)** | The gap in services located east of Fallon along US-50, NV-121, and NV-361 (**See Appendix B-7)** could be reduced by a new basic rest stop facility located at the junction of US-50 and NV-121. While there are two private comparable facilities which provide bathroom services located east of US-50's junction with NV-361, there remains a need for roadside services to provide additional coverage in this area. **This new facility is expected to reduce fatigue-related traffic crashes by approximately 0.345 per year along US-50, NV-121, and NV-361.** |
| **New Basic Rest Stop along NV-447 (Near Mile Marker 45)** | The gap in services located north of Nixon along NV-447 (**See Appendix B-8**) could be reduced by a new basic rest stop facility located near mile marker 45 along NV-447. **This new facility is expected to reduce fatigue-related traffic crashes by approximately 0.127 per year along NV-447.** |
| **New Basic Rest Stop along NV-225 (Near Mile Marker 75)** | The gap in services located north of Elko along NV-225 (**See Appendix B-10**) could be reduced by a new basic rest stop facility located near mile marker 75 along NV-225. While this facility could also be located farther south, closer to the junction of NV-225 and NV-226 (which would help to provide coverage along NV-226 as well as higher risk portions of NV-225 farther south), it should be noted that there are private comparable facilities available in this area which provide traveler services. The location near mile marker 75 provides spatial coverage of a 45-mile corridor area with no services. **This new facility is expected to reduce fatigue-related traffic crashes by approximately 0.227 per year along NV-225.** |

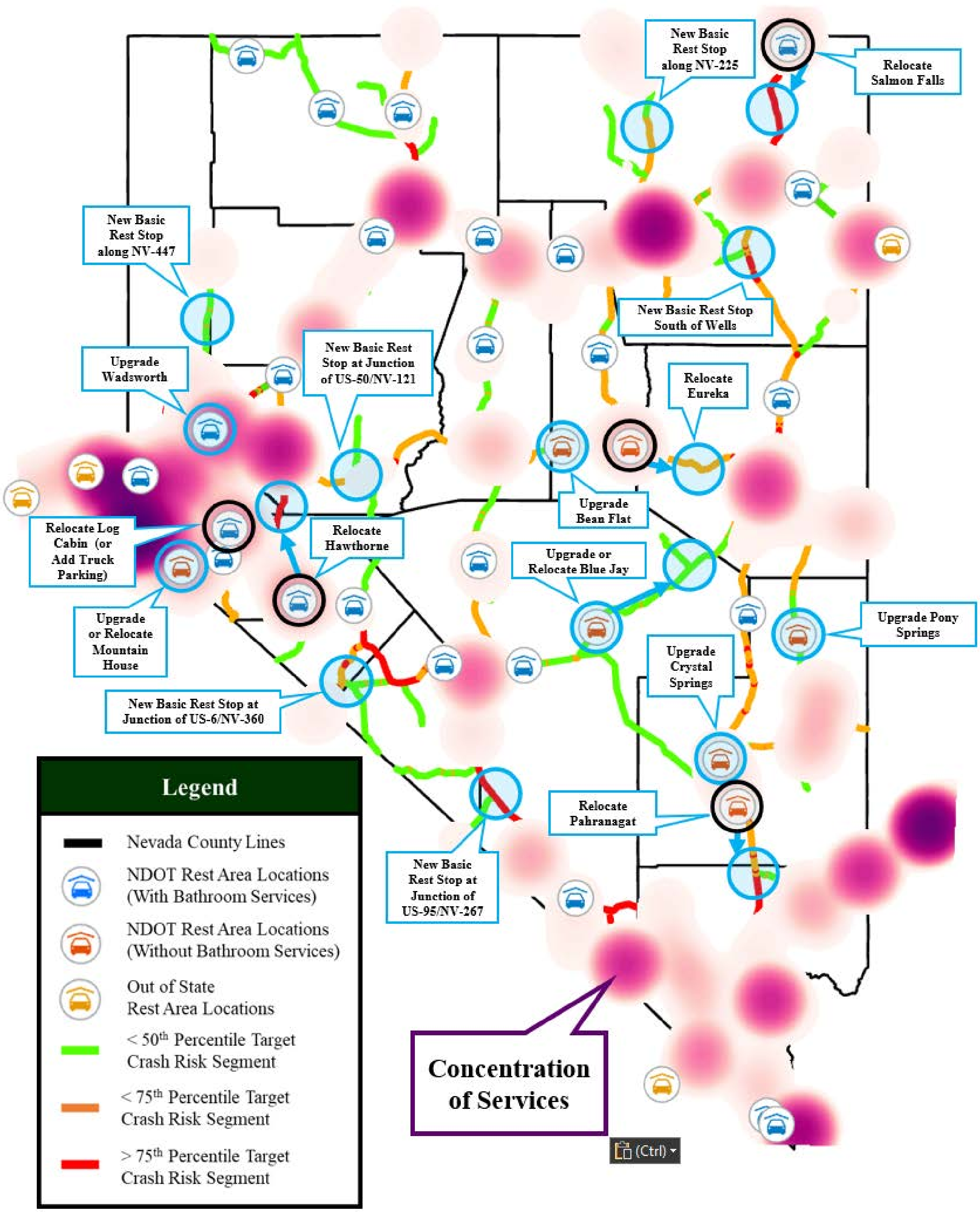



**Figure 25. Map of Potential Modifications to Consider for Further Economic Analysis**

## 5.4 Economic Analysis of Proposed Modifications to the NDOT Rest Area Network

A comprehensive economic analysis was performed to determine the economic impacts provided by potential improvements to the NDOT rest area system. Several arithmetical methods for economic assessment of MDOT rest areas were evaluated for use in this research, with the benefit/cost ratio method being most applicable to assessment of rest areas. Benefit/cost (or B/C) methodologies for economic analysis of rest areas have been utilized in previous rest area research, most notably NCHRP 324 [*2*] and a 2011 study of Texas rest areas and welcome centers [*43*] a 2010 evaluation of Michigan welcome centers by Vogt [*44*], and a 2012 study of the economic benefits and costs of rest areas and welcome centers for the Michigan DOT [*5*].

The benefit/cost ratio is simply an expression of the ratio of total net road user benefits (and disbenefits) to total net agency costs and is most useful for comparing the relative economic viability of highway infrastructure alternatives. The benefits and costs may be expressed either as equivalent annualized values or net present values, although annualized values are utilized herein. Alternatives with B/C greater than 1.0 are considered economically beneficial.

Benefit/cost ratios were computed for each proposed rest area modification. Note that only modifications to the NDOT network were considered herein. Reconstruction of an existing facility to the same type of facility at the same site assume that the existing facility is at the end of its service life, and were not included. The first step in the benefit/cost calculation was to determine the quantifiable annualized benefits and costs associated with upgrading an NDOT rest area. Benefits, which are entered into the numerator, are estimated for each modified facility as the incremental changes from the prior (or "do nothing") condition. The benefits associated with rest areas typically include one or more of the following:

- safety benefits,
- comfort and convenience benefits,
- travel savings (fuel and travel time associated with diversions off-route), and
- tourism benefits (only applicable to welcome centers).

In the case of improvements recommended herein for the NDOT rest area network, only safety benefits and comfort/convenience benefits are applicable. Cost components are entered into the denominator and include all capital investments (annualized) in addition to annual maintenance costs. The basic form of the equation as it relates to rest areas is provided as follows:

$$\frac{B}{C} = \frac{Annual\ Safety\ Benefits + Annual\ Comfort\ and\ Convenice\ Benefits}{Capital\ Investments\ (Annualized) + Annual\ Maintenance\ Costs - Salvage\ Value\ (Annualized)}$$

Using this method, rest areas have typically been shown in the literature to have favorable B/C ratios. NCHRP 324 estimated that the benefit/cost ratio of rest areas based on comfort/convenience of motorists, reduction in excess travel, and reduction in shoulder crashes was found to fall between 3.2 and 7.4 [*2*]. The 2011 Texas study by Carson et al suggested that B/C for rest areas along several Texas corridors ranged from 8.7 to 29.5, with a majority of the benefits associated with either safety or tourism benefits [*43*]. Using a slightly different approach, Vogt estimated the average return-on-investment for Michigan welcome centers to be at $0.49 in tax revenue back to the State per dollar spent in annual operating costs [*44*]. Finally, Gates, et al., found that all but three of the Michigan DOT's 81 public rest areas possessed B/C ratios that exceeded 1.0, with values ranging between 0.78 and 11.66 [*5*].

### *5.4.1 Safety Benefits*

The comprehensive value of the benefits due to expected reductions in fatigue-related target crashes for each rest area modification were assessed as follows:

(1) The safety benefit for each proposed rest area modification can be quantified by computing the estimated reduction in target crashes. This was performed by computing the difference in estimated fatigue-related crashes between the proposed rest area and the current rest area within the 20-mile radius of each rest area using the safety performance models for described earlier. The reduction in annual expected fatigue-related target crashes for each modification is provided in **Table 25 of Section 5.3**.

(2) The estimated target crash reductions were then multiplied by the corresponding comprehensive crash cost. Comprehensive costs consider both the tangible economic costs of motor-vehicle crashes, which include wage and productivity losses, medical expenses, administrative expenses, motor vehicle damage, and employers' uninsured costs, in addition to a measure of the intangible costs, including the value of lost quality of life, physical pain, and emotional suffering of people injured in crashes and their families. Thus, the comprehensive costs are much greater than the economic costs alone due to the inclusion of the intangible costs. The National Safety Council provides an estimate of comprehensive crash costs (in 2020 dollars) for each of the KABCO injury levels, as displayed in **Table 26** [*125*]. Also shown in **Table 26** are the average number of occurrences of each KABCO injury per target crash. In total 1.70 persons were involved in each crash event. Based on this, a weighted average comprehensive cost of $622,092 was computed per target crash occurrence.

**Table 26. Comprehensive Costs of Weighted Average Fatigue-Related Target Crashes**

| Injury Severity | Average Number in Target Crashes | Comprehensive Cost per Injury (2020 dollars) | Weighted Average Value |
|---|---|---|---|
| **Fatality** | 0.033 | $11,148,000 | $367,884 |
| **Serious Injury** | 0.068 | $1,219,000 | $83,421 |
| **Minor Injury** | 0.219 | $336,000 | $73,691 |
| **Possible Injury** | 0.257 | $155,000 | $39,873 |
| **No Injury Observed** | 1.122 | $51,000 | $57,222 |
| **Average Per Fatigue-Related Target Crash** | **1.700** | **-** | **$622,092** |

(3) The annual value of safety performance benefits is then computed for each of the proposed rest area modifications as follows:

**Annual Value of Safety Benefits =**
Reduction in Annual Expected Fatigue-Related Target Crashes x
Weighted Average Value of Fatigue-Related Target Crash

### *5.4.2 Comfort and Convenience Benefits*

Although the "value" of a rest area to a motorist depends on several factors, it may be proxied by obtaining data on the dollar value that travelers place on services utilized while stopped at a rest area. This value is often obtained by surveying rest area users as to their "willingness to pay" to utilize a rest area, although it is noted that such questions are typically undervalued by respondents [*2*]. The range of "willingness to pay" values reported in NCHRP 324 ranged from $0.82 - $2.08 per vehicle in December 2020 dollars [*2*]. The 2012 rest area study for the Michigan DOT by Gates et al. sought to obtain an estimate of the value of services provided by a rest area by asking motorists stopping at public rest areas in Michigan the following question: "What value do you place on the service utilized during your stop today". Analysis of the survey data showed that users' valuation of the services utilized varied significantly between standard rest areas and welcome centers, with median values (inflation adjusted from July 2011 to Dec. 2020) of $1.93 and $2.54, respectively [*5*].

Thus, in lieu of willingness to pay data from Nevada, which was not collected due to the COVID-19 pandemic that occurred during this project, each stop at a Nevada rest area that included running water along with toilet facilities and parking (i.e., full rest area) was valued at $1.93 per vehicle, while welcome centers were valued at $2.54 per vehicle. Although basic rest stops do not have running water, the general lack of any comparable private facilities in these areas suggests that the value to road users for a basic rest stop with a toilet is comparable to full rest areas. However, if toilets are not provided, then it was assumed that the value to users was 50% of a facility that included toilets. The value of services is reflected by facility type in **Table 27**. Note that the increase in value provided by a modified rest area (e.g., adding toilets to a basic rest area) is assumed as the difference between the modified facility type and the original facility type.

To compute the annual value of services, it was also necessary to estimate the annual daily traffic volumes entering each rest area. As NDOT does not collect rest area traffic volumes for each facility systemwide, average turn-in rates were computed for each of the three rest area facility types using the limited sample of rest area traffic volumes provided by NDOT, which are summarized in **Table 10 of Section 3.2.3**. The estimated turn-in rates are presented in **Table 27**. An average turn-in rate of 3.9 percent was assumed for full rest areas based on the data from all eight full rest area facilities provided by NDOT. Given that no data were provided for basic rest stops, an average turn-in rate of 5.4 percent was assumed by taking the mean turn-in rate for the three full rest areas with the lowest traffic volumes (Millers, Amargosa, and Luning). The annual rest area traffic volumes could then be estimated for each facility by multiplying the average annual mainline traffic volume along the adjacent route by the rest area turn-in rate for the original facility type. The annual value of comfort and convenience benefits is given by the following equation.

**Annual Value of Comfort and Convenience Benefits =**
Estimate of Annual Average Daily Rest Area Traffic Volume x
Estimated Value of Services Provided by Rest Area

**Table 27. Estimated Rest Area Turn-In Rate and Value of Services by Facility Type**

| Facility Type | Average Turn-in Rate | Average Value of Services |
|---|---|---|
| **Welcome Center** | 4.7% | $2.54 |
| **Full Rest Area** | 3.9% | $1.93 |

| | | |
|---|---|---|
| **Basic Rest Stop (with Toilets)** | 5.4% | $1.93 |
| **Basic Rest Stop (without Toilets)** | 5.4% | $0.97 |

#### *5.4.3 Rest Area Facility Costs*

The construction and annual maintenance costs associated with roadside rest areas in Nevada were estimated by using information provided by NDOT early in the project and may be considered as 2020 dollars. Note that costs for vault toilets were estimated from various online resources. These base construction and maintenance costs were then used to develop costs for each of the possible facility modification scenarios recommended for the NDOT rest area network, which included:

- Construct new facility at new site:
  - Construct welcome center at new site
  - Construct full rest area at new site
  - Construct basic rest stop (with vault toilets) at new site
- Upgrade facility to higher facility type:
  - Convert full rest area to welcome center
  - Convert basic rest stop to full rest area
  - Add two vault toilets to basic rest stop

For the scenarios that included upgrades to an existing facility, only incremental costs between the new condition and the existing condition were assumed. Costs to upgrade a facility to a higher facility type were assumed as the difference between the costs for existing and new facilities, which assumed that the existing facility was in good condition. The estimated construction and maintenance costs for each of these scenarios are summarized in **Table 28** by scenario.

**Table 28. Summary of Construction and Maintenance Costs for NDOT Roadside Rest Areas**

| New Construction on New Site | Construction Cost | Annual Maintenance Costs |
|---|---|---|
| **Construct Welcome Center** | $9,900,000 | $124,000 |
| **Construct Full Rest Area** | $4,700,000 | $100,500 |
| **Construct Basic Rest Stop (with Vault Toilets)** | $1,500,000 | $77,000 |
| **Upgrade Facility to Higher Facility Type** | **Construction Cost** | **Annual Maintenance Costs*** |
| **Convert Full Rest Area to Welcome Center** | $5,200,000 | $23,500 |
| **Convert Basic Rest Stop to Full Rest Area** | $3,200,000 | $23,500 |
| **Add Two Vault Toilets to Basic Rest Stop** | $100,000 | $50,000 |

*Additional maintenance costs above and beyond existing scenario

It was also necessary to convert all construction costs, which are given as present values, to an equivalent uniform annual cost based on an assumed design service-life and discount rates. Based on data obtained from the Michigan DOT, current rest area facilities are designed for a 40-year service life. The construction costs, which are provided as a present value, were converted to equivalent uniform costs annualized across the service life by assuming discount rates of 3 percent and 7 percent in accordance with the federal Office of Management and Budget (OMB) Circular A-94 [*126*]. The estimated annualized construction and maintenance costs, assuming a 40-year design life and discount rates of 3 percent and 7 percent, are provided for each analysis scenario in **Table 29**.

**Table 29. Annualized Construction and Maintenance Costs for NDOT Roadside Rest Areas**

| New Construction on New Site | Annualized Costs 3% Discount Rate | Annualized Costs 7% Discount Rate |
|---|---|---|
| Construct Welcome Center | $552,298 | $866,590 |
| Construct Full Rest Area | $303,833 | $453,043 |
| Construct Basic Rest Stop (with Vault Toilets) | $141,894 | $189,514 |
| **Upgrade Facility to Higher Facility Type** | **Annualized Costs 3% Discount Rate** | **Annualized Costs 7% Discount Rate** |
| Convert Full Rest Area to Welcome Center | $248,464 | $413,548 |
| Convert Basic Rest Stop to Full Rest Area | $161,940 | $263,529 |
| Add Two Vault Toilets to Basic Rest Stop | $54,326 | $57,501 |

### *5.4.4 Benefit-Cost Analysis of Proposed Rest Area Modifications*

Benefit/cost ratios were calculated for each of the proposed facility modifications displayed in **Table 30**. The benefit/cost ratios were computed based on the performance and comfort/convenience benefits divided by the construction and maintenance costs. All benefits and costs were converted to equivalent annualized values in 2020 dollars. Cases where the benefit/cost ratio exceeded 1.0 were considered economically favorable alternatives.

**Table 30. Benefit-Cost Analysis of Proposed Rest Area Facility Modifications**

| Facility | Proposed Modification | Annual Benefits | | Annualized Construction and Maintenance Costs | | Benefit-Cost Ratios | |
|---|---|---|---|---|---|---|---|
| | | Safety Performance | Comfort and Convenience | 3% Discount Rate | 7% Discount Rate | B/C Ratio (3%) | B/C Ratio (7%) |
| Bean Flat Basic Rest Stop | Add Vault Toilets | $80,250 | $11,854 | $54,326 | $57,501 | 1.70 | 1.60 |
| Blue Jay Basic Rest Stop | Add Vault Toilets | $44,791 | $4,780 | $54,326 | $57,501 | 0.91 | 0.86 |
| | Relocate Facility to Junction of US-6/NV-379 | $73,407 | $13,314 | $141,894 | $189,514 | 0.61 | 0.46 |
| Crystal Springs Basic Rest Stop | Add Vault Toilets and Relocate Facility Away from Curve (Safety Issues) | $266,877 | $44,355 | $141,894 | $189,514 | 2.19 | 1.64 |
| Mountain House Basic Rest Stop | Add Vault Toilets | $472,790 | $139,567 | $54,326 | $57,501 | 11.27 | 10.65 |

| Facility | Proposed Modification | Annual Benefits | | Annualized Construction and Maintenance Costs | | Benefit-Cost Ratios | |
|---|---|---|---|---|---|---|---|
| | | Safety Performance | Comfort and Convenience | 3% Discount Rate | 7% Discount Rate | B/C Ratio (3%) | B/C Ratio (7%) |
| Pahranagat Basic Rest Stop | Add Vault Toilets | $237,639 | $38,237 | $54,326 | $57,501 | 5.08 | 4.80 |
| | Relocate Facility Further South along US-93 (Near Clark County Line) | $365,168 | $77,983 | $141,894 | $189,514 | 3.12 | 2.34 |
| Pony Springs Basic Rest Stop | Add Vault Toilets | $71,541 | $10,133 | $54,326 | $57,501 | 1.50 | 1.42 |
| Eureka Basic Rest Stop | Relocate Facility Further Southeast along US-50 (Near Mile Marker 31) | $121,308 | $25,867 | $141,894 | $189,514 | 1.04 | 0.78 |
| Hawthorne Rest Area | Relocate Facility Further Northwest along US-95 (Near Mile Marker 3 in Churchill County) | $95,802 | $86,542 | $141,894 | $189,514 | 1.29 | 0.96 |
| Salmon Falls Basic Rest Stop | Relocate Facility Further South along US-93 (Near Mile Marker 108) | $200,314 | $106,513 | $141,894 | $189,514 | 2.16 | 1.62 |
| New Facilities | Add Eastbound Rest Area near the Existing Wadsworth Westbound Rest Area | $2,178,566 | $206,897 | $303,833 | $453,043 | 7.85 | 5.27 |
| | Add New Basic Rest Stop at Junction of US-6/NV-379 (Blue Jay Rest Stop to Remain In-Place) | $91,448 | $13,314 | $141,894 | $189,514 | 0.74 | 0.55 |
| | Add New Basic Rest Stop on US-93 South of Wells (Near Junction with NV-229) | $335,930 | $59,153 | $141,894 | $189,514 | 2.78 | 2.08 |
| | Add New Basic Rest Stop on US-6 in Mineral County (Near Junction of NV-360) | $260,657 | $46,980 | $141,894 | $189,514 | 2.17 | 1.62 |
| | Add New Basic Rest Stop on US-95 in Nye County (Near Junction of NV-267) | $521,935 | $107,654 | $141,894 | $189,514 | 4.44 | 3.32 |
| | Add New Basic Rest Stop on US-50 in Churchill County (Near Junction of NV-121) | $214,622 | $32,144 | $141,894 | $189,514 | 1.74 | 1.30 |
| | Add New Basic Rest Stop on NV-447 (Near Mile Marker 45) | $79,006 | $10,651 | $141,894 | $189,514 | 0.63 | 0.47 |

| Facility | Proposed Modification | Annual Benefits | | Annualized Construction and Maintenance Costs | | Benefit-Cost Ratios | |
|---|---|---|---|---|---|---|---|
| | | Safety Performance | Comfort and Convenience | 3% Discount Rate | 7% Discount Rate | B/C Ratio (3%) | B/C Ratio (7%) |
| | **Add New Basic Rest Stop along NV-225 (Near Mile Marker 75)** | $141,215 | $28,530 | $141,894 | $189,514 | 1.20 | 0.90 |
| **Log Cabin Rest Area** | **Close Facility (Aging Facility; Lack of Truck Parking; Abundance of Comparable Services Nearby)** | Not applicable | | | | | |

# 6.0 CONCLUSIONS AND RECOMMENDATIONS

Public rest areas in Nevada serve a variety of needs for all travelers, including vacation/recreational travelers, commercial vehicle drivers, commuters, motorcyclists, and others. A majority of travelers stopping at rest areas desire a restroom break or simply a stretch or short break. Other patrons utilize rest areas for picnicking, relief for children or pets, vehicle maintenance, to change drivers, obtain travel information, or to even sleep. Rest areas provide the distinct advantage of quick access and facilities that are open 24 hours per day.

Given the rapid development of private comparable facilities in the years since Nevada's rest areas were first opened, as well as the fact that many rest areas are near the end of their service lives, research was conducted to inform both short- and long-term decision-making by NDOT as it relates to its rest area program. This objective was achieved by development of a series of data-driven recommendations for potential modifications to NDOT's rest area network. In developing these recommendations, consideration was given to the needs of Nevada highway users, along with agency costs. Specific facility recommendations, including modifications to existing rest areas and construction of new facilities, were based on identification of areas of unmet needs (i.e., service gaps) for travelers on the NDOT highway network, with consideration given to the availability of both NDOT rest areas and private comparable facilities.

To help prioritize the recommended facility modifications, benefit/cost ratios were computed to determine the economic viability for each proposed rest area modification. Benefit/cost ratios are useful in prioritization as they help distinguish between economically favorable and unfavorable alternatives. The benefits were estimated for each modified facility as the incremental changes from the prior condition, considering safety benefits (e.g., expected crash reduction and injury prevention) along with comfort and convenience benefits for travelers (e.g., value of services). These benefits were then compared to the agency costs, which included the construction costs for the proposed new or modified facility, annualized over a 40-year service life, in addition to the change in annual maintenance costs for the proposed facility.

## 6.1 Recommended Modifications to NDOT's Rest Area System

Using the benefit/cost ratios, a final list of recommendations was developed to assist NDOT with prioritization of proposed modifications to its rest area network. These recommendations are provided in the following list and corresponding map in **Figure 26**. Where applicable, the recommendations are listed in order of highest to lowest B/C ratio within the category. Only those proposed modifications with B/C ratios greater than 1.0 for a 3 percent discount rate are included in the recommendations that follow. All other facilities in the NDOT rest area network that are not noted below should continue to be maintained at current levels and replaced with a similar facility at the end-of-service-life. Please see **Appendix C** for a full description of the recommendations for each facility within the NDOT rest area network.

- Add vault toilets to the following basic rest stops:
  - Mountain House
  - Pahranagat
  - Crystal Springs
  - Bean Flat
  - Pony Springs
- Relocate the following facilities to fill gaps in services or eliminate safety hazards:
  - Relocate Pahranagat Rest Stop further south along US-93, near Clark Co. line
  - Relocate Crystal Spring Rest Stop away from the curve to eliminate safety hazard
  - Relocate Salmon Falls Rest Stop further south along US-93, near M.M. 108
  - Relocate Hawthorne Rest Area further northwest along US-95, near M.M. 3
  - Relocate Eureka Rest Stop further southeast along US-50, near M.M.31
- Construct the following new facilities to fill gaps in services:
  - Construct new EB rest area near the existing Wadsworth WB Rest Area
  - Construct new basic rest stop along US-95 near junct. of NV-267 (Nye Co.)
  - Construct new basic rest stop along US-93 near junct. of NV-229 (south of Wells)
  - Construct new basic rest stop along US-6 near junct. of NV-360 (Mineral Co.)
  - Construct new basic rest stop along US-50 near junct. of NV-121 (Churchill Co.)
  - Construct new basic rest stop along NV-225, near M.M. 75
- Consider closure of the Log Cabin Rest Area due to end-of-service life, lack of truck parking, and an abundance of comparable traveler services available within close proximity.

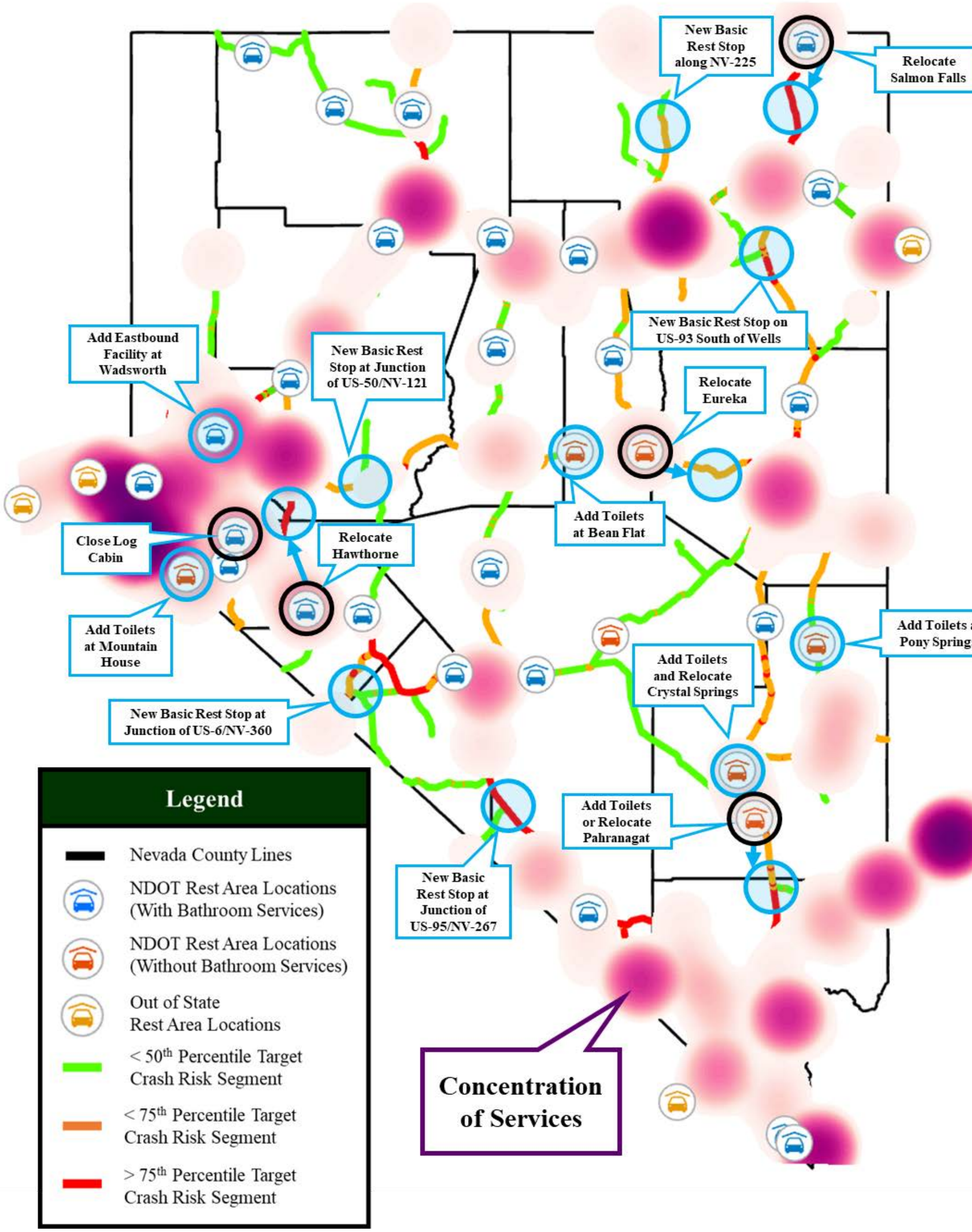



**Figure 26. Map of Recommended Modifications to NDOT Rest Area System**

# REFERENCES


1. American Association of State Highway Transportation Officials (2001). Guide For Development of Rest Areas on Major Arterials and Freeways (Third Edition). Washington, D.C.
2. King, G.F. (1989). National Cooperative Highway Research Program Report 324: Evaluation of Safety Roadside Rest Areas. Transportation Research Board, Washington, D.C.
3. Federal Highway Administration (2015). Jason's Law Truck Parking Survey Results and Comparative Analysis. Retrieved February 2019 from: https://ops.fhwa.dot.gov/freight/infrastructure/truck_parking/jasons_law/truckparkingsurvey/index.htm
4. Al-Kaisy, A., Kirkemo, Z., Veneziano, D. and Dorrington, C. (2011). Traffic Use of Rest Areas on Rural Highways: Recent Empirical Study. Transportation Research Record, Vol. 2255, No. 1.
5. Gates, T.J., P.T. Savolainen, T.K. Datta, R.G. Todd, and S. Boileau (2012). Evaluating the Appropriate Level of Service for Michigan Rest Areas and Welcome Centers Considering Safety and Economic Factors. Michigan Department of Transportation, OR10-045
6. United States Government Publishing Office (2011). 23 CFR 752.5 - Safety rest areas. Retrieved February 2019 from: https://www.govinfo.gov/app/details/CFR-2011-title23-vol1/CFR-2011-title23-vol1-sec752-5
7. Minnesota Department of Transportation. Types of rest areas. Retrieved February 2019 from: https://www.dot.state.mn.us/restareas/types.html
8. Al-Kaisey, A., D. Veneziano, and Z. Kirkemo (2014). Rest Area Use: Data Acquisition and Usage Estimation. FHWA/MT-10-009/8202
9. Plonvick, A., A. Berthaume, C. Poe, and T. Hodges (2017). Sustainable Rest Area Design and Operations. Federal Highway Administration.
10. Gardner, P.E. and N. Bosonetto (2002). Quantifying Roadside Rest Area Usage. University of Maine, New England Transportation Consortium, University of Connecticut, Storrs, CT.
11. Byrne, B. (1991). Usage of Three Rest Areas in Vermont (Abridgement). In Transportation Research Record 1326. Transportation Research Board, National Research Council, Washington, D.C.
12. Jha, M. K. (2004). Model to Analyze the Effectiveness of Highway Rest Area Performance. Transportation Research Record, Vol. 1877, No. 1.
13. Blomquist, D., J. Carson (1998). Rest Area User Survey. Western Transportation Institute, Montana Department of Transportation.
14. Todd, R., T.J. Gates, and P.T. Savolainen (2013). Evaluating Traveler Preferences, Values, and Behaviors Associated with Public Rest Areas. Transportation Research Record, Vol. 2358.
15. Kay, Jonathan. T.J. Gates, P.T. Savolainen, A. McArthur, and B.J. Russo (2014). Empirical Models of Demand Levels and Turn-In Rates at Roadside Rest Areas. Transportation Research Record, Vol. 2430.
16. Code of Federal Regulations. Title 49, Part 395 – HOURS OF SERVICE OF DRIVERS. Retrieved February 2019 from: https://www.ecfr.gov/current/title-49/subtitle-B/chapter-III/subchapter-B/part-395
17. Birdsey, J., W.K. Sieber, GX. Chen, E.M. Hitchcock, J.E. Lincoln, A. Nakata, C.F. Robinson, and M.H. Sweeney (2015). National Survey of US Long-Haul Truck Driver Health and

Injury: health behaviors. Occup. Environ. Med. (57(2). doi: 10.1097/JOM.0000000000000338.
18. Federal Motor Carrier Safety Administration (2019). Large Truck Crash Causation Study. Retrieved February 2019 from: https://www.fmcsa.dot.gov/research-and-analysis/research/large-truck-crash-causation-study
19. National Academies of Sciences, Engineering, and Medicine (2016). Commercial Motor Vehicle Driver Fatigue, Long-Term Health, and Highway Safety: Research Needs. Washington, DC: The National Academies Press.
20. Federal Motor Carrier Safety Administration (2019). 84 FR 48077. Retrieved February 2019 from: https://www.federalregister.gov/documents/2019/09/12/2019-19648/hours-of-service-of-drivers-restart-provisions
21. Federal Motor Carrier Safety Administration (2022). Summary of Hours of Service Regulations. Retrieved February 2019 from: https://www.fmcsa.dot.gov/regulations/hours-service/summary-hours-service-regulations#:~:text=Drivers%20must%20take%20a%2030,combination%20of%20these%20taken%20consecutively).
22. Davis, R. (1997). Commercial Driver Rest and Parking Requirements: Making Space for Safety. In Transportation Research Record 1595. Transportation Research Board, National Research Council.
23. Federal Highway Administration (1996). Commercial Driver Rest Area Requirements: Making Space for Safety. Washington, D.C.
24. Chatterjee, A. and F.J. Wegmann (2000). Overnight Truck Parking Along Tennessee's Interstate Highways and Rest Areas. Transportation Research Record, Vol. 1734.
25. Garber, N., and Wang, H (2004). Estimation of the Demand for Commercial Truck Parking on Interstate Highways in Virginia. Virginia Transportation Research Council, VTRC 04-R10.
26. A. M. Boggs, A. M. Hezaveh, and C. R. Cherry (2019). Shortage of Commercial Vehicle Parking and Truck-Related Interstate Ramp Crashes in Tennessee. Transp. Res. Rec. J. Transp. Res. Board, Vol. 2673, No. 10, doi: 10.1177/0361198119849586.
27. American Transportation Research Institute (2016). Managing Critical Truck Parking Case Study.
28. Trucker Path (2017). How the Lack of Parking can Cost the Trucking Industry $5 billion Annually.
29. Federal Highway Administration (1999). Rest Area Forum: Summary of Proceedings. Washington, D.C.
30. Fleger, S.A., R.P. Haas, J.W. Trombly, R.H. Cross, J.E. Noltenius, K.K. Pecheux, and K.J. Chen (2002). Study of Adequacy of Commercial Truck Parking Facilities – Technical Report. Federal Highway Administration, FHWA-RD-01-158.
31. Fitch, G.M., A. Moruza and M. Perfater (2011). Review of Nonpublic Funding Options to the Virginia Department of Transportation for the Operation and Maintenance of Its Safety Rest Areas and Welcome Centers. Virginia Transportation Research Council, VCTIR 11-R22.
32. Bayraktar, M.E., Y. Zhu, and F. Arif (2012). Commercial motor vehicle parking trends at rest areas and weigh stations. Florida Department of Transportation.

33. W. S. Associates (2008). The Minnesota Interstate Truck Parking Study. Minnesota Department of Transportation.
34. Hernanadez, S. and J. Anderson (2017). Truck Parking: An Emerging Safety Hazard to Highway Users. Oregon Department of Transportation.
35. Smith, J.G. (2021). More needed in bid for Ontario truck parking, says researcher. Retrieved June 2022 from: https://www.trucknews.com/health-safety/more-needed-in-bid-for-ontario-truck-parking-says-researcher/1003148219/
36. Hernandez, S. and N.S.S. Al-Bdairi (2018). Understanding Truck Parking Behavior and Choice of Commercial Motor Vehicle Operators: Impacts on Roadway Safety. Pacific Northwest Transportation Consortium.
37. Washburn, S., W. Sun, and E. Stoop (2016). Commercial Truck Parking Detection Technology Evaluation for Columbia County Rest Areas. Florida Department of Transportation.
38. Morris, T., D. Murray, K. Fender, A. Weber, V. Morellas, D. Cook, and N. Papanikolopoulos (2017). A Comprehensive System for Assessing Truck Parking Availability. Federal Highway Administration, CTS 17-02.
39. Morris, T., T. Henderson, V. Morellas, and N. Papanikolopoulos (2018). A Real-Time Truck Availability System for the State of Wisconsin. University of Minnesota.
40. Best, J. and A.T. Moreno (2019). Truck Parking Demand Modeling Using Microscopic Traffic Simulation: A Case Study of the New York State Thruway. Institute of Transportation Engineers Journal, Vol. 89, No. 10.
41. Haque, K., S. Mishra, R. Paleti, M.M. Golilas, A.A. Sarker, and K. Pujat (2016). Truck Parking Utilization Analysis Using Truck GPS data. Transportation Research Board 95th Annual Meeting.
42. Ioannou, P. and F.A.A. Vitall (2018). Intelligent Parking Assist for Trucks with Prediction. United States Department of Transportation.
43. Carson, J., V. Pezoldt, N. Koncz, and K. Obeng-Boampong (2011). Benefits of Public Roadside Safety Rest Areas in Texas: Technical Report. Texas Transportation Institute, Texas Department of Transportation.
44. Vogt C., and D. Holecek (2010). A Survey of Travel Michigan Welcome Center Visitors, Michigan Economic Development Corporation.
45. National Highway Traffic Safety Administration. Drowsy Driving. Retrieved February 2019 from: https://www.nhtsa.gov/risky-driving/drowsy-driving
46. Nevada Executive Committee on Traffic Safety. 2016-2020 Nevada Strategic Highway Safety Plan. Retrieved February 2019 from: https://www.nevadadot.com/home/showdocument?id=4728
47. De Valck, E., and R. Cluydts (2001). Slow-release caffeine as a countermeasure to driver sleepiness induced by partial sleep deprivation. Journal of Sleep Research.
48. Banerjee, I., J. Lee, K. Jang, S. Pande, and D. Ragland (2009). Rest Areas: Reducing Accidents Involving Driver Fatigue. UC Berkeley Traffic Safety Center, California Department of Transportation.
49. Taylor, W.C., N. Sung, K. Kolody, and A. Jawad (1999). A Study of Highway Rest Area Characteristics and Fatigue Related Truck Crashes. Michigan State University.

50. McArthur, A., J. Kay, P.T. Savolainen, and T.J. Gates (2013). Effects of Public Rest Areas on Fatigue-Related Crashes. Transportation Research Record: Journal of the Transportation Research Board, Vol. 2386.
51. SRF Consulting Group, Inc. (2007). "Interstate Highway Safety Study: Analysis of Vehicle Crashes Related to Safety Rest Area Spacing". Minnesota Department of Transportation.
52. Murphy, M., Z. Han, N. Jiang, D. Hazlett, A.S. Ahsan, A. Cooper, C. Baumanis, Z. Zhanag, R. Machemehl, R. Harrison (2018). Evaluating Safety and Economic Impacts of Texas Travel Information Centers. Texas Department of Transportation.
53. Steinhauer, J. (2010). Closing of Rest Stops Stirs Anger in Arizona. New York Times. Retrieved February 2019: https://www.nytimes.com/2010/03/05/us/05reststop.html
54. Fischer, H. (2010). ADOT plans to reopen closed rest areas. Capitol Media Services. Retrieved February 2019 from: https://www.eastvalleytribune.com/arizona/adot-plans-to-reopen-closed-rest-areas/article_36e60242-7e2b-11df-9180-001cc4c002e0.html
55. Arizona Department of Transportation (2013). Public-private partnership to manage state's highway rest areas. Retrieved February 2019 from: https://azdot.gov/adot-news/public-private-partnership-manage-states-highway-rest-areas
56. The Associated Press (2016). Arkansas rest area on I-40 to close for $4.8M renovations. Retrieved February 2019 from: https://www.arkansasonline.com/news/2016/feb/12/arkansas-rest-area-i-40-close-48m-renovations/
57. Weber, S. (2010). Budget Woes Force Closure of Highway Rest Areas. NBC Los Angeles. Retrieved February 2019 from: https://www.nbclosangeles.com/news/budget-woes-force-closure-of-highway-rest-areas/1841183/
58. Dornbush, D., and J. Ramey (2009). Partnership Strategies for Safety Roadside Rest Areas. California Department of Transportation.
59. Kress, E.N. and D.M. Dombusch (1991). Commercialization of Rest Areas in California. Transportation Research Record, No. 1326.
60. Dornbusch Associates (2011). Final Task 5 Report: Strategic Recommendation-Safety Roadside Rest Area Master Plan. California Department of Transportation.
61. Dornbush, D.M. (1996). Feasibility of Financing Public Information in Rest Area Interactive Kiosks through Private Advertising. Federal Highway Administration, DTFH61-94-00220.
62. Colorado Department of Transportation (2012). CDOT Closes Rest Area on I-70 at Glenwood Springs. Retrieved February 2019 from: https://www.codot.gov/news/2012-news-releases/12-2012/cdot-closes-rest-area-on-i-70-at-glenwood-springs
63. Howes, B. (2013). Alternatives to the Public Funding and Operating of Colorado's Rest Areas. Colorado Department of Transportation.
64. Keating, C. (2019). Gov. Lamont re-opens all highway rest areas 24 hours starting Monday. Retrieved February 2019 from: https://www.courant.com/politics/hc-pol-highway-rest-areas-reopened-20190628-a3dj6xyjtjhnlbzcqk7v4y46sy-story.html
65. Pew Charitable Trusts (2010). As Some States Close Highway Rest Stops, Others See Roadside Revenue. Retrieved February 2019 from:

https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2010/07/28/as-some-states-close-highway-rest-stops-others-see-roadside-revenue
66. Pew Charitable Trusts (2017). Old-Fashioned Rest Stops Disappearing in Some States. Retrieved February 2019 from: https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2017/03/31/old-fashioned-rest-stops-disappearing-in-some-states
67. Spokesman Review. Retrieved January 2011 from: http://www.spokesmanreview.com/breaking/story.asp?ID=13645
68. Idaho Department of Transportation (2018). SAFETY REST AREAS AND OASIS PARTNERSHIPS PROGRAM. Retrieved February 2019 from: https://itd.idaho.gov/wp-content/uploads/2018/08/min-July_Exhibit_498.pdf
69. Wisniewski, M. and E. Olumhense (2017). What do you think of Illinois rest areas? State considering fixing up some, maybe closing others. Chicago Tribune. Retrieved February 2019 from: https://www.chicagotribune.com/news/breaking/ct-met-rest-stops-20171023-story.html
70. South Dakota Department of Transportation (2018). Interstate Oasis Signing Inquiry. Retrieved February 2019 from: https://traffic.transportation.org/wp-content/uploads/sites/26/2019/10/Interstate-Oasis-Signing-Inquiry.pdf
71. Associated Press News (2019). INDOT to shutter 2 southern Indiana rest stops along I-64. Retrieved February 2019 from: https://apnews.com/article/2dbbb825daf2422dbfbffe93ef5b4e4f
72. Petroski, W. (2018). Iowa DOT looks to close 11 highway rest areas; worries arise for travelers, truckers. Retrieved February 2019 from: https://www.desmoinesregister.com/story/news/politics/2018/06/25/iowa-dot-department-transportation-could-close-highway-rest-areas-driving-travel-interstate-35-80-29/730509002/
73. Iowa Department of Transportation (2018). Iowa Rest Area Management Plan: Implementation Plan. Retrieved February 2019 from: https://iowadot.gov/restareaplan/Rest-Area-Implementation-Plan-Draft.pdf
74. KTBS 3 ABC (2008). Louisiana Rest Areas Closing. Retrieved February 2019 from: https://www.ktbs.com/news/louisiana-rest-areas-closing/article_062aaab9-3737-504c-b866-f2ee0cbb9294.html
75. American Press. Interstate East Visitors Center to Open Soon. Retrieved February 2019 from: https://www.americanpress.com/news/local/interstate--east-visitor-s-center-to-open-soon/article_2d0bc810-b51d-11e8-8343-531588965b0e.html
76. USA Today. States close rest areas to save money. Retrieved February 2019 from: https://usatoday30.usatoday.com/travel/2009-07-16-reststop_N.htm
77. WTOP News (2012). Renovations planned for Md.'s I-95 rest stops. Retrieved February 2019 from: https://wtop.com/news/2012/03/renovations-planned-for-mds-i-95-rest-stops/
78. Veselenak, D. (2018). MDOT closing rest stop along I-275 in Canton. Retrieved February 2019 from: https://www.hometownlife.com/story/news/local/canton/2018/10/03/mdot-closing-rest-stop-along-275-canton/1509601002/
79. Cook Research and Consulting, Inc. (2003). Rest Area Sponsorship Focus Group. Minnesota Department of Transportation.

80. Smith, S. (2012). 2 Mississippi Rest Areas Shut Down. Retrieved February 2019 from: https://cdllife.com/2012/2-mississippi-rest-areas-shut-down/
81. Heavy Duty Trucking Staff (2013). Missouri Rest Areas Closing, to be Converted for Trucks Only. Retrieved February 2019 from: https://www.truckinginfo.com/111515/missouri-rest-areas-closing-to-be-converted-for-trucks-only
82. Montana Department of Transportation (2004). Montana Rest Area Plan. Retrieved February 2019 from: https://www.mdt.mt.gov/pubinvolve/restareaplan/
83. Coen, A. (2017). New Hampshire transforms highway rest stops to revenue. The Bond Buyer. Retrieved February 2019 from: https://www.bondbuyer.com/news/new-hampshire-transforms-highway-rest-stops-to-revenue
84. Davis, T. (2019). 3 Rest Areas To Close As Gov. Murphy Makes Decision On NJ Gas Tax. Patch. Retrieved February 2019 from: https://patch.com/new-jersey/cinnaminson/s/gtpdl/3-rest-areas-to-close-as-gov-murphy-makes-decision-on-nj-gas-tax?utm_source=alert-breakingnews&utm_medium=email&utm_term=politics&utm_campaign=alert
85. Nott, R. (2020). New Mexico wants $30 million to revamp rest stops. Santa Fe New Mexican. Retrieved February 2019 from: https://www.santafenewmexican.com/news/legislature/new-mexico-wants-million-to-revamp-rest-stops/article_6bab0d30-41ec-11ea-b32d-5bd1319929f3.html
86. Heavy Duty Trucking Staff (2010). New York Closing Rest Areas. Retrieved February 2019 from: https://www.truckinginfo.com/105192/new-york-closing-rest-areas
87. Office of the New York State Comptroller (2019). Welcome Center and Rest Area Planning and Implementation. Retrieved February 2019 from: https://www.osc.state.ny.us/files/state-agencies/audits/pdf/sga-2019-17s25.pdf
88. Lee, R. (2017). New Iredell Rest Area Closure. Retrieved February 2019 from: https://statesville.com/news/new-iredell-rest-area-means-closure-of-others-along-i/article_12d64a7c-d281-11e6-8128-13f33995059f.html
89. Cole, M. (2016). North Dakota planning to close five rest areas amid revenue shortfall. Overdrive. Retrieved February 2019 from: https://www.overdriveonline.com/business/article/14889873/north-dakota-planning-to-close-five-rest-areas-amid-revenue-shortfall
90. Pelzer, J. (2019). DeWine administration, in '180-degree turn,' focuses on improving Ohio highway rest areas. Cleveland.com. Retrieved February 2019 from: https://www.cleveland.com/open/2019/12/dewine-administration-in-180-degree-turn-focuses-on-improving-ohio-highway-rest-areas.html
91. The Associated Press (2013). Oklahoma considers what to do with old rest stops. Retrieved February 2019 from: https://www.normantranscript.com/news/oklahoma-considers-what-to-do-with-old-rest-stops/article_cfebc3c9-54de-5828-872e-c084222cf370.html
92. CDL Life (2019). PennDOT warns drivers about 18-month rest area closures. Retrieved from: https://cdllife.com/2019/penndot-warns-drivers-about-18-month-rest-area-closures/
93. The State (2010). 4 interstate rest areas closing in S.C. Retrieved February 2019 from: https://www.thestate.com/news/local/article14374577.html
94. KTXS 12 ABC (2013). Safety effort: Rest areas being built on I-20 near Ranger to aid 'weary drivers'. Retrieved February 2019 from:

https://ktxs.com/news/big-country/safety-effort-rest-areas-being-built-on-i-20-near-ranger-to-aid-weary-drivers
95. The Fayette County Record. State Closing All Five County Highway Rest Stops. Retrieved February 2019 from: https://www.fayettecountyrecord.com/articles/2019/06/25/state-closing-all-five-county-highway-rest-stops
96. Bennington Banner (2008). Plan to close rest areas. Retrieved February 2019 from: https://www.benningtonbanner.com/local-news/plan-to-close-rest-areas/article_eaf165cc-8239-5874-96fb-7030834f6a08.html
97. Hochberg, A. (2010). Virginia Highway Rest Stops to Reopen. National Public Radio. Retrieved February 2019 from: https://www.npr.org/templates/story/story.php?storyId=122799590
98. Shenk, S. (2016). VDOT to Rebuild Three Rest Areas. Richmond Times-Dispatch. Retrieved February 2019 from: https://richmond.com/news/virginia/vdot-to-rebuild-three-i--rest-areas-including-two/article_26c0fbff-3c9c-5a72-91e1-5833791251df.html
99. Phillips, A.W.M. and M.A. Perfater (1991). Opportunities for the Privatization of Virginia's Rest Areas and Welcome Centers: Final Report. Virginia Transportation Research Council.
100. Virginia Department of Transportation (2011). VDOT Safety Rest Area & Welcome Center Sponsorship, Advertising and Vending Enhancement Program. Request for Proposal, RFP #123-ABJ (Revised).
101. Landlinemag.com (2011). VDOT announces public-private partnership to maintain rest areas. Retrieved September 2011 from: http://www.landlinemag.com/todays_news/Daily/2011/Aug11/082911/083111-06.shtml
102. Heffernan, J. (2011) Local Firm to Partner on Rest Areas. NVDAILY.com. Retrieved September 2011 from: http://www.nvdaily.com/news/2011/08/local_firm_to_partner_on_rest_areas-print.html
103. LA Cross Tribute (2019). I-90 Rest Area Near Bangor Will Close. Retrieved February 2019 from: https://lacrossetribune.com/news/local/i--rest-area-near-bangor-will-close/article_5e16b35e-4b14-5fc3-aac9-2c93cffd1745.html
104. Wisconsin Department of Transportation (2016). Rest Area and Wayside Implementation Plan. Retrieved February 2019 from: https://trust.dot.state.wi.us/ftp/dtsd/bhm/roadside-facilities/Roadside-Fac-Needs-Study/WisDOT_RFNS_Volume_2_Rest_Area_Wayside_Implementation_Plan-p.pdf
105. Learned, N. (2017). Wyoming DOT Expands Wi-Fi Access to Rest Areas Along I-25. Retrieved February 2019 from: https://k2radio.com/wyoming-dot-expands-wi-fi-access-to-rest-areas-along-i-25/
106. United States Code, Title 23, Section 111, United States Congress, 1956.
107. Associated Press (2017). Gov. Ducey wants Federal government to allow private business at AZ rest stops. Retrieved February 2019 from: https://www.abc15.com/news/state/gov-ducey-wants-federal-government-to-allow-private-business-at-az-rest-stops
108. Euritt, M.A., R. Harrison, and S. Grant (1992). Feasibility of Safety Rest Area Commercialization in Texas: Final Report. University of Texas – Austin, Center for Transportation Research, Texas DOT, FHWA, Austin, TX.

109. Petroleum Marketers Association of America (2011). Interstate Rest Area Commercialization.
110. Neuman, T.W. (2019). NATSO Urges House T&I Committee to Maintain Prohibitions on Commercial Rest Areas, Tolling in Infrastructure Legislation. Retrieved May 2019 from: https://www.natso.com/topics/natso-outlines-policy-priorities-for-ti-committee
111. Federal Highway Administration (2011). ACTION: Rest Area Sponsorship Policy Interpretation.
112. Federal Highway Administration (2006) Interstate Oasis Program: FHWA Docket No. FHWA-2006-23550.
113. Federal Highway Administration (2021). Highway Performance Monitoring System. Retrieved August 2021 from: https://www.fhwa.dot.gov/policyinformation/hpms.cfm
114. Nevada Department of Transportation. Geospatial Data. Retrieved August 2021 from: https://www.dot.nv.gov/doing-business/about-ndot/ndot-divisions/engineering/location/geospatial-data
115. Stamatiadis, N., A. Kirk, D. Hartman, J. Jasper, S. Wright, M. King, and R. Chellman (2018). NCHRP Research Report 855: An Expanded Functional Classification System for Highways and Streets. Transportation Research Board, Washington, D.C.
116. Nevada Department of Transportation. TRINA Traffic Information System. Retrieved August 2021 from: https://www.arcgis.com/apps/webappviewer/index.html?id=278339b4605e4dda8da9bddd2fd9f1e9
117. American Association of State Highway and Transportation Officials (2018). A Policy on Geometric Design of Highways and Streets.
118. Google, LLC., Google Maps. Retrieved August 2021 from: https://www.google.com/maps.
119. Nevada Department of Transportation (2019). Speed Limit Map. Retrieved August 2021 from: https://www.dot.nv.gov/home/showpublisheddocument/17053/637069878487100000
120. Bl, M., R. Andrasik, J. Sedonik, and V. Cicha (2018). ROCA – An ArcGIS Toolbox for Road Alignment Identification and Horizontal Curve Radii Computation. PLOS ONE 13(12): e0208407. Retrieved August 2021 from: https://doi.org/10.1371/journal.pone.0208407
121. Nevada Department of Transportation (2019). Road Design Guide. Retrieved August 2021 from: https://www.dot.nv.gov/home/showpublisheddocument?id=16066
122. Nevada DOT. Traffic Crash Data. Retrieved August 2021 from: https://www.dot.nv.gov/safety/traffic-crash-data
123. United States Department of Transportation (2022). USDOT National Roadway Safety Strategy. Retrieved June 2022 from: https://www.transportation.gov/nrss/usdot-national-roadway-safety-strategy
124. American Association of State Highway and Transportation Officials (2010). Highway Safety Manual, First Edition.
125. National Safety Council. Guide to Calculating Costs. Retrieved August 2021 from: https://injuryfacts.nsc.org/all-injuries/costs/guide-to-calculating-costs/data-details/
126. United States Office of Management and Budget (OMB) Circular A-94: Guidelines and Discount Rates for Benefit-Cost Analysis Of Federal Programs

# APPENDICES

**Schedule of Appendices**

| Appendix | Description |
|---|---|
| **A** | Heat Maps of Road User Services Provided by Nevada DOT Rest Areas and Comparable Private Facilities |
| **B** | Maps of Areas with Unmet Needs |
| **C** | Summary of Assessment and Recommendations for Nevada DOT's Rest Area System |
| **D** | Summary Sheets for Nevada DOT Rest Areas |

# Appendix A: Heat Maps of Road User Services Provided by Nevada DOT Rest Areas and Comparable Private Facilities

**This page intentionally left blank**

**Figure A-1. Heat Map of All NDOT Rest Areas (N=33) and Private Comparable Facilities (N=2,313)**

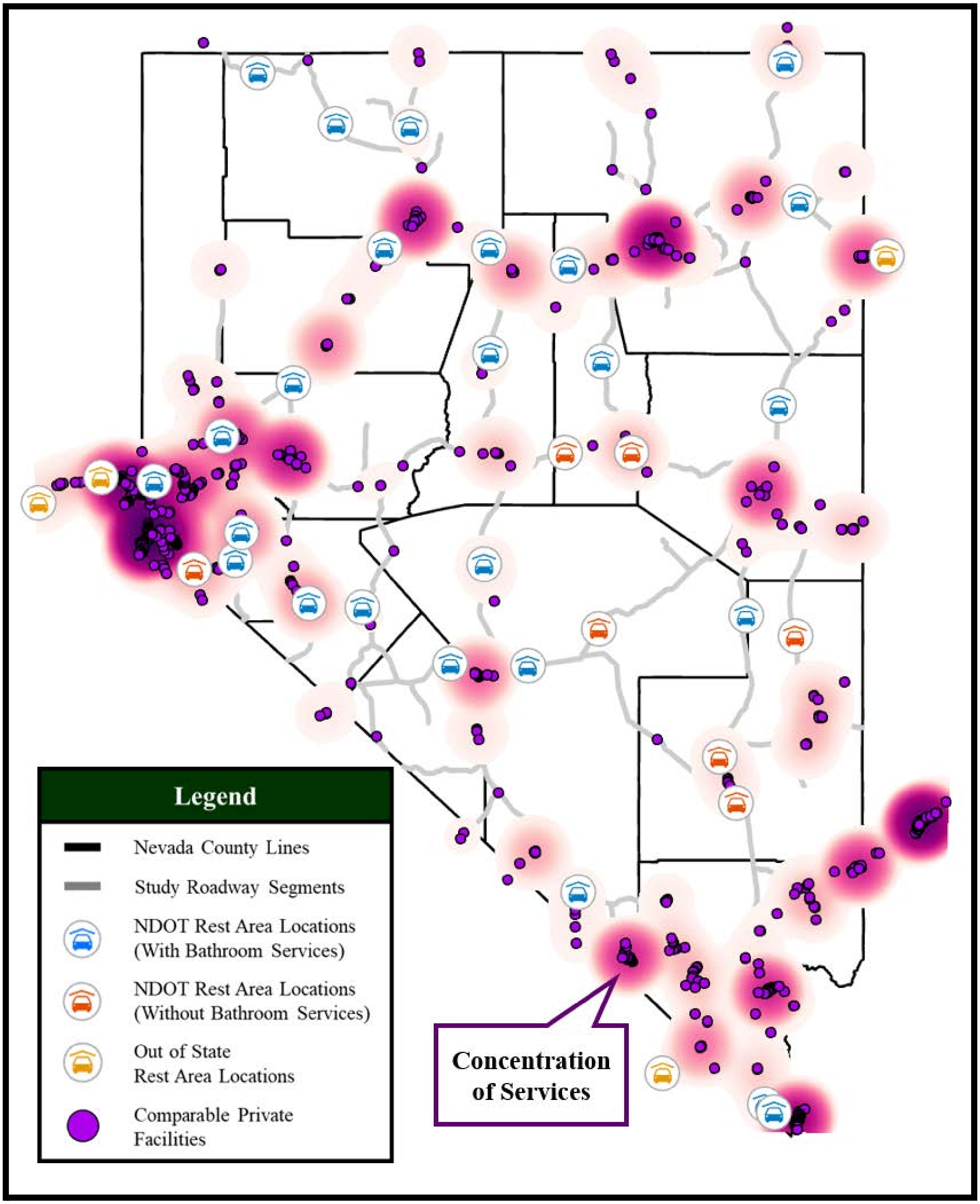


**Figure A-2. Heat Map of Truck Parking Spaces Provided by NDOT Rest Areas (N=27) and Private Comparable Facilities (N=88) with Truck Annual Average Daily Traffic**

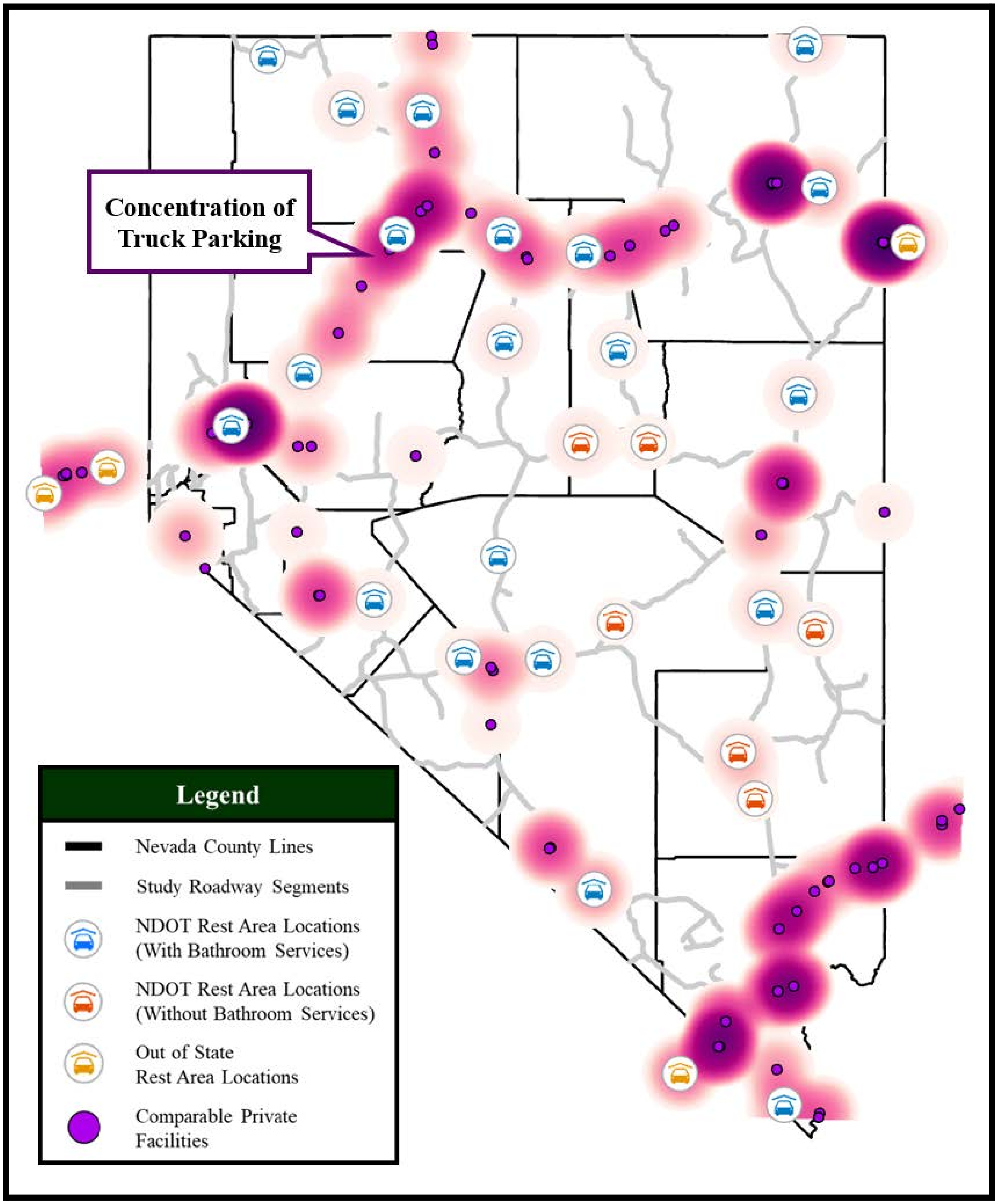


**Figure A-3. Heat Map of NDOT Rest Areas (N=26) and Private Comparable Facilities (N=2,082) which Include Bathroom Facilities**

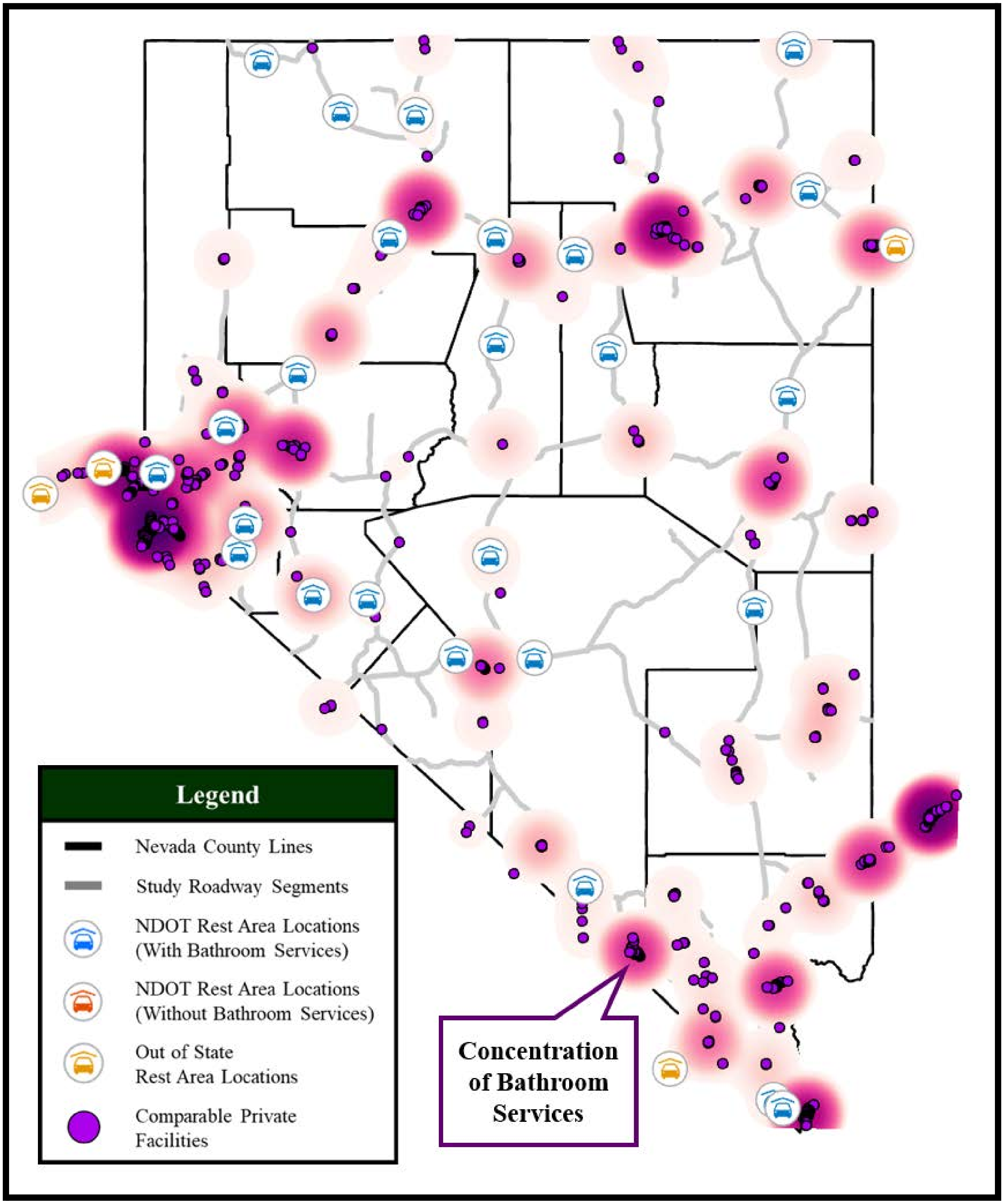


**Figure A-4. Heat Map of Private Comparable Facilities (N=1,093) which Provide Prepared Meals**

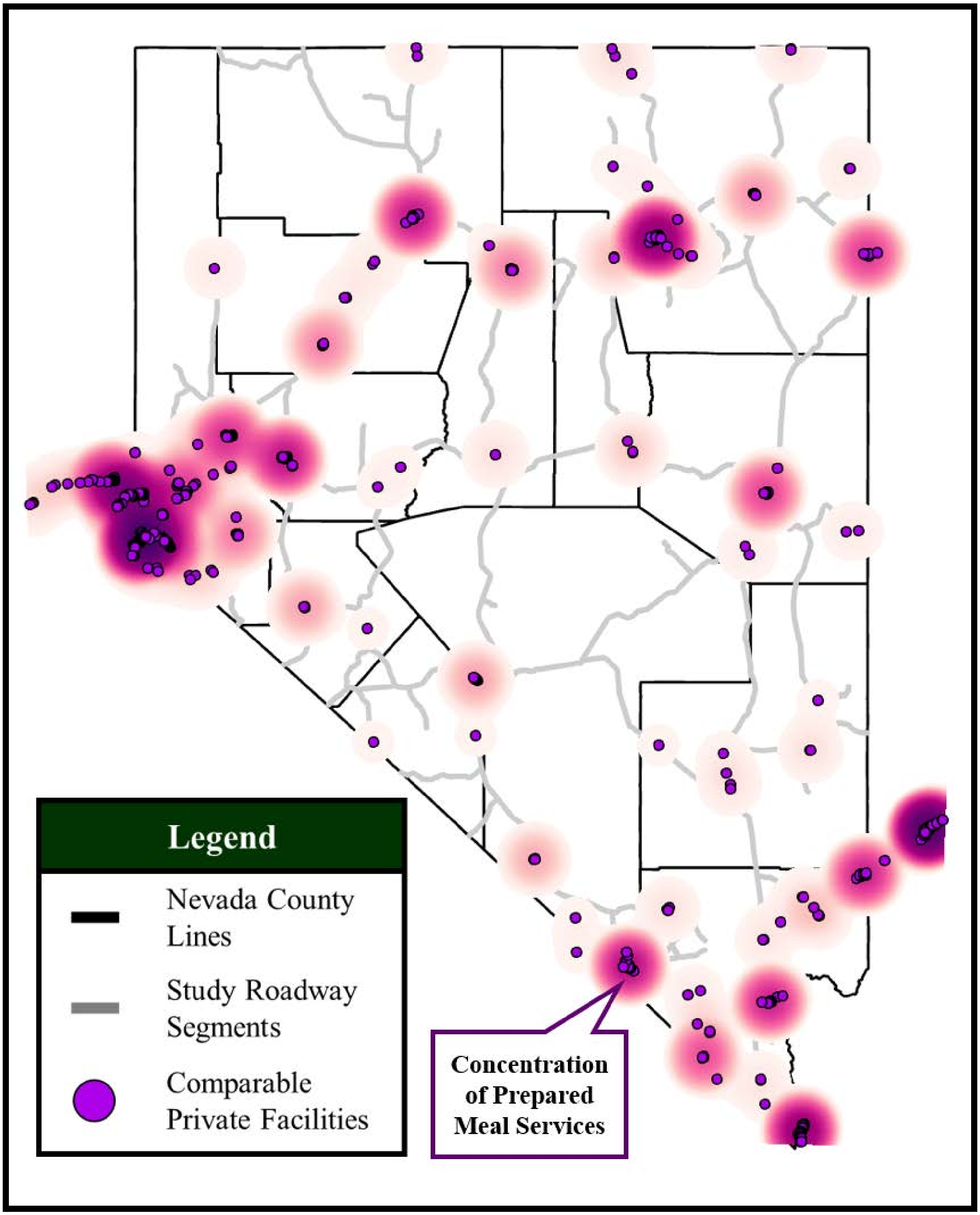


**Figure A-5. Heat Map of Private Comparable Facilities (N=297) which Provide Fuel**

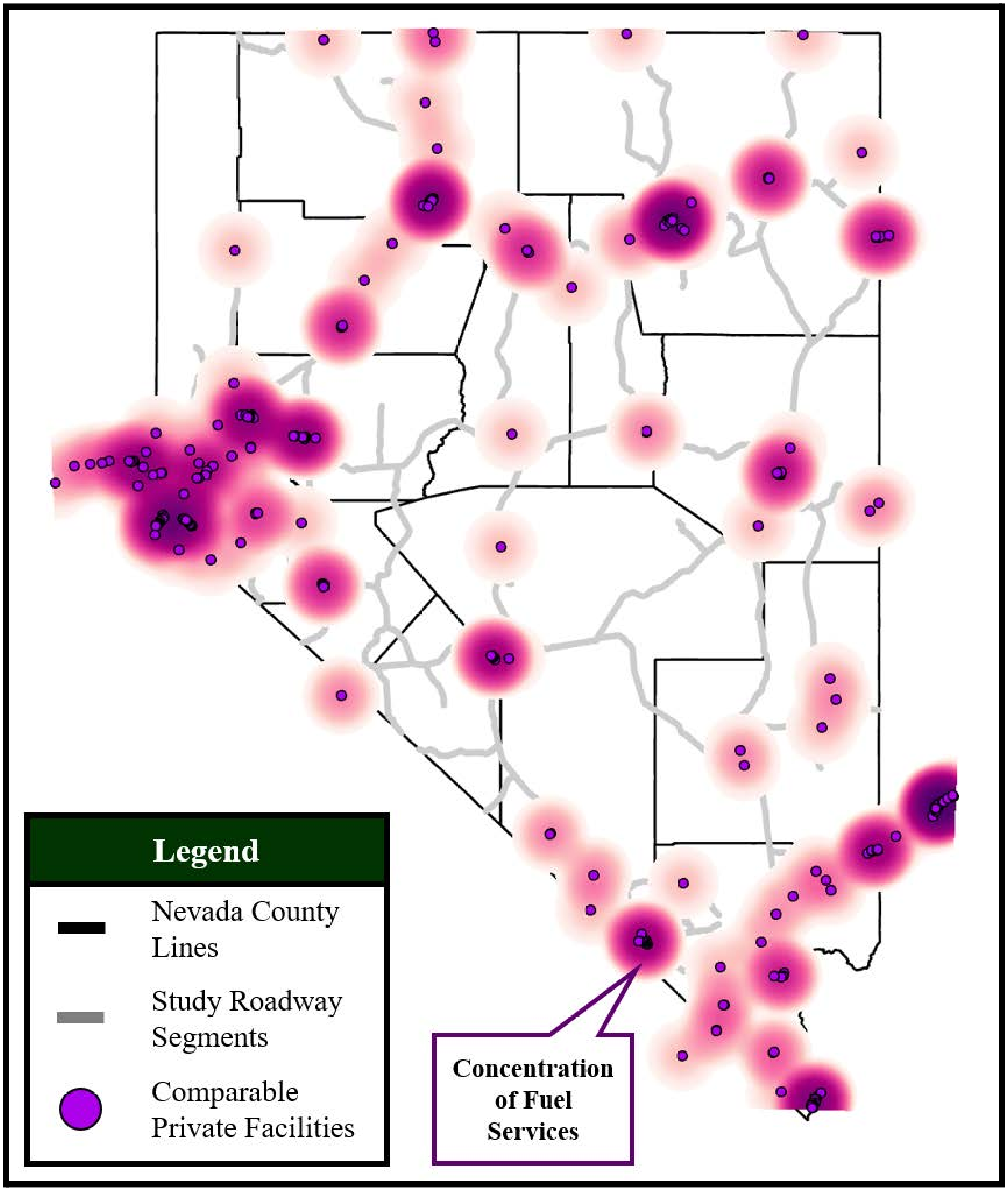
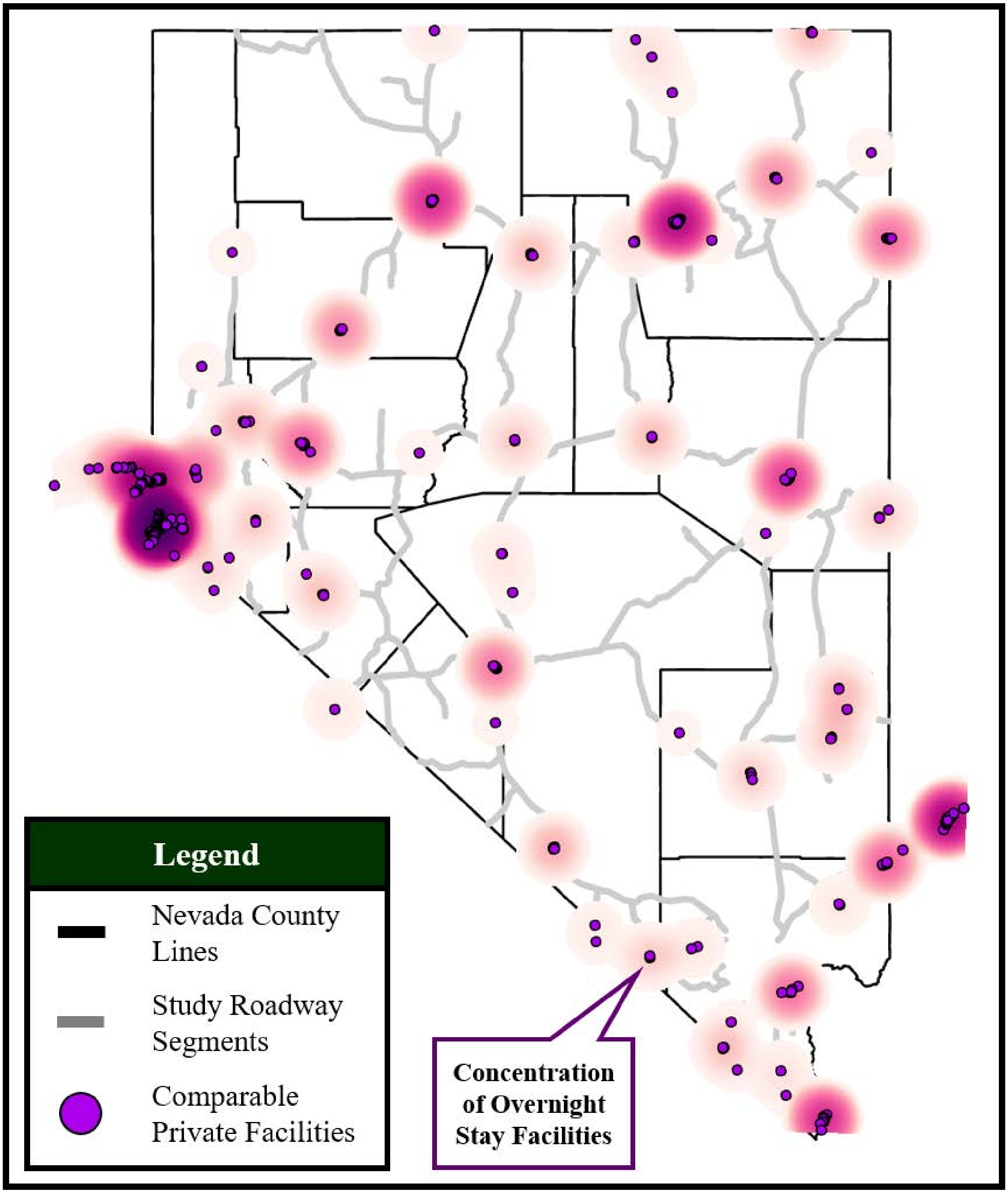


**Figure A-6. Heat Map of Private Comparable Facilities (N=554) which Provide Overnight Stays**



# Appendix B: Maps of Areas with Unmet Needs

**Figure B-1. Map of Area with Unmet Needs: US-93/US-93A/NV-229 North of Ely**

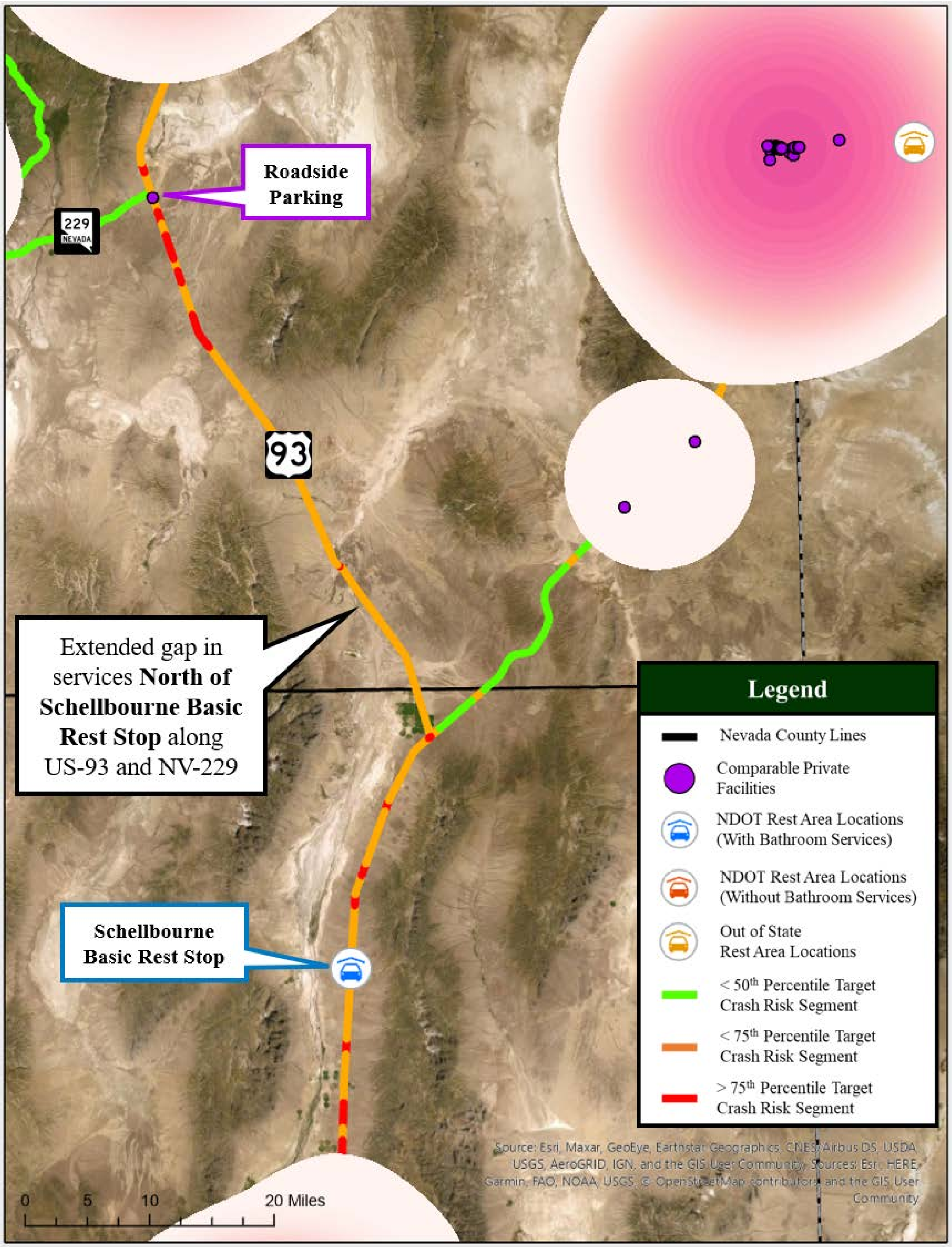


**Figure B-2. Map of Area with Unmet Needs: US-93 North of Wells**

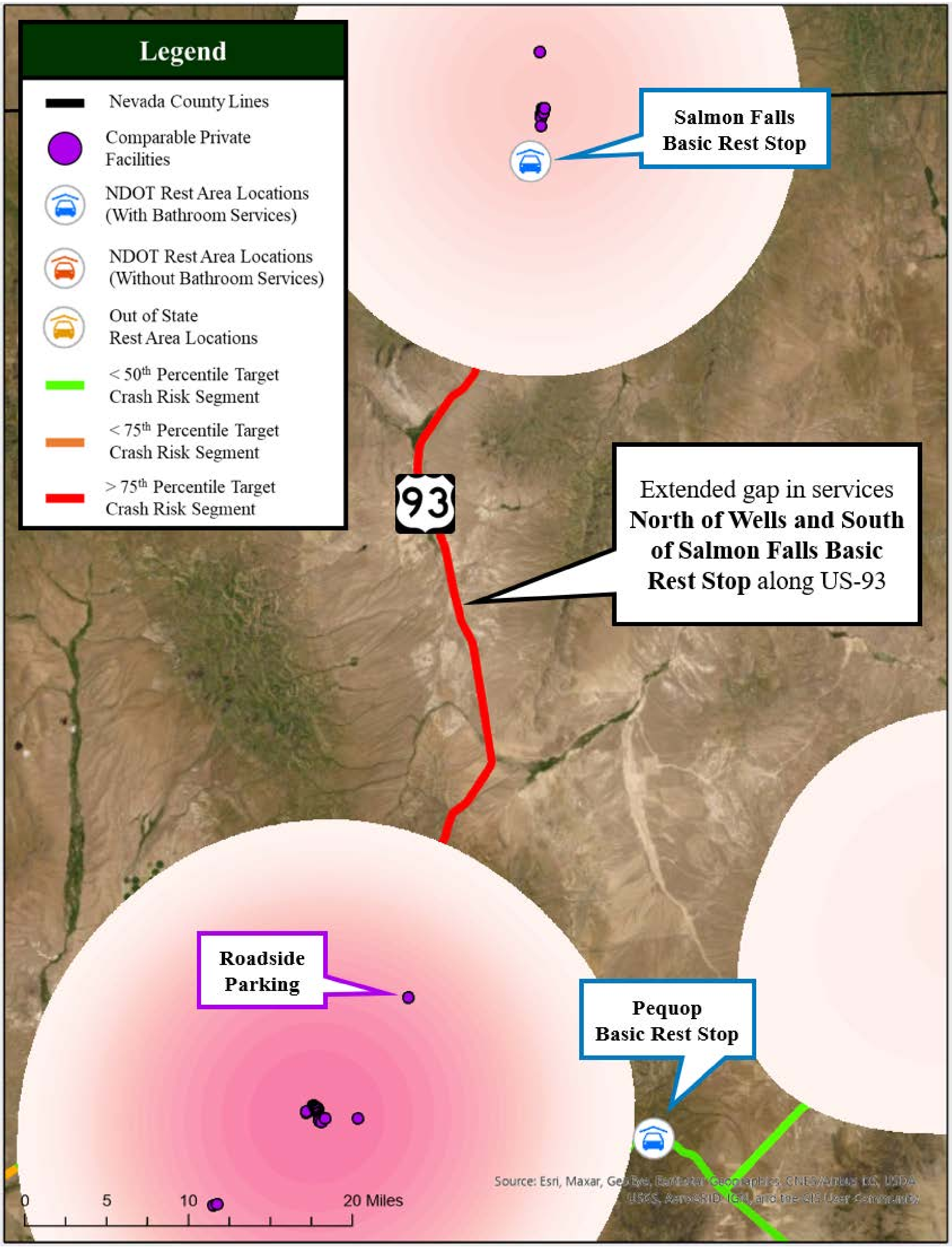


**Figure B-3. Map of Area with Unmet Needs: US-6, US-95, NV-264, NV-265, and NV-360 West of Tonopah**

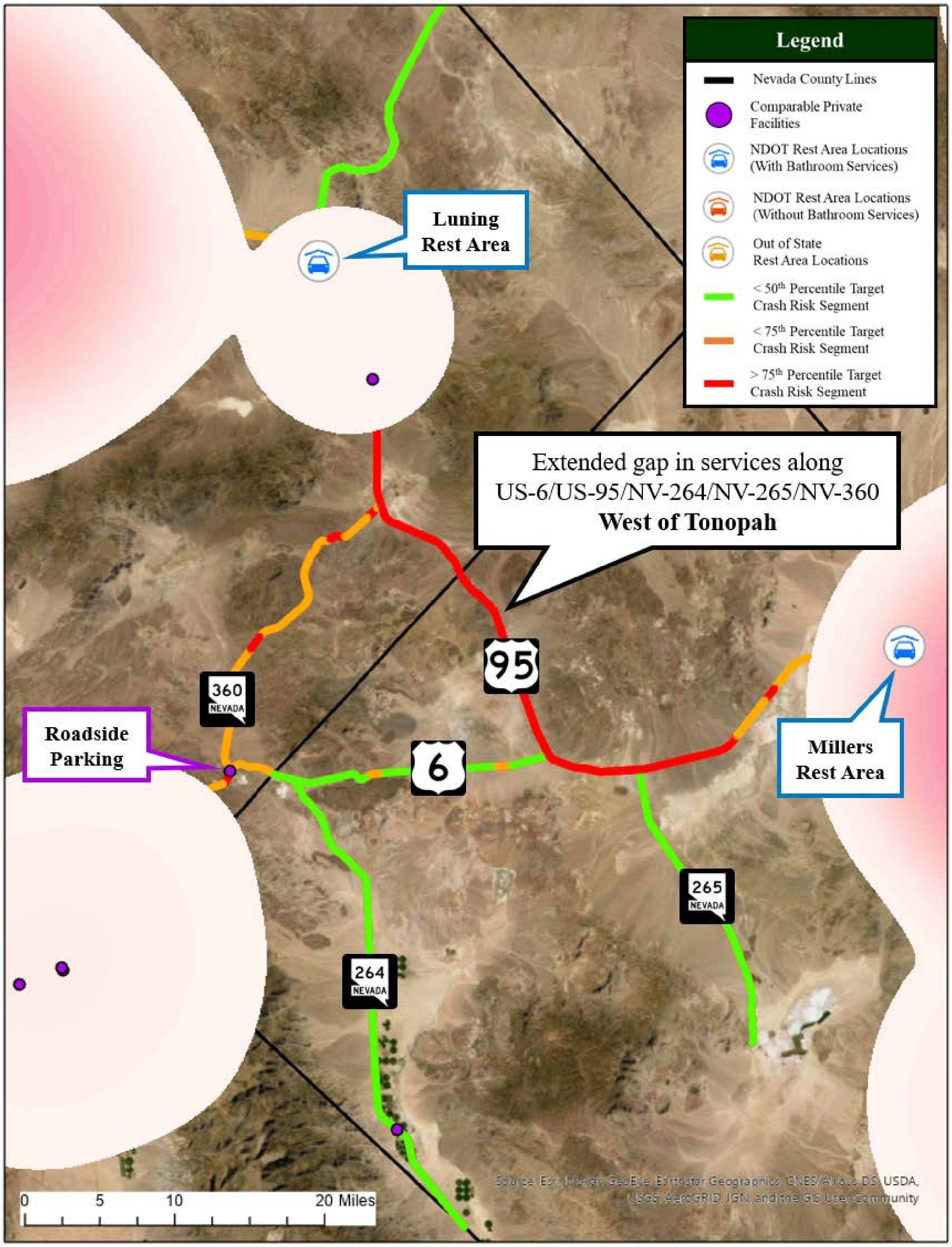


**Figure B-4. Map of Area with Unmet Needs: US-95, NV-266, and NV-267 South of Goldfield**

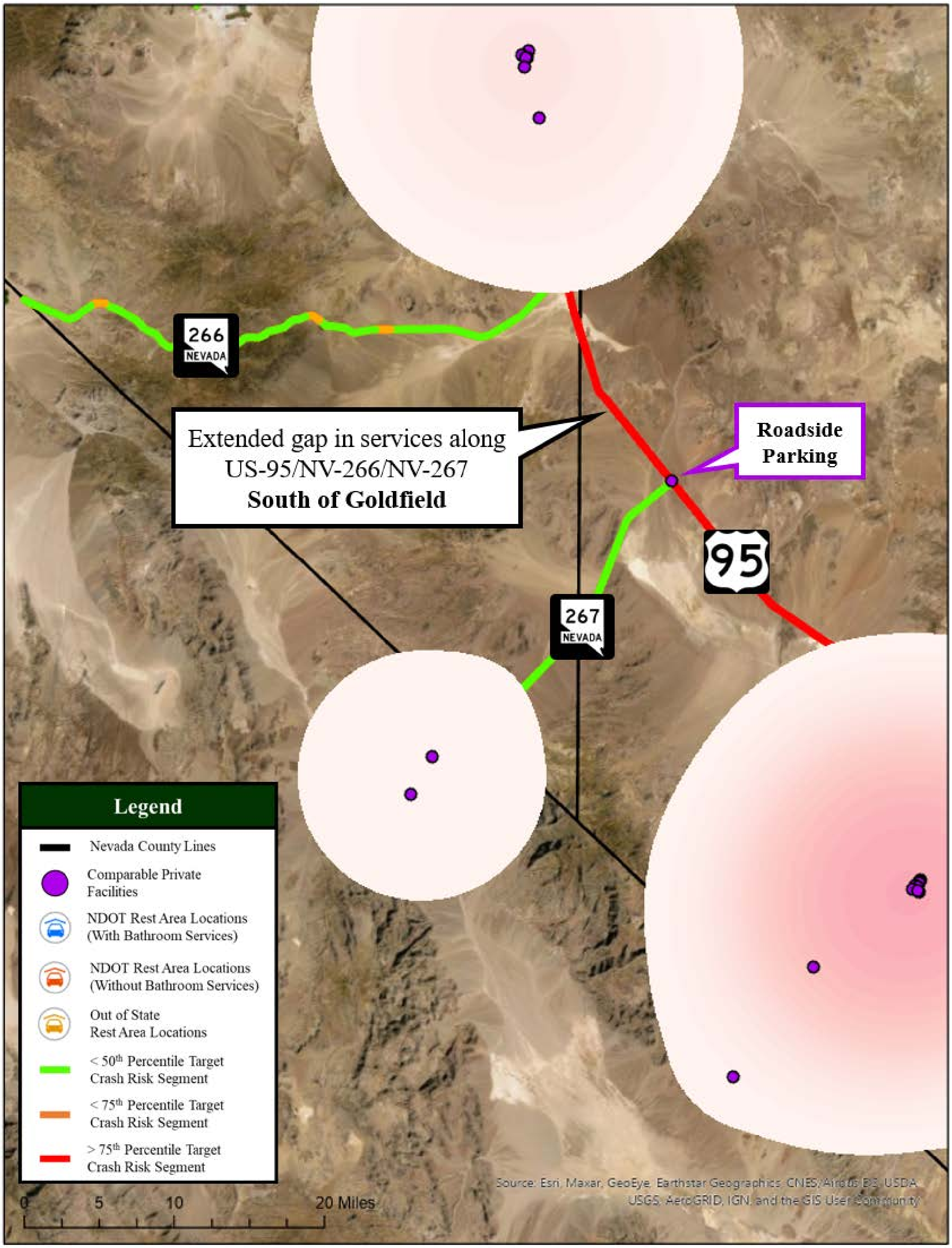


**Figure B-5. Map of Area with Unmet Needs: US-93 North of Pioche**

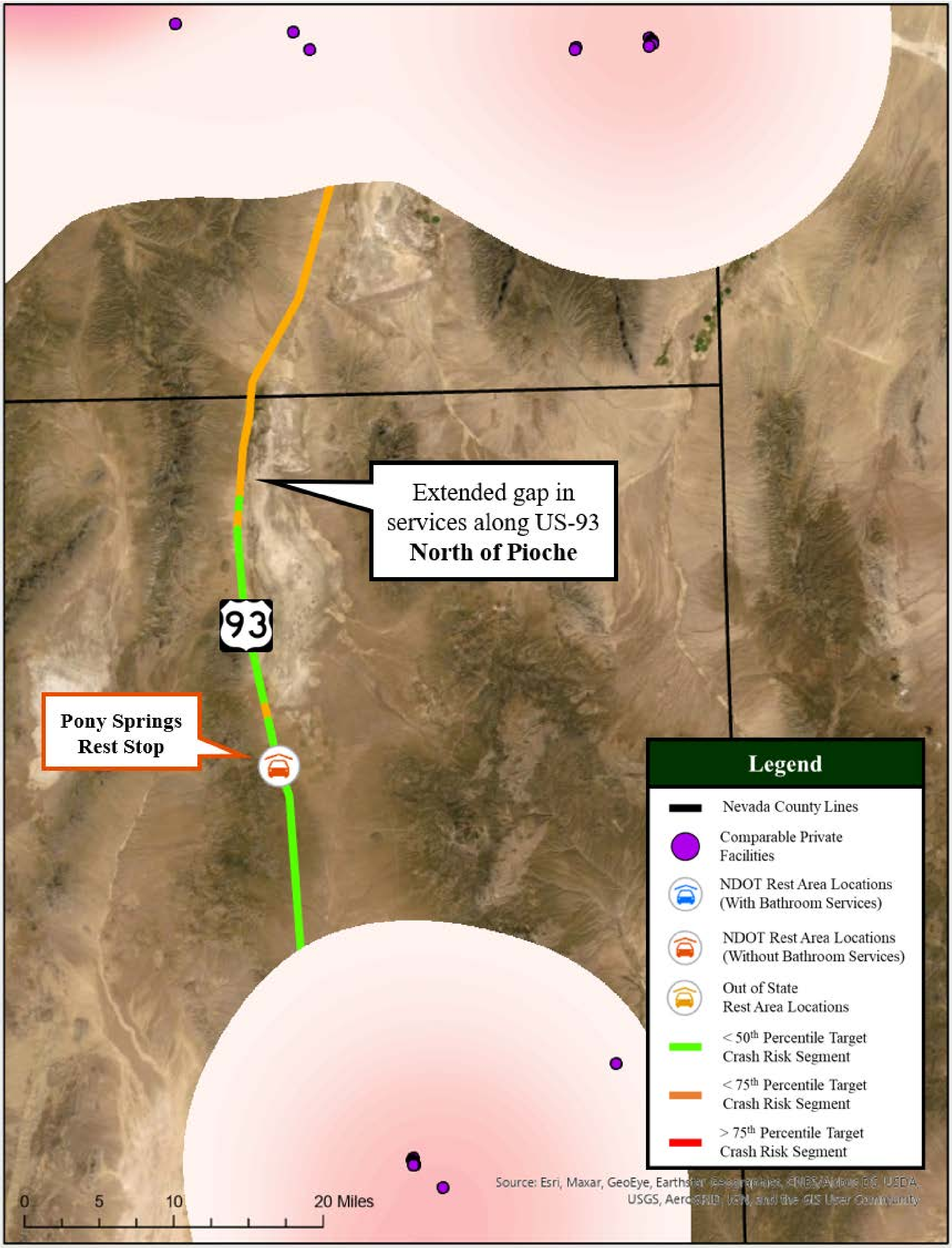


**Figure B-6. Map of Area with Unmet Needs: US-6, NV-375, and NV-379 East of Tonopah**

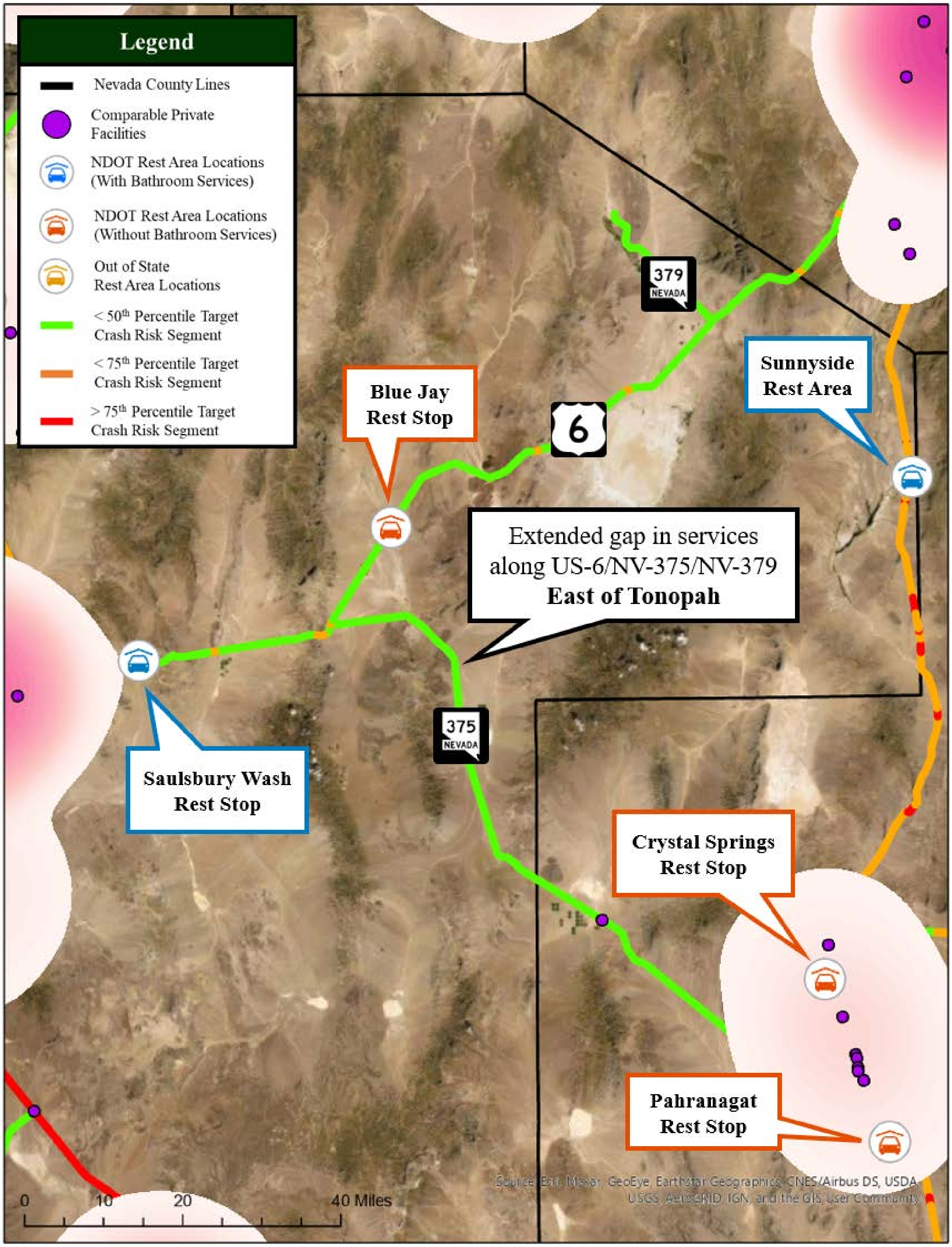


**Figure B-7. Map of Area with Unmet Needs: US-50, NV-361, and NV-121 East of Fallon**

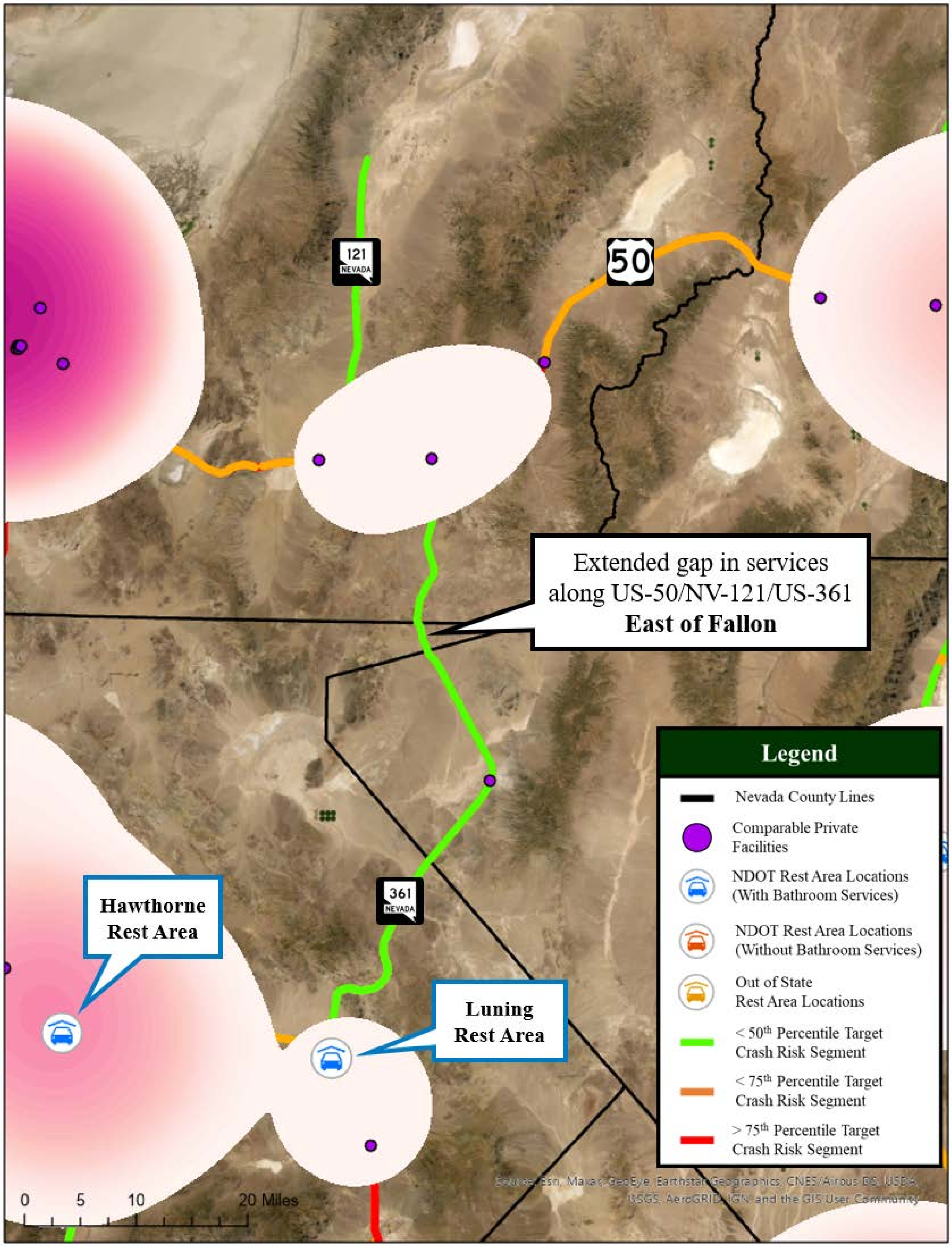


**Figure B-8. Map of Area with Unmet Needs: NV-447 North of Nixon**

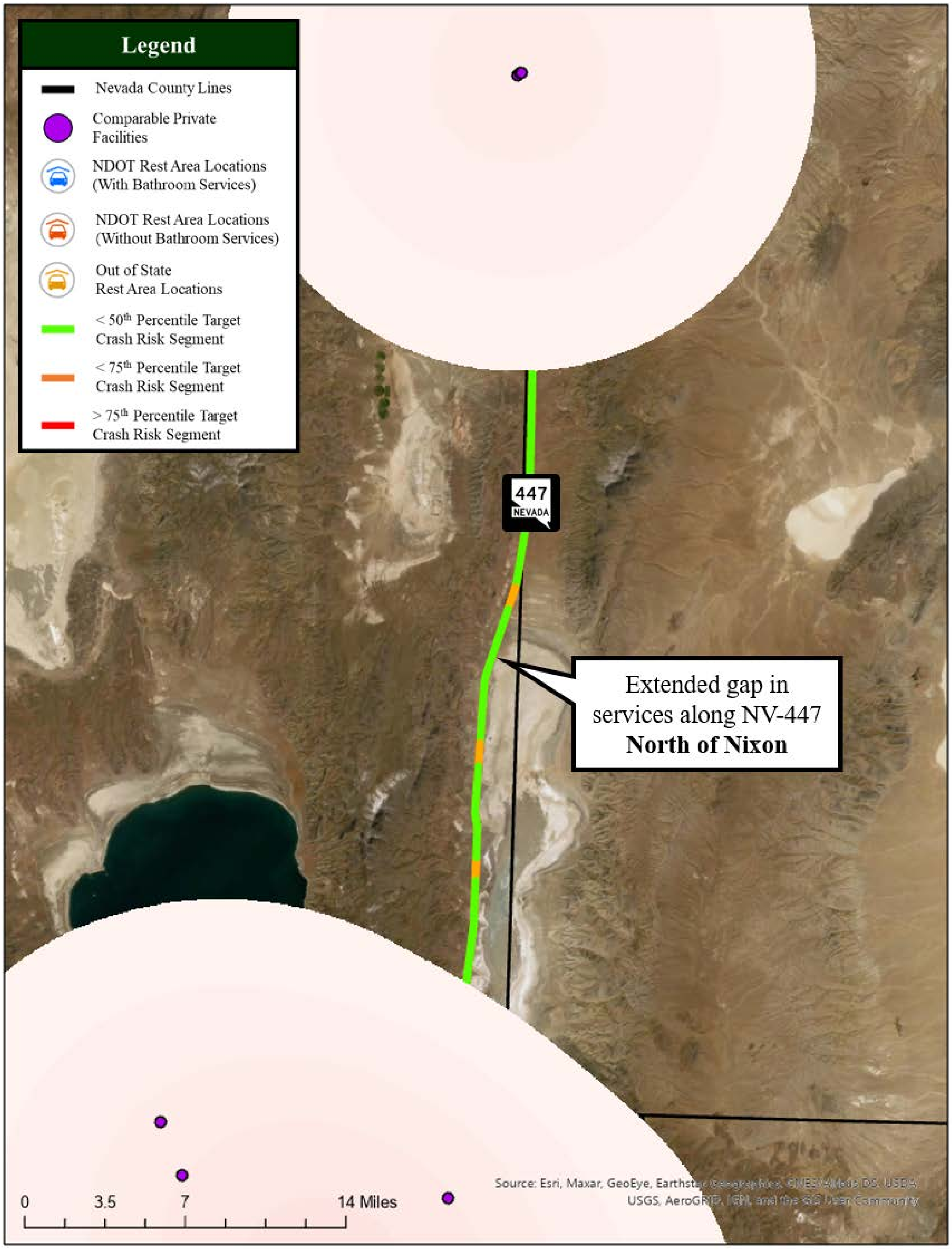


**Figure B-9. Map of Area with Unmet Needs: US-50 East of Eureka**

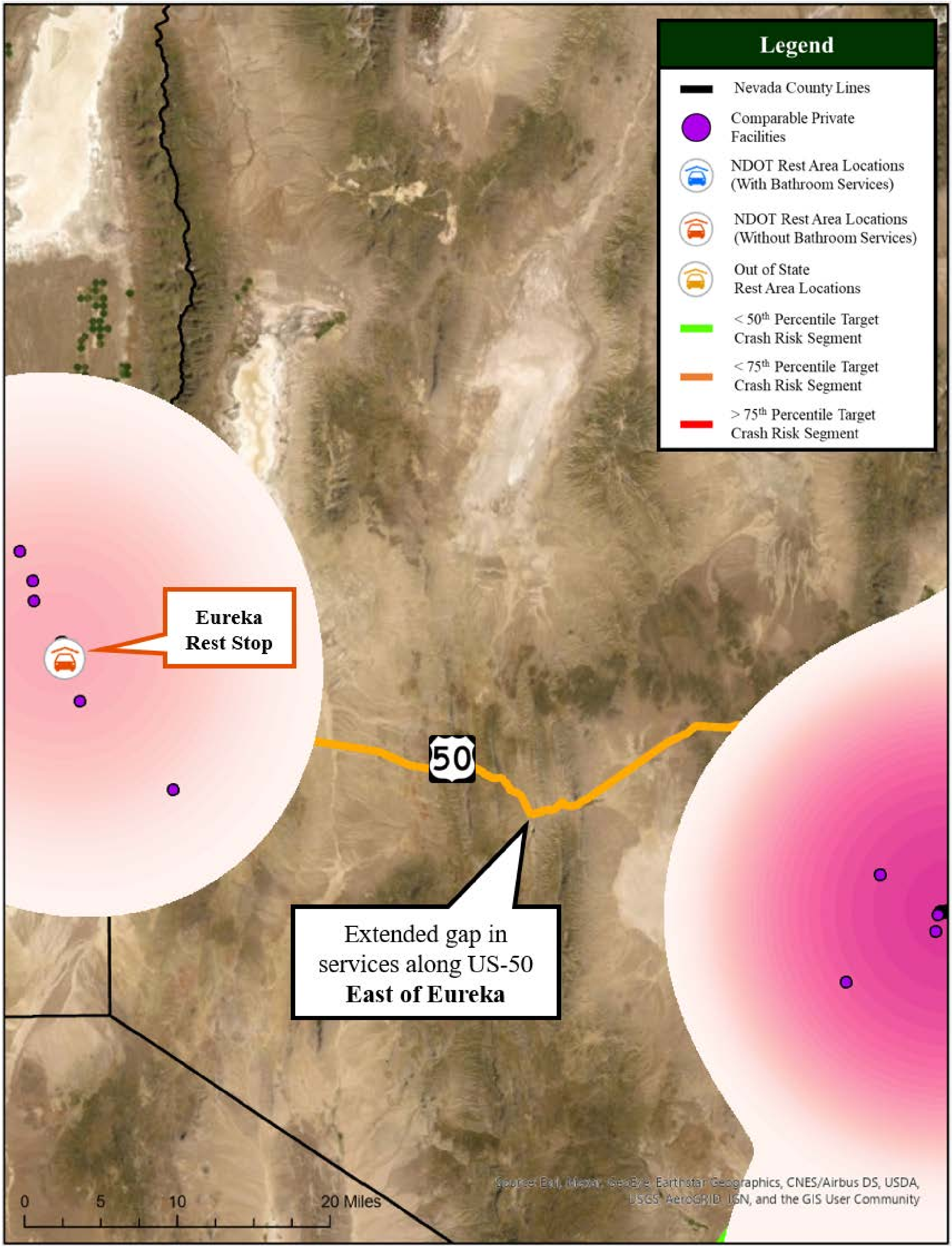
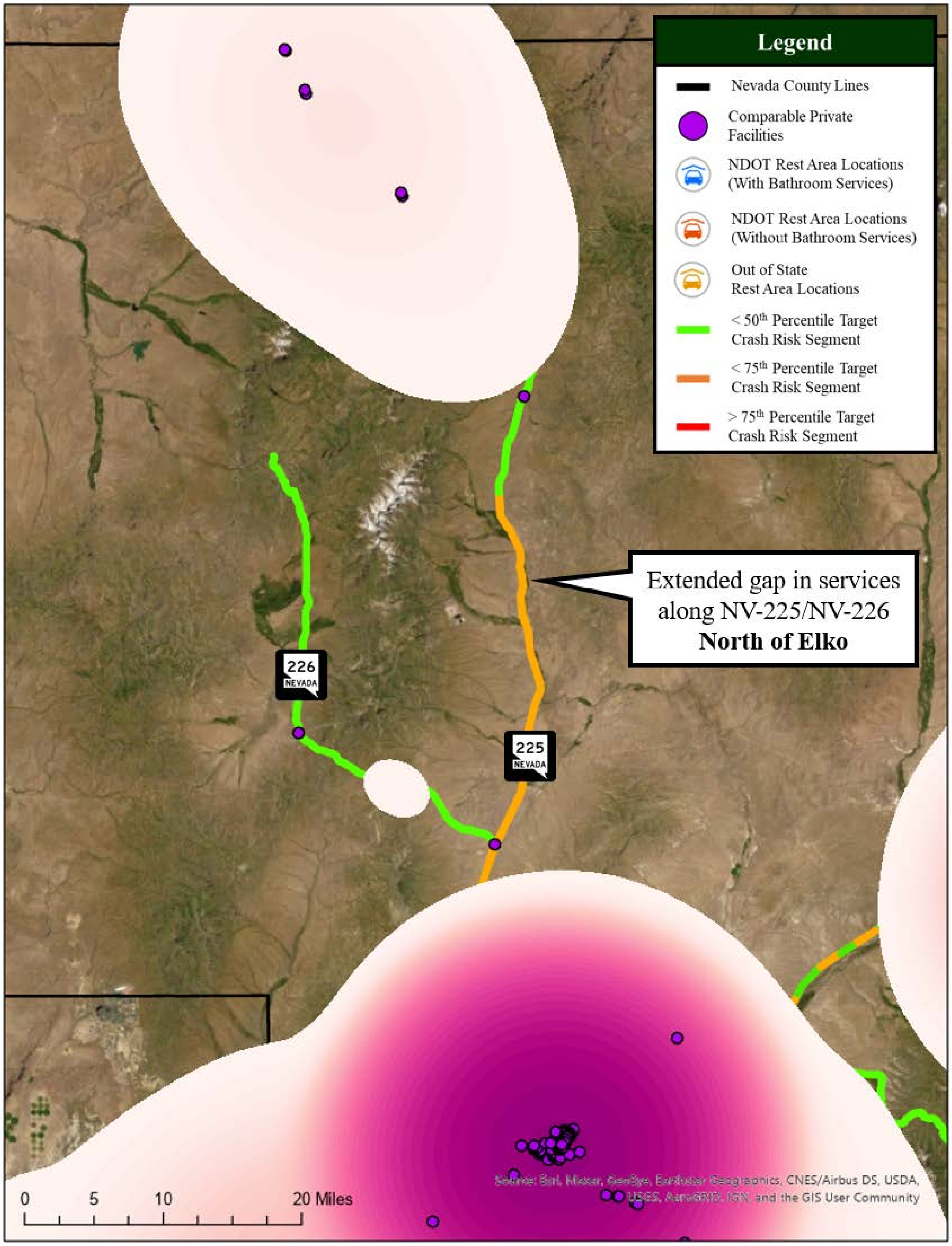


**Figure B-10. Map of Area with Unmet Needs: NV-225 and NV-226 North of Elko**



# Appendix C: Summary of Assessment and Recommendations for Nevada DOT's Existing Rest Areas

| Facility Name | Level of Importance | MSU Recommendation | Details |
|---|---|---|---|
| **Amargosa Rest Area** | **Moderate** | **Continue to Maintain** | The Amargosa Rest Area is located at the junction of US-95 and NV-375 southeast of Beatty. While the rest area is located adjacent to other private comparable facilities, there is otherwise a 70-mile gap in services between Beatty and Indian Springs outside of Amargosa Valley. Amargosa helps to reduce fatigue-related target crashes along portions of US-95 (3,050 vehicles per day, including 577 trucks), NV-160 (1,450 vehicles per day, including 76 trucks), and NV-375 (810 vehicles per day).<br><br>**The department should continue to maintain this rest area as it helps to address a gap in services between Beatty and Indian Springs outside of the adjacent private comparable facilities. However, it is recognized that given that there are other facilities within a reasonable distance this location provides comparatively moderate value to the NDOT system.** |
| **Bean Flat Rest Stop** | **Low** | **Consider Improvements** | The Bean Flat Rest Stop is located between Austin and Eureka along US-50. Bean Flat helps to reduce fatigue-related target crashes along US-50 (620 vehicles per day, including 84 trucks). It is important to note that the rest stop does not include bathroom services and is located along a 70-mile gap in bathroom services along US-50.<br><br>**While the rest stop is centrally located within a corridor between Austin and Eureka where there is an existing gap in traveler services, Beat Flat does not include bathroom services and therefore currently provides only a low level of value to the system. The department should consider improvements to Bean Flat Rest Stop to incorporate bathroom services to close the large gap present in this area.** |
| **Beowave Rest Areas (Eastbound and Westbound)** | **High** | **Continue to Maintain** | The Beowave Rest areas located between Battle Mountain and Tyrol serve a critical within the transportation network along I-80. These rest areas help to reduce fatigue-related target crashes along I-80 (8,100 vehicles per day, including 2,387 trucks). Additionally, without the Beowave Rest Areas there would be a 50-mile gap in bathroom services along I-80. The westbound rest area serves approximately 272 vehicles per day and the eastbound rest area serves approximately 294 vehicles per day. Both rest areas tend to serve larger entering volumes in the summer months.<br><br>**These facilities provide a high level of value to NDOT's rest area system, and they should continue to be maintained by the department. Per discussions with the NDOT team, it should be noted that these rest areas have been selected for reconstruction.** |

| Facility Name | Level of Importance | MSU Recommendation | Details |
|---|---|---|---|
| **Big Smoky Rest Stop** | **High** | **Continue to Maintain** | The Big Smoky Rest Area is located between Austin and Tonopah along NV-376. The rest stop is centrally located within a 110-mile corridor where there are limited services outside of a small concentration in Carvers, adjacent to the rest stop. The facility helps to reduce fatigue-related crashes along NV-376 (1,200 vehicles per day, including 116 trucks) and NV-377 (110 vehicles per day).<br><br>**This rest stop provides a high level of value to NDOT's rest area system and should continue to be maintained by the department given its location along this 110-mile corridor where there are limited private comparable facilities available. If relocation were considered at the end of the current service life, moving the rest stop either north along NV-376 (near the Lander/Nye County Line) or south along NV-376 (near Mile Maker 26) could help to reduce the overall gaps in traveler services while providing similar safety performance.** |
| **Blue Jay Rest Stop** | **Low** | **Consider Relocation or Improvements** | The Blue Jay Rest Stop is located along US-6 in between Tonopah and Ely. While the rest stop is centrally located within an area with unmet needs, Blue Jay only offers parking and basic services with no restrooms. The facility helps to reduce fatigue-related target crashes along US-6 (250 vehicles per day, including 34 trucks) and NV-375 (200 vehicles per day, including 17 trucks).<br><br>**While the rest stop is located along a corridor which has an existing gap in bathroom services of approximately 140 miles, the facility provides only a relatively low level of value to NDOT's rest area system given the lack of bathroom services. The department should consider improvements to the rest stop which include bathroom services.**<br><br>**Alternatively, moving the facility northeast to the junction of US-6 and NV-379 could help to reduce the overall gaps in traveler services to installing bathrooms at the current location. The department could also consider both modifications in tandem if sufficient budget were available.** |

| Facility Name | Level of Importance | MSU Recommendation | Details |
|---|---|---|---|
| **Cosgrave Rest Area** | **High** | **Continue to Maintain** | The Cosgrave Rest Area is located southwest of Winnemucca and serves a critical role within the transportation network, helping to reduce fatigue-related target crashes along I-80 (9,300 vehicles per day, including 2,736 trucks). Additionally, without Cosgrove Rest Area there would be a 20-mile gap in services along I-80. The rest area serves approximately 260 vehicles per day, with volumes tending to be larger during summer months.<br>**This rest area should continue to be maintained by the department as it provides a high level of value to the NDOT system. It should also be noted that the rest area was constructed in 1969 and could be due for reconstruction.** |
| **Crystal Springs Rest Stop** | **Low** | **Consider Relocation or Improvements** | The Crystal Springs Rest Stop is located at the junction of US-93, NV-375, and NV-318. The rest stop is located on the outside edge of a horizontal curve and immediately adjacent to an intersection. The location only includes basic services (including picnic tables) and does not provide bathroom facilities. The facility helps to reduce fatigue-related target crashes along US-93 (2,000 vehicles per day, including 432 trucks), NV-318 (1,750 vehicles per day, including 216 trucks), and NV-375 (340 vehicles per day, including 17 trucks).<br>**While the convergence of the three routes allows for Crystal Springs Rest Stop to provide services for a considerable portion of Nevada's rural highway network, the lack of bathroom services results in the facility providing a relatively low level of value to the system. The department should consider improving the facility to include bathroom services and move the rest stop away from the horizonal curve in a similar location near the junction.** |
| **Eureka Rest Stop** | **Low** | **Consider Relocation or Improvements** | The Eureka Rest Stop is located just south of Eureka along US-50. The facility helps to reduce fatigue-related target crashes along US-50 (1,100 vehicles per day, including 149 trucks) and NV-278 (650 vehicles per day, including 76 trucks). The facility currently does not provide bathroom services and is located within a rural town where there are other private comparable facilities available.<br>**Therefore, Eureka Rest Stop currently provides a relatively low level of value to the NDOT system. While upgrading the facility to include bathroom services would represent an improvement over the existing condition, the department should consider constructing an improved rest stop with bathroom services to the southeast along US-50 (near Mile Maker 31) to provide better coverage of an area with a gap in services.** |

| Facility Name | Level of Importance | MSU Recommendation | Details |
|---|---|---|---|
| **Garden Valley Rest Stop** | **High** | **Continue to Maintain** | The Garden Valley Rest Stop is located north of Eureka along NV-278. The rest stop critical to the transportation network as it is located within the center of a 55-mile gap in concentrations of existing traveler services. The facility helps to reduce fatigue-related target crashes along NV-278 (650 vehicles per day, including 76 trucks).<br><br>**The facility provides a high level of value to NDOT's system and should continue to be maintained by the department. It should be noted that without its presence there would be an approximate 85-mile gap in services along NV-278.** |
| **Hawthorne Rest Area** | **Moderate** | **Consider Relocation or Improvements** | The Hawthorne Rest Area is located at the junction of US-95 and NV-359 near the state border. It is important to note that the facility is located within a developed area where there is a concentration of available private comparable facilities. The facility helps to reduce fatigue-related target crashes along US-95 (3,550 vehicles per day, including 478 trucks) and NV-359 (460 vehicles with limited truck traffic). The rest area is located within the same parcel as a veteran's park and a dog park.<br><br>**The rest area does provide a moderate value to the NDOT system given it provides coverage along both US-95 and NV-359 as well as the basic traveler information for road users entering the state via NV-359. However, given the proximity of private comparable facilities located in Hawthorne as well as the age of the facility (constructed in 1968), the rest area could be considered for either relocation or improvements by the department. This could include relocating the facility to the northwest along US-95 (near Mile Marker 3 in Churchill County) outside of the developed area to help to address a gap in bathroom facilities between Hawthorne and Fallon. It should be noted that the rest area could be constructed as a basic rest stop to control costs.** |
| **Laughlin Brake Check** | **High** | **Continue to Maintain** | The Laughlin Brake Check is located west of Laughlin along NV-163. NV-163 serves approximately 4,800 vehicles per day, including 594 trucks. The brake check does include a bathroom facility.<br><br>**Given the function of the brake check which varies from a traditional roadside rest area, the department should continue to maintain the facility which represents an important safety component of the transportation network.** |

| Facility Name | Level of Importance | MSU Recommendation | Details |
|---|---|---|---|
| **Leonard Creek Rest Stop** | **Moderate** | **Continue to Maintain** | The Leonard Creek Rest Stop is located in northwest Nevada along NV-140, south of the junction with NV-292. While this rest stop does represent the only bathroom facility between the junction with NV-292 and west of US-95, NV-140 serves only 400 vehicles per day along the corridor, including 70 trucks.<br>**This rest stop should continue to be maintained by the department as without its presence there would be an approximate 75-mile gap in services. However, it is recognized that given the limited traffic volumes served by NV-140 along this corridor this location provides comparatively moderate value to the NDOT system.** |
| **Log Cabin Rest Area** | **Low** | **Consider Relocation or Improvements** | The Log Cabin Rest Area is located at the junction of US-95 Alternate and NV-339 in Yerington. US-95A serves approximately 6,900 vehicles per day along the corridor, including 933 trucks. NV-339 serves approximately 1,850 vehicles per day along the corridor, including 248 trucks. While the facility is located within an area where there is a concentration of available traveler services, there is a gap in truck parking availability in the vicinity of the rest area.<br>**Given that there is a concentration of other services available in close proximity to Log Cabin Rest Area, the facility provides comparatively low value to the NDOT system. Additionally, the rest area provides only limited opportunity for a truck to park and there is a gap in truck parking availability in the area around Yerington. As the facility was constructed in 1967 is likely nearing the end of its service life, consider either relocating the rest area to cover gaps in service elsewhere in the state or reconstructing Log Cabin to include truck parking facilities.** |
| **Luning Rest Area** | **High** | **Continue to Maintain** | The Luning Rest Area is located at the junction of US-95 and NV-361 east of Hawthorne. It is important to note that Luning Rest Area helps to provide coverage for two areas with unmet needs and serves an important role in the transportation network. The facility helps to reduce fatigue-related target crashes along US-95 (3,300 vehicles per day, including 442 trucks) and NV-361 (100 vehicles per day, including 14 trucks). The Luning Rest Area serves approximately 165 vehicles per day, with higher volumes observed in the summer months.<br>**Luning Rest Area provides a high level of value to NDOT's system, and the department should continue to maintain the facility.** |

| Facility Name | Level of Importance | MSU Recommendation | Details |
|---|---|---|---|
| **Millers Rest Area** | **High** | **Continue to Maintain** | The Millers Rest Area is located along US-6 west of Tonopah. It is important to note that the Millers Rest Area helps to provide coverage for an area with unmet needs and serves an important role in the transportation network. The facility helps to reduce fatigue-related target crashes along US-6 (2,400 vehicles per day, including 546 trucks). Millers Rest Area serves approximately 141 vehicles per day, with slightly larger volumes observed during the summer months.<br>**The department should continue to maintain this rest area as it helps to cover a gap in services west of Tonopah. Per discussions with the NDOT team, it should be noted that this rest area has been selected for reconstruction.** |
| **Mountain House (Holbrook) Rest Stop** | **Low** | **Consider Relocation or Improvements** | The Mountain House Rest Stop is located just north of Holbrook Junction along US-395. It is important to note that the rest stop includes only roadside parking and basic services with no rest room. Additionally, the rest stop is located along a corridor which has a number of available private comparable facilities. The facility helps to reduce fatigue-related target crashes along US-395 (7,300 vehicles per day, including 986 trucks) and NV-208 (3,500 vehicles per day with limited truck traffic).<br>**Given that Mountain House Rest Stop is located in an area where there is a concentration of traveler services provided by private comparable facilities and does not provide bathroom services, the facility currently provides a relatively low level of value to the system. The department should consider either relocating the rest stop to cover gaps in service elsewhere in the state (which would result in additional spatial coverage of traveler services) or reconstructing Mountain House to include bathroom services (which would increase the value of the facility along this relatively high-volume corridor).** |
| **Mt. Rose Rest Stop** | **High** | **Continue to Maintain** | The Mt. Rose Rest Stop is located northeast of Incline Village along NV-431. The rest stop is centrally located along NV-431 where there would otherwise be a gap of 15 miles in restroom services. The facility helps to reduce fatigue-related target crashes along NV-431 (5,050 vehicles per day, including 683 trucks). It is also worth noting there are a considerable number of horizontal curves present along NV-431.<br>**This rest stop provides a high level of value to the system given the unique nature of NV-431 which includes a number of horizontal curves which can increase the risk for fatigue-related target crashes. The facility should be maintained by the department. While not a heavy trucking route, it is worth noting that there is limited truck parking available in the** |

| Facility Name | Level of Importance | MSU Recommendation | Details |
|---|---|---|---|
| | | | **general area and the Mt. Rose Rest Stop does not provide for truck parking.** |
| **Orovada Rest Stop** | **High** | **Continue to Maintain** | The Orovada Rest Stop is located along US-95 north of Winnemucca. The rest stop is located along a corridor where there is otherwise a considerable gap in traveler services between Winnemucca and McDermitt. The facility helps to reduce fatigue-related target crashes along US-95 (2,200 vehicles per day, including 564 trucks), NV-293 (240 vehicles per day, including 33 trucks), and NV-140 (400 vehicles per day, including 70 trucks).<br><br>**The department should continue to maintain Orovada Rest Stop as it provides a high level of value to the system by covering a gap in services between Winnemucca and McDermitt.** |
| **Pahranagat Rest Stop** | **Low** | **Consider Relocation or Improvements** | The Pahranagat Rest Stop is located along US-93 north of the junction with I-15. The rest stop does not include permanent bathroom structures and is located along a corridor with a 70-mile gap in bathroom services. It should be noted that recent street view imagery suggests a portable toilet may have been placed at this location as of 2021. The facility helps to reduce fatigue-related target crashes along US-93 (2,000 vehicles per day, including 488 trucks).<br><br>**Pahranagat Rest Stop currently provides a relatively low level of value to the system given the proximity to Alamo and the lack of permanent bathroom services. The department should consider potential improvements to Pahranagat Rest Stop, including permanent bathroom structures. It should be noted that recent street view imagery from 2021 suggests a portable toilet has been placed at this location. Additionally, the department could also consider relocating the rest stop farther south along US-93 (near the Clark County Line) to increase the spatial coverage of traveler services given that private comparable facilities are available nearby in Alamo. This would also include coverage along NV-168.** |
| **Pequop Rest Stop** | **High** | **Continue to Maintain** | The Pequop Rest Stop is located within an approximate 20-mile gap in concentrations of services of between Wells and West Wendover along I-80 (5,700 vehicles per day, including 1,687 trucks), northwest of its junction with NV-233. This rest stop serves a critical role within the transportation network, helping to reduce fatigue-related crashes along the corridor, as there would be a 55-mile gap in services without its presence.<br><br>**Pequop Rest Stop provides a high level of value to the system and should continue to be maintained by the department. Given that I-80 along this corridor serves a relatively high traffic volume, this location provides traveler services for a considerable number of road users. Therefore, the department could consider** |

| Facility Name | Level of Importance | MSU Recommendation | Details |
|---|---|---|---|
| | | | **reconstructing Pequop to be a full rest area at the end of its current service life.** |
| **Pony Springs Rest Stop** | **Low** | **Consider Improvements** | The Pony Springs Rest Stop is located along US-93 north of Pioche. The rest stop does not include bathroom services and is located along a route which has a 105-mile gap in bathroom services. The facility helps to reduce fatigue related target crashes along US-93 (530 vehicles per day, including 66 trucks).<br><br>**Pony Springs Rest Stop currently provides only a relatively low level of value to the system given the lack of bathroom services. The department should consider potential improvements to Pony Springs Rest Stop, including bathroom services. Additionally, the department could also consider relocating the rest stop farther north along US-93 (closer to the Lincoln County Line) to better cover the gap in services. This modification is expected to have only a minor impact on safety performance and is only intended to identify the location which would minimize the gap in services.** |
| **Salmon Falls Rest Stop** | **Low** | **Consider Relocation** | The Salmon Falls Rest Stop is located along US-93 just south of Jackpot. The facility includes bathroom services and helps to reduce fatigue-related target crashes along US-93 (4,100 vehicles per day, including 553 trucks). While the rest a rea is in good condition, it is located adjacent to a concentration of traveler services provided by private comparable facilities near Jackpot. Additionally, the rest stop is located at the northern end of a 65-mile gap in bathroom services.<br><br>**Salmon Falls Rest Stop currently provides only a relatively low level of value to the system due to the nearby private comparable facilities. The department should consider relocation of this rest stop farther south along US-93 (near Mile Marker 108) to address an area of unmet needs.** |
| **Saulsbury Wash Rest Stop** | **Moderate** | **Continue to Maintain** | The Saulsbury Wash Rest Stop is located east of Tonopah along US-6. While US-6 serves only approximately 420 vehicles per day with limited truck traffic in this area, the rest stop represents a core component of the transportation network as there would otherwise be a 160-mile gap in bathroom services between Tonopah and Ely.<br><br>**This rest stop should continue to be maintained by the department given there would be an extended gap with no bathroom facilities east of Tonopah without its presence. However, given the limited traffic served by US-6 in this area it is recognized that this location provides comparatively moderate value to the NDOT system. A long-term consideration, contingent on the department relocating Blue Jay Rest Stop to the junction of NV-379, would be to reconstruct** |

| Facility Name | Level of Importance | MSU Recommendation | Details |
|---|---|---|---|
| | | | **Saulsbury Wash Rest Stop (after its service life has ended) near the junction of NV-375. This would help to optimize the spatial coverage of traveler services.** |
| **Schellbourne Rest Stop** | **High** | **Continue to Maintain** | The Schellbourne Rest Stop is located north of Ely along US-93. It should be noted that the rest stop is located at the southern end of an area with unmet needs and ultimately represents a critical component of the transportation network. The facility helps to reduce fatigue-related target crashes along US-93 (1,900 vehicles per day, including 254 trucks).<br><br>**The department should continue to maintain this rest area as it provides a high level of value to the system.** |
| **Southern Nevada Visitor Center** | **High** | **Continue to Maintain** | The Southern Nevada Visitor Center is located along US-95 at the southern border. The facility is relatively new (constructed in 2011) and represents an important component of the transportation system by providing traveler services to road users crossing into Nevada. Additionally, the Visitor Center helps to reduce fatigue-related target crashes along US-95 (7,500 vehicles per day, including 927 trucks). The Visitor Center serves approximately 352 vehicles per day, with lower volumes observed during the summer months.<br><br>**While the Southern Nevada Visitor Center is located in an area which has a concentration of available private comparable facilities along US-95, the department should continue to maintain the Visitor Center given the importance of the specific traveler services provided by the facility.** |
| **Sunnyside Rest Area** | **High** | **Continue to Maintain** | The Sunnyside Rest Area is located between Hiko and Ely along NV-318. The rest area is located along a corridor where there would otherwise be a 100-mile gap in any services along NV-318. The facility helps to reduce fatigue-related target crashes along NV-318 (1,600 vehicles per day, including 202 trucks).<br><br>**This rest stop provides a high level of value to the system as without its presence there would be an approximate 100-mile gap in services. The department should continue to maintain Sunnyside Rest Area.** |
| **Thousand Springs Rest Stop** | **Moderate** | **Continue to Maintain** | The Thousand Springs Rest Stop is located in northwest Nevada along NV-140. While this rest stop does represent the only bathroom facility within 30 miles west of the junction with NV-292, NV-140 serves only 350 vehicles per day with limited truck traffic along the corridor.<br><br>**This rest stop should continue to be maintained by the department as without its presence there would be an approximate 45-mile gap in services leading to the state border. However, it is recognized that given the** |

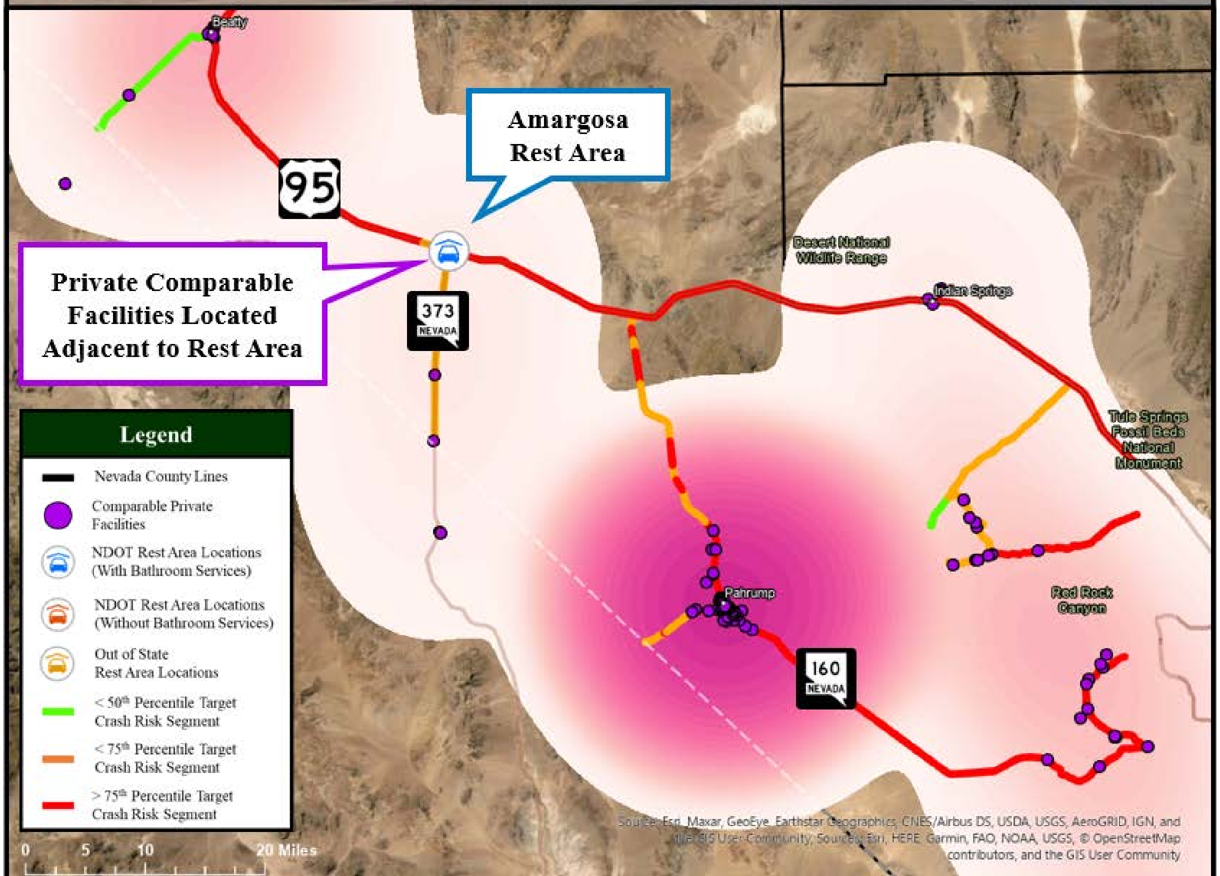
| Facility Name | Level of Importance | MSU Recommendation | Details |
|---|---|---|---|
| | | | **limited traffic volumes served by NV-140 along this corridor this location provides comparatively moderate value to the NDOT system.** |
| **Trinity Rest Area** | **High** | **Continue to Maintain** | The Trinity Rest Area is located within an approximate 20-mile gap in concentrations of traveler services of between Femley and Lovelock along I-80 at its junction with US-95. This rest area serves a critical role within the transportation network as there would be a 65-mile gap in services without its presence. The facility helps to reduce fatigue-related target crashes along I-80 (9,150 vehicles per day, including 2,687 trucks) and US-95 (940 vehicles per day, including 262 trucks).<br><br>**This rest area provides a high level of value to the system and should continue to be maintained by the department. Per discussions with the NDOT team, it should be noted that this rest area has been selected for reconstruction.** |
| **Valley of the Moon Rest Stop** | **Moderate** | **Continue to Maintain** | The Valley of the Moon Rest Stop is located between Austin and Battle Mountain along NV-305. While there is roadside parking available along the corridor, there are no other bathroom between Austin and Battle Mountain. The facility helps to reduce fatigue-related target crashes along NV-305 (360 vehicles per day with limited truck traffic).<br><br>**The rest stop should continue to be maintained by the department as without its presence there would be an approximate 90-mile gap in services. However, given the limited traffic served by NV-305 in this area it is recognized that this location provides comparatively moderate value to the NDOT system.** |

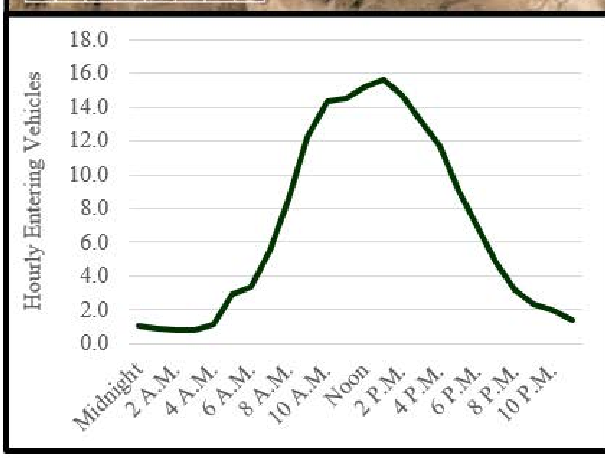
| Facility Name | Level of Importance | MSU Recommendation | Details |
|---|---|---|---|
| **Valmy Rest Area** | **High** | **Continue to Maintain** | The Valmy Rest Area is located southeast of Winnemucca and serves a critical role within the transportation network by reducing fatigue-related target crashes along I-80 (8,350 vehicles per day, including 2,373 trucks). It should be noted that without Valmy Rest Area, there would be a 50-mile gap in bathroom services along this portion of I-80. The rest area serves approximately 232 vehicles per day, with volumes tending to be larger during summer months.<br><br>**Valmy Rest Area provides a high level of value to the system and should continue to be maintained by the department. It should also be noted that the rest area was constructed in 1970 and could be due for reconstruction.** |
| **Wadsworth Westbound Rest Area** | **High** | **Consider Improvements** | While the Wadsworth Rest Area along westbound I-80 is located within an area where there is a concentration of existing traveler services available in the surrounding area, it serves a critical role within the transportation network given that it is located along a 15-mile stretch of I-80 between Clark and Fernley where there are limited comparable facilities present. The facility helps to reduce fatigue-related target crashes along westbound I-80 (26,700 vehicles per day, including 4,903 trucks) as well as a portion of road users along NV-447 (1,350 vehicles per day, including 183 trucks) and NV-439 (19,200 vehicles per day, including 1,783 trucks). The rest area serves approximately 280 vehicles per day, with volumes tending to be larger during summer months.<br><br>**The westbound rest area currently provides a high level of value to the system given the relatively high volume of road users present along the corridor as well as the potential gap in services without the facility. The department could also consider constructing an eastbound rest area in an adjacent area as there is currently only a weigh station directly across from the existing westbound access only facility. While this facility is located within a concentration of existing traveler services, providing a roadside facility for eastbound road users has the potential increase safety performance. This rest area was also constructed in 1970 and could be due for reconstruction.** |

| Facility Name | Level of Importance | MSU Recommendation | Details |
|---|---|---|---|
| **Wilson Canyon Rest Stop** | **Moderate** | **Continue to Maintain** | The Wilson Canyon Rest Stop is located east of Smith along NV-208. The facility helps to reduce fatigue-related crashes along NV-208 (1,600 vehicles per day, including 134 trucks) and NV-339 (1,850 vehicles per day, including 248 trucks). While the rest stop is located within an area where there is a concentration of services available, it should be noted that without the facility there would be a 20-mile gap in services along NV-208 and NV-339.<br><br>**This rest stop should continue to be maintained by the department as without its presence there would be an approximate 20-mile gap in services. However, it is recognized that given that there are other facilities within a reasonable distance this location provides comparatively moderate value to the NDOT system.** |

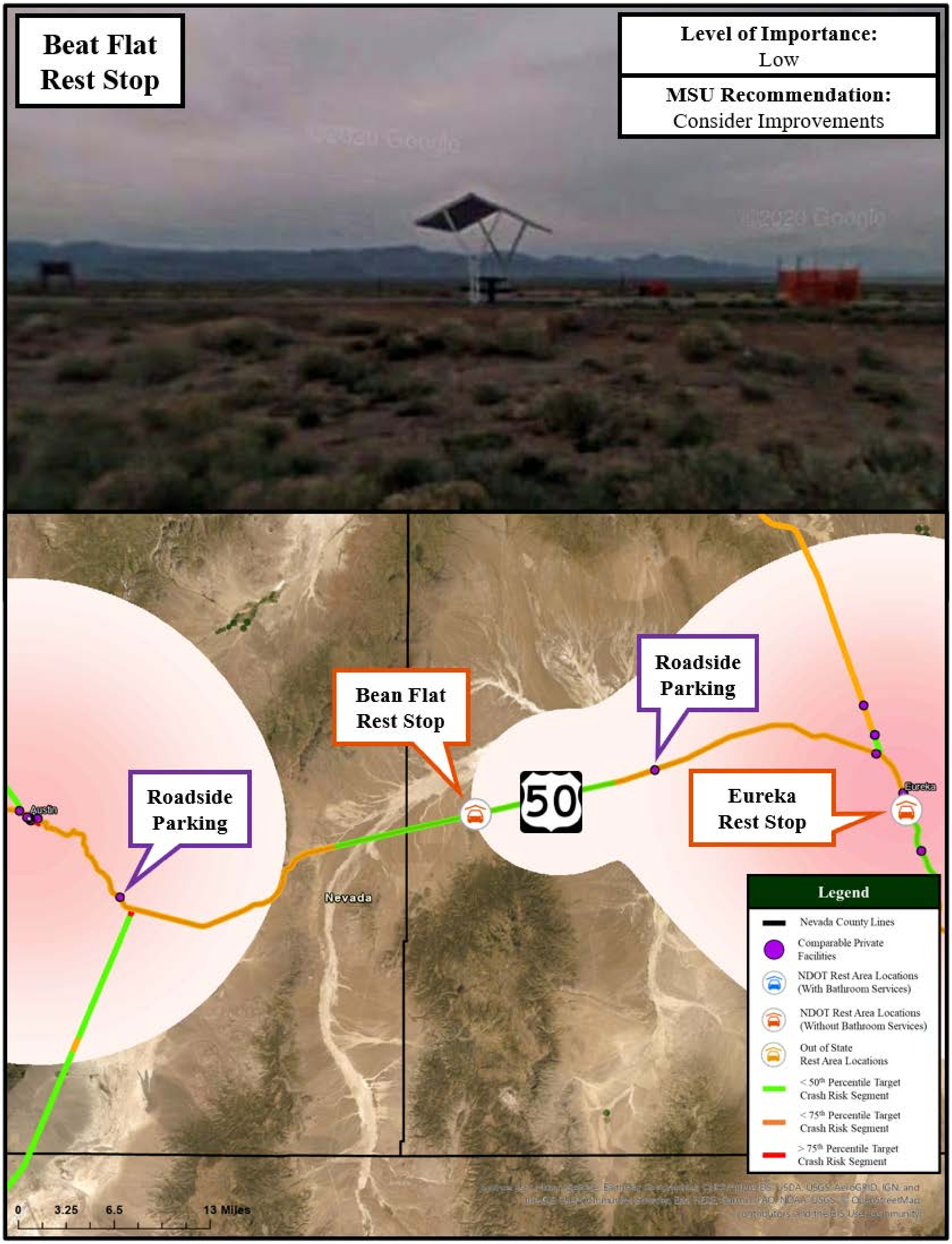
# Appendix D: Summary Sheets for Nevada DOT Rest Areas

## Appendix D-1. Amargosa Rest Area Summary Sheet

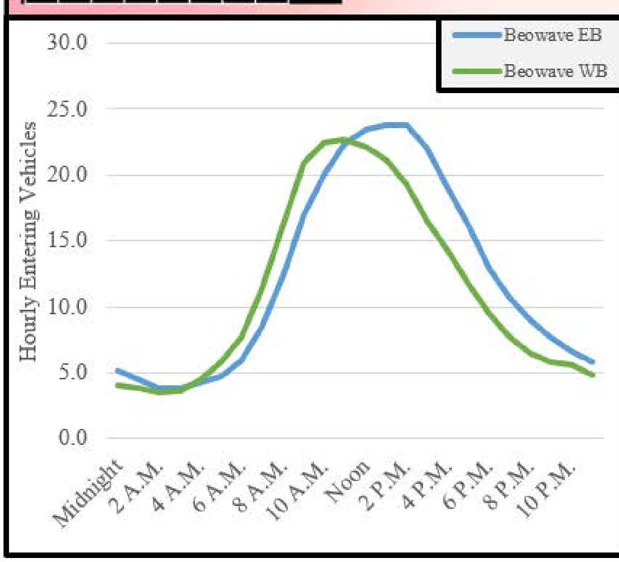



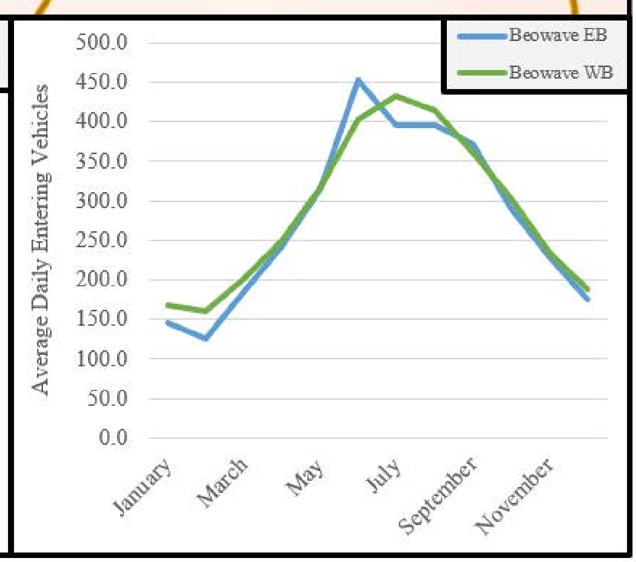

**Appendix D-2. Bean Flat Rest Stop Summary Sheet**



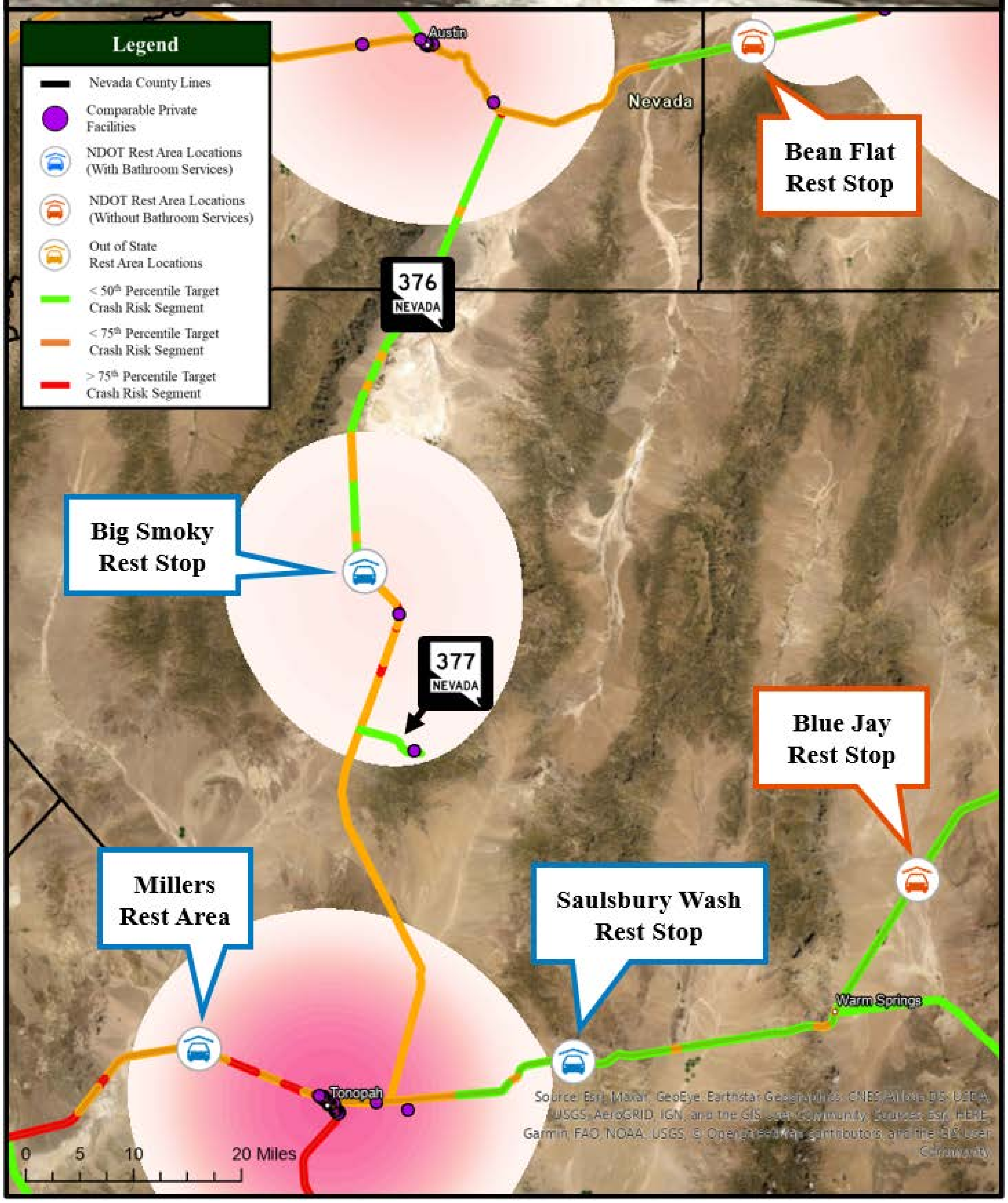
**Appendix D-3. Beowave Rest Areas Summary Sheet**



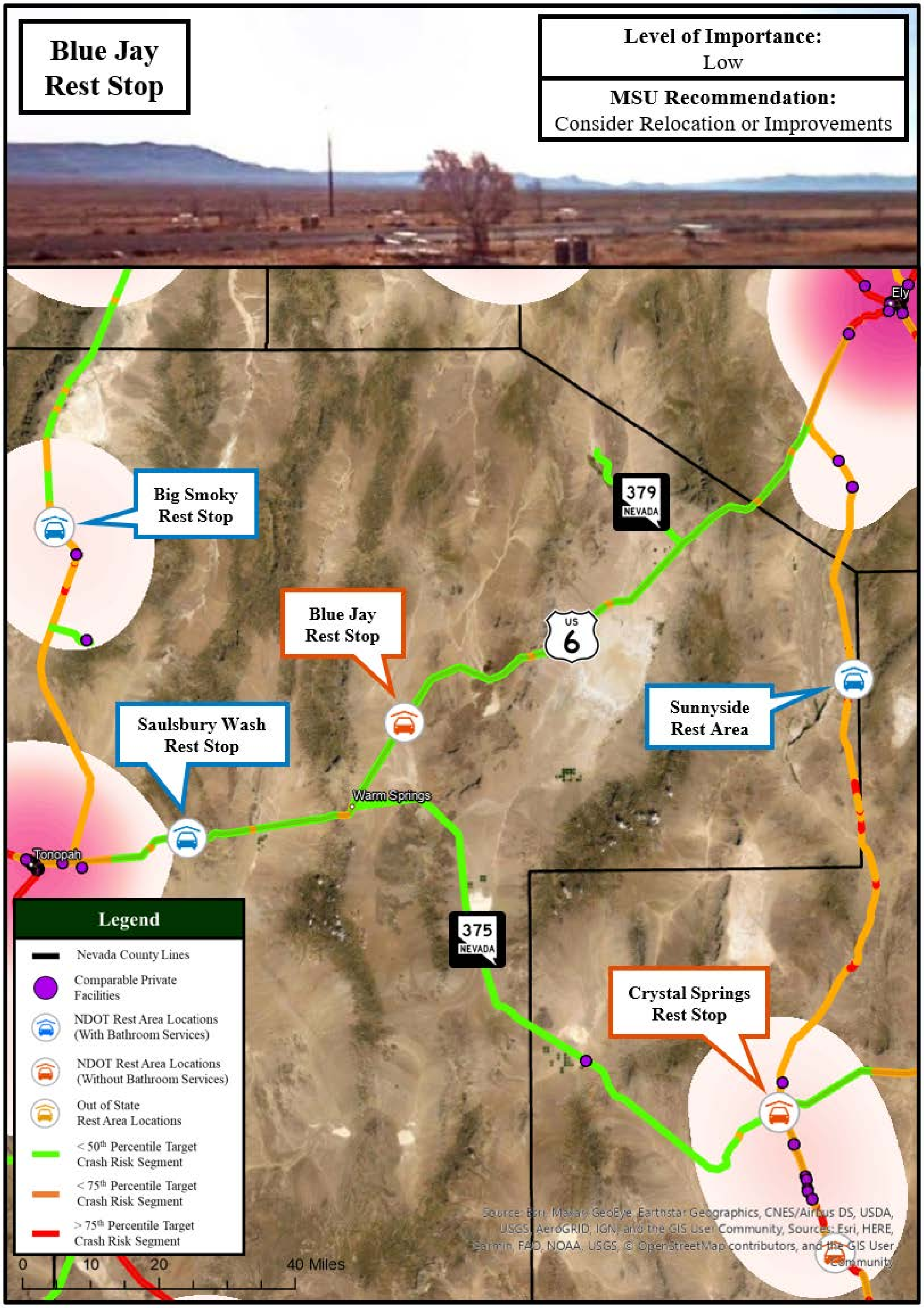


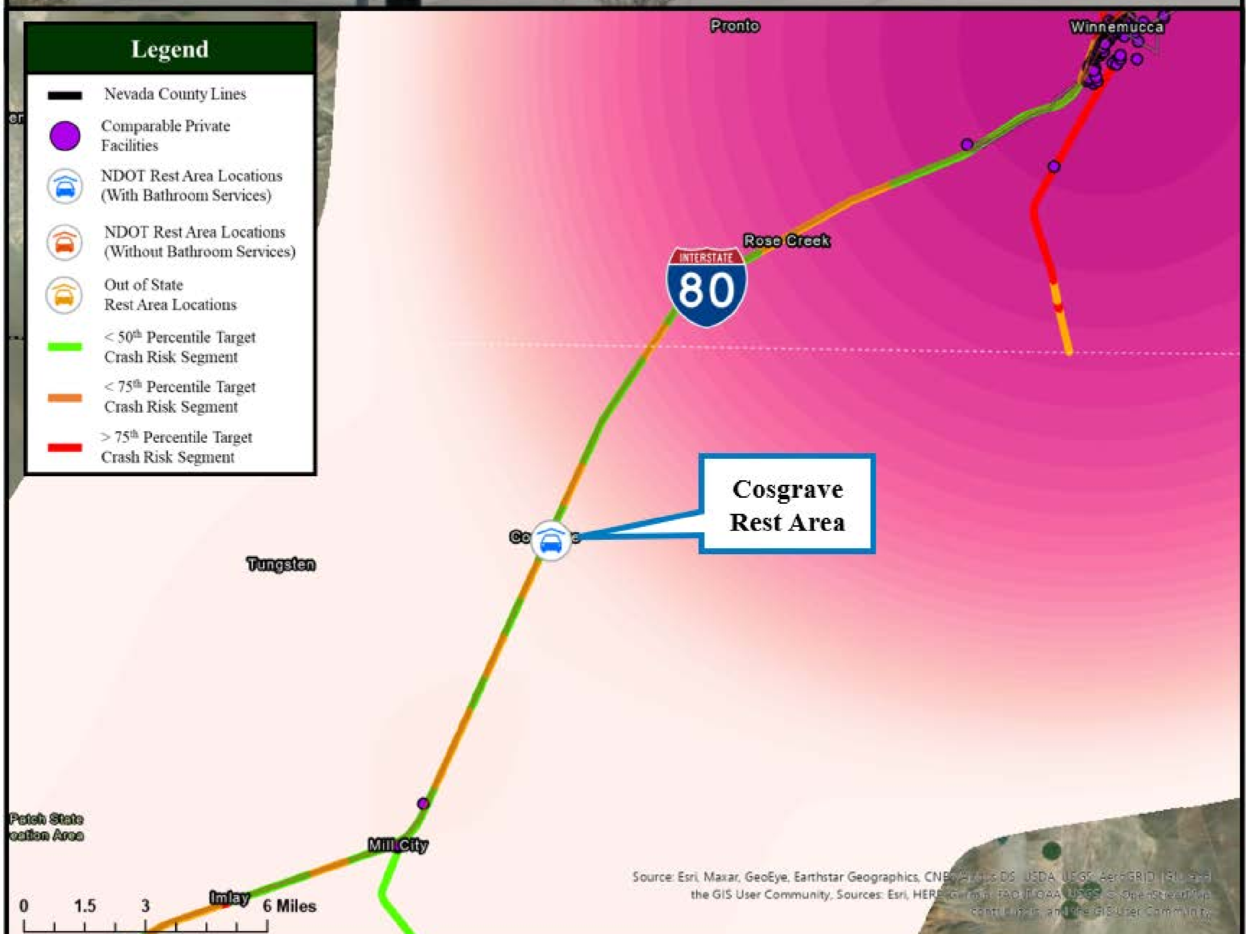
## Appendix D-4. Big Smoky Rest Stop Summary Sheet

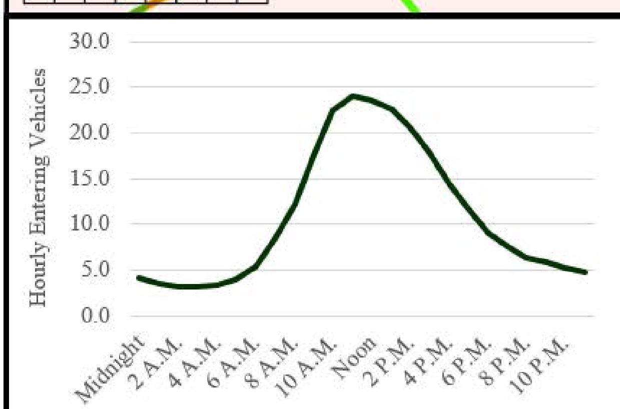



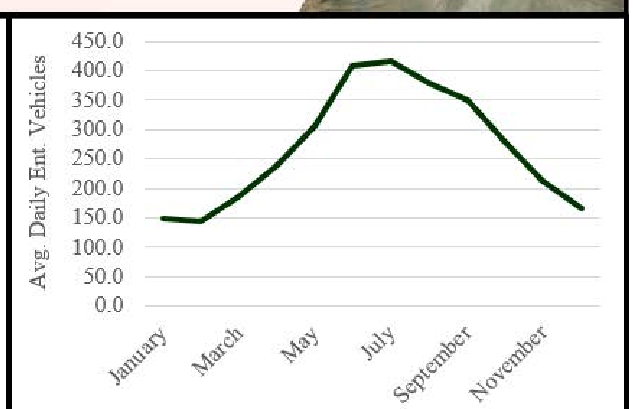
**Appendix D-5. Blue Jay Rest Stop Summary Sheet**



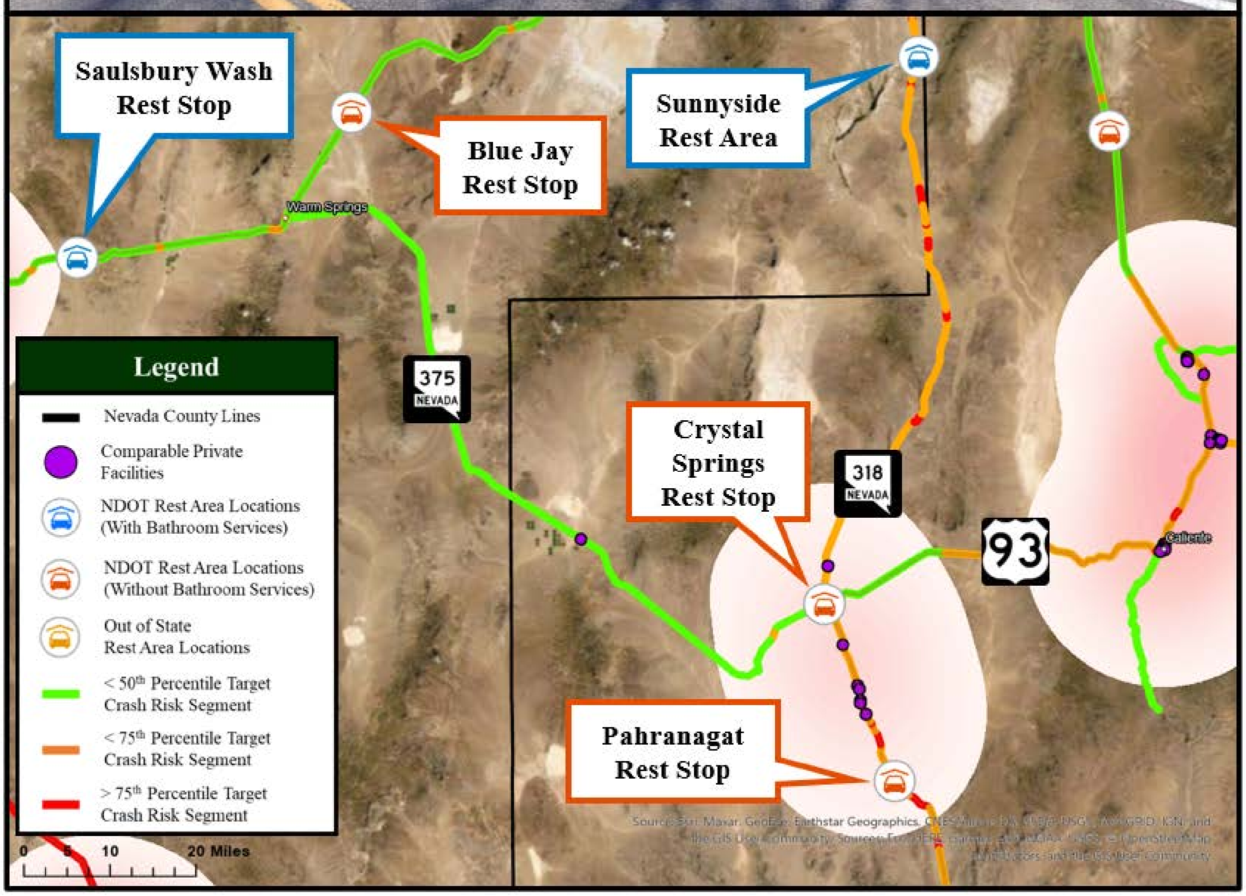
## Appendix D-6. Cosgrave Rest Area Summary Sheet

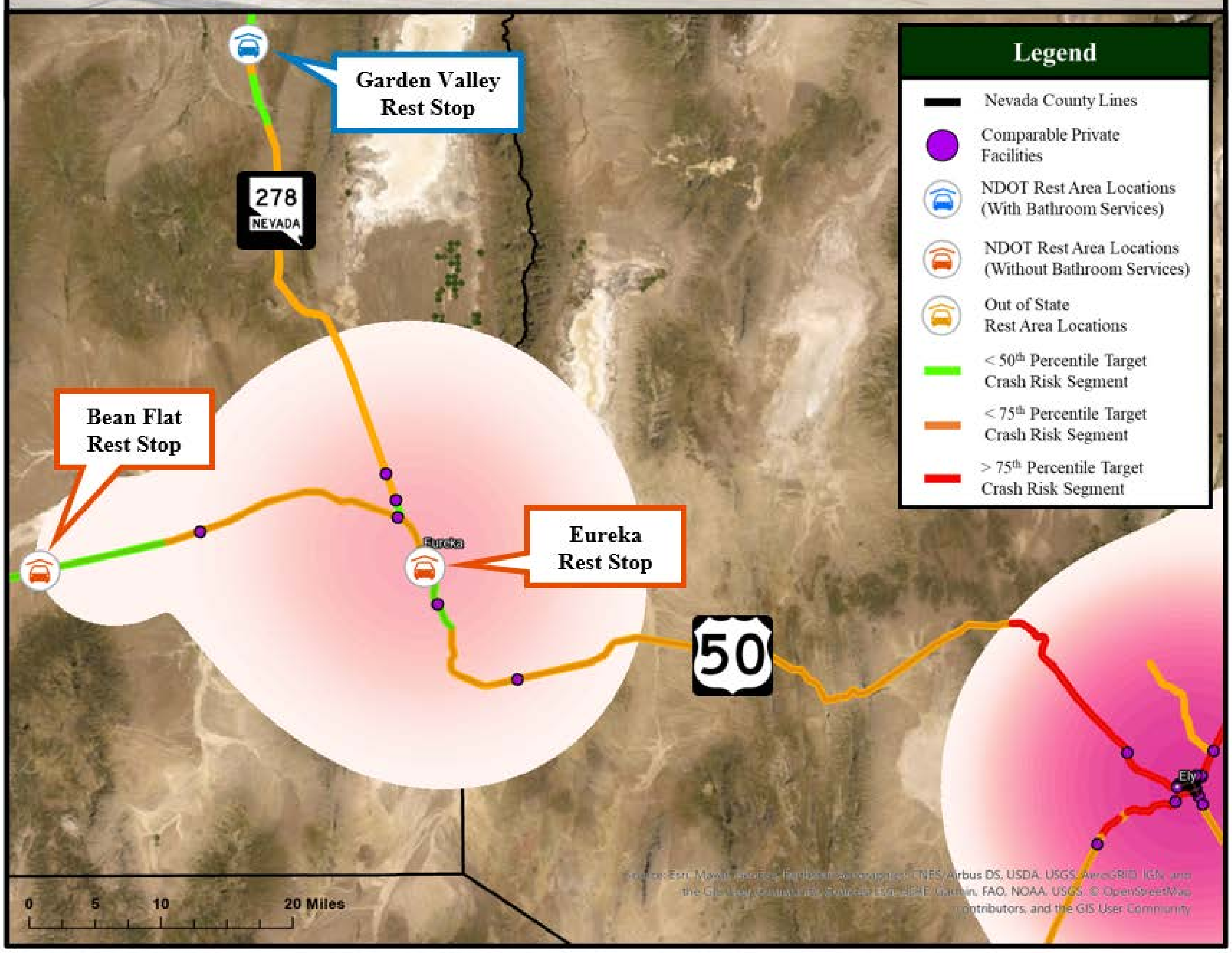



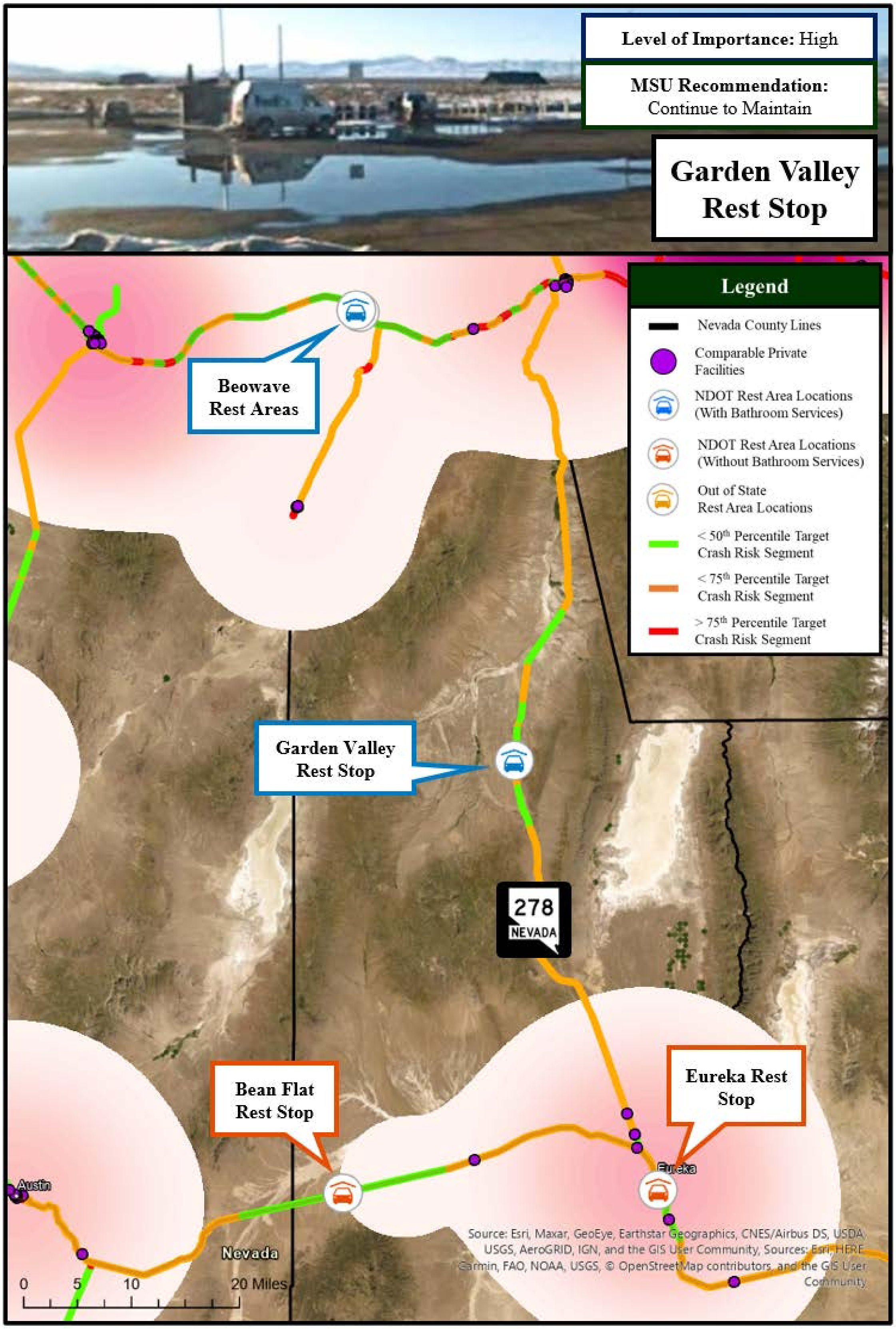
**Appendix D-7. Crystal Springs Rest Stop Summary Sheet**

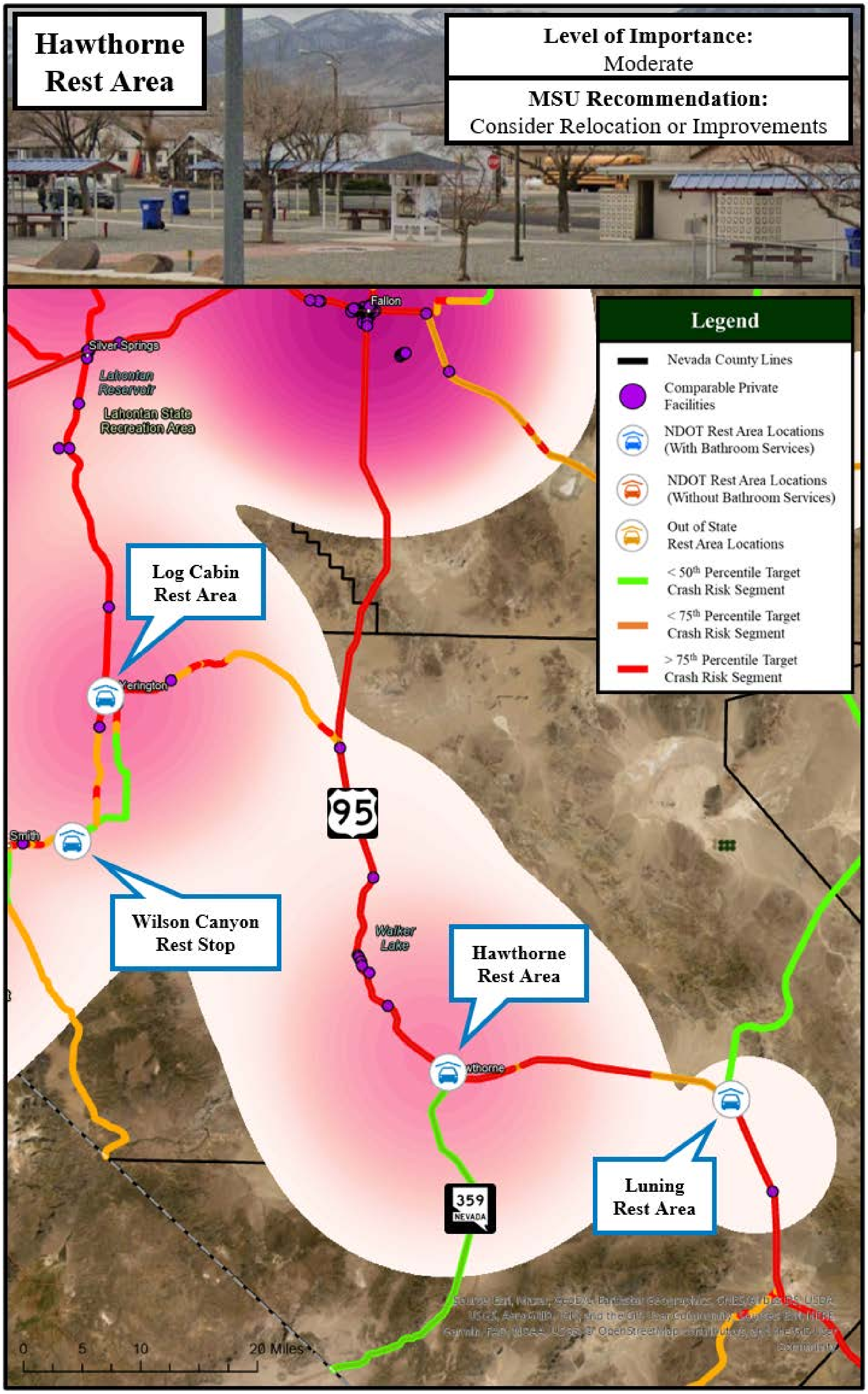
## Appendix D-8. Eureka Rest Stop Summary Sheet

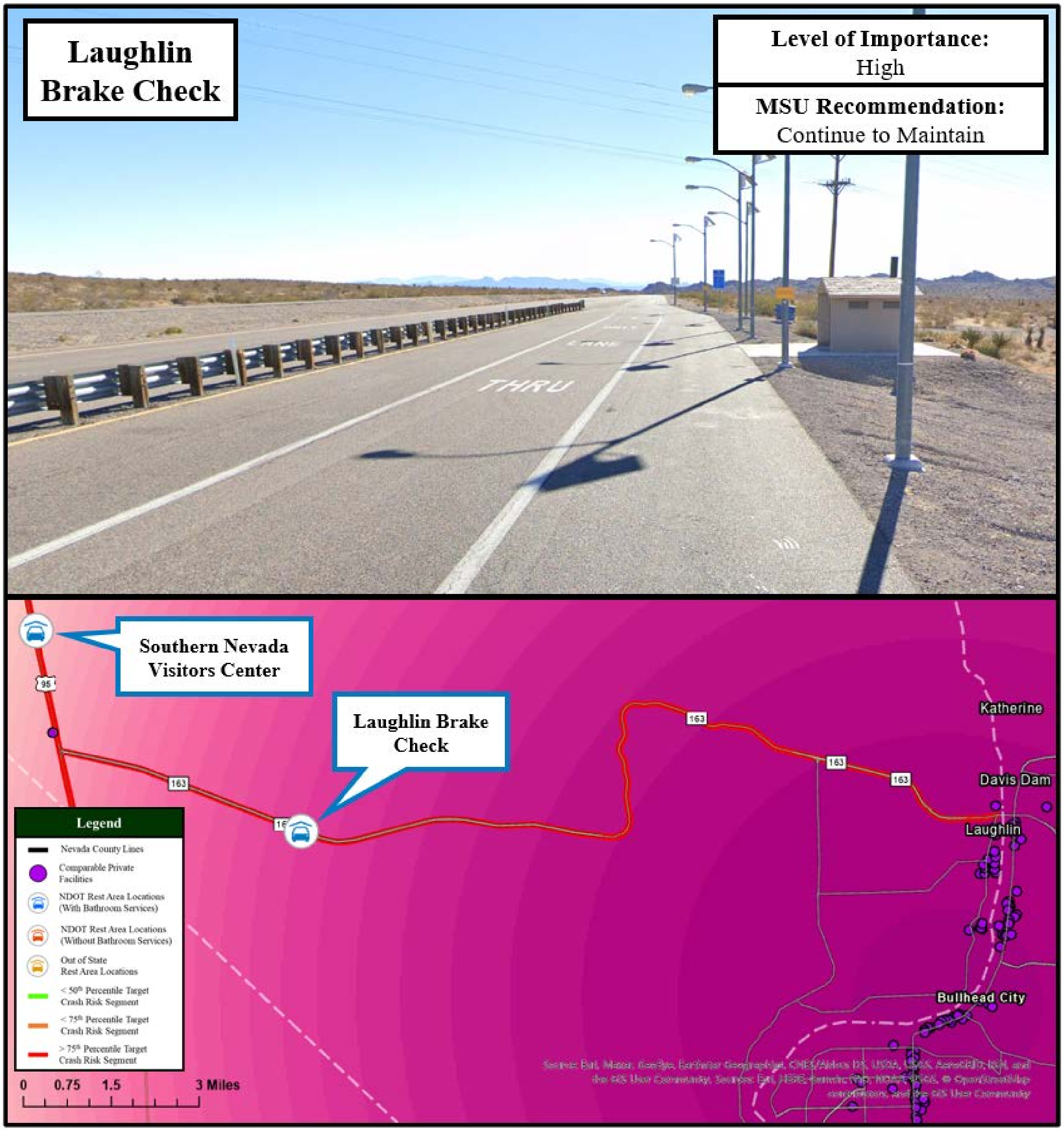
## Appendix D-9. Garden Valley Rest Stop Summary Sheet



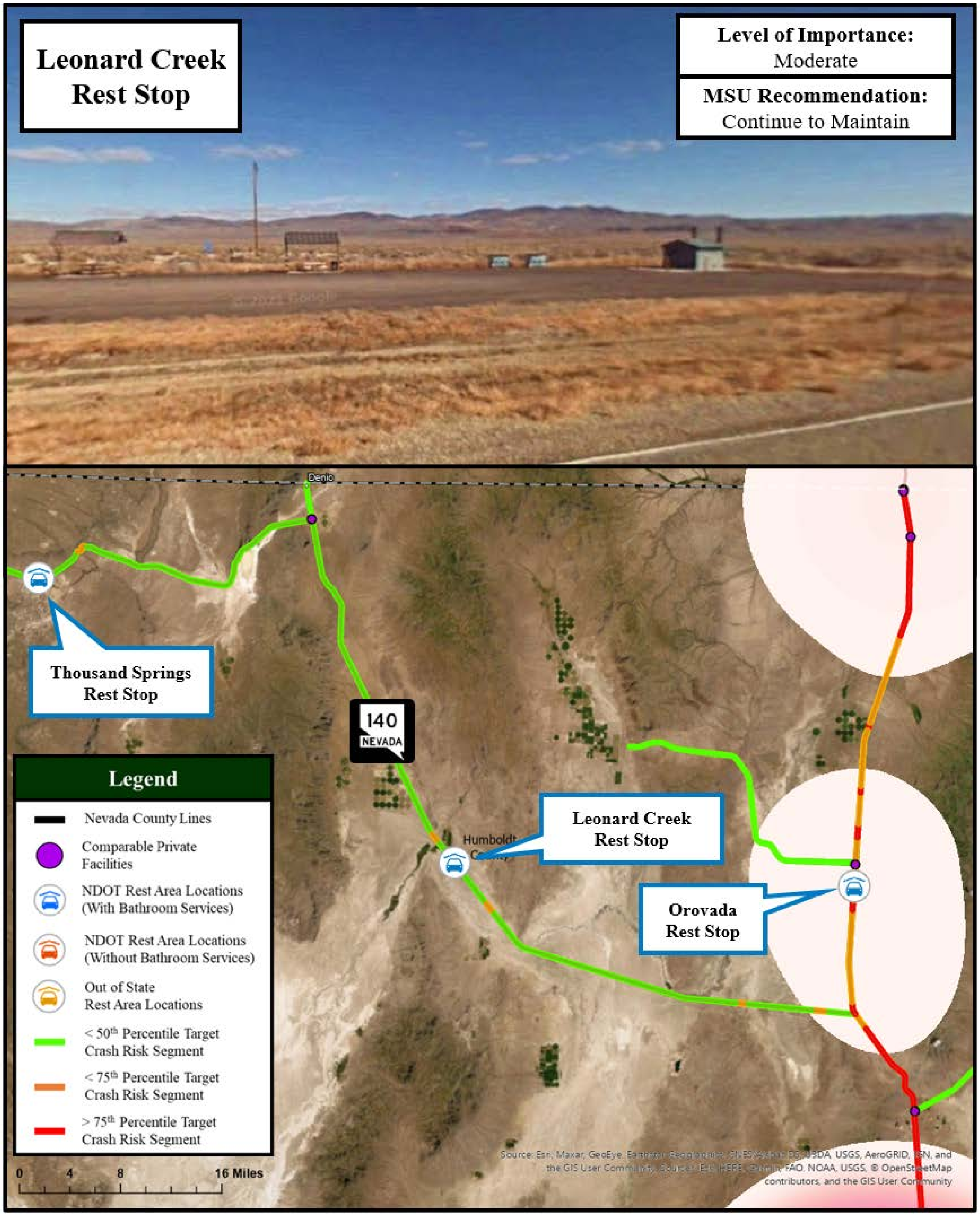
## Appendix D-10. Hawthorne Rest Area Summary Sheet



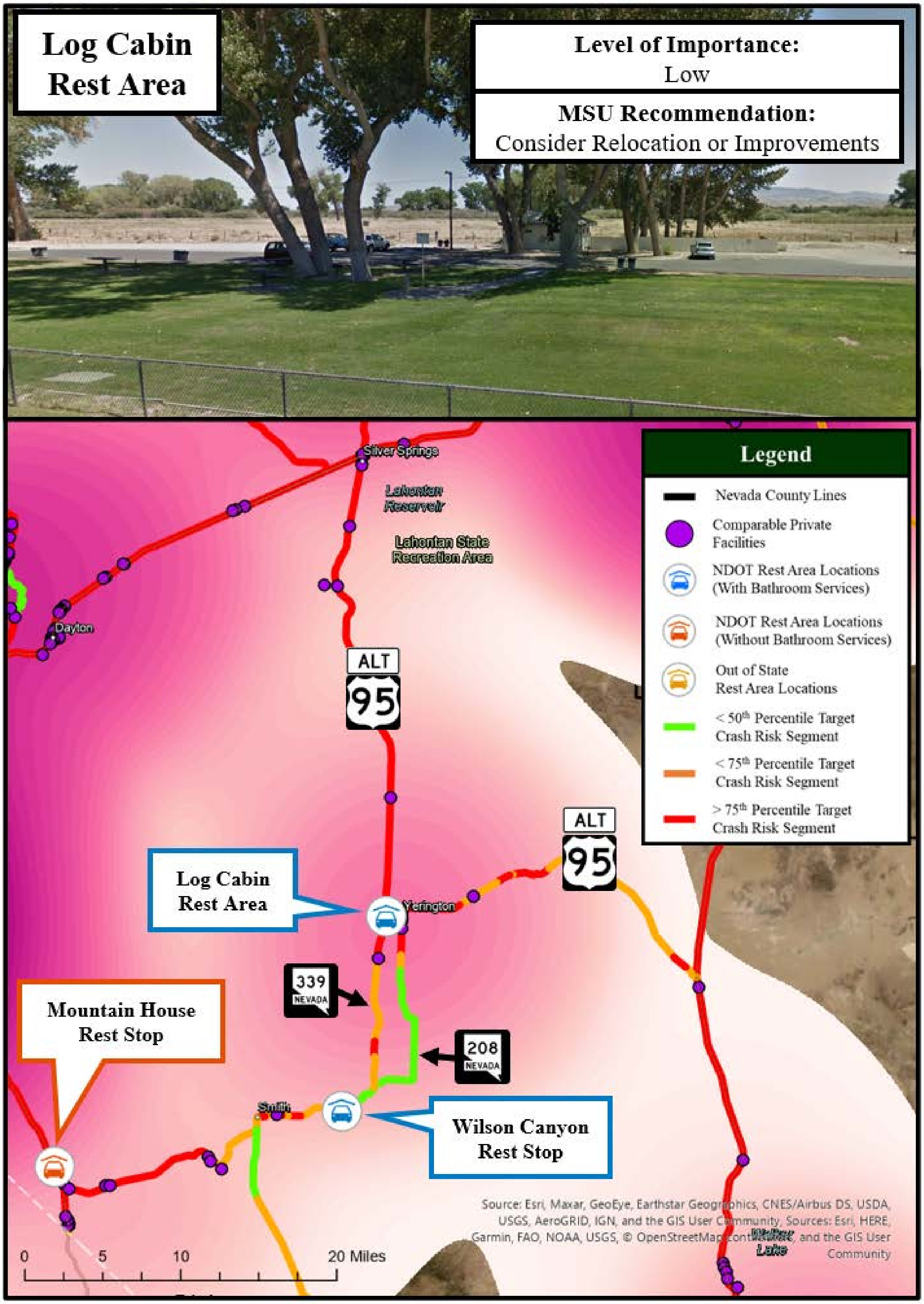
## Appendix D-11. Laughlin Brake Check Summary Sheet



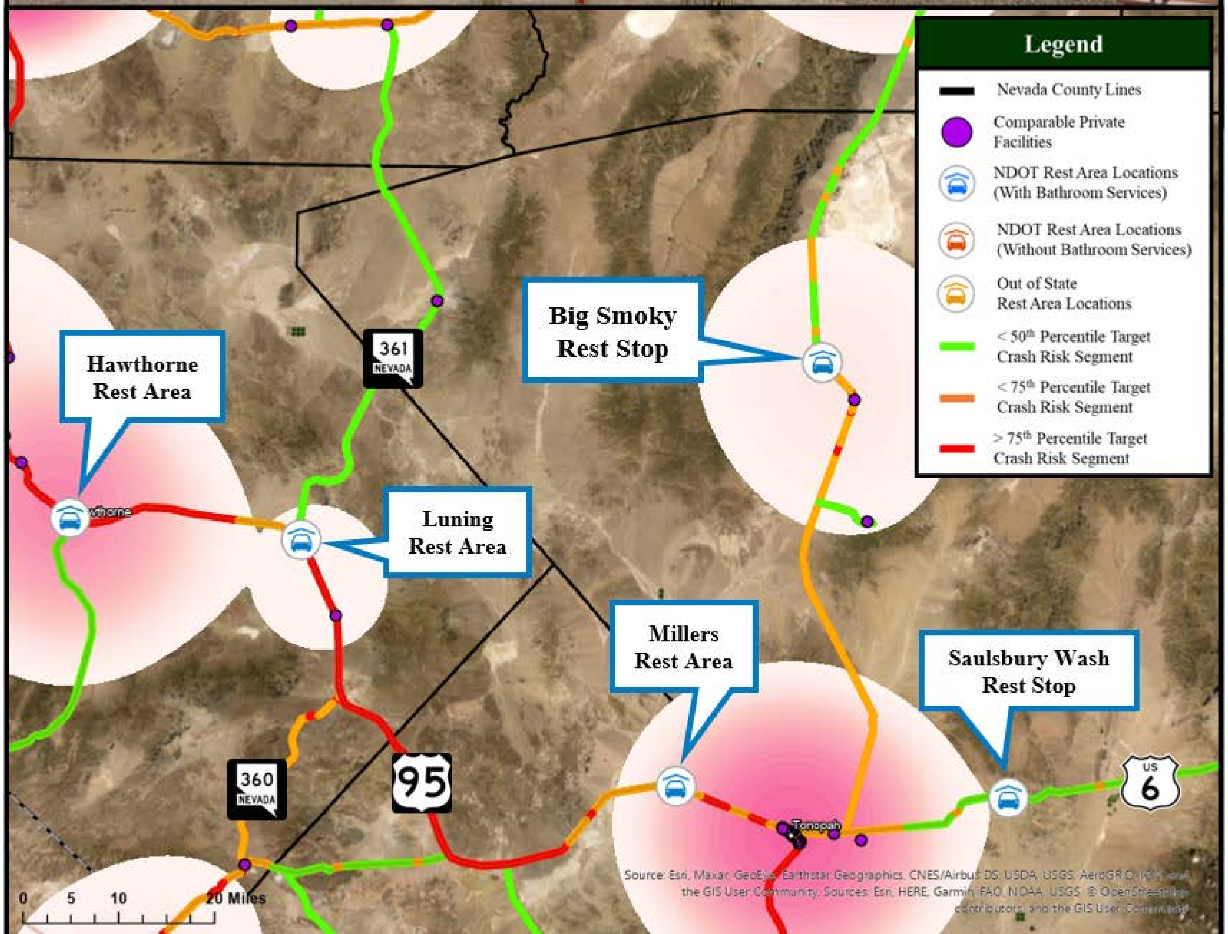
## Appendix D-12. Leonard Creek Rest Stop Summary Sheet

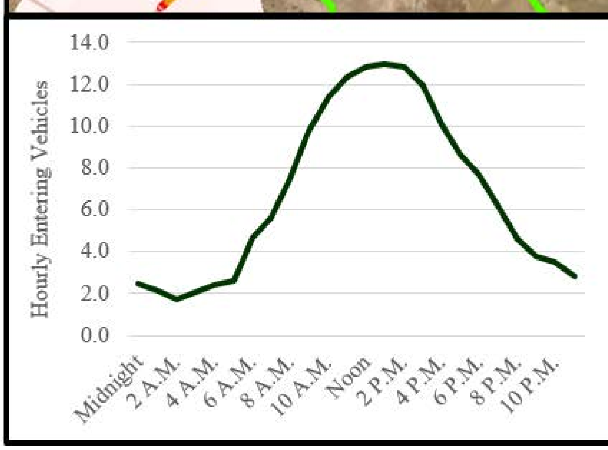


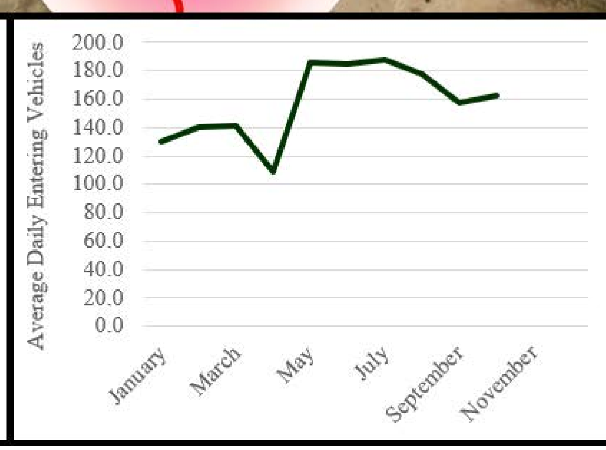
**Appendix D-13. Log Cabin Rest Area Summary Sheet**



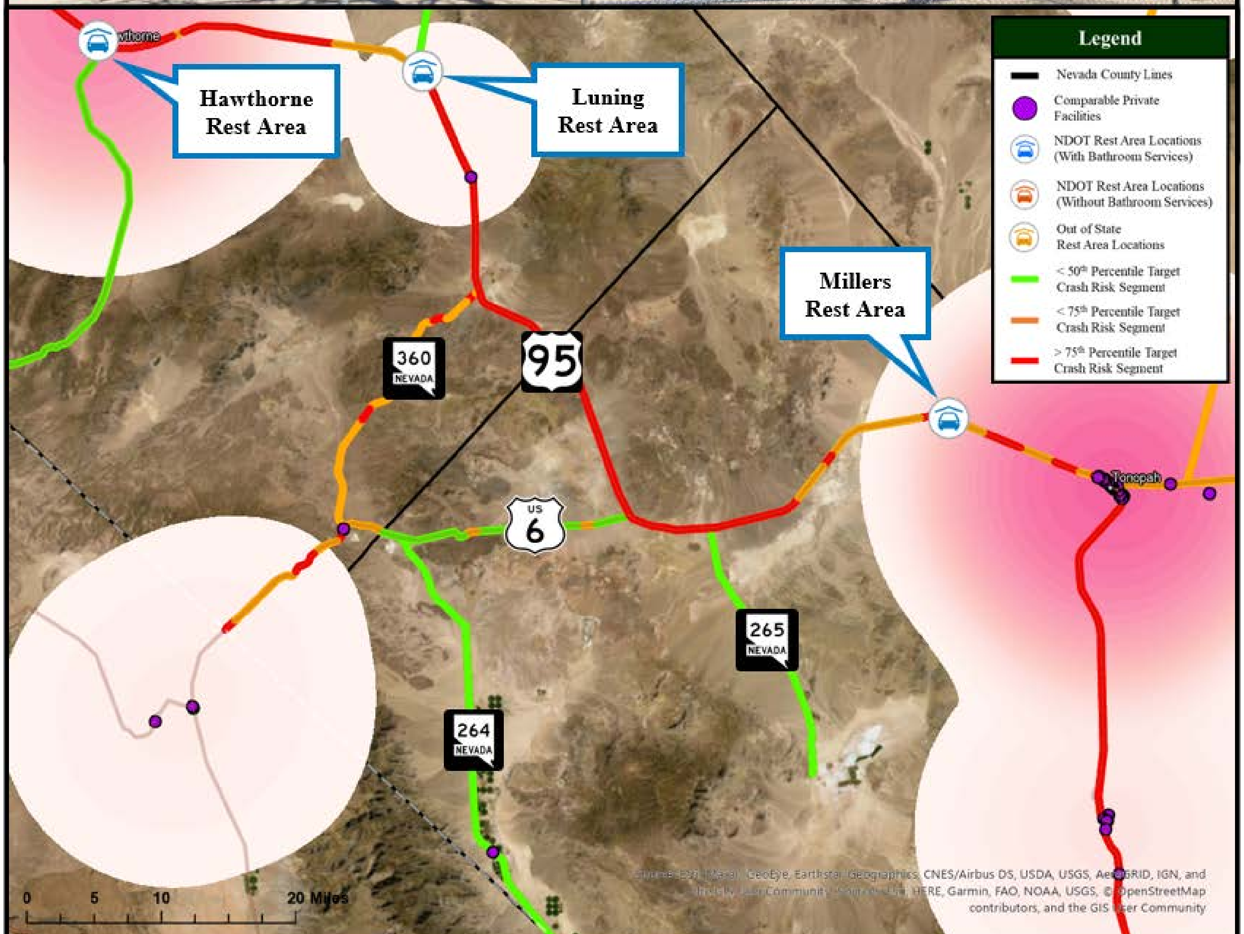
# Appendix D-14. Luning Rest Area Summary Sheet

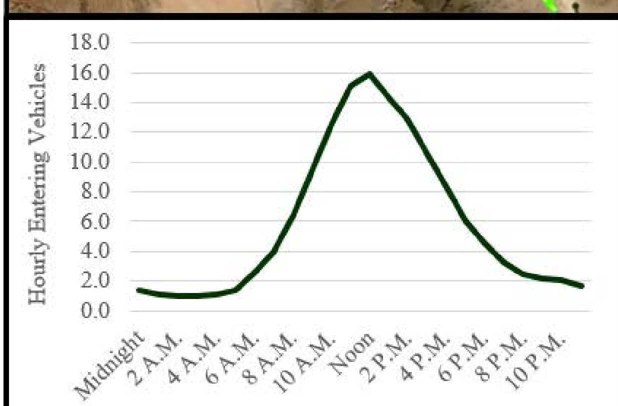



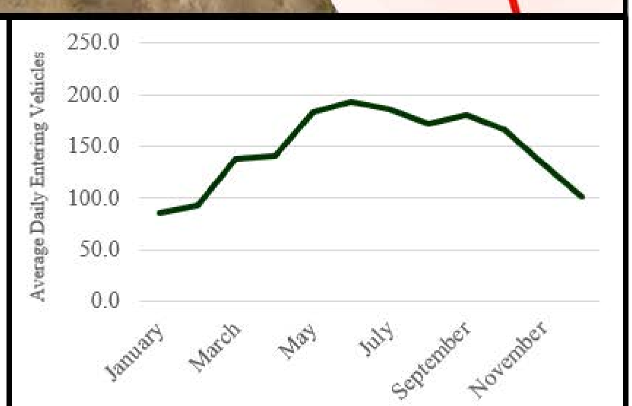



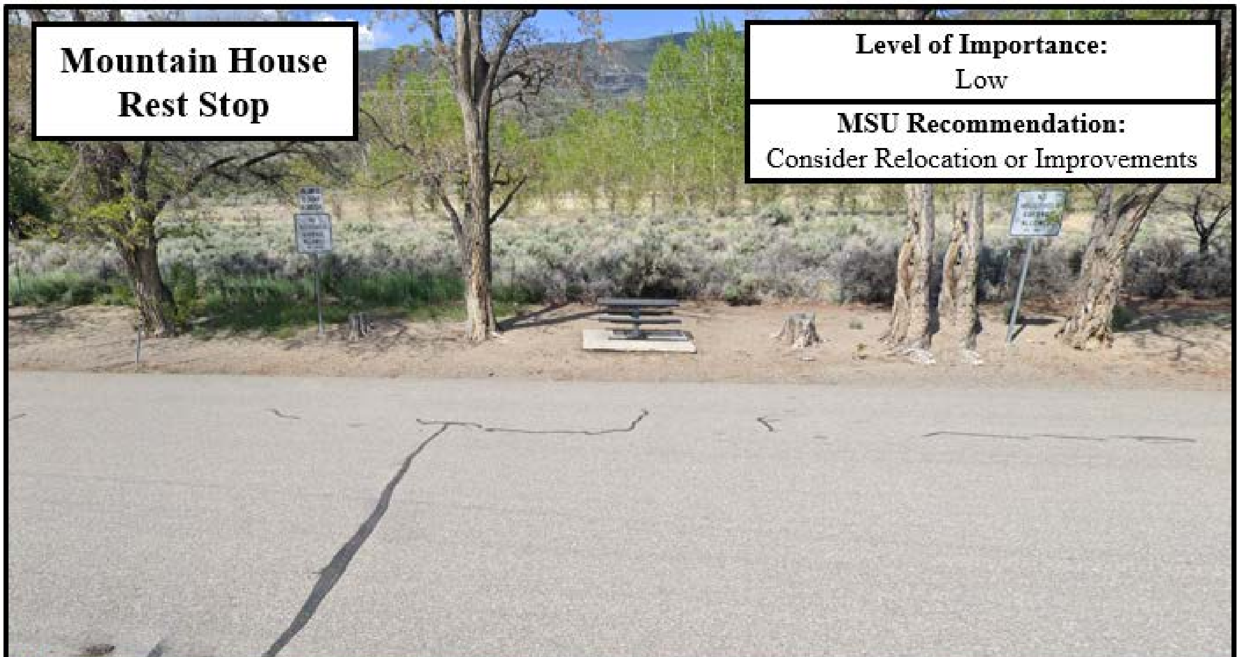
## Appendix D-15. Millers Rest Area Summary Sheet

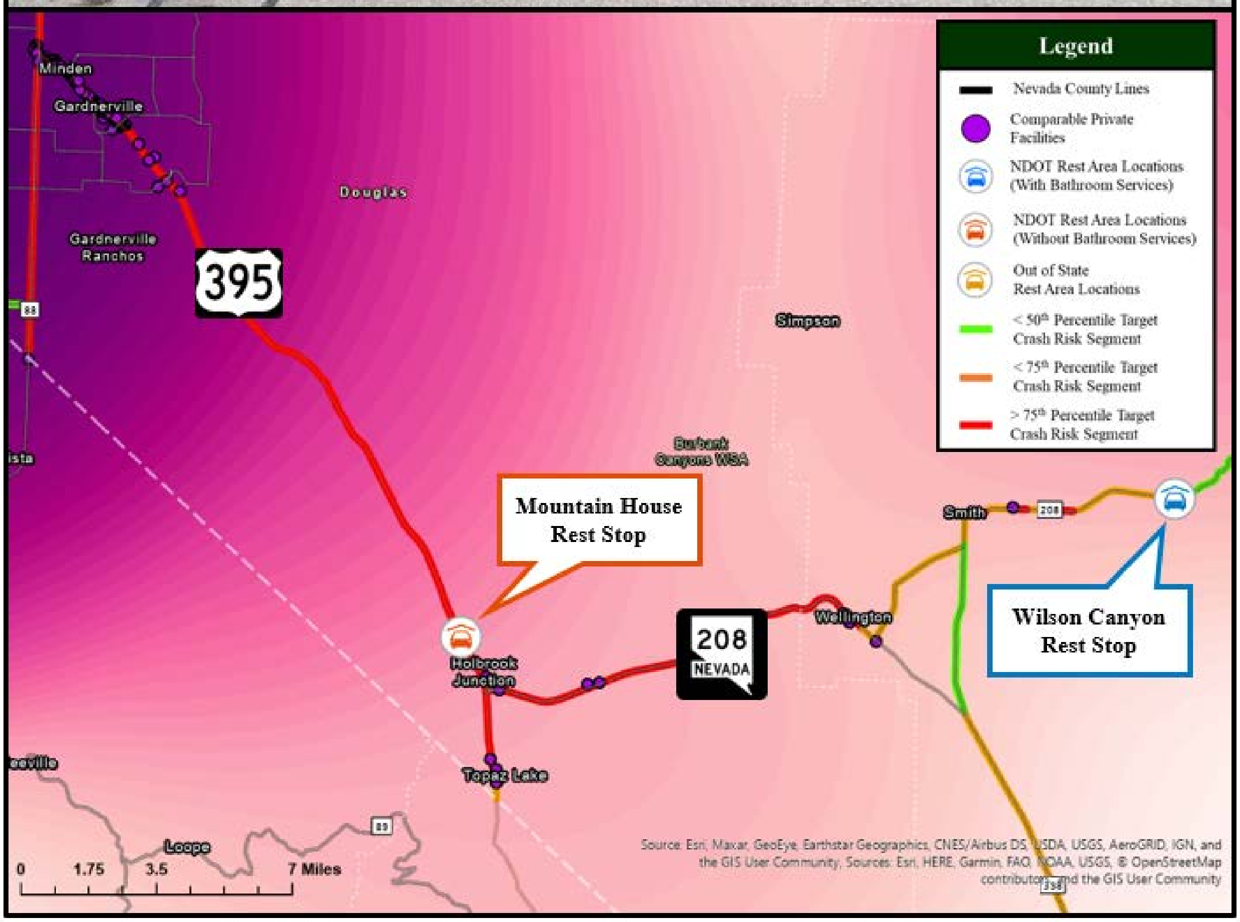



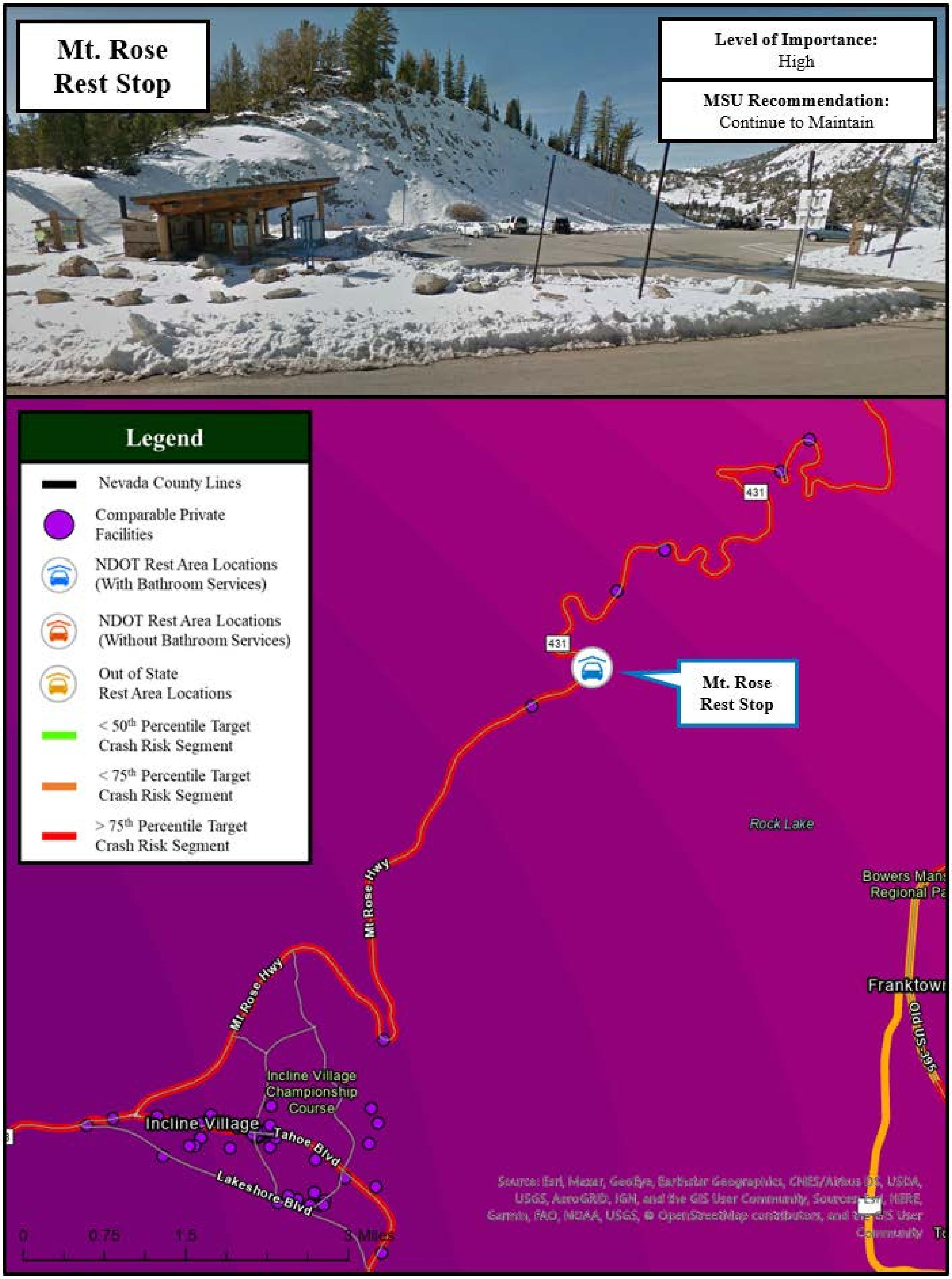



**Appendix D-16. Mountain House Rest Stop Summary Sheet**

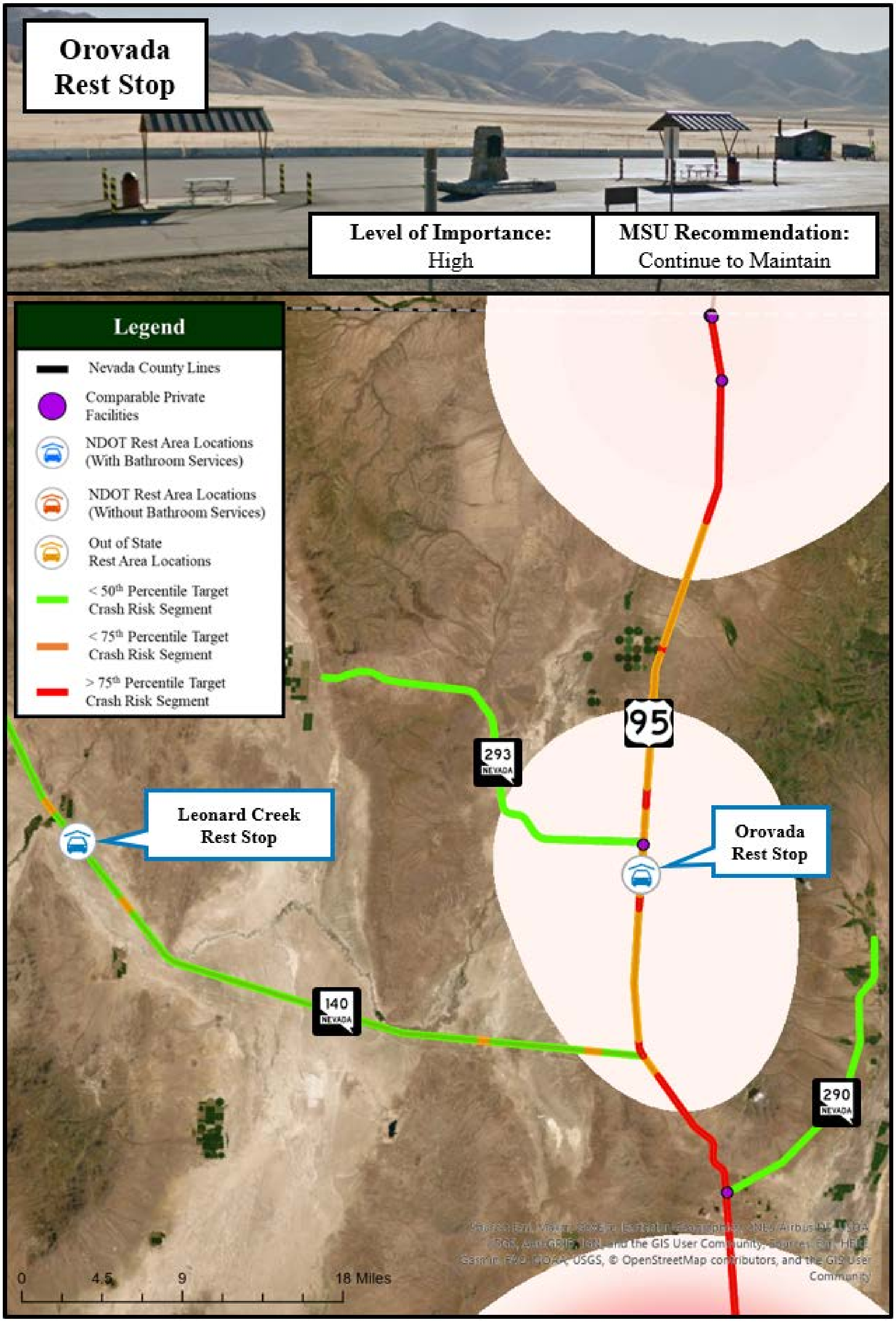


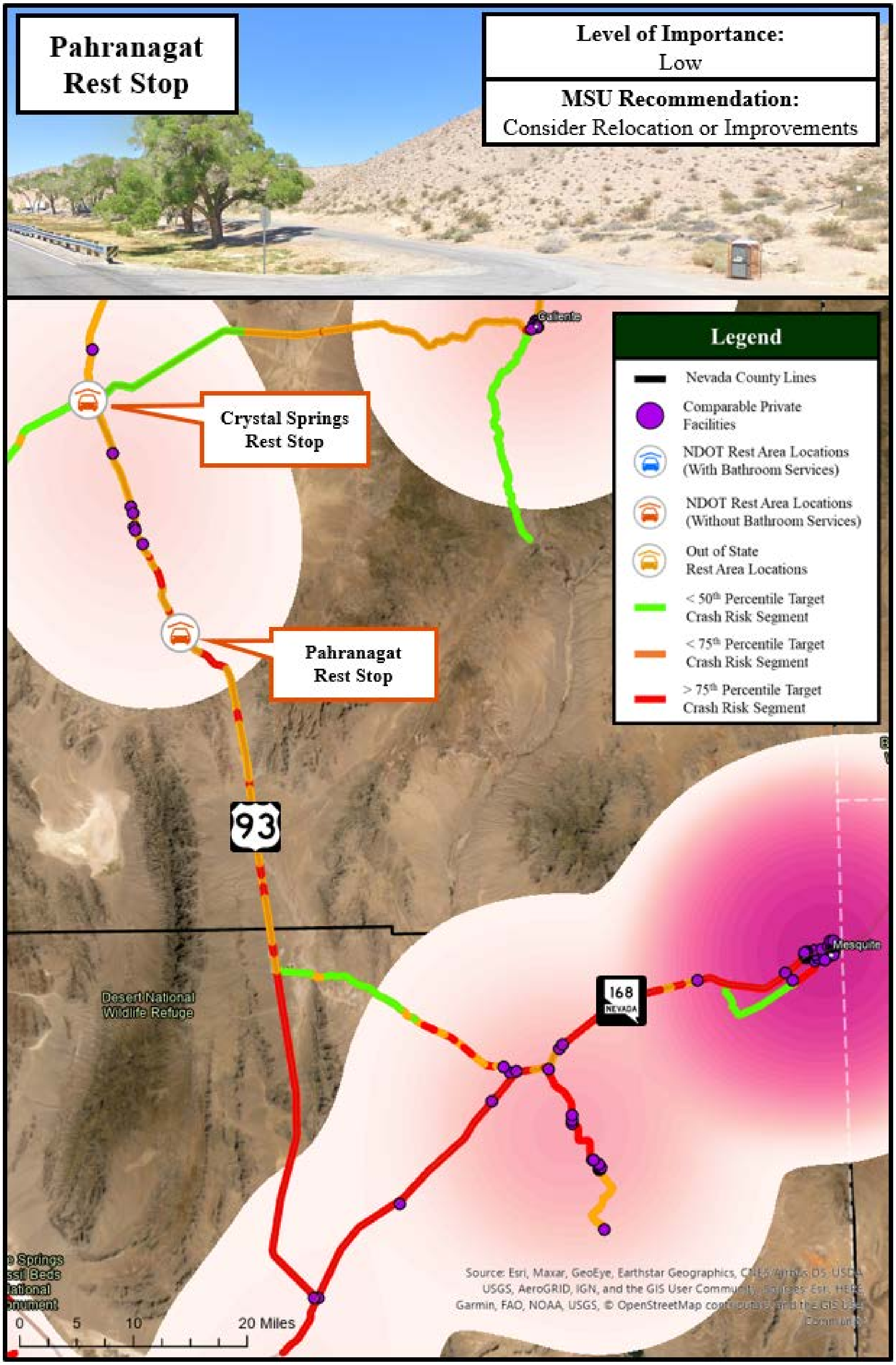
## Appendix D-17. Mt. Rose Rest Stop Summary Sheet



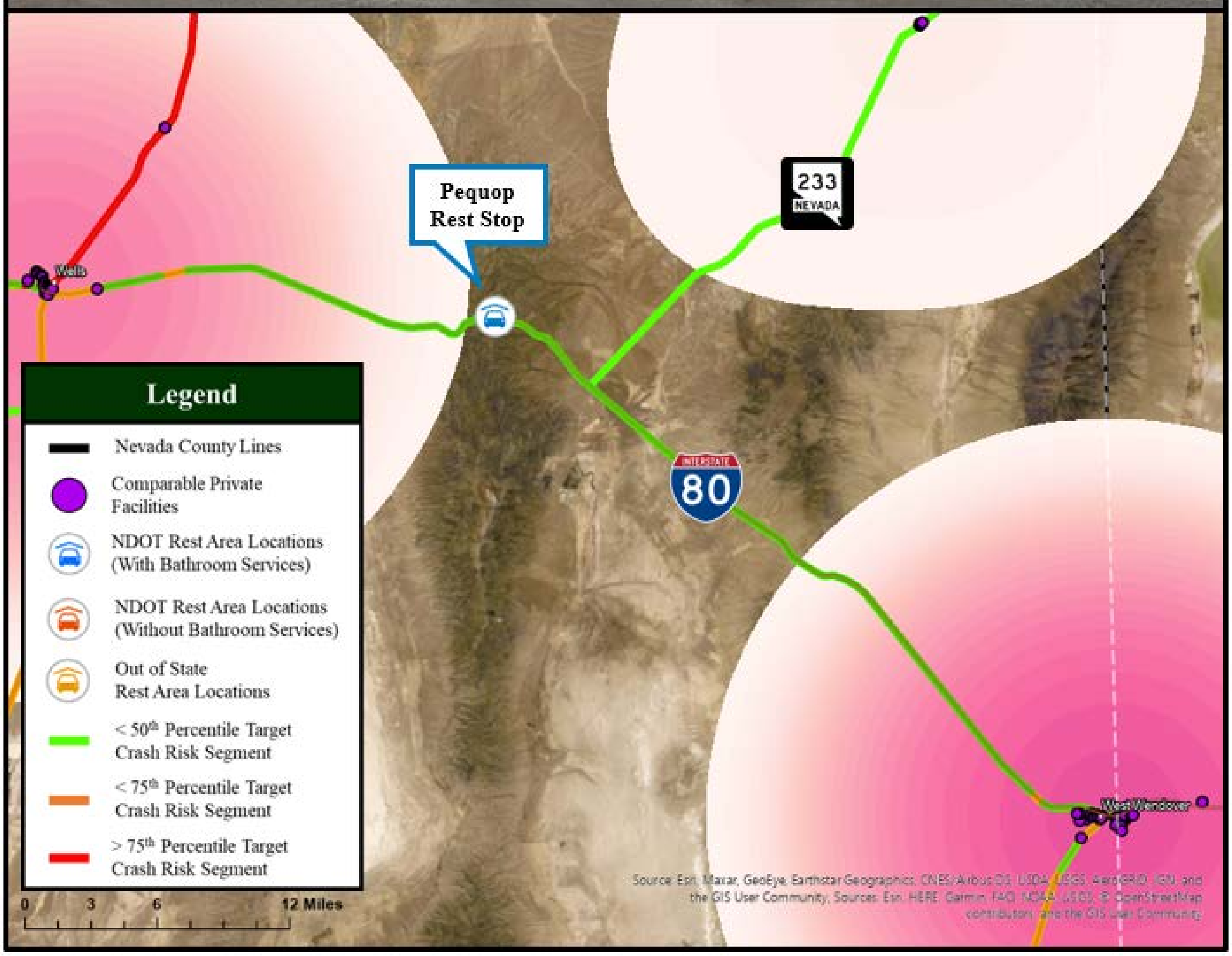
**Appendix D-18. Orovada Rest Stop Summary Sheet**



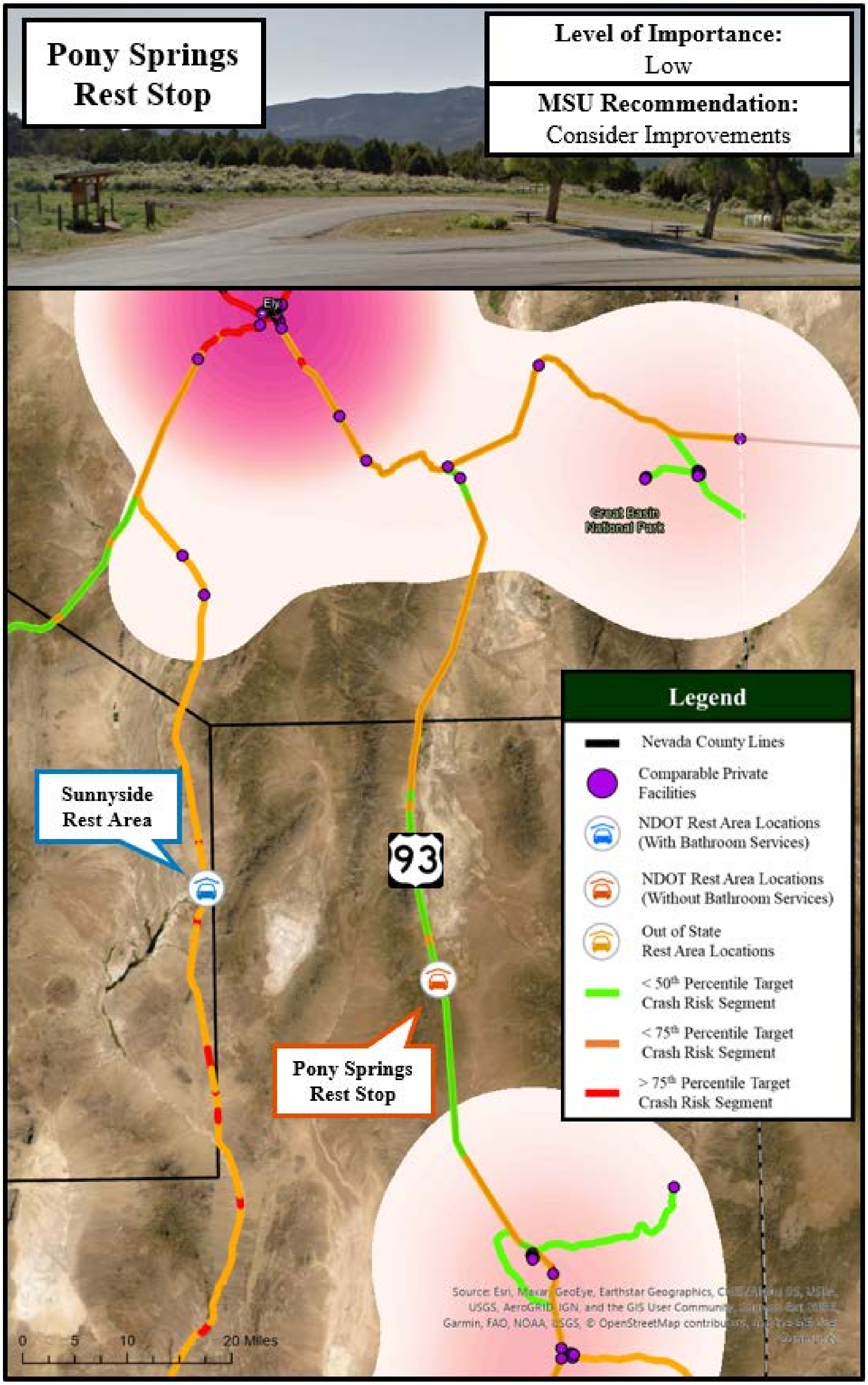
**Appendix D-19. Pahranagat Rest Stop Summary Sheet**



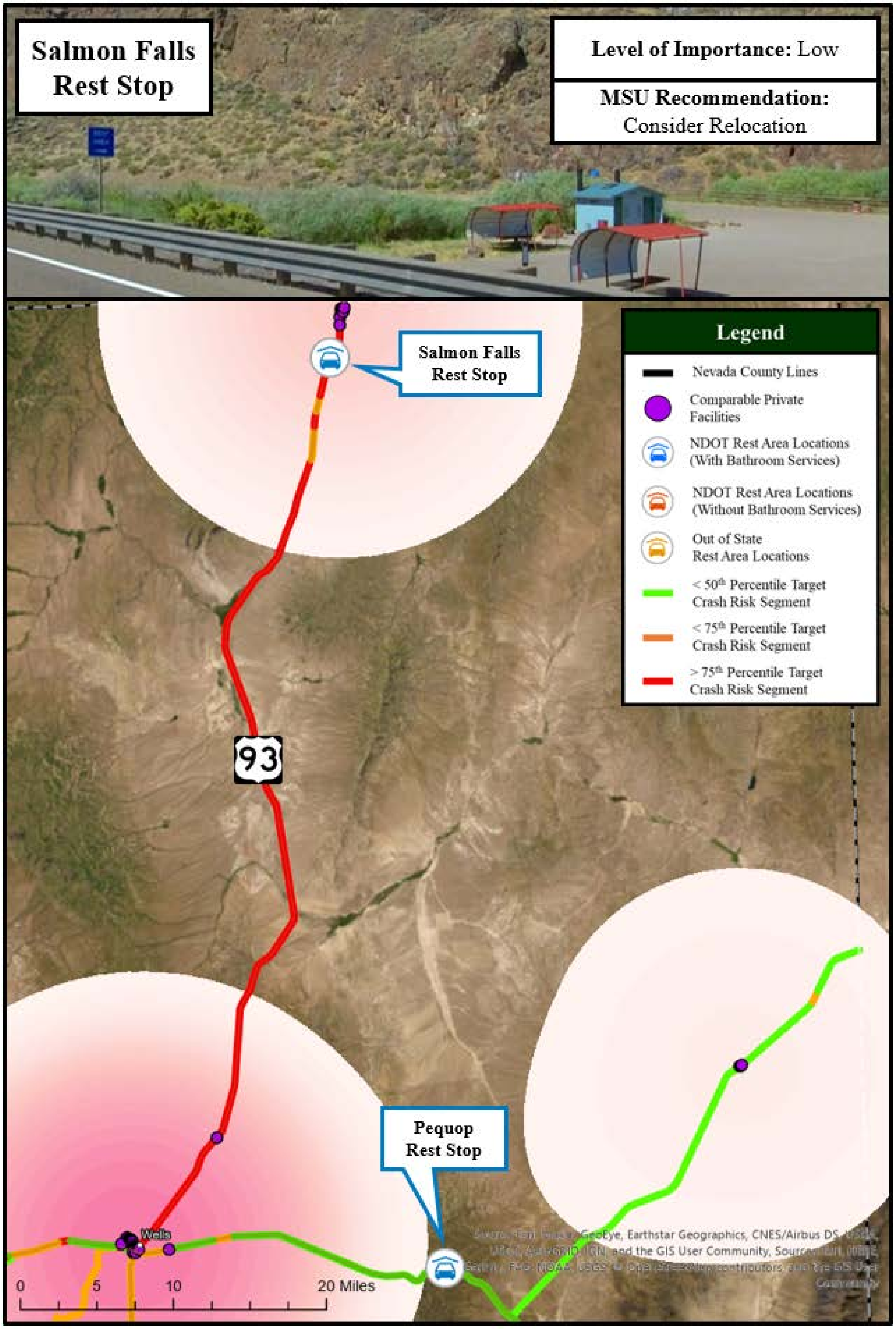
## Appendix D-20. Pequop Rest Stop Summary Sheet

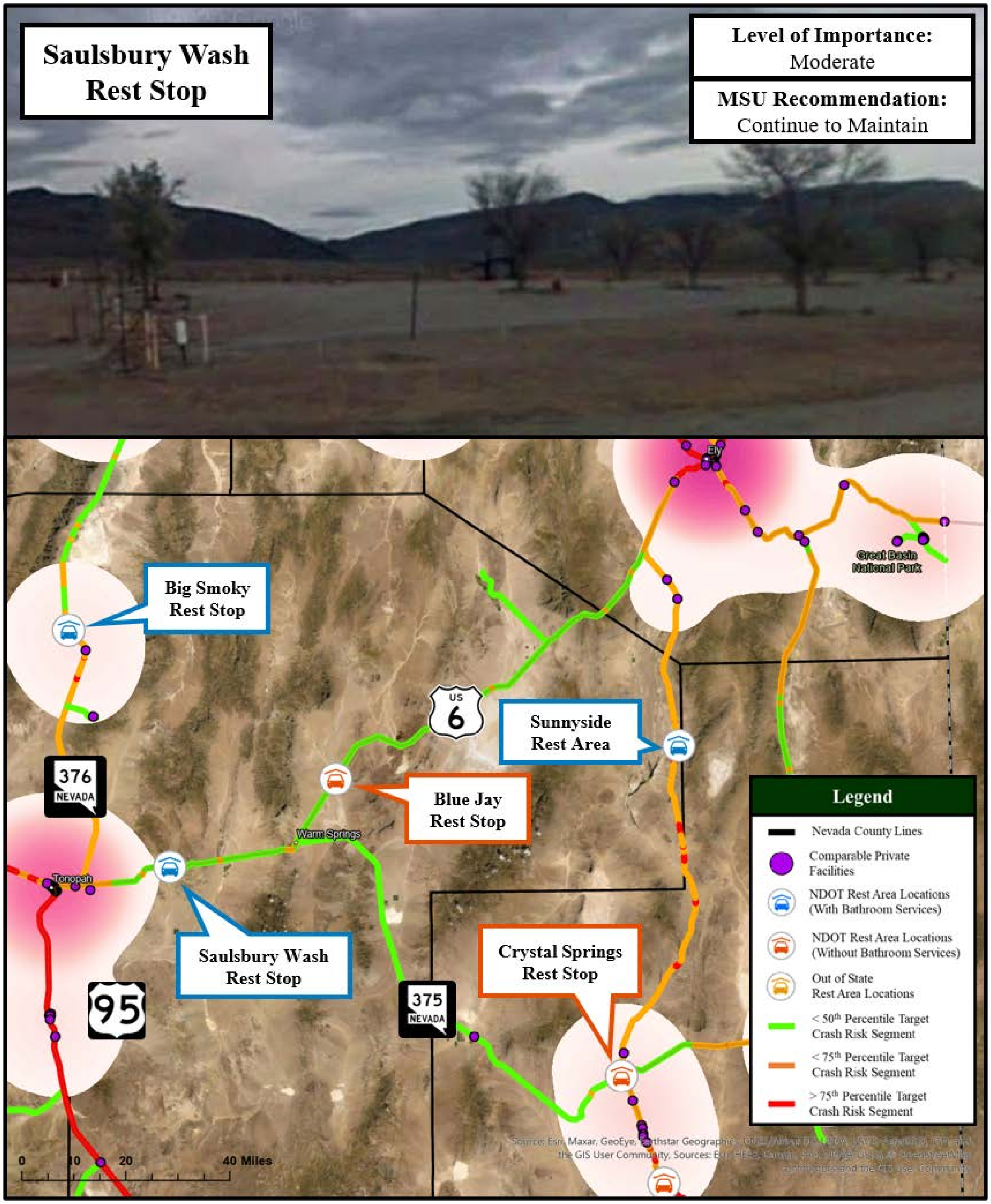
**Appendix D-21. Pony Springs Rest Stop Summary Sheet**



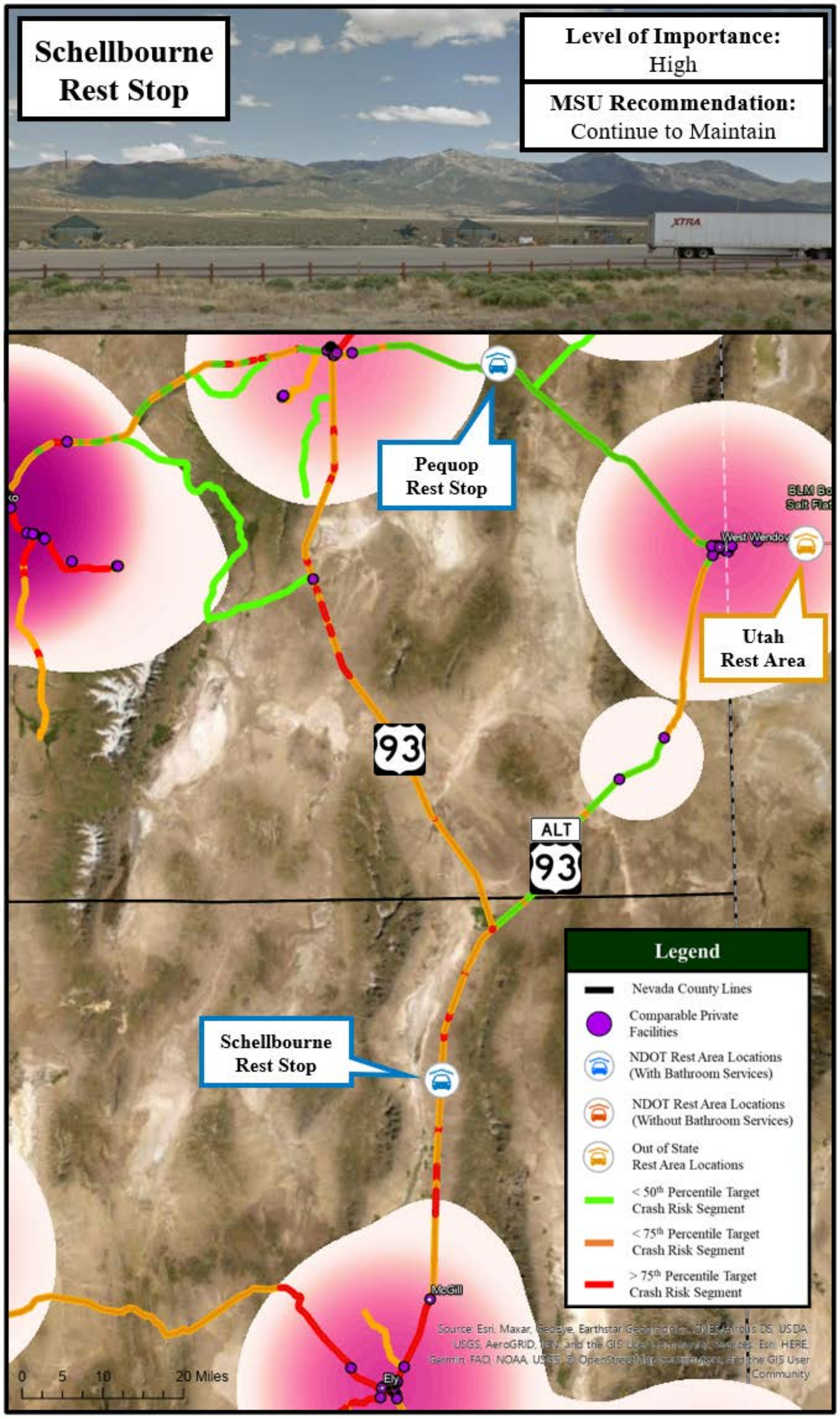
## Appendix D-22. Salmon Falls Rest Stop Summary Sheet



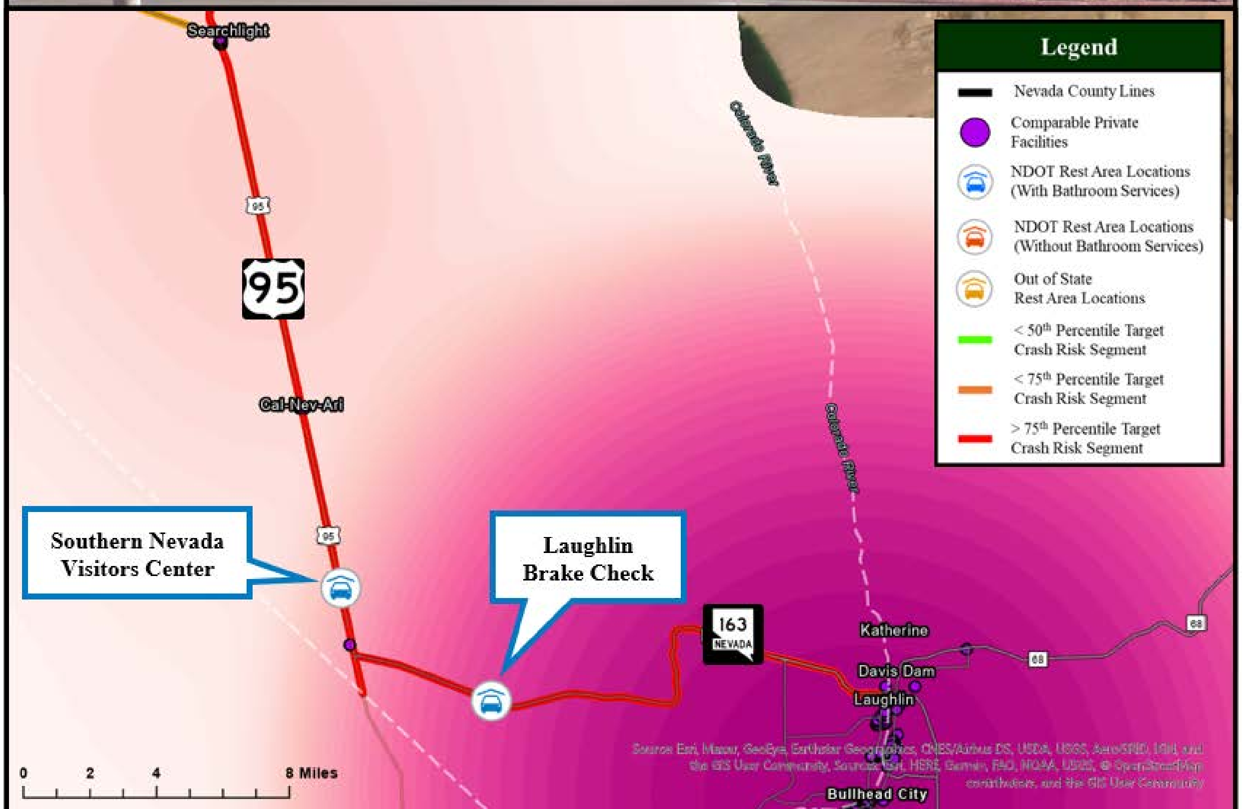
## Appendix D-23. Saulsbury Wash Rest Stop Summary Sheet

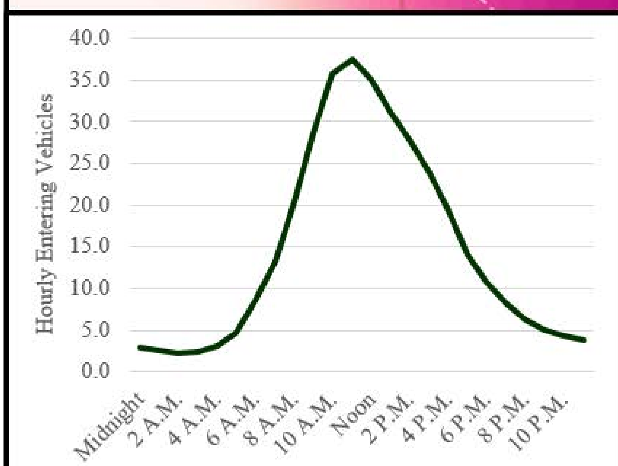


**Appendix D-24. Schellbourne Rest Stop Summary Sheet**

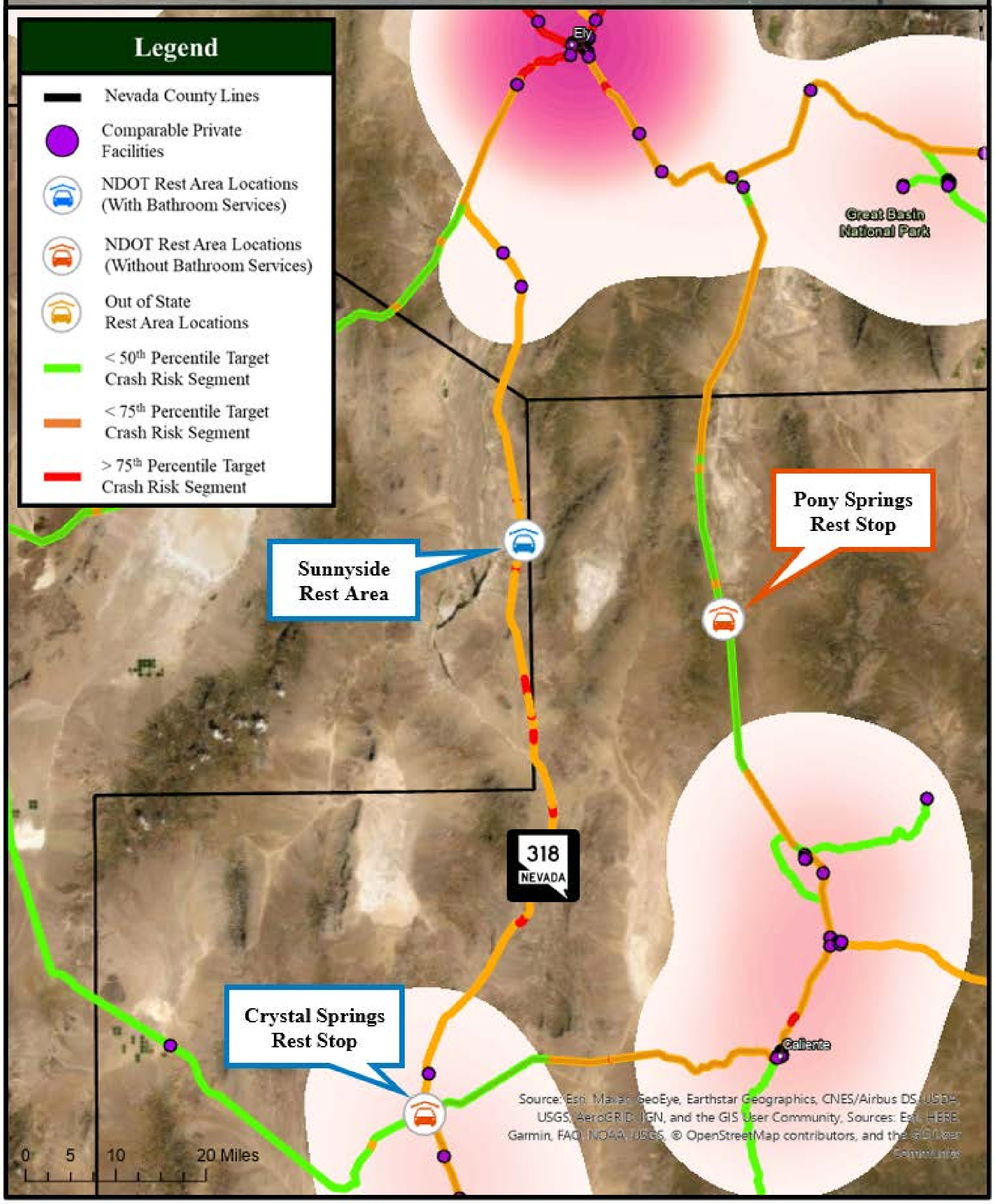


## Appendix D-25. Southern Nevada Visitor Center Summary Sheet

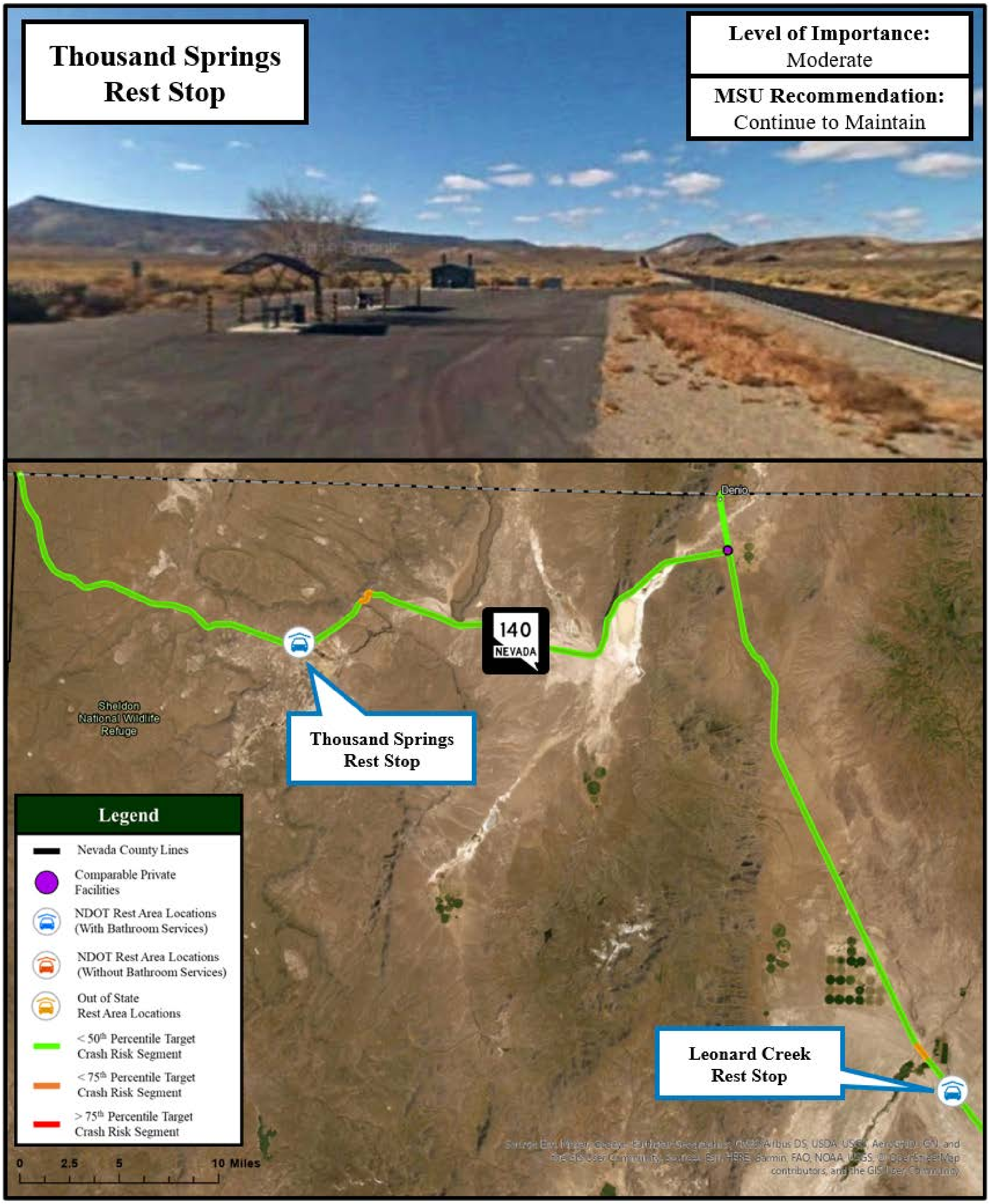



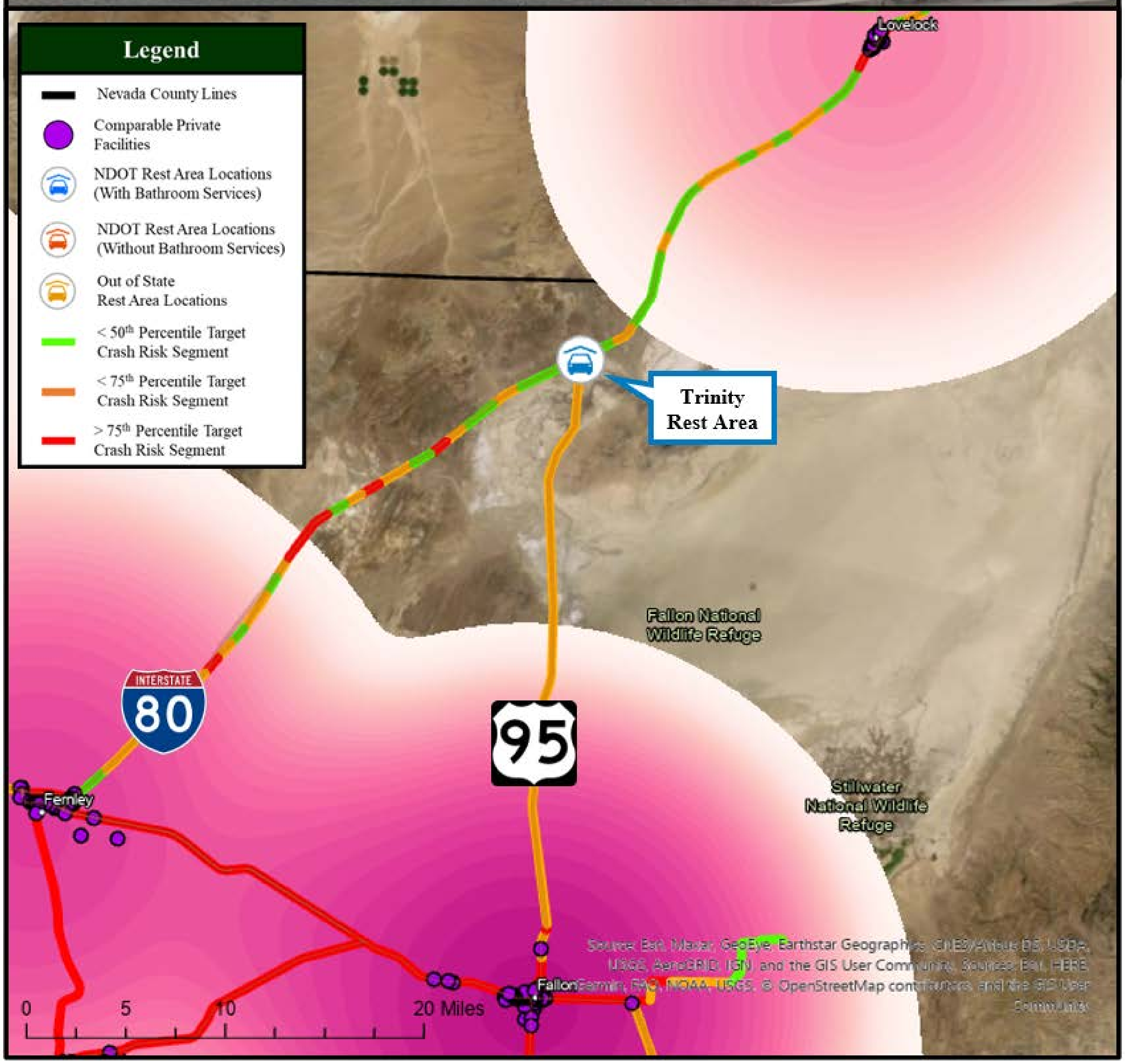

## Appendix D-26. Sunnyside Rest Area Summary Sheet

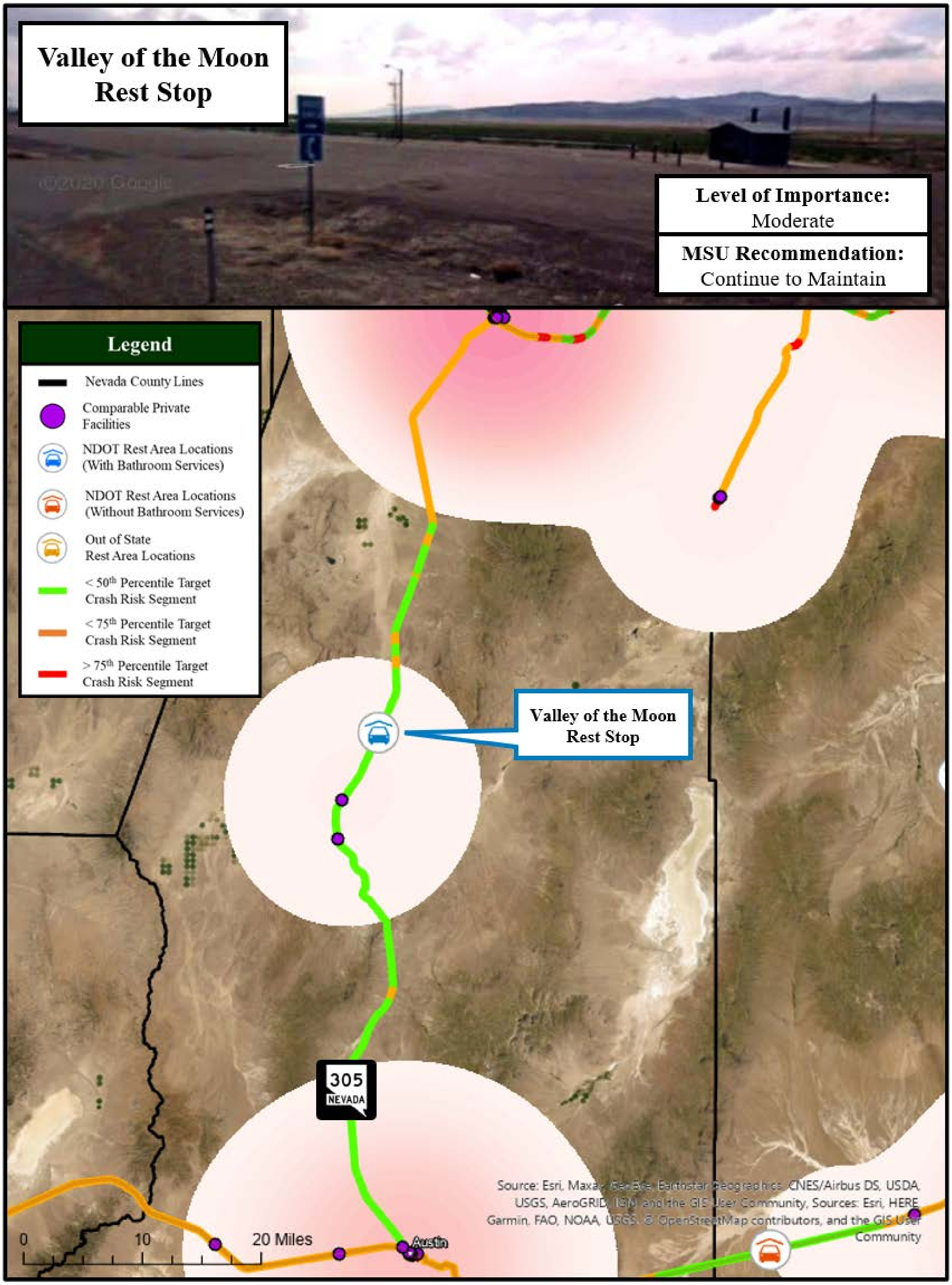
## Appendix D-27. Thousand Springs Rest Stop Summary Sheet



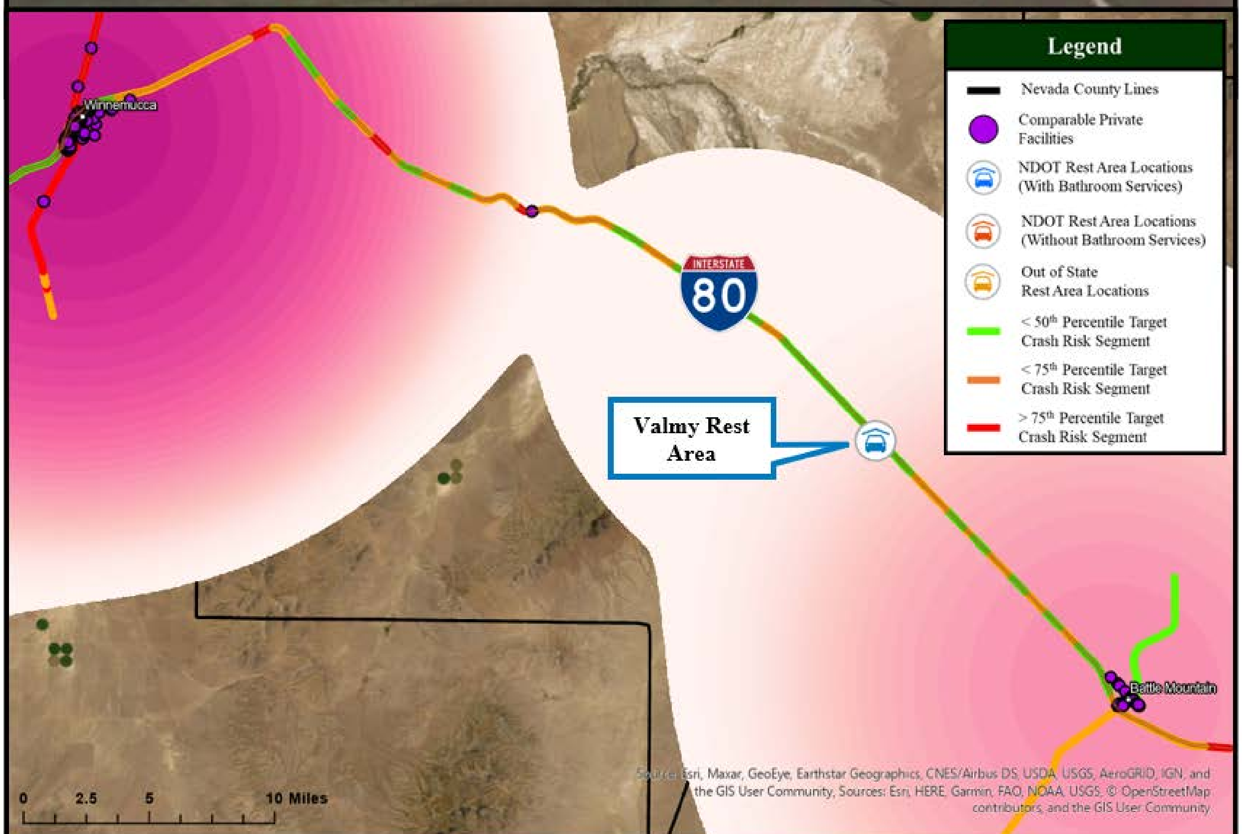
**Appendix D-28. Trinity Rest Area Summary Sheet**

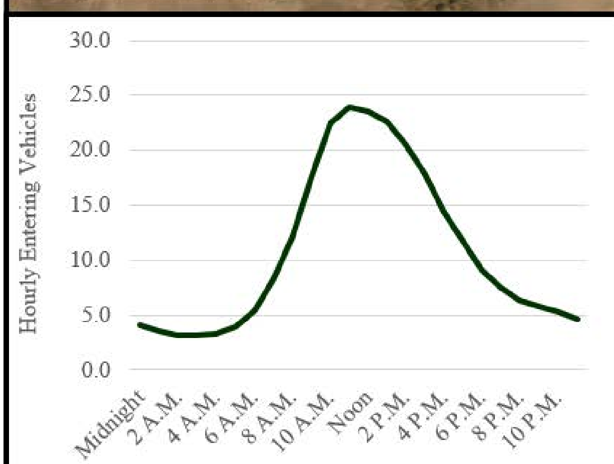



## Appendix D-29. Valley of the Moon Rest Stop Summary Sheet

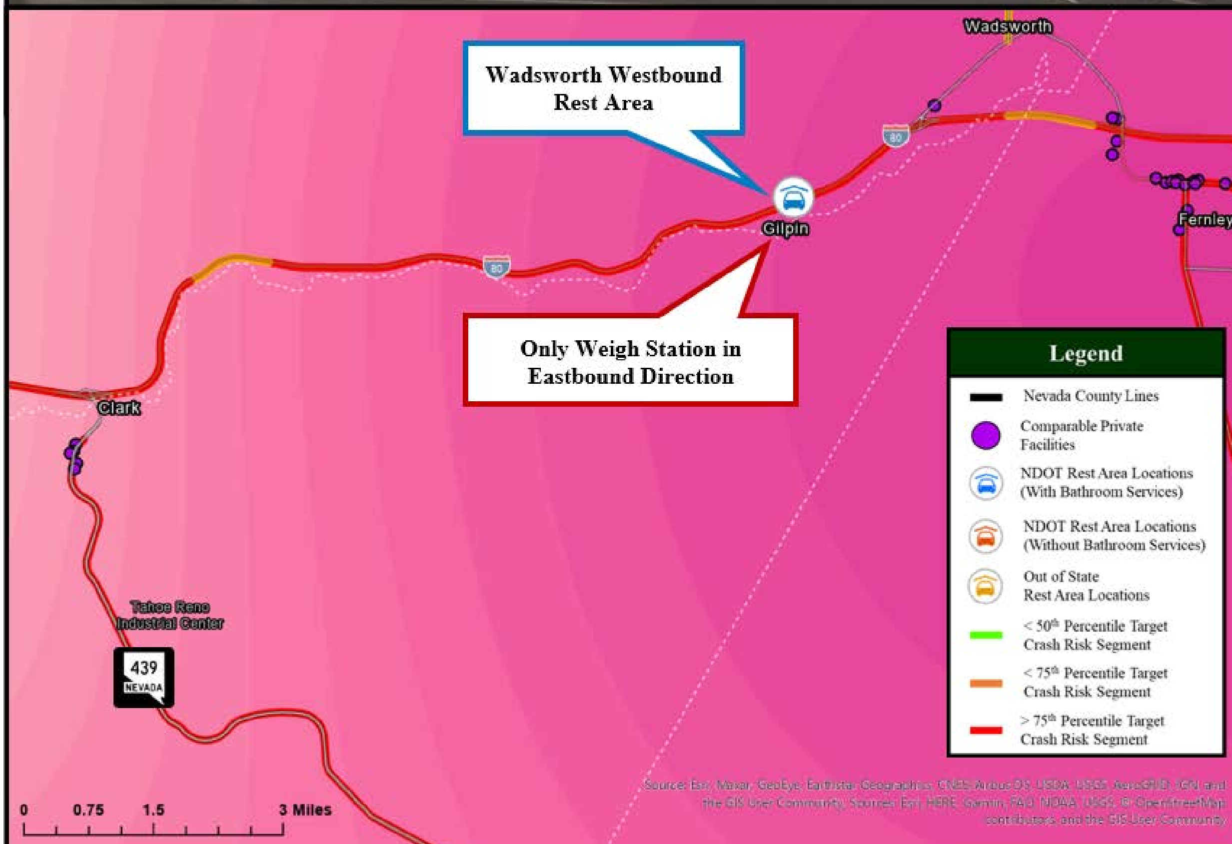


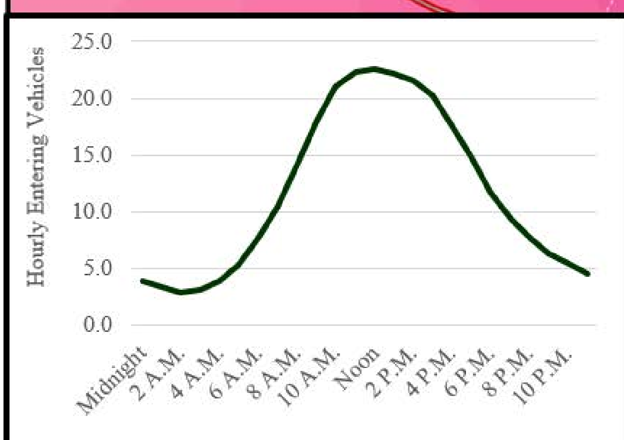
## Appendix D-30. Valmy Rest Area Summary Sheet

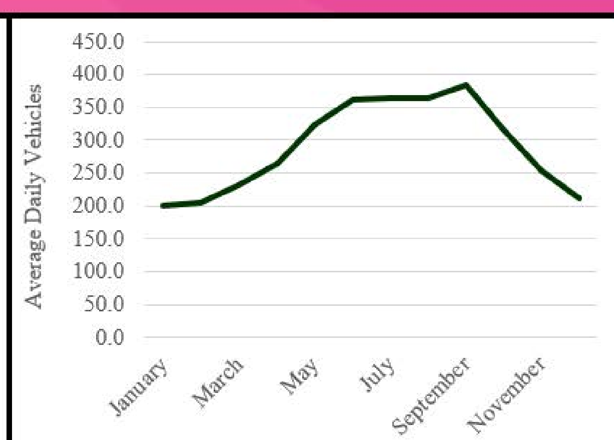



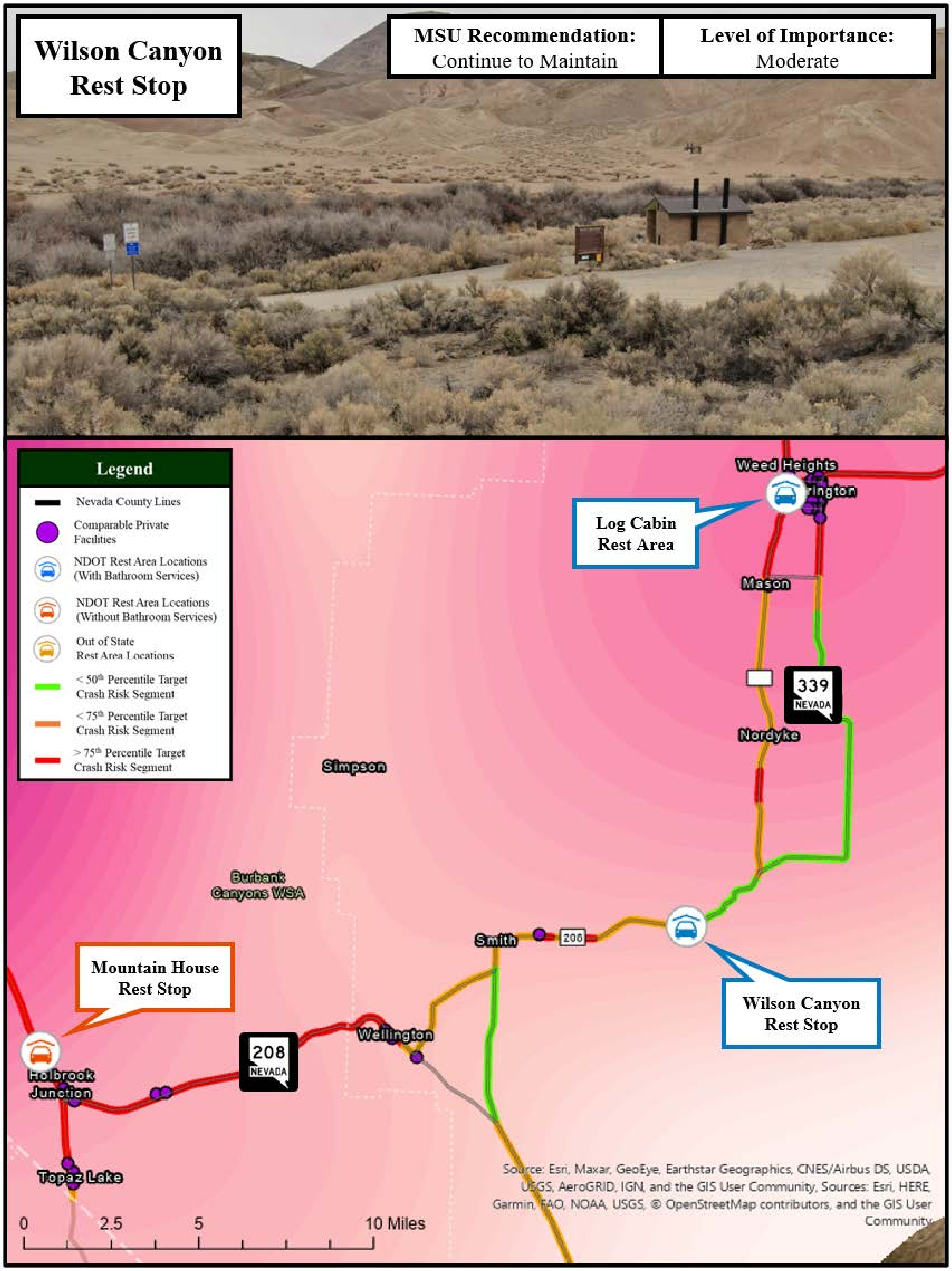

## Appendix D-31. Wadsworth Westbound Rest Area Summary Sheet

## Appendix D-32. Wilson Canyon Rest Stop Summary Sheet



**Nevada Department of Transportation**

Kristina L. Swallow, P.E. Director

Ken Chambers, Research Division Chief

(775) 888-7220

kchambers@dot.nv.gov

1263 South Stewart Street

Carson City, Nevada 89712