REGION 4 U.S. ROUTE 191 PASSING LANES (MP 0-126)

InterPlan Project Number 100286

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Executive Summary

U.S. Highway 191 (U.S. 191), located in eastern Utah, is a critical transportation corridor for the movement of freight, vehicle travel and access to recreational opportunities. The project area for this passing lanes study is located between milepost (MP) 0 at the Utah/Arizona state line to MP 126 in Moab. This analytical report represents the first stage in the implementation of a passing lane project. Through a diagnostic effort that includes a field assessment, analysis of crash data and traffic engineering expertise, proposed passing lanes have been identified that will enhance safety and improve the long-term efficiency, reliability, and cost competitiveness to move people and freight along U.S. 191. From this study, the table below shows the proposed passing lanes for U.S. 191 between MP 0 and MP 129.

Table 1 – U.S. 191 Recommended New Passing Lanes

Direction	Map Label (Figure 7)	Begin MP	End MP	Total Length (miles)	Comments	Prioritization Score
Southbound	SB P-1	90.3	91.3	1.0	Start after access (FAU 2448). Straight, long, steady grade	44
Northbound	NB P-1	95.5	96.0	0.5	Start after guard rail	66
	NB P-2	86.8	88.3	1.5	Longer, gentler grade	65
	NB P-3	80.0	81.0	1.0	Downhill passing lane	65
	NB P-4	41.0	42.0	1.0	Longer, gentler grade	35
	NB P-5	26.0	27.0	1.0	Traveling north out of Bluff. Very steep. Limited room for widening	44

In addition to new passing lanes, the following improvements are recommended for existing passing lanes:

1. Lengthen Passing Lane SB 3 – The start of this passing lane could be extended back to approximately MP 110.1 so as to capture the grade just before the start of the existing passing lane.

2. Lengthen Passing Lane SB 6 – This passing lane could be lengthened over the crest of the grade and possibly as far as the county road access to Canyon Rims Recreational Area near MP 93. The existing passing lane stops just short of an existing guardrail.

3. Lengthen Passing Lane SB 7 – This passing lane is extremely short - only 0.2 miles - and terminates short of the crest of the hill. This passing lane could be extended south past the crest of the hill to allow for slow-moving vehicles to accelerate back to within 10 mph of general traffic speeds before merging into the single travel lane. However, considering that there is an access to Canyonlands National Park (State route 211) just past the crest of the hill, the

passing lane could be extended past the access so that vehicles slowing to turn right into the access do not interfere with merge maneuvers.

4. Lengthen Passing Lane SB 8 – While this passing lane currently traverses the steepest parts of a two-mile grade, it could be lengthened further past MP 79.

5. Lengthen Passing Lane SB 10 – This passing lane could be lengthened to approximately MP 69 to carry the passing lane beyond the crest of the hill. This improvement would need to be weighed against the costs of possible modifications to an existing structure, however.

6. Connect Passing Lanes NB 5 and NB 6 – These two passing lanes are separated by only approximately 0.7 miles. Connecting the two passing lanes will result in a continuous two mile passing lane.

7. Lengthen Passing Lane NB 5 – This passing lane could be lengthened to approximately MP 68 to carry the passing lane beyond the crest of the hill. As with SB 10, this improvement would need to be weighed against the costs of possible modifications to an existing structure.

Table 2 – U.S. 191 Recommended Improvements to Existing Passing Lanes

Direction	Map Label (Figure 7)	Begin MP	End MP	Improvements
Southbound	SB 3	108.5	109.8	Extend to approximately MP 110.1
	SB 6	93.7	94.5	Extend over hill and possibly to access to Canyon Rims Recreational Area
	SB 7	86.5	86.7	Extend over hill and past S.R. 211 access
	SB 8	79.2	81.5	Extend over hill to approximately MP 79
	SB 10	70.1	70.8	Extend to approximately MP 69. Consider structure costs.
Northbound	NB 5 & NB 6			Connect these two passing lanes
	NB 5	66.9	67.8	Extend to approximately MP 68. Consider structure costs.

Finally, improvements to passing lane signage are recommended. Existing passing lane signing schemes are inconsistent with Utah Department of Transportation (UDOT) standard drawings. Part of the reason for inconsistent signage may be due to a lack of detail or changing guidelines in previous versions of the MUTCD. It is recommended that signage be phased into conformity with UDOT standard drawings as part of regular sign maintenance and/or replacement. It is also recommended that the "NEXT PASSING LANE XX MILES" (D17-1) sign begin to be used consistently along the corridor. The consistent use of this sign at the end of each passing lane and between long stretches of passing lanes would be especially beneficial so as to alert drivers of the next passing lane opportunity. Being aware of the distance to the next passing lane can help reduce driver anxiety and over-aggressive passing behavior.

Introduction

Passing lane and signage improvements are important along the U.S. 191 corridor to enhance safety and improve the long-term efficiency, reliability and cost competitiveness required to move people and freight through a key transportation corridor. Historically, UDOT has programmed transportation improvement projects along U.S. 191 and this current effort will benefit the flow of commercial and recreational traffic to national parks, state parks, and national monuments. Most importantly, commercial motor vehicles will be served by the design and implementation of passing lane projects that will enhance safety on U.S. 191. The goals of passing lanes on U.S. 191 include the following.

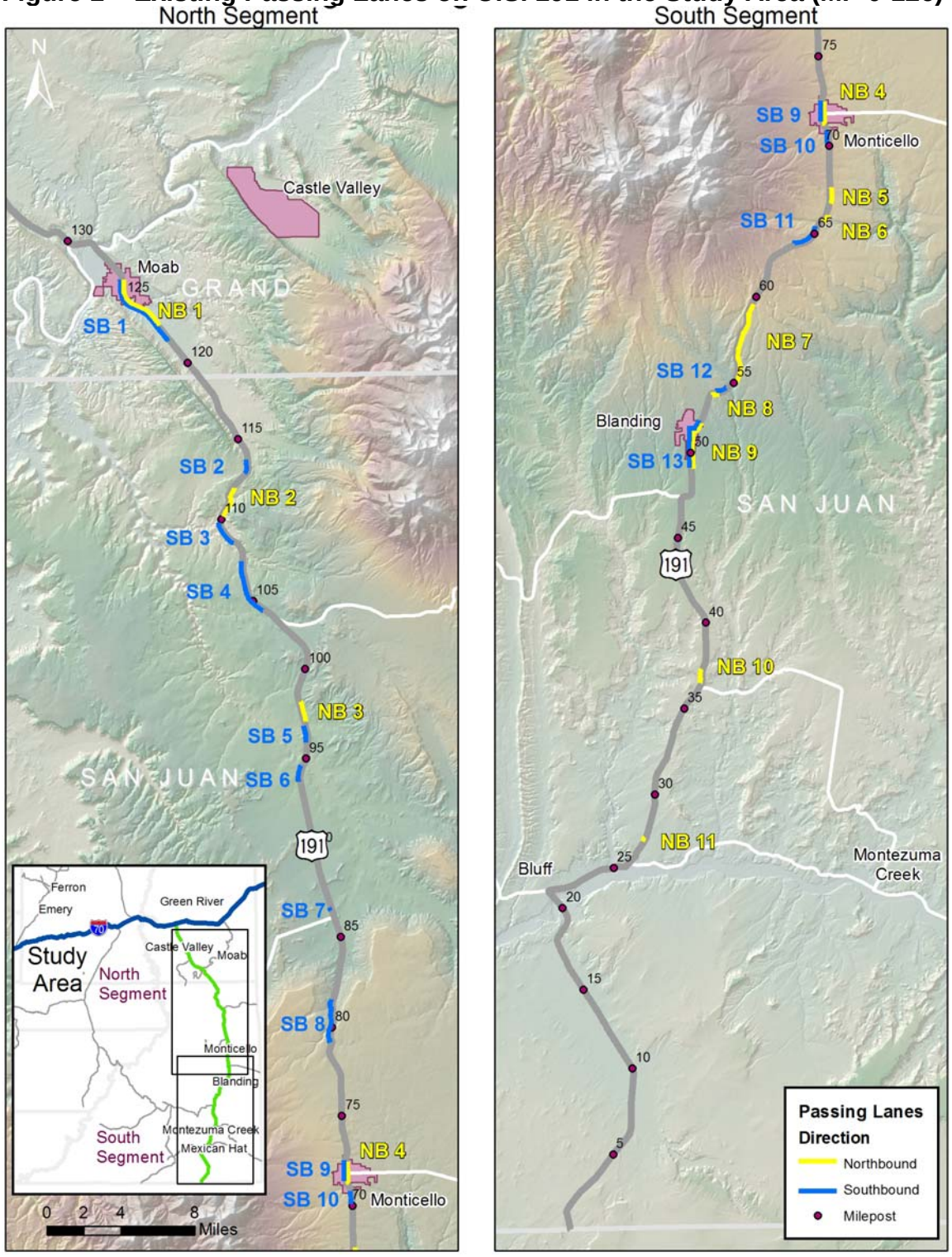
- Allow vehicles to pass slower traffic without crossing over into the oncoming lane of traffic.
- Decrease congestion that will help U.S. 191 maintain its function as an important transportation link between major rural and urban areas.
- Help maintain U.S. 191 as a major truck route by enhancing safety and reducing congestion.

Study Area

U.S. 191 is a major highway that traverses through much of eastern Utah. The route begins at the Utah/Arizona state line south of the town of Bluff, and then proceeds northerly through Blanding, Monticello, and Moab to Interstate 70 (I-70) at Crescent Junction. The route then runs concurrent with I-70 and U.S. 6. North of the town of Helper, U.S. 191 branches off from U.S. 6 and runs north to U.S. 40 at Duchesne. The route runs concurrent with U.S. 40 eastward to Vernal, finally breaking off towards the north to the Utah-Wyoming state line. The section of U.S. 191 addressed by this study begins at the Utah/Arizona state line at MP 0.0 to approximately MP 126 in Moab.

Major towns along the U.S. 191 study area include Bluff, Blanding, Monticello, and Moab. As a direct connection to I-70, U.S. 191 serves as an important link for freight traffic between Salt Lake City, New Mexico, and Texas. Additionally, U.S. 191 provides access to many recreational areas located in southeastern Utah, such as Moab, Arches National Park, Canyonlands National Park, Hovenweep National Monument, Manti-La Sal National Forest, Dead Horse Point State Park, and The Edge of the Cedars State Park Museum. U.S. 191 also serves the Ute Mountain Tribal Lands and accesses remote portions of the Navajo Nation Tribal Lands that include connections to Monument Valley Navajo Tribal Park and the Four Corners Monument.

Figure 1 – Existing Passing Lanes on U.S. 191 in the Study Area (MP 0-126)



Recent Projects

Three passing lane projects were completed on U.S. 191 within the study area in recent years. Two southbound passing lanes were installed between MP 96 and MP 97 and between MP 109 and MP 110, respectively. A third project lengthened the beginning of the existing southbound passing lane at MP 106 to MP 107 by about two miles. All other passing lanes in the study area existed prior to 2004.

Passing Lane/Turnout Standards

A policy on Geometric Design of Highways and Streets 2011

A Policy on Geometric Design of Highways and Streets 2011 (commonly known as the "AASHTO Green Book") published by the American Association of State Highway and Transportation Officials (AASHTO) provides policy and geometric design guidance on highways. The AASHTO Green Book outlines recommendations for both "climbing lane" and "passing lane" facilities.

Climbing lanes provide opportunities for vehicles to pass slower moving heavy vehicles on significant grades. Climbing lanes are often installed when a grade results in 10 mph or greater speed reduction for heavy vehicles, since the 10 mph speed differential is correlated with a sharp increase in crash potential (AASHTO Green Book, p.3-120, p.3-127).

Though similar to climbing lanes in that they provide an additional lane for passing opportunities, passing lanes do not have to be installed on significant grades. Passing lanes can be installed on two-lane highways in places of poor passing sight distance, or where traffic volumes result in poor level of service. When used to improve traffic operations, passing lanes should be provided systematically at regular intervals (AASHTO Green Book, p.3-132).

Both climbing lanes and passing lanes should extend an adequate distance before tapering down to one lane. For climbing lanes, ideally, the lane would extend beyond the crest of the hill to where a typical truck could accelerate back to a speed within 10 mph of other vehicles. When impractical, the taper should occur where sight distance is sufficient to allow passing in the absence of oncoming traffic (AASHTO Green Book p.3-128). Passing lanes should provide a taper that allows at least 1,000 feet of sight distance (AASHTO Green Book p.3-132).

Further AASHTO guidelines specify that the selection of a location for a passing lane should consider the locations of intersections and high-volume driveways in order to minimize the volume of turning movements on a road section where passing is encouraged. A continuous shoulder should also be present in passing lane lengths. The full documentation of climbing and passing lanes in sections 3.4.3 and 3.4.4 of the AASHTO Green Book should be consulted prior to the design and construction of any passing lanes on U.S. 191.

Manual on Uniform Traffic Control Devices 2009

The *Manual on Uniform Traffic Control Devices 2009* (MUTCD), published by the Federal Highway Administration, establishes national signing requirements and guidelines for public streets. Information regarding passing and/or climbing lane signing in the MUTCD falls within the realm of "Guidance" or "Option" material and thus, reserves some flexibility for

individual governing agencies. The MUTCD offers several optional regulatory signs for the beginning of a climbing/passing lane, including a "KEEP RIGHT EXCEPT TO PASS" sign (R4-16), a "SLOWER TRAFFIC KEEP RIGHT" sign (R4-3), and a "TRUCKS USE RIGHT LANE" sign (R4-5). In advance of a climbing/passing lane, the MUTCD provides optional guide signs, such as a "NEXT TRUCK LANE XX MILES" sign (D17-1) and a "TRUCK LANE XX MILES" sign (D17-2). The MUTCD specifies that the words "PASSING" or "CLIMBING" may be used in place of "TRUCK" on such signs. Although not directly discussed with passing lanes, the MUTCD Lane Ends (W4-2) and "LANE ENDS MERGE LEFT" (W9-2) signs are applicable where passing lanes reduce back to one lane of travel. Figures 2, 3, and 4 provide examples of these signs.

Figure 2 – Regulatory Signs (MUTCD, Figure 2B-10)

R4-16 R4-3 R4-5

Figure 3 – Guide Signs* (MUTCD, Figure 2D-21)

*The words "PASSING" or "CLIMBING" may be substituted for the word "TRUCK"

D17-1 D17-2

Figure 4 – Warning Signs (MUTCD, Figure 2C-8)

W4-2 W9-2

UDOT Standard Drawings

UDOT publishes standard drawings for the design, construction and maintenance of the state highway system. In regards to climbing/passing lanes, UDOT standard drawings contain climbing lane installation criteria, pavement marking requirements, and taper length requirements consistent with the AASHTO Green Book. Signing requirements are also in line with MUTCD guidance in the use of the "KEEP RIGHT EXCEPT TO PASS" sign, "PASSING LANE XX MILES" sign, and the "LANE ENDS MERGE LEFT" sign.

UDOT standard drawings address the option of allowing passing maneuvers for the single travel lane in the opposing direction of the passing lane. Signing and roadway striping permitting such passing maneuvers may be installed provided passing zone criteria are met and receive approval from the UDOT region traffic engineer. The UDOT standard drawings relevant to passing lanes, drawing DD 3, drawing ST 5, and drawing ST 6 are provided in the appendix.

Relevant Planning Documents

The UDOT 2011-2040 Long Range Plan addresses the need for improvement projects on state-owned roads outside the planning jurisdiction of metropolitan planning organizations. These projects may include new roads, additional lanes, passing lanes, and new or upgraded interchanges which UDOT plans to implement by 2040, based on revenue assumptions and a selected funding alternative.

The current UDOT Long Range Plan specifies a Phase 3 (2031-2040) widening project from the current terminus of the five-lane cross section just south of Moab to MP 118. This project may include new travel lanes or passing lanes. The Long Range Plan also includes a passing lane project in the unfunded phase. This project is for a northbound passing lane on U.S. 191 from MP 26.5 to MP 28, just north of Bluff. The Statewide Transportation Improvement Program (STIP) lists several projects within the study area as contained below.

1. Monticello Main Street – Pavement rehabilitation
2. Port-of-Entry – Port-of-Entry construction
3. MP 12 to 21 Crack Repairs – Functional repair/seal coat
4. Wilson Arch to New Passing Lane – Bituminous pavement, rehabilitation

Existing Conditions

Site Visit and Data Collection

Outside of the towns of Bluff, Blanding, Monticello, and Moab, U.S. 191, serves as a major, two-lane rural highway, with infrequent access points and high speeds. Within these towns, U.S. 191 serves multiple accesses, features lower speeds, and can open up to multiple travel lanes. Due to the more urban nature of U.S. 191 within towns, this analysis was limited to the rural area between towns in its evaluation of passing lane locations. The data

gathered and presented for the duration of this report will focus mainly on the rural portions of U.S. 191.

U.S. 191 is a high-speed corridor with a speed limit of 65 miles per hour throughout the study area. According to Traffic on Utah Highways 2010, published by UDOT, the average annual daily traffic (AADT) for 2010 ranges from approximately 1,500 to vehicles per day near the Utah/Arizona State Line to approximately 4,300 vehicles per day near Moab. Generally, daily traffic volumes increase northward along the study corridor.

A significant portion of the traffic along U.S. 191 is heavy trucks. Traffic on Utah Highways 2010 reports truck percentages ranging between 17 and 31 percent south of Monticello. North of Monticello, the truck percentage increases sharply to 40 to 50 percent. This is likely due to the influx of freight traffic on U.S. 491 from Colorado.

U.S. 191 experiences a strong seasonal fluctuation. Due to the influx of recreational traffic, summer month traffic can be up to 20 percent higher than the annual average, while winter month volumes can be as low as 70 percent of the annual average.

A field assessment of U.S. 191 passing lanes was conducted on February 22 and 23, 2012. The weather during the field assessment was clear and the roadway was dry with no snow or ice build-up from the winter season. The assessment inventoried existing passing lanes. Twenty-four existing passing lanes were observed and are listed in Table 3. Each passing lane is identified by its starting and ending milepost. The interval between each passing lane is also displayed along with the year of construction. The table also includes and notes the passing opportunities within towns where U.S. 191 opens up to a four or five-lane cross section.

Photo on U.S. 191 near Wilson Arch.

Table 3 – U.S. 191 Passing Lane Inventory

Direction	Map Label (Figure 1)	Begin MP	End MP	Total Length (Miles)	Distance to Next Passing Lane	Year of Construction
Southbound	SB 1	121.6	126.0	4.4	7.8	Moab
	SB 2	112.9	113.8	0.9	3.1	Pre 2004
	SB 3	108.5	109.8	1.3	1.2	2007
	SB 4	104.3	107.3	3.0	7.5	2007*
	SB 5	95.9	96.8	1.0	1.3	2007
	SB 6	93.7	94.5	0.8	7.0	Pre 2004
	SB 7	86.5	86.7	0.2	5.0	Pre 2004
	SB 8	79.2	81.5	2.3	6.6	Pre 2004
	SB 9	71.4	72.6	1.1	0.6	Monticello
	SB 10	70.1	70.8	0.8	4.7	Pre 2004
	SB 11	63.7	65.4	1.7	9.2	Pre 2004
	SB 12	53.9	54.6	0.6	1.9	Pre 2004
	SB 13	49.2	52.0	2.8		Blanding
Northbound	NB 1	123.8	126.0	2.3	11.8	Moab
	NB 2	110.2	112.0	1.8	12.0	Pre 2004
	NB 3	97.0	98.2	1.2	24.5	2007
	NB 4	71.2	72.5	1.3	3.5	Monticello
	NB 5	66.9	67.8	0.8	0.7	Pre 2004
	NB 6	65.9	66.3	0.4	6.2	Pre 2004
	NB 7	55.2	59.6	4.5	1.1	Pre 2004
	NB 8	53.6	54.1	0.4	1.7	Pre 2004
	NB 9	49.2	51.9	2.8	11.7	Blanding
	NB 10	36.7	37.5	0.8	9.1	Pre 2004
	NB 11	27.4	27.6	0.3		Pre 2004

*Lengthened in 2007. Original passing lane pre-dates 2004.

In addition to the passing lane inventory, the following general observations were made. First, passing lane intervals are not optimized for spacing and length so as to reduce delays caused by inadequate passing opportunities. This is particularly evident in the northbound direction where there are intervals of up to 25 miles between passing lanes. The southbound direction provides passing lanes at much more regular intervals; however, there are no passing lanes south of Blanding.

Second, passing lane signage was not consistent among passing lanes throughout the study area, nor with recent guideline updates published in the MUTCD. Specifically, the regulatory signs were placed at irregular intervals prior to individual passing lanes. Also, the guide signs are supposed to be all green with white lettering telling how many miles before the next passing lane.

Finally, the start and end points of some passing lanes could be lengthened to improve vehicle speeds and allow for heavy vehicles to safely accelerate to appropriate speeds after cresting a vertical grade.

2006-2010 Crash History

Transportation safety is a key component of the transportation system. Top priority is usually given to funding roadway improvements that will reduce crashes.

Crash and Severity Type

The two tables below summarize crashes by the manner of collision and crash severity. Eighty-eight percent of crashes are "single vehicle" crashes, which are often associated with run off road crashes or animal hits. Additionally, 79 percent of crashes resulted in no injury to the vehicle occupants. Approximately five percent of crashes resulted in a "severe" injury (incapacitation injury or a fatality). It should be noted that all crash data is for the sections of roadway between towns only.

Table 4 – Manner of Collision with Number and Percentage

Manner of Collision	Number	Percentage
Angle	14	2.0
Front to Rear	23	3.3
Head-on	5	0.7
Sideswipe (same direction)	21	3.0
Sideswipe (opposite direction)	16	2.3
Parked Vehicle	2	0.3
Rear to Side	0	0.0
Rear to Rear	1	0.1
Single Vehicle	622	88.4
Total	**704**	**100.1**

Source: UDOT Traffic and Safety Division

Table 5 – Crash Severity with Number and Percentage

Injury	Number	Percentage
No Injury	557	79
Possible Injury	65	9
Non-incapacitating Injury	47	7
Incapacitating Injury	27	4
Fatal	8	1
Total	**704**	**100**

Source: UDOT Traffic and Safety Division

Crash Statistics

The following safety statistics were gathered for the study area to help summarize roadway safety conditions:

- Crash Rate
- Severe Crash Rate

The Crash Rate is a calculation that normalizes the number of crashes on a road segment against the segment length and traffic volume. Crash rates are typically expressed in units of crashes per year per hundred million vehicle-miles. The Severe Crash Rate also normalizes

crashes against length and volume, but only considers "severe crashes" (incapacitating injury and fatal crashes combined). Severe crash rates are expressed in units of severe crashes per hundred million vehicle-miles. Both crash rates and severe crash rates can be compared against the statewide average rates for similar road segments according to volume and functional type.

Table 6 summarizes the overall crash statistics for the study area. Generally, crash rates increase from south to north. In most cases, both the crash rate and severe crash rate are lower than the statewide average for roadways of similar volume and functional class. However, the rural road segment between Blanding and Monticello has a crash rate that exceeds the statewide average. Discussions with local UDOT officials suggest this may be associated with an increased number of animal hits through the area.

Table 6 – Study Area Crash Data

Segment (U.S.191)	Begin MP	End MP	Functional Class	Crashes		Actual		Statewide Average[3]	
				Total	Severe	Crash Rate[1]	Severe Crash Rate[2]	Crash Rate[1]	Severe Crash Rate[2]
Arizona State line to Bluff	0.00	24.54	Rural Principal Arterial	54	1	0.80	1.48	1.56	7.6
Bluff to Blanding	26.23	49.18	Rural Principal Arterial	71	3	0.73	3.10	1.56	7.6
Blanding to Monticello	51.57	70.63	Rural Principal Arterial	238	5	3.06	6.43	1.56	7.6
Monticello to Moab	73.02	123.40	Rural Principal Arterial	341	26	0.91	6.95	1.56	7.6
All Segments Between Towns			Rural Principal Arterial	704	35	1.14	5.68	1.56	7.6

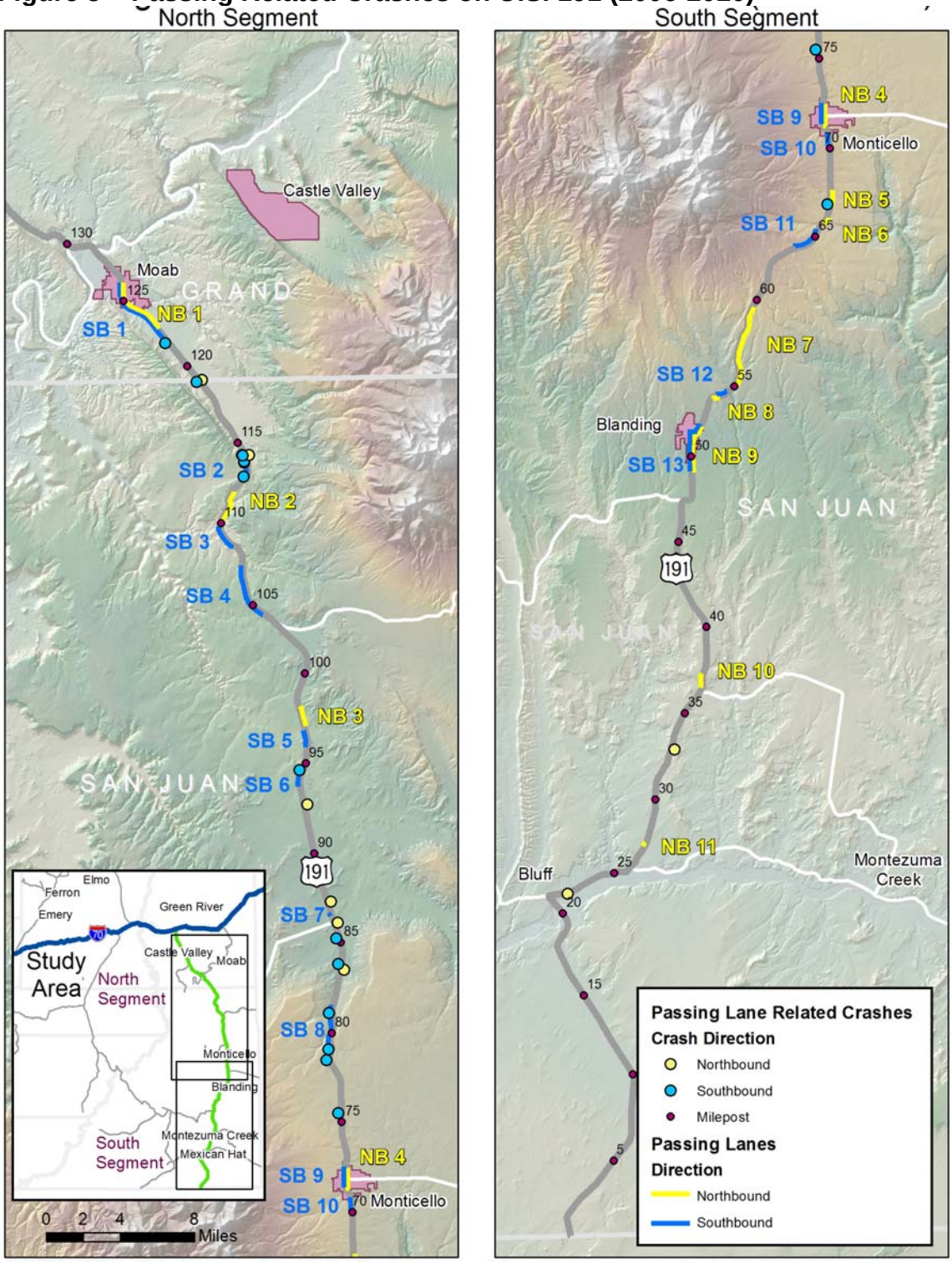
[1]Crashes per million vehicle miles
[2]Severe crashes per hundred million vehicle miles
[3]Based on 2008-2010 statewide average rates per functional class and AADT

Passing-Related Crashes

Crash data were further examined to attempt to identify crashes involving passing maneuvers. Crashes within the UDOT Traffic and Safety database maintain a number of quantitative and qualitative attributes. While no single attribute can consistently confirm whether a crash involved a passing maneuver, several factors can provide an indication. Thus, the passing maneuver-related crashes identified in this study represent a best, but not exact, approximation of actual occurrences.

Figure 5 illustrates the 2006-2010 passing related-crashes in the study area. Some of the crashes occur where there are existing passing lanes, while others occur in sections where there is not a passing lane.

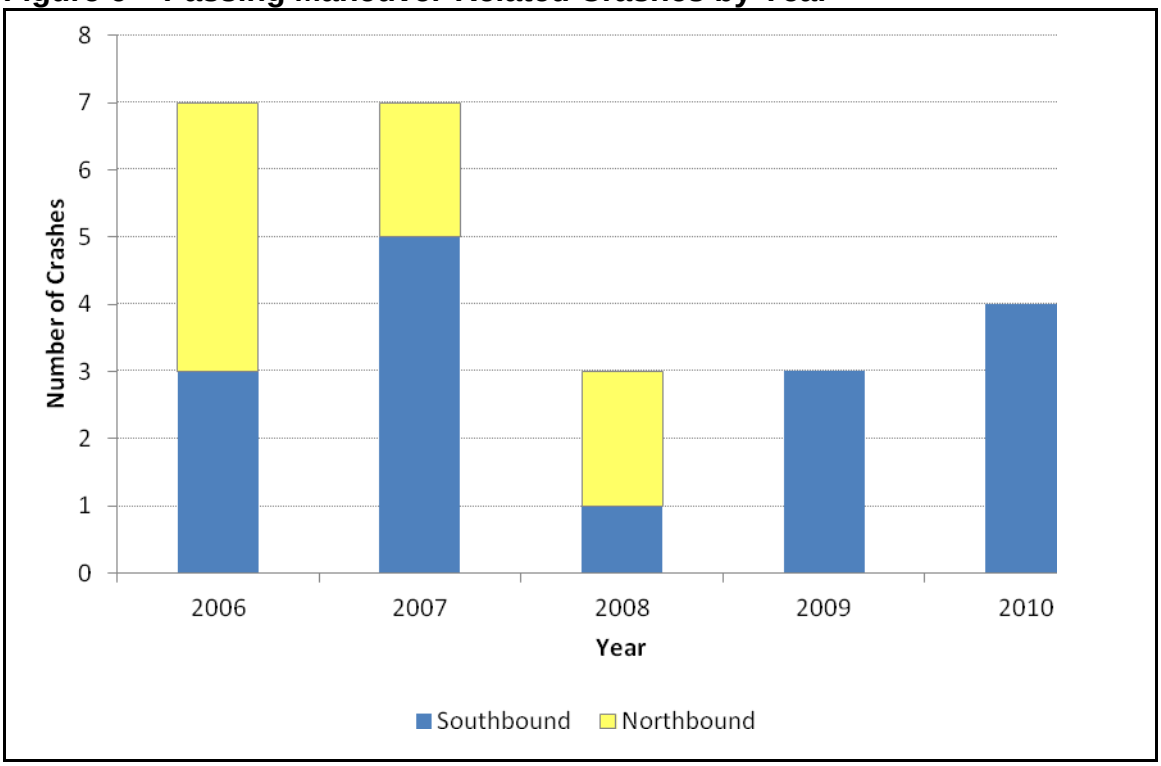
Figure 5 – Passing Related Crashes on U.S. 191 (2006-2010)



CONFIDENTIAL: This data, as well as all UDOT safety program information, are protected under 23 USC 409.

Figure 6 illustrates a general trend of decreasing frequency of passing-related crashes from the 2006 to 2010. The trend may be related to a number of factors including increased passing opportunities, fluctuating traffic volumes, and road construction.

Figure 6 – Passing Maneuver-Related Crashes by Year



Recommendations

New Passing Lanes

Using information and observations gathered during the site visit and data collection process, new passing lane recommendations were prepared for the study area. A total of six potential locations for new passing lanes were identified, five for the northbound direction of travel and one for the southbound direction. Table 7 and Figure 7 summarize and illustrate the recommendations.

The northbound passing lane recommendations address the largest deficiency in passing lane frequency for the northbound direction. Whereas the worst northbound passing lane interval is 24 miles, the recommended passing lanes would break that interval into smaller intervals of less than eight miles each (see Table 8). Additionally, the northbound recommendations would implement passing lanes along a few long, sustained grades (and one steep downhill grade) where heavy vehicles are likely to experience significant speed reductions.

Table 7 – U.S. 191 Recommended New Passing Lanes

Direction	Map Label (Figure 7)	Begin MP	End MP	Total Length (miles)	Comments
Southbound	SB P-1	90.3	91.3	1.0	Start after access (FAU 2448). Straight, long, steady grade
Northbound	NB P-1	95.5	96.0	0.5	Start after guard rail
	NB P-2	86.8	88.3	1.5	Longer, gentler grade
	NB P-3	80.0	81.0	1.0	Downhill passing lane
	NB P-4	41.0	42.0	1.0	Longer, gentler grade
	NB P-5	26.0	27.0	1.0	Traveling north out of Bluff. Very steep. Limited room for widening

Figure 7 – Existing and Proposed Passing Lanes on U.S. 191

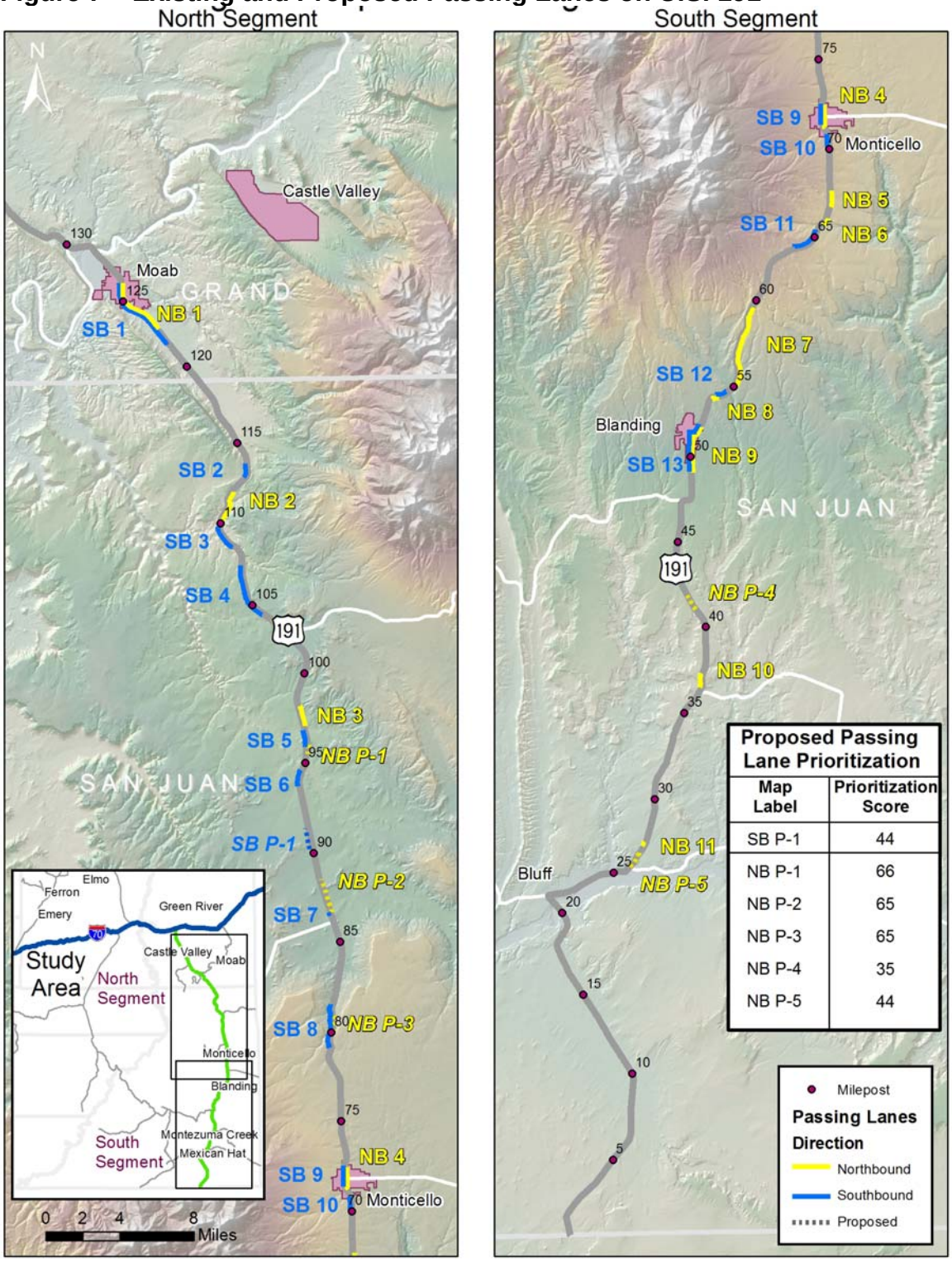


Table 8 – Passing Lane Interval Comparison

Direction	Map Label	Begin MP	End MP	Total Length (miles)	Existing Interval	Proposed Interval
Southbound	SB 1	121.6	126.0	4.4	7.8	7.8
	SB 2	112.9	113.8	0.9	3.1	3.1
	SB 3	108.5	109.8	1.3	1.2	1.2
	SB 4	104.3	107.3	3.0	7.5	7.5
	SB 5	95.9	96.8	1.0	1.3	1.3
	SB 6	93.7	94.5	0.8	7.0	3.2
	SB P-1	**90.3**	**91.3**	**1.0**		**4.6**
	SB 7	86.5	86.7	0.2	5.0	5.0
	SB 8	79.2	81.5	2.3	6.6	6.6
	SB 9	71.4	72.6	1.1	0.6	0.6
	SB 10	70.1	70.8	0.8	4.7	4.7
	SB 11	63.7	65.4	1.7	9.2	9.2
	SB 12	53.9	54.6	0.6	1.9	1.9
	SB 13	49.2	52.0	2.8	49.2	49.2
Northbound	NB 1	123.8	126.0	2.3	11.8	11.8
	NB 2	110.2	112.0	1.8	12.0	12.0
	NB 3	97.0	98.2	1.2	24.5	1.0
	NB P-1	**95.5**	**96.0**	**0.5**		**7.2**
	NB P-2	**86.8**	**88.3**	**1.5**		**5.8**
	NB P-3	**80.0**	**81.0**	**1.0**		**7.5**
	NB 4	71.2	72.5	1.3	3.5	3.5
	NB 5	66.9	67.8	0.8	0.7	0.7
	NB 6	65.9	66.3	0.4	6.2	6.2
	NB 7	55.2	59.6	4.5	1.1	1.1
	NB 8	53.6	54.1	0.4	1.7	1.7
	NB 9	49.2	51.9	2.8	11.7	11.7
	NB 10	36.7	37.5	0.8	9.1	9.1
	NB 11	27.4	27.6	0.3	27.4	0.4
	NB P-5	**26.0**	**27.0**	**1.0**		**26.0**

Prioritization

A prioritization process was utilized to rank the recommended new passing lane locations in this study. The process was based on the prioritization scoring methods the UDOT Planning Division uses to rank statewide passing lane projects for the Utah Transportation Commission. The Planning Division methodology reports a 0-100 score and utilizes the following four criteria and weighting to rank passing lane projects:

1. AADT – 30 percent
2. Truck AADT – 20 percent
3. Crash History – 30 percent
4. Freight Corridor – 20 percent

Because the Planning Division methodology is targeted towards comparing corridor to corridor, and because of the homogeneous nature of the study area, a fifth criterion was added to help further refine the passing lane recommendations. This criterion is defined as "Passing Lane Interval" and scores the existing interval between passing lanes where the passing is proposed. Road segments with greater distance between passing lanes receive higher scores to reflect a greater need for a passing lane. The new criterion was assigned a maximum value of 20 points to bring the maximum potential score up to 120 points. The breakdown of individual scoring schemes is provided in the appendix.

Table 9 summarizes the prioritization scores for the recommended new passing lanes. Generally, northbound passing lane recommendations result in higher scores than the southbound passing lane recommendation. The relative comparison among scores yields two groups of recommendations with NB P-1, NB P-2, and NB P-3 in the upper scoring group and NB P-4, NB P-5, and SB P-1 in the lower group.

It should be noted that this prioritization process is intended to be used for planning-level decisions. Other factors, such as cost, constructability, pavement condition, or grade may be considered in any final decision-making process. Furthermore, the proposed new passing lane locations are generic. Actual passing lane locations could be extended or shortened based on engineering analysis of structures, culverts, horizontal and vertical curvature, or cut and fill parameters.

Table 9 – U.S. 191 Recommended Passing Lanes Prioritization

Potential Passing Lane Locations			Prioritization Criteria										
			AADT		Truck AADT		Crash History		Freight Corridor		Passing Lane Interval		
Map Label	Begin MP	End MP	2010	Score	2010	Score	Safety Index[1]	Score	Type	Score	Interval	Score	Total Score
SB P-1	90.3	91.3	3,905	6	1,835	8	1.5	5	Major	20	7.0	5	44
NB P-1	95.5	96.0	3,905	6	1,835	8	4.0	12	Major	20	24.5	20	66
NB P-2	86.8	88.3	3,575	6	1,823	8	3.5	11	Major	20	24.5	20	65
NB P-3	80.0	81.0	3,575	6	1,823	8	3.5	11	Major	20	24.5	20	65
NB P-4	41.0	42.0	2,525	6	556	4	1.5	5	Major	20	1.7	0	35
NB P-5	26.0	27.0	2,070	3	352	2	4.5	14	Major	20	5.9	5	44
Points Possible				**30**		**30**		**30**		**20**		**20**	**120**

[1]Proposed passing lane +/-0.5 mile (2006-2010)

Improve Existing Passing Lanes

During the field review, passing lane start and end points were examined to determine whether they provide adequate service for traveling vehicles. Based on the review, the following improvements to existing passing lanes are recommended:

1. Lengthen Passing Lane SB 3 – The start of this passing lane could be extended back to approximately MP 110.1 so as to capture the grade just before the start of the existing passing lane.

2. Lengthen Passing Lane SB 6 - This passing lane could be lengthened over the crest of the grade and possibly as far as the county road access to Canyon Rims Recreational Area near MP 93. The existing passing lane stops just short of an existing guardrail.

3. Lengthen Passing Lane SB 7 – This passing lane is extremely short - only 0.2 miles - and terminates short of the crest of the hill. This passing lane could be extended south past the crest of the hill to allow for slow-moving vehicles to accelerate back to within 10 mph of general traffic speeds before merging into the single travel lane. However, considering that there is an access to Canyonlands National Park (S.R. 211) just past the crest of the hill, the passing lane could be extended past the access so that vehicles slowing to turn right into the access do not interfere with merge maneuvers.

4. Lengthen Passing Lane SB 8 – While this passing lane currently traverses the steepest parts of a two-mile grade, it could be lengthened further past MP 79.

5. Lengthen Passing Lane SB 10 – This passing lane could be lengthened to approximately MP 69 to carry the passing lane beyond the crest of the hill. This improvement would need to be weighed against the costs of possible modifications to an existing structure, however.

6. Connect Passing Lanes NB 5 and NB 6 – These two passing lanes are separated by only approximately 0.7 miles. Connecting the two passing lanes will result in a continuous two mile passing lane.

7. Lengthen Passing Lane NB 5 – This passing lane could be lengthened to approximately MP 68 to carry the passing lane beyond the crest of the hill. As with SB 10, this improvement would need to be weighed against the costs of possible modifications to an existing structure.

Table 10 – U.S. 191 Recommended Improvements to Existing Passing Lanes

Direction	Map Label (Figure 7)	Begin MP	End MP	Improvements
Southbound	SB 3	108.5	109.8	Extend to approximately MP 110.1
	SB 6	93.7	94.5	Extend over hill and possibly to access to Canyon Rims Recreational Area
	SB 7	86.5	86.7	Extend over hill and past S.R. 211 access
	SB 8	79.2	81.5	Extend over hill to approximately MP 79
	SB 10	70.1	70.8	Extend to approximately MP 69. Consider structure costs.
Northbound	NB 5 & NB 6			Connect these two passing lanes
	NB 5	66.9	67.8	Extend to approximately MP 68. Consider structure costs.

Taper Length

Tapers can be used in the transition from a passing lane to a general purpose lane after passing a slow-moving vehicle. According to Section 6C.08 of the MUTCD 2009 Edition, a merging taper requires the longest distance because drivers are required to merge into a general purpose lane. On U.S. 191 the taper lengths in the study area looked correct, and any new passing lanes will need to meet the MUTCD specifications.

Signage

Currently, passing lane signing schemes are inconsistent through the study area. While all passing lanes regularly feature the "LANE ENDS MERGE LEFT" sign, the use of the advance warning signs is irregular. Some passing lanes have a one or two mile advance warning sign, while others have a 500 foot warning sign. Part of the reason for inconsistent signage may be due to lack of detail or changing guidelines in previous versions of the MUTCD. While the advance warning irregularity is not anticipated to significantly diminish

passing lane functionality, it is recommended that signage be phased into conformity with UDOT standard drawings as part of regular sign maintenance/replacement. Other insufficiencies include wrong size of sign and the sign's retro-reflectivity has dissipated.

It is also recommended that the "NEXT PASSING LANE XX MILES" (D17-1) sign begin to be used consistently along the corridor. The consistent use of this sign at the end of each passing lane and between long stretches of passing lanes would be especially beneficial so as to alert drivers of the next passing lane opportunity. Being aware of the distance to the next passing lane can help reduce driver anxiety and over-aggressive passing behavior.

Finally, given the length of passing lanes NB 7 (4.5 miles) and SB 4 (3.0 miles), the "KEEP RIGHT EXCEPT OT PASS" sign (R4-16) should be repeated at one mile intervals to remind drivers of the function of the passing lane as per UDOT Standard Drawing ST 6.

Turnouts

Designated turnouts are sections of roadways where slower vehicles can pull over to the right and allow traffic to pass on the left without crossing over the center line. Turnouts reduce the risk of passing by allowing a vehicle to move over to allow other motorists to pass rather than crossing the center line and facing possible oncoming traffic. Additionally, turnouts may ease rural traffic congestion and keep the roadway safe. Along U.S. 191 within the study area there are no designated turnouts for slow moving vehicles. None are recommended because Utah does not have a state law requiring slow-moving vehicles to use turnouts or to pull over when a queue of vehicles are following. Some states do have laws that require pulling over to allow vehicles to pass when the queue reaches a certain number.

Cost Estimates

Passing lane construction costs can vary widely due to a number of site-specific factors, such as terrain, pavement condition, cut & fill, structures, drainage, and traffic mitigation. Nevertheless, a basic, planning-level cost estimate of $1 million per mile was assumed to provide some context for the decision-making process. (This estimate was derived from a brief examination of previous passing lane projects and Region Four consultation)

Table 11 – New Passing Lane Cost Estimate

Direction	Map Label (Figure 7)	Begin MP	End MP	Total Length (miles)	Planning-Level Cost Estimate ($)
Southbound	SB P-1	90.3	91.3	1.0	$1,000,000
Northbound	NB P-1	95.5	96.0	0.5	$500,000
	NB P-2	86.8	88.3	1.5	$1,500,000
	NB P-3	80.0	81.0	1.0	$1,000,000
	NB P-4	41.0	42.0	1.0	$1,000,000
	NB P-5	26.0	27.0	1.0	$1,000,000

Note: Planning-level costs only. Actual passing lane costs can vary due to a number of individual factors.

Appendix

1. UDOT DD 3 Standard Drawing for Climbing Lanes
2. UDOT ST 5 Standard Drawing for Painted Median and Auxiliary Lane Details
3. UDOT ST 6 Standard Drawing for Passing/Climbing Lanes
4. Passing Lane Prioritization Criteria

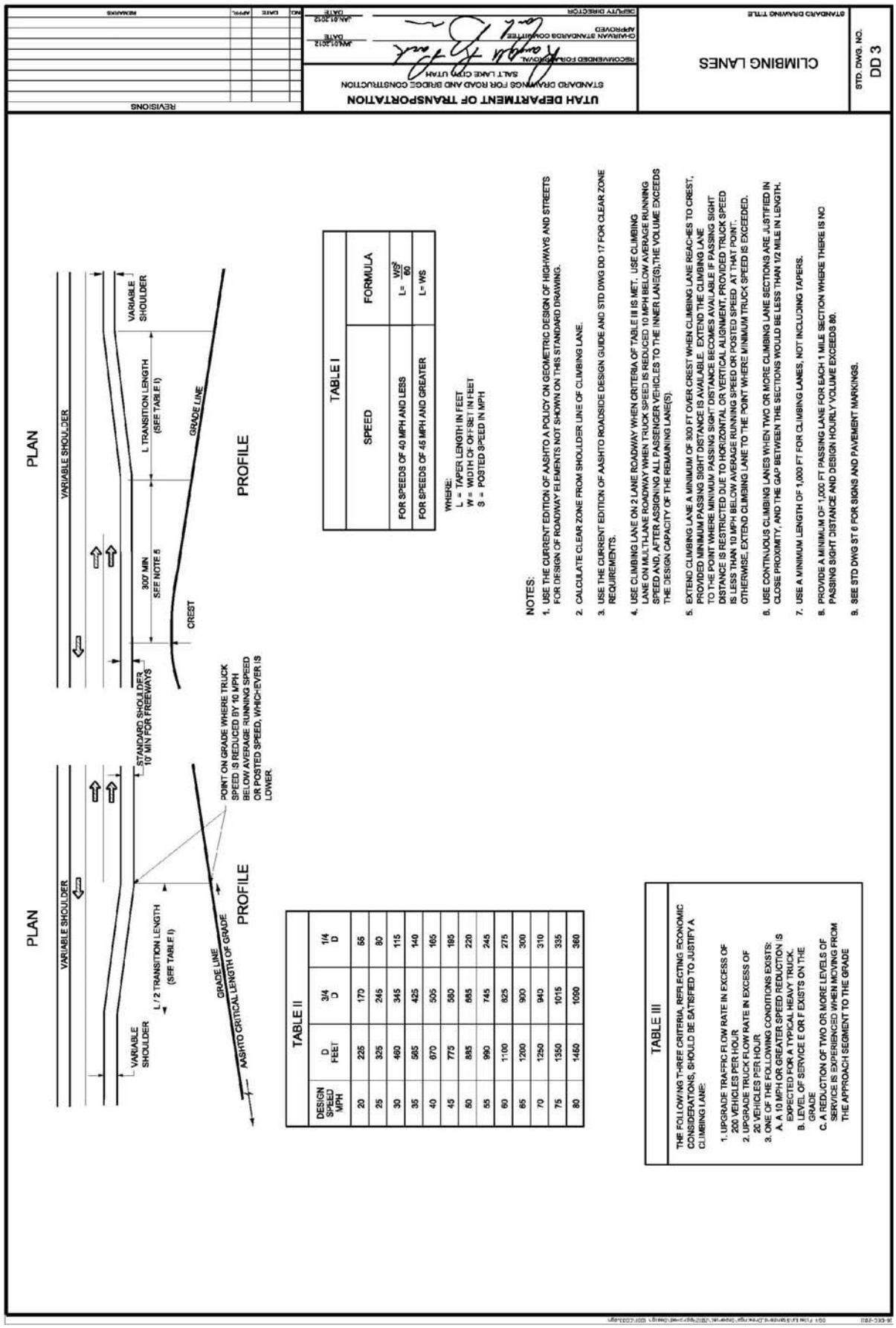


TABLE II

DESIGN SPEED MPH	D FEET	3/4 D	1/4 D
20	225	170	55
25	325	245	80
30	460	345	115
35	585	425	140
40	670	505	165
45	775	580	195
50	885	665	220
55	990	745	245
60	1100	825	275
65	1200	900	300
70	1250	940	310
75	1350	1015	335
80	1460	1090	360

TABLE III

THE FOLLOWING THREE CRITERIA, REFLECTING ECONOMIC CONSIDERATIONS, SHOULD BE SATISFIED TO JUSTIFY A CLIMBING LANE:

1. UPGRADE TRAFFIC FLOW RATE IN EXCESS OF 200 VEHICLES PER HOUR
2. UPGRADE TRUCK FLOW RATE IN EXCESS OF 20 VEHICLES PER HOUR
3. ONE OF THE FOLLOWING CONDITIONS EXISTS:
   - A. A 10 MPH OR GREATER SPEED REDUCTION IS EXPECTED FOR A TYPICAL HEAVY TRUCK.
   - B. LEVEL OF SERVICE E OR F EXISTS ON THE GRADE
   - C. A REDUCTION OF TWO OR MORE LEVELS OF SERVICE IS EXPERIENCED WHEN MOVING FROM THE APPROACH SEGMENT TO THE GRADE

TABLE I

SPEED	FORMULA
FOR SPEEDS OF 40 MPH AND LESS	$L = \frac{WS^2}{60}$
FOR SPEEDS OF 45 MPH AND GREATER	$L = WS$

WHERE:
L = TAPER LENGTH IN FEET
W = WIDTH OF OFFSET IN FEET
S = POSTED SPEED IN MPH

NOTES:

1. USE THE CURRENT EDITION OF AASHTO A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS FOR DESIGN OF ROADWAY ELEMENTS NOT SHOWN ON THIS STANDARD DRAWING.
2. CALCULATE CLEAR ZONE FROM SHOULDER LINE OF CLIMBING LANE.
3. USE THE CURRENT EDITION OF AASHTO ROADSIDE DESIGN GUIDE AND STD DWG DD 17 FOR CLEAR ZONE REQUIREMENTS.
4. USE CLIMBING LANE ON 2 LANE ROADWAY WHEN CRITERIA OF TABLE III IS MET. USE CLIMBING LANE ON MULTI-LANE ROADWAY WHEN TRUCK SPEED IS REDUCED 10 MPH BELOW AVERAGE RUNNING SPEED AND, AFTER ASSIGNING ALL PASSENGER VEHICLES TO THE INNER LANE(S), THE VOLUME EXCEEDS THE DESIGN CAPACITY OF THE REMAINING LANE(S).
5. EXTEND CLIMBING LANE A MINIMUM OF 300 FT OVER CREST WHEN CLIMBING LANE REACHES TO CREST, PROVIDED MINIMUM PASSING SIGHT DISTANCE IS AVAILABLE. EXTEND THE CLIMBING LANE TO THE POINT WHERE MINIMUM PASSING SIGHT DISTANCE BECOMES AVAILABLE IF PASSING SIGHT DISTANCE IS RESTRICTED DUE TO HORIZONTAL OR VERTICAL ALIGNMENT. PROVIDED TRUCK SPEED IS LESS THAN 10 MPH BELOW AVERAGE RUNNING SPEED OR POSTED SPEED AT THAT POINT. OTHERWISE, EXTEND CLIMBING LANE TO THE POINT WHERE MINIMUM TRUCK SPEED IS EXCEEDED.
6. USE CONTINUOUS CLIMBING LANES WHEN TWO OR MORE CLIMBING LANE SECTIONS ARE JUSTIFIED IN CLOSE PROXIMITY, AND THE GAP BETWEEN THE SECTIONS WOULD BE LESS THAN 1/2 MILE IN LENGTH.
7. USE A MINIMUM LENGTH OF 1,000 FT FOR CLIMBING LANES, NOT INCLUDING TAPERS.
8. PROVIDE A MINIMUM OF 1,000 FT PASSING LANE FOR EACH 1 MILE SECTION WHERE THERE IS NO PASSING SIGHT DISTANCE AND DESIGN HOURLY VOLUME EXCEEDS 80.
9. SEE STD DWG ST 6 FOR SIGNS AND PAVEMENT MARKINGS.

REVISIONS

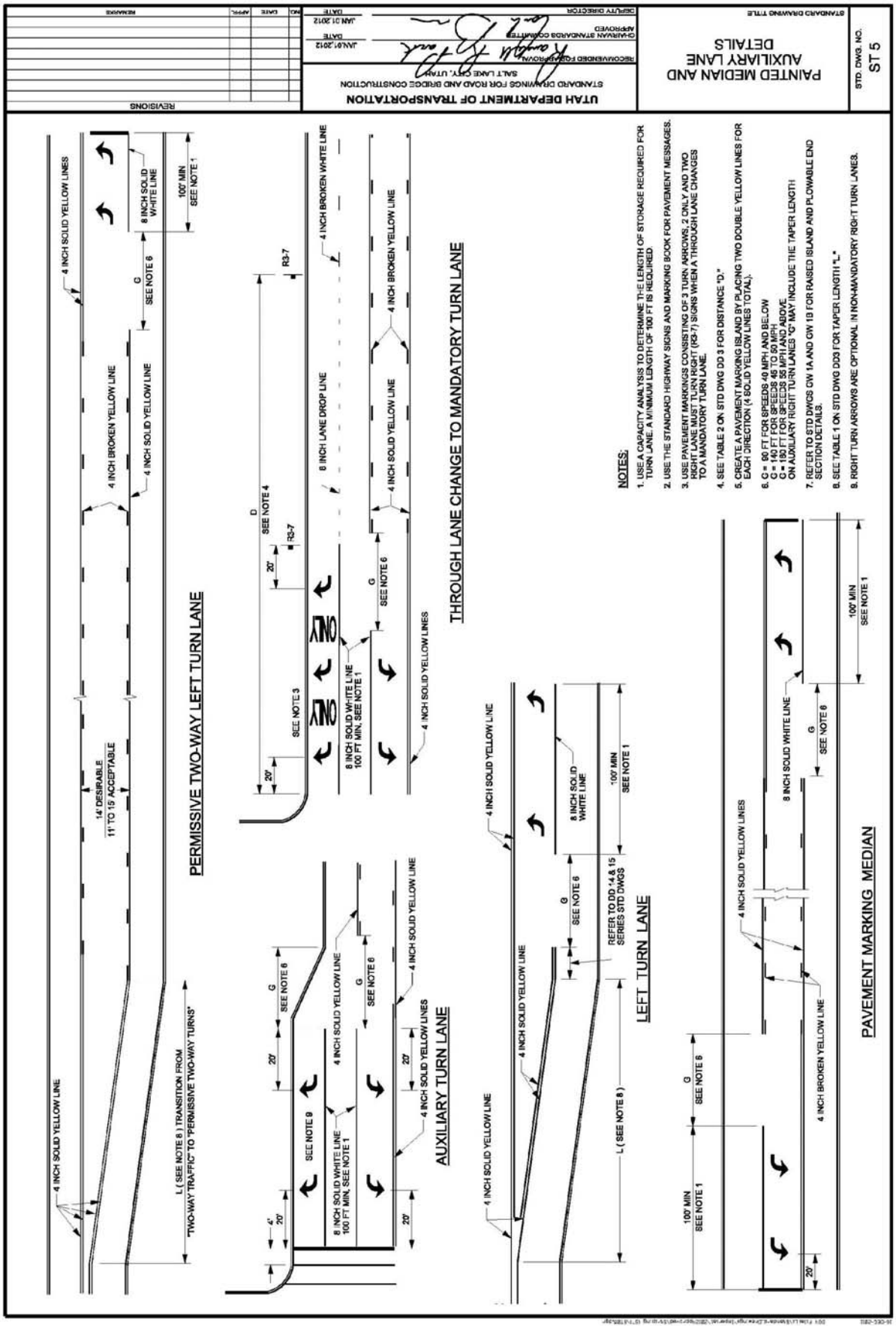
NO.	DATE	APPR.	REMARKS

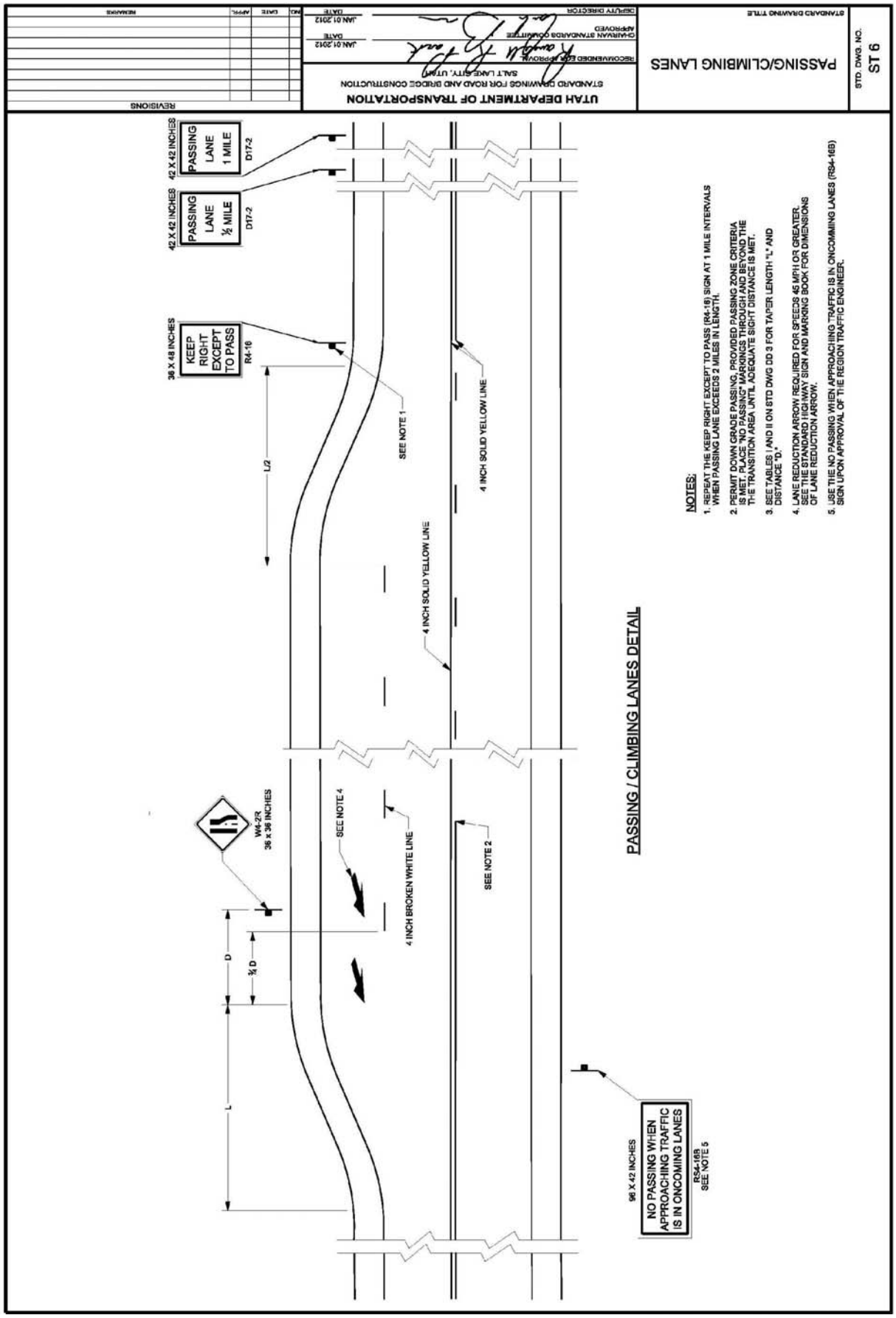
UTAH DEPARTMENT OF TRANSPORTATION
STANDARD DRAWINGS FOR ROAD AND BRIDGE CONSTRUCTION
SALT LAKE CITY, UTAH

RECOMMENDED FOR APPROVAL
CHAIRMAN STANDARDS COMMITTEE — DATE: JAN 01 2012
APPROVED
DEPUTY DIRECTOR — DATE: JAN 01 2012

STANDARD DRAWING TITLE
CLIMBING LANES

STD. DWG. NO.
DD 3


UTAH DEPARTMENT OF TRANSPORTATION
STANDARD DRAWINGS FOR ROAD AND BRIDGE CONSTRUCTION
SALT LAKE CITY, UTAH
RECOMMENDED FOR APPROVAL
CHAIRMAN STANDARDS COMMITTEE
APPROVED
DEPUTY DIRECTOR
JAN 01 2012
REVISIONS
NO. DATE APPR. REMARKS
STANDARD DRAWING TITLE
PAINTED MEDIAN AND AUXILIARY LANE DETAILS
STD. DWG. NO.
ST 5
PERMISSIVE TWO-WAY LEFT TURN LANE
4 INCH SOLID YELLOW LINE
14' DESIRABLE
11' TO 15' ACCEPTABLE
4 INCH BROKEN YELLOW LINE
4 INCH SOLID YELLOW LINE
8 INCH SOLID WHITE LINE
100' MIN SEE NOTE 1
G SEE NOTE 6
L (SEE NOTE 8) TRANSITION FROM "TWO-WAY TRAFFIC" TO "PERMISSIVE TWO-WAY TURNS"
THROUGH LANE CHANGE TO MANDATORY TURN LANE
D SEE NOTE 4
20'
SEE NOTE 3
R3-7
8 INCH LANE DROP LINE
4 INCH BROKEN WHITE LINE
ONLY
8 INCH SOLID WHITE LINE 100 FT MIN. SEE NOTE 1
4 INCH SOLID YELLOW LINE
4 INCH SOLID YELLOW LINES
AUXILIARY TURN LANE
4'
SEE NOTE 9
4 INCH SOLID YELLOW LINES
LEFT TURN LANE
4 INCH SOLID YELLOW LINE
8 INCH SOLID WHITE LINE
REFER TO DD 14 & 15 SERIES STD DWGS
L (SEE NOTE 8)
PAVEMENT MARKING MEDIAN
8 INCH SOLID WHITE LINE
4 INCH BROKEN YELLOW LINE
NOTES:
1. USE A CAPACITY ANALYSIS TO DETERMINE THE LENGTH OF STORAGE REQUIRED FOR TURN LANE. A MINIMUM LENGTH OF 100 FT IS REQUIRED.
2. USE THE STANDARD HIGHWAY SIGNS AND MARKING BOOK FOR PAVEMENT MESSAGES.
3. USE PAVEMENT MARKINGS CONSISTING OF 3 TURN ARROWS, 2 ONLY AND TWO RIGHT LANE MUST TURN RIGHT (R3-7) SIGNS WHEN A THROUGH LANE CHANGES TO A MANDATORY TURN LANE.
4. SEE TABLE 2 ON STD DWG DD 3 FOR DISTANCE "D."
5. CREATE A PAVEMENT MARKING ISLAND BY PLACING TWO DOUBLE YELLOW LINES FOR EACH DIRECTION (4 SOLID YELLOW LINES TOTAL).
6. G = 60 FT FOR SPEEDS 40 MPH AND BELOW
G = 440 FT FOR SPEEDS 45 MPH AND 50 MPH
G = 180 FT FOR SPEEDS 55 MPH AND ABOVE
ON AUXILIARY RIGHT TURN LANES "G" MAY INCLUDE THE TAPER LENGTH
7. REFER TO STD DWGS GW 1A AND GW 1B FOR RAISED ISLAND AND PLOWABLE END SECTION DETAILS.
8. SEE TABLE 1 ON STD DWG DD3 FOR TAPER LENGTH "L."
9. RIGHT TURN ARROWS ARE OPTIONAL IN NON-MANDATORY RIGHT TURN LANES.


UTAH DEPARTMENT OF TRANSPORTATION
STANDARD DRAWINGS FOR ROAD AND BRIDGE CONSTRUCTION
SALT LAKE CITY, UTAH
PASSING/CLIMBING LANES
STD. DWG. NO.
ST 6
REVISIONS
PASSING / CLIMBING LANES DETAIL
42 X 42 INCHES
PASSING LANE 1 MILE
D17-2
42 X 42 INCHES
PASSING LANE ½ MILE
D17-2
36 X 48 INCHES
KEEP RIGHT EXCEPT TO PASS
R4-16
SEE NOTE 1
L/2
4 INCH SOLID YELLOW LINE
4 INCH SOLID YELLOW LINE
W4-2R
36 x 36 INCHES
SEE NOTE 4
4 INCH BROKEN WHITE LINE
SEE NOTE 2
D
¾ D
L
96 X 42 INCHES
NO PASSING WHEN APPROACHING TRAFFIC IS IN ONCOMING LANES
R54-16B
SEE NOTE 5
NOTES:
1. REPEAT THE KEEP RIGHT EXCEPT TO PASS (R4-16) SIGN AT 1 MILE INTERVALS WHEN PASSING LANE EXCEEDS 2 MILES IN LENGTH.
2. PERMIT DOWN GRADE PASSING, PROVIDED PASSING ZONE CRITERIA IS MET. PLACE "NO PASSING" MARKINGS THROUGH AND BEYOND THE TI-E TRANSITION AREA UNTIL ADEQUATE SIGHT DISTANCE IS MET.
3. SEE TABLES I AND II ON STD DWG DD 3 FOR TAPER LENGTH "L" AND DISTANCE "D."
4. LANE REDUCTION ARROW REQUIRED FOR SPEEDS 45 MPH OR GREATER. SEE THE STANDARD HIGHWAY SIGN AND MARKING BOOK FOR DIMENSIONS OF LANE REDUCTION ARROW.
5. USE THE NO PASSING WHEN APPROACHING TRAFFIC IS IN ONCOMMING LANES (R54-16B) SIGN UPON APPROVAL OF THE REGION TRAFFIC ENGINEER.

Passing Lane Prioritization Criteria

AADT Score

Min AADT	Score
0	3
2,501	6
5,001	9
7,501	12
10,001	15
12,501	18
15,001	21
17,501	24
20,001	27
22,501	30

Passing Lane Interval Score

Min Interval (mi)	Score
0	0
5	5
10	10
15	15
20	20

Truck AADT Score

Min Truck AADT	Score
0	2
501	4
1,001	6
1,501	8
2,001	10
3,001	12
4,001	14
5,001	16
6,001	18
7,001	20

Freight Corridor Score

Classification	Score
Energy Route	15
Interstate	5
Major Route	20
None	0

Crash History Score

Safety Index	Score
Value	Value x 3