WINTER ROADWAY CLOSURE STUDY

Prepared for:

Utah Department of Transportation

PIN S-ST99(213)

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ROAD
CLOSED

INTRODUCTION

Utah is home to "The Greatest Snow on Earth." It is also home to some of the most scenic alpine highways to be found anywhere in the world. Residents and visitors alike enjoy the vistas as a respite from everyday urban life. These highways also serve what typical rural highways do: to connect communities. The combination of light, fluffy snow; high altitude highways; and desert winds create a preponderance of mountain passes that have been closed during winter months for safety and maintenance reasons. Figure 1 shows the magnitude of the difficulties for winter roadway maintenance for Utah.

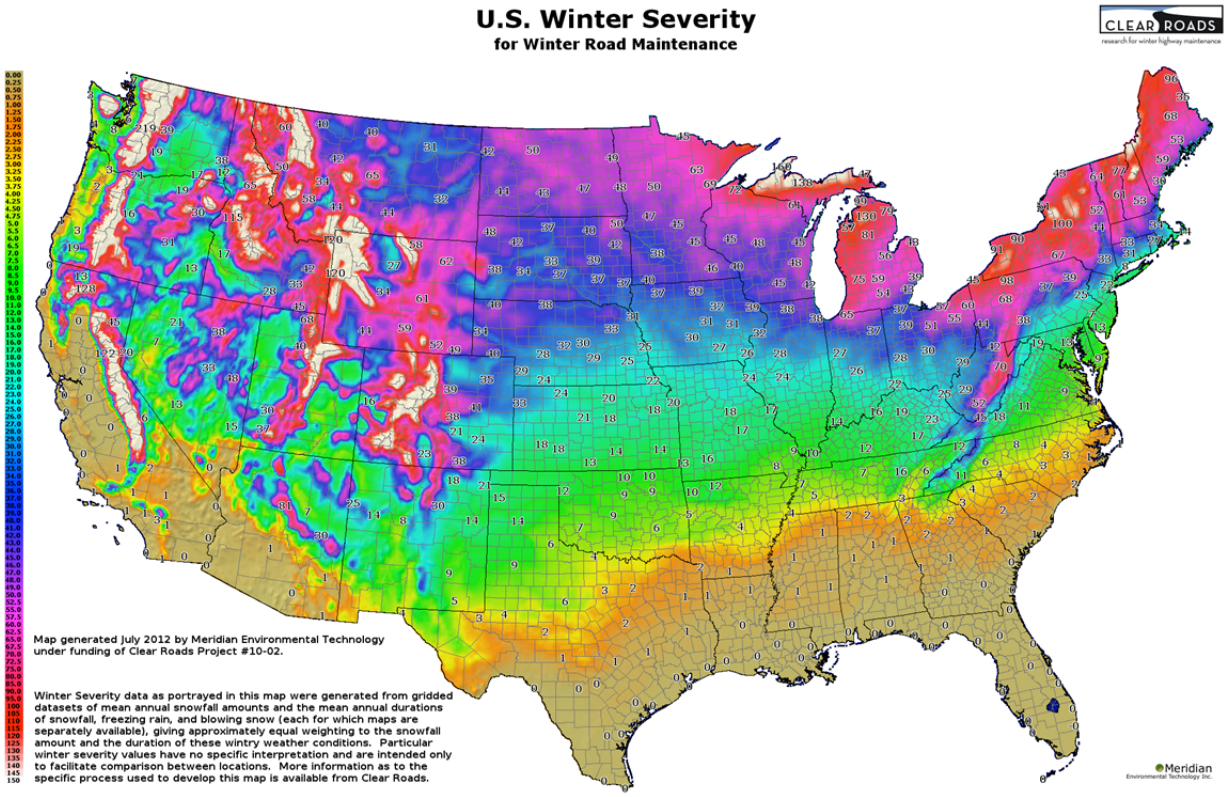


Figure 1. U.S. Winter Severity

The Utah Department of Transportation (UDOT) is responsible for the maintenance of eight mountain passes that are closed during the winter months. These roadways are shown in Figure 2, and include two roadways in the high plateaus of southern Utah and six in the northern mountains. These seasonally-closed routes generally traverse high-elevation areas, making winter maintenance difficult and costly. While UDOT considered opening some of the passes over the years, this is the first comprehensive statewide review of all winter passes subject to closure using uniform data and methodology.

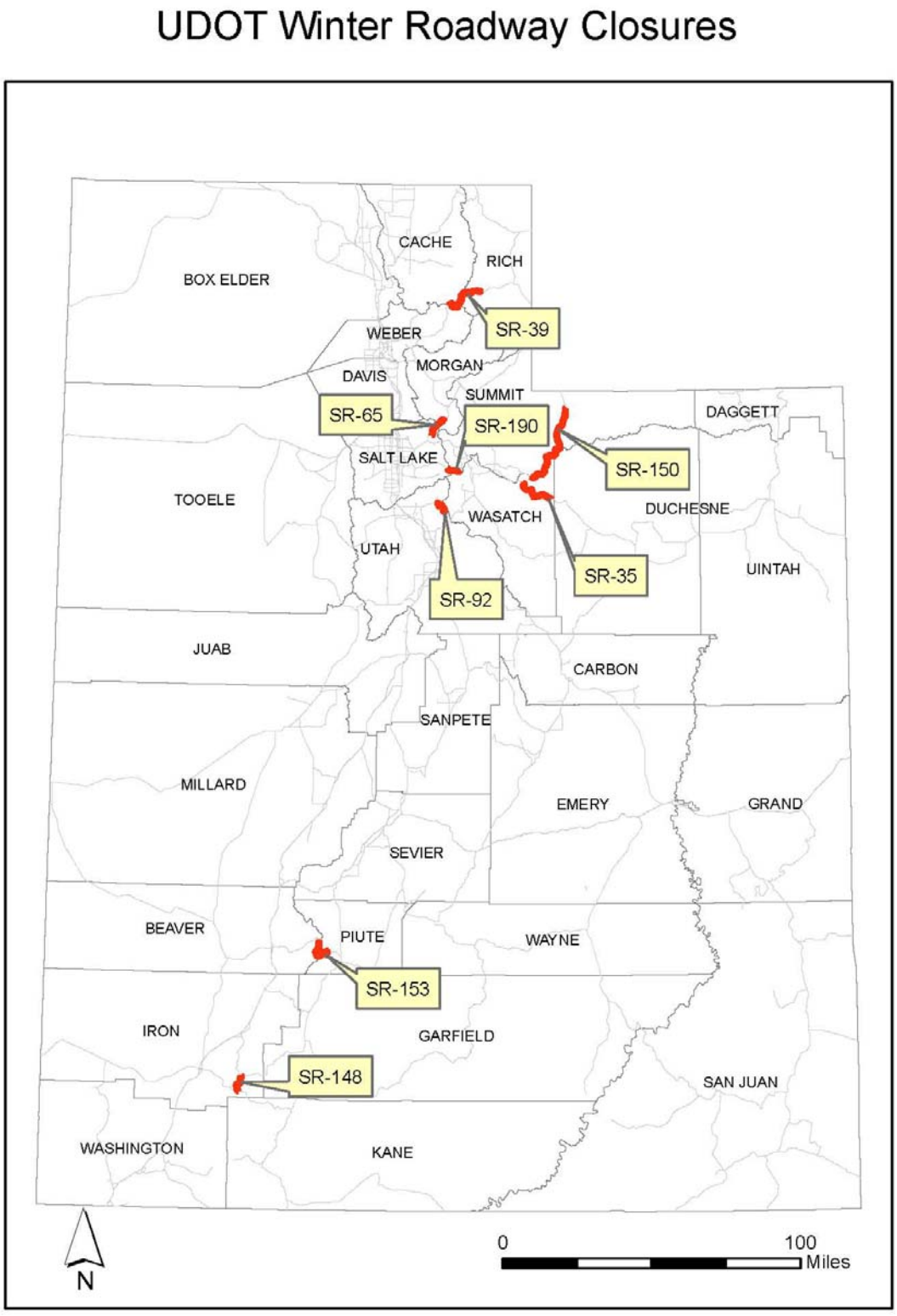


Figure 2. Location of Closures

PURPOSE AND PROCESS

In response to requests to consider opening some of the state roadways subject to seasonal closure, UDOT is assessing all eight winter passes subject to closure in a consistent and comprehensive manner. The study was designed as a feasibility study to provide updated decision-making and communication procedures to UDOT Leadership for opening seasonal roads. It was not the intent of this study to conduct significant outreach to the general public or other stakeholders or provide a comprehensive environmental assessment.

This preliminary effort evaluates opportunities and constraints associated with stakeholder input, alternative routes, economic impacts, user benefits, and costs associated with the roadways, shown in Figure 2, if they were to stay open through the winter season. This statewide review also provides information to help UDOT leadership update decision-making procedures for all seasonal conditions.

This study used a tiered approach to review roadway closure decisions. Tier One provided a need-based screening while Tier Two analysis the financial and economic impact to keep a given road open year-round.

- Tier One screening - provided a qualitative level of screening, incorporating information from UDOT staff that have direct experience and oversight of the corridors. Specific evaluation criteria included:
    - Community/stakeholder request or interest
    - Viable alternative routes as determined by travel time and trip purpose
    - Potential economic impacts
    - Roadway authority
    - Safety

- Tier Two analysis - included quantitative analysis of the passes with higher potential to open. The analysis included:
    - A cost/benefit analysis that included:
        - Estimated roadway construction, capital equipment, and operations/maintenance costs necessary to maintain the passes year-round
        - A travel shed analysis that developed potential user cost savings
    - Economic Development Potential
        - Assessed land development opportunities, given access as driving factor
        - Estimated property tax valuation changes of potential land development
        - Trip generation analysis resulting from potential development

TIER ONE

The Tier One screening process applied a fatal flaw review of all roadways subject to winter closure. This review allowed the project team to quickly identify potential year-round roadway candidates, and eliminate others from further consideration. The process by which roadways were evaluated and then forwarded to Tier Two or eliminated from consideration is described below.

PROCESS

The project team screened roadways subject to winter closure to determine whether they should be kept open year-round instead of only during the summer season. These roadways were located across the State of Utah and included:

- SR-35, Wolf Creek Pass, Francis to Hanna
- SR-39, Monte Cristo, east of Ogden
- SR-65, East Canyon, northeast of Salt Lake City
- SR-92, American Fork Canyon/Alpine Loop
- SR-148, Cedar Breaks, east of Cedar City
- SR-150, Mirror Lake Highway
- SR-153, Mt. Holly Junction Road
- SR-190/Guardsman Pass Road/SR-224, Big Cottonwood Canyon/Bonanza Flats/Park City

These roadways were evaluated on an individual basis, using a range of criteria. The criteria are described below. Details associated with the criteria rankings for each roadway are provided in the Roadway Summaries section.

Community/Stakeholder Request or Interest

The project team conducted interviews and meetings with a range of stakeholders (Appendix A contains a summary of the stakeholder meetings held for this study). Some communities and stakeholders want particular roadways to stay open year-round. Reasons for these requests include shorter travel times; shorter commute distances for residents in selected areas; emergency evacuation routes; emergency access inside a closed area; and potential economic development opportunities. It is worth noting that while some stakeholders desire year-round access for selected roadways, other stakeholders expressed concerns about the potential issues associated with eliminating winter closure or oppose the opening because of winter recreation uses of the roadways. In order for a roadway to receive a positive mark for this criterion, a community or stakeholder had to have requested that the roadway stay open.

Only Viable Alternative

Several of the roadways analyzed in this Winter Roadway Closure Study connect remote locations where available access alternatives are limited. In some cases, the roadway that is closed during winter could provide a travel time advantage were it to be kept open year-round. However, the magnitude of that advantage (trip delays in excess of 30 minutes) was considered when determining if there were viable alternative routes. The study team also made a distinction between trip types (commuter trips, recreational trips, or other non-commute trips) when evaluating potential alternative routes. The project team used Google Maps to estimate driving distances and travel times between potential origins and destinations, using both the roadways under consideration as well as likely alternate routes. The study team did not evaluate every potential route alternative, nor, given data limitations, did the study team have a detailed understanding of the origin and destinations for the travel sheds. Table 1 summarizes the routes analyzed, their alternatives, and travel time comparisons; maps for each alternative considered can be found in the Roadway Summaries section. Roadways receiving a positive mark in this criterion were determined to be the only viable route.

Potential Economic Impact

Year-round access to recreation areas and shortened travel times between existing destinations may generate positive economic impacts. Economic impacts include increased tourist visitation, higher rates of winter recreation activity, and saved time and travel costs between areas. Economic benefit is realized through increased property values, higher sales tax collection, and travel cost savings. For the purposes of this study, areas that may generate year-round visitation or year-round recreational development were identified along the routes advanced for more in-depth study. The team identified developable property (generally slopes below 30 percent) that would be accessible on a year-round basis. Some of the areas have summer-only recreational activities and others are wholly undeveloped at this time. The evaluation did not include a macro-level assessment of the winter recreation or tourism industry, but was instead focused on localized impacts. A positive mark for this criterion generally showed a potential for positive near-term impact of some kind associated with year-round opening.

UDOT Authority

This criterion addresses the jurisdiction of each roadway, and whether UDOT has the authority to keep a roadway open, or whether there is a reasonable likelihood that UDOT could assume jurisdictional control over the roadway. Roadways that were under full UDOT authority or could relatively easily be transferred to UDOT authority received a positive mark for this criterion.

Safe without Major Improvements

The project team evaluated roadways to determine whether roadway users could safely travel the route during the winter months, and whether UDOT's maintenance crews could safely operate in winter conditions given the existing roadway characteristics. The team assessed the existing physical improvements and design limitations to

determine whether roadway improvement would be needed. It should be noted that the safety evaluation assessed conditions that would be experienced if the roadway were operated in a manner consistent with other, like roadways and adhering to UDOT design criteria. There are alternative operating scenarios, such as imposing vehicle restrictions, which may allow UDOT to open a roadway with exceptions to those criteria and, hence, fewer improvements. The roadways evaluated in this study all share similar safety issues: deep snow, high elevations, and the need for additional snow removal equipment and staff. Specific safety-related concerns that are not shared among all roadways are outlined in Table 1. Roadways receiving a positive mark in this criterion were those not requiring major construction or improvements for safe passage.

CONCLUSIONS AND SUMMARY TABLE

The criteria described above were applied to each of the roadways under evaluation. The Tier One screening process allowed the project team to remove several roadways from further consideration, and focus on the remaining roadways in more detail in the Tier Two analysis process. In order for roadways to pass into Tier Two screening, they had to receive positive marks in at least three of the five criteria described above. Three roadway passes made it through the Tier One screening and were moved to the Tier Two screening process: SR-35, SR-65, and SR-190/Guardsman Pass Road/SR-224. The table below summarizes details regarding the routes under consideration

Table 1: Tier One Summary Table

Roadway	Closure Section	Decision Factors	Tier Two?
SR-35, Wolf Creek Pass	MP 12.5-28.5 between Woodland and Hanna	• **Community/Stakeholder Request or Interest:** Yes • **Only Viable Alternative:** No, US-40 provides an alternative route. o Travel time savings of 22 minutes from Hanna to Quinn's Junction via SR-35, compared to US-40 o Savings of 11 minutes from Tabiona to Quinn's Junction via SR-35, compared to US-40 • **Potential Economic Impact:** Low; o 23,000 acres of undeveloped private property near Hanna o Not clear whether opening roadway would influence development potential • **UDOT Authority:** Yes • **Safe without Major Improvements:** Yes	Yes
SR-39, Monte Cristo Road	MP 37-55.5 between Huntsville and	• **Community/Stakeholder Request or Interest**: No • **Only Viable Alternative:** No, SR-16, I-80 and I-84 provide alternate routes	No

Table 1: Tier One Summary Table			
Roadway	Closure Section	Decision Factors	Tier Two?
	Woodruff	o Travel time savings of 7 minutes over alternatives o Most trips within closed portion are considered recreational • **Potential Economic Impact:** Low • **UDOT Authority:** Yes • **Safe without Major Improvements:** Yes	
SR-65, East Canyon	MP 3-14 between Mountain Dell and Henefer	• **Community/Stakeholder Request or Interest:** No • **Only Viable Alternative:** No o I-80 and Jeremy Ranch Road provide alternatives; SR-65 provides no travel time savings over alternatives (I-80, or Jeremy Ranch Road) o Primary trip purpose is recreational • **Potential Economic Impact:** Medium; would provide year-round access to private property • **UDOT Authority:** Yes • **Safe without Major Improvements:** Yes	Yes
SR-92, Alpine Loop	MP 13.5-225 between American Fork Canyon and Sundance	• **Community/Stakeholder Request or Interest:** No • **Only Viable Alternative:** No, US-189 is 31 minutes faster o Primary trip purpose is recreational • **Potential Economic Impact:** Low • **UDOT Authority:** Yes • **Safe without Major Improvements:** No, extremely narrow roadway with switchback curves	No
SR-148, Cedar Breaks	MP 0.2-19 near Cedar Breaks National Monument	• **Community/Stakeholder Request or Interest**: No • **Only Viable Alternative:** No o US-89, SR-143 do provide travel time savings of 27 minutes from Kanab to Brian Head over SR-148 ▪ Primary trip purpose is recreational o No travel time savings from Cedar City to Brian Head via SR-148 • **Potential Economic Impact:** Low • **UDOT Authority:** No o National Park Service jurisdiction over roadway within Cedar Breaks National Monument o Jurisdictional transfer or NPS approval to open roadway would take significant effort o Roadway within National Monument is used for winter recreational purposes • **Safe without Major Improvements:** No, roadway within Cedar Breaks National Monument would likely require significant improvements to bring up to state standards	No

Table 1: Tier One Summary Table			
Roadway	Closure Section	Decision Factors	Tier Two?
SR-150, Mirror Lake Highway	MP 14.7-48.6 between Kamas and Evanston, WY	• Community/Stakeholder Request or Interest: No • Only Viable Alternative: No o From Park City to Evanston, I-80 is 1 hour and 6 minutes faster • Potential Economic Impact: Low • UDOT Authority: Yes • Safe without Major Improvements: Yes	No
SR-153, Mount Holly Junction	MP 21.3-39.5 between Beaver and Junction	• Community/Stakeholder Request or Interest: No • Only Viable Alternative: No, SR-20/US-89 provide 9 minute travel time savings over SR-153 • Potential Economic Impact: Low; Eagle Point Ski Resort has access from the west • UDOT Authority: Yes, there are discussions with local government to transfer jurisdiction of SR-153 on the east side of the summit. • Safe without Major Improvements: No, from MP 21.2 east, SR-153 is a dirt road, significant roadway improvements would be required	No

SR-190/ Guardsman Pass/SR-224	MP 17.7 (SR-190)-0.84 (SR-224)between Brighton and Park City	• Community/stakeholder Request or Interest: Yes
		• Only Viable Alternative: No, I-80, US-40/US-189
		  o There is a travel time savings of 28 minutes from Brighton to Park City via SR-190/Guardsman Pass Road/SR-224 compared to alternatives (I-215, I-80)
		  o Travel time savings of 8 minutes from Sandy to Bonanza Flats via SR-190 compared to alternatives (I-215, I-80)
		  o Primary trip purpose is recreational
		• Potential Economic Impact: Medium; would year-round access to private property
		• UDOT Authority:
		  o Yes for SR-190 and SR-224
		  o No for Guardsman Pass Road. Discussions with Wasatch County suggest there is interest in transferring jurisdiction of this section of roadway to UDOT
		• Safe without Major Improvements: No
		  o To bring the roadway to UDOT standards, significant improvements would be necessary
		  o Avalanche risk can be mitigated
			Yes

TIER TWO

PROCESS

As stated previously, the project team identified three roadways that met Tier One criteria for year-round opening. These included SR-35, Wolf Creek Pass; SR-65, East Canyon; and SR-190/Guardsman Pass Road/SR-224, Guardsman Pass. The Tier Two screening process evaluated each of the three roadways based on the following:

- Cost/Benefit Analysis
    - Estimated roadway construction, capital equipment, and operations/maintenance costs necessary to maintain the passes year-round
    - Travel shed analysis that developed potential user cost savings
- Economic Development Potential
    - Assessed land development opportunities
    - Estimated near-term property tax valuation changes of potential land development
    - Trip generation analysis resulting from potential development

COST/BENEFIT ANALYSIS

Roadway Construction Costs

The project team coordinated with maintenance station supervisors and Region District Engineers to determine if improvements would be necessary to bring the roadways up to UDOT standards and provide a safe environment, given certain roadway operating scenarios, for UDOT personnel and the traveling public. Depending on the roadway being evaluated, roadway construction improvements often included:

- Guardrails
- Snow fences
- Retaining walls
- Roadway widening, including right-of-way
- Rock-fall catchment locations
- Avalanche control

Estimated construction costs for each Tier Two roadway are provided below, listed by SR-35, SR-65, and Guardsman Pass, respectively. No environmental mitigation or utility costs were included in the cost estimates.

Table 2: SR-35 Construction Costs						
Key Items	Quantity	Units	Low Price	High Price	Low Cost	High Cost
Snow Fence	13,040	Ft	$20	$24	$260,820	$312,984
Guard Rail	3,350	Ft	$30	$36	$100,500	$120,600
Crash Cushion	20	Each	$4,000	$4,800	$80,000	$96,000
Mobilization & Traffic Control	1	Lump	$80,000	$96,000	$80,000	$96,000
PE/CE	1	Lump	$114,700	$137,640	$114,700	$137,640
Right-of-Way		Lump	$750,000	$1,500,000	$750,000	1,500,000
Contingency	1	Lump	$108,980	$130,776	$108,980	$130,776
Total					**$1,495,000**	**$2,394,000**

Table 3: SR-35 Shed Construction Costs					
Item	Quantity	Units	Unit Cost	Low Cost	High Cost
Satellite Facility (assumes 4-bay shed with 40' X 80' salt shed)	1	Lump	$1,750,000 – $2,000,000	$1,750,000	$2,000,000
Contingency (20%)				$350,000	$400,000
Total				**$2,100,000**	**$2,400,000**
**2014 dollars; shed costs provided by Bill Juszak, UDOT*					

Table 4: SR-65 Construction Costs						
Key Items	Quantity	Units	Low Price	High Price	Low Cost	High Cost
Snow Fence	2,218	Ft	$20	$24	$44,360	$53,232
Guard Rail	16,949	Ft	$30	$36	$508,470	$610,164
Crash Cushion	20	Each	$4,000	$4,800	$80,000	$96,000
Roadway Widening with Retaining Walls	1	Lump	$862,114	$26,823,218	$862,114	$26,823,218
PE/CE	1	Lump	$299,000	$5,516,600	$299,000	$5,516,600
Right-of-Way		Lump	$750,000	$1,500,000	$750,000	$1,500,000
Contingency	1	Lump	$299,000	$5,516,600	$299,000	$5,516,600
Total					**$2,843,000**	**$40,116,000**

Table 5: SR-65 Shed Construction Costs					
Item	Quantity	Units	Unit Cost	Low Cost	High Cost
Satellite Facility (assumes 4-bay shed with 40' X 80' salt shed)	1	Lump	$1,750,000 – $2,000,000	$1,750,000	$2,000,000
Contingency (20%)				$350,000	$400,000
Total				**$2,100,000**	**$2,400,000**
**2014 dollars; shed costs provided by Bill Juszak, UDOT*					

Table 6: SR-190/Guardsman Pass Road/SR-224 Construction Costs		
Design Alternative	Assumptions	Cost*
Full-Width Typical Section	Includes $23M in roadway costs, $2.3M in drainage costs, $1.5M in barrier costs$23.9M in wall costs, and , $57M in right-of-way	$135,821,000
Reduced-Width Typical Section	Includes $19.6M in roadway costs, $2M in drainage costs, $800K in barrier costs, $14.8M in wall costs, and $47M in right-of-way	$104,985,000
Curve Modification & Guardrail Improvements	Includes $6.9M in roadway costs, $400K in barrier costs $700K in wall costs, and , $5.5M in right-of-way	$17,866,000

**2014 dollars; cost estimates do not include right-of-way, utility, or environmental mitigation costs.*

Table 7: SR-190/Guardsman Pass Road/SR-224 Shed Costs					
Item	Quantity	Units	Unit Cost	Low Cost	High Cost
Satellite Facility (assumes 4-bay shed with 300 ton salt shed)	1	Lump	$1.75 million – $2 million	$1,750,000	$2,000,000
Contingency (20%)				$350,000	$400,000
Total				**$2,100,000**	**$2,400,000**
**2014 dollars; shed costs provided by Bill Juszak, UDOT*					

Capital Equipment Costs

Maintaining these roadways during the winter would necessitate up-front capital equipment costs. Due to the high elevation and large amount of annual snow, additional specialized equipment would be needed. Types of equipment included:

- 10 Wheel trucks
- Snow Blowers – truck mounted or self-propelled
- Graders
- Snow cats
- Loaders
- Pickups (4WD)

In addition, satellite snow sheds would often be needed somewhere near the roadway summit to store the equipment, materials, and salt. Sheds need to be located near roadway summits because maintenance staff need to be able to plow the snow downhill, due to the steep grades. Where satellite sheds are needed, right-of-way would need to be purchased for the facility.

Estimated capital equipment costs for each Tier Two roadway are provided in the tables below.

Table 8: SR-35 Capital Equipment Costs

Equipment	Quantity	Units	Unit Cost	Low Cost	High Cost (10% Contingency)	Estimated Life (yrs)	Low Annualized Cost	High Annualized Cost (10% Contingency)
10-wheeler (chained w/10 wheel drive)	1	Each	$230,000	$230,000	$253,000	15	$15,333	$16,867
Loader	1	Each	$160,000	$160,000	$176,000	25	$6,400	$7,040
Equipment Subtotal				**$390,000**	**$429,000**		**$21,700**	**$23,900**

**2014 dollars; equipment costs provided by Jeff Casper, UDOT*

Table 9: SR-65 Capital Equipment Costs								
Equipment	Quantity	Units	Unit Cost	Low Cost	High Cost (10% Contingency)	Estimated Life (yrs)	Low Annualized Cost	High Annualized Cost (10% Contingency)
10-wheeler (chained w/ 10 wheel-drive)	2	Each	$230,000	$460,000	$506,000	15	$30,667	$33,733
Loader	2	Each	$160,000	$320,000	$352,000	25	$12,800	$14,080
Subtotal				**$780,000**	**$858,000**		**$43,500**	**$47,800**
**2014 dollars; equipment cost provided by Jeff Casper, UDOT*								

Table 10: SR-190/Guardsman Pass Road/SR-224 Capital Equipment Costs								
Equipment	Quantity	Units	Unit Cost	Low Cost	High Cost	Estimated Life (yrs.)	Low Annualized Cost	High Annualized Cost
10-wheeler (chained with 10-wheel drive)	1	Each	$230,000	$230,000	$253,000	15	$15,333	$16,867
Blower	1	Each	$500,000	$500,000	$550,000	25	$20,000	$22,000
Grader	1	Each	$280,000	$280,000	$308,000	20	$14,000	$15,400
Snow Cat	1	Each	$300,000	$300,000	$330,000	20	$15,000	$16,500
Loader	1	Each	$160,000	$160,000	$176,000	20	$8,000	$8,800
Pickup (4WD)	1	Each	$30,000	$30,000	$33,000	5	$6,000	$6,600
Equipment Subtotal				**$1,500,000**	**$1,650,000**		**$78,300**	**$86,200**
**2014 dollars; equipment cost information provided by Jeff Casper, UDOT*								

Operations and Maintenance Costs

Operations and Maintenance (O&M) costs for SR-35, SR-65, and SR-190/Guardsman Pass Road/SR-224 were estimated using the snow removal cost per lane mile for comparable mountain passes that are currently maintained during the winter. These comparable roadways, and maintenance sheds, were selected based on discussions with UDOT maintenance personnel and are listed below:

- Shed 1145, Logan Summit
- Shed 2433, Cottonwood
- Shed 4456, Huntington
- Shed 4461, Mount Pleasant
- Shed 4471, Long Valley
- Shed 4478, Parowan

O&M costs for SR-35, SR-65, and SR-190/Guardsman Pass Road/SR-224 are provided in the tables below. More detailed discussions of roadway construction, capital, equipment and O&M cost estimates for each roadway are provided in Appendix B. It should be noted that snow removal costs do not include the total, annual costs for new FTEs. Additionally, if new FTEs are not added, the staff resources to plow these roadways would be shifted from other locations.

Table 11: SR-35 Annual O&M Costs*		
Item	Average Annual Cost	High Annual Cost
Snow & Ice Removal*	$170,000	$382,000
Misc. Code Cost*	$12,000	$29,000
Total	$182,000	$411,000
*2014 dollars; OMS information provided by Mike Marz, UDOT		

Table 12: SR-65 Annual O&M Costs*		
Item	Average Annual Cost	High Annual Cost
Snow & Ice Removal*	$114,000	$256,000
Misc. Code Cost*	$8,000	$20,000
Total	$122,000	$276,000
*2014 dollars; OMS information provided by Mike Marz, UDOT		

Table 13: SR-190/Guardsman Pass Road/SR-224 Annual O&M Costs*		
Item	Average Annual Cost	High Annual Cost
Snow & Ice Removal*	$60,000	$135,000
Misc. Code Cost*	$5,000	$11,000
Summer Maintenance	$30,000	$36,000
Total	$95,000	$182,000
*2014 dollars; OMS information provided by Mike Marz, UDOT		

Travel Shed Analysis

The project team evaluated the travel shed characteristics for each of the remaining roadways by assessing the commuter travel, recreation travel, and the impact to travel given potential economic development activity. Travel shed analyses varied based on the individual roadway and area characteristics, as follows:

- SR-35: The study team focused on the commuter characteristics and potential travel savings that could be realized if the roadway were opened year-round.
- SR-65: East Canyon: The study team discounted the commuter travel in this corridor given the travel time savings if alternate facilities are used. The study team concluded the primary trip on SR-65 is recreational. The study team did not consider travel demand related to future economic development potential because the opening the roadway was considered a driving factor for future development potential.
- SR-190/Guardsman Pass Road/SR-224: The study team focused on recreation and development potential travel characteristics. The study team concluded that commuter travel was not a driving factor in the travel characteristics of the roadway given the travel time penalties for using the pass as a commuter link over alternative routes. However, the study team did allot 3% of existing ADT to capture potential commuter travel between Park City and Big Cottonwood Canyon ski resorts.

To determine the increase in daily traffic at Guardsman Pass as a result of development potential in the Bonanza Flats area, a trip generation analysis was performed on an illustrative development scenario. This analysis assumed 677 housing units and 100 hotel rooms. The units are based on data from the Mountain Accord Study and the economic development analysis completed for this study. The rate used to calculate the trip generation for the housing units is based on rates for Tollgate, which is a similar site in Summit County where many of the houses are recreational/seasonal and are a fair distance from many services. The rate used to calculate the trip

generation for the hotel units is based on rates and data from hotels in Park City and occupancy rates from the Park City Chamber of Commerce. The resulting Bonanza Flats trip generation for the total development potential is estimated at 1,400 trips per day.

The study team also estimated the potential increase in traffic over Guardsman Pass as a result of improving the roadway to current UDOT design standards. Traffic was projected to increase by 48% by bringing the roadway up to UDOT standards. The 2012 ADT on SR-190 near Guardsman Pass is approximately 930. A 48% increase (446 vehicles) in daily traffic is 1,376 ADT on SR-190 near Guardsman Pass.

Neither the projected development-related trips, nor the estimated trips from widening the roadway were used in the cost/benefit assessment because the trips were determined to be discretionary; and given current travel demand model limitations it is difficult to assess the productions and attractions for those trips.

Cost/Benefits Assessment

The benefit/cost analysis compared the capital equipment and O&M costs associated with each roadway to potential user cost benefits. User benefits were developed based on current, estimated non-discretionary trip demand and took into account:

- The typical daily traffic on each roadway;
- The percent of trips generated by users that might potentially utilize the roadway year-round;
- The estimated delay currently experienced by those users when they must take alternate routes; and
- A standardized estimate of the user cost of delay.

This monetized value was then compared to the computed O&M costs, which also included the amortized costs for the capital equipment, to develop an estimate of annual user cost/benefit ratios. It should be noted that the benefit/cost analysis did not account for the construction costs (including right-of-way) of the roadway, which in some cases are significant (see Tables 2, 3 and 4, and Appendix B). The cost/benefit analysis results are summarized for each Tier Two roadway in Tables 14, 15 and 16.

Table 14: SR-35 Travel Time Cost/Benefit Analysis		
Days per closure "season"	140	
Total ADT	510	
Delay cost/hour	$ 22.20	
Delay cost/minute	$ 0.37	
ADT origin trip %	22%	
Tabiona to Quinn's Junction		
Affected ADT	56	
Total minutes/minutes saved	81/11	
Hanna to Quinn's Junction		
Affected ADT	56	
Minutes saved	22	
Annual user cost savings:	$ 95,897	(Cost)/Benefit
Equipment Amortized	$ 21,700	
O&M	$ 182,000	
Total	$ 203,700	$ (107,803)

Table 15: SR-65 Travel Time Cost/Benefit Analysis		
Henefer to Salt Lake City		
Days per closure "season"	140	
ADT	485	
ADT origin trip %	100%	
Affected ADT	485	
Delay cost/hour	$22.20	
Delay cost/minute	$0.37	
Total minutes/minutes saved	58/0	
Annual user cost savings:	$ -	(Cost)/Benefit
Equipment Amortized	$43,500	
O&M	$122,000	
Total	$165,500	$(165,500)

Table 16: SR-190/GP Rd/SR-224 Travel Time Cost/Benefit Analysis		
Brighton to Park City		
Days per closure "season"	140	
ADT	930	
ADT origin trip %	3%	
Affected ADT	28	
Delay cost/hour	$2.20	
Delay cost/minute	$0.37	
Minutes saved/Total minutes	28/58	
Annual user cost savings:	$40,466	(Cost)/Benefit
Equipment Amortized	$78,300	
O&M	$95,000	
Total	$173,300	$(132,834)

ECONOMIC DEVELOPMENT POTENTIAL

The analysis assessed the economic development potential of each of the road sections evaluated. Likelihood of new near-term, year-round development was determined based on projected winter conditions (i.e. elevation), presence of amenities to support visitation, and current level of summer usage. Current value is an estimate of the value of the property as it currently sits. Future development value will depend on several factors but generally results in an increase in value of the developed parcels of 100 percent. However, future value is limited by actual market demand. The development scenarios are for illustrative purposes; a detailed market development analysis was beyond the scope of this study.

SR-35 Wolf Creek Pass

There is substantial privately owned and potentially developable land in and around Hanna on the eastern end of SR-35. However, this stretch of highway traverses a long stretch of high elevation terrain subject to poor weather conditions in winter (8.5 miles at 8000 feet in elevation or more). Hanna and Tabiona are largely

undeveloped farming communities, with good access to the Grandaddy's area of the High Uintah's and surrounding forest lands but very few amenities within a reasonable driving distance. These lands fall within the Uintah and Ouray Reservation and tribal lands adjoin privately held areas immediately to the east.

There is approximately 24,000 acres of privately held, potentially developable land north of Hanna. Dispersed home/cabin sites that would be the draw to an area like this - something similar to the North Snyderville Basin. There is a spider web of dirt roads in the area, so existing access is probably not a limiting factor. The Duchesne County online zoning map is incomplete (no future land use map is available), but it does illustrate that most land in the Duchesne River Valley is zoned 2.5 units/acres with some commercial land set aside near the towns of Hanna and Tabiona and that the surrounding hills that are included are zoned 10 units/acres.

SR-65 East Canyon

SR-65 leads northeast approximately 15 miles to Henefer and ultimately I-84 and SR-66 leads due north approximately 20 miles to the community of Morgan. The communities in Morgan County are small in comparison to the Wasatch Front. To the south, SR-65 provides direct access to I-80 at Mountain Dell Reservoir, which is about halfway between Salt Lake City and Snyderville Basin. A large amount of privately held land exists north and east of Big Mountain Pass in Morgan and Weber Counties. East Canyon includes a summer-focused resort community, East Canyon Resort. While opening SR-65 during the winter months will improve access to the resort they current have winter access via a Summit County road that traverses through Jeremy Ranch. Much of the private land within the closure area is owned by East Canyon Resort and is used for their summer related resort activities.

SR-190 (Guardsman Pass) to Junction with SR-224

Private land in the basin immediately east of Guardsman Pass in Wasatch Canyon is owned in part by Girl Scouts of America, Talisker, and a number of private individuals. Bonanza Mountain Resort includes two large parcels that is bordered by Salt Lake County on the west and Summit County on the north and is owned by Talisker. South and east of these two large parcels, was subdivided into the Brighton Estate Subdivision in the 1960's, but due to concerns around unsuitable soils for septic and lack of a central culinary water system, many lots are undeveloped. The Wasatch County's general plan advises adoption of regulations that discourage development in this area. However, the Wasatch County Council voted to establish Special Service District for Brighton Estates Subdivision which would provide water, sewer and transportation services on October 2, 2013. Despite these changes in the

development potential of lots, access has always been available via Provo Canyon and US-40. Better access to area ski areas in Park City and Big Cottonwood Canyon may increase the value of lots in this subdivision and put increasing development pressure on these private lands, as it represents an ever narrowing segment of the housing market as available mountainside lots continue to be developed. Access is quite good via Park City in the summer months with gated access in the winter months. Development on the north of Empire Pass is robust, suggesting other factors than accessibility has kept these lands in an around Brighton Estates undeveloped to date. According to the Wasatch County 2008 General Plan, soils in this area are generally unsuitable for septic and substantial portions of the western part of privately held land are impacted by moderate landslide potential. The development of the Brighton Estate SSD signals that restrictive attitudes may be loosening. The lands north and east of the platted Bonanza Mountain Resort and are currently incorporated into the Brighton and Park City Ski Areas, excepting land surrounding Scottish Chief Mine Rd. in Salt Lake County, north of SR-190.

Summary of Potential Value Change

The table below summarizes the economic development potential of each of the road sections evaluated. Likelihood of near-term new year-round development was determined based on projected winter conditions (i.e. elevation), presence of amenities to support visitation, and current level of summer usage. The current value is an estimate of the value of the property as it currently sits. Future development value will depend on several factors but generally results in an increase in value of the developed parcels of 100 percent. However, future value is limited by actual market demand. Further, it should be noted that the development scenarios are illustrative or straw man scenarios, and are used to show potential land value changes.

Table 17: Year-Round Development Value

Route Segment	Gross Developable Acres	Likelihood of Near-Term Year-Round Development	Current Value/Acre (2014$)	Futre Value/Acre (2014$)
SR-35	23,389	Low	$250	$600
SR-65	47,901	Medium	$475	$900
SR-190	1,388	Medium	$500	$975

Source: ACRC, GSBS Richman

CONCLUSIONS AND SUMMARY TABLE

SR-65 and SR-35

- After considering the potential economic impacts and the costs and user benefits for SR-65 and SR-35, the study indicates that there are no compelling reasons to change direction in how these roadways are managed during the winter.

SR-190/Guardsman Pass Rd/SR-224

- The construction costs needed to bring this roadway up to UDOT design standards are significant. However, there may be alternative, non-traditional operating scenarios for SR-190/Guardsman Pass Rd/SR-224 that would allow for a lower level of investment.
- The cost/benefit analysis focused on current, non-discretionary trip purposes and all of the alternate routes for those trips provide travel time savings. Given this fact, the costs to maintain the roadway during the winter months are greater than the current, non-discretionary user benefits.
- Because of stakeholder interests, the potential for economic development along the closed section of this roadway, the role access may play in realizing this potential, and the current evaluation of mountain transportation solutions by the Mountain Accord Study, warrant continued evaluation of the roadway.

The table below outlines construction, capital equipment, and O&M costs associated with improving the Tier Two roadways, as well as the results of the cost/benefit analysis conducted for each roadway. A brief summary of technical and stakeholder issues associated with each roadway is also provided in the table; more information is available in the Roadway Summaries section.

Table 18: Tier Two Summary			
Criteria	SR-35, Wolf Creek Pass	SR-65, East Canyon	SR-190/Guardsman Pass Road/SR-224
Construction Cost[1]	$3.6M - $4.8M	$4.9M – $42.5M	$20M – $138.2M
Capital Equipment Cost	$390K - $429K	$780K - $858K	$1.5M - $1.65M
Annual O&M Cost[2]	$204K - $435K	$166K - 324K	$173K - $268K
(Cost)/Benefit Analysis	($107K)	($166K)	($133K)
Technical and Stakeholder Issues	• Requests from a small number of residents of Hanna and Tabiona to open • Minor roadway improvements would be necessary. • Closed roadway is a popular snowmobile route, opening roadway would disperse parking up the canyon where there are no facilities to accommodate parking – would result in parking on side of roadway • Potential for economic development likely not affected by roadway closure decisions, since viable alternative access exists	• No formal request to open the roadway and there is an alternative Summit County roadway that provides access • Minor roadway improvement would be necessary to open SR-65 • Closed roadway is a popular cross-country-ski route	• Major roadway improvements • Jurisdictional transfers of Guardsman Pass from Wasatch County to UDOT • Park City concerns related to development pressure, increased traffic impacts and provision of emergency services

Notes:
1. Construction costs include shed and right of way costs
2. Annual O&M costs include annualized equipment costs

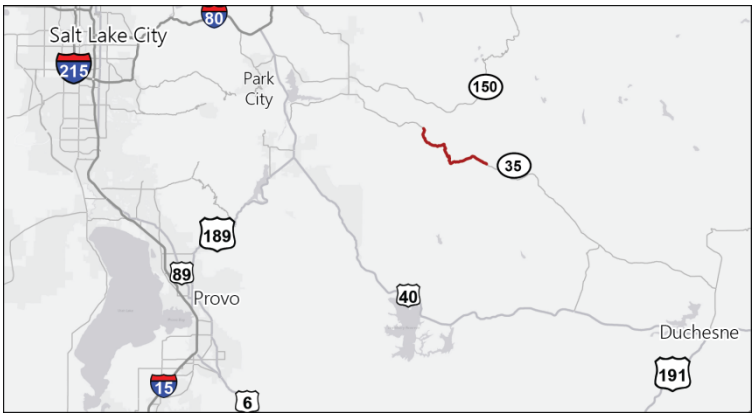
ROADWAY SUMMARIES

This section summarizes each individual roadway, including the following information:

- Jurisdiction (UDOT Region and County)
- Station shed location and contacts
- Closure mileposts
- Roadway and area characteristics
- Travel data (Average Annual Daily Traffic, truck percentages, and travel time)
- Stakeholder issues
- Technical issues

SR-35, WOLF CREEK PASS

UDOT Region 3 | Wasatch County | Station 3433 Tabiona, 435-848-5665 | MP 12.5-28.5

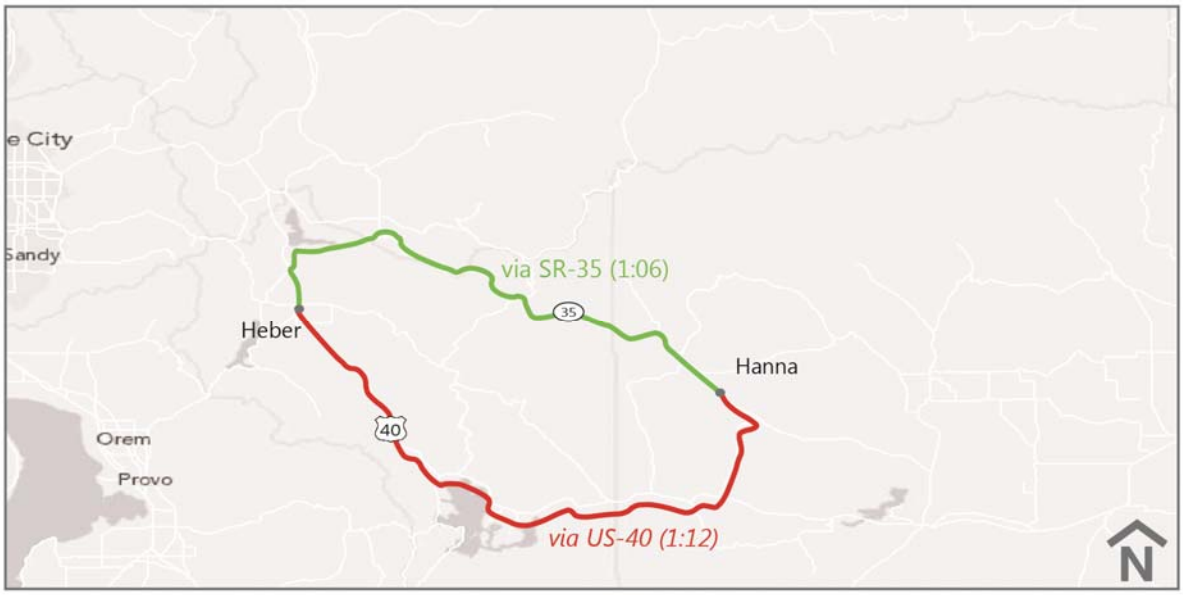


Roadway and area characteristics:

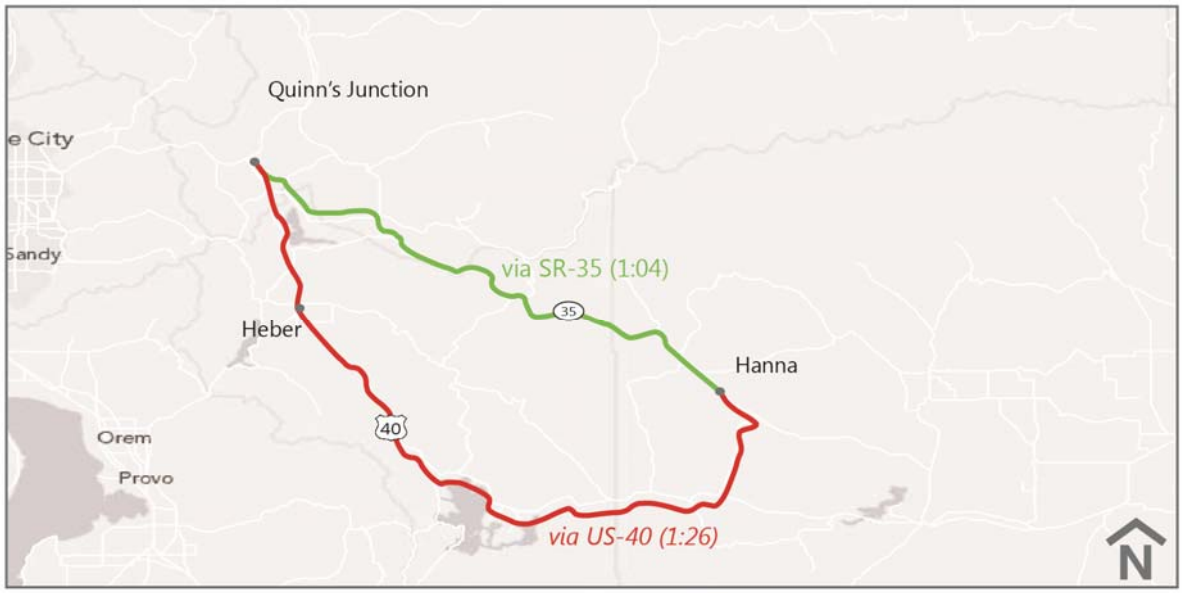
- Maximum elevation of approximately 9,000 feet
- Surrounding land use is primarily public lands with trailheads, camping sites, and other recreational uses
- Roadway groomed during winter for snowmobile use
- Connects Woodland/Francis area with Hanna and Tabiona

Travel data:

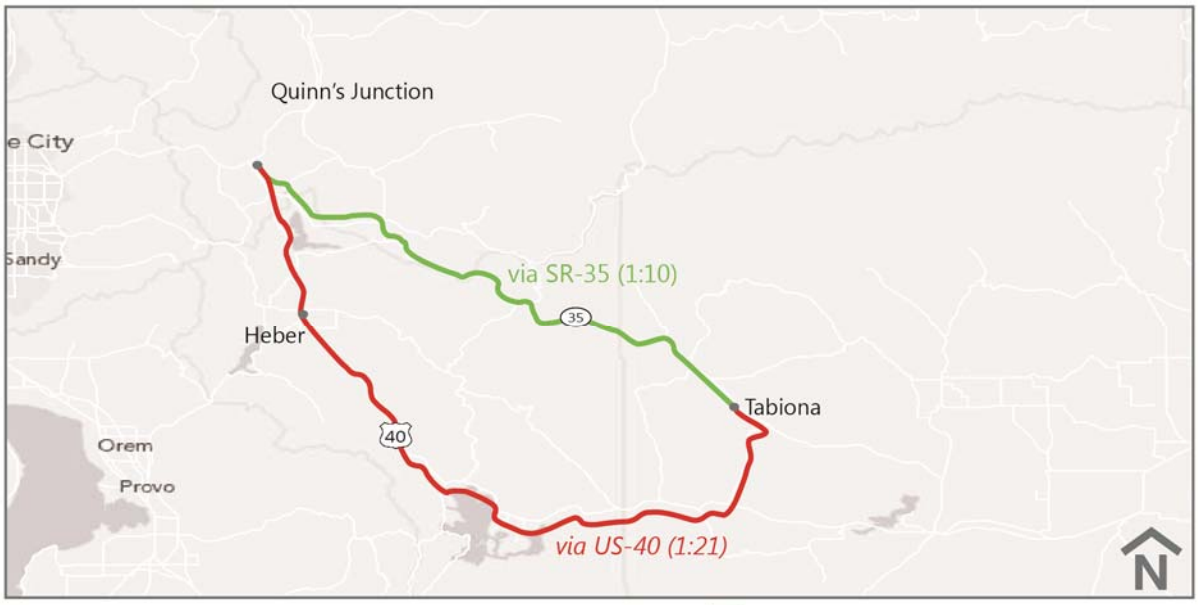
- 510 AADT in 2012
- 16% trucks in 2012
- AADT has increased 9.2% in past five years
- Hanna to Quinn's Junction via SR-35 is 22 minutes faster than alternate route (US-40); Hanna to Heber via SR-35 is 6 minutes faster than US-40
- Tabiona to Quinn's Junction via SR-35 is 11 minutes faster than alternate route (US-40); Tabiona to Heber via SR-35 is 5 minutes slower than US-40



Hanna to Heber City: SR-35 Wolf Creek Pass



Hanna to Quinn's Junction: SR-35 Wolf Creek Pass



Tabiona to Quinn's Junction: SR-35 Wolf Creek Pass

Stakeholder Issues:

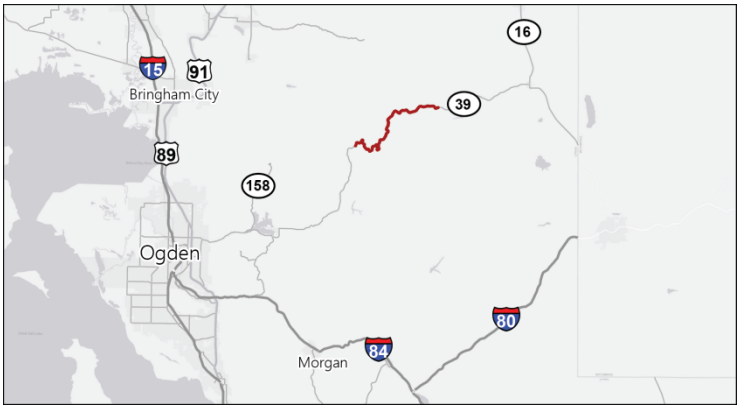
- Hanna and Tabiona residents have requested keeping the roadway open
- SR-35 is currently groomed for snowmobile users, who would be disrupted if the roadway were kept open year-round
- Opening the roadway would disperse current snowmobile parking. Without adequate new facilities, this parking would likely park along SR-35 and may pose safety hazards. New, off roadway parking facilities would likely require environmental review and significant USFS coordination.
- Snowmobile trail network would need to be reconfigured if the roadway were kept open and would alter State Parks grooming practices
- USFS funds were used to build the road for recreational access purposes, and USFS would need to be involved in discussions about keeping the roadway open
- Freight vehicles do not typically use the roadway even in good conditions, due to steep grades and curves

Technical Issues:

- Roadway improvements needed include some sections of guardrail and snow fence, a satellite shed facility near the summit, and associated right-of-way, and more snow removal equipment.
- Roadway is otherwise adequate geometrically to accommodate winter travel.
- There is development potential north of Hanna, along SR-65 for approximately 23,000 acres of private property, which could develop into dispersed cabin and home sites. Study team concluded that the seasonal nature of the roadway was not a driving factor in the development of property.

SR-39, MONTE CRISTO ROAD

UDOT Region 1 | Cache, Rich, and Weber Counties | Station 1425 Huntsville, 801-745-3777; and Station 1437A Randolph, 435-946-3290 | MP 37-55.5

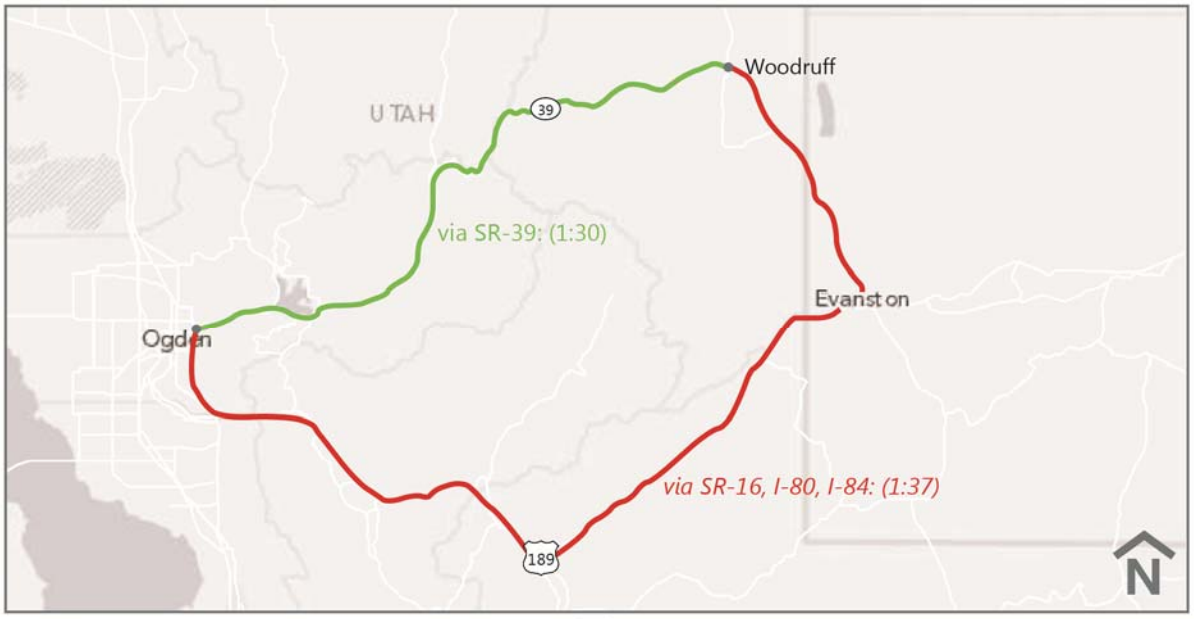


Roadway and area characteristics:

- Maximum elevation of approximately 9,000 feet
- Roadway provides access to private recreation parcels.
- There are areas of private land east of the summit, which had been planned for development prior to economic downturn, but those plan have not resurfaced
- Small pockets of dispersed development
- Roadway groomed during winter for snowmobile use, State Parks operates a large, fee based parking lot at the west closure gate
- Connects Huntsville with Woodruff and Randolph

Travel data:

- 400 AADT in 2012
- 28% trucks in 2012
- AADT has decreased 47.5% in last five years
- Woodruff to Ogden via SR-39 is 7 minutes faster than the alternative (SR-16, I-80, I-84)



Woodruff to Ogden: SR-39 Monte Cristo

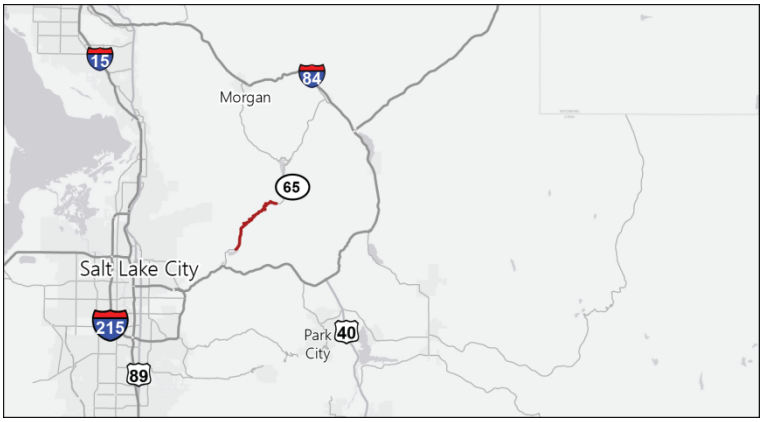
Stakeholder issues:

- SR-39 is currently used for winter recreation, and opening the roadway would disrupt that use
- Year-round opening may also affect connectivity of the State Parks winter trail system and opening roadway would alter State Parks grooming practices

Technical issues:

- Year-round opening may require shoulder widening for snow storage, in addition to more equipment and staff resources

SR-65, EAST CANYON



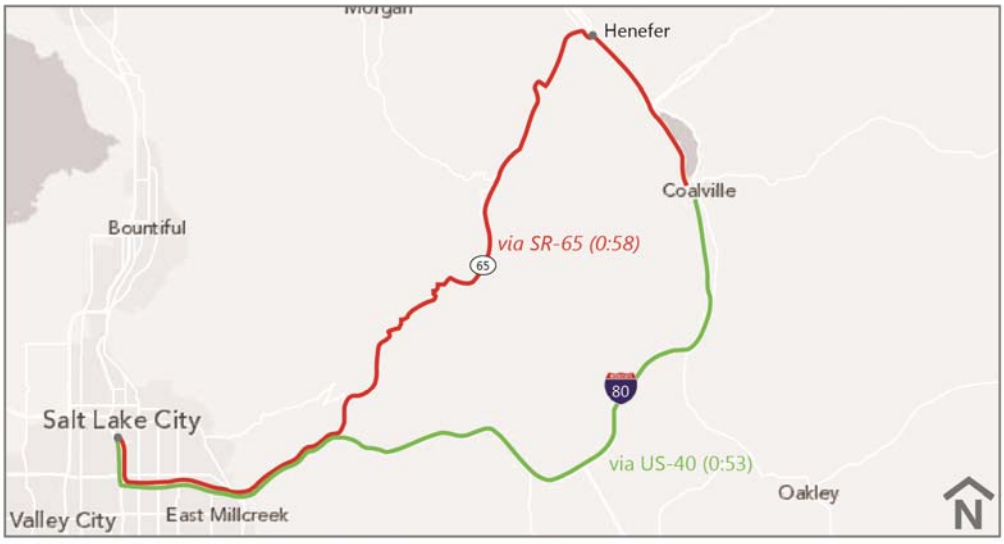
UDOT Regions 1 and 2 | Morgan and Salt Lake Counties | Station 2434 Parley's, 801-582-2115; and Station 1426 Morgan, 801-829-3433 | MP 3-14

Roadway and area characteristics:

- Maximum elevation is approximately 7,500 feet
- Public lands on west side of pass, including camping areas and trailheads
- Privately held land east and north of the pass (approximately 48,000 acres)
- Closed roadway is groomed by The Utah Nordic Alliance and used extensively by cross country skiers and snowmobilers in winter
- Connects Emigration and Parley's Canyons to East Canyon Resort, Henefer and Morgan. There is a Summit County roadway that traverses from I-80 through Jeremy Ranch Golf Couse and connects with East Canyon Resort that is kept open during the winter months and provides alternative access.

Travel data:

- 485 AADT in 2012
- 21% trucks in 2012
- AADT has increased 3.9% in last five years
- No travel time advantage: Salt Lake City to Henefer is five minutes slower via SR-65 than via the alternative (I-80, I-84); negligible travel time savings from Salt Lake City to East Canyon Resort, SR-65 is 2 minutes faster than the Wasatch County roadway alternative



Salt Lake City to Henefer: SR-65 East Canyon

Salt Lake City to East Canyon Resort: SR-65 East Canyon

Stakeholder issues:

- East Canyon Resort expressed some interest in year-round access via SR-65, however they recognize that there are alternative uses during the winter months and would not formally make a request to open the roadway; East Canyon Resort's activities are focused in the summer, but their members do use the facility in the winter
- Snowmobile and other winter recreation activity would be disrupted if the roadway were kept open year-round

Technical issues:

- Rock-fall catchment areas, snow fence, and guard rail, widening, and retaining walls would be needed to keep SR-65 open year-round

SR-92, ALPINE LOOP

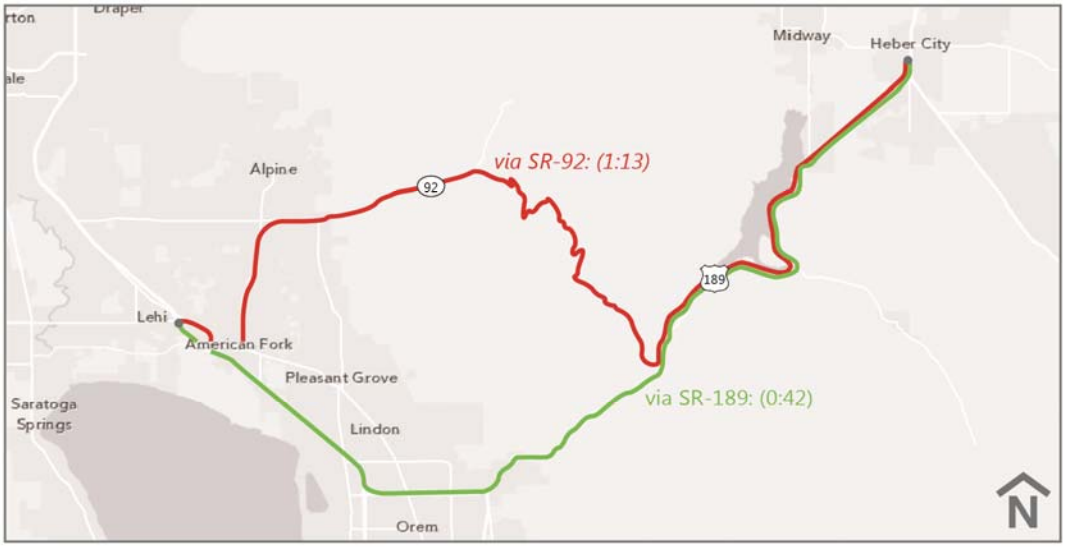
UDOT Region 3 | Utah County | Station 3425 Provo Canyon, 801-434-7470 | MP 13.5-22.5

Roadway and area characteristics:

- Maximum elevation of approximately 8,100 feet
- Primarily USFS land with trailheads and campgrounds in closed section
- Connects Sundance Ski Resort with American Fork Canyon during summer months; access to the resort is limited to SR-92 from US-189 in winter months

Travel data:

- 430 AADT in 2012
- 13% trucks in 2012
- AADT has decreased 3.5% in last five years
- No travel time advantage: Lehi to Heber is 31 minutes slower via SR-92 than via the alternate route (I-15, SR-189)



Lehi to Heber: SR-92 American Fork/Alpine Loop

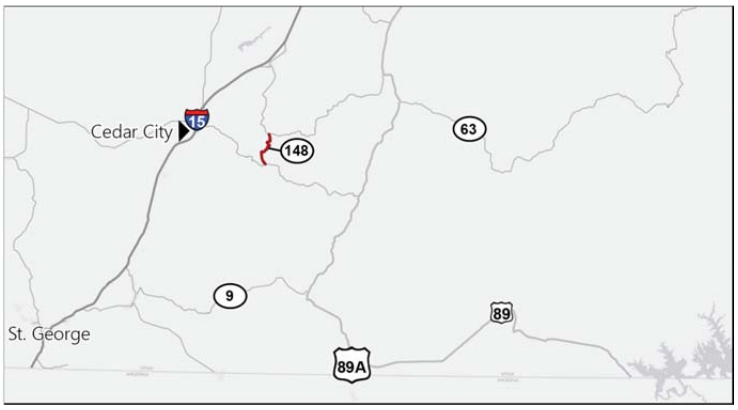
Stakeholder issues:

- Winter recreation activities on SR-92 could be affected if the roadway is kept open year-round

Technical issues:

- Roadway is very narrow, (one lane width), with tight switchbacks and steep drop-offs.

SR-148, CEDAR BREAKS



UDOT Region 4 | Iron County | Station 4477 Cedar Mountain, 435-586-0182; and Station 4478 Parowan, 435-477-3715 | MP 0.2-19

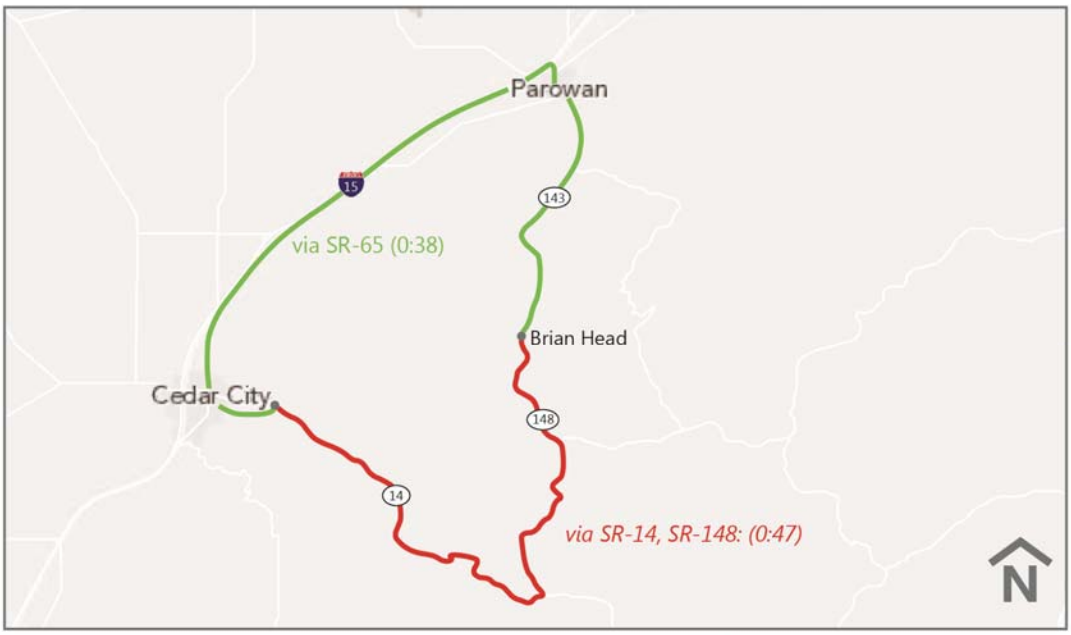
Roadway and area characteristics:

- Maximum elevation is approximately 10,300 feet
- UDOT has jurisdiction over only 2.5 miles of the roadway, and the rest is managed by the National Park Service
- SR-148 is the primary (but not only) means of access to Cedar Breaks National Monument

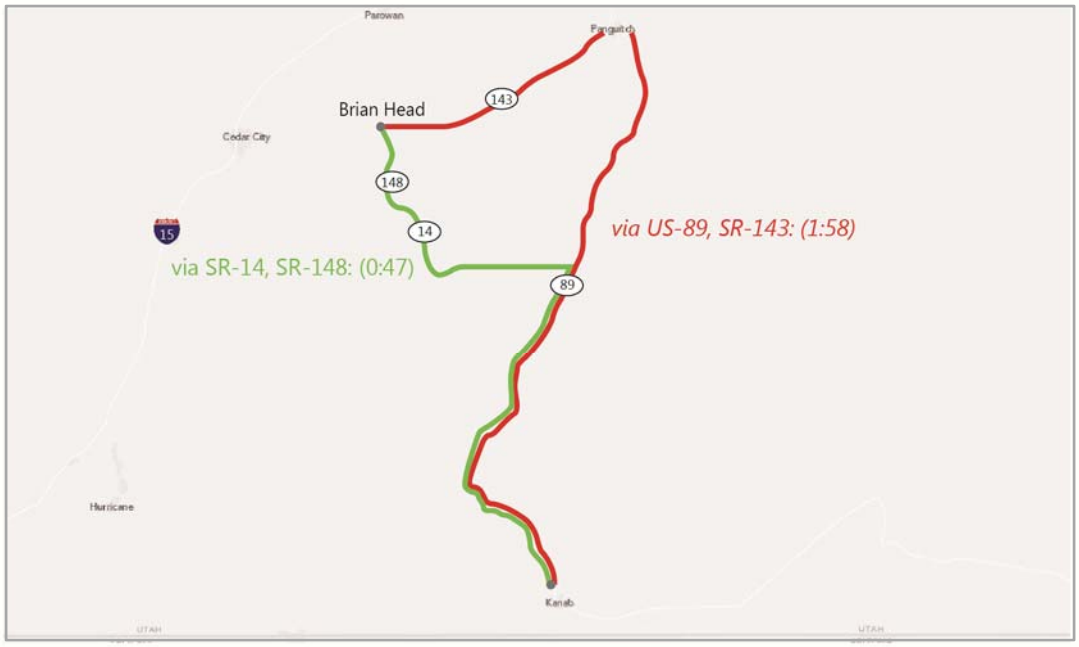
Travel data:

- 870 AADT in 2012

- 14% trucks in 2012
- AADT has decreased 3.3% in last five years
- No travel time advantage between Cedar City and Brian Head via SR-148, it is 9 minutes slower than via the alternate route (I-15 to SR-148 via Parowan)
- There is a 27 minute travel time advantage between Kanab and Brian Head via SR-148 compared to the alternate routes



Cedar City to Brian Head: SR-148 Cedar Breaks



Kanab to Brian Head: SR-148 Cedar Breaks

Stakeholder issues:

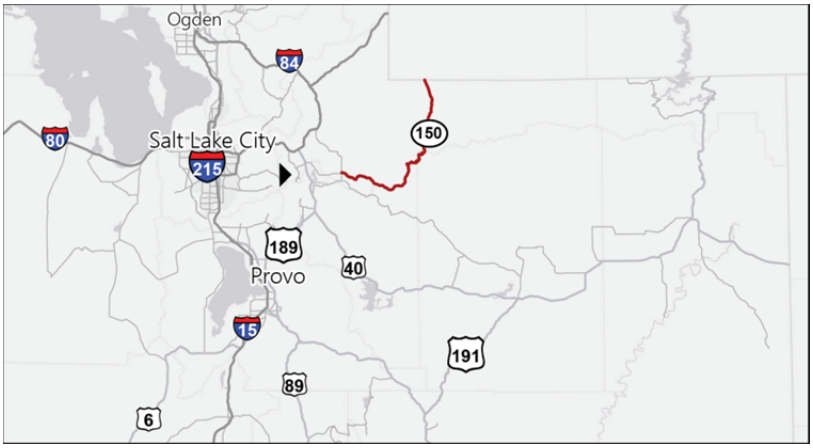
- Stakeholders have expressed interest in recreation access from Kanab to Brian Head ski resort via SR-148 given shorter travel times
- National Park Service controls the section of SR-148 within the National Monument boundaries, and it is questionable whether they would support opening the roadway year-round given the recreational uses of the roadway within the National Monument
- While there is some potential for jurisdictional transfer of SR-148, such a transfer would likely be complicated and time-intensive

Technical issues:

- Narrow roadway with thin pavement and minimal shoulders within National Monument
- Major roadway improvements would be needed to keep roadway open year-round

SR-150, MIRROR LAKE HIGHWAY

UDOT Region 2 | Summit County | Station 2437 Kamas, 435-783-4502, MP 14.7-48.6 | MP0.2-19

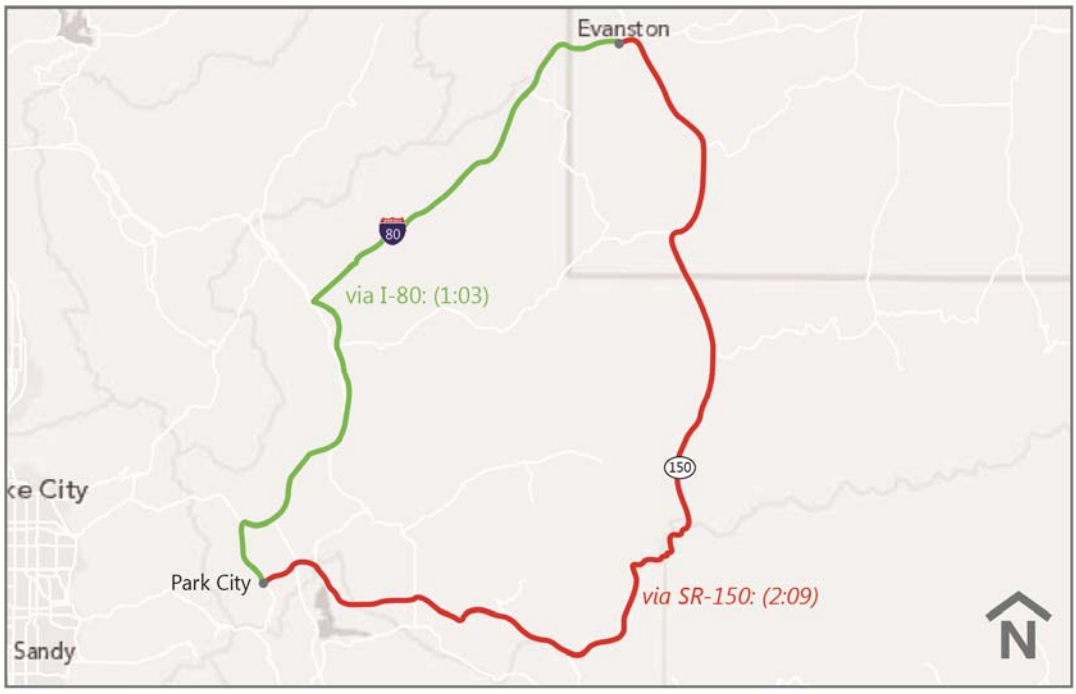


Roadway and area characteristics:

- Maximum elevation is approximately 10,500 feet
- Closed roadway is a popular snowmobile route
- Connects Kamas, Utah with Evanston, Wyoming

Travel data:

- 955 AADT in 2012
- 23% trucks in 2012
- AADT has decreased 5.6% in last five years
- No travel time advantage: Park City to Evanston is one hour and five minutes slower on SR-150 than via the alternative (I-80)



Park City to Evanston: SR-150 Mirror Lake Highway

Stakeholder issues:

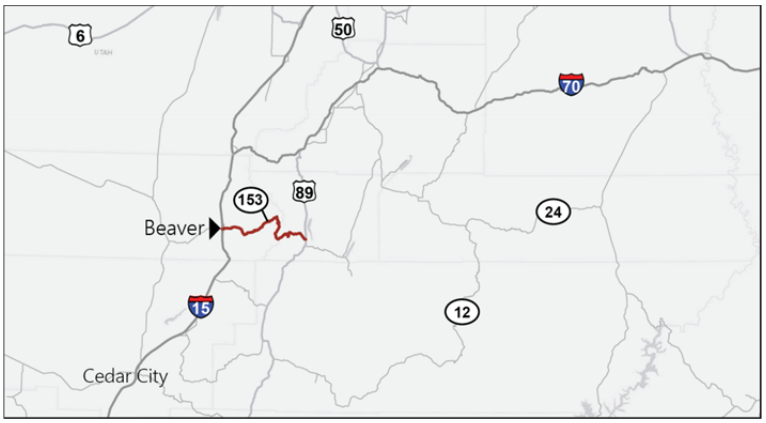
- Opening the roadway would disrupt snowmobiler use of the roadway

Technical issues:

- Needed improvements to keep the roadway open include avalanche control and monitoring, turnarounds, and parking areas

SR-153, MOUNT HOLLY JUNCTION

UDOT Region 4 | Beaver and Piute Counties | Station 4468 Junction, 435-577-2873; and Station 4479 Beaver, 435-438-2624 | MP 21.3-39.5 |



Roadway and area characteristics:

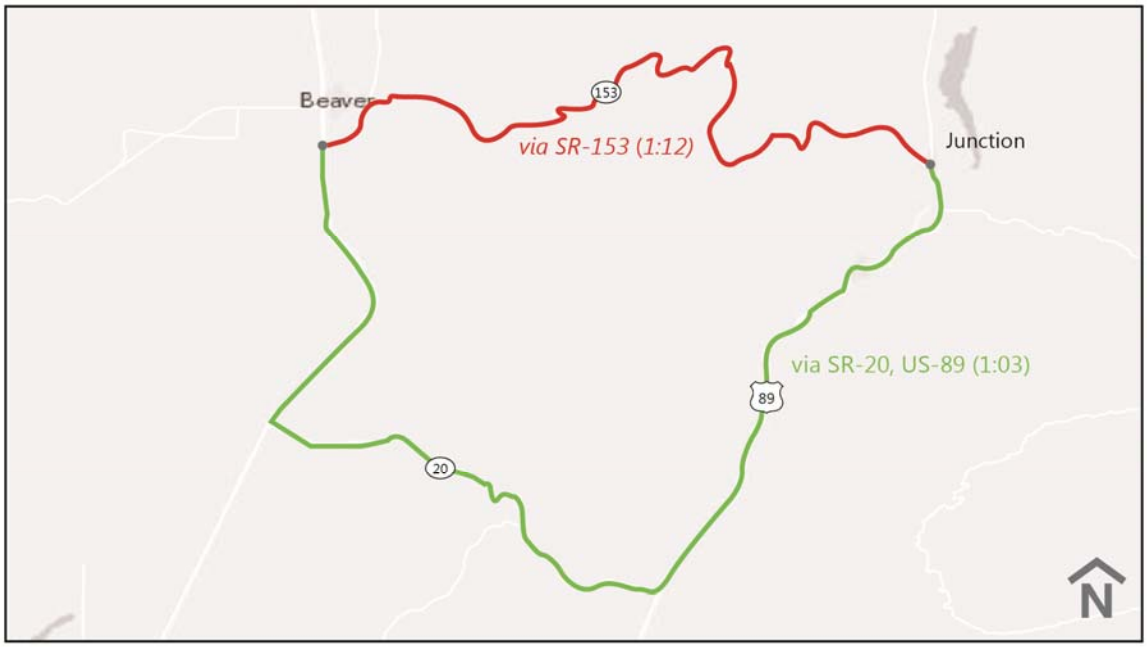
- Maximum elevation is approximately 10,300 feet
- Eagle Point ski area is

accessed via SR-153, from Parowan

- Closed roadway connects snowmobilers from the east side of the closure to Eagle Point and to the snowmobiling areas of Beaver Mountain
- Connects Beaver to Junction

Travel data:

- 20 AADT in 2012
- 37% trucks in 2012
- AADT has increased 0.0% in last five years
- No travel time advantage: Beaver to Junction is 9 minutes slower via SR-153 than via the alternate route (SR-20 and US-89)



Beaver to Junction: SR-153 Mt. Holly Junction Road

Stakeholder issues:

- Snowmobilers use would be disrupted if the roadway were open year-round

Technical issues:

- Roadway would require major investment to keep open year-round including likely widening, pavement (currently it is a dirt road) and safety improvements

SR-190/GUARDSMAN PASS ROAD/SR-224

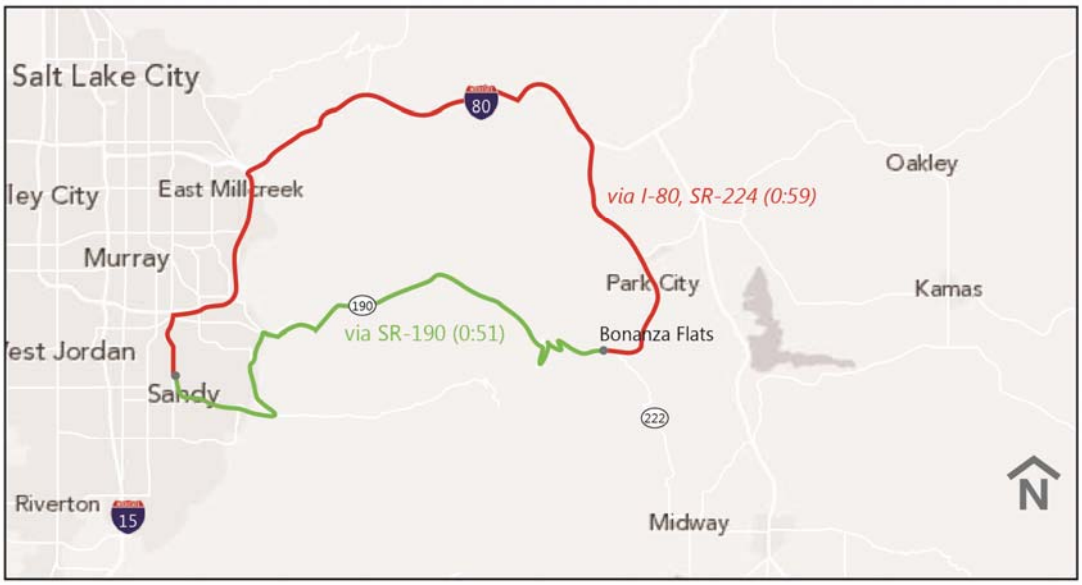
UDOT Regions 2 and 3 | Salt Lake, Summit, and Wasatch Counties | Station 2433 Cottonwood, 801-943-9448, and Station 2435 Silver Summit, 435-649-9701 | MP 17.7 (SR-190)-0.84

Roadway and area characteristics:

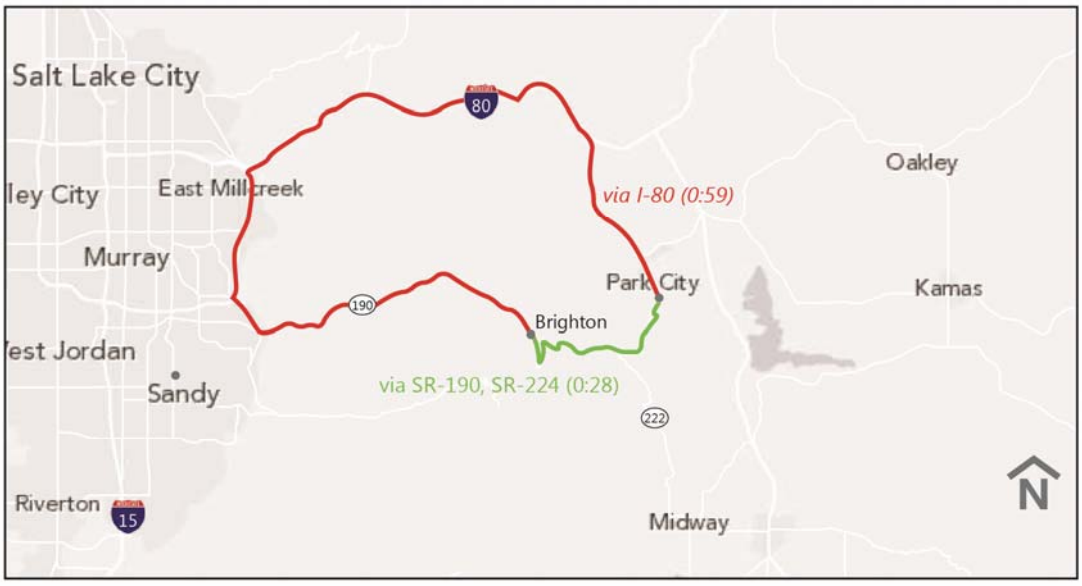
- Maximum elevation is approximately 9,800 feet
- Several areas of developed private property including parcels owned by the Girl Scouts of America and United Park City Mines, Brighton Estates Subdivision and other owners
- Development potential in Bonanza Flats and areas east continuing to US-40
- UDOT jurisdiction on SR-190 and SR-224, Wasatch County jurisdiction on Guardsman Pass Road
- Connects Brighton to Park City
- Primary travel demand use is recreational

Travel data:

- Range in 2012 AADT depending on route: 930 on SR-190 in Big Cottonwood Canyon near the seasonal gate
- 9% trucks on SR-190 (near the seasonal gate) in 2012
- AADT has increased 1.3% in last five years
- Travel time advantage varies depending on origins/destinations of trips (see maps):
    - Sandy to Bonanza Flats is 8 minutes faster via SR-190 than alternate routes (I-215, I-80, SR-224)
    - Sandy to Midway is 12 minutes slower via SR-190 and SR-222 than alternate routes (I-15, US-189)
    - Sandy to Park City is 16 minutes slower via SR-190 and SR-224 than alternate routes (I-215, I-80, SR-224)
    - Brighton to Park City is 28 minutes faster via SR-190 and SR-224 than alternate routes (I-215, I-80, SR-224)

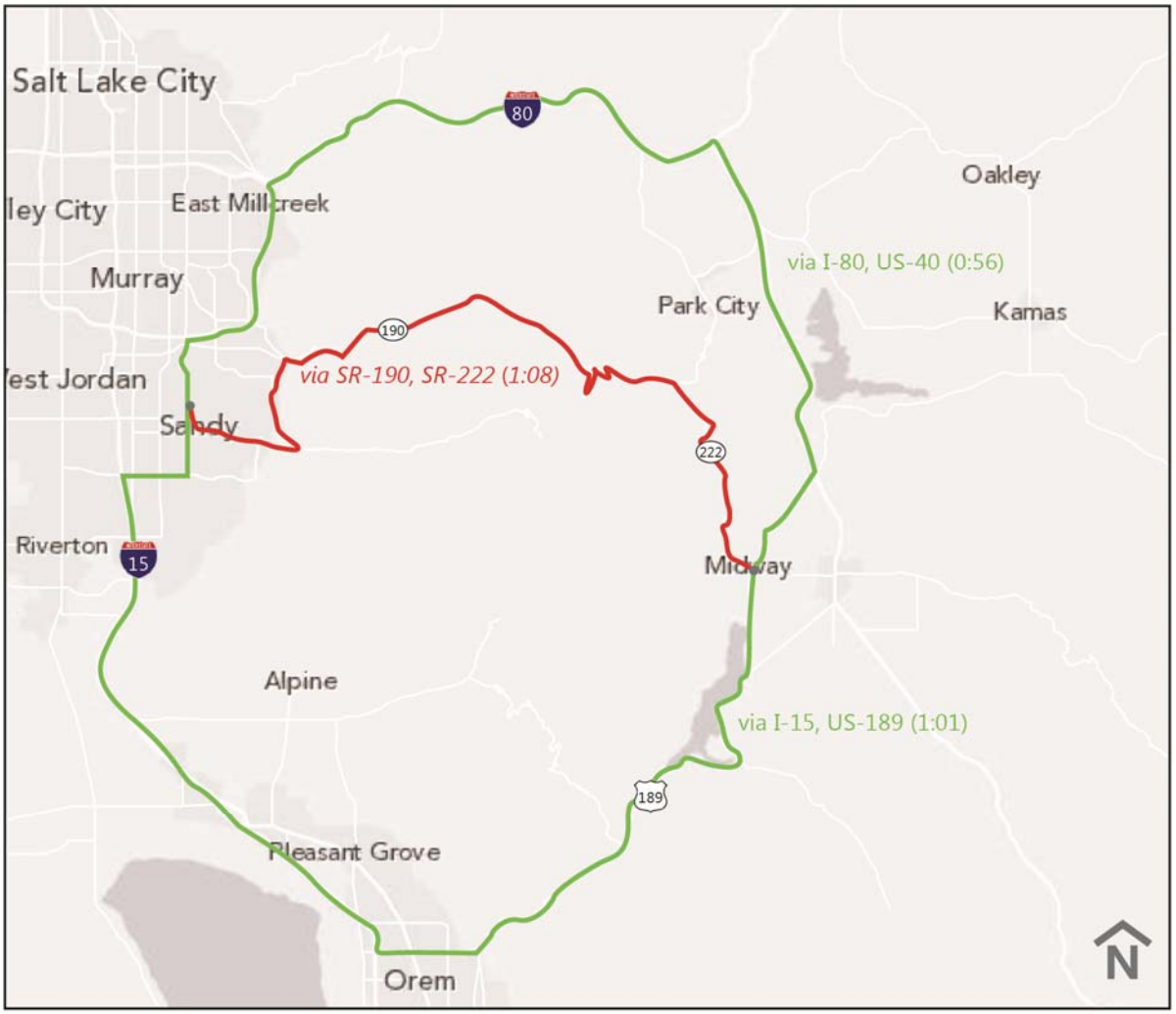


Sandy to Bonanza Flats: SR-190/SR-224 Guardsman Pass



Brighton to Park City: SR-190/SR-224 Guardsman Pass

Sandy to Park City: SR-190/SR-224 Guardsman Pass



Sandy to Midway: SR-190/SR-224 Guardsman Pass

Stakeholder issues:

- Concern from Park City officials about increasing development pressure in Bonanza Flats area, increasing traffic impacts in Park City and the provision of emergency services
- Resort representatives have expressed interest in opportunities for more access for resort visitors
- Jurisdictional transfers from Wasatch County to UDOT (Guardsman Pass Road) and/or from UDOT to Park City (SR-224) may need to be considered
- Big Cottonwood Canyon Community Council expressed interest in having an alternative route in and out of the canyon

Technical issues:

- Roadway improvements needed to bring roadway up to UDOT standards

APPENDIX A: STAKEHOLDER INVOLVEMENT

The study was designed as a feasibility study to provide data internally to UDOT Leadership. It was not the intent of this study to conduct significant outreach to the general public or other stakeholders. However, the study benefited by targeting outreach with key stakeholders associated with the mountain passes.

The project team contacted the following agencies and organizations:

- Park City
- Wasatch County
- Utah State Parks Division
- Utah Snowmobilers Association
- Save Our Canyons
- Utah Office of Outdoor Recreation
- United States Forest Service (USFS)
- Big Cottonwood Canyon Community Council
- Deer Valley Resort
- East Canyon Resort
- Governor's Office of Economic Development (GOED)

The study team also conducted field visits and met with the UDOT maintenance and engineering staff directly involved with the operation of the winter closure roadways. These visits provided context and understanding of the individual roadways.

These conversations were valuable in helping the study team gained insight and perspective into the many issues and potential stakeholder concerns. The meetings also helped establish lines of communications and a level of trust in the process. The following table summarizes the comments heard in these meetings.

Table 19: Stakeholder Meeting Summary		
Date	Agency	Discussion Topics
November 2013	GOED	• Value to GDP • Winter recreation users • Six categories for access consideration • Improved road striking a balance between part-time and full-time access
January 2014	Park City	• Year-round service to Bonanza Flats would hasten development • Traffic impact on Marsac Avenue near Old Town and roundabout • Jurisdictional transfer • Emergency access, provision of services
January 2014	Utah State Parks Division of the Utah Department of Natural Resources	• Business impact • Snowmobile community • Motorized recreation • Trail connectivity and grooming
February 2014	Deer Valley Resort	• Benefit in opening Guardsman year-round and connecting resorts
February 2014	Save Our Canyons	• Increased auto use of canyons • Impact to critical lands and watersheds
February 2014	Utah Snowmobilers Association	• Opposed opening SR-35 and SR-39 • Trail connectivity and crossing paved roadway • Economic impact of use
March 2014	USFS - Salt Lake Ranger District	• Trail usage • Parking overflow • Pricing for canyon access
March 2014	Wasatch County	• Do not see a lot of benefit from opening Guardsman Pass • Pine Canyon Road is expensive to maintain • Would support jurisdiction transfer to UDOT
March 2014	East Canyon Resort	• Some interest in seeing SR-65 opened year-round, but acknowledged they have access via Wasatch County Road • Acknowledged winter recreation use of SR-65 • Resort members do use resort in winter months
April 2014	Big Cottonwood Canyon Community Council	• Interested in an alternative route out of the canyon in the event of an emergency
April 2014	USFS - Heber District	• Set a date to close and keep the road closed • Concern with dispersed parking from Nobblets parking lot-no place for them to park up the canyon • Opening SR-65 would open access to winter, backcountry use

APPENDIX B: TIER TWO ROADWAY COST ESTIMATES

LOCHNER

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MEMORANDUM

Date: June 3, 2014

To: Jon Nepstad, Fehr & Peers

cc: Jeff Harris, UDOT

From: Andrea Clayton, Lochner

Re: **COST ESTIMATES**
Winter Roadway Closure Study
Project No.: S-ST99(213); PIN 12084

Attachments:

- Appendix 1: Coordination with Maintenance Supervisors
- Appendix 2: Construction Costs
- Appendix 3: Capital Costs
- Appendix 4: O&M Costs

1 Introduction and Summary

This memo includes information on estimated costs to keep roads that passed through Tier One screening open year-round. Rough order of magnitude costs were evaluated for SR-190/Guardsman Pass Rd/SR-224, SR-35, and SR-65. In addition to summarizing the methodology and assumptions that went into determining costs for these roadways, this memo provides estimates of the following initial and ongoing costs for each roadway:

- Roadway construction costs (if roadway improvements would be required to safely open the road during winter and/or alter existing travel patterns)
- Capital costs (one-time initial costs for equipment and construction of a satellite shed)
- Operation and maintenance (O&M) costs (snow removal and additional maintenance personnel)

1.1 Construction Costs

The roadway construction cost estimates were identified by the design team through coordination with maintenance station supervisors to determine if improvements would be necessary to safely maintain the roadway during winter months. Discussion with maintenance supervisors identified necessary safety improvements, including guardrail, snow fencing, roadway widening, and rock-fall catchment locations.

1.2 Capital Costs

Maintaining mountainous roadways during the winter would necessitate up-front capital costs. Due to the high elevation and large amount of annual snow, additional specialized equipment would be needed. In

addition, satellite snow sheds may be needed somewhere near the highway summit to store the equipment, materials, and salt.

1.3 O&M Costs

O&M costs were developed using UDOT's operation management system (OMS) database. Based on discussions with UDOT maintenance personnel, a list of comparable maintenance sheds was developed. These costs were then broken down to a cost per mile and were applied to each roadway. Shed supervisors also identified how many additional staff would be required.

1.4 Cost Summary

A cost summary for each roadway is provided in Tables 1 to 3.

Table 1. SR-190/Guardsman Pass Rd/SR-224 Cost Summary

Item	Low Initial Cost	High Initial Cost	Low Annual Cost	High Annual Cost
Construction	$12,366,000	$78,821,000	N/A	N/A
O&M	N/A	N/A	$95,000	$182,000
Capital Cost, Equipment	$1,500,000	$1,650,000	$78,300	$86,200
Capital Cost, Shed	$2,100,000	$2,400,000	N/A	N/A
Capital Cost, Right-of-Way	$5,564,000	$56,966,000	N/A	N/A
Total	**$21,530,000**	**$139,837,000**	**$173,300**	**$268,200**

Table 2. SR-35 Cost Summary

Item	Low Initial Cost	High Initial Cost	Low Annual Cost	High Annual Cost
Construction	$745,000	$894,000	N/A	N/A
O&M	N/A	N/A	$182,000	$411,000
Capital Cost, Equipment	$390,000	$429,000	$21,700	$23,900
Capital Cost, Shed	$2,100,000	$2,400,000	N/A	N/A
Capital Cost, Right-of-Way	$750,000	$1,500,000	N/A	N/A
Total	**$3,985,000**	**$5,223,000**	**$203,700**	**$434,900**

Table 3. SR-65 Cost Summary

Item	Low Initial Cost	High Initial Cost	Low Annual Cost	High Annual Cost
Construction	$2,093,000	$38,616,000	N/A	N/A
O&M	N/A	N/A	$122,000	$276,000
Capital Cost, Equipment	$780,000	$858,000	$43,500	$47,800
Capital Cost, Shed	$2,100,000	$2,400,000	N/A	N/A
Capital Cost, Right-of-Way	$750,000	$1,500,000	N/A	N/A
Total	**$5,723,000**	**$43,374,000**	**$165,500**	**$323,800**

2 Methodology and Assumptions

2.1 Construction Costs

The design team coordinated with maintenance station supervisors to identify roadway construction cost estimates and determine if improvements would be necessary to safely maintain the roadway during winter months. Documentation of this coordination is provided in Appendix 1. The maintenance supervisors identified the following necessary improvements, which were used to determine the construction costs:

- Guardrail to protect cars from sliding off steep drop-offs during icy conditions. Guardrail is included in the estimates for SR-190/Guardsman Pass Rd/SR-224, SR-35, and SR-65.
- Snow fence to prevent snow from drifting onto the roadway (typically located near the summit of a mountain or where there is no vegetation to act as a natural break). Snow fence is included in the estimates for SR-35 and SR-65.
- Roadway widening to allow two vehicles to safely pass each other on narrow mountain roads. Three improvement scenarios were prepared for SR-190/Guardsman Pass Rd/SR-224, as discussed below. Roadway widening is included in two of the three estimates. The minimum improvement option does not provide widening for the roadway, and, therefore, does not provide enough room for two vehicles to safely pass each other.
- Rock-fall catchment locations to provide space for falling rocks outside the roadway. Freeze/thaw cycles break rock apart, and during the springtime rocks fall from the rock cuts onto the roadway below. Rock-fall locations are included in the estimate for SR-65.

After discussions with each supervisor, the locations, length, and general geometric needs for guardrail, snow fence, and rock-fall catchment were estimated using Google Earth imagery for SR-35 and SR-65. Proposed improvements on SR-190/Guardsman Pass Rd/SR-224 were estimated using MicroStation, based on contour information obtained from the Utah Automated Geographic Reference Center (AGRC). Earthwork quantities in all situations were estimated based upon the mapping available.

Individual construction costs for each roadway are provided in Appendix 2. No environmental mitigation or utility costs were included in the construction cost estimates.

2.2 Capital Costs

Maintaining these roadways during the winter would necessitate up-front capital costs. Due to the high elevation and large amount of annual snow, additional specialized equipment would be needed. In addition, satellite snow sheds would be needed somewhere near the roadway summit to store the equipment, materials, and salt. The shed would need to be located near the top of the road because maintenance staff need to be able to plow the snow downhill, due to the steep grades. Where satellite sheds are needed, right-of-way would need to be purchased for the facility.

Station supervisors were contacted to determine additional specialized equipment needs. They provided information on shed needs, including number of bays, shed features, and the amount of salt storage

required. The estimated right-of-way required for a shed was quantified based on assumptions of shed size and the terrain of proposed sites.

Appendix 3 provides information used to determine capital costs for each roadway.

2.3 O&M Costs

O&M costs for SR-190/Guardsman Pass Rd/SR-224, SR-35, and SR-65 were estimated using the cost per lane mile for comparable mountain passes that are currently maintained during the winter. Comparable roads and maintenance sheds were selected based on discussions with UDOT maintenance personnel, taking into account such factors as elevation and snowfall. Costs for these comparable roads were then developed based on data from UDOT's Operational Management System (OMS) database of comparable sheds and discussions with shed supervisors. The following comparable roads were identified:

- 1145 – Logan Summit
- 2433 – Cottonwood
- 4456 – Huntington
- 4461 – Mt. Pleasant
- 4471 – Long Valley
- 4478 – Parowan

Costs for the last five years were obtained from UDOT's OMS database for the maintenance billing codes outlined below.

Primary Code:

- 7S78 – Snow and ice control

Miscellaneous Snow Removal Codes:

- 7D81 – Snow; open and close roads
- 7D83 – Avalanche control
- 7M95 – On-call/TATS reporting
- 7S75 – Stockpiling for snow removal
- 7S77 – Anti-icing
- 7S79 – Snow fence, mark and BBLS
- 7S80 – Snow and ice control (other)

The OMS database stores data by shed, not by roadway. The total cost for the shed with the comparable road was obtained, and the station supervisor was asked to estimate what percent of the shed budget was dedicated to the comparable road. From this data, a high and average annual cost per lane mile were developed for snow and ice removal. The high cost was established using the Cottonwood shed (which maintains SR-210 and SR-190) of $11,918 per lane mile, and an overall average cost per lane mile of $5,284 per lane mile. These numbers were used to develop a range in O&M costs for each roadway (see Table 4).

*Table 4. Comparable Road O&M Costs**

Shed	Length (mi.)	# Lanes	Snow & Ice Removal (5-yr. avg.)	Percent of Budget** (%)	Snow & Ice Removal Cost (per lane mile)	Average # of Days Plowing	High Elevation
1445 - Logan Summit	37	2	$354,000	100%	$4,784	187	7500
2433 - Cottonwood	22	2	$874,000	60%	$11,918	131	9000
4456 - Huntington	36	2	$288,000	70%	$2,800	99	9000
4461 - Mt. Pleasant	23	2	$201,000	70%	$3,059	125	6000
4471 - Long Valley Jct.	19	2	$111,000	50%	$1,461	80	9500
4478 - Parowan	14	2	$326,000	66%	$7,684	250	9500
Average					**$5,284**	**145**	8400

**2014 dollars; OMS information provided by Mike Marz, UDOT*

***Percent of snow removal budget for shed used to maintain the length described (as estimated by station supervisor)*

In addition to snow maintenance costs, each station supervisor estimated the additional full-time staff that would be needed to keep the roads clear during the winter months. This is described in the relevant section for each roadway.

Information used to determine O&M costs is provided in Appendix 4.

2.4 Inflation

All costs in this memo assume current 2014 statewide unit prices. Unit prices were adjusted for the difficult-to-access location of these mountainous roads. An inflation factor was also used to inflate these costs to their projected construction year. UDOT assumes a construction inflation rate of 5.5% for projects with an estimated construction year of five or more years out.

Typically, capital costs and O&M costs inflate at a lesser rate than construction. For capital costs and O&M costs, an inflation rate of 3% (+/- 1%) was assumed.

Cost estimates in this memo assume 2014 costs. Costs for future years should apply the above-mentioned inflation factors.

3 Costs

3.1 SR-190/Guardsman Pass Rd/SR-224

SR-190/Guardsman Pass Rd/SR-224 (Guardsman Pass) currently has 5.6 miles of roadway that are not maintained during the winter months (2.2 miles on SR-190, 0.8 miles on SR-224, and 2.6 miles in between on Guardsman Pass Road). Based on team engineering analysis and conversations with Cottonwood

maintenance supervisor George Priskos, geometric deficiencies have been identified that would require major improvements to maintain the roadway year-round. With the high estimated cost to fix the deficiencies, the project team looked at three different scenarios of construction improvements. Due to the high cost of the desirable full-width option, the project team also considered additional alternatives that, though less desirable, could be more affordable.

It should be noted that, in general, the more money spent on construction improvements, the easier it will be to perform snow maintenance of the roadway. Some of the scenarios, described below, have limitations of vehicle access during snow maintenance.

Cost estimates were developed for SR-190/Guardsman Pass Rd/SR-224 for construction, capital, annual maintenance, and right-of-way, as summarized below. Cost estimates include the entire section of Guardsman Pass from the gate on SR-190 by Forest Glen to the gate on SR-224 by Deer Valley.

3.1.1 Construction Costs

Design Alternatives: Construction cost estimates were developed for the following three possible scenarios to open Guardsman Pass during the winter. These scenarios included two high-level designs of Guardsman Pass, as well as a lower-cost option for a location-specific modification:

- Full-Width Typical Section: This design—a desirable full-width typical section with 12′ lanes and 5′ shoulders (see Guardsman Pass Full Width Typical Section in Appendix 2)—would limit design exceptions and waivers (see Project Design Criteria in Appendix 2). This alternative assumes the entire 5.6-mile section of road that is closed during the winter would be widened to the desirable full width. In addition, the 0.9-mile-long section of SR-190 from the main road in Big Cottonwood Canyon to the seasonal gate would also be widened to the desirable full width to match.

- Reduced-Width Typical Section: This design would reduce the width of the typical section to 10′ lanes and 2′ shoulders (see Guardsman Pass Reduced Width Typical Section in Appendix 2). This alternative would prohibit large delivery trucks from using the road, but would reduce the amount of walls needed compared to the full-width section. This option does not provide enough room for a vehicle to pass a snowplow or blower, and would require Guardsman Pass to be closed during snow maintenance operations. Based on the average over the last five years, Guardsman Pass would be closed approximately 130 times per year for snow removal. This alternative assumes the entire 5.6-mile section of road that is closed during the winter would be widened to the reduced width. In addition, roughly half of the 0.9-mile-long section of SR-190 from the main road in Big Cottonwood Canyon to the seasonal gate would also need to be widened to the reduced width.

- Existing Typical Section with Pavement Reconstruction, Curve Modification, and Guardrail Improvements: This option would reconstruct the existing pavement from gate to gate without widening. The existing pavement varies from 24′ to 16′. In addition, the hairpin curve at MP 18.8 would be modified and guardrail would be added in some areas. Cottonwood maintenance

supervisor George Priskos noted that a 10-wheeler snowplow, needed for the steep terrain, cannot currently make the hairpin turn. To enable a 10-wheeler to make that turn, the radius of the curve would need to be increased or realigned. The reduced-width design of 10' lanes was used for the design of the curve modification–only option. It is assumed right-of-way would be required only in the area where the curve would be realigned. In addition, this option would add guardrail to protect the large portions of Guardsman Pass that are adjacent to steep drop-offs. Approximately 10,000 feet, or nearly 2 miles, of guardrail would be needed. Adding guardrail without providing additional widening would further constrain the already-tight corridor; adding guardrail could take up to 4' of existing roadway width. Although this option is the minimum construction option, it is less desirable than the other alternatives because it does not address areas where two vehicles cannot safely pass each other, and it would require closure of the roadway during snow maintenance since vehicles and snowplows would not have enough room to operate at the same time. Based on the average over the last five years, Guardsman Pass would be closed approximately 130 times per year for snow removal.

- See Appendix 2 for plan view design layouts and design cross section assumptions for each design alternative.

Construction Cost Estimates: Construction cost estimates are summarized in Table 5 (see Appendix 2 for detailed estimates). These estimates do not include right-of-way, utility or environmental mitigation costs.

Table 5. SR-190/Guardsman Pass Rd/SR-224 Construction Costs

Design Alternative	Assumptions	Cost*
Full-Width Typical Section	Includes $23M in roadway costs, $2.3M in drainage costs, $1.5M in barrier costs, and $23.9M in wall costs	$78,821,000
Reduced-Width Typical Section	Includes $19.6M in roadway costs, $2M in drainage costs, $800K in barrier costs, and $14.8M in wall costs	$57,985,000
Curve Modification & Guardrail Improvements	Includes $6.9M in roadway costs, $400K in barrier costs, and $700K in wall costs	$12,366,000

**2014 dollars; cost estimates do not include right-of-way, utility, or environmental mitigation costs.*

3.1.2 Capital Costs

Equipment and maintenance shed facility needs were identified by station supervisor George Priskos. Right-of-way was assumed to be needed for a satellite shed and for the portions of Guardsman Pass not owned by UDOT. Additional equipment needed and associated costs are listed in Table 6.

*Table 6. SR-190/Guardsman Pass Rd/SR-224 Equipment Costs**

Equipment	Quantity	Units	Unit Cost	Low Cost	High Cost	Estimated Life (yrs.)	Low Annualized Cost	High Annualized Cost
10-wheeler (chained with 10-wheel drive)	1	Each	$230,000	$230,000	$253,000	15	$15,333	$16,867
Blower	1	Each	$500,000	$500,000	$550,000	25	$20,000	$22,000
Grader	1	Each	$280,000	$280,000	$308,000	20	$14,000	$15,400
Snow Cat	1	Each	$300,000	$300,000	$330,000	20	$15,000	$16,500
Loader	1	Each	$160,000	$160,000	$176,000	20	$8,000	$8,800
Pickup (4WD)	1	Each	$30,000	$30,000	$33,000	5	$6,000	$6,600
Equipment Subtotal				**$1,500,000**	**$1,650,000**		**$78,300**	**$86,200**

**2014 dollars; equipment cost information provided by Jeff Casper, UDOT*

To clear the snow year-round, an additional satellite facility would be required somewhere near the summit. The satellite facility would require three to four bays and a 300-ton salt shed. Table 7 provides the estimated costs for the maintenance shed.

*Table 7. SR-190/Guardsman Pass Rd/SR-224 Maintenance Shed Costs**

Item	Quantity	Units	Unit Cost	Low Cost	High Cost
Satellite Facility (assumes 4-bay shed with 300 ton salt shed)	1	Lump	$1.75 million – $2 million	$1,750,000	$2,000,000
Contingency (20%)				$350,000	$400,000
Total				**$2,100,000**	**$2,400,000**

**2014 dollars; shed costs provided by Bill Juszak, UDOT*

Right-of-way costs were determined using land ownership data from Salt Lake and Wasatch counties. UDOT does not have an existing right-of-way for Guardsman Pass. For the purposes of estimating right-of-way costs, it was assumed that UDOT would need to acquire right-of-way for the entire section that would be widened for the full-width and reduced-width options. For the pavement reconstruction, curve modification, and guardrail option, it was assumed UDOT would acquire right-of-way only in the curve reconstruction area. Right-of-way would also be required to construct a shed for all options. This section of roadway is categorized as U.S. Forest Service land, private land – undevelopable, and private land – developable. Broad assumptions were made regarding whether the land was developable. Development in this area is limited by a number of factors including slope, avalanche hazard, access to sewer, and water. A development suitability analysis was beyond the scope of this project. The right-of-way costs are summarized in Table 8 (full-width option), Table 9 (reduced-width option), and Table 10 (pavement reconstruction, curve modification, and guardrail option) below.

*Table 8. SR-190/Guardsman Pass Rd/SR-224 Full-Width Option Right-of-Way Costs**

Location	Length (mi)	Assumed Width (ft)	Area (sq ft)	Unit Cost	Units	Cost
Salt Lake County (U.S. Forest Service Land)	1.16	100	612,480	$0.00	sq ft	-
Salt Lake County (Private Land – Undevelopable)	1.88	60	595,584	$23.50	sq ft	$13,966,224
Wasatch County (Private Land – Undevelopable)	2.00	60	633,600	$23.50	sq ft	$14,889,600
Wasatch County (Private Land – Developable)	0.55	60	174,240	$53.50	sq ft	$9,321,840
Summit County (Private Land – Developable)	0.87	60	275,616	$53.50	sq ft	$14,745,456
Maintenance Shed (Private Land – Developable)	0.09	150	75,000	$53.50	sq ft	$4,012,500
Total	**6.55**					**$56,966,000**

**2014 dollars; right-of-way cost information provided by Randy Smith, UDOT*

*Table 9. SR-190/Guardsman Pass Rd/SR-224 Reduced-Width Option Right-of-Way Costs**

Location	Length (mi)	Assumed Width (ft)	Area (sq ft)	Unit Cost	Units	Cost
Salt Lake County (U.S. Forest Service Land)	1.16	100	612,480	$0.00	sq ft	-
Salt Lake County (Private Land – Undevelopable)	1.62	50	427,680	$23.50	sq ft	$10,050,480
Wasatch County (Private Land – Undevelopable)	2.00	50	528,000	$23.50	sq ft	$12,408,000
Wasatch County (Private Land – Developable)	0.55	50	145,200	$53.50	sq ft	$7,768,200
Summit County (Private Land – Developable)	0.87	50	229,680	$53.50	sq ft	$12,287,880
Maintenance Shed (Private Land – Developable)	0.09	150	75,000	$53.50	sq ft	$4,012,500
Total	**6.29**					**$46,527,000**

**2014 dollars; right-of-way cost information provided by Randy Smith, UDOT*

*Table 10. SR-190/Guardsman Pass Rd/SR-224 Pavement Reconstruction, Curve Modification, and Guardrail Option Right-of-Way Costs**

Location	Length (mi)	Assumed Width (ft)	Area (sq ft)	Unit Cost	Units	Cost
Salt Lake County (Curve Improvements)	0.25	50	66,000	$23.50	sq ft	$1,551,000
Maintenance Shed (Private Land – Developable)	0.09	150	75,000	$53.50	sq ft	$4,012,500
Total	**0.34**					**$5,564,000**

**2014 dollars; right-of-way cost information provided by Randy Smith, UDOT*

3.1.3 O&M Costs

SR-190/Guardsman Pass Rd/SR-224, Guardsman Pass, would be a difficult roadway to maintain during the winter due to elevation, annual snowfall, avalanche problems, and roadway geometrics. Based on input from George Priskos, as well as the high snowfall and elevation, the project team anticipates that a satellite shed would be needed somewhere near the summit of Guardsman Pass. Mr. Priskos stated that four to six additional staff would be needed to operate this section of Guardsman Pass. However, because it would be difficult to hire new staff, the salary of additional operators is not included in Table 11. It is more likely that staff would be shifted from other sheds. O&M costs for SR-190/Guardsman Pass Rd/SR-224 are summarized in Table 11.

*Table 11. SR-190/Guardsman/SR-224 Annual O&M Costs**

Item	Average Annual Cost	High Annual Cost
Snow & Ice Removal*	$60,000	$135,000
Misc. Code Cost*	$5,000	$11,000
Summer Maintenance	$30,000	$36,000
Total	**$95,000**	**$182,000**

**2014 dollars; OMS information provided by Mike Marz, UDOT*

In addition to these items, Mr. Priskos estimated a range of $30,000 to $36,000 for summer maintenance would be needed. Since Guardsman Pass is not currently owned by UDOT, additional maintenance costs that are not in the current Cottonwood shed budget would be required during the summer months.

Avalanche Control: Avalanche control would be an important part of keeping SR-190/Guardsman Pass Rd/SR-224 open during the winter. Avalanche control could be approached using active or passive control measures. Active control measures require action from personnel when avalanche risk is high (for example, firing artillery into the starting zones to induce avalanches when the road is closed). Active control does not require a large capital investment, but costs continue over time. Passive control measures are always in place (for example, snow sheds or snow fences). Passive control measures require a large capital investment but cost less over time.

- At a minimum, one additional avalanche forecaster would be required to control avalanches on Guardsman Pass. However, because it would be difficult to hire new staff, the salary of an additional forecaster is not included. It is more likely that resources would be shifted from other locations.

- Options for passive control include snow fence and snow shed; the cost for passive control measures ranges as follows:
  - $750,000 for snow retention structure (personal communication with Dave Scroggin, IGES)
  - $5,000 per linear foot per traffic lane (Mountain Transportation Study) – a study would need to be completed to determine the length of shed

For this estimate only, the cost of an additional forecaster was used. Up-front passive control costs were not assumed for any of the construction scenarios.

3.1.4 Cost Summary

Table 12 provides an overall cost summary for opening SR-190/Guardsman Pass Rd/SR-224 year-round.

*Table 12. SR-190/Guardsman Pass Rd/SR-224 Year-Round Cost Summary**

Item	Low Initial Cost	High Initial Cost	Low Annual Cost	High Annual Cost
Construction	$12,366,000	$78,821,000	N/A	N/A
O&M	N/A	N/A	$95,000	$182,000
Capital Cost, Equipment	$1,500,000	$1,650,000	$78,300	$86,200
Capital Cost, Shed	$2,100,000	$2,400,000	N/A	N/A
Capital Cost, Right-of-Way	$5,564,000	$56,966,000	N/A	N/A
Total	**$21,530,000**	**$139,837,000**	**$173,300**	**$268,200**

**Shed cost from Table 7; right-of-way cost from Table 8*

3.2 SR-35

SR-35 currently has 16 miles of roadway that are not maintained during the winter months (from MP 12.5 to MP 28.5). Based on conversations with station supervisor Ervan Rhoads, SR-35 geometrically is in good shape and would not need major improvements to safely maintain the road during the winter months.

3.2.1 Construction Costs

Mr. Rhoads identified safety concerns and recommended guardrail and snow fence be added to maintain SR-35 year-round. The majority of SR-35 has adequate guardrail; however, a few spot locations would either need the extension or addition of guardrail to protect vehicles from sliding off the road. Also, approximately 2.5 miles of snow fencing would be needed near the summit to prevent snow from drifting onto SR-35.

There is a large snowmobile presence on SR-35 during the winter. Currently, parking at the gate accommodates the trailers that haul snowmobiles to the corridor. If the road were to be maintained year-round, an additional parking lot at the summit may be necessary to accommodate snowmobile trailers. The cost of that parking lot is not included in this estimate. Additional study and coordination would be necessary to determine specifics regarding size and cost sharing.

The estimated construction costs for snow fencing and guardrail on SR-35 are shown in Table 13 (see Appendix 2 for additional details).

Table 13. SR-35 Construction Costs

Key Items	Quantity	Units	Low Price	High Price	Low Cost	High Cost
Snow Fence	13,040	Ft	$20	$24	$260,820	$312,984
Guard Rail	3,350	Ft	$30	$36	$100,500	$120,600
Crash Cushion	20	Each	$4,000	$4,800	$80,000	$96,000
Mobilization & Traffic Control	1	Lump	$80,000	$96,000	$80,000	$96,000
PE/CE	1	Lump	$114,700	$137,640	$114,700	$137,640
Contingency	1	Lump	$108,980	$130,776	$108,980	$130,776
Total					**$745,000**	**$894,000**

3.2.2 Capital Costs

Equipment and maintenance shed facility needs were identified by station supervisor Ervan Rhoads. Due to the location, Mr. Rhoads thought a satellite shed would be needed. Right-of-way was assumed to be needed for a satellite shed.

Due to the additional length of roadway, high elevation, and amount of snowfall, additional equipment is needed. This list includes one 10-wheeler and a blower-mounted loader (see Table 14).

Table 14. SR-35 Equipment Costs

Equipment	Quantity	Units	Unit Cost	Low Cost	High Cost (10% Contingency)	Estimated Life (yrs)	Low Annualized Cost	High Annualized Cost (10% Contingency)
10-wheeler (chained w/10 wheel drive)	1	Each	$230,000	$230,000	$253,000	15	$15,333	$16,867
Loader	1	Each	$160,000	$160,000	$176,000	25	$6,400	$7,040
Equipment Subtotal				**$390,000**	**$429,000**		**$21,700**	**$23,900**

**2014 dollars; equipment costs provided by Jeff Casper, UDOT*

To clear the snow year-round on SR-35, an additional satellite facility would be required somewhere near the summit. The satellite facility would require three to four bays and a 40' X 80' salt shed (see Table 15).

*Table 15. SR-35 Maintenance Shed Costs**

Item	Quantity	Units	Unit Cost	Low Cost	High Cost
Satellite Facility (assumes 4-bay shed with 40' X 80' salt shed)	1	Lump	$1,750,000 – $2,000,000	$1,750,000	$2,000,000
Contingency (20%)				$350,000	$400,000
Total				**$2,100,000**	**$2,400,000**

**2014 dollars; shed costs provided by Bill Juszak, UDOT*

Right-of-way needed for the maintenance facility was estimated based on an assumed length and width of 500' x 150 '. Right-of-way costs were based on engineering judgment and were assumed to be $10 to $20 per square foot (see Table 16).

Table 16. SR-35 Right-of-Way Costs

Location	Length (ft)	Assumed Width (ft)	Area (sq ft)	Unit Cost	Units	Low Cost	High Cost
SR-35 Near Top of Wolf Creek Pass	500	150	75,000	$10 – $20	sq ft	**$750,000**	**$1,500,000**

3.2.3 O&M Costs

O&M costs for SR-35 are summarized in Table 17. In addition, Mr. Rhoads identified the need for two additional snowplow operators to keep SR-35 clear during the winter. However, because it would be difficult to hire new staff, the salary of additional operators is not included in Table 17. It is more likely that staff would be shifted from other sheds.

*Table 17. SR-35 Annual O&M Costs**

Item	Average Annual Cost	High Annual Cost
Snow & Ice Removal*	$170,000	$382,000
Misc. Code Cost*	$12,000	$29,000
Total	**$182,000**	**$411,000**

**2014 dollars; OMS information provided by Mike Marz, UDOT*

3.2.4 Cost Summary

Table 18 provides an overall cost summary for opening SR-35 year-round.

*Table 18. SR-35 Year-Round Cost Summary**

Item	Low Initial Cost	High Initial Cost	Low Annual Cost	High Annual Cost
Construction	$745,000	$894,000	N/A	N/A
O&M	N/A	N/A	$182,000	$411,000
Capital Cost, Equipment	$390,000	$429,000	$21,700	$23,900
Capital Cost, Shed	$2,100,000	$2,400,000	N/A	N/A
Capital Cost, Right-of-Way	$750,000	$1,500,000	N/A	N/A
Total	**$3,985,000**	**$5,223,000**	**$203,700**	**$434,900**

**Shed cost from Table 15; right-of-way cost from Table 16*

3.3 SR-65

SR-65 currently has 11 miles of roadway that are not maintained during the winter months (MP 3 to MP 14). Based on conversations with station supervisor Roger Frantz, SR-65 has would require multiple

roadway and safety improvements (to address rock-fall issues, steep unprotected slopes, and snow drifts) to keep SR-65 open during the winter months.

3.3.1 Construction Costs

Mr. Frantz identified three safety concerns that would necessitate improvements before SR-65 could be safely maintained during the winter—rock-fall catchment areas, guardrail, and snow fence. SR-65 near the summit has 2 miles of roadway with an existing rock wall feature located directly adjacent to the roadway. During spring freeze/thaw cycles the rock breaks apart and falls onto the roadway. To keep this road open during winter/spring conditions, the roadway would need to be widened to allow space for rocks to fall onto an unpaved shoulder. This widening would be difficult since this section of roadway has several switchbacks with steep drop-offs. Any widening would most likely result in retaining walls.
In addition to the roadway widening, approximately 3.2 miles of guardrail would be needed to protect vehicles from potential slide-offs. Around a half-mile of snow fencing would also be required near the summit to prevent snow drifts.

Without survey, the project team did not develop design concepts or quantities for SR-65. Instead, rough construction cost estimates for roadway widening, snow fencing, and guardrail were developed using the range of construction costs for SR-190/Guardsman Pass Rd/SR-224 and breaking those costs into cost per mile. SR-190/Guardsman Pass Rd/SR-224 provides a good comparable cost to SR-65 because SR-65 has a similar 2-mile section with a narrow roadway and steep drop-offs.

Using the range of costs from SR-190/Guardsman Pass Rd/SR-224 provides a range of options to fix the existing 2-mile section with rock-fall issues. The full width construction cost on SR-190/Guardsman Pass Rd/SR-224 provides a comparable cost for a roadway widening solution. This option would enable the roadway to be widened and provide sufficient rock-fall catchment areas. Adding rock-fall catchment areas would require large retaining walls for the widening, which is included in the full width widening scenario cost per mile. The cost per mile developed for the full width widening scenario was applied to the 2 miles of roadway on SR-65 with an existing rock-fall issue.

Additionally, the rock-fall issue could be addressed with a cheaper solution. Instead of completely addressing the issue, guardrail could be added to protect the steep drop-offs, and fencing could be installed to limit the amount of rocks that would fall onto the highway. This scenario may require the highway to close during springtime periods when the freeze/thaw cycles are at their highest. This scenario used the cost per mile from the SR-190/Guardsman Pass Rd/SR-224 guardrail and curve modification option a comparable cost, for the 2 miles of roadway on SR-65 with an existing rock-fall issue.

Beyond the 2-mile segment, guardrail and snow fence improvements were added to the cost per mile estimates to develop the full construction cost (see Table 19).

Table 19. SR-65 Construction Costs

Key Items	Quantity	Units	Low Price	High Price	Low Cost	High Cost
Snow Fence	2,218	Ft	$20	$24	$44,360	$53,232
Guard Rail	16,949	Ft	$30	$36	$508,470	$610,164
Crash Cushion	20	Each	$4,000	$4,800	$80,000	$96,000
Roadway Widening with Retaining Walls	1	Lump	$862,114	$26,823,218	$862,114	$26,823,218
PE/CE	1	Lump	$299,000	$5,516,600	$299,000	$5,516,600
Contingency	1	Lump	$299,000	$5,516,600	$299,000	$5,516,600
Total					**$2,093,000**	**$38,616,000**

3.3.2 Capital Costs

Equipment and maintenance shed facility needs were identified by station supervisor Roger Frantz. Due to the elevation, Mr. Frantz thought a satellite shed would be needed. Right-of-way was assumed to be needed for a satellite shed. Additional equipment needs include two Unimog 4-wheel drive trucks and two blower-mounted loaders (see Table 20).

*Table 20. SR-65 Equipment Costs**

Equipment	Quantity	Units	Unit Cost	Low Cost	High Cost (10% Contingency)	Estimated Life (yrs)	Low Annualized Cost	High Annualized Cost (10% Contingency)
10-wheeler (chained w/ 10 wheel-drive)	2	Each	$230,000	$460,000	$506,000	15	$30,667	$33,733
Loader	2	Each	$160,000	$320,000	$352,000	25	$12,800	$14,080
Subtotal				**$780,000**	**$858,000**		**$43,500**	**$47,800**

**2014 dollars; equipment cost provided by Jeff Casper, UDOT*

To clear the snow year-round on SR-65, an additional satellite facility would be required somewhere near the summit. The satellite facility would require three to four bays and a 40' X 80' salt shed (see Table 21).

*Table 21. SR-65 Maintenance Shed Costs**

Item	Quantity	Units	Unit Cost	Low Cost	High Cost
Satellite Facility (assumes 4-bay shed with 40' X 80' salt shed)	1	Lump	$1,750,000 – $2,000,000	$1,750,000	$2,000,000
Contingency (20%)				$350,000	$400,000
Total				**$2,100,000**	**$2,400,000**

**2014 dollars; shed costs provided by Bill Juszak, UDOT*

Right-of-way needed for the maintenance facility was estimated based on an assumed length and width of 500' x 150'. Right-of-way costs, based on engineering judgment, were assumed to be $10 to $20 per square foot (see Table 22).

Table 22. SR-35 Right-of-Way Costs

Location	Length (ft)	Assumed Width (ft)	Area (sq ft)	Unit Cost	Units	Low Cost	High Cost
SR-65 Near Top of Big Mountain	500	150	75,000	$10 – $20	sq ft	**$750,000**	**$1,500,000**

3.3.3 O&M Costs

O&M costs for SR-65 are summarized in Table 22. Roger Frantz identified the need for four additional snowplow operators to keep SR-65 clear during the winter. However, because it would be difficult to hire new staff, the salary of additional operators is not included in Table 23. It is more likely that staff would be shifted from other sheds.

*Table 23. SR-65 Annual O&M Costs**

Item	Average Annual Cost	High Annual Cost
Snow & Ice Removal*	$114,000	$256,000
Misc. Code Cost*	$8,000	$20,000
Total	**$122,000**	**$276,000**

**2014 dollars; OMS information provided by Mike Marz, UDOT*

3.3.4 Cost Summary

Table 24 provides an overall cost summary for opening SR-65 year-round.

Table 24. SR-65 Year-Round Cost Summary

Item	Low Initial Cost	High Initial Cost	Low Annual Cost	High Annual Cost
Construction	$2,093,000	$38,616,000	N/A	N/A
O&M	N/A	N/A	$122,000	$276,000
Capital Cost, Equipment	$780,000	$858,000	$43,500	$47,800
Capital Cost, Shed	$2,100,000	$2,400,000	N/A	N/A
Capital Cost, Right-of-Way	$750,000	$1,500,000	N/A	N/A
Total	**$5,723,000**	**$43,374,000**	**$165,500**	**$323,800**