I-70 Mountain Corridor PEIS Geologic Hazards Technical Report

August 2010

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B – Programmatic Agreement Among the Federal Highway Administration, the Advisory Council on Historic Preservation, the United States Department of Agriculture Forest Service-Rocky Mountain Region, the Colorado Department of Transportation and the State Historic Preservation Officer Regarding Rockfall Mitigation Projects along Interstate 70 within the Georgetown-Silver Plume National Historic Landmark District

C – Memorandum of Understanding Related to Activities Affecting the State Transportation System, National Forest System Lands, and Bureau of Land Management National System of Public Lands in the State of Colorado

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Section 1. Purpose of the Report

This *I-70 Mountain Corridor PEIS Geotechnical Hazards Technical Report* supports the information contained in **Chapter 3, Section 3.5** of the I-70 Mountain Corridor Programmatic Environmental Impact Statement (PEIS). It identifies:

- Methods used to identify geologic hazards and determine potential impacts of alternatives
- Coordination with local, state, and federal agencies
- Description of the geologic hazards in the Corridor
- Consequences of the Action Alternatives evaluated in the I-70 Mountain Corridor PEIS
- Considerations for Tier 2 processes
- Proposed mitigation for geologic hazards

Section 2. Background and Methodology

2.1 Background

A geologic hazard is a geologic process that creates risk or potential danger for human life or property (Rahn, 1996). The geologic state of the Corridor includes highly complex and varied ground conditions found in both the natural and man-made settings of the area. The I-70 highway is located along a mountainous corridor influenced by numerous faults, adverse rock structure, landslides, rockfalls, debris flows, avalanches, and collapsible soil. Some of the hazards were intensified as a result of the initial construction of the I-70 highway.

Many of these naturally occurring geologic hazards have affected and continue to affect the safety, service, and mobility of the existing transportation system. Some of these features pose risks to humans either directly by encounter or indirectly by effect on roadways, railways, and/or buildings. Conditions that may adversely affect both humans and/or proposed improvements in the Corridor include faults, poor rock structure and/or quality, and existing geologic hazards (debris flow, mudflow, rockfall, landslides, avalanches, collapsible soil, and rapid subsidence).

Geologic structure, slope configuration, precipitation, wind, and extreme temperature fluctuations all contribute to geologic hazards along the Corridor. Changes in climate conditions lead to wetting and drying, precipitation, freeze-thaw, and snowmelt. Little vegetation on most slopes makes them highly susceptible to erosion.

Geologic Hazards in the Corridor

- **Adverse faulting** – Fault that tends to decrease the stability or coherence of a rock mass or decrease the stability of a structure to be constructed in a rock mass
- **Adverse rock structure** – A structure in a rock mass that potentially detracts from the performance of the mass itself or from a structure constructed in the rockmass if not accommodated for
- **Poor rock quality** – Rock that by virtue of its fracturing, alteration, or inherent characteristics has a low or unreliable mechanical strength
- **Debris flow and mudflow** – A moving mass of rock fragments, soil, and mud
- **Rockfall** – Falling of boulders or detached blocks of rock from a cliff or very steep slope
- **Landslides** – Downward movement of rock masses and soil
- **Avalanche** – Large mass of snow or ice that moves rapidly down a slope
- **Erosion/collapsible soil** – Fine sandy and silty soils with a loose, open structure that collapse when wet

2.2 Methodology

The study area for geologic hazards includes the areas surrounding the Corridor that may be encountered during construction or operation of the Action Alternatives. Existing geologic conditions in the Corridor were identified using information from geologic maps, United

States Geological Survey (USGS) reports, Colorado Geological Survey publications, topographic maps, and aerial photographs. In addition, drilling, field mapping, literature reviews, and information from the *I-70 Georgetown Incline Rockfall Mitigation Feasibility Study* (Colorado Department of Transportation [CDOT], 2005) (see **Appendix A**) were used to identify geologic hazards in the area.

Soil erosion potential was determined based on maps and reports from the Natural Resources Conservation Service and the United States Forest Service. The Natural Resources Conservation Service provided K and T factors, erodibility groups, and soil descriptions. The soil loss tolerance (T) value represents the average annual rate of soil erosion that could occur without causing a decline in long-term productivity, and K is the soil erodibility factor. The United States Forest Service provided erodibility descriptions and management considerations. The Natural Resources Conservation Service and the United States Forest Service rate soils' potential for erosion as slight, moderate, or severe.

Ratings for the existing geologic hazards were developed to evaluate the severity of disturbance to the areas. Criteria included the influence of climate, proximity to the I-70 highway, history of occurrence, impact on transportation and mobility, and potential to affect alternatives. Based on these criteria, five categories for geologic hazard severity were developed: Severe, High, Moderate, Low, and Slight. Criteria for each of the five categories of severity are listed in **Table 1** (to be classified as such, the hazard meets most, but not necessarily all of the criteria listed):

Table 1. Categories of Geologic Hazard Severity for the Corridor

Rating	Definition
SEVERE	• The geologic hazard is generally directly adjacent to the alternative • Any disturbance of the hazard for improvements is not recommended. • If the geologic hazard fails, the traveling public must stop, long-term loss of service could occur, and immediate mitigation is required.
HIGH	• The geologic hazard is generally less than 50 feet from the alternative or will have a direct impact on alternative • Evidence of very recent activity (1 to 3 years) [frequent recurrence interval is present]. • If the geologic hazard fails, there is long-term loss of service, the traveling public must stop, and immediate mitigation is required.
MODERATE	• The hazard is generally less than 500 feet from the alternative. • Evidence of recent activity (3 to 10 years) is present. • If the geologic hazard fails, half or less of the roadway is affected • Moderate loss of service could occur • Traveling public may need to avoid obstruction.
LOW	• Hazard is generally more than 500 feet from the alternative • No visual evidence of recent activity (more than 10 years) is present. • If the geologic hazard fails, there is little or no loss of service, shoulders are not impeded, and no noticeable damage is present.
SLIGHT	• The geologic hazard does not pose an operational problem. • If the geologic hazard fails, no loss of service occurs. • If hazard is within 500 feet of the roadway, the area is in an unmodified "Undifferentiated Hazards" from USGS 1o x 2o map or is blocked from the highway by a physical barrier (ridgeline, valley, negative difference in elevation, stream).

Additionally, calculations were made to estimate the amount of construction debris would be generated from the proposed tunnels bores under the Action Alternatives. The length of the section (in miles) was multiplied by the height and width of the tunnel bore to approximate the volume of tunnel waste in cubic yards. Truck load calculations were based on the assumption of 13 cubic yards per truckload, rounded to next truckload.

Section 3. Description of Alternatives

This section summarizes the alternatives considered in the I-70 Mountain Corridor PEIS. A more complete description of these alternatives is available in **Chapter 2** of the PEIS and in the *I-70 Mountain Corridor PEIS Alternatives Screening and Development Technical Report* (CDOT, August 2010).

3.1 Minimal Action Alternative

The Minimal Action Alternative provides a range of local transportation improvements along the Corridor without providing major highway capacity widening or dedicated transit components. The Minimal Action Alternative includes elements of the Transportation System Management family and the Localized Highway Improvements family, including: transportation management, interchange modifications, curve safety modifications, and auxiliary lanes. These elements are also incorporated into the other Action Alternative Packages.

3.2 Transit Alternatives

Four Transit alternatives are considered in the PEIS as a reasonable range representing the Fixed Guideway and Rubber Tire Transit families:

- Rail with Intermountain Connection Alternative
- Advanced Guideway System Alternative
- Dual-Mode Bus in Guideway Alternative
- Diesel Bus in Guideway Alternative

3.2.1 Rail with Intermountain Connection

The Rail with Intermountain Connection Alternative would provide rail transit service between the Eagle County Regional Airport and C-470. Between Vail and C-470 the rail would be primarily at-grade running adjacent to the I-70 highway. The segment between Vail and the Eagle Count Airport would be constructed within the existing Union Pacific Railroad right-of-way. A new Vail Transportation Center, including new track, would be constructed between Vail and Minturn to complete the connection between the diesel and electric trains. This alternative also includes auxiliary lane improvements at eastbound Eisenhower-Johnson Memorial Tunnels to Herman Gulch and westbound Downieville to Empire and the other Minimal Action Alternative elements except for curve safety modifications at Dowd Canyon, buses in mixed traffic and other auxiliary lane improvements.

3.2.2 Advanced Guideway System

The Advanced Guideway System Alternative would provide transit service between the Eagle County Regional Airport and C-470 with a 24-foot-wide, 118 mile, fully elevated system. The Advanced Guideway System Alternative would use a new technology that provides higher speeds than the other Fixed Guideway Transit technologies studied for the PEIS. Any Advanced Guideway System would require additional research and review before it could be implemented in the Corridor. Although the Federal Transit Administration-researched urban magnetic levitation system is considered in the PEIS, the

actual technology would be developed in a Tier 2 process. This alternative includes the same Minimal Action elements as described previously for the Rail with Intermountain Connection Alternative.

3.2.3 Dual-mode Bus in Guideway

This alternative includes a guideway located in the median of the I-70 highway with dual-mode buses providing transit service between the Eagle County Regional Airport and C-470. This guideway would be 24 feet wide with 3 foot high guiding barriers and would accommodate bidirectional travel. The barriers direct the movement of the bus and separate the guideway from general purpose traffic lanes. While traveling in the guideway, buses would use guidewheels to provide steering control, thus permitting a narrow guideway and providing safer operations. The buses use electric power in the guideway and diesel power when traveling outside the guideway in general purpose lanes. This alternative includes the same Minimal Action Alternative elements as described previously for the Rail with Intermountain Connection Alternative.

3.2.4 Diesel Bus in Guideway

This includes the components of the Dual-mode Bus in Guideway Alternative except that the buses use diesel power at all times.

3.3 Highway Alternatives

Three Highway alternatives are advanced for consideration in the PEIS as a reasonable range and representative of the Highway improvements, including Six-Lane Highway 55 mph, Six-Lane Highway 65 mph, and Reversible/HOV/HOT Lanes. The Highway alternatives considered both 55 and 65 mph design speeds to 1) establish corridor consistency and 2) address deficient areas within the Corridor. The 55 mph design speed establishes a consistent design speed throughout the Corridor, which currently does not exist. The 65 mph design speed further improves mobility and addresses safety deficiencies in key locations such as Dowd Canyon and the Twin Tunnels. Both the 55 mph and the 65 mph design speed options are augmented by curve safety improvements, but the 65 mph design speed constructs tunnels in two of the locations: Dowd Canyon and Floyd Hill/Hidden Valley.

3.3.1 Six-Lane Highway 55 mph Alternative

This alternative includes six-lane highway widening in two locations: Dowd Canyon and the Eisenhower-Johnson Memorial Tunnels to Floyd Hill. This alternative includes auxiliary lane improvements at eastbound Avon to Post Boulevard, both directions on the west side of Vail Pass, eastbound Frisco to Silverthorne and westbound Morrison to Chief Hosa, and the Minimal Action Alternative elements except for buses in mixed traffic and other auxiliary lane improvements.

3.3.2 Six-Lane Highway 65 mph Alternative

This alternative is similar to the Six-Lane Highway 55 mph Alternative; it includes the same six-lane widening and all of the Minimal Action Alternative elements except the curve safety modification at Dowd Canyon. The higher design speed of 65 mph alternatives requires the curve safety modifications near Floyd Hill and Fall River Road to be replaced with tunnels.

3.3.3 Reversible Lanes Alternative

This alternative is a reversible lane facility accommodating high occupancy vehicles and high occupancy toll lanes. It changes traffic flow directions as needed to accommodate peak traffic demands. It includes two additional reversible traffic lanes from the west side of the Eisenhower-Johnson Memorial Tunnels to just east of Floyd Hill. From the Eisenhower-Johnson Memorial Tunnels to US 6, two lanes are built with one lane continuing to US 6 and the other lane to the east side of Floyd Hill. This alternative includes one

additional lane in each direction at Dowd Canyon. This alternative includes the same Minimal Action Alternative Elements as the Six-Lane Highway 55 mph Alternative.

3.4 Combination Alternatives

Twelve Combination alternatives, combining Highway and Transit alternatives are considered in the PEIS. Four of these alternatives involve the buildout of highway and transit components simultaneously. Eight alternatives include preservation options, the intent of which is to include, or not preclude, space for future modes in the I-70 Mountain Corridor. The Combination alternatives all include the Six-Lane Highway 55 mph Alternative for highway components.

Combination Rail and Intermountain Connection and Six-Lane Highway Alternative—This alternative includes the 55 mph six-lane highway widening between Floyd Hill and Eisenhower-Johnson Memorial Tunnels, the Rail and Intermountain Connection transit components, and most of the components of the Minimal Action Alternative. The exception is that only one of the Minimal Action auxiliary lane improvements (from Morrison to Chief Hosa westbound) is included.

Combination Advanced Guideway System and Six-Lane Highway Alternative—This alternative includes the 55 mph six-lane highway widening between Floyd Hill and Eisenhower-Johnson Memorial Tunnels and the Advanced Guideway System transit components. It includes the same Minimal Action Alternative elements as the Combination Rail and Intermountain Connection and Six-Lane Highway Alternative.

Combination Bus in Guideway (Dual-Mode) and Six-Lane Highway Alternative—This alternative the 55 mph six-lane highway widening between Floyd Hill and Eisenhower-Johnson Memorial Tunnels and the dual-mode bus in guideway transit components. It includes the same Minimal Action Alternative elements as the Combination Rail and Intermountain Connection and Six-Lane Highway Alternative.

Combination Bus in Guideway (Diesel) and Six-Lane Highway Alternative—This alternative includes the 55 mph six-lane highway widening between Floyd Hill and Eisenhower-Johnson Memorial Tunnels and the diesel bus in guideway transit components. It includes the same Minimal Action Alternative elements as the Combination Rail and Intermountain Connection and Six-Lane Highway Alternative.

Combination Rail & Intermountain Connection and Preservation of Six-Lane Highway Alternative—This alternative includes the Rail and Intermountain Connection Alternative and preserves space to construct the Six-Lane Highway 55 mph at a later point.

Combination Advanced Guideway System and Preservation of Six-Lane Highway Alternative— This alternative includes the Advanced Guideway System and preserves space to construct the Six-Lane Highway 55 mph at a later point.

Combination Bus in Guideway (Dual-Mode) and Preservation of Six-Lane Highway Alternative— This alternative includes the Combination Bus in Guideway (Dual-Mode) Alterative and preserves space to construct the Six-Lane Highway 55 mph at a later point.

Combination Bus in Guideway (Diesel) and Preservation of Six-Lane Highway Alternative—This alternative includes the Bus in Guideway (Diesel) Alternative and preserves space to construct the Six-Lane Highway 55 mph at a later point.

Combination Preservation of Rail and Intermountain Connection and Six-Lane Highway Alternative—This alternative includes the Six-Lane 55 mph Highway Alternative and also preserves space to construct the Rail and Intermountain Connection at a later point.

Combination Preservation of Advanced Guideway System and Six-Lane Highway Alternative— This alternative includes the Six-Lane 55 mph Highway Alternative and also preserves space to construct the Advanced Guideway System at a later point.

Combination Preservation of Bus in Guideway (Dual-Mode) and Six-Lane Highway Alternative— This alternative includes the Six-Lane Highway Alternative and also preserves space to construct the Bus in Guideway (Dual-Mode) at a later point.

Combination Preservation of Bus in Guideway (Diesel) and Six-Lane Highway Alternative—This alternative includes the Six-Lane Highway Alternative and also preserves space to construct the Bus in Guideway (Diesel) at a later point.

3.5 Preferred Alternative—Minimum and Maximum Programs

The Preferred Alternative provides for a range of improvements. Both the Minimum and the Maximum Programs include the Advanced Guideway System Alternative. The primary variation between the Minimum and Maximum Programs is the extent of the highway widening between the Twin Tunnels and the Eisenhower-Johnson Memorial Tunnels. The Maximum Program includes six-lane widening between these points (the Twin Tunnels and the Eisenhower-Johnson Memorial Tunnels), depending on certain events and triggers and a recommended adaptive management strategy.

3.6 No Action Alternative

The No Action Alternative provides for ongoing highway maintenance and improvements with committed funding sources highly likely to be implemented by the 2035 planning horizon. The projected highway maintenance and improvements are committed whether or not any other improvements are constructed with the I-70 Mountain Corridor project. Specific improvements under the No Action Alternative include highway projects, park and ride facilities, tunnel enhancements, and general maintenance activities.

Section 4. Affected Environment

4.1 Geologic Setting

A wide range of geologic conditions exist and are exposed throughout the Corridor, with a vast amount of time represented in the multiple rock formations. The geologic time represented in the Corridor ranges from recent river, debris, and mudflow deposits to Precambrian rocks between 1 and 2 billion years old. (Precambrian is the longest period in geologic time, ranging from the formation of the Earth about 4.6 billion years ago to approximately 550 years ago.) Most of the rugged terrain associated with the Rocky Mountains was formed approximately 72 million years ago during the Cretaceous period, which lasted about 7 million years. Numerous faults and folds along the Corridor depict the extensive tectonic episodes.

The Corridor's multiple sedimentary units result from erosion of a mountain range that predates the present Rocky Mountains, and numerous advances and retreats of inland seas. The resulting formations include shale deposits representing shallow sea environments; sandstone and quartzite deposits representing beach environments; and limestone deposits representing offshore coral reefs.

The present topography represents 20,000 years of erosion. With the notable exception of widespread glaciers, the processes that impose hazards on current activities have been active during these years. Most of the present configuration of valleys, mountains, and canyons seen along the Corridor resulted either directly or indirectly from alpine glaciation. Cirques and U-shaped valleys are features associated with glaciation.

After the periods of glaciation, streams and rivers cut most of today's valleys to form the classic V-shape. Rain, snowmelt, and wind created deposits of talus and alluvial fans.

4.2 Overview of Geologic Hazards

Figure 1 through Figure 7 illustrate the locations of these hazards in the Corridor. Some of the hazards include the following:

- **Adverse faulting** – Fault that tends to decrease the stability or coherence of a rock mass or decrease the stability of a structure to be constructed in a rock mass
- **Adverse rock structure** – A structure in a rock mass that potentially detracts from the performance of the mass itself or from a structure constructed in the rockmass if not accommodated for
- **Poor rock quality** – Rock that by virtue of its fracturing, alteration, or inherent characteristics has a low or unreliable mechanical strength
- **Debris flow and mudflow** – A moving mass of rock fragments, soil, and mud
- **Rockfall** – Falling of boulders or detached blocks of rock from a cliff or very steep slope
- **Landslides** – Downward movement of rock masses and soil
- **Avalanche** – Large mass of snow or ice that moves rapidly down a slope
- **Erosion/collapsible soil** – Fine sandy and silty soils with a loose, open structure that collapse when wet

The Corridor contains a wide variety of soils. Source materials for soils in the Corridor vary from gneiss, granite, volcanics, sandstone, and shales to colluvium, alluvium, and glacial deposits. Slope angles range from nearly horizontal along valley floors to vertical along valley sides. Soil and productivity loss are related to the degree of slope, reclamation effort, footprint of impact and climate. Challenges to revegetation are limited water availability, low water retention, low inherent fertility, and steep slopes.

For discussion purposes, the Corridor was divided into 10 geologic domains from west to east, ranging from less than 10 miles to almost 25 mile stretches of roadway. **Table 2** summarizes the current geologic conditions in the Corridor based on each of the 10 domains described. An index indicating the severity (slight, low, moderate, high, or severe) for each hazard is also included. Hazard ratings are based on the criteria discussed in **Section 2.2** of this report.

Table 2. Geologic Hazards Present in the Corridor

Geologic Domains	Geologic Hazards									
	Adverse faulting	Adverse rock structure	Poor rock quality	Debris flow	Rockfall	Landslide	Avalanche	Collapsible soil	Rapid settlement	Soil erosion
Glenwood Canyon (Whiter River Plateau) (mp 119 to133)	Low	Low	Low	Low	High	Low	—	Moderate	High	Moderate
Eagle Valley to Wolcott (mp 133 to 157)	Low	Low	High	High	Low	Severe	—	High	—	Slight to Severe
Wolcott to Dowd Canyon (Red Sandstone) (mp 157 to 171)	Low	Low	High	Moderate	Low	Severe	—	High	—	Slight to Moderate
Dowd Canyon to Wheeler Junction (Gore Range) (mp 171 to 195)	Moderate	High	Moderate	High	High	High	High	—	—	Moderate to Severe
Wheeler Junction to Silverthorne (Tenmile Canyon) (mp 195 to 203)	Moderate	Severe	Low	Moderate	Moderate	Low	Moderate	—	—	Moderate to Severe
Silverthorne to Silver Plume (Continental Divide) (mp 203 to 227)	Severe	Severe	Severe	High	Moderate	Severe	High	—	Moderate	Moderate to Severe
Silver Plume to Dumont (Glaciated Valley) (mp 227to 234)	Moderate	Moderate	Low	High	Severe	Low	—	—	—	Severe
Dumont to Idaho Springs (Mineralized Zone) (mp 234 to 241)	Moderate	High	Low	Low	High	Low	—	—	—	Severe
Idaho Springs to Hogback (Rolling Hills) (mp 241 to 259)	High	High	Moderate	—	Low	Severe	—	—	—	Moderate to Severe
Hogback to C-470 (Front Range Hogback) (mp 259 to 262)	Moderate	Moderate	Moderate	—	Low	Low	—	—	—	Severe

Key to Abbreviations/Acronyms
mp = milepost — = not a known hazard

Sections 4.2.1 through **Section 4.2.10** below describe these geologic domains and associated geologic hazards encountered in these areas.

4.2.1 Glenwood Canyon (Milepost 119 to Milepost 133)

Glenwood Canyon is a 16-mile-long canyon along the Colorado River that begins in the town of Glenwood Springs and stretches to the east. As the I-70 highway follows the river through the canyon, the most prevalent geologic hazard is rockfall (see **Figure 1**). Although some risk still exists, mitigation measures have reduced rockfall incidents. Soils between milepost 130 and milepost 134 have the potential to subside or settle rapidly due to the subsurface geologic lake deposition of soft clay material.

4.2.2 Eagle Valley to Wolcott (Milepost 133 to Milepost 157)

Beginning at milepost 133, the Eagle Valley cuts through bedrock of highly erodible, sparsely vegetated sedimentary rocks bounded on both sides by Eagle Valley Evaporites (from the Middle Pennsylvanian period approximately 300 million years old). The Eagle Valley Evaporites are composed mainly of halite, gypsum, and anhydrite, with some potassium salt deposits. This evaporative rock is prone to risks from collapsible soils and debris flows.

Moving farther east through this domain, collapsible soils (from mine subsistence) are found near Gypsum (milepost 140) and Eagle (milepost 147), as shown on **Figure 2** (Robinson, 1975). Subsidence is generalized and not typically accompanied by differential movement that affects structures. In this area, the I-70 highway was originally built in the deposit zone of a series of debris flows, but construction did not affect the source areas.

Figure 2 also shows the Wolcott landslide complex, which is located on the south side of the highway from milepost 154 to milepost 159 (Colton, 1975). Overburden and blocks of sedimentary rock moving in a chemically unstable (metastable) state characterize this complex landslide. During construction of the I-70 highway, large blocks of bedrock slid on the west side of the Wolcott exit (milepost 157). The road was realigned because no reasonable mitigation was possible. Just east of this exit, where US 6 runs parallel along the north side of the I-70 highway, the overburden of the landslide was mitigated with tieback anchors to avoid additional costly pavement repairs to either highway. Because of this impact on the I-70 highway alignment and the potential for future movement, this slide is classified as Severe.

4.2.3 Wolcott to Dowd Canyon (Milepost 157 to Milepost 171)

Red sandstones of the Pennsylvanian-Permian periods (250 to 325 million years ago) characterize much of this domain. The rock is fractured with interbedded shale and sandstone layers. The more massive sandstone layers create many of the cliff-forming slopes (Lidke, 1998). Due to the complex folding that occurred here, the bedding (rock layers) dips into the highway in some places, creating potentially unstable slopes. The dip of the bedding contributes to severe landslide hazards, especially near the western portion of the Dowd Canyon (mileposts 167 to 171), as shown on **Figure 3** and **Figure 8**.

Two large landslide features referred to as Dowd's No. 1 Landslide and Dowd's No. 2 Landslide (see **Figure 8**) are present in this domain. The Dowd's No. 1 Landslide is located between approximate milepost 170.4 and milepost 171.1 on the I-70 highway and extends south of the I-70/US 24 junction along the west side of US 24. The Dowd's No. 1 Landslide extends upslope to the southwest approximately 4,000 feet above the I-70 highway. The Dowd's No. 2 Landslide is located just west of the Dowd's No. 1 Landslide. The Dowd's No. 2 Landslide extends upslope to the southwest approximately 2,000 feet above the I-70 highway.

Figure 1. Corridor Geologic Hazards (Window 1 of 7)

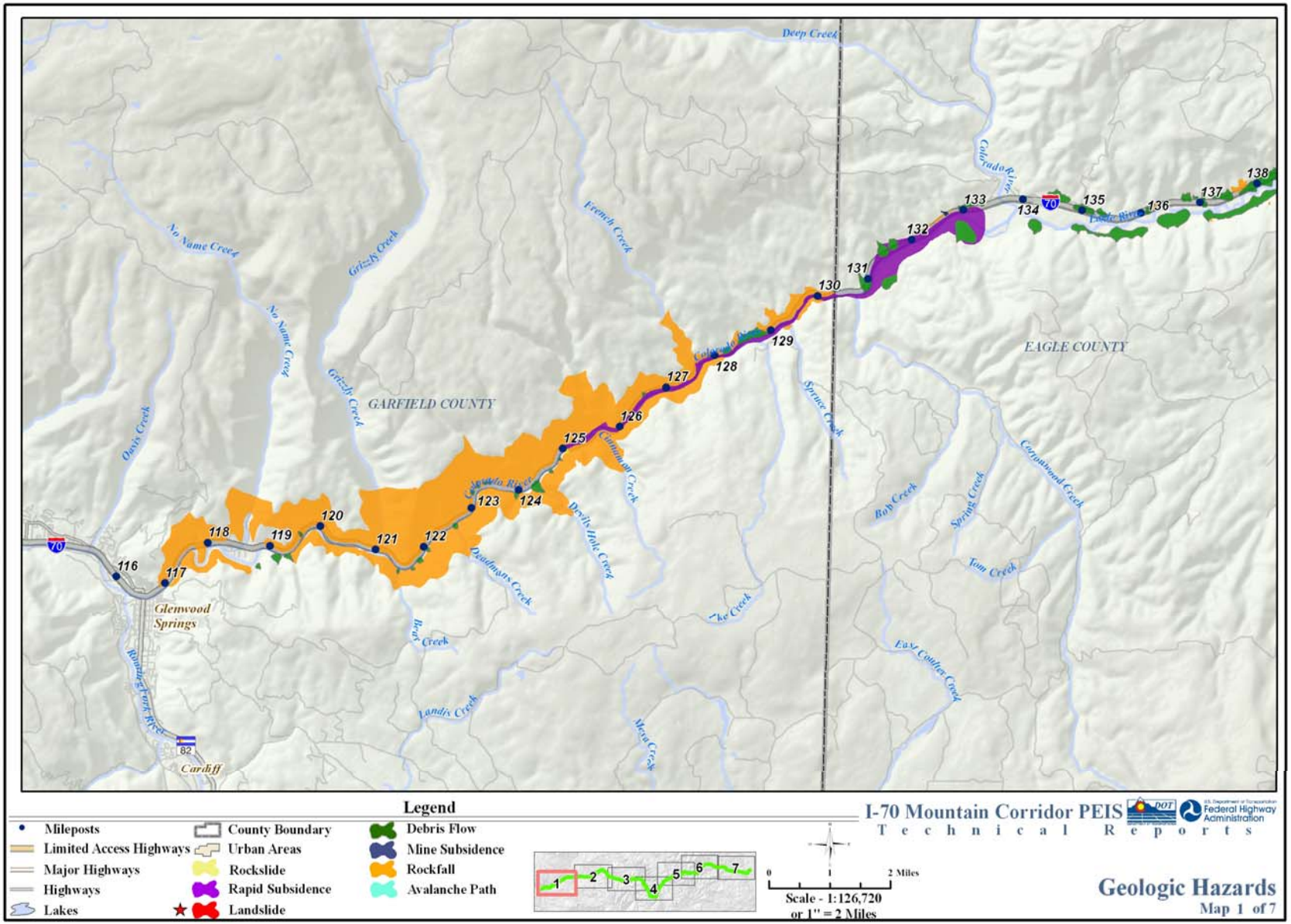


Figure 2. Corridor Geologic Hazards (Window 2 of 7)

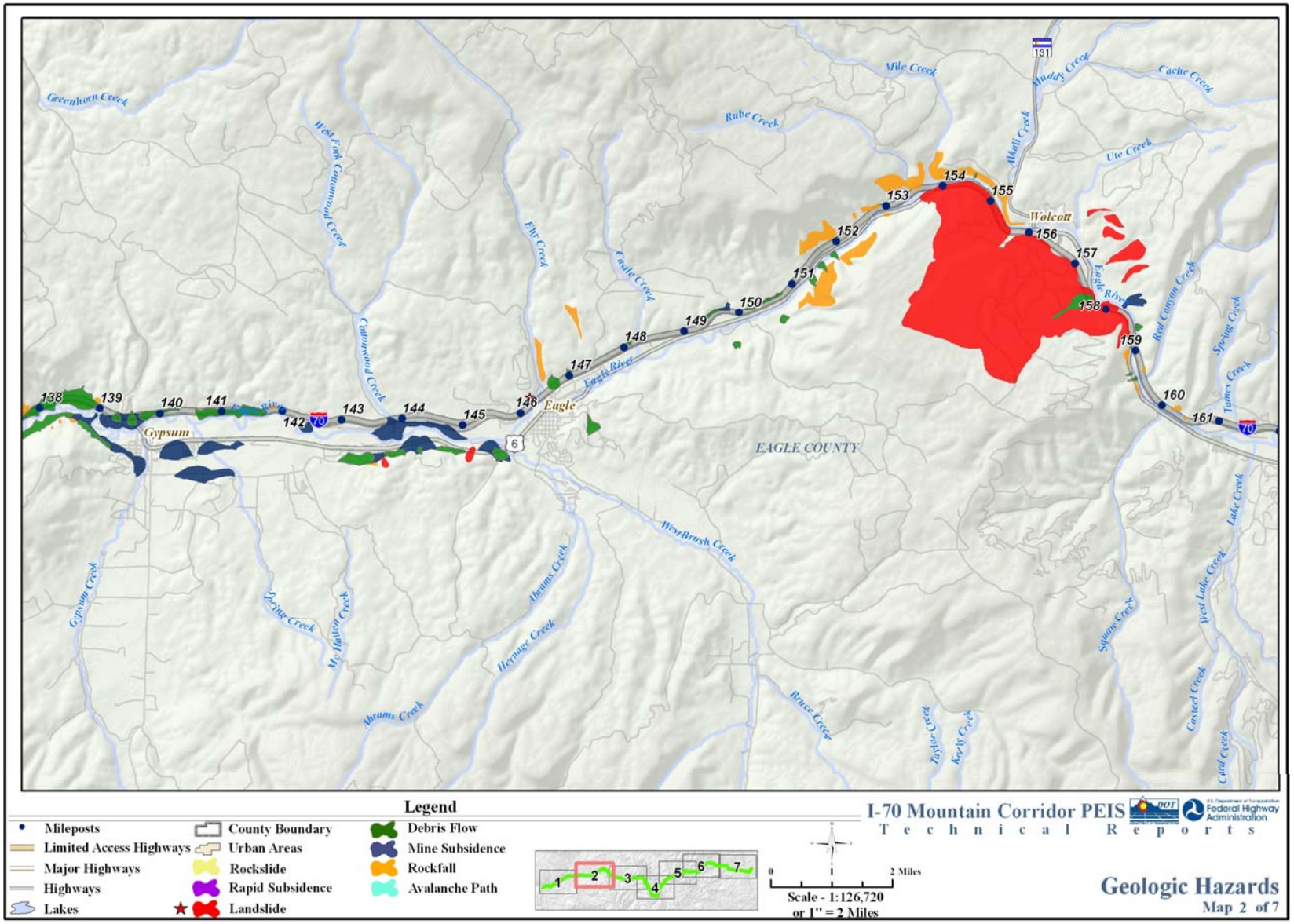


Figure 3. Corridor Geologic Hazards (Window 3 of 7)

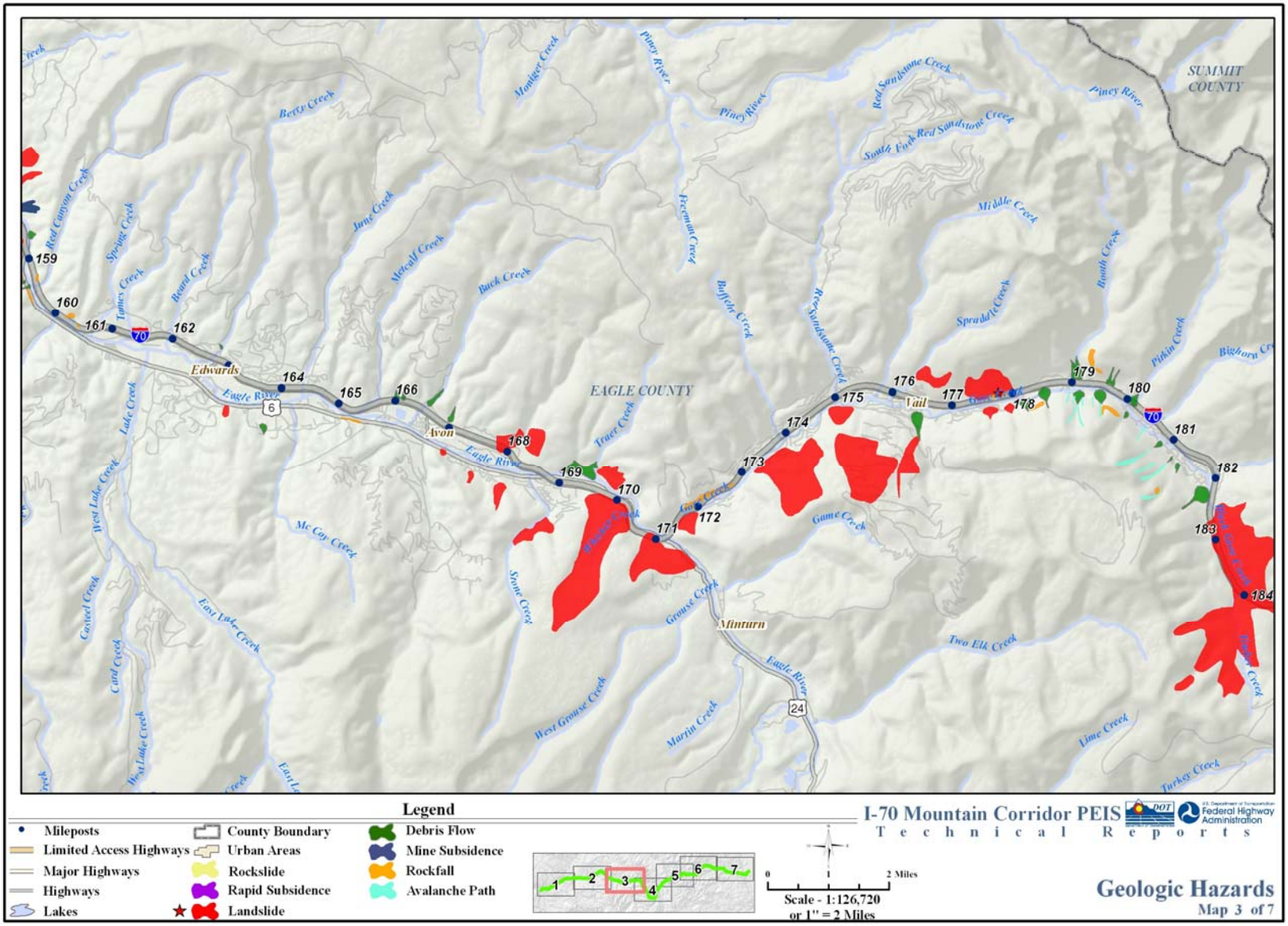


Figure 4. Corridor Geologic Hazards (Window 4 of 7)

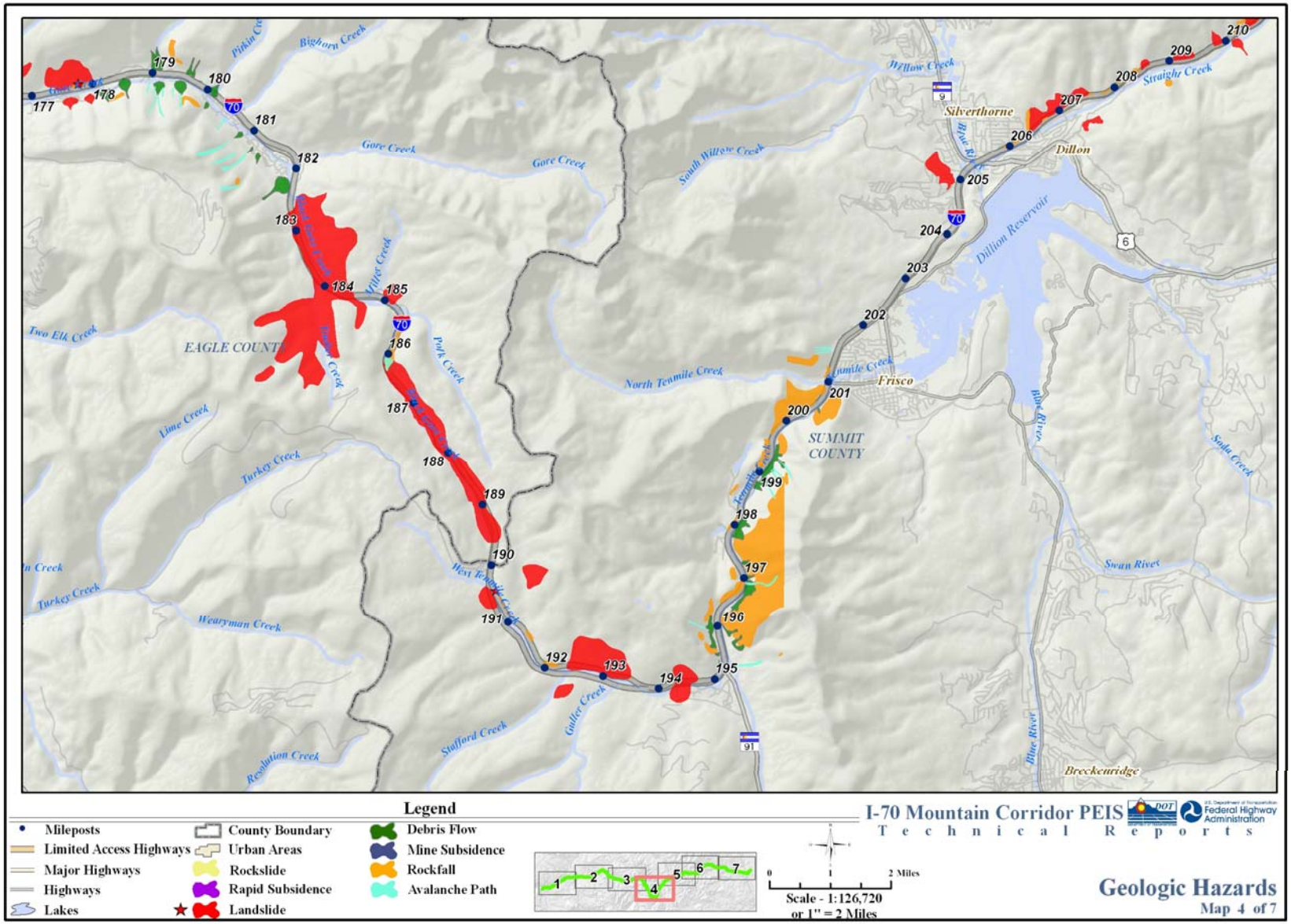


Figure 5. Corridor Geologic Hazards (Window 5 of 7)

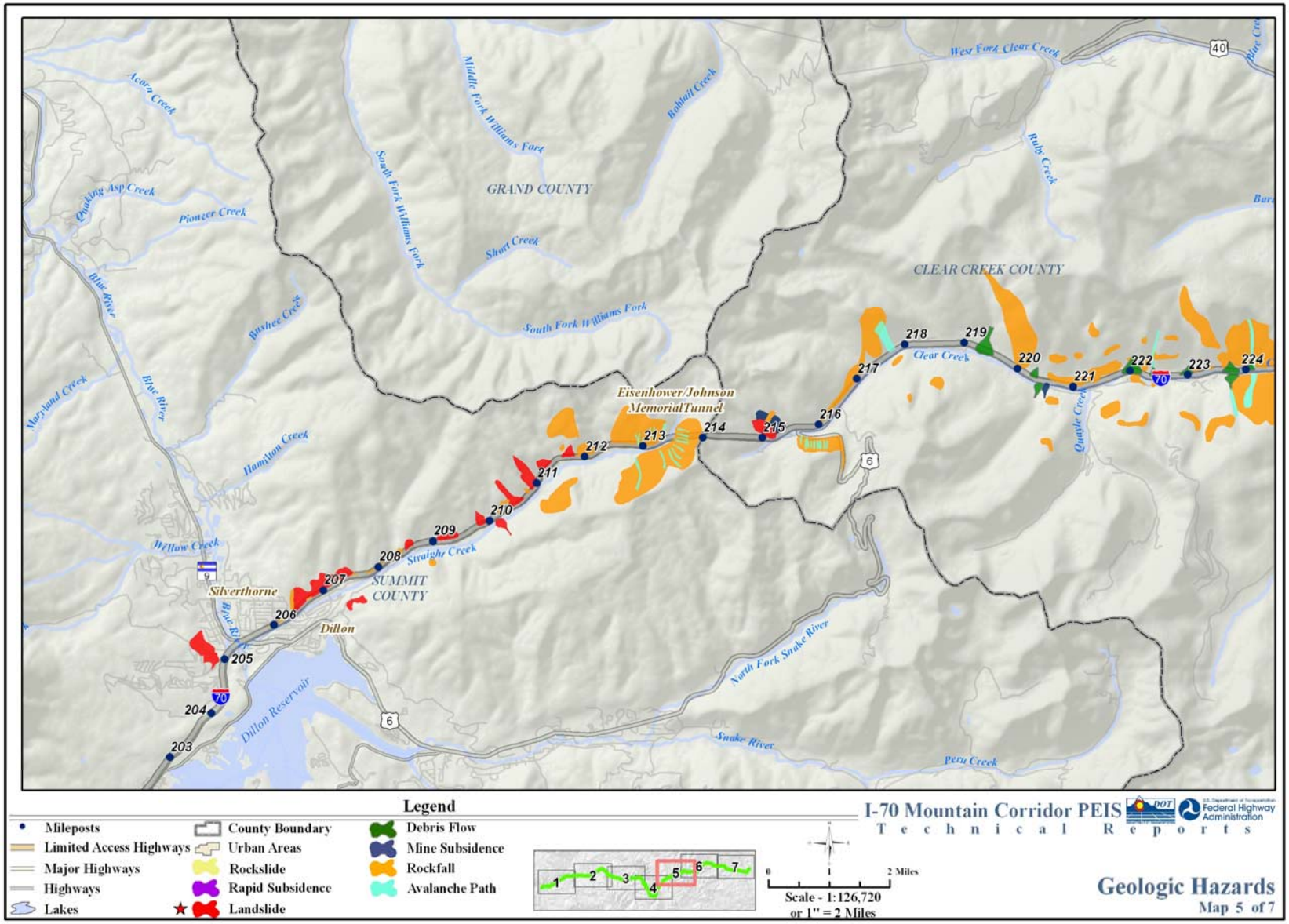


Figure 6. Corridor Geologic Hazards (Window 6 of 7)

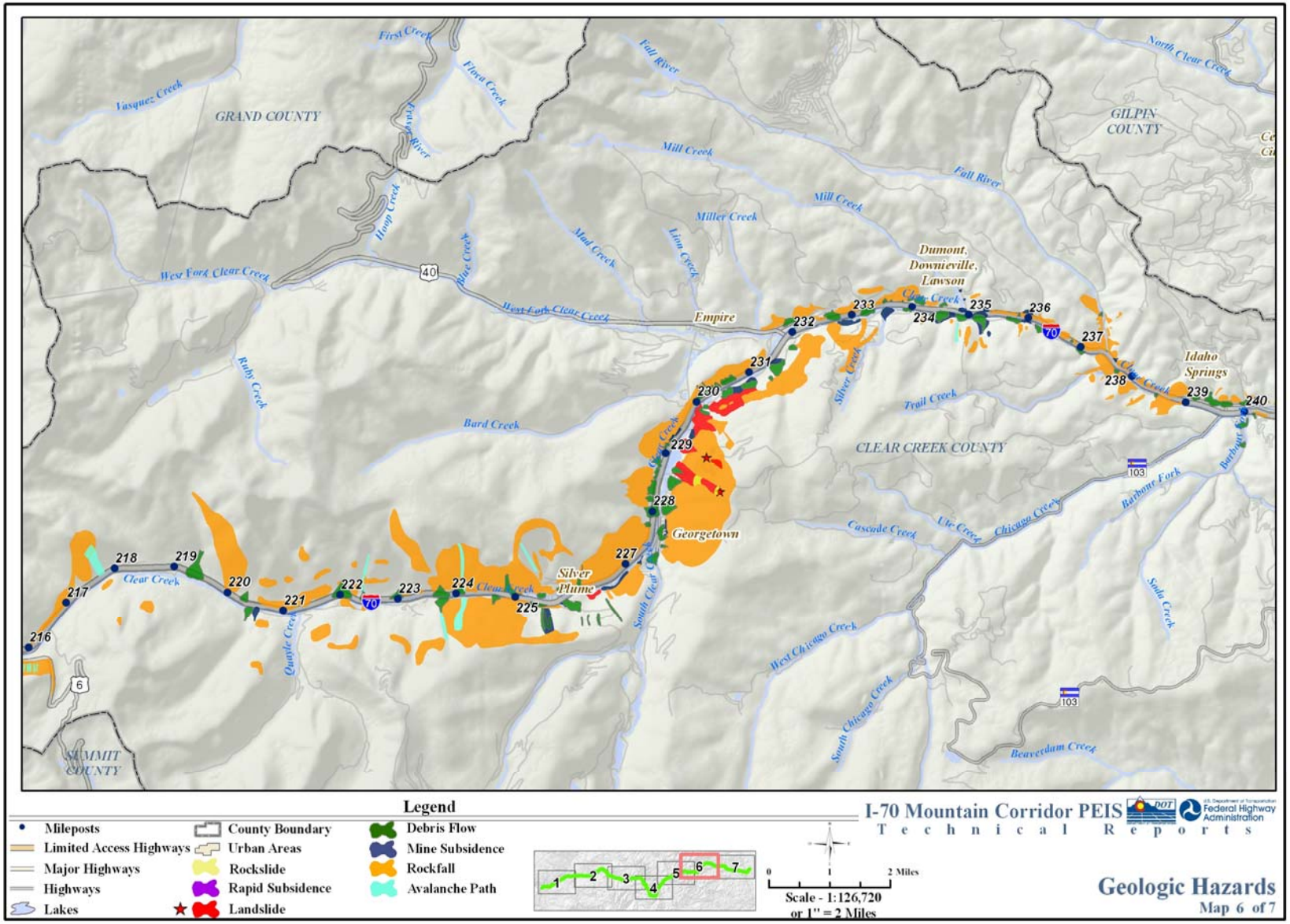
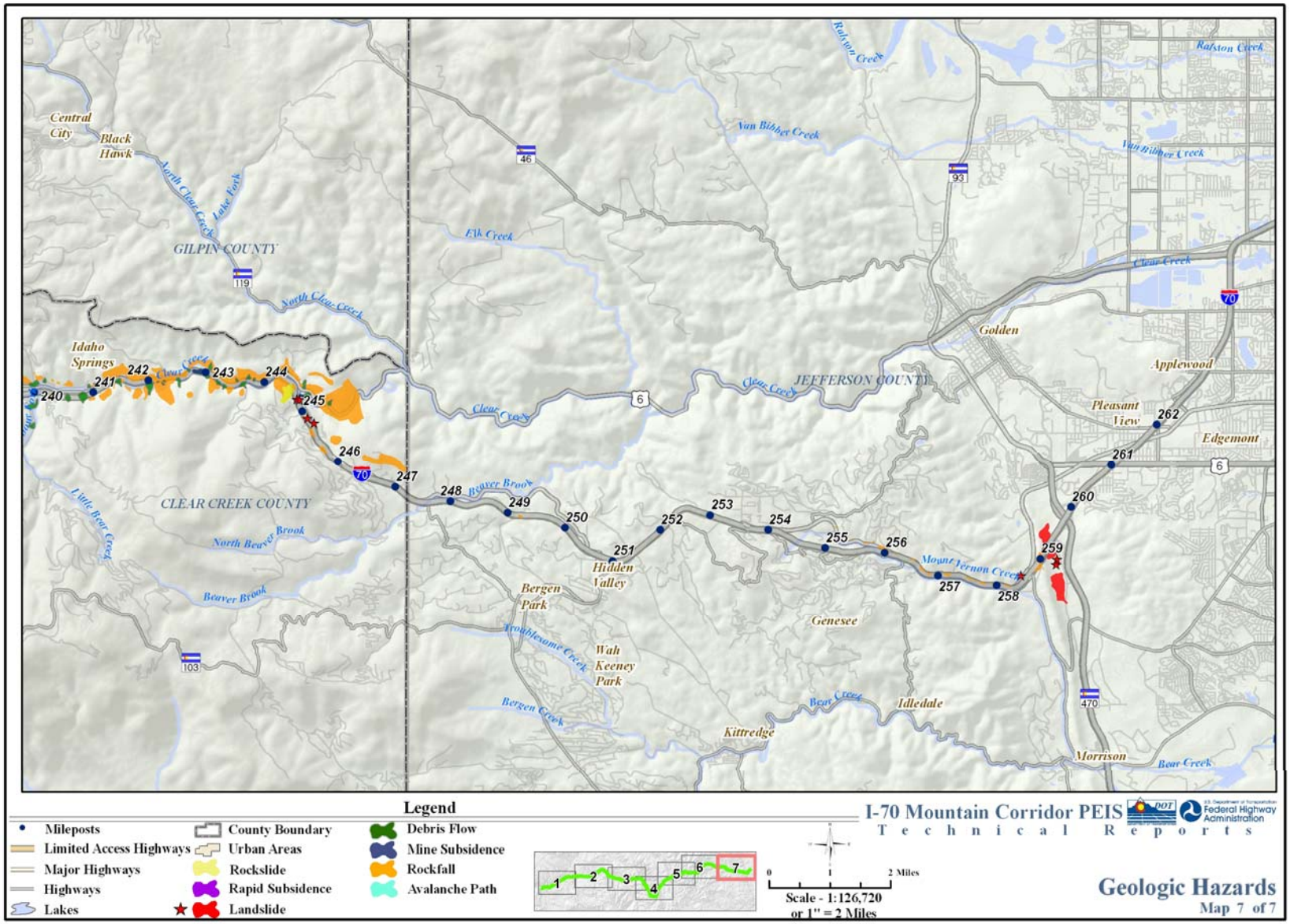
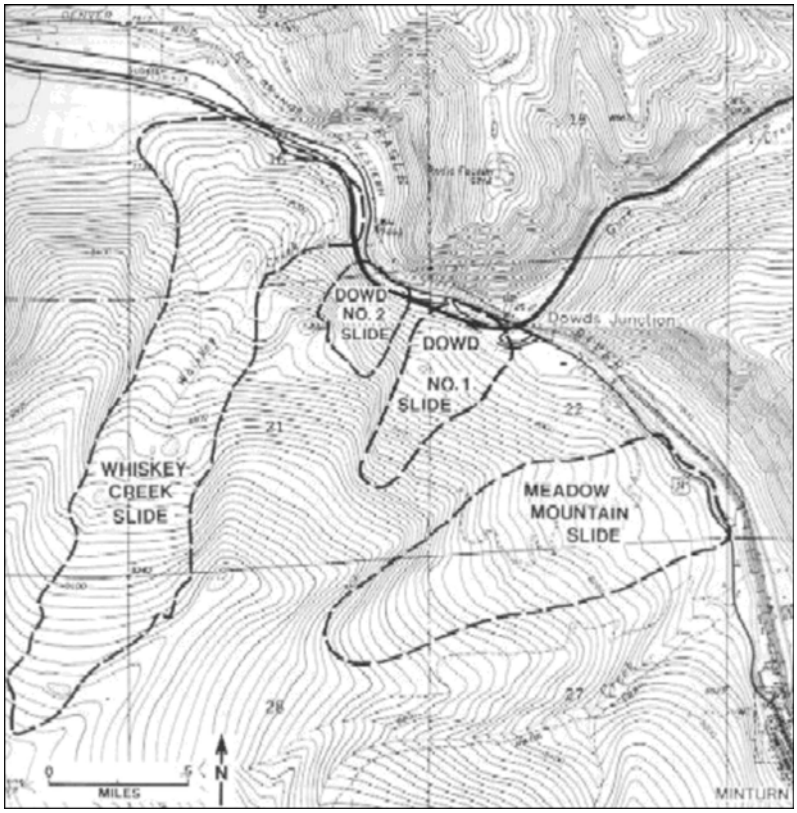


Figure 7. Corridor Geologic Hazards (Window 7 of 7)



Two even larger landslides known as the Meadow Mountain Landslide and the Whiskey Creek Landslide (see **Figure 8**) are located adjacent to the Dowd's landslides. The Meadow Mountain Landslide is on the west side of US 24 and in the past has caused partial loss of US 24 and damage to the bridge at the I-70/US 24 interchange. The Whiskey Creek Landslide on the south side of the highway between milepost 169 and milepost 171 is a complex group of old landslides where alluvium, colluvium, and glacial deposits overlay sedimentary rocks on dipping surfaces.

Figure 8. Whiskey Creek Landslide Complex (Source: Jochim et al., 1988)



Construction of the I-70 highway encountered continual slope failures in this area, with parts of the construction shut down for extended periods of time. Existing retaining structures and bridges show signs of damage and continued movement due to the slides in the area. Geologic investigations, field mapping, and exploratory drilling and monitoring programs are ongoing. The landslide complex is rated Severe and is on the state's landslide priority list.

4.2.4 Dowd Canyon to Wheeler Junction (Milepost 171 to Milepost 195)

In its entirety, Down Canyon extends from approximately Avon (milepost 167) to Vail (milepost 176) along the Corridor. In this domain, the eastern portion of Dowd Canyon includes a series of rock excavations between milepost 171 and milepost 173 that have exposed weaker bedrock units and result in landslides originating from the cut slopes. The sedimentary units are comprised primarily of an adverse structure of interbedded sandstone and shale with joint sets that run perpendicular to the bedding planes. This adverse structure and the differential erosion between the units, coupled with the designed cut slope, created the unstable slope condition. Although catchment areas are provided at the base of cut slopes, the volume of material overwhelms the catchment area capacity, and rock and debris have reached the highway. Some failures have been massive, forcing closure of the I-70 highway.

The soils on valley and mountain sides from Dowd Canyon to West Vail are moderately to severely susceptible to water erosion. Soils from Vail Pass (milepost 183) to Wheeler Junction (milepost 195) present a moderate erosion hazard. This segment of the I-70 highway was one of the first projects to incorporate modern erosion control measures and aesthetics into its design. Overall, reclamation has proven to be effective and mimics the natural landscape. However, a few steep rock cuts on the north side of the road are exposed without mitigation, creating an erosional surface.

Any construction along Vail Pass requires mitigation of existing slope instability. During the construction of Vail Pass, cuts made into the hillside mobilized numerous preexisting landslides (Barrett and Cochran, 1975). Slides are common in overburden, alluvium, colluvium, glacial deposits, and dipping beds of sedimentary rock between mileposts 182 and 190 (see **Figure 4**). In previous Vail Pass projects, horizontal drains and buttresses were used extensively and have been performing to date. Tiebacks and other positive reinforcement methods also may be required, depending on the amount of excavation and other slope geometry requirements (Robinson and Cochran, 1983).

4.2.5 Wheeler Junction to Silverthorne (Milepost 195 to Milepost 203)

This area known as Tenmile Canyon was formed by glaciers and stream erosion that occurred along a zone of weakness (a fault line). Area bedrock is highly resistive and is composed primarily of granite and metasedimentary gneisses. Glacial deposits, colluvium, and stream deposits from the Quaternary period (18 million years ago or less) make up most of the surface deposits. Extensive glacial deposits are present along the slopes north of Frisco (milepost 201). Runoff from the Gore Mountain Range deeply incised these deposits (Bergendahl, 1963). The subsurface material in the area between the Frisco and Silverthorne area (milepost 203) is composed of Pierre Shale (Late Cretaceous period, formed between 50 and 100 million years ago). Poorly designed excavations in the shale unit have caused shallow landslides along the north side of Silverthorne (Bergendahl, 1969).

Rockfall hazards and several small avalanche chutes are located along the south side of Tenmile Canyon between milepost 195 and milepost 201 (see **Figure 4**). The rockfall hazards originated from the initial construction of the I-70 highway, where overbreak or fractures in the rock from blasting created most of the localized failures. The avalanche chutes rarely reach the valley floor (or I-70 highway) during the average winter snowfall.

4.2.6 Silverthorne to Silver Plume (Milepost 203 to Milepost 227)

This domain is located partially in Summit County and partially in Clear Creek County. The Eisenhower-Johnson Memorial Tunnels traverse through the Continental Divide in the middle of this domain. Straight Creek is west of the Eisenhower-Johnson Memorial Tunnels, and Clear Creek is east of the Eisenhower-Johnson Memorial Tunnels. These sections of the domain are described in more detail below.

Straight Creek

The I-70 highway follows Straight Creek to the west of the Continental Divide. The area is characterized by metamorphic and igneous rock from the Precambrian period. A number of geologic hazards along Straight Creek are associated with the poor rock quality and several substantial faults that intersect the area.

Landslides on the west side of the Continental Divide were exposed and reactivated during the original construction of the I-70 highway and are still a prevalent hazard (see **Figure 5**). These landslides are remnants from earlier slope failures and are located on steep bedrock of poor rock quality and adverse structure. Original construction of the I-70 highway removed the toe of the slides above the roadway, causing the slides to move into the roadway. Drainage, realignment, and flattened slopes were used to mitigate the slides. The original I-70 highway grade is buried under the slide, and the current alignment passes around it at milepost 211.5 (Noble, 1969).

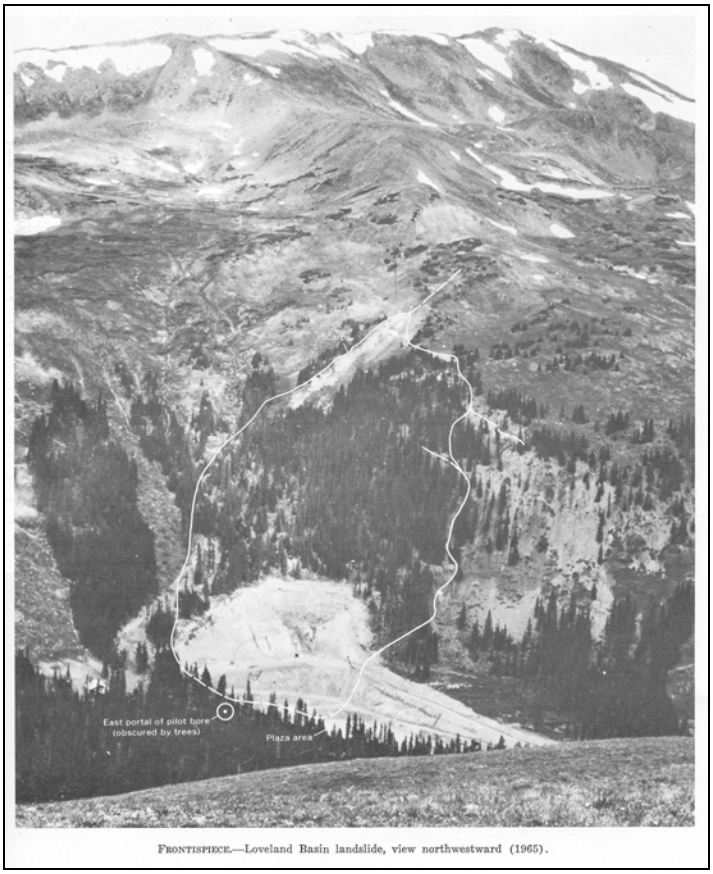
Soils in the cut slopes of the western approach to the Eisenhower-Johnson Memorial Tunnels consist of glacial deposits and igneous and metamorphic rock that are highly sensitive to erosion, particularly because of steep slopes. The exposed bedrock has adverse structural characteristics that have been responsible for large slope failures and slides during construction. Attempts to revegetate and stabilize the soils have been hindered by steep slopes in rock and soil, the short growing season, and active avalanches.

Eisenhower-Johnson Memorial Tunnels

The Eisenhower-Johnson Memorial Tunnels consist of east and west bound bores just over 1.6 miles in length, traversing the Continental Divide. Constructed in the 1960s and 1970s, the geology of the tunnels is complex with the eastern and western sides of the Continental Divide differing greatly from each other along the tunnel alignments. The primary rock type on the western side is hard granite from the Precambrian period, relatively intact with minimal fracturing and/or faulting. On the other hand, rock types on the eastern side consist of granites and granite/migmatite mixtures that are less stable.

On the eastern side of the Continental Divide, large-scale fault and shear zones are relatively common. The Loveland Shear Zone is the major fault system in this area. This shear zone consists of numerous faults and smaller shear zones of diverse orientation that generally trend northeast to southwest. The Loveland Shear Zone appears to encompass the ground from the top of the Continental Divide to east of the current I-70 highway eastern tunnel portals. In many places along the zone, fault movement has sheared the bedrock into a fault gouge having the consistency of sandy clay. Tunneling operations/excavation through the fault gouge encountered "squeezing" ground conditions, or an area where the ground stress around the tunnel opening exceeds the strength of the intact or in-situ rock. In this case, the ground tends to deform and mold around (squeeze) the tunnel opening. Due to the amount of overburden (weight) above the tunnel, the pressures encountered can be considerable and, consequently, extensive delays occurred during the Eisenhower-Johnson Memorial Tunnels construction. Successful excavation through the squeezing ground involved the use of multiple drift tunneling methods through the fault gouge in a perimeter around the final tunnel excavation.

Figure 9. East Portal Landslide, 1965



FRONTISPIECE.—Loveland Basin landslide, view northwestward (1965).

Excavation of the Eisenhower-Johnson Memorial Tunnels' east portal triggered a landslide of approximately 6 million cubic yards, known as the East Portal Landslide. **Figure 9** illustrates the landslide area in 1965. The slide self-arrested (halted naturally) in an unstable (metastable) state on a complex slip plane of highly fractured rock. It was then stabilized with a large berm equaling approximately 20 percent the slide mass of the toe (Robinson et al., 1972). As much as 14 feet of displacement was reported at the apex of the slide after the event. The fact that this was an area of historic mass movement and that the slope was in a metastable state was apparently not recognized until after the slope failure.

Runout zones of several avalanches are located along the western approach to the Eisenhower-Johnson Memorial Tunnels. The chutes on the mountainside above the west portals (as shown on **Figure 10**) are more active, and the I-70 highway has been closed in the past due to avalanche hazard here. Additionally, avalanches originate from Mount Bethel on the north-east side of the tunnels in this area.

Figure 10. Avalanche Chutes, Eisenhower-Johnson Memorial Tunnels West Approach

Clear Creek

East of the Eisenhower-Johnson Memorial Tunnels and Continental Divide, the I-70 highway follows Clear Creek. Generalized soils derived from granite are found on 30 percent to 80 percent slopes from Bakerville (milepost 221) to Silver Plume (milepost 226) (see **Figure 6**). These soils are severely susceptible to erosion. Large debris flows have developed in Watrous Gulch (milepost 219.8) and at the former town site of Brownville (milepost 224.8), which was buried in a debris flow in 1912. This area has been part of an aggressive revegetation and erosion control program implemented by CDOT to mitigate many of the effects of previous I-70 highway construction. In **Figure 11**, cut-and-fill sections are shown from the poorly vegetated slopes left after construction.

Figure 11. Poorly Vegetated Cut-and-Fill Slopes East of the Eisenhower-Johnson Memorial Tunnels

Just west of Silver Plume on Pendleton Mountain is a large avalanche path. Although this area is known to produce avalanches, the weather, terrain, and snowpack conditions combined to produce an unusually large avalanche in 2003. In 2003, a devastating avalanche fell to the frontage road burying 500 feet of the road with 20 feet of material (ice, snow, rocks, trees, etc.), spilled debris onto the I-70 highway, buried a building at the Silver Plume Water Works, and dammed Clear Creek (Colorado Avalanche Information Center, March 2003).

4.2.7 Silver Plume to Dumont (Milepost 227 to Milepost 234)

Deformations during the Precambrian and the Laramide orogeny in the Tertiary Period (40 to 50 million years ago) influence the structure of the rock units in this area. The Silver Plume Formation rock units (Precambrian 1.4 billion-year age group) are less fractured and more resistant to weathering, and form steeper and more massive sidewalls. On the east side of this domain, relatively poorer rock quality and more pervasive rock structure characterize the Idaho Springs Formation (Precambrian, more than 1.7 billion years old).

Stream and glacial erosion, and deposition influence the present topography and surficial deposits in the area. Overburden soils consist of soil mixed with country rock developed through weathering and freeze-thaw cycles on the bedrock. Oversteepened slopes resulting from glacial activity in the area were exposed when the glaciers retreated. Unstable colluvium and rocks from debris flows are exposed near the surface of the steep slopes. Debris flows continue to occur during certain climatic conditions. Glaciation effects terminate near the I-70 highway and US 40 junction at milepost 232. From this point eastward, the valley has a more classic V-shape indicative of stream erosion.

Georgetown Hill climbs up a narrow valley near Georgetown between milepost 225.5 and milepost 227.9, and is the steepest segment along the Corridor. The I-70 highway was built through a number of rockfall, debris flow, and avalanche deposition zones (see **Figure 6**). The original construction of the I-70 highway cut into the colluvium slopes and bedrock leaving vertical rock cuts and oversteepened colluvium slopes. Although many of the unstable colluvium slopes were excavated, some lie directly above the rock cuts and contribute to rockfall. Some of the excavated deposits were used to build the highway embankment. Oversteepened colluvium slopes can become unstable, resulting in shallow slope failures (Hecox, 1977). Also, some sections of the rock cuts contain loose and highly fractured material.

The area between Silver Plume and Georgetown (mileposts 226 to 228), commonly referred to as the Georgetown Incline, has the most prevalent rockfall hazards in the Corridor. The steep cut-and-fill sections were left with minimal mitigation after highway construction. The recorded history of rockfall events includes crashes on the roadway with injuries and fatalities. Major unreported rockfall activity and events have occurred as well, as evidenced by the full ditches along the westbound I-70 highway and boulders and cobbles covering the embankments of the eastbound I-70 highway. **Figure 12** depicts numerous rockfall chutes along the Georgetown Incline. The Colorado Geological Survey considers two potential rockfall areas in Silver Plume to be “perilous.”

Figure 12. Rockfall Chutes along the Georgetown Incline

Appendix B contains the programmatic agreement among the Federal Highway Administration (FHWA), the Advisory Council on Historic Preservation, the United States Forest Service-Rocky Mountain Region, CDOT, and the State Historic Preservation Officer regarding rockfall mitigation within the Georgetown-Silver Plume National Historic Landmark District. The agreement identifies a need to mitigate rockfall hazards between mileposts 226 and 228 for safety.

Georgetown Incline Rockfall Evaluation

The *I-70 Georgetown Incline Rockfall Evaluation Study* (CDOT, 2005) (see **Appendix A**) identified a system to rate sections along the Corridor with greater rockfall potential based on previous cut and natural slope rating systems. The study found direct correlation between climatic influences on rockfall, where precipitation and snowfall with associated freeze and thaw activity appear to be the most influential triggering mechanisms of rockfall on the Georgetown Incline. **Figure 13** suggests a correlation between reported crashes and increased precipitation when the average temperature is near the freezing point, typically during the spring months of March, April, and May.

To determine the long-term climatic conditions for the Georgetown Incline area, historical documents, tree rings, archaeological remains, lake sediment, and geomorphic data compiled by the National Oceanic and Atmospheric Administration (NOAA) (Woodhouse and Overpeck, 1998) was reviewed. The data, which focused on droughts and drought variability, are generally not a good indicator of extremely wet periods. **Figure 14** depicts the Palmer Drought Severity Index (PDSI) reconstructed from tree rings for the Georgetown Incline (which is within NOAA Division 4 for the State of Colorado). The PDSI is a relative index that uses temperature and rainfall information to determine dryness. Positive numbers represent wet periods, negative numbers represent dry periods, and zero represents normal conditions. A negative 4 indicates an extreme drought, while a positive 4 indicates an extremely wet period.

Figure 13. Relationship Between Reported Crashes and Increased Precipitation

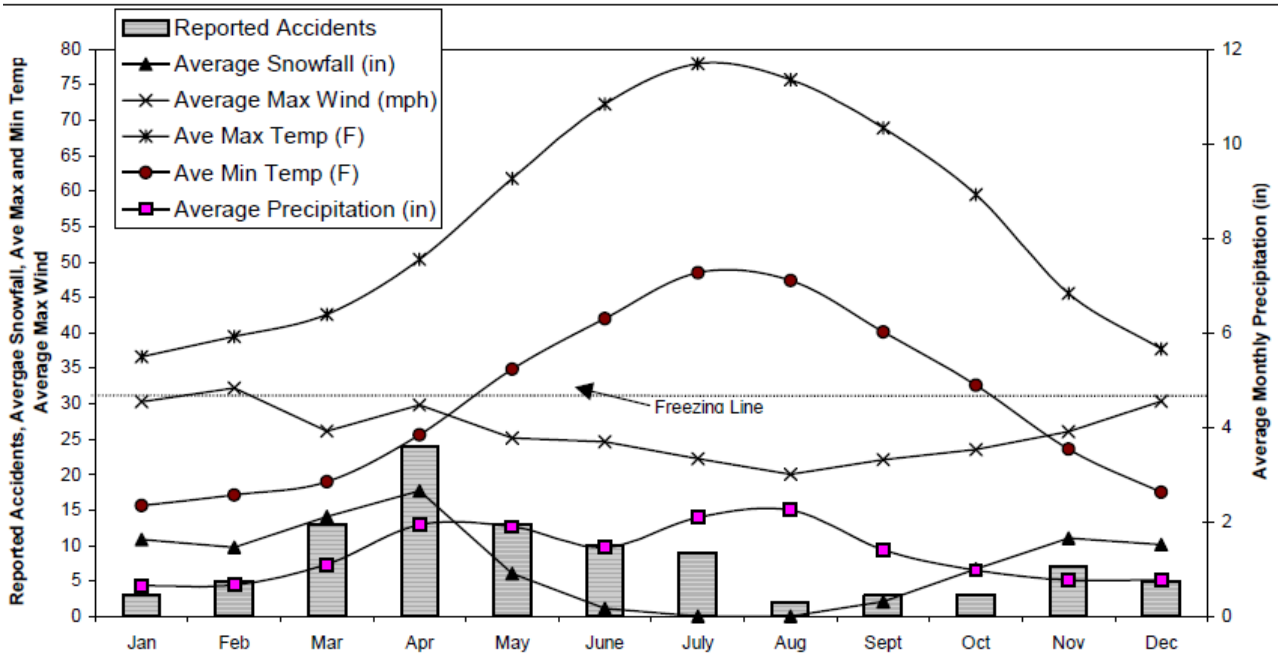
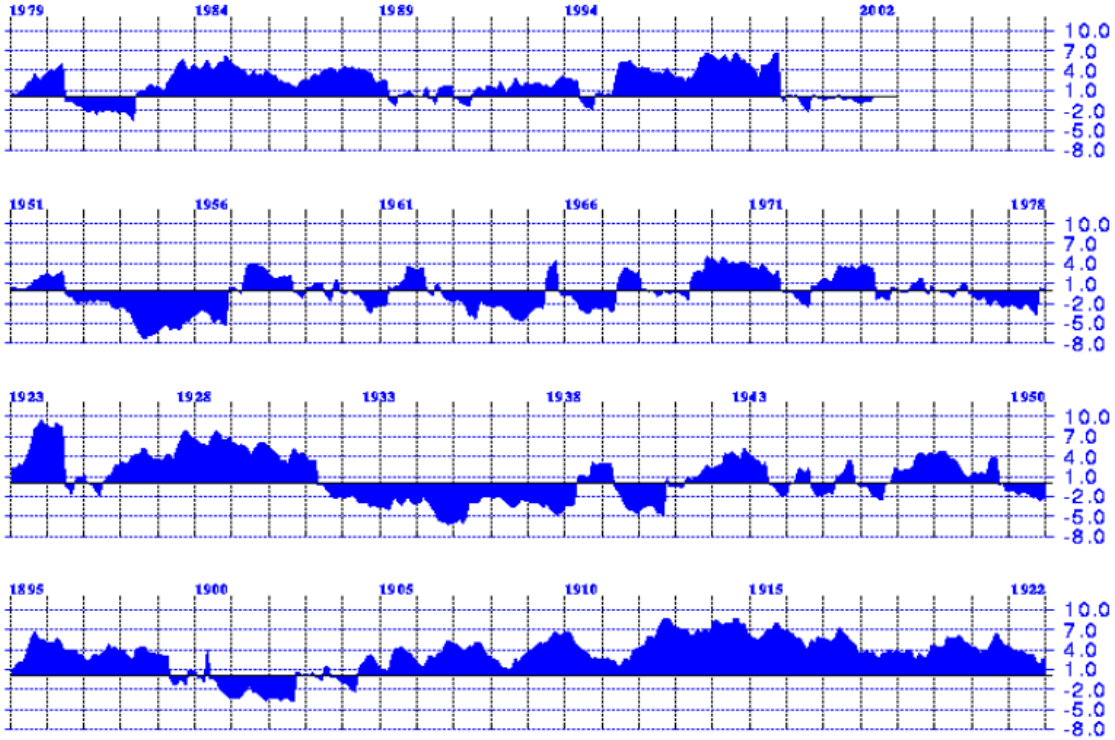


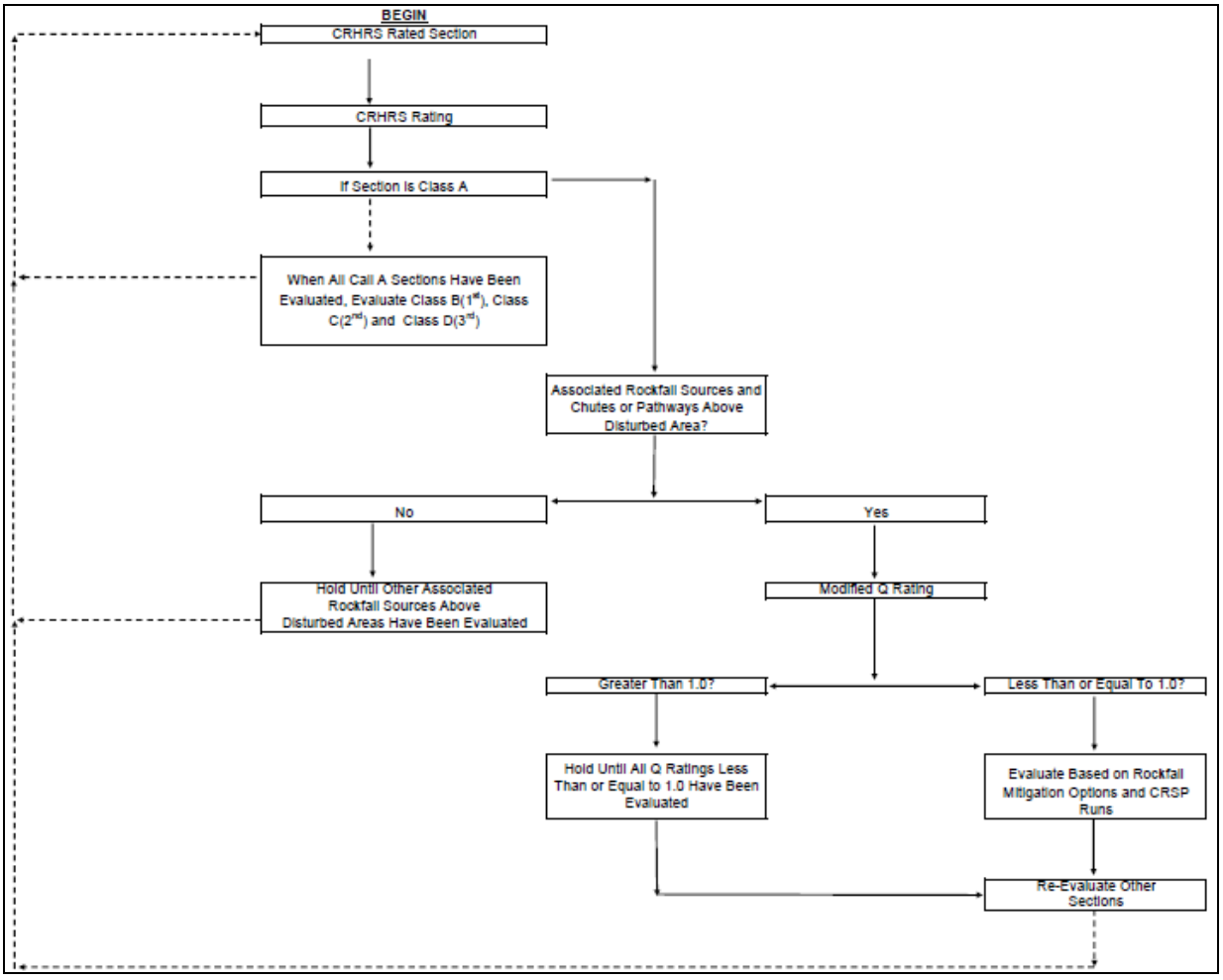
Figure 14. Palmer Drought Severity Index
Colorado Division 04: Monthly Average 1895 to 2002



In the study, evaluation of the rockfall potential was typically divided into two separate areas on the Georgetown Incline: (1) cutslopes that were developed during the construction of the I-70 highway, and (2) the natural hillside above the area disturbed by the construction activities. Colorado Department of Transportation employees evaluated the cutslopes adjacent to the I-70 highway using the Colorado Rockfall Hazard Rating System (CRHRS) in 1992, and subsequently in 1998. The natural hillslopes above the cutslopes were evaluated as part of this study using a modified Q-rating system. A Q-rating system is a statistical estimate for slope stability and the likelihood of a geologic structure to fail given certain conditions. In general, the CRHRS was applied only to the highway cutslopes, and the Q-rating system was applied only to the natural slopes above the cutslopes. Approximate locations of bed rock outcrops and rated sections are shown in **Appendix A** to the *I-70 Georgetown Incline Rockfall Mitigation Feasibility Study* (see **Appendix A**).

Figure 15 depicts a flowchart for evaluating the rockfall potential along the Georgetown Incline. **Appendix B** to the *I-70 Georgetown Incline Rockfall Mitigation Feasibility Study* (see **Appendix A**) expands on the flowchart. The flowchart incorporates both the ratings of the CRHRS and the modified Q-system to determine areas with the most critical ratings for CDOT to consider for rockfall mitigation. The flowchart first evaluates the cutslope sections based on CRHRS. Class A ratings, in combination with bedrock outcrops with Q-ratings less than 1.0, are evaluated in the first tier. Then CRHRS Class B ratings, with associated Q-rated bedrock outcrops less than 1.0, are rated in the second tier by an iterative process. The process eventually groups sections of roadway with a higher potential for rockfall to occur based on the two rating systems.

Figure 15. Flowchart for Georgetown Incline Evaluation of Rockfall Potential



This study of the Georgetown Incline provided a review of the available CDOT information on rockfall events, the mechanisms, and the conditions that contribute to rockfall. As a result of the evaluation and analysis, a rockfall mitigation matrix for the Georgetown Incline was created. The matrix that rates the various mitigative options based on effectiveness, constructability, maintenance, environmental constraints, and costs is included in **Appendix C** of the *I-70 Georgetown Incline Rockfall Mitigation Feasibility Study* (see **Appendix A**). The matrix of rockfall potential ranks specific sections from highest to lowest potential for a rockfall occurrence. The matrix may be used for identifying which sections are most appropriate for mitigation.

4.2.8 Dumont to Idaho Springs (Milepost 234 to Milepost 241)

Mineralized metamorphic rock from the Idaho Springs Formation characterizes this area. The terrain is rugged with steep V-shaped canyons. Rock quality ranges from good to poor, and structure may be adverse, depending on valley side. Steep slopes on the north side and Clear Creek on the south side confine the highway platform. Rockfall is the most prevalent geologic hazard in this domain (see **Figure** 6 **and Figure** 7). The original designs of I-70 and US 40 (merged in this area near milepost 232) are the cause of many of the rock slope stability problems here.

Rock excavations during original construction of US 40 (and later the I-70 highway) exposed areas of mineralized rock. The exposed mineralized rock is evident between Fall River Road at milepost 237 and

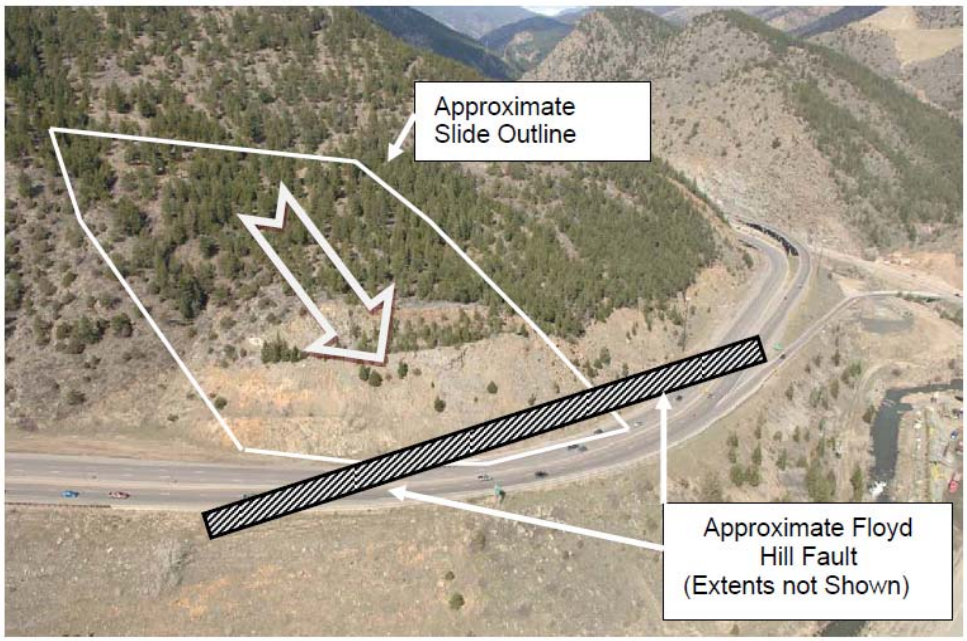
Idaho Springs near milepost 239, in the colorization of the outcrops. The *I-70 Mountain Corridor PEIS Regulated Materials and Historic Mining Technical Report* (CDOT, August 2010) discusses areas of mineralized rock further.

4.2.9 Idaho Springs to Hogback (Milepost 241 to Milepost 259)

Metamorphic rocks characterize this domain. The terrain is steep with V-shaped canyons and includes amphiboles, schist, and gneiss. Geologic exposures are dramatic, and the steep cut through the friable (crumbly or easily broken) rock has deposited a continuous rain of boulders and gravel at the base of the slopes. Lack of soil, organic matter, nutrients, and water, combined with the oversteepened slope, has left exposed, unproductive bare rock susceptible to erosion.

The Floyd Hill rockslide, on the south side of the I-70 highway where US 6 merges with the highway at Clear Creek Canyon (milepost 244.5), consists of highly fractured and foliated rock. Rockslides (and landslides) are prevalent in this area as shown in **Figure 7**. A series of rock cuts made through this area during construction of US 6 and the I-70 highway removed material at the base of the slope and caused a large rockslide. **Figure 16** shows an oblique aerial view of the landslide. Slope movement has been noticeable during the life of the existing roadway in this location and has had an impact on the Corridor on multiple occasions. The Floyd Hill rockslide remains active on approximately 500 feet to 700 feet of the existing I-70 roadway alignment; major movements follow extended periods of heavy precipitation.

Figure 16. Floyd Hill Landslide



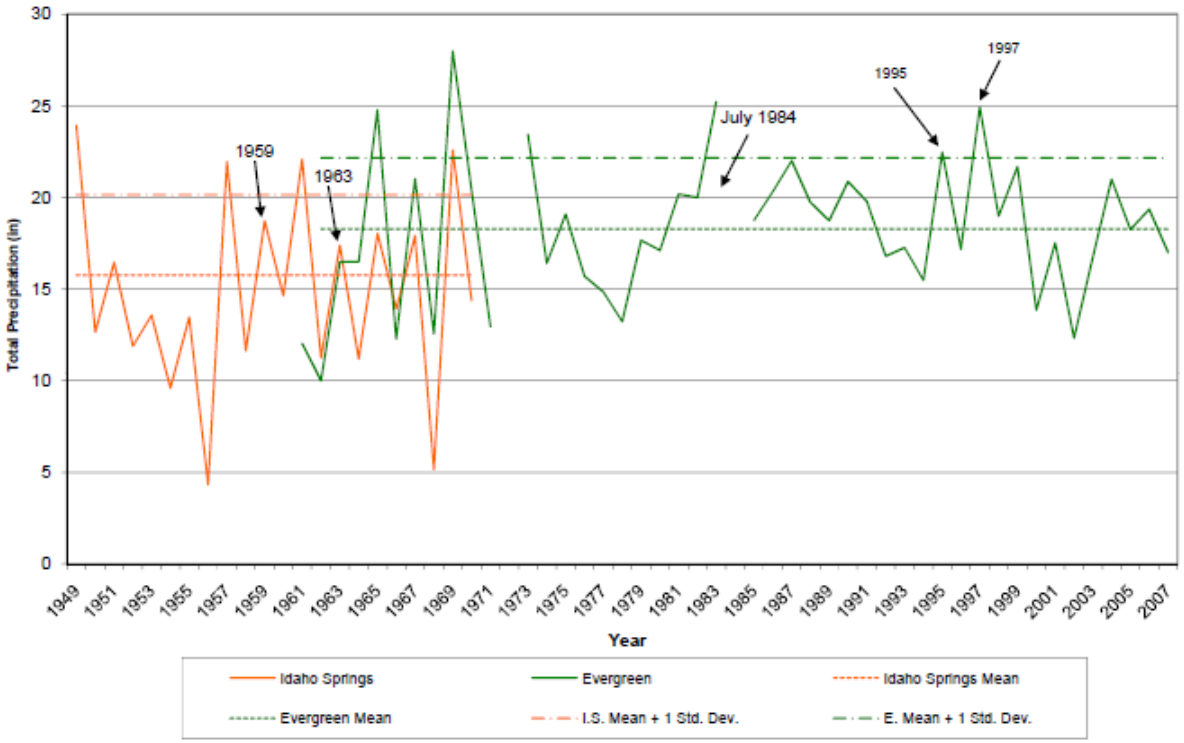
The Colorado Department of Transportation conducted a study to evaluate the extent of the Floyd Hill rockslide, potential triggering mechanisms, and mitigation options (Yeh and Associates, August 2008a). This study was conducted between July 18 and August 21, 2007 and consisted of drilling seven boreholes, and installing one inclinometer and four Time Domain Reflectometry (TDR) instruments in five of the borings to record movement of the slide. In addition to the field investigation, the study reviewed the historic movements of the slide and corresponding climatic conditions.

Review of the precipitation data indicates a correlation between higher-than-average precipitation years and years in which slope movement has occurred. Major slope movement occurred at Floyd Hill in 1959,

1963, 1984, and 1995. In each of these years, precipitation measured at both the Idaho Springs (5 miles from the Corridor) and Evergreen (15 miles from the Corridor) weather stations was above average (see **Figure 17**) (WRCC, 2007).

During the years 2001 to 2004, 0.5 to 0.75 inches of total lateral slide movement was measured using inclinometers at the project site (Hepworth-Pawlak, August 2001). This was a period of low to average precipitation, and many meteorologists considered this a drought period. Based on a review of the documented visible landslide movements and/or impacts on the roadway, it appears that precipitation totals greater than one standard deviation above the yearly average for more than 1 or 2 years likely result in major slope movements. The documentation also indicates that heavy precipitation events and/or monthly accumulations may also contribute to the slope movements (see **Figure 17**). Therefore, as a general monitoring tool for slope movement, the average precipitation should be monitored. If the precipitation is greater than one standard deviation above the normal, the rockslide may become more active.

Figure 17. Total Annual Precipitation, Idaho Springs and Evergreen, Colorado



Rock excavations along US 40 through Mount Vernon Canyon near mileposts 247 to 251 (runs parallel to the Corridor and at a higher elevation on the north) generate rockfalls that affect US 40 and occasionally the I-70 highway. Isolated areas in these road cuts have generated larger, more troublesome rockslides. Some slides have been large enough to close US 40 for extended periods of time.

4.2.10 Hogback to C-470 (Milepost 259 to Milepost 262)

Bedrock changes abruptly just west of the Morrison exit (milepost 259) from metamorphic rock from the Precambrian period to the steeply dipping upper Paleozoic sedimentary rocks formed approximately 250 to 300 million years ago. The Dakota Hogback is capped by the resistive Dakota Sandstone (approximately 100 to 150 million years old), and runs along much of the Front Range near Denver. Although the road cut at the Hogback is highly erodible, little rockfall has originated from this cut.

The road cut east of the Morrison exit displays many rock units of the Mesozoic Era (250 to 50 million years old). Embankment material for the I-70 highway between the Hogback and C-470 has been more problematic. In the early 1980s, large failures in the fill material developed into a major landslide. Several eastbound lanes of the I-70 highway were closed for 9 months until the slide was stabilized and repaired.

Section 5. Environmental Consequences

The evaluation of the environmental impacts considers the engineering geology, constructability, and severity rating of the geologic hazards and their effect on the safety, service, and mobility of the transportation facility. As described in **Section 2.2** of this technical report, five degrees of severity make up the overall geologic hazard rating system: Severe, High, Moderate, Low, and Slight. A hazard should meet a majority, not necessarily all, of the criteria listed, and each criterion is weighted differently. The significance of impacts by alternatives was determined on a comparative basis, with consideration given to the context and intensity of updated geological processes and the potential for change.

In general, all of the Action Alternatives have similar effects on existing geologic conditions. Excavations in rock and soil would cause both temporary impacts from construction activities and long-term impacts associated with achieving and maintaining slope stability Therefore, slope design, stabilization, and geologic hazard mitigation requirements are similar, with a few exceptions. **Table 3** summarizes the geologic conditions that would affect the specific Action Alternatives. The following sections discuss the common impacts for all of the Action Alternatives and describe the impacts unique to each specific alternative.

Table 3. Potential Geologic Conditions and Severity Index for Alternatives

Alternative	Adverse Faulting	Adverse Rock Structure	Poor Rock Quality	Debris Flows	Rockfall	Landslide	Avalanche
No Action	N/A	Moderate	N/A	Moderate	High	High	N/A
Minimal Action	N/A	Moderate	Moderate	High	Severe	Severe	Moderate
Rail with IMC	High	High	High	High	Severe	Severe	Moderate
AGS	High	High	High	Low	High	Severe	Moderate
Dual-Mode Bus in Guideway	High	High	High	High	Severe	High	Moderate
Diesel-Mode Bus in Guideway	High	High	High	High	Severe	High	Moderate
Six-Lane Highway 55 mph	High	Moderate	Moderate	High	Severe	High	Moderate
Six-Lane Highway 65 mph	High	High	Moderate	High	Severe	Low	Moderate
Reversible/HOV/HOT Lanes	High	Moderate	Moderate	High	Severe	High	Moderate
Combination Six-Lane Highway with Rail and IMC	High	High	High	High	Severe	Severe	Moderate
Combination Six-Lane Highway with AGS	High	High	High	Low	Severe	Severe	Moderate

Alternative	Adverse Faulting	Adverse Rock Structure	Poor Rock Quality	Debris Flows	Rockfall	Landslide	Avalanche
Combination Six-Lane Highway with Bus in Guideway	High	High	High	High	Severe	Severe	Moderate
Preferred Alternative*	High	High	High	Low to Moderate	Low to Severe	Severe	Moderate to High

The range of ratings for the Preferred Alternative represents the range between the Minimum and Maximum Programs and is reflective of the adaptive management component of the Preferred Alternative, which allows it to be implemented based on future needs and associated triggers for further action.* ***Chapter 2, Section 2.7* *of the PEIS describes the triggers for implementing components of the Preferred Alternative.*

Key to Abbreviations/Acronyms
AGS = Advanced Guideway System EJMT = Eisenhower-Johnson Memorial Tunnels
IMC = Intermountain Connection mph = miles per hour
N/A = not rated (although existing hazards would persist, construction activities would not exacerbate hazards)

5.1 Direct Impacts

All the alternatives, including the No Action Alternative, result in disturbance of geologic hazards.

5.1.1 No Action Alternative

The No Action Alternative includes several projects that could directly affect existing geological conditions; additionally, existing problems with slope erosion and geological hazards would continue. The greatest hazards are landslides, rockfall, avalanches, and debris flow/mudflows. To a lesser degree, the potential effects of collapsible soils and rapid subsidence may impact existing facilities. These impacts require ongoing highway maintenance and have the potential to cause roadway closures.

Landslides are an existing hazard in the following areas:

- In Dowd Canyon, the extent and severity of existing areas of slope instability could cause roadway closure and/or dam the river (in the event of an extensive landslide).
- Existing landslides on Vail Pass would continue to create roadway maintenance problems in isolated locations.
- The Floyd Hill rockslide is presently unstable, with ongoing movement and maintenance problems along the shoulder of the interstate.

Rockfall is the most prevalent hazard in the area. Particular areas of concern for rockfall hazards would include rockfall excavations through Dowd Canyon and along US 40 through Mount Vernon Canyon, where rocks originating from US 40 (runs parallel to the I-70 highway and at a higher elevation on the north) roll onto the I-70 highway. Rockfall is also an ongoing and severe hazard along the Georgetown Incline. Additionally, debris flow/mudflows will continue to occur with the potential to affect the highway in such areas as Waltrous Gulch, multiple chutes at Georgetown Lake, and west of Silver Plume at the former town site of Brownville. Both triggered and natural avalanches result in impacts to the roadway, especially at the chutes west of the Eisenhower-Johnson Memorial Tunnels and on Vail Pass. Ground subsidence from past mining has affected the highway at Hidden Valley and Idaho Springs, but the extent of this hazard is unknown.

Projects currently in development or under construction included as part of the No Action Alternative that could encounter geologic hazards include the Eagle County Airport interchange, widening of SH 9, and widening of shoulders near Vail Pass. These projects are relatively limited in scope of disturbance so will not have severe effects even in areas where hazards are severe.

5.1.2 Minimal Action Alternative

Components of the Minimal Action Alternative affected by geologic conditions include proposed interchange improvements, climbing lanes, and auxiliary lanes. The interchange improvements at Minturn (milepost 171) may be affected by the Whiskey Creek landslide complex. Previous interchange projects at this location experienced considerable delays and slope movements immediately after construction, resulting in highway closure. In addition, any modifications to existing highway geometry at the base of Floyd Hill could potentially disturb and mobilize the Floyd Hill rockslide.

Climbing lanes in Dowd Canyon (mileposts 170 to 173) would be in an area where the dip of the bedding contributes to landslides and rockfall hazards. Climbing lanes on Vail Pass (mileposts 180 to 190) would be constructed in terrain affected by alpine glaciations, where extensive landslides persist as a result of glacial events and poor rock quality. Widening on the cut slope side of the highway along the west approach to the Eisenhower-Johnson Memorial Tunnels (mileposts 215.3 to 218.3) may trigger large slope failures.

5.1.3 Transit Alternatives

Transit alternatives include Rail with Intermountain Connection, Advanced Guideway System, and Dual-mode or Diesel Bus in Guideway. The alignment and impact of the Rail with Intermountain Connection and Advanced Guideway System alternatives would essentially be the same; however, the on-grade Intermountain Connection would be more susceptible to geologic hazards than the elevated Advanced Guideway System. The Bus in Guideway alternatives would encounter the same geologic conditions as the Rail with Intermountain Connection with the exception of the bus placement in the median, which may reduce effects of roadway debris on Corridor bus travel.

The Advanced Guideway System elevated structure allows for debris flow or any other material to potentially pass underneath with no impact to operations; whereas debris flow could affect operations at Dowd Canyon, Watrous Gulch, Silver Plume, and Georgetown Lake with the other Transit alternatives. The alternatives proposed would impede efforts to use the I-70 highway median as a catchment area of debris/mudflow from the highway when necessary.

The Transit alternatives would pass through avalanche areas on the west side of Vail Pass, through Tenmile Canyon, along the Straight Creek approach to the Eisenhower-Johnson Memorial Tunnels and both portals, and the base of Mount Bethel. These alternatives would not increase exposure to these hazards more than the No Action or other proposed alternatives, except for the location of a new tunnel bore to cross through the Continental Divide. North and south bore alignments would pass beneath the more active avalanche chutes that originate from the Continental Divide just west of the western portals.

The Rail with Intermountain Connection and Advanced Guideway System alternatives extend farther than the Bus in Guideway (and Highway-only alternatives) and would have the greatest impact on existing slides on the Western Slope (Vail Pass). The Rail with Intermountain Connection alternative would cross several active landslides: the Vail Pass slides, Straight Creek slides, and Floyd Hill rockslide. In general, any type of rail system would require an immobile platform and would not accommodate large slope movements.

All Transit alternatives would include a new tunnel bore at the Continental Divide. The new bore on the north side of the existing Eisenhower-Johnson Memorial Tunnels would need to be designed to avoid the

existing landslide that was activated during construction of the westbound bore. The cut-and-cover section at the east portal would require extensive stabilization due to the height of the cuts and relative poor conditions of the subsurface material and fractured bedrock. The Transit alternatives constructed from the east portal of the Eisenhower-Johnson Memorial Tunnels (milepost 215) to C-470 (milepost 260) would be affected by the Floyd Hill rockslide.

The Transit alternatives would impact rockfall, as it is the most prevalent geologic hazard in the Corridor. Key locations that would be impacted by the alternatives would be the Georgetown Incline, Dowd Canyon, Vail Pass, and the Straight Creek approach to the west portal of the Eisenhower-Johnson Memorial Tunnels, and around the Twin Tunnels. Proposed climbing lanes in Dowd Canyon (milepost 170 to milepost 173) are not included in the Transit-only alternatives; in this location, the structure of geologic layers contributes to landslides and rockfall hazards, and avoiding construction in this area reduces landslide and rockfall hazards.

5.1.4 Highway Alternatives

The three proposed Highway alternatives (Six-Lane Highway 55 and 65 mph alternatives, and the Reversible Lanes Alternative) are very similar in their impacts to the geologic hazards of the Corridor with a few exceptions. The Highway alternatives would have little to no impact on the geologic hazard in the Idaho Springs area, whereas the most impacts would be encountered at Dowd Canyon.

Six-Lane Highway 55 mph Alterative

The Six-Lane Highway 55 mph Alternative includes widening at Dowd Canyon and at the Eisenhower-Johnson Memorial Tunnels to Floyd Hill. The Whiskey Creek, Dowd No. 1 and Dowd No. 2 landslides would be impacted by the additional lanes at Dowd Canyon. At Floyd Hill, in conjunction with the study for the proposed Black Hawk Tunnel, a preliminary geotechnical investigation was conducted to determine the surface extent and depth of this rockslide (Hepworth-Pawlak Geotech, August 2001). Based on the information gathered, excavation at the toe of the slide would adversely affect current slide stability.

The Mount Bethel avalanche would be impacted, although current mitigation measures of snow fences and maintenance would help limit the impact. Impact to active debris flow locations, such as Georgetown Lake (mileposts 227 to 231), would be considerable. Additionally, enlarging the existing cuts on the north side of the I-70 highway from Dowd Canyon to the West Vail interchange without extensive mitigation measures would increase the rockfall hazard. Likewise, active rockfall areas in Clear Creek County would be impacted extensively.

Six-Lane Highway 65 mph Alternative

In general the geologic hazards would be the same as those for the Six-Lane Highway 55 mph alternative, except at Dowd Canyon and Floyd Hill. The 65 mph variation of the Six-Lane Highway alternative includes a proposed tunnel at Dowd Canyon. This proposed tunnel would avoid many of the geologic hazards and would provide a safer highway condition than the No Action and all other alternatives. At Floyd Hill, the alternative would include wider curves, but because the alternative bypasses the slide by placing the eastbound lanes in a new three-lane tunnel, resulting impacts from rockslides would be low.

Reversible Lanes Alternative

This alternative would use a roadway width similar to that of the Six-Lane Highway 55 mph alternative through Clear Creek County. The area of disturbance and related impacts for this alternative would be the same as those for the Six-Lane Highway 55 mph, discussed above.

5.1.5 Combination Highway with Transit Alternatives

The Combination alternatives extend the entire length of the Corridor. Due to the wider platform required to accommodate the various systems, the Combination alternatives would require a larger footprint than the Highway-only alternatives. The impacts of the Combination alternatives are similar to the Transit-only alternatives discussed previously.

The Combination alternatives would pass through avalanche areas located at the base of Mount Bethel, both portals of the Eisenhower-Johnson Memorial Tunnels, along the Straight Creek approach to the Eisenhower-Johnson Memorial Tunnels, through Tenmile Canyon, and on the west side of Vail Pass. Exposure to these hazards would be no greater than for any other alternatives including the No Action alternative, except for the location of a new tunnel bore through the Continental Divide. A north bore alignment would pass vehicles beneath an active chute west of the existing west portal. In their current configurations, these avalanches do not reach the highway. However, excavation near the base may expose additional hazards.

The Combination Bus in Guideway and Rail with Intermountain Connection alternatives would impact debris/mudflow the most due to improvements proposed within the median. The on-grade rail or bus would impede the effort of using the median as a catchment area for removal of debris/mudflow when necessary. An elevated platform, as required for the Combination Advanced Guideway System alternative, may allow for faster removal of material.

The area of impact on existing slides would be larger for the Combination alternatives than for other alternatives. The most susceptible area would be a transit platform (either elevated or on-grade) constructed on the south side of the I-70 highway along the Straight Creek approach to the Eisenhower-Johnson Memorial Tunnels. Large embankments built during original highway construction show signs of instability that may adversely affect the transit portion of Combination alternatives. Most of the active landslides are located on the Western Slope where the Transit portion of Combination alternatives would extend. The Combination alternatives would cross several active landslides, including the Floyd Hill rockslide, the Straight Creek slides, and the Vail Pass slides. In general, rail transit would require an immobile platform and would not accommodate large slope movements.

The domains represented along the section of highway through Clear Creek County proposed for widening would be some of the more active rockfall sites in the state. The area of disturbance in the active rockfall zones would be among the largest for Combination alternatives. The alignment for the Combination alternatives would have to be adjusted in the Georgetown Incline area to minimize the effect of rockfall on the proposed highway platform. It would not be feasible to completely eliminate the hazard from rockfall, only to try to prevent some of the material from reaching the traveled roadway.

5.1.6 Preferred Alternative – Minimum and Maximum Programs

The range of improvements of the Preferred Alternative extends the entire length of the Corridor. The proposed improvements of the Preferred Alternative are impacted by rockfall, debris flow, and avalanches. The six-lane component from Floyd Hill through the Twin Tunnels, including a bike trail and frontage roads from Idaho Springs East to Hidden Valley and Hidden Valley to US 6, cuts through rugged terrain with areas of adverse structure and poor rock quality. Debris flow and erosion are common in the Empire Junction area (US 40 and the I-70 highway connection at milepost 232) and may affect improvements at that location, as the effects of glaciation terminate and the valley develops a “V” shape that directs debris materials toward the Corridor. Debris flow and potential avalanches could impact auxiliary lanes eastbound from the Eisenhower-Johnson Memorial Tunnels to Herman Gulch and westbound from Bakerville to the Eisenhower-Johnson Memorial Tunnels. Climbing lanes on Vail Pass (milepost 180 to milepost 190) constructed in terrain are affected by alpine glaciation where extensive

landslides persist as a result of glacial events and poor rock quality. Widening on the cut slope side of the highway along the west approach to the Eisenhower-Johnson Memorial Tunnels (milepost 215.3 to milepost 218.3), included in the Maximum Program, may trigger large slope failures.

The adaptive management approach of the Preferred Alternative allows the project components and mitigations to be phased or adapted in implementation to address geologic hazard conditions that exist at the time improvements are constructed.

5.2 Indirect Impacts

Indirect impacts from geologic hazards result from operations and maintenance activities that are required for all of the alternatives, including the No Action Alternative. Hazards persist in the Corridor, but the probability of such hazards creating impacts are no greater than the existing conditions. Regular avalanche control and rockfall mitigation continues under all alternatives. Avalanches are often controlled by triggering slides. In some circumstances avalanche or rockfall control work fails resulting in the roadway being covered and causing temporary road closures.

The Action Alternatives reduce the risks posed by geologic hazards in some cases where construction stabilizes slopes. In other cases, the elevated system improvement could help reduce the impact of heavy debris and rockfall because the debris could potentially flow under the structure.

5.3 Construction Impacts

Construction of tunnels would create large quantities of waste rock. CDOT would use waste materials onsite wherever possible. Onsite uses of rock and clayey materials would minimize truck traffic and disposal fees, in addition to avoiding environmental effects of transportation and disposal. Onsite uses might include having onsite crushers and concrete or asphalt plants for the creation of aggregate and riprap. These materials might be used for drainage channels, avalanche chutes, rockslide stabilization, berms, and road base. If onsite use is not possible or feasible, numerous disposal options have been identified. The *Waste Rock Management for Tunnel Construction* (Huyck, September 2002) contains details on waste rock management, including potential temporary storage, resale, or disposal sites.

Constructing tunnels is a common element of most of the Action Alternatives and would create large quantities of waste rock. The waste rock would be used on-site whenever possible for such uses as drainage channels, avalanche chutes, rockslide stabilization, berms or as road base. However, sometimes on-site usage is not possible or feasible, and the waste rock must be sold, disposed of, or stored temporarily. **Table 4** lists the locations where material originates, the maximum amount of waste to be generated, and the rock type to be generated.

Construction also disturbs unstable rock formations and creates rockfalls or landslides.

Table 4. Tunnel Construction Waste

Waste Source	Location (mp)	Amount of Waste (cubic yard)	No. of Truckloads[a]	Rock Type
Dowd Canyon	169 to 173	973,520	74,887	Sand/shale
Continental Divide – north[b]	213.5 to 215	1,221,810	93,986	75 percent hard granite/gneiss, 25 percent clay or crumbly material
Continental Divide – south[b]	213.5 to 215	1,054,450	81,112	75 percent hard granite/gneiss, 25 percent clay or crumbly material
Twin Tunnels [c]	242.1 to 242.3[a]	95,450	7,343	Hard granite/gneiss
65 mph curves – eastbound	242 to 242.8[a]	204,540	15,726	Hard granite/gneiss
65 mph curves – westbound	242 to 242.8[a]	470,430	36,187	Hard granite/gneiss
Floyd Hill Tunnel	243.2 to 245.2	756,770	58,214	Hard granite/gneiss

a Assumes 13 cubic yards per truckload, rounded to next truckload.

b The total for the Continental Divide borings would be 2,276,260 cubic yards. Since about 25 percent of this material is estimated to be crumbly or clayey, the amount of material unlikely to be resold would be about 569,070 cubic yards.

c For Six-Lane Highway (55 or 65 mph) or Rail with Intermountain Connection alternatives, options include either increasing the bores at the Twin Tunnels or creating 65 mph curve tunnels that would pass around the existing Twin Tunnels.

Key to Abbreviations/Acronyms
AGS = Advanced Guideway System
EJMT = Eisenhower-Johnson Memorial Tunnels
IMC = Intermountain Connection
mph = miles per hour
mp = milepost

5.4 Impacts in 2050

Geologic hazards continue in the Corridor, with and without the Action Alternatives. The effects of geologic hazards in 2050 relate to timing of the implementation of the Action Alternatives, including mitigations that could improve rockfalls, avalanches, or other hazardous conditions, as well as disturbance of unstable geologic units that could create long-term maintenance or safety issues. Some conditions may be improved, while others may worsen. The longer implementation timeframe does not change impacts in a meaningful way because some potentially adverse impacts of disturbing geologic hazards might be avoided temporarily but mitigations that may reduce hazards from geologic conditions may also be delayed.

Section 6. Tier 2 Considerations

Tier 2 processes will involve a more detailed analysis of the geologic hazards present in the Corridor and identify specific mitigation measures that will be required. For alternatives requiring tunneling, the Tier 2 processes will address impacts of blasting activities and the disposal of waste materials. In locations where a strong potential for rockfall or avalanches exists, the Tier 2 processes will consider the options that may be used to avoid or contain debris. The most recent studies for active mitigation strategies will be used during Tier 2, including active fencing and terracing.

During Tier 2 processes, the lead agencies will:

- Develop specific and more detailed mitigation strategies and measures
- Develop best management practices specific to each project
- Adhere to any new laws and regulations that may be in place when Tier 2 processes are underway

Section 7. Mitigation

The lead agencies will incorporate mitigation strategies learned from previous projects, such as:

- Incorporating new design features to minimize slope excavation and follow natural topography.
- Using excavation and landscaping techniques to minimize soil loss and reverse existing erosion problems.
- Using rock sculpting, which involves blasting rock by using the existing rock structure to control overbreak and blast damage to create a more natural-looking cut.
- Using proven techniques, such as rockfall catchments, mesh, cable netting, and fences, as well as scaling and blasting, to address rockfall from cut slope areas.
- Reusing excavated material from tunnel construction onsite where possible. If materials are used on United States Forest Service lands, the lead agencies will follow the *Memorandum of Understanding Related to Activities Affecting the State Transportation System, National Forest System Lands, and Bureau of Land Management National System of Public Lands in the State of Colorado* (see **Appendix A** to the *I-70 Georgetown Incline Rockfall Mitigation Feasibility Study* in **Appendix A** of this Technical Report).
- Adhering to the *Programmatic Agreement among the Federal Highway Administration, Advisory Council on Historic Preservation, the United States Department of Agriculture Forest Service – Rocky Mountain Region, the Colorado Department of Transportation and the State Historic Preservation Officer Regarding Rockfall Mitigation Projects along Interstate 70 within the Georgetown-Silver Plume National Historic Landmark District* (2009) (see **Appendix B**).

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Three appendices support the Geologic Hazards Technical Report:

- Appendix A is the I-70 Georgetown Incline Rockfall Mitigation Feasibility Study, which was prepared in 2005 to assess rockfall potential from both cut and natural slopes above the I-70 highway along the Georgetown Incline (milepost 225.7 to milepost 227.9). All of the alternatives evaluated in the PEIS have some interaction with this area. The report includes several appendices referenced in this technical report. The I-70 Georgetown Incline Rockfall Mitigation Feasibility Study provides more detailed information about this specific area of rockfall concern and specifically recommends mitigation options that could be implemented for future projects in the Corridor, including the Action Alternatives. The report is primarily an evaluation of the existing condition and remains relevant since geologic conditions are very slow to change and the timing of failures of geologic hazards is nearly impossible to predict.
- Appendix B contains a Programmatic Agreement signed in February 2009 regarding rockfall mitigation projects within the Georgetown-Silver Plume National Historic Landmark District. The Programmatic Agreement was developed largely in response to the I-70 Georgetown Incline Rockfall Mitigation Feasibility Study in Appendix A to this report. The terms of the Programmatic Agreement remain in effect until October 1, 2018.
- Appendix C contains a Memorandum of Understanding signed on July 1, 2010 regarding activities affecting the state transportation system, National Forest system lands, and Bureau of Land Management national system of public lands in the state of Colorado. The Memorandum of Agreement is effective through June 30, 2015.

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Appendix A.
I-70 Georgetown Incline Rockfall Mitigation Feasibility Study

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I-70 Georgetown Incline
Rockfall Mitigation Feasibility Study
June 30, 2005,
Clear Creek County, Colorado

Prepared for:

Colorado Department of Transportation
Region 1 – Foothills Residency
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PURPOSE AND SCOPE

This mitigation feasibility study presents the results of our evaluation of the rockfall potential from both the cut and natural slopes above I-70 along the Georgetown Incline. Based on our review, analysis, and direction from CDOT, this study presents a tiered rating (bundle) of sections along I-70 with a greater rockfall potential based on previous cut and natural slope rating systems. This study was prepared to assist CDOT in considering which sections along I-70 may be incorporated into CDOT's Rockfall Mitigation Project Plan (RMPP). This report supplements the previously submitted "Final I-70 Georgetown Incline Rockfall Evaluation, Clear Creek County, Colorado" dated November 13, 2003 from Yeh and Associates, Inc. The overview and rockfall potential rating systems sections presented in this report were previously described in the abovementioned rockfall evaluation study. These sections were presented in this study to provide background information for this phase of the mitigation feasibility study. This study also references the Colorado Rockfall Hazard Rating System (CRHRS) implemented by CDOT.

It should be noted that rockfall and rockfall events are sporadic and unpredictable. This study does not attempt to predict the recurrence interval, magnitude, or location of a rockfall. These factors cannot be predicted. Consequently, neither the rockfall potential in terms of probability of a rockfall at any specific location, nor the risk to people or facilities to such events are assessed in this report. Furthermore, along the Georgetown Incline rockfall can potentially occur at any time and at any location.

OVERVIEW

The Georgetown Incline consists of a 2.2-mile section along I-70 between Georgetown and Silver Plume, Colorado. Figure A-1 (Appendix A) illustrates a photographic plan view of the project site with approximate locations of rated cutslopes, bedrock outcrops, mile markers, chutes, pathways, and other rockfall related data. The study area is located between Mile Markers 225.7 to 227.9 on Interstate I-70. In this section, the overall elevation change of the site is approximately 500 feet, with westbound I-70 climbing uphill from Georgetown to Silver Plume at grades ranging from

5% to 8%, and eastbound descending from Silver Plume to Georgetown. The highway alignment is cut into relatively steep mountainous slopes that exceed 1H:1V in many places with numerous exposed bedrock outcrops located above the highway. The natural backslopes above the current highway alignment exceed 1700 feet vertically throughout much of the project area. Cutslopes and disturbed areas just above the highway generally range from 20 to 150 feet vertically with cutslope angles ranging from vertical to 60 degrees.

The surfical materials comprising the steep backslopes above the current alignment typically consist of colluvial, talus, and isolated mine tailing deposits. Numerous bedrock outcrops form vertical cliff faces in many locations creating potential source areas for rockfall. The combination of steep slopes, relatively loose surficial materials and particle sizes ranging from silt to boulders, creates an area that has experienced numerous rockfall events in the past.

ROCKFALL POTENTIAL RATING SYSTEMS

Based on the previous rating systems, the rockfall potential was divided into two areas on the Georgetown Incline, cutslopes and natural slopes. The cutslopes are adjacent to I-70 and are usually included in the disturbed areas that were excavated or impacted during construction of I-70. The cutslopes have been rated by employees of CDOT using the Colorado Rockfall Hazard Rating System (CRHRS). The natural slopes above the cutslopes are undisturbed slopes that were rated by Yeh and Associates personnel using a modified Q-rating system.

It is important to distinguish between the two areas and rating systems. In general, the CRHRS system was applied only to the highway cutslopes and the Q-rating system was applied only to the bedrock outcrops in the natural slopes above the cutslopes.

Cutslope Evaluation Using CRHRS

The Colorado Rockfall Hazard Rating System (CRHRS) was developed for the Colorado Department of Transportation as a rating system for identifying, evaluating, and prioritizing sites in Colorado, which may produce rockfall (Andrew, 1994). The

methodology is based on the rating system developed by the Oregon Department of Transportation (ODOT). The CRHRS consists of Phase I and Phase II. Phase I identifies and ranks segments of state highways that have chronic problems with rockfall. Cut slope segments with rockfall problems are identified by occurrence of vehicle accidents caused by rockfall or identification by highway maintenance personnel as rockfall prone areas. The information gathered from Phase I is used to direct the locations of where more detailed evaluation is needed. The sites are ranked from 0 to 4 with 4 being the most active. Sites ranking 3 or higher were evaluated first under Phase II of the program.

Phase II is a site-specific rating system, further delineating, describing, and scoring individual rockfall source areas or sites. Geologic and physical site data is collected. The evaluation and scoring criteria is used to define distinct segments with similar geologic, slope, and rockfall criteria within stretches of highways. The rating scheme is broken up into 15 categories representing the significant elements of rockfall that contribute to the overall hazard. The points in each category range from 3 to 81 points with 81 being the worst. A summary of the categories and their ratings of the CRHRS are provided in Table 1.

The sum of all the points from each category is the overall rating for the segment of highway. The sites are classified according to classes based on their rating. Classes A and B are typically considered for mitigation first (See Table 2). Both cost and complexity of the problem can be considered in determining which sites are considered practical to mitigate. Table 2 summarizes the rating scale of the CRHRS.

The Georgetown Incline between Mile Markers 226-228 was rated by CDOT personnel on three occasions, 1992, 1998, and 2003, using the CRHRS. Segments of the Georgetown Incline included 6 of the top 10 sites in CDOT Region 1 and in the top twenty sites in the state that were evaluated for rockfall hazard. Table 3 illustrates the locations and CRHRS ratings of the sections along the Georgetown Incline.

Rockfall Hazard Rating System						
Factor			**Rank**			
			3 points	**9 points**	**27 points**	**81 points**
Slope Profile		**Slope Height**	25 to 50 ft	50 to 75 ft	75 to 100 ft	>100 ft
		Slope Inclination	35° to 45°	45° to 55°	55° to 65°	>65°
		Launching Features	Possible	Minor	Many	Major
		Ditch Catchment	Good	Moderate	Limited	None
Geologic Characteristics		**Block Size**	<1 ft	1 to 2 ft	2 to 5 ft	>5 ft
		Quantity of Rockfall Event	<1 cy	1 to 3 cy	3 to 10 cy	>10 cy
		Precipitation/ Seepage/ Exposure	Low/ None/ Favorable	Moderate/ Some/ Moderate	High/ Moderate/ Moderate	High/ High/ Adverse
	Case 1	**Fractures/ Orientation**	Discontinuous/ Favorable	Discontinuous/ Random	Discontinuous/ Adverse	Continuous/ Adverse
		Rock Friction	Rough, Irregular	Undulating, Smooth	Planar	Clay Infilling, Slickensided
	Case 2	**Erosional Features**	Few	Occasional	Many	Extreme
		Difference in Erosion	Small	Moderate	Large	Extreme
Road Information		**% Site Distance**	>80%	60%-80%	40%-60%	<40%
		ADT	<1000	1000-5000	5000-15000	>15000
		Number of Accidents	0 to 2	3 to 5	6 to 8	9 or more
		Observed History	Few	Occasional	Many	Constant

Table 1. Colorado Rockfall Hazard Rating System (2003).

Class	Rating
A	550 or higher
B	450-550
C	350-450
D	Below 350

Table 2. Rating scale of the CRHRS (2003)

Segment ID	Mile Markers	1992 CRHR	1998 CRHR	2003 CRHR
1	226.0-226.05	435	534	390
2	226.05-226.29	633	648	684
3	226.29-226.49	615	594	594
4	226.49-226.57	399	522	414
5	226.57-226.58	222	405	252
6	226.58-226.70	399	471	417
7	226.70-226.83	549	570	543
8	226.84-226.94	375	489	420
1a	227.13-227.22	339	456	399
2a	227.22-227.29	531	552	366
3a	227.29-227.31	501	588	339
4a	227.31-227.36	531	621	462
5a	227.36-227.40	375	486	405
6a	227.40-227.43	501	612	354
7a	227.43-227.72	549	498	570

Table 3. Colorado Rockfall Ratings for I-70 at the Georgetown Incline

Figure A-1 (Appendix A) illustrates the sections for the CRHRS along the Georgetown Incline.

Natural Backslope Evaluation Using Modified Q-System

Evaluation of the rock mass quality of the bedrock located on the natural undisturbed slopes above the present cutslopes adjacent to I-70 was done using a modified Q-rating system based on evaluation of seismic rockfall susceptibility by Harp & Noble (1993). Harp & Noble recognized that evaluating slope stability for an entire mountainous slope or to characterize the stability of rock slopes on a regional basis is generally beyond the capabilities of standard rock slope stability analyses. Therefore the Q-Rating System, which was previously developed by Barton for tunneling support design and cost estimation in mining, was modified to provide a relative rock mass quality rating. This system was chosen for the Georgetown Incline since it was not feasible to access the natural steep slopes above I-70 since the area is prohibitively large and walking on the slopes could potentially trigger a rockfall. This method was presented in greater detail in the 2003 Rockfall Evaluation Report mentioned previously.

The following equation illustrates the modified Q-Rating system methodology:

$$Q = \left(\frac{RQD}{J_n}\right) * \left(\frac{J_r}{J_a}\right) * \left(\frac{Jw}{AF}\right)$$

The six factors used to calculate Q are rock quality designation (RQD), joint set number (Jn), joint roughness number (Jr), joint alteration number (Ja), joint water reduction (Jw), and aperture factor (AF). Aperture factor replaces the Stress Reduction Factor (SRF) in the original Q rating system by Barton. Each factor has an associated rating for varying conditions. A description of each rating for the parameters for the modified Q system is included in Table 4. The RQD is usually measured from core obtained from diamond drilling, however since drilling was not conducted or feasible at the Georgetown Incline, RQD was estimated by observation of the joints for each outcrop.

Most of the Q ratings were done from across the valley using binoculars and telescopes. For most of the bedrock outcrops on the Silver Plume end of the project site at least two and sometimes three ratings were performed at differing angles on the same bedrock outcrop in an attempt to average the overall rating. Some rock outcrops only have 1 rating since it was not possible to view alternative angles. Appendix G has a summary of the all the ratings and associated notes. Overall, the lower the Q rating the higher the potential of rockfall from bedrock outcrops. Figure A-1 (Appendix A) illustrates the approximate locations of larger bedrock outcrops. These outcrops have been rated according to the modified Q system and color-coded to illustrate the relative Q ratings. Q ratings can vary from 0 to 400, 0 representing the lowest quality rock (i.e. heavily fractured, decomposing) and 400 representing the best quality rock (i.e. an intact rock that is structurally flawless). The majority of the bedrock outcrops along the Incline were rated between 0.5 and 5.0.

Rating Category	Rating	Notes
1. Rock Quality Designation	**RQD**	Where RQD is reported or measured as = 10 (including 0) a nominal value of 10 is used to evaluate\ate Q. RQD intervals of 5, i.e. 100,95,90, etc. are sufficient.
Very Poor	0-25	
Poor	25-50	
Fair	50-75	
Good	75-90	
Excellent	90-100	
2. Joint Set Number	**J_n**	For intersections (3 x Jn)
Massive, no or few joints	0.5-1.0	
One joint set	2	
One joint set plus random	3	
Two joint sets	4	
Two joint sets plus random	6	
Three joint sets	9	
Three joint sets plus random	12	
Four or more joint sets, random, heavily jointed, "sugar cube", etc.	15	
Crushed rock, earthlike	20	
3. Joint Roughness Number	**J_r**	
a. Rock wall contact and rock wall contact before 10 cm shear		
Discontinuous joints	4	
Rough or irregular, undulating	3	
Smooth, undulating	2	
Slickensided, undulating	1.5	
Rough or irregular, planar	1.5	
Smooth, planar	1	
Slickensided, planar	0.5	
b. No rock wall contact when sheared		
Zone containing clay minerals thick enough to prevent rock wall contact	1	
sandy, gravelly or crushed zone thick enough to prevent rock wall contact	1	
4. Joint Alteration Number	**J_a**	**ϕ_r (approx.)**	Values of ϕ_r are intended as an approx. guide to the mineralogical properties of the alteration products, if present.
a. Rock wall contact			
Tightly healed, hard, non-softening, impermeable filling, i.e.. quartz or epidote	0.75		
Unaltered joint walls, surface only	1	20-35	
Slightly altered joint walls, non-softening mineral coatings, sandy particles, clay-free disintegrated rock, etc.	2	25-30	
Silty-or sandy coatings, small clay -fraction (non-softening)	3	20-25	
Softening or low-friction clay mineral coatings (Discontinuities coatings , 1-2 mm or less)	4	8-16	
5. Joint Water Reduction Factor	**J_w**	
Dry	1	
Seeps present < or = to 5 gpm	.7	
Well defined seeps> 5 gpm, < or = to 10 gpm	.3	
Well established groundwater flow > 10 gpm	.1	
6. Joint Aperture	**AF**	If perched or loose rocks are common, increase by one. If pervasive joints dip out of slope, increase by one.
All joints tight	1	
Most joints tight, a few open as much as 2 cm (<1 in)	2.5	
Most joints tight, a few loose, open as much as 5 cm (2 in)	5	
Significantly (20 percent) open, as much as 10 cm (4 in)	7.5	
Greatly (60 percent) open, as much as 20 cm (8 in)	10	
Gaping open, many joints open > 20 cm	15	

$Q = (RQD/J_n) \times (J_r/J_a) \times (J_w/AF)$

Table 4. General Description of Modified Q Rock Rating System.

For the purposes of this study, chutes and pathways were used to define features that could potentially allow rockfall to reach I-70. Chutes were defined as natural drainage features in the natural slopes that rockfall could roll down without trees or natural barriers to prevent rockfall from reaching the highway. Pathways were defined as open areas without trees or natural barriers to prevent rockfall from reaching the highway but are not natural drainage features. In general, pathways are considered to be areas that were excavated or disturbed during original construction of I-70. Chutes and pathways are depicted on Figure A-1 (Appendix A).

ROCKFALL MITIGATION MATRIX

In order to evaluate the rockfall mitigation options, a meeting was held with CDOT representatives from the CDOT Rockfall Program and CDOT Region 1. At this meeting, the various mitigation options suggested from the previous Rockfall Evaluation Report were presented. A matrix was developed to rate the various mitigative options based on effectiveness, constructability, maintenance, environmental constraints, and costs. CDOT representatives determined the factors and multipliers for each of the mitigative options. Figure B-1 (Appendix B) illustrates the matrix table. Based on the results of the matrix evaluation, rockfall protection fences, rockfall protection fences with attenuators, and attenuators were considered (and approved) by CDOT to be the best options to mitigate potential rockfall for this location along I-70.

ROCKFALL EVALUATION FLOWCHART

At the same meeting with CDOT representatives, a flowchart for evaluating the rockfall potential at the Georgetown Incline was presented. The flowchart was intended to incorporate both the ratings of the CRHRS (by CDOT) and the modified Q System (by Yeh and Associates) to determine areas with the most critical ratings for CDOT to consider for rockfall mitigation. The flowchart is depicted in Figure C-1a (Appendix C). The flowchart first evaluates the cutslope sections based on CRHRS. Class A ratings, in combination with bedrock outcrops with Q ratings less than 1.0, are evaluated in the first tier. Then CRHRS Class B ratings with associated Q rated bedrock outcrops less than 1.0, are rated in the second tier by an iterative process. The process eventually

groups sections of roadway with a higher potential for rockfall to occur based on the two rating systems. Appendix C also includes a printout of the iterative process that was used to evaluate the project area. Tier 1 sections are considered to have the greater rockfall potential when compared with Tiered 2 sections and so forth. However, it should be noted that rockfall can occur at any place along the Georgetown Incline and this evaluation merely combines the results of the two rating systems.

Based on the tiered results of the flowchart evaluation the areas with chutes and/or pathways with low Q ratings (i.e. less quality bedrock) were matched with areas with higher rated CRHRS sections (i.e. more rockfall potential). The results of this evaluation are presented in Appendix D. The results depicted in Appendix D also show approximate lengths across each section if rockfall protection fences or attenuators are to be used based on the mitigation matrix approved by CDOT. Approximate linear foot costs associated with these mitigation systems are also provided. The costs typically include all associated bid items that are required to construct a fence or attenuator based on previous projects in the area.

SUMMARY OF FLOWCHART EVALUATION AND CRSP ANALYSIS

Based on the results of the flowchart evaluation and the Colorado Rockfall Simulation Program (CRSP) analysis from the previous Rockfall Evaluation Report a summary table is depicted on Figure E-1 (Appendix E) with an associated tier rating for each section. The tier ratings are relative for the project area. Tier 1 ratings are relative and should be considered to have a higher potential for rockfall than Tier 2 ratings. It should be noted that Chute 10 and Chute 5 have higher tier ratings (i.e. Tier 6 and 7) however, these areas have low Q rated bedrock outcrops with lower rated CRHRS ratings. CDOT may want to consider these sections higher in the tier rating when evaluating mitigation sites.

At CDOT's direction, 5-foot diameter boulders originating from the top of a natural slope and a 2-foot diameter boulders originating from the top of a disturbed slope were analyzed using CRSP. The CRSP results are presented in Appendix E as the average energy, average speed, and average bounce height. Two analysis points were evaluated, one analysis point (AP1) at the top of the cut slope adjacent to the highway

and the other analysis point (AP3), at the edge of the roadway. It should be noted the CRSP sections are approximate and based on visual observations, topographical maps, photographs, and limited roadway cross-sections. CRSP analysis should be reviewed prior to placement of a proposed rockfall mitigation system. Additionally, as emerging technologies progress, it may be possible to map or generate a more detailed slope profile that will provide more accurate CRSP results.

ODOT SUMMARY OF CUTSLOPES

Figure F-1 (Appendix F) provides an evaluation of the cutslopes based on the research conducted by the Oregon Department of Transportation (ODOT) Research Group – Rockfall Catchment Area Design Guidelines (December 2001). The cutslopes adjacent to I-70 were evaluated based on the profiles and dimensions of the slope and catchment areas and compared with the ODOT study. The existing roadway profiles were on 500-foot station intervals (provided by others). It is our understanding these profiles were used for the I-70 Programmatic Environmental Impact Study (PEIS). In general, this table was provided to CDOT for evaluating rockfall from the cutslopes and determining percentage of rocks that were contained in the present catchment areas.

It should be noted that this evaluation is based on long station intervals and should be considered very broad. A more detailed evaluation with tighter stationing control should be considered to provide a more detailed assessment of the cutslopes. Additionally, several sections of the existing cutslopes exhibited planar or wedge failures. This study did not consider the kinematic stability of the cut or natural slopes.

SUMMARY

The intent of this study is to provide CDOT with an evaluation tool, which combines both the cutslope rating system (CRHRS) and the Modified Q rating System to provide CDOT with combined rating for sections of I-70 that are to be considered for rockfall mitigation. This report does not direct or suggest to CDOT which mitigation option or mitigation location are preferred.

LIMITATIONS OF STUDY

This study has been conducted in accordance with generally accepted geological and geotechnical engineering practices in this area for use by the client for evaluation purposes. The suggestions submitted in this report are based upon the data obtained from field reconnaissance and review of previous projects or reports. It should be noted that rockfall and rockfall events are sporadic and unpredictable. This report does not attempt to predict the average recurrence interval, magnitude, or location of a rockfall event. These factors cannot be predicted. Consequently, neither the rockfall hazard in terms of probability of a rockfall at a any specific location, nor the risk to people or facilities to such events are not assessed in this report. Furthermore, along the Georgetown Incline rockfall can potentially occur at any time and at any location.

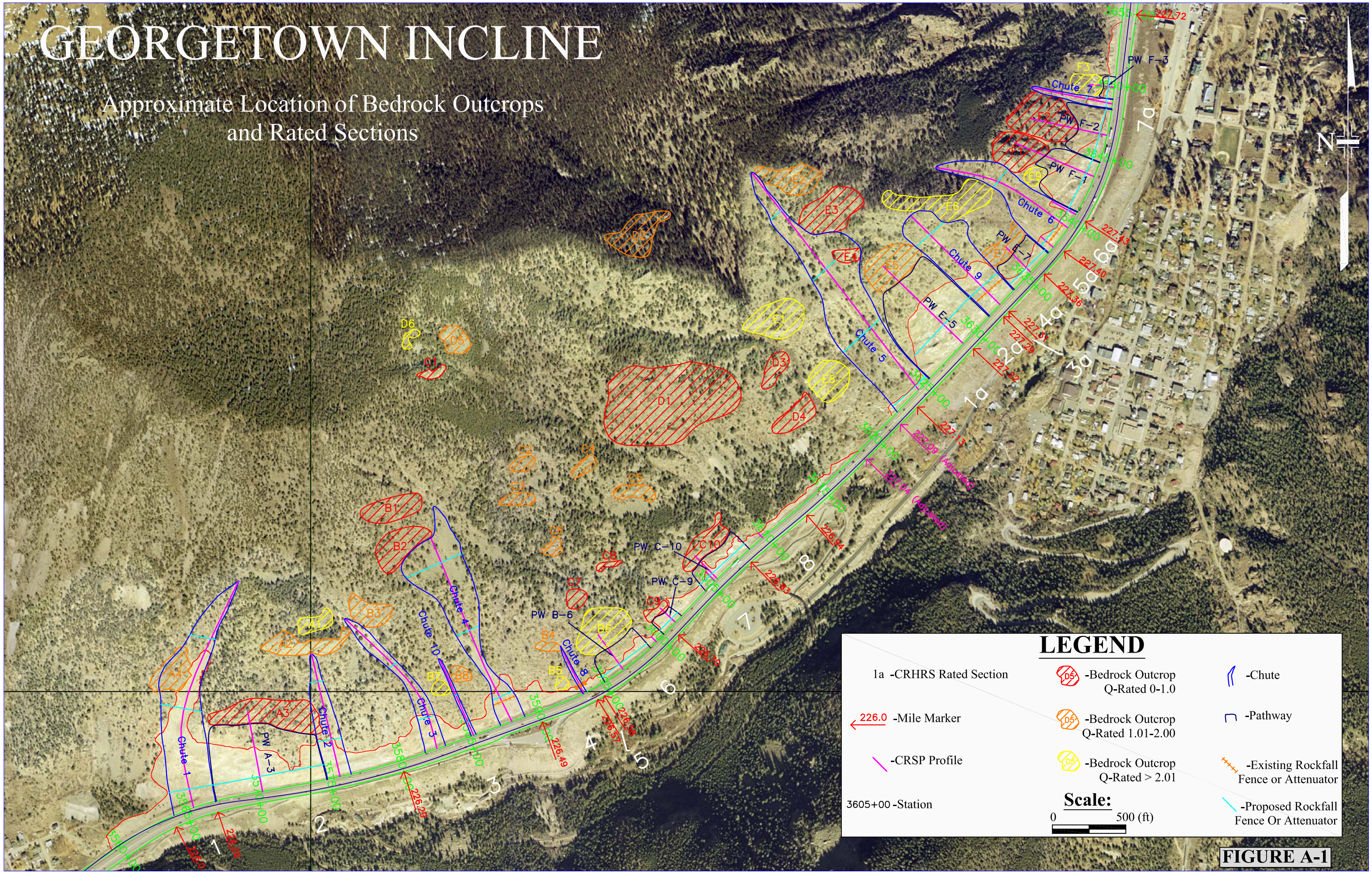
Respectfully Submitted,

YEH AND ASSOCIATES, INC.

APPENDIX A - PHOTOGRAPHIC PLAN VIEW OF SITE

GEORGETOWN INCLINE

Approximate Location of Bedrock Outcrops and Rated Sections



LEGEND

- 1a -CRHRS Rated Section
- 226.0 -Mile Marker
- -CRSP Profile
- 3605+00 -Station
- -Bedrock Outcrop Q-Rated 0-1.0
- -Bedrock Outcrop Q-Rated 1.01-2.00
- -Bedrock Outcrop Q-Rated > 2.01
- -Chute
- -Pathway
- -Existing Rockfall Fence or Attenuator
- -Proposed Rockfall Fence Or Attenuator

Scale: 0 500 (ft)

FIGURE A-1

APPENDIX B - MATRIX EVALUATION OF MITIGATION METHODS

Rockfall Mitigation Matrix For Georgetown Incline

		Effectiveness Rating	Constructability Rating	Maintenance Requirements Rating	Environmental Constraints Rating	Cost Rating	Overall Score	Rank
	Weighted Average:	5.0	4.0	1.0	3.0	2.0		
Rockfall Mitigation Options*:								
Avoidance	Tunnel Bypass**	10.0	2.0	1.0	1.0	1.0	64	11
	Cut and Cover Tunnels	9.0	3.0	1.0	7.0	2.0	83	8
	Rock Sheds	8.0	4.0	4.0	2.0	3.0	72	9
Relocation	Structured Lanes with Barriers	6.0	2.0	3.0	2.0	2.0	51	16
	Highway Relocation with Ditch and Barrier	6.0	5.0	9.0	7.0	3.0	86	5
	Tunneled Lanes - Stacked Lanes	7.0	2.0	3.0	2.0	2.0	56	14
Protection	**Rockfall Protection Fences**	**5.0**	**7.0**	**5.0**	**8.0**	**6.0**	**94**	**1**
	Draped Cable Net / Wire Mesh	2.0	2.0	5.0	2.0	5.0	39	17
	Attenuators	**4.0**	**7.0**	**5.0**	**8.0**	**6.0**	**89**	**3**
	Diversion Berms	5.0	4.0	3.0	1.0	4.0	55	15
	Ditches	3.0	5.0	8.0	9.0	7.0	84	7
	Rockfall Barriers with Walls	3.0	8.0	7.0	7.0	5.0	85	6
	Warning Fences	1.0	8.0	5.0	9.0	9.0	87	4
	Rock Keepers with Fence	5.0	3.0	6.0	4.0	3.0	61	13
	Rockfall Protection Fences with Attenuators	**6.0**	**6.0**	**5.0**	**7.0**	**5.0**	**90**	**2**
Stabilization	Scaling and Trimming	1.0	2.0	5.0	9.0	8.0	61	13
	Rock Bolting	2.0	3.0	9.0	8.0	4.0	63	12
	Cable Lashing	2.0	5.0	8.0	7.0	5.0	69	10
	Anchored Cable Nets	3.0	2.0	7.0	6.0	4.0	56	14

Notes

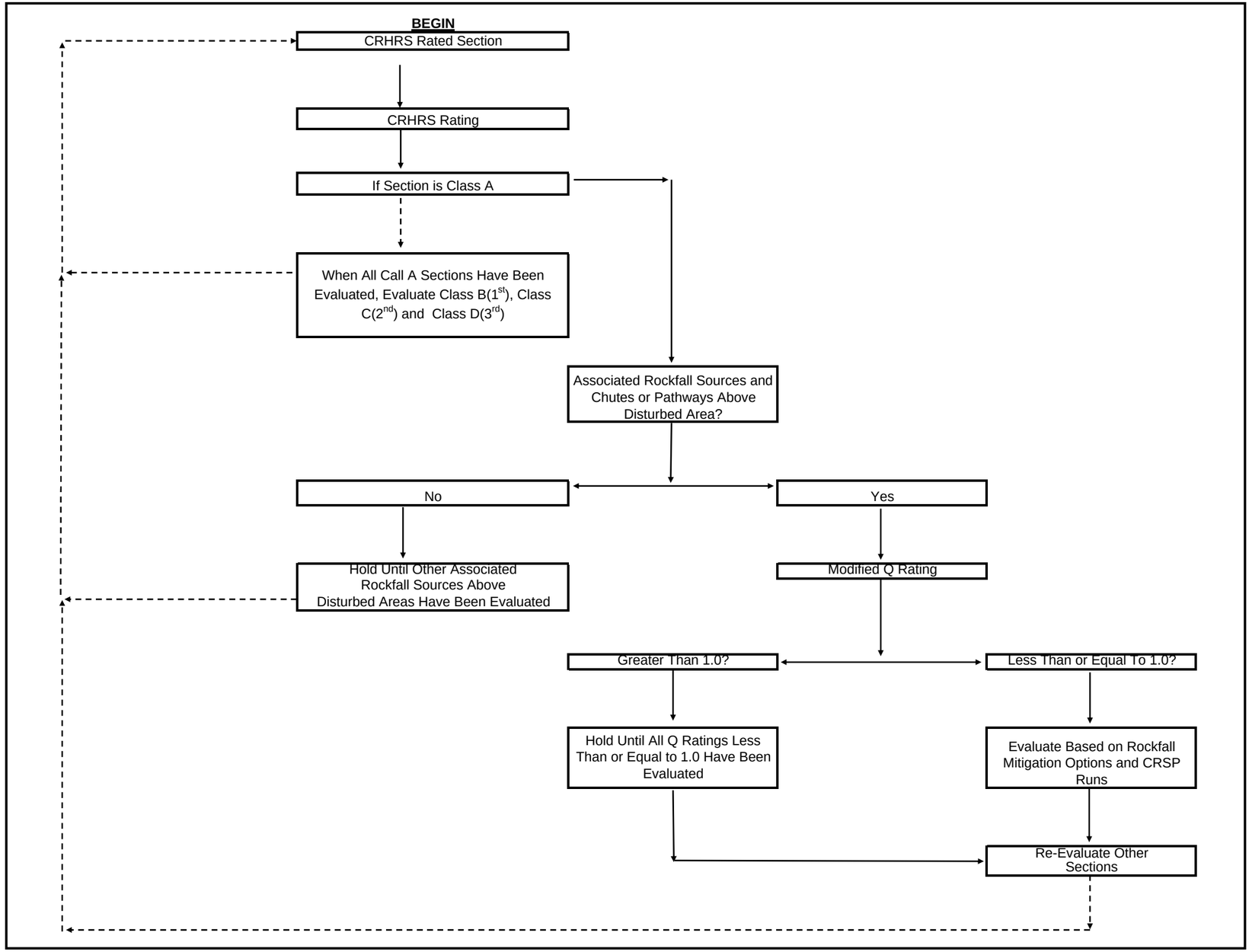
*Mitigation Option Must have an effectiveness greater than 3.0 to be considered.

** Tunnel Bypass Feasibility was addressed in the I-70 PEIS.

1 Least Effective	1 Least Constructible	1 Most Maintenance	1 Greater Impact	1 Higher Cost
10 Most Effective	10 Most Constructible	10 Least Maintenance	10 Less Impact	10 Lower Cost

APPENDIX C - FLOWCHART EVALUATION OF CRHRS AND Q RATING SYSTEMS

Flow Chart For Georgetown Incline Evaluation of Rockfall Potential



Flowchart Evaluation Of Rockfall Potential

TIER 1

Section (Associated Chutes/Pathways)	CRHRS Rating	CRHRS Class	Class A?	Associated Rock Fall Sources Above disturbed Area?	Lowest Modified Q Rating	Modified Q Rating Less than or Equal to 1?	Result
1(1)	390	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
2(2)	684	**A**	**yes**	yes	0.5	yes	Evaluate as Tier 1
2(PW A-3)	684	**A**	**yes**	yes	0.5	yes	Evaluate as Tier 1
3(3, 4, 10)	594	**A**	**yes**	yes	0.52	yes	Evaluate as Tier 1

TIER 1							
Section (Associated Chutes/Pathways)	**CRHRS Rating**	**CRHRS Class**	**Class A?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Less than or Equal to 1?**	**Result**
3(3, 4, 10)	594	**A**	**yes**	yes	0.52	yes	Evaluate as Tier 1
4(8)	414	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
5(NA)	252	**D**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6(PW B-6)	417	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6(PW C-9)	417	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
7(PW C-9)	543	**B**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D

TIER 1							
Section (Associated Chutes/Pathways)	**CRHRS Rating**	**CRHRS Class**	**Class A?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Less than or Equal to 1?**	**Result**
7(PW C-10)	543	**B**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
8(NA)	399	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
1a(5)	300	**D**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
1a(PW E-5)	300	**D**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
2a(9)	366	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
2a(PW E-5)	366	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D

TIER 1							
Section (Associated Chutes/Pathways)	**CRHRS Rating**	**CRHRS Class**	**Class A?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Less than or Equal to 1?**	**Result**
3a(9)	339	**D**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
4a(9)	462	**B**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
4a(PW E-7)	462	**B**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
5a(6)	405	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
5a(PW E-7)	405	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6a(6)	354	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D

TIER 1							
Section (Associated Chutes/Pathways)	**CRHRS Rating**	**CRHRS Class**	**Class A?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Less than or Equal to 1?**	**Result**
7a(7)	570	**A**	**yes**	yes	0.92	yes	Evaluate as Tier 1
7a(PW F-1)	570	**A**	**yes**	yes	0.42	yes	Evaluate as Tier 1
7a(PW F-2)	570	**A**	**yes**	yes	0.92	yes	Evaluate as Tier 1
7a (PW-F3)	570	**A**	**yes**		2.33	no	0

TIER 2							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class A?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Greater Than 1?**	**Result**
1(1)	390	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
4(8)	414	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
5(NA)	252	**D**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6(PW B-6)	417	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6(PW C-9)	417	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
7(PW C-9)	543	**B**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D

TIER 2							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class A?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Greater Than 1?**	**Result**
7(PW C-10)	543	**B**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
8(NA)	399	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
1a(5)	300	**D**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
1a(PW E-5)	300	**D**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
2a(9)	366	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
2a(PW E-5)	366	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D

TIER 2							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class A?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Greater Than 1?**	**Result**
3a(9)	339	**D**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
4a(9)	462	**B**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
4a(PW E-7)	462	**B**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
5a(6)	405	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
5a(PW E-7)	405	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6a(6)	354	**C**	**no**				Hold Until All Class A sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D

TIER 3							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class B?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Less than or Equal to 1?**	**Result**
7a(PW F-3)	570	**A**	**yes**	yes	2.33	yes	Evaluate as Tier 2
1(1)	390	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
4(8)	414	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
5(NA)	252	**D**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6(PW B-6)	417	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6(PW C-9)	417	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D

TIER 3							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class B?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Less than or Equal to 1?**	**Result**
7(PW C-9)	543	**B**	**yes**	yes	0.45	yes	Evaluate as Tier 3
7(PW C-10)	543	**B**	**yes**	yes	0.45	yes	Evaluate as Tier 3
8(NA)	399	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
1a(5)	300	**D**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
1a(PW E-5)	300	**D**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
2a(9)	366	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D

TIER 3							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class B?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Less than or Equal to 1?**	**Result**
2a(PW E-5)	366	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
3a(9)	339	**D**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
4a(PW E-7)	462	**B**	**yes**	yes	1.35	no	0
5a(6)	405	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
5a(PW E-7)	405	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6a(6)	354	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D

TIER 4							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class B?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Greater than 1?**	**Result**
1(1)	390	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
4(8)	414	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
5(NA)	252	**D**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6(PW B-6)	417	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6(PW C-9)	417	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
8(NA)	399	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D

TIER 4							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class B?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Greater than 1?**	**Result**
1a(5)	300	**D**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
1a(PW E-5)	300	**D**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
2a(9)	366	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
2a(PW E-5)	366	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
3a(9)	339	**D**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
4a(9)	462	**B**	**yes**	yes	1.35	yes	Evaluate as Tier 4

TIER 4							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class B?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Greater than 1?**	**Result**
4a(PW-E7)	462	**B**	**yes**	yes	1.35	yes	Evaluate as Tier 4
5a(PW E-7)	405	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6a(6)	354	**C**	**no**				Hold Until All Class B sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D

TIER 5							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class C?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Less than or Equal to 1?**	**Result**
1(1)	390	**C**	**yes**	yes	1.78	no	0
4(8)	414	**C**	**yes**	yes	0.92	yes	Evaluate as Tier 5
5(NA)	252	**D**	**no**				Hold Until All Class C sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6(PW B-6)	417	**C**	**yes**	yes	1.35	no	0
6(PW-C9)	417	**C**	**yes**	yes	0.45	yes	Evaluated As Tier 3
8(NA)	399	**C**	**yes**	yes	0.33	yes	Evaluate **No Associated Chute**

TIER 5							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class B?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Greater than 1?**	**Result**
1a(5)	300	**D**	**no**				Hold Until All Class C sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
1a(PW E-5)	300	**D**	**no**				Hold Until All Class C sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
2a(9)	366	**C**	**yes**	yes	0.56	yes	Evaluated As Tier 4
2a(PW E-5)	366	**C**	**yes**	yes	1.67	no	0
3a(9)	339	**D**	**no**				Hold Until All Class C sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
5a(6)	405	**C**	**yes**	yes	1.35	no	0

TIER 5							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class B?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Greater than 1?**	**Result**
5a(PW E-7)	405	**C**	**yes**	yes	1.35	no	0
6a(6)	354	**C**	**yes**	yes	0.27	yes	Evaluate as Tier 5

TIER 6							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class C?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Greater Than 1?**	**Result**
1(1)	390	**C**	**yes**	yes	1.78	Yes	Evaluate as Tier 6
5(NA)	252	**D**	**no**				Hold Until All Class C sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
6(PW-B6)	417	**C**	**yes**	yes	2.15	yes	Evaluate as Tier 6
1a(5)	300	**D**	**no**				Hold Until All Class C sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
1a(PW E-5)	300	**D**	**no**				Hold Until All Class C sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
2a(PW E-5)	366	**C**	**yes**	yes	1.67	yes	Evaluate as Tier 6

TIER 6							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class B?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Greater than 1?**	**Result**
3a(9)	339	**D**	**no**				Hold Until All Class C sections Have Been Evaluated, Then Evaluate Class B, Class C, and Class D
5a(6)	405	**C**	**yes**	yes	1.35	Yes	Evaluated As Tier 5
5a(PW E-7)	405	**C**	**yes**	yes	1.35	yes	Evaluated As Tier 4

TIER 7							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class D?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Less than or Equal to 1?**	**Result**
5(NA)	252	**D**	**yes**	yes	2.00	no	0
1a(5)	300	**D**	**yes**	yes	0.56	yes	Evaluate as Tier 7
1a(PW E-5)	300	**D**	**yes**	yes	1.67	no	0
3a(9)	339	**D**	**yes**	yes	4.00	no	0

TIER 8							
Section (Associated Chutes)	**CRHRS Rating**	**CRHRS Class**	**Class D?**	**Associated Rock Fall Sources Above disturbed Area?**	**Lowest Modified Q Rating**	**Modified Q Rating Greater Than 1?**	**Result**
5(NA)	252	**D**	**yes**	yes	2.00	yes	**No Associated Chute**
1a(PW-E5)	300	**D**	**yes**	yes	1.67	yes	Evaluated As Tier 6
3a(9)	339	**D**	**yes**	yes	4.00	yes	Evaluated As Tier 4

APPENDIX D - RESULTS OF FLOWCHART EVALUATION OF RATING SYSTEMS

Summary Sheet Results of Flowchart Evaluation

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker	Costs

Pathway A-3 (CRHRS A)

Tier Rating: 1 | **Chute/Pathway (Section):** Pathway A-3 (Section 2) | **Approximate Station to Station:** 3567+05 - 3574+75 | **Approximate Mile Marker to Mile Marker:** 226.05 - 226.20

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	760	760	LF	$2,000	$1,520,000	**$1,520,000**
Edge of Roadway	765	765	LF	$1,500	$1,147,500	**$1,147,500**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	760	760	LF	$2,000	$1,520,000	**$1,520,000**
Attenuator	0	0	LF	$2,000	$0	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	765	765	LF	$1,500	$1,147,500	**$2,667,500**
Attenuator	760	760	LF	$2,000	$1,520,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	760	760	LF	$2,000	$1,520,000	**$1,520,000**

Chute 2 (CRHRS A)

Tier Rating: 1 | **Chute/Pathway (Section):** Chute 2 (Section 2) | **Approximate Station to Station:** 3574+75 - 3576+40 | **Approximate Mile Marker to Mile Marker:** 226.20 - 226.23

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	165	165	LF	$2,000	$330,000	**$330,000**
Edge of Roadway	0	NA	LF	$1,500	NA	**NA**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	165	165	LF	$2,000	$330,000	**$510,000**
Attenuator	90	90	LF	$2,000	$180,000	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	165	165	LF	$1,500	$247,500	**$757,500**
Attenuator	255	255	LF	$2,000	$510,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	255	255	LF	$2,000	$510,000	**$510,000**

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker	Costs

Chute 3 (CRHRS A)

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	125	125	LF	$2,000	$250,000	**$250,000**
Edge of Roadway	145	145	LF	$1,500	$217,500	**$217,500**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	125	125	LF	$2,000	$250,000	**$390,000**
Attenuator	70	70	LF	$2,000	$140,000	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	145	145	LF	$1,500	$217,500	**$607,500**
Attenuator	195	195	LF	$2,000	$390,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	195	195	LF	$2,000	$390,000	**$390,000**

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker
1	Chute 3 (Section 2)	3581+70 - 3573+15	226.32 - 226.35

Chute 10 (CRHRS A)

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	30	30	LF	$2,000	$60,000	**$60,000**
Edge of Roadway	0	NA	LF	$1,500	NA	**NA**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	30	30	LF	$2,000	$60,000	**$120,000**
Attenuator	30	30	LF	$2,000	$60,000	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	35	35	LF	$1,500	$52,500	**$112,500**
Attenuator	30	30	LF	$2,000	$60,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	30	30	LF	$2,000	$60,000	**$60,000**

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker
1	Chute 10 (Section 2)	3585+15 - 3585+50	226.39 - 226.40

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker	Costs
1	Chute 4 (Section 2)	3587+30 - 3589+00	226.43 - 226.46	**Chute 4 (CRHRS A)**

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	155	155	LF	$2,000	$310,000	**$310,000**
Edge of Roadway	0	NA	LF	$1,500	NA	**NA**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	155	155	LF	$2,000	$310,000	**$1,490,000**
Attenuator	590	590	LF	$2,000	$1,180,000	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	200	200	LF	$1,500	$300,000	**$1,790,000**
Attenuator	745	745	LF	$2,000	$1,490,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	745	745	LF	$2,000	$1,490,000	**$1,490,000**

1	Pathway F-1 (Section 7a)	3640+45 - 3644+15	227.45 - 227.52	**Pathway F-1 (CRHRS A)**

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	365	365	LF	$2,000	$730,000	**$730,000**
Edge of Roadway	0	NA	LF	$1,500	NA	**NA**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	365	365	LF	$2,000	$730,000	**$730,000**
Attenuator	0	0	LF	$2,000	$0	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	370	370	LF	$1,500	$555,000	**$1,285,000**
Attenuator	365	365	LF	$2,000	$730,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	365	365	LF	$2,000	$730,000	**$730,000**

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker	Costs

Pathway F-2 (CRHRS A)

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	350	350	LF	$2,000	$700,000	**$700,000**
Edge of Roadway	370	370	LF	$1,500	$555,000	**$555,000**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	350	350	LF	$2,000	$700,000	**$700,000**
Attenuator	0	0	LF	$2,000	$0	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	370	370	LF	$1,500	$555,000	**$1,255,000**
Attenuator	350	350	LF	$2,000	$700,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	350	350	LF	$2,000	$700,000	**$700,000**

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker
1	Pathway F-2 (Section 7a)	3644+15 - 3647+85	227.52 - 227.59

Chute 7 (CRHRS A)

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	0	NA	LF	$2,000	NA	**NA**
Edge of Roadway	0	NA	LF	$1,500	NA	**NA**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	65	65	LF	$2,000	$130,000	**$250,000**
Attenuator	60	60	LF	$2,000	$120,000	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	60	60	LF	$1,500	$90,000	**$220,000**
Attenuator	65	65	LF	$2,000	$130,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	65	65	LF	$2,000	$130,000	**$130,000**

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker
1	Chute 7 (Section 7a)	3647+85 - 3648+45	227.59 - 227.61

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker	Costs

Pathway F-3 (CRHRS A)

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	150	150	LF	$2,000	$300,000	**$300,000**
Edge of Roadway	0	NA	LF	$1,500	NA	**NA**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	150	150	LF	$2,000	$300,000	**$300,000**
Attenuator	0	0	LF	$2,000	$0	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	150	150	LF	$1,500	$225,000	**$525,000**
Attenuator	150	150	LF	$2,000	$300,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	150	150	LF	$2,000	$300,000	**$300,000**

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker
2	Pathway F-3 (Section 7a)	3648+45 - 3650+50	227.61 - 226.64

Pathway C-9 (CRHRS B)

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	170	170	LF	$2,000	$340,000	**$340,000**
Edge of Roadway	175	175	LF	$1,500	$262,500	**$262,500**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	170	170	LF	$2,000	$340,000	**$340,000**
Attenuator	0	0	LF	$2,000	$0	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	175	175	LF	$1,500	$262,500	**$602,500**
Attenuator	170	170	LF	$2,000	$340,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	170	170	LF	$2,000	$340,000	**$340,000**

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker
3	Pathway C-9 (Section 6, 7)	3600+00 - 3602+05	226.68 - 226.71

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker	Costs
3	Pathway C-10 (Section 7, 8)	3604+40 - 3608+50	226.76 - 226.84	**Pathway C-10 (CRHRS B)** **Option I** — **Rockfall Fence** Top of Cut: Length 410, Quantity 410, LF, $2,000, Subtotal $820,000, **Total $820,000** Edge of Roadway: Length 0, NA, LF, $1,500, NA, **Total NA** **If Avg CRSP Bounce Height >20ft Then "NA"** **Option IIa** — **Rockfall Fence With Attenuators (Top of Cut)** Fence (TOC): Length 410, Quantity 410, LF, $2,000, Subtotal $820,000 Attenuator: Length 0, Quantity 0, LF, $2,000, $0 **Total $820,000** **Option IIb** — **Rockfall Fence With Attenuators (Edge of Roadway)** Fence (EOR): Length 410, Quantity 410, LF, $1,500, $615,000 Attenuator: Length 410, Quantity 410, LF, $2,000, $820,000 **Total $1,435,000** **Option III** — **Attenuator (Without Rockfall Fence)** Attenuator: Length 410, Quantity 410, LF, $2,000, Amount $820,000, **Total $820,000**
4	Chute 9 (Section 2a, 3a, 4a)	3631+20 - 3633+60	227.27 - 227.32	**Chute 9 (CRHRS B)** **Option I** — **Rockfall Fence** Top of Cut: Length 250, Quantity 250, LF, $2,000, Subtotal $500,000, **Total $500,000** Edge of Roadway: Length 240, Quantity 240, LF, $1,500, $360,000, **Total $360,000** **If Avg CRSP Bounce Height >20ft Then "NA"** **Option IIa** — **Rockfall Fence With Attenuators (Top of Cut)** Fence (TOC): Length 250, Quantity 250, LF, $2,000, Subtotal $500,000 Attenuator: Length 255, Quantity 255, LF, $2,000, $510,000 **Total $1,010,000** **Option IIb** — **Rockfall Fence With Attenuators (Edge of Roadway)** Fence (EOR): Length 240, Quantity 240, LF, $1,500, $360,000 Attenuator: Length 505, Quantity 505, LF, $2,000, $1,010,000 **Total $1,370,000** **Option III** — **Attenuator (Without Rockfall Fence)** Attenuator: Length 505, Quantity 505, LF, $2,000, Amount $1,010,000, **Total $1,010,000**

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker	Costs
4	Pathway E-7 (Section 4a, 5a)	3633+60 - 3637+10	227.32 - 227.38	**Pathway E-7 (CRHRS B)**

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	340	340	LF	$2,000	$680,000	**$680,000**
Edge of Roadway	340	340	LF	$1,500	$510,000	**$510,000**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	340	340	LF	$2,000	$680,000	**$680,000**
Attenuator	0	0	LF	$2,000	$0	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	340	340	LF	$1,500	$510,000	**$1,190,000**
Attenuator	340	340	LF	$2,000	$680,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	340	340	LF	$2,000	$680,000	**$680,000**

5	Chute 8 (Section 4)	3593+30 - 3593+60	226.55 - 226.56	**Chute 8 (CRHRS C)**

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	30	30	LF	$2,000	$60,000	**$60,000**
Edge of Roadway	35	35	LF	$1,500	$52,500	**$52,500**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	30	30	LF	$2,000	$60,000	**$60,000**
Attenuator	0	0	LF	$2,000	$0	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	35	35	LF	$1,500	$52,500	**$112,500**
Attenuator	30	30	LF	$2,000	$60,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	30	30	LF	$2,000	$60,000	**$60,000**

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker	Costs
5	(Section 8) No Associated Chute or Pathway	3608+10 - 3618+60	226.83 - 227.04	
5	Chute 6 (Section 5a, 6a)	3637+10 - 3640+45	227.38 - 227.45	**Chute 6 (CRHRS C)**

Option I — **Rockfall Fence**

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	320	320	LF	$2,000	$640,000	**$640,000**
Edge of Roadway	345	345	LF	$1,500	$517,500	**$517,500**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — **Rockfall Fence With Attenuators (Top of Cut)**

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	320	320	LF	$2,000	$640,000	**$970,000**
Attenuator	165	165	LF	$2,000	$330,000	

Option IIb — **Rockfall Fence With Attenuators (Edge of Roadway)**

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	345	345	LF	$1,500	$517,500	**$1,487,500**
Attenuator	485	485	LF	$2,000	$970,000	

Option III — **Attenuator (Without Rockfall Fence)**

	Length	Quantity	Type	Price	Amount	Total
Attenuator	485	485	LF	$2,000	$970,000	**$970,000**

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker	Costs
6	Chute 1 (Section 1)	3564+10 - 3567+10	226.00 - 226.59	**Chute 1 (CRHRS C)**

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	300	300	LF	$2,000	$600,000	**$600,000**
Edge of Roadway	300	300	LF	$1,500	$450,000	**$450,000**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	300	300	LF	$2,000	$600,000	**$1,520,000**
Attenuator	460	460	LF	$2,000	$920,000	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	300	300	LF	$1,500	$450,000	**$1,970,000**
Attenuator	760	760	LF	$2,000	$1,520,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	760	760	LF	$2,000	$1,520,000	**$1,520,000**

6	Pathway B-6 (Section 6)	3595+00 - 3597+20	226.68 - 226.71	**Pathway B-6 (CRHRS C)**

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	380	380	LF	$2,000	$760,000	**$760,000**
Edge of Roadway	400	400	LF	$1,500	$600,000	**$600,000**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	380	380	LF	$2,000	$760,000	**$760,000**
Attenuator	0	0	LF	$2,000	$0	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	400	400	LF	$1,500	$600,000	**$1,360,000**
Attenuator	380	380	LF	$2,000	$760,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	380	380	LF	$2,000	$760,000	**$760,000**

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker	Costs
6	Pathway E-5 (Section 1a, 2a)	3625+40 - 3608+50	227.16 - 227.27	**Pathway E-5 (CRHRS C)**

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	545	545	LF	$2,000	$1,090,000	**$1,090,000**
Edge of Roadway	0	NA	LF	$1,500	NA	**NA**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	545	545	LF	$2,000	$1,090,000	**$1,090,000**
Attenuator	0	0	LF	$2,000	$0	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	600	600	LF	$1,500	$900,000	**$1,990,000**
Attenuator	545	545	LF	$2,000	$1,090,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	545	545	LF	$2,000	$1,090,000	**$1,090,000**

7	Chute 5 (Section 1a)	3622+30 - 3625+40	227.10 - 227.16	**Chute 5 (CRHRS D)**

Option I — Rockfall Fence

	Length	Quantity	Type	Price	Subtotal	Total
Top of Cut	305	305	LF	$2,000	$610,000	**$610,000**
Edge of Roadway	315	315	LF	$1,500	$472,500	**$472,500**

If Avg CRSP Bounce Height >20ft Then "NA"

Option IIa — Rockfall Fence With Attenuators (Top of Cut)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (TOC)	305	305	LF	$2,000	$610,000	**$1,940,000**
Attenuator	665	665	LF	$2,000	$1,330,000	

Option IIb — Rockfall Fence With Attenuators (Edge of Roadway)

	Length	Quantity	Type	Price	Subtotal	Total
Fence (EOR)	315	315	LF	$1,500	$472,500	**$2,412,500**
Attenuator	970	970	LF	$2,000	$1,940,000	

Option III — Attenuator (Without Rockfall Fence)

	Length	Quantity	Type	Price	Amount	Total
Attenuator	970	970	LF	$2,000	$1,940,000	**$1,940,000**

Tier Rating	Chute/Pathway (Section)	Approximate Station to Station	Approximate Mile Marker to Mile Marker	Costs
8	(Section 5) No Associated Chute or Pathway	3594+00 - 3594+50	226.57 - 226.58	

APPENDIX E - SUMMARY SHEET OF TIER RATINGS AND CRSP RESULTS

Summary Of CRSP Results From Selected Cross Sections

Chute/Pathway (Section)	Rockfall From Top Of Slope (Chute or Pathway)								Rockfall From Top Of Disturbed (Chute or Pathway)									
	Average Energies				Average Speed		Average Bounce Height		Average Energies				Average Speed		Average Bounce Height		Approximate Length	Tier Rating
	ft-lbs		KJ		ft/sec		ft		ft-lbs		KJ		ft/sec		ft		ft	
	AP1	AP3	AP1	AP3	AP1	AP3	AP1	AP3	AP1	AP3	AP1	AP3	AP1	AP3	AP1	AP3		
2 (2)	786786	1130459	1067	1533	59	74	5	28	28126	54173	38	73	45	66	4	20	165	1
3 (3)	1080822	783670	1466	1063	71	53	12	5	58055	42363	79	57	66	49	9	5	125	1
4 (4)	1063947	1723215	1443	2337	71	93	16	40	23119	83009	31	113	40	76	3	18	155	1
7 (7a)	1917615	2404145	2600	3260	96	109	9	33	82280	121733	112	165	78	99	6	29	65	1
Pathway A3	1298376	367308	1761	498	77	36	5	1	76773	14827	104	20	73	29	4	1	760	1
Pathway F1	2830444	3319940	3838	4502	115	127	21	70	144794	178276	196	242	103	117	9	54	365	1
Pathway F2	1413833	1177082	1917	1596	81	67	10	9	NA	1508	NA	2	NA	9	NA	0	350	1
Pathway F3	623395	1221821	845	1657	77	54	6	26	NA	593	NA	1	NA	6	NA	0	150	2
Pathway C9	-	-	-	-	-	-	-	-	60496	2192	82	3	68	11	7	0	170	3
Pathway C10	675019	1406610	915	1907	56	85	5	28	32928	84167	45	114	49	82	3	17	410	3
9 (2a, 3a, 4a)	1048667	1010696	1422	1370	71	65	13	13	57209	54232	78	74	65	59	10	13	250	4
Pathway E7	823757	394249	1117	535	62	34	8	2	NA	1453	NA	2	NA	9	NA	0	340	4
6a (6a)	1180880	542882	1601	736	76	39	12	4	338818	17008	459	23	54	27	5	1	320	5
6b (5a)	-	-	-	-	-	-	-	-	28998	41108	39	56	47	54	6	11	-	5
8 (4)	465497	475783	631	645	46	47	2	3	3598	*NA	5	*NA	16	*NA	1	*NA	30	5
1 (1)	727178	424482	986	576	56	36	7	3	53786	26731	73	36	61	35	7	3	300	6
10 (3)	1052983	916869	1428	1243	72	66	11	31	24324	8671	33	12	43	19	6	1	30	**6
Pathway B6	1501113	228808	2035	310	83	27	6	1	50350	2395	68	3	61	11	5	0	380	6
Pathway E5	2752717	1706496	3732	2314	116	77	24	16	92606	55568	126	75	84	55	18	7	545	6
5 (1a)	748926	794287	1015	1077	59	60	4	4	29866	2268	40	3	48	11	9	0	305	**7

Notes:

1) AP1 is located approximately at top of cut slope.
2) AP3 is located approximately at edge of roadway.
3) Rockfall from top of chute consisted of a 5 foot diameter boulder.
4) Rockfall from top of disturbed consisted of a 2 foot diameter boulder.
5) NA denotes AP 1 not evaluated due to source being located at top of cut slope.
6) *NA denotes no rocks past AP.
7) ** Denotes areas with lower CRHRS ratings and lower Modified Q ratings

APPENDIX F - ODOT EVALUATION SUMMARY

ODOT Catchment Area Analysis (From Top of Cut to Edge of Roadway)

	Approximate Slope Height (feet/meters)	Approximate Measured Slope Angle (Degrees)	Slope Ratio Used (H:V)	Approximate Measured Catchment Area Angle (Degrees)	Approximate Measured Catchment Ratio (V:H)	Catchment Area Ratio Used	Approximate Catchment Area Width (feet/meters)	Percentage of Rocks Remaining In Catchment Area	Approximate Distance to Edge Of Asphalt (feet)	99th Percentile Impact Distance
Section 2 3570+00	130/40	45	1:1	8	1:7	1:6	18/5	54	26	10
Section 3 3585+00	20/6	78	4:1	10	1:5.5	1:6	28/9	99	32	10
Section 4 3595+00	100/31	67	2:1	11	1:5	1:5	24/7	96	30	19
Section 6 3600+00	90/27	67	2:1	18	1:3	1:4	3-Oct	75	22	22
Section 7 3605+00	85/26	72	4:1	9	1:6	1:6	30/9	89	34	22
Section 8 3615+00	80/24	36	1:1	10	1:5.5	1:6	18/5	54	24	10
Section 1a 3625+00	105/32	76	4:1	8	1:7	1:6	38/12	99	28	22
Section 2a 3630+00	50/50	71	4:1	12	1:5	1:4	16/6	97	20	12
Section 4a 3635+00	80/24	69	2:1	10	1:5.5	1:6	26/8	95	28	19
Section 6a 3640+00	55/17	76	4:1	10	1:5.5	1:6	20/6	82	24	16
Section 7a 3645+00	100/31	76	4:1	13	1:4	1:4	18/5	75	24	22

Notes:

1) Ratings Based on Rockfall Catchment Area Design Guide, Oregon Department Of Transportation Research Group, December 2001
2) Slope measurements are approximate.

APPENDIX G - MODIFIED Q RATINGS FROM PREVIOUS ROCKFALL EVALUATION REPORT (11/13/03)

Georgetown Incline Q Ratings

Chute	Mile Range	Outcrops	Ratings									Ave.
1	226.0-226.05	A3,A4	0.44	0.56	1.78							0.93
2	226.20-226.23	A1,A2	4.00	1.56	1.33	3.00	2.00					2.38
3	226.32-226.35	A1,A2,B3,B7,B8	4.00	1.56	1.33	3.00	2.00	1.00	1.11	3.50	1.73	2.14
4	226.43-226.46	B1,B2,B3,B4	0.52	0.69	0.69	0.64	1.00	1.11	0.92	2.33	1.88	1.09
5	227.10-227.16	E1,E2,E3,E4,E5,E8	2.22	1.11	0.56	0.56	1.67	5.00				1.85
6	227.38-227.45	E6,E7,E9,F1,F4	4.00	1.35	2.50	0.50	0.27	0.50	0.00			1.30
7	227.55-227.61	F2,F3										
8	226.55-226.56	B4,B6,C7	0.92	2.33	1.88	2.31	2.00	0.98	0.93			1.62
9	227.27-227.32	E1,E2,E3,E5,E6	2.22	1.11	0.56	1.67	4.00					1.91
10	226.39-226.40	B3,B7,B8	1.00	1.11	3.50	1.73						1.84
Pathway A-3	226.05-226.20	A-3	0.40	0.56								0.50
Pathway B-6	226.59-226.66	B-6	2.31	2.00								2.15
Pathway C-9	226.68-226.71	C-9	0.44	0.46								0.45
Pathway C-10	226.76-226.84	C-10	0.77	0.42								0.60
Pathway E-5	227.16-227.27	E-5	1.67									1.67
Pathway E-7	227.32-227.38	E-7	1.35									1.35
Pathway F-1	227.45-227.52	F-1	0.50	0.27	0.50							0.42
Pathway F-2	227.52-227.59	F-2	0.83	1.00								0.92
Pathway F-3	227.61-227.64	F-3	2.33									2.33

Notes:Chute 8 is already meshed. Chute 4 fenced and meshed Nov. 2000. Chute 6 fenced and meshed Jan. 2001.

Outcrops	Mile Range	Ratings							Ave.
A1,A2	226.12-226.36	1.56	1.33	2.00	3.00				1.97
A3	226.06-226.19	0.44	0.56						0.50
A4	226.0-226.05	1.78	0.98						1.38
B1,B2,B3,B7,B8	226.36-226.57	1.00	1.11	1.73	0.52	0.69	0.64		0.95
B4,B5	226.5-226.6	0.92	2.33	1.88	2.73				1.96
B6	226.64-226.67	2.31	2.00						2.15
C's	226.58-226.83	1.48	1.67	1.67	1.85	1.28	0.46	0.77	1.09
		1.39	0.98	0.93	1.00	0.93	0.44	0.42	
D's	226.83-226.92	0.33	1.00	1.00					0.78
E1,E8	226.92-227.16	2.22	5.00						3.61
E2,E3,E4,E5	227.22-227.25	1.11	0.56	1.67	0.56				0.97
E6,E7,F4	227.32-227.37	1.35	0.00						0.67
E9	227.37-227.44	2.50							2.50
F1,F2,F3	227.44-227.63	0.50	0.27	0.50	0.83	1.00			0.62

Note: outcrops that do not have a path to highway are not included

Outcrop	A-1		A-1		A-1		A-2		A-2		A-3		A-3	
Date/Engineer	6/28/00	BA	2/2/01	KP/BA	6/15/00	BA	6/28/00	BA	6/15/00	BA	6/28/00	BA	6/28/00	BA
RQD	60-80	60	70-80	70	50-100	70	60-90	60	50-100	60	30-60	40	30-60	40
J_n		6		7		6		12		6		12		12
J_r		2		1.5		1		2		1.5		2		2.5
J_{alt}		1		1		1		1		1		1		1
J_w		1		1		1		1		1		1		1
J_{apr}		5		5		7.5		7.5		7.5		15		15
Q Rating		4.00		3.00		1.56		1.33		2.00		0.44		0.56

Outcrop	A-4		B-1		B-2		B-2		B-2		B-3		B-3	
Date/Engineer	06/28/00	BA	06/15/00	BA	09/28/00	KP	06/15/00	BA	02/02/01	BA/KP	06/15/00	BA	06/15/00	BA
RQD	30-60	40	30-90	40	40-75	50	30-80	50	50	50	60-90	60	60-90	60
J_n		6		9		12		9		12		6		6
J_r		2		1		1.5		1.5		1		1		1
J_{alt}		1		1		1		1		1		1		1
J_w		1		1		1		1		1		1		1
J_{apr}		7.5		8.5		9		12		6.5		10		9
Q Rating		1.78		0.52		0.69		0.69		0.64		1.00		1.11

Outcrop	B-4		B-4		B-4		B-5		B-6		B-6		B-7	
Date/Engineer	9/28/00	KP	9/28/00	KP	9/28/00	KP	10/16/00	KP	10/16/00	KP	6/28/00	BA	10/23/00	KP
RQD	50-80	60	60-90	60	30-60	60	50-80	60	30-70	45	30-60	45	70-100	70
J_n		13		6		6		6		6		6		6
J_r		1.5		1.75		1.5		1.5		2		2		1.5
J_{alt}		1		1		1		1		1		1		1
J_w		1		1		1		1		1		1		1
J_{apr}		7.5		7.5		8		5.5		6.5		7.5		5
Q Rating		0.92		2.33		1.88		2.73		2.31		2.00		3.50

Outcrop	B-8		B-9		C-1		C-1		C-2		C-3		C-3	
Date/Engineer	10/23/00	KP	2/2/01	KP/BA	6/28/00	BA	6/30/00	BA	6/30/00	BA	6/30/00	BA	2/2/01	KP/BA
RQD	60-80	60	60-80	70	40-70	50	40-70	50	50-90	50	40-60	50	60-80	60
J_n	8		4		9		9		9		6		9	
J_r	1.5		1.5		1		2		2		1.5		1.5	
J_{alt}	1		1		1		1		1		1		1	
J_w	1		1		1		1		1		1		1	
J_{apr}	6.5		3		10		15		7.5		7.5		6	
Q Rating	1.73		8.75		0.56		0.74		1.48		1.67		1.67	

Outcrop	C-4*		C-4		C-5		C-6*		C-6		C-7*		C-7	
Date/Engineer	11/6/00	KP	2/2/01	KP/BA	6/30/00	BA	11/6/00	KP	2/2/01	KP/BA	11/7/00	KP	2/2/01	KP/BA
RQD	70-100	70	50-60	55	50-70	50	40-80	50	50	50	50-70	50	50	50
J_n	11		9		9		9		9		6		6	
J_r	1.5		1.25		2.5		1.5		1.25		1		1	
J_{alt}	1		1		1		1		1		1		1	
J_w	1		1		1		1		1		1		1	
J_{apr}	6.5		5		7.5		6.5		5		8.5		9	
Q Rating	1.47		1.53		1.85		1.28		1.39		0.98		0.93	

Outcrop	C-8*		C-8		C-9*		C-9		C-10*		C-10		D-1	
Date/Engineer	11/7/00	KP	2/2/01	KP/BA	11/7/00	KP	2/2/01	KP/BA	11/7/00	KP	2/2/01	KP/BA	6/28/00	BA
RQD	40-80	50	40-60	50	30-70	40	30-50	40	40-80	40	40	40	20-50	30
J_n	10		9		12		12		12		12		12	
J_r	1.5		1.5		1		1.25		1.5		1		1.2	
J_{alt}	1		1		1		1		1		1		1	
J_w	1		1		1		1		1		1		1	
J_{apr}	7.5		9		7.5		9		6.5		8		9	
Q Rating	1.00		0.93		0.44		0.46		0.77		0.42		0.33	

Outcrop	D-2		D-3/D-4		D-5		D-6		E-1		E-2		E-3	
Date/Engineer	6/29/00	BA	6/29/00	BA	2/2/01	KP/BA	2/2/01	BA/KP	6/30/00	BA	6/29/00	BA	2/2/01	KP/BA
RQD	30-60	30	30-60	30	40-60	50	50-60	55	40-80	40	40-80	50	40-60	50
J_n		6		12		6		2		6		9		12
J_r		2		1		1.5		1.5		2		1.5		1
J_{alt}		1		1		1		1		1		1		1
J_w		1		1		1		1		1		1		1
J_{apr}		10		2.5		8		5		6		7.5		7.5
Q Rating		1.00		1.00		1.56		8.25		2.22		1.11		0.56

Outcrop	E-4		E-5		E-6 (SOUTH)		E-7		E-8		E-9		F-1	
Date/Engineer	6/29/00	BA	6/29/00	BA	6/29/00	BA	10/23/00	KP	6/30/00	BA	9/27/00	BA/KP	9/27/00	BA/KP
RQD	40-80	50	50-90	50	60-100	60	70-100	70	50-60	50	70-90	70	40-60	40
J_n		9		6		6		12		4		7		12
J_r		1.5		1.5		2		1.5		2		1.5		1.5
J_{alt}		1		1		1		1		1		1		1
J_w		1		1		1		1		1		1		1
J_{apr}		15		7.5		5		6.5		5		6		10
Q Rating		0.56		1.67		4.00		1.35		5.00		2.50		0.50

Outcrop	F-1		F-1 (GT)		F-2		F-2		F-3	
Date/Engineer	6/29/00	BA	6/29/00	BA	9/27/00	KP/BA	9/27/00	BA/KP	9/27/00	BA/KP
RQD	30-60	40	30-80	40	40-70	50	50-70	50	70-90	70
J_n		12		12		12		10		6
J_r		1		1.5		1.5		1.5		1.5
J_{alt}		1		1		1		1		1
J_w		1		1		1		1		1
J_{apr}		12.5		10		7.5		7.5		7.5
Q Rating		0.27		0.50		0.83		1.00		2.33

* Rated from photos

Comments

A-1:	Cliff forms vertical face approx. 100 ft, buttress by A-2, natural catchments.
A-2:	Prominent cliff from vertical faces, > 200 ft vertical, 1 joint set dips into cliff face, topple/wedge failures, chute goes directly to I-70.
A-3:	Loose rocks visible on face approx. 6" to 2' in size.
B-2:	perched rocks ready to fall, areas of poor rock, probable source for rockfall, talus on slope in front of outcrop..
B-4:	1 joint set perpendicular to I-70, areas of "sugar cubes".
B-6:	Vertical joint set perpendicular to I-70.
C-1:	Very high on slope, surrounded by trees.
C-4:	A lot of loose rocks on top of outcrop, talus in front, no direct path to highway, trees in pathway.
C-6	Small outcrop surrounded by trees, covered with gravel, colluvium, talus in front.
C-7:	Glacial polished, large boulder ~20'x30' pending wedge failure.
C-9:	Prominent vertical joints, evidence of past wedge failures.
C-10:	1 area of outcrop is very bad, just above highway, wedge failures.
D-1:	Distinct cliff face with wedge and joint failures, y intersection of two pervasive fractures readily visible.
D-2:	Probably too high to have major rock fall to I-70, trees and multiple gullies for rocks.
D-4/D-3:	D-4 is below and very similar to D-3, both D-3 and D-4 rockfall is partially stopped by old mine tailings.
D-5:	Talus below outcrop.
E-1:	DV end of outcrop is in chute zone to I-70, but not main chute.
E-2:	Loose rock on outcrop. Top most likely source for chute. E-3 is connected with similar characteristics.
E-3:	Wedge failures, perched rocks, lots of trees in outcrop.
E-4:	Glacially polished with talus slope on up side of outcrop. Exfoliation-talus slope source area for rockfall in chute, perched rocks.
E-5:	Outcrop is above I-70. Probably contributes rockfall, but not major.
E-6 (SOUTH):	Prominent joint set along foliation plane vertical and perpendicular to I-70. Top of outcrop is glacially polished.
E-8:	Tight with small boulders on outcrop.
F-1:	Large planar and wedge failures, visible planar failure 20x60x60 ft. Perched rock ready to fall.
F-2:	A lot of perched rock ready to fall.
F-3:	Glacially polished.
F-4:	Scree slope at base of outcrop, probable source outcrop for rockfall

Appendix B.
Programmatic Agreement Among the Federal Highway Administration, the Advisory Council on Historic Preservation, the United States Department of Agriculture Forest Service-Rocky Mountain Region, the Colorado Department of Transportation and the State Historic Preservation Officer Regarding Rockfall Mitigation Projects along Interstate 70 within the Georgetown-Silver Plume National Historic Landmark District

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Programmatic Agreement
Among
The Federal Highway Administration,
the Advisory Council on Historic Preservation,
the United States Department of Agriculture Forest Service-Rocky Mountain Region,
the Colorado Department of Transportation,
and the State Historic Preservation Officer

Regarding Rockfall Mitigation Projects along Interstate 70 within the Georgetown-Silver Plume National Historic Landmark District (5CC3)

WHEREAS, the Federal Highway Administration (FHWA), in cooperation with the Colorado Department of Transportation (CDOT), has identified the need to mitigate rockfall hazards along Interstate 70 between highway mileposts 226 and 228 for safety purposes; and

WHEREAS, the proposed rockfall mitigation projects will take place within the boundary of the Georgetown-Silver Plume National Historic Landmark District (5CC3) and the FHWA has determined that these projects may have a cumulative *adverse effect* on the NHL, which is listed in the National Register of Historic Places; and

WHEREAS, the proposed rockfall mitigation projects involve the installation of rockfall containment systems along the north side of Interstate 70 on the Georgetown incline and consist of rockfall fencing, attenuator systems, draped wire mesh, other rockfall prevention measures, and possible rockfall scaling in areas identified as rockfall hazards; and

WHEREAS, FHWA has consulted with the State Historic Preservation Officer (SHPO) pursuant to 36 CFR Part 800 and SHPO has concurred with FHWA's determination of that the proposed rockfall projects will result in a cumulative *adverse effect* on the Georgetown-Silver Plume NHL; and

WHEREAS, FHWA has notified the Advisory Council on Historic Preservation (Council) of the cumulative *adverse effect* pursuant to 36 CFR 800.6(a)(1), the Council has participated in the development of the agreement, and has been invited to sign the Agreement; and

WHEREAS, FHWA has notified the United States Department of Agriculture Forest Service, Rocky Mountain Region (USFS) of the cumulative *adverse effect*, the USFS has participated in the development of this Agreement, and has been invited to sign the Agreement; and

WHEREAS, Clear Creek County, the Town of Georgetown, the Town of Silver Plume, the Georgetown Silver Plume Historic District Public Lands Commission, and the Colorado Historical Society have participated in consultations leading to the development of this document and have been invited to concur in the Agreement; and

WHEREAS, FHWA has notified the Secretary of the Interior of the potential for effects to the Georgetown-Sliver Plume NHL, pursuant to 36 CFR 800.10, and the National Park Service, Intermountain Region (NPS) has participated in consultations and has been invited to concur in this Agreement; and

WHEREAS, this Agreement was developed in accordance with the Advisory Council on Historic Preservation's Regulations, Section 800.14(b) of the regulation (36 CFR Part 800) implementing Section 106 of the National Historic Preservation Act (16 U.S.C. 470s) and Section 110(f) of the same Act (16 U.S.C. 470h-2(f)), and its purpose is to streamline the Section 106 review process for rockfall mitigation projects between mileposts 226 and 228 along Interstate 70 and to provide guidelines for mitigation for the NHL; and

WHEREAS, execution of this Agreement does not terminate or supersede the Programmatic Agreement (PA) for the Interstate 70 Mountain Corridor Project, which outlines the Section 106 process for the Tier I and Tier II phases of that project, including the area along Interstate 70 between mileposts 226 and 228; and

WHEREAS, FHWA and CDOT have consulted with the Cheyenne and Arapaho Tribes of Oklahoma, Kiowa Tribe of Oklahoma, Northern Arapaho Tribe, Northern Cheyenne Tribe, Rosebud Sioux Tribe, Southern Ute Indian Tribe, Standing Rock Sioux Tribe, Ute Mountain Ute Tribe, Ute Tribe of the Uintah and Ouray Agency, and White Mesa Ute Tribe for the Interstate 70 Mountain Corridor Project and addressed the treatment of properties of religious and cultural significance to those tribes, no additional tribal consultation will be conducted for the I-70 rock fall mitigation projects described herein; and

WHEREAS, CDOT carries out activities for federal aid transportation projects on behalf of FHWA, including Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's regulations, and the National Environmental Policy Act (NEPA) and, FHWA has requested CDOT to sign this Agreement as an invited signatory; and

NOW THEREFORE, FHWA, the Colorado SHPO, and the Council agree, and CDOT and the consulting parties concur, that the proposed rockfall mitigation projects along Interstate 70 within the boundary of the Georgetown-Silver Plume NHL shall be implemented in accordance with the following stipulations to satisfy FHWA's Section 106 responsibilities.

FHWA shall ensure that the following measures are carried out:

STIPULATIONS

A. Section 106 Consultation:

1. Rockfall mitigation projects between mileposts 226 and 228 on Interstate 70 along Georgetown Hill have been determined to have a cumulative *adverse effect*

on the Georgetown-Silver Plume NHL. Once these projects have been identified, CDOT, acting on behalf of FHWA, shall provide documentation to SHPO, NPS, USFS, Clear Creek County, the Town of Georgetown, the Town of Silver Plume, the Georgetown Silver Plume Historic District Public Lands Commission, and the Colorado Historical Society (hereafter, the consulting parties), including a description of the proposed project and the intention to invoke this Agreement to fulfill FWHA's responsibilities under Section 106. The documentation will include the elements outlined in 36 CFR Section 800.11 (e)(1) through (6).

2. For the purposes of Section 106, all resources identified within the project Area of Potential Effect (APE) are assumed to be contributing elements of the Georgetown-Silver Plume NHL as part of a larger cultural mining landscape. FHWA will not complete individual site forms or inventories of these resources.

3. For each rockfall mitigation project covered by this Agreement, CDOT will develop a treatment plan to be used in lieu of a standard Memorandum of Agreement (MOA) as outlined in 36 CFR Section 800.11(f). The following considerations will be made for each mitigation option method:

   a. Selection of colors for rockfall containment system materials will involve identification of terrain colors in proposed locations where fencing and other materials will be installed. Paint colors will be derived from actual landscape colors to develop a color spectrum for specific locations. The spectrum of colors will be applied to test panels and taken into the field where they will be photographed at different angles and distances to determine which colors are compatible with the surrounding hillside.

   b. Interpretive mitigation that describes the relationship between the geology of the surrounding landscape/hillsides and the historic mining industry in the Georgetown area. This could consist of signage, brochures, pamphlets, or other printed material. Content, design, materials, location, and other details will be determined on a project-by-project basis. A single interpretive sign or bird's-eye view sign may be applicable for all projects along this corridor. SHPO, NPS, and the consulting parties will be provided an opportunity to comment on any interpretive mitigation options.

   c. Other creative mitigation ideas identified during the course of project development and Section 106 consultation will also be considered but are not required under the terms of this agreement.

4. CDOT shall provide the consulting parties 30 days, from receipt, to review the documentation provided pursuant to Stipulation A.1, including any proposed treatment plan developed under Stipulation 3. Comments provided by consulting parties within this 30 day review period will be taken into account in finalizing the treatment plan. If, within the 30 day review period, any party objects to the

proposed project or treatment plan, CDOT will consult with FHWA and the objecting party, in accordance with Stipulation G. to resolve the objection.

B. **Coordination with National Environmental Policy Act (NEPA):** FHWA shall use this agreement as part of its responsibility to meet the requirements of NEPA, including rockfall projects that are classified as Categorical Exclusions, Environmental Assessments, and Environmental Impact Statements according to the NEPA guidelines.

C. **Coordination with Section 4(f) of the Department of Transportation Act (Section 4(f)):** When applicable, FHWA shall use this agreement as part of its responsibility to comply with Section 4(f) as it applies to historic properties.

D. **Post-Review Discoveries:** If it appears that an undertaking may affect a previously unidentified property that may be eligible for inclusion in the National Register or affect a known historic property in an unanticipated manner, FHWA will take all reasonable measures to avoid or minimize harm to the property until it concludes consultation with the SHPO and, if applicable, interested consulting tribes. If the newly discovered property has not previously been included in or determined eligible for inclusion in the National Register, FHWA may assume that the property is eligible for purposes of this Agreement. FHWA will notify the SHPO and, if applicable, the consulting tribes at the earliest possible time and consult to develop actions that will take the effects of the undertaking into account. FHWA will notify the SHPO and, if applicable, the tribes of any time constraints, and FHWA and the SHPO and, if applicable, the tribes will mutually agree upon time frames for this consultation. FHWA will develop written recommendations reflecting its consultation with SHPO and, if applicable, the tribes and will modify the scope of work as necessary to implement these recommendations.

E. **Emergencies:** The State of Colorado has in the past experienced various natural disasters and emergencies, including rockfall hazards that close the highway, that are likely to occur again in the future. During such a time FHWA may not be able to, and accordingly is not required to, contact the SHPO regarding actions that may involve effects to historic properties. FHWA shall undertake emergency actions pursuant to the terms of this agreement to assess historic properties and prevent further damage without SHPO consultation. Where possible, such emergency measures will be undertaken in a manner that does not foreclose future preservation or restoration efforts. FHWA will consult with SHPO on all emergency measures taken that will impact historic properties at the earliest time permitted by the emergency circumstances. Permanent repairs to historic properties beyond the scope of emergency repairs are not authorized by this stipulation. This stipulation does not apply to undertakings that will be implemented 30 days after the disaster or emergency.

F. **Review:** The Council and SHPO may review activities carried out pursuant to this Agreement and will review such activities, if so requested. FHWA and CDOT will cooperate with the Council and SHPO in carrying out their review responsibilities.

G. **Resolving objections**: Should any signatory to this Agreement or any consulting party object in writing to FHWA regarding any action carried out or proposed with respect to the implementation of this Agreement, FHWA shall consult with the objecting party. If after initiating such consultation FHWA determines that the objection cannot be resolved through consultation, it shall forward all documentation relevant to the objection to the Council, including FHWA's proposed response to the objection. Within 30 calendar days after receipt of all pertinent documentation, the Council shall exercise one of the following options:

a. Advise FHWA that the Council concurs with FHWA's proposed response to the objection, whereupon FHWA will respond to the objection accordingly; or

b. Provide FHWA with recommendations, which FHWA shall take into account in reaching a final decision regarding its response to the objection; or

c. Should the Council not exercise one of the above options within 30 calendar days after receipt of the pertinent documentation, FHWA may assume Council concurrence in its proposed response to the objection.

d. FHWA shall take into account any Council recommendation or comment provided in accordance with this stipulation with reference only to the subject of the objection; FHWA's responsibility to carry out all actions under this Agreement that are not the subjects of the objection shall remain unchanged.

e. At any time during implementation of any stipulation in this Agreement, should an objection to any such stipulation or its manner of implementation be raised by a member of the public, FHWA shall take the objection into account and consult as needed with the objecting party, the Council and SHPO to address the objection.

H. **Reporting requirements**: By July 1 of each year this agreement is in effect, CDOT will provide a report to the parties to this Agreement on the status of the Programmatic Agreement, including mitigation measures applied to the NHL.

I. **Amendment**: The Council, SHPO, FHWA, or CDOT may request that this Agreement be amended, whereupon they will consult to consider such amendment. No amendment shall take effect until it has been executed by all signatories.

J. **Termination**: The Council, SHPO, FHWA, or CDOT may propose to terminate this Agreement by providing thirty (30) calendar days notice to the other parties explaining the reason(s) for the proposed termination. The Council, SHPO, and FHWA and CDOT will consult during this period to seek agreement on amendments or other actions that would avoid termination. In the event of termination, FHWA will comply with 36 CFR Sections 800.3 through 800.7 with regard to individual undertakings covered by this Agreement.

K. **Failure to carry out agreement**: In the event FHWA does not carry out the terms of this Agreement or if the Council determines under 36 CFR Section 800.14(b)(2)(v) that the terms of this Agreement are not being carried out, FHWA will comply with 36 CFR Sections 800.3 through 800.7 with regard to individual undertakings covered by this Agreement.

L. **Duration**: This Agreement shall become effective upon execution by FHWA, SHPO and the Council. The terms of this agreement shall expire on October 1, 2018 unless the signatory parties agree, in writing, to an extension of this term prior to the date of expiration.

M. **FHWA Coordination:** Prior to submitting documentation to SHPO and consulting parties under the terms of this Agreement, CDOT will coordinate with FHWA. FHWA has the responsibility of oversight of the implementation of this PA.

Execution and implementation of this Programmatic Agreement evidences that FHWA has taken into account the effects of the rockfall mitigation projects on historic properties and afforded the Council an opportunity to comment.

BY: Federal Highway Administration

Stephan P Gibson 2/5/09

for Karla S. Petty, P.E. (Date)
Division Administrator

BY: Colorado State Historic Preservation Officer

1/8/09

for Edward C. Nichols (Date)
Colorado State Historic Preservation Officer

BY: Advisory Council on Historic Preservation

2/5/09

John M. Fowler (Date)
Executive Director

BY: USDA Forest Service, Rocky Mountain Region, Arapaho and Roosevelt National Forests and Pawnee National Grasslands

1/23/09

Glenn P. Cassamassa (Date)
Forest Supervisor

INVITED SIGNATORY
BY: Colorado Department of Transportation

12/19/08

Russell George (Date)
Executive Director

CONCURRING PARTIES

Town of Georgetown

_____

(Date)

Town of Silver Plume

_____

(Date)

Clear Creek County

_____

(Date)

Colorado Historical Society

_____

(Date)

Georgetown Silver Plume Historic District Public Lands Commission

_____

(Date)

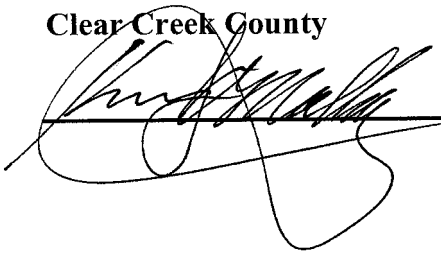
National Park Service

_____

Intermountain Region (Date)

CONCURRING PARTY

Clear Creek County



3/18/09
(Date)

CONCURRING PARTIES

Town of Silver Plume

3/16/09
(Date)

Appendix C.
Memorandum of Understanding Related to Activities Affecting the State Transportation System, National Forest System Lands, and Bureau of Land Management National System of Public Lands in the State of Colorado

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FS Agreement No. 10-MU-11020000-038
BLM Agreement No. BLM-MOU-CO-487

MEMORANDUM OF UNDERSTANDING
Between The
BUREAU OF LAND MANAGEMENT,
THE COLORADO DEPARTMENT OF TRANSPORTATION, AND THE FEDERAL HIGHWAY ADMINISTRATION
And The
USDA, FOREST SERVICE
ROCKY MOUNTAIN REGION

This MEMORANDUM OF UNDERSTANDING (MOU) is hereby made and entered into by and between the Bureau of Land Management, the Colorado Department of Transportation, and the Federal Highway Administration, hereinafter referred to as "BLM, CDOT, and FHWA," and the USDA, Forest Service, Rocky Mountain Region, hereinafter referred to as the "U.S. Forest Service."

Background: This MOU supersedes and replaces the MOU of December 27, 2003 (USDA FS R2# 04-MU-11020000-001 and BLM MOU Number BLM-MOU-CO-483) between the BLM, the CDOT, the FHWA, and the U.S. Forest Service. This MOU does not supersede or replace the requirements of any national agreements, easements, or permits between the affected parties. This MOU does not alter or supersede the authorities and responsibilities of any of the Agencies on any matter under their respective jurisdictions.

Title: Memorandum of Understanding Related to Activities Affecting the State Transportation System, National Forest System Lands, and Bureau of Land Management National System of Public Lands in the State of Colorado

I. PURPOSE: The purpose of this MOU is to establish procedures for coordinating activities affecting the state transportation system and lands administered by the U.S. Forest Service/BLM within the State of Colorado.

II. STATEMENT OF MUTUAL BENEFIT AND INTERESTS:

For the FHWA and CDOT, effectiveness is manifested by transportation projects that are planned, designed, constructed and maintained with appropriate engineering standards and safety considerations, in a timely and cost efficient manner.

For the U.S. Forest Service and the BLM, effectiveness is measured by transportation projects that are planned, designed, constructed and maintained with appropriate consideration of land management objectives and with emphasis on conservation and enhancement of Federal lands and resources.

This MOU seeks to enhance interagency coordination, cooperation and the mutual understanding of transportation projects on Federal lands and resources. It documents mutual agreement regarding specific "Implementing Procedures" to be followed as a means to achieve these purposes (See **Implementing Procedures** attached).

In consideration of the above premises, the parties agree to the following **Roles and Responsibilities:**

III. FHWA SHALL:

A. Administer Federal-aid highway funding and function as the lead agency for implementing the National Environmental Policy Act of 1969 (NEPA) as it relates to federal-aid transportation projects (40 CFR 1500-1508, Title 23 U.S.C.). Federal-aid highways (Chapter One, Title 23 U.S.C.) include the Interstate System, the National Highway System, and selected state highways.

B. Facilitate the acquisition (through the Federal Land Appropriation process) of highway easement deeds for the use of U. S. Forest Service National Forest System (NFS) land and BLM National System of Public Lands (NSPL) for transportation purposes.

IV. CDOT SHALL:

Be responsible for the planning, location, design, construction, operation and maintenance, and perpetuation of a safe and efficient transportation system needed for the benefit of the public in accordance with Title 23, U.S.C. CDOT is also responsible for ensuring that social, economic, and environmental effects are considered in the planning, development, and maintenance of state transportation projects and that the projects are in the best overall interest of the public.

V. THE U.S. FOREST SERVICE SHALL:

Function as a Cooperating Agency for Federal-Aid highway projects. It is responsible for the protection and multiple use management of NFS lands and resources for the benefit of the people of the United States. This responsibility extends to the development of a public lands transportation system both within and providing direct access to NFS lands.

VI. THE BLM SHALL:

Function as a Cooperating Agency for Federal-Aid highway projects. It is responsible for the protection and multiple use management of public lands and interests for the benefit of the people of the United States. This responsibility

extends to the development of a public lands transportation system both within and providing direct access to BLM-managed lands.

VII. IT IS MUTUALLY UNDERSTOOD AND AGREED BY AND BETWEEN THE PARTIES THAT:

Since many public highways traverse NFS lands and NSPL, CDOT will need authorization to occupy such lands for rights-of-way (ROW), waste areas, material sources, highway construction, mitigation, and maintenance operations.

The agencies recognize that there are a number of complex issues regarding transportation, many of which are interrelated. The agencies recognize that studies and investigations should be coordinated to ensure the application of sound planning science and that duplication of work activities does not occur, taxpayer funds are used wisely and efficiently, and that the full body of information is available to the agencies and the public. In recognition of the responsibilities, interests, and limitations set forth above and the mutual benefits of established procedures to facilitate agreement on specific transportation matters on or adjacent to NFS/BLM Public Lands, CDOT, FHWA, USFS, and BLM mutually agree to abide by the procedures outlined in this MOU.

Authority to enter into this MOU is provided by:

1. The Federal Land Policy and Management Act of 1976, 43 U.S.C. 1737
2. The Act of August 27, 1958, As amended 23 U.S.C. Sections 107(d), 204(f) and 317.
3. Federal Land Policy and Management Act of 1976; 43 U.S.C. § 1701, et seq.

PRINCIPAL CONTACTS. Individuals listed below are authorized to act in their respective areas for matters related to this instrument.

FHWA Program Manager Contact	CDOT Program Manager Contact
Name: Chris Horn Right of Way Program Manager Address: 12300 West Dakota Ave. City, State, Zip: Lakewood, CO, 80228 Telephone: 720-963-3000 FAX: 720-963-3001	Name: Brad Beckham Environmental Programs Branch Manager Address: 4201 E. Arkansas Ave. City, State, Zip: Denver, CO 80222 Telephone: 303-757-9637 FAX: (303)757-9445

Principal U.S. Forest Service and BLM Contacts:

U.S. Forest Service Program Manager Contact	BLM Program Manager Contact
Name: Jeff Moll Regional Transportation Engineer Address: 740 Simms St. City, State, Zip: Golden, CO, 80401 Telephone: 303-275-5199 FAX: 303-275-5170	Name: Maryanne Kurtinaitis Branch of Lands and Realty Address: 2850 Youngfield St. City, State, Zip: Lakewood, CO 80215 Telephone: 303-239-3708 FAX: 303-239-3799

A. NOTICES. Any communications affecting the operations covered by this agreement given by the U.S. Forest Service or BLM, CDOT, or FHWA is sufficient only if in writing and delivered in person, mailed, or transmitted electronically by e-mail or fax, as follows:

To the U.S. Forest Service Program Manager, at the address specified in the MOU.

To BLM, CDOT, or FHWA, at BLM, CDOT, or FHWA's address shown in the MOU or such other address designated within the MOU.

Notices are effective when delivered in accordance with this provision, or on the effective date of the notice, whichever is later.

B. PARTICIPATION IN SIMILAR ACTIVITIES. This MOU in no way restricts the U.S. Forest Service or BLM, CDOT, or FHWA from participating in similar activities with other public or private agencies, organizations, and individuals.

C. ENDORSEMENT. Any of BLM, CDOT, or FHWA's contributions made under this MOU do not by direct reference or implication convey U.S. Forest Service endorsement of BLM, CDOT, or FHWA's products or activities.

D. NONBINDING AGREEMENT. This MOU creates no right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity. The parties shall manage their respective resources and activities in a separate, coordinated and mutually beneficial manner to meet the purposes(s) of this MOU. Nothing in this MOU authorizes any of the parties to obligate or transfer funds. Specific projects or activities that involve the transfer of funds, services, or property among the parties require execution of separate agreements and are contingent upon the availability of appropriated funds. These activities must be independently authorized by statute. This MOU does not provide that authority. Negotiation, execution, and administration of these agreements must comply with all applicable law. Each party operates under its own laws, regulations, and policies, subject to the availability of appropriated funds. Nothing in this MOU is intended to alter, limit, or expand the agencies' statutory and regulatory authority.

E. USE OF U.S. FOREST SERVICE INSIGNIA. In order for BLM, CDOT, or FHWA to use the U.S. Forest Service insignia on any published media, such as a Web page, printed publication, or audiovisual production, permission must be granted from the U.S. Forest Service's Office of Communications. A written request must be submitted and approval granted in writing by the Office of Communications (Washington Office) prior to use of the insignia.

F. FREEDOM OF INFORMATION ACT (FOIA). Public access to MOU or agreement records must not be limited, except when such records must be kept confidential and would have been exempted from disclosure pursuant to Freedom of Information regulations (5 U.S.C. 552).

G. TERMINATION. Any of the parties, in writing, may terminate this MOU in whole, or in part, at any time before the date of expiration.

H. DEBARMENT AND SUSPENSION. BLM, CDOT, or FHWA shall immediately inform the U.S. Forest Service if they or any of their principals are presently excluded, debarred, or suspended from entering into covered transactions with the federal government according to the terms of 2 CFR Part 180. Additionally, should BLM, CDOT, or FHWA or any of their principals receive a transmittal letter or other official Federal notice of debarment or suspension, then they shall notify the U.S. Forest Service without undue delay. This applies whether the exclusion, debarment, or suspension is voluntary or involuntary.

I. MODIFICATIONS. Modifications within the scope of this MOU must be made by mutual consent of the parties, by the issuance of a written modification signed and dated by all properly authorized, signatory officials, prior to any changes being performed. Requests for modification should be made, in writing, at least 30 days prior to implementation of the requested change.

J. COMMENCEMENT/EXPIRATION DATE. This MOU is executed as of the date of the last signature and is effective through June 30, 2015 at which time it will expire, unless extended by an executed modification, signed and dated by all properly authorized, signatory officials.

K. AUTHORIZED REPRESENTATIVES. By signature below, each party certifies that the individuals listed in this document as representatives of the individual parties are authorized to act in their respective areas for matters related to this MOU. In witness whereof, the parties hereto have executed this MOU as of the last date written below.

Russell George — July 1, 2010

RUSSELL GEORGE, Executive Director — Date
Colorado Department of Transportation

6-29-10

Douglas Bennett, Acting Division Administrator — Date
Federal Highway Administration

6-25-2010

HELEN M. HANKINS, Colorado State Director — Date
Bureau of Land Management

for Maribeth Gustafson 6/24/10

RICK D. CABLES, Regional Forester — Date
U.S. Forest Service, Rocky Mountain Region

The authority and format of this instrument have been reviewed and approved for signature.

LuAnn Waida 6/23/10

LUANN WAIDA — Date
U.S. Forest Service Grants & Agreements Specialist

IMPLEMENTING PROCEDURES

For Colorado Department of Transportation Roadway Projects involving National Forest System Lands or Bureau of Land Management Public System Lands

ACRONYMS AND DEFINITIONS USED IN THIS DOCUMENT

CDOT – Colorado Department of Transportation
CEQ - Council on Environmental Quality
CE - Categorical Exclusion
CFR - Code of Federal Regulations
CLOC - Corridor Letter of Consent
DEIS - Draft Environmental Impact Statement
EA - Environmental Assessment
EIS - Environmental Impact Statement
FEIS - Final Environmental Impact Statement
FHWA - Federal Highway Administration
FLRMP – Forest Land & Resource Management Plan
FONSI - Finding of No Significant Impact
4(f) - Section 4(f) of the 1966 Department of Transportation Act
GIS - Geographic Information System
ID Team – Interdisciplinary Team
ITS – Intelligent Transportation System
LOC - Letter of Consent
LOGO - Referring to signs with company logos/emblems on them
MERCHANTABLE TIMBER – Trees with a diameter of 7" or greater at breast height
MOU - Memorandum of Understanding
MUTCD - Manual on Uniform Traffic Control Devices
NEPA - National Environmental Policy Act
NFS - National Forest System (U.S. Forest Service)
NSPL – National System of Public Lands (BLM)
NOI - Notice of Intent
PDEIS - Pre-Draft Environmental Impact Statement
PLH - Public Lands Highway
ROD - Record of Decision
STIP - State Transportation Improvement Program
TODS - Tourist Oriented Directional Signs
U.S.C. - United States Code
USFS – USDA - Forest Service

I. Long Range Planning

For all project level activities, the terms USFS, BLM, and CDOT will refer to the appropriate USFS Forest Supervisor, BLM Field Manager, and CDOT Region Director unless otherwise noted in this MOU or designated by the respective agency. Addresses and phone numbers for administrative units of each agency are included in the attachments.

A. Information to be shared between Agencies

The CDOT will provide the USFS and BLM with copies of the Statewide Transportation Plan, the Statewide Transportation Improvement Program, and with inventories and functional classification of the State transportation system. One copy of each will be sent to each USFS Forest Supervisor and BLM Field Manager, and two copies of each will be sent to the USFS Regional Forester and BLM State Director. These plans will also be available on the web at:

www.dot.state.co.us/DevelopProjects/PlanStudies

The USFS and BLM will provide CDOT's Division Director of Transportation Development with Forest Land and Resource Management Plans (Forest Plans) and plan corrections, land management plans (including amendments or revisions, if applicable), transportation plans that indicate existing and planned land uses, and the relationship between these uses and related travel. The USFS and BLM plans may be available on the web through the following websites:

http://www.fs.fed.us/r2/projects/ (Under the Forest Planning tab)

http://www.blm.gov/co/st/en/BLM_Programs/land_use_planning/rmp.html

Geographic information system data will be shared between signatories of the MOU at no cost when such data are available.

The USFS and BLM will include Regional CDOT offices on their mailing list for notification of possible actions regarding NEPA documents, forest plans and plan amendments, and transportation plan related documents.

B. National Forest System and Forest Highway Program

The CDOT Headquarters Office, USFS Regional Office, and FHWA Central Federal Lands Highway Division ("Tri-Agency") will annually develop and review multi-year Forest Highway programs in accordance with the Tri-Agency MOU established for that purpose. CDOT will follow the requirements of the Tri-Agency MOU for incorporating Forest Highway projects into the State Transportation Improvement Program.

C. Programmatic Agreements

Early and continuous coordination between agencies will occur. Signatories will notify designated agency contacts when a programmatic agreement is initiated which may affect any other agency's activities. Each agency will assign a specific person to be the point of contact for each agreement. Each agency will agree to review and comment on the draft agreements according to an agreed upon schedule.

II. Project Coordination

A. Designation of Project Coordinators

Each agency shall designate a Project Coordinator to act as a key point of contact for all matters regarding the specific project. Agencies shall assure that a Project Coordinator is named and available throughout the life of a project. Designation of a project coordinator will be done in writing; this document will also prescribe the roles and responsibilities of Project Coordinators.

The CDOT, USFS, and BLM Project Coordinators will ensure the efficient flow of project related information between the agencies and within their respective agencies throughout the planning and implementation of the project.

The CDOT, USFS, and BLM Project Coordinators shall prepare a coordination schedule to aid in scheduling and tracking project milestones that will include response times. An example coordination schedule is attached to this MOU as Attachment 1.

B. Procedural Steps

A. Initial Project Coordination.

1. CDOT Project Coordinator will:

   Write a letter notifying the USFS/BLM of the highway development project. Notification will include:

   a. Description of why the project is proposed,

   b. Draft Project Purpose and Need statement,

   c. Extent of the proposed activity, and

   d. Estimated time schedule.

   The letter will request that the USFS/BLM designate a Project Coordinator.

2. USFS/BLM will:

Designate a Project Coordinator within 30 days, and notify the CDOT Project Coordinator and provide contact information for the Project Coordinator.

2. USFS/BLM Project Coordinator and other appropriate personnel will:

   a. Participate in the reconnaissance inspection and provide comments to CDOT Project Manager on the report and determine if any other necessary agency staff should attend the reconnaissance inspection.

   b. Identify the recommendation that would need to be incorporated into CDOT highway development project's planning and design criteria.

c. Provide CDOT Project Manager with existing information relative to the project.

d. USFS/BLM Project Coordinator should advise CDOT Project Manager on USFS/BLM issues and concerns as dictated by the project scope and extent. These may include:

1) Potential inconsistencies with Forest Plans/ Resource Management Plans,

2) Anticipated social, economic, and environmental impacts,

3) Travel demand estimates for the highway, NFSR, or Public Lands roads,

4) Areas intentionally managed for recreation, including those without physical recreation features or where recreation is managed through authorized activities,

5) Endangered, threatened, proposed, and sensitive species inventories, biological evaluations, and biological assessment requirements,

6) Existing and potentially needed wildlife crossings or aquatic organism passage,

7) Potential cultural properties, and other recreational resources that will be protected under Section 4(f) (recreation facilities covered under 23 U.S.C. 138, 49 U.S.C. 303),

8) Public lands survey monuments, location, and monument protection requirements,

9) Potential staging, stockpile or storage areas,

10) Timber clearing, means of removal and appraisal,

11) Material sources, disposal sites and borrow pits,

12) Public involvement needs for each agency,

13) Identify facilities, such as cattle guards, stock passes, fences, approaches, signs, etc. necessary to the management of NFS lands that need to be incorporated into CDOT project design.

14) Other issues of special concern.

The USFS/BLM will promptly notify CDOT of proposed projects that may affect the physical or operational characteristics of transportation facilities and associated environmental mitigation within CDOT right-of-way including but not limited to those falling under the State Highway Access Code (C.R.S. 43-2-147(4)), oil and gas or mining development, ski area expansions, or developments that require federal action.

Notification of projects will include a description of why the project is proposed, the extent of the proposed activity, and an estimated time schedule. Where CDOT determines that such activities will have an impact on the

state highway system the same coordination activities outlined for CDOT projects should be followed to the extent feasible.

C. Agency Requests for Coordination

The requesting agency will attempt to resolve the issue at the lowest organizational level consistent with the established project timeline if an agency fails to respond to requests for:

- Designation of a coordinator,
- Attendance at scoping/coordination meetings,
- Other participation in project planning/design,
- Review/comments, or
- Permits.

If no resolution is achieved at the lowest organizational level, the requesting agency may initiate the dispute resolution process discussed within **Section XIII** of this MOU.

D. Collection Agreements

Agencies may explore options for ensuring agency participation, such as: collection agreements, to cover agency costs; Forest Service Enterprise Teams; reduction of the burden of participation by identification of key process points; or by other means of addressing the issues restraining participation.

Collection agreements between the agencies will be negotiated on a case-by-case basis. Approval by authorized executive management of the applicable agencies is required.

III. Environmental Coordination and NEPA Document Preparation

A. NEPA Documentation and Agency Decisions for Federal Aid Projects

The FHWA, USFS, and BLM must comply with the National Environmental Policy Act (NEPA) in reaching decisions related to agency actions. Although the agencies comply with the same law, each agency has its own set of regulations, directives, and policies defining how the agency shall implement NEPA. On a single highway construction project, there may be multiple agency decisions each requiring a different level of documentation per each agency's own implementing direction. Although every project must be evaluated on its own merits, the chart in Table 1 lays out the possible decisions and the typical NEPA documentation required by the agencies.

Action	FHWA/CDOT	USFS	BLM
CDOT construction or maintenance activities within existing easement right-of-way	CE, EA, EIS	No NEPA action, coordination only	No NEPA action, coordination only
Temporary authorization outside right-of-way (Special Use Permit or Right-of-way)	Typically CE	Typically CE.USFS Decision tiered to FHWA/CDOT NEPA Special Use Permit issued	Typically EA
Permanent easement/ land appropriation	Typically CE	Administrative Determination	Typically EA
Mineral materials sale	N/A	Typically CE or EA. USFS decision tiered to FHWA/CDOT NEPA. Mineral Material permit issued	Typically EA
Long term disposal or storage sites	N/A (Part of project NEPA clearance)	Typically CE or EA. FS decision tiered to FHWA/CDOT NEPA. Special use permit issued.	Typically EA
Associated amendment to land management plans	N/A	Typically EA	Typically EA
New construction on new alignment	EA/EIS	Administrative Determination	EA/EIS

Table 1. Examples of Possible Decisions and the Typical NEPA Documentation Required by the Agencies.
[CDOT=Colorado Department of Transportation, FHWA-Federal Highway Administration, USFS=U.S. Forest Service, BLM=Bureau of Land Management, CE=Categorical Exclusion, EA=Environmental Analysis, EIS=Environmental Impact Statement, N/A=Not Applicable, NEPA=National Environmental Policy Act]

All agencies that are party to this MOU recognize that each agency's NEPA process represents what each has defined as necessary through public review and comment, case law, and experience. Federal agencies must comply with the Council on Environmental Quality regulations (at Title 40—Protection of Environmental Quality, Code of Federal Regulation (CFR) Part 1500 to 1508) and with the intent of NEPA for better decisions and public disclosure.

The 40 CFR 1500 to 1508 is available online at

http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title40/40cfr1500_main_02.tpl

Agency direction regarding NEPA compliance and processes can be found at:

CDOT - Colorado Department of Transportation, 2008, National Environmental Policy Act Handbook, Version 2. Available online at URL
http://www.coloradodot.info/programs/environmental/nepa-program/nepa-manual

USFS - U.S. Code of Federal Regulations 36 CFR 220 and U.S. Forest Service, 2008, Environmental Policy and Procedures Handbook, FSH 1909.15. Available on line at URL
http://www.fs.fed.us/im/directives/dughtml/fsh_1000.html

BLM - Bureau of Land Management, National Environmental Policy Act Handbook, H-1790-1. Available online at URL
http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/blm_handbooks.html

FHWA - U.S. Code of Federal Regulations, Title 23—Highways, Part 771, Federal Highway Administration, Environmental Impact and Related Procedures. Available online at URL
http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title23/23cfr771_main_02.tpl

B. One Shared Analysis

The CDOT, USFS, BLM, and FHWA agree to use one shared analysis as the common ground for developing NEPA documents. Agencies shall coordinate early to determine the scope of the analyses to be conducted. This means that the data and the analysis performed on that data is to be adequate for all highway related decisions required of the USFS, BLM, or FHWA. The analysis would include data and coordination with other environmental laws (such as consultation under Section 7 of the Endangered Species Act with the U.S. Fish and Wildlife Service) required for FHWA's decision to proceed and the associated decisions by the land management agencies to authorize temporary occupancy, execute a plan amendment, or approval a NEPA decision.

The analysis then forms the basis of the resulting environmental documentation (categorical exclusion [CE], environmental assessment [EA], or environmental impact statement [EIS]) prepared by or for each agency. It also provides information needed to comply with other laws such as the Endangered Species Act.

Such a comprehensive analysis meets the intent of NEPA for better decisions and the intent of streamlining the process by ensuring effective cooperation early in the process, thereby avoiding late-arising issues and delays. The one shared analysis is consistent with the existing roles and responsibilities as defined by the CEQ regulations and outlined in this MOU.

C. NEPA Roles and Responsibilities

The Federal Highway Administration is the Federal Lead Agency for federally funded transportation projects and has final decision authority for such projects (40 CFR 1501.5). As such, FHWA is responsible for ensuring compliance with NEPA and for providing guidance and direction to CDOT in the preparation of NEPA documents. FHWA ensures that the regulatory requirement and coordination, for all agencies affected by the transportation project, are met during the planning and design phase.

The USFS consents to the appropriation and transfer of NFS land interests for transportation purposes through the Letter of Consent based on the NEPA documents. The BLM decision authorizing the issuance of a Letter of Consent (LOC) for land transfer is based on the NEPA document(s).

The Colorado Department of Transportation is the Joint Lead Agency and is responsible for preparation and processing of technical environmental reports, and NEPA documents developed for those projects. CDOT is also responsible for maintaining the formal record file for environmental documentation.

Upon request of the Lead Agency, any other Federal agency which has jurisdiction by law shall be a Cooperating Agency. In addition any other Federal agency which has special expertise with respect to any environmental issue may be a Cooperating Agency upon request of the Lead Agency. An agency may request the Lead Agency to designate it a Cooperating Agency (40 CFR 1501.6).

For projects within or adjacent to NFS or BLM lands, the U.S. Forest Service/Bureau of Land Management will be requested to be a Cooperating Agency unless the USFS/BLM specifically state that their interests are not affected by the project. The USFS and BLM are responsible for providing recommendations or stipulations to eliminate/mitigate the adverse effects of the projects on NFS/BLM lands and resources and are responsible for issuing a Letter of Consent. This includes a statement of consistency with the Forest Plan, and those stipulations necessary for the protection and utilization of NFS/BLM lands. The USFS/BLM may be Joint Lead Agencies with the FHWA on federally funded transportation projects involving or affecting NFS or Public Lands for which the preparation of an EIS is required.

The USFS or the BLM is the Lead Agency for any USFS/BLM land and resource management project or USFS federally funded transportation project. The FHWA/CDOT may be Joint Lead Agencies with the USFS or BLM or Cooperating Agencies on those agencies' land and resource management projects where significant impacts to the State transportation system may be reasonably anticipated.

The Federal Highway Administration (40 CFR 1501.6) and the CDOT may be Cooperating Agencies on any USFS/BLM project where significant impacts to the State transportation system may be reasonably anticipated.

In some instances each Federal agency must prepare a separate NEPA document. In the case of a Federal Aid highway project where the project qualifies for a Categorical Exclusion (CE) under the FHWA regulations, but not under USFS or BLM regulations, the CDOT (with FHWA oversight) will produce a document containing sufficient information to satisfy the content requirements of the USFS and BLM for production of an Environmental Assessment (EA). For a CDOT project that must be documented as an EA for USFS or BLM purposes, CDOT will develop the purpose and need statement, brief alternatives discussion (build, no build), environmental analyses, and forward to the land agencies for their public notification requirements.

Using the one shared analysis process, the shared data and analyses in the NEPA document is essentially the same for all agencies environmental reviews.

D. Interagency Project Scoping

Effective and early interagency cooperation is crucial to the success of the one shared analysis process. Initiation of project coordination and the formal designation of a Project Coordinator are described in **Section II. Project Coordination**. If the steps described in **Section II.A. Designation of Project Coordinators** have not been taken, they should occur as part of project scoping.

During early scoping and consultation, Project Coordinators will identify the issues and concerns listed **Section II.B.2.d.** to the maximum extent possible.

The Project Coordinators will also identify the decisions that are required by their agency in order for the project to move forward, and whether additional analysis is necessary for these decisions. These needs will be addressed in the analysis done for the project.

In identifying the decisions required, the Project Coordinators will identify the anticipated level of NEPA required for their agency to support the decision: categorical exclusion, environmental assessment, or environmental impact statement.

The Lead Agency will ensure that the approvals received for the project include the regulatory requirements of other agencies that are not party to this MOU. Examples include the Endangered Species Act Section 7 Consultation with the U.S. Fish and Wildlife Service; Section 404 of the Clean Water Act permit, from the U.S. Army Corps of Engineers; and Section 106 of the National Historic Preservation Act, in consultation with the State Historic Preservation Office.

Agencies will cooperate in addressing issues as early as possible to identify information needs and avoid late-arising concerns. Resolution of issues will be documented in agency files for reference and consistency through the life of the project.

E. Section 4(f)

Section 4(f) of the 1966 DOT Act as Amended and 23 CFR 774 apply to publicly owned parks, recreation areas, wildlife refuges, and to historic sites regardless of ownership. It is a separate environmental process required for projects under the jurisdiction of, or funded by, any agency of the U.S. Department of Transportation including the FHWA. It applies in instances where property from any one of these resources is converted to a transportation use. Conversion of land to a transportation use from USFS/BLM lands does not necessarily trigger a Section 4(f) evaluation. Only those areas intentionally managed for purposes protected by Section 4(f), such as recreation areas, campgrounds, or historic sites trigger Section 4(f) requirements. Determination of applicability of Section 4(f) to a specific project will be made by the FHWA in consultation with CDOT, USFS/BLM, and other agencies as required.

F. Public Involvement

The Lead Agency will work with the Cooperating Agencies to assure the public outreach and notification is sufficient for any related decisions. As part of early scoping, the agencies shall jointly develop a public involvement plan that shall adequately meet the needs of the agencies.

G. Preparation, Review, and Adoption of NEPA Environmental Documentation

As part of the interagency scoping (See **Section III.D.**), the agencies identify the level of documentation necessary for each agency to make their required decisions. Agencies may have different documentation needs for related decisions due to differing agency regulations; however the analysis that results from the early coordination and consultation should serve the needs of all.

Options to facilitate the preparation of a NEPA document for the USFS or BLM will be discussed early in the project scoping. Determination of how the document would be produced depends upon the project, the impacts, or the resources the USFS/BLM have available to devote to the project. The Lead Agency can prepare the NEPA document, contract with a Cooperating Agency for preparation of the documents, or contract with a private consultant for preparation of the document. **Section III.A.** provides guidance on locating agency NEPA requirements.

IV. Post – NEPA Project Design, Permits, Survey, Field Inspection Review, Final Office Review, and Schedule

The purpose of this section is to outline the coordinated process used by CDOT as they progress from preliminary design to final design.

The CDOT and USFS/BLM will jointly determine necessary authorizations or permits required prior to starting any field surveys or site investigations.

The USFS/BLM will authorize CDOT (and/or it's consultant) to survey, with any needed terms and conditions, and will provide data on survey monuments, maps, access routes, fire regulations, clearing limitations, material sources, and other information pertinent to the survey.

The CDOT and USFS/BLM will participate in a joint Preliminary Field Review/CDOT design scoping review. A report documenting the review will be prepared and distributed by the originating agency.

The USFS/BLM will participate in the Field Inspection Review and submit comments to CDOT Project Manager in accordance with the agreed upon project schedule. This should include any features of construction/reconstruction that may have an effect on the protection and utilization of the land traversed by the right-of-way and adjoining land under the administration of USFS/BLM. Items to be added to CDOT construction plans and specifications will be mutually agreed upon by USFS/BLM, FHWA and CDOT by conference or other communication during the preparation of the plans and specifications for each project.

The CDOT Project Manager will review recommendations and return them to the USFS/BLM Project Coordinator if revisions are needed. USFS recommendations need to be agreed upon and finalized prior to final design. Recommendations received from USFS/BLM will be included in subsequent plans when feasible. Recommendations should be incorporated into the design plans as much as possible to keep Letter of Consent stipulations to a minimum. FHWA will request a Letter of Consent (LOC) from the USFS/BLM. The Colorado Department of Transportation will incorporate any construction stipulations required by the USFS/BLM in the LOC into the final designs and specifications for the project. The CDOT will provide the USFS/BLM with two sets of preliminary plans and notify the USFS/BLM District and Field Offices of the scheduled CDOT Field Inspection Review. Contract specifications resulting from stipulations in the USFS/BLM LOC cannot be modified without USFS agreement at delegated authority level for LOC (Regional Office).

Within 30 working days from the date of the design scoping meeting, the CDOT, USFS/BLM, and FHWA will coordinate a project schedule which will include timetables related to merchantable timber and mineral materials sale(s) contract/permit.

Prior to final design, CDOT will define work limits and notify USFS/BLM of proposed clearing limits and timber and mineral materials to be removed. USFS/BLM will determine appropriate method of disposing of merchantable timber and mineral materials and will coordinate with CDOT Road Design for inclusion in final plans

The CDOT will provide the USFS/BLM with two sets of construction and ROW plans along with proposed general contract provisions covering work affecting NFS/BLM Public Lands, and notify the USFS/BLM of the scheduled CDOT Final Office Review. The general contract provisions will include any appropriate USFS/BLM Fire Plan, Clearing Plan, and Erosion Control Plan.

The USFS/BLM local office personnel will participate in the Final Office Review and submit a concurrence letter to the CDOT, acknowledging approval and/or recommended changes to the final plans and specifications in accordance with the agreed upon project schedule. The CDOT will incorporate mutually agreeable recommendations from the Final Inspection Review and Final Office Review in plans and specifications. Disputes will be resolved as per **Section XIII** of this MOU.

A. TIMBER

The U.S. Forest Service and BLM will retain the right to any merchantable timber not specifically appropriated. The CDOT will notify the USFS/BLM of timber within the clearing limits scheduled for removal. The USFS/BLM will determine whether a timber sale to an independent contractor or another authorization for removal is appropriate.

Any merchantable timber, defined as meeting current utilization standards for saw timber (logs) and wood products other than logs will be, as determined by the USFS/BLM:

(1) Stockpiled in an area designated by the USFS/BLM to be disposed of by other means,

(2) Acquired by the CDOT or the CDOT contractor at fair market value as determined by an appraisal, or

(3) Permitted for removal as a non-sale disposal, if regulations apply, to be disposed of in whatever manner is most cost-efficient to CDOT, granted they actually remove the material from the site.

When the USFS/BLM retain ownership of the timber cut within the clearing limits, the USFS/BLM will stipulate the necessary procedures and specifications that must be followed for items such as marking, bucking, and decking (cutting and stacking). If the USFS/BLM retain ownership they will also be responsible for final disposal.

The CDOT will notify the USFS/BLM of any merchantable timber that may need to be removed as a result of construction or maintenance activities. All activities related to the removal of merchantable timber will be completed in accordance with the jointly developed project schedule described under the **Section IV** above. The clearance area required for construction will be staked by the CDOT for review by the USFS/BLM in accordance with the mutually agreed upon project schedule and prior to the scheduled timber cruising operations.

The USFS/BLM will provide a written appraisal (if required) and contract or permit in accordance with the joint project schedule developed under the **Section IV.** It is understood that the objective is for the appraisal (if

required) to be completed at least 30 days prior to the bid opening. A forest products contract or permit (if required) would be completed no later than 30 days after the CDOT awards the construction contract.

If merchantable timber is being acquired by the CDOT or the CDOT's contractor, at a fair market value as determined by an appraisal, CDOT or the CDOT's contractor will provide direct payment to the USFS/BLM for the appraised value of the timber prior to cutting. The negotiated schedule in **Section IV** above should reflect the applicable dates for flagging of the cutting limit boundaries, the completion of volume estimates and corresponding appraisal, and the issuance of the contact. The USFS/BLM will not work directly with any subcontractors unless specified under the project schedule.

If the timber is stockpiled on NFS land/Public Land, the site must be identified by the USFS/BLM and agreed to by the CDOT, and any necessary environmental clearances obtained.

If so allowed by the USFS/BLM, the timber can be sold to the public or given to the public under non-sale disposal authorities.

B. Borrow Pits and Mineral Material Sales

The USFS must collect fair market value for mineral materials taken from NFS.

The USFS retains the federal management responsibilities for all mineral materials. The negotiated project schedule must reflect all issues and decisions regarding the disposal or use of mineral resources. Excess mineral materials that are generated during construction activities will be temporarily stockpiled in an area designated by the USFS/BLM. The site and length of time the material may be stored will be designated in the project specifications. Such materials are the property of the United States and the sale or disposal of this material will follow the procedures outlined below.

A USFS mineral material contract is required whenever material is removed from a borrow pit or excess material is removed from the construction site. This contract/permit for a borrow pit is for the excavation, crushing, screening, and removal only. Further processing of the material on NFS/Public Lands such as batch plants will require a separate authorization from the USFS or BLM. The BLM will only issue the Free Use Permit to the appropriate government agency (CDOT). CDOT may contract out the removal of the material but the contractor may not charge for the minerals. The permit from BLM is for removal of the minerals and allows minerals to be stockpiled onsite.

The mineral materials contract will be issued by the USFS to CDOT's contractor within 20 working days from the date of the CDOT's notification to the USFS that the construction contract has been awarded. The BLM does not require a separate authorization for processing materials onsite. If further processing is required and the proposed activity is to be located on Public Lands, a permit will be necessary to authorize that activity.

Mineral material generated on NFS/Public Lands and used in a public purpose project, such as a highway construction project, is free of charge to FHWA or CDOT. Coordination between the USFS and CDOT will be required. A 'free use' contract/permit may be required. If required, the 'free use' contract/permit maybe issued to a designated agent (contractor) of FHWA or CDOT at the discretion of the USFS. BLM will not issue a permit to a contractor; the BLM will only issue the Free Use Permit to the appropriate government agency (CDOT). CDOT may contract out the removal of the material but the contractor may not charge for the minerals.

Excess material removed from NFS/Public Lands and/or sold for commercial purposes, other than for public projects, must be purchased by CDOT or by CDOT's contractor at fair market value. Fair Market Value may be determined by use of existing USFS value schedule or by separate appraisal at the discretion of CDOT. Appraisals conducted by CDOT or private parties must be reviewed and approved by USFS/BLM specialists.

The USFS mineral materials contracts and permits will contain requirements to rehabilitate the used borrow pits. The BLM may require a bond covering the cost of reclamation. The CDOT will hold the contractor responsible for meeting these requirements.

C. Impacts to National Forest System Lands or Public Lands

Features of construction/reconstruction projects that may have an effect on the protection and utilization of the land traversed by the ROW and adjoining land under the administration of the USFS/BLM will be mutually agreed upon by the USFS Forest Supervisor/BLM Field Manager and the CDOT Regional Transportation Director or their designees by conference or other communication during the preparation of the plans and specifications for each project. The responsibilities will be documented in writing on each project.

D. Final Design Specification Concurrence

The CDOT will submit final design and construction specifications to the USFS Regional Forester/BLM State Director, or their delegated representative, for written concurrence. Construction shall not begin prior to receiving written concurrence.

V. Right of Way

A. Perpetual Right-of-Way for Transportation Purposes

All Right-of-Way (ROW) appropriations by the CDOT from USFS/BLM will be conducted consistent with the FHWA Federal Lands Transfer Manual. A USFS Special Use Permit held by CDOT is no longer the appropriate legal ROW document for highway/transportation purposes.

After preliminary design is complete and following the Field Inspection Review, the CDOT will submit to the FHWA a request for appropriation and transfer of land interests for transportation purposes sufficient to accommodate the proposed project. The FHWA/CDOT will ensure that all permanent facilities (such as drainage structures or bridge abutments) will be included in the request for permanent ROW. The request for permanent ROW will include sufficient ROW to maintain any permanent highway related features and structures. The request will be accompanied by the final ROW plans (including alignment, topography, and proposed ROW lines).

The FHWA will evaluate the request for appropriation and, if in agreement, request a Letter of Consent (LOC) from the USFS/BLM. The USFS/BLM has four months from the date of receipt of the request to respond for a Letter of Consent. If the USFS/BLM does not respond within the four months, FHWA may proceed with the appropriation of lands.

The USFS/BLM will review the request for a Letter of Consent and, if approved, issue a LOC with stipulations to the FHWA, with a copy to the CDOT. The BLM decision may be appealable under their administrative appeals process. Upon issuance of the LOC, the USFS/BLM authorizes immediate entry on the NFS/BLM Public Lands subject to the terms set forth in the stipulations and LOC.

The CDOT will prepare a U.S. Department of Transportation easement deed based upon authorized ROW plans that contain the stipulations and reduced plan set showing the property requested. The CDOT's Chief Engineer will execute the easement deed for the CDOT, approving the stipulations, and the Colorado Attorney General's office will review the easement deed for legal sufficiency and return the easement deed to CDOT to be forwarded to the FHWA.

The FHWA and the FHWA's Chief Counsel will review the easement deed. If it meets the requirements of the LOC and its stipulations, the FHWA will execute the deed and return it to the CDOT for recording.

The CDOT Headquarters Office will provide four (4) copies of the recorded easement to the FHWA for distribution to the appropriate offices of the USFS/BLM.

B. Conversion of Existing Highways to Easement Deeds in the Absence of Reconstruction

On existing State Highways, where no request for appropriation and transfer of land interests for transportation purposes has been requested and no Highway Easement Deed (HED) has been issued, the following Conversion process should be used to obtain the HED:

1. Follow the steps outlined above in **Section V. Right Of Way** to request a HED.

2. The requested target easement width is *150 feet, (75 feet* parallel with and perpendicular to either side of the physical centerline of the highway), with allowances for cuts, fills, drainage structures, etc. as mutually identified and agreed upon.

3. Prior to submitting a request for conversion of any highway, the CDOT Project Manager, CDOT Region Right of Way Manager and/or CDOT Region Survey/Plans Coordinator, and the USFS/BLM Authorized Officer (or their designated representative) shall travel the highway(s) involved in the conversion request. The CDOT Project Manager and USFS/BLM Authorized Officer shall make a determination as to whether an easement width of 75 feet on each side of centerline is appropriate. Where this width is not appropriate to cover the area required operating and maintaining the highway a more appropriate (either reduced or increased) width shall be identified.

4. The set of ROW Plans or Exhibit Maps reflecting the agreed upon easement locations and widths being requested shall be submitted by CDOT to the USFS/BLM Project Coordinator for review prior to submittal to FHWA to request a LOC.

C. Authorization for Other Uses on NFS/Public Lands

The CDOT easement applies only to facilities directly used for transportation purposes and in the right-of-way. All other facilities on USFS/BLM land, including maintenance yards and other structures, will require a Special Use Permit or Right-Of Way Grant from the BLM.

D. Notification of Land Ownership Adjustment

The USFS/BLM will notify the CDOT Headquarters Right-of-Way Office of any proposed land ownership adjustment or land exchanges affecting CDOT facilities or ROW. Upon notification, the CDOT will determine the necessity of applying for an easement deed to protect its interest prior to completion of the land exchange.

VI. Authorization for Entry during Emergency Situation

In the case of emergencies (floods, landslides, wildfires, hazardous material spill(s), etc.), the CDOT may conduct work outside the ROW to repair, stabilize or neutralize the problem area(s) and will promptly notify the USFS/BLM of actions taken or proposed.

The USFS/BLM may construct temporary approaches as necessary during fire fighting or other emergencies without formal CDOT approval. The USFS/BLM will notify the CDOT as soon as practicable. Following emergency use, necessary obliteration and restoration measures will be made at no expense to the CDOT. The USFS/BLM will take precautions during such emergencies to safeguard highway users.

VII. Construction/Reconstruction

A. Designation of Construction Coordinators

The CDOT and the USFS/BLM will designate respective Construction Coordinators to provide coordination on matters related to the construction work or changed conditions that may alter the land allocations for approved plans.

B. Coordination during Construction/Reconstruction

The CDOT will invite the USFS/BLM to attend the pre-construction conference with the successful bidder.

After the LOC is issued and during construction, and before committing to any action, CDOT will consult with the USFS/BLM Construction Coordinators prior to approving any changes in design, materials, plans, or specifications that may affect NFS/BLM Public Lands or resources.

Changes in ROW requirements or conditions affecting the project NEPA decision that occur during construction or reconstruction activities may necessitate additional analysis and coordination.

In preparation for final inspection, the CDOT will invite USFS/BLM to participate in a site visit.

C. Post-Construction Coordination

The FHWA/CDOT, in coordination with the USFS/BLM, will continue to monitor project mitigation measures to ensure effectiveness and compliance with NEPA decisions and permit requirements.

Project and construction coordinators shall evaluate, on a project specific basis, what processes or coordination worked well or did not work well. Processes that worked well should be implemented into future projects.

VIII. Maintenance

A. General Maintenance Within the Right-of-Way

Maintenance activities within the right-of-way (ROW) will not require coordination unless specifically required in either the Highway Easement Deed or this MOU.

Maintenance is defined as restoration and upkeep to preserve the entire facility (including roadway, shoulders, slopes, drainage improvements, safety devices, and other features consistent with the stipulations in the Letter of

Consent). Maintenance also includes snow removal, sanding, mowing, vegetation removal, culvert and ditch cleaning, and other services necessary for safe and efficient operation of the state highway system. Maintenance does not include activities that result in betterment or a higher service level of the facility, such as realignment, widening, or other improvements considered to be reconstruction.

The CDOT will conduct maintenance activities to preserve and enhance scenic, environmental, and safety characteristics of transportation facilities to be compatible with the adjacent NFS/BLM Public Lands and resources. The Department of Agriculture's guidelines for weed spraying and the CDOT Standard Operating principles for Snow Removal shall be used as a baseline for maintenance operation by CDOT within ROW on NFS/BLM Public Lands.

With respect to maintenance activities only, the term right-of-way (ROW) is defined as the legal limits of the easement if an easement exists, or the area between the existing top of cuts and toe of fills if no easement exists.

For use of biological or chemical control in clearing or vegetation maintenance on any NFS/BLM Public Lands, the CDOT will follow the provisions contained in the highway easement deed if within a ROW covered by an easement; consult with the USFS/BLM if within a ROW not covered by an easement; or obtain written approval for outside the limits of the ROW.

The CDOT will notify the USFS/BLM of any merchantable timber that may be removed or damaged as a result of maintenance activities, prior to that activity (see **Section IV.A**).

The CDOT may assess right-of-way corridors for potentially hazardous trees, bug damaged trees, and sufficient clear zones/areas and will request that USFS include removal of such trees in any future timber sales planned for the area. The USFS shall determine the method of removal within its authorities including sale of trees to the CDOT for removal. If the Forest Service is not able to remove the trees, the CDOT may request authority as outlined in **Section IV.A.**

The USFS shall notify the CDOT of planned timber sales and vegetative management projects and provide maps identifying planned management areas. The CDOT shall review the planning areas for trees that need to be cleared for public safety of the highways. The trees will be identified to the USFS for inclusion in timber sales or other vegetative management where possible. If the Forest Service is not able to remove the trees, the CDOT may request authority as outlined in **Section IV.A.**

The CDOT will notify the USFS/BLM when facilities (such as fences or cattle guards) that are USFS/BLM responsibility are not being adequately maintained or will be impacted by CDOT maintenance within the ROW.

B. Imminent Hazards

The CDOT may remove imminent hazards, such as rockslides or trees, without formal USFS/BLM approval and will notify the USFS/BLM as soon as practicable. Removed material will be disposed of at locations mutually agreeable to the CDOT and the USFS/BLM.

C. Maintenance outside the Right-of-Way

The CDOT will coordinate with the USFS/BLM on any maintenance activities, which may affect NFS/ Public Lands outside the ROW and will require prior approval by the FS/BLM. Snow avalanche control is covered in **Section XII**.

D. Non-Routine Maintenance Activities

Non-routine maintenance activities within the ROW such as significant amounts of clearing, changes in established drainage patterns, and material sources and storage/disposal sites will be mutually agreed upon by the USFS/BLM and the CDOT by conference or other communication prior to commencing the work.

IX. Signing and Pavement Markings

A. General Policies and Responsibilities

The agencies should jointly develop a project public access sign plan in accordance with the Manual on Uniform Traffic Control Devices (MUTCD) and the Colorado supplement of the MUTCD. Examples of common signs are shown, but are not limited to those, in Attachment 2 of this agreement.

Any signing needs not covered under this section will be proposed, mutually reviewed and approved on a site-specific basis by the USFS/BLM and the CDOT. Unresolved problems and items requiring approval of higher authority will first be referred to the CDOT Sign Variance Committee. If the USFS/BLM and the Sign Variance Committee do not resolve the issues, they will be referred to upper management using the dispute resolution process.

The CDOT will furnish, install, and maintain all regulatory, warning, and guide signs, other than those requested by the USFS/BLM, within the ROW along the interstate and State highway systems. CDOT will maintain all pavement markings including lines, words and symbols

The USFS/BLM requested signs will be mutually reviewed and agreed upon by the USFS/BLM and the CDOT to assure compliance with this MOU, the "Manual on Uniform Traffic Control Devices (MUTCD)", CDOT "Guide Signing Practices and procedures", and CDOT standards. The USFS/BLM will furnish, install, and maintain the following signs:

- USFS/BLM boundary signs (see Attachment 2 examples BDY-1, BDY-2, and BDY-3)
- USFS/BLM signs RD-1 and RD-2
- Special interpretive signing
- Other signs needed for USFS/BLM management.

The USFS/BLM requested signs guiding motorists to USFS/BLM facilities will be funded as follows:

- Furnishing of signs and initial sign installation will be funded on a case-by-case basis, depending on the scope of the proposal and funding availability, and, may be provided by either agency or on a cost shared basis (for example, USFS/BLM furnish and CDOT install).
- The CDOT will maintain these signs in CDOT ROW only after installation. Any special signs will be maintained by the USFS/BLM.
- USFS/BLM recreation site guide and identifier signs shall consist of white lettering or symbols on a brown background.

Location and installation of specific service (LOGO) signs and tourist oriented directional signs (TODS) within the limits of USDOT easements across NFS/BLM lands, is the responsibility of the CDOT or their contractor (Colorado Logos), and will be done in conformance with the Manual on Uniform Traffic Control Devices and the CDOT standards.

The CDOT will review proposed sign locations with the USFS/BLM prior to selecting final locations.

Only the most direct route for any destination will be signed.

Existing signs on the State Highway System, which do not meet the standards established in this MOU, may be removed by the CDOT after prior written notification to the USFS Ranger District/BLM Field Office of signs to be removed.

USFS/BLM boundary signs shall include the respective agency's shield.

B. Criteria for Sign Locations

The U.S. Forest Service/BLM land access signs (see Attachment 2 examples ACC-1, ACC-2, and ACC-3) are installed at locations where roads provide all-weather, passenger car access to USFS/BLM developed recreation sites originating from State highways.

The National Forest Boundary/BLM Boundary signs (see Attachment 2 examples BDY-1, BDY-2, and BDY-3) are installed at points where a highway first crosses a USFS/BLM boundary.

Visitor Information Site signs (see Attachment 2 examples INF-1 and INF-2) are installed for staffed facilities that are adjacent to a State highway, are within ten (10) road miles of a Federal lands boundary, and are located in a rural area or a community of less than 50,000 population.

Developed Recreation Sites and other recreation areas – Signs will meet the requirements of MUTCD Section 2H-08 and depicted in Figure 2H-2 of the MUTCD. Sites generally should be located within one mile of the State highway, have physical improvements (other than roadway), be identified on USFS or BLM visitor maps, and provide parking for at least ten vehicles. Included are such sites as:

- Campgrounds—when sanitary facilities are provided
- Picnic areas—when sanitary facilities are provided
- Overlooks—when interpretive signing is provided
- Fishing Access Sites—when accessible for handicapped persons (exempt from ten vehicle minimum parking limitation)
- Historical information sites
- Other points of interest as mutually agreed

Primary access roads signs (see Attachment 2 examples RD-1 and RD-2) are installed at junctions with USFS/BLM roads, which are maintained for passenger car traffic.

Scenic Byway signs (see Attachment 2 example SB-1) are installed at locations established under the Guidelines for Scenic Byway Signing (see Attachment 3). Signs will be installed by CDOT along highways.

Wildlife Viewing Area signs (see Attachment 2 example WW-1) are installed at sites identified in the Colorado Wildlife Viewing Guides and in accordance with CDOT guidelines. Signs will be installed by CDOT along highways.

Other areas are to be mutually agreed upon (e.g. interpretive waysides and scenic overlooks).

X. Access Control

Access to interstate highways will be only by established interchanges, except for emergency use in accordance with the rules and regulations governing the Interstate Highway System.

The USFS/BLM or its permit holders will obtain a State Highway Access Permit for any new or revised road approaches to State highways. New approaches and any other requirements for complying with the State Highway Access Permit will be the responsibility of the USFS/BLM permit holders unless specifically addressed in the permit.

If planned activities of the USFS/BLM, or its permit holders, will affect highway operations, any necessary permits from CDOT will be obtained, for example traffic control permits.

XI. Third Party Occupancy

The grant of an easement to the CDOT by the FHWA does not include the grant of any rights for non-highway purposes, facilities, or occupancy by third parties.

In the case of a third party, such as a public utility, wishing to locate on highway ROW over NFS/Public Lands, the CDOT will advise the third party that it must first apply to the USFS/BLM for a permit pursuant to the Third Party Occupancy Consultation Requirements contained in Attachment 3.

The CDOT, USFS, and BLM will consult before any third party occupancy permits and/or other encumbrances are acted upon to determine if such occupancy may impact highway safety, maintenance, and efficiency. Requirements for consultation are included in Attachment 3, Third Party Occupancy Consultation Requirements.

XII. Snow Avalanche Control

A statewide avalanche management plan will be prepared and maintained by the CDOT to specify methods of snow avalanche hazard reduction, public and employee safety, protection of public and private property, rescue procedures related to highway operations, and other elements of avalanche control operations that are uniform across the State. Local operating procedures will be developed to prescribe site-specific avalanche management activities and may include: maps and photographs, area control measures, gun placements, media contacts, location and responsibility for warning signs, and names and/or positions of personnel responsible for various activities. These local procedures will become part of the statewide avalanche management plan and will be prepared in cooperation with CDOT Regions and local USFS/BLM field offices.

The CDOT, the USFS and the BLM mutually agree to cooperate in highway maintenance and advance warning signing as it relates to snow avalanche reduction activities and safety in accord with the general principles and specific procedures outlined in this MOU.

XIII. Dispute Resolution

All agencies agree to work cooperatively to avoid and resolve conflicts. The agencies agree to explore issues thoroughly before seeking to use this dispute resolution mechanism by ensuring that adequate communication has occurred, that all agencies fully understand the issues, and the reasons why an agency is committed to a position.

If disagreements emerge which cannot be resolved, the impasse shall be escalated as illustrated in Table 2.

1	FS Project Coordinator	BLM Project Coordinator	CDOT Project Coordinator	FHWA Operation Engineer
2	Director/Forest Supervisor	Field Manager and District Manager	Resident Engineer/ Program Engineer/Regional Transportation Director	Program Delivery Engineer
3	Deputy Regional Forester	Deputy State Director, Division of Energy, Lands, and Minerals	Chief Engineer	Assistant Division Administrator
4	Regional Forester	State Director	Executive Director	Division Administrator

TABLE 2. LIST OF AGENCY CONTACTS AND LEVEL OF DISPUTE RESOLUTION (BEGINNING WITH LEVEL 1 AND PROGRESSING TO LEVEL 4).

When the parties at the lowest organizational level of the agencies have agreed to escalate, a meeting date will be established within 5 days. At that time, representatives from the agencies at both levels will meet to discuss the issues and come up with a resolution. If an agreement cannot be reached, then the issue will be escalated to the next level and a meeting date established within 5 working days. At that time, representatives from the agencies at all three levels will meet to discuss the issues and come to a resolution. If an agreement cannot be reached, the issue will be escalated to the highest level and a meeting date established within 5 working days. At that time, all agencies will come to resolution.

Mediation and facilitation may be used at any level to help expedite resolution.

Documentation of all disagreements and resolutions shall be furnished to all involved agencies and included in the project file.

ATTACHMENT 1: EXAMPLE COORDINATION SCHEDULE

Project_____ County_____

Date Prepared_____ Revised_____

CDOT Project Manager_____ USFS/BLM Manager_____

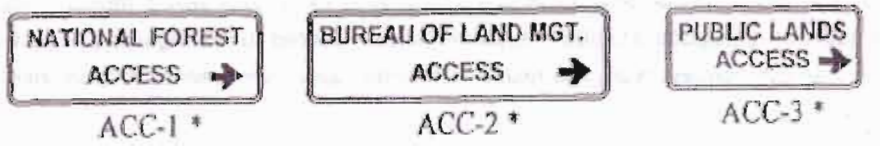
	Scheduled Tasks	Schedule Date	Schedule Date
A.	**CDOT/USFS/BLM** review STIP and/or land management plans to determine project compatibility.		
B.	**USFS/BLM/CDOT** provide necessary authorizations or For surveys or site investigations.		
C.	**CDOT/USFS/BLM** conduct joint Preliminary Field Review/CDOT Scoping Review. Develop schedules.		
	1. **CDOT** flag clearing limits for timber valuation.		
	2. **USFS/BLM** cruise and appraise timber (at least 30 before construction starts).		
	3. **USFS/BLM**issue timber contract before construction commences.		
D.	**CDOT/FHWA/USFS/BLM** tentatively determine NEPA document required CE_____ EA _____ EIS _____		
E.	**CDOT/FHWA/BLM** submit NEPA document, and construction plans to USFS/BLM/CDOT.		
F.	(**USFS/BLM** submit recommendations, if needed, to CDOT).		
G.	**(CDOT)** submit ROW plans to FHWA.		
H.	(**FHWA)** request Letter of Consent (LOC) from USFS Regional Office/BLM State Office.		
I.	(**USFS Regional Forester/ BLM State Director** issue LOC with stipulations to FHWA, copy to CDOT.		

J	**CDOT/USFS/BLM submit final plans to USFS/BLM/CDOT.**	_____	_____
K	**CDOT/USFS/BLM** advertise project.	_____	_____
L	(**CDOT** process easement deed with FHWA)	_____	_____
M	CDOT/USFS/BLM conduct final project inspection	_____	_____

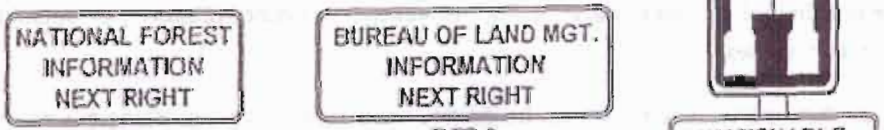
N	Construction Coordinators: (name and phone number)	CDOT _____ USFS/BLM_____

ATTACHMENT 2: TYPICAL SIGNS

BDY-1 BDY-2 BDY-3



ACC-1 * ACC-2 * ACC-3 *



INF-1 INF-2

WW-1

SB-1

RD-1

RD-2

* May include road name.

ATTACHMENT 3: THIRD PARTY OCCUPANCY CONSULTATION REQUIREMENTS

USFS/BLM/CDOT/FHWA Third Party Agreement Process

There are four variations of third party requests for access/use of CDOT ROW. Three of the request types require coordination between the USFS/BLM and CDOT to determine the proposed occupancy does not adversely affect the safety, operations and maintenance of the highway. The remaining request type requires only the review and approval by CDOT.

The first type of third party request would be one in which the requester would like to make modifications to, or add to, the CDOT transportation facility. Examples of this type of request would include, but are not limited to: bike/pedestrian paths or recreational facilities appurtenant/connected to the highway; pedestrian underpasses; or bridge structures. In this request type, the facility ownership and maintenance responsibilities remain with the third party.

The second type of third party request would be one in which long term, or permanent, improvements are constructed within the ROW, but do not physically impact the CDOT facility. Examples of this type of request would include, but are not limited to: cell towers; utilities; driveways to private property; or detached bike/pedestrian paths or recreational facilities.

The third type of third party request would be limited to a temporary ingress/egress to and from the ROW (crossing the highway Access Control line). Examples of this type of request would include but not be limited to: temporary logging roads; or other motorized or non-motorized access to/from NFS land/public land.

The first three types of third party requests should be handled as set forth below:

Request Type: 1 Actual Improvements to CDOT Facilities

1. Third Party submits proposal to USFS/BLM
2. USFS or BLM screens the proposal. If proposal passes screening, USFS/ BLM accepts the proposal as an application. USFS/BLM forwards the application to CDOT Region ROW Office for review, and to conceptually approve that the proposed occupancy does not adversely affect the safety, operations and maintenance of the highway.
3. Upon notification of conceptual approval from CDOT, USFS/BLM requests the Third Party prepare more detailed documents required for CDOT, USFS/BLM and FHWA (when request involves Interstate ROW) for NEPA analysis.
4. Third Party submits the following to USFS/BLM:
    a. Location Maps
    b. Construction Plans
    c. Site Photos
    d. All available environmental documents
5. USFS/BLM forwards applicant information to CDOT Region ROW Office
6. USFS/BLM conducts NEPA in consultation with CDOT. As NEPA requires, USFS/BLM, CDOT and Third Party will work in concert to refine the project design
7. CDOT Region ROW determines the appropriate approval documents
    a. Access Control line Crossing License (Exhibit A) *
    b. License to cover use and maintenance of improvements (Exhibit B) **
    c. CDOT Special Use Permit for construction (Exhibit C) **

8. If the request involves Interstate ROW, CDOT Property Management will request FHWA approval of:
    a. Access Control line Crossing License (Requires Form 128 Environmental Clearance, prepared from USFS/BLM NEPA document).
    b. License to cover use and maintenance of improvements (Requires Form 128 Environmental Clearance)
9. CDOT Region ROW Office will issue all necessary CDOT permits/licenses to Third Party
10. CDOT Property Management will forward concurrence letter to USFS/BLM along with all applicable CDOT permits and the executed A-Line license, if necessary.
11. USFS/BLM will make a NEPA decision. If the decision is to authorize the use, the USFS will issue the Special Use Permit or the BLM will issue the right-of-way grant, including any CDOT stipulations in the operation and maintenance plan and will forward a copy of the executed permit to CDOT.

Request Type 2: Permanent Improvements within the ROW, with no Direct Impact to the CDOT Transportation Facility, and

Request Type 3: Ingress/Egress to and From CDOT Transportation Facility

1. Third Party submits proposal to USFS/BLM
2. USFS or BLM screens the proposal. If proposal passes screening, USFS/BLM accepts the proposal as an application. USFS/BLM forwards the application to CDOT Region ROW Office for review, and to conceptually approve that the proposed occupancy does not adversely affect the safety, operations and maintenance of the highway.
3. Upon notification of conceptual approval from CDOT, USFS/BLM requests the Third Party prepare more detailed documents required for CDOT, USFS/BLM and FHWA (when request involves Interstate ROW) for NEPA analysis.
4. Third Party submits the following to USFS/BLM:
    a. Location Maps
    b. Construction Plans
    c. Site Photos
    d. All Available Environmental Documents
5. USFS/BLM forwards application information to CDOT Region ROW Office
6. USFS/BLM conducts NEPA. If the request involves an A-Line Crossing on an interstate highway, then NEPA is done in consultation with CDOT. As NEPA requires, USFS/BLM, CDOT and Third Party will work in concert to refine the project design.
7. CDOT Region Office determines impacts to the highway facility, and drafts necessary stipulations and forwards them to CDOT Property Management.
8. CDOT Property Management will draft concurrence letter with the necessary stipulations.
9. If the request involves an A-Line Crossing an A-Line Crossing License will be drafted
    a. If the request involves Interstate ROW, Property Management will request FHWA approval of an Access Control line Crossing License (Requires Form 128 Environmental Clearance prepared from USFS/BLM NEPA document)
    b. CDOT Region ROW Office will issue the A-Line Control licenses to Third Party
10. CDOT Property Management will forward concurrence letter to USFS/BLM along with the executed A-Line license, if necessary
11. USFS/BLM will make a NEPA decision. If the decision is to authorize the use, the USFS will issue the Special Use Permit or the BLM will issue the right-of-way grant, along with CDOT stipulations for the maintenance and operation plan and will forward a copy of the executed permit to CDOT.

The fourth type of third party request would be one in which the requestor wishes to use the transportation facility only (no access to NFS land/public land outside the CDOT ROW) for a temporary use. Examples of this type of request would include, but are not limited to: bike or pedestrian races/events.

The fourth type of third party requests should be handled as set forth below:

Request Type 4: Use of CDOT Transportation Facility Only

1. Third Party Submits request for use of ROW to CDOT Region ROW office.
2. CDOT Region ROW Office to Determine Need for/Request Appropriate Approval Documents
    a. CDOT Special Use Permits (Exhibit D)
3. CDOT Region Traffic Section issues Special Use Permit for Event

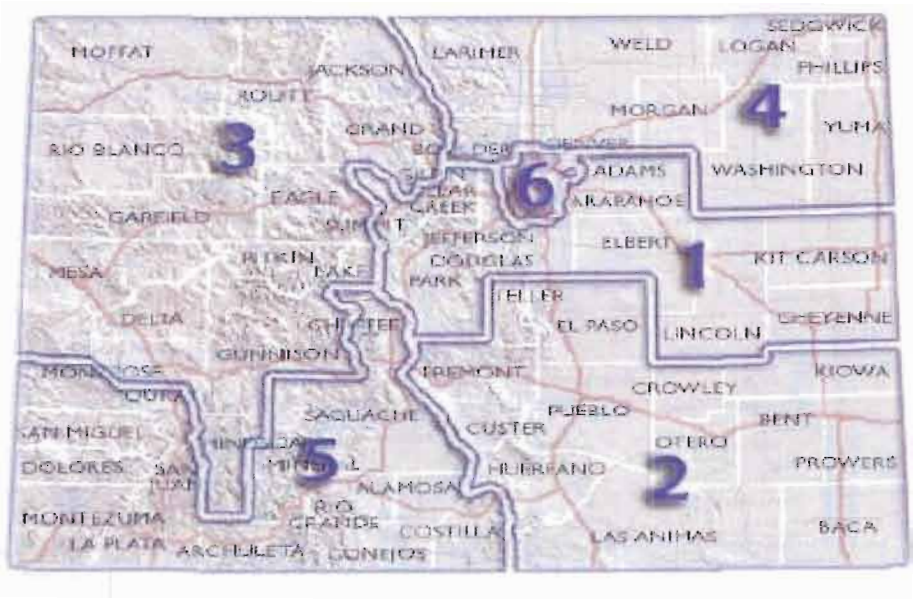
* Title 23 of the Act of August 27, 1958, as amended, 'Highway Act' gives FHWA the authority to approve crossing of the Access Control (A-line) for interstate highways.

ISTEA gives authority to the state DOTs to approve changes to the A-lines of non-interstate highways. Change to the A-line includes crossing of the A-line, moving the A-line, etc. Note: not all non-interstate highways have A-lines. It will be necessary to look at the ROW plans to determine if an A-line is present. If no A-line then the Access Control line Crossing License will not be applicable.

** These documents are necessary as the improvement is connected to the highway

5/4/10

ATTACHMENT 4: COLORADO DEPT. OF TRANSPORTATION REGION MAP AND CONTACTS



Region 1
18500 E. Colfax Ave.
Aurora, CO 80011
Phone: (303) 757-9371

Region 2
905 Erie Ave.
Pueblo, CO 81002
Phone: (719) 546-5452

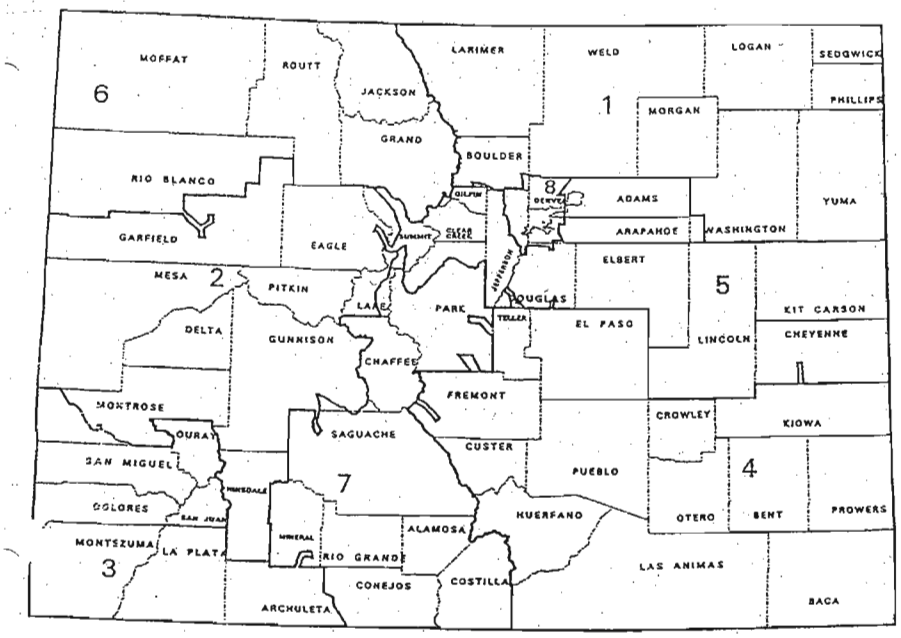
Region 3
222 South 6th St., #317
Grand Jct., CO 81501-2769
Phone: (970) 248-7225

Region 4
1420 2nd Street
Greeley, CO 80632
Phone: (970) 350-2101

Region 5
3803 N. Main Ave., #306
Durango, CO 81301
Phone: (970) 385-1402

Region 6
2000 South Holly St.
Denver, CO 80222
Phone: (303) 757-9459

ATTACHMENT 5: COLORADO DEPT. OF TRANSPORTATION MAINTENANCE MAP AND CONTACTS



Section 1 – Greeley
1420 – 2nd Street
Greeley, CO 80631
(970) 350-2122

Section 2 – Grand Junction
606 S. 9th Street
Grand Junction, CO 81501
(970) 248-7362

Section 3 – Durango
20581 W. Hwy. 160
Durango, CO 81301
(970) 385-1652

Section 4 – Pueblo
905 Erie Avenue
Pueblo, CO 81002
(719) 546 -5419

Section 5 – Aurora
18500 East Colfax Avenue
Aurora, CO 80011
(303) 757 -9649

Section 6 – Craig
260 Ranney Street
Craig, CO 81625
(970) 824 -5104

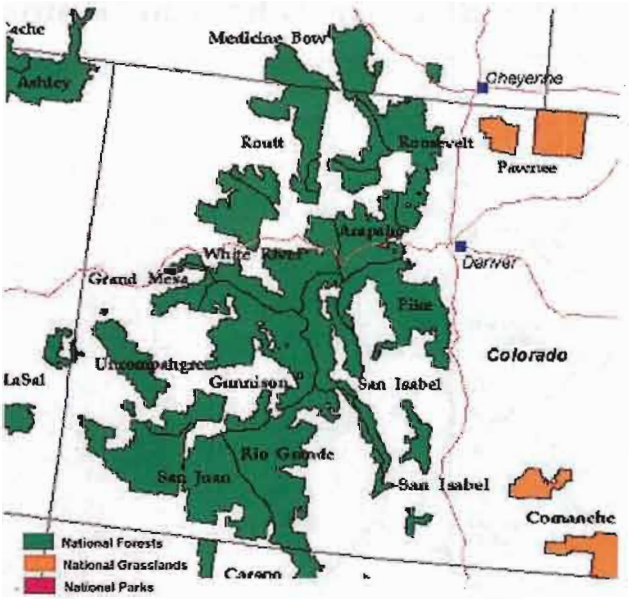
Section 7 – Alamosa
P.O. Box 478
Alamosa, CO 81101
(719) 589 -3616

Section 8 – Denver
5640 East Atlantic Place
Denver, CO 80211
(303) 757-9514

Section 9 – Eisenhower Tunnel
P.O. Box 397
Idaho Springs, CO 80452
(303) 512-5730

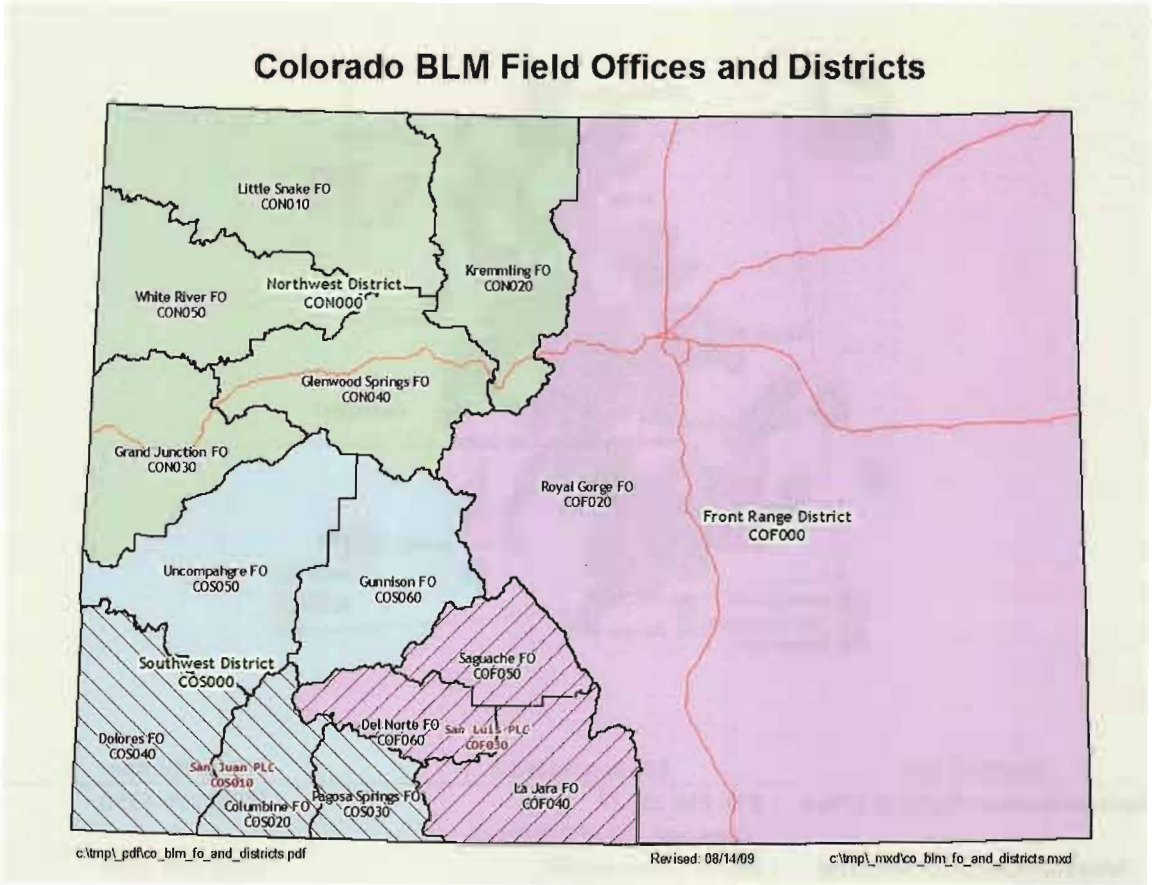
Headquarters – Staff Mtce.
15285 S. Golden Road
Golden, CO 80401
(303) 273-1840

ATTACHMENT 6: U.S. FOREST SERVICE COLORADO FIELD OFFICES MAP AND CONTACTS



Forest Office	Mailing Address	Phone Number
Rocky Mountain Regional Office	P.O. Box 25127 Lakewood, CO 80225-0127	(303) 275-5350
Arapaho/Roosevelt National Forest& Pawnee National Grasslands	240 W. Prospect Rd. Ft. Collins, CO 80526-2098	(970) 498-1100
Grand Mesa, Uncompahgre,& Gunnison National Forests	2250 Highway 50 Delta, CO 81416-8723	(970) 874-6600
Pike/San Isabel National Forests, National Grasslands	1920 Valley Drive Comanche/Cimarron Pueblo, CO 81008	(719) 545-8737
Rio Grande National Forest	1803 W. Hwy 160 Monte Vista, CO 81144	(719) 852-5941
San Juan National Forest	15 Burnett Ct Durango, CO 81301	(970) 247-4874
White River National Forest	900 Grand Ave. P.O. Box 948 Glenwood Springs, CO 81602	(970) 945-2521

ATTACHMENT 7: COLORADO BLM FIELD OFFICE BOUNDARIES AND CONTACTS



Front Range District Office

3028 East Main Street
Cañon City, Colorado 81212
719-269-8500
FAX 719-269-8599

Del Norte Field Office
13308 W. Hwy. 160
Del Norte, Colorado 81132
719-657-3321
FAX 719-657-6035

Royal Gorge Field Office
3028 East Main Street
Cañon City, Colorado 81212
719-269-8500
FAX 719-269-8599

La Jara Field Office
15571 County Rd T5
La Jara, CO 81140
719-274-8971
FAX 719-274-6301

Saguache Field Office
46525 Highway 114
PO Box 67
Saguache, Colorado 81149
719-655-2547
FAX 719-655-2502

San Luis Valley Public Lands Center
1803 West Hwy 160
Monte Vista, CO 81144
719-852-5941
FAX 719-852-6250

Northwest District Office

2815 H Road
Grand Junction, Colorado 81506
970-244-3000
FAX 970-244-3083

Grand Junction Field Office
2815 H Road
Grand Junction, Colorado 81506
970-244-3000
FAX 970-244-3083

Colorado River Valley Field Office
2300 River Frontage Road
Silt, CO 81652
970-876-9000
FAX 970-876-9090

Kremmling Field Office
2103 E. Park Avenue
P.O. Box 68
Kremmling, Colorado 80459
970-724-3000
FAX 970-724-9590

Little Snake Field Office
455 Emerson Street
Craig, Colorado 81625
970- 826-5000
FAX 970- 826-5002

White River Field Office
220 East Market St.
Meeker, Colorado 81641
970-878-3800
FAX 970-878-3805
TDD 970-878-4227

Southwest District Office

2465 South Townsend Avenue
Montrose, Colorado 81401
970-240-5300
FAX 970-240-5367

Columbine Field Office
PO Box 439, 367 Pearl St.
Bayfield, CO 81122
970-884-2512
FAX 970-385-1375

Dolores Public Lands Office
29211 Hwy. 184
Dolores, Colorado 81323
970-882-7296
FAX 970-882-6841

Gunnison Field Office
216 N. Colorado
Gunnison, Colorado 81230
970-641-0471
FAX 970-642-4425

Pagosa Field Office
P.O. Box 310
Pagosa Springs, Colorado 81147
970-264-2268

San Juan Public Lands Center
15 Burnett Court
Durango, CO 81301
970- 247-4874
FAX: 970- 385-1243

Uncompahgre Field Office
2465 South Townsend Avenue
Montrose, Colorado 81401
970-240-5300
FAX 970-240-5367