WB I-70 Peak Period Shoulder Lane

GEOLOGY AND SOILS TECHNICAL REPORT

October 26, 2018

Categorical Exclusion

GEOLOGY AND SOILS TECHNICAL REPORT

WESTBOUND I-70
PEAK PERIOD SHOULDER LANE

Prepared for:

Prepared by:

October 26, 2018

Contents

Figures

Tables

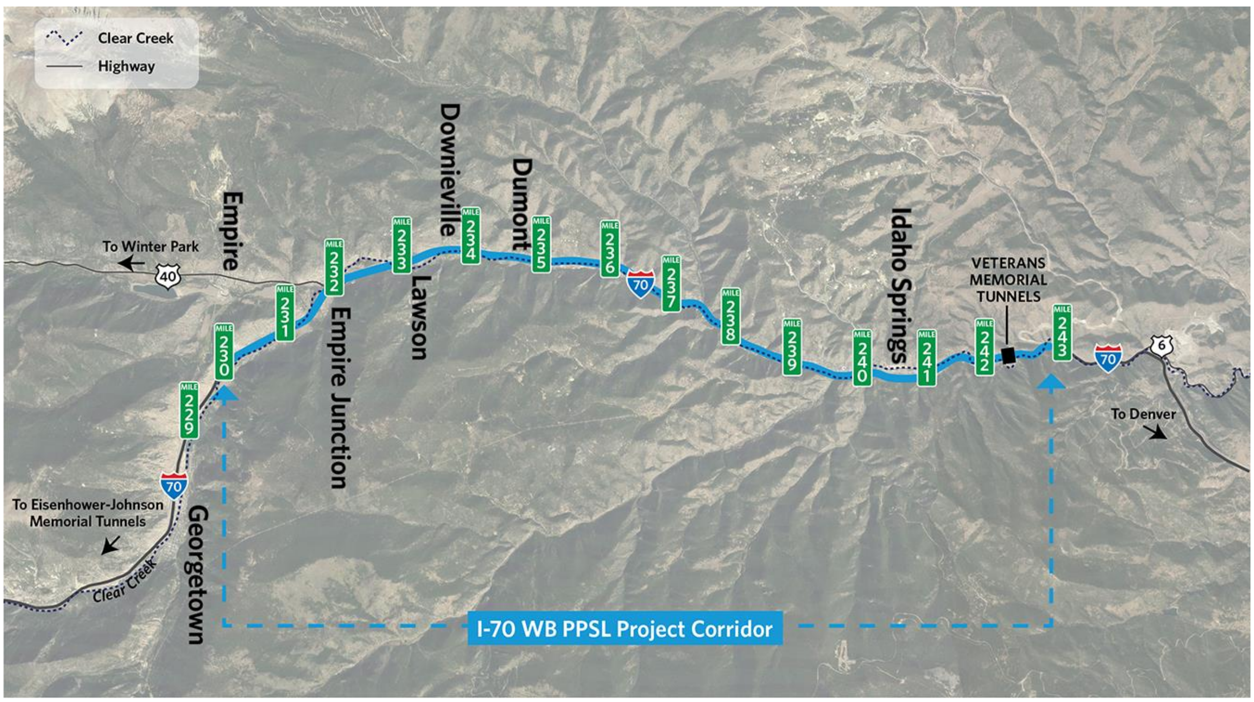
Acronyms and Abbreviations

CDOT	Colorado Department of Transportation
CSS	Context Sensitive Solutions
EA	Environmental Assessment
EB	eastbound
FHWA	Federal Highway Administration
FONSI	Finding of No Significant Impact
I-70	Interstate 70
MP	Milepost
NRCS	Natural Resources Conservation Service
PPSL	Peak Period Shoulder Lane
PEIS	Programmatic Environmental Impact Statement
ROD	Record of Decision
SH	State Highway
US 40	U.S. Highway 40
USFS	U.S. Forest Service
WB	Westbound

Section 1. Purpose of the Report

The Federal Highway Administration (FHWA), in cooperation with the Colorado Department of Transportation (CDOT), is preparing a Categorical Exclusion for proposed changes to the westbound (WB) lanes of Interstate 70 (I-70) between approximately milepost (MP) 230 and MP 243, in Clear Creek County, Colorado (Proposed Action; Figure 1). The Proposed Action includes the addition of a 12-mile tolled Peak Period Shoulder Lane (PPSL) between east Idaho Springs and the U.S. Highway 40 (US 40)/I-70 interchange in the WB direction and improvements to the State Highway (SH) 103 interchange. The Proposed Action improves operations and travel time reliability in the WB direction of I-70 in the study area. Additionally, the improvements are consistent with the *I-70 Mountain Corridor Programmatic Environmental Impact Statement* (PEIS; CDOT 2011), PEIS Record of Decision (ROD; FHWA 2011), Context Sensitive Solutions (CSS) on the I-70 Mountain Corridor (CDOT 2009) process, and other commitments of the PEIS and ROD. The Proposed Action fits within the definition of “expanded use of existing transportation infrastructure in and adjacent to the corridor” included in the “Non-Infrastructure Related Components” element within the Preferred Alternative’s Minimum Program of Improvements.

Figure 1. Project Corridor



Source: HDR 2018.

This document discusses the regulatory setting, and describes the affected environment and the impacts of the Proposed Action on geology and soils within the study area. This document also identifies mitigation measures, including applicable measures identified in the I-70 Mountain Corridor PEIS, which would reduce impacts during construction and operation.

Section 2. Summary of Geologic Resources from Previous NEPA Analyses

2.1 How were Geologic Resources Treated in the I-70 Mountain Corridor PEIS and ROD (Tier 1)?

The Tier 1 I-70 Mountain Corridor PEIS provided an overview of geologic hazards from a corridor perspective. Rock types on the eastern side of the Continental Divide, including those in Clear Creek County, were found to consist of granites and granite/migmatite mixtures. The *I-70 Mountain Corridor PEIS Geologic Hazards Technical Report* (CDOT 2011b) detailed the geologic conditions and hazards in the corridor. These hazards included 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 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); and erosion/collapsible soil (fine sandy and silty soils with a loose, open structure that collapse when wet). The PEIS found that rockfall is the most prevalent hazard.

Excavations in rock and soil cause both temporary impacts from construction activities and long-term impacts associated with achieving and maintaining slope stability. 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; however, the probability of such hazards creating impacts are no greater than the existing conditions. The Action Alternatives reduce the risks posed by geologic hazards in some cases where construction stabilizes slopes. Regular avalanche control and rockfall mitigation continues under all alternatives. In some cases avalanche or rockfall control work fails resulting in the roadway being covered and causing temporary road closures.

The PEIS and ROD committed to mitigation strategies for future projects, including:

- 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.

2.2 How were Geologic Resources Treated in the Twin Tunnels Expansion Projects (Tier 2)?

The FHWA, in cooperation with CDOT, prepared an Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for proposed changes (2012 Westbound I-70 Twin Tunnels Expansion project) to the eastbound (EB) section of the Twin Tunnels between MP 241 and MP 244 in Clear Creek County, Colorado (CDOT 2012a). The EA provided an inventory of existing and future recreational resources within the study area between MP 241 and MP 244.5.

CDOT prepared a Categorical Exclusion for the Twin Tunnels for the WB lanes of I-70 (CDOT 2012b), which is the same study area as the Twin Tunnels EA and FONSI (EB). Findings from this study were similar to the findings from Twin Tunnels EA and FONSI completed for the EB direction.

The EA noted that the Twin Tunnels project cut through rugged terrain with areas of adverse structure and poor rock quality, with the most common hazard being rockfall. The widened tunnel portals increased the exposure to rockfall, and the widening of the roadway template slightly increased the amount of erosion. However, the project reduced the risks posed by geologic hazards by implementing rockfall mitigation as part of the new portal design and using best management practices during construction to control erosion.

The EA and FONSI committed to mitigation strategies described in the PEIS, including:

- Incorporating permanent rockfall mitigation during construction and in the design of the new portals and evaluation of the rock mass prior to blasting for the likelihood of rockfall occurring.
- Using proven techniques (such as rockfall catchments, mesh, cable netting, fences, scaling, and blasting) to address rockfall from cut slope areas.
- Managing erosion and surface water away from water sources and ensuring best management practices are in place to prevent migration of sediment from waste piles, slopes and excavations.
- Implementing best management practices for stormwater runoff.

2.3 How were Geologic Resources Treated in the EB I-70 Peak Period Shoulder Lane Categorical Exclusion (Tier 2)?

The EB I-70 PPSL Categorical Exclusion (Tier 2; CDOT 2014) examined geologic resources along the I-70 corridor between MP 230 and MP 243. An increased risk of rockfall danger during construction was identified. Therefore, the project incorporated rockfall mitigation in two locations near Soda Creek Road; at approximately MP 240.06 and MP 240.43 where existing rock slopes are near the roadway edge. A mesh fence was bolted to the rock face to minimize rockfall risk. Mesh at the western location was about 375 feet long and 55 feet high, and the mesh at the eastern location was about 500 feet long and 50 feet high.

Section 3. What Process was Followed to Analyze Geology and Soils?

3.1 Methodology

The study area for geology and soils includes the regional geology, soils, and geologic hazards that are near, underlie, or are located along I-70 between the Veterans Memorial Tunnels and US 40. Geologic conditions present along the I-70 Mountain Corridor are well described in the I-70 PEIS and the EB PPSL Categorical Exclusion from information obtained from geologic maps, topographic maps, aerial photographs, U.S. Geological Survey reports, CDOT reports, Colorado Geological Survey publications, and geotechnical consulting reports. This information was supplemented during the Tier 2 process with field reconnaissance, communications with local engineering and planning personnel, and communications with individuals with first-hand knowledge of mine subsidence and mitigation. Evaluation of existing geologic conditions was based on proximity to the study area, history of occurrence, and impact of occurrence on transportation and mobility.

The erosional susceptibility of the soils is based on mapping and ratings conducted by the Natural Resources Conservation Service (NRCS) and the U.S. Forest Service (USFS). The NRCS provided erodibility groups as well as the soil description. The USFS provided erodibility descriptions in the soil use and management considerations. Using the NRCS and USFS information and known conditions in the corridor, the generalized descriptions are rated as slight, moderate, or severe susceptibility to erosion. The variation in susceptibility index along the corridor is highly dependent on the topography, vegetation cover, and the orientation of the slope.

Geologic units and soil characteristics were assessed within the study area to establish the affected environment for geology and soils. Geotechnical borings were drilled along the lengths of the proposed shoulder and median walls. These borings were advanced to approximately 20 feet depth using an ODEX system and two borings were supplemented with diamond core drilling. Twenty-one additional borings were drilled using solid stem auger to a maximum depth of 5 feet for pavement design.

Drone aerial photogrammetry was also used to analyze the study area. Drones equipped with GPS technology and high-resolution cameras were flown along the south-facing rock slopes between Idaho Springs and Dumont (approximately MP 239 to MP 235). The Pix4D software package was used to stitch and process all photos taken into a 3-dimensional model. Maptek's I-Site Geotechnical Module was then used to analyze geomechanical structures exposed in the rock faces.

The study area for specific issues related to geology and soils is defined as the area within approximately 100 feet on either side of the Proposed Action. However, when assessing the geology and soil characteristics, it was also necessary to consider geology on a regional basis to understand the mechanisms leading to current geology. The need for a regional review is particularly important to geologic hazards because the hazard could originate from anywhere along a slope, from the base to the ridgeline, throughout the project route.

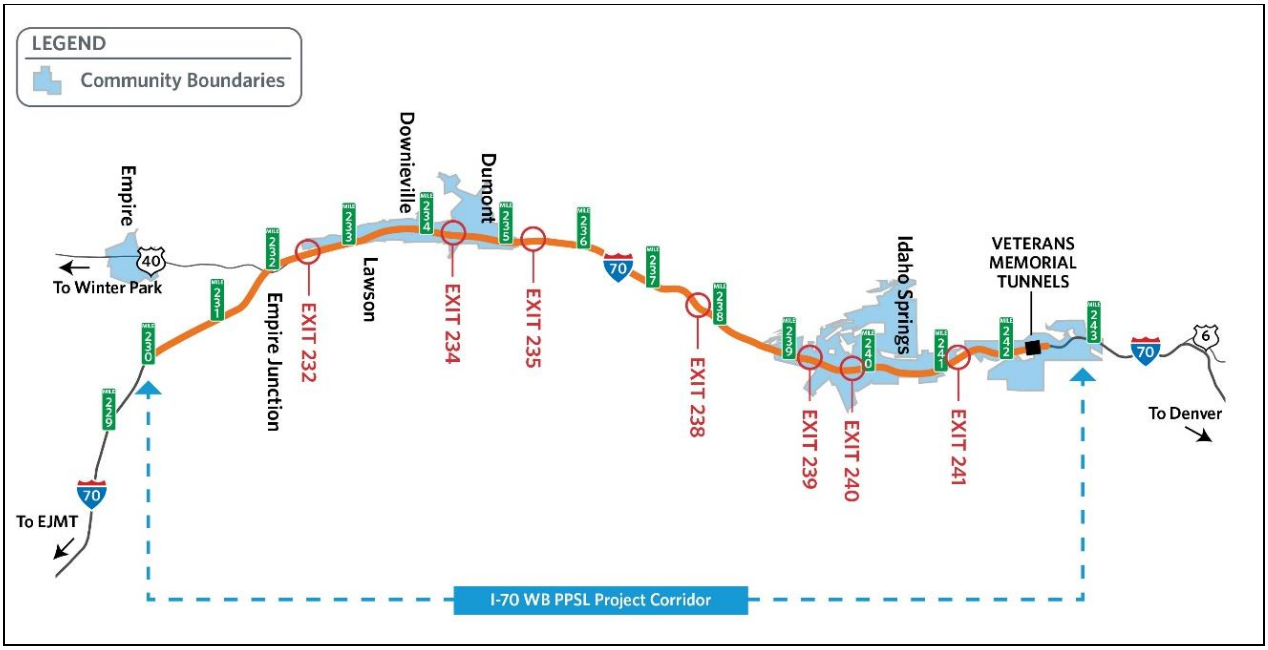
3.2 Study Area

The study area for the WB PPSL project encompasses CDOT right-of-way along I-70 in both directions from MP 243 to MP 230 and areas immediately adjacent to the right-of-way. This study area was used to evaluate the **direct** effects of the Proposed Action.

For transportation and socioeconomic impacts, the study area for **indirect** effects includes Clear Creek County and the communities of Idaho Springs, Downieville-Lawson-Dumont, and the town of Empire. This area is broadly defined and includes the communities and other areas that would be **indirectly** affected by the Proposed Action. The indirect effects study area includes the communities shown in Figure 2.

For the remaining resources, the study area for **indirect** effects generally includes a 0.25-mile buffer around the study area. This area encompasses the communities and other areas that would be indirectly affected by the Proposed Action.

Figure 2. Study Area Communities



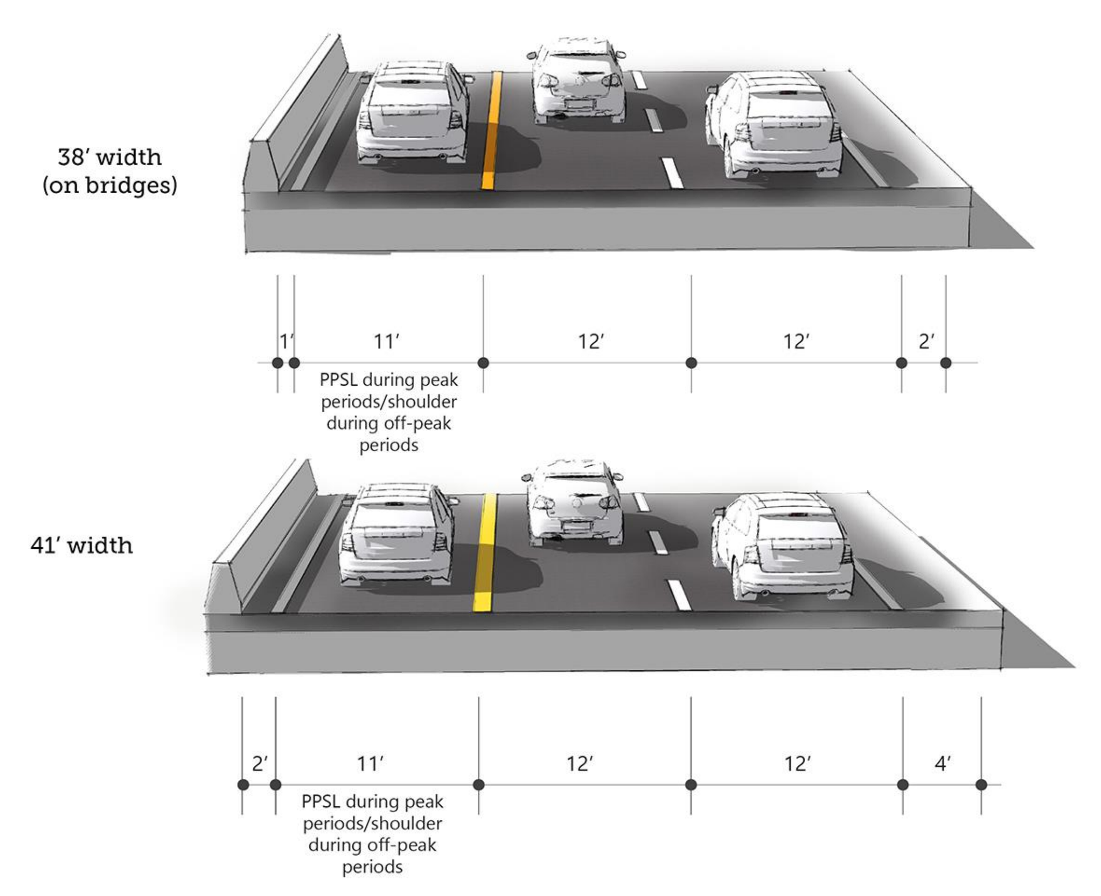
Section 4. Description of the Proposed Action

The WB PPSL project adds an approximate 12-mile tolled PPSL on WB I-70 between the Veterans Memorial Tunnels (just west of MP 243) and the US 40/I-70 interchange (MP 232). The lane entrance begins approximately 500 feet east of the Veterans Memorial Tunnels portal. The WB PPSL maximizes the use of the existing alignment and infrastructure in order to minimize any new impacts within the study area. The 11-foot-lane is open for use only during peak periods, and otherwise serves as the shoulder of the interstate. Use of the WB PPSL is prohibited for trucks, buses, or any vehicle over 25 feet long. Overhead signs showing the lane status and toll rate are located throughout the corridor and at the entrance point.

An ingress/entrance point for traffic coming onto WB I-70 from Idaho Springs is provided approximately 2,500 feet west of Exit 239. An egress point for traffic exiting to Downieville is provided about 4,400 feet east of Exit 235, and an egress point for traffic exiting to US 40 is provided approximately 4,400 feet east of Exit 232.

The WB PPSL ends approximately 1/2 mile west of Exit 232. Figure 3 illustrates the typical cross sections of the Proposed Action.

Figure 3. WB PPSL Proposed Action Typical Cross Sections



Source: HDR 2018.

Improvements include:

I-70 Modifications. The general purpose lanes and shoulder of WB I-70 are resurfaced and widened in select locations on the existing alignment between approximately MP 241.5 and MP 232 to accommodate a lane on the shoulder during peak travel periods. Drainage enhancements include a storm system for minor and major storm events and water quality facilities. At SH 103, I-70 is slightly realigned to enhance safety and improve drainage.

SH 103 Interchange Improvements. Ramp improvements address sight distance problems. The pedestrian sidewalk is improved by adding lighting and a decorative paving buffer adjacent to the existing sidewalk on the SH 103 bridge over I-70. This sidewalk connects to a new sidewalk buffered from 13th Avenue between the interchange ramp and Idaho Street in Idaho Springs.

Safety Pull-Outs. A total of seven new safety pull-outs are built—five along WB I-70 and two along EB I-70. One existing safety pull-out on EB I-70 is improved. The intention of these is to provide a space for vehicles to use if they experience a break down and for law enforcement to use.

Rockfall Mitigation. Rockfall mitigation measures are added at five locations to reduce the chance of rocks or other debris from falling on travel lanes or shoulders and reduce the potential for crashes and travel disruptions. Rockfall mitigation measures are included in the WB direction at MP 239, MP 238.4, MP 237.1, and MP 236.4, and in the EB direction at MP 240.3.

Active Traffic Management. Dynamic signage informs drivers so the WB PPSL is appropriately used to reduce congestion. This innovative design improves mobility.

Fiber Optic Upgrades. Fiber optics are designed to accommodate future emerging technologies for autonomous and connected vehicles, improving driver information and emergency response capabilities.

Dumont Port-of-Entry Interchange. Merge area improvements to the Dumont interchange acceleration lane includes restriping of I-70 to reduce merge conflicts between truck traffic and the general-purpose lane traffic.

Dynamic signage

Section 5. What are the Geology and Soil Resources in the Study Area?

5.1 Current Conditions

5.1.1 Topography

Most of the present configuration of the study area is characterized by moderately rugged topographic relief. The mountains to the south and north are deeply incised by Clear Creek and its tributaries. The maximum local relief is about 3,000 feet. Clear Creek ranges from about 8,400 feet at the west end of the study area to about 7,200 feet at the east end of the study area. The highest elevations in the study area are greater than 10,000 feet. Slopes are typically steep, averaging approximately 35 degrees (70 percent) in Clear Creek Canyon. Topographic forms are generally influenced by minor faulting, fractures, and zones of weakness in rock. Further influences from Clear Creek, rain, snowmelt, and wind have created deposits of alluvium (stream deposits), talus (rockfall deposits), and alluvial fans (debris flow deposits).

5.1.2 Bedrock

Bedrock is generally well exposed. The south-facing slopes and existing cuts are sparsely vegetated. Bedrock in the study area consists primarily of metamorphic Precambrian-age biotite gneiss, quartz-feldspar gneiss and migmatite. Hornblende gneiss, amphibolite and the igneous Silver Plume Granite and Boulder Creek Granite become more abundant in the western portion of the project area. The metamorphic rock is well foliated and trends at a regional strike of about 055 degrees (azimuthal bearing with respect to North). Locally, along I-70, strike is generally 055 to 075 degrees with a dip ranging from about 25 to 65 degrees to the northwest. Dips are steeper to the east end of the project and foliation orientations have greater variability to the west.

5.1.3 Groundwater

Groundwater was not encountered during drilling operations along the WB I-70 route for the activities of interest, i.e. retaining wall and foundation investigations. This is because of the very permeable and readily draining nature of the overburden gavels and sands which immediately overlay bedrock along the WB highway alignment, and to the typically dry weather conditions.

No surface flow (e.g., springs and seeps) in the rock cuts along the highway alignment were observed, also due to dry weather conditions and the permeable nature of the fractured surface rock which drains readily.

5.1.4 Mineralized Rock

Small intrusions of porphyritic rock are numerous in the mining district. The district is generally zoned with a large area of gold bearing pyrite-quartz veins in the interior, an intermediate zone of pyrite-quartz veins bearing copper, lead and zinc, minerals, and a peripheral one containing galena-sphalerite-quartz-carbonate veins (Sims 1989). The veins are typically fill planar fissures (sometimes mapped as “faults”) that strike northeast to east and dip north to northwest at medium angles. The principal vein minerals are pyrite, sphalerite, galena, chalcopyrite, arsenopyrite, tennantite, quartz, and local carbonate minerals. Mineralized veins are exposed in the rock face on the north side of I-70 throughout the project area, most notably between mileposts 239 and 237.

5.1.5 Mineral Resources

The Idaho Springs mining district represents a succession of gold deposits extending from Idaho Springs in Clear Creek County, to Central City and Black Hawk in Gilpin County. The district has an area of about 25 square miles. Gold, silver, copper, lead, zinc, and uranium ores occur in the district, but the area is known primarily for its gold and silver production (Colorado Geological Survey 2018).

There are numerous adits and old workings in the area in the mountainsides that form the northern roadway limit of westbound I-70. Virtually all of the sites that were observed in the field were abandoned long ago and have never been reclaimed. There are several old abandoned underground workings that pass beneath both the eastbound and westbound lanes of the existing I-70 highway. Some of these workings can be generally identified from historical records but detailed records do not exist in many cases, making locations of underground working and shafts approximate and sometimes incomplete.

5.1.6 Geologic Hazards

The varied and complex geologic and geomorphic processes have created several zones of instability and marginal subsurface material. Although a natural process, these features can pose a risk to the public either directly by an encounter with the hazard or indirectly through effect of the hazard on the highway or multi-use trails.

Unstable slope hazard areas. Existing rock slopes along I-70 through the study area generate rockfalls that occasionally impact the interstate. Isolated areas in these road cuts have generated larger and more problematic rockslides. Some of the slides have been of sufficient size to close portions of I-70 for short periods. The highly fractured metamorphic and igneous rocks along the highway are vulnerable to rockfall along many of the existing cut slopes and natural slopes. Rockfall may occur during construction when 1) new slopes cut through adverse rock structure and the boundaries between rock types, weakening the rock, or 2) where cut slopes are subject to construction activities such as blasting. The potential instability of the rock slopes depends on the material strength and the character and geometric relations of discontinuities in the rock mass.

The CDOT Rockfall Program has identified 16 slope locations along I-70 within the proposed area with previous rockfall history. Details on the locations and ratings for unstable slopes may be found in the Colorado Rockfall Hazard Rating System performed from 1991 to 1994 (Andrew 1994); ratings have been updated through 2012 as part of the CDOT's Rockfall Management Program (CDOT Geohazards Program, 2018).

Debris flows. A debris flow is a flood that incorporates, transports, and deposits so much solid material (such as rock debris, valley fill, bed load, and/or large woody debris) that the solid material is a major component of the event, drastically increasing the destructive power of the flood and the resulting damage. When infrequent, intense rains fall on the hillside and cause flooding, the mountain watersheds can add into the flood waters both inorganic (rocky debris) and organic (woody debris) materials that can increase the destructiveness of the flood on the highway.

Debris flow deposits have been mapped throughout the study area. Although the exact number in the study area has not been documented, 44 debris flow deposits have been documented between Floyd Hill and Georgetown (Coe and Godt 1997). The south-facing slopes on the north side of I-70 are particularly susceptible to debris flows because of sparse vegetation and frequent freeze-thaw cycles (Widmann and Rogers 2002). Debris flows may originate on slopes outside the study area and mobilize down chutes, gulches, or stream channels towards I-70 and Clear Creek.

Mine subsidence. Mine subsidence occurs when a void at depth collapses and causes vertical displacement (settlement) to the surface. Mine subsidence occurs at depth, rather than near the surface, as with collapsing soils. Underground mining of mineralized veins occurred within the study area from the 1860s to 1959, concentrated between MP 232 and MP 241. Mine workings typically consist of adits, shafts, drifts, and "small amounts" of stoping (Hawley and Moore 1967). Over time, the empty void propagates to the surface creating a collapse feature.

5.1.7 Faults and Seismicity

The study area is considered to be in a seismically inactive area. There are no known active faults either on or adjacent to the study area, so the potential for surface fault rupture is low.

5.1.8 Soils

Generalized soils for the entire corridor are categorized by the NRCS as primarily Resort-Cathedral-Rubble land and Rock outcrop (Web Soil Survey 2018). Cathedral soils typically occur on 30 to 70 percent slopes and ridges primarily derived from weathered mica schist or granite. Resort soils are typically found on 30 to 60 percent slopes and ridges primarily derived from weathered mica schist or granite. Rubble land occurs on talus slopes at 30 to 60 percent. The rock outcrop is found on 30 to 70 percent slopes and is typically composed of weathered mica schist or granite. All of these soils in the study area are severely susceptible to erosion (NRCS 2003). Lone Rock-Breece gravelly sandy loams become more abundant as one moves further west of Idaho Springs as the valley widens. Lone Rock-Breece soils are slightly to moderately susceptible to erosion.

5.2 Future Conditions

No significant change in future geologic conditions is anticipated. To some degree, structures which are part of the Proposed Action improve conditions in those locations where they are constructed.

Section 6. What are the Environmental Consequences?

6.1 How Does the Proposed Action Affect Geology and Soil Resources?

6.1.1 What Direct Effects are Anticipated?

The following activities directly affect soils and geologic resources in the study area:

- Rockfall mitigation applied at five locations west of Idaho Springs to reduce rockfall hazards and closures of I-70 to clean up rockfalls.
- Slope and rock stabilization to reduce erosion.

Rockfall mitigation generates some loose rock which will be removed. Scaling of the existing slope is performed with hand tools to remove loose rock. Contained blasting and rock sculpting is conducted to mitigate for unstable rock slopes near MP 237.1. Blasting or vibration caused by rock mitigation activities may cause loose rock and soil to travel downhill towards the highway, which results in safety concerns. Excess waste rock will be utilized on site where feasible, or stockpiled for use on highway construction. If this is not feasible, it will be disposed of offsite.

Further exploratory drilling in the roadway in the study area has intersected little or no groundwater. The rock slopes adjacent to the roadway also display no springs or streams and are essentially dry. Soil impacts are surficial to the median which is currently fill and remain as fill after the widening. Some regrading of the right-hand shoulder ditch for drainage and rockfall catchment may occur. No interference with old mine excavations occurs.

There is no direct or indirect change to existing debris flow activity because there is no change to geomorphic drainage features in the study area. Many of the existing rock cuts along I-70 in the study area include mineralized zones. Therefore, there is no measurable increase in the amount of exposed mineralization. Air and surface water may chemically react with freshly exposed mineralized surfaces and mobilize contaminants.

6.1.2 What Indirect Effects Are Anticipated?

Indirect effects from geologic hazards result from operations and maintenance activities, including periodic maintenance of rockfall mitigation features, cleanup of potential rock slides and debris flows, and sealing or filling of open mines potentially encountered during construction. Within the indirect study area, little or no rock slope excavation is anticipated and very limited impact occurs.

During rock cutting activities, mineralized rock may be disturbed, which can increase loading of metals, dissolved solids, and suspended solids.

6.1.3 What Construction Effects Are Anticipated?

Construction activities temporarily increase rockfall hazards where new slopes intersect either weak rock, or loose or marginally stable slopes. The Proposed Action includes stabilizing rock slopes and providing rockfall mitigation, as discussed in Table 1.

Mineralized veins are exposed in the rock face on the north side of I-70 throughout the study area, most notably between MP 239 and MP 237. Rock cutting activities, including blasting and scaling, disturb mineralized rock, which can increase loading of metals, dissolved solids, and suspended solids to Clear Creek.

Erosion from excavation and construction of new retaining walls may occur, especially in the areas where loose soil conditions exist. Erosion could also occur in areas of steep grades where surface water is directed to vulnerable areas. Areas most susceptible to soil erosion are located along the I-70 embankment adjacent to Idaho Springs and parts of the median along I-70 between mileposts 239 and 235 where walls are constructed.

6.1.4 Would there be Cumulative Effects?

When combined with the effects of past, present, and reasonably foreseeable future projects, the cumulative effects of the Proposed Action are primarily positive, because rock stabilization and rockfall mitigation reduces the most prevalent hazard identified in the I-70 Mountain Corridor ROD, which is rockfall.

Section 7. What Mitigation Is Needed?

7.1 Mitigation

CDOT has identified mitigation measures for potential impacts on geologic resources that could arise. These are presented in Table 1.

Table 1. Mitigation Tracking

Mitigation Category	Impact from NEPA Document	Commitment From Mitigation Table In Source Document (Use Exact Wording from Table in Source Document)	Responsible Branch	Timing/Phase of Construction Mitigation to be Constructed
Geology	Rock cuts exposing fresh rock including mineralized zones.	Encapsulate mineralized rock generated during blasting activities, away from groundwater, to prevent chemical reactions that could mobilize contaminants into water. If encapsulation is not feasible, mineralized rock will be removed from the area to an appropriate disposal site.	CDOT Engineering and Contractor	During Construction/Post-Construction
Geology	Erosion during construction	Manage erosion and surface water away from water sources and ensure best management practices, such as wattles, silt fence, or temporary berms, are in place to prevent migration and sediment from waste piles, slopes and excavations. Implement best management practices, such as vehicle tracking pads, wattles, and mulching, for stormwater runoff. Apply for and comply with a CDPHE Construction Activities Stormwater Discharge Permit	CDOT Environmental, CDOT Engineering, and Contractor	Pre-Construction/During Construction/Post-Construction
Geology	Safety concerns during blasting	Steel blast mats will be used during blasting to constrain flyrock generated during blasts. All blasting will take place only during daylight hours. All blasting workers will have safety training.	CDOT Engineering and Contractor	During Construction
Mine Subsidence	Potential to encounter underground mines during construction	Voids will be backfilled, or concreted as encountered. Awareness will be maintained when near previously encountered voids and/or mapped historical mine workings. Information awareness and warnings will be instituted that historical workings may not be mapped or known in areas undergoing construction.	CDOT Engineering and Contractor	Pre-Construction/During Construction

Section 8. References

Andrew, 1994. Colorado Rockfall Hazard Rating System.

CDOT. 2009. Context Sensitive Solutions on the I-70 Mountain Corridor. Accessed January 22, 2018, at: https://www.codot.gov/projects/contextsensitivesolutions.

———. 2011a. I-70 Mountain Corridor Final Programmatic Environmental Impact Statement. March. Accessed January 16, 2018, at: https://www.codot.gov/projects/i-70-old-mountaincorridor/final-peis/final-peis-documents/MainText_combined_withTabs.pdf.

———. 2011b. I-70 Mountain Corridor PEIS Geologic Hazards Technical Report. August 2010. Reissued March 2011. Accessed July 16, 2018, at: https://www.codot.gov/projects/i-70mountaincorridor/final-peis/final-peis-documents/technical-reports/Vol4_I-70_Mntn_Corridor_Final_PEIS_Geologic_Hazards_TR.pdf.

———. 2012a. Twin Tunnels Environmental Assessment and Section 4(f) Evaluation. July. Accessed July 16, 2018, at: https://www.codot.gov/library/studies/i70twintunnels-environmental-assessment/TwinTunnels_EA_July2012.pdf/view.

———. 2012b. Twin Tunnels Finding of No Significant Impact and Section 4(f) Finding. October. Accessed July 16, 2018, at: https://www.codot.gov/library/studies/i70twintunnels-environmental-assessment/finding-of-no-significant-impact-fonsi/TT-FONSI_Complete_Document.pdf/view.

———. 2014. EB I-70 Peak Period Shoulder Lane Categorical Exclusion. April. Accessed January 16, 2018, at: https://www.codot.gov/projects/I70mtnppsl/i-70-ppsl-categorical-exclusion.

———. 2018. Geohazards Program. CDOT Rockfall Management Program. Personal communication between Nicole Oester, CDOT, and Howard Hume, Yeh and Associates. August 28.

Colorado Geological Survey. 2018. Idaho Springs District. Accessed September 15, 2018: http://coloradogeologicalsurvey.org/mineral-resources/historic-mining-districts/clear-creek-county/idaho-springs/.

Coe and Godt. 1997. Characteristics of alluvial fans from tributaries of Clear Creek, Floyd Hill to Georgetown, Colorado.

FHWA. 2011. I-70 Mountain Corridor Final Programmatic Environmental Impact Statement Record of Decision. June. Accessed January 16, 2018, at: https://www.codot.gov/projects/i-70-old-mountaincorridor/documents/Final_I70_ROD_Combined_061611maintext.pdf.

Hawley, C.C and Moore, F.B. 1967. Mines and Prospects, Lawson-Dumont-Fall River District, Clear Creek County, Colorado.

Moench, R.H. and Drake, A.A. 1966. Economic Geology of the Idaho Springs District, Clear Creek and Gilpin Counties, Colorado.

Natural Resources Conservation Service. 2003. Soil Survey of Georgetown Area, Colorado, parts of Clear Creek, Gilpin, and Park Counties.

———. Natural Resources Conservation Service. (n.d.). U.S. Department of Agriculture. Web Soil Survey. Accessed July 6, 2018, at: http://websoilsurvey.nrcs.usda.gov/.

Sims, P.K. 1964. Geology of the Central City Quadrangle, Colorado.

———. 1989. Ore Deposits of the Central City – Idaho Springs Area.

Widmann, B.L and Miersemann, U. 2001. Geologic Map of the Georgetown Quadrangle, Clear Creek County, Colorado.

Widmann, B.L, Kirkham, R.M, and Beach, S.T. 2000. Geologic Map of the Idaho Springs Quadrangle, Clear Creek County, Colorado.

Widmann, B.L. and Rogers, W.P. 2002. Geologic Hazards of the Georgetown, Idaho Springs, and Squaw Pass Quadrangles, Clear Creek County, Colorado.