4.2.9.1.6 Cumulative Impacts

As mentioned above, poaching, vandalism at the tunnel and other illegal activities have occurred and continue to occur in the Park. As tourism increases and residential populations in the study area surrounding GSMNP continue to grow, these activities would be likely to continue and potentially increase. The limited impacts to public health and safety from the proposed alternatives would have a slight cumulative effect on public health and safety in the study area when added to the effects of past, present and reasonably foreseeable actions in the area.

4.3 Impacts to the Physical Environment

4.3.1 Topography, Geology, and Soils

4.3.1.1 Methodology for Assessing Impacts to Topography, Geology, and Soils

The following paragraphs summarize the impact topics, thresholds and durations as defined for topography, geology, and soils. A more detailed report is included in Appendix I.

To develop the impact thresholds related to the topography, geology, and soils, the following topics were reviewed for each alternative corridor.

- Topographic relief
- Engineering aspects
- Site layout
- Natural drainage patterns
- Views and vistas
- Uniqueness and historical significance
- Environmental aspects
- Rock and soil types and mineral assemblages
- Similar projects occurring under the same geologic conditions

Type

In regards to geology, topography, and soil resources, any disturbance of the existing geology, topography, and soils as a result of the proposed project is considered to be an adverse impact.

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Duration

To assign durations of impact, the following parameters were considered for each alternative corridor: area of disturbance, volume of disturbance, revegetation process, erosion characteristics, and construction intervals. The durations are short-term and long-term and have been defined as follows.

Short-term impacts include areas that would not be impacted for longer than 2 years past completion of construction and re-vegetation. This involves smaller areas of minimal disturbance where re-vegetation is relatively simple and quickly achieved.

Long-term impacts include areas that would be impacted for greater than 2 years past completion of construction and re-vegetation. These areas would have substantial cuts or fills, considerable topographic relief, and modifications that involve complete clearing on steep slopes.

Intensity

To help quantify potential impacts, a set of thresholds were defined so that a relative comparison could be made within the study corridors. The impact thresholds were: no/negligible, minor, moderate, and major. They are defined below.

No/Negligible

Disturbances of geologic features, soils, and topographic features are slightly detectable in localized areas. These disturbances occur only in areas where rock and soil have no acid potential. The disturbances result in no changes to natural drainage patterns.

Minor

Disturbances of geologic features, soils and topographic features are detectable including the removal and relocation of relatively small volumes of rock and soil cover. The disturbance of acid-producing (AP) rock and acidic soil would be avoided within the corridor. Localized areas of cut and fill would require slightly detectable slope modifications. Subtle changes to topographic features would occur without detectable changes occurring to the natural drainage patterns. No slope hazards would be created by excavation.

Moderate

Disturbances of and modifications to the geologic features, soils, and topographic features are readily apparent. Large areas are disturbed by excavation across multiple locations. The disturbance of AP rock and acidic soil is unavoidable, and modifications would require localized, engineered cut and fill areas capable of encapsulating rock and soil that have acid potential. Regional areas would require slope modifications

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including man-made reinforcement measures. Large, localized changes to topographic features would occur, requiring slight modifications to natural drainage patterns.

Major

Disturbance of and modifications to geologic features, soils, and topographic features are readily apparent and change the character of these features over large areas. Large areas of cut and fill would be required, and excavation of AP rock and acidic soil is unavoidable. Large quantities of AP rock and acidic soil would require treatment or transport offsite. If used onsite as fill, large encapsulation cells would be necessary for proper disposal. Disturbances will require extensive slope stability modifications, and large areas of fill would be necessary to maintain road alignment. Natural drainage patterns would be disturbed and modified.

4.3.1.2 Summary of Impacts

Impacts for each alternative and the southern options, where applicable, are summarized below and in the impact matrix summary in Appendix I. The impacts on the Park's natural resources from disturbing AP rock and acidic soils are addressed in Impacts to the Natural Environment, Section 4.4. All excavated materials were assumed to require treatment to neutralize AP rock.

Some of the study area's underlying rocks are known to contain "black shales" or monazite deposits. Monazite contains varying levels of variety elements, such as thorium and uranium, which are radioactive. Such rocks have been termed NORMs – Naturally Occurring Radioactive Materials (Kohn, 2005). The need for geotechnical testing related to NORMs would be considered if an alternative involving construction is implemented.

4.3.1.2.1 No-Action

The No-Action Alternative is not expected to cause adverse impacts to geology, topography, or soils.

4.3.1.2.2 Monetary Settlement

The Monetary Settlement Alternative is not expected to cause adverse impacts to geology, topography, or soils. Impacts to topography, geology, and soils could occur at a later date, time, and at locations outside of GSMNP, depending on the use of local funds.

4.3.1.2.3 Laurel Branch Picnic Area

Functional designs for the Laurel Branch Picnic Area Alternative include a 0.766-mile-long (1.2 km) paved, two-way entrance/exit road. This alternative would involve excavation of approximately 24,700 cubic yards

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(18,900 m^3) and embankment of approximately 25,300 cubic yards (19,300 m^3) of rock and soil with the potential to produce acid. All disturbed rock and soil would require testing for acid potential and may require major mitigation and monitoring efforts such as encapsulation, removal, and pre- and post-construction monitoring. Soils within this corridor are members of the Soco series and classify as very strongly acidic with thicknesses averaging 30 inches (76.2 cm). The acidic nature of these soils indicates that rocks within this corridor would produce acid. The rocks underlying this corridor are mapped as the Copperhill Formation, which includes feldspathic metasandstone with interbedding of metaconglomerate, graphitic and sulfidic mica schist, and nodular calc-silicate granofels. Adverse impacts to topographic features and natural drainage patterns would be major due to a topographic relief of approximately 70 feet (76 cm) within the footprint. Erosion control measures would be required throughout construction and re-vegetation. Based on the impact threshold definitions, this alternative would have major, adverse, long-term impacts to both geology and soils, and the topographic features would face major, adverse, and short-term impacts.

4.3.1.2.4 Partial-Build Alternative to Bushnell (Primitive and Principal Park Roads)

The Primitive Park Road to and development at Bushnell would involve excavation of approximately 693,900 cubic yards (530,600 m^3) and embankment of approximately 356,500 cubic yards (272,500 m^3) of rock and soil. The Principal Park Road to and development at Bushnell would involve excavation of approximately 945,100 cubic yards (722,600 m^3) and embankment of approximately 662,800 cubic yards (506,700 m^3) of rock and soil. Again, it is likely that this material would produce acid drainage if disturbed. The soils are Junaluska series and classify as very strongly to strongly acidic, and the rocks are of the Copperhill Formation as described for the previous alternative. The topographic relief across this alternative is approximately 300 feet (91.4 m), and the area to be disturbed by excavation and embankment construction averages 95 acres (38.4 ha) for either road design. Based on the impact threshold definitions, this alternative would have major, adverse, long-term impacts to topography, geology, and soils.

Southern Option at Forney Creek Embayment

While there is a decrease in the amount of soil disturbed with the southern option to the Partial-Build Alternative to Bushnell, these changes do not alter the overall geologic impact of this alternative.

4.3.1.2.5 Northern Shore Corridor (Primitive and Principal Park Roads)

Construction of the Primitive Park Road would involve excavation of approximately 1,714,300 cubic yards (1,310,700 m^3) and embankment of approximately 1,299,500 cubic yards (993,600 m^3) of rock and soil. The baseline Northern Shore Corridor (Principal Park Road) would involve excavation of approximately 2,906,600 cubic yards (2,222,300 m^3) and embankment of approximately 2,512,600 cubic yards (1,921,000 m^3) of rock and soil. While problematic rock formations are located throughout the study area, this corridor would involve construction west of the confluence of Hazel Creek and Fontana Lake, where the underlying rocks are believed to have the highest potential for acid production and are likely to contain higher

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concentrations of metallic minerals than the surrounding rocks. The soils are Junaluska series and classify as very strongly to strongly acidic, and the rocks are of the Copperhill Formation previously described. The topographic relief across this alternative is approximately 300 feet (91.4 m), and the area of disturbance averages 395 acres (159.9 ha), depending upon the road type. Based on the impact threshold definitions, this alternative would have major, adverse, long-term impacts to topography, geology, and soils.

Southern Options at Forney Creek Embayment, Hazel and Eagle Creek Embayments, and Crossing Fontana Dam (Primitive and Principal Park Roads)

While there is a decrease in the amount of soil disturbed with the southern options of the Northern Shore Corridor, these changes do not alter the overall geologic impact of this alternative.

4.3.1.2.6 Construction Impacts

Each alternative corridor involves complex mountainous terrain with complicated geologic structures. This combination would necessitate geological, geotechnical, and engineering expertise throughout all phases of the project, including design and construction. The potential impact with primary concern is the disturbance of AP rock and acidic soils. If disturbed, this material can only be dealt with in two ways. This material could be blended with neutralizing agents and reused as common fill in embankments. If this is not an option, the material must be disposed of in an appropriate off-site area. Should a partial-build or build alternative be implemented, additional testing would be conducted prior to construction to determine the extent of AP rock. (Note: Geotechnical drilling may cause impacts to other resources within the Park.) A more detailed report regarding the potential for construction impacts related to topography, geology and soils is included as Appendix I.

For road construction, mountainous topography requires the greatest extent of earthwork. Additionally, a warm and humid environment greatly increases the oxidation rate of sulfide minerals. Therefore, rock and soil with acid potential must be dealt with immediately upon excavation. To avoid, minimize or mitigate adverse impacts to plants, wildlife, and water quality when excavating AP material, special design and construction practices are required.

4.3.1.2.7 Cumulative Impacts

Several past actions have occurred within the study area that affected topographic, geologic, and soil resources in addition to the effects of the presently proposed action. Past actions that have affected these resources date back to the mining and the timber industries during the early 1900s and include the construction of Fontana Dam and the partial construction of Lake View Road (up to the tunnel). The timber and mining industries of the early 1900s resulted in a loss of topsoil and removed geologic resources. The mining industry also exposed AP rock to the elements, causing other resources within the Park to be affected by acid drainage. The creation and expansion of the GSMNP preserved large natural areas, allowing vegetation to re-establish in many areas, stabilizing topsoil and minimizing exposure of AP rock. The

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flooding of land as a result of construction of Fontana Dam in the early 1940s permanently altered the topography and soils in the area. The construction of Lake View Road required blasting and exposed AP rock to the elements, affecting other resources with acid drainage. The proposed partial-build and build alternatives would require large quantities of excavation resulting in major impacts to geology, topography and soils as discussed above and resulting in the potential for acid drainage. Additional information on the effects of exposing AP rock to the elements is discussed in Water Quality, Section 4.4.3.

Other projects, such as completed sections of Foothills Parkway and Cherohala Skyway, have changed specific topography and removed/altered soils in the study area vicinity. Future projects, such as the completion of Foothills Parkway, have the potential to further these impacts. The addition of soils and rock to the existing landscape can result in indirect impacts such as the spread of invasive exotics. Offsite materials used for fill material often harbor seeds of invasive exotics and other non-native pests. These impacts are discussed in Invasive Exotics, Section 4.4.9.

4.3.1.3 Avoidance and Minimization Techniques

The best technique for avoiding and minimizing deleterious rock would involve designing road grades and alignments based on the rock's AP potential. Totally avoiding AP rock and acidic soil would not be practical, however. To minimize the disturbance of this material, a "plan-in-hand" method may be the best approach for road alignment. Designing with the plan-in-hand method involves characterizing the rock and soil along the road alignment far in advance of any earthwork for road construction. However, getting the equipment necessary for preliminary drilling into the sampling locations would involve earthwork to create an access road. An analysis of the impacts of preliminary drilling would need to be conducted before beginning such activities. The plan-in-hand method involves preliminary drilling and sampling and visual classification of the material supplemented by laboratory testing. Early characterization is beneficial when adjustments in road alignments are necessary to minimize disturbance of AP rock.

4.3.1.4 Mitigation and Monitoring Techniques

If an alternative involved road construction were executed, an approved work plan and material handling plan would be in place prior to any disturbance or excavation. Standard guidelines for handling deleterious material are included in the FHWA's 1990 publication, *Guidelines For Handling Excavated Acid-Producing Materials*. This publication offers detailed guidelines for the preliminary investigations, the design phase, and the construction phase for projects that involve the excavation of deleterious rock and associated acidic soil.

The three most restrictive characteristics regarding this project are:

- the inability of the local rocks and soils to buffer or neutralize acid,
- the distance to a rock quarry that contains sufficient quantities of acid-neutralizing rocks, and

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- the volumes of cut and fill necessary for construction in the mountainous terrain.

Based on the mineralogy, geochemistry, and low concentration of alkalinities in the waters of the study area, the rocks are believed to have an extremely low acid-buffering capacity. AP rock and acidic soil excavated for the project would be used fill for embankments would have to be treated with limestone and encapsulated. Excess excavated AP rock and acidic soil would be hauled offsite and also would be treated with limestone. Preliminary estimates show that the volumes of limestone required to construct encapsulated embankments for the partial-build and build alternatives would vary from approximately 25,000 tons for Laurel Branch Picnic Area to 544,000 tons of limestone for the Northern Shore Corridor (Principal Park Road). The nearest limestone quarry is 85 miles (137 km) away in Maryville, Tennessee.

Gravel can be a vector for seeds of invasive exotic plants, thus bringing limestone into GSMNP to construct the encapsulated embankments could increase the spread of invasive exotic plants in the area. Quarry inspections and other Park protocol should be followed to reduce the introduction of weeds.

4.3.1.5 Impairment Evaluation

Impairment to the topography, geology, and soils of GSMNP and the AT would not occur under the No-Action Alternative, Monetary Settlement Alternative, Laurel Branch Picnic Area, and the Partial-Build Alternative to Bushnell. The Northern Shore Corridor is not likely to impair the topography, geology, and soils of GSMNP or the AT based on the information obtained to date. Due to the magnitude of this alternative, it is likely that additional NEPA documentation would be required to address site specific impacts not currently known and to determine detailed mitigation measures as they relate to final design. The impairment determination related to topography, geology, and soils would be re-evaluated in such documentation.

4.3.2 Floodplains and Floodways

While the No-Action and Monetary Settlement would not impact floodplains within GSMNP, Laurel Branch Picnic Area, the Partial-Build Alternative to Bushnell, and the Northern Shore Corridor would encroach on the 100-year floodplain at locations of major stream crossings (Figure 3-3). If an alternative involving construction is implemented, encroachments could be minimized during more detailed design.

In compliance with Executive Order 11988 and Director's Order #77-2, a Statement of Findings for floodplains would be developed and released for public review if a partial-build or build alternative was selected for implementation. A Statement of Findings explains why an alternative with floodplain impacts was identified as the preferred alternative, and details such information as a description of the flood hazard assumed by implementation of the proposed action, an analysis of the comparative flood risk among alternatives, a summary of the effects on floodplain values associated with the proposed action, and an evaluation of the proposed mitigation measures. For any study alternative that impacts floodplains, more detailed design and additional field surveys may be required before a Statement of Findings is developed.

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