

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 streams would be re-evaluated in such documentation.

### **4.4.3 Water Quality**

#### **4.4.3.1 Methodology for Assessing the Water Quality Impacts**

Detailed methodologies for water quality impact analyses are listed in Appendix M. As described in Section 3.4.3.1 of this report, NCDWQ classifies surface waters of the state based on their existing or proposed uses and subsequent water quality standards. Impacts were assessed based on the designated use and classification of the water body. Each stream and/or waterbody directly crossed by the potential road or the lake downstream of the crossed streams is evaluated for each applicable water quality standard. A summary list of North Carolina state water quality standards is available in Table 4-19 (NCDENR 2004).

Because data from water quality sampling is often episodic, biological indices are another method of evaluating water quality of streams and represent long-term (several years) water quality conditions. Impacts are evaluated on changes to the comprehensive NCBI scores: Excellent (<4.05), Good (4.06 – 4.88), Good-Fair (4.89 – 5.74), Fair (5.75 – 7.00), or Poor (>7.00).

Potential impacts to Fontana Lake are evaluated by the NCTSI. The NCTSI is based on a numerical score that classifies lakes as oligotrophic, mesotrophic, eutrophic, or hypereutrophic. Currently, TVA and NCDWQ collect samples from eight points on Fontana Lake. The impacts are considered for any of the sampling sites, not the overall classification for the lake.

#### Type

Impact types are either beneficial and/or adverse. Beneficial impacts are defined as having a positive effect on water quality. Adverse impacts have a negative effect on water quality.

#### Context

Context is defined as site-specific, local, or regional. The region of influence for water quality is based on the number of stream crossings and size of watersheds impacted. Site-specific impacts occur to individual stream crossings with drainage areas less than 100 acres (40.5 ha). Local impacts occur with any number of stream crossings, but with one of the stream drainage areas greater than 100 acres (40.5 ha). This drainage of greater than 100 acres (40.5 ha) is considered a large watershed. Regional impacts occur when two or more large watersheds are affected.

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Clarification of the term “baseline” for this project:

The Partial-Build Alternative to Bushnell and the Northern Shore Corridor include a baseline route, as well as options to that route. Baseline routes and options are detailed in Section 2.5 and shown on Figure 2-8. Baseline routes have been compared to existing conditions. Impact analyses for the options are shown as a difference from the associated baseline route.

Table 4-19. NCDWQ Water Quality Standards per Use Classification

Parameter	Class C	Trout Waters	Class WS-IV
Temperature	<5.04°F (2.8°C) above natural water temperature; not to exceed 84°F (29°C)	< 0.9°F (0.5°C) above natural water temperature; not to exceed 68°F (20°C)	5.04°F (2.8°C) above natural water temperature; not to exceed 84°F (29°C)
pH (su)	6.0 - 9.0	6.0 – 9.0; <1.0 over 24 hours	6.0 - 9.0
Dissolved Oxygen (mg/l)	> 5.0	> 6.0	> 5.0
Turbidity (NTU)	50 streams 25 lakes	10 streams and lakes	50 streams 25 lakes
Arsenic (µg/l)	50	50	10
Cadmium (µg/l)	2.0	0.04	0.04
Chromium (µg/l)	50	50	50
Copper (µg/l)	7	7	7
Lead (µg/l)	25	25	25
Nickel (µg/l)	88	88	25
Silver (µg/l)	0.06	0.06	0.06
Zinc (µg/l)	50	50	50
Iron (mg/l)	1.0	1.0	1.0
Nitrate (mg/l)	None	None	10
Sulfate (mg/l)	None	None	250
Fecal Coliform (MPN/100ml)	400	400	400
Chlorophyll-a (µg/l)	40	15	40

## Notes:

Class C – Usage of waters for aquatic life propagation, maintenance of biological integrity, wildlife, secondary recreation, or agriculture.

Trout Waters – freshwaters protected for natural trout propagation and survival of stocked trout.

Class Water Supply (WS-IV) – waters protected as water supplies for drinking of food-processing purposes.

## Duration

Short-term impacts are those that would occur for less than 1 year, typically as an episodic or temporary event. Long-term effects occur as a result of construction activities at a specific location throughout the life of construction (this is assumed to be between 1 year and 15 years), but the impact is more than that of a temporary event. Permanent impacts are considered to be anything that persist throughout the construction period. These impacts are expected to cause water quality degradation due to continuous pollution sources.

## Clarification of the term “baseline” for this project:

The Partial-Build Alternative to Bushnell and the Northern Shore Corridor include a baseline route, as well as options to that route. Baseline routes and options are detailed in Section 2.5 and shown on Figure 2-8. Baseline routes have been compared to existing conditions. Impact analyses for the options are shown as a difference from the associated baseline route.

### Intensity

Intensity is the degree to which resources are affected and is categorized as negligible, minor, moderate, or major. The definitions for each category are based on the best available scientific information and are specific for an individual EIS. As previously described, the NCDWQ uses water quality standards that are based upon the designated use of each water system. The impacts to water resources are based upon criteria for meeting or exceeding these standards.

#### 4.4.3.1.1 Water Quality Standards

##### *No/Negligible*

Measurable changes in water quality parameters would be within natural variability and water quality would remain within current North Carolina (15A NCAC 02B.0200 and .0300) standards for designated uses.

##### *Minor*

Changes in water quality would be measurable and greater than the natural variability, but water quality would remain within current North Carolina (15A NCAC 02B.0200 and .0300) standards for designated uses.

##### *Moderate*

Changes in water quality would be measurable and greater than the natural variability and water quality may violate current North Carolina (15A NCAC 02B.0200 and .0300) standards for designated uses.

##### *Major*

Changes in water quality would be measurable and greater than the natural variability and water quality is likely to violate current North Carolina (15A NCAC 02B.0200 and .0300) standards for designated uses.

#### 4.4.3.1.2 Benthic Macroinvertebrates

Biological indices for macroinvertebrates represent water quality and habitat quality conditions over the life span of the aquatic organisms. Natural variability would exist from year to year depending upon time of year of the sampling, annual rainfall, and recent weather conditions. Since all streams sampled within the study area are rated as Excellent (Appendix M, Attachment M-7), degradation of the water quality and/or habitat would have to occur in order for the class rating to drop to Good or Good-Fair. If episodic degradation of a macroinvertebrate community occurs, the streams are expected to recover to pre-disturbance ratings.

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Clarification of the term "baseline" for this project:

The Partial-Build Alternative to Bushnell and the Northern Shore Corridor include a baseline route, as well as options to that route. Baseline routes and options are detailed in Section 2.5 and shown on Figure 2-8. Baseline routes have been compared to existing conditions. Impact analyses for the options are shown as a difference from the associated baseline route.

*No/Negligible*

Changes in biotic metrics are within the natural variability of sampling.

*Minor*

Changes in the biotic metrics are not due to natural variability, but do not alter the bioclassification/integrity class rating.

*Moderate*

Changes in the biotic metrics are measurable and decrease the bioclassification/ integrity class rating by one level.

*Major*

Changes in the biotic metrics are measurable and decrease the bioclassification/ integrity class rating by two or more levels.

**4.4.3.1.3 Lake Trophic Level**

The waters of Fontana Lake are subject to the same use classification and water quality standards as streams. The NCTSI is a compilation of water quality parameters at specified depths that determine the productivity of the lake. Currently, Fontana Lake is classified as oligotrophic (Section 3.4.3.2). The impacts are considered for any of the sampling sites, not the overall classification for the lake.

*No/Negligible*

No measurable changes in the NCTSI score and no changes in the individual scores of the index.

*Minor*

Changes in the NCTSI score are measurable, but do not change the classification of the trophic state.

*Moderate*

Changes in the NCTSI score are measurable and the trophic state of the lake is mesotrophic.

*Major*

Changes in the NCTSI score are measurable and the trophic state of the lake is eutrophic or hypereutrophic.

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Clarification of the term "baseline" for this project:

The Partial-Build Alternative to Bushnell and the Northern Shore Corridor include a baseline route, as well as options to that route. Baseline routes and options are detailed in Section 2.5 and shown on Figure 2-8. Baseline routes have been compared to existing conditions. Impact analyses for the options are shown as a difference from the associated baseline route.

#### 4.4.3.2 Summary of Impacts

Each stream crossing creates an opportunity for water quality impacts within 320 feet (100 m) upstream and in all the waterways downstream of the crossing to Fontana or Cheoah lakes. The steep terrain causes streams to respond quickly to rainfall events, and any pollutants would quickly enter waterbodies during these events. In addition, the unknown geology and soils create a potential for water quality impacts throughout the project study corridors. Atmospheric deposition also has the potential to alter water quality. (Nitrogen and sulfur deposition rate impacts are presented in Section 4.3.4.) These concerns can be addressed with minimization and avoidance techniques; however, impact analysis is conducted without the implementation of any of these techniques. Table 4-20 and Attachment M-1 both summarize the impacts for each partial-build and build alternative.

**pH:** Based on Section 3.3.1, all portions of the proposed alternatives contain rock and soil capable of producing acid runoff. The current NCDWQ standard for pH is a range from 6.0-9.0 for all waters; however, impacts are anticipated to be in the acidic range of <6. Without avoidance, minimization, or mitigation practices, exposure of this rock could lead to stream impacts as seen on early construction of the Cherohala Skyway in Tennessee, where streams had pH values of less than 5 and 100 percent mortality of fish in 1978 (Morgan et al. 1978).

**Dissolved Oxygen:** Dissolved oxygen is necessary for the respiration of aquatic organisms and is consumed by the decomposition of organic matter. Oxygen is supplied to streams and lakes from the air (aeration) and plant respiration. Generally, the higher the dissolved oxygen concentrations are, the better the water quality is. During construction, sediment and organic matter from vegetation would likely enter receiving streams. As a result of the breakdown of organic matter, there would likely be a temporary decrease in dissolved oxygen concentrations (American Road & Transportation Builders Association 2000).

**Heavy Metals:** High concentrations of metallic minerals exist in the slate of the underlying bedrock in the project study corridors. These metals included copper (Cu), zinc (Zn), lead (Pb), aluminum (Al), iron (Fe) and arsenic (As). Low pH would mobilize heavy metals in the watershed, and they would be deposited into streams and Fontana and Cheoah lakes. Since detailed subsurface geology is unknown, large areas containing these metallic minerals might be exposed in any portion of the project study corridors. Toxic levels of heavy metals may be reached in receiving water, causing human consumption warnings and/or loss of aquatic life.

Another source of heavy metals is roadway runoff from vehicles (brake dust, tires, fluid leakage). The wearing of tires and brakes are primary sources of cadmium, copper, lead, and zinc (Sansalone and Buchberger 1997). The Principal Park Road would generate higher concentrations of brake and tire debris than the Primitive Park Road due to higher traffic volumes and more braking due to the higher travel speed. The parking and recreation facilities at Laurel Branch and Bushnell alternatives would have higher metal concentrations not only from travel but from fluids leaking from parked vehicles. However, compared with urban roadways, the expected traffic volume would be extremely low.

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Clarification of the term "baseline" for this project:

The Partial-Build Alternative to Bushnell and the Northern Shore Corridor include a baseline route, as well as options to that route. Baseline routes and options are detailed in Section 2.5 and shown on Figure 2-8. Baseline routes have been compared to existing conditions. Impact analyses for the options are shown as a difference from the associated baseline route.

**Table 4-20. Water Quality Impacts – Quantity and Usage Classification of Streams within the Partial-Build and Build Alternatives**

	<b>Laurel Branch Picnic Area*</b>	<b>Partial-Build Alternative to Bushnell (baseline)</b>	Southern Option at Forney Creek Embayment	<b>Northern Shore Corridor (baseline)</b>	Southern Option at Forney Creek Embayment	Southern Option at Hazel/Eagle Creek Embayments	Southern Option Crossing Fontana Dam
<b>Primitive Park Road</b>							
Stream Crossings	9	34	8 less than baseline	131	8 less than baseline	8 less than baseline	15 less than baseline
Large Watersheds	1	5	2 less than baseline	25	2 less than baseline	5 less than baseline	5 less than baseline
Trout Streams	9	21	No change from baseline	96	No change from baseline	22 less than baseline	17 less than baseline
Water Supply Streams	0	0	No change from baseline	39	No change from baseline	35 less than baseline	2 more than baseline
<b>Principal Park Road</b>							
Stream Crossings	NA	35	12 less than baseline	141	12 less than baseline	17 less than baseline	16 less than baseline
Large Watersheds	NA	4	1 less than baseline	22	1 less than baseline	3 less than baseline	5 less than baseline
Trout Streams	NA	18	1 more than baseline	99	1 less than baseline	25 less than baseline	18 less than baseline
Water Supply Streams	NA	0	No change from baseline	39	No change	14 less than baseline	2 more than baseline

\* The entrance/exit road to Laurel Branch Picnic Area is best discussed as Primitive Park Road, but its design does not necessarily conform to the NPS design criteria for a Primitive Park Road.

N/A Not Applicable

**Turbidity:** For the purpose of this impact analysis, suspended sediment is deemed to be the main cause of increased turbidity. The severity and type of sedimentation would depend on the type of road: gravel Primitive Park Road vs. asphalt Principal Park Road. The gravel Primitive Park Road would become a permanent source of sedimentation, whereas the asphalt Principal Park Road would provide a short-term source (Clinton and Vose 2003). Road length between culverts, gradient, and soil type were important

Clarification of the term “baseline” for this project:

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factors in erosion of the road surface, while ditch length and roughness were important factors in ditch erosion. Vehicular traffic on the Primitive Park Road will cause dust emissions from the force of the wheels, pulverizing the surface material (USEPA 2004b).

**Other Water Quality Factors:** Oil and grease from potential fuel spills or from leaking vehicles would be potential pollutants from construction equipment, passenger vehicles once the road is complete, and boats as a result of the Partial-Build Alternative to Bushnell. Potential spills during construction would be addressed in the BMPs for construction. The boat ramp and dock proposed for the facility at Bushnell would be intended for temporary docking and storage of boats and would most likely operate from later spring to early fall, when the water level of the lake is close to the permanent pool elevation. No fuel or maintenance capabilities are planned for such a facility. Therefore, there would be negligible potential impacts for any portion of the road with the implementation of proper minimization and avoidance practices.

NPS does not employ widespread application pesticides and herbicides to maintain roadside vegetation or suppress nuisance species. Selective application of these chemicals is used for site-specific treatment of nuisance species. Therefore, no impacts are anticipated from these chemicals entering the water system. NPS practices call for manual mowing and vegetation control along roadsides and at recreational facilities. No impacts are anticipated under any of the proposed alternatives.

Snow removal would be managed by the NPS, and all of the potential alternatives would follow the practices currently used on Lake View Road. The road would be plowed, but only after Newfound Gap Road is cleared. Therefore, sometimes Lake View Road and any new road would be plowed, and other times they would remain closed. In addition to plowing, a mixture of sand and chat could also be applied to the road. However, due the low elevation of a new road (as compared with Newfound Gap Road), it is anticipated that treatment would be rare (Wegwerth, personal communications, 2005). Due to the low level of occurrence, negligible impacts would be anticipated unless a revised snow removal plan were implemented.

For the purpose of this impact analysis, only areas with restroom and/or picnic facilities are assumed to potentially provide a negligible source of increased fecal coliform bacteria. An adequate number of restroom facilities to serve the public need are necessary to prevent nonpoint source water quality concerns related to people that may be drawn to a similar area yet do not utilize the restroom facilities (e.g., if there is a wait). This can unintentionally result in a limited outdoor area having a concentration of human waste.

**Benthic Macroinvertebrates:** Macroinvertebrates reflect the combined impact of all the previously listed water quality parameters, including changes in habitat and flow regime. In general, acidic waters have lower species richness, abundance, and biomass than non-acidic waters (Arnold et al. 1981). Aquatic insects are negatively impacted by low pH in at least three ways: (1) low pH affects the physiology of organisms; (2) metal released at low pH may be toxic to the organisms; and (3) indirect effects occur through the reduction of primary productivity (Hall et al. 1980).

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Clarification of the term "baseline" for this project:

The Partial-Build Alternative to Bushnell and the Northern Shore Corridor include a baseline route, as well as options to that route. Baseline routes and options are detailed in Section 2.5 and shown on Figure 2-8. Baseline routes have been compared to existing conditions. Impact analyses for the options are shown as a difference from the associated baseline route.

Sedimentation from road construction likely would decrease the species richness and abundance and decrease the NCBI. Cline et al. (1981) suggest that the effects of road construction are minimal and, where changes occur, recovery is rapid. Insects in mountain streams have evolved to withstand periods of high runoff and their associated high levels of sediments. Another study has shown sedimentation from road construction leads to decreased abundance for at least 6 years (Taylor and Roff 1986). The recovery of macroinvertebrates may occur after the depositional material is flushed out of the system. For this to occur, however, recolonization by drift from upstream areas is necessary (Resh and Rosenberg 1984). This recolonization has been seen with GSMNP, where the fish toxicant, antimycin, was applied to streams for the re-introduction of brook trout; normal macroinvertebrate populations were present within 4 to 6 months (Walker 2003).

#### 4.4.3.2.1 No-Action

The No-Action Alternative would not impact water quality in the project study corridors.

#### 4.4.3.2.2 Monetary Settlement

The Monetary Settlement Alternative would not directly impact water quality in GSMNP and indirect impacts to water quality within GSMNP are unlikely. Impacts outside GSMNP from this alternative would depend on how funds are used by Swain County.

#### 4.4.3.2.3 Laurel Branch Picnic Area

##### *Water Quality Standards*

##### pH

Impacts would be moderate (violations may occur), adverse, long-term, and permanent if there were no special mitigation or avoidance of acid runoff. Cut and fill slopes could expose acid-producing rock to rain. It is assumed that acidic runoff would be a chronic condition.

##### Dissolved Oxygen

All streams within the Laurel Branch Picnic Area are classified as trout waters, which has more stringent water quality standards for DO than Class C and Water Supply waters. The source of organic input (vegetation) would occur for less than 1 year. Therefore, moderate (violations may occur), adverse, local, short-term impacts would be anticipated.

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Clarification of the term "baseline" for this project:

The Partial-Build Alternative to Bushnell and the Northern Shore Corridor include a baseline route, as well as options to that route. Baseline routes and options are detailed in Section 2.5 and shown on Figure 2-8. Baseline routes have been compared to existing conditions. Impact analyses for the options are shown as a difference from the associated baseline route.

#### Heavy Metals

Based upon the geology of the Laurel Branch Picnic Area, minor, adverse, local, short-term, long-term, and permanent impacts would be anticipated if there were no avoidance or minimization techniques. Due to the anticipated traffic volume, impacts from vehicular sources of heavy metals would be minor, adverse, local, long-term, and permanent.

#### Turbidity

Trout waters have more stringent water quality standard than Class C and Water Supply waters. All streams within the Laurel Branch Picnic Area Alternative are classified as trout waters. Impacts would be major (violations would likely occur), adverse, local, and short-term due to sedimentation from construction-related activities. Long-term and permanent impacts from runoff from the parking lot and recreational activities would be minor, adverse, and local.

#### *Benthic Macroinvertebrates*

Short-term impacts due to construction activities would be moderate (violations may occur), adverse, and local. Long-term and permanent impacts would be minor, adverse, and local due to changes in habitat, water quality, and allochthonous inputs.

#### *Lake Trophic Level*

Impacts from the Laurel Branch Picnic Area are expected to be negligible, adverse, local, short-term, long-term, and permanent due to the distance from Fontana Lake and the dilution of pollutants before the runoff would impact water quality of the lake.

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

#### *Water Quality*

#### pH

Since detailed geology is unknown, impacts for the baseline Partial-Build Alternative to Bushnell would be moderate (violations may occur), adverse, regional, long-term and permanent due to the potential of acid-producing rocks.

#### Dissolved Oxygen

Over half of the streams within the baseline Partial-Build Alternative to Bushnell are classified as trout waters, which have more stringent water quality standards for DO than Class C and Water Supply waters.

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Clarification of the term "baseline" for this project:

The Partial-Build Alternative to Bushnell and the Northern Shore Corridor include a baseline route, as well as options to that route. Baseline routes and options are detailed in Section 2.5 and shown on Figure 2-8. Baseline routes have been compared to existing conditions. Impact analyses for the options are shown as a difference from the associated baseline route.

The source organic input (vegetation) would occur for between 1 and 15 years. As a result, the short-term and long-term impacts would likely be moderate (violations may occur), adverse, and regional, and the permanent impacts would be negligible, adverse, and regional. The impacts would be the same for the Primitive and Principal Park Roads.

#### Heavy Metals

Based upon the geology for the baseline Partial-Build Alternative to Bushnell, moderate (violations may occur), adverse, local, short-term, long-term, and permanent impacts would be anticipated from potential naturally occurring heavy metals. Due to the potential recreational and parking facilities at Bushnell, minor, adverse, local, long-term and permanent impacts are anticipated from vehicular sources and runoff from parking areas. Impacts would be the same for the Primitive and Principal Park Roads

#### Turbidity

Trout waters have a more stringent numerical standard for turbidity than Class C and Water Supply waters. Over half of the streams within the baseline Partial-Build Alternative to Bushnell are classified as trout waters (21 for the Primitive Park Road and 18 for the Principal Park Road). Major, adverse, regional, short-term and long-term impacts due to construction runoff and sedimentation would be expected. The Primitive Park Road would likely have minor, adverse, regional, and permanent impacts due to runoff from the gravel surface of the road. The Principal Park Road would have negligible, adverse, regional, and permanent impacts due to increased volume of runoff.

#### Bacteria

Increased bacteria from the potential recreational facilities and visitor use would likely cause minor, adverse, regional, long-term and permanent impacts.

#### *Benthic Macroinvertebrates*

The baseline Partial-Build Alternative to Bushnell would have moderate, adverse, regional, short-term and long-term impacts associated with construction activities. Macroinvertebrate communities are expected to recover sufficiently to have minor, adverse, regional, permanent impacts. However, some change in the communities is expected due to permanent alteration of flow regime, sediment load, canopy coverage, input of terrestrial insects and organic matter, and water quality. Impacts would be similar for both road types.

#### *Lake Trophic Level*

The Partial-Build Alternative to Bushnell would likely result in minor, adverse, regional, short-term impacts to Fontana Lake, mainly due to sedimentation and nutrient runoff during land-disturbing activities. Decreased turbidity or increased nitrogen and phosphorus could alter the NCTSI. However, the permanent

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Clarification of the term "baseline" for this project:

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impacts to lake trophic state would be negligible, adverse, and regional due to the size and mixing of the lake. Impacts would be similar for the Primitive and Principal Park Roads.

*Southern Option at Forney Creek Embayment (Primitive and Principal Park Roads)*

The Southern Option at Forney Creek Embayment could potentially reduce impacts by crossing fewer streams than the baseline Partial-Build Alternative to Bushnell. However, this option would not reduce the number of trout waters crossed for the Primitive Park Road and would cross one fewer for the Principal Park Road. Therefore, intensities would not change for either road type. There would be no change in impacts from the proposed recreational facilities at Bushnell.

4.4.3.2.5 Northern Shore Corridor (Primitive and Principal Park Roads)

*Water Quality*

pH

The impacts would be major (violations likely to occur), adverse, regional, long-term and permanent for the baseline Northern Shore Corridor due to intrusive rock between Eagle Creek and Hazel Creek. Cut-and-fill slopes could expose this acid-producing rock to rain. It is assumed that acidic runoff would be a chronic condition. Impacts would be similar for the Primitive and Principal Park Roads.

Dissolved Oxygen

The baseline Northern Shore Corridor and all of its options would cross trout waters. The short-term and long-term impacts from decreased DO would be moderate (violations may occur), adverse, and regional. After construction was completed, the DO concentrations would return to pre-construction levels, since no additional organic matter (vegetation) would be entering the system. Thus, permanent impacts to DO would likely be negligible, adverse, and regional. Impacts would be similar for the Primitive and Principal Park Roads.

Heavy Metals

Most of the potential impacts to water quality from heavy metals would be anticipated from naturally-occurring sources. Based on the geology for the Northern Shore Corridor, there would be major (violations likely to occur), adverse, regional impacts for the baseline Northern Shore Corridor. The potential for the impacts would exist in the short-term and long-term during construction, when the minerals could be exposed at unknown locations. There would be subsequent permanent impacts if these areas were not mitigated. Due to the low traffic volumes, the impacts from vehicular sources of metals would be negligible, adverse, regional, and permanent for the Principal Park Road and minor, adverse, regional, and permanent for the Primitive Park Road.

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Clarification of the term "baseline" for this project:

The Partial-Build Alternative to Bushnell and the Northern Shore Corridor include a baseline route, as well as options to that route. Baseline routes and options are detailed in Section 2.5 and shown on Figure 2-8. Baseline routes have been compared to existing conditions. Impact analyses for the options are shown as a difference from the associated baseline route.

#### Turbidity

Sedimentation and an increase in turbidity would have the greatest impact at stream crossings (Lane and Sheridan 2001). The baseline Northern Shore Corridor would have major (violations likely to occur), regional, short-term and long-term impacts during construction; the permanent impacts would be minor for the Primitive Park Road and negligible for the Principal Park Road.

#### *Benthic Macroinvertebrates*

Short-term and long-term impacts to benthic macroinvertebrates would be moderate, adverse, and regional. After completion of construction, macroinvertebrate communities would have minor, adverse, regional, and permanent impacts. However, some change in the communities would be expected due to permanent alteration of flow regime, sediment load, canopy coverage, input of terrestrial insects and organic matter, and water quality.

#### *Lake Trophic Level*

Short-term and long-term impacts to benthic macroinvertebrates would be moderate, adverse, and regional. After completion of construction, macroinvertebrate communities would likely recover, and have minor, adverse, regional, and permanent impacts. However, some change in the communities would be expected due to permanent alteration of flow regime, sediment load, canopy coverage, input of terrestrial insects and organic matter, and water quality.

#### *Southern Option at Forney Creek Embayment (Primitive and Principal Park Roads)*

Selection of the Southern Option at Forney Creek Embayment would potentially decrease impacts on water quality and benthic macroinvertebrates by crossing fewer streams for both road types. However, the intensity of the impacts would not likely change. Impacts to water quality would still occur; just at fewer locations. The Southern Option at Forney Creek Embayment would reduce impacts from stream sedimentation during construction by reducing the number of stream crossings. This would reduce impacts to Fontana Lake and the bridge structure would not increase impacts.

#### *Southern Option at Hazel and Eagle Creek Embayments (Primitive and Principal Park Roads)*

The Southern Option at Hazel and Eagle Creek Embayments would reduce but not eliminate impacts on pH by largely avoiding areas of known pyritic rock. In addition, this option would reduce the number of streams crossed, especially the popular trout waters associated with Eagle and Hazel creeks. Subsequently, this would be expected to reduce impacts to streams within the baseline Northern Shore Corridor. Impacts would occur to other streams crossed by this option and Fontana Lake.

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Clarification of the term "baseline" for this project:

The Partial-Build Alternative to Bushnell and the Northern Shore Corridor include a baseline route, as well as options to that route. Baseline routes and options are detailed in Section 2.5 and shown on Figure 2-8. Baseline routes have been compared to existing conditions. Impact analyses for the options are shown as a difference from the associated baseline route.

*Southern Option Crossing Fontana Dam (Primitive and Principal Park Roads)*

As compared to the baseline Northern Shore Corridor, the Southern Option Crossing Fontana Dam would avoid potential impacts to Cheoah Lake by crossing 17 fewer streams draining to Cheoah Lake and could increase impacts to Fontana Lake by crossing two additional Water Supply streams draining to Fontana Lake. However, an existing road already crosses these streams, so impacts to Fontana Lake would not be expected to increase.

**4.4.3.2.6 Cumulative Impacts**

Cumulative effects to water quality were determined by combining the impacts of the alternatives being considered with other past, present, and reasonably foreseeable future actions in the study area vicinity. These cumulative effects have occurred and will continue to occur as a result of landscape modification. Water quality in the study area has been altered by commercial and residential development, mining, tourism, timber operations, and agricultural practices. For example, the byproducts of mining operations in the study area continue to contribute to the degradation of water resources.

In the foreseeable future, water quality will be largely influenced by development in the region and atmospheric deposition. However, the large amount of protected lands, including GSMNP and the adjacent national forests, greatly limits the impacts of potential development in the study area as well as the region.

Impacts that may result from either of the two partial-build alternatives or the build alternative for the proposed project would contribute to any cumulative effects on water quality in the study area. Mitigation to protect and enhance water quality would minimize the potential cumulative effects on the region's water resources.

**4.4.3.3 Options to Address Potential Impacts**

NPS would employ a sequence of avoiding adverse water quality impacts to the extent practicable, minimizing impacts that could not be avoided, and compensating for remaining unavoidable adverse impacts via restoration of degraded waters. It will not be possible to avoid or mitigate for all water quality impacts. Examples of water quality degradation include low pH, increased turbidity, and increased levels of heavy metals. The options to address potential impacts to streams described in Section 4.4.2.3 would also be applicable to address potential water quality impacts.

*Avoidance Techniques*

Avoidance examines all appropriate and practicable possibilities of averting impacts to "Waters of the United States." According to a 1990 MOA between the USEPA and the USACE, "appropriate and practicable" measures to offset unavoidable impacts, would be appropriate to the scope and degree of those impacts and practicable in terms of cost, existing technology, and logistics in light of overall project

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Clarification of the term "baseline" for this project:

The Partial-Build Alternative to Bushnell and the Northern Shore Corridor include a baseline route, as well as options to that route. Baseline routes and options are detailed in Section 2.5 and shown on Figure 2-8. Baseline routes have been compared to existing conditions. Impact analyses for the options are shown as a difference from the associated baseline route.

purposes. The main avoidance technique is to relocate the footprint of a road to eliminate stream crossings or bridge an entire stream and its floodplain and to avoid known areas of pyritic rock. Stream crossings could be eliminated by having a road on high elevations; however, due to the steep terrain in the project study area, these options would not always be practicable.

#### *Minimization Techniques*

Where no alternatives that avoid adverse impacts on streams are found to be practicable, minimization steps must be employed to reduce adverse impacts. These steps would include design modifications and implementation of enhanced BMPs to limit and control impacts during and after project construction. A complete list of minimization techniques is provided in Section 4.3.2 of Appendix M. Every practicable effort would be made to maintain the integrity of the natural stream systems, preserving their features and functions.

The encapsulation of acid-producing rock would minimize impacts from pH and heavy metals. Basic procedures for handling acid-producing materials during construction were established by Byerly (1990a,b) and have been used by the FHWA, NCDOT, NPS, and TVA. The FHWA design for on-site encapsulation at the Cherohala Skyway has been found effective to prevent water quality impairment (ARCADIS 2004b). Detailed descriptions of this technique are provided in Appendix L and minimization techniques are described in Sections 4.3.1.3 and 4.3.1.4.

#### *Mitigation Techniques*

After avoidance and minimization have been applied to the maximum practicable extent, remaining water quality degradation may be offset through compensatory mitigation. In addition to sedimentation, acidity and heavy metals would be the two main water quality concerns for building any section of the road. Potential acidification from the road would be very similar to problems associated with acid mine drainage typical of areas in Pennsylvania, Virginia, and West Virginia. Mitigation techniques used there could be adapted to treat potential acidic impacts (see Appendix M).

Enhancement is a type of mitigation that manipulates the physical, chemical, or biological characteristics of a stream or wetland to improve the overall water quality of the system. Enhancement measures that would manipulate the physical characteristics of streams to achieve water quality improvements include stabilizing stream banks to reduce sedimentation. The chemical characteristic of a water body can be altered by addition of storm water BMPs to treat rainwater runoff from impervious sites. Establishment or enhancement of riparian buffers along streams and wetlands provides water quality improvement by trapping and filtering pollutants and providing additional organic input (food) for aquatic wildlife. These mitigation techniques may not be able to offset all water quality impacts.

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**4.4.3.4 Impairment Evaluation**

Impairment of water quality in GSMNP and along 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 water quality in GSMNP or along 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 water quality would be re-evaluated in such documentation.

**4.4.4 Aquatic Ecology****4.4.4.1 Methodology for Assessing the Aquatic Ecology Impacts**

Analysis of impacts to aquatic wildlife within the lake, streams, and wetlands (collectively referred to as aquatic habitat) utilizes the approximate acreage expected to be permanently lost or temporarily affected by the presence of a road and/or disturbances that would occur during construction. The locations of streams and wet habitats in the project study corridors are depicted in Figure 3-5. Area of aquatic habitat potentially impacted and linear feet of impacts to riparian buffers were calculated using ArcGIS software (Appendix M). Direct impacts would occur from loss of habitat within the construction footprint of the potential road design. Indirect impacts would occur as a result of the potential road design, such as alteration of hydrology, vegetation, or other environmental factors that influence the composition and function of the habitat. Indirect impacts to aquatic habitats were defined as those that could affect aquatic habitats within 330 feet (100 m) upstream and 1,320 feet (400 m) downstream of the construction footprint.

**Type**

Impacts are beneficial and/or adverse. Beneficial impacts are defined as having a positive effect on aquatic wildlife. Adverse impacts have a negative effect on aquatic wildlife.

**Duration**

Short-term impacts are those that would occur for less than 1 year, typically as an episodic or temporary event. These impacts may occur as land disturbing activities begin or when BMPs fail. Typically, the source of the impact would be stabilized or repaired. Long-term effects occur as a result of construction activities at a specific location throughout the life of construction (this is assumed to be between 1 year and 15 years), but the impact is more than that of a temporary event. Permanent impacts are considered to be anything that persist throughout the construction period.

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